India's International Cooperation in Earth Observation Missions

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ISRO's EO International cooperation

EO Data exchange	• Access to data from foreign satellites to complement and supplement our satellite data • Contributing data to other agencies
Joint satellite missions	• Augment data sources through international cooperative satellite missions • Building advanced sensors to meet growing data demand
Data quality & Joint experiment	• Enhancing data quality through joint calibration-validation • Joint campaign for proof of concepts
Data reception	• Providing satellite data reception for global studies • Support in Telemetry Tracking and data reception
Capacity building	• Capacity building for other country through UN-CSSTEAP and joint workshops
International platforms	• Participation in key international meetings, bodies, etc. • Support to global initiatives, leadership roles.

EO Data exchange

Data Exchange / Sharing

- International Disaster Charter and Sentinel Asia for Disaster Management Support
- USGS: (Landsat– 7/8 ; Resourcesat-2)
- EUMETSAT: Oceanography & Met data
- ESA: IRS & Sentinal data
- BRICS: Virtual RS satellite Constellation
- NASA: Scatsat/Rapidsat data utilization
- Canada & Italy : Microwave data
- UN-ESCAP – Drought monitoring for Srilanka

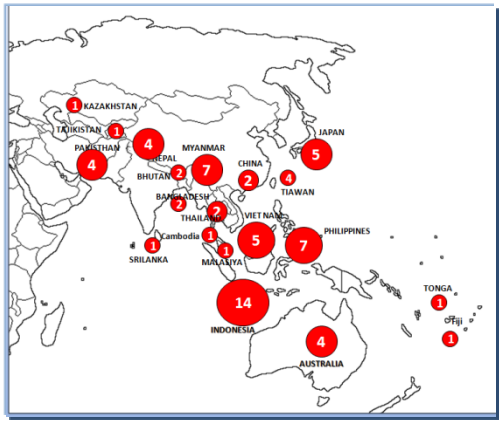
In-situ Data Observation

- SAARC STORM: Establishment of weather observation network in Bangladesh, Nepal & Bhutan for severe thunderstorm prediction
  - 24 AWS & 1 GPS Radiosonde - Bangladesh
  - 16 AWS, 2 GPS Radiosonde & 1 Doppler Weather Radar in Nepal
  - 10 AWS and 1 GPS Radiosonde in Bhutan

International Charter

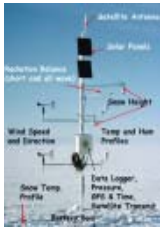
2014	2015	2016
Activations 32	Activations: 14	Activations: 22

ISRO took responsibility of Lead Role for Charter Operations during April-October, 2015.



Sentinel Asia

2008-2016 – data support for 73 events



50 AWS

4 GPS Sonde stations

1 DWR

Regional Cooperation - India-ASEAN space cooperation

- To establish a Tracking, Data Reception Station and Data Processing Facility
- Training in Space Science, Technology & Applications
- Heads of Agencies Meet in June 2012 at Bangalore
- RF Noise Survey in Oct 2015
- Framework Agreement in Sep 2016
- Training on ‘Small Satellites Engineering’ in Nov -Dec 2016
- ISRO-MONRE meeting in Jan 2017

Indonesia | Thailand | Malaysia | Singapore | Philippines | VietNam | Laos | Cambodia | Myanmar | Brunei

BRICS RS Satellite Constellation

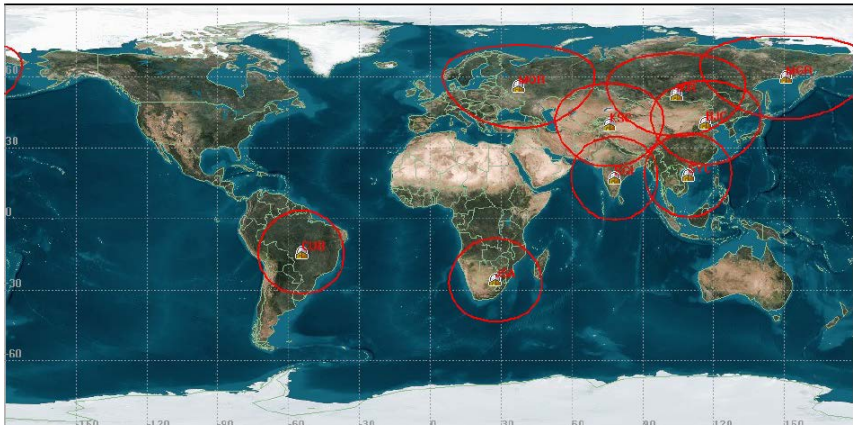
STEP1: form virtual constellation consisting of several operating RS satellites

STEP 2: form actual constellation

Negotiating the text of Agency-level cooperation agreement.

Planned contributions

- AEB and CNSA : CBERS-04
- AEB : Cuiaba Station
- Roscosmos: Kanopus-V1.
- ISRO: Resourcesat-2; Shadnagar station
- CNSA : GF-1 and ZY-3/02; Sanya Station
- SANSA: Hartebeesthook Station located



CBERS 04						Kanopus-V1		Resourcesat-2			GF-1			ZY-3/02	
5	10	20	40	80	73	2.5	12	5.8	23.5	56	2	8	16	27 25	6

Data Sharing efforts from ISRO

Geophysical Products

- Oceanographic products
  - Chlorophyll-a map
  - Total Suspended Sediment map
  - Diffusion Attenuation Coefficient map
  - Aerosol Optical Depth map
- Land Products
  - Vegetation products (NDVI, VF)
  - Broad band albedo products

OSCAT wind vector products

- 12 hourly/Daily Analyzed Ocean Winds

Disaster purposes

- International Charter
- Sentinel Asia
- UN-SPIDER
- ASEAN countries (resource assessment)
- SAARC countries (severe thunderstorm predictions)

Global Products generated from ISRO

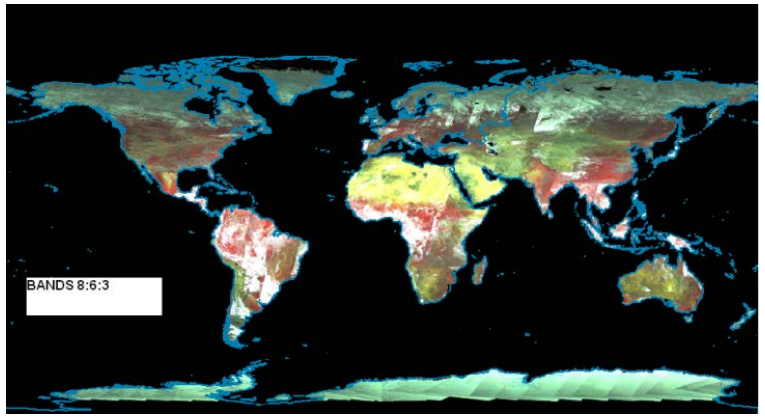
- Land products from OCM sensor 5km
- Ocean products from OCM at 5 km
- Wind products from OSCAT at 25 km

Local Products within Indian Ground station visibility

- Land geophysical products (≤ 1km)
- Ocean geophysical products (1km)

Tropical products (+/- 20 deg Lat.) from Megha-Tropiques

- Water vapor profile (10km res) from Saphir
- Outgoing Long wave Radiation (OLR) (40km. res)-Scarab

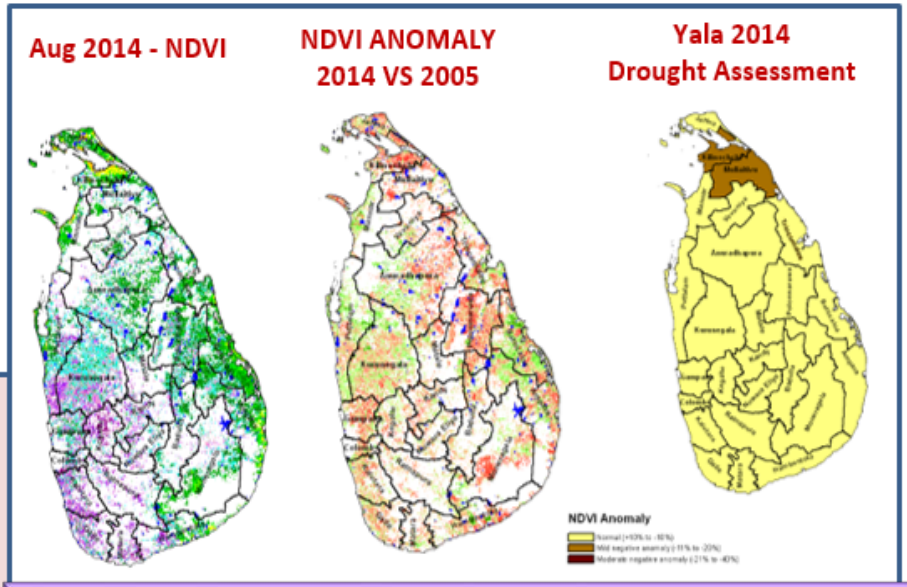


Sri Lanka Drought Monitoring Mechanism

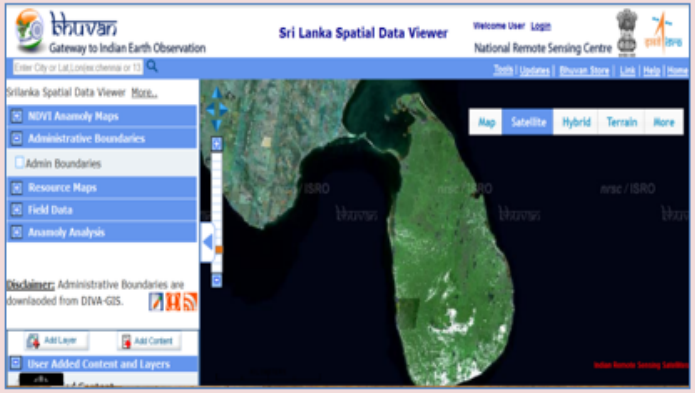
Highlights of the Initiative

- Under Regional Cooperative Mechanism of UN-ESCAP, India is offering services to provide technical support to Sri Lanka to enable it to monitor and assess agricultural drought.
- Development of Drought Monitoring System – Sri Lanka (DMS-SL) software
- Development of Sri Lanka Data Viewer in Bhuwan
- Development of a Field Data Collection system
- Monitoring of *yala* cropping season using satellite data

Drought Monitoring System – SL Software



Sri Lanka Data Viewer in Bhuvan



Field Data Collection using Smart Phone for Sri Lanka

- Drought Assessment using Interactive tools and data download
- Exclusive access to Srilanka for online information
- Training & hand-holding for data processing and analysis

International Cooperation on Joint Missions

Joint Satellite Missions

- CNES: SARAL, Megha –Tropiques, Satellite with Thermal Infrared Sensor, ARGOS onboard Oceansat-3
- Russia : Youthsat
- JPL/ NASA: NISAR (L & S Band SAR)

Discussions are on for:

- JAXA: EO Mission for Climate Change Studies
- NASA: Climate Observing Mission (LaRC) ; Atmospheric & Oceanography mission (GSFC)
- DLR: Micro Wave & HYSI

Building Advanced Sensors

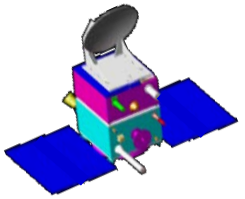
- US, Germany, Canada, Israel…
- Global missions for ECV, Climate change studies

MEGHA TROPIQUES (2011)

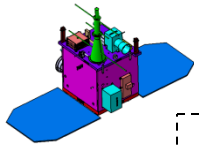
Joint Indo-French mission for studying water cycle & energy exchanges of tropical convective system.

SARAL (2013)

Joint Indo-French satellite mission for oceanographic studies



YOUTHSAT (2007)



satellite built by Indian & Russian youths for joint development of the experimental satellite

NISAR (2020)

Joint Indo-US satellite mission for earth science studies

Dual frequency (L & S band) Radar Imaging Satellite

International Cooperation in EO Missions

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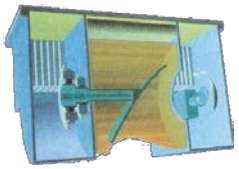
SAPHIR



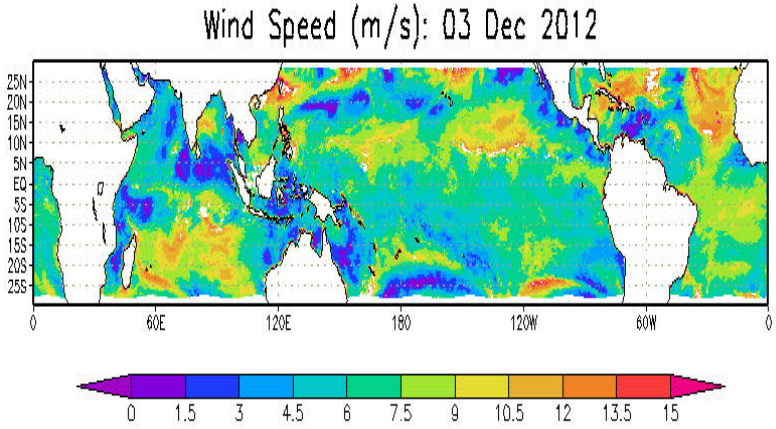
SCARAB

MADRAS

ROSA

Observations of tropics for -

Water vapour, Clouds, Cloud condensed water, Precipitation, Evaporation



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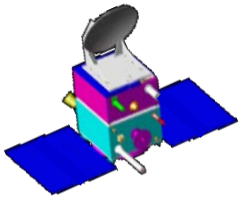
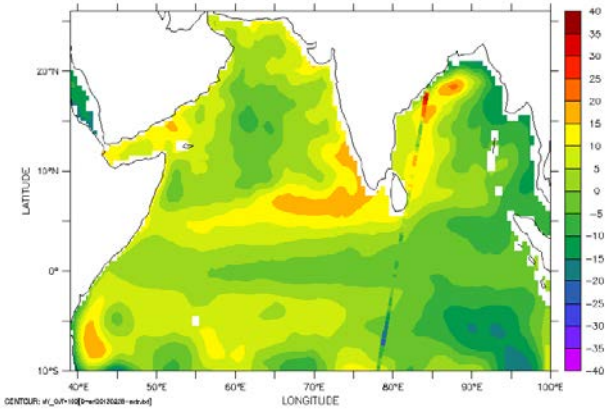


- ALTIKA - Altimeter in Ka band (35.75 GHz)
- ARGOS - Data Collection Platform

Observations for -

Ocean circulation, sea surface elevation, Marine meteorology & sea state forecasting,



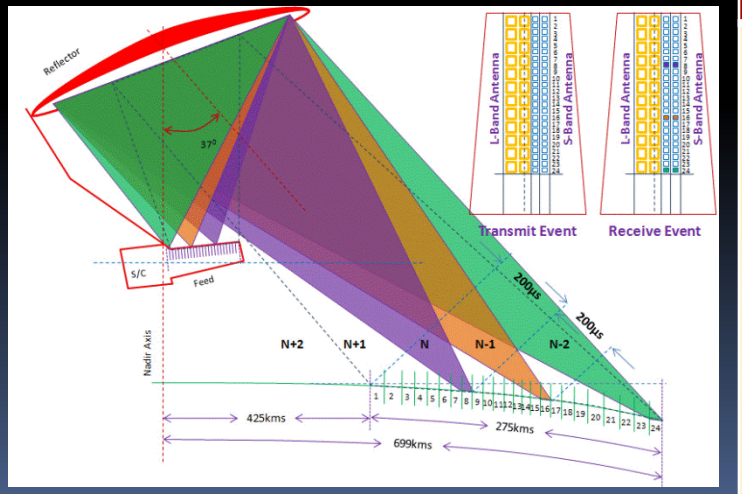
SSHA observation overpass over Indian Ocean

NASA-ISRO Synthetic Aperature Radar (NISAR) Satellite

LAUNCH
2020 – 2021
On board GSLV

- Indo-US Joint EO mission for earth science studies
- Dual frequency (L & S band) Radar Imaging Satellite
- SweepSAR technique to image wide swath at high resolution
- Systematic global coverage over all the landmass including cryosphere
- Launch by GSLV in 2020-21

- 12 m unfurlable antenna
- Ultra-precision GPS system
- 4 Terabits capacity Solid State Recorder
- Ka band data transmission system



SWEEP SAR SYSTEM

MAJOR SCIENCE APPLICATIONS

- Natural resources mapping & monitoring
- Agriculture Biomass over full duration of crop cycle
- Soil Moisture
- Monitoring of Floods, Oil slick, Forest fires
- Coastal erosion & Coastline changes
- Land Subsidence & Landslide
- Surface deformation studies
- Mountain / glacier snow; Mountain Glacier dynamics
- Ice sheet dynamics; Sea Ice thickness & dynamics

Participation & Contribution in International Platforms/Bodies

Lead positions

- Chair of CEOS WGCapD, ISPRS TC-V Chair
- Host for 24th APRSAF, 38th ACRS, APSLF, UN-ESCAP
- CEOS (2020), GEOSS-AP, CGMS (2018)

ISRO's Contribution to CEOS

1. Land Surface Imaging (LSI) – Resourcesat-2
2. Ocean Colour Radiometry (OCR) – Oceansat-2 OCM
3. Ocean Surface Vector Wind (OSVW) - Oceansat-2 Scatterometer
4. Precipitation (PC) – Megha-Tropiques
5. Ocean Surface Topography (OST) – SARAL
6. Sea Surface Temperature (SST-VC) – INSAT 3D/3DR

Contribution to GEO

- Participation in GEOSS Societal Benefit Areas (SBAs)
- Supporting the GEO Task on Forest Carbon Tracking (FCT)
- Supporting the G20 initiative of GEO, including Global Agricultural Monitoring initiative (GEO-GLAM), Global Forest Observation Initiative and GEOSS Data CORE (Collection of Open Resources for Everyone)

International Cooperation in Capacity building

More than 1600 officials from 93 Countries are offered training by IIRS & CSSTEAP

Indian Institute of Remote Sensing (IIRS) at Dehradun

- Offers 8-weeks course on RS & GIS under Indian Technical Economic Cooperation (ITEC) sponsored by MEA

UN affiliated Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), Dehra Dun (Nov 1, 1995)

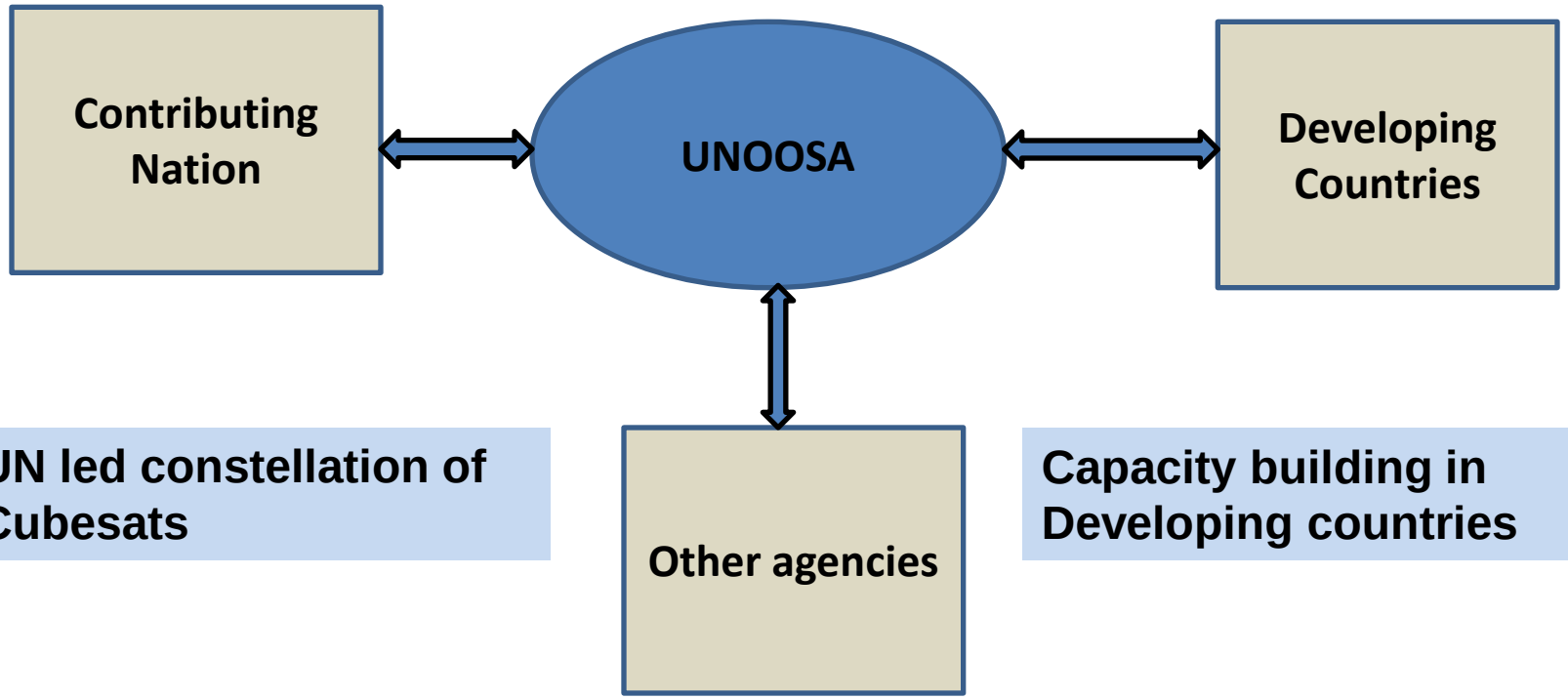
- 55 Countries of East Asia; South-East Asia; South Asia; Central Asia; Pacific
- Offers short-term training courses & 9-months PG Diploma on space technology applications
- 5 Themes: RS & GIS; SATCOM, SATMET, Space Science & GNSS
- Uses facility & expertise of IIRS, ISAC, SAC, PRL

ISRO AEM Workshop

best practices in disaster management

Mexico in July 2016

Suggestions towards UNISPACE+50....



UN led constellation of Cubesats

Capacity building in Developing countries

Space Economy, Space Society, Space accessibility and Space Diplomacy

India invites to Bengaluru for APRSAF 24

The 24th Session of the Asia-Pacific Regional Space Agency Forum

Space Technology for Enhanced Governance and Development

14-17 November 2017, Bengaluru, India

Organized by
Indian Space Research Organization (ISRO)
Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT)
Japan Aerospace Exploration Agency (JAXA)

Website: http://aprsaf.org

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MEXT

JAXA

24TH APRSAF
ASIA-PACIFIC REGIONAL SPACE AGENCY FORUM
INDIA

Well developed Indian Remote Sensing Programme is open for international Cooperation for -

- Advancing the technology

- Protecting the Planet Earth &

-Benefitting the humanity

THANKS..