ESA-JAXA Pre-Launch EarthCARE Science and Validation Workshop

13 – 17 November 2023 | ESA-ESRIN, Frascati (Rome), Italy

EVID37: Calibration and Validation of EarthCARE Retrieved Products Using Measurements from the UK Facility for Airborne Atmospheric Measurements (FAAM)

Mroz K[1] , Brindley H[2] , Hogan R[3] , Mason S[3] , Stein T[4], Westbrook C[4]

[1]National Centre for Earth Observation, [2]Imperial College London, [3]ECMWF, [4]University of Reading

The FAAM Airborne Laboratory

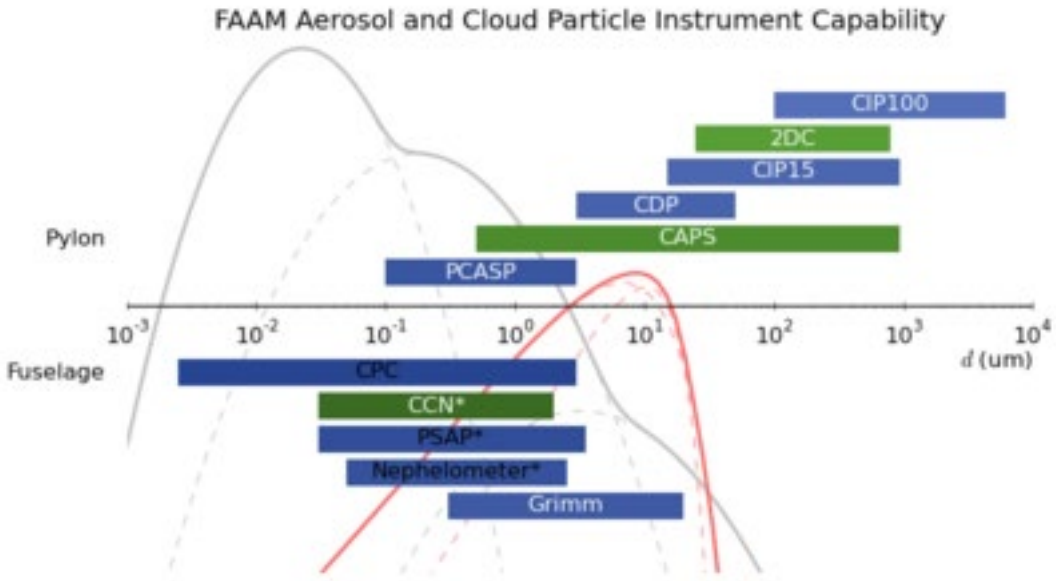
- Based at Cranfield Airport at Cranfield University
- Flying since January 2005
- BAE-146-301 large research aircraft
- Speed: 400-660 km/h
- Altitude: from 30m over water (150m over land) to 10km (depending on payload)
- FAAM is undergoing its mid-life upgrade - **out of action from July 2024 until early 2025**

The aircraft payload

- The aircraft can carry up to 4 tonnes of scientific equipment
- Meteorology: Temperature, Humidity, Pressure, Air motion, CO_2 and CH_4 concentration
- Remote sensing:
  Broadband Radiometers, Imaging Infrared Radiometer, ISMAR-International Sub-Millimetre Airborne Radiometer, Microwave Airborne Radiometer Scanning System, Mini-Lidar

The aircraft payload

- Cloud physics:
  droplet counters, imaging probes covering sizes from 3um to 6.5mm , bulk ice and water content
  (Nevzorov & TWC probe)



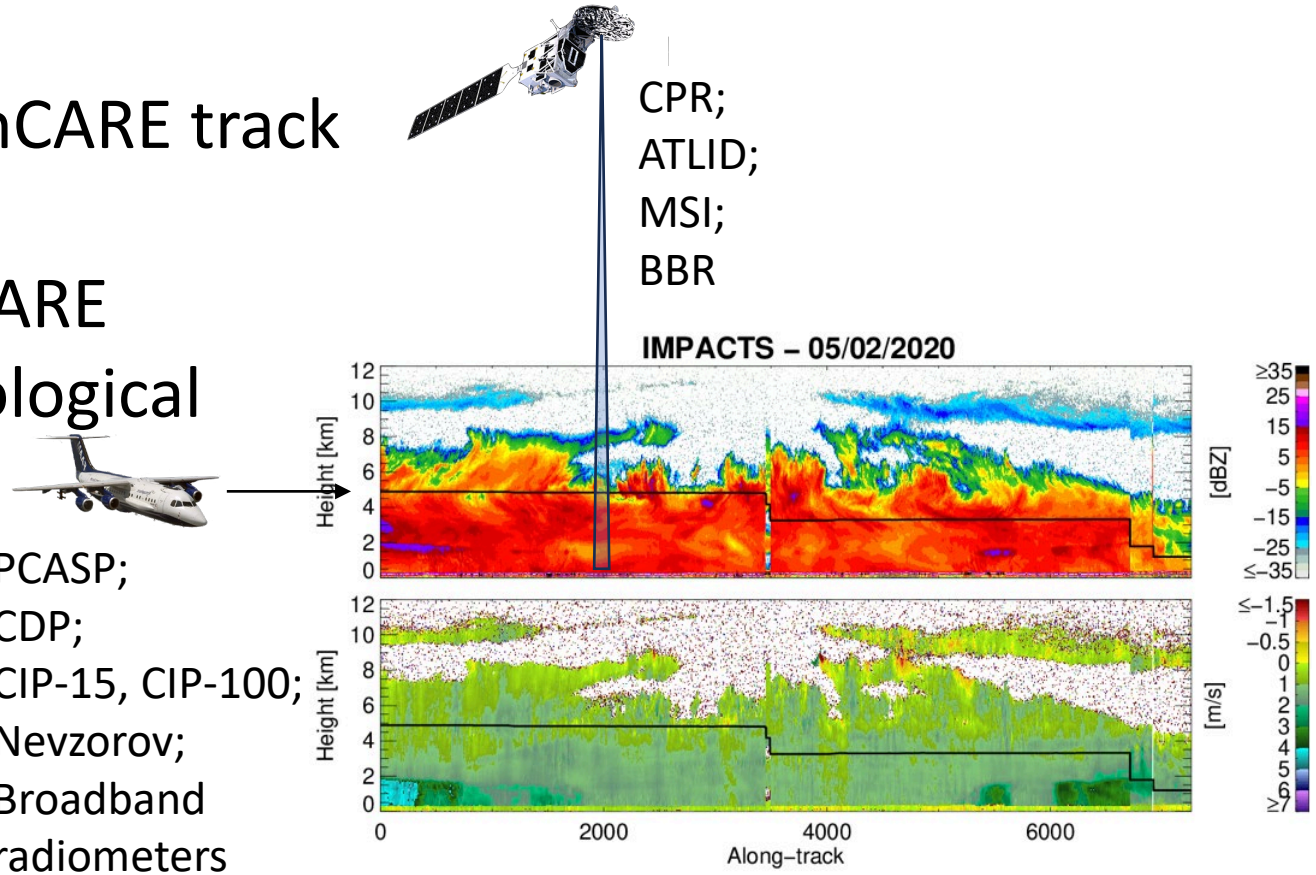
- Aerosol properties:
  Particle Soot Absorption Photometer, Nephelometer, Cloud Condensation Nuclei Counter, Condensation Particle Counter (0.03 to 2.5um)

Mid-life upgrade (£49M)

- Aerosol: AMS upgrade (higher res); aerosol lidar (upgrading downward pointing, installing upward pointing); new aerosol inlets (allowing a larger size range from 0.001 to 10 microns); potentially greater discrimination on aerosol type from a couple of new spectrometers
- Cloud: new Optical Array Probes - higher res. cloud particle data; new ice microphysics measurement suite (not much detail on that).
- Radiation: UNIRAS (Far-mid infrared spectrometer), potentially a replacement for the SHIMS instrument (spectral hemispheric irradiance in the shortwave), possibly OSIRIS (14 channel radiometer, with polarizing and angular capability, prototype of 3MI)

Objectives

- Collect measurements within clouds
- At least 10 overpasses
- Within 20 minutes of the EarthCARE track
- at least 120 km long
- prioritise runs beneath EarthCARE
- Sample wide range of meteorological conditions
- Piggyback on existing campaigns involving another aircraft with radar onboard



Conditions of particular interest

- Continental aerosol – its properties derived primarily from ATLID
- Broken cumulus and marine aerosol – drizzle free cumulus, low Z regime
- Marine stratocumulus – CPR dominated by drizzle, ATLID penetrating cloud tops
- Large-scale rain – evaluation of information content of Doppler data
- Snow above the melting layer – embedded supercooled layers causing attenuation and affecting snow density – CPR Doppler sensitivity
- Altocumulus – mixed phase cloud with supercooled layer on top
- Cirrus – synergy of radar & lidar, consistency of forward models
- Convective clouds – retrieval uncertainty in challenging conditions

Evaluation of the products

- Particle size distribution shape assumptions
- Representative ice habits
- Ice particles scattering properties assessment
- Ice falling velocity parametrization
- Large particle size regime (>1mm)
- Distribution of the liquid cloud mass in the column (thickness/#layers)
- Potential benefits of brightness temperature measurements assimilation

Summary

- The FAAM aircraft is a world-class research facility
- The mid-life upgrade coincides with EarthCARE commissioning phase
- The current proposal is to make opportunistic use of FAAM
  - Potential 1-2 flights June 2024 from Cranfield, UK.
  - Potential flights spring 2025 from UK and Ireland (to piggyback on CARES).
- Our team is open to explore options for using FAAM during an extended campaign incorporating airborne system with EarthCARE equivalent payload