Aeolus satellite wind observations

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Overview and Objectives

Context, Issues and Interests:

ESA's Aeolus mission - 2018

First mission to measure global wind profiles

There is no measurement of the wind above the ocean:

The measurement methods are based on the techniques developed by the Aeronomy Service

Digital models suffer from a lack of GW information

Objectives:

Detect the presence and impact of gravity waves on their environment by measuring their kinetic energy

Approach:

Analysis of wind disturbance patterns (amplitude/spectrum)

Comparative study with lidars on the ground and radiosoundings

Comparative study with GPS radio-occultation (Temperature)

Expected results:

First climatology of gravity wave parameters based on global wind and temperature profiles Review of ALADIN lidar capabilities to resolve GW

What is Aeolus ?

SATELLITE PROFILE

Global wind profile observer

Approved 1999 **Launched** Aug 2018

Altitude : 320 km

Orbit : Sun-Synchronous

Initial mission duration : 3 years

Payload : **ALADIN** (**A**tmospheric **LA**ser **D**oppler **IN**strument)

First doppler wind lidar in space

SCIENTIFIC OBJECTIVES

Improve the quality of weather forecasts

Advance our understanding of atmospheric dynamics and climate processes

Demonstrate potential for operational use of space-based Doppler wind LIDARs (DWL)

FUNCTIONING PRINCIPLE

Wind velocity using ALADIN

First 30km of the Atmosphere (LT/UT-LS)

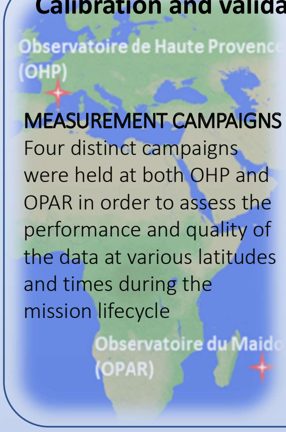
Vertical profiles of wind, detection of aerosols and clouds along orbital path

Measurement derived from backscattered signal along the lidar line of sight (LOS)

Horizontal line of sight products (HLOS)

Rayleigh and Mie channels

Calibration and validation of the satellite



MEASUREMENT CAMPAIGNS

Four distinct campaigns were held at both OHP and OPAR in order to assess the performance and quality of the data at various latitudes and times during the mission lifecycle

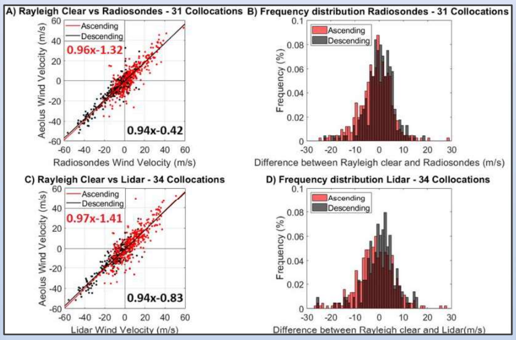


Fig. 1 :a) The Aeolus winds versus the radiosonde measurements made during all the campaigns. b) Frequency distribution of the difference between Aeolus and radiosonde wind speeds for the same data set. Red represents measurements of an ascending orbit, while black represents measurements of a descending orbit. c) and d) for lidars

DETECTION OF ERRORS

We can use the ground-based instruments to compare the results and detect possible outliers or recurring error patterns in the data

QUALITY ASSESSMENT

Through the use various metrics, we're able to tell how well the satellite is performing and where it shows room for improvement

OHP

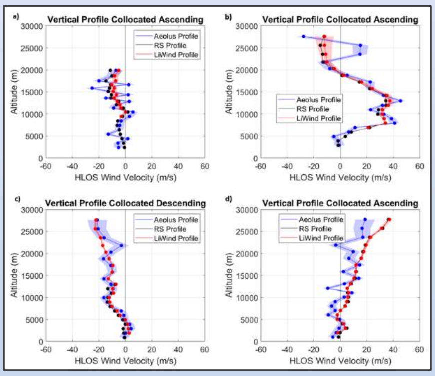


Fig. 2: Wind velocity profiles measured by the radiosonde (black) with the closest Aeolus Level 2B Rayleigh clear (blue) and ground based lidar (red) profiles.

Climatology results

With some detrending techniques, we're able to retrieve the kinetic energy of gravity waves from the Aeolus wind profiles. It is then possible to display the variance, a proxy for kinetic energy, on a global map to try and see if the satellite manages to resolve the physical phenomenon generating GWs. The resulting patterns are then interpreted critically, in order to assess the quality of the data and its physical accuracy. With the help of radio-occultation, an independent measurement process done through other satellites, we're able to validate our results and compare it to various datasets.

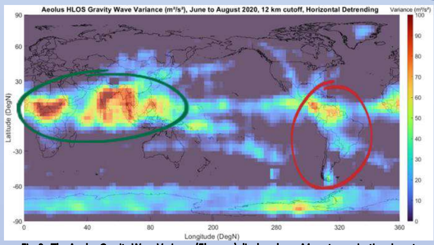


Fig. 3: The Aeolus Gravity Wave Variance (Ek proxy) displayed on a Mercator projection, June to August 2019

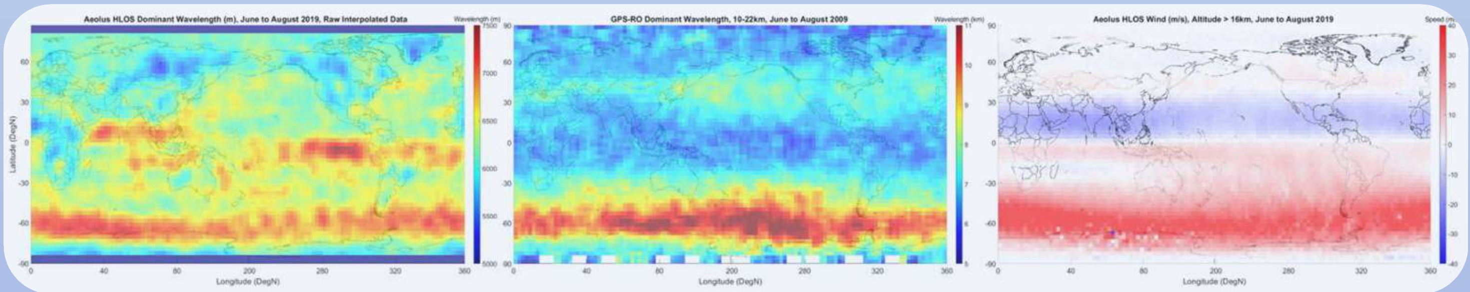


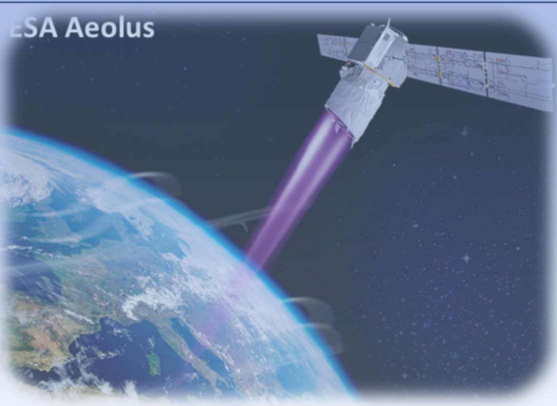
Fig. 4 :a) The Aeolus Dominant wavelength displayed on a Mercator projection, June to August 2019 b) The ROMSAF GPS-RO dominant wavelength displayed on a Mercator projection, June to August 2019 c) The Aeolus HLOS Wind speed at altitude higher than 16km displayed on a Mercator projection, June to August 2019

Conclusions and Outlook

- *Aeolus is capable of detecting gravity wave activity, but is prone to overestimate it*
- *Aeolus faces random yet recurrent issues : hot pixels, I2OP, increased high RBS random errors*
- *Horizontal and vertical detrending approaches have been applied to derive global distribution and variability of wind variance, which is used as a proxy for GW activity*
- Aeolus captures the well known orographic and non-orographic GW sources: mountain ridges, tropical land convection, polar vortex dynamics
- *Recurrent (reproducible) season-specific patterns of GW activity in Aeolus 3 year record were observed*
- *Global distribution of GW activity from Aeolus is found consistent with that derived from GPS-RO temperature profiling despite different capacities of measurement techniques*
- *Distribution of the dominant GW vertical wavelength follows the expected pattern driven by large-scale flow*

However, several should be investigated in the future:

- *Region-specific and special case studies*
- *Analysis the recent GPS-RO data (Metop, COSMIC-2) data for a finer comparison with Aeolus*
- *Second Paper to be submitted soon for AGU*



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