Observing mesoscale frontal convection and dry intrusions during NAWDIC using multi-dropsonde measurements

K. L. Yeung[1], B. Kirsch[1], C. Hoose, A. K. Miltenberger[2], and A. Oertel[1]

[1] Institute of Meteorology and Climate Research Troposphere Research (IMKTRO), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

[2] Institute for Atmospheric Physics, Johannes Gutenberg University Mainz, Mainz, Germany

Karlsruhe Institute of Technology

This presentation participates in OSPP

Outstanding Student & PhD candidate Presentation contest

North Atlantic Waveguide, Dry Intrusion and Downstream Impact Campaign

NAWDIC

- Improve understanding of the dry intrusion (DI) and its relationship to high impact weather in North Atlantic winter
- Jan-Feb 2026 international observational field campaign

NAWDIC - MESO

- Understand the mesoscale structure and convection-triggering mechanisms in the cold frontal region
- Using observations from KITsonde onboard HALO and KITcube ground-based systems, we investigate the interaction between DI and cold fronts

KITsonde

- Multi-sensor dropsonde system → mesoscale variability
- Spatio-temporal vertical profiles of temperature, humidity, pressure, and wind at ~ 1 s resolution

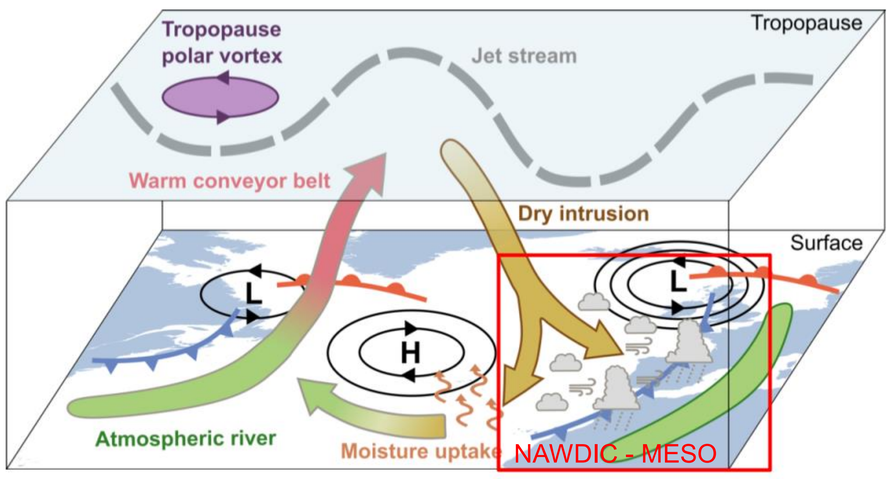

Fig 1. Meteorological features and processes targeted during the North Atlantic Waveguide, Dry Intrusion, and Downstream Impact Campaign (NAWDIC).

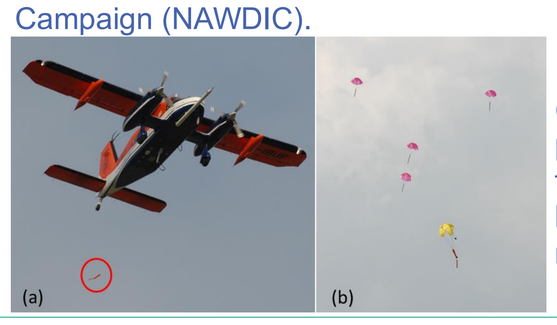

Fig 2. (a) Release container. (b) Four dropsondes, with a parachute of different sizes, fall at varying speeds after being separated from the release container (yellow)

KITsonde simulator

- To simulate KITsonde trajectories based on forecasting / reanalysis data and trace variables along trajectories
- To compare observed profiles and forecasted profiles

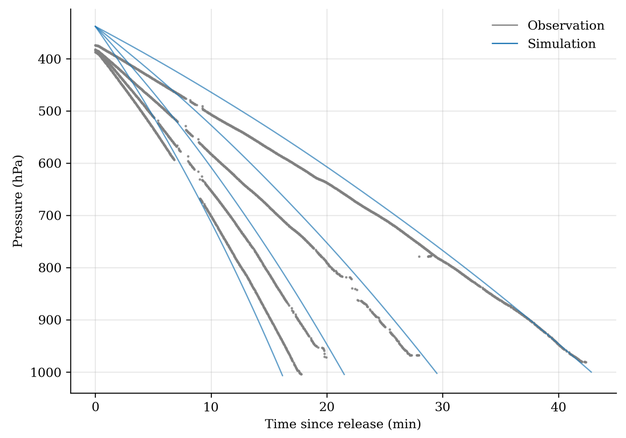

Fig 3. Observed trajectories vs simulated trajectories

Case study: IOP Killaloe

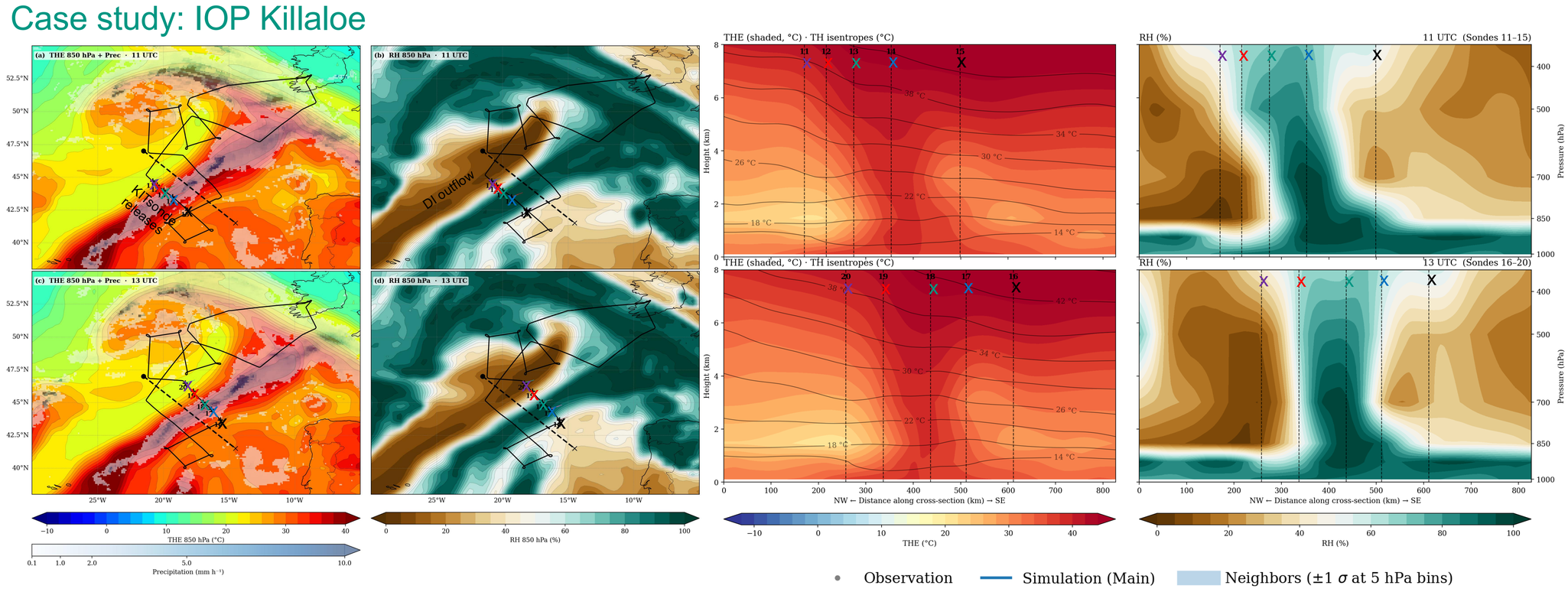

Fig 3. Synoptic condition plotted using GPM IMERG (precipitation) and ERA5 (other variables) showing the flight track (black line)

- DI outflow reaches at 850 hPa at the cold sector
- Alternating moisture layers at the DI – cold front interface
  - Not represented in the forecast model (IFS)
  - Mixing between air masses
  - Marine boundary layer eroded by the DI at 900 hPa
- Uncertainty in simulation decreases away from the cold front
  - Maximum at the precipitating cloud close to the cold front
- Mesoscale variance of RH is largest at the boundary of air masses (up 50 %² to 400 %²)
- Temperature compared to RH have less variability

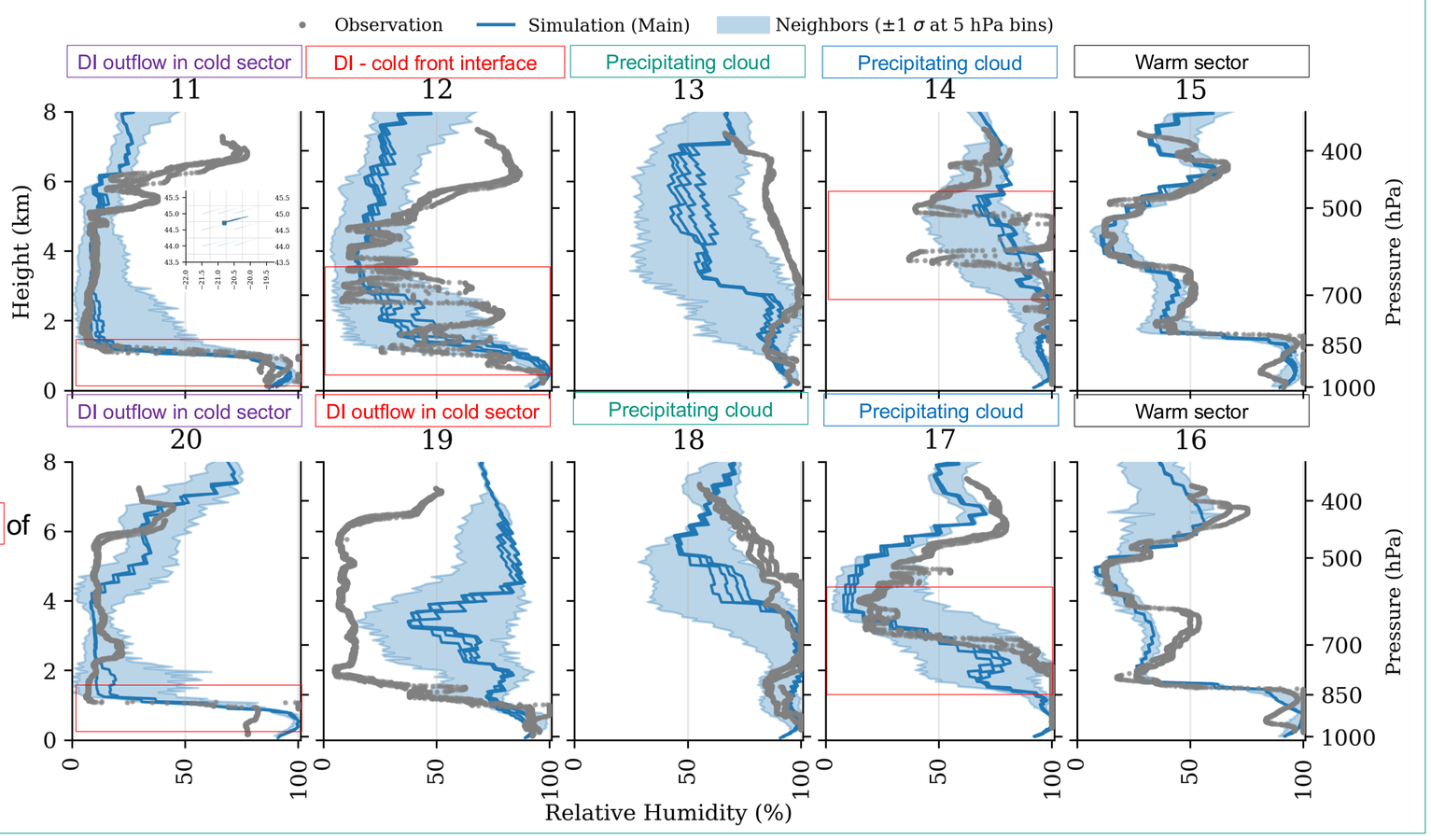

Fig 4: Observed RH profiles from the KITsonde (gray) and simulated RH profiles (blue) with uncertainty (shaded) from the KITsonde simulator.

Outlook

- High-resolution modelling and Lagrangian trajectory analysis on the DI – cold front interaction
- Quantify mesoscale variability and representativity of the KITsonde profiles
- Comparison of the simulated trajectories from different model (ICON, IFS)

Kam Lam Yeung – kam.yeung@kit.edu
PhD student
Mesoscale Processes and Predictability Group