Coastal sea level time series and trends from reprocessed Jason altimetry (2002-2018)

Yvan Gouzènes[1] and The Climate Change Initiative Coastal Sea Level Team

The Climate Change Initiative Coastal Sea Level Team
Jérôme Benveniste[1] , Florence Birol[2] , Francisco Calafat[3] , Anny Cazenave[2,4], Habib Dieng[2,5] , Yvan Gouzenes[2] , Jean François Legeais[6] , Fabien Léger[2] , Fernando Niño[2] ,Marcello Passaro[7], Christian Schwatke[7] & Andrew Shaw[8]

[1] ESA/ESRIN, Frascati, Italy. [2] LEGOS, Toulouse, France. [3] NOC, Liverpool, UK. [4] ISSI, Bern, Switzerland. [5] OceanNext, Grenoble, France. [6] CLS, Ramonville St Agne, France. [7] TUM, Munich, Germany. [8] SKYMAT, Southampton, UK.

ESA CLIMATE CHANGE INITIATIVE EXTENSION (CCI+)

The Coastal Sea Level Project (2019-2022)

4 Partners →

CLS · LEGOS · TECHNISCHE UNIVERSITÄT MÜNCHEN · National Oceanography Centre, NATURAL ENVIRONMENT RESEARCH COUNCIL

Objectives of the project:

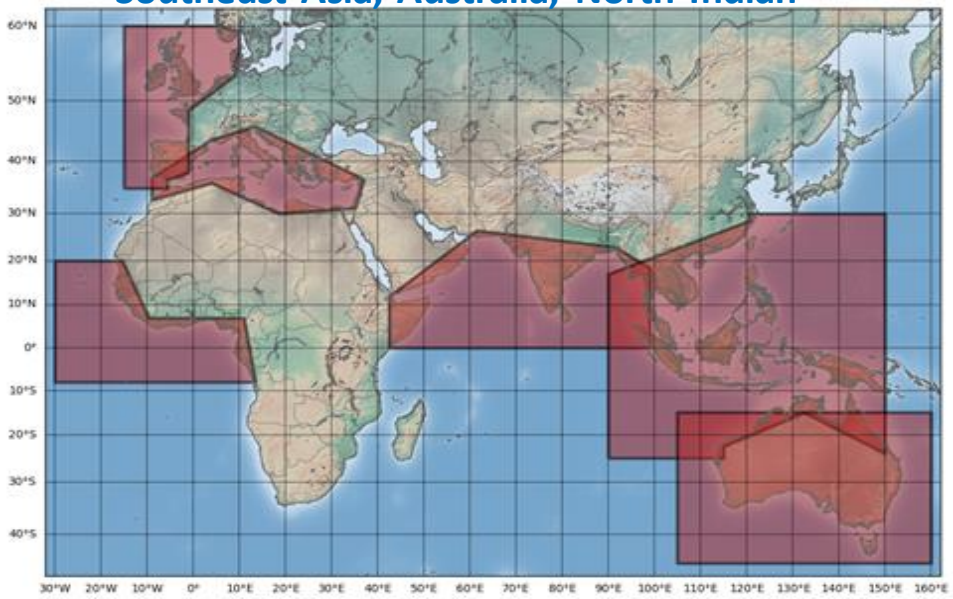
- Produce, validate and deliver consistent sea level time series in several coastal regions worldwide over the altimetry era
- Compute sea level trends as close as possible to the coast in order to answer the question :

" Is sea level at the coast rising at the same rate as in the open ocean?"

- Does the answer depend on sites?
- If differences are observed, what are the causes?

6 regions considered:

Western Europe, Mediterranean Sea, Western Africa, Southeast Asia, Australia, North Indian



1. Aproach

➢ Use of ALES (Adaptative Leading Edge Subwaveform) retracking

- developed by Passaro et al. 2014 (TUM)
- + associated Sea State Bias (SSB) (Passaro et al., 2018)

➢ Use of X-TRACK processing system developed at LEGOS (CTOH; Birol et al., 2017)

➢ Missions reprocessed: Jason 1, Jason 2, Jason 3

➢ Resolution : 20 Hz along track (350 m)

➢ Period covered: June 2002 to May 2018: 16 years

➢ Selection of valid data between 0 and 20 km from the coast at 429 coastal sites

➢ Severe editing was performed in order to remove outliers (based on error, % of missing data, trend continuity between successive 20 Hz points, ...)

2. Outcome

- **429 coastal sites have been selected in the 6 studied regions at which reprocessed sea level time series and sea level trends along 20 km-long Jason tracks are provided at 300 m resolution over June 2002 – May 2018**

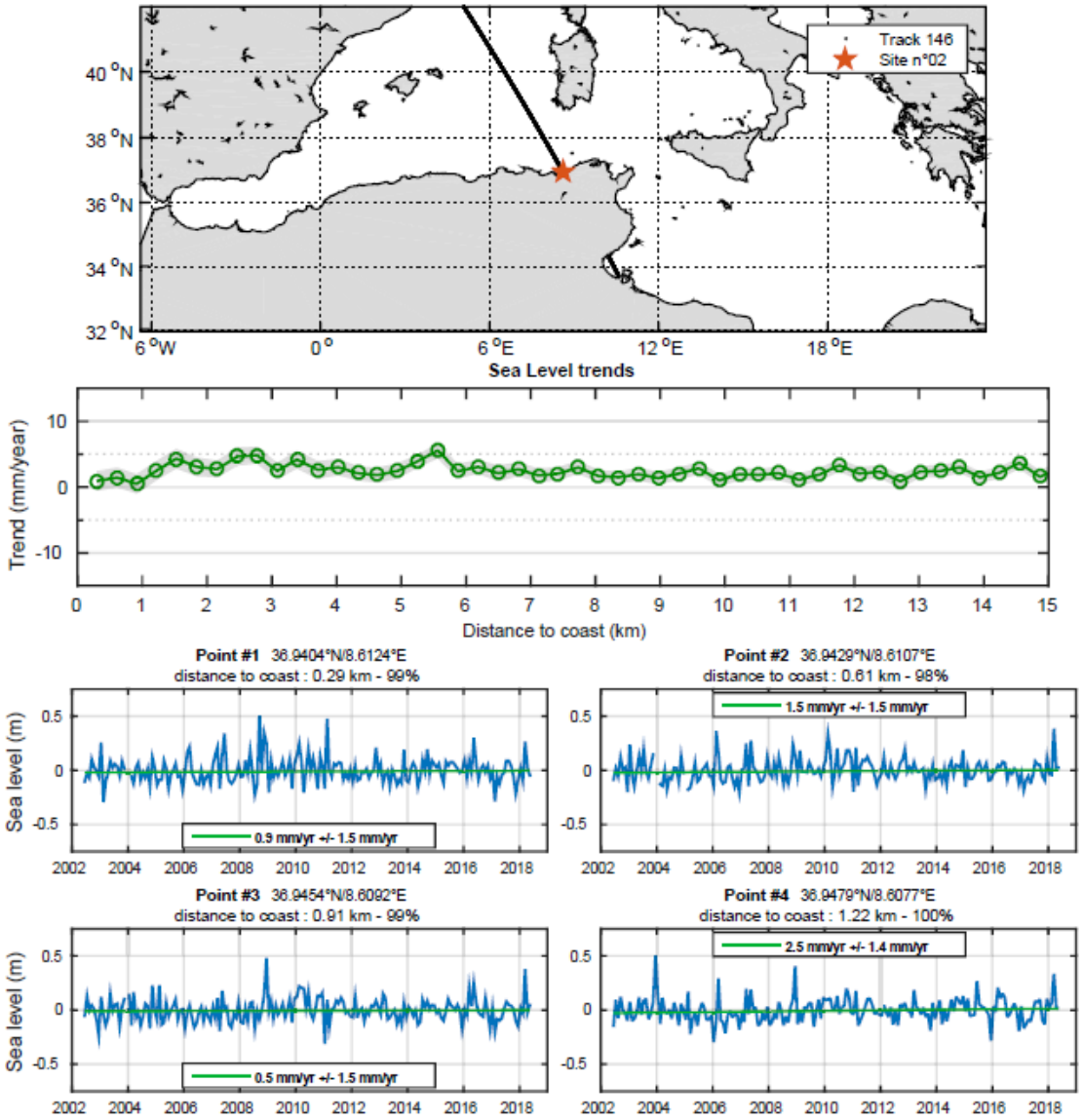
- **The corresponding data set is presented in the following article:**

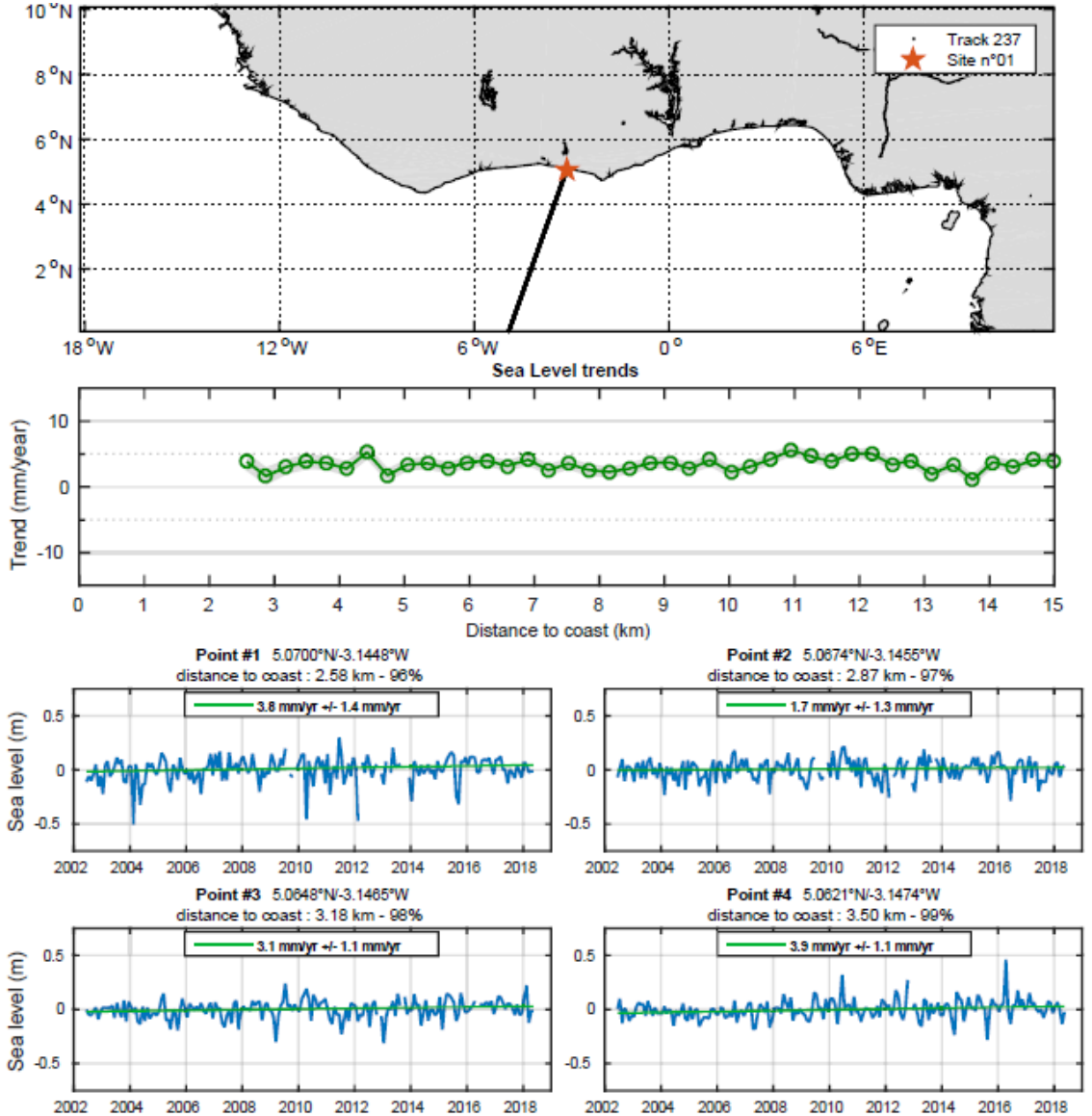
  The Climate Change Coastal Sea Level Team: A database of coastal sea level anomalies and associated trends from Jason satellite altimetry from 2002 to 2018, Nature Scientific Data, in press, SEANOE, https://doi.org/10.17882/74354, 2020.

3. A few examples (1/3)

A few examples of the results are presented below. The figures show from top to bottom, a map with the location of the selected site, the corresponding sea level trends against distance to the coast, and sea level anomaly time series of the 4 first points closest to the coast.

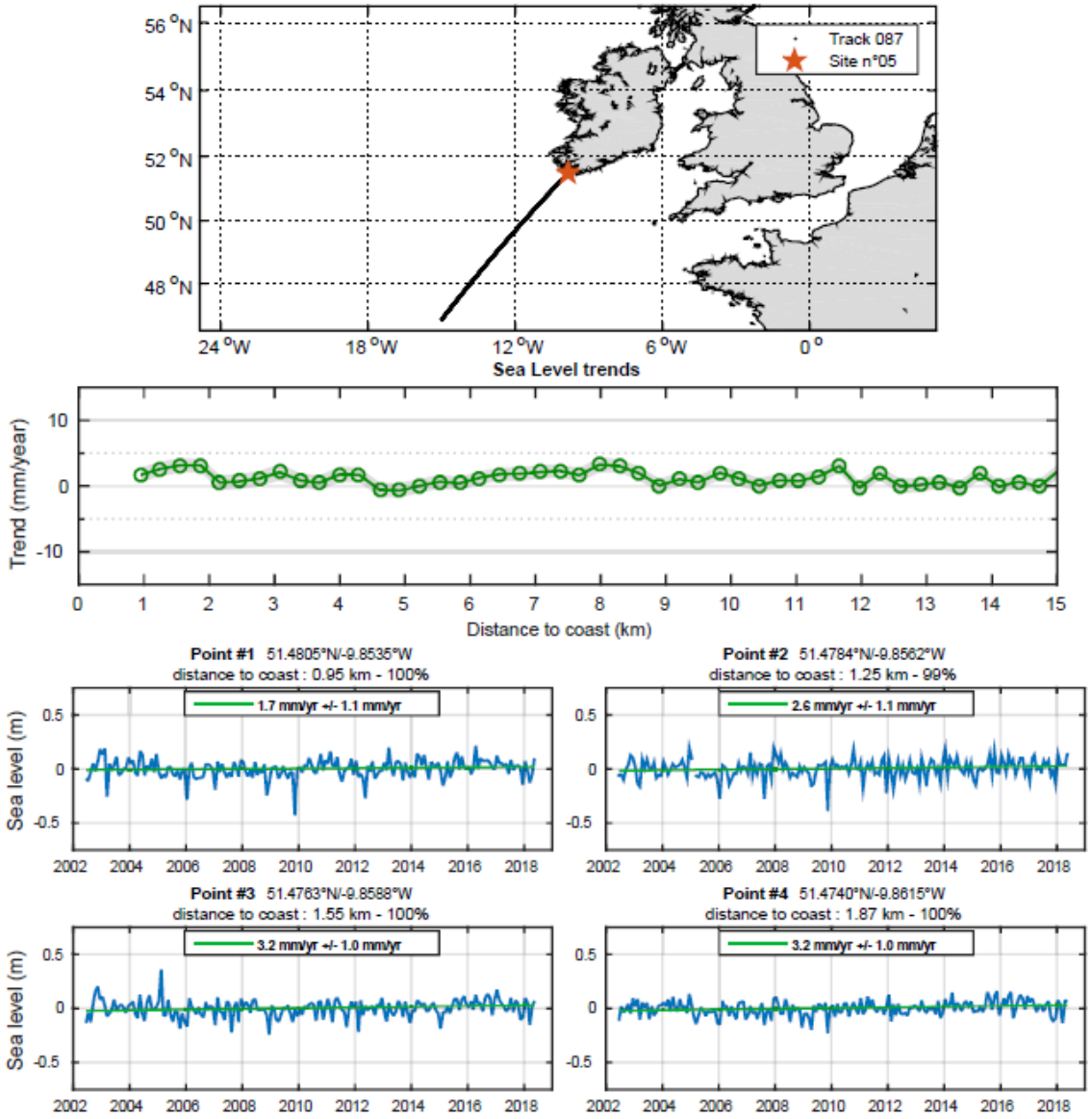
Mediterranean Sea – track 146 site n°2 oriented northward



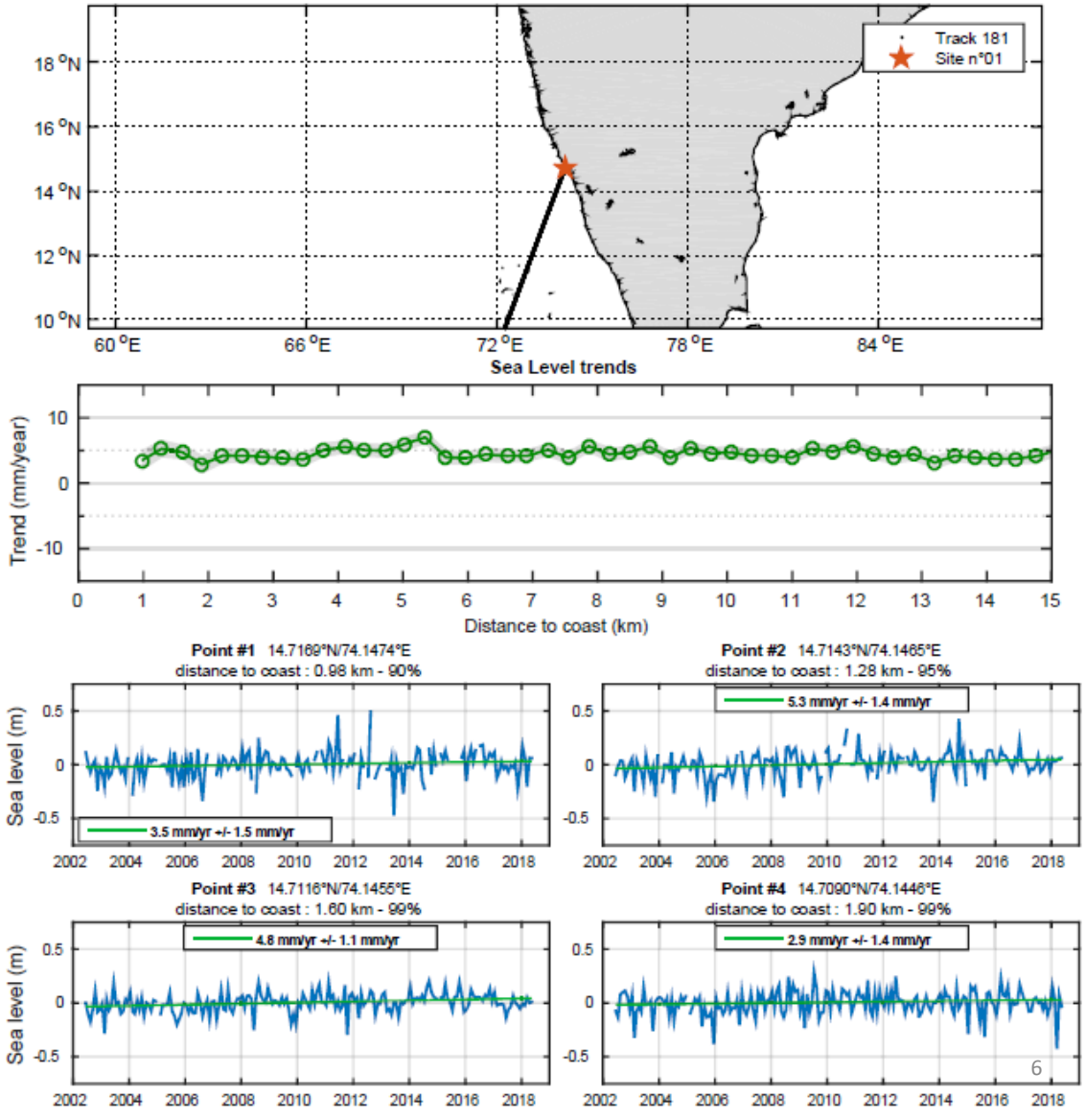


3. A few examples (2/3)

North East Atlantic – track 087 site n°5 oriented southward

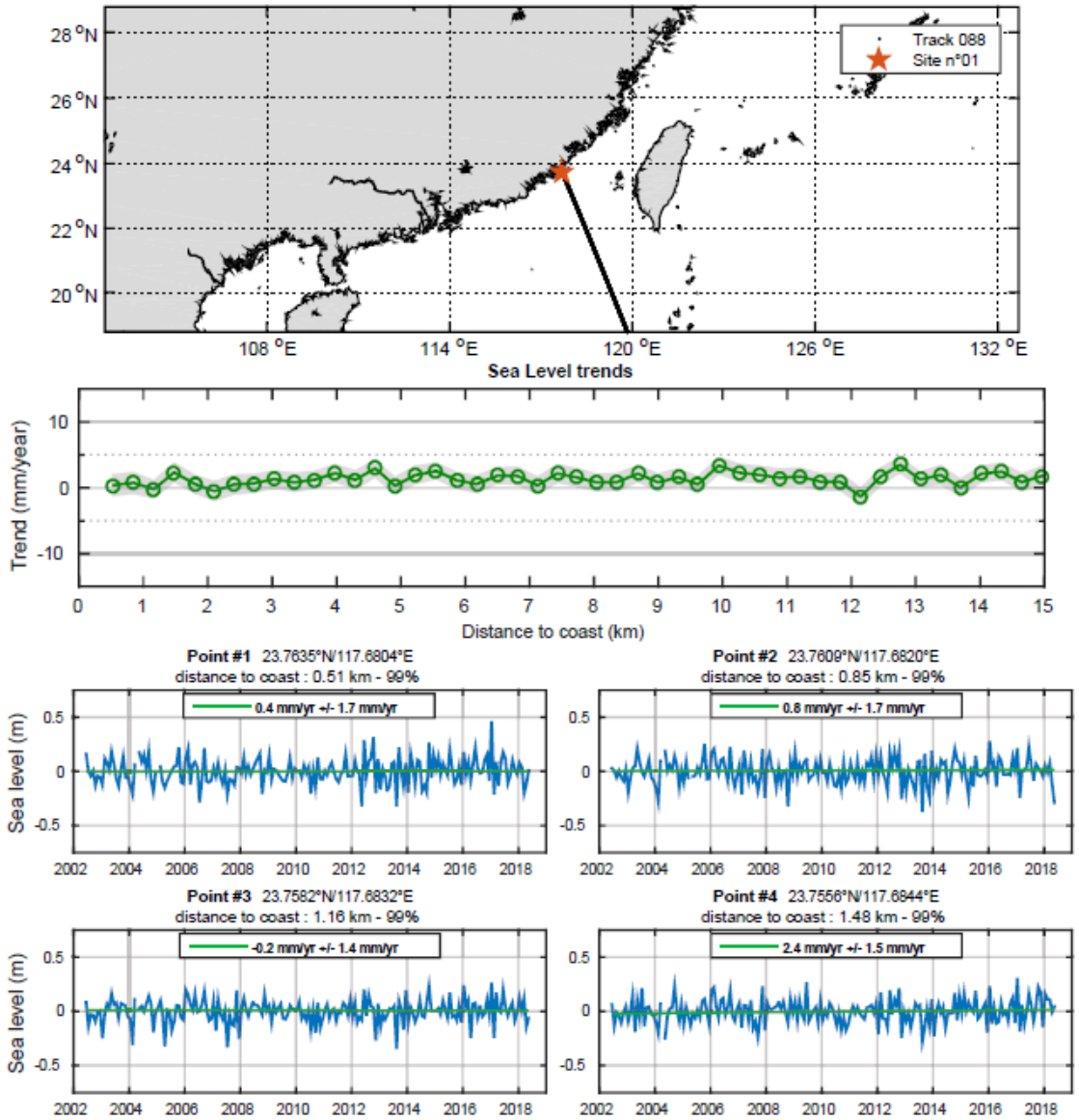


North Indian Ocean – track 181 site n°1 oriented southward

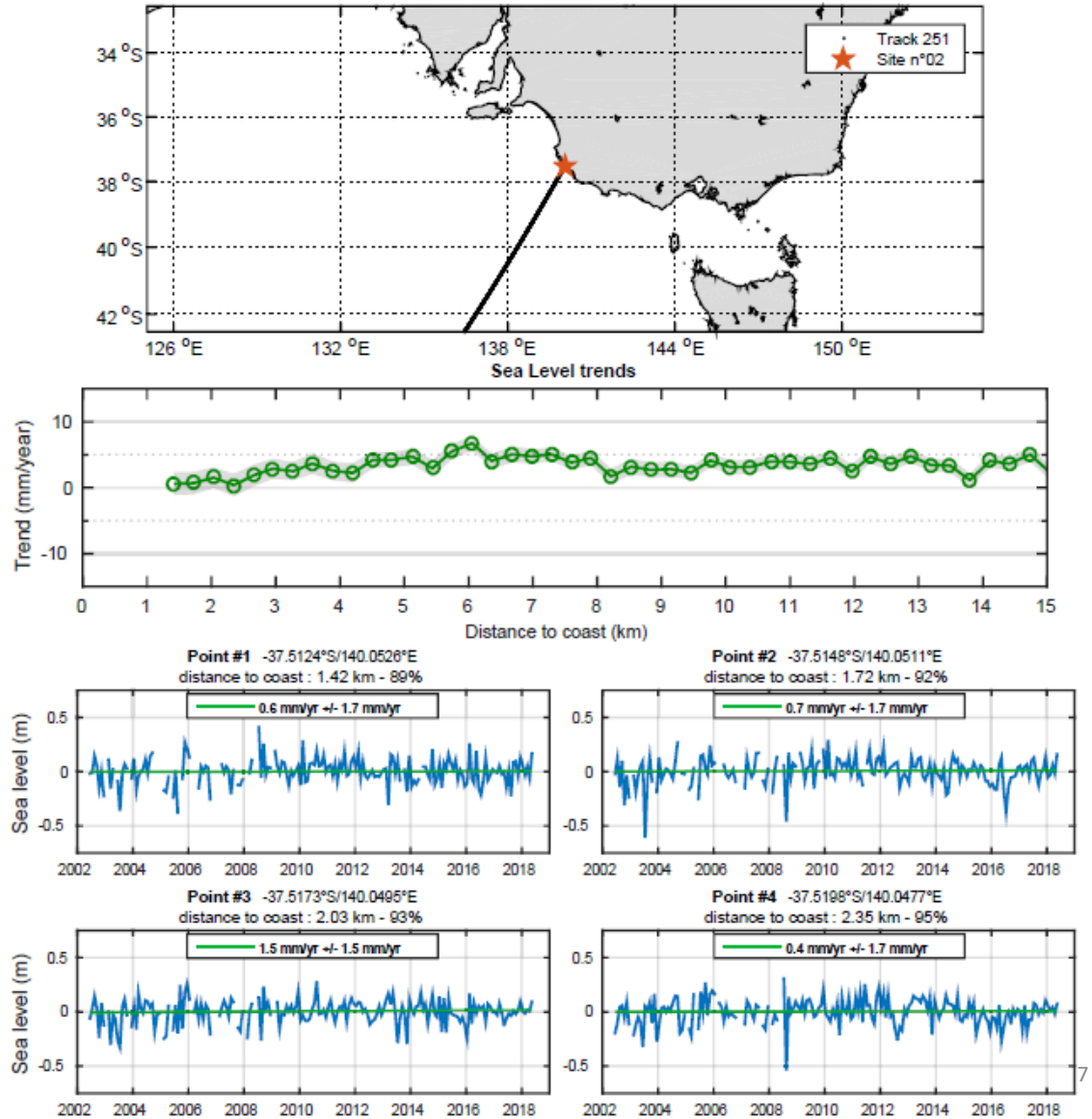


3. A few examples (3/3)

South East Asia – track 088 site n° 1 oriented southward

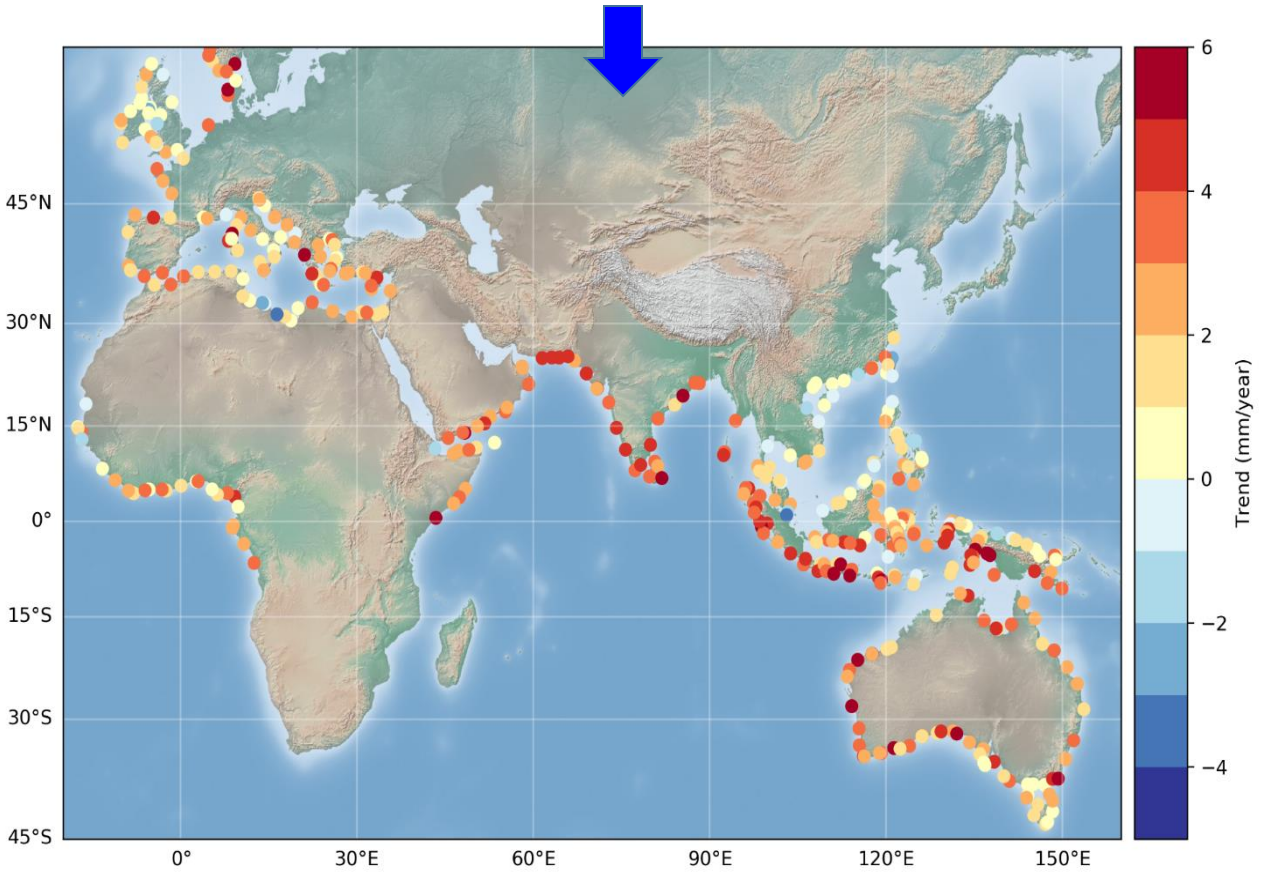


South Australia – track 251 site n°2 oriented southward

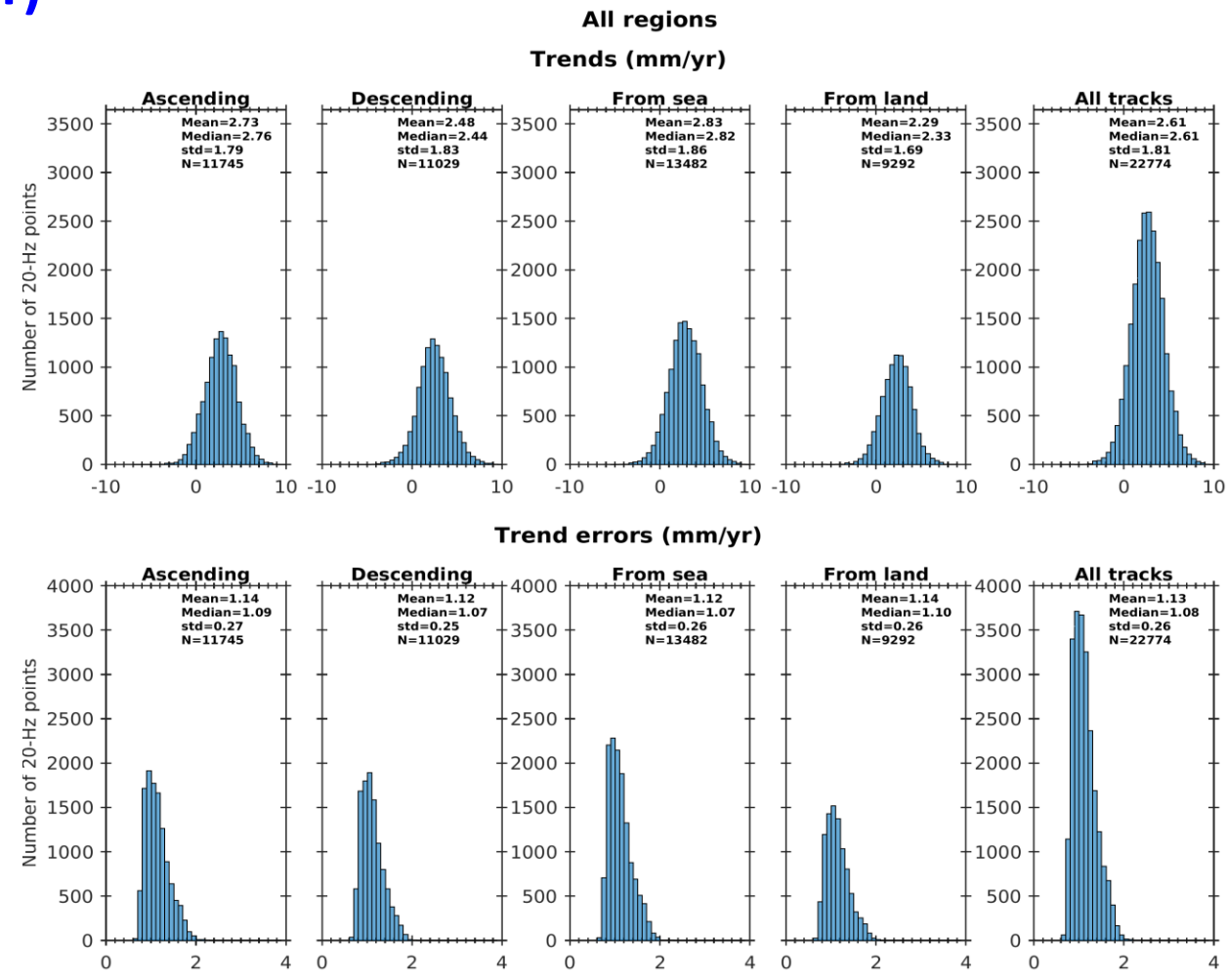


4. Results (1/3)

Altimetry-based coastal sea level trends (mm/yr) over 2002-2018 at the 429 selected sites



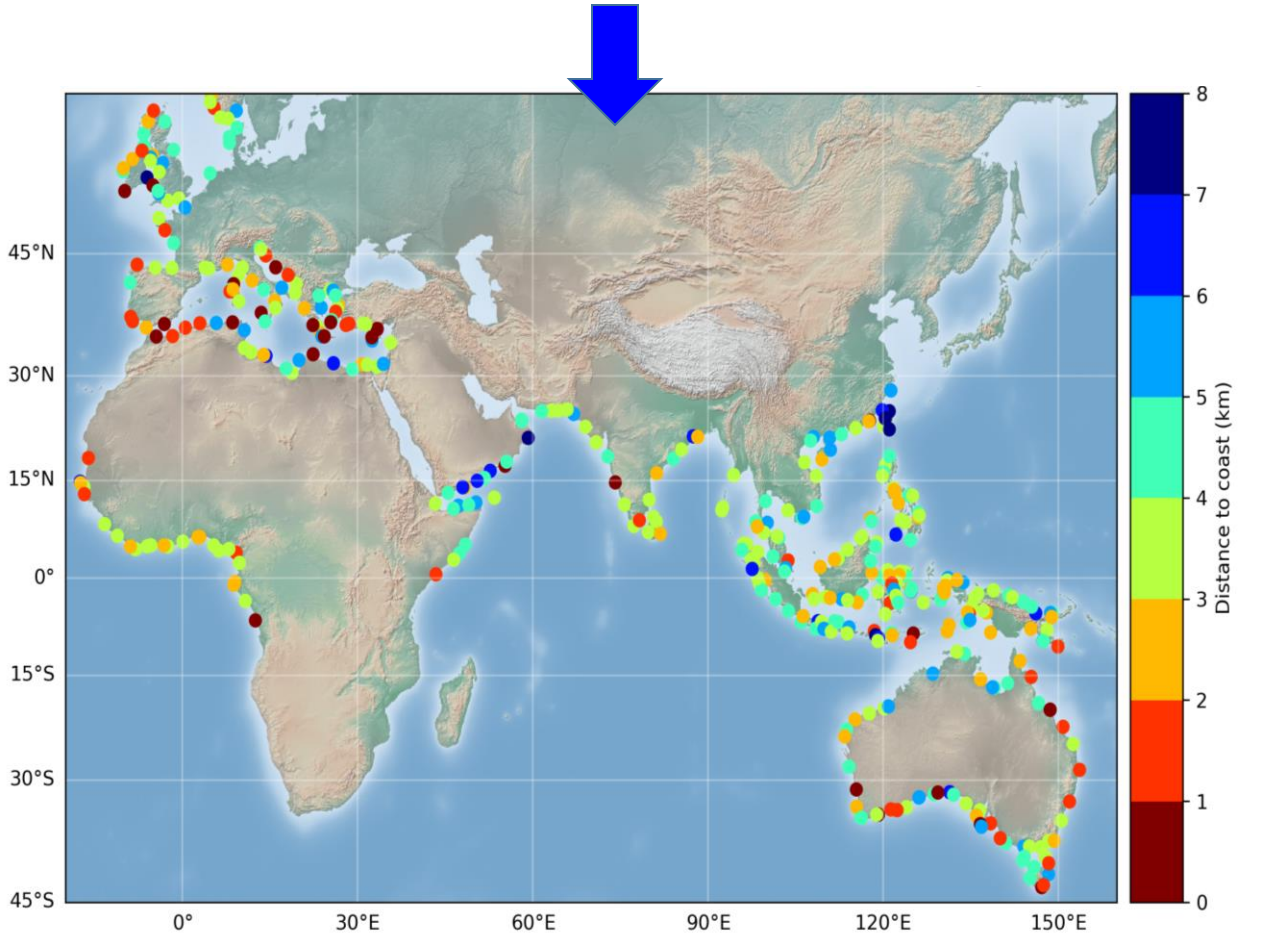
Coastal sea level trends (mm/yr) over 2002-2018 of the first valid points near the coast (average over 2 km)

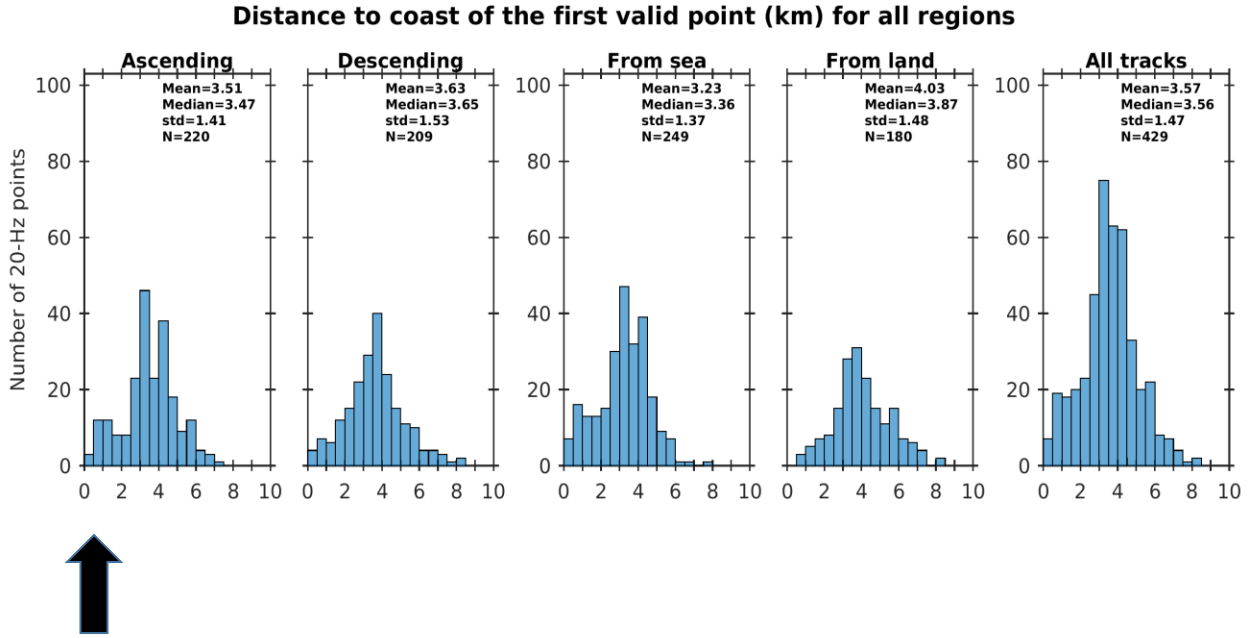


Histograms of trends and trend errors for ascending and descending tracks, tracks oriented sea to land and land to sea, and all tracks together

4. Results (2/3)

- **Distance to the coast (km) of the first valid sea level trend data at the 429 selected sites (average closest distance to coast for all regions)**

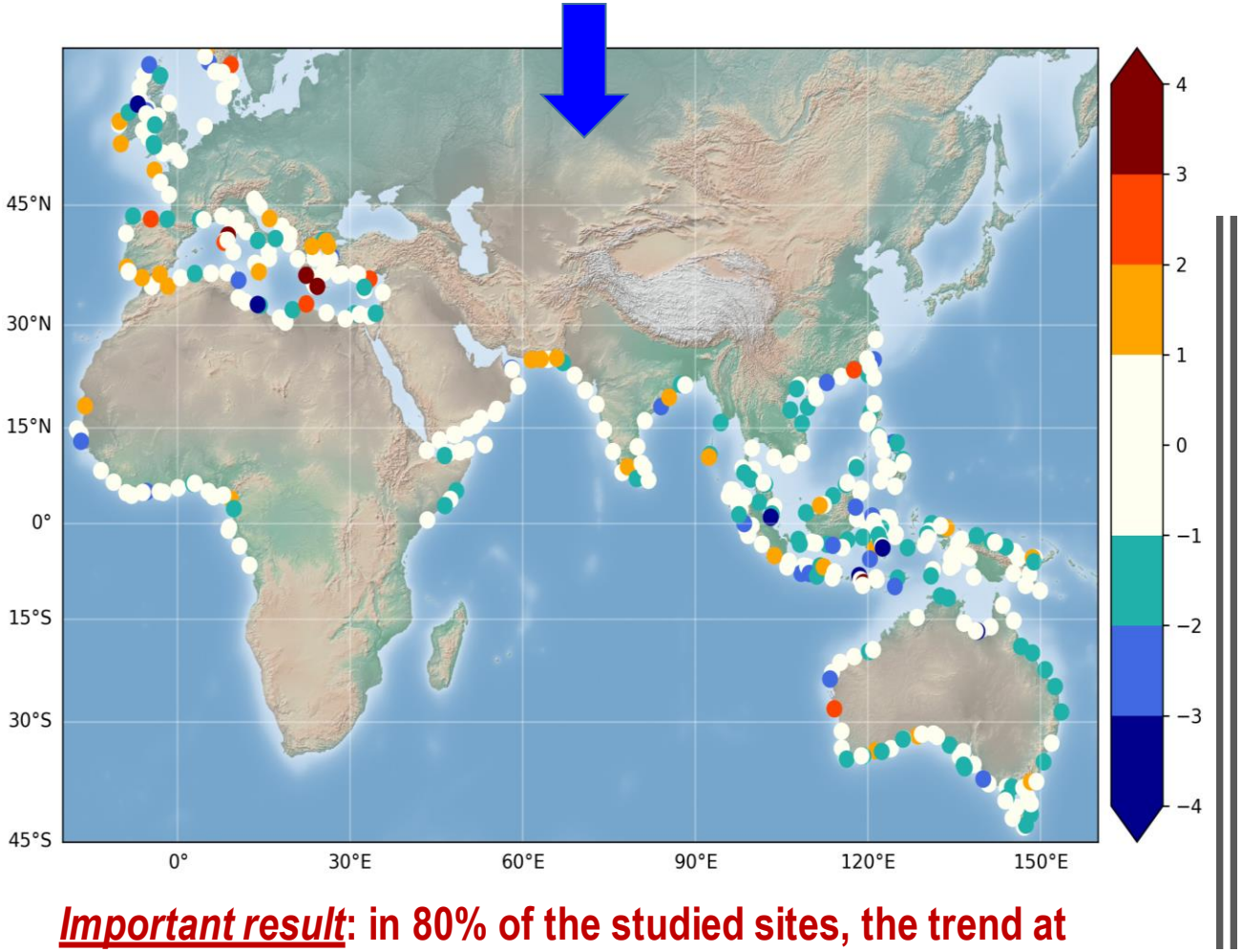


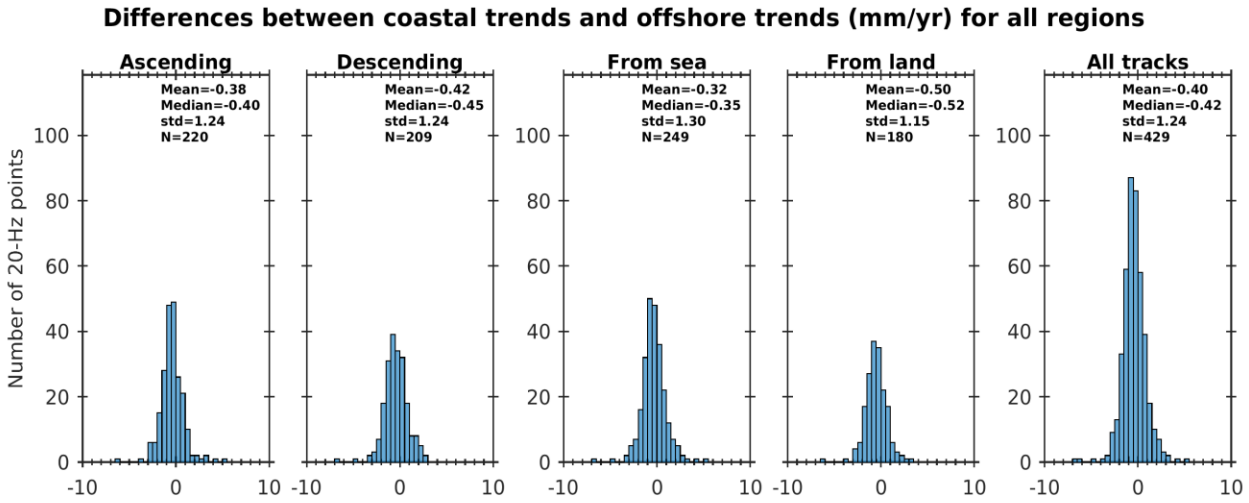


Histograms of the closest distances to coast reached at the first along-track valid point, for ascending and descending tracks, sea to land and land to sea tracks, and all tracks together.
Best results (shortest distances to coast) are obtained for sea to land tracks.

4. Results (3/3)

Trend differences between the first valid point near the coast (average over 2 km) and open ocean (average over 14-16 km from coast)





Histograms of the closest distances to the coast for ascending and descending tracks, sea to land and land to sea tracks and all tracks together

Important result: in 80% of the studied sites, the trend at the coast does NOT differ from the open ocean trend (within +/- 1 mm/yr)

However, at the 20% remaining sites, coastal trends are either larger or smaller than open ocean trends. This may result from small scale coastal processes (e.g., wind-waves, coastal currents, fresh water input from rivers, etc.)

The calibration site of Topex and Jason altimetry missions is one these cases (Gouzenes et al., Ocean Sciences, 2020)

5. Synthesis

- Mean coastal trend (averaged over all regions) is 2.6 +/- 1.1 mm/yr
- Lowest trends are seen in the Mediterranean Sea
- Largest trends are observed in the north Indian Ocean and around Australia
- On average, there is no difference between ascending and descending tracks
- We note more valid data when track come from sea in the Mediterranean Sea and Northeast Atlantic

- There are no significant trend differences between open ocean and the coast (closest valid point to coast) at 80% of the studied sites
- ***This is a totally unexpected result!***

- The average distance to coast of the first valid point is 3.5 km (all regions)
- In the Mediterranean Sea and around Australia, we note a significant number of sites with distance of the first valid point at less than 2 km from the coast

How to get the data?

The Climate Change Coastal Sea Level Team, A database of coastal sea level anomalies and associated trends from Jason satellite altimetry from 2002 to 2018, *Nature Scientific Data*, in press (2020)

SEANOE repository, https://doi.org/10.17882/74354