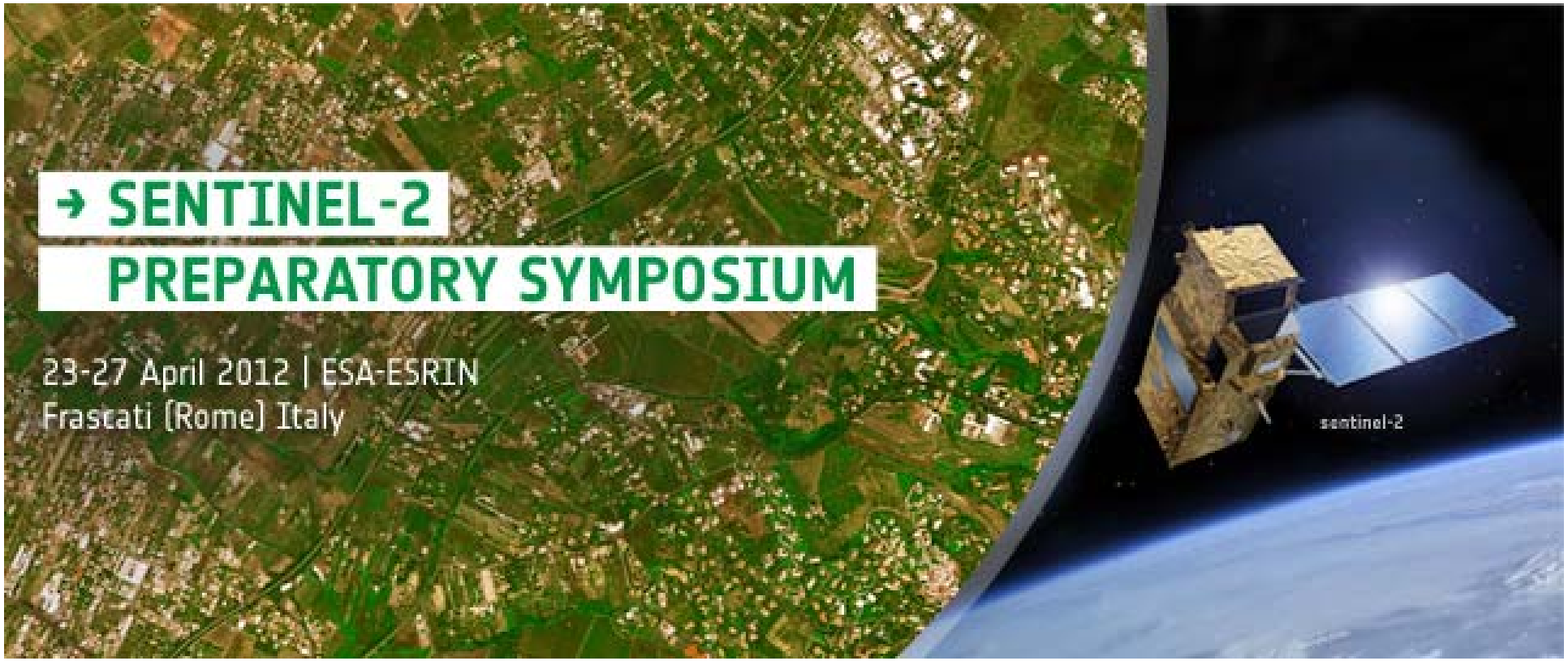

radiometric and geometric QC for S2

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magellium

Do we need vicarious calibration?

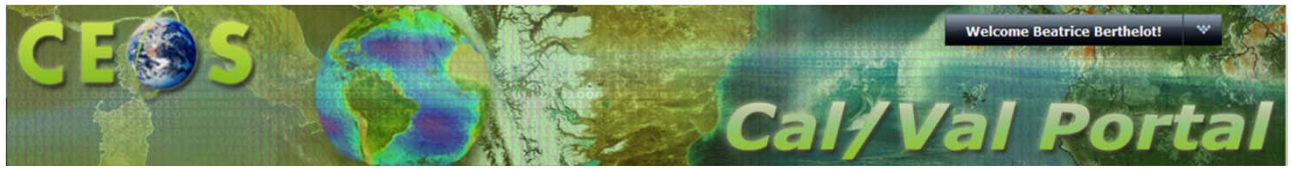
- Radiometry: QC of the onboard calibration and implementation
- Spectral
- Geometrical
- Cal⇔Val

Radiometric calibration

- Absolute: accuracy depends on the L2 product
- Inter temporal: complementary to on board calibration
- Inter bands: driven by multi-spectral algorithms
- Inter sensors:
  - inter-comparibility of the sensors
  - to a sensor of reference

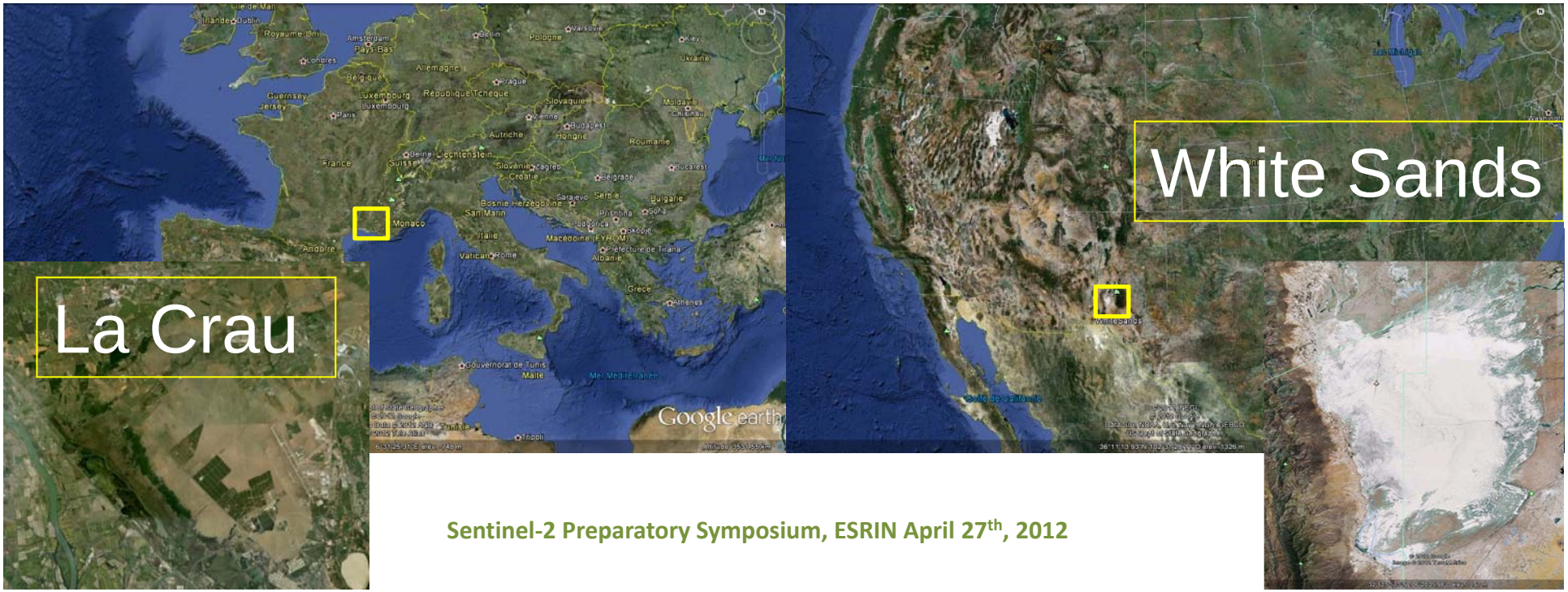
Heritage

- SPOT HRV1 and Landsat, Absolute calibration :
  → Land Equipped Site: **LES**
- AVHRR and the inter-temporal calibration :
  → Land Non Equipped Site: **LNES**
- AVHRR, POLDER, the « Rayleigh calibration :
  → Water Non Equipped Site: **WNES**
- Others: inter spectral
  → clouds, glint
- The outputs of ESA-CEOS study: ”**Calibration Test Sites Selection and Characterisation**”, available at :



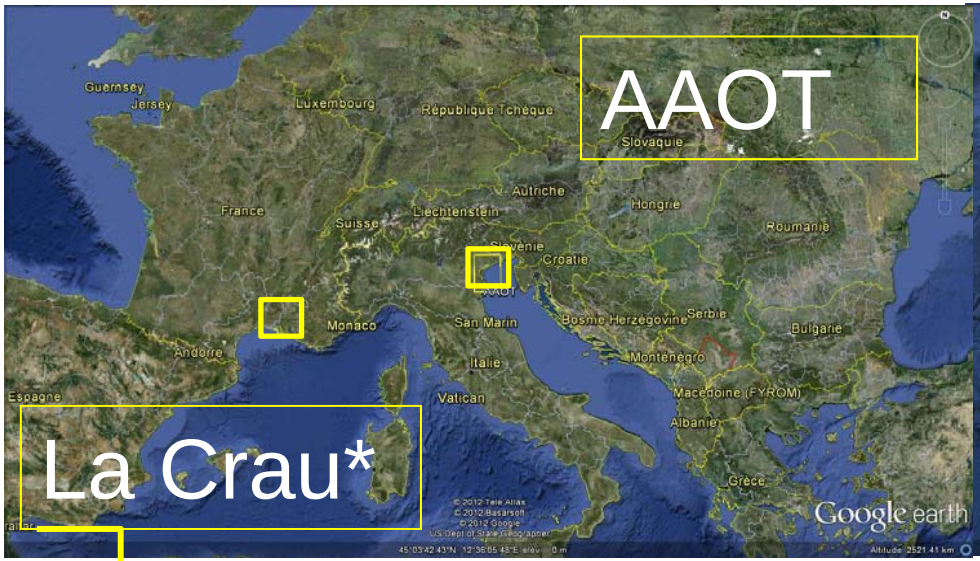
Vicarious calibration for S2

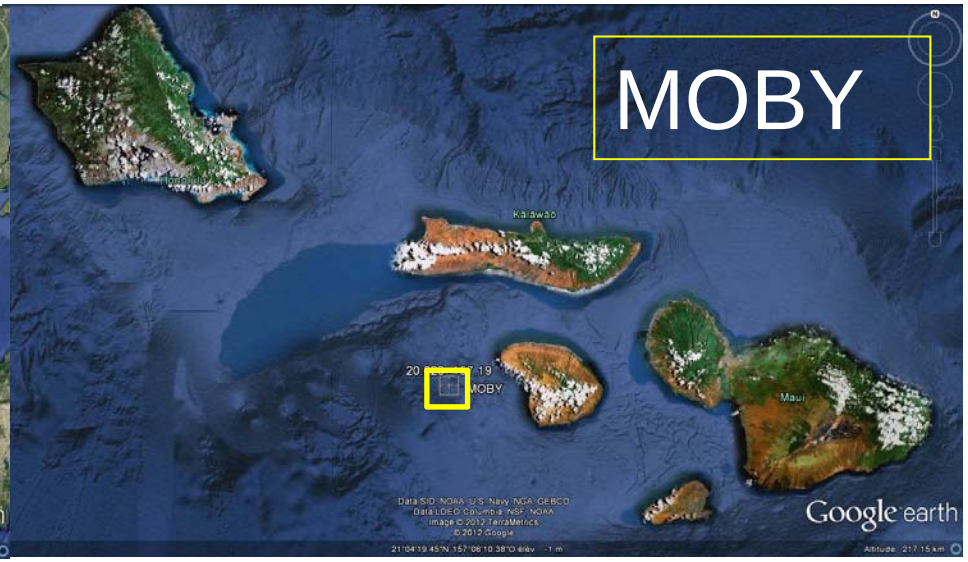
- LES (bright targets)



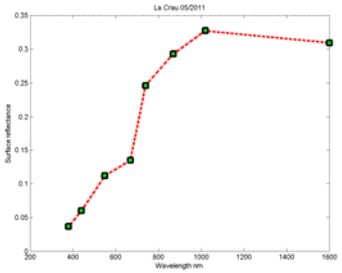
Vicarious calibration for S2

- WES (dark targets)





* La Crau is dark in the blue



Inputs to the error analysis

- Nominal conditions
- Nominal satellite signal
- Error bars (random)
  - Current values for accuracy
- Error bars (systematic)
  - On input assumptions (aerosol model,…)
- Bias (systematic)
  - On physical simplifications (BRDF,..)

La Crau and White Sands (total)

- Error budget assessed for Landsat

	B1: 0.45 - 0.52	B2: 0.52 - 0.60	B3: 0.63 - 0.69	B4: 0.76 - 0.90	B5: 1.55 - 1.75
Summer	C1	C2	C3	C4	C5
23 km	4.49	4.60	4.16	3.83	3.31
Winter	C11	C12	C13	C14	C15
23 km	5.54	5.64	4.81	4.11	3.32
Summer	C21	C22	C23	C24	C25
50 km	3.09	3.56	3.43	3.41	3.24
Winter	C31	C32	C33	C34	C35
50 km	3.76	4.20	3.70	3.42	3.16

	B1: 0.45 - 0.52	B2: 0.52 - 0.60	B3: 0.63 - 0.69	B4: 0.76 - 0.90	B5: 1.55 - 1.7
Summer	WS1	WS2	WS3	WS4	WS5
23 km	4.59	4.52	4.12	3.80	3.30
Winter	WS11	WS12	WS13	WS14	WS15
23 km	5.28	5.27	4.65	4.06	3.32
Summer	WS21	WS22	WS23	WS24	WS25
50 km	3.60	3.82	3.60	3.51	3.26
Winter	WS31	WS32	WS33	WS34	WS35
50 km	3.84	4.20	3.74	3.45	3.17

WES and MERIS, nominal

- Winter and summer
- Gaseous correction
- Aerosol (AOT)
- Surface: 5 percent error

Site	B1	B2	B4	B7	B13
λ (µm)	0.412	0.440	0.510	0.665	0.865
VE	0.025	0.027	0.035	0.006	0
MB	0.043	0.032	0.005	0.001	0

AAOT

	AAOT	B1	B2	B4	B7	B13
	Summer	V1	V2	V3	V4	V5
	23 km	0.54	0.77	1.50	0.78	0.00
	Winter	V11	V12	V13	V14	V15
surface	23 km	0.38	0.55	1.12	0.55	0.00
	Summer	V21	V22	V23	V24	V25
	50 km	0.58	0.82	1.61	0.91	0.00
	Winter	V31	V32	V33	V34	V35
	50 km	0.43	0.62	1.27	0.68	0.00

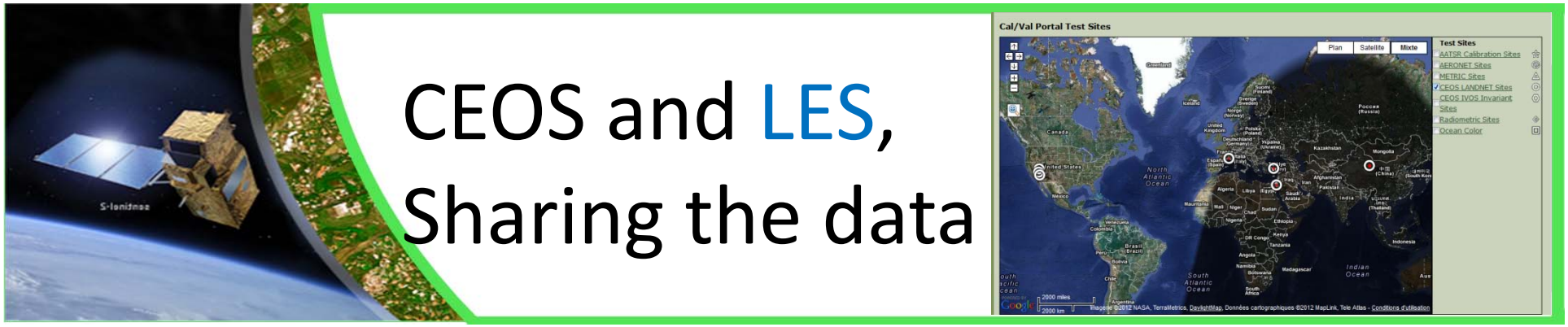
	Summer	V1	V2	V3	V4	V5
	23 km	-0.03	0.09	0.26	-1.06	-4.35
	Winter	V11	V12	V13	V14	V15
AOT	23 km	0.30	0.85	1.23	0.39	-1.94
	Summer	V21	V22	V23	V24	V25
	50 km	-0.07	0.07	0.09	-1.51	-5.62
	Winter	V31	V32	V33	V34	V35
	50 km	0.81	1.18	1.31	0.19	-2.69

	Summer	V1	V2	V3	V4	V5
	23 km	2.70	2.94	3.29	6.59	10.34
	Winter	V11	V12	V13	V14	V15
model	23 km	2.95	3.20	3.61	7.23	10.81
	Summer	V21	V22	V23	V24	V25
	50 km	1.89	2.06	2.35	5.28	8.61
	Winter	V31	V32	V33	V34	V35
	50 km	1.74	1.89	2.14	4.69	8.04

	Summer	V1	V2	V3	V4	V5
	23 km	2.76	3.04	3.62	6.72	11.22
	Winter	V11	V12	V13	V14	V15
Total	23 km	2.99	3.35	3.98	7.26	10.98
	Summer	V21	V22	V23	V24	V25
	50 km	1.97	2.22	2.85	5.56	10.29
	Winter	V31	V32	V33	V34	V35
	50 km	1.97	2.31	2.81	4.74	8.47

Recommendations for S2

- LES:
  - Share in situ measurements
  - Best practises
  - New practises: use of sky radiance measurements, correction of the adjacency effects
  - Error bars



CEOS and LES, Sharing the data

- The CEOS should be the forum to propose to exchange data for vicarious calibration purposes with:
  - (i) A site to put in the different pieces of information. The calval portal is an opportunity.
  - (ii) A monthly bulletin to inform in advance about the field campaigns.
  - (iii) An agreement on the content of in situ database (content, format,…).
  - (iv) The generation of a satellite data base over test sites.
  - (v) A maintained web site for this in situ and satellite sensors data base (Again the calval portal?)

Recommendations for S2

- WES:
  - AERONET Ocean Colour
  - Best (improved) practises
  - Error bars

Recommendations for S2

- LNES: Desertic /ice sites
  - Inter calibration: time, sensors (reference sensor)
- **Spectral**: Inter calibration with high spectral resolution sensors
  - Radiometry
  - In the S2 absorption bands (differential for H2O)
  - Inter comparison of spectral indices (MTCI,..)

Objectives of the vicarious calibration?

- Radiometric for L1
- For L2 upstream
- For L2 downstream

How to apply the vicarious calibration ?

- Vicarious calibration returns TOA reflectance (mostly of geophysical approach)
- For L1: conversion reflection to radiance
- For L2 upstream: consistant with the L2 LUTs
  - Same gaseous absorption correction
  - Same radiative transfert code
  - A forward model as an open source
- For L2 downstream:
  - vicarious adjustment on in situ measurements

Conclusion on the radiometric calibration

- Radiometry (inter calibrations) as usual
- Geophysic (modelling the TOA):
  - Understand the radiative transfer!
  - Collaborative to investigate a significant number of matchups over land
  - Network of radiometers (AERONET OC) over water: 500 MERIS matchups at AAOT!

CAL/VAL Test site, Geometric Activities

SCOPE

Calibration/Validation & System/Product performance

- Description of methods,
- Inventory of related Geometric Calibration Sites.

- Methodology for creation of GCP network,
- Requirement for GCP Database.

- Inventory of existing ESA reference data source,
- Inventory of worldwide reference data.

Recommendations for S2 / S3

CAL/VAL Test site, Geometric Activities

Data

Image And Model

Digital elevation model

GCP Database

Site properties

Dense

Worldwide

Correlation specific

Methods

Calibration

Viewing direction (Absolute, Relative)

Frame alignment (Absolute, Relative)

A priori/ A posteriori Performance

Geolocation

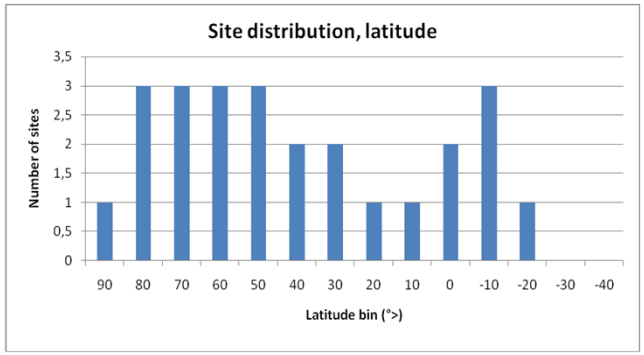
Band 2 band registration

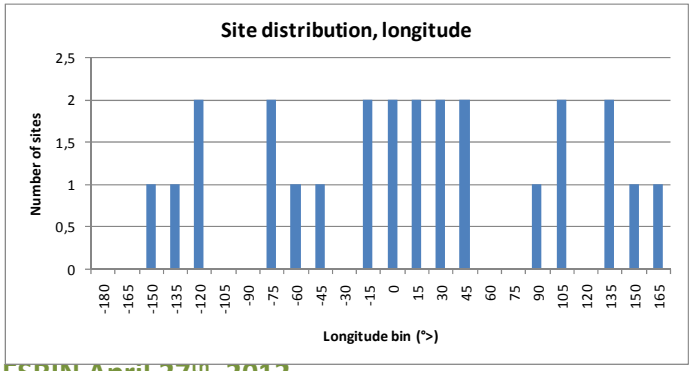
CAL/VAL Test site, Geometric Activities

- Dense site, viewing direction calibration (La Crau site)
  - Extent; more than 290 km width to cover 12 CCDs footprint
  - DEM accuracy better than 2.5 m (in using PRISM data)
  - Existing GCPs set is available (~45) but an additional GPS test field survey is required to cover the S2 scene footprint extent (~40 GCPs).
  - Raster data to be considered (image + model) depends on the funding
    - PRISM - Panchromatic
    - IKONOS – better because multispectral

CAL/VAL Test site, Geometric Activities

- <u>Worldwide sites, frame alignment calibration and geolocation performance monitoring</u>
  - Tradeoff analysis for North/South and East/west coverage site distribution,
  - To equip one site located in Russia to refine the along path reference data (Russia / Turkey / South Africa),
  - To refine East/West coverage depending on the funding.





CAL/VAL Test site, Geometric Activities

- Correlation specific site for band to band alignment calibration and band to band registration performance
  - A very flat terrain in order to minimize the effect of terrain relief but with 290 km swath width, a DEM is required,
  - The effects due to the atmosphere should be monitored,
  - The features should be visible at any spatial resolution and for any spectral bands (Vegetation features should be avoided),
  - To define interband site for Sentinel 2 in using appropriate approach (TBD).

CAL/VAL Test site, Geometric Activities

- All documents available on the cal/val portal..

http://calvalportal.ceos.org/cvp/web/guest/calibration-test-sites

Calibration requirement	WP110 - Needs for calibration
Site identification	WP210 - Geometry Sites
	WP210 - MTF Sites
	WP210 - Radiometric Sites
Calibration methods	WP221-WP223 – Radiometric Calibration methods
	WP222 - Geometric Calibration methods
	WP224 - Image Quality Calibration methods
Site characterisation	WP230 - Site characterisation from climatological dataset
	WP230 - Sea Equipped Sites
Site equipment	WP240 - Site equipment and Auxiliary data
	WP250 - Group of sites
Error Balance	WP260 - Error Balance
Recommendation	WP310 - Recommendation for the Sentinels calibration (S2-S3)