Moisture supply to the Atacama desert by atmospheric rivers

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Various studies show that atmospheric rivers can cause extreme precipitation events which can refuel water reservoirs and trigger major changes in the land surface shape. In particular in hyperarid regions, such as the Atacama desert in northern Chile, the very rarely occurring precipitation events can leave long lasting traces in the landscape. A recently taken drill core (at 21.5°S, 69.9°W) might lead to the discovery of several individual precipitation events dating back as far as hundreds of thousands of years. Determining the origin and pathways of the moisture which fuels such episodes of precipitation is subject of ongoing research. Investigating the circumstances of precipitation events in the present day climate facilitates this research. For example a study of the March 2015 Atacama flood by Bozkurt et al. (2016) examined the synoptic situation leading up to the extreme event. In conclusion increased sea surface temperatures due to an El Niño weakening the tropospheric stability and moistening the lower troposphere together with a cut-off low are believed to be the reason for this event. Whether the enhanced tropospheric moisture was transported via an atmospheric river has not been addressed in the literature yet.

Intriguingly the study of Guan and Waliser (2015) reveals that on average a few atmospheric rivers per year make landfall in northern Chile based on the evaluation of reanalyses data. Here, we study such events and the associated moisture supply to the Atacama desert in more detail by investigating the following hypotheses:

i. A substantial amount of moisture supplied to the Atacama desert is due to atmospheric rivers.

ii. The impact of atmospheric rivers which make landfall in northern Chile depends on the concurrent synoptic and large scale situation (e.g. the presence of a cut-off low).

iii. Atmospheric rivers enhance moisture supply to the Atacama desert via precipitation and increased cloud (fog) water.

Within the German Science Foundation funded Collaborative Research Center "Earth – Evolution at the dry limit" our overarching goal is to understand the moisture supply to the Atacama desert and its variability which is driven by synoptic and large scale patterns. In the study presented here we aim to determine the role of atmospheric rivers to the overall moisture variability. We detect atmospheric rivers based on satellite measurements of precipitable water provided by the operational Microwave Integrated Retrieval System (MIRS) and the Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data (HOAPS). Frequency of occurrence of atmospheric rivers is investigated and their impact on precipitation and cloud water supply due to orographically induced fog.