NWP impact of Aeolus observation as characterized by Ensemble Data Assimilation experiments

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Introduction

ESA’s Earth Explorer Atmospheric Dynamics Mission Aeolus carries a Doppler wind lidar which will provide global line-of-sight wind profiles.

The vertical sampling is limited to 24 range gates both in the Rayleigh and Mie receiver channels for the molecular and aerosol scattering respectively. Number and error of the observations depend upon various factors, such as air density, aerosol loading, visibility, and wind shear.

In this study, it is examined how both different vertical and horizontal sampling scenarios for Aeolus affect the forecast quality in a global NWP system. Furthermore, changed instrument design moved the lidar operations from burst to continuous mode. Moreover the impact is estimated of a decrease in pulse energy of the laser from 110 mJ to 80 mJ. We investigate what effect these instrumental changes will have on the data and finally on the improvement of the weather forecast.

The assessment will be carried out with the 4D-variational data assimilation of the ECMWF operational system. ADM-Aeolus observations are generated artificially by short-range forecasts of the UK met office and with cloud and aerosol information from Calipso.

Design of experiments

ECMWF’s its model cy35G, T399L91

Ensemble of 10 members with perturbed observations

Time span: January 2007

1) Calibration test with radiosonde denial experiments.
2) Experiments for vertical sampling:
   2A) ADM-LT with focus on lower troposphere (WWM)
   2B) ADM-ULTS with focus on upper UTLS region (WWM-2m-2)
2C) ADM-strato with focus on stratosphere (WWM-stratosphere-noac, increased top-height of observations to 36.5 km)
3) Experiments with burst (BM110mJ, 50 km) and continuous mode (CM110mJ, 84 km)
4) Experiment with reduced laser power to 80 mJ (CM80mJ)
5) Experiment with increased horizontal sampling length to 250 km (CM250km, 80 mJ)

Two test scenarios

Impact: Aeolus vs radiosondes

Area averaged impact for zonal wind in ADM-ULTS (left) and Radiosonde (right). Aeolus impact is doubled due to only half of expected sampling. Blue color indicates positive impact.

Impact: Aeolus vertical sampling

Globally averaged impact for zonal wind in different Aeolus experiments for short-range (0.25-2 days) and mid-range (3-6 days).

Method EDA: Data assimilation ensemble technique

It was demonstrated that a data assimilation ensemble with perturbed observations can be used to sample the background and the analysis error. We use the ensemble spread to estimate the impact of a simulated observing system, i.e., Aeolus.

Impact(new obs.) = Spread(Exp. without new obs) minus Spread(Exp. with new obs.)

Calibrating the impact of an observing system by comparing the ensemble spread with a reference case, e.g., impact of radiosondes.

Spatial map of impact

Impact of new observing systems can be simulated with Ensemble Data Assimilation (EDA) experiments. The simulated Aeolus impact is comparable in magnitude to the radiosonde impact. Aeolus impact is expected especially in high latitudes, over the oceans and in the Tropics. Higher sampling in the lower troposphere or in the stratosphere results in increased impact in the respective region. The recent changes in Aeolus’ instrumental design do not degrade strongly the impact in our experiments.

References


Summary

Impact of new observing systems can be simulated with Ensemble Data Assimilation (EDA) experiments. The simulated Aeolus impact is comparable in magnitude to the radiosonde impact. Aeolus impact is expected especially in high latitudes, over the oceans and in the Tropics. Higher sampling in the lower troposphere or in the stratosphere results in increased impact in the respective region. The recent changes in Aeolus’ instrumental design do not degrade strongly the impact in our experiments.

Area averaged impact for zonal wind in ADM-ULTS (left) and Radiosonde (right). Aeolus impact is doubled due to only half of expected sampling. Blue color indicates positive impact.