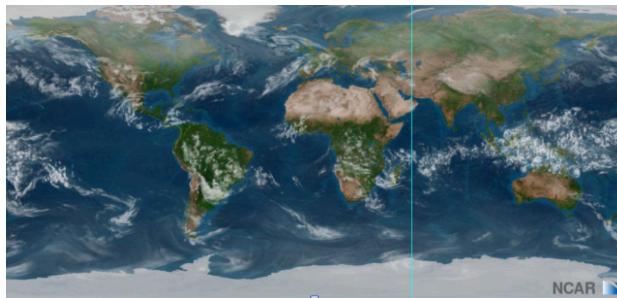
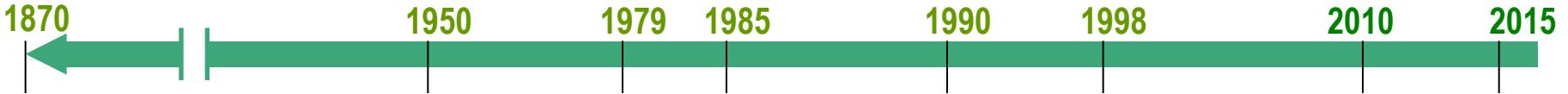


Global reconstructed daily surge levels from the 20th century reanalysis (1871-2010)

Alba Cid, Paula Camus, Sonia Castanedo, Fernando Méndez and Raúl Medina

Environmental Hydraulics Institute "IH Cantabria", Universidad de Cantabria (Spain)

Motivation

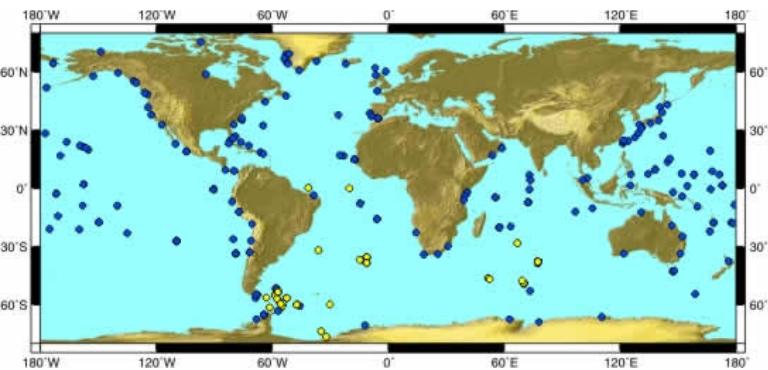


Atmospheric Reanalysis

NCEP/NCAR

20CRv2

ERA-INTERIM/CFSR/MERRA

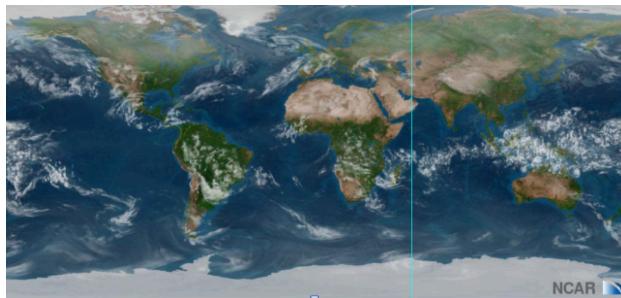
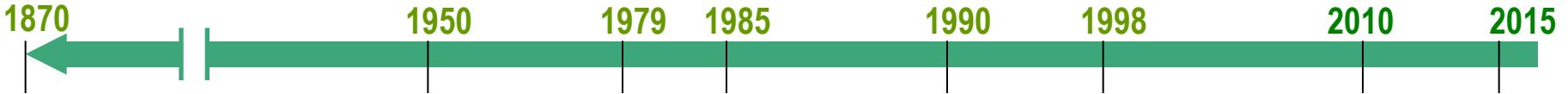


Observations

SATELLITE

TIDAL GAUGES

Motivation

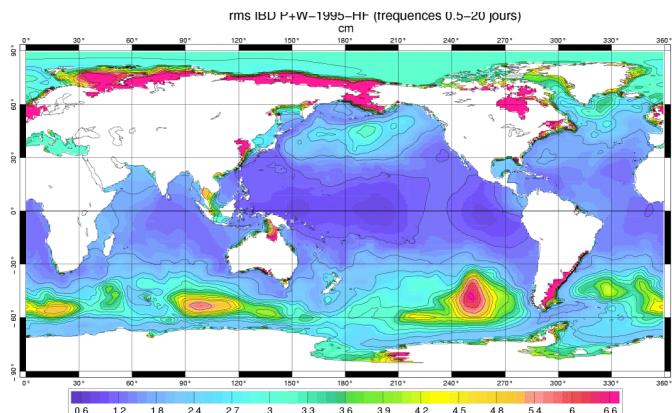


Atmospheric Reanalysis

NCEP/NCAR

20CRv2

ERA-INTERIM/CFSR/MERRA



Surge Hindcast
(2D shallow water models forced
by atmospheric reanalysis)

Regional Surge Hindcasts (Haigh et al 2013, Cid et al 2013, forced with NCEP/NCAR)

Global Surge Hindcast, DAC (AVISO), forced with ERA-INTERIM

OBJECTIVE



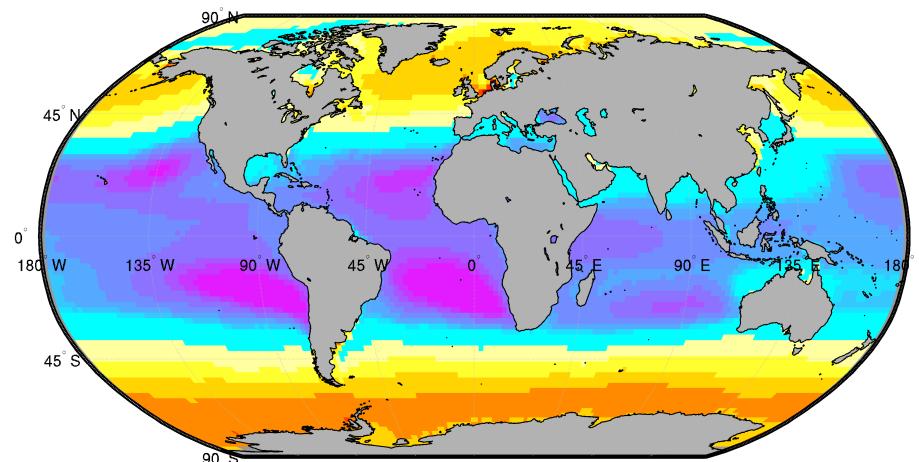
20CRv2, 20th century reanalysis, Compo et al 2011

Global Surge Hindcast, DAC (AVISO), forced with ERA-INTERIM

DAC* "Dynamic atmospheric Corrections are produced by CLS Space Oceanography Division using the Mog2D model from Legos and distributed by Aviso, with support from Cnes (<http://www.aviso.altimetry.fr/>)".

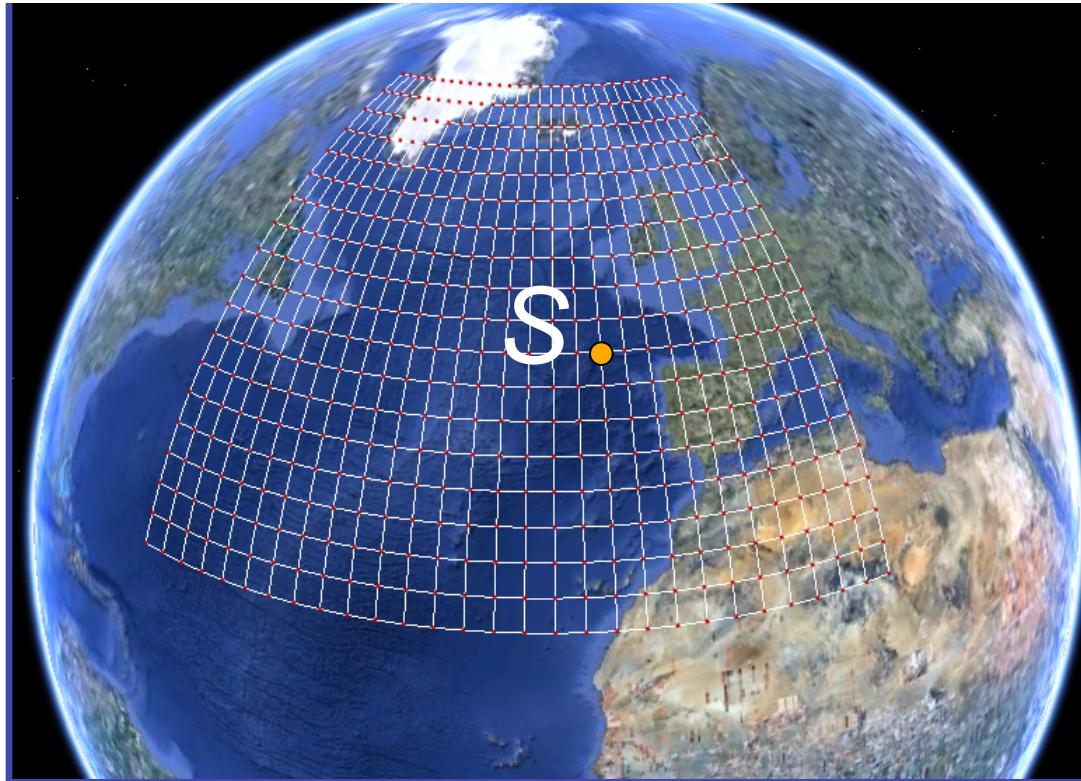
Global Surge Hindcast forced by 20CRv2

Development of a **global** and **long-term surge database**
(1871-2010) based on statistical downscaling

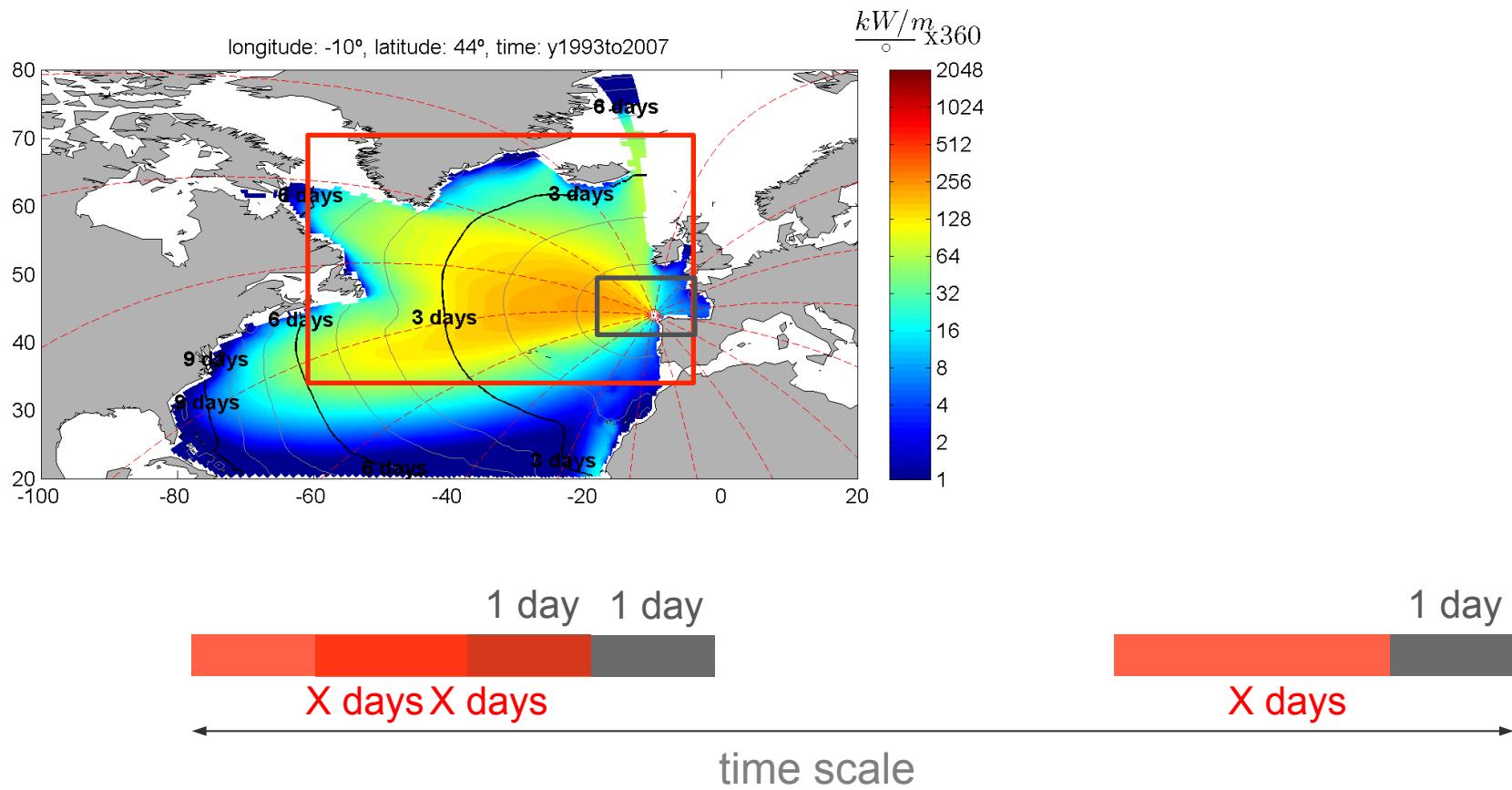


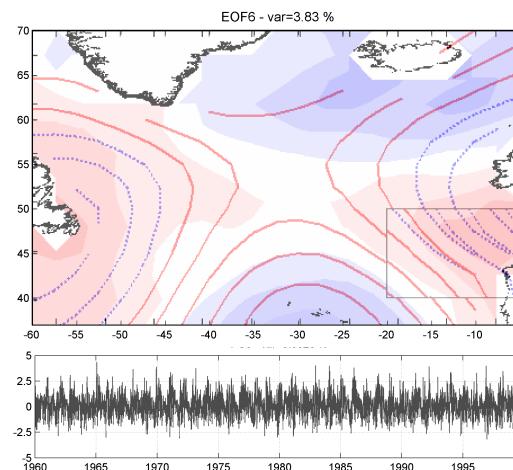
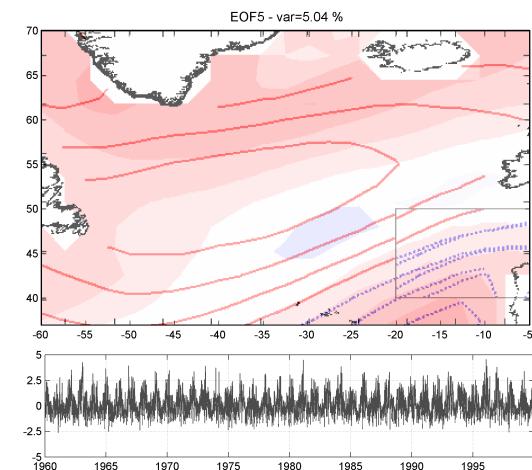
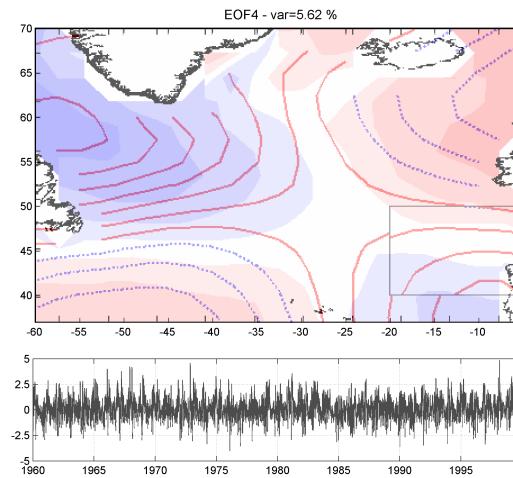
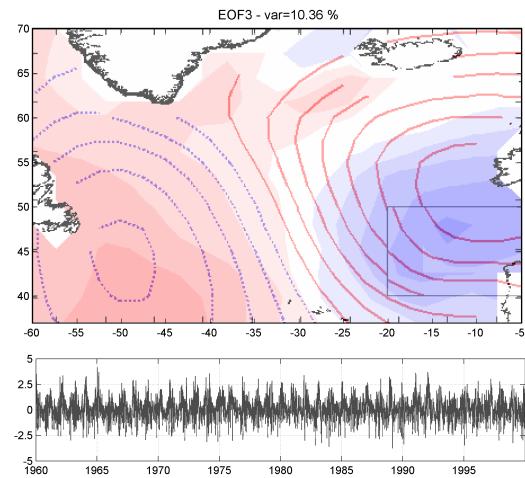
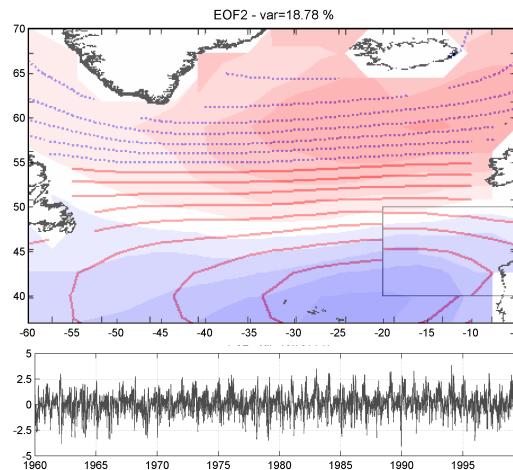
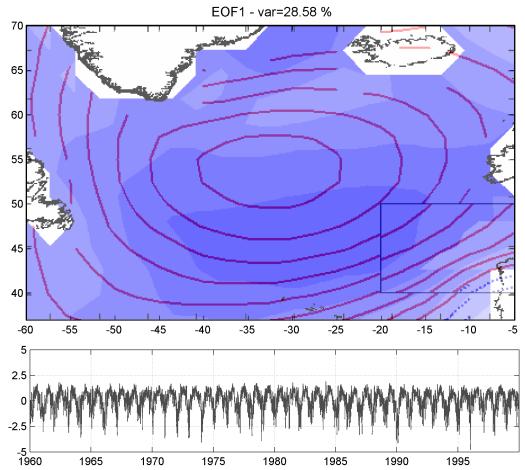
A method for finding the optimal predictor indices for local wave climate conditions

Paula Camus · Fernando J. Méndez · Inigo J. Losada ·
Melisa Menéndez · Antonio Espejo · Jorge Pérez ·
Ana Rueda · Yanira Guanche



DEFINITION OF PREDICTOR AT DAILY SCALE: Spatial domain and historical temporal coverage ESTELA (Pérez et al., 2014)





MULTIVARIATE LINEAR REGRESSION

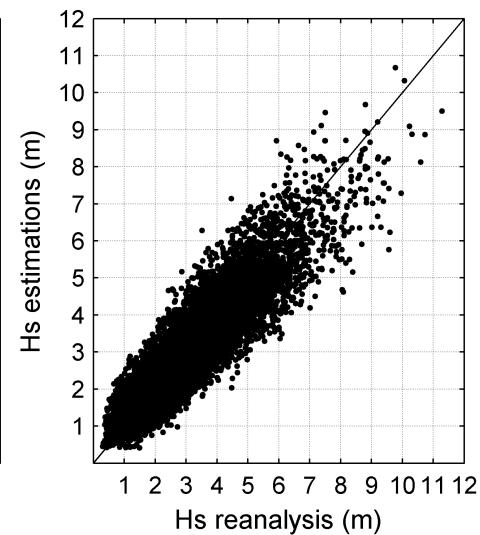
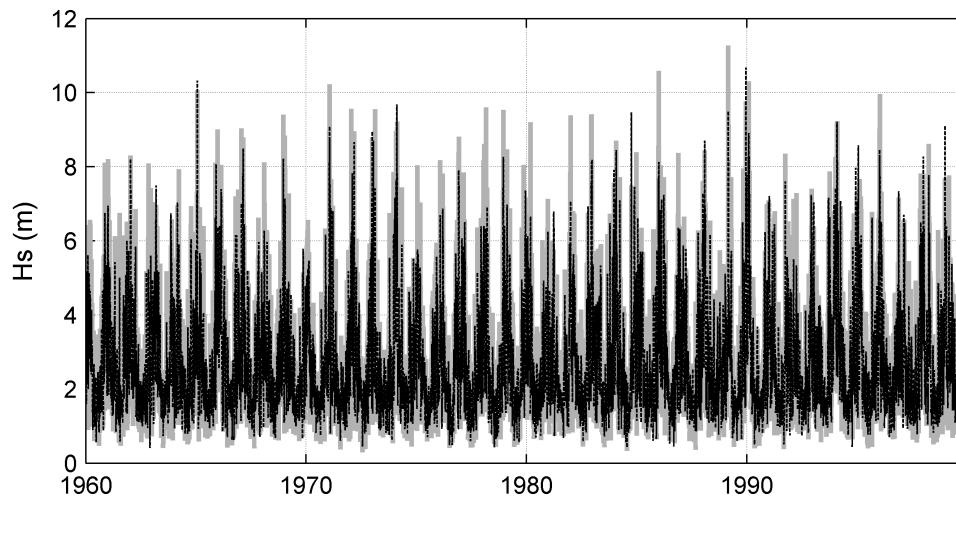
Predictors are selected in a forward procedure $Y_d = f(X_d)$

$$M_1 : Y_d(t) = a + b_1 PC_d^1(t)$$

$$M_2 : Y_d(t) = a + b_1 PC_d^1(t) + b_2 PC_d^2(t)$$

...

$$M_N : Y_d(t) = a + \sum_{i=1}^N b_i PC_d^i(t)$$



Ocean database

DAC (Dynamic Atmospheric Correction)

- Global coverage at 0.25°
- Sept 1992 – present
- Every 6 hours
- MOG2D* (T<20 days) + IB (T>20 days)
- MOG2D forced with ERA-Interim **pressure** & **wind** fields

Atmospheric databases

ERA-interim

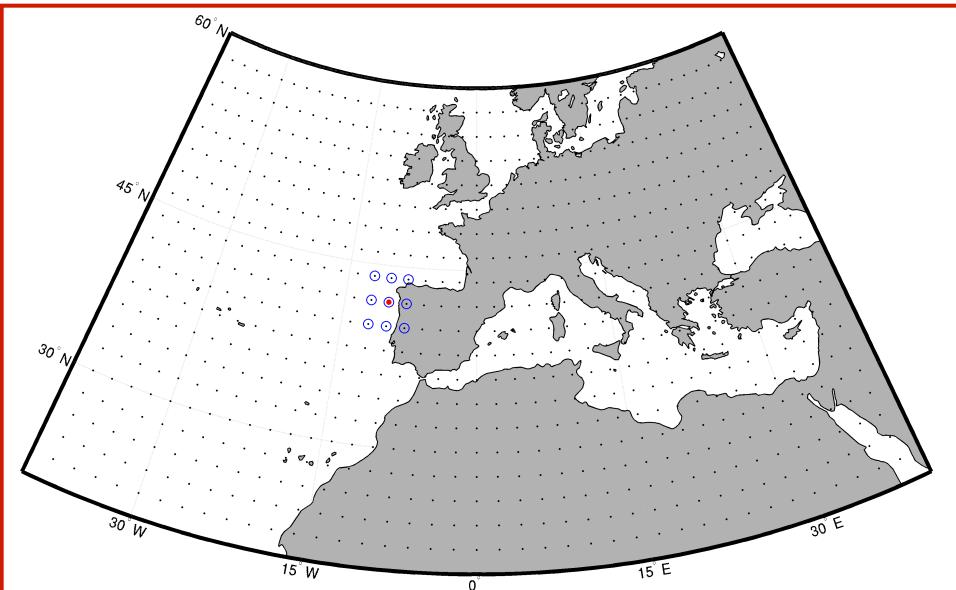
- Global coverage at 0.75°
- 1979 – present → from sept 1992
- Every 6 hours

20th century reanalysis

- Global coverage at 2°
- 1871-2010
- Every 6 hours

* Derived from Lynch and Gray (1979)

Ocean database



Spatial domain of $4^{\circ} \times 4^{\circ}$ centred at predictand point

Predictor: **PCs** of SLP and gradients that **explain 95% of the variance**

Atmospheric databases

ERA-interim

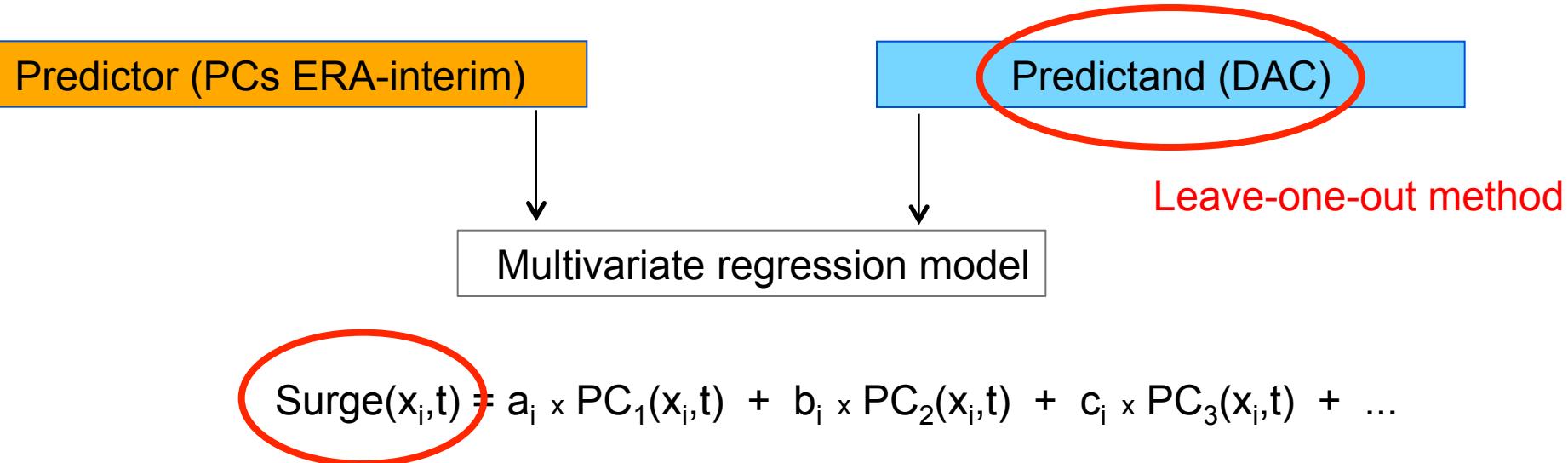
Daily means of SLP and gradients every 2°

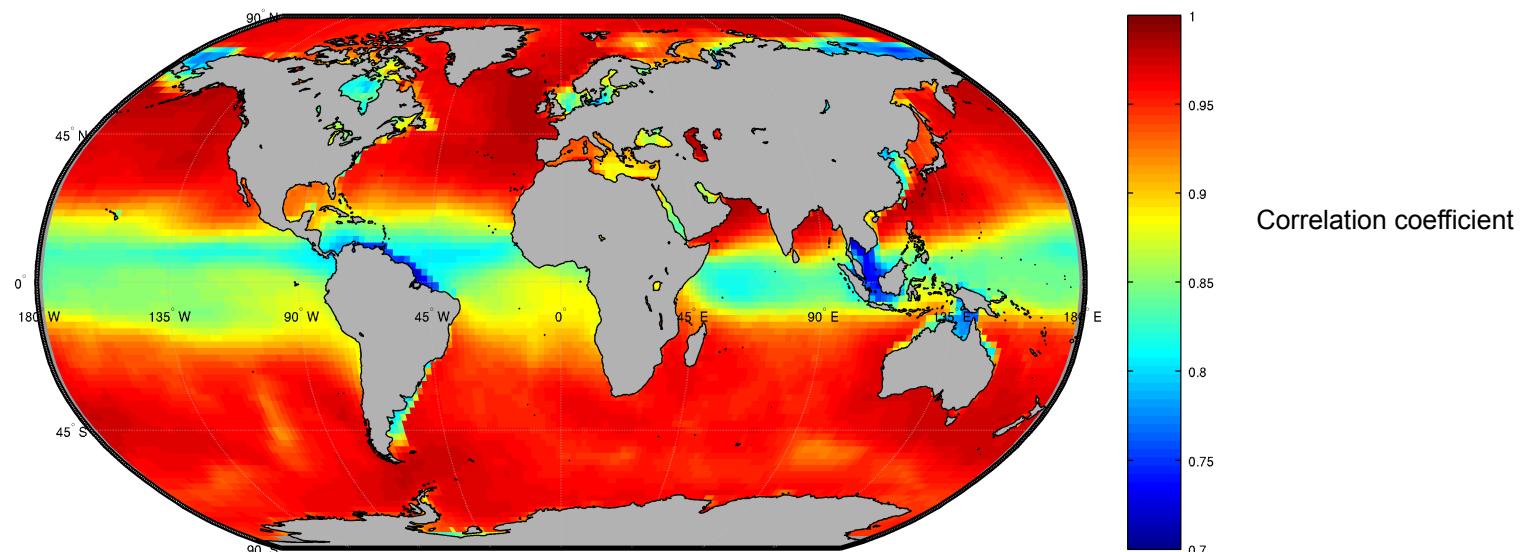
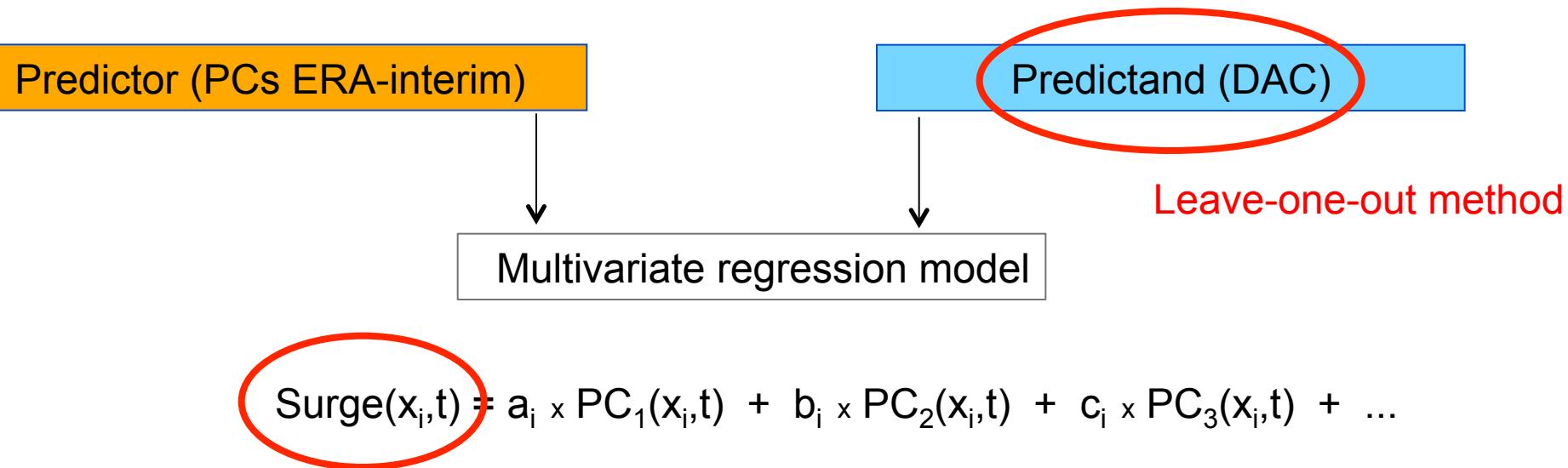
20th century reanalysis

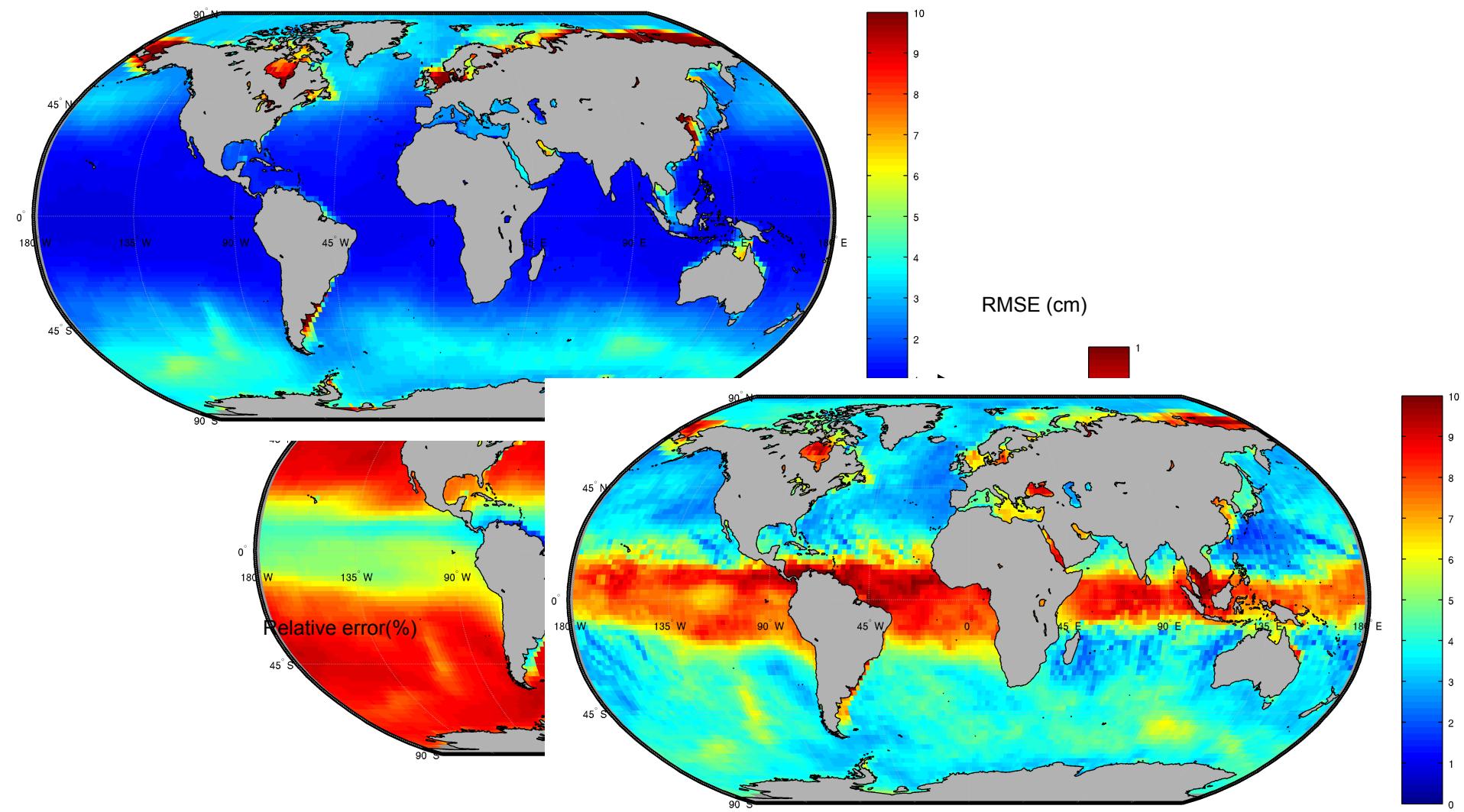
Daily means of SLP and gradients every 2°

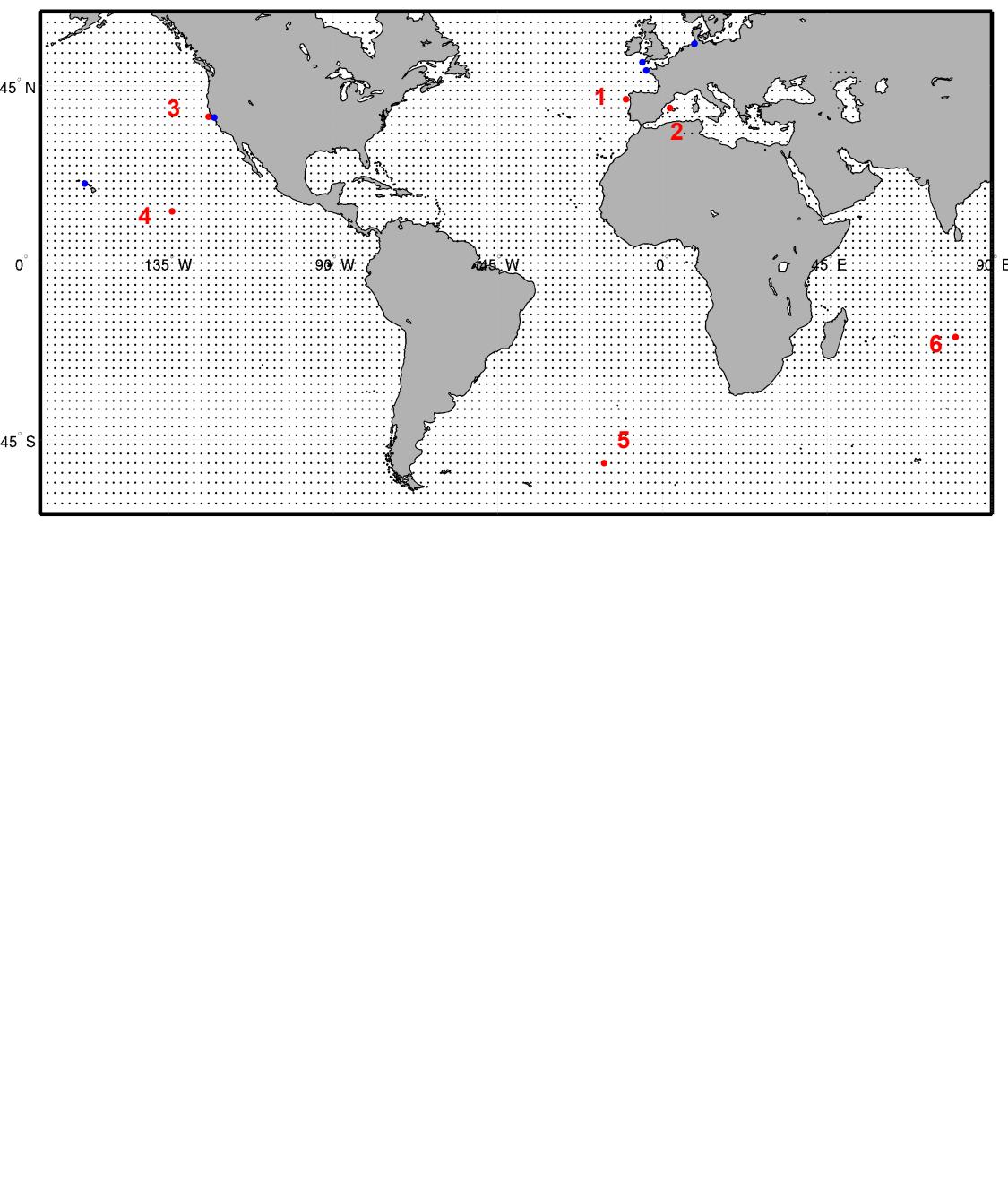
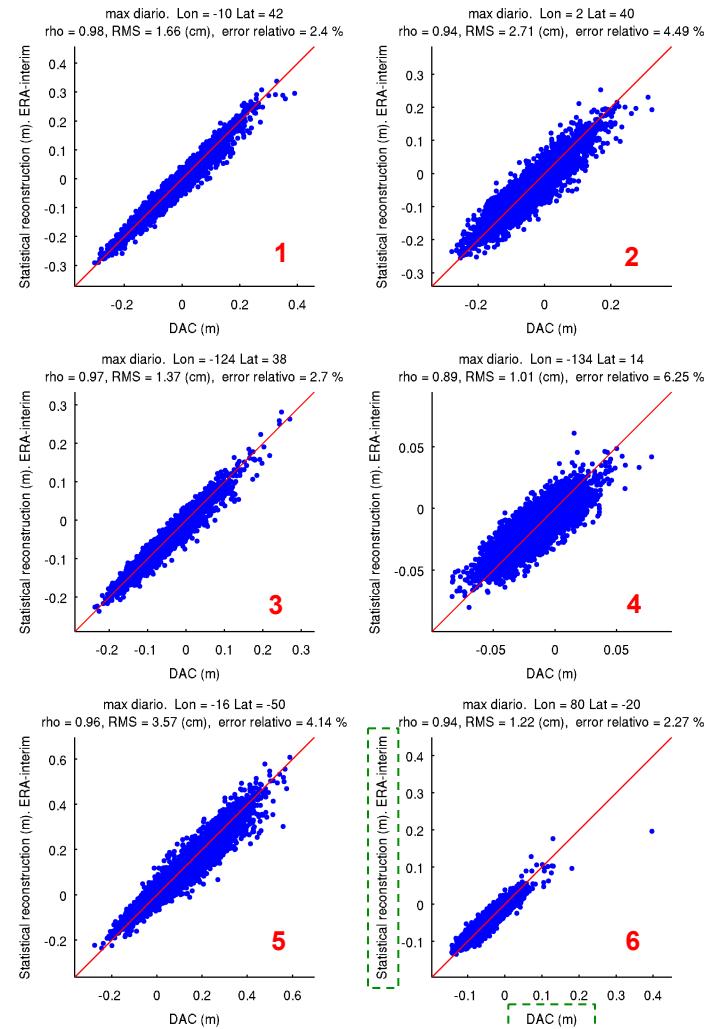


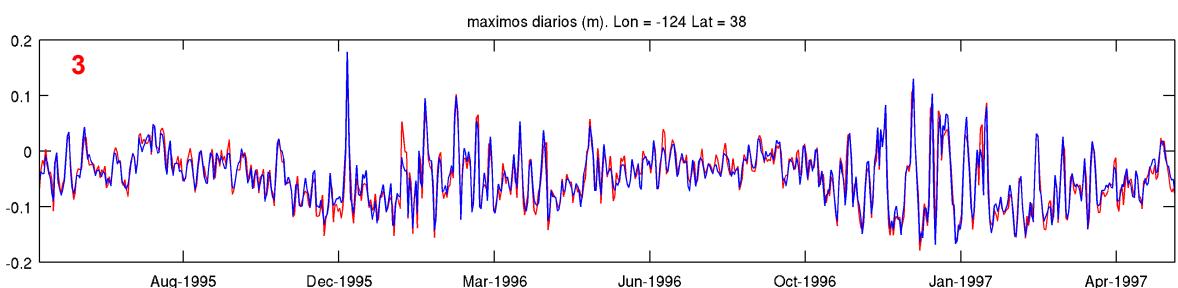
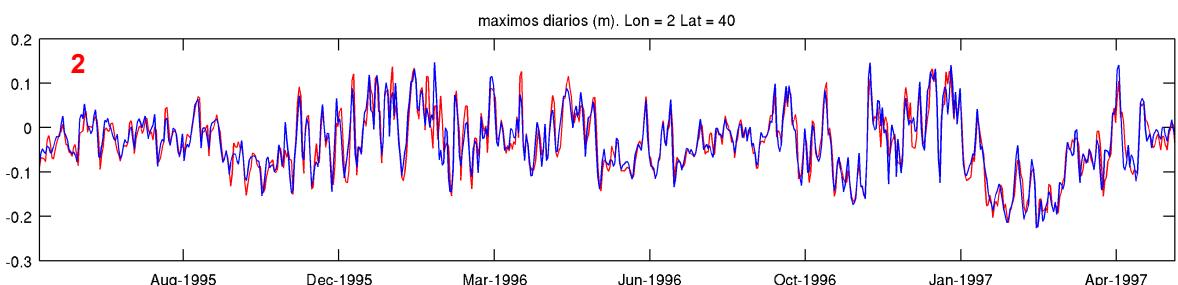
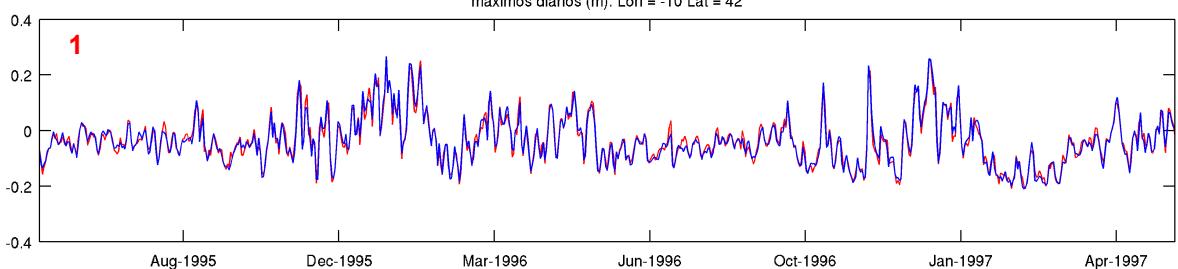
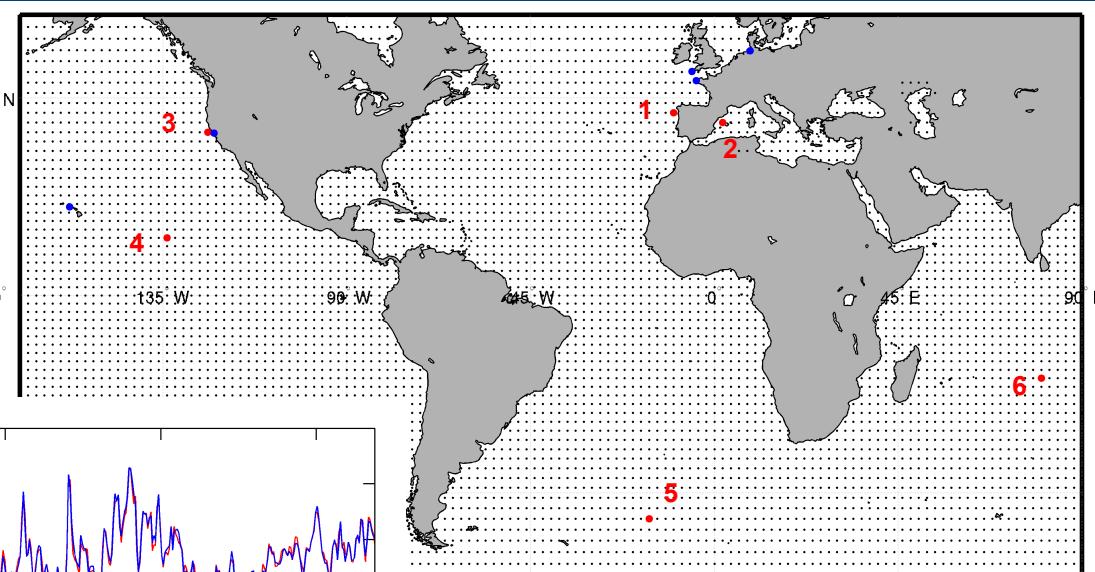
$$\text{Surge}(x_i, t) = a_i \times PC_1(x_i, t) + b_i \times PC_2(x_i, t) + c_i \times PC_3(x_i, t) + \dots$$



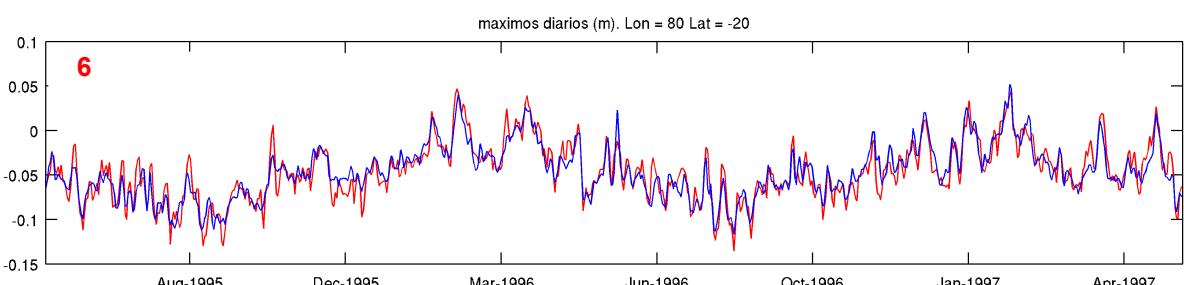
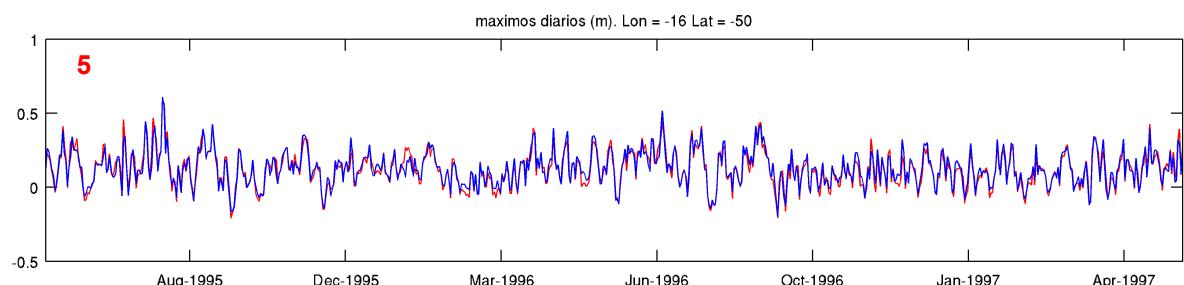
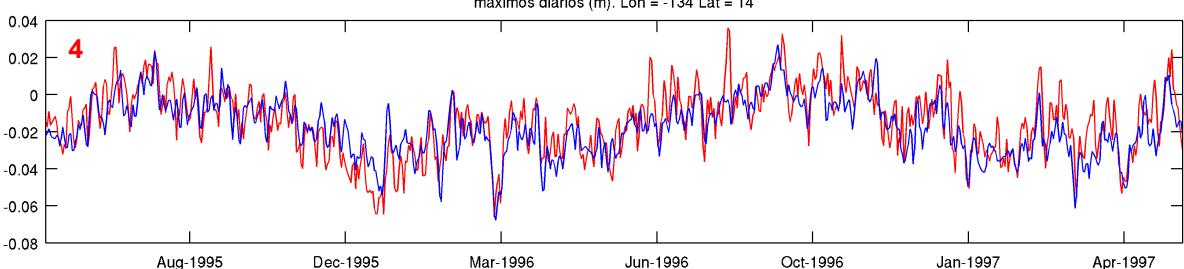
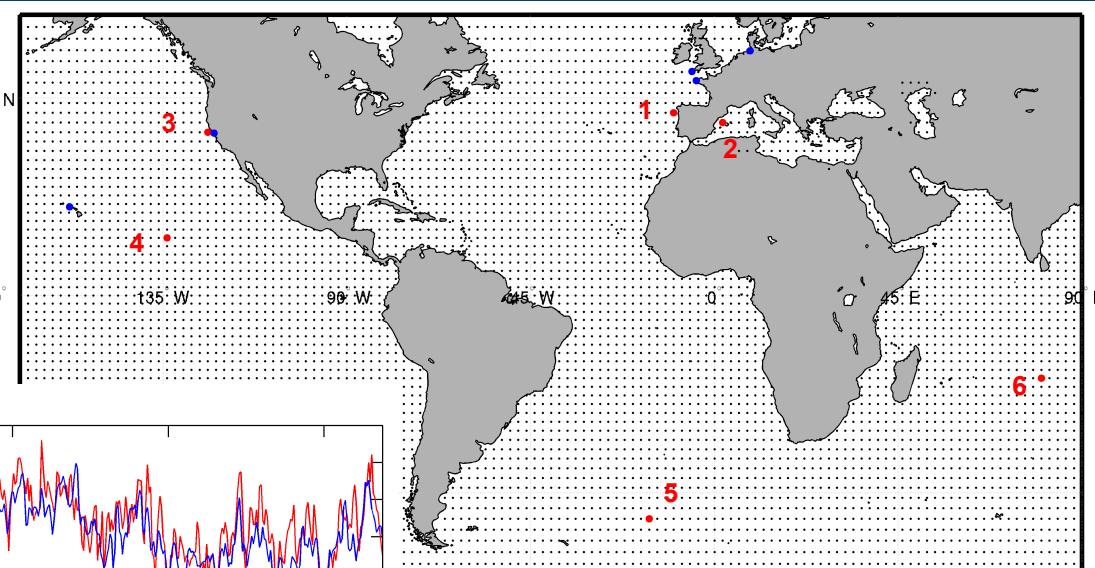




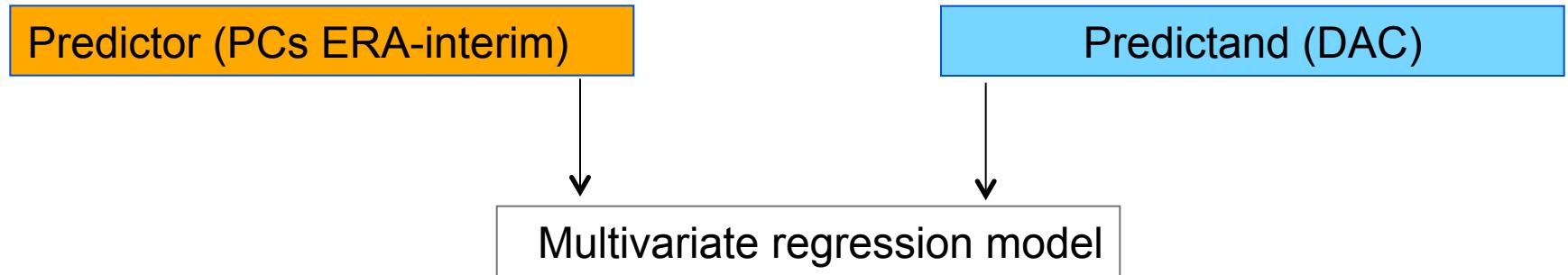




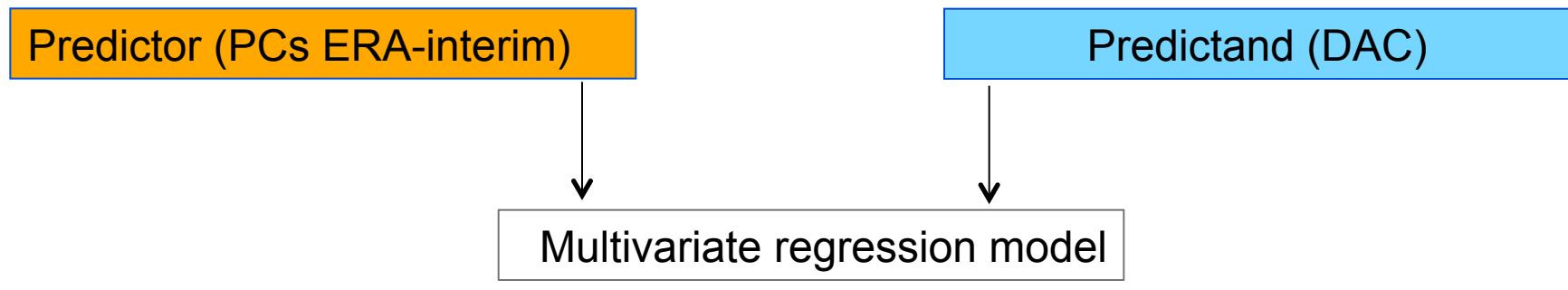
— DAC
Reconstruction ERA-interim



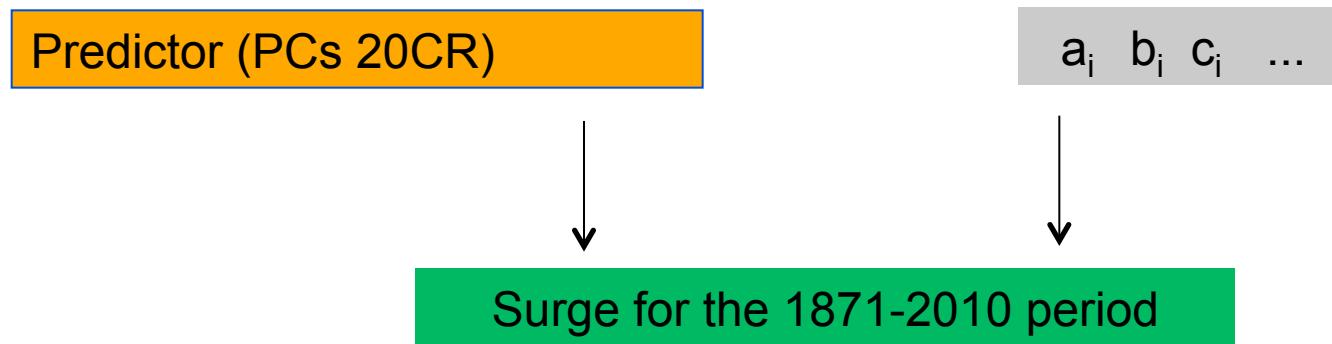
— DAC
— Reconstruction ERA-interim

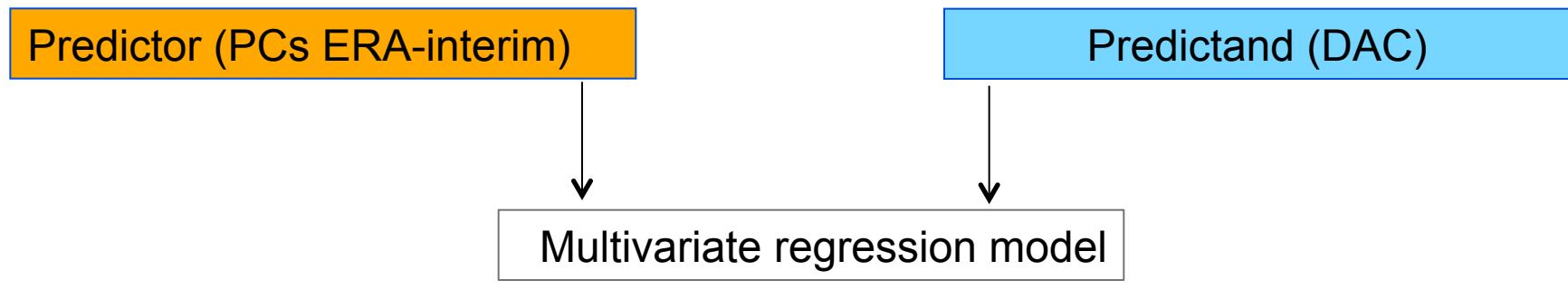


$$\text{Surge}(x_i, t) = a_i \times \text{PC}_1(x_i, t) + b_i \times \text{PC}_2(x_i, t) + c_i \times \text{PC}_3(x_i, t) + \dots$$

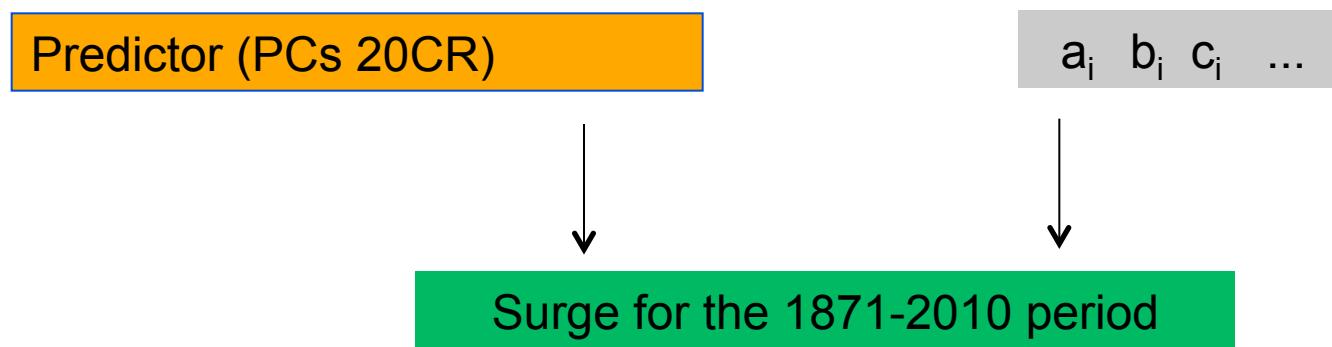


$$\text{Surge}(x_i, t) = a_i \times \text{PC}_1(x_i, t) + b_i \times \text{PC}_2(x_i, t) + c_i \times \text{PC}_3(x_i, t) + \dots$$



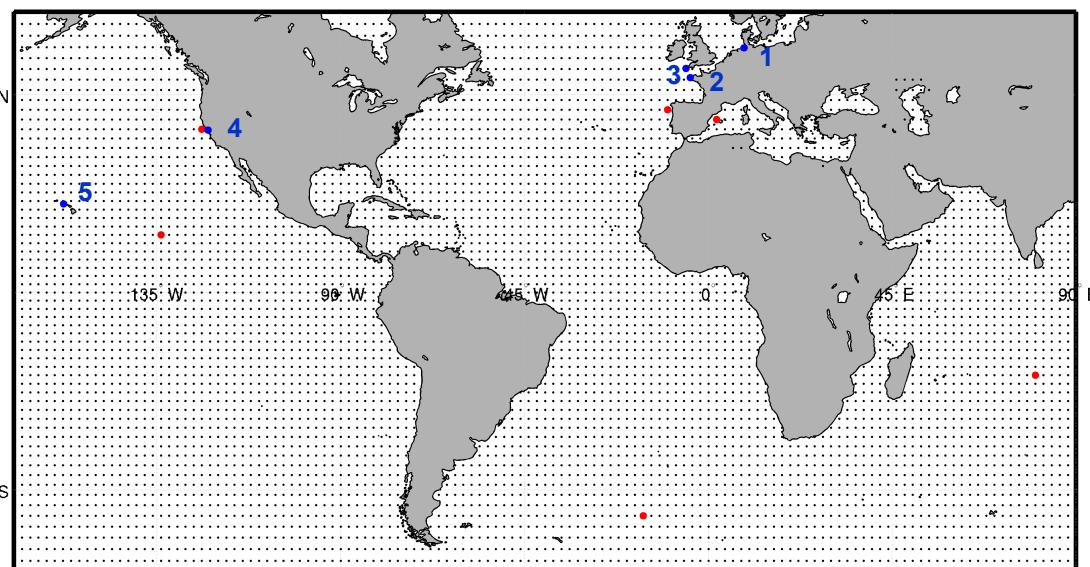


$$\text{Surge}(x_i, t) = a_i \times \text{PC}_1(x_i, t) + b_i \times \text{PC}_2(x_i, t) + c_i \times \text{PC}_3(x_i, t) + \dots$$

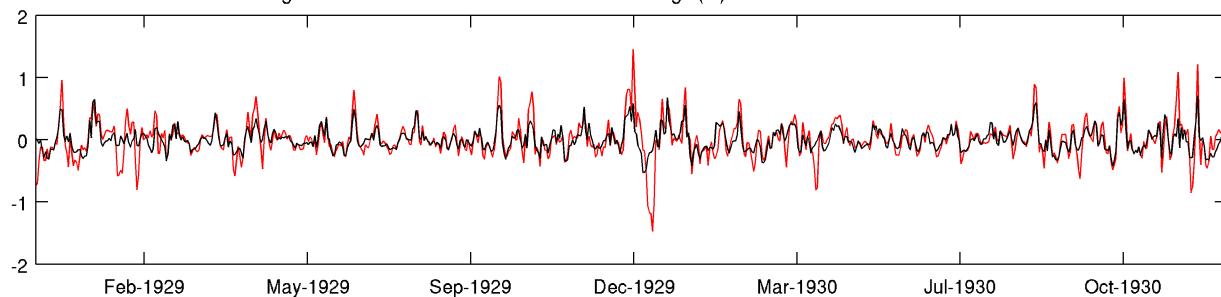


Comparison with tide gauges (from UHSLC)

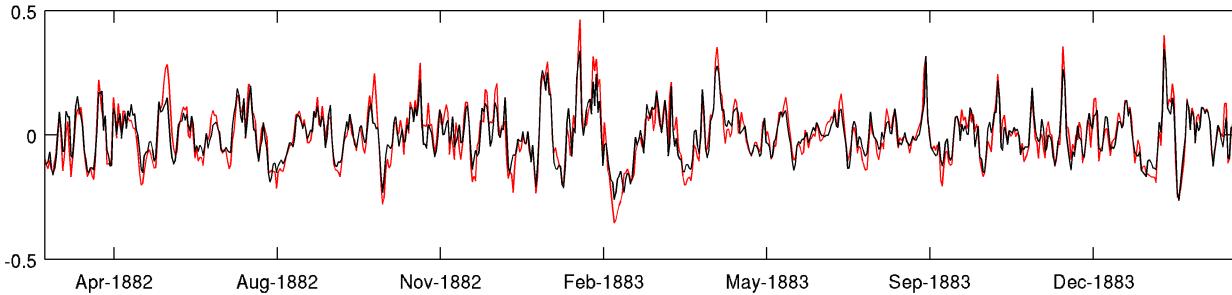
— Tide gauge
— Reconstruction 20CR

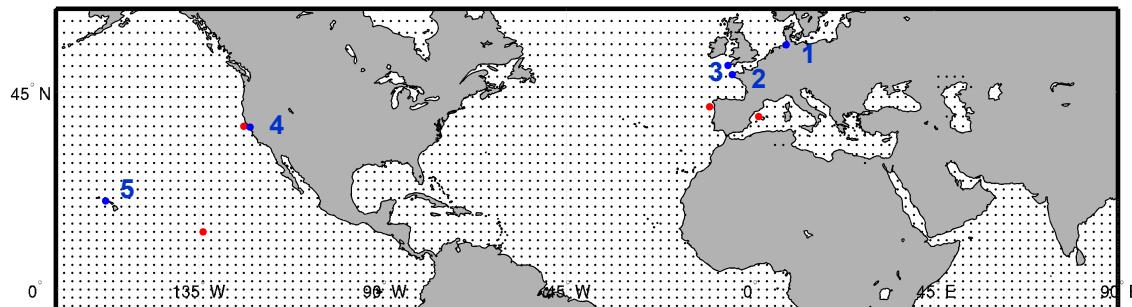


Mareógrafo de Cuxhaven. máximos diarios storm surge (m) restando la media mensual a ambos

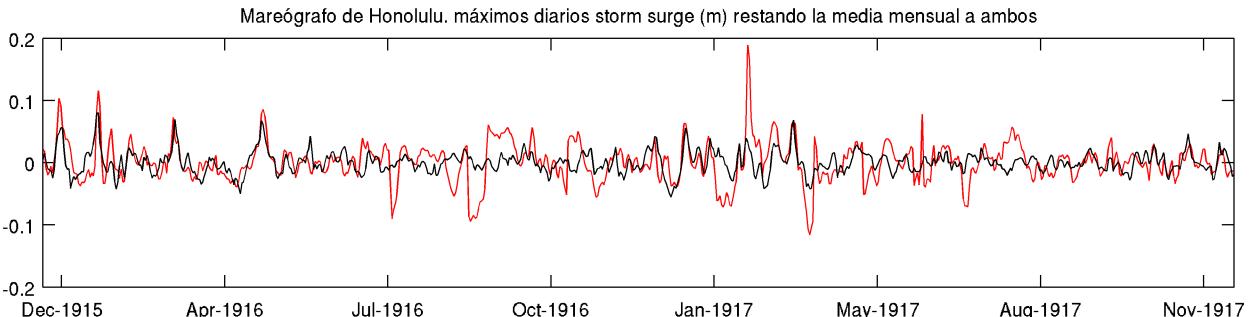
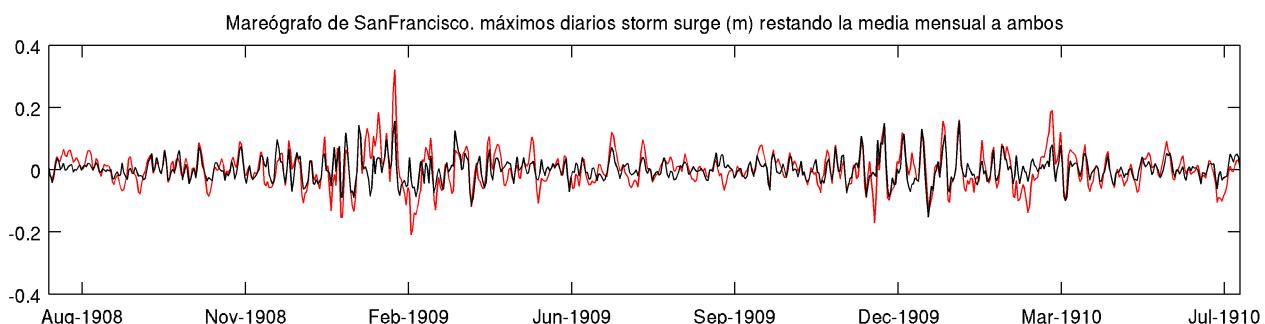
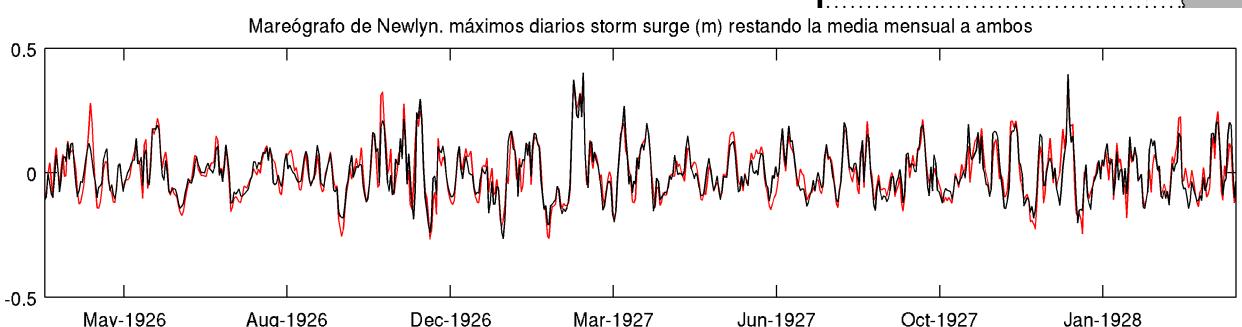


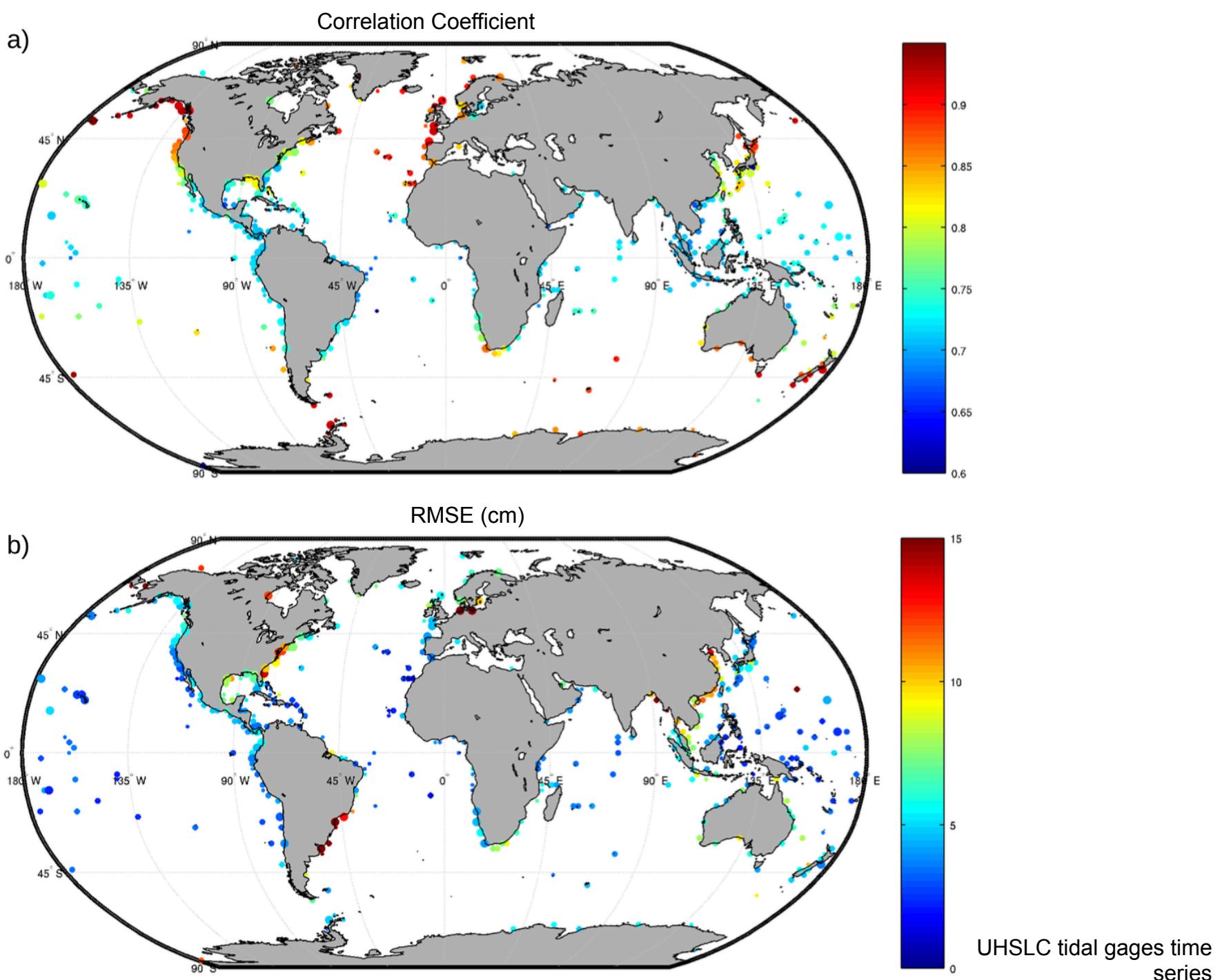
Mareógrafo de Brest. máximos diarios storm surge (m) restando la media mensual a ambos



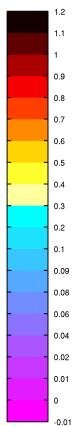
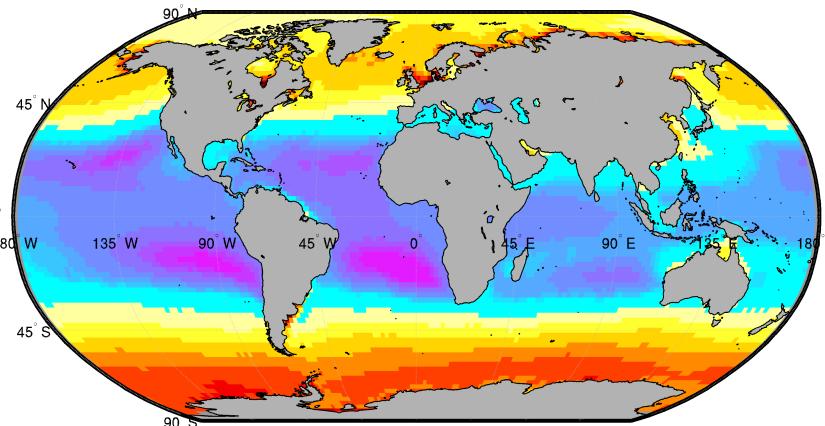


Tide gauge
Reconstruction 20CR

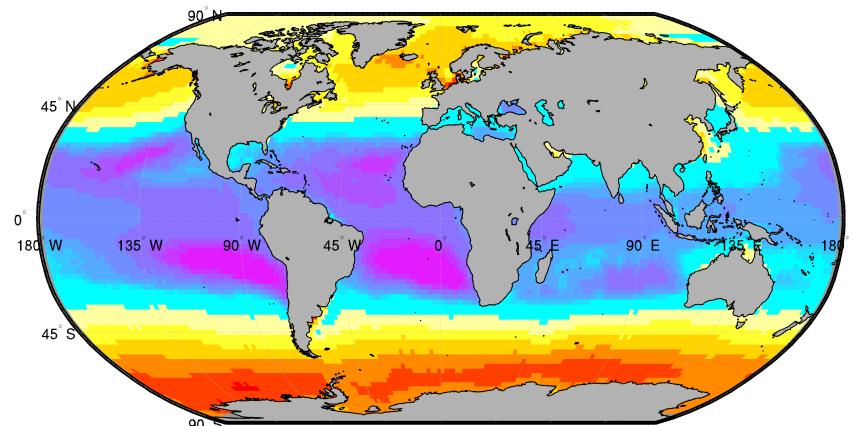




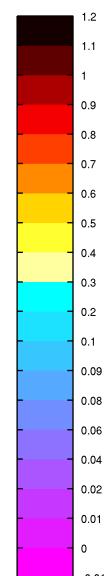
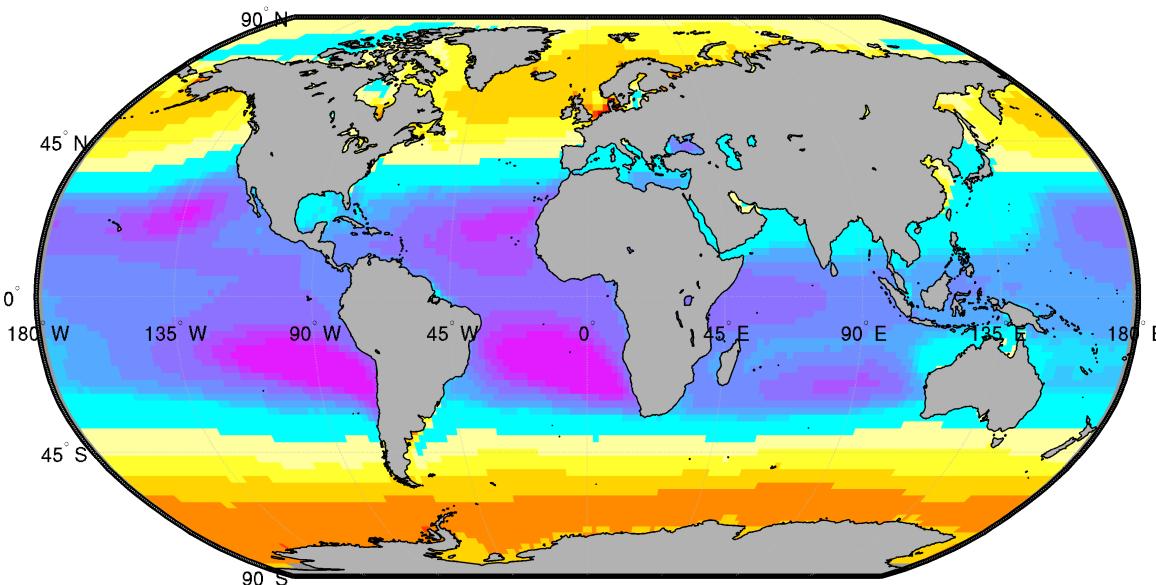
DAC 99.5% percentile (m)



20CR(1992-2010) 99.5% percentile (m)

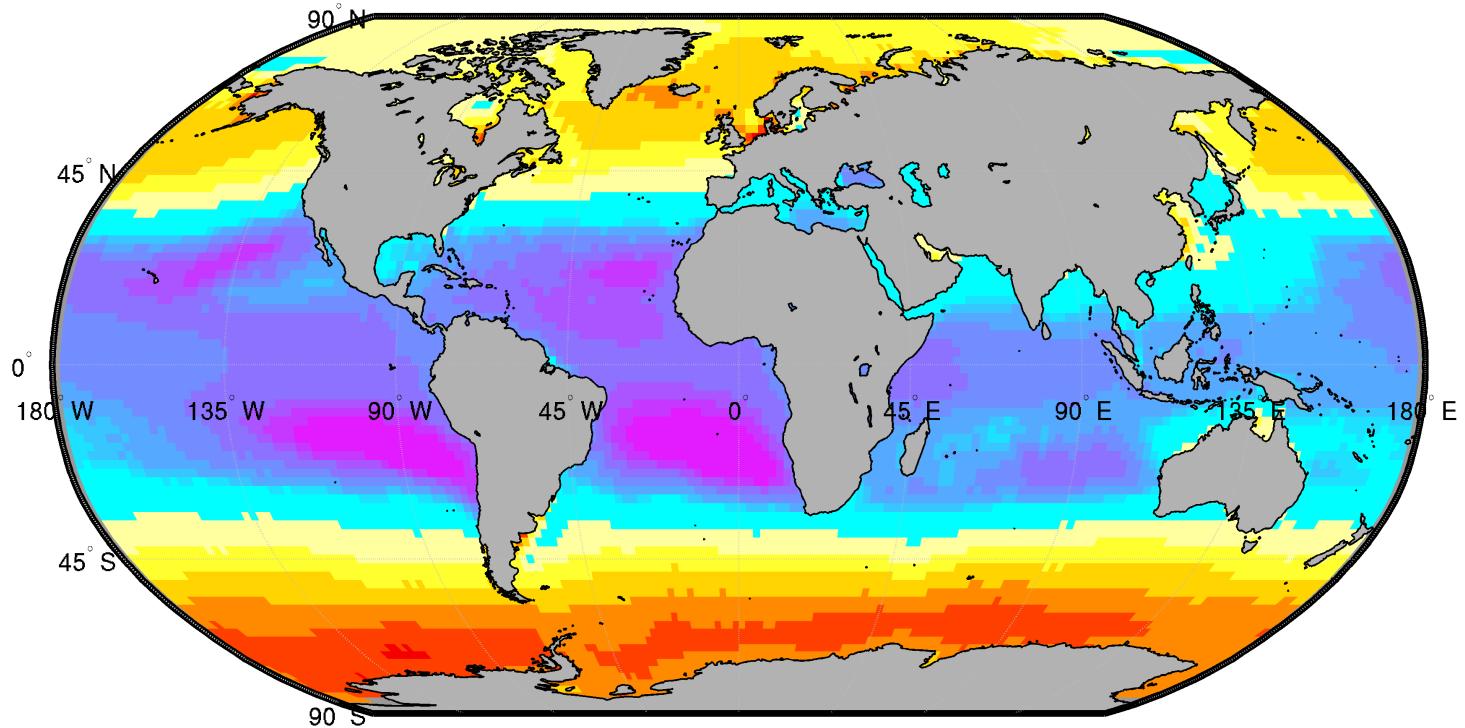


20CR(1871-2010) 99.5% percentile (m)



Concluding remarks

- Multivariate linear regression model: predictor (daily SLP and SLPG in $4^{\circ} \times 4^{\circ}$ area), predictand (daily surge level)
- New database of global atmospheric surges from 1871-2010
- Daily PCs at each location can be daily predictors / covariates of time-dependent statistical models
- Other time scales of interest: climate change projections, seasonal forecast
- The model can be applied also to fill gaps / extend time series



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