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Performance of four PBL schemes in WRF at Villum Research Station, Station Nord, Greenland

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The Weather Research and Forecasting (WRF) model is applied for boundary layer study at the Villum Research Station located at Station Nord (81.65N, 16.65W) in Greenland, and the results are evaluated against radiosoundings from 2 experimental campaigns of about 2 weeks duration each. The first campaign was conducted in July-August 2011 when the sun elevation was between 9 and 28 degrees. The second campaign was conducted in March 2012 at day length between 7 and 12 h and sun elevation at non between 3 and 8 degrees. During the summer campaign radiosondes were launched every 6 h and in winter every 12 h. The model performance is tested with 3 TKE schemes: MYJ, MYNN and QNSE and the non-local YSU. Comparison between modelled and measured temperature (T), potential temperature (θ), wind speed (WS) and wind direction (WD) up to 8000 m reveals that all schemes overestimate θ (in winter), RH (both campaigns, except YSU run in winter) and WS (both campaigns) with higher values of correlation coefficient (r) for summer (for WS at 00 UTC in summer) and lower biases for WS. Sensitivity tests to the resolution show that increasing horizontal resolution from 4 km to 1.33 km does not improve model performance. Increasing the number of vertical layers leads to closer to observed profiles and slightly improved statistics by layers. Sensitivity tests to the forecast lead time reveals that forecasts for day 1 and day 2 are similar for the summer, while T and WS biases in winter are 1 K and 1 ms-1 larger for 48 h compared to 24 h lead time. Both campaigns are characterized with lack of pronounced diurnal variation, which is correctly simulated by all schemes. Direct comparison between modelled (by 4 schemes) profiles and measured ones revealed that near the ground θ and RH are closer to the observations in cloudy conditions than in clear sky, while WS and WD are better reproduced in clear sky conditions. Results for 3500 layer divided into 6 sublayers: 0-100 m, 100-200 m, 200-500 m, 500-800 m, 800-1500 m, 1500-3500 m show that values of r calculated for θ increase with elevation of the sublayer, simultaneously with decrease of biases and NRMSE for both seasons and 4 schemes. Such clear trend for WS is observed in winter but not in summer. The performed tests showed that TKE schemes outperformed YSU scheme and as a whole the best scores are obtained for the MYNN runs.