Mid Twenty-First Century Wave Climate Changes in the North Atlantic

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Liverpool, September 15th, 2017

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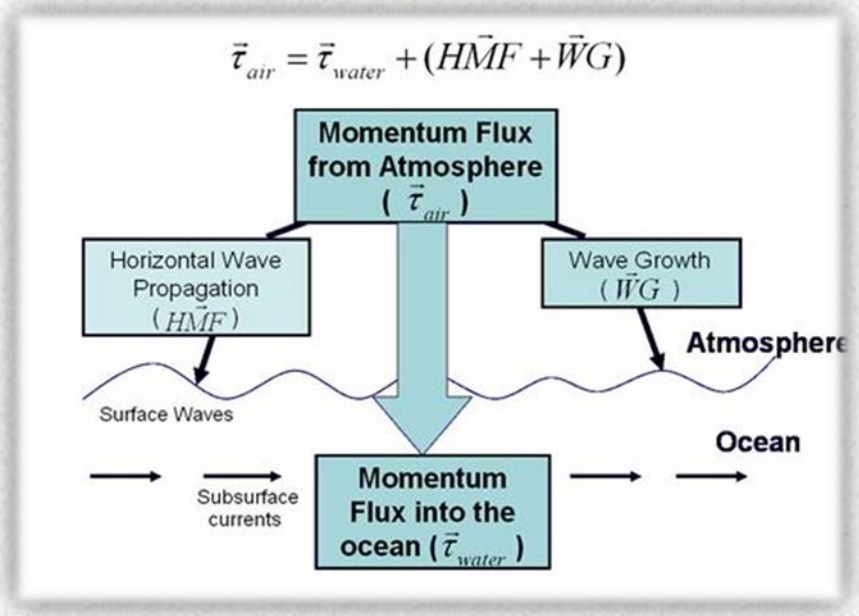
➢ Wave climate projections: **why are they important?**

Wind waves: ocean surface gravity waves caused by the transfer of **momentum** from the **wind** to the **water**.



- **Most energetic ones**

(> 50% of the energy carried by all waves at the ocean surface)

Climatic changes in the atmosphere

Changes in the close to surface **wind speeds**

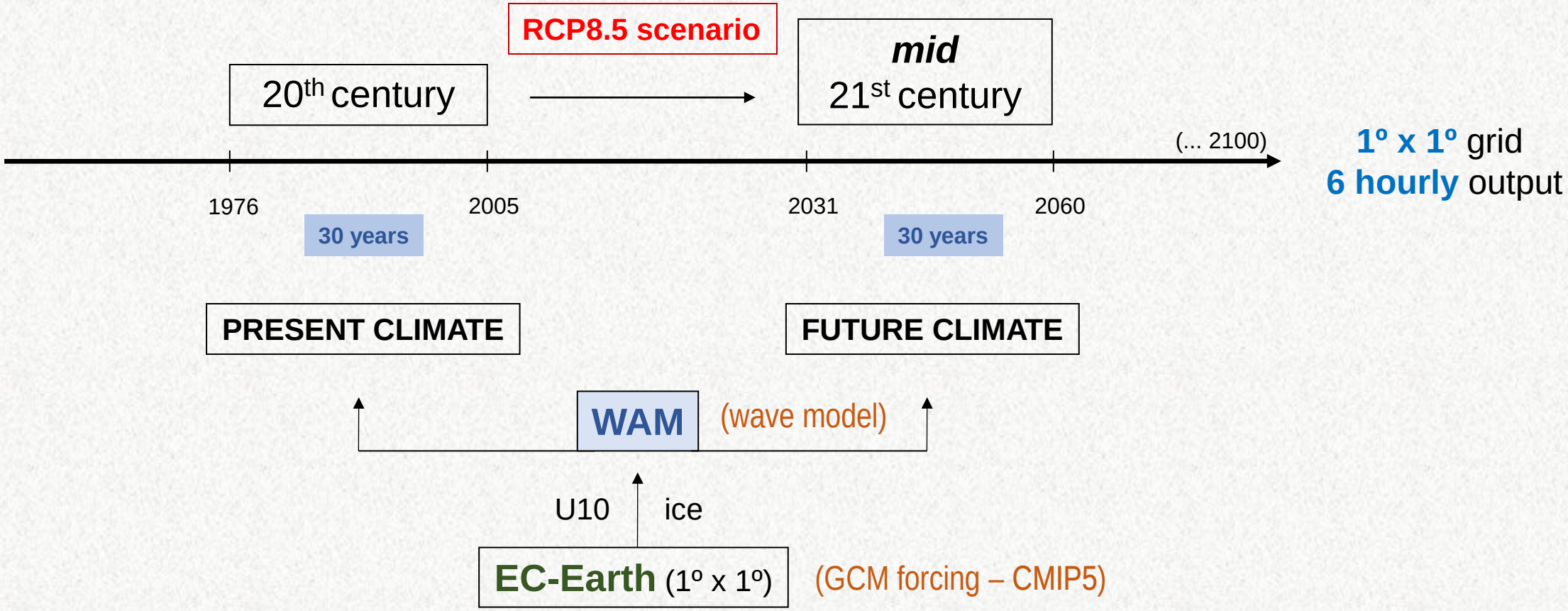
Changes in **FUTURE WAVE CLIMATE**

Why mid-21st century?

- **Less uncertainty regarding the emission scenario** (and between the range of E. Ss.) and the climatic projections (Prein et al. 2011, Gobiet et al. 2013)
- A great portion of the living population now will be living during the mid-21st century:
  – **applies directly to most of us and not only to the future generations**.

➢ Wave climate projections: **methodology**

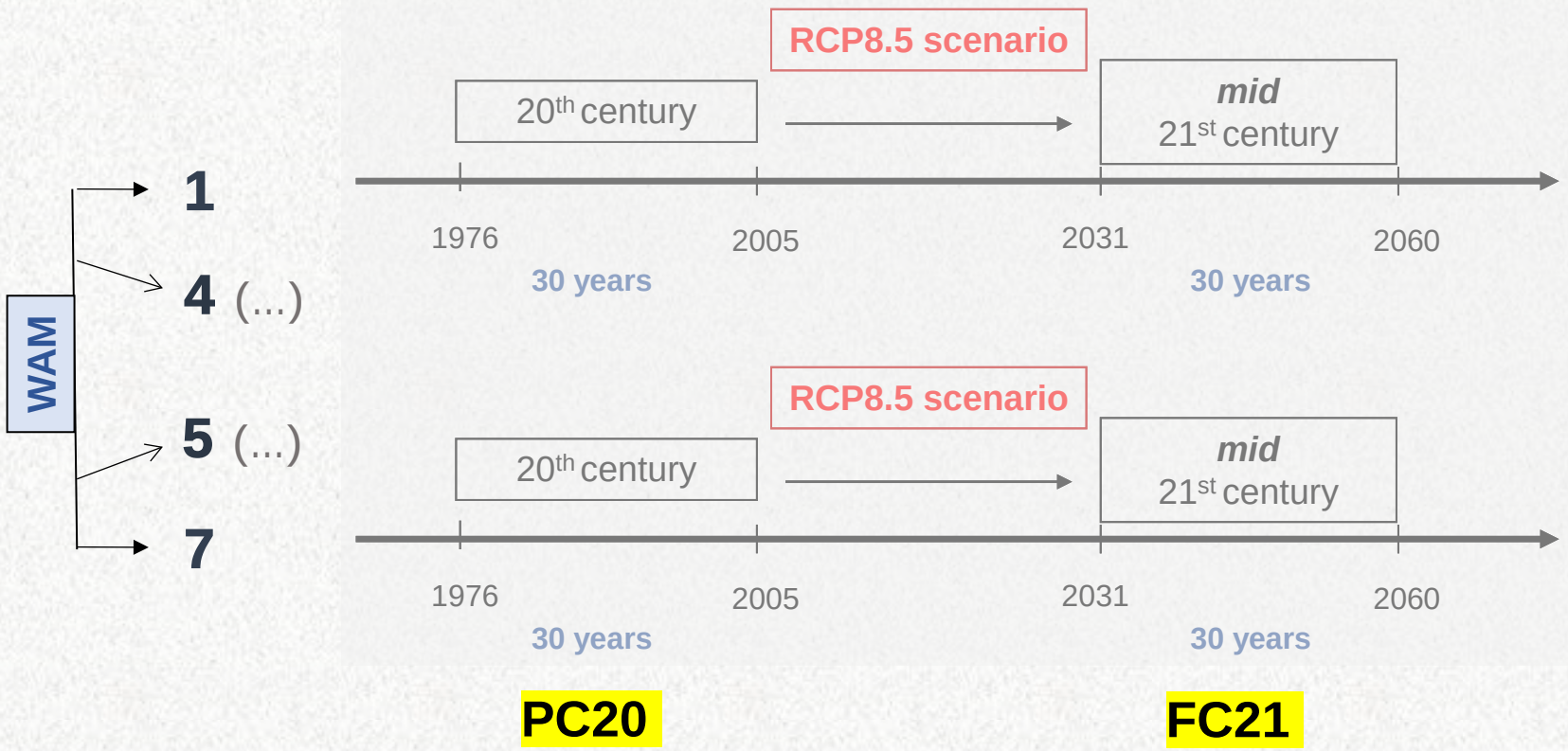
How each simulation was generated…



➢ Wave climate projections: **methodology**

4-member ens.

- **1** – IDL, Portugal
- **2,3,6** – DMHI, Denmark (do not cover this period)
- **4,5,7** – SMHI, Sweeden

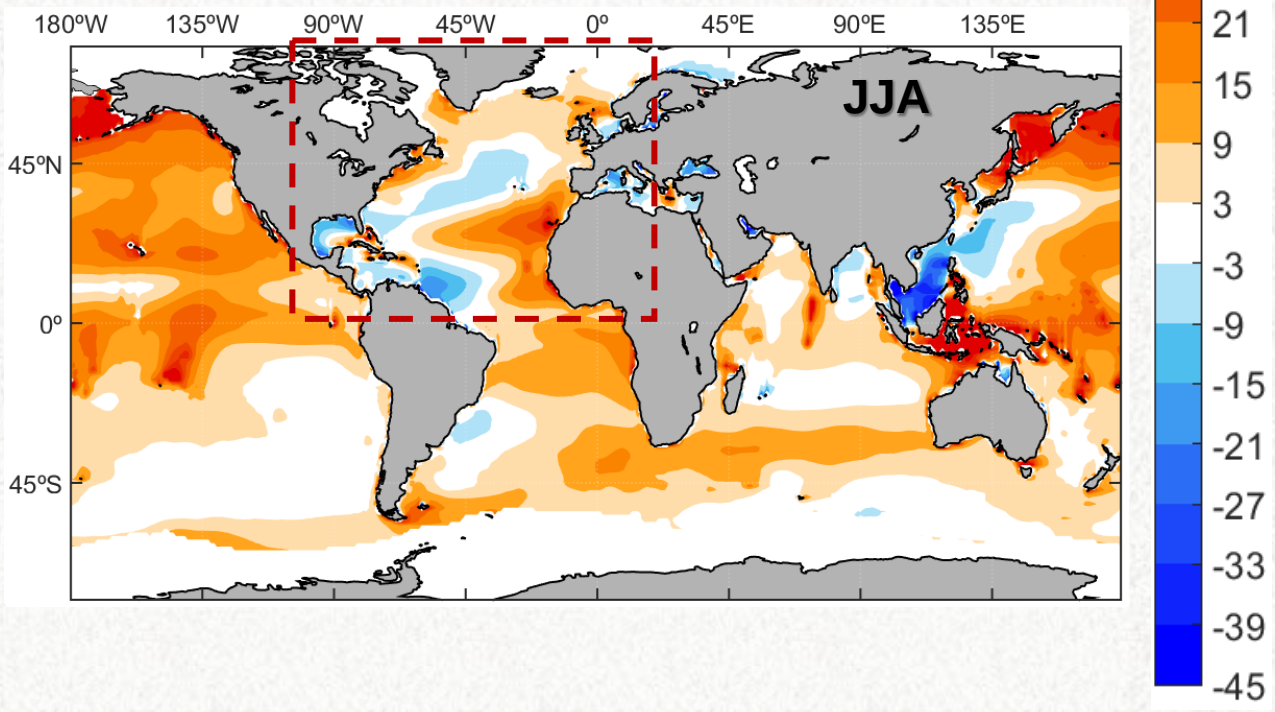


➢ Results: **ensemble validation**

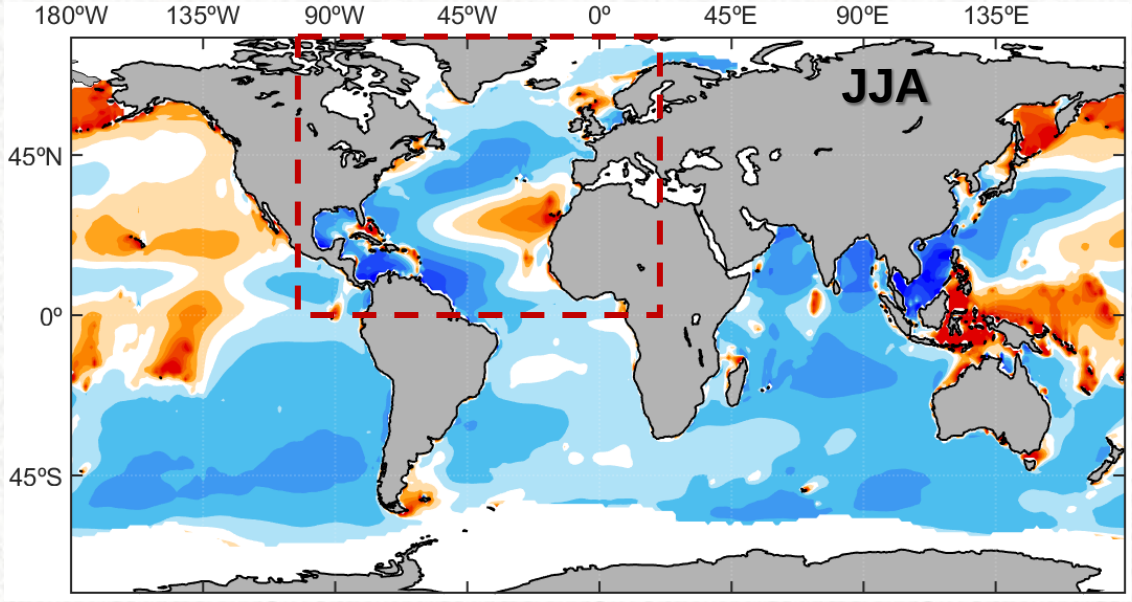
In order to gain **confidence** in the wave model medium-term **future** climate simulations, it is crucial to assess the **model capability to represent the present wave climate**.

Significant wave height (**Hs**) – normalized differences (%)

against **ERA-Interim**
6 hourly



against **CFSR**
3 hourly



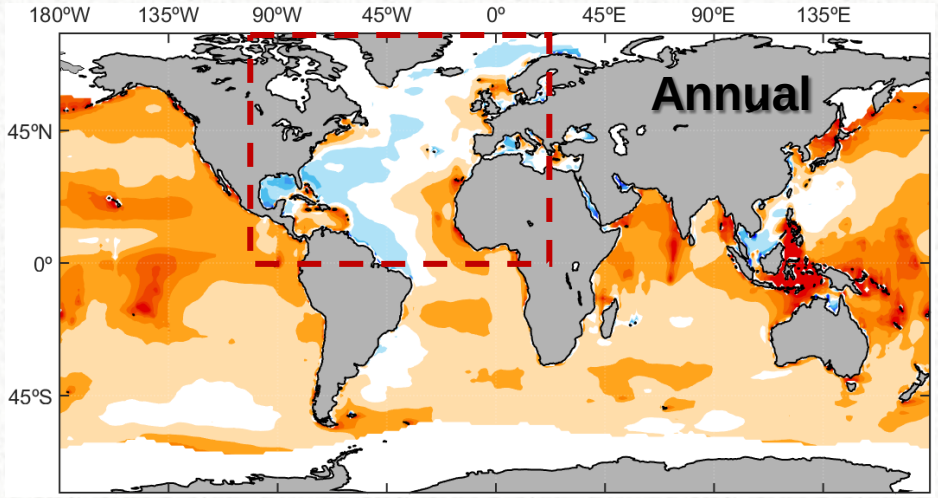
➢ Results: **ensemble validation**

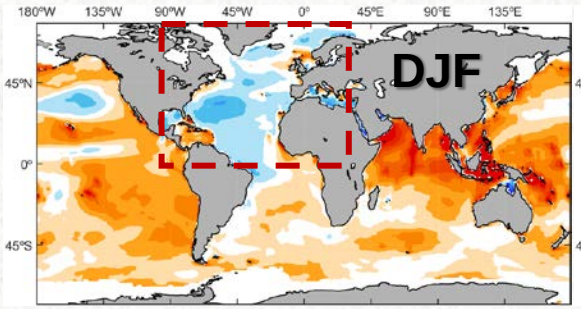
Significant wave height (**Hs**) – normalized differences (%)

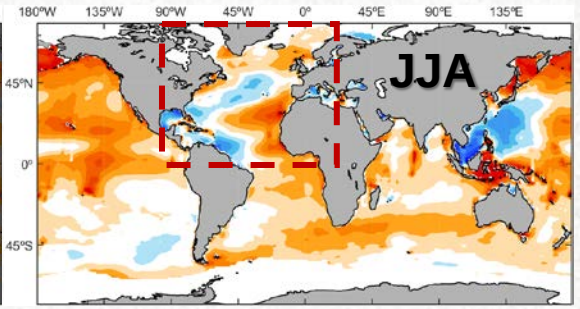
95% percentile

against **ERA-Interim**

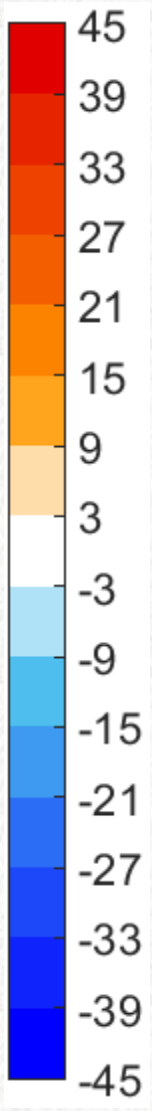
6 hourly





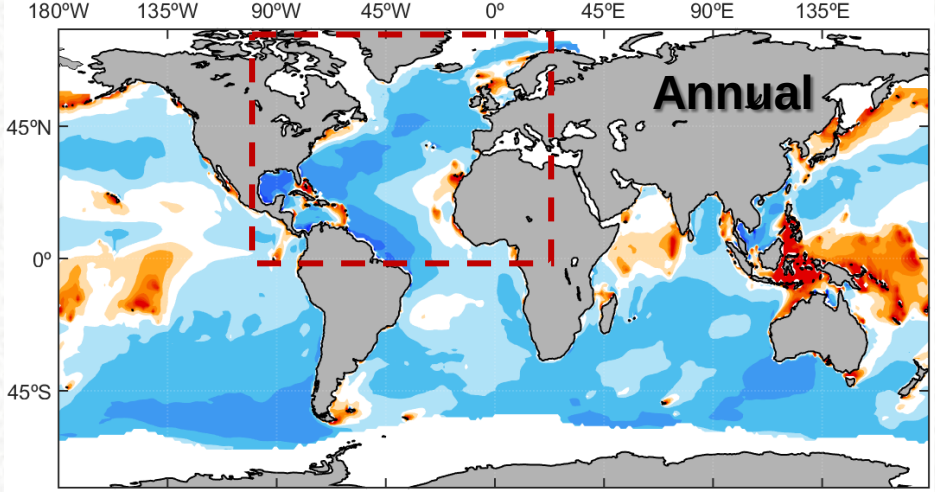


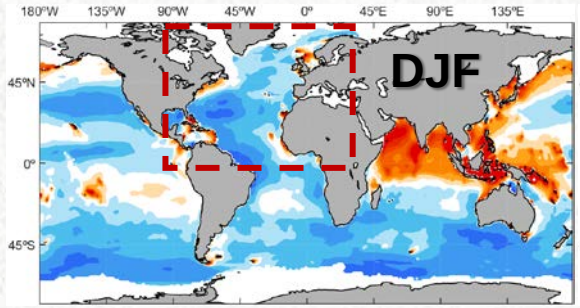
(%)

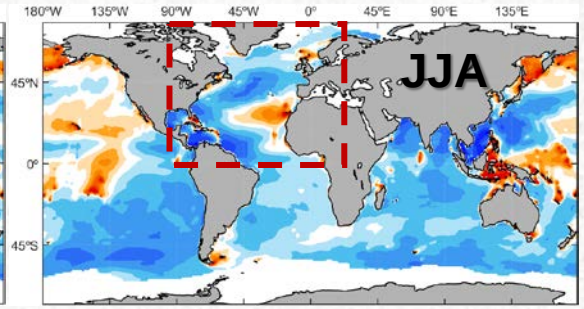


against **CFSR**

3 hourly

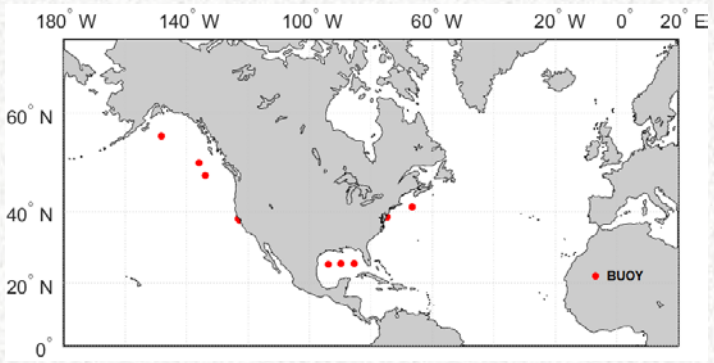




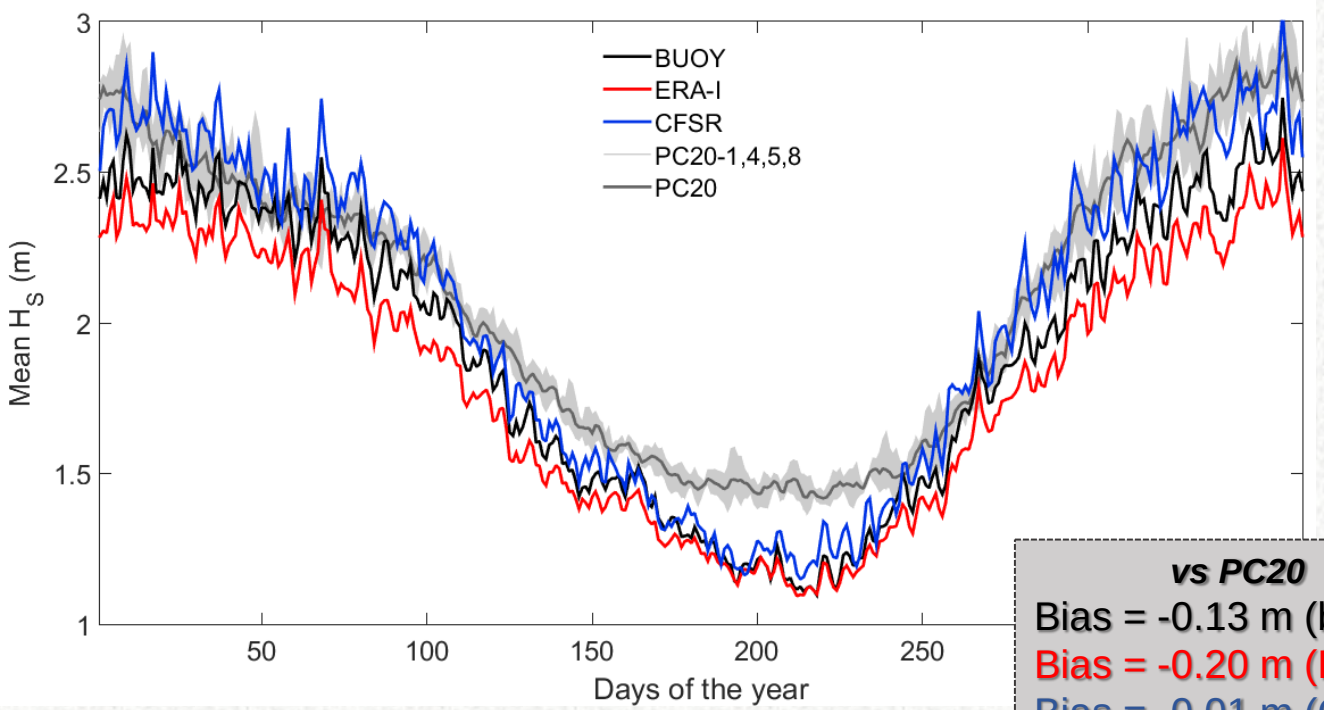


➢ Results: **ensemble validation**

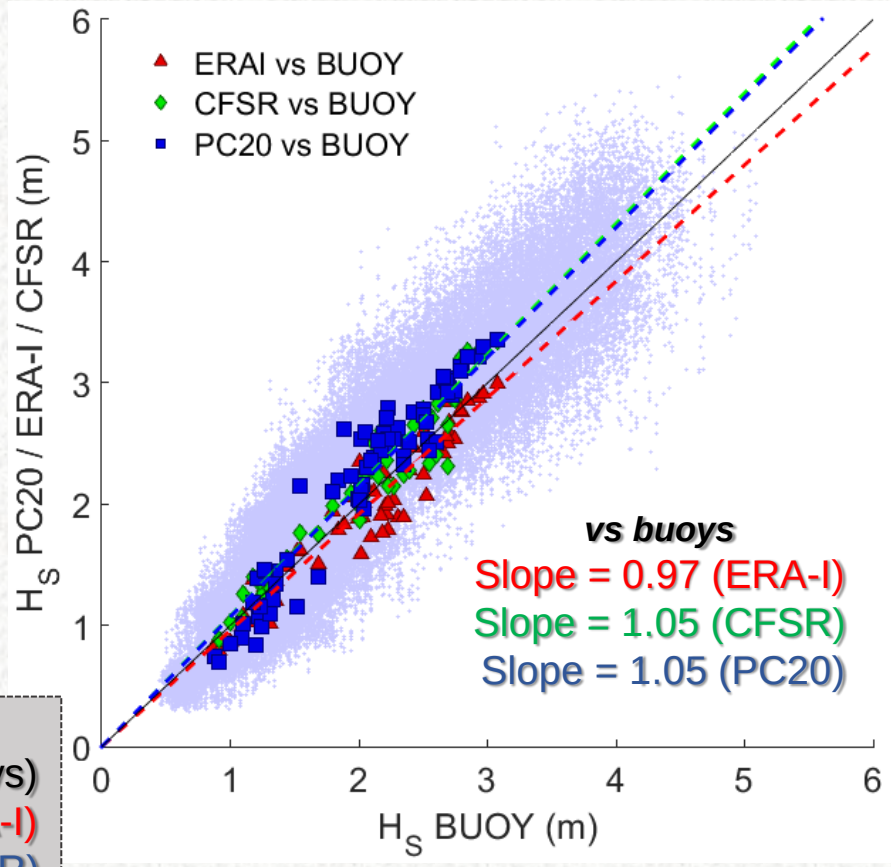
Significant wave height (**Hs**)
against **buoy** observations



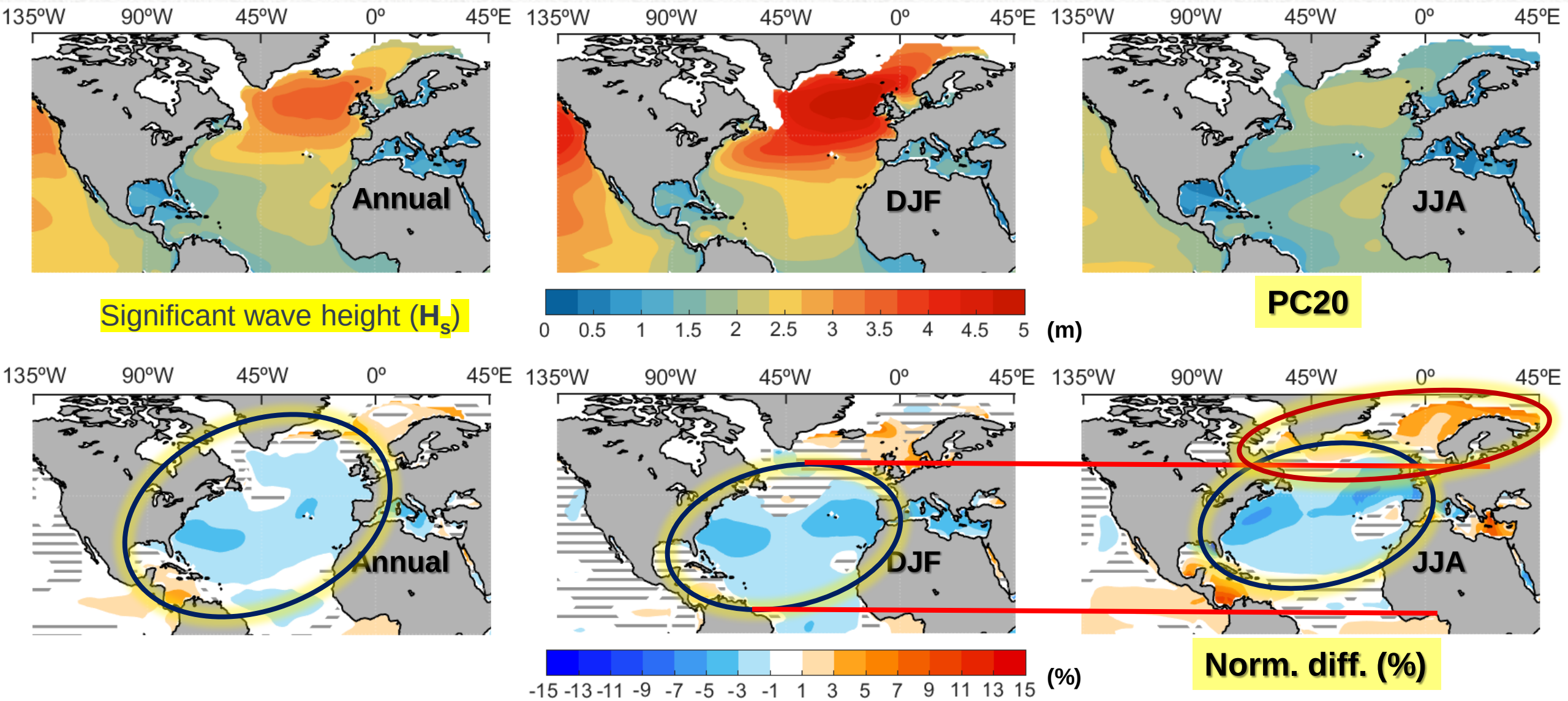
***10** buoys with long records (34 to 37 y)*



vs PC20
Bias = -0.13 m (buoys)
Bias = -0.20 m (ERA-I)
Bias = -0.01 m (CFSR)

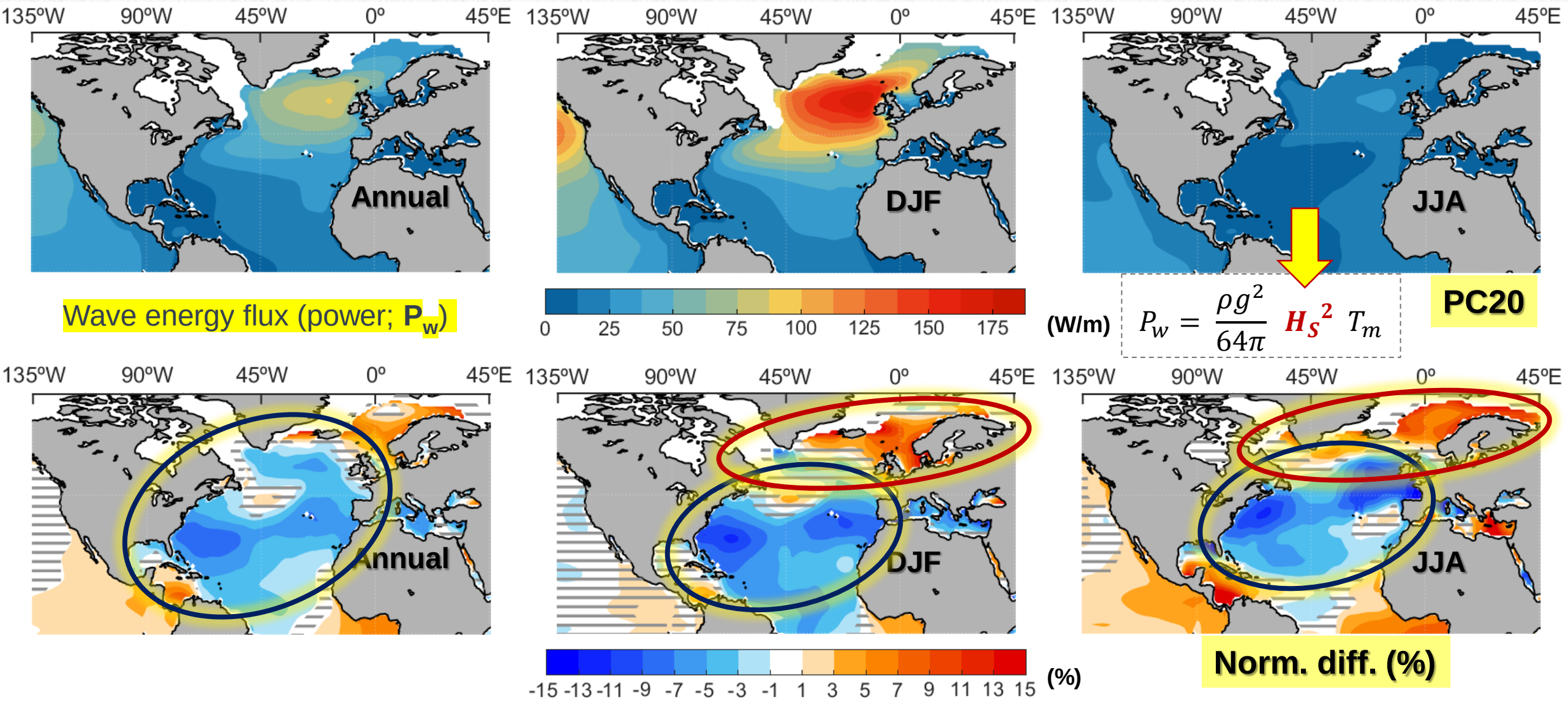


➢ Results: **projected changes in wave climate** (2031-2060) – normalized differences (%)



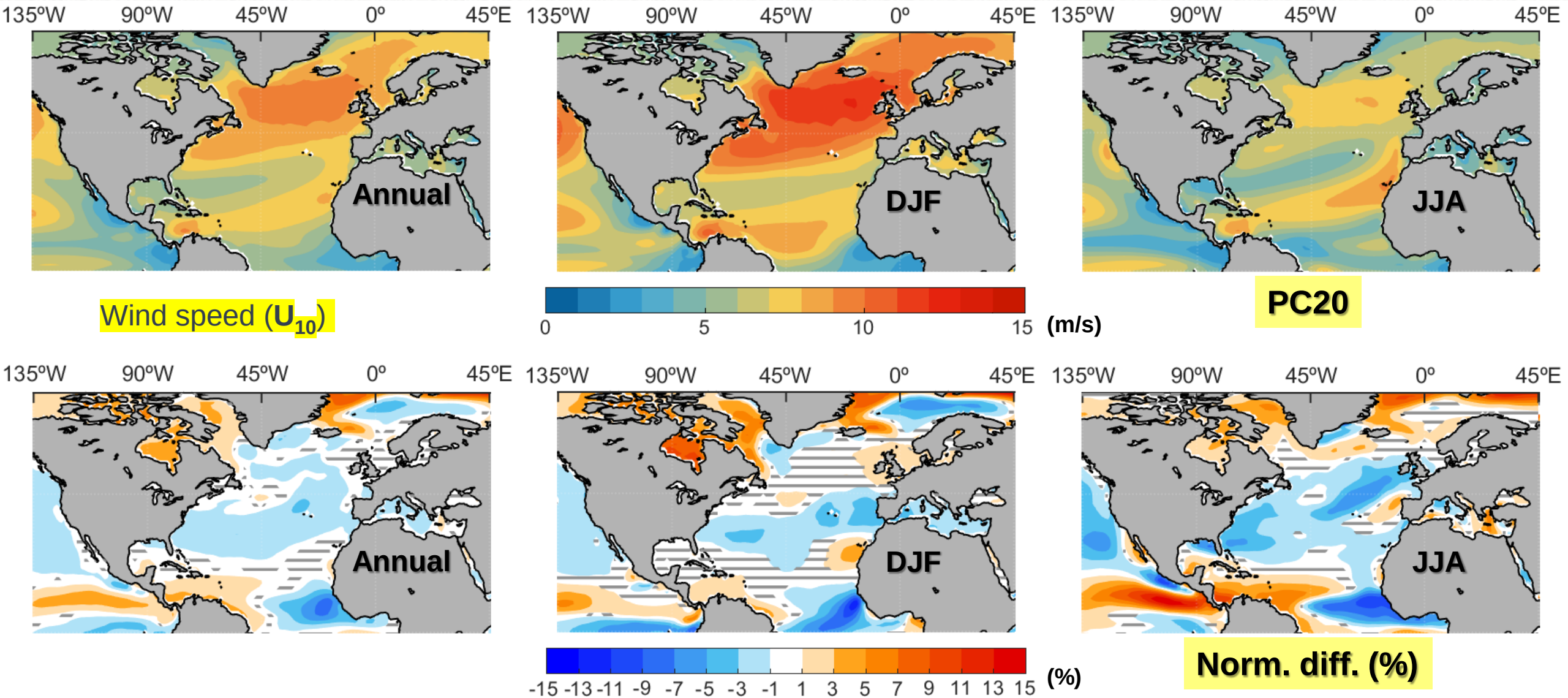
Annual, DJF and JJA means for PC20 H_s and normalized differences (%) between FC21 and PC20.
Regions where the projected changes are not statistically significant (at 95% confidence level) are shaded.

➢ Results: **projected changes in wave climate** (2031-2060) – normalized differences (%)



Annual, DJF and JJA means for PC20 P_w and normalized differences (%) between FC21 and PC20.
Regions where the projected changes are not statistically significant (at 95% confidence level) are shaded.

➢ Results: **projected changes in wave climate** (2031-2060) – normalized differences (%)

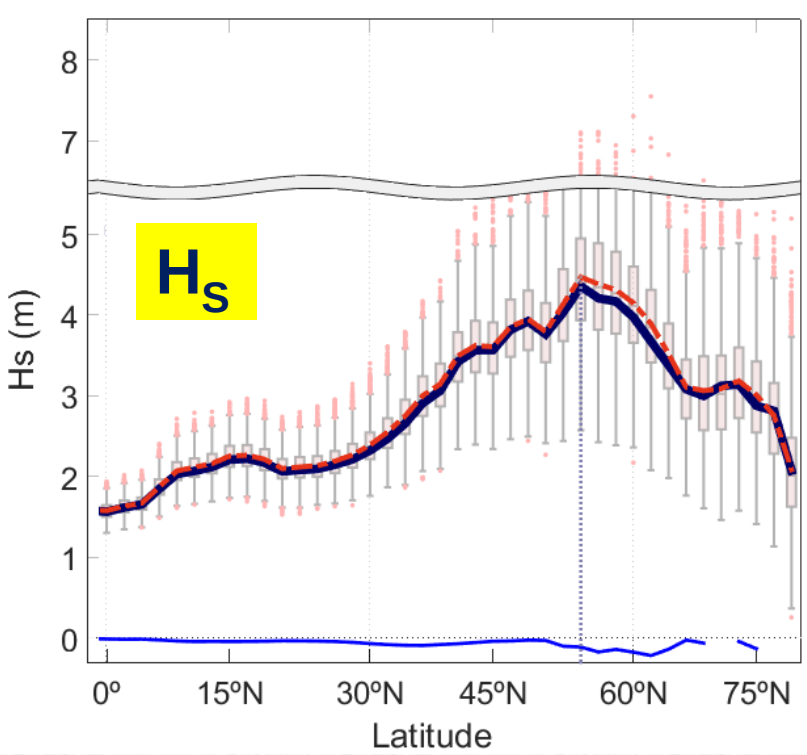


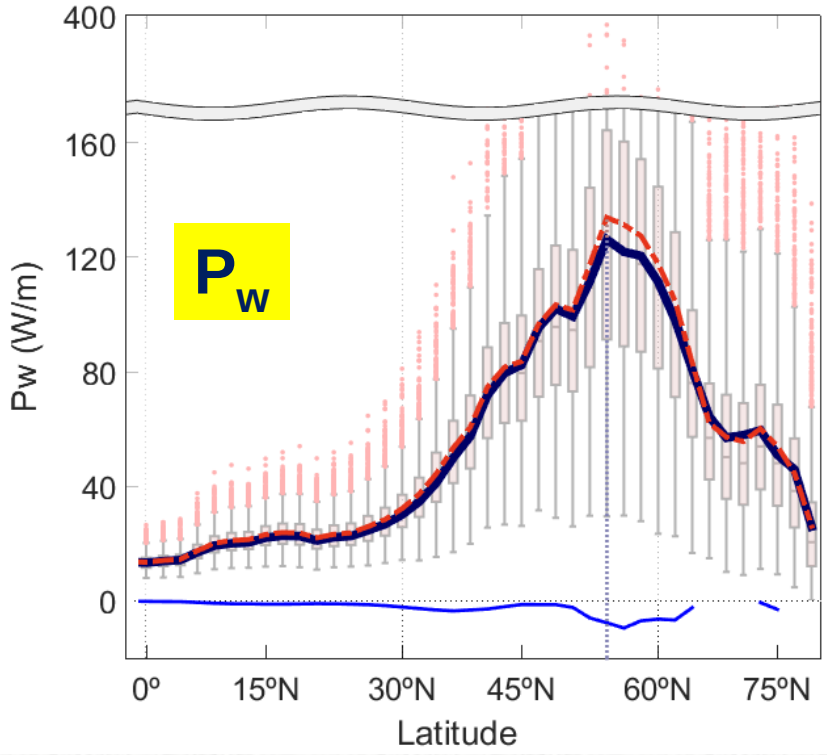
Annual, DJF and JJA means for PC20 U_{10} and normalized differences (%) between FC21 and PC20.
Regions where the projected changes are not statistically significant (at 95% confidence level) are shaded.

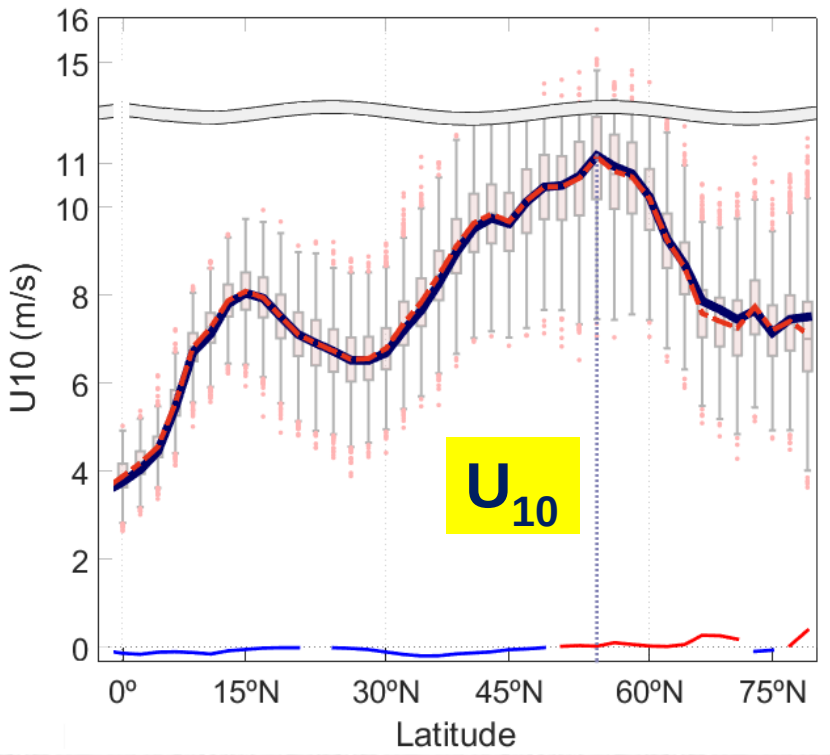
➢ Results: **projected changes in wave climate** (2031-2060)

Cross sections of the mean zonal values (for each degree of latitude)

Only DJF (local WINTER)







FC21 (& boxplot)
PC20
Diff (+)
Diff (-)

➢ Main **CONCLUSIONS**

- **The WAM / reanalysis comparison provided the required confidence** in the ability of the wave model to simulate a realistic climate change signal.

- By the mid-21st century, due to climate change, H_s (and consequently P_w), is estimated to **decrease** in the North Atlantic Ocean, with patters that can be connected to decreases in the mean wind speeds due to the migration of the storm tracks to higher latitudes.

(in JJA some areas exhibit projected increases connected to sea ice cover retraction and local increases in the mean wind speed)

- Although, globally, both are estimated to **increase** (**~1%** and **~4%**) mostly in **mid and high latitudes of the southern Hemisphere,** with the highest projected differences in the Southern Ocean in JJA.

(due to extensive sea ice cover extent retraction and possible increase in the westerlies)

JJA
Global mean increase of
~3% and **~7%**
H_s P_w

THANK YOU!

➢ References

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