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Interactive comment

Interactive comment on “The Alberta Smoke Plume Observation Study” *by* Kerry Anderson et al.

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The authors appreciate the initial review of the manuscript, which presents a number of valid criticisms that we hope to adequately address. The authors intend to provide the necessary answers in a revised manuscript shortly. As we work towards integrating this discussion into the revision, we are interested in this reviewer’s response as well as comments from other reviewers.

The purpose for studying smoke plumes is outlined in the introduction. The impact of wildland fire smoke on air quality is becoming a public health concern in western Canada (and other parts of the World). Six examples of smoke events in recent years

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Discussion paper

were included to illustrate the impact. And this may only get worse given the potential increase of wildland fire activity due to global warming.

The introduction further discusses that predicting the penetration height is largely an unresolved problem and that there is a lack of detailed plume observations to validate models. This data set attempts to address this. We are currently developing a plume rise model and expect to use this data for validation purposes but felt that the dataset itself needed its own detailed documentation.

Smoke plume modelling from wildland fires is a relatively new topic and one that mixes a variety of disciplines. A forest fire's behaviour drives the processes that lead to smoke emissions and concentrations while the energy generated by the fire leads to the buoyancy, vertical lift and plume penetration height. This study attempts to capture these through fire weather and fire behaviour and include them in the dataset. An effort was placed on linking ground-based fire reports with associated plume observations. The following studies used remotely-sensed data to evaulate smoke plume predictions:

- BlueSky, the currently accepted smoke forecasting framework (Larkin et al 2009), uses satellite and ground reports for fire size and emissions and the Briggs model for plume rise (Briggs 1965). The Briggs model was designed to model plume rise from industrial stacks and is not appropriate for wildland fire smoke. Rolf et al (2009) used the BlueSky system to evaluate the National Oceanic and Atmospheric Administration's (NOAA) Smoke Forecasting System (SFS). Fire reports were based on satellite-detected hotspots from the Geostationary Operational Environmental Satellite (GOES)and NOAA Advanced Very High Resolution Radiometer (AVHRR). Raffuse et al (2012) compared smoke plume heights produced by BlueSky to Multi-angle Imaging SpectroRadiometer (MISR) data;
- Martin et al (2010) compared Fire Radiative Power (FRP) from the MODerate Resolution Imaging Spectroradiometer (MODIS) and plume heights from MISR for fires in North America from 2002 to 2007;

- Sofiev et al (2009, 2012) described a new approach to plume rise and evaluated it and other plume-rise model using MODIS and MISR data.

While quality work, these studies lacks the link to ground observations and observed fire behaviour characteristics. It is our argument that satellite-based information is a poor substitute for ground observations. Satellites do not provide an accurate measure of fire size due to instrument resolution. Likewise, FRP measurements do not discern between small, high intensity fires and larger, low-intensity fires at the sub-pixel level of the satellite resolution. Finally, the timing of satellite passes is an issue, as often these do not occur in the mid to late afternoon when fire intensity is at its maximum . These factors are important to determine the size and shape of the plume, leading to the volume of the smoke column.

There have been detailed studies of individual fires and their resulting plumes. Liu et al (2010) compared their model DAYSMOKE to a prescribed burn in Tennessee (TN) in 2006. Achtemeier et al (2011) expanded these studies to seven and Liu et al (2013) to twenty prescribed burns in the southeastern US. Lareau and Clements (2016) studied two pyrocumulus clouds using light detection and ranging (LiDAR). Extensive ground information was included in these studies but either the limited sample size (Lareau and Clements 2016) or the low intensity of prescribed burns prevent a rigorous evaluation of plume rise models of higher intensity wildfires.

The reviewer raises concerns about the quality of our data. Throughout the text, we have attempted to explain reasons for any short comings. While the project seemed a practical, straight-forward means of collecting the data necessary to validate plume rise models, unanticipated problems arose. Amidst these problems, analysis of the data did show the appropriate response to fire behaviour. We also think of this study in terms of defining a methodology required for future plume rise observations while describing our experiences in term of lessons learned.

1 References

Achtemeier, G. L., Goodrick, S. A., Liu, Y., Garcia-Menendez, F., Hu, Y., Odman, M. T. (2011). Modeling smoke plume-rise and dispersion from southern United States prescribed burns with daysmoke. Atmosphere, 2(3), 358-388.

Briggs, G. A. (1965). A plume rise model compared with observations. Journal of the Air Pollution Control Association, 15(9), 433-438.

Lareau, N. P., Clements, C. B. (2016). Environmental controls on pyrocumulus and pyrocumulonimbus initiation and development. Atmospheric Chemistry and Physics, 16(6), 4005.

Liu, Y., Achtemeier, G. L., Goodrick, S. L., Jackson, W. A. (2010). Important parameters for smoke plume rise simulation with Daysmoke. Atmospheric Pollution Research, 1(4), 250-259.

Liu, Y., Goodrick, S. L., Achtemeier, G. L., Forbus, K., Combs, D. (2013). Smoke plume height measurement of prescribed burns in the south-eastern United States. International Journal of Wildland Fire, 22(2), 130-147.

Martin, M. V., Logan, J. A., Kahn, R. A., Leung, F. Y., Nelson, D. L., Diner, D. J. (2010). Smoke injection heights from fires in North America: analysis of 5 years of satellite observations. Atmos. Chem. Phys, 10(4), 1491-1510.

Raffuse, S. M., Craig, K. J., Larkin, N. K., Strand, T. T., Sullivan, D. C., Wheeler, N. J., Solomon, R. (2012). An evaluation of modeled plume injection height with satellite-derived observed plume height. Atmosphere, 3(1), 103-123.

Rolph, G. D., Draxler, R. R., Stein, A. F., Taylor, A., Ruminski, M. G., Kondragunta, S., ... Davidson, P. M. (2009). Description and verification of the NOAA smoke forecasting system: the 2007 fire season. Weather and Forecasting, 24(2), 361-378.

Sofiev, M., Ermakova, T., Vankevich, R. (2012). Evaluation of the smoke-injection height from wild-land fires using remote-sensing data. Atmospheric Chemistry and Physics, 12(4), 1995-2006.

Sofiev, M., Vankevich, R., Lotjonen, M., Prank, M., Petukhov, V., Ermakova, T., ... Kukkonen, J. (2009). An operational system for the assimilation of the satellite information on wild-land fires for the needs of air quality modelling and forecasting. Atmospheric Chemistry and Physics, 9(18), 6833-6847.