Multi-frequency radar observations of mixed-phase clouds and mountainous precipitation during the CHOPIN campaign

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Introduction: the CHOPIN campaign

The CleanCloud Helmos OrograPhic slte experimeNt (CHOPIN) campaign is one of the main observational activities of the CleanCloud project, a Horizon Europe project among 20 European research institutes that studies **aerosol-cloud interactions** (ACI).

The main goal of the CHOPIN campaign is to improve the understanding of the processes involved in the formation of orographic mixed-phase clouds (MPCs), and to improve & develop algorithms used for **remote sensing of ACI**.

Preliminary results

MIRA

MXPol

The radars were collecting data on site between October 10th, 2024 and end January 24th, 2025. Data processing is currently ongoing, but a preliminary inspection shows that many precipitation events took place throughout the measurement period (> 1 m of snow accumulated on the site). Despite rather many operational challenges, multiple precipitation events are covered by triple-frequency observations.









Location and site characteristics

- Mt. Helmos: 2340 m above sea level (Peloponnese region, Greece).
- Many different air masses in a climate-sensitive region that is experiencing rapid changes.
- Helmos Hellenic Atmospheric Aerosol & Climate Change station, (HAC)²:
 - Frequently situated in the free troposphere (FT) or at its interface with the planetary boundary layer (**FT-PBL interface**)¹.
 - Wide range of atmospheric particles for ACI, including biomass burning emissions, continental anthropogenic pollutants, marine spray aerosols, Saharan dust, and biogenic particles.



MIRA and MXPol were scanning following the scan pattern below: 2 perpendicular RHI's (roughly N-S and E-W), and a sector scan at 8° elevation between 340° and 100° azimuth. Due to pedestal issues, MXPol only carried out vertical PPI's after December 24th, 2024.



Scan strategy (left) and MIRA reflectivity data around 03:00 UTC during the rainy night of 19.10.2024 (right).



Images: Google Earth; NASA (https://earthobservatory.nasa.gov)

The (HAC)² station is situated about 4 km south of the Kalavryta Ski Centre, which is at a distance of approximately 8 km from the village of Kalavryta.

During the CHOPIN campaign, two further sites have been instrumented around the Kalavryta Ski Centre: a "low altitude station" for in-situ observations at ~1750 m a.s.l., and a site where remote sensing instruments have been installed. Apart from the ground-based remote sensing instrumentation, UAV flights and Helikite measurements as well as radiosondes provide additional in-situ observations of atmospheric variables

Link to the CHOPIN campaign webpage for full instrumentation details:

Remote sensing instrumentation

On the remote sensing site, three meteorological radars (X-, Ka- and W-band) have been deployed to capture radar moments and multi-wavelength polarimetric Doppler spectra.

From left to right on the below picture:

- BASTA (W-band / 95 GHz vertically pointing Doppler radar)
- HALO (pulsed Doppler wind lidar)
- MIRA (Ka-band / 35 GHz polarimetric spectral scanning radar)



First snowfall on 01.12.2024: 24-hr MIRA zenith-pointing reflectivity data (top), webcam images showing solid precipitation at 11:50 and 15:20 UTC (bottom left), and MXPol sector scan & RHI around 20:00 UTC (bottom right)



Outlook – stay tuned!

1. Finalise data processing: perform multi-frequency radar calibration using the transfer methodology by Jorquera et al. (2023)², and Zdr calibration of the X-band data following the approach in Ferrone & Berne $(2020)^3$.

- Multispectral sun photometer
- MXPol (X-band / 9.4 GHz polarimetric spectral scanning radar)



- 2. Conduct case studies analysing spectral and multi-frequency polarimetric data for specific events focusing on cloud microphysical processes, particularly secondary ice production (SIP).
- 3. Integrate radar data with the in-situ observations, synoptic conditions, and measurements from other remote sensing instruments.

References

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