EGU24-21791, updated on 30 Apr 2024
https://doi.org/10.5194/egusphere-egu24-21791
EGU General Assembly 2024

Water vapor transport into the Atacama desertsimulated with a high resolution atmospheric model

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The Atacama at the west coast of South America is one of the driest regions on earth. Any atmospheric transport of water vapor into this desert which may form fog or dew is accordingly important for its supply with freshwater. Within the CRC 'Earth Evolution at the dry Limit' a network of climate stations has been installed in the core of the Atacama (Schween et al 2020). This network shows a very regular circulation with strong winds from the west during day time and weaker winds from the east during night. These winds are part of a circulation pattern between the coast and the slopes of the Andes known as Rutllant cell. The daytime westerly winds in the desert are moister than the night-time easterlies but this day-night difference in moisture vanishes at the slope of the Andes. Accordingly there is a net transport of water vapor into the desert. But from these surface measurements it remains unclear whether this moisture remains in the surface layer or leaves the region at higher levels,
To get better insight in the circulation we performed simulations with the ICON-LEM model in a 300x300km domain centered around 20.75degS and 69.75W with a resolution of 624m. It covers the ocean as well the high Andes including the coastal mountain range and the central depression. A simulation of a typical winter day showed that the circulation is rather a complex movement of airmasses than a closed circulation. The moist air from the ocean reaches only partly up the slopes of the Andes before it switches to the night time pattern and flows back into the central depression of the desert. There the moist air collects as shallow pools in the basins and valleys where it eventually forms fog. When the following morning the breeze propagates into the desert, convergence at its head leads to injection of moist air into the free troposphere.
We use the model data to identify corridors in which moist air from the ocean enters the desert. In the regions where fog forms we calculate the horizontal transport of liquid (fog) water which can be used to estimate fog water deposition to the surface. We calculate a moisture budget for different layers of the atmosphere to identify where and when water vapor enters and leaves the desert.

Reference:
Schween, J. H., D. Hoffmeister, and U. Löhnert, 2020: Filling the Observational Gap in the Atacama Desert with a new Network of Climate Stations, Global and Planetary Change, 184, https://doi.org/10.1016/j.gloplacha.2019.103034