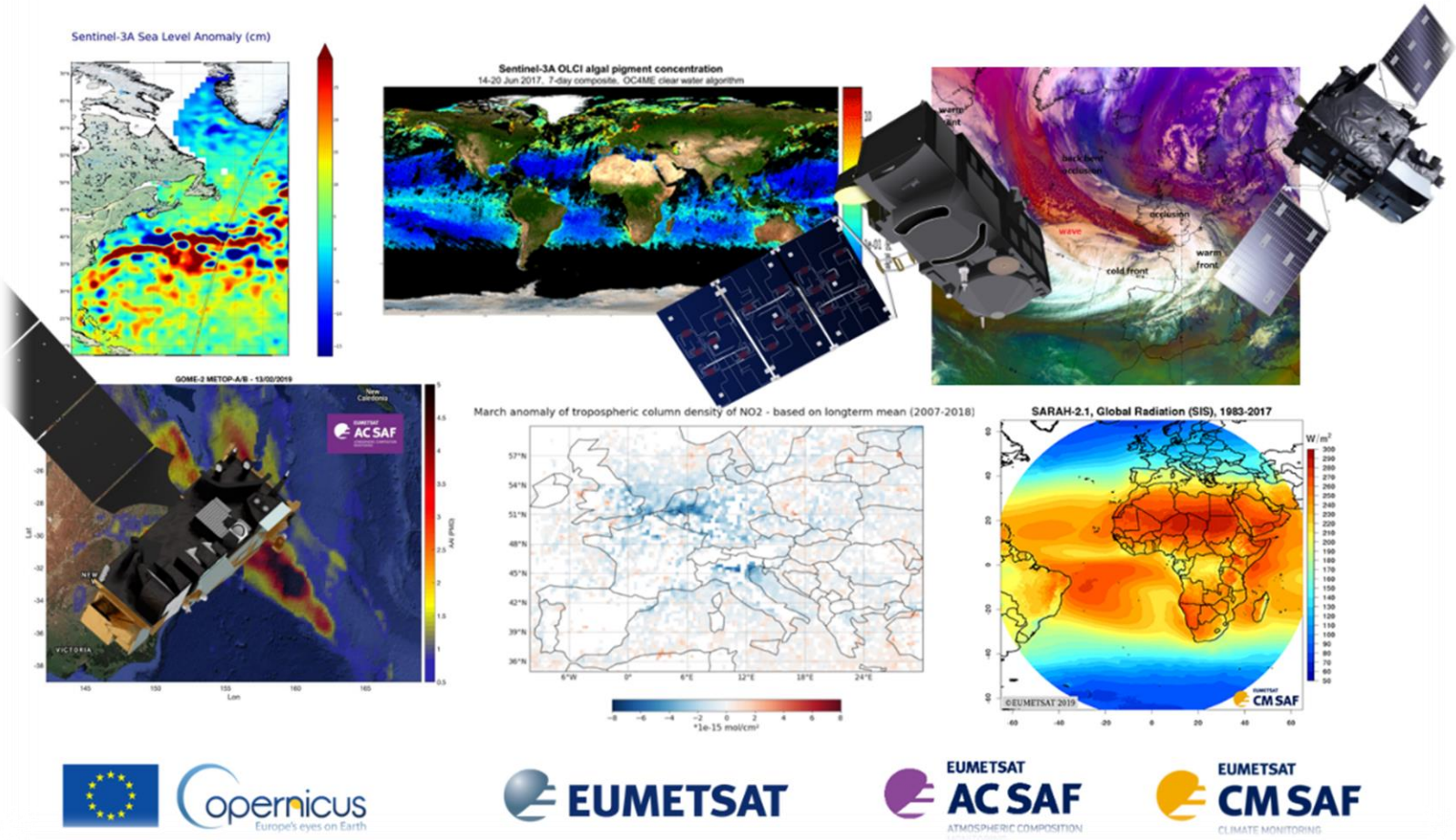
Welcome to the first short online course in the series
The session will begin at 12 UTC



If you have technical issues, please send a message in the chat box to **Support**.

For **Q&A**: go to Slido.com – event code: **#EUMSC1**

How high is the sea?
A discovery of altimetry data

EUMETSAT

with Vinca Rosmorduc and Oliver Clements

Moderator: Federico Fierli

Welcome to EUMETSAT short courses !

- Intergovernmental organization since 1986 – Darmstadt - Germany
- Supply weather, ocean, environment and climate-related satellite data 24H 356D
- Users – Weather Services of Member States in Europe, and many other worldwide
- > 600 staff from all Europe with diverse competences

EUMETSAT current programs

- METOP (trident)
  - Meteosat
  - Jason
  - Sentinel3

New programs !

- Meteosat III Gen
- Polar II Gen
- Monitor CO2
- Sentinel 6,5,4

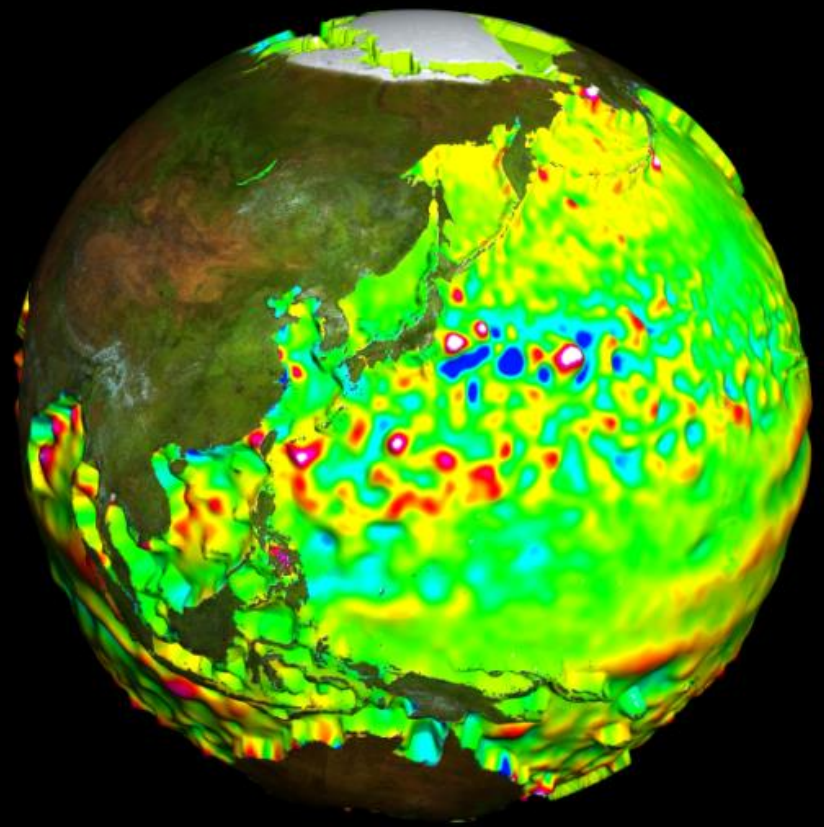
EUMETSAT

Make data available at best

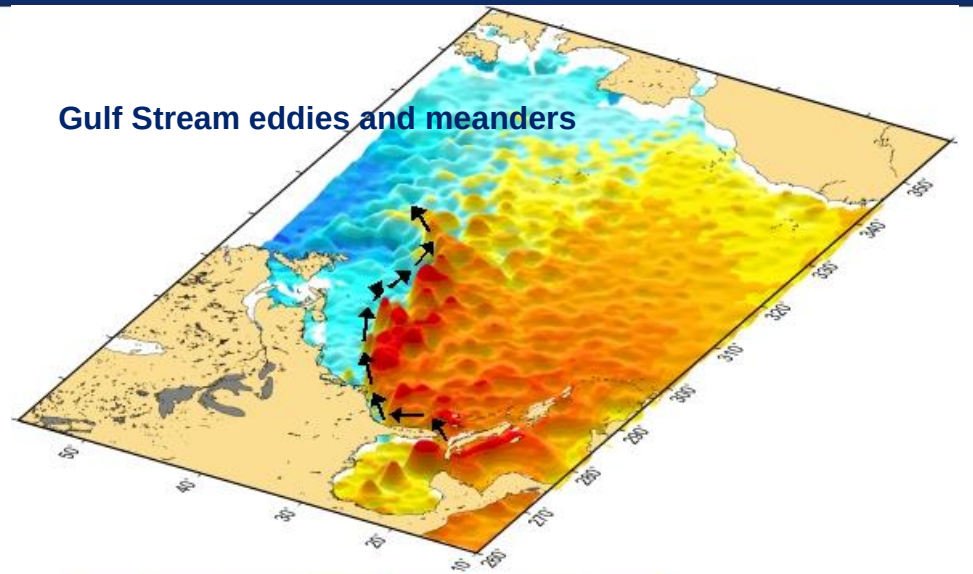
- Gather (and satisfy) needs
- Grant data access
- Help and support Users
- Training (also on-line)
- Explore applications
- Communicate - outreach

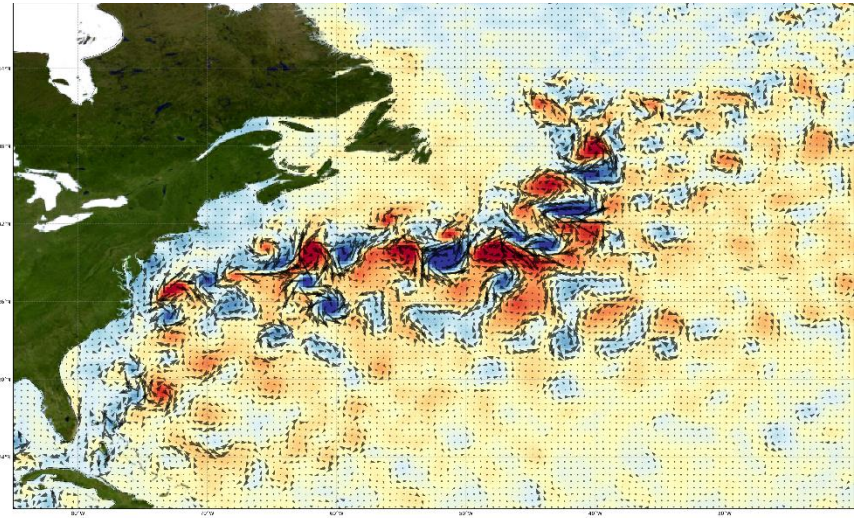
What can sea heights show? Eddies, gyres and meanders – variability in the ocean

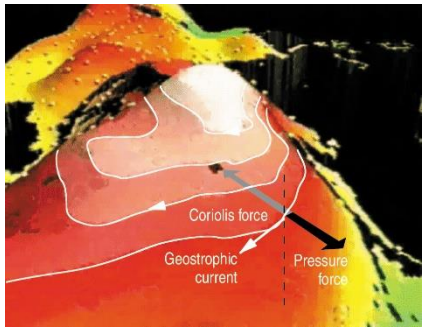
Eddies (turbulence) in a major current (Kuroshio)



Gulf Stream eddies and meanders







Gulf Stream eddies and associated currents

➔ **forecast**

Q&A: go to Slido.com – event code: #EUMSC1

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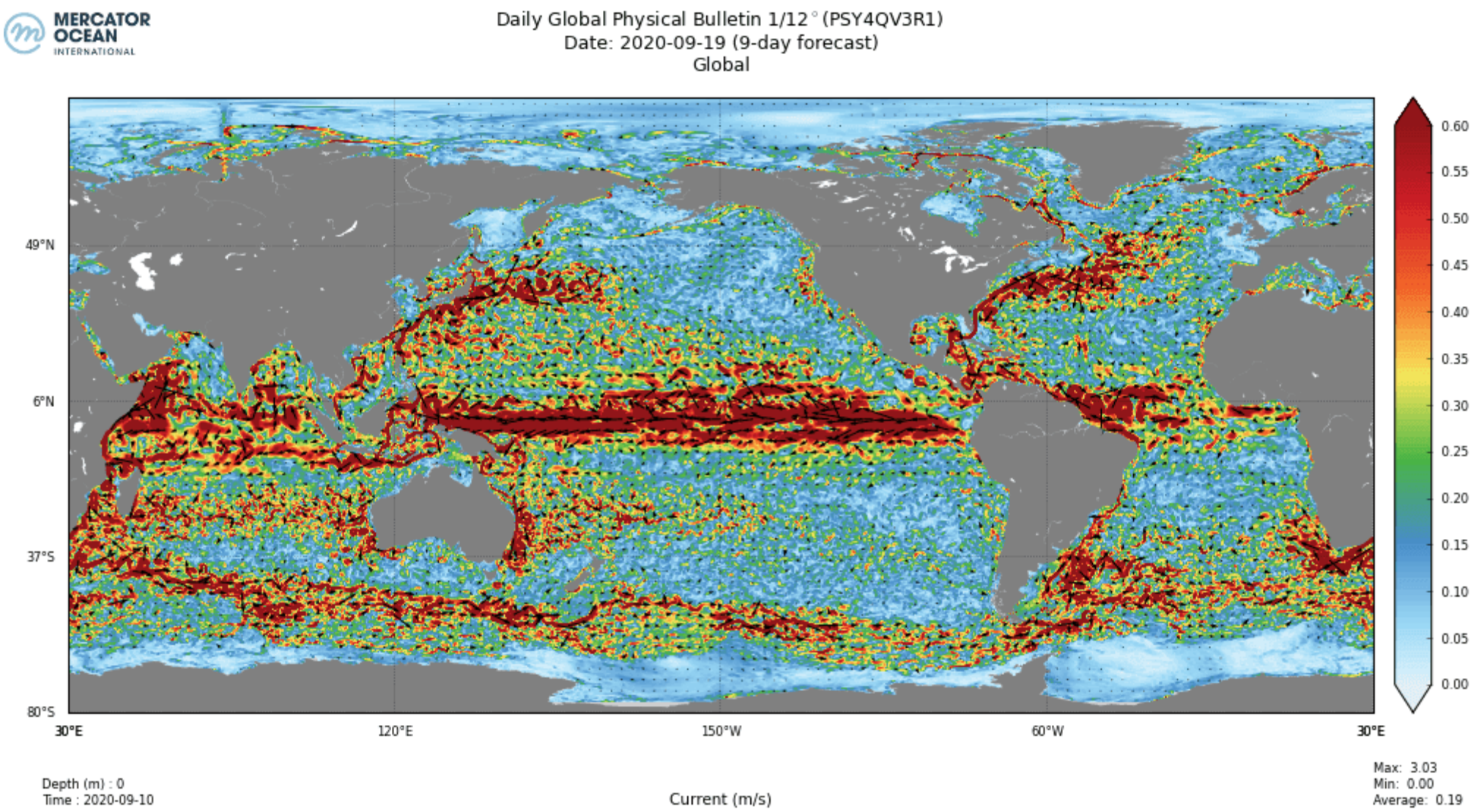
Forecasting the ocean (currents)



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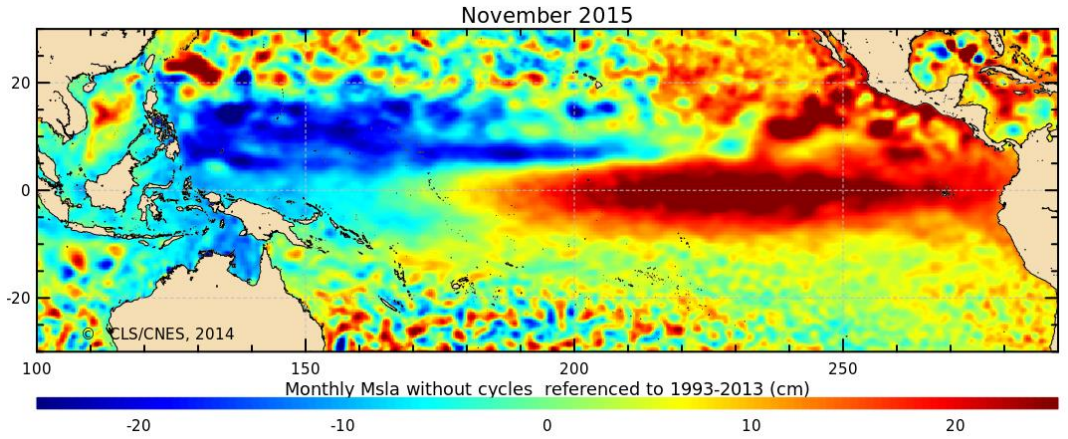
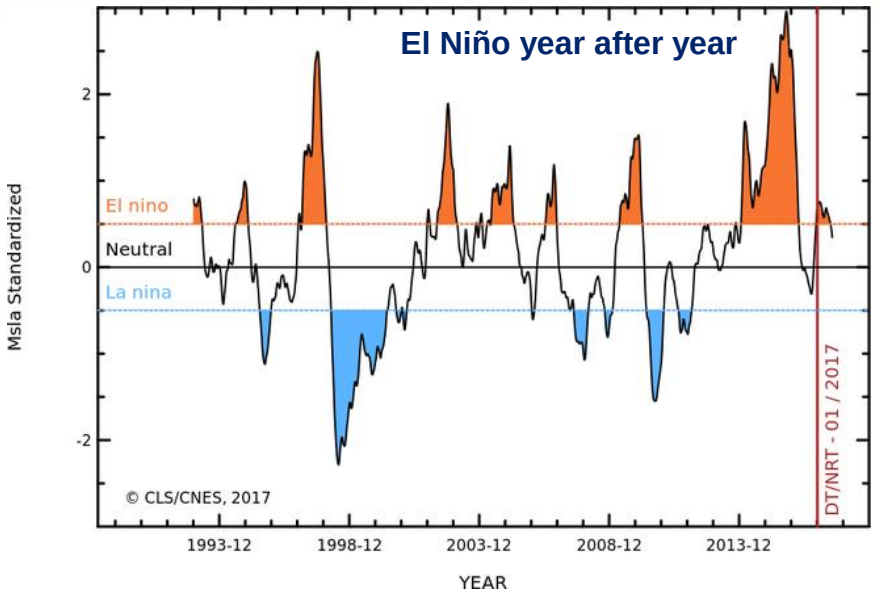
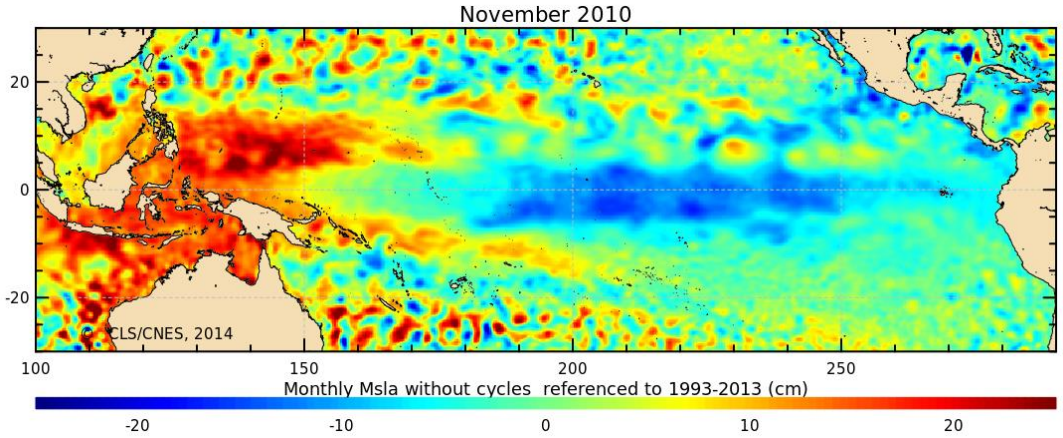
What can sea heights show? Large-scale ocean – atmosphere coupled phenomena

El Niño

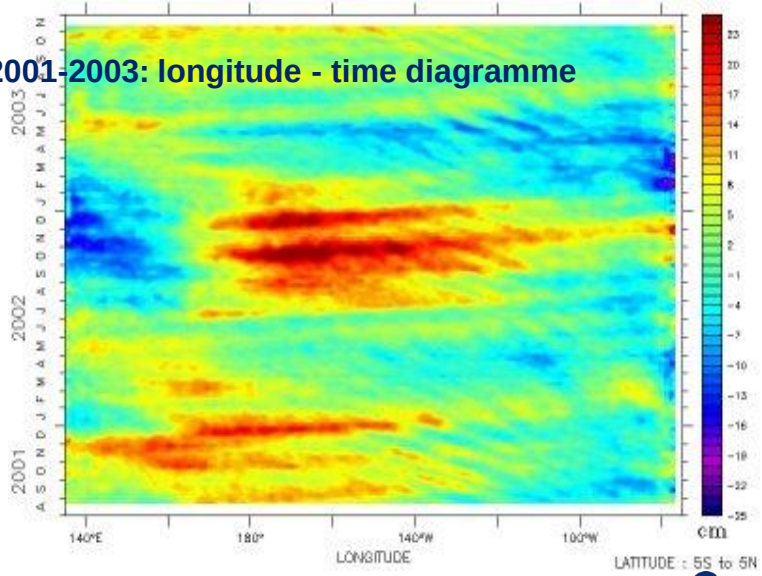




La Niña



El Niño 2001-2003: longitude - time diagramme



➔ **forecast**

Q&A: go to Slido.com – event code: #EUMSC1

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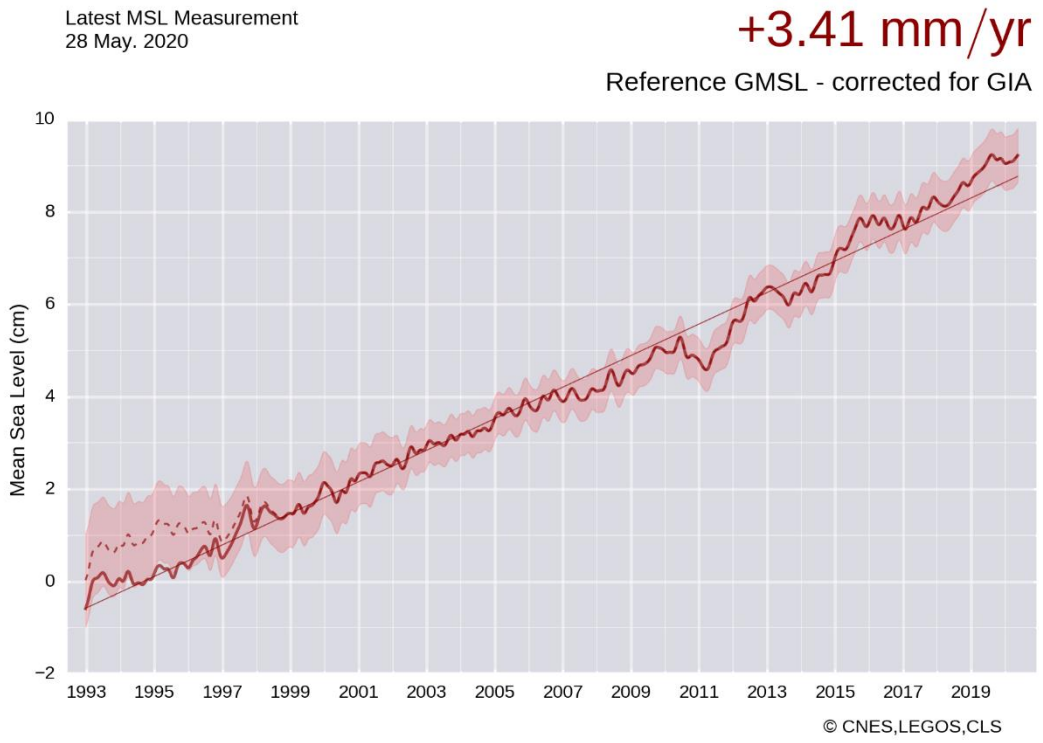
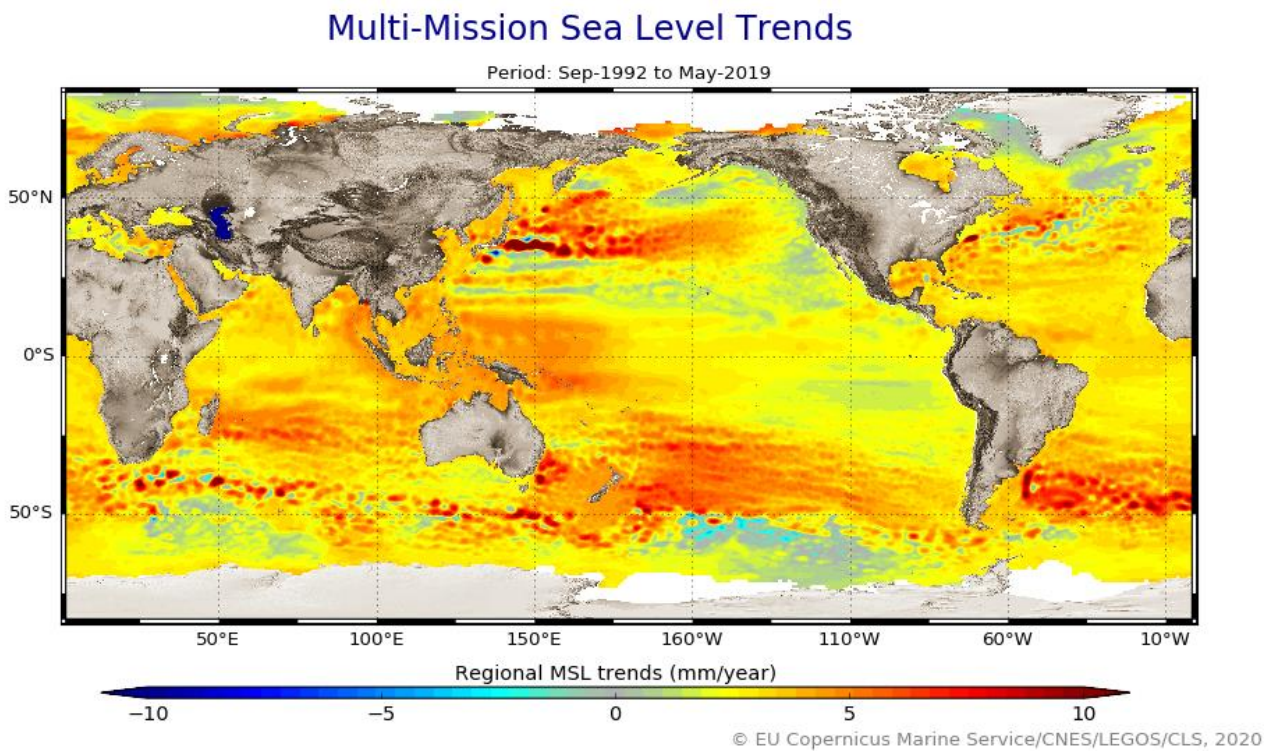
What can sea heights show? Long-term global-averaged variations

Global Mean Sea Level



& its geographical variations



Q&A: go to Slido.com – event code: #EUMSC1

- How would you measure sea height?

1- go at sea & launch a rope?

2- use a telemeter from a plane or satellite?

3- use a tide gauge?

Q&A: go to Slido.com – event code: #EUMSC1

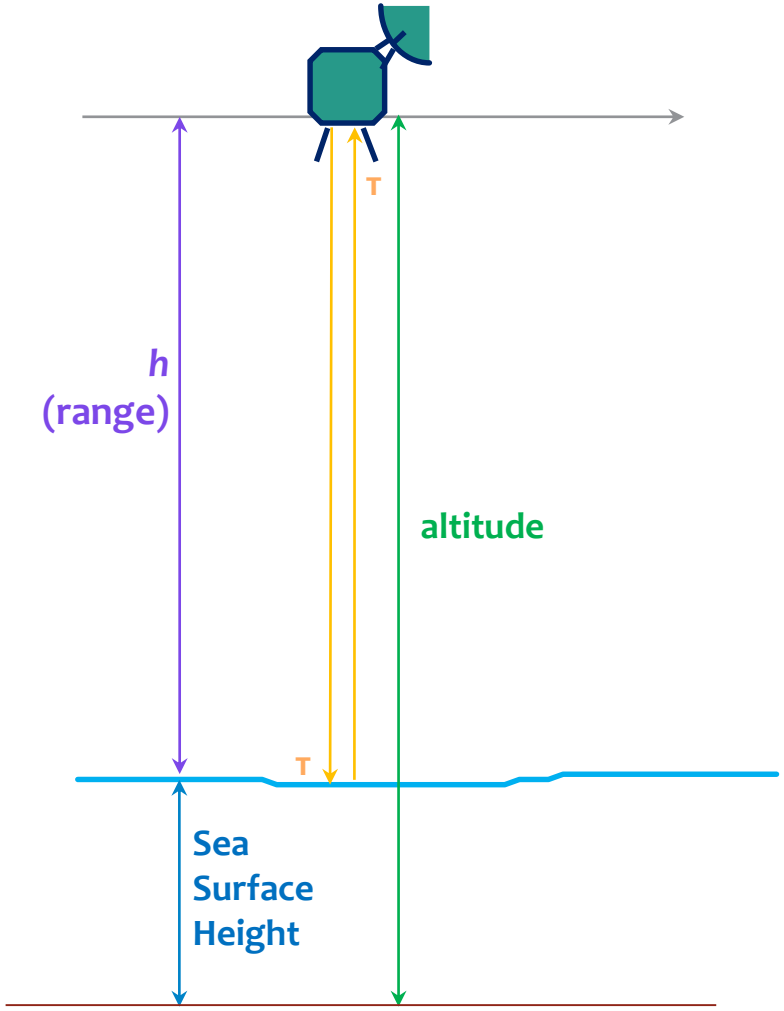
How it works? (ultra-simplified)

- Satellite emits a radar signal towards the surface
- Measures its travel time 2T, from emit to return
- Satellite-to-surface distance (range)

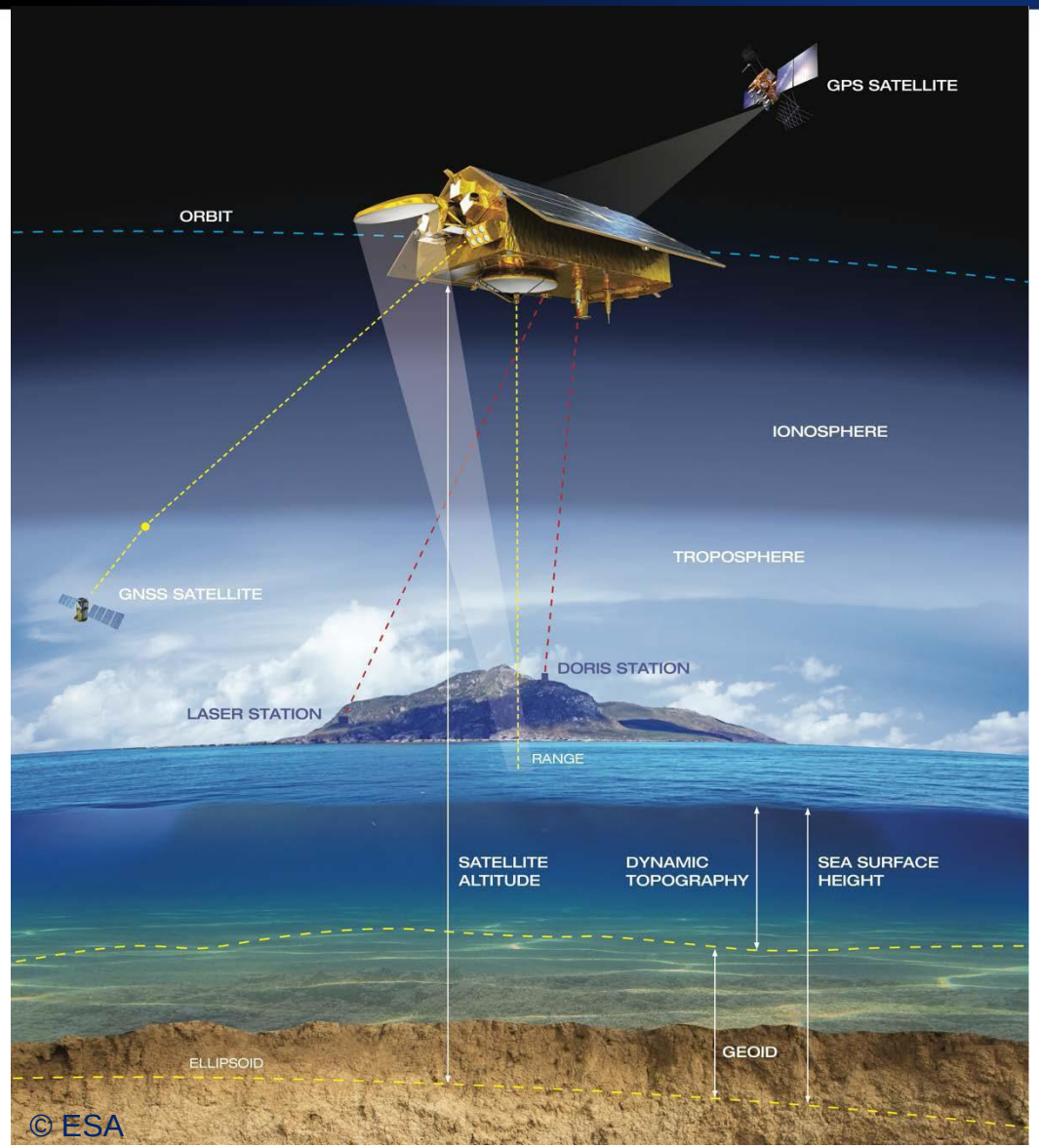
  $h = T*c$

  (c: light velocity ≈ $3x10^8$ m/s)
- altitude measured by dedicated instruments
- Sea Surface Height is

  SSH = altitude - range



How it works (slightly more realistic)



SSH_{corr} = Altitude – Range – Corrections

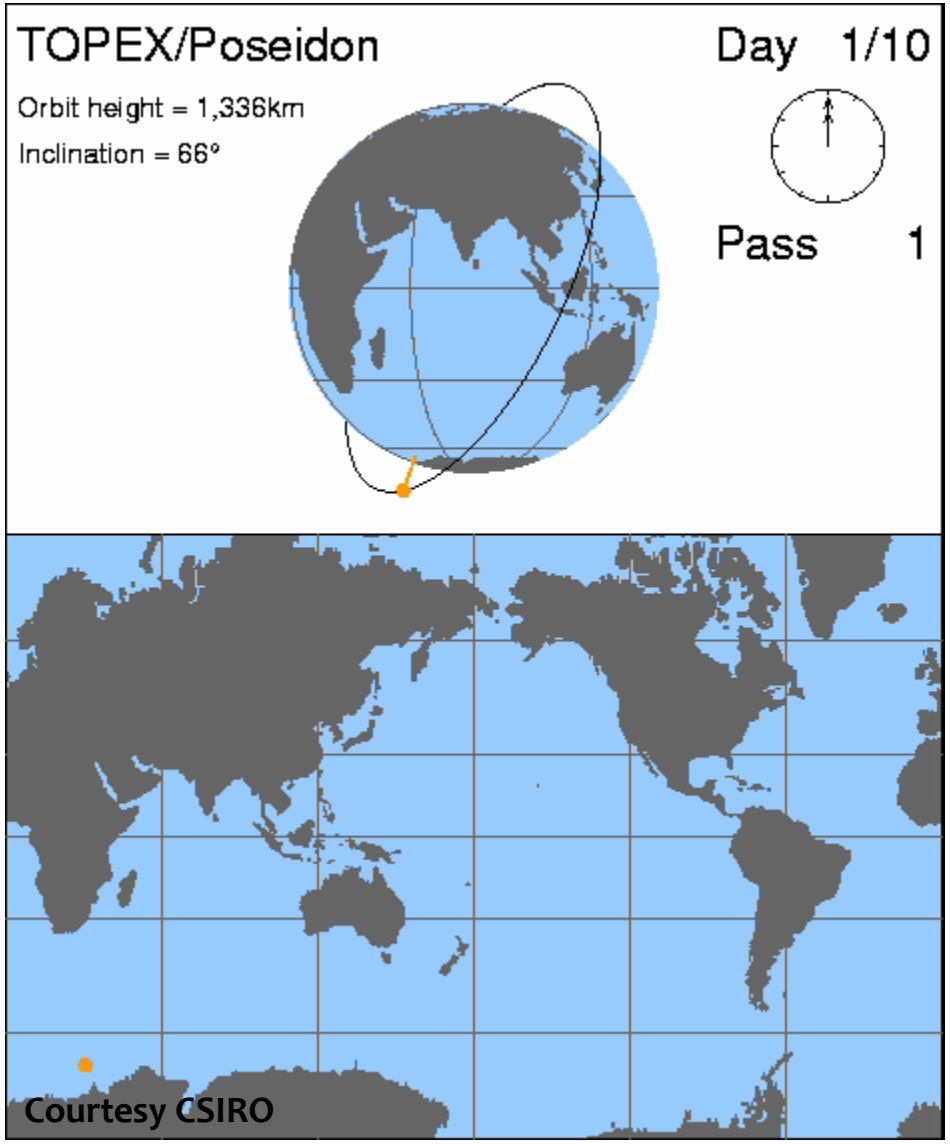
Corrections applied:

- water in the troposphere (“wet tropo”)
- electrons in the ionosphere
- dry gases in the atmosphere (“dry tropo”)
- atmospheric pressure (“inverse barometer”)
- sea state bias (wave crests reflect radar beam less than troughs)
- tides (ocean, solid Earth, pole)

All are **subtracted** from the rough SSH.

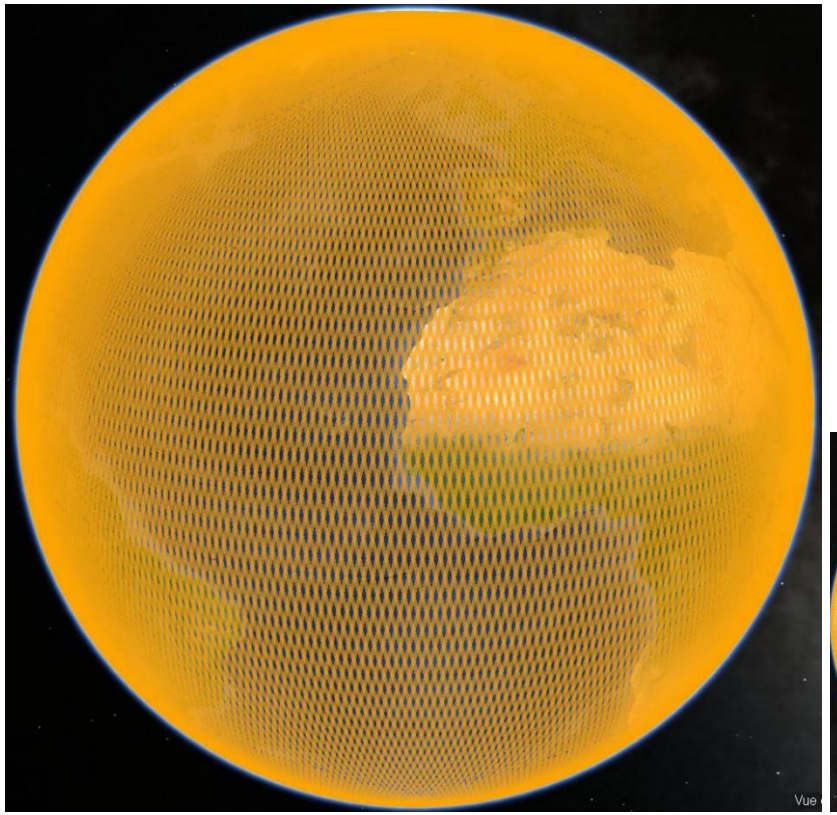
Level-2 “reduced” or “standard” data

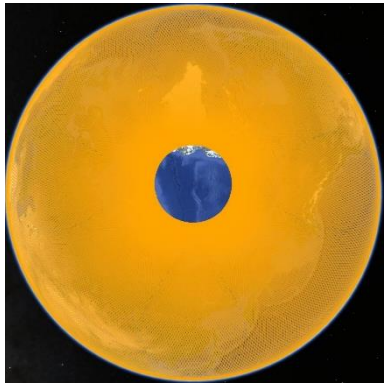
!! Altimetry is not imagery… (for now)



NB. altimetry data = a narrow thread of measurements just beneath the satellite.

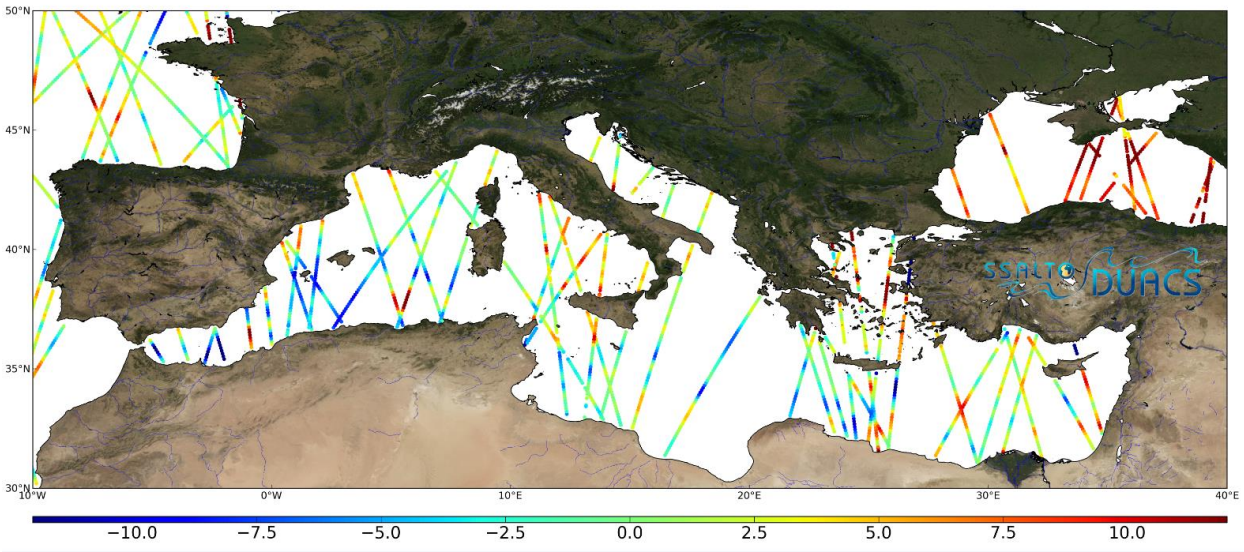
“along-track” data





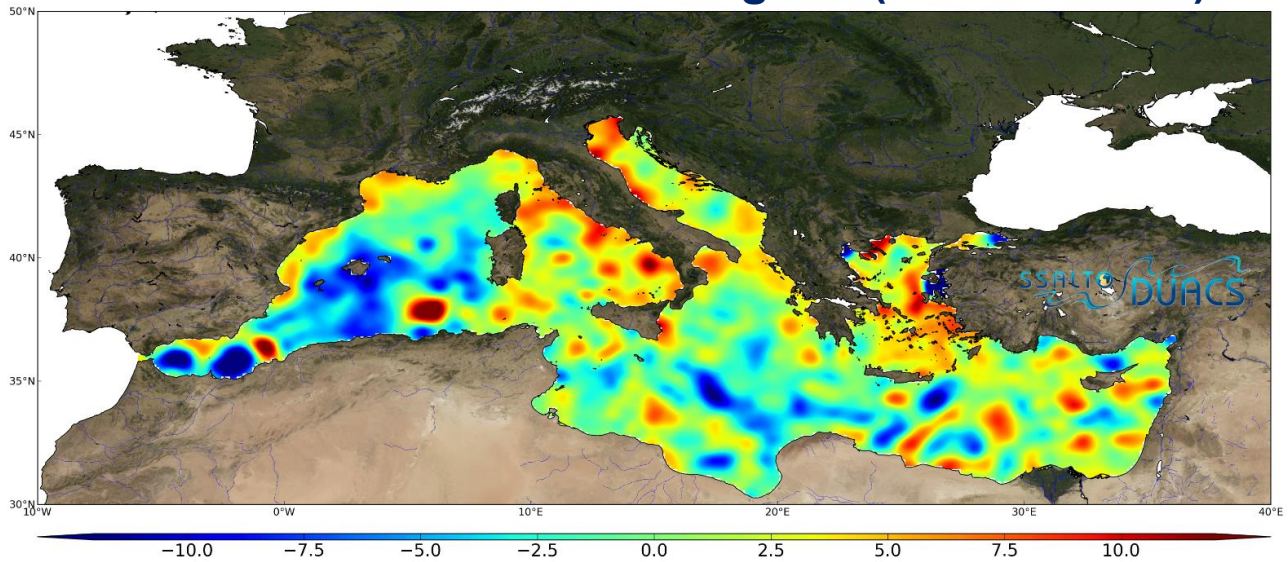
Sentinel-3:
27-day track revisit

Merging satellites to improve spatial resolution



Optimal interpolation method

grids (“level 4 data”)



Intercalibrated data (“level 3”) from <u>all</u> satellites available on a given period

(data available through https://marine.copernicus.eu)

Q&A: go to Slido.com – event code: #EUMSC1

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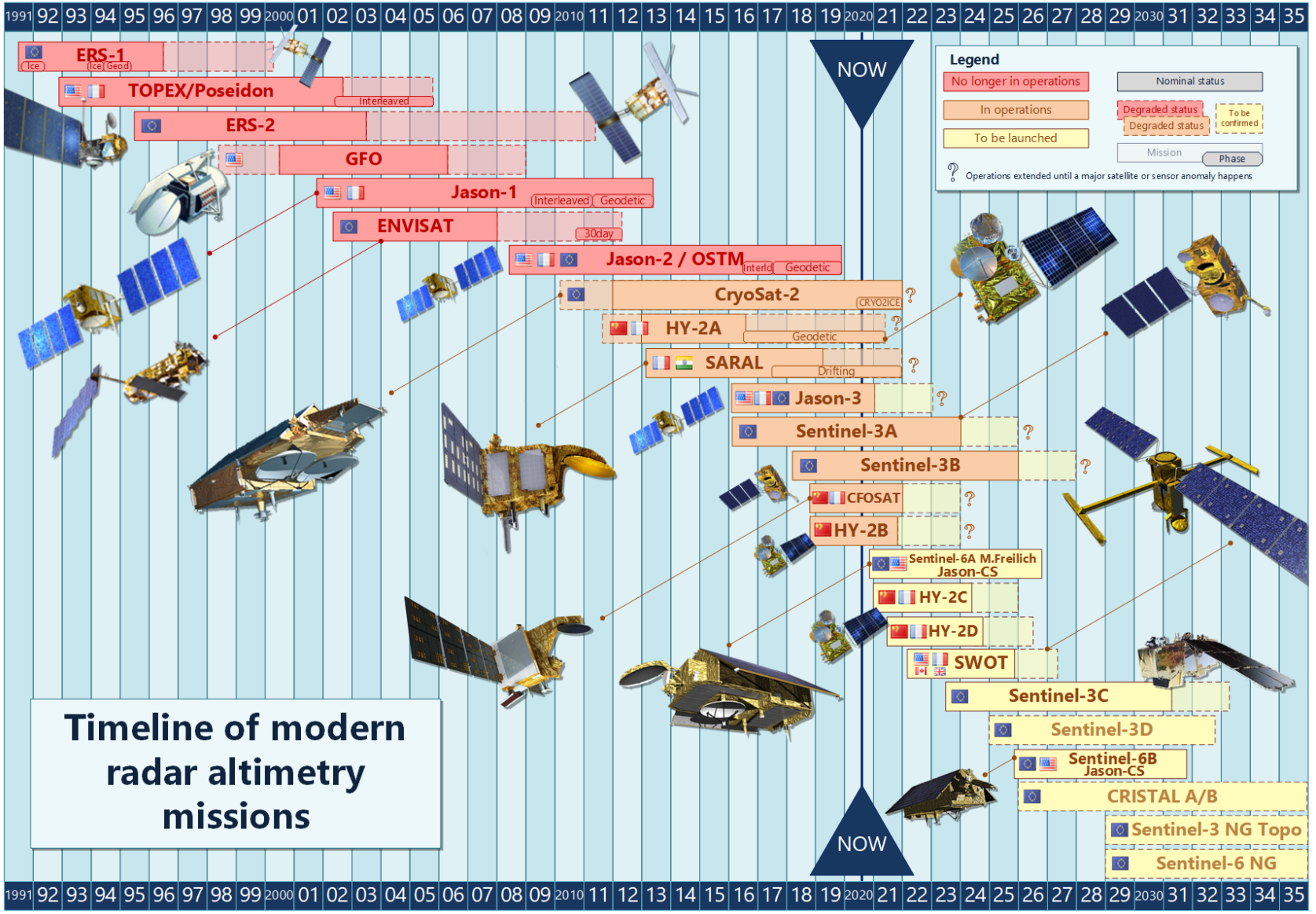
Altimetry since 1990s



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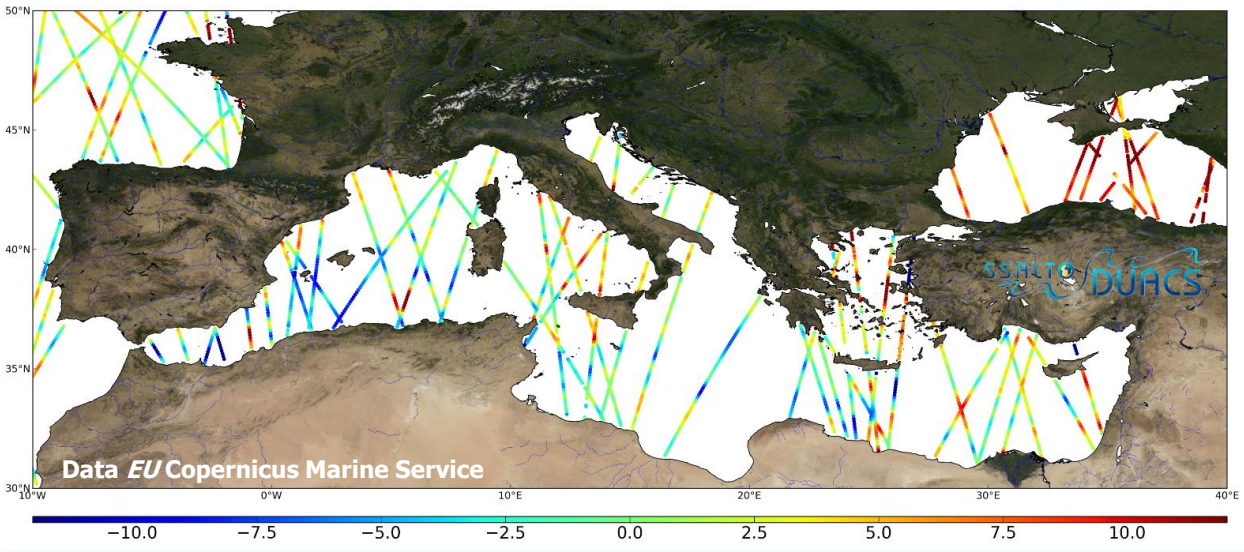

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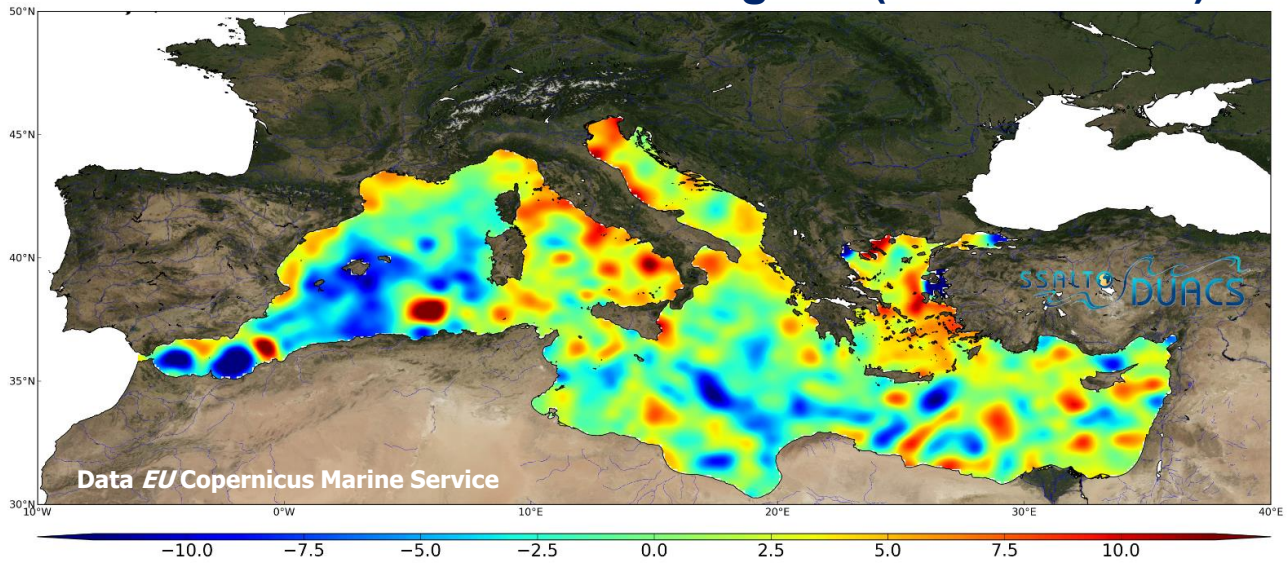
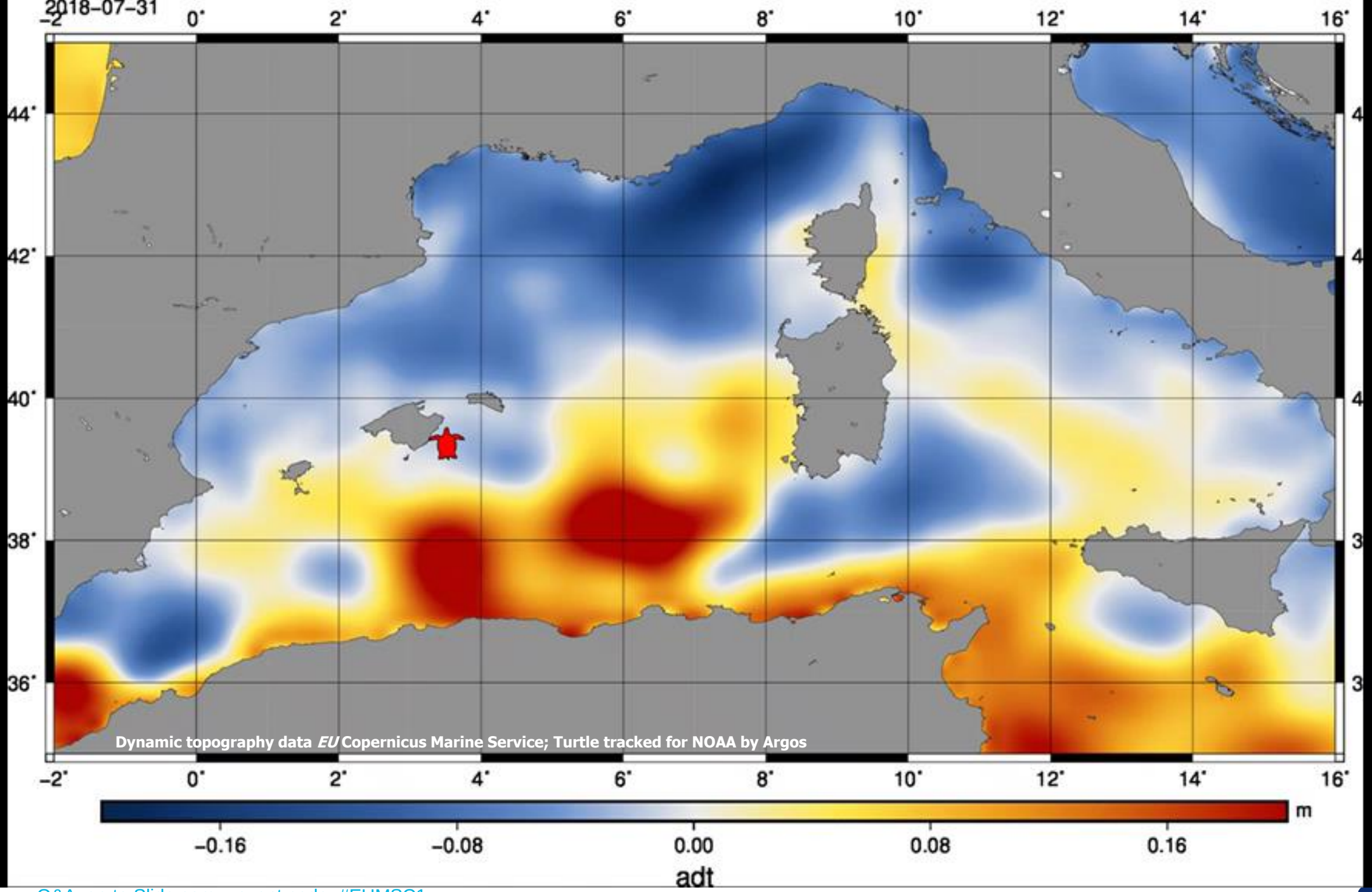


Some use cases

Follow Vita, the loggerhead turtle

- Marine animals live in an environment of currents, temperature and nutriments

- The satellite tracks can show correlations with satellite oceanography data – including sea surface heights and associated currents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Dynamic topography data *EU* Copernicus Marine Service; Turtle tracked for NOAA by Argos
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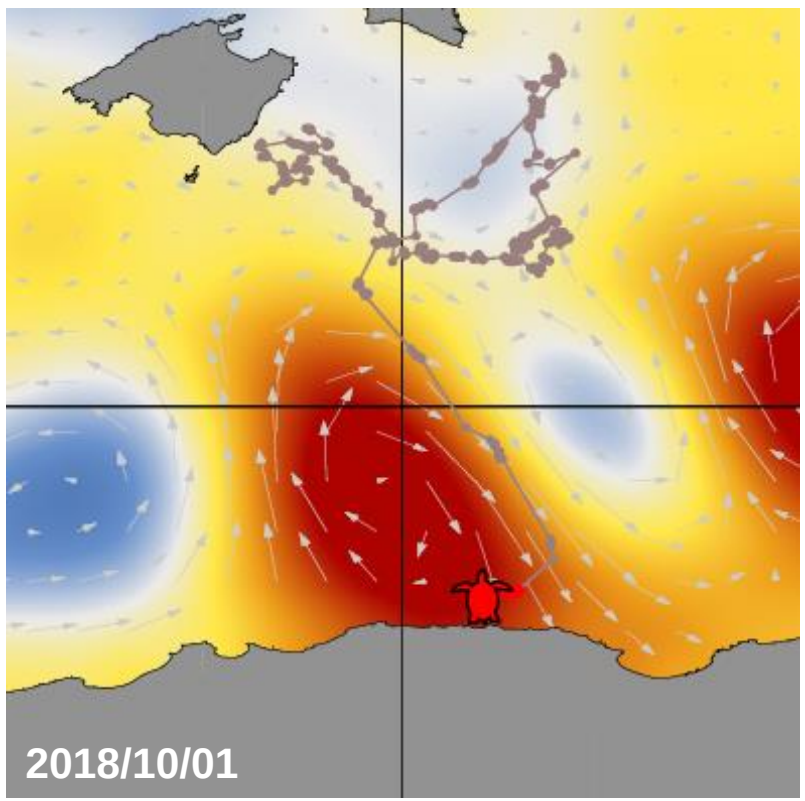
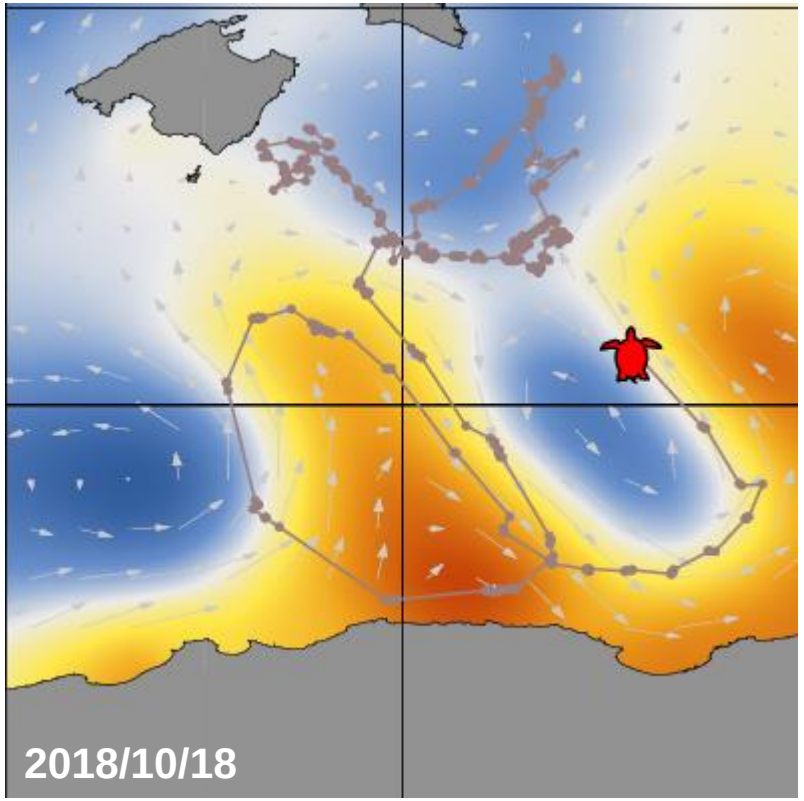
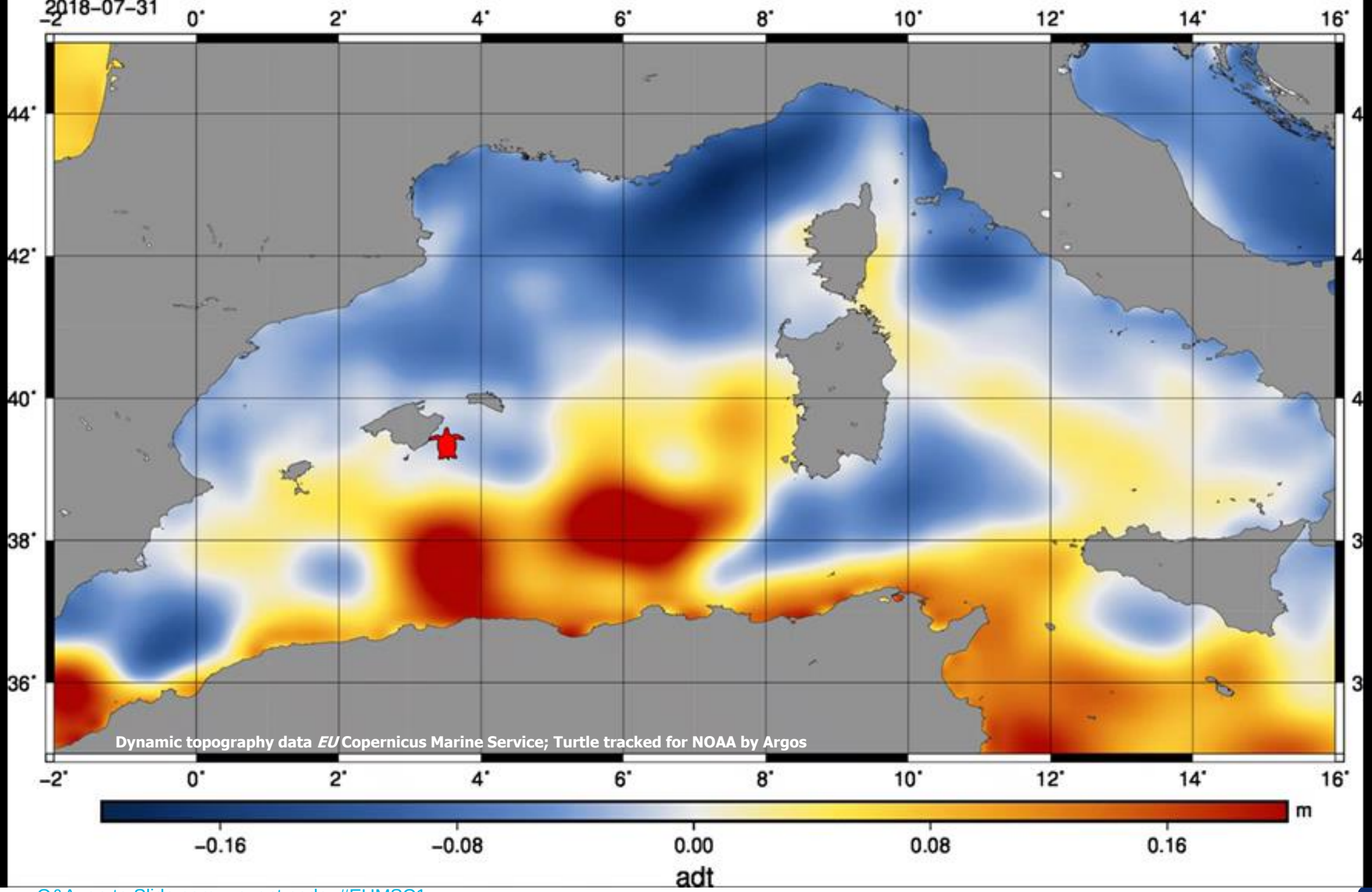
Follow Vita, the loggerhead turtle





Dynamic topography data *EU* Copernicus Marine Service; turtle tracked for Noaa by Argos

Q&A: go to Slido.com – event code: #EUMSC1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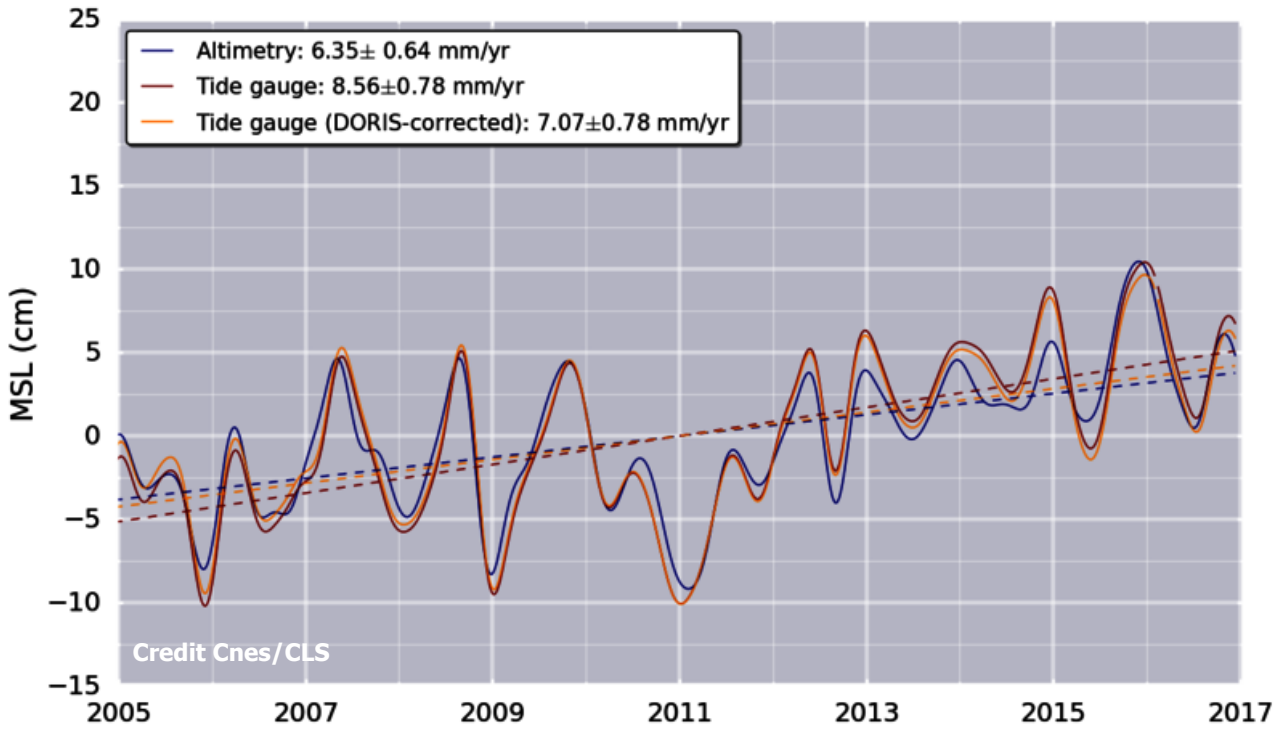
Sea Level at Miami (FL, USA)

Photo Miami Dade County

Photo Miami Dade County

Sea Level at Miami (FL, USA)

- NB. you need to know alsc the land vertical moves (GPS gauge, Doris…) to assess possible problems
- Here land is going down by 1.5 mm/yr
- and sea level from altimetry is rising by 6.35 mm/yr



- Now it’s your turn to investigate the data