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Understanding atmospheric differences in the water vapor transport for the Atacama and Namib deserts

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The Atacama and Namib Deserts are one of the driest places in the world. They are both located west coast of their respective continents (18-28ºS), under the effects of the east margin of the subtropical anticyclones, strong subsidence and cold ocean currents. However, they also differ in terms of topography, precipitation, and humidity, being the Atacama much higher and drier than the Namib. Our understanding of how water vapor is brought to these regions and interacts with the different local circulations and topography is still limited. The objective of this study is to investigate similarities and differences of the spatio-temporal variability of water vapor between both deserts in order to assess the impact of the distinctive local factors. To this end, we use state-of-the-art satellite observations and reanalysis for a long-term perspective on total column water vapor (TCWV) as well as on the vertical distribution of humidity, temperature and on cloud structure. The analysis is aided by a one-year measurement campaign at Iquique airport (22ºS).

We found a marked seasonal cycle in the total column water vapor (TCWV) in both offshore deserts areas. While both deserts share a similar timing of the annual TCWV peak between January and March, the values of the maxima differ. The Namib surpasses the Atacama by 30%. Our analysis suggests that at least two factors contribute to the common summer maxima of the TCWV. First, warmer sea surface temperatures (SSTs) along the west coasts produce a moistening of the marine boundary layer (MBL). Second, as a consequence of the southward displacement of the subtropical anticyclones, weaker southerly winds decrease the dry advection in the MBL. The excess of humidity in the Namib is associated with a strong moisture advection feature observed in the lower part of the free-troposphere (900-750 hPa). The easterlies also transport clouds and precipitation. In the Atacama, the presence of the Andes cordillera blocks most of the potential exchange of humidity with the continent, resulting in the Pacific Ocean being the main source of moisture.

While the respective driest period presents similar TCWV amounts (~12 Kg/m2) for both deserts, it is surprising to find that it occurs later in the Atacama (spring season) than in the Namib (winter). Potential causes for this shift, such as a stronger dependence of TCWV on the SST for the Atacama, are investigated and discussed.

Furthermore, we identified a recurring atmospheric feature for the summer which exhibits a strong northerly humidity advection above the MBL. This structure is only observed in the Atacama Desert and has not been described in the literature. However, it could be a major source

of humidity for the inland region in Atacama.