EGU 2020 - Aeolus data and its application – Virtual chat session

Summary

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Session description:

With the launch of the novel Aeolus wind profiling mission, a wealth of direct wind and atmospheric backscatter profile observations have become available across the globe, revealing new information on atmospheric dynamics and optical properties to the benefit of a number of applications. For example, improvements in Numerical Weather Prediction (NWP), General Circulation Models (GCMs) and their included parameterized processes, such as land and ocean drag, convection, stratosphere-troposphere interaction and atmospheric waves, air quality and air pollution transport etc. In this session, we discussed the new data products and their validation, as well as studies using the Aeolus data for application in meteorology, air quality, and climate studies. Topics varied from observation interpretation, GCM or NWP model diagnostics, parameterization, and data assimilation experiments. This is the first EGU session on scientific analysis of Aeolus mission data, including inter-comparisons to different collocated wind profiling, aerosol and cloud in-situ and remote sensing measurements or atmospheric models. Contributions concerning Aeolus data calibration, processing, tools for data access and exploitation are also provided.

The session included:

- 101 active chat members (50% Aeolus DISC/Cal/Val/ESA & 50% external);
- 21 uploaded presentations;
- 4.5 min discussion for each presenter;
- 10 min final session discussion.

Session Recommendations/ Requests by participants:

- The application of a feature finder mask on measurement scale, for the sorting of strong and weak particle backscatter signals, would strongly support the wind, L2A aerosol and cloud product validation and scientific application activities
- A vertical resolution of <250 m would be desirable for backscatter and extinction profiles
- Would reprocessing of L2A data with the latest processor, but with higher horizontal resolution, possible?
- Special request by TROPOS to retrieve L2A data up to highest range bin of AUMATEX RBS box

- Recommendations for future Doppler Wind Lidars: Higher SNR, higher vertical and horizontal sampling
    - A depolarization channel would help to further discriminate between aerosol and clouds, which remains challenging with the current measurement capabilities of Aeolus. It would also allow improved aerosol typing.

Session Announcements:

- A special issue AMT will be launched and will be open also for Aeolus publications which haven't been presented at the EGU → An announcement will be made on the ESA Earth Online pages: https://earth.esa.int/eogateway/missions/aeolus

- 15th International Winds Workshop, KNMI, de Bilt, NL, (http://cimss.ssec.wisc.edu/iwwg/iww15/index.html)

- Aeolus CAL/VAL and Science workshop on 2-6 November 2020, at EUMETSAT, Darmstadt, Germany (http://aeolus-science-calval-2020.org/)

Session highlights:

Aeolus mission status and Aeolus DISC reporting:

- ESA will release the Aeolus Near-Real Time (NRT) Level 1B (preliminary product) and Level 2B wind (fully processed wind profiles) products on 12 May 2020 → Available dataset starts on 20 April 2020 (https://aeolus-ds.eo.esa.int/oads/access/)
- The NRT product is available with a timeliness of less than 3 hours
- A novel bias correction has been applied to the released data, which are hence fit for NWP and scientific exploitation.
- Thermal variations of the telescope mirror lead to Rayleigh wind biases depending on orbital phase and longitude → These biases are now corrected by using the telescope temperature causing a decrease of systematic biases to around 1 m/s – a big milestone in the mission
- L1B and L2B data from July-December 2019 will be reprocessed to include the telescope temperature bias correction, and will be made available to the public around September 2020
- CAL/VAL PIs will get access to reprocessed L2A data from July-December 2019
- Reprocessed data from September 2018-July 2019, and from January to 20 April 2020, will be released in 2021
- The Aeolus winds from molecular and particle backscatter are in general consistent with each other.

Aeolus wind observations (L2B); quality, impact and exploitation:

- Aeolus is the only satellite which measures vertical wind profiles from space
- Positive impact of Aeolus observations shown in NWP experiments, particularly in the tropics and in the upper troposphere and lower stratosphere
- The recent bias correction leads to significantly increased short-range forecast impact
- ECMWF reports an increased impact of Aeolus data for NWP in Northern Hemisphere due to less air traffic during COVID-19
- Model statistics from the global ICON model from DWD and the ECMWF model serve to examine the results and to investigate Aeolus product bias dependencies - orbit phase and longitude

- Two presentations showed that gravity wave structures are captured by Aeolus measurements in the Upper Troposphere and Lower stratosphere (UTLS), which can help to constrain parameterizations in NWP and climate models
    - Aeolus data detrending and possible NWP model assimilation overfitting to Aeolus measurements of gravity waves are under investigation
- Ground-based Doppler Wind Lidar (DWL) at Haute-Provence and La Reunion show good agreement to collocated Aeolus measurements (mean bias between -3.6 and 2.9 m/s), also for one gravity wave case study

Aeolus aerosol and cloud observations (L2A); quality and exploitation:

- Aeolus is in only high spectral resolution UV lidar in space, providing particle backscatter and extinction coefficient and lidar ratio profile measurements. This allows for the provision of a new global aerosol and cloud dataset for scientific exploitation.
- Other space-based lidars are coming to the end of their mission lifetime (CALIPSO and CATS) and the next space-based lidar, EarthCARE, will be launched in a couple of years.
- Aeolus only measures the co-polar part of the atmospheric backscatter, which allows limited aerosol typing and cloud classification. A depolarization channel would have helped both aerosol typing and to better discriminate between aerosol and clouds, which remains challenging with the Aeolus measurement capacities
- Since 2 April 2020, the L2A product processor includes radiometric correction. This is an important product milestone.
- Aeolus was shown to successfully detect aerosol layers from elevated forest fire and dust layers in the troposphere and stratosphere, despite of a relatively low vertical resolution. Occasionally, PBL aerosol have also been well detected.
- L2A validation results from ground-based lidar observations show good agreement for homogeneous scenes. The introduction of a feature finder mask on measurement scale would strongly support the validation activities for heterogeneous scenes.
- Ground-based lidar station from TROPOS has measured smoke layers over Punta Arenas, Chile, originating from the Australian fires in January-February 2020.
    - Layers at altitudes up to 30 km were detected, which is a very unique event.
    - The Aeolus range bin setting were adjusted for that region to measure up to 29 km for the first time
    - The stratospheric smoke layer has very high depolarization ratios
- An assimilation study at ECMWF shows that a successful cloud screening is essential before assimilation of Aeolus L2A data in the CAMS air quality model → Until cloud screening can be successfully implemented in the Aeolus L2A product, model data will be used for the cloud screening

Aeolus campaigns:

- In July 2021, ESA is organizing a combined airborne and ground-based campaign in Cape Verde together with European partners, NASA and other American partners. The campaign is focusing on Tropical wind systems and dust/aerosol transport for the Aeolus validation and scientific exploitation and for EarthCARE preparations
- NWP models are less accurate in the tropics, and one objective of Aeolus is to improve the monitoring and understanding of tropical dynamics
- A tropical stratospheric campaign, Strateole-2, deploying constant level balloons at 20 km circumventing the earth provided unique wind measurements currently being compared to Aeolus winds.
- ESA is confident in a working laser for the summer 2021 Tropical validation campaign and the foreseen mission lifetime (end of 2021).

Aeolus operations, data availability and data tools:

- Aeolus wind data have been available in NRT (within 3 hours of sensing) to Aeolus CAL/VAL teams since 20 December 2018 and will be publicly available as of 12 May 2020. Data can be browsed and downloaded manually, or with automatics scripts. Aeolus L2B wind data in BUFR format will be available via EUMETCAST and GTS as of 19 May.
- Aeolus operational data processing from L1B to L2B takes around 10-15 min per orbit, L2B data are NWP monitored in NRT, and reprocessed Aeolus data will be consolidated
- Aeolus mission planning is published here: https://www.aeolus.esa.int/confluence/display/CALVAL/Schedule+Aeolus
- Aeolus calibration and validation teams can propose new vertical range bin settings on the Confluence pages, which will be assessed by the Range Bin Setting Working Group and ratified by the Aeolus Operations Board.
- The virtual research platform VirES (https://aeolus.services) is a useful platform for visualizing and downloading Aeolus data, also in netCDF format → Access to VirES will be possible following the public wind data release on 12 May 2020

Future Doppler Wind Lidars:

- Aeolus follow-on investigations show that increased spatial and temporal coverage is most important for NWP, which could be improved by multiple Aeolus-like satellites flying in a constellation
- Analysis of Aeolus observations show that a doubling of the molecular backscatter signal is estimated to double the forecast impact.
- Furthermore, more vertical range bins, higher vertical and horizontal resolution, an improved SNR, and a depolarization channel for better aerosol capacities is desirable
- A vertical resolution of <250 m would be desirable for backscatter and extinction profiles, which are moreover used in cloud/aerosol feature detection before wind profile processing