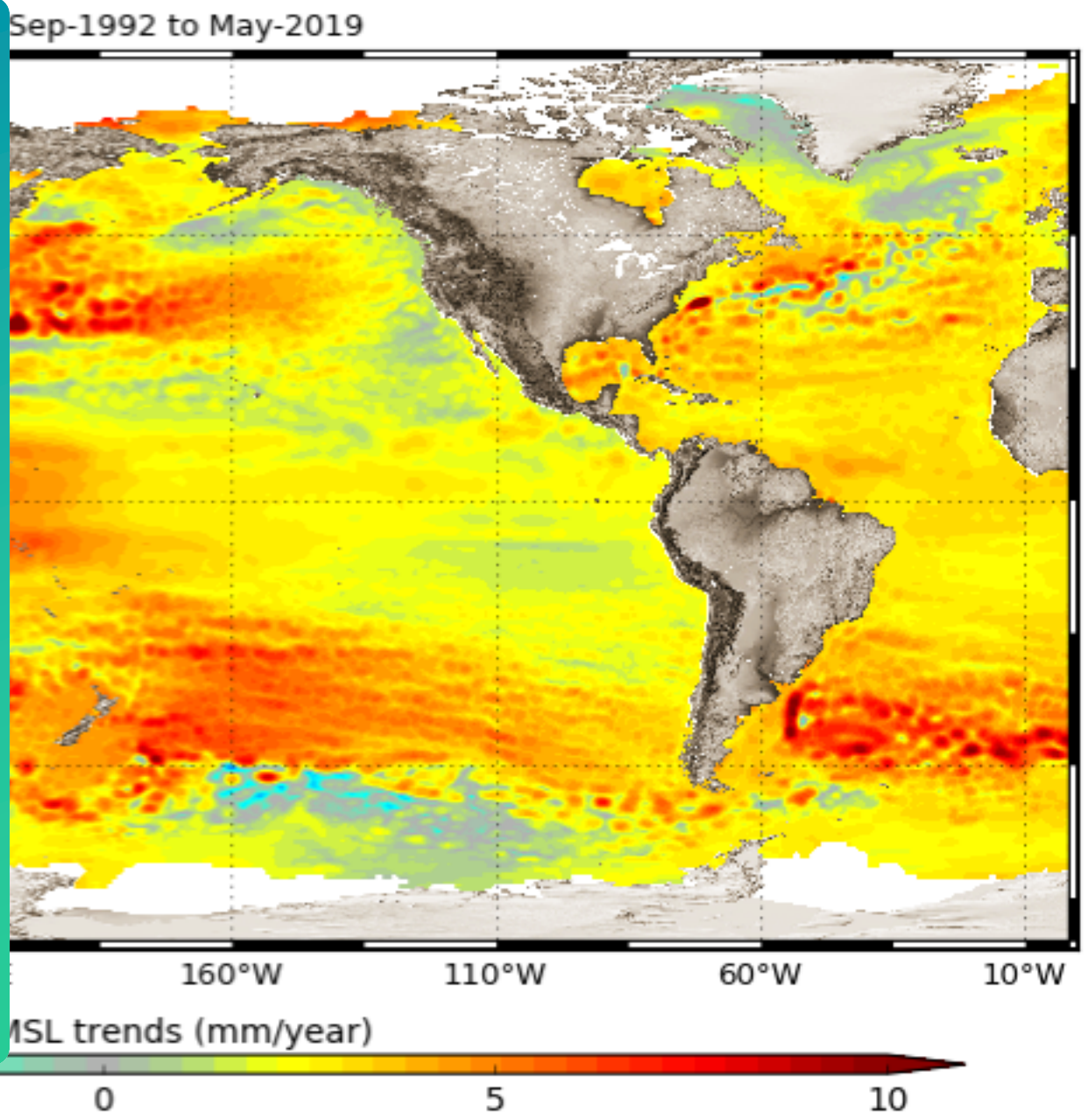
Multi-Mission Sea Level Trends



Local sea level trends, accelerations, and uncertainties

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Introduction

What is this work about ?

In this study we estimate accurate uncertainties affecting local sea level trends and accelerations.

We also model the error covariance of the altimetric system. This can be used to estimate uncertainties on any quantity.

Results regarding trend and acceleration uncertainties are provided as a NetCDF file. As well as all necessary information and code to reproduce the results. With the hope that it will benefit the community.

Why ?

Accurate uncertainty estimation is essential. It is necessary to discriminate true signal from artifacts arising from errors.

When comparing to models or in-situ data, it is useful to establish what is, or is not, a significant difference.

Uncertainties are required for climate science applications and their delivery with ECVs is encouraged.

How ?

We estimate the magnitude of the main error sources in the estimation of regional sea level from altimetry.

Error covariances are modeled for each source and the total error covariance built as the sum of all error sources, under an error independence assumption.

Local error covariance are used in an extended least squares formulation to derive uncertainties on trends and accelerations.

Errors sources

Error sources considered in this study are listed below

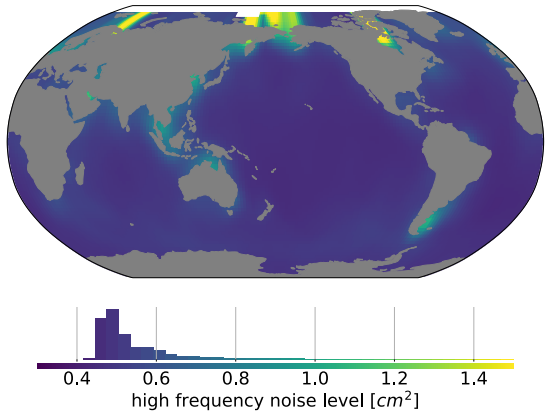
type	description	value
correlated	high frequency noise from orbit determination and geophysical corrections	$\lambda = 1\ yr$, σ location dependent
correlated	low frequency noise from the wet tropospheric correction	$\lambda = 10\ yrs$, σ location dependent
drift	drift errors from the orbit determination	$\delta = 0.33\ mm.yr^{-1}$
drift	drift errors from the GIA correction	δ location dependent
jump	inter-mission TP-a/TP-b and TP-b/J1 biases	$\Delta = 10\ mm$
jump	inter-mission J1/J2 and J2/J3 biases	$\Delta = 6\ mm$

Location dependent errors are described on the next page,

Long-term errors from orbit solutions and inter-mission biases are not location dependent (not in our model at least),

Location dependent errors

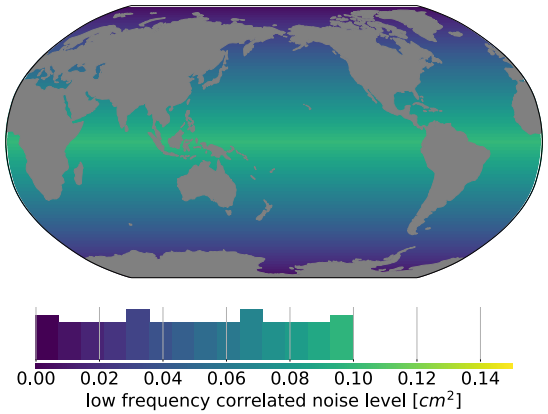
HF noise



Designed to account for high frequency errors from orbit determination and intrumental and geophysical corrections.

Estimated from SSH crossovers, empirical orbit errors and long wavelength errors.

LF WTC error

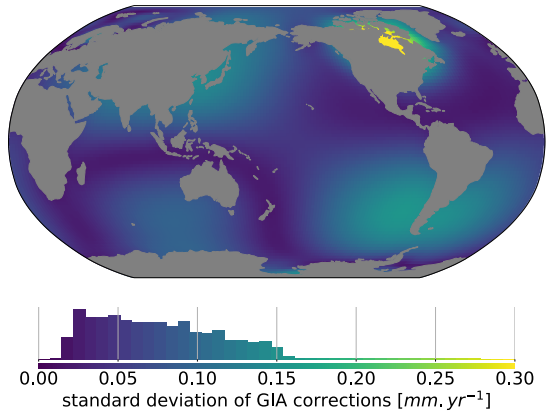


Designed to account for long-term errors in the wet tropospheric corrections due to radiometers.

Higher in the tropcis, where WTC itself is larger.

Typical decorrelation scale is 10 yrs.

GIA error

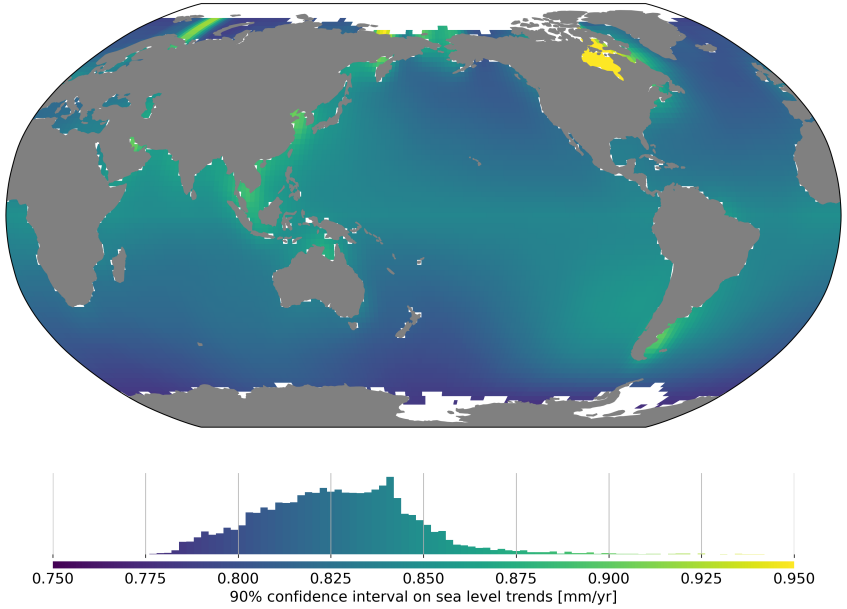


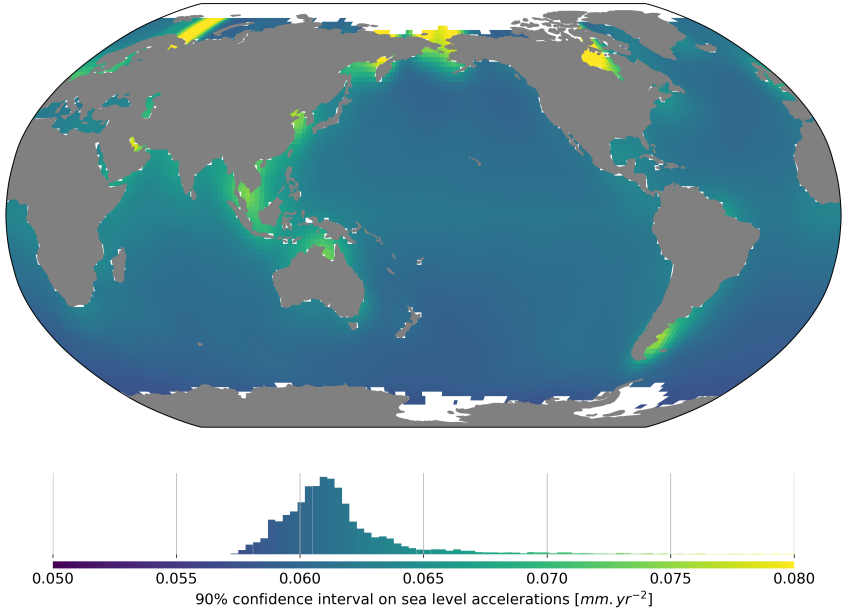
Design to represent error in local GIA correction.

Estimated from 27 runs of GIA model with varying Earth rheology.

Modeled as a drift.

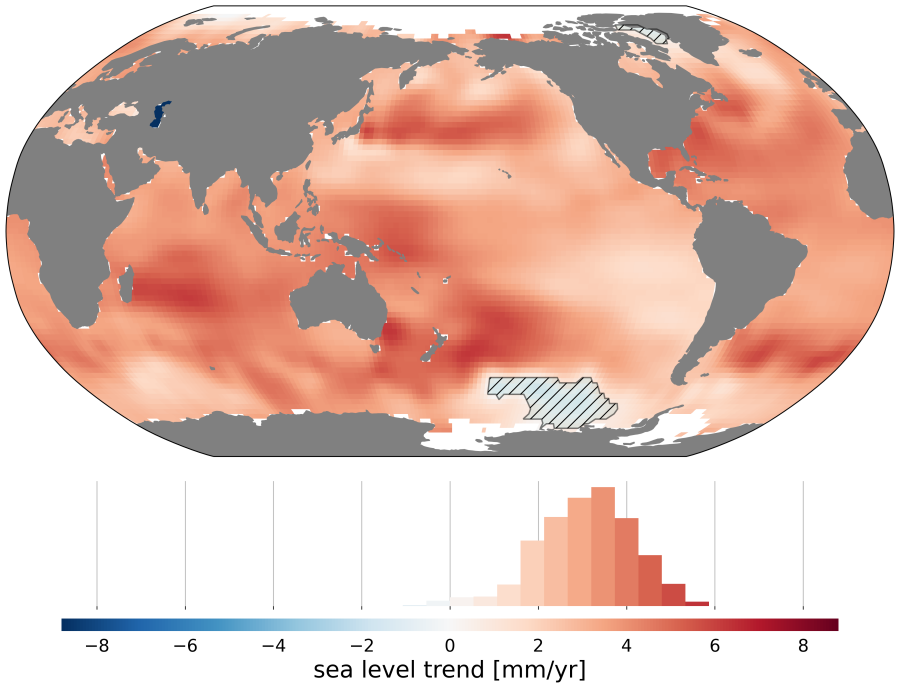
Local SL uncertainties on trends and uncertainties



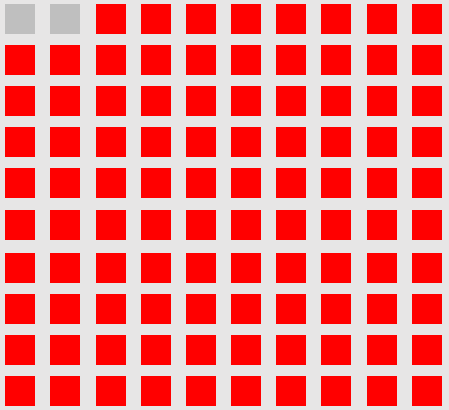


Uncertainties are given at the 90% confidence level

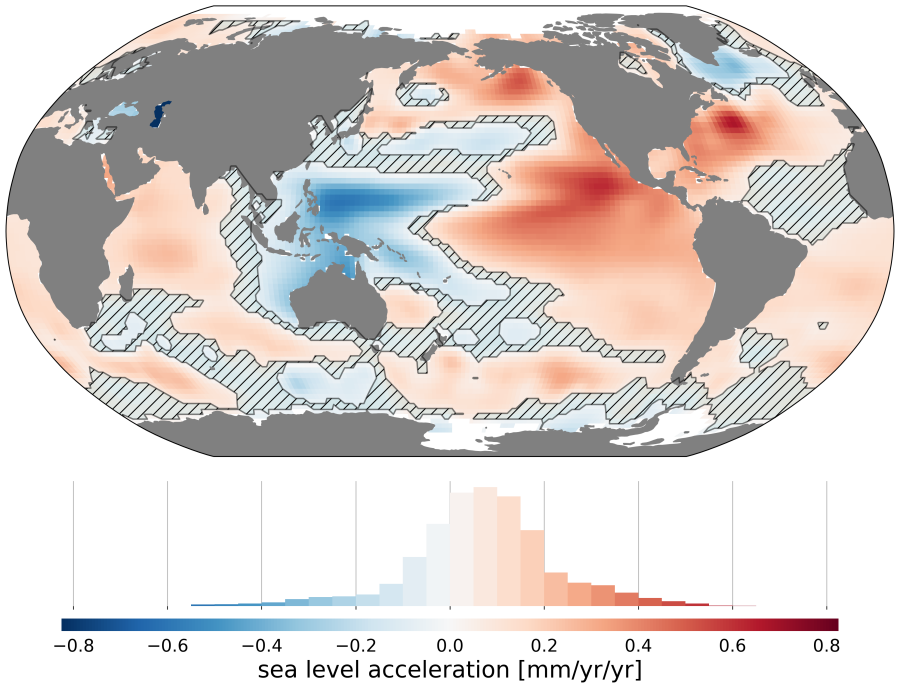
Significant trends



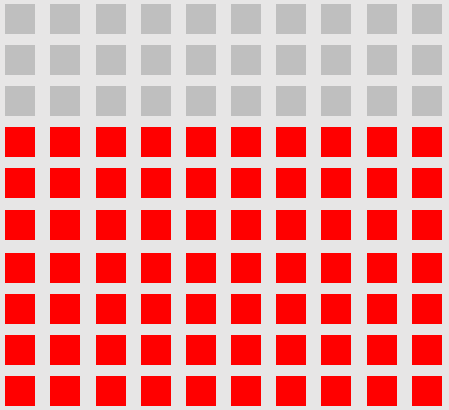
98 % of the ocean experiences significant SL rise



Significant accelerations



70 % of the ocean experiences significant SL acceleration



Accessing the data

The dataset is available from SEANOE (https://doi.org/10.17882/74862) under CC-BY license,

- It will be updated to include error levels

Code to reproduce the study will be distributed

- Git repo under construction at https://github.com/pierre-prandi/rsl
- GNU GPL v3 license, copies, modifications and reuse are all free

Data descriptor under revision for publication in Nature Scientific Data.

Limits and future work

The results presented here are limited in several ways:

- We do not provide information about geographical error correlations,
- We do not account for natural ocean variability in the uncertainty estimation,
- The error budget is based on our current knowledge

To improve error characterization, uncertainty estimation and user engagement we need to

- Describe error spatial covariances and build a comprehensive space/time error covariance,
- Revisit the error budget on a regular basis,
- Provide error and uncertainty information in a user-friendly way.