



# Connecting Space-Based Missions to Existing Communities:

**NASA Surface Biology and Geology (SBG), EU-Copernicus and the  
Global Lake Ecological Observatory Network (GLEON)**

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<sup>1</sup>NASA Goddard Space Flight Center

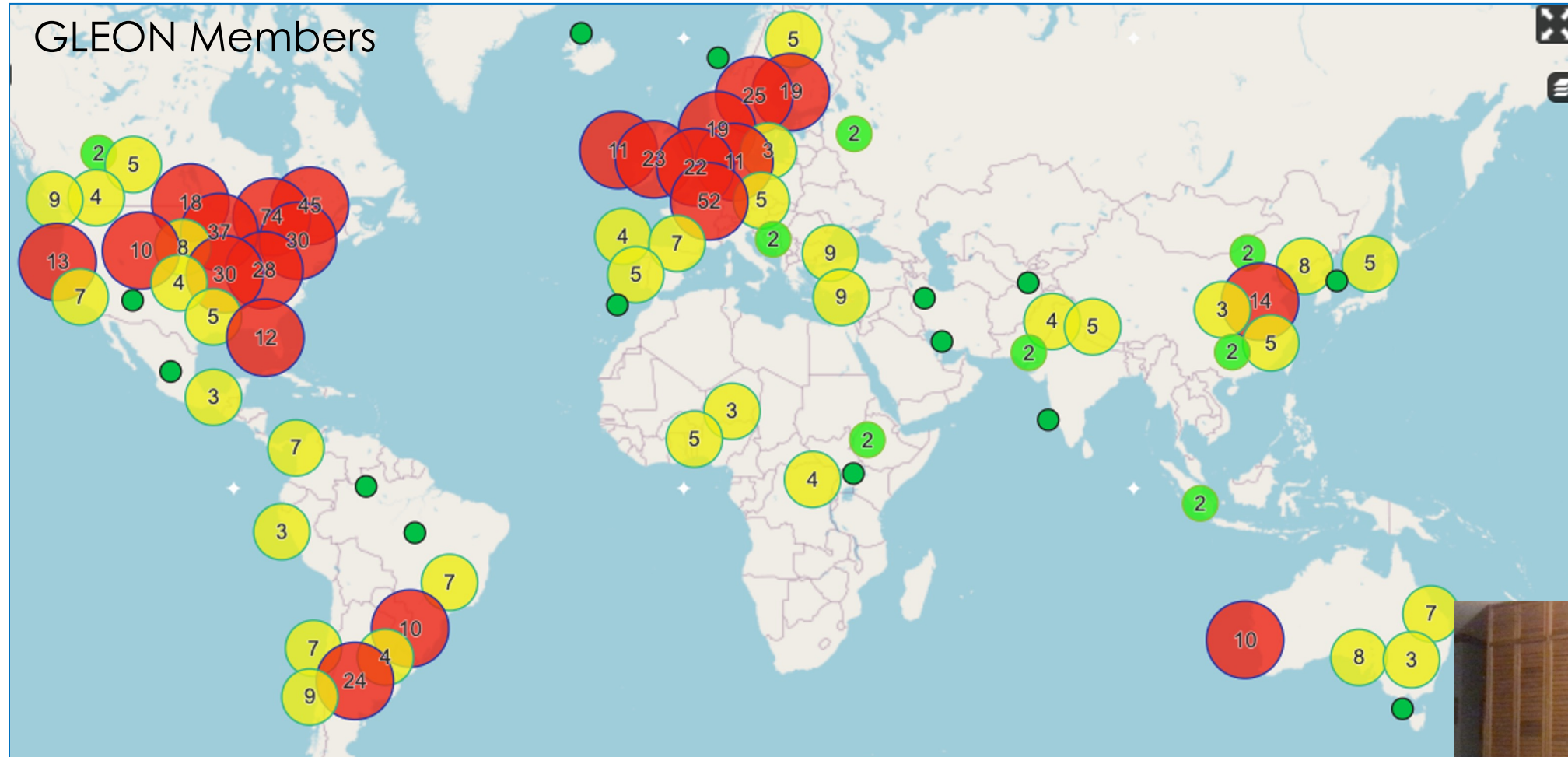
<sup>2</sup>University of Wisconsin Madison

<sup>3</sup>Cary Institute of Ecosystem Studies

<sup>4</sup>Plymouth Marine Laboratory



## ***Understand, Predict and Communicate the Role and Response of Lakes in a Changing Global Environment***



890 members represent 62 countries  
1/3 of members are graduate students







Yuan Yang Lake,  
Taiwan



Lake Annie, USA



Ormajärven,  
Finland



Lake Erken,  
Sweden



Crystal Bog, USA



Lake Sunapee, USA



Torrens Lake,  
Australia



Lake Rotorua,  
NZ



Lake Plomo,  
Chile

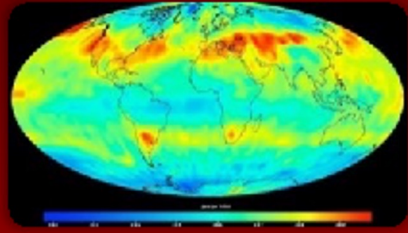




# Copernicus 2.0 – New Monitoring Missions

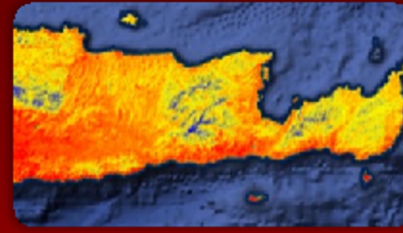


## Anthropogenic CO<sub>2</sub> Mon. Mission



Causes of  
Climate Change

## Land Surface Temperature Mission



Agriculture & Water  
Productivity

## CRISTAL – Polar Ice & Snow Topography



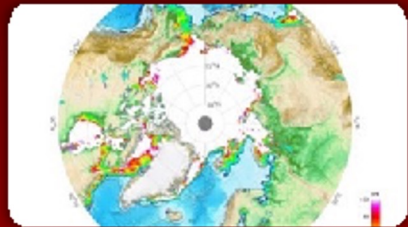
Effects of  
Climate Change

## CHIME – Hyperspectral Imaging Mission



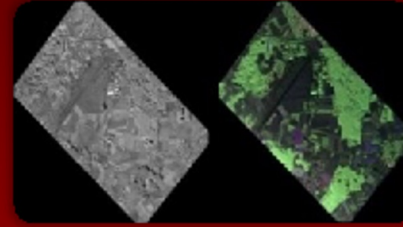
Food Security, Soil,  
Biodiversity

## CIMR – Passive Microwave Radiometer



Sea: Surface Temp.  
& Ice Concentration

## L-band SAR Mission



Vegetation &  
Ground Moisture





# Current Earth Observing Fleet

National Aeronautics and  
Space Administration



## EARTH FLEET

### INVEST/CUBESATS

- TEMPEST-D 2021
- CSIM-FD 2023
- HARP 2022
- CIRIS 2023
- CTIM\* 2022
- HYTI\* 2022
- SNOOPI\* 2022
- NACHOS\* 2022
- NACHOS2\* 2022

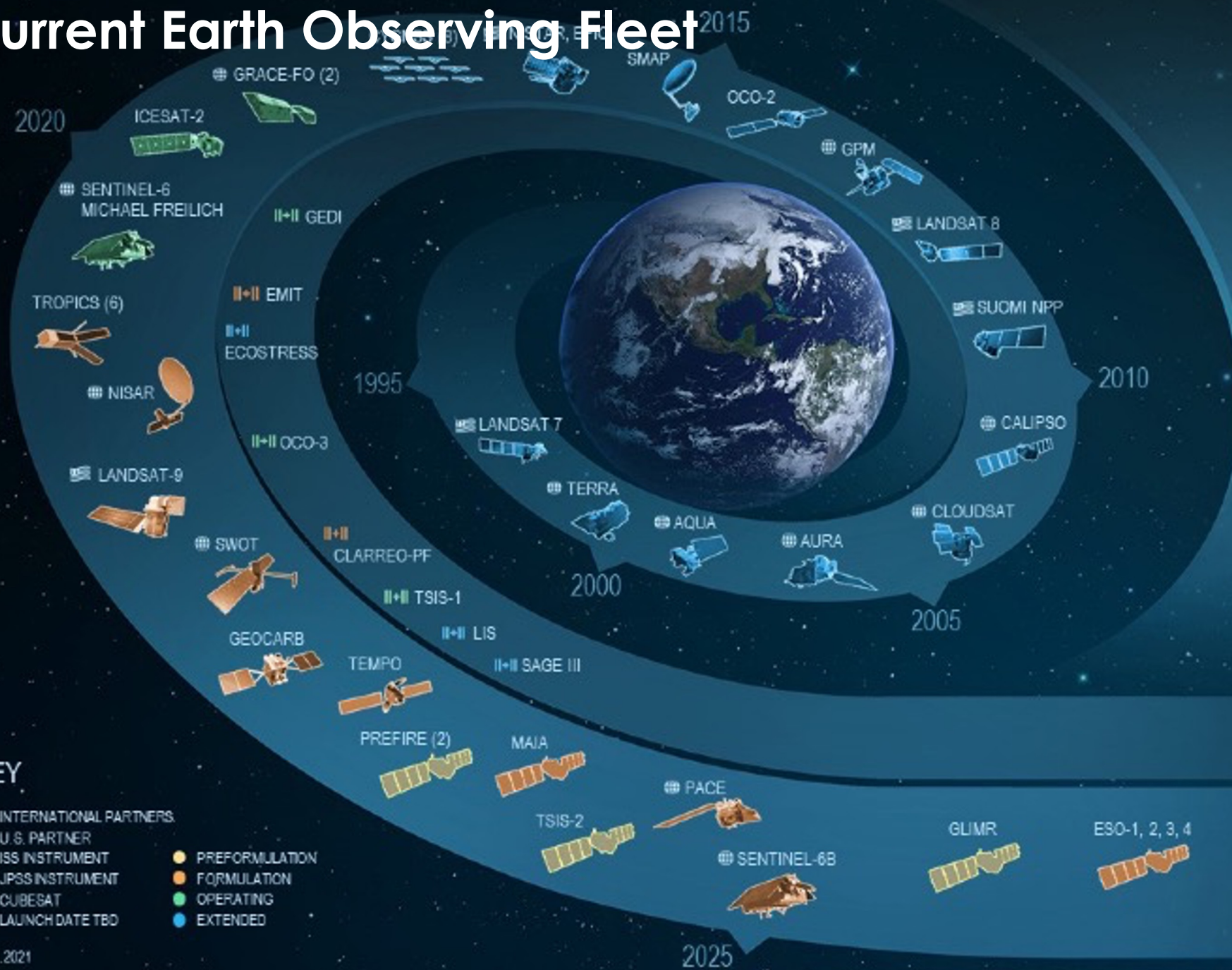
### JPSS INSTRUMENTS

- OMPS-LIMB 2022
- LIBERA 2027

### KEY

- INTERNATIONAL PARTNERS
- U.S. PARTNER
- ISS INSTRUMENT
- JPSS INSTRUMENT
- CUBESAT
- LAUNCH DATE TBD
- PREFORMULATION
- FORMULATION
- OPERATING
- EXTENDED

06.1.2021





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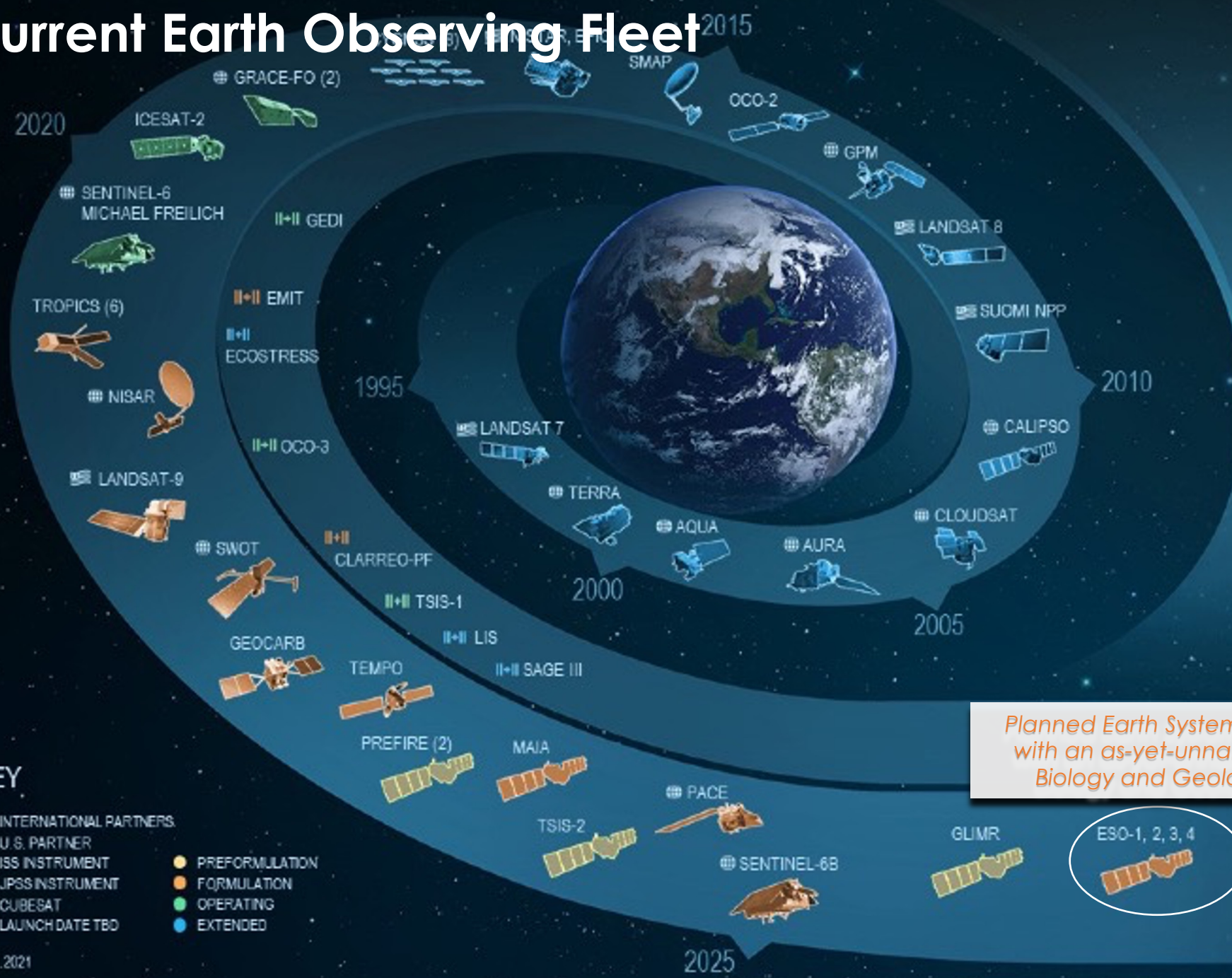
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Planned Earth System Observatory  
with an as-yet-unnamed Surface  
Biology and Geology mission

### ISS INSTRUMENTS





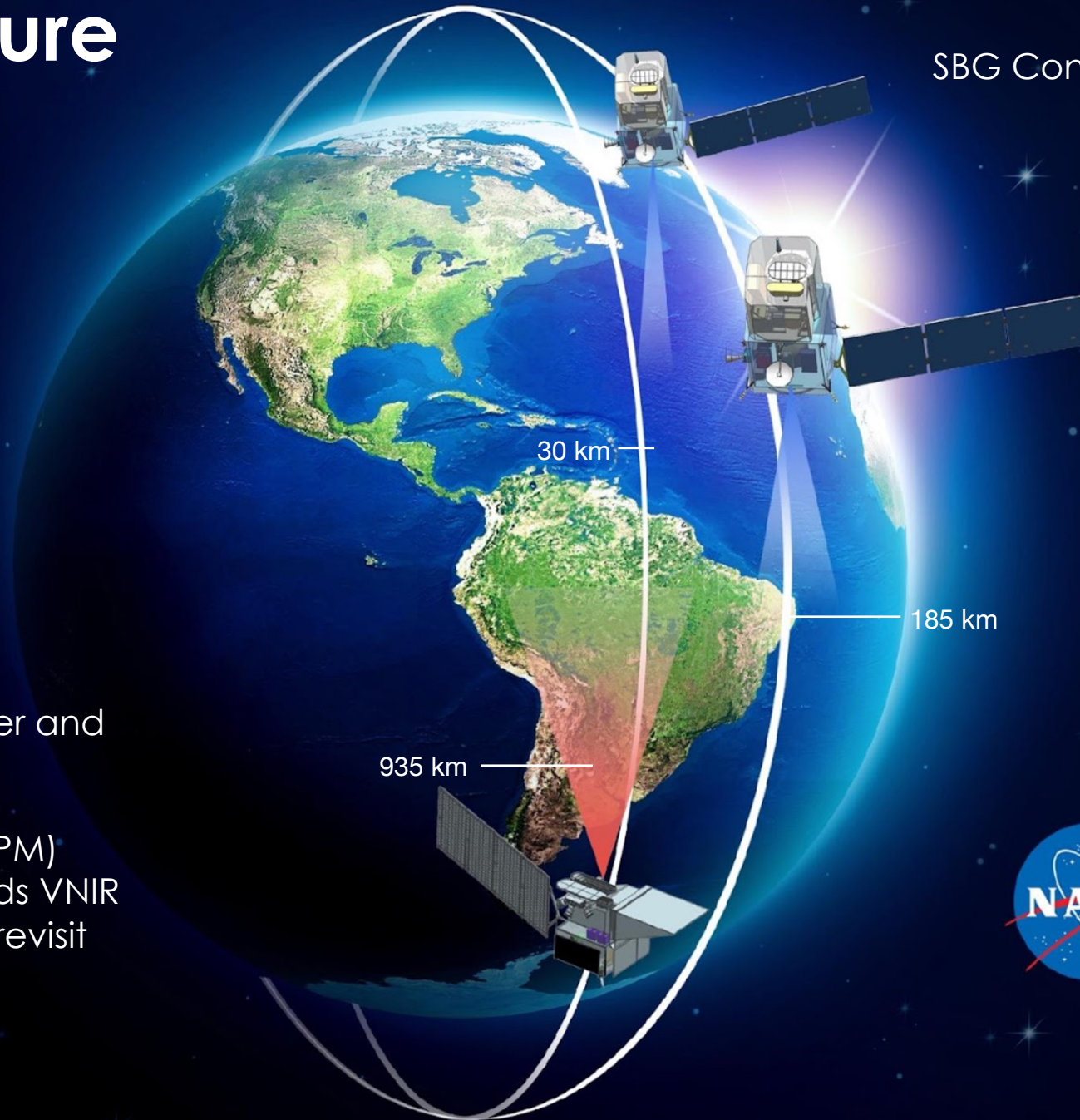
# SBG Architecture



## **SBG Heat**

Wide-swath TIR imager and  
ASI VNIR camera

Sun-sync orbit (early PM)  
5+ bands TIR, 2+ bands VNIR  
935 km swath, 3 day revisit  
60 meter GSD  
0.2K NeDT



SBG Constellation Pathfinder

## **SBG Light**

Wide-swath VSWIR  
spectrometer

Sun-sync orbit (late AM)  
185 km swath  
16 day revisit  
10 nm, 200+ bands  
30 meter GSD  
High SNR and  
radiometric  
performance





# SBG Applications : Water Resources Management

Community survey and valuation study with RTI: 560 unique respondents, 21 different communities

76% from federal government, academia

24% from NGO, private sector, state and local government

Algal Bloom and Water Quality										
Relative Importance to User	Capability									
	Spectral			Spatial		Temporal				
	VIS-NIR	SWIR	TIR	VSWIR	TIR	VSWIR	TIR	Coincidence	Sensitivity	Latency <sup>^</sup>
Hi	●		●	●	●	○			●	◐
Med		◐					◐	◐		
Low										
<b>Legend:</b> Users' assessment of the ability of an SBG capability to meet their needs in their priority applications: <div> <div>● Is a significant benefit addressing unmet need(s)</div> <div>◐ Is benefit that adequately meets need(s)</div> <div>○ Does not meet need(s) in some application(s)</div> <div>○ Does not meet need(s) in key applications</div> </div> <sup>^</sup> Latency <48 hrs. - only if matched with useful revisit rates										





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*Greatest opportunity: Inland/coastal water quality monitoring for health (importance to sector and dissatisfaction with current methods)*





# Water scenarios For Copernicus Exploitation (Water-ForCE)

**Abundance of data collection:**  
**Aquatic vegetation, production, light and nutrients**  
**Particulate / dissolved matter, colour**

Overall **relatively good analysis** of chlorophyll-*a*, water clarity, and nutrient concentrations measured in labs, but large gaps in biogeochemical variables.

*Formulate approach to improve bio-geochemical data collection.*

Overall **lack** of particle/dissolved optical properties, colour indices and reflectance components being collected

*Investigate in situ community support barriers, and pathways to enhance bio-optical data collection rates*

**water quality data users** (n=37)



Water-ForCE received funding from the European Union's Horizon 2020





# Data quality recommendations: location, resolution, precision

Sample transect measurements for sub-pixel and adjacency studies

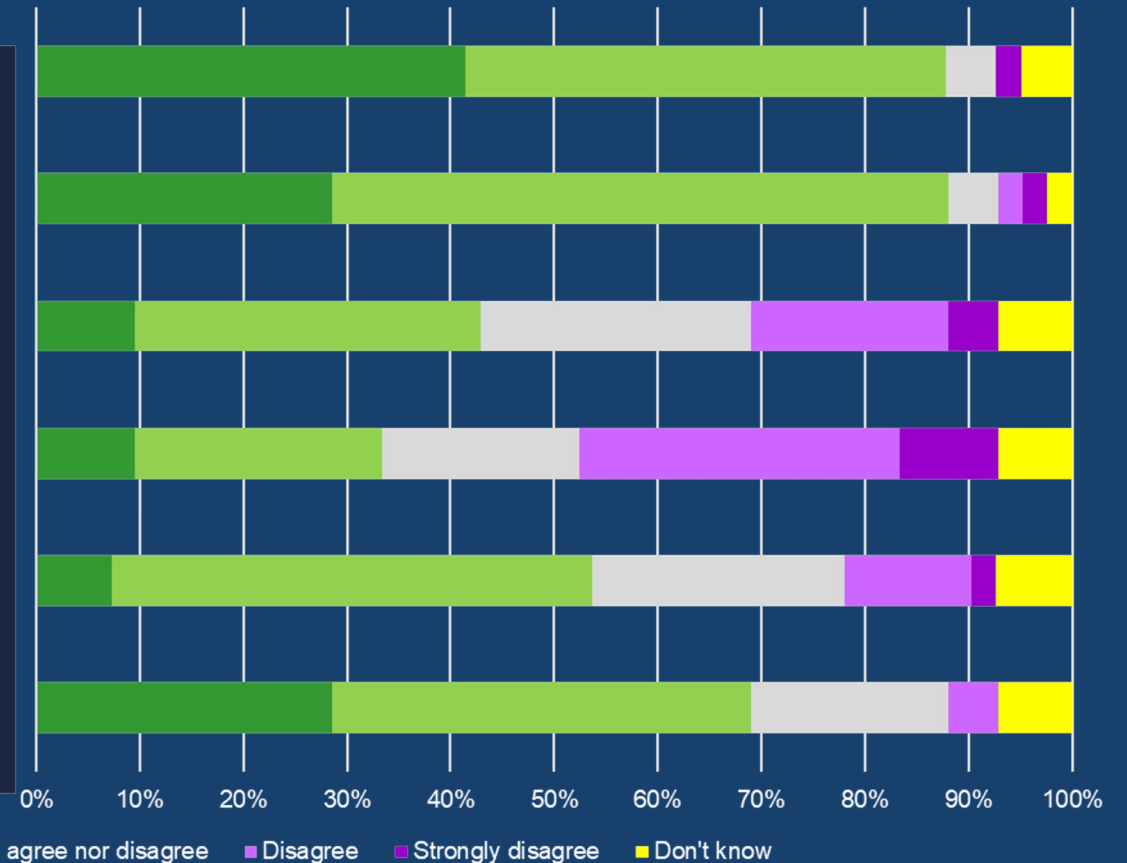
Sample stations which best represent the biogeochemistry of a water body

Sample stations with limited horizontal and temporal variability

Samples taken near shore are useful for satellite cal/val

Sampling for water quality cal/val should be >100m off-shore

Location precision should be better than satellite pixel location accuracy



(n=42)

Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree Don't know

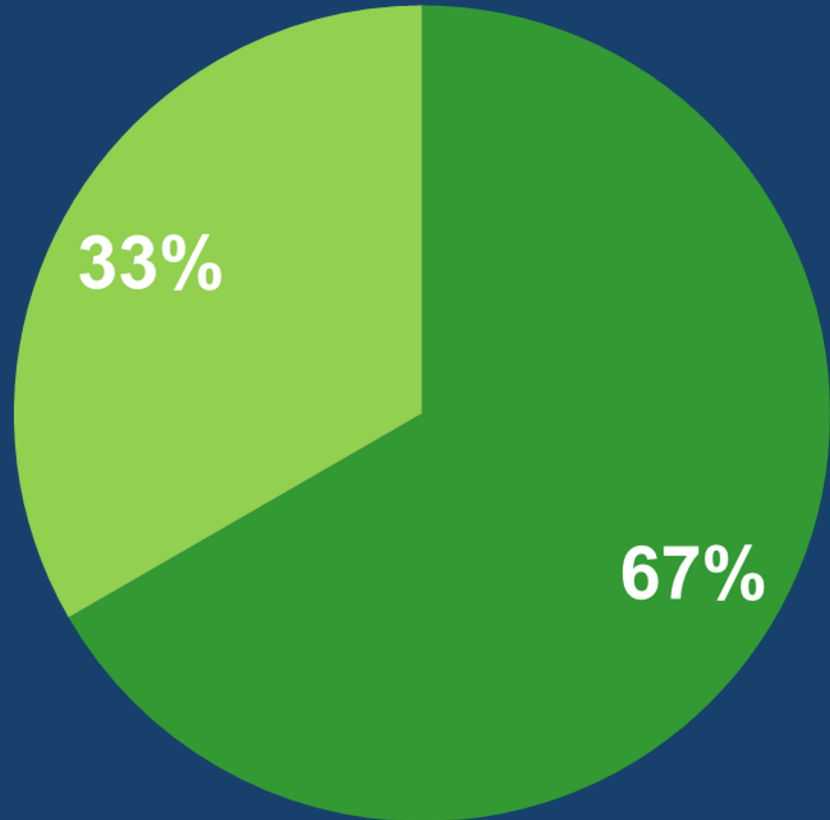
**General agreement** on precision, transect requirements and representativeness.

**Discuss:** benefits of including **stable (trend/baseline) vs variable (cal/val range) stations.**





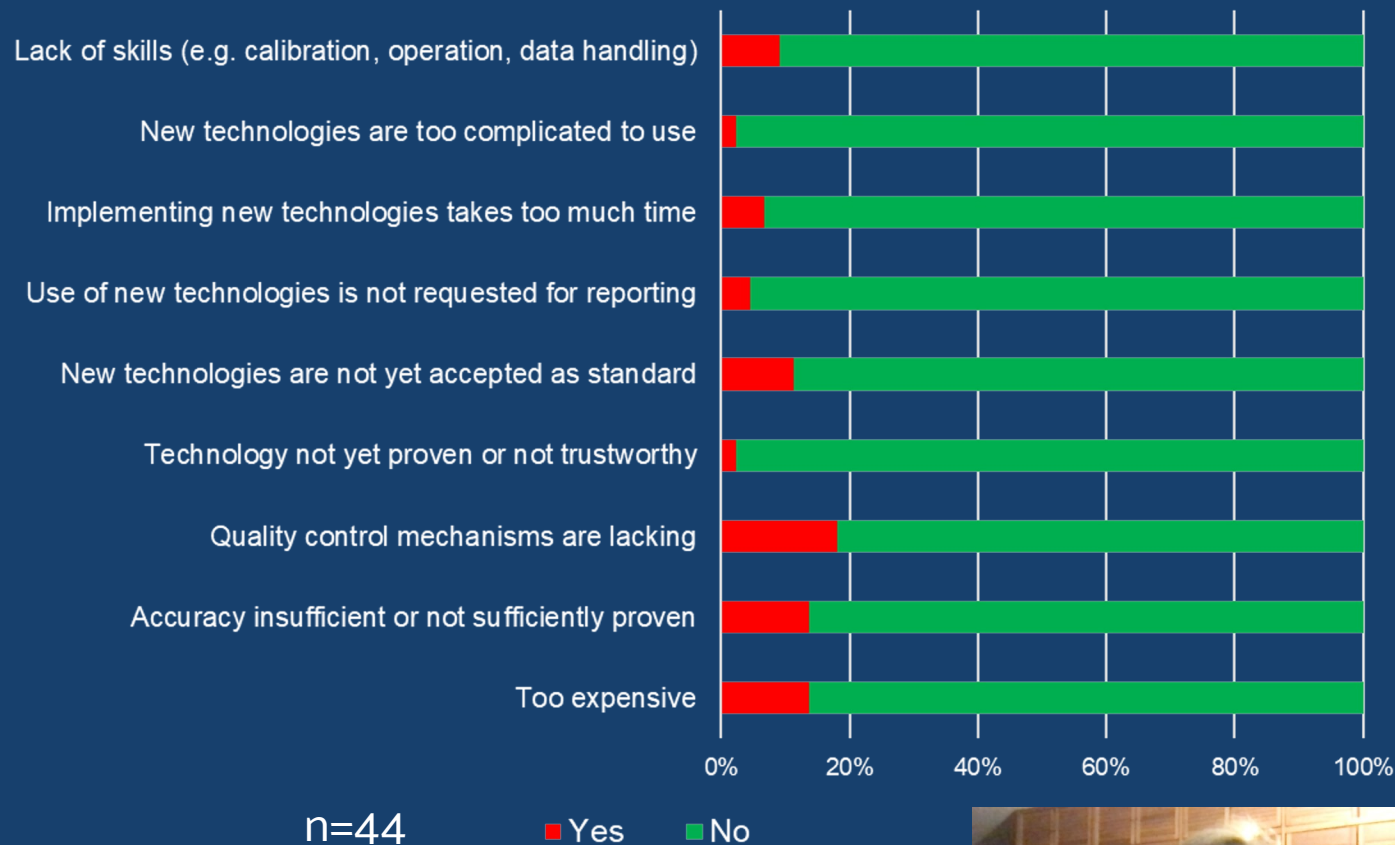
# Willingness to use emerging technologies, barriers to uptake



n=39

■ Definitely willing ■ Probably willing

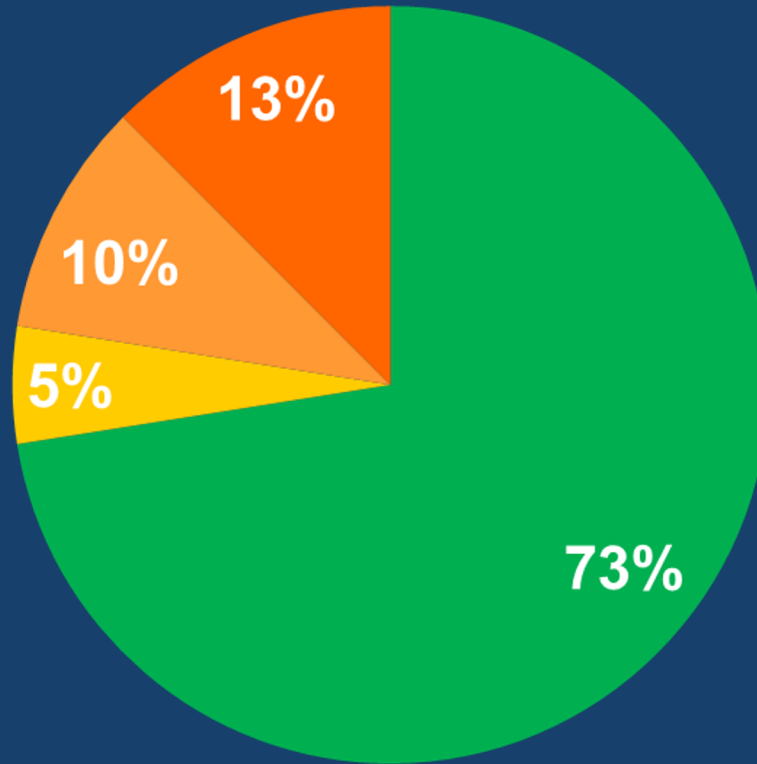
## Barriers to uptake





# Do you use spectroradiometers in your data collection?

n=40



■ Yes

■ No: too expensive

■ No: The data aren't used in my organisation

■ No: other reasons

Other reasons:

- Do not collect
- Plan to start the collection
- Radiometric data is collected by partners





# Objectives of Connection

Mutual interest to advance the science of lake ecosystem response to climate change

Explore socio-technological areas for collaboration: establishing a framework for sustained monitoring and data collection for satellite calibration/validation

Collaborate with complementary U.S. and international missions

Share data sets and methodologies, engaging the GLEON community around space-based observing challenges





# The GLEON Fellowship Program



**\*Cohort 5: Lake Expedition 2022\***  
Recruiting 10-12 graduate students

Network science  
Modeling  
Big data



## Why?

- Supporting science formulation for SBG
- Future of science includes collaboration
- Creates the transdisciplinary network needed for the science of remote sensing of inland lake water quality

## How?

- **Develop technical skills**  
Interpretation of satellite data and high frequency/complex database construction and synthesis, modeling
- **Create products**  
Open source models, publications, presentations
- **Learn, utilize leadership & collaborative skills**  
Facilitation, conflict mediation, network science
- **Engage GLEON and NASA Networks toward sustained observing for cal/val of satellite products**

Cohort 1, 2013  
*U.S. Water quality  
Lake metabolism*



Cohort 2, 2015  
*Carbon cycling  
Lake salt*



Cohort 3, 2017  
*Bayesian blooms*



Cohort 4,  
*Changing lake  
Machine learning*





## Additional information:

### Today 17:00-19:00:

H45S-1404 - Connecting Lake Observatories to Space-Based Missions: Global Lake Ecological Observatory Network (GLEON), NASA Surface Biology and Geology (SBG), and the Environmental Data Initiative (EDI)

*Convention Center - Poster Hall, D-F and online*

NASA Surface Biology and Geology (SBG) - <https://sbg.jpl.nasa.gov/>

EU Water scenarios For Copernicus Exploitation (Water-ForCE) - <https://waterforce.eu/>

Global Lake Ecological Observatory Network - <https://gleon.org/>

## References:

Schollaert Uz, S., T. Culver, J. Luvall, C. Lee, D. Lapidus, M. Gallaher, (in revision), Assessing the Applications Potential of a NASA SBG Mission through a User Needs Valuation Study: Key Points and Lessons Learned. *Journal of Geophys. Res. Biogeosciences*

Simis, S.G.H., Horsburgh, N., Walker, P., Ogashawara, I., Cillero, C. (2021). Survey response of the H2020 Water-ForCE expert meeting on: In situ calibration and validation of satellite products of water quality and hydrology. doi: 10.5281/zenodo.5119010

