Geophysical Research Abstracts
Vol. 18, EGU2016-6544, 2016
EGU General Assembly 2016

Two Arctic winter states observed during the N-ICE 2015 campaign

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Surface observations during winter are presented from the Norwegian Young Sea Ice Project (N-ICE 2015). These data include longwave radiative fluxes, 2 m air temperature, and mean sea level pressure. As part of the N-ICE 2015 Cruise, the R/V Lance was frozen into first year sea ice at approximately 83˚N 21˚E on 15th January 2015 and allowed to drift with the ice. The cruise continued until 21^{st} June 2015, and measurements were taken on 4 separate ice floes. The data presented here correspond to the first floe, which was occupied from 15^{th} January – 21^{st} February 2015.

The N-ICE 2015 data from the Atlantic sector of the Arctic Ocean are compared with measurements during winter 1998 from the SHEBA campaign in the Beaufort Sea. Both sets of observations are also compared with 6 hourly output from a 10-member ensemble run with the coupled Arctic regional climate model HIRHAM-NAOSIM and the ERA-Interim Reanalysis product.

Two distinct Arctic winter states are apparent from the temperature and net longwave flux observations. The net longwave flux preferentially occupies values near -40 Wm^{-2} and 0 Wm^{-2} for both the N-ICE and SHEBA campaigns. This result is remarkable given that the N-ICE and SHEBA sites are located in different sectors of the Arctic Ocean and represent thin first-year and thick multi-year ice respectively, and the substantial temperature difference between the sites. Thus, these analysis provide evidence that two radiative Arctic winter states are representative of the Arctic Basin.

The two states are less apparent in the ERA-Interim reanalysis, compared with the observations. The ERA-Interim net longwave flux occupies a preferred value of -60 Wm^{-2}, for both the SHEBA and N-ICE sites, corresponding to a 'radiatively clear' state. This represents a negative net longwave radiation bias of 20 Wm^{-2} compared with the observations. This excessive radiative cooling is associated with a consistent warm 2 m temperature bias in ERA-Interim during radiatively clear phases. Values of net longwave radiation peak at around 0 Wm^{-2}in the opaque states, consistent with the observations. However, the transition between opaque and clear states is less abrupt in ERA-Interim compared with the observations. The transitions between clear and opaque states are synoptically driven with opaque states typically occurring as the surface pressure drops. The opaque states are believed to indicate the presence of mixed-phase clouds. There is little evidence of the two states in the HIRHAM-NAOSIM output. The model shows a near Gaussian distribution of the net longwave flux, with a preferred value of -20 Wm^{-2}. This value is close to the monthly mean value of the observations and thus highlights limitations using monthly mean statistics only to assess model performance.