

# 2<sup>nd</sup> Workshop on International Cooperation in Spaceborne Imaging Spectroscopy

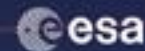
19–21 October 2022 | La Collinetta Eventi, Frascati IT



## Imaging Spectroscopy Missions from Space - Cooperation, Requirements and Opportunities since Frascati 2019

J. Adams, V. Boccia, M. Celesti, J. Dozier, S. Förster, A. Gabriele, F. Gascon, R. Green, K. Cawse-Nicholson, J. Masek, K. Miner, J. Nastal, C. Miller, J. Nieke, B. Poulter, D. Schimel, A. Sen, D. Thompson, K. Thome, P. Townsend, M. Rast





## → IMAGING SPECTROSCOPY – COOPERATION IN SPACE

From Hyperion & CHRIS via PRISMA & EnMAP to SBG & CHIME



9-11 July 2019 | ESA-ESRDM | Frascati (Rome), Italy

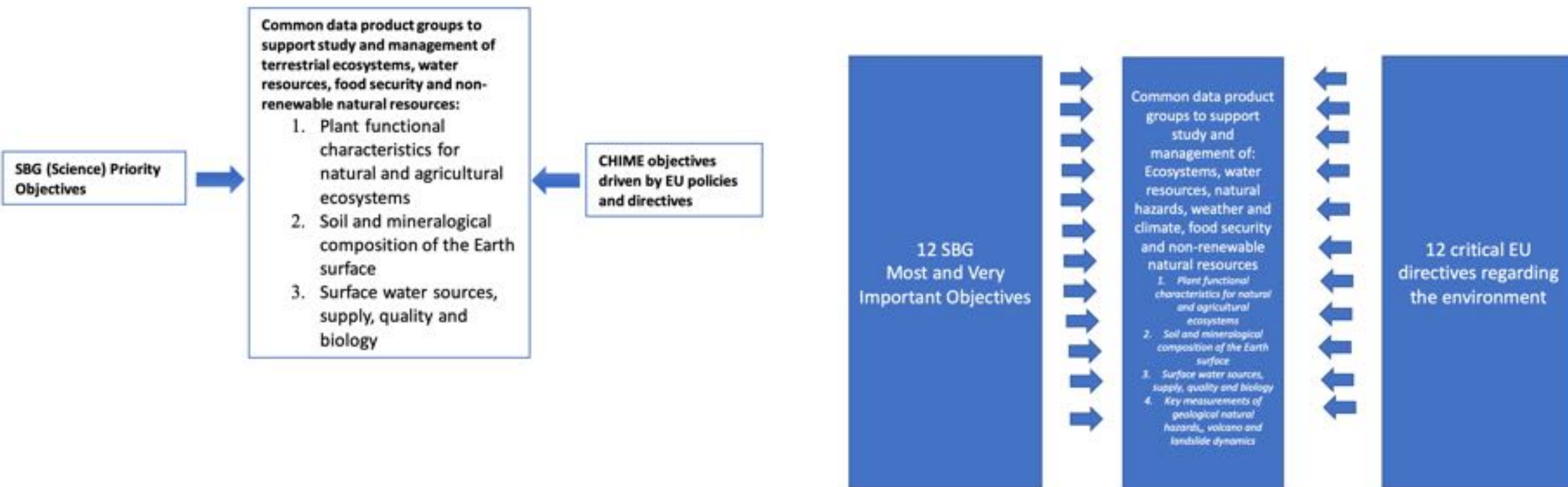


The first Roadmap - a 'white paper'

### Recommendations for SBG-CHIME Cooperation

A workshop on **International Cooperation in Spaceborne Imaging Spectroscopy** was held July 9-11 at Frascati, hosted by ESA and organized by an international programme committee. The workshop convened experts in Imaging Spectroscopy from Space to chart a roadmap supporting the harmonization of practices and procedures. The vision is to deliver seamless and quality assured global imaging spectroscopy data describing state and quantities of the Earth System – focusing on terrestrial, coastal and inland aquatic regions – to the Earth Observing (EO) community and related service providers.

### SBG and CHIME converge on a common set of core data products despite different driving directives





# Recommendations from the Frascati Workshop 2019

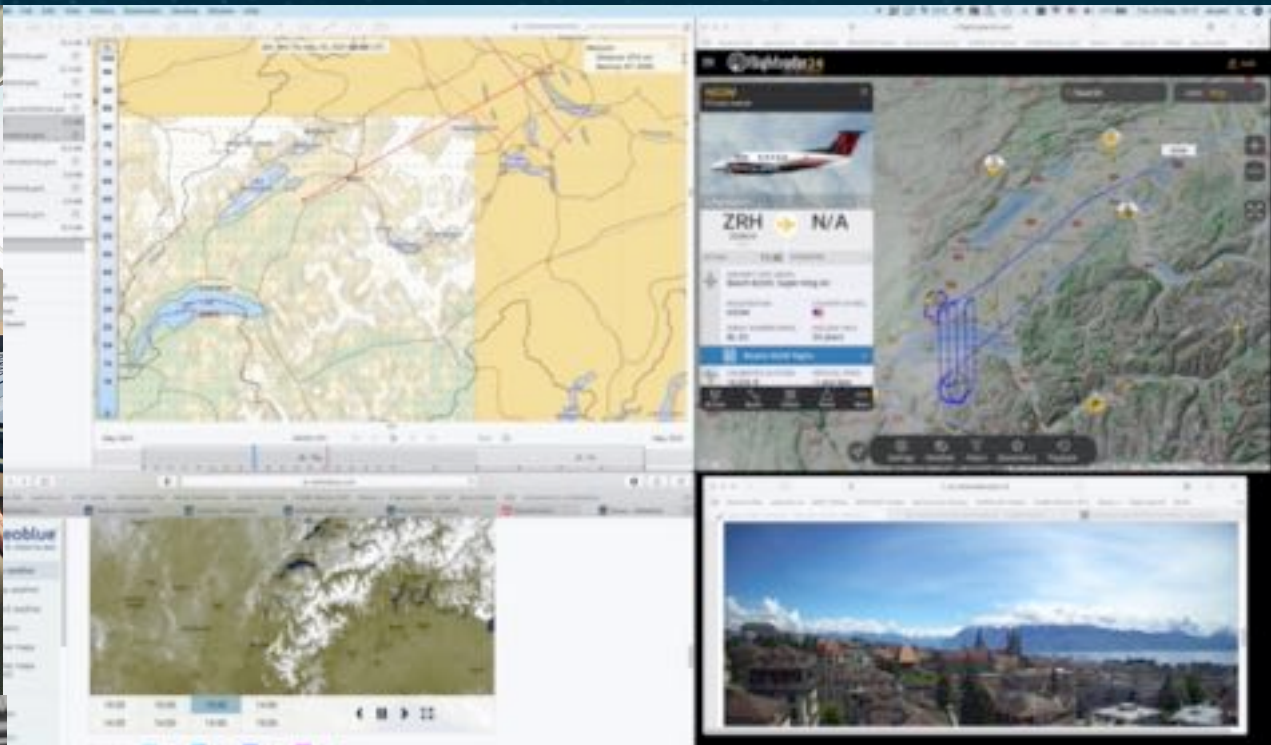
**These challenging needs can be more fully met by an international constellation than by any single observing system.**

We recommend that NASA and ESA evaluate the opportunities for SBG - CHIME coordination through pre-Phase A collaborative studies to:

- Identifying and defining **key data products** essential for the mission requirements for both concepts.
- Performing **end-to-end mission simulations**, which allow development teams to understand the basis of each system's traceability, objectives and technical performance capabilities and constraints, and using the complementary systems developed by each team.
- Reviewing the **impact of orbit decisions on interoperability** and cross-calibration.
- Planning a **joint airborne campaign** to simulate both missions and exercise the capabilities needed for eventual interoperability (incl. data collection, calibration, data product production) beginning in 2020.
- Reviewing existing and **innovative atmospheric correction** schemes as a common understanding of atmospheric correction, which is essential to data integration across platforms.
- Examining and prototyping common **ground data system elements needed for interoperability**, in the anticipated Big Data environment (Tb/day), as well as investigating the fusion of hyperspectral products with other needed synergistic / coordinated data products to produce the information optimal for addressing NASA and ESA's needs.
- Identifying other **opportunities for efficiency** and success through cooperation on calibration and validation, downlink capabilities and shared algorithms (e.g. compression and on-board data reduction).

**The goal of these studies is to establish the basis for interoperability of imaging spectrometers in space for the demanding applications called for on both sides.**

# 'Hypersense' Campaign with AVIRIS-NG in 2021



[https://ares-observatory.ch/esa\\_chime\\_mission\\_2021/](https://ares-observatory.ch/esa_chime_mission_2021/)  
[https://twitter.com/AVIRIS\\_NG\\_RSL](https://twitter.com/AVIRIS_NG_RSL)

- Demonstrate key algorithms (Ecosystems, Agriculture, Soils, Geology, Hazards, Snow/Ice, etc.) for the science and applications objectives of CHIME and SBG.
- Collect a diverse set of large data sets in Europe that can be used in preparation for CHIME and SBG (e.g. Western Diversity Time Series, California).
- Test and evaluate new state-of-the-art science algorithms: atmospheric correction, etc.
- Grow international science collaboration in support of ESA CHIME and NASA SBG.
- Test/Demonstrate calibration, validation, and uncertainty quantification approaches.
- Strategic cross comparison under flights of space missions: DESIS, PRISMA, Sentinels, etc.



# 12th EARSeL Workshop on Imaging Spectroscopy in Potsdam



**Round Table:** Marco Celesti (ESA), Patrick Hostert (HU Berlin), Inge Jonckheere (FAO), Godela Rossner (DLR), Phil Townsend (UW Madison)

- Where will we stand in **2030 in terms of data, models, products and harmonisation** internationally?
- What are major challenges also in the area of **practices and procedures, including traceability and quality assurance**?
- What are promising avenues of international collaboration on the way **towards 'Global Spectroscopy'**?
- What key applications or **questions related to science and policy** could imaging spectroscopy contribute to/unlock by 2030"



# Where will we stand in 2030 in terms of data, models, products and harmonisation internationally?

- First EARSel Workshop with **open spaceborne IS data available**; by 2030 global IS missions expected in space, way prepared by Prisma, EnMAP and others
- **Intensification in international collaboration** in various fields expected
- Spaceborne multi- and hyperspectral observations expected **from niche to mainstream**
- Data mainly in cloud systems with **fully integrated multi-sensor data**
- **Open source** w.r.t. tools, resources, data for wider community
- Variety variable retrieval algorithms to choose from
- On-demand processing
- Increasing harmonization and coordination of tools
- **Long time series** will be key

## Discussion:

- Role of commercial sector in IS field?
  - Need for actors to be brought together, and open discussions with the commercial sector
  - Starting commercial investments in IS in terms of services but also development of small hyperspectral satellites





What are major challenges also in the area of practices and procedures, including traceability and quality assurance?

- Need common ways to trace uncertainty of data
- Reproducibility: provide all data (incl. metadata) and code needed to reproduce results
- Need for better use of existing funding schemes and funding continuity; currently large funding gap for bringing scientific product to operational level
- Need to reach out to developing countries - end users
- Bring more policy people in science conferences, crucial to have stronger linkages between science and policy
- Need for in-situ data sharing mechanisms

Discussion:

- Challenges in reproducibility: Funding gap, commercial sector is taking up



## What are promising avenues of international collaboration on the way towards 'Global Spectroscopy'?

Workshop on Imaging Spectroscopy  
Potsdam



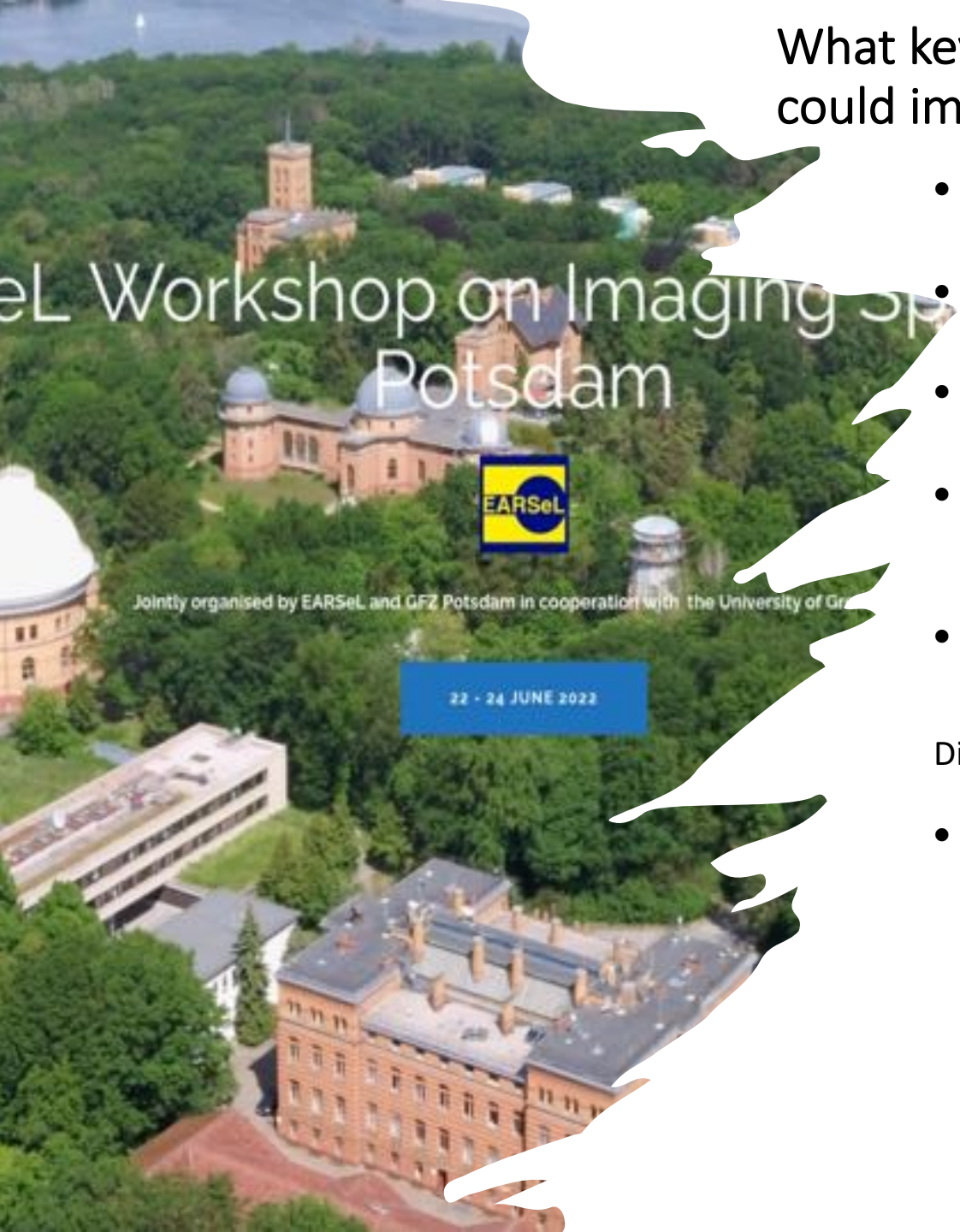
Jointly organised by EARSeL and GFZ Potsdam in cooperation with the University of Göttingen

22 - 24 JUNE 2022

- Need strong science team(s) across missions that bridges gap to policy and application sector
- Established successful example: Landsat-8/S-2 role model for CHIME/SBG
- Harmonization SBG/CHIME ongoing and started very early. Further community support/pressure needed.
- Better 'reach out' to end users needed (stakeholder meetings?)
- Streamline funding streams, avoid duplication
- Use existing funding streams towards downstream users and user exploitation (incl. commercial sector). Push for better user preparation.
- Open up discussion and data (increasingly open data policy)

### Discussion

- Continued/further harmonization needed
- Large user fraction interested in products only (not how they were generated)



## What key applications or questions related to science and policy could imaging spectroscopy contribute to/unlock by 2030” ?

- By 2030 IS will contribute to large extent, **interlinkages between ecosystems** and processes towards sustainable resource use better understood
- **Need** to look more towards **process understanding** and Earth’s response to climate change (both mitigation and adaptation)
- IS will reach sufficient maturity by 2030, open for **multi-mission, multi-domain approaches**
- **Basic research still required** as basis for development of operational products. Operational products are key, as well as a “marriage” between science and stakeholders
- Wall to wall observations, **early warning systems** and **time series** analysis will be standard

### Discussion:

- What is the contribution of IS for climate adaptation and mitigation given that it is more than likely that we will miss the 2015 Paris agreement?
  - Need to focus on this topic and the derivation of relevant variables
  - Not only climate crisis, but also **biodiversity crisis** and environmental pollution
  - Need to **better quantify carbon, nitrogen, methane** (from vegetation, soil, oceans)
  - Need for smoother transfer of findings from science to operation





# CHIME – SBG collaboration opportunity in a nutshell



## Programmatics

How to implement the collaboration

Working Groups on Cal/Val, Product Harmonisation and Modelling/e2e Simulation

Identify added value to Decadal Survey and EO programmes

Harmonisation of Practices and procedures for coordinated operations and exploitation

## Science Goals

Decadal Survey

ESA Living Planet Strategy

CHIME Sust. Agri./Food security

## Applications and services

Copernicus Services

EU Directives/Policies/Green Deal

NOAA, USGS, US EPA, USDA

## Improved Observations

Revisit

Coverage

Continuity

Core and Priority Products

Atmospheric Correction

Information Content (ATBD/algorithm development)

## Implementation

Orbit definition

Tandem flight manoeuvres

Schedule

Joint Campaigns

End-to-End Simulator/Observation Simulation System Experiments

Common ground data system elements

A decorative border on the left and bottom of the slide, composed of a grid of colorful puzzle pieces. The pieces feature various scientific and space-related images, including galaxies, planets, and abstract patterns. The border is thicker on the left side and tapers off towards the bottom right.

**Thank you for your attention**

[www.issibern.ch](http://www.issibern.ch)