Fog in Arid regions, 23.07.2021

Fog in the Atacama and coastal clouds

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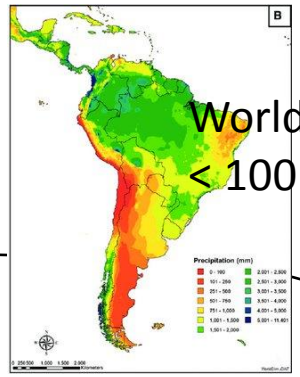
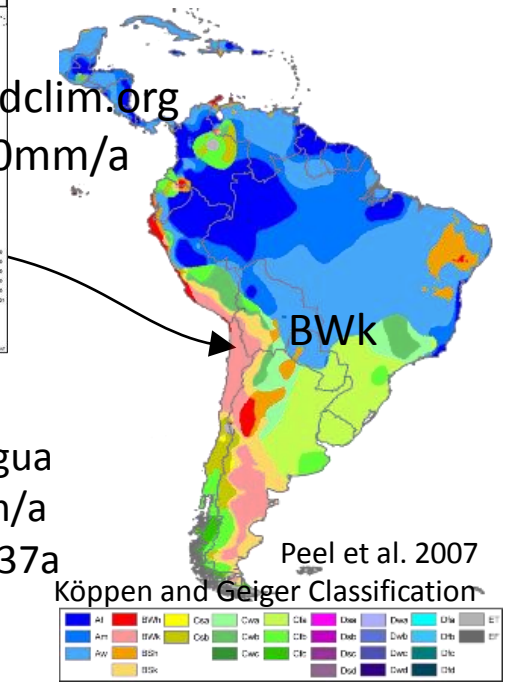
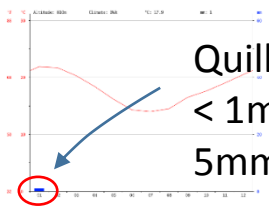
Earth – Evolution
at the dry limit



Worldclim.org
< 100mm/a



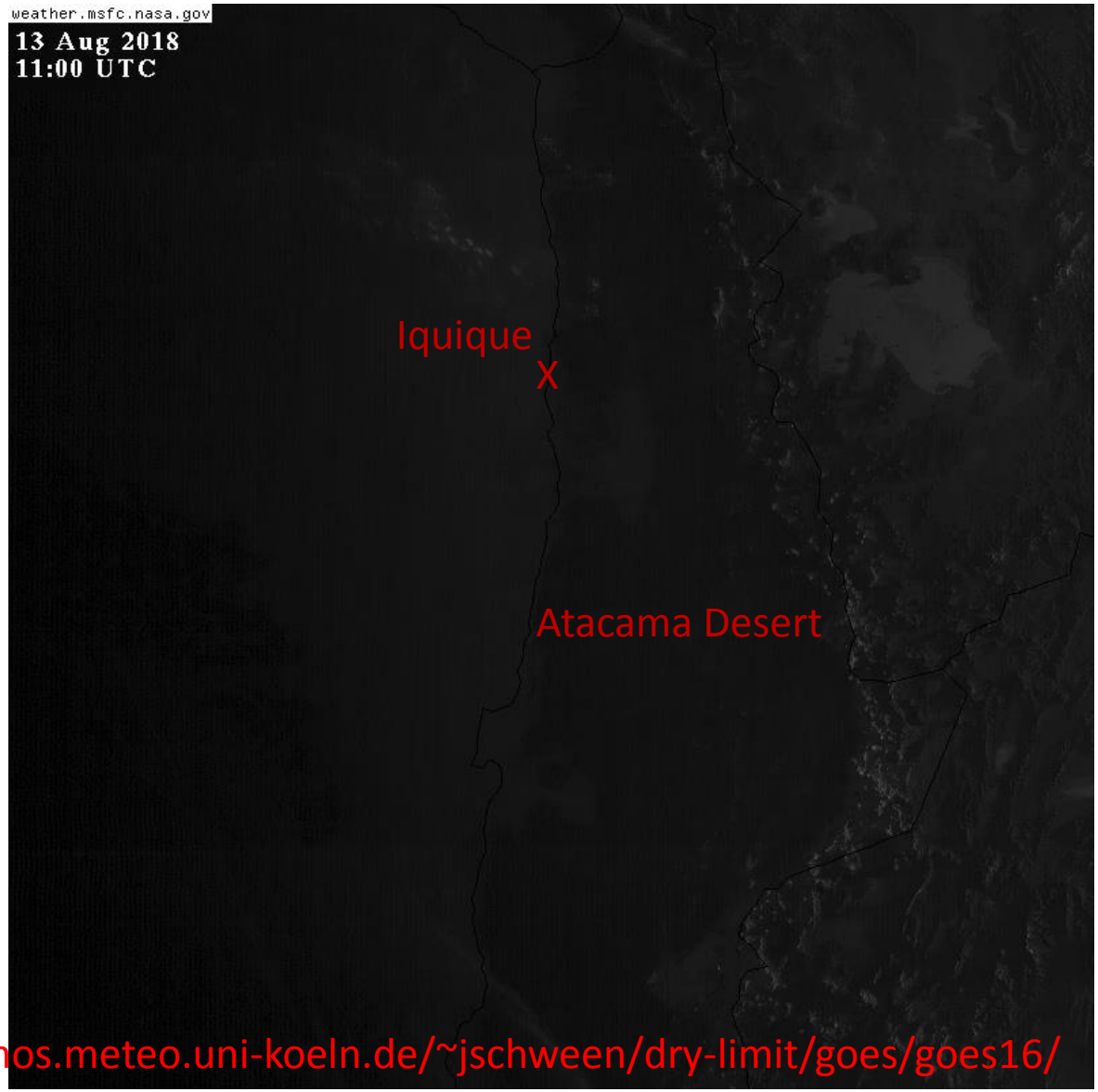


Quillagua
< 1mm/a
5mm/37a

Peel et al. 2007
Köppen and Geiger Classification

- The *Atacama is the driest place on earth* with in some places no precipitation for years
- It has been dry for at least 10 million years. Nevertheless life has adapted to his extreme in isolated places
- Water forms the surface of earth, surface processes in absence of water are widely unknown
- There are signs of erosion by water indicating ‘wet’ phases
- Colaborative research center **CRC-1211 ‘Earth evolution at the dry limit’** aims to:
  - Understand surface processes (mechanisms, age, climate, …)
  - Relate evolutionary processes to these phases

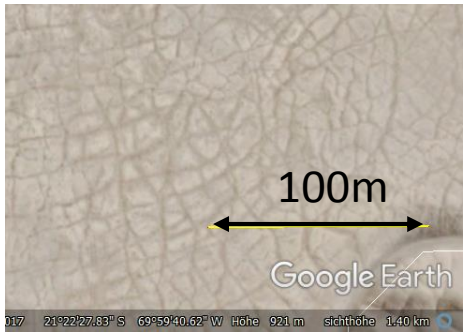
Stratocumulus from GOES16

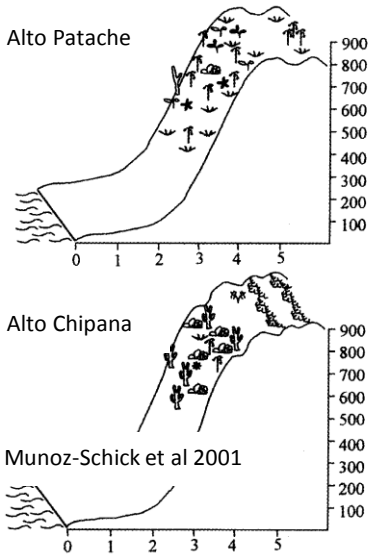


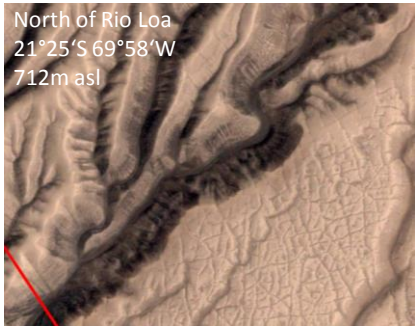
See https://atmos.meteo.uni-koeln.de/~jschween/dry-limit/goes/goes16/

Pacific Sc and fog

- Sc intercepts the coastal cliff and “Cordillera Costal” as fog
  - Fog oases: Lichens, Cacti, Tillandsia, …
  - Soil: Gypsum – Anhydrite conversions
  - Moisture forms landscape
- Height of Sc above ocean defines where fog occurs
- Wind and water content determine how much is available at the surface



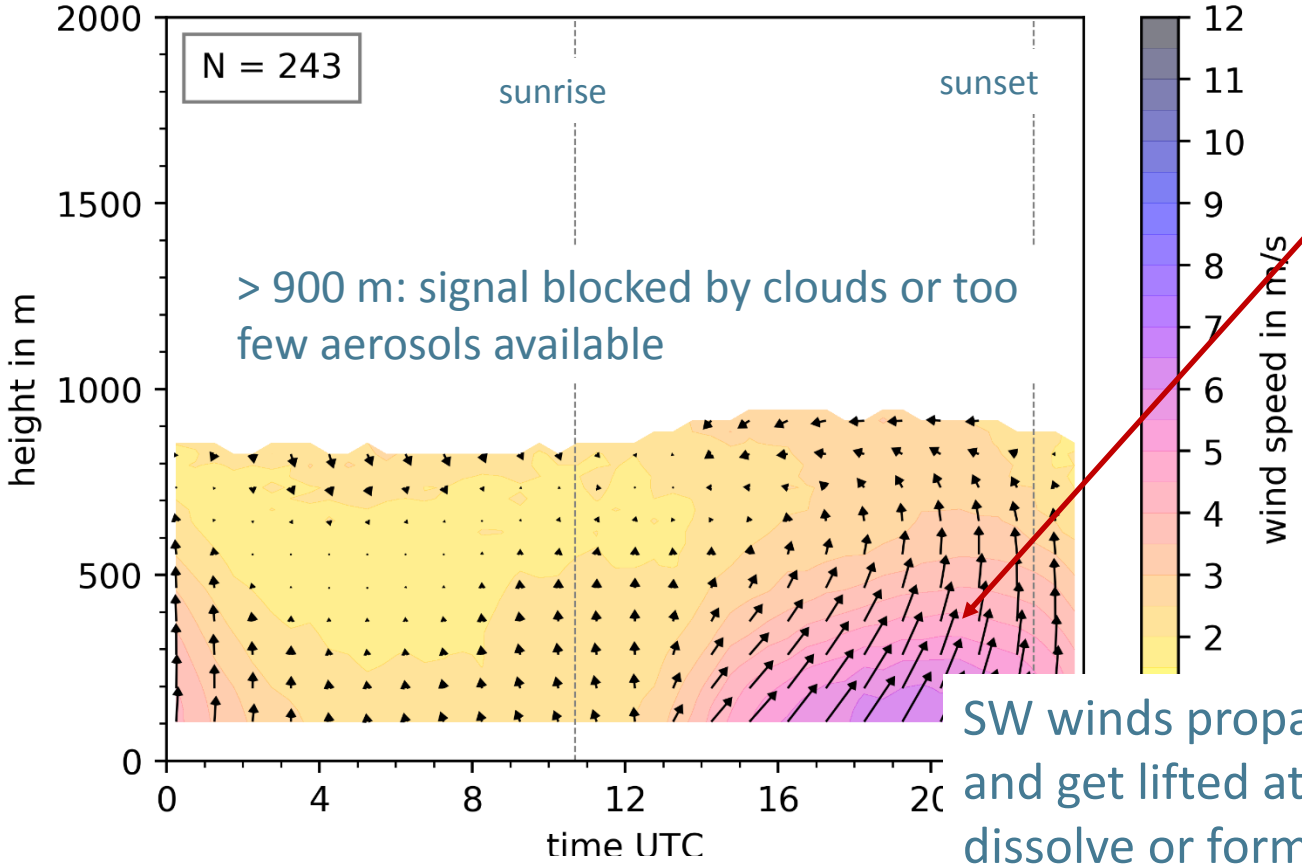




Ground-based remote sensing station at Iquique Airport (2018/2019)

Diurnal cycle of wind (Doppler lidar)

"Coastal cliff circulation"

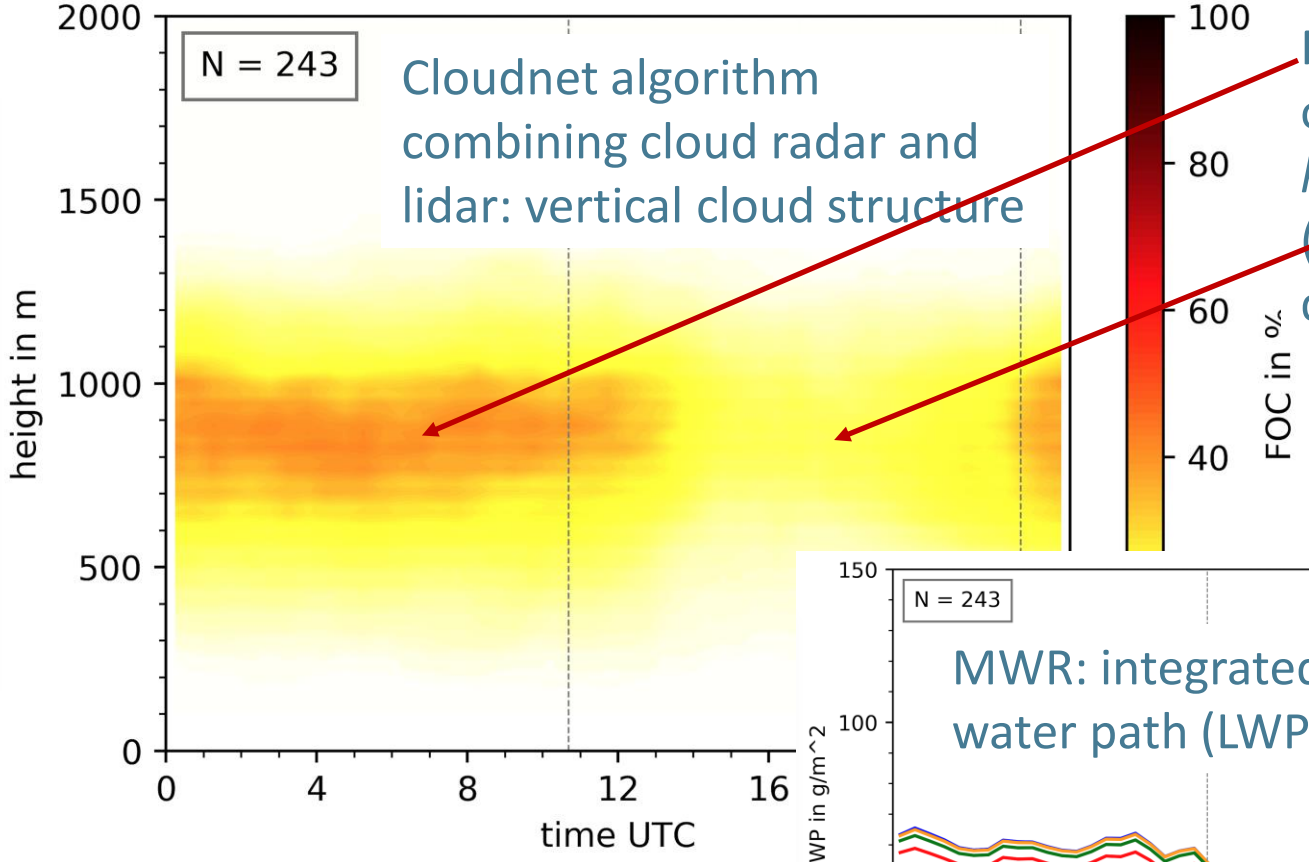


Strong low SW winds, turning to S → SE → E with height at cloud base

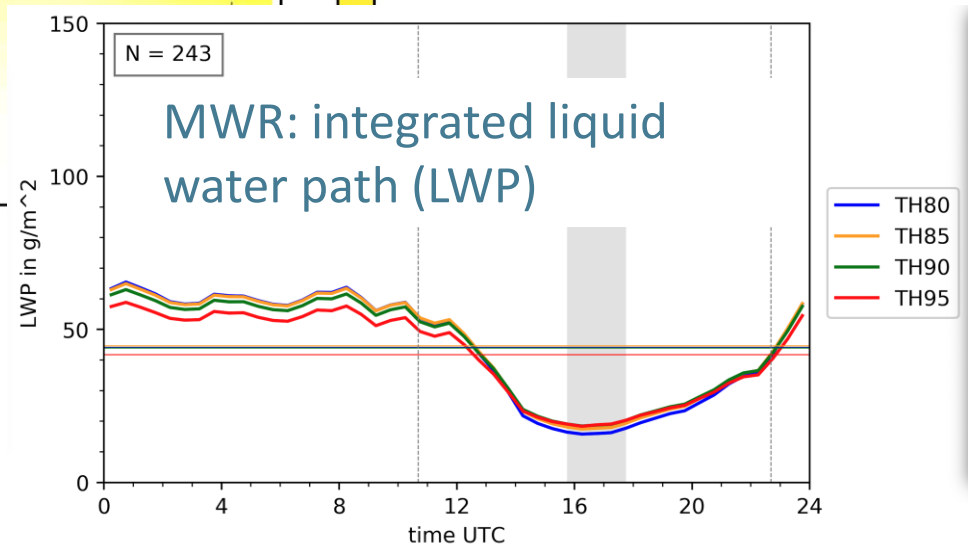
SW winds propagate land-inward and get lifted at coastal cliff to dissolve or form clouds..

Generally low winds at night…

Diurnal cycle of clouds (Cloudnet)

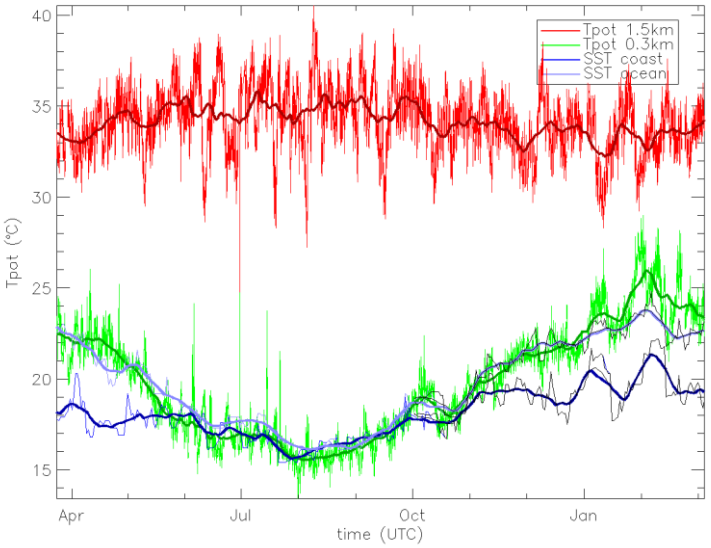


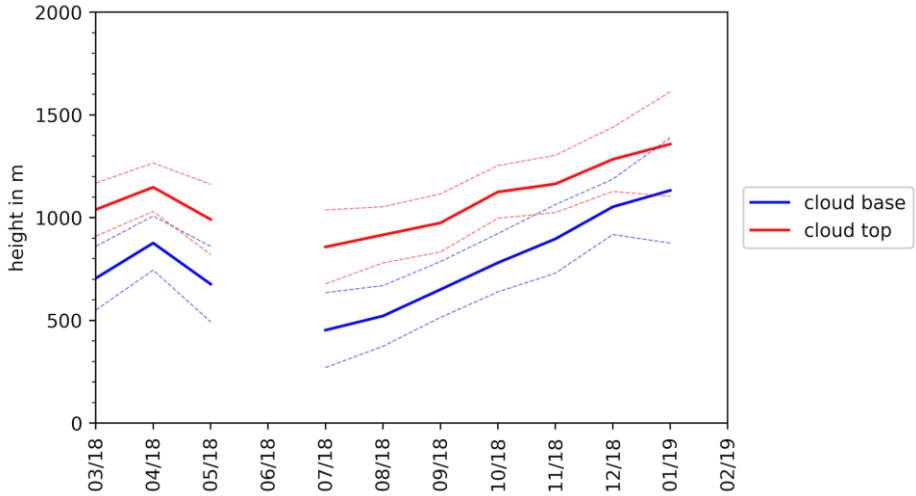
Maximum cloud occurrence *per height* at night (60%), minimum at day (20%)



Maximum LWP (60 gm^{-2}) during night, minimum during day (20 gm^{-2})

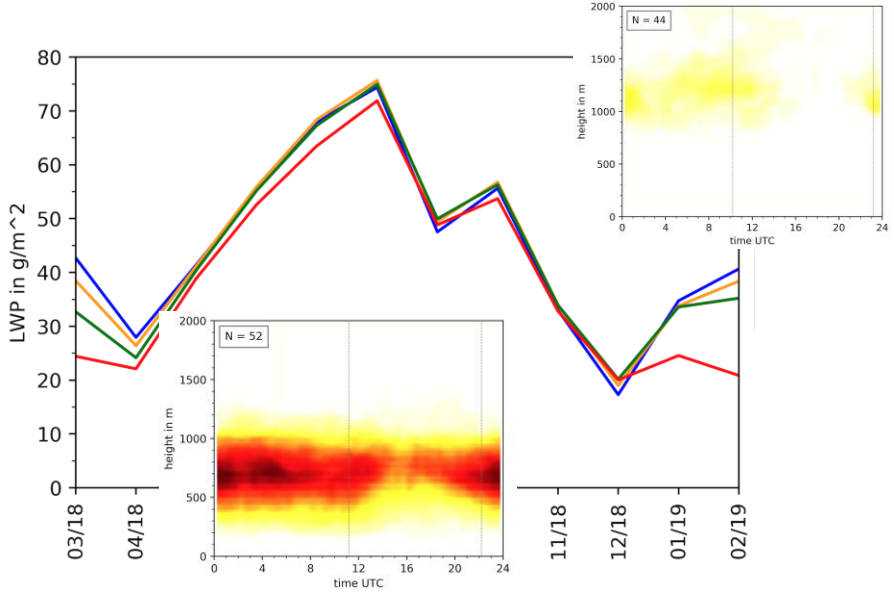
Annual cycle of Atacama coastal clouds



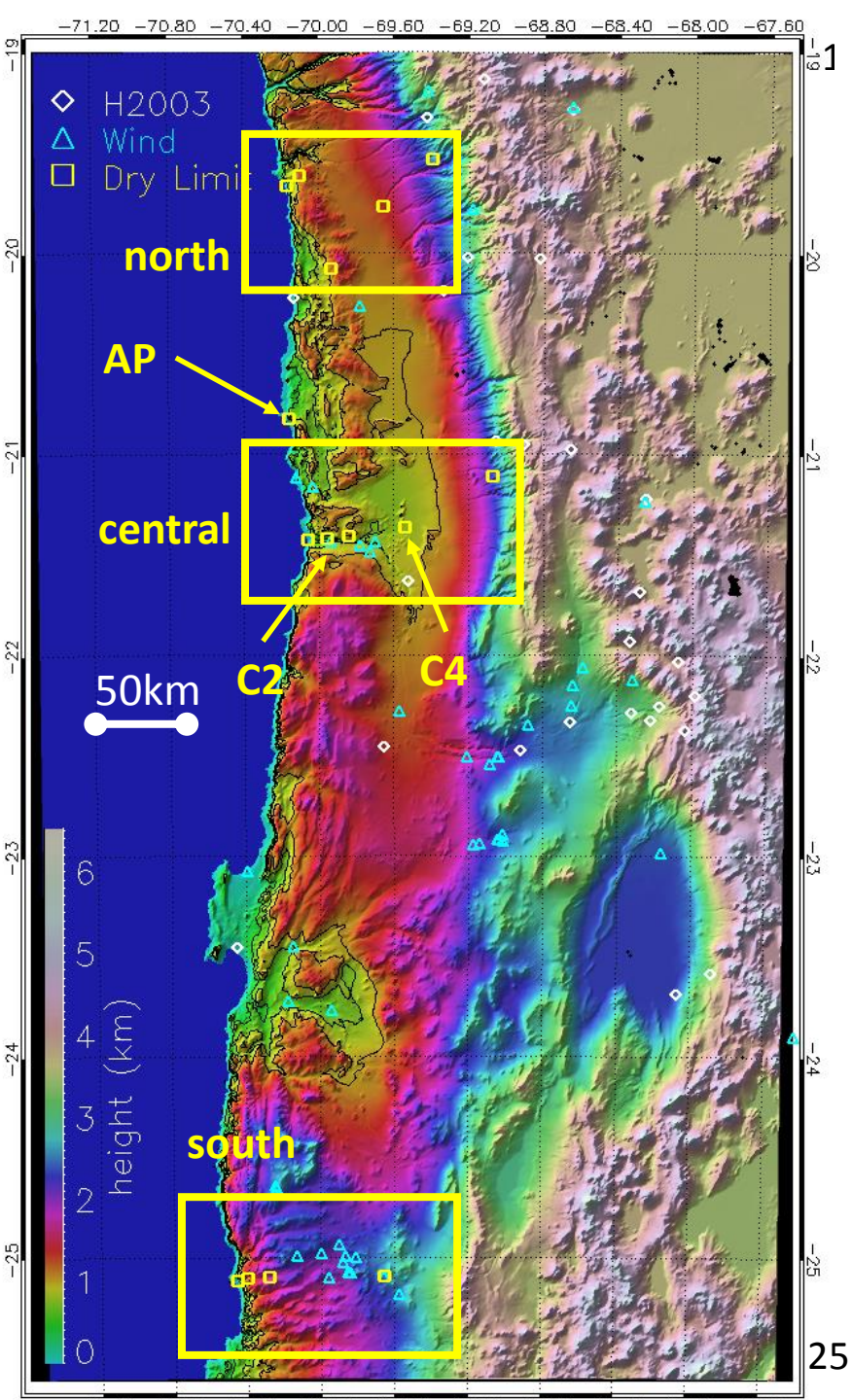


Winter: low SST, strong subsidence, low ABL → low, abundant, thick clouds, high LWP

Summer: "opposite conditions"



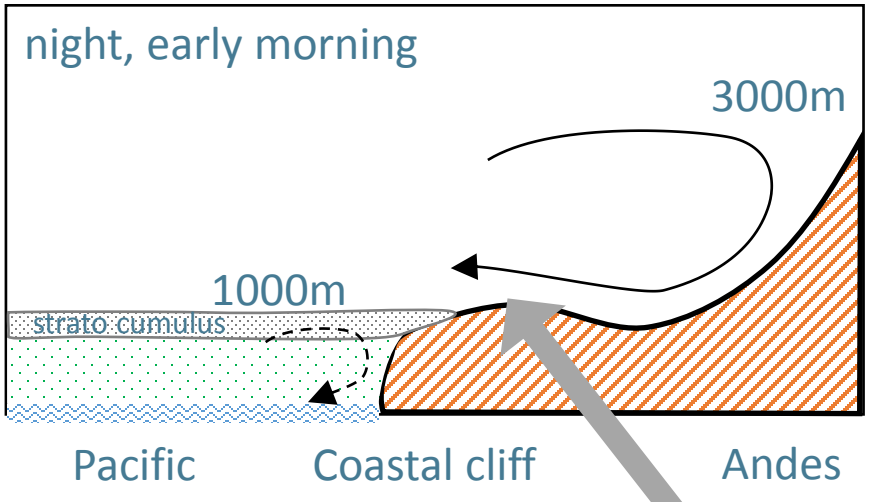
Climate Station network

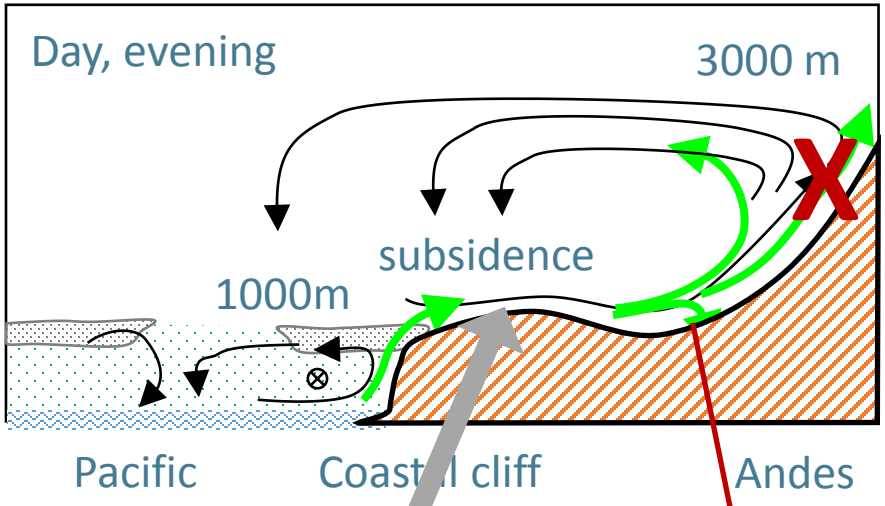


Three transsects with 5(4) stations:

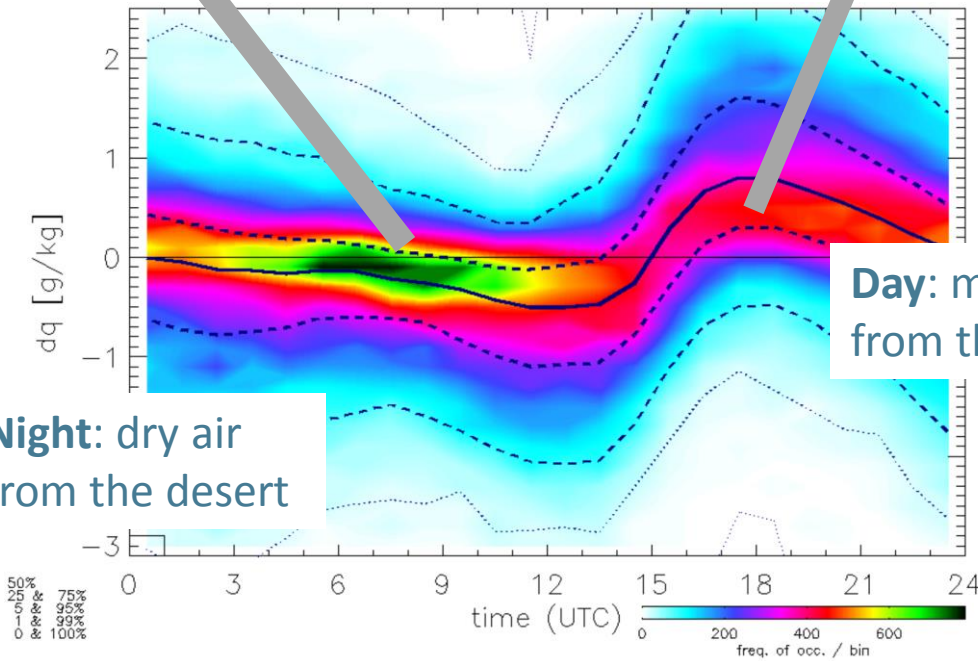
- one station close to the coast
- one station at around 2300m AMSL
- stations are numbered from W to E.
- There is one ‚Master' per transsect.
- Leaf wetness sensor as fog detector

Diurnal cycle of local circulation patterns





Diurnal cycle specific humidity (FOC colored)



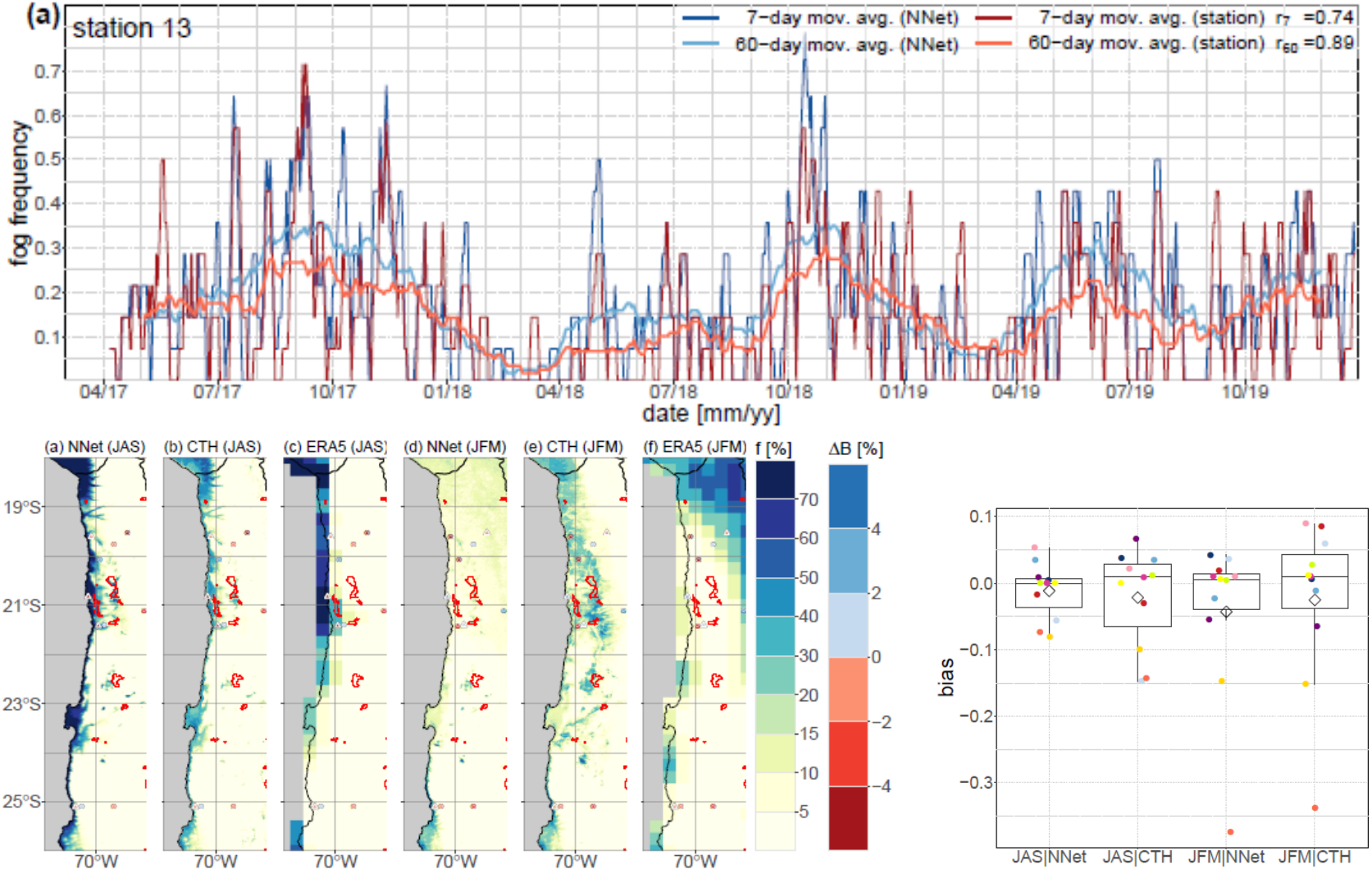
Night: dry air from the desert

Day: moist air from the ocean

0.2 mm/day…!?

Schween et al. 2020

Fog frequency via multi-spectral satellite data and machine learning techniques
Christoph Böhm et al 2021,



Next steps…

- Add water vapor MWR observations around 2600 m MSL (Paranal)
- Perform regional high-resolution Large Eddy Simulations (LES , Δx~50 m)
- Evaluate LES with observations

Looking for a more complete picture for the Atacama moisture supply: Where (and how…) does the water go??

Thank you for your attention!

Thanks to

Juan-Luis Garcia, Pablo Osses Mc Intyre and Camillo del Rio, who made the remote sensing deployment at IQQ possible.

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