German Aerospace Center
Space Administration - National Report

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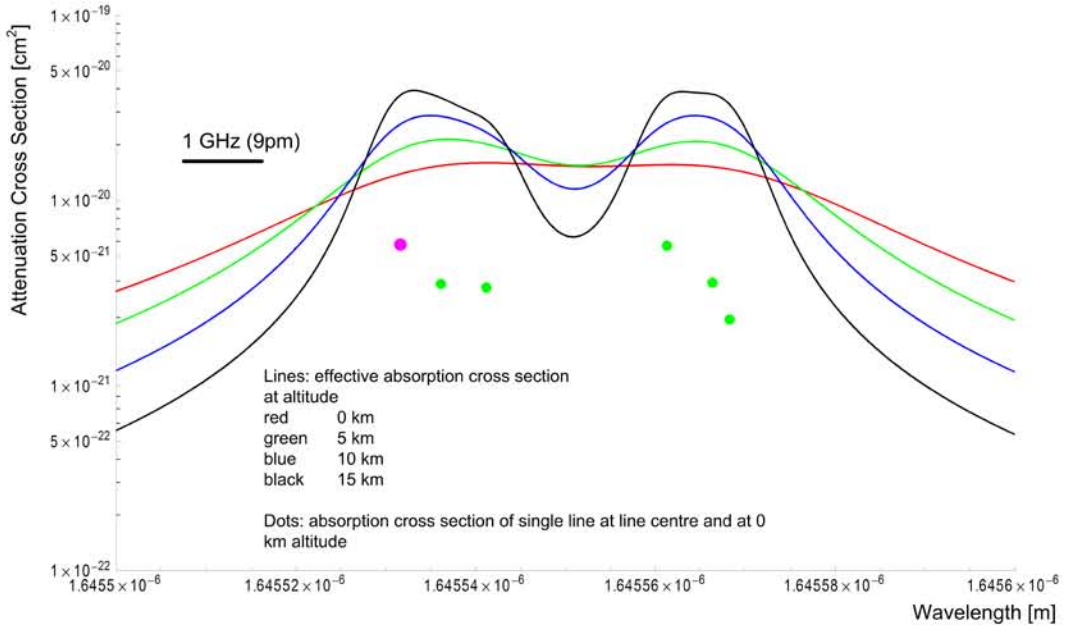
DLR

Outline

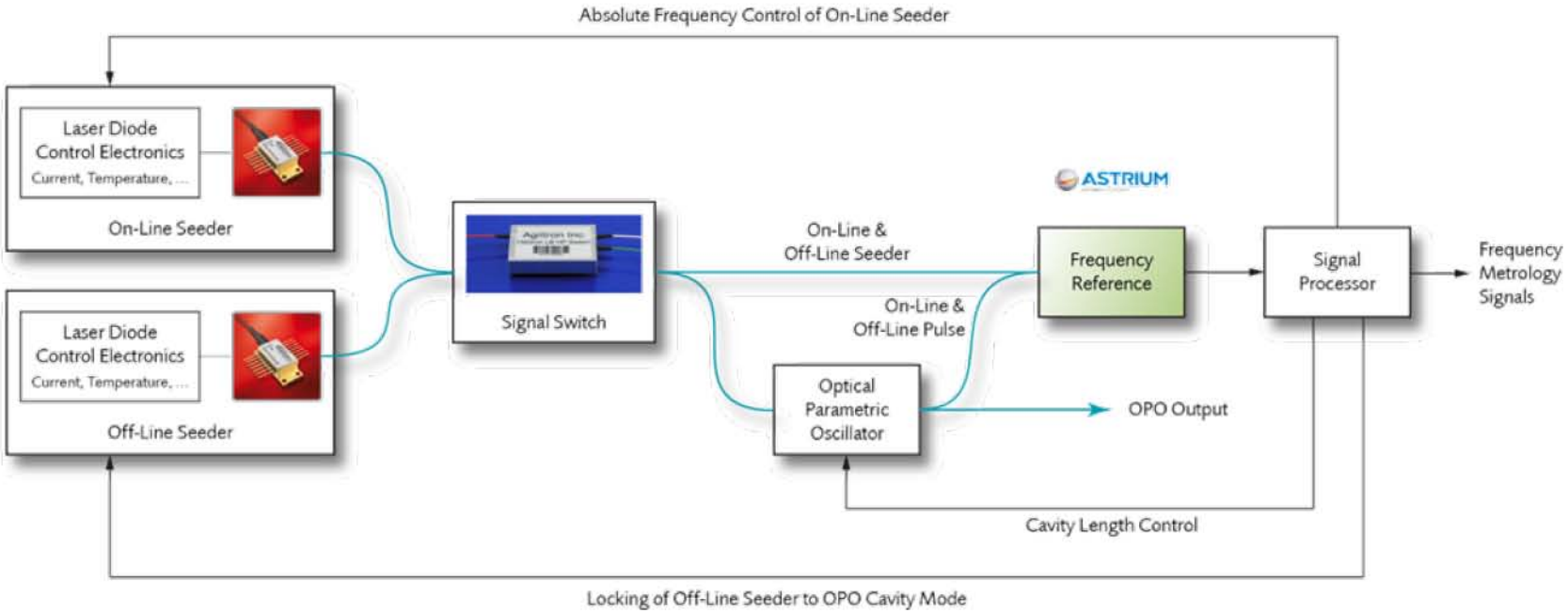
- Cal/Val of atmospheric composition missions
  - **Merlin**
    - Calibration scheme (DLR, Astrium, Kayser & Threde)
    - Validation plan outline
  - **SCIAMACHY**
    - Degradation correction
    - Inter-calibration needs
  - Status **TerraSAR-X and TanDEM-X** mission

Merlin LIDAR Calibration
Frequency control (I)

- Merlin requires an high precise control of the emitted laser frequency
- Choice: the Methane CH4 line sextet around 1645.55 nm
- The Doppler broadened line profile is illustrated



Merlin LIDAR Calibration
Frequency control (II)



Merlin LIDAR Calibration
Pulse Energy Calibration (Kayser-Threde)

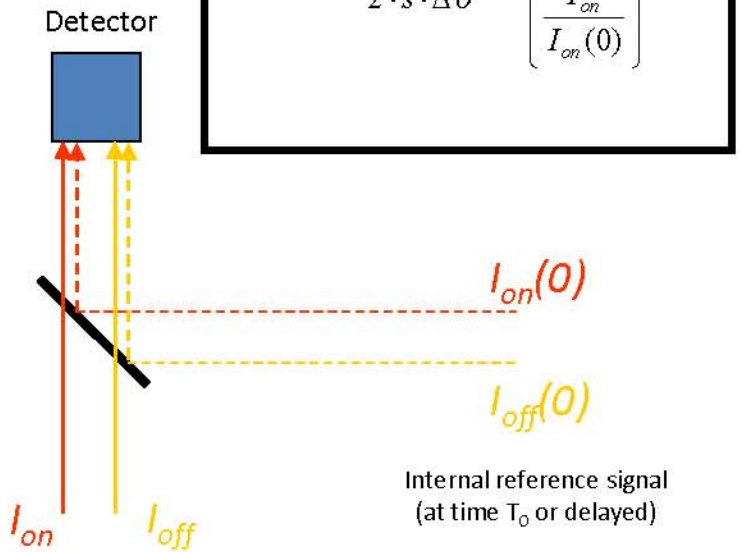
LIDAR system is purely based on intensity measurements (comparison of ground return signals on λ_{on} and λ_{off})

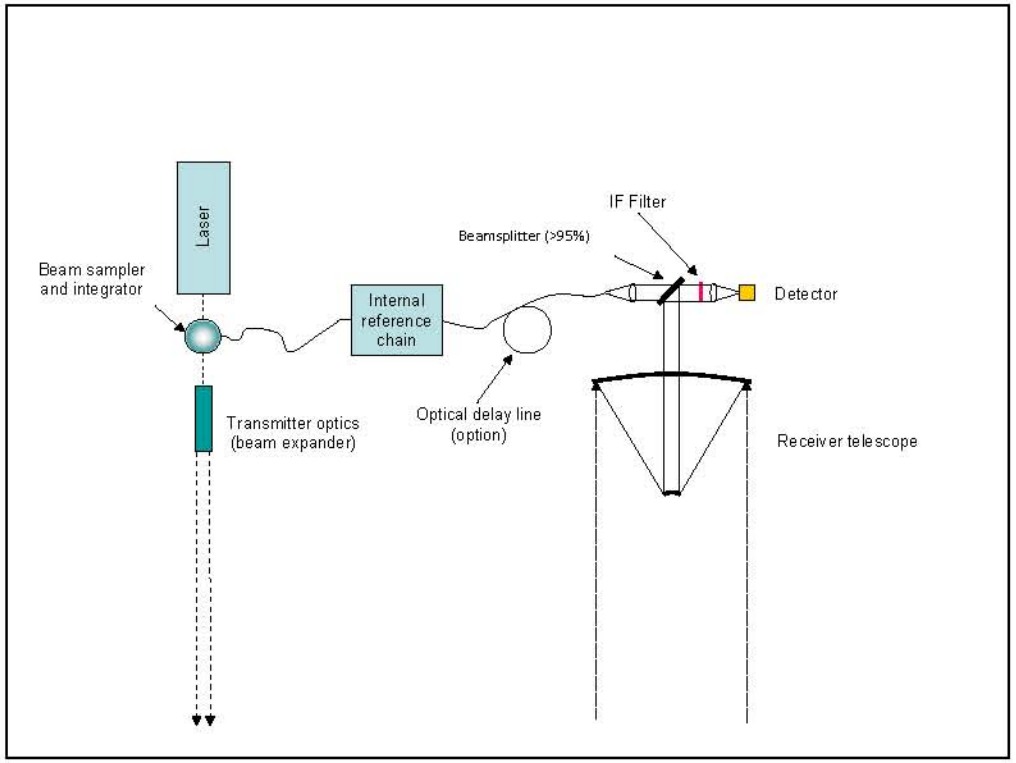
- Only **relative** intensity measurements – no absolute scaling.
- Intensity of received ground return signal is affected by:
  1: Attenuation due to optical throughput of transmitter and receiver optics, filter characteristics, detector responsitivity.
  2: Attenuation due to atmospheric trace gas of interest; (λ_{on} only).
  3: Attenuation due to atmospheric extinction and Earth albedo.
  4: Variation of laser pulse energy (up to 3…5%).

- Points 1 and 3: Equally affected for "λ_{on}" and „λ_{off}" → cancelled out.
- Point 2: Parameter of interest → to be quantified.
- Point 4: Individual effect → cannot be removed.

Merlin
Principle of Laser Pulse Energy Calibration

$$n = \frac{1}{2 \cdot s \cdot \Delta\sigma} \cdot \ln\left\{\frac{\frac{I_{off}}{I_{off}(0)}}{\frac{I_{on}}{I_{on}(0)}}\right\}$$





Single detector: → Both signals (I_x and I_x (0)) need to be of similar intensity

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Merlin
Validation Plan Organization

- **DLR Space Administration provided a DRD for a Validation Plan**
  (first time developed for EnMAP, then adopted for MERLIN)
- **Strategy (*Based on representativity with respect to instrument sampling, time window, space separation)***
- ***Preparation and tests (pre-launch) Validation***
  (Can be done in framework of national or international campaigns)
- ***Validation (Post-Launch) by operational networks***
- ***Validation during field Campaigns (Post-Launch)***
  (Opportunities, Special field campaigns organized by MERLIN project)

➔ **Recommendation: Development of DRD for Validation Plans!**
(this slides is an extract of some more……)

SCIAMACHY on ENVISAT

Recent Results and Achievements

H. Bovensmann (University of Bremen),
and the SCIAMACHY Quality Working Group
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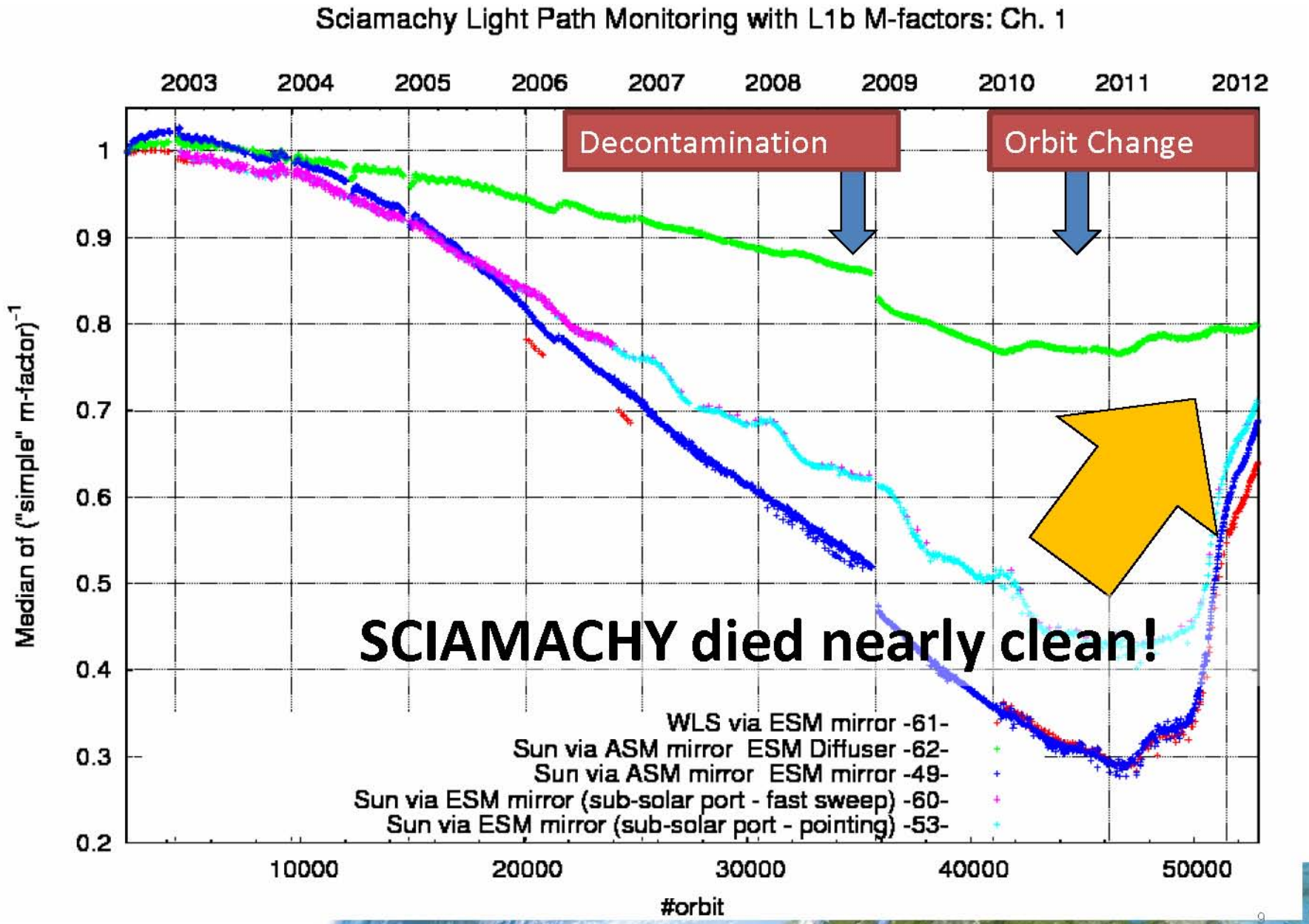
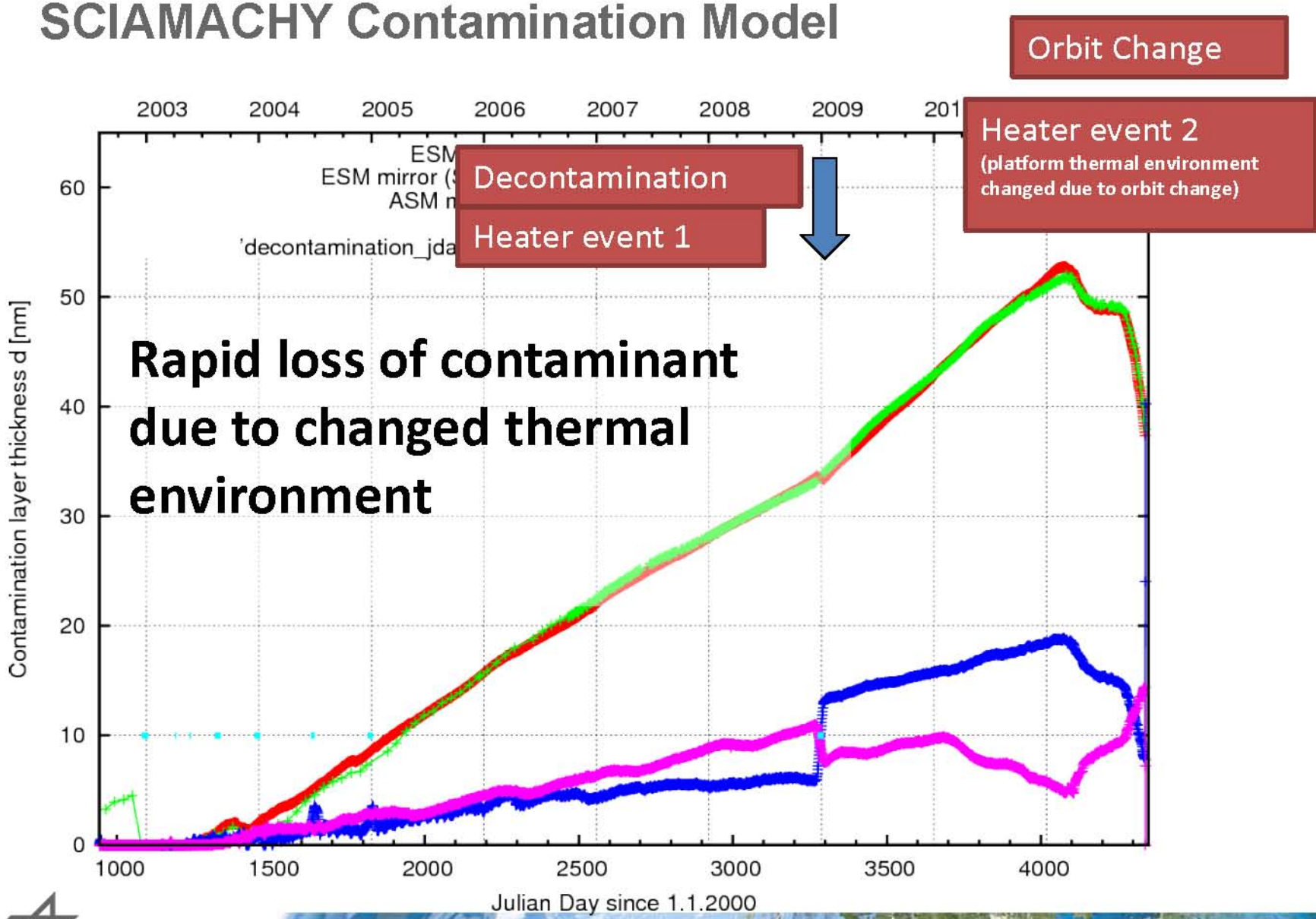

Sciamachy Light Path Monitoring with L1b M-factors: Ch. 1
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Decontamination
Orbit Change
Median of ("simple" m-factor)$^{-1}$
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
SCIAMACHY died nearly clean!
WLS via ESM mirror -61-
Sun via ASM mirror ESM Diffuser -62-
Sun via ASM mirror ESM mirror -49-
Sun via ESM mirror (sub-solar port - fast sweep) -60-
Sun via ESM mirror (sub-solar port - pointing) -53-
10000
20000
30000
40000
50000
#orbit

SCIAMACHY Contamination Model



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SCIAMACHY stratospheric NO2: ESA V5.02 vs. IUP V3.1

Mean relative difference

Tropics (30°S-30°N)

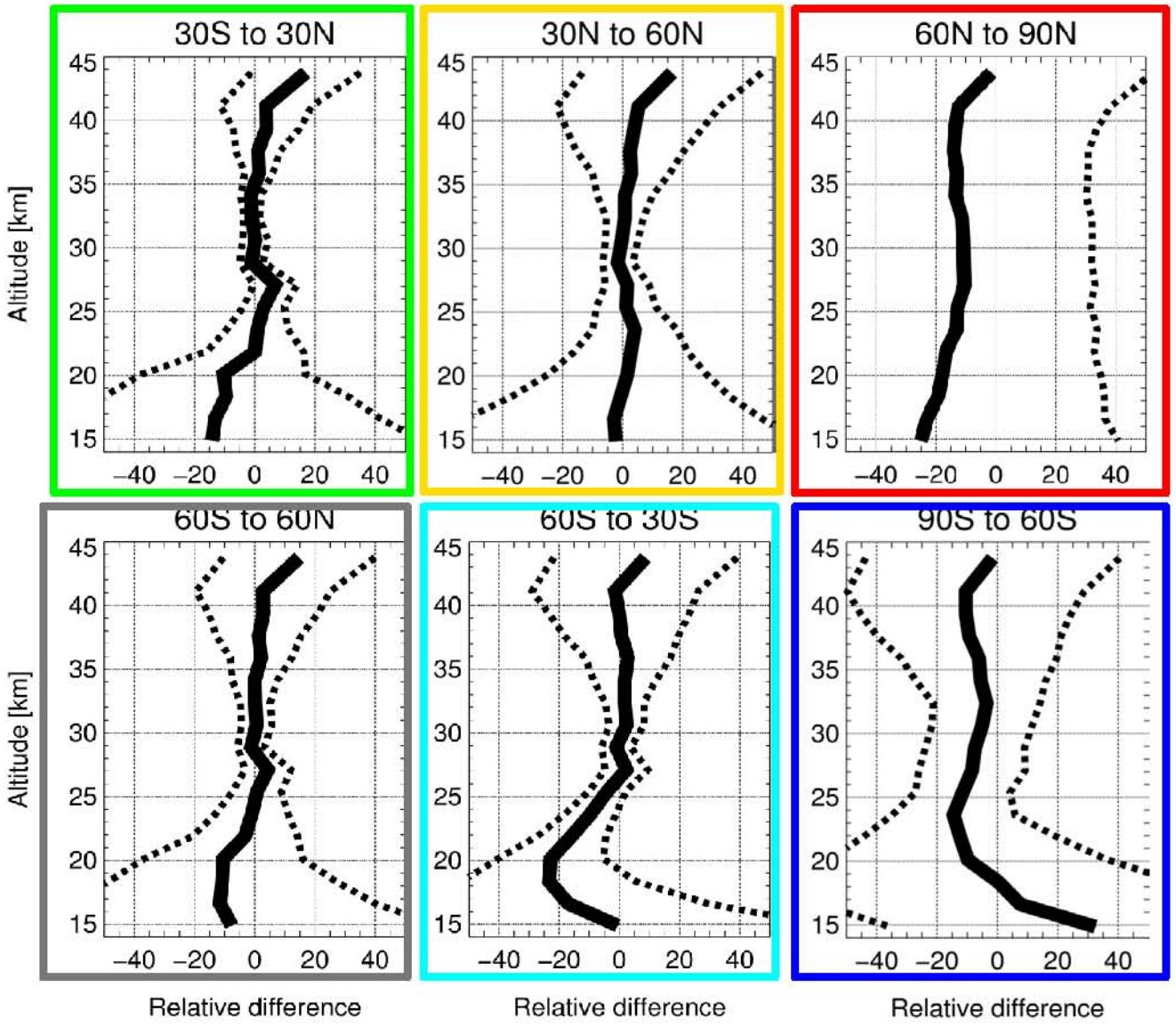
Near global (60°S-60°N)

NH mid latitudes (30°N-60°N)

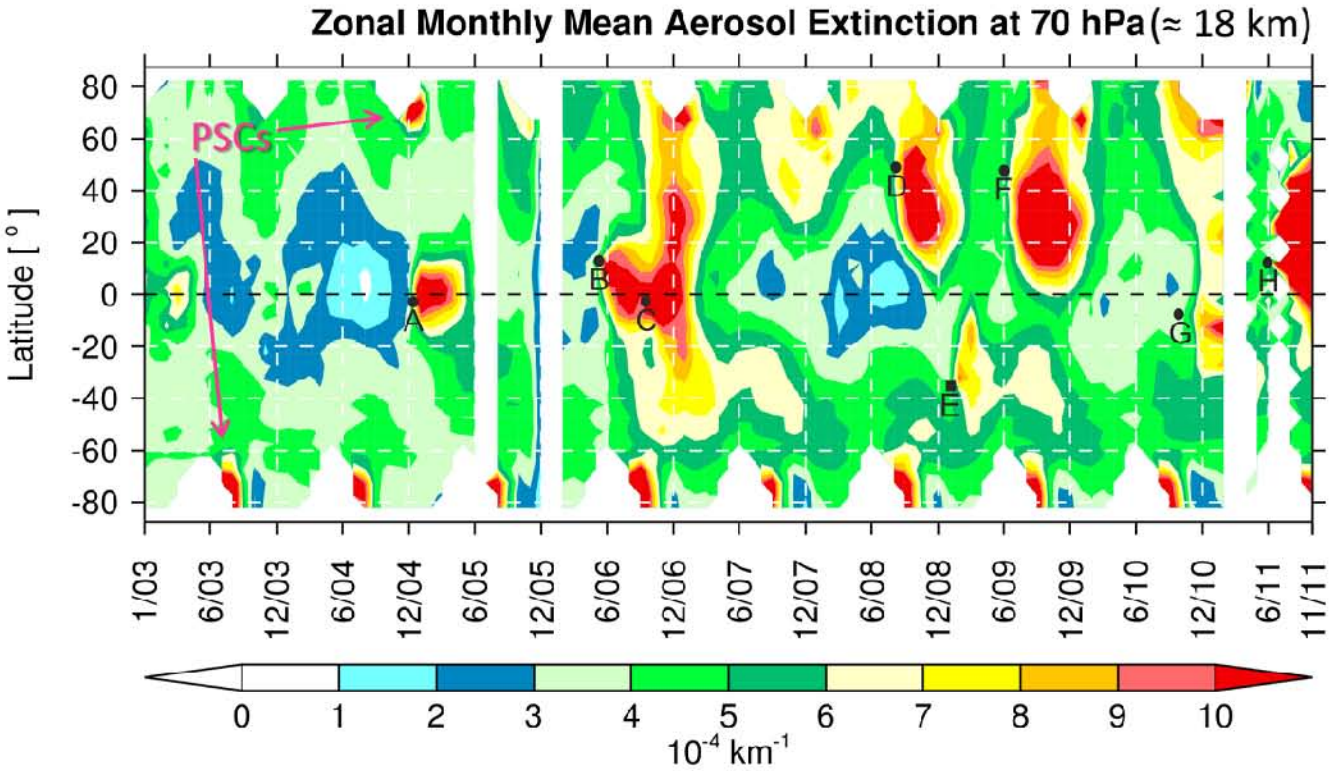
SH mid latitudes (60°S-30°S)

NH arctic (60°N-90°N)

SH arctic (90°S-60°S)

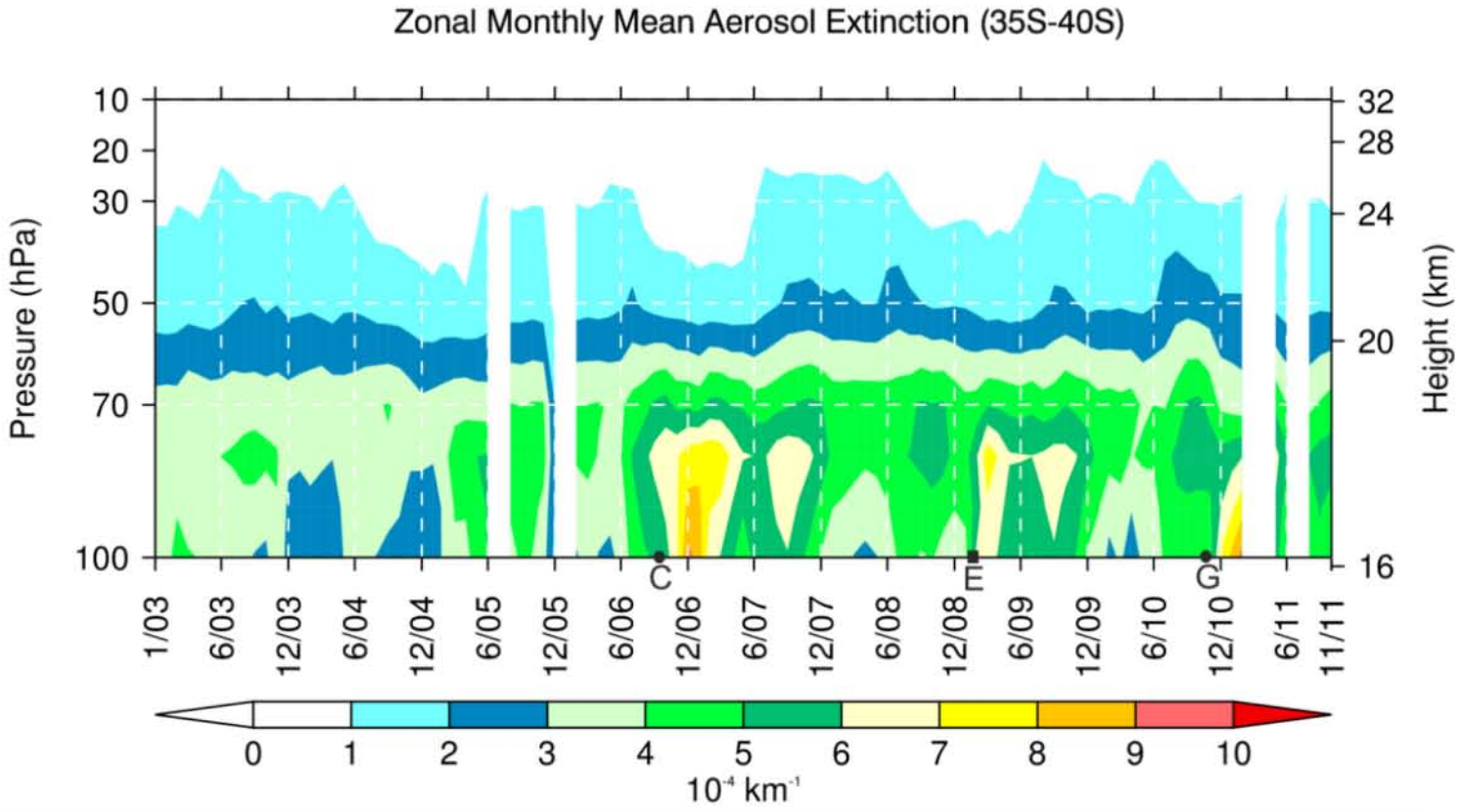


SCIAMACHY lower strat. aerosol: volcaneos and bushfires



A) Manam, Jan `05, 4°S	E) Black Saturday Australia, 7 Feb-14 March `09 37°S
B) Soufriere Hills, May `06, 16°N	F) Sarychev Peak, June `09, 48°N
C) Tavurvur, Oct `06, 4°S	G) Mount Merapi, Oct `10, 7°S
D) Kasatochi, Aug `08, 52°N	H) Nabro, June `11, 13°N

DLR



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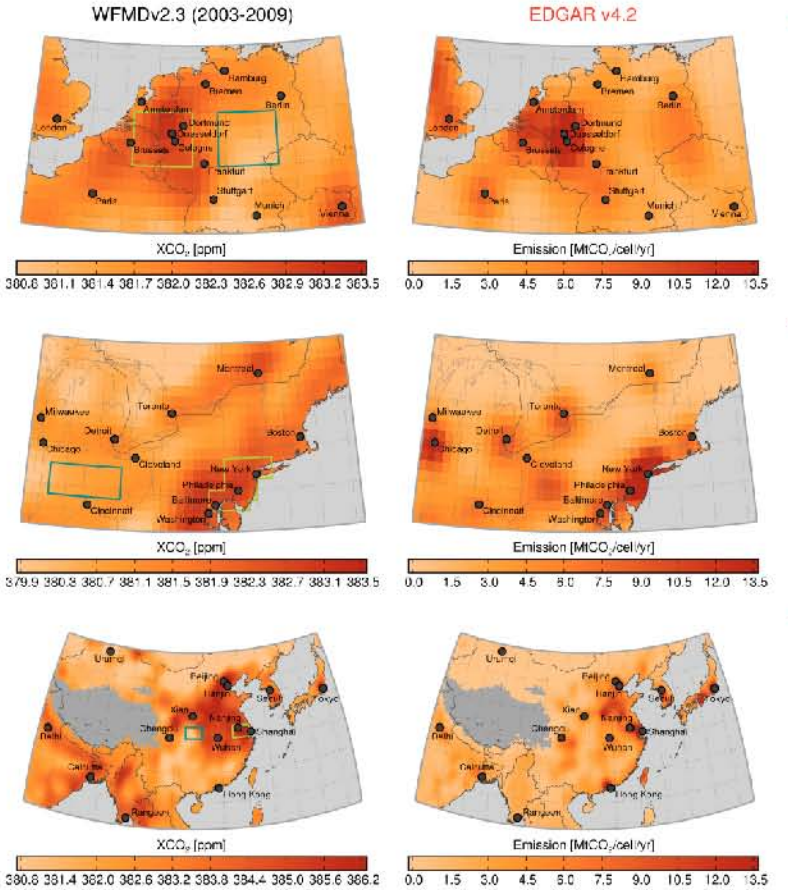
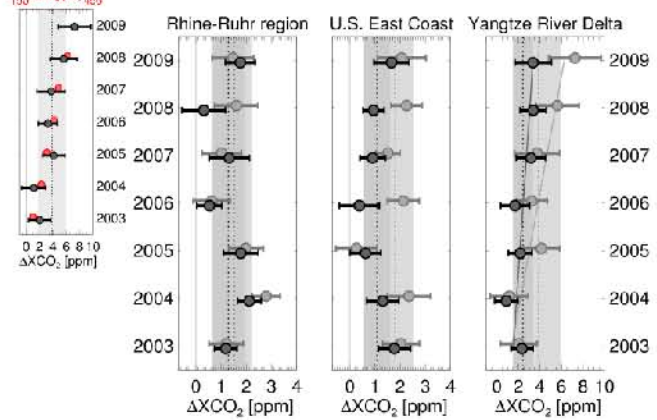
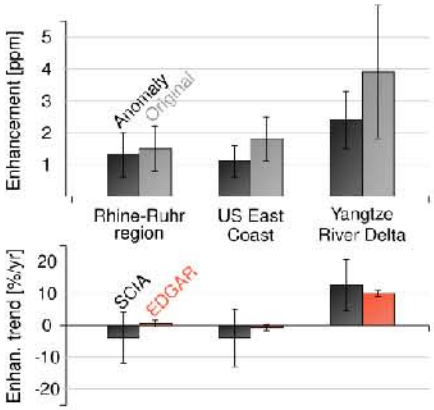
SCIAMACHY CO_2: Anthropogenic source regions



- Enhanced concentrations observable in anthropogenic source regions
- Signal stable over the years
- Positive trend in China
- Trends consistent with EDGAR emissions





Schneising et al., 2012 (ACP)

Recommendations or Suggestions

- Consistent and long time series of atmospheric constituents needs Cal/Val accompanied with instrument performance monitoring activity over mission lifetime
- Linkage between „historic“ data sets (GOME, SCIAMACHY), currently running missions (GOME-2, OMI, SUOMI-NPP OMPS) and future missions (Sentinel 5P/5, Sentinel 4, GEMS, TEMPO, etc.) needs to be calibrated consistently
- Cross-calibration projects needs to be established.

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Status TerraSAR-X / TanDEM-X

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Staring Spotlight Mode Product Characteristics

Parameter	Value
Scene extent for (20° - 45°)	[2.1 to 2.7 km] azimuth x [6 to 3.8 km] ground range - worst case x [7.5 to 4.6 km] ground range - typical case
Full performance incidence angle range	20° - 45°
Data access incidence angle range	15° - 60°
Number of elevation beams	58 (full performance) 122 (data access)
Number of azimuth beams	Depending on target area
Azimuth steering angle	± 2.2°
Azimuth resolution	**0.24 m** (single polarization)
Ground range resolution	0.85 m – 1.77 m (45°...20° at 300 MHz)
Polarizations	HH or VV (single)

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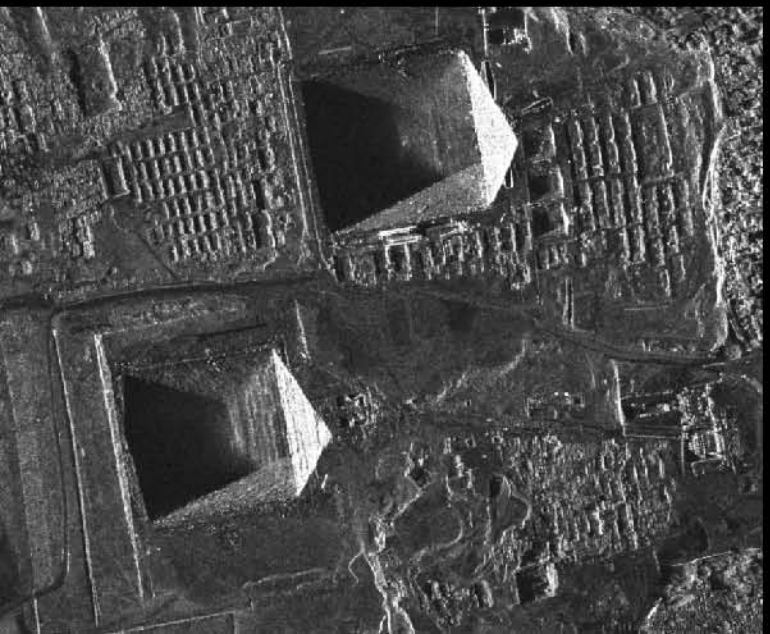
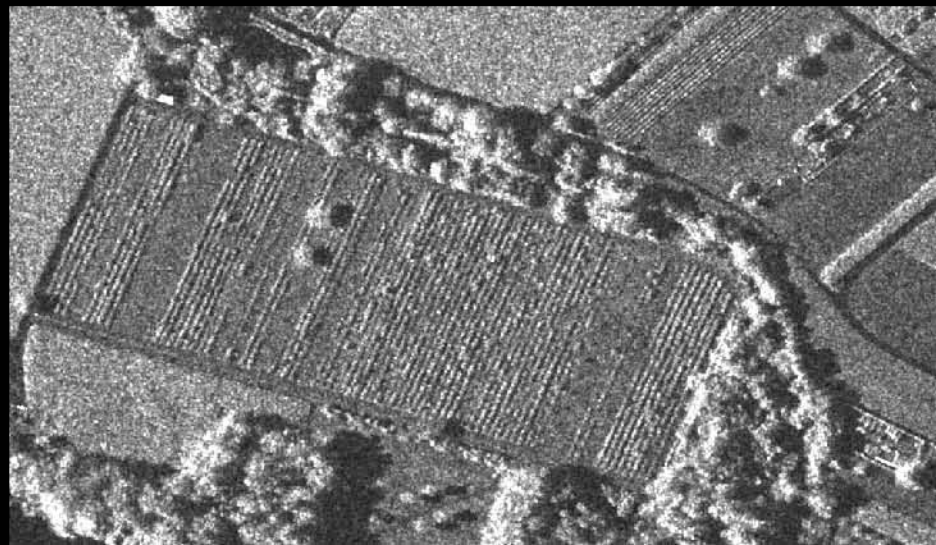
Examples...





Six Beam Wide ScanSAR Mode Product Characteristics

Parameter	Four beam ScanSAR	Six beam ScanSAR
Number of sub-swaths	4	6
Swath width (ground range)	100 km	**266 to 194 km** (wide_001 to wide_005)
Nominal L1b product length	150 km	200 km
Full performance incidence angle range	20° - 45°	15.6° - 49°
Data access incidence angle range	15° - 60°	15.6° - 49°
Number of elevation beams	27 (9 x 4 stripmap beam combinations in full perf. Range)	10 specific wide beams (5 x 6-beam combinations)
Azimuth resolution	18.5 m	40m
Range bandwidth	100 and 150 MHz	81.25 to 31.25 MHz
Ground range resolution	1.70 m - 3.49 m (@ 45°..20° incidence angle)	6-10m (projected slant range)
Polarizations	HH or VV (single)	HH or VV (single) or experimental HV or VH TBC

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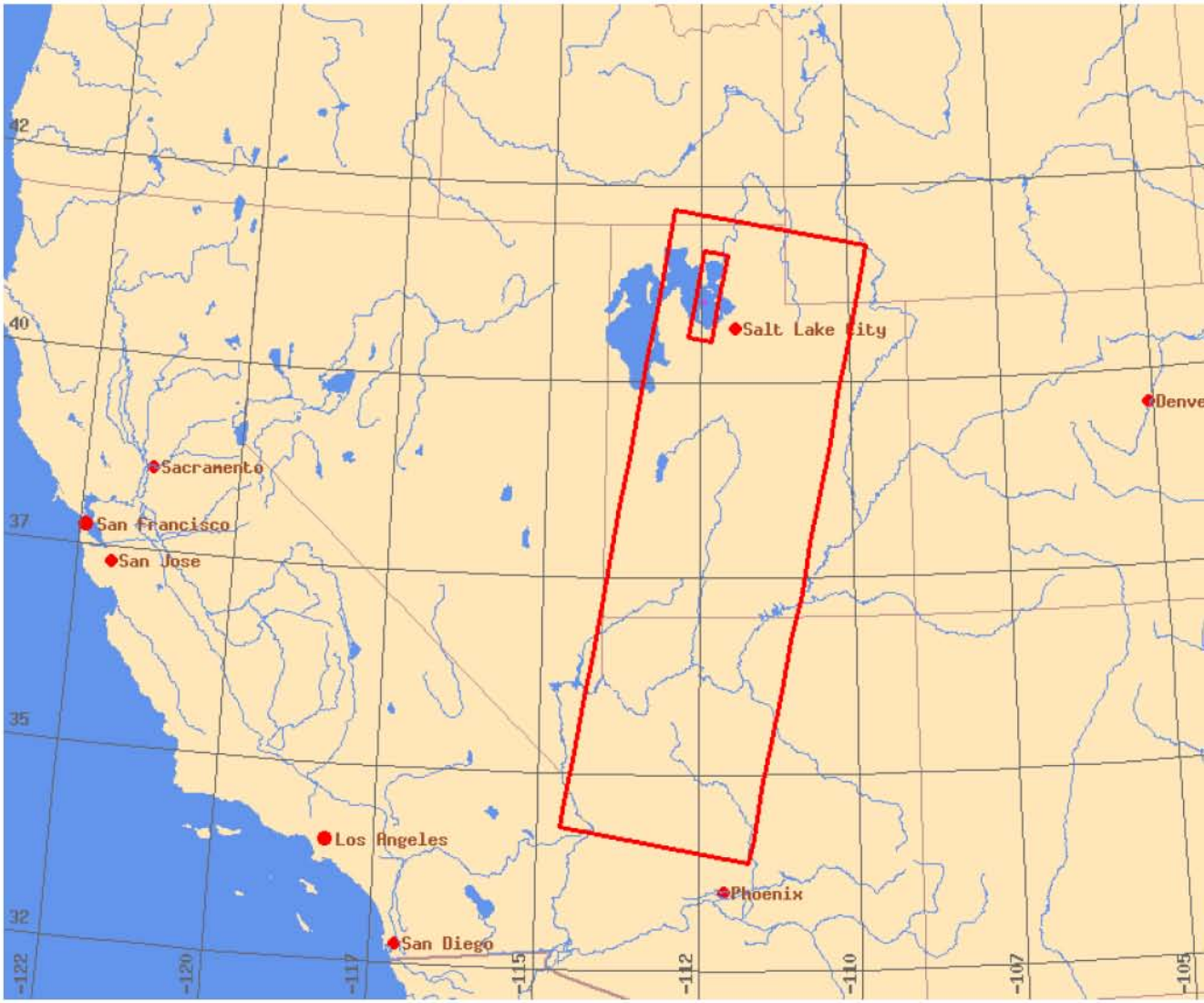
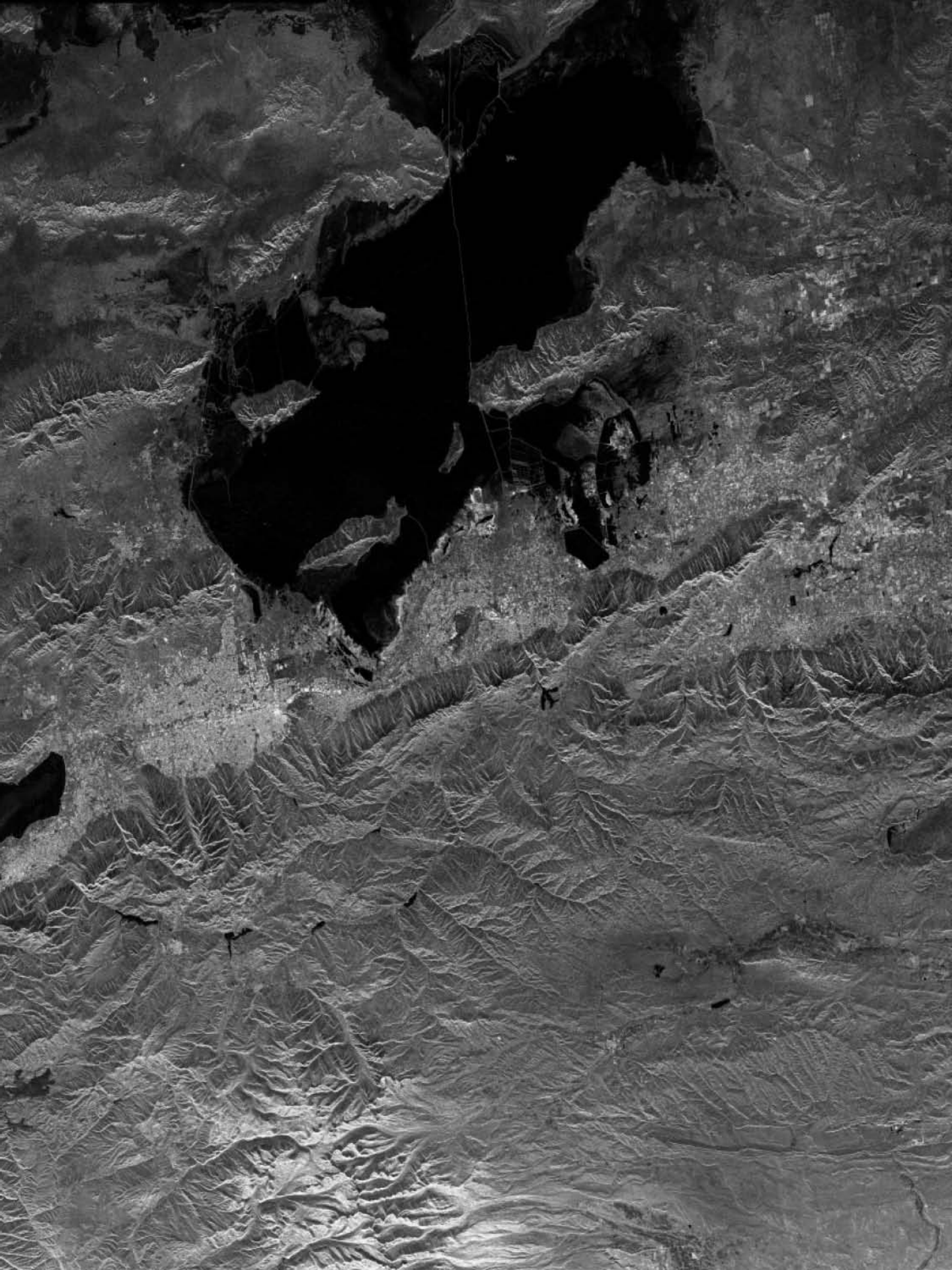
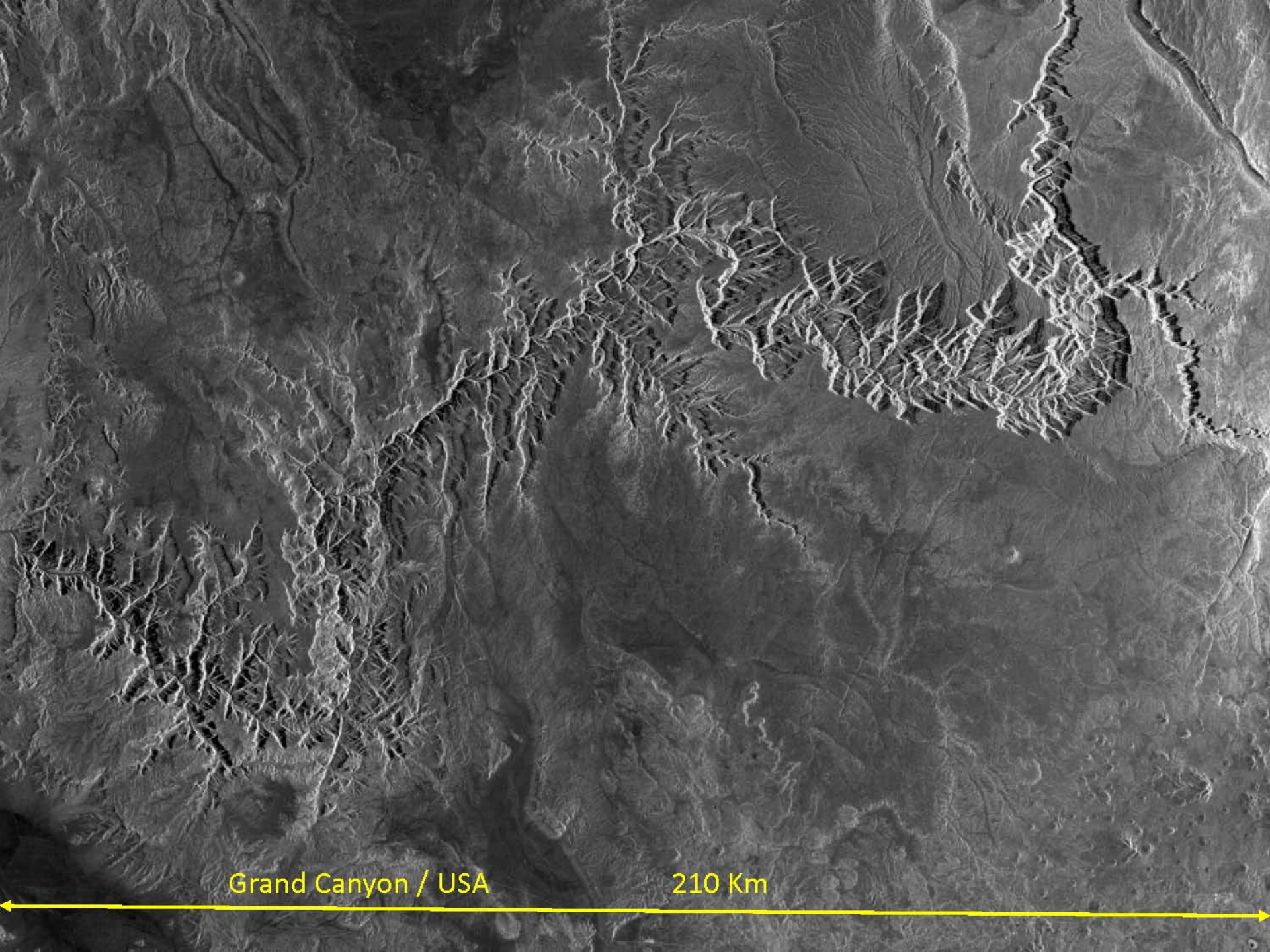
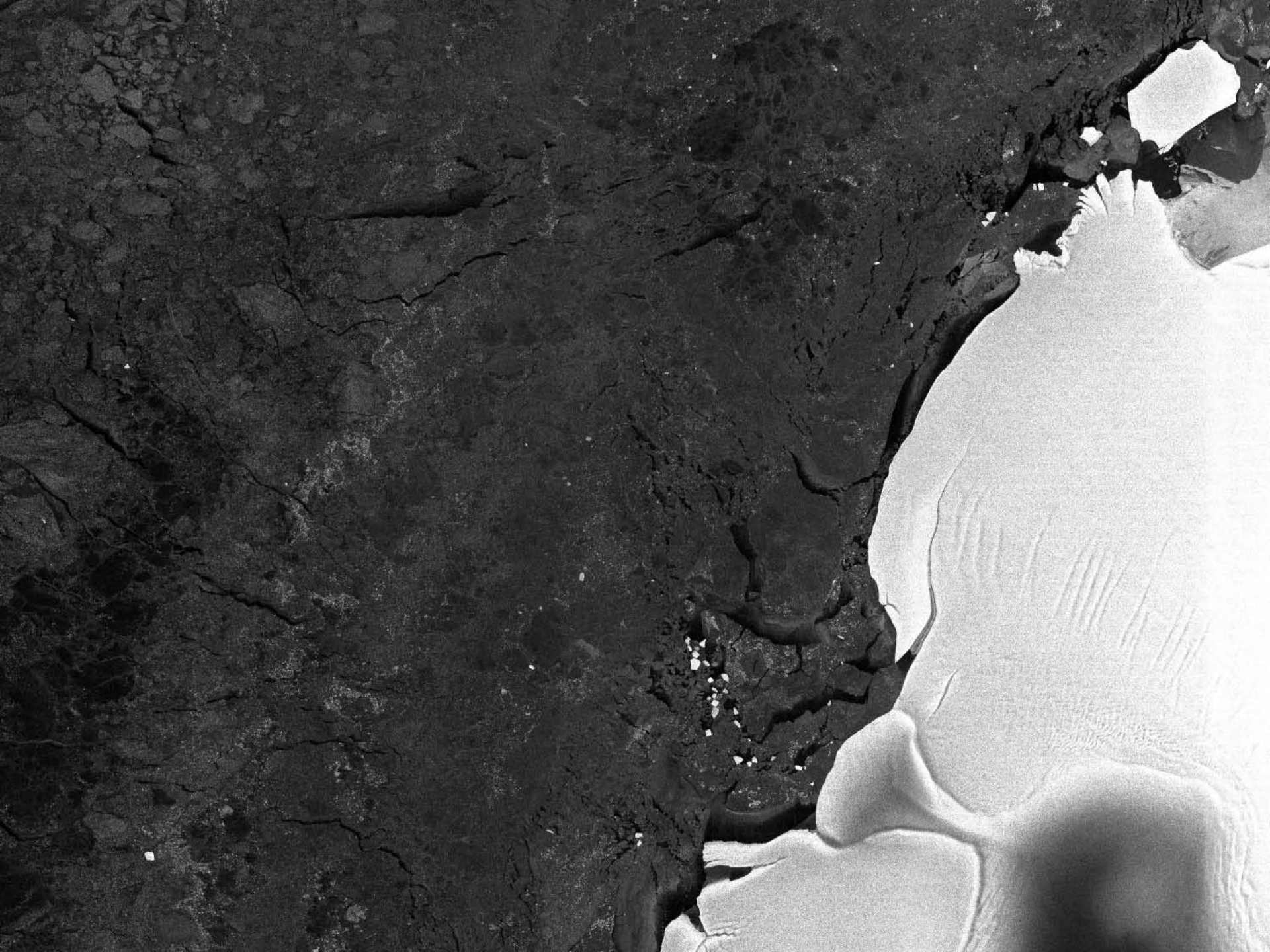
From Salt Lake to Grand Canyon

Wide_001
2013-04-06T13:39:50
2013-04-06T13:41:55






Grand Canyon / USA
210 Km



TanDEM-X Processing Status & Performance

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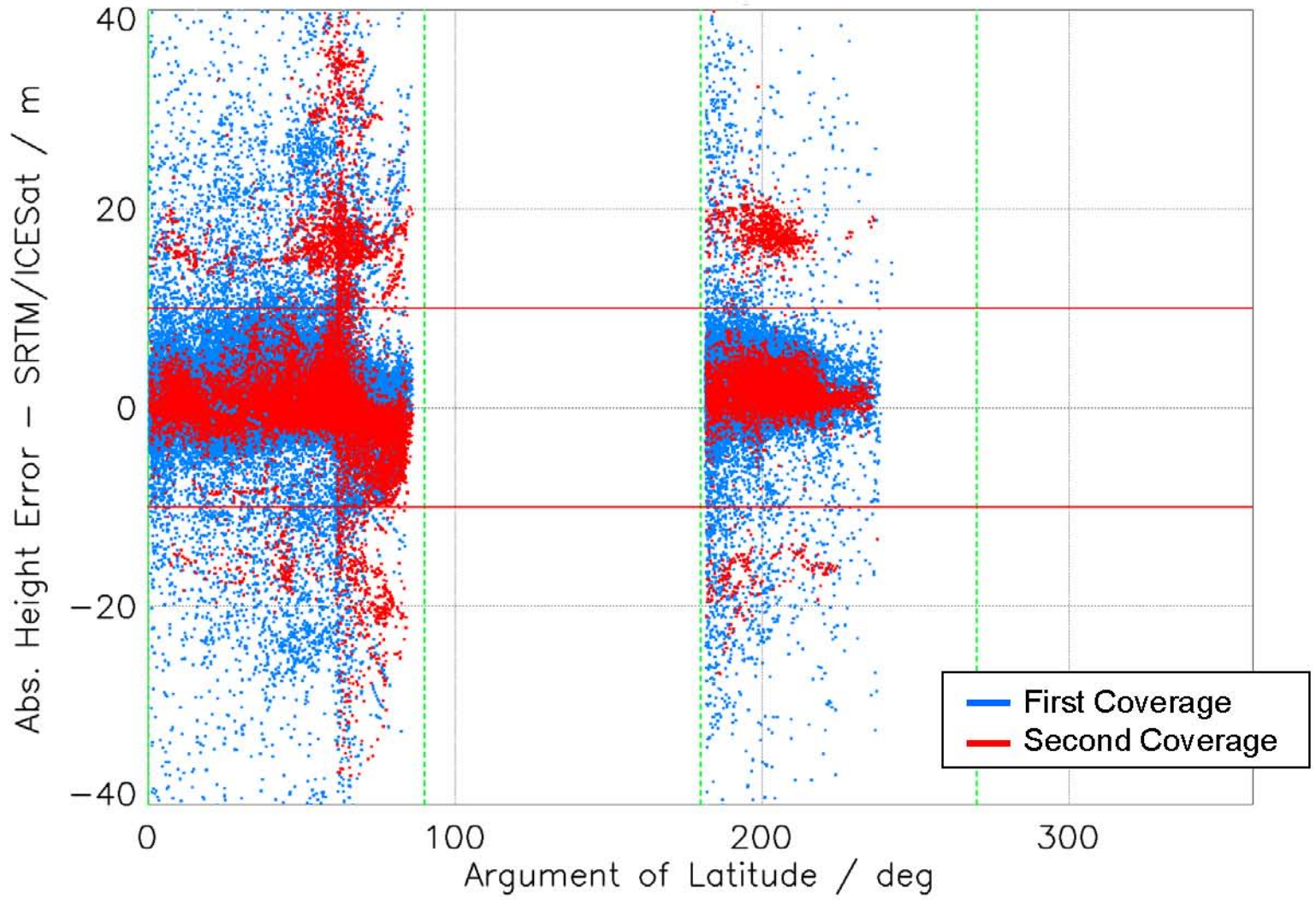
Absolute Height Error – First & Second Coverage



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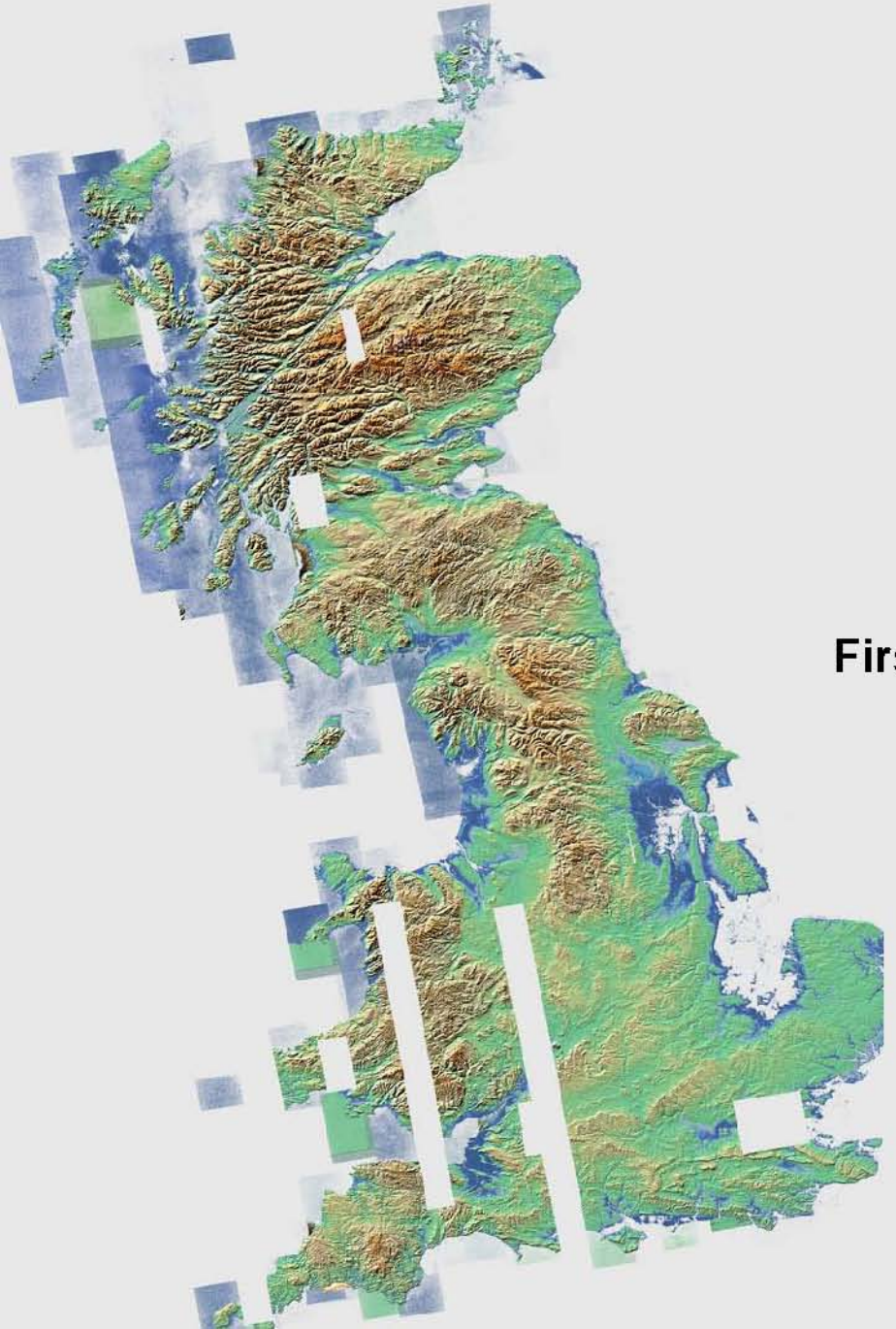
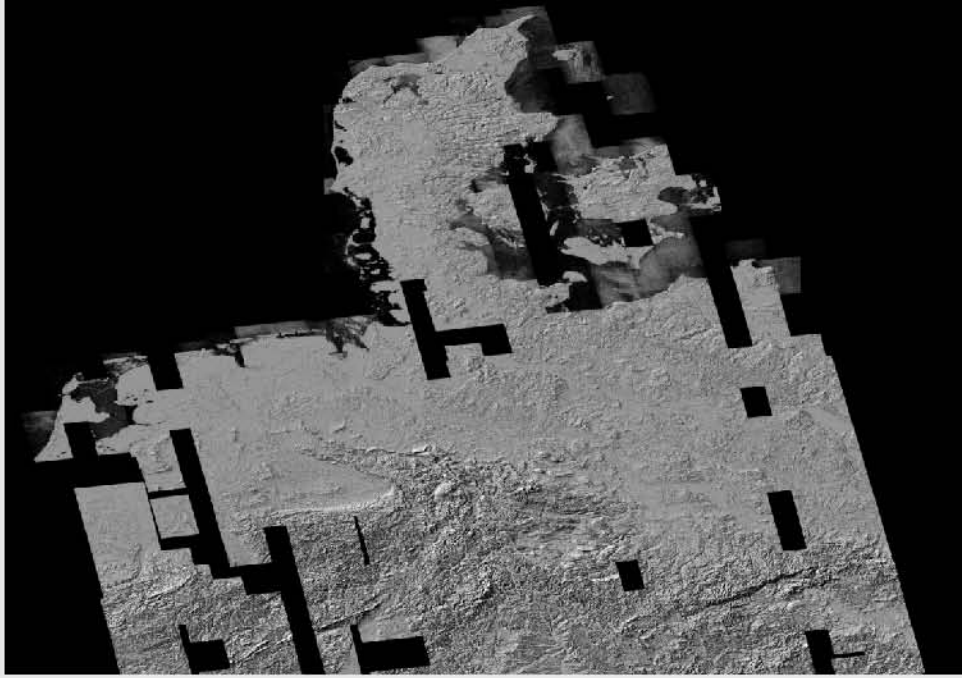
Mission Status

- Second global acquisition finished
- Currently first acquisition of Antarctica and recovery of gaps
- Starting from August acquisitions over difficult terrain from opposite viewing geometry
- Intermediate DEMs (based on first coverage only) to become available mid June 2013 for specific regions
- Final DEM delivery to commence early 2014





First IDEM Samples