# Space for Climate in Polar Regions

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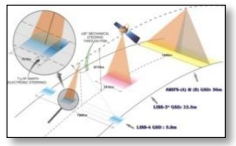
*MoES, New Delhi June 03, 2025*

# Current Operational Remote Sensing Capabilities

## Space Segment

### RESOURCESAT & RISAT
**Natural Resources & Disaster Management**



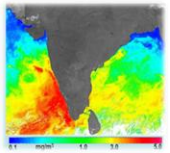
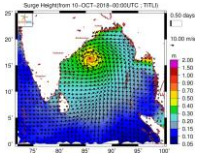
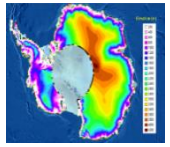
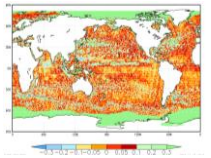

- Three tier imaging : 56 m / 23 m / 5.8 m
- Revisit Capability : 03 / 11 / 03 days
- C-Band SAR (3-50m resolution) / 17 to 24 days repetivity

### CARTOSAT
**Cartography & Large Scale Mapping**



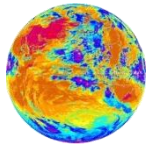
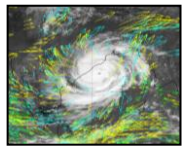
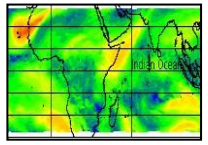
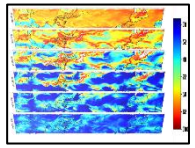

- 60 cm PAN & 1.5 m Multi-spectral
- 28 cm PAN & 1 m Multi-spectral

### OCEANSAT-3, SARAL
**Ocean State Forecast ; Ocean Altimetry, Wind Vector**

- Ocean colour
- Sea-surface wind vector
- Ocean Altimeter

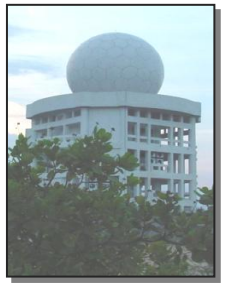
### INSAT 3D, 3DR & 3DS, MHS
**Weather Forecasting; Atm. and Climate studies**

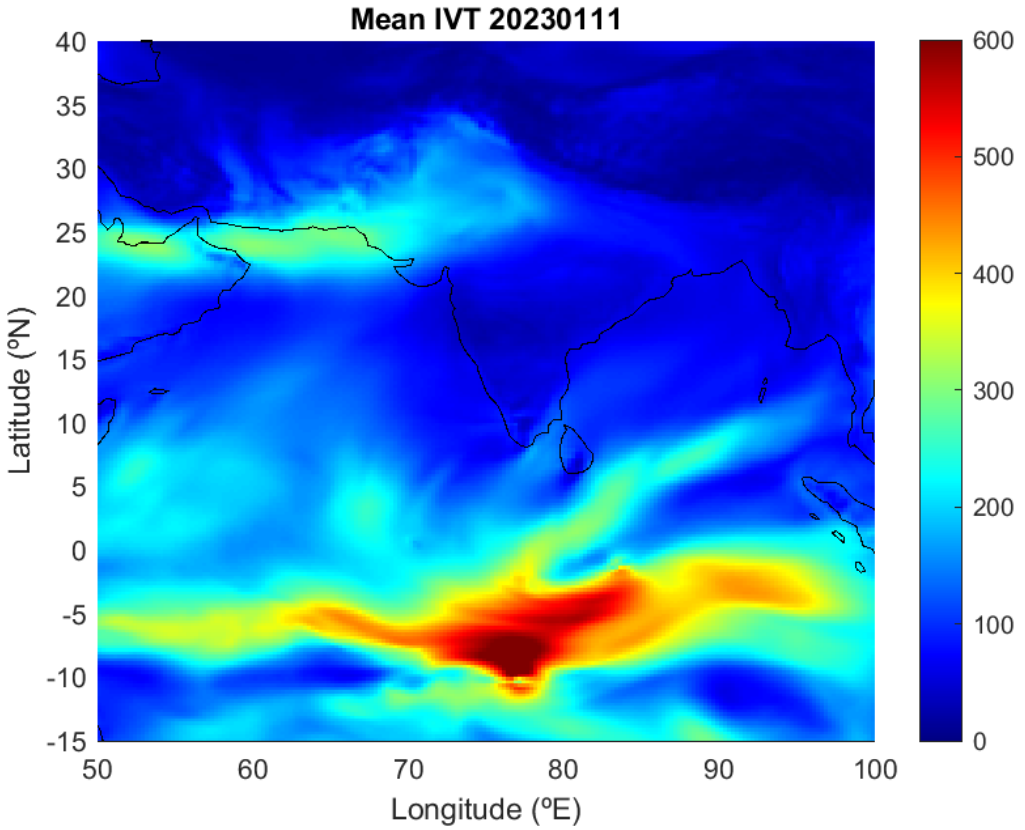
- 6 Channel Imager –48 images per day
- 19 Channel Sounder –Atm. Profiles

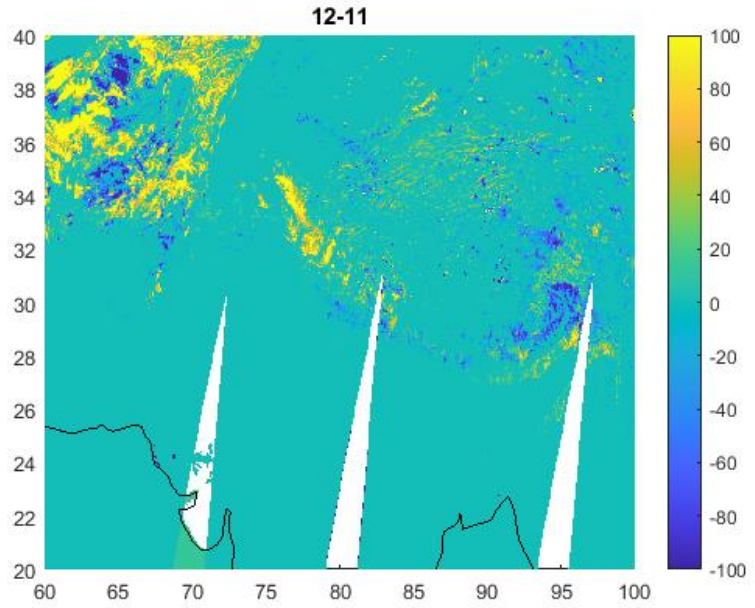
## Aerial & UAVs

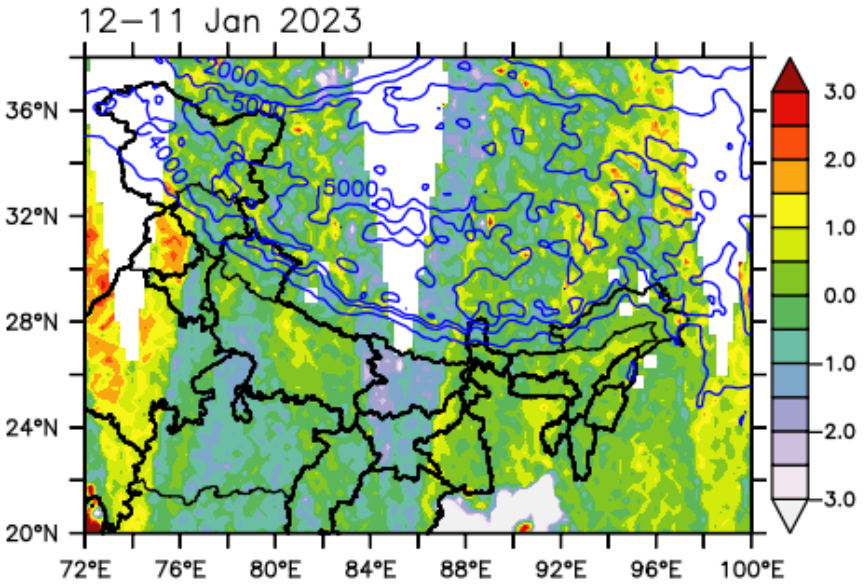

## Terrestrial

# Climate Change induced enhancement of Water vapor over NW Himalayas




IVT magnitude as high as 100-to-400 kg/m/s in the core

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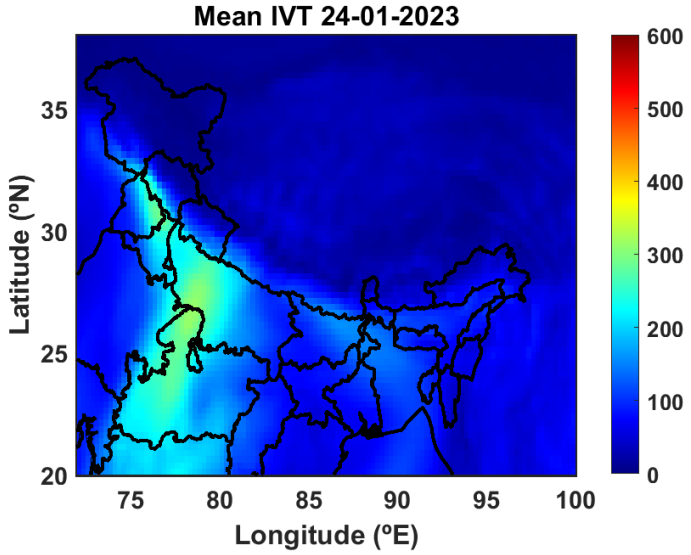
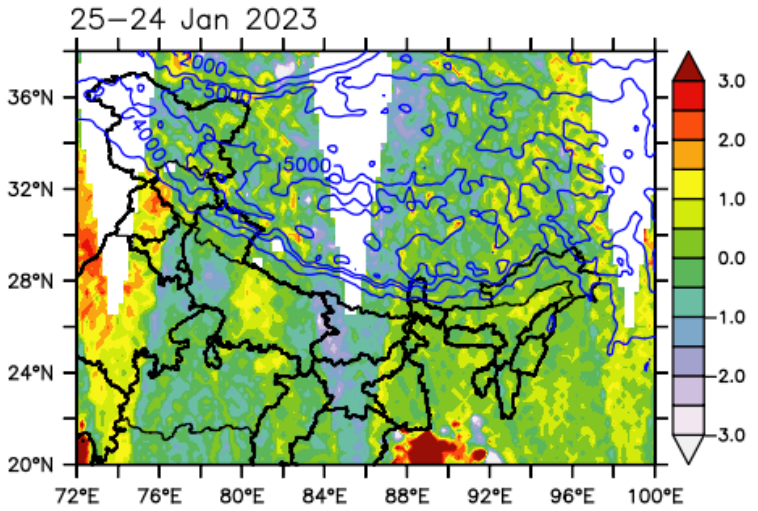
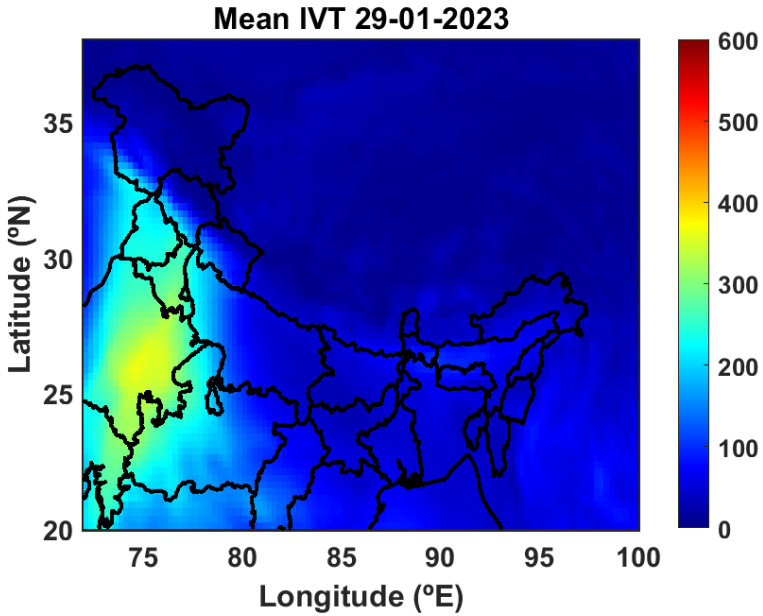
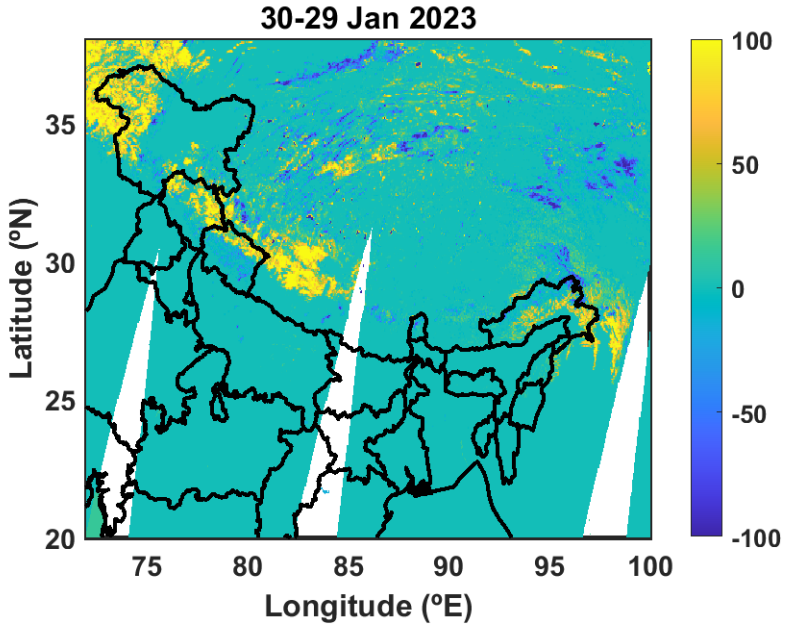


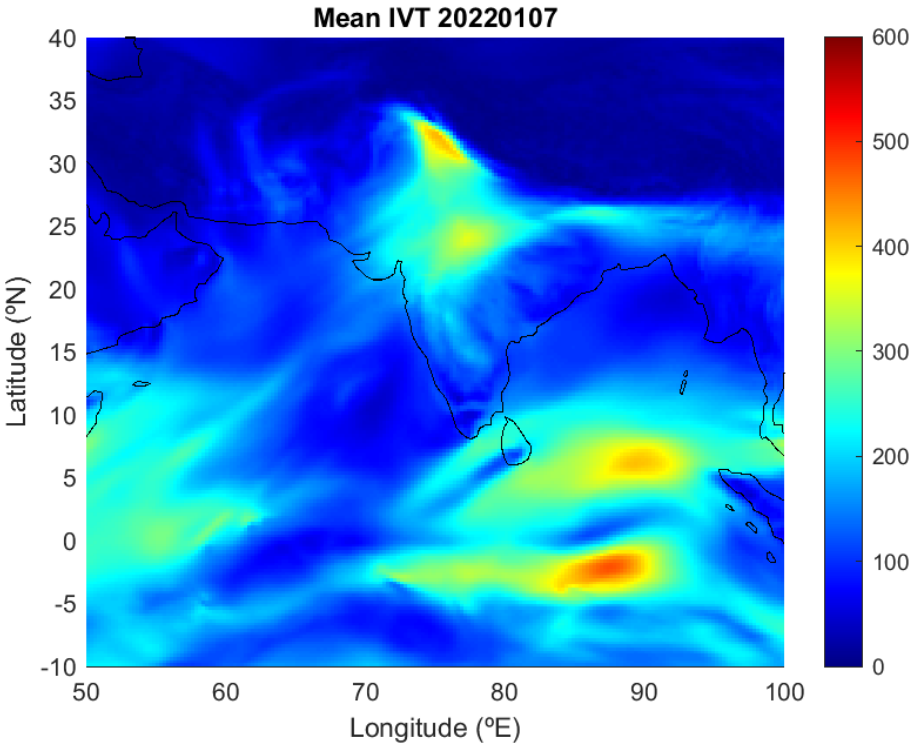




TIVT values ranging from 0.5 to 3.0 × $10^8$ kg/s.

The average discharge of the Indus River water into the Arabian Sea is around 3.0 × $10^3$ $m^3$/s;

(for comparison, the average water vapor flux in the observed events is nearly five-orders of magnitude more than the liquid water discharge into the Arabian Sea from the Indus River).

# Water vapor – Precipitation over NW Himalayas

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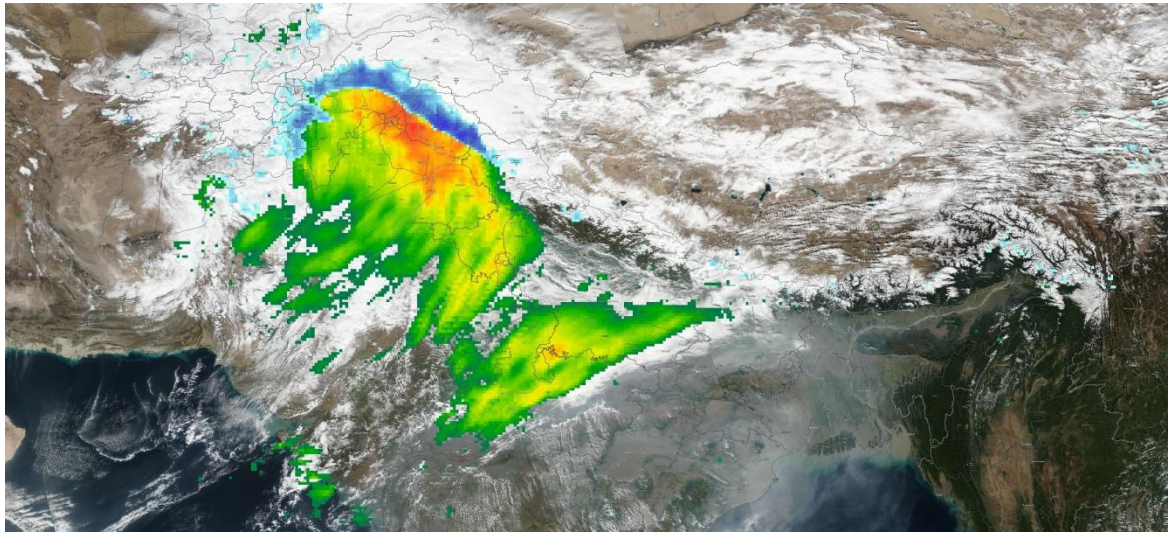
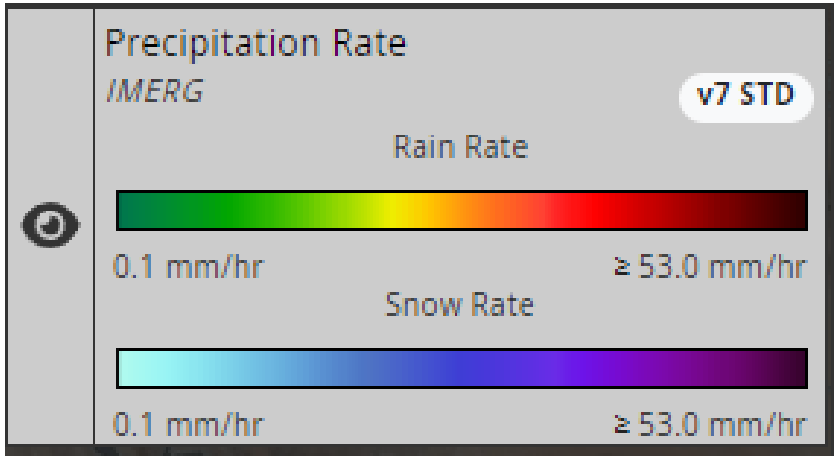
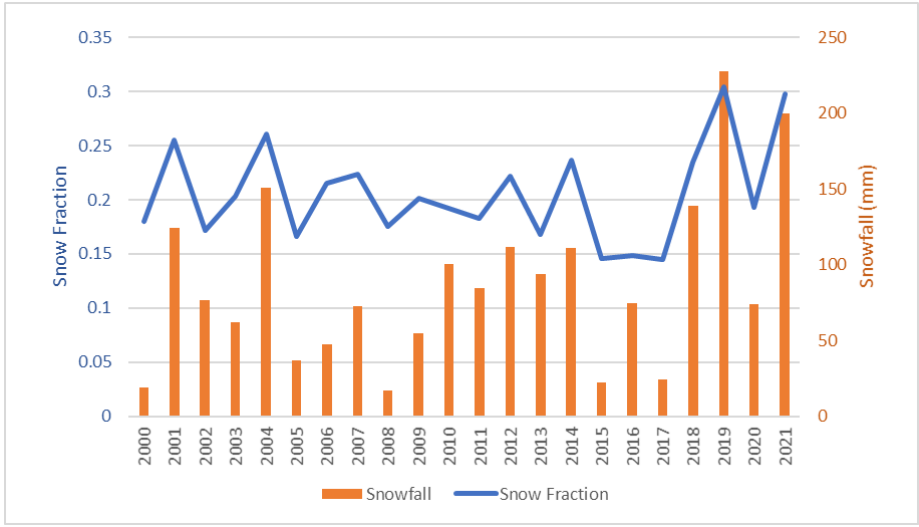




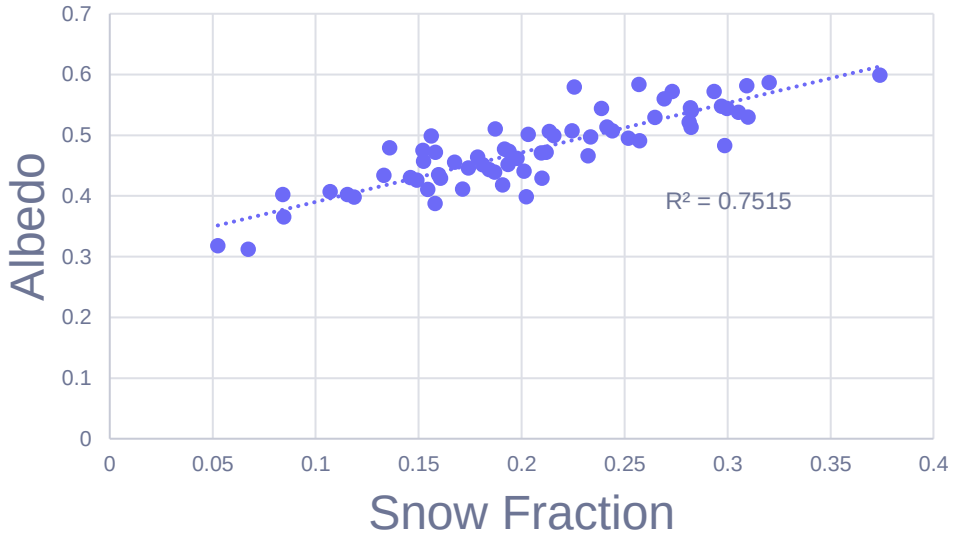
## Insights into long-term Variability over Himalayas

- Long-term snow-cover changes over the Western Himalayas
  - Snow cover from ISRO EO
  - Snow fall from IMERG data
  - Albedo from CERES and MODIS dataset.



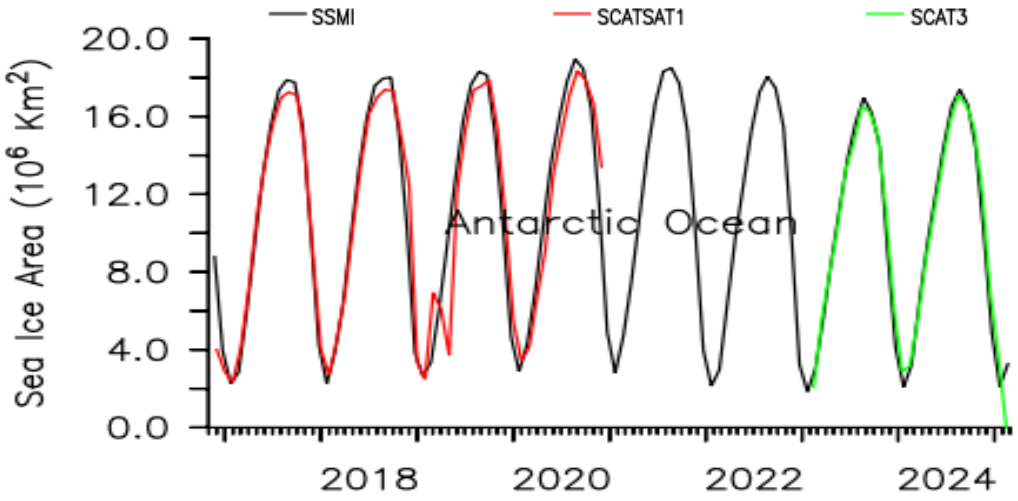

- Higher snowfall linked to increased snow cover

- Higher albedo changes: highlighting snow's role in regulating local climate.

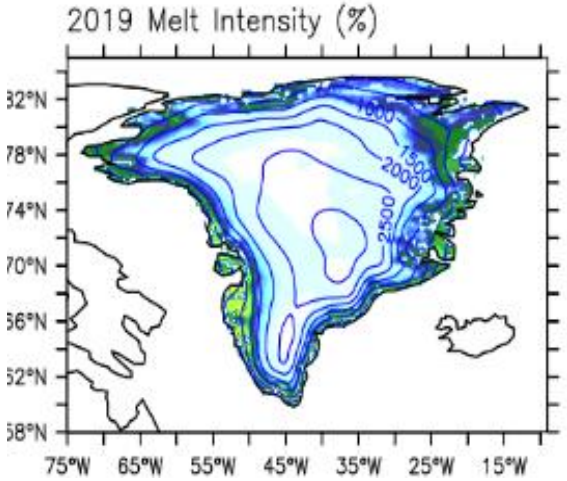


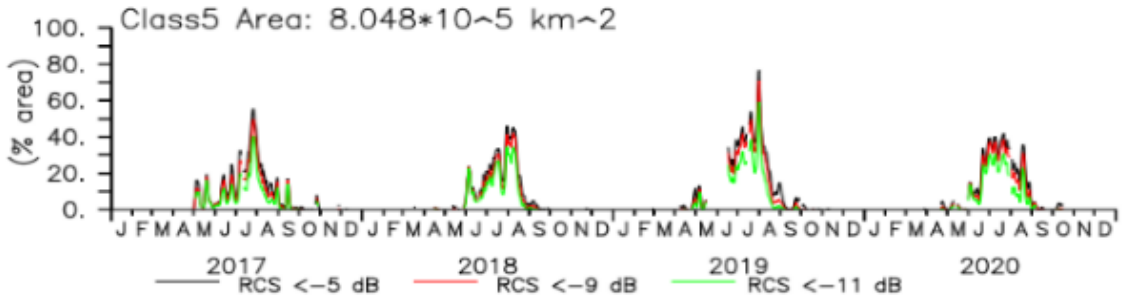
# Sea-Ice extent using EOS 06/SCAT3 and SCATSAT-1

- An algorithm to delineate the sea ice in the Antarctic Ocean and Arctic Ocean from EOS06/SCAT3 and SCATSAT-1 Normalized Radar Cross Section (RCS) has been developed.

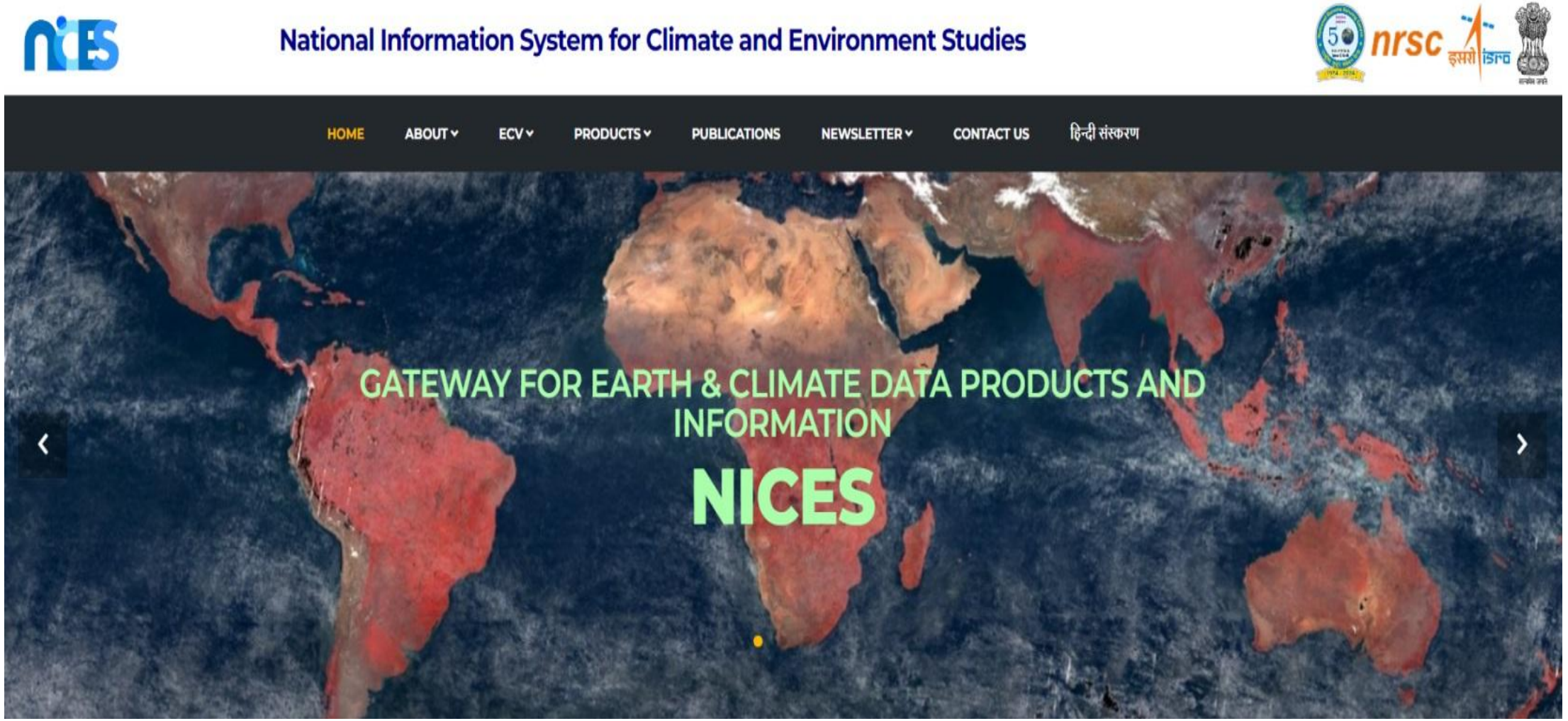



***Snow-Ice study of Greenland:*** Region was sub-divided into 6 classes based on RCS and topography to quantify snow melt intensity during the study period.



# NICES Homepage




**Terrestrial Products (30)**

**Ocean Products (25)**

**Atmospheric Products (6)**

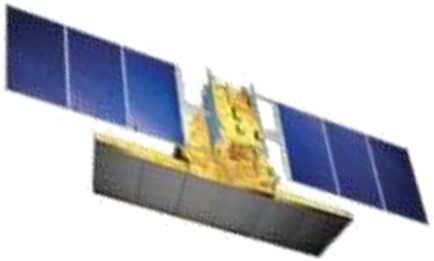
**Model Derived Products (9)**

# NICES Products timespan

| Time span (products) | NICES Geophysical products |
|---|---|
| 21 - 30 years (6) | Surface Soil Moisture, Ocean Heat Content, Ocean Mean Temperature, Tropical Cyclone Heat Potential, Eddy Kinetic Energy, Total Alkalinity |
| 16 - 20 years (4) | Land use land cover, Forest Fire, **Snow Melt and Freeze**, Mean Sea Level Anomaly |
| 11 - 15 years (7) | Chlorophyll, Kd_490, LULC, Land degradation, Tropospheric Ozone, Net sown area (Agriculture), Cloud Amount |
| 5 - 10 years (15) | Albedo, NDVI, Vegetation Fraction, Surface Water Body Fraction, **Snow Cover Fraction, Himalaya Glaciers, Snow albedo**, Model-TCHP, Model-D26, Ocean Surface Currents, Total Alkalinity – Dissolved Inorganic Carbon, PBLH<br><br>Ocean Surface Winds, Wind Stress, Wind Curl, Sea Level Pressure, Albedo, NDVI, Vegetation Fraction, Surface Water Body Fraction, Snow Cover Fraction, Himalaya Glaciers, Snow albedo, Ocean Surface Currents, Total Alkalinity, Dissolved Inorganic Carbon, Planetary Boundary layer Height. |
| ***Model derived products*** | |
| 30 years (5) | Net Ecosystem Productivity , Net Primary Productivity, VIC Model -Surface Soil Moisture , VIC Model-Evapotranspiration , VIC Model-Surface Runoff |
| 5 - 10 years (2) | Model-Tropical Cyclone Heat Potential , Model-Depth of 26° Isotherm |

# Upcoming Earth Observation Missions

## RISAT-1 B



All-weather;
Day& Night Imaging

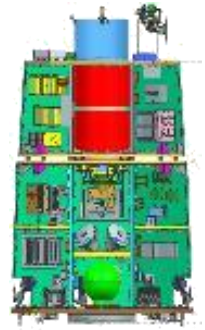
## Oceansat-3A

Ocean Color & Wind vector – Continuity + SST

## L & S Band SAR

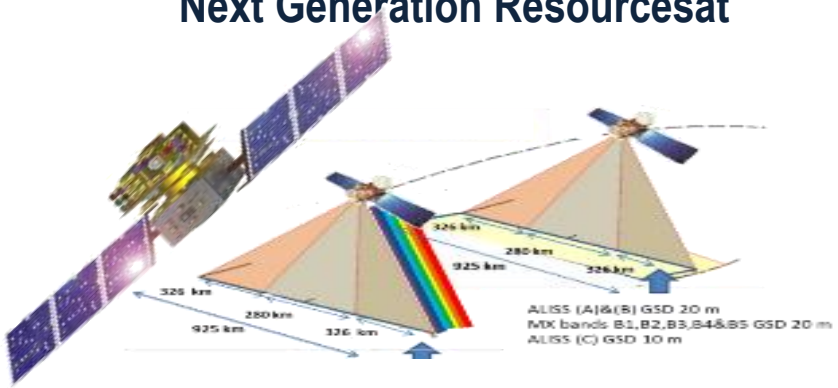
All-weather;
Day & Night Imaging

## HRSAT



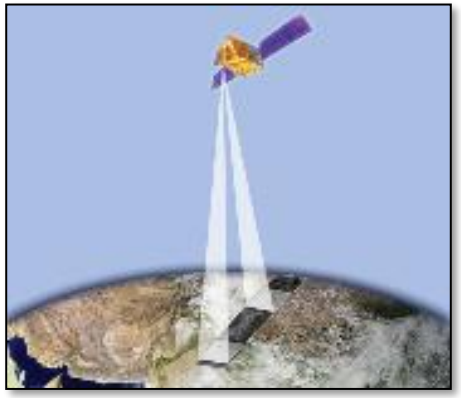
Daily re-visit of Area of Interest

## Next Generation Resourcesat



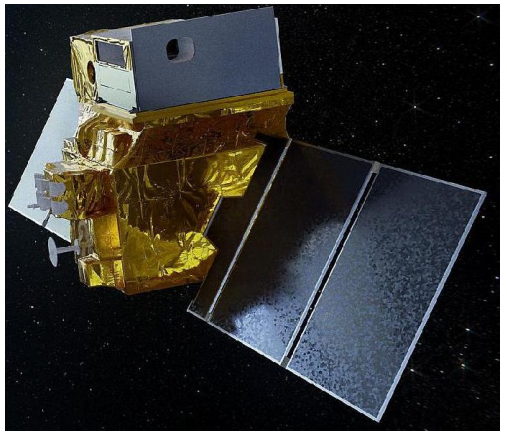

Wide Swath imaging with improved spatial resolution

## High resolution Stereo



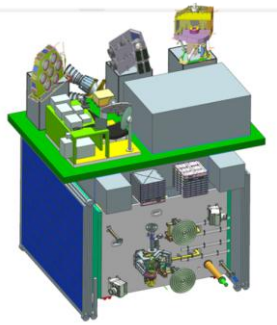
Concurrent Stereo & MX imaging

## High res. TIR & VSNIR



ThermalImaging

## G20 Satellite



Environment & climate change

# Conclusions

**Space for climate in polar regions:**

3rd pole:

- Climate Induced Water vapor transport
    - Observed to play a major role
- Albedo – induced Warming *versus* altitude

Polar regions:

- Cryosphere products from the existing sensors – NICES web portal
- Next-generation satellites are essential
    - Need to identify the Gap areas

*Thank You*