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Evaluating central Arctic summer conditions in the Arctic System Reanalysis (ASR) and ERA-Interim using Arctic-Summer Cloud-Ocean-Study (ASCOS) data

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The Arctic has experienced large climate changes over recent decades, the largest for any region on Earth. The warming has been more than twice as large as the global average, and substantial changes in, for example, sea-ice cover, thickness and permafrost have been observed. To understand the underlying reasons for this apparent climate sensitivity, reanalysis is an invaluable tool.

The Arctic System Reanalysis (ASR) is a regional reanalysis using the polar version of the Weather and Research Forecast (WRF) atmospheric model that, by the virtue of being regional, can be affordably run at higher resolution. The ASR is forced at the lateral boundaries by the ECMWF ERA-Interim global reanalysis; ERA-Interim is the latest global reanalysis from ECMWF. The ASR reanalysis products need to be evaluated preferably using independent data; this is a problem in the Arctic where data are sparse and as much as possible of the available data is assimilated in the reanalysis.

In this study we evaluate the performance of an experimental version of ASR, with a nominal resolution of $\sim$30 km, for the central Arctic, using data from the Arctic Summer Cloud-Ocean Study (ASCOS) from August and early September 2008.. The ASCOS field experiment was deployed on the Swedish icebreaker Oden north of 87°N in the Atlantic sector of the Arctic; data was collected both during the transits to and from Longyearbyen on Svalbard and during a three-week ice drift with the Oden moored to a drifting multi-year ice floe, when intensive measurements were taken on the ice and onboard. These observations have the advantages of being independent of ASR, i.e. they were not assimilated into the reanalysis, and being detailed enough to evaluate the process descriptions in the ASR.

In addition to the ASR, the ERA-Interim reanalysis was also included in the evaluation. In the version of ASR evaluated here, lateral boundaries were forced by ERA-Interim and therefore this makes it possible to evaluate the added value of a high-resolution regional reanalysis, comparing the ASR performance to that of the global reanalysis forcing it.

When comparing the observations with reanalyses, several conclusions were made. While ASR and ERA-Interim captures basic meteorological variations coupled to the synoptic scale systems well, they have difficulties in estimating the radiation balance and the humidity content of the atmosphere. The turbulent fluxes were in relative good agreement with the measurements in terms of averages, while their correlation was poor, but the biases in the radiation fluxes are clearly coupled to the cloud cover and cloud processes that are not well understood. Similar differences have also been seen when comparing to other models, e.g. the Unified Model. Especially optically thin clouds are not correctly described. These leads to errors in the air temperature and adding to the impression that this reanalysis can not reproduce the cloud properties sufficiently well. Also, the study shows clearly differences between the global and regional reanalysis when reproducing the cloud layer and radiative as well as turbulent fluxes.