PMAp
Aerosol Optical Properties operational retrieval at global scale

A. Cacciari, R. Lang, A. Holdak, A. Kokhanovsky, M. Grzegorski, R. Munro, C. Retscher, R. Lindstrot, G. Poli, R. Huckle, N. Hao, S. Gimeno Garcia

The Polar Multi-sensor Aerosol Product
Operational near-real time AOD from EPS/Metop

OUTLINE

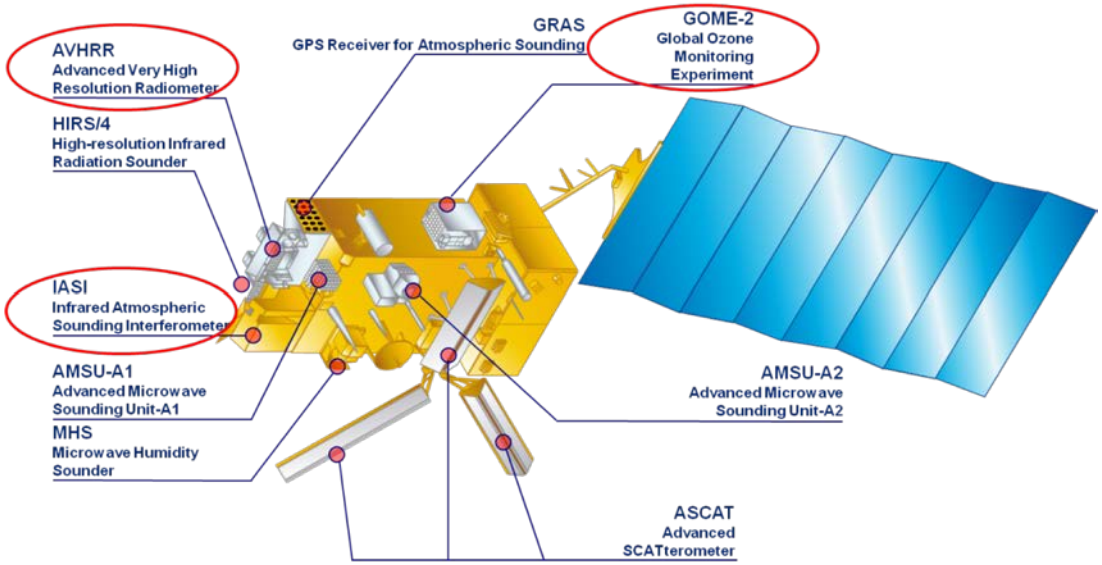
- Sensors' characteristics and PMAp Aerosol product
- PMAp retrieval algorithm: current operational version 2.1
- Towards new release: version 2.2

  Impact of the new features
  - IASI IR spectral information for improved ash and dust detection
  - degradation correction for PMD radiances

The Polar Multi-sensor Aerosol Product
Operational near-real time AOD from EPS/Metop

PMAp: Polar Multi-sensor Aerosol product from GOME-2, AVHRR and IASI on Metop

- AOD @550nm over land & water aerosol type classification
- at GOME-2 PMD spatial resolution
10x40 km^2 Metop-B; 5x40 km^2 Metop-A



- Retrieval over water
fully operational product since October 2014

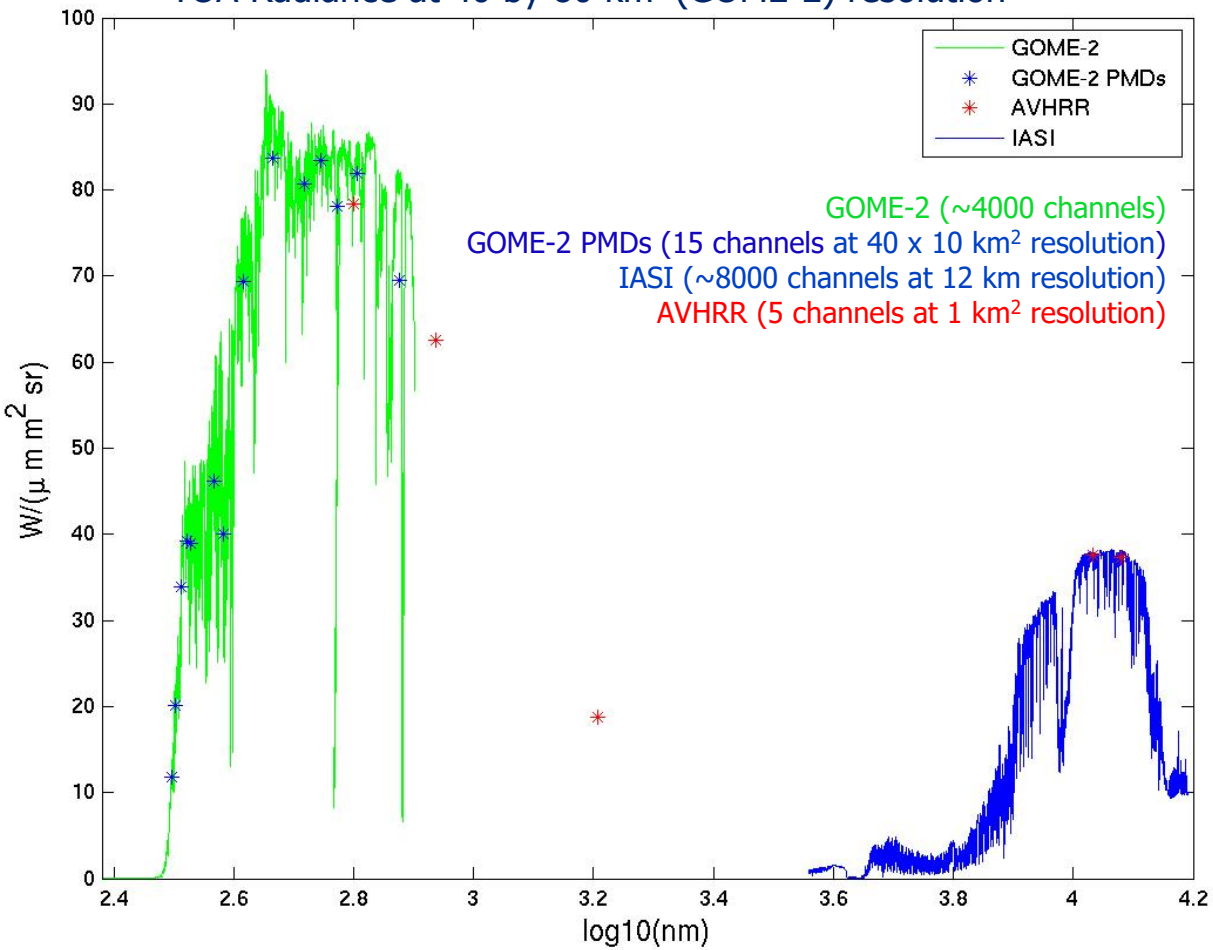
- Retrieval over water & land **PMAp version 2**
fully operational product since February 2017

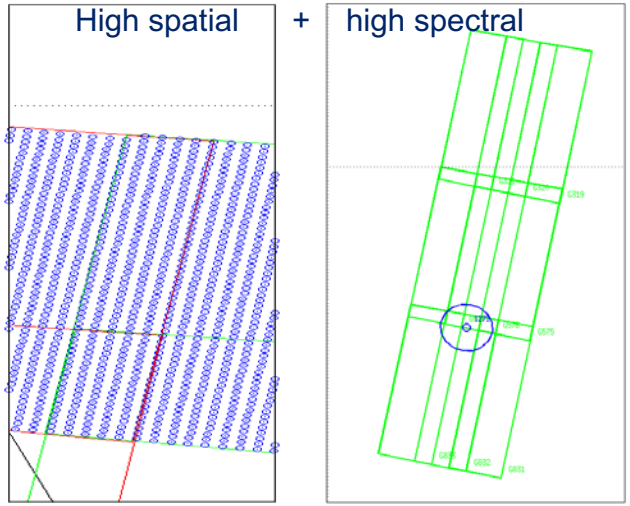
EUMETSAT

PMAp: creating a hyper-instrument

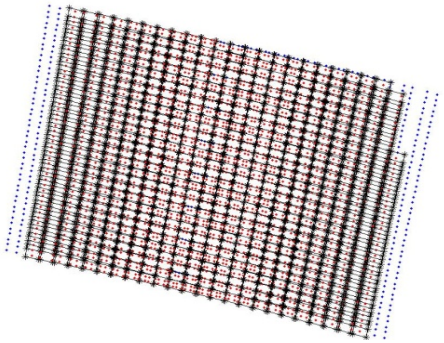
Merging spectral and spatial information from GOME-2, AVHRR and IASI

TOA Radiance at 40 by 80 km^2 (GOME-2) resolution





co-location



GOME-2 3-min sample footprint
with co-located IASI states

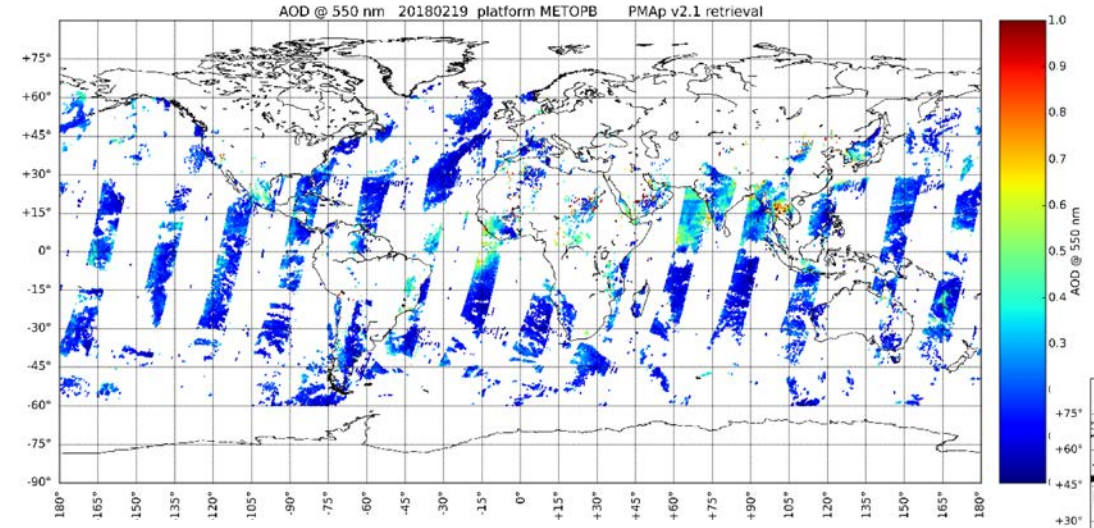
➡ Combining hyper-spectral with hyper-spatial information in a new hyper-instrument

EUMETSAT

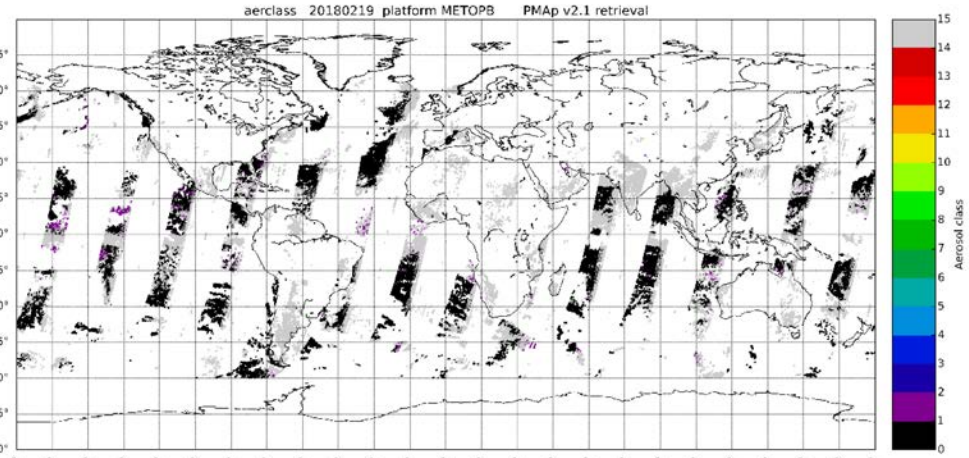
The Polar Multi-sensor Aerosol Product

Operational near-real time AOD from EPS/Metop

19 02 2018 MetopB



AOD @ 550 nm



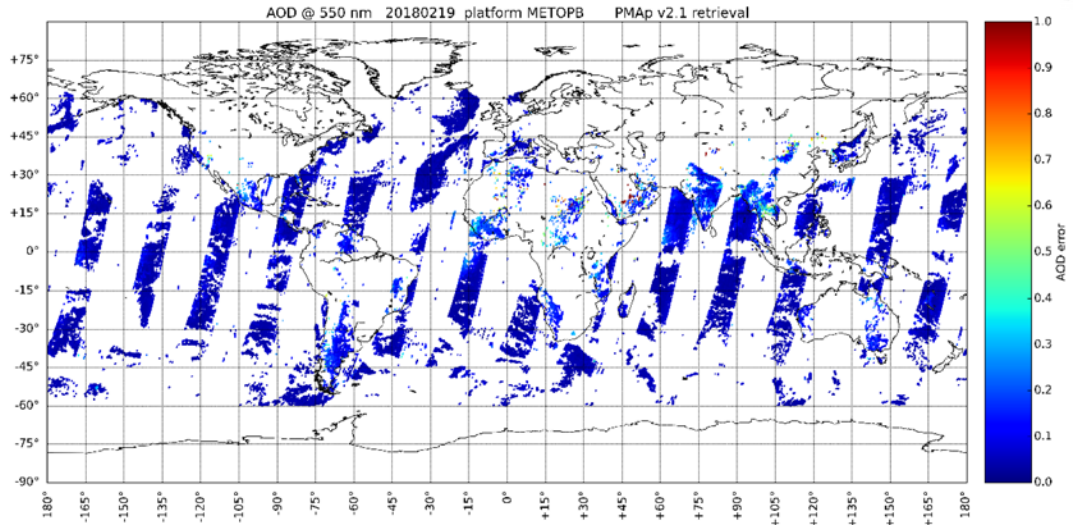
Aerosol Class

fine mode

coarse mode

volcanic ash / thick dust

volcanic ash with SO_2



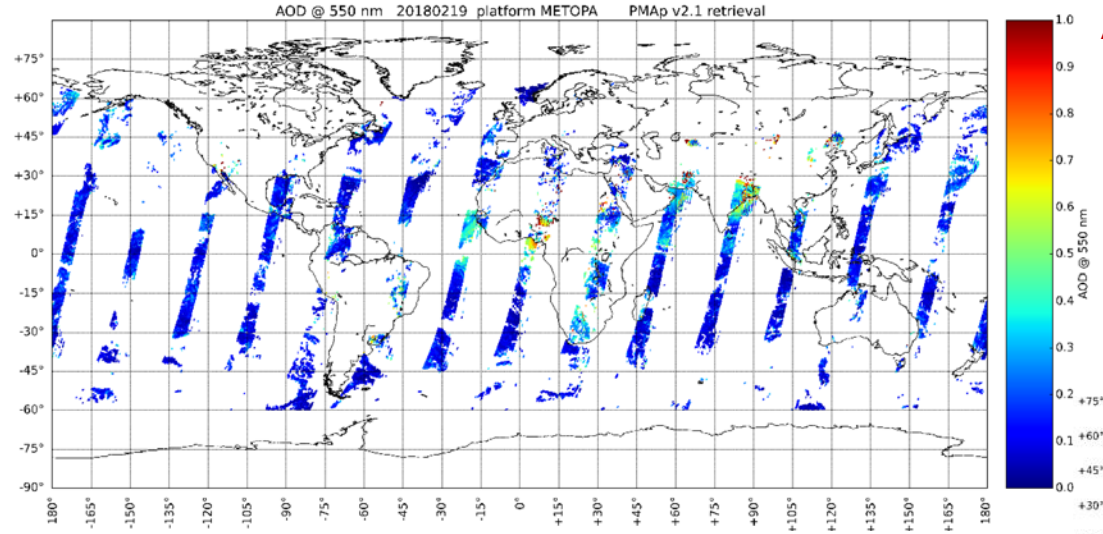
AOD Error

EUMETSAT

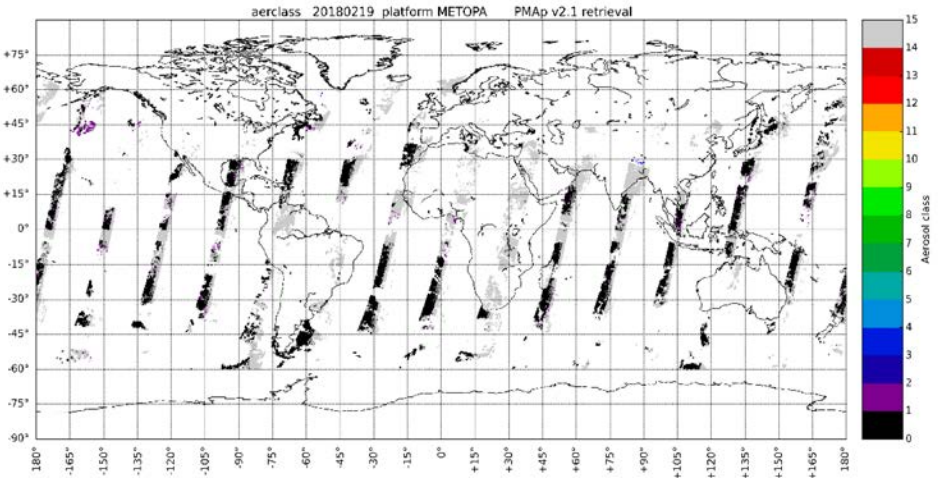
The Polar Multi-sensor Aerosol Product

Operational near-real time AOD from EPS/Metop

19 02 2018 MetopA

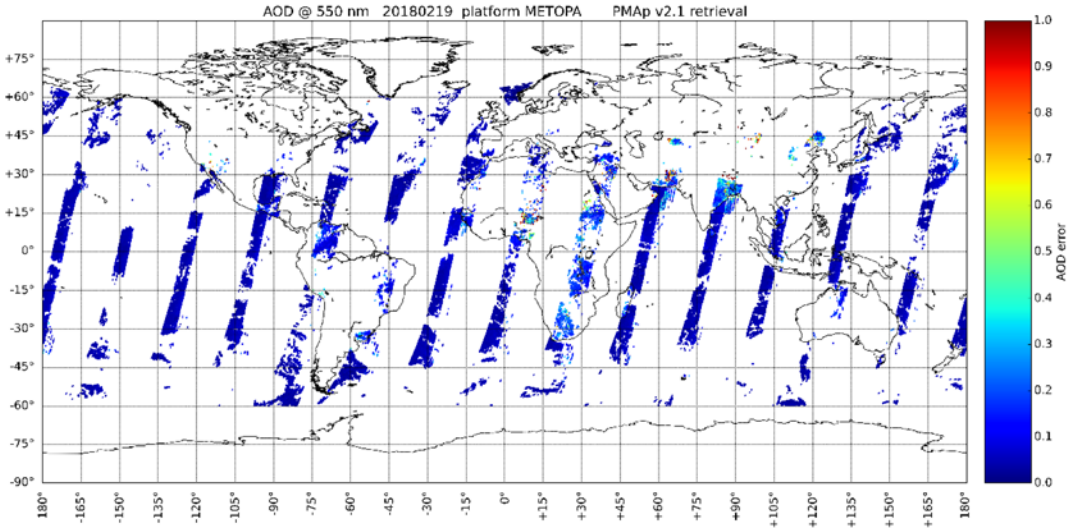


AOD @ 550 nm



Aerosol Class

- fine mode
- coarse mode
- volcanic ash / thick dust
- volcanic ash with SO_2



AOD Error

EUMETSAT

PMAp AOP retrieval algorithm design

v 2.1 current operational release

Cloud / Aerosol Discrimination

- Volcanic Ash Detection

10 set of thresholds tests AVHRR + IASI BTDs tests → Ash presence

- Clouds' Detection & Correction

clouds detection and cloud fraction calculation (CF)

cloud free PMD Reflectance .OR. PMD Reflectance Correction (for CF < 0.65; partly cloudy pixels)

- Preliminary Aerosol Type

if Ash presence → aerosol type = ash

VIS/NIR test for Coarse/Fine mode determination

} list of preselected aerosol types

Retrieve AODs

- AODs retrieval for all aerosol models in the LUT

over water PMD 12 (617.867 - 661.893 nm)

over land PMD 8 (399.581 - 428.585 nm) or PMD 7 (380.186 - 383.753 nm)

best fit selection

- Microphysics fit : $\chi 2$ minimization of the AODs

if cloud free: list of preselected aerosol types

if partly cloud: all aerosol models

} → best {AOD, aerosol type}

- Estimation of error on AOD

PMAp AOP retrieval algorithm design

towards v2.2 – next operational release

Cloud / Aerosol Discrimination

- Volcanic Ash Detection

10 set of thresholds tests AVHRR + IASI BTDs tests → Ash presence

- Desert Dust Detection

IASI dust index → Dust presence

- Clouds' Detection & Correction

clouds detection and cloud fraction calculation (CF)

cloud free PMD Reflectance .OR. PMD Reflectance Correction (for CF < 0.65; partly cloudy pixels)

- Preliminary Aerosol Type

if Ash presence → aerosol type = ash

if Dust presence → aerosol type = dust

VIS/NIR test for Coarse/Fine mode determination

} list of preselected aerosol types

Retrieve AODs

- AODs retrieval for all aerosol models in the LUT

over water PMD 12 (617.867 - 661.893 nm)

over land PMD 8 (399.581 - 428.585 nm) or PMD 7 (380.186 - 383.753 nm)

best fit selection

- Microphysics fit : $\chi 2$ minimization of the AODs

if cloud free: list of preselected aerosol types

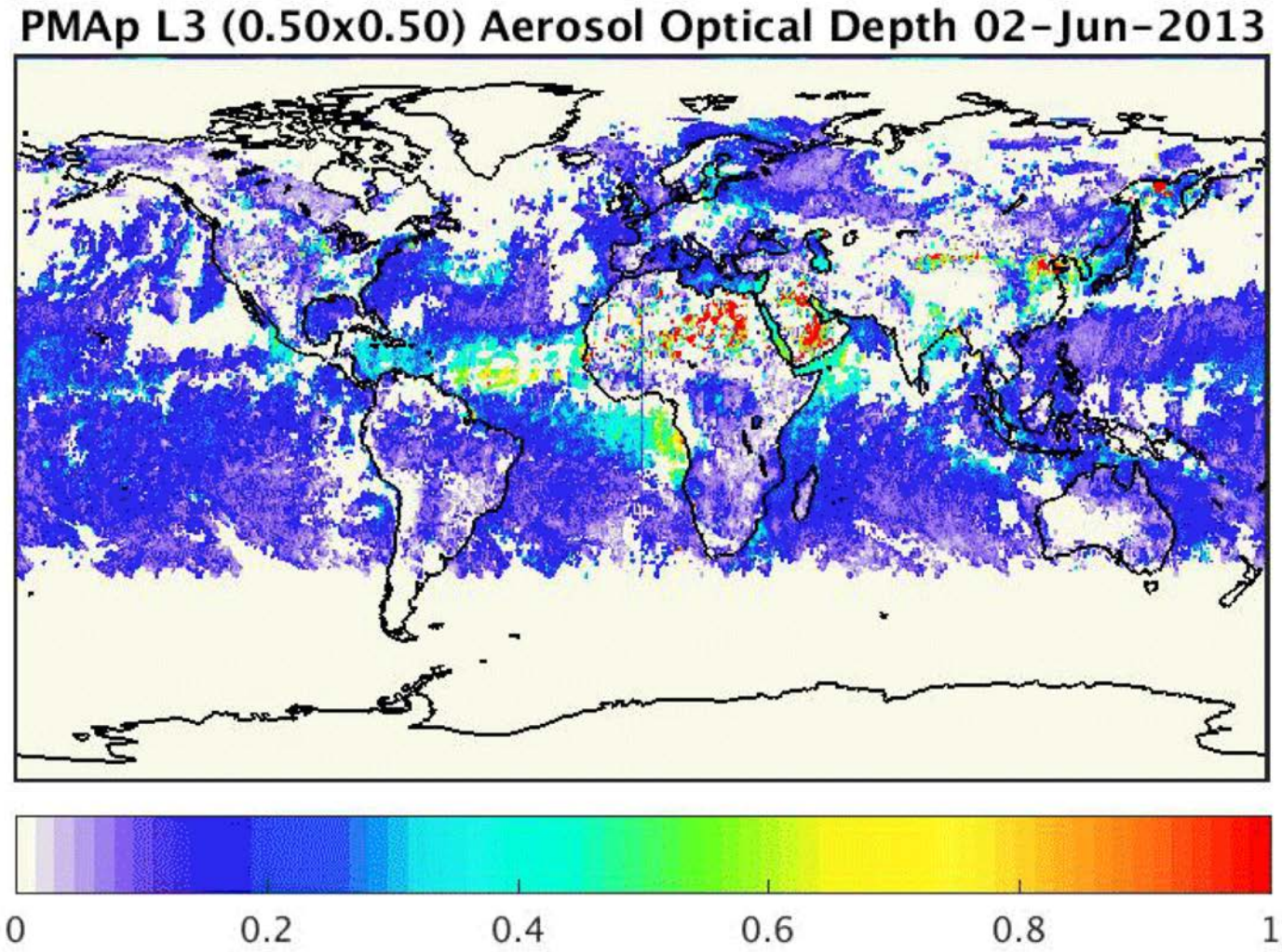
if partly cloud: all aerosol models

} → best {AOD, aerosol type}

- Estimation of error on AOD

PMAp AOD results

Version 2 L3 gridded results – Summer 2013 – Metop-A&B



PMAp AOP retrieval
desert dust detection

Unified approach to detect aerosol type exploiting the IR spectral range

Distance approach

Atmos. Chem. Phys., 13, 2195–2221, 2013
www.atmos-chem-phys.net/13/2195/2013/
doi:10.5194/acp-13-2195-2013

Atmospheric Chemistry and Physics
Open Access

A unified approach to infrared aerosol remote sensing and type specification

L. Clarisse[1], P.-F. Coheur[1], F. Prata[2], J. Hadji-Lazaro[3], D. Hurtmans[1], and C. Clerbaux[3,1]

Set of 'polluted' spectra
ash, dust, same aerosol type

μ_p mean spectra
by RTM simulation $\mu_p = K + \mu_c$
or measured

Set of clear spectra
not affected by aerosol

μ_c mean spectra
S_c clear covariance matrix

$$R_N = \frac{(\mu_p - \mu_c)^T S^{-1}}{\sqrt{(\mu_p - \mu_c)^T S^{-1} (y - \mu_c)}} (y - \mu_c) \geq \text{threshold}$$

Y = measured spectra
G = f (λ, surf_type)
C = bias correction; f (lon,lat)
threshold to be manually tuned

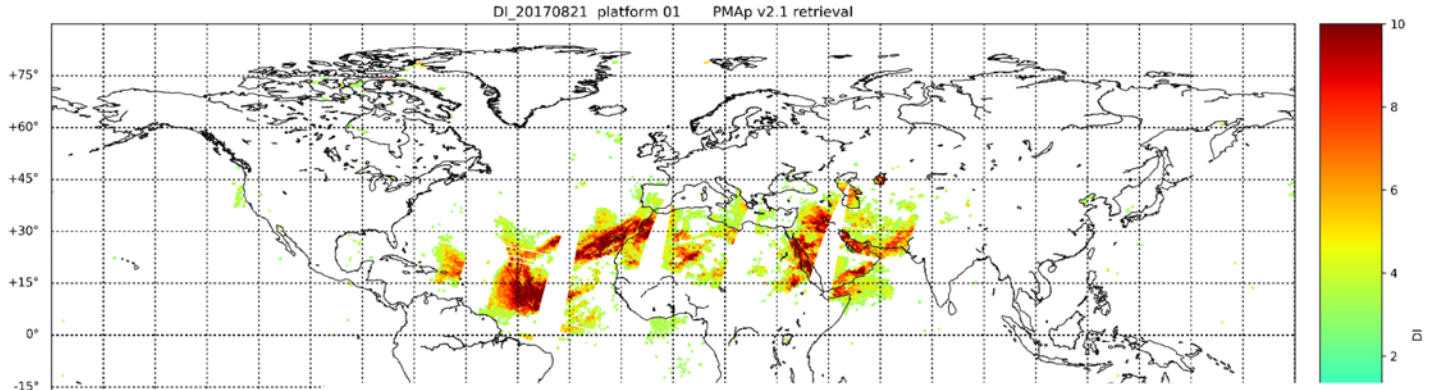
$$R_N = G\ (y - \mu_c) + C \geq \text{threshold}$$

Dust

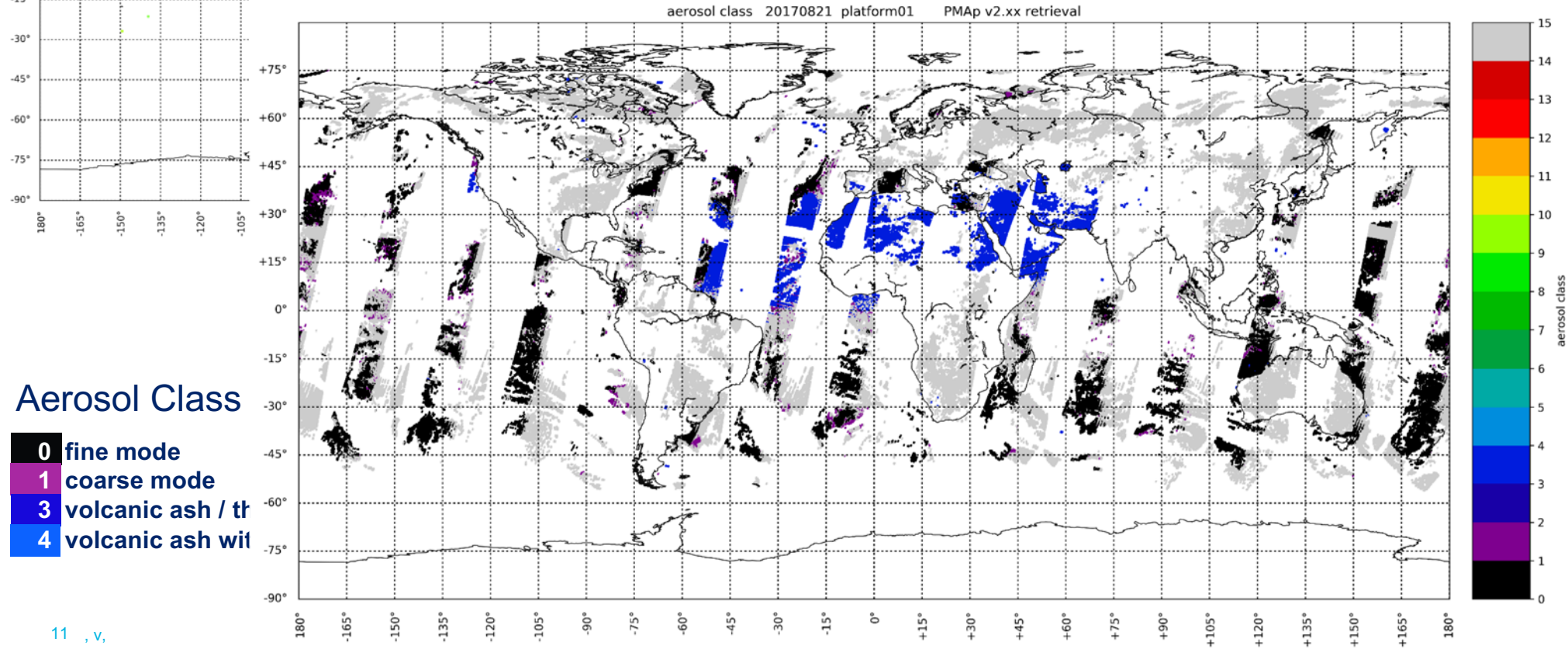
EUMETSAT

PMAp AOP retrieval
desert dust detection

21 08 2017 MetopB



Dust Index

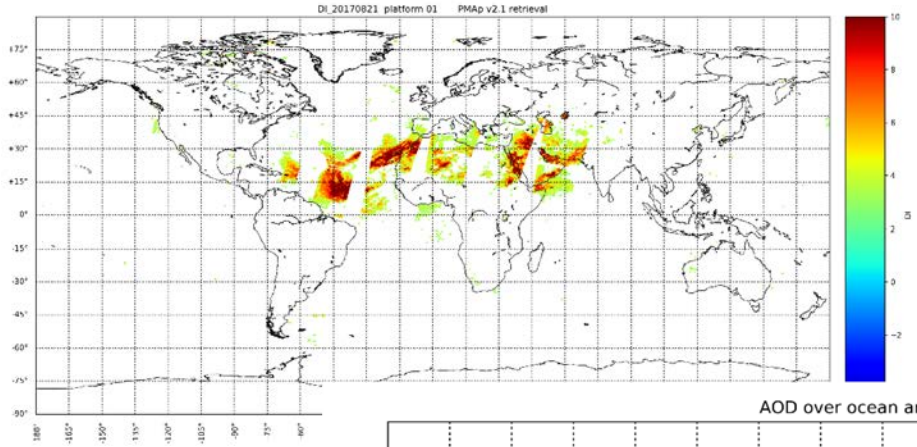


Aerosol Class

0	fine mode
1	coarse mode
3	volcanic ash / th
4	volcanic ash wit

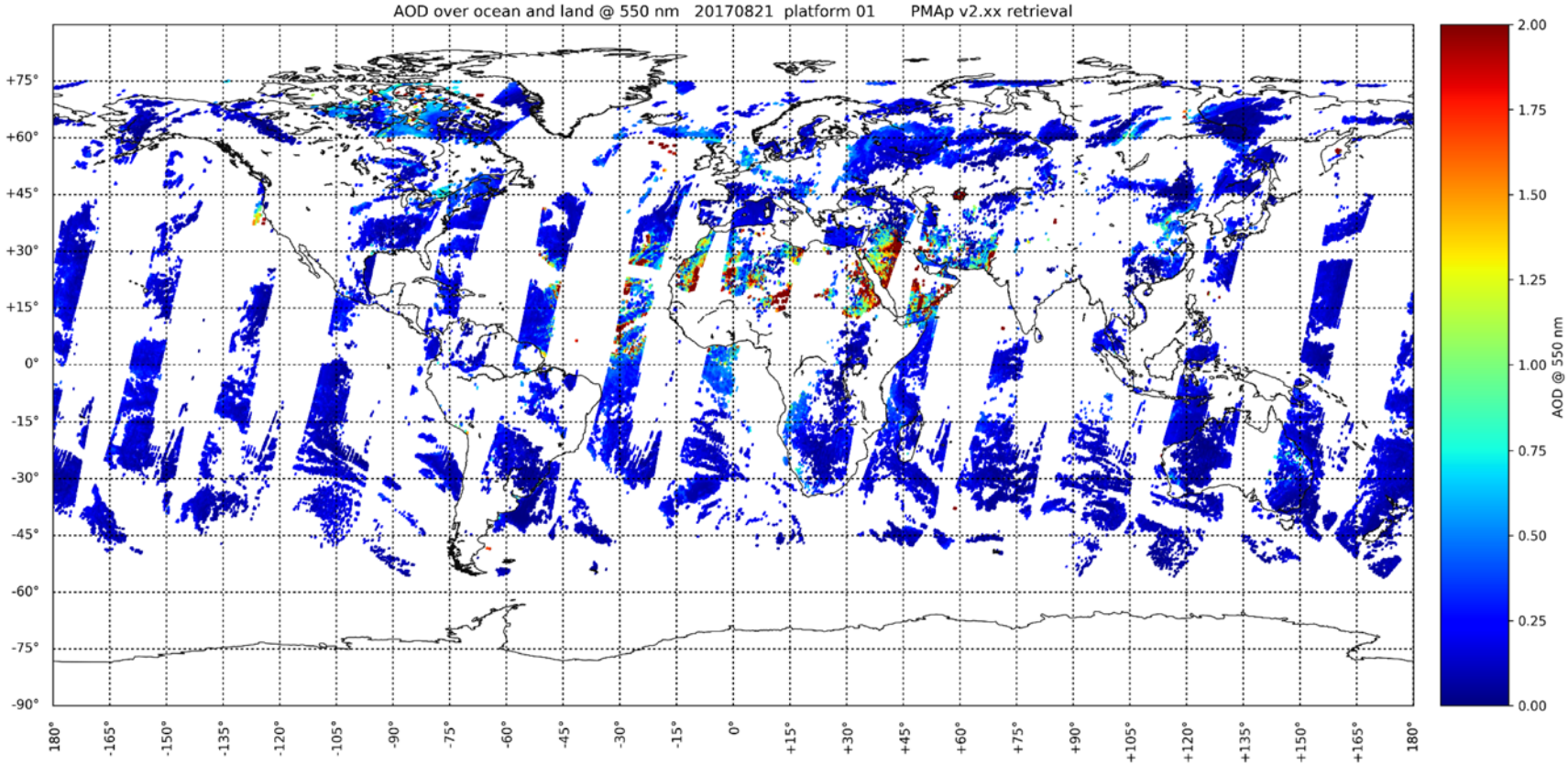
PMAp AOP retrieval
desert dust detection

21 08 2017 MetopB



Dust Index

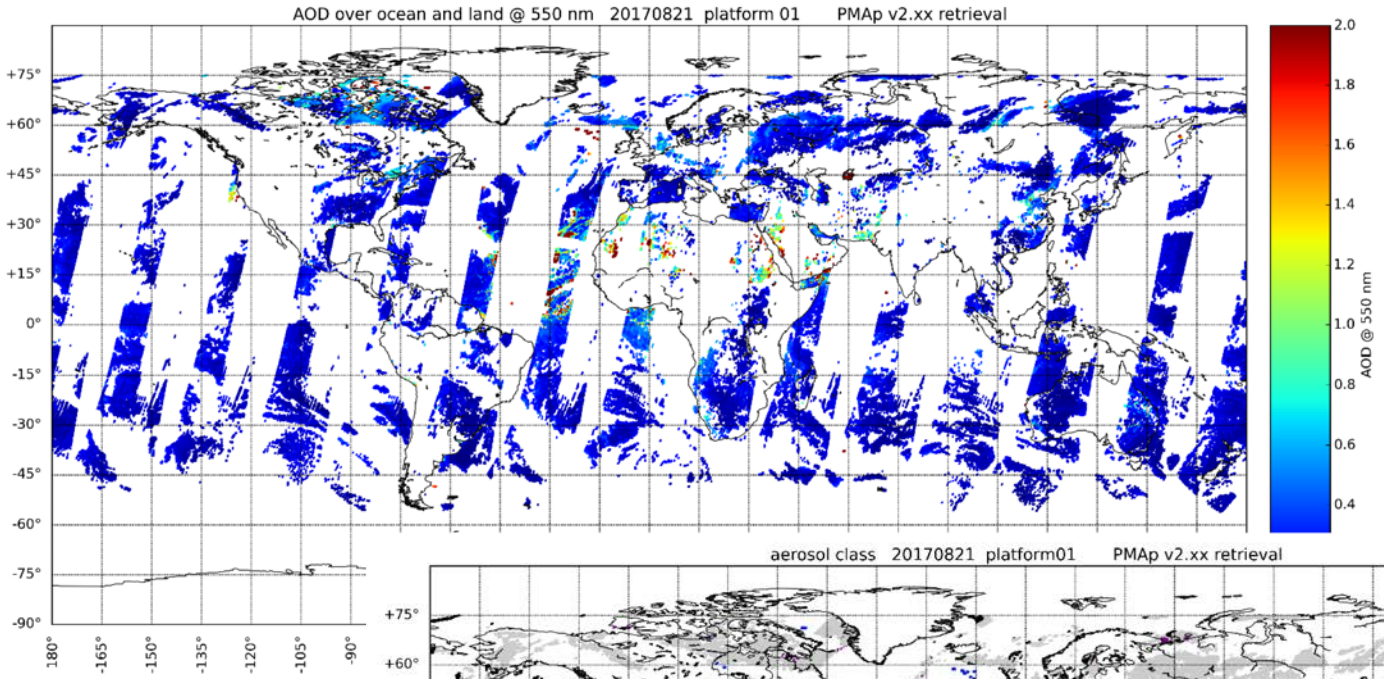
Aerosol Optical Depth @ 550 nm

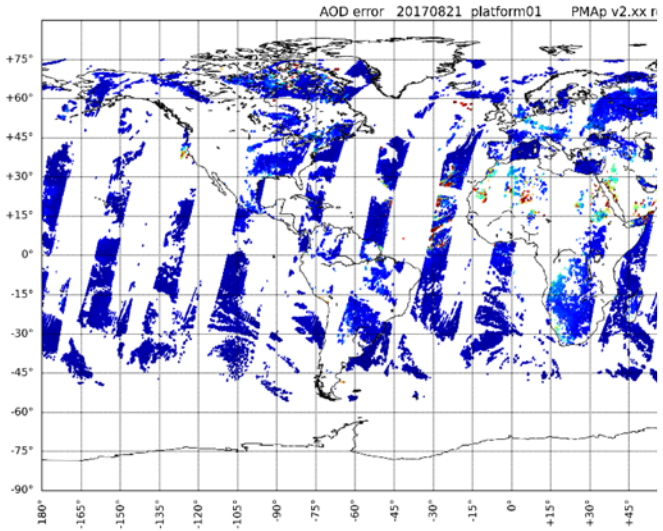


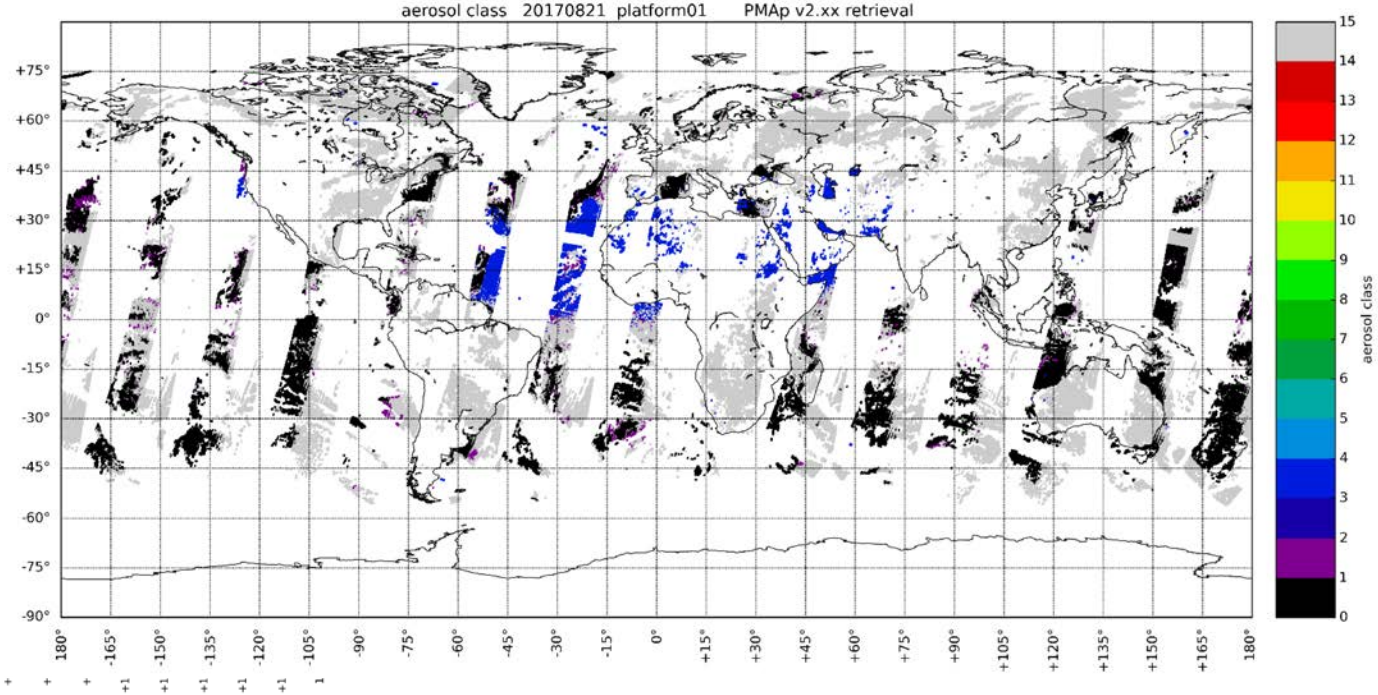
PMAp AOP retrieval

desert dust detection

21 08 2017 MetopB





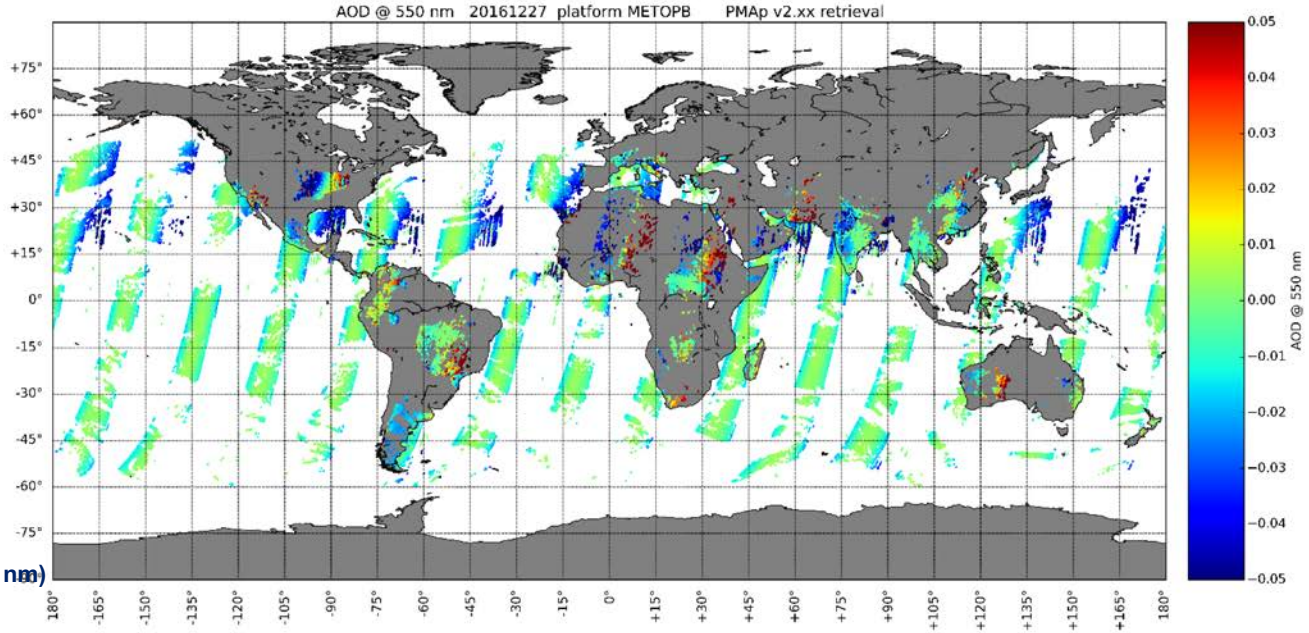


PMAp AOP retrieval

Lev1B → Lev1C : impact on AOD retrieval

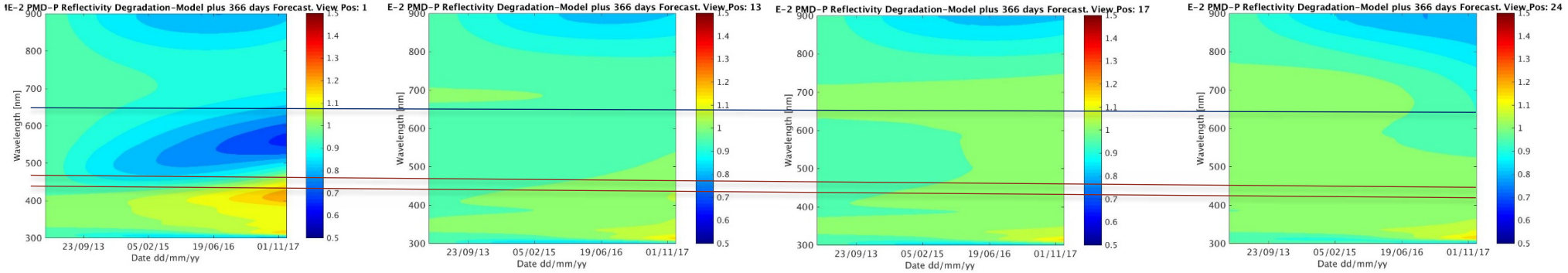
27 12 2016 MetopB

AOD_1B – AOD _1C



over water
PMD 12 (617.867 - 661.893 nm)

over land
PMD 8 (399.581 - 428.585 nm)
PMD 7 (380.186 - 383.753 nm)



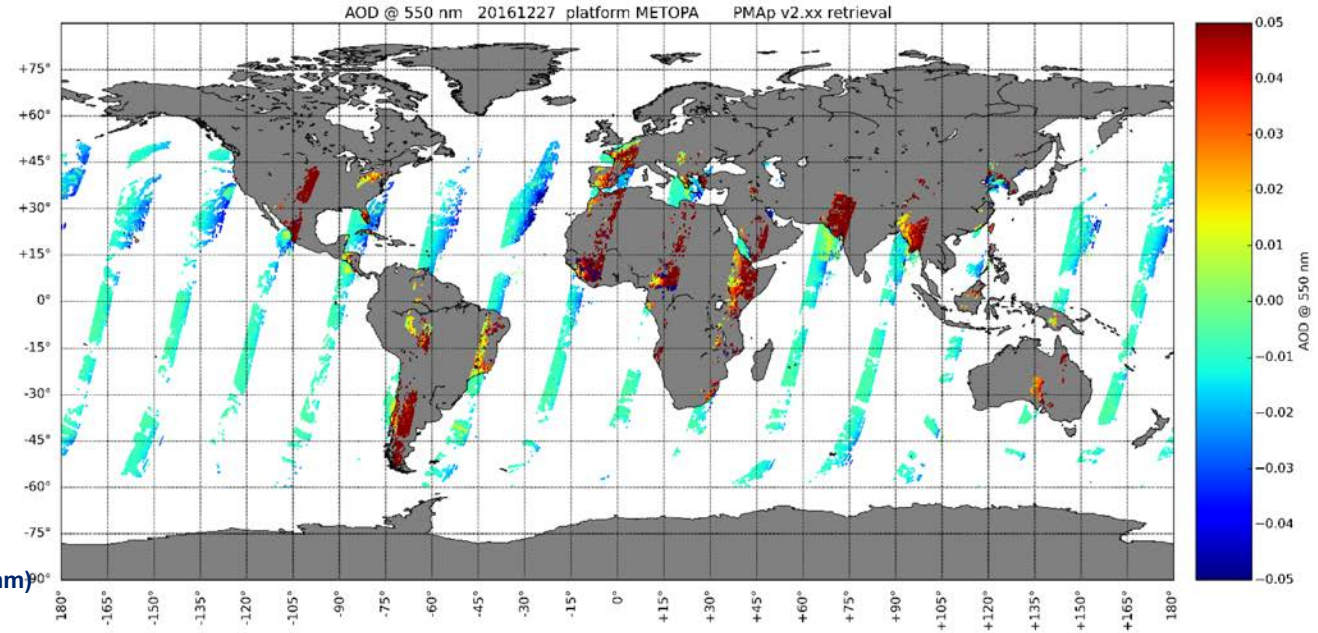
EUMETSAT

PMAp AOP retrieval

Lev1B → Lev1C : impact on AOD retrieval

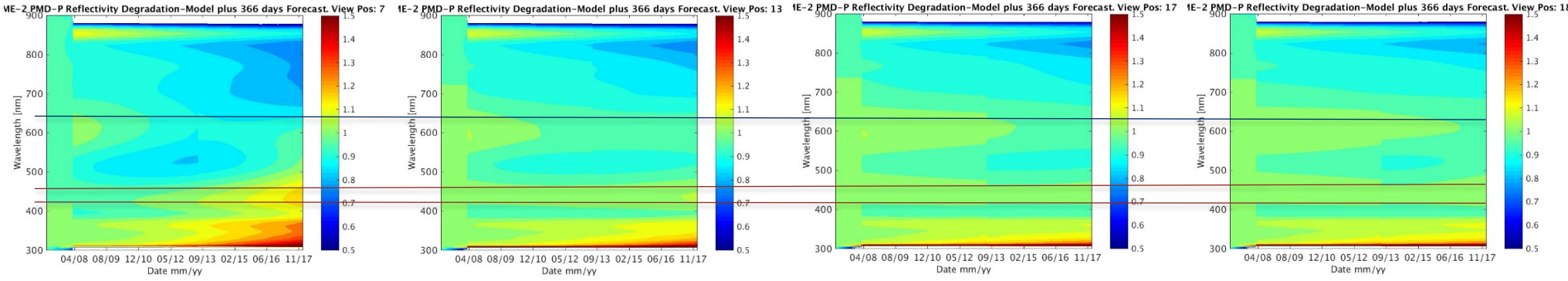
27 12 2016 MetopA

AOD_1B – AOD _1C



over water
PMD 12 (617.867 - 661.893 nm)

over land
PMD 8 (399.581 - 428.585 nm)
PMD 7 (380.186 - 383.753 nm)



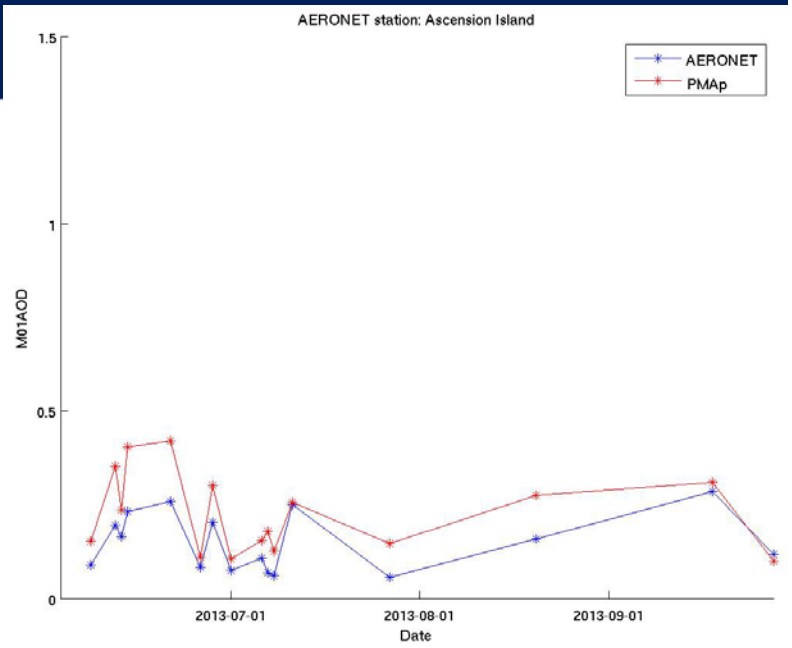
EUMETSAT

PMAp AOP retrieval

AOD Validation — Water surface

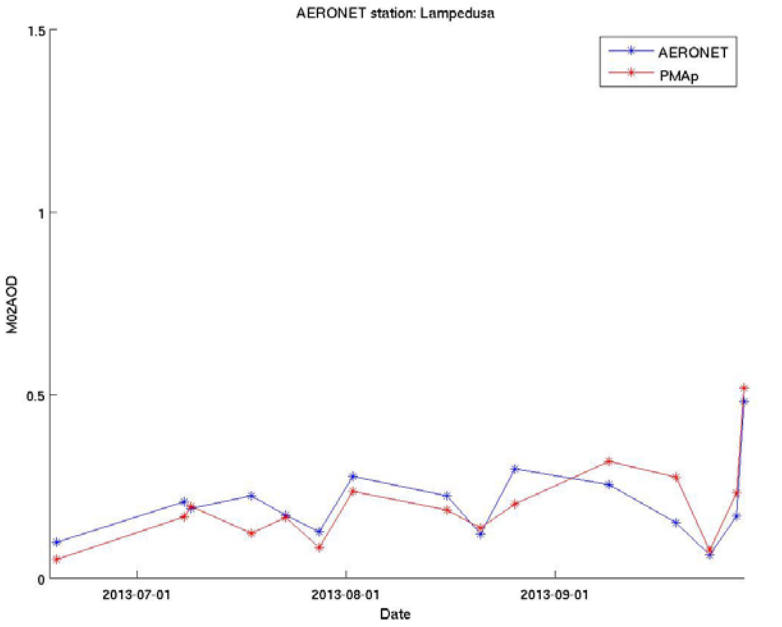
PMAp 2.1 vs Aeronet Lev2 Over Ocean

	June - Sept 2013		Feb-May 2015	
	METOP-B	METOP-A	METOP-B	METOP-A
gain	0.838	0.783	0.493	0.535
bias	0.076	0.045	0.115	0.084
correlation	0.870	0.836	0.777	0.871
N	110	90	22	51



PMAp 2.2 vs Aeronet Lev2 Over Ocean

	June - Sept 2013		Feb-May 2015	
	METOP-B	METOP-A	METOP-B	METOP-A
gain	0.949	0.922	0.836	0.744
bias	0.098	0.049	0.044	0.091
correlation	0.549	0.819	0.873	0.81
N	110	92	19	60



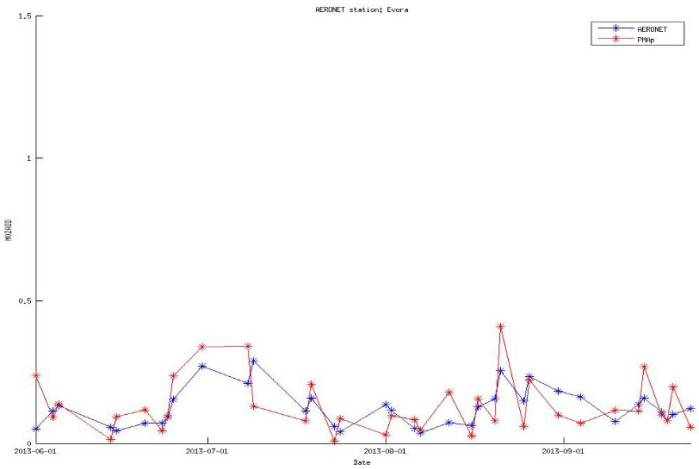
PMAp AOP retrieval
AOD Validation — Land surface

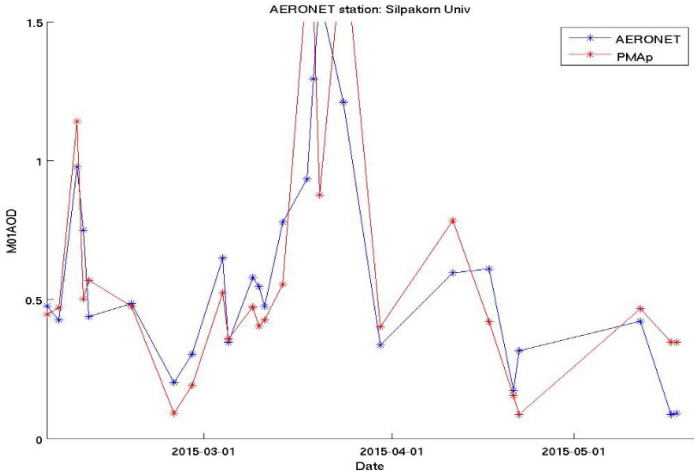
PMAp 2.1 vs Aeronet Lev2 Over Land

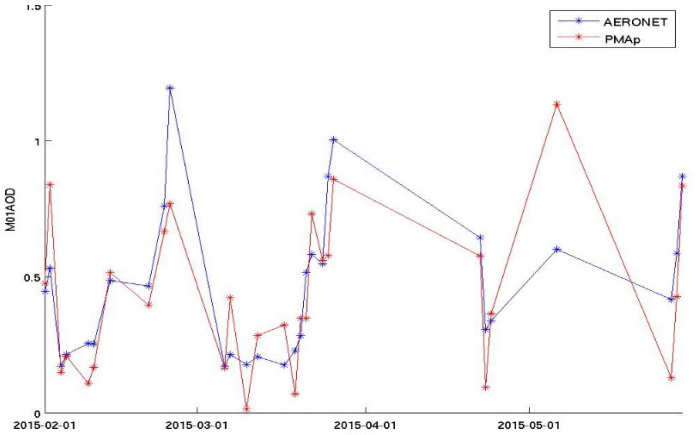
	June - Sept 2013		Feb-May 2015	
	METOP-B	METOP-A	METOP-B	METOP-A
gain	0.597	0.752	0.540	0.503
bias	0.113	0.081	0.168	0.158
correlation	0.589	0.636	0.552	0.612
N	906	830	1232	1000

PMAp 2.2 vs Aeronet Lev2 Over Land

	June - Sept 2013		Feb-May 2015	
	METOP-B	METOP-A	METOP-B	METOP-A
gain	0.762	0.979	0.839	0.615
bias	0.128	0.057	0.189	0.108
correlation	0.431	0.541	0.559	0.644
N	931	838	1675	1205







The Polar Multi-sensor Aerosol Product
Operational near-real time AOD from EPS/Metop

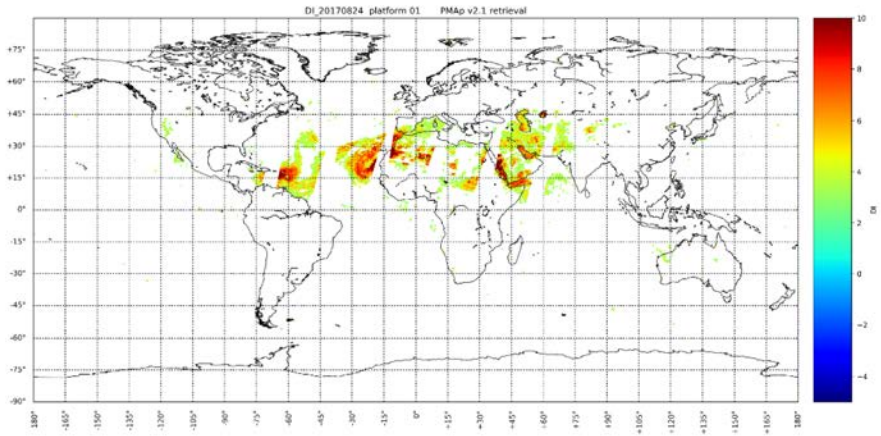
In summary

PMAp version 2.2 – upcoming release

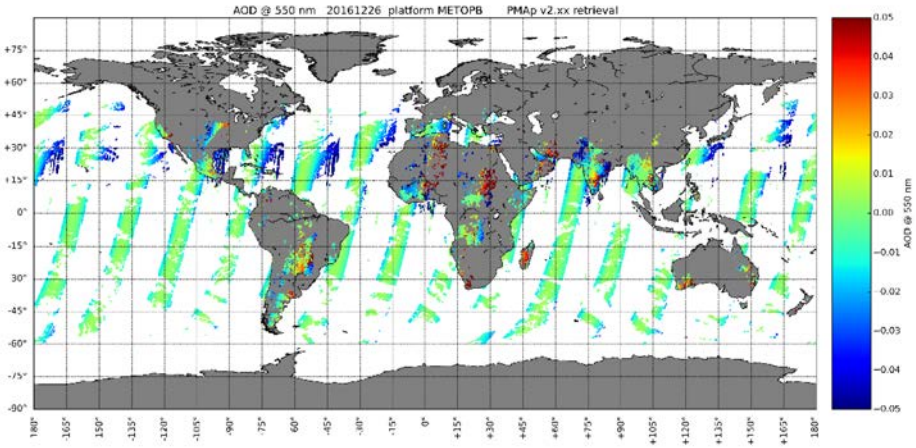
- Improved dust/ash detection using IASI (Clarisse et al.)

- Degradation correction for PMD radiances (TBC)
  - reduce overall biases and the biases between Metop-A and B

- Provide a level-3 gridded daily AOD product (offline TBC)
  - 0.5 x 0.5, gap-filled, quality controlled



IASI Dust Index (Clarisse et al.,)



Differences in AOD L1b to L1C correction

EUMETSAT

Thank you