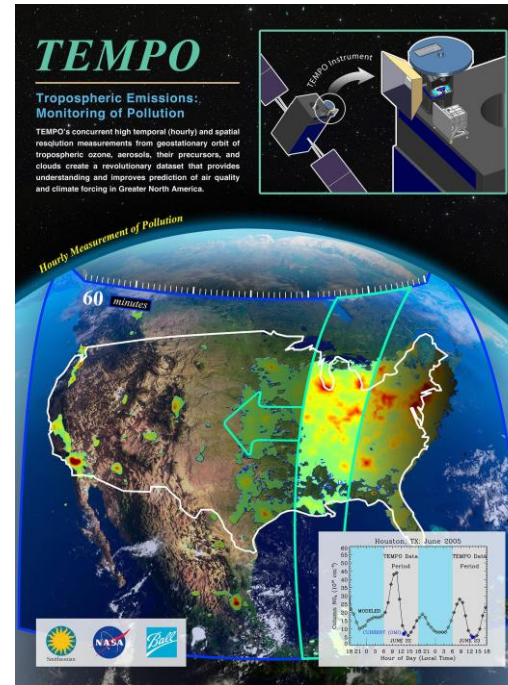
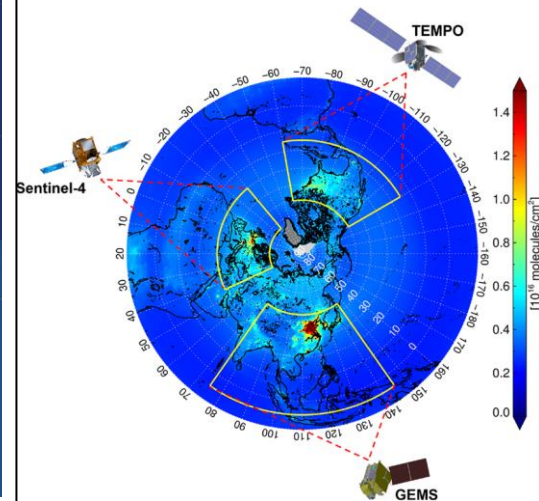
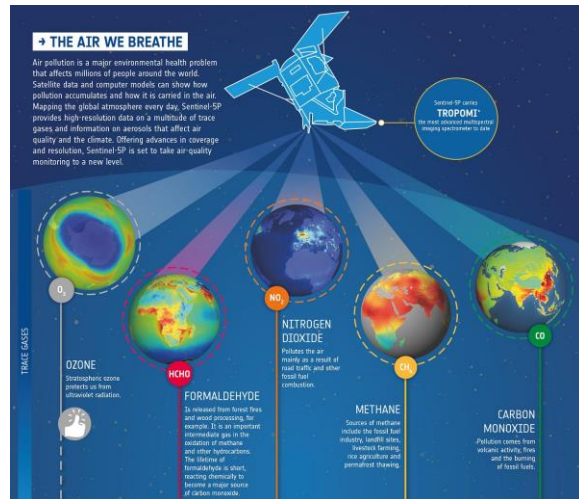

XI Giornata della Modellistica in ARIA(NET)
Milano, 11 aprile 2024

Assimilazione dati satellitari in FARM

Alessandro D'Ausilio, Camillo Silibello



A new ERA of geostationary satellites

2017
Sentinel 5P

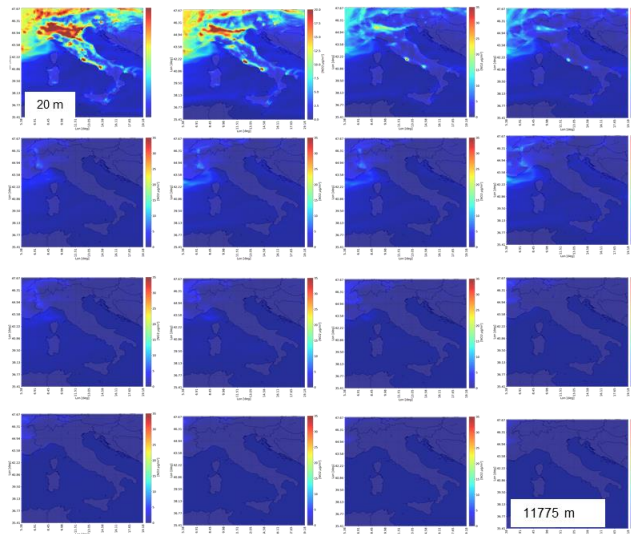
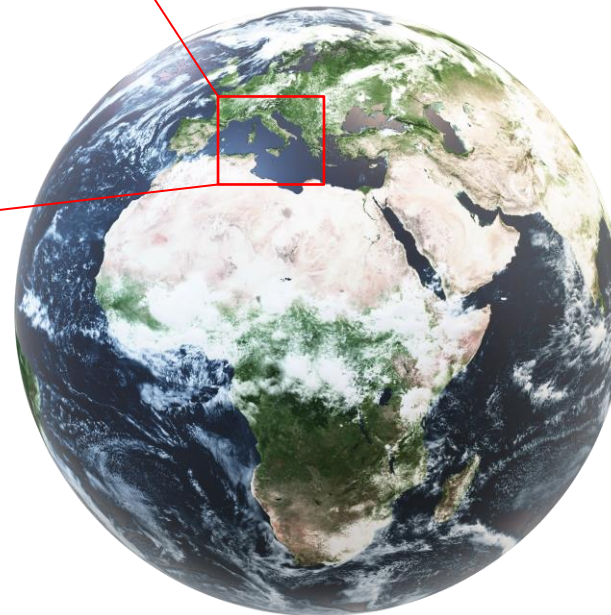
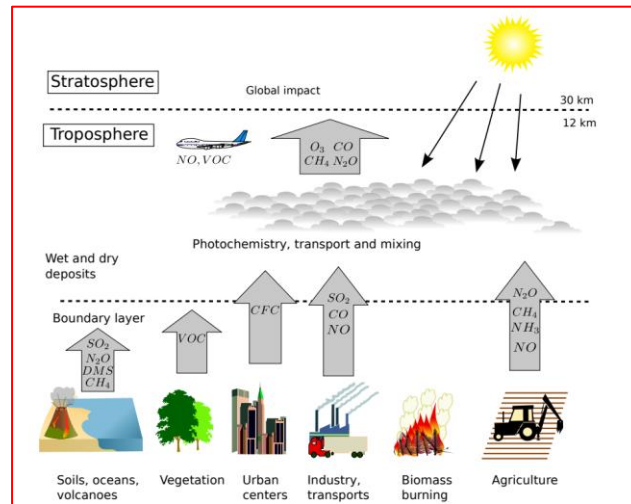
2019/2020
GEMS

2022
TEMPO

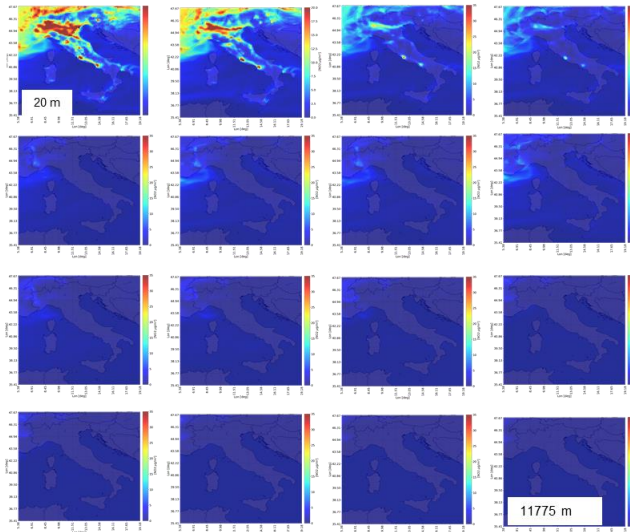
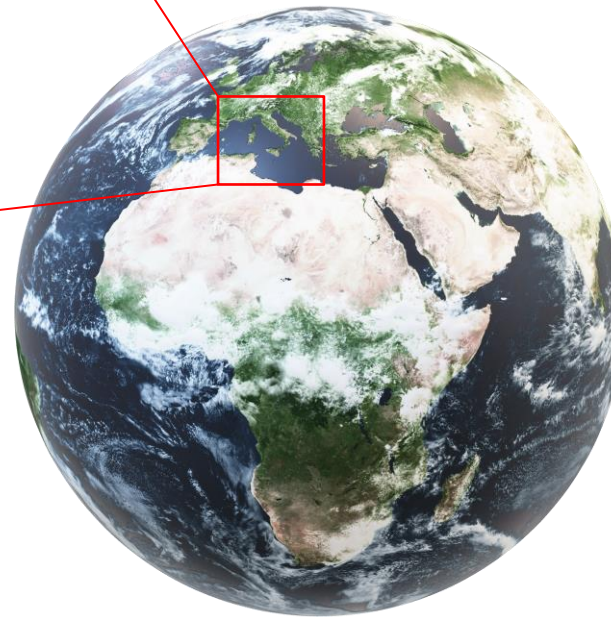
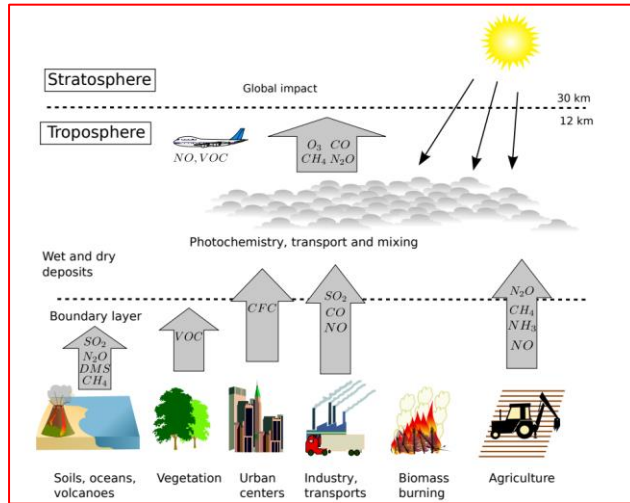
2023-2024
Sentinel-4



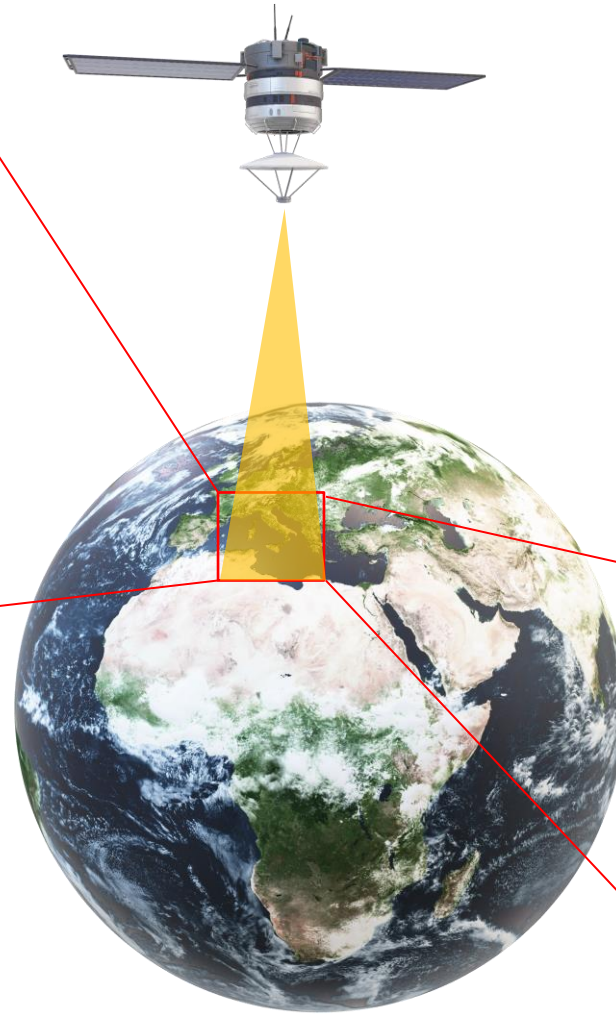
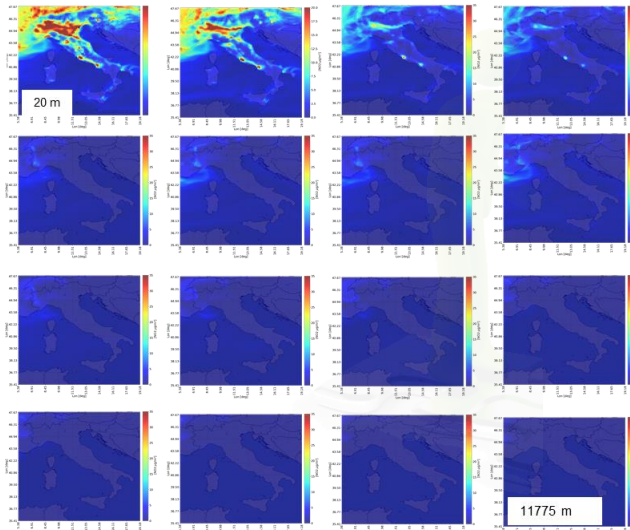
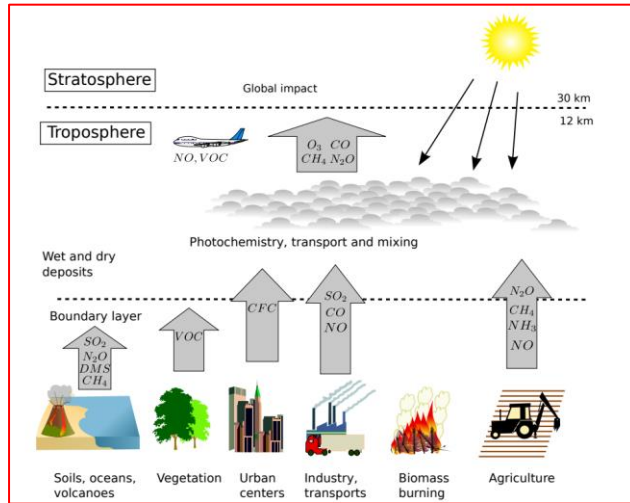
Chemistry Transport Model



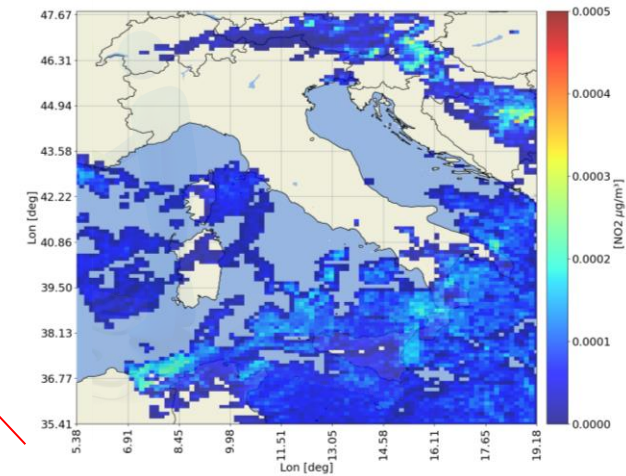
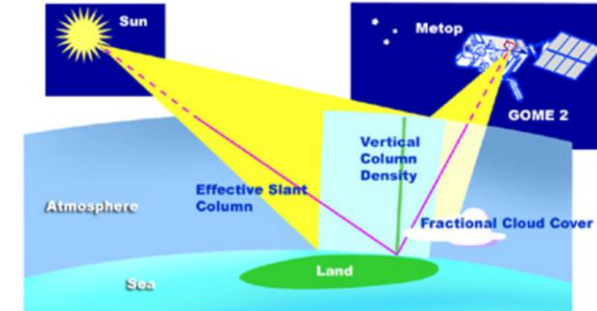
Chemistry Transport Model



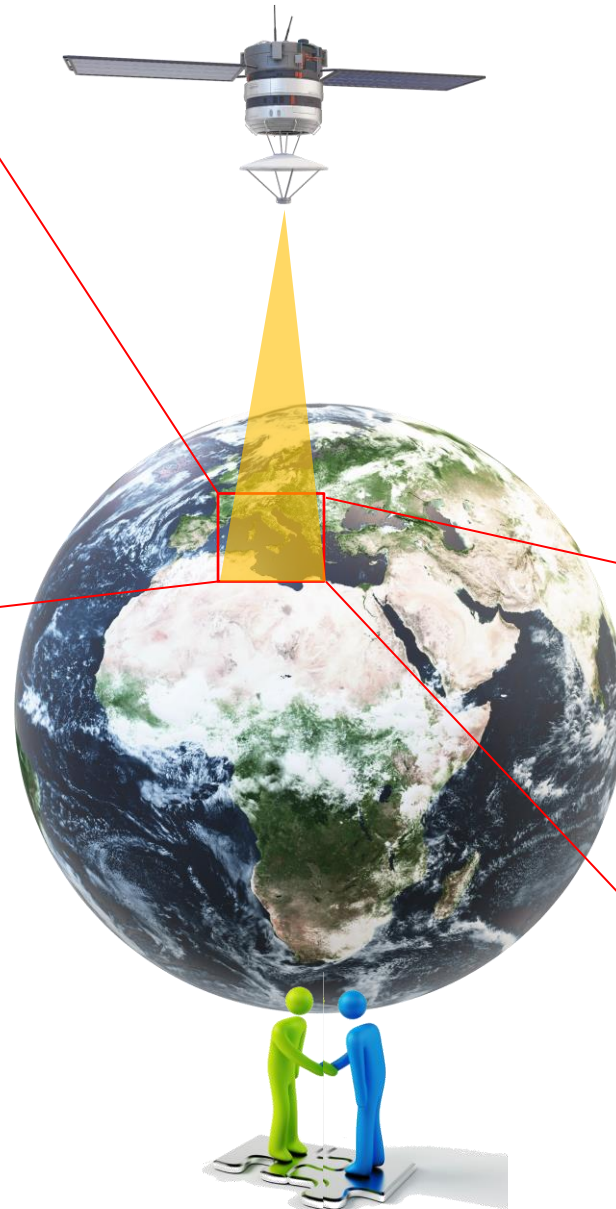
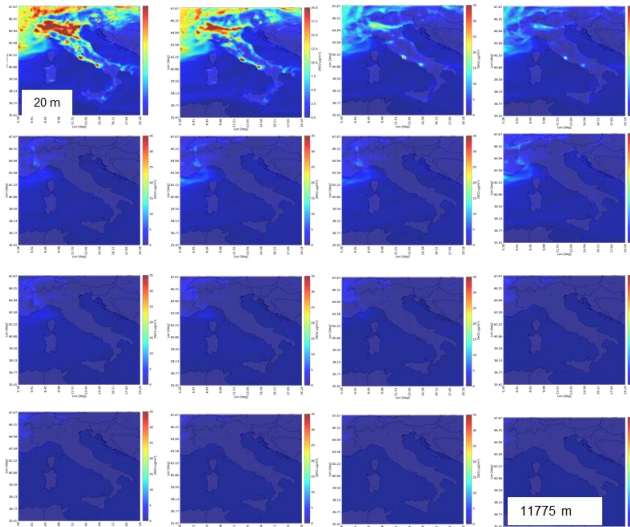
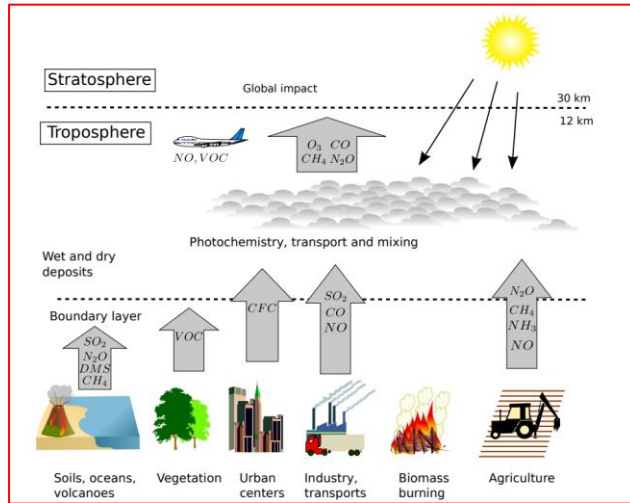
Chemistry Transport Model



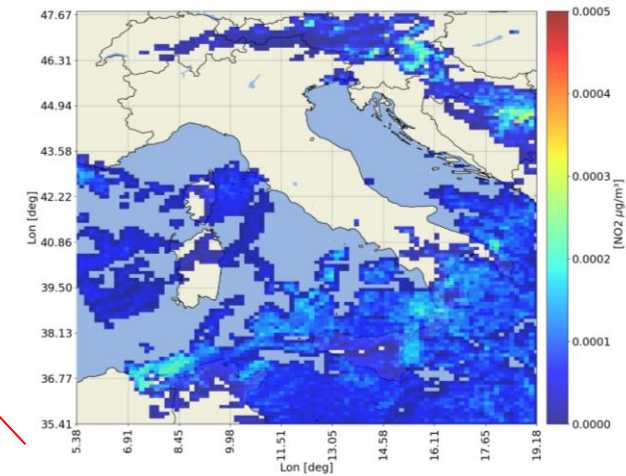
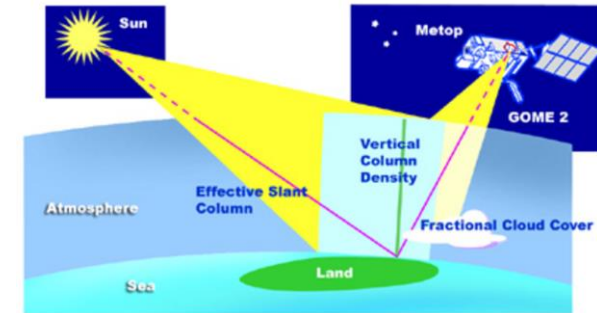
Earth Observation

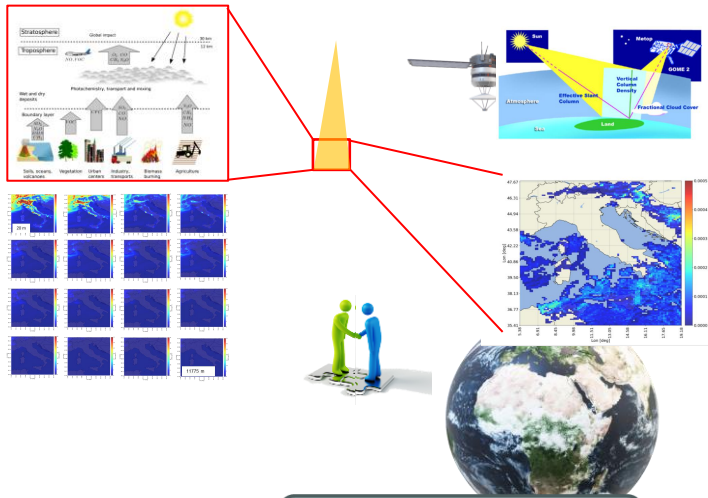


Chemistry Transport Model

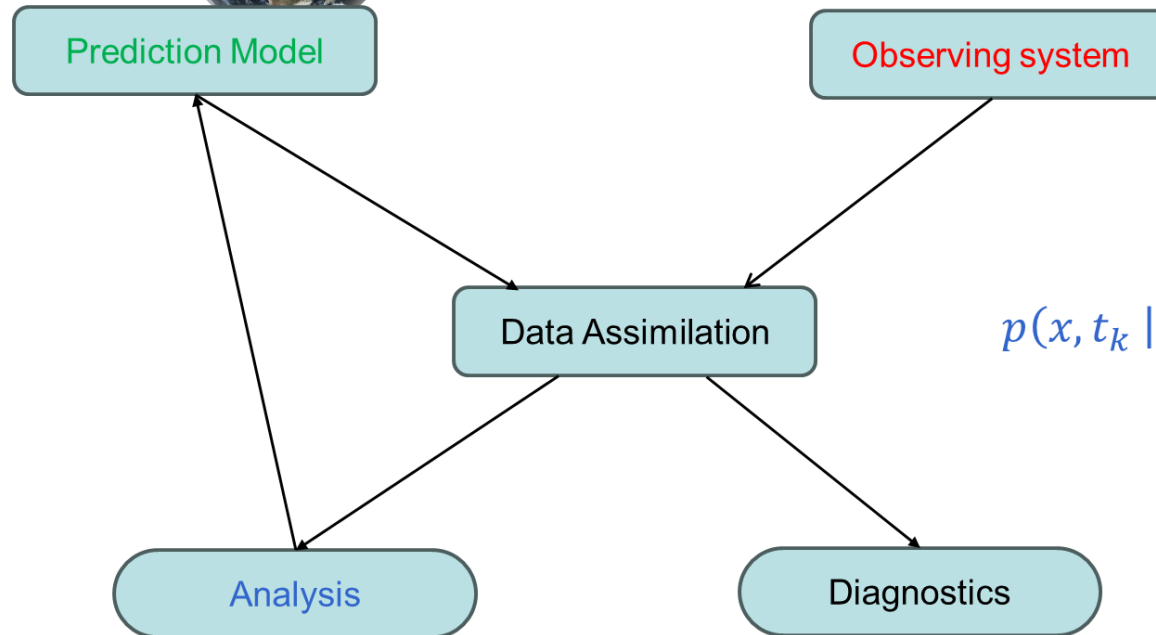


Earth Observation



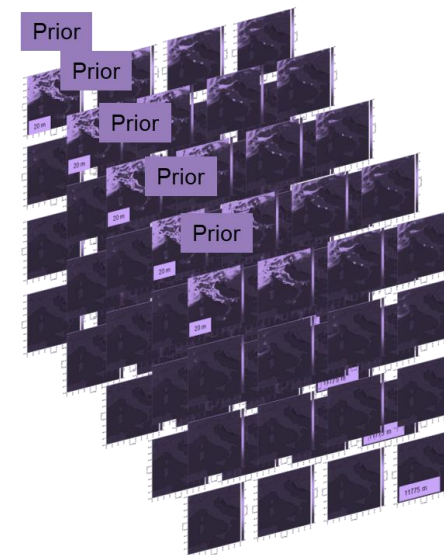
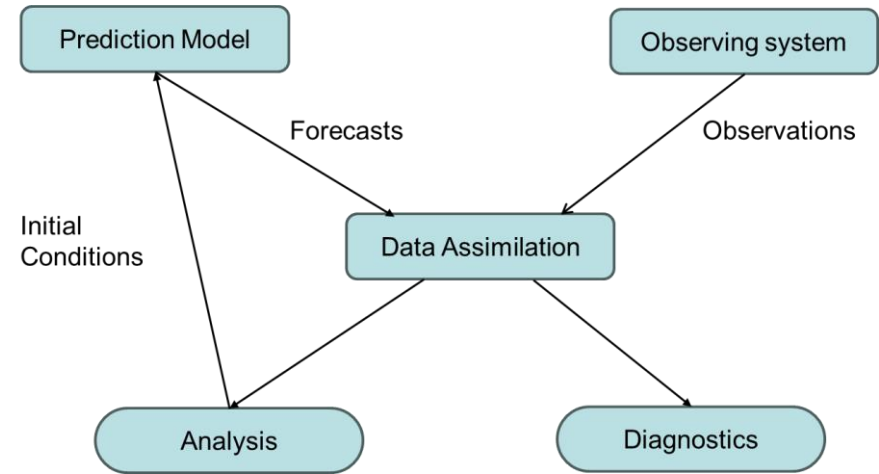
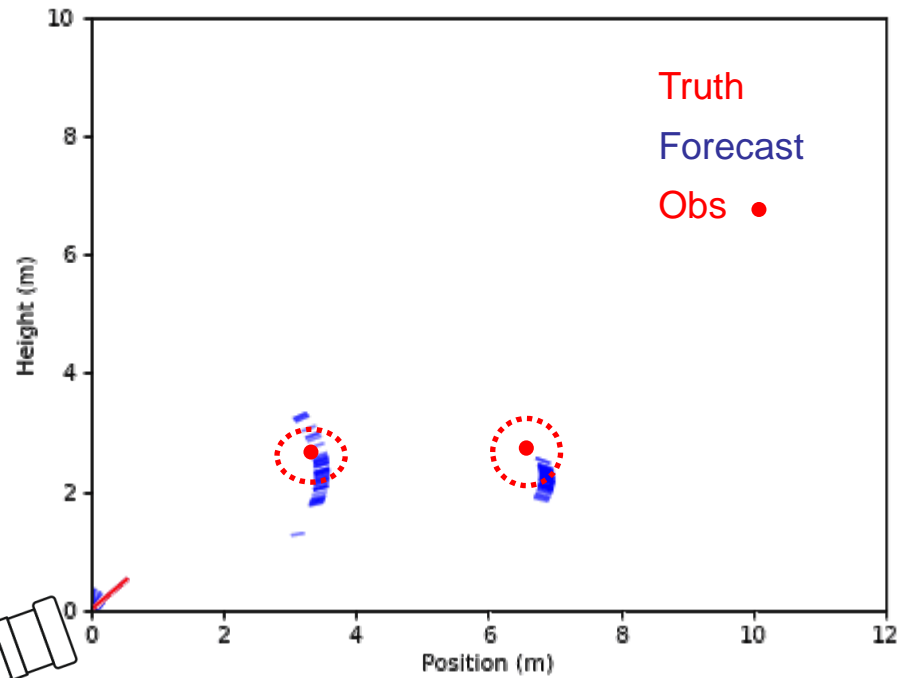


- Forecasts
- Estimate model free parameters
- Identify Systematic Errors
- Estimate Tracer Sources/Sinks
- Observing system simulation experiment (OSSE)



Bayes Theorem

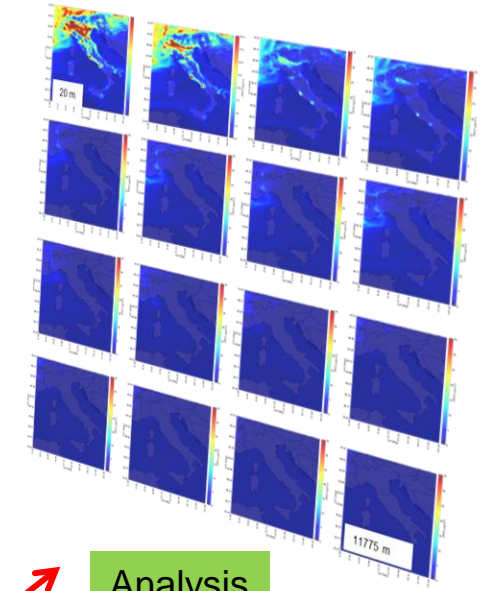
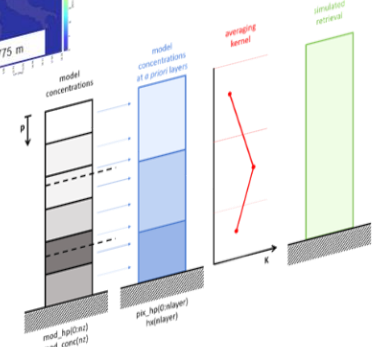
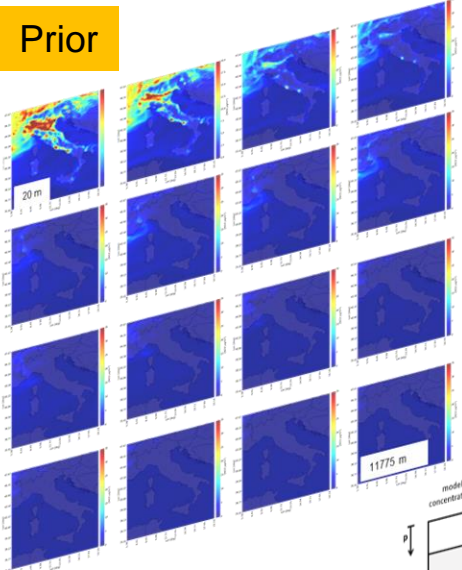
$$p(x, t_k | Y_{t_k}) = \frac{p(y_k | x) p(x, t_k | Y_{t_{k-1}})}{\int p(y_k | \xi) p(\xi, t_k | Y_{t_{k-1}}) d\xi}$$



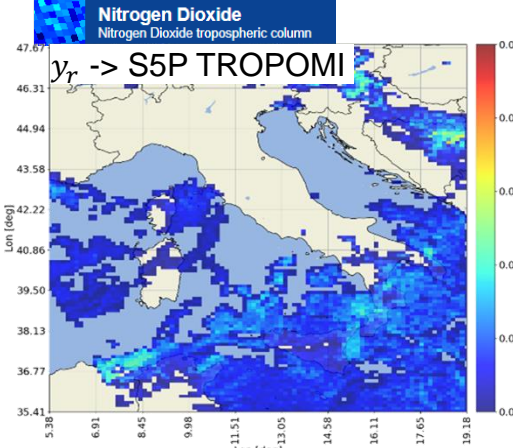
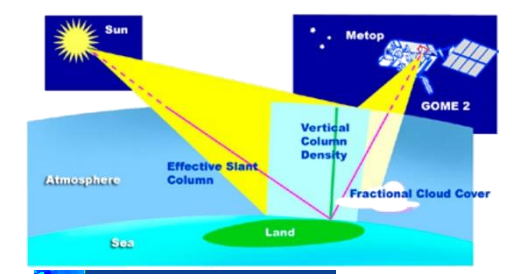
EnKF needs N members for the ensemble

Challenges: from model to observation space

Prior



Analysis



$H(x)$

Forward Operator
Function that maps model variables to observed quantities.

$$X_a = X_p + K[y_0 - Hx_f]$$

K: Filter

Increment

IRIDE



MEEO



S2-Qualita' dell'aria
 Monitoraggio e previsione qualita' dell'aria
 Monitoraggio e valutazione delle emission
 inquinanti
 Rianalisi della qualita' dell'aria su scala nazionale



Domande Risposte	Formato di IRIDE Service User's Choice	Formato di IRIDE OSP Products (Primo Versione Pubblicata)
S2- Qualita' dell'aria	SE-S2-03 for analysis of air quality at national scale Total SVCS: 3	OU-S2-03-01: Combined trace gases (NO2, O3, AQI) OU-S2-03-02: Combined PM (PM10, PM2.5)

environmental activities
 proceedings

Proceeding Paper
IRIDE the Euro-Italian Earth Observation Program: Overview, Current Progress, Global Expectations and Recommendations
 Tommaso Orusa ^{1,1*}, Annalisa Viani ^{1*} and Enrico Bolognani-Mondino ^{1*}

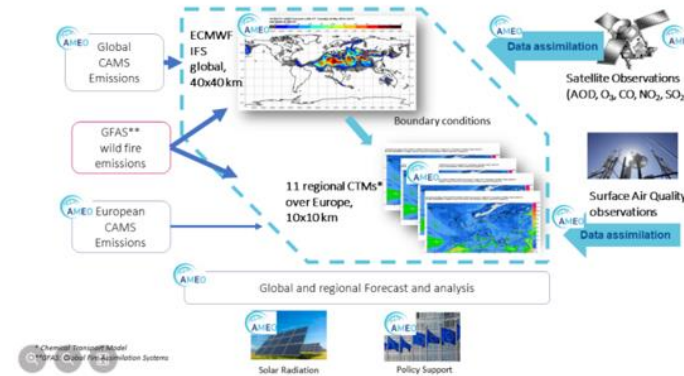
Online GEOmedia 6 2023 - Speciale costellazione IRIDE (rivistageoedia.it)

CAMEO

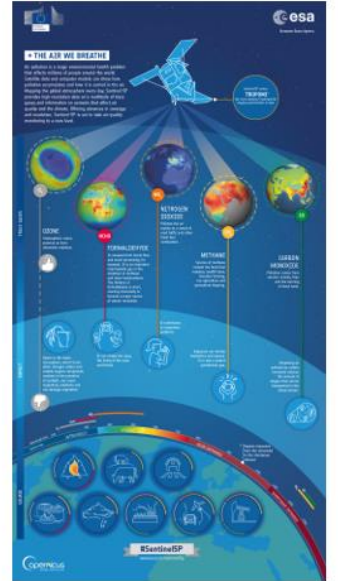


ENEA

CAM Service Evolution: CAMEO



Progetto CAMEO | Dipartimento Sostenibilità, circolarità e adattamento al cambiamento climatico dei Sistemi Produttivi e Territoriali (enea.it)





IRIDE: DAI SERVIZI DEFINITI DALL'UTENTE ALLE COSTELLAZIONI DI SATELLITI, IL PRIMO SISTEMA ITALIANO END-TO-END DI OSSERVAZIONE DELLA TERRA
 DI FEDERICA MASTRACCI E SERENA GERALDINI



S2-Qualita' dell'aria
 Monitoraggio e previsione qualita' dell'aria
 Monitoraggio e valutazione delle emission inquinanti
 Rianalisi della qualita' dell'aria su scala nazionale

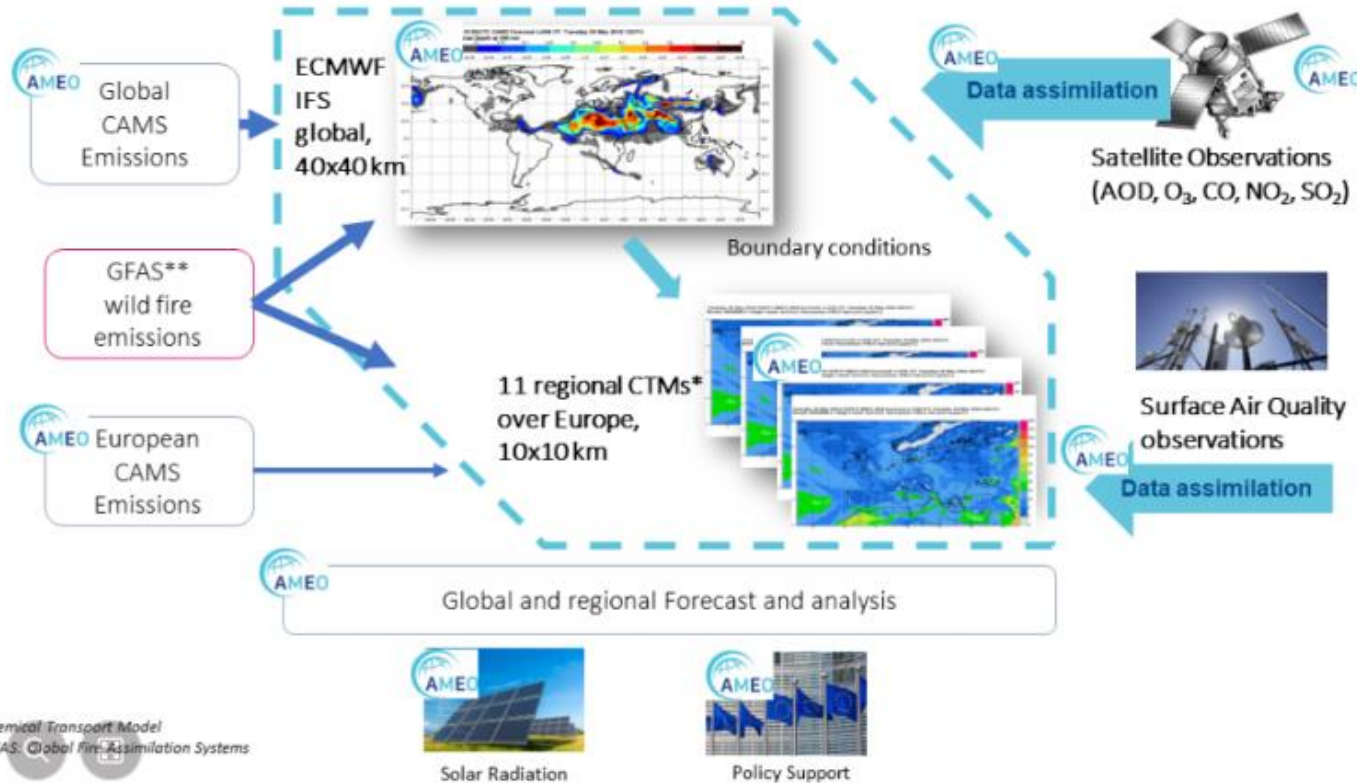
Dominio Tematico	Esempi di IRIDE Service Value Chains (Prima Versione-Precursor)	Esempi di IRIDE GSP Products (Prima Versione-Precursor)
S2- Qualità dell'Aria	SE-S2-03 Re-analysis of air quality at national scale Total SVCs: 3	OU-S2-03-01 Combined trace gases (NO2, O3, AQI) OU-S2-03-02 Combined PM (PM10, PM2.5)



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Tommaso Orusa ^{1,2,3,*}, Annalisa Viani ^{3,4} and Enrico Borgogno-Mondino ^{1,4}

CAM Service Evolution: CAMEO



* Chemical Transport Model
 ** GFAS: Global Fire Assimilation Systems

→ THE AIR WE BREATHE

Air pollution is a major environmental health problem that affects millions of people around the world. Satellite data and computer models can show how pollution accumulates and how it is carried in the air. Mapping the global atmosphere every day, Sentinel-5P provides high-resolution data on a multitude of trace gases and information on aerosols that affect air quality and the climate. Offering advances in coverage and resolution, Sentinel-5P is set to take air-quality monitoring to a new level.

Sentinel-5P orbits TROPOMI the most advanced multi-spectral mapping spectrometer to date.

TRACE GASES

- OZONE**: Stratospheric ozone protects us from ultraviolet radiation.
- FORMALDEHYDE (HCHO)**: Is released from forest fires and wood processing, for example. It is an important intermediate gas in the oxidation of methane and other hydrocarbons. The lifetime of formaldehyde is short, reacting chemically to become a major source of carbon monoxide.
- NITROGEN DIOXIDE (NO₂)**: Pollutes the air mainly as a result of road traffic and other fossil fuel combustion. It contributes to respiratory problems.
- METHANE (CH₄)**: Sources of methane include the fossil fuel industry, landfills, rice, livestock farming, rice agriculture and permafrost thawing. Exposure can include headaches and nausea. It is also a potent greenhouse gas.
- CARBON MONOXIDE (CO)**: Pollution comes from volcanic activity, fires and the burning of fossil fuels. Breathing air polluted by carbon monoxide reduces the amount of oxygen that can be transported in the blood stream.

IMPACT

- Ozone in the lower atmosphere, which forms when nitrogen oxides and volatile organic compounds combine in the presence of sunlight, can cause respiratory problems and can damage vegetation.
- It can irritate the eyes, the lining of the nose and throat.
- Exposure can include headaches and nausea. It is also a potent greenhouse gas.

SOURCE

- Wildfires
- Industry
- Transport
- Agriculture
- Landfills
- Permafrost
- Residential heating
- Power generation
- Maritime shipping
- Aviation
- Shipping
- Offshore oil and gas

#Sentinel5P
www.esa.int/sentinel5p

Copernicus

- Coupling FARM with DART
- Assimilation Sentinel 5P, S4, IRIDE
- Assimilation ground stations with DART
- Bring FARM to the SOA DA techniques

Thank you for your attention