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The Atmospheric Physics Group

Aeolus vertical sampling strategy for improved weather forecasting

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Introduction 1

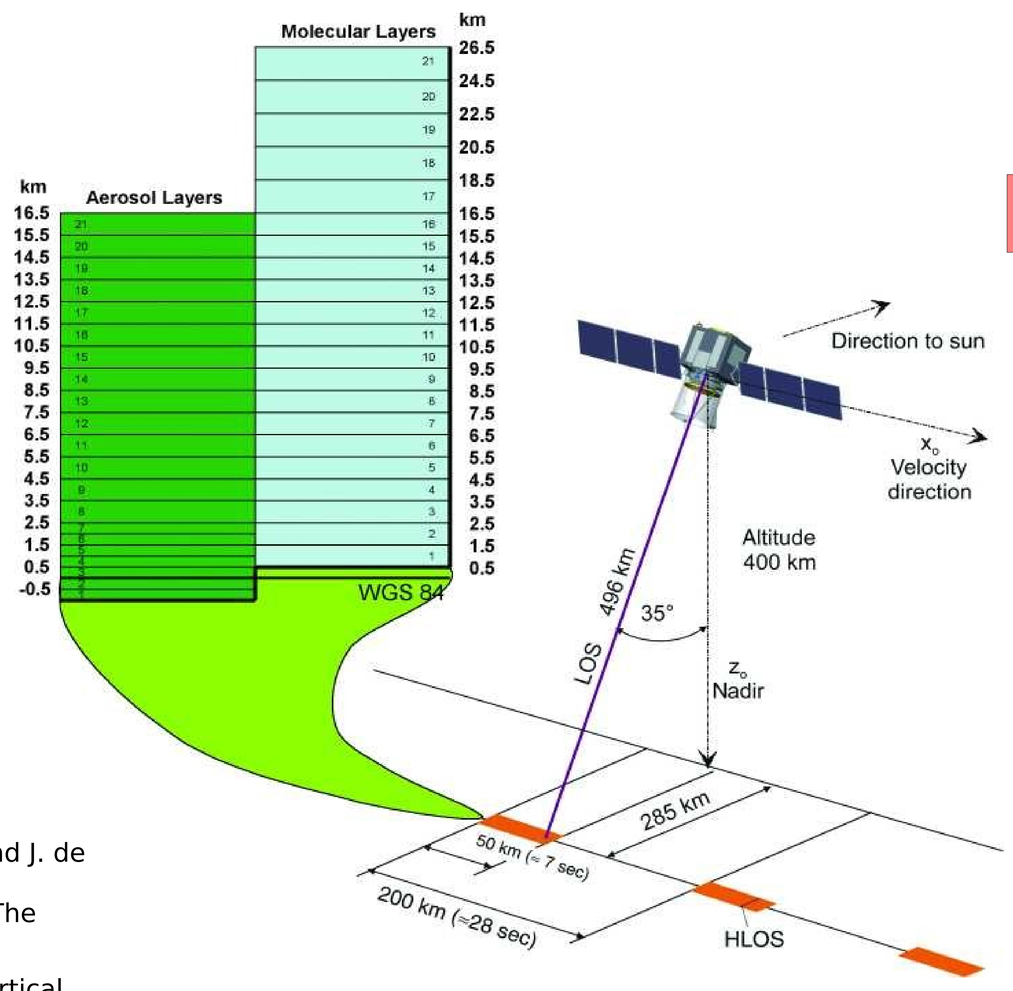
ESA's Earth Explorer Atmospheric Dynamics Mission Aeolus is planned for launch in 2011. The polar-orbiting satellite carries a Doppler wind lidar which will provide global line-of-sight wind profiles.

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 Aeolus improve the forecast quality. A special focus lies on stratospheric dynamics. A better description of the stratosphere might improve intra-seasonal forecasts of European winters.

We will estimate the impact of the future satellite observations on the weather forecasting with a new data assimilation ensemble technique. The assessment will be carried out with the 4D-variational data assimilation of the ECMWF operational system.

ESA's Earth Explorer Atmospheric Dynamics Mission Aeolus 2

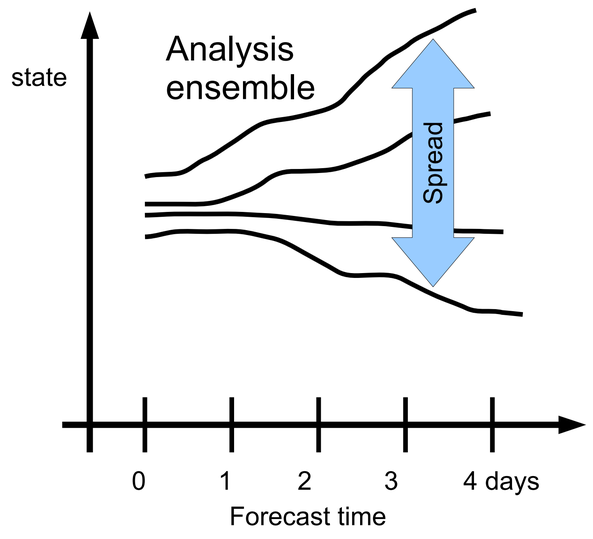


Method: Data assimilation ensemble technique 3

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, ie. Aeolus.

Impact(Aeolus) = Spread(Exp. with Aeolus) minus Spread(Exp. without Aeolus)

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



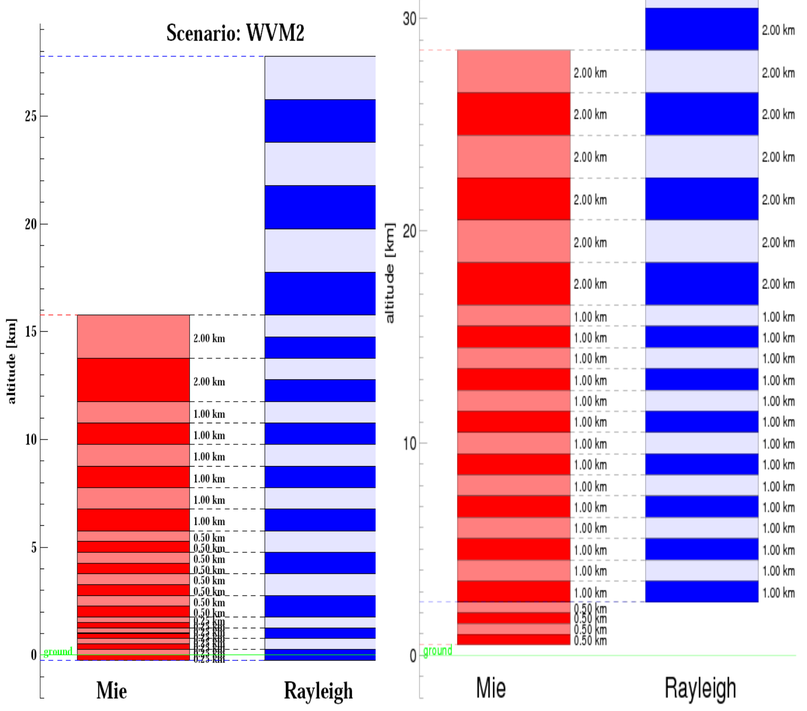
References

- Stoffelen, A., H. Körnich, G.-J. Marseille, K. Houchi, and J. de Kloe, 2010: Assessment of Optical and Dynamical Atmospheric Heterogeneity. Technical Note, ESTEC, The Netherlands.
- Körnich, H., and H. Schyberg, 2010: Impact of the Vertical Sampling Scenarios on NWP and Stratospheric Wind Analysis. Technical Note, ESTEC, The Netherlands.
- 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.

Design of experiments 4

- **ECMWF's ifs** model cy35r1/r2? T159L91
- **Ensemble of 10 members** with perturbed observations
- Time span: January 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 short-range 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.

Two test scenarios 5

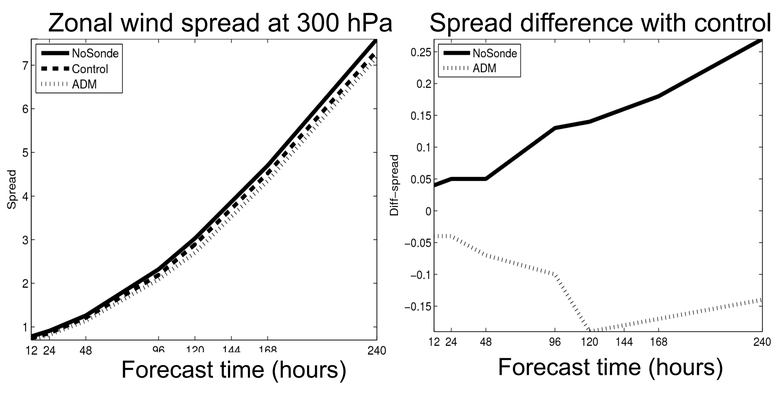


Example of results 6

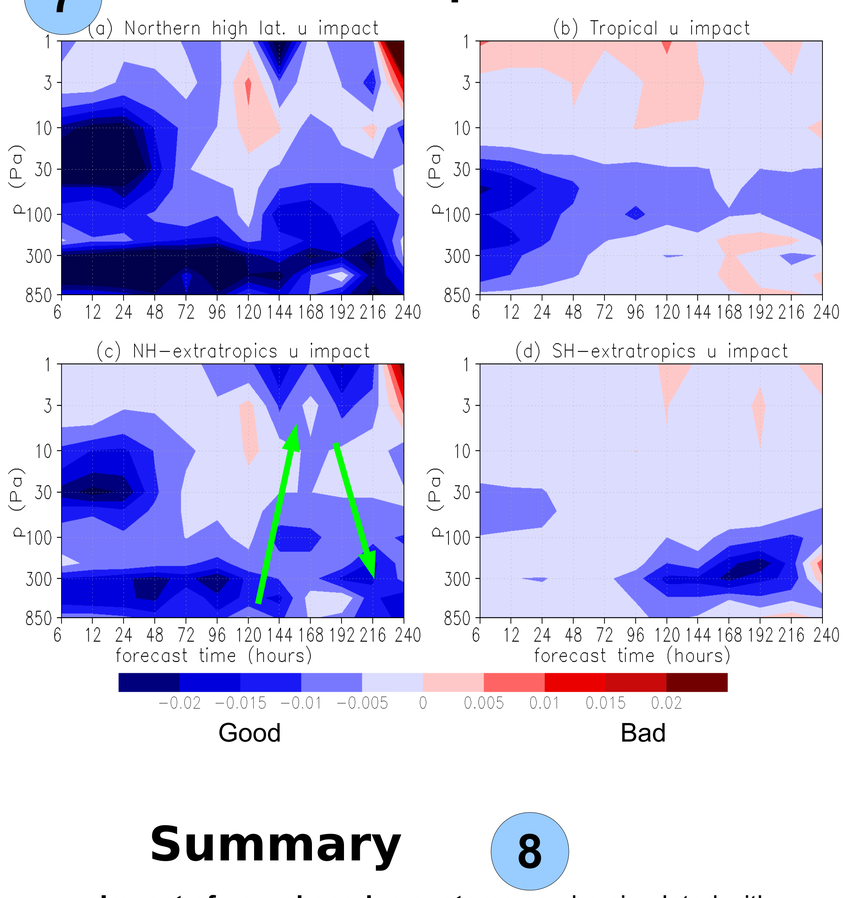
Here, three simulations by Tan et al. (2007) are analysed:
- **Control**: All ECMWF obs
- **NoSondes**: No radiosondes
- **ADM**: Create artificial Aeolus obs from UKMO short-term forecasts. Artificial Aeolus observations are created with a constant vertical sampling scenario up to a level of 50 hPa.

The artificial Aeolus-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.

a) Aeolus-impact in the troposphere



Zonal wind-impact ½-Aeolus 7



Summary 8

- **Impact of new observing systems** can be simulated with Ensemble Data Assimilation experiments.
- Aeolus impact **comparable** to radiosonde impact.
- Aeolus impact **regions**: Oceans, tropics, Arctic
- **Vertical propagation of Aeolus impact** at forecast time of 2 and 4-7 days. Impact seems to propagate vertically with gravity waves and large-scale Rossby waves, respectively.
- A **recommendation** for the vertical sampling was given:
  - In winterly high latitudes, WVM2; in winterly subtropics and tropics, WVM-et-zwc2; in winterly midlatitudes, either of both; in the summer hemisphere, WVM2.
  - Stratospheric scenario performs best in winterly midlatitudes.
- Role of **crosstalk** could not be decided.

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