Aeolus Calibration, Validation and Science Campaigns

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European Space Agency

Paper EGU2020-19778, Session AS1.35 - Aeolus data and its application
For a comprehensive overview of the Aeolus Mission and its status see:

T. Parrinello et al., ESA’s Wind Mission Paper EGU2020-4091. Session AS1.35 – Aeolus data and its application
Main Aeolus Product – Line-of-Sight Wind

Level 2B

Rayleigh Wind Profiles
02 January 2020
Aeolus Products – Optical Products

Level 2A

Particle Ext. Coef. Profiles
02 January 2020
Aeolus Airborne Campaigns since Launch

- **Aeolus Launch**
  - 22 August 2018

- **AVATAR-E**
  - May 2019
  - Central Europe Aircraft

- **AVATAR-I**
  - September 2019
  - Iceland/Arctic Aircraft

- **TAPAPA/pre Strateole-2**
  - Nov. 2019-Feb. 2020
  - Tropics Stratospheric Balloons

- **Windual-III**
  - Nov./Dec. 2018
  - Central Europe Aircraft

- **Aeolus Tropical Campaign**
  - June/July 2021
  - Cape Verde/Tropics Aircraft/Ground Based
Aircraft Campaigns before Launch (DLR/NASA/CNES)

Aircraft Campaigns since Launch (DLR)
### DLR Falcon with ALADIN Airborne Demonstrator A2D and 2-µm wind lidar

<table>
<thead>
<tr>
<th></th>
<th>ALADIN airborne demonstrator</th>
<th>2-µm Doppler wind lidar DWL (&quot;Reference System&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wavelength</strong></td>
<td>354.9 nm (UV)</td>
<td>2.022 µm (IR)</td>
</tr>
<tr>
<td><strong>Backscatter</strong></td>
<td>molecules, aerosol, clouds</td>
<td>aerosol, clouds</td>
</tr>
<tr>
<td><strong>Wind</strong></td>
<td>line-of-sight LOS, 20°</td>
<td>LOS, hor. wind vector, vertical wind w</td>
</tr>
<tr>
<td><strong>Vertical res.</strong></td>
<td>250 m – 2 km</td>
<td>100 m / 500 m (for Aeolus)</td>
</tr>
<tr>
<td><strong>Time res.</strong></td>
<td>14 s (+4 s)</td>
<td>1 s LOS, 30 – 40 s vector</td>
</tr>
<tr>
<td><strong>Horizontal res. @ 200 m/s</strong></td>
<td>3.6 km</td>
<td>200 m LOS, 6 – 8 km vector, 42 km (for Aeolus)</td>
</tr>
<tr>
<td><strong>Precision</strong></td>
<td>2 m/s (mol.) 1.5 m/s (aer.)</td>
<td>&lt; 1 m/s vector 0.3 m/s vertical</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>0.5 – 1 m/s</td>
<td>&lt; 0.1 m/s</td>
</tr>
</tbody>
</table>

Campaigns – Central Europe and Arctic (DLR)

3 campaigns, 34 research flights, 120 flight hours in 12 months!

Lux et al., AMT, 2020
Witschas et al., AMT, 2020
Validation throughout the mission

Windval-III  AVATAR-E  AVATAR-I

Source: DLR

Lux et al., Optics Lett., 2020
First results available already during campaign!

Preliminary Data
Only flight legs with ascending orbit
Key results from WindVal-III, AVATAR-E/-I (DLR)

- Rayleigh random error scales with the range bin size ➔ Poisson noise limited
- Mie random error does not scale with resolution ➔ SNR driven
- Rayleigh random error AVATAR-E and -I similar, despite factor 1.5 in reported UV energy ➔ higher solar background in September (Iceland, 66°N) compared to May (Central Europe)
- Campaigns during mission implementation phase fundamental to the early Aeolus success
Objectives:

- Few direct stratospheric wind observations exist, but are fundamental to understand the global circulation, in particular in the Tropics.
- Support to Aeolus Cal/Val activities using wind observations from CNES stratospheric balloons during the LMD/CNES pre Stratéole-2 Campaign 2019/20.

Campaign Details:

- Circum-terrestrial, 3-month stratospheric balloon flights in the Tropics.
- Pressure, temperature and GPS location every 30 s at flight level.
  - 3D winds deduced from successive GPS positions.
- Data analysis ongoing.

Source: CNES
TAPAPA / pre-Strateole-2 (CNES/LMD)

Balloon trajectories
677 Flight Days
231 Collocations (100km/2h)

Collocations with Aeolus

Source: ESA/LMD/CNES
Aeolus Tropical Campaign

- Largest impact of the Aeolus observations expected in the Tropics and in particular over the Tropical oceans

- Airborne Campaign in Cape Verde/Tropics:
  - Correlative observation between Aeolus and the airborne and ground-based remote sensing and in-situ reference systems
  - Tropical wind systems, e.g., Easterly Waves, ITCZ
  - Aerosols, i.e., Saharan dust
  - Tropical clouds and convection
  - Providing proxy data for EarthCARE E2E
  - Planning prepared for July 2020
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COVID-19
Campaign moved to July 2021
Wind Systems, dust and clouds

- African Easterly Waves
- Cape Verde
- African Easterly Jet
- Trade Winds
- ITCZ
Wind Systems, dust and clouds
Tropical Campaign 2021 – Projects and Participants

Light Aircraft
- Uni. Novo Goriza
- IJS
- The Cyprus Institute
- HAZE Instruments
- Aerovizja

Askos
- NOA
- TROPOS
- The Cyprus Institute
- CNR-IMAA
- ECMWF

OSCM São Vincente

Sal

AVATAR-T
- DLR

CADDIWA
- LATMOS
- Météo France
- SAFIRE

CPEX-AW
- NASA

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Tropical Campaign 2021– Airborne Fleet

- **Askos**
- **Light Aircraft**
- **OSCM São Vincente**
- **Sal**
- **AVATAR-T**
- **CADDIWA**
- **CPEX-AW**

[Image of various aircraft and a globe]
Tropical Campaign 2021 – Instruments (prelim.)

Unique set of instruments for Aeolus Validation and Science

- Askos
  - WALL-E
  - ESA-EVE
  - ACTRIS Aerosol
  - ACTRIS Cloud
  - Doppler wind lidar

- Light Aircraft
  - Nephelometers
  - Filter light abs. photom.
  - Optical particle counters

- AVATAR-T
  - A2D
  - 2μm-DWL
  - CADDIWA
    - LNG
    - RASTA
    - CLIMAT
    - Dropsondes
    - UHSAS/FSSP
  - CPEX-AW
    - DAWN
    - HALO
    - APR-3
    - Dropsondes

- OSCM São Vincente
- Sal

European Space Agency

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Conclusion & Outlook

Campaigns are an important tool supporting the Aeolus mission

- Supporting the processor and instrument developments during mission development
- Providing perfectly collocated observations for the in-orbit calibration and validation
- Establishing reference data for future mission developments and science communities
- Responding to recommendations from the instrument experts and Science Advisory Group

Future Perspectives

- Successful implementation of the Tropical Campaign 2021
- Identification of campaign needs for further product improvement (e.g., L2A products)
- Evolution of airborne instruments and campaign to support Aeolus-FO activities