Spaceborne Wind Lidar Observations by Aeolus – Data Products and Pre-Launch Validation with an Airborne Instrument

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Europe: DLR and UCL
China: OUC, CMA and SIOM

German Aerospace Center DLR, Institute of Atmospheric Physics
University College London UCL, Mullard Space Science Laboratory MSSL
Ocean University of China OUC, Ocean Remote Sensing Institute ORSI
China Meteorological Administration CMA, Nat. Satellite Meteorological Center
Shanghai Institute of Optics and Mechanics SIOM, Chinese Academy Sciences
Wind Lidar Observations from ADM-Aeolus

- Validation with ground-based and airborne campaigns in Europe and China (DLR, OUC, SIOM)
- Study of atmospheric dynamics and assimilation of wind lidar observations (DLR, CMA)
- Derivation of high-resolution land-surface albedo observations in the UV (DLR, MSSL)
- Derivation of cloud motion winds from multi-angle imaging spectroradiometer and comparison of wind and cloud height with ADM-Aeolus (MSSL)
- Development and test of new retrieval algorithms for wind and land surface observations (Young Scientist)
Outline of the talk

- ADM-Aeolus – the 1st wind lidar in space – latest status
- ESA-NASA-DLR airborne campaign from May 2015
- Future airborne campaigns
Aeolus is the first European lidar mission from ESA and first wind lidar mission worldwide.

Objective is to improve weather forecasting by providing global wind-profile observations.

Polar orbiting satellite at 400 km with single payload instrument - the Doppler lidar ALADIN.
Aeolus – the first wind lidar in space - first time that retrieval algorithms for spaceborne wind lidars are developed

- High requirement on random error (precision): 1 m/s (0-2 km) to 2 m/s (2-16 km) HLOS

- Very demanding requirements for the systematic error (accuracy): bias <0.4 m/s and linearity error <0.7 % of actual wind

- Wind products need to be available for NWP users within 3 hours after observation => different to other lidar missions and science-driven missions
ADM-Aeolus Data Products

<table>
<thead>
<tr>
<th>Data Product</th>
<th>Content</th>
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</thead>
<tbody>
<tr>
<td>Level 1b</td>
<td>Line-of-Sight LOS wind geo-located, calibrated</td>
</tr>
<tr>
<td>Level 2a</td>
<td>aerosol backscatter and extinction coefficient</td>
</tr>
<tr>
<td>Level 2b</td>
<td>LOS wind corrected for atmospheric temperature, pressure</td>
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<tr>
<td>Level 2c</td>
<td>horizontal wind vector after assimilation at ECMWF</td>
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</tbody>
</table>
Aeolus workshop in Feb 2015 with representatives from WMO, WCRP, ECMWF re-emphasized need for global wind profiles

Major milestone achieved by finalisation of 2nd Flight Model lasers in April 2015

Integration of lasers into instrument on-going => performance testing of instrument starts in summer

Ready for launch by end 2016
ADM-Aeolus WindVal Campaign in May 2015

Iceland and Greenland

credits-ESA/ATG-Medialab
First time with 4 Wind Lidars on 2 aircrafts


wind observations along Greenland coast 2009.
Greenland East Coast

Greenland East Coast Sea Ice
Greenland Summit Station (3216 m ASL, 72.58°N) with Wind Lidar from University Leeds (UK)

Fig. courtesy Ryan Neely (Leeds)
Jet Stream Flight on 15 May 2015 during Textbook example of “Iceland” Low Pressure System

Track of DLR Falcon and NASA DC 8
Jet Stream with wind speeds up to 70 m/s observed by 2-µm Wind Lidar on May 15, 2015
Factors modifying waveguide disturbances

Evolution of Rossby waves along the waveguide

Downstream impact of diabatically modified PV anomalies

THORPEX North Atlantic Waveguide and Downstream Impact Experiment (NAWDEX) in Sept-Oct 2016

German HALO aircraft
- Water Vapor + HSRL-Lidar + Doppler Radar + Microwave Radiometer: EarthCARE Payload

ADM-Aeolus
- DLR Falcon aircraft with ALADIN airborne demonstrator and 2-µm wind lidar

Preparation by
- A. Schäfler (DLR) and
- G. Craig (University Munich)
Central Europe Campaign
- Coordination of German, French, and UK aircrafts
- Overflights of radar windprofilers and lidar

North Atlantic Campaign
- Coordination of DLR and NASA aircrafts
- Validation of Aeolus winds in sensitive regions and high-wind speed conditions
- Validation of Aeolus in-flight calibration over Greenland Ice sheet

Cooperation for ground-based validation of Aeolus in China within Dragon Project
Perspectives for Earth Observation with Lidar

**ADM-Aeolus**
The first Doppler lidar in space for wind

**EarthCARE**
The first high spectral resolution lidar in space for aerosol and clouds

**MERLIN**
The first differential absorption lidar in space for methane
Summary and Conclusion

- ADM-Aeolus will sense the vertical profile of wind up to the lower stratosphere (20-30 km) with high accuracy of 1-2 m/s.
- ADM-Aeolus is planned to be ready for launch by end 2016.
- First time that 4 wind lidars were deployed on 2 aircrafts during ESA-NASA-DLR Windval campaign in 2015.
- Dragon 3 activities are used to prepare and coordinate a Chinese-European effort to validate ADM-Aeolus mission after launch with ground and airborne campaigns in 2017.
Xièxiè! 谢谢!

Animation by
Uwe Marksteiner (DLR)