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Evaluation of regional NWP results for sea ice covered Bothnia Bay (Baltic Sea) in winter 2020.

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The ongoing development of NWP (Numerical Weather Prediction) models and their increasing horizontal resolution have significantly improved forecasting capabilities. However, in the polar regions models struggle with the representation of near-surface atmospheric properties and the vertical structure of the atmospheric boundary layer (ABL) over sea ice. Particularly difficult to resolve are near-surface temperature, wind speed, and humidity, along with diurnal changes of those properties. Many of the complex processes happening at the interface of sea ice and atmosphere, i.e. vertical fluxes, turbulence, atmosphere - surface coupling are poorly parameterized or not represented in the models at all. Limited data coverage and our poor understanding of the complex processes taking place in the polar ABL limit the development of suitable parametrizations. We try to contribute to the ongoing effort to improve the forecast skill in polar regions through the analysis of unmanned aerial vehicles (UAVs) and automatic weather station (AWS) atmospheric measurements from the coastal area of Bothnia Bay (Wenta et. al., 2021), and the application of those datasets for the analysis of regional NWP models' forecasts.

Data collected during HAOS (Hailuoto Atmospheric Observations over Sea ice) campaign (Wenta et. al., 2021) is used for the evaluation of regional NWP models results from AROME (Applications of Research to Operations at Mesoscale) - Arctic, HIRLAM (High Resolution Limited Area Model) and WRF (Weather Research and Forecasting). The presented analysis focuses on 27 Feb. 2020 - 2 Mar. 2020, the time of the HAOS campaign, shortly after the formation of new, thin sea ice off the westernmost point of Hailuoto island. Throughout the studied period weather conditions changed from very cold (-14□), dry and cloud-free to warmer (~ -5□), more humid and opaquely cloudy. We evaluate models' ability to correctly resolve near-surface temperature, humidity, and wind speed, along with vertical changes of temperature and humidity over the sea ice. It is found that generally, models struggle with an accurate representation of surface-based temperature inversions, vertical variations of humidity, and temporal wind speed changes. Furthermore, a WRF Single Columng Model (SCM) is launched to study whether specific WRF planetary boundary layer parameterizations (MYJ, YSU, MYNN, QNSE), vertical resolution, and more accurate representation of surface conditions increase the WRF model's ability to resolve the ABL above sea ice in the Bay of Bothnia. Experiments with WRF SCM are also used to determine the possible reasons behind model's biases. Preliminary results show that accurate representation of sea ice conditions, including thickness, surface temperature, albedo, and snow coverage is crucial for increasing the

quality of NWP models forecasts. We emphasize the importance of further development of parametrizations focusing on the processes at the sea ice-atmosphere interface.

Reference:

Wenta, M., Brus, D., Doulgeris, K., Vakkari, V., and Herman, A.: Winter atmospheric boundary layer observations over sea ice in the coastal zone of the Bay of Bothnia (Baltic Sea), Earth Syst. Sci. Data, 13, 33–42, https://doi.org/10.5194/essd-13-33-2021, 2021.