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Investigating the life cycle of a polar low with the Coupled-Ocean-Atmosphere- Wave-Sediment Transport modeling system

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A polar low that formed on 3 March 2008 over the Norwegian Sea is simulated using the Coupled-Ocean-Atmosphere-Wave-Sediment Transport (COAWST) modeling system. COAWST is a high-resolution NWP system involving WRF, ROMS and SWAN models with a fully interactive ice module (CRIM) in ROMS. It can be run both in coupled and uncoupled modes and is a potential tool to study regional extremes and the associated air-sea-wave interactions. The objective of this study is to assess the importance of atmosphere-ocean coupling in simulating polar lows. The polar low under question provides an ideal platform to carry out such a study given the availability of measurements of its structure and full lifecycle. The observations were taken with dropsondes and wind lidar by the Norwegian IPY-THORPEX research mission. These observations show that the polar low had a sharp frontal structure below 700 hPa during the cyclogenesis phase. As the polar low grew, the associated circulation extended from $\sim$ 700 hPa up to $\sim$ 450 hPa. The maximum wind speed observed atlower-levels during the development was $\sim$ 28 ms-1. Total surface fluxes rose from $\sim$ 375 Wm-2 to $\sim$ 580 Wm-2 during the growth stage suggesting an important role for air-sea interactions in contributing to the strength of the low. The lifetime of the low was quite long, $\sim$ 2 days, relative to that of a normal polar low, which is usually less than 24 hours. In this work, two simulations are performed, one with a 2-way coupling between the atmosphere and the ocean, and the second with an atmosphere-only set-up. The simulations begin at 0000 UTC on 2 March 2008 and are run at a horizontal resolution of $\sim$ 12 km. Initial and boundary conditions are obtained from the NCEP Climate Forecast System Reanalysis (CFSR). Parameters such as surface fluxes of sensible and latent heat, temperature, wind speed, surface pressure, precipitation, vertical temperature gradient are analysed and compared in the coupled and uncoupled simulations. Conclusions are drawn based on the performance of these individual simulations with respect to the available observations and reanalysis.