CIRCCREX – A new cirrus dataset for model evaluation

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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.
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**
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
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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.
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

FAAM T & RH

TAFTS (Imperial) FIR radiometer

SID2/3 (Herts) Small Ice Detector

Manchester Cloud Probes: 2DS, CPI

SWS (Met Office) Visible/NIR radiometer

FAAM Core Cloud Probes: CIP-100, 2DC, CDP

ARIES (Met Office) MIR radiometer

Dropsondes
TAFTS

Tropospheric Airborne Fourier Transform Spectrometer

- Dual-input Martin-Puplett polarizing FTS
- Spectral range: 80-800 cm\(^{-1}\) (12-125 \(\mu\)m)
- 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

dropsondes

dropsonde T and RH profiles
Case study - flight B818

B818 run6 DW Radiances

radiance measurements above & below cirrus (TAFTS & ARIES)

TAFTS
ARIES
Clear Sky Simulation
Case study - flight B818

- Radiance measurements above & below cirrus (TAFTS & ARIES)
- Particle sampling within cirrus (cloud probes)
- SID2 particle count
- 2DS particle images
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

Simulated

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

RH & T profile

HITRAN spectral database

LBLRTM (S. Clough et al)

Clear sky optical depths

Measured PSD

Single scattering properties

Cirrus layer bulk scattering properties

Ensemble model

LBLDIS (D. Turner)

Measured radiances

Simulated radiance spectrum
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?