Connecting Space-Based Missions to Existing Communities: NASA Surface Biology and Geology (SBG), EU-Copernicus and the Global Lake Ecological Observatory Network (GLEON)

Stephanie Schollaert Uz[1], Paul Hanson[2], Kathleen Weathers[3], Benjamin Poulter[4], and Stefan Simis[5]

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Abstract

Global environmental science challenges in the limnological research and applications communities can only be advanced when harnessing the collective expertise and capabilities of the satellite remote sensing community and well-established in situ communities such as the Global Lake Ecological Observatory Network (GLEON). At first glance, the groups seem wildly divergent: GLEON is a grass-roots effort which has been active since 2005 and connects researchers and practitioners from around the world to ask and answer questions about lake ecosystems. Earth observing missions can take a decade to plan, build, and launch. NASA and ESA have different missions as space agencies: one primarily focused on exploration and basic research with a year-to-year appropriations cycle, while the other presents a long-term commitment to address societal needs through the Copernicus program Sentinel satellite series. The Surface Biology and Geology (SBG) mission is a future NASA satellite that will launch toward the end of this decade as part of the Earth Systems Observatory. Working together to advance the science of lake ecosystem response to climate change, each group brings different complementary strengths and assets to this societal challenge. Increasing access through open science and cloud computing are creating opportunities for better collaboration. We describe our strategy for international engagement between these groups – cultural and methodological differences aside – to derive new information, learn new insights, and expand the body of knowledge around these unique natural resources.

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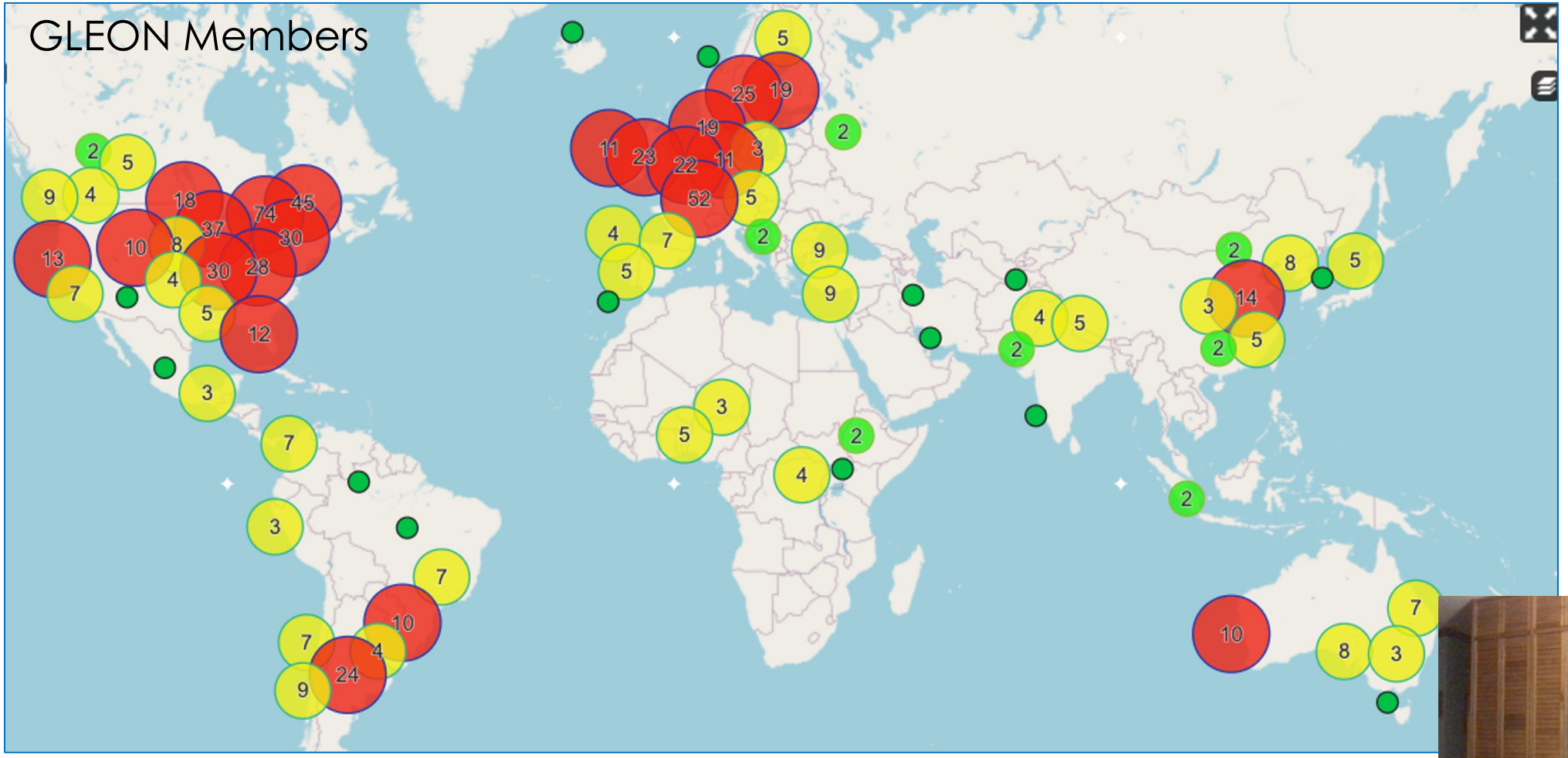
Understand, Predict and Communicate the Role and Response of Lakes in a Changing Global Environment



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


Yuan Yang Lake,
Taiwan


Lake Annie, USA


Ormajärven,
Finland

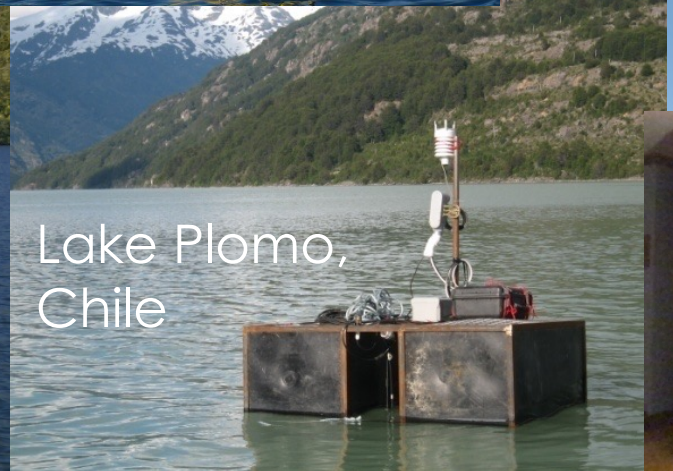

Lake Erken,
Sweden


Crystal Bog, USA


Lake Sunapee, USA
LSPA


Torrens Lake,
Australia

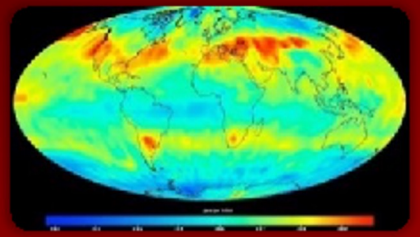

Lake Rotorua,
NZ


Lake Plomo,
Chile

Copernicus 2.0 – New Monitoring Missions

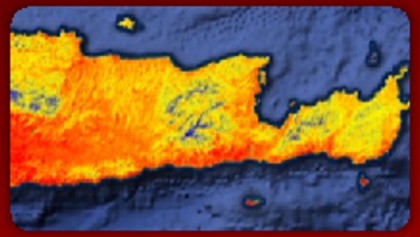
esa

Anthropogenic CO_2 Mon. Mission



Causes of Climate Change

Land Surface Temperature Mission



Agriculture & Water Productivity

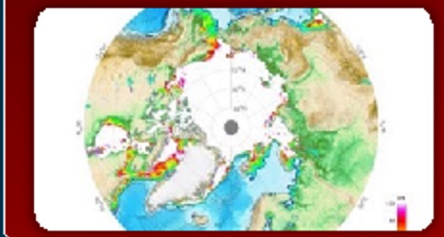
CRISTAL – Polar Ice & Snow Topography

Effects of Climate Change

CHIME – Hyperspectral Imaging Mission

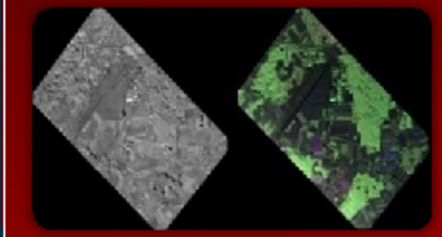
Food Security, Soil, Biodiversity

CIMR – Passive Microwave Radiometer



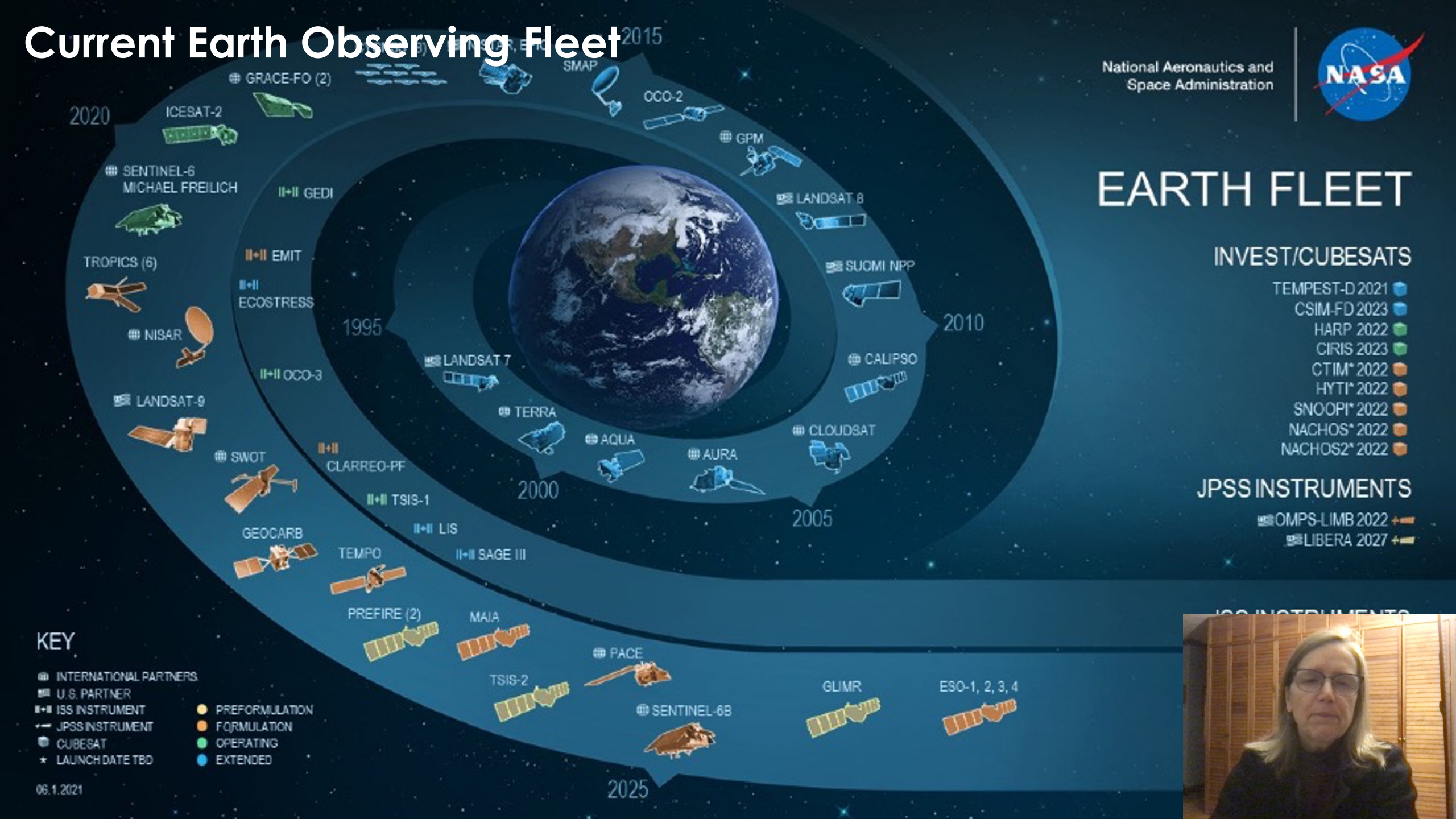
Sea: Surface Temp. & Ice Concentration

L-band SAR Mission



Vegetation & Ground M Moisture

Current Earth Observing Fleet



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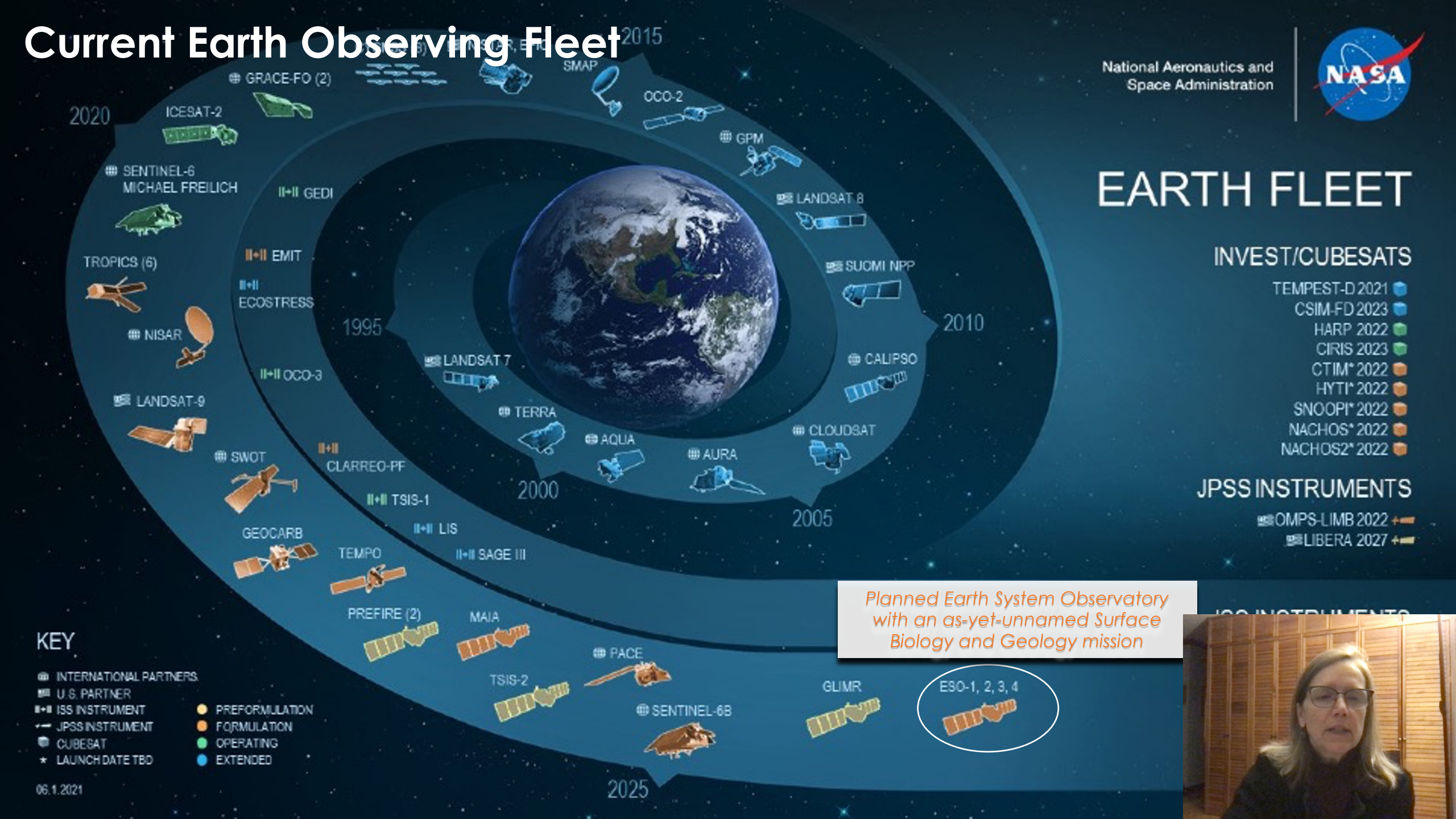
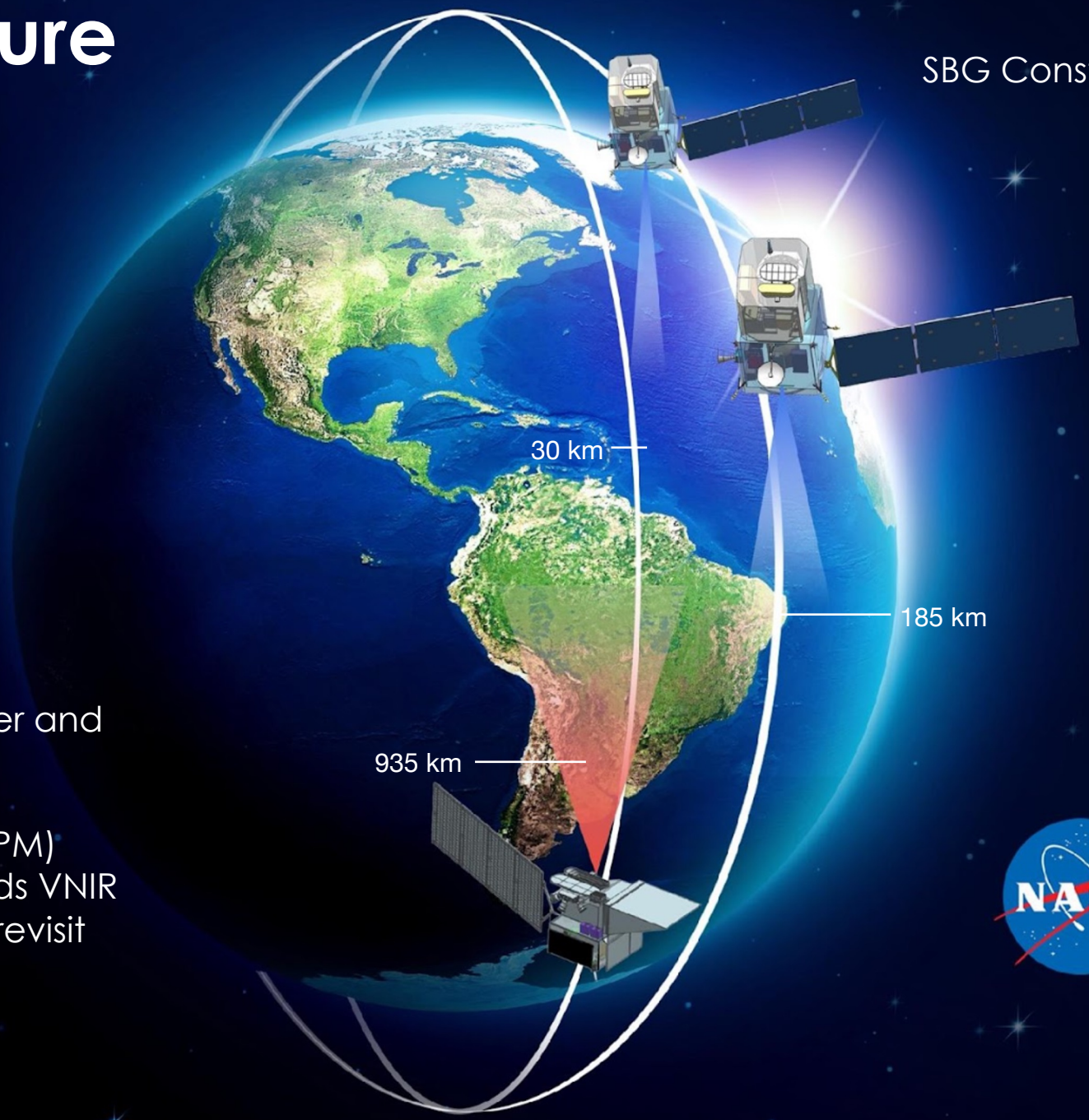


SBG Architecture

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 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 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^
Hi	●		●	●	●	○			●	◕
Med		◕					◔	◕		
Low										

Legend: Users' assessment of the ability of an SBG capability to meet their needs in their priority applications:

- ● Is a significant benefit addressing unmet need(s)
- ◕ Is benefit that adequately meets need(s)
- ◔ Does not meet need(s) in some application(s)
- ○ Does not meet need(s) in key applications

^ 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.

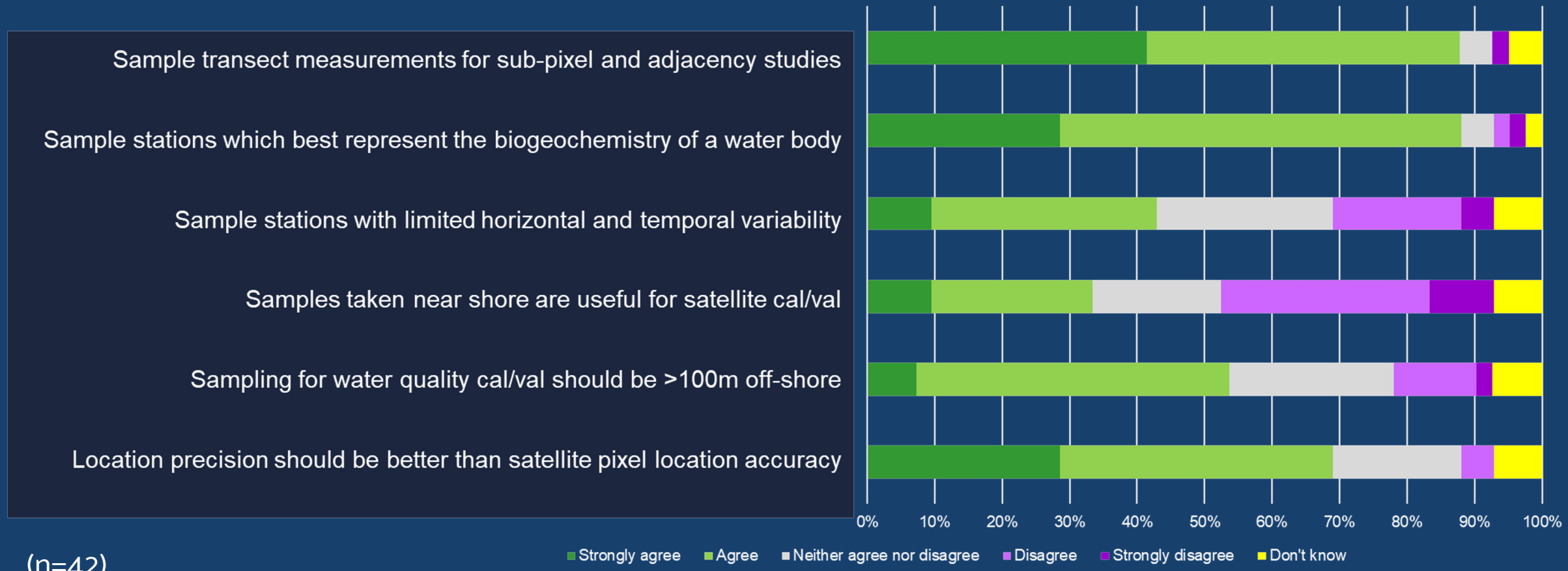
Overall **lack** of particle/dissolved optical properties, colour indices and reflectance components being collected

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

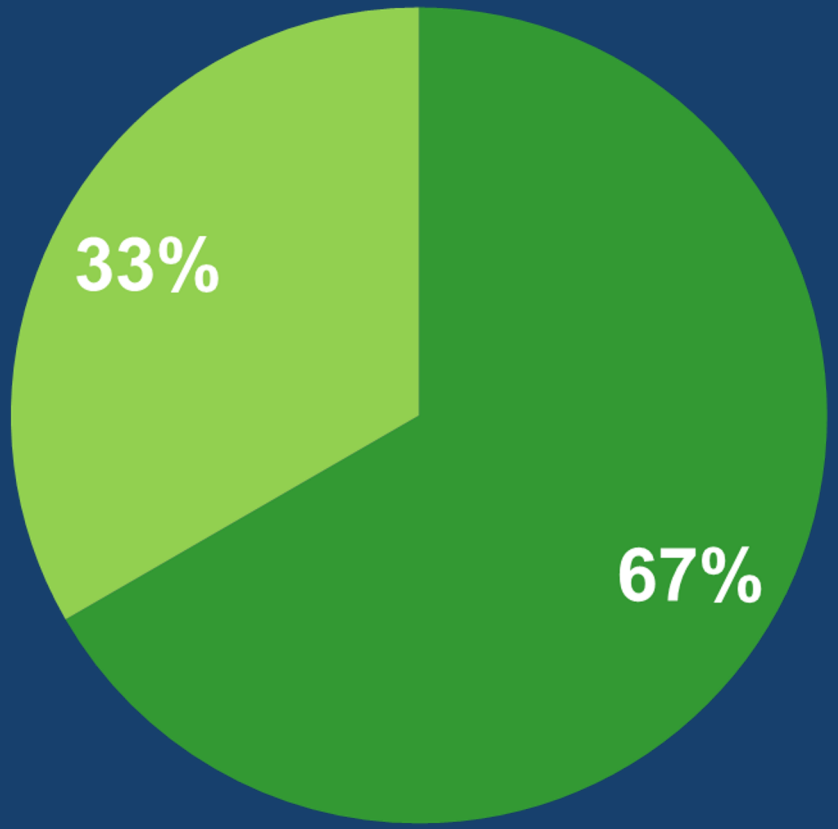


(n=42)

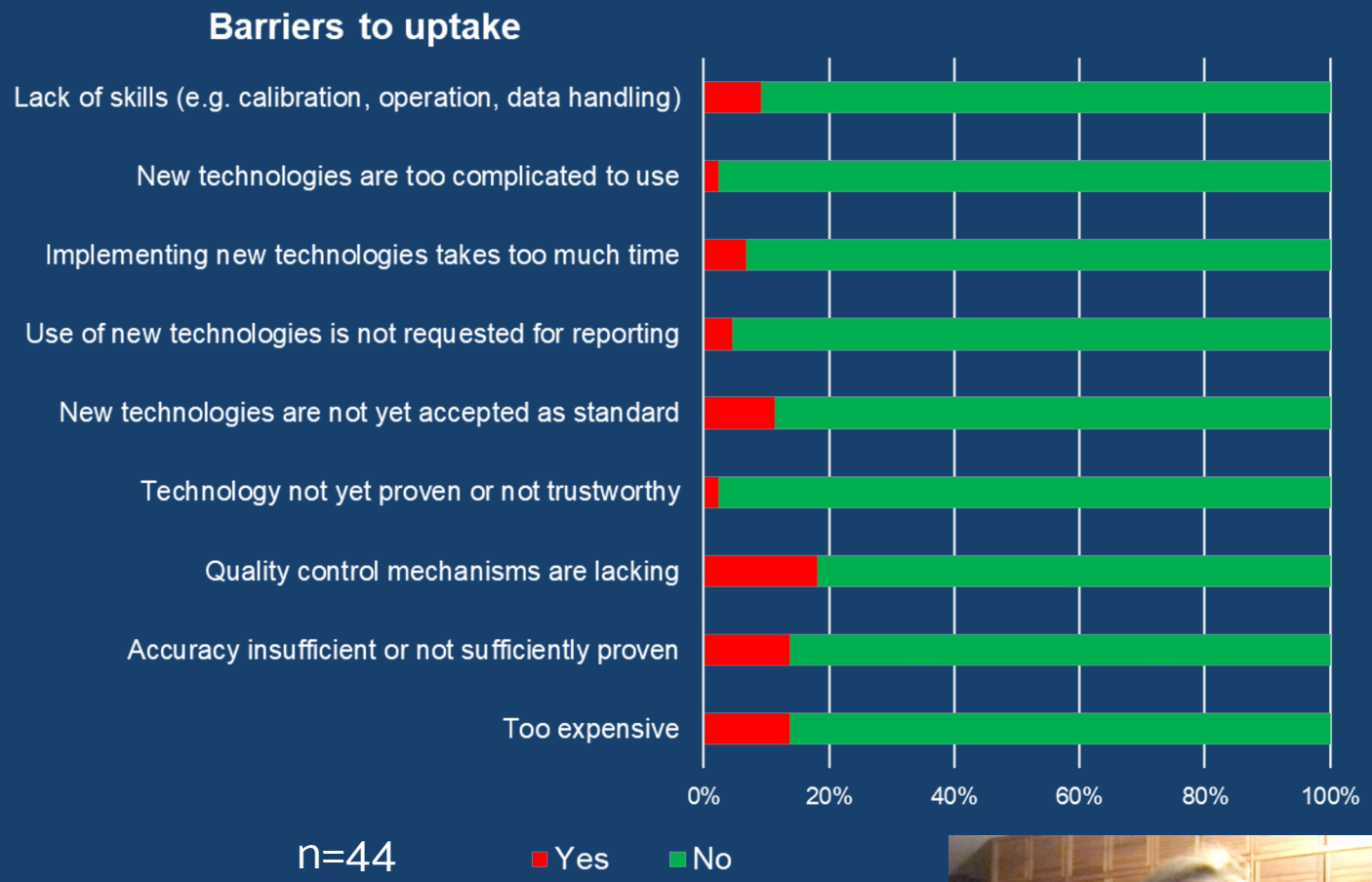
General agreement on precision, transect requirements and representativeness.

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

Willingness to use emerging technologies, barriers to uptake



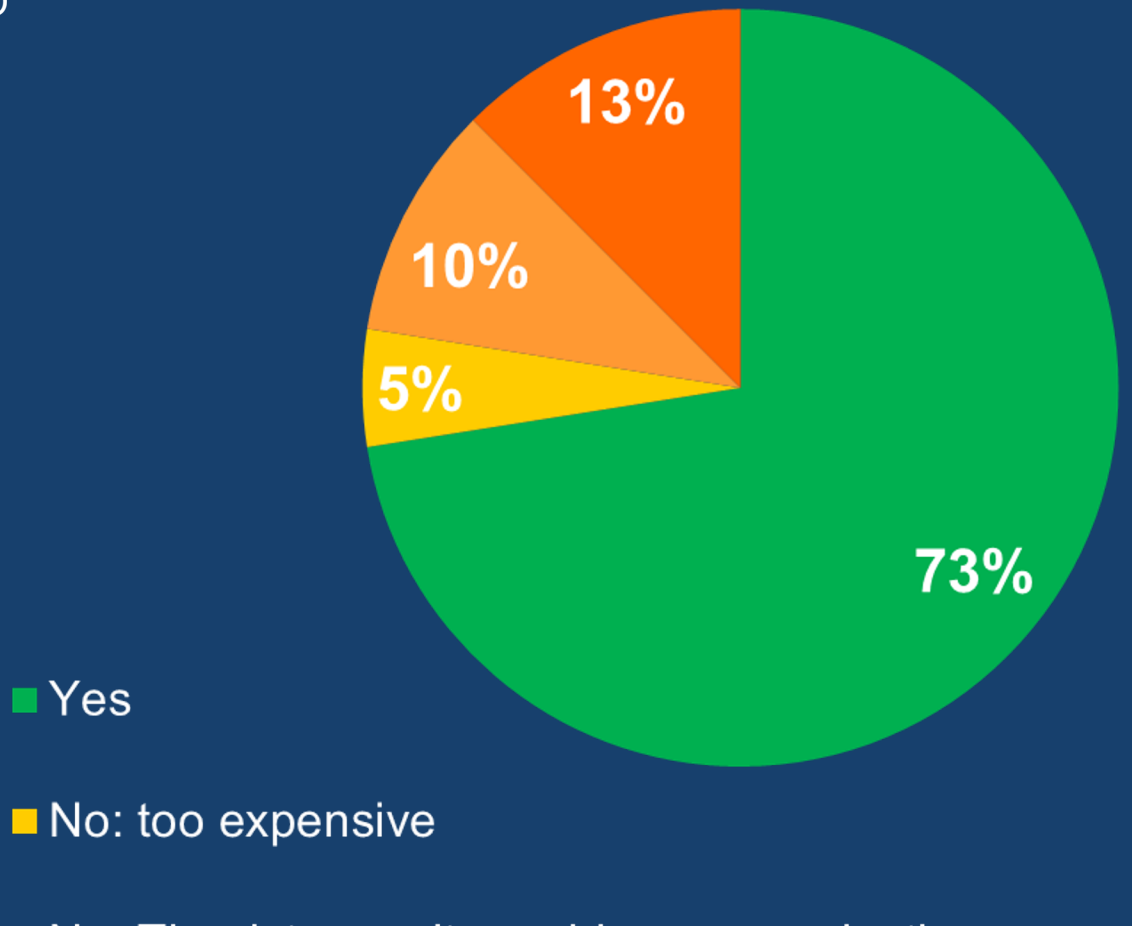
n=39 ■ Definitely willing ■ Probably willing



n=44 ■ Yes ■ No

Do you use spectroradiometers in your data collection?

n=40



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

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

Cohort 2, 2015
Carbon cycling
Lake salt

Cohort 3, 2017
Bayesian blooms

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 4,
Changing lake
Machine le

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