ATMOS 2024

CNR Intro

An overview of Earth Observation activities, with a focus on terrestrial Atmosphere and its interfaces with other components of the Earth's System

Ugo Cortesi (CNR-IFAC), on behalf of representatives of the Italian EO scientific community

Introduction

- In response to ESA's invitation, this opening talk provides **a brief overview of CNR's Earth Observation activities** conducted in cooperation with ESA, along with other national and international parties, and **focusing on terrestrial atmosphere and its interfaces with other components of the Earth System**.
- As the largest among the Public Research Entities (EPR) in Italy, CNR seizes the opportunity of a strong **multidisciplinary and interdisciplinary environment** especially valuable in sectors like Earth Observation from Space.
- **National collaborations with ASI, academic groups and other EPRs** (INAF, INGV, etc.) lay the necessary foundation to effectively address the challenges within the European context
- **Various interactions between CNR and ESA** are here represented in a nutshell, spanning from contributions to new mission concepts, to feasibility and requirement studies, to subsequent phases of both scientific and operational missions, including major efforts in development of new algorithms/products, and in Cal/Val activities.

(*)Hakuryu

Launch 28 May 2024
22:20 UTC (29 maggio ore 00:20 locale)
from Wandenberg (CA)

EarthCARE

ESA/JAXA Earth Clouds Aerosol Radiation Explorer

EarthCARE and CNR contributions

- **CNR-ISAC** has been contributing to
  - **ESA EarthCARE MAG** together with top scientist colleagues from University of Reading, ECMWF, Politecnico di Torino, Stony Brook University, Leipzig Institute for Meteorology, KNMI, Environment Canada, Royal meteorological Institute of Belgium, DLR, FU Berlin, Max-Planck-Institute for Meteorology

- **CNR** is contributing to
  - **EarthCARE Validation** through “An Italian coordinated contribution to the Validation of EarthCARE products from three atmospheric observatories in the Central Mediterranean Sea” (CNR ISMAR, CNR ISAC, Sapienza, ENEA and the support of ASI through the ASI call for Ideas 2022) and “EACARE” (ACTRIS for EarthCARE L2 product evaluation)
  - **Best practices for the validation of Aerosol, Cloud, and Precipitation Profiles** initiative (CNR ISAC, ISMAR, IMAA)

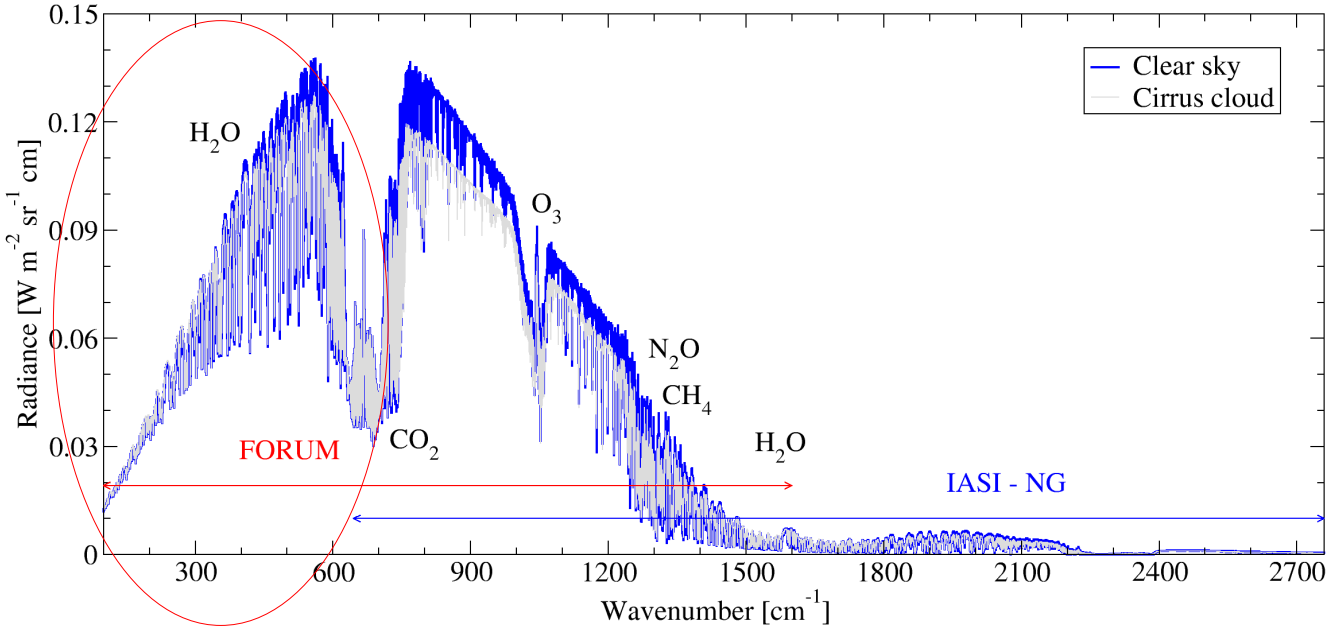
HISTORY OF FORUM EARTH EXPLORER 9 MISSION

CNR page
https://www.forum-ee9.eu/

- Radiation Explorer for the Far-infrared (EU project 1998 Coordinated by UniBO, Italy)
- FORUM: Submitted by CNR to ESA Earth Explorer 8 (2010) – top 4 but not selected (PI. L.Palchetti)
- Earth Explorer 9 Call (Dec. 2016) – FORUM proposal submitted by CNR (PI. L.Palchetti)
  - Selected as 1 of 2 missions to enter competitive feasibility studies (Phase A, Nov. 2017)
  - Submitted Report for Mission Selection (June 2019)
  - ESA Earth Explorer 9 User Consultation Meeting (July 2019
    - ACEO provide their recommendation to PB-EO
    - MSR: https://www.forum-ee9.eu/forum-report-for-selection/
- FORUM formally approved by PB-EO as the Earth Explorer 9 (Sept 2019)
- Currently in Phase C
- Launch planned for 2027

The FORUM measurement

First global observations of the spectrally resolved Earth's OLR in the FIR with sufficient precision and absolute accuracy to evaluate the role of the FIR in shaping the current climate and thus reduce uncertainty in predictions of future climate change.

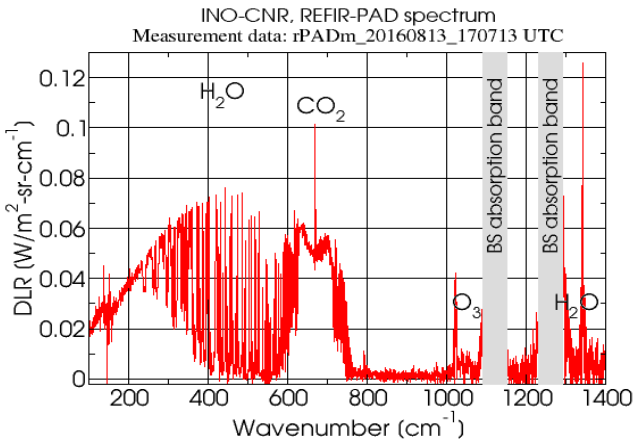


It is proposed to fly in tandem with IASI-NG to deliver a measurement of the spectrum with unprecedented coverage from **100 to 2760 cm^{-1}** (3.62-100µm)

Scientific support to mission preparation: field FIR campaigns

Unique FIR spectral measurements from ground and stratospheric platforms

REFIR-PAD (CNR-INO, ASI) from 2005 to date
From stratospheric balloon (34 km) and high-altitude sites (>3km)
FIRMOS (ESA – CNR-INO – ASI)
From high-altitude sites
FIRMOS-B (ESA – CNR-INO – ASI)
From stratospheric balloons



Data analysis studies with specific forward / inverse tools:

- SACR (Simultaneous Atmosphere and Cloud Retrieval): CNR-INO code
- FARM (Fast Retrieval Model): developed at CNR-INO with support of CNR-ISAC, exploits the **σ**-F2N fast forward model developed at University of Basilicata and University of Bologna.

Scientific support to mission preparation, ASI support

- **FORUM –SCIENZA (ASI, CNR-INO, 2019-2022)**

Goals: to develop a new algorithm for direct FIR simulations and simultaneous data retrievals of atmospheric parameters and optical and microphysical properties of clouds, and to optimise some subsystems of FIRMOS for balloon stratospheric flights

- **FORUM-BALLOON ((ASI, CNR-INO, 2021-2024)**

Goals: to design and build a new prototype starting from the ground prototype FIRMOS, optimised for balloon stratospheric flights

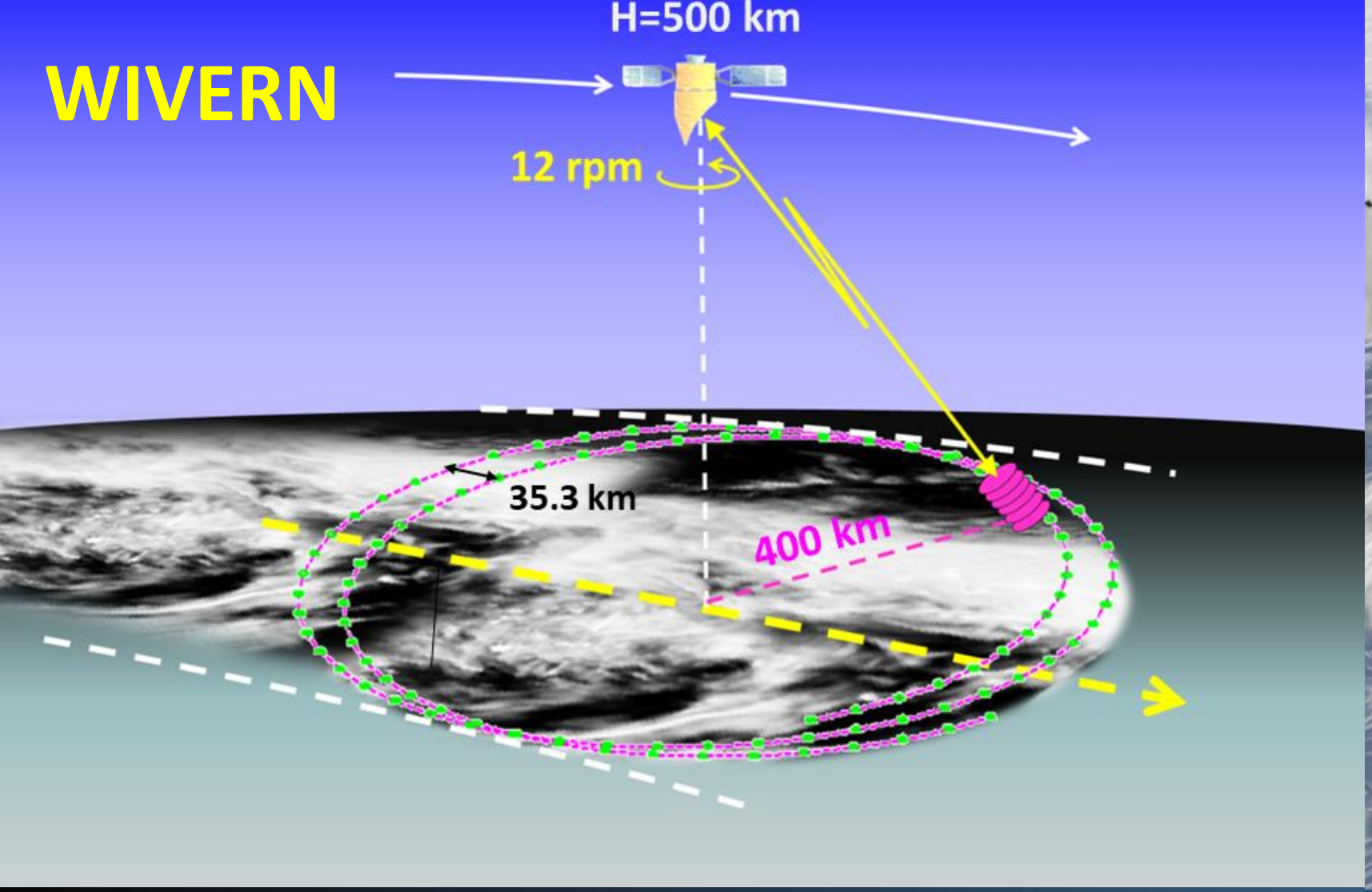
- **FIT-FORUM – Forward and Inverse Tool for FORUM (ASI, Univ. Bologna, 2023-2025)**

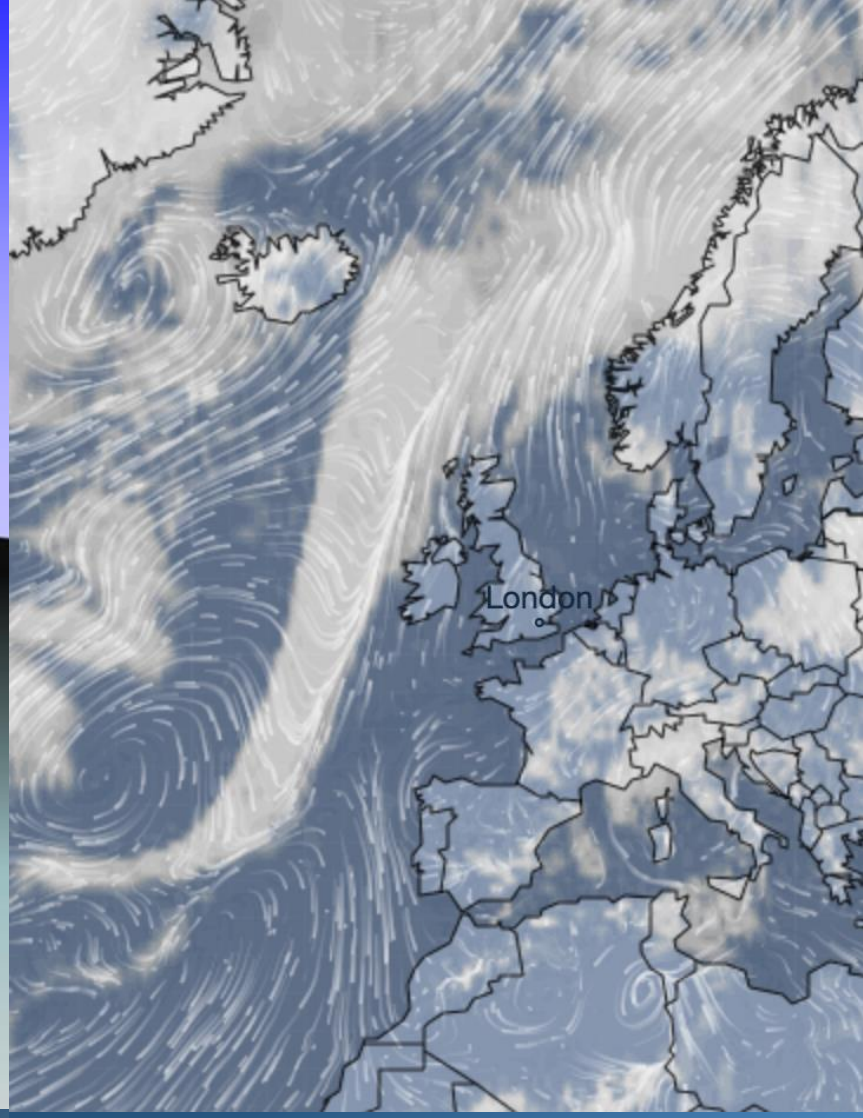
Goal: to develop and implement a modular and flexible radiative transfer code for the forward simulation and the inversion of spectral radiances in the (Far and Mid) infrared part of the spectrum, with focus on FORUM observations.

- **MC-FORUM - Meteo and Climate exploitation of FORUM (ASI, CNR-IBE, 2023-2025)**

Goal: to develop tools and competencies for the exploitation of the future FORUM measurements in support of numerical weather predictions and climate models.

WIVERN





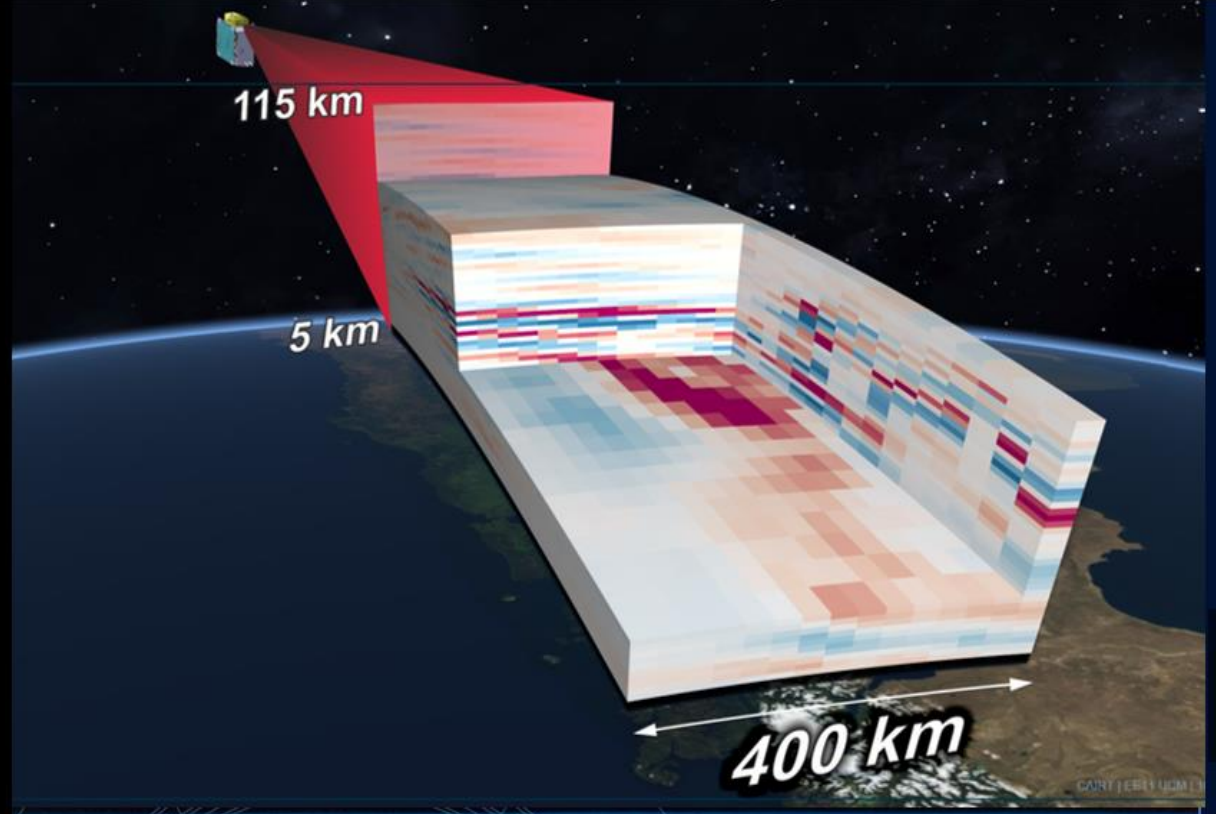
- ESA EE11 candidate mission for the study of the **global in-cloud winds**
- Currently in **Phase A** (launch in 2030 if selected in July 2025).
- First-ever **conically scanning** 94GHz **radar** with **Doppler** capabilities
- Flagship product: **in-cloud vertical profiles of winds** over 800km swath
- Other products: **CloudSat/EarthCARE heritage** but with **30-40 times better sampling**

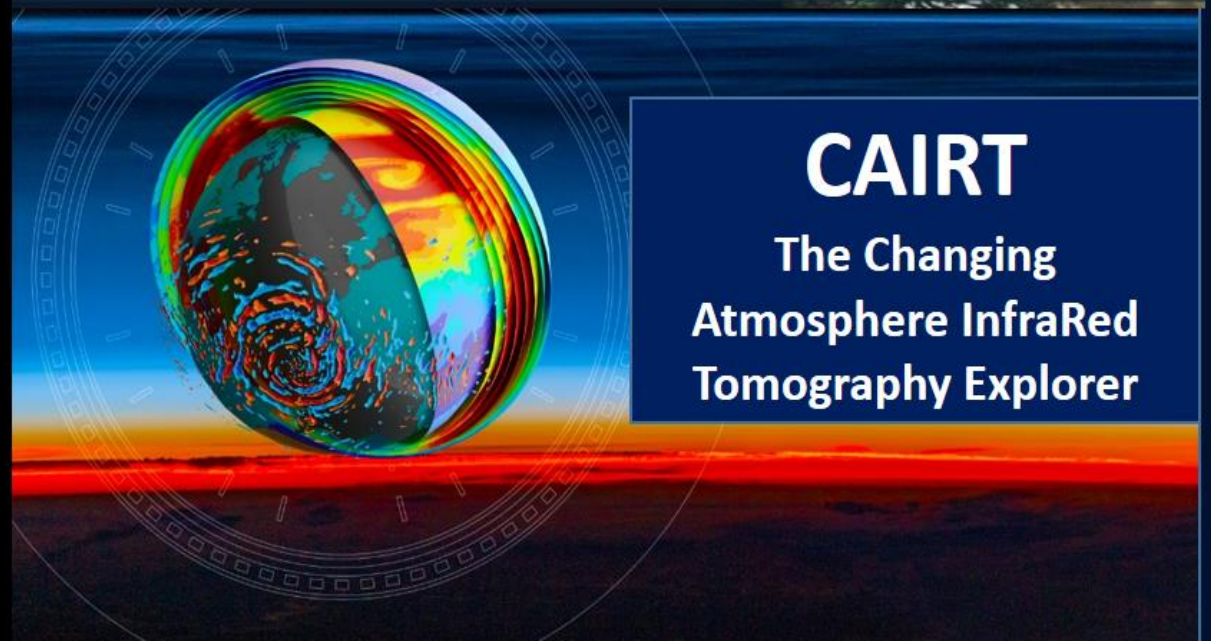
Wolde et al., AMT 2018
Battaglia et al, AMT, 2018, 2022, 2023
Illingworth et al., BAMS, 2018.
Battaglia et al, IEEE TGRS, 2017

WIVERN and CNR Contributions

- **CNR-ISAC** is contributing to **Wivern MAG** together with top scientist colleagues from University of Reading, Politecnico of Turin, University of Leicester, CNRS, Meteo France, Swedish Meteorological and Hydrological Institute, Max Planck Institute for Meteorology, Stony Brook University, Leipzig Institute for Meteorology, ECMWF, National Observatory of Athens and the Finnish Meteorological Institute.

- **CNR-ISAC** is contributing, through sub-contracts from Politecnico of Turin to:
  - **ASI call for Ideas** (*Wivern data assimilation study of extratropical cyclones*, *AI applied to Wivern retrievals of ice content*, *Wivern polarimetry for ice content constraints*)
  - **ESA phase A studies** *(Wivern data assimilation studies for diversified type of severe events, mission validations plans, Wivern products of ice retrievals).*



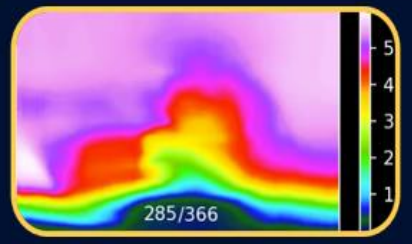


CAIRT

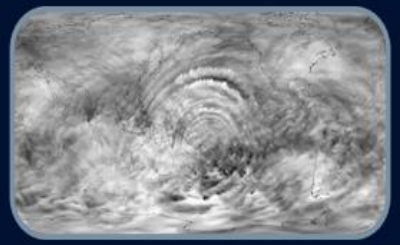
The Changing Atmosphere InfraRed Tomography Explorer

- CAIRT is one of the two ESA EE11 candidate missions for the study of the coupling between composition, circulation and climate change
- Main scientific objectives:

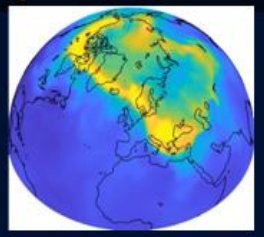
Diagnostics of the atmospheric circulation



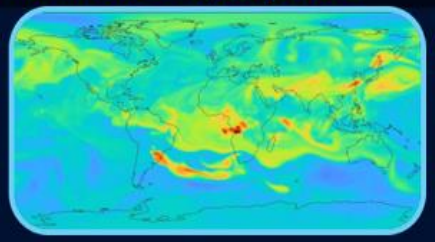
and its driving: gravity waves



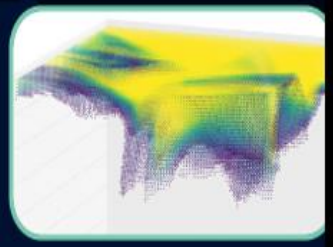
Investigation of coupling of middle atmosphere with space weather



Quantification of injection of pollutants and aerosols from the troposphere



Resolving Stratosphere-Troposphere Exchange and impact on climate



- It exploits MIPAS heritage but it is the first **imaging limb instrument from space allowing 3D observations with un-precedented spatial resolution**
- Currently in **Phase A**

CAIRT and CNR Contributions

- After a pluri-decennial activity for the L2 analysis of MIPAS on ENVISAT, **CNR-IFAC** is contributing to **CAIRT MAG** together with Karlsruhe Institute of Technology (Germany), Forschungszentrum Jülich (Germany), University of Leeds (United Kingdom), Royal Belgian Institute of Space Aeronomy (Belgium), Instituto de Astrofísica de Andalucía (Spain), National Centre for Scientific Research (France), ECMWF, University of Toronto (Canada), University of Oxford (United Kingdom), University of Oulu and Finnish Meteorological Institute (Finland)

- **CNR-IFAC** is contributing, together with other CNR Institutes (ISAC-CNR, INO-CNR, IAC-CNR), INGV and other Italian Academic Institutions (University of Bologna and University of Basilicata) to:
  - **ASI call for Ideas** (*CASIA: CAIRT Analysis and Synergy with IASI-NG*)
  - **ESA phase A studies** *(Performance and Requirement Consolidation-CAIRT, impact study on volcanic hazard on air traffic).*

Copernicus Sentinel-4 and Sentinel-5 missions and CNR Contributions

- **CNR-IFAC** is contributing to **Sentinel-4/Sentinel-5 MAG** together with IUP-Bremen, BIRA/IASB, Wageningen University, ECMWF, SRON, Rutherford Appleton Laboratory, DLR, KNMI, Eumetsat, University Warsaw, EC, Brussels.
- **CNR-IFAC has been** contributing to the preparatory studies for explotation of S-4 and S-5 data products by coordinating the Horizon 2020 project AURORA in a joint effort with ECMWF, KNMI, BIRA-IASB, FMI, and industrial partners
- AURORA (Advanced Ultraviolet Radiation and Ozone Retrieval for Applications) investigated the potential of assimilating synergistic products obtained by applying to synthetic data of S.4 and S.5 the CDF (Complete Data Fusion) a posteriori data fusion algorithm developed at CNR-IFAC
- The CDF has been continuously upgraded and tested by CNR-IFAC in the last decade and it is now ready tor completing the investigation on assimilation of fused products through experiments on S-4 and S-5 real measurements.

ESA/EUM contracts related to TCWV retrieval from ATSR instruments using AIRWAVE

[2015/2016] ESA ATSR Long Term Stability (ALTS)

- WP 3100 - TCWV (sea) Algorithm Implementation
- WP 3200 - TCWV (land) feasibility study

[2016/2017] ESA IDEAS+ WP 3610 Radiative Transfer Simulation for QA4EO and radiation budget studies.

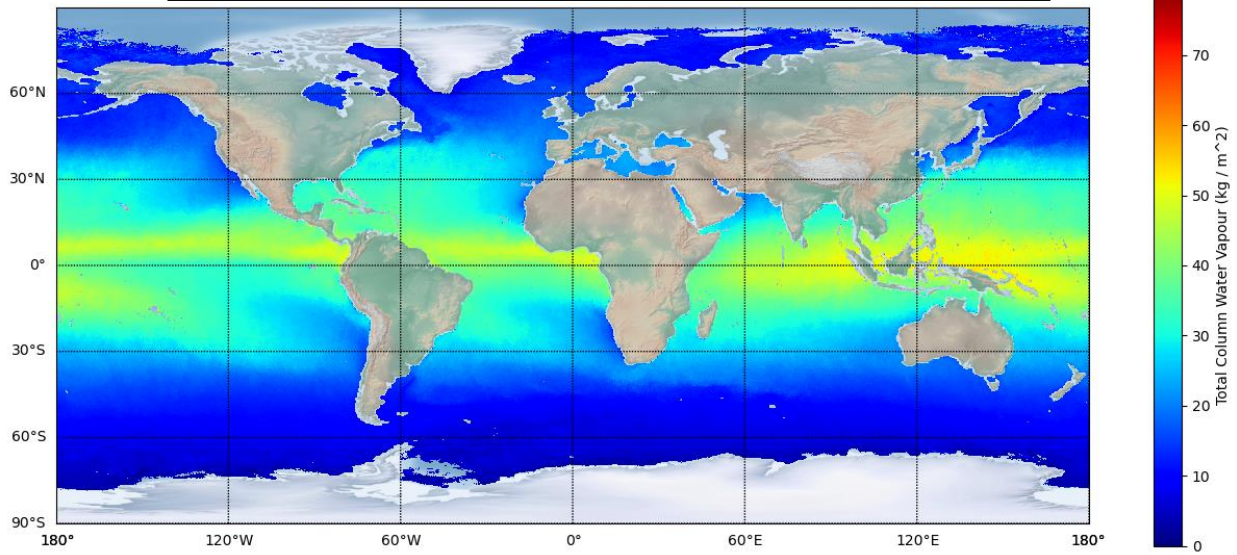
[2018/2019] ESA IDEAS+ WP 3490 AIRWAVE water vapour exploitation for coastal altimetry.

[2019/2023] EUMETSAT AIRWAVE-SLSTR: an algorithm to retrieve TCWV from SLSTR measurements over water surfaces + follow-on study.

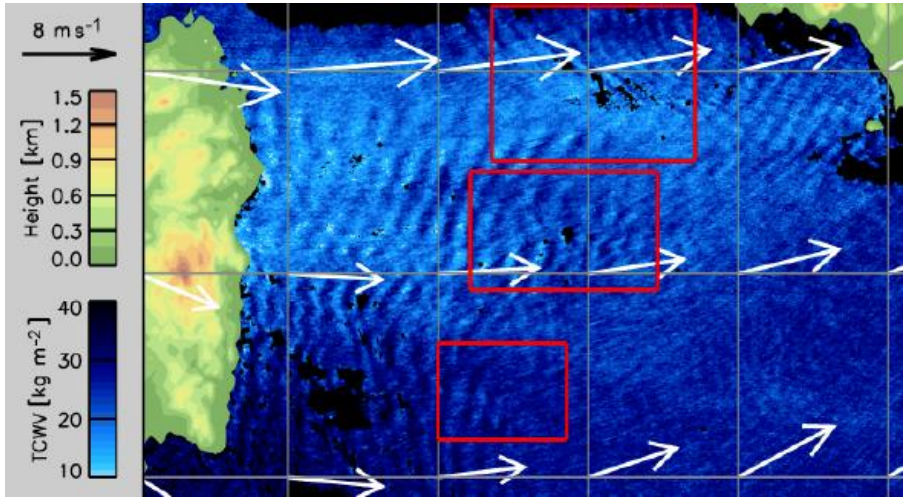
[2023/2024] ESA IDEAS-QA4EO Total Column Water Vapour Essential Climate Variable from (A)ATSR(-1/2) reprocessed L1 data series using AIRWAVE-V3

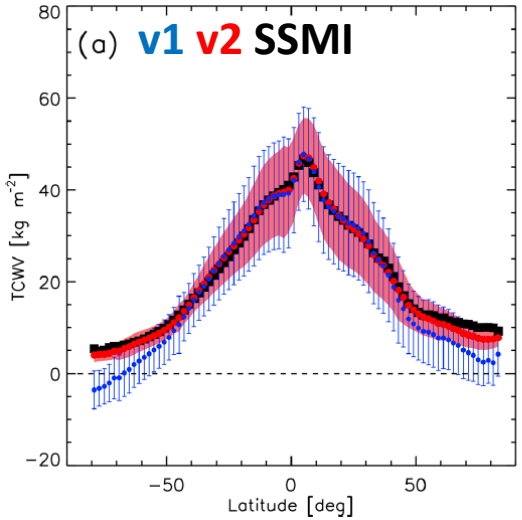
AIRWAVE results

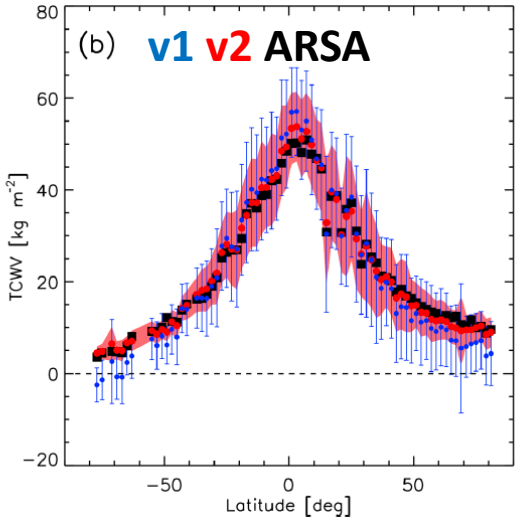
Global TCWV mean, AIRWAVEv3 ATSR data



Lee waves, AIRWAVEv2, 18 July 1997
Tyrrhenian Sea (Papandrea et al., 2019)



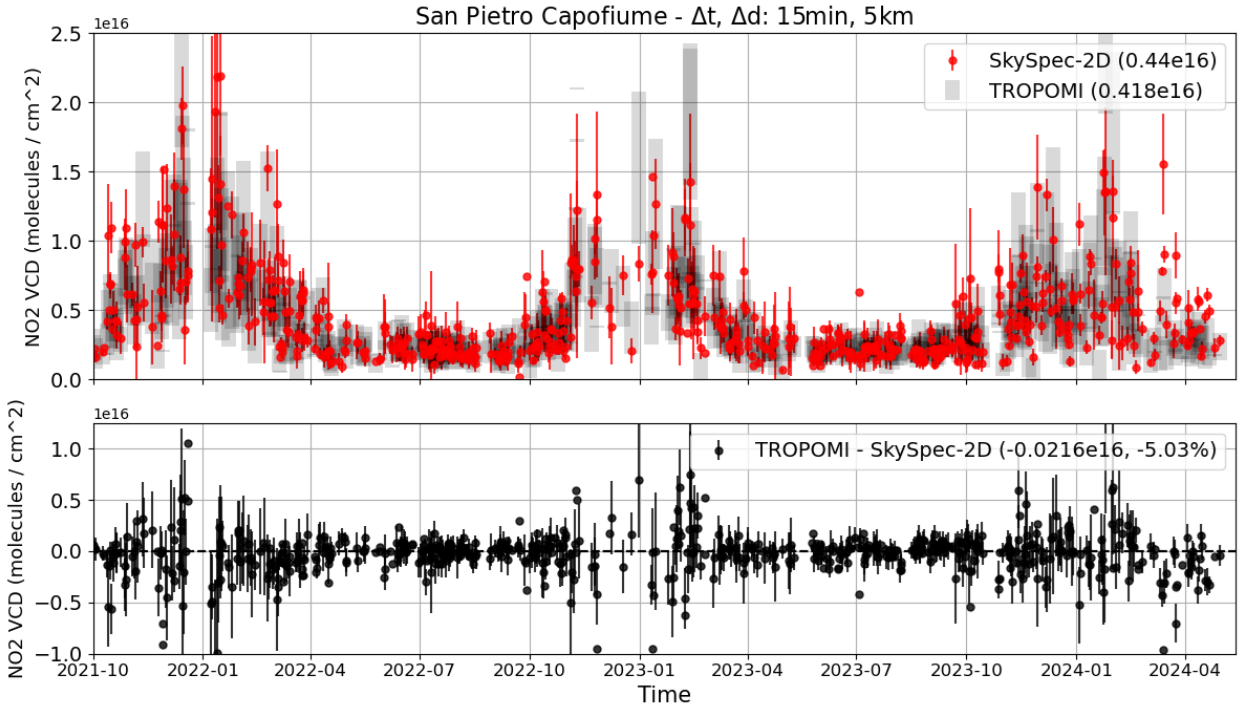




During the projects two version of AIRWAVE have been developed and validated. The figures show zonal means of TCWV for AIRWAVEv1 (blue), AIRWAVEv2 (red) and correlative measurements (black): Satellite SSM/I (a) and Radiosondes ARSA (b). (Castelli et al., 2019)

ESA contracts related to QA4EO activities

[2021/2024] IDEAS-QA4EO WP2250: Towards a new FRM4DOAS-compliant site



FRM4AER - Scientific Service for Fiducial Reference Measurements for Aerosol Product Cal/Val Activities (2022-2023) EUMETSAT

The goal of this service is to provide an aerosol FRMs database (FRM4AER) to support the Copernicus mission Cal/Val (starting with S3 in WP#1)

Activity 1: Ground-based Aerosol Retrieval for Copernicus Missions Cal/Val

→ Definition and development of ground-based aerosol retrieval algorithms for satellite Cal/Val (e.g. for SLSTR and OLCI)

Activity 2: Ground-based Aerosol Profiling Copernicus Missions Cal/Val

→ Provision of fiducial aerosol reference measurements (i.e. ground based remote sensing also covering spatial and timeliness needs)

Activity 3: Assessment of Uncertainties of Ground-based Aerosol Measurements

→ assessment of the uncertainties of the output of Activity 2 which specifies the strategy for continuous quality monitoring and Cal/Val of the generated products.

Activity 4: Campaigns for Copernicus Missions Cal/Val

→ propose campaigns (i.e. based on opportunity) to support the provision of fiducial aerosol reference measurements.

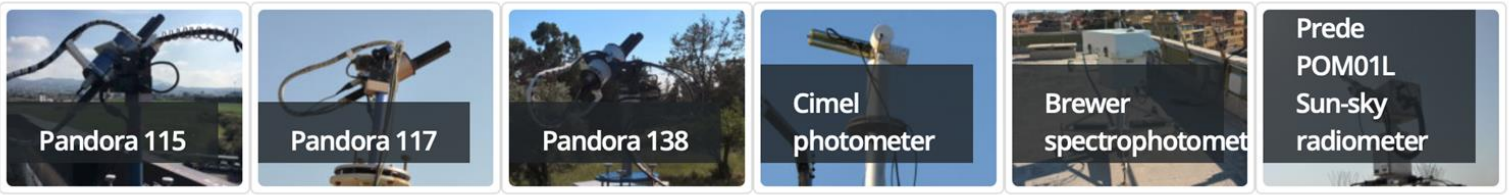
Activity 5: Integration and Maintenance of the Aerosol FRM Database into the EUMETSAT Processing Environment

→ integrate and maintain the aerosol FRM database setup in the previous tasks into EUMETSAT environment.

Satellite Calibration/Validation and Urban Environment Monitoring Super- Site: Boundary-layer Air Quality-analysis Using Network of INstruments – "BAQUNIN" [2017 to present]

Boundary-layer Air Quality-analysis Using Network of Instruments Super Site

https://www.baqunin.eu/



CNR-ISAC

Sapienza

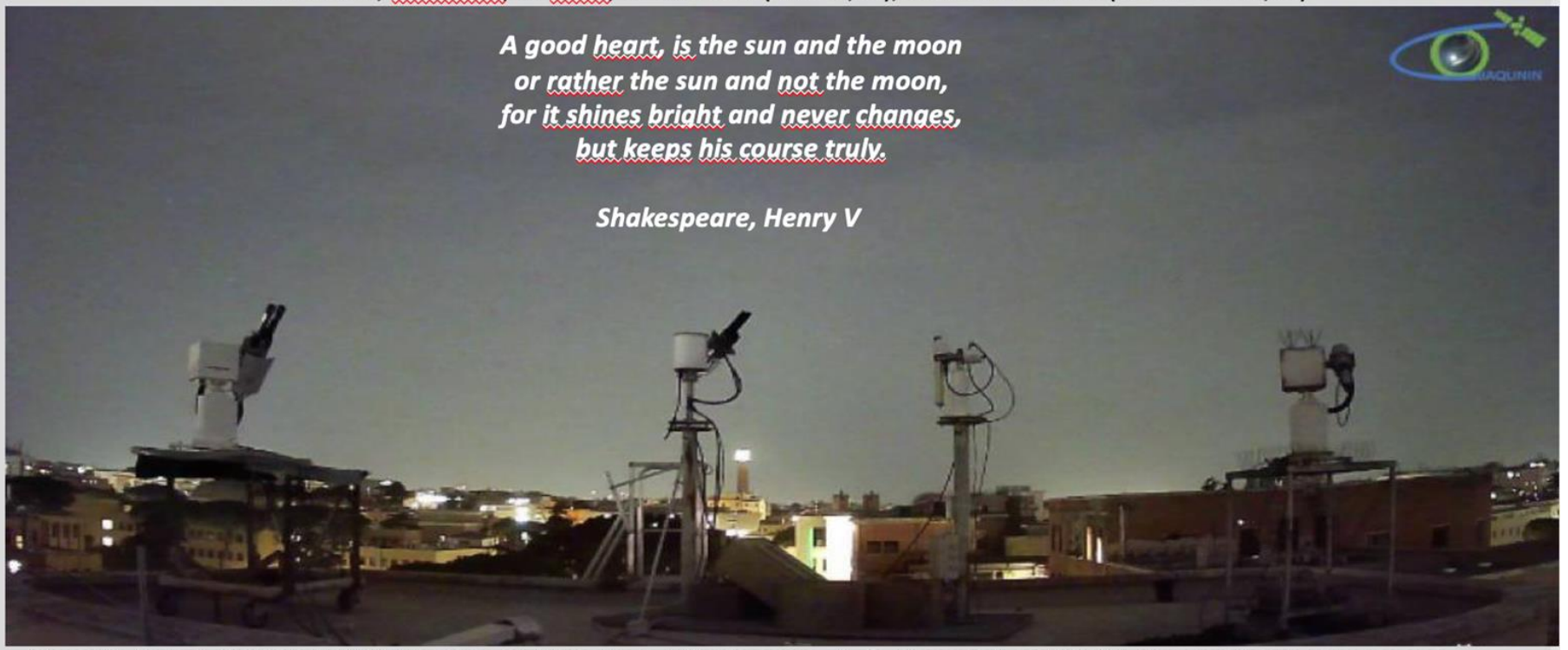
CNR-IIA

Night-time (lunar) aerosol and trace gases columnar observations: towards a new product's generation : ESA-Serco CCN3 contract: QA4EO/SER/SUB/28 (QA4EO-SER-MGT-PLN-4307) [2020-2023].

The Skynet network for the retrieval of aerosol properties from the moon irradiance measurements

M. Campanelli (ISAC- CNR, IT) , G. Kumar and V. Estelles (UV, SP), A. Uchiyama and T. Matsunaga (NIES, JP),

A. Iannarelli, S.Casadio, G. Mevi, N. Ferrante (SERCO, IT), A. Di Bernardino (U. SAPIENZA, IT)



Fourth Joint GSICS/IVOS Lunar Calibration Workshop, 4-8 December 2023, Darmstadt, Germany

“Atmosphere Cal/Val: Improved AOD@440nm - phase 1” ESA-Serco contract: CCN5 QA4EO/SER/SUB/28, 2021-2022

Atmos. Meas. Tech., 16, 2989–3014, 2023
https://doi.org/10.5194/amt-16-2989-2023

Atmospheric Measurement Techniques — Open Access — EGU

Evaluating the effects of columnar NO_2 on the accuracy of aerosol optical properties retrievals

Theano Drosoglou[1], Ioannis-Panagiotis Raptis[1,2], Massimo Valeri[3], Stefano Casadio[3], Francesca Barnaba[4], *
Marcos Herreras-Giralda[5], Anton Lopatin[5], Oleg Dubovik[6], Gabriele Brizzi[3], Fabrizio Niro[7], Monica Campanelli[4], *
and Stelios Kazadzis[8]

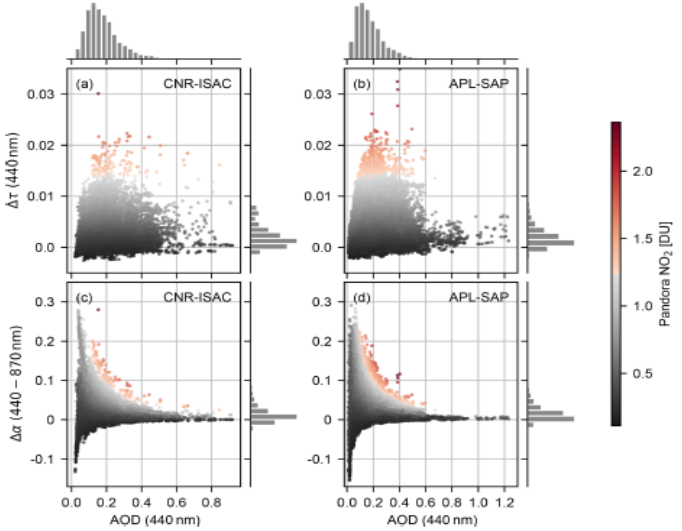


Figure 6. The differences in the modified AERONET AOD at 440 nm (**a**, **b**) and AE at 440–870 nm (**c**, **d**) over CNR-ISAC and APL-SAP from the standard products illustrated with respect to the standard AERONET AOD measurements at 440 nm and the actual NO_2 observed by Pandora (color scale). The corresponding distributions of all variables are also included.

“ Atmosphere Cal/Val: Improved AOD@440nm - phase 2” ESA-Serco contract: CCN8 QA4EO/SER/SUB/28, 2022-2023

https://doi.org/10.5194/egusphere-2024-682
Preprint. Discussion started: 19 March 2024

Under revision

EGUsphere — Preprint repository

Assessment of NO_2 uncertainty impact on aerosol optical depth retrievals at a global scale

Akriti Masoom[1], Stelios Kazadzis[1], Masimo Valeri[2], Ioannis-Panagiotis Raptis[3,4], Gabrielle Brizzi[2], Kyriakoula Papachristopoulou[5], Francesca Barnaba[6], Stefano Casadio[2], Axel Kreuter[7,8], Fabrizio Niro[9]
*

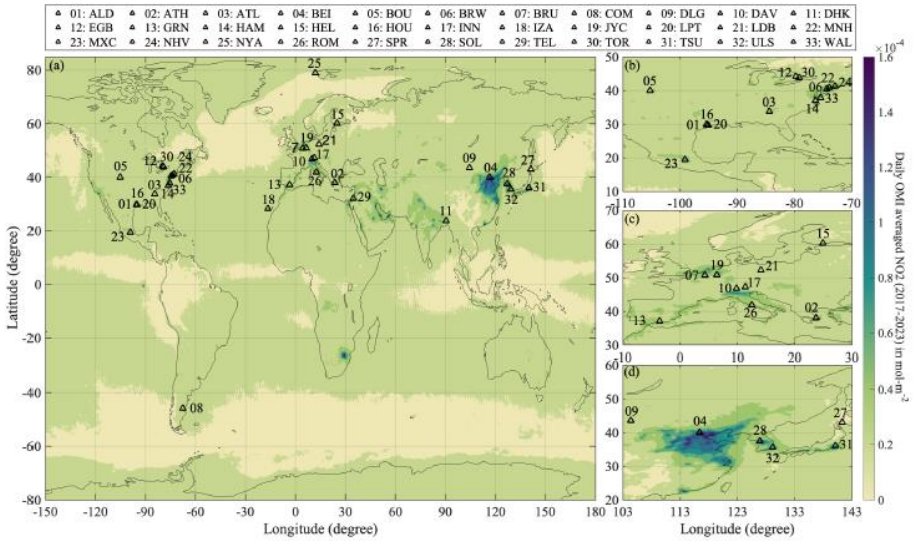


Figure 1: (a) Overview of the co-located AERONET and PGN stations and 7-year (2017-2023) averaged NO_2 (mol-m^{-2}) from OMId satellite measurements. Panels (b), (c) and (d) are the focused maps for the clustered locations in North America, Europe and northeast Asia, respectively.

“ Cloud effects on AOD and trace gas retrievals” ESA-Serco contract: CCN11 QA4EO/SER/SUB/28, 2024 ….ongoing…

* CNR ISAC

How do Ocean Currents affect the Earth System?
Can we optimize the monitoring of the ocean currents exploiting a multivariate approach?

Ocean currents are among the key factors regulating oceanic and atmospheric processes->2D/3D transport of heat, salt, nutrients

Need for synoptic, high spatio-temporal resolution observations

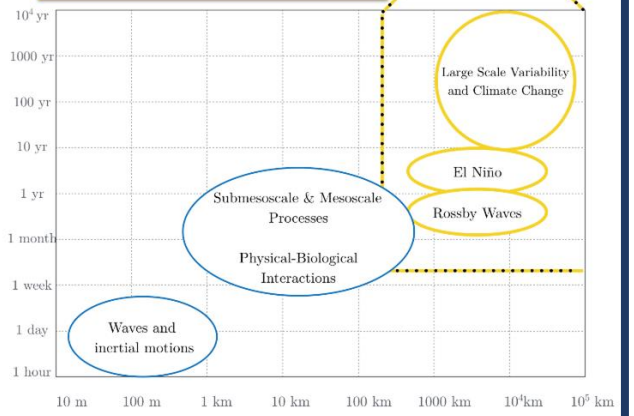
Satellite Altimetry ~since 1993

Our approach: Synergy of SSH, SST, Chl (2018 to present)

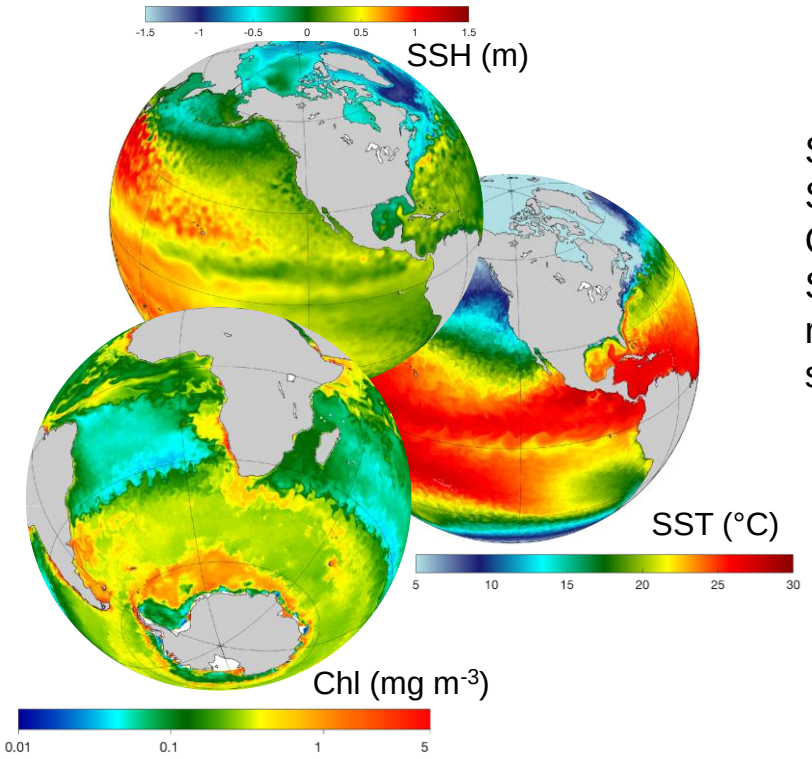
New HR satellite missions for ocean currents monitoring (CNES/NASA SWOT, 2024 + ESA-Harmony 2029) + Synergy

$$(u_g, v_g) = \frac{g}{f}\left(-\frac{\partial h}{\partial y}, \frac{\partial h}{\partial x}\right)$$

h=sea level



Satellite Altimetry, through observation of sea surface height (SSH) provides a large scale estimate of the ocean surface currents at global scale



Research Activity

Synergistic exploitation of satellite Sea Surface Height, Temperature, Chlorophyll concentration (SSH, SST, Chl) to enhance the effective resolution of the Altimetry-derived 2D surface currents

Tools

Multivariate Algorithms
Artificial Intelligence

Projects:

ESA-Globcurrent (in Kind)
ESA-CIRCOL
ESA-WOC
ESA WOC Extension

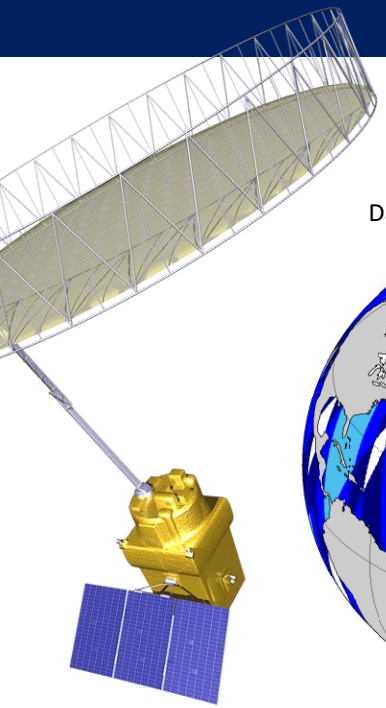
PIs:
-Daniele Ciani (CIRCOL) [CNR-ISMAR]

-Bruno Buongiorno Nardelli (World Ocean Circulation-WOC) [CNR-ISMAR]

-Ciani, D., Asdar, S., & Buongiorno Nardelli, B. (2024). Improved Surface Currents from Altimeter-Derived and Sea Surface Temperature Observations: Application to the North Atlantic Ocean. Remote Sensing, 16(4), 640.

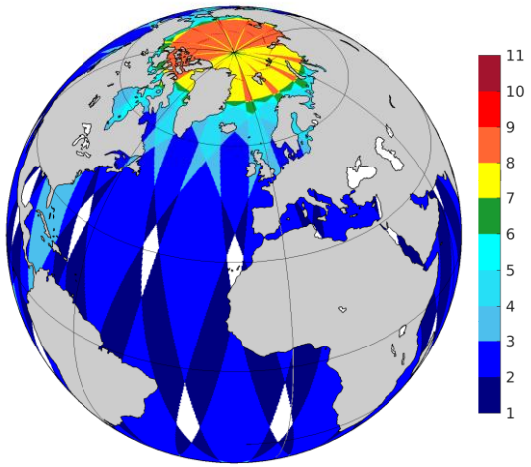
-Asdar, S., Ciani, D., & Buongiorno Nardelli, B. (2024). 3D reconstruction of horizontal and vertical quasi-geostrophic currents in the North Atlantic Ocean. Earth System Science Data, 16(2), 1029-1046.

ESA Copernicus Imaging Microwave Radioemter – CIMR (part of Copernicus expansion satellite missions)

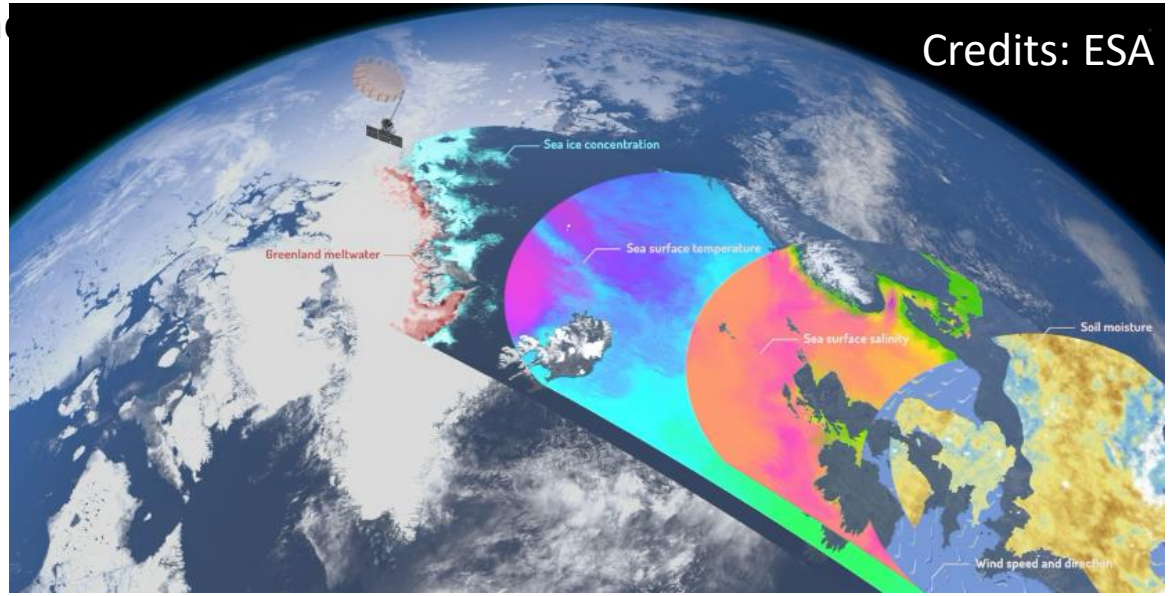


CIMR: Wide-swath (~1900 km), passive Microwave Radiometer. Expected Launch: 2029+ tim

Daily Coverage (visits per day)



Measured Quantities:
-Sea Surface Temperature
-Sea Surface Salinity
-Soil Moisture
-Sea ice concentration /thickness
-Wind vectors

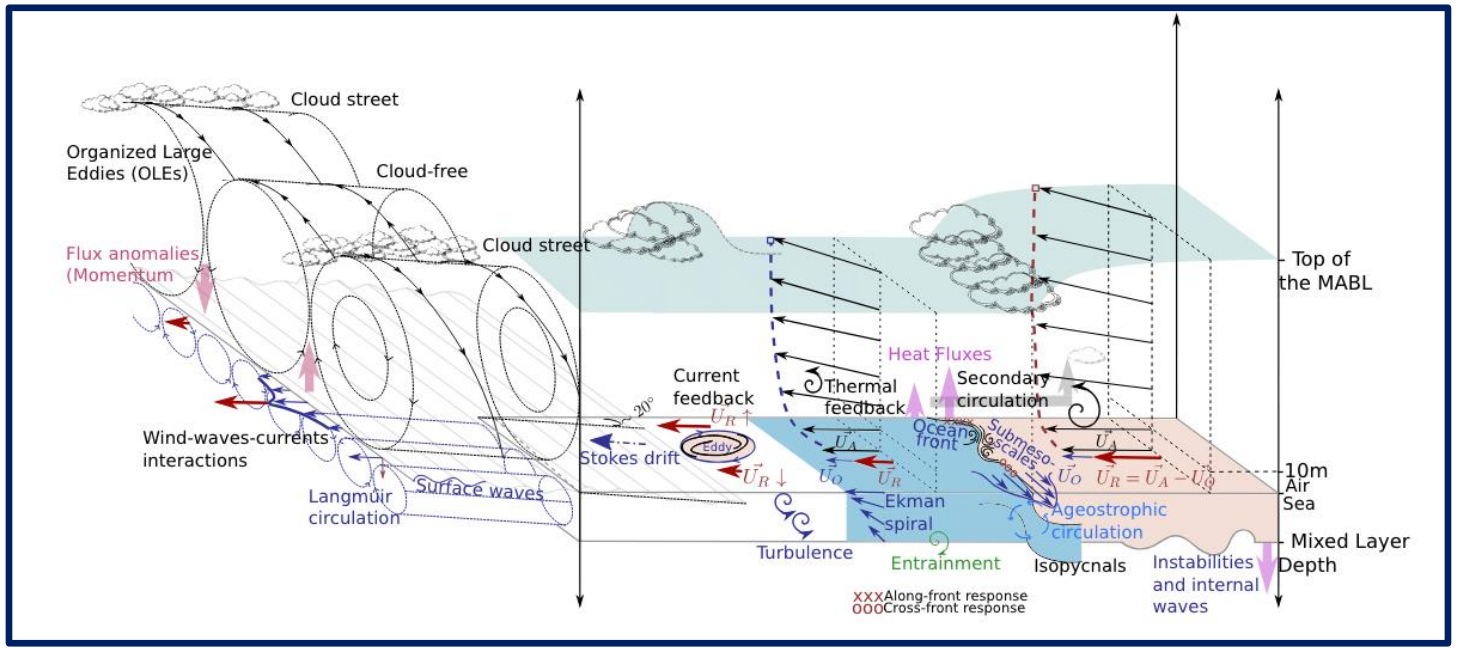


CNR-ISMAR main contributions:

- Involvement in the CIMR Mission Advisory Group:
  Rosalia Santoleri (2018-2023), Daniele Ciani (2024+)
- Involvement in the CIMR Apps project (CIMR Mission application studies): quantify the CIMR contribution for the CNR Scient. Coordinator (D. Ciani)
- R&D studies on the impact of the CIMR Sea Surface Temperature (SST) observations for the Regional SST monitoring (Mediterranean)
- R&D on the ingestion of CIMR Brightness Temperature observations for data assimilation applications

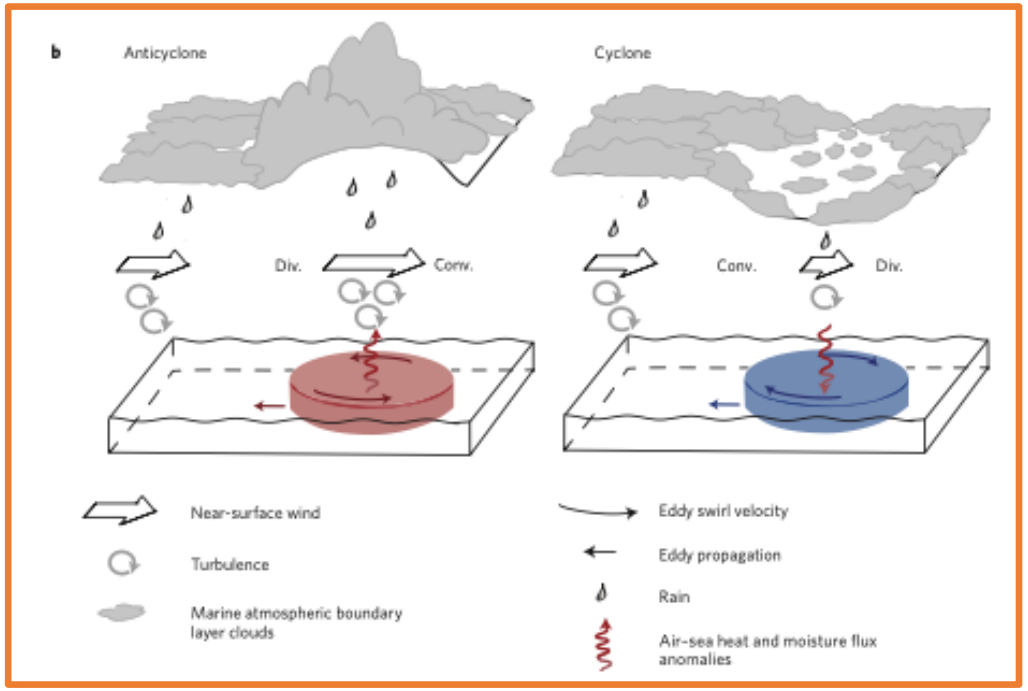
-Ciani, D. et al. (2019). Copernicus Imaging Microwave Radiometer (CIMR) Benefits for the Copernicus Level 4 Sea-Surface Salinity Processing Chain. *Remote Sensing*, *11*(15), 1818.
-Storto, A. et al., Towards the air-sea coupled assimilation of satellite radiances: Assimilating CIMR brightness temperatures in a strongly coupled single-column variational analysis system. In preparation
-Sabatini, M. et al., The Copernicus Imaging Microwave Radiometer (CIMR): a preliminary study on the CIMR contribution to the Copernicus operational L4 Mediterranean SSTs. In preparation

Ocean surface currents /sea surface temperature impacts on the planetary atmospheric boundary layer



Thermal ocean fronts modulate the stability of the atmosphere, increasing the surfacestress the warmer side of the front, which in turn leads to increased momentum, heat and CO2 fluxes across the air-sea interface. Ocean front instabilities and eddy perturbations at the mesoscale and submesoscale drive intense vertical exchanges with the deep ocean.

ESA(2020). Report for Assessment: Earth Explorer 10 Candidate Mission Harmony, European Space Agency, Noordwijk, The Netherlands, ESA-EOPSM-HARM-RP-3784, 133pp



Impact Eddy-induced sea surface temperature anomalies
on the cloud cover and rain rate

Frenger, I., Gruber, N., Knutti, R., & Münnich, M. (2013). Imprint of Southern Ocean eddies on winds, clouds and rainfall. Nature geoscience,

SEASTARex

Technical Assistance to Earth Explorer 11 SEASTAR Phase- 0 campaign

- First scientific campaign of the unique 3-look Ocean Surface Current Airborne Radar ATI-SAR demonstrator
- Two successful campaigns over the Iroise Sea and the Mediterranean
- Two fantastic datasets combining OSCAR SAR imagery, EO imagery, numerical model data and in situ observations
- Successfully validated the SeaSTAR concept in a dynamic, macrotidal coastal environment
- Imagery acquired coincident with SWOT overpass during its fast-repeat Cal/Val phase

SEASTAR

Funded By ESA (400017623/22/NL/IA)

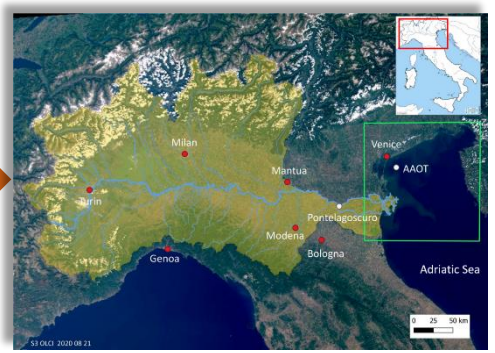
Synergy of observational analyses for assessing inland and coastal water connectivity:
ESA SOON - Satellite Observations for inland and cOastal water quality during COVID lock-downN

CNR ISMAR ISTITUTO DI SCIENZE MARINE

- **Analysis of weekly mean anomalies** of OC products from *Sentinel-3* OLCI (300m)
- **Diagnosis** of inland-marine water *connectivity* from *Sentinel-2* MSI (10m)
- **Diagnosis** of SST product from *optimally interpolated multiplatform product* (1km)

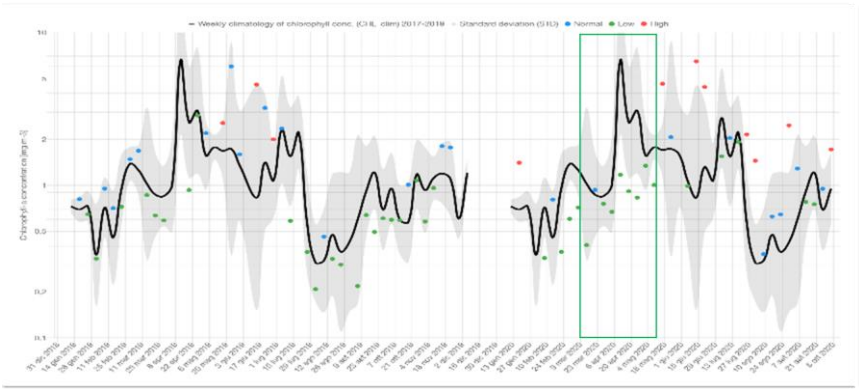
Sentine2/3 based products on ESA-RACE Dashboard

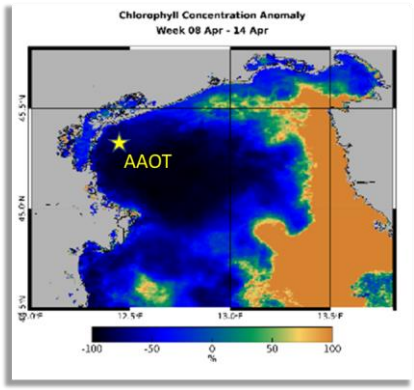
Synergy of SST (multi-sensor), Chl (S3-OLCI), Water Turbidity and Rrs (S2-MSI), Wind and river discharge (in situ)

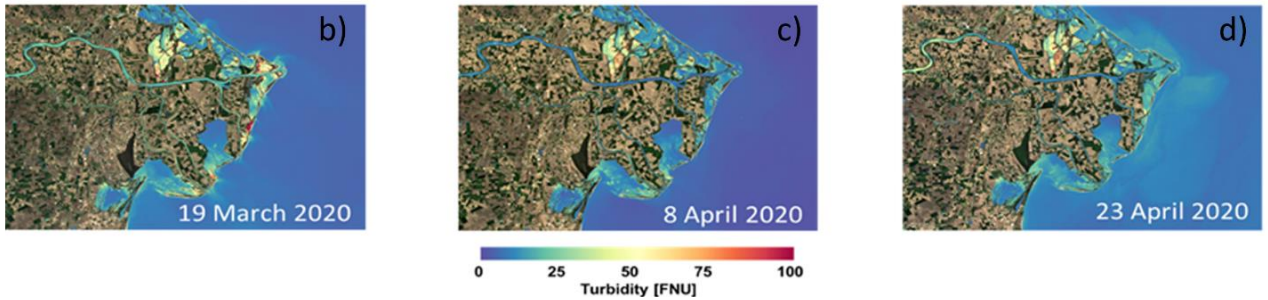


Project: ESA-SOON

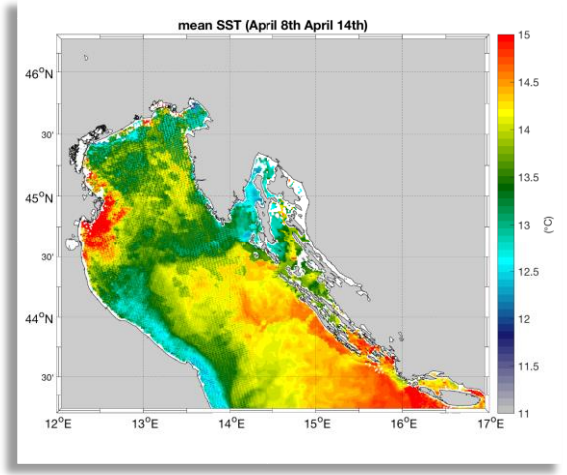
PI: Federico Falcini [CNR-ISMAR]







Negative Chl-a anomalies …till the end of the COVID2019 lockdown !!!



Disentangling perception versus reality from synergic analysis:

Seasonal-environmental conditions make hard to disentangle lockdown effects.

Environmental (first-order) causes enhanced water quality during the lockdown.

Braga, F., Ciani, D., Colella, S., Organelli, E., Pitarch, J., Brando, V. E., ... & Falcini, F. (2022). COVID-19 lockdown effects on a coastal marine environment: Disentangling perception versus reality. Science of the Total Environment, 817, 153002.

Development of Multistressor Cumulative Hazard Index - CHI

MITHO
MULTIPLE THREATS ON OCEAN HEALTH

PI: Angela Landolfi [CNR-ISMAR]

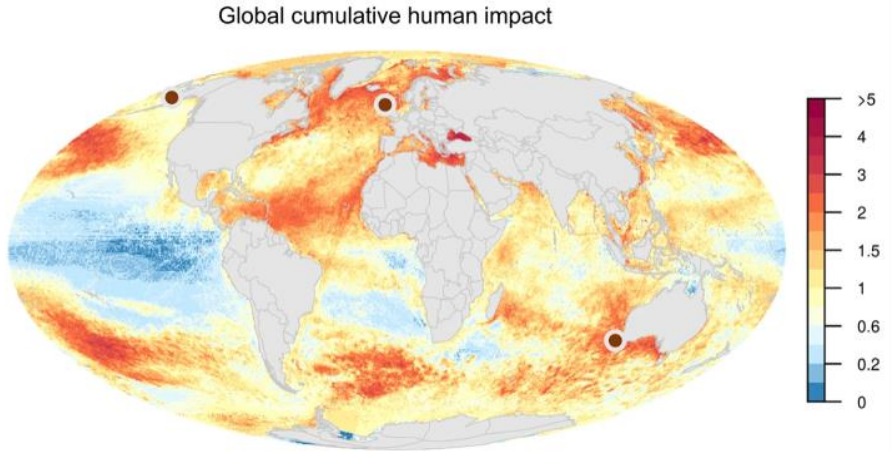
Project: ESA-MITHO

PROVIDE a set of cumulative multi-hazard index (CHI) from EO-derived products

IDENTIFY areas & times of high vulnerability

TEST Feasibility of AI-based O2 detection methods from EO-derived data for deoxygentation monitoring

CHI	Multi -Stressors	Area of Interest	Spatial resolution	Data type	Scientific Case Study
CHI_1	SST, pH	Global/surface	1°x 1°	Satellite	SC 1 Biodiversity SC 2 Desertification SC 3 Zooplankton
CHI_2	SST, SSD, pH, O_2	Global / depth	1°x 1°	Satellite+model	SC 1 Biodiversity SC 4 Zooplankton
CHI_3	SST, SSD, pH, Wind	Global/surface	0.25°x 0.25°	Satellite	SC 2 Desertification SC 4 Sargassum
CHI_4	SST, Fishing effort	Global/surface	1°x 1°	Satellite+In Situ	SC 3 Fish
CHI_5	SST, SSS, pH, O_2	NW European Shelf depth	0.111°x 0.067°	Model	SC 1 Biodiversity
CHI_6	SST, SSS, TSM, Wind	Mediterranean Sea (Po River); Black Sea (Danube River)	0.01° x 0.01°	Satellite	SC 6 Inland and marine water connectivity



Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA

EARTH MOON MARS

Overview of the NPRR Research Infrastructure under development in the framework of the EMM project by INAF, CNR and ASI

Ugo Cortesi (CNR-IFAC)
and the EMM team

MAIN OBJECTIVES

1. The creation of a new infrastructure for the deep space communications, starting from the Sardinia Radio Telescope located in Cagliari – Italy, to establish a powerful link between Earth-Moon-Mars → DSN, ESTRACK;
2. to explore the capability of the Moon as a multi-purpose research laboratory dedicated to the Earth and Universe Science from the Moon;
3. to perform R&D activities to develop pathfinders of innovative instruments for the observation of the Earth and the Universe, to be accommodated on a Lunar Infrastructure;
4. a step-forward to Mars, i.e. a) create a network of experts in data analysis and theoretical models to follow an interdisciplinary approach to improve our knowledge of the Earth and Planetary atmospheres, by sharing their own expertise in the respective fields; b) combine datasets from different instrumentations with complementary information;
5. to train a new generation of scientists and engineers, and give them the possibility of leading the scientific revolutions that these infrastructures will make possible;
6. to establish a closer relationship and networking between the Italian research institutes and industries, in order to boost their synergies and optimize the allocation of resources at the national level.

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Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA

Project «Earth-Moon-Mars» – WP-1500

WP-1500 [CNR] Earth and Mars Research Network

WP-1500.1 [CNR]
Review, test and inter-comparison of existing fast RT Models

WP-1500.2 [CNR]
Selection and Optimization of Fast Radiative Transfer model

WP-1500.3 [CNR]
Development of procedures for data assimilation of future measurements in weather forecasting models

WP-1500.4 [CNR]
Development and implementation of an ensemble data assimilation system for limited area models

WP-1500.5 [CNR]
Implementation/test of fast RT Models in the GLOBO/BOLAM climate model at ISAC-CNR

WP-1500.6 [CNR]
Numerical modeling at regional/global scale on planetary atmospheres

WP-1500.7 [CNR]
Improving the Italian remote sensing network : from satellite validation to air quality studies

WP-1500.8 [CNR]
Nadir and limb RT models for Earth, Mars and other Planetary atmospheres

WP-1500.9 [CNR]
Observation and characterization of Saharan dust events.

WP-1500.10 [CNR]
Optimization and upgrade of the KLIMA radiative transfer and inversion model

WP-1500.11 [CNR]
Infrastructure for the application of the Complete Data Fusion to real data

WP-1500.12 [INAF]
Martian facility for sand/dust mobilization: planetary images, lab experiment, terrestrial analogues

WP-1500.13 [INAF]
Laboratory of molecular spectroscopy in planetary atmospheres