Towards the next generation of synergy product: Multi-senor Aerosol Product (MAP) from sensors on-board the EPS-SG satellites

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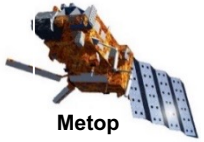
MAP - PMAP

Multi-sensor **A**erosol **p**roduct (**MAP**)

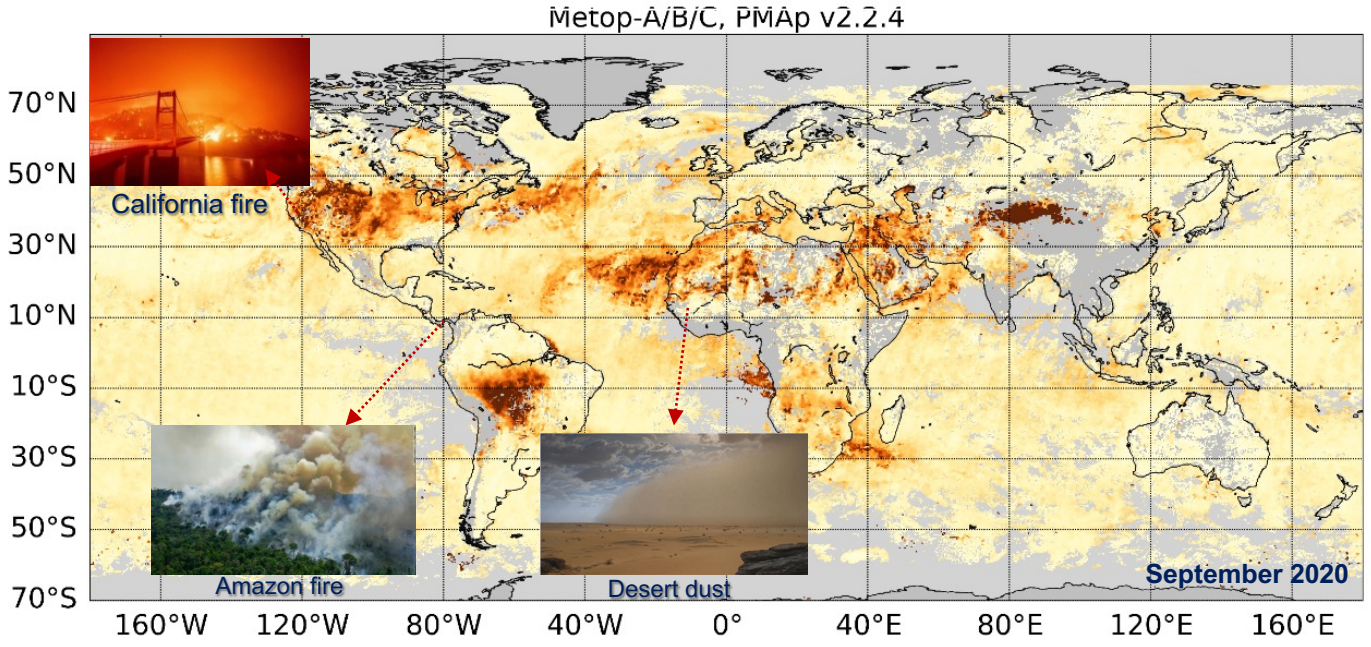
will be the follow-on product of the **P**olar **M**ulti-sensor **A**erosol **p**roduct (**PMAp**)



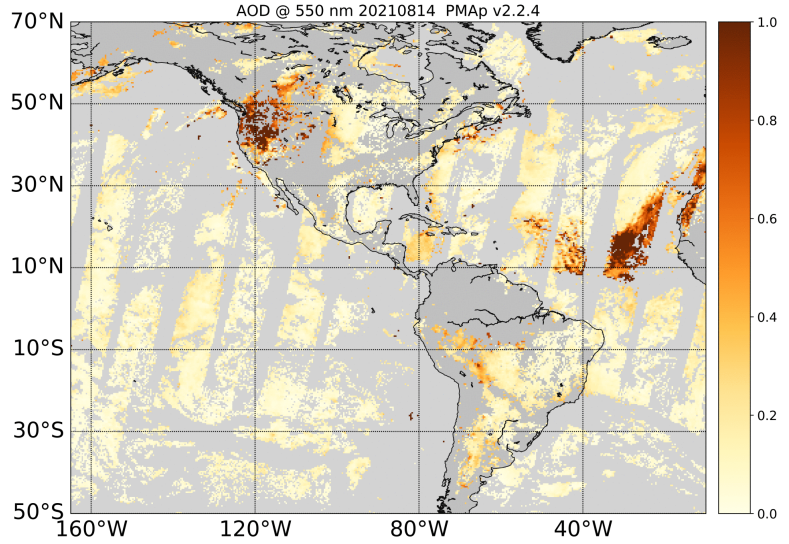
PMAp is an operational **synergistic** aerosol product retrieved from sensors on-board **Metop** (AVHRR, IASI and GOME-2) from **EUMETSAT** Polar System **(EPS)**.

Dissemination started over ocean since April 2014, over land since April 2016.

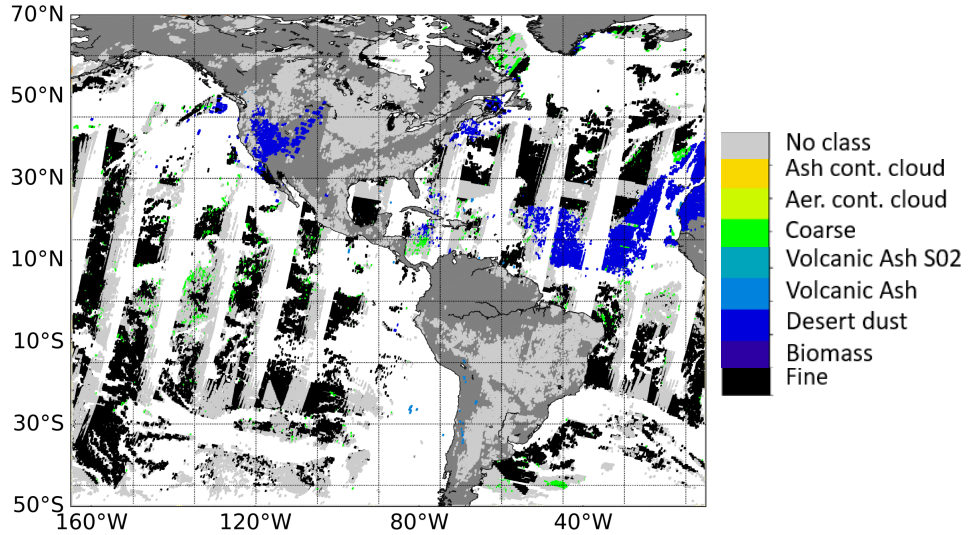
Near Real Time **Aerosol Optical Depth** at 550 nm and **Aerosol Type**



PMAp v2.2. daily AOD, Metop (A+B+C), August 2021



PMAp v2.2. daily aerosol type, Metop (A+B+C), August 2021



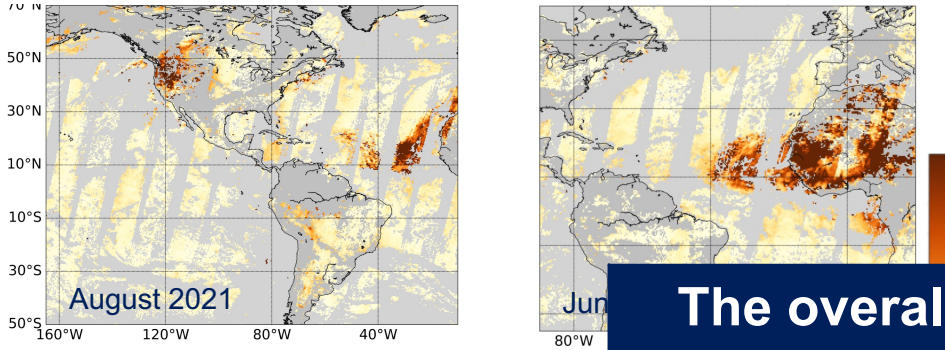
PMAp CDR (2007-2019) and validation report to be released soon.

PMAp paper Grzegorski et al., Multi-sensor Retrieval of Aerosol Optical Properties for Near-Real-Time Applications Using the Metop Series of Satellites: Concept, Detailed Description and First Validation, Remote Sensing, 2022.

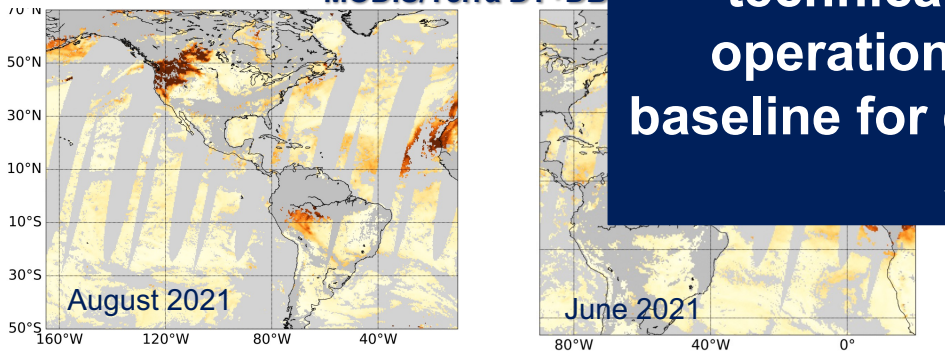
PMAp: validation

Comparison of PMAp to satellite AOD products

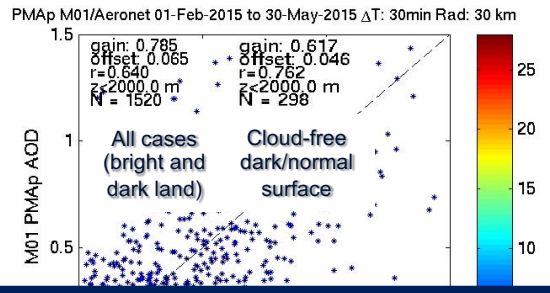
Metop (A+B+C), PMAp v 2.2



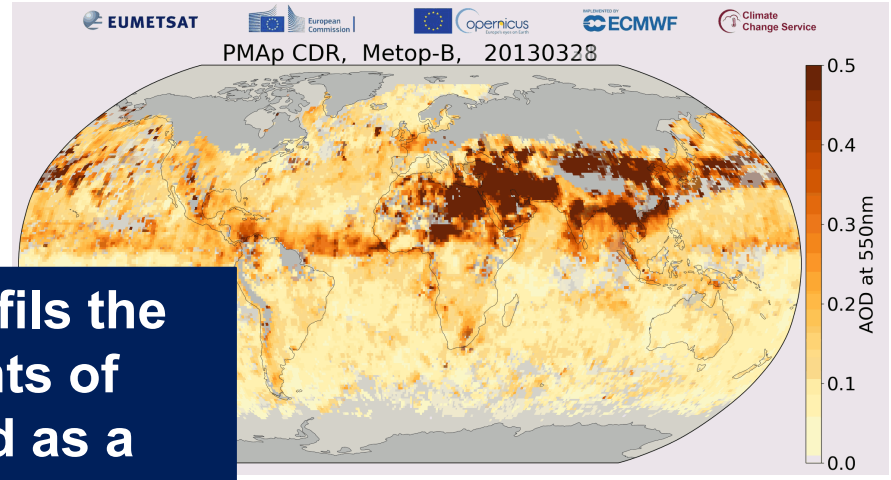
MODIS/Terra DT+DB



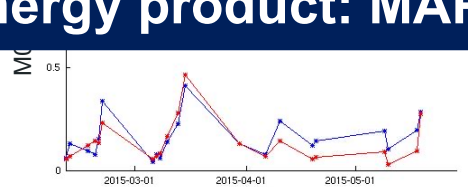
Validation of PMAp vs AERONET



Reprocessing PMAp to create a climate data record (CDR) in the context of Copernicus Climate Change Service (C3S)

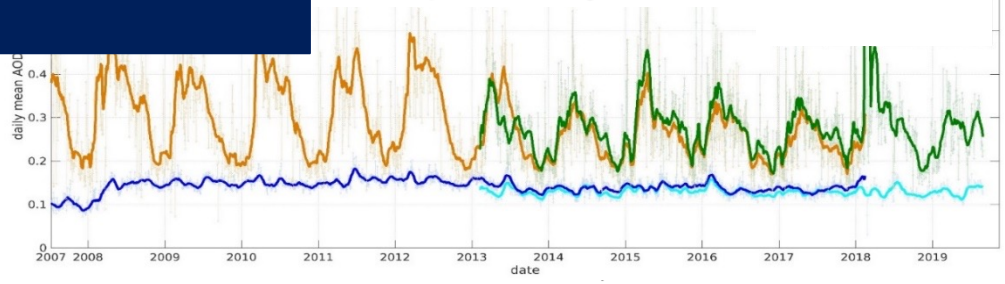


The overall performance of PMAp fulfils the technical and scientific requirements of operational users and it will be used as a baseline for development of next generation of synergy product: MAP

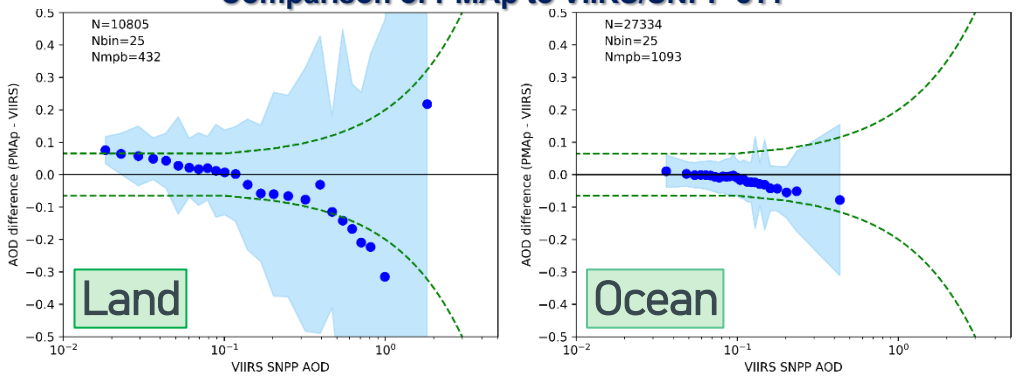


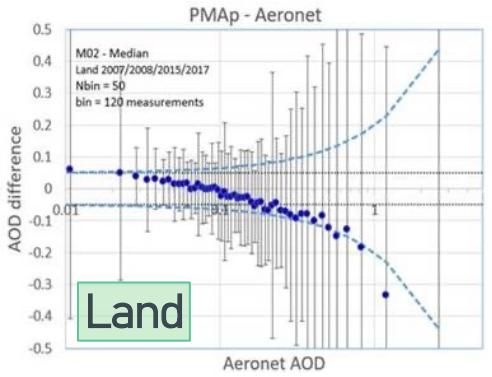
Date

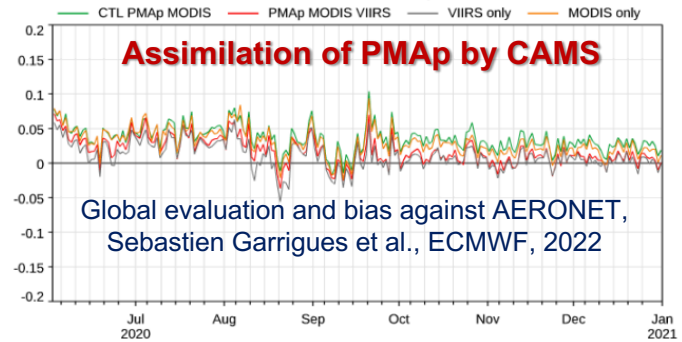
R, Metop-A/B, daily AOD in 2007-2019



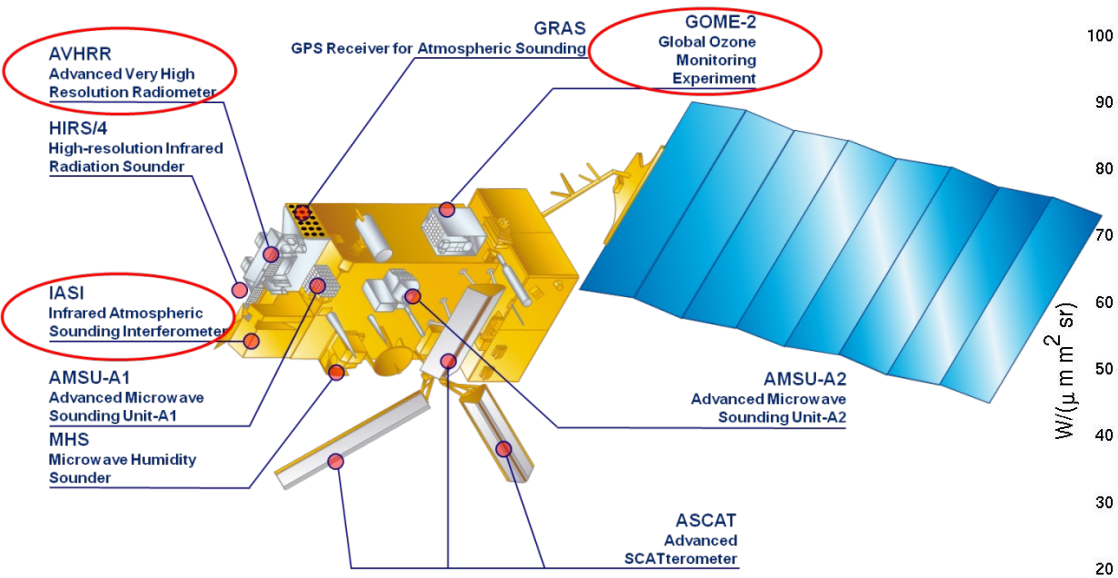
Comparison of PMAp to VIIRS/SNPP c11



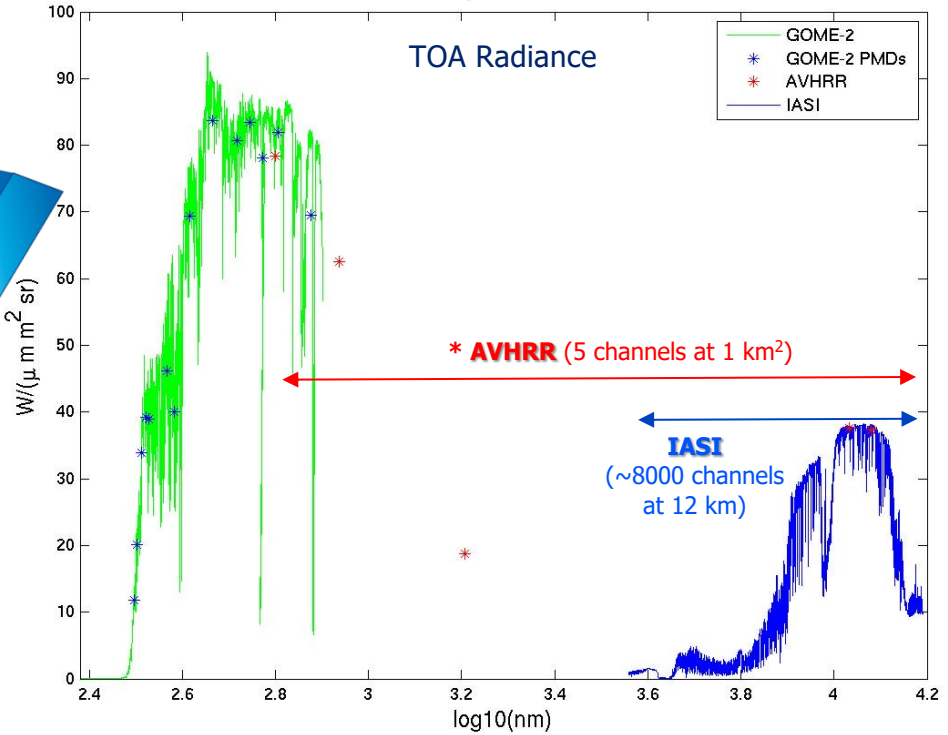




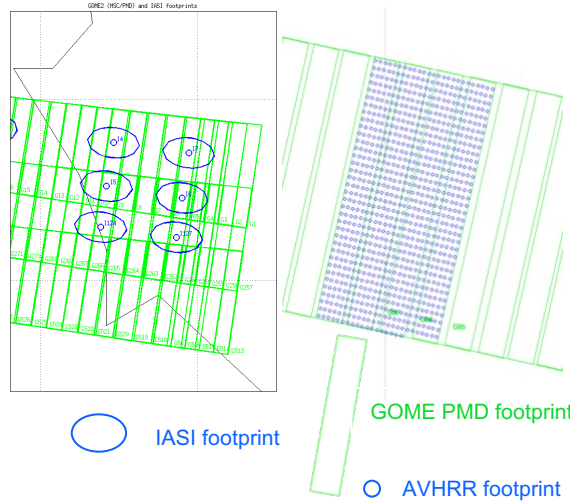
PMAp: synergy concept



Multi-sensor spectral information



Multi-sensor co-location

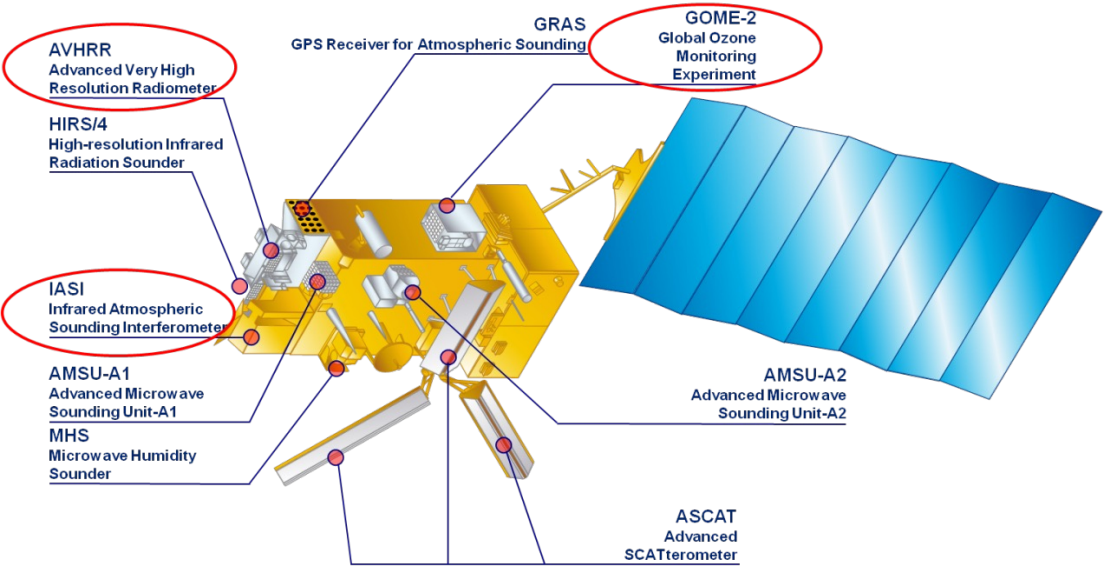


Merging hyper-spectral and high spatial information from GOME-2, AVHRR and IASI

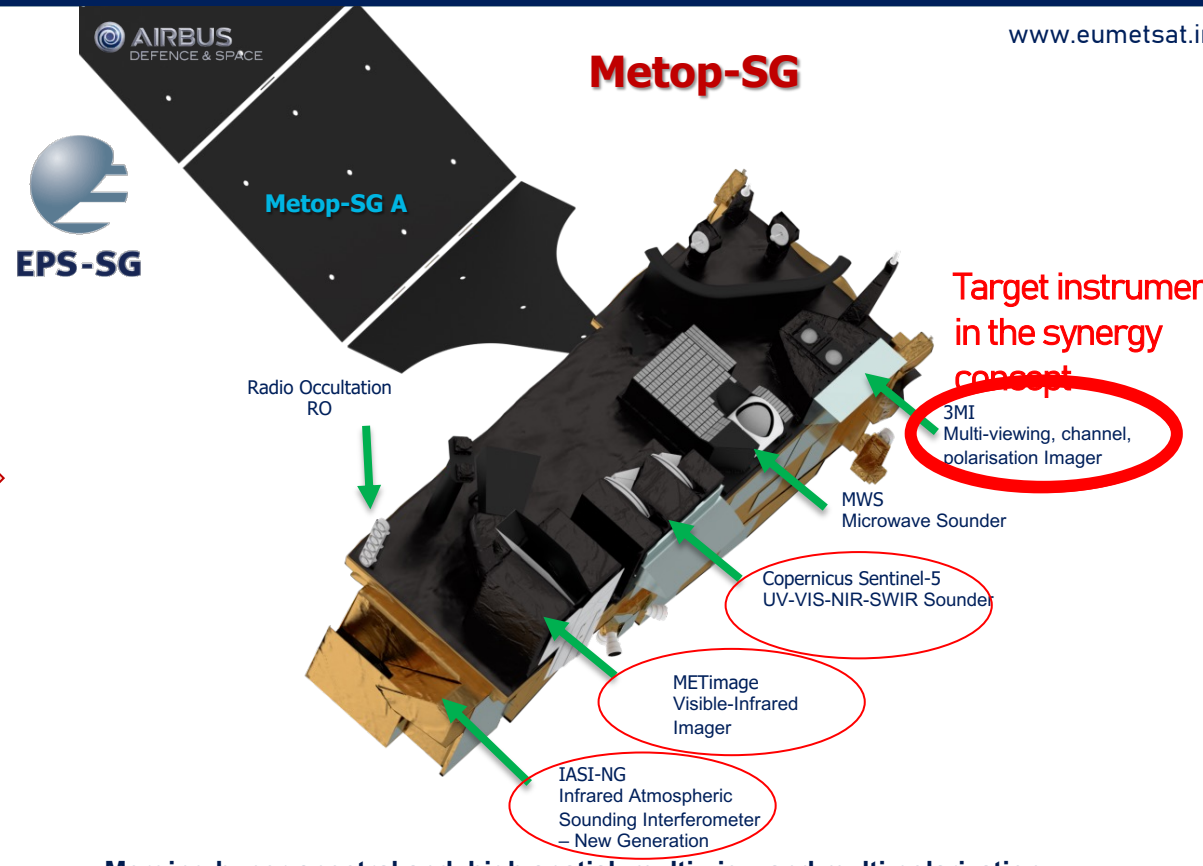
Instruments for L1 data	Spatial resolution	Spectral range
GOME PMD	Metop B and C: 10×40 km^2 Metop A: 5×40 km^2	311 nm – 803 nm (15 band)
AVHRR	1.08 × 1.08 km^2	580 nm – 12500 nm (5 band)
IASI	12 km (circular)	3700 nm – 15500 nm (resolution 0.5 cm^{-1})

PMAp to MAP

Metop



Metop-SG



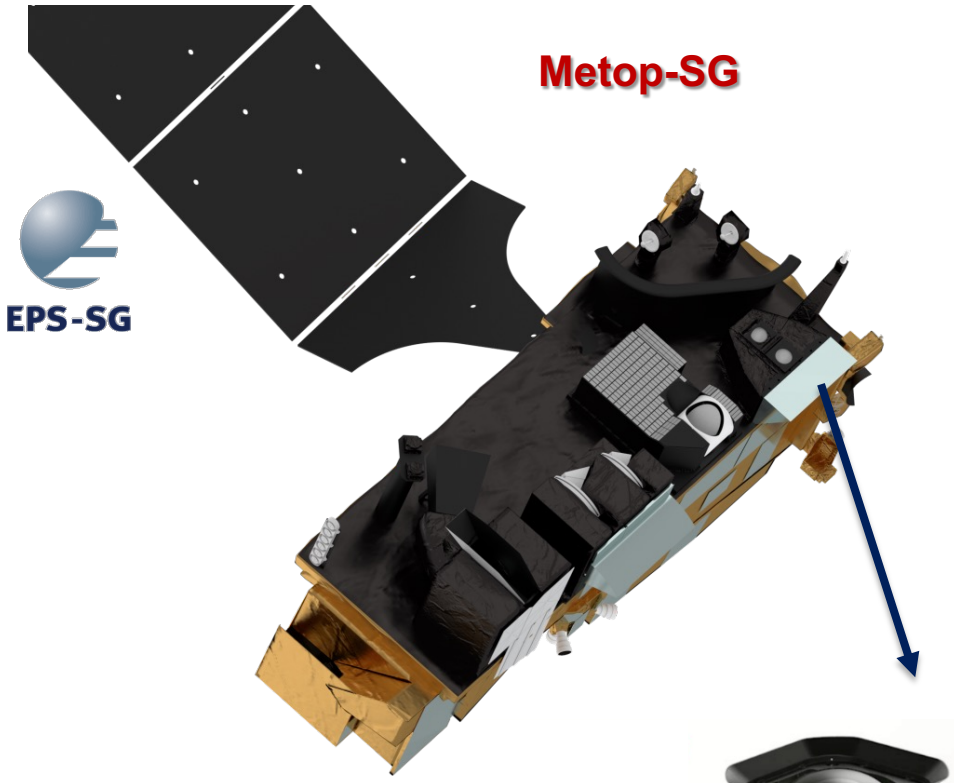
Merging hyper-spectral and high spatial information from GOME-2, AVHRR and IASI

Instruments for L1 data	Spatial resolution	Spectral range
-	-	-
GOME-2 PMD	Metop B and C: 10×40 km^2 Metop A: 5×40 km^2	311 nm – 803 nm (15-? bands)
AVHRR	1.08 × 1.08 km^2	580 nm – 12500 nm (5 bands)
IASI	12 km (circular)	3700 nm – 15500 nm (resolution 0.5 cm^{-1})

Merging hyper-spectral and high spatial, multi-view and multi polarization information from 3MI, METimage and IASI-NG and Sentinel-5

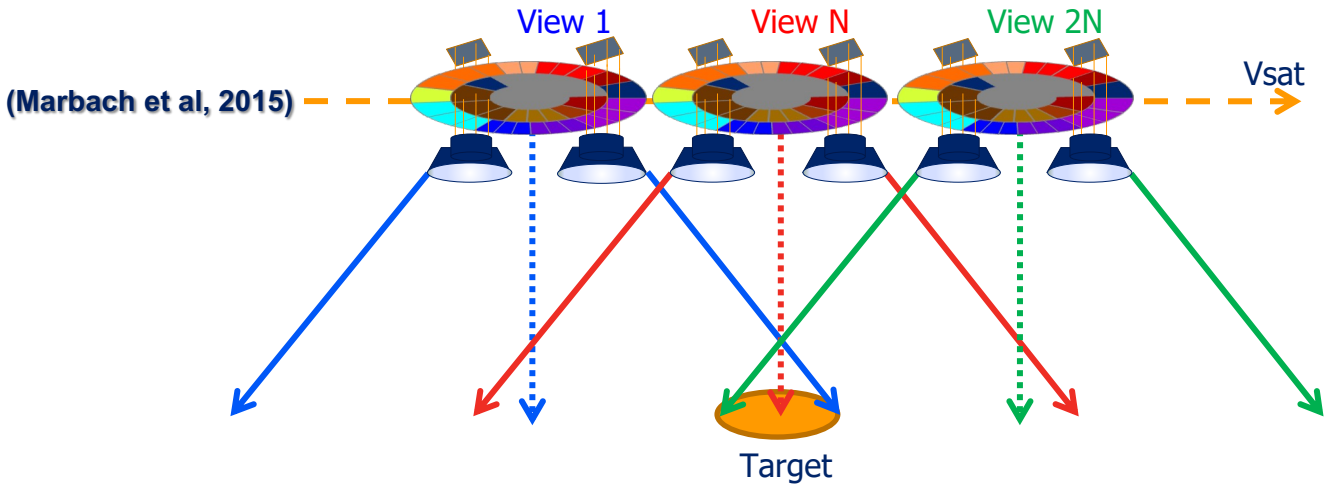
Instruments for L1 data	Spatial resolution	Spectral range
3MI	4×4 km^2	410 nm – 2130 nm (12 bands)
Sentinel-5	7.5×7.5 km^2 (<300nm) 50×50 km^2	270 nm – 2385 nm (1669 bands)
METimage	0.5 × 0.5 km^2	443 nm – 2250 nm (20 bands)
IASI-NG	12 km (circular)	645 nm – 2760 cm^{-1} (resolution 0.25 cm^{-1})

3MI: the core instrument of MAP



1 view: all spectral channels

up to 14 views: N = 7



- Multi-Viewing Multi-Channel Multi-Polarisation Imaging (3MI) is the core instrument of the synergy concept in MAP;
- The 3MI instrument concept has a direct heritage from the POLDER instruments;
- The primary objective of the 3MI mission is to provide high quality imagery of aerosol variables over ocean and land;
- 3MI will further support observation of cloud microphysical properties, water vapour load, Earth radiation budget, and land-surface characteristics.

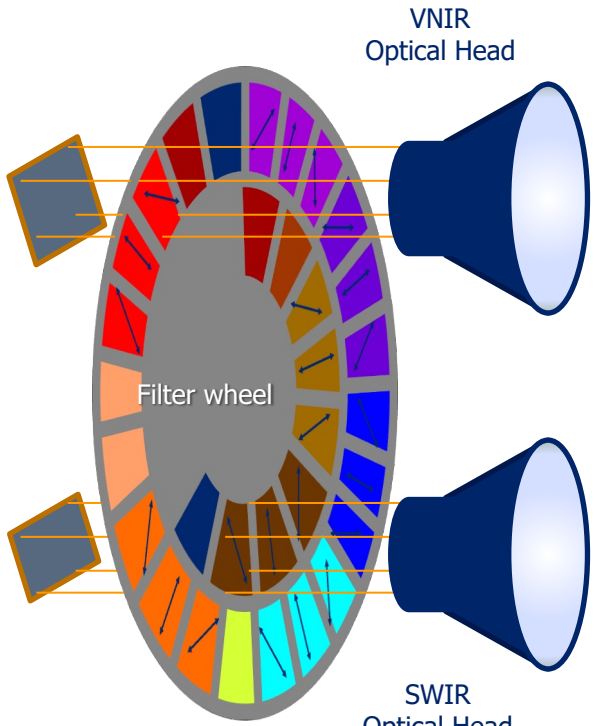
3MI Design

3MI channels
410-P ± 10 nm
443-P ± 10 nm
490-P ± 10 nm
555-P ± 10 nm
670-P ± 10 nm
763 ± 5 nm
765 ± 20 nm
865-P ± 20 nm
910 ± 10 nm

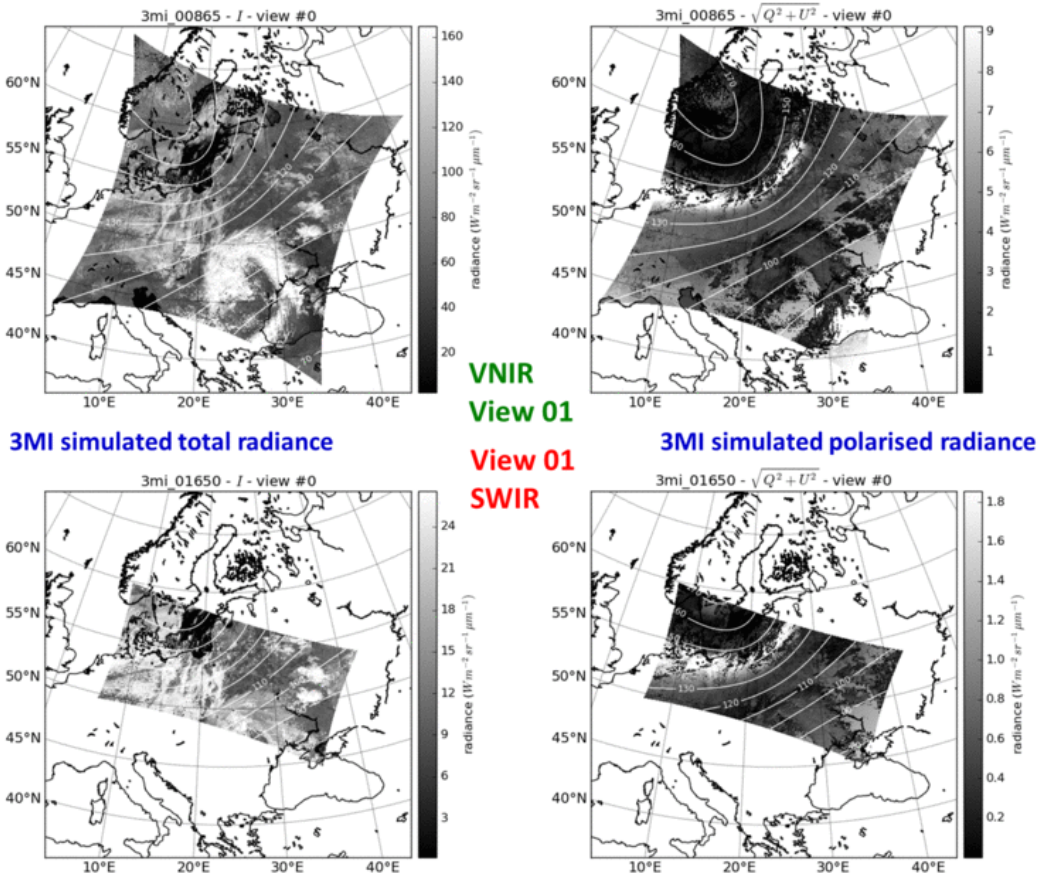
CCD VNIR Detector (509x509 pixels)

1370-P ± 20 nm
1650-P ± 20 nm
2130-P ± 20 nm

CMOS SWIR Detector (255x499 pixels)



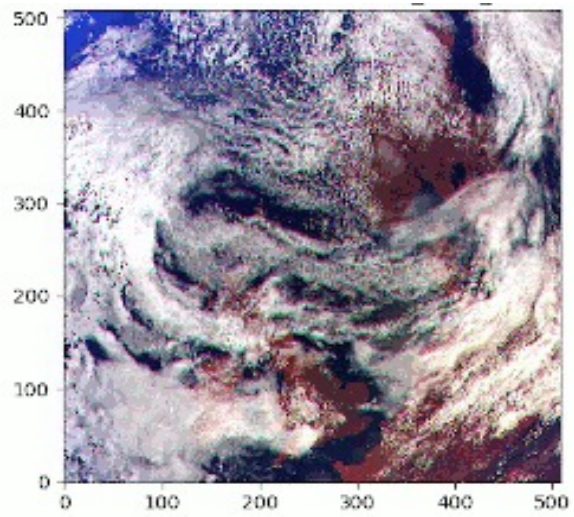
(Fougnie et al, 2018)



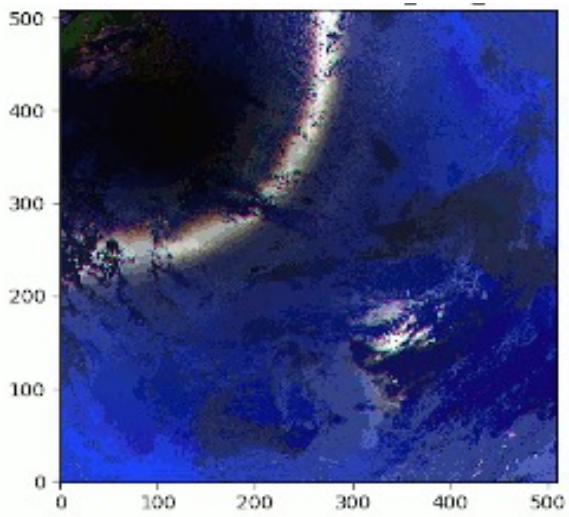
(Marbach et al, 2015)

The added-value of directional polarimetry

Standard RGB

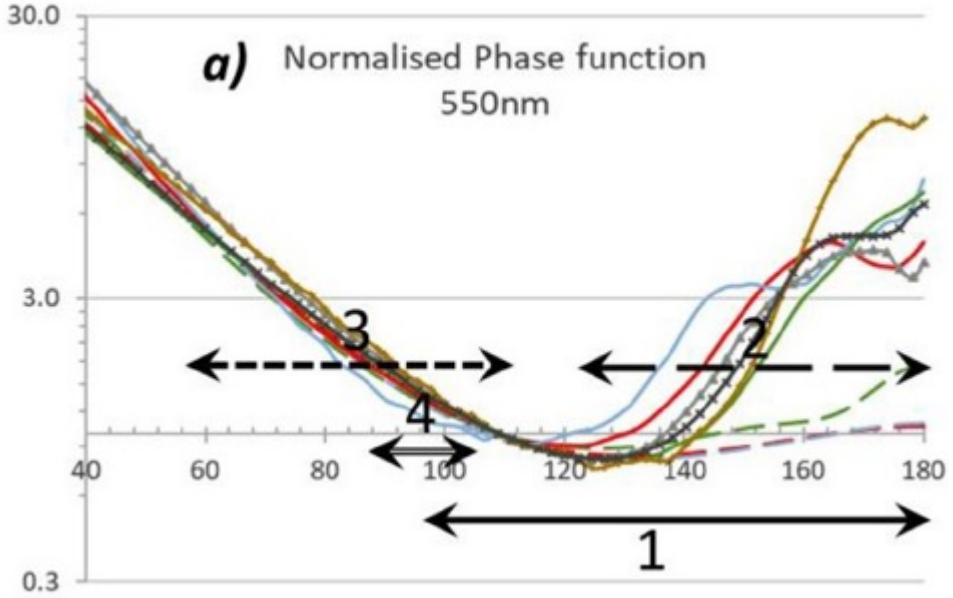


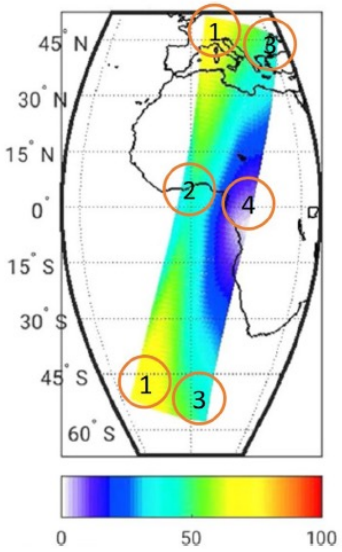
Polarisation

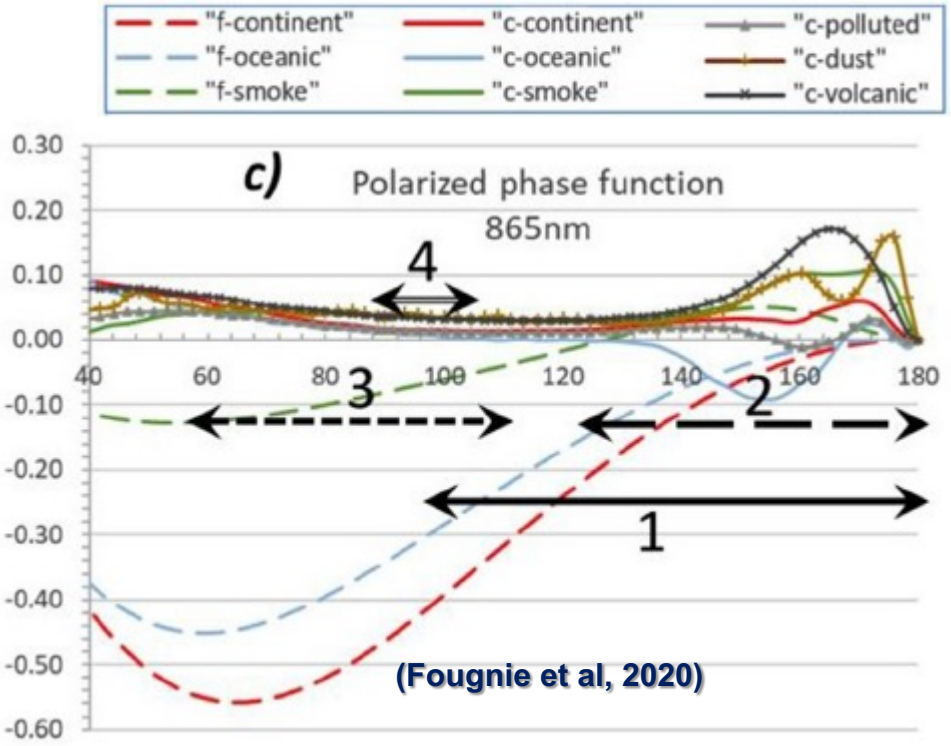


What's the added-value of the synergy concept for 3MI?

Associated Information Content

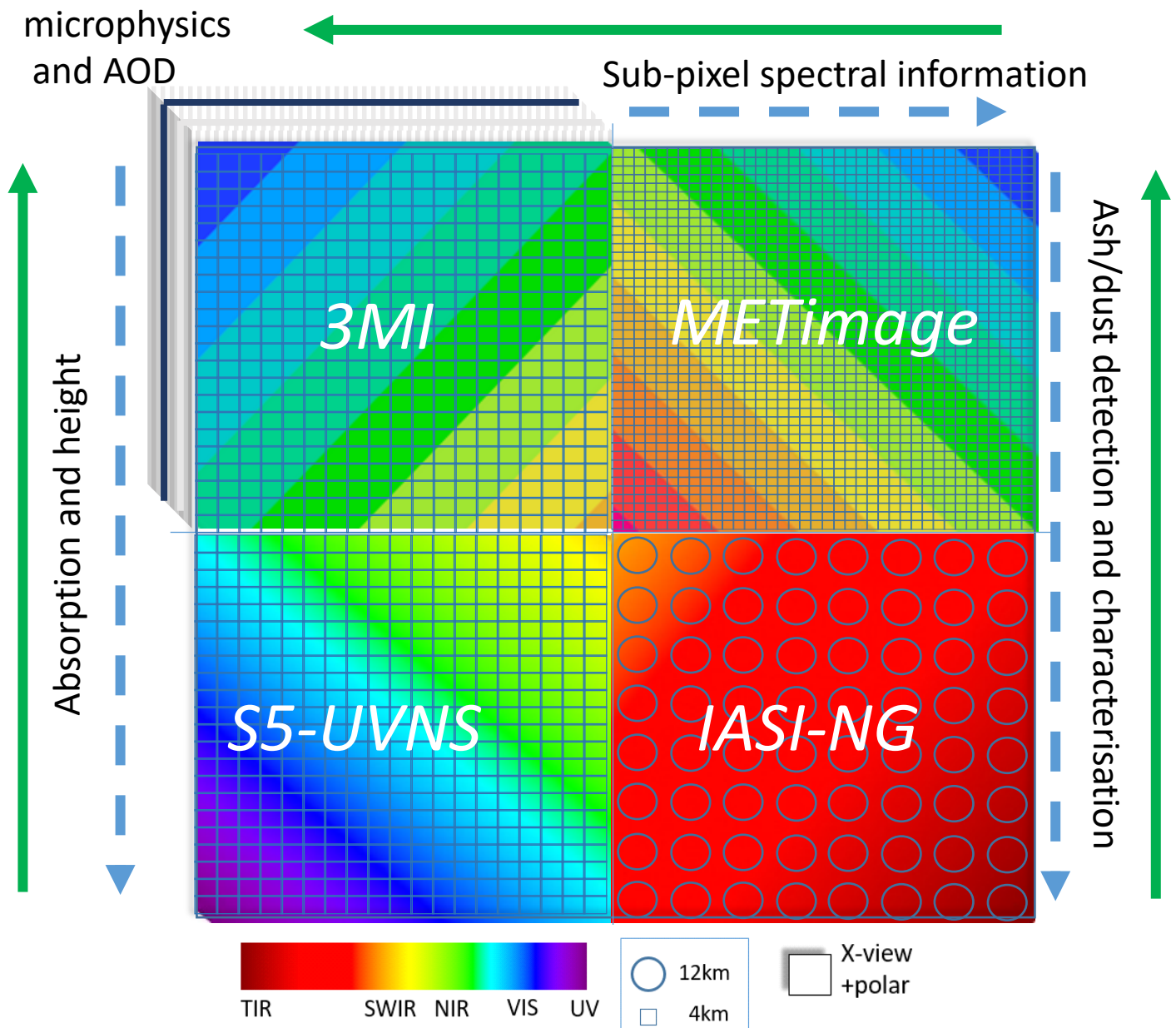






(Fougnie et al, 2020)

The Aerosol Observatory from EPS-SG sensors



Characterisation	3MI	METimage	S5-UVN	IASI-NG
Cloud identification	X	O		
Cloud decontamination		O		
Ash/Dust detection	X	O		O
Aerosol height	O	X	O	
Aerosol over clouds	O	X		O
Aerosol model	O	X	X	
Aerosol fine fraction	O			
Aerosol Optical Depth	O	X	X	
Aerosol absorption	O		O	

From PMAp to MAP

- Baseline for the design of MAP version 1:
  - PMAP synergy adapted to EPS-SG: colocation, cloud masking, pre-classification, ash/dust detection…
  - AOD and model retrieval from 3MI/GRASP
- Extension to other parameters: improve ash & dust, aerosol height, SSA, PM25?
- Revisions could consider feeding GRASP directly with some inputs from UVNS/Metimage/IASI-NG

PMAp instruments on-board Metop **EPS** for L1 data	**MAP** instruments on-board Metop **EPS-SG** for L1 data
-	3MI
GOME-2 PMD	S5
AVHRR	VII
IASI	IASI-NG

Target instrument of each product

PMAp

Instruments for L1 data	Purpose
GOME-2 PMD	AOD, Aerosol Type
AVHRR	Clouds, scene heterogeneity, volcanic ash, thick dust
IASI	Volcanic ash, desert dust

MAP

Instruments for L1 data	Purpose
3MI	Retrieval of aerosol properties (> 10 parameters)
VII	Cloud, scene homogeneity, volcanic ash, thick dust
S5	Retrieval of aerosol properties, Clouds, scene homogeneity
IASI-NG	Volcanic ash, desert dust, aerosol height

Summary

- MAP will be the follow-on product of PMAp, a multi-sensor aerosol product from EPS-SG;
- PMAp is operational since April 2014 and the latest version was released in February 2023;

  For more information see:

  https://www.eumetsat.int/new-version-metop-pmap-product-released-soon
- The overall good performance of PMAp is indicated in the feedbacks from operational users (e.g., CAMS), PMAp CDR validation, internal validation studies, etc.
- PMAp can be used as a baseline for the development of MAP;
- The target instrument of the synergy concept in MAP will be 3MI, and other instruments will be used for sub-pixel information, ash/dust detection and characterization, aerosol layer height, etc.
- A similar concept of synergy could be implemented on the instruments onboard MTG (FCI, S4 and IRS) in future, explained in the *presentation "Aerosol from GEO with MTG/FCI. Coming development and perspective for a GEO-ring"* by Bertrand Fougnie

References

[1] Grzegorski et al., Multi-sensor Retrieval of Aerosol Optical Properties for Near-Real-Time Applications Using the Metop Series of Satellites: Concept, Detailed Description and First Validation, Remote Sensing, 2022.

[2] Fougnie, B., Marbach, T., Lacan, A., Lang, R., Schlüssel, P., Poli, G., Munro, R., Couto, A. B., The multi-viewing multi-channel multi-polarisation imager – Overview of the 3MI polarimetric mission for aerosol and cloud characterization, Journal of Quantitative Spectroscopy and Radiative Transfer, 2018.

[3] Fougnie, B., Chimot, J., Vázquez-Navarro, M., Marbach, T., Bojkov, B., Aerosol retrieval from space – how does geometry of acquisition impact our ability to characterize aerosol properties, Journal of Quantitative Spectroscopy and Radiative Transfer,
2020.

[4] T. Marbach, J. Riedi, A. Lacan, P. Schlüssel, "The 3MI mission: multi-viewingchannel-polarisation imager of the EUMETSAT polar system: second generation (EPS-SG) dedicated to aerosol and cloud monitoring," Proc. SPIE 9613, Polarization Science and Remote Sensing VII, 2015.