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Unravelling the role of turbulent mixing, land surface coupling and radiation in a coupled GABLS1 experiment

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The Arctic regions are very sensitive to climate change and have shown to warm the last few decades. Global climate models show a similar signal for the Arctic, but their magnitude varies substantially, and they show a large spread in temporal and spatial patterns. This uncertainty may partly be caused by differences in formulations for snow/ice physics, atmospheric mixing and radiation used in the various models. This multiplicity of processes forces us to examine which process has the relatively most impact in accurately modelling the Arctic stable boundary layer (SBL).
This study extends the case of the GABLS1 model intercomparison (Cuxart et al., 2006) to obtain more insight in the relative role of physical processes in the SBL over sea-ice. The GABLS1 case is a relatively simple shear driven case over ice. The Single Column Model (SCM) version of the Weather Research and Forecasting (WRF) mesoscale meteorological model is a coupled model and is run for different combinations of boundary-layer, land-surface and radiation schemes. As such, an intercomparison of schemes within a single model is obtained.
Using a novel analysis method based on time-integrated SBL development (Bosveld et al., 2010), the variation between the different runs indicate the relative orientation of model sensitivities to variations in atmospheric mixing, radiation, and land-surface coupling. Preliminary results show that a change in mixing and coupling gives the strongest impact for the Arctic. Approximately, the sensitivities to mixing and coupling have a similar orientation, while the sensitivity to radiation is approximately perpendicular to the other processes. These relative orientations compare well with results in the GABLS3 model intercomparison (Bosveld et al., 2010). However, it emerges that the selected vertical resolution influences the orientation of the model sensitivities. Finally, the above study is repeated for a range of geostrophic wind speeds in order to represent a large range of synoptic conditions.