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Earth System Science Data Discussions

Interactive comment on "Observations of the atmosphere and surface state over Terra Nova Bay, Antarctica using unmanned aircraft systems" *by* J. J. Cassano et al.

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We thank the anonymous reviewer for their comments on our manuscript.

Reviewer: The authors report on a data set obtained during several flights with unmanned aerial systems in the Antarctic, above a polynya with open water and above sea ice. The data set is of high scientific interest, and will be used for different meteorological studies as well as serving as input for modelling activities. The data set is definitely unique – obtained at a remote region, and using unmanned aerial systems operating outside direct eye contact. The data set is useful for studying the interaction of ocean, sea ice and atmosphere, and especially for estimation of the sensible

and latent heat flux from open water in very cold surroundings. The authors provide the complete data set that was obtained during the field experiment. Altogether, the significance of the data set is very high.

Response: We thank the reviewer for their positive comments regarding the significance of these data.

Reviewer: The data quality seems ok at a first glance. However, I would suggest including more information, either directly in the data set, or at least in the manuscript. For example, it would be interesting for the reader to know if the temperature data are raw data, or if any kind of post processing was applied. For example was a correction for the response time of the sensor applied? In Fig. 5, only temperature profiles of ascents are presented. How does this fit with the descents? Is there a shift in the atmospheric features, which might be an artifact caused by sensor response time (which is specified as < 20s in Table 2)? Did the authors calculate the static air temperature from the observed air temperature?

Response: No post-processing of the temperature data was applied. No correction was applied to account for the sensor lag. For the temperature measurements there is no noticeable shift in the temperature profiles for ascending versus descending profiles and thus the sensor lag is likely much smaller than the vendor stated sensor lag due to the increased ventilation on the UAS platform compared to a stationary deployment of this instrument. The sensor lag for the relative humidity measurements is larger and there is a noticeable shift in the relative humidity profiles for ascending versus descending profiles, but we have not corrected for this sensor lag in the published data. Due to the low wind speed of the UAS and the small change in air speed we have not calculated the static air temperature and provide the raw temperature data measured by the UAS. We now state in section 3 that no corrections to the data were applied.

Reviewer: This criticism holds true even more for the wind. In the article, the accuracy

of the wind speed is not specified, not even in Table 2. On the other hand, the wind speed values in u and v component are provided with values like 5.3 m/s, suggesting that it is possible to derive such exact values from the data. The method for deriving the wind vector without a five-hole probe should be explained more in detail, with an estimation of measurement uncertainties. At least a reference should be given, where the calculation is shown in detail.

Response: The wind speed is provided directly by Aerosonde Pty. Ltd. and no information is provided on the details of the wind speed calculation so we are unable to provide a reference or equation for this calculation. Previous atmospheric research using Aerosonde UAS (McGeer and Holland (1993) and Holland et al. (1992)) indicate a wind speed accuracy of 1 m s-1 and we now indicate this in the revised manuscript.

Reviewer: The section about data availability should contain more information about the percent- age that the individual sensors were working and provided correct data. By going through the data set, I noticed that the surface temperature was not recorded for entire flights. Maybe it would be useful to include this information in Table 3, which sensor was working how much of the time.

Response: Thank you for suggesting that we explicitly comment on the percent of data available for each flight. We have added the following paragraph at the end of section 3 that states how much data is available for the different instruments. Since more than 98% of the data is available for all observations, other than surface temperature, we have not listed specific values of data availability by variable or flight. Because of the large amount of missing surface temperature data we have now listed the percent of available data for each flight in Table 3.

For all 14 flights more than 98% of the possible pressure, temperature, humidity, wind speed and wind direction values and all of the GPS and aircraft flight data are available in the quality controlled dataset. Surface temperature data is available for 7 of the 14 flights but quality controlled data is present for just over 30% of the flight time for 5 of

the flights and for less than 20% of the flight time for 2 of the flights (Table 3).

Reviewer: The section about data processing and quality control should contain more precise information about how the raw data were screened and treated to get the values in the repository. E.g. p. 1004, l. 8 “found the values to be reasonable and within the range of expectations” – did you perform a sensor calibration? Did you maybe compare with measurements of a ground-based site, or with a radiosonde?

Response: The observations were assessed for reasonable values based on expected weather conditions and other limited in-situ observations in the vicinity of Ross Island and Terra Nova Bay. Basically, we sought to remove any physically unrealistic values and identify any abrupt jumps in data that were physically implausible. Other than the small number of measurements removed the observations were all within the range of reasonable values.

Reviewer: Instead, the paragraph starting at p. 1003 l. 21 could be removed.

Response: We feel that this paragraph provides useful information regarding the data processing procedure we used and provides a context for the published dataset so we have not removed this paragraph.

Reviewer: Specific comments On p. 998, l. 3, there could be some more references added about research activities, measurements and modelling at other places in the polar regions, that require atmospheric data above polynyas, to highlight the importance of the data set.

Response: We feel that the introduction adequately describes the scientific issues related to polynyas and as such we have not added any additional references based on this comment.

Reviewer: Please quantify what you mean with “strong winds” (p. 998, l. 5). In this case you are talking about wind speed of typically xx m/s, or up to xx m/s?

Response: Morales Maqueda et al. (2004) found that wind speeds in excess of 20 m

s-1are required to maintain ice free polynyas in coastal Antarctica. We have added a reference to this paper but felt that stating a threshold wind speed in the current manuscript provides more detail than is necessary in a manuscript focused primarily on the data collected during the 2012 field campaign.

Reviewer: On p. 998, l. 24 I suggest that you already state that some flights were performed simultaneously parallel and perpendicular to the wind. This underlines the uniqueness of the data set.

Response: We have added the following statement to the manuscript at this location. On five of the flight days two UAS made simultaneous observations of the atmosphere over Terra Nova Bay while flying in both the downwind and cross-wind direction.

Reviewer: On p. 999, l. 19, please specify the limits up to which wind speed the Aerosonde can be used.

Response: We have added the following text to the revised manuscript. In fact, observations were made in wind speeds in excess of the UAS's maximum flight speed of 33 m s-1.

Reviewer: On p. 1000, l. 6 ff, please provide at least an estimation of the error bar of the derived wind speed and wind direction. For sure you have done intercomparison flights with a meteorological tower or tested the data quality in another field experiment.

Response: We now state the accuracy of the derived wind speeds in Table 2.

Reviewer: P. 1000, l. 11: Please quantify the cold bias of the surface temperature, to make clear if the effect is acceptable or a problem for other studies on a first glance.

Response: We now state that any use of the surface temperature data should be done only after careful assessment of the magnitude of this error based on the flight level.

Reviewer: P. 1000, l. 19: Was icing a problem for the measurements? It sounds as if there was a lot of humidity transported into the cold atmosphere. . . maybe you can

comment on this?

Response: Icing was a major concern for the UAS safety and as such we mostly avoided icing conditions. As a result icing of the instruments is not an issue for this dataset.

Reviewer: P. 1001: For the reader, it would be nice to get information about the dimensions of this polynya. What was the length and width? Is this typical for this season? Maybe you could give the dimensions of the polynya in Fig. 6 and 7? This is also important for comparing to measurements and modelling results above other polynyas. In the literature, usually the effect of polynyas on the air temperature is most pronounced below 100 m, where you did not measure. But maybe the other polynyas were typically of smaller dimensions.

Response: In the introduction we now state that the TNB polynya varies in size from 3000 to 7000 km2 during the winter (Hauser et al. 2002).

Reviewer: P. 1002, l. 4: please rephrase "neither of the 14 . . .flights made it to TNB". This sounds as if no flight reached the goal of investigating TNB.

Response: This sentence has been rephrased as "Neither of the flights on 14 September 2012 (Figs. 3b, 3c) made it to TNB due to problems with the Aerosondes".

Reviewer: P. 1003, l. 15: Did I understand correctly that during 14 flights, 2 aircraft were lost? This seems quite a risky operation. Can you give an explanation? Was it due to icing?

Response: Table 3 states the reasons for both lost UAS. One aircraft crashed due to icing of the pitot tube and the second aircraft crashed due to failure of the generator belt.

Reviewer: P. 1004, l. 21: Please describe more in detail thee wind finding maneuvers.

Response: The wind speed is provided directly by Aerosonde Pty. Ltd. and no infor-

mation is provided on the details of the wind speed calculation so we are unable to provide a reference or equation for this calculation.

Reviewer: p. 1005: why do you use the GPS altitude and not the barometric altitude?

Response: Due to the long flight time and distances covered during the UAS missions changes in surface pressure will result in significantly larger changes in altitude derived from the onboard barometer than the errors in the GPS altitude.

Reviewer: In Fig. 5 it would be nice to know at what distance from the beginning of the polynya the profiles were obtained. Maybe you can add it in the caption.

Response: We have now stated in the caption that the initial profile is located 4 km from the coast.

Reviewer: Fig. 6: would it be possible to choose another colour scale? It is really difficult to know about the change in the temperature with just similar blue colours.

Response: We have revised the color scale for Figure 6 to better highlight the variation in temperature over the polynya.

Interactive comment on Earth Syst. Sci. Data Discuss., 8, 995, 2015.