



ESA

Report on Cal/Val Activities

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ESA

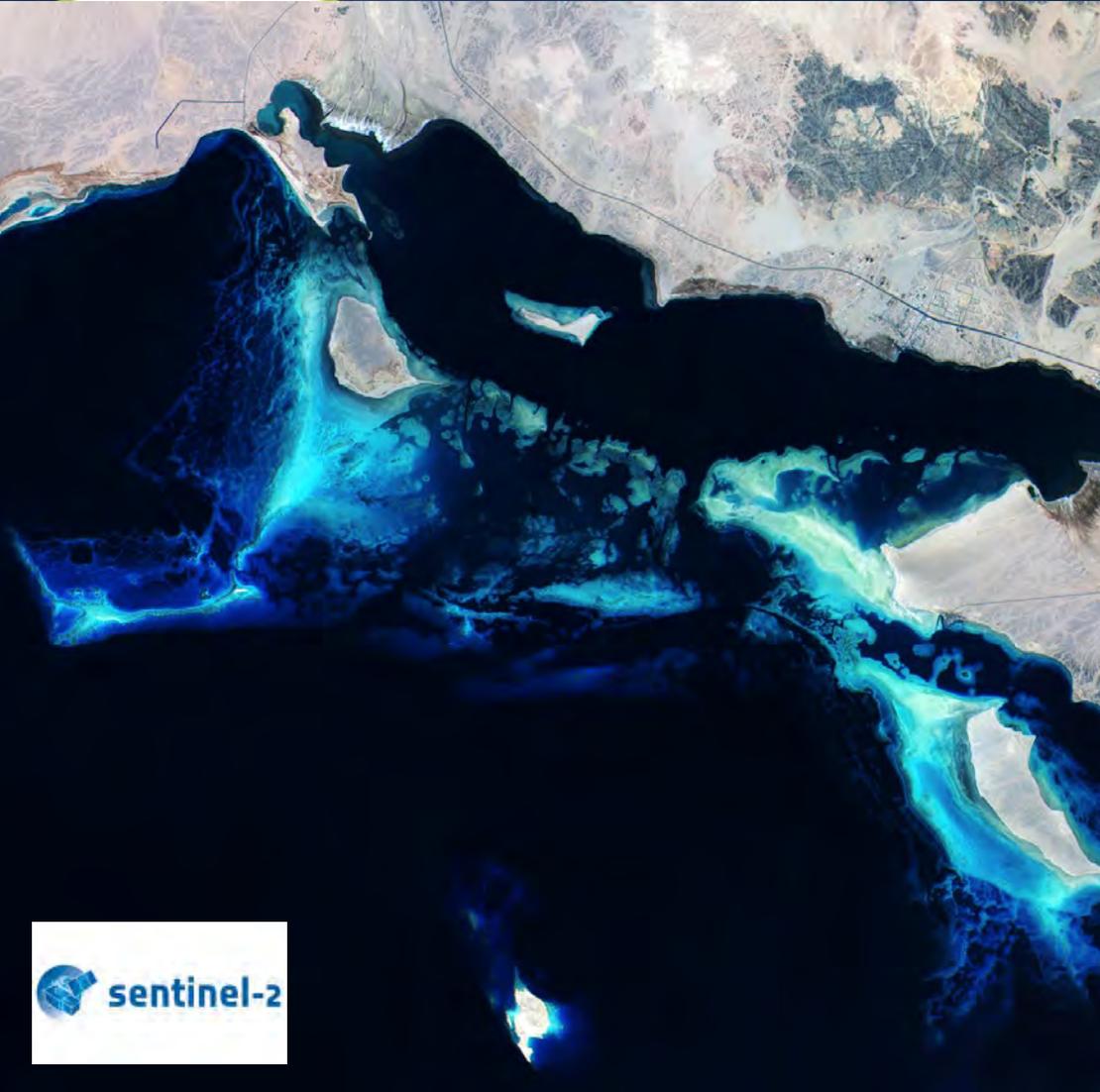
WGCV Plenary # 40

Canberra

March 14–18 2016



Working Group on Calibration and Validation





ESA satellite missions update

ESA Earth Explorers status:

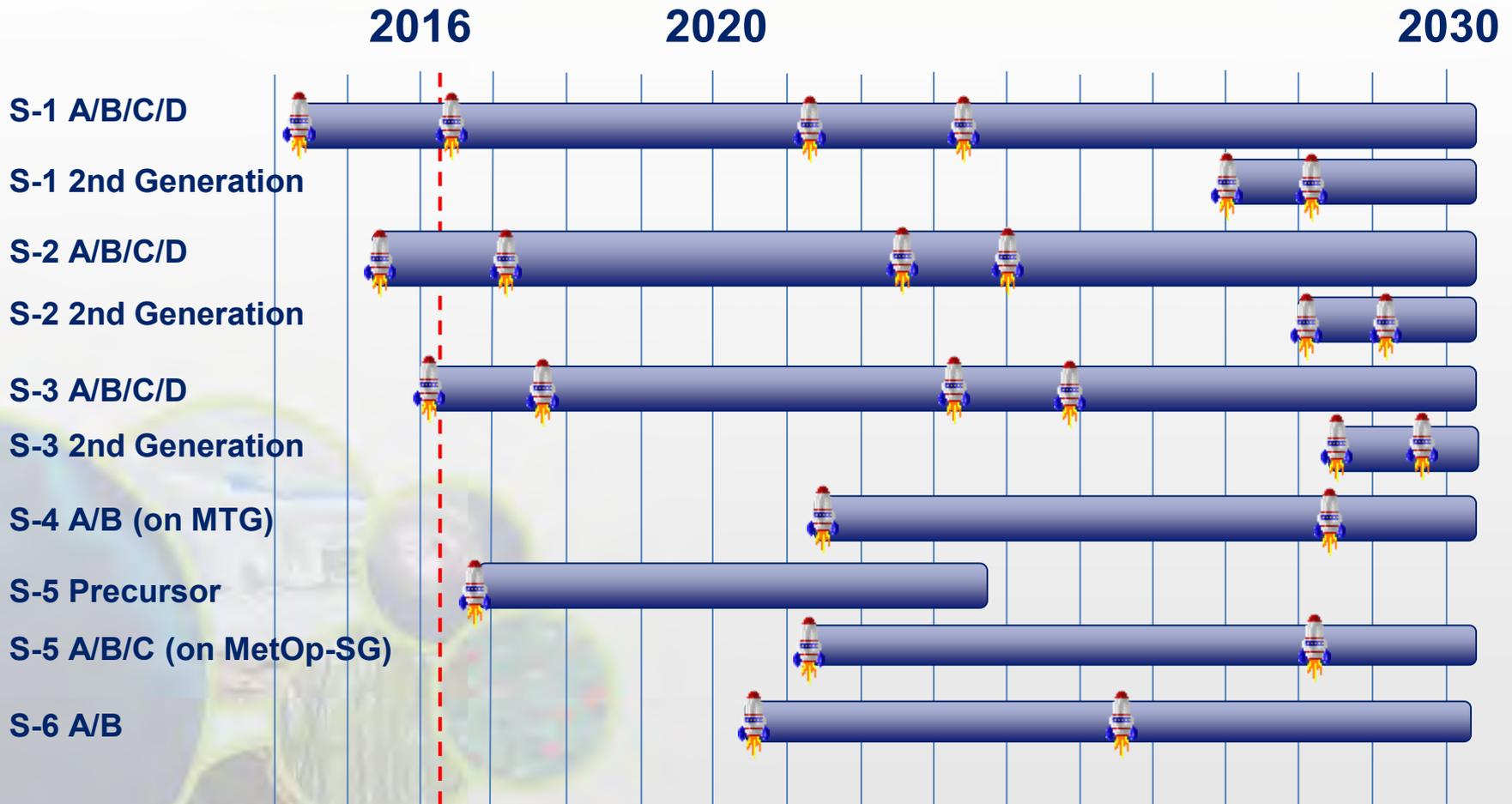
- CryoSat, SMOS, SWARM operating nominally.
- ADM-Aeolus launch planned for Q3/2017.
- EarthCARE (2017), BIOMASS (2020) and FLEX (2022) under preparation.
- Earth observation Explorer 9 selection process started.

Copernicus Sentinels status:

- Sentinel-1a operating nominally since almost two years.
- Sentinel-2a launched on 22 June 2015 and operating nominally.
- Sentinel-3a launched on 16 February 2016 under commissioning.
- Sentinel-1b launch planned for 22 April 2016.
- Sentinel-5P launch planned for Q4/2016.
- Sentinel-2b launch planned for Q1/2017.
- ...



Copernicus Sentinels Schedule





Fiducial Reference Measurements (FRMs)

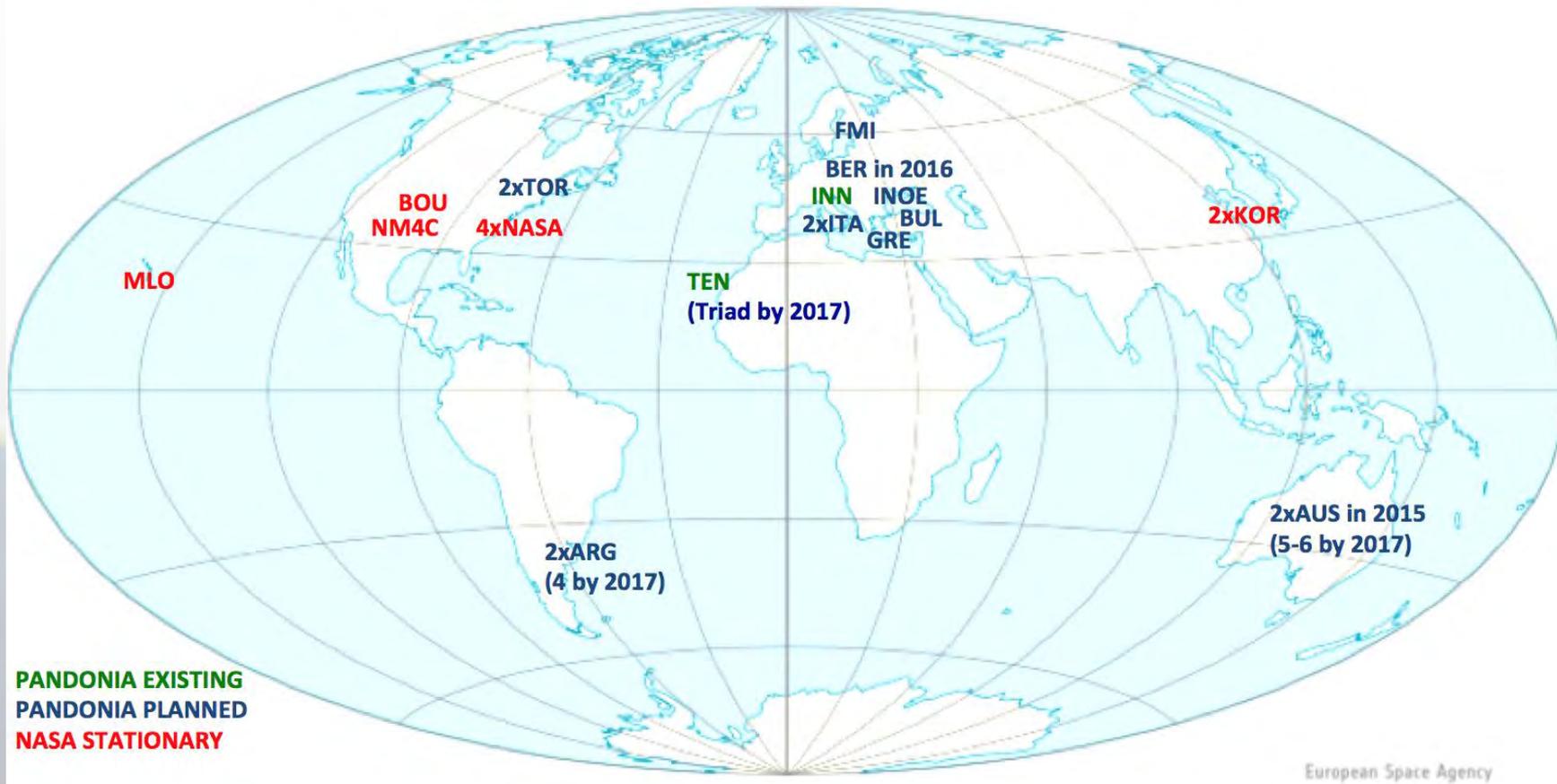
- *FRMs are an integral element to help address QA4EO traceability requirements*

Current activities:

- **Pandonia** mini-spectrometer network for total ozone and air quality measurements, in close collaboration with NASA, GA, and WRC. Prime: Luftblick, (A); POC: A. Cede (Luftblick) and T. Fehr (ESA)
- **RadCalNet Gobabeb Station** project in close collaboration with CNES (as well as NASA, CAS/AOE). Prime: NPL (UK); POC. N. Fox (NPL), M. Bouvet (ESA)
- **FRM4STS**: calibration and traceability of land, ocean and ice surface temperature measurements (LST, SST and ICT). Prime: NPL (UK); POC. N. Fox, C. Donlon (ESA)



Existing and planned Pandonia stations





Fiducial Reference Measurements (FRMs) (1/2)

✓ Planned activities:

- **FRM4SOC**: development of best practices for the calibration, characterisation and operation of FRM optical systems for the validation of space-borne ocean colour products. Prime: TBD; POC: C. Donlon (ESA). KO planned Q2 2016.
- **FRM4SAR**: characterisation of the multi-mission corner reflector setup in Australia with Geosciences Australia (GA) for the calibration of SAR. Prime: TBD; POC: N. Miranda (ESA)/M. Garthwaite (GA). KO planned Q2 2016.
- **FRM4ALT**: development of best practices for the characterisation and operation of FRM systems for the calibration of altimeters. Prime: Space Geomatica Ltd (GR) supported by Technical University of Crete, Research Committee (GR) and Technical University of Denmark (DK) POC: C. Donlon (ESA). In final negotiation an KO planned Q2 2016.



Fiducial Reference Measurements (FRMs) (2/2)

✓ Planned activities:

- **FRM4DOAS** (PI. M. van Roozendaal, BIRA/IASB): MaxDOAS algorithm development and preparation of the second air quality intercomparison campaign (Cabauw, NL). Key: NDACC UV-Vis WG. KO: Q2 2016.
- **FRM4GHG** (co chairs: J. Notholt, IUP/Bremen; PI M. de Maziere, BIRA/IASB). IR instrument intercomparisons and best practice development for GHG measurements. Key: TCCON and NDACC IR WG. KO: Q2 2016 Campaign in Spring.
- **Ground-based aerosol DIVA** (PI. D. Nicolae, INOE 2000). Preparation of aerosol FRM infrastructure/calibrations, and algorithm consolidation. Key: PHOTONS/RIMA/AERONET, EARLINET, Pandonia (2018 with NDACC UV-Vis WG). KO Q3 2016.



FRM4SAR

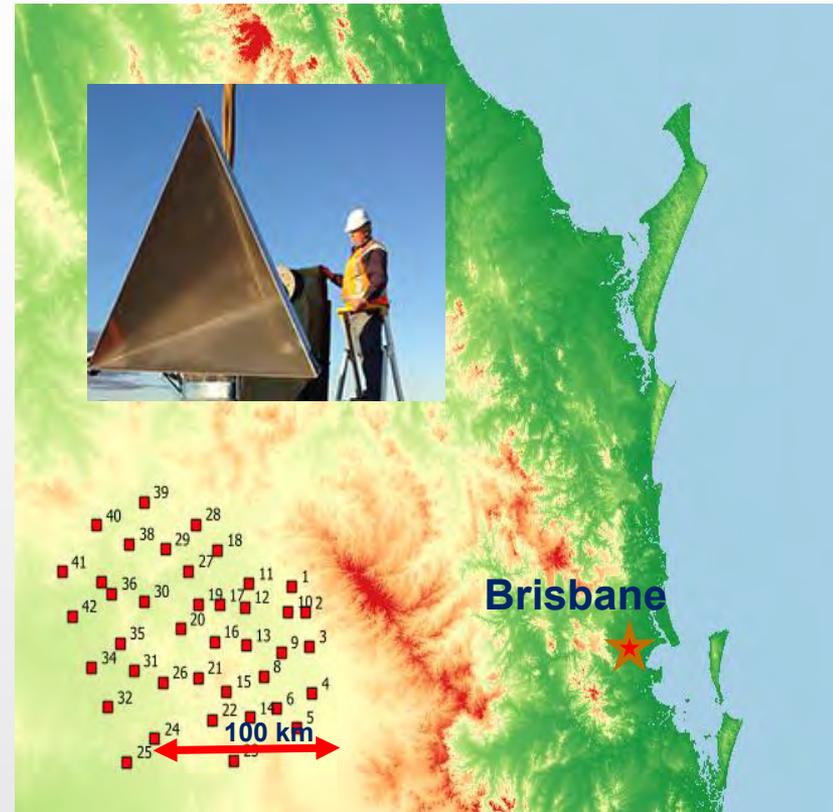
Surat basin (~300km west of Brisbane)

- Coal seam gas extraction study site
- RADARSAT, RISAT and ALOS PALSAR acquisitions
- Sentinel-1 routine acquisitions from 17 January 2015

ESA's plan in cooperation with GA is to initiate:

- A QA4EO project to document the survey approach and to support the geodesy group during the next survey campaigns.
- More ambitiously, proposed to deploy a setting of 4 corner reflectors (2 ascending, 2 descending) similar to what was done in Switzerland in the past - *but in a more stable geological location*

POC: N. Miranda (ESA) and M. Garthwaite (GA)





Sentinel-2 Data Quality Status



Lake Amadeus, in Australia's Northern Territory.



Sentinel-2 Data Quality

Requirement	Description	Measured Performance
Absolute geolocation (without using the Global Reference Image)	The geo-location uncertainty shall be better than 20m at 2σ confidence level (without using the Global Reference Image)	10.5m at 2σ
Multi-spectral registration	The inter-band spatial co-registration of any couple of spectral bands shall be better than 0.30 of the coarser achieved spatial sampling distance of these two bands at 3σ confidence level.	< 0.1 SSD typical < 0.3 SSD CE@2s for all band couples <0.3 SSD CE@3s for most band couples
Absolute radiometric uncertainty	The absolute radiometric uncertainty shall be better than 5% (goal 3%) over the reduced dynamic range.	B1, B2, B3, B4: < $2\% \pm 2\%$
SNR	The Signal-to-Noise (SNR) shall be higher than the values specified in [SSRD].	All bands compliant with >20% margin



data quality report on-line

at <https://sentinels.copernicus.eu/documents/247904/685211/Sentinel-2+Data+Quality+Report>

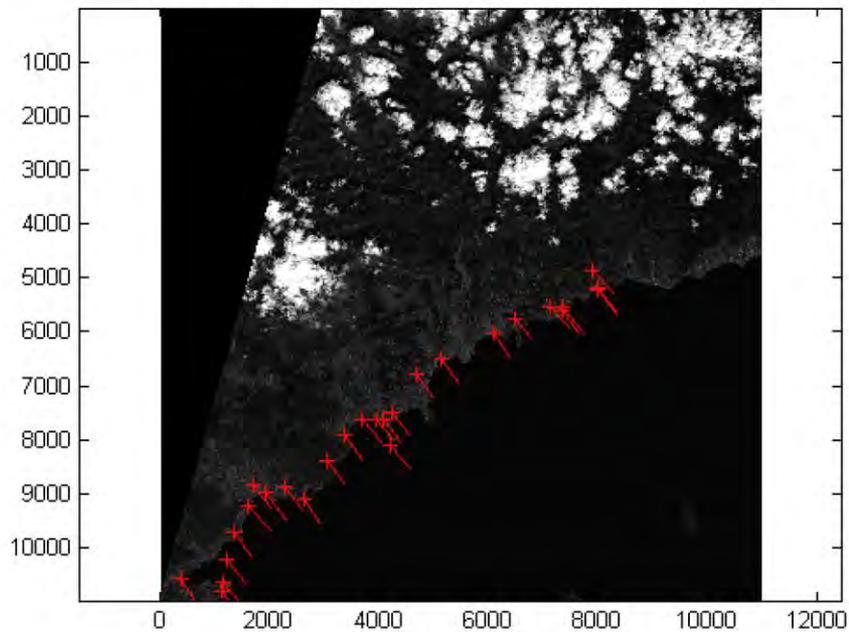
Working Group on Calibration and Validation



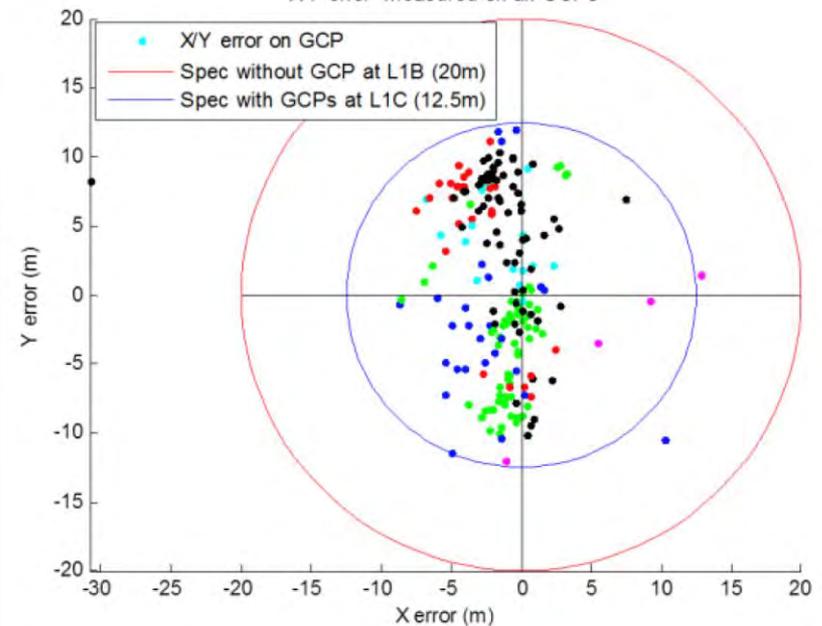
Sentinel-2 Data Quality

- ✓ Absolute geolocation performances (without geometric refinement) measured over 17 test sites.
- ✓ Measurements in line with requirements.

Estimated Geolocation error at GCPs on band B04 (shifts x356)



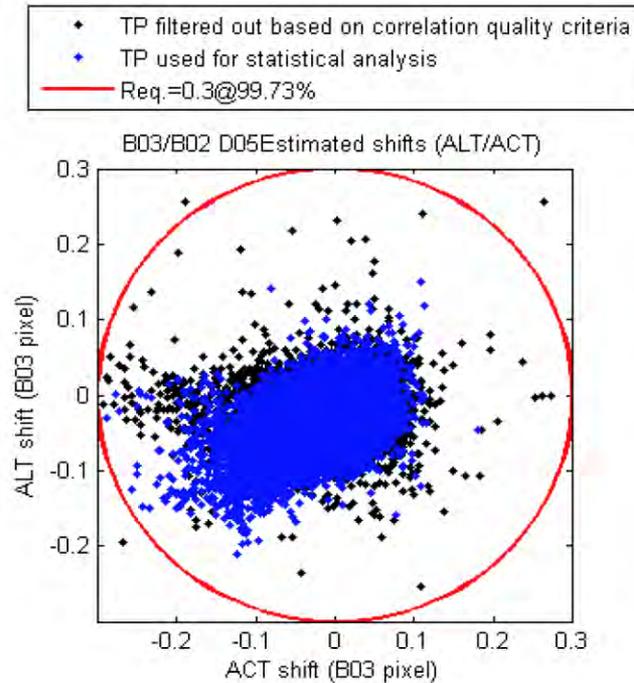
X/Y error measured on all GCPs





Sentinel-2 Data Quality

- ✓ Multi-spectral registration performances measured show that the mean circular error over all band couples and detectors is lower than 0.23 pixel of the coarser band.





Sentinel-2 Data Quality

- ✓ Signal-to-Noise Ratio (SNR) calculated from images of the MSI sun diffuser.
- ✓ Measured SNR values largely exceeding requirements.



	REQUIREMENT		S2-MPC MEASUREMENT	
	SNR@Lref	Lref	SNR	Margin
Band/Unit	-	W/m2/Sr/μm	-	%
B01	129	129.0	1016,50	688
B02	154	128.0	201,90	31
B03	168	128.0	228,60	36
B04	142	108.0	214,50	51
B05	117	74.5	238,50	104
B06	89	68.0	206,10	132
B07	105	67.0	208,80	99
B08	174	103.0	208,10	20
B8A	72	52.5	153,10	113
B09	114	9.0	164,70	44



Sentinel-2 Data Quality

- ✓ Fix Pattern Noise (FPN) measured using a vicarious method with products over Greenland homogeneous sites
- ✓ Results in line with requirements except for B11 and B12
→ the performance will be consolidated with more samples

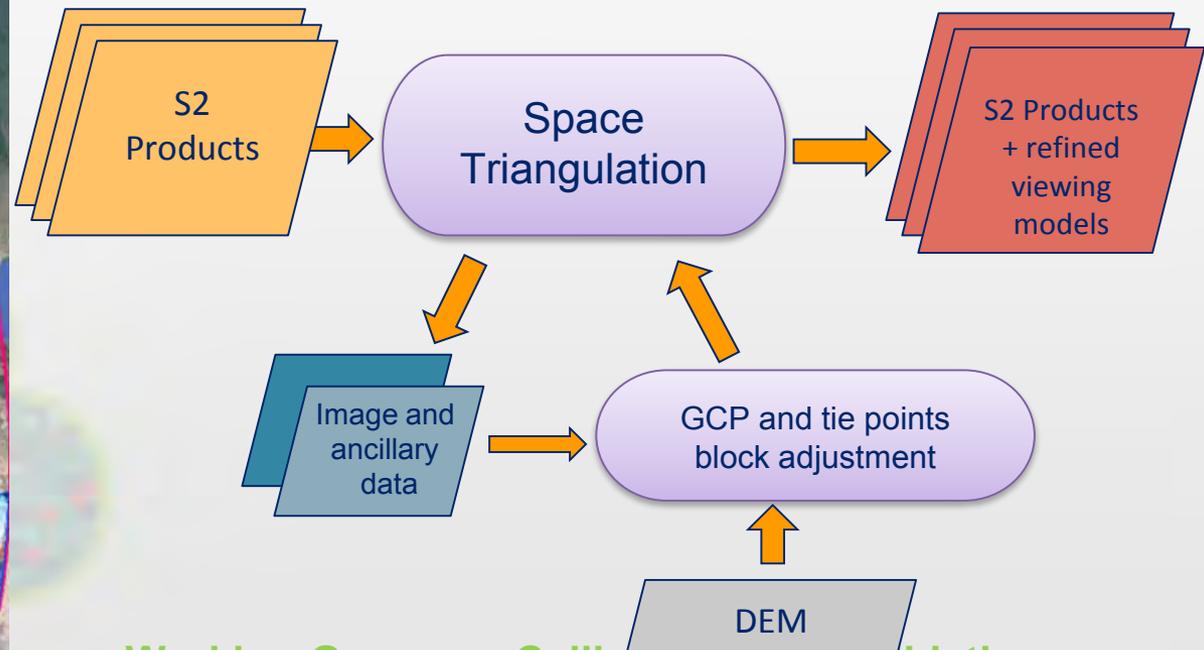
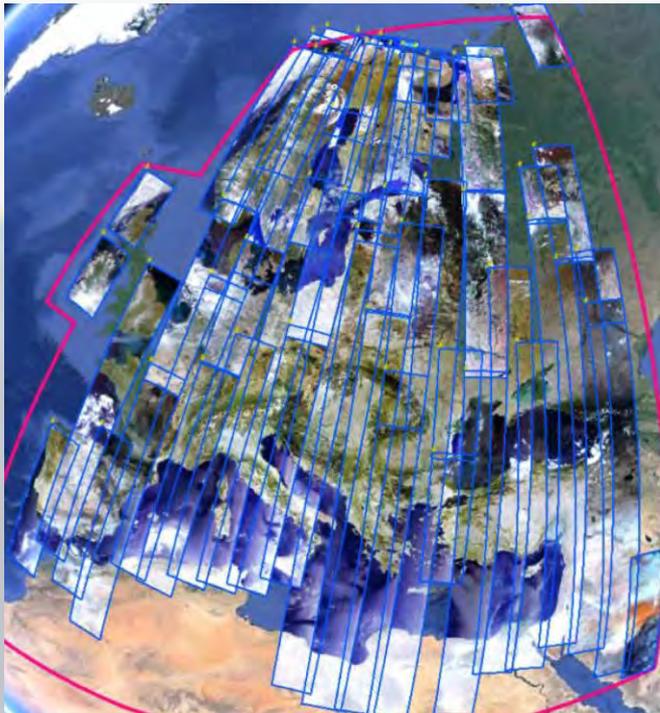


	REQUIREMENT		MPC MEASUREMENT	
	FPN@Lref	Lref	FPN	Mean radiance
Band/Unit	W/m2/Sr/μm	W/m2/Sr/μm	W/m2/Sr/μm	W/m2/Sr/μm
B01	0.258	129.0	0.047	230.86
B02	0.256	128.0	0.075	229.01
B03	0.256	128.0	0.073	204.71
B04	0.216	108.0	0.055	174.93
B05	0.149	74.5	0.041	163.85
B06	0.136	68.0	0.046	148.42
B07	0.133	67.0	0.051	131.73
B08	0.206	103.0	0.044	113.78
B8A	0.114	52.5	0.045	105.17
B09	0.027	9.0	0.047	57.62
B11	0.008	4.0	0.012	4.45
B12	0.003	1.5	0.007	1.85



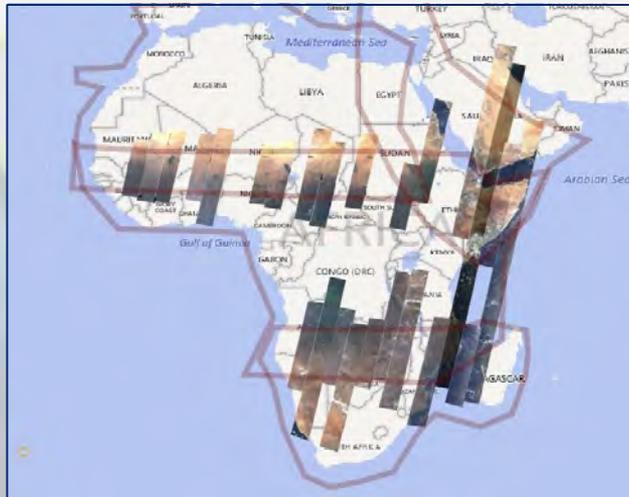
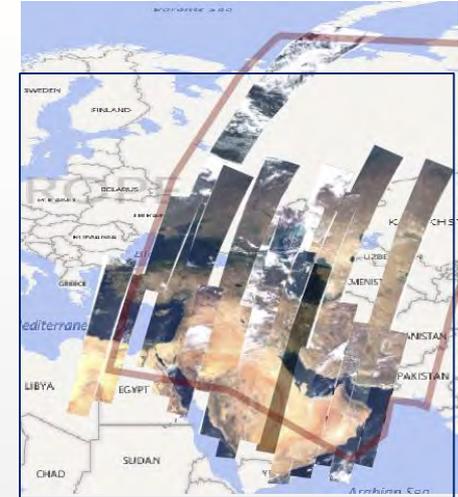
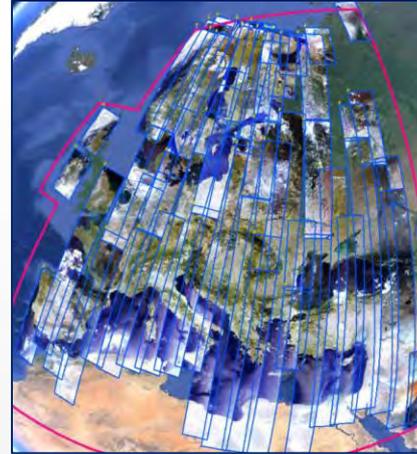
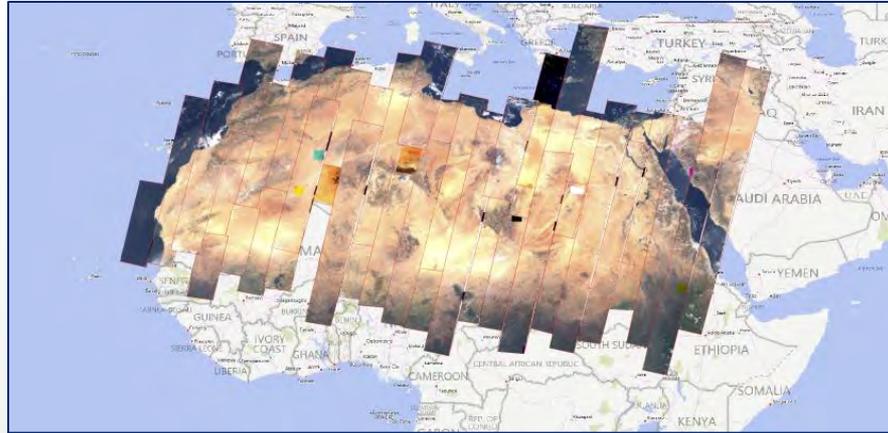
S2 Global Reference Image (GRI)

- Objective: To obtain a full repeat cycle dataset of well-localized mono-spectral Level-1B images (band 4) which will be used as reference images in the processing chain.
- Methodology: Massive spatio-triangulation on large blocks.
- A set of blocks defined: cf. following slide.





S2 Global Reference Image (GRI)



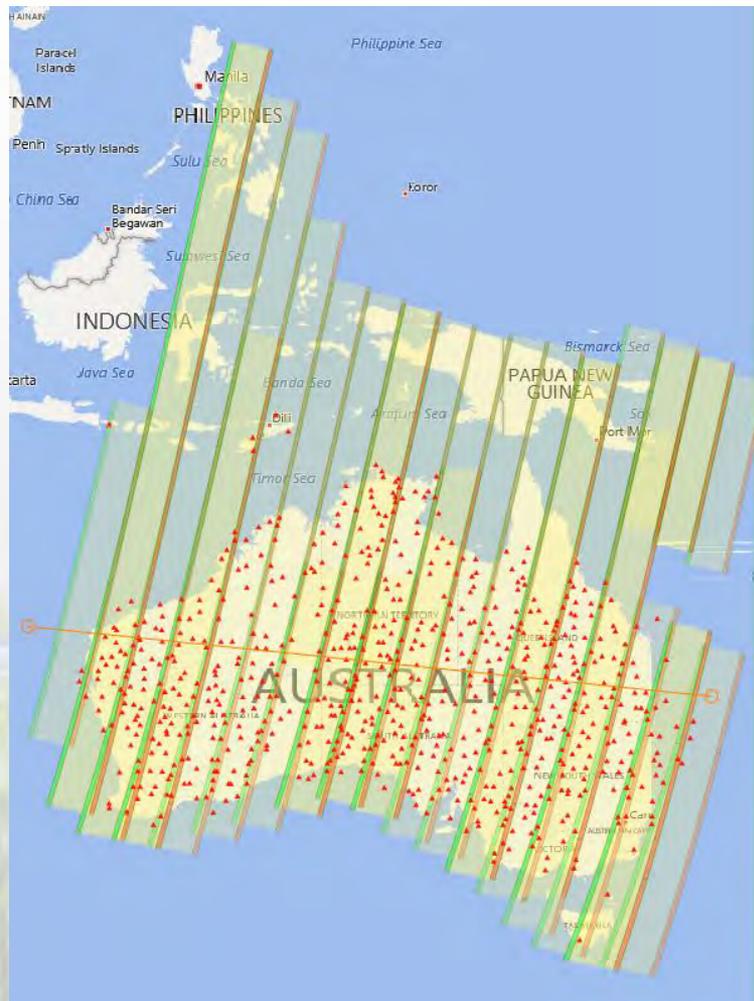


S2 Global Reference Image (GRI)





S2 Global Reference Image (GRI)





Thank you for you attention!

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