The role of atmospheric rivers for the Atacama Desert

Christoph Böhm, Institute of Geophysics and Meteorology, University of Cologne, Albertus-Magnus-Platz, Cologne, D-50923, Germany; c.boehm@uni-koeln.de; +49 (0)221 470-6112

Mark Reyers, **Leon Knarr**, **Susanne Crewell**, Institute of Geophysics and Meteorology, University of Cologne, Cologne, Germany

In hyper-arid regions, such as the Atacama Desert in northern Chile, very rarely occurring precipitation events can leave long lasting geomorphological traces and have a strong impact on biota. While precipitation events can trigger the spectacular "blooming desert" (Chávez et al., 2019) and germination of many species (Pliscoff et al., 2017), they pose a threat to surface soil microbial species which are exquisitely adapted to persistent hyper-aridity (Azua-Bustos et al., 2018). For instance, various microbial species vanished in a lagoon within the hyper-arid core of the desert (near Yungay) which ponded after a heavy precipitation event on 07 June 2017 (Azua-Bustos et al., 2018). This event was related to an atmospheric river (AR) which made landfall at the coast of the Atacama Desert. Enhanced integrated water vapor transport (IVT) associated with an upper level trough fueled the Atacama Desert with moisture from the northwest (Figure 1). This case illustrates the impact of ARs on this unique ecosystem.

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 driven by synoptic and large scale patterns. Here, we investigate the impact of ARs under the following guiding hypothesis:

i A substantial amount of winter precipitation within the Atacama Desert is due to atmospheric rivers.

ii The main origin of the AR related moisture is the Amazon Basin.

iii AR related moisture transport and precipitation formation mostly takes place in mid- and upper tropospheric layers and is decoupled from the maritime boundary layer (elevated ARs).

For our study, we use the AR catalog by Bin Guan (`https://ucla.box.com/ARcatalog`; Guan and Waliser, 2015 and Guan et al., 2018). AR related precipitation is analyzed using a long-term simulation with the regional climate model WRF, which suitably represents precipitation according to a validation against station measurements (Reyers et al., 2020, in press). To determine origin and pathways of the AR related moisture, we calculate backward trajectories and quantify the IVT at different height levels

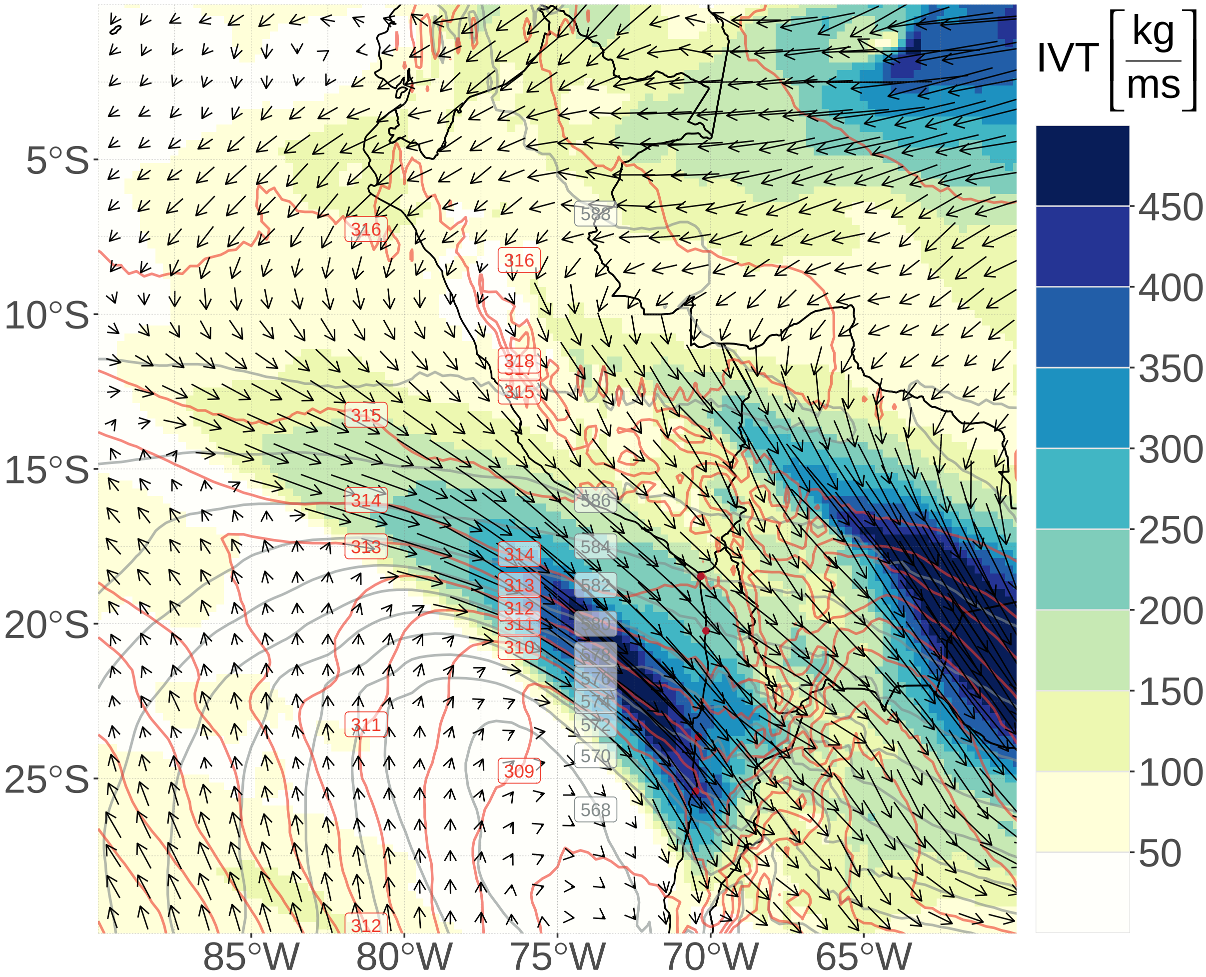

Figure 1: Integrated water vapor transport (IVT), here between 850 hPa and 200 hPa (arrows and shading) and geopotential at 500 hPa (gray contours; in gpdam) and 700 hPa (red contours; in gpdam) derived from the ECMWF 5th generation reanalysis (ERA5) for 07 June 2017 at 6 UTC. The Atacama Desert is located on the land area roughly between 18°S and 30°S and 71°W and 68°W. Red circles mark coastal cities Arica, Iquique, Antofagasta (radio sounding station), and Taltal from North to South at the Pacific edge of the Atacama Desert.

based on reanalysis data. In a case study, we investigate the interplay between ARs and the maritime boundary layer near the coast of the Atacama Desert based on vertical cross sections from the WRF-model output and radio soundings. The aim is to distinguish precipitation related to the elevated ARs and precipitation which results from drizzling maritime stratus.