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# A compilation of tropospheric measurements of gas-phase and aerosol chemistry in polar regions

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## Abstract

Measurements of atmospheric chemistry in polar regions have been made for more than half a century. Probably the first Antarctic ozone data were recorded in 1958 during the International Geophysical Year. Since then, many measurement campaigns followed, and the results are now spread over many publications in several journals. Here, we have compiled measurements of tropospheric gas-phase and aerosol chemistry made in the Arctic and the Antarctic. It is hoped that this data collection is worth more than the sum of its components and serves as a basis for future analyses of spatial and temporal trends in polar atmospheric chemistry.

## 1 Introduction

Atmospheric chemists have been investigating several phenomena in the troposphere of polar regions. Early studies focused on ozone (Roscoe and Roscoe, 2006). Later, Arctic haze was a major research topic for several decades (Raatz, 1984; Quinn et al., 2007). More recently, bromine-induced ozone depletion events (Barrie et al., 1988; Simpson et al., 2007b) and mercury depletion events (Schroeder et al., 1998; Steffen et al., 2008) were discovered. Many measurements of tropospheric gas-phase and aerosol chemistry in polar regions have been made and subsequently published in miscellaneous journals. In this work, we attempt to provide an overview of these measurements. The tables do not claim completeness but it is hoped they they can serve as a starting point when searching for data of a particular compound. This work is an update of the data compilation that was published as a supplement to Simpson et al. (2007b) which only contained measurements until 2007.

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## 2 Literature data

The collection includes chemical measurements in the troposphere of the polar regions. Abbreviations and acronyms used in the tables are defined in Table 1. The measurement sites in the Northern and Southern Hemisphere are listed in Tables 2 and 3, respectively. They are also shown in the map of Fig. 1. To facilitate the discrimination between the hemispheres, abbreviations for Arctic measurement sites are printed in black upper-case letters (e.g., “BA” for Barrow), while those for Antarctic sites are shown in red lower-case letters (e.g., “ha” for Halley).

Gas-phase data are shown in Table 4. The entries are sorted by elements in the following order:

- oxygen and hydrogen (e.g., ozone, OH)
- nitrogen (e.g., NO<sub>2</sub>)
- carbon: C, H (alkanes)
- carbon: C, H (unsaturated)
- carbon: C, H, O (e.g., alcohols, aldehydes, acids)
- carbon: C, H, O, N (e.g., PAN)
- fluorine (CFCs)
- chlorine (inorganic and organic)
- bromine (inorganic and organic)
- iodine (inorganic and organic)
- sulfur (inorganic and organic)
- mercury

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Aerosol data are shown in Table 5. The entries are sorted by elements in the following order:

- nitrogen (e.g.,  $\text{NO}_3^-$ )
- fluorine
- 5 – chlorine
- bromine
- iodine
- sulfur ( $\text{SO}_4^{2-}$ , MSA)
- carbon (black carbon, organic acids)
- 10 – metals (alphabetically sorted by element symbol)

If the publication presents the mean, median or range of the measurements, these values are shown in the tables. Otherwise, the reader needs to refer to the original paper for more information. The units reported here are mostly the same as in the original publication. However, in a few cases concentrations in [ $\text{ng m}^{-3}$ ] were converted to mixing ratios assuming a molar volume of  $20 \text{ l mol}^{-1}$  for the cold air.

To keep the size of the collection within reasonable limits, the following data are excluded:

- Meteorological data (e.g., temperature, pressure, humidity, wind speed) are excluded. Only chemical measurements are listed.
- 20 – The compilation is restricted to atmospheric data, snow-chemistry is not included.
- Only tropospheric chemistry is included. Publications about stratospheric data, which are mostly related to ozone depletion and climate change, are excluded.
- $\text{CO}_2$  is not included because gathering all data for this species would be beyond the scope of this work.

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### 3 Data on the internet

In addition to the data presented in the literature, there are several web sites providing large data sets. The information presented here is mostly taken from their web pages:

- <http://ds.data.jma.go.jp/gmd/wdceg>

The World Data Centre for Greenhouse Gases (WDCGG) is established under the Global Atmosphere Watch (GAW) programme to collect, archive and provide data for greenhouse (CO<sub>2</sub>, CH<sub>4</sub>, CFCs, N<sub>2</sub>O, etc.) and related (CO, NO<sub>x</sub>, SO<sub>2</sub>, VOC, etc.) gases and surface ozone in the atmosphere and ocean, measured under GAW and other programmes. From the web site, information including measurement data can be obtained that have been contributed by organizations and individual researchers in the world.

- <http://www.gaw-wdca.org>

The World Data Centre for Aerosols (WDCA) is the data repository and archive for microphysical, optical, and chemical properties of atmospheric aerosol of the World Meteorological Organisation's (WMO) Global Atmosphere Watch (GAW) programme.

- <http://www.esrl.noaa.gov/gmd/ccgg/iadv/>

The Interactive Atmospheric Data Visualization web page provides data for CH<sub>4</sub>, CO, CO<sub>2</sub>, H<sub>2</sub>, N<sub>2</sub>O, SF<sub>6</sub>, and other gases. The global coverage includes several Arctic and Antarctic stations.

- <http://www.amap.no/Assessment/ScientificBackground.htm>

The Arctic Monitoring and Assessment Programme (AMAP) offers several scientific reports.

- [http://www-igge.obs.ujf-grenoble.fr/CESOA/article.php3?id\\_article=56](http://www-igge.obs.ujf-grenoble.fr/CESOA/article.php3?id_article=56)

Data sets for Concordia and Dumont d'Urville (in French, registration required).

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– <http://saga.pmel.noaa.gov/data>

The Pacific Marine Environmental Laboratory (PMEL) Atmospheric Chemistry Data Server provides data sets for several cruises. Some of them include data from polar regions, e.g., RITS93, RITS94, ICEALOT.

– <http://www.nilu.no/projects/ccc/emepdata.html>

The EMEP (European Monitoring and Evaluation Programme) webpage contains some Arctic data sets, e.g. ozone, heavy metals, and persistent organic pollutants (POPs) for Iceland and Spitzbergen.

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## References

Albrecht, T., Notholt, J., Wolke, R., Solberg, S., Dye, C., and Malberg, H.: Variations of CH<sub>2</sub>O and C<sub>2</sub>H<sub>2</sub> determined from ground-based FTIR measurements and comparison with model results, *Adv. Space Res.*, 29, 1713–1718, 2002. 652, 654

Allegrini, I., Montagnoli, M., and Sparapani, R.: Evaluation of gas phase and particulate components relevant to polar tropospheric processes, *Int. J. Environ. Anal. Chem.*, 55, 267–283, 1994. 644, 671, 678, 685

Allegrini, I., Ianniello, A., Montagnoli, M., Sparapani, R., and Mazziotti Gomez de Teran, C.: Carbon-coated annular denuders and ion chromatographic measurements for the determination of nitrogen-containing species (NO<sub>2</sub> and NO<sub>y</sub>) in remote atmospheres, *J. Chromatogr. A*, 846, 265–268, 1999. 641, 643

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- Amoroso, A., Beine, H. J., Sparapani, R., and Nardino, M.: Observation of coinciding Arctic boundary layer ozone depletion and snow surface emissions of nitrous acid, *Atmos. Environ.*, 40, 1949–1956, 2005. 638, 644
- 5 Amoroso, A., Domine, F., Esposito, G., Morin, S., Savarino, J., Nardino, M., Montagnoli, M., Bonneville, J.-M., Clement, J.-C., Ianniello, A., and Beine, H. J.: Microorganisms in dry polar snow are involved in the exchanges of reactive nitrogen species with the atmosphere, *Environ. Sci. Technol.*, 44, 714–719, 2010. 641, 642, 644, 645
- Anastasio, C. and Jordan, A. L.: Photoformation of hydroxylradical and hydrogenperoxide in aerosol particles from Alert, Nunavut: implications for aerosol and snowpack chemistry in the Arctic, *Atmos. Environ.*, 38, 1153–1166, 2004. 677, 678, 681, 683, 686
- 10 Anderson, P. S. and Bauguitte, S. J.-B.: Behaviour of tracer diffusion in simple atmospheric boundary layer models, *Atmos. Chem. Phys.*, 7, 5147–5158, doi:10.5194/acp-7-5147-2007, 2007. 641, 642
- Anlauf, K. G., Mickle, R. E., and Trivett, N. B. A.: Measurement of ozone during Polar Sunrise Experiment 1992, *J. Geophys. Res.*, 99D, 25345–25353, 1994. 636
- 15 Arimoto, R., Nottingham, A. S., Webb, J., Schloesslin, C. A., and Davis, D. D.: Non-sea salt sulfate and other aerosol constituents at the South Pole during ISCAT, *Geophys. Res. Lett.*, 28, 3645–3648, 2001. 679, 681, 686, 688, 700
- Arimoto, R., Hogan, A., Grube, P., Davis, D., Webb, J., Schloesslin, C., Sage, S., and Raccach, F.: Major ions and radionuclides in aerosol particles from the South Pole during ISCAT-2000, *Atmos. Environ.*, 38, 5473–5484, 2004a. 679, 681, 686, 688, 700
- 20 Arimoto, R., Schloesslin, C., Davis, D., Hogan, A., Grube, P., Fitzgerald, W., and Lamborg, C.: Lead and mercury in aerosol particles collected over the South Pole during ISCAT-2000, *Atmos. Environ.*, 38, 5485–5491, 2004b. 696, 701
- 25 Ariya, P. A., Jobson, B. T., Sander, R., Niki, H., Harris, G. W., Anlauf, K. G., and Hopper, J. F.: Measurements of C<sub>2</sub>-C<sub>7</sub> hydrocarbons during the polar sunrise experiment 1994: Further evidence for halogen chemistry in the troposphere, *J. Geophys. Res.*, 103D, 13169–13180, 1998. 636, 646, 647, 648, 649, 650, 651, 652, 653, 662
- Ariya, P. A., Niki, H., Harris, G. W., Anlauf, K. G., and Worthy, D. E. J.: Polar sunrise experiment 1995: Hydrocarbon measurements and tropospheric Cl and Br-atoms chemistry, *Atmos. Environ.*, 33, 931–938, 1999. 636, 646, 647, 648, 649, 650, 651, 652, 653
- 30 Aspö, K., Gauchard, P.-A., Steffen, A., Temme, C., Berg, T., Bahlmann, E., Banic, C., Dommergue, A., Ebinghaus, R., Ferrari, C., Pirrone, N., Sprovieri, F., and Wibetoe, G.: Measurements

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of atmospheric mercury species during an international study of mercury depletion events at Ny-Ålesund, Svalbard, spring 2003. How reproducible are our present methods?, *Atmos. Environ.*, 39, 7607–7619, 2005. 675, 676, 696

Atkinson, H. M., Huang, R.-J., Chance, R., Roscoe, H. K., Hughes, C., Davison, B., Schönhardt, A., Mahajan, A. S., Saiz-Lopez, A., Hoffmann, T., and Liss, P. S.: Iodine emissions from the sea ice of the Weddell Sea, *Atmos. Chem. Phys. Discuss.*, 12, 11595–11639, doi:10.5194/acpd-12-11595-2012, 2012. 667, 668, 669, 670, 671

Avallone, L. M., Toohey, D. W., Fortin, T. J., McKinney, K. A., and Fuentes, J. D.: In situ measurements of bromine oxide at two high-latitude boundary layer sites: Implications of variability, *J. Geophys. Res.*, 108D, 4089, doi:10.1029/2002JD002843, 2003. 665

Bales, R. C., Losleben, M. V., McConnell, J. R., Fuhrer, K., and Neftel, A.: H<sub>2</sub>O<sub>2</sub> in snow, air and open pore space in firn at Summit, Greenland, *Geophys. Res. Lett.*, 22, 1261–1264, 1995a. 639

Bales, R. C., McConnell, J. R., Losleben, M. V., Conklin, M. H., Fuhrer, K., Neftel, A., Dibb, J. E., Kahl, J. D. W., and Stearns, C. R.: Diel variations of H<sub>2</sub>O<sub>2</sub> in Greenland: A discussion of the cause and effect relationship, *J. Geophys. Res.*, 100D, 18661–18668, 1995b. 636, 639

Banic, C. M., Beauchamp, S. T., Tordon, R. J., Schroeder, W. H., Steffen, A., Anlauf, K. A., and Wong, H. K. T.: Vertical distribution of gaseous elemental mercury in Canada, *J. Geophys. Res.*, 108D, 4264, doi:10.1029/2002JD002116, 2003. 674

Barret, M., Domine, F., Houdier, S., Gallet, J., Weibring, P., Walega, J., Fried, A., and Richter, D.: Formaldehyde in the Alaskan Arctic snowpack: Partitioning and physical processes involved in air-snow exchanges, *J. Geophys. Res.*, 116D, D00R03, doi:10.1029/2011JD016038, 2011. 655

Barrie, L. A. and Barrie, M. J.: Chemical components of lower tropospheric aerosols in the high Arctic: Six years of observations, *J. Atmos. Chem.*, 11, 211–226, 1990. 682, 684, 692, 699, 701

Barrie, L. A. and Delmas, R. J.: Polar atmosphere and snow chemistry, in: *Global Atmospheric Biospheric Chemistry*, edited by: Prinn, R. G., 149–164, Plenum Press, NY, 1994. 658, 678

Barrie, L. A. and Hoff, R. M.: The oxidation rate and residence time of sulphur dioxide in the Arctic atmosphere, *Atmos. Environ.*, 18, 2711–2722, 1984. 671, 684

Barrie, L. A. and Hoff, R. M.: Five years of air chemistry observations in the Canadian Arctic, *Atmos. Environ.*, 19, 1995–2010, 1985. 677, 678, 679, 680, 682, 684, 691, 692, 693, 694, 695, 697, 698, 699, 701, 702, 703, 704



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- Barrie, L. A., Hoff, R. M., and Daggupaty, S. M.: The influence of mid-latitude pollution sources on haze in the Canadian Arctic, *Atmos. Environ.*, 15, 1407–1419, 1981. 677, 678, 680, 684, 692, 695, 698, 699, 701, 703, 704
- 5 Barrie, L. A., Bottenheim, J. W., Schnell, R. C., Crutzen, P. J., and Rasmussen, R. A.: Ozone destruction and photochemical reactions at polar sunrise in the lower Arctic atmosphere, *Nature*, 334, 138–141, 1988. 586
- Barrie, L. A., Li, S.-M., Toom, D. L., Landsberger, S., and Sturges, W.: Lower tropospheric measurements of halogens, nitrates, and sulphur oxides during Polar Sunrise Experiment 1992, *J. Geophys. Res.*, 99D, 25453–25467, 1994a. 644, 658, 662, 663, 664, 667, 671, 678, 683, 686
- 10 Barrie, L. A., Staebler, R., Toom, D., Georgi, B., den Hartog, G., Landsberger, S., and Wu, D.: Arctic aerosol size-segregated chemical observations in relation to ozone depletion during Polar Sunrise Experiment 1992, *J. Geophys. Res.*, 99D, 25439–25451, 1994b. 681, 684
- Bauguitte, S. J.-B., Bloss, W. J., Evans, M. J., Salmon, R. A., Anderson, P. S., Jones, A. E., Lee, J. D., Saiz-Lopez, A., Roscoe, H. K., Wolff, E. W., and Plane, J. M. C.: Summertime NO<sub>x</sub> measurements during the CHABLIS campaign: can source and sink estimates unravel observed diurnal cycles?, *Atmos. Chem. Phys.*, 12, 989–1002, doi:10.5194/acp-12-989-2012, 2012. 641, 642
- 15 Begoin, M., Richter, A., Weber, M., Kaleschke, L., Tian-Kunze, X., Stohl, A., Theys, N., and Burrows, J. P.: Satellite observations of long range transport of a large BrO plume in the Arctic, *Atmos. Chem. Phys.*, 10, 6515–6526, doi:10.5194/acp-10-6515-2010, 2010. 666
- Beine, H. J.: Measurements of CO in the high Arctic, *Chemosphere – Global Change Science*, 1, 145–151, 1999. 636, 657
- Beine, H. J. and Krognes, T.: The seasonal cycle of peroxyacetyl nitrate (PAN) in the Arctic, *Atmos. Environ.*, 34, 933–940, 2000. 636, 658
- 20 Beine, H. J., Engardt, M., Jaffe, D. A., Hov, Ø., Holmén, K., and Stordal, F.: Measurements of NO<sub>x</sub> and aerosol particles at the Ny-Ålesund Zeppelin mountain-station on Svalbard: Influence of local and regional pollution sources, *Atmos. Environ.*, 30, 1067–1079, 1996a. 636, 642
- 25 Beine, H. J., Jaffe, D. A., Blake, D. R., Atlas, E., and Harris, J.: Measurements of PAN, alkyl nitrates, ozone and hydrocarbons during spring in interior Alaska, *J. Geophys. Res.*, 101D, 12613–12619, 1996b. 636, 653, 658, 661
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- 5 Beine, H. J., Jaffe, D. A., Stordal, F., Engardt, M., Solberg, S., Schmidbauer, N., and Holmen, K.: NO<sub>x</sub> during ozone depletion events in the Arctic troposphere at Ny-Ålesund, Svalbard, *Tellus*, 49B, 556–565, 1997b. 636, 642, 652
- Beine, H. J., Allegrini, I., Sparapani, R., Ianniello, A., and Valentini, F.: Three years of springtime trace gas and particle measurement at Ny-Ålesund, Svalbard, *Atmos. Environ.*, 35, 3645–3658, 2001. 636, 640, 641, 643, 645, 661, 662, 665, 672, 677, 678, 679, 681, 686, 700
- 10 Beine, H. J., Honrath, R. E., Dominé, F., Simpson, W. R., and Fuentes, J. D.: NO<sub>x</sub> during background and ozone depletion periods at Alert: Fluxes above the snow surface, *J. Geophys. Res.*, 107D, 4584, doi:10.1029/2002JD002082, 2002. 641, 642
- Beine, H. J., Dominé, F., Ianniello, A., Nardino, M., Allegrini, I., Teinilä, K., and Hillamo, R.: Fluxes of nitrates between snow surfaces and the atmosphere in the European high Arctic, *Atmos. Chem. Phys.*, 3, 335–346, doi:10.5194/acp-3-335-2003, 2003. 644, 645, 677, 679
- 15 Beine, H. J., Amoroso, A., Dominé, F., King, M. D., Nardino, M., Ianniello, A., and France, J. L.: Surprisingly small HONO emissions from snow surfaces at Browning Pass, Antarctica, *Atmos. Chem. Phys.*, 6, 2569–2580, doi:10.5194/acp-6-2569-2006, 2006. 644
- Berg, T., Bartnicki, J., Munthe, J., Lattila, H., Hrehoruk, J., and Mazur, A.: Atmospheric mercury species in the European Arctic: Measurements and modelling, *Atmos. Environ.*, 35, 2569–2582, 2001. 674, 695
- 20 Berg, T., Sekkesæter, S., Steinnes, E., Valdal, A.-K., and Wibetoe, G.: Springtime depletion of mercury in the European Arctic as observed at Svalbard, *Sci. Total Environ.*, 304, 43–51, 2003. 674, 676, 696
- 25 Berg, T., Kallenborn, R., and Manø, S.: Temporal trends in atmospheric heavy metal and organochlorine concentrations at Zeppelin, Svalbard, *Arct. Antarct. Alp. Res.*, 36, 284–291, 2004. 674, 694, 695, 699, 701, 703, 704
- Berg, W. W., Sperry, P. D., Rahn, K. A., and Gladney, E. S.: Atmospheric bromine in the Arctic, *J. Geophys. Res.*, 88C, 6719–6736, 1983. 664, 680, 682, 683, 699
- 30 Berg, W. W., Heidt, L. E., Pollock, W., Sperry, P. D., and Cicerone, R. J.: Brominated organic species in the Arctic atmosphere, *Geophys. Res. Lett.*, 11, 429–432, 1984. 667, 668

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- Bergin, M. H., Jaffrezo, J. L., Davidson, C. I., Caldow, R., and Dibb, J.: Fluxes of chemical species to the Greenland ice sheet at Summit by fog and dry deposition, *Geochim. Cosmochim. Acta*, 58, 3207–3215, 1994. 686, 688
- 5 Bergin, M. H., Jaffrezo, J.-L., Davidson, C. I., Dibb, J. E., Pandis, S. N., Hillamo, R., Maenhaut, W., Kuhns, H. D., and Makela, T.: The contributions of snow, fog, and dry deposition to the summer flux of anions and cations at Summit, Greenland, *J. Geophys. Res.*, 100D, 16275–16288, 1995. 677, 678, 686, 688, 693, 697, 698, 700
- Berresheim, H.: Biogenic sulfur emissions from the Subantarctic and Antarctic oceans, *J. Geophys. Res.*, 92D, 13245–13262, 1987. 671, 672, 685, 687
- 10 Berresheim, H., Huey, J. W., Thorn, R. P., Eisele, F. L., Tanner, D. J., and Jefferson, A.: Measurements of dimethyl sulfide, dimethyl sulfoxide, dimethyl sulfone, and aerosol ions at Palmer Station, Antarctica, *J. Geophys. Res.*, 103D, 1629–1637, 1998. 673, 686, 688
- Blake, N. J., Blake, D. R., Sive, B. C., Katzenstein, A. S., Meinardi, S., Wingenter, O. W., Atlas, E. L., Flocke, F., Ridley, B. A., and Rowland, F. S.: The seasonal evolution of NMHCs and light alkyl nitrates at middle to high northern latitudes during TOPSE, *J. Geophys. Res.*, 108D, 8359, doi:10.1029/2001JD001467, 2003. 637, 647, 648, 652, 653, 659, 660
- 15 Bloss, W. J., Lee, J. D., Heard, D. E., Salmon, R. A., Bauguitte, S. J.-B., Roscoe, H. K., and Jones, A. E.: Observations of OH and HO<sub>2</sub> radicals in coastal Antarctica, *Atmos. Chem. Phys.*, 7, 4171–4185, doi:10.5194/acp-7-4171-2007, 2007. 639
- 20 Bloss, W. J., Camredon, M., Lee, J. D., Heard, D. E., Plane, J. M. C., Saiz-Lopez, A., Bauguitte, S. J.-B., Salmon, R. A., and Jones, A. E.: Coupling of HO<sub>x</sub>, NO<sub>x</sub> and halogen chemistry in the antarctic boundary layer, *Atmos. Chem. Phys.*, 10, 10187–10209, doi:10.5194/acp-10-10187-2010, 2010. 638, 639, 641, 642, 644, 646, 655, 658, 666, 669
- Bodhaine, B. A.: Aerosol absorption measurements at Barrow, Mauna Loa and the south pole, *J. Geophys. Res.*, 100D, 8967–8975, 1995. 689
- 25 Bodhaine, B. A., Deluisi, J. J., Harris, J. M., Houmère, P., and Bauman, S.: Aerosol measurements at the South Pole, *Tellus*, 38B, 223–235, 1986. 680, 684, 699
- Bottenheim, J. W., Gallant, A. G., and Brice, K. A.: Measurements of NO<sub>y</sub> species and O<sub>3</sub> at 82°N latitude, *Geophys. Res. Lett.*, 13, 113–116, 1986. 635, 641, 644, 658
- 30 Bottenheim, J. W., Barrie, L. A., Atlas, E., Heidt, L. E., Niki, H., Rasmussen, R. A., and Shepson, P. B.: Depletion of lower tropospheric ozone during Arctic spring: The polar sunrise experiment 1988, *J. Geophys. Res.*, 95D, 18555–18568, 1990. 641, 644, 654, 655, 664, 667, 668, 671, 677, 678, 680, 682, 684, 685, 692, 693, 697, 698, 699, 700, 703

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- Bottenheim, J. W., Barrie, L. A., and Atlas, E.: The partitioning of nitrogen oxides in the lower Arctic troposphere during spring 1988, *J. Atmos. Chem.*, 17, 15–27, 1993. 641, 643, 644, 658, 661, 671, 678, 685
- 5 Bottenheim, J. W., Boudries, H., Brickell, P. C., and Atlas, E.: Alkenes in the Arctic boundary layer at Alert, Nunavut, Canada, *Atmos. Environ.*, 36, 2585–2594, 2002a. 647, 648, 649, 651, 652
- Bottenheim, J. W., Fuentes, J. D., Tarasick, D. W., and Anlauf, K. G.: Ozone in the Arctic lower troposphere during winter and spring 2000 (ALERT2000), *Atmos. Environ.*, 36, 2535–2544, 2002b. 637, 643, 657, 674, 689
- 10 Bottenheim, J. W., Netcheva, S., Morin, S., and Nghiem, S. V.: Ozone in the boundary layer air over the Arctic Ocean: measurements during the TARA transpolar drift 2006–2008, *Atmos. Chem. Phys.*, 9, 4545–4557, doi:10.5194/acp-9-4545-2009, 2009. 638
- Boudries, H. and Bottenheim, J. W.: Cl and Br atom concentrations during a surface boundary layer ozone depletion event in the Canadian high Arctic, *Geophys. Res. Lett.*, 27, 517–520, 2000. 636, 646, 647, 648, 649, 652, 662, 665
- 15 Boudries, H., Bottenheim, J. W., Guimbaud, C., Grannas, A. M., Shepson, P. B., Houdier, S., Perrier, S., and Dominé, F.: Distribution and trends of oxygenated hydrocarbons in the high Arctic derived from measurements in the atmospheric boundary layer and interstitial snow air during the ALERT2000 field campaign, *Atmos. Environ.*, 36, 2573–2583, 2002. 653, 654, 655, 656
- 20 Brooks, S., Arimoto, R., Lindberg, S., and Southworth, G.: Antarctic polar plateau snow surface conversion of deposited oxidized mercury to gaseous elemental mercury with fractional long-term burial, *Atmos. Environ.*, 42, 2877–2884, 2008a. 675, 676, 696
- Brooks, S., Lindberg, S., Southworth, G., and Arimoto, R.: Springtime atmospheric mercury speciation in the McMurdo, Antarctica coastal region, *Atmos. Environ.*, 42, 2885–2893, 2008b. 675, 676, 696
- 25 Brooks, S., Moore, C., Lew, D., Lefer, B., Huey, G., and Tanner, D.: Temperature and sunlight controls of mercury oxidation and deposition atop the Greenland ice sheet, *Atmos. Chem. Phys.*, 11, 8295–8306, doi:10.5194/acp-11-8295-2011, 2011. 675, 676, 696
- 30 Brooks, S. B., Saiz-Lopez, A., Skov, H., Lindberg, S. E., Plane, J. M. C., and Goodsite, M. E.: The mass balance of mercury in the springtime arctic environment, *Geophys. Res. Lett.*, 33, L13812, doi:10.1029/2005GL025525, 2006. 665, 676

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- 5 Buys, Z., Brough, N., Huey, G., Tanner, D., von Glasow, R., and Jones, A. E.: Br<sub>2</sub>, BrCl, BrO and surface ozone in coastal Antarctica: a meteorological and chemical analysis, *Atmos. Chem. Phys. Discuss.*, 12, 11035–11077, doi:10.5194/acpd-12-11035-2012, 2012. 638, 666, 667
- 10 Cahill, T. A. and Eldred, R. A.: Elemental composition of Arctic particulate matter, *Geophys. Res. Lett.*, 11, 413–416, 1984. 680, 685, 699
- Cantrell, C. A., Edwards, G. D., Stephens, S., Mauldin, L., Kosciuch, E., Zondlo, M., and Eisele, F.: Peroxy radical observations using chemical ionization mass spectrometry during TOPSE, *J. Geophys. Res.*, 108D, 8371, doi:10.1029/2002JD002715, 2003. 637, 641, 647, 657, 658
- 15 Carpenter, L. J., Hopkins, J. R., Jones, C. E., Lewis, A. C., Parthipan, R., Wevill, D. J., Poissant, L., Pilote, M., and Constant, P.: Abiotic source of reactive organic halogens in the sub-arctic atmosphere?, *Environ. Sci. Technol.*, 39, 8812–8816, 2005. 668, 670, 675
- Chance, K.: Analysis of BrO measurements from the global ozone monitoring experiment, *Geophys. Res. Lett.*, 25, 3335–3338, 1998. 665
- 20 Chang, R. Y.-W., Leck, C., Graus, M., Müller, M., Paatero, J., Burkhardt, J. F., Stohl, A., Orr, L. H., Hayden, K., Li, S.-M., Hansel, A., Tjernström, M., Leaitch, W. R., and Abbatt, J. P. D.: Aerosol composition and sources in the central Arctic Ocean during ASCOS, *Atmos. Chem. Phys.*, 11, 10619–10636, doi:10.5194/acp-11-10619-2011, 2011a. 687, 689
- Chang, R. Y.-W., Sjostedt, S. J., Pierce, J. R., Papakyriakou, T. N., Scarratt, M. G., Michaud, S., Levasseur, M., Leaitch, W. R., and Abbatt, J. P. D.: Relating atmospheric and oceanic DMS levels to particle nucleation events in the Canadian Arctic, *J. Geophys. Res.*, 116D, D00S03, doi:10.1029/2011JD015926, 2011b. 673
- 25 Choi, S., Wang, Y., Salawitch, R. J., Canty, T., Joiner, J., Zeng, T., Kurosu, T. P., Chance, K., Richter, A., Huey, L. G., Liao, J., Neuman, J. A., Nowak, J. B., Dibb, J. E., Weinheimer, A. J., Diskin, G., Ryerson, T. B., da Silva, A., Curry, J., Kinnison, D., Tilmes, S., and Levelt, P. F.: Analysis of satellite-derived Arctic tropospheric BrO columns in conjunction with aircraft measurements during ARCTAS and ARCPAC, *Atmos. Chem. Phys.*, 12, 1255–1285, doi:10.5194/acp-12-1255-2012, 2012. 666
- Cicerone, R. J., Heidt, L. E., and Pollock, W. H.: Measurements of atmospheric methyl bromide and bromoform, *J. Geophys. Res.*, 93D, 3745–3749, 1988. 667, 668
- 30 Clarkson, T. S., Martin, R. J., and Rudolph, J.: Ethane and propane in the Southern marine troposphere, *Atmos. Environ.*, 31, 3763–3771, 1997. 646, 647
- Clemitshaw, K. C.: Coupling between the tropospheric photochemistry of nitrous acid (HONO) and nitric acid (HNO<sub>3</sub>), *Environ. Chem.*, 3, 31–34, 2006. 644

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- Cobbett, F. D., Steffen, A., Lawson, G., and Van Heyst, B. J.: GEM fluxes and atmospheric mercury concentrations (GEM, RGM and Hg<sup>p</sup>) in the Canadian Arctic at Alert, Nunavut, Canada (February–June 2005), *Atmos. Environ.*, 41, 6527–6543, 2007. 675, 676, 696
- 5 Cole, A. S. and Steffen, A.: Trends in long-term gaseous mercury observations in the Arctic and effects of temperature and other atmospheric conditions, *Atmos. Chem. Phys.*, 10, 4661–4672, doi:10.5194/acp-10-4661-2010, 2010. 674
- Constant, P., Poissant, L., Villemur, R., Yumvihoze, E., and Lean, D.: Fate of inorganic mercury and methyl mercury within the snow cover in the low arctic tundra on the shore of Hudson Bay (Québec, Canada), *J. Geophys. Res.*, 112D, D08309, doi:10.1029/2006JD007961, 2007. 638, 675
- 10 Corr, C. A., Hall, S. R., Ullmann, K., Anderson, B. E., Beyersdorf, A. J., Thornhill, K. L., Cubison, M. J., Jimenez, J. L., Wisthaler, A., and Dibb, J. E.: Spectral absorption of biomass burning aerosol determined from retrieved single scattering albedo during ARCTAS, *Atmos. Chem. Phys. Discuss.*, 12, 13967–14008, doi:10.5194/acpd-12-13967-2012, 2012. 658, 689
- 15 Cunningham, W. C. and Zoller, W. H.: The chemical composition of remote area aerosols, *J. Aerosol Sci.*, 12, 367–384, 1981. 680, 682, 683, 684, 691, 692, 693, 694, 695, 696, 697, 698, 699, 702, 703
- Dassau, T. M., Shepson, P. B., Bottenheim, J. W., and Ford, K. M.: Peroxyacetyl nitrate photochemistry and interactions with the Arctic surface, *J. Geophys. Res.*, 109D, D18302, doi:10.1029/2004JD004562, 2004. 659
- 20 Davidson, C. I., Jaffrezo, J.-L., Mosher, B. W., Dibb, J. E., Borys, R. D., Bodhaine, B. A., Rasmussen, R. A., Boutron, C. F., Ducroz, F. M., Cachier, M., Ducret, J., Colin, J.-L., Heidam, N. Z., Kemp, K., and Hillamo, R.: Chemical constituents in the air and snow at Dye 3, Greenland – II. Analysis of episodes in April 1989, *Atmos. Environ.*, 27A, 2723–2738, 1993a. 640, 646, 657, 661, 662, 663, 685, 687, 692, 693, 700, 704
- 25 Davidson, C. I., Jaffrezo, J.-L., Mosher, B. W., Dibb, J. E., Borys, R. D., Bodhaine, B. A., Rasmussen, R. A., Boutron, C. F., Gorlach, U., Cachier, H., Ducret, J., Colin, J.-L., Heidam, N. Z., Kemp, K., and Hillamo, R.: Chemical constituents in the air and snow at Dye 3, Greenland – I. Seasonal variations, *Atmos. Environ.*, 27A, 2709–2722, 1993b. 640, 646, 657, 661, 662, 663, 685, 687, 692, 693, 700, 704
- 30 Davis, D., Chen, G., Kasibhatla, P., Jefferson, A., Tanner, D., Eisele, F., Lenschow, D., Neff, W., and Berresheim, H.: DMS oxidation in the Antarctic marine boundary layer: Comparison of

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- model simulations and field observations of DMS, DMSO, DMSO<sub>2</sub>, H<sub>2</sub>SO<sub>4</sub>(g), MSA(g), and MSA(p), *J. Geophys. Res.*, 103D, 1657–1678, 1998. 639, 672, 673
- Davis, D., Nowak, J. B., Chen, G., Buhr, M., Arimoto, R., Hogan, A., Eisele, F., Mauldin, L., Tanner, D., Shetter, R., Lefer, B., and McMurry, P.: Unexpected high levels of NO observed at South Pole, *Geophys. Res. Lett.*, 28, 3625–3628, 2001. 640
- Davis, D., Chen, G., Buhr, M., Crawford, J., Lenschow, D., Lefer, B., Shetter, R., Eisele, F., Mauldin, L., and Hogan, A.: South Pole NO<sub>x</sub> chemistry: an assessment of factors controlling variability and absolute levels, *Atmos. Environ.*, 38, 5375–5388, 2004. 640
- de Mora, S. J., Patterson, J. E., and Bibby, D. M.: Baseline atmospheric mercury studies at Ross Island, Antarctica, *Antarct. Sci.*, 5, 323–326, 1993. 674
- de Mora, S. J., Wylie, D. J., and Dick, A. L.: Methanesulphonate and non-sea salt sulphate in aerosol, snow, and ice on the East Antarctic plateau, *Antarct. Sci.*, 9, 46–55, 1997. 680, 685, 688, 700
- de Serves, C.: Gas phase formaldehyde and peroxide measurements in the Arctic atmosphere, *J. Geophys. Res.*, 99D, 25 391–25 398, 1994. 639, 654
- Dibb, J. E. and Arsenault, M.: Shouldn't snowpacks be sources of monocarboxylic acids?, *Atmos. Environ.*, 36, 2513–2522, 2002. 656
- Dibb, J. E., Talbot, R. W., and Bergin, M. H.: Soluble acidic species in air and snow at Summit, Greenland, *Geophys. Res. Lett.*, 21, 1627–1630, 1994. 644, 656, 671, 678, 686, 689
- Dibb, J. E., Talbot, R. W., Whitlow, S. I., Shipham, M. C., Winterle, J., McConnell, J., and Bales, R.: Biomass burning signatures in the atmosphere and snow at Summit, Greenland: An event on 5 August 1994, *Atmos. Environ.*, 30, 553–561, 1996. 639, 640, 645, 671, 677, 678, 681, 686, 689, 690, 693, 697, 698
- Dibb, J. E., Talbot, R. W., Munger, J. W., Jacob, D. J., and Fan, S.-M.: Air-snow exchange of HNO<sub>3</sub> and NO<sub>y</sub> at Summit, Greenland, *J. Geophys. Res.*, 103D, 3475–3486, 1998. 643, 644, 656
- Dibb, J. E., Arsenault, M., Peterson, M. C., and Honrath, R. E.: Fast nitrogen oxide photochemistry in Summit, Greenland snow, *Atmos. Environ.*, 36, 2501–2511, 2002. 640, 642, 643
- Dibb, J. E., Huey, L. G., Slusher, D. L., and Tanner, D. J.: Soluble reactive nitrogen oxides at South Pole during ISCAT 2000, *Atmos. Environ.*, 38, 5399–5409, 2004. 643, 645
- Dibb, J. E., Albert, M., Anastasio, C., Atlas, E., Beyersdorf, A. J., Blake, N. J., Blake, D. R., Bocquet, F., Burkhardt, J. F., Chen, G., Cohen, L., Conway, T. J., Courville, Z., Frey, M. M., Friel, D. K., Galbavy, E. S., Hall, S., Hastings, M. G., Helmig, D., Huey, L. G., Hutterli, M. A.,



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5 Dibb, J. E., Ziemba, L. D., Luxford, J., and Beckman, P.: Bromide and other ions in the snow, firn air, and atmospheric boundary layer at Summit during GSHOX, *Atmos. Chem. Phys.*, 10, 9931–9942, 2010,

<http://www.atmos-chem-phys.net/10/9931/2010/>. 644, 645, 665

10 Dommergue, A., Ferrari, C., Poissant, L., Gauchard, P.-A., and Boutron, C. F.: Diurnal cycles of gaseous mercury within the snowpack at Kuujuarapik/Whapmagoostui, Québec, Canada, *Environ. Sci. Technol.*, 37, 3289–3297, 2003a. 675, 676

Dommergue, A., Ferrari, C. P., Gauchard, P.-A., Boutron, C. F., Poissant, L., Pilote, M., Jitaru, P., and Adams, F. C.: The fate of mercury species in a sub-arctic snowpack during snowmelt, *Geophys. Res. Lett.*, 30, 1621, doi:10.1029/2003GL017308, 2003b. 675, 676

15 Dommergue, A., Sprovieri, F., Pirrone, N., Ebinghaus, R., Brooks, S., Courteaud, J., and Ferrari, C. P.: Overview of mercury measurements in the Antarctic troposphere, *Atmos. Chem. Phys.*, 10, 3309–3319, doi:10.5194/acp-10-3309-2010, 2010. 675, 676

Doskey, P. V. and Gaffney, J. S.: Non-methane hydrocarbons in the Arctic atmosphere at Barrow, Alaska, *Geophys. Res. Lett.*, 19, 381–384, 1992. 646, 647, 648, 649, 650, 651, 652, 653

20 Duce, R. A., Winchester, J. W., and van Nahl, T. W.: Iodine, bromine, and chlorine in winter aerosols and snow from Barrow, Alaska, *Tellus*, 18, 238–248, 1966. 680, 681, 683

Duce, R. A., Zoller, W. H., and Moyers, J. L.: Particulate and gaseous halogens in the Antarctic atmosphere, *J. Geophys. Res.*, 78, 7802–7811, 1973. 664, 669, 680, 681, 683

25 Dupont, R., Pierce, B., Worden, J., Hair, J., Fenn, M., Hamer, P., Natarajan, M., Schaack, T., Lenzen, A., Apel, E., Dibb, J., Diskin, G., Huey, G., Weinheimer, A., Kondo, Y., and Knapp, D.: Attribution and evolution of ozone from Asian wild fires using satellite and aircraft measurements during the ARCTAS campaign, *Atmos. Chem. Phys.*, 12, 169–188, doi:10.5194/acp-12-169-2012, 2012. 638, 643, 658, 659, 672, 689

30 Ebinghaus, R., Kock, H. H., Temme, C., Einax, J. W., Löwe, A. G., Richter, A., Burrows, J. P., and Schroeder, W. H.: Antarctic springtime depletion of atmospheric mercury, *Environ. Sci. Technol.*, 36, 1238–1244, 2002. 637, 675

Edwards, P., Evans, M. J., Commane, R., Ingham, T., Stone, D., Mahajan, A. S., Oetjen, H., Dorsey, J. R., Hopkins, J. R., Lee, J. D., Moller, S. J., Leigh, R., Plane, J. M. C., Carpenter,



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L. J., and Heard, D. E.: Hydrogen oxide photochemistry in the northern Canadian spring time boundary layer, *J. Geophys. Res.*, 116D, D22306, doi:10.1029/2011JD016390, 2011. 638, 639, 641, 642, 647, 648, 649, 651, 652, 655, 658, 666, 670

Eisele, F., Davis, D. D., Helmig, D., Oltmans, S. J., Neff, W., Huey, G., Tanner, D., Chen, G., Crawford, J., Arimoto, R., Buhr, M., Mauldin, L., Hutterli, M., Dibb, J., Blake, D., Brooks, S. B., Johnson, B., Roberts, J. M., Wang, Y., Tan, D., and Flocke, F.: Antarctic tropospheric chemistry investigation (ANTCI) 2003 overview, *Atmos. Environ.*, 42, 2749–2761, 2008. 637, 639, 640, 641, 645, 646, 647, 654, 656, 657, 658, 659, 672, 673, 674, 679, 687, 688, 696, 701

Elsässer, C., Wagenbach, D., Weller, R., Auer, M., Wallner, A., and Christl, M.: Continuous 25-yr aerosol records at coastal Antarctica Part 2: variability of the radionuclides  $^7\text{Be}$ ,  $^{10}\text{Be}$  and  $^{210}\text{Pb}$ , *Tellus*, 63B, 920–934, 2011. 692, 701

Eneroeth, K., Holmén, K., Berg, T., Schmidbauer, N., and Solberg, S.: Springtime depletion of tropospheric ozone, gaseous elemental mercury and non-methane hydrocarbons in the European Arctic, and its relation to atmospheric transport, *Atmos. Environ.*, 41, 8511–8526, 2007. 636, 652, 674

Evans, M. J., Jacob, D. J., Atlas, E., Cantrell, C. A., Eisele, F., Flocke, F., Fried, A., Mauldin, R. L., Ridley, B. A., Wert, B., Talbot, R., Blake, D., Heikes, B., Snow, J., Walega, J., Weinheimer, A. J., and Dibb, J.: Coupled evolution of  $\text{BrO}_x$ - $\text{ClO}_x$ - $\text{HO}_x$ - $\text{NO}_x$  chemistry during bromine-catalyzed ozone depletion events in the Arctic boundary layer, *J. Geophys. Res.*, 108D, 8368, doi:10.1029/2002JD002732, 2003. 637, 639, 640, 641, 642, 643, 646, 647, 648, 649, 650, 652, 654, 657, 658, 659, 665

Fenger, M., Sørensen, L. L., Kristensen, K., Jensen, B., Nquyen, Q. T., Nøjgaard, J. K., Massling, A., Skov, H., and Glasius, M.: Sources of anions in aerosols in northeast Greenland during late winter, *Atmos. Chem. Phys. Discuss.*, 12, 14813–14836, doi:10.5194/acpd-12-14813-2012, 2012. 679, 681, 687

Ferek, R. J., Hobbs, P. V., Radke, L. F., Herring, J. A., Sturges, W. T., and Cota, G. F.: Dimethyl sulfide in the Arctic atmosphere, *J. Geophys. Res.*, 100D, 26093–26104, 1995. 671, 672, 673, 685, 686

Ferrari, C. P., Dommergue, A., Boutron, C. F., Skov, H., Goodsite, M., and Jensen, B.: Nighttime production of elemental gaseous mercury in interstitial air of snow at Station Nord, Greenland, *Atmos. Environ.*, 38, 2727–2735, 2004. 637, 675

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- Ferrari, C. P., Padova, C., Faïn, X., Gauchard, P.-A., Dommergue, A., Aspino, K., Berg, T., Cairns, W., Barbante, C., Cescon, P., Kaleschke, L., Richter, A., Wittrock, F., and Boutron, C.: Atmospheric mercury depletion event study in Ny-Ålesund (Svalbard) in spring 2005. Deposition and transformation of Hg in surface snow during springtime, *Sci. Total Environ.*, 397, 167–177, 2008. 638, 666, 675, 676, 696
- 5 Fischer, R., Weller, R., Jacobi, H.-W., and Ballschmiter, K.: Levels and pattern of volatile organic nitrates and halocarbons in the air at Neumayer Station (70°S), Antarctic, *Chemosphere*, 48, 981–992, 2002. 659, 660, 661, 663, 664, 667, 668, 669
- Ford, K., Campbell, B., Shepson, P. B., Bertman, S. B., Honrath, R. E., Peterson, M. C., and Dobb, J. E.: Studies of peroxyacetyl nitrate (PAN) and its interaction with the snowpack at Summit, Greenland, *J. Geophys. Res.*, 107D, 4102, doi:10.1029/2001JD000547, 2002. 642, 643, 659
- 10 Foster, K. L., Plastridge, R. A., Bottenheim, J. W., Shepson, P. B., Finlayson-Pitts, B. J., and Spicer, C. W.: The role of Br<sub>2</sub> and BrCl in surface ozone destruction at polar sunrise, *Science*, 291, 471–474, 2001. 663, 666, 667
- 15 Frey, M. M., Stewart, R. W., McConnell, J. R., and Bales, R. C.: Atmospheric hydroperoxides in West Antarctica: Links to stratospheric ozone and atmospheric oxidation capacity, *J. Geophys. Res.*, 110D, D23301, doi:10.1029/2005JD006110, 2005. 637, 640, 654, 657
- Fried, A., Wang, Y., Cantrell, C., Wert, B., Walega, J., Ridley, B., Atlas, E., Shetter, R., Lefer, B., Coffey, M. T., Hannigan, J., Blake, D., Blake, N., Meinardi, S., Talbot, B., Dobb, J., Scheuer, E., Wingenter, O., Snow, J., Heikes, B., and Ehhalt, D.: Tunable diode laser measurements of formaldehyde during the TOPSE 2000 study: Distributions, trends, and model comparisons, *J. Geophys. Res.*, 108D, 8365, doi:10.1029/2002JD002208, 2003. 654
- 20 Frieß, U., Wagner, T., Pundt, I., Pfeilsticker, K., and Platt, U.: Spectroscopic measurements of tropospheric iodine oxide at Neumayer station, Antarctica, *Geophys. Res. Lett.*, 28, 1941–1944, 2001. 669
- 25 Frieß, U., Hollwedel, J., König-Langlo, G., Wagner, T., and Platt, U.: Dynamics and chemistry of tropospheric bromine explosion events in the Antarctic coastal region, *J. Geophys. Res.*, 109D, D06305, doi:10.1029/2003JD004133, 2004. 637, 665
- 30 Frieß, U., Sihler, H., Sander, R., Pöhler, D., Yilmaz, S., and Platt, U.: The vertical distribution of BrO and aerosols in the Arctic: Measurements by active and passive differential optical absorption spectroscopy, *J. Geophys. Res.*, 116D, D00R04, doi:10.1029/2011JD015938, 2011. 666

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- Fuhrer, K., Hutterli, M. A., and McConnell, J. R.: Overview of recent field experiments for the study of the air-snow transfer of  $\text{H}_2\text{O}_2$  and  $\text{HCHO}$ , in: Chemical Exchange Between the Atmosphere and Polar Snow, NATO ASI Series, Vol. I43, edited by: Wolff, E. W. and Bales, R. C., 307–318, Springer Verlag, Berlin, 1996. 639, 654
- 5 Galaktionov, V. V., Khattatov, V. U., and Rudakov, V. V.: Aircraft observations of ozone in the Arctic troposphere in April 1994, *Atmos. Res.*, 44, 191–198, 1997. 636
- Gao, S. S., Sjostedt, S. J., Sharma, S., Hall, S. R., Ullmann, K., and Abbatt, J. P. D.: PTR-MS observations of photo-enhanced VOC release from Arctic and midlatitude snow, *J. Geophys. Res.*, 117D, D00R17, doi:10.1029/2011JD017152, 2012. 653, 654, 655, 656
- 10 Gauchard, P.-A., Aspö, K., Temme, C., Steffen, A., Ferrari, C., Berg, T., Ström, J., Kaleschke, L., Dommergue, A., Bahlmann, E., Magand, O., Planchon, F., Ebinghaus, R., Banic, C., Nagorski, S., Baussand, P., and Boutron, C.: Study of the origin of atmospheric mercury depletion events recorded in Ny-Ålesund, Svalbard, spring 2003, *Atmos. Environ.*, 39, 7620–7632, 2005a. 675, 676, 696
- 15 Gauchard, P.-A., Ferrari, C. P., Dommergue, A., Poissant, L., Pilote, M., Guehenneux, G., Boutron, C. F., and Baussand, P.: Atmospheric particle evolution during a nighttime atmospheric mercury depletion event in sub-Arctic at Kuujuaarapik/Whapmagoostui, Québec, Canada, *Sci. Total Environ.*, 336, 215–224, 2005b. 637, 675, 676, 696
- 20 Gilman, J. B., Burkhardt, J. F., Lerner, B. M., Williams, E. J., Kuster, W. C., Goldan, P. D., Murphy, P. C., Warneke, C., Fowler, C., Montzka, S. A., Miller, B. R., Miller, L., Oltmans, S. J., Ryerson, T. B., Cooper, O. R., Stohl, A., and de Gouw, J. A.: Ozone variability and halogen oxidation within the Arctic and sub-Arctic springtime boundary layer, *Atmos. Chem. Phys.*, 10, 10223–10236, doi:10.5194/acp-10-10223-2010, 2010. 638, 647, 648, 649, 650, 653, 655, 656, 658, 668
- 25 Gong, S. L. and Barrie, L. A.: Trends of heavy metal components in the Arctic aerosols and their relationship to the emissions in the Northern Hemisphere, *Sci. Total Environ.*, 342, 175–183, 2005. 692, 693, 695, 696, 697, 698, 699, 701, 703, 704
- Gong, S. L., Walmsley, J. L., Barrie, L. A., and Hopper, J. F.: Mechanisms for surface ozone depletion and recovery during polar sunrise, *Atmos. Environ.*, 31, 969–981, 1997. 636
- 30 Grannas, A. M., Shepson, P. B., Guimbaud, C., Sumner, A. L., Albert, M., Simpson, W., Dominé, F., Boudries, H., Bottenheim, J., Beine, H. J., Honrath, R., and Zhou, X.: A study of photochemical and physical processes affecting carbonyl compounds in the Arctic atmospheric boundary layer, *Atmos. Environ.*, 36, 2733–2742, 2002. 654, 655

- Gruzdev, A. N., Elokhov, A. S., Makarov, O. V., and Mokhov, I. I.: Some recent results of Russian measurements of surface ozone in Antarctica. A meteorological interpretation, *Tellus*, 45B, 99–105, 1993. 635
- Guimbaud, C., Grannas, A. M., Shepson, P. B., Fuentes, J. D., Boudries, H., Bottenheim, J. W., Dominé, F., Houdier, S., Perrier, S., Biesenthal, T. B., and Splawn, B. G.: Snowpack processing of acetaldehyde and acetone in the Arctic atmospheric boundary layer, *Atmos. Environ.*, 36, 2743–2752, 2002. 655
- Hagler, G. S. W., Bergin, M. H., Smith, E. A., and Dibb, J. E.: A summer time series of particulate carbon in the air and snow at Summit, Greenland, *J. Geophys. Res.*, 112D, D21309, doi:10.1029/2007JD008993, 2007. 689
- Hagler, G. S. W., Bergin, M. H., Smith, E. A., Town, M., and Dibb, J. E.: Local anthropogenic impact on particulate elemental carbon concentrations at Summit, Greenland, *Atmos. Chem. Phys.*, 8, 2485–2491, doi:10.5194/acp-8-2485-2008, 2008. 689
- Hansen, A. D. A. and Rosen, H.: Vertical distributions of particulate carbon, sulfur, and bromine in the Arctic haze and comparison with ground-level measurements at Barrow, Alaska, *Geophys. Res. Lett.*, 11, 381–384, 1984. 682, 689
- Hansen, G., Aspö, K., Berg, T., Edvardsen, K., Fiebig, M., Kallenborn, R., Krognes, T., Lunder, C., Stebel, K., Schmidbauer, N., Solberg, S., and Yttri, K. E.: Atmospheric monitoring at the Norwegian Antarctic Station Troll: Measurement programme and first results, *Polar Res.*, 28, 353–363, 2009. 638, 658, 681, 697, 701
- Hara, K., Osada, K., Matsunaga, K., Iwasaka, Y., Shibata, T., and Furuya, K.: Atmospheric inorganic chlorine and bromine species in Arctic boundary layer of the winter/spring, *J. Geophys. Res.*, 107, 4361, doi:10.1029/2001JD001008, 2002a. 662, 664, 678, 681, 683, 700
- Hara, K., Osada, K., Nishita, C., Yamagata, S., Yamanouchi, T., Herber, A., Matsunaga, K., Iwasaka, Y., Nagatani, M., and Nakata, H.: Vertical variations of sea-salt modification in the boundary layer of spring Arctic during the ASTAR 2000 campaign, *Tellus*, 54B, 361–376, 2002b. 645, 662, 672, 679, 687, 700
- Hara, K., Osada, K., Kido, M., Hayashi, M., Matsunaga, K., Iwasaka, Y., Yamanouchi, T., Hashida, G., and Fukatsu, T.: Chemistry of sea-salt particles and inorganic halogen species in Antarctic regions: Compositional differences between coastal and inland stations, *J. Geophys. Res.*, 109D, D20208, doi:10.1029/2004JD004713, 2004. 662, 665, 681, 683, 700

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- Harder, S., Warren, S. G., and Charlson, R. J.: Sulfate in air and snow at the South Pole: Implications for transport and deposition at sites with low snow accumulation, *J. Geophys. Res.*, 105D, 22825–22832, 2000. 686, 700
- 5 Hausmann, M. and Platt, U.: Spectroscopic measurement of bromine oxide and ozone in the high Arctic during Polar Sunrise Experiment 1992, *J. Geophys. Res.*, 99D, 25399–25413, 1994. 643, 665
- Heidam, N. Z.: Crustal enrichments in the Arctic aerosol, *Atmos. Environ.*, 19, 2083–2097, 1985. 680, 682, 684, 691, 693, 694, 695, 696, 698, 701, 702, 703
- 10 Heidam, N. Z., Christensen, J., Wahlin, P., and Skov, H.: Arctic atmospheric contaminants in NE Greenland: levels, variations, origins, transport, transformations and trends 1990–2001, *Sci. Total Environ.*, 331, 5–28, 2004. 636, 644, 671, 674, 677, 685, 692, 693, 695, 697, 699, 701, 702, 703, 704
- Heintzenberg, J. and Leck, C.: Seasonal variation of the atmospheric aerosol near the top of the marine boundary layer over Spitsbergen related to the Arctic sulphur cycle, *Tellus*, 46B, 15 52–67, 1994. 685, 688, 700
- Helmig, D., Boulter, J., David, D., Birks, J. W., Cullen, N. J., Steffen, K., Johnson, B. J., and Oltmans, S. J.: Ozone and meteorological boundary-layer conditions at Summit, Greenland, during 3–21 June 2000, *Atmos. Environ.*, 36, 2595–2608, 2002. 637
- 20 Helmig, D., Bocquet, F., Cohen, L., and Oltmans, S. J.: Ozone uptake to the polar snowpack at Summit, Greenland, *Atmos. Environ.*, 41, 5061–5076, 2007a. 637
- Helmig, D., Oltmans, S. J., Carlson, D., Lamarque, J.-F., Jones, A., Labuschagne, C., Anlauf, K., and Hayden, K.: A review of surface ozone in the polar regions, *Atmos. Environ.*, 41, 5138–5161, 2007b. 635
- 25 Helmig, D., Oltmans, S. J., Morse, T. O., and Dibb, J. E.: What is causing high ozone at Summit, Greenland?, *Atmos. Environ.*, 41, 5031–5043, 2007c. 637
- Helmig, D., Johnson, B., Oltmans, S. J., Neff, W., Eisele, F., and Davis, D. D.: Elevated ozone in the boundary layer at South Pole, *Atmos. Environ.*, 42, 2788–2803, 2008a. 637
- Helmig, D., Johnson, B. J., Warshawsky, M., Morse, T., Neff, W. D., Eisele, F., and Davis, D. D.: Nitric oxide in the boundary-layer at South Pole during the Antarctic Tropospheric Chemistry Investigation (ANTCI), *Atmos. Environ.*, 42, 2817–2830, 2008b. 641
- 30 Herring, J. A., Jaffe, D. A., Beine, H. J., Madronich, S., and Blake, D. R.: High latitude springtime photochemistry part II: Sensitivity studies of ozone production, *J. Atmos. Chem.*, 27, 155–178, 1997. 646, 647, 648, 649, 651, 652, 657

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- Hoff, R. M., Leaitch, W. R., Fellin, P., and Barrie, L. A.: Mass size distribution of chemical constituents of the winter Arctic aerosol, *J. Geophys. Res.*, 88C, 10947–10956, 1983. 671, 677, 678, 680, 682, 684, 699
- 5 Hönninger, G.: Halogen Oxide Studies in the Boundary Layer by Multi Axis Differential Optical Absorption Spectroscopy and Active Longpath-DOAS, Ph.D. thesis, Institut für Umweltphysik, Universität Heidelberg, Germany, <http://www.ub.uni-heidelberg.de/archiv/1940>, 2002. 669
- Hönninger, G. and Platt, U.: Observations of BrO and its vertical distribution during surface ozone depletion at Alert, *Atmos. Environ.*, 36, 2481–2489, 2002. 665
- 10 Hönninger, G., Leser, H., Sebastián, O., and Platt, U.: Ground-based measurements of halogen oxides at the Hudson Bay by longpath DOAS and passive MAX-DOAS, *Geophys. Res. Lett.*, 31, L04111, doi:10.1029/2003GL018982, 2004. 637, 665
- Honrath, R. E., Peterson, M. C., Guo, S., Dibb, J. E., Shepson, P. B., and Campbell, B.: Evidence of NO<sub>x</sub> production within or upon ice particles in the Greenland snowpack, *Geophys. Res. Lett.*, 26, 695–698, 1999. 640, 641, 643
- 15 Honrath, R. E., Lu, Y., Peterson, M. C., Dibb, J. E., Arsenault, M. A., Cullen, N. J., and Steffen, K.: Vertical fluxes of NO<sub>x</sub>, HONO, and HNO<sub>3</sub> above the snowpack at Summit, Greenland, *Atmos. Environ.*, 36, 2629–2640, 2002. 642, 644, 645
- Hopper, J. F., Peters, B., Yokouchi, Y., Niki, H., Jobson, B. T., Shepson, P. B., and Muthuramu, K.: Chemical and meteorological observations at ice camp SWAN during Polar Sunrise Experiment 1992, *J. Geophys. Res.*, 99D, 25 489–25 498, 1994a. 636, 664
- 20 Hopper, J. F., Worthy, D. E. J., Barrie, L. A., and Trivett, N. B. A.: Atmospheric observations of aerosol black carbon, carbon dioxide and methane in the high arctic, *Atmos. Environ.*, 28, 3047–3054, 1994b. 646, 689
- Hopper, J. F., Barrie, L. A., Silis, A., Hart, W., Gallant, A. J., and Dryfhout, H.: Ozone and meteorology during the 1994 Polar Sunrise Experiment, *J. Geophys. Res.*, 103D, 1481–1492, 1998. 636
- 25 Hov, Ø., Penkett, S. A., Isaksen, I. S. A., and Semb, A.: Organic gases in the Norwegian Arctic, *Geophys. Res. Lett.*, 11, 425–428, 1984. 646, 647, 648, 649, 650, 651, 652, 653, 661, 662, 663, 664, 667, 670, 673
- Hov, Ø., Schmidbauer, N., and Oehme, M.: Light hydrocarbons in the Norwegian Arctic, *Atmos. Environ.*, 23, 2471–2482, 1989. 646, 647, 648, 649, 650, 651, 652, 653

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- Huey, L. G., Tanner, D. J., Slusher, D. L., Dibb, J. E., Arimoto, R., Chen, G., Davis, D., Buhr, M. P., Nowak, J. B., Mauldin III, R. L., Eisele, F. L., and Kosciuche, E.: CIMS measurements of HNO<sub>3</sub> and SO<sub>2</sub> at the South Pole during ISCAT 2000, *Atmos. Environ.*, 38, 5411–5421, 2004. 645, 672
- 5 Hutterli, M. A., Röthlisberger, R., and Bales, R. C.: Atmosphere-to-snow-to-firn transfer studies of HCHO at Summit, Greenland, *Geophys. Res. Lett.*, 26, 1691–1694, 1999. 654
- Hutterli, M. A., McConnell, J. R., Stewart, R. W., Jacobi, H.-W., and Bales, R. C.: Impact of temperature-driven cycling of hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) between air and snow on the planetary boundary layer, *J. Geophys. Res.*, 106D, 15 395–15 404, 2001. 639
- 10 Hutterli, M. A., McConnell, J. R., Chen, G., Bales, R. C., Davis, D. D., and Lenschow, D. H.: Formaldehyde and hydrogen peroxide in air, snow and interstitial air at South Pole, *Atmos. Environ.*, 38, 5439–5450, 2004. 639, 654
- Ianniello, A., Beine, H. J., Sparapani, R., Di Bari, F., Allegrini, I., and Fuentes, J.: Denuder measurements of gas and aerosol species above Arctic snow surfaces at Alert 2000, *Atmos. Environ.*, 36, 5299–5309, 2002. 645, 661, 662, 665, 672, 677, 679, 681, 683, 686, 700
- 15 Ianniello, A., Sparapani, R., Allegrini, I., Vazzana, C., Mazziotti Gomez de Teran, C., Montagnoli, M., Fino, A., and Felici, A.: Study of nitrogen containing compounds in the polar troposphere, *Ann. Chim. Rome*, 93, 69–76, 2003. 641, 643
- Ianniello, A., Beine, H. J., Landis, M. S., Stevens, R. K., Esposito, G., Amoroso, A., and Allegrini, I.: Comparing field performances of denuder techniques in the high Arctic, *Atmos. Environ.*, 41, 1604–1615, 2007. 644, 645, 662, 672
- 20 Impey, G. A., Shepson, P. B., Hastie, D. R., Barrie, L. A., and Anlauf, K. G.: Measurements of photolyzable chlorine and bromine during the Polar Sunrise Experiment 1995, *J. Geophys. Res.*, 102D, 16005–16010, 1997. 662, 664
- 25 Impey, G. A., Mihele, C. M., Anlauf, K. G., Barrie, L. A., Hastie, D. R., and Shepson, P. B.: Measurements of photolyzable halogen compounds and bromine radicals during the Polar Sunrise Experiment 1997, *J. Atmos. Chem.*, 34, 21–37, 1999. 662, 666
- Jacob, D. J., Field, B. D., Li, Q., Blake, D. R., de Gouw, J., Warneke, C., Hansel, A., Wisthaler, A., Singh, H. B., and Guenther, A.: Global budget of methanol: Constraints from atmospheric observations, *J. Geophys. Res.*, 110D, D08303, doi:10.1029/2004JD005172, 2005. 653, 654
- 30 Jacobi, H.-W. and Schrems, O.: Peroxyacetyl nitrate (PAN) distribution over the South Atlantic Ocean, *Phys. Chem. Chem. Phys.*, 1, 5517–5521, 1999. 637, 659



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- Jacobi, H.-W., Weller, R., and Schrems, T. B. O.: Latitudinal distribution of peroxyacetyl nitrate (PAN) over the Atlantic Ocean, *J. Geophys. Res.*, 104D, 26901–26912, 1999. 659
- Jacobi, H.-W., Weller, R., Jones, A. E., Anderson, P. S., and Schrems, O.: Peroxyacetyl nitrate (PAN) concentrations in the Antarctic troposphere measured during the photochemical experiment at Neumayer (PEAN'99), *Atmos. Environ.*, 34, 5235–5247, 2000. 640, 641, 642, 645, 659, 679
- Jacobi, H.-W., Frey, M. M., Hutterli, M. A., Bales, R. C., Schrems, O., Cullen, N. J., Steffen, K., and Koehler, C.: Measurements of hydrogen peroxide and formaldehyde exchange between the atmosphere and surface snow at Summit, Greenland, *Atmos. Environ.*, 36, 2619–2628, 2002. 640, 654
- Jacobi, H.-W., Bales, R. C., Honrath, R. E., Peterson, M. C., Dibb, J. E., Swanson, A. L., and Albert, M. R.: Reactive trace gases measured in the interstitial air of surface snow at Summit, Greenland, *Atmos. Environ.*, 38, 1687–1697, 2004. 641, 642, 644, 645, 656
- Jacobi, H.-W., Kaleschke, L., Richter, A., Rozanov, A., and Burrows, J. P.: Observation of a fast ozone loss in the marginal ice zone of the Arctic Ocean, *J. Geophys. Res.*, 111D, D15309, doi:10.1029/2005JD006715, 2006. 637
- Jaeschke, W., Beltz, N., Dierssen, J. P., Haunold, W., Krischke, U., Reinecke, A., Salkowski, T., and v. Trümbach, J.: Measurements on the distribution of trace substances in the Arctic troposphere, *Atmos. Res.*, 44, 199–221, 1997. 636, 645, 658, 671, 678, 686
- Jaffrezo, J. L., Davidson, C. I., Legrand, M., and Dibb, J. E.: Sulfate and MSA in the air and snow on the Greenland ice sheet, *J. Geophys. Res.*, 99D, 1241–1254, 1994. 685, 687, 688
- Jefferson, A., Tanner, D. J., Eisele, F. L., Davis, D. D., Chen, G., Crawford, J., Huey, J. W., Torres, A. L., and Berresheim, H.: OH photochemistry and methane sulfonic acid formation in the coastal Antarctic boundary layer, *J. Geophys. Res.*, 103D, 1647–1656, 1998. 639, 672, 673
- Jobson, B. T., Niki, H., Yokouchi, Y., Bottenheim, J., Hopper, F., and Leaitch, R.: Measurements of C<sub>2</sub>-C<sub>6</sub> hydrocarbons during the polar sunrise 92 experiment: Evidence for Cl-atom and Br-atom chemistry, *J. Geophys. Res.*, 99D, 25355–25368, 1994. 646, 647, 648, 649, 650, 651, 652, 653, 662, 665
- Johnson, B. J., Helmig, D., and Oltmans, S. J.: Evaluation of ozone measurements from a tethered balloon sampling platform at South Pole Station in December, 2003, *Atmos. Environ.*, 42, 2780–2787, 2008. 637



Jones, A. E., Weller, R., Minikin, A., Wolff, E. W., Sturges, W. T., McIntyre, H. P., Leonard, S. R., Schrems, O., and Bauguitte, S.: Oxidized nitrogen chemistry and speciation in the Antarctic troposphere, *J. Geophys. Res.*, 104D, 21355–21366, 1999. 640, 643, 645, 659, 678

Jones, A. E., Anderson, P. S., Wolff, E. W., Turner, J., Rankin, A. M., and Colwell, S. R.: A role for newly forming sea ice in springtime polar tropospheric ozone loss? Observational evidence from Halley station, Antarctica, *J. Geophys. Res.*, 111D, D08306, doi:10.1029/2005JD006566, 2006. 637

Jones, A. E., Wolff, E. W., Salmon, R. A., Bauguitte, S. J.-B., Roscoe, H. K., Anderson, P. S., Ames, D., Clemishaw, K. C., Fleming, Z. L., Bloss, W. J., Heard, D. E., Lee, J. D., Read, K. A., Hamer, P., Shallcross, D. E., Jackson, A. V., Walker, S. L., Lewis, A. C., Mills, G. P., Plane, J. M. C., Saiz-Lopez, A., Sturges, W. T., and Worton, D. R.: Chemistry of the Antarctic Boundary Layer and the Interface with Snow: an overview of the CHABLIS campaign, *Atmos. Chem. Phys.*, 8, 3789–3803, doi:10.5194/acp-8-3789-2008, 2008. 645, 658, 679

Jones, A. E., Anderson, P. S., Wolff, E. W., Roscoe, H. K., Marshall, G. J., Richter, A., Brough, N., and Colwell, S. R.: Vertical structure of Antarctic tropospheric ozone depletion events: characteristics and broader implications, *Atmos. Chem. Phys.*, 10, 7775–7794, doi:10.5194/acp-10-7775-2010, 2010. 635, 638

Jones, A. E., Wolff, E. W., Ames, D., Bauguitte, S. J.-B., Clemishaw, K. C., Fleming, Z., Mills, G. P., Saiz-Lopez, A., Salmon, R. A., Sturges, W. T., and Worton, D. R.: The multi-seasonal NO<sub>y</sub> budget in coastal Antarctica and its link with surface snow and ice core nitrate: results from the CHABLIS campaign, *Atmos. Chem. Phys.*, 11, 9271–9285, doi:10.5194/acp-11-9271-2011, 2011. 641, 642, 644, 645, 659, 660, 679

Jourdain, B. and Legrand, M.: Seasonal variations of atmospheric dimethylsulfide, dimethylsulfoxide, sulfur dioxide, methanesulfonate, and non-sea-salt sulfate aerosols at Dumont d'Urville (coastal Antarctica) (December 1998 to July 1999), *J. Geophys. Res.*, 106D, 14391–14408, 2001. 672, 673, 686, 688

Jourdain, B. and Legrand, M.: Year-round records of bulk and size-segregated aerosol composition and HCl and HNO<sub>3</sub> levels in the Dumont d'Urville (coastal Antarctica) atmosphere: Implications for sea-salt aerosol fractionation in the winter and summer, *J. Geophys. Res.*, 107D, 4645, doi:10.1029/2002JD002471, 2002. 645, 662, 677, 678, 681, 686, 688, 690, 693, 697, 700

Jourdain, B., Preunkert, S., Cerri, O., Castebrunet, H., Udisti, R., and Legrand, M.: Year-round record of size-segregated aerosol composition in central Antarctica (Concordia station):

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Implications for the degree of fractionation of sea-salt particles, *J. Geophys. Res.*, 113D, D14308, doi:10.1029/2007JD009584, 2008. 701

Kawamura, K. and Kasukabe, H.: Source and reaction pathways of dicarboxylic acids, ketoacids and dicarbonyls in Arctic aerosols: One year of observations, *Atmos. Environ.*, 30, 1709–1722, 1996. 691

Keil, A. D. and Shepson, P. B.: Chlorine and bromine atom ratios in the springtime Arctic troposphere as determined from measurements of halogenated volatile organic compounds, *J. Geophys. Res.*, 111, D17303, doi:10.1029/2006JD007119, 2006. 638, 664, 668

Kellerhals, M., Beauchamp, S., Belzer, W., Blanchard, P., Froude, F., Harvey, B., McDonald, K., Pilote, M., Poissant, L., Puckett, K., Schroeder, B., Steffen, A., and Tordon, R.: Temporal and spatial variability of total gaseous mercury in Canada: results from the Canadian Atmospheric Mercury Measurement Network (CAMNet), *Atmos. Environ.*, 37, 1003–1011, 2003. 674

Kerbrat, M., Legrand, M., Preunkert, S., Gallée, H., and Kleffmann, J.: Nitrous acid at Concordia (inland site) and Dumont d'Urville (coastal site), East Antarctica, *J. Geophys. Res.*, 117D, D08303, doi:10.1029/2011JD017149, 2012. 644

Kerminen, V.-M. and Leck, C.: Sulfur chemistry over the central Arctic Ocean during the summer: Gas-to-particle transformation, *J. Geophys. Res.*, 106D, 32087–32099, 2001. 686, 688, 700

Khalil, M. A. K. and Rasmussen, R. A.: Gaseous tracers of arctic haze, *Environ. Sci. Technol.*, 17, 157–164, 1983. 657, 661, 662, 663, 664

Kieser, B. N., Bottenheim, J. W., Sideris, T., and Niki, H.: Spring 1989 observations of lower tropospheric chemistry in the Canadian high Arctic, *Atmos. Environ.*, 27A, 2979–2988, 1993. 644, 646, 647, 648, 651, 652, 677, 678, 680, 683, 685, 697, 700

Kim, K.-H., Ebinghaus, R., Schroeder, W. H., Blanchard, P., Kock, H. H., Steffen, A., Froude, F. A., Kim, M.-Y., Hong, S., and Kim, J.-H.: Atmospheric mercury concentrations from several observatory sites in the northern hemisphere, *J. Atmos. Chem.*, 50, 1–24, 2005. 674

Kirk, J. L., St. Louis, V. L., and Sharp, M. J.: Rapid reduction and reemission of mercury deposited into snowpacks during atmospheric mercury depletion events at Churchill, Manitoba, Canada, *Environ. Sci. Technol.*, 40, 7590–7596, 2006. 675, 676, 696

Kleefeld, C.: Untersuchungen der Saisonalität von atmosphärischem Dimethylsulfid in der Arktis und Antarktis, Ph.D. thesis, Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, Germany, 1998. 673

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Kreher, K., Johnston, P. V., Wood, S. W., Nardi, B., and Platt, U.: Ground-based measurements of tropospheric and stratospheric BrO at Arrival Heights, Antarctica, *Geophys. Res. Lett.*, 24, 3021–3024, 1997. 636, 641, 663, 665

5 Kukai, A., Legrand, M. R., Ancellet, G., Gros, V., Bekki, S., Sarda-Estève, R., Loisel, R., and Preunkert, S.: Measurements of OH and RO<sub>2</sub> radicals at the coastal Antarctic site of Dumont d'Urville (East Antarctica) in summer 2010–2011, *J. Geophys. Res.*, 117, D12310, doi:10.1029/2012JD017614, 2012. 639, 657

Lahoutifard, N., Poissant, L., and Scott, S. L.: Scavenging of gaseous mercury by acidic snow at Kuujuarapik, Northern Québec, *Sci. Total Environ.*, 355, 118–126, 2006. 675, 676

10 Lazrus, A. L. and Ferek, R. J.: Acidic sulfate particles in the winter Arctic atmosphere, *Geophys. Res. Lett.*, 11, 417–419, 1984. 685

Leaitch, W. R., Barrie, L. A., Bottenheim, J. W., Li, S. M., Shepson, P. B., Muthuramu, K., and Yokouchi, Y.: Airborne observations related to ozone depletion at polar sunrise, *J. Geophys. Res.*, 99D, 25499–25517, 1994. 642, 644, 664, 667, 668, 669

15 Leck, C. and Persson, C.: Seasonal and short-term variability in dimethyl sulfide, sulfur dioxide and biogenic sulfur and sea salt aerosol particles in the arctic marine boundary layer during summer and autumn, *Tellus*, 48B, 272–299, 1996. 671, 673, 677, 685, 688

Legrand, M. and Pasteur, E. C.: Methane sulfonic acid to non-sea-salt sulfate ratio in coastal Antarctic aerosol and surface snow, *J. Geophys. Res.*, 103D, 10991–11006, 1998. 685, 686, 687, 688

20 Legrand, M., Ducroz, F., Wagenbach, D., Mulvaney, R., and Hall, J.: Ammonium in coastal Antarctic aerosol and snow: Role of polar ocean and penguin emissions, *J. Geophys. Res.*, 103D, 11043–11056, 1998. 640, 677, 678, 681, 686, 688, 690, 693, 697, 698

25 Legrand, M., Sciare, J., Jourdain, B., and Genthon, C.: Subdaily variations of atmospheric dimethylsulfide, dimethylsulfoxide, methanesulfonate, and non-sea-salt sulfate aerosols in the atmospheric boundary layer at Dumont d'Urville (coastal Antarctica) during summer, *J. Geophys. Res.*, 106D, 14409–14422, 2001. 672, 673, 686, 688

Legrand, M., Preunkert, S., Jourdain, B., and Aumont, B.: Year-round records of gas and particulate formic and acetic acids in the boundary layer at Dumont d'Urville, coastal Antarctica, *J. Geophys. Res.*, 109D, D06313, doi:10.1029/2003JD003786, 2004. 656, 689

30 Legrand, M., Preunkert, S., Jourdain, B., Gallée, H., Goutail, F., Weller, R., and Savarino, J.: Year-round record of surface ozone at coastal (Dumont d'Urville) and inland (Concordia) sites in East Antarctica, *J. Geophys. Res.*, 114D, D20306, doi:10.1029/2008JD011667, 2009. 638

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- Legrand, M., Gros, V., Preunkert, S., Sarda-Estève, R., Thierry, A.-M., Pépy, G., and Jourdain, B.: A reassessment of the budget of formic and acetic acids in the boundary layer at Dumont d'Urville (coastal Antarctica): The role of penguin emissions on the budget of several oxygenated volatile organic compounds, *J. Geophys. Res.*, 117D, D06308, doi:10.1029/2011JD017102, 2012. 640, 655, 656, 690, 697
- Li, S.-M.: Equilibrium of particle nitrite with gas phase HONO: Tropospheric measurements in the high Arctic during polar sunrise, *J. Geophys. Res.*, 99D, 25469–25478, 1994. 643, 677
- Li, S.-M. and Barrie, L. A.: Biogenic Sulfur Aerosol in the Arctic Troposphere: 1. Contributions to Total Sulfate, *J. Geophys. Res.*, 98D, 20613–20622, 1993. 684, 687, 699
- Li, S.-M. and Winchester, J. W.: Resolution of ionic components of late winter Arctic aerosols, *Atmos. Environ.*, 23, 2387–2399, 1989a. 677, 678, 680, 682, 685, 687, 689, 691, 697, 700
- Li, S.-M. and Winchester, J. W.: Geochemistry of organic and inorganic ions of late winter Arctic aerosols, *Atmos. Environ.*, 23, 2401–2415, 1989b. 677, 678, 680, 682, 685, 687, 689, 691, 697, 700
- Li, S.-M., Barrie, L. A., Talbot, R. W., Harriss, R. C., Davidson, C. I., and Jaffrezo, J.-L.: Seasonal and geographic variations of methanesulfonic acid in the Arctic troposphere, *Atmos. Environ.*, 27A, 3011–3024, 1993. 687, 688
- Li, S.-M., Yokouchi, Y., Barrie, L. A., Muthuramu, K., Shepson, P. B., Bottenheim, J. W., Sturges, W. T., and Landsberger, S.: Organic and inorganic bromine compounds and their composition in the Arctic troposphere during polar sunrise, *J. Geophys. Res.*, 99D, 25415–25428, 1994. 667, 668, 669, 683
- Liang, Q., Rodriguez, J. M., Douglass, A. R., Crawford, J. H., Olson, J. R., Apel, E., Bian, H., Blake, D. R., Brune, W., Chin, M., Colarco, P. R., da Silva, A., Diskin, G. S., Duncan, B. N., Huey, L. G., Knapp, D. J., Montzka, D. D., Nielsen, J. E., Pawson, S., Riemer, D. D., Weinheimer, A. J., and Wisthaler, A.: Reactive nitrogen, ozone and ozone production in the Arctic troposphere and the impact of stratosphere-troposphere exchange, *Atmos. Chem. Phys.*, 11, 13181–13199, doi:10.5194/acp-11-13181-2011, 2011. 638, 639, 641, 642, 643, 645, 658, 659, 661
- Liao, J., Huey, L. G., Tanner, D. J., Brough, N., Brooks, S., Dibb, J. E., Stutz, J., Thomas, J. L., Lefer, B., Haman, C., and Gorham, K.: Observations of hydroxyl and peroxy radicals and the impact of BrO at Summit, Greenland in 2007 and 2008, *Atmos. Chem. Phys.*, 11, 8577–8591, doi:10.5194/acp-11-8577-2011, 2011a. 638, 639, 641, 644, 645, 657, 666

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- Liao, J., Sihler, H., Huey, L. G., Neuman, J. A., Tanner, D. J., Friess, U., Platt, U., Flocke, F. M., Orlando, J. J., Shepson, P. B., Beine, H. J., Weinheimer, A. J., Sjostedt, S. J., Nowak, J. B., Knapp, D. J., Staebler, R. M., Zheng, W., Sander, R., Hall, S. R., and Ullmann, K.: A comparison of Arctic BrO measurements by chemical ionization mass spectrometry and long path-differential optical absorption spectroscopy, *J. Geophys. Res.*, 116D, D00R02, doi:10.1029/2010JD014788, 2011b. 666
- Liao, J., Huey, L. G., Scheuer, E., Dibb, J. E., Stickel, R. E., Tanner, D. J., Neuman, J. A., Nowak, J. B., Choi, S., Wang, Y., Salawitch, R. J., Canty, T., Chance, K., Kurosu, T., Suleiman, R., Weinheimer, A. J., Shetter, R. E., Fried, A., Brune, W., Anderson, B., Zhang, X., Chen, G., Crawford, J., Hecobian, A., and Ingall, E. D.: Characterization of soluble bromide measurements and a case study of BrO observations during ARCTAS, *Atmos. Chem. Phys.*, 12, 1327–1338, doi:10.5194/acp-12-1327-2012, 2012a. 638, 666
- Liao, J., Huey, L. G., Tanner, D. J., Flocke, F. M., Orlando, J. J., Neuman, J. A., Nowak, J. B., Weinheimer, A. J., Hall, S. R., Smith, J. N., Fried, A., Staebler, R. M., Wang, Y., Koo, J.-H., Cantrell, C. A., Weibring, P., Walega, J., Knapp, D. J., Shepson, P. B., and Stephens, C. R.: Observations of inorganic bromine (HOBr, BrO, and Br<sub>2</sub>) speciation at Barrow, Alaska, in spring 2009, *J. Geophys. Res.*, 117D, D00R16, doi:10.1029/2011JD016641, 2012b. 666, 667
- Liao, W., Case, A. T., Mastromarino, J., Tan, D., and Dibb, J. E.: Observations of HONO by laser-induced fluorescence at the South Pole during ANTCl 2003, *Geophys. Res. Lett.*, 33, L09810, doi:10.1029/2005GL025470, 2006. 644
- Lindberg, S. E., Brooks, S., Lin, C.-J., Scott, K., Meyers, T., Chambers, L., Landis, M., and Stevens, R.: Formation of reactive gaseous mercury in the Arctic: Evidence of oxidation of Hg<sup>0</sup> to gas-phase Hg–II compounds after Arctic sunrise, *Water Air Soil Pollut. Focus*, 1, 295–302, 2001. 674, 676
- Lindberg, S. E., Brooks, S., Lin, C.-J., Scott, K. J., Landis, M. S., Stevens, R. K., Goodsite, M., and Richter, A.: Dynamic oxidation of gaseous mercury in the Arctic troposphere at polar sunrise, *Environ. Sci. Technol.*, 36, 1245–1256, 2002. 674, 676, 696
- Lu, J. Y., Schroeder, W. H., Barrie, L. A., Steffen, A., Welch, H. E., Martin, K., Lockhart, L., Hunt, R. V., Boila, G., and Richter, A.: Magnification of atmospheric mercury deposition to polar regions in springtime: the link to tropospheric ozone depletion chemistry, *Geophys. Res. Lett.*, 28, 3219–3222, 2001. 674, 695

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Interactive Discussion



- Maenhaut, W., Cornille, P., Pacyna, J. M., and Vitols, V.: Trace element composition and origin of the atmospheric aerosol in the Norwegian Arctic, *Atmos. Environ.*, 23, 2551–2569, 1989. 680, 682, 684, 685, 692, 693, 694, 695, 696, 697, 699, 701, 702, 703, 704
- Maenhaut, W. R., Zoller, W. H., Duce, R. A., and Hoffman, G. L.: Concentration and size distribution of particulate trace elements in the South Polar atmosphere, *J. Geophys. Res.*, 84C, 2421–2431, 1979. 680, 682, 683, 684, 691, 692, 693, 694, 695, 696, 697, 698, 699, 701, 702, 703
- Mahajan, A. S., Shaw, M., Oetjen, H., Hornsby, K. E., Carpenter, L. J., Kaleschke, L., Tian-Kunze, X., Lee, J. D., Moller, S. J., Edwards, P., Commane, R., Ingham, T., Heard, D. E., and Plane, J. M. C.: Evidence of reactive iodine chemistry in the Arctic boundary layer, *J. Geophys. Res.*, 115D, D20303, doi:10.1029/2009JD013665, 2010. 670
- Martinez, M., Arnold, T., and Perner, D.: The role of bromine and chlorine chemistry for arctic ozone depletion events in Ny-Ålesund and comparison with model calculations, *Ann. Geophys.*, 17, 941–956, doi:10.1007/s00585-999-0941-4, 1999. 636, 641, 665, 671, 683, 684
- Mauldin III, R. L., Cantrell, C. A., Zondlo, M. A., Kosciuch, E., Ridley, B. A., Weber, R., and Eisele, F. E.: Measurements of OH, H<sub>2</sub>SO<sub>4</sub>, and MSA during Tropospheric Ozone Production About the Spring Equinox (TOPSE), *J. Geophys. Res.*, 108D, 8366, doi:10.1029/2002JD002295, 2003. 639, 672, 673
- Mauldin III, R. L., Kosciuch, E., Henry, B., Eisele, F. L., Shetter, R., Lefer, B., Chen, G., Davis, D., Huey, G., and Tanner, D.: Measurements of OH, HO<sub>2</sub>+RO<sub>2</sub>, H<sub>2</sub>SO<sub>4</sub>, and MSA at the South Pole during ISCAT 2000, *Atmos. Environ.*, 38, 5423–5437, 2004. 639, 657, 672
- Mickle, R. E., Bottenheim, J. W., Leaitch, W. R., and Evans, W.: Boundary layer ozone depletion during AGASP-II, *Atmos. Environ.*, 23, 2443–2449, 1989. 635
- Miller, H. L., Weaver, A., Sanders, R. W., Arpag, K., and Solomon, S.: Measurements of arctic sunrise surface ozone depletion events at Kangerlussuaq, Greenland (67°N, 51°W), *Tellus*, 49B, 496–509, 1997. 636, 663, 665
- Mills, G. P., Sturges, W. T., Salmon, R. A., Bauguitte, S. J.-B., Read, K. A., and Bandy, B. J.: Seasonal variation of peroxyacetylnitrate (PAN) in coastal Antarctica measured with a new instrument for the detection of sub-part per trillion mixing ratios of PAN, *Atmos. Chem. Phys.*, 7, 4589–4599, doi:10.5194/acp-7-4589-2007, 2007. 659
- Minikin, A., Legrand, M., Hall, J., Wagenbach, D., Kleefeld, C., Wolff, E., Pasteur, E. C., and Ducroz, F.: Sulfur-containing species (sulfate and methanesulfonate) in coastal Antarctic

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aerosol and precipitation, *J. Geophys. Res.*, 103D, 10975–10990, 1998. 685, 686, 687, 688

Moller, S. J., Lee, J. D., Commane, R., Edwards, P., Heard, D. E., Hopkins, J., Ingham, T., Mahajan, A. S., Oetjen, H., Plane, J., Roscoe, H., Lewis, A. C., and Carpenter, L. J.: Measurements of nitrogen oxides from Hudson Bay: Implications for NO<sub>x</sub> release from snow and ice covered surfaces, *Atmos. Environ.*, 44, 2971–2979, 2010. 641, 642

Morin, S., Hönninger, G., Staebler, R. M., and Bottenheim, J. W.: A high time resolution study of boundary layer ozone chemistry and dynamics over the Arctic Ocean near Alert, Nunavut, *Geophys. Res. Lett.*, 32, L08809, doi:10.1029/2004GL022098, 2005. 638, 665

Morin, S., Savarino, J., Bekki, S., Gong, S., and Bottenheim, J. W.: Signature of Arctic surface ozone depletion events in the isotope anomaly ( $\Delta^{17}\text{O}$ ) of atmospheric nitrate, *Atmos. Chem. Phys.*, 7, 1451–1469, doi:10.5194/acp-7-1451-2007, 2007. 638, 679

Morin, S., Savarino, J., Frey, M. M., Yan, N., Bekki, S., Bottenheim, J. W., and Martins, J. M. F.: Tracing the origin and fate of NO<sub>x</sub> in the Arctic atmosphere using stable isotopes in nitrate, *Science*, 322, 730–732, 2008. 679

Morin, S., Savarino, J., Frey, M. M., Domine, F., Jacobi, H.-W., Kaleschke, L., and Martins, J. M. F.: Comprehensive isotopic composition of atmospheric nitrate in the Atlantic Ocean boundary layer from 65°S to 79°N, *J. Geophys. Res.*, 114D, D05303, doi:10.1029/2008JD010696, 2009. 679

Morin, S., Erbland, J., Savarino, J., Domine, F., Bock, J., Friess, U., Jacobi, H.-W., Sihler, H., and Martins, J. M. F.: An isotopic view on the connection between photolytic emissions of NO<sub>x</sub> from the Arctic snowpack and its oxidation by reactive halogens, *J. Geophys. Res.*, 117D, D00R08, doi:10.1029/2011JD016618, 2012. 645

Mosher, B. W., Winkler, P., and Jaffrezo, J.-L.: Seasonal aerosol chemistry at Dye 3, Greenland, *Atmos. Environ.*, 27A, 2761–2772, 1993. 680, 683, 684, 692, 693, 695, 698, 699, 700, 703

Munger, J. W., Jacob, D. J., Fan, S.-M., Colman, A. S., and Dibb, J. E.: Concentrations and snow-atmosphere fluxes of reactive nitrogen at Summit, Greenland, *J. Geophys. Res.*, 104D, 13721–13734, 1999. 636, 643

Murayama, S., Nakazawa, T., Tanaka, M., Aoki, S., and Kawaguchi, S.: Variations of tropospheric ozone concentration over Syowa station, Antarctica, *Tellus*, 44B, 262–272, 1992. 635



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- Muthuramu, K., Shepson, P. B., Bottenheim, J. W., Jobson, B. T., Niki, H., and Anlauf, K. G.: Relationships between organic nitrates and surface ozone destruction during Polar Sunrise Experiment 1992, *J. Geophys. Res.*, 99D, 25369–25378, 1994. 642, 660, 661, 662
- 5 Narukawa, M., Kawamura, K., Li, S.-M., and Bottenheim, J. W.: Dicarboxylic acids in the Arctic aerosols and snowpacks collected during ALERT 2000, *Atmos. Environ.*, 36, 2491–2499, 2002. 690, 691
- Neuman, J. A., Nowak, J. B., Huey, L. G., Burkholder, J. B., Dibb, J. E., Holloway, J. S., Liao, J., Peischl, J., Roberts, J. M., Ryerson, T. B., Scheuer, E., Stark, H., Stickel, R. E., Tanner, D. J.,  
10 and Weinheimer, A.: Bromine measurements in ozone depleted air over the Arctic Ocean, *Atmos. Chem. Phys.*, 10, 6503–6514, doi:10.5194/acp-10-6503-2010, 2010. 638, 666, 667
- Nghiem, S. V., Rigor, I. G., Richter, A., Burrows, J. P., Shepson, P. B., Bottenheim, J., Barber, D. G., Steffen, A., Latonas, J., Wang, F., Stern, G., Clemente-Colón, P., Martin, S., Hall, D. K., Kaleschke, L., Tackett, P., Neumann, G., and Asplin, M. G.: Field and satellite observations of the formation and distribution of Arctic atmospheric bromine above a rejuvenated sea ice  
15 cover, *J. Geophys. Res.*, 117D, D00S05, doi:10.1029/2011JD016268, 2012. 638, 666, 675
- Norman, A. L., Barrie, L. A., Toom-Saunry, D., Sirois, A., Krouse, H. R., Li, S. M., and Sharma, S.: Sources of aerosol sulphate at Alert: Apportionment using stable isotopes, *J. Geophys. Res.*, 104D, 11619–11631, 1999. 684, 687, 699
- Ockelmann, G. and Georgii, H.-W.: The distribution of sulfur dioxide over the Norwegian Arctic  
20 Ocean during summer, *Tellus*, 36B, 179–185, 1984. 671
- Olson, J. R., Crawford, J. H., Brune, W., Mao, J., Ren, X., Fried, A., Anderson, B., Apel, E., Beaver, M., Blake, D., Chen, G., Crouse, J., Dibb, J., Diskin, G., Hall, S. R., Huey, L. G., Knapp, D., Richter, D., Riemer, D., Clair, J. St., Ullmann, K., Walega, J., Weibring, P., Weinheimer, A., Wennberg, P., and Wisthaler, A.: An analysis of fast photochemistry over high  
25 northern latitudes during spring and summer using in-situ observations from ARCTAS and TOPSE, *Atmos. Chem. Phys. Discuss.*, 12, 9377–9450, doi:10.5194/acpd-12-9377-2012, 2012. 637, 638, 639, 640, 641, 645, 647, 651, 654, 655, 657, 658, 666
- Oltmans, S., Johnson, B., and Helmig, D.: Episodes of high surface ozone amounts at South Pole during summer and their impact on the long-term surface ozone variation, *Atmos. Environ.*, 42, 2804–2816, 2008. 635
- 30 Oltmans, S. J.: Surface ozone measurements in clean air, *J. Geophys. Res.*, 86C, 1174–1180, 1981. 635



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- Oltmans, S. J. and Komhyr, W. D.: Surface ozone distributions and variations from 1973-1984 measurements at the NOAA geophysical monitoring for climatic change baseline observatories, *J. Geophys. Res.*, 91D, 5229–5236, 1986. 635
- Oltmans, S. J., Schnell, R. C., Sheridan, P. J., Peterson, R. E., Li, S.-M., Winchester, J. W., Tans, P. P., Sturges, W. T., Kahl, J. D., and Barrie, L. A.: Seasonal surface ozone and filterable bromine relationship in the high Arctic, *Atmos. Environ.*, 23, 2431–2441, 1989. 635, 668, 682
- Oltmans, S. J., Lefohn, A. S., Harris, J. M., Galbally, I., Scheel, H. E., Bodeker, G., Brunke, E., Claude, H., Tarasick, D., Johnson, B. J., Simmonds, P., Shadwick, D., Anlauf, K., Hayden, K., Schmidlin, F., Fujimoto, T., Akagi, K., Meyer, C., Nichol, S., Davies, J., Redondas, A., and Cuevas, E.: Long-term changes in tropospheric ozone, *Atmos. Environ.*, 40, 3156–3173, 2006. 635
- Oltmans, S. J., Johnson, B. J., and Harris, J. M.: Springtime boundary layer ozone depletion at Barrow, Alaska: Meteorological influence, year-to-year variation, and long-term change, *J. Geophys. Res.*, 117D, D00R18, doi:10.1029/2011JD016889, 2012. 635, 638
- Oncley, S. P., Buhr, M., Lenschow, D. H., Davis, D., and Semmer, S. R.: Observations of summertime NO fluxes and boundary-layer height at the South Pole during ISCAT 2000 using scalar similarity, *Atmos. Environ.*, 38, 5389–5398, 2004. 642
- Pacyna, J. M. and Ottar, B.: Transport and chemical composition of the summer aerosol in the Norwegian Arctic, *Atmos. Environ.*, 19, 2109–2120, 1985. 680, 685, 692, 693, 694, 695, 696, 698, 701, 703, 704
- Pfaffhuber, K. A., Berg, T., Hirdman, D., and Stohl, A.: Atmospheric mercury observations from Antarctica: seasonal variation and source and sink region calculations, *Atmos. Chem. Phys.*, 12, 3241–3251, doi:10.5194/acp-12-3241-2012, 2012. 638, 676
- Piel, C., Weller, R., Huke, M., and Wagenbach, D.: Atmospheric methane sulfonate and non-sea-salt sulfate records at the European Project for Ice Coring in Antarctica (EPICA) deep-drilling site in Dronning Maud Land, Antarctica, *J. Geophys. Res.*, 111D, D03304, doi:10.1029/2005JD006213, 2006. 677, 679, 681, 687, 688, 693, 697, 698, 700
- Pöhler, D., Vogel, L., Frieß, U., and Platt, U.: Observation of halogen species in the Amundsen Gulf, Arctic, by active long-path differential optical absorption spectroscopy, *P. Natl. Acad. Sci. USA*, 107, 6582–6587, 2010. 638, 663, 666, 670
- Poissant, L. and Hoenninger, G.: Atmospheric mercury & ozone depletion events observed at the Hudson Bay in northern Quebec along with BrO (DOAS) measurements, *RMZ Mater. Geoenviron.*, 51, 1722–1725, 2004. 637, 665, 675, 676, 696

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Interactive Discussion



- Poissant, L. and Pilote, M.: Time series analysis of atmospheric mercury in Kuujuaupik/Whapmagoostui (Québec), *J. Phys. IV France*, 107, 1079–1082, 2003. 637, 674, 675, 676, 696
- 5 Pommier, M., Law, K. S., Clerbaux, C., Turquety, S., Hurtmans, D., Hadji-Lazaro, J., Coheur, P.-F., Schlager, H., Ancellet, G., Paris, J.-D., Nédélec, P., Diskin, G. S., Podolske, J. R., Holloway, J. S., and Bernath, P.: IASI carbon monoxide validation over the Arctic during POLARCAT spring and summer campaigns, *Atmos. Chem. Phys.*, 10, 10655–10678, doi:10.5194/acp-10-10655-2010, 2010. 658
- 10 Prados-Roman, C., Butz, A., Deutschmann, T., Dorf, M., Kritten, L., Minikin, A., Platt, U., Schlager, H., Sihler, H., Theys, N., Van Roozendael, M., Wagner, T., and Pfeilsticker, K.: Airborne DOAS limb measurements of tropospheric trace gas profiles: case studies on the profile retrieval of O<sub>4</sub> and BrO, *Atmos. Meas. Tech.*, 4, 1241–1260, doi:10.5194/amt-4-1241-2011, 2011. 638, 658, 666
- 15 Preunkert, S., Legrand, M., Jourdain, B., Moulin, C., Belviso, S., Kasamatsu, N., Fukuchi, M., and Hirawake, T.: Interannual variability of dimethylsulfide in air and seawater and its atmospheric oxidation by-products (methanesulfonate and sulfate) at Dumont d'Urville, coastal Antarctica (1999–2003), *J. Geophys. Res.*, 112D, D06306, doi:10.1029/2006JD007585, 2007. 673, 686, 688
- 20 Preunkert, S., Jourdain, B., Legrand, M., Udisti, R., Becagli, S., and Cerri, O.: Seasonality of sulfur species (dimethyl sulfide, sulfate, and methanesulfonate) in Antarctica: Inland versus coastal regions, *J. Geophys. Res.*, 113D, D15302, doi:10.1029/2008JD009937, 2008. 673, 687, 688, 689
- 25 Preunkert, S., Ancellet, G., Legrand, M. R., Kukui, A., Kerbrat, M., Sarda-Estève, R., Gros, V., and Jourdain, B.: Oxidant Production over Antarctic Land and its Export (OPALE) project: An overview of the 2010–2011 summer campaign, *J. Geophys. Res.*, doi:10.1029/2011JD017145, in press, 2012. 640, 655, 657, 658
- Prospero, J. M., Savoie, D. L., Saltzman, E. S., and Larsen, R.: Impact of oceanic sources of biogenic sulphur on sulphate aerosol concentrations at Mawson, Antarctica, *Nature*, 350, 221–223, 1991. 685, 687
- 30 Pszenny, A. A. P., Castelle, A. J., Galloway, J. N., and Duce, R. A.: A study of the sulfur cycle in the Antarctic marine boundary layer, *J. Geophys. Res.*, 94, 9818–9830, 1989. 671, 682, 685, 687, 700

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- Quinn, P. K., Shaw, G., Andrews, E., Dutton, E. G., Ruoho-Airola, T., and Gong, S. L.: Arctic haze: current trends and knowledge gaps, *Tellus*, 59B, 99–114, 2007. 586, 678, 684, 687, 689, 693, 697, 698
- Quinn, P. K., Bates, T. S., Schulz, K., and Shaw, G. E.: Decadal trends in aerosol chemical composition at Barrow, Alaska: 1976–2008, *Atmos. Chem. Phys.*, 9, 8883–8888, doi:10.5194/acp-9-8883-2009, 2009. 677, 684, 688, 699, 703
- Raatz, W.: Observations of “Arctic Haze” during the “Pfarmigan” weather reconnaissance flights, 1948–1961, *Tellus*, 36B, 126–136, 1984. 586
- Radke, L. F., Lyons, J. H., Hegg, D. A., and Hobbs, P. V.: Airborne observations of Arctic aerosols. I: Characteristics of Arctic haze, *Geophys. Res. Lett.*, 11, 393–396, 1984. 671, 678, 680, 685
- Rahn, K. A.: The Mn/V ratio as a tracer of large-scale sources of pollution aerosol for the Arctic, *Atmos. Environ.*, 15, 1457–1464, 1981. 691, 698, 703
- Rahn, K. A. and McCaffrey, R. J.: Compositional differences between Arctic aerosol and snow, *Nature*, 280, 479–480, 1979. 691, 693, 694, 695, 697, 698, 699, 703
- Ramacher, B., Rudolph, J., and Koppmann, R.: Hydrocarbon measurements during tropospheric ozone depletion events: Evidence for halogen atom chemistry, *J. Geophys. Res.*, 104C, 3633–3653, 1999. 651, 652
- Rankin, A. M. and Wolff, E. W.: A year-long record of size-segregated aerosol composition at Halley, Antarctica, *J. Geophys. Res.*, 108D, 4775, doi:10.1029/2003JD003993, 2003. 679, 681, 687, 688, 700
- Rasmussen, A., Kiilsholm, S., Sørensen, J. H., and Mikkelsen, I. S.: Analysis of tropospheric ozone measurements in Greenland, *Tellus*, 49B, 510–521, 1997. 636
- Rasmussen, R. A. and Khalil, M. A. K.: Gaseous bromine in the Arctic and Arctic haze, *Geophys. Res. Lett.*, 11, 433–436, 1984. 667, 668, 669
- Read, K. A., Lewis, A. C., Salmon, R. A., Jones, A. E., and Bauguitte, S.: OH and halogen atom influence on the variability of non-methane hydrocarbons in the Antarctic Boundary Layer, *Tellus*, 59B, 22–38, 2007. 647, 648, 649, 652, 663, 665
- Read, K. A., Lewis, A. C., Bauguitte, S., Rankin, A. M., Salmon, R. A., Wolff, E. W., Saiz-Lopez, A., Bloss, W. J., Heard, D. E., Lee, J. D., and Plane, J. M. C.: DMS and MSA measurements in the Antarctic Boundary Layer: impact of BrO on MSA production, *Atmos. Chem. Phys.*, 8, 2985–2997, doi:10.5194/acp-8-2985-2008, 2008. 673, 688

- Reifenhäuser, W. and Heumann, K. G.: Determinations of methyl iodide in the Antarctic atmosphere and the South Polar Sea, *Atmos. Environ.*, 26A, 2905–2912, 1992. 670
- Rempillo, O., Seguin, A. M., Norman, A.-L., Scarratt, M., Michaud, S., Chang, R., Sjostedt, S., Abbatt, J., Else, B., Papakyriakou, T., Sharma, S., Grasby, S., and Lévassieur, M.: Dimethyl sulfide air-sea fluxes and biogenic sulfur as a source of new aerosols in the Arctic fall, *J. Geophys. Res.*, 116D, D00S04, doi:10.1029/2011JD016336, 2011. 672, 673, 687, 689
- Ricard, V., Jaffrezo, J.-L., Kerminen, V.-M., Hillamo, R. E., Sillanpää, M., Ruellan, S., Liousse, C., and Cachier, H.: Two years of continuous aerosol measurements in northern Finland, *J. Geophys. Res.*, 107D, 4129, doi:10.1029/2001JD000952, 2002. 677, 678, 679, 681, 683, 686, 688, 689, 690, 691, 693, 697, 698, 700
- Richter, A., Wittrock, F., Eisinger, M., and Burrows, J. P.: GOME observations of tropospheric BrO in northern hemispheric spring and summer 1997, *Geophys. Res. Lett.*, 25, 2683–2686, 1998. 665
- Richter, A., Wittrock, F., Ladstätter-Weissenmayer, A., and Burrows, J. P.: Gome measurements of stratospheric and tropospheric BrO, *Adv. Space Res.*, 29, 1667–1672, 2002. 665
- Ridley, B. A., Atlas, E. L., Montzka, D. D., Browell, E. V., Cantrell, C. A., Blake, D. R., Blake, N. J., Cinquini, L., Coffey, M. T., Emmons, L. K., Cohen, R. C., DeYoung, R. J., Dibb, J. E., Eisele, F. L., Flocke, F. M., Fried, A., Grahek, F. E., Grant, W. B., Hair, J. W., Hannigan, J. W., Heikes, B. J., Lefer, B. L., Mauldin, R. L., Moody, J. L., Shetter, R. E., Snow, J. A., Talbot, R. W., Thornton, J. A., Walega, J. G., Weinheimer, A. J., Wert, B. P., and Wimmers, A. J.: Ozone depletion events observed in the high latitude surface layer during the TOPSE aircraft program, *J. Geophys. Res.*, 108D, 8356, doi:10.1029/2001JD001507, 2003. 637, 639, 640, 641, 642, 643, 646, 647, 648, 649, 650, 652, 654, 657, 658, 659, 665
- Ridley, B. A., Zeng, T., Wang, Y., Atlas, E. L., Browell, E. V., Hess, P. G., Orlando, J. J., Chance, K., and Richter, A.: An ozone depletion event in the sub-arctic surface layer over Hudson Bay, Canada, *J. Atmos. Chem.*, 57, 255–280, 2007. 637, 641, 642, 643, 647, 652, 657, 658, 665, 667, 668
- Riedel, K., Weller, R., and Schrems, O.: Variability of formaldehyde in the Antarctic troposphere, *Phys. Chem. Chem. Phys.*, 1, 5523–5527, 1999. 654
- Riedel, K., Weller, R., Schrems, O., and König-Langlo, G.: Variability of tropospheric hydroperoxides at a coastal surface site in Antarctica, *Atmos. Environ.*, 34, 5225–5234, 2000. 639, 657

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- Roscoe, H. K. and Roscoe, J.: Polar tropospheric ozone depletion events observed in the International Geophysical Year of 1958, *Atmos. Chem. Phys.*, 6, 3303–3314, doi:10.5194/acp-6-3303-2006, 2006. 586, 635
- Rudolph, J., Khedim, A., and Wagenbach, D.: The seasonal variation of light nonmethane hydrocarbons in the Antarctic troposphere, *J. Geophys. Res.*, 94, 13039–13044, 1989. 646, 647, 651, 652
- 5 Saiz-Lopez, A., Chance, K., Liu, X., Kurosu, T. P., and Sander, S. P.: First observations of iodine oxide from space, *Geophys. Res. Lett.*, 34, L12812, doi:10.1029/2007GL030111, 2007a. 669, 670
- 10 Saiz-Lopez, A., Mahajan, A. S., Salmon, R. A., Bauguitte, S. J.-B., Jones, A. E., Roscoe, H. K., and Plane, J. M. C.: Boundary layer halogens in coastal Antarctica, *Science*, 317, 348–351, 2007b. 666, 669
- Salawitch, R. J., Canty, T., Kurosu, T., Chance, K., Liang, Q., da Silva, A., Pawson, S., Nielsen, J. E., Rodriguez, J. M., Bhartia, P. K., Liu, X., Huey, L. G., Liao, J., Stickel, R. E., Tanner, D. J., Dibb, J. E., Simpson, W. R., Donohoue, D., Weinheimer, A., Flocke, F., Knapp, D., Montzka, D., Neuman, J. A., Nowak, J. B., Ryerson, T. B., Oltmans, S., Blake, D. R., Atlas, E. L., Kinnison, D. E., Tilmes, S., Pan, L. L., Hendrick, F., Van Roozendael, M., Kreher, K., Johnston, P. V., Gao, R. S., Johnson, B., Bui, T. P., Chen, G., Pierce, R. B., Crawford, J. H., and Jacob, D. J.: A new interpretation of total column BrO during Arctic spring, *Geophys. Res. Lett.*, 37, L21805, doi:10.1029/2010GL043798, 2010. 638, 666
- 15 Salmon, R. A., Bauguitte, S. J.-B., Bloss, W., Hutterli, M. A., Jones, A. E., Read, K., and Wolff, E. W.: Measurement and interpretation of gas phase formaldehyde concentrations obtained during the CHABLIS campaign in coastal Antarctica, *Atmos. Chem. Phys.*, 8, 4085–4093, doi:10.5194/acp-8-4085-2008, 2008. 655
- 20 Sander, R., Keene, W. C., Pszenny, A. A. P., Arimoto, R., Ayers, G. P., Baboukas, E., Cainey, J. M., Crutzen, P. J., Duce, R. A., Hönninger, G., Huebert, B. J., Maenhaut, W., Mihalopoulos, N., Turekian, V. C., and Van Dingenen, R.: Inorganic bromine in the marine boundary layer: a critical review, *Atmos. Chem. Phys.*, 3, 1301–1336, doi:10.5194/acp-3-1301-2003, 2003. 682, 700
- 25 Savarino, J., Kaiser, J., Morin, S., Sigman, D. M., and Thiemens, M. H.: Nitrogen and oxygen isotopic constraints on the origin of atmospheric nitrate in coastal Antarctica, *Atmos. Chem. Phys.*, 7, 1925–1945, doi:10.5194/acp-7-1925-2007, 2007. 679
- 30

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- Schall, C. and Heumann, K. G.: GC determination of volatile organoiodine and organobromine compounds in Arctic seawater and air samples, *Fresenius J. Anal. Chem.*, 346, 717–722, 1993. 667, 668, 669, 670, 671
- 5 Scheuer, E., Talbot, R. W., Dibb, J. E., Seid, G. K., DeBell, L., and Lefer, B.: Seasonal distributions of fine aerosol sulfate in the North American Arctic basin during TOPSE, *J. Geophys. Res.*, 108D, 8370, doi:10.1029/2001JD001364, 2003. 686
- Schnell, R. C., Liu, S. C., Oltmans, S. J., Stone, R. S., Hofmann, D. J., Dutton, E. G., Deshler, T., Sturges, W. T., Harder, J. W., Sewell, S. D., Trainer, M., and Harris, J. M.: Decrease of summer tropospheric ozone concentrations in Antarctica, *Nature*, 351, 726–729, 1991. 635
- 10 Schofield, R., Johnston, P. V., Thomas, A., Kreher, K., Connor, B. J., Wood, S., Shooter, D., Chipperfield, M. P., Richter, A., von Glasow, R., and Rodgers, C. D.: Tropospheric and stratospheric BrO columns over Arrival Heights, Antarctica, 2002, *J. Geophys. Res.*, 111D, D22310, doi:10.1029/2005JD007022, 2006. 665
- Schönhardt, A., Richter, A., Wittrock, F., Kirk, H., Oetjen, H., Roscoe, H. K., and Burrows, J. P.: 15 Observations of iodine monoxide columns from satellite, *Atmos. Chem. Phys.*, 8, 637–653, doi:10.5194/acp-8-637-2008, 2008. 670
- Schönhardt, A., Begoin, M., Richter, A., Wittrock, F., Kaleschke, L., Gómez Martín, J. C., and Burrows, J. P.: Simultaneous satellite observations of IO and BrO over Antarctica, *Atmos. Chem. Phys.*, 12, 6565–6580, doi:10.5194/acp-12-6565-2012, 2012. 666, 669
- 20 Schroeder, W. H., Ebinghaus, R., Shoeib, M., Timoschenko, K., and Barrie, L. A.: Atmospheric mercury measurements in the northern hemisphere from 56° to 82.5°N latitude, *Water Air Soil Pollut.*, 80, 1227–1236, 1995. 674
- Schroeder, W. H., Anlauf, K. G., Barrie, L. A., Lu, J. Y., Steffen, A., Schneeberger, D. R., and Berg, T.: Arctic springtime depletion of mercury, *Nature*, 394, 331–332, 1998. 586, 674
- 25 Seabrook, J. A., Whiteway, J., Staebler, R. M., Bottenheim, J. W., Komguem, L., Gray, L. H., Barber, D., and Asplin, M.: LIDAR measurements of Arctic boundary layer ozone depletion events over the frozen Arctic Ocean, *J. Geophys. Res.*, 116D, D00S02, doi:10.1029/2011JD016335, 2011. 638
- Sharma, S., Lavoué, D., Cachier, H., Barrie, L. A., and Gong, S. L.: Long-term trends of the black carbon concentrations in the Canadian Arctic, *J. Geophys. Res.*, 109D, D15203, doi:10.1029/2003JD004331, 2004. 685, 689
- 30 Sharma, S., Andrews, E., Barrie, L. A., Ogren, J. A., and Lavoué, D.: Variations and sources of the equivalent black carbon in the high Arctic revealed by long-term observations at Alert and

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Barrow: 1989–2003, *J. Geophys. Res.*, 111D, D14208, doi:10.1029/2005JD006581, 2006. 689

Shepson, P. B., Sirju, A.-P., Hopper, J. F., Barrie, L. A., Young, V., Niki, H., and Dryfhout, H.: Sources and sinks of carbonyl compounds in the Arctic ocean boundary layer: Polar ice floe experiment, *J. Geophys. Res.*, 101D, 21081–21089, 1996. 654, 655

Sherman, L. S., Blum, J. D., Douglas, T. A., and Steffen, A.: Frost flowers growing in the Arctic ocean-atmosphere-sea ice-snow interface: 2. Mercury exchange between the atmosphere, snow, and frost flowers, *J. Geophys. Res.*, 117D, D00R10, doi:10.1029/2011JD016186, 2012. 675

Sigg, A., Staffelbach, T., and Neftel, A.: Gas phase measurements of hydrogen peroxide in Greenland and their meaning for the interpretation of H<sub>2</sub>O<sub>2</sub> records in ice cores, *J. Atmos. Chem.*, 14, 223–232, 1992. 639

Sihler, H., Platt, U., Beirle, S., Marbach, T., Kühl, S., Dörner, S., Verschaeve, J., Frieß, U., Pöhler, D., Vogel, L., Sander, R., and Wagner, T.: Tropospheric BrO column densities in the Arctic from satellite: retrieval and comparison to ground-based measurements, *Atmos. Meas. Tech. Discuss.*, 5, 3199–3270, doi:10.5194/amtd-5-3199-2012, 2012. 666

Simpson, W. R., Carlson, D., Hönninger, G., Douglas, T. A., Sturm, M., Perovich, D., and Platt, U.: First-year sea-ice contact predicts bromine monoxide (BrO) levels at Barrow, Alaska better than potential frost flower contact, *Atmos. Chem. Phys.*, 7, 621–627, doi:10.5194/acp-7-621-2007, 2007.a. 638, 666

Simpson, W. R., von Glasow, R., Riedel, K., Anderson, P., Ariya, P., Bottenheim, J., Burrows, J., Carpenter, L. J., Frieß, U., Goodsite, M. E., Heard, D., Hutterli, M., Jacobi, H.-W., Kaleschke, L., Neff, B., Plane, J., Platt, U., Richter, A., Roscoe, H., Sander, R., Shepson, P., Sodeau, J., Steffen, A., Wagner, T., and Wolff, E.: Halogens and their role in polar boundary-layer ozone depletion, *Atmos. Chem. Phys.*, 7, 4375–4418, doi:10.5194/acp-7-4375-2007, 2007.b. 586

Sirois, A. and Barrie, L. A.: Arctic lower tropospheric aerosol trends and composition at Alert, Canada: 1980–1995, *J. Geophys. Res.*, 104, 11599–11618, 1999. 677, 678, 680, 682, 684, 687, 692, 693, 695, 696, 697, 698, 699, 701, 703, 704

Sjostedt, S. J., Huey, L. G., Tanner, D. J., Peischl, J., Chen, G., Dibb, J. E., Lefer, B., Hutterli, M. A., Beyersdorf, A. J., Blake, N. J., Blake, D. R., Sueper, D., Ryerson, T., Burkhardt, J., and Stohl, A.: Observations of hydroxyl and the sum of peroxy radicals at Summit, Greenland during summer 2003, *Atmos. Environ.*, 41, 5122–5137, doi:10.1016/j.atmosenv.2006.06.065, 2008. 639, 657



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- Sjostedt, S. J., Leaitch, W. R., Levasseur, M., Scarratt, M., Michaud, S., Motard-Côté, J., Burkhardt, J. H., and Abbatt, J. P. D.: Evidence for the uptake of atmospheric acetone and methanol by the Arctic Ocean during late summer DMS-Emission plumes, *J. Geophys. Res.*, 117, D12303, doi:10.1029/2011JD017086, 2012. 653, 654, 656, 658, 673
- 5 Skov, H., Christensen, J. H., Goodsite, M. E., Heidam, N. Z., Jensen, B., Wählín, P., and Geernaert, G.: Fate of elemental mercury in the Arctic during atmospheric mercury depletion episodes and the load of atmospheric mercury to the Arctic, *Environ. Sci. Technol.*, 38, 2373–2382, 2004. 637, 674, 683
- 10 Skov, H., Brooks, S. B., Goodsite, M. E., Lindberg, S. E., Meyers, T. P., Landis, M. S., Larsen, M. R. B., Jensen, B., McConville, G., and Christensen, J.: Fluxes of reactive gaseous mercury measured with a newly developed method using relaxed eddy accumulation, *Atmos. Environ.*, 40, 5452–5463, 2006a. 676
- 15 Skov, H., Wahlin, P., Christensen, J., Heidam, N. Z., and Petersen, D.: Measurements of elements, sulphate and SO<sub>2</sub> in Nuuk Greenland, *Atmos. Environ.*, 40, 4775–4781, 2006b. 672, 681, 683, 687, 692, 694, 695, 697, 699, 701, 702, 703, 704
- Slemr, F., Brunke, E.-G., Ebinghaus, R., Temme, C., Munthe, J., Wängberg, I., Schroeder, W., Steffen, A., and Berg, T.: Worldwide trend of atmospheric mercury since 1977, *Geophys. Res. Lett.*, 30, 1516, doi:10.1029/2003GL016954, 2003. 674
- 20 Slusher, D. L., Huey, L. G., Tanner, D. J., Chen, G., Davis, D. D., Buhr, M., Nowak, J. B., Eisele, F. L., Kosciuch, E., Mauldin, R. L., Lefer, B. L., Shetter, R. E., and Dibb, J. E.: Measurements of pernitric acid at the South Pole during ISCAT 2000, *Geophys. Res. Lett.*, 29, 2011, doi:10.1029/2002GL015703, 2002. 645
- 25 Solberg, S., Dye, C., Schmidbauer, N., Herzog, A., and Gehrig, R.: Carbonyls and nonmethane hydrocarbons at rural European sites from the mediterranean to the arctic, *J. Atmos. Chem.*, 25, 33–66, 1996a. 646, 647, 648, 649, 651, 652, 654, 655
- Solberg, S., Schmidbauer, N., Semb, A., Stordal, F., and Hov, Ø.: Boundary layer ozone depletion as seen in the Norwegian Arctic in spring, *J. Atmos. Chem.*, 23, 301–332, 1996b. 636, 646, 647, 648, 651, 652, 653, 686
- 30 Solberg, S., Krognes, T., Stordal, F., Hov, Ø., Beine, H. J., Jaffe, D. A., Clemitshaw, K., and Penkett, S. A.: Reactive nitrogen compounds at Spitsbergen in the Norwegian Arctic, *J. Atmos. Chem.*, 28, 209–225, 1997a. 643, 659
- Solberg, S., Stordal, F., and Hov, Ø.: Tropospheric ozone at high latitudes in clean and polluted air masses, a climatological study, *J. Atmos. Chem.*, 28, 111–123, 1997b. 635



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- Sommar, J., Wängberg, I., Berg, T., Gårdfeldt, K., Munthe, J., Richter, A., Urba, A., Wittrock, F., and Schroeder, W. H.: Circumpolar transport and air-surface exchange of atmospheric mercury at Ny-Ålesund (79° N), Svalbard, spring 2002, *Atmos. Chem. Phys.*, 7, 151–166, doi:10.5194/acp-7-151-2007, 2007. 675, 676, 696
- 5 Sommar, J., Andersson, M. E., and Jacobi, H.-W.: Circumpolar measurements of speciated mercury, ozone and carbon monoxide in the boundary layer of the Arctic Ocean, *Atmos. Chem. Phys.*, 10, 5031–5045, doi:10.5194/acp-10-5031-2010, 2010. 638, 658, 675, 676, 696
- 10 Spicer, C. W., Plastridge, R. A., Foster, K. L., Finlayson-Pitts, B. J., Bottenheim, J. W., Grannas, A. M., and Shepson, P. B.: Molecular halogens before and during ozone depletion events in the Arctic at polar sunrise: concentrations and sources, *Atmos. Environ.*, 36, 2721–2731, 2002. 663, 666, 667
- Sprovieri, F. and Pirrone, N.: A preliminary assessment of mercury levels in the Antarctic and Arctic troposphere, *J. Aerosol Sci.*, 31, S757–S758, 2000. 636, 674, 695
- 15 Sprovieri, F., Pirrone, N., Hedgecock, I. M., Landis, M. S., and Stevens, R. K.: Intensive atmospheric mercury measurements at Terra Nova Bay in Antarctica during November and December 2000, *J. Geophys. Res.*, 107D, 4722, doi:10.1029/2002JD002057, 2002. 675, 676
- 20 Sprovieri, F., Pirrone, N., Landis, M. S., and Stevens, R. K.: Atmospheric mercury behavior at different altitudes at Ny Ålesund during Spring 2003, *Atmos. Environ.*, 39, 7646–7656, 2005a. 637, 675, 676, 696
- Sprovieri, F., Pirrone, N., Landis, M. S., and Stevens, R. K.: Oxidation of gaseous elemental mercury to gaseous divalent mercury during 2003 polar sunrise at Ny-Ålesund, *Environ. Sci. Technol.*, 39, 9156–9165, 2005b. 637, 675, 676, 696
- 25 Sprovieri, F., Pirrone, N., Ebinghaus, R., Kock, H., and Dommergue, A.: A review of worldwide atmospheric mercury measurements, *Atmos. Chem. Phys.*, 10, 8245–8265, doi:10.5194/acp-10-8245-2010, 2010. 674, 675
- Steen, A. O., Berg, T., Dastoor, A. P., Durnford, D. A., Hole, L. R., and Pfaffhuber, K. A.: Dynamic exchange of gaseous elemental mercury during polar night and day, *Atmos. Environ.*, 43, 5604–5610, 2009. 675, 696
- 30 Steffen, A., Schroeder, W., Bottenheim, J., Narayan, J., and Fuentes, J. D.: Atmospheric mercury concentrations: measurements and profiles near snow and ice surfaces in the Canadian Arctic during Alert 2000, *Atmos. Environ.*, 36, 2653–2661, 2002. 674

- Steffen, A., Schroeder, W. H., Edwards, G., and Banic, C.: Mercury throughout polar sunrise 2002, *J. Phys. IV France*, 107, 1267–1270, 2003. 675, 676, 696
- Steffen, A., Schroeder, W., Macdonald, R., Poissant, L., and Konoplev, A.: Mercury in the Arctic atmosphere: An analysis of eight years of measurements of GEM at Alert (Canada) and a comparison with observations at Amderma (Russia) and Kuujuarapik (Canada), *Sci. Total Environ.*, 342, 185–198, 2005. 674, 675
- Steffen, A., Douglas, T., Amyot, M., Ariya, P., Aspmo, K., Berg, T., Bottenheim, J., Brooks, S., Cobbett, F., Dastoor, A., Dommergue, A., Ebinghaus, R., Ferrari, C., Gardfeldt, K., Goodsite, M. E., Lean, D., Poulain, A. J., Scherz, C., Skov, H., Sommar, J., and Temme, C.: A synthesis of atmospheric mercury depletion event chemistry in the atmosphere and snow, *Atmos. Chem. Phys.*, 8, 1445–1482, doi:10.5194/acp-8-1445-2008, 2008. 586
- Stephens, C. R., Shepson, P. B., Steffen, A., Bottenheim, J. W., Liao, J., Huey, L. G., Apel, E., Weinheimer, A., Hall, S. R., Cantrell, C., Sive, B. C., Knapp, D. J., Montzka, D. D., and Hornbrook, R. S.: The relative importance of chlorine and bromine radicals in the oxidation of atmospheric mercury at Barrow, Alaska, *J. Geophys. Res.*, 117D, D00R11, doi:10.1029/2011JD016649, 2012. 663, 665, 675
- Sturges, W. T. and Barrie, L. A.: Chlorine, bromine and iodine in Arctic aerosols, *Atmos. Environ.*, 22, 1179–1194, 1988. 682
- Sturges, W. T. and Shaw, G. E.: Halogens in aerosols in central Alaska, *Atmos. Environ.*, 27A, 2969–2977, 1993. 680, 682, 684, 692, 699, 702, 703
- Sturges, W. T., Hopper, J. F., Barrie, L. A., and Schnell, R. C.: Stable lead isotope ratios in Alaskan Arctic aerosols, *Atmos. Environ.*, 27A, 2865–2871, 1993a. 701
- Sturges, W. T., Schnell, R. C., Dutton, G. S., Garcia, S. R., and Lind, J. A.: Spring measurements of tropospheric bromine at Barrow, Alaska, *Geophys. Res. Lett.*, 20, 201–204, 1993b. 636, 664, 667, 683
- Sturges, W. T., Schnell, R. C., Landsberger, S., Oltmans, S. J., Harris, J. M., and Li, S. M.: Chemical and meteorological influences on surface ozone destruction at Barrow, Alaska, during spring 1989, *Atmos. Environ.*, 27A, 2851–2863, 1993c. 635, 664, 668, 669, 683
- Sturges, W. T., Sullivan, C. W., Schnell, R. C., Heidt, L. E., and Pollock, W. H.: Bromoalkane production by Antarctic ice algae, *Tellus*, 45B, 120–126, 1993d. 635, 667, 668
- Stutz, J., Thomas, J. L., Hurlock, S. C., Schneider, M., von Glasow, R., Piot, M., Gorham, K., Burkhart, J. F., Ziemba, L., Dibb, J. E., and Lefer, B. L.: Longpath DOAS observations of

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- surface BrO at Summit, Greenland, *Atmos. Chem. Phys.*, 11, 9899–9910, doi:10.5194/acp-11-9899-2011, 2011. 638, 666
- Sumner, A. L. and Shepson, P. B.: Snowpack production of formaldehyde and its effect on the Arctic troposphere, *Nature*, 398, 230–233, 1999. 654
- 5 Sumner, A. L., Shepson, P. B., Grannas, A. M., Bottenheim, J. W., Anlauf, K. G., Worthy, D., Schroeder, W. H., Steffen, A., Dominé, F., Perrier, S., and Houdier, S.: Atmospheric chemistry of formaldehyde in the Arctic troposphere at Polar Sunrise, and the influence of the snowpack, *Atmos. Environ.*, 36, 2553–2562, 2002. 637, 654
- 10 Swanson, A. L., Blake, N. J., Atlas, E., Flocke, F., Blake, D. R., and Rowland, F. S.: Seasonal variations of C<sub>2</sub>-C<sub>4</sub> nonmethane hydrocarbons and C<sub>1</sub>-C<sub>4</sub> alkyl nitrates at the Summit research station in Greenland, *J. Geophys. Res.*, 108D, doi:10.1029/2001JD001445, 2003. 646, 647, 648, 649, 652, 659, 660
- 15 Swanson, A. L., Davis, D. D., Arimoto, R., Roberts, P., Atlas, E. L., Flocke, F., Meinardi, S., Rowland, F. S., and Blake, D. R.: Organic trace gases of oceanic origin observed at South Pole during ISCAT 2000, *Atmos. Environ.*, 38, 5463–5472, 2004. 659, 660, 668, 670, 673
- Taalas, P., Kyrö, E., Supperi, A., Tafuri, V., and Ginzburg, M.: Vertical distribution of tropospheric ozone in Antarctica and in the European Arctic, *Tellus*, 45B, 106–119, 1993. 635
- Tackett, P. J., Cavender, A. E., Keil, A. D., Shepson, P. B., Bottenheim, J. W., Morin, S., Deary, J., Steffen, A., and Doerge, C.: A study of the vertical scale of halogen chemistry in the Arctic troposphere during polar sunrise at Barrow, Alaska, *J. Geophys. Res.*, 112D, D07306, doi:10.1029/2006JD007785, 2007. 638, 648, 655, 656, 675
- 20 Tarasick, D. W. and Bottenheim, J. W.: Surface ozone depletion episodes in the Arctic and Antarctic from historical ozonesonde records, *Atmos. Chem. Phys.*, 2, 197–205, doi:10.5194/acp-2-197-2002, 2002. 635, 636
- 25 Teinilä, K., Hillamo, R., Kerminen, V.-M., and Beine, H. J.: Aerosol chemistry during the NICE dark and light campaigns, *Atmos. Environ.*, 37, 563–575, 2003. 677, 679, 681, 687, 688, 690, 693, 697, 698, 700
- Temme, C., Einax, J. W., Ebinghaus, R., and Schroeder, W. H.: Measurements of atmospheric mercury species at a coastal site in the Antarctic and over the South Atlantic Ocean during polar summer, *Environ. Sci. Technol.*, 37, 22–31, 2003. 675, 676
- 30 Temme, C., Ebinghaus, R., Einax, J. W., Steffen, A., and Schroeder, W. H.: Time series analysis of long-term data sets of atmospheric mercury concentrations, *Anal. Bioanal. Chem.*, 380, 493–501, 2004. 674

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- Temme, C., Blanchard, P., Steffen, A., Banic, C., Beauchamp, S., Poissant, L., Tordon, R., and Wiens, B.: Trend, seasonal and multivariate analysis study of total gaseous mercury data from the Canadian atmospheric mercury measurement network (CAMNet), *Atmos. Environ.*, 41, 5423–5441, 2007. 674, 675
- 5 Theys, N., Van Roozendaal, M., Hendrick, F., Yang, X., De Smedt, I., Richter, A., Begoin, M., Errera, Q., Johnston, P. V., Kreher, K., and De Mazière, M.: Global observations of tropospheric BrO columns using GOME-2 satellite data, *Atmos. Chem. Phys.*, 11, 1791–1811, doi:10.5194/acp-11-1791-2011, 2011. 666
- 10 Toyota, K., McConnell, J. C., Lupu, A., Neary, L., McLinden, C. A., Richter, A., Kwok, R., Semeniuk, K., Kaminski, J. W., Gong, S.-L., Jarosz, J., Chipperfield, M. P., and Sioris, C. E.: Analysis of reactive bromine production and ozone depletion in the Arctic boundary layer using 3-D simulations with GEM-AQ: inference from synoptic-scale patterns, *Atmos. Chem. Phys.*, 11, 3949–3979, doi:10.5194/acp-11-3949-2011, 2011. 637, 665
- 15 Trivett, N. B. A., Worthy, D. E. J., and Brice, K. A.: Surface measurements of carbon dioxide and methane at Alert during an Arctic haze event in April, 1986, *J. Atmos. Chem.*, 9, 383–397, 1989. 646
- Tuckermann, M., Ackermann, R., Gölz, C., Lorenzen-Schmidt, H., Senne, T., Stutz, J., Trost, B., Unold, W., and Platt, U.: DOAS-observation of halogen radical-catalysed Arctic boundary layer ozone destruction during the ARCTOC campaign 1995 and 1996 in Ny-Ålesund, Spitzbergen, *Tellus*, 49B, 533–555, 1997. 636, 641, 663, 665, 669, 671
- 20 Tuncel, G., Aras, N. K., and Zoller, W. H.: Temporal variations and sources of elements in the south pole atmosphere 1. nonenriched and moderately enriched, *J. Geophys. Res.*, 94D, 13025–13038, 1989. 680, 682, 684, 691, 692, 693, 694, 695, 696, 697, 698, 699, 702, 703, 704
- 25 Villena, G., Wiesen, P., Cantrell, C. A., Flocke, F., Fried, A., Hall, S. R., Hornbrook, R. S., Knapp, D., Kosciuch, E., III, R. L. M., McGrath, J. A., Montzka, D., Richter, D., Ullmann, K., Walega, J., Weibring, P., Weinheimer, A., Staebler, R. M., Liao, J., Huey, L. G., and Kleffmann, J.: Nitrous acid (HONO) during polar spring in Barrow, Alaska: A net source of OH radicals?, *J. Geophys. Res.*, 116D, D00R07, doi:10.1029/2011JD016643, 2011. 644
- 30 von Schneidmesser, E., Schauer, J. J., Hagler, G. S. W., and Bergin, M. H.: Concentrations and sources of carbonaceous aerosol in the atmosphere of Summit, Greenland, *Atmos. Environ.*, 43, 4155–4162, 2009. 689

- Wagenbach, D., Ducroz, F., Mulvaney, R., Keck, L., Minikin, A., Legrand, M., Hall, J. S., and Wolff, E. W.: Sea-salt aerosol in coastal Antarctic regions, *J. Geophys. Res.*, 103D, 10961–10974, 1998a. 680, 681, 682, 683, 685, 686, 693, 696, 697, 698, 699, 700
- Wagenbach, D., Legrand, M., Fischer, H., Pichlmayer, F., and Wolff, E. W.: Atmospheric near-surface nitrate at coastal Antarctic sites, *J. Geophys. Res.*, 103D, 11007–11020, 1998b. 678
- Wagner, T. and Platt, U.: Satellite mapping of enhanced BrO concentrations in the troposphere, *Nature*, 395, 486–490, 1998. 665
- Wang, Y., Ridley, B., Fried, A., Cantrell, C., Davis, D., Chen, G., Snow, J., Heikes, B., Talbot, R., Dibb, J., Flocke, F., Weinheimer, A., Blake, N., Blake, D., Shetter, R., Lefer, B., Atlas, E., Coffey, M., Walega, J., and Wert, B.: Springtime photochemistry at northern mid and high latitudes, *J. Geophys. Res.*, 108D, 8358, doi:10.1029/2002JD002227, 2003. 637, 640, 641, 643, 652, 654, 657, 658, 659
- Wang, Y., Choi, Y., Zeng, T., Davis, D., Buhr, M., Huey, L. G., and Neff, W.: Assessing the photochemical impact of snow NO<sub>x</sub> emissions over Antarctica during ANTCTI 2003, *Atmos. Environ.*, 41, 3944–3958, 2007. 641, 645, 646
- Weber, R. J., Orsini, D., Wang, B., Scheuer, E., Talbot, R. W., Dibb, J. E., Seid, G. K., DeBell, L., Mauldin, R. L., Kosciuch, E., Cantrell, C., and Eisele, F.: Investigations into free tropospheric new particle formation in the central Canadian arctic during the winter/spring transition as part of TOPSE, *J. Geophys. Res.*, 108D, 8357, doi:10.1029/2002JD002239, 2003. 672
- Weller, R. and Wagenbach, D.: Year-round chemical aerosol records in continental Antarctica obtained by automatic samplings, *Tellus*, 59B, 755–765, 2007. 677, 678, 679, 680, 681, 685, 687, 688, 693, 694, 697, 698, 699, 701
- Weller, R., Minikin, A., König-Langlo, G., Schrems, O., Jones, A. E., Wolff, E. W., and Anderson, P. S.: Investigating possible causes of the observed diurnal variability in Antarctic NO<sub>y</sub>, *Geophys. Res. Lett.*, 26, 2853–2856, 1999. 643, 645
- Weller, R., Jones, A. E., Wille, A., Jacobi, H.-W., McIntyre, H. P., Sturges, W. T., Huke, M., and Wagenbach, D.: Seasonality of reactive nitrogen oxides (NO<sub>y</sub>) at Neumayer Station, Antarctica, *J. Geophys. Res.*, 107D, 4673, doi:10.1029/2002JD002495, 2002. 640, 643, 645, 659, 660
- Weller, R., Woltjen, J., Piel, C., Resenberg, R., Wagenbach, D., König-Langlo, G., and Kriews, M.: Seasonal variability of crustal and marine trace elements in the aerosol at Neumayer station, Antarctica, *Tellus*, 60B, 742–752, 2008. 692, 693, 697, 698, 700, 702

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- Weller, R., Wagenbach, D., Legrand, M., Elsässer, C., Tian-Kunze, X., and König-Langlo, G.: Continuous 25-yr aerosol records at coastal Antarctica – I: inter-annual variability of ionic compounds and links to climate indices, *Tellus*, 63B, 901–919, 2011. 678, 685, 687, 699
- Wespes, C., Emmons, L., Edwards, D. P., Hannigan, J., Hurtmans, D., Saunio, M., Coheur, P.-F., Clerbaux, C., Coffey, M. T., Batchelor, R. L., Lindenmaier, R., Strong, K., Weinheimer, A. J., Nowak, J. B., Ryerson, T. B., Crounse, J. D., and Wennberg, P. O.: Analysis of ozone and nitric acid in spring and summer Arctic pollution using aircraft, ground-based, satellite observations and MOZART-4 model: source attribution and partitioning, *Atmos. Chem. Phys.*, 12, 237–259, doi:10.5194/acp-12-237-2012, 2012. 638, 645
- Wessel, S., Aoki, S., Winkler, P., Weller, R., Herber, A., Gernandt, H., and Schrems, O.: Tropospheric ozone depletion in polar regions: A comparison of observations in the Arctic and Antarctic, *Tellus*, 50B, 34–50, 1998. 636
- Winchester, J. W., Schnell, R. C., Fan, S., Li, S., Bodhaine, B. A., Naegele, P. S., Hansen, A. D. A., and Rosen, H.: Particulate sulfur and chlorine in Arctic aerosols, spring 1983, *Atmos. Environ.*, 19, 2167–2173, 1985. 680, 685
- Wingenter, O. W., Sive, B. C., Blake, D. R., Rowland, F. S., and Ridley, B. A.: Unexplained enhancements of CH<sub>3</sub>Br in the Arctic and sub-Arctic lower troposphere during TOPSE spring 2000, *Geophys. Res. Lett.*, 30, doi:10.1029/2003GL018159, 2003. 667
- Wittrock, F.: The retrieval of oxygenated volatile organic compounds by remote sensing techniques, Ph.D. thesis, University of Bremen, Germany, <http://nbn-resolving.de/urn:nbn:de:gbv:46-diss000104818>, 2006. 655
- Wittrock, F., Müller, R., Richter, A., Bovensmann, H., and Burrows, J. P.: Measurements of iodine monoxide (IO) above Spitsbergen, *Geophys. Res. Lett.*, 27, 1471–1474, 2000. 669
- Wittrock, F., Oetjen, H., Richter, A., Fietkau, S., Medeke, T., Rozanov, A., and Burrows, J. P.: MAX-DOAS measurements of atmospheric trace gases in Ny-Ålesund – Radiative transfer studies and their application, *Atmos. Chem. Phys.*, 4, 955–966, doi:10.5194/acp-4-955-2004, 2004. 642
- Wolff, E. W. and Cachier, H.: Concentrations and seasonal cycle of black carbon in aerosol at a coastal Antarctic station, *J. Geophys. Res.*, 103D, 11033–11042, 1998. 689
- Wolff, E. W., Jones, A. E., Bauguitte, S. J.-B., and Salmon, R. A.: The interpretation of spikes and trends in concentration of nitrate in polar ice cores, based on evidence from snow and atmospheric measurements, *Atmos. Chem. Phys.*, 8, 5627–5634, doi:10.5194/acp-8-5627-2008, 2008. 679, 701

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Worthy, D. E. J., Trivett, N. B. A., Hopper, J. F., and Bottenheim, J. W.: Analysis of long-range transport events at Alert, Northwest Territories, during the Polar Sunrise Experiment, *J. Geophys. Res.*, 99D, 25329–25344, 1994. 646

5 Yang, J., Honrath, R. E., Peterson, M. C., Dibb, J. E., Sumner, A. L., Shepson, P. B., Frey, M., Jacobi, H.-W., Swanson, A., and Blake, N.: Impacts of snowpack emissions on deduced levels of OH and peroxy radicals at Summit, Greenland, *Atmos. Environ.*, 36, 2523–2534, 2002. 637, 639, 640, 642, 643, 646, 654, 657

10 Yokouchi, Y., Akimoto, H., Barrie, L. A., Bottenheim, J. W., Anlauf, K. G., and Jobson, B. T.: Serial gas chromatographic/mass spectrometric measurements of some volatile organic compounds in the Arctic atmosphere during the 1992 Polar Sunrise Experiment, *J. Geophys. Res.*, 99D, 25379–25389, 1994. 648, 649, 653, 655, 657, 663, 664, 667, 668, 669, 670, 673

15 Zhou, X., Beine, H. J., Honrath, R. E., Fuentes, J. D., Simpson, W., Shepson, P. B., and Bottenheim, J. W.: Snowpack photochemical production of HONO: a major source of OH in the Arctic boundary layer in springtime, *Geophys. Res. Lett.*, 28, 4087–4090, 2001. 644, 645

Ziamba, L. D., Dibb, J. E., Griffin, R. J., Huey, L. G., and Beckman, P.: Observations of particle growth at a remote, Arctic site, *Atmos. Environ.*, 44, 1649–1657, 2010. 638, 641, 672

20 Zoller, W. H., Gladney, E. S., and Duce, R. A.: Atmospheric concentrations and sources of trace metals at the South Pole, *Science*, 183, 198–200, 1974. 681, 691, 693, 694, 695, 696, 697, 698, 699, 701, 702, 703



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**Table 1.** Abbreviations and acronyms used in the tables.

date	
spr	= spring
sum	= summer
fal	= fall
win	= winter
chemistry	
DMS	= dimethyl sulfide, CH <sub>3</sub> SCH <sub>3</sub>
GEM	= gaseous elementary mercury, Hg
MSA	= methanesulfonic acid, CH <sub>3</sub> SO <sub>3</sub> H
PAN	= peroxyacetyl nitrate, CH <sub>3</sub> CO <sub>3</sub> NO <sub>2</sub>
PPN	= peroxypropionyl nitrate, C <sub>2</sub> H <sub>5</sub> CO <sub>3</sub> NO <sub>2</sub>
RGM	= reactive gaseous mercury
TGM	= total gaseous mercury
other	
bgr	= background air
DL	= detection limit
SCD	= slant column density [molecules cm <sup>-2</sup> ]
VCD	= vertical column density [molecules cm <sup>-2</sup> ]
ODE	= ozone depletion event
non-ODE	= data during ODE excluded

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**Table 2.** List of measurement sites in the Northern Hemisphere.

abbrev	name	latitude	longitude	altitude*
AG	Amundsen Gulf	≈ 71° N	≈ 122° W	
AL	Alert, Nunavut, Canada	82.45° N	62.52° W	210 m a.s.l.
AM	Amderma, Russia	69.72° N	61.62° E	
ARC	Arctic (miscellaneous sites)	—	—	
BA	Barrow, Alaska, USA	71.32° N	156.6° W	8 m a.s.l.
BI	Bear Island	74.5° N	19.0° E	
BS	Beaufort Sea	≈ 75° N	≈ 140° W	
CH	Churchill, Manitoba, Canada	59° N	94° W	
DY	Dye 3, Greenland	65.2° N	43.8° W	
EU	Eureka, Canada	80° N	86° W	
FC	Fort Chipewyan	58.78° N	111.12° W	232 m a.s.l.
IG	Igloolik, Nunavut, Canada	69° N	82° W	
KA	Kangerlussuaq (Søndre Strømfjord), Greenland	67° N	51° W	
KU	Kuujuarapik, Hudson Bay, Quebec, Canada	55.5° N	77.7° W	
MB	Mould Bay, Nunavut, Canada	76.25° N	119.33° W	58 m a.s.l.
NA	Ny Ålesund Zeppelin Station, Spitzbergen, Norway	78.9° N	11.87° E	475 m a.s.l.
NO	Norwegian Arctic (miscellaneous sites)	—	—	
NU	Nuuk, Greenland	64.1° N	51.4° W	
NW	Narwhal ice floe camp, Arctic (140 km NW of Alert)	83.9° N	63.28° W	
PF	Poker Flat, Alaska, USA	64.18° N	147.72° W	501 m a.s.l.
PS	Pallas-Sodankylä, Finland	67.37° N	26.65° E	
RE	Resolute, Nunavut, Canada	75° N	95° W	
SC	Scoresbysund, Greenland	70.48° N	21.97° W	
SE	Sevettijarvi, Finland	69.58° N	28.83° E	130 m a.s.l.
SN	Station Nord, Greenland	81.6° N	16.67° W	
SU	Summit, Greenland	72.58° N	38.48° W	3238 m a.s.l.
SW	SWAN ice floe camp, Arctic (160 km N of Alert)	83.9° N	63.1° W	
TH	Thule, Greenland	76.527° N	68.83° W	

\* a.s.l. = above sea level



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**Table 3.** List of measurement sites in the Southern Hemisphere.

abbrev	name	latitude	longitude	altitude*
ant	Antarctic (miscellaneous sites)	–	–	
bp	Browning Pass, Ross Sea	74.6° S	163.93° E	
by	Byrd Station	80.00° S	120.00° W	
co	Concordia (Dome C)	75.1° S	123.33° E	3233 m a.s.l.
df	Dome Fuji	77.37° S	39.62° E	
du	Dumont d'Urville	66.67° S	140.02° E	40 m a.s.l.
ea	East Antarctic Plateau	78.03° S	139.80° E	2849 m a.s.l.
ha	Halley	75.58° S	26.65° W	32 m a.s.l.
ks	Kohnen Station	75° S	0° E	2892 m a.s.l.
ma	Marambio	64.2° S	57.7° W	
mi	Mirny	66.33° S	93.01° E	
mm	McMurdo station, Arrival Heights	77.82° S	166.58° E	11 m a.s.l.
mo	Molodezhnaya	67.4° S	45.5° E	
mw	Mawson	67.6° S	62.88° E	
nm	Neumayer Station	70.65° S	8.25° W	42 m a.s.l.
pa	Palmer Station	64.92° S	64° W	10 m a.s.l.
sb	Scott Base	77.85° S	166.75° E	
sp	South Pole	90° S	—	2810 m a.s.l.
sy	Syowa	69° S	39.58° E	
tn	Terra Nova Bay (Mario Zucchelli Station)	74.7° S	164.1° E	
tr	Troll Research Station	72.02° S	2.53° E	1275 m a.s.l.
ws	Weddell Sea	≈ 75° S	≈ 47° E	

\* a.s.l. = above sea level

**Table 4:** Gas phase data.

species	value	date	site	reference
<b>Oxygen and Hydrogen</b>				
O <sub>3</sub>		1958	ha	Roscoe and Roscoe (2006)
O <sub>3</sub>		1962–2006	sp	Oltmans et al. (2008)
O <sub>3</sub>		1966–2000	RE	Tarasick and Bottenheim (2002)
O <sub>3</sub>		1973–1978	BA	Oltmans (1981)
O <sub>3</sub>		1973–1984	BA	Oltmans and Komhyr (1986)
O <sub>3</sub>		1973–2009	BA	Oltmans et al. (2012)
O <sub>3</sub>		1973–2005	ARC, ant	Helmig et al. (2007b)
O <sub>3</sub>		1974–2000	CH	Tarasick and Bottenheim (2002)
O <sub>3</sub>		1975–1978	sp	Oltmans (1981)
O <sub>3</sub>		1975–1984	sp	Oltmans and Komhyr (1986)
O <sub>3</sub>		1975–2004	BA, sp	Oltmans et al. (2006)
O <sub>3</sub>	monthly mean: 20...35 nmol mol <sup>-1</sup>	1975–1989	sp	Schnell et al. (1991)
O <sub>3</sub>	monthly mean: 18...25 nmol mol <sup>-1</sup>	1975–1989 (Feb)	sp	Schnell et al. (1991)
O <sub>3</sub>	monthly mean: 32...38 nmol mol <sup>-1</sup>	1975–1989 (Aug)	sp	Schnell et al. (1991)
O <sub>3</sub>		1979–1986	ARC	Oltmans et al. (1989)
O <sub>3</sub>	17...37 nmol mol <sup>-1</sup>	Mar 1985	AL	Bottenheim et al. (1986)
O <sub>3</sub>		Apr 1986	AL	Mickle et al. (1989)
O <sub>3</sub>		1987	ha	Jones et al. (2010)
O <sub>3</sub>		1987–1988	mo, mi	Gruzdev et al. (1993)
O <sub>3</sub>		1988–1990	BI	Taalas et al. (1993)
O <sub>3</sub>		1988–1991	ma	Taalas et al. (1993)
O <sub>3</sub>		1988–1991	PS	Taalas et al. (1993)
O <sub>3</sub>		1989–1994	NA	Solberg et al. (1997b)
O <sub>3</sub>	14...32 nmol mol <sup>-1</sup>	Sep–Oct 1989	mm	Sturges et al. (1993d)
O <sub>3</sub>	2...48 nmol mol <sup>-1</sup>	Mar–Apr 1989	BA	Sturges et al. (1993c)
O <sub>3</sub>		1989–1990	NA	Taalas et al. (1993)
O <sub>3</sub>		1989–1990	sy	Murayama et al. (1992)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
O <sub>3</sub>		1989–1993	NA	Solberg et al. (1996b)
O <sub>3</sub>		Mar–Apr 1990	BA	Sturges et al. (1993b)
O <sub>3</sub>	seasonal cycle	1992–2001	NA	Eneroth et al. (2007)
O <sub>3</sub>	<0.4...20 nmol mol <sup>-1</sup>	Apr 1992	SW	Hopper et al. (1994a)
O <sub>3</sub>	<0.5...45 nmol mol <sup>-1</sup>	Apr 1992	AL	Anlauf et al. (1994)
O <sub>3</sub>	0.9...57.4 nmol mol <sup>-1</sup>	1992–1993	NA	Beine (1999)
O <sub>3</sub>		1993	nm	Wessel et al. (1998)
O <sub>3</sub>	0...72 nmol mol <sup>-1</sup>	Mar–May 1993	PF	Beine et al. (1996b)
O <sub>3</sub>		May–Jun 1993	SU	Bales et al. (1995b)
O <sub>3</sub>		1993–1994	NA	Wessel et al. (1998)
O <sub>3</sub>		1993–2000	EU	Tarasick and Bottenheim (2002)
O <sub>3</sub>		1994–1996	SC	Rasmussen et al. (1997)
O <sub>3</sub>		1994–1996	TH	Rasmussen et al. (1997)
O <sub>3</sub>	<0.5...36 nmol mol <sup>-1</sup>	spr 1994	NW	Ariya et al. (1998)
O <sub>3</sub>		spr 1994	ARC	Galaktionov et al. (1997)
O <sub>3</sub>	4.0...51.0 nmol mol <sup>-1</sup>	Feb–May 1994	NA	Beine et al. (1996a, 1997a,b)
O <sub>3</sub>		Mar–Apr 1994	ARC	Hopper et al. (1998)
O <sub>3</sub>		Mar–Jun 1994	ARC	Jaeschke et al. (1997)
O <sub>3</sub>	15...45 nmol mol <sup>-1</sup>	1994–1996	NA	Beine and Krognes (2000)
O <sub>3</sub>		Apr 1994	NW	Gong et al. (1997)
O <sub>3</sub>		Jan–May 1995	KA	Miller et al. (1997)
O <sub>3</sub>		Feb–Apr 1995	AL	Ariya et al. (1999)
O <sub>3</sub>	bgr.: 30.0...61.6 nmol mol <sup>-1</sup>	Mar–May 1995	PF	Beine et al. (1997a)
O <sub>3</sub>	mean: 54 nmol mol <sup>-1</sup>	May–Jul 1995	SU	Munger et al. (1999)
O <sub>3</sub>		Sep 1995	mm	Kreher et al. (1997)
O <sub>3</sub>		1995–1996	KA	Rasmussen et al. (1997)
O <sub>3</sub>		1995–1996	NA	Martinez et al. (1999)
O <sub>3</sub>		1995, 1996	NA	Tuckermann et al. (1997)
O <sub>3</sub>		1995–2001	SN	Heidam et al. (2004)
O <sub>3</sub>	0...49.8 nmol mol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
O <sub>3</sub>		Apr–May 1998	AL	Boudries and Bottenheim (2000)
O <sub>3</sub>		Jun 1998	NA	Sprovieri and Pirrone (2000)

**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
O <sub>3</sub>		1998, 2000	AL	Sumner et al. (2002)
O <sub>3</sub>	12...21 nmolmol <sup>-1</sup>	Mar 1999	ant	Jacobi and Schrems (1999)
O <sub>3</sub>	40.5 nmolmol <sup>-1</sup>	sum 1999	SU	Yang et al. (2002)
O <sub>3</sub>		1999–2000	nm	Frieß et al. (2004)
O <sub>3</sub>		1999–2002	SN	Skov et al. (2004)
O <sub>3</sub>	1.28...56.32 nmolmol <sup>-1</sup>	1999–2002	KU	Poissant and Pilote (2003)
O <sub>3</sub>	51.9 nmolmol <sup>-1</sup>	sum 2000	SU	Yang et al. (2002)
O <sub>3</sub>		2000–2001	nm	Ebinghaus et al. (2002)
O <sub>3</sub>		Feb–May 2000	AL	Bottenheim et al. (2002b)
O <sub>3</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Ridley et al. (2007); Cantrell et al. (2003); Blake et al. (2003); Wang et al. (2003); Olson et al. (2012)
O <sub>3</sub>		Jun 2000	SU	Helmig et al. (2002)
O <sub>3</sub>		2000–2004	SU	Helmig et al. (2007c)
O <sub>3</sub>		spr 2001	KU	Hönninger et al. (2004)
O <sub>3</sub>		Apr 2001	ARC	Toyota et al. (2011)
O <sub>3</sub>	median: 36.5 nmolmol <sup>-1</sup>	Apr–May 2001	KU	Poissant and Pilote (2003); Poissant and Hoenninger (2004)
O <sub>3</sub>	mean: 14.5 nmolmol <sup>-1</sup>	Dec 2001	ant	Frey et al. (2005)
O <sub>3</sub>		Mar 2002	SN	Ferrari et al. (2004)
O <sub>3</sub>		Apr 2002	KU	Gauchard et al. (2005b)
O <sub>3</sub>	mean: 19.3 nmolmol <sup>-1</sup>	Dec 2002	ant	Frey et al. (2005)
O <sub>3</sub>	mean: 27.9 nmolmol <sup>-1</sup>	Jan 2003	sp	Frey et al. (2005)
O <sub>3</sub>		Apr–May 2003	NA	Sprovieri et al. (2005a,b)
O <sub>3</sub>	< 1...42 nmolmol <sup>-1</sup>	Mar–Apr 2003	ARC	Jacobi et al. (2006)
O <sub>3</sub>	19...42 nmolmol <sup>-1</sup>	Mar–Apr 2003	NA	Jacobi et al. (2006)
O <sub>3</sub>		Aug–Oct 2003	ha	Jones et al. (2006)
O <sub>3</sub>		Nov–Dec 2003	sp	Eisele et al. (2008)
O <sub>3</sub>		Dec 2003	sp	Helmig et al. (2008a); Johnson et al. (2008)
O <sub>3</sub>		2003–2005	SU	Helmig et al. (2007a)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
O <sub>3</sub>		Mar 2004	KU	Constant et al. (2007)
O <sub>3</sub>	15... 58 nmol mol <sup>-1</sup>	Apr–May 2004	NA	Amoroso et al. (2005)
O <sub>3</sub>		spr 2004	AL	Morin et al. (2007)
O <sub>3</sub>		spr 2004	AL	Morin et al. (2005)
O <sub>3</sub>		2004–2005	NA	Ferrari et al. (2008)
O <sub>3</sub>	mean: 7.0 nmol mol <sup>-1</sup>	2004–2005	ha	Bloss et al. (2010)
O <sub>3</sub>	18... 35 nmol mol <sup>-1</sup>	2004–2008	du	Legrand et al. (2009)
O <sub>3</sub>		2005	BA	Simpson et al. (2007a)
O <sub>3</sub>		Jan–Apr 2005	BA	Keil and Shepson (2006)
O <sub>3</sub>		Mar–Apr 2005	BA	Tackett et al. (2007)
O <sub>3</sub>	mean: 21.4 nmol mol <sup>-1</sup>	Jul–Sep 2005	ARC	Sommar et al. (2010)
O <sub>3</sub>		2006–2008	ARC	Bottenheim et al. (2009)
O <sub>3</sub>		2007	ha	Jones et al. (2010)
O <sub>3</sub>		Apr 2007	ARC	Prados-Roman et al. (2011)
O <sub>3</sub>	mean: 55.6 pmol mol <sup>-1</sup>	May–Jun 2007	SU	Ziamba et al. (2010)
O <sub>3</sub>		Aug–Sep 2007	ha	Buys et al. (2012)
O <sub>3</sub>		2007, 2008	SU	Liao et al. (2011a); Stutz et al. (2011)
O <sub>3</sub>	21... 35 nmol mol <sup>-1</sup>	2007–2008	co	Legrand et al. (2009)
O <sub>3</sub>		2007–2011	NA	Pfaffhuber et al. (2012)
O <sub>3</sub>		2007–2011	tr	Hansen et al. (2009); Pfaffhuber et al. (2012)
O <sub>3</sub>		2008	ARC	Wespes et al. (2012); Olson et al. (2012)
O <sub>3</sub>	mean: 30 nmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)
O <sub>3</sub>	up to 46 nmol mol <sup>-1</sup>	Mar–Apr 2008	AG	Pöhler et al. (2010); Nghiem et al. (2012); Seabrook et al. (2011)
O <sub>3</sub>		Mar–Apr 2008	ARC	Gilman et al. (2010)
O <sub>3</sub>	mean: 63 nmol mol <sup>-1</sup>	Apr 2008	ARC	Liang et al. (2011); Neuman et al. (2010); Salawitch et al. (2010); Dupont et al. (2012); Liao et al. (2012a)
O <sub>3</sub>	mean: 57 nmol mol <sup>-1</sup>	Jun–Jul 2008	ARC	Liang et al. (2011)
O <sub>3</sub>	ozonesondes	2008–2009	BA	Oltmans et al. (2012)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
H <sub>2</sub>	mean: 546 pmol mol <sup>-1</sup>	2004–2005	ha	Bloss et al. (2010)
OH	mean: 1.1 × 10 <sup>5</sup> cm <sup>-3</sup>	Feb 1994	pa	Jefferson et al. (1998); Davis et al. (1998)
OH		2000	sp	Mauldin III et al. (2004)
OH		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Mauldin III et al. (2003)
OH	median: 6.4 × 10 <sup>6</sup> cm <sup>-3</sup>	2003	SU	Sjostedt et al. (2008)
OH		Nov–Dec 2003	sp	Eisele et al. (2008)
OH	mean: 3.9 × 10 <sup>5</sup> cm <sup>-3</sup>	Jan–Feb 2005	ha	Bloss et al. (2007, 2010)
OH		2007, 2008	SU	Liao et al. (2011a)
OH		2008	ARC	Olson et al. (2012)
OH	noontime mean: 0.77 × 10 <sup>6</sup> cm <sup>-3</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)
OH	mean: 0.04 pmol mol <sup>-1</sup>	Apr 2008	ARC	Liang et al. (2011)
OH	mean: 0.13 pmol mol <sup>-1</sup>	Jun–Jul 2008	ARC	Liang et al. (2011)
OH	mean: 2.1 × 10 <sup>6</sup> cm <sup>-3</sup>	2010–2011	du	Kukui et al. (2012)
HO <sub>2</sub>	mean: 0.76 pmol mol <sup>-1</sup>	Jan–Feb 2005	ha	Bloss et al. (2007, 2010)
HO <sub>2</sub>	mean: 1.34 × 10 <sup>8</sup> cm <sup>-3</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)
HO <sub>2</sub>		2008	ARC	Olson et al. (2012)
HO <sub>2</sub>	mean: 3.5 pmol mol <sup>-1</sup>	Apr 2008	ARC	Liang et al. (2011)
HO <sub>2</sub>	mean: 8.9 pmol mol <sup>-1</sup>	Jun–Jul 2008	ARC	Liang et al. (2011)
H <sub>2</sub> O <sub>2</sub>	0.3 ... 3.5 nmol mol <sup>-1</sup>	Jun–Jul 1990	SU	Sigg et al. (1992)
H <sub>2</sub> O <sub>2</sub>		1992	AL	de Serves (1994)
H <sub>2</sub> O <sub>2</sub>	up to 0.5 nmol mol <sup>-1</sup>	1993–1994	ant	Fuhrer et al. (1996)
H <sub>2</sub> O <sub>2</sub>		May–Jun 1993	SU	Bales et al. (1995b)
H <sub>2</sub> O <sub>2</sub>		May–Jul 1993	SU	Bales et al. (1995a)
H <sub>2</sub> O <sub>2</sub>		Aug 1994	SU	Dibb et al. (1996)
H <sub>2</sub> O <sub>2</sub>	mean: 1.4 nmol mol <sup>-1</sup>	Jun 1996	SU	Hutterli et al. (2001)
H <sub>2</sub> O <sub>2</sub>	<DL... 0.91 nmol mol <sup>-1</sup>	1997–1999	nm	Riedel et al. (2000)
H <sub>2</sub> O <sub>2</sub>	1.78 nmol mol <sup>-1</sup>	sum 1999	SU	Yang et al. (2002)
H <sub>2</sub> O <sub>2</sub>	mean: 278 pmol mol <sup>-1</sup>	Dec 2000	sp	Hutterli et al. (2004)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
H <sub>2</sub> O <sub>2</sub>	mean: 321 pmol mol <sup>-1</sup>	Dec 2000	ant	Frey et al. (2005)
H <sub>2</sub> O <sub>2</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Wang et al. (2003); Olson et al. (2012)
H <sub>2</sub> O <sub>2</sub>	80... 1600 pmol mol <sup>-1</sup>	Jun–Jul 2000	SU	Jacobi et al. (2002)
H <sub>2</sub> O <sub>2</sub>	mean: 650 pmol mol <sup>-1</sup>	Dec 2001	ant	Frey et al. (2005)
H <sub>2</sub> O <sub>2</sub>	mean: 363 pmol mol <sup>-1</sup>	Dec 2002	by	Frey et al. (2005)
H <sub>2</sub> O <sub>2</sub>	mean: 230 pmol mol <sup>-1</sup>	Jan 2003	sp	Frey et al. (2005)
H <sub>2</sub> O <sub>2</sub>		Nov–Dec 2003	sp	Eisele et al. (2008)
H <sub>2</sub> O <sub>2</sub>		2008	ARC	Olson et al. (2012)
H <sub>2</sub> O <sub>2</sub>	145... 1000 pmol mol <sup>-1</sup>	2010–2011	du	Preunkert et al. (2012)

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NH <sub>3</sub>		Jan 1994	du	Legrand et al. (1998)
NH <sub>3</sub>		Aug 1994	SU	Dibb et al. (1996)
NH <sub>3</sub>	0... 4645.0 pmol mol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
NH <sub>3</sub>	monthly mean: 0.23... 28 nmol mol <sup>-1</sup>	2005–2010	du	Legrand et al. (2012)
N <sub>2</sub> O	mean: 341 pmol mol <sup>-1</sup>	1988–1989	DY	Davidson et al. (1993b,a)
N <sub>2</sub> O		1997–2005	SU	Dibb et al. (2007)
NO	median: 225 pmol mol <sup>-1</sup>	1989–1999	sp	Davis et al. (2001)
NO	bgr.: 0... 43.4 pmol mol <sup>-1</sup>	Feb–May 1994	NA	Beine et al. (1997a)
NO	0... 1501.8 pmol mol <sup>-1</sup>	Mar–May 1995	PF	Beine et al. (1997a)
NO	mean: 3 pmol mol <sup>-1</sup>	Jan–Mar 1997	nm	Jones et al. (1999)
NO		Jul 1998	SU	Honrath et al. (1999)
NO		1998, 2000	sp	Davis et al. (2004)
NO	mean: 1.2 pmol mol <sup>-1</sup>	Jan–Feb 1999	nm	Jacobi et al. (2000)
NO		Jul 1999	SU	Dibb et al. (2002)
NO	24.7 pmol mol <sup>-1</sup>	sum 1999	SU	Yang et al. (2002)
NO	<1... 7.6 pmol mol <sup>-1</sup>	1999–2000	nm	Weller et al. (2002)
NO	16.0 pmol mol <sup>-1</sup>	sum 2000	SU	Yang et al. (2002)

**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
NO		Jun 2000	SU	Jacobi et al. (2004)
NO		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Ridley et al. (2007); Cantrell et al. (2003); Wang et al. (2003); Olson et al. (2012)
NO	0...24.7 pmol mol <sup>-1</sup>	Feb–May 2000	AL	Beine et al. (2002)
NO		Nov–Dec 2003	sp	Eisele et al. (2008); Wang et al. (2007)
NO		Dec 2003	sp	Helmig et al. (2008b)
NO	mean: 7.3 pmol mol <sup>-1</sup>	2004–2005	ha	Jones et al. (2011); Bloss et al. (2010); Anderson and Bauguitte (2007); Bauguitte et al. (2012)
NO	median: 1.8 pmol mol <sup>-1</sup>	Feb–Apr 2006	NA	Amoroso et al. (2010)
NO	mean: 10.9 pmol mol <sup>-1</sup>	May–Jun 2007	SU	Ziemba et al. (2010)
NO		2007, 2008	SU	Liao et al. (2011a)
NO		2008	ARC	Olson et al. (2012)
NO	mean: 4 pmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Moller et al. (2010); Edwards et al. (2011)
NO	mean: 11 pmol mol <sup>-1</sup>	Apr 2008	ARC	Liang et al. (2011)
NO	mean: 9 pmol mol <sup>-1</sup>	Jun–Jul 2008	ARC	Liang et al. (2011)
NO <sub>2</sub>	17...97 pmol mol <sup>-1</sup>	Mar 1985	AL	Bottenheim et al. (1986)
NO <sub>2</sub>	85 pmol mol <sup>-1</sup>	spr 1988	AL	Bottenheim et al. (1990)
NO <sub>2</sub>		Mar–Apr 1988	AL	Bottenheim et al. (1993)
NO <sub>2</sub>	SCD	1995	mm	Kreher et al. (1997)
NO <sub>2</sub>		1995–1996	NA	Martinez et al. (1999)
NO <sub>2</sub>		1995, 1996	NA	Tuckermann et al. (1997)
NO <sub>2</sub>	0...358.3 pmol mol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
NO <sub>2</sub>	10...170 ng m <sup>-3</sup>	May–Jun 1997	NA	Allegrini et al. (1999)
NO <sub>2</sub>	10...300 ng m <sup>-3</sup>	Dec 1997	tn	Allegrini et al. (1999)
NO <sub>2</sub>	4.94...620.73 ng m <sup>-3</sup>	1997–1999	tn	Ianniello et al. (2003)
NO <sub>2</sub>		Jul 1998	SU	Honrath et al. (1999)
NO <sub>2</sub>	mean: 3.2 pmol mol <sup>-1</sup>	Jan–Feb 1999	nm	Jacobi et al. (2000)

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species	value	date	site	reference
NO <sub>2</sub>		Jul 1999	SU	Dibb et al. (2002)
NO <sub>2</sub>	32.7 pmol mol <sup>-1</sup>	sum 1999	SU	Yang et al. (2002)
NO <sub>2</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Ridley et al. (2007)
NO <sub>2</sub>	0...38.8 pmol mol <sup>-1</sup>	Feb–May 2000	AL	Beine et al. (2002)
NO <sub>2</sub>		Jun 2000	SU	Jacobi et al. (2004)
NO <sub>2</sub>	15.2 pmol mol <sup>-1</sup>	sum 2000	SU	Yang et al. (2002)
NO <sub>2</sub>	bgr.: 30 pmol mol <sup>-1</sup>	Jul 2003	NA	Wittrock et al. (2004)
NO <sub>2</sub>	mean: 4.3 pmol mol <sup>-1</sup>	2004–2005	ha	Jones et al. (2011); Bloss et al. (2010); Anderson and Bauguitte (2007); Bauguitte et al. (2012)
NO <sub>2</sub>	median: 20.2 pmol mol <sup>-1</sup>	Feb–Apr 2006	NA	Amoroso et al. (2010)
NO <sub>2</sub>	mean: 39 pmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Moller et al. (2010); Edwards et al. (2011)
NO <sub>2</sub>	mean: 6 pmol mol <sup>-1</sup>	Apr 2008	ARC	Liang et al. (2011)
NO <sub>2</sub>	mean: 18 pmol mol <sup>-1</sup>	Jun–Jul 2008	ARC	Liang et al. (2011)
NO <sub>x</sub>	≤30 pmol mol <sup>-1</sup>	spr 1992	AL	Muthuramu et al. (1994)
NO <sub>x</sub>	<20...100 pmol mol <sup>-1</sup>	Apr 1992	ARC	Leaitch et al. (1994)
NO <sub>x</sub>	0...637.5 pmol mol <sup>-1</sup>	Feb–May 1994	NA	Beine et al. (1996a)
NO <sub>x</sub>	bgr.: 0...143.9 pmol mol <sup>-1</sup>	Feb–May 1994	NA	Beine et al. (1997b)
NO <sub>x</sub>	bgr.: 0...143.9 pmol mol <sup>-1</sup>	Feb–May 1994	NA	Beine et al. (1997a)
NO <sub>x</sub>	bgr.: 0...955.5 pmol mol <sup>-1</sup>	Mar–May 1995	PF	Beine et al. (1997a)
NO <sub>x</sub>		1998–1999	SU	Ford et al. (2002)
NO <sub>x</sub>	<2...20.2 pmol mol <sup>-1</sup>	Jan–Feb 1999	nm	Jacobi et al. (2000)
NO <sub>x</sub>	49.4 pmol mol <sup>-1</sup>	sum 1999	SU	Yang et al. (2002)
NO <sub>x</sub>		Jun 2000	SU	Honrath et al. (2002); Jacobi et al. (2004)
NO <sub>x</sub>	39.7 pmol mol <sup>-1</sup>	sum 2000	SU	Yang et al. (2002)
NO <sub>x</sub>		2000	sp	Oncley et al. (2004)



**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
NO <sub>x</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Ridley et al. (2007)
NO <sub>x</sub>	mean: 25 pmol mol <sup>-1</sup>	Apr 2008	ARC	Liang et al. (2011); Dupont et al. (2012)
NO <sub>x</sub>	mean: 25 pmol mol <sup>-1</sup>	Jun–Jul 2008	ARC	Liang et al. (2011)
NO <sub>y</sub>		Mar–Apr 1988	AL	Bottenheim et al. (1993)
NO <sub>y</sub>	mean: 300 pmol mol <sup>-1</sup>	Feb–May 1994	NA	Solberg et al. (1997a)
NO <sub>y</sub>	mean: 850 pmol mol <sup>-1</sup>	May–Jul 1995	SU	Munger et al. (1999)
NO <sub>y</sub>		1995	SU	Dibb et al. (1998)
NO <sub>y</sub>	mean: 24 pmol mol <sup>-1</sup>	Jan–Mar 1997	nm	Jones et al. (1999); Weller et al. (1999)
NO <sub>y</sub>	100...600 ng m <sup>-3</sup>	May–Jun 1997	NA	Allegrini et al. (1999)
NO <sub>y</sub>	300...700 ng m <sup>-3</sup>	Dec 1997	tn	Allegrini et al. (1999)
NO <sub>y</sub>	14.58...701.20 ng m <sup>-3</sup>	1997–1999	tn	Ianniello et al. (2003)
NO <sub>y</sub>		Jul 1998	SU	Honrath et al. (1999)
NO <sub>y</sub>		1998–1999	SU	Ford et al. (2002)
NO <sub>y</sub>	46 pmol mol <sup>-1</sup>	1999–2000	nm	Weller et al. (2002)
NO <sub>y</sub>		Feb–Mar 2000	AL	Bottenheim et al. (2002b)
NO <sub>y</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Wang et al. (2003)
NO <sub>y</sub>	mean: 410 pmol mol <sup>-1</sup>	Apr 2008	ARC	Liang et al. (2011)
NO <sub>y</sub>	mean: 320 pmol mol <sup>-1</sup>	Jun–Jul 2008	ARC	Liang et al. (2011)
HONO	0...≤240 pmol mol <sup>-1</sup>	Apr 1992	AL	Hausmann and Platt (1994)
HONO	<1.7...68 pmol mol <sup>-1</sup>	win 1992	AL	Li (1994)
HONO	<1.7...20 pmol mol <sup>-1</sup>	spr 1992	AL	Li (1994)
HONO	0...64.8 pmol mol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
HONO		Jul 1999	SU	Dibb et al. (2002)
HONO	7.24 pmol mol <sup>-1</sup>	sum 1999	SU	Yang et al. (2002)
HONO	12.7 pmol mol <sup>-1</sup>	sum 2000	SU	Yang et al. (2002)
HONO		2000	sp	Dibb et al. (2004)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
HONO		Feb–May 2000	AL	Zhou et al. (2001)
HONO		Jun 2000	SU	Honrath et al. (2002); Jacobi et al. (2004)
HONO	<DL...20 pmolmol <sup>-1</sup>	Feb–May 2001	NA	Beine et al. (2003)
HONO	see note <sup>1</sup>	Apr–May 2003	NA	Ianniello et al. (2007)
HONO	median: 5.8 pmolmol <sup>-1</sup> , see note <sup>2</sup>	Nov–Dec 2003	sp	Liao et al. (2006)
HONO	0...48.3 pmolmol <sup>-1</sup>	Apr–May 2004	NA	Amoroso et al. (2005)
HONO	0...7 pmolmol <sup>-1</sup>	Nov 2004	bp	Beine et al. (2006)
HONO	mean: 7 pmolmol <sup>-1</sup> , see note <sup>3</sup>	2004–2005	ha	Bloss et al. (2010)
HONO	mean: 10.2 pmolmol <sup>-1</sup>	Jan 2005	ha	Clemitshaw (2006)
HONO	median: 4.2 pmolmol <sup>-1</sup>	Feb–Apr 2006	NA	Amoroso et al. (2010)
HONO		2007, 2008	SU	Dibb et al. (2010); Liao et al. (2011a)
HONO	<0.4...500 pmolmol <sup>-1</sup>	Mar–Apr 2009	BA	Villena et al. (2011)
HONO	5...60 pmolmol <sup>-1</sup>	2010–2011	co	Kerbrat et al. (2012)
HONO	2...10 pmolmol <sup>-1</sup>	Feb 2011	du	Kerbrat et al. (2012)
HNO <sub>3</sub> (g+aq)	24...72 pmolmol <sup>-1</sup>	Mar 1985	AL	Bottenheim et al. (1986)
HNO <sub>3</sub>	3.5...180 pmolmol <sup>-1</sup>	spr 1988	AL	Bottenheim et al. (1990)
HNO <sub>3</sub>		Mar–Apr 1988	AL	Bottenheim et al. (1993)
HNO <sub>3</sub>	mean: 77 ngm <sup>-3</sup>	May 1989	AL	Kieser et al. (1993)
HNO <sub>3</sub> (g+aq)		1990–2001	SN	Heidam et al. (2004)
HNO <sub>3</sub>		Jan–Feb 1991	tn	Allegrini et al. (1994)
HNO <sub>3</sub>	5...100 pmolmol <sup>-1</sup>	win/spr 1992	AL	Barrie et al. (1994a)
HNO <sub>3</sub>	≤40...110 pmolmol <sup>-1</sup>	Apr 1992	ARC	Leaitch et al. (1994)
HNO <sub>3</sub>	mean: 0.9 nmolm <sup>-3</sup> (STP)	Jun–Jul 1993	SU	Dibb et al. (1994)
HNO <sub>3</sub>		1994–1995	SU	Dibb et al. (1998)

<sup>1</sup> Means from denuder comparison: 23.4 and 19.2 ngm<sup>-3</sup>.

<sup>2</sup> A comparison to mist chamber data shows a large discrepancy.

<sup>3</sup> Jones et al. (2011) state that this value likely represents an over-estimate.

**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
HNO <sub>3</sub>		Mar–Jun 1994	ARC	Jaeschke et al. (1997)
HNO <sub>3</sub>		Aug 1994	SU	Dibb et al. (1996)
HNO <sub>3</sub>	mean: 5 pmol mol <sup>-1</sup>	Jan–Mar 1997	nm	Jones et al. (1999); Weller et al. (1999)
HNO <sub>3</sub>	0...229.1 pmol mol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
HNO <sub>3</sub>	mean: 4.0 pmol mol <sup>-1</sup>	Jan–Feb 1999	nm	Jacobi et al. (2000)
HNO <sub>3</sub>	<1...24 pmol mol <sup>-1</sup>	1999–2000	nm	Weller et al. (2002)
HNO <sub>3</sub>		2000–2001	du	Jourdain and Legrand (2002)
HNO <sub>3</sub>	mean: 14.5 ng m <sup>-3</sup>	Feb 2000	AL	Ianniello et al. (2002)
HNO <sub>3</sub>		Mar–Apr 2000	NA	Hara et al. (2002b)
HNO <sub>3</sub>	mean: 54.9 ng m <sup>-3</sup>	Apr–May 2000	AL	Ianniello et al. (2002)
HNO <sub>3</sub>		Jun 2000	SU	Honrath et al. (2002); Jacobi et al. (2004)
HNO <sub>3</sub>		2000	sp	Dibb et al. (2004)
HNO <sub>3</sub>		2000	sp	Huey et al. (2004)
HNO <sub>3</sub>		Feb–May 2000	ARC	Olson et al. (2012)
HNO <sub>3</sub>	0.9...70 pmol mol <sup>-1</sup>	Feb–May 2001	NA	Beine et al. (2003)
HNO <sub>3</sub>	see note <sup>4</sup>	Apr–May 2003	NA	Ianniello et al. (2007)
HNO <sub>3</sub>		Nov–Dec 2003	sp	Wang et al. (2007); Eisele et al. (2008)
HNO <sub>3</sub>		2004–2005	ha	Jones et al. (2011, 2008)
HNO <sub>3</sub>	median: 1.8 pmol mol <sup>-1</sup>	Feb–Apr 2006	NA	Amoroso et al. (2010)
HNO <sub>3</sub>		2007, 2008	SU	Dibb et al. (2010); Liao et al. (2011a)
HNO <sub>3</sub>		2008	ARC	Wespes et al. (2012); Olson et al. (2012)
HNO <sub>3</sub>	mean: 30 pmol mol <sup>-1</sup>	Apr 2008	ARC	Liang et al. (2011)
HNO <sub>3</sub>	mean: 70 pmol mol <sup>-1</sup>	Jun–Jul 2008	ARC	Liang et al. (2011)
HNO <sub>3</sub> (g+aq)		2009–2010	BA	Morin et al. (2012)
HNO <sub>4</sub>		Feb–May 2000	AL	Zhou et al. (2001)
HNO <sub>4</sub>	mean: 25 pmol mol <sup>-1</sup>	Dec 2000	sp	Slusher et al. (2002)

<sup>4</sup>Means from denuder comparison: 80.4 and 36.1 ng m<sup>-3</sup>.

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
HNO <sub>4</sub>		Nov–Dec 2003	sp	Eisele et al. (2008); Wang et al. (2007)

### Organic: C, H (alkanes)

CH <sub>4</sub>		Apr 1986	AL	Trivett et al. (1989)
CH <sub>4</sub>	mean: 1780 nmol mol <sup>-1</sup>	1988–1989	DY	Davidson et al. (1993b,a)
CH <sub>4</sub>		1989–1990	AL	Hopper et al. (1994b)
CH <sub>4</sub>	1800... 1950 nmol mol <sup>-1</sup>	win/spr 1992	AL	Worthy et al. (1994)
CH <sub>4</sub>		Apr 1994	AL, NW	Ariya et al. (1998)
CH <sub>4</sub>		Feb–Apr 1995	AL	Ariya et al. (1999)
CH <sub>4</sub>		1997–2005	SU	Dibb et al. (2007)
CH <sub>4</sub>	1800 nmol mol <sup>-1</sup>	sum 1999	SU	Yang et al. (2002)
CH <sub>4</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003)
CH <sub>4</sub>	1816 nmol mol <sup>-1</sup>	sum 2000	SU	Yang et al. (2002)
CH <sub>4</sub>	mean: 1720 pmol mol <sup>-1</sup>	2004–2005	ha	Bloss et al. (2010)
C <sub>2</sub> H <sub>6</sub>		1982, 1983	NO	Hov et al. (1984)
C <sub>2</sub> H <sub>6</sub>	mean: 370 pmol mol <sup>-1</sup>	1982–1985	nm	Rudolph et al. (1989)
C <sub>2</sub> H <sub>6</sub>		1983–1986	NA	Hov et al. (1989)
C <sub>2</sub> H <sub>6</sub>		1989–1994	NA	Solberg et al. (1996a)
C <sub>2</sub> H <sub>6</sub>	2000... 4300 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
C <sub>2</sub> H <sub>6</sub>	mean: 853 pmol mol <sup>-1</sup>	Apr 1989	AL	Kieser et al. (1993)
C <sub>2</sub> H <sub>6</sub>	mean: 683 pmol mol <sup>-1</sup>	May 1989	AL	Kieser et al. (1993)
C <sub>2</sub> H <sub>6</sub>	mean: 288 pmol mol <sup>-1</sup>	1990–1996	sb	Clarkson et al. (1997)
C <sub>2</sub> H <sub>6</sub>	1500... 4000 pmol mol <sup>-1</sup>	win/spr 1992	AL	Jobson et al. (1994)
C <sub>2</sub> H <sub>6</sub>		Mar–Jun 1993	NA	Solberg et al. (1996b)
C <sub>2</sub> H <sub>6</sub>		Apr 1994	AL, NW	Ariya et al. (1998)
C <sub>2</sub> H <sub>6</sub>		Feb–Apr 1995	AL	Ariya et al. (1999)
C <sub>2</sub> H <sub>6</sub>	1366... 2594 pmol mol <sup>-1</sup>	Mar–May 1995	PF	Herring et al. (1997)
C <sub>2</sub> H <sub>6</sub>		1997–1998	SU	Swanson et al. (2003)
C <sub>2</sub> H <sub>6</sub>		1997–2004	SU	Dibb et al. (2007)
C <sub>2</sub> H <sub>6</sub>		Apr–May 1998	AL	Boudries and Bottenheim (2000)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
C <sub>2</sub> H <sub>6</sub>		1998, 2000	AL	Bottenheim et al. (2002a)
C <sub>2</sub> H <sub>6</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Blake et al. (2003)
C <sub>2</sub> H <sub>6</sub>		Nov–Dec 2003	sp	Eisele et al. (2008)
C <sub>2</sub> H <sub>6</sub>	mean: 186 pmol mol <sup>-1</sup>	2004–2005	ha	Read et al. (2007)
C <sub>2</sub> H <sub>6</sub>	mean: 3194 pmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)
C <sub>2</sub> H <sub>6</sub>	mean: 1.694 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
C <sub>3</sub> H <sub>8</sub>		1982, 1983	NO	Hov et al. (1984)
C <sub>3</sub> H <sub>8</sub>	mean: 70 pmol mol <sup>-1</sup>	1982–1985	nm	Rudolph et al. (1989)
C <sub>3</sub> H <sub>8</sub>		1983–1986	NA	Hov et al. (1989)
C <sub>3</sub> H <sub>8</sub>		1989–1994	NA	Solberg et al. (1996a)
C <sub>3</sub> H <sub>8</sub>	800...2200 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
C <sub>3</sub> H <sub>8</sub>	mean: 505 pmol mol <sup>-1</sup>	Apr 1989	AL	Kieser et al. (1993)
C <sub>3</sub> H <sub>8</sub>	mean: 288 pmol mol <sup>-1</sup>	May 1989	AL	Kieser et al. (1993)
C <sub>3</sub> H <sub>8</sub>	mean: 43 pmol mol <sup>-1</sup>	1990–1996	sb	Clarkson et al. (1997)
C <sub>3</sub> H <sub>8</sub>	500...3000 pmol mol <sup>-1</sup>	win/spr 1992	AL	Jobson et al. (1994)
C <sub>3</sub> H <sub>8</sub>		Mar–Jun 1993	NA	Solberg et al. (1996b)
C <sub>3</sub> H <sub>8</sub>		Apr 1994	AL, NW	Ariya et al. (1998)
C <sub>3</sub> H <sub>8</sub>		Feb–Apr 1995	AL	Ariya et al. (1999)
C <sub>3</sub> H <sub>8</sub>	188...1542 pmol mol <sup>-1</sup>	Mar–May 1995	PF	Herring et al. (1997)
C <sub>3</sub> H <sub>8</sub>		1997–1998	SU	Swanson et al. (2003)
C <sub>3</sub> H <sub>8</sub>		1997–2004	SU	Dibb et al. (2007)
C <sub>3</sub> H <sub>8</sub>		Apr–May 1998	AL	Boudries and Bottenheim (2000)
C <sub>3</sub> H <sub>8</sub>		1998, 2000	AL	Bottenheim et al. (2002a)
C <sub>3</sub> H <sub>8</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Ridley et al. (2007); Cantrell et al. (2003); Blake et al. (2003); Olson et al. (2012)
C <sub>3</sub> H <sub>8</sub>	mean: 31 pmol mol <sup>-1</sup>	2004–2005	ha	Read et al. (2007)
C <sub>3</sub> H <sub>8</sub>		2008	ARC	Olson et al. (2012)
C <sub>3</sub> H <sub>8</sub>	mean: 1841 pmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
C <sub>3</sub> H <sub>8</sub>	mean: 0.654 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		1982, 1983	NO	Hov et al. (1984)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		1983–1986	NA	Hov et al. (1989)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>	460...910 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>	mean: 167 pmol mol <sup>-1</sup>	Apr 1989	AL	Kieser et al. (1993)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>	mean: 60 pmol mol <sup>-1</sup>	May 1989	AL	Kieser et al. (1993)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		1989–1994	NA	Solberg et al. (1996a)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>	100...1500 pmol mol <sup>-1</sup>	win/spr 1992	AL	Jobson et al. (1994)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>	19.6...126.2 pmol mol <sup>-1</sup>	Apr 1992	AL	Yokouchi et al. (1994)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		Mar–Jun 1993	NA	Solberg et al. (1996b)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		Apr 1994	AL, NW	Ariya et al. (1998)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		Feb–Apr 1995	AL	Ariya et al. (1999)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>	22...912 pmol mol <sup>-1</sup>	Mar–May 1995	PF	Herring et al. (1997)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		1997–1998	SU	Swanson et al. (2003)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		Apr–May 1998	AL	Boudries and Bottenheim (2000)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		1998, 2000	AL	Bottenheim et al. (2002a)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Blake et al. (2003)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>	mean: 4.9 pmol mol <sup>-1</sup>	2004–2005	ha	Read et al. (2007)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		Mar–Apr 2005	BA	Tackett et al. (2007)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>	mean: 496 pmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)
<i>n</i> -C <sub>4</sub> H <sub>10</sub>	mean: 0.182 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>		1982, 1983	NO	Hov et al. (1984)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>		1983–1986	NA	Hov et al. (1989)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>		1989–1994	NA	Solberg et al. (1996a)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>	140...350 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>	mean: 459 pmol mol <sup>-1</sup>	Apr 1989	AL	Kieser et al. (1993)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>	mean: 344 pmol mol <sup>-1</sup>	May 1989	AL	Kieser et al. (1993)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>	100...800 pmol mol <sup>-1</sup>	win/spr 1992	AL	Jobson et al. (1994)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>		Apr 1994	AL, NW	Ariya et al. (1998)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>		Feb–Apr 1995	AL	Ariya et al. (1999)

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**Table 4:** Gas phase data (... continued).

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<i>i</i> -C <sub>4</sub> H <sub>10</sub>	12... 525 pmol mol <sup>-1</sup>	Mar–May 1995	PF	Herring et al. (1997)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>		1997–1998	SU	Swanson et al. (2003)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>		Apr–May 1998	AL	Boudries and Bottenheim (2000)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>		1998, 2000	AL	Bottenheim et al. (2002a)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>	mean: 3.2 pmol mol <sup>-1</sup>	2004–2005	ha	Read et al. (2007)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>	mean: 288 pmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)
<i>i</i> -C <sub>4</sub> H <sub>10</sub>	mean: 0.106 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
<i>n</i> -C <sub>5</sub> H <sub>12</sub>	140... 330 pmol mol <sup>-1</sup> 20... 600 pmol mol <sup>-1</sup>	1982, 1983	NO	Hov et al. (1984)
<i>n</i> -C <sub>5</sub> H <sub>12</sub>		1983–1986	NA	Hov et al. (1989)
<i>n</i> -C <sub>5</sub> H <sub>12</sub>		1989–1994	NA	Solberg et al. (1996a)
<i>n</i> -C <sub>5</sub> H <sub>12</sub>		Mar 1989	BA	Doskey and Gaffney (1992)
<i>n</i> -C <sub>5</sub> H <sub>12</sub>		win/spr 1992	AL	Jobson et al. (1994)
<i>n</i> -C <sub>5</sub> H <sub>12</sub>		Apr 1994	AL, NW	Ariya et al. (1998)
<i>n</i> -C <sub>5</sub> H <sub>12</sub>		Feb–Apr 1995	AL	Ariya et al. (1999)
<i>n</i> -C <sub>5</sub> H <sub>12</sub>		Apr–May 1998	AL	Boudries and Bottenheim (2000)
<i>n</i> -C <sub>5</sub> H <sub>12</sub>		1998, 2000	AL	Bottenheim et al. (2002a)
<i>n</i> -C <sub>5</sub> H <sub>12</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003)
<i>n</i> -C <sub>5</sub> H <sub>12</sub>	mean: 0.051 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
<i>i</i> -C <sub>5</sub> H <sub>12</sub>	76... 220 pmol mol <sup>-1</sup> 20... 600 pmol mol <sup>-1</sup> 7.2... 50.3 pmol mol <sup>-1</sup>	1982, 1983	NO	Hov et al. (1984)
<i>i</i> -C <sub>5</sub> H <sub>12</sub>		1983–1986	NA	Hov et al. (1989)
<i>i</i> -C <sub>5</sub> H <sub>12</sub>		1989–1994	NA	Solberg et al. (1996a)
<i>i</i> -C <sub>5</sub> H <sub>12</sub>		Mar 1989	BA	Doskey and Gaffney (1992)
<i>i</i> -C <sub>5</sub> H <sub>12</sub>		win/spr 1992	AL	Jobson et al. (1994)
<i>i</i> -C <sub>5</sub> H <sub>12</sub>		Apr 1992	AL	Yokouchi et al. (1994)
<i>i</i> -C <sub>5</sub> H <sub>12</sub>		Apr 1994	AL, NW	Ariya et al. (1998)
<i>i</i> -C <sub>5</sub> H <sub>12</sub>		Feb–Apr 1995	AL	Ariya et al. (1999)
<i>i</i> -C <sub>5</sub> H <sub>12</sub>		Apr–May 1998	AL	Boudries and Bottenheim (2000)
<i>i</i> -C <sub>5</sub> H <sub>12</sub>		1998, 2000	AL	Bottenheim et al. (2002a)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
<i>i</i> -C <sub>5</sub> H <sub>12</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003)
<i>i</i> -C <sub>5</sub> H <sub>12</sub>	mean: 0.056 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
dimethylpropane		1983–1986	NA	Hov et al. (1989)
<i>n</i> -C <sub>6</sub> H <sub>14</sub>		1982, 1983	NO	Hov et al. (1984)
<i>n</i> -C <sub>6</sub> H <sub>14</sub>		1983–1986	NA	Hov et al. (1989)
<i>n</i> -C <sub>6</sub> H <sub>14</sub>	35... 139 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
<i>n</i> -C <sub>6</sub> H <sub>14</sub>	7... 200 pmol mol <sup>-1</sup>	win/spr 1992	AL	Jobson et al. (1994)
<i>n</i> -C <sub>6</sub> H <sub>14</sub>		Apr 1994	AL, NW	Ariya et al. (1998)
<i>n</i> -C <sub>6</sub> H <sub>14</sub>		Feb–Apr 1995	AL	Ariya et al. (1999)
<i>n</i> -C <sub>6</sub> H <sub>14</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003)
<i>n</i> -C <sub>6</sub> H <sub>14</sub>	mean: 0.011 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
2-methylpentane		1982, 1983	NO	Hov et al. (1984)
2-methylpentane		1983–1986	NA	Hov et al. (1989)
2-methylpentane	7... 200 pmol mol <sup>-1</sup>	win/spr 1992	AL	Jobson et al. (1994)
2-methylpentane		Apr 1994	AL, NW	Ariya et al. (1998)
2-methylpentane		Feb–Apr 1995	AL	Ariya et al. (1999)
3-methylpentane		1982, 1983	NO	Hov et al. (1984)
3-methylpentane		1983–1986	NA	Hov et al. (1989)
3-methylpentane	42... 98 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
3-methylpentane		Apr 1994	AL, NW	Ariya et al. (1998)
3-methylpentane		Feb–Apr 1995	AL	Ariya et al. (1999)
2,2-dimethylbutane		1983–1986	NA	Hov et al. (1989)
2,2-dimethylbutane	<2... 82 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
cyclohexane		1982, 1983	NO	Hov et al. (1984)
methylcyclopentane	23... 60 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
<i>n</i> -C <sub>7</sub> H <sub>16</sub>	14... 50 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
<i>n</i> -C <sub>7</sub> H <sub>16</sub>		Apr 1994	AL, NW	Ariya et al. (1998)
<i>n</i> -C <sub>7</sub> H <sub>16</sub>		Feb–Apr 1995	AL	Ariya et al. (1999)
methylhexane	24... 60 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)

### Organic: C, H (unsaturated)

C <sub>2</sub> H <sub>4</sub>	mean: 360 pmol mol <sup>-1</sup>	1982–1985	nm	Rudolph et al. (1989)
C <sub>2</sub> H <sub>4</sub>		1982, 1983	NO	Hov et al. (1984)
C <sub>2</sub> H <sub>4</sub>		1983–1986	NA	Hov et al. (1989)
C <sub>2</sub> H <sub>4</sub>		1989–1994	NA	Solberg et al. (1996a)
C <sub>2</sub> H <sub>4</sub>	330... 1000 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
C <sub>2</sub> H <sub>4</sub>	mean: 40 pmol mol <sup>-1</sup>	Apr 1989	AL	Kieser et al. (1993)
C <sub>2</sub> H <sub>4</sub>	0... 1000 pmol mol <sup>-1</sup>	win/spr 1992	AL	Jobson et al. (1994)
C <sub>2</sub> H <sub>4</sub>		Mar–Jun 1993	NA	Solberg et al. (1996b)
C <sub>2</sub> H <sub>4</sub>	23... 509 pmol mol <sup>-1</sup>	Mar–May 1995	PF	Herring et al. (1997)
C <sub>2</sub> H <sub>4</sub>	mean: 26 pmol mol <sup>-1</sup>	Mar–May 1996	NA	Ramacher et al. (1999)
C <sub>2</sub> H <sub>4</sub>		1998, 2000	AL	Bottenheim et al. (2002a)
C <sub>2</sub> H <sub>4</sub>		Feb–May 2000	ARC	Olson et al. (2012)
C <sub>2</sub> H <sub>4</sub>		2008	ARC	Olson et al. (2012)
C <sub>2</sub> H <sub>4</sub>	mean: 245 pmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)
C <sub>3</sub> H <sub>6</sub>		1982, 1983	NO	Hov et al. (1984)
C <sub>3</sub> H <sub>6</sub>	mean: 210 pmol mol <sup>-1</sup>	1982–1985	nm	Rudolph et al. (1989)
C <sub>3</sub> H <sub>6</sub>		1983–1986	NA	Hov et al. (1989)
C <sub>3</sub> H <sub>6</sub>		1989–1994	NA	Solberg et al. (1996a)
C <sub>3</sub> H <sub>6</sub>	160... 330 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
C <sub>3</sub> H <sub>6</sub>	mean: 94 pmol mol <sup>-1</sup>	Apr 1989	AL	Kieser et al. (1993)
C <sub>3</sub> H <sub>6</sub>	mean: 117 pmol mol <sup>-1</sup>	May 1989	AL	Kieser et al. (1993)
C <sub>3</sub> H <sub>6</sub>	18... 169 pmol mol <sup>-1</sup>	Mar–May 1995	PF	Herring et al. (1997)
C <sub>3</sub> H <sub>6</sub>	mean: 216 pmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)
1-butene	mean: 34 pmol mol <sup>-1</sup>	Apr 1989	AL	Kieser et al. (1993)
1-butene	mean: 30 pmol mol <sup>-1</sup>	May 1989	AL	Kieser et al. (1993)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
cis-2-butene		1983–1986	NA	Hov et al. (1989)
trans-2-butene		1983–1986	NA	Hov et al. (1989)
isobutene		1983–1986	NA	Hov et al. (1989)
isobutene	mean: 77 pmol mol <sup>-1</sup>	Apr 1989	AL	Kieser et al. (1993)
isobutene	mean: 115 pmol mol <sup>-1</sup>	May 1989	AL	Kieser et al. (1993)
C <sub>2</sub> H <sub>2</sub>		1982, 1983	NO	Hov et al. (1984)
C <sub>2</sub> H <sub>2</sub>	mean: 11 pmol mol <sup>-1</sup>	1982–1985	nm	Rudolph et al. (1989)
C <sub>2</sub> H <sub>2</sub>		1983–1986	NA	Hov et al. (1989)
C <sub>2</sub> H <sub>2</sub>		1989–1994	NA	Solberg et al. (1996a)
C <sub>2</sub> H <sub>2</sub>	900... 1800 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
C <sub>2</sub> H <sub>2</sub>	mean: 53 pmol mol <sup>-1</sup>	Apr 1989	AL	Kieser et al. (1993)
C <sub>2</sub> H <sub>2</sub>	mean: 80 pmol mol <sup>-1</sup>	May 1989	AL	Kieser et al. (1993)
C <sub>2</sub> H <sub>2</sub>		1992–1999	NA	Albrecht et al. (2002)
C <sub>2</sub> H <sub>2</sub>	seasonal cycle	1992–2001	NA	Eneroth et al. (2007)
C <sub>2</sub> H <sub>2</sub>	0... 1600 pmol mol <sup>-1</sup>	win/spr 1992	AL	Jobson et al. (1994)
C <sub>2</sub> H <sub>2</sub>		Mar–Jun 1993	NA	Solberg et al. (1996b)
C <sub>2</sub> H <sub>2</sub>	bgr.: 123.0... 939.0 pmol mol <sup>-1</sup>	Feb–May 1994	NA	Beine et al. (1997b)
C <sub>2</sub> H <sub>2</sub>		Apr 1994	AL, NW	Ariya et al. (1998)
C <sub>2</sub> H <sub>2</sub>		Feb–Apr 1995	AL	Ariya et al. (1999)
C <sub>2</sub> H <sub>2</sub>	190... 1080 pmol mol <sup>-1</sup>	Mar–May 1995	PF	Herring et al. (1997)
C <sub>2</sub> H <sub>2</sub>	mean: 329 pmol mol <sup>-1</sup>	Mar–May 1996	NA	Ramacher et al. (1999)
C <sub>2</sub> H <sub>2</sub>		1997–1998	SU	Swanson et al. (2003)
C <sub>2</sub> H <sub>2</sub>		1997–2004	SU	Dibb et al. (2007)
C <sub>2</sub> H <sub>2</sub>		Apr–May 1998	AL	Boudries and Bottenheim (2000)
C <sub>2</sub> H <sub>2</sub>		1998, 2000	AL	Bottenheim et al. (2002a)
C <sub>2</sub> H <sub>2</sub>		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Ridley et al. (2007); Blake et al. (2003); Wang et al. (2003)
C <sub>2</sub> H <sub>2</sub>	mean: 19 pmol mol <sup>-1</sup>	2004–2005	ha	Read et al. (2007)
C <sub>2</sub> H <sub>2</sub>	mean: 917 pmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
C <sub>2</sub> H <sub>2</sub>	mean: 0.365 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
C <sub>3</sub> H <sub>4</sub>		1983–1986	NA	Hov et al. (1989)
isoprene	0.6 ... 7.3 pmol mol <sup>-1</sup>	Jan 1992	AL	Yokouchi et al. (1994)
isoprene	0.6 ... 10.3 pmol mol <sup>-1</sup>	Apr 1992	AL	Yokouchi et al. (1994)
benzene		1982, 1983	NO	Hov et al. (1984)
benzene	390 ... 470 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
benzene	200 ... 400 pmol mol <sup>-1</sup>	win/spr 1992	AL	Jobson et al. (1994)
benzene		Mar–Jun 1993	NA	Solberg et al. (1996b)
benzene		Apr 1994	AL, NW	Ariya et al. (1998)
benzene		Feb–Apr 1995	AL	Ariya et al. (1999)
benzene		1997–2004	SU	Dibb et al. (2007)
benzene		Feb–May 2000	AL	Boudries et al. (2002)
benzene		Feb–May 2000	ARC	Blake et al. (2003)
benzene	mean: 0.097 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
benzene	mean: 12 pmol mol <sup>-1</sup>	Aug–Sep 2008	ARC	Sjostedt et al. (2012)
benzene		Apr 2009	BA	Gao et al. (2012)
toluene		1982, 1983	NO	Hov et al. (1984)
toluene	23 ... 150 pmol mol <sup>-1</sup>	Mar 1989	BA	Doskey and Gaffney (1992)
toluene		Apr 1994	AL, NW	Ariya et al. (1998)
toluene		Feb–Apr 1995	AL	Ariya et al. (1999)
toluene	mean: 4 pmol mol <sup>-1</sup>	Aug–Sep 2008	ARC	Sjostedt et al. (2012)
total NMHC	5.6 ... 15.7 nmol C mol <sup>-1</sup>	Mar–May 1993	PF	Beine et al. (1996b)

### Organic: C, H, O

CH <sub>3</sub> OH		Feb–May 2000	AL	Boudries et al. (2002)
CH <sub>3</sub> OH	see note <sup>5</sup>	Feb–May 2000	ARC	Jacob et al. (2005)

<sup>5</sup> Unpublished data from TOPSE.

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
CH <sub>3</sub> OH	see note <sup>6</sup>	Jul–Aug 2001	ARC	Jacob et al. (2005)
CH <sub>3</sub> OH		Aug–Sep 2008	ARC	Sjostedt et al. (2012)
CH <sub>3</sub> OH		Apr 2009	BA	Gao et al. (2012)
C <sub>2</sub> H <sub>5</sub> OH		Feb–May 2000	AL	Boudries et al. (2002)
HCHO	≤ 39 pmol mol <sup>-1</sup>	spr 1988	AL	Bottenheim et al. (1990)
HCHO		1989–1994	NA	Solberg et al. (1996a)
HCHO	100... 700 pmol mol <sup>-1</sup>	win 1992	AL	de Serves (1994)
HCHO	30... 600 pmol mol <sup>-1</sup>	spr 1992	AL	de Serves (1994)
HCHO		1992–1999	NA	Albrecht et al. (2002)
HCHO	0.2... 0.3 nmol mol <sup>-1</sup>	1993–1994	ant	Fuhrer et al. (1996)
HCHO	mean: 0.3 nmol mol <sup>-1</sup>	1993–1994	SU	Fuhrer et al. (1996)
HCHO	mean: 193 pmol mol <sup>-1</sup>	Apr 1994	AL	Shepson et al. (1996)
HCHO	mean: 0.23 nmol mol <sup>-1</sup>	Jun 1996	SU	Hutterli et al. (1999)
HCHO	0.03... 0.7 nmol mol <sup>-1</sup>	1997–1999	nm	Riedel et al. (1999)
HCHO	78... 372 pmol mol <sup>-1</sup>	Feb 1998	AL	Sumner and Shepson (1999)
HCHO	52... 690 pmol mol <sup>-1</sup>	Apr 1998	AL	Sumner and Shepson (1999)
HCHO		1998, 2000	AL	Sumner et al. (2002)
HCHO	0.74 nmol mol <sup>-1</sup>	sum 1999	SU	Yang et al. (2002)
HCHO	mean: 103 pmol mol <sup>-1</sup>	Dec 2000	sp	Hutterli et al. (2004)
HCHO	166 pmol mol <sup>-1</sup>	2000	AL	Grannas et al. (2002)
HCHO		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Fried et al. (2003); Wang et al. (2003); Olson et al. (2012)
HCHO	30... 420 pmol mol <sup>-1</sup>	Jun–Jul 2000	SU	Jacobi et al. (2002)
HCHO	mean: 121 pmol mol <sup>-1</sup>	Dec 2002	by	Frey et al. (2005)
HCHO	mean: 154 pmol mol <sup>-1</sup>	Dec 2002	ant	Frey et al. (2005)
HCHO		Nov–Dec 2003	sp	Eisele et al. (2008)

<sup>6</sup> Unpublished data from AOE-2001.

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
HCHO	more than 600 pmol mol <sup>-1</sup> , see note <sup>7</sup>	2003–2005	NA	Wittrock (2006)
HCHO	mean: 127 pmol mol <sup>-1</sup>	2004–2005	ha	Salmon et al. (2008); Bloss et al. (2010)
HCHO		2008	ARC	Olson et al. (2012)
HCHO	mean: 363 pmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)
HCHO		Mar–Apr 2009	BA	Barret et al. (2011)
HCHO		Apr 2009	BA	Gao et al. (2012)
HCHO	70... 500 pmol mol <sup>-1</sup>	2010–2011	du	Preunkert et al. (2012)
CH <sub>3</sub> CHO	65 pmol mol <sup>-1</sup>	spr 1988	AL	Bottenheim et al. (1990)
CH <sub>3</sub> CHO		1989–1994	NA	Solberg et al. (1996a)
CH <sub>3</sub> CHO	mean: 93 pmol mol <sup>-1</sup>	Apr 1994	AL	Shepson et al. (1996)
CH <sub>3</sub> CHO	53 pmol mol <sup>-1</sup>	2000	AL	Grannas et al. (2002)
CH <sub>3</sub> CHO		Feb–May 2000	AL	Boudries et al. (2002)
CH <sub>3</sub> CHO		Mar–May 2000	AL	Guimbaud et al. (2002)
CH <sub>3</sub> CHO	mean: 0.065 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
CH <sub>3</sub> CHO	bgr.: 80 pmol mol <sup>-1</sup>	Jan 2011	du	Legrand et al. (2012)
C <sub>2</sub> H <sub>5</sub> CHO		Feb–May 2000	AL	Boudries et al. (2002)
C <sub>2</sub> H <sub>5</sub> CHO	mean: 0.029 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
C <sub>3</sub> H <sub>7</sub> CHO		Feb–May 2000	AL	Boudries et al. (2002)
C <sub>3</sub> H <sub>7</sub> CHO	mean: 0.013 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
CH <sub>3</sub> COCH <sub>3</sub>	393 pmol mol <sup>-1</sup>	spr 1988	AL	Bottenheim et al. (1990)
CH <sub>3</sub> COCH <sub>3</sub>		1989–1994	NA	Solberg et al. (1996a)
CH <sub>3</sub> COCH <sub>3</sub>	901... 1585 pmol mol <sup>-1</sup>	Apr 1992	AL	Yokouchi et al. (1994)
CH <sub>3</sub> COCH <sub>3</sub>	mean: 1730 pmol mol <sup>-1</sup>	Apr 1994	AL	Shepson et al. (1996)
CH <sub>3</sub> COCH <sub>3</sub>	385 pmol mol <sup>-1</sup>	2000	AL	Grannas et al. (2002)
CH <sub>3</sub> COCH <sub>3</sub>		Feb–May 2000	AL	Boudries et al. (2002)
CH <sub>3</sub> COCH <sub>3</sub>		Mar–May 2000	AL	Guimbaud et al. (2002)
CH <sub>3</sub> COCH <sub>3</sub>		Mar–Apr 2005	BA	Tackett et al. (2007)
CH <sub>3</sub> COCH <sub>3</sub>	mean: 0.476 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)

<sup>7</sup>Maximum values in May and June of each year.

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
CH <sub>3</sub> COCH <sub>3</sub>		Aug–Sep 2008	ARC	Sjostedt et al. (2012)
CH <sub>3</sub> COCH <sub>3</sub>		Apr 2009	BA	Gao et al. (2012)
CH <sub>3</sub> COCH <sub>3</sub>	bgr.: 128 pmol mol <sup>-1</sup>	Jan 2011	du	Legrand et al. (2012)
C <sub>2</sub> H <sub>5</sub> COCH <sub>3</sub>		Feb–May 2000	AL	Boudries et al. (2002)
C <sub>2</sub> H <sub>5</sub> COCH <sub>3</sub>		Mar–Apr 2005	BA	Tackett et al. (2007)
C <sub>2</sub> H <sub>5</sub> COCH <sub>3</sub>	mean: 0.070 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
HCOOH	mean: 49 nmol m <sup>-3</sup> (STP)	Jun–Jul 1993	SU	Dibb et al. (1994)
HCOOH		1994–1995	SU	Dibb et al. (1998)
HCOOH	monthly mean: 60...311 pmol mol <sup>-1</sup>	1997–2002	du	Legrand et al. (2004)
HCOOH		Jun 2000	SU	Jacobi et al. (2004)
HCOOH	mean: 159 pmol mol <sup>-1</sup>	Dec 2000	SU	Dibb and Arsenaault (2002)
HCOOH	mean: 460 pmol mol <sup>-1</sup>	Jun–Jul 2000	SU	Dibb and Arsenaault (2002)
HCOOH		Nov–Dec 2003	sp	Eisele et al. (2008)
HCOOH	monthly mean: 9...109 pmol mol <sup>-1</sup>	2005–2010	du	Legrand et al. (2012)
HCOOH		Apr 2009	BA	Gao et al. (2012)
HCOOH	monthly mean: 3...143 pmol mol <sup>-1</sup>	2009–2011	co	Legrand et al. (2012)
CH <sub>3</sub> COOH	mean: 32 nmol m <sup>-3</sup> (STP)	Jun–Jul 1993	SU	Dibb et al. (1994)
CH <sub>3</sub> COOH		1994–1995	SU	Dibb et al. (1998)
CH <sub>3</sub> COOH	monthly mean: 52...698 pmol mol <sup>-1</sup>	1997–2002	du	Legrand et al. (2004)
CH <sub>3</sub> COOH		Jun 2000	SU	Jacobi et al. (2004)
CH <sub>3</sub> COOH	mean: 310 pmol mol <sup>-1</sup>	Dec 2000	sp	Dibb and Arsenaault (2002)
CH <sub>3</sub> COOH	mean: 445 pmol mol <sup>-1</sup>	Jun–Jul 2000	SU	Dibb and Arsenaault (2002)
CH <sub>3</sub> COOH		Nov–Dec 2003	sp	Eisele et al. (2008)
CH <sub>3</sub> COOH	monthly mean: 10...717 pmol mol <sup>-1</sup>	2005–2010	du	Legrand et al. (2012)
CH <sub>3</sub> COOH		Apr 2009	BA	Gao et al. (2012)
CH <sub>3</sub> COOH	monthly mean: 3...70 pmol mol <sup>-1</sup>	2009–2011	co	Legrand et al. (2012)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
CH <sub>3</sub> OOH	<DL... 0.89 nmol mol <sup>-1</sup>	1997–1999	nm	Riedel et al. (2000)
CH <sub>3</sub> OOH		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Wang et al. (2003); Olson et al. (2012)
CH <sub>3</sub> OOH	mean: 317 pmol mol <sup>-1</sup>	Dec 2001	ant	Frey et al. (2005)
CH <sub>3</sub> OOH	mean: 426 pmol mol <sup>-1</sup>	Dec 2002	by	Frey et al. (2005)
CH <sub>3</sub> OOH	mean: 102 pmol mol <sup>-1</sup>	Jan 2003	sp	Frey et al. (2005)
CH <sub>3</sub> OOH		2008	ARC	Olson et al. (2012)
CH <sub>3</sub> OOH	75... 550 pmol mol <sup>-1</sup>	2010–2011	du	Preunkert et al. (2012)
ROOH+H <sub>2</sub> O <sub>2</sub>	10... 40 pmol mol <sup>-1</sup>	win 1992	AL	Yokouchi et al. (1994)
ROOH+H <sub>2</sub> O <sub>2</sub>	100... 400 pmol mol <sup>-1</sup>	spr 1992	AL	Yokouchi et al. (1994)
ROOH+H <sub>2</sub> O <sub>2</sub>	mean: 3.3 × 10 <sup>8</sup> cm <sup>-3</sup>	2010–2011	du	Kukui et al. (2012)
RO <sub>2</sub>		Feb–May 2000	ARC	Cantrell et al. (2003); Ridley et al. (2003); Evans et al. (2003); Ridley et al. (2007); Wang et al. (2003)
RO <sub>2</sub> +HO <sub>2</sub>		2000	sp	Mauldin III et al. (2004)
RO <sub>2</sub> +HO <sub>2</sub>	median: 2.2 × 10 <sup>8</sup> cm <sup>-3</sup>	2003	SU	Sjostedt et al. (2008)
RO <sub>2</sub> +HO <sub>2</sub>		Nov–Dec 2003	sp	Eisele et al. (2008)
RO <sub>2</sub> +HO <sub>2</sub>		2007, 2008	SU	Liao et al. (2011a)
CO		1980–1982	BA	Khalil and Rasmussen (1983)
CO	mean: 131 nmol mol <sup>-1</sup>	1988–1989	DY	Davidson et al. (1993b,a)
CO	52.3... 302.0 nmol mol <sup>-1</sup>	1992–1993	NA	Beine (1999)
CO	89... 216 nmol mol <sup>-1</sup>	Mar–May 1995	PF	Herring et al. (1997)
CO		1997–2005	SU	Dibb et al. (2007)
CO	90 nmol mol <sup>-1</sup>	sum 1999	SU	Yang et al. (2002)
CO	110 nmol mol <sup>-1</sup>	sum 2000	SU	Yang et al. (2002)
CO		Feb–Mar 2000	AL	Bottenheim et al. (2002b)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
CO		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Ridley et al. (2007); Cantrell et al. (2003); Wang et al. (2003); Olson et al. (2012)
CO		Nov–Dec 2003	sp	Eisele et al. (2008)
CO	mean: 34.4 nmol mol <sup>-1</sup>	2004–2005	ha	Bloss et al. (2010)
CO		2004–2005	ha	Jones et al. (2008)
CO	mean: 84.4 nmol mol <sup>-1</sup>	Jul–Sep 2005	ARC	Sommar et al. (2010)
CO		Apr 2007	ARC	Prados-Roman et al. (2011)
CO		2007	tr	Hansen et al. (2009)
CO		2008	ARC	Olson et al. (2012)
CO	mean: 169 nmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)
CO		Mar–Apr 2008	ARC	Gilman et al. (2010)
CO	mean: 144 nmol mol <sup>-1</sup>	Apr 2008	ARC	Liang et al. (2011); Pommier et al. (2010); Dupont et al. (2012)
CO	mean: 103 nmol mol <sup>-1</sup>	Jun–Jul 2008	ARC	Liang et al. (2011); Pommier et al. (2010)
CO	33... 50 nmol mol <sup>-1</sup>	2011	du	Preunkert et al. (2012)

### Organic: C, H, O, N

CH <sub>3</sub> CN		Apr, Jun 2008	ARC	Corr et al. (2012)
CH <sub>3</sub> CN		Aug–Sep 2008	ARC	Sjostedt et al. (2012)
PAN	189... 234 pmol mol <sup>-1</sup>	Mar 1985	AL	Bottenheim et al. (1986)
PAN	200... 500 pmol mol <sup>-1</sup>	spr 1988	AL	Barrie and Delmas (1994)
PAN		Mar–Apr 1988	AL	Bottenheim et al. (1993)
PAN	150... 600 pmol mol <sup>-1</sup>	win/spr 1992	AL	Barrie et al. (1994a)
PAN	27... 371 pmol mol <sup>-1</sup>	Mar–May 1993	PF	Beine et al. (1996b)
PAN		Mar–Jun 1994	ARC	Jaeschke et al. (1997)
PAN	69.0... 729.0 pmol mol <sup>-1</sup>	Feb–May 1994	NA	Beine et al. (1997a)
PAN	19.7... 1608.2 pmol mol <sup>-1</sup>	1994–1996	NA	Beine and Krognés (2000)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
PAN	bgr.: 2.9 ... 739.0 pmol mol <sup>-1</sup>	Mar–May 1995	PF	Beine et al. (1997a)
PAN	100. ... 420 pmol mol <sup>-1</sup>	Mar 1998	NA	Jacobi et al. (1999)
PAN		1998–1999	SU	Ford et al. (2002)
PAN		1998–1999	SU	Dassau et al. (2004)
PAN		1998,2000	AL	Dassau et al. (2004)
PAN	<5. ... 47.9 pmol mol <sup>-1</sup>	Feb 1999	nm	Jacobi et al. (2000)
PAN	mean: 18 pmol mol <sup>-1</sup>	Mar 1999	ant	Jacobi and Schrems (1999)
PAN		Feb–May 2000	ARC	Ridley et al. (2003); Evans et al. (2003); Wang et al. (2003)
PAN		Nov–Dec 2003	sp	Eisele et al. (2008)
PAN	<0.6. ... 52.3 pmol mol <sup>-1</sup>	2004–2005	ha	Mills et al. (2007); Jones et al. (2011)
PAN	mean: 205 pmol mol <sup>-1</sup>	Apr 2008	ARC	Liang et al. (2011); Dupont et al. (2012)
PAN	mean: 210 pmol mol <sup>-1</sup>	Jun–Jul 2008	ARC	Liang et al. (2011)
PPN	mean: 26 pmol mol <sup>-1</sup>	Feb–May 1994	NA	Solberg et al. (1997a)
methyl nitrate	mean: 10 pmol mol <sup>-1</sup>	Jan–Mar 1997	nm	Jones et al. (1999); Weller et al. (2002)
methyl nitrate		1997–1998	SU	Swanson et al. (2003)
methyl nitrate		1997–2004	SU	Dibb et al. (2007)
methyl nitrate	mean: 9.5 pmol mol <sup>-1</sup>	Feb 1999	nm	Weller et al. (2002)
methyl nitrate	mean: 84 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
methyl nitrate		2000	sp	Swanson et al. (2004)
methyl nitrate		Feb–May 2000	ARC	Blake et al. (2003)
methyl nitrate		2004–2005	ha	Jones et al. (2011)
ethyl nitrate	mean: 3 pmol mol <sup>-1</sup>	Jan–Mar 1997	nm	Jones et al. (1999); Weller et al. (2002)
ethyl nitrate		1997–1998	SU	Swanson et al. (2003)
ethyl nitrate		1997–2004	SU	Dibb et al. (2007)
ethyl nitrate	mean: 2.3 pmol mol <sup>-1</sup>	Feb 1999	nm	Weller et al. (2002)
ethyl nitrate	mean: 4.6 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
ethyl nitrate		2000	sp	Swanson et al. (2004)

**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
ethyl nitrate		Feb–May 2000	ARC	Blake et al. (2003)
ethyl nitrate		2004–2005	ha	Jones et al. (2011)
1-propyl nitrate	3.14...3.33 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
1-propyl nitrate		1997–1998	SU	Swanson et al. (2003)
1-propyl nitrate	mean: 1.1 pmol mol <sup>-1</sup>	Feb 1999	nm	Weller et al. (2002)
1-propyl nitrate	mean: 1.1 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
1-propyl nitrate		2004–2005	ha	Jones et al. (2011)
2-propyl nitrate	12.44...13.08 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
2-propyl nitrate		1997–1998	SU	Swanson et al. (2003)
2-propyl nitrate		1997–2004	SU	Dibb et al. (2007)
2-propyl nitrate	mean: 1.2 pmol mol <sup>-1</sup>	Feb 1999	nm	Weller et al. (2002)
2-propyl nitrate	mean: 0.7 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
2-propyl nitrate		2000	sp	Swanson et al. (2004)
2-propyl nitrate		Feb–May 2000	ARC	Blake et al. (2003)
2-propyl nitrate		2004–2005	ha	Jones et al. (2011)
1-butyl nitrate	1.18...1.7 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
1-butyl nitrate	mean: 0.03 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
2-butyl nitrate	13.73...18.41 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
2-butyl nitrate		1997–1998	SU	Swanson et al. (2003)
2-butyl nitrate		1997–2004	SU	Dibb et al. (2007)
2-butyl nitrate	mean: 0.5 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
2-butyl nitrate		Feb–May 2000	ARC	Blake et al. (2003)
1-pentyl nitrate	0.53...1.01 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
1-pentyl nitrate	mean: 0.7 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
2-pentyl nitrate	2.47...5.44 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
2-pentyl nitrate	mean below DL	Feb 1999	nm	Fischer et al. (2002)
3-pentyl nitrate	2.31...4.31 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
3-pentyl nitrate	mean: 0.03 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
2-methyl-1-butyl nitrate	0.39...0.77 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
3-methyl-1-butyl nitrate	0.30... 0.55 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
3-methyl-2-butyl nitrate	2.32... 4.84 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
1-hexyl nitrate	mean: 0.5 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
2-hexyl nitrate	0.98... 2.46 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
2-hexyl nitrate	mean: 1.0 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
3-hexyl nitrate	1.65... 4.27 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
3-hexyl nitrate	mean: 0.08 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
2-heptyl nitrate	0.56... 1.45 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
2-heptyl nitrate	mean: 0.18 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
3-heptyl nitrate	0.68... 1.86 pmol mol <sup>-1</sup>	Jan–Apr 1992	AL	Muthuramu et al. (1994)
4-heptyl nitrate	mean: 0.02 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
alkyl nitrates	11... 66 pmol mol <sup>-1</sup>	Mar–May 1993	PF	Beine et al. (1996b)
organic nitrates		Mar–Apr 1988	AL	Bottenheim et al. (1993)
organic nitrates	0... 2828.0 pmol mol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
organic nitrates	mean: 1038.8 ng m <sup>-3</sup>	Apr–May 2000	AL	Ianniello et al. (2002)
organic nitrates	mean: 309 ng m <sup>-3</sup>	Feb 2000	AL	Ianniello et al. (2002)
hydroxy nitrates	mean: 1.1 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
organic dinitrates	mean: 4.6 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
alkyl nitrates	mean: 20 pmol mol <sup>-1</sup>	Jun–Jul 2008	ARC	Liang et al. (2011)

### Fluorine (CFCs)

CFC <sub>3</sub> (F11)		1980–1982	BA	Khalil and Rasmussen (1983)
CFC <sub>3</sub> (F11)		1982, 1983	NO	Hov et al. (1984)
CFC <sub>3</sub> (F11)	mean: 285 pmol mol <sup>-1</sup>	1988–1989	DY	Davidson et al. (1993b,a)

**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
CF <sub>2</sub> Cl <sub>2</sub> (F12)		1980–1982	BA	Khalil and Rasmussen (1983)
CF <sub>2</sub> Cl <sub>2</sub> (F12)		1982, 1983	NO	Hov et al. (1984)
CF <sub>2</sub> Cl <sub>2</sub> (F12)	mean: 465 pmol mol <sup>-1</sup>	1988–1989	DY	Davidson et al. (1993b,a)
C <sub>2</sub> F <sub>3</sub> Cl <sub>3</sub> (F113)		1982, 1983	NO	Hov et al. (1984)
C <sub>2</sub> F <sub>3</sub> Cl <sub>3</sub> (F113)	mean: 44.6 pmol mol <sup>-1</sup>	1988–1989	DY	Davidson et al. (1993b,a)
C <sub>2</sub> F <sub>4</sub> Cl <sub>2</sub> (F114)		1982, 1983	NO	Hov et al. (1984)
CHF <sub>2</sub> Cl		1980–1982	BA	Khalil and Rasmussen (1983)

### Chlorine (inorganic)

inorg–Cl	0...500 pmol mol <sup>-1</sup>	win/spr 1992	AL	Barrie et al. (1994a)
photolyzable Cl	<9...100 pmol mol <sup>-1</sup>	Feb–Apr 1995	AL	Impey et al. (1997)
photolyzable Cl		Mar–Apr 1997	AL	Impey et al. (1999)
gaseous Cl		1996–1999	NA	Hara et al. (2002a)
gaseous Cl	annual mean: 1.20 nmol m <sup>-3</sup>	1997–1998	sy	Hara et al. (2004)
gaseous Cl		Mar–Apr 2000	NA	Hara et al. (2002b)
HCl	0...303.6 pmol mol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
HCl	mean: 11.3 ng m <sup>-3</sup>	Feb 2000	AL	Ianniello et al. (2002)
HCl	mean: 32.7 ng m <sup>-3</sup>	Apr–May 2000	AL	Ianniello et al. (2002)
HCl		2000–2001	du	Jourdain and Legrand (2002)
HCl	see note <sup>8</sup>	Apr–May 2003	NA	Ianniello et al. (2007)
Cl atoms	3.9×10 <sup>3</sup> ...7.7×10 <sup>4</sup> cm <sup>-3</sup>	spr 1992	AL	Jobson et al. (1994)
Cl atoms	3.8×10 <sup>3</sup> ...1.0×10 <sup>4</sup> cm <sup>-3</sup>	spr 1992	AL	Muthuramu et al. (1994)
Cl atoms	4.5×10 <sup>3</sup> cm <sup>-3</sup>	spr 1994	NW	Ariya et al. (1998)
Cl atoms	7.5×10 <sup>4</sup> cm <sup>-3</sup>	Apr–May 1998	AL	Boudries and Bottenheim (2000)

<sup>8</sup> Means from denuder comparison: 55.6 and 123.6 ng m<sup>-3</sup>.

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
Cl atoms	$1.7 \times 10^3 \dots 3.4 \times 10^4 \text{ cm}^{-3}$	2004–2005	ha	Read et al. (2007)
Cl atoms	up to $4 \times 10^5 \text{ cm}^{-3}$	Mar 2009	BA	Stephens et al. (2012)
ClO		1995, 1996	NA	Tuckermann et al. (1997)
ClO	below DL	Mar–Apr 2008	AG	Pöhler et al. (2010)
OCIO	SCD	1995	mm	Kreher et al. (1997)
OCIO		Jan–May 1995	KA	Miller et al. (1997)
OCIO	up to $24 \text{ pmol mol}^{-1}$	Mar–Apr 2008	AG	Pöhler et al. (2010)
Cl <sub>2</sub>	below DL of $2 \text{ pmol mol}^{-1}$	Feb–Mar 2000	AL	Foster et al. (2001); Spicer et al. (2002)

### Chlorine (organic)

org–Cl	$1200 \dots 3400 \text{ pmol mol}^{-1}$	win/spr 1992	AL	Barrie et al. (1994a)
CH <sub>3</sub> Cl		1980–1982	BA	Khalil and Rasmussen (1983)
CH <sub>3</sub> Cl		1982, 1983	NO	Hov et al. (1984)
CH <sub>2</sub> Cl <sub>2</sub>		1982, 1983	NO	Hov et al. (1984)
CH <sub>2</sub> Cl <sub>2</sub>	$53.4 \dots 69.8 \text{ pmol mol}^{-1}$	Apr 1992	AL	Yokouchi et al. (1994)
CHCl <sub>3</sub>		1982, 1983	NO	Hov et al. (1984)
CHCl <sub>3</sub>	mean: $23.0 \text{ pmol mol}^{-1}$	1988–1989	DY	Davidson et al. (1993b,a)
CHCl <sub>3</sub>	$9.7 \dots 15.8 \text{ pmol mol}^{-1}$	Apr 1992	AL	Yokouchi et al. (1994)
CCl <sub>4</sub>		1982, 1983	NO	Hov et al. (1984)
CCl <sub>4</sub>	mean: $125 \text{ pmol mol}^{-1}$	1988–1989	DY	Davidson et al. (1993b,a)
CCl <sub>4</sub>	mean: $95 \text{ pmol mol}^{-1}$	Feb 1999	nm	Fischer et al. (2002)
CH <sub>3</sub> CCl <sub>3</sub>		1980–1982	BA	Khalil and Rasmussen (1983)
CH <sub>3</sub> CCl <sub>3</sub>		1982, 1983	NO	Hov et al. (1984)
CH <sub>3</sub> CCl <sub>3</sub>	mean: $211 \text{ pmol mol}^{-1}$	1988–1989	DY	Davidson et al. (1993b,a)
CH <sub>3</sub> CCl <sub>3</sub>	mean: $75 \text{ pmol mol}^{-1}$	Feb 1999	nm	Fischer et al. (2002)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
C <sub>2</sub> Cl <sub>6</sub>	mean: 0.06 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
C <sub>2</sub> HCl <sub>3</sub>		1980–1982	BA	Khalil and Rasmussen (1983)
C <sub>2</sub> HCl <sub>3</sub>		1982, 1983	NO	Hov et al. (1984)
C <sub>2</sub> HCl <sub>3</sub>	5.4 ... 11.5 pmol mol <sup>-1</sup>	Jan 1992	AL	Yokouchi et al. (1994)
C <sub>2</sub> HCl <sub>3</sub>	0.5 ... 4.3 pmol mol <sup>-1</sup>	Apr 1992	AL	Yokouchi et al. (1994)
C <sub>2</sub> HCl <sub>3</sub>	0.1 ... 1.2 pmol mol <sup>-1</sup>	Apr 1992	SW	Hopper et al. (1994a)
C <sub>2</sub> HCl <sub>3</sub>	0.17 ... 4.77 pmol mol <sup>-1</sup>	Apr 1992	ARC	Leaitch et al. (1994)
C <sub>2</sub> HCl <sub>3</sub>	mean below DL	Feb 1999	nm	Fischer et al. (2002)
C <sub>2</sub> Cl <sub>4</sub>		1980–1982	BA	Khalil and Rasmussen (1983)
C <sub>2</sub> Cl <sub>4</sub>		1982, 1983	NO	Hov et al. (1984)
C <sub>2</sub> Cl <sub>4</sub>	6.6 ... 9.7 pmol mol <sup>-1</sup>	Jan 1992	AL	Yokouchi et al. (1994)
C <sub>2</sub> Cl <sub>4</sub>	4.3 ... 9.5 pmol mol <sup>-1</sup>	Apr 1992	AL	Yokouchi et al. (1994)
C <sub>2</sub> Cl <sub>4</sub>	6.08 ... 15.05 pmol mol <sup>-1</sup>	Apr 1992	ARC	Leaitch et al. (1994)
C <sub>2</sub> Cl <sub>4</sub>		1997–2004	SU	Dibb et al. (2007)
C <sub>2</sub> Cl <sub>4</sub>	mean: 0.3 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
chloroacetaldehyde		Jan–Apr 2005	BA	Keil and Shepson (2006)
chloroacetone		Jan–Apr 2005	BA	Keil and Shepson (2006)

### Bromine (inorganic)

gaseous Br	7.4 ng m <sup>-3</sup> (STP)	Nov–Dec 1970	sp	Duce et al. (1973)
gaseous Br	7.9 ng m <sup>-3</sup> (STP)	Nov–Dec 1970	nm	Duce et al. (1973)
gaseous Br		1976–1980	BA	Berg et al. (1983)
gas–Br <sub>x</sub>	0.3 ... 61 pmol mol <sup>-1</sup>	spr 1988	AL	Bottenheim et al. (1990)
inorg–Br	0 ... 45 ng m <sup>-3</sup>	Mar–Apr 1989	BA	Sturges et al. (1993c)
inorg–Br		Mar–Apr 1990	BA	Sturges et al. (1993b)
inorg–Br	<5 ... 80 pmol mol <sup>-1</sup>	win/spr 1992	AL	Barrie et al. (1994a)
photolyzable Br	<4 ... 38 pmol mol <sup>-1</sup>	Feb–Apr 1995	AL	Impey et al. (1997)
gaseous Br		1996–1999	NA	Hara et al. (2002a)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
gaseous Br soluble bromide (g+aq)	up to $1.38 \text{ nmol m}^{-3}$	1997–1998 Feb–May 2000	sy ARC	Hara et al. (2004) Ridley et al. (2003); Evans et al. (2003); Ridley et al. (2007)
soluble bromide		2007, 2008	SU	Dibb et al. (2010)
HBr	$0 \dots 16.5 \text{ pmol mol}^{-1}$	1997–1999 (spr)	NA	Beine et al. (2001)
HBr	mean: $16.7 \text{ ng m}^{-3}$	Feb 2000	AL	Ianniello et al. (2002)
HBr	mean: $41.5 \text{ ng m}^{-3}$	Apr–May 2000	AL	Ianniello et al. (2002)
Br atoms	$3.0 \times 10^6 \dots 6.1 \times 10^7 \text{ cm}^{-3}$	spr 1992	AL	Jobson et al. (1994)
Br atoms	$1.4 \times 10^7 \text{ cm}^{-3}$	Apr–May 1998	AL	Boudries and Bottenheim (2000)
Br atoms	$4.8 \times 10^6 \dots 9.6 \times 10^7 \text{ cm}^{-3}$	2004–2005	ha	Read et al. (2007)
Br atoms	up to $1.6 \times 10^9 \text{ cm}^{-3}$	Mar 2009	BA	Stephens et al. (2012)
BrO	$<4 \dots 17 \text{ pmol mol}^{-1}$	Apr 1992	AL	Hausmann and Platt (1994)
BrO	SCD	1995	mm	Kreher et al. (1997)
BrO		Jan–May 1995	KA	Miller et al. (1997)
BrO		1995, 1996	NA	Tuckermann et al. (1997)
BrO		1995–1996	NA	Martinez et al. (1999)
BrO	$0 \dots 15 \text{ pmol mol}^{-1}$	Apr–May 1996	NA	Avallone et al. (2003)
BrO		Sep 1996	ant	Wagner and Platt (1998)
BrO		1997	ARC	Richter et al. (1998)
BrO		1997	ARC	Chance (1998)
BrO		1999–2000	nm	Frieß et al. (2004)
BrO		1999–2000	ARC, ant	Richter et al. (2002)
BrO		Apr–May 2000	AL	Hönninger and Platt (2002)
BrO	$0 \dots 30 \text{ pmol mol}^{-1}$	Apr–May 2000	AL	Avallone et al. (2003)
BrO	VCD	Apr 2001	ARC	Toyota et al. (2011)
BrO	median: $0.35 \text{ pmol mol}^{-1}$	Apr–May 2001	KU	Poissant and Hoenninger (2004); Hönninger et al. (2004)
BrO	SCD	Sep–Oct 2002	mm	Schofield et al. (2006)
BrO		Mar–Apr 2003	BA	Brooks et al. (2006)
BrO	$0 \dots 15 \text{ pmol mol}^{-1}$	spr 2004	AL	Morin et al. (2005)

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J. Bottenheim

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
BrO		2004–2005	NA	Ferrari et al. (2008)
BrO		2004–2005	ha	Saiz-Lopez et al. (2007b)
BrO	mean: 2.5 pmol mol <sup>-1</sup>	2004–2005	ha	Bloss et al. (2010)
BrO	VCD	2004–2009	ant	Schönhardt et al. (2012)
BrO	SCD	2005	BA	Simpson et al. (2007a)
BrO		Mar 2007	ARC	Begoin et al. (2010)
BrO		Apr 2007	ARC	Prados-Roman et al. (2011)
BrO	up to 13 pmol mol <sup>-1</sup>	Aug–Sep 2007	ha	Buys et al. (2012)
BrO	VCD	2007–2010	ARC	Sihler et al. (2012)
BrO	VCD	2007–2008	ARC	Theys et al. (2011)
BrO		2007, 2008	SU	Stutz et al. (2011); Liao et al. (2011a)
BrO		2008	ARC	Olson et al. (2012)
BrO	mean: <1 pmol mol <sup>-1</sup>	Feb–Mar 2008	KU	Edwards et al. (2011)
BrO	up to 41 pmol mol <sup>-1</sup>	Mar–Apr 2008	AG	Pöhler et al. (2010); Nghiem et al. (2012)
BrO		Apr 2008	ARC	Choi et al. (2012); Neuman et al. (2010); Salawitch et al. (2010); Liao et al. (2012a)
BrO	VCD	2008–2009	ARC	Nghiem et al. (2012)
BrO	0...40 pmol mol <sup>-1</sup>	spr 2009	BA	Liao et al. (2011b)
BrO		spr 2009	BA	Frieß et al. (2011)
OBrO	below DL	Mar–Apr 2008	AG	Pöhler et al. (2010)
HOBr		Mar–Apr 1997	AL	Impey et al. (1999)
HOBr (“active or soluble bromine”)		Apr 2008	ARC	Neuman et al. (2010); Salawitch et al. (2010); Liao et al. (2012a)
HOBr	daytime mean: 10 pmol mol <sup>-1</sup>	Mar–Apr 2009	BA	Liao et al. (2012b)
Br <sub>2</sub>		Mar–Apr 1997	AL	Impey et al. (1999)
Br <sub>2</sub>	up to 25 pmol mol <sup>-1</sup>	Feb–Mar 2000	AL	Foster et al. (2001); Spicer et al. (2002)
Br <sub>2</sub>	up to 45 pmol mol <sup>-1</sup>	Aug–Sep 2007	ha	Buys et al. (2012)
Br <sub>2</sub>	below DL	Mar–Apr 2008	AG	Pöhler et al. (2010)

**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
Br <sub>2</sub>	nighttime mean: 13 pmol mol <sup>-1</sup>	Mar–Apr 2009	BA	Liao et al. (2012b)
BrCl	up to 35 pmol mol <sup>-1</sup>	Feb–Mar 2000	AL	Foster et al. (2001); Spicer et al. (2002)
BrCl	up to 6 pmol mol <sup>-1</sup>	Aug–Sep 2007	ha	Buys et al. (2012)
BrCl		Apr 2008	ARC	Neuman et al. (2010)

### Bromine (organic)

org–Br		Mar–Apr 1990	BA	Sturges et al. (1993b)
org–Br	9. . . 80 pmol mol <sup>-1</sup>	win/spr 1992	AL	Barrie et al. (1994a)
CH <sub>3</sub> Br		1982, 1983	NO	Hov et al. (1984)
CH <sub>3</sub> Br	11 pmol mol <sup>-1</sup>	spr 1983	ARC	Berg et al. (1984)
CH <sub>3</sub> Br	9.1. . . 14.7 pmol mol <sup>-1</sup>	all 1983	BA	Rasmussen and Khalil (1984)
CH <sub>3</sub> Br		1985–1987	BA	Cicerone et al. (1988)
CH <sub>3</sub> Br	7.5. . . 9.5 pmol mol <sup>-1</sup>	Nov 1989	mm	Sturges et al. (1993d)
CH <sub>3</sub> Br		Feb–May 2000	ARC	Wingenter et al. (2003); Ridley et al. (2007)
CH <sub>2</sub> Br <sub>2</sub>	15 pmol mol <sup>-1</sup>	spr 1983	ARC	Berg et al. (1984)
CH <sub>2</sub> Br <sub>2</sub>	4.7. . . 5.6 pmol mol <sup>-1</sup>	all 1983	BA	Rasmussen and Khalil (1984)
CH <sub>2</sub> Br <sub>2</sub>	0.1. . . 1.48 pmol mol <sup>-1</sup>	spr 1988	AL	Bottenheim et al. (1990)
CH <sub>2</sub> Br <sub>2</sub>	≤0.1. . . 1 pmol mol <sup>-1</sup>	win/spr 1992	AL	Li et al. (1994)
CH <sub>2</sub> Br <sub>2</sub>	0.5. . . 1.0 pmol mol <sup>-1</sup>	Jan 1992	AL	Yokouchi et al. (1994)
CH <sub>2</sub> Br <sub>2</sub>	0.6. . . 1.0 pmol mol <sup>-1</sup>	Apr 1992	AL	Yokouchi et al. (1994)
CH <sub>2</sub> Br <sub>2</sub>	0.7. . . 1.67 pmol mol <sup>-1</sup>	Apr 1992	ARC	Leaitch et al. (1994)
CH <sub>2</sub> Br <sub>2</sub>	mean: 0.45 pmol mol <sup>-1</sup>	Sep 1992	NA	Schall and Heumann (1993)
CH <sub>2</sub> Br <sub>2</sub>	mean: 0.8 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
CH <sub>2</sub> Br <sub>2</sub>	mean: 1.1 pmol mol <sup>-1</sup>	Jan–Mar 2009	ws	Atkinson et al. (2012)
CHBr <sub>3</sub>	15 pmol mol <sup>-1</sup>	spr 1983	ARC	Berg et al. (1984)

**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
CHBr <sub>3</sub>	4...8 pmol mol <sup>-1</sup>	all 1983	BA	Rasmussen and Khalil (1984)
CHBr <sub>3</sub>		1984–1987	ARC	Oltmans et al. (1989)
CHBr <sub>3</sub>		1984–1987	BA	Cicerone et al. (1988)
CHBr <sub>3</sub>	0.90...4.13 pmol mol <sup>-1</sup>	spr 1988	AL	Bottenheim et al. (1990)
CHBr <sub>3</sub>	0.36...2.0 pmol mol <sup>-1</sup>	Nov 1989	mm	Sturges et al. (1993d)
CHBr <sub>3</sub>	0...18 pmol mol <sup>-1</sup>	Mar–Apr 1989	BA	Sturges et al. (1993c)
CHBr <sub>3</sub>	0.6...5 pmol mol <sup>-1</sup>	win/spr 1992	AL	Li et al. (1994)
CHBr <sub>3</sub>	2.0...3.7 pmol mol <sup>-1</sup>	Jan 1992	AL	Yokouchi et al. (1994)
CHBr <sub>3</sub>	0.9...3.2 pmol mol <sup>-1</sup>	Apr 1992	AL	Yokouchi et al. (1994)
CHBr <sub>3</sub>	0.93...3.1 pmol mol <sup>-1</sup>	Apr 1992	ARC	Leaitch et al. (1994)
CHBr <sub>3</sub>	mean: 0.45 pmol mol <sup>-1</sup>	Sep 1992	NA	Schall and Heumann (1993)
CHBr <sub>3</sub>	mean: 0.3 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
CHBr <sub>3</sub>		2000	sp	Swanson et al. (2004)
CHBr <sub>3</sub>	non-ODE median: 1.1 pmol mol <sup>-1</sup>	Mar–Apr 2000	ARC	Ridley et al. (2007)
CHBr <sub>3</sub>		Mar 2004	KU	Carpenter et al. (2005)
CHBr <sub>3</sub>	mean: 0.002 nmol mol <sup>-1</sup>	Mar–Apr 2008	ARC	Gilman et al. (2010)
CHBr <sub>3</sub>	mean: 3.3 pmol mol <sup>-1</sup>	Jan–Mar 2009	ws	Atkinson et al. (2012)
C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	0.10...0.25 pmol mol <sup>-1</sup>	spr 1988	AL	Bottenheim et al. (1990)
CH <sub>2</sub> BrCH <sub>2</sub> Br	11 pmol mol <sup>-1</sup>	spr 1983	ARC	Berg et al. (1984)
CH <sub>2</sub> BrCH <sub>2</sub> Br	1.0...1.9 pmol mol <sup>-1</sup>	all 1983	BA	Rasmussen and Khalil (1984)
CH <sub>2</sub> BrCH <sub>2</sub> Br	mean: 0.1 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
bromoacetaldehyde		Jan–Apr 2005	BA	Keil and Shepson (2006)
bromoacetone		Jan–Apr 2005	BA	Keil and Shepson (2006)
CH <sub>2</sub> BrCl	2.3...3.1 pmol mol <sup>-1</sup>	all 1983	BA	Rasmussen and Khalil (1984)
CH <sub>2</sub> BrCl	≤0.2 pmol mol <sup>-1</sup>	win/spr 1992	AL	Li et al. (1994)
CH <sub>2</sub> BrCl	0.15...0.34 pmol mol <sup>-1</sup>	Apr 1992	AL	Yokouchi et al. (1994)
CHBr <sub>2</sub> Cl	0.17...0.53 pmol mol <sup>-1</sup>	spr 1988	AL	Bottenheim et al. (1990)



**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
CHBr <sub>2</sub> Cl	0...1.6 pmol mol <sup>-1</sup>	Mar–Apr 1989	BA	Sturges et al. (1993c)
CHBr <sub>2</sub> Cl	0.06...0.4 pmol mol <sup>-1</sup>	win/spr 1992	AL	Li et al. (1994)
CHBr <sub>2</sub> Cl	0.1...0.5 pmol mol <sup>-1</sup>	Jan 1992	AL	Yokouchi et al. (1994)
CHBr <sub>2</sub> Cl	0.1...0.4 pmol mol <sup>-1</sup>	Apr 1992	AL	Yokouchi et al. (1994)
CHBr <sub>2</sub> Cl	0.16...0.36 pmol mol <sup>-1</sup>	Apr 1992	ARC	Leaitch et al. (1994)
CHBr <sub>2</sub> Cl	mean: 0.33 pmol mol <sup>-1</sup>	Sep 1992	NA	Schall and Heumann (1993)
CHBr <sub>2</sub> Cl	mean: 0.02 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
CHBr <sub>2</sub> Cl	mean: 0.4 pmol mol <sup>-1</sup>	Jan–Mar 2009	ws	Atkinson et al. (2012)
CHBrCl <sub>2</sub>	0...1.6 pmol mol <sup>-1</sup>	Mar–Apr 1989	BA	Sturges et al. (1993c)
CHBrCl <sub>2</sub>	0.11...0.39 pmol mol <sup>-1</sup>	Apr 1992	AL	Yokouchi et al. (1994)
CHBrCl <sub>2</sub>	0.3...1.3 pmol mol <sup>-1</sup>	win/spr 1992	AL	Li et al. (1994)
CHBrCl <sub>2</sub>	0.38...0.73 pmol mol <sup>-1</sup>	Apr 1992	ARC	Leaitch et al. (1994)
CHBrCl <sub>2</sub>	mean: 0.12 pmol mol <sup>-1</sup>	Sep 1992	NA	Schall and Heumann (1993)
CHBrCl <sub>2</sub>	mean: 0.05 pmol mol <sup>-1</sup>	Feb 1999	nm	Fischer et al. (2002)
CBrClF <sub>2</sub>	0.9...1.2 pmol mol <sup>-1</sup>	all 1983	BA	Rasmussen and Khalil (1984)
<b>Iodine (inorganic)</b>				
gaseous I	2.2 ngm <sup>-3</sup> (STP)	Nov–Dec 1970	mm	Duce et al. (1973)
gaseous I	2.7 ngm <sup>-3</sup> (STP)	Nov–Dec 1970	sp	Duce et al. (1973)
I <sub>2</sub>	mean: 5.8 pmol mol <sup>-1</sup>	Jan–Mar 2009	ws	Atkinson et al. (2012)
IO		1995–1996	NA	Tuckermann et al. (1997)
IO		1995–1998	NA	Wittrock et al. (2000)
IO	up to 10 pmol mol <sup>-1</sup>	1999	nm	Frieß et al. (2001)
IO		May 2000	AL	Hönninger (2002)
IO		2004–2005	ha	Saiz-Lopez et al. (2007b)
IO	mean: 3.3 pmol mol <sup>-1</sup>	2004–2005	ha	Bloss et al. (2010)
IO	VCD	2004–2009	ant	Schönhardt et al. (2012)
IO	VCD < DL of $\approx 2 \times 10^{12}$ cm <sup>-2</sup>	Oct 2005	ARC	Saiz-Lopez et al. (2007a)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
IO	VCD	Oct 2005	ant	Saiz-Lopez et al. (2007a)
IO	VCD < DL of $\approx 5 \times 10^{12} \text{ cm}^{-2}$	2005-2006	ARC	Schönhardt et al. (2008)
IO	VCD	2005-2006	ant	Schönhardt et al. (2008)
IO	up to $3.4 \text{ pmol mol}^{-1}$	Feb–Mar 2008	KU	Mahajan et al. (2010); Edwards et al. (2011)
IO	below DL, see note <sup>9</sup>	Mar–Apr 2008	AG	Pöhler et al. (2010)
IO	mean: $5.1 \text{ pmol mol}^{-1}$	Jan–Mar 2009	ws	Atkinson et al. (2012)
<b>Iodine (organic)</b>				
CH <sub>3</sub> I		1982, 1983	NO	Hov et al. (1984)
CH <sub>3</sub> I	mean: $2.4 \text{ pmol mol}^{-1}$	Oct–Dec 1987	ant	Reifenhäuser and Heumann (1992)
CH <sub>3</sub> I	$0.9 \dots 1.4 \text{ pmol mol}^{-1}$	Jan 1992	AL	Yokouchi et al. (1994)
CH <sub>3</sub> I	$0.2 \dots 0.6 \text{ pmol mol}^{-1}$	Apr 1992	AL	Yokouchi et al. (1994)
CH <sub>3</sub> I	mean: $1.04 \text{ pmol mol}^{-1}$	Sep 1992	NA	Schall and Heumann (1993)
CH <sub>3</sub> I		2000	sp	Swanson et al. (2004)
CH <sub>3</sub> I	up to $3.83 \text{ pmol mol}^{-1}$	Feb–Mar 2008	KU	Mahajan et al. (2010)
CH <sub>3</sub> I	mean: $0.1 \text{ pmol mol}^{-1}$	Jan–Mar 2009	ws	Atkinson et al. (2012)
CH <sub>2</sub> I <sub>2</sub>	mean: $0.46 \text{ pmol mol}^{-1}$	Sep 1992	NA	Schall and Heumann (1993)
CH <sub>2</sub> I <sub>2</sub>	up to $1.4 \text{ pmol mol}^{-1}$	Mar 2004	KU	Carpenter et al. (2005)
CH <sub>2</sub> I <sub>2</sub>	below DL of $0.05 \text{ pmol mol}^{-1}$	Feb–Mar 2008	KU	Mahajan et al. (2010)
CH <sub>2</sub> ICl	mean: $0.07 \text{ pmol mol}^{-1}$	Sep 1992	NA	Schall and Heumann (1993)
CH <sub>2</sub> ICl		Mar 2004	KU	Carpenter et al. (2005)
CH <sub>2</sub> ICl	up to $0.165 \text{ pmol mol}^{-1}$	Feb–Mar 2008	KU	Mahajan et al. (2010)
CH <sub>2</sub> ICl	mean: $0.07 \text{ pmol mol}^{-1}$	Jan–Mar 2009	ws	Atkinson et al. (2012)
CH <sub>2</sub> I <sub>2</sub> Br	up to $3.7 \text{ pmol mol}^{-1}$	Mar 2004	KU	Carpenter et al. (2005)
CH <sub>2</sub> I <sub>2</sub> Br	up to $0.11 \text{ pmol mol}^{-1}$	Feb–Mar 2008	KU	Mahajan et al. (2010)
CH <sub>2</sub> I <sub>2</sub> Br	mean: $0.03 \text{ pmol mol}^{-1}$	Jan–Mar 2009	ws	Atkinson et al. (2012)

<sup>9</sup>The DL varied between 0.3 and  $2.5 \text{ pmol mol}^{-1}$ .

**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
C <sub>2</sub> H <sub>5</sub> I	mean: 0.2 pmol mol <sup>-1</sup>	Jan–Mar 2009	ws	Atkinson et al. (2012)
1-C <sub>3</sub> H <sub>7</sub> I	mean: 0.20 pmol mol <sup>-1</sup>	Sep 1992	NA	Schall and Heumann (1993)
1-C <sub>3</sub> H <sub>7</sub> I	mean: 0.07 pmol mol <sup>-1</sup>	Jan–Mar 2009	ws	Atkinson et al. (2012)
2-C <sub>3</sub> H <sub>7</sub> I	mean: 2.00 pmol mol <sup>-1</sup>	Sep 1992	NA	Schall and Heumann (1993)
2-C <sub>3</sub> H <sub>7</sub> I	mean: 0.03 pmol mol <sup>-1</sup>	Jan–Mar 2009	ws	Atkinson et al. (2012)

### Sulfur (inorganic)

SO <sub>2</sub>	5...100 pmol mol <sup>-1</sup>	Jun–Aug 1980	NO	Ockelmann and Georgii (1984)
SO <sub>2</sub>	5...100 pmol mol <sup>-1</sup>	Jun–Aug 1980	ARC	Ockelmann and Georgii (1984)
SO <sub>2</sub>	100...200 pmol mol <sup>-1</sup>	Nov/Dec 1981	IG	Hoff et al. (1983)
SO <sub>2</sub>	700...1300 pmol mol <sup>-1</sup>	Feb 1982	IG	Hoff et al. (1983)
SO <sub>2</sub>	<110...590 pmol mol <sup>-1</sup>	Apr 1982	IG	Barrie and Hoff (1984)
SO <sub>2</sub>	0...>1000 pmol mol <sup>-1</sup>	Apr 1983	BA	Radke et al. (1984)
SO <sub>2</sub>	mean: 0.36 nmol m <sup>-3</sup>	Mar–Apr 1986	ant	Pszenny et al. (1989)
SO <sub>2</sub>	11 pmol mol <sup>-1</sup>	Mar–Apr 1986	ant	Berresheim (1987)
SO <sub>2</sub>	6...1600 pmol mol <sup>-1</sup>	spr 1988	AL	Bottenheim et al. (1990)
SO <sub>2</sub>		Mar–Apr 1988	AL	Bottenheim et al. (1993)
SO <sub>2</sub>		Jun 1990	ARC	Ferek et al. (1995)
SO <sub>2</sub>		1990–2001	SN	Heidam et al. (2004)
SO <sub>2</sub>		Jan–Feb 1991	tn	Allegrini et al. (1994)
SO <sub>2</sub>		May–Oct 1991	BA	Ferek et al. (1995)
SO <sub>2</sub>	0.042...1.7 nmol m <sup>-3</sup>	Aug–Oct 1991	ARC	Leck and Persson (1996)
SO <sub>2</sub>	0...5000 pmol mol <sup>-1</sup>	win/spr 1992	AL	Barrie et al. (1994a)
SO <sub>2</sub>		Apr 1992	ARC	Ferek et al. (1995)
SO <sub>2</sub>	mean: 0.9 nmol m <sup>-3</sup> (STP)	Jun–Jul 1993	SU	Dibb et al. (1994)
SO <sub>2</sub>		Mar–Jun 1994	ARC	Jaeschke et al. (1997)
SO <sub>2</sub>		Aug 1994	SU	Dibb et al. (1996)
SO <sub>2</sub>		1995–1996	NA	Martinez et al. (1999)
SO <sub>2</sub>		1995, 1996	NA	Tuckermann et al. (1997)

**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
SO <sub>2</sub>	0...2592.7 pmolmol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
SO <sub>2</sub>		1998–1999	du	Jourdain and Legrand (2001); Legrand et al. (2001)
SO <sub>2</sub>	mean: 1487.5 ngm <sup>-3</sup>	Mar–Apr 2000	NA	Hara et al. (2002b)
SO <sub>2</sub>		Feb 2000	AL	Ianniello et al. (2002)
SO <sub>2</sub>		Feb–May 2000	ARC	Weber et al. (2003)
SO <sub>2</sub>	mean: 280.0 ngm <sup>-3</sup>	Apr–May 2000	AL	Ianniello et al. (2002)
SO <sub>2</sub>		2000	sp	Huey et al. (2004)
SO <sub>2</sub>		2002–2005	NU	Skov et al. (2006b)
SO <sub>2</sub>	see note <sup>10</sup>	Apr–May 2003	NA	Ianniello et al. (2007)
SO <sub>2</sub>		Nov–Dec 2003	sp	Eisele et al. (2008)
SO <sub>2</sub>	mean: 7.4 nmolm <sup>-3</sup>	fal 2007	ARC	Rempillo et al. (2011)
SO <sub>2</sub>		Apr 2008	ARC	Dupont et al. (2012)
SO <sub>2</sub>	mean: 2.0 nmolm <sup>-3</sup>	fal 2008	ARC	Rempillo et al. (2011)
H <sub>2</sub> SO <sub>4</sub>	mean: 1.61 × 10 <sup>6</sup> cm <sup>-3</sup>	Feb 1994	pa	Jefferson et al. (1998); Davis et al. (1998)
H <sub>2</sub> SO <sub>4</sub>		2000	sp	Mauldin III et al. (2004)
H <sub>2</sub> SO <sub>4</sub>	mean: 1.32 × 10 <sup>6</sup> cm <sup>-3</sup>	Feb–May 2000	ARC	Mauldin III et al. (2003); Weber et al. (2003)
H <sub>2</sub> SO <sub>4</sub>		Nov–Dec 2003	sp	Eisele et al. (2008)
H <sub>2</sub> SO <sub>4</sub>		May–Jun 2007	SU	Ziamba et al. (2010)
SF <sub>6</sub>		1997–2005	SU	Dibb et al. (2007)

### Sulfur (organic)

CH <sub>3</sub> SH	<0.04 nmolm <sup>-3</sup>	Mar–Apr 1986	ant	Berresheim (1987)
DMS	96 pmolmol <sup>-1</sup>	Mar–Apr 1986	ant	Berresheim (1987)
DMS		Jun 1990	ARC	Ferek et al. (1995)
DMS		May–Oct 1991	BA	Ferek et al. (1995)

<sup>10</sup>Means from denuder comparison: 145.7 and 97.0 ngm<sup>-3</sup>.

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
DMS	0.047... 17 nmolm <sup>-3</sup>	Aug–Oct 1991	ARC	Leck and Persson (1996)
DMS	<0.3 pmolmol <sup>-1</sup>	Jan–Apr 1992	AL	Yokouchi et al. (1994)
DMS		Apr 1992	ARC	Ferek et al. (1995)
DMS	0.2... 74.5 pmolmol <sup>-1</sup>	1992–1993	nm	Kleefeld (1998)
DMS	mean: 119 pmolmol <sup>-1</sup>	Jan–Feb 1994	pa	Berresheim et al. (1998)
DMS	0.1... 89.6 pmolmol <sup>-1</sup>	Mar–Apr 1994	NA	Kleefeld (1998)
DMS	0.5... 138.9 pmolmol <sup>-1</sup>	Apr 1995	NA	Kleefeld (1998)
DMS		1998–1999	du	Jourdain and Legrand (2001); Legrand et al. (2001)
DMS		1999–2003	du	Preunkert et al. (2007)
DMS		2000	sp	Swanson et al. (2004)
DMS		Nov–Dec 2003	sp	Eisele et al. (2008)
DMS	mean: 38.1 pmolmol <sup>-1</sup>	2004–2005	ha	Read et al. (2008)
DMS		2007	du	Preunkert et al. (2008)
DMS		2007	co	Preunkert et al. (2008)
DMS	mean: 0.44 nmolm <sup>-3</sup>	fal 2007	ARC	Rempillo et al. (2011)
DMS		Aug–Sep 2008	ARC	Sjostedt et al. (2012)
DMS	mean: 1.3 nmolm <sup>-3</sup>	fal 2008	ARC	Rempillo et al. (2011); Chang et al. (2011b)
CH <sub>3</sub> SOCH <sub>3</sub>		Jan 1994	pa	Davis et al. (1998)
CH <sub>3</sub> SOCH <sub>3</sub>	mean: 2.3 pmolmol <sup>-1</sup>	Jan–Feb 1994	pa	Berresheim et al. (1998)
CH <sub>3</sub> SOCH <sub>3</sub>		1998–1999	du	Jourdain and Legrand (2001); Legrand et al. (2001)
CH <sub>3</sub> SOCH <sub>3</sub>		1999–2003	du	Preunkert et al. (2007)
CH <sub>3</sub> SO <sub>2</sub> CH <sub>3</sub>		Jan 1994	pa	Davis et al. (1998)
CH <sub>3</sub> SO <sub>2</sub> CH <sub>3</sub>	mean: 1.7 pmolmol <sup>-1</sup>	Jan–Feb 1994	pa	Berresheim et al. (1998)
OCS		1982, 1983	NO	Hov et al. (1984)
MSA (gaseous)	mean: 9.5×10 <sup>5</sup> cm <sup>-3</sup>	Feb 1994	pa	Jefferson et al. (1998); Davis et al. (1998)
MSA (gaseous)		Feb–May 2000	ARC	Mauldin III et al. (2003)

**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
MSA (gaseous)		Nov–Dec 2003	sp	Eisele et al. (2008)
<b>Mercury</b>				
Hg (TGM)	trend analysis	1977–2000	ARC, ant	Slemr et al. (2003)
Hg (TGM)	mean: 0.55 ng m <sup>-3</sup>	1985–1989	ant	de Mora et al. (1993)
Hg (TGM)	mean: 1.47 ng m <sup>-3</sup>	1992–1993	AL	Schroeder et al. (1995)
Hg (GEM)	seasonal cycle	1992–2001	NA	Eneroth et al. (2007)
Hg	annual mean: 1.50...1.79 ng m <sup>-3</sup>	1994–2002	NA	Berg et al. (2004)
Hg (TGM)		1995	AL	Schroeder et al. (1998)
Hg (GEM)		1995–1999	AL	Banic et al. (2003)
Hg (GEM)	mean: 1.55 ng m <sup>-3</sup>	1995–2000	AL	Temme et al. (2004)
Hg (GEM)	mean: 1.55 ng m <sup>-3</sup>	1995–2001	AL	Kim et al. (2005)
Hg (GEM)	median: 1.58 ng m <sup>-3</sup>	1995–2002	AL	Steffen et al. (2005)
Hg (TGM)	mean: 1.55 ng m <sup>-3</sup>	1995–2005	AL	Temme et al. (2007); Sprovieri et al. (2010)
Hg (GEM)	decreasing trend	1995–2007	AL	Cole and Steffen (2010)
Hg	mean: 1.26 ng m <sup>-3</sup>	1996–1997	PS	Berg et al. (2001)
Hg	mean: 1.43 ng m <sup>-3</sup>	1996–1997	NA	Berg et al. (2001)
Hg (TGM)	mean: 1.55 ng m <sup>-3</sup>	1997–1998	AL	Kellerhals et al. (2003)
Hg (GEM)		Apr–May 1998	AL	Lu et al. (2001)
Hg (GEM)		Apr 1998	BS	Banic et al. (2003)
Hg (TGM)		Jun 1998	NA	Sprovieri and Pirrone (2000)
Hg (GEM)		1998–2002	SN	Skov et al. (2004)
Hg (TGM)		Nov 1999	tn	Sprovieri and Pirrone (2000)
Hg (GEM)	median: 1.8 ng m <sup>-3</sup>	1999–2000	KU	Steffen et al. (2005)
Hg (GEM)		1999–2000	BA	Lindberg et al. (2001)
Hg (GEM)		1999–2001	BA	Lindberg et al. (2002)
Hg (GEM)		1999–2001	SN	Heidam et al. (2004)
Hg (TGM)	0.29...3.17 ng m <sup>-3</sup>	1999–2002	KU	Poissant and Pilote (2003)
Hg (GEM)	median: 1.47 ng m <sup>-3</sup>	2000	NA	Berg et al. (2003)
Hg (GEM)		Feb–May 2000	AL	Steffen et al. (2002)
Hg		Feb–Mar 2000	AL	Bottenheim et al. (2002b)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
Hg (GEM)	mean: 0.9 ngm <sup>-3</sup>	2000–2001	tn	Sprovieri et al. (2002); Dommergue et al. (2010)
Hg (TGM)	mean: 1.08 ngm <sup>-3</sup>	2000–2001	nm	Ebinghaus et al. (2002); Temme et al. (2003); Dommergue et al. (2010)
Hg (TGM)	mean: 1.36 ngm <sup>-3</sup>	2000–2001	FC	Temme et al. (2007); Sprovieri et al. (2010)
Hg (TGM)	median: 1.93 ngm <sup>-3</sup>	Apr–May 2001	KU	Poissant and Pilote (2003); Poissant and Hoenninger (2004)
Hg (GEM)	median: 1.7 ngm <sup>-3</sup>	2001–2003	AM	Steffen et al. (2005)
Hg (GEM)		Mar 2002	SN	Ferrari et al. (2004)
Hg (GEM)		Apr 2002	AL	Steffen et al. (2003)
Hg (GEM)		Apr 2002	KU	Lahoutifard et al. (2006); Gauchard et al. (2005b); Dommergue et al. (2003a,b)
Hg (TGM)		Apr–May 2002	NA	Sommar et al. (2007)
Hg (GEM)		Apr–May 2003	NA	Sprovieri et al. (2005a,b)
Hg (GEM)		Apr–May 2003	NA	Aspmo et al. (2005); Gauchard et al. (2005a)
Hg (GEM)	mean: 1.20 ngm <sup>-3</sup>	Oct–Nov 2003	mm	Brooks et al. (2008b)
Hg (GEM)	mean: 0.539 ngm <sup>-3</sup>	Nov–Dec 2003	sp	Brooks et al. (2008a)
Hg (TGM)		Mar 2004	KU	Carpenter et al. (2005); Constant et al. (2007)
Hg (GEM)		Apr–Aug 2004	CH	Kirk et al. (2006)
Hg (GEM)		2004–2005	NA	Ferrari et al. (2008)
Hg (GEM)	mean: 1.0 ngm <sup>-3</sup>	Feb–Jun 2005	AL	Cobbett et al. (2007)
Hg (GEM)		Mar–Apr 2005	BA	Tackett et al. (2007)
Hg (TGM)	mean: 1.73 ngm <sup>-3</sup>	Jul–Sep 2005	ARC	Sommar et al. (2010)
Hg (GEM)	mean: 1.31 ngm <sup>-3</sup>	2007	SU	Brooks et al. (2011)
Hg (GEM)	mean: 1.45 ngm <sup>-3</sup>	2008	SU	Brooks et al. (2011)
Hg (GEM)		Feb–Jun 2008	NA	Steen et al. (2009)
Hg (GEM)		Mar 2008	AG	Nghiem et al. (2012)
Hg (TGM)		Mar 2009	BA	Sherman et al. (2012)
Hg (GEM)		Mar 2009	BA	Stephens et al. (2012)

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**Table 4:** Gas phase data (... continued).

species	value	date	site	reference
Hg (GEM)	mean: 1.57 ng m <sup>-3</sup>	2007–2011	NA	Pfaffhuber et al. (2012)
Hg (GEM)	mean: 0.93 ng m <sup>-3</sup>	2007–2011	tr	Pfaffhuber et al. (2012)
Hg (GEM)	mean: 0.85 ng m <sup>-3</sup>	Jan 2009	co	Dommergue et al. (2010)
Hg (RGM)		1999–2000	BA	Lindberg et al. (2001)
Hg (RGM)		1999–2001	BA	Lindberg et al. (2002)
Hg (RGM)		2000	NA	Berg et al. (2003)
Hg (RGM)		2000–2001	nm	Temme et al. (2003); Dommergue et al. (2010)
Hg (RGM)	mean: 116.2 pg m <sup>-3</sup>	2000–2001	tn	Sprovieri et al. (2002); Dommergue et al. (2010)
Hg (RGM)	median: 22 pg m <sup>-3</sup>	Apr–May 2001	KU	Poissant and Pilote (2003); Poissant and Hoenninger (2004)
Hg (RGM)		2001–2004	BA	Skov et al. (2006a)
Hg (RGM)		Apr 2002	AL	Steffen et al. (2003)
Hg (RGM)		Apr 2002	KU	Lahoutifard et al. (2006); Gauchard et al. (2005b); Dommergue et al. (2003a,b)
Hg (RGM)		Apr–May 2002	NA	Sommar et al. (2007)
Hg (RGM)		Mar–Apr 2003	BA	Brooks et al. (2006)
Hg (RGM)		Apr–May 2003	NA	Sprovieri et al. (2005a,b)
Hg (RGM)		Apr–May 2003	NA	Aspmo et al. (2005); Gauchard et al. (2005a)
Hg (RGM)	mean: 116 pg m <sup>-3</sup>	Oct–Nov 2003	mm	Brooks et al. (2008b)
Hg (RGM)	mean: 344 pg m <sup>-3</sup>	Nov–Dec 2003	sp	Brooks et al. (2008a)
Hg (RGM)		Apr–Aug 2004	CH	Kirk et al. (2006)
Hg (RGM)		2004–2005	NA	Ferrari et al. (2008)
Hg (RGM)	mean: 44.4 pg m <sup>-3</sup>	Feb–Jun 2005	AL	Cobbett et al. (2007)
Hg (RGM)	mean: 3.2 pg m <sup>-3</sup>	Jul–Sep 2005	ARC	Sommar et al. (2010)
Hg (RGM)	mean: 41.6 pg m <sup>-3</sup>	2007	SU	Brooks et al. (2011)
Hg (RGM)	mean: 13.2 pg m <sup>-3</sup>	2008	SU	Brooks et al. (2011)

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Table 5: Aerosol data.

species	value	date	site	reference
<b>Nitrogen</b>				
NH <sub>4</sub> <sup>+</sup>		1979–1984	ARC	Barrie and Hoff (1985)
NH <sub>4</sub> <sup>+</sup>		1980–1995	AL	Sirois and Barrie (1999)
NH <sub>4</sub> <sup>+</sup>		Apr–May 1980	MB, IG	Barrie et al. (1981)
NH <sub>4</sub> <sup>+</sup>	115... 1030 ng m <sup>-3</sup>	Feb 1982	IG	Hoff et al. (1983)
NH <sub>4</sub> <sup>+</sup>	mean: 6.2 ng m <sup>-3</sup>	1983–2005	nm	Weller and Wagenbach (2007)
NH <sub>4</sub> <sup>+</sup>		Mar–May 1986	BA	Li and Winchester (1989a,b)
NH <sub>4</sub> <sup>+</sup>	20... 701 ng m <sup>-3</sup>	spr 1988	AL	Bottenheim et al. (1990)
NH <sub>4</sub> <sup>+</sup>	mean: 180 ng m <sup>-3</sup>	May 1989	AL	Kieser et al. (1993)
NH <sub>4</sub> <sup>+</sup>	0.030... 3.9 nmol m <sup>-3</sup>	Aug–Oct 1991	ARC	Leck and Persson (1996)
NH <sub>4</sub> <sup>+</sup>		1990–2001	SN	Heidam et al. (2004)
NH <sub>4</sub> <sup>+</sup>		1991–1995	du	Legrand et al. (1998)
NH <sub>4</sub> <sup>+</sup>		1991–1995	nm	Legrand et al. (1998)
NH <sub>4</sub> <sup>+</sup>		1991–1999	du	Jourdain and Legrand (2002)
NH <sub>4</sub> <sup>+</sup>	mean: 69 ng m <sup>-3</sup>	May–Jul 1993	SU	Bergin et al. (1995)
NH <sub>4</sub> <sup>+</sup>		Jan 1994	du	Legrand et al. (1998)
NH <sub>4</sub> <sup>+</sup>		Aug 1994	SU	Dibb et al. (1996)
NH <sub>4</sub> <sup>+</sup>	0... 969.6 pmol mol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
NH <sub>4</sub> <sup>+</sup>	mean: 161 ng m <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
NH <sub>4</sub> <sup>+</sup>	decreasing trend in winter	1997–2008	BA	Quinn et al. (2009)
NH <sub>4</sub> <sup>+</sup>	mean: 124.5 ng m <sup>-3</sup>	Feb 2000	AL	Ianniello et al. (2002)
NH <sub>4</sub> <sup>+</sup>	mean: 89.9 ng m <sup>-3</sup>	Apr–May 2000	AL	Ianniello et al. (2002)
NH <sub>4</sub> <sup>+</sup>	sum mean 9.2... 14.8 ng m <sup>-3</sup>	2000–2002	ks	Piel et al. (2006)
NH <sub>4</sub> <sup>+</sup>	mean: 105 ng m <sup>-3</sup>	Apr–May 2001	NA	Teinilä et al. (2003)
NH <sub>4</sub> <sup>+</sup>	mean: 108 ng m <sup>-3</sup>	Feb–Mar 2001	NA	Teinilä et al. (2003)
NO <sub>2</sub> <sup>-</sup>	<23 ng m <sup>-3</sup>	win/spr 1992	AL	Li (1994)
NO <sub>2</sub> <sup>-</sup>		Mar–Apr 1995	AL	Anastasio and Jordan (2004)
NO <sub>2</sub> <sup>-</sup>	<DL... 20 pmol mol <sup>-1</sup>	Feb–May 2001	NA	Beine et al. (2003)

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**Table 5:** Aerosol data.

species	value	date	site	reference
NO <sub>2</sub> <sup>-</sup>	mean: 1.41 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
NO <sub>2</sub>	0...260.1 pmolmol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
NO <sub>3</sub> <sup>-</sup>		1979–1984	ARC	Barrie and Hoff (1985)
NO <sub>3</sub>		Apr–May 1980	MB, IG	Barrie et al. (1981)
NO <sub>3</sub>	10...100 ngm <sup>-3</sup>	1980–1988	AL	Barrie and Delmas (1994)
NO <sub>3</sub>		1980–1995	AL	Sirois and Barrie (1999)
NO <sub>3</sub>	trend analysis	1980–2004	ARC	Quinn et al. (2007)
NO <sub>3</sub>	17...260 ngm <sup>-3</sup>	Feb 1982	IG	Hoff et al. (1983)
NO <sub>3</sub>	mean: 42 ngm <sup>-3</sup>	1983–2005	nm	Weller and Wagenbach (2007)
NO <sub>3</sub> <sup>-</sup>		1983–2007	nm	Weller et al. (2011)
NO <sub>3</sub>	30 ngm <sup>-3</sup>	Apr 1983	BA	Radke et al. (1984)
NO <sub>3</sub>		1983–1996	nm	Wagenbach et al. (1998b)
NO <sub>3</sub>		Mar–May 1986	BA	Li and Winchester (1989a,b)
NO <sub>3</sub>	7.1...245.7 ngm <sup>-3</sup>	spr 1988	AL	Bottenheim et al. (1990)
NO <sub>3</sub>		Mar–Apr 1988	AL	Bottenheim et al. (1993)
NO <sub>3</sub>	mean: 189 ngm <sup>-3</sup>	May 1989	AL	Kieser et al. (1993)
NO <sub>3</sub>		Jan–Feb 1991	tn	Allegrini et al. (1994)
NO <sub>3</sub>		1991–1995	du	Wagenbach et al. (1998b)
NO <sub>3</sub>		1991–2001	du	Jourdain and Legrand (2002)
NO <sub>3</sub> <sup>-</sup>		1991–2007	du	Weller et al. (2011)
NO <sub>3</sub>	30...400 ngm <sup>-3</sup>	win/spr 1992	AL	Barrie et al. (1994a)
NO <sub>3</sub>	mean: 26 ngm <sup>-3</sup>	May–Jul 1993	SU	Bergin et al. (1995)
NO <sub>3</sub>	mean: 0.06 nmolm <sup>-3</sup> (STP)	Jun–Jul 1993	SU	Dibb et al. (1994)
NO <sub>3</sub>		Jan 1994	du	Legrand et al. (1998)
NO <sub>3</sub>		Mar–Jun 1994	ARC	Jaeschke et al. (1997)
NO <sub>3</sub>		Aug 1994	SU	Dibb et al. (1996)
NO <sub>3</sub>		Mar–Apr 1995	AL	Anastasio and Jordan (2004)
NO <sub>3</sub> <sup>-</sup>		1996–1999	NA	Hara et al. (2002a)
NO <sub>3</sub>	mean: 4 pmolmol <sup>-1</sup>	Jan–Mar 1997	nm	Jones et al. (1999)

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**Table 5:** Aerosol data.

species	value	date	site	reference
NO <sub>3</sub> <sup>-</sup>	mean: 69.4 ng m <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
NO <sub>3</sub>	0...3537.1 pmol mol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
NO <sub>3</sub>	mean: 39 ng m <sup>-3</sup>	1998–1999	sp	Arimoto et al. (2001)
NO <sub>3</sub>		1998, 2000	sp	Arimoto et al. (2004a)
NO <sub>3</sub>	mean: 4.2 pmol mol <sup>-1</sup>	Jan–Feb 1999	nm	Jacobi et al. (2000)
NO <sub>3</sub>	mean: 81.3 ng m <sup>-3</sup>	Feb 2000	AL	Ianniello et al. (2002)
NO <sub>3</sub>		Mar–Apr 2000	NA	Hara et al. (2002b)
NO <sub>3</sub>	mean: 137.4 ng m <sup>-3</sup>	Apr–May 2000	AL	Ianniello et al. (2002)
NO <sub>3</sub>	sum mean 20.3...52.7 ng m <sup>-3</sup>	2000–2002	ks	Piel et al. (2006)
NO <sub>3</sub> <sup>-</sup>		2001	du	Savarino et al. (2007)
NO <sub>3</sub>		Jan–Dec 2001	ha	Rankin and Wolff (2003)
NO <sub>3</sub>	mean: 59 ng m <sup>-3</sup>	Feb–Mar 2001	NA	Teinilä et al. (2003)
NO <sub>3</sub>	7...80 pmol mol <sup>-1</sup>	Feb–May 2001	NA	Beine et al. (2003)
NO <sub>3</sub>	mean: 65 ng m <sup>-3</sup>	Apr–May 2001	NA	Teinilä et al. (2003)
NO <sub>3</sub>		Nov–Dec 2003	sp	Eisele et al. (2008)
NO <sub>3</sub>	mean: 25 ng m <sup>-3</sup>	2003–2005	ks	Weller and Wagenbach (2007)
NO <sub>3</sub> <sup>-</sup>		spr 2004	AL	Morin et al. (2007)
NO <sub>3</sub>		2004–2005	ha	Jones et al. (2011, 2008); Wolff et al. (2008)
NO <sub>3</sub> <sup>-</sup>	Nov–May 140 ng m <sup>-3</sup> , Jun–Oct 40 ng m <sup>-3</sup>	2005–2006	AL	Morin et al. (2008)
NO <sub>3</sub> <sup>-</sup>		Feb–Apr 2006	NA	Morin et al. (2009)
NO <sub>3</sub>		Sep–Oct 2006	ws	Morin et al. (2009)
NO <sub>3</sub>	2...298 ng m <sup>-3</sup>	Mar 2009	SN	Fenger et al. (2012)

## Fluorine

F		1979–1984	ARC	Barrie and Hoff (1985)
F <sup>-</sup>	mean: 0.9 ng m <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)

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**Table 5:** Aerosol data.

species	value	date	site	reference
<b>Chlorine</b>				
Cl	< 20...4000 ngm <sup>-3</sup> (STP)	Jan 1965	BA	Duce et al. (1966)
Cl	<0.01 ngm <sup>-3</sup> (STP)	Nov–Dec 1970	sp	Duce et al. (1973)
Cl	0.07 ngm <sup>-3</sup> (STP)	Nov–Dec 1970	mm	Duce et al. (1973)
Cl	sum 68000, win 6600 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Cl	mean: 2600 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Cl		1976–1980	BA	Berg et al. (1983)
Cl		1979–1980	ARC	Heidam (1985)
Cl	sum 9.6, win 38 ngm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Cl		1979–1984	ARC	Barrie and Hoff (1985)
Cl <sup>-</sup>		Apr–May 1980	MB, IG	Barrie et al. (1981)
Cl <sup>-</sup>		1980–1995	AL	Sirois and Barrie (1999)
Cl		1982	sp	Bodhaine et al. (1986)
Cl	87.9...411 ngm <sup>-3</sup>	Feb 1982	IG	Hoff et al. (1983)
Cl <sup>-</sup>	149...563 ngm <sup>-3</sup>	Feb 1982	IG	Hoff et al. (1983)
Cl <sup>-</sup>	230 ngm <sup>-3</sup>	Apr 1983	BA	Radke et al. (1984)
Cl		spr 1983	ARC	Winchester et al. (1985)
Cl	<20...302 ngm <sup>-3</sup>	spr 1983	ARC	Cahill and Eldred (1984)
Cl		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
Cl		1983–1986	NA, NO	Maenhaut et al. (1989)
Cl <sup>-</sup>		1983–1996	nm	Wagenbach et al. (1998a)
Cl <sup>-</sup>	mean: 480 ngm <sup>-3</sup>	1983–2005	nm	Weller and Wagenbach (2007)
Cl		1984–1987	PF	Sturges and Shaw (1993)
Cl <sup>-</sup>		Mar–May 1986	BA	Li and Winchester (1989a,b)
Cl	21...2575 ngm <sup>-3</sup>	spr 1988	AL	Bottenheim et al. (1990)
Cl	0.028...55 ngm <sup>-3</sup>	1988–1989	DY	Mosher et al. (1993)
Cl	0.53...20 ngm <sup>-3</sup>	1988–1989	SU	Mosher et al. (1993)
Cl <sup>-</sup>	mean: 286 ngm <sup>-3</sup>	May 1989	AL	Kieser et al. (1993)
Cl <sup>-</sup>	median: 0.16 nmolm <sup>-3</sup> (STP)	1990–1991	ea	de Mora et al. (1997)
Cl <sup>-</sup>		1991–1993	ha	Wagenbach et al. (1998a)

**Table 5:** Aerosol data.

species	value	date	site	reference
Cl <sup>-</sup>		1991–1995	du	Wagenbach et al. (1998a)
Cl <sup>-</sup>		1991–2001	du	Jourdain and Legrand (2002)
Cl	0...1200 ngm <sup>-3</sup>	win/spr 1992	AL	Barrie et al. (1994b)
Cl <sup>-</sup>		Jan 1994	du	Legrand et al. (1998)
Cl <sup>-</sup>		Aug 1994	SU	Dibb et al. (1996)
Cl <sup>-</sup>		Mar–Apr 1995	AL	Anastasio and Jordan (2004)
Cl <sup>-</sup>		1996–1999	NA	Hara et al. (2002a)
Cl <sup>-</sup>		1997–1998	sy, df	Hara et al. (2004)
Cl <sup>-</sup>	mean: 379 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
Cl <sup>-</sup>	0...1391.0 pmolmol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
Cl	mean: 34 ngm <sup>-3</sup>	1998–1999	sp	Arimoto et al. (2001)
Cl <sup>-</sup>		1998, 2000	sp	Arimoto et al. (2004a)
Cl <sup>-</sup>	mean: 73.9 ngm <sup>-3</sup>	Feb 2000	AL	Ianniello et al. (2002)
Cl <sup>-</sup>	mean: 220.9 ngm <sup>-3</sup>	Apr–May 2000	AL	Ianniello et al. (2002)
Cl <sup>-</sup>	sum mean 4.3...28.3 ngm <sup>-3</sup>	2000–2002	ks	Piel et al. (2006)
Cl <sup>-</sup>		Jan–Dec 2001	ha	Rankin and Wolff (2003)
Cl <sup>-</sup>	mean: 449 ngm <sup>-3</sup>	Feb–Mar 2001	NA	Teinilä et al. (2003)
Cl <sup>-</sup>	mean: 373 ngm <sup>-3</sup>	Apr–May 2001	NA	Teinilä et al. (2003)
Cl	mean: 519.43 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Cl <sup>-</sup>	mean: 38 ngm <sup>-3</sup>	2003–2005	ks	Weller and Wagenbach (2007)
Cl <sup>-</sup>		2007	tr	Hansen et al. (2009)
Cl <sup>-</sup>	53...507 ngm <sup>-3</sup>	Mar 2009	SN	Fenger et al. (2012)

### Bromine

Br	1...30 ngm <sup>-3</sup> (STP)	Jan 1965	BA	Duce et al. (1966)
Br	0.43 ngm <sup>-3</sup> (STP)	Nov–Dec 1970	sp	Duce et al. (1973)
Br	0.96 ngm <sup>-3</sup> (STP)	Nov–Dec 1970	mm	Duce et al. (1973)
Br	0.63 ngm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)

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species	value	date	site	reference
Br	sum 320, win 800 $\text{pgm}^{-3}$	1971–1978	sp	Cunningham and Zoller (1981)
Br	see note <sup>11</sup>	1974–1975	sp	Maenhaut et al. (1979)
Br		1976–1980	ARC	Oltmans et al. (1989)
Br		1976–1980	BA	Berg et al. (1983)
Br		1977–1978	NA	Berg et al. (1983)
Br		1979–1980	ARC	Heidam (1985)
Br	see note <sup>12</sup>	1979–1983	sp	Tuncel et al. (1989)
Br	4.2 ... 10.4 $\text{ngm}^{-3}$	win 1979–84	AL	Sturges and Barrie (1988)
Br	9.0 ... 27.8 $\text{ngm}^{-3}$	spr 1979–84	AL	Sturges and Barrie (1988)
Br	0.5 ... 0.7 $\text{ngm}^{-3}$	Jun–Nov 1979–84	AL	Sturges and Barrie (1988)
Br	3.8 ... 21.1 $\text{ngm}^{-3}$	win 1979–84	IG	Sturges and Barrie (1988)
Br	13.0 ... 30.4 $\text{ngm}^{-3}$	spr 1979–84	IG	Sturges and Barrie (1988)
Br	1.4 ... 3.8 $\text{ngm}^{-3}$	Jun–Nov 1979–84	IG	Sturges and Barrie (1988)
Br	3.4 ... 14.5 $\text{ngm}^{-3}$	win 1979–84	MB	Sturges and Barrie (1988)
Br	20.5 ... 54.6 $\text{ngm}^{-3}$	spr 1979–84	MB	Sturges and Barrie (1988)
Br		1979–1984	ARC	Barrie and Hoff (1985)
Br	<0.5 ... 1.8 $\text{ngm}^{-3}$	Jun–Nov 1979–84	MB	Sturges and Barrie (1988)
Br		1980–1986	AL	Barrie and Barrie (1990)
Br		1980–1995	AL	Sirois and Barrie (1999)
Br	16.9 ... 39.2 $\text{ngm}^{-3}$	Feb 1982	IG	Hoff et al. (1983)
Br	25 ... 63 $\text{ngm}^{-3}$	Mar 1983	BA	Hansen and Rosen (1984)
Br		1983–1986	NA, NO	Maenhaut et al. (1989)
Br <sup>-</sup>		1983–1996	nm	Wagenbach et al. (1998a)
Br	monthly mean: 0 ... 5 $\text{ngm}^{-3}$	1984–1987	PF	Sturges and Shaw (1993)
Br <sup>-</sup>	see note <sup>13</sup>	Mar–Apr 1986	ant	Pszenny et al. (1989)
Br <sup>-</sup>		Mar–May 1986	BA	Li and Winchester (1989a,b)
Br <sup>-</sup>	1 ... 54 $\text{ngm}^{-3}$	spr 1988	AL	Bottenheim et al. (1990)
Br	3.1 ... 84.5 $\text{ngm}^{-3}$	spr 1988	AL	Bottenheim et al. (1990)

<sup>11</sup> Different values for Whatman filters and Nuclepore filters: 1370 or 2600  $\text{pgm}^{-3}$ (STP), resp.

<sup>12</sup> Different values for Whatman filters and Fluoropore filters: sum 610 or 140, win 110 or 90  $\text{pgm}^{-3}$ .

<sup>13</sup> Data available in supplement of Sander et al. (2003).

**Table 5:** Aerosol data.

species	value	date	site	reference
Br	0.02... 5.0 ngm <sup>-3</sup>	1988–1989	DY	Mosher et al. (1993)
Br	0.17... 1.6 ngm <sup>-3</sup>	1988–1989	SU	Mosher et al. (1993)
Br	0... 260 ngm <sup>-3</sup>	Mar–Apr 1989	BA	Sturges et al. (1993c)
Br <sup>-</sup>	mean: 45 ngm <sup>-3</sup>	May 1989	AL	Kieser et al. (1993)
Br		Mar–Apr 1990	BA	Sturges et al. (1993b)
Br <sup>-</sup>		1991–1995	du	Wagenbach et al. (1998a)
Br <sup>-</sup>	10... 20 ngm <sup>-3</sup>	win 1992	AL	Li et al. (1994)
Br <sup>-</sup>	20... 120 ngm <sup>-3</sup>	spr 1992	AL	Li et al. (1994)
Br	4... 100 ngm <sup>-3</sup>	win/spr 1992	AL	Barrie et al. (1994a)
Br <sup>-</sup>		Mar–Apr 1995	AL	Anastasio and Jordan (2004)
Br		1996	NA	Martinez et al. (1999)
Br <sup>-</sup>		1996–1999	NA	Hara et al. (2002a)
Br <sup>-</sup>		1997–1998	sy, df	Hara et al. (2004)
Br <sup>-</sup>	mean: 1.0 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
filterable Br		1999–2002	SN	Skov et al. (2004)
Br <sup>-</sup>	mean: 5.2 ngm <sup>-3</sup>	Feb 2000	AL	Ianniello et al. (2002)
Br <sup>-</sup>	mean: 13.1 ngm <sup>-3</sup>	Apr–May 2000	AL	Ianniello et al. (2002)
Br	mean: 0.72 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
BrO <sub>3</sub> <sup>-</sup>		1996–1999	NA	Hara et al. (2002a)

### Iodine

I	0.3... 10 ngm <sup>-3</sup> (STP)	Jan 1965	BA	Duce et al. (1966)
I	0.49 ngm <sup>-3</sup> (STP)	Nov–Dec 1970	sp	Duce et al. (1973)
I	0.93 ngm <sup>-3</sup> (STP)	Nov–Dec 1970	mm	Duce et al. (1973)
I	sum 180, win 80 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
I	see note <sup>14</sup>	1974–1975	sp	Maenhaut et al. (1979)
I		1976–1980	BA	Berg et al. (1983)

<sup>14</sup>Different values for Whatman filters and Nuclepore filters: 83 or 740 pgm<sup>-3</sup>(STP), resp.

**Table 5:** Aerosol data.

species	value	date	site	reference
I	sum 260, win 130 $\text{pgm}^{-3}$	1979–1983	sp	Tuncel et al. (1989)
I		1979–1984	ARC	Barrie and Hoff (1985)
I		1980–1986	AL	Barrie and Barrie (1990)
I		1980–1995	AL	Sirois and Barrie (1999)
I	0.28... 1.11 $\text{ngm}^{-3}$	Feb 1982	IG	Hoff et al. (1983)
I		1983–1986	NA, NO	Maenhaut et al. (1989)
I	monthly mean: 0... 1 $\text{ngm}^{-3}$	1984–1987	PF	Sturges and Shaw (1993)
I	0.34... 2.62 $\text{ngm}^{-3}$	spr 1988	AL	Bottenheim et al. (1990)
I	0.017... 1.2 $\text{ngm}^{-3}$	1988–1989	DY	Mosher et al. (1993)
I	0.14... 0.89 $\text{ngm}^{-3}$	1988–1989	SU	Mosher et al. (1993)
I	0.3... 2 $\text{ngm}^{-3}$	win/spr 1992	AL	Barrie et al. (1994b)
I		1996	NA	Martinez et al. (1999)

### Sulfur

S	sum 29, win 76 $\text{ngm}^{-3}$	1971–1978	sp	Cunningham and Zoller (1981)
S	mean: 49000 $\text{pgm}^{-3}$ (STP)	1974–1975	sp	Maenhaut et al. (1979)
nss-SO <sub>4</sub> <sup>2-</sup>		1976–2008	BA	Quinn et al. (2009)
S		1979–1980	ARC	Heidam (1985)
S	sum 45, win 10 $\text{ngm}^{-3}$	1979–1983	sp	Tuncel et al. (1989)
SO <sub>4</sub> <sup>2-</sup>		1979–1984	ARC	Barrie and Hoff (1985)
SO <sub>4</sub> <sup>2-</sup>		Apr–May 1980	MB, IG	Barrie et al. (1981)
SO <sub>4</sub> <sup>2-</sup>		1980–1995	AL	Barrie and Barrie (1990); Li and Barrie (1993); Sirois and Barrie (1999); Norman et al. (1999)
SO <sub>3</sub> <sup>2-</sup>	trend analysis	1980–2004	ARC	Quinn et al. (2007)
SO <sub>4</sub> <sup>2-</sup>	360... 540 $\text{ngm}^{-3}$	Nov/Dec 1981	IG	Hoff et al. (1983)
S		1982	sp	Bodhaine et al. (1986)
SO <sub>4</sub> <sup>2-</sup>	560... 2730 $\text{ngm}^{-3}$	Feb 1982	IG	Hoff et al. (1983)
SO <sub>4</sub> <sup>2-</sup>	1460... 3810 $\text{ngm}^{-3}$	Apr 1982	IG	Barrie and Hoff (1984)
SO <sub>4</sub> <sup>2-</sup>	384... 4380 $\text{ngm}^{-3}$	Feb 1982	IG	Hoff et al. (1983)



**Table 5:** Aerosol data.

species	value	date	site	reference
S		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
S	185... 1070 ngm <sup>-3</sup>	spr 1983	ARC	Cahill and Eldred (1984)
S		spr 1983	ARC	Winchester et al. (1985)
SO <sub>4</sub> <sup>2-</sup>	mean: 3200 ngm <sup>-3</sup>	Mar–Apr 1983	BA	Lazrus and Ferek (1984)
SO <sub>4</sub> <sup>2-</sup>	2600 ngm <sup>-3</sup>	Apr 1983	BA	Radke et al. (1984)
S		1983–1986	NA, NO	Maenhaut et al. (1989)
nss-SO <sub>4</sub> <sup>2-</sup>		1983–1994	nm	Minikin et al. (1998)
nss-SO <sub>4</sub> <sup>2-</sup>		1983–1995	nm	Legrand and Pasteur (1998)
SO <sub>4</sub> <sup>2-</sup>		1983–1996	nm	Wagenbach et al. (1998a)
SO <sub>4</sub> <sup>2-</sup>	mean: 150 ngm <sup>-3</sup>	1983–2005	nm	Weller and Wagenbach (2007)
nss-SO <sub>4</sub> <sup>2-</sup>		1983–2007	nm	Weller et al. (2011)
nss-SO <sub>4</sub> <sup>2-</sup>	mean: 0.34 nmolm <sup>-3</sup>	Mar–Apr 1986	ant	Pszenny et al. (1989)
nss-SO <sub>4</sub> <sup>2-</sup>	0.31 nmolm <sup>-3</sup>	Mar–Apr 1986	ant	Berresheim (1987)
SO <sub>4</sub> <sup>2-</sup>		Mar–May 1986	BA	Li and Winchester (1989a,b)
nss-SO <sub>4</sub> <sup>2-</sup>	mean: 90 ngm <sup>-3</sup>	1987–1989	mw	Prospero et al. (1991)
SO <sub>4</sub> <sup>2-</sup>	440... 5870 ngm <sup>-3</sup>	spr 1988	AL	Bottenheim et al. (1990)
SO <sub>4</sub> <sup>2-</sup>		Mar–Apr 1988	AL	Bottenheim et al. (1993)
SO <sub>4</sub> <sup>2-</sup>	mean: 82 ngm <sup>-3</sup>	1988–1989	DY	Davidson et al. (1993b,a); Jaffrezo et al. (1994)
SO <sub>4</sub> <sup>2-</sup>		1989–2002	AL	Sharma et al. (2004)
SO <sub>4</sub> <sup>2-</sup>	mean: 1450 ngm <sup>-3</sup>	May 1989	AL	Kieser et al. (1993)
nss-SO <sub>4</sub> <sup>2-</sup>		Jun 1990	ARC	Ferek et al. (1995)
nss-SO <sub>4</sub> <sup>2-</sup>	median: 0.88 nmolm <sup>-3</sup> (STP)	1990–1991	ea	de Mora et al. (1997)
SO <sub>4</sub> <sup>2-</sup>		1990–1991	SU	Jaffrezo et al. (1994)
nss-SO <sub>4</sub> <sup>2-</sup>		1990–1992	NA	Heintzenberg and Leck (1994)
SO <sub>4</sub> <sup>2-</sup>		1990–2001	SN	Heidam et al. (2004)
SO <sub>4</sub> <sup>2-</sup>		Jan–Feb 1991	tn	Allegrini et al. (1994)
nss-SO <sub>4</sub> <sup>2-</sup>	0.028... 6.9 nmolm <sup>-3</sup>	Aug–Oct 1991	ARC	Leck and Persson (1996)
nss-SO <sub>4</sub> <sup>2-</sup>		1991–1992	ha	Minikin et al. (1998)
nss-SO <sub>4</sub> <sup>2-</sup>		1991–1992	ha	Legrand and Pasteur (1998)

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**Table 5:** Aerosol data.

species	value	date	site	reference
SO <sub>4</sub> <sup>2-</sup>		1991–1993	ha	Wagenbach et al. (1998a)
nss-SO <sub>4</sub> <sup>2-</sup>		1991–1995	du	Minikin et al. (1998)
SO <sub>4</sub> <sup>2-</sup>		1991–1995	du	Wagenbach et al. (1998a)
nss-SO <sub>4</sub> <sup>2-</sup>		1991–1995	nm	Legrand et al. (1998)
nss-SO <sub>4</sub> <sup>2-</sup>		1991–1996	du	Legrand and Pasteur (1998)
SO <sub>4</sub> <sup>2-</sup>		1991–2001	du	Jourdain and Legrand (2002)
nss-SO <sub>4</sub> <sup>2-</sup>		1991–2003	du	Preunkert et al. (2007)
nss-SO <sub>4</sub> <sup>2-</sup>		Jul–Aug 1996	ARC	Kerminen and Leck (2001)
SO <sub>4</sub> <sup>2-</sup>	720...7700 ngm <sup>-3</sup>	win/spr 1992	AL	Barrie et al. (1994a)
nss-SO <sub>4</sub> <sup>2-</sup>		Apr 1992	ARC	Ferek et al. (1995)
SO <sub>4</sub> <sup>2-</sup>	mean: 120 ngm <sup>-3</sup>	Jun–Jul 1992	SU	Bergin et al. (1994)
SO <sub>4</sub> <sup>2-</sup>		Jul–Dec 1992	sp	Harder et al. (2000)
SO <sub>4</sub> <sup>2-</sup>		Mar–Jun 1993	NA	Solberg et al. (1996b)
SO <sub>4</sub> <sup>2-</sup>	mean: 402 ngm <sup>-3</sup>	May–Jul 1993	SU	Bergin et al. (1995)
SO <sub>4</sub> <sup>2-</sup>	mean: 3.0 nmolm <sup>-3</sup> (STP)	Jun–Jul 1993	SU	Dibb et al. (1994)
SO <sub>4</sub> <sup>2-</sup>		Jan 1994	du	Legrand et al. (1998)
nss-SO <sub>4</sub> <sup>2-</sup>	mean: 69.1 pmolmol <sup>-1</sup>	Jan–Feb 1994	pa	Berresheim et al. (1998)
SO <sub>4</sub> <sup>2-</sup>		Mar–Jun 1994	ARC	Jaeschke et al. (1997)
SO <sub>4</sub> <sup>2-</sup>		Aug 1994	SU	Dibb et al. (1996)
SO <sub>4</sub> <sup>2-</sup>		Mar–Apr 1995	AL	Anastasio and Jordan (2004)
SO <sub>4</sub> <sup>2-</sup>	0...611.1 pmolmol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
nss-SO <sub>4</sub> <sup>2-</sup>	mean: 1143 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
nss-SO <sub>4</sub> <sup>2-</sup>		1998–1999	du	Jourdain and Legrand (2001); Legrand et al. (2001)
SO <sub>4</sub> <sup>2-</sup>	mean: 224 ngm <sup>-3</sup>	1998–1999	sp	Arimoto et al. (2001)
SO <sub>4</sub> <sup>2-</sup>		1998, 2000	sp	Arimoto et al. (2004a)
SO <sub>4</sub> <sup>2-</sup>	mean: 1111.1 ngm <sup>-3</sup>	Feb 2000	AL	Ianniello et al. (2002)
SO <sub>4</sub> <sup>2-</sup>		Feb–May 2000	ARC	Scheuer et al. (2003)
SO <sub>4</sub> <sup>2-</sup>	mean: 746.3 ngm <sup>-3</sup>	Apr–May 2000	AL	Ianniello et al. (2002)

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**Table 5:** Aerosol data.

species	value	date	site	reference
SO <sub>4</sub> <sup>2-</sup>		Mar–Apr 2000	NA	Hara et al. (2002b)
SO <sub>4</sub> <sup>2-</sup>	sum mean 164...353 ng m <sup>-3</sup>	2000–2002	ks	Piel et al. (2006)
nss-SO <sub>4</sub> <sup>2-</sup>		Jan–Dec 2001	ha	Rankin and Wolff (2003)
nss-SO <sub>4</sub> <sup>2-</sup>	mean: 929 ng m <sup>-3</sup>	Feb–Mar 2001	NA	Teinilä et al. (2003)
nss-SO <sub>4</sub> <sup>2-</sup>	mean: 1430 ng m <sup>-3</sup>	Apr–May 2001	NA	Teinilä et al. (2003)
S	mean: 119.31 ng m <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
SO <sub>4</sub> <sup>2-</sup>		Nov–Dec 2003	sp	Eisele et al. (2008)
SO <sub>4</sub> <sup>2-</sup>	mean: 90 ng m <sup>-3</sup>	2003–2005	ks	Weller and Wagenbach (2007)
nss-SO <sub>4</sub> <sup>2-</sup>		2005–2006	du	Preunkert et al. (2008)
nss-SO <sub>4</sub> <sup>2-</sup>		2005–2006	co	Preunkert et al. (2008)
nss-SO <sub>4</sub> <sup>2-</sup>	mean: 3.0 nmol m <sup>-3</sup>	fal 2007	ARC	Rempillo et al. (2011)
nss-SO <sub>4</sub> <sup>2-</sup>	mean: 0.4 nmol m <sup>-3</sup>	fal 2008	ARC	Rempillo et al. (2011)
SO <sub>4</sub> <sup>2-</sup>	up to 0.42 µg m <sup>-3</sup>	Aug–Sep 2008	ARC	Chang et al. (2011a)
SO <sub>4</sub> <sup>2-</sup>	535...1087 ng m <sup>-3</sup>	Mar 2009	SN	Fenger et al. (2012)
MSA		1980–1995	AL	Sirois and Barrie (1999); Li and Barrie (1993); Norman et al. (1999)
MSA	trend analysis	1980–2003	ARC	Quinn et al. (2007)
MSA		1983–1994	nm	Minikin et al. (1998)
MSA		1983–1995	nm	Legrand and Pasteur (1998)
MSA	mean: 44 ng m <sup>-3</sup>	1983–2005	nm	Weller and Wagenbach (2007)
MSA		1983–2007	nm	Weller et al. (2011)
MSA	mean: 0.22 nmol m <sup>-3</sup>	Mar–Apr 1986	ant	Pszenny et al. (1989)
MSA	0.27 nmol m <sup>-3</sup>	Mar–Apr 1986	ant	Berresheim (1987)
MSA		Mar–May 1986	BA	Li and Winchester (1989a,b)
MSA	0.3...6 pmol mol <sup>-1</sup>	1986–1988	AL	Li et al. (1993)
MSA	mean: 20 ng m <sup>-3</sup>	1987–1989	mw	Prospero et al. (1991)
MSA		sum 1988	ARC	Li et al. (1993)
MSA	mean: 0.58 ng m <sup>-3</sup>	1988–1989	DY	Davidson et al. (1993b,a); Jaffrezo et al. (1994); Li et al. (1993)

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**Table 5:** Aerosol data.

species	value	date	site	reference
MSA	1...25 pmolmol <sup>-1</sup>	Mar–Apr 1989	BA	Li et al. (1993)
MSA	median: 0.14 nmolm <sup>-3</sup> (STP)	1990–1991	ea	de Mora et al. (1997)
MSA		1990–1991	SU	Jaffrezo et al. (1994)
MSA		1990–1992	NA	Heintzenberg and Leck (1994)
MSA		1991–1992	ha	Minikin et al. (1998)
MSA		1991–1992	ha	Legrand and Pasteur (1998)
MSA		1991–1995	du	Minikin et al. (1998)
MSA		1991–1995	nm	Legrand et al. (1998)
MSA		1991–1996	du	Legrand and Pasteur (1998)
MSA		1991–2003	du	Preunkert et al. (2007)
MSA		Jul–Aug 1996	ARC	Kerminen and Leck (2001)
MSA		1991–2001	du	Jourdain and Legrand (2002)
MSA	0.002...1.4 nmolm <sup>-3</sup>	Aug–Oct 1991	ARC	Leck and Persson (1996)
MSA	mean: 3.2 ngm <sup>-3</sup>	Jun–Jul 1992	SU	Bergin et al. (1994)
MSA	mean: 5.6 ngm <sup>-3</sup>	May–Jul 1993	SU	Bergin et al. (1995)
MSA		Jan 1994	du	Legrand et al. (1998)
MSA	mean: 42.3 pmolmol <sup>-1</sup>	Jan–Feb 1994	pa	Berresheim et al. (1998)
MSA	mean: 19.6 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
MSA	increasing trend in summer	1997–2008	BA	Quinn et al. (2009)
MSA		1998–1999	du	Jourdain and Legrand (2001); Legrand et al. (2001)
MSA	mean: 12 ngm <sup>-3</sup>	1998–1999	sp	Arimoto et al. (2001)
MSA		1998, 2000	sp	Arimoto et al. (2004a)
MSA	sum mean 19.0...74.5 ngm <sup>-3</sup>	2000–2002	ks	Piel et al. (2006)
MSA		Jan–Dec 2001	ha	Rankin and Wolff (2003)
MSA	mean: 50 ngm <sup>-3</sup>	Apr–May 2001	NA	Teinilä et al. (2003)
MSA		Nov–Dec 2003	sp	Eisele et al. (2008)
MSA	mean: 17 ngm <sup>-3</sup>	2003–2005	ks	Weller and Wagenbach (2007)
MSA	mean: 42 ngm <sup>-3</sup>	2004–2005	ha	Read et al. (2008)
MSA		2005–2006	du	Preunkert et al. (2008)

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**Table 5:** Aerosol data.

species	value	date	site	reference
MSA		2005–2006	co	Preunkert et al. (2008)
MSA	mean: 0.04 nmolm <sup>-3</sup>	fal 2007	ARC	Rempillo et al. (2011)
MSA	mean: 0.06 nmolm <sup>-3</sup>	fal 2008	ARC	Rempillo et al. (2011)
MSA	up to 0.08 µgm <sup>-3</sup>	Aug–Sep 2008	ARC	Chang et al. (2011a)

### Carbon

black carbon	206. . . 295 ngm <sup>-3</sup>	Mar 1983	BA	Hansen and Rosen (1984)
black carbon	mean: 0.65 ngm <sup>-3</sup>	1987–1990	sp	Bodhaine (1995)
black carbon	mean: 41 ngm <sup>-3</sup>	1988–1993	BA	Bodhaine (1995)
black carbon		1989–1990	AL	Hopper et al. (1994b)
black carbon		1989–2002	AL	Sharma et al. (2004)
black carbon		1989–2003	AL	Sharma et al. (2006)
black carbon		1989–2003	BA	Sharma et al. (2006)
black carbon	trend analysis	1990–2001	AL	Quinn et al. (2007)
black carbon		1992–1995	ha	Wolff and Cachier (1998)
black carbon	mean: 146 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
black carbon		Feb–Mar 2000	AL	Bottenheim et al. (2002b)
black carbon	7 ngm <sup>-3</sup>	May–Jul 2006	SU	Hagler et al. (2007, 2008)
black carbon	mean: 20 ngm <sup>-3</sup>	May–Dec 2006	SU	von Schneidemesser et al. (2009)
black carbon		Apr 2008	ARC	Dupont et al. (2012)
black carbon		Apr,Jun 2008	ARC	Corr et al. (2012)
formate		Mar–May 1986	BA	Li and Winchester (1989a,b)
formate	mean: 1.05 nmolm <sup>-3</sup> (STP)	Jun–Jul 1993	SU	Dibb et al. (1994)
formate		Aug 1994	SU	Dibb et al. (1996)
formate		1998–2002	du	Legrand et al. (2004)
acetate		Mar–May 1986	BA	Li and Winchester (1989a,b)
acetate	mean: 0.16 nmolm <sup>-3</sup> (STP)	Jun–Jul 1993	SU	Dibb et al. (1994)
acetate		Aug 1994	SU	Dibb et al. (1996)
acetate		1998–2002	du	Legrand et al. (2004)
propanoate		Mar–May 1986	BA	Li and Winchester (1989a,b)

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**Table 5:** Aerosol data.

species	value	date	site	reference
oxalic acid		1991–1995	du	Legrand et al. (1998)
oxalic acid		1991–2001	du	Jourdain and Legrand (2002)
oxalic acid		Jan 1994	du	Legrand et al. (1998)
oxalic acid		Aug 1994	SU	Dibb et al. (1996)
oxalic acid	mean: 8.6 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
oxalic acid		Feb–May 2000	AL	Narukawa et al. (2002)
oxalic acid	mean: 8.6 ngm <sup>-3</sup>	Apr–May 2001	NA	Teinilä et al. (2003)
oxalic acid	mean: 9.0 ngm <sup>-3</sup>	Feb–Mar 2001	NA	Teinilä et al. (2003)
oxalic acid	up to 20 ngm <sup>-3</sup>	2005–2010	du	Legrand et al. (2012)
malonic acid	mean: 1.5 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
malonic acid		Feb–May 2000	AL	Narukawa et al. (2002)
succinic acid	mean: 2.9 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
succinic acid		Feb–May 2000	AL	Narukawa et al. (2002)
glutaric acid	mean: 2.5 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
glutaric acid		Feb–May 2000	AL	Narukawa et al. (2002)
adipic acid		Feb–May 2000	AL	Narukawa et al. (2002)
pimelic acid		Feb–May 2000	AL	Narukawa et al. (2002)
suberic acid		Feb–May 2000	AL	Narukawa et al. (2002)
azelaic acid		Feb–May 2000	AL	Narukawa et al. (2002)
sebacic acid		Feb–May 2000	AL	Narukawa et al. (2002)
undecanedioic acid		Feb–May 2000	AL	Narukawa et al. (2002)
methylmalonic acid		Feb–May 2000	AL	Narukawa et al. (2002)
methylsuccinic acid		Feb–May 2000	AL	Narukawa et al. (2002)
2-methylglutaric acid		Feb–May 2000	AL	Narukawa et al. (2002)

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**Table 5:** Aerosol data.

species	value	date	site	reference
4-ketopimelic acid		Feb–May 2000	AL	Narukawa et al. (2002)
maleic acid		Feb–May 2000	AL	Narukawa et al. (2002)
fumaric acid		Feb–May 2000	AL	Narukawa et al. (2002)
methylmaleic acid		Feb–May 2000	AL	Narukawa et al. (2002)
methylfumaric acid		Feb–May 2000	AL	Narukawa et al. (2002)
phthalic acid	mean: 1.1 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
phthalic acid		Feb–May 2000	AL	Narukawa et al. (2002)
malic acid	mean: 3.3 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
pyruvic acid		Mar–May 1986	BA	Li and Winchester (1989a,b)
glycolic acid	mean: 1.7 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
glyoxylic acid	mean: 1.0 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
organic acids		1987–1988	AL	Kawamura and Kasukabe (1996)

### Metals

Al	0.57 ngm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
Al	sum <300, win 830 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Al		1973–1978	ARC	Rahn (1981)
Al	mean: 820 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Al	mean: 30 ngm <sup>-3</sup>	1976–1978 (win)	BA	Rahn and McCaffrey (1979)
Al		1979–1980	ARC	Heidam (1985)
Al	sum 730, win 320 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Al		1979–1984	ARC	Barrie and Hoff (1985)

**Table 5:** Aerosol data.

species	value	date	site	reference
Al		1980–1986	AL	Barrie and Barrie (1990)
Al		1980–1995	AL	Sirois and Barrie (1999)
Al		1980–2000	AL	Gong and Barrie (2005)
Al		Apr–May 1980	MB, IG	Barrie et al. (1981)
Al		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
Al		1983–1986	NA, NO	Maenhaut et al. (1989)
Al		1984–1987	PF	Sturges and Shaw (1993)
Al	15... 976 ngm <sup>-3</sup>	spr 1988	AL	Bottenheim et al. (1990)
Al	mean: 4.2 ngm <sup>-3</sup>	1988–1989	DY	Davidson et al. (1993b,a)
Al	mean: 5.5 ngm <sup>-3</sup>	1988–1989	DY	Davidson et al. (1993b,a)
Al	0.29... 260 ngm <sup>-3</sup>	1988–1989	DY	Mosher et al. (1993)
Al	1.1... 48 ngm <sup>-3</sup>	1988–1989	SU	Mosher et al. (1993)
Al		1990–2001	SN	Heidam et al. (2004)
Al	mean: 1.0 ngm <sup>-3</sup>	1999–2003	nm	Weller et al. (2008)
Al	mean: 44.36 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
As	sum 17, win 8.4 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
As	see note <sup>15</sup>	1974–1975	sp	Maenhaut et al. (1979)
As	sum 11, win 11 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
As		1984–1987	PF	Sturges and Shaw (1993)
As		1990–2001	SN	Heidam et al. (2004)
As	mean: 0.02 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Ba	sum 20, win 19 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Ba	mean: 16 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Ba	sum 40, win 50 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Ba		1979–1984	ARC	Barrie and Hoff (1985)
Ba		1980–2000	AL	Gong and Barrie (2005)
Ba		1983–1986	NA, NO	Maenhaut et al. (1989)
Be		1983–2008	nm	Elsässer et al. (2011)

<sup>15</sup>Different values for Whatman filters and Nuclepore filters: 7.1 or 31 pgm<sup>-3</sup>(STP), resp.



**Table 5:** Aerosol data.

species	value	date	site	reference
Ca	0.5 ngm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
Ca	sum 1900, win 550 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Ca	mean: 490 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Ca	mean: 55 ngm <sup>-3</sup>	1976–1978 (win)	BA	Rahn and McCaffrey (1979)
Ca		1979–1980	ARC	Heidam (1985)
Ca	sum 1000, win 1800 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Ca		1979–1984	ARC	Barrie and Hoff (1985)
Ca		1980–1995	AL	Sirois and Barrie (1999)
Ca		1980–2000	AL	Gong and Barrie (2005)
Ca		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
Ca <sup>2+</sup>		1983–1996	nm	Wagenbach et al. (1998a)
Ca <sup>2+</sup>	mean: 12.5 ngm <sup>-3</sup>	1983–2005	nm	Weller and Wagenbach (2007)
Ca		1983–1986	NA, NO	Maenhaut et al. (1989)
Ca <sup>2+</sup>	mean: 15.9 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
Ca	19...915 ngm <sup>-3</sup>	spr 1988	AL	Bottenheim et al. (1990)
Ca	mean: 2.7 ngm <sup>-3</sup>	1988–1989	DY	Davidson et al. (1993b,a)
Ca	mean: 4.2 ngm <sup>-3</sup>	1988–1989	DY	Davidson et al. (1993b,a)
Ca	0.095...170 ngm <sup>-3</sup>	1988–1989	DY	Mosher et al. (1993)
Ca	0.5...110 ngm <sup>-3</sup>	1988–1989	SU	Mosher et al. (1993)
Ca		1990–2001	SN	Heidam et al. (2004)
Ca <sup>2+</sup>		1991–1995	du	Wagenbach et al. (1998a)
Ca <sup>2+</sup>		1991–1999	du	Jourdain and Legrand (2002)
Ca <sup>2+</sup>	mean: 29 ngm <sup>-3</sup>	May–Jul 1993	SU	Bergin et al. (1995)
Ca <sup>2+</sup>		Jan 1994	du	Legrand et al. (1998)
Ca <sup>2+</sup>		Aug 1994	SU	Dibb et al. (1996)
nss-Ca <sup>2+</sup>	trend analysis	1997–2004	ARC	Quinn et al. (2007)
Ca	mean: 15 ngm <sup>-3</sup>	1999–2003	nm	Weller et al. (2008)
Ca <sup>2+</sup>	sum mean 2.1...3.8 ngm <sup>-3</sup>	2000–2002	ks	Piel et al. (2006)
nss-Ca <sup>2+</sup>	mean: 32 ngm <sup>-3</sup>	Apr–May 2001	NA	Teinilä et al. (2003)
nss-Ca <sup>2+</sup>	mean: 8.7 ngm <sup>-3</sup>	Feb–Mar 2001	NA	Teinilä et al. (2003)

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**Table 5:** Aerosol data.

species	value	date	site	reference
Ca	mean: 51.66 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Ca <sup>2+</sup>	mean: 1.3 ngm <sup>-3</sup>	2003–2005	ks	Weller and Wagenbach (2007)
Cd	sum <200, win 49 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Cd	mean: ≤18 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Cd	mean: 0.37 ngm <sup>-3</sup>	1976–1978 (win)	BA	Rahn and McCaffrey (1979)
Cd	sum 110, win 50 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Cd	annual mean: 0.01...0.03 ngm <sup>-3</sup>	1994–2002	NA	Berg et al. (2004)
Co	0.84 pgm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
Co	sum 0.40, win 0.60 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Co	mean: 0.49 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Co	sum 0.77, win 0.45 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Co	annual mean: 0.055...0.14 ngm <sup>-3</sup>	1994–2002	NA	Berg et al. (2004)
Cr	5.3 pgm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
Cr	sum 11, win 13 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Cr	mean: <40 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Cr		1979–1980	ARC	Heidam (1985)
Cr	sum 29, win 20 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Cr		1979–1984	ARC	Barrie and Hoff (1985)
Cr		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
Cr		1983–1986	NA, NO	Maenhaut et al. (1989)
Cr	annual mean: 0.04...0.9 ngm <sup>-3</sup>	1994–2002	NA	Berg et al. (2004)
Cr	mean: 0.11 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Cu	36 pgm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
Cu	sum 79, win 59 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)

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**Table 5:** Aerosol data.

species	value	date	site	reference
Cu	mean: 29 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Cu		1979–1980	ARC	Heidam (1985)
Cu	sum 190, win 130 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Cu		1979–1984	ARC	Barrie and Hoff (1985)
Cu		Apr–May 1980	MB, IG	Barrie et al. (1981)
Cu		1980–1995	AL	Sirois and Barrie (1999)
Cu		1980–2000	AL	Gong and Barrie (2005)
Cu		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
Cu		1983–1986	NA, NO	Maenhaut et al. (1989)
Cu		1990–2001	SN	Heidam et al. (2004)
Cu	annual mean: 0.25...0.41 ngm <sup>-3</sup>	1994–2002	NA	Berg et al. (2004)
Cu	mean: 0.36 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Fe	0.84 ngm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
Fe	sum 250, win 680 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Fe	mean: 620 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Fe		1979–1980	ARC	Heidam (1985)
Fe	sum 660, win 280 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Fe		1979–1984	ARC	Barrie and Hoff (1985)
Fe		1980–2000	AL	Gong and Barrie (2005)
Fe		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
Fe		1983–1986	NA, NO	Maenhaut et al. (1989)
Fe	0.1...260 ngm <sup>-3</sup>	1988–1989	DY	Mosher et al. (1993)
Fe	0.45...44 ngm <sup>-3</sup>	1988–1989	SU	Mosher et al. (1993)
Fe		1990–2001	SN	Heidam et al. (2004)
Fe	mean: 33.42 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Ga	mean: 0.02 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Hg	mean: < 0.4 ngm <sup>-3</sup>	1976–1978 (win)	BA	Rahn and McCaffrey (1979)
Hg	mean: 1.44 pgm <sup>-3</sup>	1996–1997	PS	Berg et al. (2001)
Hg	mean: 2.67 pgm <sup>-3</sup>	1996–1997	NA	Berg et al. (2001)
Hg		Apr–May 1998	AL	Lu et al. (2001)
Hg		Nov 1999	tn	Sprovieri and Pirrone (2000)

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**Table 5:** Aerosol data.

species	value	date	site	reference
Hg		2000	sp	Arimoto et al. (2004b)
Hg		2000	NA	Berg et al. (2003)
Hg		Apr–Jun 2001	BA	Lindberg et al. (2002)
Hg	median: 183 pgm <sup>-3</sup>	Apr–May 2001	KU	Poissant and Pilote (2003); Poissant and Hoenninger (2004)
Hg		Apr 2002	AL	Steffen et al. (2003)
Hg		Apr 2002	KU	Gauchard et al. (2005b)
Hg		Apr–May 2002	NA	Sommar et al. (2007)
Hg		Apr–May 2003	NA	Sprovieri et al. (2005a,b)
Hg		Apr–May 2003	NA	Aspmo et al. (2005); Gauchard et al. (2005a)
Hg	mean: 49 pgm <sup>-3</sup>	Oct–Nov 2003	mm	Brooks et al. (2008b)
Hg	mean: 224 pgm <sup>-3</sup>	Nov–Dec 2003	sp	Brooks et al. (2008a); Eisele et al. (2008)
Hg		Apr–Aug 2004	CH	Kirk et al. (2006)
Hg		2004–2005	NA	Ferrari et al. (2008)
Hg	mean: 102.6 pgm <sup>-3</sup>	Feb–Jun 2005	AL	Cobbett et al. (2007)
Hg	mean: 1.0 pgm <sup>-3</sup>	Jul–Sep 2005	ARC	Sommar et al. (2010)
Hg	mean: 37.2 pgm <sup>-3</sup>	2007	SU	Brooks et al. (2011)
Hg	mean: 6.7 pgm <sup>-3</sup>	2008	SU	Brooks et al. (2011)
Hg	up to 370 pgm <sup>-3</sup>	Feb–Jun 2008	NA	Steen et al. (2009)
K	0.3 ngm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
K	sum 1300, win 610 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
K	mean: 680 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
K		1979–1980	ARC	Heidam (1985)
K	sum 740, win 1600 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
K <sup>+</sup>		1980–1995	AL	Sirois and Barrie (1999)
K		1980–2000	AL	Gong and Barrie (2005)
K		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
K <sup>+</sup>		1983–1996	nm	Wagenbach et al. (1998a)
K		1983–1986	NA, NO	Maenhaut et al. (1989)

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**Table 5:** Aerosol data.

species	value	date	site	reference
K <sup>+</sup>	mean: 11 ngm <sup>-3</sup>	1983–2005	nm	Weller and Wagenbach (2007)
K <sup>+</sup>		Mar–May 1986	BA	Li and Winchester (1989a,b)
K <sup>+</sup>	3.6...62.8 ngm <sup>-3</sup>	spr 1988	AL	Bottenheim et al. (1990)
K <sup>+</sup>	mean: 37 ngm <sup>-3</sup>	May 1989	AL	Kieser et al. (1993)
K		1990–2001	SN	Heidam et al. (2004)
K <sup>+</sup>		1991–1995	du	Wagenbach et al. (1998a)
K <sup>+</sup>		1991–1999	du	Jourdain and Legrand (2002)
K <sup>+</sup>	mean: 3.4 ngm <sup>-3</sup>	May–Jul 1993	SU	Bergin et al. (1995)
K <sup>+</sup>		Jan 1994	du	Legrand et al. (1998)
K <sup>+</sup>		Aug 1994	SU	Dibb et al. (1996)
K <sup>+</sup>	mean: 22.0 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
nss-K <sup>+</sup>	trend analysis	1997–2004	ARC	Quinn et al. (2007)
K	mean: 16 ngm <sup>-3</sup>	1999–2003	nm	Weller et al. (2008)
K <sup>+</sup>	sum mean 0.4...2.1 ngm <sup>-3</sup>	2000–2002	ks	Piel et al. (2006)
nss-K <sup>+</sup>	mean: 6.0 ngm <sup>-3</sup>	Apr–May 2001	NA	Teinilä et al. (2003)
nss-K <sup>+</sup>	mean: 8.8 ngm <sup>-3</sup>	Feb–Mar 2001	NA	Teinilä et al. (2003)
K	mean: 42.89 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
K <sup>+</sup>	mean: 2.7 ngm <sup>-3</sup>	2003–2005	ks	Weller and Wagenbach (2007)
nss-K <sup>+</sup>	up to 100 ngm <sup>-3</sup>	2005–2010	du	Legrand et al. (2012)
K <sup>+</sup>		2007	tr	Hansen et al. (2009)
Mg	1.0 ngm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
Mg	sum 5700, win 930 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Mg	mean: 720 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Mg	mean: 160 ngm <sup>-3</sup>	1976–1978 (win)	BA	Rahn and McCaffrey (1979)
Mg	sum 1600, win 4600 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Mg		1979–1984	ARC	Barrie and Hoff (1985)
Mg		1980–1995	AL	Sirois and Barrie (1999)
Mg		1980–2000	AL	Gong and Barrie (2005)
Mg		1983–1986	NA, NO	Maenhaut et al. (1989)

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species	value	date	site	reference
Mg <sup>2+</sup>		1983–1996	nm	Wagenbach et al. (1998a)
Mg <sup>2+</sup>	mean: 41 ngm <sup>-3</sup>	1983–2005	nm	Weller and Wagenbach (2007)
Mg	13...262 ngm <sup>-3</sup>	spr 1988	AL	Bottenheim et al. (1990)
Mg	0.69...92 ngm <sup>-3</sup>	1988–1989	DY	Mosher et al. (1993)
Mg	2.5...27 ngm <sup>-3</sup>	1988–1989	SU	Mosher et al. (1993)
Mg <sup>2+</sup>		1991–1993	ha	Wagenbach et al. (1998a)
Mg <sup>2+</sup>		1991–1995	du	Wagenbach et al. (1998a)
Mg <sup>2+</sup>	mean: 6.8 ngm <sup>-3</sup>	May–Jul 1993	SU	Bergin et al. (1995)
Mg <sup>2+</sup>		Jan 1994	du	Legrand et al. (1998)
Mg <sup>2+</sup>		Aug 1994	SU	Dibb et al. (1996)
Mg <sup>2+</sup>	mean: 34 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
nss-Mg <sup>2+</sup>	trend analysis	1997–2004	ARC	Quinn et al. (2007)
Mg	mean: 52 ngm <sup>-3</sup>	1999–2003	nm	Weller et al. (2008)
Mg <sup>2+</sup>	sum mean 0.5...1.7 ngm <sup>-3</sup>	2000–2002	ks	Piel et al. (2006)
nss-Mg <sup>2+</sup>	mean: 7.3 ngm <sup>-3</sup>	Apr–May 2001	NA	Teinilä et al. (2003)
nss-Mg <sup>2+</sup>	mean: 7.7 ngm <sup>-3</sup>	Feb–Mar 2001	NA	Teinilä et al. (2003)
Mg <sup>2+</sup>	mean: 3.9 ngm <sup>-3</sup>	2003–2005	ks	Weller and Wagenbach (2007)
Mn	10.3 pgm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
Mn	sum 6.7, win 14 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Mn		1973–1978	ARC	Rahn (1981)
Mn	mean: 13.3 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Mn	mean: 1.12 ngm <sup>-3</sup>	1976–1978 (win)	BA	Rahn and McCaffrey (1979)
Mn		1979–1980	ARC	Heidam (1985)
Mn	sum 8.9, win 4.2 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Mn		1979–1984	ARC	Barrie and Hoff (1985)
Mn		Apr–May 1980	MB, IG	Barrie et al. (1981)
Mn		1980–1995	AL	Sirois and Barrie (1999)
Mn		1980–2000	AL	Gong and Barrie (2005)
Mn		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)

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species	value	date	site	reference
Mn		1983–1986	NA, NO	Maenhaut et al. (1989)
Mn	0.19... 6.7 ngm <sup>-3</sup>	spr 1988	AL	Bottenheim et al. (1990)
Mn	0.004... 3.3 ngm <sup>-3</sup>	1988–1989	DY	Mosher et al. (1993)
Mn	0.052... 0.84 ngm <sup>-3</sup>	1988–1989	SU	Mosher et al. (1993)
Mn		1990–2001	SN	Heidam et al. (2004)
Mn	annual mean: 0.24... 0.57 ngm <sup>-3</sup>	1994–2002	NA	Berg et al. (2004)
Mn	mean: 0.60 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Mn		1976–2008	BA	Quinn et al. (2009)
Na	7.2 ngm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
Na	sum 40000, win 5100 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Na	mean: 3300 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Na	mean: 770 ngm <sup>-3</sup>	1976–1978 (win)	BA	Rahn and McCaffrey (1979)
Na		1976–1980	BA	Berg et al. (1983)
Na	sum 8.7, win 31 ngm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Na		1979–1984	ARC	Barrie and Hoff (1985)
Na <sup>+</sup>		1980–2000	AL	Barrie and Barrie (1990); Li and Barrie (1993); Sirois and Barrie (1999); Gong and Barrie (2005); Norman et al. (1999)
Na <sup>+</sup>		Apr–May 1980	MB, IG	Barrie et al. (1981)
Na		1982	sp	Bodhaine et al. (1986)
Na <sup>+</sup>	74... 289 ngm <sup>-3</sup>	Feb 1982	IG	Hoff et al. (1983)
Na	14... 188 ngm <sup>-3</sup>	Feb 1982	IG	Hoff et al. (1983)
Na	<40... 236 ngm <sup>-3</sup>	spr 1983	ARC	Cahill and Eldred (1984)
Na		1983–1986	NA, NO	Maenhaut et al. (1989)
Na <sup>+</sup>		1983–1996	nm	Wagenbach et al. (1998a)
Na <sup>+</sup>	mean: 270 ngm <sup>-3</sup>	1983–2005	nm	Weller and Wagenbach (2007)
Na <sup>+</sup>		1983–2007	nm	Weller et al. (2011)
Na		1984–1987	PF	Sturges and Shaw (1993)

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**Table 5:** Aerosol data.

species	value	date	site	reference
Na	see note <sup>16</sup>	Mar–Apr 1986	ant	Pszenny et al. (1989)
Na <sup>+</sup>		Mar–May 1986	BA	Li and Winchester (1989a,b)
Na	24... 1240 ngm <sup>-3</sup>	spr 1988	AL	Bottenheim et al. (1990)
Na	0.1... 300 ngm <sup>-3</sup>	1988–1989	DY	Mosher et al. (1993)
Na	0.52... 17.4 ngm <sup>-3</sup>	1988–1989	SU	Mosher et al. (1993)
Na	mean: 8.0 ngm <sup>-3</sup>	1988–1989	DY	Davidson et al. (1993b,a)
Na <sup>+</sup>	mean: 117 ngm <sup>-3</sup>	May 1989	AL	Kieser et al. (1993)
Na <sup>+</sup>	median: 0.33 nmolm <sup>-3</sup> (STP)	1990–1991	ea	de Mora et al. (1997)
Na <sup>+</sup>		1990–1992	NA	Heintzenberg and Leck (1994)
Na <sup>+</sup>		1991–1993	ha	Wagenbach et al. (1998a)
Na <sup>+</sup>		1991–1995	du	Wagenbach et al. (1998a)
Na <sup>+</sup>		1991–1999	du	Jourdain and Legrand (2002)
Na <sup>+</sup>		Jul–Dec 1992	sp	Harder et al. (2000)
Na <sup>+</sup>	mean: 14 ngm <sup>-3</sup>	May–Jul 1993	SU	Bergin et al. (1995)
Na <sup>+</sup>		Jul–Aug 1996	ARC	Kerminen and Leck (2001)
Na <sup>+</sup>		1996–1999	NA	Hara et al. (2002a)
Na <sup>+</sup>		1997–1998	sy, df	Hara et al. (2004)
Na <sup>+</sup>	mean: 289 ngm <sup>-3</sup>	1997–1999	SE	Ricard et al. (2002)
Na <sup>+</sup>	0... 1062.0 pmolmol <sup>-1</sup>	1997–1999 (spr)	NA	Beine et al. (2001)
Na	mean: 45 ngm <sup>-3</sup>	1998–1999	sp	Arimoto et al. (2001)
Na <sup>+</sup>		1998, 2000	sp	Arimoto et al. (2004a)
Na	mean: 330 ngm <sup>-3</sup>	1999–2003	nm	Weller et al. (2008)
Na <sup>+</sup>	mean: 339.3 ngm <sup>-3</sup>	Apr–May 2000	AL	Ianniello et al. (2002)
Na <sup>+</sup>	mean: 69.1 ngm <sup>-3</sup>	Feb 2000	AL	Ianniello et al. (2002)
Na		Mar–Apr 2000	NA	Hara et al. (2002b)
Na <sup>+</sup>	sum mean 2.4... 12.0 ngm <sup>-3</sup>	2000–2002	ks	Piel et al. (2006)
Na		Jan–Dec 2001	ha	Rankin and Wolff (2003)
Na <sup>+</sup>	mean: 312 ngm <sup>-3</sup>	Feb–Mar 2001	NA	Teinilä et al. (2003)
Na <sup>+</sup>	mean: 261 ngm <sup>-3</sup>	Apr–May 2001	NA	Teinilä et al. (2003)

<sup>16</sup>Data available in supplement of Sander et al. (2003).

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**Table 5:** Aerosol data.

species	value	date	site	reference
Na <sup>+</sup>		Nov–Dec 2003	sp	Eisele et al. (2008)
Na <sup>+</sup>	mean: 24 ngm <sup>-3</sup>	2003–2005	ks	Weller and Wagenbach (2007)
Na		2004–2005	ha	Wolff et al. (2008)
Na <sup>+</sup>	up to 40 ngm <sup>-3</sup>	2006	co	Jourdain et al. (2008)
Na <sup>+</sup>		2007	tr	Hansen et al. (2009)
Ni		1979–1980	ARC	Heidam (1985)
Ni		1979–1984	ARC	Barrie and Hoff (1985)
Ni		Apr–May 1980	MB, IG	Barrie et al. (1981)
Ni		1980–2000	AL	Gong and Barrie (2005)
Ni		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
Ni		1983–1986	NA, NO	Maenhaut et al. (1989)
Ni		1990–2001	SN	Heidam et al. (2004)
Ni	annual mean: 0.07...0.19 ngm <sup>-3</sup>	1994–2002	NA	Berg et al. (2004)
Ni	mean: 0.17 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Pb	0.63 ngm <sup>-3</sup> (STP) see note <sup>17</sup>	1971	sp	Zoller et al. (1974)
Pb		1974–1975	sp	Maenhaut et al. (1979)
Pb		1979–1980	ARC	Heidam (1985)
Pb		1979–1984	ARC	Barrie and Hoff (1985)
Pb		Apr–May 1980	MB, IG	Barrie et al. (1981)
Pb		1980–1986	AL	Barrie and Barrie (1990)
Pb		1980–1995	AL	Sirois and Barrie (1999)
Pb		1980–2000	AL	Gong and Barrie (2005)
Pb		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
Pb		1983–1986	NA, NO	Maenhaut et al. (1989)
<sup>210</sup> Pb		1983–2008	nm	Elsässer et al. (2011)
Pb		Feb–Mar 1990	BA	Sturges et al. (1993a)
Pb		1990–2001	SN	Heidam et al. (2004)
Pb	annual mean: 0.48...0.83 ngm <sup>-3</sup>	1994–2002	NA	Berg et al. (2004)
Pb		2000	sp	Arimoto et al. (2004b)

<sup>17</sup>Different values for Whatman filters and Nuclepore filters: 27 or 76 pgm<sup>-3</sup>(STP), resp.

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**Table 5:** Aerosol data.

species	value	date	site	reference
Pb	mean: 0.48 ng m <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Rb	sum 3.0, win <4 pg m <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Rb	mean: 1.9 pg m <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Rb	sum 2.4, win 1.3 pg m <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Rb	mean: 0.11 ng m <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Se	5.6 pg m <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
Se	sum 6.9, win 6.3 pg m <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Se	mean: 6.2 pg m <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Se	sum 8.4, win 4.8 pg m <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Se		1983–1986	NA, NO	Maenhaut et al. (1989)
Se	monthly mean: 0.03...0.08 ng m <sup>-3</sup>	1984–1987	PF	Sturges and Shaw (1993)
Se	mean: 19 pg m <sup>-3</sup>	1999–2003	nm	Weller et al. (2008)
Se	mean: 0.05 ng m <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Si		1990–2001	SN	Heidam et al. (2004)
Si	mean: 143.46 ng m <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Sr	sum <150, win 31 pg m <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Sr		1979–1980	ARC	Heidam (1985)
Sr		1979–1984	ARC	Barrie and Hoff (1985)
Sr		1983–1986	NA, NO	Maenhaut et al. (1989)
Sr		1990–2001	SN	Heidam et al. (2004)
Sr	mean: 0.29 ng m <sup>-3</sup>	1999–2003	nm	Weller et al. (2008)
Sr	mean: 0.79 ng m <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
Ti	sum 180, win 110 pg m <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Ti	mean: 100 pg m <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Ti	sum 290, win 160 pg m <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
Ti		1979–1984	ARC	Barrie and Hoff (1985)

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**Table 5:** Aerosol data.

species	value	date	site	reference
Ti		1980–2000	AL	Gong and Barrie (2005)
Ti		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
Ti		1983–1986	NA, NO	Maenhaut et al. (1989)
Ti		1990–2001	SN	Heidam et al. (2004)
Ti	mean: 3.09 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
V	1.5 pgm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
V	sum 0.9, win 1.6 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
V		1973–1978	ARC	Rahn (1981)
V	mean: 1.33 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
V	mean: 0.65 ngm <sup>-3</sup>	1976–1978 (win)	BA	Rahn and McCaffrey (1979)
V	sum 1.1, win 0.42 pgm <sup>-3</sup>	1979–1983	sp	Tuncel et al. (1989)
V		1979–1984	ARC	Barrie and Hoff (1985)
V		Apr–May 1980	MB, IG	Barrie et al. (1981)
V		1980–1995	AL	Sirois and Barrie (1999)
V		1980–2000	AL	Gong and Barrie (2005)
V		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
V		1983–1986	NA, NO	Maenhaut et al. (1989)
V		1984–1987	PF	Sturges and Shaw (1993)
V	0.05... 1.72 ngm <sup>-3</sup>	spr 1988	AL	Bottenheim et al. (1990)
V	0.014... 5.5 ngm <sup>-3</sup>	1988–1989	DY	Mosher et al. (1993)
V	0.006... .25 ngm <sup>-3</sup>	1988–1989	SU	Mosher et al. (1993)
V		1990–2001	SN	Heidam et al. (2004)
V	annual mean: 0.07... 0.20 ngm <sup>-3</sup>	1994–2002	NA	Berg et al. (2004)
V	mean: 0.17 ngm <sup>-3</sup>	2002–2005	NU	Skov et al. (2006b)
V	decreasing trend	1976–2008	BA	Quinn et al. (2009)
Zn	30 pgm <sup>-3</sup> (STP)	1971	sp	Zoller et al. (1974)
Zn	sum 77, win 35 pgm <sup>-3</sup>	1971–1978	sp	Cunningham and Zoller (1981)
Zn	mean: 33 pgm <sup>-3</sup> (STP)	1974–1975	sp	Maenhaut et al. (1979)
Zn	mean: 14.8 ngm <sup>-3</sup>	1976–1978 (win)	BA	Rahn and McCaffrey (1979)
Zn		1979–1980	ARC	Heidam (1985)

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**Table 5:** Aerosol data.

species	value	date	site	reference
Zn	sum 250, win 170 $\text{pgm}^{-3}$	1979–1983	sp	Tuncel et al. (1989)
Zn		1979–1984	ARC	Barrie and Hoff (1985)
Zn		Apr–May 1980	MB, IG	Barrie et al. (1981)
Zn		1980–1995	AL	Sirois and Barrie (1999)
Zn		1980–2000	AL	Gong and Barrie (2005)
Zn		Aug–Sep 1983	ARC	Pacyna and Ottar (1985)
Zn		1983–1986	NA, NO	Maenhaut et al. (1989)
Zn	mean: 0.63 $\text{ngm}^{-3}$	1988–1989	DY	Davidson et al. (1993b,a)
Zn		1990–2001	SN	Heidam et al. (2004)
Zn	annual mean: 1.2...1.9 $\text{ngm}^{-3}$	1994–2002	NA	Berg et al. (2004)
Zn	mean: 2.62 $\text{ngm}^{-3}$	2002–2005	NU	Skov et al. (2006b)
Zr	mean: 0.10 $\text{ngm}^{-3}$	2002–2005	NU	Skov et al. (2006b)

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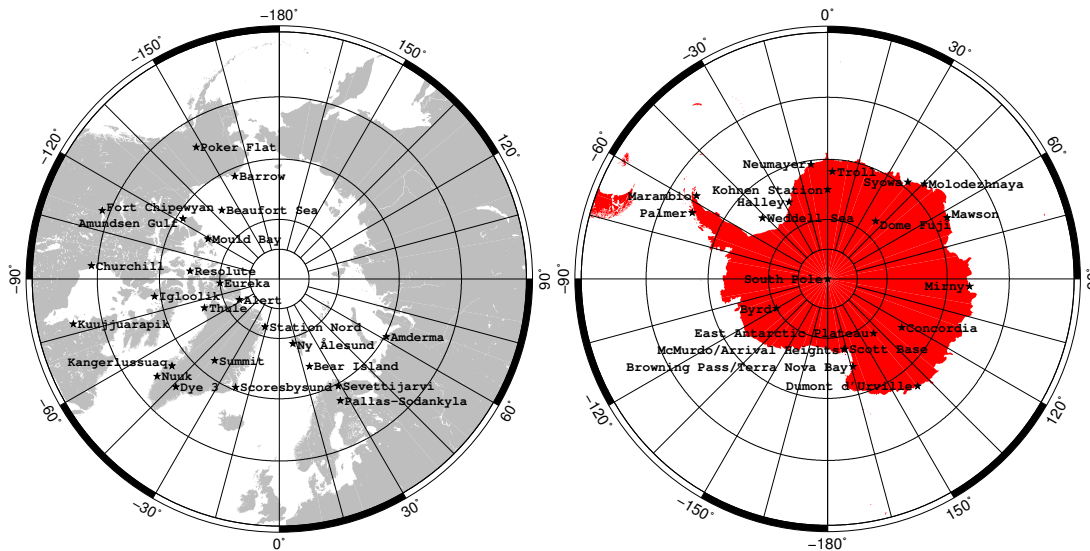


Fig. 1. Measurement sites in the Arctic (left) and the Antarctic (right).