Imperial College London

NERC SCIENCE OF THE ENVIRONMENT

CIRCCREX – A new cirrus dataset for model evaluation

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FAAM

Campaign overview

Cirrus Coupled Cloud-Radiation Experiment

Aims:

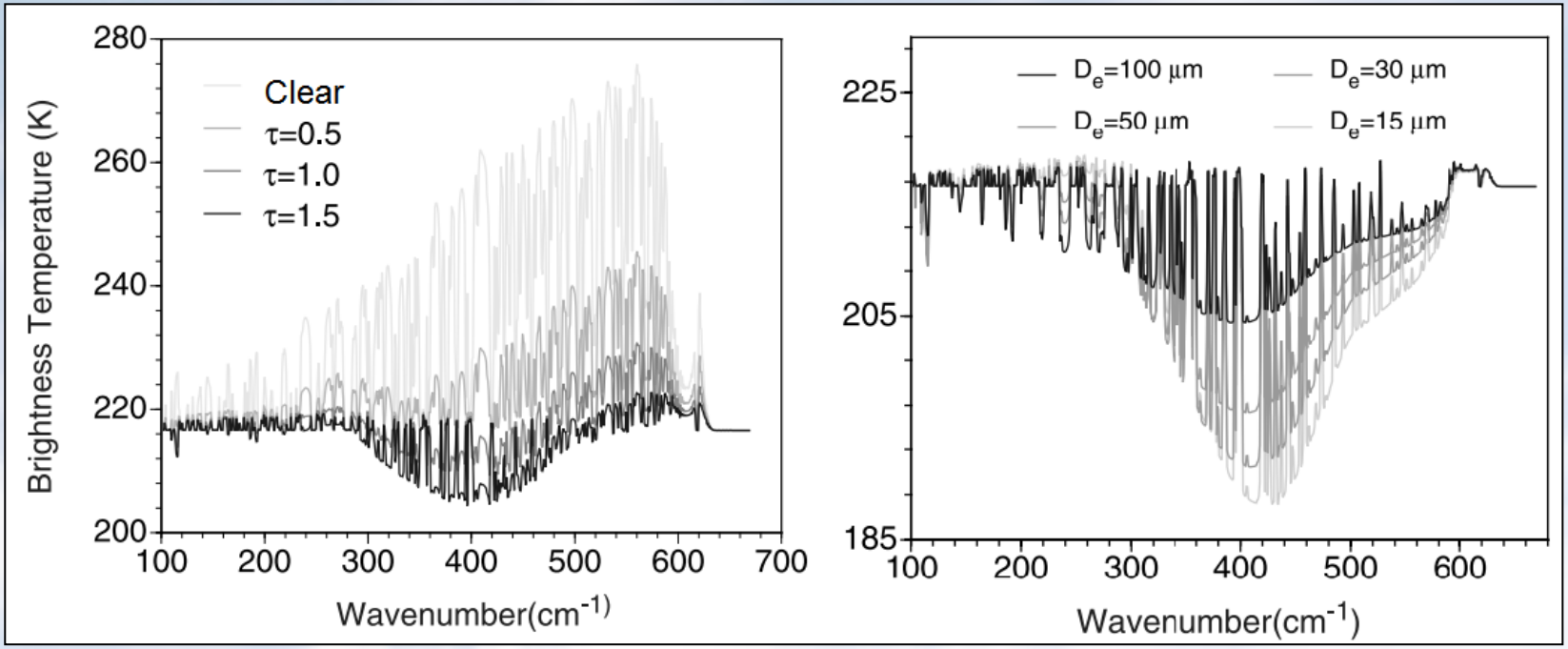
- to understand the link between cirrus microphysical properties and macrophysical radiative signatures

- to obtain, through collaboration, an accurate parameterisation of cirrus optical properties in global climate modelling and Numerical Weather Prediction.

Motivation & Background

Radiative effect of cirrus = cooling/warming, depending on:

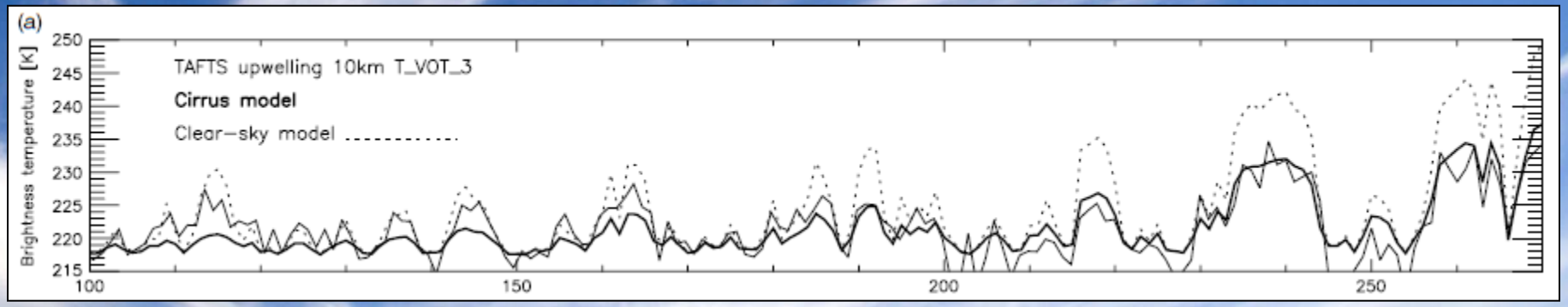
- altitude
- location
- optical thickness
- particle size
- particle shape
- particle complexity



Dependence of FIR Brightness Temp on (L) cirrus optical thickness ; (R) particle effective size (Yang et al. 2003)

Previously…

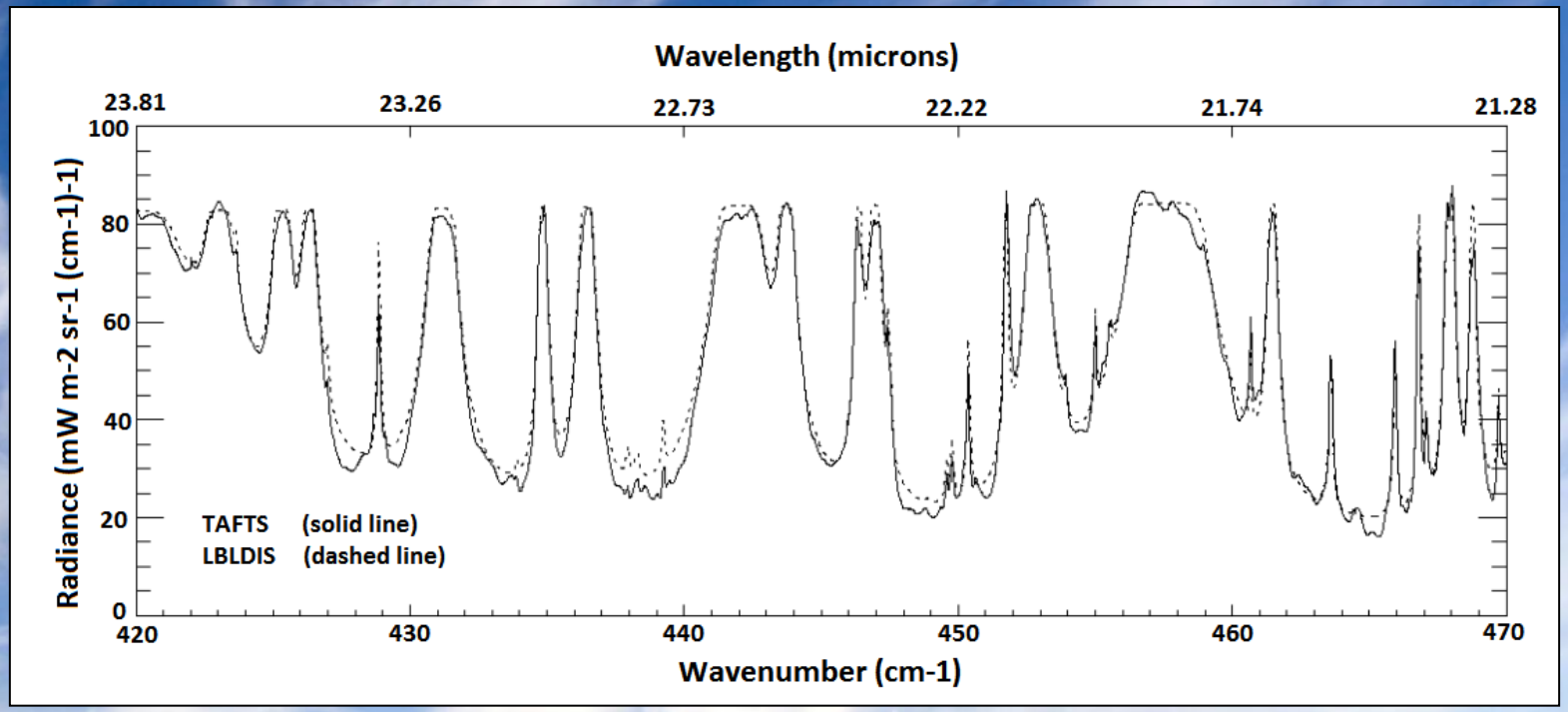
- **WINTEX UK 2005 (Cox et al 2010)**
  - first high resolution far-infrared study of cirrus
  - inadequate sampling of cloud and atmosphere
- RHUBC Alaska 2007 (N Humpage PhD 2010)
- CAESAR UK 2006-08



Cox et al. (2010)

Previously…

- WINTEX UK 2005 (Cox et al 2010)
- **RHUBC Alaska 2007 (N Humpage PhD 2010)**
  - ground-based cirrus observations, instrument intercomparison
  - no in-situ particle measurements
- CAESAR UK 2006-08



Humpage (2010)

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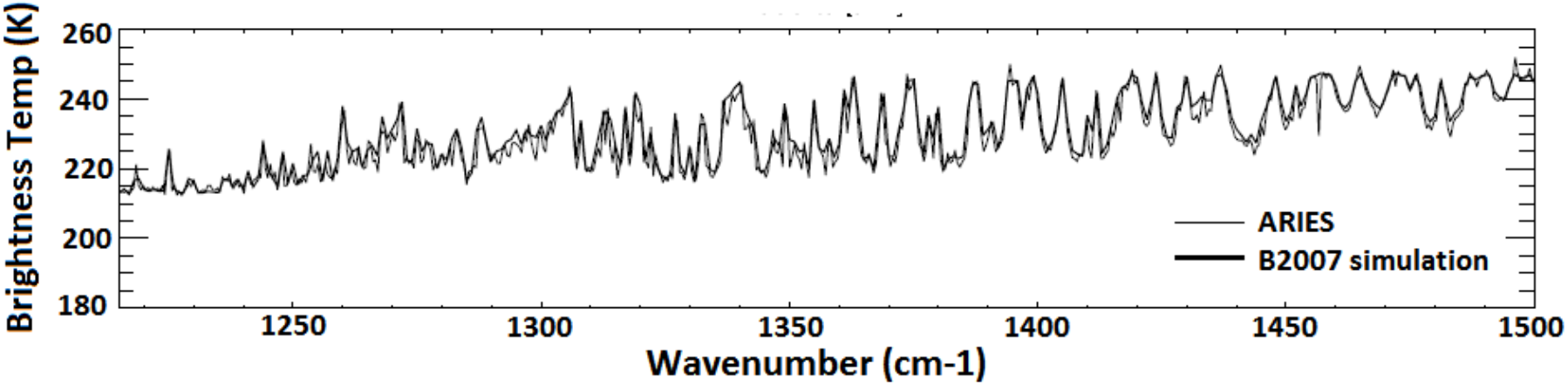
  - measurements of broadband radiances
  - particle shattering, some noise issues



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No campaign dataset currently exists combining broadband radiances with accurate cloud microphysics and detailed atmospheric state measurements

Campaign details

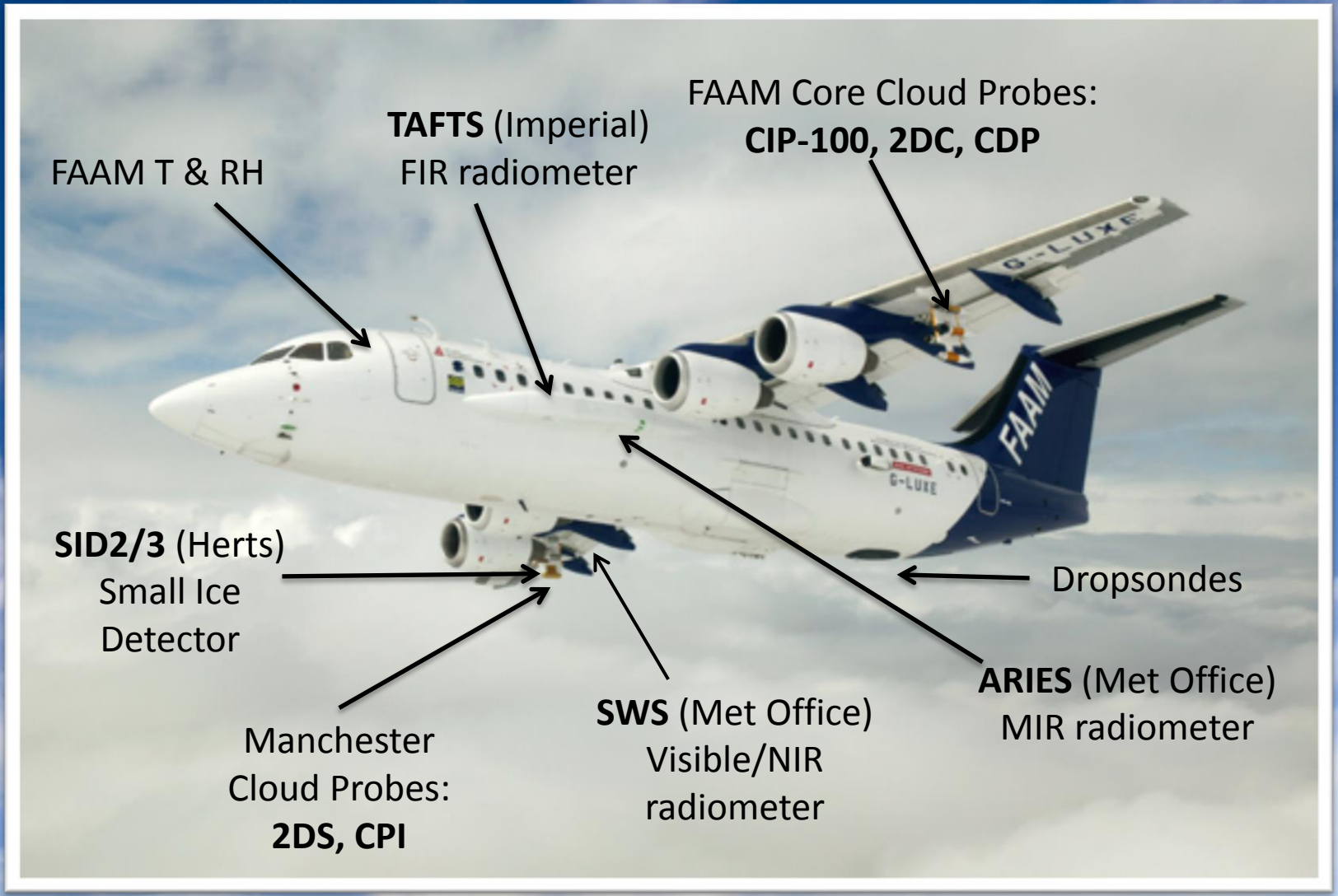
Radiative closure cirrus cloud-radiation experiments in northern and mid latitudes

- 3 campaigns:
  - Prestwick Nov 2013 & winter 2014
  - Goose Bay spring 2015

Measurements:

- radiances 0.2-125 µm above, below and within an extensive layer of well developed cirrus
- Relative Humidity (RH) and temperature profiles of column above and below cirrus
- ice crystal particle size distribution, habit and crystal complexity (including roughness, concavity) within cirrus layer

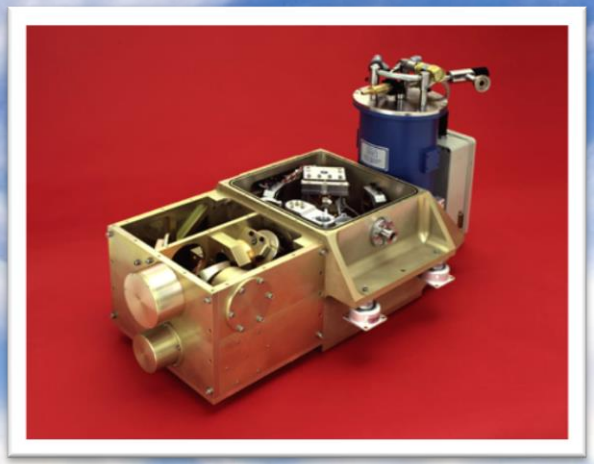
Instrumentation



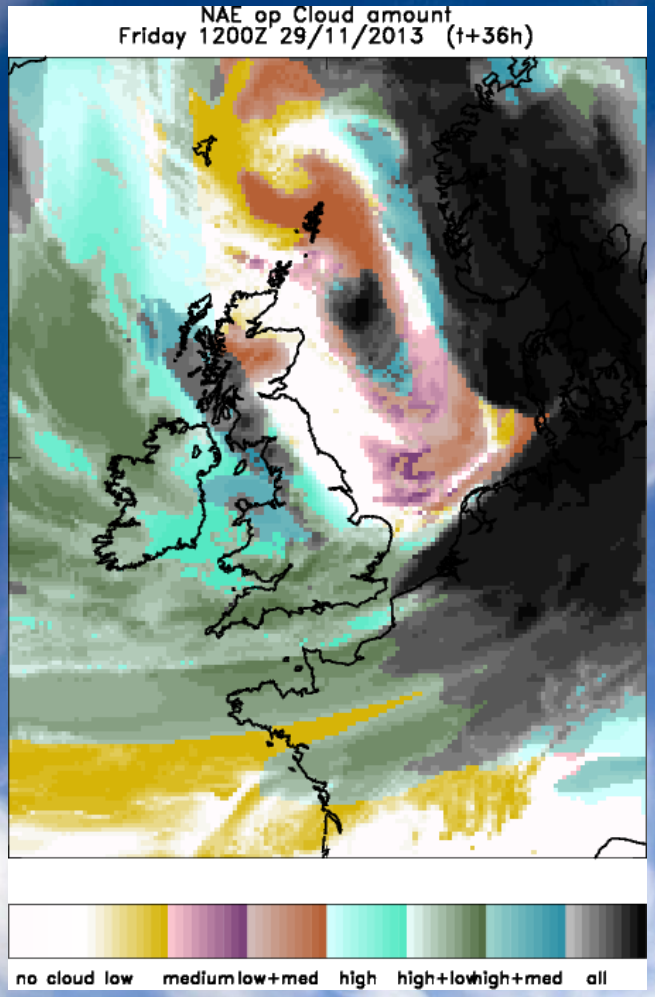
TAFTS

Tropospheric Airborne Fourier Transform Spectrometer

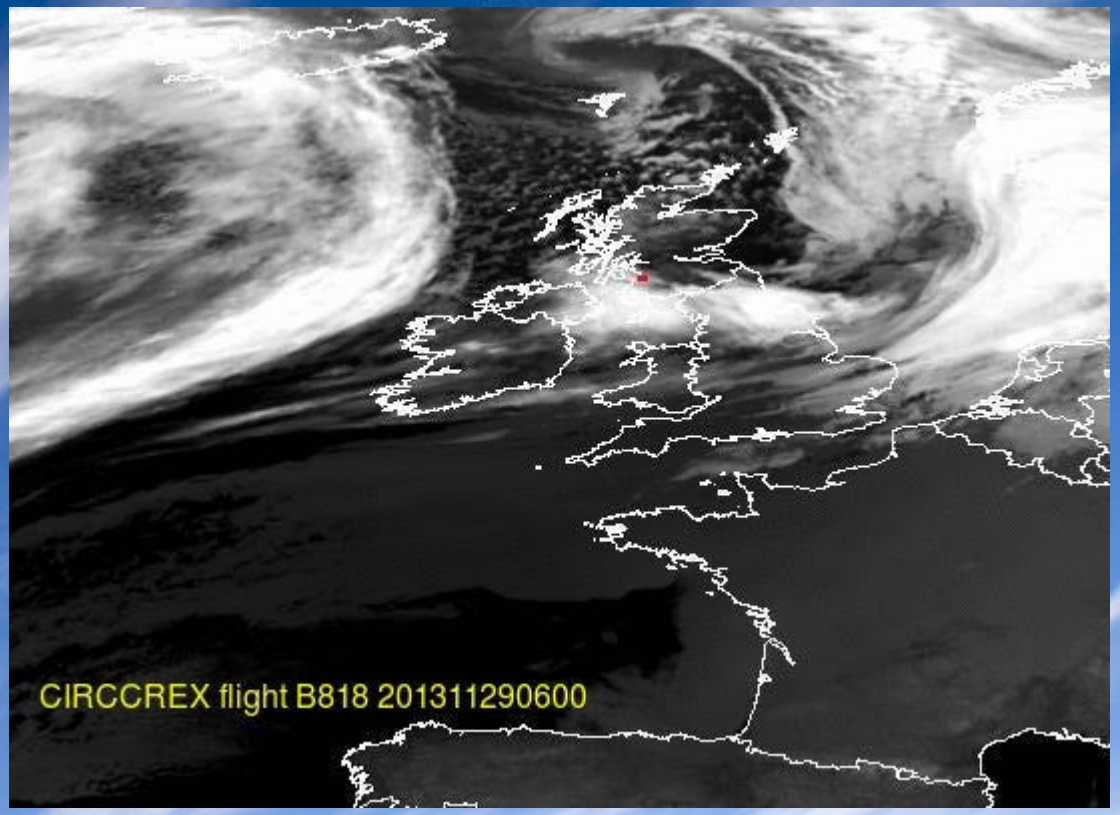
- Dual-input Martin-Puplett polarizing FTS
- Spectral range: 80-800 cm^{-1} (12-125 µm)
- Resolution: 0.12 cm^{-1}
- Observes both nadir and zenith radiation
- Scan time: 2 seconds
- 4 on-board calibration BBs



Case study - flight B818

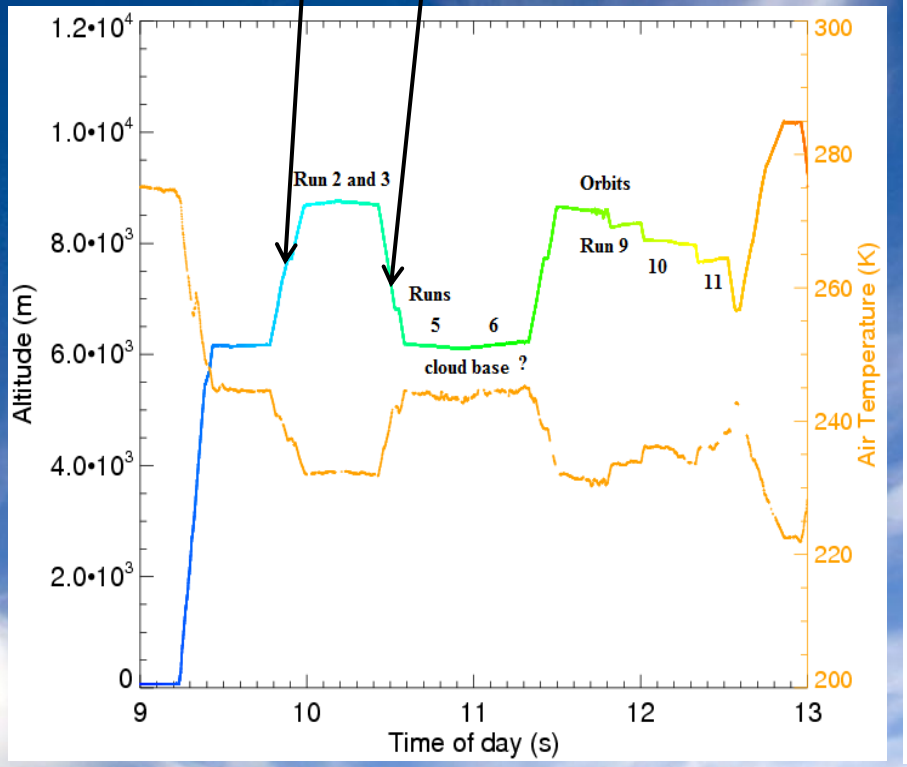


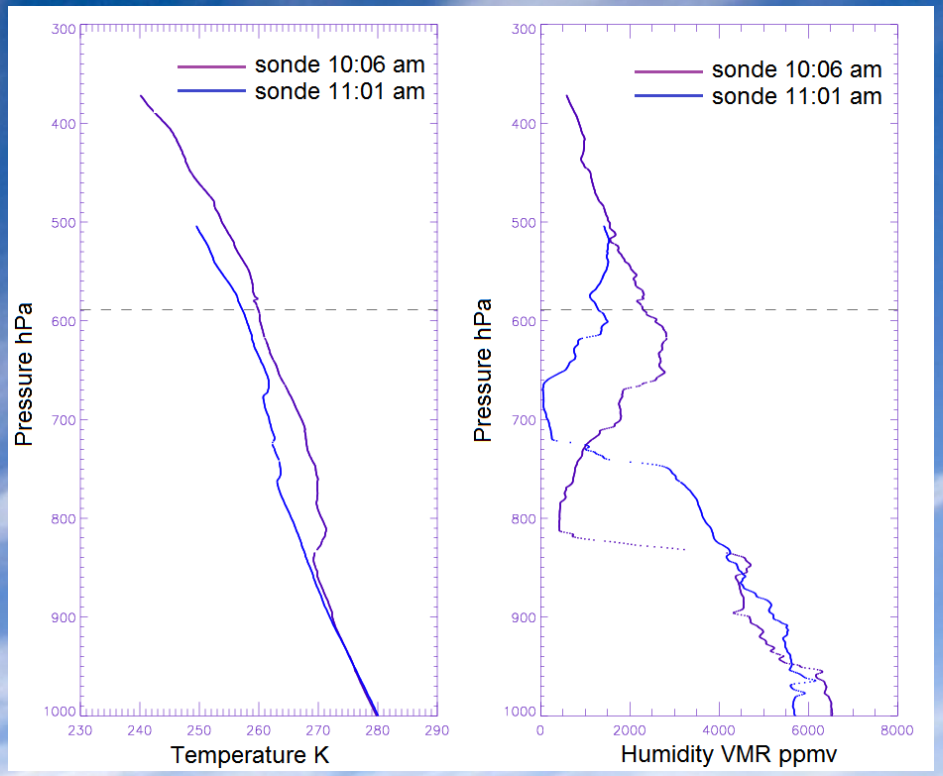
MO cloud forecast model 1200Z



SEVIRI satellite images

Case study - flight B818





dropsonde T and RH profiles

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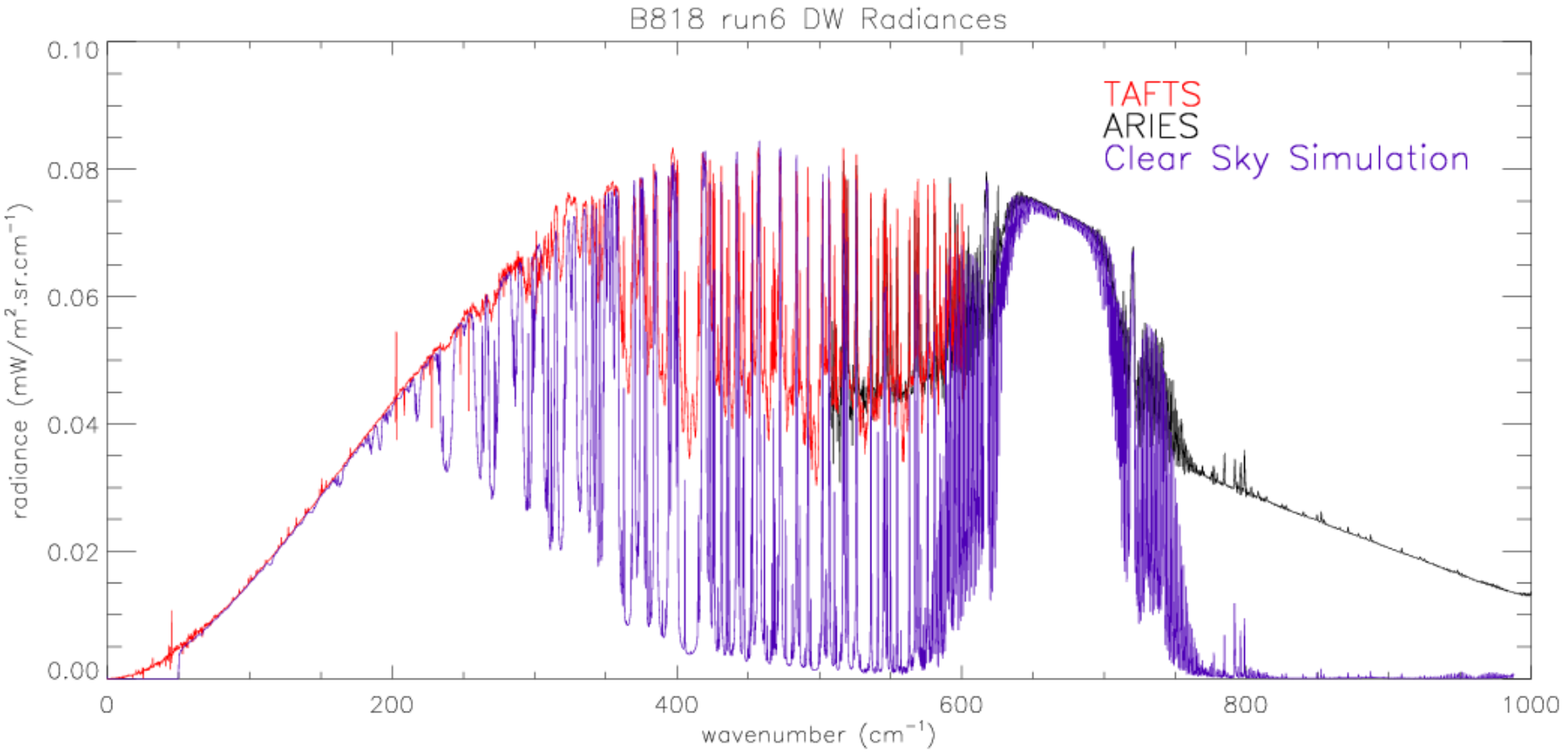
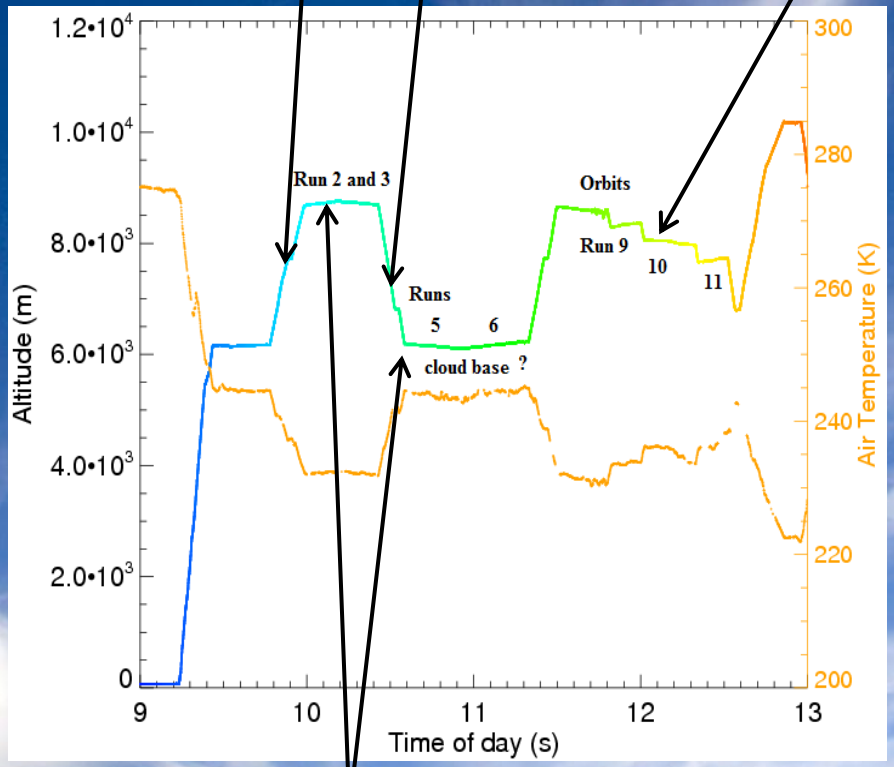


radiance measurements above & below cirrus (TAFTS & ARIES)

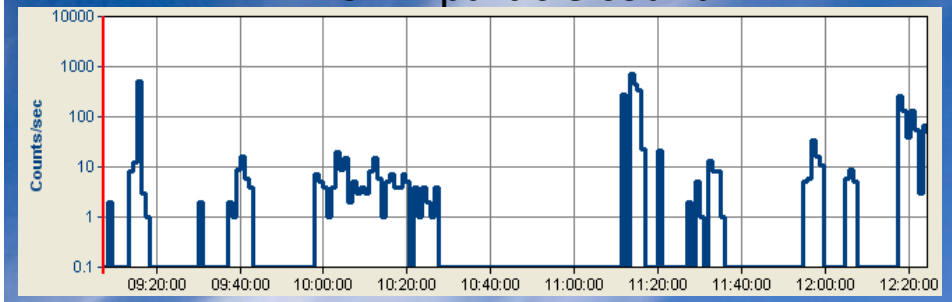
Case study - flight B818

dropsondes

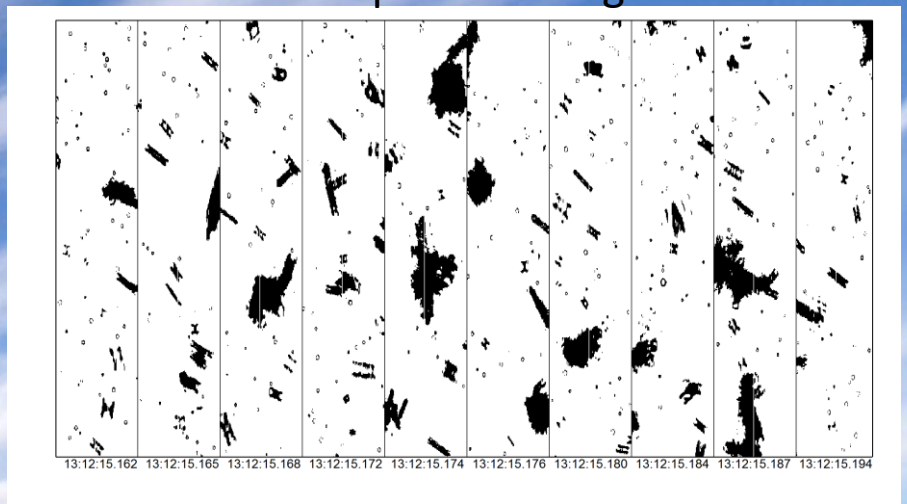
particle sampling within cirrus (cloud probes)



SID2 particle count



2DS particle images



radiance measurements above & below cirrus (TAFTS & ARIES)

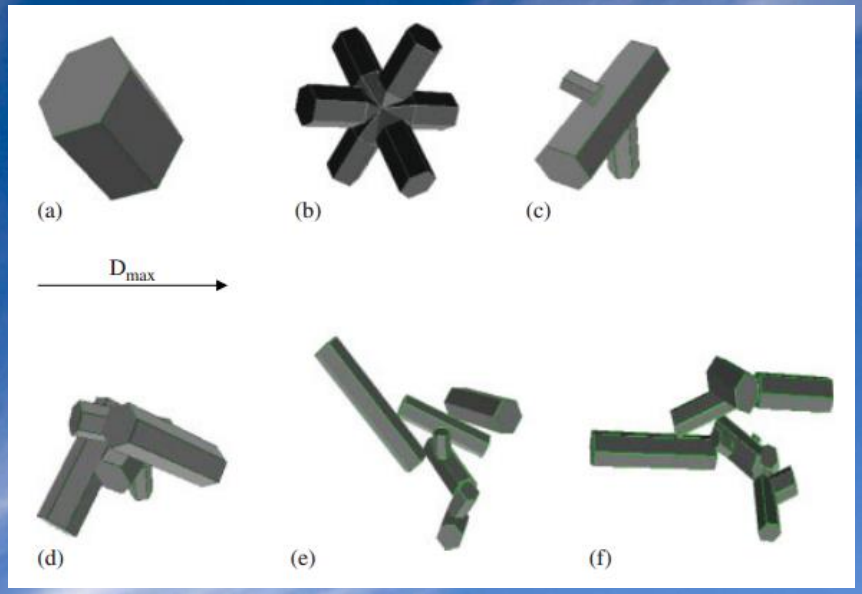
Particle Size Distribution

Measured

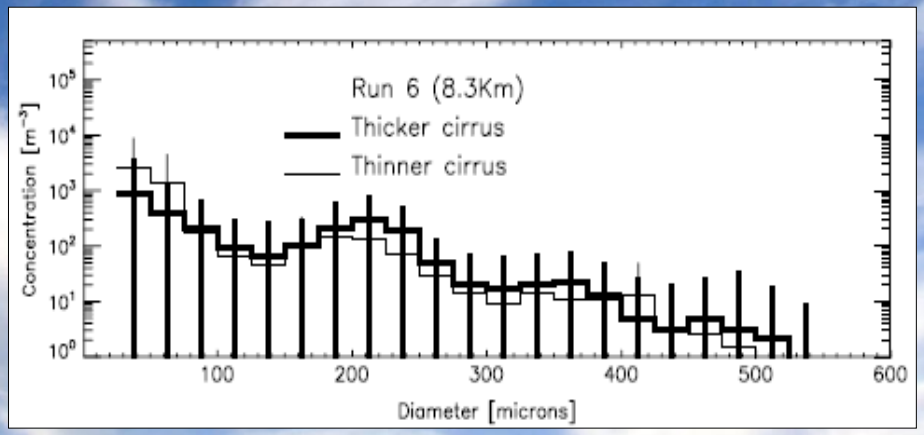
- 2DC 100-800 µm
- CIP100 400-6400 µm
- 2DS 40-1280 µm
- SID2 10-150 µm
- CDP < 50 µm

Composite PSDs derived from all probes, taking into account error estimates

Anti-shattering tips reduce small ice error



Ensemble model for ice crystals (Baran & Labonnote 2007)



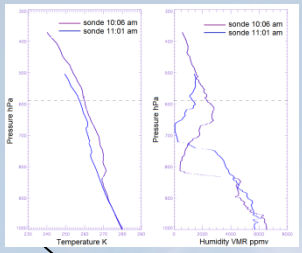
Measured PSD from WINTEX (Cox et al. 2010)

Simulated

- Field et al. (2007) moment estimation parameterization
- Single scattering functions
- Ensemble model (Baran & Labonnote 2007)

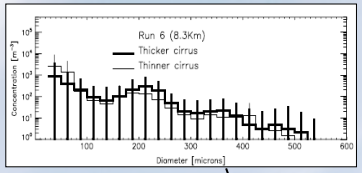
Radiance simulation

RH & T profile



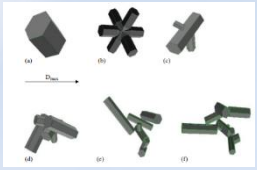
HITRAN spectral database

Measured PSD



Single scattering properties

Ensemble model



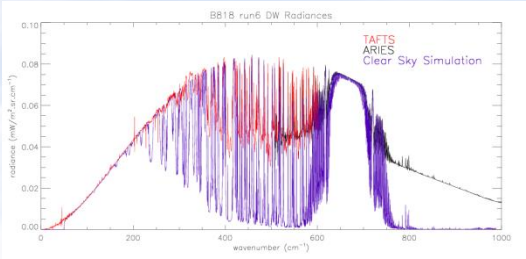
LBLRTM (S. Clough et al)

Clear sky optical depths

Cirrus layer bulk scattering properties

LBLDIS (D. Turner)

Measured radiances ⟷ Simulated radiance spectrum



Summary & Looking Forward

CIRCCREX provides a new cirrus dataset, with the capability to take better in-situ measurements of radiances and particle properties than any previous campaign.

- Current work - ongoing collation and analysis of measurements taken during 1st campaign
- Instrument updates in preparation for 2nd & 3rd campaigns in Winter 2014 and Spring 2015

Questions?