ESA satellite Cal/Val activities platform prototype: DIVA (Demonstration of an Integrated approach for the Validation and exploitation of Atmospheric missions)

David Fuertes(1), Doina Nicolae(2), Oleg Dubovik(3), Benjamin Torres(3), Anton Lopatin(1) , Ioannis Binietoglou(2), Livio Belegante(2), Dragos Ene(2), Alexander Cede(4), Axel Kreuter(4), Michael Aspetsberger(5), Verena Lanzinger(5), Marcos Herreras-Giralda(1), Milagros Herrera(3), Jonas von Bismarck (6)

(1) GRASP SAS, Lille, France
(2) National Institute of R&D for Optoelectronics, Ilfov, Romania,
(3) Laboratoire d'Optique Atmospherique, CNRS/University of Lille, Lille, France
(4) LuftBlick, Innsbruck, Austria
(5) Catalysts GmbH, Vienna, Austria
(6) European Space Agency (ESA/ESRIN), Frascati, Italy

Motivation

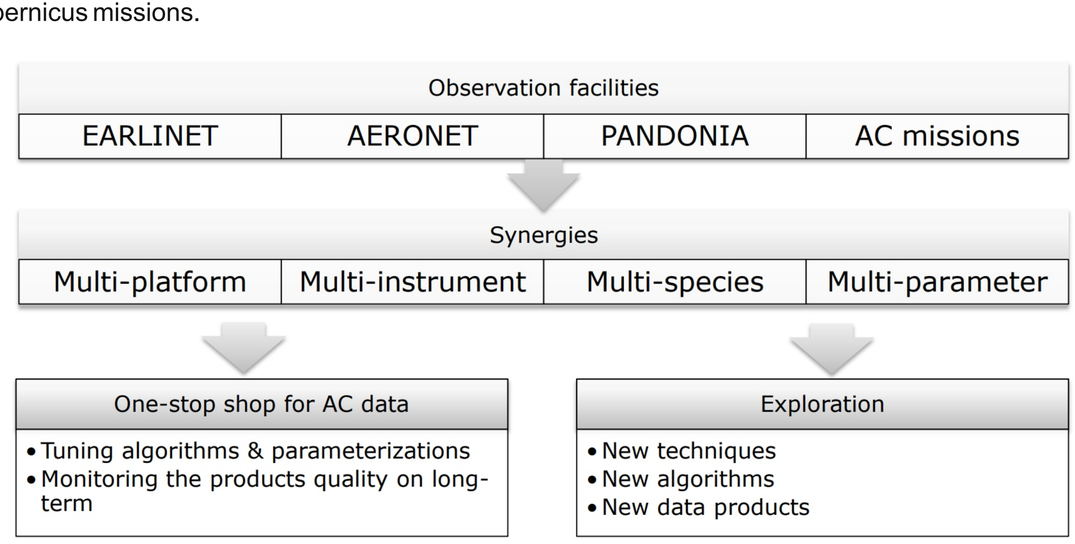
Earth observation has a key role to understand the climate, which has an impact in human health and activities. Satellite measurements can help us to improve our knowledge of the climate, but its treatment is difficult due to the amount of data, complexity of the instruments and complexity of the measurements itself. Therefore, a validation of the satellite products is fundamental to ensure its quality.

Different ground-based networks (e.g. in Europe AERONET, EARLINET, PANDONIA, etc.) are collecting long-term records of atmospheric information for, among other goals, satellite validation. These networks are facing several challenges like harmonization of the protocols, data handling, and data distribution. Initiatives to join and homogenize networks are on-going, like ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure). However, there is still a lack of tools that allows the users to manipulate in a synergistic way all data together. The goal of this project is to create an advance database of ground reference products for ESA calibration/validation activities.

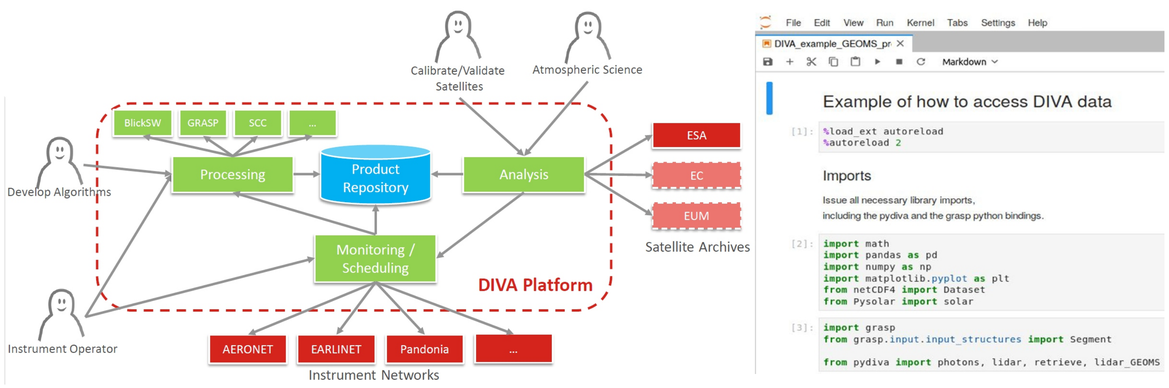
Objective

DIVA is setting-up of an online pilot hub to:
- collect, homogenize, and archive ground-based observational data;
- give scientist access and processing power to exploit data in a synergetic way;
- allow quick experimentation, algorithm development, and collaboration;

Using this platform scientist can efficiently produce tailored-made dataset for the validation of ESA and Copernicus missions.



Arquitecture and python interface



A Python API has been developed for GRASP which allows direct access to the retrieval code from a Jupyter Notebook. The interface allows GRASP input preparation, configuration, execution of the inversion code and handling of the results. The data in the platform (input and output) is standarized to GEOMS format

Building on existing capacities

DIVA is linking with ACTRIS and builds on it:
- Support for AC missions (e.g. GEOMS format)
- Working environment for experiments (e.g. Python coding, Notebook)

Challenges

Data
- Standardization
- Quality control
- Availability

Algorithms
- Synergy
- Flexibility
- Upgradeability

Requirements

- Near-real time delivery of raw data (level 0)
- Standard Operation Procedures
- In-house check-up tools
- Near-real time processing of data (level 1, level 2)
- Automatic processing chain / Automatic connection to existing chains
- Synergistic data products (level 3)
- GRASP
- Storage, visualization, open and easy access
- DIVA data format: complete, user-friendly
- Definition of variables
- Visualization tools
- Working environment

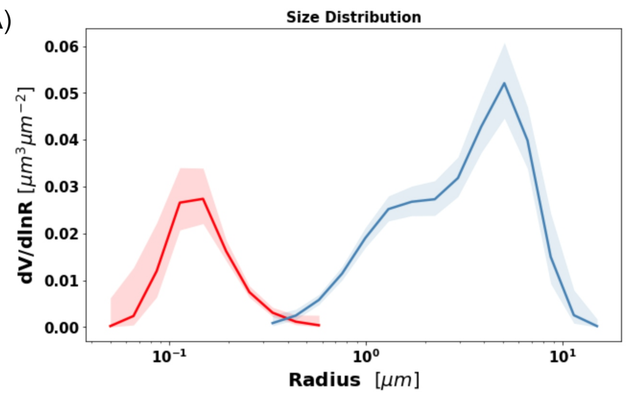
List of sites

Station name	Coordi-nates	Facilities	Lidar	Photometer	Pandora	GRASP
Bucharest	44.35N 26.03E 93m	Aerosol, ozone, and water vapour lidars, sun/lunar photometer, Pandora-2S, microwave radiometer, optical laboratory	x	x	x	x
Lille	50.61N 3.14E 60m	Aerosol and water vapor LiDARs, photometers (sun/sky/lunar/polarization, AERONET), UV spectro radiometer (ozone, NDACC), FTIR, calibration site (optical labs), Infrared scanning radiometer, aerosol in situ optical measurements, particle counter, aerosols sample for chemical analysis, Solar and Infrared radiative fluxes	x	x		x
Innsbruck	47°N 11°E 616m	Pandora, double-monochromator scanning spectrometer with polarization capability, photometers, optical laboratory		x	x	
Izaña	28°N 16°W 2360m	Pandora, radio- & ozone-sondes, Brewer triad, FTIR, photometers, optical laboratory		x	x	
Carpentras	44.08N 5.06E 100m	AERONET sun calibration site (sun/sky/lunar/polarization), solar and infrared radiative fluxes.		x		
Dakar	14.39N -16.96E 12m	Aerosol LiDAR, photometers (sun/sky/lunar/polarization, AERONET), FTIR (temporary), Infrared Scanning Radiometer, aerosol in situ optical measurements, TEOM, Solar and Infrared radiative fluxes	x	x		x
Rome	42°N 12.52°E 75m	Pandora, Sun photometers, Spectrophotometer, Radiometer, Lidar, Sodar, meteorological sensors	x	x	x	x

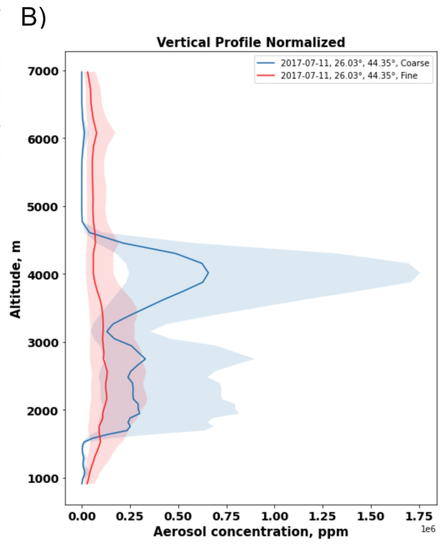
GRASP synergistic results

GRASP (Generalized Retrieval of Atmosphere and Surface Properties) allows to exploit the data in a synergistic way, retrieving advanced properties from the combination of several instruments. Illustrations A and B show the combined processing of sunphtometer and lidar data to produce the vertical distribution of the aerosols and the size distribution (both with error area) for a real case in Bucharest.

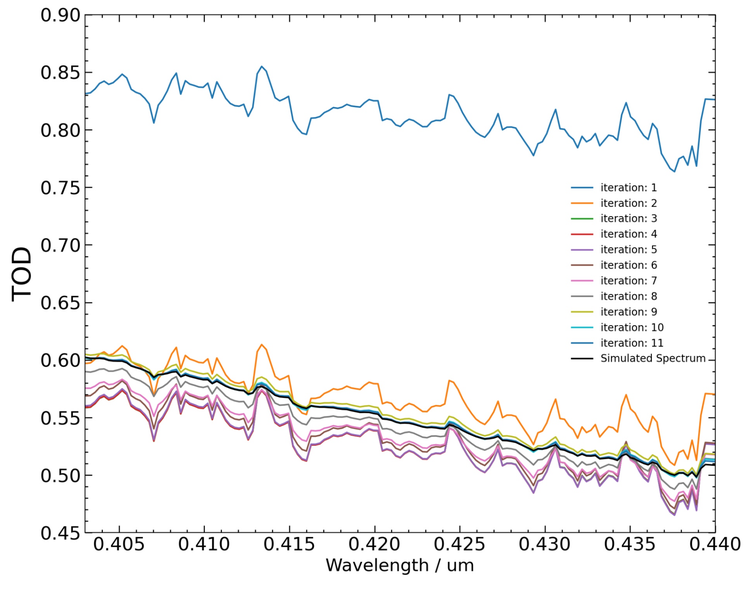
A)



B)



C)



In the synergistic framework of DIVA, new GRASP hyperspectral features have been developed. Now it is possible to account for fine gas absorption line structures with line-by-line or K-distribution techniques. This enhancement enables the possibility to jointly retrieve spectrometers (as the Pandora instrument) with lidar and sun photometers, to obtain gas concentrations in addition to the already well established aerosol products. In the illustration C it can be seen how GRASP, in a synthetic scenario, is able to fit the hyperspectral characteristics of the Pandora TOD measurements in the channels between 400 and 440 nm.

Acknowledgements

This work has received funding from ESAESRI through the contract 4000121773/17/I-EF