Introducing the Indian-French TRISHNA mission for high resolution SST observations in coastal ocean and continental waters

TRISHNA mission (Thermal infraRed Imaging Satellite for High-resolution Natural resource Assessment) : a cooperation between the French (CNES) and Indian (ISRO) space agencies

- Focus on **ecosystem stress and water use** + **coastal & inland waters**

Objectives

- primary scientific objectives of the mission : provide **high-quality imagery of vegetation, snow, ice and sea surface temperature and albedo**

- ***ecosystem stress and water use*** **:** help land managers and policymakers make informed decisions about **natural resources and the environment** on the seasonal scale and to **evaluate allocation between irrigation activities and hydrology of groundwater and rivers** => to **estimate water budgets** and to **warn about water stress**

- ***Monitoring coastal and continental waters***

TRISHNA mission (launch end of 2024) is a precursor of the LSTM (Land Surface Temperature Mission) from ESA foreseen to be launched in 2028.

The specificities of the TRISHNA mission

- measure the optical and thermal spectra emitted and reflected by the Earth from a low-altitude Sun synchronous orbit

- Instruments :
  - 1 **visible**, near infrared and short wave infrared instrument (VSWIR):
    - 5 spectral bands in the VNIR region (blue, green, red, NIR, Water vapor)
    - 2 spectral bands in the SWIR region (Cirrus, SWIR)
  - 1 **TIR** instrument: 4 spectral bands (TIR1 to TIR4)

- swath with a width of **1026 km**

- Revisit : ~ **3 days** (3 at equator to 6 acquisitions at 60-degree latitude for each 8-day cycle)

- Spatial resolution :
  - **57m** for nadir observations for continental surface and coastal areas
  - Other surfaces (deep oceans), ~ 1km

Spectral bands

Band name	Wavelength Center (nm)	FWHM (nm)	Purpose
Blue	485	70	Detection of low clouds
Green	555	70	Coastal, sediments, snow
Red	670	60	Vegetation (LAI, fCOVER, NDVI, …)
NIR	860	40	Vegetation (LAI, fCOVER, NDVI, …)
WV	910	20	Water vapour content estimation
Cirrus	1380	30	Detection of thin cirrus clouds
SWIR	1610	100	AOD, snow/cloud discrimination, vgt stress, burnt areas

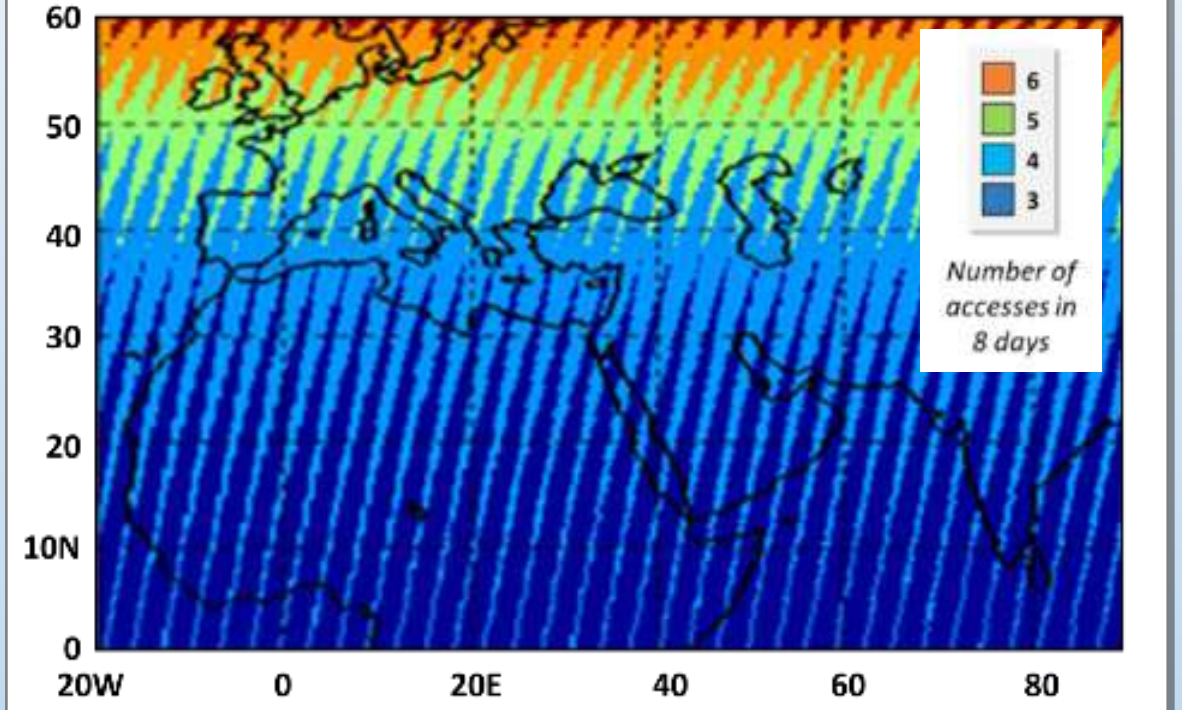
Band name	Wavelength Center (µm)	FWHM (µm)	Purpose
TIR 1	8.65	0.35	Temperature/emissivity separation
TIR 2	9.0	0.35	Temperature/emissivity separation
TIR 3	10.6	0.7	Split-window
TIR 4	11.6	1.0	Split-window

Source: TRISHNA SMRD V3.0

Coverage and revisit

TRISHNA full resolution data coverage (in green)

All continental land surfaces (including inland waters)
All coastal waters up to 100km from the shore
Bathymetry > 250m



TRISHNA geometric revisit frequency due to the overlap between adjacent orbits

Monitoring coastal waters, alluvial plains, shrinking sea ice, inland waters and lakes from TRISHNA :

Coastal ocean

- Large variations of SST in time and space due to intense **exchanges between Ocean, Atmosphere and Land**
- Coastal zones subject to local and remote forcings implying a wide range of phenomena: fronts, eddies, horizontal currents, strong vertical velocities, plumes, tides, waves, turbulence and mixing, stratification, ice formation.
- ~ 40% of the world's population within 100 km of the coast. In many regions, populations are exposed to a variety of **natural hazards** (e.g., extreme weather, storm surges), to the **effects of global climate change** (e.g., sea level rise), and to the **impacts of human activities** (e.g., urbanisation, modern agriculture, industrialization)
- **Coastal marine ecosystems** are rich and diverse, supporting much of the commercial fisheries of the world.

aters

Monitoring coastal waters, alluvial plains, shrinking sea ice, inland waters and lakes from TRISHNA :

❑ Scientific context

Alluvial plains

- strategic environments for human settlement
- sustain many services, such as for instance pollution removal
- crucial for the development of human society but the hydrological and biological functioning of those environments is not well described

Inland waters and lakes

- Surface water temperature a key water quality parameter driving the ecological status of lakes
- Monitoring water temperature is an important issue, especially in the context of climate changes

Temperature from Landsat 8, Simon, 2014, Prats, 2016

Monitoring coastal waters, alluvial plains, shrinking sea ice, inland waters and lakes from TRISHNA :

❑ Scientific questions

*How to better assess the **productivity and biodiversity of coastal and inland waters**?*
*How such **productivity and biodiversity are impacted by climate change**?*
*How spatial variability of SST serves the **mixing processes** within the coastal areas?*
*How SST gradients influence **winds and air-sea fluxes**?*
*How SST and temperature over lakes form useful **indexes to monitor climate change**?*
*How **sea ice melting processes** in polar caps contribute to ongoing climate drift?*
*How SST is linked to **biogeochemical cycles, biological activity and water quality**?*
*How to develop strategic approaches of **management for continental and coastal water quality**?*
*How continental waters are used for warning and monitoring **water borne diseases**?*
*How to estimate e**nergy fluxes in alluvial plains,** considering surface and groundwater flows as well as their interaction with the vegetation ?*
*How to better understand the i**nteractions between the water bodies** (sea, river, groundwater) in the estuarine and coastal zones ?*

Monitoring coastal waters, alluvial plains, shrinking sea ice, inland waters and lakes from TRISHNA :

❑ What TRISHNA brings

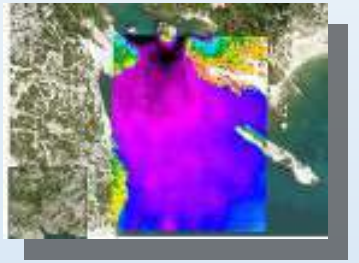
UHR observations that allow understanding, simulating and validating the physical and biogeochemical processes involved at this scale **clearly needed.**

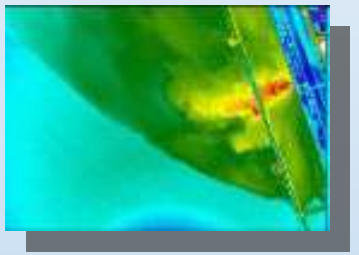
TRISHNA will monitor at fine scale the **interactions between land and coastal areas** : estuaries, tidal zone, fresh groundwater discharges into the sea

Highlighting SST gradients at a few ten of meters will support

- a better understanding of the onset and entailment of **air-sea fluxes** and winds at the benefit of a multi-scale characterization of the turbulence and **mixing processes** in ocean, shoreline and coastline, including land/coast interaction

- a better understanding of the **transport of biogeochemical constituents** and nutrients, the **monitoring of the productivity and pollutants drift**, also the **river discharges and fresh water resurgences**





TRISHNA science teams organization

Joint Science Team :

- ❑ Joint Science Advisory group
- ❑ Ecosystem stress and water use
- ❑ Coastal and inland waters
- ❑ Urban microclimate monitoring
- ❑ Solid Earth
- ❑ Cryosphere
- ❑ Atmosphere
- ❑ CAL/VAL
- ❑ Definition of the products

Organization :

- ❑ French / Indian mirror organization involving local research entities
- ❑ Objectives: definition of the expected variables and associated precision, products, algorithms, cal/val strategy
  - joint Indo-french ATBDs
- ❑ Synergies with ECOSTRESS, SBG, LSTM science teams

Coastal and inland waters : Science team

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Mission datasheet

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- ISRO/CNES cooperation, launch 2025, 5-year lifetime
- Scientific & operational applications
- Focus on **ecosystem stress and water use** + **coastal & inland waters**
- Global coverage
- 4 TIR bands + 5 VNIR bands + 2 SWIR bands
- Revisit : 3 acquisitions at equator per 8 days period

  761km-8day orbit reducing hot spot constraints in intertropical zone
- ± 34° scan angle, 1030km swath
- Nadir spatial resolution (VIS-NIR-SWIR-TIR): 57 m for continental and coastal areas, binned at 1 km over open ocean
- Overpass time : 1 PM (LTDN)
- NeDT 0.2K
- Indo-French(*) Joint Science Team, synergies with ECOSTRESS, SBG, LSTM science & application teams

  (*) with other contributors
- Free and open data policy for worldwide scientific community

Learn more about TRISHNA !
https://labo.obs-mip.fr/multitemp/trishna
https://trishna.cnes.fr/en