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

Tuomas Naakka, Tiina Nygård, Timo Vihma, Finnish Meteorological Institute, Helsinki, Finland. Correspondence to tuomas.naakka@fmi.fi

Data

- ERA5 reanalysis data from years 2004 – 2018
- 0.5° x 0.5° horizontal resolution
- 58 model levels from surface to approx. 250 hPa level
- 6h time step

Methods

- Study area, polar cap south of 50°S, is divided into five region (see *Regions*)
- Year is divided in two seasons winter, April–October, and summer, November–March,
- Time steps when vertically integrated moisture transport is form north or south are studied separately

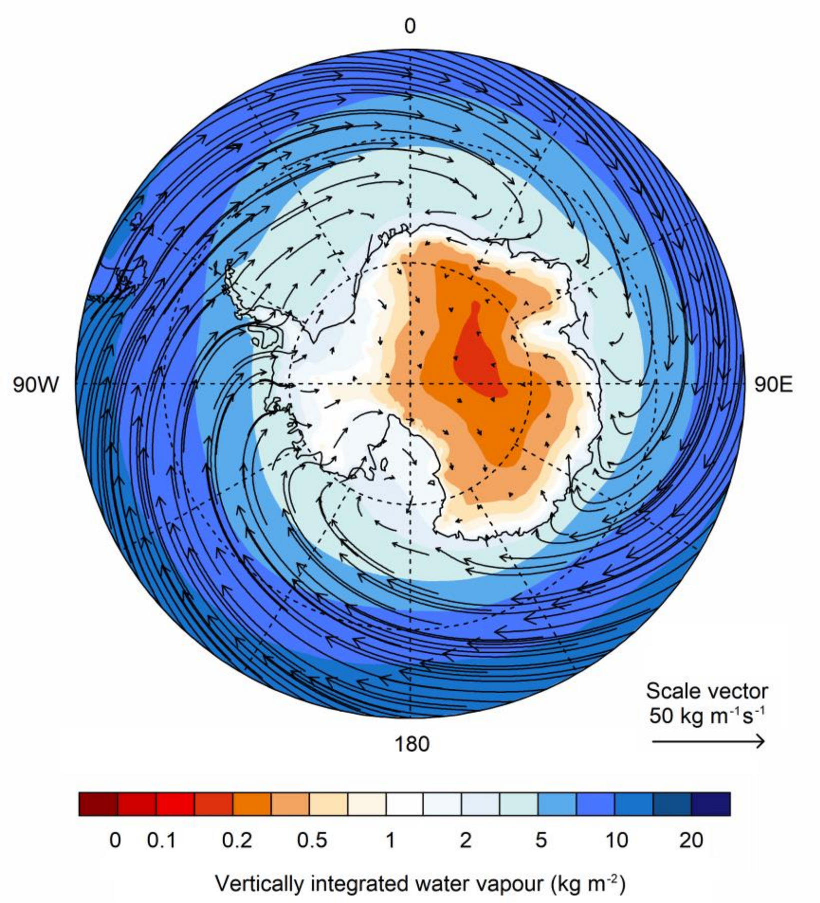


FIGURE 1. Vertically integrated water vapour VIWV (colours) and vertically integrated moisture transport (vectors) in winter

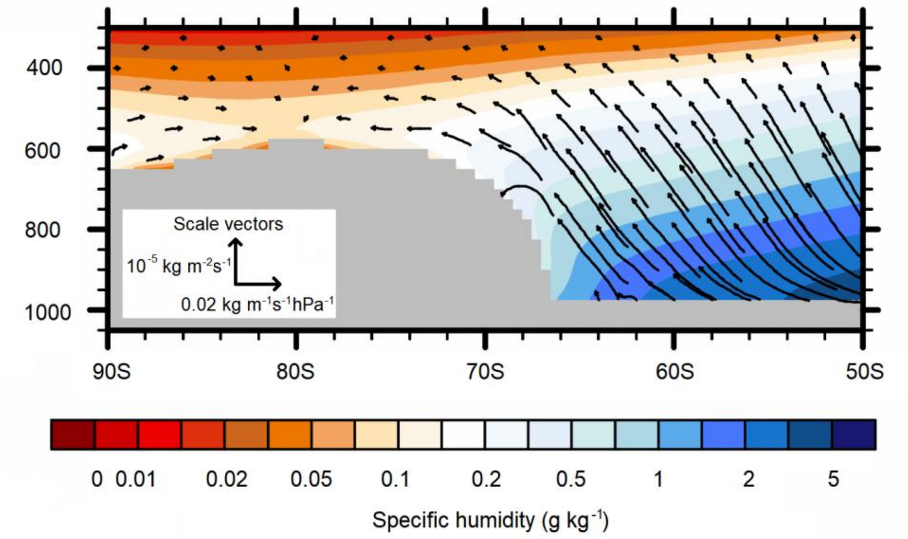


FIGURE 2. Mean specific humidity (colours) and meridional and vertical moisture transport (vectors) profile along longitude 90°E in winter

Regional Moisture Characteristics

West Antarctica

- On coastal areas between 150°W - 65°W, southward moisture transport (*Figure 1*) causes moisture convergence and large precipitation.
- On south-west side of Ross Ice Shelf almost permanent flow of dry air from higher elevation areas results surface evaporation and low occurrence of specific humidity inversions (*Figure 3*).
- In inner parts of West Antarctica moisture conditions are composition of conditions in East Antarctica Plateau and slopes.

East Antarctica Plateau

- Radiative cooling causes high relative humidity (*Figure 4*), and frequently occurring saturated conditions with respect to ice especially in winter, despite of downward motion of air.
- Relatively strong, and mostly surface-based, specific humidity inversion is almost always present (*Figure 3*) due to condensation moisture (*Figure 5*).
- Condensation of moisture results in formation of absolutely very dry near-surface air mass (*Figure 2*), which further enables evaporation on slopes (*Figure 5*).

East Antarctica Slopes

- Moisture conditions over slopes can be vertically divided into two layers: 1) near surface layer, where influence of katabatic wind dominates and 2) above troposphere, where varying moisture advections have important role.
- In katabatic layer, frequently occurring downward winds bring dry air from inner continent and adiabatic warming decreases relative humidity (*Figure 4*) enabling evaporation (*Figure 5*) which decreases occurrence of, especially surface based, specific humidity inversions (*Figure 3*).
- Above the layer of katabatic winds, changes in direction of meridional moisture transport cause relatively large variation in water vapour content (*Figure 7*) and in cloud water (*Figure 6*) suggesting occurrence of geometrically thick cloud, when moisture transport is from north, due to moisture condensation to clouds caused by orographic lifting.

Sea Ice

- Sea-ice area is transition zone between continental and oceanic moisture conditions, in addition moisture conditions on sea ice undergo a large seasonal variation.
- In winter, katabatic winds brings dry and cold air from continent into near surface layer enabling efficient evaporation from leads and polynyas (*Figure 5*). This layer is capped by specific humidity and temperature inversion which isolates the layer from above atmosphere.
- In summer, solar radiation strengthens surface heat and moisture fluxes and leads to weakening of stratification and removing of specific humidity (*Figure 3*) and temperature inversions.

Open Ocean

- Over open ocean a shallow well-mixed and unsaturated layer (*Figure 4*) near surface allows large surface evaporation (*Figure 5*).
- Moisture transport from lower latitudes increases VIWV and decreases evaporation (*Figure 7*).
- In winter, advection from sea ice to open ocean causes strong upward sensible heat flux and leads to formation of well-mixed boundary and increases cloud water content on top of boundary layer (*Figure 6*).

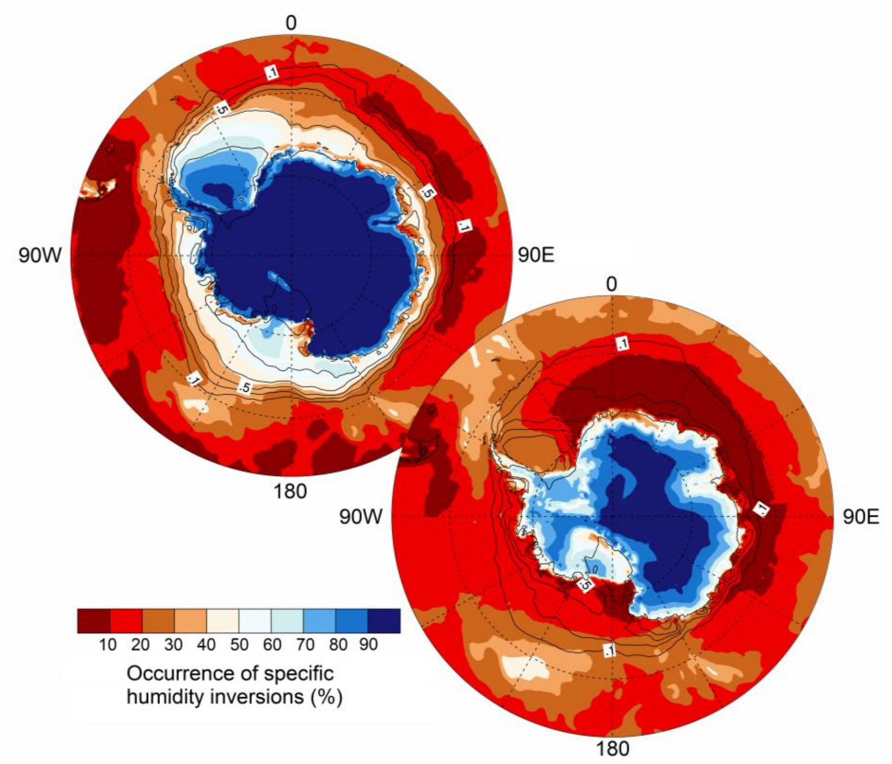


FIGURE 3. Occurrence of specific humidity inversions (specific humidity maximum not located in the lowest model level) and mean sea ice concentration in winter (upper left corner) and in summer (lower right corner)

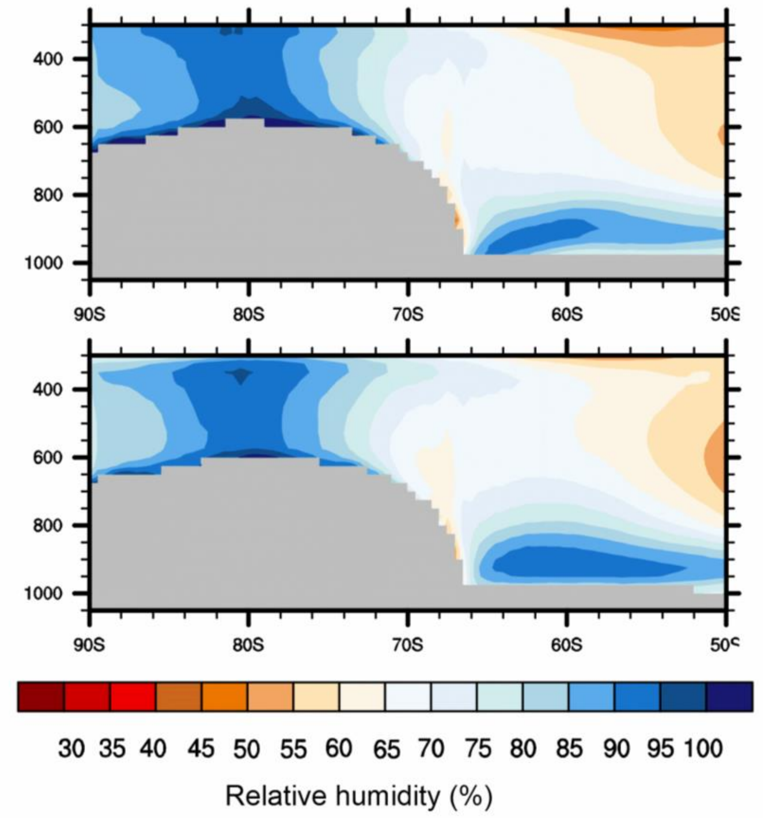


FIGURE 4. Mean relative humidity profile along longitude 90°E in winter (upper figure) and in summer (lower figure)

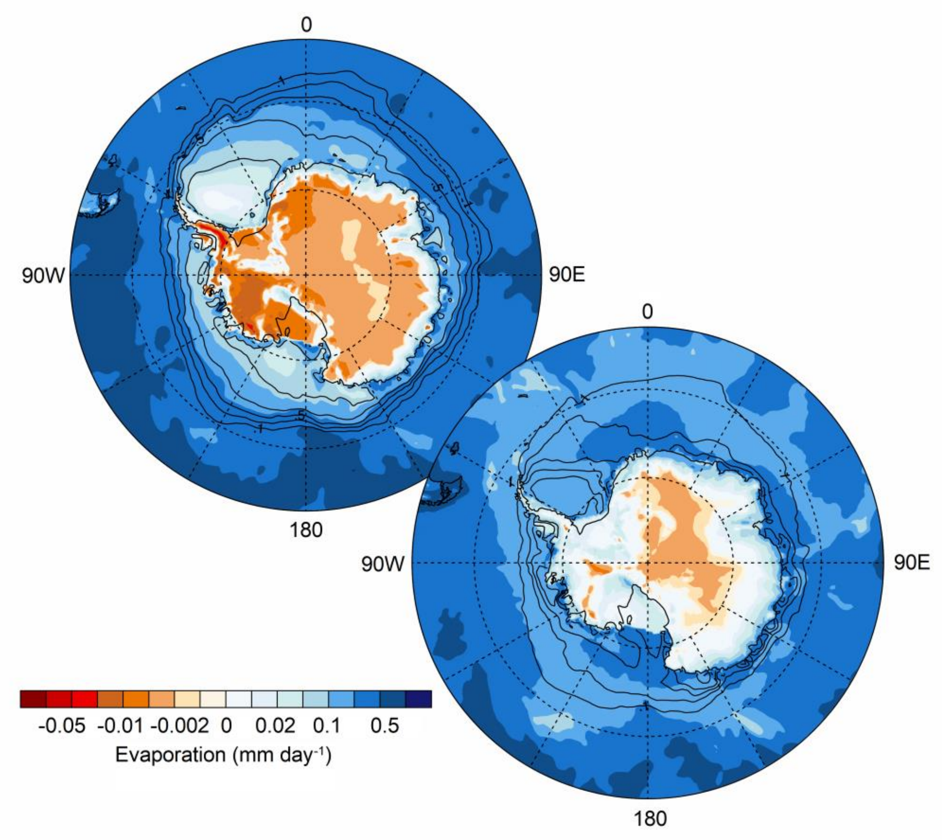
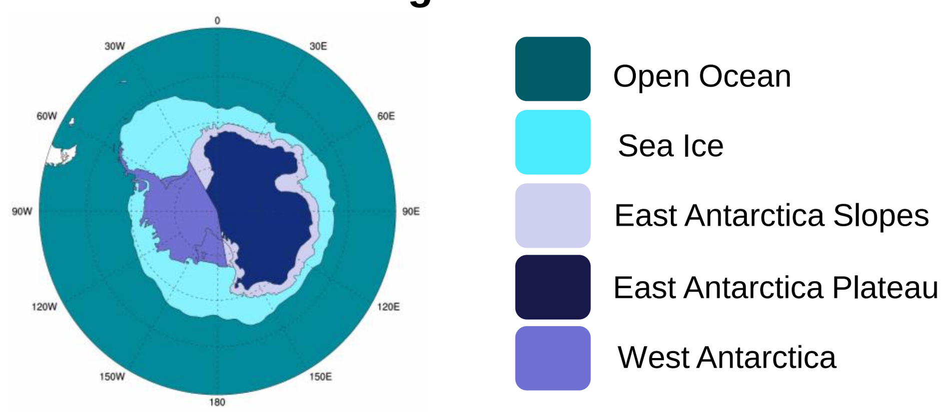


FIGURE 5. Evaporation in winter (upper left corner) and in summer (lower right corner)

Regions



The area of sea ice region and open ocean region is varied monthly. 0.5 sea ice concentration is used as a threshold for the sea ice region. Figure presents situation in May.

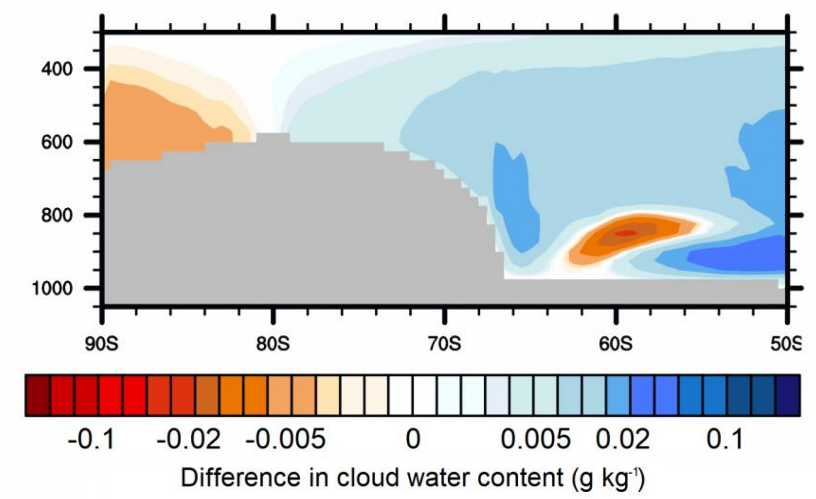


FIGURE 6. Difference in cloud water content (including liquid and ice) between northerly and southerly moisture transport cross section along longitude 90°E in winter.

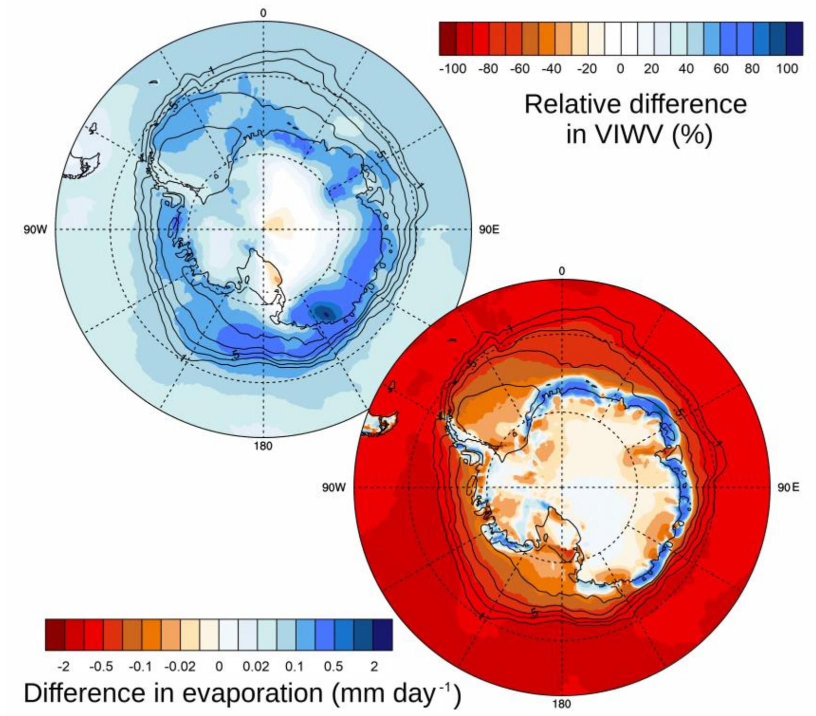


FIGURE 7. Relative difference in vertically integrated water vapour (upper left corner) and difference in evaporation between northerly and southerly moisture transport (lower right corner) in winter.

Acknowledgement

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