Remote sensing measurements from the Dornier 228 during VOCALS
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Overall aim of WP4

Compare remotely-sensed cloud property measurements to similar retrievals from satellites (e.g. MODIS) and in-situ measurements on board the BAE-146 and C-130 aircraft.

Objectives

• To use the spectrally-resolved reflectivity measurements to derive cloud effective radius and optical depth (where thin)

• To derive the scale structure of reflectivity from the hyperspectral imagers, for comparison with the LES model
Remote sensing suite onboard the Dornier DO-228

3 remote sensing instruments:
- SPECIM’s Eagle & Hawk hyperspectral imagers
- Leosphere LIDAR
- Airborne Multispectral Sunphoto- and Polarimeter
Eagle and Hawk sample data, VA02_081028

Eagle pixel
2.8 x 2.4 m
1024 pixels
400-970 nm
$\Delta \lambda = 2.9$ nm

Hawk pixel
1.6 x 4.6 m
320 pixels
1000 - 2400 nm
$\Delta \lambda = 8$ nm
Eagle sensor (400-988 nm), VA09, sample flight transect 06/11/2008
Terra MODIS overpass at 1505 UTC

Return leg along the same line reaching Point X at 1505 UTC and Point C at 1540 UTC; spiral down at Point C and return to Arica at 1611 UTC
Leosphere aerosol lidar

- Wavelength: 355nm
- Max. range: 5000m
- Spatial resolution: 1.5m
- Temporal resolution: 1s => 100m @ 200kt
- Real-time aerosol processing
- Cloud top height
- Aerosol backscatter coeff.
VA15 – pollution profiling 14/11/2008
Dornier aerosol lidar – coastal pollution profiling along 71W

Lidar backscatter – VA15 – 14/11/2008

Height [m]

Backscatter x height²

1000.0 1600.0 2200.0 2800.0 3400.0
Difference between WGS84 spheroid used by GPS and actual seal level.
AMSSP-EM Specifications during Vocals

**Option: Pointing polarimeter**

Status: System under development (during Vocals nadir look direction)

- Spectral range: 450 – 750 nm
- Spectral channels: 150 (256)
- Spectral resolution: ~8nm

**Option: Sunphotometer**

Status: System under development (not used during Vocals)
AMSSP-EM:

Data analysis is an ongoing work

Degree of polarization depends on:

- cloud droplet size
- cloud droplet size distribution
- cloud optical thickness
- cloud thermodynamic phase
- viewing geometry
- wavelength

Figure 3. Polarized phase function $P_P(\psi)$ as a function of scattering angle for cloud droplet size distributions as in eq. (3). In Fig. 3a, we show how $P_P(\psi)$ varies with the wavelength. Fig. 3b illustrates the variation of $P_P(\psi)$ with the size distribution variance.
Nerc Dornier flight 2. Nov. 2008 during Vocals

AMSSP-EM measurements

Degree of linear polarization 10-15% within the rainbow scattering region

Degree of circular polarization <5%
Eagle and Hawk hyperspectral imagers data status:

- Data available for 2 test flights: VA01 (26/10/08), VA02 (28/10/08) and 3 science flights: VA03 (30/10/08) VA09 (06/11/08) and VA11 (10/11/08)
- Data geo-referenced and geocorrected
- Four known Aqua/Terra (MODIS) overpasses during VOCALS-Dornier Flights, including 06/11/08
VOCALS Nov 6 2008 – VA09

Aqua MODIS overpass at 1835 UTC
Terra MODIS overpass at 1520 UTC

Two underflights by BAe146 – position not clear from report
VOCALS Nov 9 2008 – VA10

Terra MODIS overpass at 1440 UTC

Rendezvous with BAe146 west of 20S 72W during the outbound leg
Task WP 4.2 Determination of cloud properties from airborne radiation measurements.

- Retrieval of cloud effective radius and liquid water path from hyperspectral imager
- **Validation** by the in-situ measurements, from FAAM and C130 aircraft.
- **High resolution mapping** of the effective radius and liquid water content of polluted/unpolluted clouds
- **Comparison** made against satellite retrievals.
- In addition, the **effects of aerosol overlying cloud will be investigated using lidar**; this has been shown to exert significant biases in effective radius and cloud liquid water retrievals leading to an artifact known as the 'apparent indirect effect' (Haywood et al., 2004).
WP 4.1

Task WP 4.1 Assessment of the heterogeneity of cloud properties on a wide range of spatial scales.

This task will use hyperspectral imager and lidar to provide cloud top height variability.

Spectral analysis techniques (Fourier and fractal analysis) will be used to determine the scale distribution of structures across the region.

This information will be used in two ways:

• to assess whether the scale distribution varies in a systematic way across the region, possibly correlated with the aerosol;

• to compare with simulations by the LES model and WRF.
Initial analysis of E+H - Lorenzo

- Learn to read the data!
- Calculate scale sizes of cloud features.
- Investigate regions of aerosol gradient (measured by FAAM/C130) for cloud brightness features
- Compare measured cloud reflectivity to satellites
- Pay particular attention to overpasses of FAAM/C130
Plan of attack

• Run data through MODIS algorithm and compare with MODIS retrievals – collaboration with Purdue Uni, NASA
• Use polarimeter data of Thomas Ruhtz – they will derive cloud properties also
• In the longer term, develop expertise in the group to do this ourselves