Report on Aerosol Session at CEOS AC-VC 13th meeting Paris, France, June 2017

Omar Torres
NASA Goddard Space Flight Center

5th AeroSAT workshop
FMI, Helsinki, Finland
October 2017

What is CEOS?

Committee on **E**arth **O**bservation **S**atellites

-Established in 1984 by recommendation of a panel of experts on Remote Sensing from Space

-Sponsored by G7 Economic Summit of Industrial Nations Working Group on Growth, Technology, and Employment

In five Working Groups, CEOS addresses topics such as

- Calibration/validation
- Data portals
- Capacity building
- Disaster management
- Climate, and common data processing standards shared across a wide range of Earth observation domains
- Common data processing standards

Website: http://ceos.org/

Virtual Constellation (VC)

A ***CEOS VC*** is a coordinated set of space and/or ground segment capabilities from different partners that focuses on ***observing a particular parameter*** or set of parameters of the Earth system.

VC's leverage inter-agency collaboration and partnerships to ***address observational gaps***, ***sustain the routine collection*** of critical observations, and ***minimize duplication***/ overlaps, while maintaining the independence of individual CEOS Agency contributions.

Currently, CEOS Virtual Constellations include:

- Atmospheric Composition (AC-VC)
- Land Surface Imaging (LSI-VC)
- Ocean Color Radiometry (OCR-VC)
- Ocean Surface Topography (OST-VC)
- Ocean Surface Vector Wind (OSVW-VC)
- Precipitation (P-VC)
- Sea Surface Temperature (SST-VC)

Atmospheric Composition VC

Goal: Collection and delivery of data to ***improve monitoring***, ***assessment***, and ***predictive capabilities*** for changes in the ozone layer, air quality, and climate forcing associated with changes in the environment through coordination of existing and future international space assets.

AC-VC Co-Chairs:

Jay Al-Saadi(NASA) j.a.al-saadi@nasa.gov

Ben Veihelmann(ESA) Ben.Veihelmann@esa.int

Recent Meetings

AC-VC-13 : Paris, France | June, 2017

AC-VC-12 : Seoul, Korea | October, 2016

AC-VC-11 : Frascati, Italy |April, 2015

AC-VC-10 : College Park, Maryland, USA | June, 2014

AC-VC-9 : Darmstadt, Germany | April, 2013

AC-VC-8 : Columbia, Maryland, USA |April, 2012

Adding Aerosols to AC-VC AQ topics of interest

At the 12th AC-VC meeting in South Korea, ***the addition of aerosols in the context of their AQ importance*** was suggested.

Because none of existing focus groups on aerosol research (AEROCOM, AEROSAT, ICAP) deal explicitly with aerosol's AQ aspects, ***it was suggested that AC-VC could try to get that effort started in close cooperation with AEROSAT***.

GOALS:

Satellite instrumentation with aerosol -AQ capabilities
- Dedicated ***aerosol instruments***
- ***Geostationary imagers*** → NRT AQ applications

Address challenge of ***constraining near-surface PM*** concentration from satellite observations

Available data records

Stimulate ***harmonization*** of data sets

Link ***radiometric inter-calibration*** to aerosol

Thus, ***an aerosol session was scheduled for the first time*** as part of the 13th AC-VC meeting in Paris

AC-VC-13 AQ Session 3: Satellite aerosol for AQ

Aerosol: A New Topic in AC-VC	Ben Veihelmann, ESA
GEO-Based Aerosol Sensing and the Potential of Combining TEMPO & ABI	Omar Torres, NASA
Joint Retrieval of Aerosol & Surface Reflectance from SEVIRI	Yves Govaerts
Monitoring Particulate Pollution Using GOCI COMS	Jhoon Kim, Yonsei Univ
Multiangle Imaging Spectroradiometry	Dave Diner, NASA JPL
Polarimetric Multiview Imager (POLDER/3MI/DPC)	Oleg Dubovik, LOA
Polar Multi-Sensor Aerosol Optical Properties Product	Ruediger Lang, EUMETSAT
Infusing Aerosol Information From Satellite Observations into Air Quality Applications	Amy Huff, Penn State University
Assimilation of Satellite Data for Air Quality Monitoring & Forecasting	Angela Benedetti, ECMWF

Presentations available at

http://ceos.org/meetings/ac-vc-13/

A few highlights CEOS AC-VC Session on Aerosols..

GEO-based Aerosol Sensing: Combining TEMPO and ABI observations

Omar Torres
NASA-GSFC

TEMPO Mission General Description

- **Measurement technique**
  - Imaging grating spectrometer measuring solar backscattered Earth radiance
  - Spectral band & resolution: ***290-490*** + ***540-740 nm*** @ 0.6 nm
- **Spatial Coverage**
  - Mexico City/Yucatan, Cuba to the Canadian oil sands, Atlantic to Pacific
  - Radiance maps of ***Greater North America*** in ***every hour***
- **Spatial resolution**
  - ***2.1 km N/S × 4.7 km E/W*** native pixel resolution (9.8 km^2)
- ***Geostationary*** **orbit**
  - NASA is responsible for host selection, launch arrangements and hosting services
  - 80-115^o W acceptable latitude

Species/Products	Required Precision	Temporal Revisit
0-2 km O_3 (Selected Scenes) Baseline only	10 ppbv	2 hour
Tropospheric O_3	10 ppbv	1 hour
Total O_3	3%	1 hour
Tropospheric NO_2	1.0×10^{15} molecules cm^{-2}	1 hour
Tropospheric H_2CO	1.0×10^{16} molecules cm^{-2}	3 hour
Tropospheric SO_2	1.0×10^{16} molecules cm^{-2}	3 hour
Tropospheric $C_2H_2O_2$	4.0×10^{14} molecules cm^{-2}	3 hour
Aerosol Optical Depth	0.10	1 hour

NOAA Advanced Baseline Imager

ABI channels:

- ***Visible***: 0.47 (1.0 km) , 0.64 μm (***0.5 km***)
- ***Near IR***: 0.86, 1.37, 1.6 μm (***1.0 km***)
- ***SWIR/Thermal IR***: 2.2, 3.9, 6.2, 6.9, 7.3, 8.4, 9.6, 10.3, 11.2,12.3, 13.3 μm (***2.0 km***)

Spatial Coverage:

Full disk: ***4 per hour***; ***CONUS***: ***12 per hour***; ***Mesoscale***: ***30 or 60 sec***

Satellite: ***GOES-16*** (***launched November 19, 2016***)

ABI's much higher spatial resolution measurements allow the application of spatial homogeneity and spectral techniques for cloud masking.

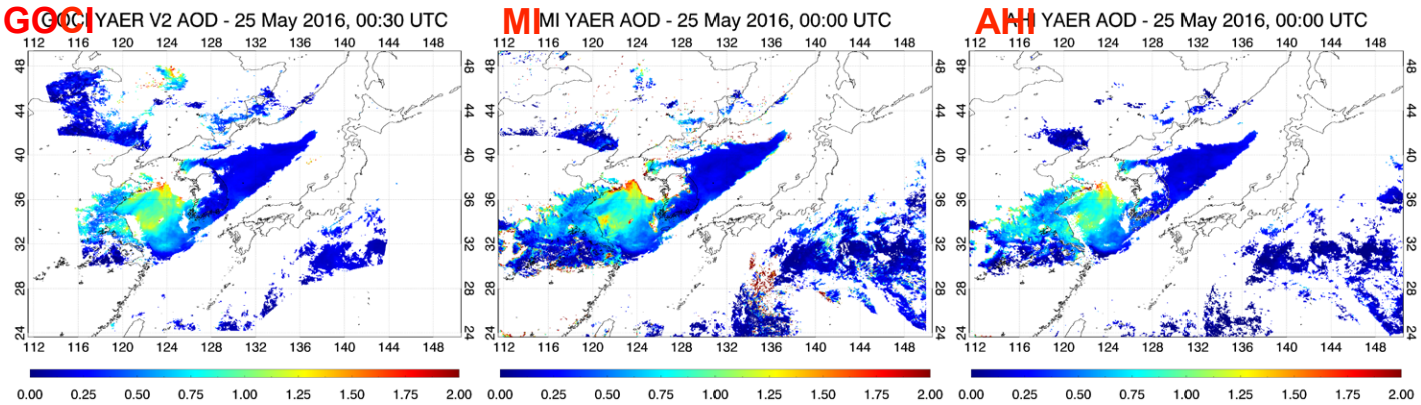
Using TEMPO and ABI observations

Options	AOD Yield*	SCC*	Absorption	AAE/ Z_{AE}*
1. TEMPO alone	Low	High	Yes	No
2. ABI alone	High	Low	No	No
3. TEMPO+ABI cloud mask	Low	Low	Yes	No
4. TEMPO+ABI cld.msk + ABI AOD	High	Low	Yes	Yes

*AOD Yield = retrieval coverage; SCC = pixel cloud contamination; Z_{AE} = aerosol layer height

Geostationary satellites aerosol observation over East Asia

Jhoon Kim
Yonsei University, Seoul, Korea



	GOCI/COMS (KOSC/KIOST, Korea)	MI/COMS (NMSC/KMA, Korea)	AHI/ Himawari-8 (JMA, Japan)
Temporal Resolution	1-hour interval for East Asia (total 8 times in daytime)	15-min interval for Asia 3-hour interval for FD	10-min interval for Full Disk
Channels	8 bands in VIS-NIR (0.5 km)	1 bands in VIS (1 km) 4 bands in IR (4 km)	4 bands in VIS-NIR (0.5/1.0 km) 12 bands in IR (2 km)
Products	AOD, FMF, AE (6 km)	AOD (4km)	AOD, FMF, AE (6 km)
Reference	*M. Choi et al.(AMT 2016)*	*M. Kim et al. (RSE 2014; ACP 2016)*	*H. Lim et al. (KJRS 2016)*

* Datasets readily available for past years for GOCI and MI. AHI dataset is under processing.

Remote sensing of airborne particulate matter using multiangle spectroradiometry and spectropolarimetry

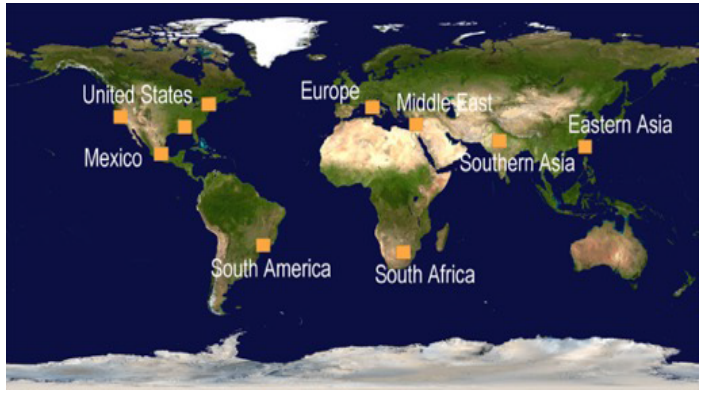
David J. Diner

Jet Propulsion Laboratory, Caltech
and the MISR/MSPI/MAIA Teams

Multi-Angle Imager for Aerosols (MAIA)

- MAIA was selected in March 2016 as part of NASA's Earth Venture Instrument program.
- The satellite instrument will target major urban areas to assess the impacts of different types of airborne PM on human health.
- TBD satellite and launch into sun-synchronous orbit, 600-850 km altitude, ~2021

birth outcomes (restricted intrauterine growth, preterm delivery, low birth weight)
acute illness events (e.g., asthma flare-ups), premature deaths
chronic cardiovascular and respiratory disease



- Candidate Primary Target Areas
- Other target areas to be observed for air quality and climate science

Liu and Diner (2017)

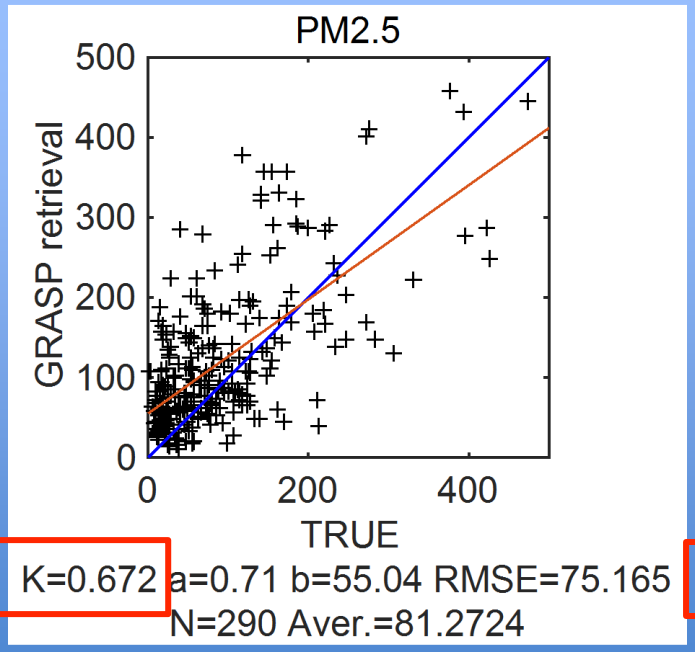
GRASP aerosol from POLDER, 3MI, etc. polarimeters: towards estimation PM2.5

Oleg Dubovik[1], Anton Lopatin[1], Pavel Litvinov[2], Yevgeny Derimian[1], Tatyana Lapyonok[1], Anton Lopatin[1], David Fuertes[2], Fabrice Ducos[1], Xin Huang[1], Benjamin Torres[2], Michael Aspsetsberger[3] and Christian Federspiel[3]

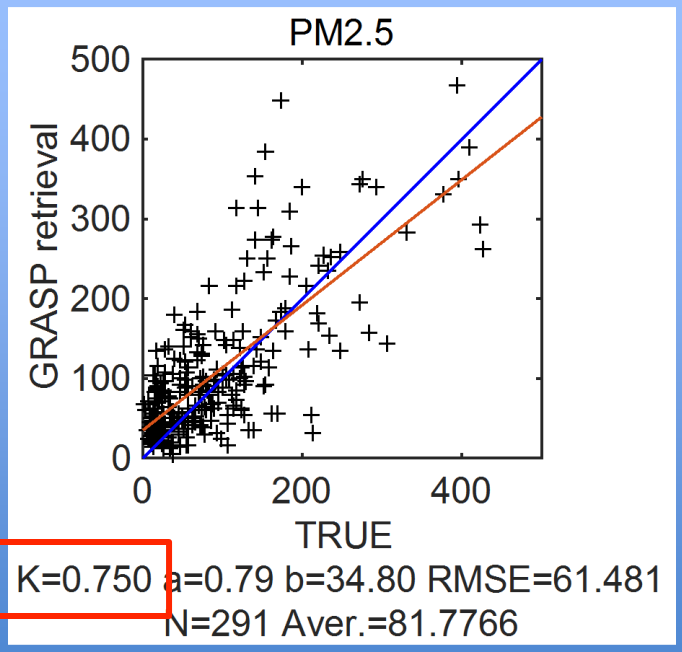
1 - Laboratoire d'Optique Atmosphérique, CNRS – Université Lille 1, France; 2 - GRASP-SAS, LOA, Université Lille 1, Villeneuve d'Ascq, France

3 - Catalysts GmbH, High Performance Computing, Linz, Austria

Sensitivity to particle drying



Fixed particle density, wet



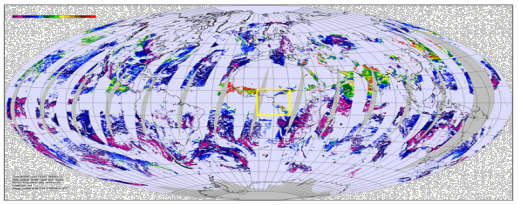
Varied particle density, wet

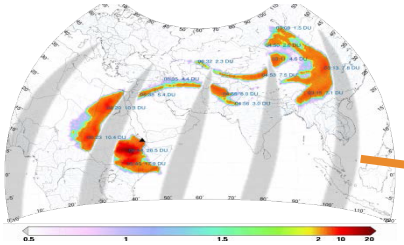
Assimilation of satellite data for air quality monitoring and forecasting

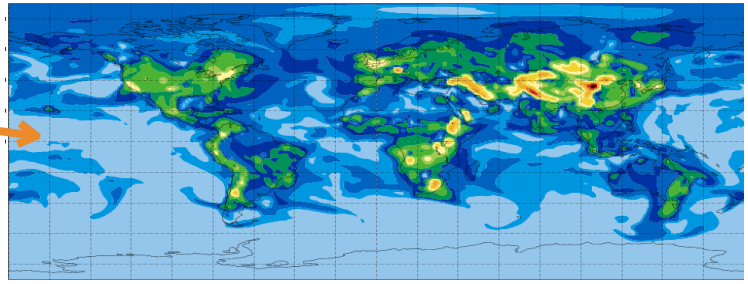
Angela Benedetti

FROM EARTH OBSERVATIONS TO AIR QUALITY PRODUCTS

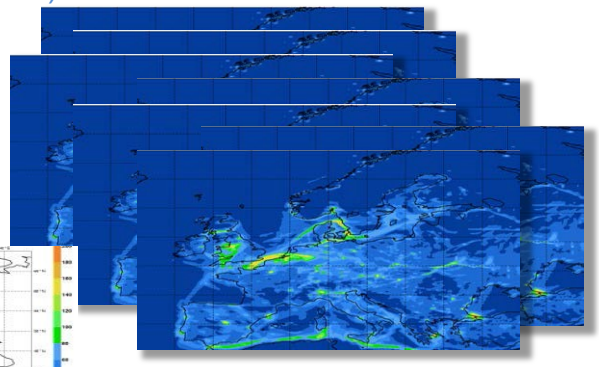
Over 70 EO instruments are assimilated in the global system



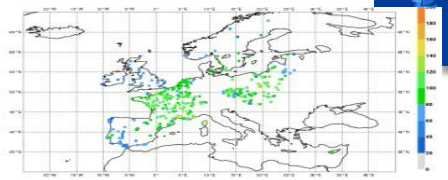


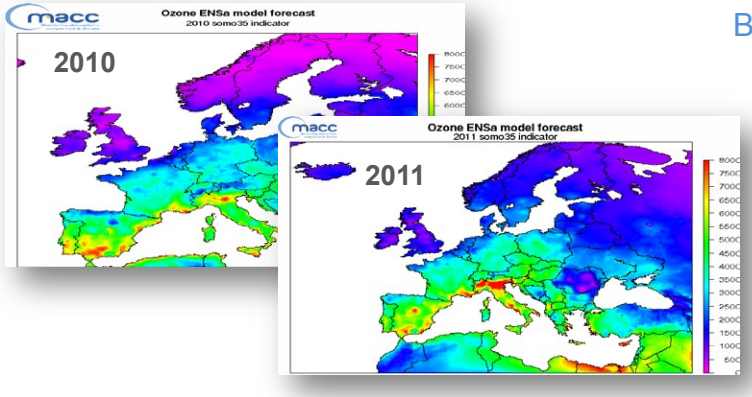


Boundary conditions feed an ensemble of high-resolution European AQ systems (in order to assess uncertainties)



More data are assimilated (particularly *in situ*) and used for extensive validation





Policy-relevant products (here health indicator for ozone) are delivered. They are “maps with no gaps”, which observations alone don’t provide, but are essential to assess impacts.

14th CEOS AC-VC Meeting
May 1-4, 2018
College Park, MD, USA