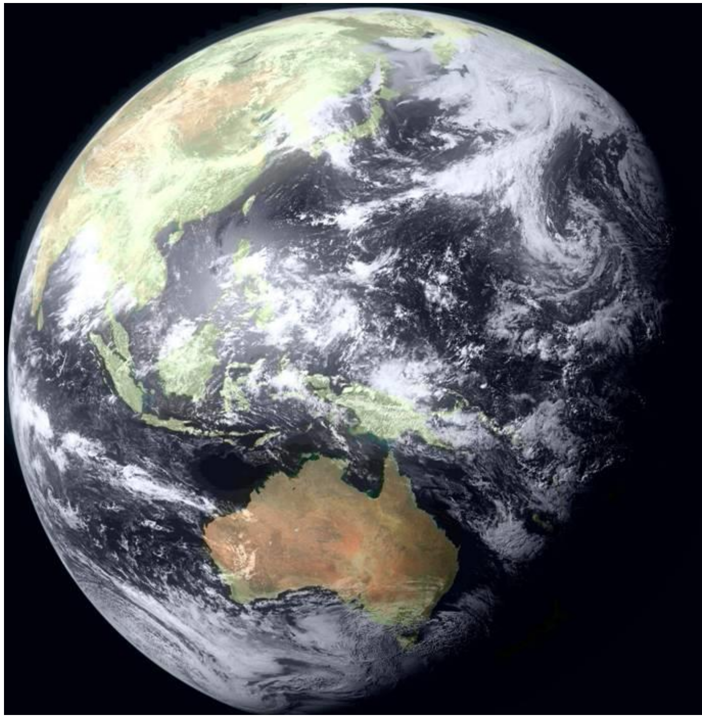
# Remote Sensing Data Sources Outlook

**Dr Arnold Dekker** | Earth Observation Informatics FSP

UN Big Data for Official Statistics Abu Dhabi 20-22nd October 2015

# Features of Satellite Earth Observation

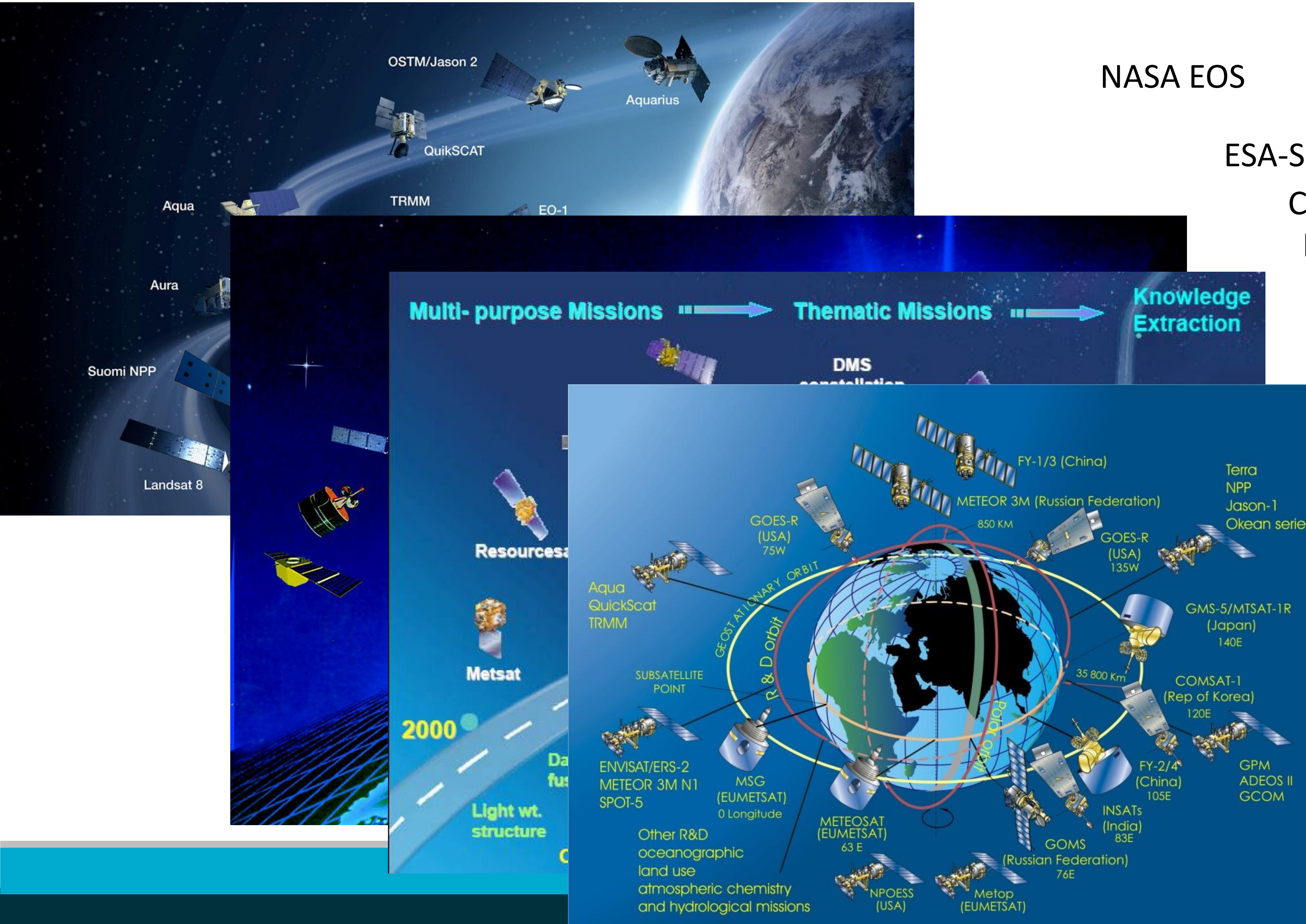
- Data is uniform, local to global, near real-time, fully archived, publicly accessible
- Complements in-situ and other data sources
- It is ‘Large Data’ – Petabytes
- Internationally coordinated constellations of satellites improve observation frequency, sophistication of data leading to enhanced uses
- With modeling, able to hind-cast, now-cast and fore-cast global to local phenomena of the Earth system



**(adapted from Dr Chu Ishida JAXA)**

# International Context: Selection of Current EOS Programs

## Only 3 satellites used currently in GWG Big Data for Official Statistics!




NASA EOS

ESA-Science

China

India

Japan

Korea

WMO

Etc….

# Improvements to earth observing sensors means:

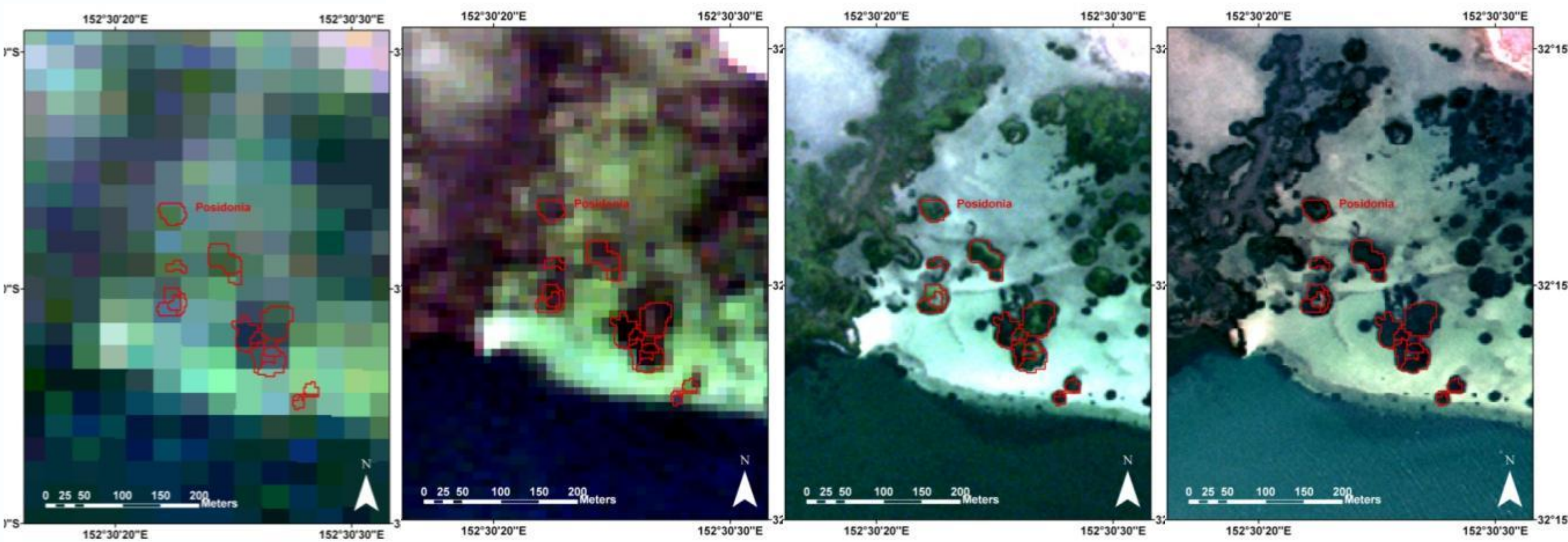
- Higher spatial resolution:
  - Less confusion, less mixed pixels, more validity, accuracy and precision
- Higher spectral resolution:
  - Less confusion, more variables, better identification, better discrimination
- Higher temporal resolution:
  - more insight into short term processes; more cloud free images
- Higher radiometric resolution:
  - Higher accuracy and precision

# Effects of spatial resolution on feature discrimination for island in tidal lagoon

**Free**
**Coarse detail**

**Higher cost**
**Fine detail**

| | Landsat TM5<br>20 September 2008 | ALOS<br>5 January 2007 | QuickBird-2<br>20 September 2008 | WorldView-2<br>10 August 2010 |
|---|---|---|---|---|




| | | | | |
|---|---|---|---|---|
| Spatial resolution: | 30m | 10m | 2.6m | 1.6m |
| Spectral Bands: | 4 VIS/NIR, 2 SWIR, 1 TIR | 4 VIS/NIR | 4 VIS/NIR | 8 VIS/NIR |



CSIRO

# Intertidal and supratidal vegetation:

## Effects of spatial and spectral resolution on classification

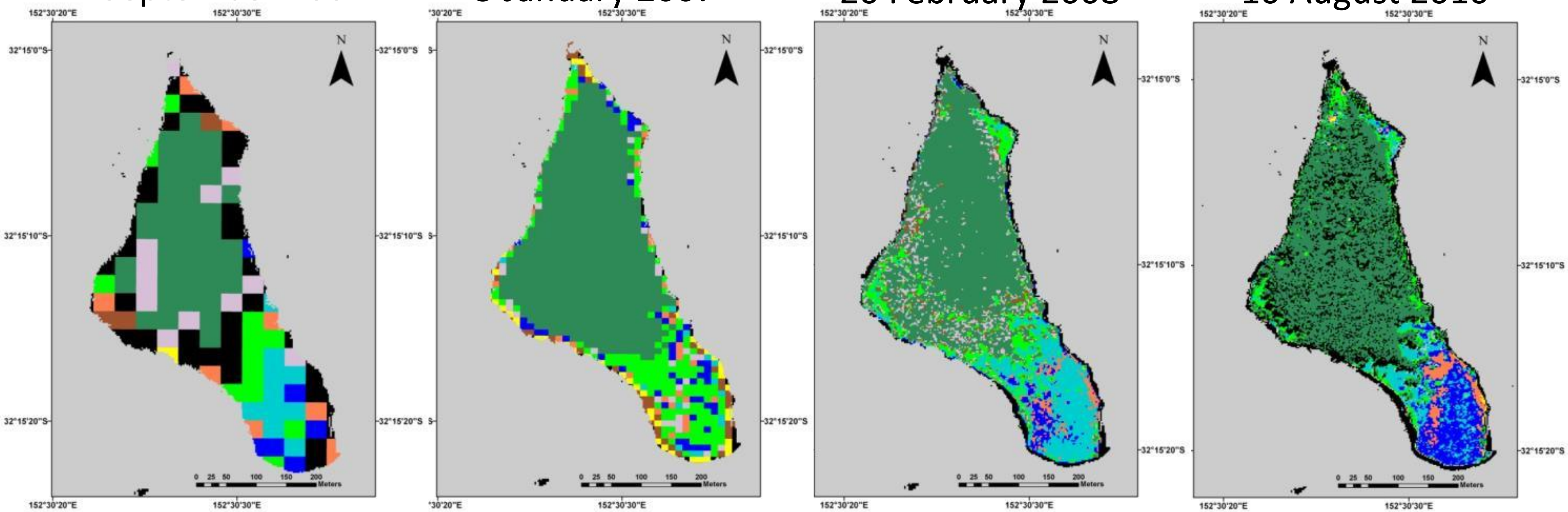
Saltmarsh and Mangrove vegetation classification: Snake Island, Wallis Lake NSW

Landsat ETM 7
12 September 2002

ALOS
5 January 2007

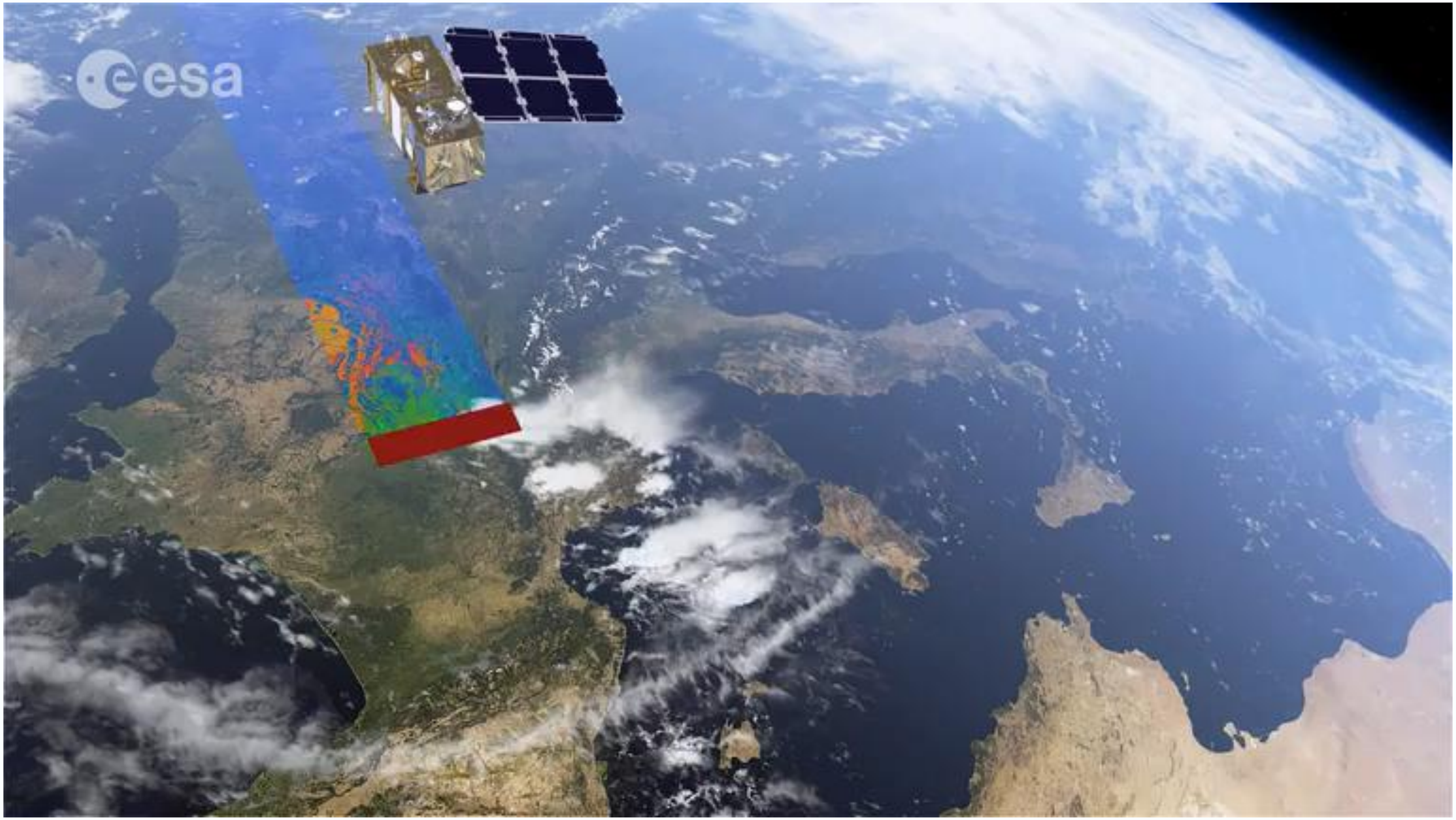
QuickBird-2
20 February 2008

WorldView-2
10 August 2010



Seagrass Wrack
Sand
*Juncus krausii*
Water mask
Mangrove
Casuarina
*Sporobolus virginicus*
Unclassified
*Suadea australia*
Succulent salt marsh vegetation

# Sentinel-2 13 spectral bands at 10, 20 and 60 m spatial resolution global coverage every 5 days



# Earth Observing Sensors are getting more sophisticated and map much more variables at higher frequency

More physical characteristics measured from space:

1. Visible light and nearby infrared reflectance and emittance (e.g. Fluorescence) from multispectral to hyperspectral
2. Short Wave Infrared reflectance; multiple spectral bands
3. Thermal Infrared Reflectance and emittance: multiple thermal bands
4. Microwave - active : more radar bands (C, X, L, S band) more polarisations
5. Microwave – passive: soil moisture and ocean salinity-increased spatial resolution
6. Altimetry: increased spatial resolution
7. LIDAR  and Altimetry(Laser and radar altimetry from space resp.))
8. Gravimetry anomaly detection ( groundwater aquifer depletion and recharge)

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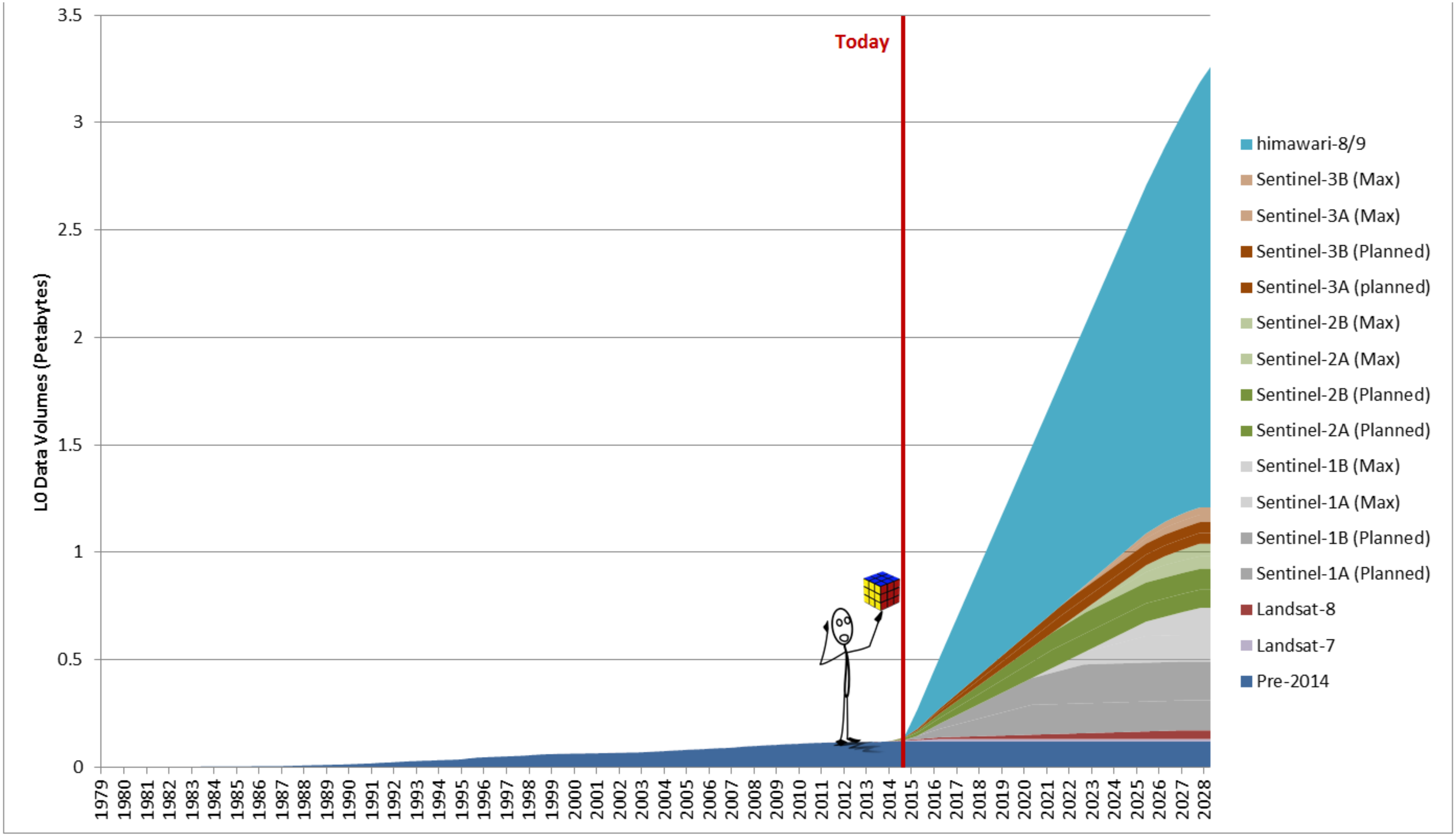
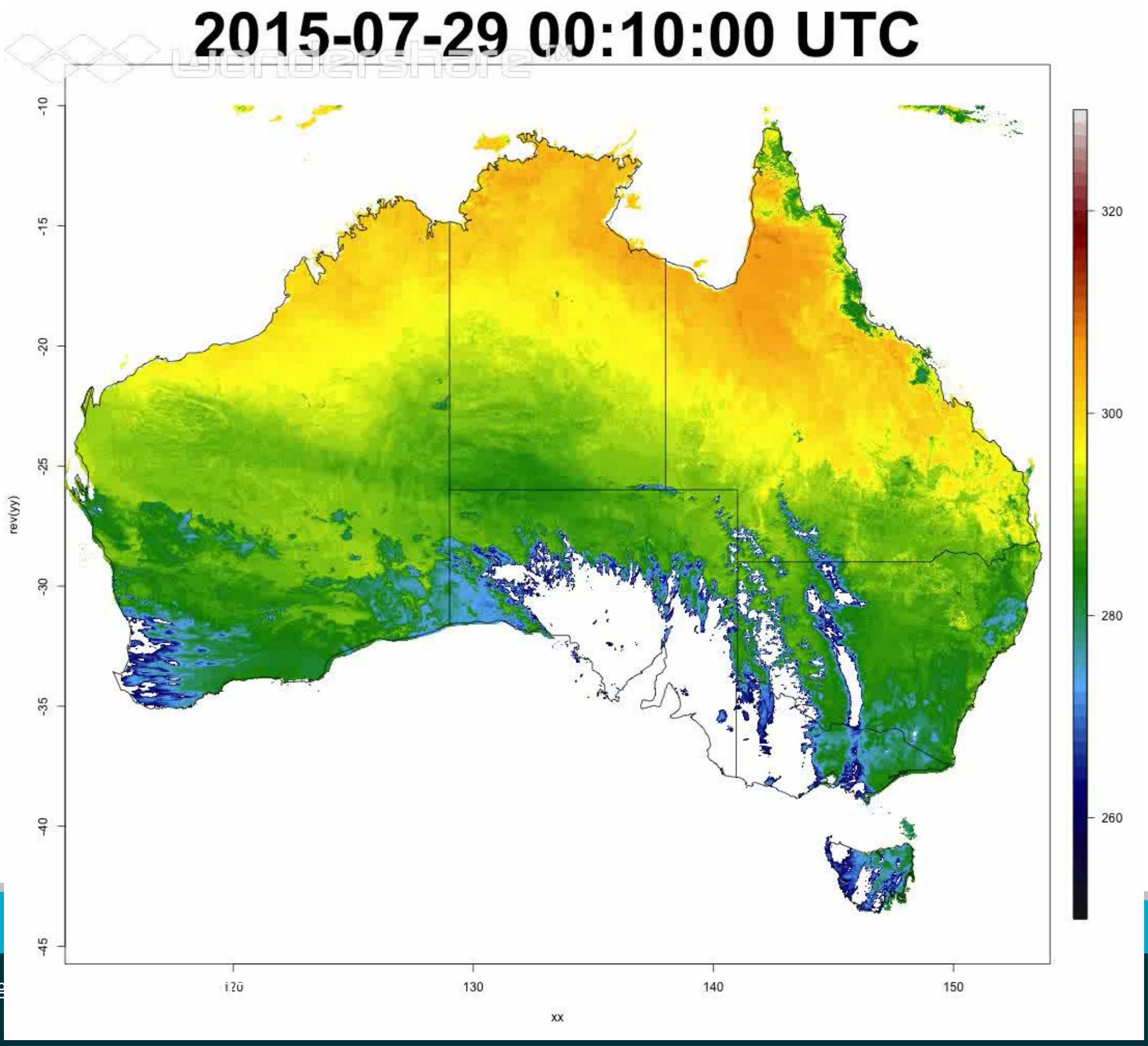
# Fusion with other types of data

- Autonomous in situ measurement systems (underwater, in the soil, in the crop, above the land, in the air)
- Mobile phone apps and digital camera apps are enabling validation of earth observation information at unprecedented scale. Issues to consider are:
  - Many more measurements at lower precision, validity and accuracy-what are trade-offs?
  - Possible mismatch between what is measured in situ and from space: e.g. Colour of water versus water quality expressed as chlorophyll a concentration, proxies etc.

# Trends in EO Data Size :Next Decade Estimated Earth Observation data volumes for 5 key EO sensor systems for next 10 years (Australia only)



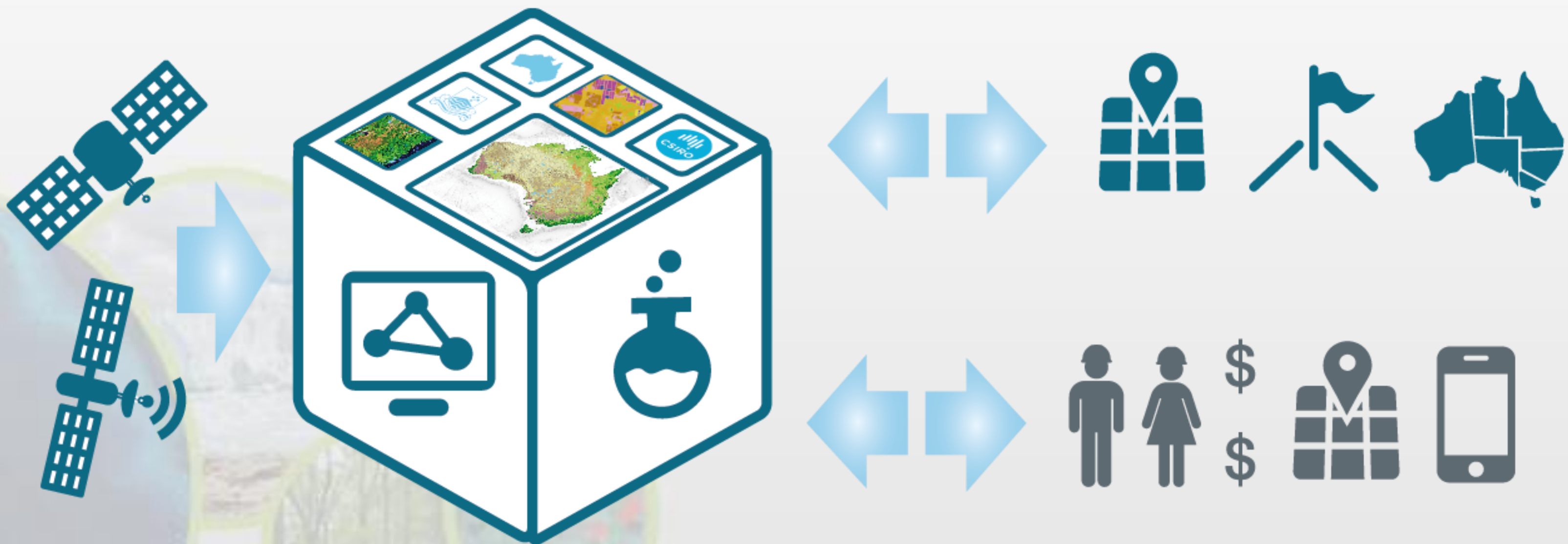
# Himawari Example Land Surface Temperature over Australia every 10 minutes from Geostationary orbit.



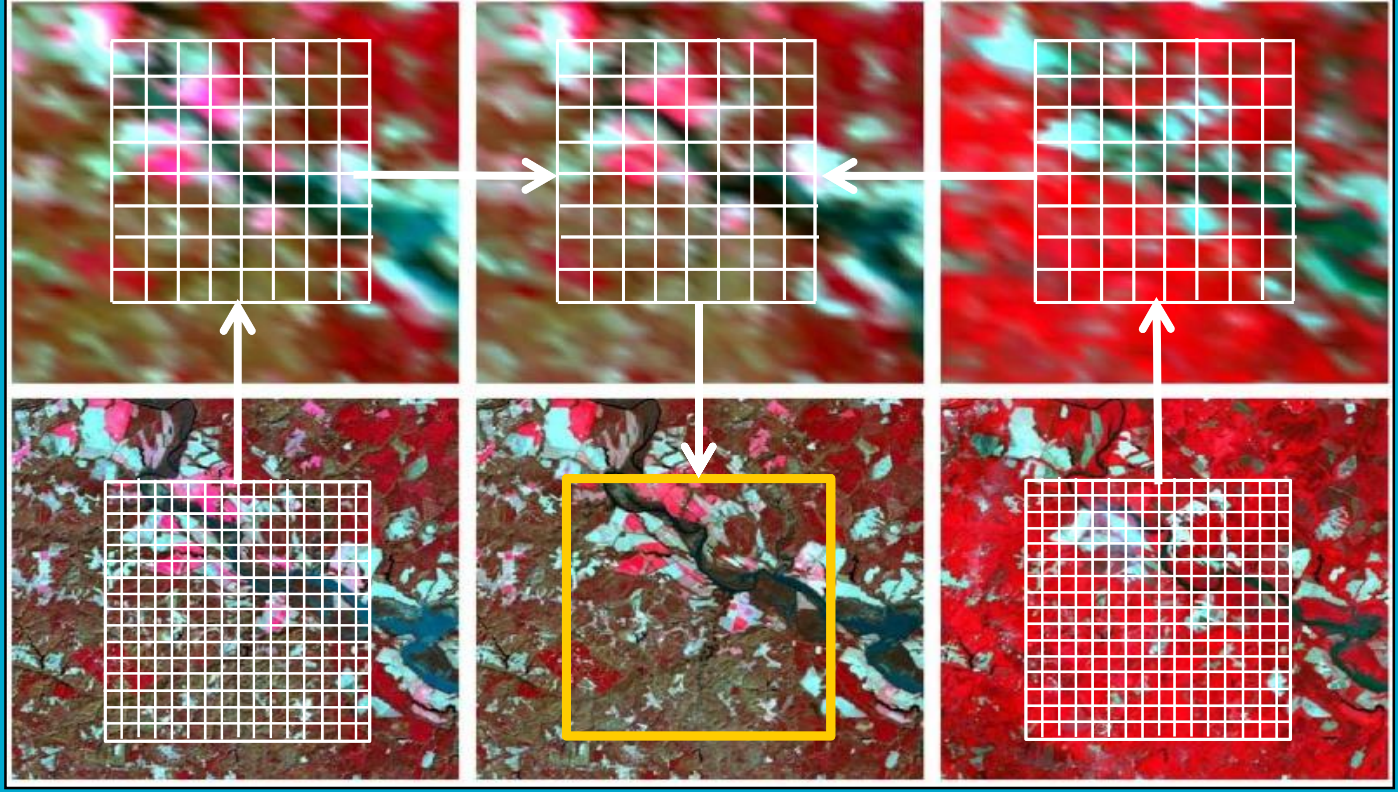
# Traditional remote sensing product processing method: process once-use once

# New Mass-Data Processing Vision
# Process once-use many times

**Such a model would provide a major source of "analysis ready data" to majority of end-users, saving up to 80% of collective effort <u>and costs</u>.**



**<u>e.g. Australian GeoScience DataCube, Google Earth Engine, EarthServer, etc</u>**



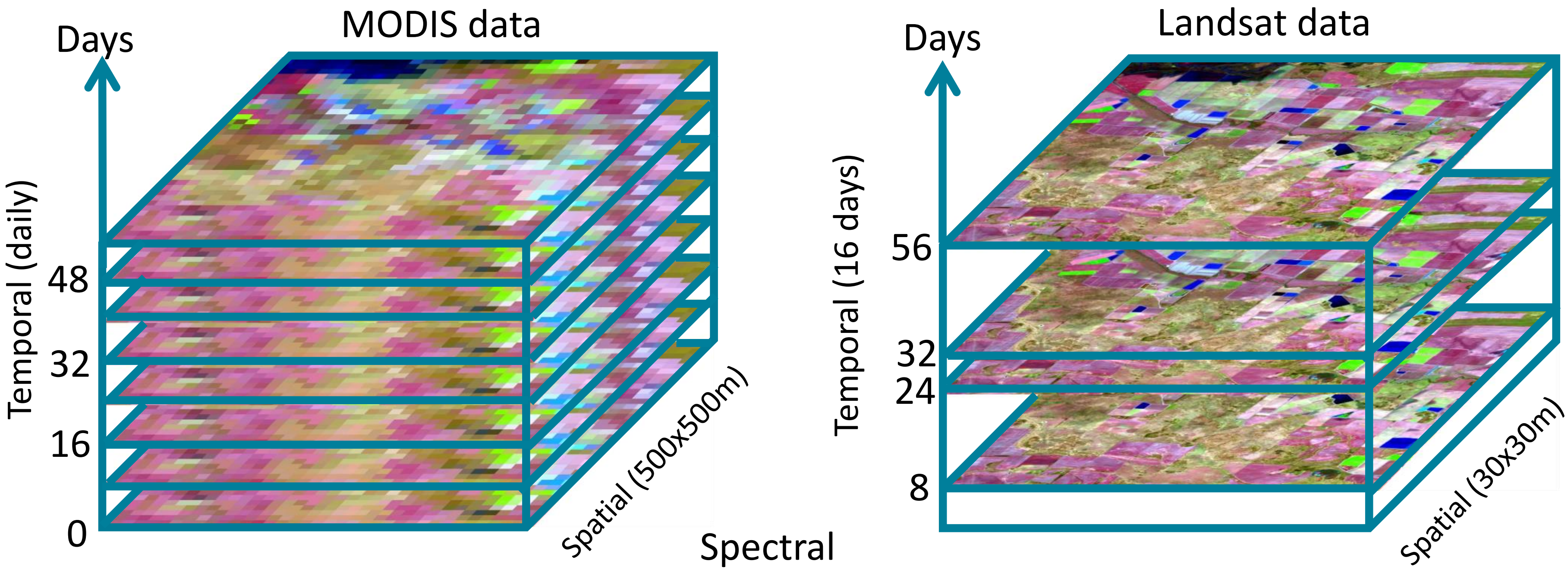
# Terminology of data-data fusion

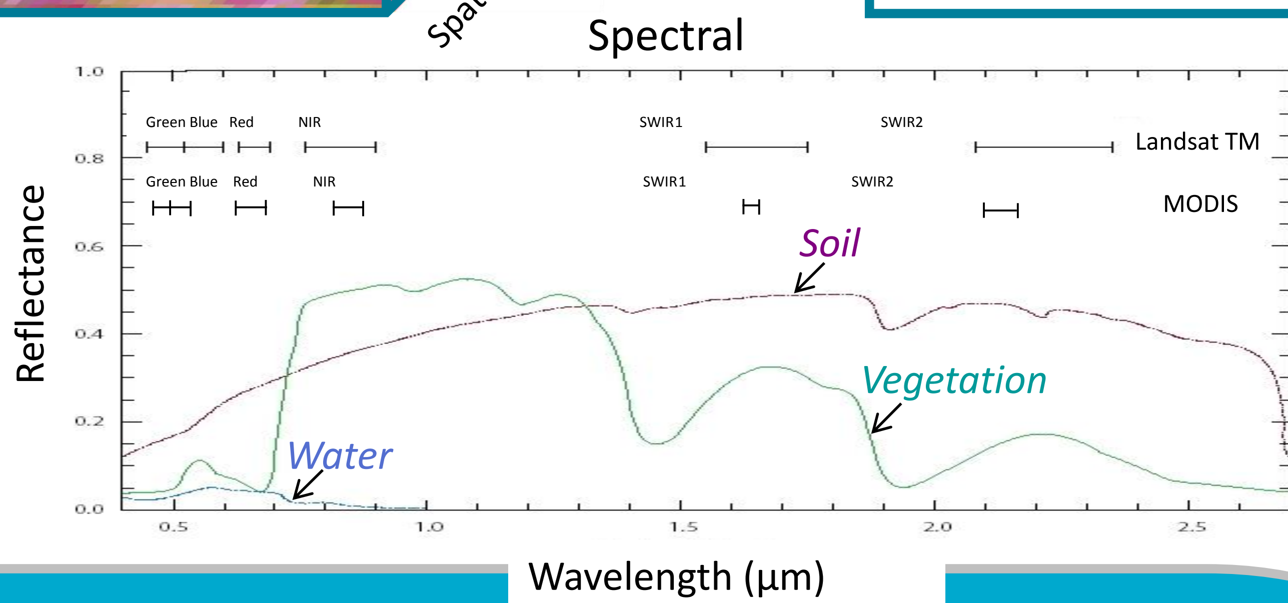
## Used by the imaging research community

**Irina Emelyanova, Tim McVicar, Tom van Niel, Ling Tao Li, Albert van Dijk**

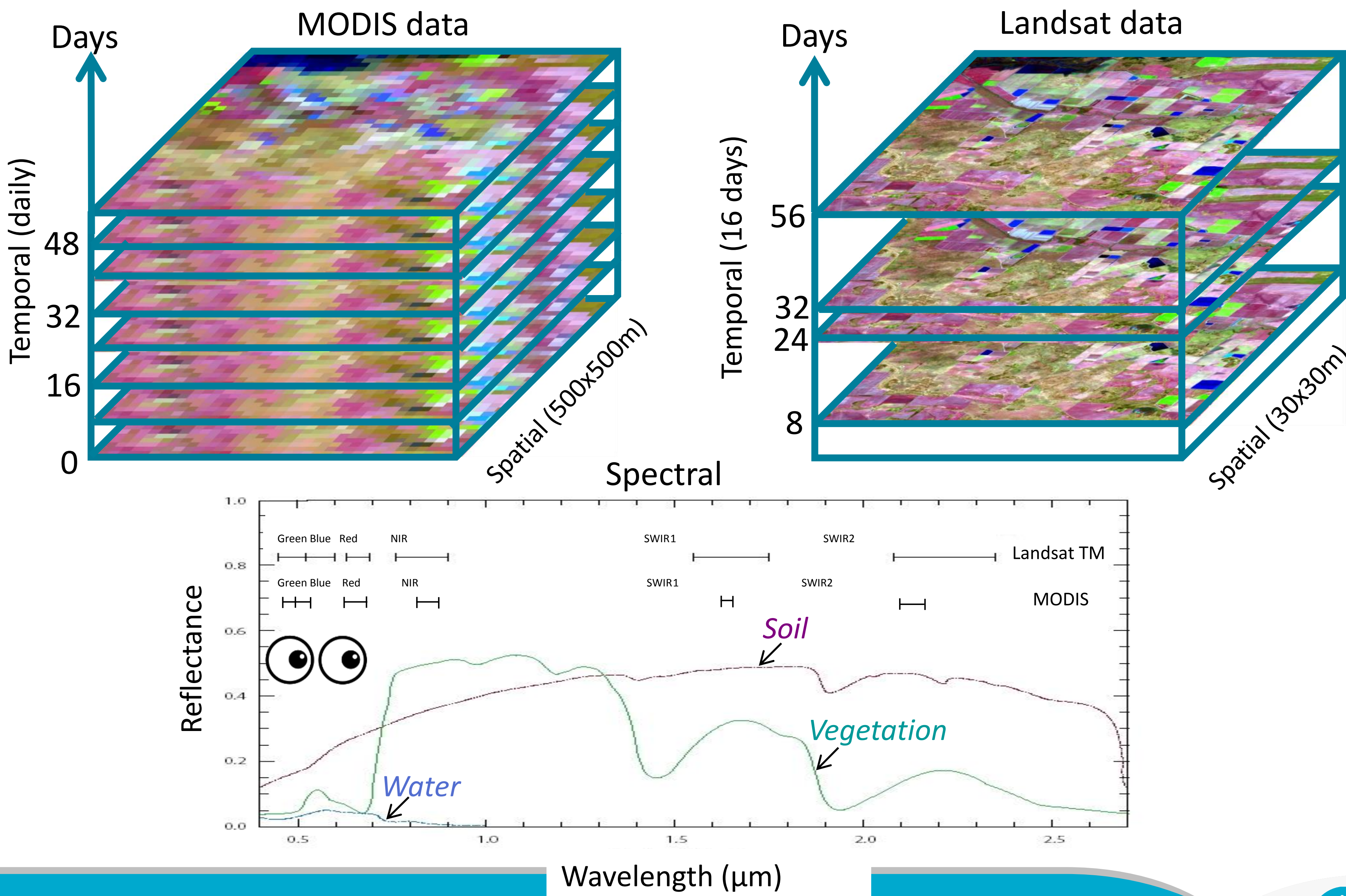
22 April 2013

# MODIS and Landsat imagery domain-characteristics



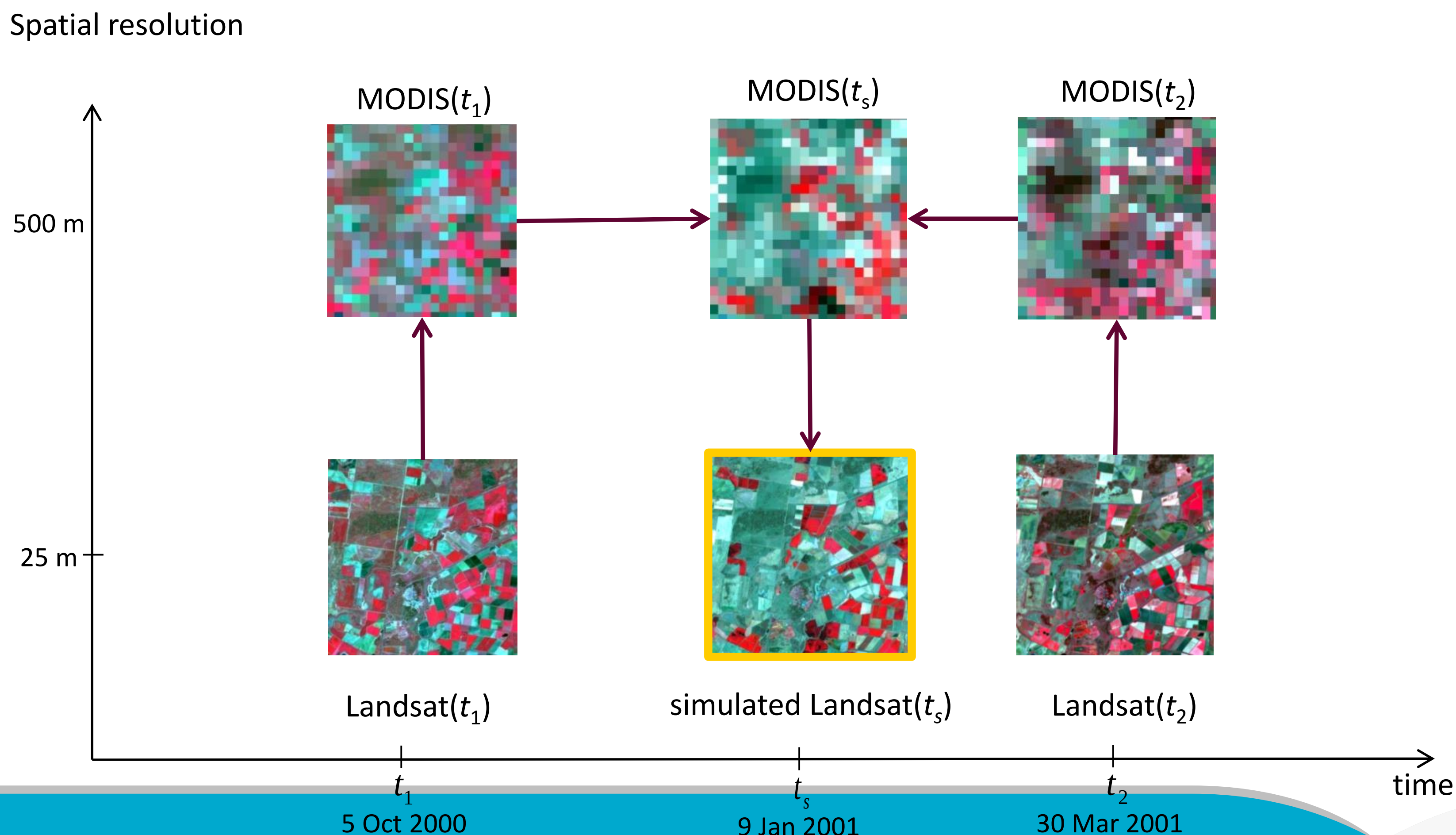



# MODIS and Landsat imagery domain-characteristics



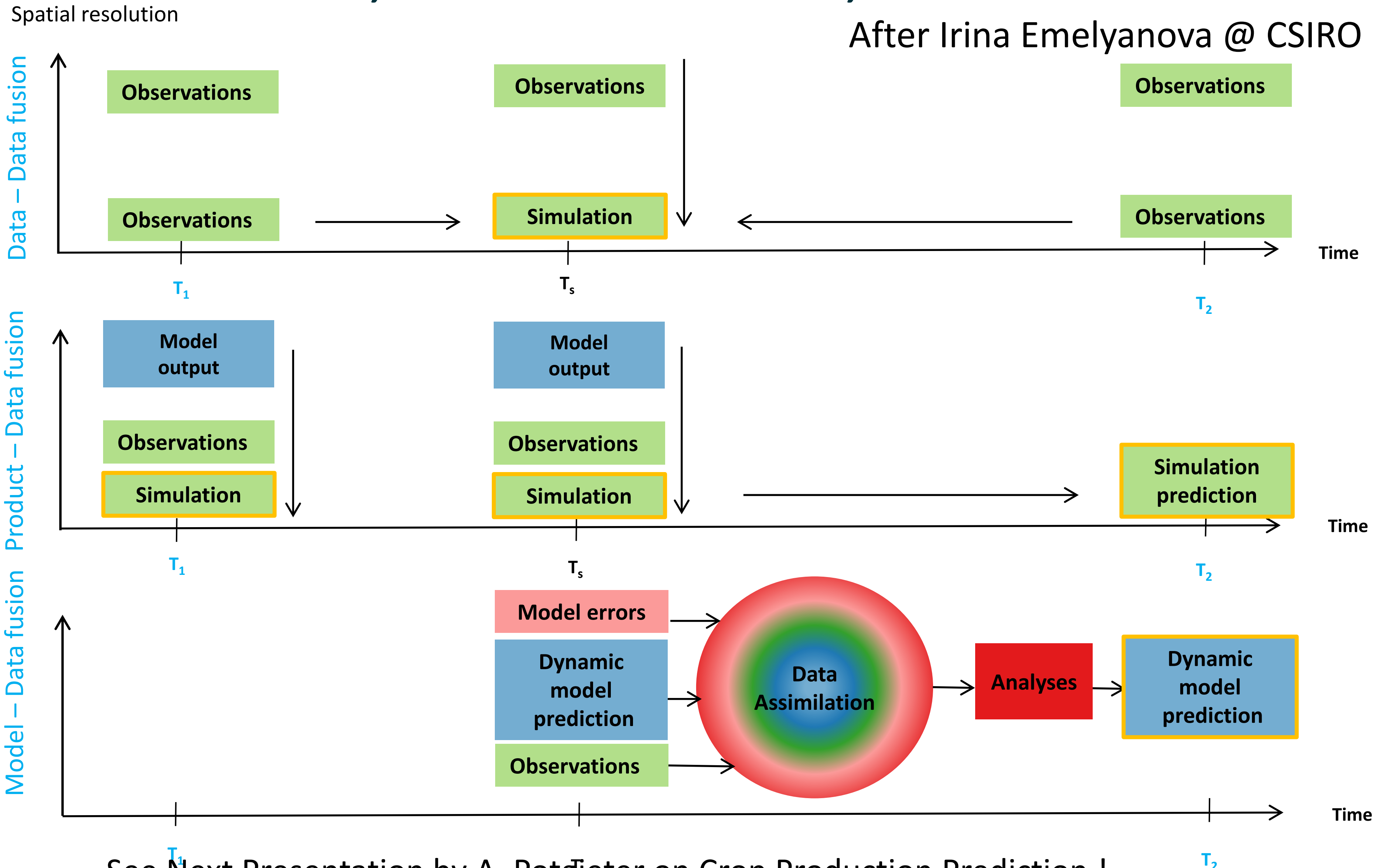
# Generic overview of Landsat-MODIS blending

Emelyanova, I. V., McVicar, T. R., Van Niel, T. G., Li, L. T., & van Dijk, A. I. J. M. (2013) Assessing the accuracy of blending Landsat-MODIS surface reflectances in two landscapes with contrasting spatial and temporal dynamics: A framework for algorithm selection. *Remote Sensing of Environment*, 133, 193-209, doi:10.1016/j.rse.2013.02.007.



# Data-Data fusion; Product-Data Fusion; Model-Data fusion

After Irina Emelyanova @ CSIRO




See Next Presentation by A. Potgieter on Crop Production Prediction !

# CEOS and GEOSS are actively considering their response to SDGs Indicators and targets

CEOS


31 Space Agencies

24 Associates

Space Arm Of

GEOSS


97 governments & EU

87 organizations

# UN-SDG's where Earth Observation can play a globally significant role (based on a GeoScience Australia and CSIRO summary)

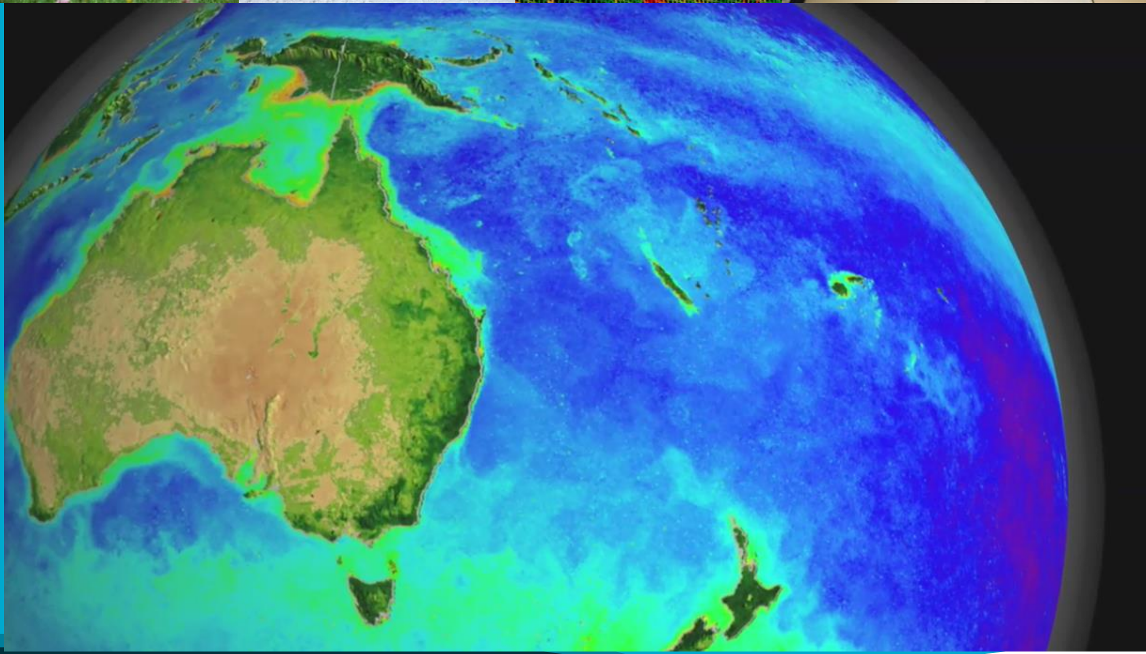
| | |
|---|---|
| Goal 1 | End poverty in all its forms everywhere |
| Goal 2 | End hunger, achieve food security and improved nutrition and promote sustainable agriculture |
| Goal 3 | Ensure healthy lives and promote well-being for all at all ages |
| Goal 6 | Ensure availability and sustainable management of water and sanitation for all |
| Goal 9 | Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation |
| Goal 11 | Make cities and human settlements inclusive, safe, resilient and sustainable |
| Goal 14 | Conserve and sustainably use the oceans, seas and marine resources for sustainable development |
| Goal 15 | Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss |

# GEO PLENARY XII SIDE EVENT: *SUSTAINABLE DEVELOPMENT GOALS: EARTH OBSERVATIONS IN SERVICE OF GLOBAL DEVELOPMENT.* November 10, 2015 • Mexico City DRAFT

## *Side Event Objectives*

- Increase awareness and understanding of GEO Community on the significance of Earth observation applications in the 2030 Agenda and the SDG process
- The development, reporting and tracking of robust indicators
- Information sources that (UNSD) and countries may need to address the SDGs, including improved or new information and methods
- Lessons learned from similar efforts using Earth observations to develop and implement policy-relevant indicators and assess progress toward policy objectives
- Identify pathways for Earth observations to support SDG goals, targets and indicators
- Reach agreement on establishing a partnership between GEO and SDG stakeholders
- Make concrete refinements to a dedicated GEO initiative on the SDGs, addressing both GEO contributions overall and GEO support to countries on SDG tracking and reporting

# Proposed: Structured dialogue UNSD with global earth observing community ( e.g. via Geo and CEOS and others.....) how NSO can make use of existing implemented methods a.s.a.p. for monitoring progress against UN SDG indicators and targets and influence developments

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‘

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**This journey has just begun!**


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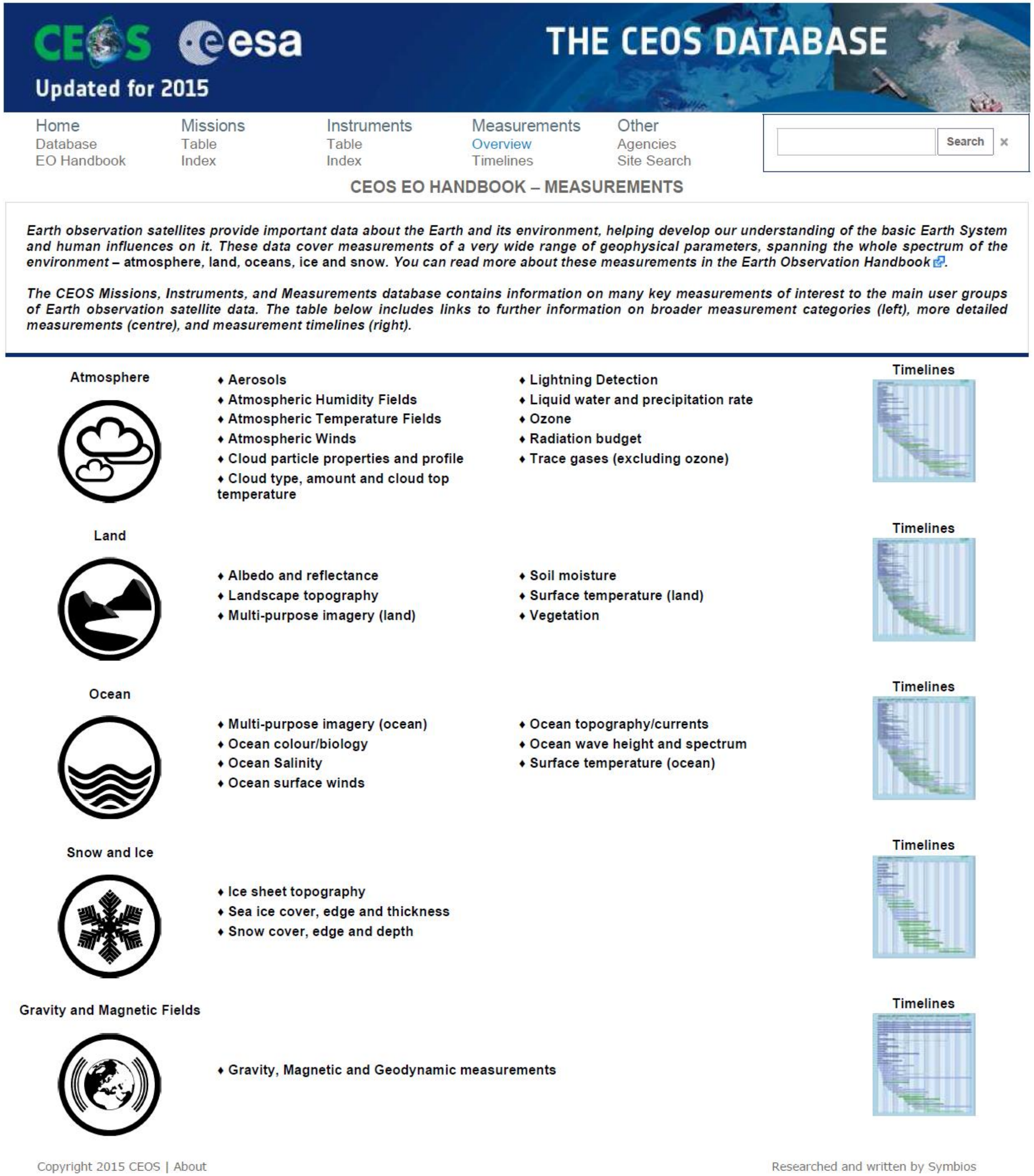

# THE CEOS DATABASE

Updated for 2015

Home | Missions | Instruments | Measurements | Other
Database | Table | Table | Overview | Agencies
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## CEOS EO HANDBOOK – MEASUREMENTS

*Earth observation satellites provide important data about the Earth and its environment, helping develop our understanding of the basic Earth System and human influences on it. These data cover measurements of a very wide range of geophysical parameters, spanning the whole spectrum of the environment* – atmosphere, land, oceans, ice and snow. *You can read more about these measurements in the Earth Observation Handbook.*

*The CEOS Missions, Instruments, and Measurements database contains information on many key measurements of interest to the main user groups of Earth observation satellite data. The table below includes links to further information on broader measurement categories (left), more detailed measurements (centre), and measurement timelines (right).*

**Atmosphere**

- Aerosols
- Atmospheric Humidity Fields
- Atmospheric Temperature Fields
- Atmospheric Winds
- Cloud particle properties and profile
- Cloud type, amount and cloud top temperature
- Lightning Detection
- Liquid water and precipitation rate
- Ozone
- Radiation budget
- Trace gases (excluding ozone)

Timelines

**Land**

- Albedo and reflectance
- Landscape topography
- Multi-purpose imagery (land)
- Soil moisture
- Surface temperature (land)
- Vegetation

Timelines

**Ocean**

- Multi-purpose imagery (ocean)
- Ocean colour/biology
- Ocean Salinity
- Ocean surface winds
- Ocean topography/currents
- Ocean wave height and spectrum
- Surface temperature (ocean)

Timelines

**Snow and Ice**

- Ice sheet topography
- Sea ice cover, edge and thickness
- Snow cover, edge and depth

Timelines

**Gravity and Magnetic Fields**

- Gravity, Magnetic and Geodynamic measurements

Timelines

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Researched and written by Symbios

See www.CEOS.org
And WMO OSCAR Database

## Atmosphere

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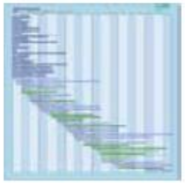

## Land

- Albedo and reflectance
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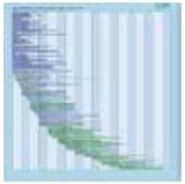
Timelines



## Ocean

- Multi-purpose imagery (ocean)
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- Ocean topography/currents
- Ocean wave height and spectrum
- Surface temperature (ocean)

Timelines

## Snow and Ice

- Ice sheet topography
- Sea ice cover, edge and thickness
- Snow cover, edge and depth

Timelines

## Gravity and Magnetic Fields

- Gravity, Magnetic and Geodynamic measurements

Timelines

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Successful Launch: KOMPSAT-3A
Successful Launch for Sentinel-2A
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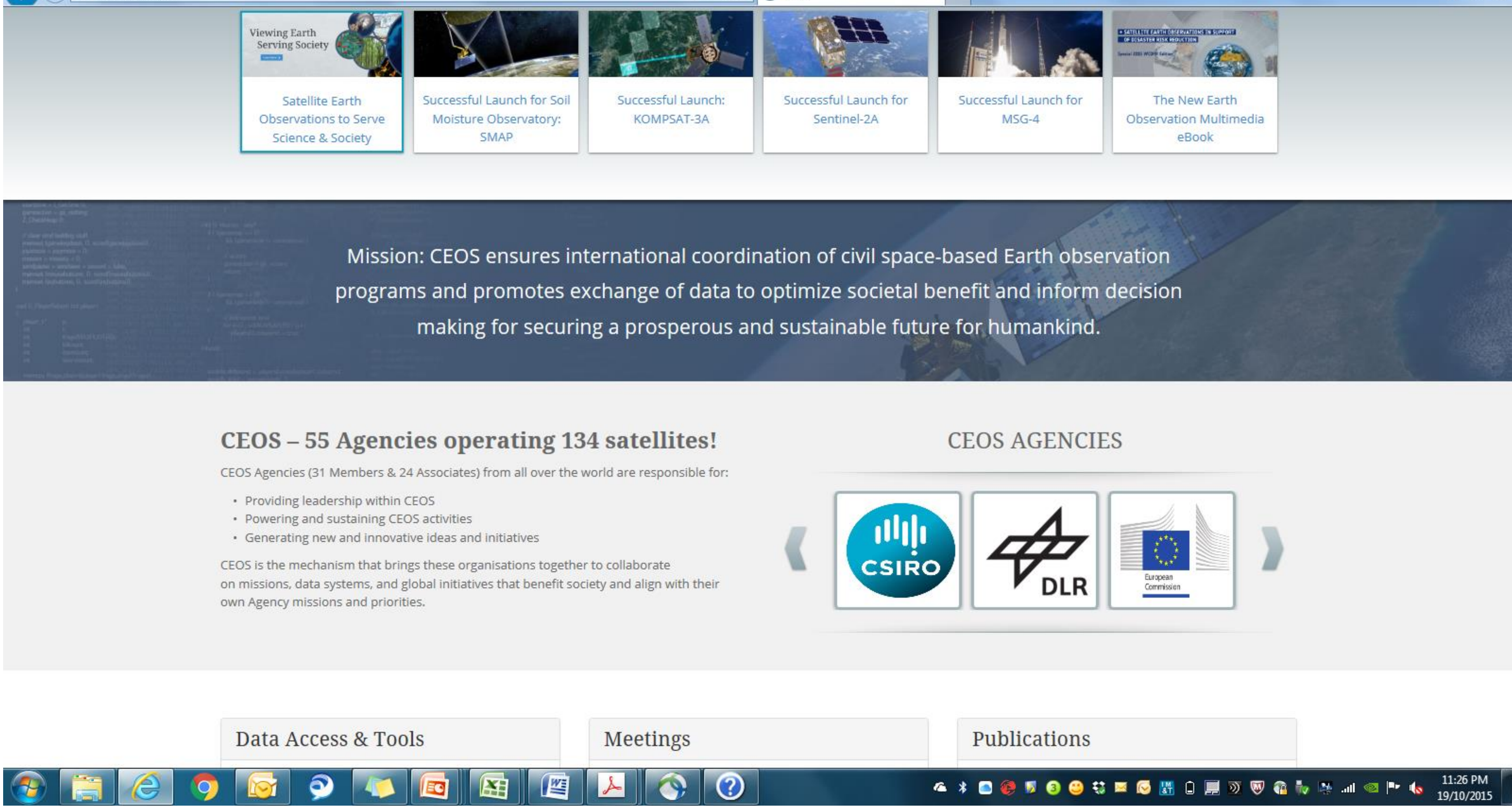
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Mission: CEOS ensures international coordination of civil space-based Earth observation programs and promotes exchange of data to optimize societal benefit and inform decision making for securing a prosperous and sustainable future for humankind.
CEOS – 55 Agencies operating 134 satellites!
CEOS Agencies (31 Members & 24 Associates) from all over the world are responsible for:
Providing leadership within CEOS
Powering and sustaining CEOS activities
Generating new and innovative ideas and initiatives
CEOS is the mechanism that brings these organisations together to collaborate on missions, data systems, and global initiatives that benefit society and align with their own Agency missions and priorities.
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European Commission
Data Access & Tools
Meetings
Publications
11:26 PM
19/10/2015

# Remote sensing data domain-characteristics

**McVicar et al., (2002).** ***An Introduction to Temporal-Geographic Information Systems (TGIS) for Assessing, Monitoring and Modelling Regional Water and Soil Processes.*** In T. R. McVicar, L. Rui, J. Walker, R. W. Fitzpatrick and L. Changming (eds.), Regional water and soil assessment for managing sustainable agriculture in China and Australia. Canberra, pp. 205-223, **http://www.eoc.csiro.au/aciar/book/PDF/Monograph_84_Chapter_16.pdf.**

| DOMAIN | CHARACTERISTIC | | |
|---|---|---|---|
| | **EXTENT** | **RESOLUTION** | **DENSITY** |
| **Spectral** | Portion(s) of the EMS being sampled | Bandwidth(s) | Number of bands in a particular portion of the EMS [1] |
| **Radiometric** | Dynamic range of radiances (min and max radiance per band) | Change in radiance due to change by one digital number | Number of bits used across the dynamic range of radiances |
| **Spatial** | Area covered by the image | Pixel size acquired | Complete [2] |
| **Temporal** | Recording period over which the data are available [3] | Period of data acquisition [4] | Satellite repeat characteristics [5] |

[1] For example, hyperspectral sensors (*e.g.*, Hyperion) have higher spectral density than broadband instruments (*e.g.*, Landsat TM/ETM+) though they sample similar EMS extents.

[2] This contrasts with the low spatial density of ground-based sampling, for example, meteorological stations.

[3] For some remotely sensed systems (*e.g.*, AVHRR and Landsat TM) data have been recorded near-continuously for ~30 years.

[4] For remotely sensed images this is a matter of seconds, which contrasts with meteorological data such as the daily rainfall totals.

[5] For some applications using optical (*i.e.*, reflective and thermal) data the availability of cloud-free images is an important consideration. Whereas the satellite repeat characteristics do not change, cloud cover will change the effective temporal density of a site over time.