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Calibration Test Sites Selection and Characterisation

Ceos Meeting
INRA/AVIGNON – 2008/09/30

Context

- The study is a contribution to CEOS/WGCV strategy to ensure the quality of data for current and future missions (**Calibration,** Validation, Operational quality)

- The study **focuses on Calibration** in relation to
  - the CEOS activities through Cal/Val Working Group (WGCV),
    - Sites identification
    - Sites characterisation
  - the Cal/Val portal
    - Data
    - Methodologies
    - Recommendations
  - the key people who manage calibration activities (sites, programs etc)

Project overview

- **Objectives :Select, identify and characterise reference test sites used for the calibration and characterisation of sensors**
  - **Method and sites overview**
  - **Define a strategy to calibrate and cross calibrate future missions**

- **Including radiometric, spectral,**

  VEGA

  Professor R. Santer

  BRIX Systems

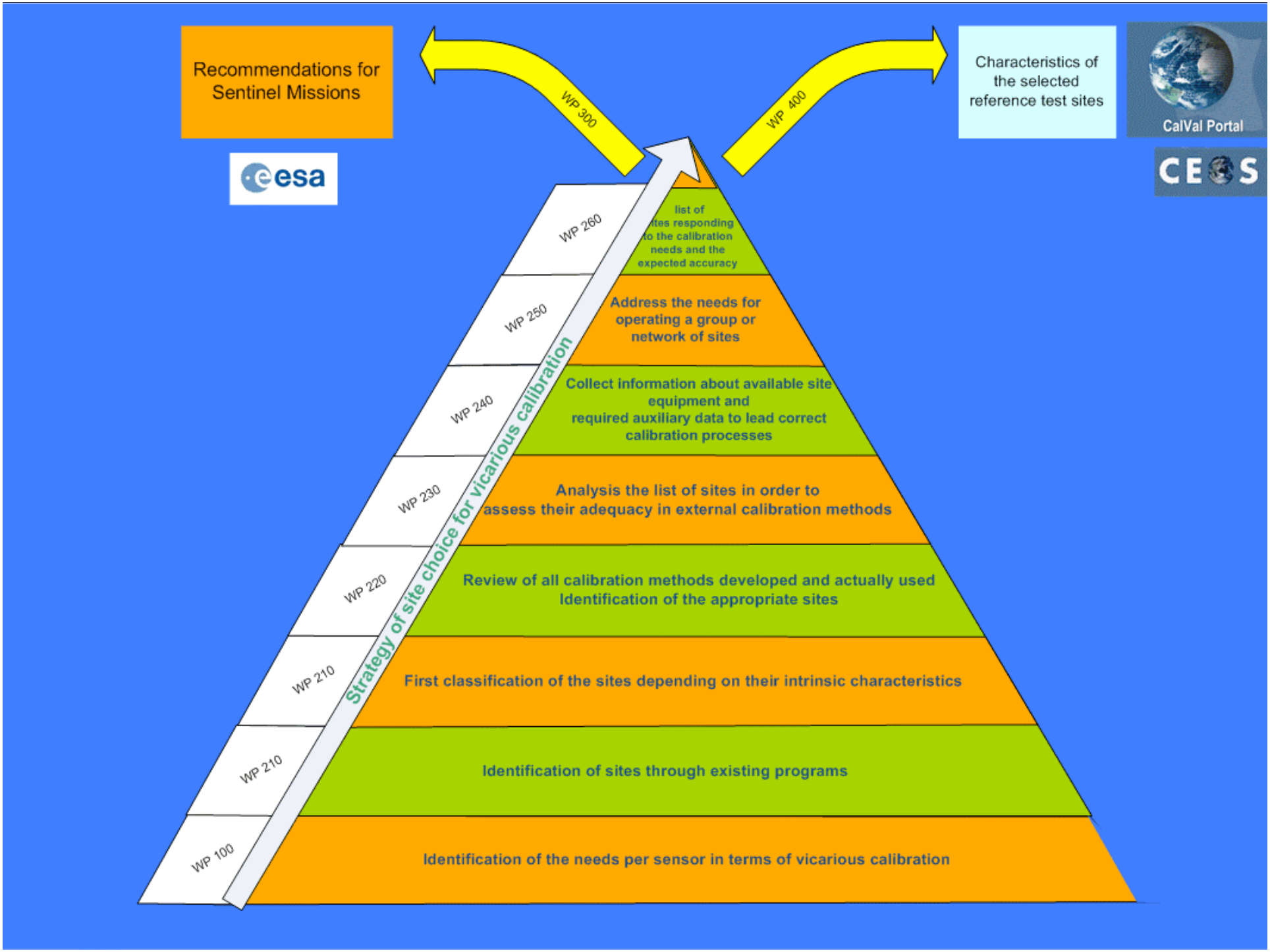
- **geometric,**

  ETH

- **image quality**

  ARMINES


Recommendations for Sentinel Missions
esa
WP 300
WP 400
Characteristics of the selected reference test sites
CalVal Portal
CEOS
Strategy of site choice for vicarious calibration
WP 100
WP 210
WP 210
WP 220
WP 230
WP 240
WP 250
WP 260
Identification of the needs per sensor in terms of vicarious calibration
Identification of sites through existing programs
First classification of the sites depending on their intrinsic characteristics
Review of all calibration methods developed and actually used
Identification of the appropriate sites
Analysis the list of sites in order to assess their adequacy in external calibration methods
Collect information about available site equipment and required auxiliary data to lead correct calibration processes
Address the needs for operating a group or network of sites
list of
ites responding
to the calibration
needs and the
expected accuracy

Task1 :Analysis of the external calibration requirements

- Objectives : identify the needs
  - What do we want to observe from space?
  - What variable (e.g. ECV) can be obtained?
  - Establish the requirements on the products
    - In terms of Accuracy and stability
  - Relate it satellite measurements (relationship is not direct and non linear)

Analysis of the external calibration requirements

- Specifying the requirements on the radiometric and spectral performances of a satellite sensor can be done by:
  - Sensitivity studies including complete calibration
    - Radiometric calibration
    - Geometric calibration
    - Instrument characterisation (Image quality)
- But the stability of the instrument is not guarantied to achieve the product requirement with time (device degradation)
- How vicarious calibration can help to meet the requirements?
  - Structure the approach
    - Class of sensors
    - Recommendations
    - Needs for vicarious calibration

Analysis of the external calibration requirements

- WP 110 – Sensor classification

Class number	Sensor type
Class 1	▪ Synthetic Aperture Radar ▪ Radar altimeter ▪ Microwave radiometer
Class 2	▪ Optical sensor medium resolution ▪ Geostationary instruments
Class 3	▪ Optical sensor high resolution
Class 4	▪ Atmospheric instruments

Class 2 main characteristics

•Large FOV (BRDF)
•Good revisiting time
•Large pixels (spatial sampling)
•Narrow filters

Class 3 main characteristics

•Small FOV
•Poor revisiting time (accuracy)
•Small pixels
•Large filters (spectral sampling)

Class 4 main characteristics

•large FOV
•Poor revisiting time (accuracy)
•large pixels
•Very Narrow filters

Class 2 specification summary

Sensor	Product spec	Calibration spec
Meris	Chl.A (30%), Sediment (30%)	2 % absolute
AATSR ATSR2	SST radiances	0.3 K (0.1 stability) 5%
AVHRR/3	SST radiances	Few tenth of degree 1; 2%
VGT		Absolute calibration accuracy 5% Multidate calibration accuracy 3% Interband calibration accuracy 3% HRVIR/VGT intercalibration accuracy 3%
MODIS		5% < 3µm ; 1% > 3µm
SeaWiFS	Chl. 1 (35 %)	5% absolute; 1% relative
SEVIRI		1K 5%
OCM		
MISR		Accuracy :3% absolute, 1% relative Stability 0.5%/month 2% /1 year
PARASOL		2% < 565 nm absolute; 3% > 565 nm 1% channel intercalibration

Class 3 specification summary

Sensor	Product spec	Calibration spec
SPOT 4/5		10%
Venμs	LAI	3-5% absolute, 3% interband
ETM		5% absolute
DMC		2-5% absolute

Only radiometric requirements

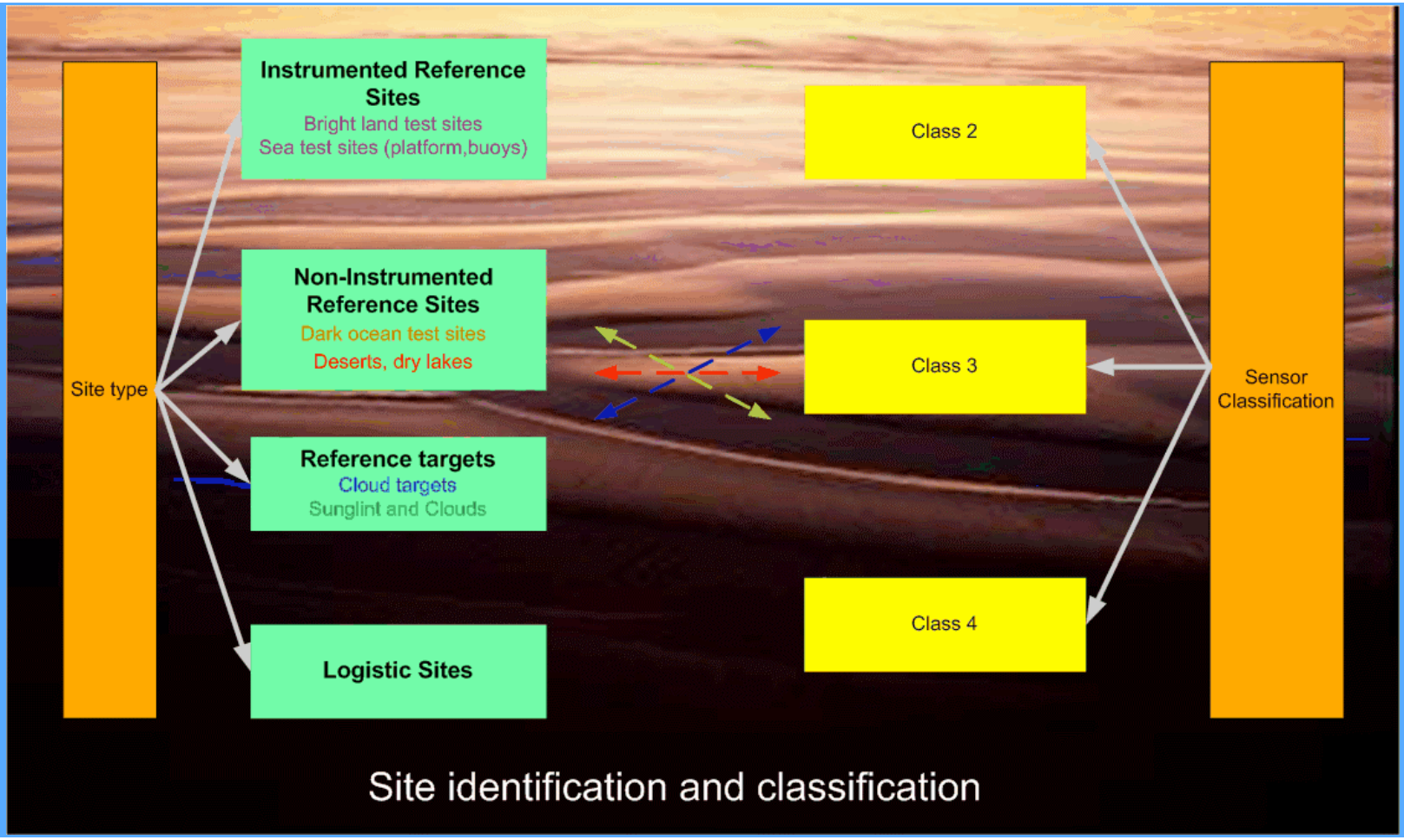
Conclusion

- Ocean : product specification available (SST, OC) (Class 2)
  - → calibration specification

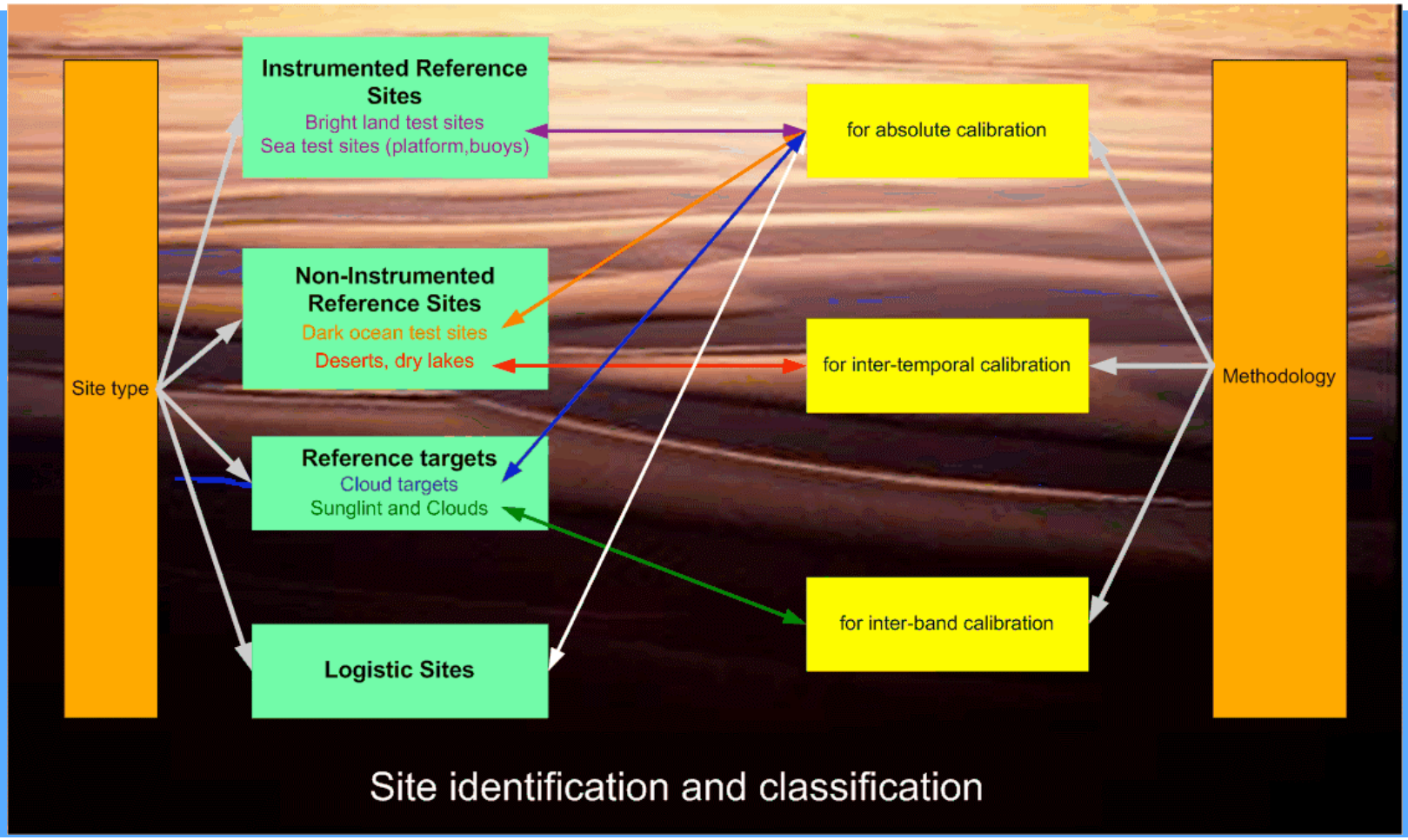
- Land : for most of sensors, there are no link between product specification and calibration accuracy (Class 2/3)
  - Calibration specification found 5% (absolute) – Nothing for class 3

  - Class 2 : Internal Calibration + vicarious
  - Class 3 : vicarious

Recommendations



Relationship with method



Relation between class of sensors and radiometric calibration sites

Correspondance between class and sites types for

- absolute,
- intertemporal

  - LES : Land Equipped Site
  - SES : Sea Equipped Site
  - LNES : Land Non Equipped Site
  - SNES : Sea Non Equipped Site

  - R: Recommanded
  - O: Optional
  - Cross Cal: Cross calibration from class i to class j

Absolute

	Land Eq. Site	Sea Eq. Site	Land Non Eq. Site	Sea Non Eq. Site
Class 2	O	O		R
Class 3	R	R	Cross Cal Clas (2,3)	O, Cross Cal Clas (2,3)

Intertemporal

	Land Eq. Site	Sea Eq. Site	Land Non Eq. Site	Sea Non Eq. Site
Class 2			R	R
Class 3			R	R

WP210 - Identification and description of calibration sites through existing programs

- Identification of the main key-actors (e.g. PI) in calibration activities
- Collection of information describing the sites (localisation, size, surface type)
- Identification of the operations conducted on the site (frequency, experimental campaigns …)

➔Information collected from various sources: common scientific community knowledge, technical publications, web information, expert networks, committees, direct contact with project leaders

➔Questionnaires dedicated to site characterisation (radiometry and geometry)

➔Difficulty to identify the future activities :

Suggestion of R. Santer : Ask to calibration responsible to communicate about the calibration activities in CEOS or calval bulletin.

Questionnaires : Land Equipped Site

Calibration test sites characteristics

Instrumented Reference test site for absolute calibration (Land)

Identification and characterisation

Site Name	
Location	
Google Earth Image 1x1 degree around the site center	
Altitude	
Description	
Environment	
Topography	

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Sea Equipped Site

Calibration test sites characteristics:

Instrumented Reference test site for absolute calibration (Over Ocean: Platform, buoys)

Identification and characterisation

Site Name	
Location	
Google Earth Image 1x1 degree around the site center	
Description	
Environment	
Topography	

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Logistic information

Site proximity from road:	
Access	
Nearest town	
Distance from nearest town/port	
Logistics (Hotel, Restaurant, ..)	
Communication mean	
Owner	

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Logistic information

Site proximity from seaport:	
Distance from nearest port	
Logistics (Hotel, Restaurant, ..)	
Communication mean	
Owner	

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Site Climatology

General atmospheric conditions	
Meteorological conditions	
Annual pluviometry	
Wind :	
Clear sky conditions:	
Atmosphere characterisation	
Seasonal variation of the aerosol	
Alpha:	
Seasonal variation of the water vapour content	
Surface characterisation	
Surface albedo	
BRDF	

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Site Climatology

General atmospheric conditions	
Meteorological conditions	
Average monthly insolation time (in 24h)	
Atmosphere characterisation	
Seasonal variation of the aerosol and of the water vapour	
Surface characterisation (water body)	

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| Proven Delivery

Site instrumentation (Nominal)

Meteorological instrumentation (list)	
Meteo station (Temperature, pressure, humidity)	
pluviometer	
Anemometer	
Atmospheric instrumentation	
Water vapour content origin	
Surface reflectance instrumentation	
Frequency of measurements	Each hour

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Site instrumentation

Meteorological instrumentation
Meteo station (Temperature, pressure, humidity)
Pluviometer
Anemometer
Atmospheric instrumentation
Surface reflectance instrumentation

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Measurement accuracy	
Aerosol optical thickness	
Nominal values of AOT at 450, 550, 650, 850 nm	
Absolute error of AOT at 450, 550, 650, 850 nm	
Model of aerosol used	
Granulometry	
Refraction index used	
Water vapour content	
Mean and accuracy	
Reflectance	
Mean reflectance at Nadir at 450, 550, 650, 850 nm	
$\Delta\rho$ at 450 nm, 550, 650, 850 nm	
BRDF correction	
Relative error on BRDF correction at θs=45 degrees,θv=30 degrees	

Measurement accuracy	
Aerosol optical thickness	
Minimum values of AOT at 450, 550, 650, 850 nm	
Absolute error of AOT at 450, 550, 650, 850 nm	
Model of aerosol used	
Granulometry	
Refraction index used	
Water vapour content	
Mean and accuracy	
Reflectance	
Mean reflectance at Nadir at 450, 550, 650, 850 nm	
$\Delta\rho$ at 450 nm, 550, 650, 850 nm	
BRDF correction	
Relative error on BRDF correction at and θv=30 degrees	

LES

Site usage	
Historical record of comparisons (ground, aircraft and satellite)	
Date / sensor / location of results	
Regularity of satellite data (if known)	
Satellite and sensor ID	

Contact information	
Instrumentation maintenance	

Dataset availability and owner		
Dataset	**Owner**	**Availability**

WES

Site usage	
Historical record of comparisons (sea, aircraft and satellite)	
Dates / sensors / location of results	
Regularity of satellite data (if known)	
Satellite and sensor ID	

References	
Bibliography	

Characterization of the site

Description of the methodology

Description of the instrumentation

Description of applications for vicarious calibration

Site Web	

Instrumented Sites over land

- La Crau
- Amburla
- Dunrobin
- Winton
- Warrabin
- Tinga Tingana
- Lake Frome
- Barreal Blanco
- Sechura Desert
- Bonneville Salt Flats
- Brookings SD 3M
- Dunhuang
- Frenchman Flats
- Negev
- Railroad Valley Playa
- Ivanpah Playa
- Rogers Dry Lake
- Lunar Lake Playa
- White Sands
- Sonoran Desert
- Tuz gulu
- Uyuni Salt Flats

All questionnaires have been pre-filled thanks to :

- USGS cal/val portal,
- CEOS
- K. Thome
- Dr. Karnieli
- Selime Gurol
- M. Bouvet
- M. Helmlinger, C. Bruegge
- M. Schaepman
- D. Smith
- D. Six
- A. Meygret
- D. Aaron
- publications, web site data

Missing information:

- Site instrumentation description
- Measurement accuracy

Instrumented Sites over Sea

- MOBY
- BOUSSOLE
- Venise

All questionnaires have been pre-filled by R. Santer
With the collaboration of
G. Zibordi
D. Antoine
S. Flora

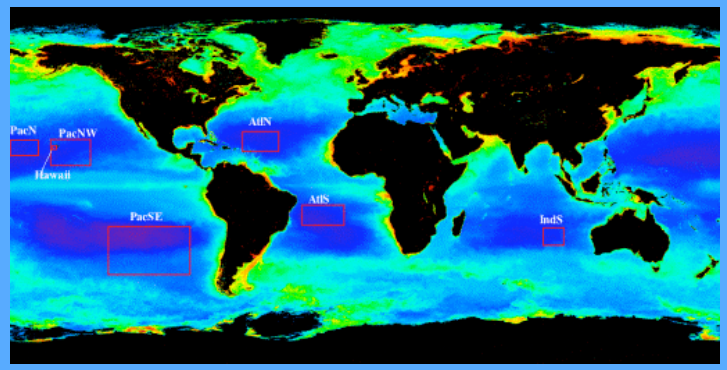
Questionnaires

- Same initiative with
  - Geometric site characterisation thanks to S. Saunier (GAEL)
  - Microwave site characterisation thanks to R. Gray (BRIX)

- Refer to Cal/val newsletter n°2 and cal/val portal to get the questionnaires
  - http://calvalportal.ceos.org/CalValPortal/showSitesInfo.do

Exploitation of questionnaires

- Assessment of the adequacy of test sites for external calibration methods
  - Classification according to methods
  - Sites which minimize the sources of errors in the calibration process
    - Spatial uniformity
    - Temporal stability
    - Minimization of directional effects
    - Water vapour and Ozone variability
    - Aerosol content variability
    - Cloud coverage
    - …



  - Appropriate criteria for geometric calibration activities discussed by S. Saunier
  - EO and auxiliary data required to characterise the calibration sites
    - Analysis based on information received or free identified auxiliary data such as AERONET, NCEP
    - Use of the CalVal Portal in order to limit data delivery delay

Exploitation of questionnaires : Site characterisation and expected accuracy: Error budget

- For each method, and each site associated to it, we will first define the nominal conditions.
- We will then identify the different sources of error.
  - Error on the gaseous content.
  - Error on the aerosols. The Rayleigh is well known and well control through accurate surface pressure measurements.
  - Error on the surface.
- If the amplitude of the errors are known from the literature or from the exploitation of the questionnaires, we will used it. If not, the error analysis will be a sensitivity analysis.
  - Use 6S to evaluate the performances of the different scenario