

S5 – Hydro-meteorology climate

The screenshot shows the homepage of the IRIDE constellation website. At the top, there's a navigation bar with links for Catalog, Training, Feedback, Contact, and a user account for Edouard Royer. Below the navigation is a large satellite map of Europe and the Mediterranean. In the top left corner of the map area, there's a circular logo for 'iride' with 'GOVERNO ITALIANO | ASI | ESA' around it. On the left side of the map, the text 'Thematic Areas' is displayed. Below the map, there are eight cards arranged in a grid, each representing a different thematic area:

- Coastal and Marine Monitoring** (blue card, icon: wavy line)
- Air Quality** (green card, icon: mountain with pollution)
- Ground Motion** (orange card, icon: location pin with heart rate)
- Monitoring of land cover and use** (yellow card, icon: globe)
- Hydro-meteorology climate** (light blue card, icon: cloud, highlighted with a red border)
- Water Management** (light blue card, icon: water drop)
- Emergency** (red card, icon: emergency light)
- Security** (light green card, icon: shield with checkmark)

About the IRIDE constellation. The IRIDE constellation is a programme of the European Union – Next GenerationEU funded by the Presidency of the Council of Ministers of the Italian Republic, pursuant to Article 1, paragraph 254, of the Italian Law 160/2019 and Funded by the Presidency of the Council of Ministers from the Complementary Fund carried out under an ESA Contract for the purposes of EO PNRR IRIDE PROGRAMME.

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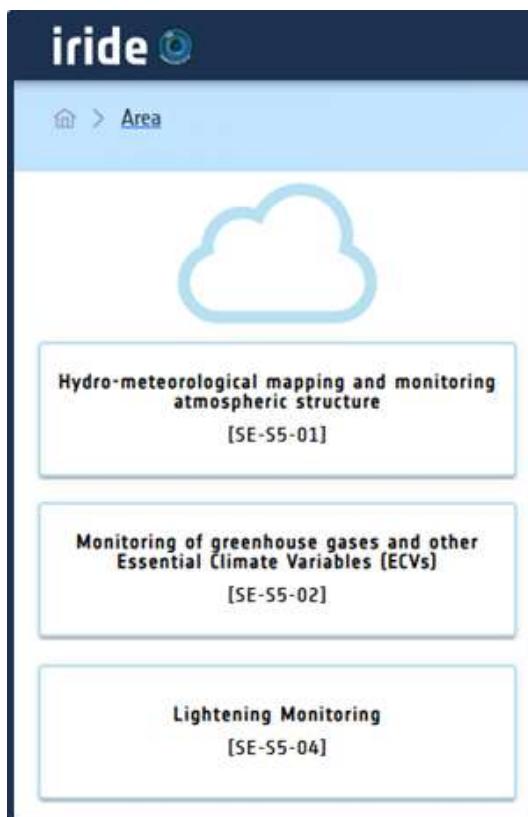
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PIANO NAZIONALE
DI RIPRESA E RESILLENZA



S5 – Hydro-meteorology climate



The screenshot shows the IRIDE web interface with a dark header bar containing the 'iride' logo and a navigation menu with 'Area'. Below the header are three service cards:

- Hydro-meteorological mapping and monitoring atmospheric structure [SE-S5-01]**: Represented by a large blue cloud icon.
- Monitoring of greenhouse gases and other Essential Climate Variables [ECVs] [SE-S5-02]**: Represented by a large blue cloud icon.
- Lightening Monitoring [SE-S5-04]**: Represented by a large blue cloud icon.

Servizi mirati a fornire prodotti derivati da satellite utili per **attività operative nazionali e regionali legate al monitoraggio idrometeorologico e alle previsioni meteorologiche**

Perché i servizi IRIDE ?

- Servizi integrati che combinano dati satellitari, in-situ e intelligenza artificiale per **migliorare le capacità di monitoraggio attuale** in termini di frequenza temporale, dettaglio spaziale ed accuratezza a livello nazionale
- **Algoritmi avanzati e strumenti di validazione** ad alta risoluzione permettono analisi accurate per fulmini, clima e meteo, utili a istituzioni e gestori del rischio
- Intelligenza artificiale e tecniche di data fusion per il **monitoraggio continuo dei gas serra e di variabili climatiche essenziali**

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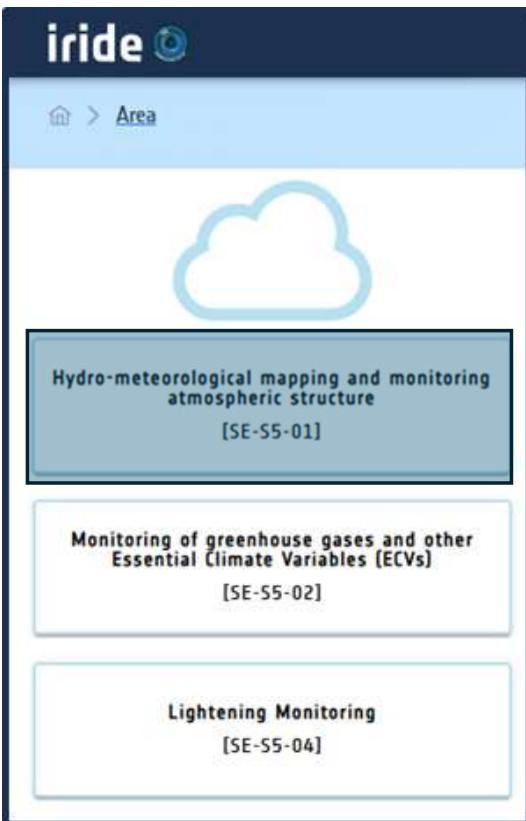
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Hydro-meteorological mapping and monitoring atmospheric structure



The screenshot shows a user interface for the IRIDE constellation. At the top, there's a header with the 'iride' logo and a 'Area' link. Below the header, there are three main service cards:

- Hydro-meteorological mapping and monitoring atmospheric structure [SE-S5-01]**: Represented by a blue cloud icon.
- Monitoring of greenhouse gases and other Essential Climate Variables [ECVs] [SE-S5-02]**: Represented by a white cloud icon.
- Lightening Monitoring [SE-S5-04]**: Represented by a white cloud icon.

Il servizio fornisce prodotti di previsione stagionale, basati su dati di Osservazione della Terra (OT) integrati con misure da reti di stazioni a terra, allo scopo di supportare il monitoraggio degli oceani, le previsioni metereologiche e servizi idro-meteo.

Inoltre include la possibilità di integrazione di modelli numerici e previsionali al fine di effettuare una comparazione automatica con dati OT ed in situ, relativamente a:

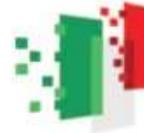
- Rianalisi atmosferica
- Proiezioni climatiche ad alta risoluzione
- Previsioni metereologiche
- Previsioni stagionali

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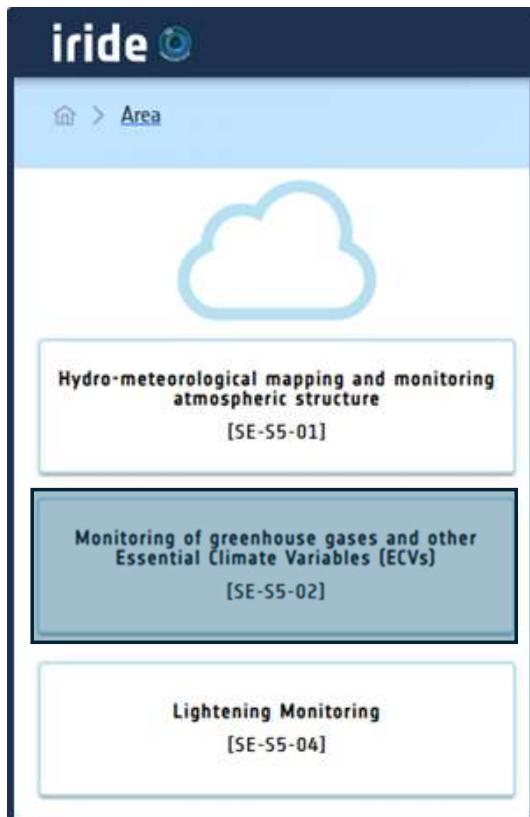
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Monitoring of greenhouse gases and other Essential Climate Variables (ECVs)



Il servizio ha l'obiettivo di supportare il monitoraggio continuo delle Variabili Climatiche Essenziali (EVC) e della concentrazione di gas serra (GHG).

Una serie di prodotti ECV e GHG, vengono generati mediante la fusione di dati provenienti da differenti sensori satellitari di Osservazione della Terra, incluso IRIDE Platino. Tale fusione permette di ottenere prodotti ad alta risoluzione spaziale e temporale, su tutto il territorio nazionale.

Tecniche di intelligenza artificiale, permettono di ottenere prodotti di temperatura superficiale a super risoluzione.

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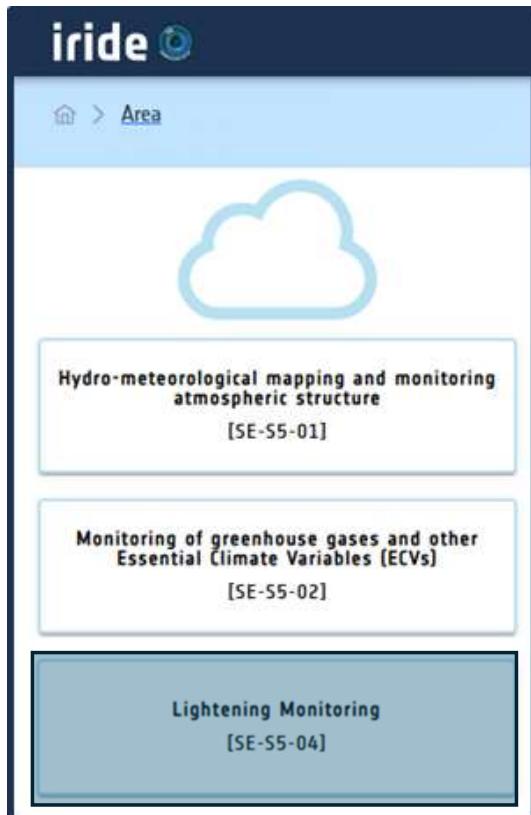
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Lightening Monitoring



The screenshot shows the IRIDE constellation interface. At the top, there's a navigation bar with 'iride' and 'Area'. Below it is a large blue cloud icon. The main content area has three sections:

- Hydro-meteorological mapping and monitoring atmospheric structure [SE-S5-01]**: Contains a small icon of a cloud with rain.
- Monitoring of greenhouse gases and other Essential Climate Variables (ECVs) [SE-S5-02]**: Contains a small icon of a globe.
- Lightening Monitoring [SE-S5-04]**: Contains a small icon of a lightning bolt.

Obiettivo del servizio è di fornire mappe di occorrenza di fulmini ad alta risoluzione spaziale (c.ca 2km) e temporale (ogni 10'), a supporto del monitoraggio dei fulmini e le previsioni a breve termine.

Tali mappe sono basate sulla combinazione di dati provenienti dalla rete LAMPINET (dell'Aeronautica Militare) e dati satellitari Meteosat Third Generation (MTG) mediante un algoritmo di intelligenza artificiale.

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Servizi a supporto della mappatura e monitoraggio dell'atmosfera e dell'oceano

Giusy Fedele, CMCC
giusy.fedele@cmcc.it

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Hydro-meteorological mapping
and monitoring atmospheric
structure
[SE-S5-01]

Monitoring of greenhouse gases
and other Essential Climate
Variables (ECVs)
[SE-S5-02]

Lightening Monitoring
[SE-S5-04]

Hydro-meteorology climate

In this thematic area, IRIDE's geospatial services are geared towards furnishing satellite-derived products useful to national and regional hydro-meteorological monitoring and weather forecasting activities. These products offer valuable information crucial for verifying forecasts and facilitating the provision of climate services.

IRIDE's geospatial services for this application domain support:

- The mapping and monitoring of hydro-meteorological atmospheric structure
- The monitoring of greenhouse gases and other essential climate variables (ECVs)
- The lightning monitoring

In this presentation we focus on S5-01 and S5-04:

These services aim at providing **satellite-based products** useful for national and regional operational activities related to **hydro-meteorological monitoring and forecasting**, ranging from short-term (weather), seasonal, and climate scales.

These products will provide valuable information for forecast verification, lightning monitoring and for supporting the delivery of climate services.

HYDRO-METEOROLOGY CLIMATE

Hydro-meteorological mapping and monitoring atmospheric structure

MISSION:
UNDERSTANDING MODEL BIASES AND ENHANCING CURRENT MODELS IN ORDER TO BETTER SUPPORT RISK PREVENTION & MANAGEMENT.

Models from the users can be integrated following a standard integration protocol.

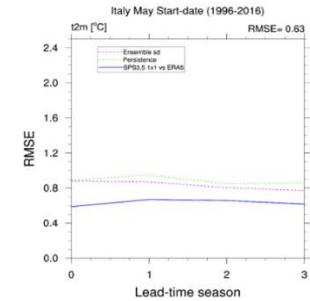
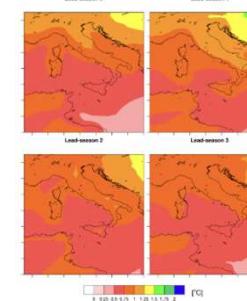
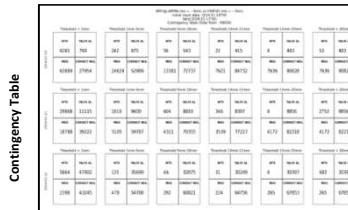
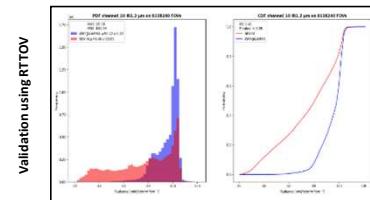
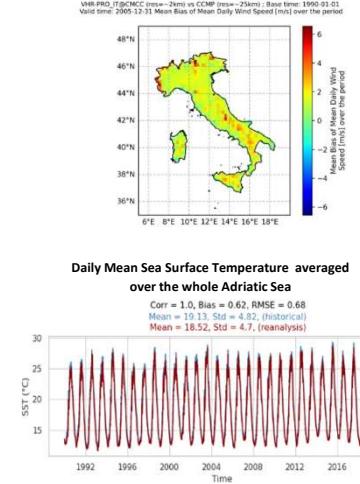
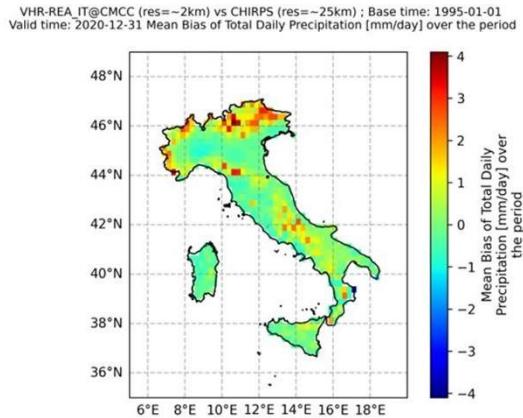
Atmospheric Reanalysis

Climate Projections

Weather Forecasting

Seasonal Forecasts

Validation Report



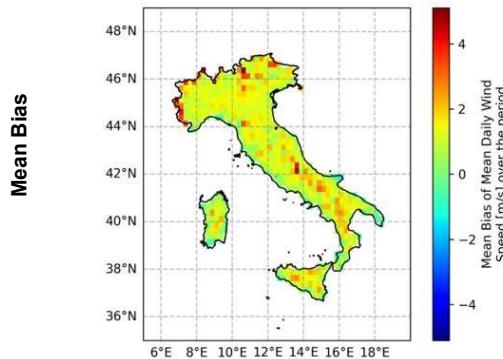
HYDRO-METEOROLOGY CLIMATE

Validation of **Atmospheric Reanalysis** and **Climate Projections** against EO derived, in situ and gridded observational data

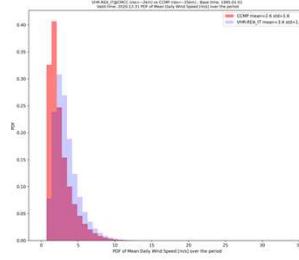
Validation Reports: Error metrics (i.e., RMSE, Mean Bias) and Diagnostics (i.e., Mean Field, PDF, Corr.)

VHR-REA@IT against CCMP (Daily Mean Wind Speed)

VHR-REA_IT@CMCC (res=~2km) vs CCMP (res=~25km); Base time: 1995-01-01
Valid time: 2020-12-31 Mean Bias of Mean Daily Wind Speed [m/s] over the period



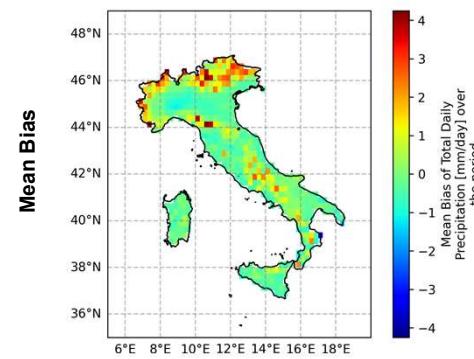
PDF



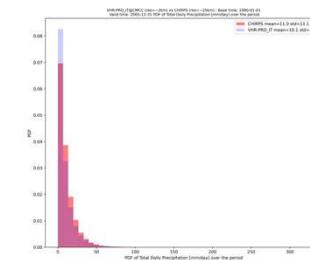
Atmospheric Reanalysis

VHR-PRO@IT against CHIRPS (Total Daily Precipitation)

VHR-PRO_IT@CMCC (res=~2km) vs CHIRPS (res=~25km); Base time: 1990-01-01
Valid time: 2005-12-31 Mean Bias of Total Daily Precipitation [mm/day] over the period



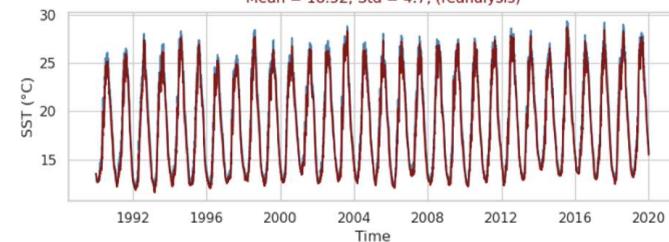
PDF



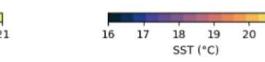
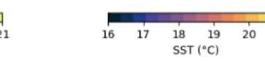
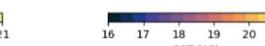
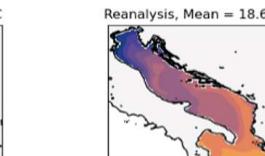
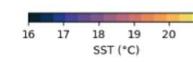
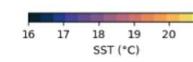
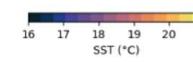
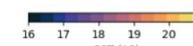
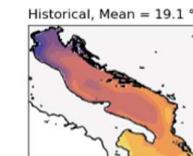
Atmospheric Climate Projection

Daily Mean Sea Surface Temperature averaged over the whole Adriatic Sea

Corr = 1.0, Bias = 0.62, RMSE = 0.68
Mean = 19.13, Std = 4.82, (historical)
Mean = 18.52, Std = 4.7, (reanalysis)



Mean Sea Surface Temperature maps averaged over the integrated period (from 01/1990 to 12/2019)



Marine Climate Projection

HYDRO-METEOROLOGY CLIMATE

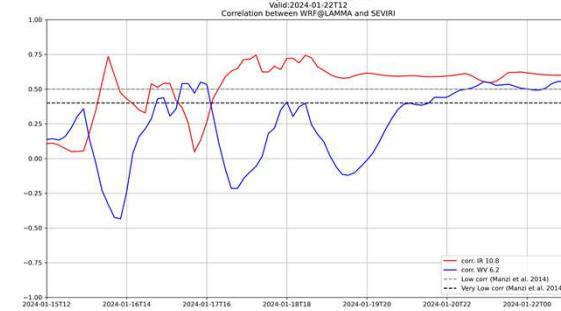
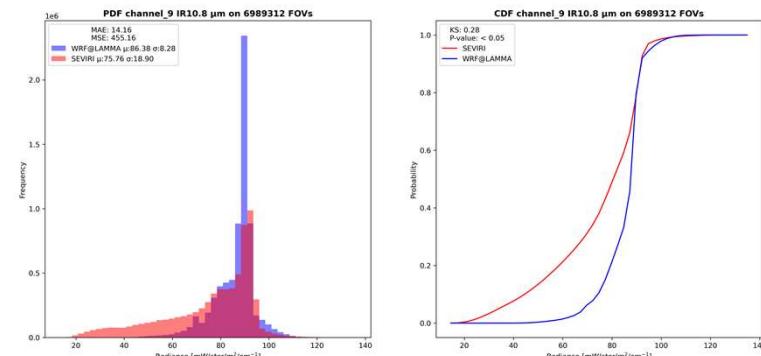
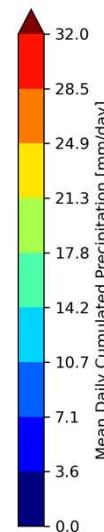
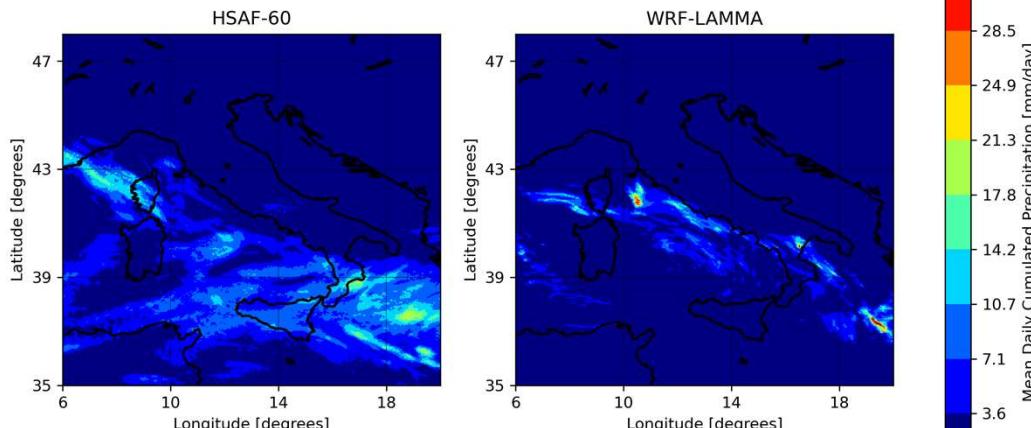
Validation of **weather forecasts** outputs from NWP model (i.e., WRF, BOLAM, MOLOCH) provided by different Italian Institutions against EO data (MSG, MTG, HSAF)

VALIDATION REPORT

Error metrics (i.e., RMSE, Mean Bias) and Diagnostics (i.e., Mean Field, Clustering, PDF, Contingency Table)

RADIATIVE TRANSFER MODEL - RTTOV
It allows the conversion from Meteorological Variables to Radiance

WRF@LAMMA (res= ~3km) against HSAF60 (res= ~3km)
Initial input data: 2024-01-10T00
Valid:2024-01-13T00
Mean daily cumulated precipitation over the period

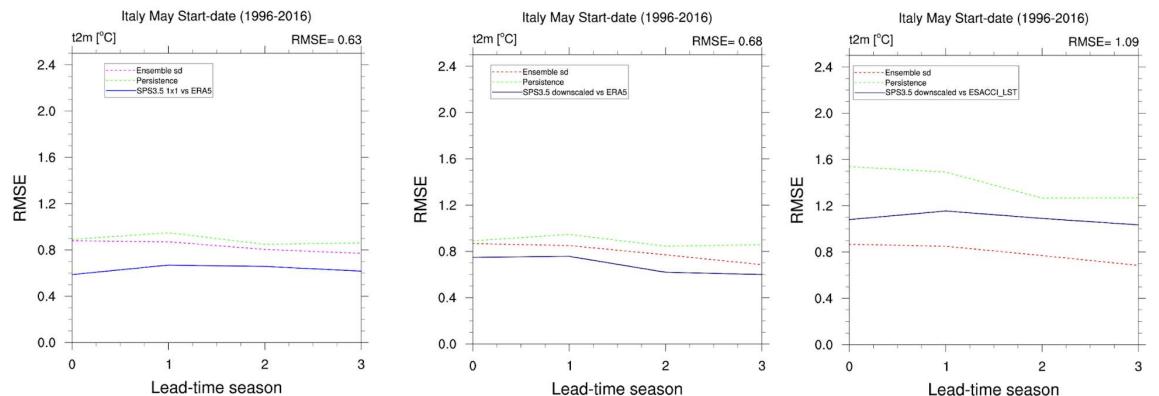


HYDRO-METEOROLOGY CLIMATE

Seasonal forecasts at higher spatial resolution geospatial products and validation report.

**GEOSPATIAL PRODUCTS AT ~25 km resolution
monthly delivered**

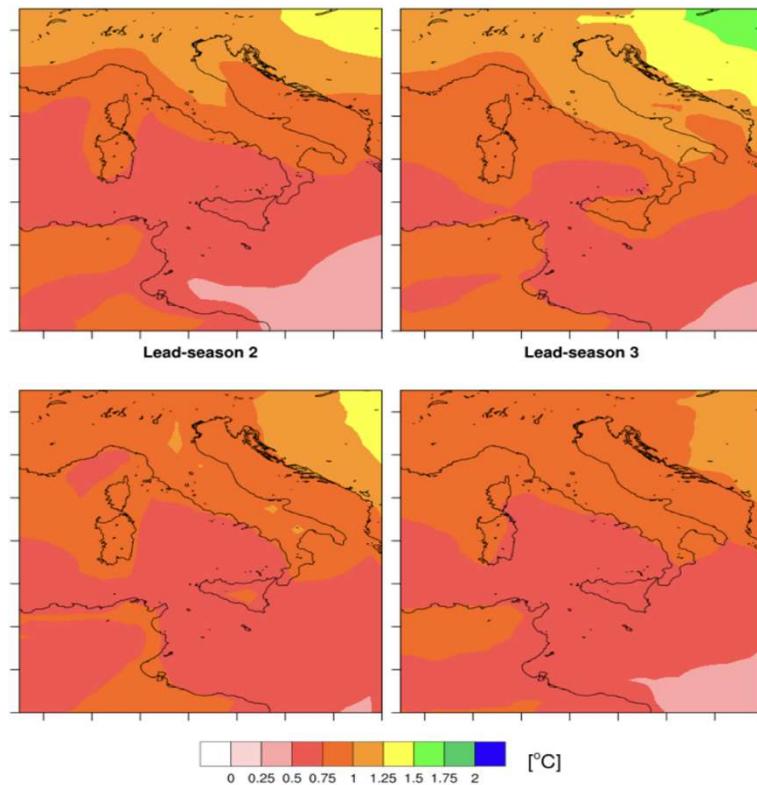
**VALIDATION REPORT – seasonal downscaled
forecasts validated against EO-derived data.**



EXTREME EVENTS INDICATORS based on 2m Air Temperature and Precipitation (by October '25)

t2m SPS3.5 quantile mapping
Ens anom stddev 202405

Lead-season 0 Lead-season 1



Lightning Monitoring



The service S5-04 consists of providing **georeferenced lightning monitoring maps** covering the Italian Territory with a **~2 km x 2 km resolution** with a **10 min time frequency**. Data are provided as WMTS and netcdf data in order to be used in several applications.

By leveraging on **Artificial Intelligence** and **Satellite data**, it is developed a Neural Network capable of **identifying convection areas with potential for lightning activity**.

Lightning monitoring is crucial for several sectors, such as energy, aviation, weather services, and telecommunication.



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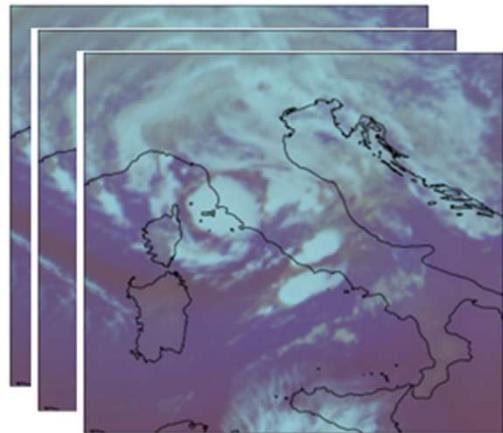
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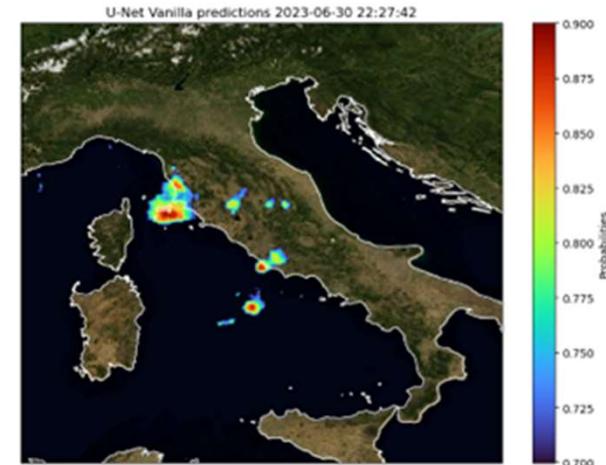
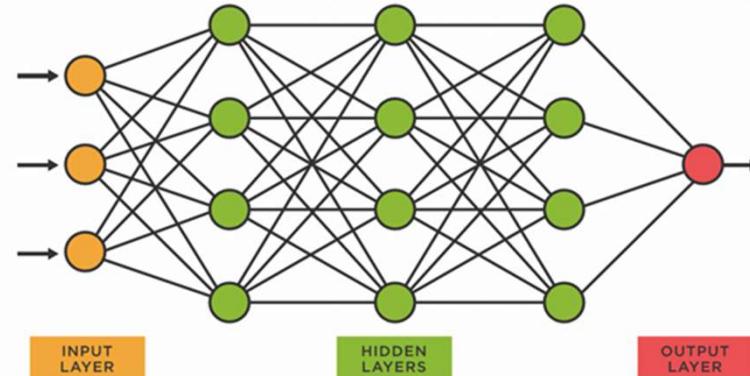
S5-04

Lightning Monitoring

SEVIRI@MSG



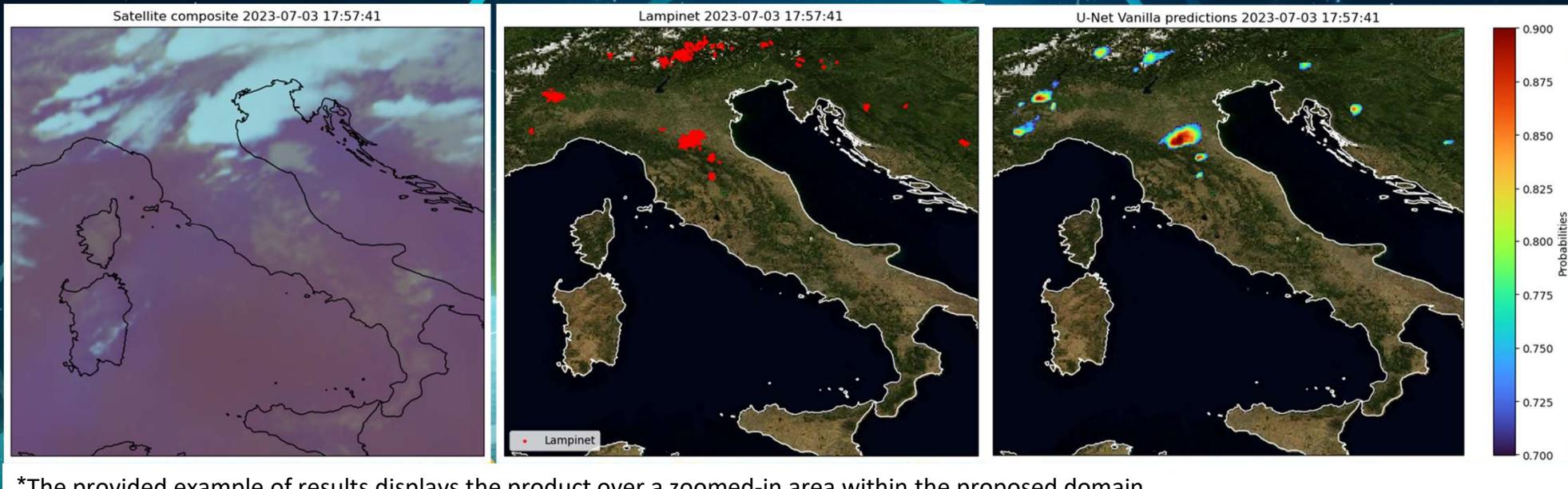
Convolutional Neural
Network (CNN)



Lightning probabilistic detection

Spatial resolution	3 km
Temporal frequency	15 minutes

Lightning Monitoring - Some results 1/2



*The provided example of results displays the product over a zoomed-in area within the proposed domain.

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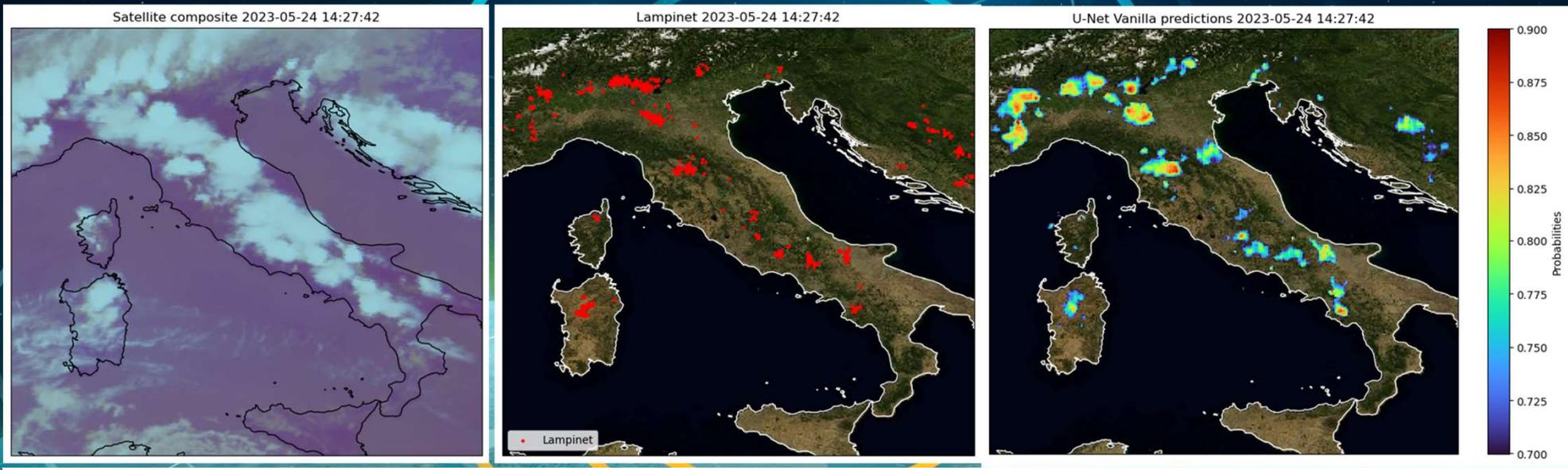
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Lightning Monitoring - Some results 2/2



*The provided example of results displays the product over a zoomed-in area within the proposed domain.

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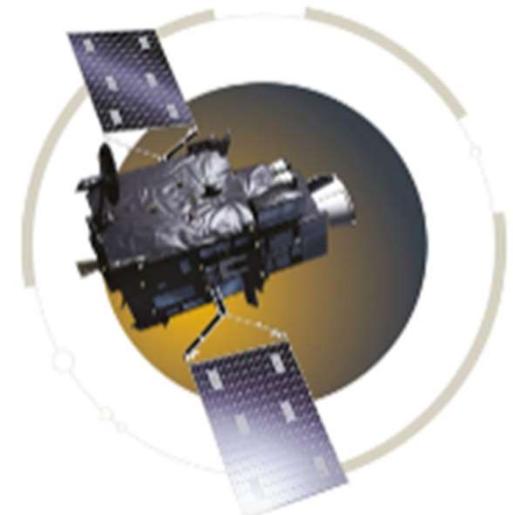


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Lightning Monitoring - Improving current methodology



Product	Description	Spatial resolution	AOI	Temporal resolution	Update frequency
Lightning Monitoring	Daily products (maps and data with lightning position) at 10 min frequency over Italian peninsula.	~ 2 km	Italian Peninsula	10 min	Daily

EO DATA

Meteosat Second Generation (MSG):

- Radiance Channels (IR3.9, WV6.2, WV7.3, IR10.8)

Meteosat Third Generation MTG:

- Radiance Channels (IR3.8, WV6.3, WV7.3, IR10.5)

- Lightning Imager

LIGHTNING IN SITU DATA

Lampinet

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