CHIME orbit, data formats and product definition

Antonio Gabriele

ESA ESTEC

19/10/2022

CHIME mission

Operational hyperspectral observations of land and coastal areas

Spectral range: 400 – 2500 nm

Spectral bandwidth and SSI ≤ 10nm

Swath width 130 km

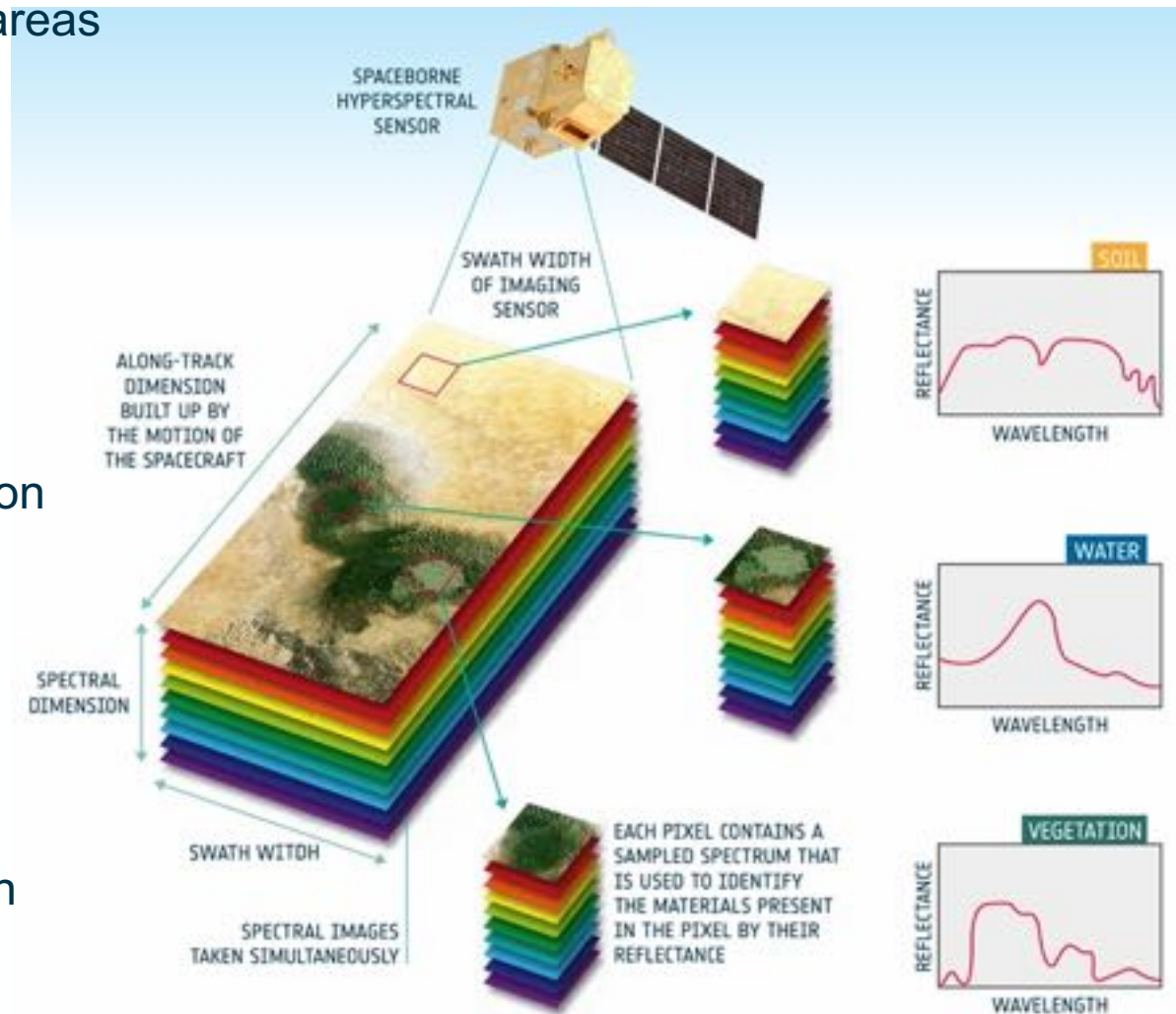Ground Resolution: 30 m

Revisit 11 days (2 satellites)

High radiometric accuracy, low spectral/spatial mis-registration

High SNR matching performance of parallel missions
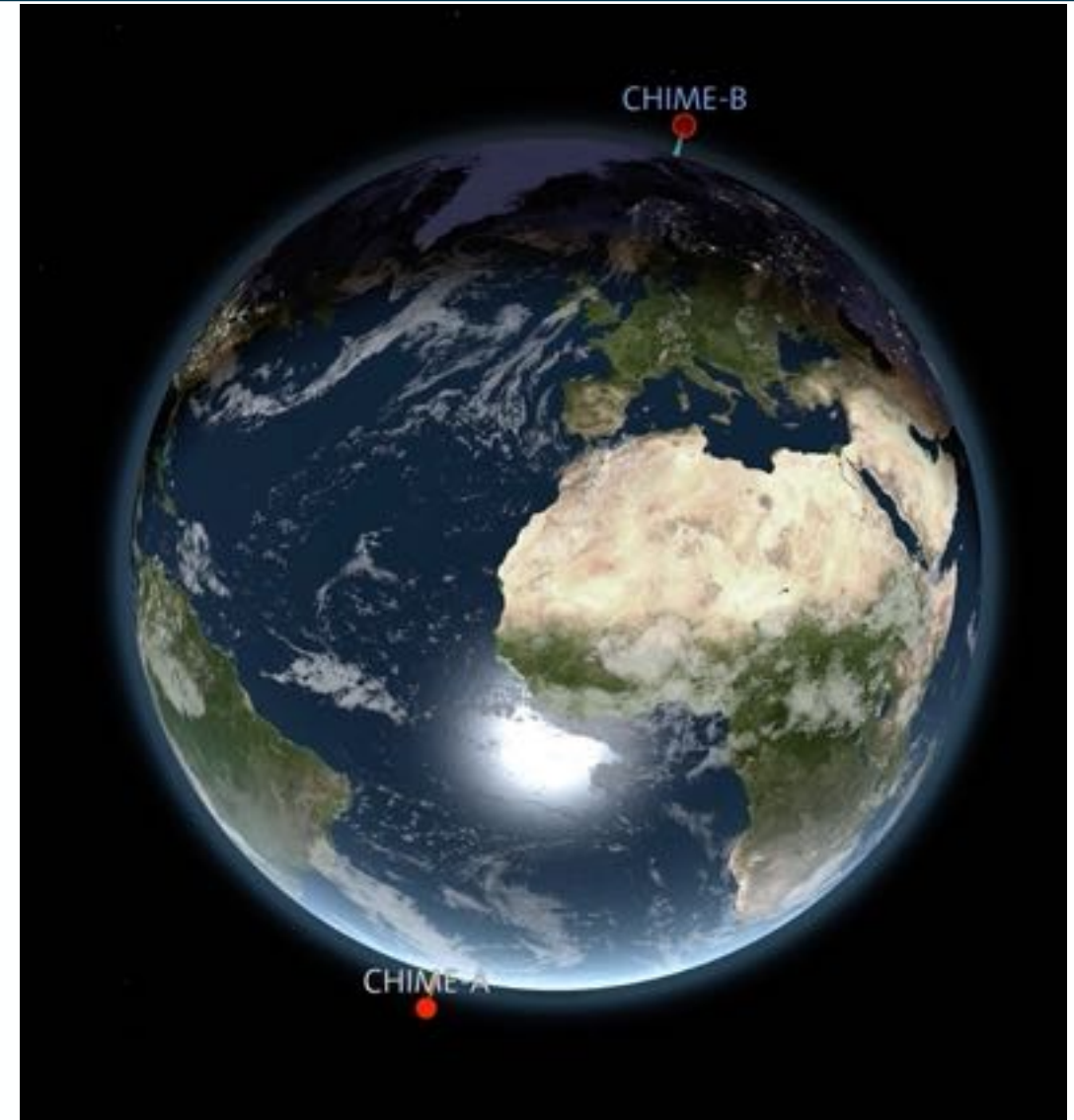
Mission duration

7.5 years nominal mission

Consumables allowing (at least) 5 years of mission extension

CHIME orbit

Two satellites separated by 180deg

- 632 km mean altitude

- 22 days repeat cycle

- 10:45 AM local time at descending node

- ~97.5 min period

- 375 orbits in a repeat cycle

- 1 km ground track margin at all latitudes

Revisit and Coverage

Revisit*

- 22 days at equator with one satellite (11 days with two satellites)
- 18 days at 40°   (9 days)
- 12 days at 60°   (6 days)

Coverage

- All land from 56° S to 84° N
- Large coastal zone (up to 370 km from land)
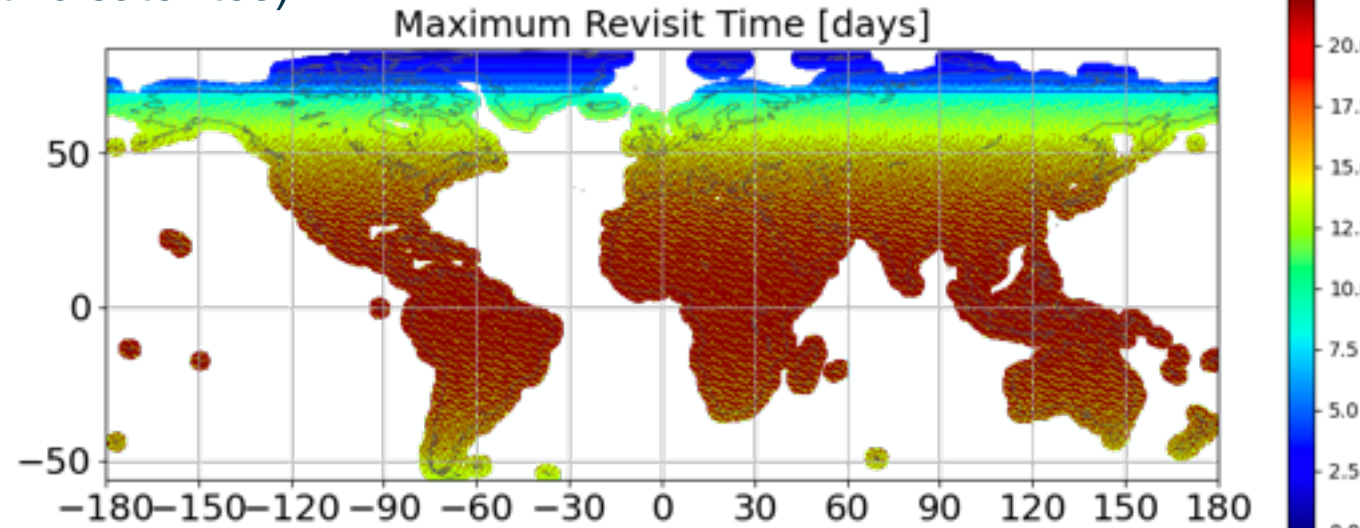

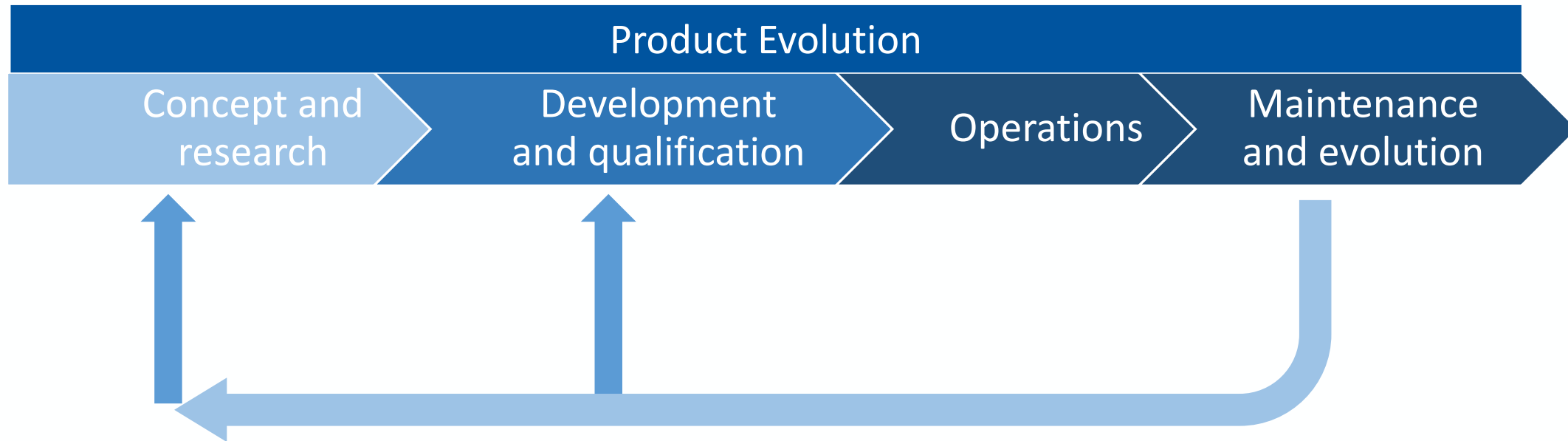Maximum Revisit Time [days]

Image courtesy of Deimos

Geometric revisit not taking into account cloud cover

Onboard Data Processing

- A dedicated Data Processing Unit (DPU) allows cloud detection and compression using artificial intelligence techniques (i.e. Support Vector Machine).
- Additional AI based on-board processing capability is currently evaluated as option.

CHIME products

CHIME Products will be available as:

- **Core:** full operational implementation and distribution

- **Demonstration:** pre-operational, mature product and candidate to become Core Product

- **Prototype:** showing the capability

Product Evolution

Concept and research → Development and qualification → Operations → Maintenance and evolution

CHIME Core Products

LEVEL-1B

Top-of-Atmosphere (**TOA**) **RADIANCE** products

- Quality controlled Level-1A data, reformatted but not resampled.

- All radiometric and spectral calibration applied.

- Geometric information (e.g. refined viewing model) computed, appended but not applied.

- Products in sensor geometry

- Quality Indicators

LEVEL-1C

Top-of-Atmosphere **(TOA) REFLECTANCE** products

- Resampled in cartographic reference frame UTM/WGS84 and framed tiles.

- Geometrically refined including geolocation correction from any residual bias and thermo-elastic distortion (intra-orbit and seasonal) and multi-temporal registration.

- Quality Indicators

CHIME Core Products

LEVEL-2A

Geometrically corrected surface **REFLECTANCE**

- Bottom-of-Atmosphere (BOA) reflectance pixel-level information.

- Ortho-rectified geometry including the usage of a Digital Elevation Model (DEM);

- Appended pixel classification (side product from the atmospheric correction process) allowing to distinguish opaque clouds, thin clouds, cloud shadows, vegetation, etc.

THE EUROPEAN SPACE AGENCY

CHIME E2E supports product development

The End-To-End Simulator Environment allows the development of Level 1, Level 2a and High Priority Prototype Products (HPPP).

The E2E is a Testbed for harmonisation efforts down to input level, such as:

- Digital Elevation Model
- Spatial resolution
- Radiometric
- Solar irradiance
- Spectral resolution
- Sentinel-2 Global Reference Image (GRI)
- BRDF correction (tbd)
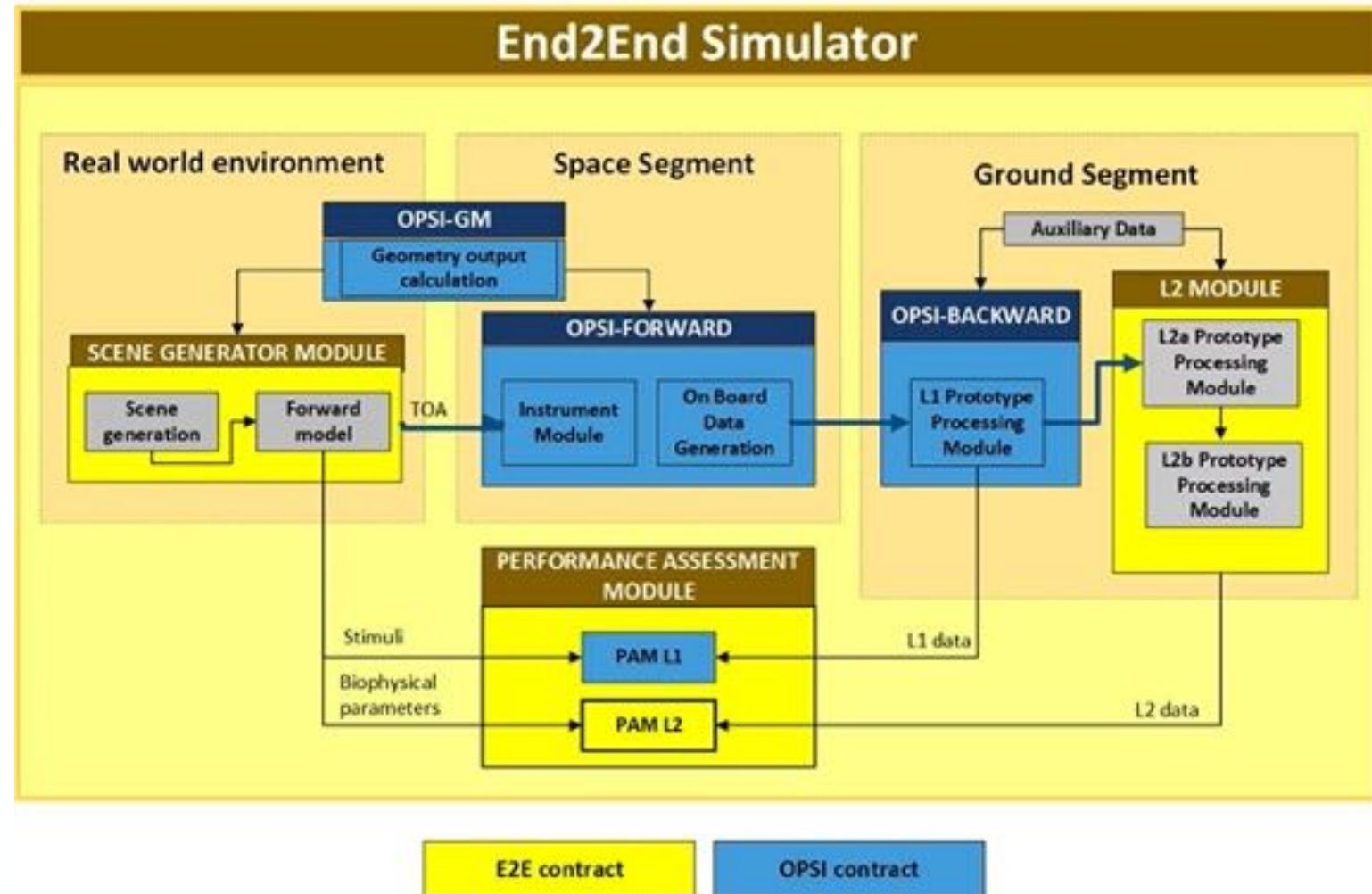
Product harmonization – international co-operation

CHIME will co-exist in orbit with several other hyperspectral missions (eg. EnMAP, Prisma, SBG)

- Product harmonization key for user community
  - Improved revisit and coverage
    - Resilience to cloud cover
    - Improved monitoring of Earth surface dynamics
  - Intercomparison, cross calibration

Cooperation with ASI, DLR and NASA | Focus: Satellite Constellation and Data Fusion | No exchange of funds and/or hardware

PRISMA

- CHIME Campaign
- advancement of algorithm development
- new retrieval techniques such as AI and machine learning are examined

EnMAP and DESIS

- End to end simulator combined usage
- Exchange of ATBDs at different product levels
- Cooperation on retrieval toolbox and operational processors

US decadal plan priority Mission SBG (Surface Biology Geology)

- established Joint Working Groups consolidating an End-Product harmonisation, Retrieval Simulations and Orbit definitions and CalVal

THE EUROPEAN SPACE AGENCY

Conclusions

- CHIME and SBG will be the first missions to provide hyperspectral observations

  - Globally

  - 8 days combined revisit times (CHIME 11 days, SBG 16 days)

  - Unprecedented data quality:

    - high signal-to-noise ratio

    - with high uniformity (low smile and keystone)

  - Freely distributed worldwide

- CHIME and SBG build on the experience gained from the success of EnMAP, PRISMA, EMIT and HISUI.

- CHIME and SBG will be the backbone of all future hyperspectral missions

- Product harmonization framework beneficial to whole user community