Exploitation of the CEOS Pseudo Invariant Calibration Sites (PICS) for Vicarious Calibration of Optical Imagers

Revisiting PICS locations
-
PICSAND database of sand optical properties

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Context & objectives

- **Revisit the list of Pseudo-Invariant Calibration Sites (PICS) over desert areas** defined 20 years ago by Cosnefroy et al. (1996)
  - use up-to-date multi-spectral remote sensing data with enhanced resolutions (spectral, directional, spatial) and temporal coverages
  - determine if possible areas identified in other activities are suitable for vicarious calibration
  - consider medium (100 km) and small (20 km) size sites

- **Collect sand samples from an ensemble of identified sites**
  - analyze in **laboratory** their physical (mineralogy and grain size analysis) and optical (spectro-directional reflectance) properties

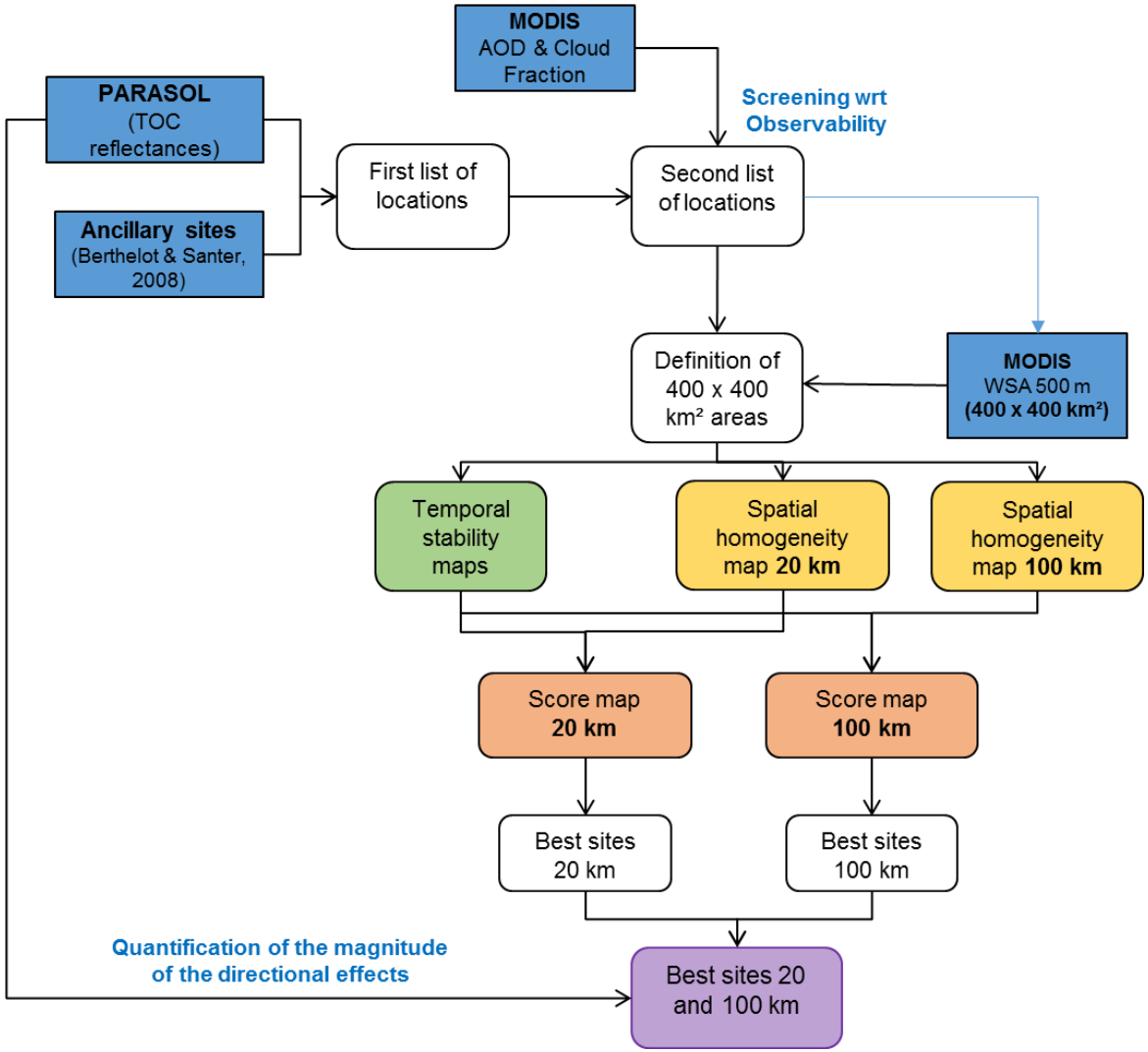
- Build a **database** combining the **sand optical properties** estimated from the sampled collected with other datasets available in the literature

Criteria for selection

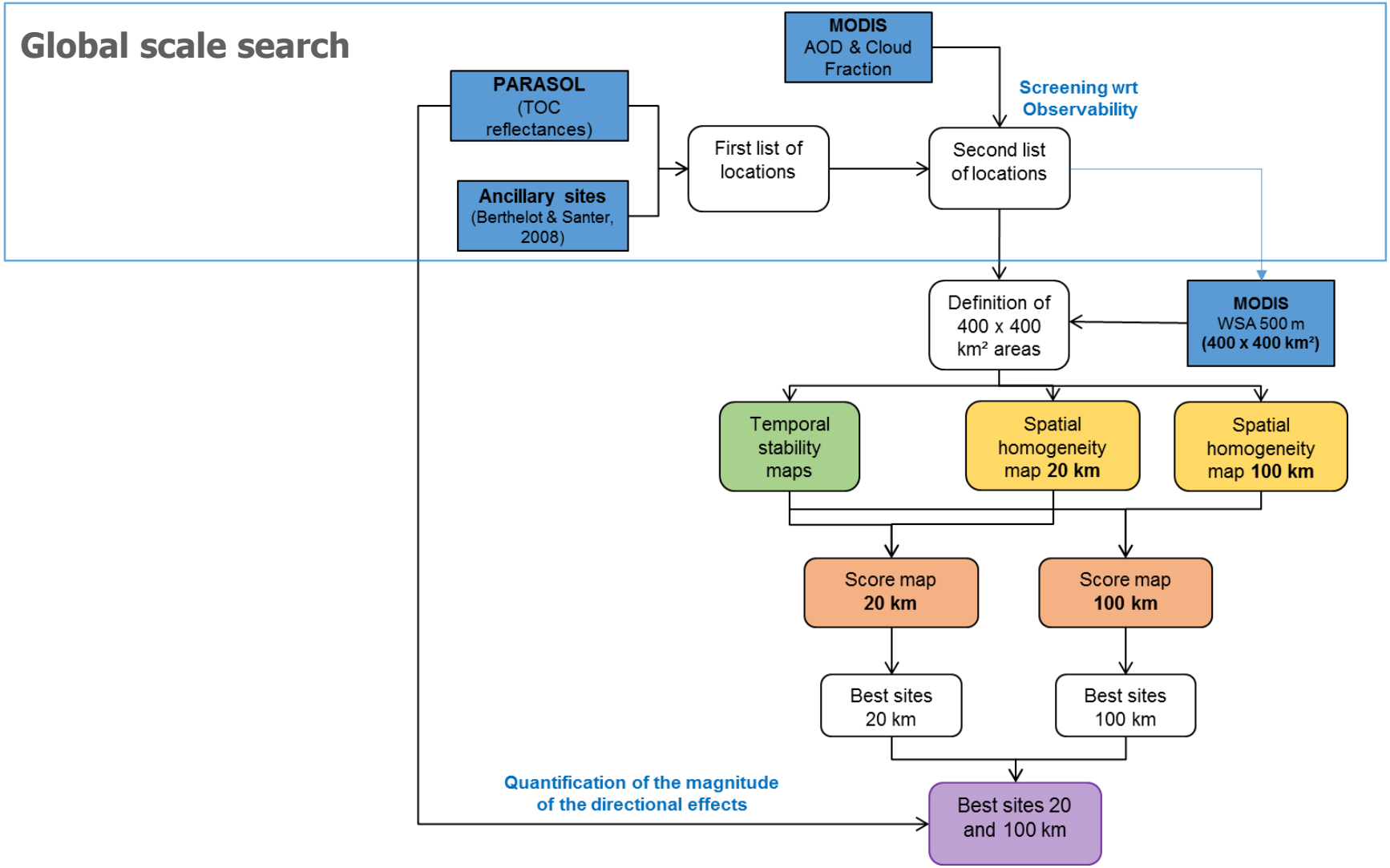
- **PICS desired properties**
  - **temporal stability** of their optical properties (< 4% as a starting value)
  - **spatial homogeneity** (< 3% as a starting value)
  - weak / well characterized directional effects
  - weak cloud cover and low aerosol load and well characterized aerosol type
  - proximity of meteorological / AERONET stations
  - importance/relevance wrt other CEOS cal/val activities
  - accessibility

- **Calculate corresponding metrics from remote-sensing data**

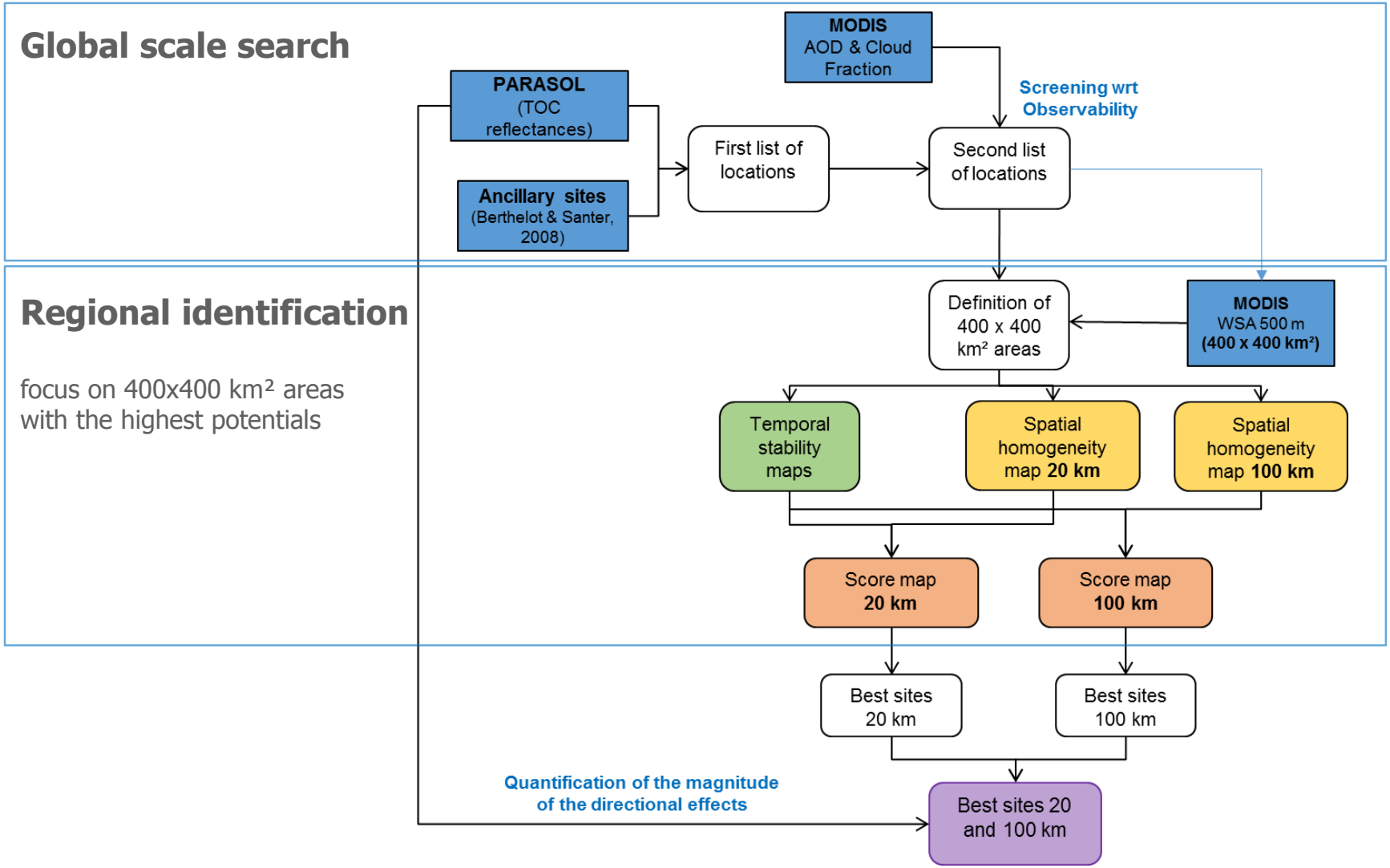
Processing steps



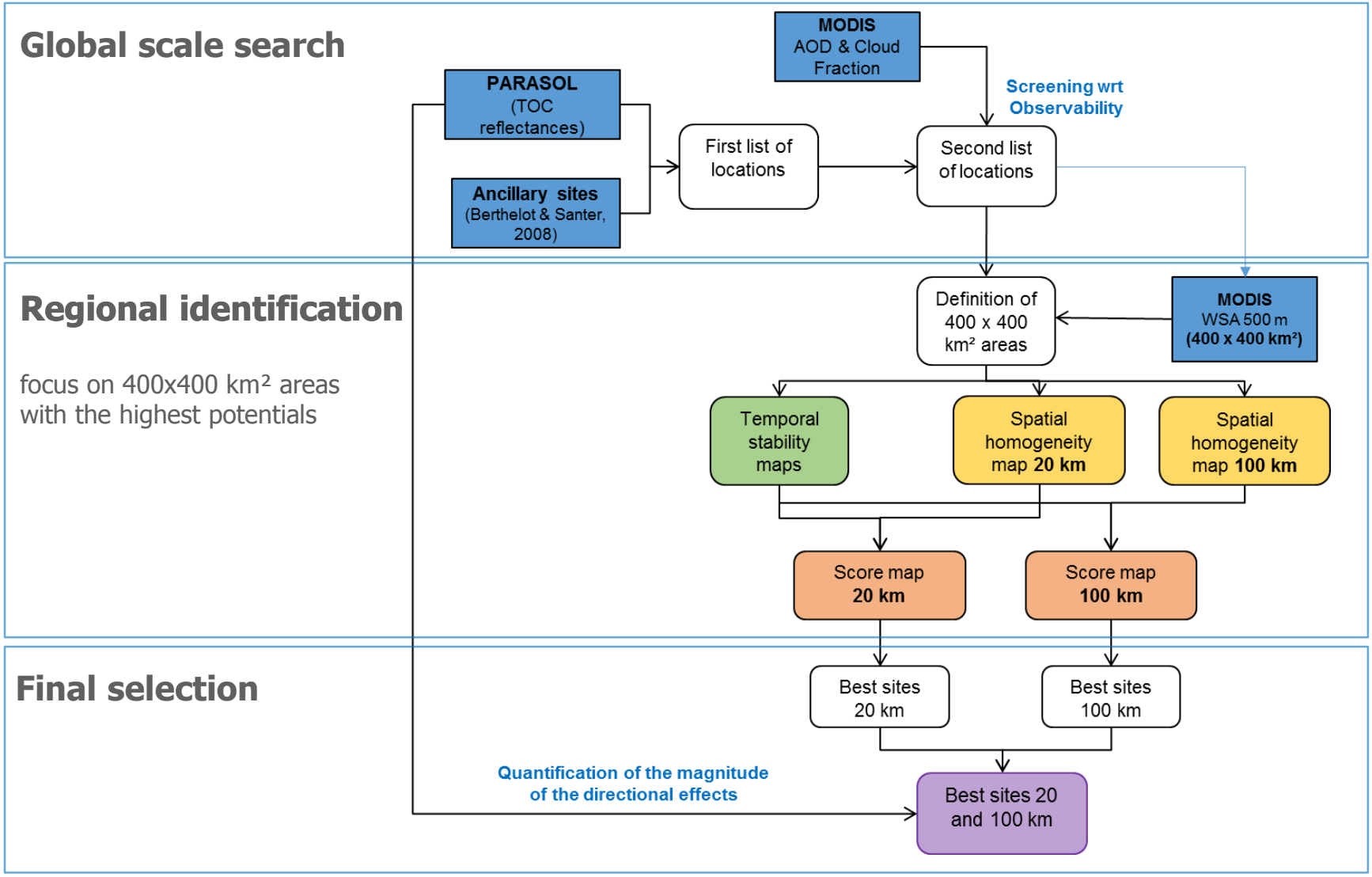
Processing steps



Processing steps



Processing steps



Processing Global Scale

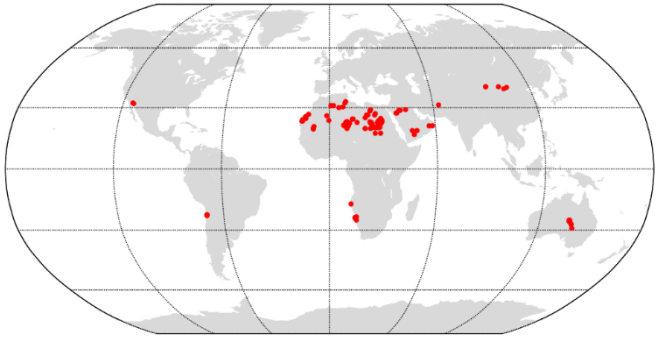
- **1st iteration – Global scale**
  - Temporal stability and directional signature reproducibility: **POLDER/PARASOL** (6km, year 2008)
  - Thematic homogeneity (Barren or sparsely vegetation): **IGBP classificication** (1km)
  - Topography/flatness: **GTOPO30 DEM** (1km)
  - Candidate locations used in Rad/Cal activities (**Berthelot and Santer, 2008**)
  - Observability (wrt AOD and cloud fraction): **MODIS MYD04_L2** (10km, 2003-2015)

- **POLDER/PARASOL processing**
  - Selection of monthly clear observations
  - Fit with the BRDF Ross Li HS model (Maignan et al., 2004) at 670 and 865 nm
  - Temporal stability : $TVar\lambda = \frac{\sigma\left(\rho_\lambda - \overline{\rho_\lambda}\right)}{\overline{\rho_\lambda}} < 0{,}014$

PARASOL: ~90 sites
Rad/Cal: ~80 sites

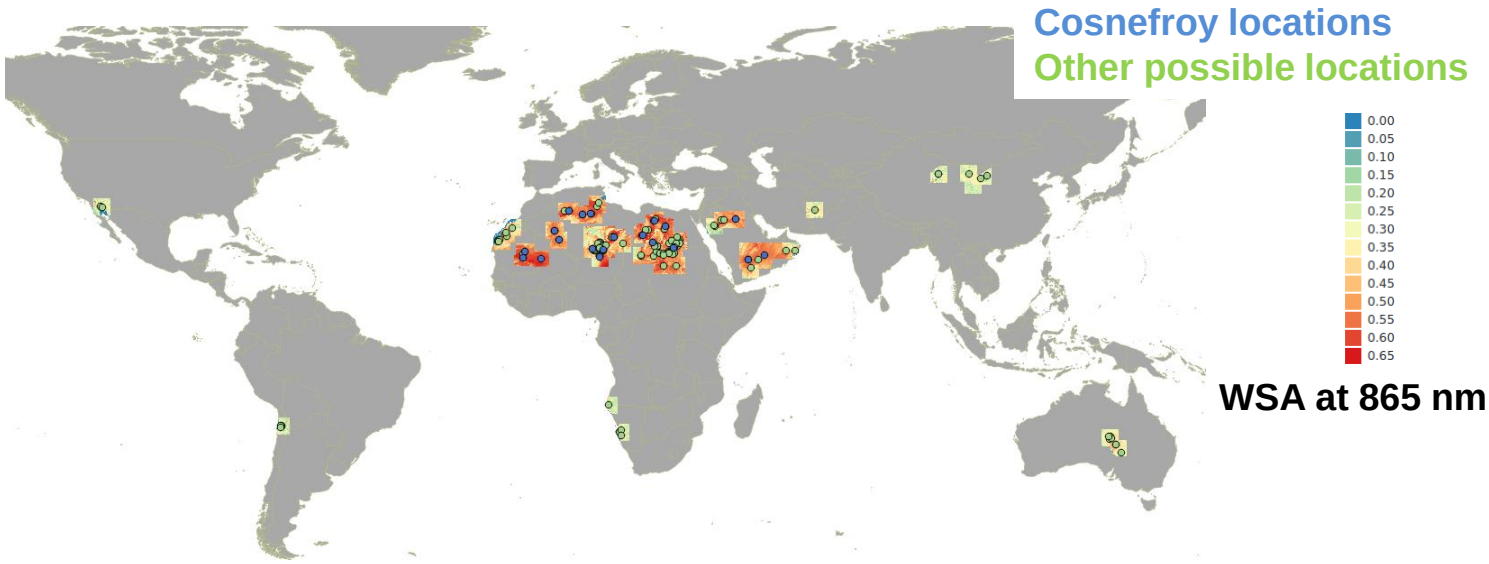
AOD/Cloud screening

identification of 125 candidate locations



Refinement of the site location - Regional scale

- Definition of 73 regions of **400 x 400km²** encompassing the 125 candidate locations
- Calculation of the temporal stability and spatial homogeneity at 20 km and 100 km
  - **MODIS MCD43A3 white sky albedo** (WSA):
    - Medium spatial resolution (500m)
    - 2011-2015 period (weekly)



- Spatial homogeneity: $homog = \sigma(\rho_n)/\overline{\rho_n}$ (moving windows of size = 20x20 and 100x100 km²)
- Temporal stability: $TVar\lambda = \sigma(\rho_\lambda - \overline{\rho_\lambda})/\overline{\rho_\lambda}$
- Score at 20/100/20+100 km:

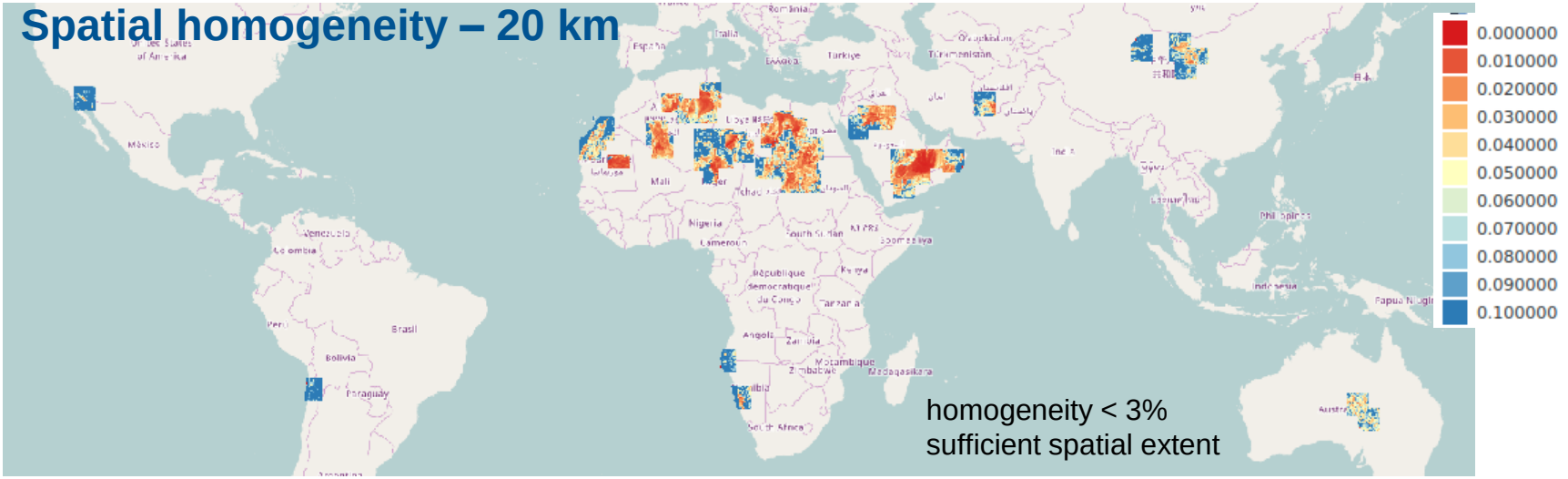
$$Score_{20km} = 2 * \overline{TVar_{\lambda,20km}} + homog_{20km}$$

$$Score_{100km} = 2 * \overline{TVar_{\lambda,100km}} + homog_{100km}$$

$$Score_{20+100km} = Score_{20km} + Score_{100km}$$

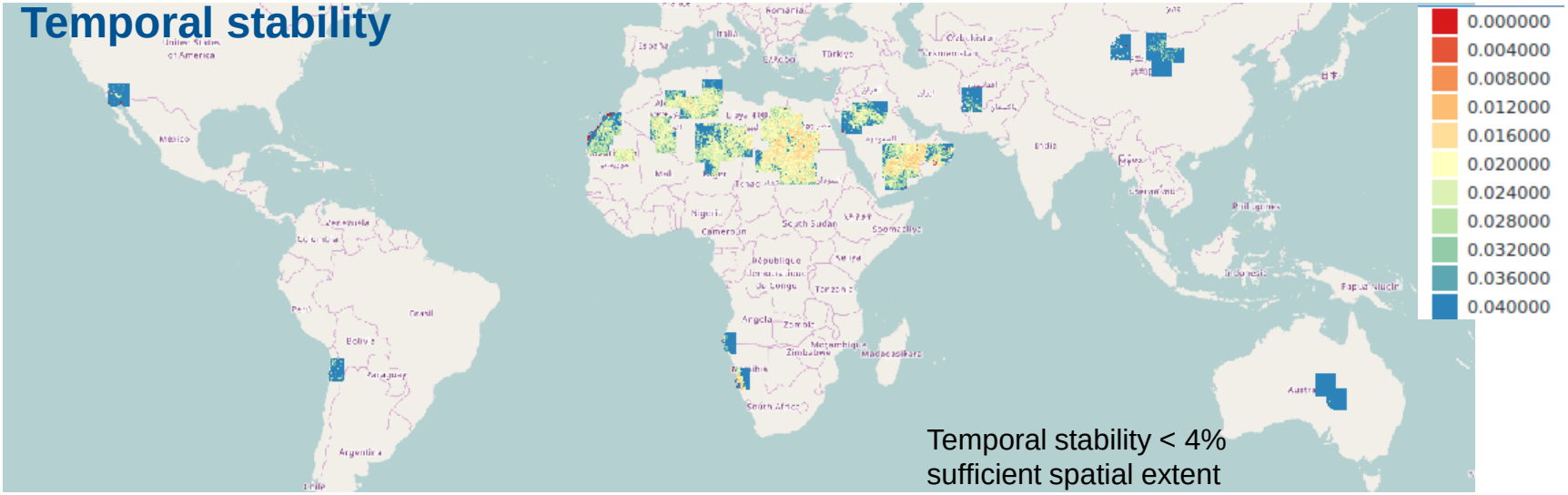
Processing
Regional scale

Spatial homogeneity – 20 km



homogeneity < 3%
sufficient spatial extent

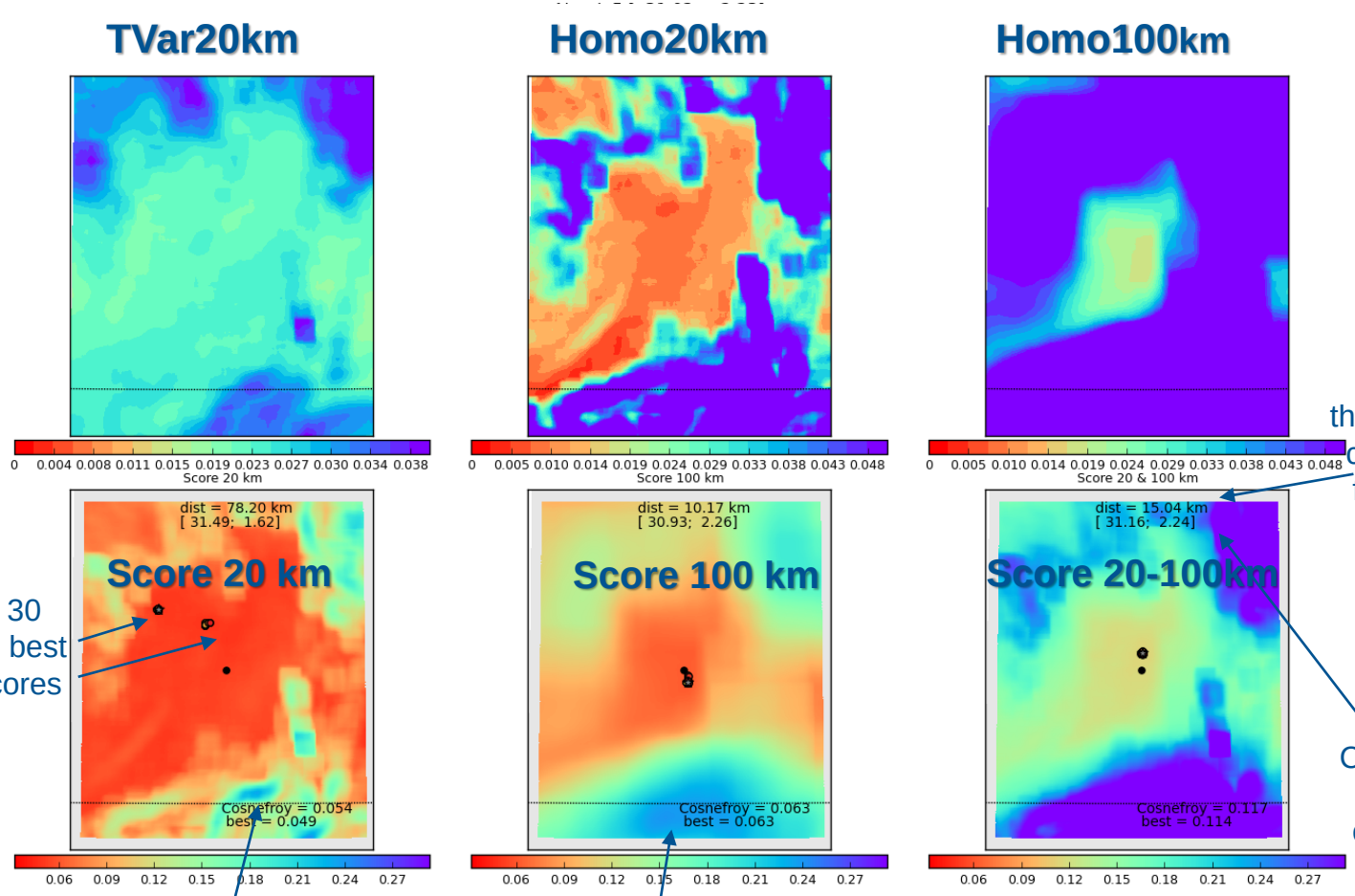
Temporal stability



Temporal stability < 4%
sufficient spatial extent

Processing
Optimal locations

- **Illustration for Algeria5**



Final selection

	Coordinates	Score 20 km	Score 100 km	Score 20+100 km
CEOS/IVOS sites / Cosnefroy				
Algeria3	[30.32°, 7.66°]	0.050	0.060	0.111
Algeria5	[31.02°, 2.23°]	0.054	0.063	0.117
Libya1	[24.42°, 13.35°]	0.052	0.075	0.127
Libya4	[28.55°, 23.39°]	0.050	0.062	0.112
Mauritania1	[19.40°, -9.30°]	0.052	0.060	0.112
Mauritania2	[20.85°, -8.78°]	0.049	0.066	0.115
Arabia1	[20.13°, 50.96°]	0.046	0.054	0.0855
Arabia2	[18.88°, 46.76°]	0.034	0.042	0.065
Site vicinity				
Algeria3ALT	[30.63°, 7.83°]	0.049	0.056	0.105
Algeria5ALT	[31.16°, 2.24°]	0.051	0.063	0.114
Mauritania1ALT	[19.51°, -8.57°]	0.048	0.057	0.105
Mauritania2ALT	[19.78°, -8.89°]	0.047	0.062	0.109
New locations				
ArabiaPICS1	[19.64°, 50.90°]	**0.031**	**0.038**	0.069
ArabiaPICS2	[29.26°, 40.91°]	0.043	0.068	0.114
NamibiaPICS1	[-25.00°, 15.25°]	**0.034**	0.253	0.287

55 km from Arabia1
276 km from Arabia3
162 km at the south-east from Gobabeb

- Marginal improvement wrt original Cosnefroy's location
- Accessibility issues for candidate sites in Egypt, Mauritania, Sudan > not retained
- New sites in Namibia and Arabia

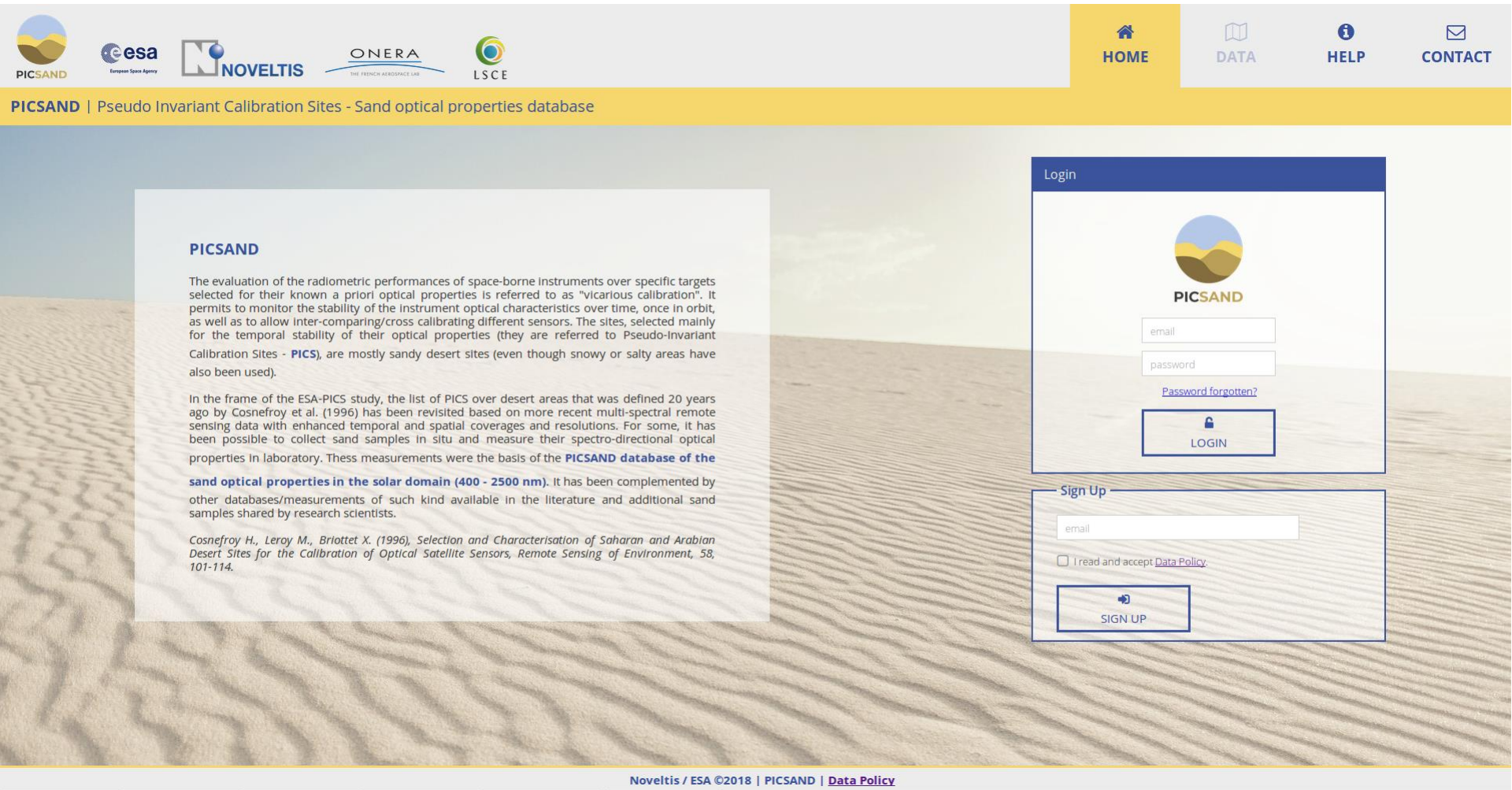
PICSAND Database

Content

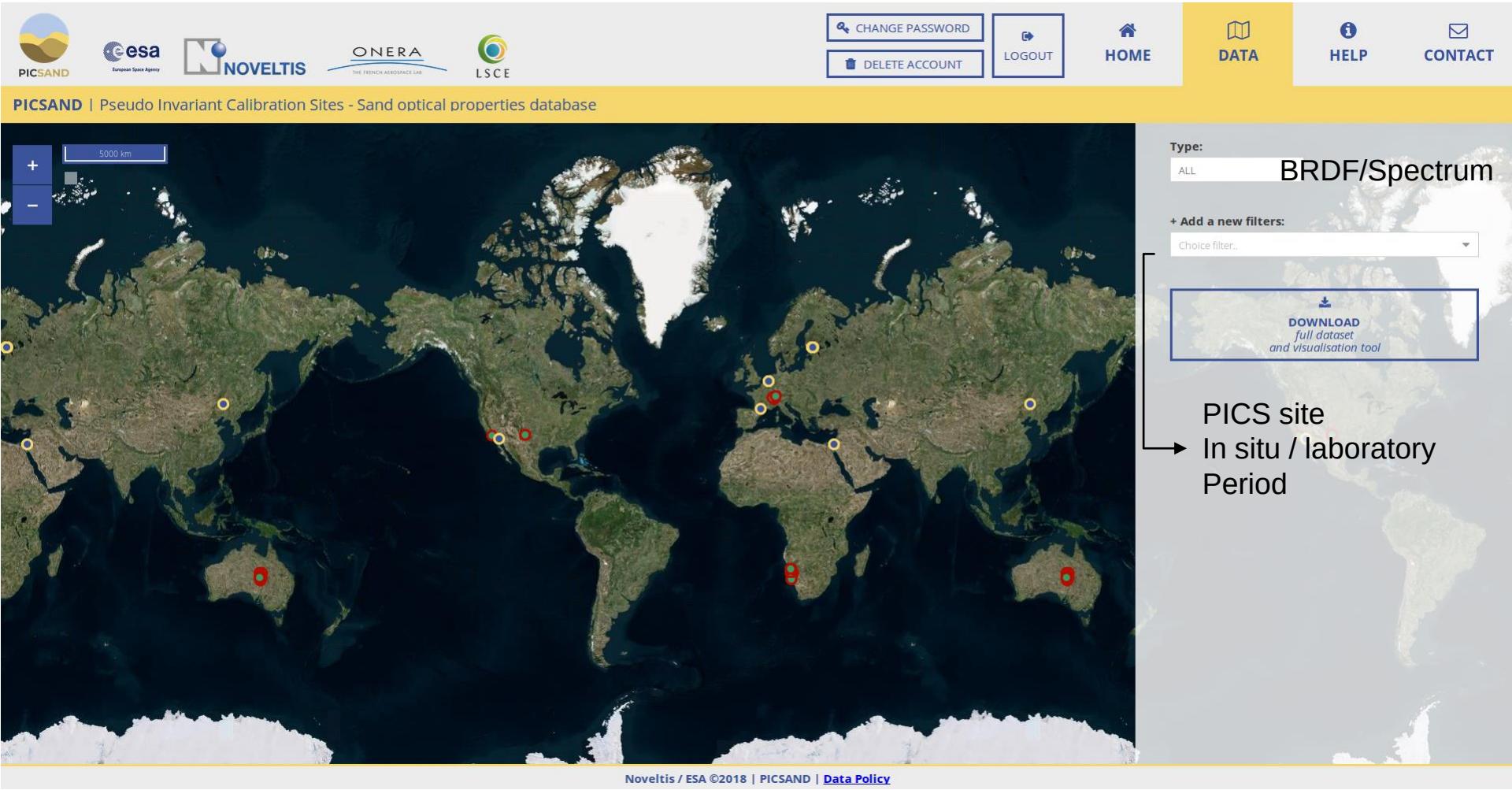
- Spectral-BRF / spectral measurements performed by ONERA
  - Sand collected for some PICS sites + other sand samples
  - see presentation by Françoise Viallefont-Robinet
- Measurements available from the literature

	PI	Country	Comments	Conditions
Spectral-BRF				
	Boucher	France	Algier / Narbonne	laboratory
	Cierniewski	Israel	Negev	laboratory
	Coburn	USA	Algodones Dunes	in situ
	Roosjen	Netherlands	sand, sandy loam	laboratory
	Hueni	Swiss	sand (bright, coarse, fine, dark..)	in situ
	Sun	China	Xianjiamu Sumu	laboratory
	Aaron	USA	Algodones dunes	in situ
	Thome			
	Voss			
	Zhang	*China*	*Sand Dunhuang*	*in situ*
Spectrum				
	ASTER			laboratory
	USGS			laboratory
	Chappell	USA	Texas	laboratory
	Peltoniemi	Finland	beach, football, car park, sand	in situ
	Hueni	Swiss	sand (bright, coarse, fine, dark..)	in situ
	NPL	Namibia		in situ
	White, Bullard	Australia	Simpson Desert	in situ
	White, Bullard	Namibia		in situ
	White, Bullard	USA	Muleshoe Dunes	in situ

PICSAND Database Online portal



PICSAND Database
Online portal



PICSAND Database Online portal

CHANGE PASSWORD | DELETE ACCOUNT | LOGOUT | HOME | DATA | HELP | CONTACT

PICSAND | Pseudo Invariant

Data

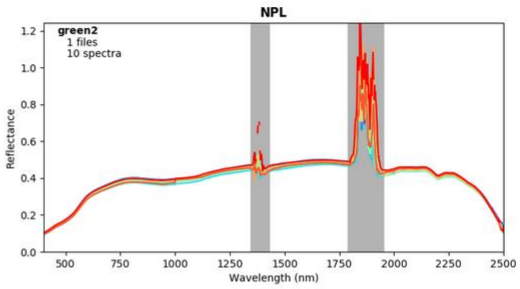
FILE PATH : *Spectrum > NPL > NPL_Namibia_white2*

TITLE : NPL_Namibia_white2

COUNTRY : Namibia

LOCATION : (-22.4022 ; 15.1162)

DATE : -



NPL green2

DOWNLOAD DATA

CAMPAIGN : November to December 2015

ENVIRONMENTAL CONDITION : 25°C-30°C, clear skies

ILLUMINATION : sun

INSTRUMENT NAME : ASD FieldSpec 4

INSTRUMENT SETTINGS : spectroradiometer - capable of measuring 350-2500nm - averaging 10 scans for each measurement - see https://www.asdi.com/products-and-services/fieldspec-spectroradiometers/fieldspec-4-standard-res

MEASUREMENT CONDITIONS : in situ

MEASUREMENT DATE : -

MEASUREMENT TYPE : spectrum

MINERALOGY : XRD diffraction analysis and SEM imaging by Maxim Lamare at RHUL - particle sizes range from 10µm to 100µm in diameter, with a stronger presence of larger particles ; Mineral composition: Quartz (51.4%) Calcite (1.6%) Feldspar (35.8) Silicate (9%) Mica (2.2%)

PROCESSING : -

REFERENCE : Bialek A., Greenwell C., Lamare M. (2016),New radiometric calibration site located at gobabeb, Namib desert, Geoscience and Remote Sensing Symposium (IGARSS), doi: 10.1109/IGARSS.2016.7730592

REFERENCE PANEL : Spectralon, 12 inches square

GEOMETRY : VZA: nadir, AZI: 0

DOWNLOAD full dataset / visualisation tool

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Data

FILE PATH : *BRDF > Sun_China-XinjiamuSumu > Sun_XinjiamuSumu_grain0.3mm_2015 Sun_XinjiamuSumu_grain0.45mm_2015 Sun_XinjiamuSumu_grain0.9mm_2015*

TITLE : Sun_XinjiamuSumu_grain0.3mm_2015 Sun_XinjiamuSumu_grain0.45mm_2015 Sun_XinjiamuSumu_grain0.9mm_2015

COUNTRY : China

LOCATION : Xinjiamu Sumu (45.047, 121.82000000)

DATE : 2015

CAMPAIGN : -

ENVIRONMENTAL CONDITION : -

ILLUMINATION : Tungsten halogen lamp: 500W and 1000W.

INSTRUMENT NAME : NENULGS (Northeast Normal University Laboratory Goniospectrometer System)

INSTRUMENT SETTINGS : The illumination zenith angles were 45° and 60° during the measurement process. The distance from the sensor to the sample surface was 0.15 m; the size of the field of view was 8° for the reflected measurements of the soil and sand samples.

MEASUREMENT CONDITIONS : laboratory

MEASUREMENT DATE : 2015

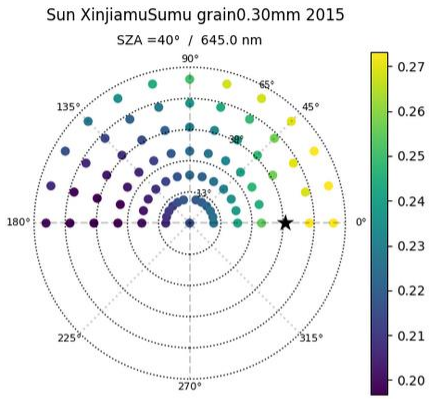
MEASUREMENT TYPE : BRDF

MINERALOGY : -

PROCESSING : -

REFERENCE : Sun, Z. et al. 2016. Effects of particle size on bidirectional reflectance factor measurements from particulate surface, Optics Express, 24, A612-A634.

REFERENCE PANEL : Spectralon



polar Sun XinjiamuSumu grain0.30mm 2015 645nm sza40.0

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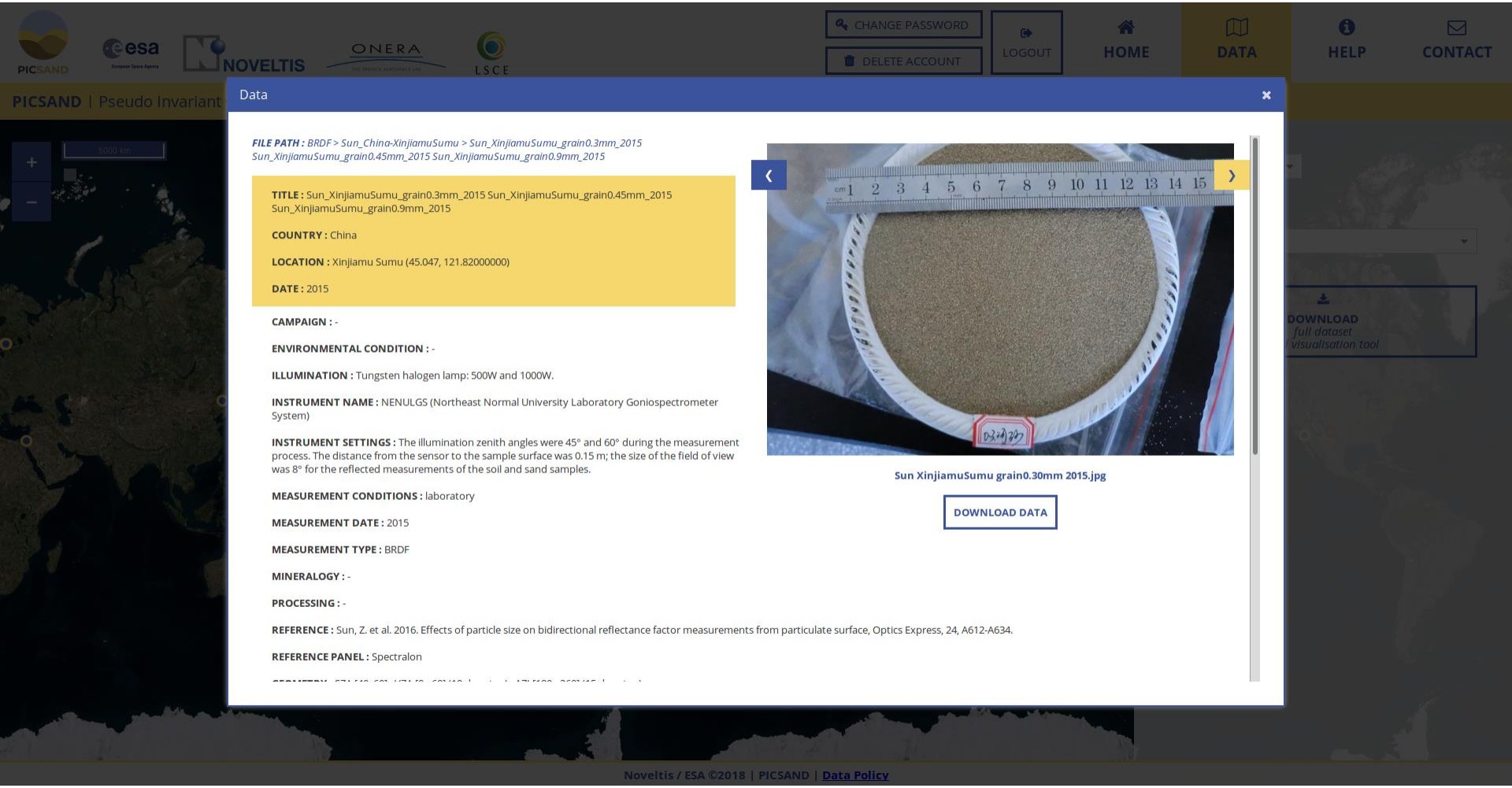

PICSAND Database

- **Availability**
  - Online portal to be hosted on the CEOS/IVOS portal with free access
    - should be available by September 2018
  - User requested to agree to a Data Use Policy
    - properly reference the datasets
  - Homogeneised file format
  - Python Toolkit to read/display the data

  - **We are open for any contribution of the community**