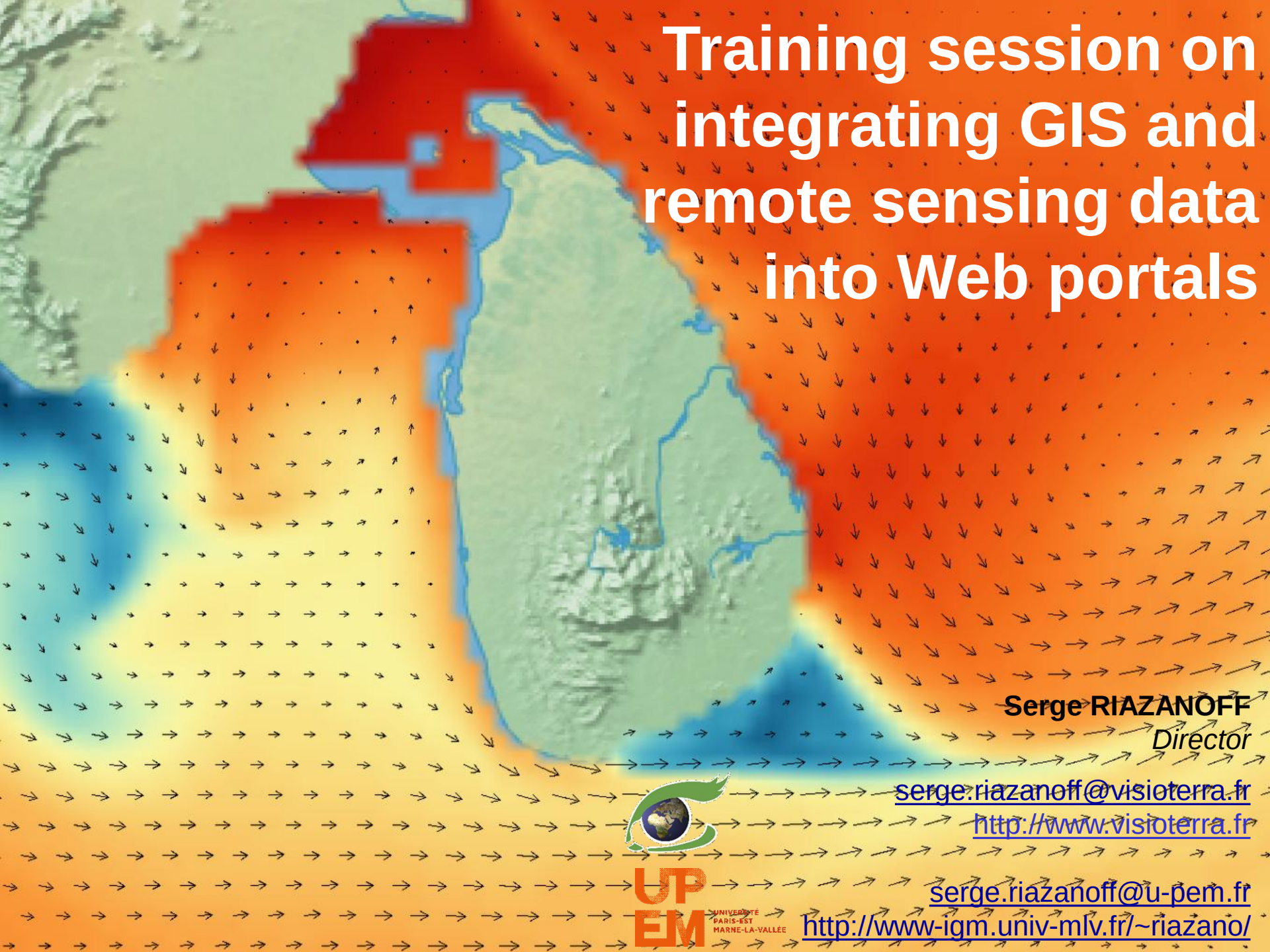
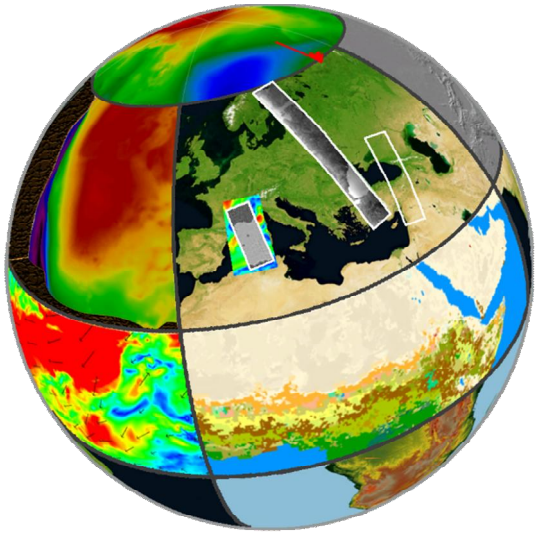
Training session on integrating GIS and remote sensing data into Web portals



Serge RIAZANOFF
Director
serge.riazanoff@visioterra.fr
http://www.visioterra.fr

serge.riazanoff@u-pem.fr
http://www-igm.univ-mlv.fr/~riazano/

Table of contents



Presentation of the trainer - VisioTerra

www.visioterra.fr

Director of VisioTerra

Founded in 2004

7 engineers

Champs-sur-Marne campus

5 business lines

- software development
- cartographic production
- communication
- studies
- education

14 rue Albert Einstein
Cité Descartes
Champs-sur-Marne
France

Presentation of the trainer – University Paris-Est (UPEM)

http://www-igm.univ-mlv.fr/~riazano/

Associated professor

Since 1993

On-line courses

- computer sciences
- image processing
- algorithmic
- remote sensing
- radar
- fusion
- DEM

Lectures
+ tutorials
+ examinations
+ correction

Courses ESA of Jean-Paul RUDANT

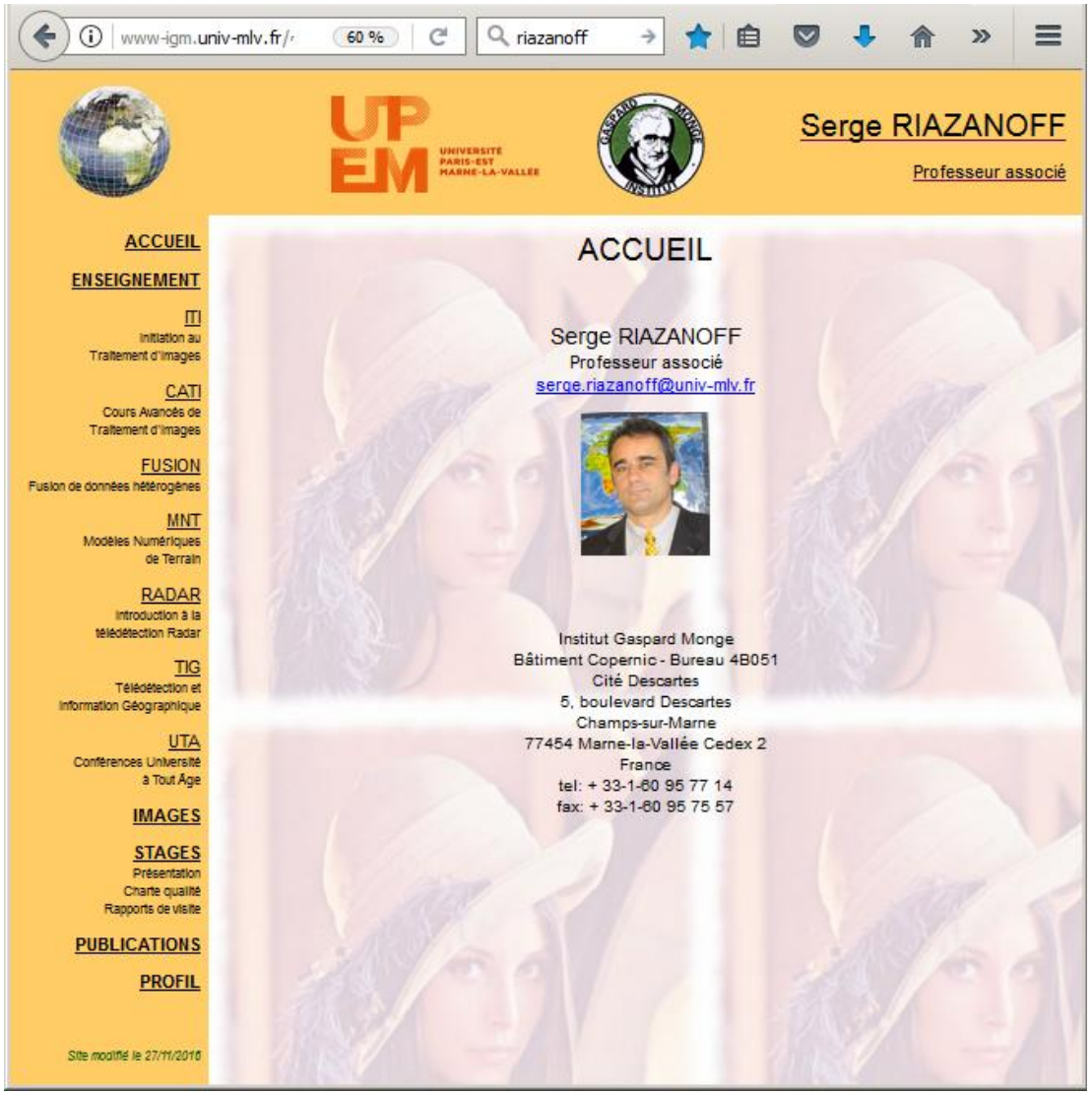
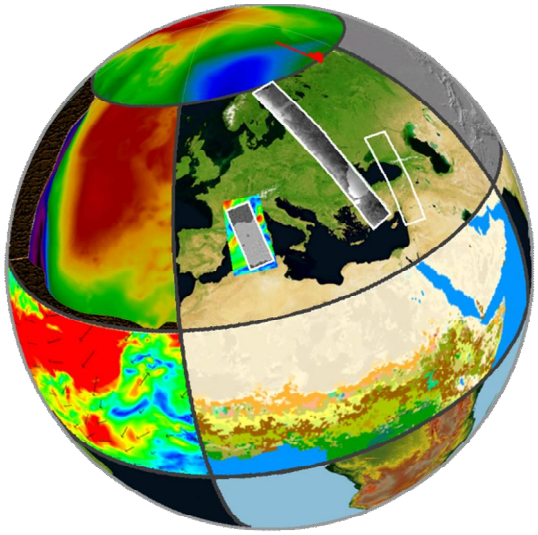


Table of contents – Section 1

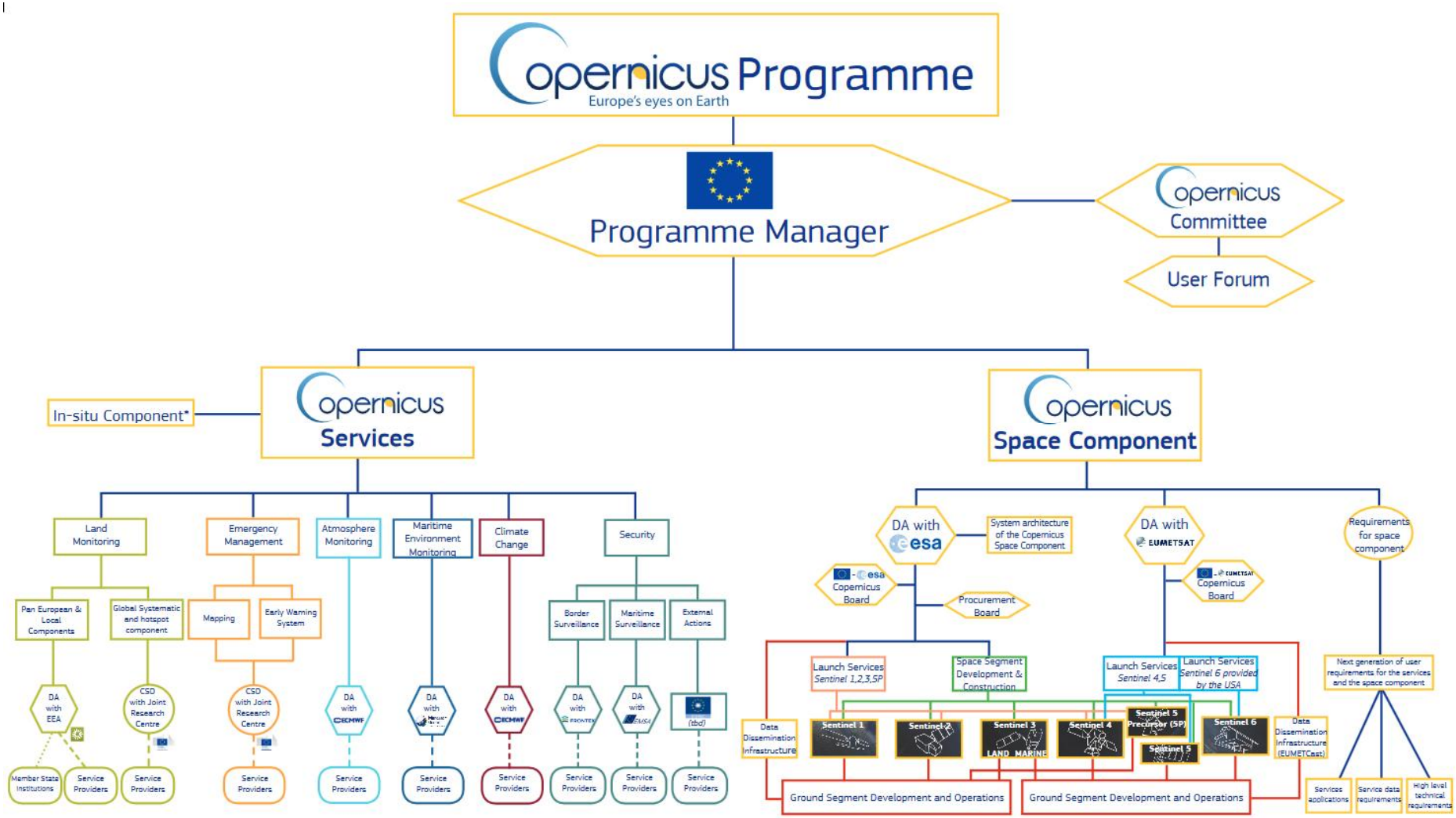
Session 1 – Available data

- Copernicus programme
  - Service component
  - Space component
- Copernicus services
  - CMEMS – Marine service
  - EMSA - European Maritime Security Agency
  - Others: Land, atmosphere, climate, emergency, risk
- Sentinel
  - Sentinel-1 – Radar
  - Sentinel-2 – HR optical
  - Sentinel-3 – MR optical + altimeter
- Other data
  - GPM – Global Precipitation Measurement
  - CGMW – Commission for the Geological Map of the World



Copernicus programme - Overview

http://www.copernicus.eu



Copernicus services - Stakeholders

http://www.copernicus.eu

EEA – European Environment Agency

JRC – Joint Research Center

ECMWF – European Centre for Medium-Range Weather Forecasts

Mercator Ocean – French institutes (CNRS + IFREMER + IRD + Météo France + SHOM)

EMSA – European Maritime Safety Agency

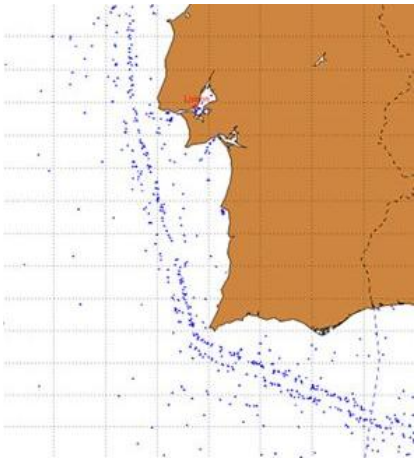
FRONTEX – European boarder and coast guard agency

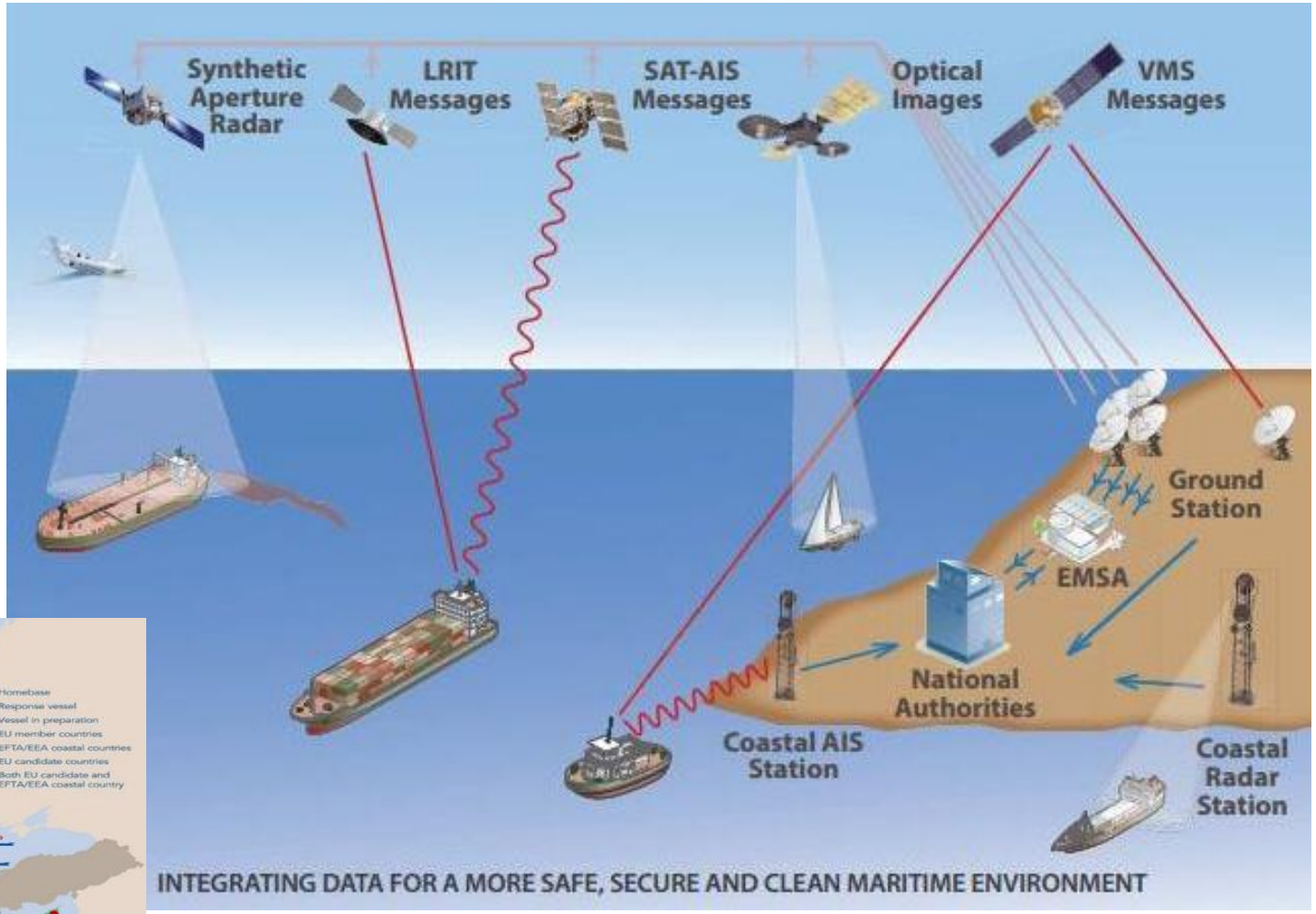
ECMWF	Mercator Ocean	EEA + JRC	ECMWF	JRC	EMSA + JRC
Atmosphere (CAMS)	Marine (CMEMS)	Land (CLMS)	Climate (C3S)	Emergency (EMS)	Security

EMSA (European Maritime Security Agency)

http://www.emsa.europa.eu/

Operational since 2003 after severe oil spills (Erika 1999 and Prestige 2002)



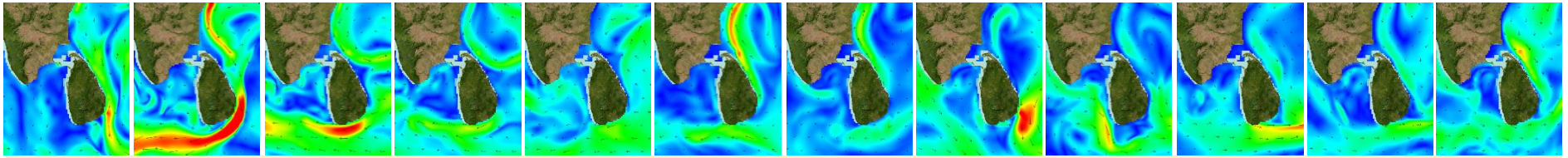


CMEMS (Copernicus Marine Environment Monitoring Service)

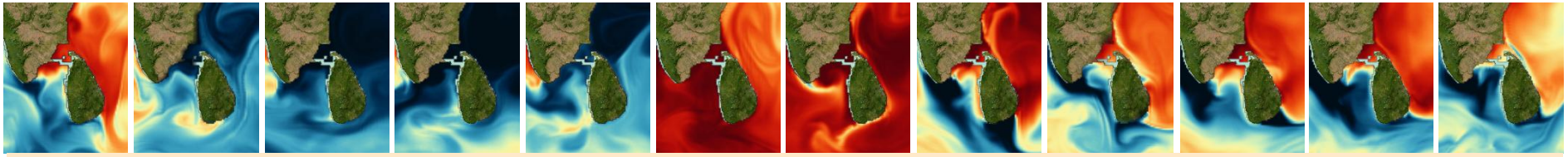
https://www.mercator-ocean.fr/solutions-expertises/produits-references-mercator-ocean/

Products seen in VtPace (2D_layer_stack)

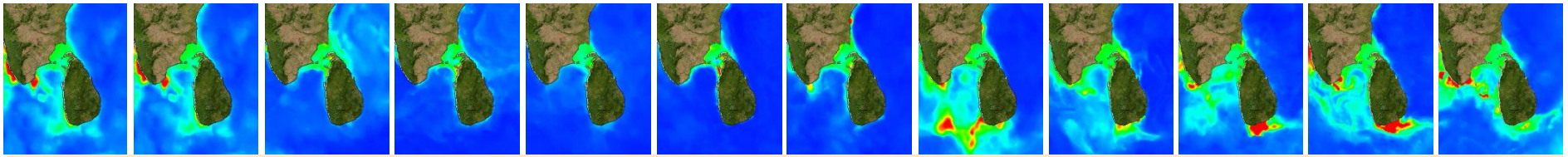
31 Oct. 2016	30 Nov. 2016	31 Dec. 2016	31 Jan. 2017	28 Feb. 2017	31 March 2017	30 April 2017	31 May 2017	30 June 2017	31 July 2017	30 Aug. 2017	30 Sep. 2017



Sea current velocity [0 m/s ; 1.5 m/s] 2D_animation 3D_animation



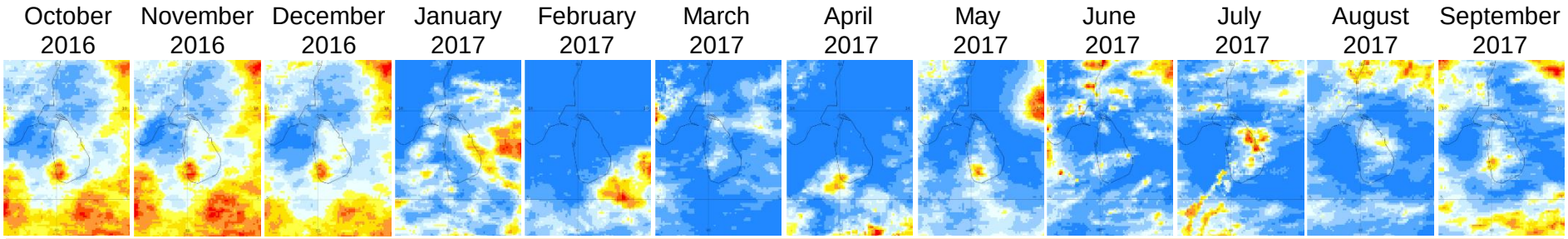
Sea surface temperature [27° ; 31°] 2D_animation 3D_animation



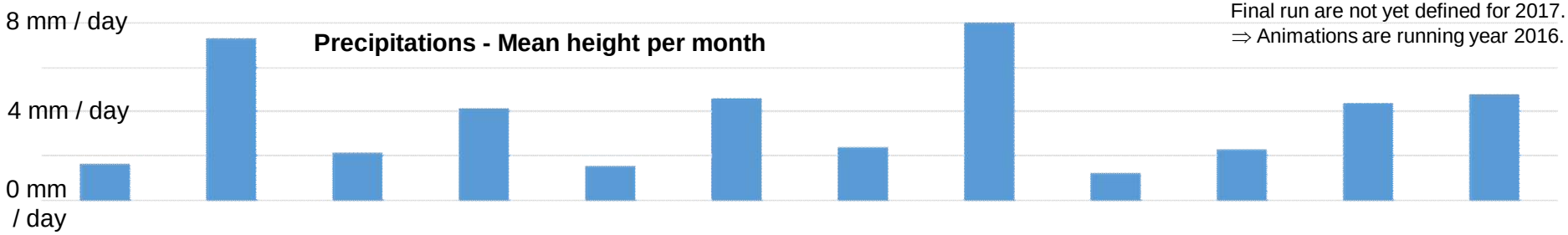
Chlorophyll (ACRI) [0 mg/m^3 ; 3 mg/m^3] 2D_animation 3D_animation

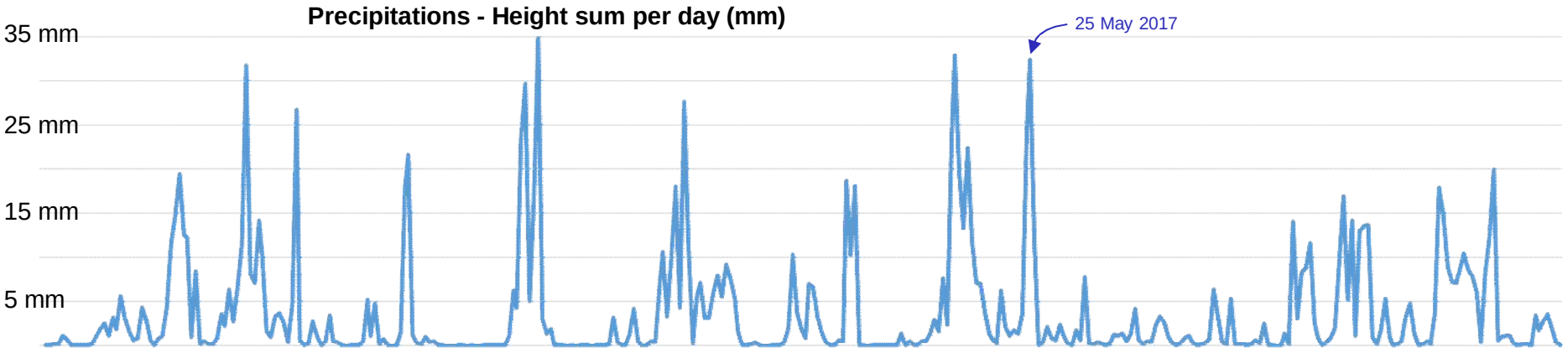
GPM (Global Precipitation Measurement) – per day, month

https://www.nasa.gov/mission_pages/GPM/main/index.html



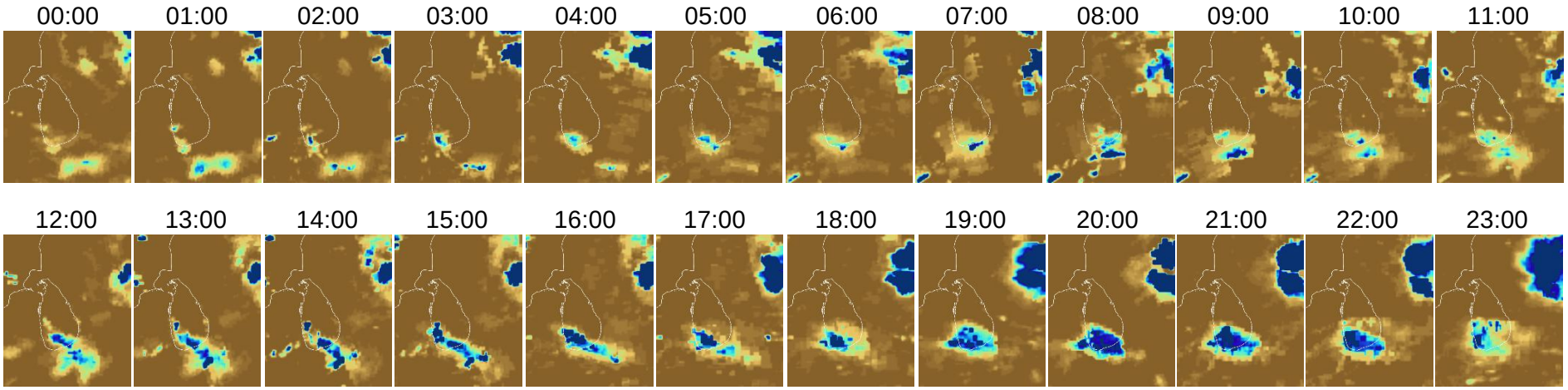
Final run are not yet defined for 2017.
⇒ Animations are running year 2016.



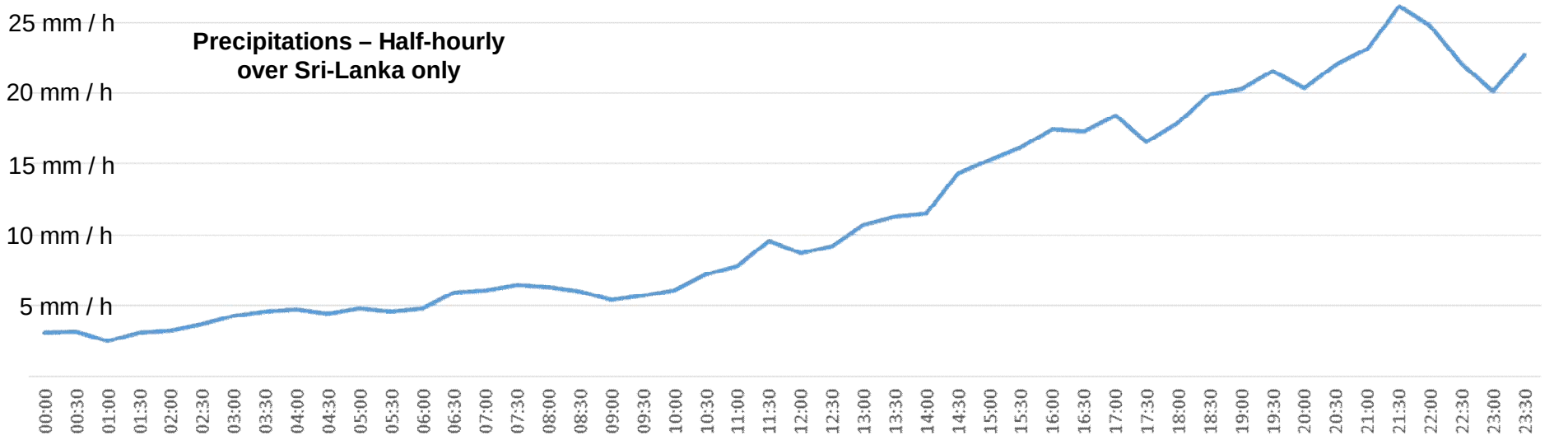


GPM (Global Precipitation Measurement) – per half-hour (30')

25 May 2017

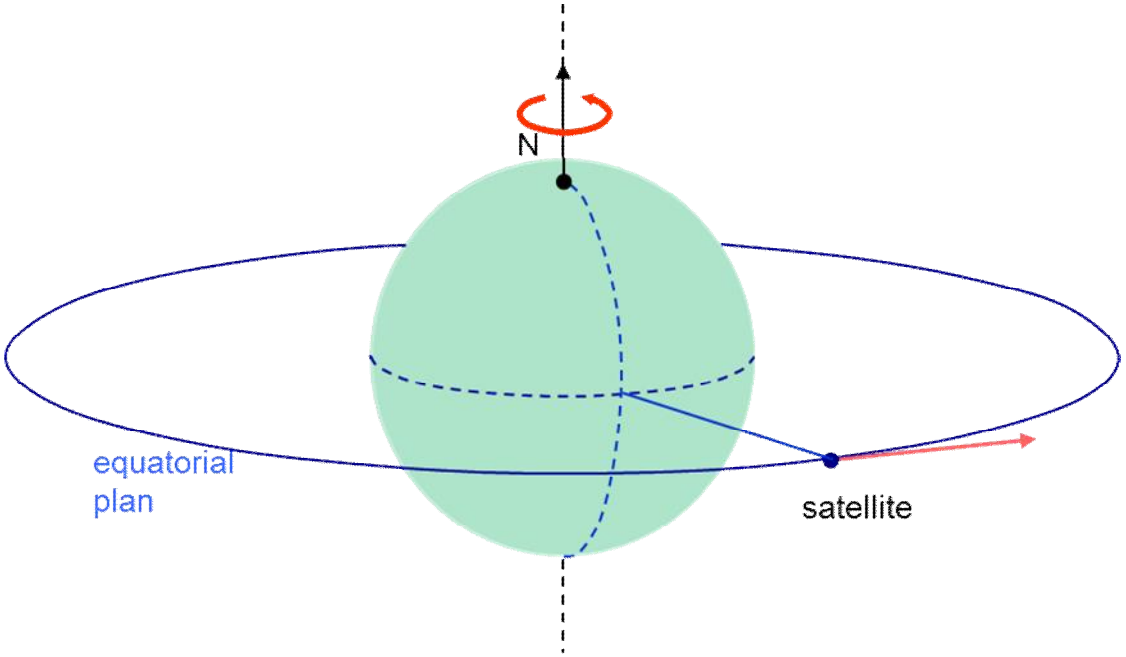


IMERG precipitations [0 mm/h ; 10 mm/h] 2D_animation 3D_animation

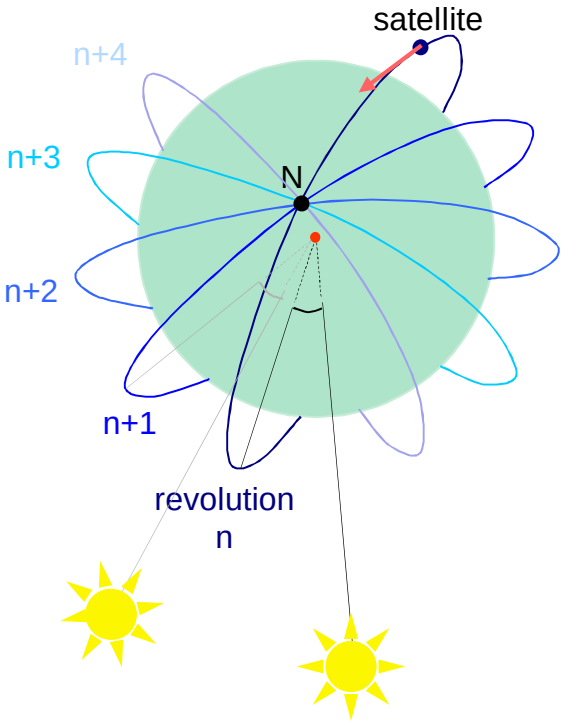


Observation from satellites

geostationary satellite



heliosynchronous satellite



Sentinel-1 – HR Radar

https://sentinel.esa.int/web/sentinel/missions/sentinel-1

Sentinel-1

12 days cycle

	launch	*1st data*
S1A	03.04.2014	03.10.2014
S1B	22.04.2016	26.09.2016

+6 days phase

Instrument

- C-SAR (Synthetic Aperture Radar)

Modes

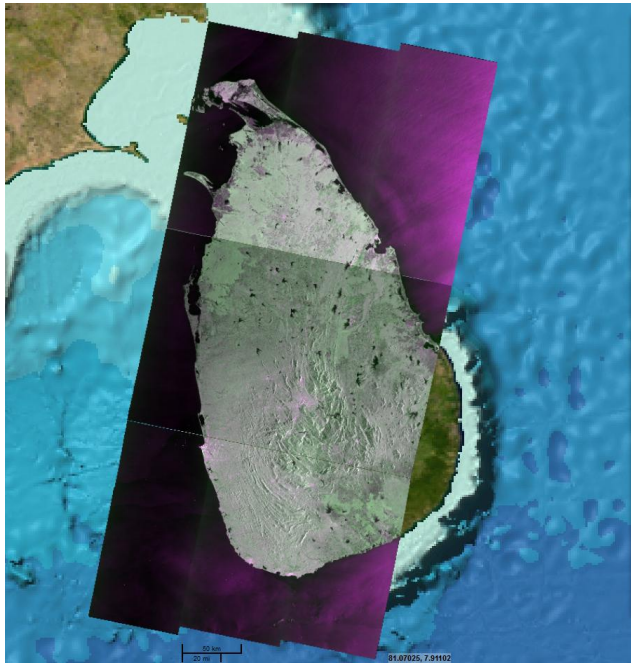
- IW (Interferometry Wide Swath) – swath=240km – GSD=10m
- EW (Extended Wide Swath) – swath=400km – GSD=40m
- SM (Stripmap) – swath=80-100km – GSD=6-10m

Polarization

- Single: Vertical (V) or horizontal (H)
- Dual: VV,VH (V emission, V or H reception) or HH, HV (H emission, V or H reception)

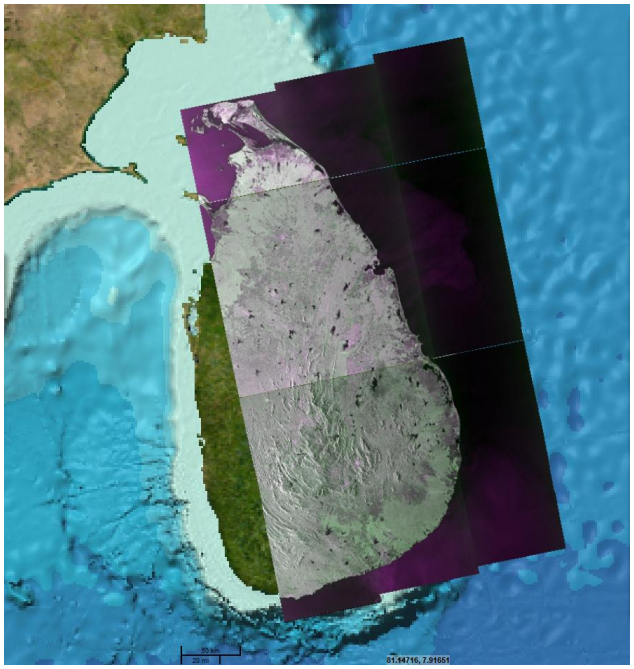
Series of 3 scenes
acquired on 21.09.2017
00:24:24 GMT
in descending orbit (left)

2D-view-left



Series of 3 scenes
acquired on 21.09.2017
12:49:54 GMT
in ascending orbit (right)

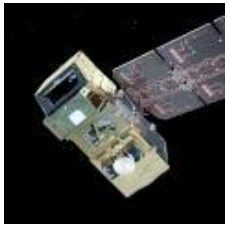
2D-view-right



Sentinel-2 – HR optical

https://sentinel.esa.int/web/sentinel/missions/sentinel-2

Sentinel-2



10 days cycle

	launch	*1st data*
S2A	23.06.2015	27.06.2015
S2B	07.03.2017	??.??.????

+5 days phase

Instrument

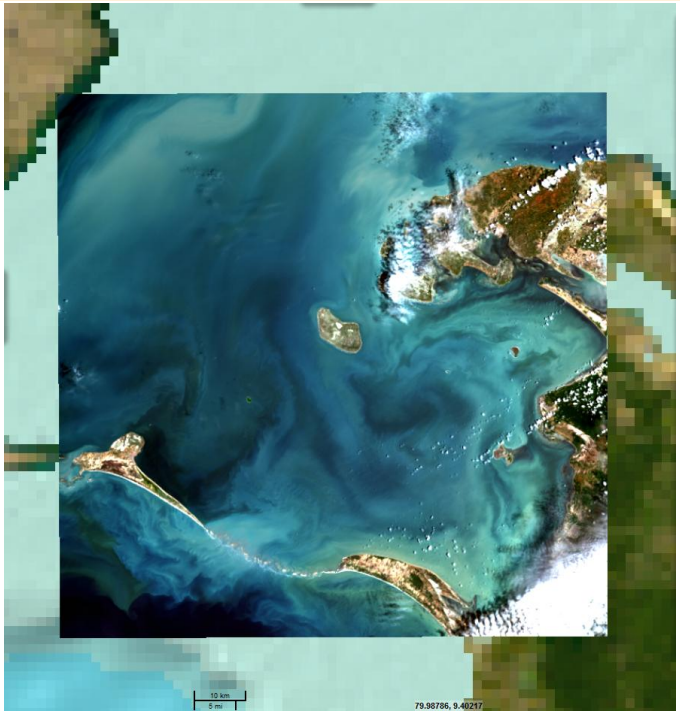
- MSI (Multi-Spectral Instrument) - optical

13 Bands

- VIS (visible): 2,3,4 (10m)
- Red edge: 5,6,7 (20m)
- NIR (Near Infrared): 8 (10m) 8A (20m)
- SWIR (Shortwave infrared): 11,12 (20m)
- Absorption (used for atmospheric corrections): 1,9,10 (60m)

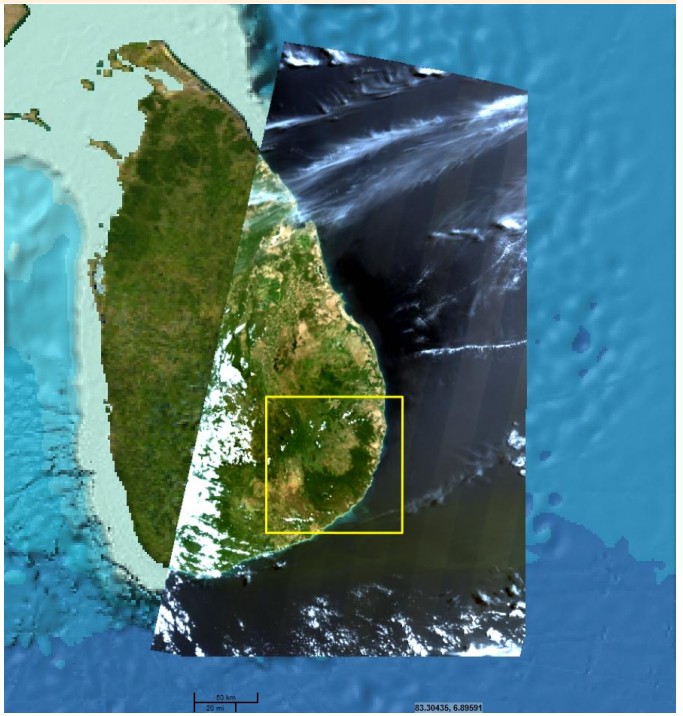
Bay of Kachchativu (North) on 18.09.2017 04:56:51 GMT
One tile (100km x 100km).

2D-view-left



East coast of Sri-Lanka on 27.07.2017 05:06:01 GMT
5x3 tiles (tile D1 highlighted).

2D-view-right

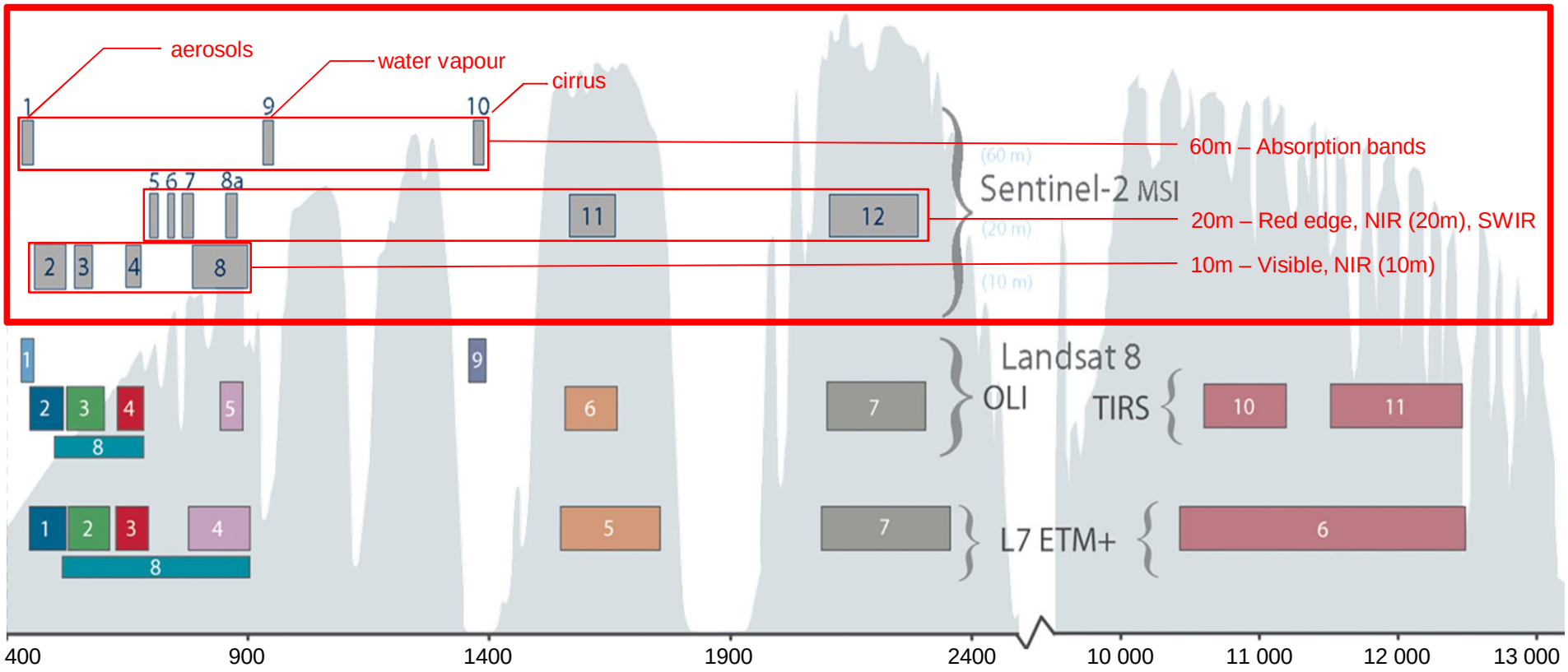


Sentinel-2 MSI – Spectral bands

MSI radiometry values: https://earth.esa.int/web/sentinel/technical-guides/sentinel-2-msi/msi-instrument

MSI 10m, 20m, 60m groups: https://earth.esa.int/web/sentinel/user-guides/sentinel-2-msi/resolutions/spatial

Landsat heritage: https://landsat.gsfc.nasa.gov/wp-content/uploads/2015/06/Landsat.v.Sentinel-2.png



Sentinel satellites (S3)

https://sentinel.esa.int/web/sentinel/missions/sentinel-3

Sentinel-3

27 days cycle

	launch	*1st data*
S3A	16.02.2016	18.10.2016
S3B	??.??.2018	

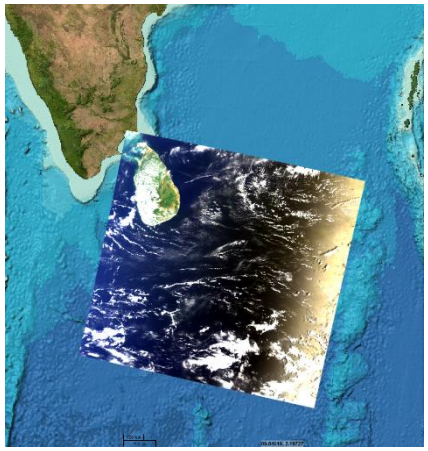
+?? days phase

Instruments

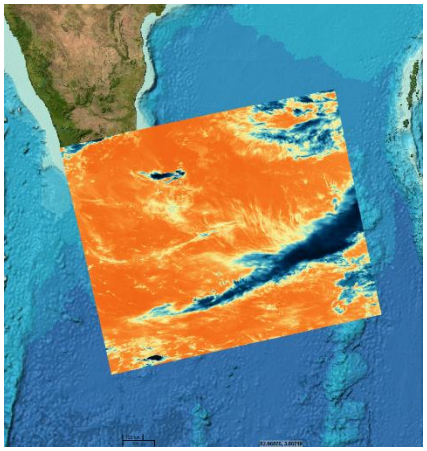
- OLCI (Ocean Land Colour Instrument) – optical
  - 21 bands [0.4-1.02] µm
  - GSD = 300m
  - swath width = 1270 km
- SLSTR (Sea and Land Surface Temperature Radiometer)
  - 9 bands [0.55-12] µm, NADIR + backward
  - GSD = 500m (VIS, SWIR), 1 km (MWIR, TIR)
  - swath width = 1420 km (NADIR), 750 km (backward)
- SRAL (SAR Radar Altimeter)
  - Range measurement: Ku-band (13.575 GHz) and C-band (5.41 GHz)
  - Sampling rate: 1 Hz (≈850m) and 10 Hz (≈85m)

Sri-Lanka seen by:

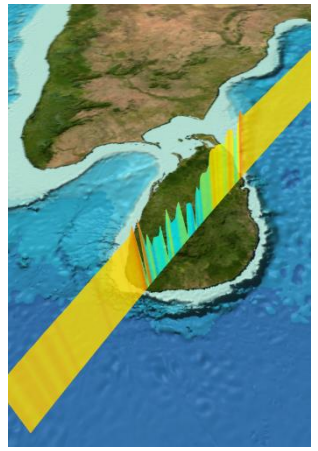
OLCI on
30.09.2017 09:30:04 GMT.
2D-view-left



SLSTR on
01.10.2017 16:28:18 GMT.
2D-view-middle



SRAL on
29.09.2017 04:35:48 GMT.
2D-view-right



Sentinel-3 OLCI – Spectral bands

OLCI bands function: https://sentinel.esa.int/web/sentinel/user-guides/sentinel-3-olci/resolutions/radiometric
Envisat MERIS heritage (https://sentinel.esa.int/web/sentinel/user-guides/sentinel-3-olci/overview/heritage)

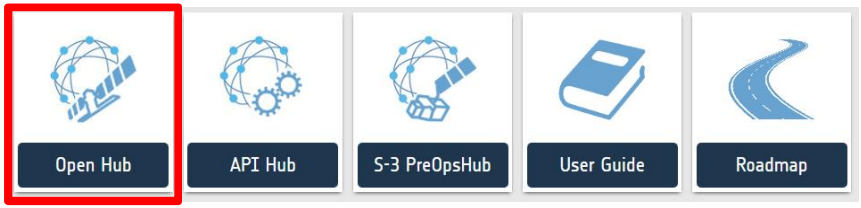
Band	λ centre (nm)	Width (nm)	Function
Oa1	400	15	Aerosol correction, improved water constituent retrieval
Oa2	412.5	10	**Yellow substance** and **detrital pigments** (turbidity)
Oa3	442.5	10	**Chlorophyll** absorption max., biogeochemistry, vegetation
Oa4	490	10	High **Chlorophyll** , other pigments
Oa5	510	10	**Chlorophyll** , **sediment**, turbidity, red tide
Oa6	560	10	**Chlorophyll** reference (Chlorophyll minimum)
Oa7	620	10	**Sediment** loading
Oa8	665	10	**Chlorophyll** (2nd Chlorophyll absolute max.), **sediment**, yellow substance / vegetation
Oa9	673.75	7.5	For improved fluorescence retrieval and to better account for smile together with the bands 665 and 680 nm
Oa10	681.25	7.5	**Chlorophyll fluorescence** peak, red edge
Oa11	708.75	10	**Chlorophyll fluorescence** baseline, red edge transition
Oa12	753.75	7.5	O2 absorption / clouds, vegetation
Oa13	761.25	2.5	O2 absorption band / aerosol correction
Oa14	764.375	3.75	Atmospheric correction
Oa15	767.5	2.5	O2A used for cloud top pressure, fluorescence over land
Oa16	778.75	15	Atmos. corr./aerosol corr.
Oa17	865	20	Atmos. corr./aerosol corr., clouds, pixel co-registration
Oa18	885	10	Water vapour absorption reference band. Common reference band with SLSTR instrument. Vegetation monitoring
Oa19	900	10	Water vapour absorption/vegetation monitoring (maximum reflectance)
Oa20	940	20	Water vapour absorption, atmosphere / aerosol correction
Oa21	1 020	40	Atmosphere / aerosol correction

bands absent in the previous Envisat / MERIS instrument

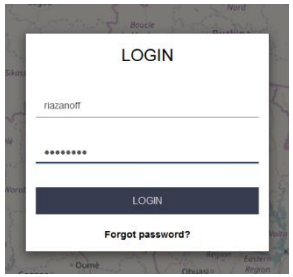
Sentinel infrastructures

https://sentinel.esa.int/web/sentinel/sentinel-data-access

Copernicus Open Access Hub (COA)
https://scihub.copernicus.eu/



https://scihub.copernicus.eu/dhus



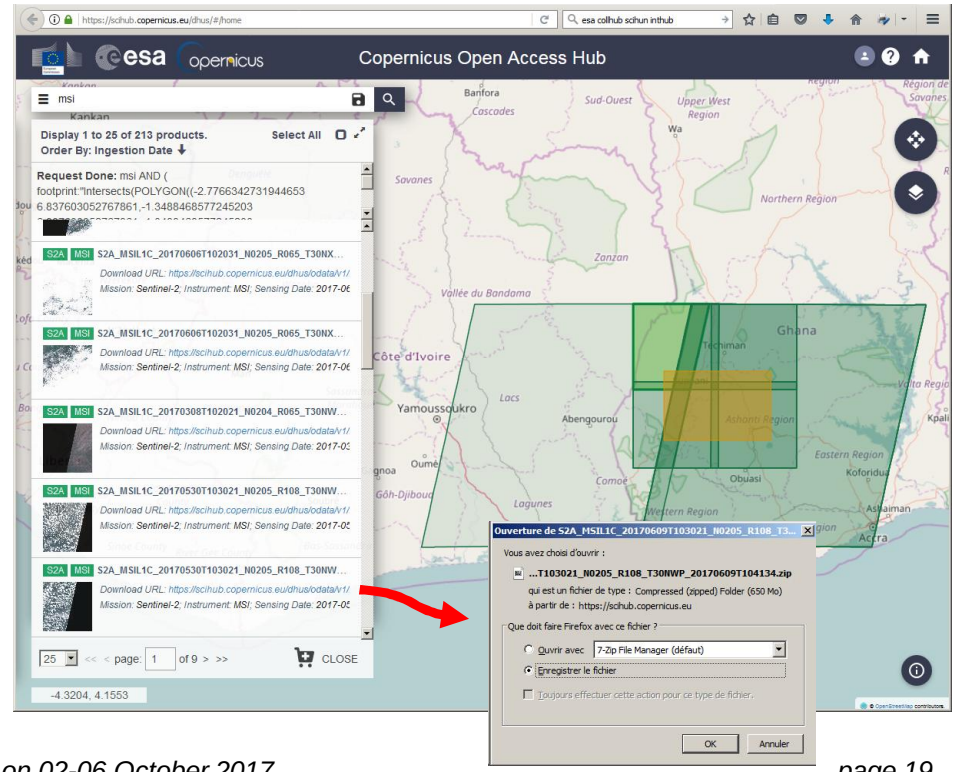
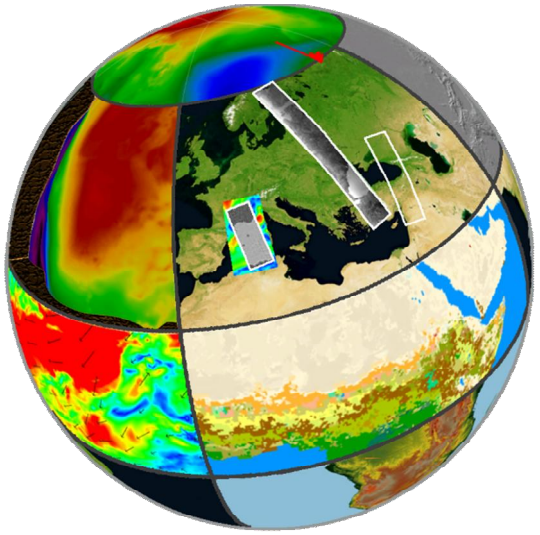


Table of contents – Session 2

Session 2 – VtPace

- Presentation of PACe project
  - Scope
  - History
- Presentation of the portal
  - Deriving from VtWeb
  - The main panels / services
- Image processing technics
  - Geometry transforms
  - Global radiometry transforms
  - Convolutive filtering
- Functionalities
  - Basemaps, elevations, 2D/3D
  - Data selection and preparation, Layer stack
  - Data sharing by hyperlooks
  - Export in KML, KMZ, GeoTIFF, JPEG



Presentation of PACe

- **Project coordinator**: Annukka PEKARINEN
- **Summary**

The main issues PACe project is responding to is the lack of knowledge concerning the cetacean populations of the world and specifically the lack of spatial data for ecosystem based management initiatives. The movements and status of regional and seasonal populations and the factors that direct the population distribution in Sri Lankan waters are largely unknown. A few scientific visual surveys have been undertaken in Sri Lanka during last ten years but comprehensive mapping of whale populations in this area is missing.

- **Objectives**
  - To produce basic data on cetacean populations to improve knowledge on cetacean biodiversity, abundance and important habitats, to be used for management purposes.
  - In addition to regular scientific reports and articles, spatial data on cetacean populations and their important habitats is produced and distributed among general public and professionals in ocean management.
  - Management procedures suitable for the study area will also be proposed.
- **Project timeline**
  - 03.12.2013 – Kick-off meeting in University of Ruhuna.
  - March 2014 to May 2016 – Field works (passive acoustic monitoring, visual survey and oceanography work).
  - 07.11.2014 – 1st steering committee in VisioTerra, Champs-sur-Marne, France.
  - 26.11.2015 – 2nd steering committee in WMU, Malmö, Sweden
  - 13.01.2017 – Final steering committee in WMU, Malmö, Sweden
  - 02-06.10.2017 – Training VtPace – Extension until end 2017.

Presentation of VtPace portal

VtPace (**http://visioterra.net/VtPace**) derives from VtWeb (http://visioterra.org/VtWeb) – video

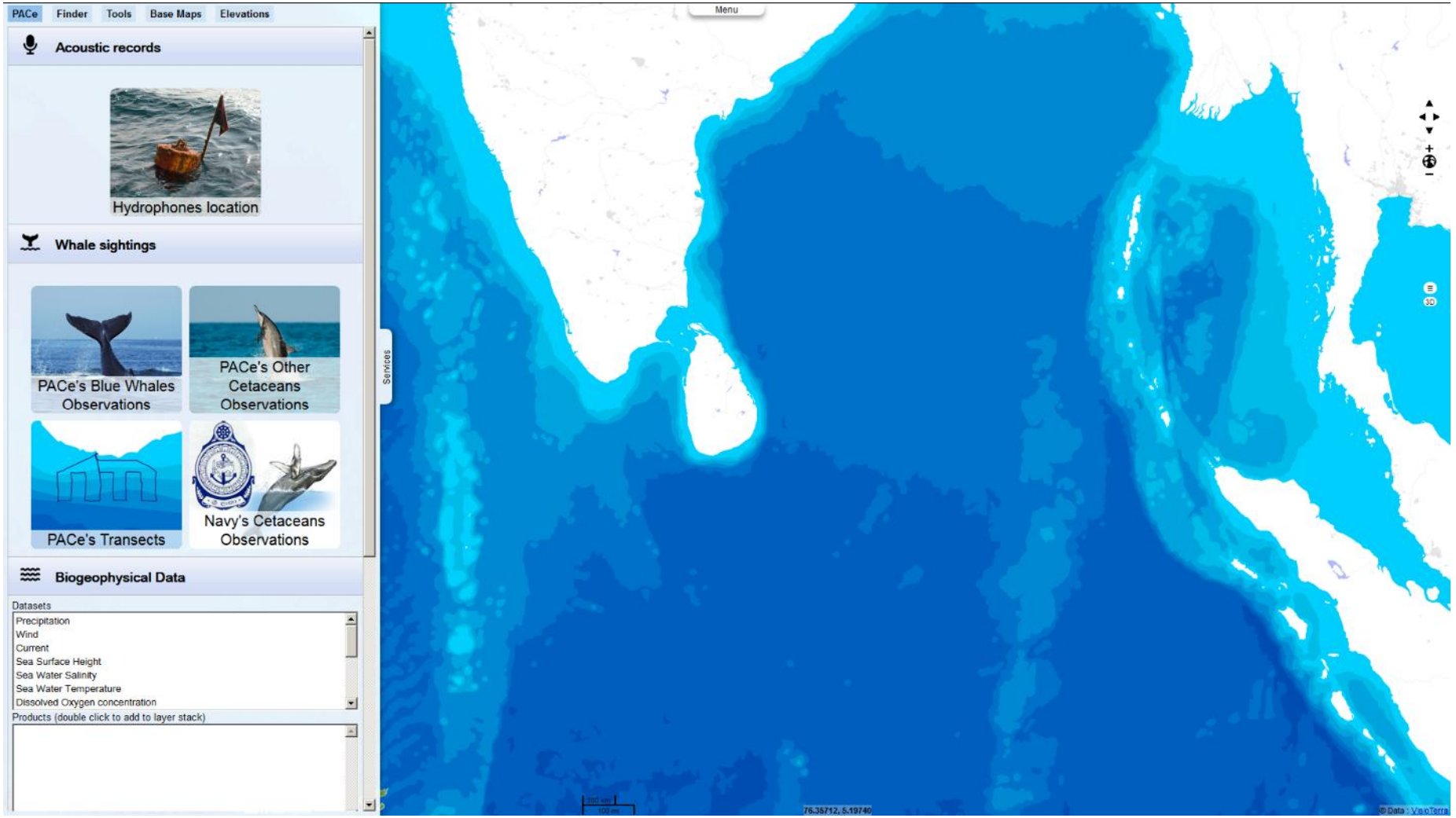
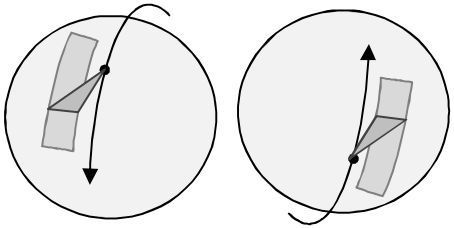


Image processing – Geometry transforms

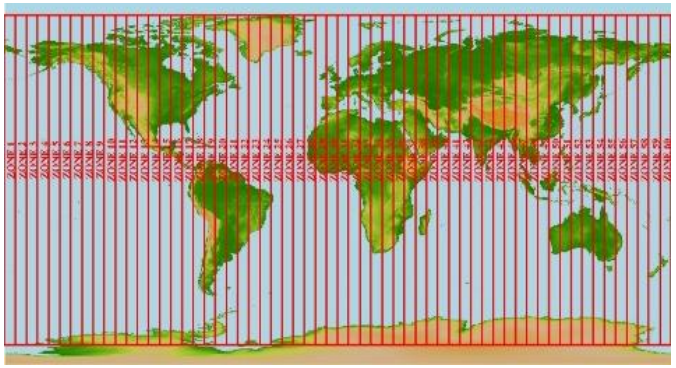
S1 level 1B



observation geometry

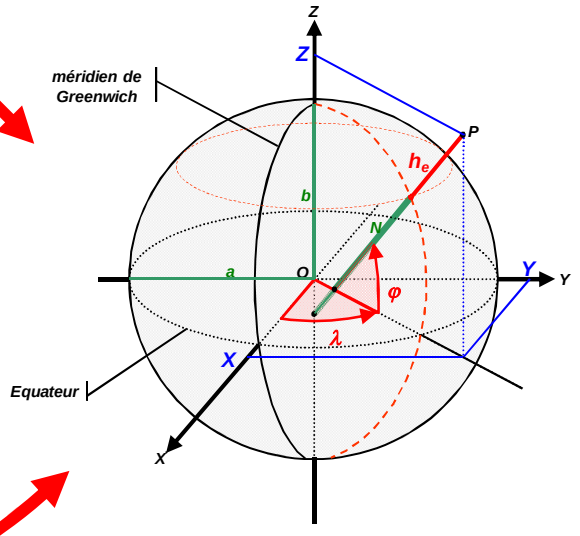
projection geometry

S2 level 1C



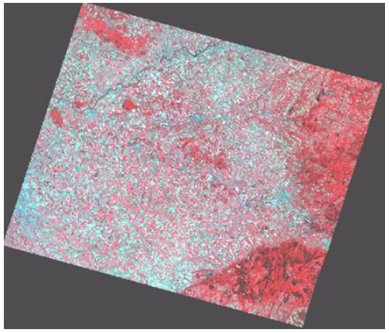
bi-linear interpolation per facet

geographic coordinates reference system



projection change

Image processing – Distributions and statistics



background pixels and image pixels

SPOT XS1 and XS3 (Roissy, France)

Landsat TM1 (San-Remo, Italy)

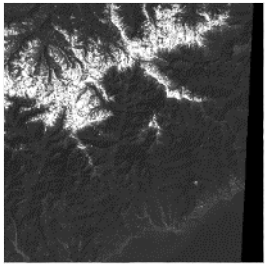


image histogram

m = 81.243
σ = 19.546

m = 59.202
σ = 11.888

m = 75.445
σ = 55.984

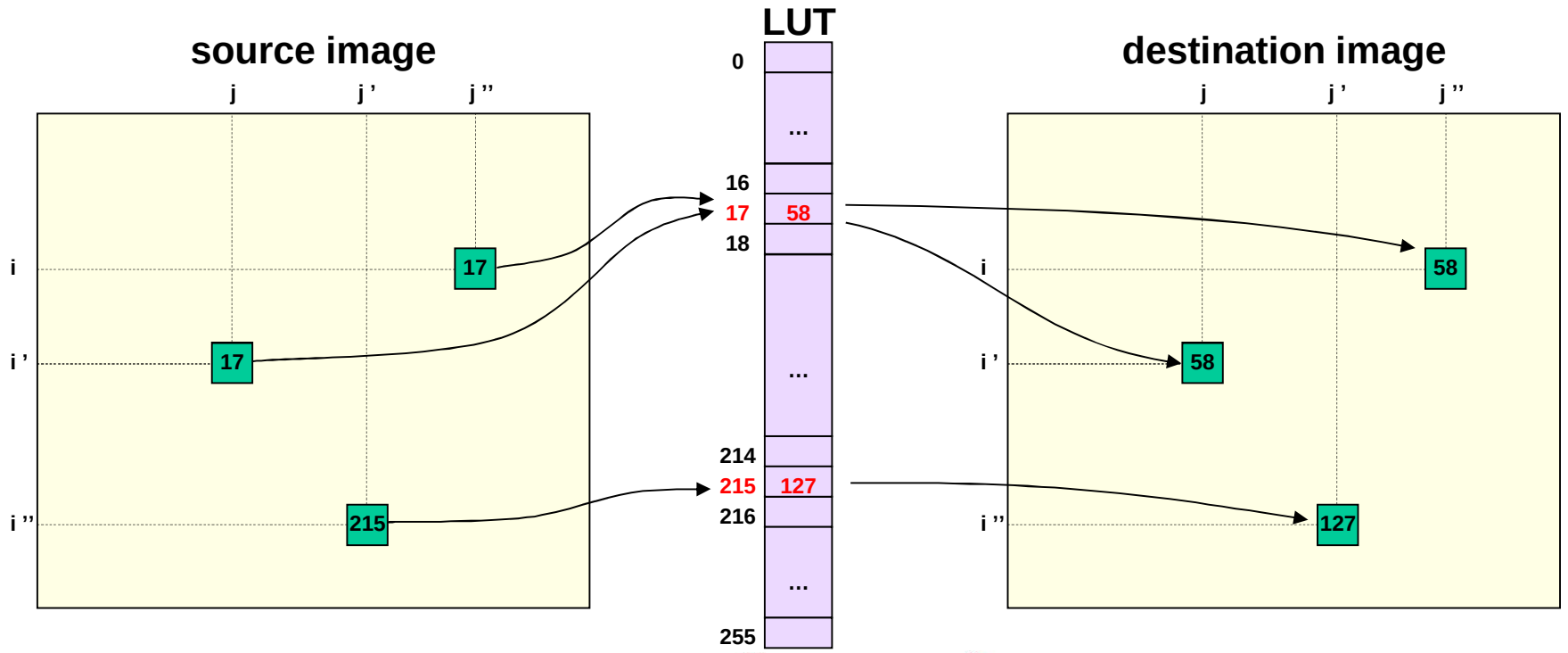
mean, variance and **standard deviation**

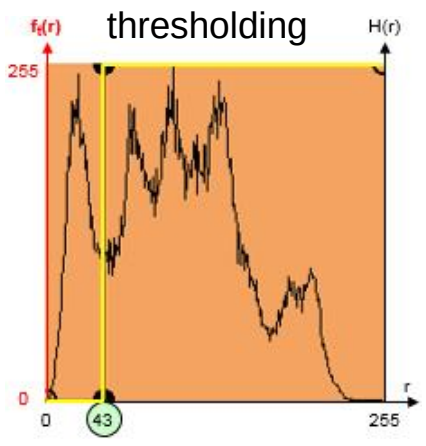
$$\overline{m} = \frac{1}{M \times N} \times \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} R(i, j)$$

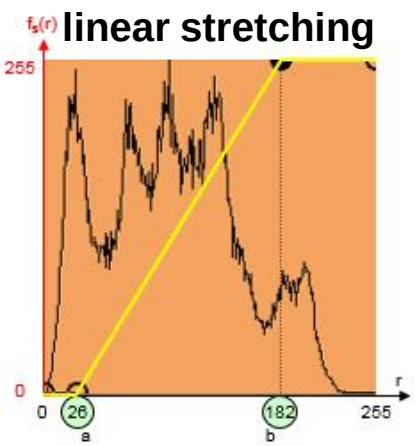
$$V = \frac{1}{M \times N} \times \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} \left[R(i, j) - \overline{m} \right]^2$$

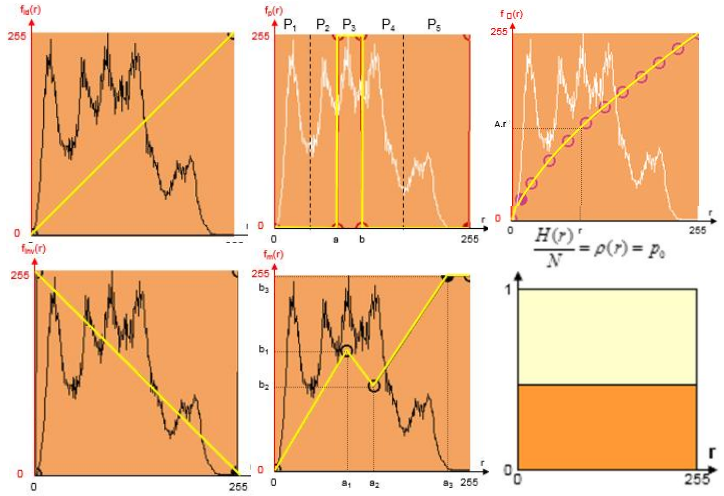
$$\sigma = \sqrt{V} = \sqrt{\frac{1}{M \times N} \times \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} \left(R(i, j) \right)^2 - \left(\overline{m} \right)^2}$$

Image processing – Global radiometry transform









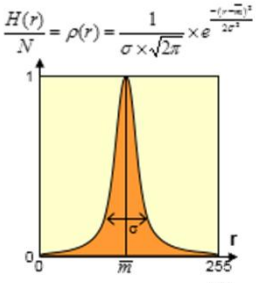
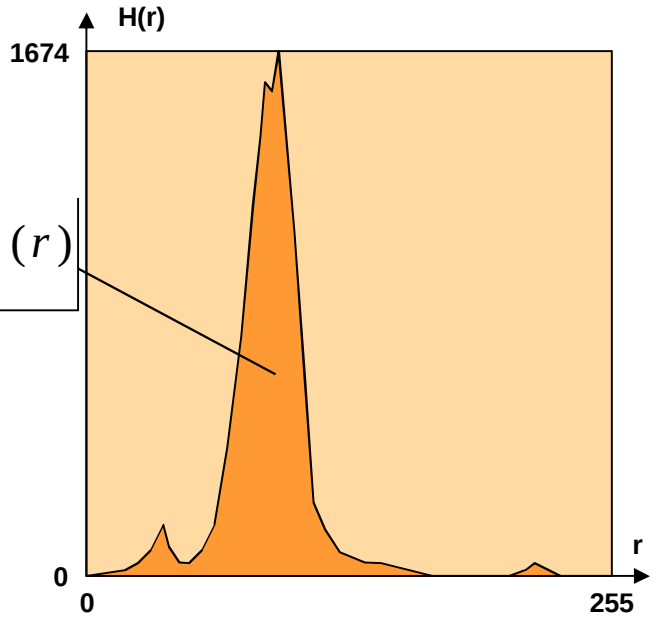


Image processing – Automatic stretching

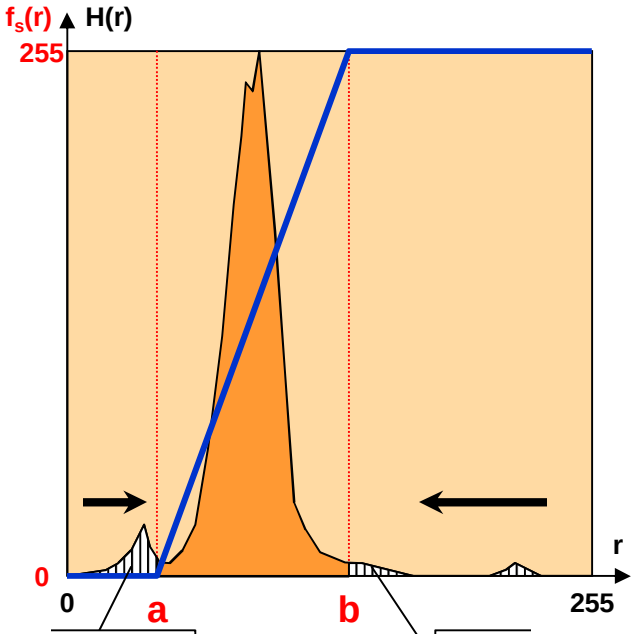
α_s : saturation percentage

$N_s = N \times \alpha_s$: number of saturated pixels



pixel number

$$N = \sum_{r=0}^{255} H(r)$$



number of left saturated pixels

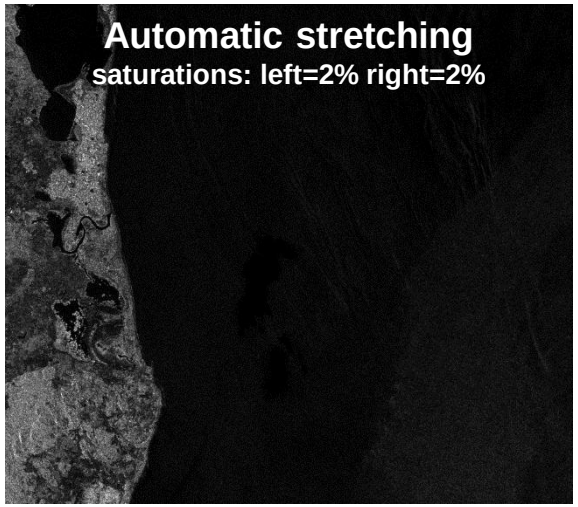
$$N_l = \sum_{r=0}^{a} H(r)$$

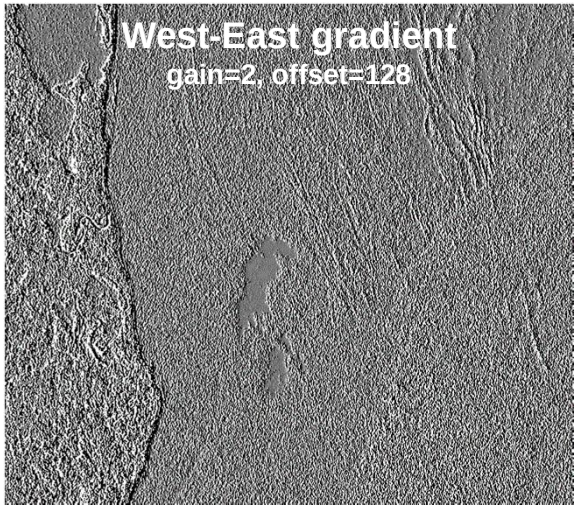
number of right saturated pixels

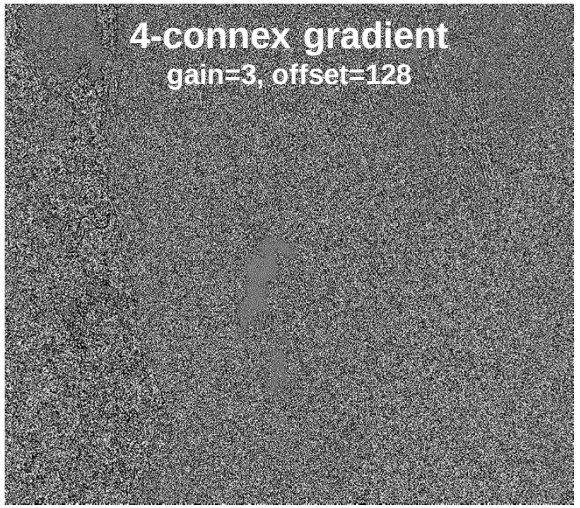
$$Nr = \sum_{r=b}^{255} H(r)$$

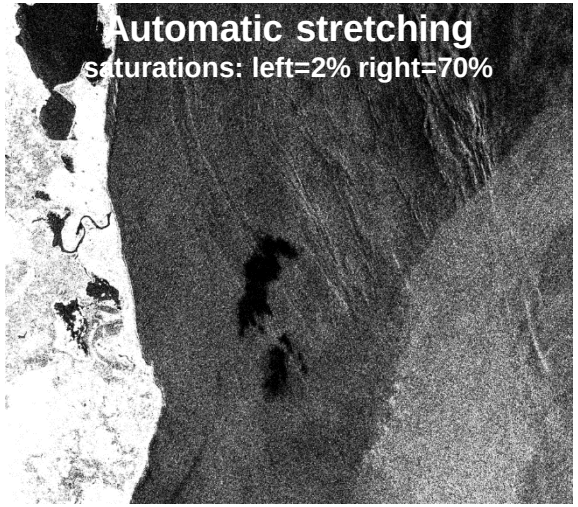
Image processing – Convolutive filters - Gradients

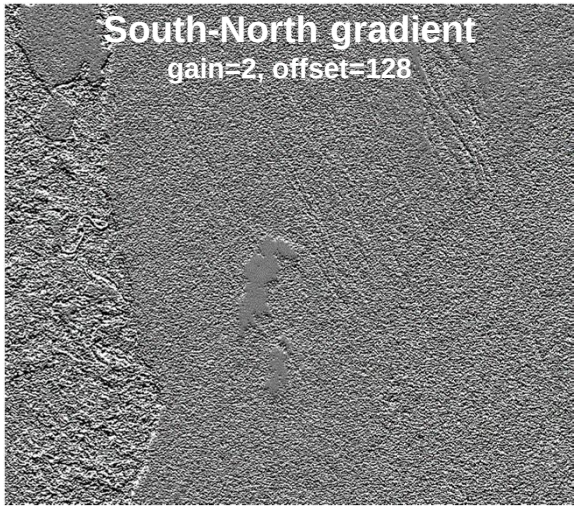
Sentinel-1A 21.09.2017 12:49:00 GMT - 2D_view











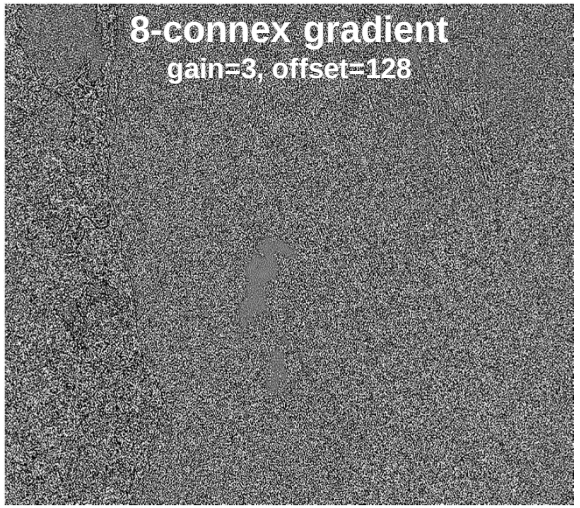
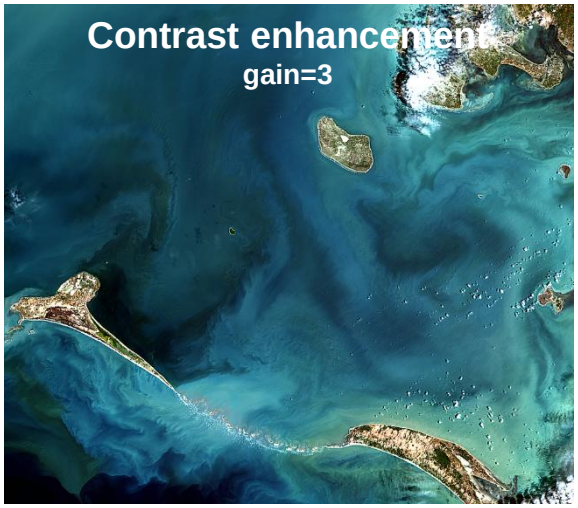
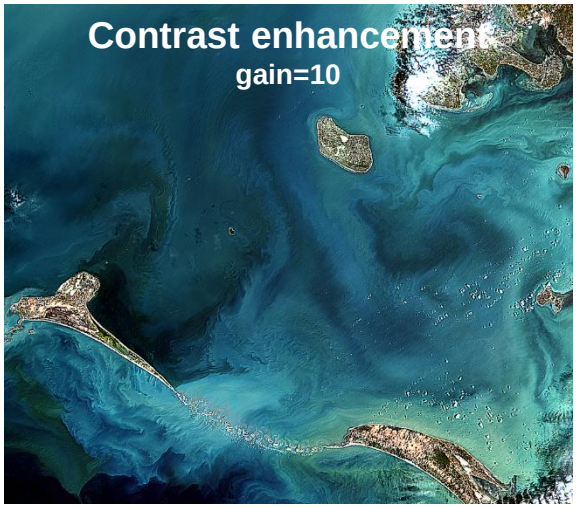


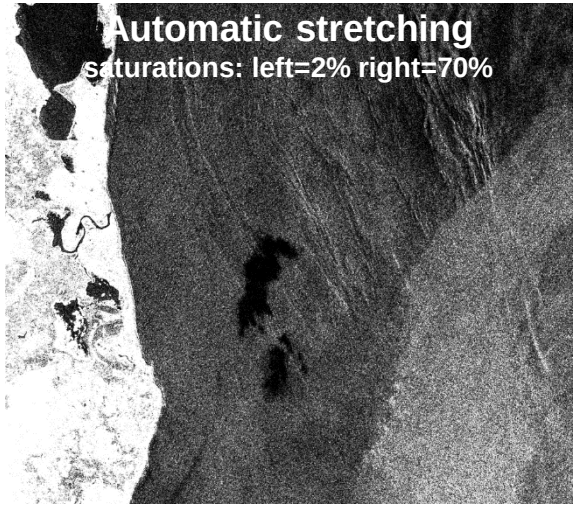
Image processing – Convolutive filters – Edge enhancement

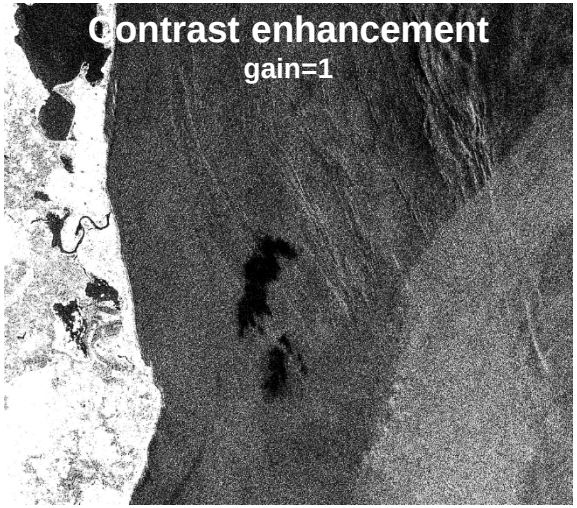
Sentinel-2A 18.09.2017 - 2D_view_top

Sentinel-1A 21.09.2017 - 2D_view_bottom









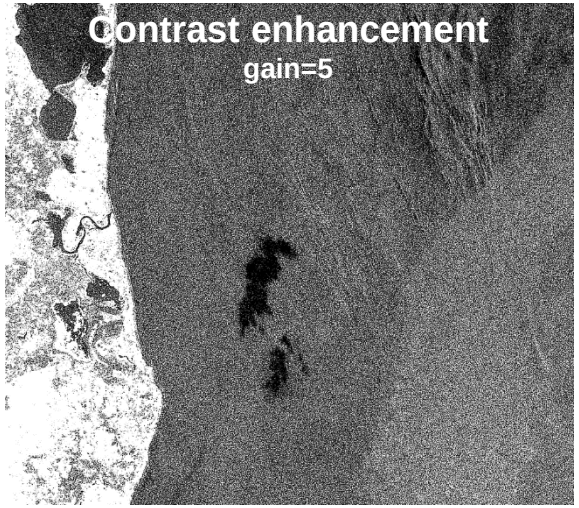
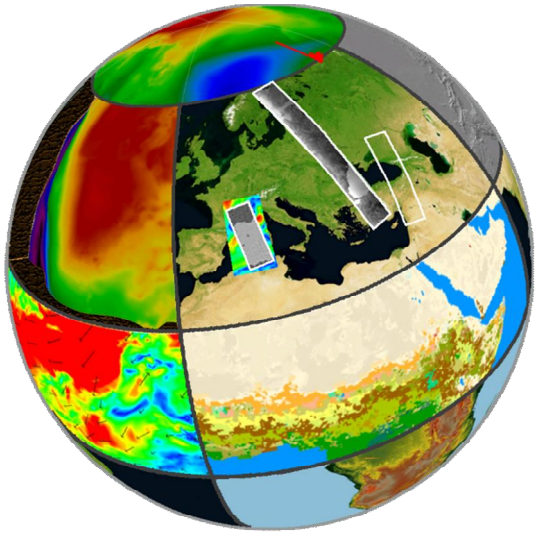


Table of contents

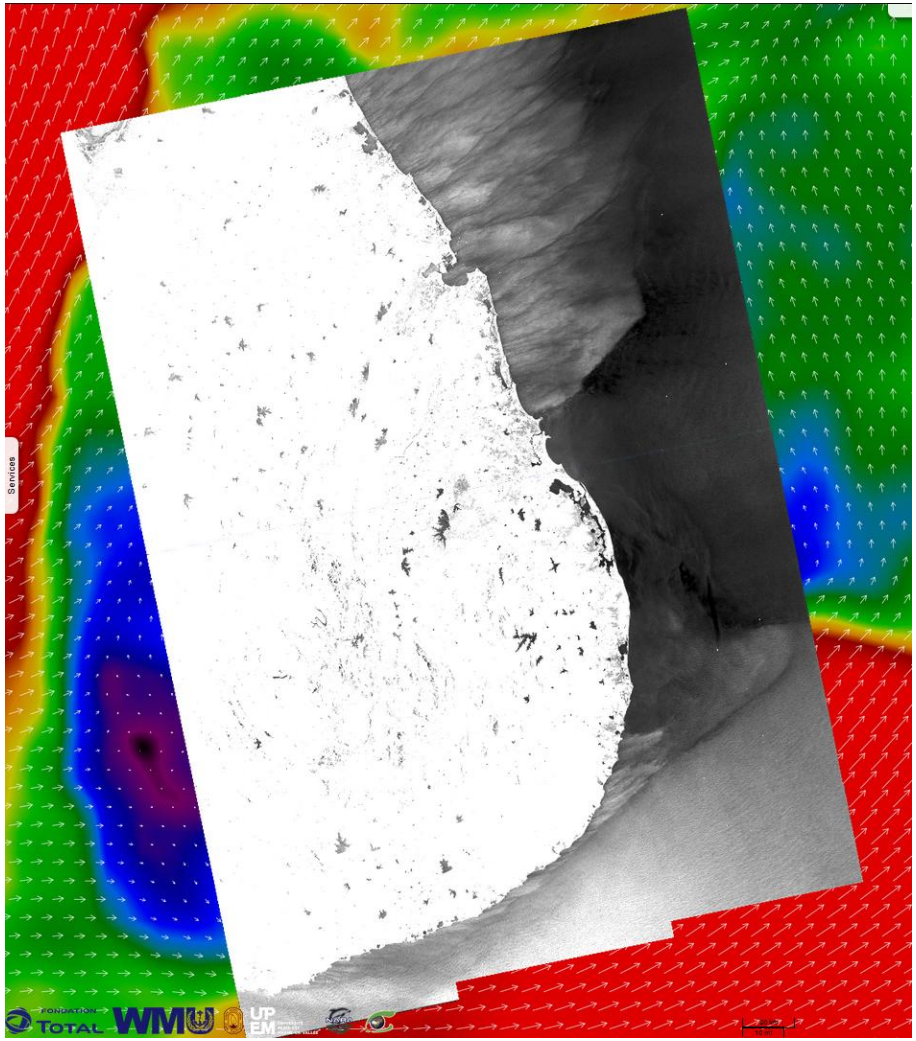
Session 3 – Themes of interest in Sri-Lanka

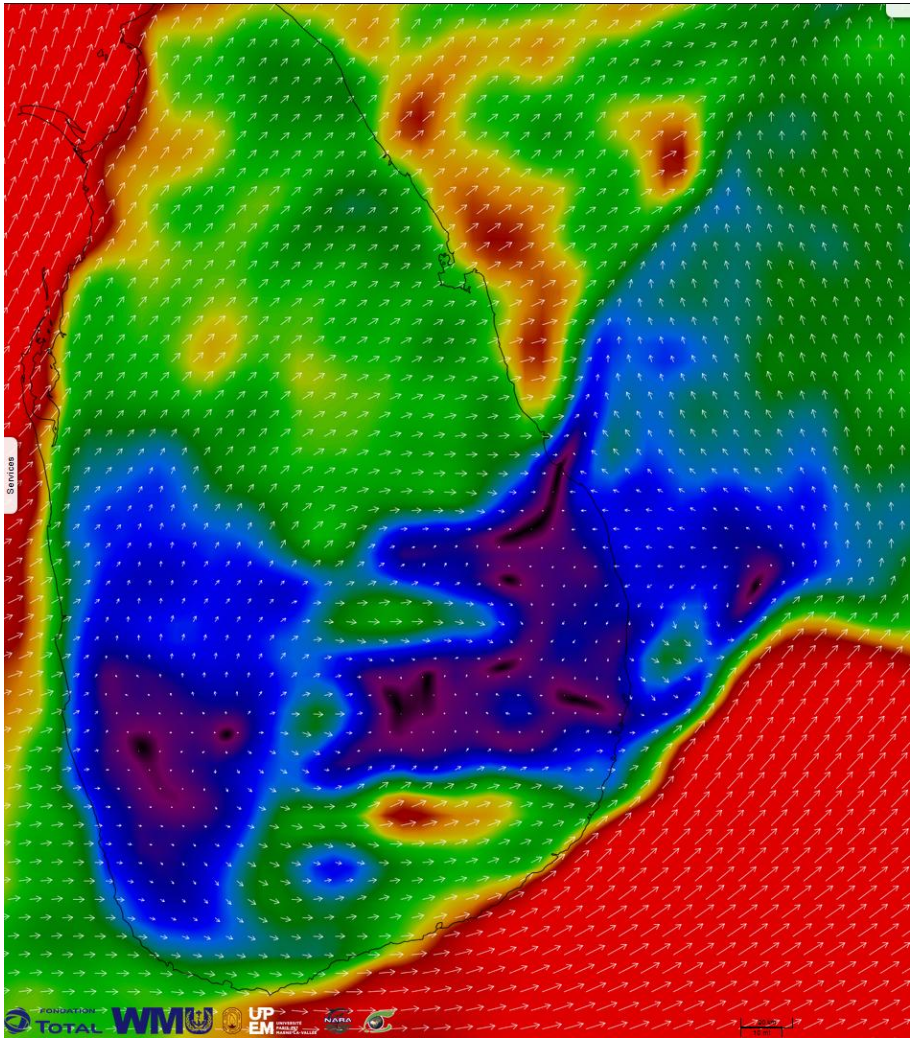
- Theme 1 – Oil spills
  - Winds around Sri-Lanka seen by Radar
  - Processing of Radar images to observe offshore objects
- Theme 2 – Mariculture farms
  - Colour compositions
  - Edge enhancement
- Theme 3 – Upwelling
  - Step 1 – Looking for black patterns in Radar images
  - Step 2 – Checking the wind strength and direction
  - Step 3 – Checking with other CMEMS products
- Theme 4 – Monitoring around oil wells
  - Looking for “bright patterns” around the well position



Winds around Sri-Lanka seen by Radar

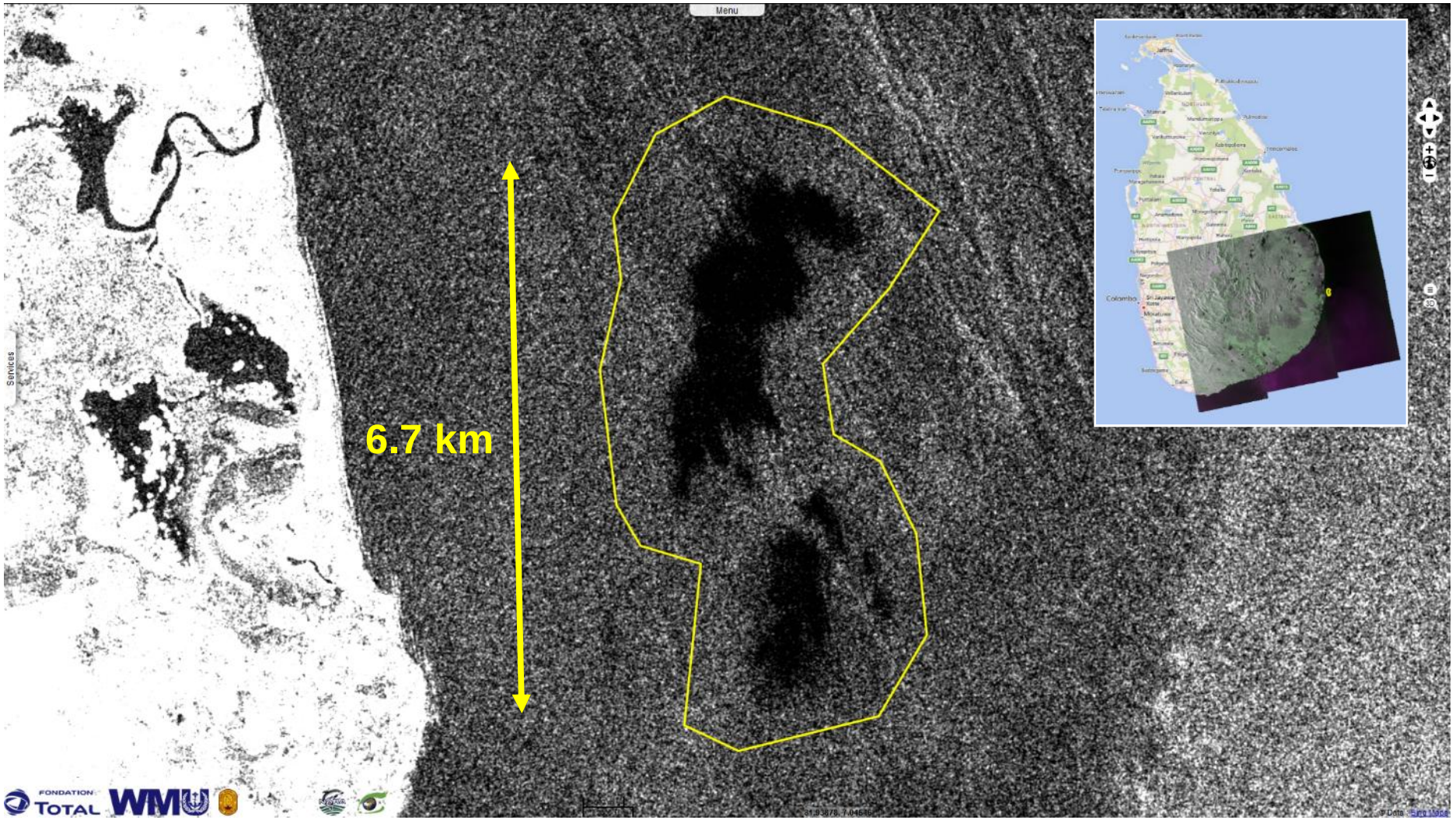
Sentinel-1 05.06.2017 12:49:24 vs. ECMWF 10W 05.06.2017 12:00 [2D_view](#) [2D_animation](#)





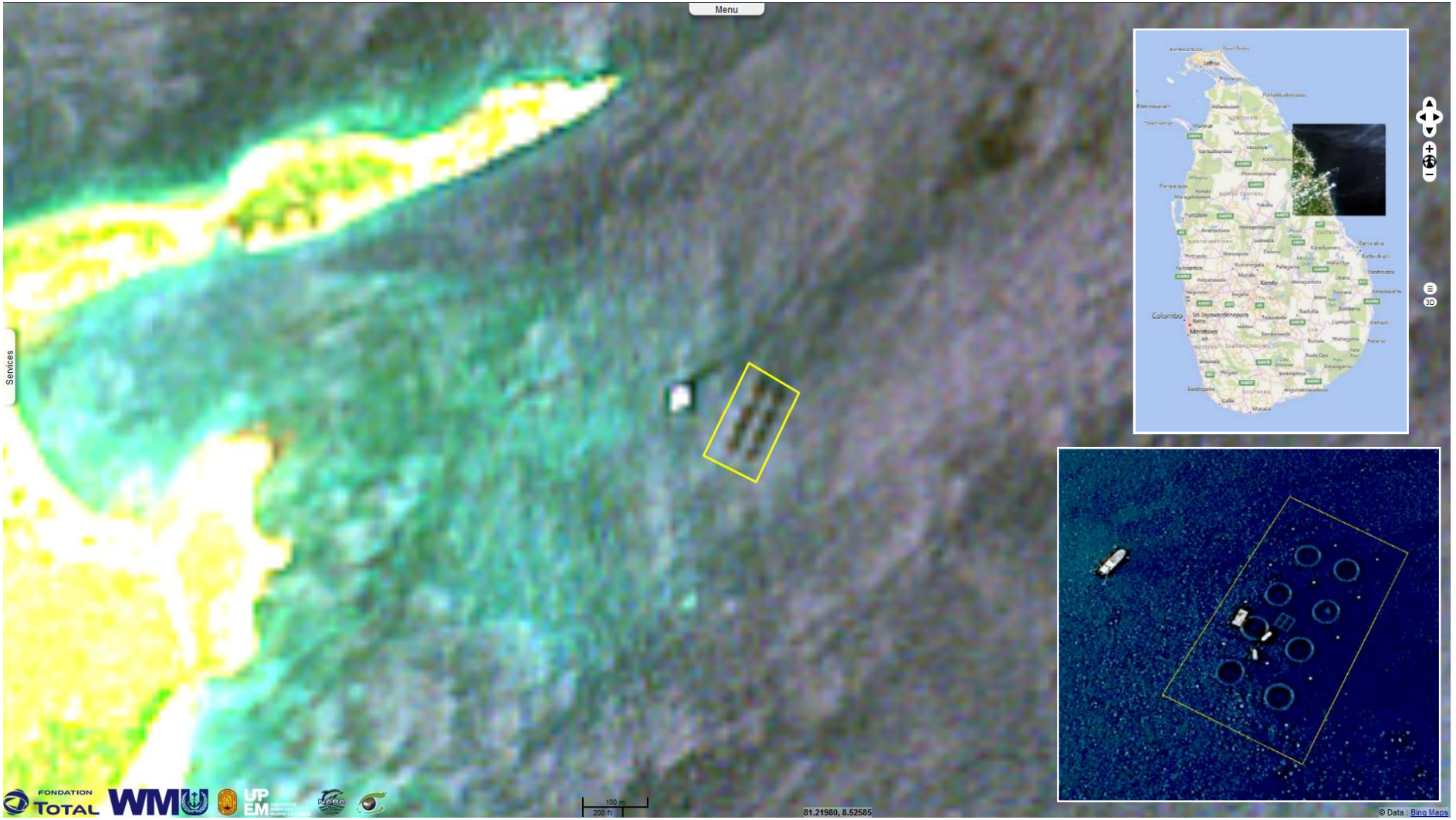
Theme 1 – Oil spill (Thandiyadi)

Sentinel-1A 21.09.2017 12:49:00 GMT - 2D_view



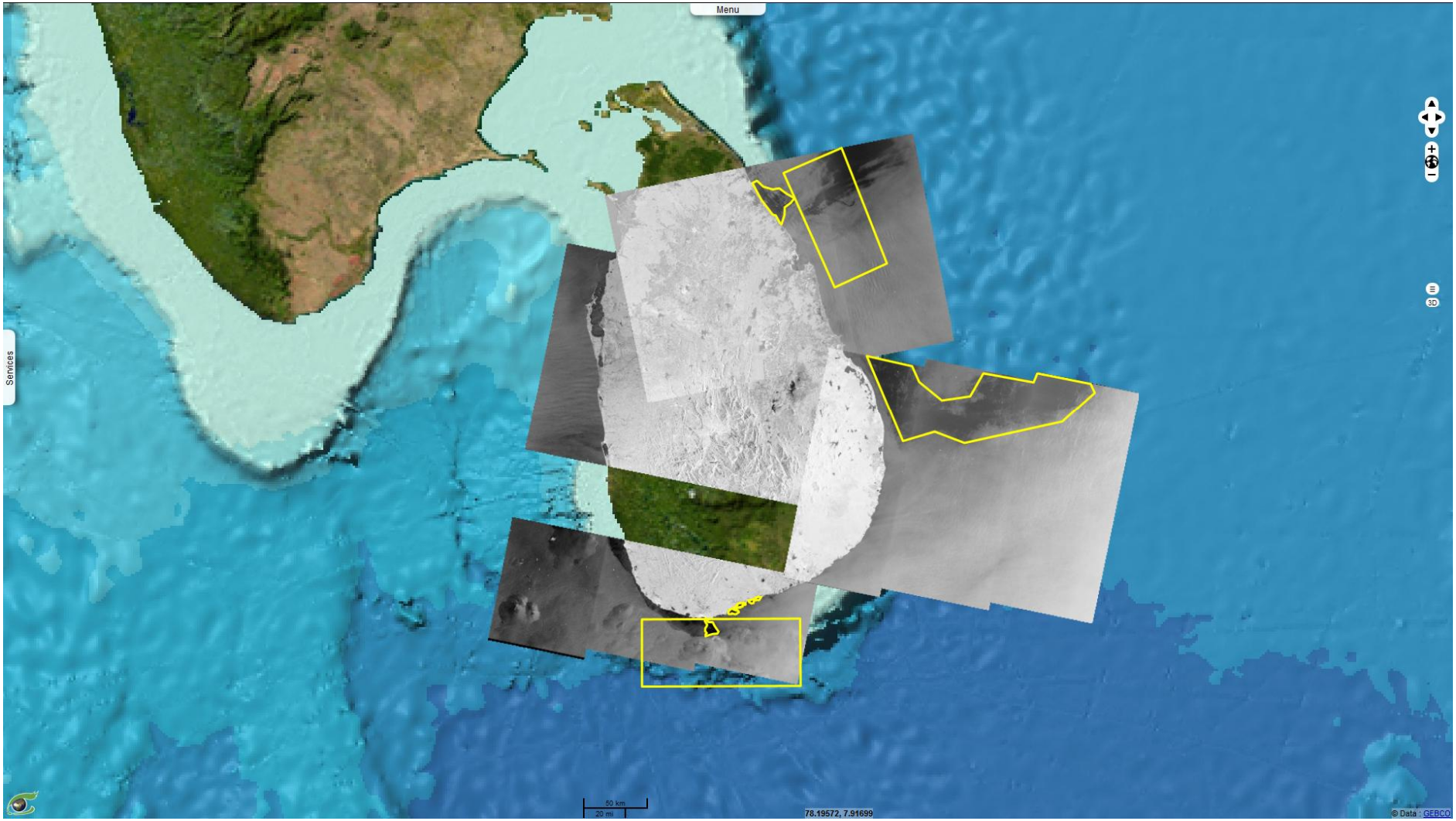
Theme 2 – Mariculture farm (Trincomalee)

AOI – Sentinel-2 17.06.2017 - 2D_view



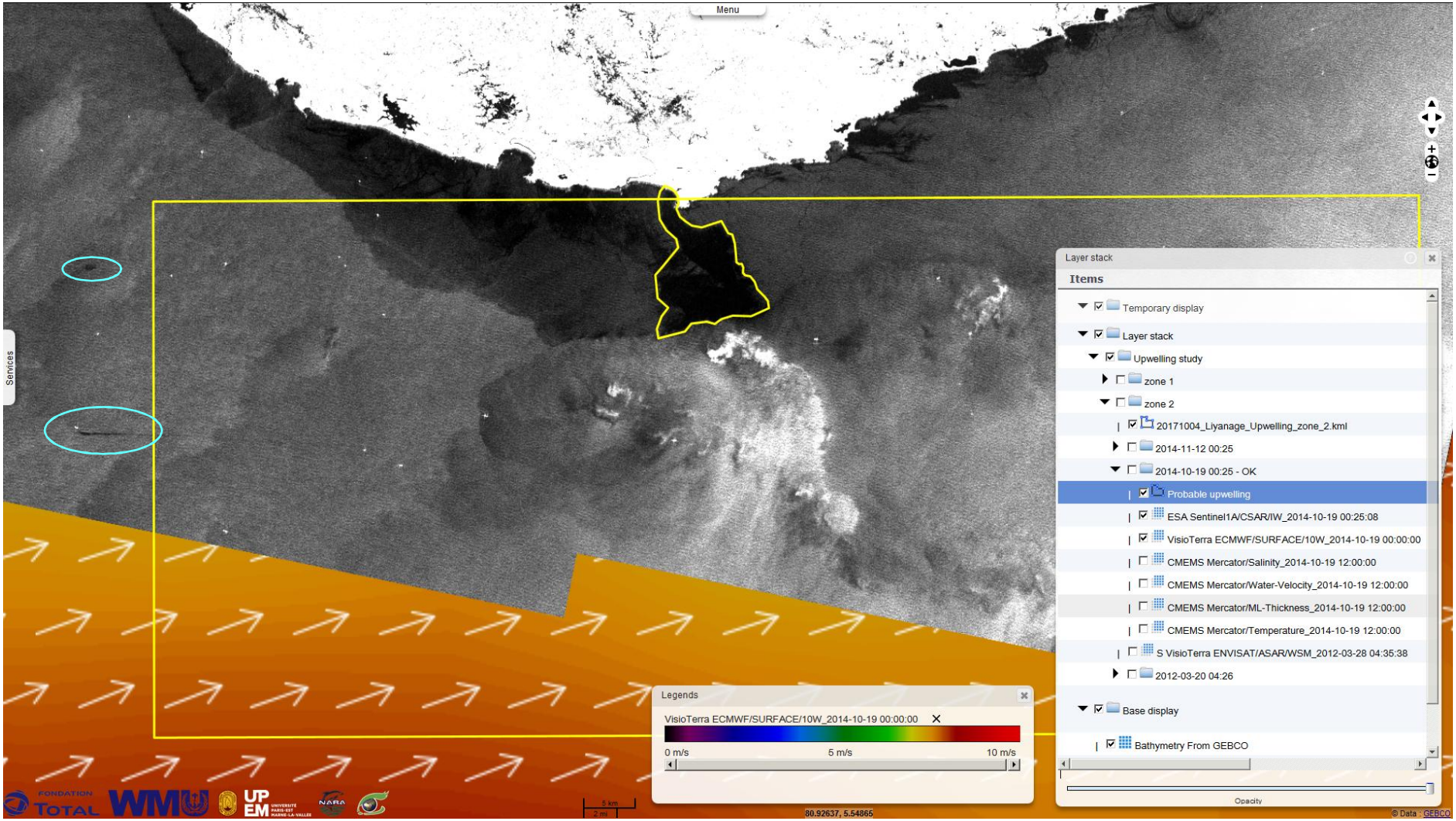
Theme 3 – Upwelling seen from Radar data

Sentinel-1 scenes with upwelling candidates in zone 1 (north-east) and zone 2 (south)



Theme 3 – Upwelling seen from Radar data (+checking meteo.)

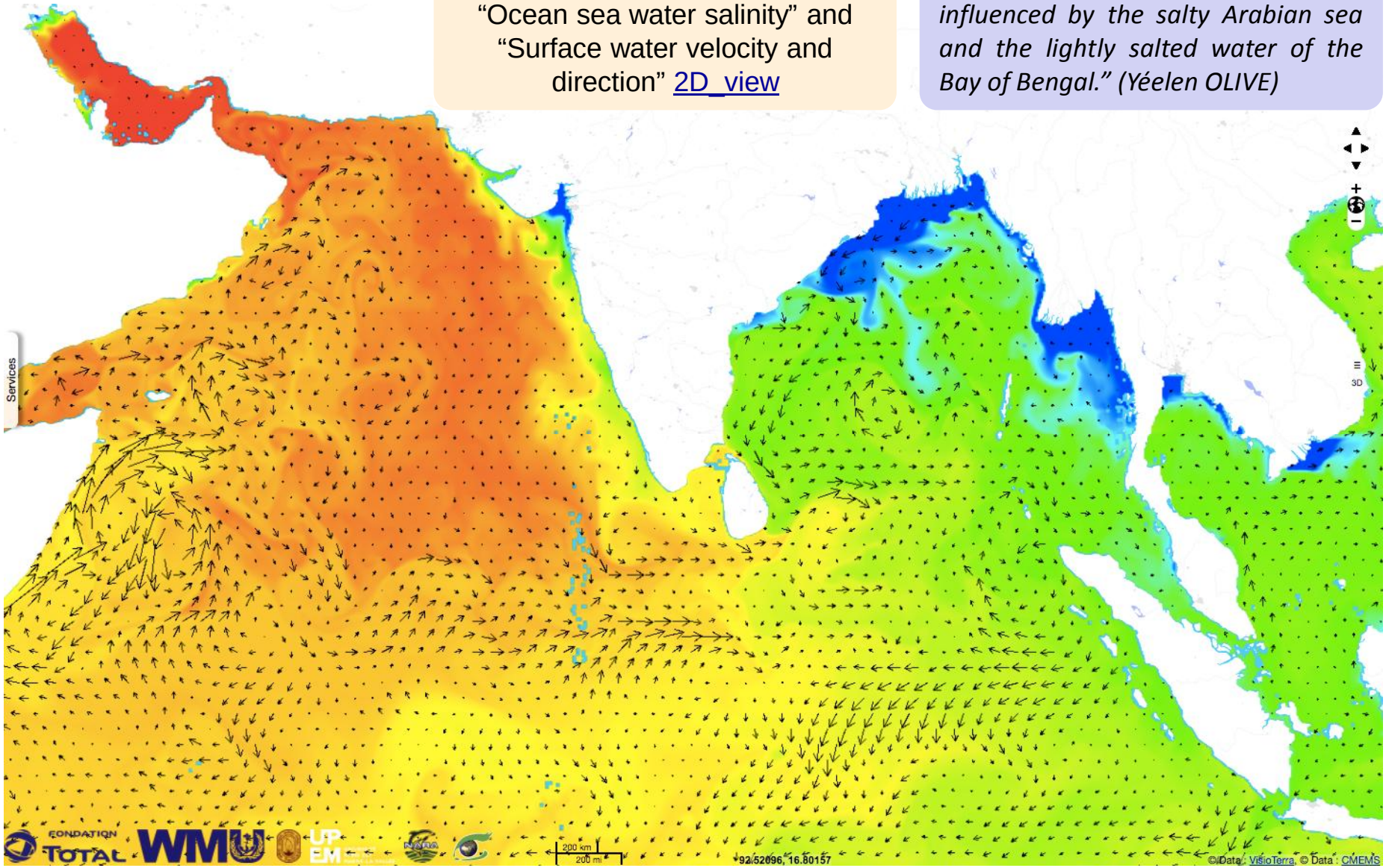
Sentinel-1 19.10.2014 00:25:08 GMT in zone 2 - 2D_view (see also zone1)



Theme 3 – Upwelling from CMEMS - Sea salinity and currents

30.09.2017 - CMEMS / Mercator
"Ocean sea water salinity" and
"Surface water velocity and
direction" 2D_view

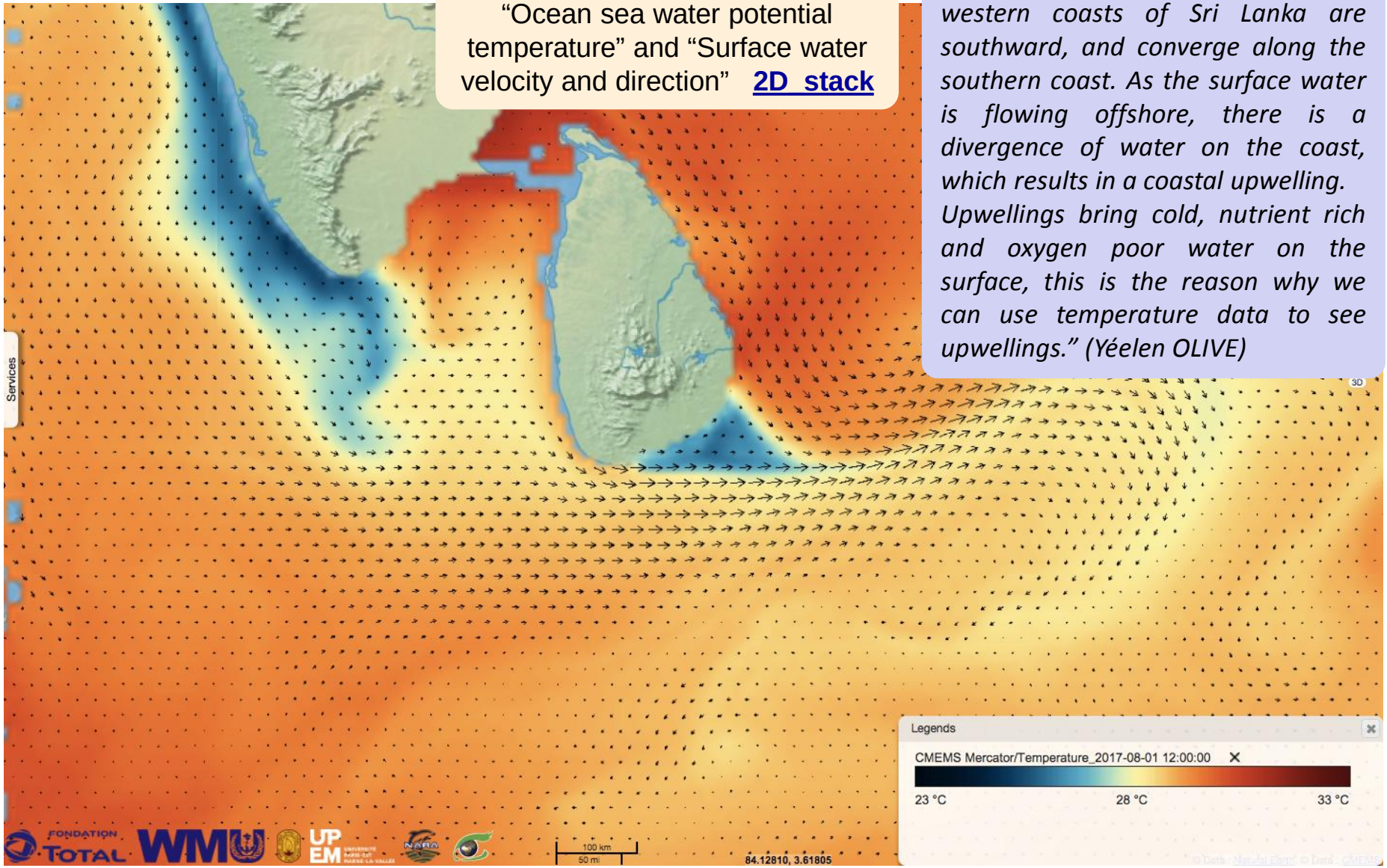
"Sri Lankan coastal waters are influenced by the salty Arabian sea and the lightly salted water of the Bay of Bengal." (Yéelen OLIVE)



Theme 3 – Upwelling from CMEMS – SST and currents

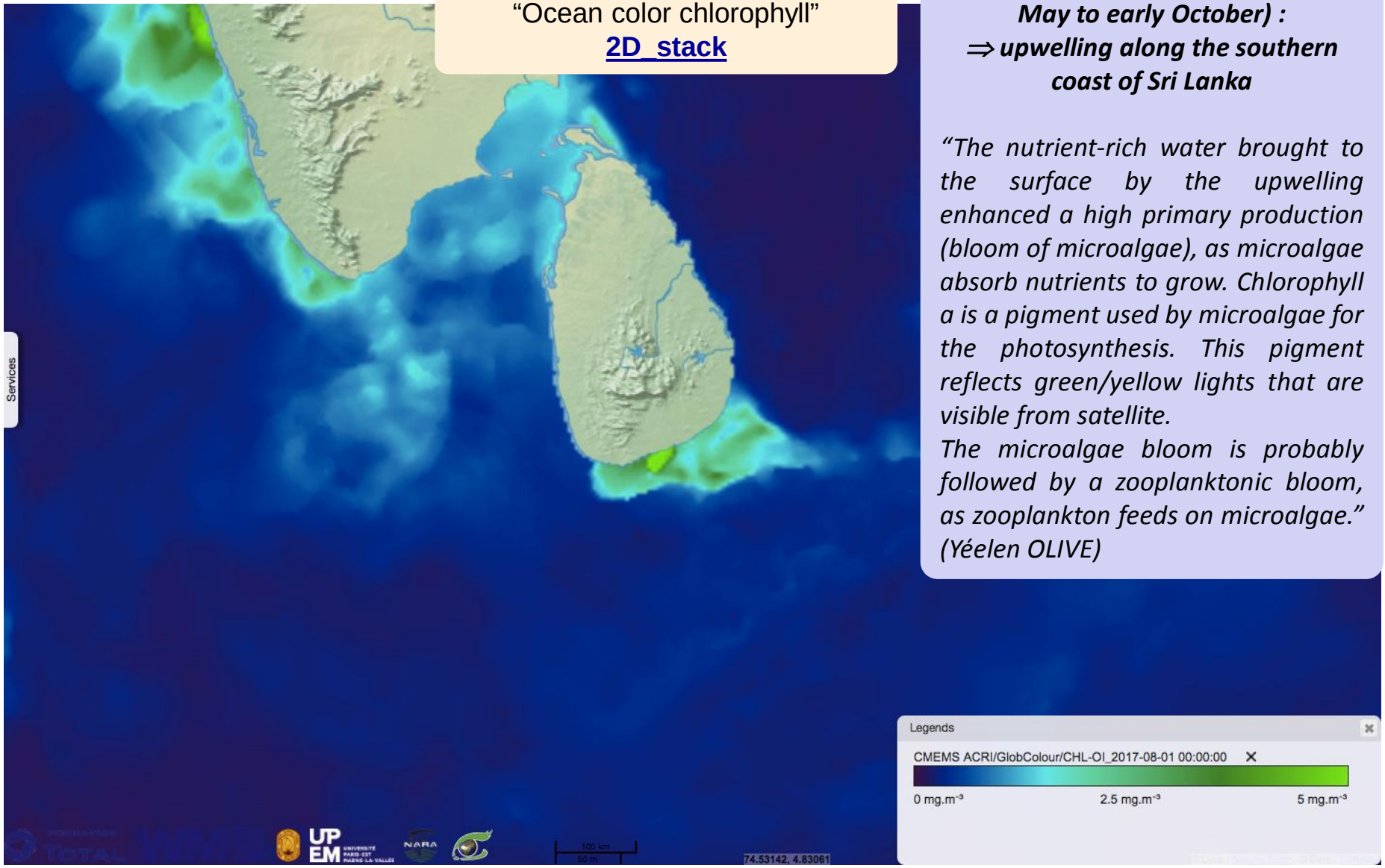
01.08.2017 - CMEMS / Mercator "Ocean sea water potential temperature" and "Surface water velocity and direction" **2D stack**

"Flows along the eastern and western coasts of Sri Lanka are southward, and converge along the southern coast. As the surface water is flowing offshore, there is a divergence of water on the coast, which results in a coastal upwelling. Upwellings bring cold, nutrient rich and oxygen poor water on the surface, this is the reason why we can use temperature data to see upwellings." (Yéelen OLIVE)



Theme 3 – Upwelling from CMEMS - Chlorophyll

01.08.2017 - CMEMS / ACRI
"Ocean color chlorophyll"
2D_stack



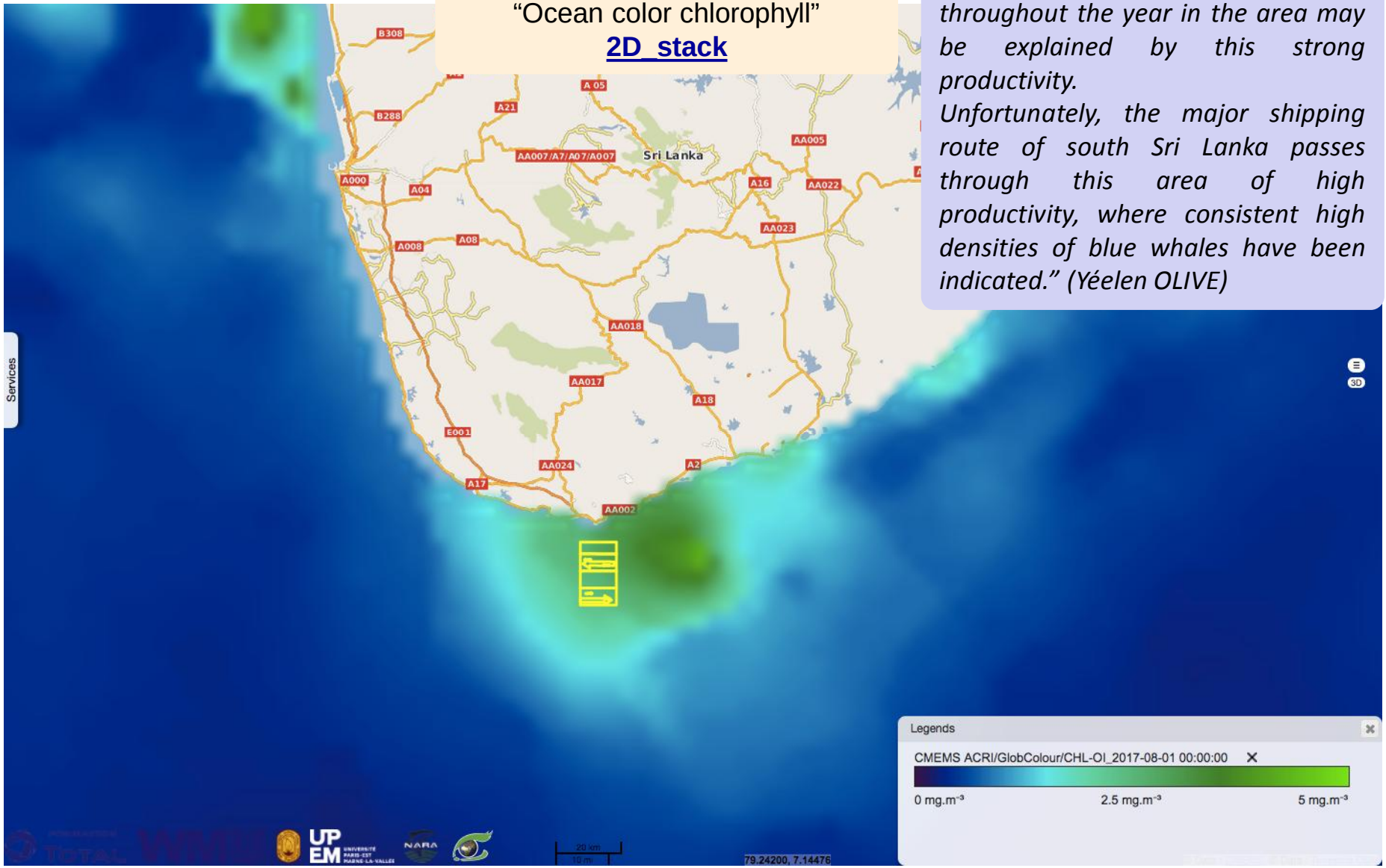
During the summer monsoon (end of May to early October) :
⇒ upwelling along the southern coast of Sri Lanka

"The nutrient-rich water brought to the surface by the upwelling enhanced a high primary production (bloom of microalgae), as microalgae absorb nutrients to grow. Chlorophyll a is a pigment used by microalgae for the photosynthesis. This pigment reflects green/yellow lights that are visible from satellite.
The microalgae bloom is probably followed by a zooplanktonic bloom, as zooplankton feeds on microalgae." (Yéelen OLIVE)

Theme 3 – Upwelling from CMEMS - Chlorophyll

21.09.2017 - CMEMS / ACRI
"Ocean color chlorophyll"
2D_stack

"The presence of blue whales throughout the year in the area may be explained by this strong productivity.
Unfortunately, the major shipping route of south Sri Lanka passes through this area of high productivity, where consistent high densities of blue whales have been indicated." (Yéelen OLIVE)



Theme 4 – Monitoring around oil wells

"Oil platforms are large metallic structures that are usually clearly detected in the Radar images but nothing is observed around the locations of the five (5) oil wells given by NARA."

Sentinel-1A 10.06.2017 00.32.51 GMT - 3D view