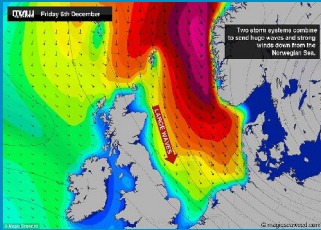# Downscaling coastal impacts in changing climates
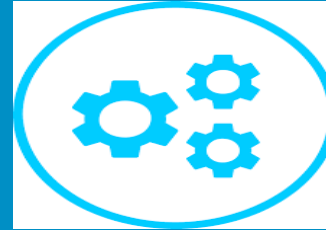
Jose A.A. Antolínez

jose.antolinez@deltares.nl
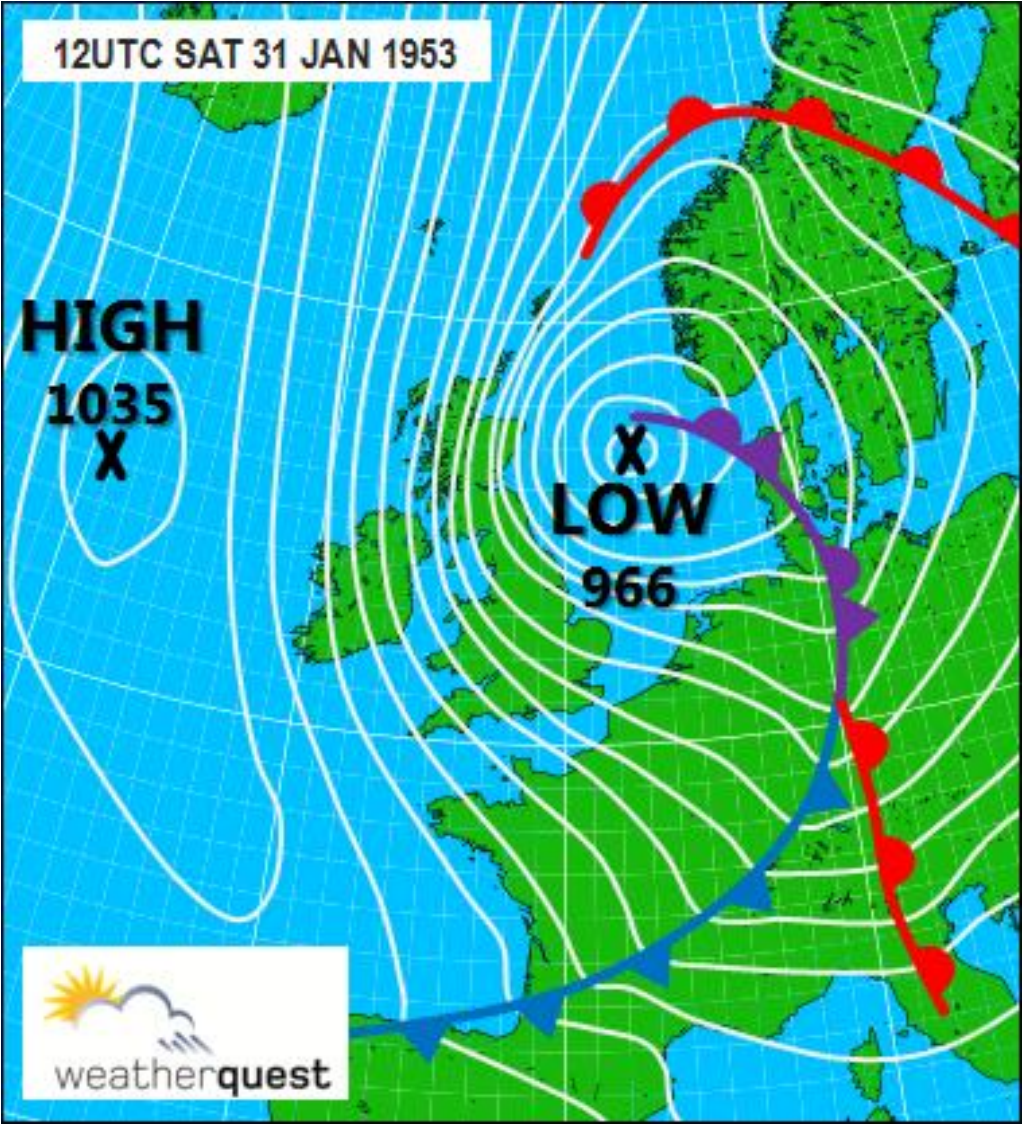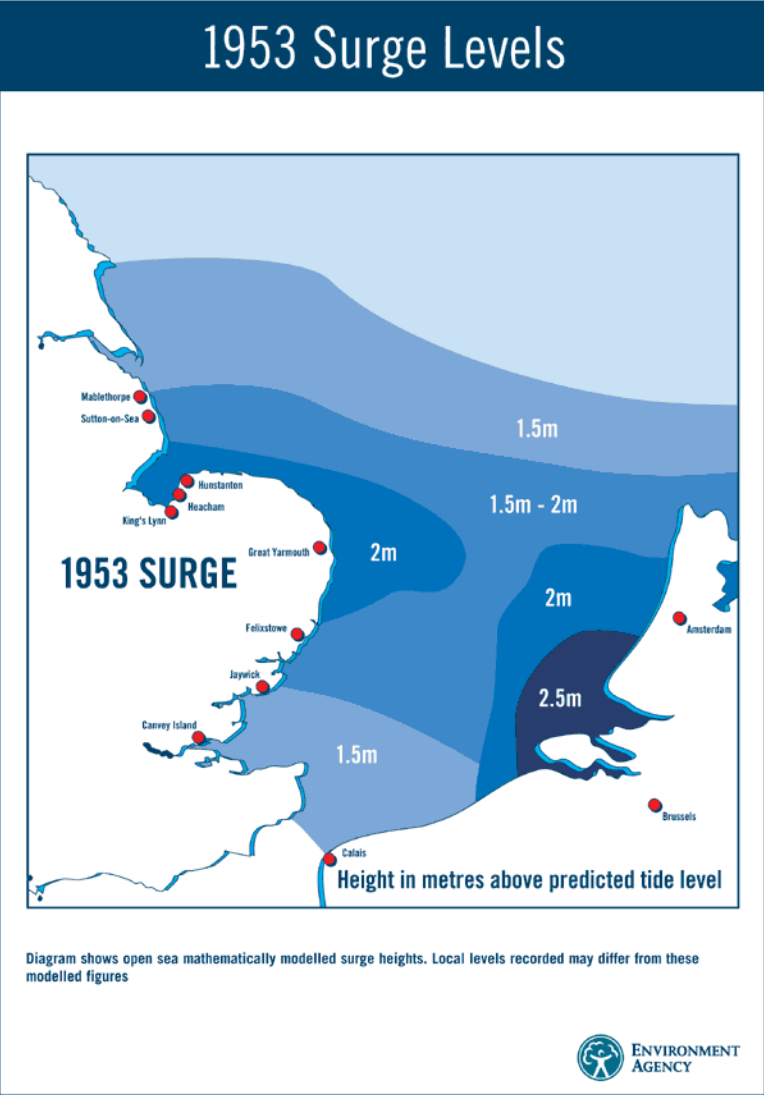
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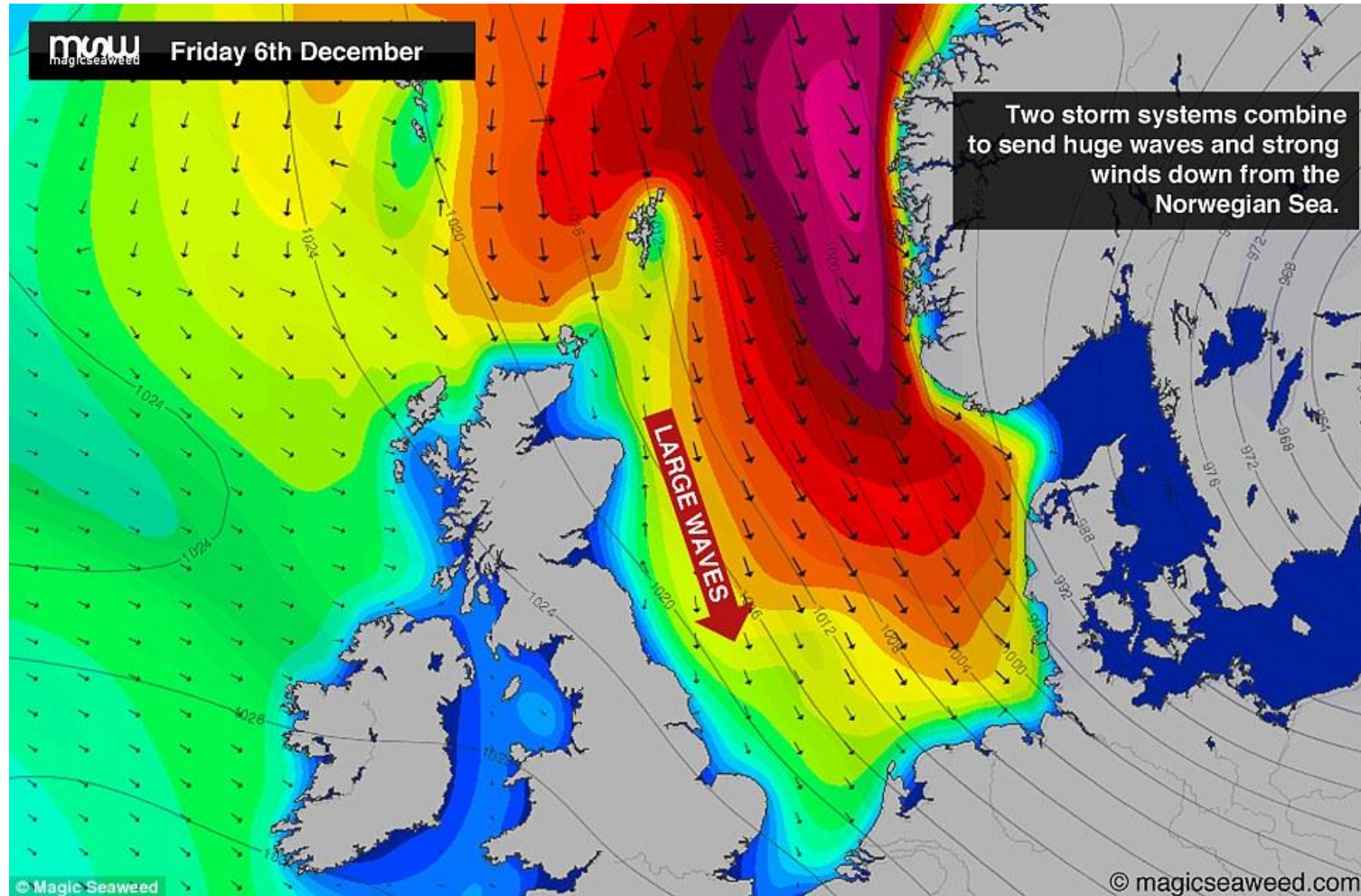
The perfect storm: 1953

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Deltares
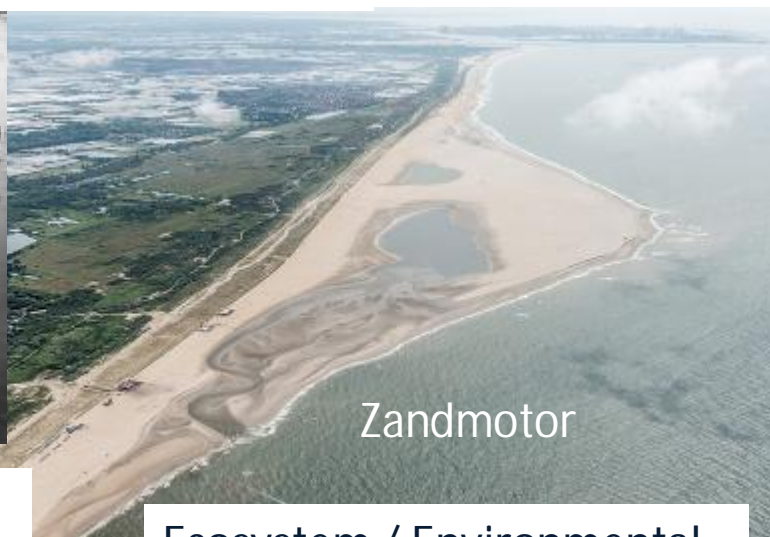
The perfect storm: Surge

The perfect storm: Waves

Applications

Defense / Protection
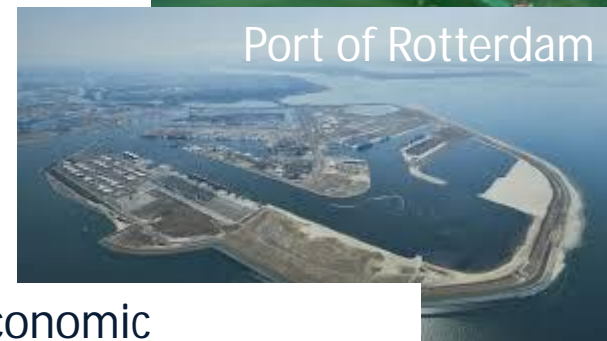
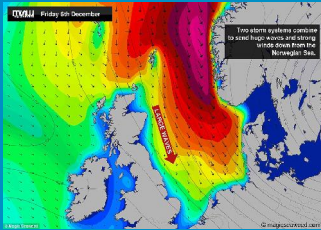Zuid-Beveland, flood of 1953

Zandmotor

Port of Rotterdam

Recreation

Scheveningen, 1900

Ecosystem / Environmental

Economic

Princess Amalia Wind Farm

Deltares

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COASTAL SEDIMENTS 2015

chapter 2 ■ Antolinez et al., 2016. A multi-scale climate emulator for long term morphodynamics. JGR Oceans

chapter 4 ■ Antolinez et al., 2018. Downscaling Changing Coastlines in a Changing Climate, the hybrid approach. JGR ES

chapter 5 ■ Antolinez et al., 2019. Predicting Climate-Driven Coastlines With a Simple and Efficient Multiscale Model. JGR ES
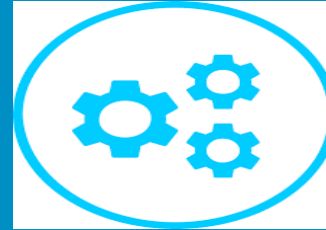
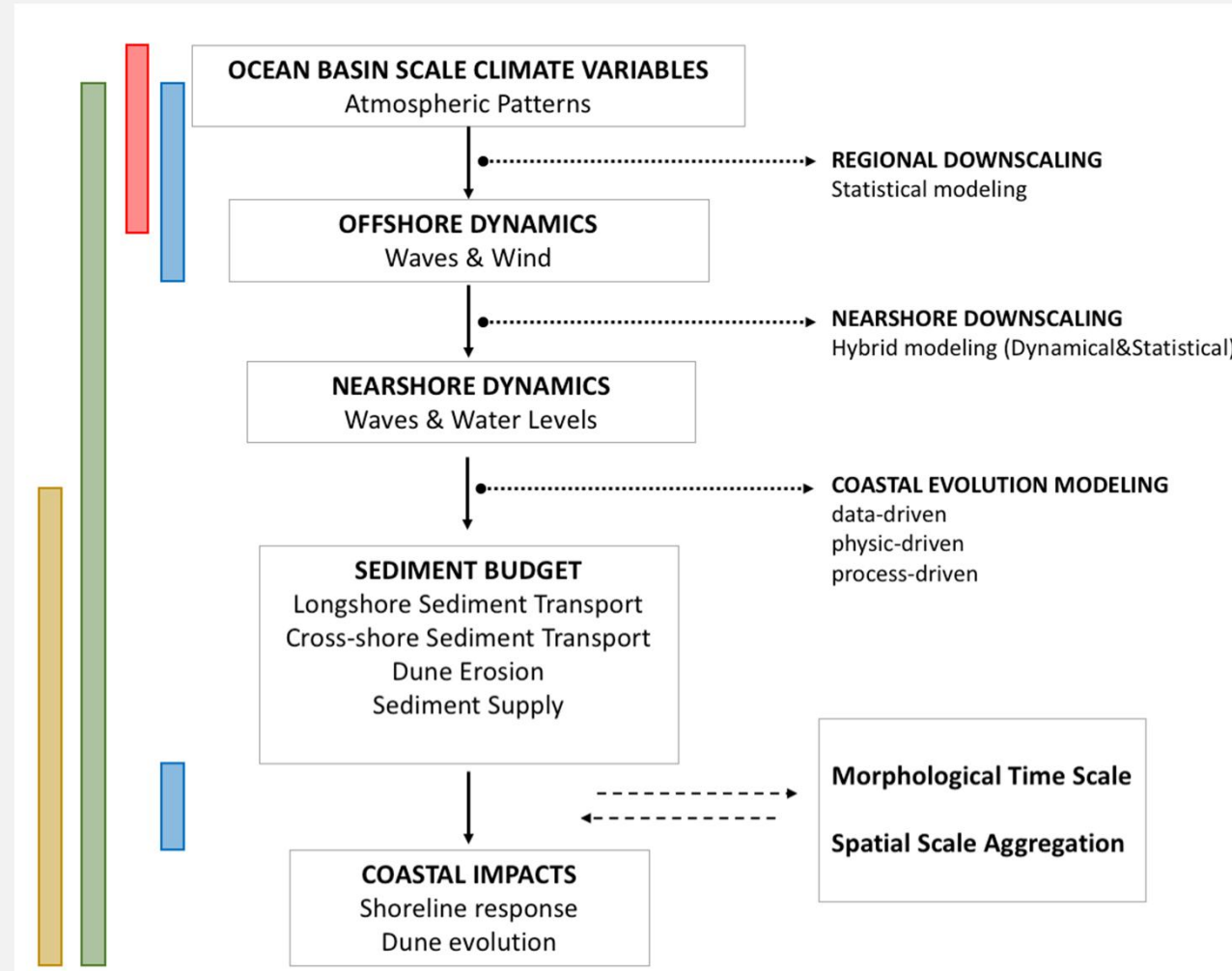COASTAL SEDIMENTS 2019

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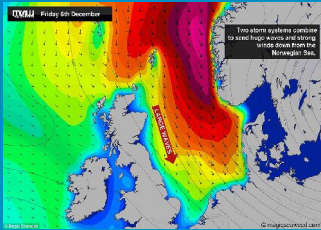COASTAL SEDIMENTS 2015

chapter 2 ■ Antolinez et al., 2016. A multi-scale climate emulator for long term morphodynamics. JGR Oceans

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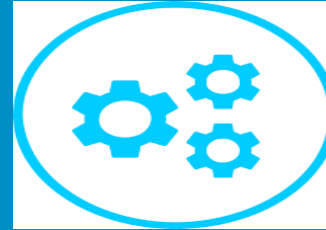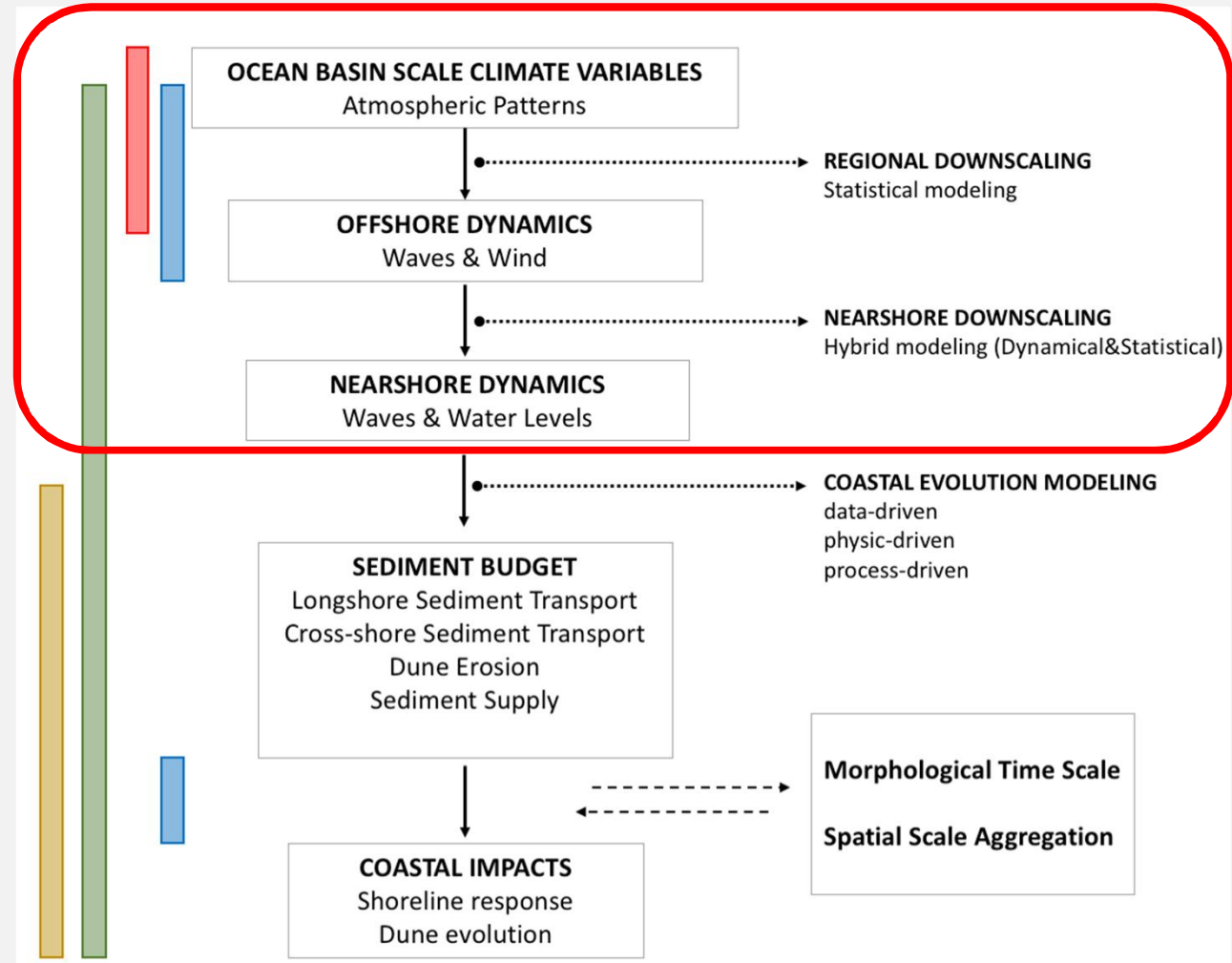
COASTAL SEDIMENTS 2019

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Regional Downscaling:
Statistical downscaling of offshore waves in Galicia
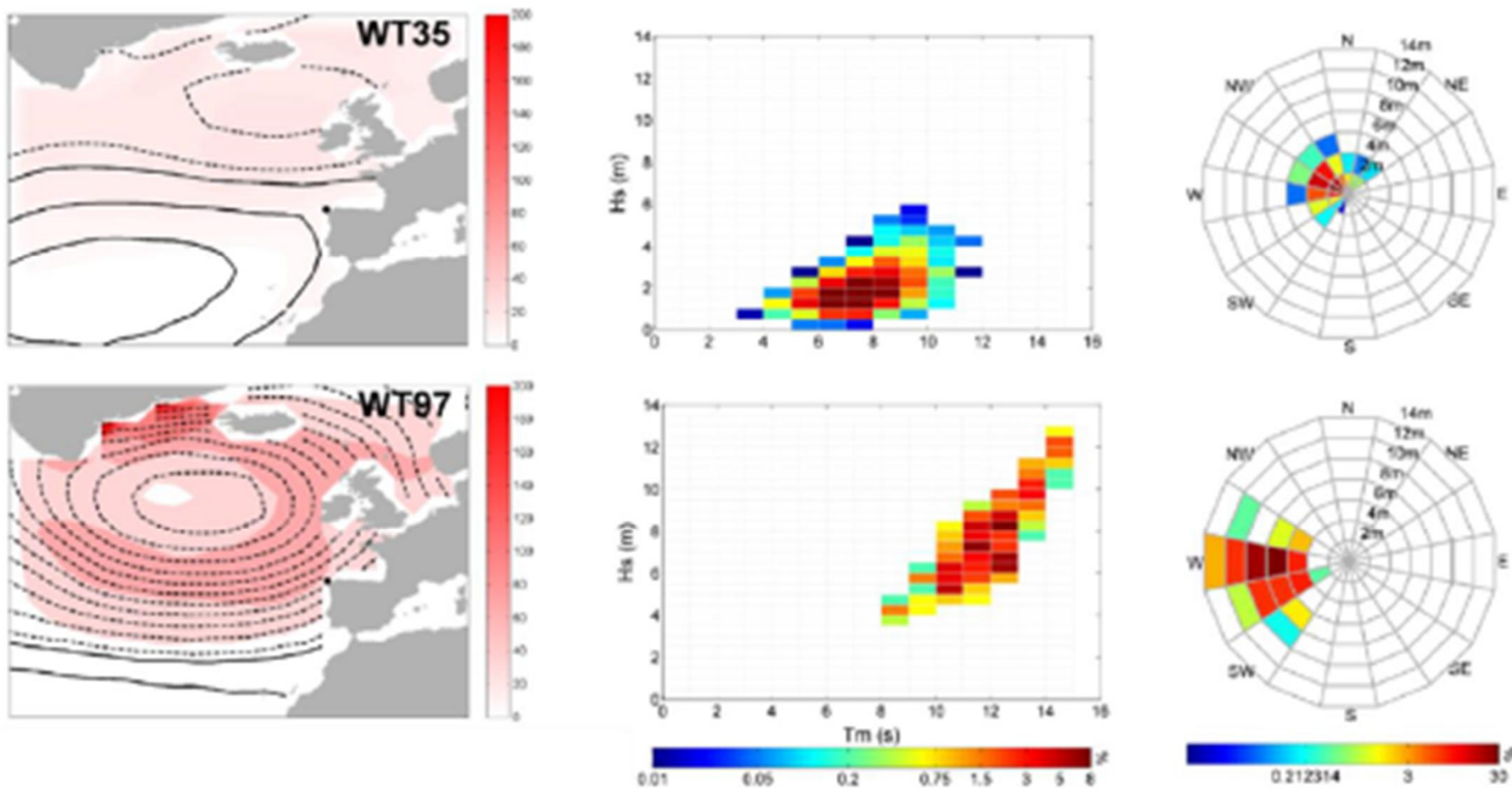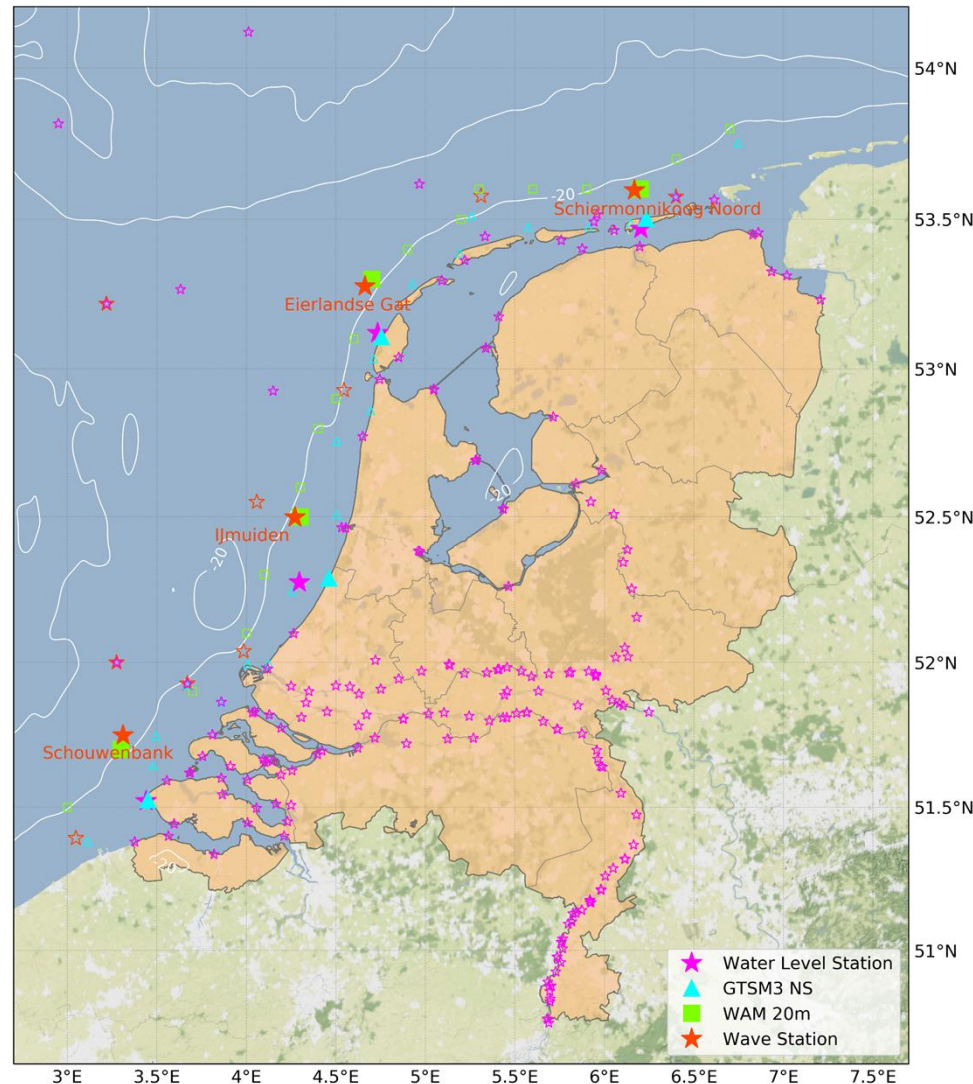

Atmospheric/Oceanographic conditions

Offshore wave dynamics
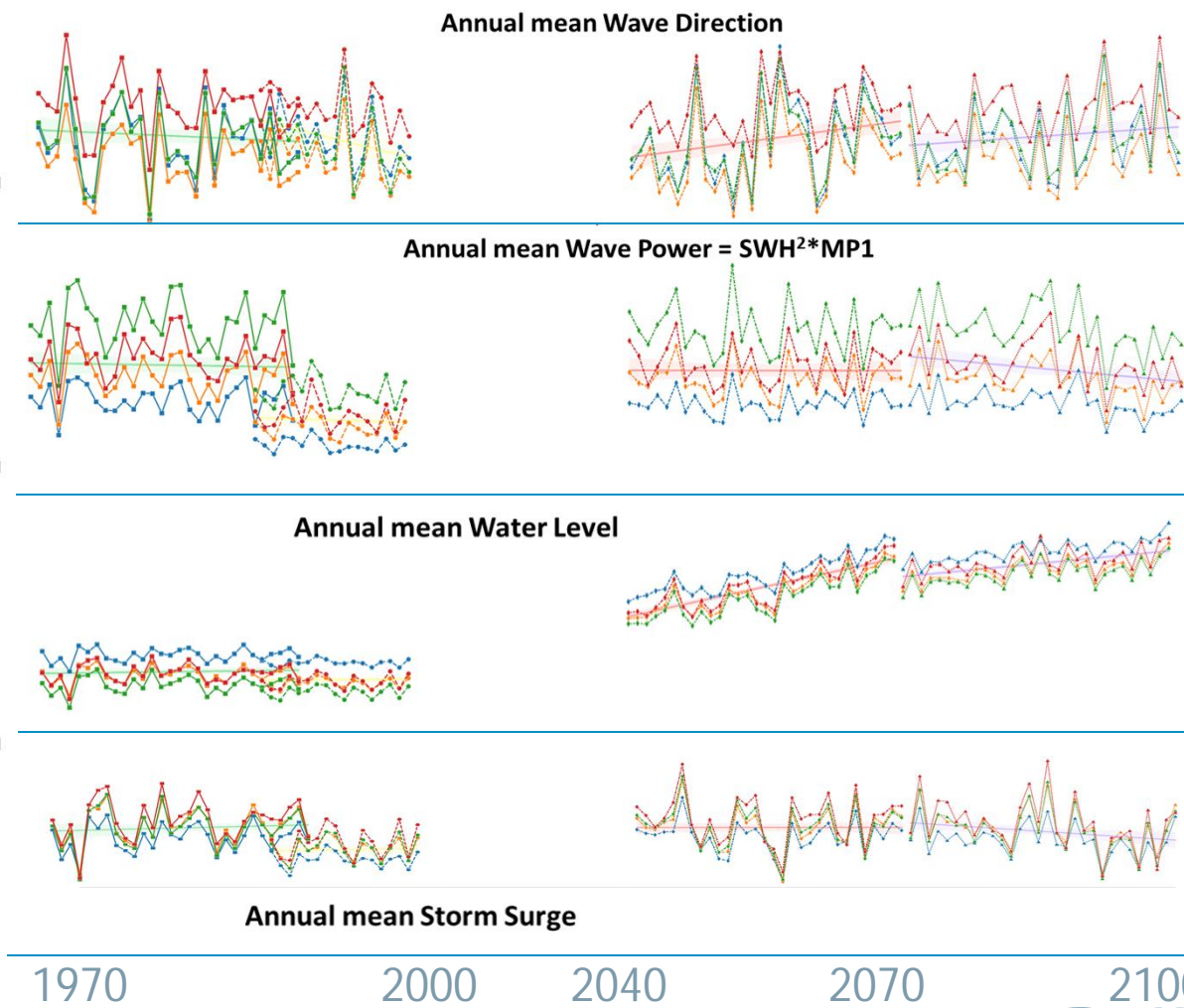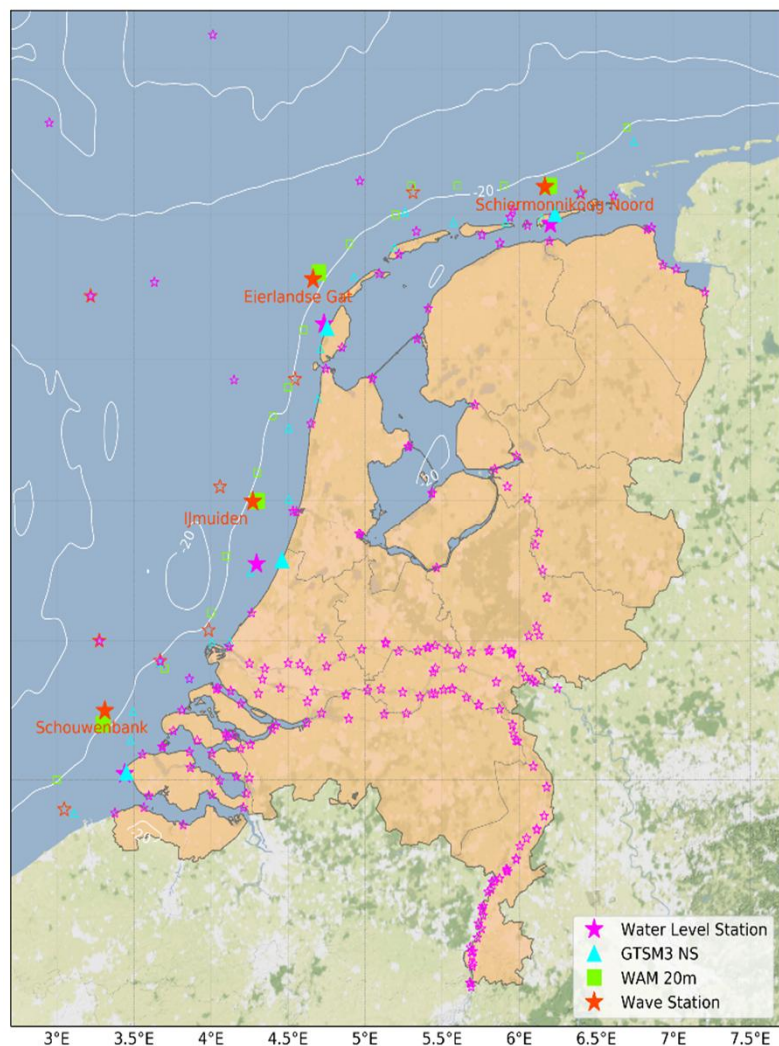
Regional Downscaling:
Statistical downscaling of offshore waves, water levels and local wind

Case study:
The Netherlands

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Regional Downscaling:
Statistical downscaling of offshore waves, water levels and local wind

Regional Downscaling:
Statistical downscaling of offshore waves, water levels and local wind

Tool boxes (or workflow)

- Data acquisition

- Predictor definition.

- Statistical model training and validation based on reanalysis data.

- Bias and variance correction for low quality data compared to reanalysis in the reference period.

- Projection of waves, water levels and wind in the historical and future period

Standard Output Format: csv, nc,...

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Regional Downscaling:
Statistical downscaling of offshore waves, water levels and local wind
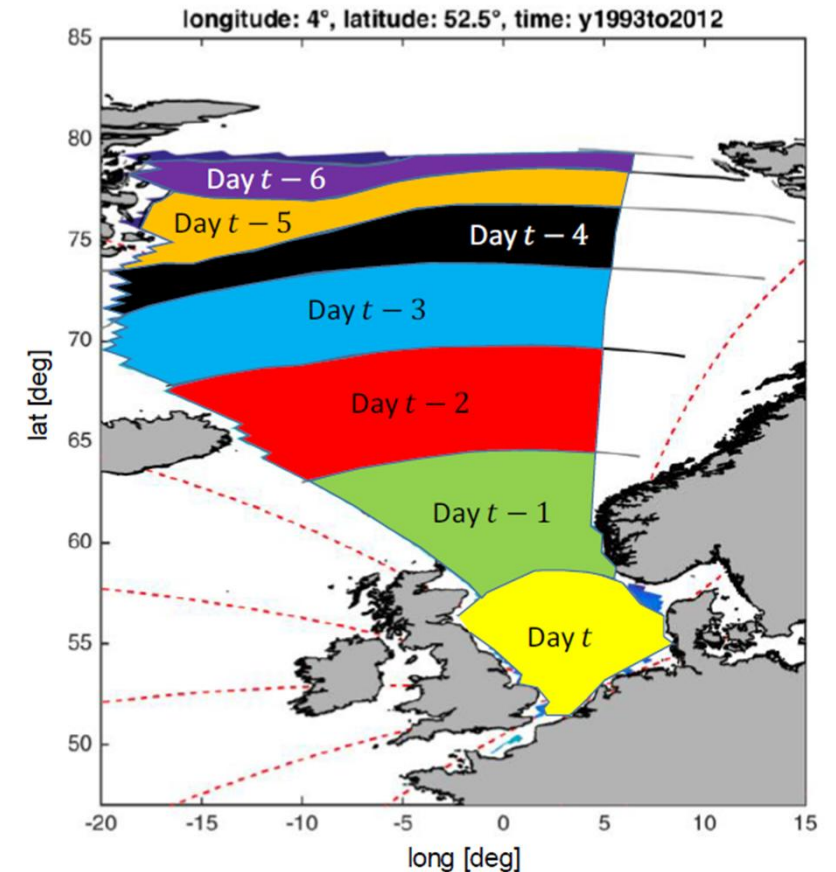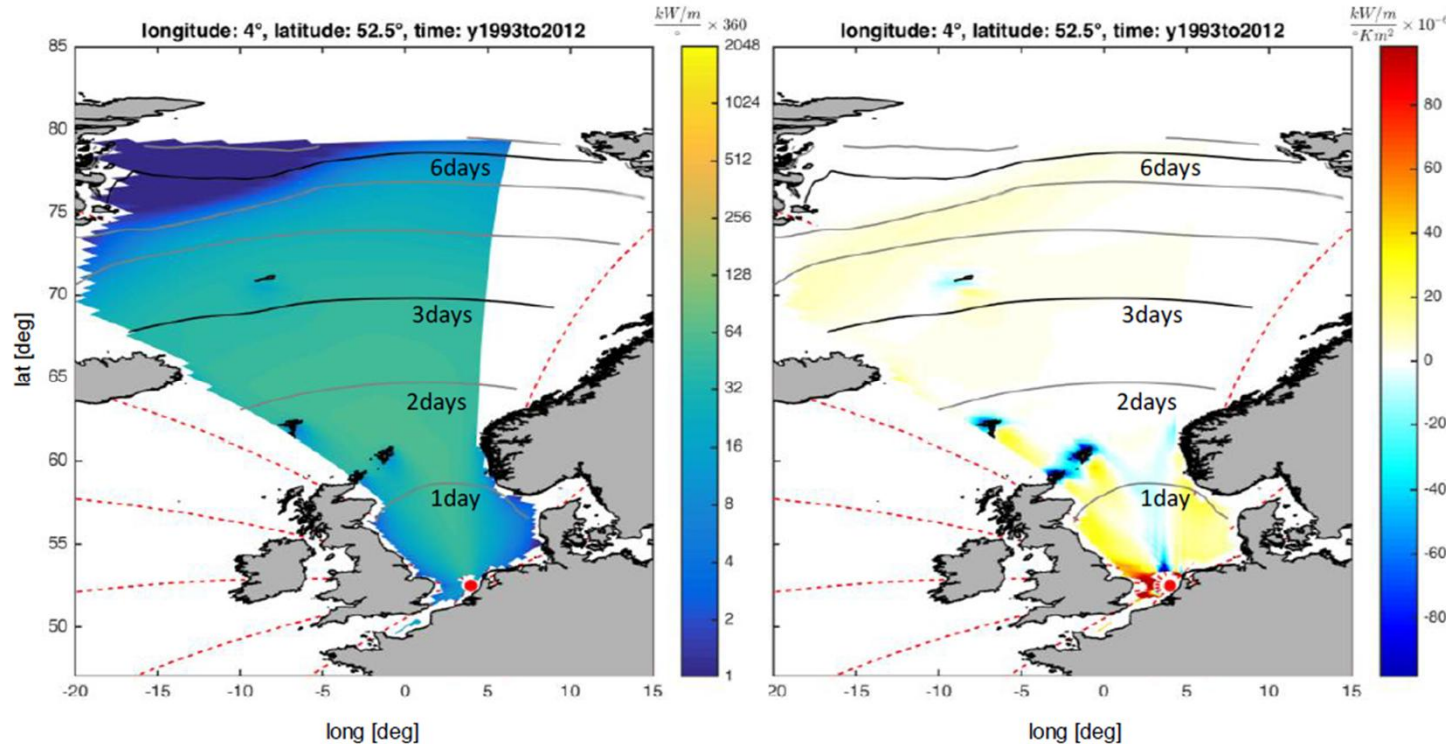
- Data acquisition

Historical Period: CERA-20C (Atmospheric) 1901-2010

Reference Period: Reanalysis ERA-5 (Atmospheric, Waves, Surge) 1978-Nowadays

Future Climate: EC-Earth (Atmospheric) 1980-2100

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Regional Downscaling:
Statistical downscaling of offshore waves, water levels and local wind

- Predictor definition based on sea level pressure.

FOOTPRINTS OF WAVE ENERGY

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Regional Downscaling:
Statistical downscaling of offshore waves, water levels and local wind

- Predictor definition based on sea level pressure.
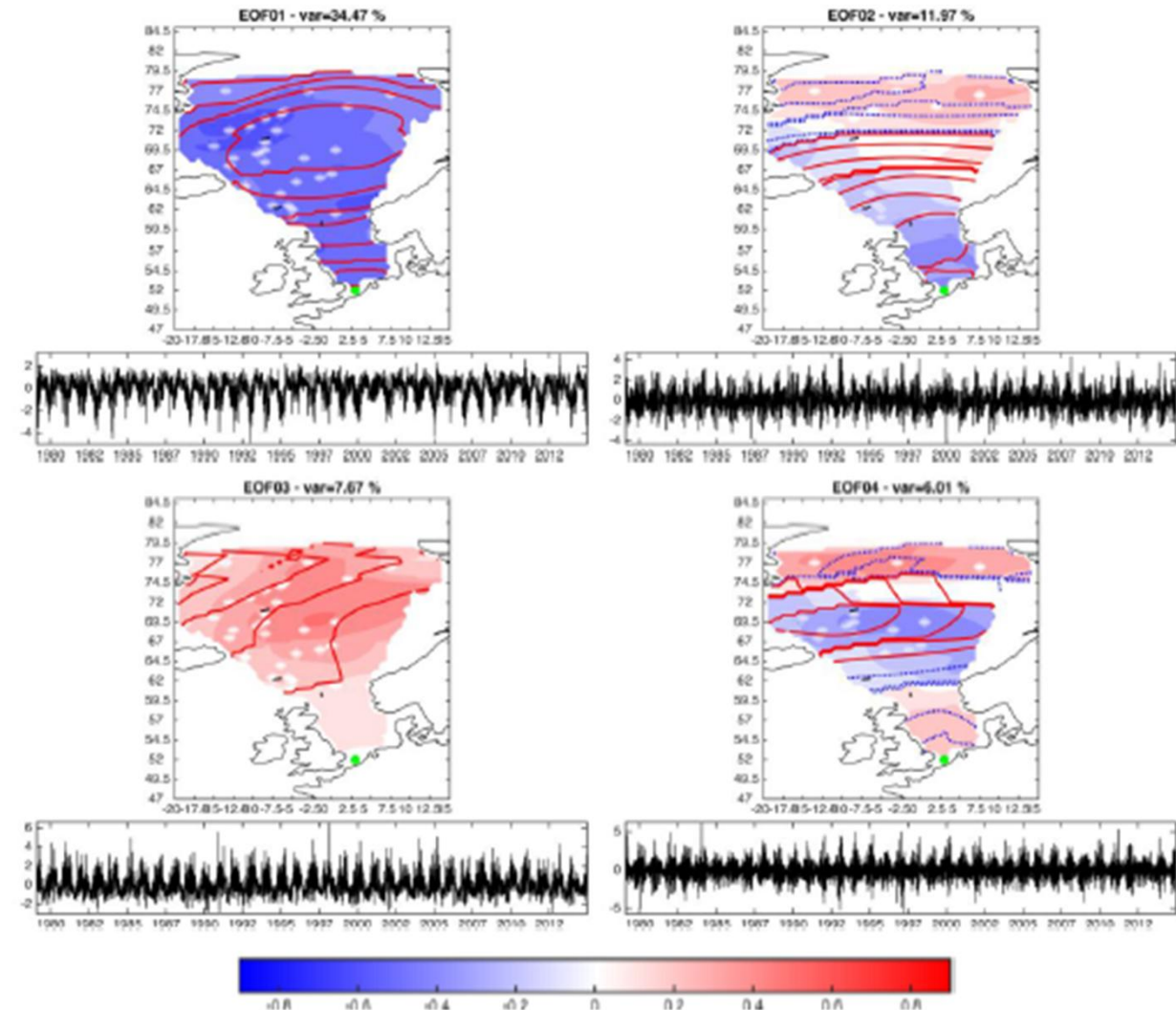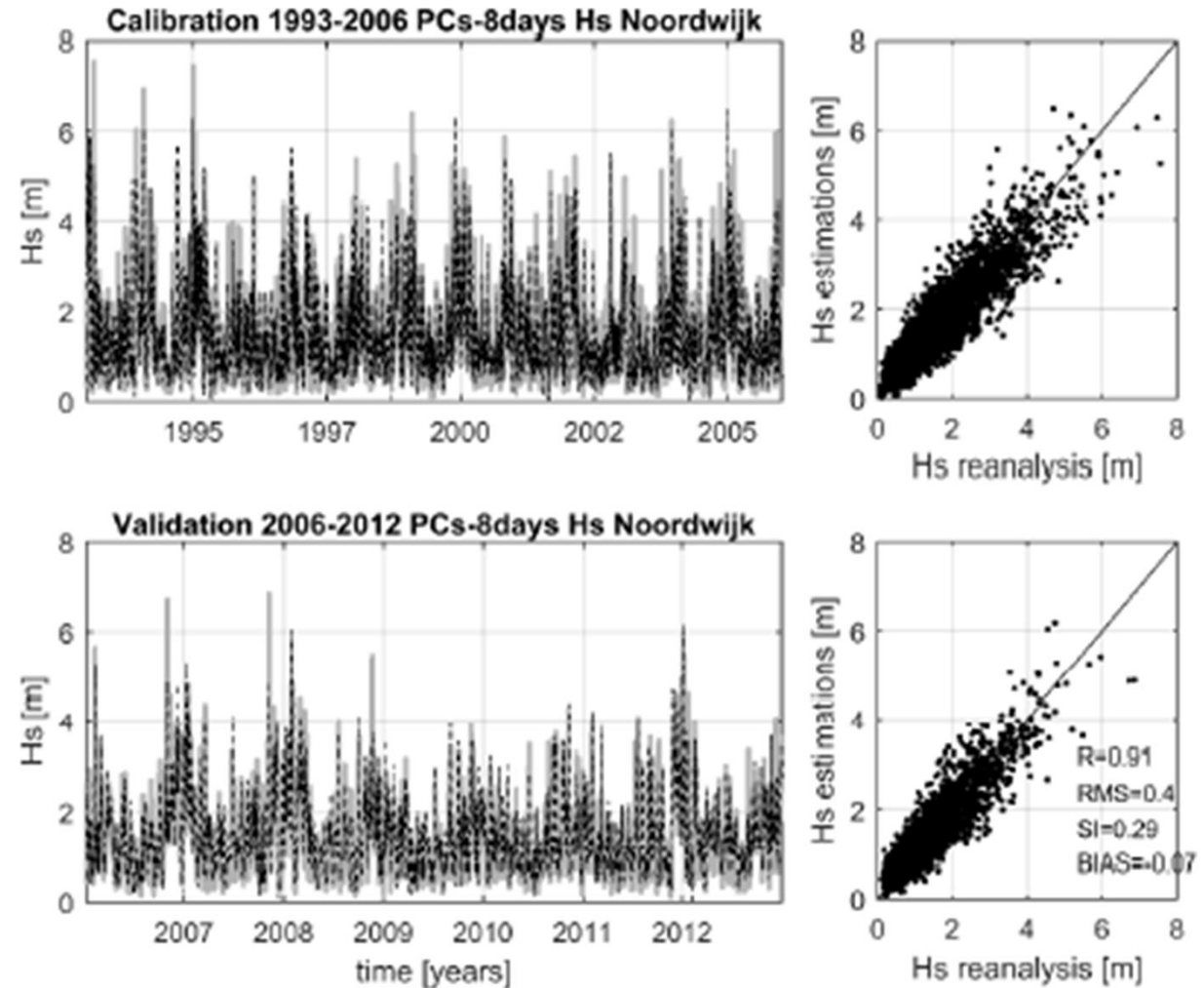
  PCA on SLP

Regional Downscaling:
Statistical downscaling of offshore waves, water levels and local wind

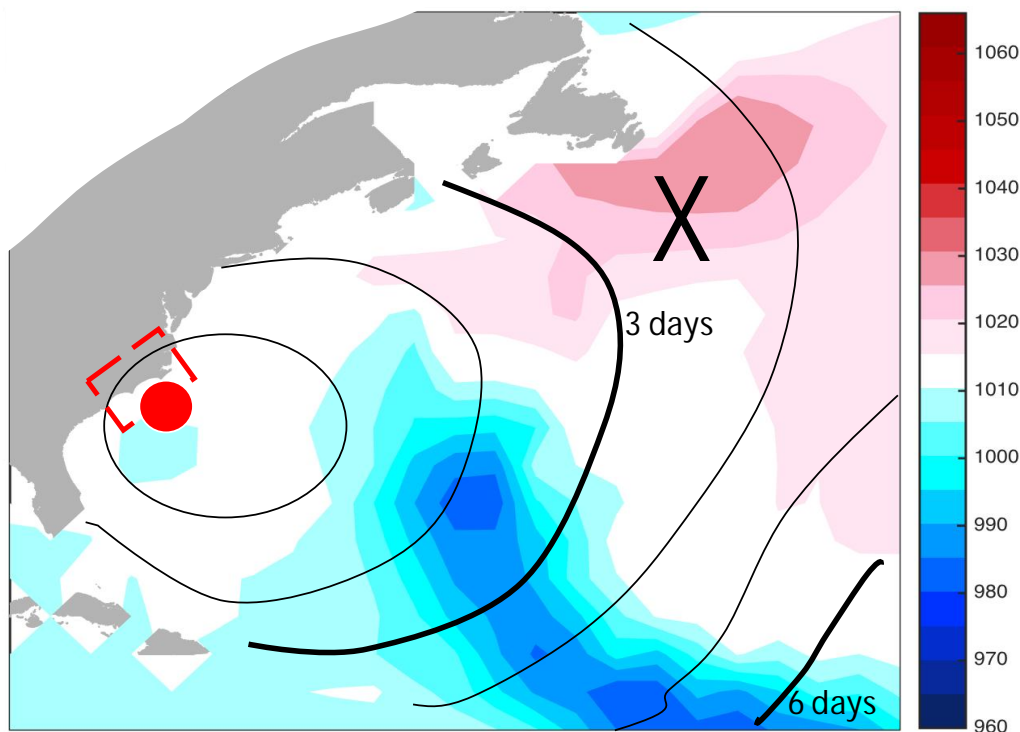- Statistical model fitting and validation based on ERA-5 reanalysis data.
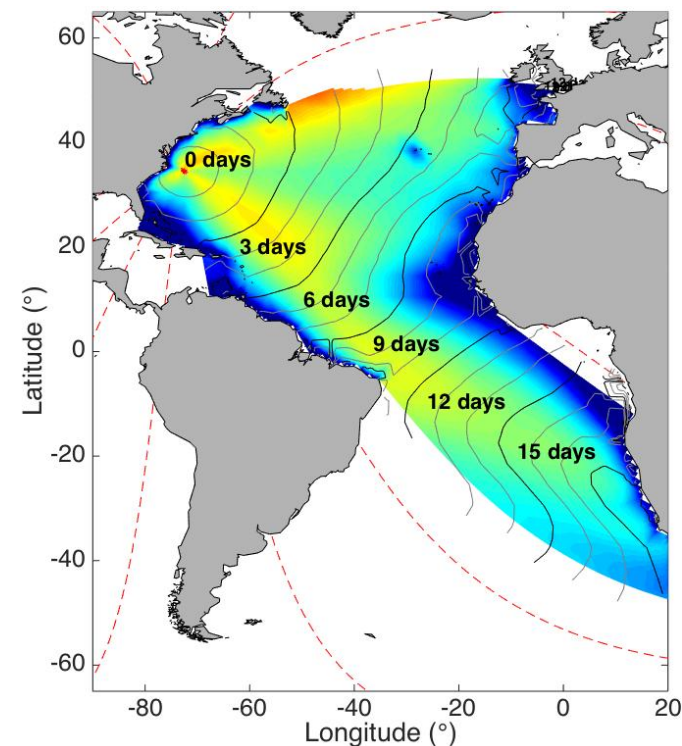
MULTIVARIATE REGRESSION MODELS

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Downscaling Changing Coastlines in a Changing Climate, the hybrid approach

Regional Downscaling: Statistical downscaling of offshore waves

$$X \rightarrow W^0 \rightarrow W^{HR} \rightarrow Y = \{Q_s, \Phi_{HR}\} \rightarrow Z = \{A, U\}$$

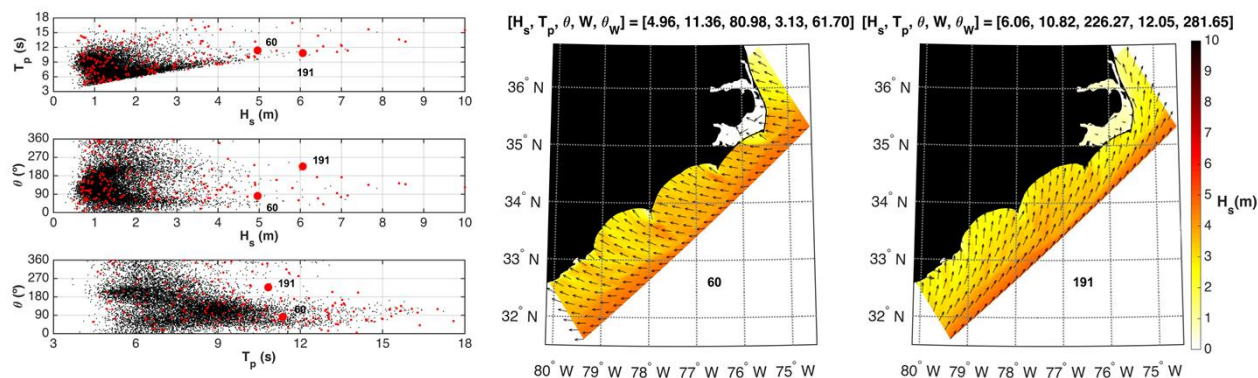

Atmospheric/Oceanographic conditions

Offshore wave dynamics

Downscaling Changing Coastlines in a Changing Climate, the hybrid approach

Nearshore Downscaling: Hybrid modelling of nearshore waves

Camus et al. 2011

$$X \rightarrow \boxed{W^0 \rightarrow W^{HR}} \rightarrow Y = \{Q_s, \Phi_{HR}\} \rightarrow Z = \{A, U\}$$

$[H_s, T_p, \theta, W, \theta_W] = [4.96, 11.36, 80.98, 3.13, 61.70]$ $[H_s, T_p, \theta, W, \theta_W] = [6.06, 10.82, 226.27, 12.05, 281.65]$
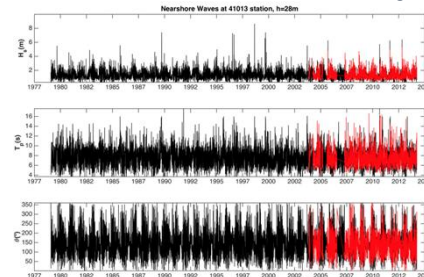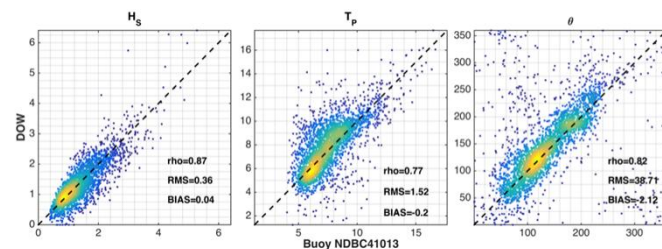
1- Selection of 200 events in W^0 using MDA

2- Propagation of selected cases with SWAN

4- Validation with NDBC buoys.

3- Reconstruction of the continuous series using RBFs.
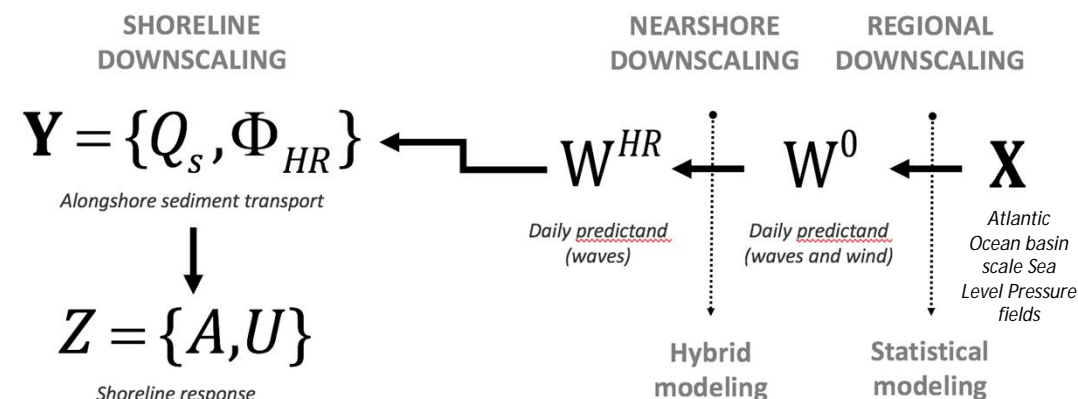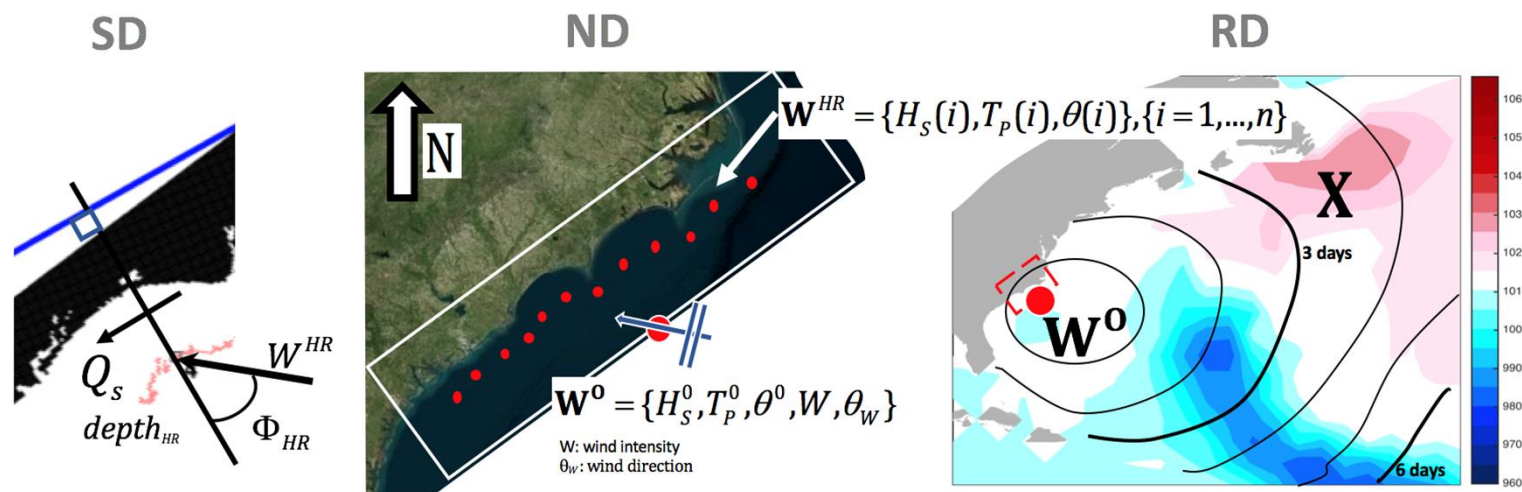
Reconstruction
1978-2014
propagated
Hs, Tp, $\boldsymbol{\theta}$

MDA+SWAN+RBF
<3h in a laptop

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Downscaling Changing Coastlines in a Changing Climate, the hybrid approach

Antolinez et al. (2018) JGR-ES

1870-2010 140 years

Hindcast of shoreline change patterns in the Carolina Capes

Downscaling Changing Coastlines in a Changing Climate, the hybrid approach

140 years of shoreline change patterns

1870 - 2010

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