

A novel approach to synergistic exploitation of Ozone data from multiple sources onboard MTG and MetOp-SG: first outcomes of the AURORA project.



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Project Overview

AURORA is a European Union Horizon 2020 project (EO-2-2015 Stimulating wider research use of Copernicus Sentinel Data) investigating the potential of assimilating fused ozone data from Sentinel 4 (S4), Sentinel 5 (S5) and Sentinel 5P (S5P) missions to develop innovative applications and services for demonstration purposes. Project Coordinator: Istituto di Fisica Applicata «Nello Carrara», IFAC-CNR, Italy (U.Cortesi@ifac.cnr.it)

(AURORA web-site: <http://www.aurora-copernicus.eu>)

Simulation

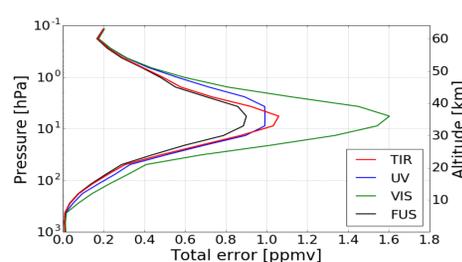
- Three **Simulation tools** have been developed for the simulation of S4 and S5 data in the UV, VIS and TIR spectral ranges. Simulations are obtained from ad-hoc atmospheric scenarios generated from the NASA MERRA-2 reanalysis [1] using the Sentinels' instrument characteristics.
- 4 months (April to July 2012) have been simulated (near 1 million pixels for each spectral range for S4 and S5)
- VIS ozone products have been simulated for S4 and S5 spectral range (425-497 nm) as well as for an extended spectral range (450-550 nm)
- A tool to convert Ozone profiles from vmr to partial columns (required in input by data assimilation systems (DASs)) has been implemented

Data Fusion

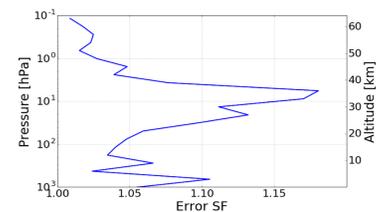
The **Complete Data Fusion (CDF)** method [2,3] has been used to fuse ozone profiles retrieved from simulated measurements in the TIR, VIS and UV spectral regions of:

1. S4-S4 (same space-time locations),
2. S4-S5 and S5-S5 (different space-time locations for the three spectral bands)

The CDF method has been modified to account for the effect of fusing measurements that refer to different true profiles and for the use of different vertical grids. Fused data shown here are S4 simulated measurements of the first week of April 2012 (23881 analyzed pixels)



Average total errors of the ozone profiles obtained from TIR (red line), UV (blue line) and VIS (green line) measurements and from the data fusion (black line)



Average error SF

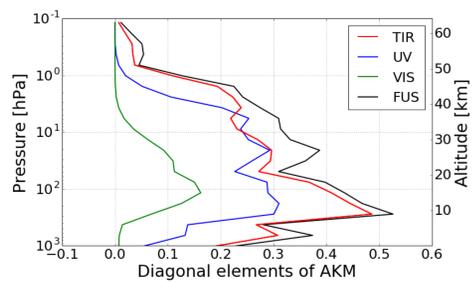
For each pressure level the error synergy factor (SF) is defined as:

$$SF_{err} = \frac{\text{Min}_{i=1,\dots,N} \sigma_{i,tot}}{\sigma_{f,tot}}$$

$\sigma_{i,tot}$ = total error of the i -th profile to be fused
 $\sigma_{f,tot}$ = total error of the fused profile

Spectral range	TIR	UV	VIS	FUS (TIR+VIS+UV)
Number of DOF	4.90	3.41	0.97	5.72

Average number of degrees of freedom (DOF) of TIR, UV, VIS and fused measurements.



Average of the diagonal elements of the AKMs

Data Assimilation

State-of-the-art **Data Assimilation Systems (DASs)** will be used to combine the LEO and GEO fused profiles, and compared with the assimilation of standard retrievals. Two DASs are available to AURORA:

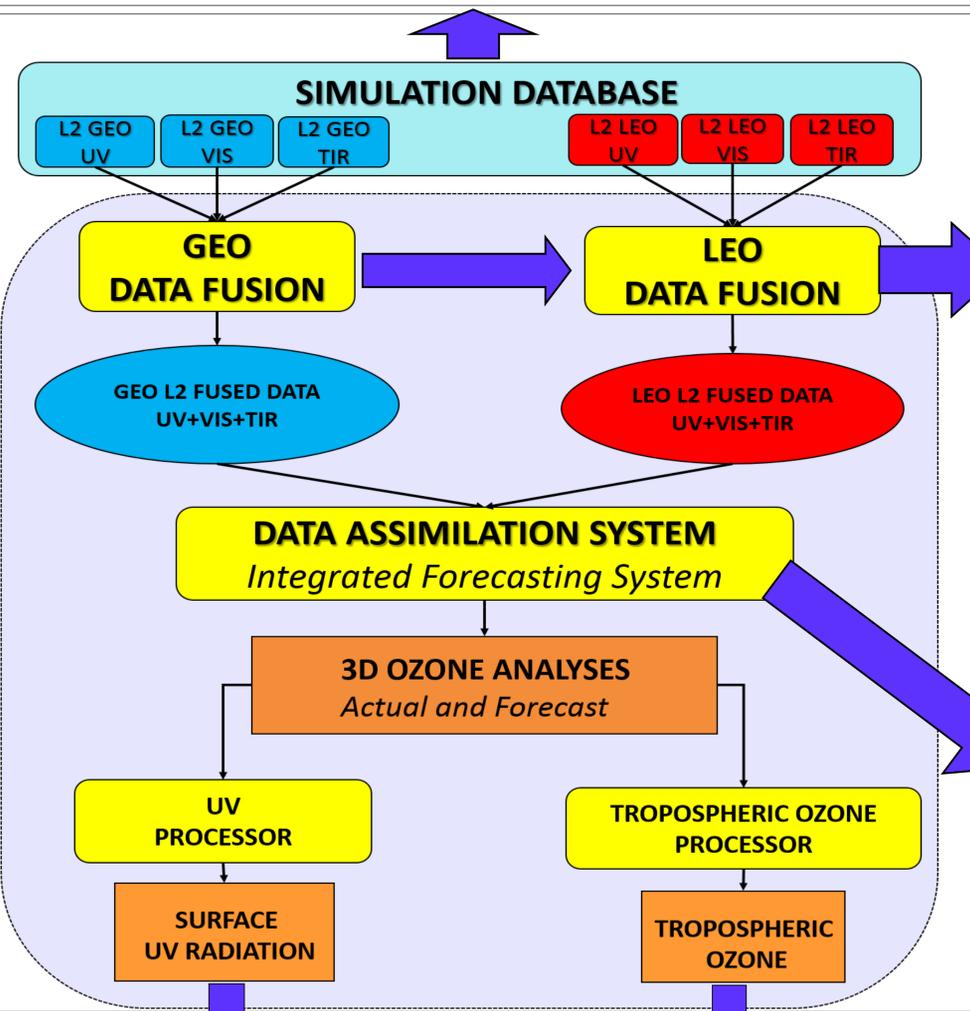
- ECMWF Integrated Forecasting System (IFS)
- KNMI Chemical Transport Model DAS (TM5DAM)

This table shows some of the assimilation experiments selected with incremental approach:

Assimilated datasets	Setup	Aim	Dataset
None	BASE	Baseline	4 months
L2-LEO	BASE+(L2-LEO)	Impact LEO	4 months
Fused LEO-LEO	BASE+(LEO-LEO)	Impact of fusion (3 vs 2)	4 months
Fused LEO-LEO & GEO-GEO	BASE+(LEO-LEO)+(GEO-GEO) ^(S4)	Impact of GEO (4 vs 3)	4 months
Fused LEO-LEO & GEO-GEO (+TEMPO & GEMS simul)	BASE+(LEO-LEO)+(GEO-GEO) ^(S4) ; TEMPO; GEMS	Impact of 3 GEO instead of 1 (5 vs 4)	1 month
Fused LEO-GEO	BASE+(LEO-GEO) ^(S4)	Impact of cross-platform fusion	4 months

Assimilation experiments

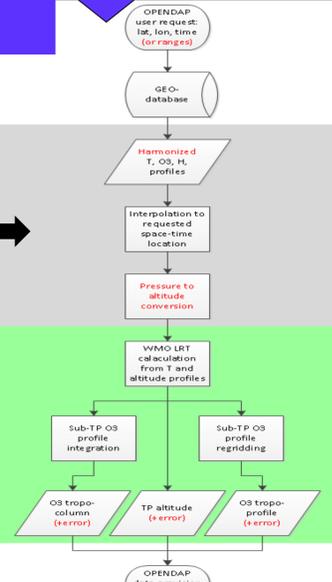
Tests on the assimilation experiments are on going as well as discussions for the section of different datasets to be used as input for the DASs.



Products

A **UV processor** is proposed within AURORA to produce clear-sky UV irradiance. It will be based on FMI's UV model. The UV models have been so far used only with LEO-based measurements, within AURORA also GEO products are planned to be exploited in the UV processor. The high temporal resolution of GEO measurements are likely to improve the daily UV estimate.

An operational **tropospheric ozone column calculation tool**, based on the vertical integration of DAS output fields, is under development



References

- [1] Bosilovich et al, 2015: MERRA-2: Initial Evaluation of the Climate, Tech. rep., NASA TM-2015-04606, from <http://gmao.gsfc.nasa.gov/pubs/tm/>.
- [2] Ceccherini et al., 2010: IASI-METOP and MIPAS-ENVISAT data fusion, Atmos. Chem. Phys., 10, 4689-4698, doi:10.5194/acp-10-4689-2010.
- [3] Ceccherini et al., 2015: Equivalence of data fusion and simultaneous retrieval, Optics Express, 23, 8476-8488.