

# **Challenges and Solutions for Utilizing Earth Observations in the "Big Data" era**

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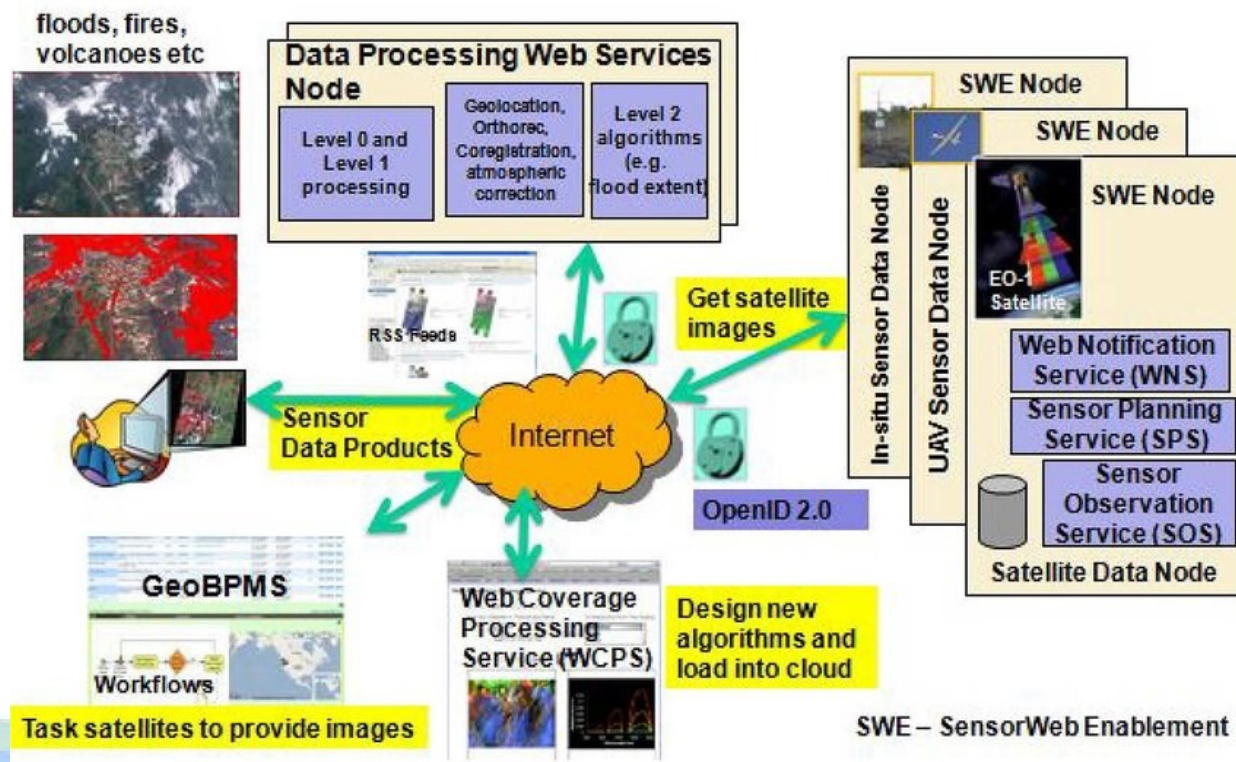
# PRESENTATION OUTLINES

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- Earth Observation (EO) data
- Mainstreams of EO Big Data Archives, Catalogs & Databases
- EO Big Data Analytics
- Conclusions / Perspectives

# Earth Observation (EO) data

- Provided by geospatial technologies
  - ✓ satellite images of over 660 satellites
  - ✓ new tools and technologies
- Empowered the modern society to tackle with environmental and climate changes
- Rapid growth of processing power and global connectivity
- “Big Data” issue
  - ✓ need for flexible solutions
  - ✓ processing, analyzing and visualizing is a challenge
  - ✓ web and mobile systems
  - ✓ satellite “**sensor web**”



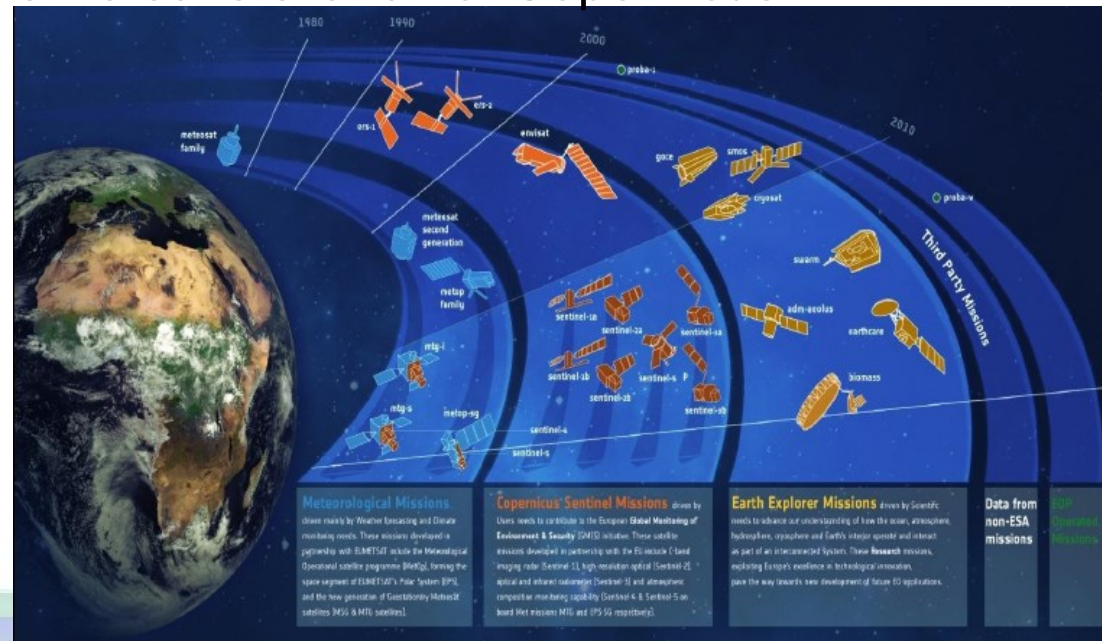
# Benefits of EO

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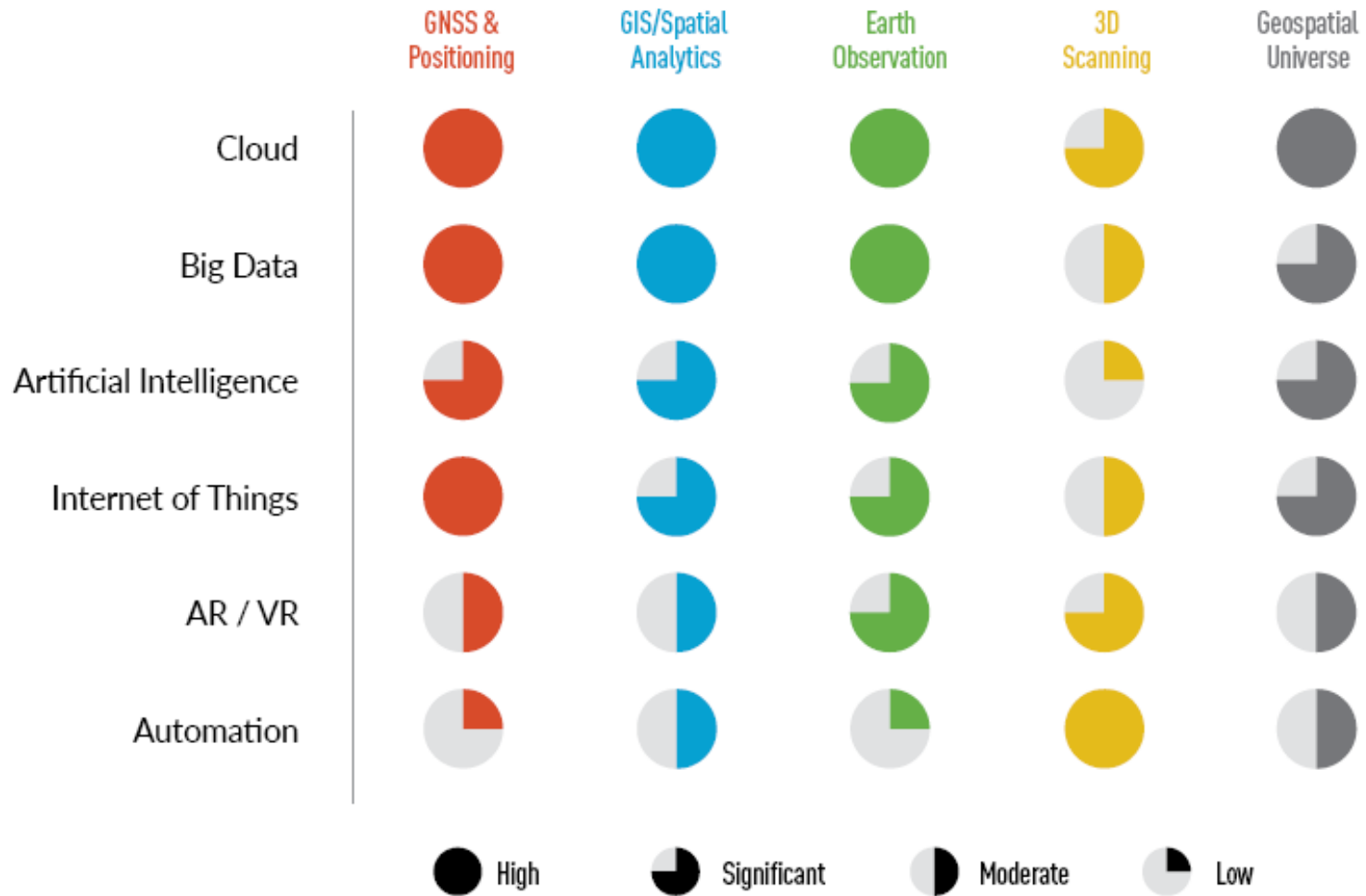
- In many areas of government, industry and science
  - ✓ a valuable information source in support of the social-economic development of modern society
- Key benefits of satellite EO data
  - ✓ they make the prospect of a Global Indicator Framework for the SDGs viable
  - ✓ potentially more timely statistical outputs for reducing the frequency of surveys, respondent burden and other costs
  - ✓ providing the data at a more disaggregated level for informed decision making
  - ✓ contribute to improving the accuracy
  - ✓ more spatially-explicit

# Mainstreams of EO Big Data Archives, Catalogs & Databases

- National and national space programs
    - ✓ NASA, ESA, Roskosmos, JAXA, DLR, INPE, ISRO, CNES, etc.
  - Big potential to be used for innovative products and services (*~95% of the EO data present in existing archives has never been accessed*)
    - ✓ EOS Project Science Office at NASA Goddard Space Flight Center
    - ✓ EU and ESA - Copernicus programme (previous GMES)
- Sentinels - the European satellite constellation of Copernicus



# Earth Observation industry

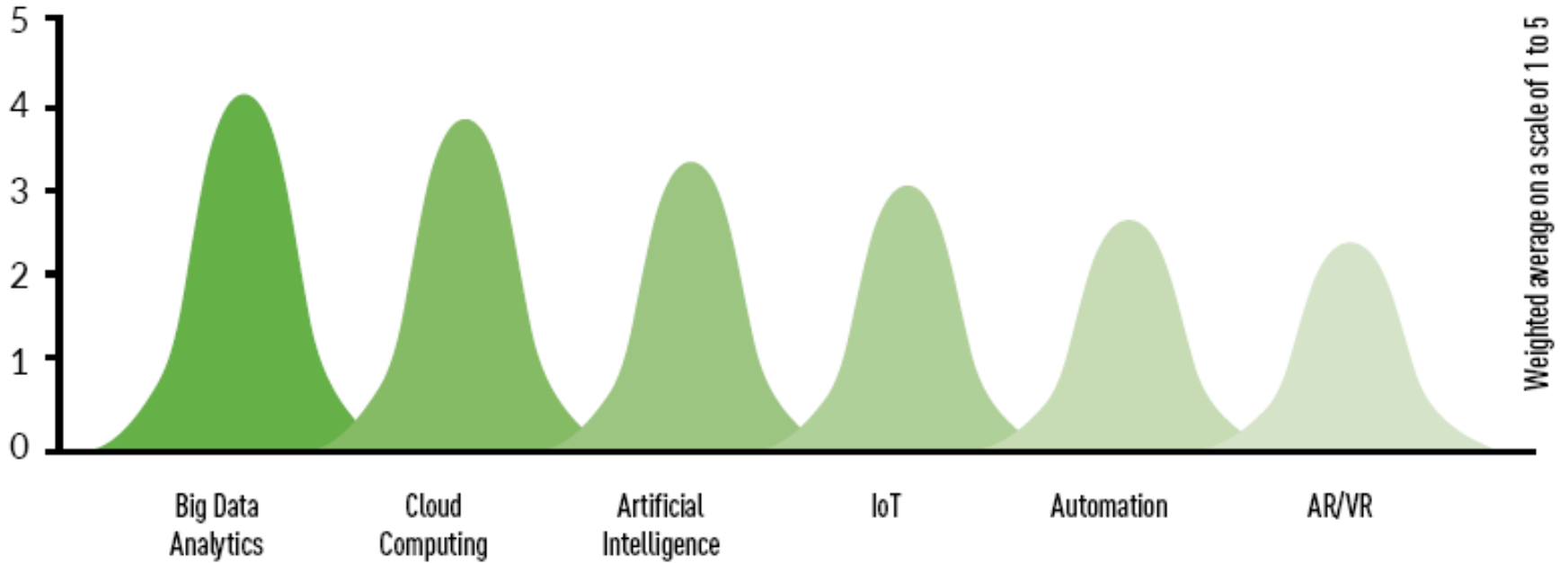


Source: Geospatial Media Analysis





# Top technology drivers of EO Market



Source: Geospatial Media Analysis



# Open “Data Cube”



Woodcock et al., 2018

# Copernicus DIAS

DIAS – Data and Information Access Services:

- CREODIAS
- MUNDI
- ONDA
- SOBLOO
- WEKEO

The logo for CREODIAS, featuring the word "CREODIAS" in a sans-serif font with a red circle around the letter "O".The logo for mundi WEB SERVICES, featuring a green and yellow circular icon to the left of the word "mundi" in a bold, lowercase sans-serif font, with "WEB SERVICES" in a smaller font below it.The logo for ONDA, featuring a blue circular icon with a white dot inside, followed by the word "ONDA" in a bold, uppercase sans-serif font.The logo for sobloo, featuring the word "sobloo" in a bold, lowercase sans-serif font with a blue gradient.The logo for WEKEO by COPERNICUS, featuring two overlapping blue circles, with the word "WEKEO" in white uppercase letters and "by COPERNICUS" in smaller white lowercase letters below it.

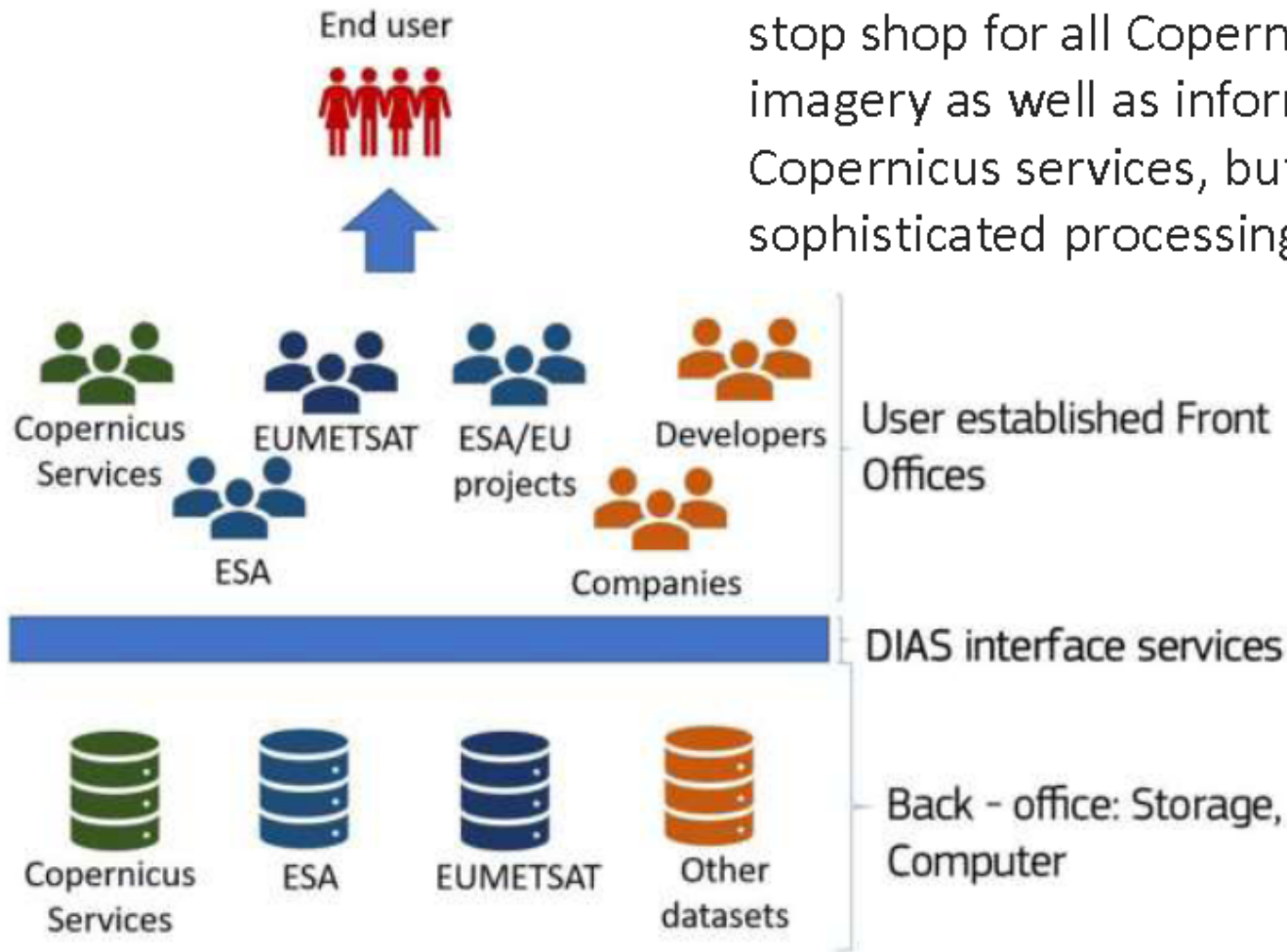
They provide:

- ✓ provide access to Copernicus Sentinel data
- ✓ information products from Copernicus' six operational services
- ✓ cloud-based tools (open source and/or on a pay-per-use basis)

**Copernicus User Uptake - RUS – Research and User Support**

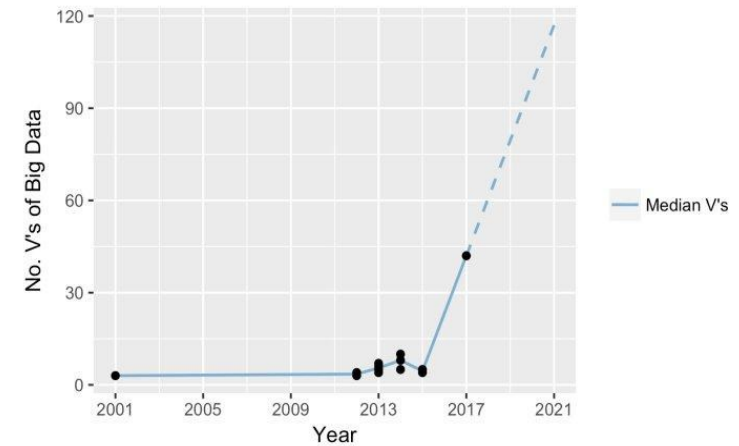
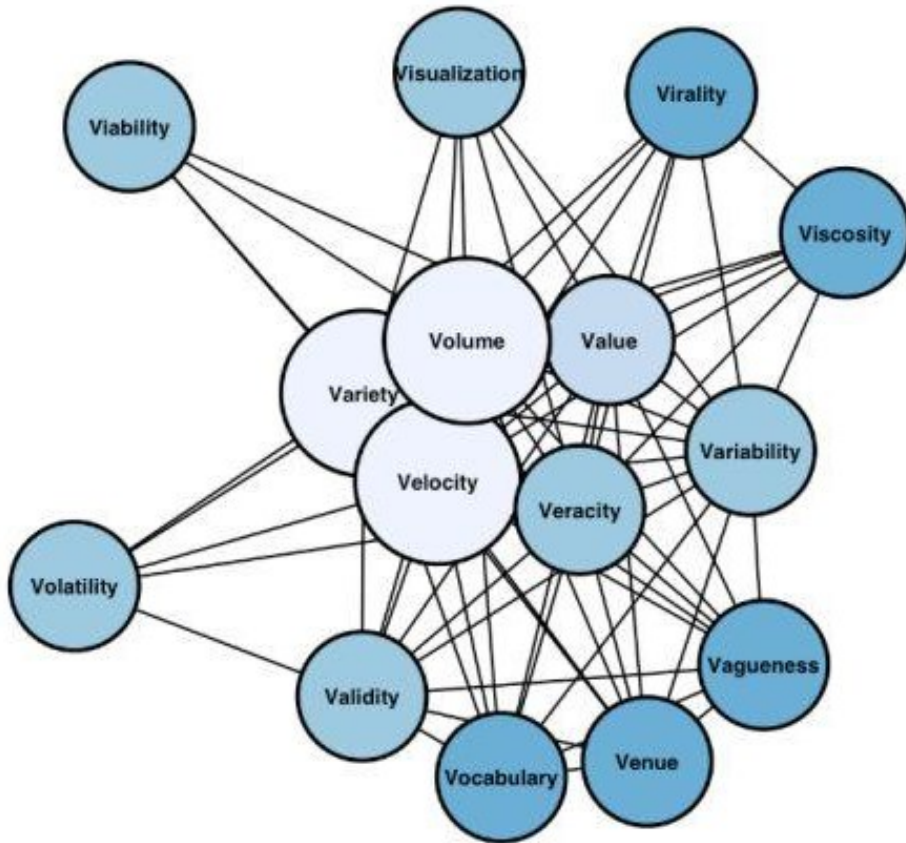
# Copernicus DIAS

DIAS will not only provide a cloud-based one-stop shop for all Copernicus satellite data and imagery as well as information from the six Copernicus services, but will also give access to sophisticated processing tools and resources.

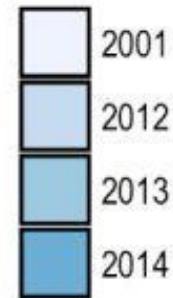


# EO Big Data Analytics

Big Data is “extensive datasets”

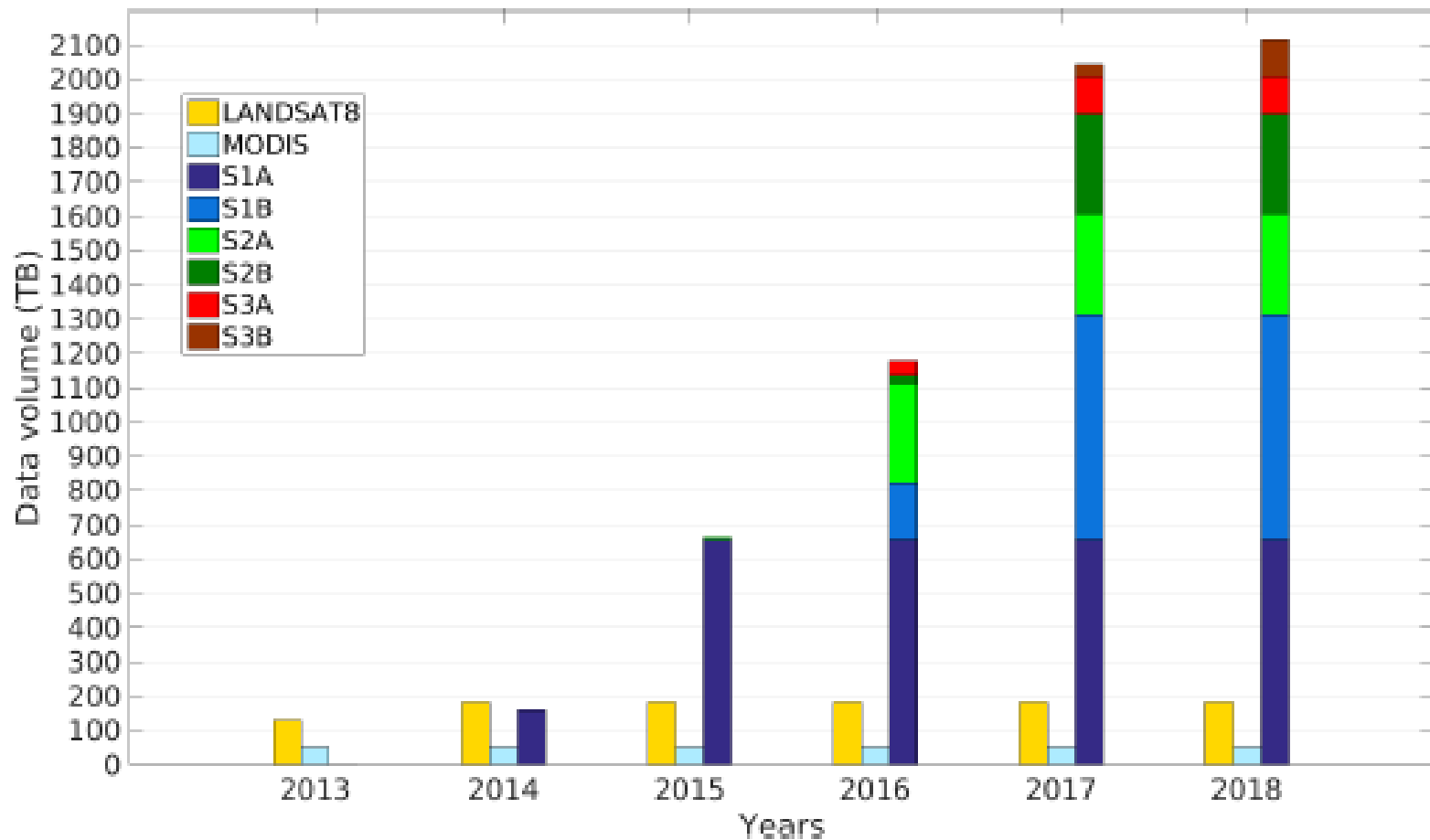


First Occurrence



Shafer, 2017

# Yearly data flow from satellites



Soille et al., 2016



# Methods for EO processing

- For sub-sampling, resampling and multi-sensor EO data fusion
- Fourier transform
- Maximum Likelihood
- Artificial Neural Network
- Decision Tree
- Spectral Angle Mapper
- Principal Component Analysis
- Wavelet and Multiwavelet Transform (discrete and continuous)

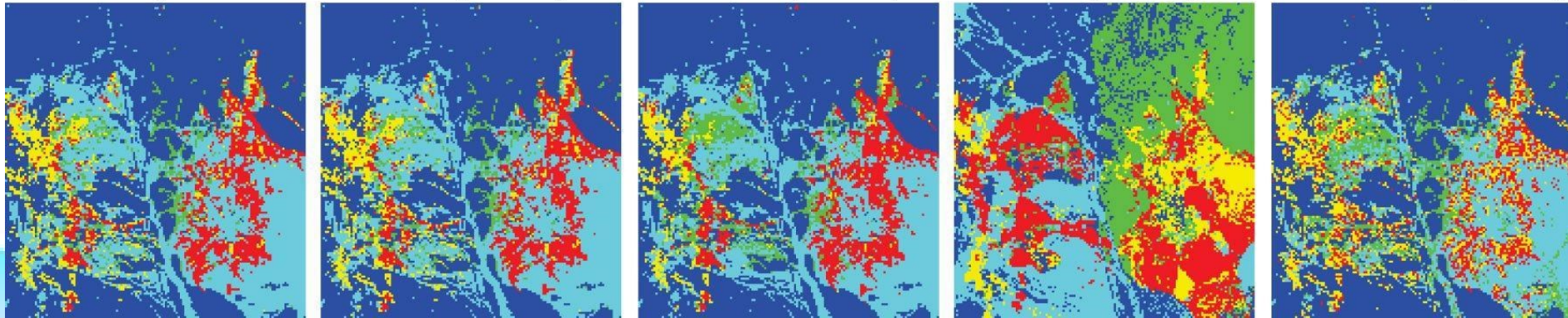
Original

PCA (99.86%)

Wavelet (92.60%)

MNF (37.92%)

Band Selection (84.33%)



# Conclusions

- Many future satellite missions are envisaged until 2030 and beyond

Company	Country	In-Orbit Satellites	Planned # of satellites	Type of Sensor	Full Constellation deployment
<b>Hera Systems</b>	USA	0	48	Optical	2020
<b>Planet</b>	USA	51	150	Optical	2017
<b>BlackSky Global</b>	USA	0	60	Optical	2019
<b>OmniEarth</b>	USA	0	18	Multispectral (MS)	2018
<b>Planetary Resources</b>	USA	0	10	Hyperspectral	2020+
<b>AxelSpace</b>	Japan	0	50	Optical	2020+
<b>IceEye</b>	Norway	0	40	SAR	2020
<b>Astro Digital</b>	USA	0	16	Optical/MS	2019-20

Basu, 2016



# Perspectives

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- The volume of EO is exponential increasing with advancement of sensor and digital technologies
- EO data offer new possibilities to understand the Earth System
- EO as Big Data into new types of information services



**THANK YOU FOR YOUR ATTENTION!**