OGC Standards & Geospatial Data Cubes

NRSC User Interaction Meet 2024

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Agenda

- OGC: In Brief

- India Space Policy: Strategy

- CEOS: Analysis Ready Data (ARD)

- Geospatial Data Cubes: Concept & Use Cases: Global & India

- Next Steps

Open Geospatial Consortium

What is OGC?

A hub for thought leadership, innovation, and standards for all things related to location

Our Vision

Building the future of location with community

and technology for the good of society

Our Mission

Make location information Findable, Accessible,

Interoperable, and Reusable (FAIR)

Our Approach

A proven collaborative and agile process combining consensus-based

standards, innovation project, and partnership building

Our Impact

Community

500+ International Members

110+ Member Meetings

60+ Alliance and Liaison partners

50+ Standards Working Groups

45+ Domain Working Groups

25+ Years of Not for Profit Work

10+ Regional and Country Forums

Innovation

120+ Innovation Initiatives

380+ Technical reports

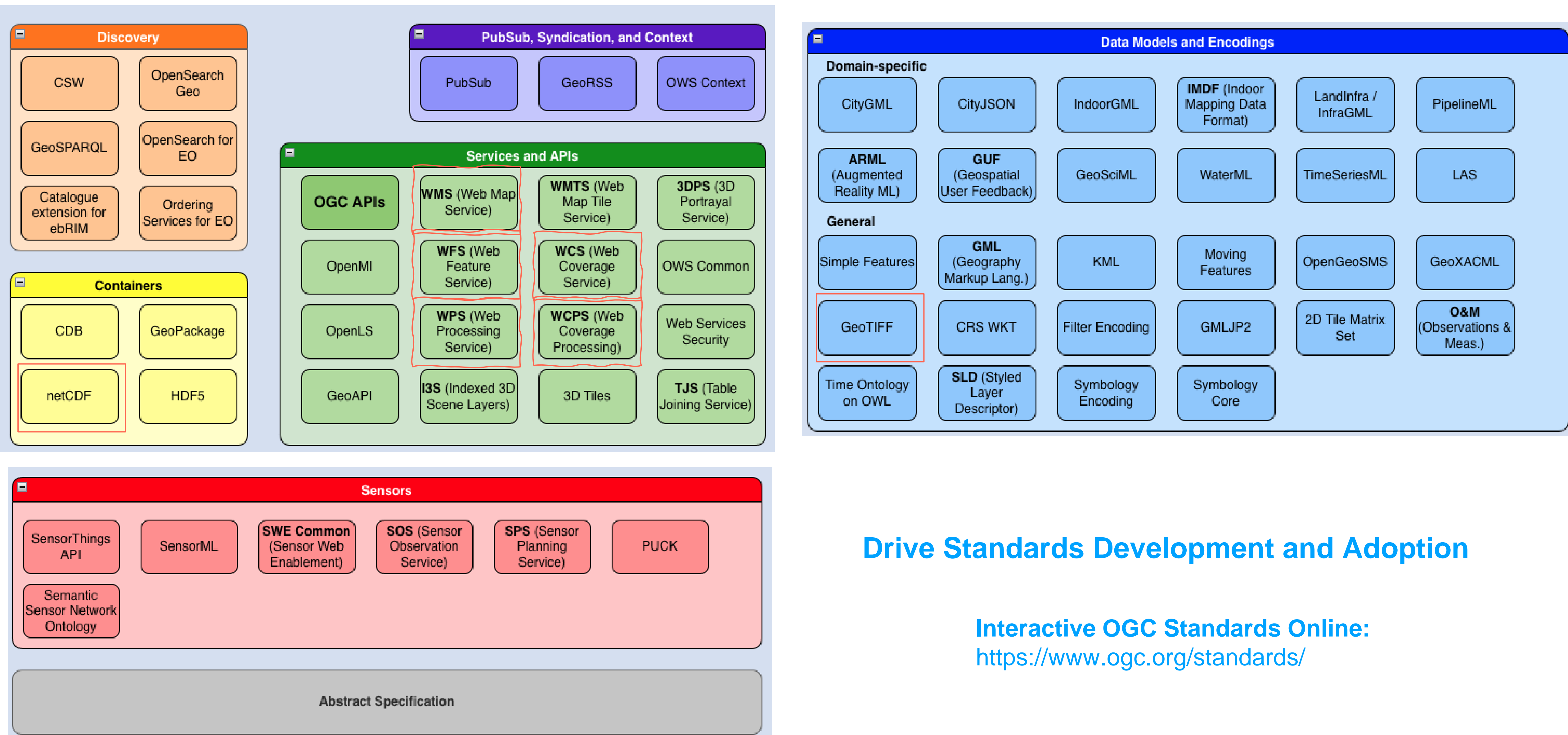**Quarterly** Tech Trends Monitoring

Standards

65+ Adopted Standards

300+ products with **1000+** certified implementations

1,700,000+ Operational Data Sets using OGC Standards

Standards Architecture Diagram

Discovery

CSW	OpenSearch Geo
GeoSPARQL	OpenSearch for EO
Catalogue extension for ebRIM	Ordering Services for EO

Containers

CDB	GeoPackage
netCDF	HDF5

PubSub, Syndication, and Context

PubSub	GeoRSS	OWS Context

Services and APIs

OGC APIs	**WMS** (Web Map Service)	**WMTS** (Web Map Tile Service)	**3DPS** (3D Portrayal Service)
OpenMI	**WFS** (Web Feature Service)	**WCS** (Web Coverage Service)	OWS Common
OpenLS	**WPS** (Web Processing Service)	**WCPS** (Web Coverage Processing)	Web Services Security
GeoAPI	**I3S** (Indexed 3D Scene Layers)	3D Tiles	**TJS** (Table Joining Service)

Data Models and Encodings

Domain-specific

CityGML	CityJSON	IndoorGML	**IMDF** (Indoor Mapping Data Format)	LandInfra / InfraGML	PipelineML
ARML (Augmented Reality ML)	**GUF** (Geospatial User Feedback)	GeoSciML	WaterML	TimeSeriesML	LAS

General

Simple Features	**GML** (Geography Markup Lang.)	KML	Moving Features	OpenGeoSMS	GeoXACML
GeoTIFF	CRS WKT	Filter Encoding	GMLJP2	2D Tile Matrix Set	**O&M** (Observations & Meas.)
Time Ontology on OWL	**SLD** (Styled Layer Descriptor)	Symbology Encoding	Symbology Core		

Sensors

SensorThings API	SensorML	**SWE Common** (Sensor Web Enablement)	**SOS** (Sensor Observation Service)	**SPS** (Sensor Planning Service)	PUCK
Semantic Sensor Network Ontology				

Abstract Specification

Drive Standards Development and Adoption

Interactive OGC Standards Online:
https://www.ogc.org/standards/

India Space Policy - 2023

Strategy – Five Key aspects

Advanced Research & Development	Public goods and services	Level playing field to Non-Government Entities
Education and innovation	Space as a driver for overall technology development	

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CEOS Analysis Ready Data (CEOS-ARD)

Why ARD: Immediate Analysis, Min. User Efforts & Interoperability

- Increase Uptake

- Increase Impact

- Stay Relevant

- Resource Efficiency

- Enable Interoperability

CEOS ANALYSIS READY DATA

CEOS Analysis Ready Data (CEOS-ARD) are satellite data that have been processed to a minimum set of requirements and organized into a form that allows immediate analysis with a minimum of additional user effort and interoperability both through time and with other datasets.

CEOS-ARD
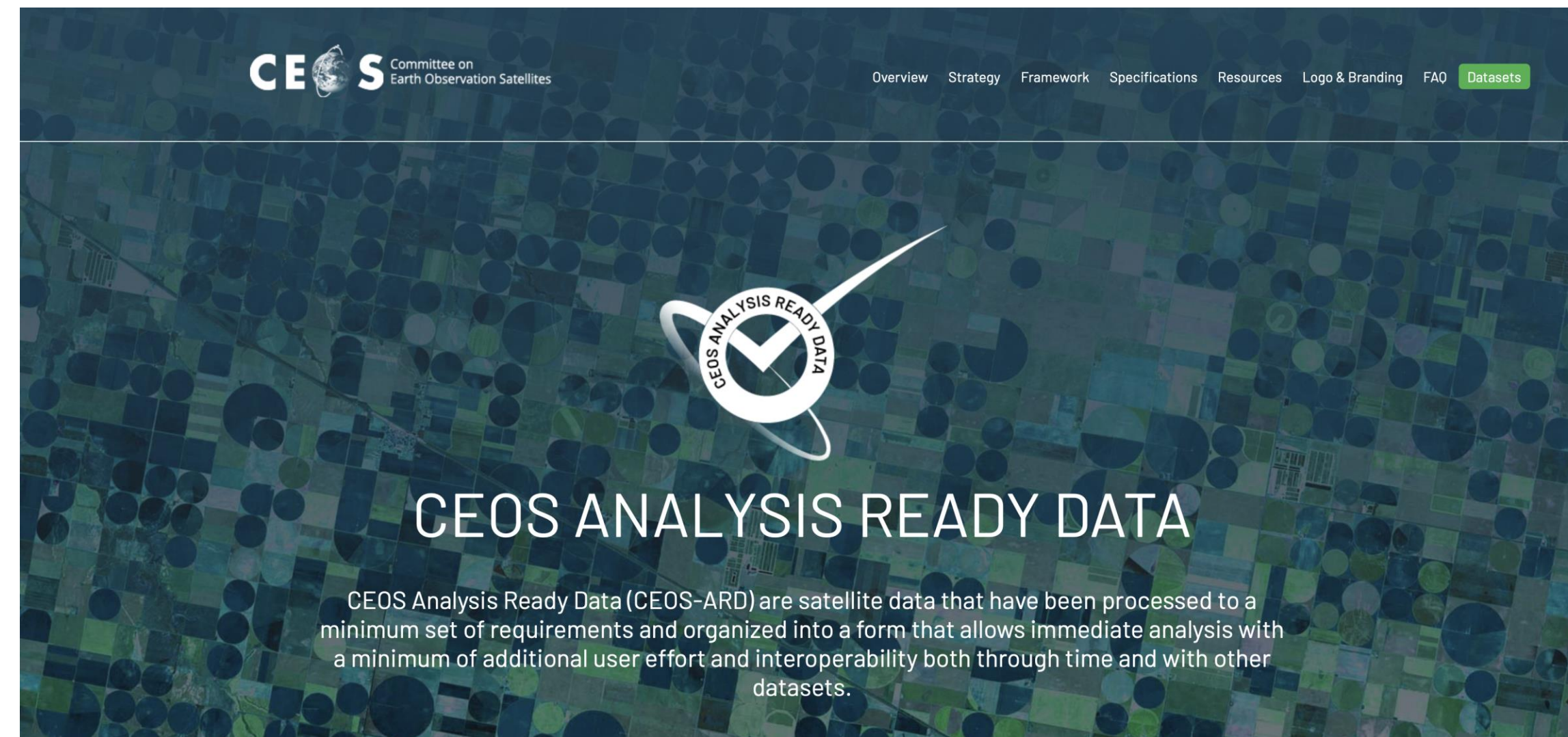
Open Data Cube

ARD in Action

- an integration of multi-temporal and multi-sensor remote sensing data set

- has been promoted by the CEOS for the sharing of remote-sensing data
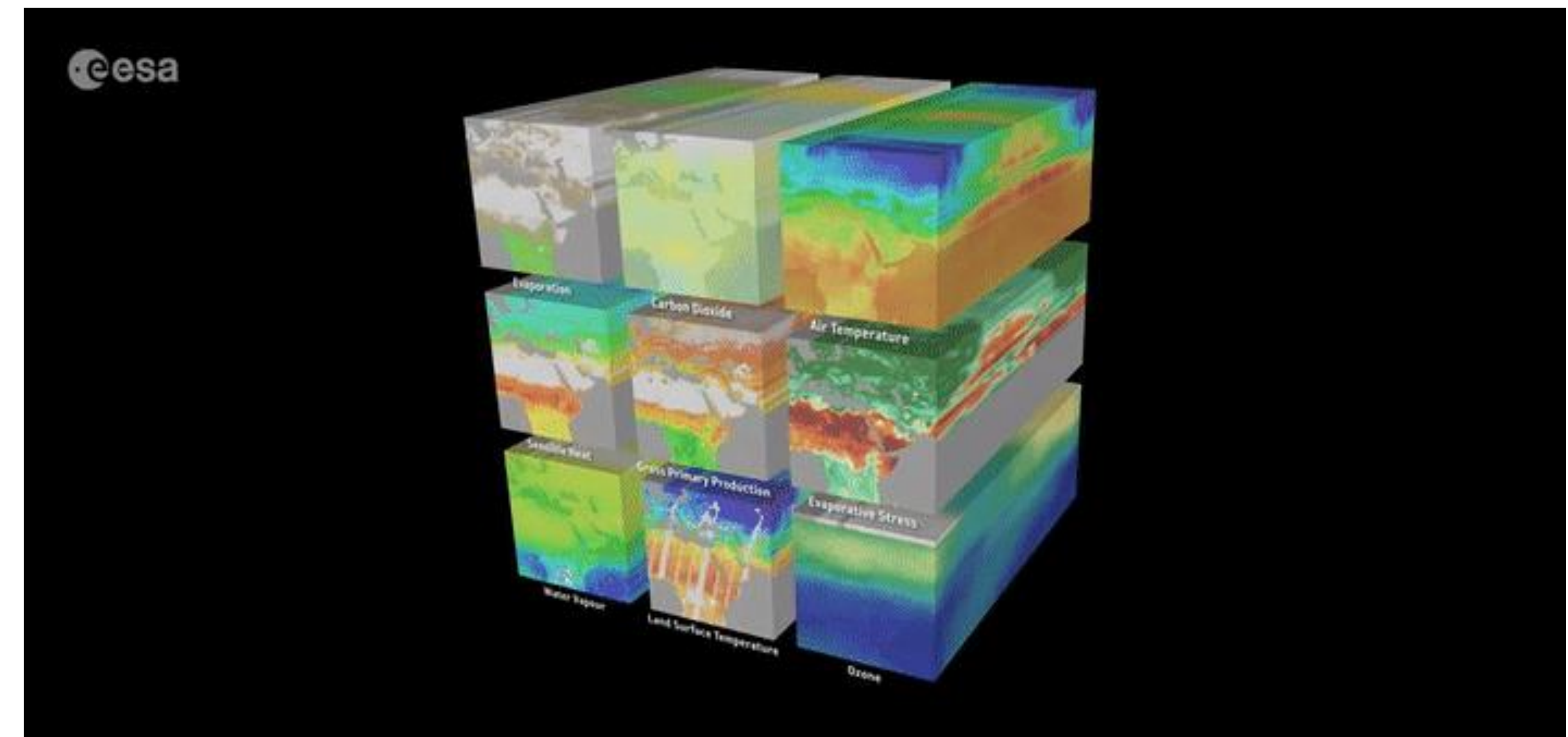
Data cubes are an accepted cornerstone for analysis-ready data - homogenization of zillions of scenes into a few space-time cubes with unified spatial and temporal access has been shown to lead to both simpler and more scalable services - earthserver.eu

Geospatial Data Cubes

Make ARD products accessible

Structured time-series

Observations → Analysis Ready Data → Products → Information for decisions

Reporting
Web services
Write code

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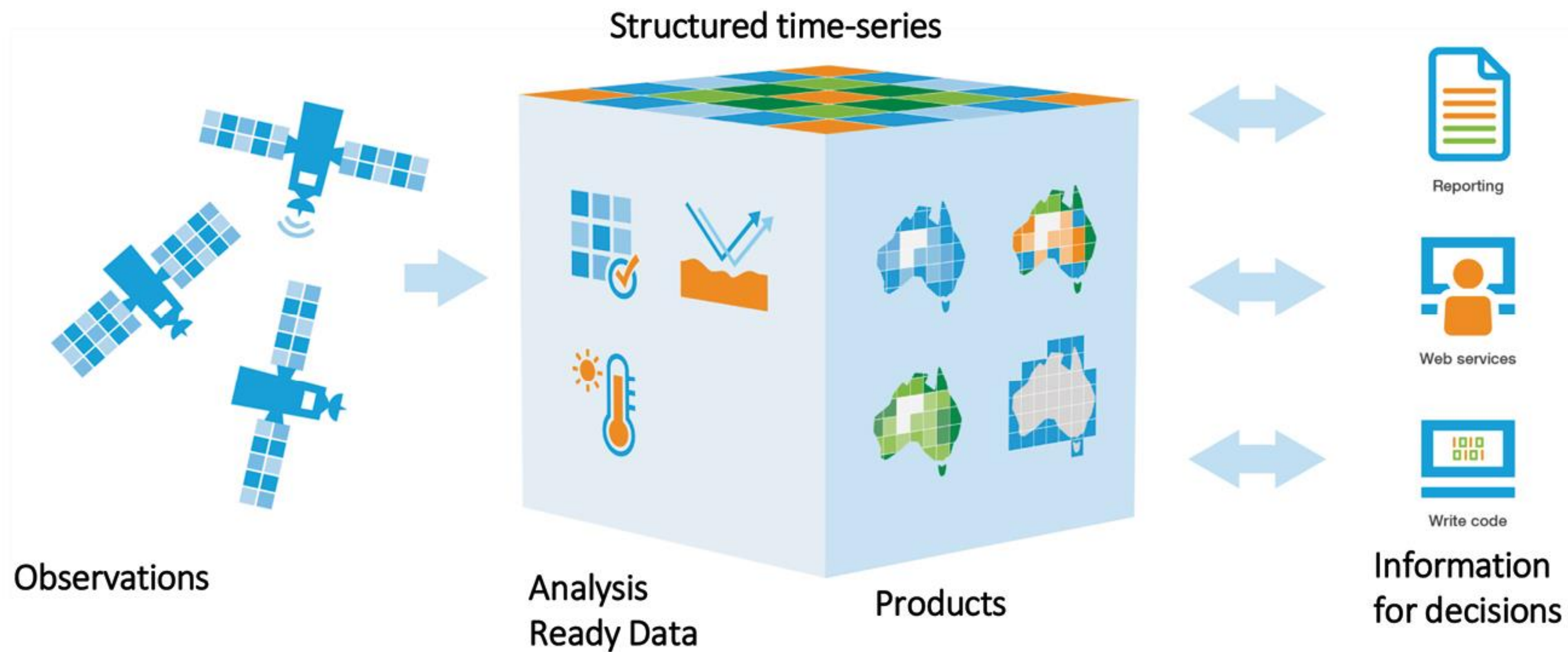
Geospatial Data Cubes

Integrating ARD products and analytics

Credits: Australian Geoscience Data Cube

1985 1990 1995 2000 2005 2010 2015

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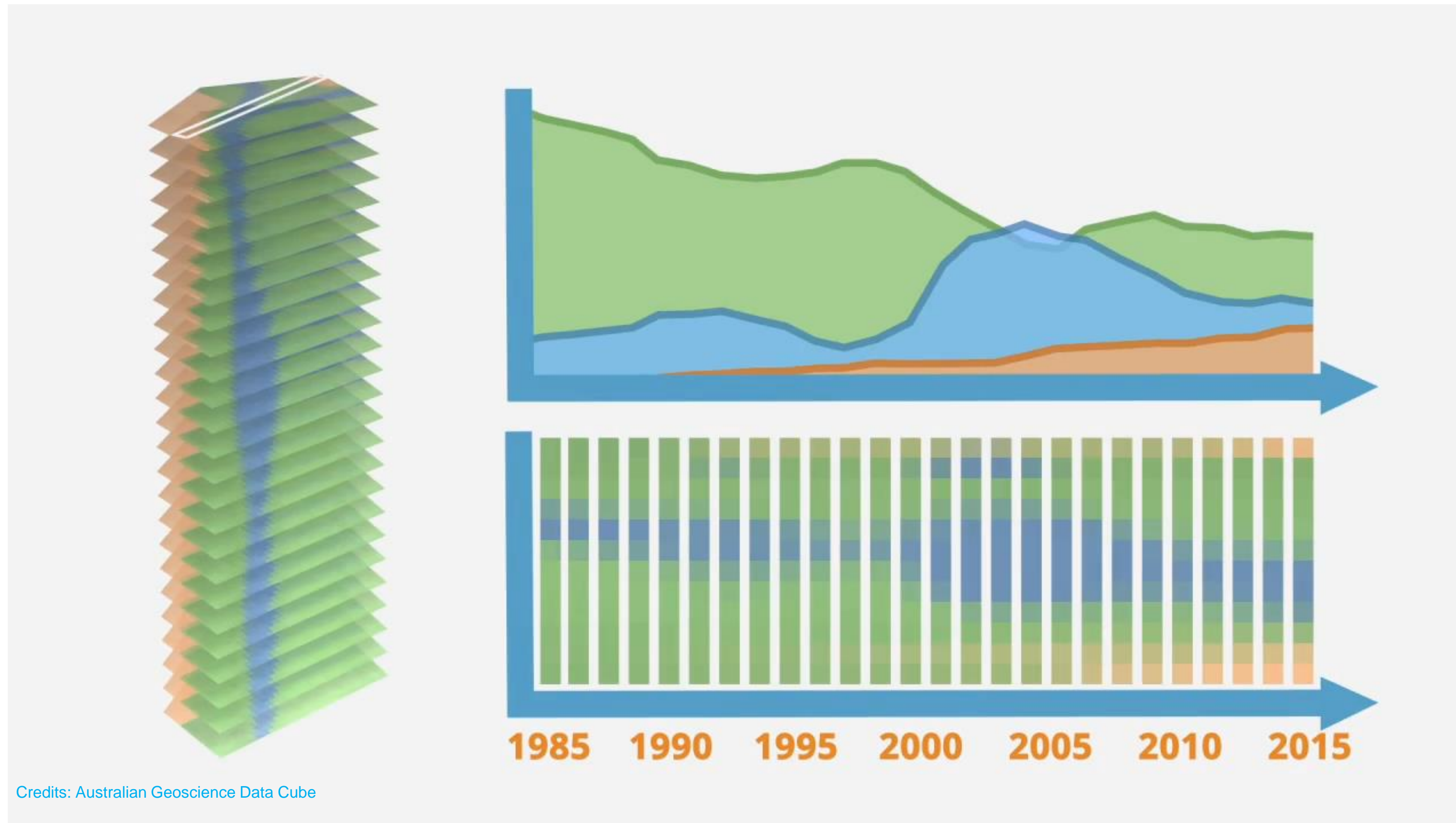
Geospatial Data Cubes

Different Implementations of Data Cubes
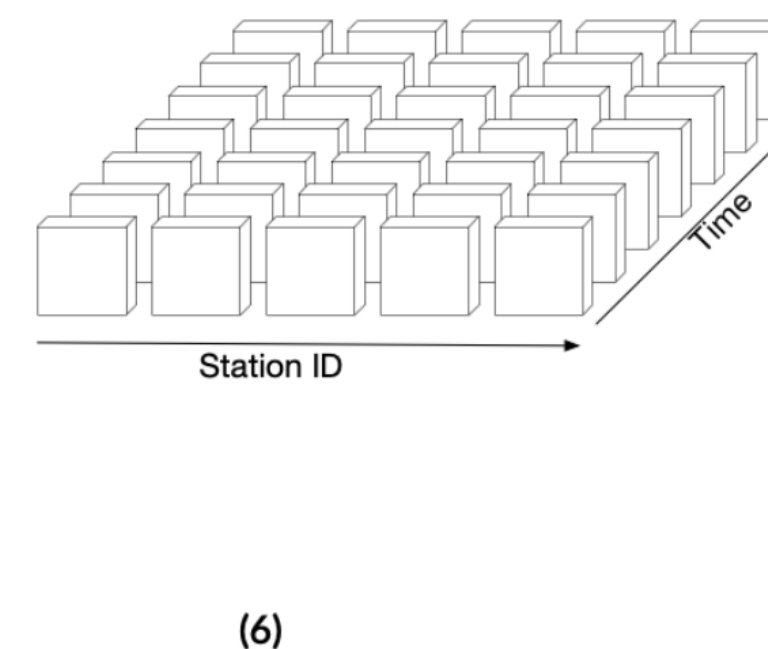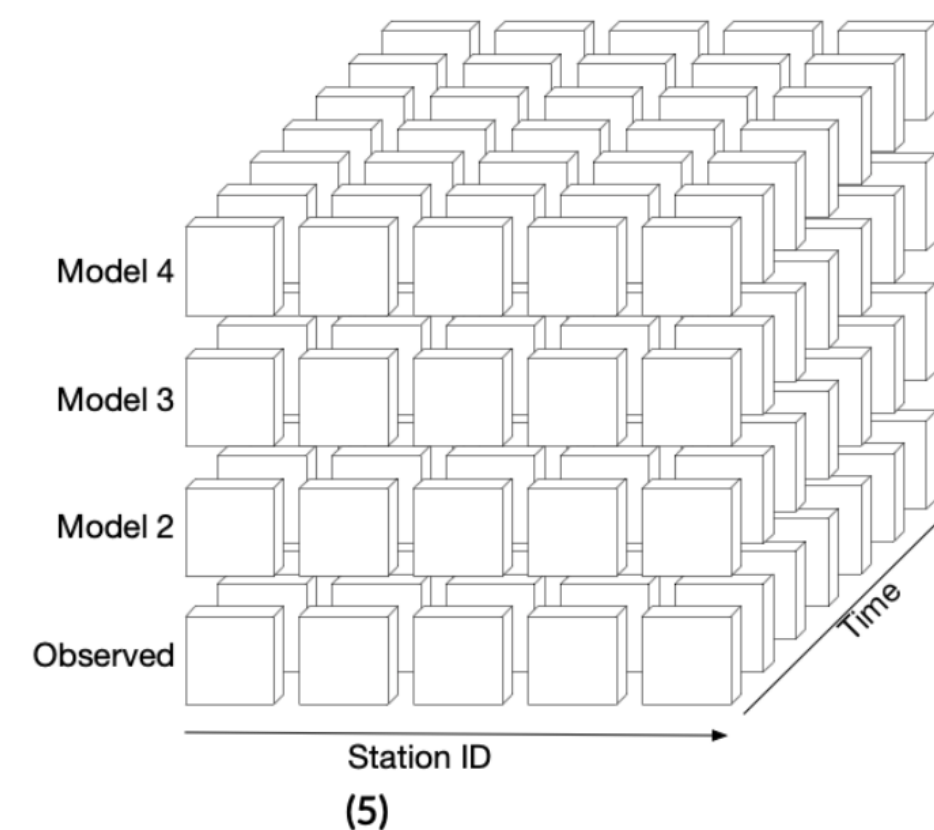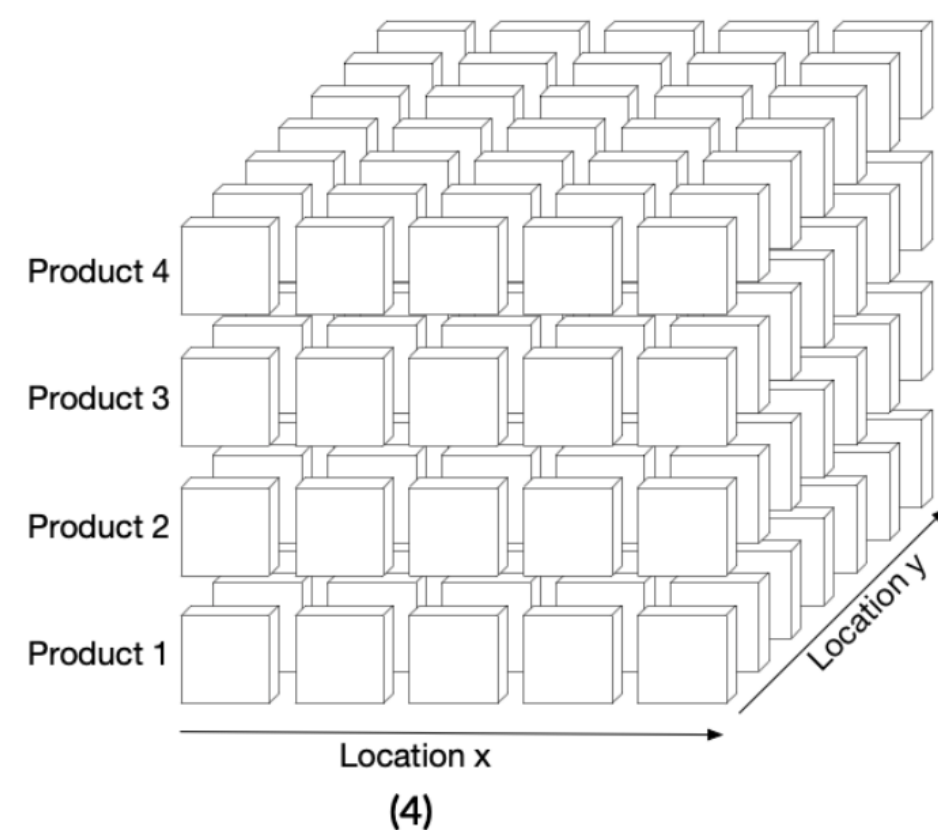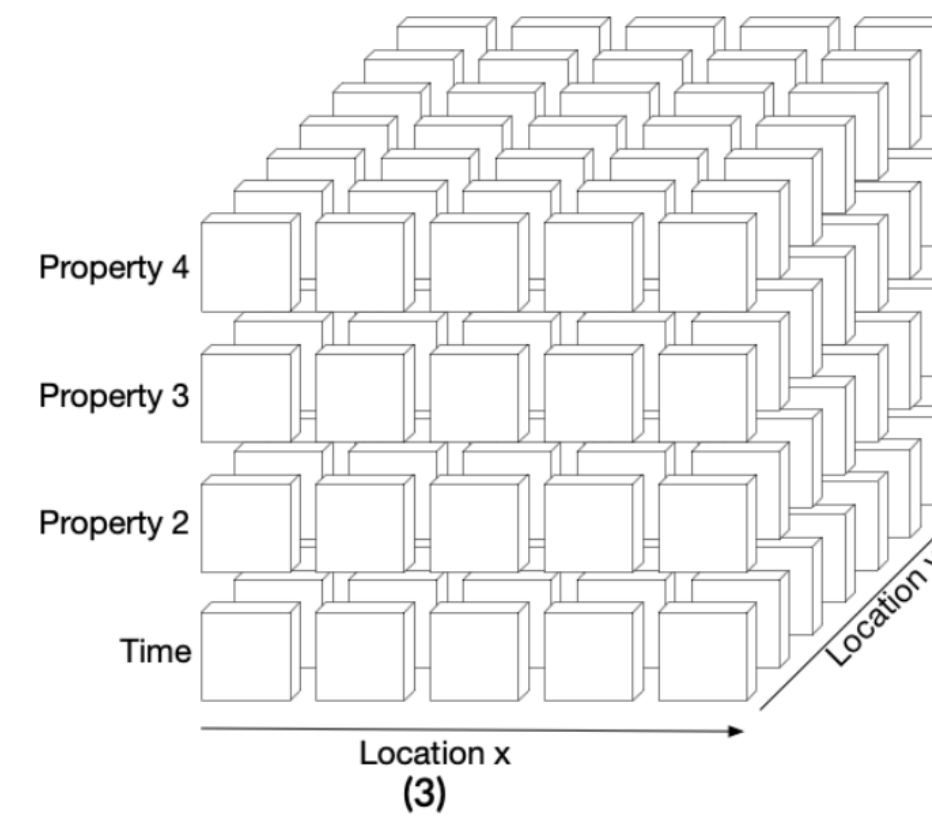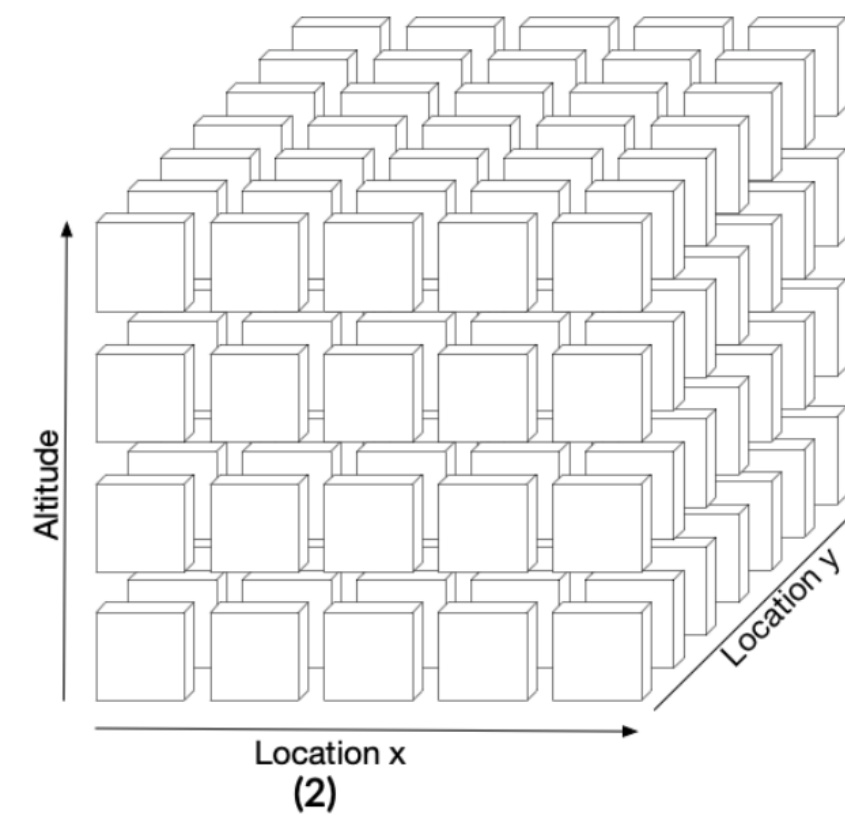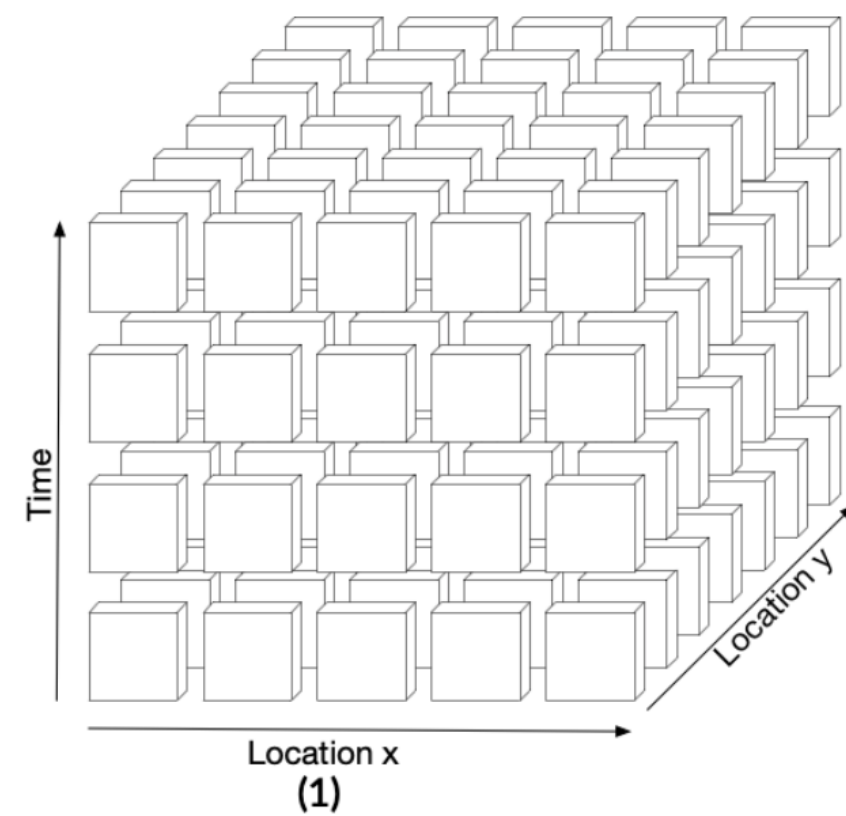
- Cube (1) organizes cells along two spatial and one temporal dimension
- Cube (2) adds altitude as a third spatial dimension
- Cube (3) organizes time similar to other variables (properties) in a specific dimension
- Cube (4) uses two spatial dimensions and represents different products in the third dimension
- Cube (5) and cube (6) represent a set of stations (e.g. in-situ sensor data)

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Geospatial Data Cubes

Global Examples – 1/4

OPEN DATA CUBE

Satellite Data — Infrastructure — Users' Apps
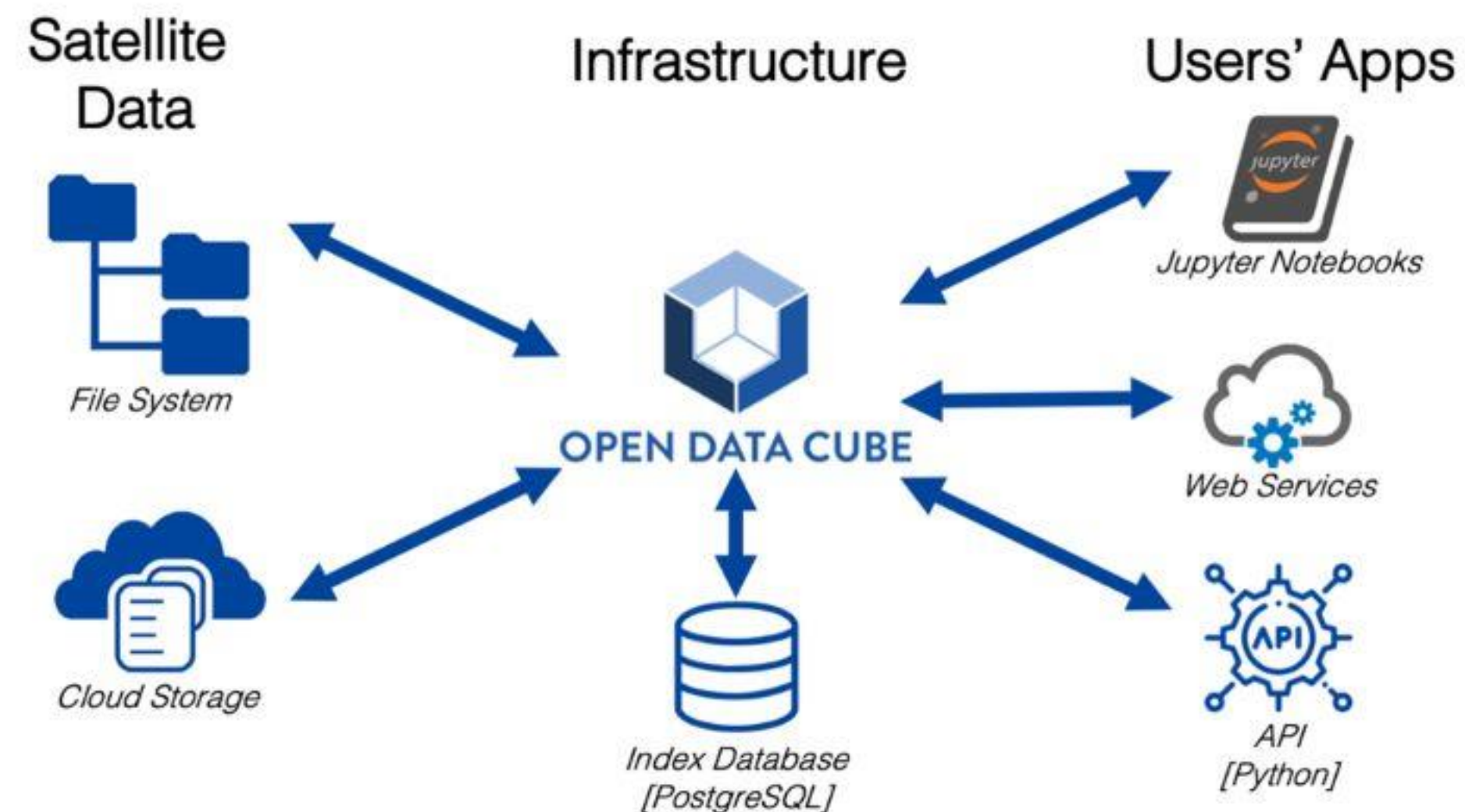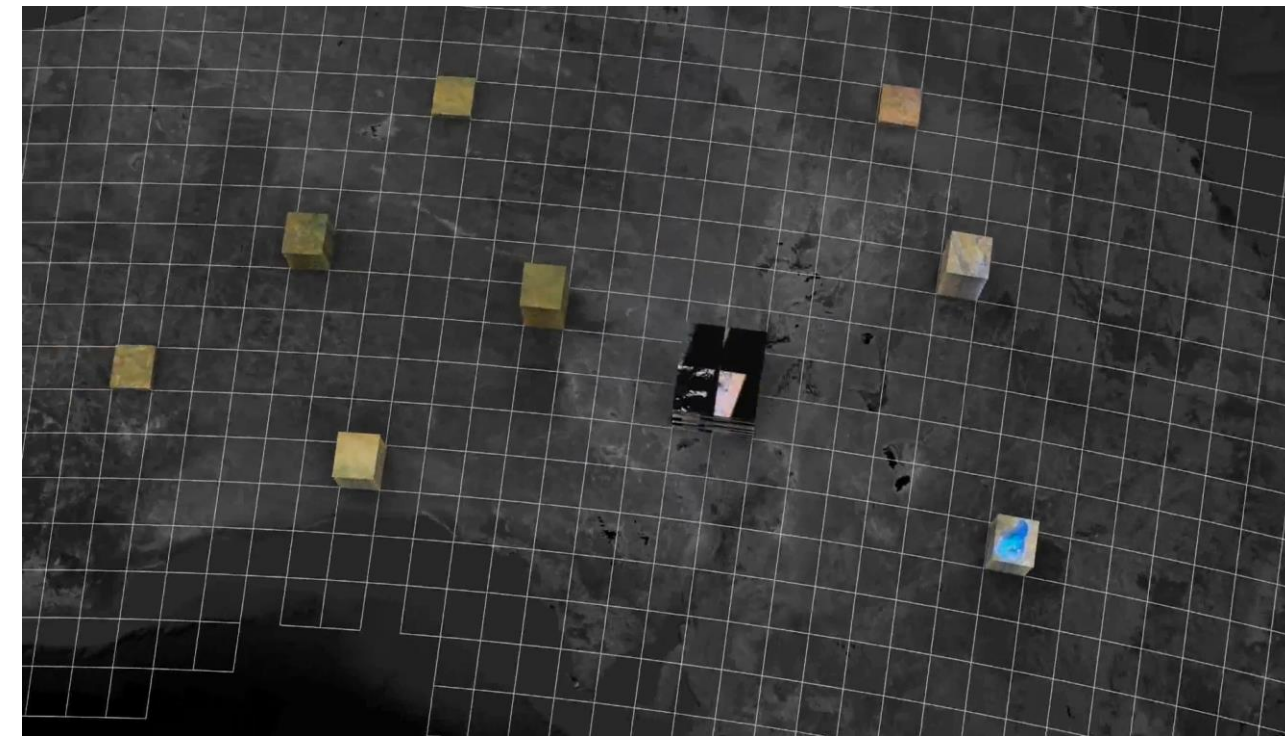
Credits: OSGeoLive

- provides an integrated gridded data analysis environment for decades of analysis-ready earth observation satellite and related data from multiple satellite and other acquisition systems

- previously, the Australian Geoscience Data Cube

- Implements web services enabled by OGC Standards such as WCS, WPS, WMS

Open Data Cube (ODC)

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Geospatial Data Cubes

## Global Examples – 2/4

EarthServer-2
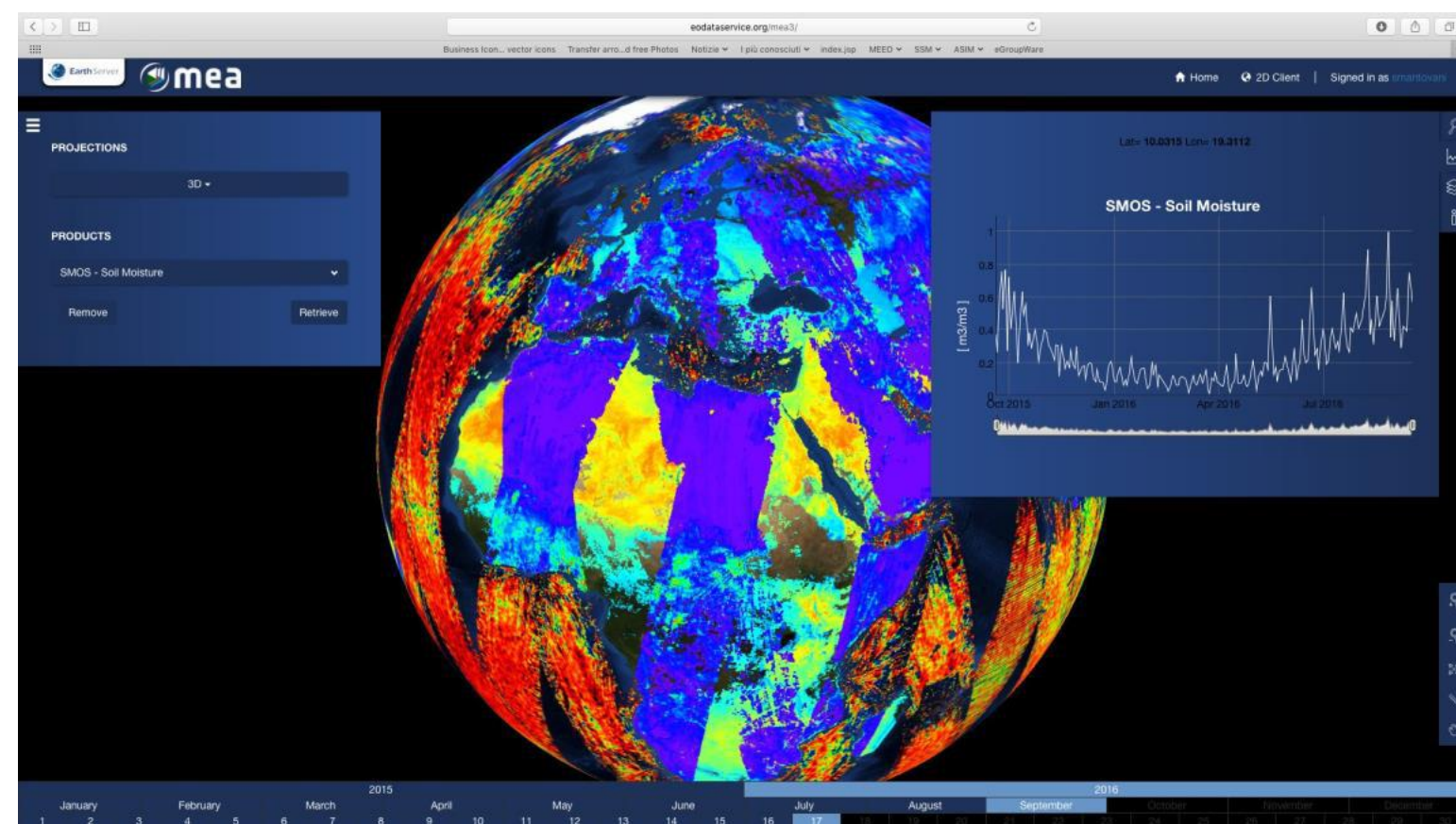
- EU Horizon 2020, funded EarthServer-2 projects, has set up WCSs for different scientific domains: ocean science, earth observation, climate science, and planetary science.

- Based on rasdaman datacube technology – an intelligent array-based server technology,

- explored the possibilities and challenges of providing access to data sizes beyond 1 PB of 3D to 4D Earth Science Data

- Based on OGC – WCS, WCPS; ISO – SQL/MDA (Multi-dimensional Arrays)

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Geospatial Data Cubes

Global Examples – 3/4
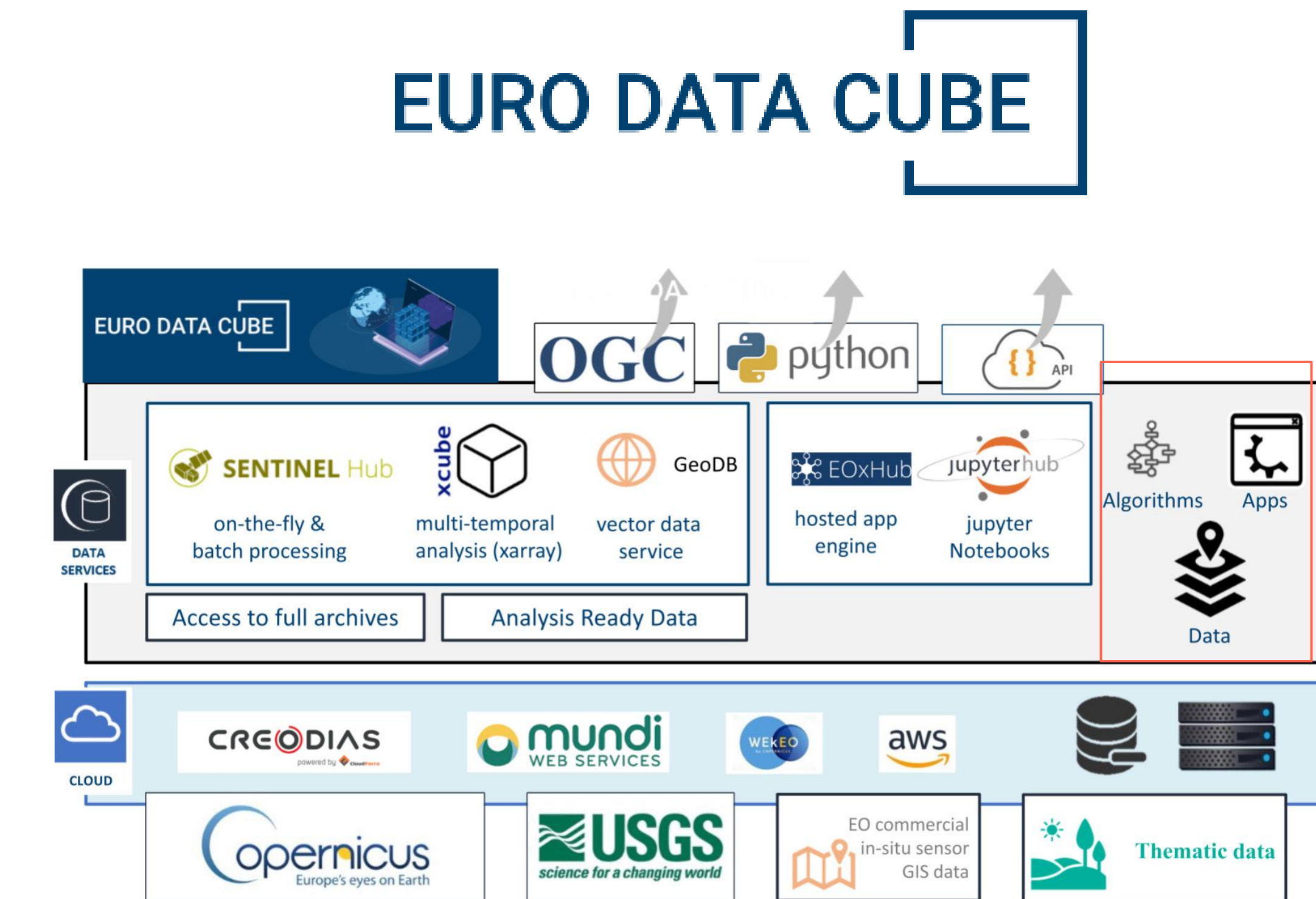
- Query and exploit large volumes of EO data and information resources

- Global Archives of Analysis Ready Data (RD): Open satellite missions - Sentinel, Landsat, MODIS, etc.

- Commercial VHR datasets - PlanetScope, Pléiades, SPOT, etc.

- Earth System Data Cube: ESA and Copernicus Climate Change Initiative

- Marketplace for free or revenue-generating options to share data, applications, and algorithms

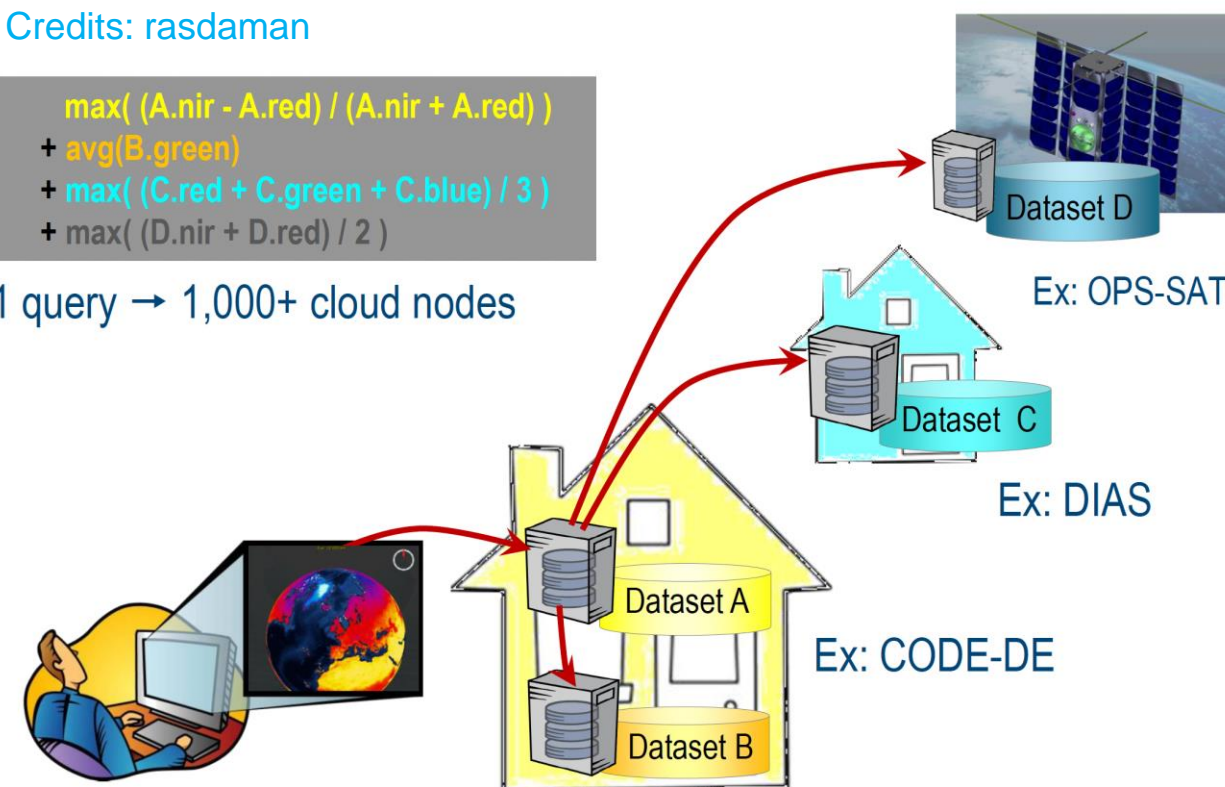- OGC standards to share data

Geospatial Data Cubes

Global Examples – 4/4

Credits: rasdaman

max((A.nir - A.red) / (A.nir + A.red))
+ avg(B.green)
+ max((C.red + C.green + C.blue) / 3)
+ max((D.nir + D.red) / 2)

1 query → 1,000+ cloud nodes

Dataset D
Ex: OPS-SAT
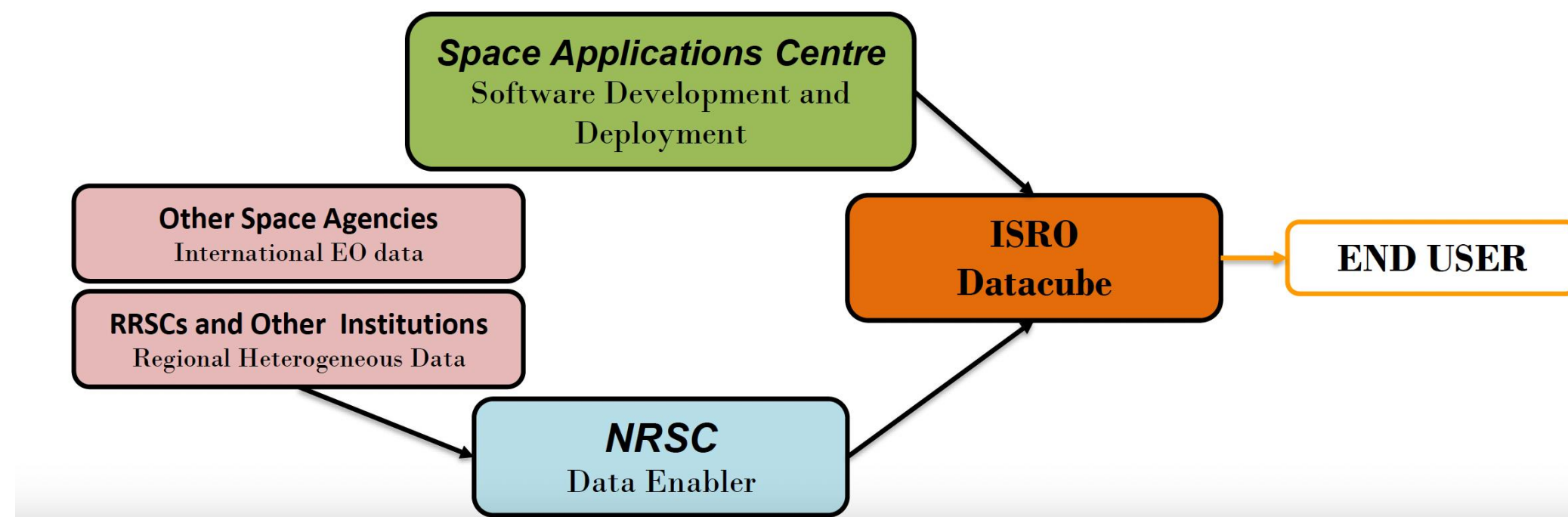
Dataset C
Ex: DIAS

Dataset A
Ex: CODE-DE

Dataset B

- EarthServer is an open community of large-scale Earth data providers, including research centers, supercomputing centers, companies, agencies.

- 16 Partners globally - members contribute jointly to the single common information space for multi-dimensional spatio-temporal Earth data which EarthServer offers as a single point of Earth data and services.

- Based on OGC WCS, together with its datacube analytics language WCPS

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Geospatial Data Cubes

Indian Context – 1/2

- IRS Data Cube Framework proposed in a 2019 paper in the Journal of Geomatics

- Talks about the ARD workflow and the development of Oceansat-2 OCM Data Cube over the Indian Subcontinent.
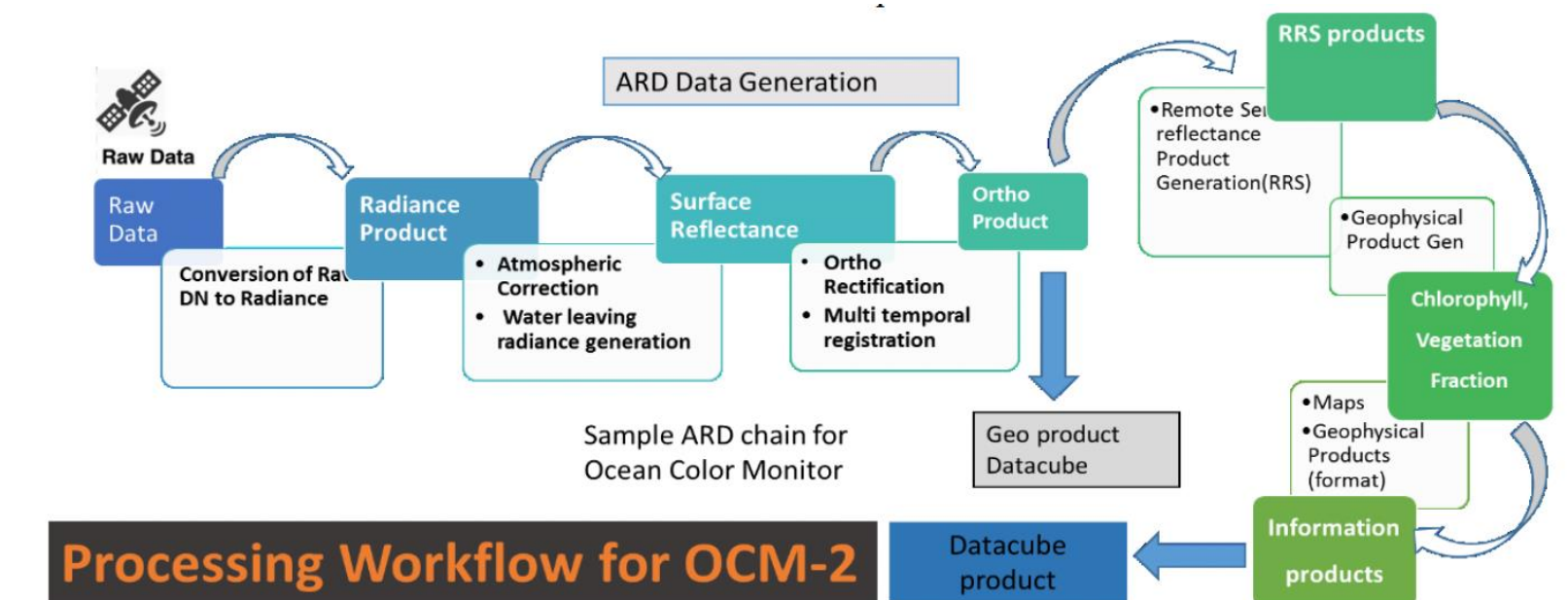
- OGC Standards - WMS/WFS/WCS

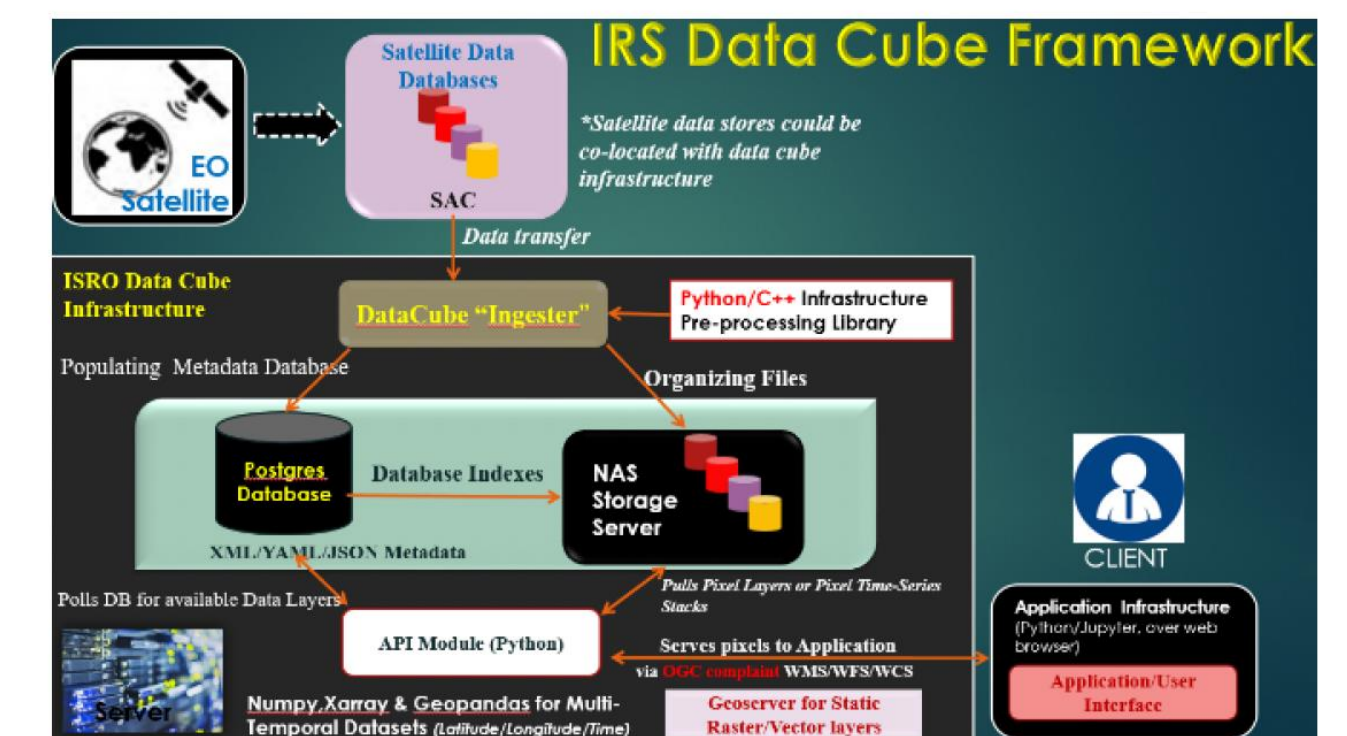Figure 3: Processing workflow for OCM-2 RAW to ARD to Datacube Chain

Figure 4: IRS Data cube framework for OCM2

Credits: Tushar Shukla*, Sampa Roy and Debajyoti Dhar - Space Applications Centre, Ahmedabad

Credits: Debajyoti Dhar - Space Applications Centre, Ahmedabad

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Geospatial Data Cubes

Indian Context – 2/2

- **Indian Institute for Human Settlements**

  - India Data Cube

    - Project sponsored by GEO and AWS credits Program

    - Using the Open Data Cube (ODC) Framework – indexed EO data from Landsat (5,8); census and sample survey data rasterized

    - State of Karnataka – 1 TB of Data

Credits: Amruth Kiran, IIHS

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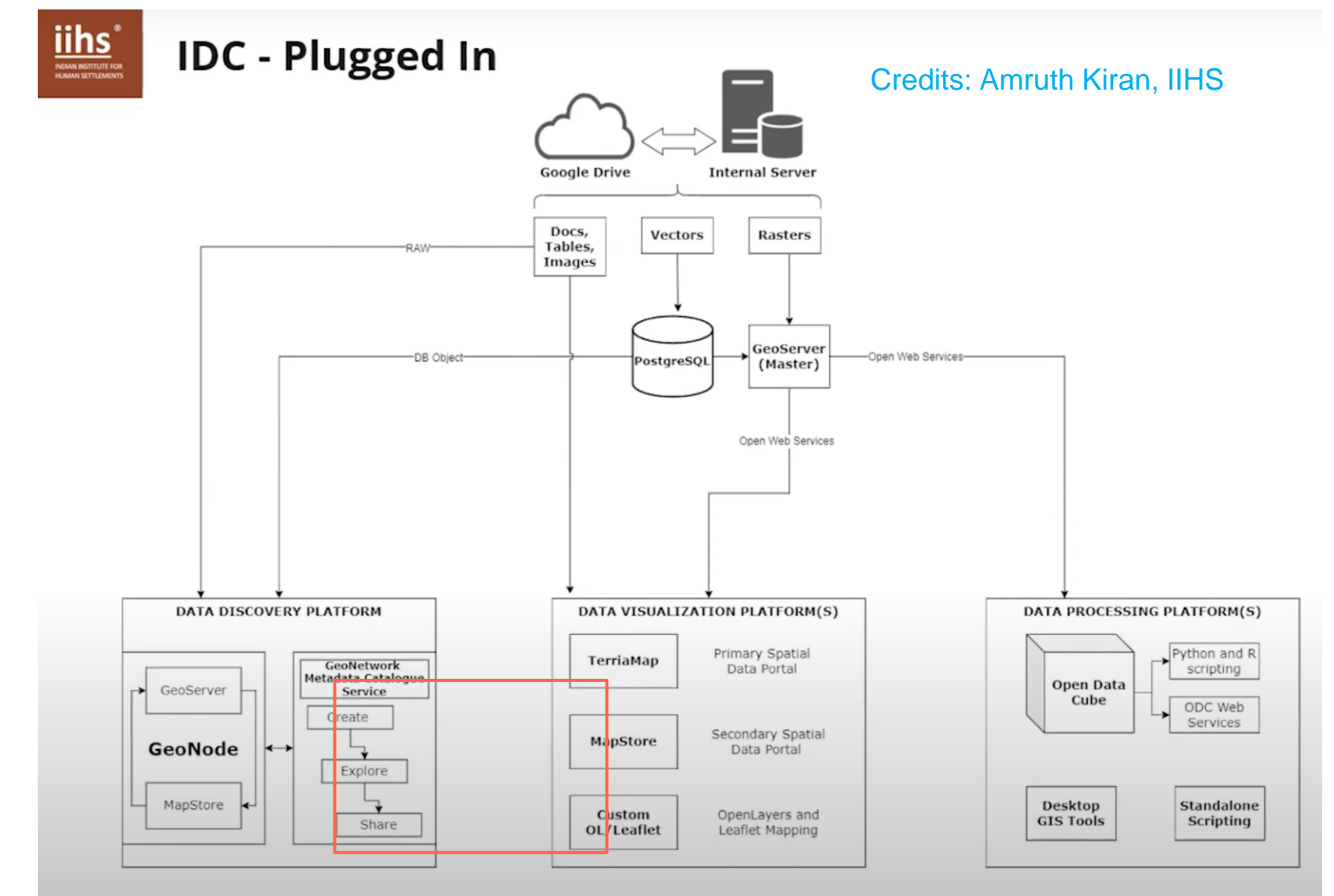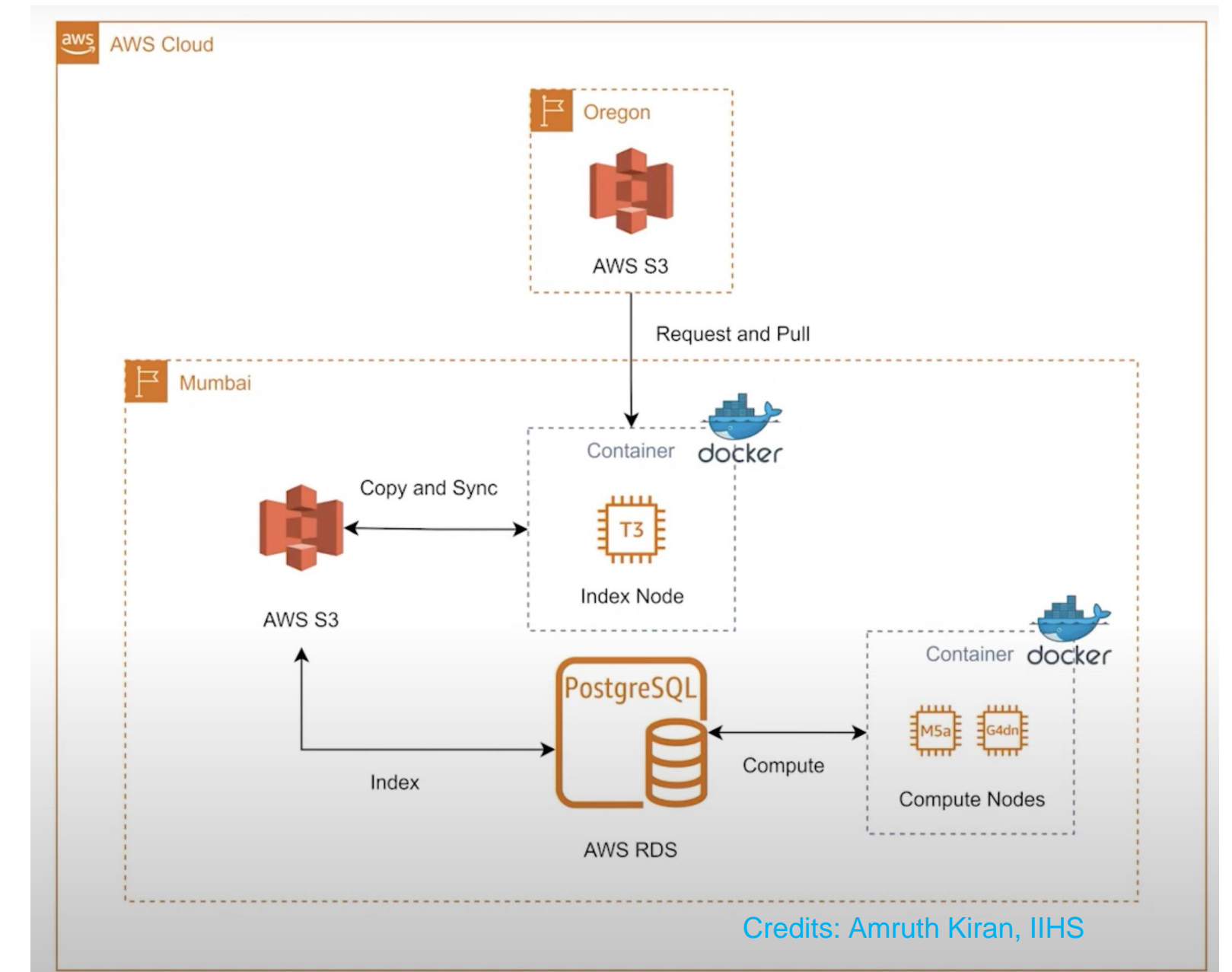
The Future

Investing In Innovation

- The Indian Space Policy and the opening of data in India provide an impetus to invest in Geospatial Data Cubes. Investing in the concepts of ARD and Geospatial Data Cubes will give the necessary push towards:

  - **Advanced Research & Development** in Government & Research Institutions – Earth observation, climate, weather – infrastructure, computing & data

  - **Public services** – Easier access to analysis-ready data for numerous use cases

  - **Non-Government Entities** – The private sector can ride on Data Cubes to create new commercial offerings in terms of algorithms, services, and solutions

  - **Education and innovation** - Investment in the innovation ecosystem

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The Future

Expanding Interoperability

OGC DRAFT DOCUMENTS

As Data cubes become commonplace, interoperability among them becomes critical

- OGC continues to advance standards for enabling Geospatial Data Cubes (GDC).

- OGC Testbeds are evolving GDC API Standard based on OGC API — Common, OGC API — Coverages Standard, OGC API — Processes Standard, the STAC API, and the open API.

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Standards

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Using OGC Standards

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