Aeolus Aerosol and Cloud Product Validation Approaches using the Cabauw Experimental Site for Atmospheric Research and EARLINET

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Outline

• General approach by two AO teams
• Cabauw
• EARLINET/ACTRIS
• Summary
General approach

- Various issues exist with Aeolus instrumental features and processing algorithms, e.g.
  - Effects of sampling strategies
  - Complex scenes/heterogeneity
  - Effects of shear
  - Effects of aeolus bin size – centre of gravity analysis
  - Wind/cloud performance
  - Effective resolution
  - Mie sampling will be changed according to conditions
  - Context sensitive along track aggregation
  - Zero wind calibration issues

- **Ground-based stations** have the ability to provide **spatio-temporal development** of the state of the atmosphere for **many parameters** simultaneously, and in much **greater detail** than from space. This offers a unique opportunity for validation of observations from space.

L2A and L2B – Comparison with wind and optical products measured by ground based (or airborne systems).
General approach

- Validation of Aeolus wind, aerosol and cloud profiles of backscatter, extinction and lidar-ratio using ground based observations during close proximity overpasses.
- Assessment of representativeness of Aeolus wind, aerosol and cloud products using time series of ground based observations.
- Assessment of local cloud and aerosol conditions on Aeolus retrieved wind profiles based on ground based records of the atmospheric state.
EARLINET CAL/VAL goals

- Validation of **Aeolus L2A** products of aerosol and cloud profiles of backscatter, extinction and lidar-ratio,
- Assessment of spatio-temporal representativeness of Aeolus aerosol and cloud products.
EARLINET Approach

• The objectives will be accomplished through correlation between ground based lidar data from EARLINET stations. For this, data will be used from:
  • The (historical) EARLINET database,
  • Correlative measurements performed by selected EARLINET stations during close proximity Aeolus overpasses.

Multiwavelength Raman lidars (red), Raman lidars (green), backscatter (purple) aeronet (yellow), depol. (Pappalardo et al., AMT, 2014)
EARLINET Approach

Proposed observation schedule is proposed according to overpasses related to clusters of lidar stations

- **Case 1 measurements**: Each station performs measurements as close as possible in time and space to the Aeolus overpasses. For validation studies, measurements made within 2 h and 40 km of the satellite overpass are preferred, but within 4 h and 100 km are acceptable.

- **Case 2 measurements**: Additional correlative observations are suggested to be made at the lidar station which is closest to the station of the actual Aeolus overflight.

- **Case 3 measurements**: If Aeolus passes over a multi-wavelength Raman lidar station (high-performance station) then also the neighbouring high-performance station performs a measurement.

Pappalardo et al., JGR, 2010
EARLNET Workplan

**WP01** – Measurement plan preparation (L-3 – L+18)

**WP02** – Database set-up and exchange (L-3 – L+18)
- The data exchange between EARLINET and ESA (EVDC) will take into account QA4EO guidelines.

**WP03** – Main correlative observational period (L+0 – L+18)
- We estimate that 40 to 50 evaluated observational cases can be available at L+3 and can serve for a very first quality check by the end of phase E1.
- The main focus of EARLINET is on the long-term validation (Phase E2).

**WP04** – Data evaluation phase (L+3 – L+21)
- Various Aeolus aspects will be taken into account. Experience gained in Calipso validation will be used.

**WP05** – Reporting (L+3, L+21, L+24)
- CalVal validation workshop attendance
- Symposium attendance
- Proceedings and peer reviewed publications

Aeolus CAL/VAL workshop, Feb. 2015, Frascati
EARLINET contribution

• Quantification of accuracy of aerosol and cloud geometrical and optical parameters using a ground-based network of quantitative aerosol and cloud lidars.

• Characterise deviations of the Aeolus-L2A products from ground truth established by the lidar network.

• Recommendations for improvement to processing algorithms based on intercomparison between observations from space and ground. Initial results, based on a limited dataset from ground-based measurements, can be provided after completion of Phase E1.

• Monitoring of product stability over the observational period foreseen in the proposal.

• Main focus on long term.
CESAR Observatory

Cabauw Experimental site for Atmospheric Research
A “Field Laboratory”

51.971° N, 4.927° E, -0.7 m ASL
CESAR Observatory

Cabauw Experimental site for Atmospheric Research
A “Field Laboratory”
CESAR Observatory
Cabauw Experimental site for Atmospheric Research
A “Field Laboratory”

Drizzle suveillance radar

In-situ meteor

Wind profiler

Raman Lidar

UV-lidar

Cellometer

Remote Sensing Site

In-situ Aerosol

Radiation site (BSRN, Aeronet)
Cabauw CAL/VAL goals

- Validation of Aeolus wind, aerosol and cloud profiles of backscatter, extinction and lidar-ratio using CESAR observations during close proximity overpasses.
- Assessment of representativeness of Aeolus wind, aerosol and cloud products using time series of CESAR observations.
- Assessment of local cloud and aerosol conditions on Aeolus retrieved wind profiles based on CESAR records of the atmospheric state.
Cabauw Approach

• The objectives will be accomplished through correlation between ground based remote sensing data from the Cabauw station.

• Data will be used from the operational CESAR suite of instrumentation, in particular the wind profiler, radars and lidars.

• Additional correlative measurements can be performed by manually or semi-automated instruments during close proximity Aeolus overpasses.

• Linking may be possible with other campaign activities, e.g.
  • Airborne Aeolus CAL/VAL activities
  • Sentinel-5p/TROPOMI
### Cabauw main instrumentation

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<tr>
<th>Instrument</th>
<th>Wind</th>
<th>Temperature</th>
<th>Aerosol Backscatter</th>
<th>Aerosol Extinction</th>
<th>Aerosol Optical Depth</th>
<th>Clouds</th>
<th>Polarisation</th>
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<th>24/7 operation</th>
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Aeolus CAL/VAL workshop, Feb. 2015, Frascati
Illingworth, BAMS, 2007
Figs. 2, 3
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Summary

• Proposals offered for collection and analysis of Aeolus L2A and L2B data, based on ground based remote sensing
• Observation strategies have been outlined for collecting correlative data and analysis for various Aeolus issues
• The Cabauw site offers an extensive set of observations to record the atmospheric state, enabling detailed analyses of Aeolus instrument and retrieval issues
• The EARLINET network has shown utility for the investigation of spatial and temporal representativeness of measurements with polar-orbiting satellites, and can be applied for Aeolus
• These infrastructures and activities can be aligned with other CAL/VAL proposals, e.g. airborne activities.