Developments in Satellite Data Assimilation at DWD


I) Operational NWP system & satellite usage

Global:
- GME: 29km triangular grid, 60 Levels up to 5 hPa
- 3Dvar for conventional and satellite data, 3h cycling

Regional:
- COSMO-EU: 7km, 40 Levels (up to ~22 km, non-hydrostatic)
- COSMO-DE: 2.8km, 50 Levels (non-hydrostatic)
- COSMO-DE: EPS ensemble at 2.8 km, 20 members (soon 40 members)

Nudging assimilation scheme for conventional and radar data

Satellite data / global GME:
- AMSU-A, HIRS, IASI, AMSU-B/MHS, and ATMS are pre-operational
- FPS-R0 bending angles
- AMVs (GEO, LEO), Scatterometer winds (ASCAT, OSCAT)

Technical aspects:
- RTTOV-10
- Flexible data ingestion & pre-processing
- Monitoring: Automatic problem detection & alert system
- Online bias correction

II) Developments in radiance assimilation

- Improved observation errors: Analysis and tuning updates based on Desroziers et al. method; scan-angle dependent errors for ATMS (see poster 1.p12 by R. Faulwetter).
- Variational bias correction is under testing with the aim to replace the current online bias correction for all satellite radiances.
- IASI: Positive impact in pre-operational tests using 46 channels (LW band) over sea in a first implementation (Fig. 1). Clear channels are selected using the McNally and Watts (2003) approach. Further tuning and development explores changes to the background error covariances B (Fig. 2) and the inclusion of more channels (WW band, over land).

III) 1Dvar as development & pre-processing tool

A 1Dvar as special mode of the 3Dvar code is being implemented. The aim is to use this tool primarily for research and also as radiation pre-processor for the treatment of more complex situations prior to the 3Dvar or VarEnKF analysis. Principal applications:

- Analysis of cloud parameters: The retrieval of cloud parameters is explored to allow using more channels in overcast situations.
- Analysis of surface emissivity and skin temperature based on a principal component decomposition approach for the emissivity spectrum and an emissivity first guess derived from alatissies (e.g. Seemann et al. for IR).
- Quality control of radiance: A new quality control scheme will be tested which checks the consistency of the observation departures against the statistical expectations based on the full B and O matrix specification, H operator and other observations (O. Stiller to be submitted).

IV) New global ICON model & VarEnKF assimilation

The ICON model will be used both for operational NWP and climate prediction applications and is developed in cooperation with the MPI for climate research (Hamburg). Improvements (compared to GME) enabling particularly an easier and much better use of radiances are a significantly raised model top (Fig 3b) and a much improved physics parameterizations package reducing biases. Currently the tuning of the cycling 3D-EnVar system is underway with operational implementation intended for end 2014. Subsequently the assimilation system is going to be updated to an ensemble based VarEnKF approach. The improved and flow dependent B matrix will allow a much better exploitation of satellite radiation information compared to the current climatological 3Dvar setting.

- Non-hydrostatic, icoshedral grid at 13 km (Fig 3a)
- 90 z-coordinate levels up to 75 km (~ 0.026hPa) (Fig 3b)
- Two-way nesting for refined grid (to replace current COSMO-EU)
- In the final setup ICON will also be used for high-resolution forecasts and replace COSMO-DE.
- Physics: DWD developments for turbulent transfers, cloud cover and microphysics, sea-surface temperature, and VarEnKF schemes for radiation, gravity and oceanic drag and convection.

V) Convective-scale assimilation: LETKF development

For regional high resolution analyses, the KENDA system (km-scale ensemble-based data assimilation) based on the LETKF (Hunt et al.) will replace the current nudging scheme. Current developments use a 40 member ensemble and focus on localization issues and the exploitation of additional observations from volume radar scans, satellites and GPS (slant) delays. Experiments are being conducted using cloud top height and cover information from SEVIRI (METEOSAT) as cloud cover, cloud top height and humidity constraints in the LETKF. First experiments focus on wintertime low stratus situations:

- Single observation experiments illustrate improvements in cloud cover and cloud liquid water profiles despite the very non-Gaussian distributions of the observation increments. The LETKF also strengthens inversions in the analyses due to RH - T cross-correlations in the ensemble background perturbations (not shown).
- 20h of 1-hourly cycling with real SEVIRI cloud top information (from NWC-SAF) with correction based on radiosonde data) followed by 24h forecasts (14-15 Nov 2011):

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