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A comparative analysis of total cloudiness in the Arctic from passive satellite observations, surface visual observations and reanalyses data

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The detection of clouds in the Arctic is a good verification for capabilities of passive satellite observations. Clouds in the Arctic are mostly optically thin and low-lying, they have a little thermal and visible contrast with the underlying surface, which makes them hardly to observe from satellite. The main obstacle to reliable surface observations in the Arctic is a very sparse network of ground-based observations.

We present here an intercomparison of the up-to-date climatologies of total cloudiness in the Arctic (north of 60° N) from passive satellite observations (APP-x, CERES, ISCCP, MODIS, PATMOS-x), surface data (EECRA) and 8 reanalyses (ERA-40, ERA-Interim, JRA-25, MERRA, NCEP/NCAR, NCEP/DOE, NCEP-CFSR, NOAA-CIRES 20CR).

We found that different observations are in a better agreement in summer than in winter and over the ocean than over land for the Arctic mean TCF as well as for the spatial distribution of TCF. The interannual variability is higher in winter than in summer according to all observation-derived data, which may be associated with uncertainties in observations that greater in winter than in summer. Total cloud fraction in the Arctic has the prominent annual cycle according to all observations excluding PATMOS-x and ISCCP.

Spatial distribution of the annual mean TCF collocates with the spatial distribution of the annual mean surface skin temperature. The annual mean TCF minimum occurs over the northeastern part of Greenland and coincides with the minimum of the skin surface temperature. Whilst, the annual mean TCF maximum is noted over the warmest part of the Arctic. The spatial distributions of TCF from different satellite observations are in a closer agreement over the ocean in winter and over land in summer. The presumable reason for this peculiarity is the mosaic structure of the underneath surface which depends on season in an opposite manner for land and for the ocean. This feature is not revealed when satellite data compared with surface observations which does not depend on surface characteristics.

For the whole year, the greatest disagreement among observations was revealed in regions with the ice/snow surface. Furthermore, we found that agreement in winter is poor in regions with the presence of strong low-tropospheric temperature inversions. This can indicate the difference in the cloud-detection algorithms as the main cause of the discrepancies among observations. Nonetheless, other causes of data discrepancies are also should taken into account (diurnal cycle, differences in averaging period, differences between observations and reanalyses in defining cloudiness).

At present, it is hard to distinguish the best observational dataset for the Arctic cloudiness. Further analyses should be carried out for the specific regions with the greatest disagreement among cloudiness datasets, particularly Greenland, the Canadian Arctic Archipelago and the northern part of East Siberia. Active sensors like radar and lidar have a potentially great capability to improve our knowledge about cloudiness in these regions.