ADM-Aeolus vertical sampling strategy for stratospheric wind analysis

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Introduction

ESA's Earth Explorer Atmospheric Dynamics Mission ADM-Aeolus is planned for launch in 2011. The polar-orbiting satellite 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 different vertical sampling scenarios for ADM-Aeolus affect the analysis of stratospheric winds. Since stratospheric dynamics are strongly influenced by vertically propagating waves, it is possible that high-quality tropospheric wind observations yield a higher impact on stratospheric analysis than low-quality stratospheric wind observations. This hypothesis is tested using a new data assimilation ensemble technique which allows to assess the impact of future observation systems.

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.

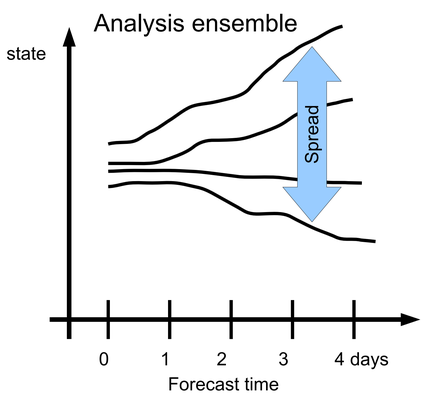
Method: Data assimilation ensemble technique (EnDA)

It was demonstrated that a data assimilation ensemble with perturbed observations can be used to sample the background and the analysis error (Žagar et al. 2007).

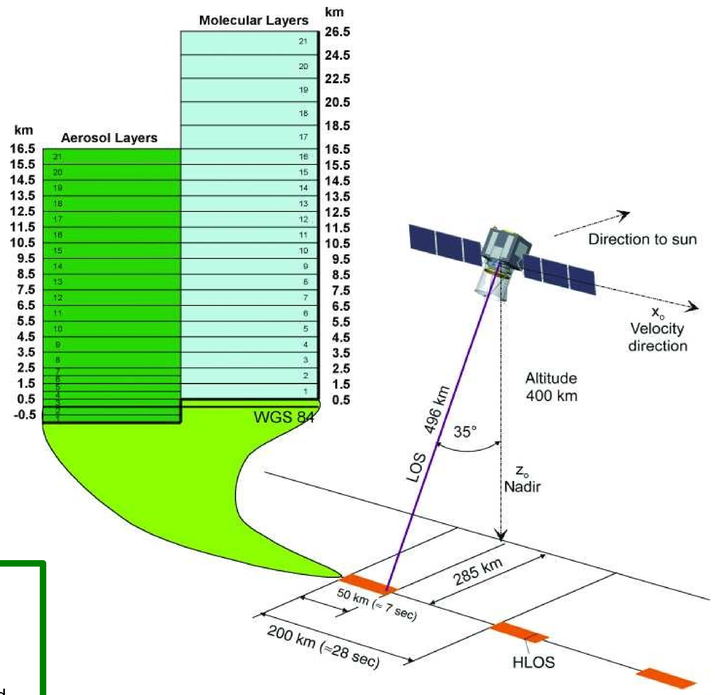
Tan et al. (2007) used the ensemble spread to assess the impact of a simulated observing system, ie. ADM-Aeolus.

Artificial observations of the line-of-sight wind were produced from short-range forecast of the UK met office.

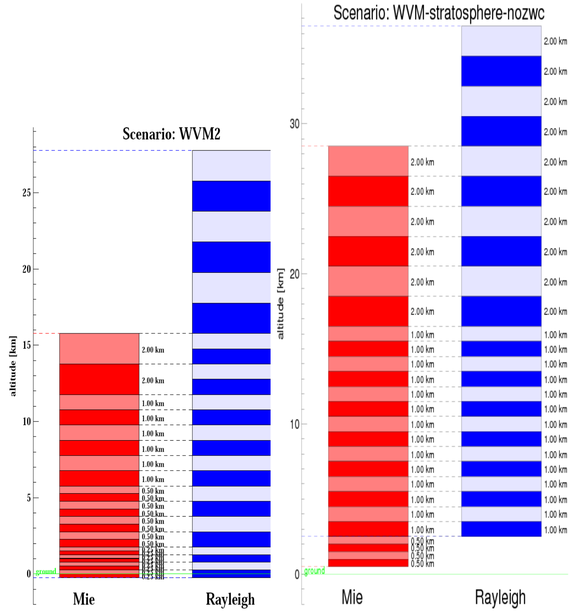
Assessing the impact of an observing system by comparing the ensemble spread with a reference case.



ESA's Earth Explorer Atmospheric Dynamics Mission ADM-Aeolus



Two test scenarios



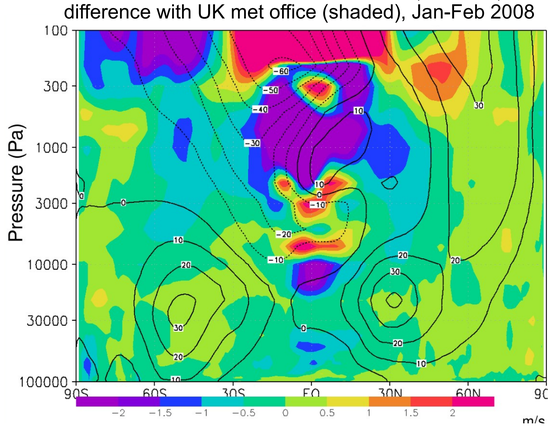
Design of experiments

- **ECMWF's ifs** model cy35r1/r2? T159L91
- **Ensemble**: 1 unperturbed simulations + 8 perturbed or more?
- Time span: January 2007, August 2007
- Cloud and Aerosol distribution from **Calipso**, thus position of Calipso **nighttime** observations for artificial wind observations!
- Collocated line-of-sight wind observations from **UK met office forecasts**
- Testing how different **vertical sampling scenarios** affect the forecast spread.
- Testing how the different issues of the signal algorithm affects the forecast spread, eg. Cloud detection, cross-talk correction, systematic errors.

Can short-range forecasts be used as a truth in the stratosphere?

We assume that the difference between ECMWF and truth is similar to the difference between UK met office and ECMWF analysis.

Time and zonal mean u-wind in ECMWF (contours) and difference with UK met office (shaded), Jan-Feb 2008

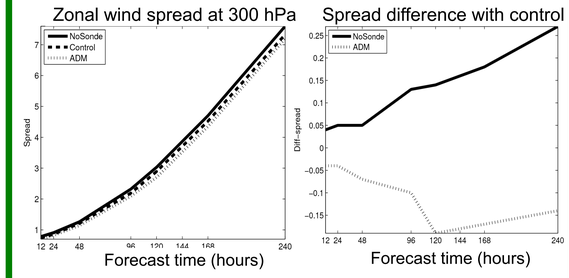


Example of results

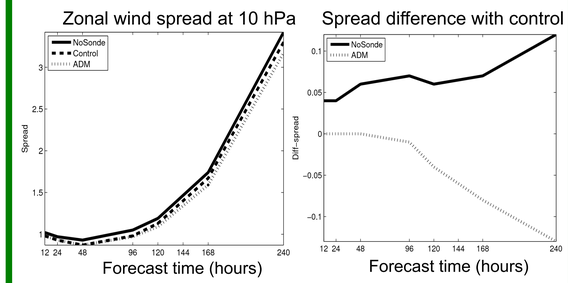
Here, three simulations by Tan et al. (2007) are analysed:

- **Control**: All ECMWF obs
- **NoSondes**: No radiosondes
- **ADM**: Create artificial ADM obs from UKMO short-term forecasts. Artificial ADM observations are created with a constant vertical sampling scenario up to a level of 50 hPa.

a) ADM-impact in the troposphere



b) ADM-impact in the stratosphere



The artificial ADM-observations have a positive impact on the ensemble spread which is comparable with the impact of the radiosondes.
In the stratosphere, the impact sets in after about 4 days which is consistent with the vertical propagation of planetary waves from the troposphere to the stratosphere.

References

- Tan, D.H., E. Andersson, M. Fisher, and L. Isaksen (2007), Observing-system impact assessment using a data assimilation ensemble technique: application to the ADM-Aeolus wind profiling mission, *Quart. J. Roy. Meteor. Soc.*, 133, 381-390.
- Žagar, N., Andersson, E., Fisher, M. and A. Untch, 2007: Influence of the quasi-biennial oscillation on the ECMWF model short-range forecast errors in the tropical stratosphere. Q. J. R. Meteorol. Soc., 133, 1843-1853.