TERRASAR-X / TANDEM-X MISSION AND CALIBRATION STATUS

with a Detailed Analysis of Rainforest LTSM Time-Series Data

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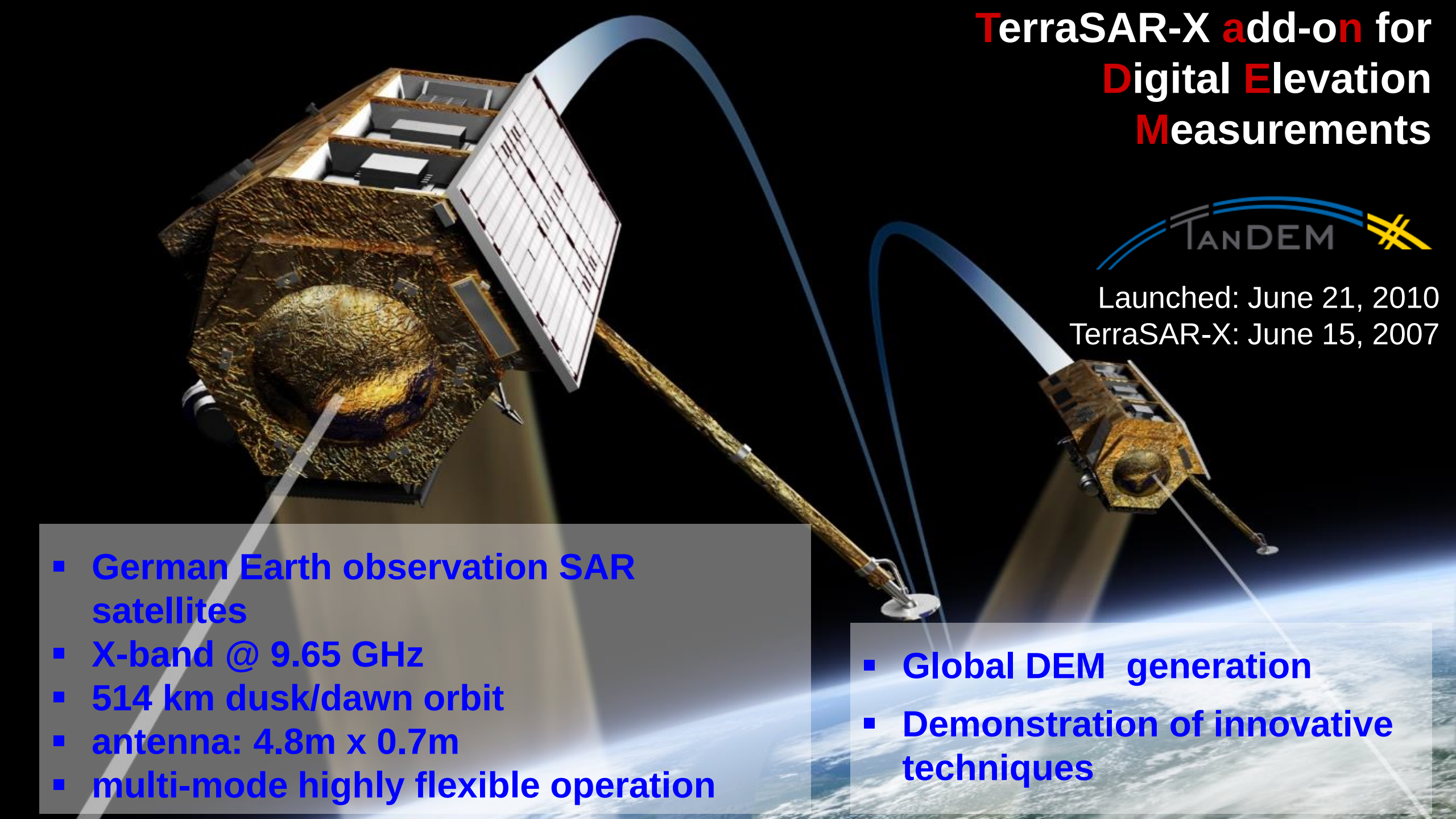
TerraSAR-X add-on for Digital Elevation Measurements

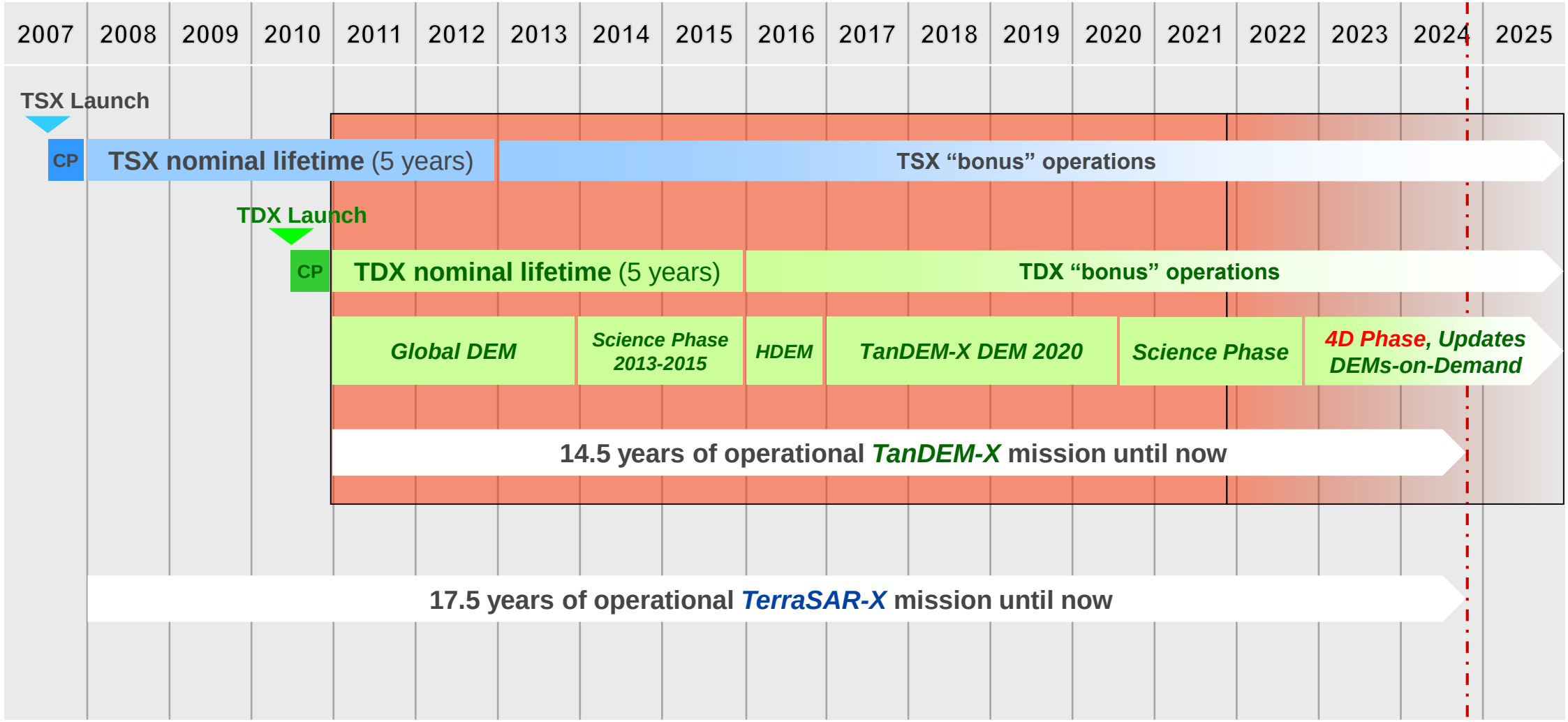


Launched: June 21, 2010
TerraSAR-X: June 15, 2007

- German Earth observation SAR satellites
- X-band @ 9.65 GHz
- 514 km dusk/dawn orbit
- antenna: 4.8m x 0.7m
- multi-mode highly flexible operation

- Global DEM generation
- Demonstration of innovative techniques

Current TerraSAR-X/TanDEM-X Mission Timeline



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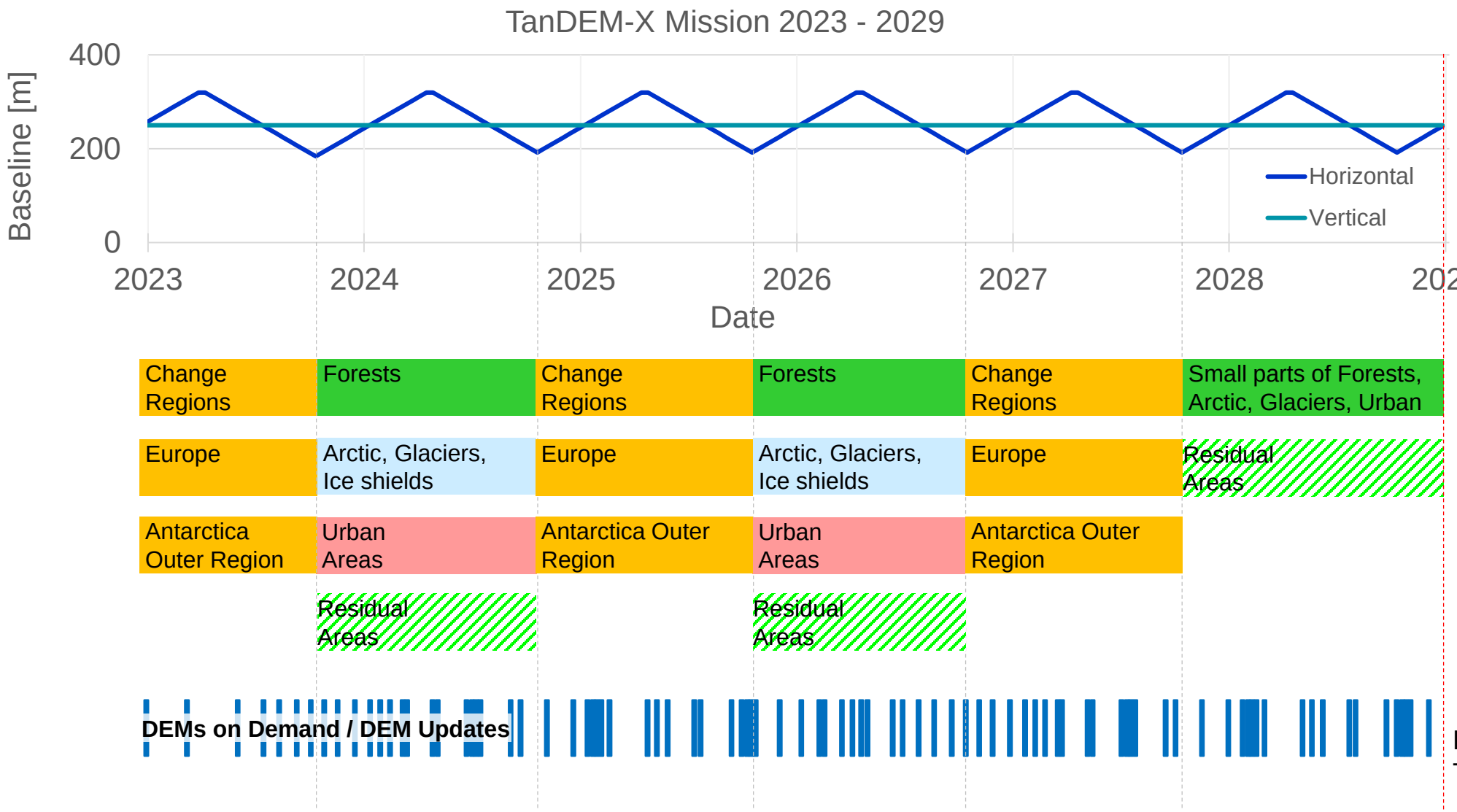
TanDEM-X 4D Phase – Long-Term Timeline 2023 - 2029



Fuel saving:
Drifting formation via inclination difference as for Tandem-L

Battery preservation:
Shorter DTs ~ 40 sec with gaps afterwards

Projected end of TanDEM-X Mission

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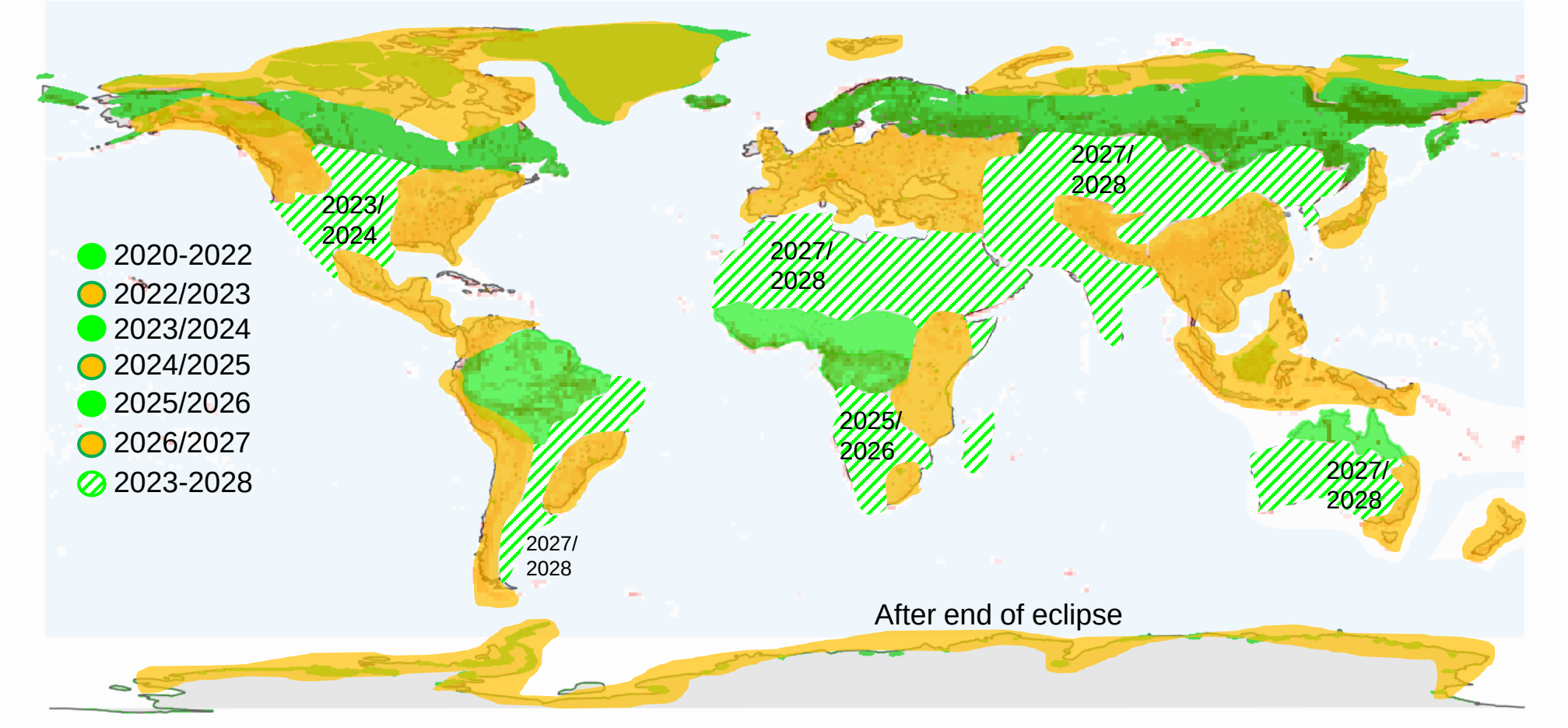
TanDEM-X 4D Phase – Long-Term Coverage Plan 2020 - 2028



- Multi-Temporal Coverages of the Earth over more dynamic height changes
- Also try to cover more stable areas once more only

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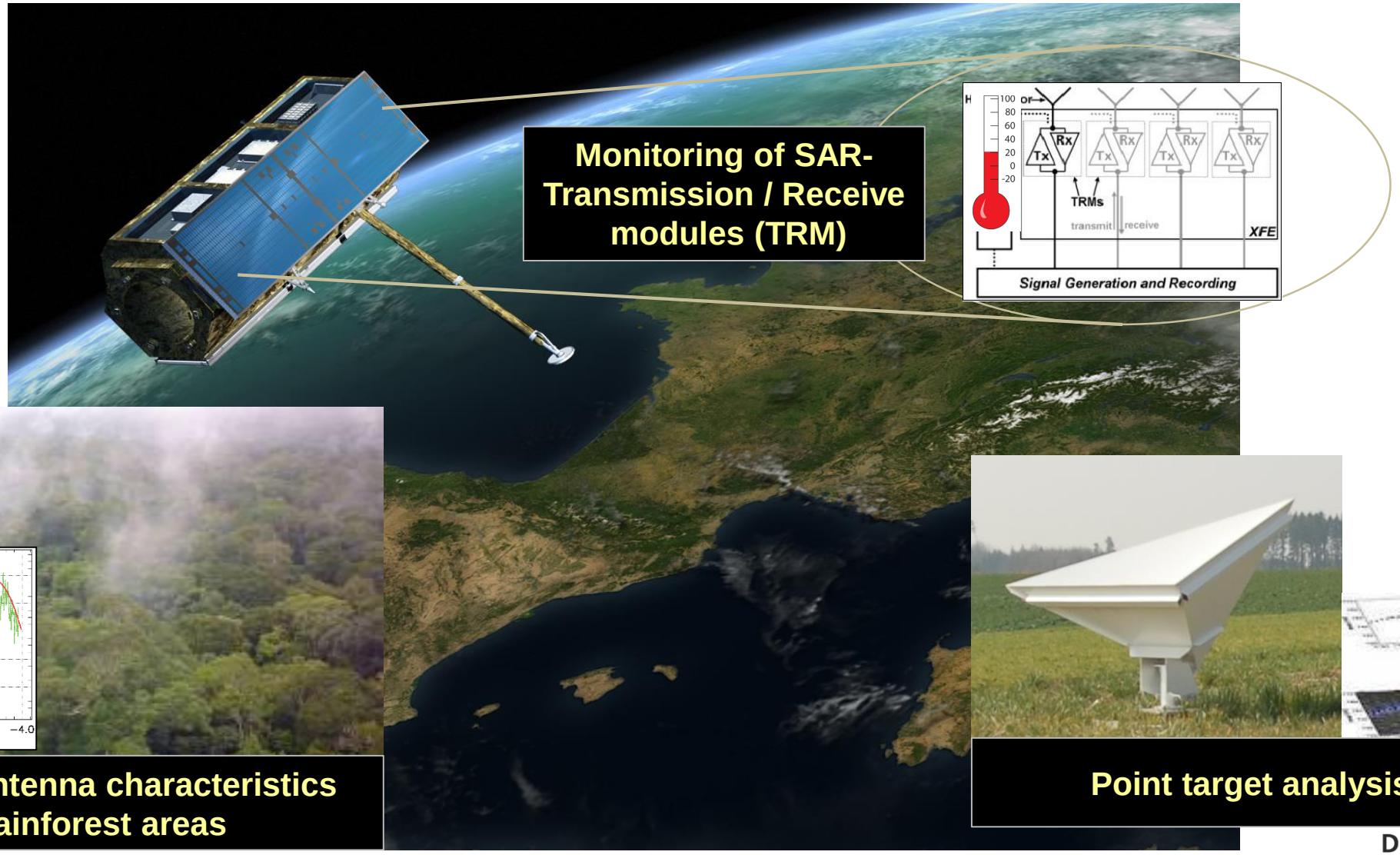
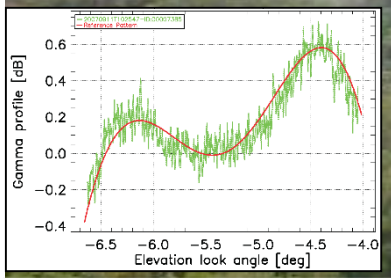
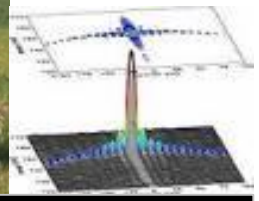
Long Term System Monitoring Tasks of TerraSAR-X / TanDEM-X



Monitoring of SAR-Transmission / Receive modules (TRM)



Monitoring antenna characteristics over rainforest areas



Point target analysis

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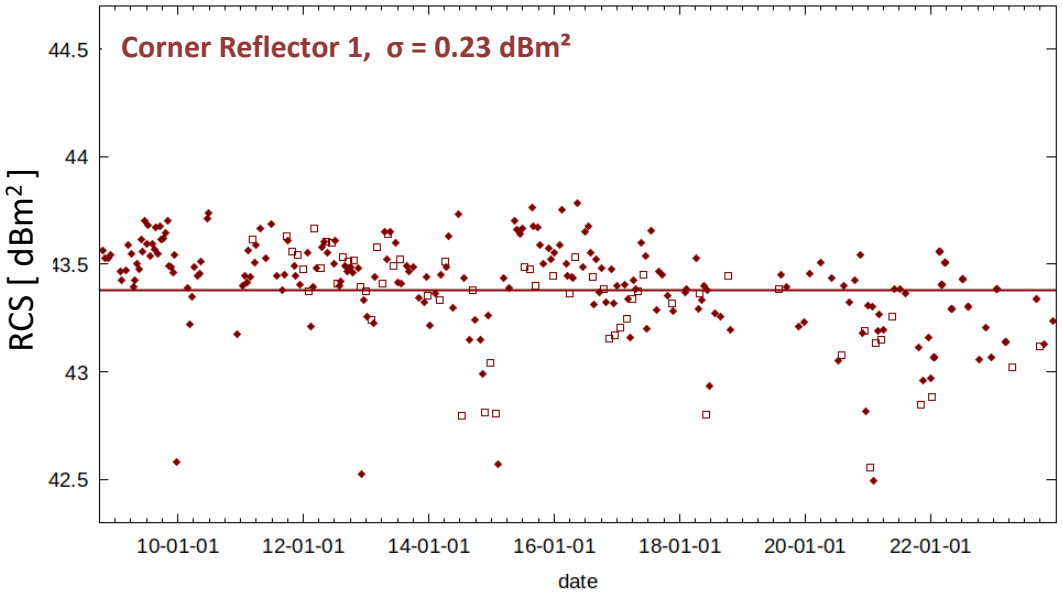
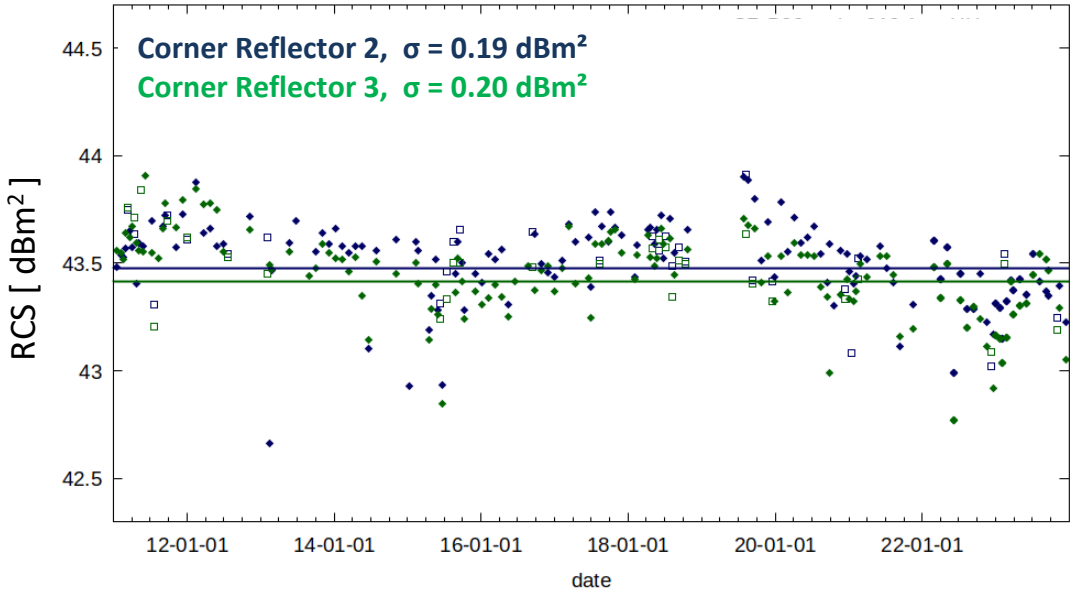
TSX / TDX Radiometric Performance (I)

TSX-1 radar cross section



TDX-1 radar cross section



DLR Calibration site Neustrelitz (Northern Germany)

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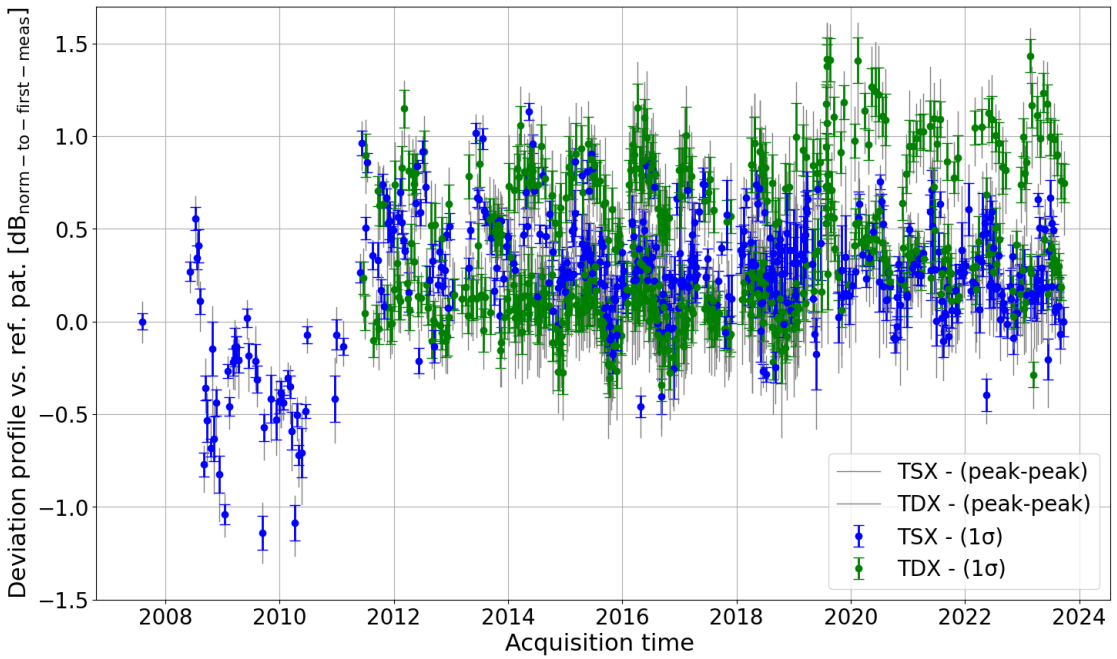
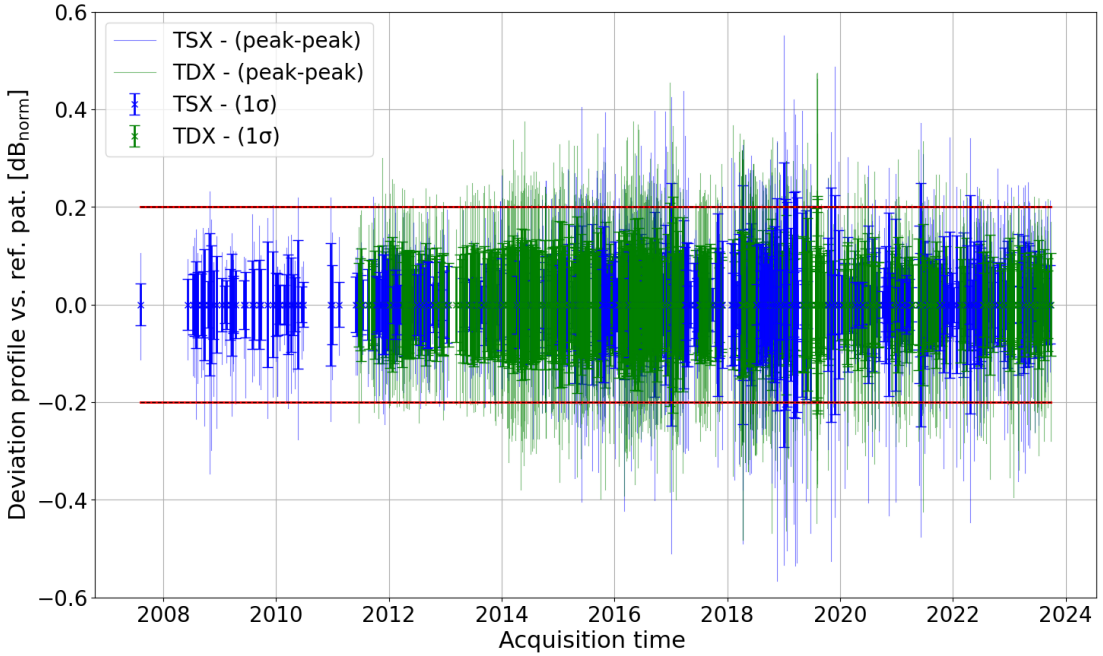
TSX / TDX Radiometric Performance (II)



TSX
TDX



- Rainforest acquisition evaluation confirms continued stable radiometric performance over mission lifetime
- Observable variation due to:
  - Seasonal / Geographic / Instrument variability
  - Unresolved topography, other non-homogeneities (e.g., due to increasing de-forestation)
  - Atmospheric variability
  - ….?

→ let's find out!

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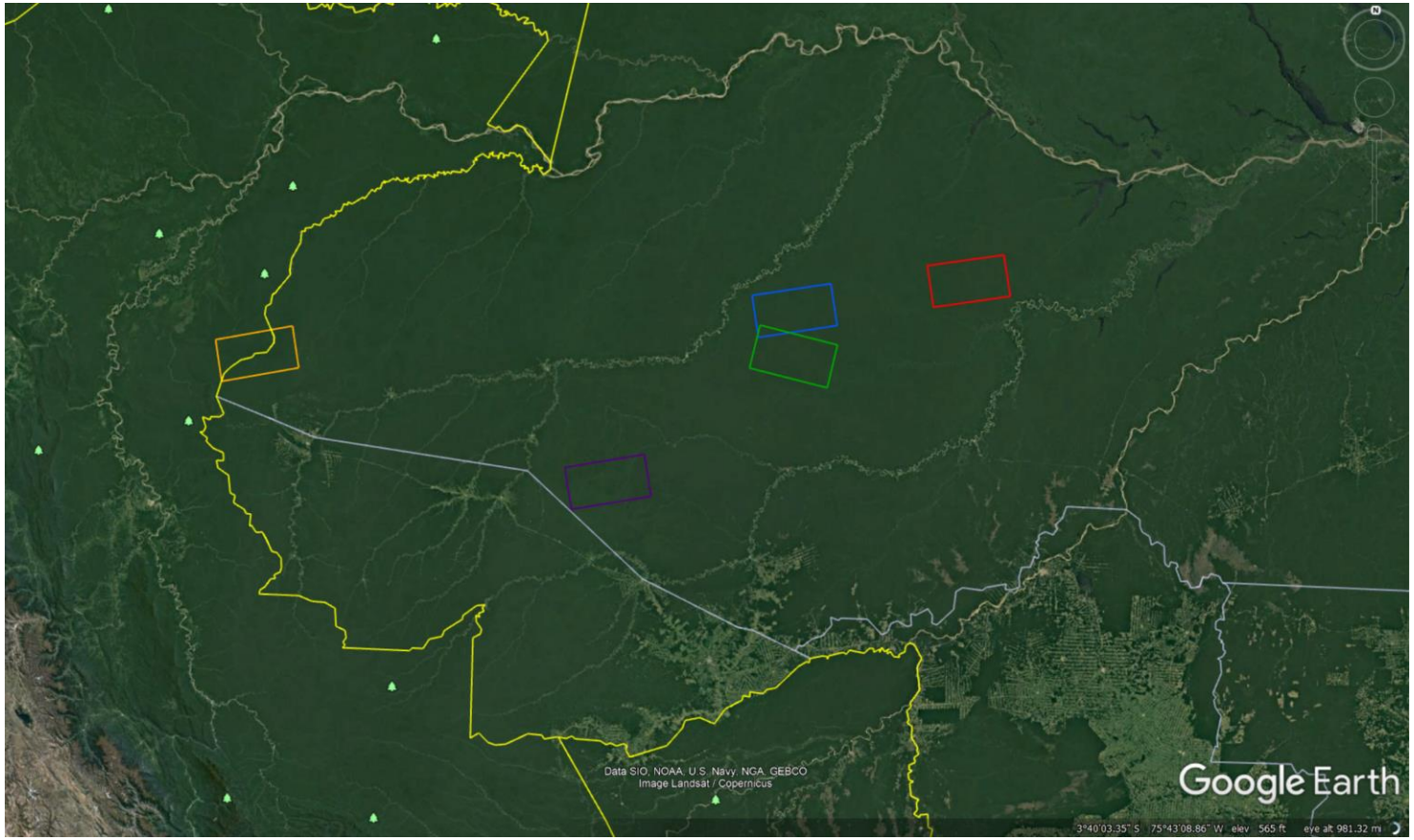
Amazon Rainforest Sites Used for LTSM - Overview

More than **15 years of ScanSAR** data taken across the Amazon rainforest**:**

- *ts1*: TDX-1 Early Afternoon (Scan_003 HH)
- *ts2*: *TSX-1* Afternoon (Scan_011 HH)
- *ts3*: TDX-1 Mid Afternoon (Scan_003 HH)
- *ts4*: *TSX-1* **Morning** datatakes (Scan_003 HH)
- *ts5*: TDX-1 Late Afternoon (Scan_003 HH)



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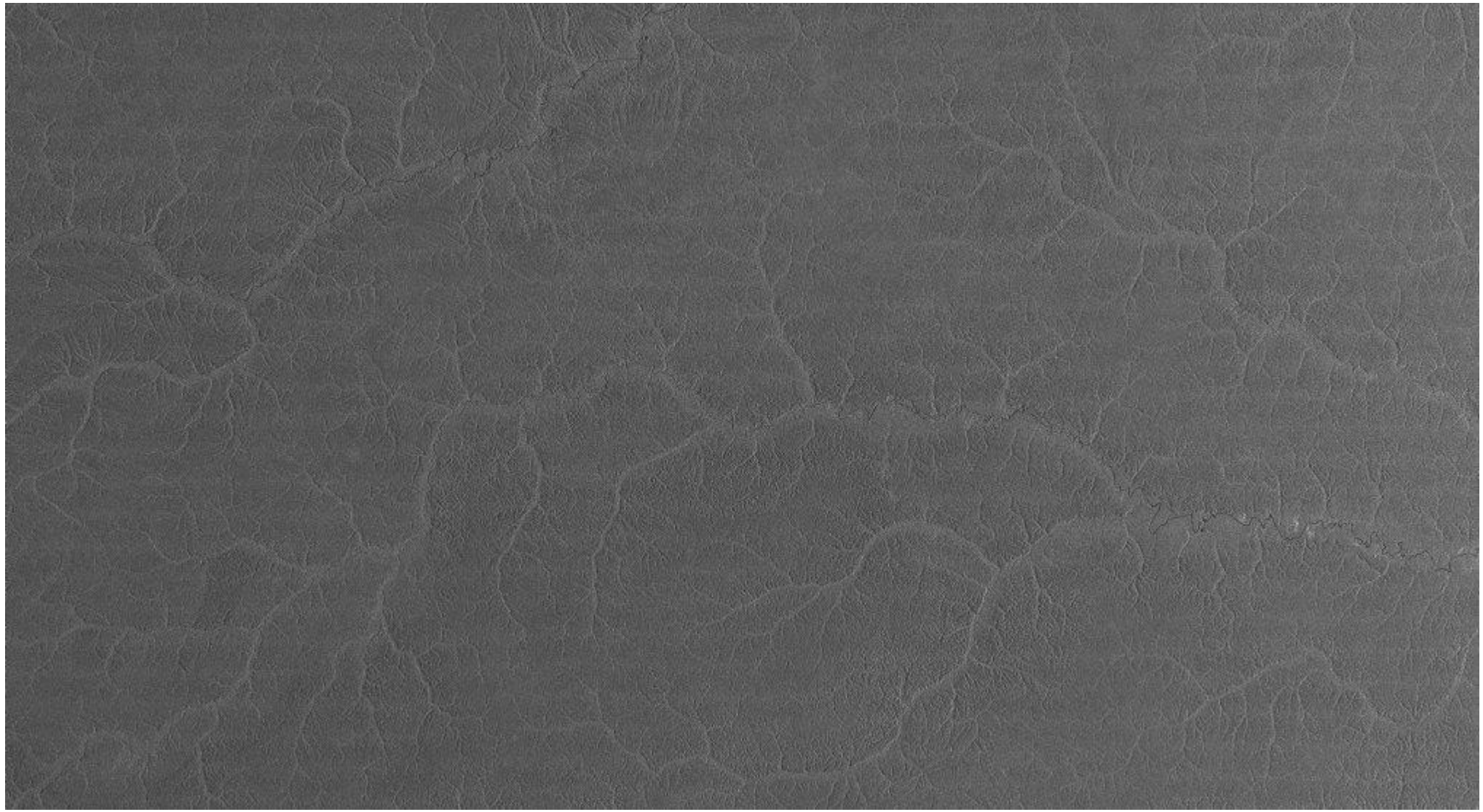
Longterm variability – Example DTs TSX 2013 - 2021



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Amazon Rainforest Sites Used for LTSM – Analysis Rationale

- Amazon Rainforest Acquisitions: Rich dataset over whole mission lifetime
- Previously only (continuously) evaluated against SAR performance requirements
- Much more to be learnt from these data, e.g. analyzing:
  - Long-term trends and seasonal variations
  - TSX vs. TDX instrument behavior
  - Morning vs. afternoon (approx. same location)
  - Different geographic locations for same instrument and same ToD
  - Different incidence angles

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Quantitative Evaluation of Trends and Variation in LTSM data

- Observed linear trend in absolute rainforest backscatter:

	ts1	*ts3*	*ts5*	*ts2*	*ts4*
Amplitude slope (dB/decade)	< -0.01	-0.09	< -0.01	-0.04	-0.24

- Seasonal variation amplitude variation

	ts1	*ts3*	*ts5*	*ts2*	*ts4*
Amplitude (dB)	0.12	0.10	0.07	0.11	0.14

- Virtually no longterm trend for afternoon DTs, very small trend for morning DT series
- Seasonal variation of about 0.1 dB consistently observable

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Conclusions & Outlook

- Both TerraSAR-X and TanDEM-X satellites are **ageing but fully functional**
- LTSM still shows their **continued excellent** SAR imaging **performance**
- Detailed analysis of Amazon rainforest data reveals:
  - Power of consistent longterm datasets
  - Virtually no longterm trends for afternoon DTs, very small decrease of absolute backscatter for morning DT series
  - **Seasonal variation of about 0.3 dB** consistently observable

- **Further Questions? Contact me @ Patrick.Klenk@dlr.de or find me here:**

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