TRISHNA: Products for Natural Resource Assessment

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May 25, 2022






TRISHNA

- ISRO/CNES cooperation
- Launch 2025, 5-year lifetime
- Design drivers: ecosystem stress and water use + coastal & inland waters
- Global coverage
- 3-day revisit, 60m, VNIR-SWIR-LWIR
- Overpass time : 1 PM & 1 AM
- NeDT 0.2K

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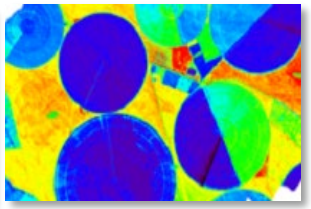
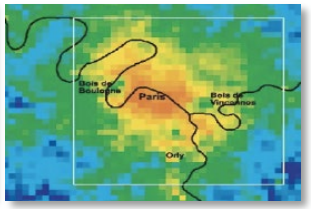
TRISHNA for Science & applications

Water mgmt, agriculture

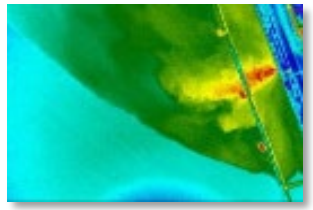
Ecosystem health, drought, fire


Urban heat

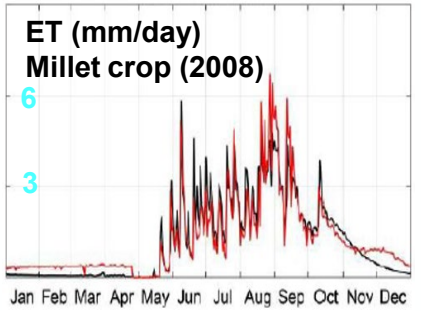
Solid Earth


Coastal and inland waters




Cryosphere


Science



Drought episodes

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Impact at soil-plant-atm interface

↓

Surface temperature **& its dynamics**

Continuity & density of time series

Applications

Rapidly changing processes **+** Severe potential impacts

↓ ↓

Quick decision-making needed

- Land Surface Temperature
- Vegetation status
- Land Surface Energy Balance
- Evapotranspiration from vegetation

- ✓ **High-repeat**
- ✓ **Field-scale**
- ✓ **Global**
- ✓ **Thermal + Optical**
- ✓ **Low latency**

TRISHNA products characteristics

- ✓ Global coverage at 60m resolution of Land + coastal areas 100 km (and more) from coastline
- ✓ High revisit: several acquisitions per week (maximum average revisit interval: 2.66 days at Equator)
- ✓ Visible + NIR + SWIR + LWIR in the same geo-referenced product (L1c, L2)
- ✓ Mid-day (9 bands for L2) & mid-night (4 LWIR bands) acquisitions
- ✓ Directionality (cf presentation by Jean-Louis Roujean) [PATHFINDER MISSION]
- ✓ Consistency with LSTM & SBG: cross-validation, products def (geo. projection, variables, formats)
- ✓ Data freely available from French Mission Center & Indian Mission Center
- ✓ Distributed L2 data include LST, SST, biophysical variables, evapotranspiration & stress index

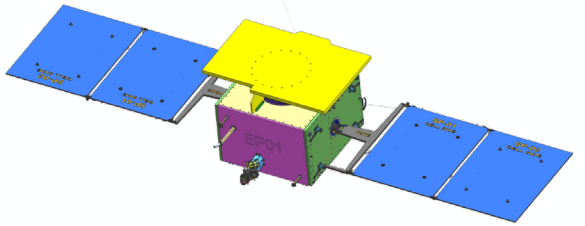
TRISHNA preparation status

Launch

- Launcher: PSLV
- Launch from Satish Dhawan Space Centre, India
- **Launch date: 2025**

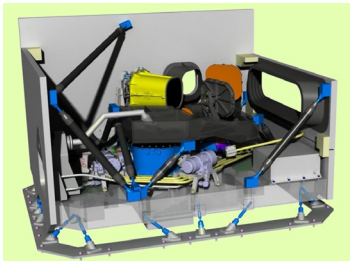
Bus development

- Internal ISRO approval for S/C is in progress
- Feasibility and Configuration studies completed
- IRS-1k bus
- Mission lifetime: 5 years (consumables for 7 years)



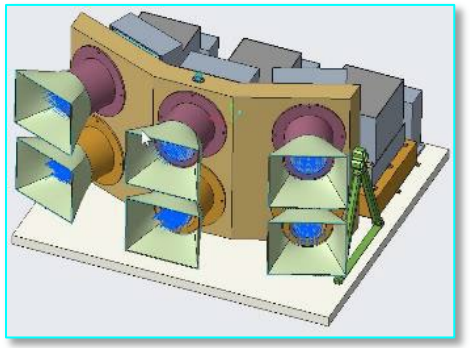
TIR instrument

- Instrument development contract signed with AIRBUS Defence & Space in March 2020
- Phase B officially started in June 2020
- Preliminary Design Review held in June 2021
- Critical Design Review planned beginning 2023
- Instrument delivery planned in 2024

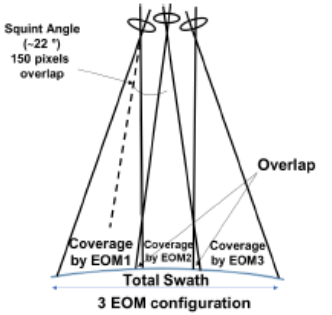


Developed by	AIRBUS DEFENCE & SPACE
Acquisition	Across track scanner
Mass	210 kg
Spectral bands	4 TIR

VSWIR instrument



Developed by	ISRO
Optical Heads	6
Acquisition	Pushbroom
Mass	95 kg
VNIR bands	5
SWIR bands	2



Synergies TRISHNA / LSTM / SBG

What for ?

- Day-to-day evapotranspiration is the ultimate goal, which can not be achieved by any mission alone
- Common challenges, associated to the physics of measurements of the thermal infrared signal
- Role of TRISHNA as pathfinder for the future operational mission

Topics

- Joint efforts on CAL/VAL — Common standards, work on protocols, JPL instrument in LaCrau, HyTES campaign
- Mission design — Mission requirements (local time), mission scenario (acquisition masks)
- Products & ATBDs — Algorithms, variables AND format (projection grid, L1C and L2 variables)

Meeting points

- Regular (monthly) meetings with LSTM project team
- Regular meetings with JPL
- Regular joint sessions during scientific conferences (TRISHNA DAYS, ECOSTRESS team meetings, Living Planet, RAQRS)

Overview of distributed TRISHNA products

UNDER CONSTRUCTION

Level 1C	TOA reflectance (x7 VNIR/SWIR bands)	TOA radiance (x4 LWIR bands)	Cloud mask
	Radiometrically and geometrically calibrated - Orthorectified and resampled on a uniform spatial grid (Sentinel-2 tiles, Copernicus DEM)		
Level 2A	Land Surface Temperature, Sea Surface Temperature Normalized Surface Temperature	Surface reflectance Normalized reflectance	Total Water Vapor Content
	Land Surface Emissivity (x4 LWIR bands)	Cloud mask	Aerosol Optical Thickness
Level 2B	Surface albedo	***Biophysical variables*** Green Area Index, fAPAR, Green Fraction	
	Energy budget at time of acquisition EvapoTranspiration (contextual), Evapotranspiration (alternative)	***Daily ecosystem stress variables*** Daily EvapoTranspiration and daily stress	
Level 3	Temporal and/or spatial synthesis of level 2 variables	***Daily ecosystem stress variables with gap-filling*** Daily EvapoTranspiration and daily stress	

All products also include quality flags

TRISHNA CAL/VAL plan overview

Objectives of the CAL/VAL process

- ✓ Validation of the system requirements
- ✓ Validation of the mission requirements
- ✓ Assessment of the data products perfo.
- ✓ Ensure consistency with ref. missions

Methods

- ✓ CEOS standards (LPV, SST-VC) + adapted protocols
- ✓ Comparisons with in situ data on validation sites
- ✓ Comparisons with airborne & satellite data
- ✓ Analysis of trends in time series of TRISHNA products
- ✓ Analysis of process model results

Strategy

- ✓ Each variable varies with space & time
  → appropriate sampling of the range of the variable
- ✓ Observation conditions:
  - ➢ Various meteorological conditions
  - ➢ Directionality (obs. angle up to 40 degrees)

- ✓ **Global distribution of sites**
- ✓ **different land cover types**
- ✓ **Different phenological regimes**
- ✓ **different measure conditions**

Data products to calibrate / validate

CALIBRATION (LEVEL 1)

- Level 1: use of vicarious calibration
- Level 2: absolute calibration from instrumented sites with well-known conditions and surfaces (SST on Lake Tahoe, LST and reflectances on LaCrau)

LEVEL 2A VALIDATION

Level 2a algorithms

- Atm. correction and temp/emiss separation
- Atm. correction for SST computation
- Surface reflectance over land
- Sea surface reflectance
- Computation of emissivity
- Generation of cloud mask
- Pixel classification

Specific level 2a issues, associated to the properties of the thermal infrared signal

- Directional anisotropy
- Turbulence
- Handling pixel heterogeneity

Validation of surf. temp. on specific land covers and water surfaces

- LST of snow
- LST in urban environement
- Uncertainties associated to water skin temp.

VALIDATION OF EVAPOTRANSPIRATION

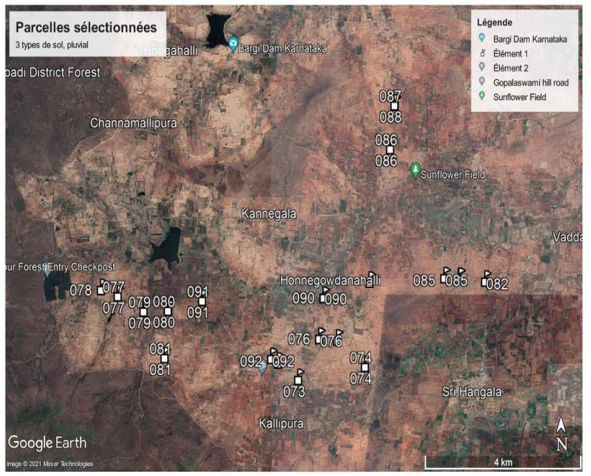
2 axes to implement the CAL/VAL for evapotranspiration:

(a) Based on existing measurements networks (ICOS, ISRO flux towers network)

(b) New sites specific to TRISHNA: “super-sites” for which surface fluxes can be measured for different types of land covers, and with measures to characterize the water status of the ground and the vgt development

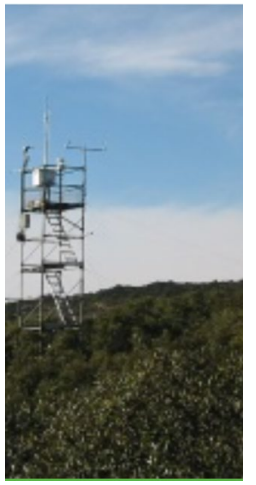
Sites & on-going activities (examples)

Nashik, INDIA
Vineyard



Berambadi watershed, Karnataka, INDIA
Agric. parcels with temp & humidity sounders

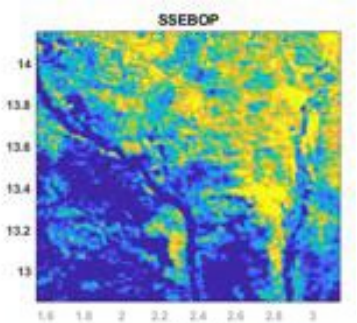
Roujan
Vineyard



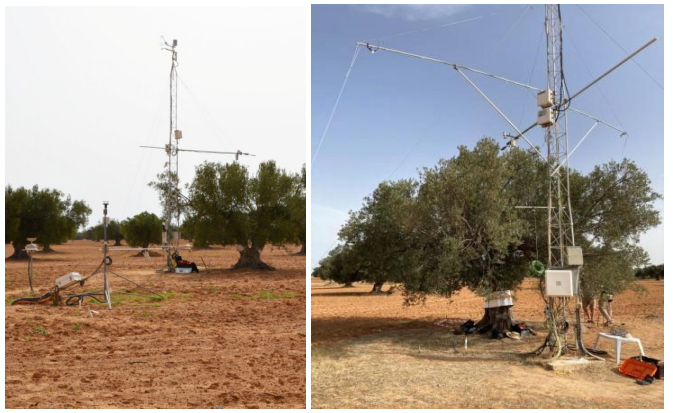
Puéchabon
Green oaks forest

Larzac
Natural meadow

Verdu, SPAIN
Vineyard



Niamey, NIGER
Annual (2007) ET



Taous, TUNISIA *Olive tree orchard*

LaCrau *RADCALNET station + meteo & surf. fluxes*

Thank you for your attention !!

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