

ESA CLIMATE CHANGE INITIATIVE EXTENSION (CCI+)

Sea Level Project

Introduction

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Science Leader



**National
Oceanography Centre**
NATURAL ENVIRONMENT RESEARCH COUNCIL

Partners

Objectives of the CCI+ Sea Level Project

1. COASTAL SEA LEVEL

- Produce, validate and deliver consistent sea level time series in a series of selected coastal regions known for their vulnerability to climate change impacts, using reprocessed LRM satellite altimetry missions plus SAR altimetry on Sentinel 3A&3B
- Estimate the rate of sea level change at the coast over the altimetry era
- building-up on previous projects (ESA SL_cci and SL_cci 'Bridging Phase' projects)

2. CCI-BASED SEA LEVEL PRODUCTS UNCERTAINTIES

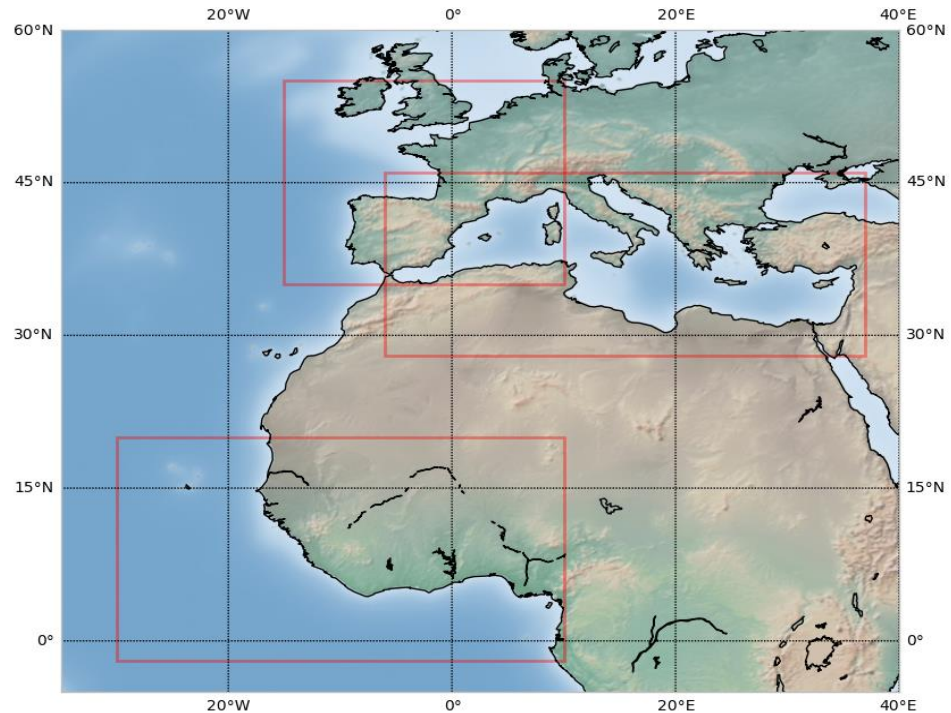
- Characterization and reduction of errors affecting sea level products from global to coastal scales

CCI+ Sea Level Project: Part 1 'Coastal Sea Level'



Preliminary results on coastal sea level trends from the ESA CCI « Bridging Phase » project (2017/18)

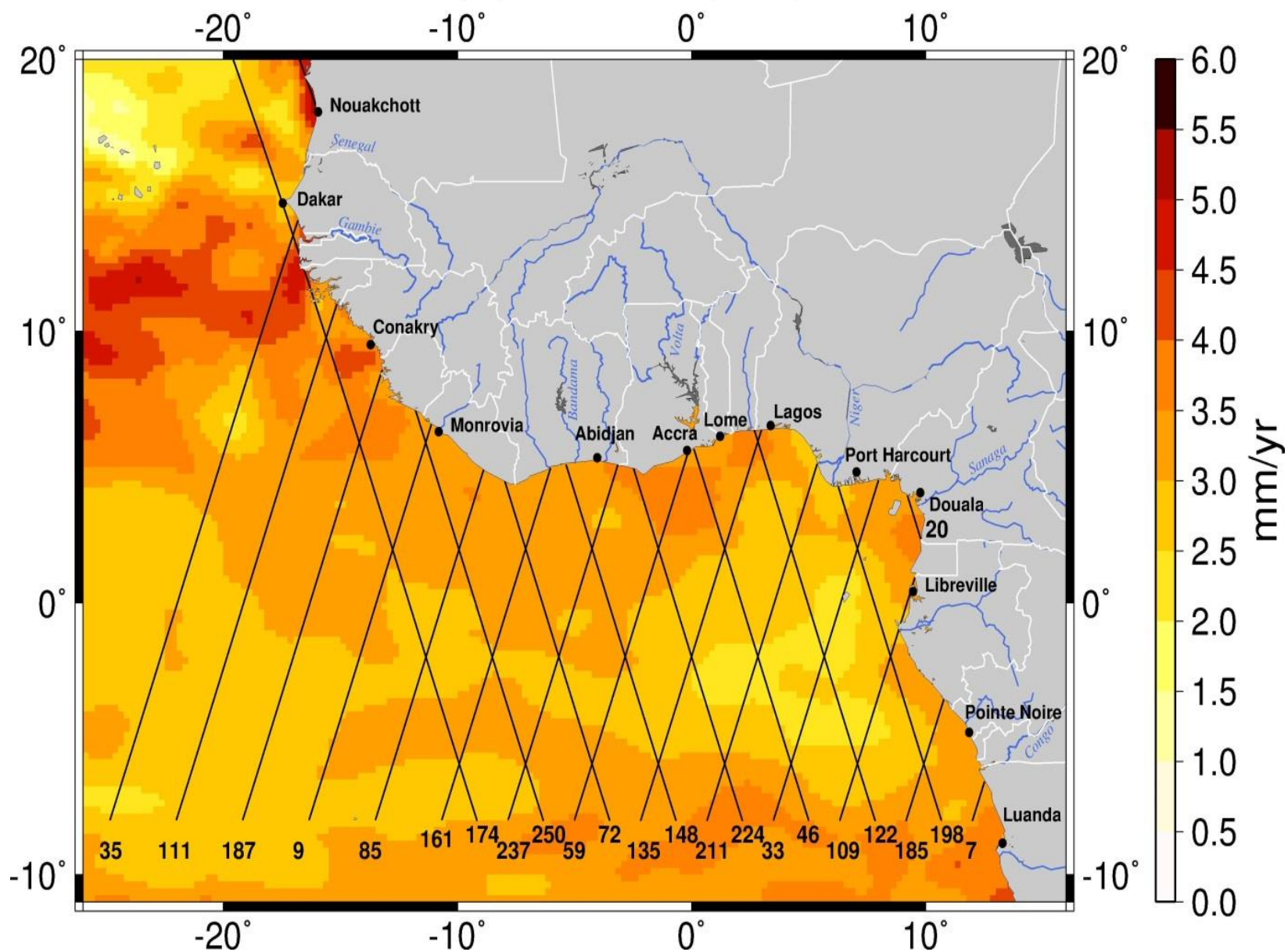
- Combination of ALES retracking with XTRACK 20-Hz sea level data
- Jason-1 + Jason-2 missions (2002-2016)
- 3 pilot regions



Partners



Sea level trends (July 2002 - June 2016) - C3S product + Jason tracks



Coastal sea level rise in Western Africa from 'reprocessed' nadir altimetry

J1+J2 SLA trends

Track 020

July 2002 - June 2016

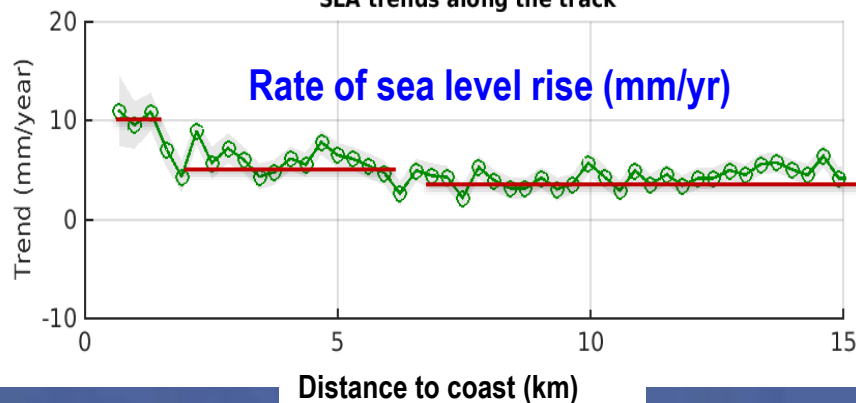


mm/yr (a)

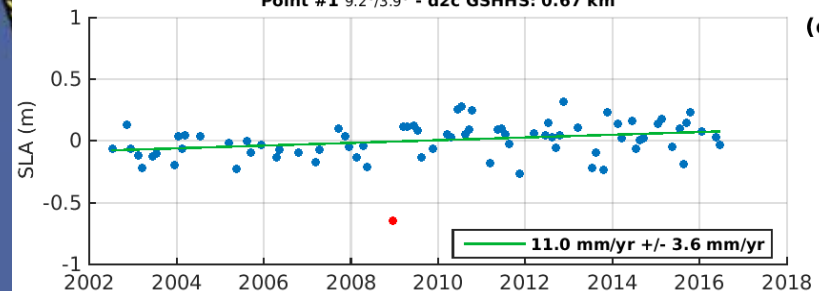
Cameroun

700 m from the coast

SLA trends along the track



Point #1 9.2°/3.9° - d2c GSHHS: 0.67 km



Google Earth

Image Landsat / Copernicus

Image © 2018 DigitalGlobe

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

10 km

ESA Climate Change Initiative (CCI) Sea level Project, 2019

J1+J2 SLA trends

Track 237

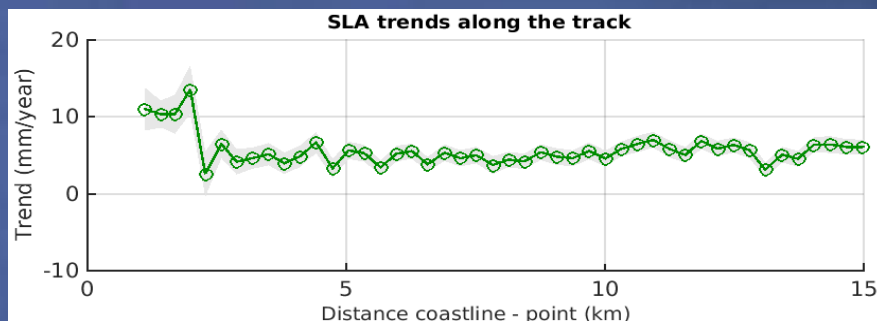
July 2002 - June 2016



mm/yr (a)

Ivory coast

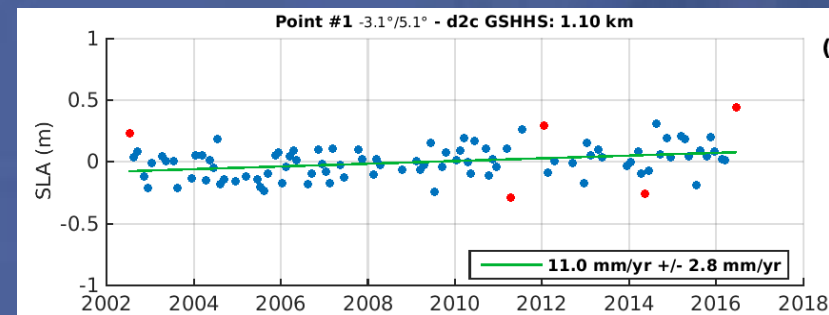
1.1 km



Google Earth

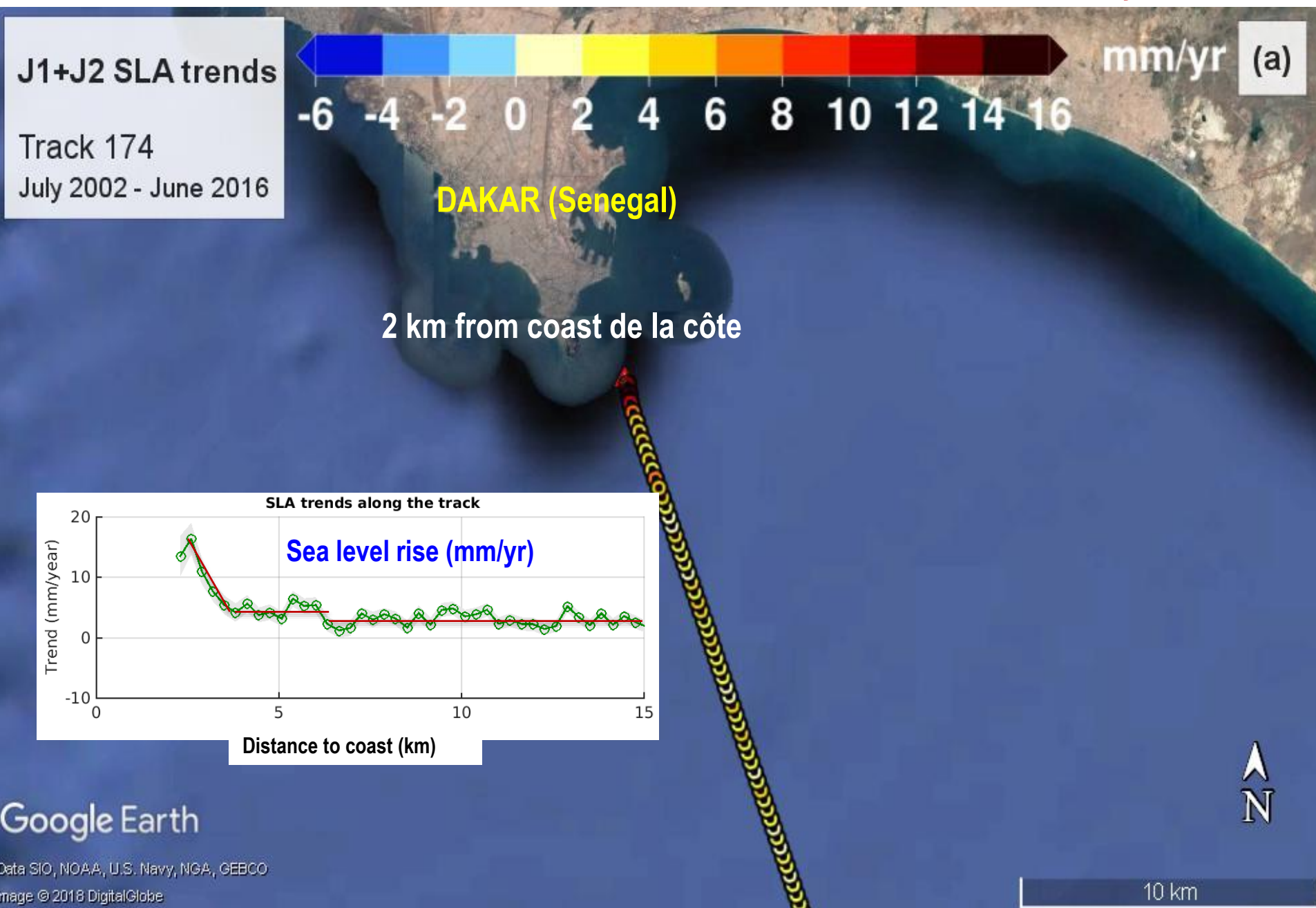
Image © 2016 CNES / Airbus

Data SIO, NOAA, U.S. Navy, NGA, GEBCO



10 km

Coastal sea level rise in Western Africa from 'reprocessed' nadir altimetry



J1+J2 SLA trends

Track 211

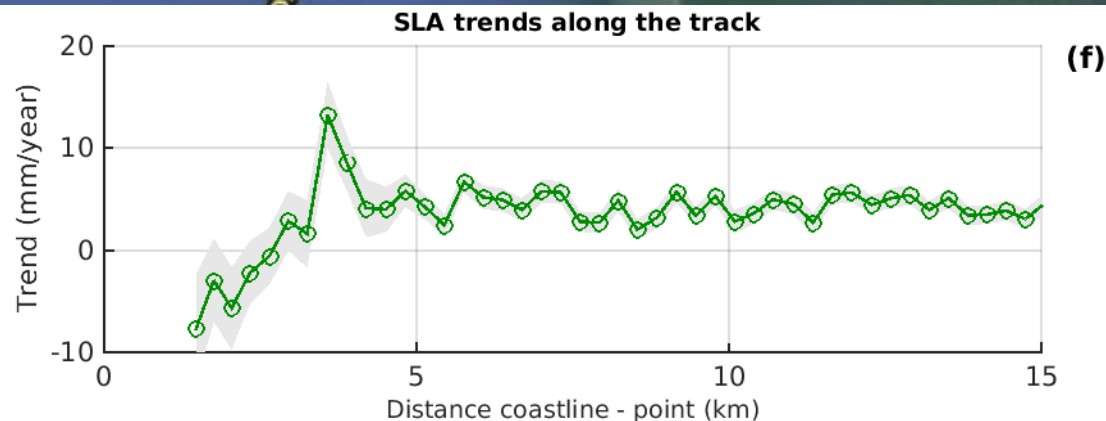
July 2002 - June 2016



Niger River delta

1.4 km

Nigeria



Google Earth

Image Landsat / Copernicus

Image © 2018 CNES / Airbus

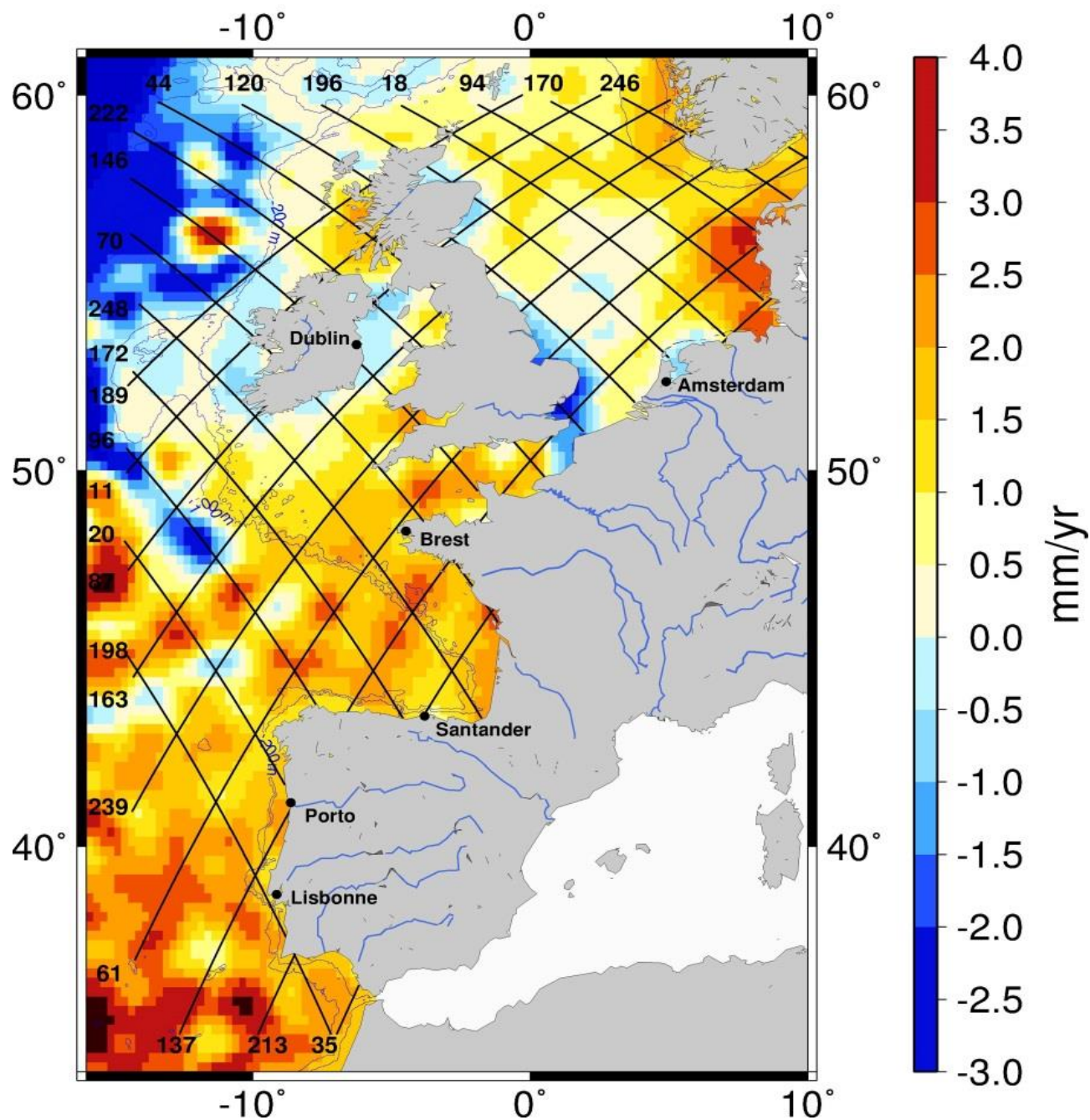
Data SIO, NOAA, U.S. Navy, NOAA, GEBCO

Image © 2018 DigitalGlobe



10 km

Sea level trends (July 2002 - June 2016) - C3S product



J1+J2 SLA trends

Track 198
July 2002 - June 2016

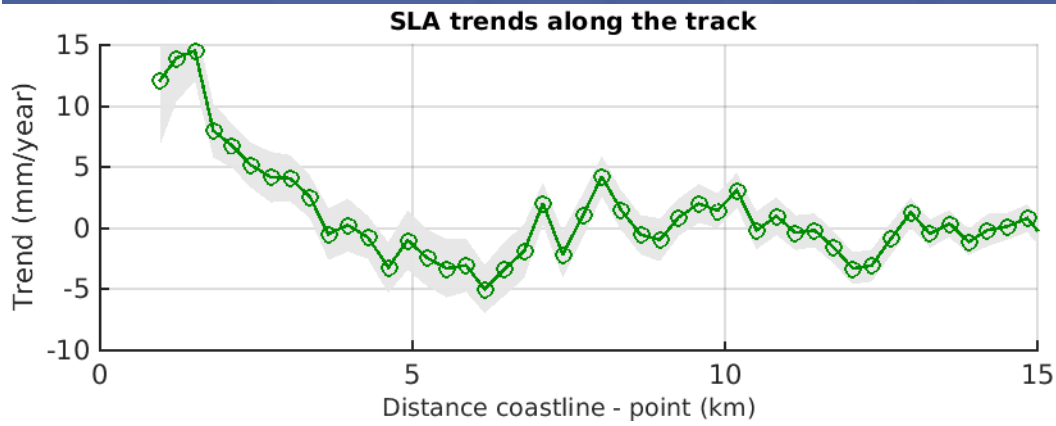


Portugal

<1 km



10 km



J1+J2 SLA trends

Track 213

July 2002 - June 2016



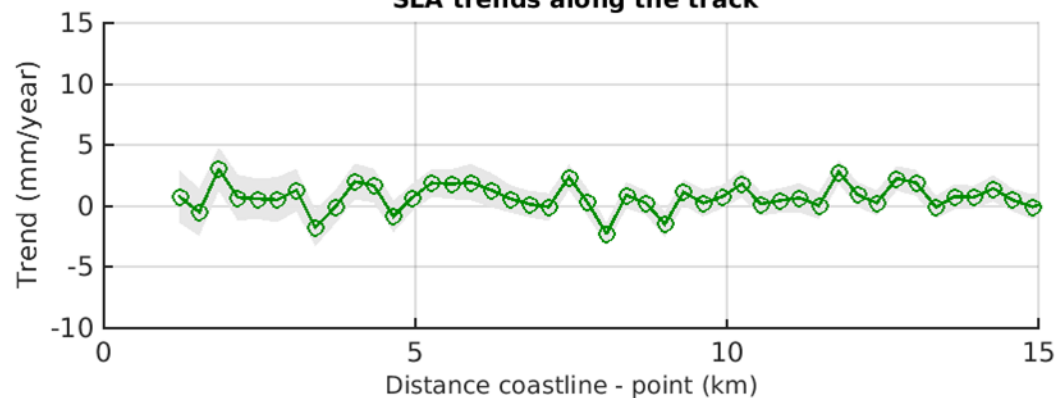
mm/yr (a)

16 14 12 10 8 6 4 2 0 2 4 6 8 10 12 14 16

Portugal

1.2 km

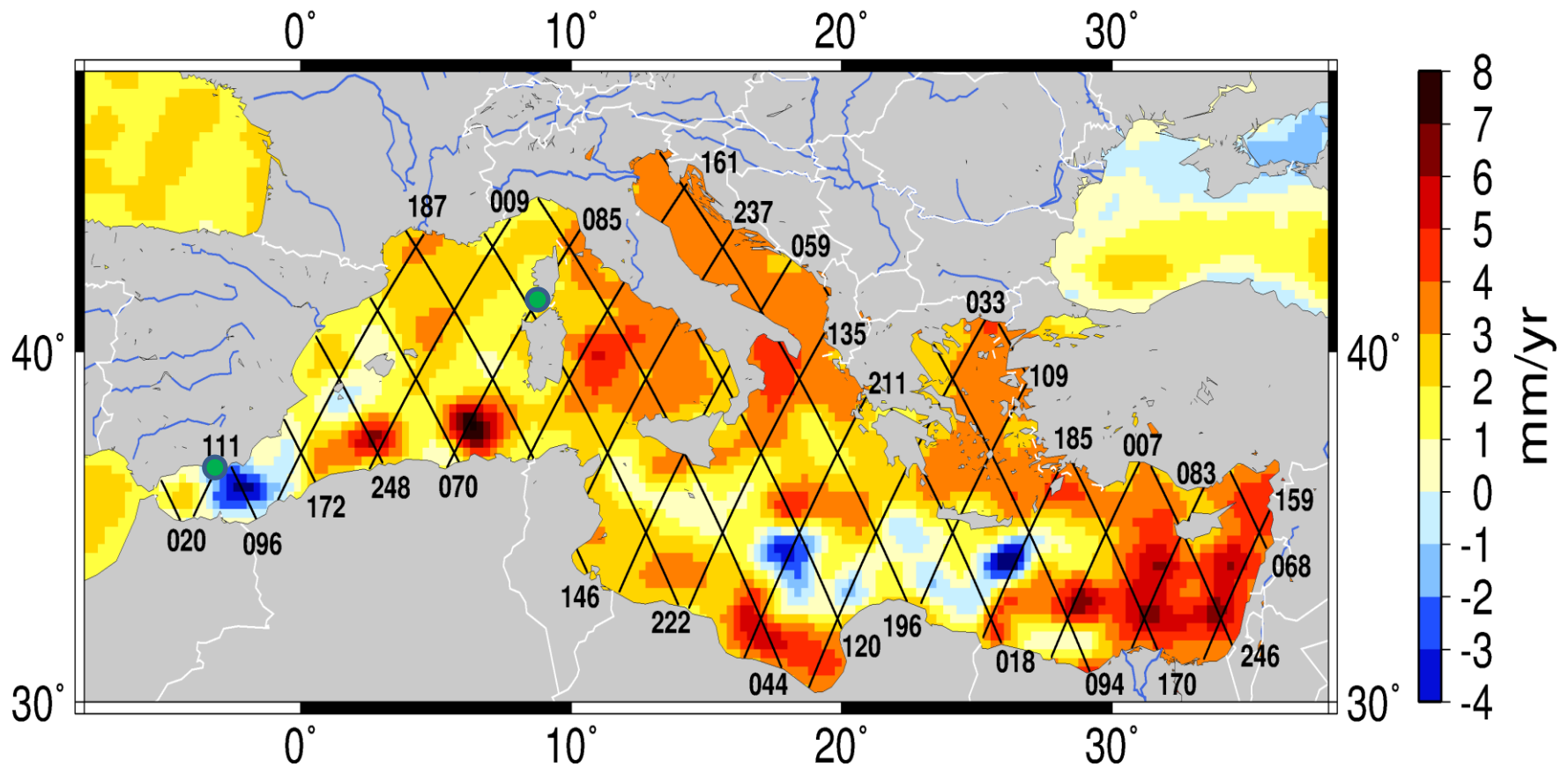
SLA trends along the track

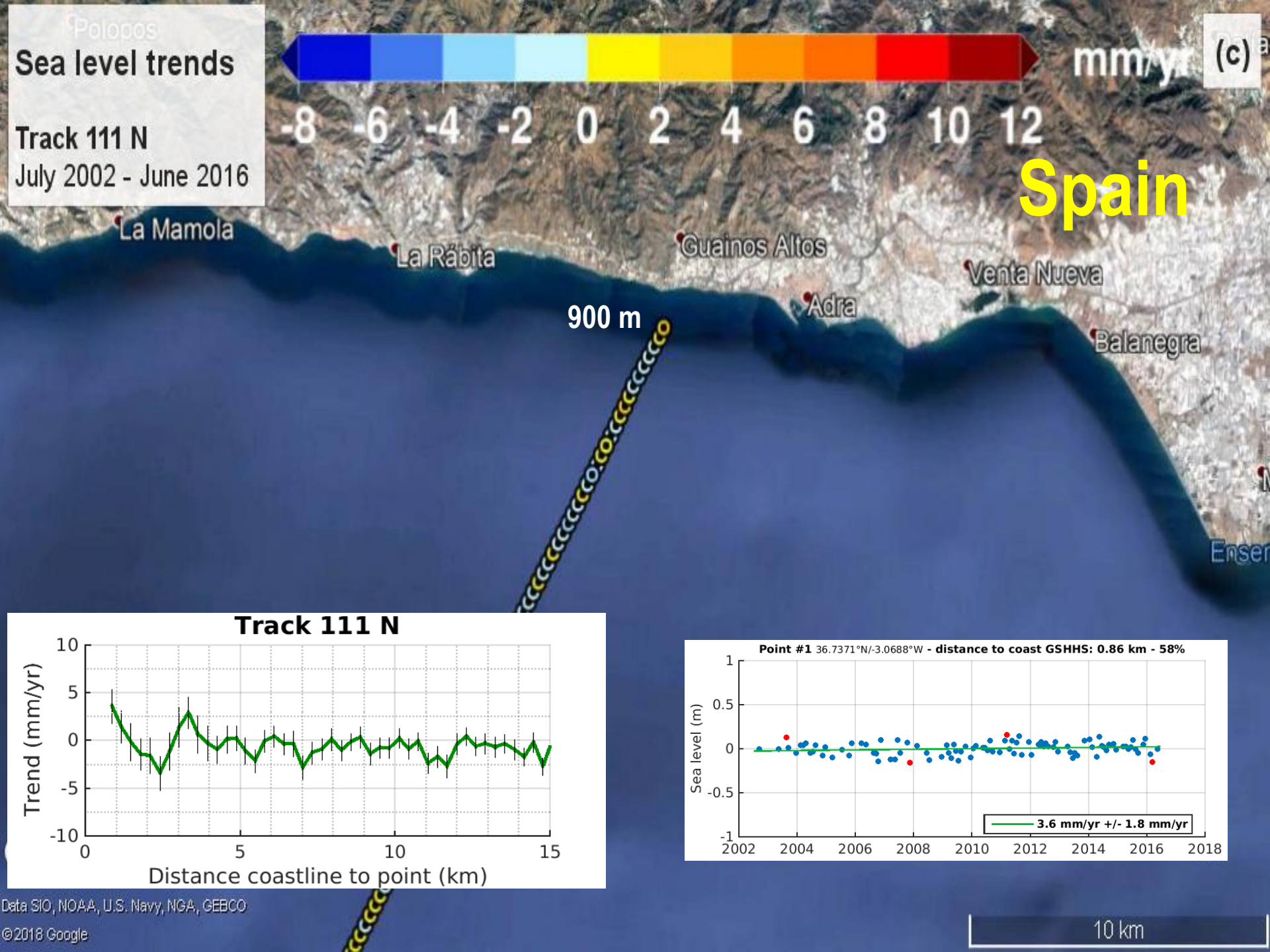


10 km

Coastal Sea Level Change in the Mediterranean Sea Jason Tracks Coverage

Sea level trends (July 2002 - June 2016) - C3S product





Sea level trends

Track 085 #2 N
July 2002 - June 2016



Corsica

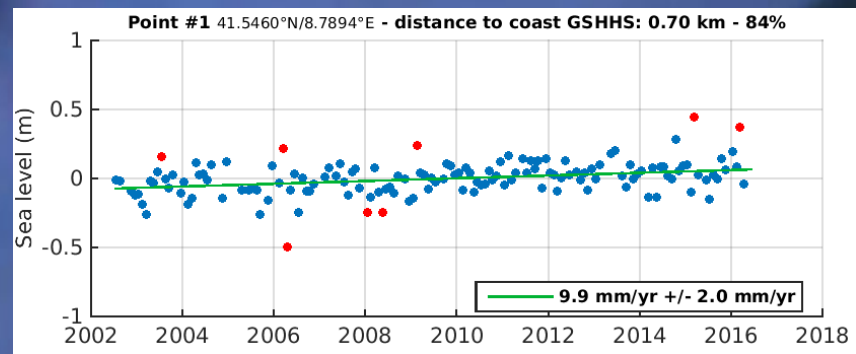
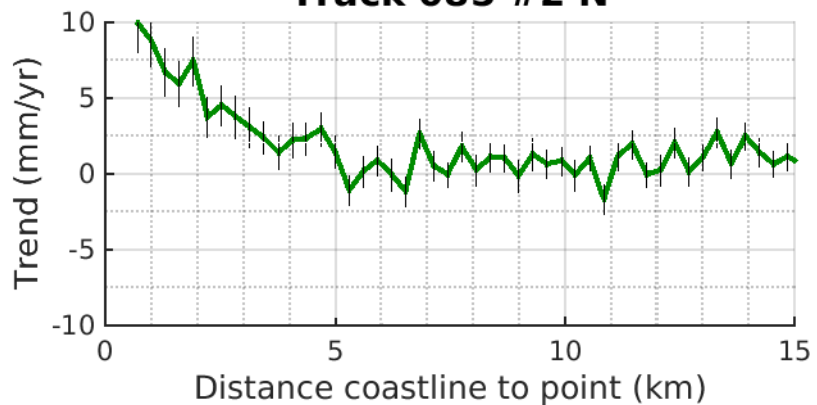
700 m

Cala d'Avena

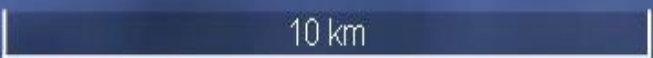
Golfe de Murtoli

Golfe de Roccapi

Track 085 #2 N



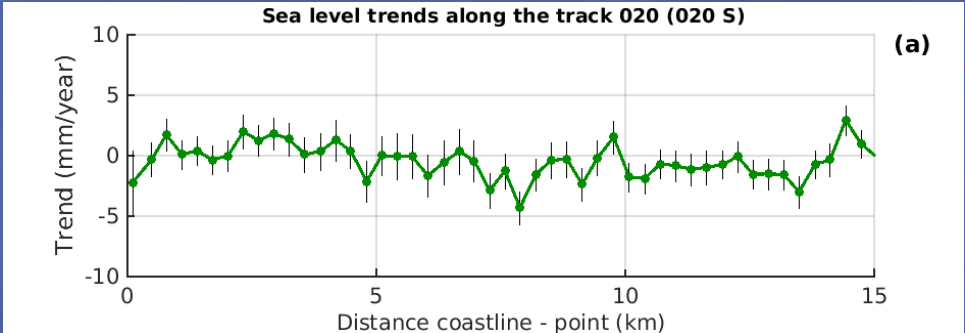
Google Earth



Sea level trends

Track 020 S

July 2002 - June 2016



Morocco

Oued S' Fetch

100 m

Oued Bades

Google Earth

© 2018 Google

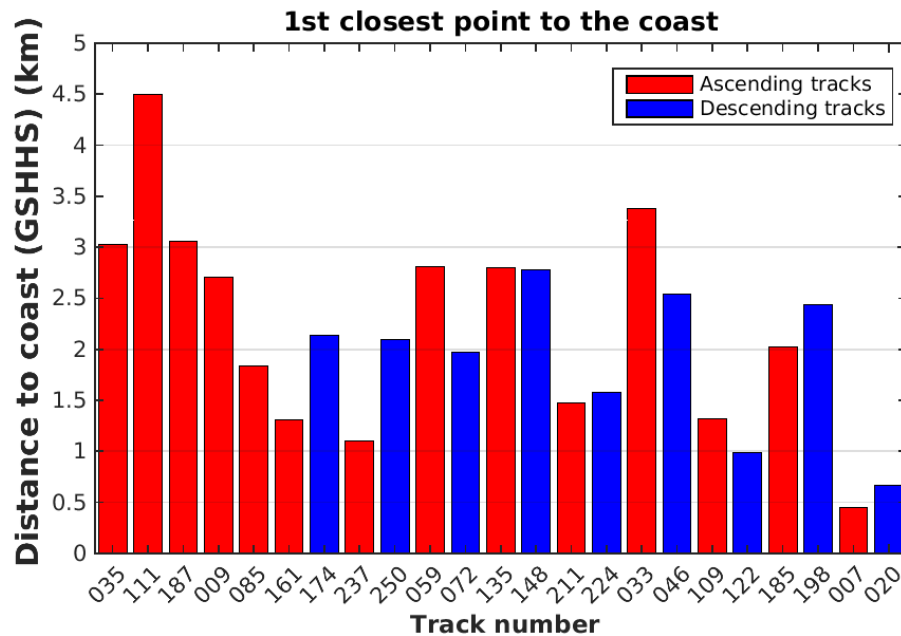
Map Data © 2018 AHD

Data SIO, NOAA, U.S. Navy, MGA, GEBCO

Image © 2019 CNES / Airbus

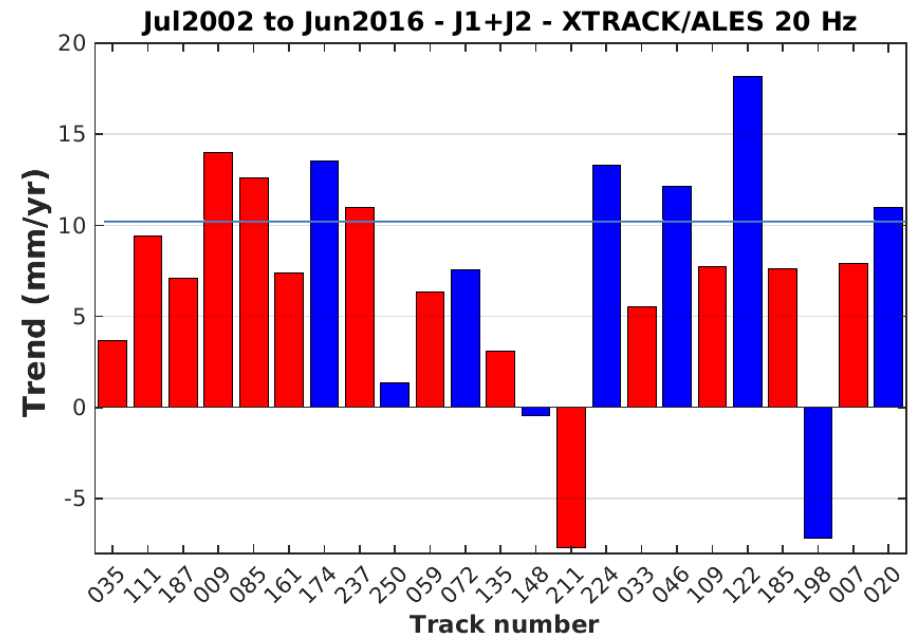


10 km



Distance to coast (km)

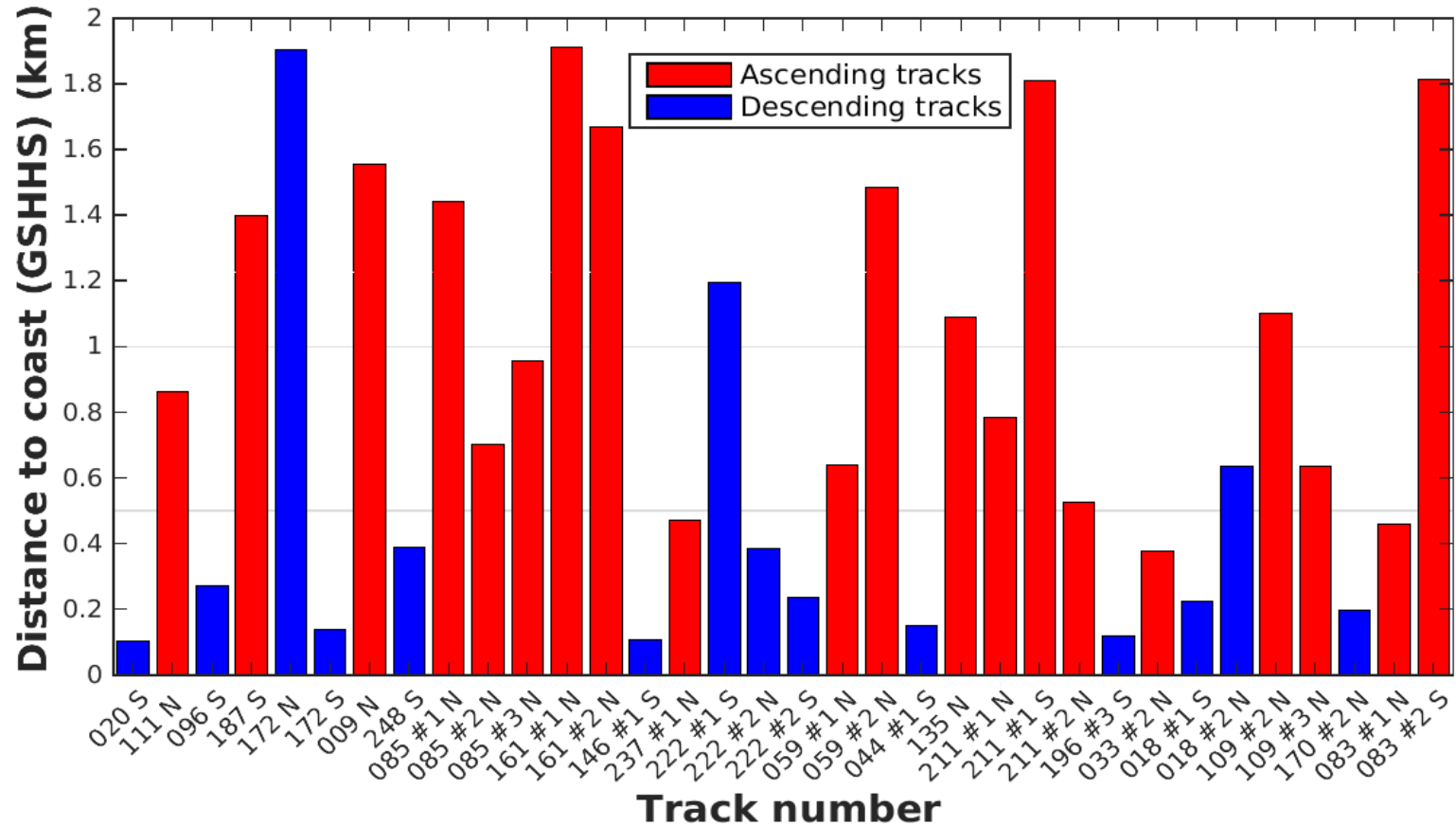
13 valid coastal points (over 23)
at distance <2 km from coast



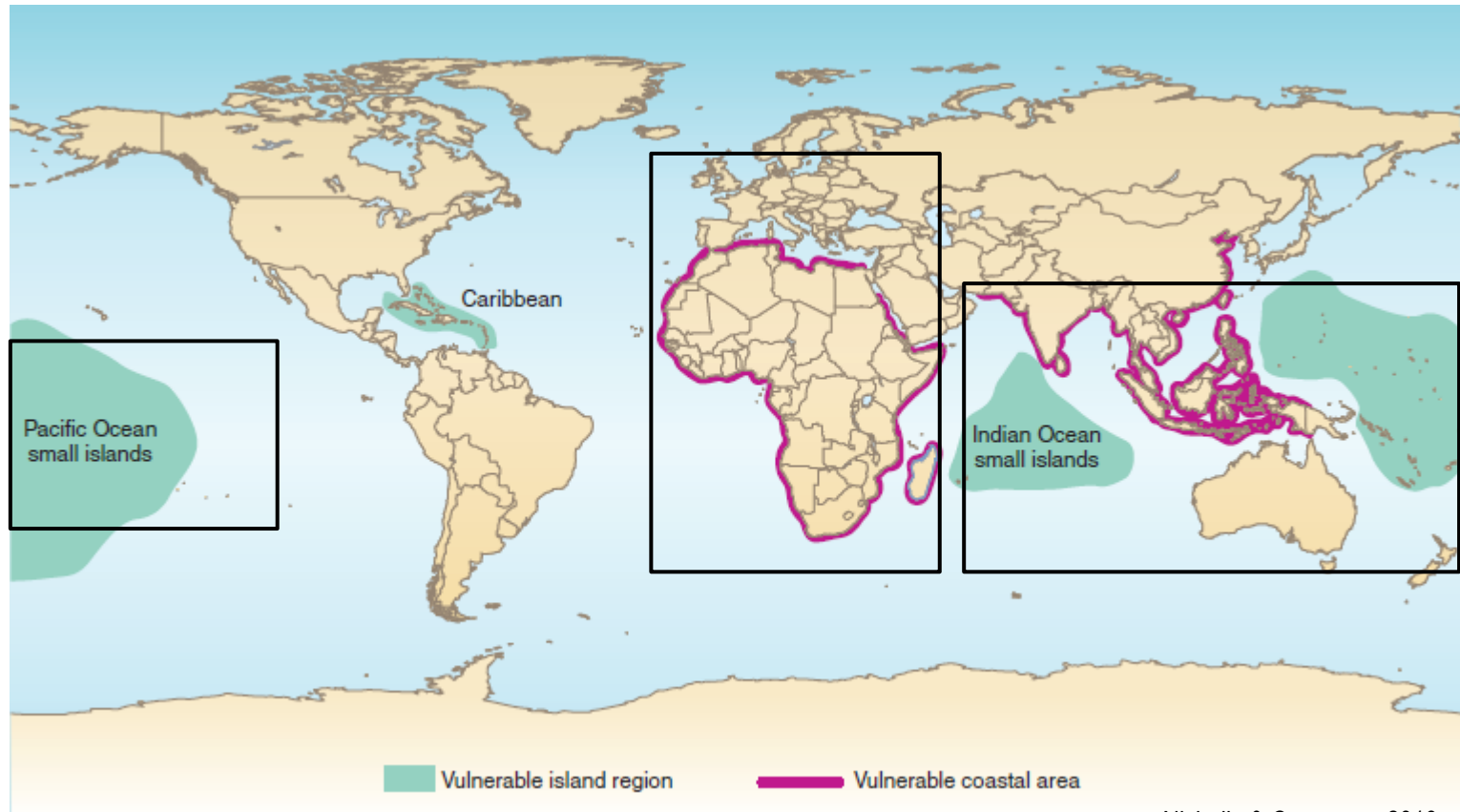
Computed trend at the closest point to coast (mm/yr)

Mediterranean Sea

Distance to coastline of the closest valid point



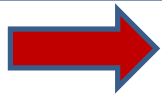
Proposed study regions in the CCI+ Sea Level Project



Nicholls & Cazenave, 2010

- LRM missions (Jason-1/2/3; Envisat; Saral/Altika) + SAR on Sentinel 3A & 3B
- « Seamless » gridded trends from open ocean to coast
- 2002 - present

- **Validation with tide gauges**
- **Interpretation**



Explain observed trends in the coastal zone

- **Trends in waves**
- **Fresh water input from rivers**
- **Small scale currents**
- **.....**

- **Comparison with high-resolution ocean reanalyses**

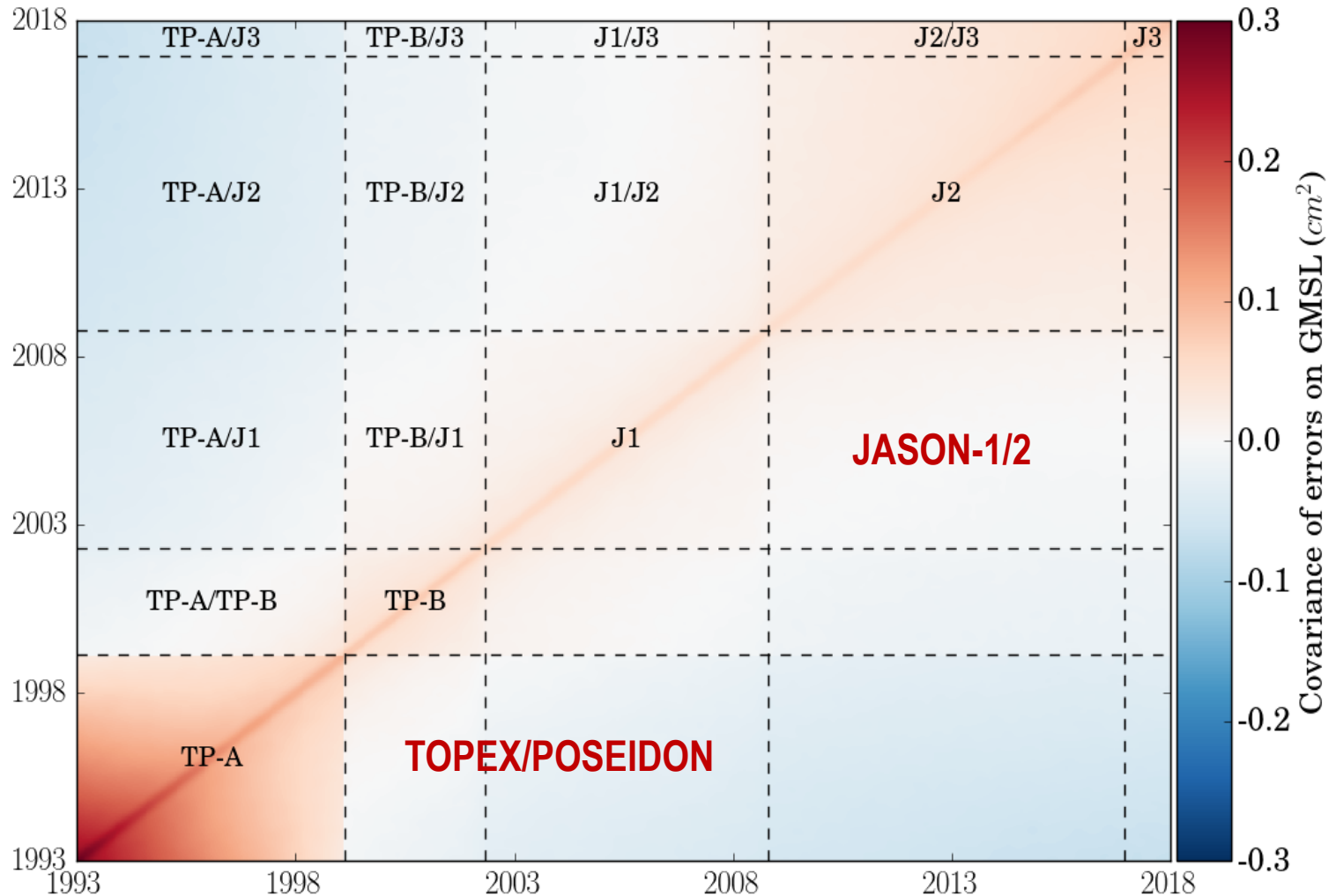
CCI+ Sea Level Project: Part 2 on 'Uncertainties'

**Uncertainty in the estimate of
Global Mean Sea Level changes, trend and acceleration
(Ablain et al., ESSD, 2019)**

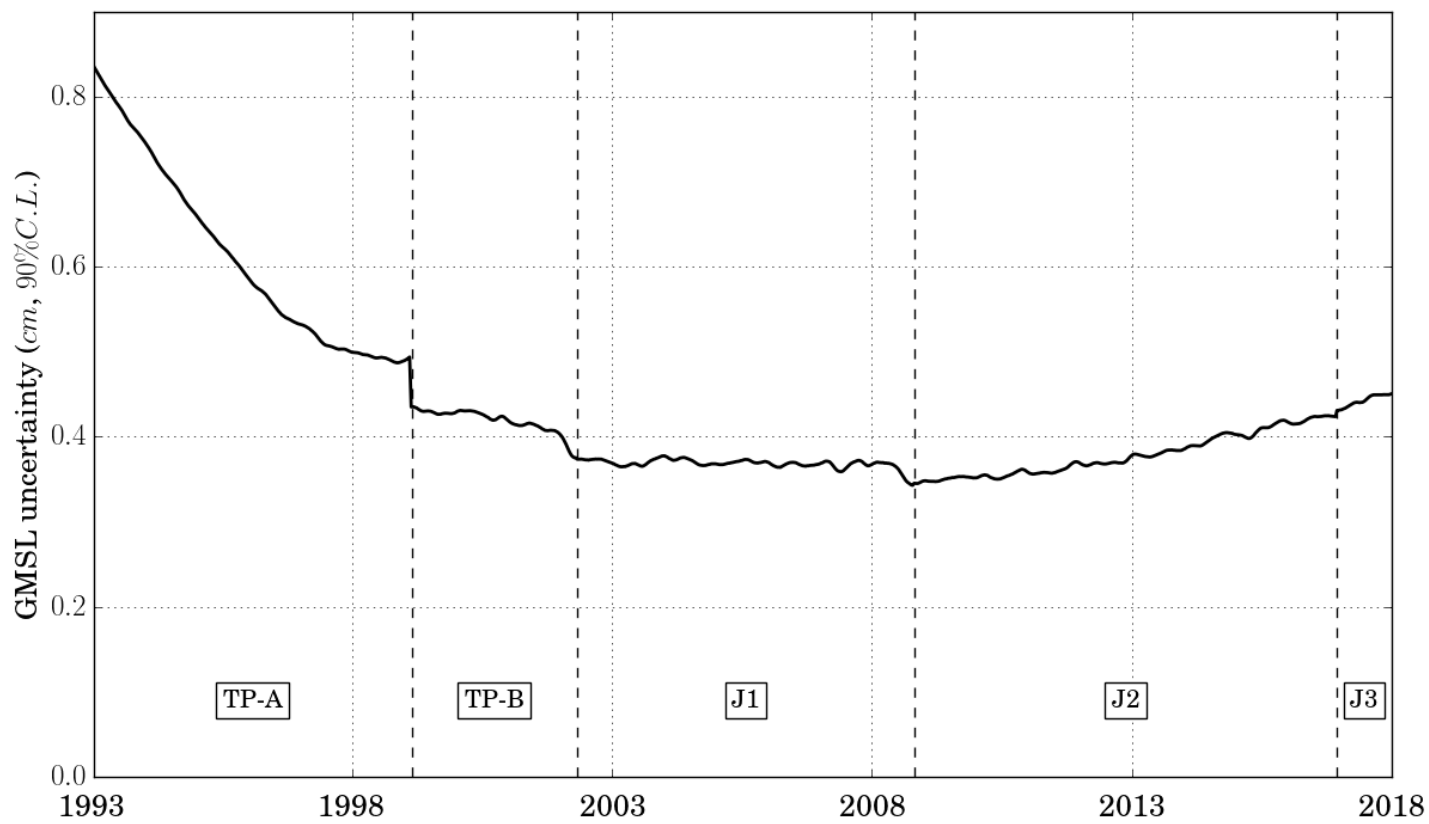
→ Quantification of the total **Error Budget** of the altimetry system for the different missions (empirical models used for each type of error)

- **TOPEX A Altimeter drift**
- **Long term orbit errors**
- **GIA secular uncertainty**
- **Interannual/decadal orbit errors**
- **Wet tropospheric error (interannual time scale)**
- **Seasonal & subseasonal errors in geophysical corrections**
- **Bias error due to imperfect link between successive altimetry missions**

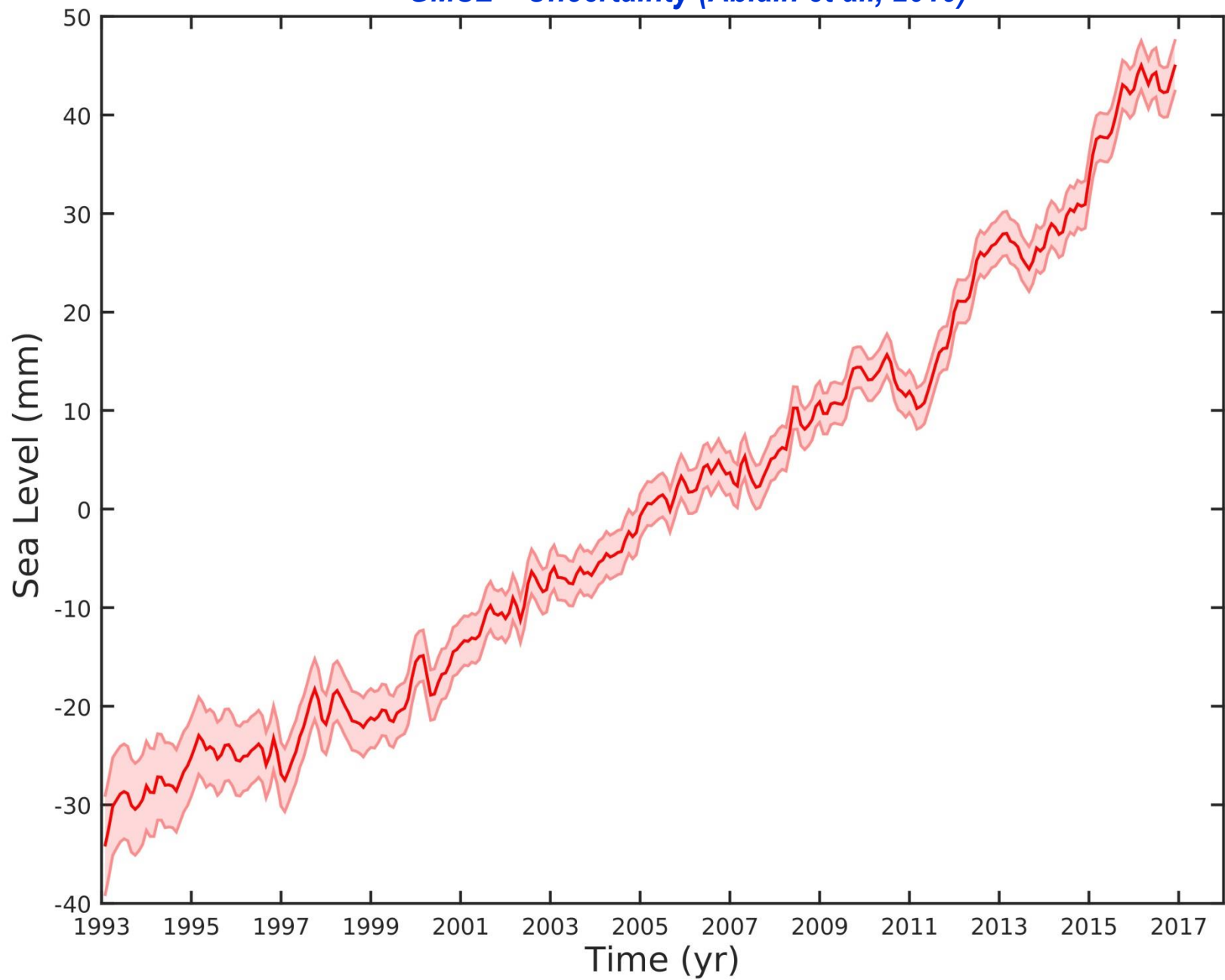
Uncertainty of the altimetry-based GMSL time series



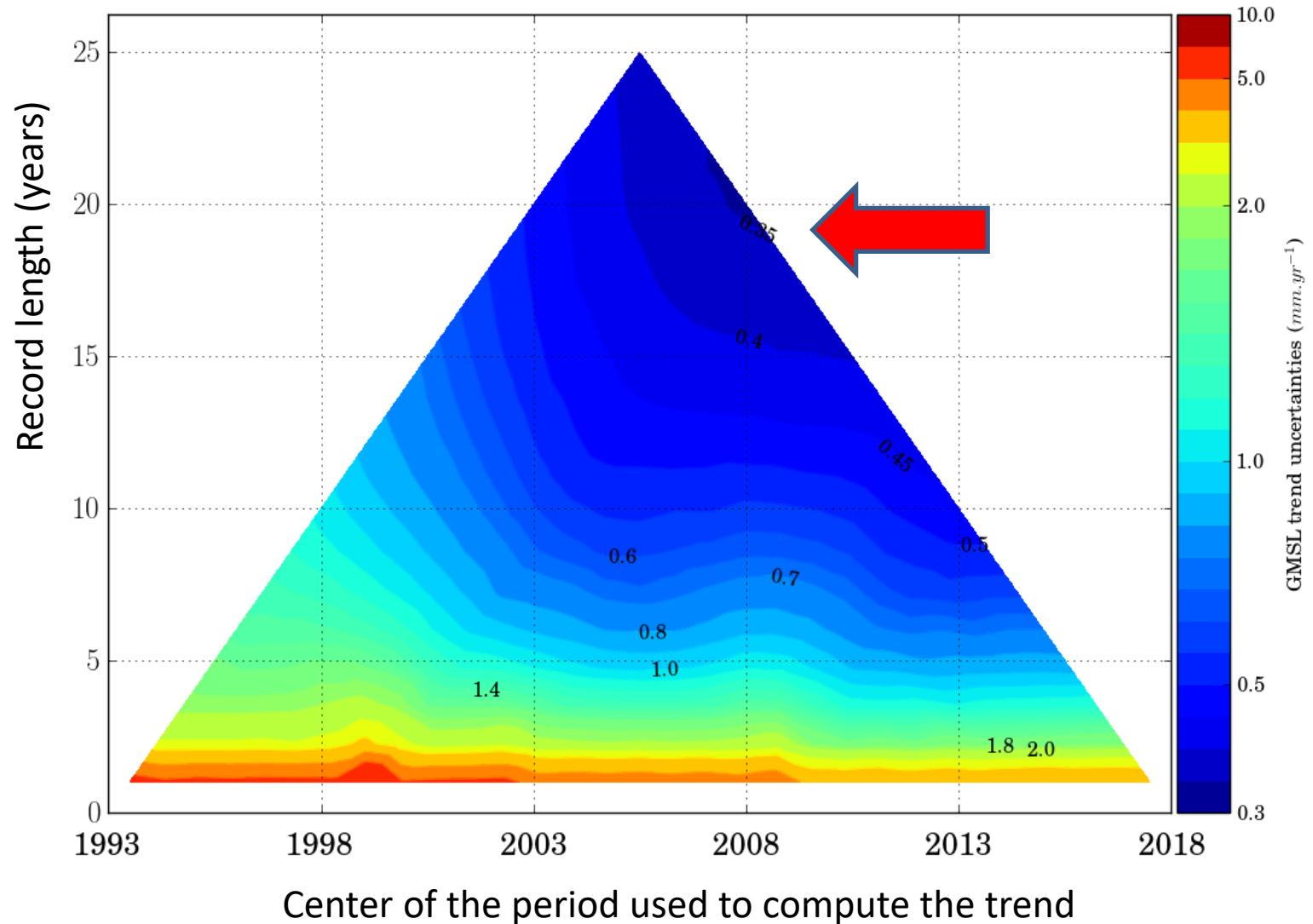
Error variance-covariance matrix of altimeter GMSL on the 25-years period (January 1993 to December 2017).



GMSL + Uncertainty (Ablain et al., 2019)

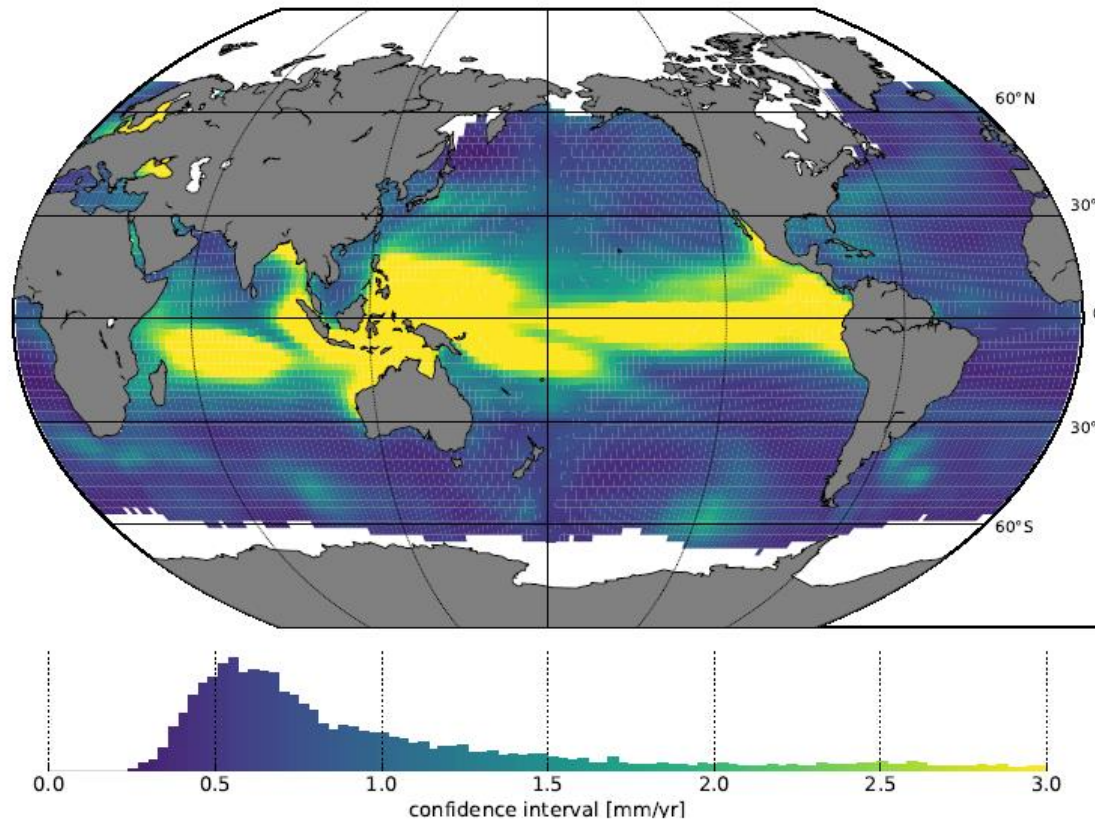


Uncertainty in the estimate of the GMSL trend



GMSL trend uncertainty (mm/yr) estimated for different record lengths over the 25-year-long time span (January 1993 to December 2017). The confidence level is 90 % (i.e. 1.65σ).

Errors in regional sea level trends



Very preliminary sea level trend uncertainties (mm/yr) estimated for the altimetry 25-years period (January 1993 to December 2017). The confidence level is 90 % (i.e. 1.65σ).

More in WP4 presentation (Pierre Prandi & Benoit Meyssignac)