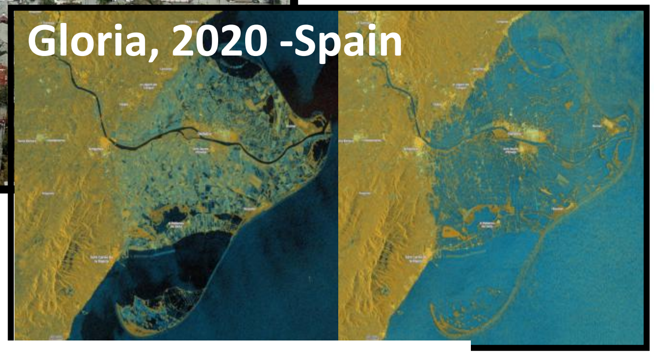
The GOS (Global Ocean Surge) hindcast

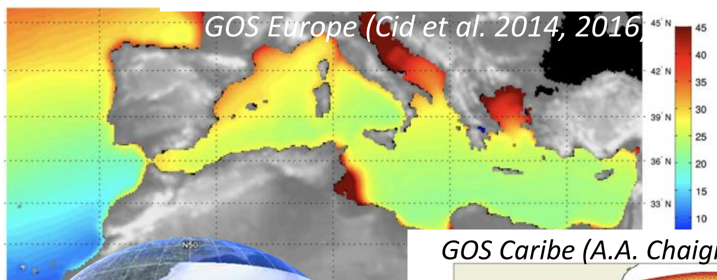
Elsy Ticse [1,2]
PhD Student
kticse@unican.es

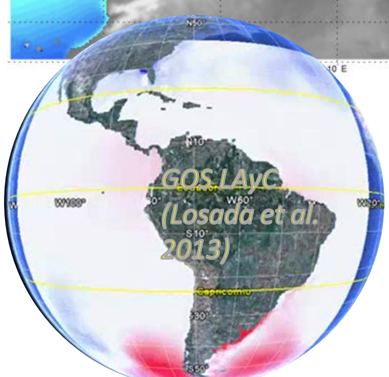
J. Valle[1], A. A. Chaigneau[1], M. Menéndez[1,2], A. J. Abascal[1]

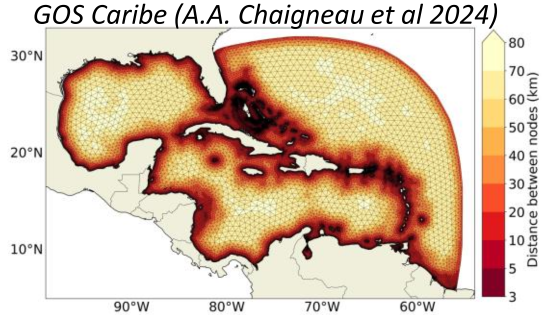
[1] *Instituto Hidráulico de Cantabria*
[2] *Universidad de Cantabria*



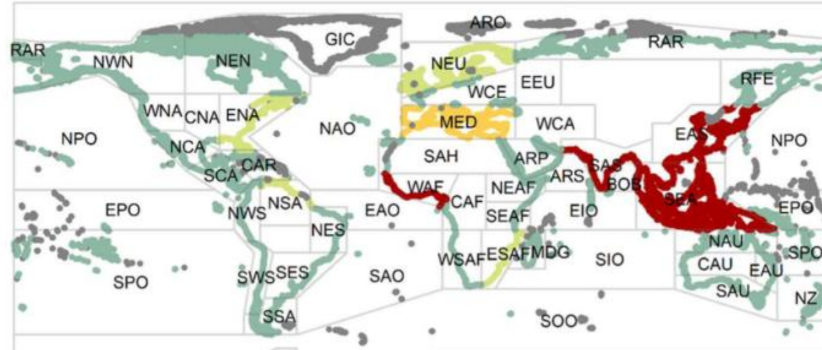
Previous Regional IH GOS - hindcast







Kirezci et al. 2023

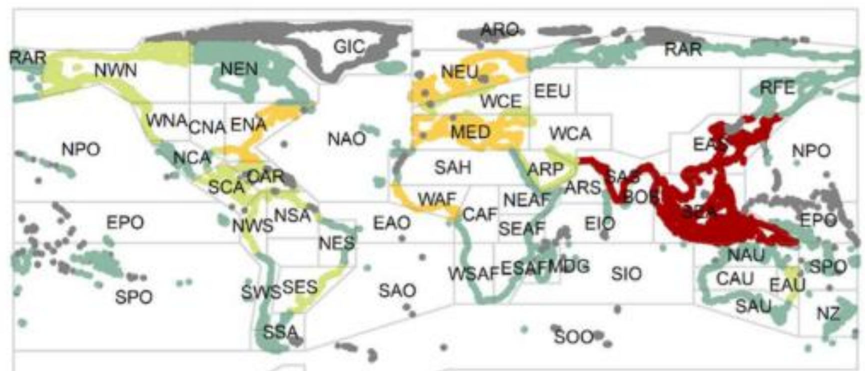


Expected Annual People Affected

EAPA - Present (million People)

< 0.2 0.2 - 0.5 0.5 - 1.5 1.5 - 3.0 3.0 <

Not Applicable



Expected Annual Damage

EAD - Present (billion $US)

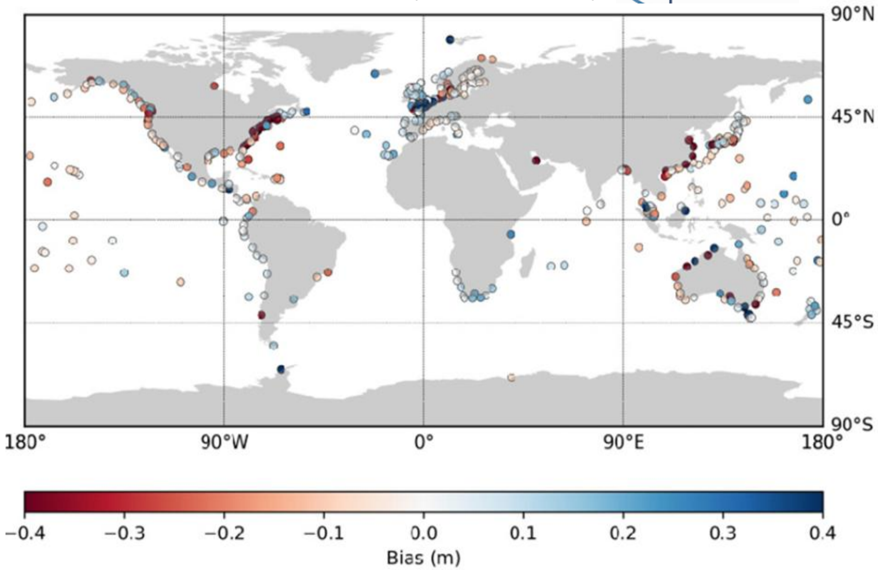
< 1 2 - 10 10 - 20 20 - 30 30 <

Not Applicable

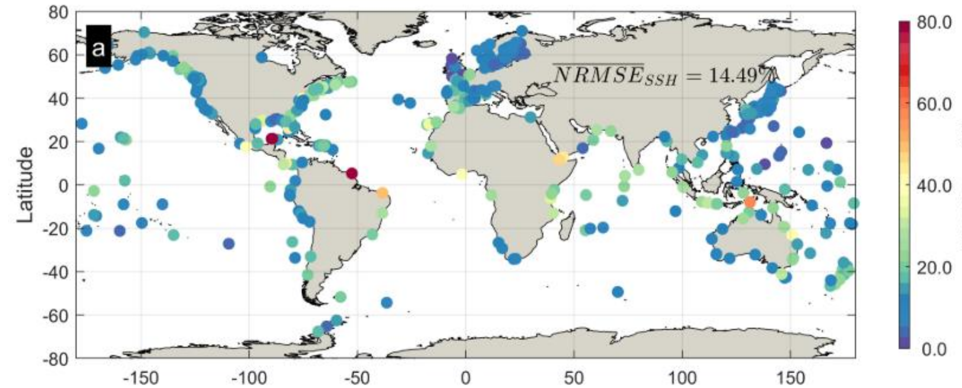
Preliminary Global Storm Surge Hindcast

CoDEC-GESLA: Bias

Muis et al. (2016, 2020)



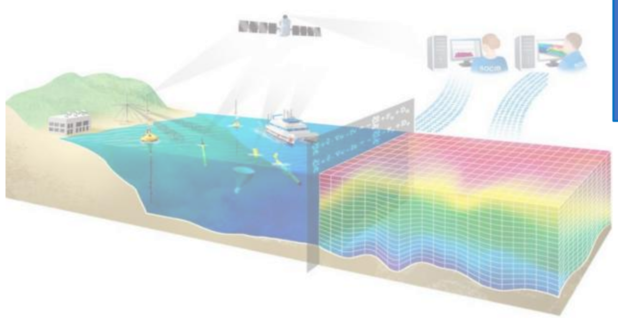
Mentaschi et al. (2023)



To advance storm surge research through the development of a >30 year global hindcast database, enabling intercomparisons and more diverse applications in climate studies and coastal hazard assessments

2. Methodology

Overview of the GOS Development

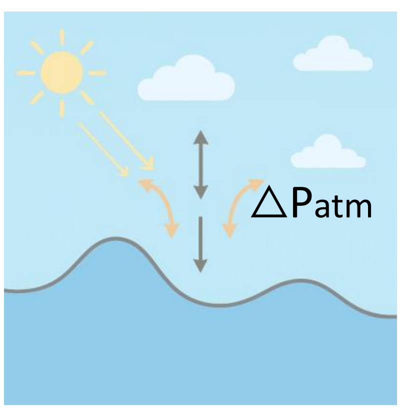


Global Ocean Numerical Modeling (Nucleus for European Modelling of the Ocean - NEMO)

- Configuration
- Def. Parameters
- Test

Radiational tide analysis

- Spectral Analysis
- Filtering



Validation
(> 200 Tide Gauges)

Climatical analysis

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1. Motivation | **2. Methodology** | 3. GOS Outcomes | 4. Conclusions

Global Numerical Modeling

NEMO - SURGE 4.0
O'neill et al., 2016

National Oceanography Centre · Centre for Polar Observation and Modelling (cpom), Natural Environment Research Council · British Antarctic Survey, Natural Environment Research Council · Met Office

(Nucleus for European Modelling of the Ocean)

2 levels

Approximations
(Spherical Earth,
Radius ≫ Depth)

Hypothesis
(Boussinesq,
Hydrostatic,
incompressibility)

Primitive Equations (Navier–Stokes)

$$\frac{\partial U_h}{\partial t} = -\left[(\nabla \times U) \times U + \frac{1}{2}\nabla\left(U^2\right)\right]_h - f\, k \times U_h - \frac{1}{\rho_o}\nabla_h p + D^U + F^U$$

Initial Condition

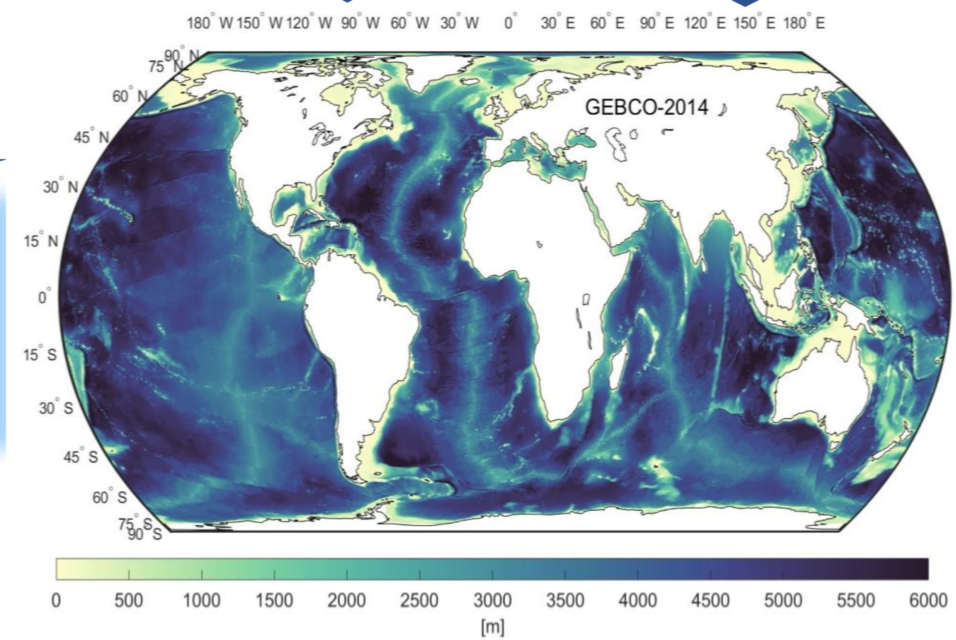
u, v = 0
T, S =ctes

Boundary Conditions

Wind
Atm. pressure

Grid ORCA025

ERA5 Reanalysis
Resol. Horiz. 0.25º,
Hourly.



> 30 years simulation from 1993 of barotropic sea level, with hourly outputs up to 12 km resolution

"GOS (Global Ocean Surge)"

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Analysis of Radiational Tides

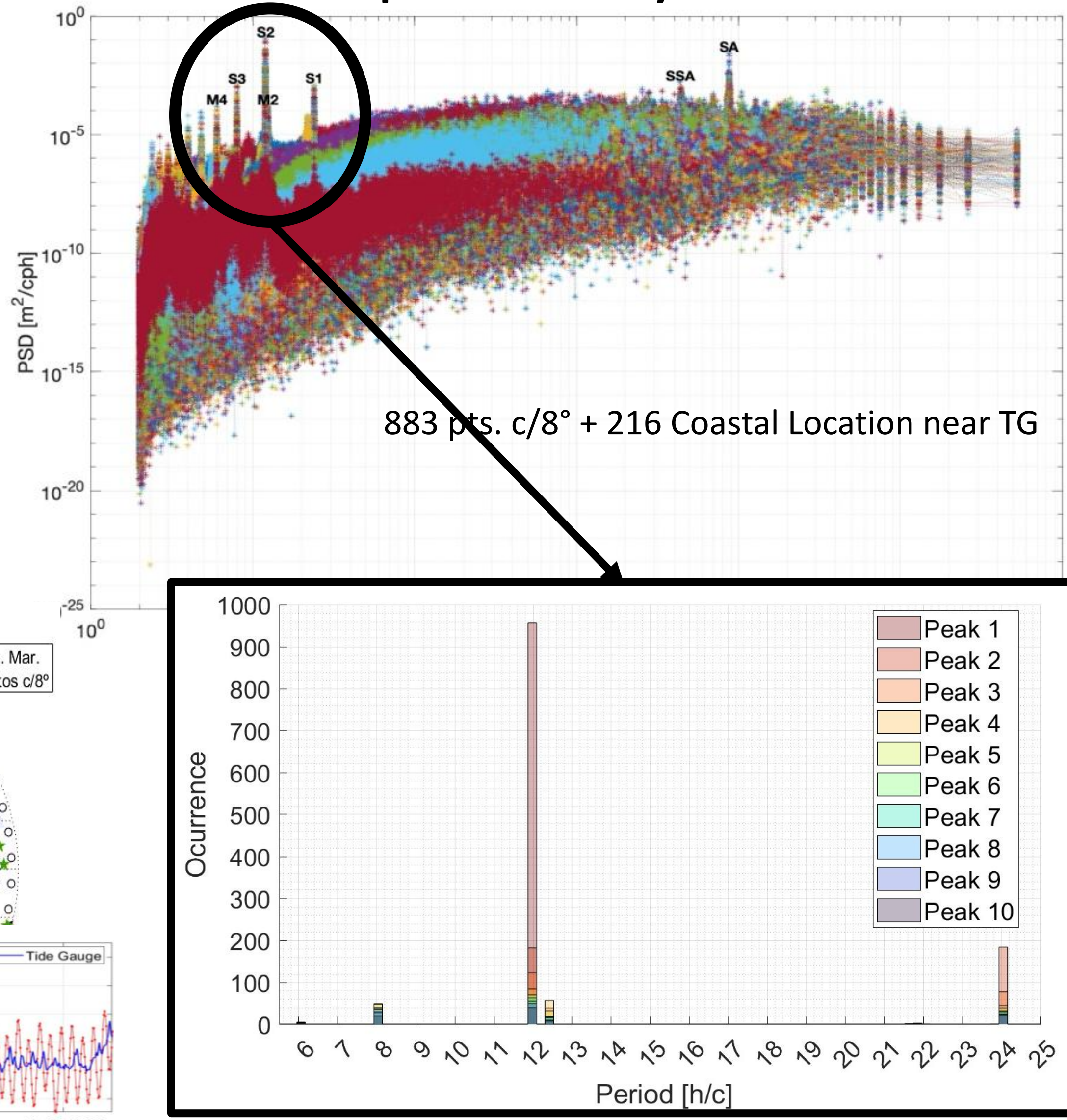
❖ Radiational Tides:

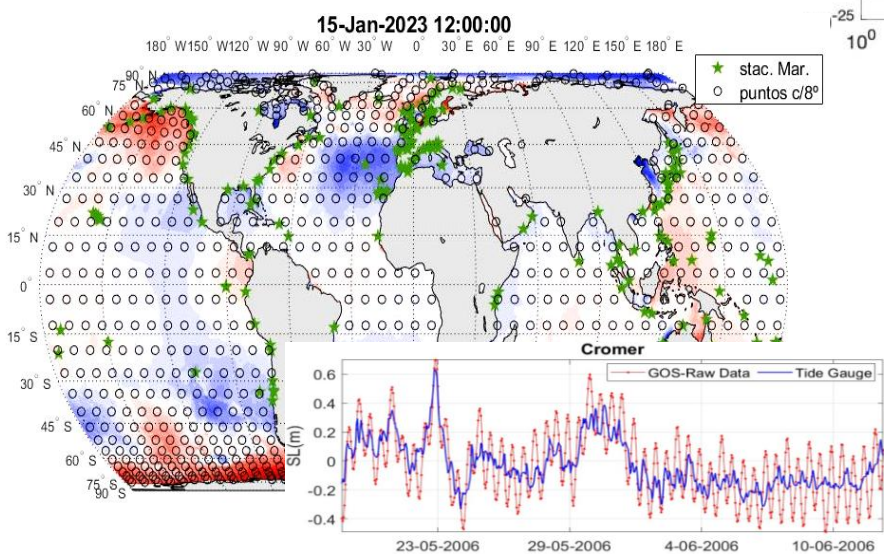
Diurnal thermal variations in the atmosphere generate periodic changes in surface pressure that act as a non-gravitational forcing on the ocean, producing sea level oscillations at frequencies similar to those of astronomical tides. These signals, can be identified in tidal records as additional contributions to several tidal constituents such as S1, S2, S3, SA, SSA, etc.

Taylor et al. (1929), Chapman et al (1956), Manfred et al. (1961), Chapman et al. (1970), Dai A. et al. (1999)

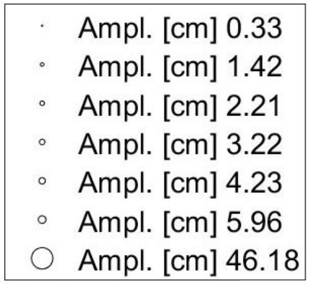
Ray et al. (2023); Williams et al. (2018) ;pugh et al. (2014) Dobslaw & Thomas (2005); Cartwright (1977)

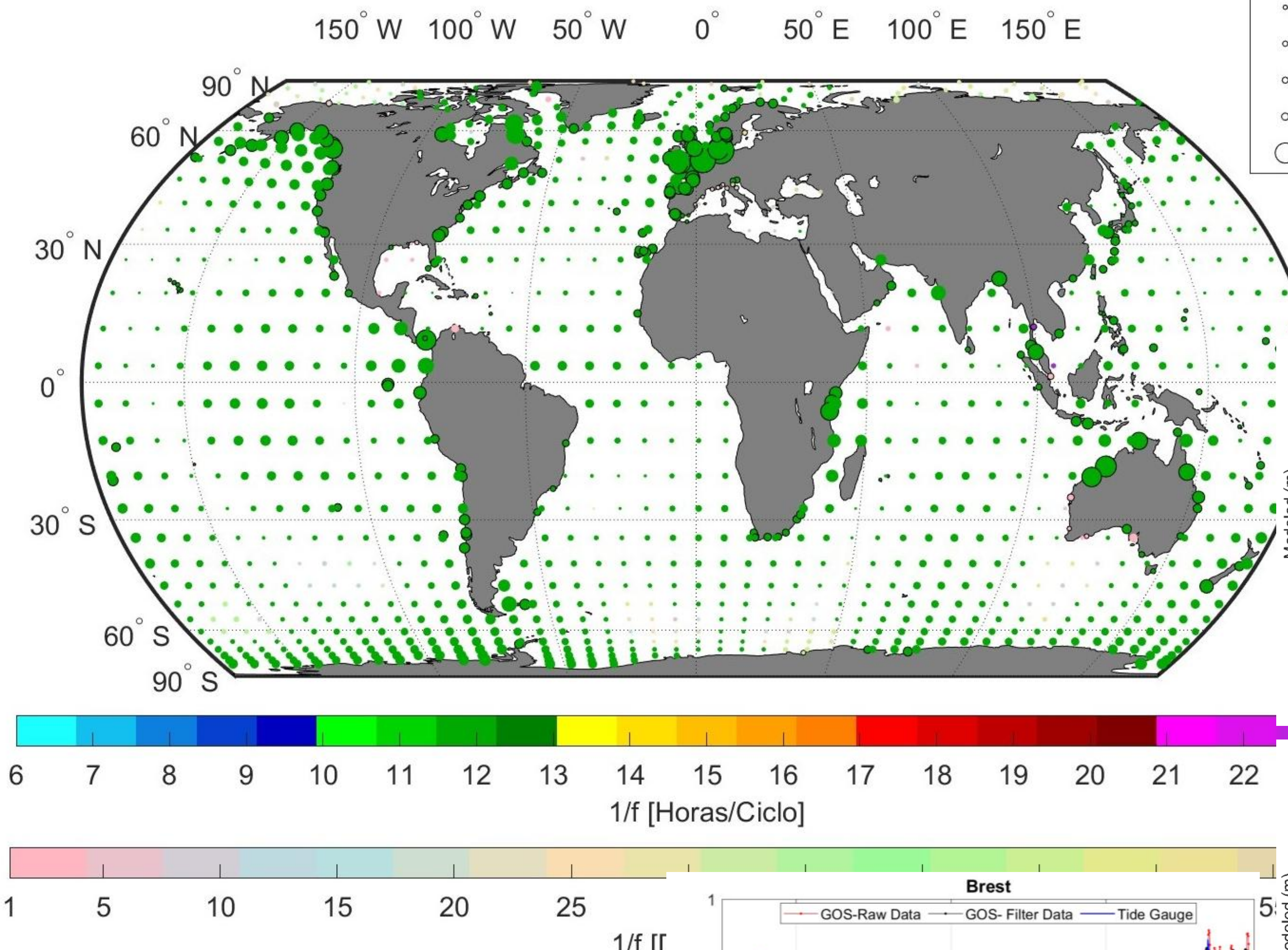
Power Spectral Density of GOS Hindcast



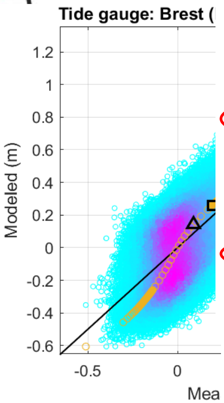


Analysis of Radiational Tides





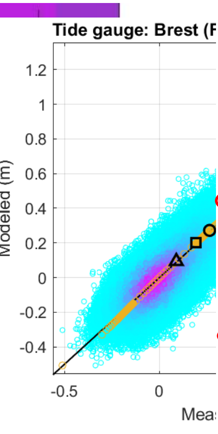
BEFORE FILTER



Location: Brest
Hindcast: ERA5
years: 1993 - 2024

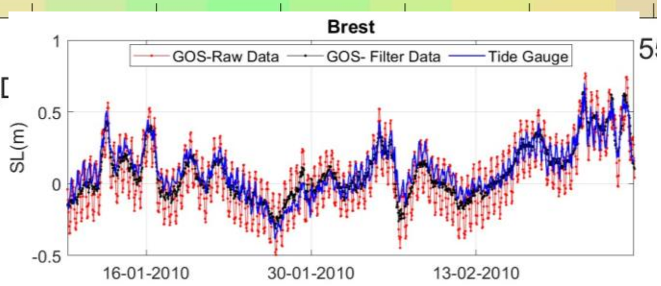
Statistical indicators:
Nobs: 267621
RMSE = 0.17m
NRMSE = 1.243m
Bias = -0.013933 m
Nbias = -0.87921m
Corr = 0.56
SI = 10.68

AFTER FILTER

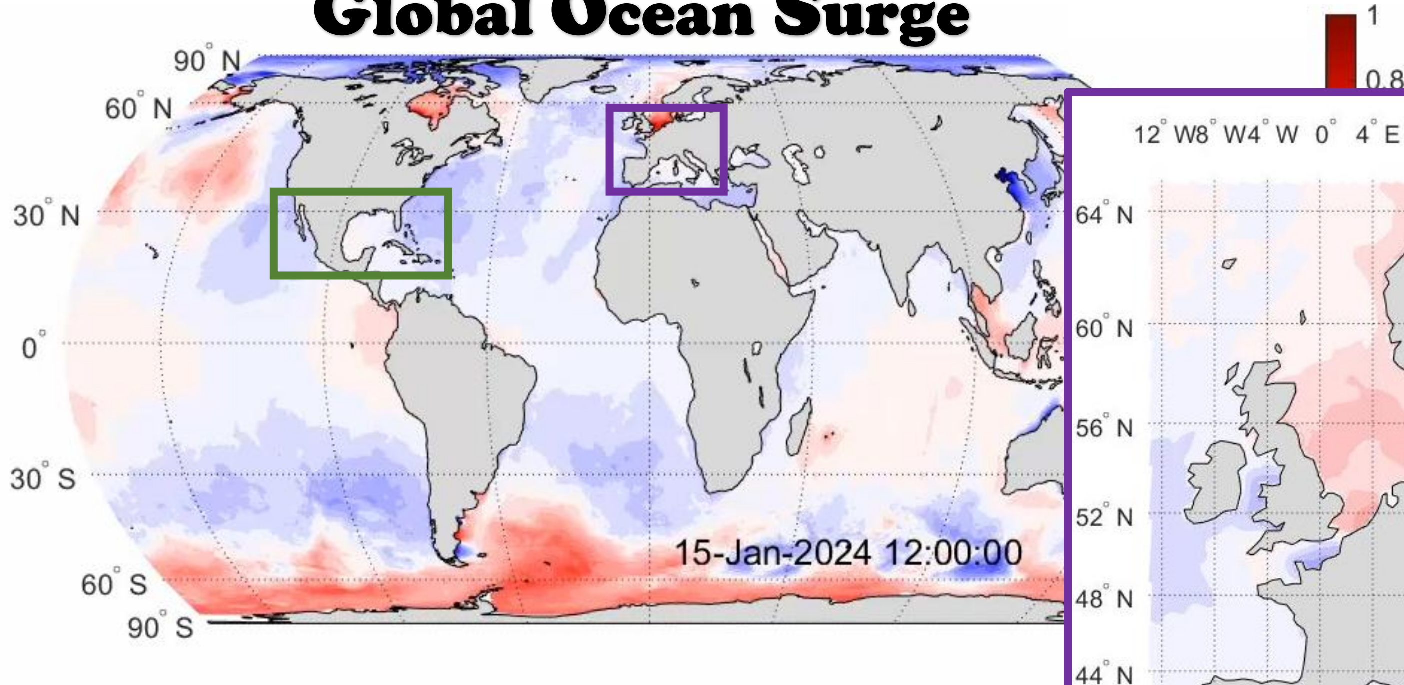


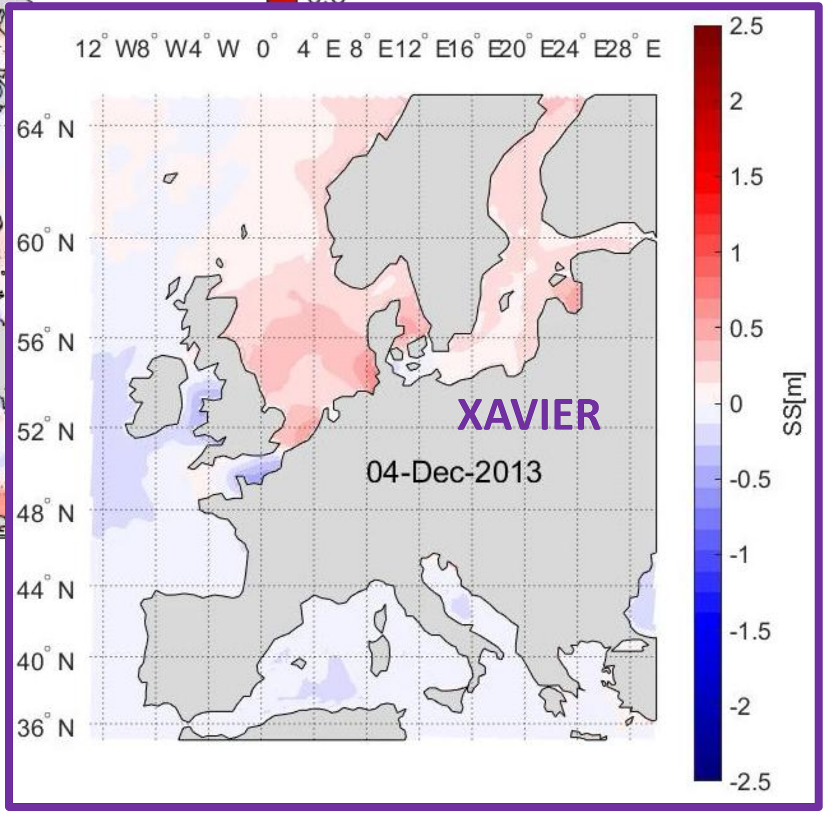
Location: Brest
Hindcast: ERA5
years: 1993 - 2024

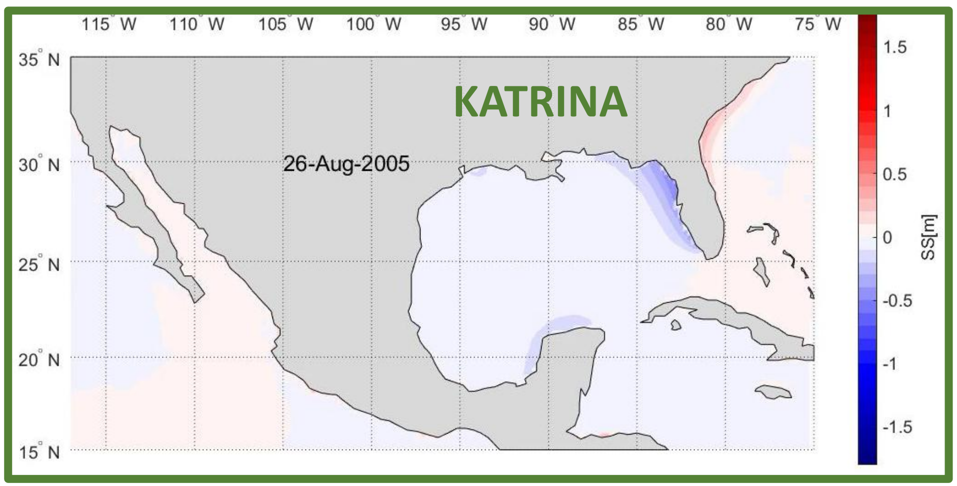
Statistical indicators:
Nobs: 267621
RMSE = 0.09m
NRMSE = 0.663m
Bias = -0.0011235 m
Nbias = -0.070895m
Corr = 0.79
SI = 5.6964



Global Ocean Surge



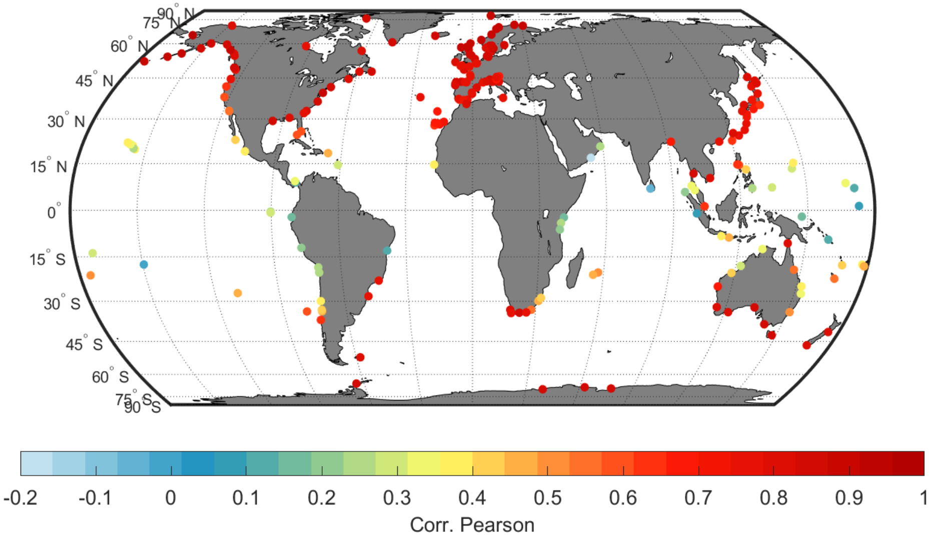




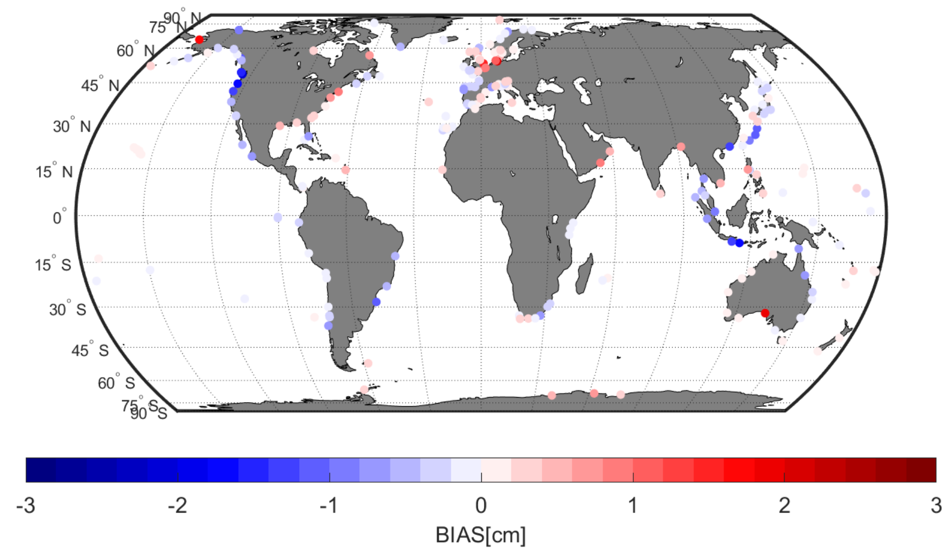
Validation

216 Tide gauges (GESLA3; UHSLC; REDMAR; CICESE; CENDHOC)

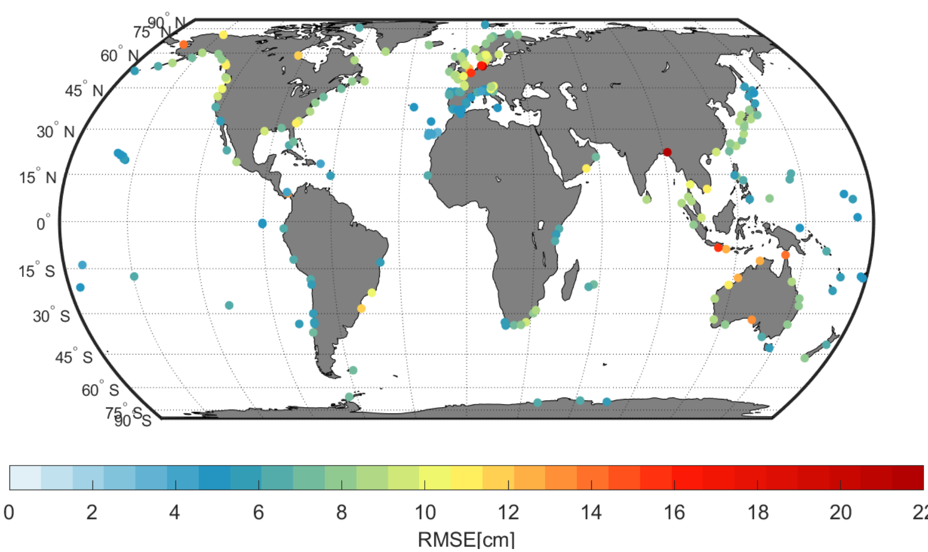
Corr. Pearson



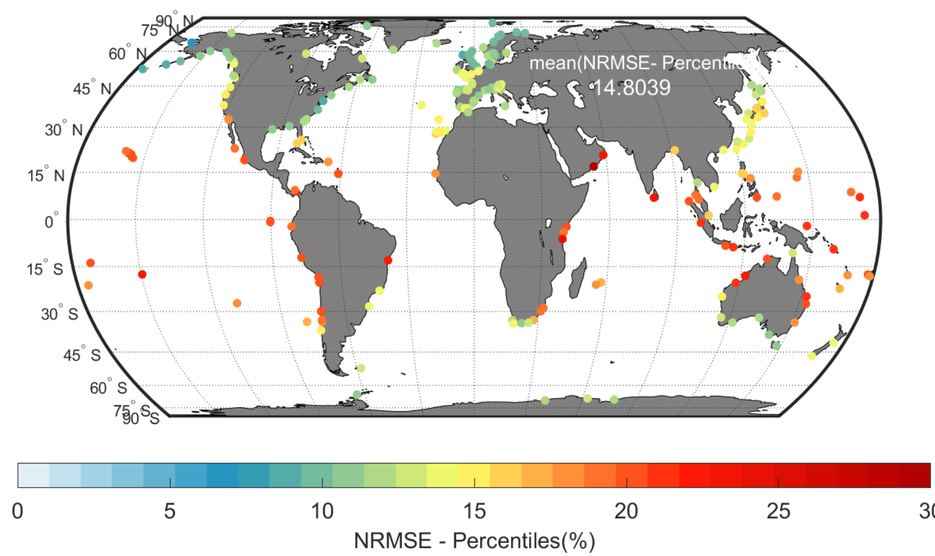
BIAS



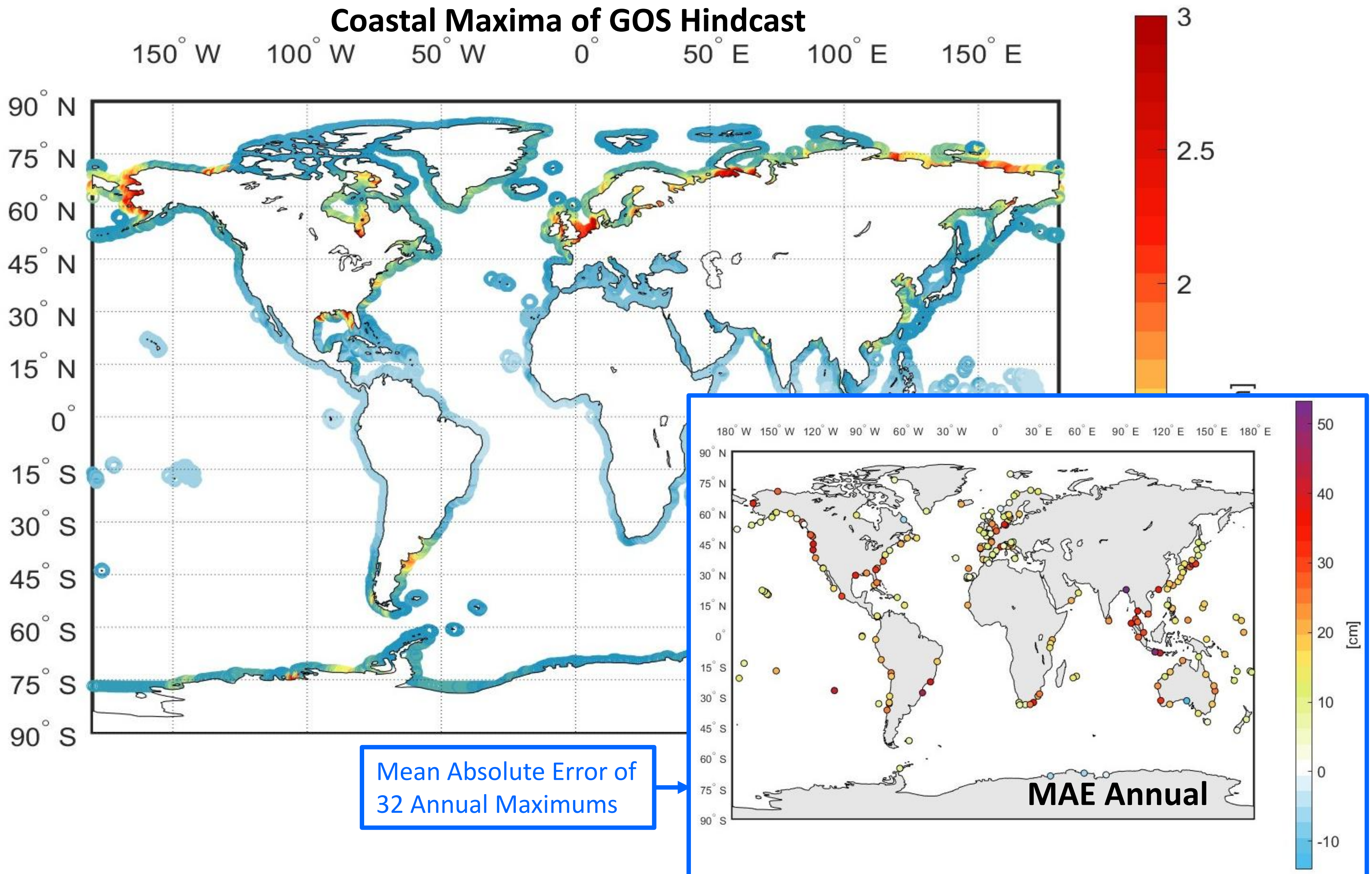
RMSE



NRMSE



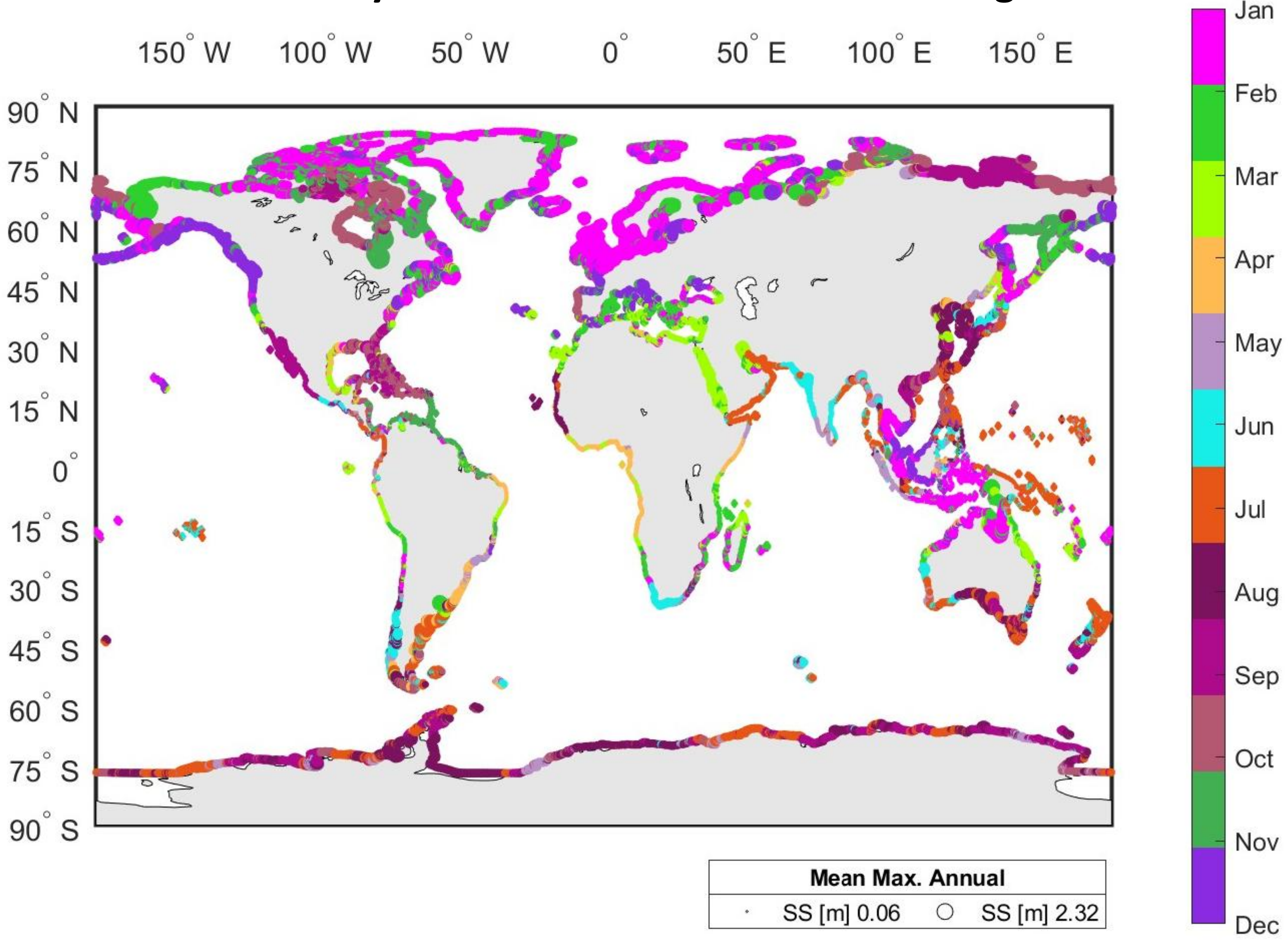
Climatical analysis



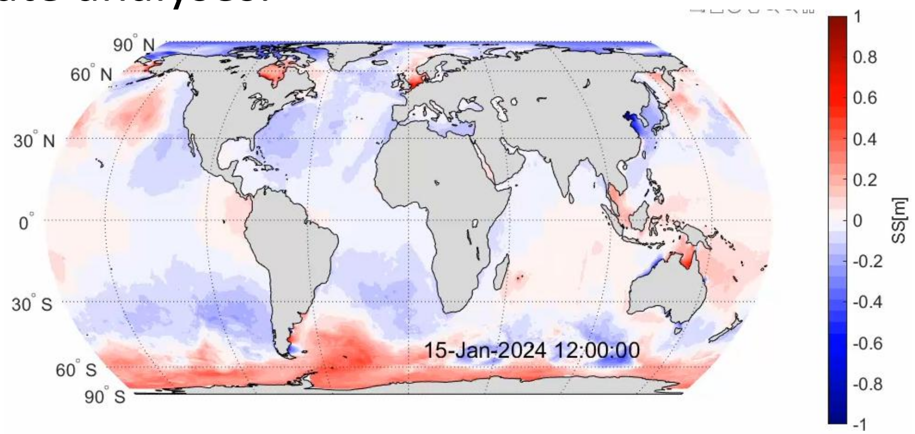
Mean Absolute Error of 32 Annual Maximums

Climatical analysis

Monthly occurrence of extreme storm surges



- ***Global Ocean surge*** has > 30-year hindcast from 1993 of storm surge with hourly resolution for climate analyses.



- **GOS** was validated against more than 200 tide gauges, showing RMSE < 15 cm and correlation > 0.9 in most cases.
- **GOS** reproduces the most relevant extreme climate events. **GOS** extreme storm surges are validated showing MAE < 15cm
- Radiational tide signal identified and extracted on the **GOS** Coastal grid points
- Characterization of extreme storm surge seasonal climatologies

Ongoing work:

- Paper in progress
- Extreme value statistical analysis

Thanks!!
The GOS (Global Ocean Surge) hindcast

Elsy Ticse
kticse@unican.es

- *Jonathan Valle*
- *Melisa Menéndez*
- *Ana Julia Abascal*
- *Alissé Chaigneau*

18 TG DE REFERENCIA