

The PRIMARY project for the generation of air quality products using PRISMA data

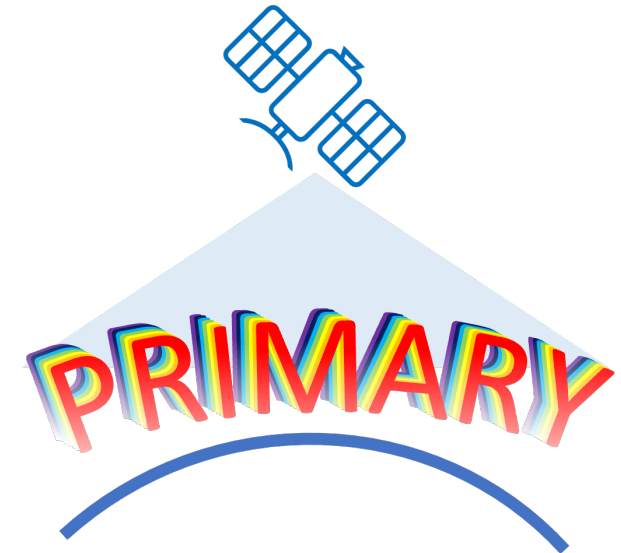
Fabio Del Frate, Davide De Santis – *University of Rome «Tor Vergata»*

Gabriele Curci – *University of L'Aquila*

Francesca Barnaba, Luca Di Liberto – *CNR ISAC*

Cristiana Bassani – *CNR IIA*

Enrico Cadau, Stefano Casadio – *SERCO*





PRIMARY


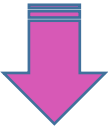

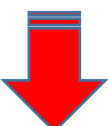
PRisma for Monitoring AiR qualityY

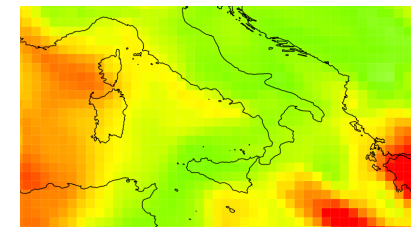
MAIN SCIENTIFIC GOAL:

use of satellites to provide qualitative and quantitative information on Atmospheric Particulate Matter at **urban scale** and to extract anthropogenic fraction

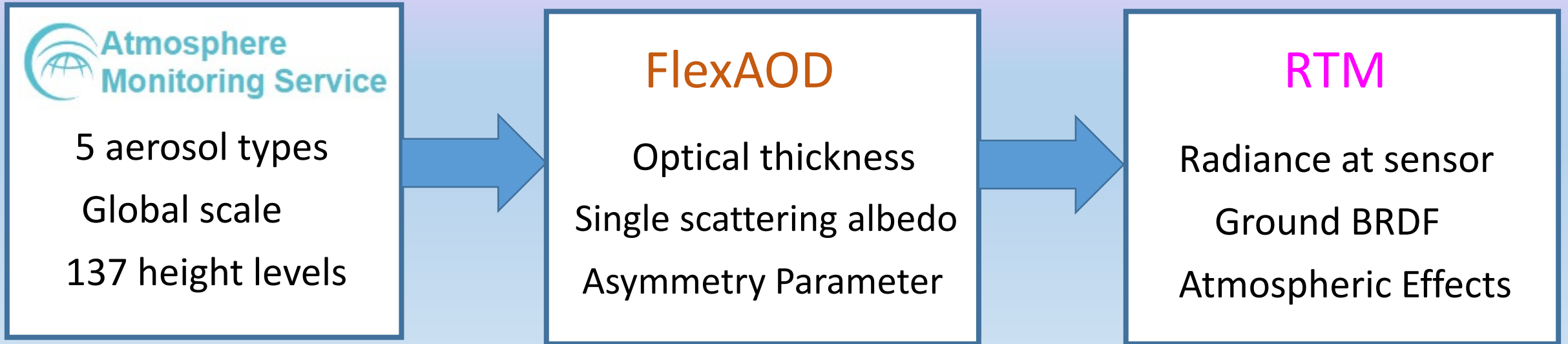
Such urban scale is not feasible at the moment due to limitations in terms of spatial and/or spectral resolution characterizing current payloads.

ROADMAP

- Generation of a statistically significant set of atmospheric profiles (CAMS, GEOS-Chem)

- PRISMA data simulation in correspondence of the generated profiles (FlexAOD, RT models)

- Design and development of AI algorithms to be applied to real satellite data

- PM products generation from PRISMA

- Test, validation and performance analysis (ground + aerial measurements)

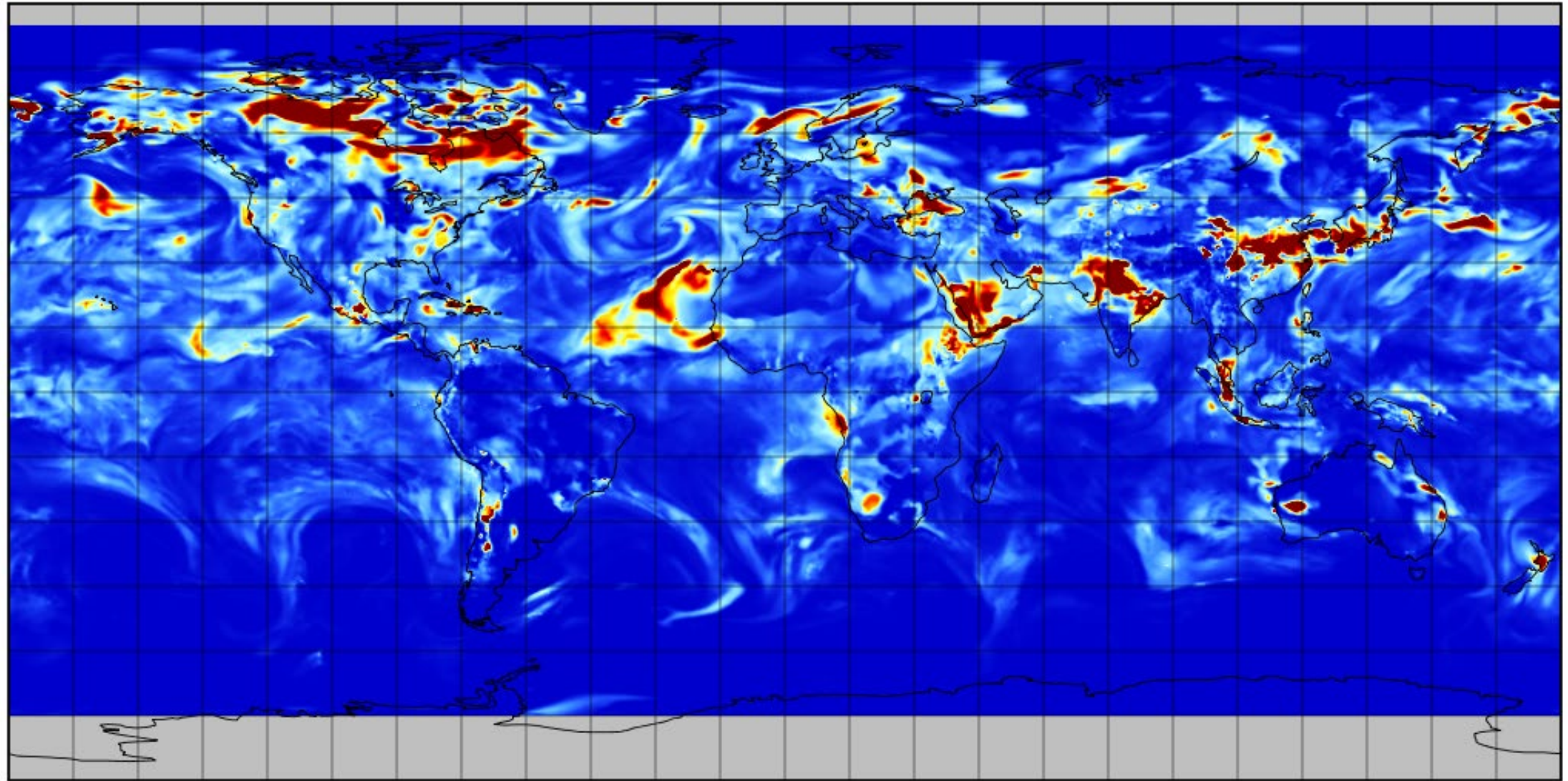


FORWARD PROBLEM IMPLEMENTATION

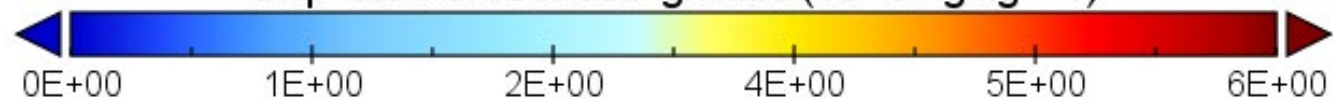


- Physics based approach
- Statistically significant number of training data

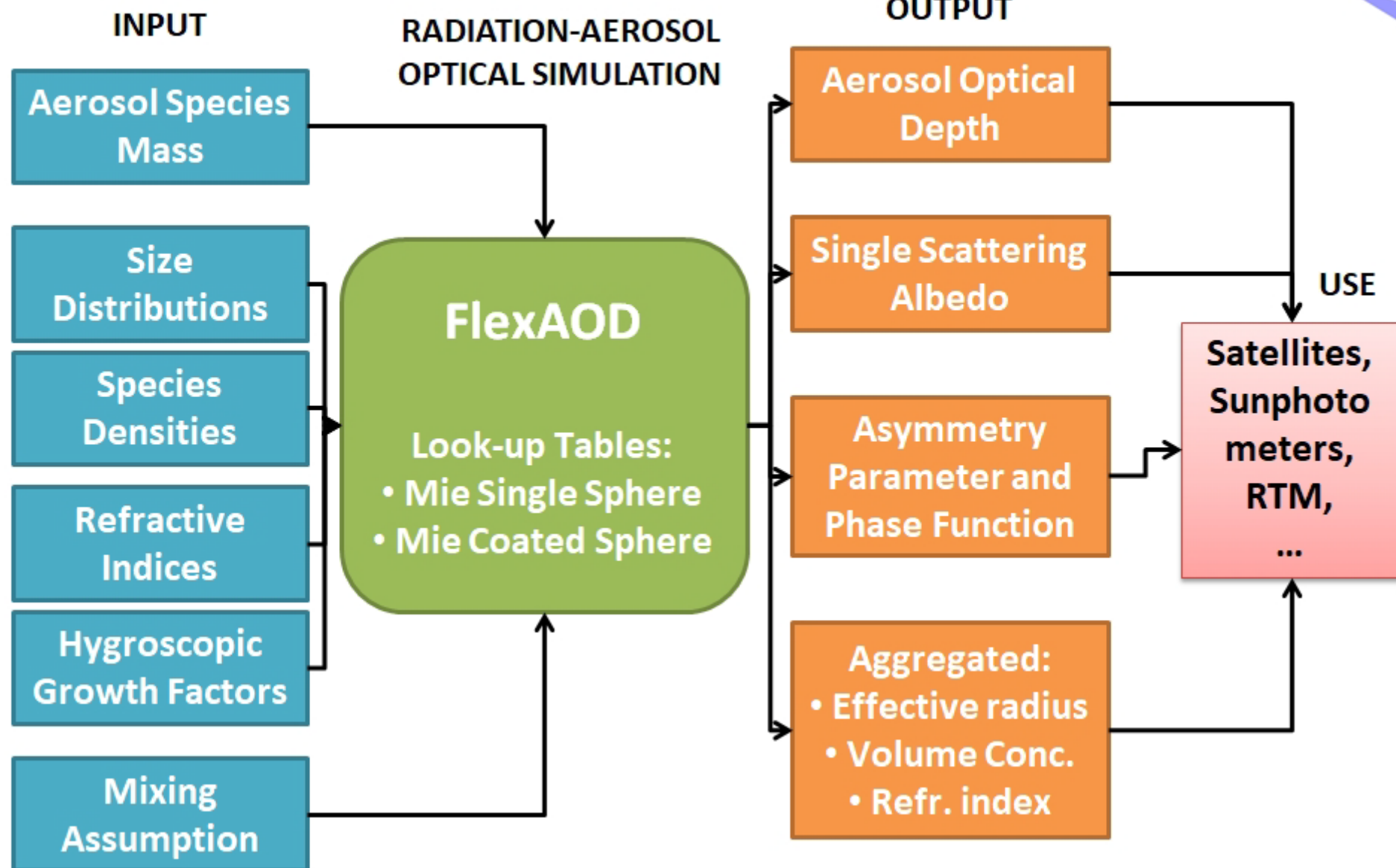
Sulphate Aerosol TOA – CAMS Global Atmospheric Composition (15 June 2020)



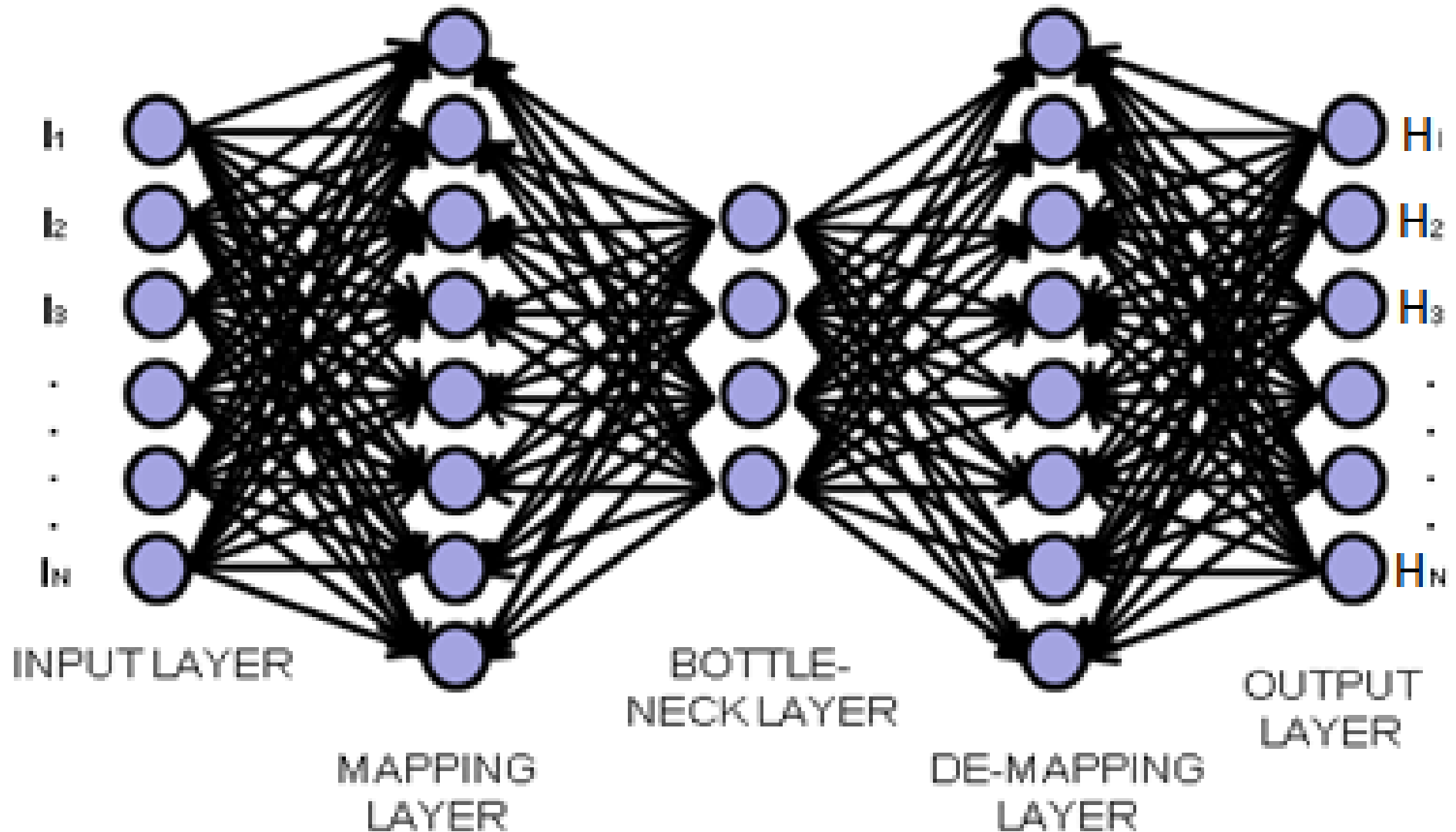
Sulphate Aerosol Mixing Ratio ($10^{-9} \text{ kg kg}^{-1}$)



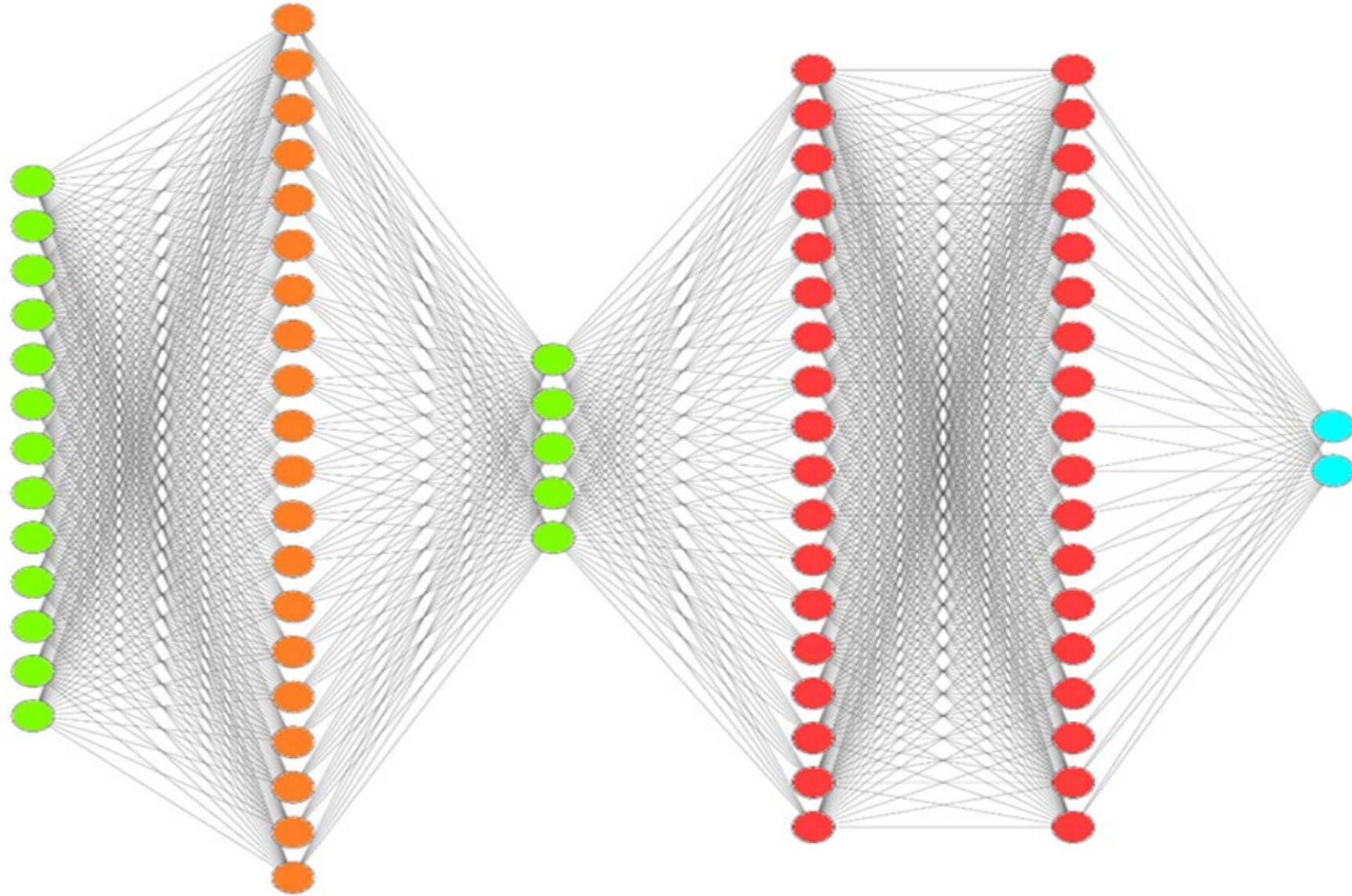
FlexAOD post-processing tool



PRISMA PRODUCT DIMENSIONALITY REDUCTION



PRODUCT GENERATION PIPELINE



Pre-processing Stage

Retrieval Stage



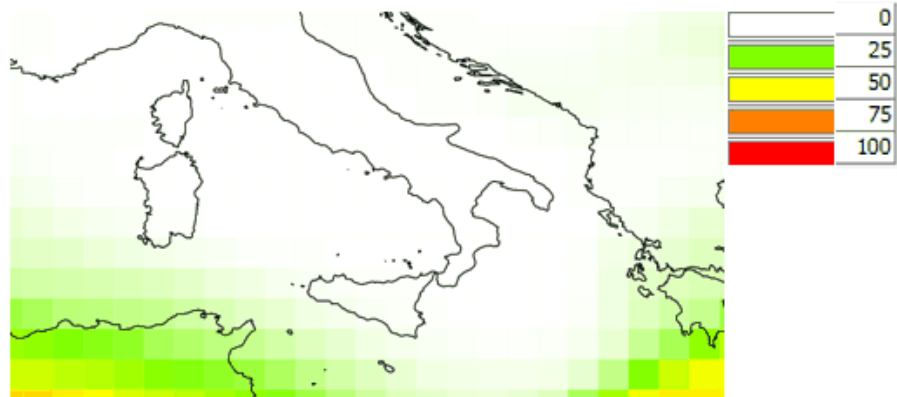
PRELIMINARY PRODUCT LIST

Total Aerosol (columnar) Abundances and mixing ratios (in ppm)

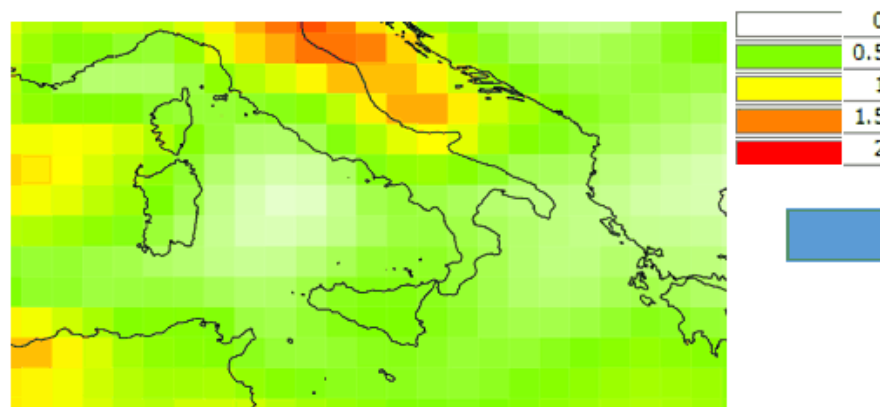
- ❖ Organic Carbon Hydrophobic
- ❖ Organic Carbon Hydrophilic
- ❖ Dust
- ❖ Sea Salt
- ❖ Black Carbon
- ❖ Sulfate

At TOA and within PBL

12 Maggio 2020, 12 UTC - **Dust** ($\mu\text{g}/\text{m}^2$)

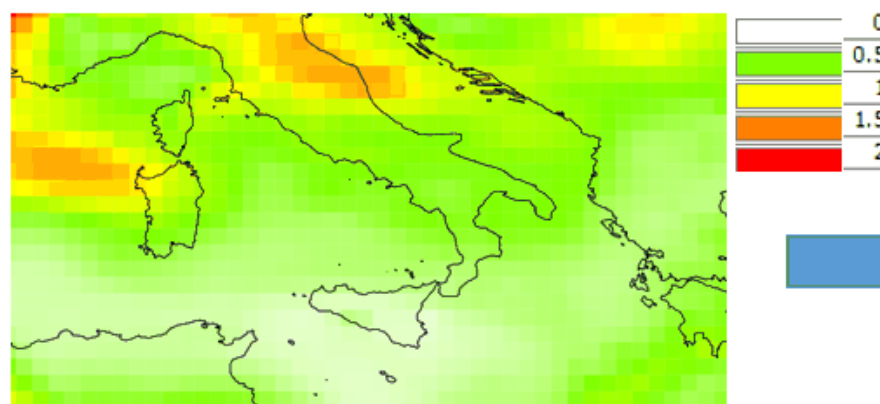
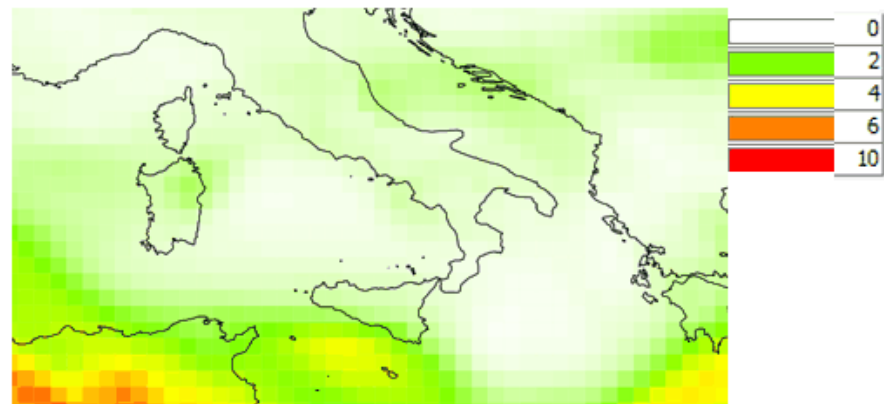


12 Maggio 2020, 12 UTC - **Black Carbon** ($\mu\text{g}/\text{m}^2$)



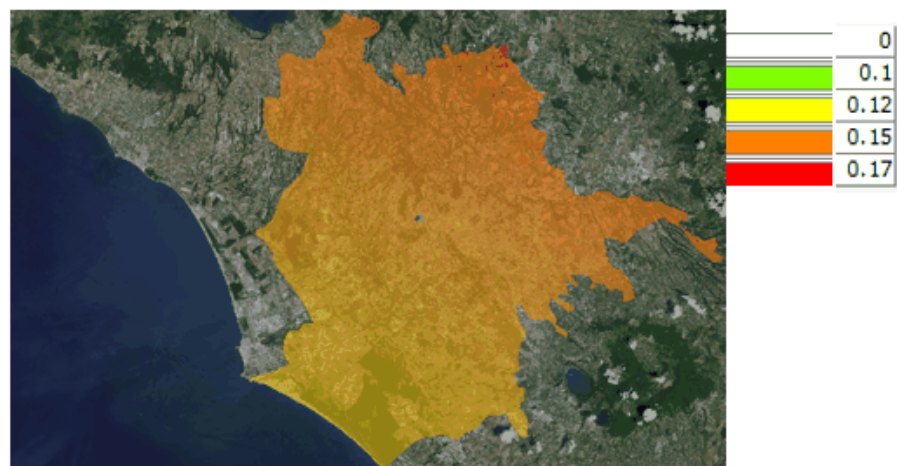
CAMS Reanalysis

- Approx 70 x 70 km spatial resolution
- Only past years



CAMS Near Real Time

- Approx 40 x 40 km spatial resolution



PRIMARY expected output (Rome)

- 30 x 30 m spatial resolution



VALIDATION PHASE



CNR-ISAC Rome Atmospheric Supersite (CIRAS, Rome-Tor Vergata)

List of CIRAS measurements

Component	Parameter	Instrument
Aerosol	Aerosol absorption coefficients, Black carbon	Aethalometer Magee AE33
	Aerosol size-distribution (range: 8 - 800 nm)	SMPS Tropos
	Aerosol size-distribution (range: 0.3 - 30 μm), PM10, PM2.5	Optical Particle Counter, GRIMM 11R
	Aerosol size-distribution (range: 0.3 - 30 μm)	Aerodynamic Particle Sizer, TSI 3321
	Fine particles Number concentration	CPC-TSI 3772
	Aerosol light scattering coefficients	Nephelometer, Ecotech Aurora 3000
	Aerosol and Wind vertical profiles	Wind Lidar, HALO/Metek GmbH - Stream Line XR
	Aerosol vertical profiles	Automated Lidar Ceilometer (ALICENET, E-PROFILE)
Trace gases	Columnar aerosol physico-optical parameters	Sun Sky Lunar Photometer, Cimel (AERONET)
	Columnar aerosol physico-optical parameters	Sun Sky Photometer, Prede (SKYNET)
	SO2	Thermo 43i
	Columnar and vertical profiles of trace gases (NO2, SO2, HCHO, HONO, Glyoxal, BrO, O3)	Max DOAS (SkySpec-2D-210)
Precipitation	Columnar NO2, O3	Pandora Spectroradiometer, Luftbrück
	In situ NO, NO2	Gas Analyzer, ThermoFisher Scientific 42i
	In situ SO2, H2S	Gas Analyzer, ThermoFisher Scientific 450i
Meteo&Radiation	Precipitation profiles	Profiling Doppler Radar K-Band, Micro Rain Radar (MRR)-PRO, Metek GmbH
	Precipitation profiles	Scanning Doppler Dual-Polarization Radar C-Band, Polar 55-C, custom made
	Rain Rate and drop particle size distribution	Laser Precipitation Monitor, Thies Clima
	Rain Rate	SmartLNB, DVB-S/S2 receiver, MBI Srl
Meteo&Radiation	Strokes counts	Linnet, Betz
	Wind vertical profiles (ws, wd), thermal structure	Sodar, custom
	In situ wind (wd ws), virtual Temp, fluxes	3D Sonic Anemometers (Metek GmbH, USA-1 and Gill Instruments, HS-50)
	In-situ meteorological variables (P-T-RH-Ws-Wd-Rad)	Meteo Station Lufft, WX700
	Radiation (Short/Long wave, Up/Down)	Radiometer, Kipp & Zonen, CNR-1
	Fluxes	15m Meteo Tower with T sensors at different altitudes

Boundary-layer Air Quality-analysis Using Network of Instruments (BAQUIN, 'Roma-La Sapienza')

Instrument	Products
MWL-LIDAR	Aerosols, H2O, clouds (profiles)
RAP-LIDAR	Aerosol, clouds (base-top-profiles)
CEILOMETER	Aerosol, Clouds (base)
Air-quality (low cost)	T, p, H2O, O3, CO, CO2, PM2.5, PM10 (in situ)
MFRSR	Radiance, aerosols, O3, H2O (column)
PREDE-POM	Radiance, aerosols, H2O (column), clouds
PANDORA-2S	Radiance, O3, NO2, SO2, HCHO, H2O, aerosols (column, trop., surf., profiles)
CIMEL	Aerosols, H2O (column), clouds
Pyranometer	Radiance, clouds
All Sky Camera (3)	Cloud screening
Meteo sensors	Air temperature and relative humidity, wind speed/direction (in situ)
SODAR	Wind vector in PBL (profiles), turbulence
Micro-barometer	Atmospheric pressure
BREWER	UV Irradiance, Radiance, O3, NO2 (column)



+ Aerial Measurements

SYNERGIES WITH MAIA and ENMAP

- Increase satellite temporal resolution (for ex. over Rome, Italy)
- Increase ground-truth collection (also with reference health effects)
- Products Cross comparison
- Generate hybrid retrieval techniques
- Super-resolve MAIA products using PRISMA products and AI

THANKS FOR YOUR ATTENTION !

