EGU22-13313
https://doi.org/10.5194/egusphere-egu22-13313
EGU General Assembly 2022
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Moisture Budget Closure of Arctic Atmospheric Rivers from Saw-Tooth Flight Pattern – A Feasibility Study in High-Resolution Model Data

Henning Dorff[1], Heike Konow[2], Vera Schemann[3], and Felix Ament[1,2]
[1]University of Hamburg, Meteorological Institute, Meteorology, Hamburg, Germany
[2]Max-Planck Institute for Meteorology, Bundesstraße 53, 20146 Hamburg, Germany
[3]University of Cologne, Institute of Geophysics and Meteorology, Cologne Germany

This study investigates in a synthetic way to what extent saw-tooth flight patterns from long-range research aircrafts can close the moisture budget of arctic atmospheric rivers (ARs). Such ARs dominate the moisture transport into the Arctic. The analysis of the moisture budget in AR corridors is key to understand the spatiotemporal AR evolution, resulting air mass transformations along their pathway and precipitation efficiency of ARs. However, the determination of moisture budget components in arctic ARs is challenging due to sparse observations. Dedicated research flight campaigns require the quantification of divergence of integral water vapour transport (IVT) using dropsondes along AR cross sections and remote sensing capturing internal water vapour load and precipitation rate. However, limited number of dropsondes and curtain-restricted remote sensing may deteriorate the AR moisture budget. Uncertainties in airborne representation of AR moisture components have to be assessed. We consider seven arctic ARs from spring season of last decade. They cover pathways over the North Atlantic and Siberia and a broad range of AR conditions representative for the Arctic. To assess airborne budget closure capabilities, we include outputs from the new C3S Arctic Regional Reanalysis (CARRA) and simulations from an adapted ICON model configuration. Both have a horizontal resolution of around 2.5 km and deliver reasonable AR representation with high spatial variability in moisture budget components. By generating synthetic flights and mirroring airborne observations (e.g. dropsondes) in both gridded datasets, we identify major sources of error that arise in the airborne quantification of IVT variability. We determine the representativeness of total precipitation and hydrometeor content derived from diagonal legs for entire AR sectors. For all ARs, levels where specific humidity and wind speed contribute most to IVT are located below 1500 m. Along horizontal AR transects, maximum IVT values and highest lateral IVT variability are located around low-level jets. Frequent soundings near the low-level jet are fundamental to lower uncertainties in moisture flux convergence that dominate against other budget terms. In CARRA, having less than six soundings within the AR cross-section causes biases of total IVT by more than 10 %. Samples along diagonal flight legs through AR sectors can reproduce mean internal precipitation rate, whereas the statistical distribution of hydrometeor contents for the entire sector differs due to the complex cold-front composition near the AR. Evaporation shows minor budget contributions in arctic ARs.

While moisture convergence uncertainties are highest close to the AR centre, uncertainty of precipitation rate increases in the AR outflow region. Moreover, we give first insights on very preliminary observations from the HALO-(AC)^3 flight campaign in March and April, 2022.