Assimilating Satellite Data in the Copernicus Atmosphere Monitoring Service Global Data Assimilation System: Current Status and Prospects for the Sentinel Era

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Data Assimilation – merging model forecast with observations

**Observations, with p error estimates**

**Background forecast** (propagates forward previous information, constrained by dynamical and physical relationships), with error estimates

12-hourly 4D-Var assimilation
September 2014: unusual SO$_2$ concentrations detected across Europe.
Copernicus Atmosphere Monitoring Service (CAMS)

- Operational delivery of atmospheric composition services
- Global and European regional scale
- Initial period from 2015 – 2020
- ECMWF is in charge of implementation
THE CAMS IDEA

From EO to policy-relevant products

Over 70 EO instruments are assimilated in the global system.

Boundary conditions feed an ensemble of high-resolution European AQ systems (in order to assess uncertainties).

More data are assimilated (in particular hourly surface AQ concentrated by EEA/EIONET).

Policy-relevant (here health indicator for ozone) products are delivered. They are "maps with no gaps", which observations alone don't provide and are essential to assess impacts.
Both MOPITT and IASI have introduced new versions in their near-real-time data streams.

Agreement much better since November 2014, as clearly shown by operational monitoring.
DLR provides a volcanic SO$_2$ flag as part of its SO$_2$ product. This allows better use of GOME-2 data. Much improved results compared to assimilation of OMI data only.
Assimilation of GOME-2 O$_3$ profiles (provided by RAL) is work-in-progress; successful assimilation should provide better constraint on vertical distribution.

First results show that use of averaging kernel for tropospheric profile is important.
Assimilation of PMAP data (AOD based on GOME-2 and IASI) provides comparable quality to assimilation of MODIS data.
Assimilating only a few GOSAT observations significantly improves the forecast of CO₂ concentrations over Park Falls.
OLCI – based on MERIS heritage

SLSTR – based on AATSR heritage

Discussions with ESA and EUMETSAT about provision of Aerosol Optical Depth and Fire Radiative Power from Sentinel-3.

These observations will be used to complement AOD and FRP from MODIS. Aim is to make observing system more robust.
Sentinel-5p will provide essential observations complementing OMI, GOME-2, MOPITT, IASI and others, and ensuring crucial observations for the coming years.

Exciting new instrument and CAMS will provide early feedback based on its own satellite data monitoring system.
• Geo-stationary Sentinel-4
• Information on diurnal cycle
• Might help with regional air quality modelling

• Polar orbiting Sentinel-5
• Continuation of crucial observational record of atmospheric composition into the future.

• OCO-2
• SNPP
• JPSS
• Metop-C
• GOSAT-2
• TANSAT
• Aeolus
• EarthCare
• GEMS
• TEMPO
• …
• MACC will enter its operational phase as CAMS on 1 July

• Using satellite data through data assimilation improves the global forecasts, which is also important for the regional air quality forecasts

• The Sentinel missions will play a crucial role for years to come by providing important observations of atmospheric composition; operational reliability and quality is key to the success of these missions for the Copernicus Atmosphere Monitoring Service

• CAMS will also make use of many other European and non-European research and operational missions in its data assimilation system