SpaceOps 2010 Huntsville
How the space operations contribute to climate change monitoring?

Land cover aspects

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How the space operations contribute to climate change monitoring? Land cover aspects

- **Observation of earth surface** with different sensors (missions), **examples**
  (actually more than 150 satellites in orbit for earth observation purposes (source britannica.com))
  - Gravitational
    - Champ / Grace / Goce
  - Optical
    - Spot, Rapideye, Ikonos, Orbview2, Terra, GeoEye, WorldView, Landsat, Kompsat-2
  - Radar
    - RadarSat, TerraSAR-X, Cosmo-Skymed, ERS-2, Envisat, HJ-1C (China)
  - Infra-red
    - TANSO (J), BIRD, Kompsat-1

How the space operations contribute to climate change monitoring? Land cover aspects

DLR / GSOC is operating different EO-missions
CHAMP (D)
GRACE (USA / D); formation flying
TerraSAR-X (D)
TanDEM-X (D; in preparation, launch Jun2010)

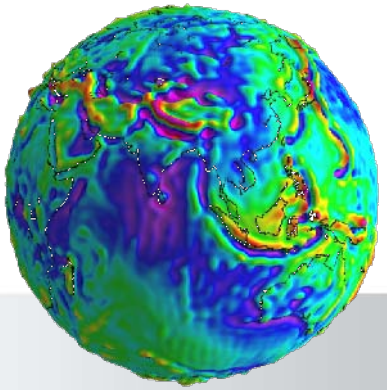
Main focus on land surface

How the space operations contribute to climate change monitoring? Land-cover aspects

- What are the relevant aspects for monitoring climate change?
  - Coverage of wide areas
  - Detailed, high resolution information (different sensors)
  - Long-term observation (repeat passes, various sight of view)
  - Accurate location on ground (long, lat)
  - Precise elevation information (DEM)
  - Up-to-date information available
  - Fast delivery of products
    (combination of different sensor information)

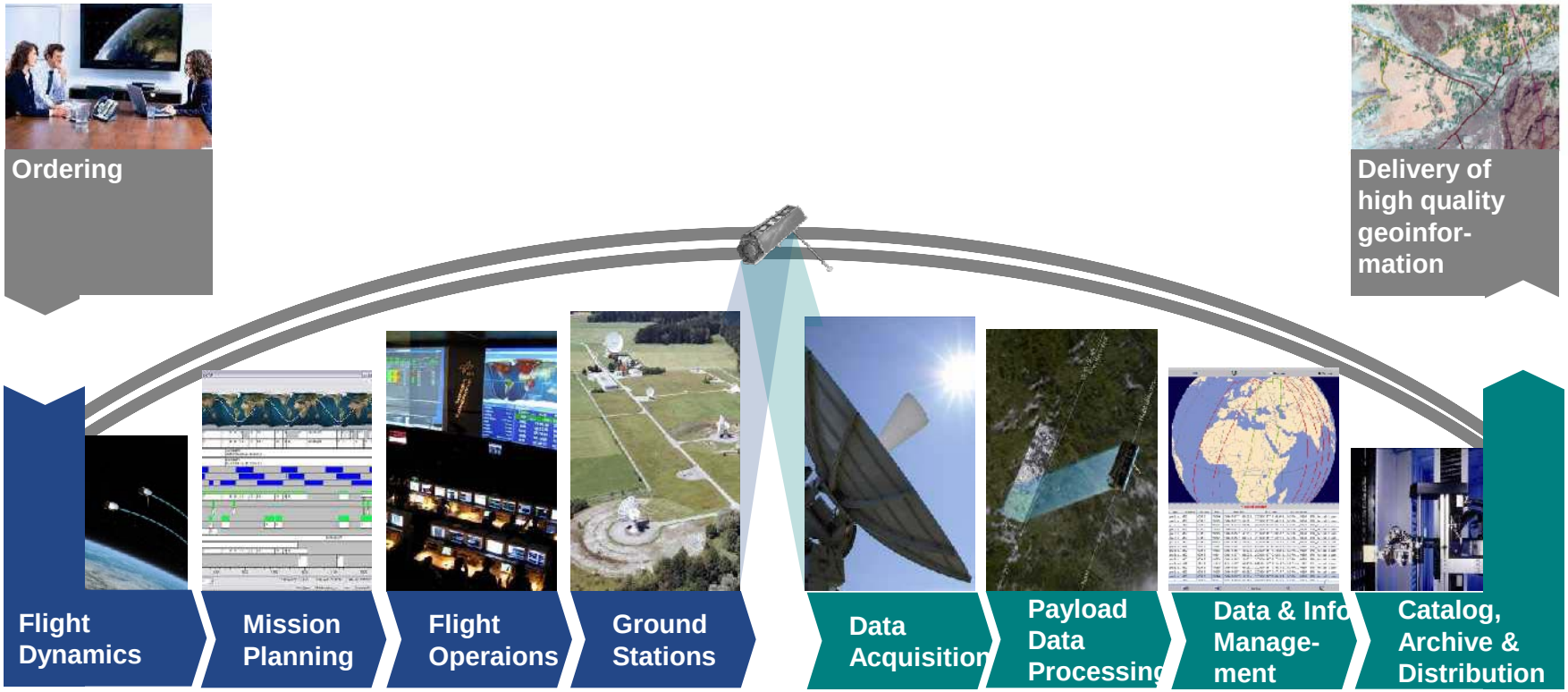
GRACE satellite

GRACE:
Measurement of gravity field of the earth



How the space operations contribute to climate change monitoring? Land-cover aspects

- End-to-end chain for EO products (from an order to a product)



How the space operations contribute to climate change monitoring? Land-cover aspects

- What are the challenging aspects for space operations? (1)
  - Flying a spacecraft in a ‘reference orbit’ (tube)
    always same observation conditions (e.g. for interferometry)
  - Flying two spacecrafts in a close formation
    (GRACE1,2: 200km; TSX & TDX: 200m)
  - Fast commanding (via uplink every orbit)
    fast reaction to special events
  - Fast downlink (direct to the user)
    no time wasted for long-lasting (expensive) data transfer

TSX satellite

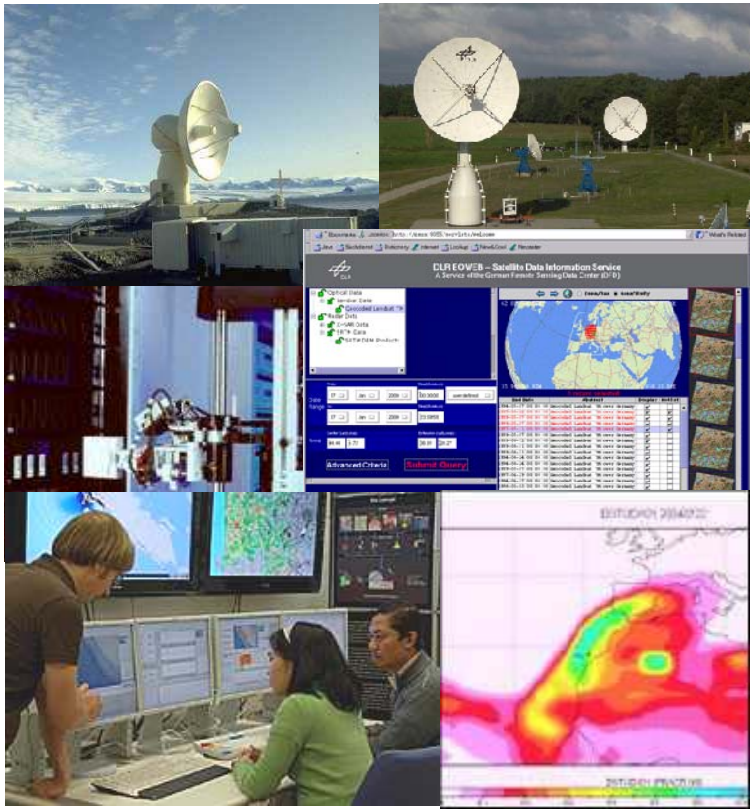
How the space operations contribute to climate change monitoring? Land-cover aspects

- What are the challenging aspects for space operations? (2)
  - Supporting a 24/7 satellite recovery to minimize the satellite outage time
  - Optimized mission-planning for a maximum of scientific / commercial return
  - Extensive instrument operations for a best quality of data
  - (Cost) effective missions operations via multi-mission approach

CHAMP satellite

How the space operations contribute to climate change monitoring? Land-cover aspects

- What are the challenging aspects for space operations? (3)
  - Data reception
  - Data processing
  - Data archiving
  - Generation of high level products

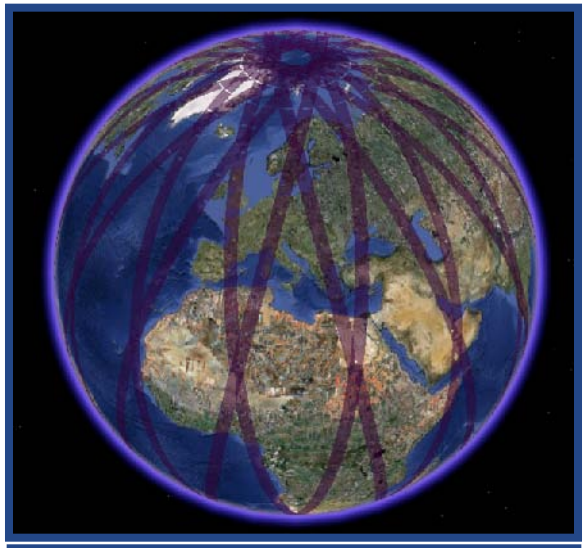


A1 highway near Rome, Italy

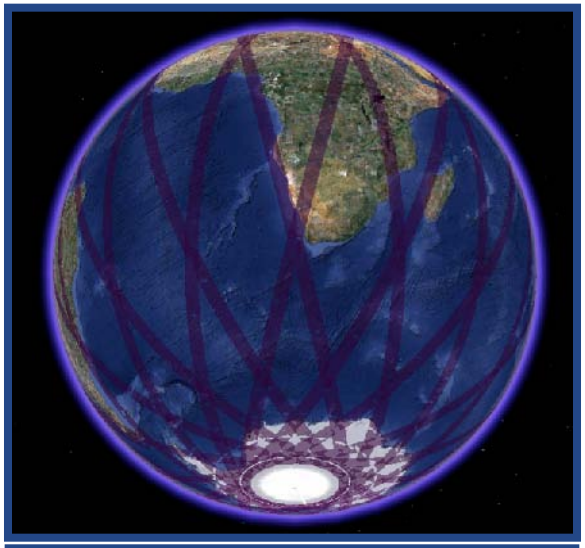
Automatic speed control of moving objects using the Doppler effect

How the space operations contribute to climate change monitoring? Land-cover aspects

- Flying a spacecraft in a ‘reference orbit’ (tube)
  always same observation conditions *(e.g. for interferometry)*



Full performance strips 2009-10-14 (north view)



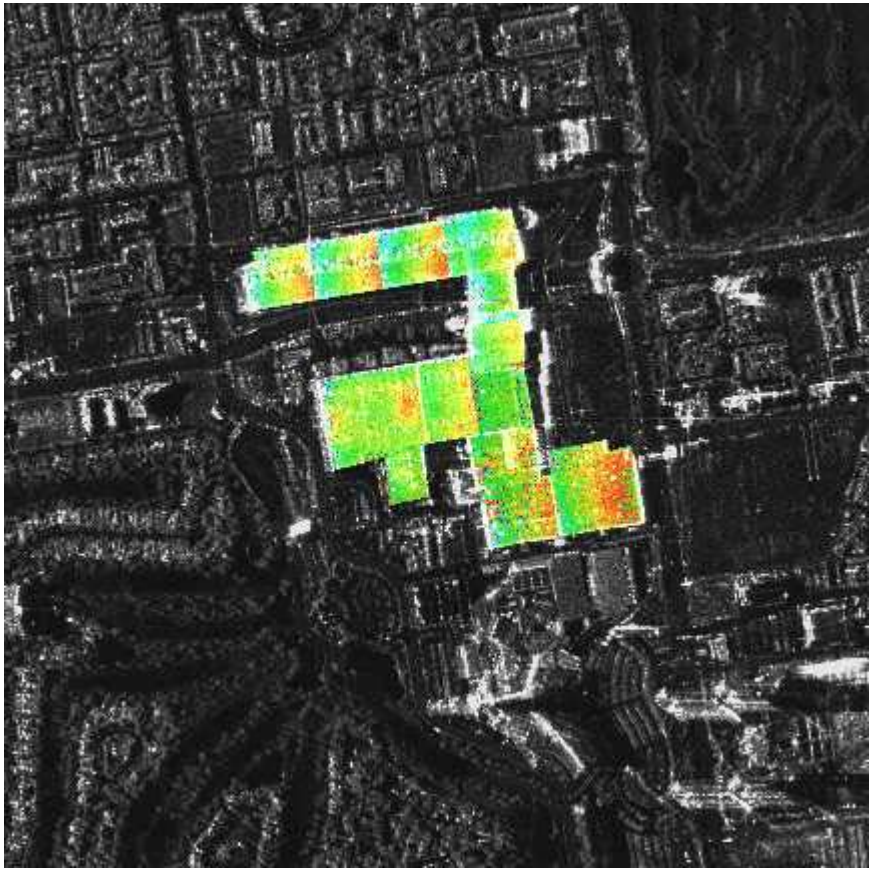
Full performance strips 2009-10-14 (south view)

Reference Orbit 1 day

Change Detection map of Baltimore Harbor, USA

© Infoterra GmbH August & September

TerraSAR-X Differential Interferometry



- 8 deformation [mm] +8

Las Vegas Convention Center

TSX-Spotlight:

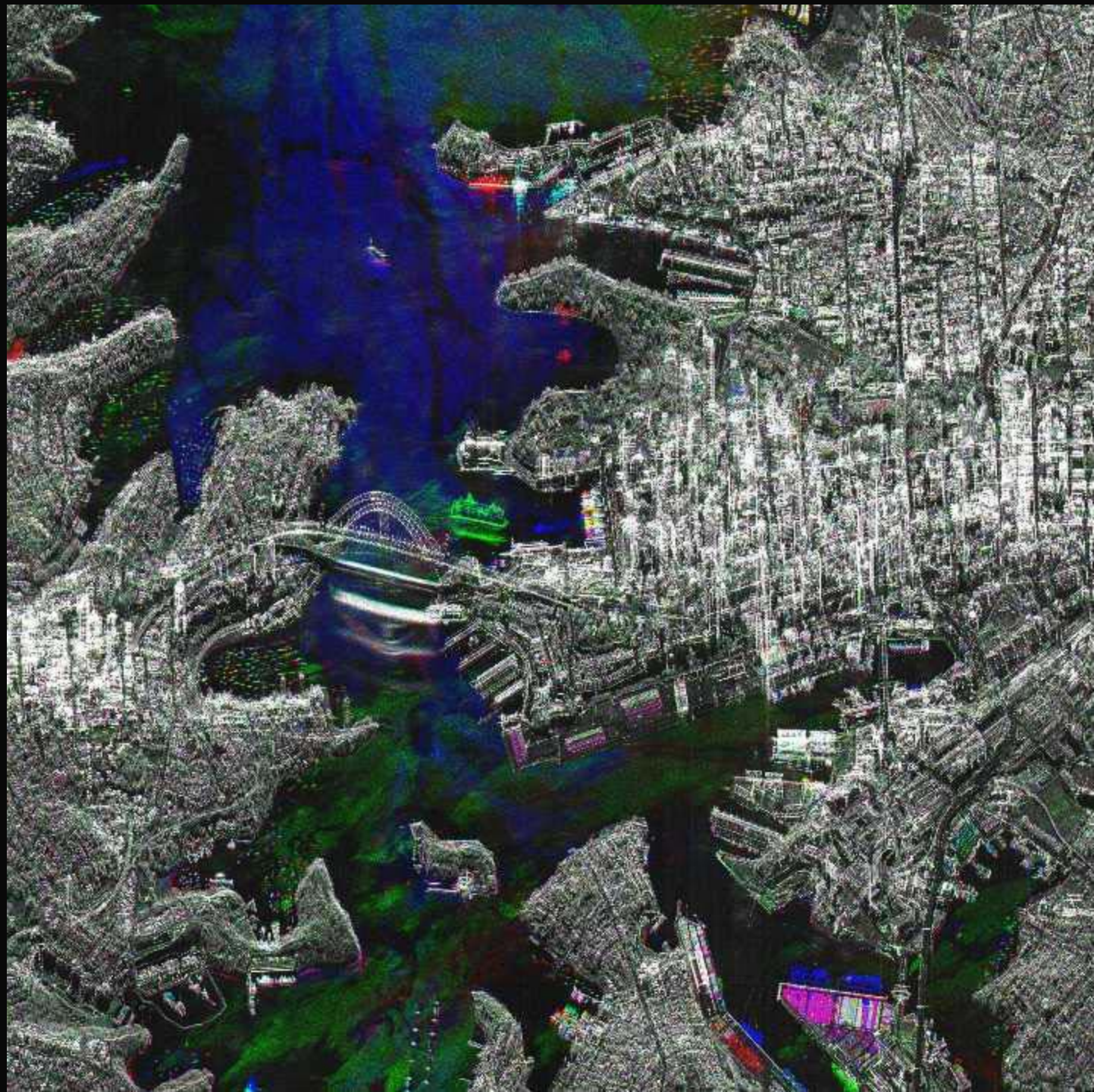
Sydney, Australia

r-g-b:

January 12, 2008

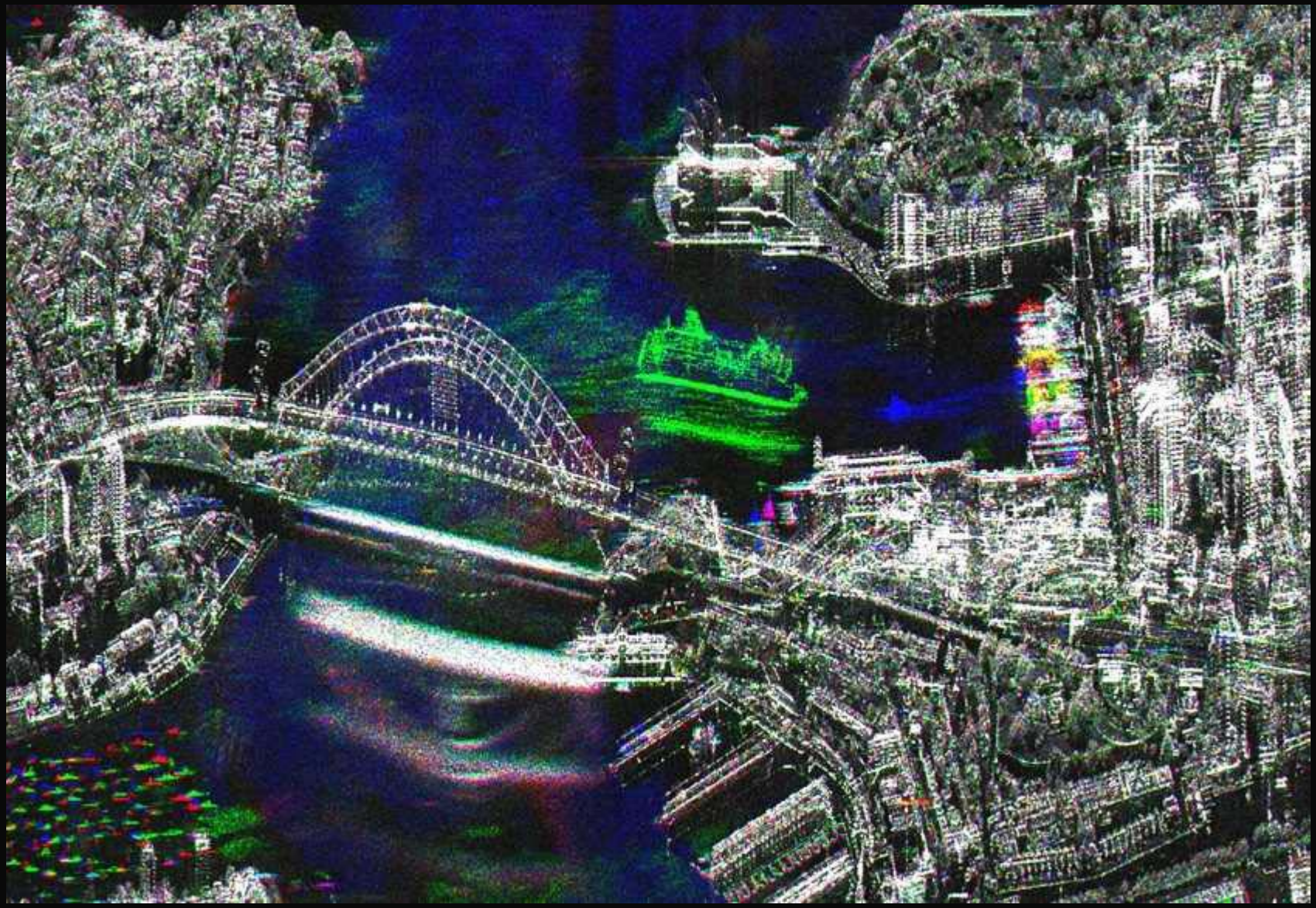
December 21, 2007

January 1, 2008



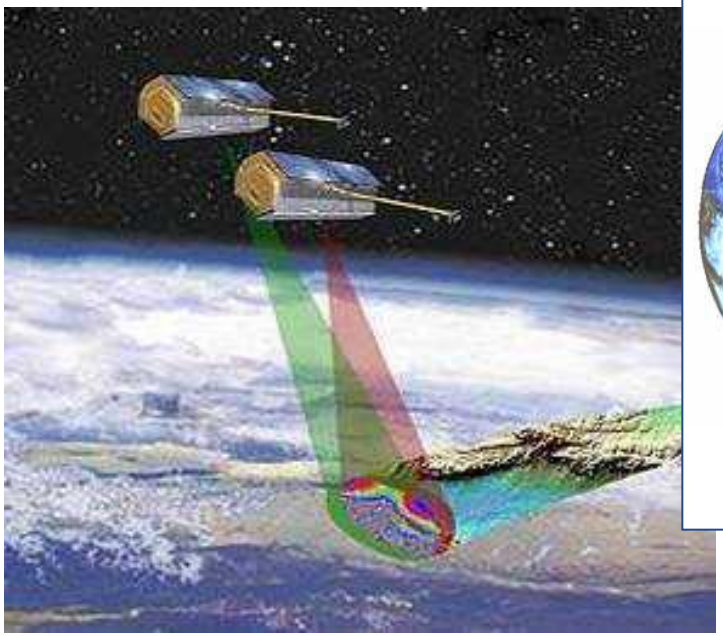
TSX-Spotlight: Sydney, Australia

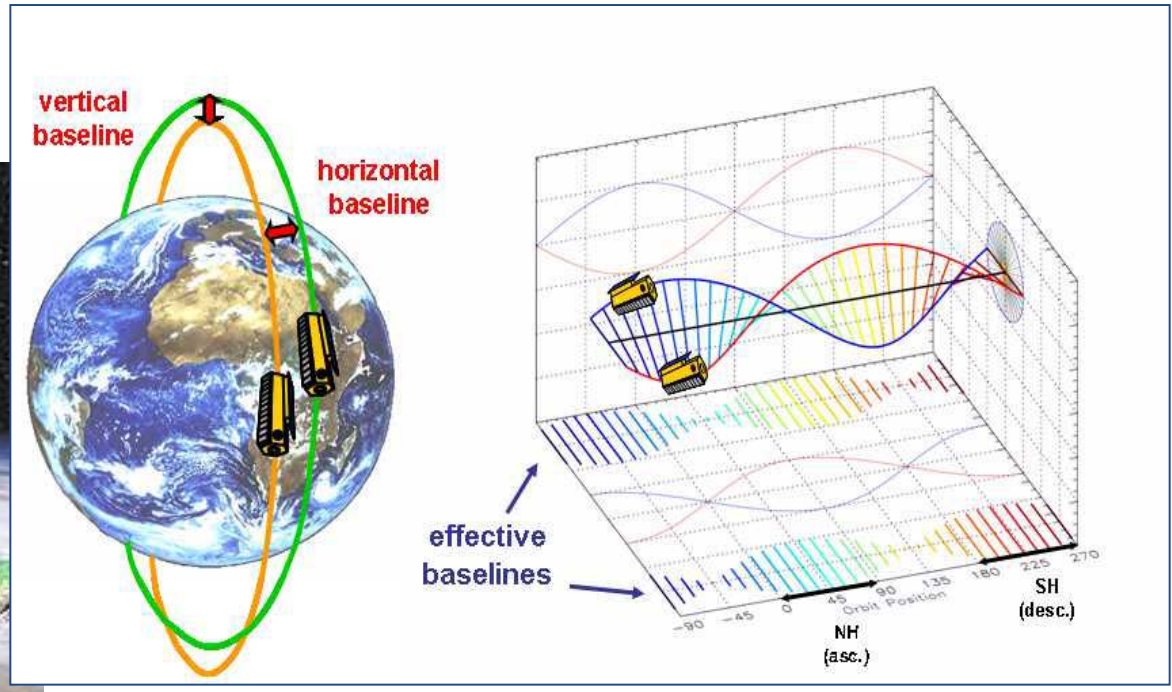
r: January 12, 2008 – g: December 21, 2007 – b: January 1, 2008



How the space operations contribute to climate change monitoring? Land-cover aspects

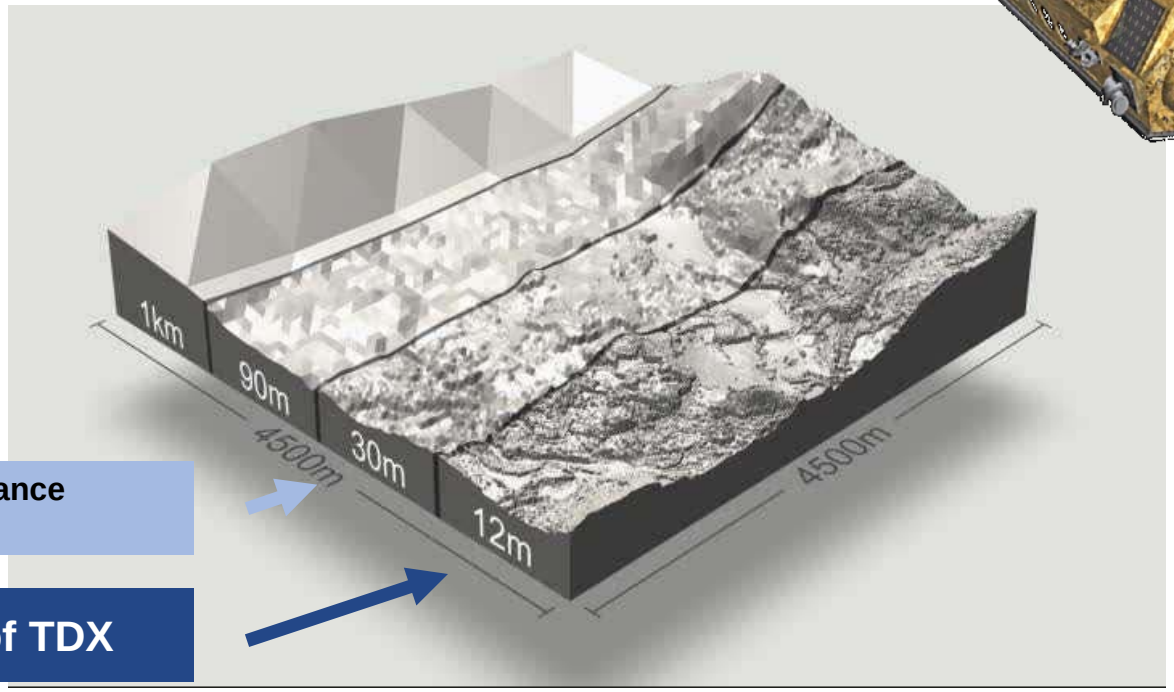
- Flying two spacecrafts in a close formation (1)





How the space operations contribute to climate change monitoring? Land-cover aspects

- Flying two spacecrafts in a close formation (2)
  - Complete Covering of the Earth's Surface
  - High Resolution Images (Level *HRTI-3 DEM = 12 x 12 m)*

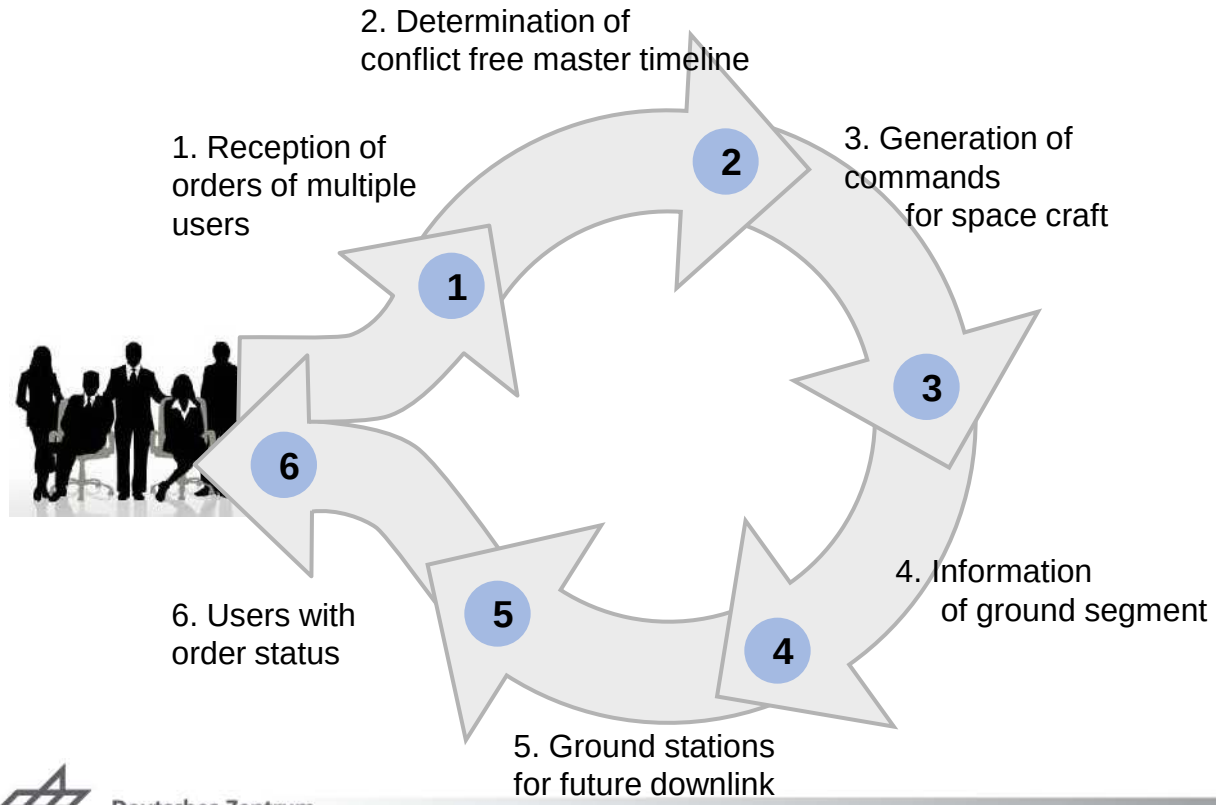


Current Performance (e.g. STRM)

Performance of TDX

How the space operations contribute to climate change monitoring? Land-cover aspects

→ Optimized mission-planning for a maximum of scientific / commercial return

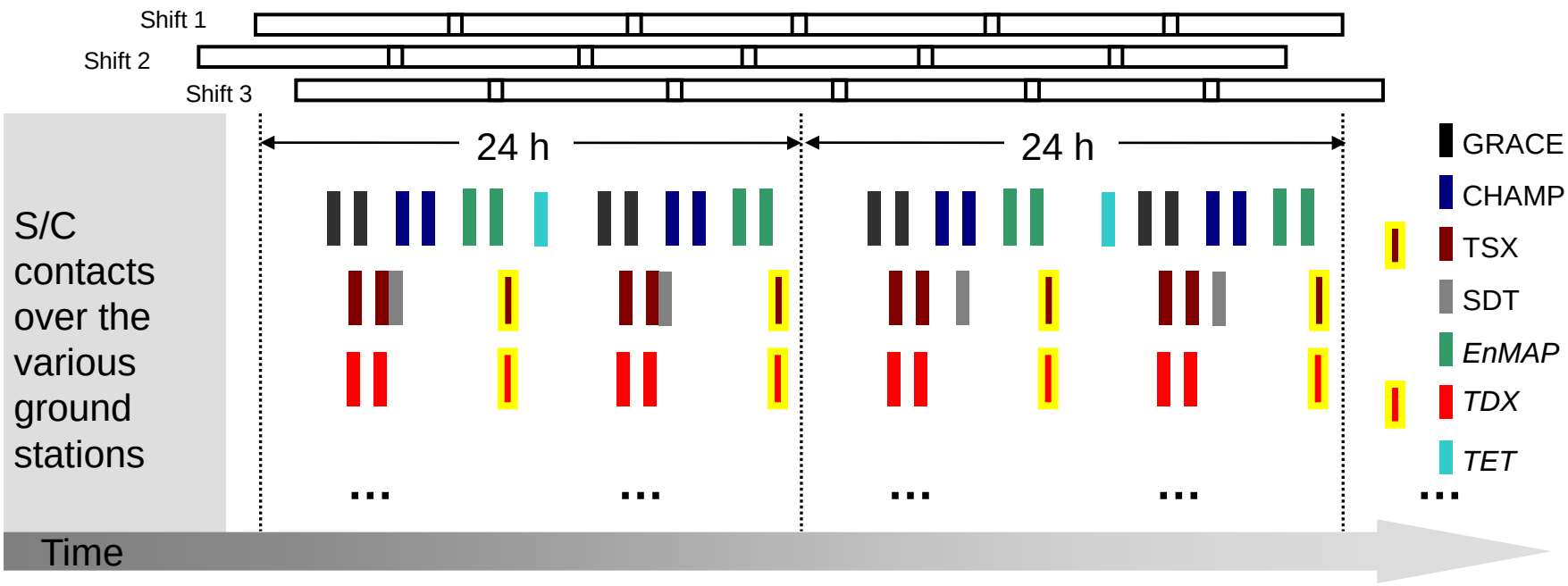


Benefits

- Automated way (Availability 24/7)
- Fast - Short-term orders possible
- High Efficiency
- Cost-effective
- Minimal effort for operations

How the space operations contribute to climate change monitoring? Land-cover aspects

- (Cost) effective missions operations via multi-mission approach (1)
- Synergy between different missions of similar aspects of operations
  - 2 TMTC-contact sessions per day per satellite (for max. 10min)



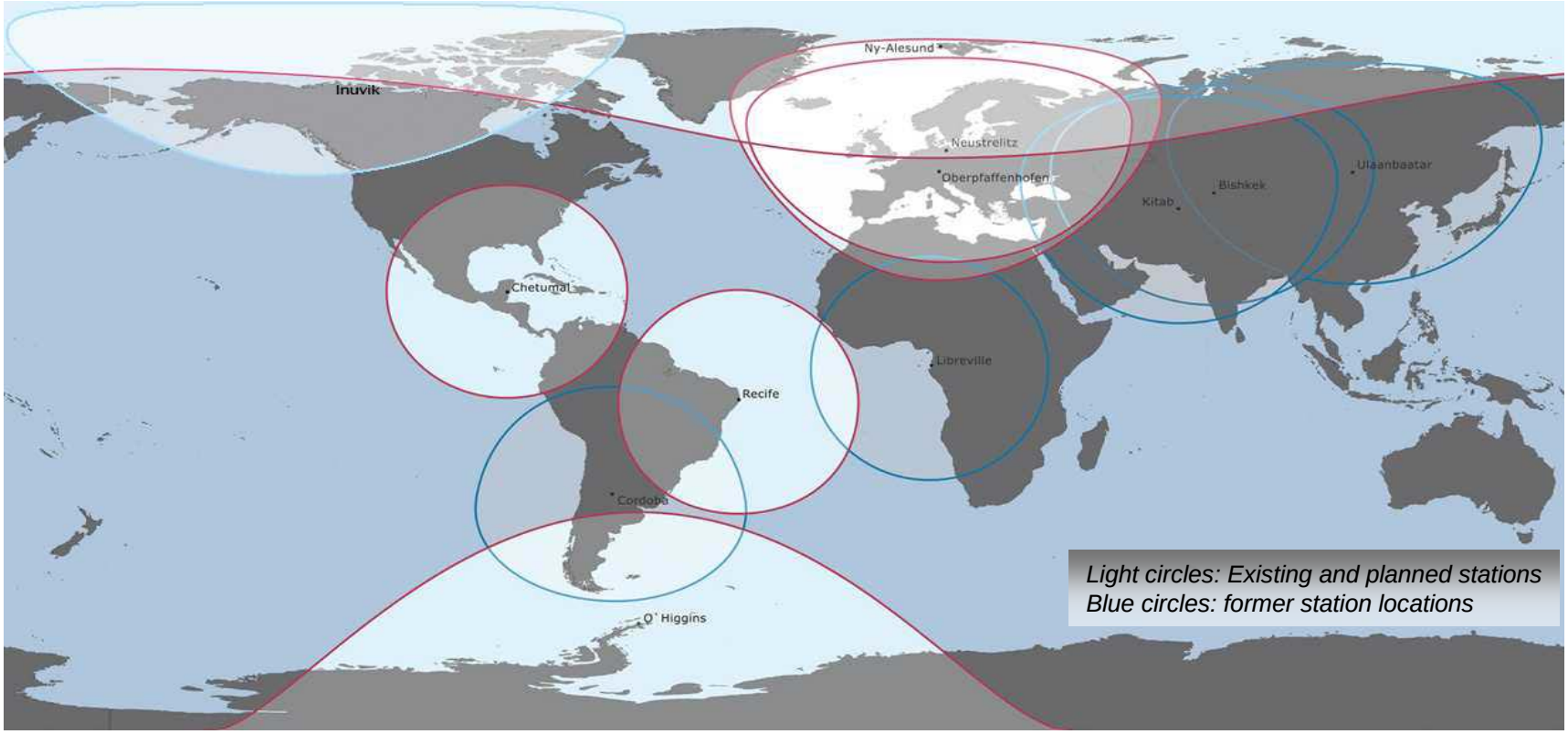
How the space operations contribute to climate change monitoring? Land-cover aspects

- (Cost) effective missions operations via multi-mission approach (2)

- Synergy between different missions of similar aspects of operations
  - Experienced operators familiar with the different types of satellites and missions
  - Within the same control room

How the space operations contribute to climate change monitoring? Land-cover aspects

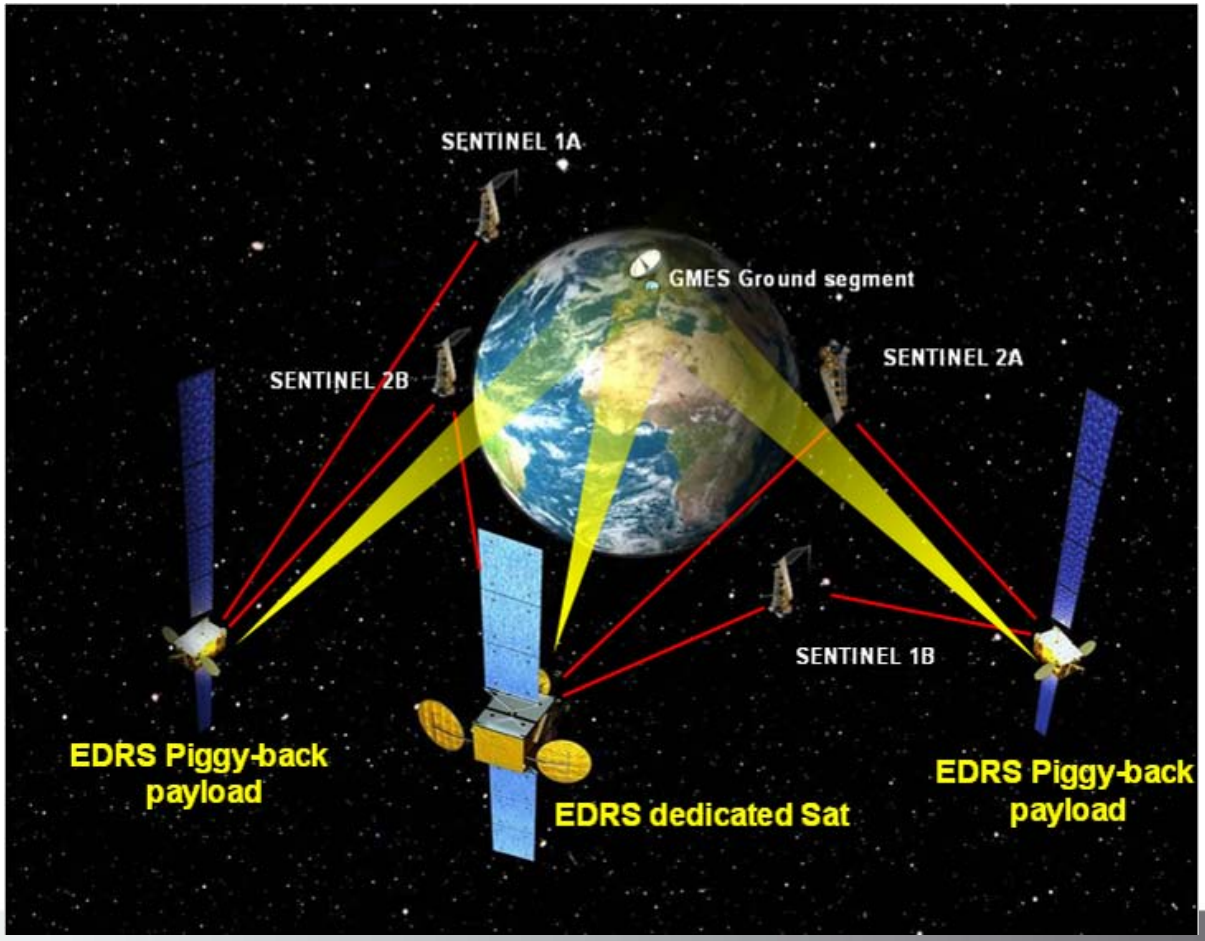
- Payload data acquisition (at the example of the DLR GS-network)



How the space operations contribute to climate change monitoring? Land-cover aspects

way forward:

European Data Relay Satellite (EDRS) & GMES



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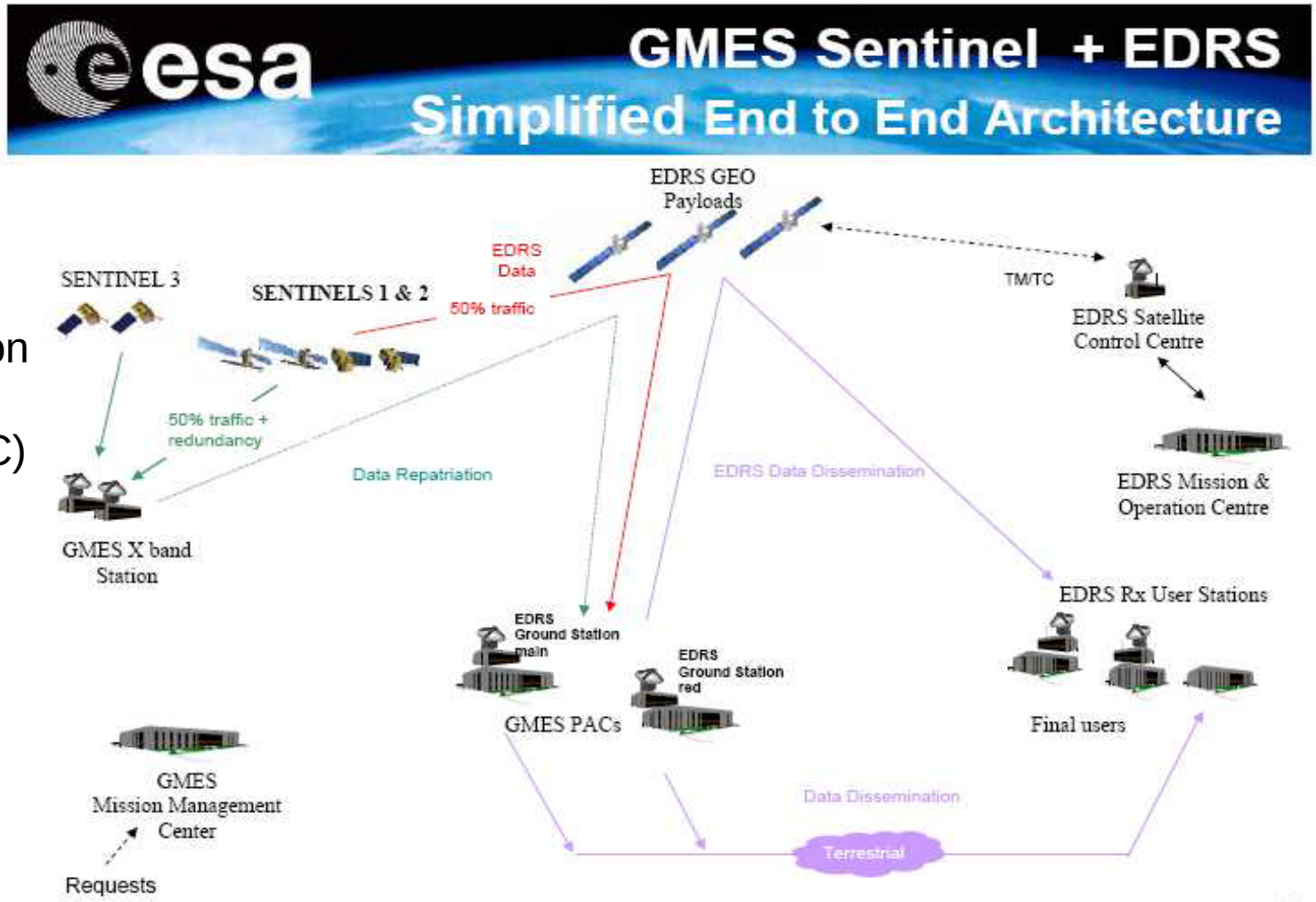
way forward: European Data Relay Satellite (EDRS) & GMES

-LCT on-board Terminals

- Ka-Band acquisition

- Data Centers (PAC)