

IAGOS Cloud Detection – the BCP

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The IAGOS Packages

Background

- The original package in IAGOS-DS used a Cloud Droplet Probe (CDP) manufactured by Droplet Measurement Technologies (DMT)
- Reliable and gives information on droplet spectra
- Presence of cloud is essential when analysing chemical species data

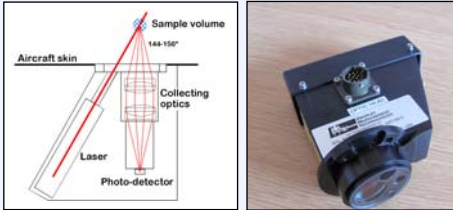
IAGOS-ERI

- IAGOS-ERI uses a DMT Backscatter Cloud Probe – the miniature BCP
- Weight 1.5kg, probe dimensions 11.7x10.7x4.5cm with 5.9cm diameter optics cap
- Is just as reliable, using common components and technology
- Mounted in-board – no extra drag, leads to lower running costs, minimal certification costs
- Used on a flange with two Rosemount inlets for the main Package 1



- Mounted on a reduced MOZAIC flange with a Rosemount housing and SAW H₂O vapour instrument as part of the Small Package

BCP: Principle of Operation



- Particles pass through open laser beam
- Scattered light in the 144-156° cone is collected by photo-detector
- Intensity of back-scattered light dependent on: size, composition and shape of particle; wavelength, intensity and shape of laser beam
- Signal is amplified, digitised and sized into 10 or 20 size bins, size range 5-75µm diameter
- Probe consists of optical head, separate electronics control box, optics mounting cap



Electronics Control Interface



Optical head, showing mounting flange

Installation: FAAM BAe 146

- Laser is non-eyesafe so cannot be operated on ground

- Operated through Weight-on-Wheels signal and interlock switch



- Modified BCP commissioned by IAGOS from DMT
- Optics cap separable from main body of instrument
- BCP can be removed from flange independently of other instruments and replaced with blanking cap
- Allows aircraft to remain in-service if probe fails: crucial for installation on commercial aircraft
- Mounted on third starboard window blank: minimises depth of aircraft boundary layer



Internal view of BCP window



Mounting of BCP Electronics Interface

Testing on the FAAM BAe 146

The BCP has been flight validated on the NERC/FAAM BAe146 UK research aircraft:

- Tried-and-tested platform with extensive experience of certifying and using new instruments
 - Comparison with a number of other cloud probes including “core instrument” CDP
 - BCP uses components common to CDP
- Issues to be addressed:**
- Sampling within the boundary layer of the aircraft: quality of data
 - Safety certification before commercial use commences
 - Reliability testing

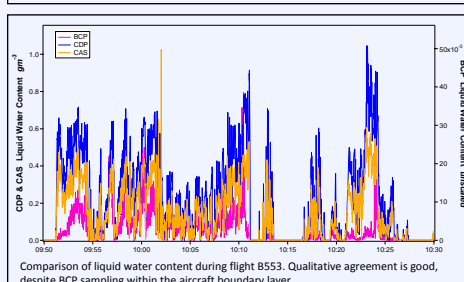
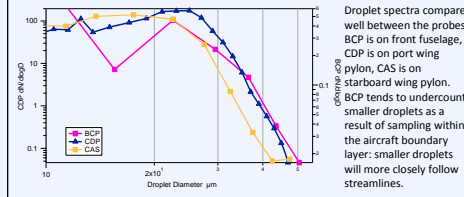
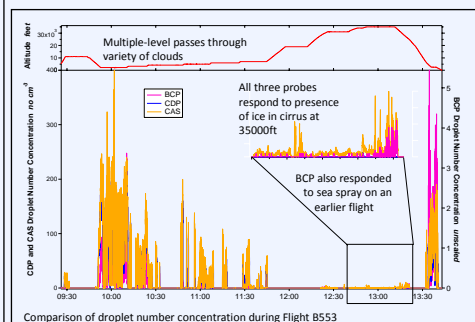
Flights

The BCP was operated on a number of flights during Septex supported by NERC and FAAM

Date	Flight	Details
7/9/2010	B551	Evolution of polluted layer advecting across North Sea covering the hours before and after sunrise
9/9/2010	B552	Tracking the pollution plume of a large cargo ship in the North Sea
14/9/2010	B553	Detailed microphysical measurements in cumulus, cirrus and stratiform, cloud, centred on Chilbolton
14/9/2010	B554	Companion flight to B554 with multiple cloud penetrations at different levels
15/9/2010	B555	Development of cumulus towers off the north coast of Scotland
16/9/2010	B556	Development of cumulus towers off the north coast of Scotland

Comparison with CDP and CAS Instruments

- Preliminary results – calibrations still to be applied
- Results for Flight B553 shown. Range of cloud conditions: pure liquid, mixed-phase, ice-only
- BCP agrees well qualitatively with CDP and CAS
- BCP responds to presence of ice



Future Work

- Full analysis of BCP data to correctly scale the data for true air speed and sample volume
- Continuing validation and reliability testing with FAAM
- Laboratory tests in the University of Manchester Ice Cloud Chamber - MICC. Comparison with a number of cloud measurement instruments under a wide range of conditions down to -50°C. More information at: www.cas.manchester.ac.uk/restools/cloudchamber/index.html



The FAAM BAe146



MICC – showing CAS and CDP cloud instruments

Summary

- STC Certification successfully completed
- Flight validation of probe FAAM BAe 146
- Good qualitative agreement with other reference probes, with limitations due to sampling within aircraft boundary layer
- Further quantitative analysis to be carried out on BCP data
- Potential to upgrade BCP in future with a depolarisation option which would enable reliable discrimination between water, ice, sea-salt spray and dust
- The IAGOS packages require that the BCP act only as a cloud indicator: this requirement is amply fulfilled, with added droplet spectra information

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