

Study of maritime convection using the HALO Microwave Package (HAMP)



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1. Motivation

The representation of **maritime clouds and precipitation** is a **major source of uncertainty** in numerical weather prediction and climate models.

► Better understanding of clouds and precipitation processes is a key for improved climate simulations. Observations are fundamental to understand cloud processes and evaluate models.

2. Need for highly resolved observations

■ **Satellites** observe the global distribution of clouds and water vapor, but miss small scale features due to their **coarse resolution**.

► **Higher spatial resolution** is achieved with research aircrafts like the High Altitude Long range research aircraft **HALO**.



Fig. 1: High Altitude Long range research aircraft (HALO)

■ HALO carries **remote sensing instruments** including HAMP:

2.1. HALO Microwave Package (HAMP)

■ active and passive remote sensing package pointing downwards (nadir).

■ **passive: Microwave Radiometer (MWR)**
► 26 channels: 22 to 183 GHz
► receives integrated signal from ground and atmosphere
► ground footprint, flying at 12 km: 1.0 to 0.6 km

■ **active: Cloud Radar (35.6 GHz)**
► emits pulse and receives the backscatter signal from particles
► range attribution via signal propagation time

■ **4 campaigns** observed of clouds:
NARVAL-I-North (Dec, 2013), NARVAL-I-South (Jan, 2014)
NARVAL-II (Aug, 2016), NAWDEX (Sep & Oct, 2016)

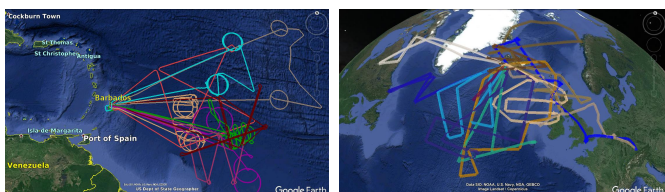


Fig. 2: Flight tracks of NARVAL-II (left) and NAWDEX (right).

6. Acknowledgment and references

The author likes to thank his supervisors S. Crewell, F. Ament and M. Mech for their support and thanks the whole NARVAL and NAWDEX teams for the successful realization of the campaigns.

■ Schnitt, S., E. Orlandi, M. Mech, A. Ehrlich, and S. Crewell, "Characterisation of Water Vapor and Clouds During the Next-generation Aircraft Remote-sensing For Validation (NARVAL)-south Studies" JSTARS, under revision 2017

3. My Goals

- **Develop retrieval algorithms:**
 - **temperature** and **humidity profiles**. (passive MWR)
 - differentiate between cloud **ice, snow, graupel, rain and cloud water**. Retrieve contents. (active + passive)
- Comparative characterization of clouds:
 - tropical North Atlantic vs. mid-latitude North Atlantic
 - cold/dry season vs. warm/wet season
- Is it possible to retrieve the profile of the **cloud drop size distribution** from liquid clouds?
- How does the **synergy of active and passive** constrain **ice particle** characterization?

4. Exemplary cloud characterization

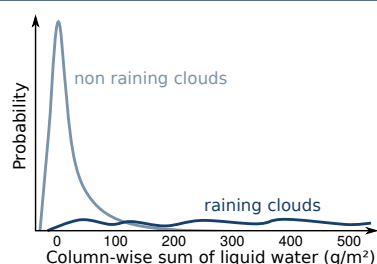


Fig. 3: Probability of a raining cloud as a function of the total liquid water content (LWC). Sketch after Schnitt et al. (2017) for the dry season over the tropical Atlantic (NARVAL-I-South).

- Synergetic use of active and passive HAMP and a solar spectrometer.
- Found drizzling clouds with little water content.
- No strong correlation between water content and rain probability.

5. Example of preliminary data

- Linear regression model to retrieve the integrated water vapor content (IWV).
- Regression model trained with a dataset of dropsonde profiles and simulated radiometer measurements
 - Uses Passive and Active Microwave TRANSfer model PAMTRA
- Water vapor is increased in the vicinity of clouds in satellite images. ► qualitative agreement
- quantitative IWV comparison with dropsondes
 - rmsd = 2.0 kg/m², bias = 1.6 kg/m²
 - next step: improve passive microwave calibration

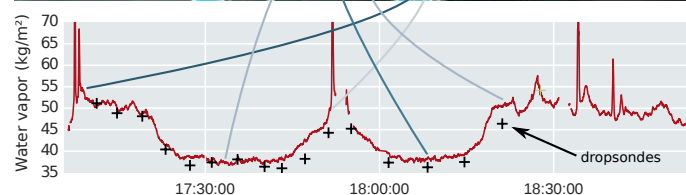


Fig. 4: Top: Water vapor signal seen from satellite (gray scale). Figure based on the NARVAL-II flight report of 2016-08-10. Bottom: Retrieved integrated water vapor (IWV) along flight track. Arrows connect time and position on map.