EGU2020-20196
https://doi.org/10.5194/egusphere-egu2020-20196
EGU General Assembly 2020

Humidity profiles and their interactions with moisture transport and surface fluxes in the Antarctic

Tuomas Naakka, Tiina Nygård, and Timo Vihma
Finnish Meteorological Institute, Helsinki, Finland

Atmospheric humidity profiles control occurrence of clouds, which in turn has a large impact on radiative fluxes in the Antarctic. In addition, humidity profiles strongly interact with surface moisture fluxes, which are an important component in the water cycle. Despite their important role in the climate system, specific and relative humidity profiles in the Antarctic have not so far been comprehensively studied. Here, we address the vertical structure of tropospheric specific and relative humidity in the area south of 50°S and focus on interactions of this structure with horizontal and vertical moisture transport and surface fluxes of sensible and latent heat. The study is based on ERA5 reanalysis data from 15-years period, 2004 - 2018.

We show that in the Antarctic, both moisture transport and surface fluxes shape the vertical structure of specific and relative humidity, but their relative contributions and effects vary considerably between regions. Therefore, we examined humidity profiles dividing the study area into five sub-regions: 1) open sea, 2) seasonal sea-ice area, 3) slopes of East Antarctica, 4) East Antarctica high plateau, and 5) West Antarctica. Expect west Antarctica, within each region the vertical structure of air moisture is relatively homogenous. Results indicate that each of these regions has own key processes (evaporation, condensation, vertical and horizontal moisture fluxes) controlling the vertical structure of relative and specific humidity.

The open ocean is a source area for atmospheric moisture. Over the open sea, a thin unsaturated well-mixed layer is seen near the surface, which is caused by year-around upward moisture flux (evaporation) and upward sensible heat flux. Above this layer, there is a layer of high relative humidity and frequently occurring cloud cover. Over sea ice, seasonal variability is large. During most of the year, moisture surface fluxes over sea ice are small, near-surface relative humidity is high, and specific humidity inversions are frequent. In summer, however, evaporation over sea ice increases, near-surface relative humidity is lower, and humidity inversions are uncommon.

The high plateau is the area where absolutely dry air masses are formed, as a consequence of near-surface condensation and downward moisture transport. There, the near-surface air is often saturated with respect to ice, and strong but thin surface-based specific humidity inversions are present during most of the year. On the slopes, adiabatic warming, due to katabatic winds, causes decrease of relative humidity when the air mass is advected downwards from the plateau. This leads to relatively high surface evaporation and makes surface-based specific humidity inversions rarer.

This study comprehensively describes the vertical structure of relative and specific humidity in the Antarctic, and increases understanding on how this vertical structure interacts with moisture transport and surface fluxes. The results can further contribute to understanding of processes related to cloud formation and water cycle in the high southern latitudes.