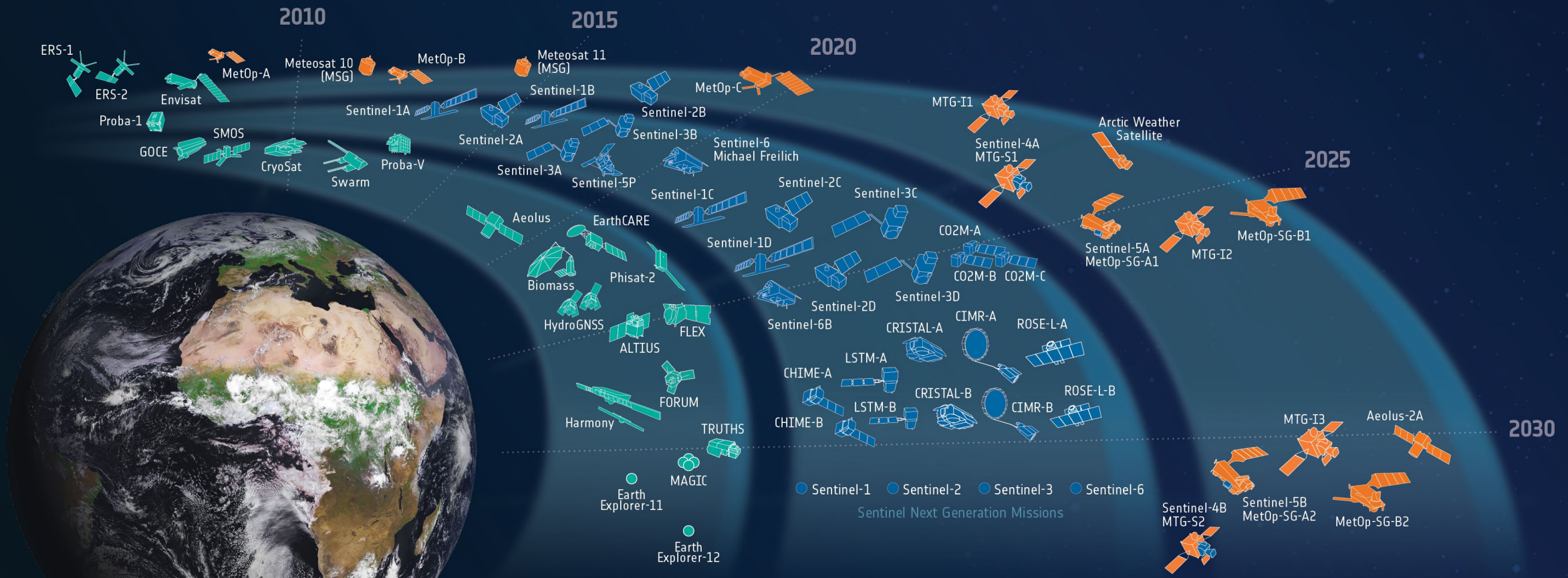


Eyes On Biodiversity: ESA's Future Optical Earth Observation Missions

Marco Celesti, Paolo Cipollini, Benjamin Koetz, Simon Proud

11/02/2025

ESA-developed Earth Observation Missions



Science



Copernicus

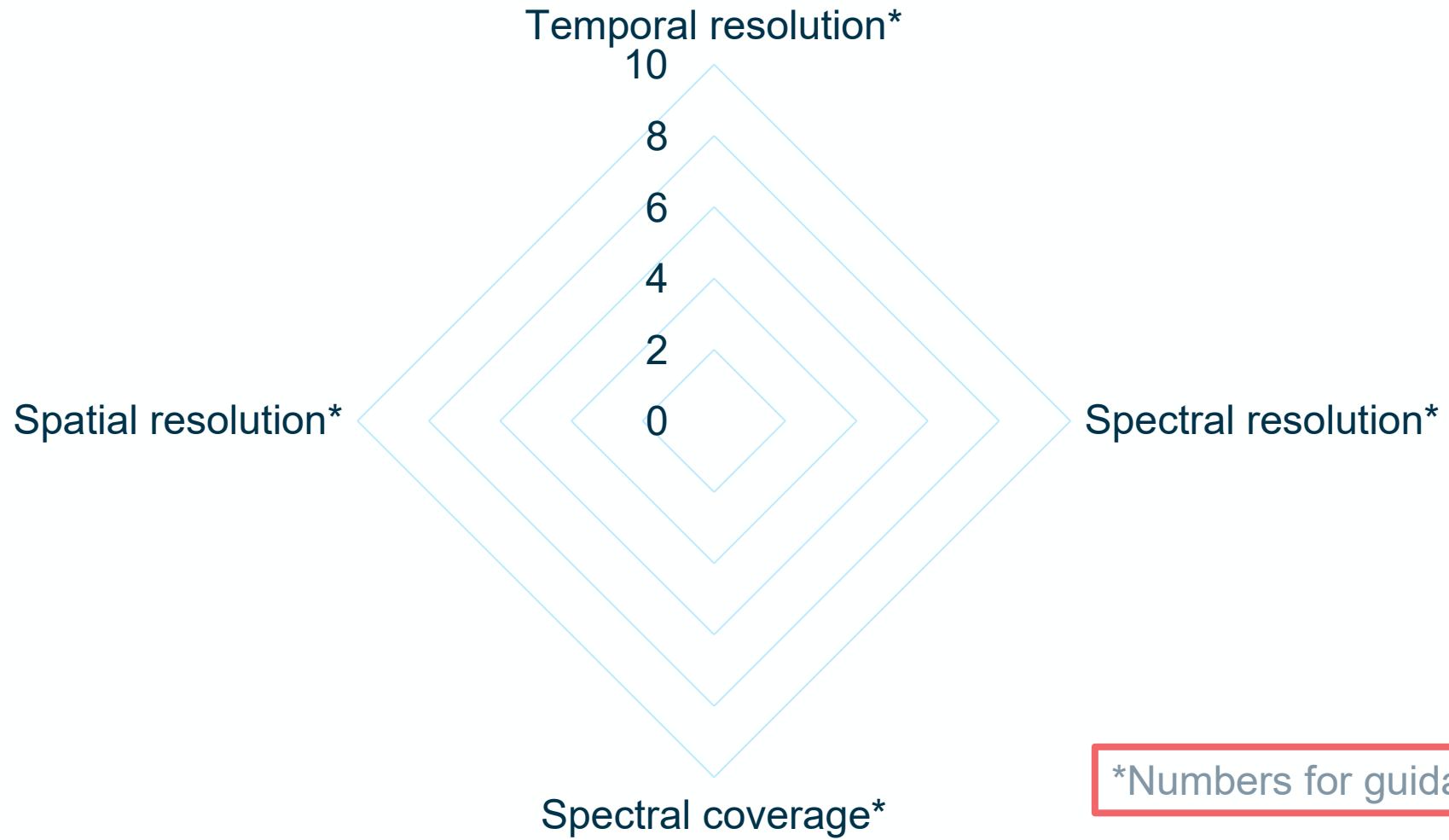


Meteorology



Which one is the Swiss Army Knife?





—●— Sentinel-2

—●— Sentinel-2 NG

—●— Sentinel-3

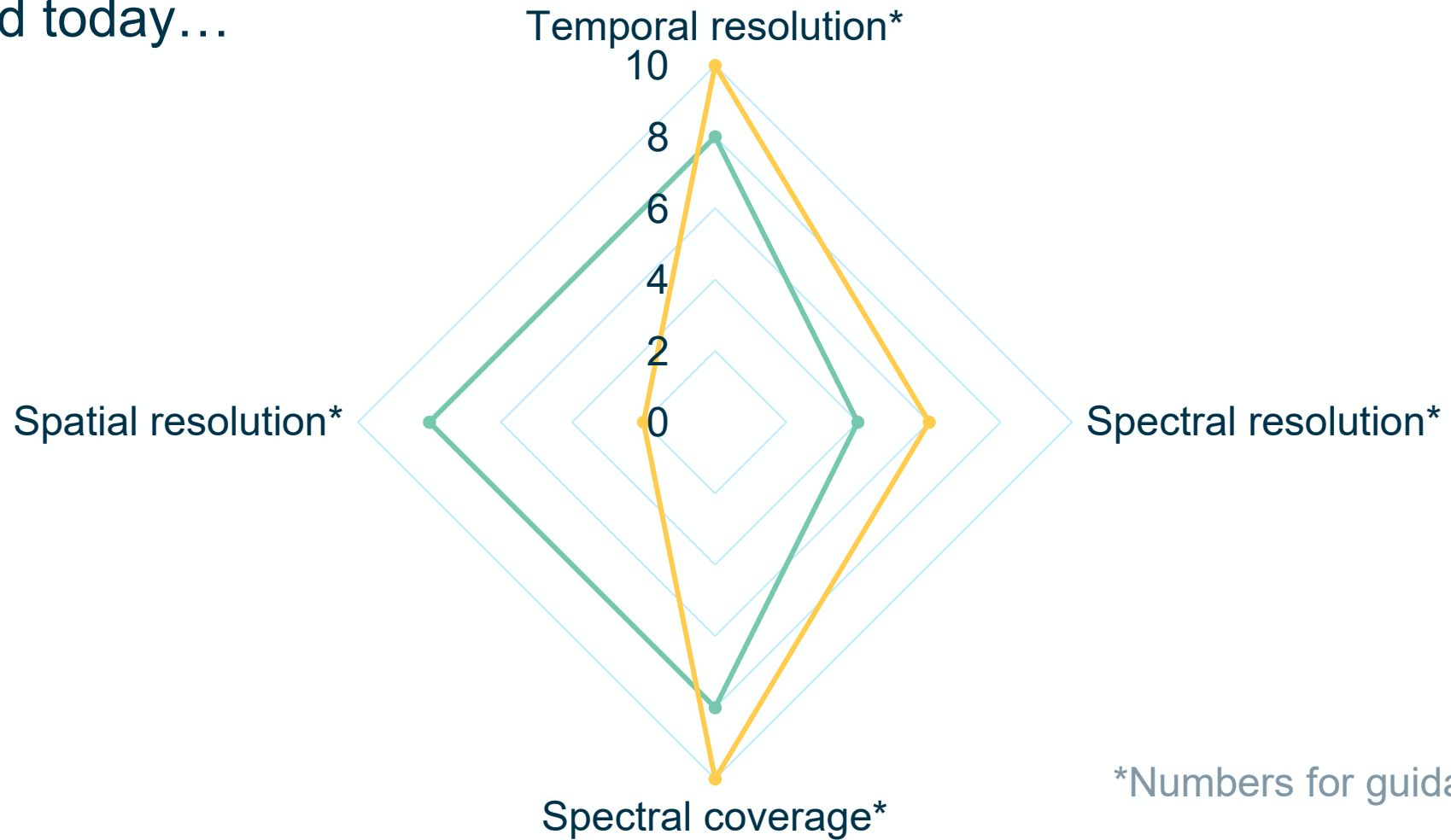
—●— Sentinel-3 NGO

—●— CHIME

—●— FLEX

—●— LSTM

Where we stand today...



*Numbers for guidance only

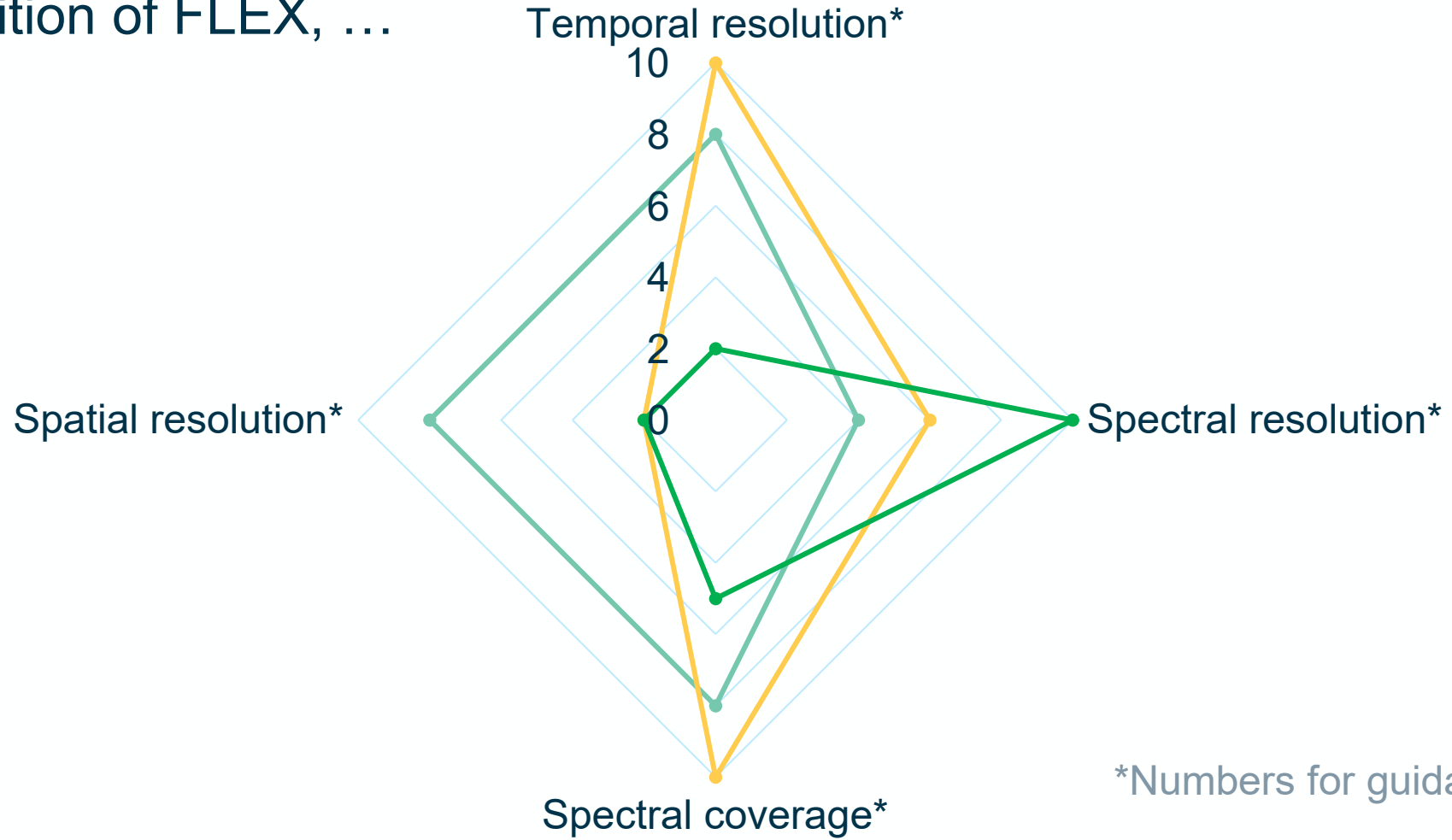
Sentinel-2
CHIME

Sentinel-2 NG
FLEX

Sentinel-3
LSTM

Sentinel-3 NGO

... with the addition of FLEX, ...



*Numbers for guidance only

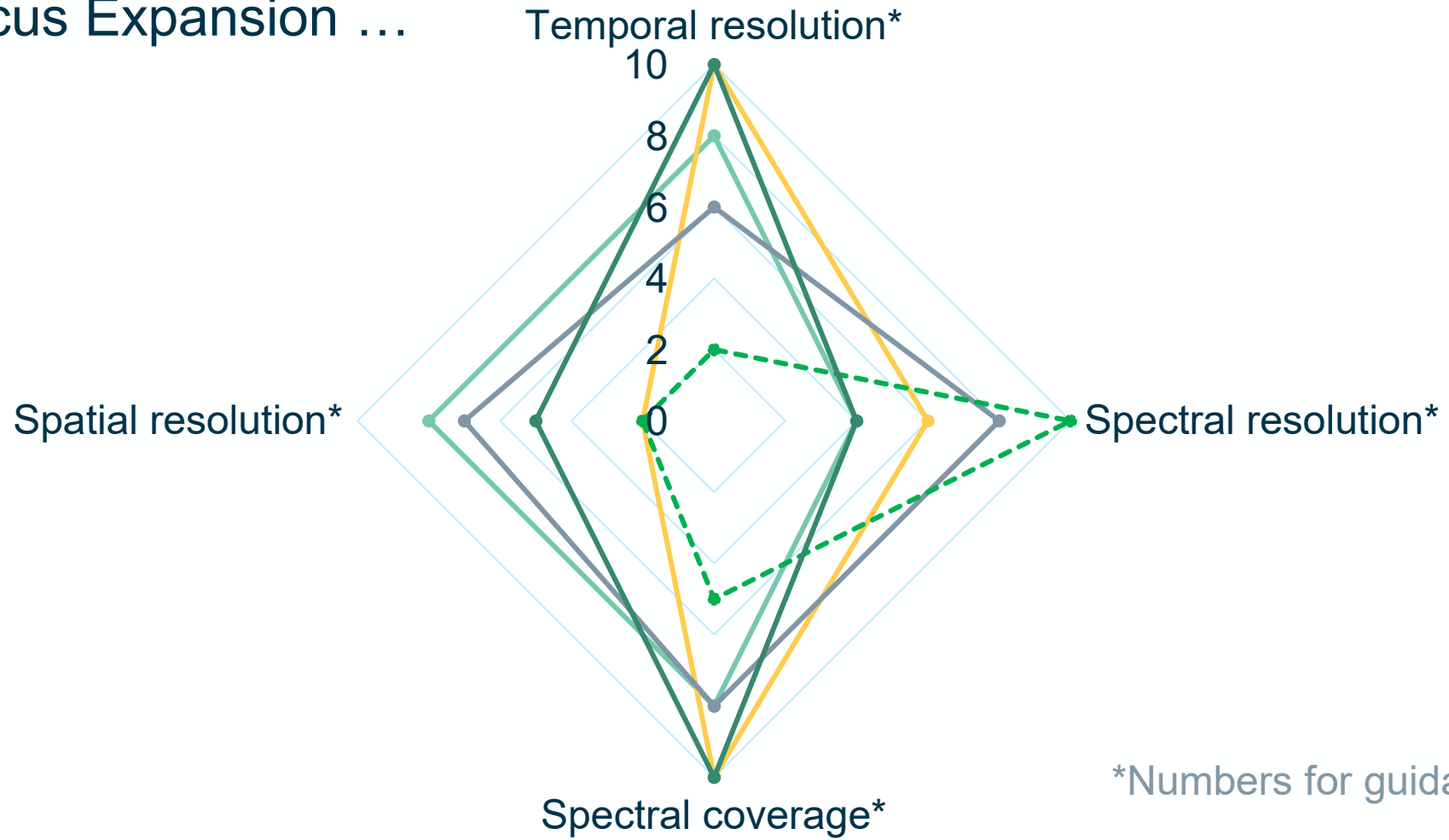
Sentinel-2
CHIME

Sentinel-2 NG
FLEX

Sentinel-3
LSTM

Sentinel-3 NGO

... the Copernicus Expansion ...



*Numbers for guidance only

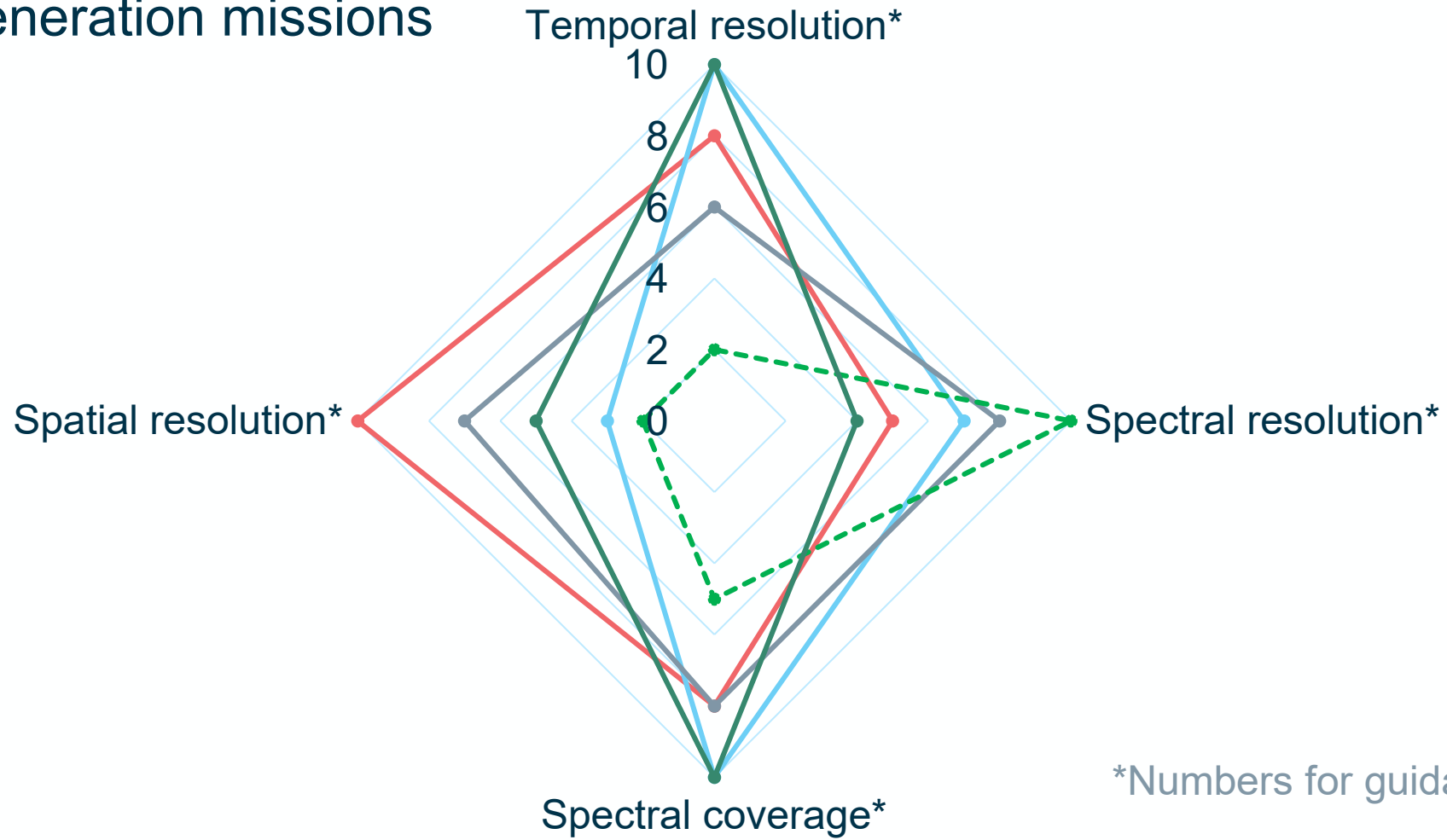
Sentinel-2
CHIME

Sentinel-2 NG
FLEX

Sentinel-3
LSTM

Sentinel-3 NGO

... and Next Generation missions



*Numbers for guidance only

—●— Sentinel-2

—●— Sentinel-2 NG

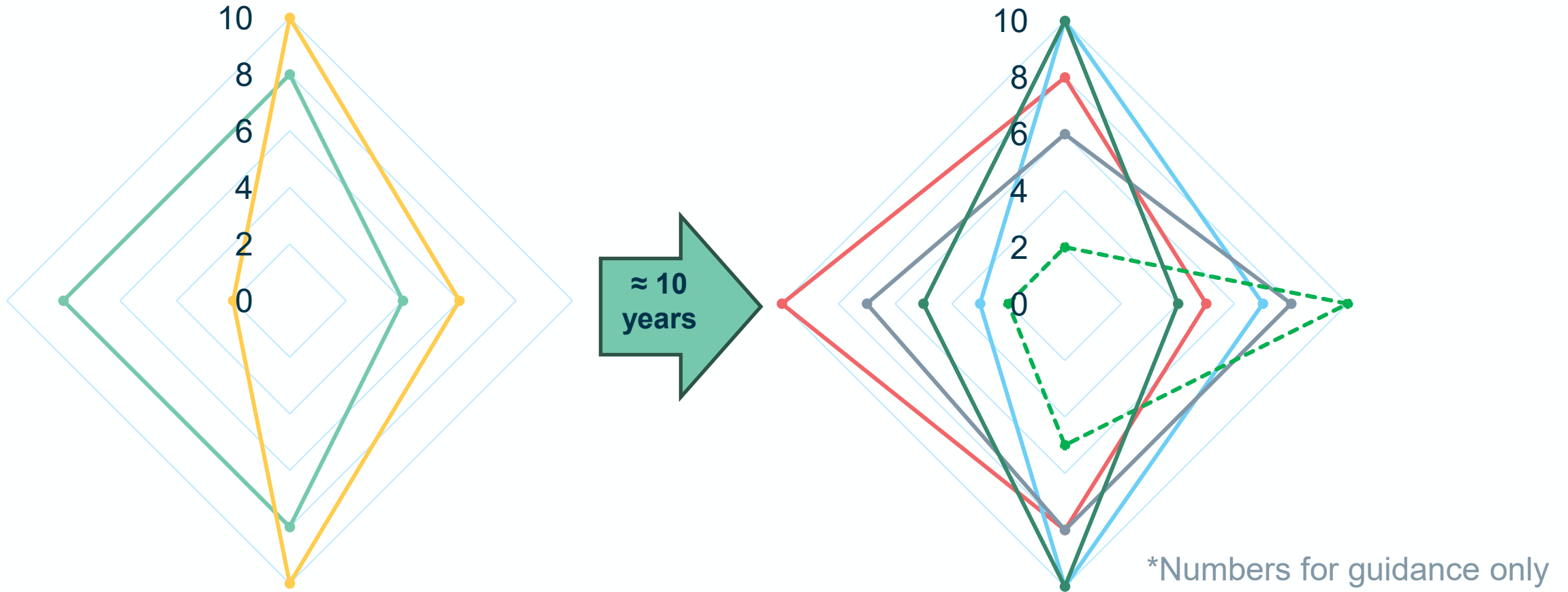
—●— Sentinel-3

—●— Sentinel-3 NGO

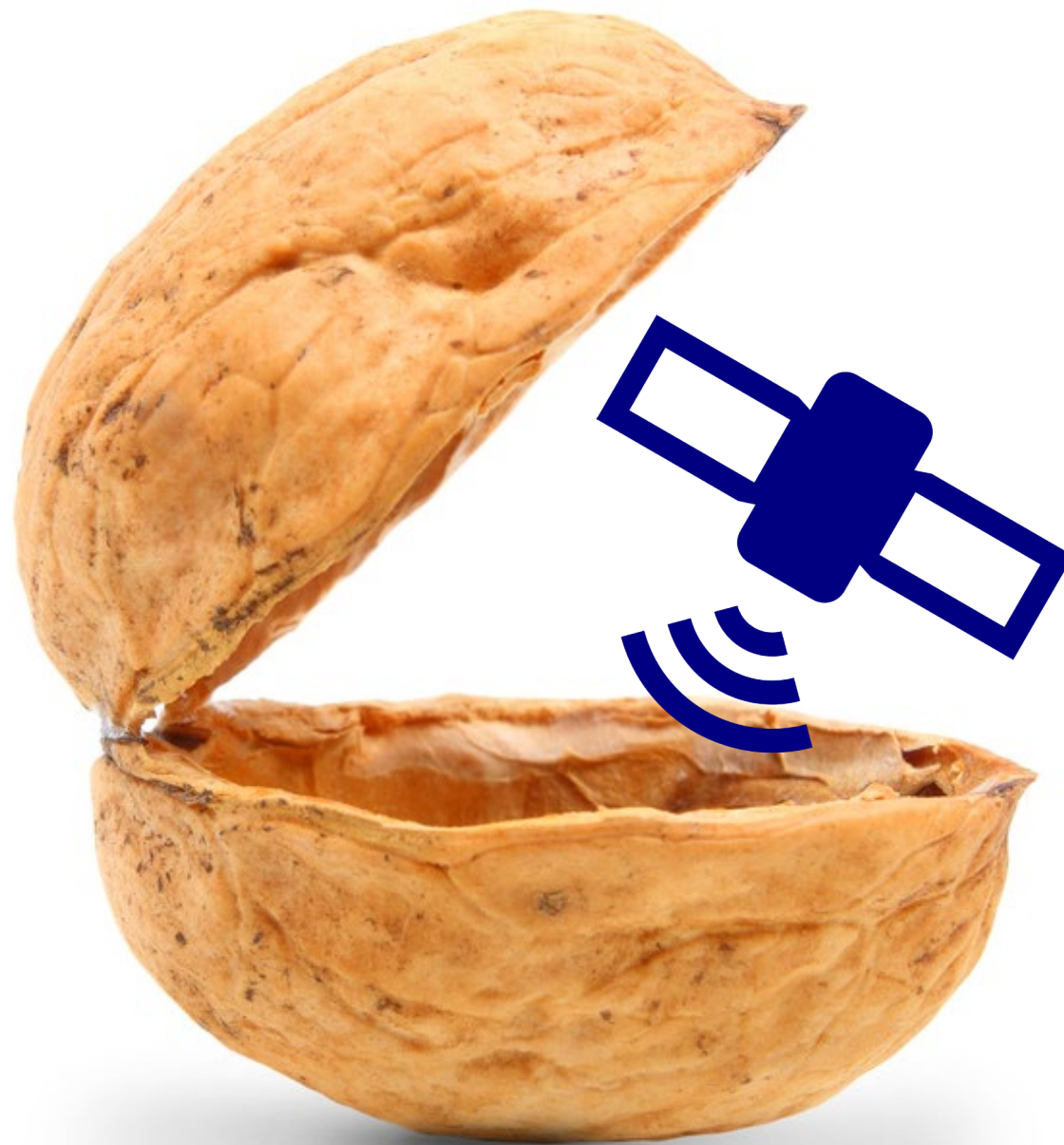
—●— CHIME

—●— FLEX

—●— LSTM



- Sentinel-2
- Sentinel-2 NG
- Sentinel-3
- Sentinel-3 NGO
- CHIME
- FLEX
- LSTM



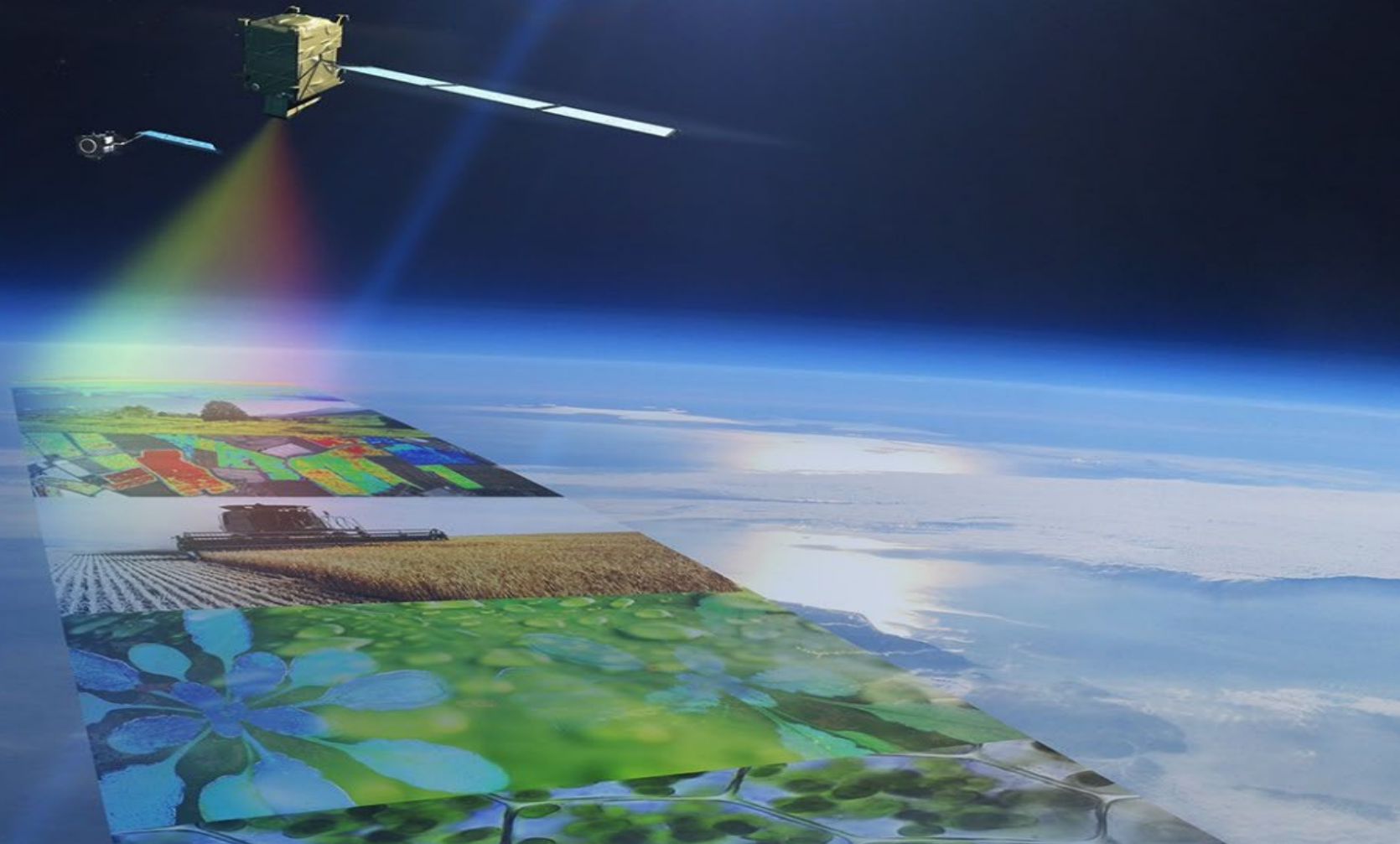
FLEX: ESA's photosynthesis mission



Mission Objectives

By retrieval of **total solar-induced chlorophyll fluorescence** and **additional vegetation parameters**, FLEX will

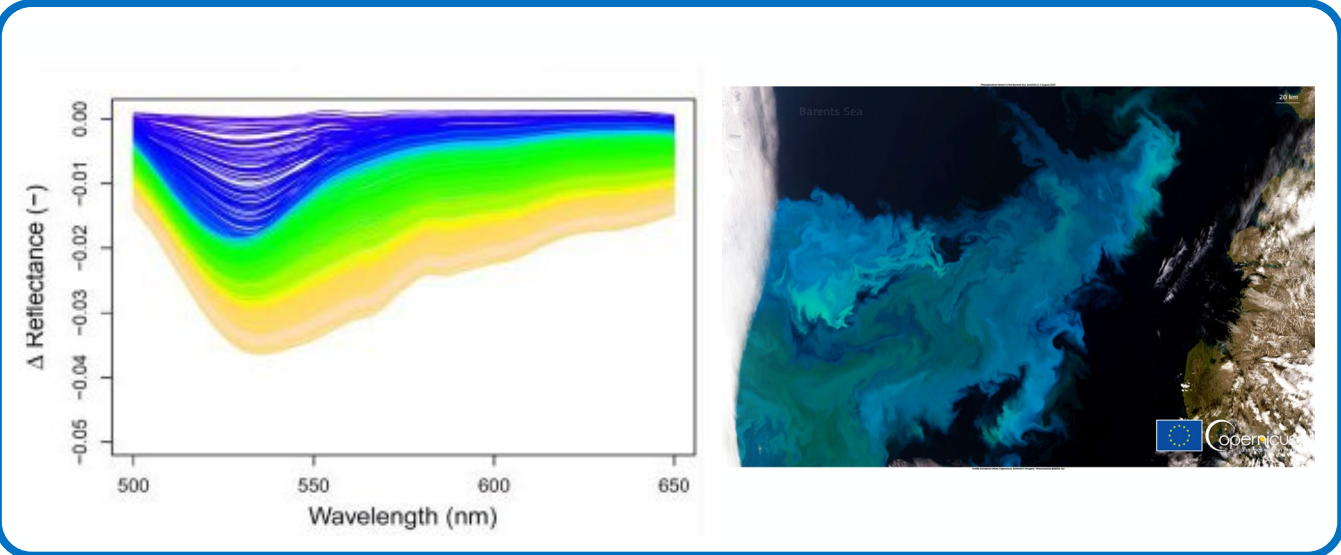
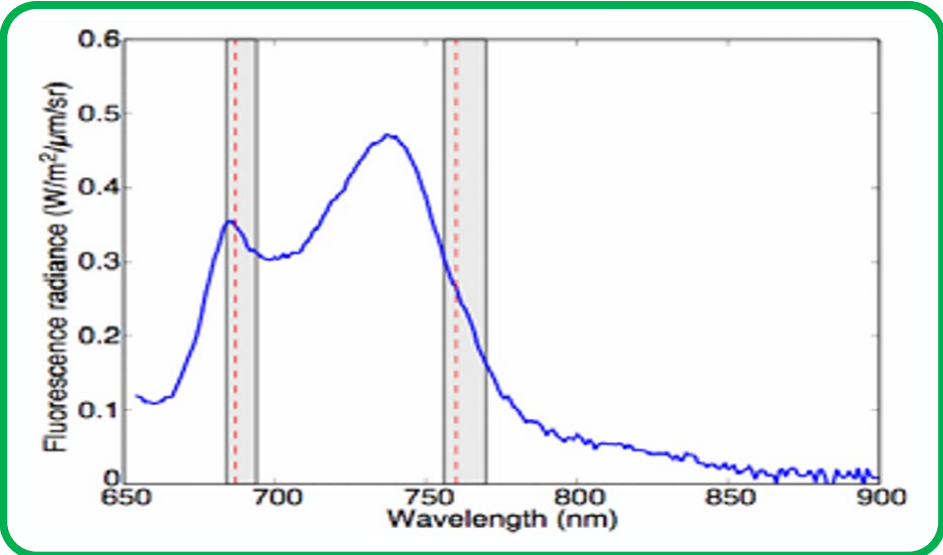
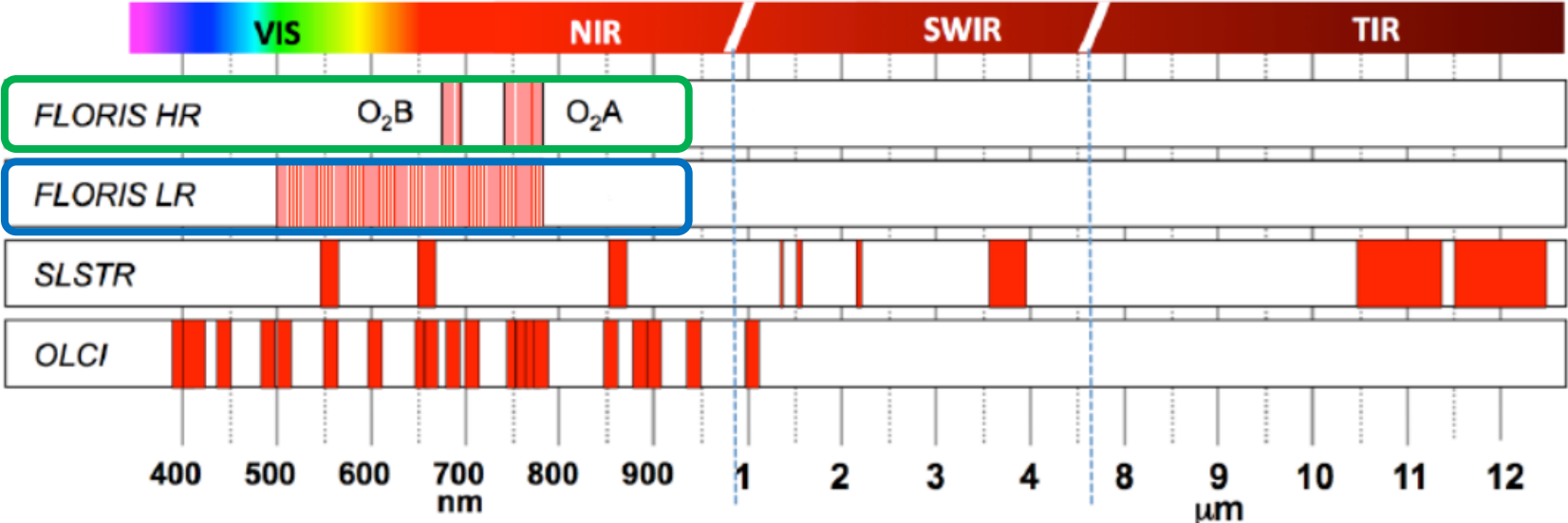
- quantify **actual photosynthetic activity** of terrestrial ecosystems
- provide **physiological indicators** for vegetation stress status



FLEX: ESA's photosynthesis mission



- High-resolution and “low resolution” VNIR spectrometers
- Very strict spectral and radiometric requirements
- 300 m
- In tandem with S3
- 27-day revisit pattern



CHIME: Copernicus Imaging Spectroscopy Mission

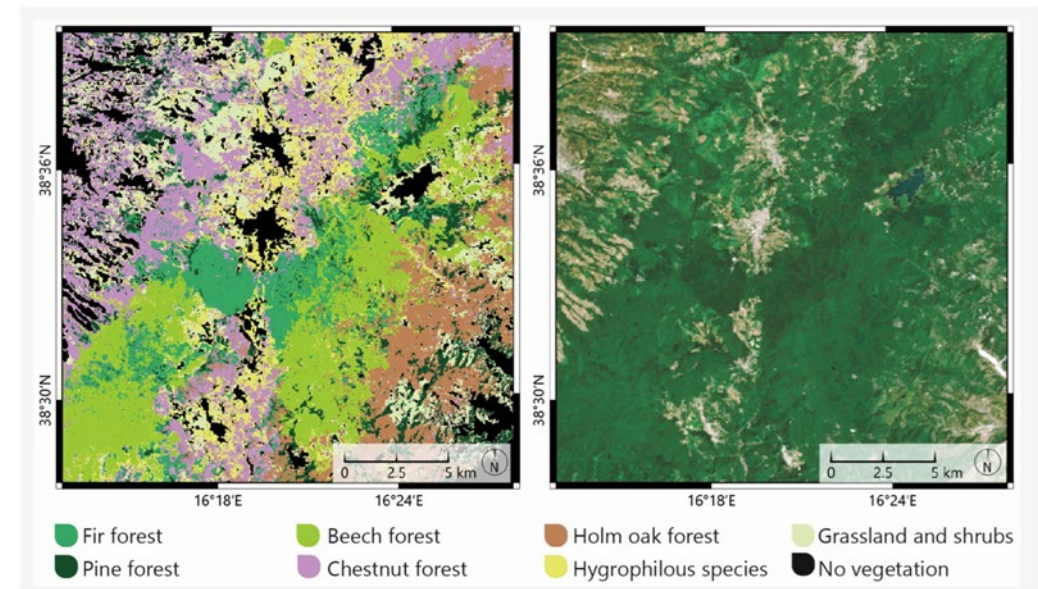
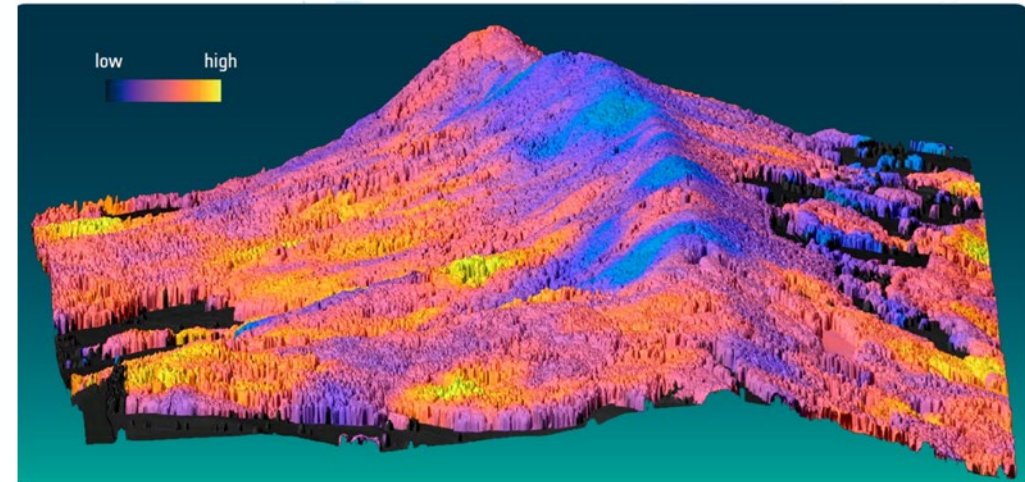


CHIME will provide **routine hyperspectral measurements** in support of EU and global policies for **monitoring and management of natural resources, and food security**

- Carpet-mapping observations of land and coastal areas
- SZA < 84°
- Spectral range: 400 – 2500 nm
- Spectral resolution: FWHM \approx 10 nm, SSI \approx 8.4 nm
- Spatial Resolution: 30 m
- Revisit 11 days (w/ 2 satellites)
- High radiometric accuracy and SNR, low spectral/spatial mis-registration
- Data latency \leq 12 hours

User data products:

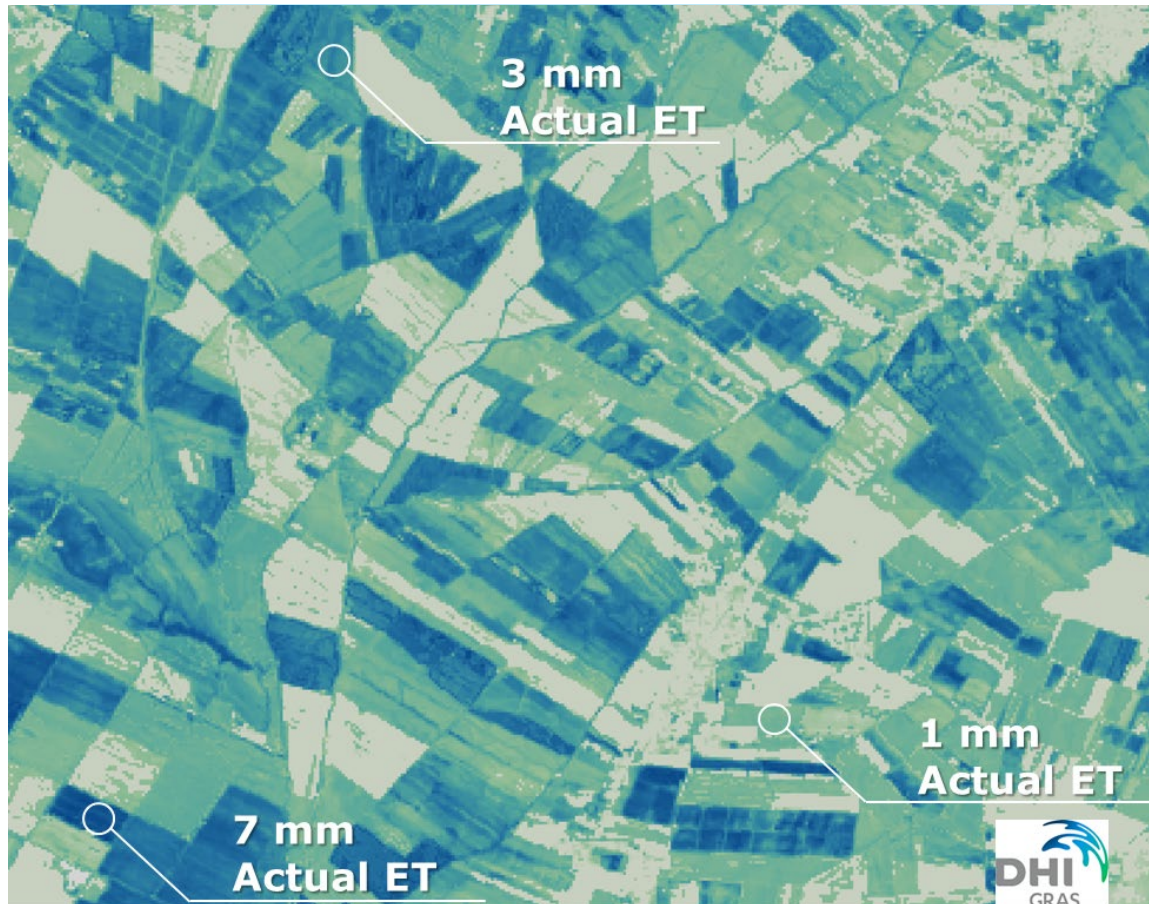
- Top-of-atmosphere (TOA) radiance in sensor geometry
- Ortho-rectified TOA reflectance
- **Bottom-of-atmosphere (BOA) land surface and aquatic reflectance** both in sensor and ortho-rectified geometry



LSTM: Copernicus Land Surface Temperature Mission



LSTM mission objective is to provide high spatio-temporal resolution Thermal Infra-Red observations over land and coastal regions *in support of agriculture management services*, and a range of additional applications



LST observations

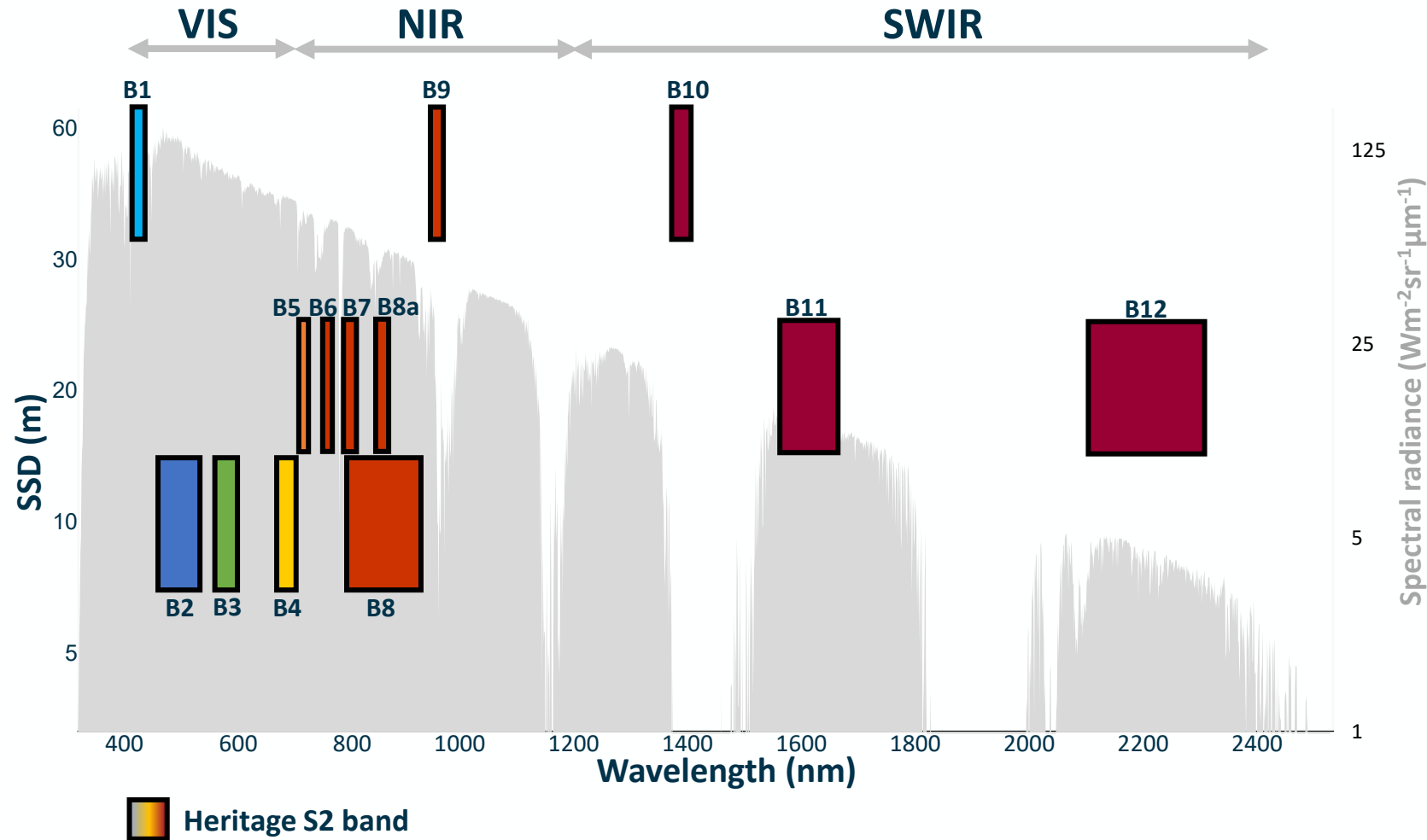
- 50 meters resolution
- 1-3 days revisit
- 1-1.5 K LST accuracy

User requirements

Evapotranspiration (goal)

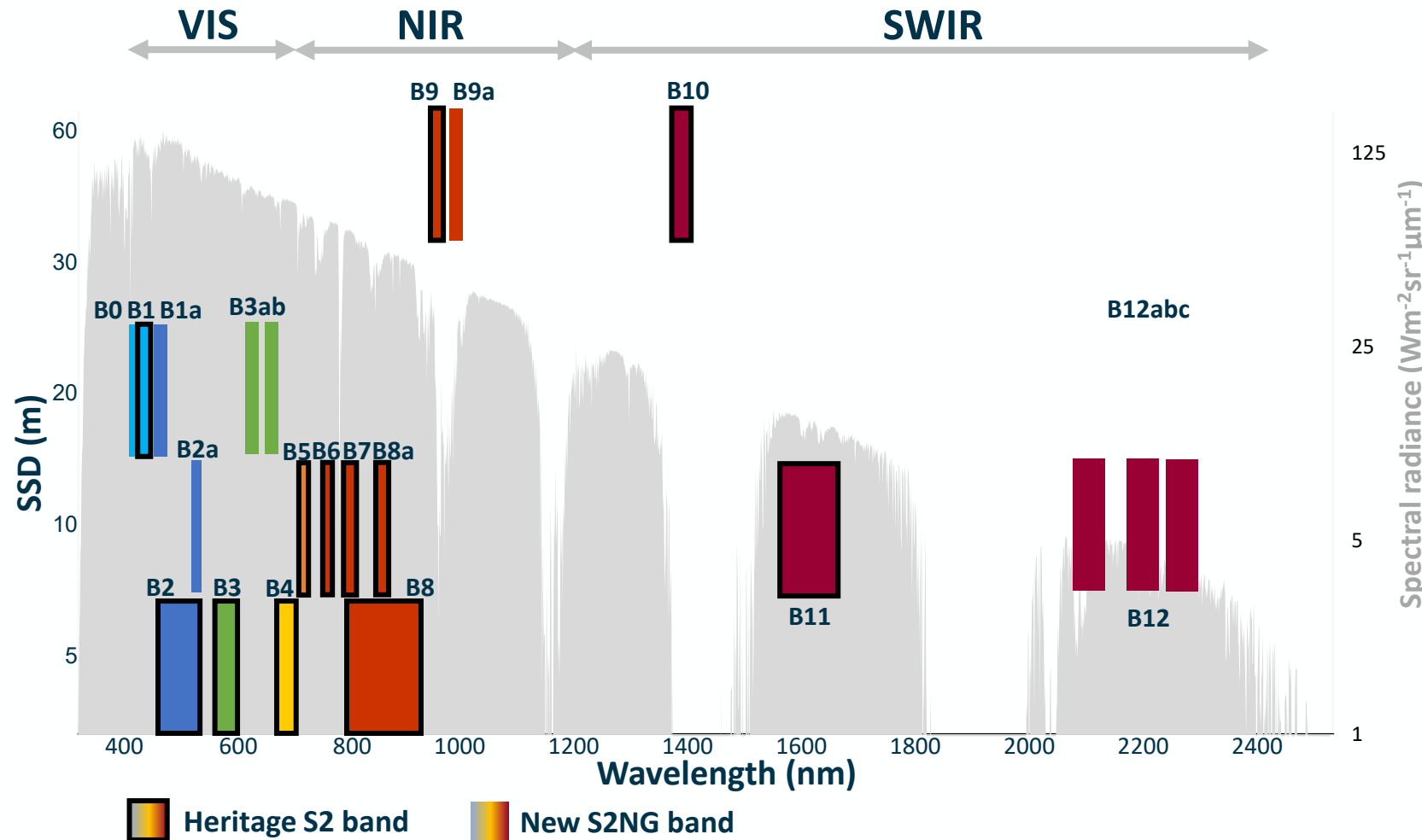
- Accuracy 15% [mm/day]
- Precision 5%
- Field scale [0.5 ha]
- Daily observations

From Sentinel-2 to Sentinel-2 NG



Key is “*enhanced continuity*”:
Keep high data quality of S2
while improving where possible.

From Sentinel-2 to Sentinel-2 NG



Key is “*enhanced continuity*”:
Keep high data quality of S2 while improving where possible.

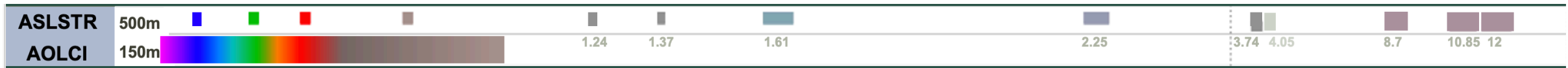
Updates:

- Additional spectral bands
- Improved spatial resolution (10m -> 5m, blue)
- Tightening of cal/val requirements across all bands
- Synergy with Landsat-Next

From S3 to S3NGO: a step up in monitoring biodiversity



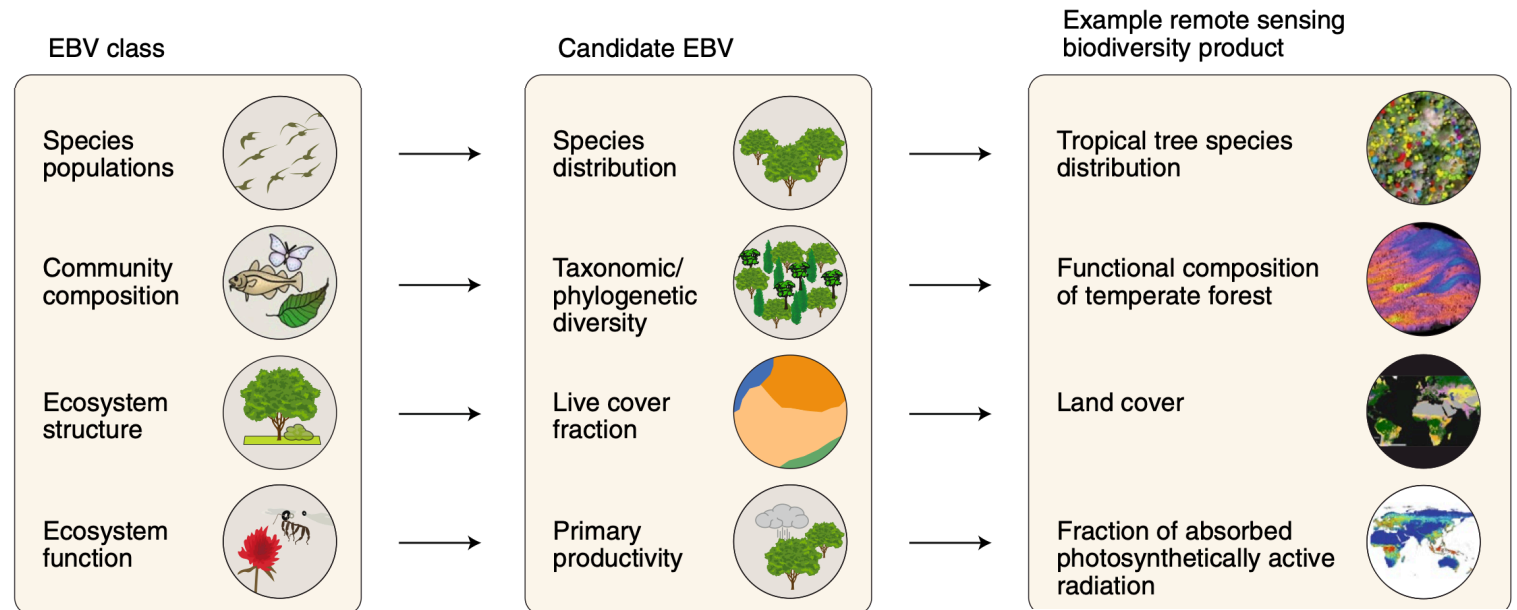
S3NGO remains the reference mission for medium-resolution, high-revisit (≤ 1 day over land, ≤ 2 day over ocean with 2 satellites). AOLCI+ASLSTR form a 'super-instrument', quasi-hyperspectral in the VIS/NIR, with dual-view capability for the ASLSTR channels



The **improved resolution** (to 150 m for AOLCI) and transition from the current multispectral OLCI to the **quasi-hyperspectral AOLCI** improve a number of remote sensing biodiversity products that target **Essential Biodiversity Variables**.

Further notable biodiversity products from S3NGO:

- **Effects of fires**
- **Effects of inundation**
- **Leaf Area Index**
- **fAPAR**
- **Phytoplankton Functional Types, major species/groups**
- **Ocean Primary Production**



Adapted from Skidmore et al., 2021

BioSpace25 - Biodiversity insight from Space
10 - 14 February 2025 | ESA-ESRIN | Frascati - Italy



Thank you for your attention

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