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THE IMPORTANCE OF PHYSICAL PARAMETERIZATION IN THE WRF MODEL TO REPRODUCE ATMOSPHERIC DYNAMICS AND BLACK CARBON TRANSPORT IN THE ARCTIC: A SENSITIVITY STUDY.

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Regional Climate Models (RCM's) are able to capture the fine-scale features of the Arctic climate due to their ability to run at high horizontal and vertical resolutions. However, realistic simulations of the relevant physical processes in the Arctic (energy balance, clouds and precipitation, snow/ice albedo feedback, and sea-ice processes) and the multiple interacting feedbacks of these processes is still a challenge to be considered in Arctic change modelling studies. Furthermore, Short-Lived Climate-forcing Pollutants (SLCP), particularly Black Carbon (BC), play a significant role in the Arctic warming mainly due to the positive albedo feedback effect of BC deposition on snow and ice. In this work we do investigate the role of physical parameterizations and systematic errors in the Weather Research and Forecast model (WRF) to represent surface/atmosphere dynamics and weather patterns associated to sea ice maxima/minima extent within the Pan-Arctic region in order to reduce the uncertainties in high-resolution projections of future Arctic climate. Simulations are performed over a two years period (2008-2009) for two cold (January, February and March) and warm (July, August and September) seasons coinciding with the maximum and minimum sea ice extent in the region respectively. These periods are also characterized with the minimum (for warm period) and maximum (for the cold period) trends in observed tropospheric concentrations of BC carbon over the Arctic above 66N, particularly for residential combustion and flaring[1]. Sensitivity analyses include simulations at 45km and 9km horizontal resolution using two land surface models (Noah and NoahMP), two planetary boundary layer (PBL) schemes (YSU and MJY) and two reanalyzes datasets for initialization (ERA-interim and ASR). The WRF model simulations are validated against surface meteorological data from automated weather stations and atmospheric profiles from radiosondes. Preliminary results show that the model is able to reproduce the diurnal cycle and vertical structure of the Arctic boundary layer reasonably well. The model is, however, sensitive to the choice of the land surface scheme with significant biases in simulated moisture and temperature profiles. The best choice of physical parameterization is then used in the WRF with coupled chemistry (WRF-Chem) to simulate and assess the role of local emissions and long-range transport of BC from outside the Arctic and the impact of atmospheric BC and deposition on snow and ice on temperature, radiation, and clouds.

[1] Stohl, A., Klimont, Z., Eckhardt, S., Kupiainen, K., Shevchenko, V. P., Kopeikin, V. M., and Novigatsky, A. N.: Black carbon in the Arctic: the underestimated role of gas flaring and residential combustion emissions, Atmos. Chem. Phys., 13, 8833-8855, doi:10.5194/acp-13-8833-2013, 2013.