Local processes modifying atmospheric humidity around Ny-Ålesund, Kongsfjorden

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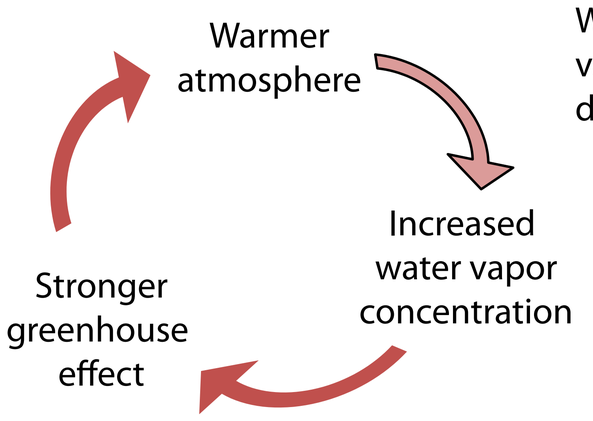
1. Water vapor feedback[1]



Warmer air *can* contain more water vapor, but amount of humidity depends on sources/sinks

- More open sea → more evaporation (?)
- Changes in transport from lower latitudes?
- More water vapor → more clouds and precipitation?

Role of local processes vs. remote forcing in modifying atmospheric humidity?

2. Objectives & Observational set-up

Measurements at AWIPEV, Ny-Ålesund

Fjord environment characterized by:

- Orography
- Glaciers
- Heterogeneous surface types (open water, snow, ice, tundra)

→ Local sources of water vapor & distribution of humidity in Kongsfjorden?

→ Relative importance of local processes compared to advection?

Fig. 1: Map from Svendsen et al. 2002[2]. The red star shows the location of the AWIPEV station.

Microwave radiometer (MWR)

- Standard observation for <u>integrated water vapor (IWV)</u> and liquid water path (LWP)
- 360° azimuth scans at 30° elevation angle 2 times/hour

  → along path IWV and LWP

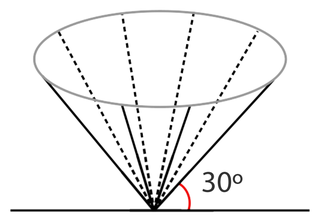


Fig 2: Sketch of MWR scan pattern.

3. Humidity advection

Atmospheric river (long narrow band of enhanced water vapor transport) event on 6 June 2017

→ Rapid increase & decrease in IWV when atmospheric river passes Ny-Å. (Fig. 4 top)

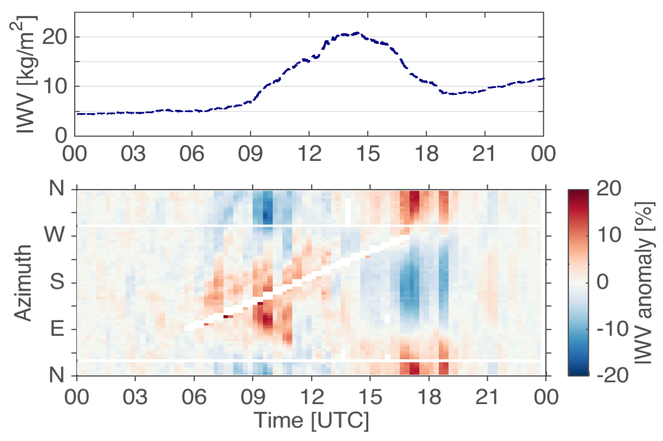


Fig. 4. Top: Time series of IWV (zenith measurement). Bottom: IWV anomaly at a given measured azimuth angle relative to the mean of each azimuth scan.

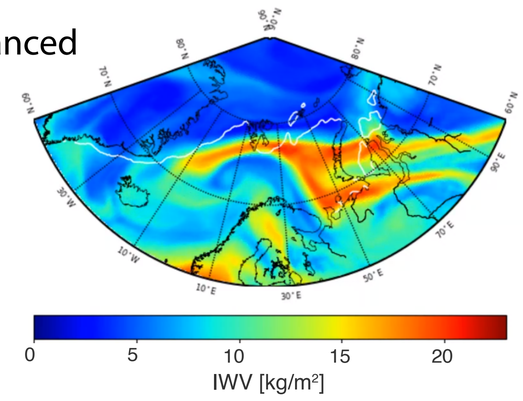


Fig. 3: IWV from ERA5 at 6 June 2017 6 UTC. Courtesy of M. Lauer.

→ Increase (decrease) in IWV is seen first in S-SE direction (Fig. 4 bottom), corresponding to the movement of the atmospheric river over Ny-Ålesund

4. Humidity variability related to local processes

Cases without humidity advection or clouds selected to reveal local influences.

Case 1: Persistent spatial anomaly

11 February 2021

Case 2: No humidity anomaly

29 January 2021

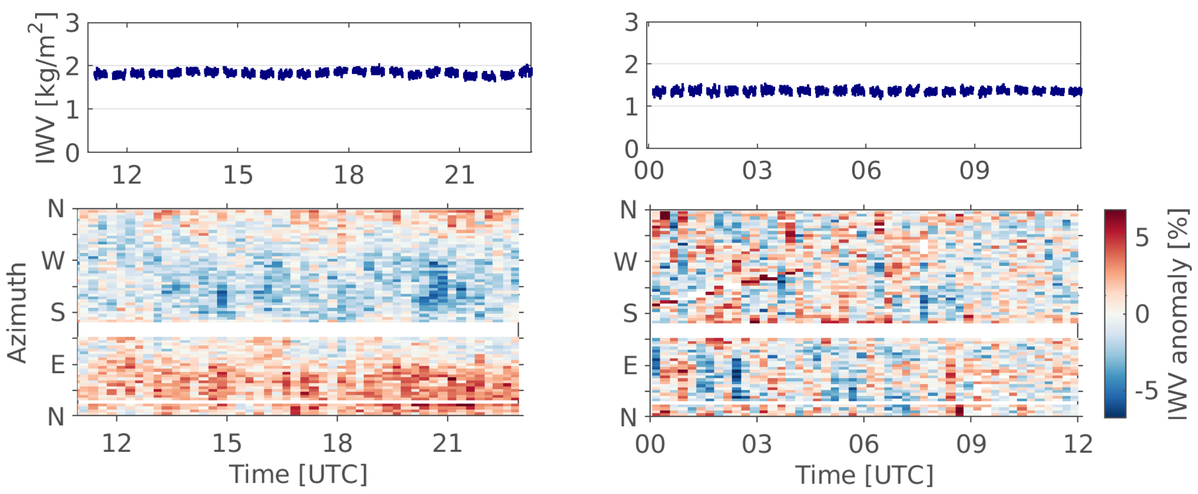


Fig. 5: As Fig. 4, for Case 1 (11 February 2021) on the left and for Case 2 (29 January 2021) on the right.

Case 1: Higher IWV in N-E direction (over water), lower in S-W direction (over land)

→ Evaporation from fjord increasing IWV?

Case 2: Stronger wind speed

→ Prevents a detectable humidity anomaly from forming?

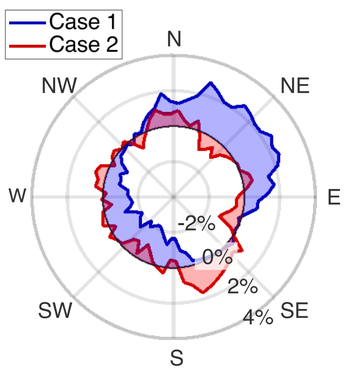


Fig. 6: Mean anomaly at each azimuth angle for both cases.

Fig. 7: Satellite image, source: https://toposvalbard.npolar.no[3]. Red star shows the location of the measurement.

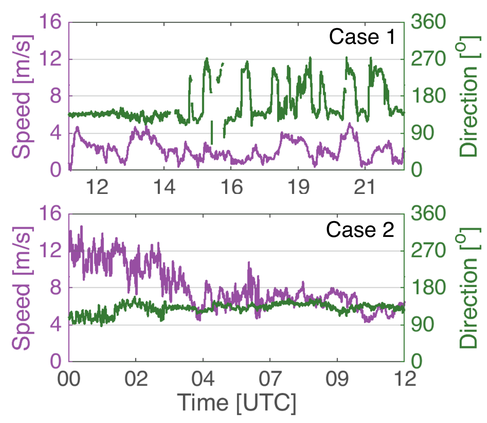


Fig. 8: 10 m wind speed (purple, left axis) and direction (green, right axis) for Case 1 (top) and Case 2 (bottom).

5. Challenges

- Off-zenith measurements sensitive to instrument tilt
- Low amount of water vapor difficult to retrieve, no data during rain
- Combination of path integrated variables (MWR technique) & shallow boundary layer (common at Ny-Å.) make detecting local processes difficult

6. Conclusions & Outlook

- Weak signals of local processes modifying atmospheric humidity detected
- Advection event clearly visible in MWR scans

Perspectives

- Statistical analysis using long term data set
- Combination with ICON model to facilitate process understanding
- Variability of cloud liquid water

References

1- Ghatak, D. and Miller, J. (2013), Implications for Arctic amplification of changes in the strength of the water vapor feedback, J. Geophys. Res. Atmos., 118, 7569–7578.
2- Svendsen et al. (2002), The physical environment of Kongsfjorden–Krossfjorden, an Arctic fjord system in Svalbard, Polar Research, 21(1), 133-166.
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