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ESA-JAXA Pre-Launch EarthCARE Science and Validation Workshop

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Assimilation of different aerosol products of the EarthCare mission during the CAL/VAL program

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The ErathCARE mission

Scientific objectives:

➢ Improvement of the vertical distribution of natural and anthropogenic aerosols on a global scale

➢ Improve our understanding of cloud-aerosol-radiation interactions (NWP and climate purposes)

➢ Derivation of profiles of atmospheric radiative heating and cooling

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For this contribution :

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Motivations …

We will try to address some key points regarding the use of EarthCARE data:

- How can data assimilation contribute to the validation of EarthCARE aerosols observations ?

- What added value can EarthCARE data give to better characterize aerosols at global scale ?

- Can the use of EarthCARE aerosol observations within a global assimilation system add value compared to all existing data ?

- How EarthCARE data could help to improve the model parametrizations using data assimilation ?

- What kind of information could EarthCARE bring to the assimilation system during extreme events (e.g., desert dust outbreaks, wildfire events or volcanic eruptions) ?

The assimilation system

➔ It is developed within the MOCAGE model: the chemical transport model of Météo-France covers both troposphere and stratosphere with gases and aerosols:

    – 47 vertical levels (from the ground up to 5 mbar : ~40m near the surface till ~800m in the stratosphere)

    – Global: 2°x2° ; 1°x1° and 0.5°x0.5°

    – Regional: 0.5°x 0.5° ; 0.2°x0.2° and 0.1°x 0.1°
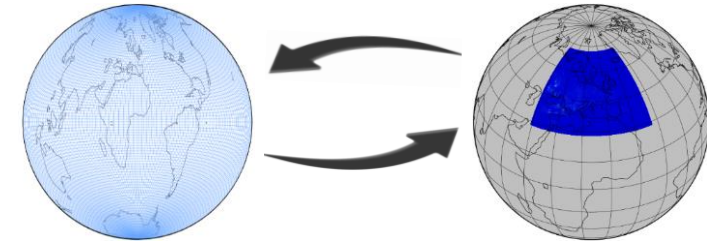
➔ Assimilated products

    – AOD observations:

        • Many wavelengths (>20: UV-IR) are implemented in MOCAGE for AOD assimilation

    – Lidar profiles :

        • The observation operator is able to solve the lidar equation for:

            o <u>Wavelengths:</u> 355, 532, 1064 nm

            o <u>Quantities:</u> the backscattered lidar signal, the extinction coefficient (α), the backscattering coefficient (β)

            o <u>Geometries:</u> Satellite, ground-based or aircraft (up or down) lidars

The Aerosol Assimilation System

AOD

Lidar Profiles

Atmospheric
Measurement
Techniques

Aerosol data assimilation in the chemical transport model MOCAGE during the TRAQA/ChArMEx campaign: aerosol optical depth

Bojan Sič[1,2], Laaziz El Amraoui[1], Andrea Piacentini[2], Virginie Marécal[1], Emanuele Emili[2], Daniel Cariolle[2], Michael Prather[3], and Jean-Luc Attié[1,4]

[1]CNRM-GAME, Météo-France – CNRS, UMR3589, Toulouse, France
[2]CECI, CERFACS – CNRS, UMR5318, Toulouse, France
[3]Department of Earth System Science, University of California, Irvine, USA
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Atmospheric
Measurement
Techniques

Aerosol data assimilation in the MOCAGE chemical transport model during the TRAQA/ChArMEx campaign: lidar observations

Laaziz El Amraoui[1], Bojan Sič[1,a], Andrea Piacentini[2], Virginie Marécal[1], Nicolas Frebourg[1,a], and Jean-Luc Attié[1,3]

[1]CNRM, Université de Toulouse, Météo-France, CNRS, Toulouse, France
[2]CERFACS, Toulouse, France
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Correspondence: Laaziz El Amraoui (laaziz.elamraoui@meteo.fr)

Assimilation of AOD (MODIS)

- The assimilation system is operational since January 2020
- Validation of MODIS AOD assimilation for many years and for specific events:
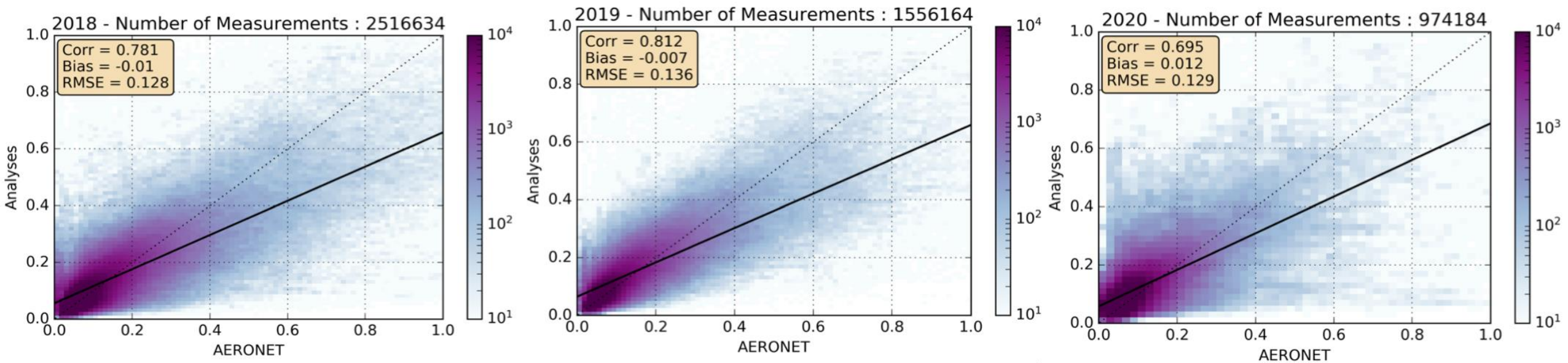
➔ Overall good agreement of assimilated fields compared to AERONET

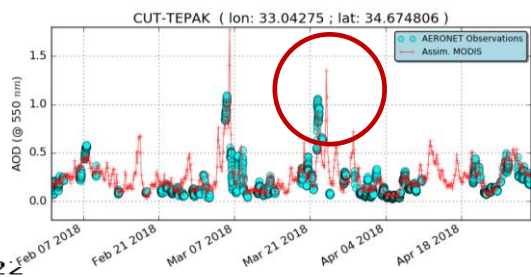# Assimilation of AOD (MODIS)
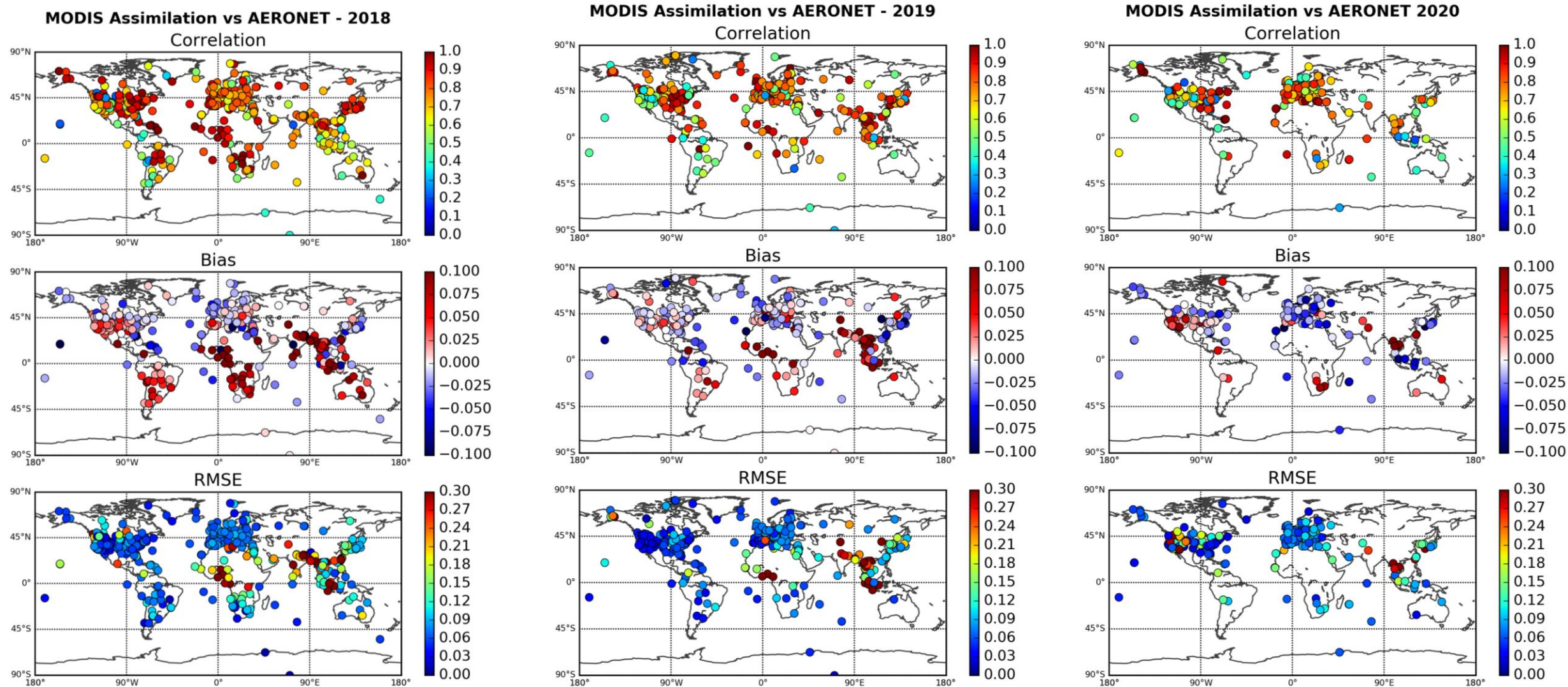
Assimilation of AOD (MODIS)

Saharan dust Outbreak over Greece (March 2018)
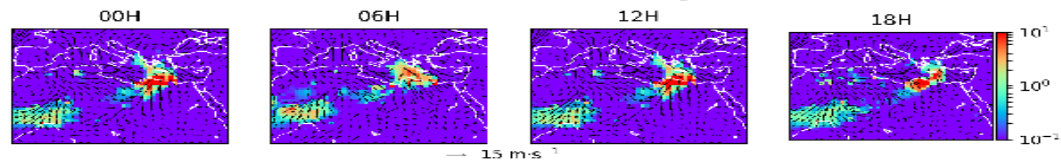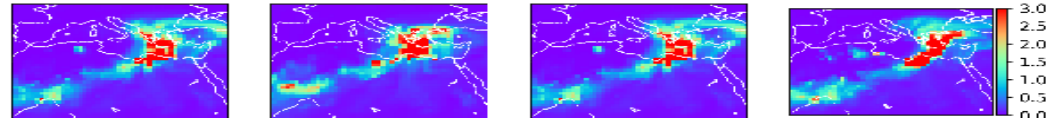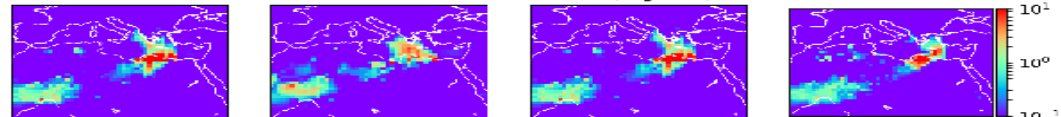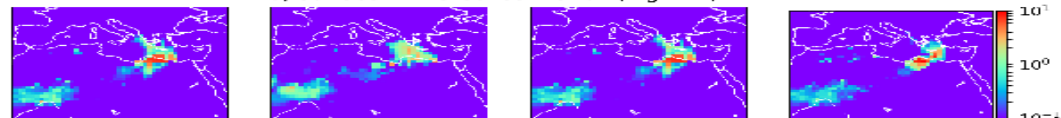
Desert dust event over France (February - March 2021):
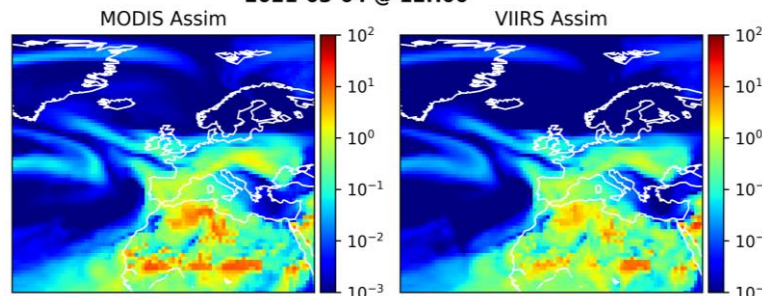
Pollution event due to dust transport over China (March 2021)
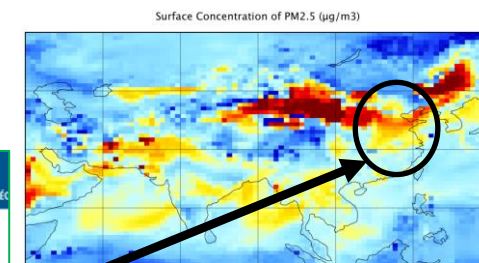
PM2.5 +10 fois la norme
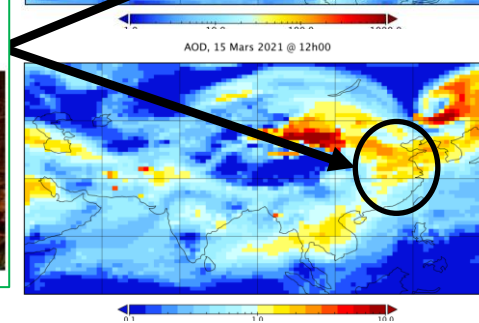
AOD ~3

Assimilation of AOD (MODIS)

Australian Wildfires: Nov – Dec 2019

January 6, 2020 @ 12h00

El Amraoui et al., 2022
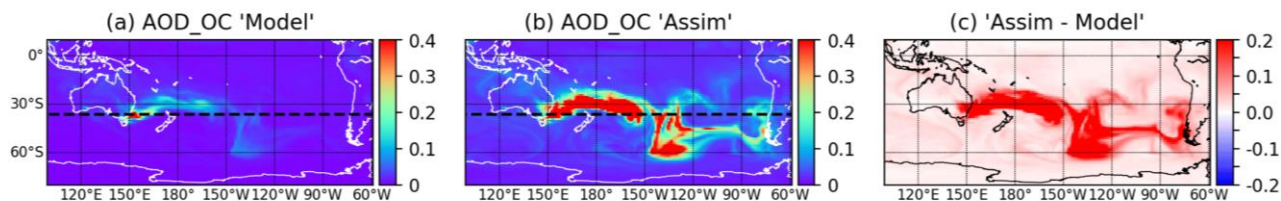
(a): CALIOP trajectory
(b): Backscatter coefficient (CALIOP)
(c): Backscatter coefficient (Model)
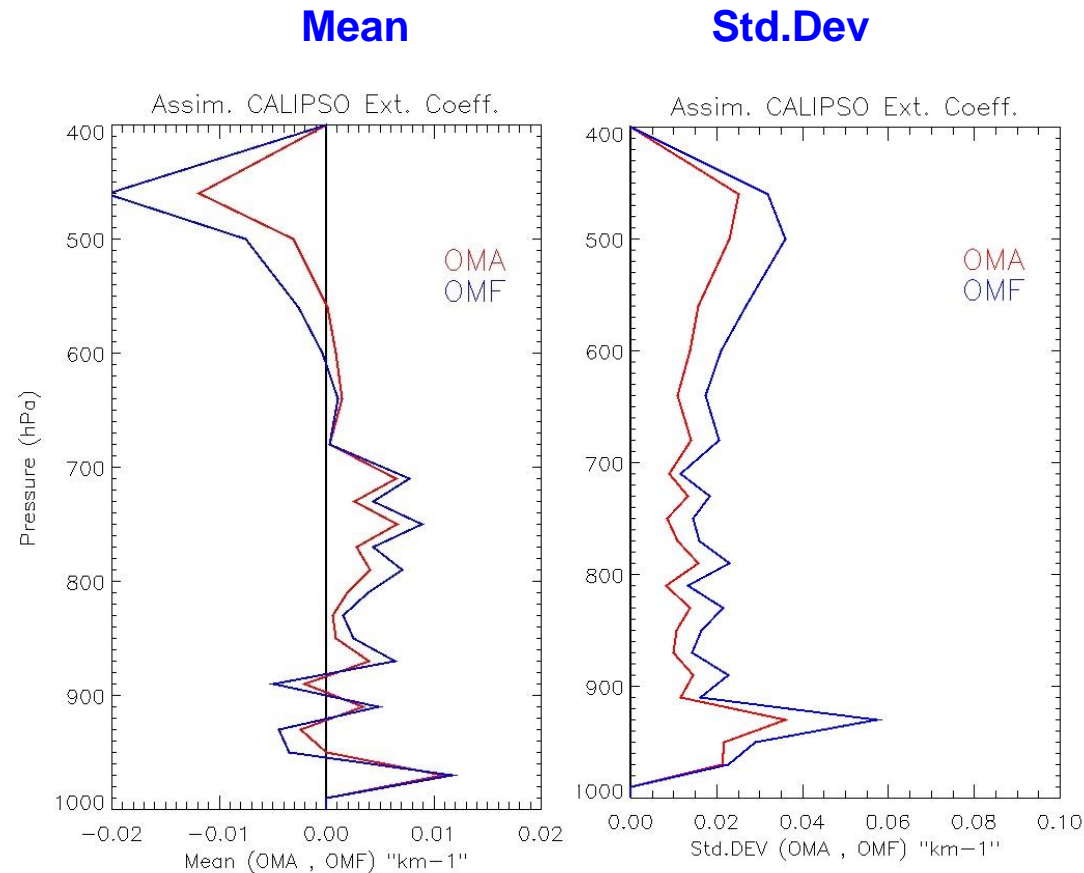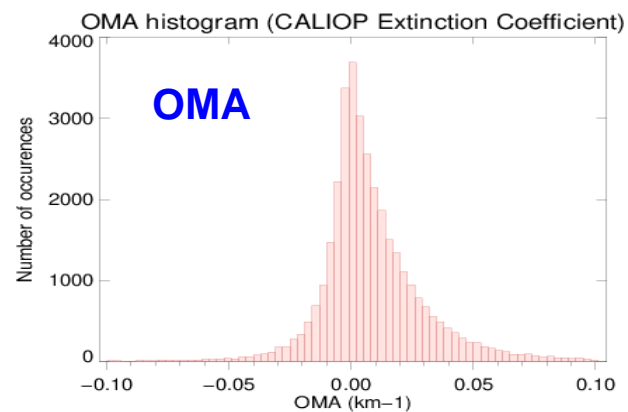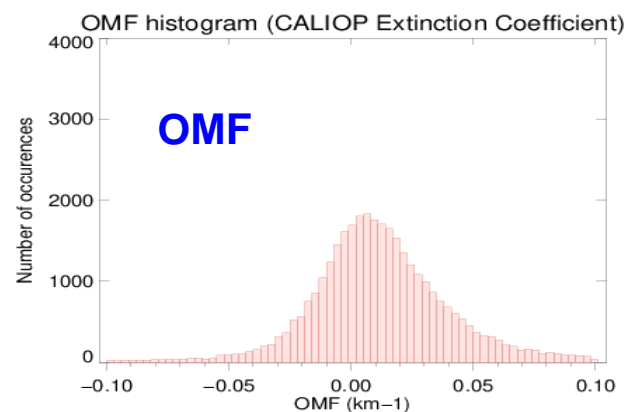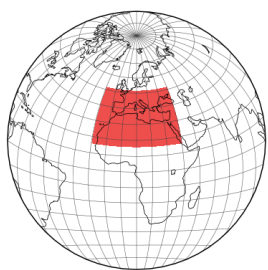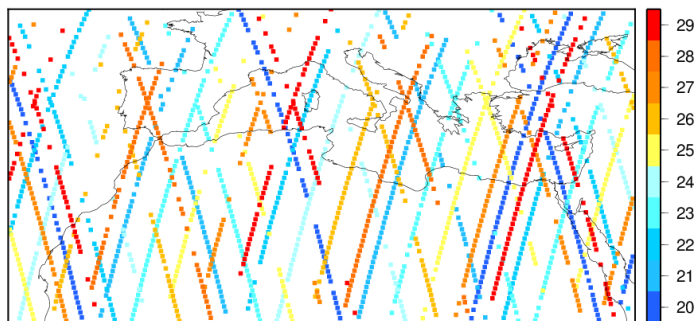(d): Backscatter coefficient (MODIS Assimilation)
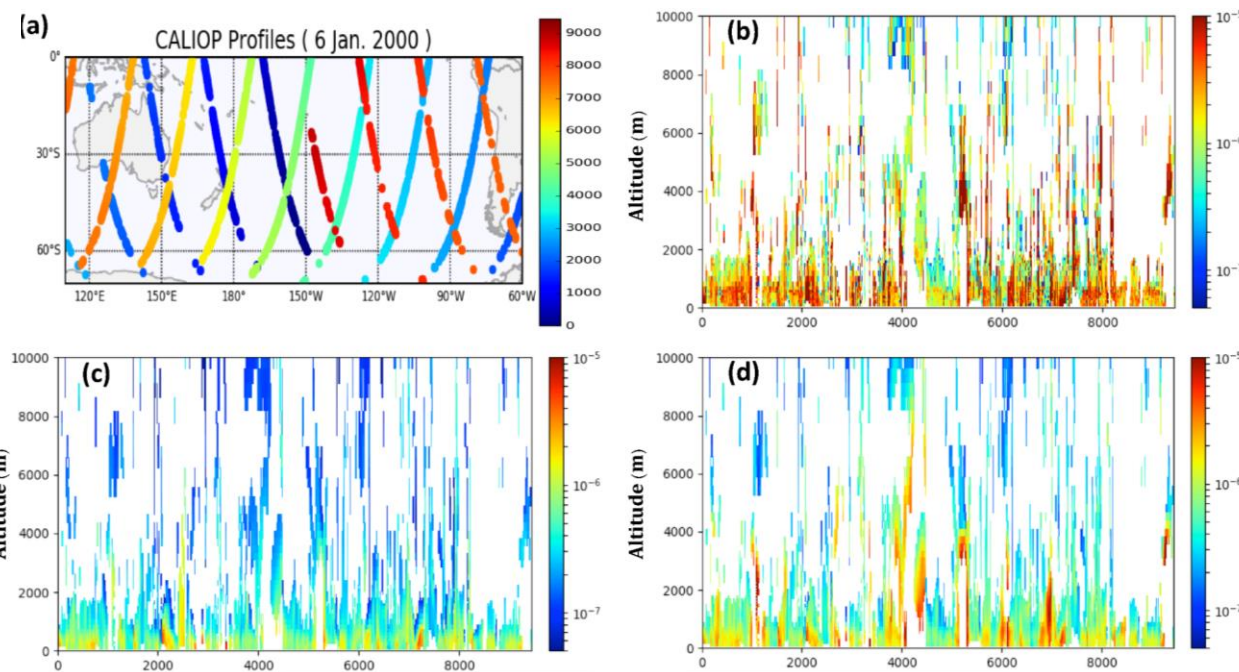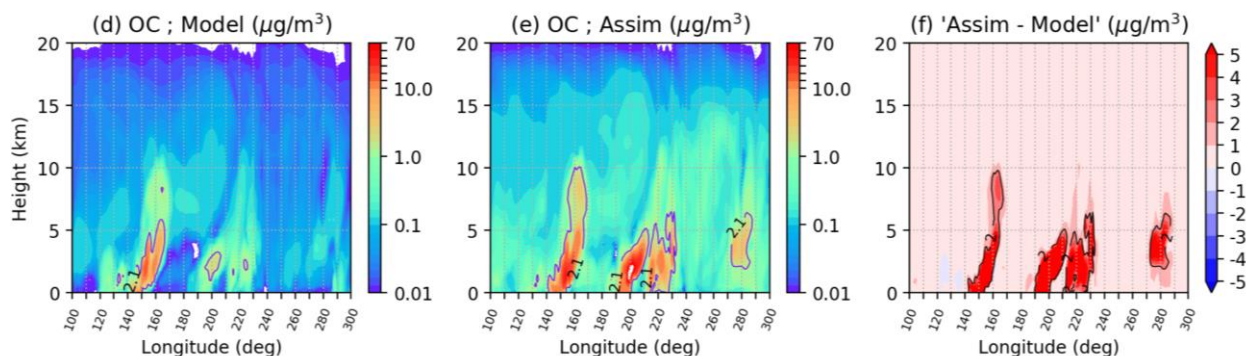
Assimilation of CALIOPE lidar profiles

Assimilation exercise :

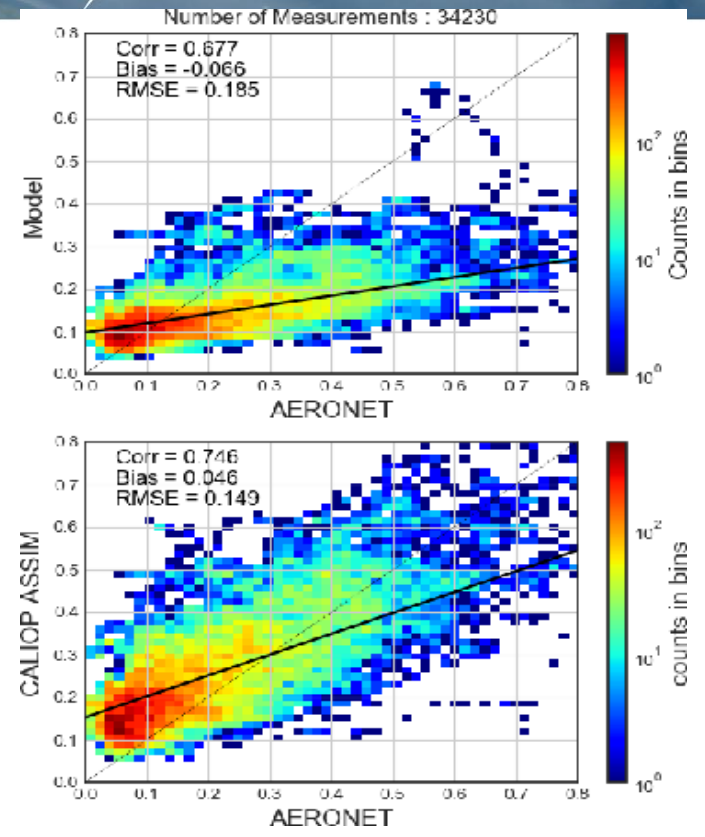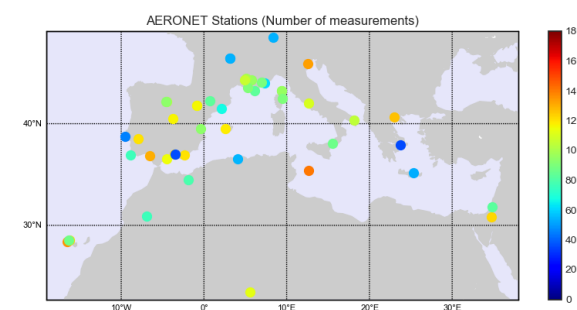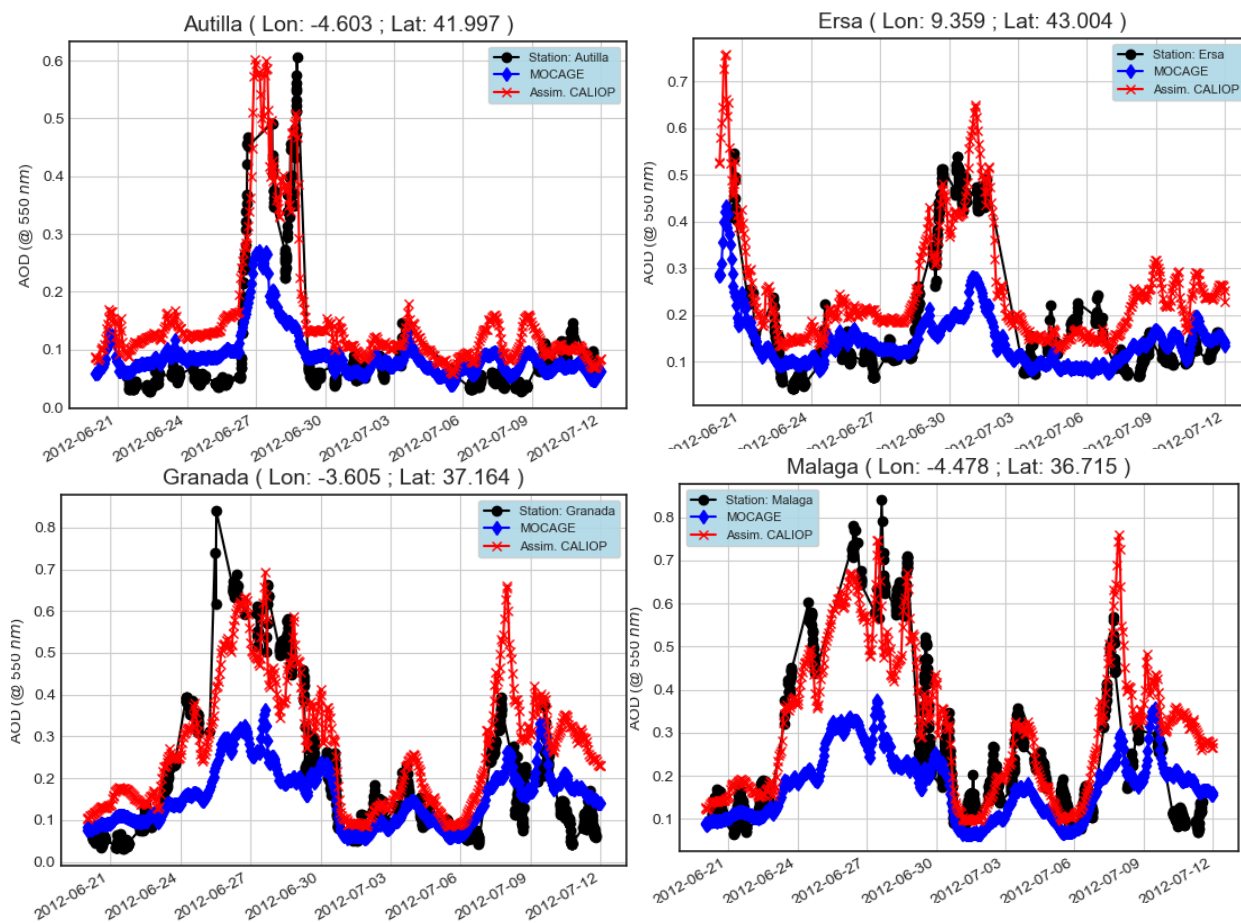➜ TRAQA-2012 (20-29 June)

➜ Saharan Dust Outbreak over The MB

➜ Extinction Coefficient

Mean   **Std.Dev**

Assimilation of CALIOPE lidar profiles

- Comparison with AERONET AOD observations

N_obs	MOCAGE free run			CALIOP Assimilation		
	Correlation	Bias	RMSE	Correlation	Bias	RMSE
34230	0.677	-0.066	0.185	0.746	0.046	0.149

Assimilation of CALIOPE lidar profiles
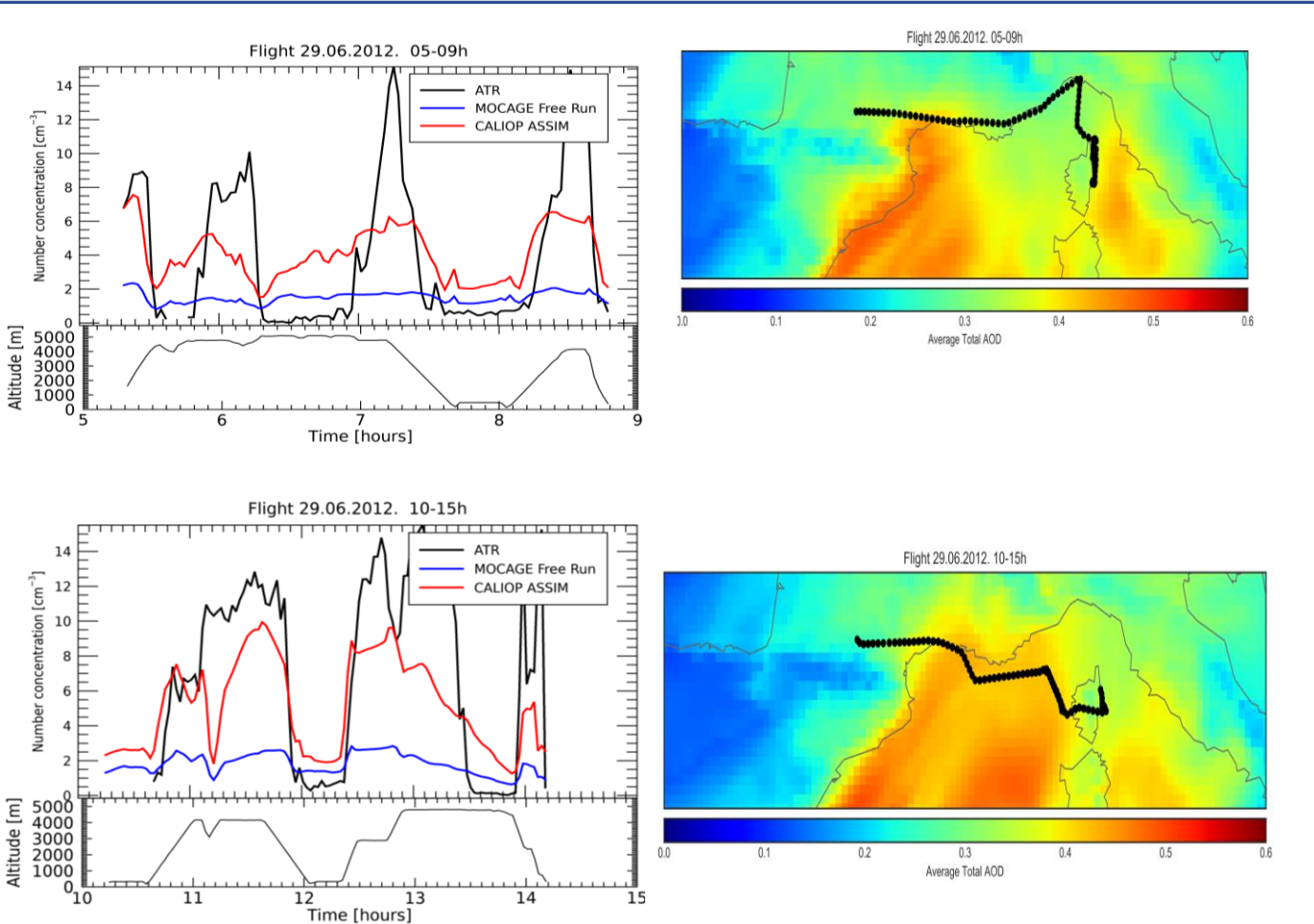
El Amraoui et al., 2020

Summary
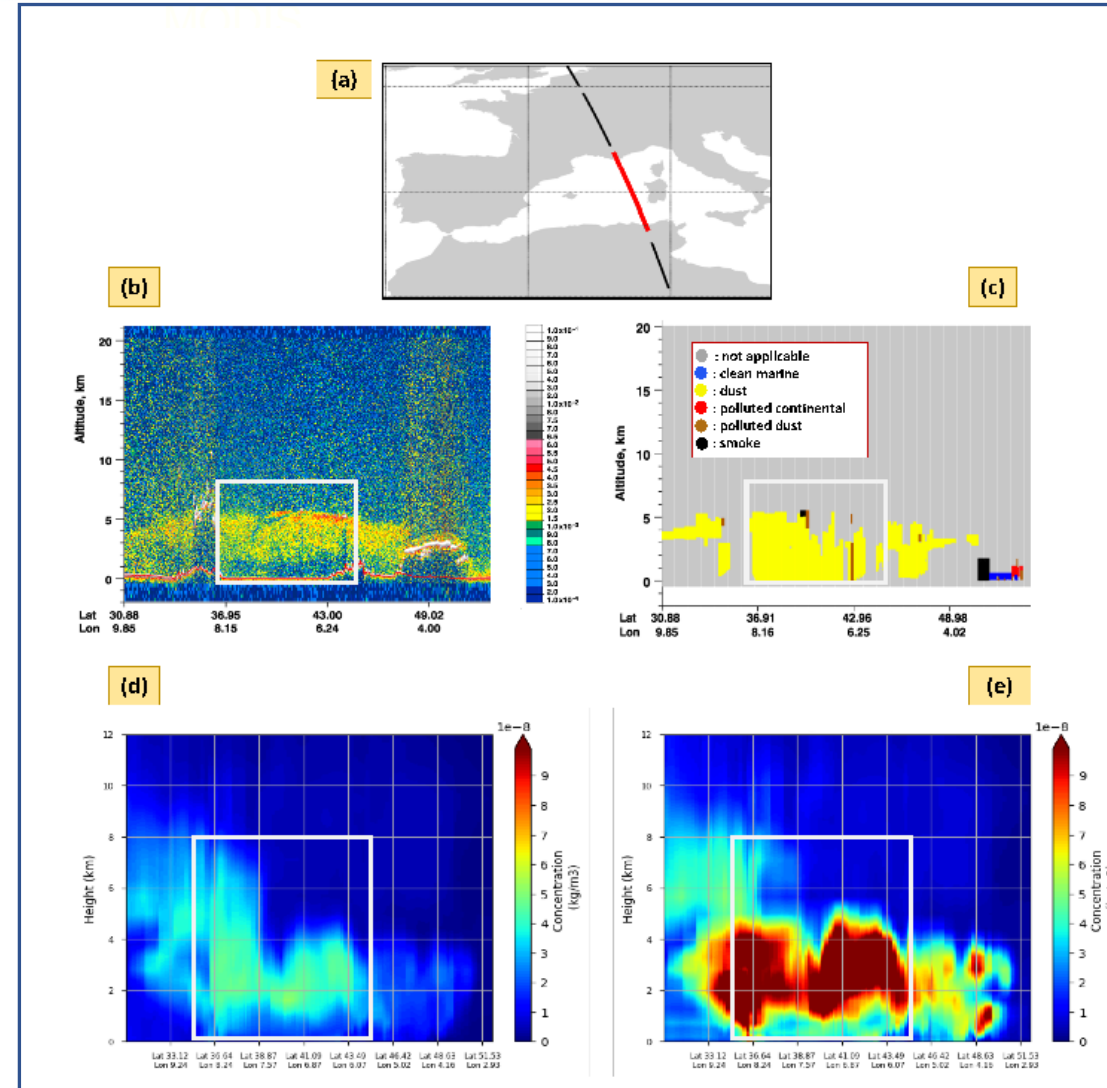
The modelling and assimilation activities during the EarthCare CAL/VAL will have as objectives :

o Assessment of the vertical structure of EarthCare products (compared to modelling fields & other observations)

o How the EarthCare products can constrain the models at global scale via data assimilation ➔ compared to independent observations performed during the CAL/VAL period

o Evaluation of the added-value of EarthCare observations within a Global Observation System using data assimilation (taking into account other observations)