The Indian-French TRISHNA mission

Monitoring our ecosystem health from space

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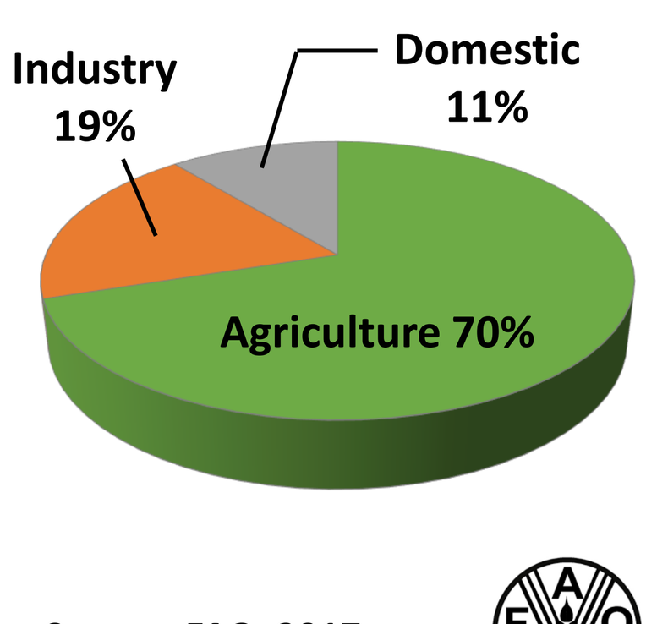
TRISHNA: what for ?

+2 billions people by 2050
- Pressure on energy and food
- Pressure on transboundary basins
- Population in fluvial & coastal zones

Biodiversity / pressure on the habitat
- In Rivers, wetlands, coastal zones
- Modified by dams, pollution

Global warming +2deg by 2050
- Impact on Carbon and water cycles
- Extreme events: droughts, floods, storms, fires

Global freshwater use



Source: FAO, 2017

Need for reliable metrics, homogeneous along time and on every scale from global to regional → TRISHNA = Frequent *AND* high-resolution measurements of the surface temperature & its dynamics

Mission datasheet

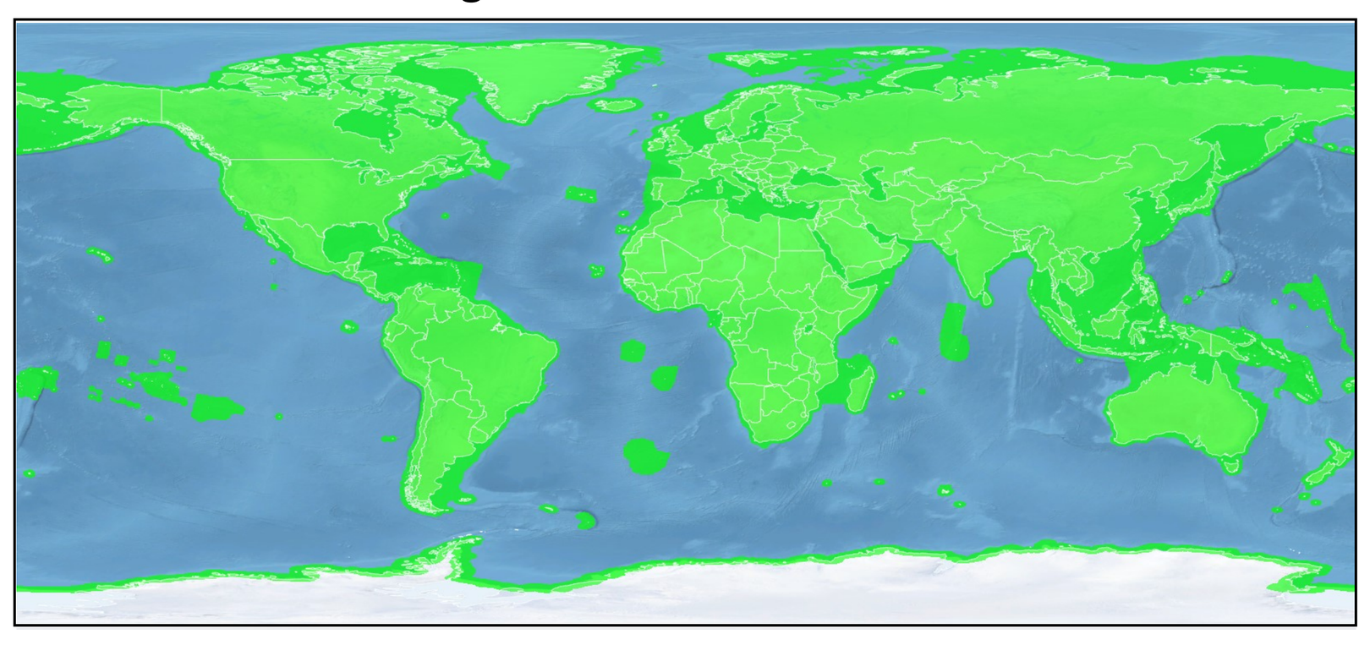
Band name	Wavelength Center (nm)	FWHM (nm)
Blue	485	70
Green	555	70
Red	670	60
NIR	860	40
WV	910	30
Cirrus	1380	30
SWIR	1610	100
TIR 1	8.65	0.35
TIR 2	9.0	0.35
TIR 3	10.6	0.7
TIR 4	11.6	1.0

Spectral Bands

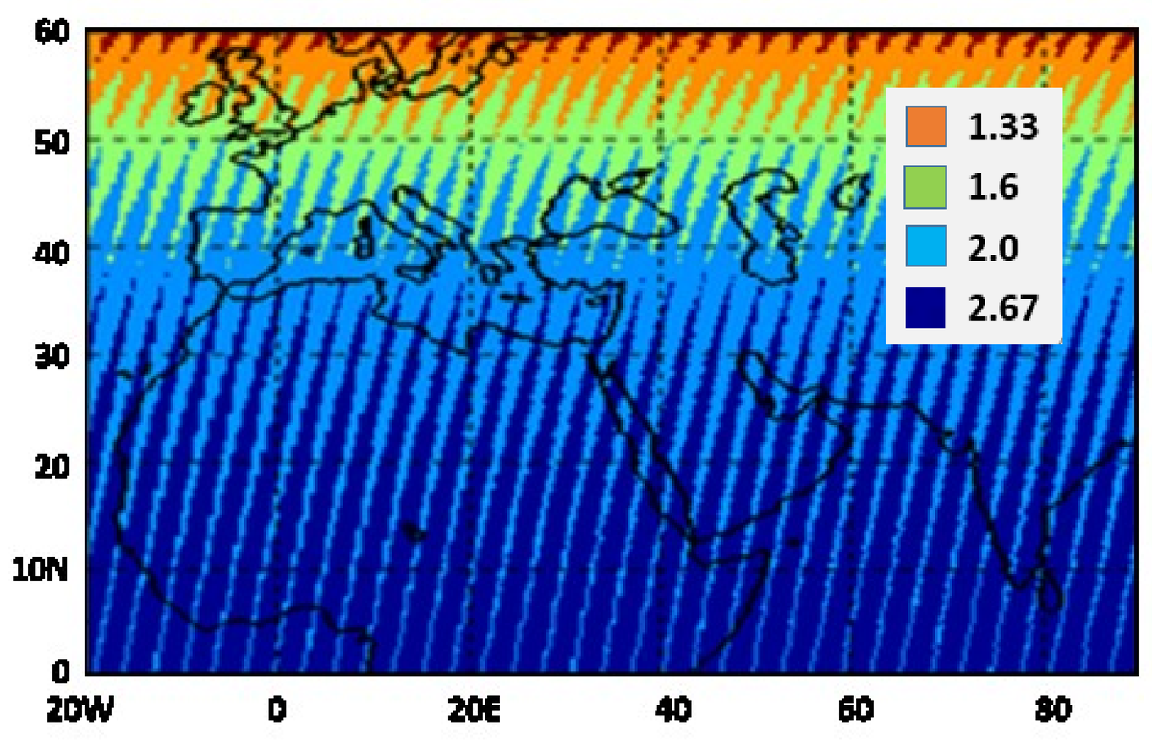
- ISRO/CNES cooperation, launch 2025, 5-year lifetime
- Scientific & operational applications
- Focus on **ecosystem stress and water use** + **coastal & inland waters**
- Global coverage of continental and coastal areas
- 60 meters nadir spatial resolution (VIS-NIR-SWIR-TIR)
- 5 VNIR bands + 2 SWIR bands + 4 LWIR 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
- Mean Overpass time : 1 PM (LTDN)
- NeDT 0.2K
- Indo-French(*) Joint Science Team (*) with other contributors
  Synergies with ECOSTRESS, SBG, LSTM science & application teams
- Free and open data policy for worldwide scientific community
- Level-2 products include reflectance, LST, LSE, EvapoTranspiration & Stress Index

Mission design

Full resolution coverage of continental surfaces and coastal areas



TRISHNA average revisit (days) as programmed



TRISHNA Products

All products also include quality flags

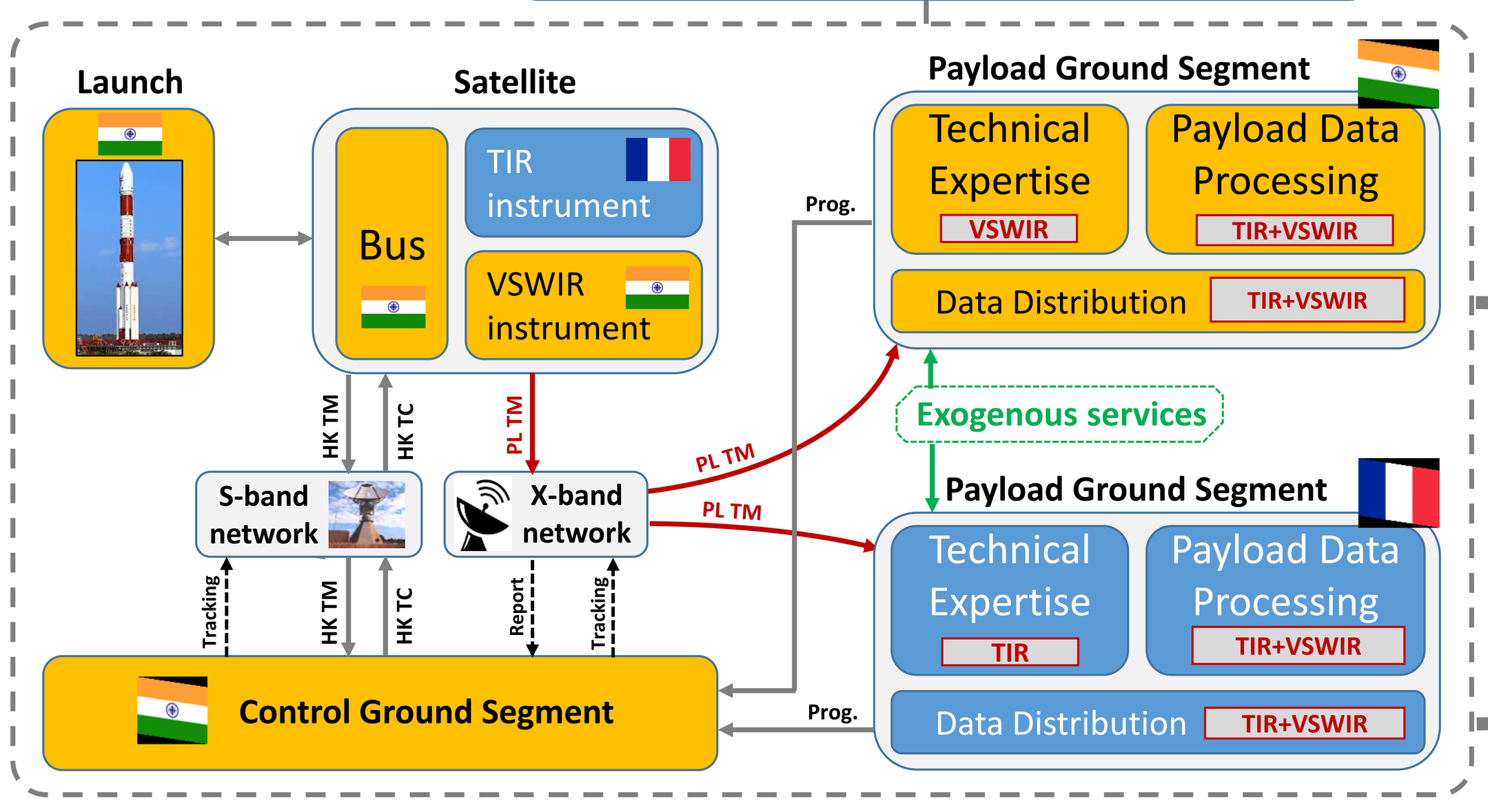
Level 1C *Top-of-atmosphere, Radiometrically and geometrically calibrated*
Orthorectified and resampled on a uniform spatial grid (Sentinel-2 tiles, Copernicus DEM)
- ✓ TOA reflectances x7 VNIR/SWIR bands
- ✓ TOA radiances x4 LWIR bands
- ✓ Cloud mask

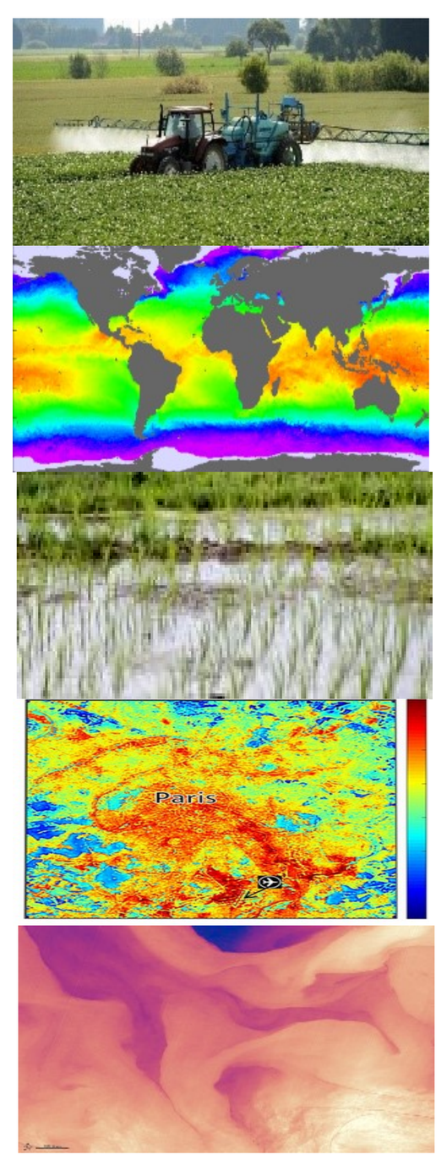
Level 2A
- ✓ Surface reflectances *x5 VNIR/SWIR bands*
- ✓ LST, SST, LSE *x4 bands*
- ✓ Cloud mask, TWVC, AOT, Scene classification

Level 2B
- ✓ Vegetation variables (NDVI, fAPAR, GAI, FCV)
- ✓ Albedo, Evaporative Fraction
- ✓ Instantaneous & Daily evapotranspiration

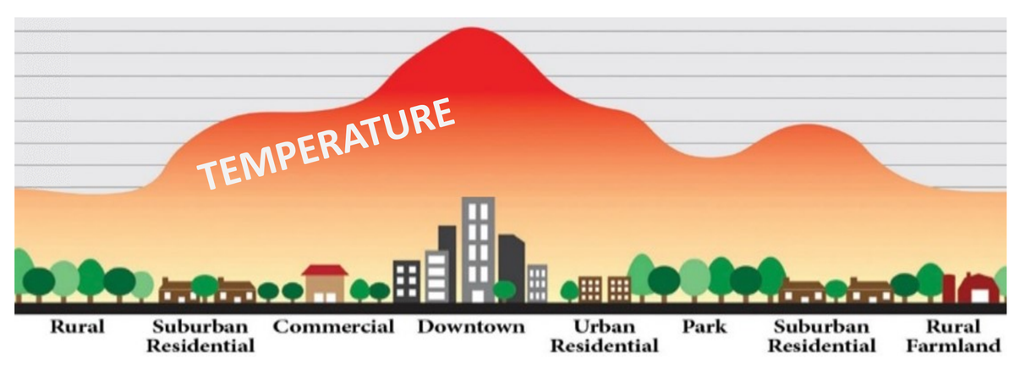
System overview

Joint Project Team





Urban microclimate monitoring

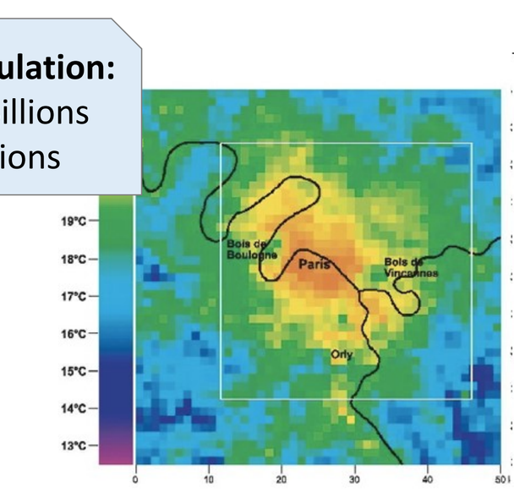


Air Temperature
Rugosity, Wind
Radiative trapping
Impermeability of the soils

Themes: Hydrology, building heat model, urban climatology

Connection with population health, comfort and safety

Urban population:
2008: 3.3 Billions
2050: 5 Billions

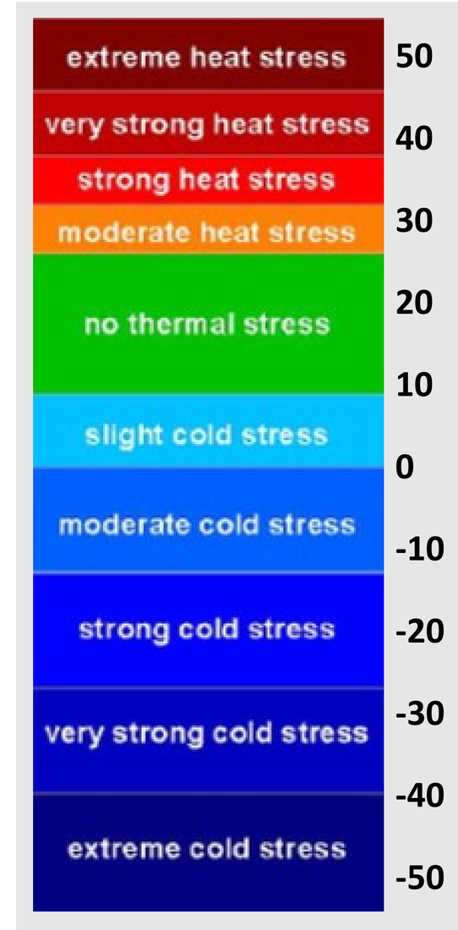


AVHRR Aug. 9, 2003 UHI over Paris (Do usset, 2007)

What TRISHNA brings:
- High revisit, global coverage
- LST, LSE
- Type of soil
- Rugosity

Exogenous data
+ Remote Sensing data
+ urban microclimatology model

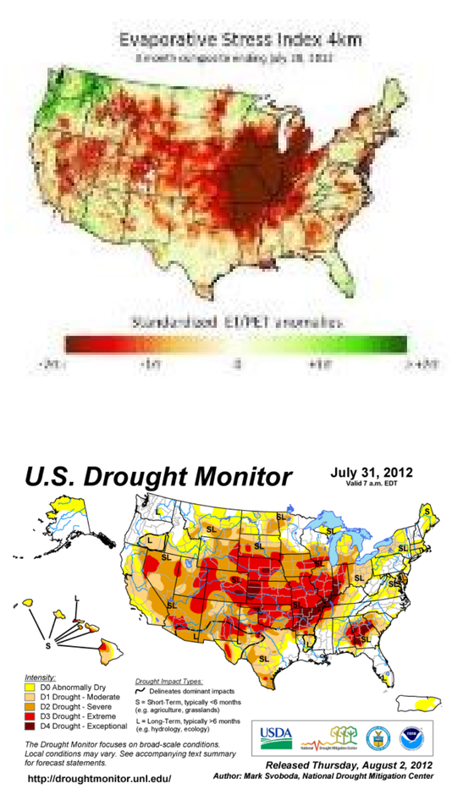
Air Temperature



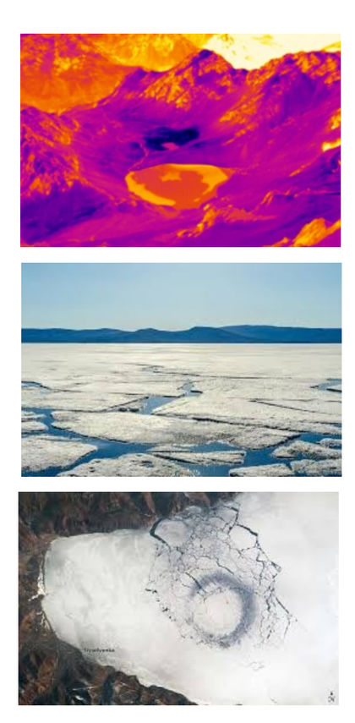
UTCI : Universal thermal confort index
www.utci.org

Ecosystem Stress and Water Use

Area	What is at stake	What TRISHNA brings
Irrigated Agriculture Rain-fed Agriculture Ecosystems	▪ Optimize irrigation ▪ Manage consumption of water ▪ arbitrate water savings ▪ additional irrigation ▪ follow the droughts and their impact on yield ▪ Better diagnosis of vulnerable areas (fire, drought, frost)	EVAPO-TRANSPIRATION STRESS TEMPERATURE



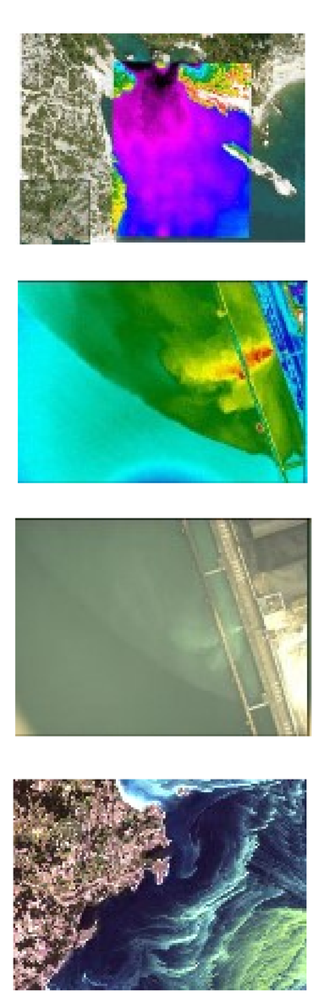
Cryosphere



Area	What is at stake	What TRISHNA brings
Sea ice, Ice sheets Ice caps Snow & Glaciers Permafrost Seasonally frozen ground River & lake ice	• Snow-melt runoff and debris thickness estimation • Snow cover change & metamorphism at sub-watershed scale • Modelling snow energy fluxes • Snow mass, Snow Water Equivalent (SWE), Snow depth	TEMPERATURE (Day & Night) EMISSIVITY Snow and Ice Albedo Snow cover

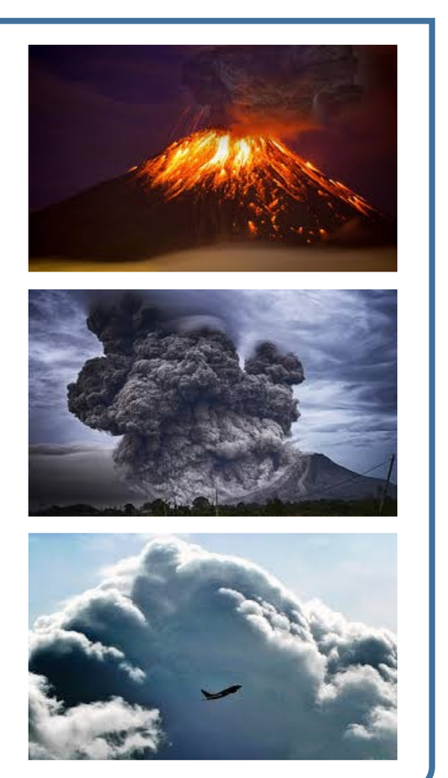
Coastal and Inland Waters

Area	What is at stake	What TRISHNA brings
Coastal Waters Inland waters Sea Ice	▪ Mixing processes • Water Quality, algal bloom, halieutic resource, spring discharge (resurgence), discharge of water, pollutants • Ecosystem Productivity (phytoplankton) • Halieutic resource • Melting and frost Processes	TEMPERATURE REFLECTANCES COLOR INDICES



Solid Earth

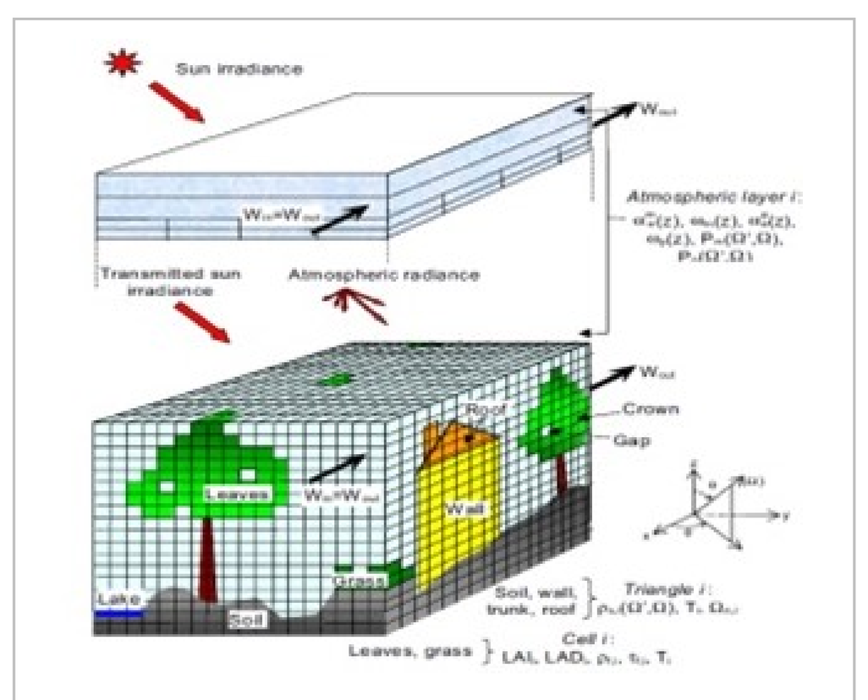
Area	What is at stake	What TRISHNA brings
Mineral exploration Volcanology Soil	• Thermal anomaly detection of coal & peat fire (location & direction), volcanic eruption • Estimating Lava effusion rate • Emissivity-based detection of granitoids • Geothermalenergy assessment • Soil properties retrieval	TEMPERATURE (Day & Night) SPECTRAL EMISSIVITY ALBEDO



Calibration / Validation

Modeling tools

SCOPE
Soil-Canopy-Observation of Photosynthesis and Energy fluxes
Van der Tol et al., 2009

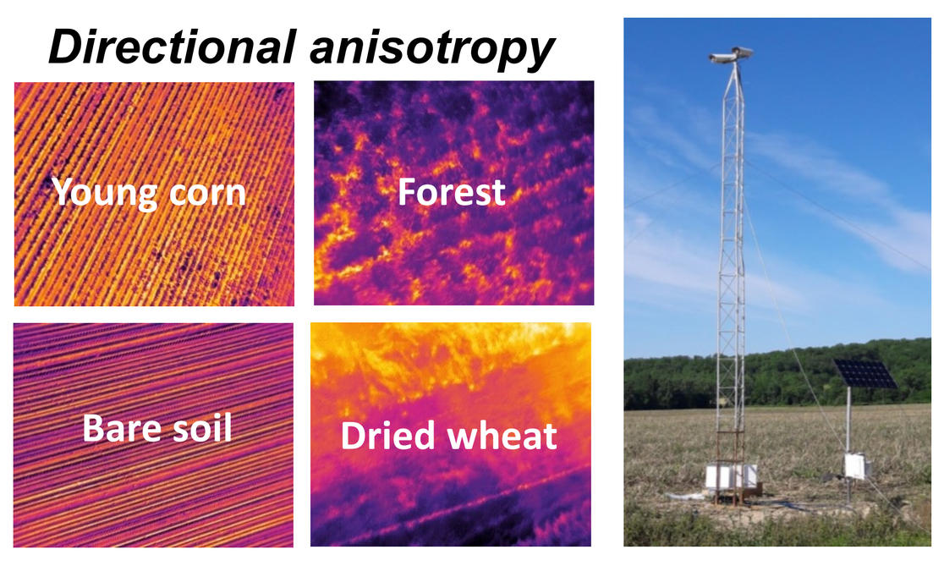


DART
Discrete Anisotropic Radiative Transfer
Gastellu-Etchegorry et al., 2017

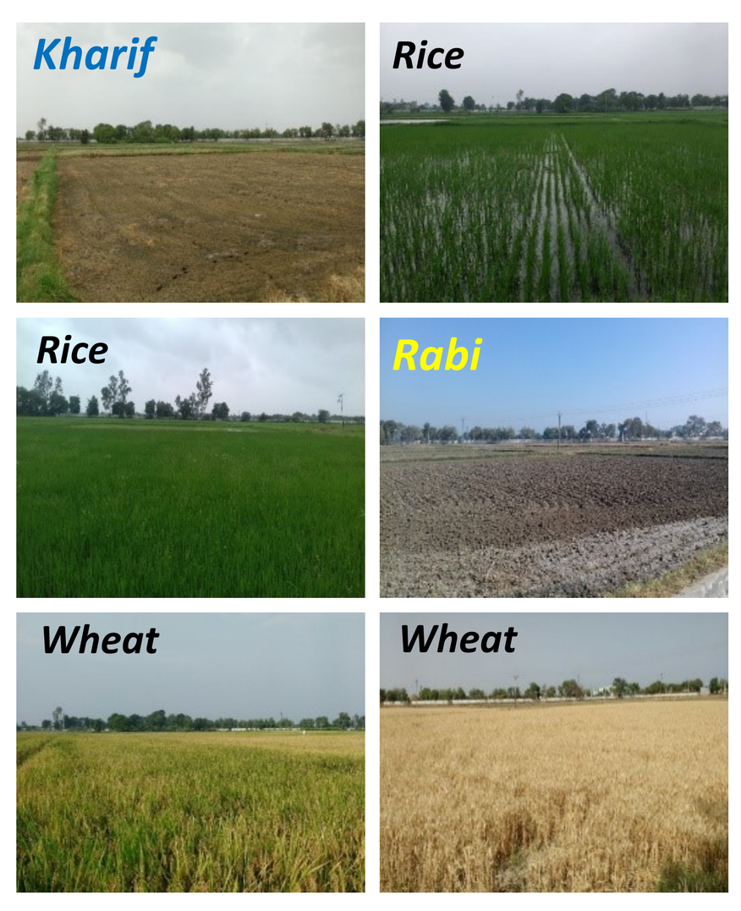
Ground-based stations and sites

South of FRANCE
TIR cameras & micromet stations

Directional anisotropy

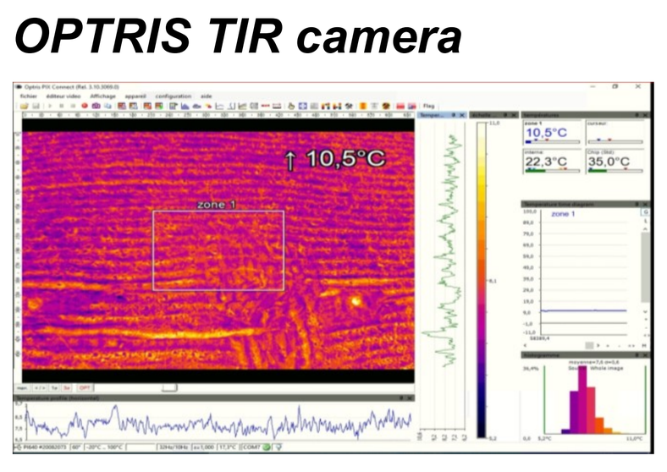


Nawagam, Gujarat, INDIA



Chichaoua, MOROCCO
(MOCTAR)

OPTRIS TIR camera



Taous, TUNISIA
Olive tree orchard

Nashik, INDIA
Vineyard