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ICRC-CORDEX 2019

International Conference On Regional Climate

Coastal flooding due to extreme events in the Mediterranean coast of Spain

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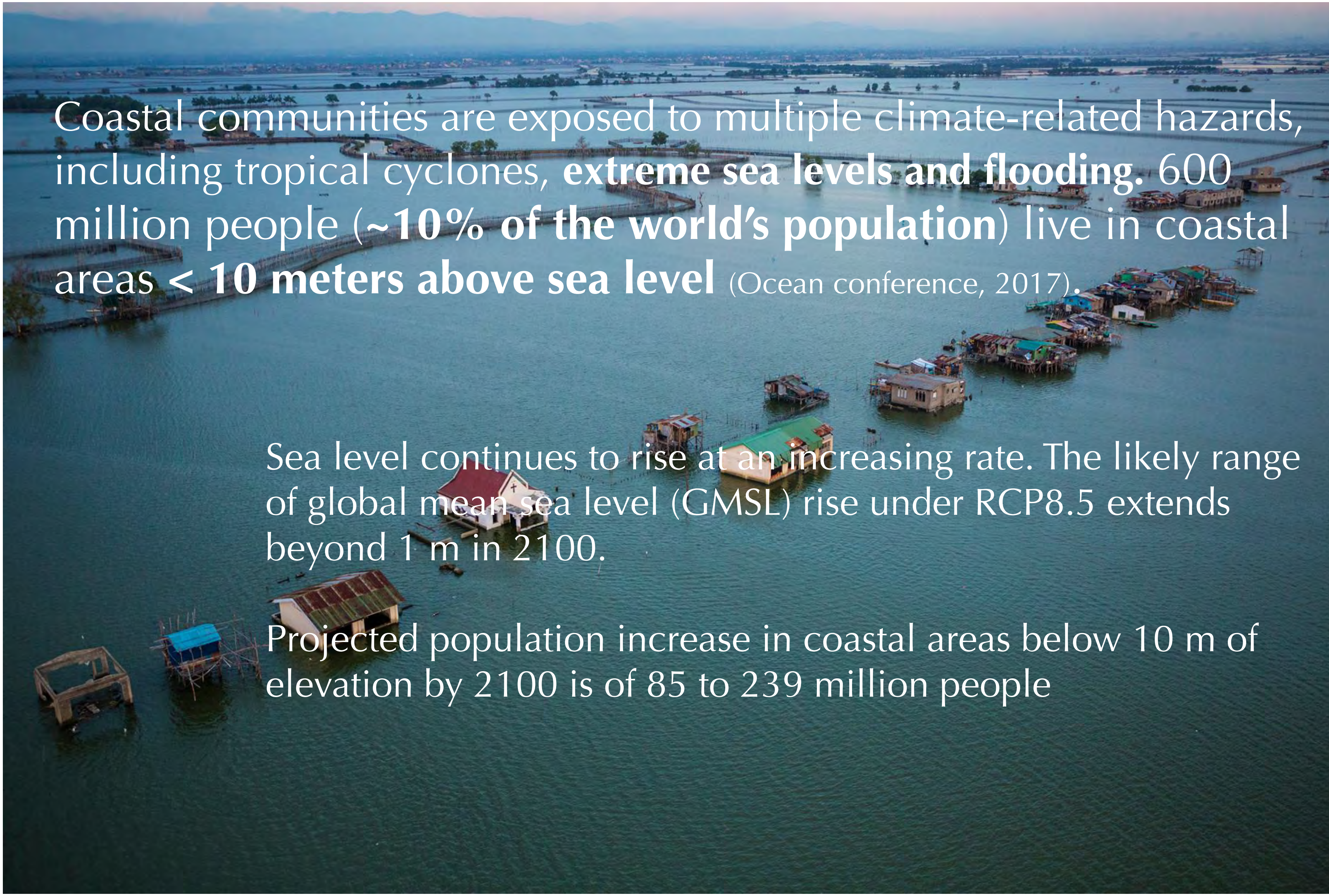


Coastal communities are exposed to multiple climate-related hazards, including tropical cyclones, **extreme sea levels and flooding.** 600 million people (**~10% of the world's population**) live in coastal areas **< 10 meters above sea level** (Ocean conference, 2017).

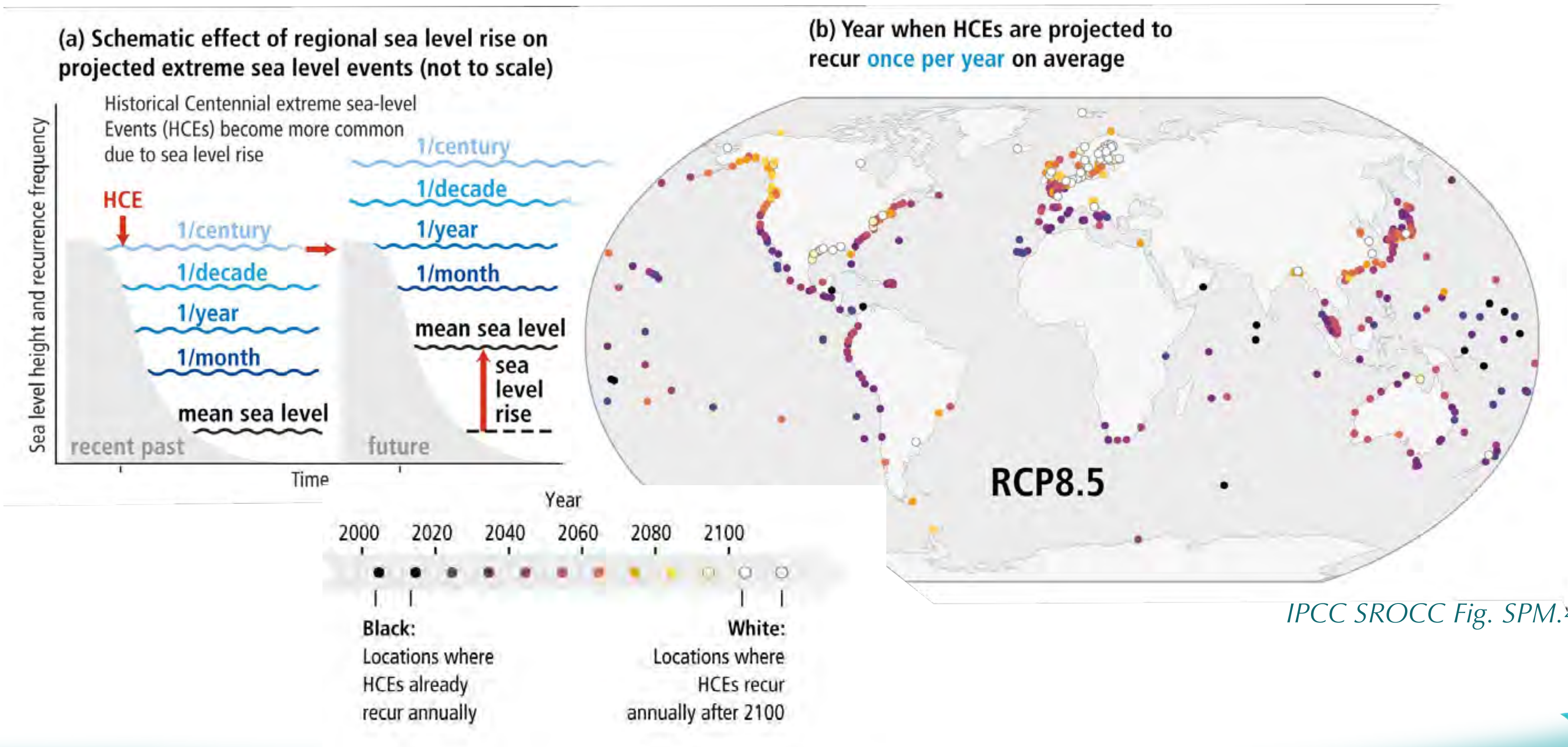
Sea level continues to rise at an increasing rate. The likely range of global mean sea level (GMSL) rise under RCP8.5 extends beyond 1 m in 2100.

Projected population increase in coastal areas below 10 m of elevation by 2100 is of 85 to 239 million people

Manila, Philippines. National Geographic Creative (photograph by George Steinmetz)

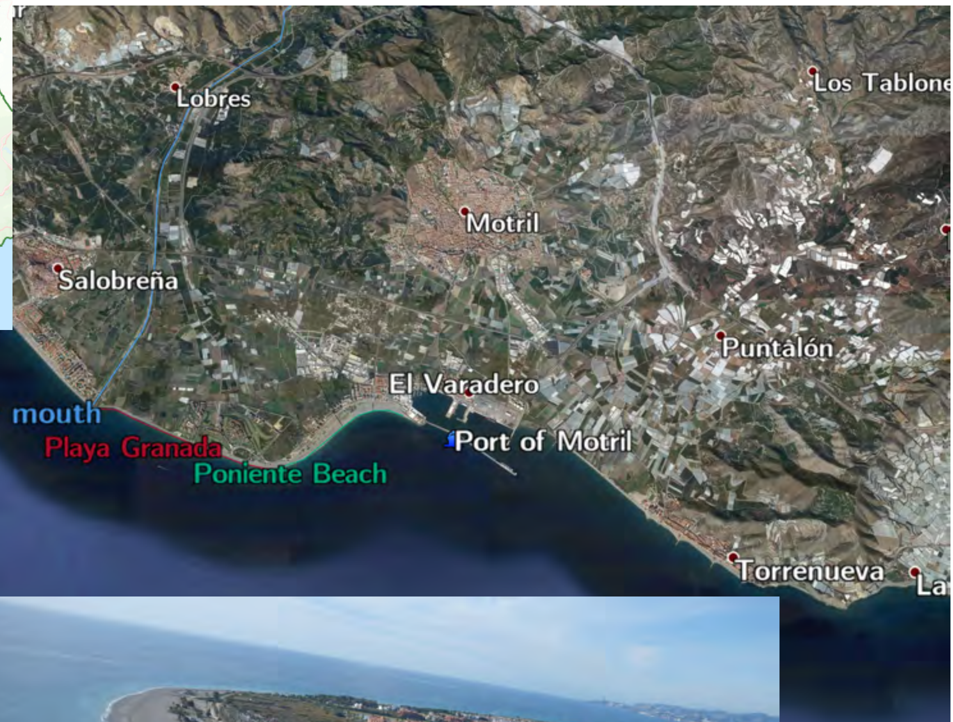
…Under current trends of increasing exposure and vulnerability of coastal communities, risks, such as **erosion** and land loss, **flooding**, salinization, and cascading impacts due to **mean sea level rise and extreme events** are projected to **significantly increase** throughout this century.

Annual coastal flood damages are projected **to increase by 2–3 orders of magnitude** by 2100 compared to today.

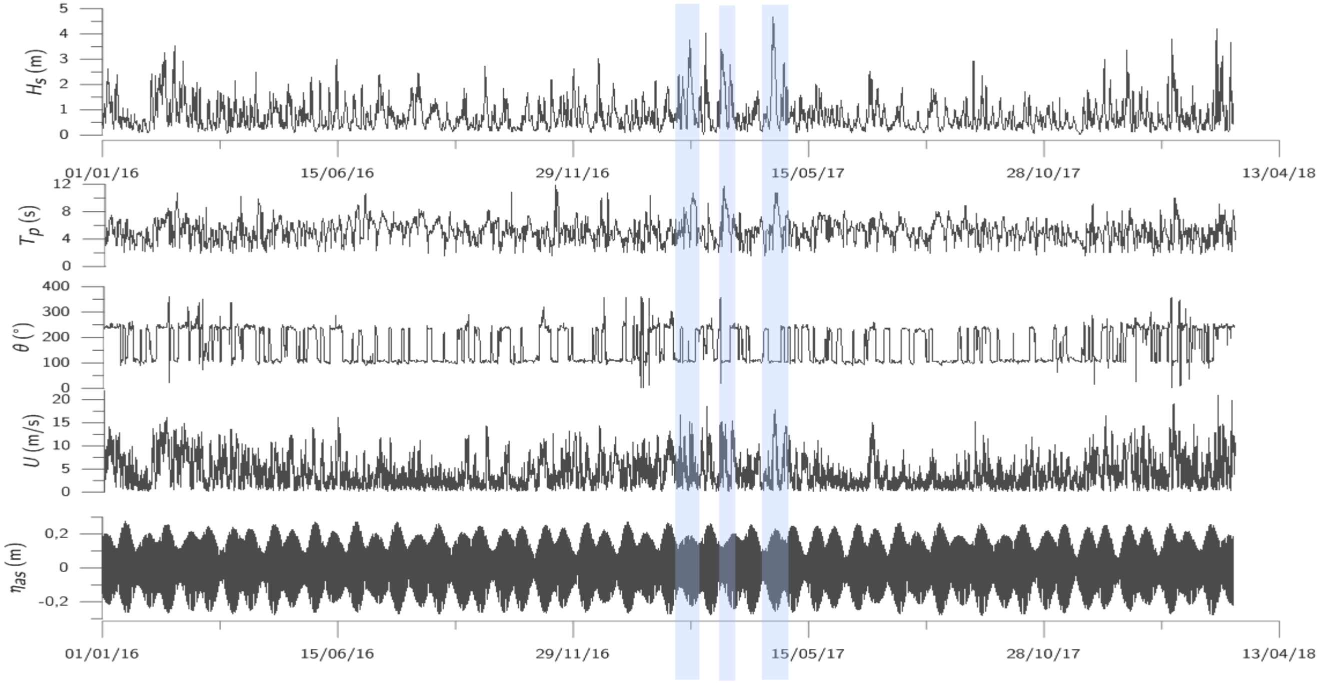


IPCC SROCC Fig. SPM.4

Coast of Granada, Spain



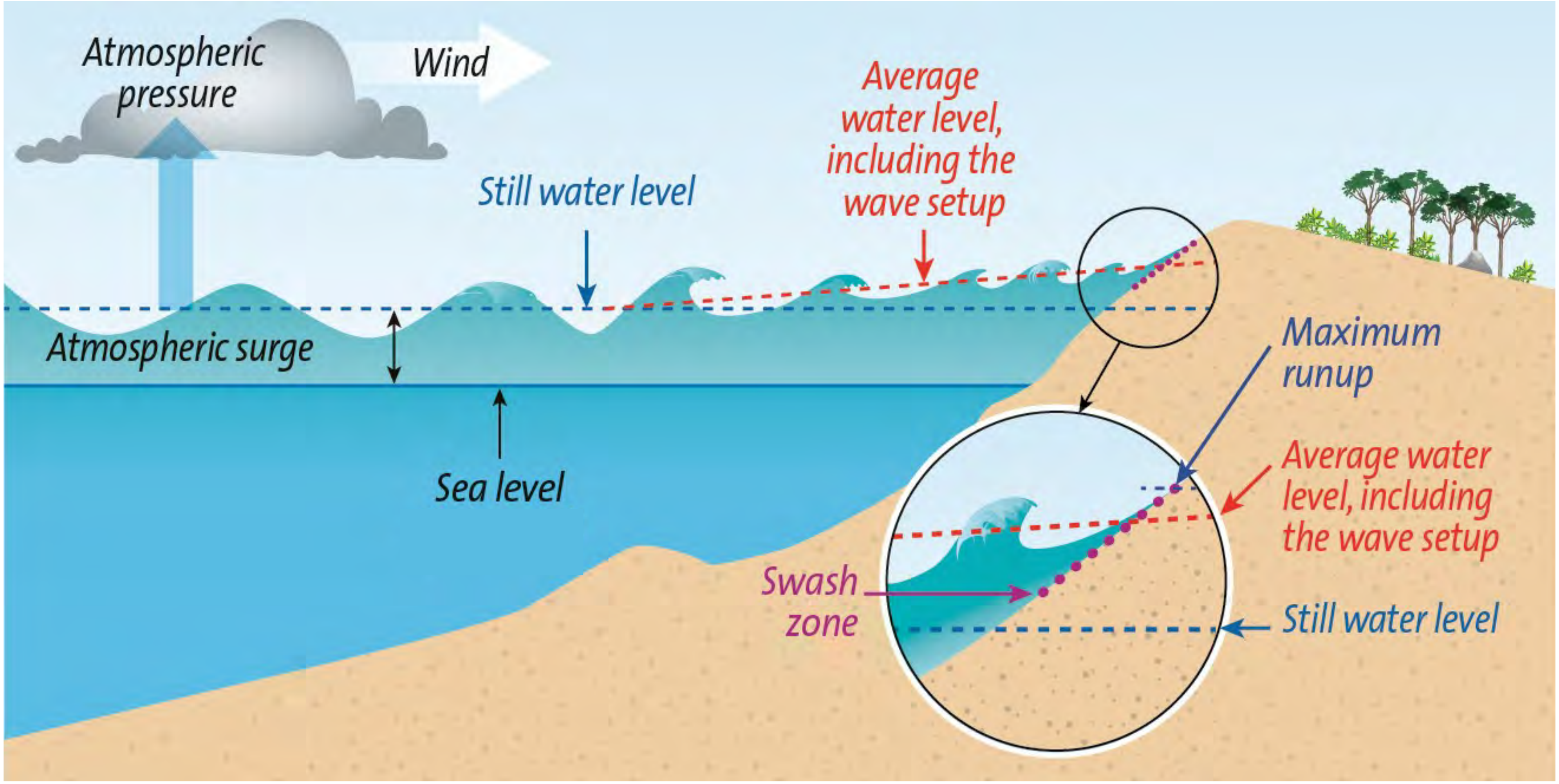

Motril
Salobreña
El Varadero
river mouth
Playa Granada
Port of Mot
Poniente Beach


H_S (m)
T_p (s)
θ (°)
U (m/s)
η_{as} (m)
01/01/16
15/06/16
29/11/16
15/05/17
28/10/17
13/04/18

Risk flooding and erosion events →

Relative sea level + {Storm surges, waves, tides} →

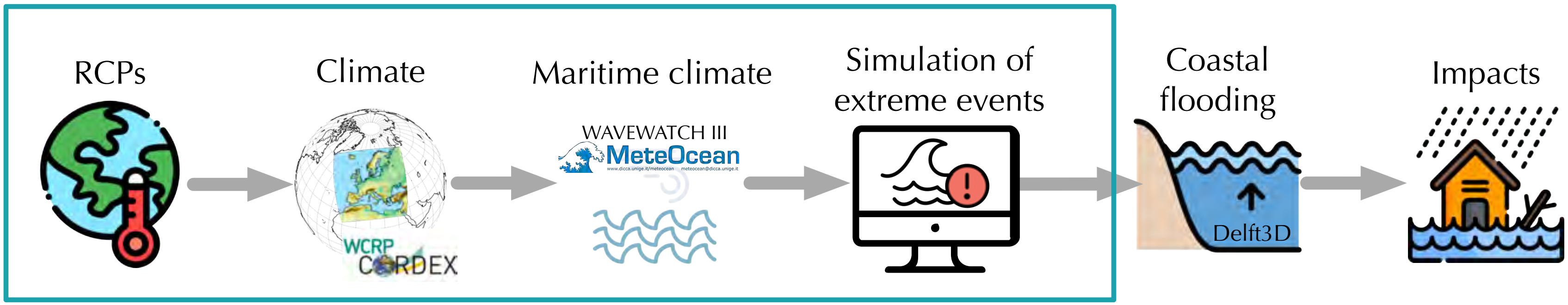
Extreme Sea Level (ESL) events



Le Cozannet, 2018

Coastal planning & decision making

→ Analysis of current and future ESL events



www.aquaclew.eu

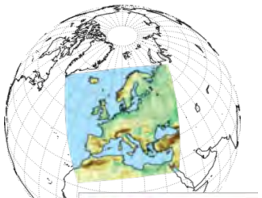
Changes in wave height and period have large effects on coastal flooding

Maritime climate projections

RCP8.5 EURO-CORDEX

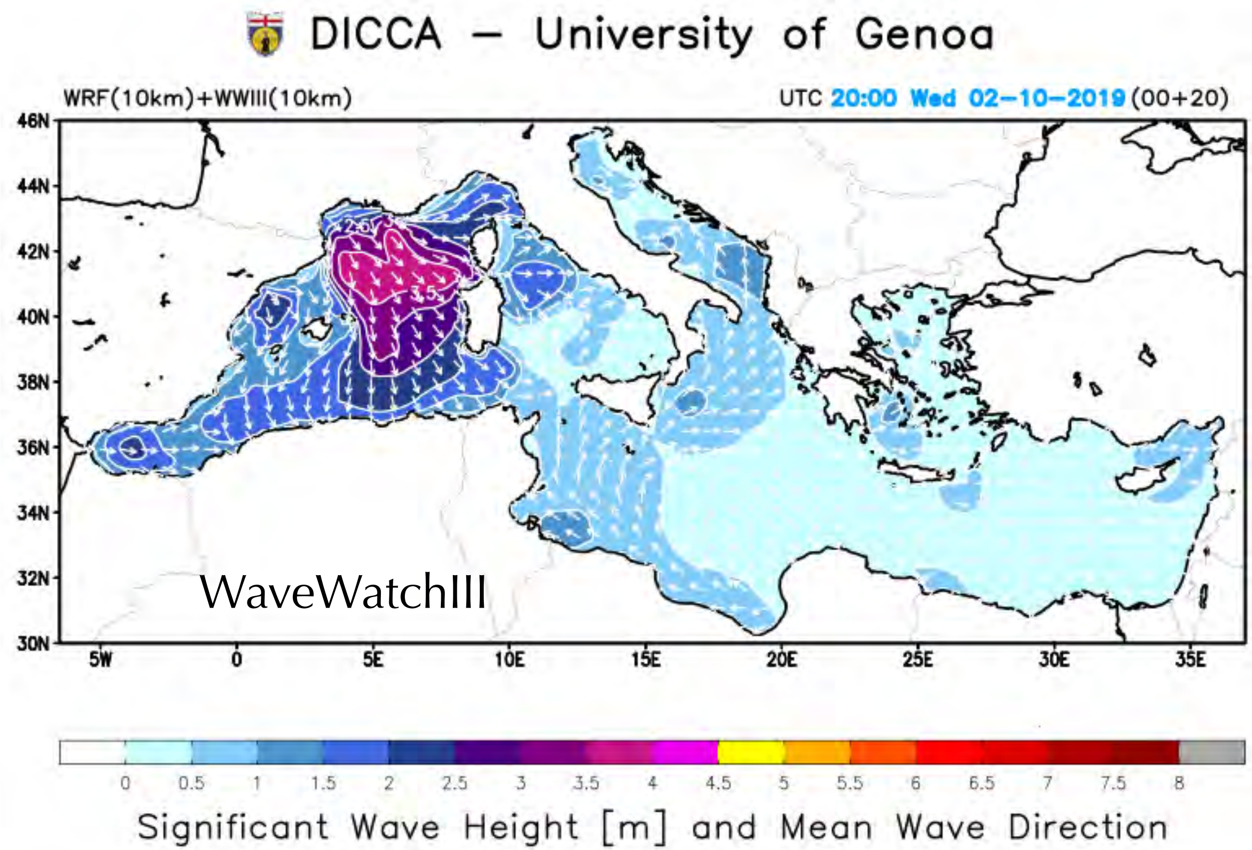
MeteOcean
www.dicca.unige.it/meteocean meteocean@dicca.unige.it

Mentaschi et al., 2015



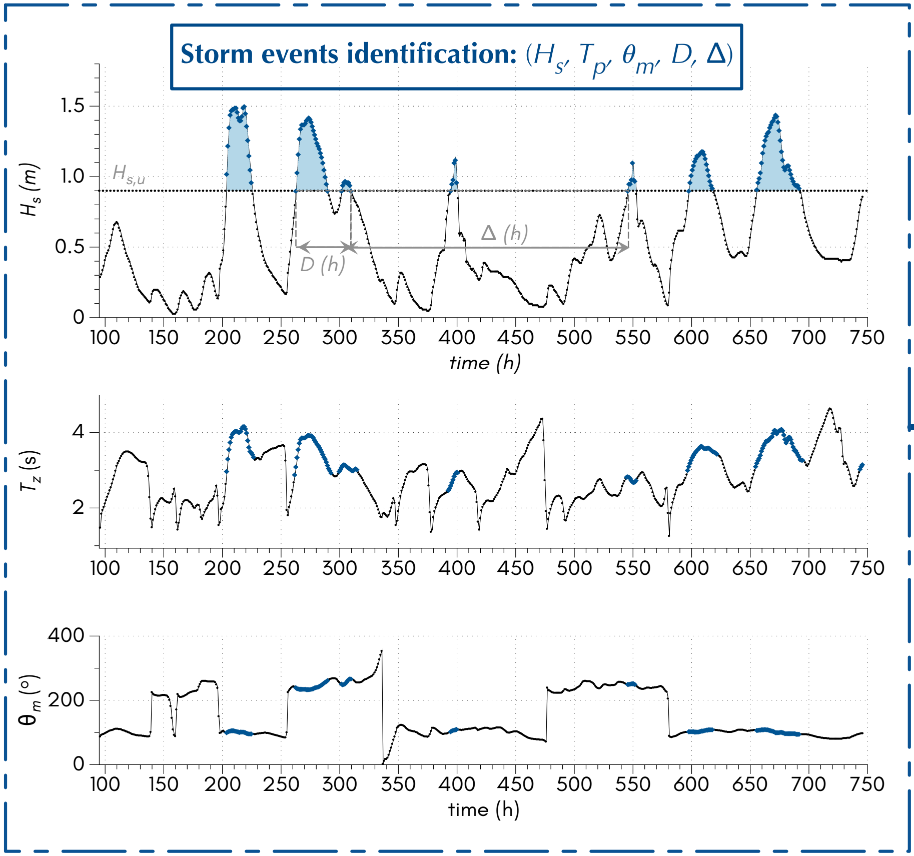
WCRP CORDEX

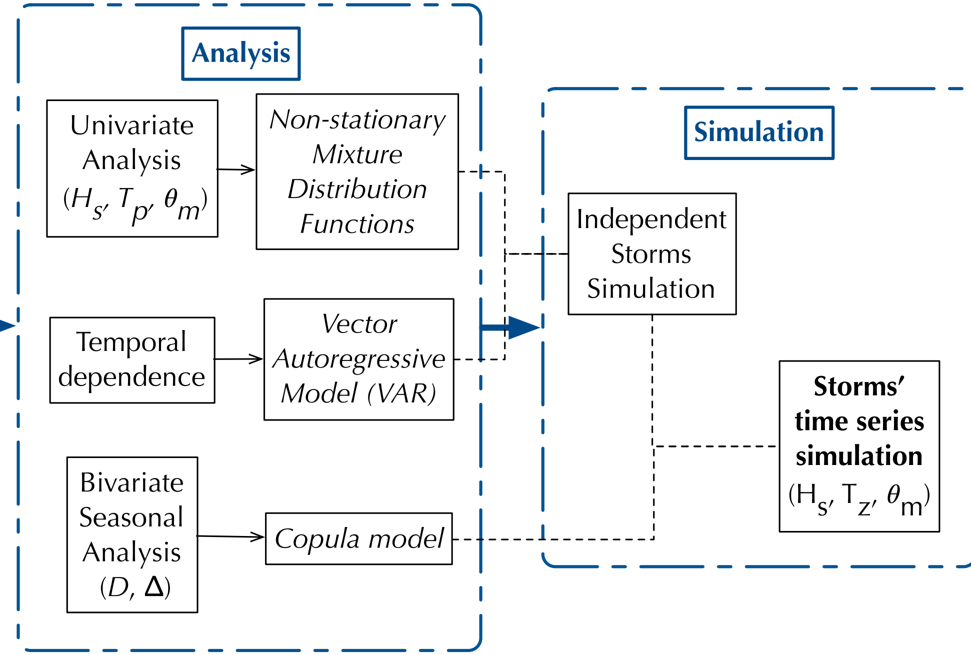
1. CLMcom_CanESM2
2. CLMcom_MIROC5
3. SMHI_MPI-ESM-LR
4. SMHI_NorESM1-M
5. SMHI_CNRM-CM5
6. SMHI_IPSL-CM5A-M
7. SMHI_HadGEM2-ES



→ Wave climate time series (H_s, T_p, θ_m) 2005-2100

Multivariate statistical characterization of storm events





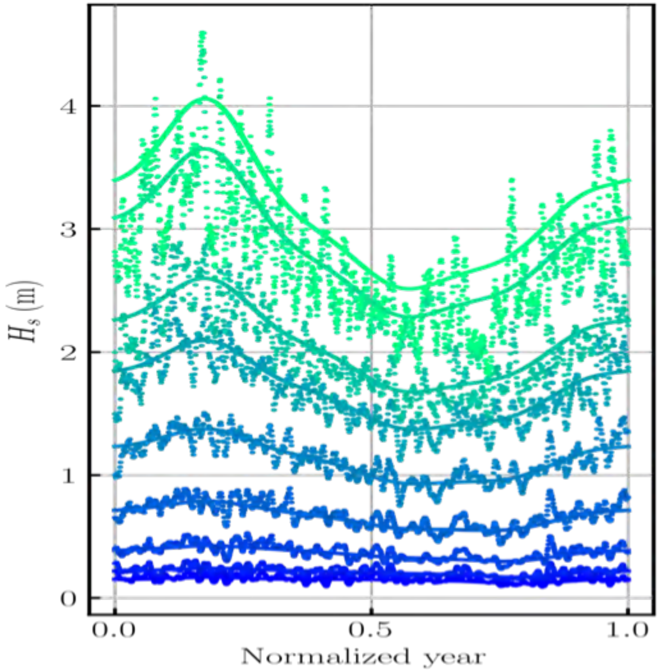
Lira-Loarca et al., 2018; 2019

H_s: GPD-LN-GPD non-stationary model
T_p: LN non-stationary model
θ_m: 2-TN stationary model

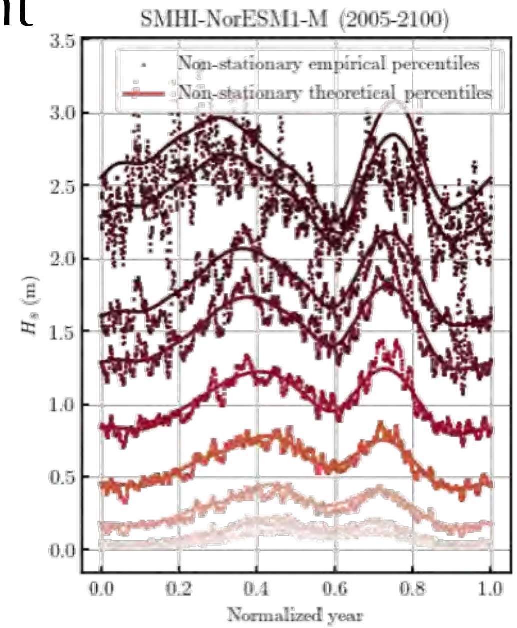
Significant wave height

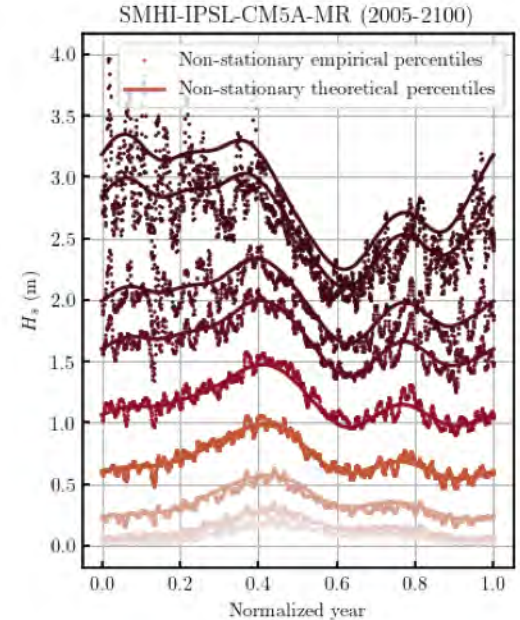
GPD-LN-GPD
non-stationary model

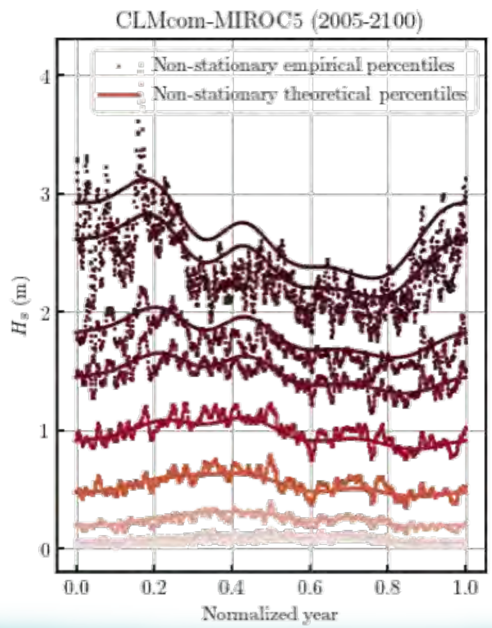
Hindcast 1979-2018

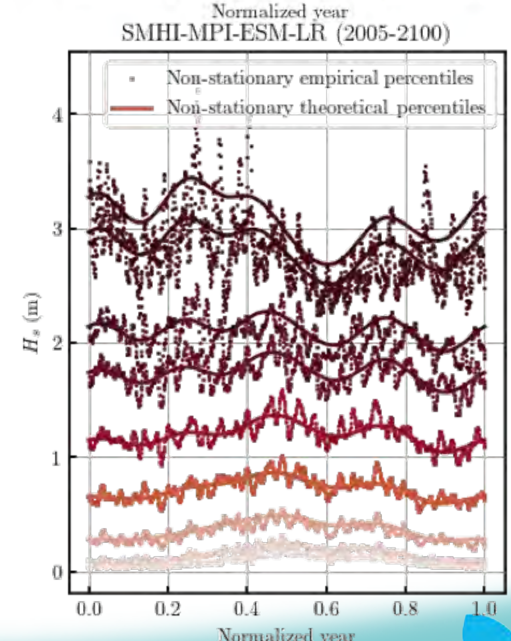


Iso-probability percentiles
5, 10, 25, 50, 75, 90, 95, 99, 99.5





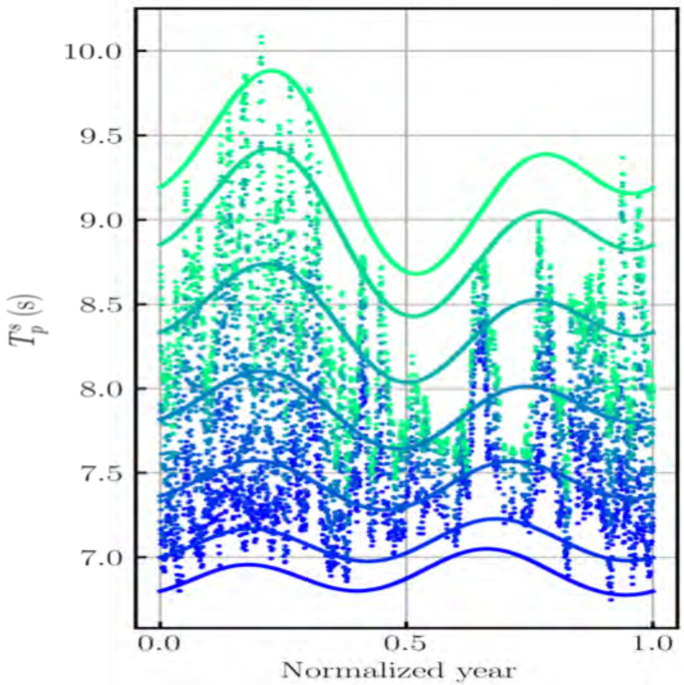




Peak period

LN non-stationary model

Hindcast 1979-2018



Iso-probability percentiles
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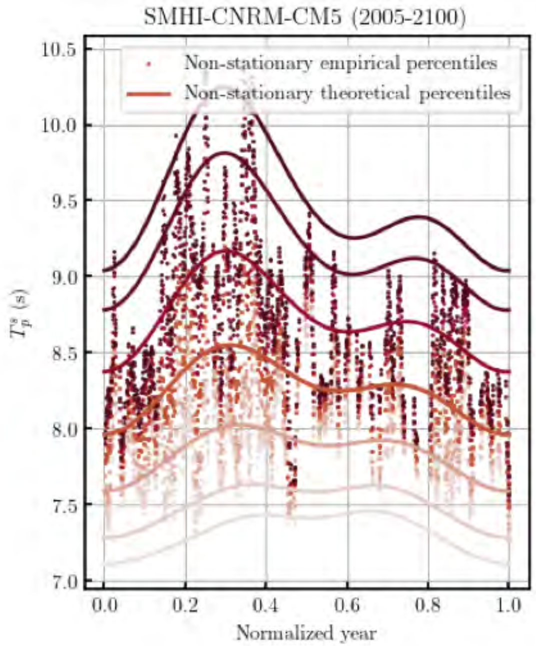
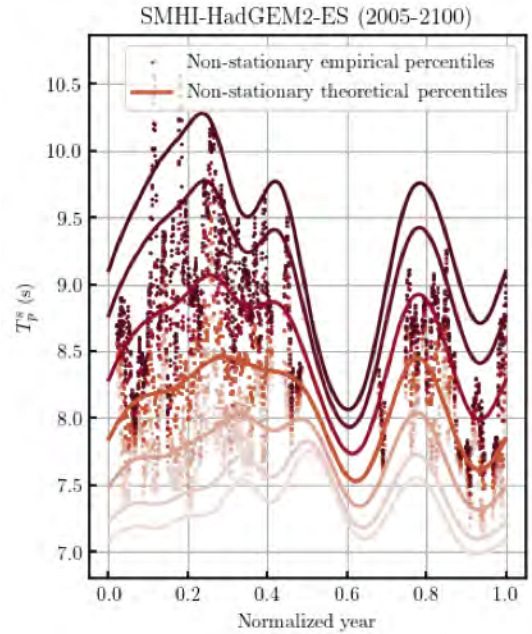
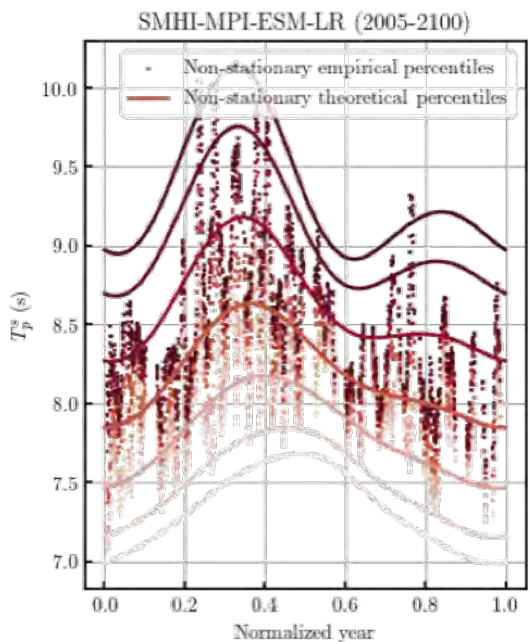
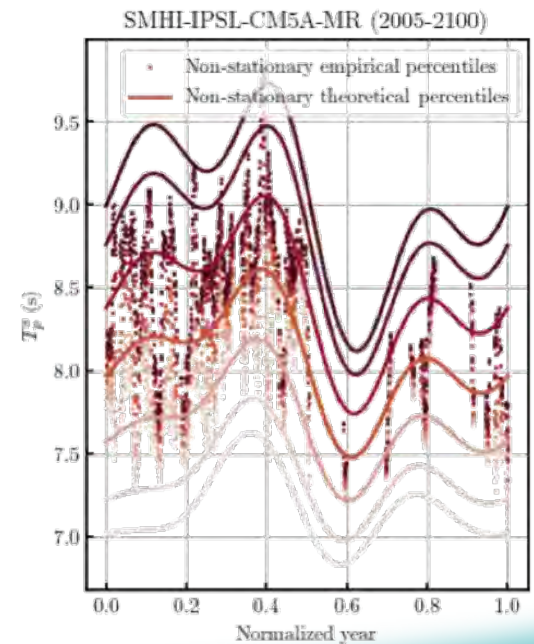




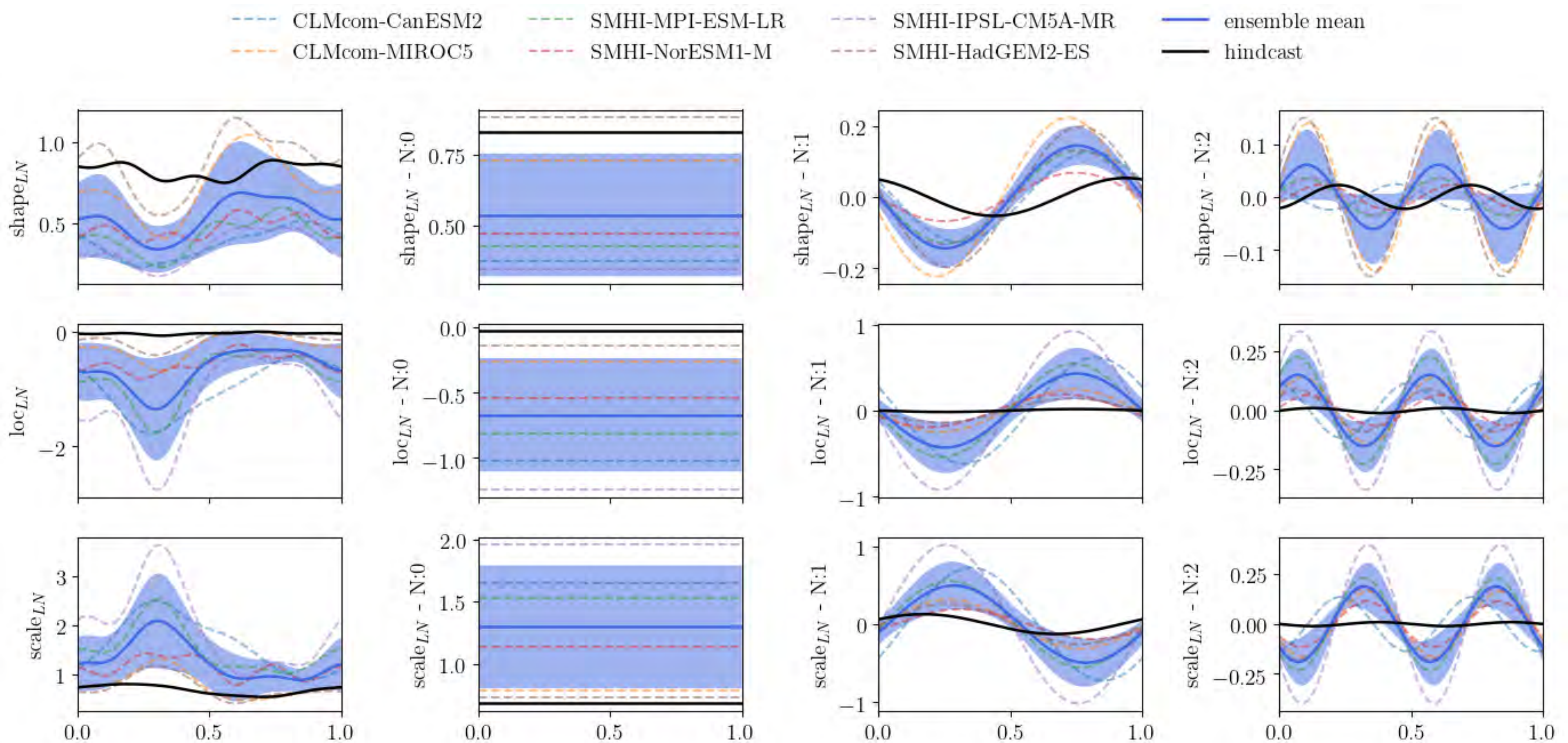




Significant wave height

Changes in mean regime – LN distribution

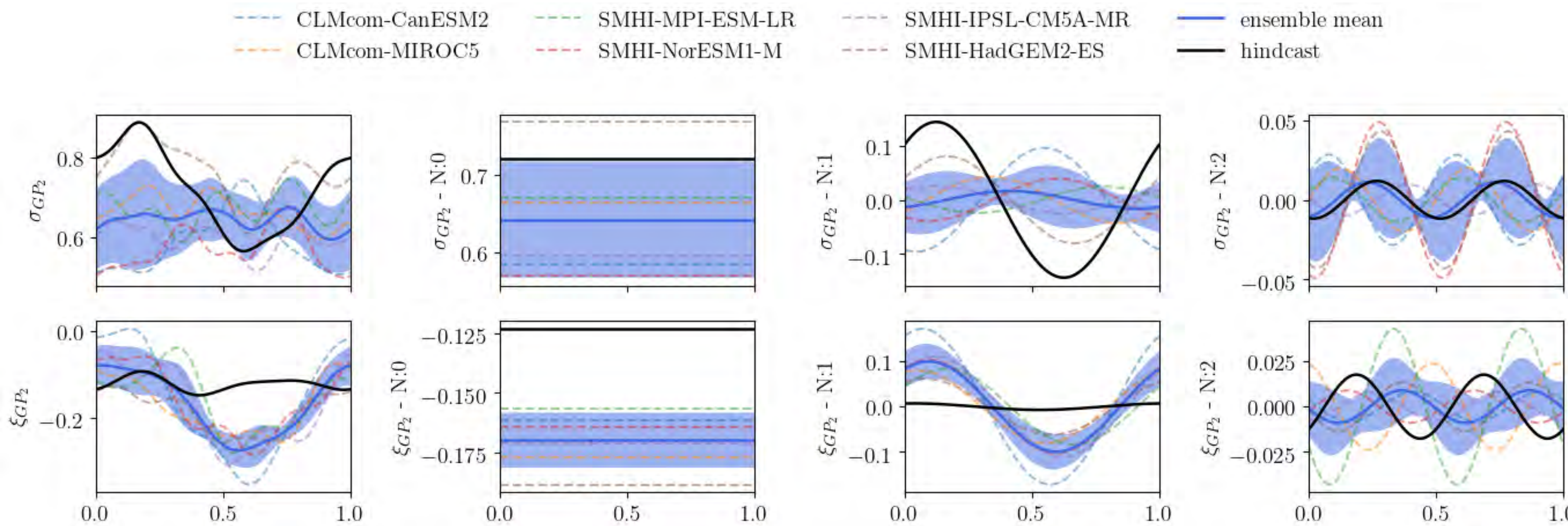
$$a(t) = a_0 + \sum_{l=1}^{N_F} \left(a_l \cos(2\pi l t) + b_l \sin(2\pi l t)\right)$$

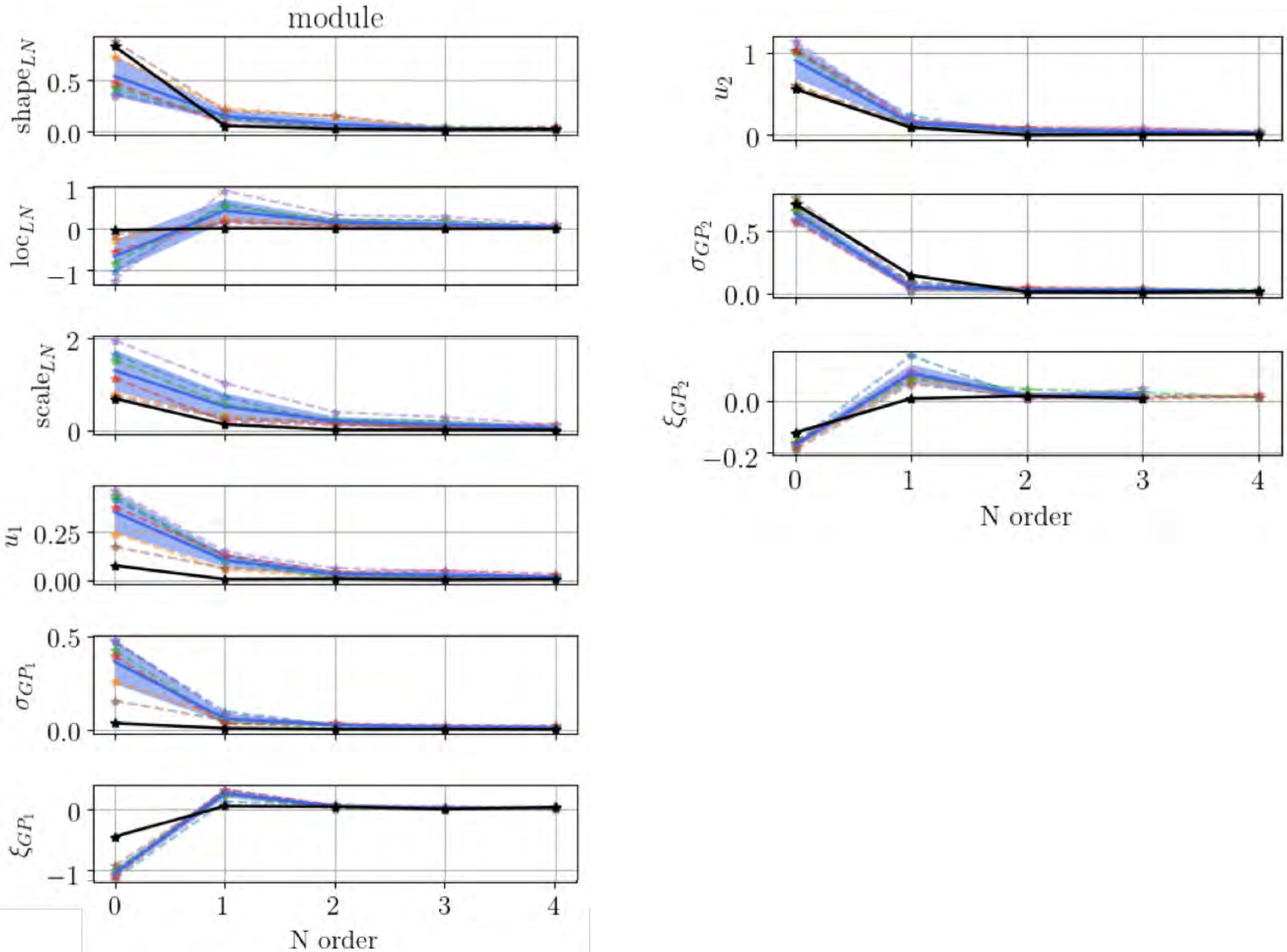


Significant wave height

Changes in upper tail – GPD distribution

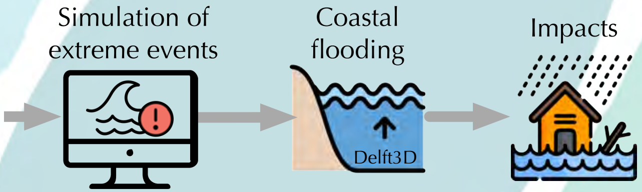
$$a(t) = a_0 + \sum_{l=1}^{N_F} (a_l \cos(2\pi l t) + b_l \sin(2\pi l t))$$




module
shape_LN
loc_LN
scale_LN
u_1
σ_GP1
ξ_GP1
u_2
σ_GP2
ξ_GP2
N order
N order

Conclusions

- EUR-11 6hr atmospheric data from 7 models are used to simulate wave climate in the Mediterranean.
- The multivariate statistical characterization and simulation models (non-stationary mixture fits, VAR, copula) used on Lira-Loarca et. al, 2019 are applied to wave projections under RCP8.5.
- The ensemble evaluation is done by means of the models' mean and standard deviation of the temporal evolution of the fitted parameters.
- The models provide a good fit for the hindcast and projections data.
- There is a variation in the semiannual and seasonal temporal behavior of the parameters of the mean and upper part of Hs as well as in the magnitude values of the mean and semiannual oscillation.
- Next steps: Propagation of wave extreme events + SLR series using Delft3D hydro-morphodynamics model



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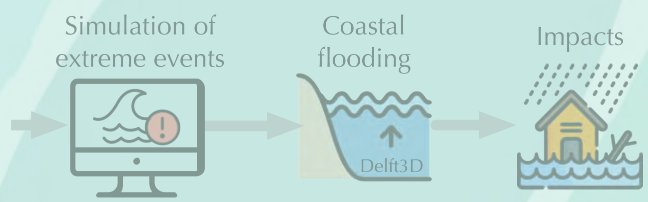

Thank you!

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