



*Mission Performance Centre*

# CalVal needs for S2/S3 data normalisation

B. Alhammoud,

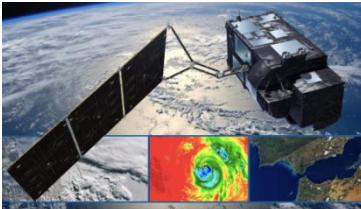
with support of R. Serra & V. Vellucci

## Disclaimer

The work performed in the frame of this contract is carried out with funding by the European Union. The views expressed herein can in no way be taken to reflect the official opinion of either the European Union or the European Space Agency.



presentation by FR Martin-Lauzer



Goal:

## EO synergy

Sentinel-2/MSI, &

Landsat8/OLI, &

Sentinel-3/OLCI & SLSTR, &

NPP-VIIRS & MODIS A

*for L2 data merging*

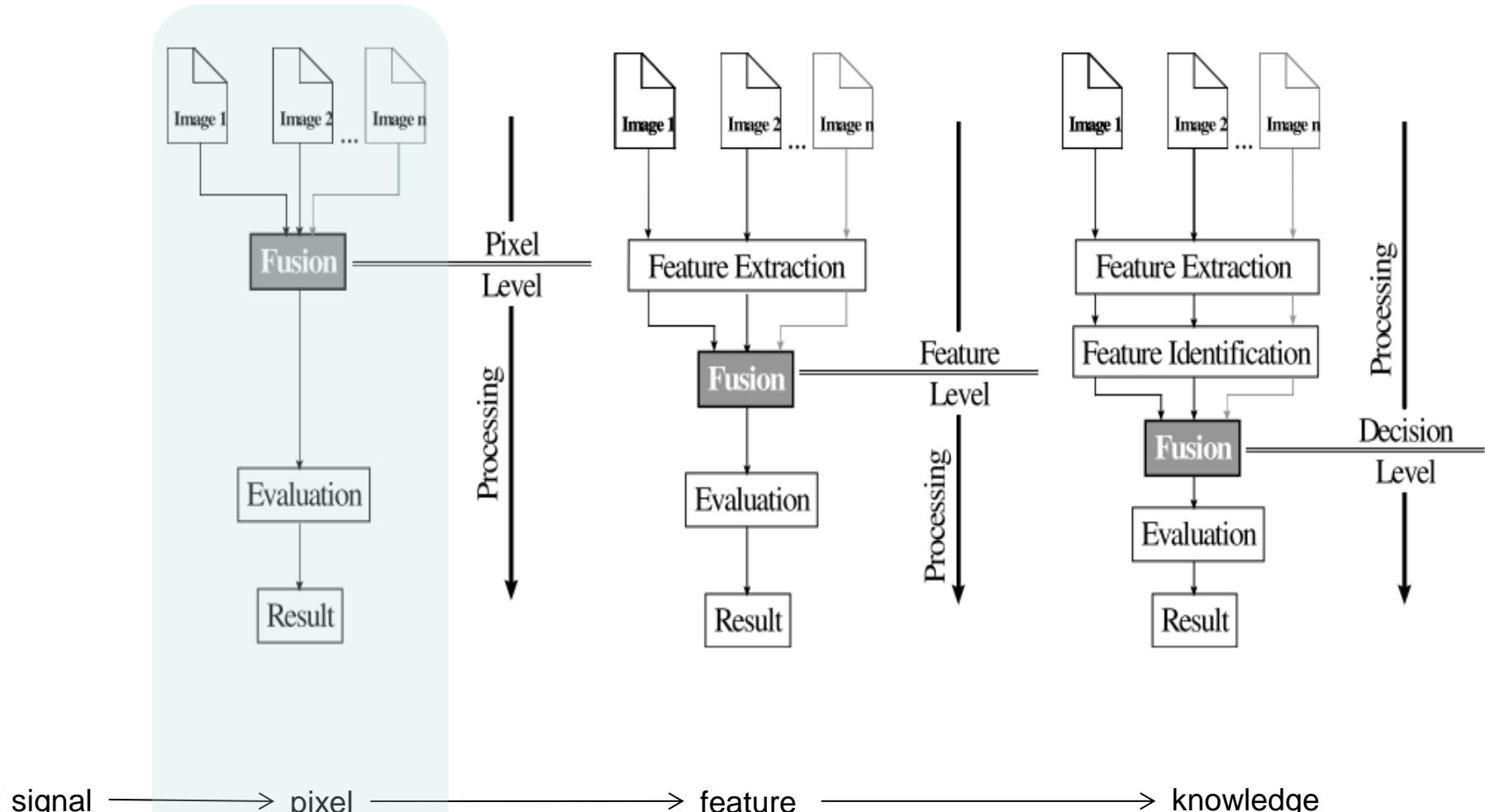
1- inter & co –validation of EO systems, i.e.  
sensors & data processors

→ ***mitigation of sparse revisit time (EO HR and VHR missions vs. MR missions)***

2- co-adjustment of L2 processors, i.e.

- data integration
  - data fusion
- } production of L3 and L4 data sets

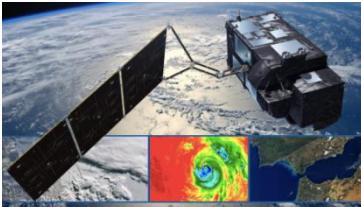
## A 3-Tier data fusion process



**EO products' fusion**

to improve feature extraction

MR data sets have the spectral resolution and HR data sets have the spatial resolution



# Requirements for data fusion

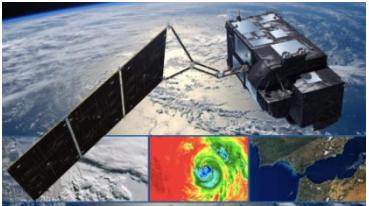
- Consistency between data sets (to apply operations)
- Differential Significance of data sets
- Accuracy & precision of data in each data sets
- Information retrieval & merging methodology

→ e.g. geometric and radiometric intercalibration

statistical consistency ←

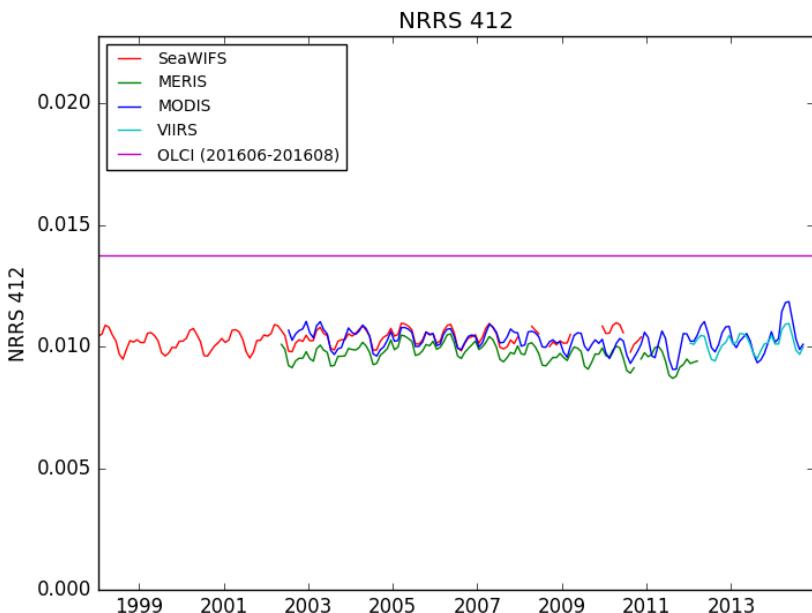
temporal consistency (everything move the same way)  
spatial consistency (same geostatistics)

→ EO data sets = different « views » / details of the same stochastic process  
**at L1 and L2**

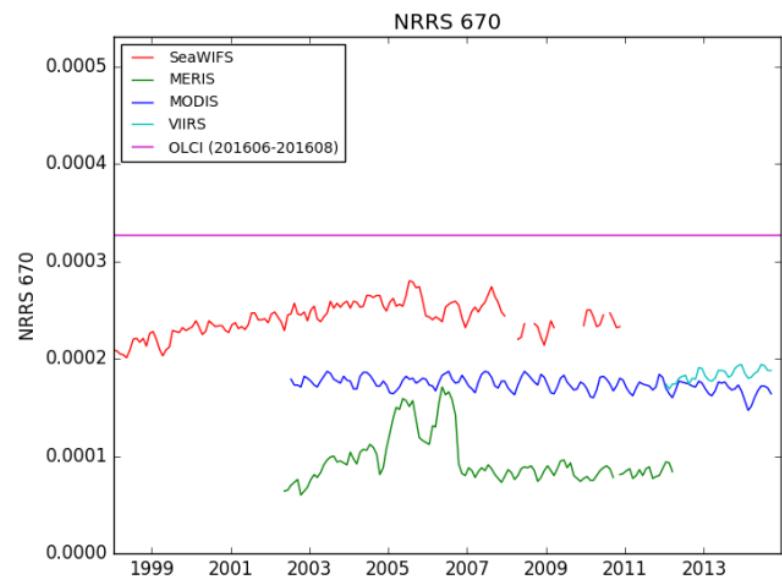


# Examples

## climatological time-series of NRRS

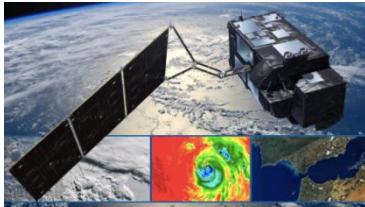


+/- easily merged

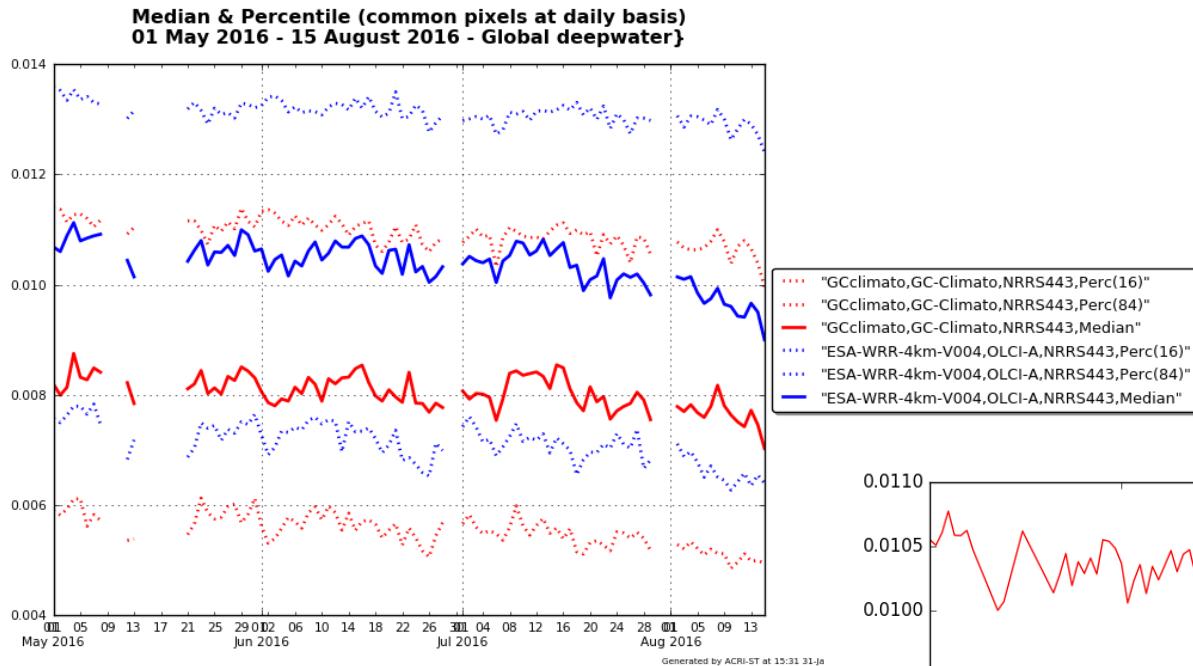


???

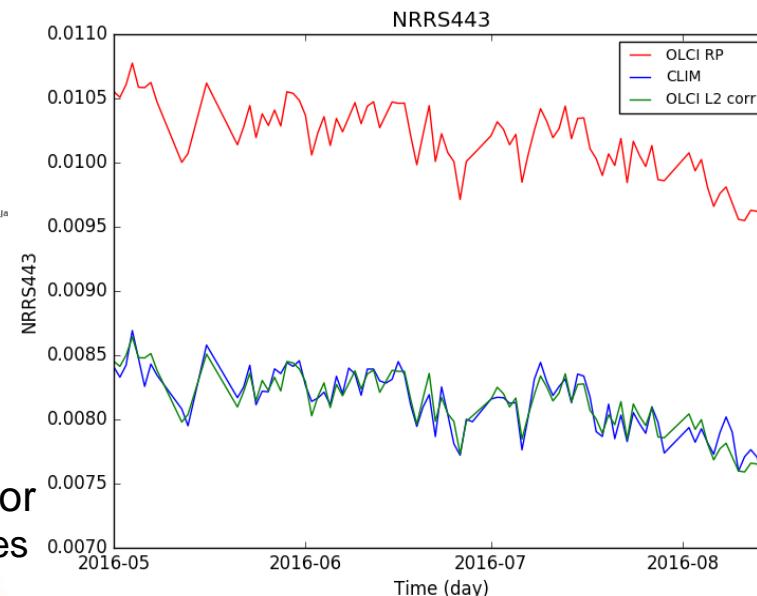
# Example (suite)



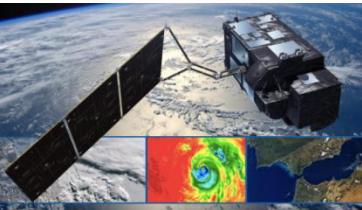
## contribution of OLCI to the NRRS climatology



median NRRS of the deep ocean  
(OLCI RP Apr-Aug 2016)

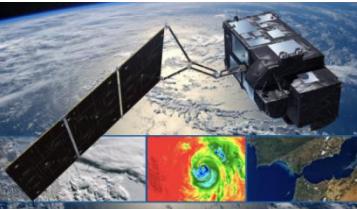


adjustment of the OLCI L2 processor  
to contribute to the climatology estimates



# Overview of OLCI/MSI/OLI/MODIS characteristics

SENSOR	Spectral density (nb of bands)	Spatial-resolution (m)	Temporal resolution (Day)	Viewing Geometry	PDGS Product-Type
MSI_A	13 (VIS/NIR/SWIR)	10/20/60	10/5 (twin)	quasi-nadir	L1C (SAFE)
OLCI_A	21 (VIS/NIR)	300-1200	4/2 (twin)	off-nadir/Max(vZA)=55°	L1B (NCDF) L2 (NCDF)
OLI-TIRS	15 (VIS/NIR/SWIR/TIRS)	15/30	16	Nadir	L1T (TIF)
MODIS_A	36 (VIS/NIR/SWIR/TIRS)	250/500/1000	1-2	Nadir-Off Nadir	L1B (HDF), etc.



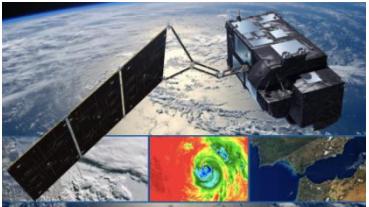
## OLCI-MSI bands

bands	Central wavelength (nm)
B01	443
B02	490
B03	560
B04	665
B05	705
B06	740
B07	775
B08	842
B8A	865
B09	940
B10	1375
B11	1610
B12	2190

Sentinel-2A/MSI

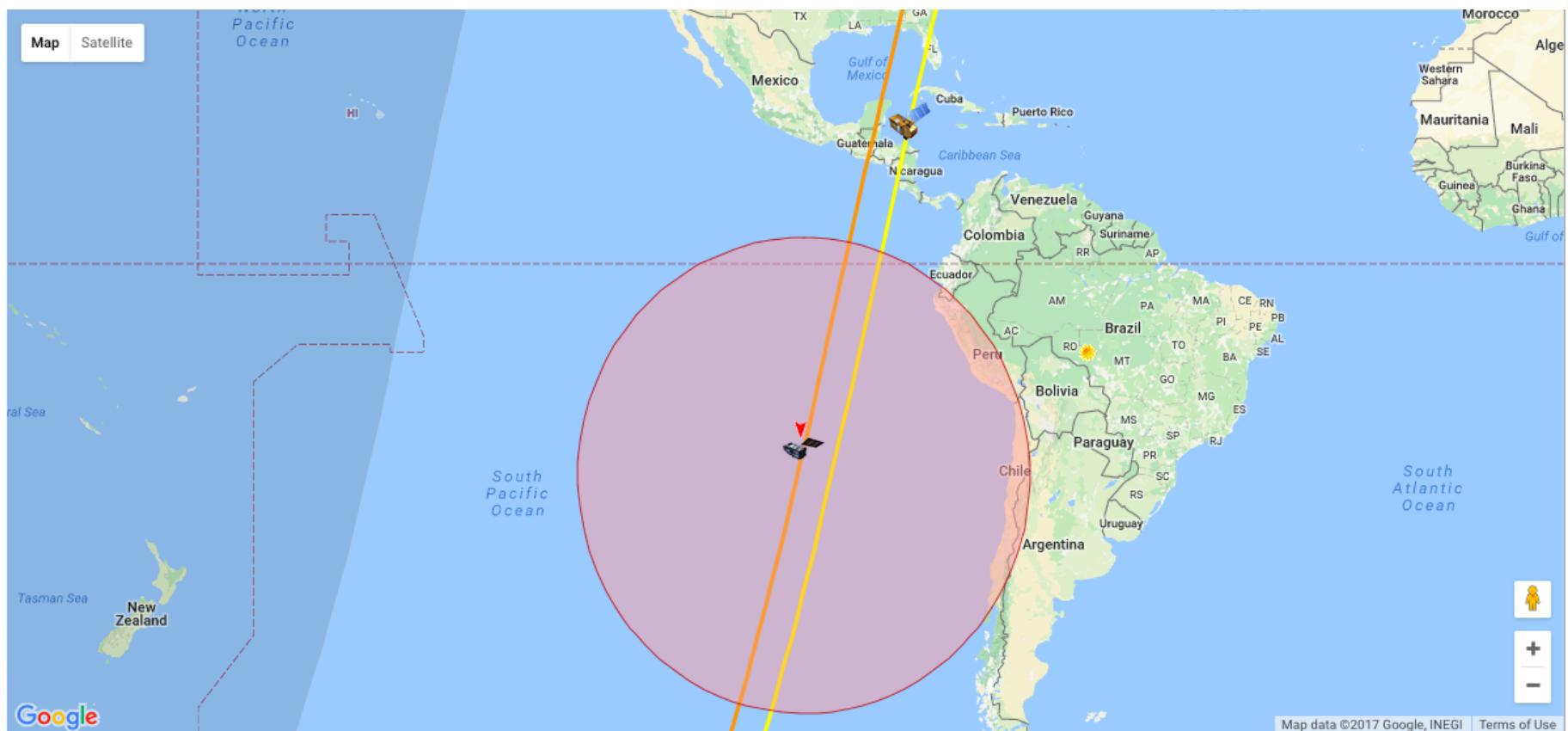
bands	nm
Oa01	400
Oa02	412
Oa03	443
Oa04	490
Oa05	510
Oa06	560
Oa07	620
Oa08	665
Oa09	674
Oa10	681
Oa11	709
Oa12	754
Oa143	761
Oa143	764
Oa15	768
Oa16	779
Oa17	865
Oa18	885
Oa19	900
Oa20	940
Oa21	1210

Sentinel-3A/OLCI

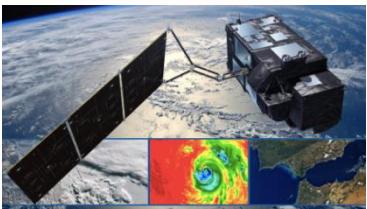


# OLCI/MSI/characteristics

**Overpasses the target area (temporal-shift )**

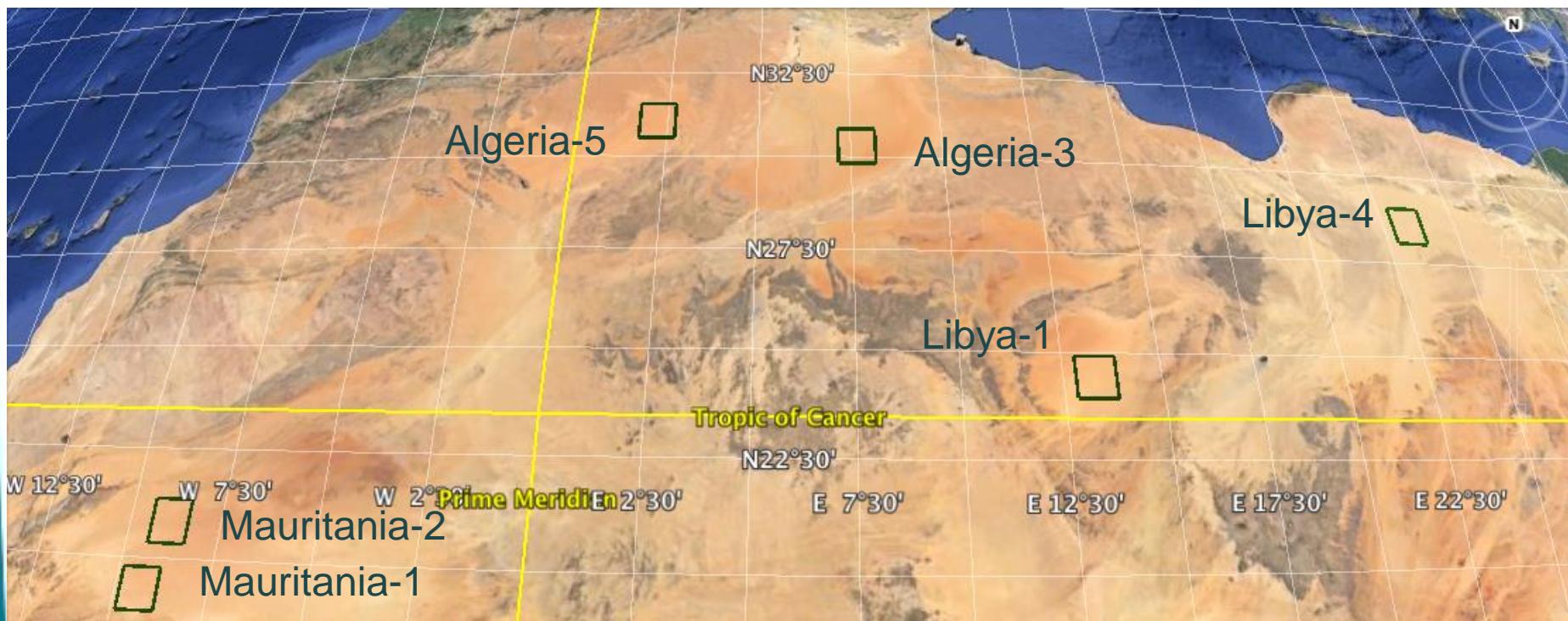


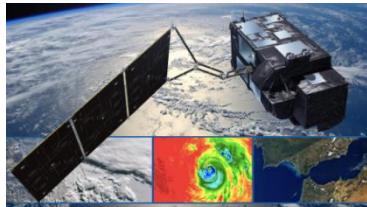
Credit: n2yo.com



# Desert Method: Application on MSI-OLCI-MODIS A-OLI

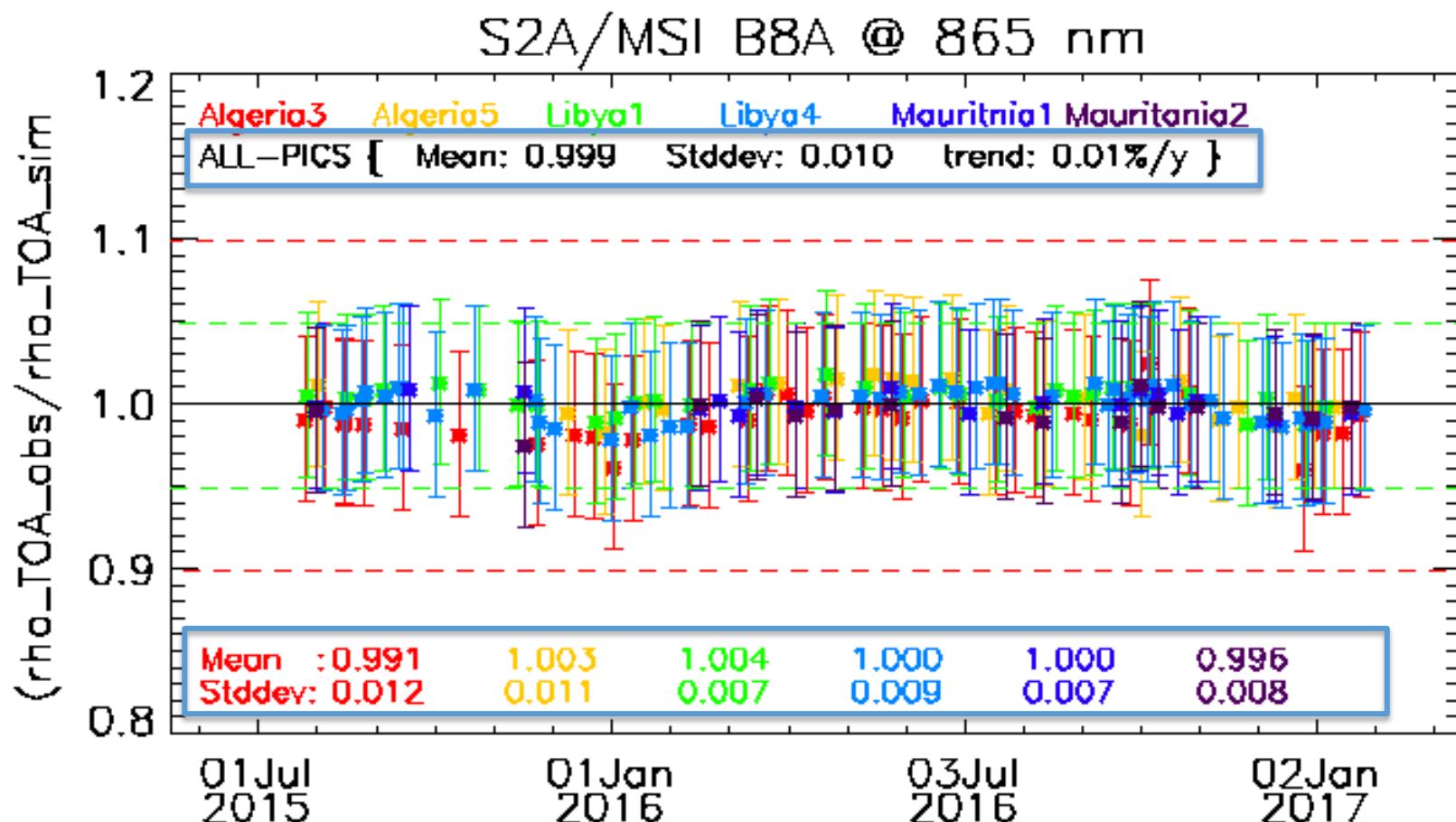
Desert Cal/Val sites -PICS  
Sub-sampled for MSI

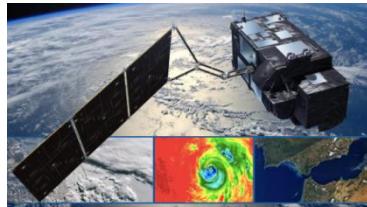




# Results from S2A/MSI over PICS

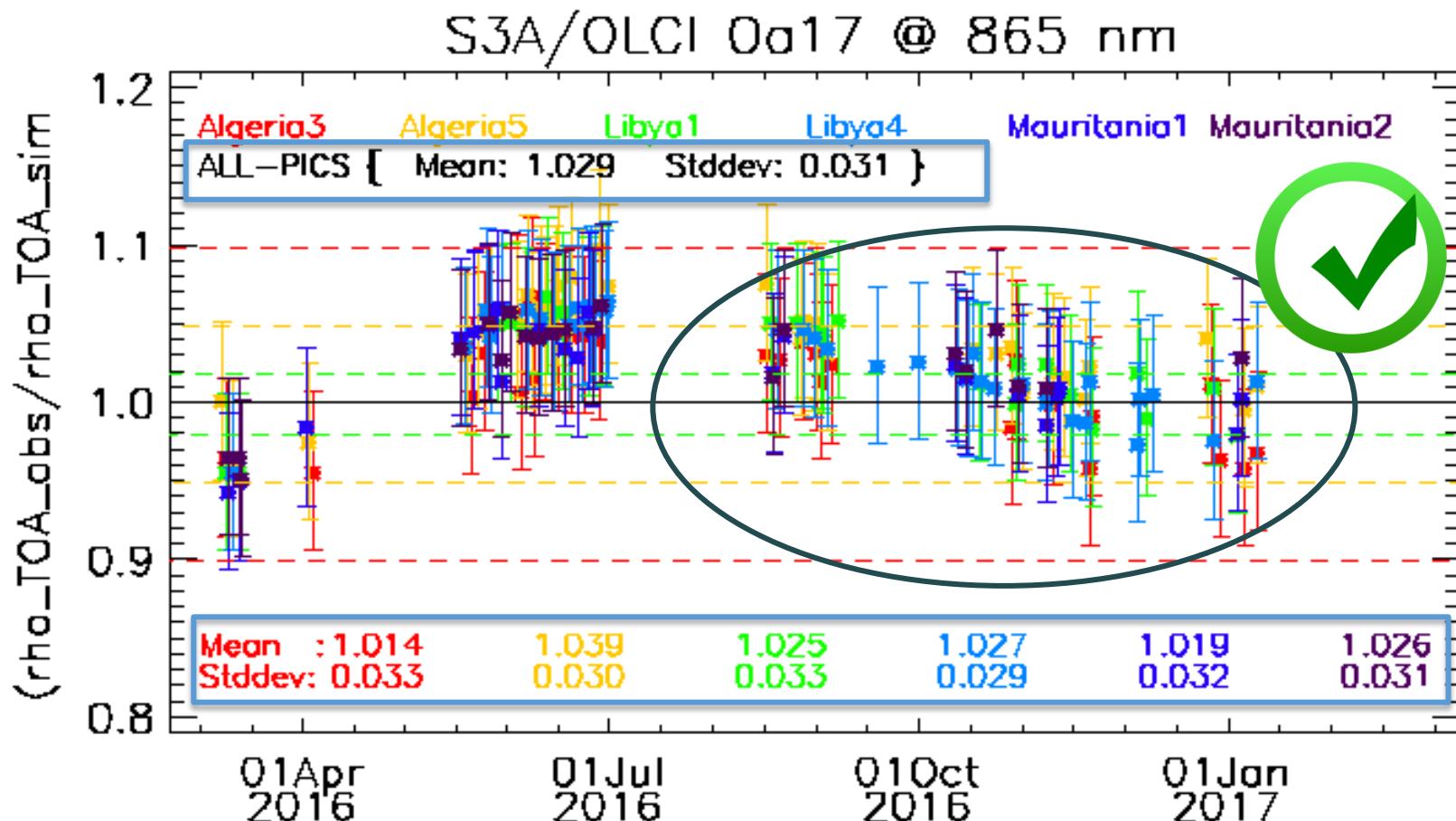
- The ratio of EO vs. simulated TOA reflectance

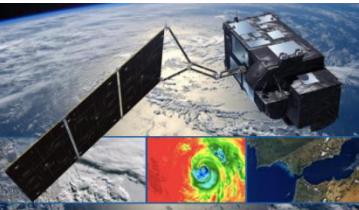




# Results from S3A/OLCI over PICS

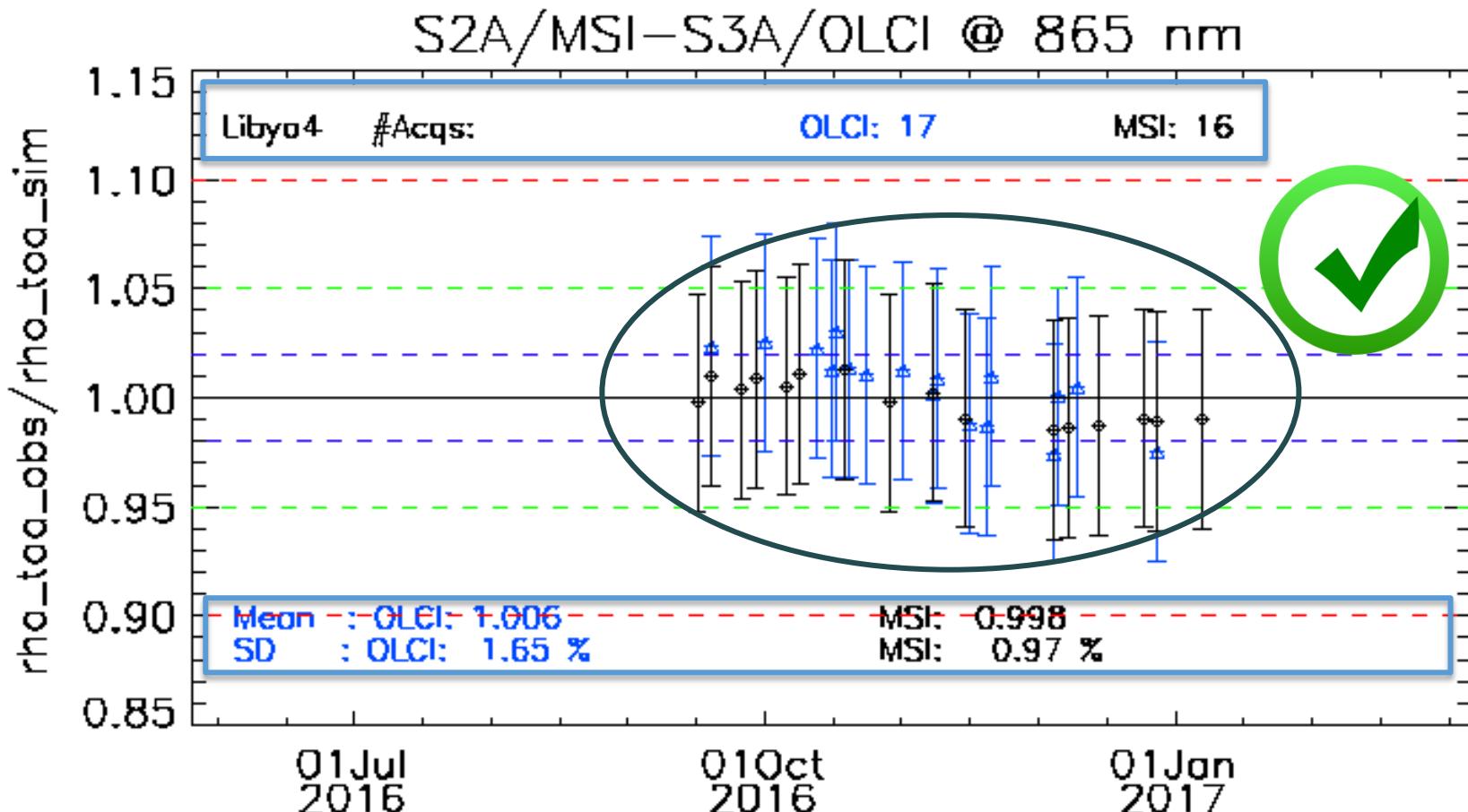
- The ratio of EO vs. simulated TOA reflectance

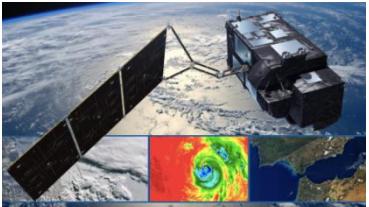




# Intercomparison MSI-OLCI over PICS

- The ratio of EO vs. simulated TOA reflectance (LIBYA4)





# OLCI-MSI SVC

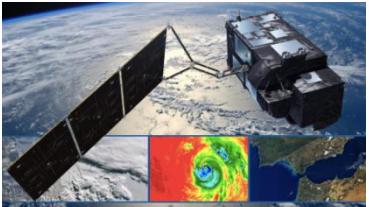
## Number of Sentinel-2 overpasses

Repeat frequency of: 10 days (geometric revisit)

The screenshot shows the Sentinel PDGS Catalogue interface. At the top, there are logos for SENTINEL PDGS, PAYLOAD DATA GROUND SEGMENT, and esa. On the left, there are login fields for Username (mfp-wsp2) and Password, and links for Change password and Logout. Below that is a Catalogue section with a search bar and a link to Catalogue status. The main area is a map of Europe with several red trapezoidal areas indicating overpass paths. A specific location is highlighted with a blue box and labeled "Lat: 42.6045 Long: 6.9764". To the right, there is a "Layers" panel with checkboxes for Graticule, Topography (checked), bnd\_polbd (unchecked), UTM-MGRS (checked), and Search Results (checked). At the bottom, there are tabs for Search, Results, Cart, Pending Orders, and Hosted Processing. The results table shows the following data:

Datatake	Satellite	Sensor	Product Type	Datatake Type	Sensing Start Time	Sensing Stop Time	Orbit Direction	Orbit Number
GS2A_20160621T102022_005210_N02.04	Sentinel-2A	MSI	S2MSI1C	INS-NOBS	2016-06-21T10:20:24.000Z	2016-06-21T10:40:00.000Z	DESCENDING	005210
GS2A_20160624T103022_005253_N02.04	Sentinel-2A	MSI	S2MSI1C	INS-NOBS	2016-06-24T10:30:23.000Z	2016-06-24T10:50:03.000Z	DESCENDING	005253
GS2A_20160701T102022_005353_N02.04	Sentinel-2A	MSI	S2MSI1C	INS-NOBS	2016-07-01T10:20:25.000Z	2016-07-01T10:40:01.000Z	DESCENDING	005353

Boussole site –revisit frequency 7 days (instead of expected 4 days)



# OLCI-MSI SVC

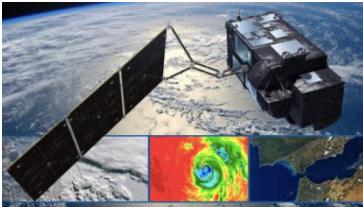
## Number of Sentinel-2 overpasses

Repeat frequency: 10 days

The screenshot shows the Sentinel PDGS Catalogue interface. At the top left is the PDGS logo and a login section. The top right features the ESA logo and a small image of the Sentinel-2 satellite. The main area is a map of the Southern Ocean with a grid overlay. A specific location is highlighted with a red polygon and a small blue square. The coordinates Lat: 19.3055 and Long: -159.7072 are displayed. On the left, there's a sidebar with 'Catalogue' and 'Search' tabs, and a bottom navigation bar with 'Search', 'Results', 'Cart', 'Pending Orders', and 'Hosted Processing'. On the right, there's a 'Layers' panel with checkboxes for 'Graticule', 'Topography', 'bnd\_polloid', 'UTM-MGRS', and 'Search Results', all of which are checked. Below the map is a table with 5 rows retrieved, showing data for five different overpasses:

Datatake	Satellite	Sensor	Product Type	Datatake Type	Sensing Start Time	Sensing Stop Time	Orbit Direction	Orbit Number
GS2A_20160620T210932_005202_N02.04	Sentinel-2A	MSI	S2MSI1C	INS-NOBS	2016-06-20T21:09:31.000Z	2016-06-20T21:10:11.000Z	DESCENDING	005202
GS2A_20160630T210932_005345_N02.04	Sentinel-2A	MSI	S2MSI1C	INS-NOBS	2016-06-30T21:09:32.000Z	2016-06-30T21:10:12.000Z	DESCENDING	005345
GS2A_20160710T210932_005488_N02.04	Sentinel-2A	MSI	S2MSI1C	INS-NOBS	2016-07-10T21:09:33.000Z	2016-07-10T21:10:13.000Z	DESCENDING	005488
GS2A_20160720T210932_005631_N02.04	Sentinel-2A	MSI	S2MSI1C	INS-NOBS	2016-07-20T21:09:34.000Z	2016-07-20T21:10:14.000Z	DESCENDING	005631
GS2A_20160730T210932_005774_N02.04	Sentinel-2A	MSI	S2MSI1C	INS-NOBS	2016-07-30T21:09:34.000Z	2016-07-30T21:10:14.000Z	DESCENDING	005774

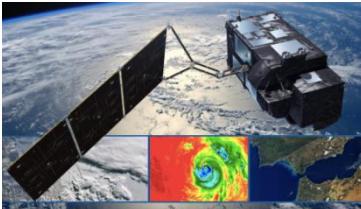
MOBY site –revisit frequency 10 days (instead of expected 6 days)



# Level-2 OLCI-MSI SVC intercomparison

## Difficulties/limitation:

- Data availability (ex. Fall 2016 – only 2 matchups on Boussole site, 3 if not considering OLCI)
- Products consistency (different transfer functions BOA→TOA)
- Glint on waves for MSI = great variability if not properly corrected



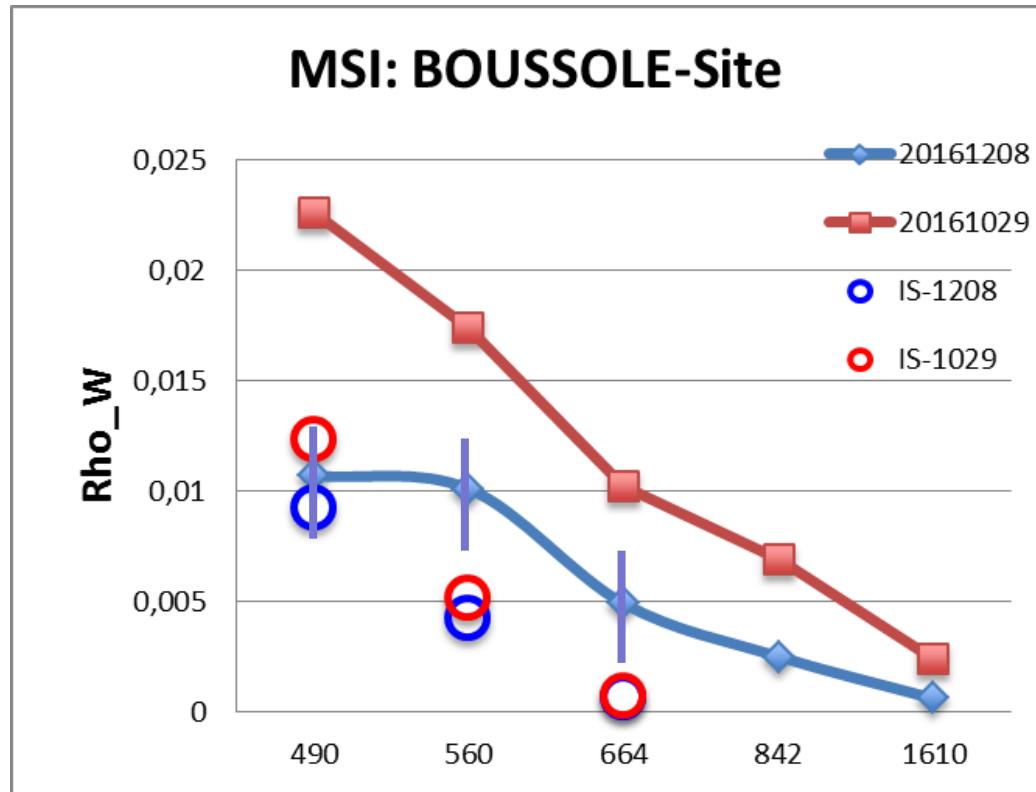
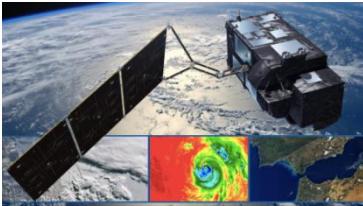
## Level-2 MSI

on a 1 km<sup>2</sup> plate

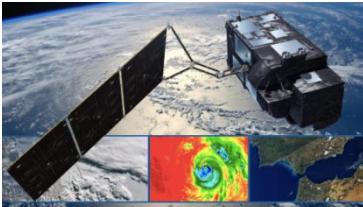
# Region	Band	rho_w				
		average	maximum	median	minimum	sigma
BOUSSOLE	band_1	0,0108	0,1085	0,0107	0,004	0,0016
BOUSSOLE	band_2	0,0101	0,1251	0,0101	0,0045	0,0013
BOUSSOLE	band_3	0,0049	0,1464	0,0049	0	0,0011
BOUSSOLE	band_4	0,0026	0,1318	0,0025	0	0,0011
BOUSSOLE	band_5	0,0007	0,0253	0,0006	0	0,0006

# Region	Band	average	maximum	median	minimum	sigma
BOUSSOLE	band_1	0,0225	0,0645	0,0226	0,0173	0,0012
BOUSSOLE	band_2	0,0173	0,0705	0,0174	0,0131	0,0009
BOUSSOLE	band_3	0,0102	0,0585	0,0102	0,007	0,0007
BOUSSOLE	band_4	0,0068	0,0112	0,0069	0,0038	0,0007
BOUSSOLE	band_5	0,0024	0,0091	0,0024	0,0003	0,0005

# Region	Band	average	maximum	median	minimum	sigma
BOUSSOLE	band_1	0,0145	0,1946	0,014	0,0037	0,006
BOUSSOLE	band_2	0,0079	0,0652	0,0078	0,0043	0,0016
BOUSSOLE	band_3	0,0019	0,0599	0,0018	-0,0003	0,0014
BOUSSOLE	band_4	0,0012	0,0587	0,0011	-0,001	0,0014
BOUSSOLE	band_5	0,0009	0,0434	0,0008	-0,0008	0,0013



with the L2a processor used in coastal waters  
–without sun glint correction



# Level-2 OLCI/MSI intercomparison

## Potential match-ups:

Site	In-Situ (day)	OLCI (scenes)	MSI (scene)
BOUSSOLE /C-OPS	5 / 13	5	3
Black Sea	13	3	2
SAGRES	3	3	2 (with 1 day shift)

# preliminary conclusions

## 1- number of EO OC validation sites and FRMs to be increased by a factor 5

- if the QC level of MSI L2 processors is to be similar to OLCI's, or
- If the L1 SVC of MSI is to be similar to OLCI's

## 2- specific measurements required on sites:

- **sunglint at 10m spatial resolution** (sea surface roughness, i.e. swell and wind waves)  
in addition to AOT