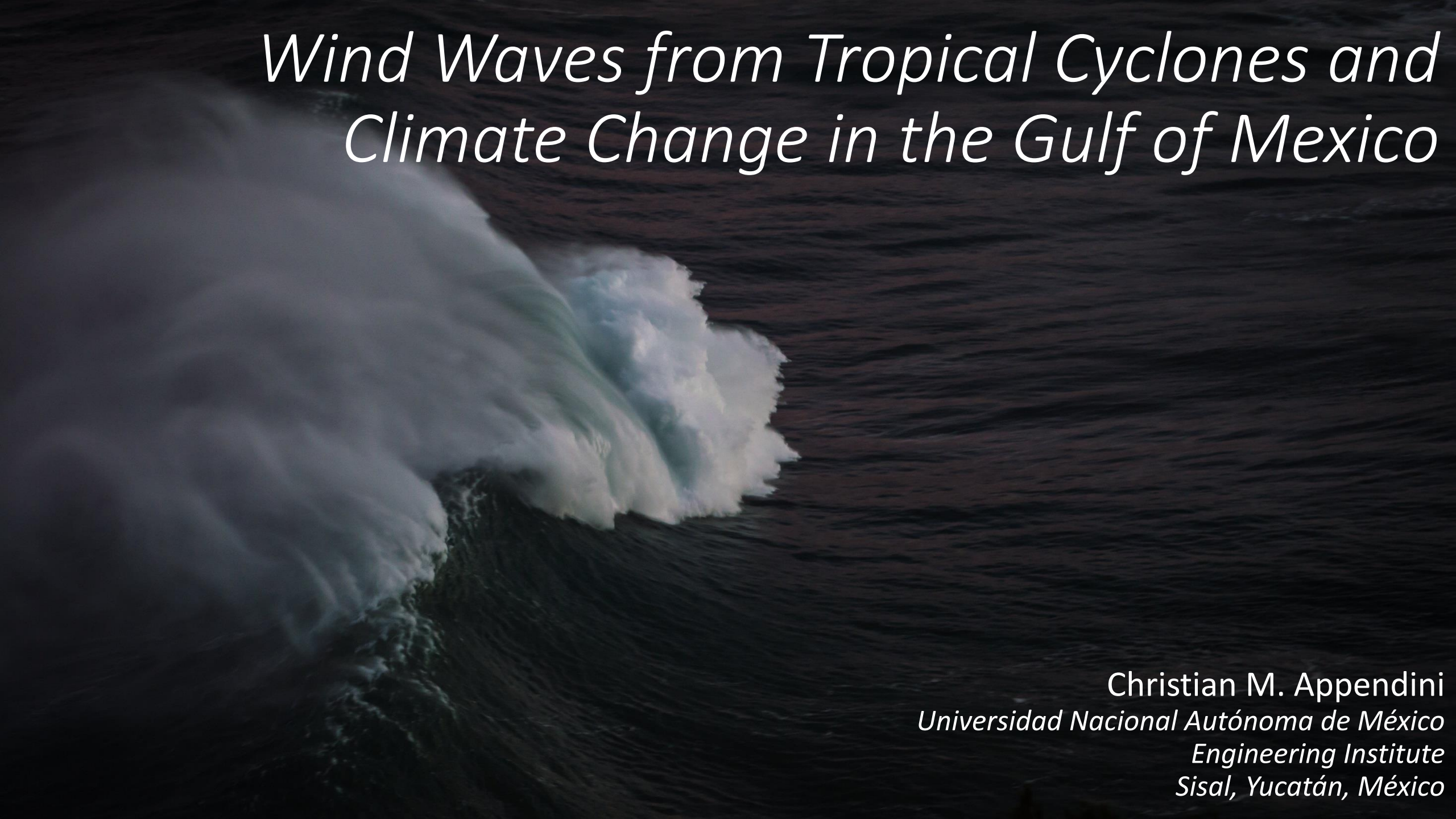
Wind Waves from Tropical Cyclones and Climate Change in the Gulf of Mexico



Christian M. Appendini
Universidad Nacional Autónoma de México
Engineering Institute
Sisal, Yucatán, México

Gulf of Mexico

Wave climate in the Gulf of Mexico

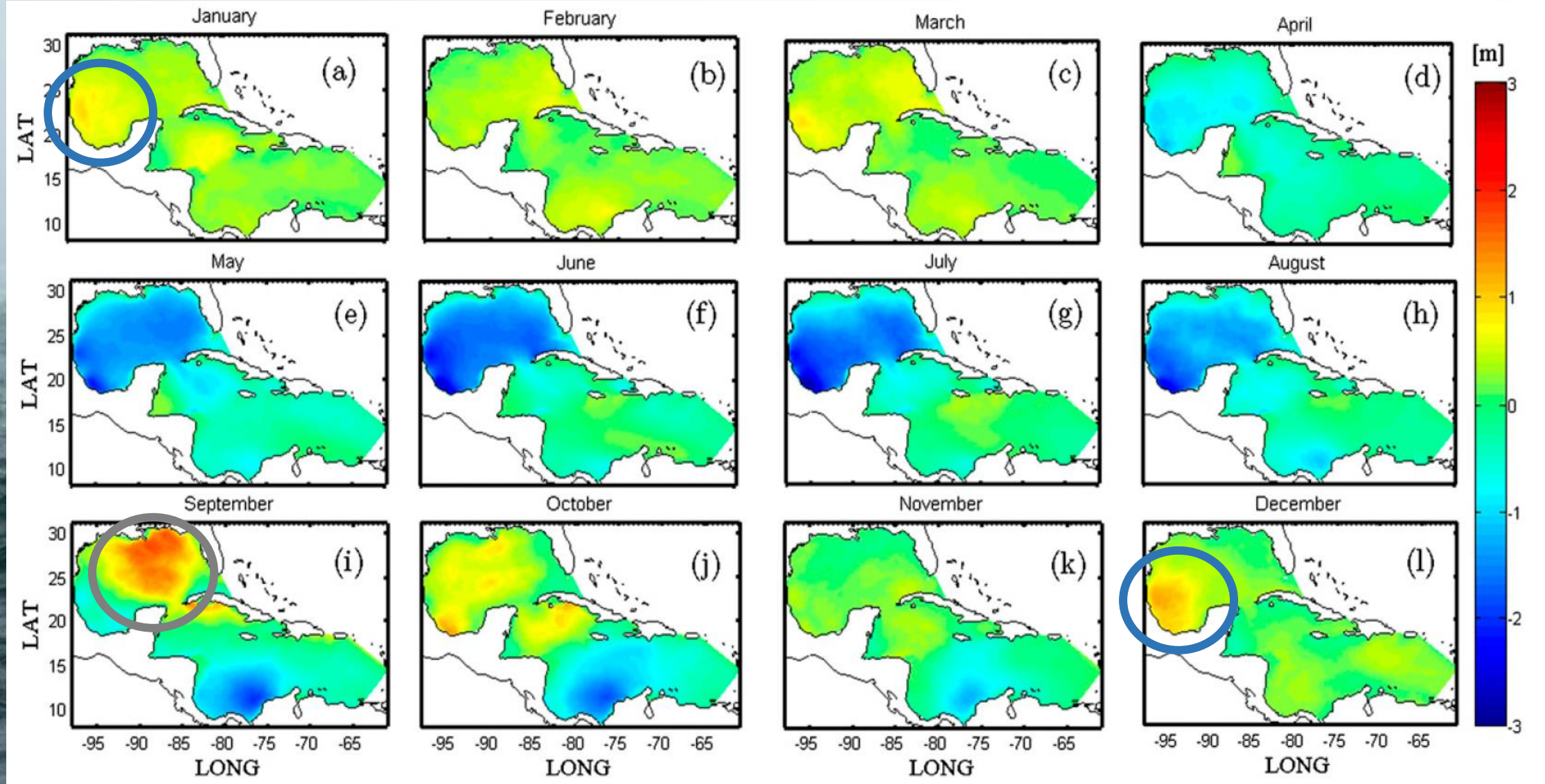


FIG. 9. Monthly 99th percentile SWH anomalies (m) at the GoM and CS based on the wave hindcast information (1979–2008).

Appendini, C. M., A. Torres-Freyermuth, P. Salles, J. Lopez-Gonzalez, and E. T. Mendoza, 2014: Wave climate and trends for the Gulf of Mexico: A 30 year wave hindcast. Journal of Climate, 27, 1619–1632.


Source: www.offshorevisie.nl/
Extreme waves...


David J. Phillip-Pool
Getty Images
and storm surge

Wave studies for extreme waves in the Gulf of Mexico area based on historical events

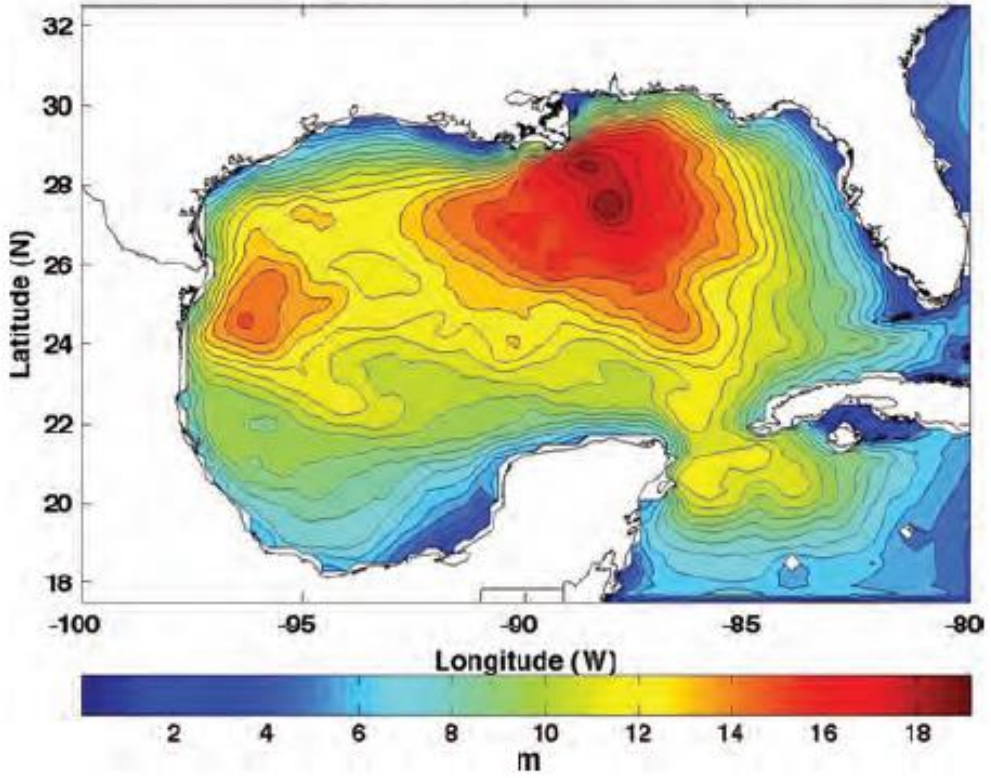


Fig. 14 Estimated SWH_{100} using the Gumbel method and 46 years (*a*) and 51 years (*b*) of data

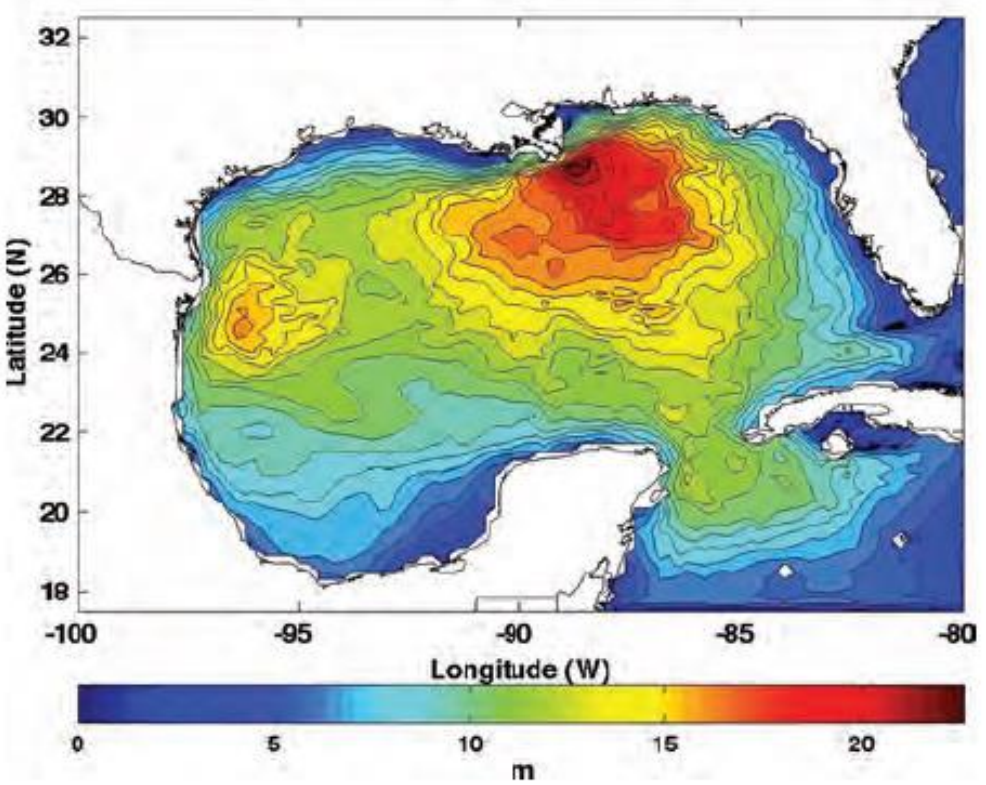
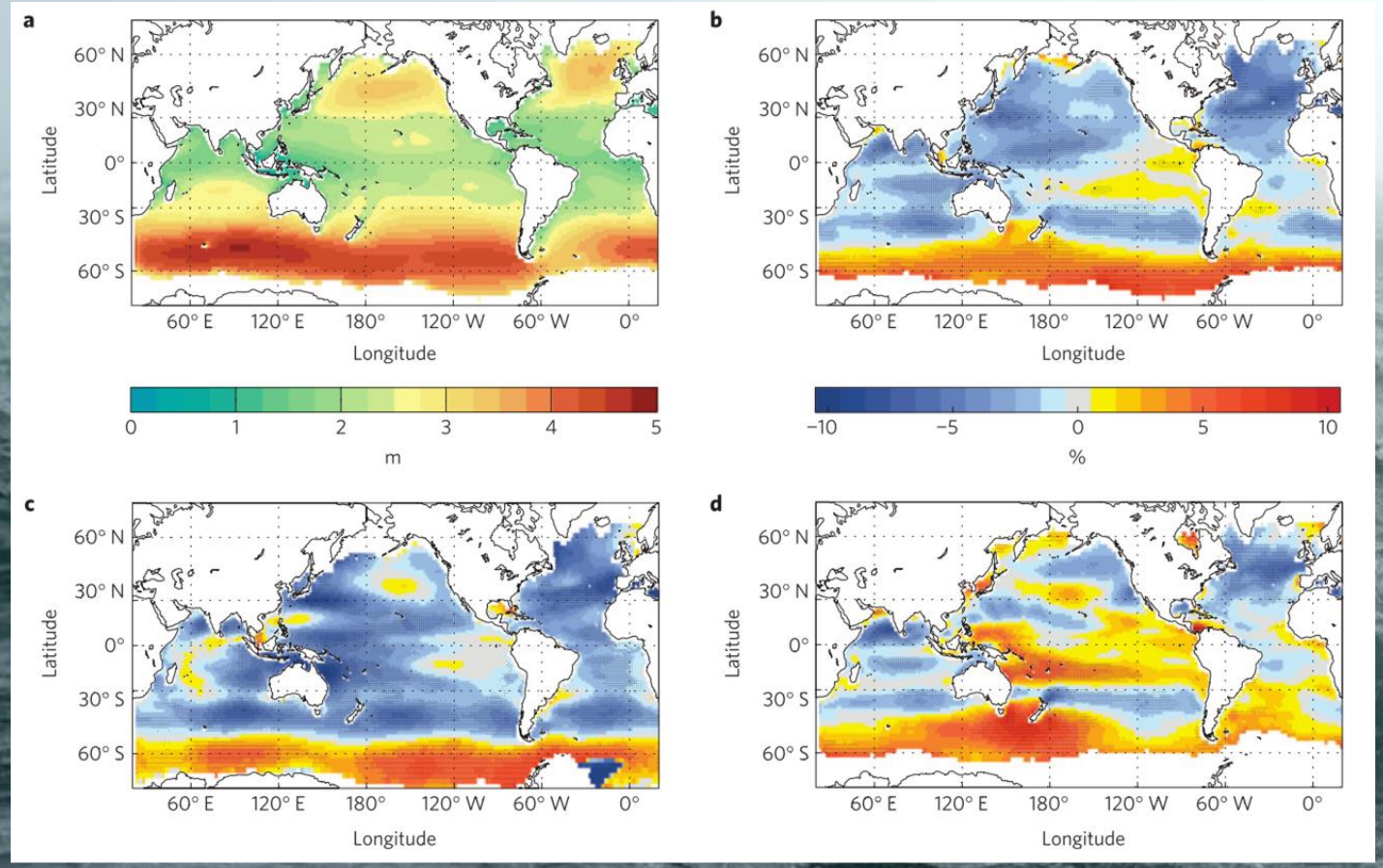


Fig. 15 Estimated SWH_{100} using the Weibull method and 46 years (*a*) and 51 years (*b*) of data

Panchang, V., C. K. Jeong, and Z. Demirbilek, 2013: Analyses of Extreme Wave Heights in the Gulf of Mexico for Offshore Engineering Applications. J. Offshore Mech. Arct. Eng., 135, 031104–031104 – 15, doi:10.1115/1.4023205.

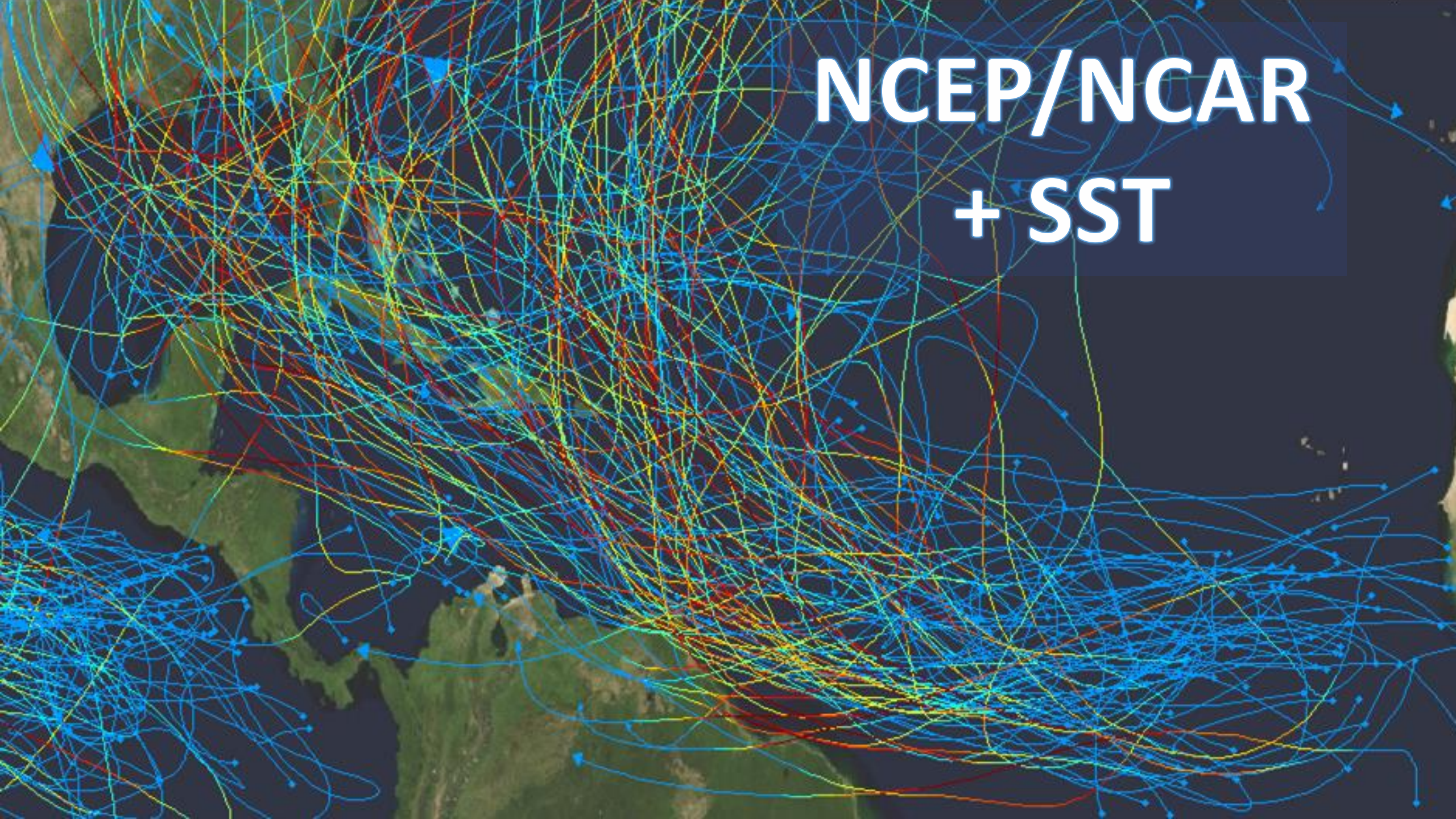
Global studies are too coarse to provide reliable information in the Gulf of Mexico

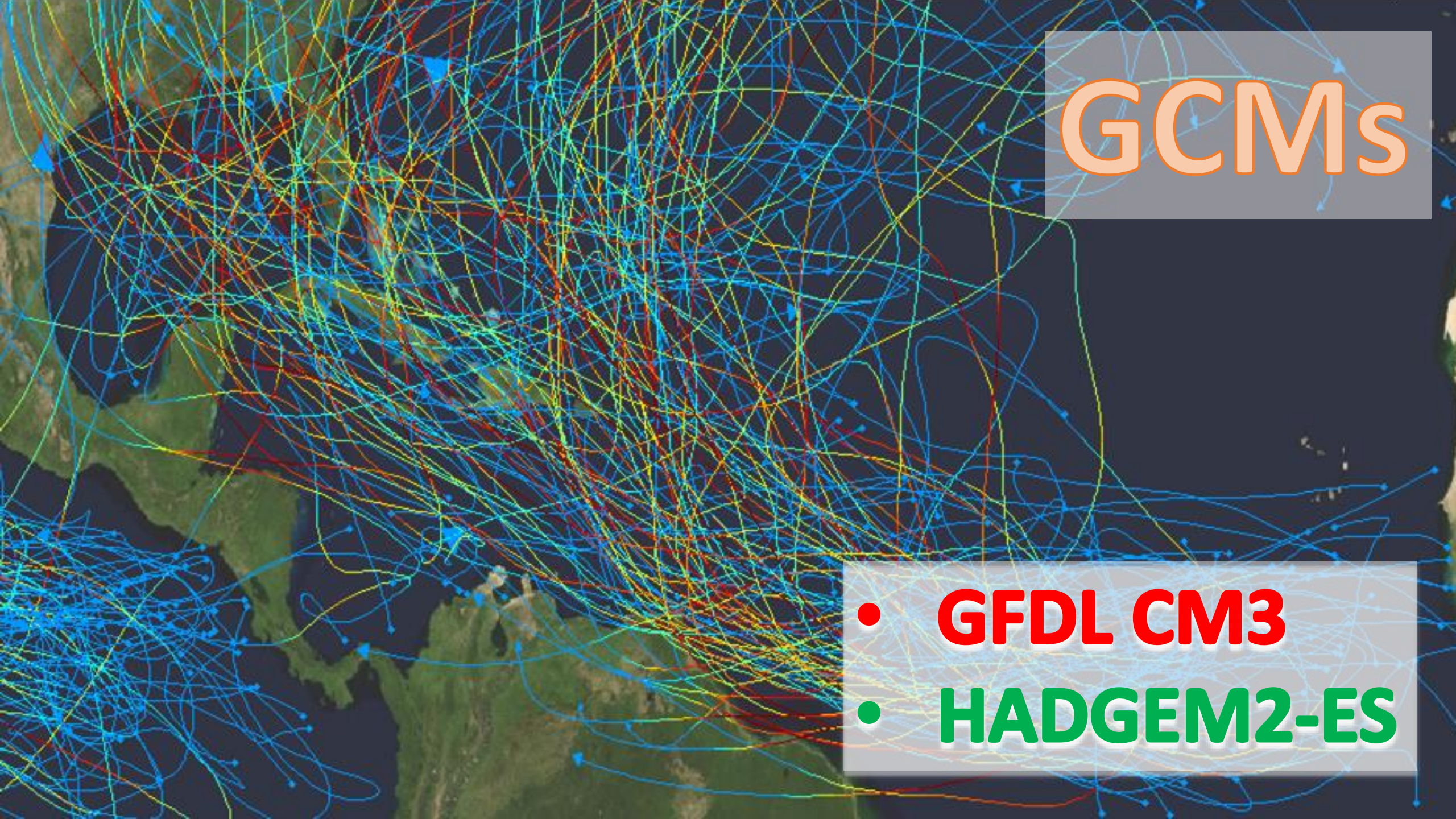


	Hemer et al. (2012)	Mori et al. (2010)	Fan et al. (2012)	Semedo et al. (2012)	Wang and Swail (2006)
SRES	A2	A1b	A1b	A1b	A2, A1b
GCM	ECHAM CSIRO Mk3.5	CMIP3 23m ens. mean	CMIP3 23m ens. mean GFDL-CM2.1	ECHAM5	HadCM3 ECHAM4 CGCM2

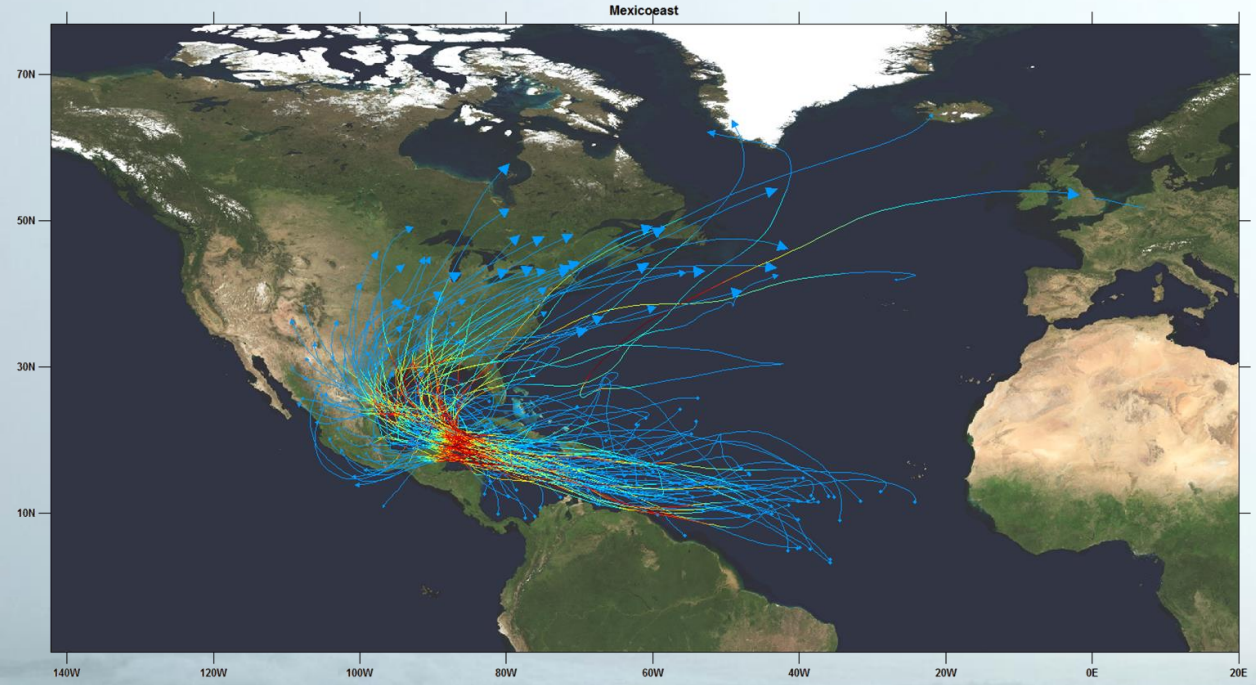
GCMs underestimate number of TC and their intensity

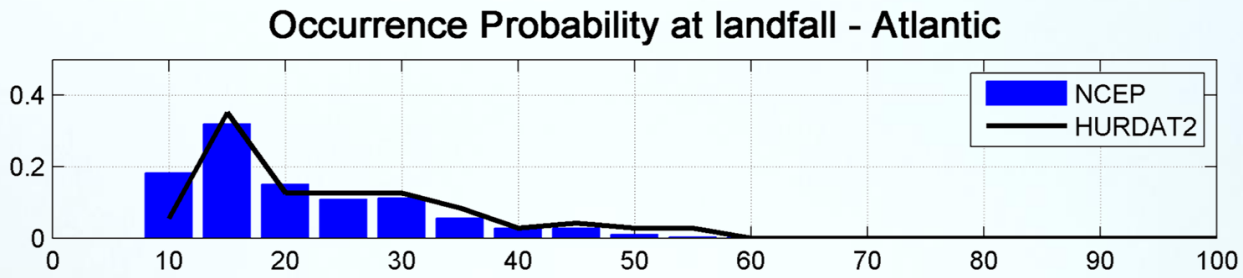
Hemer, M. a., Y. Fan, N. Mori, A. Semedo, and X. L. Wang, 2013: Projected changes in wave climate from a multi-model ensemble. Nat. Clim. Chang., 3, 1–6, doi:10.1038/nclimate1791.

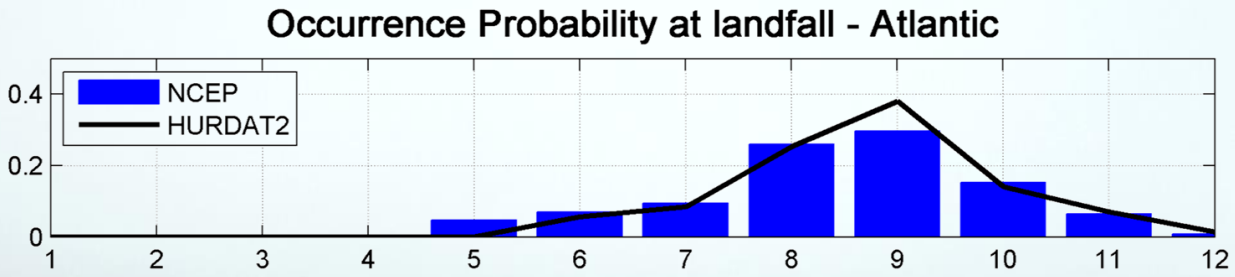

NCEP/NCAR
+ SST


GCMs
• GFDL CM3
• HADGEM2-ES

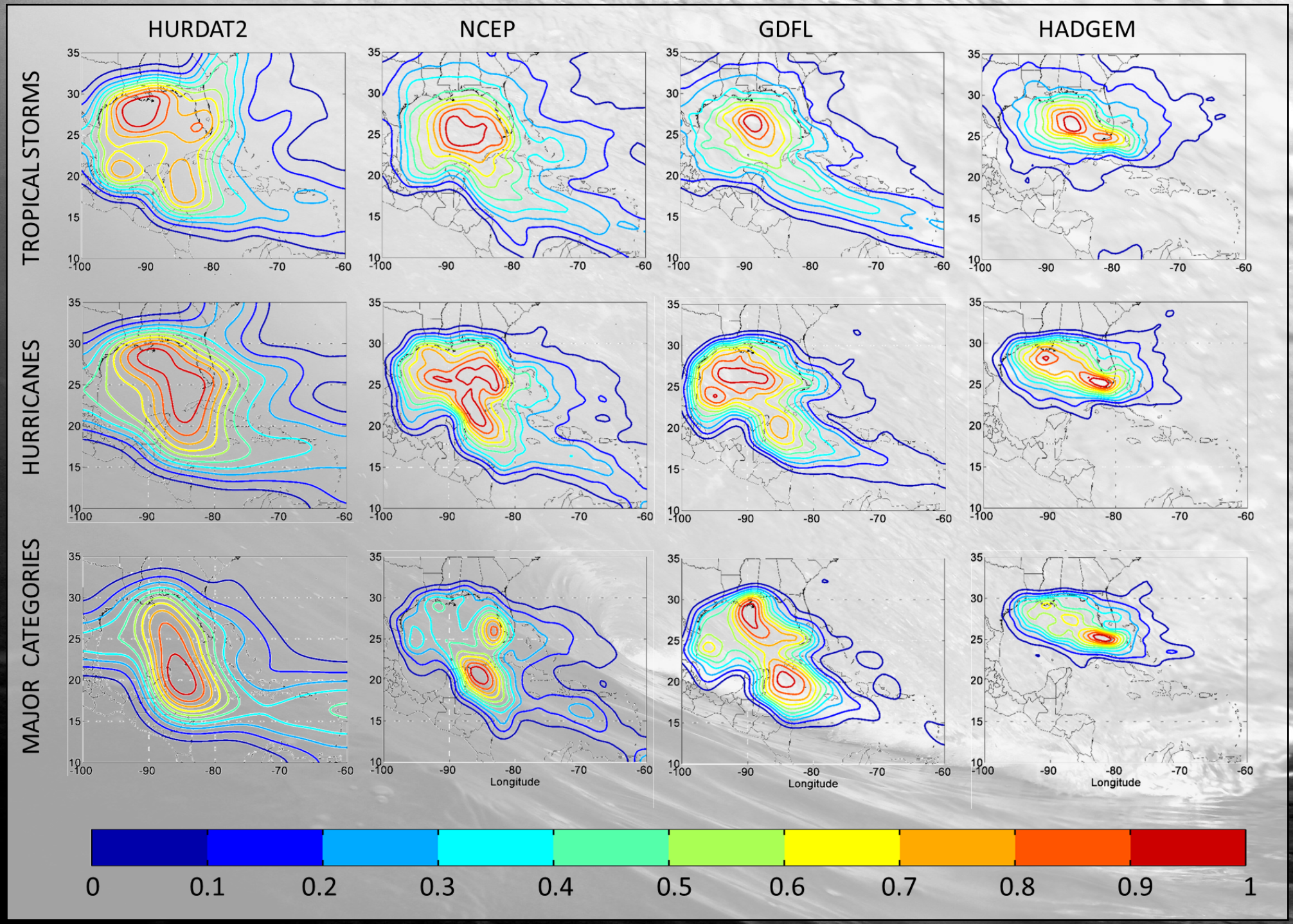
1550 synthetic events in the Gulf of Mexico

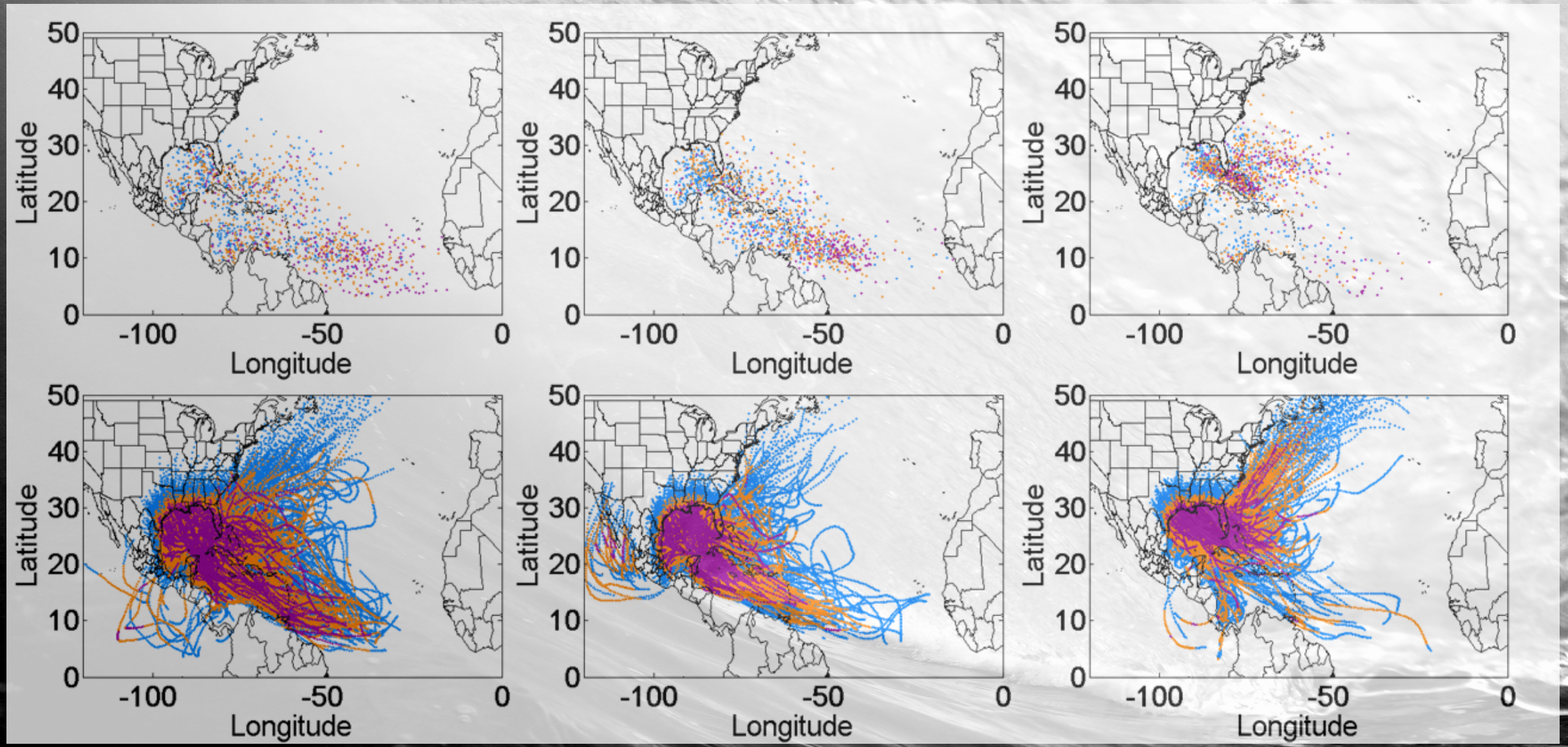






Kernel density



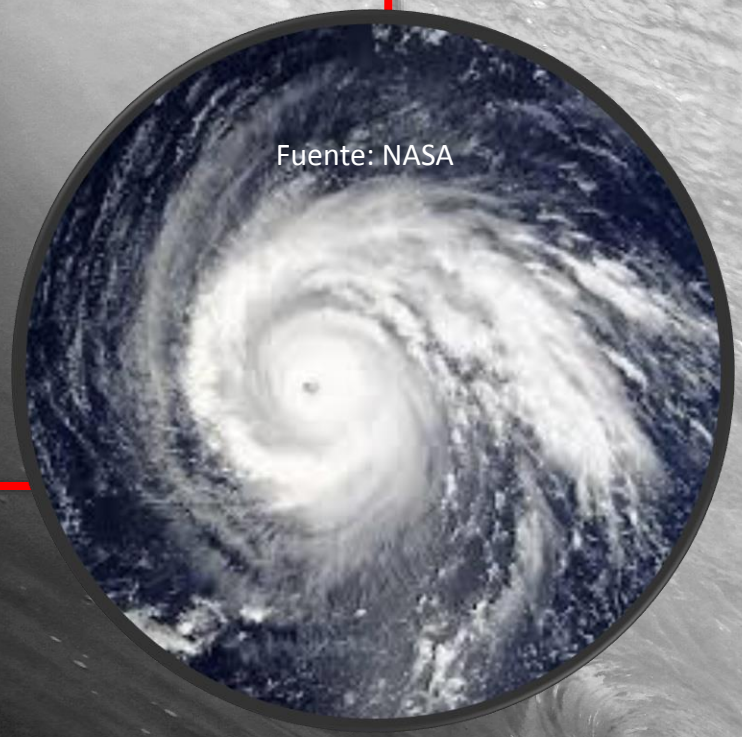

NCEP
GFDL
HADGEM
Genesis (intensity)
Maximum winds
Latitude
Longitude
50
40
30
20
10
0
-100
-50
0
TS
Cat 1-2
Cat 3-5

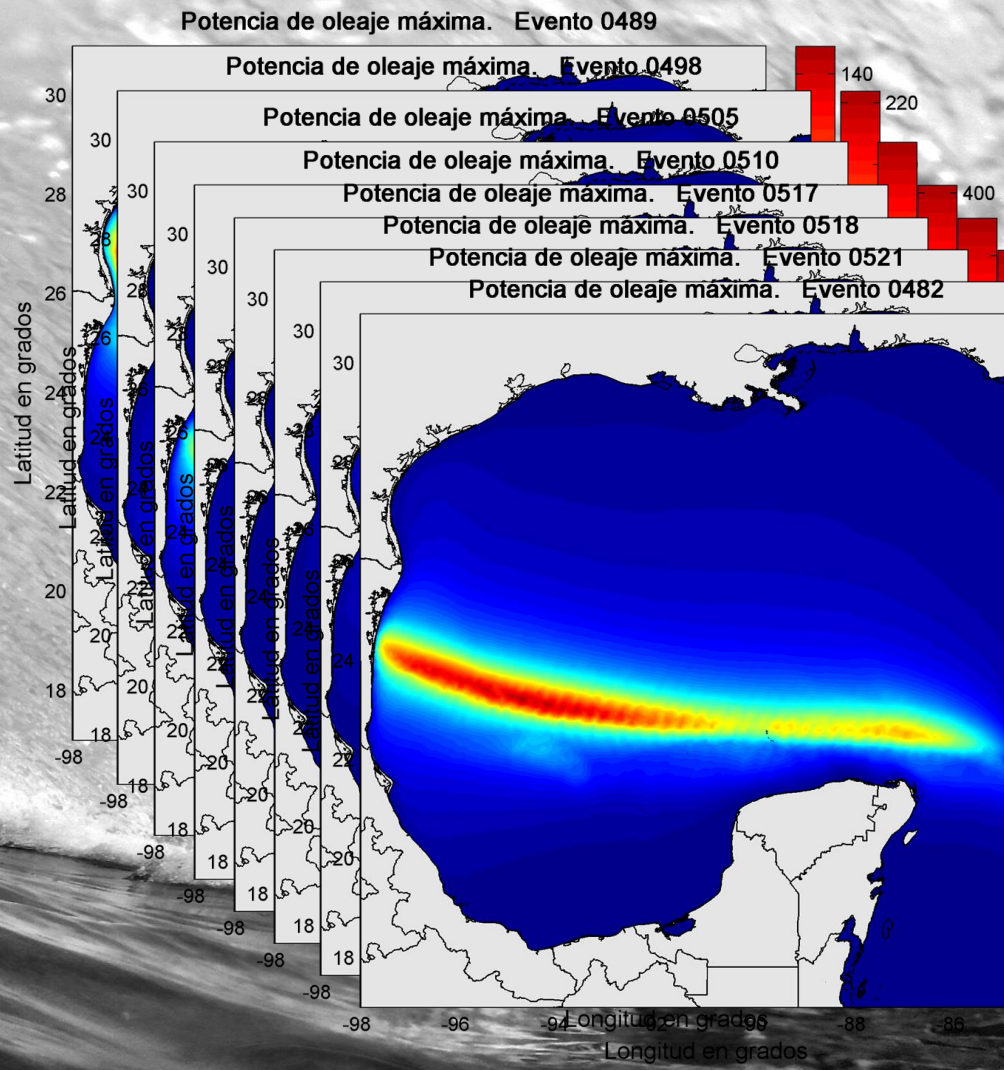
Bathymetry /Mesh

Wind fields *(NCEP, HADGEM, GFDL, RCP4.5, RCP8.5)*

MIKE 21 SW

Maximum envelopes (Hs, Tp) and Hs associated values (Tp, Dir)



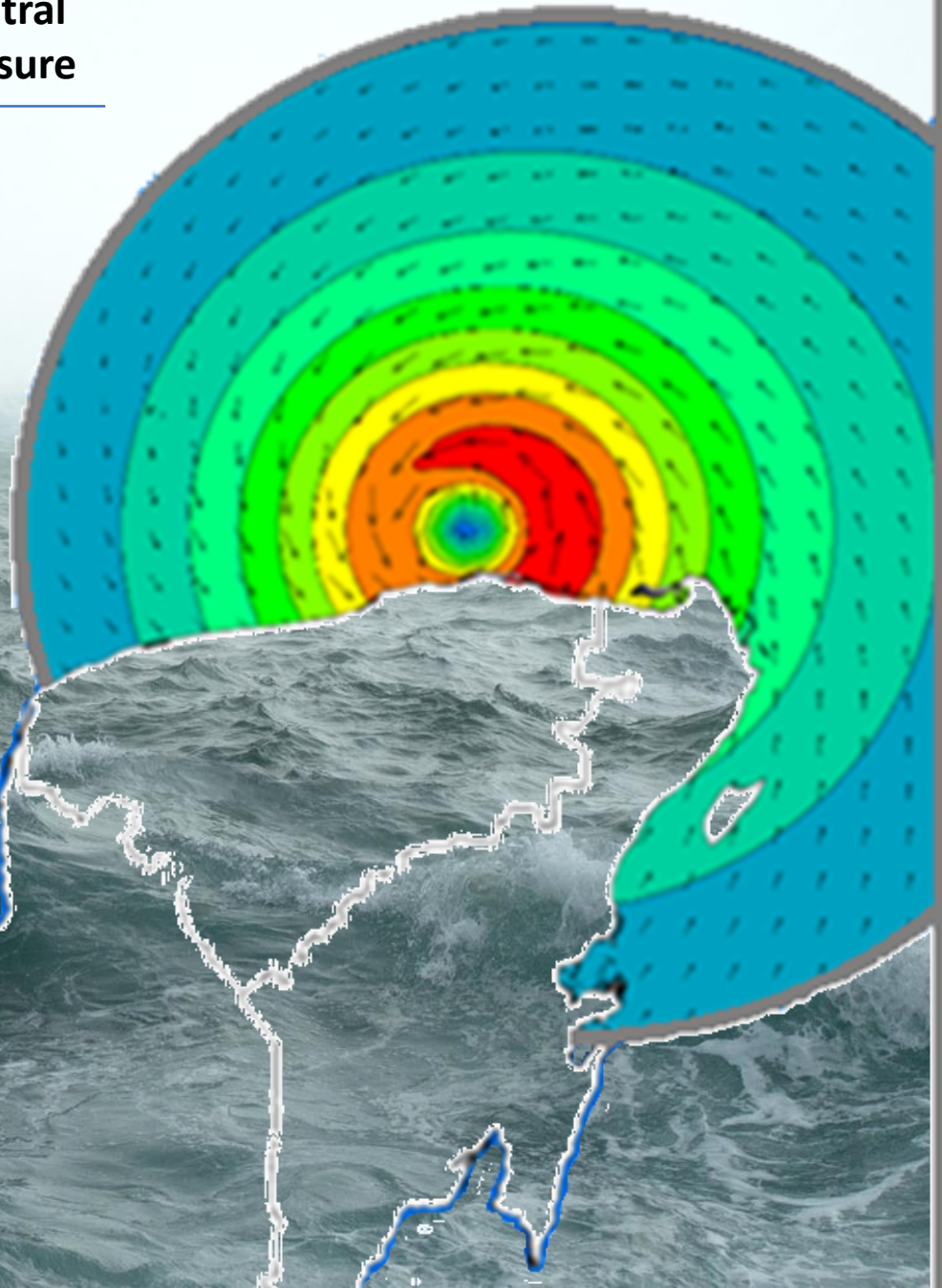


Wave modeling...

Day	Time	Long, Lat	Max winds	Radii max winds	Central pressure	Neutral pressure

$$V_r = \frac{2r\left(R_{mw}V_m + \frac{1}{2}fR_{mw}^2\right)}{R_{mw}^2 + r^2} - \frac{fr}{2}$$

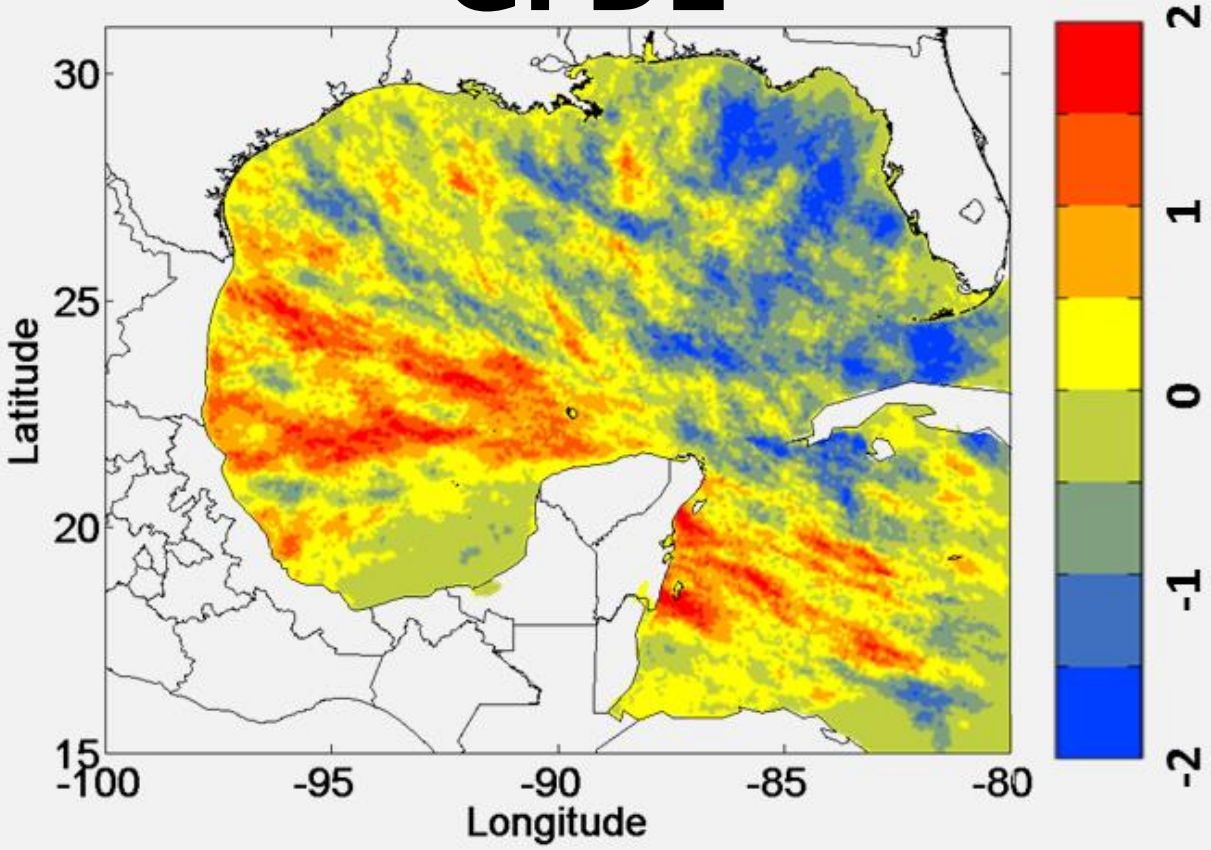
EMANUEL & ROTUNNO (2011)



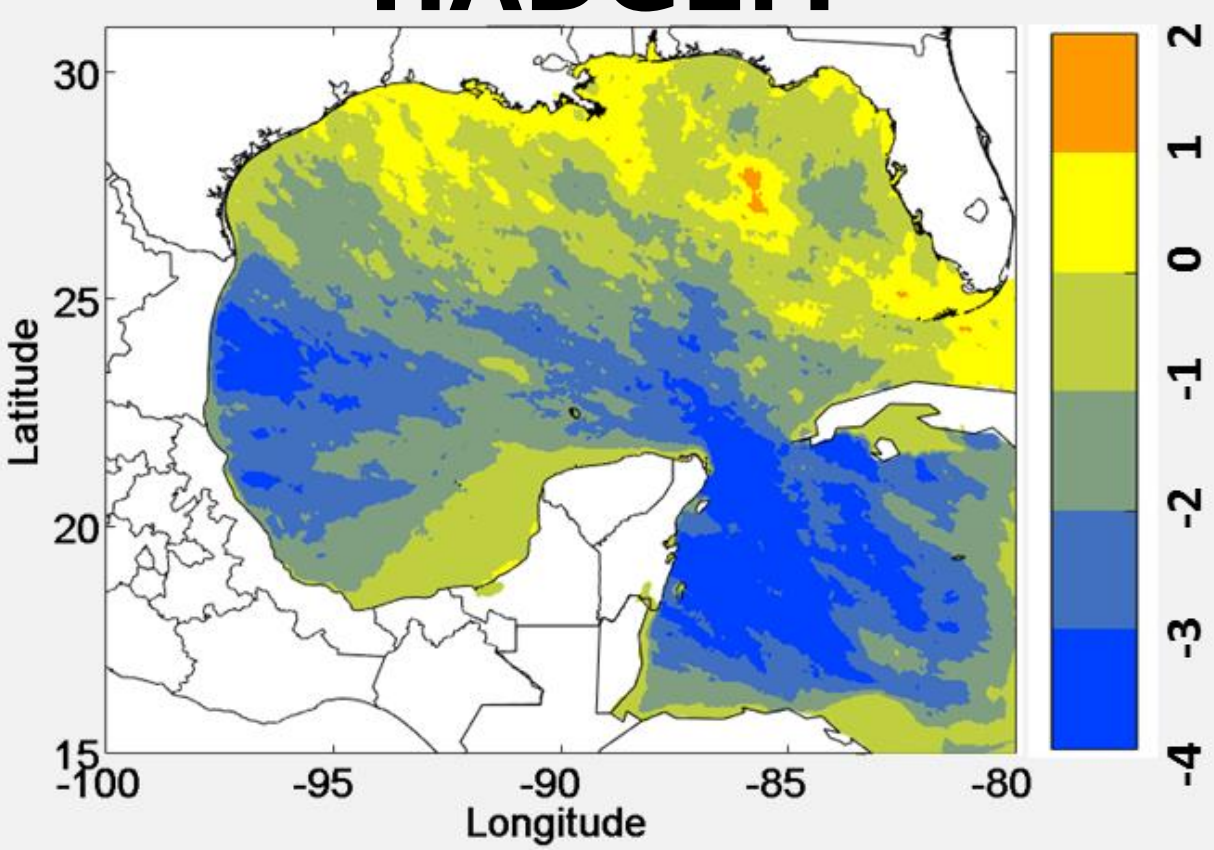
BIAS

99%-ile Hs

GFDL

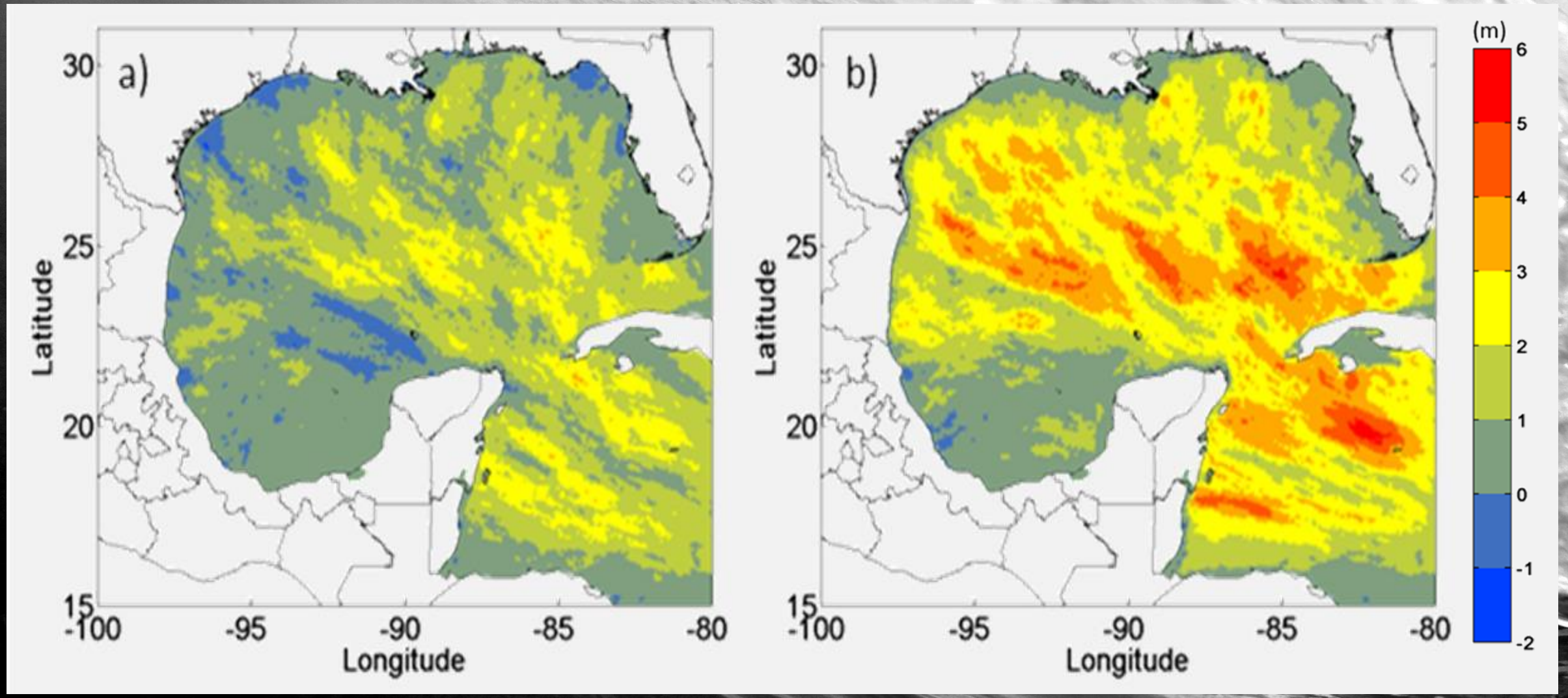


HADGEM



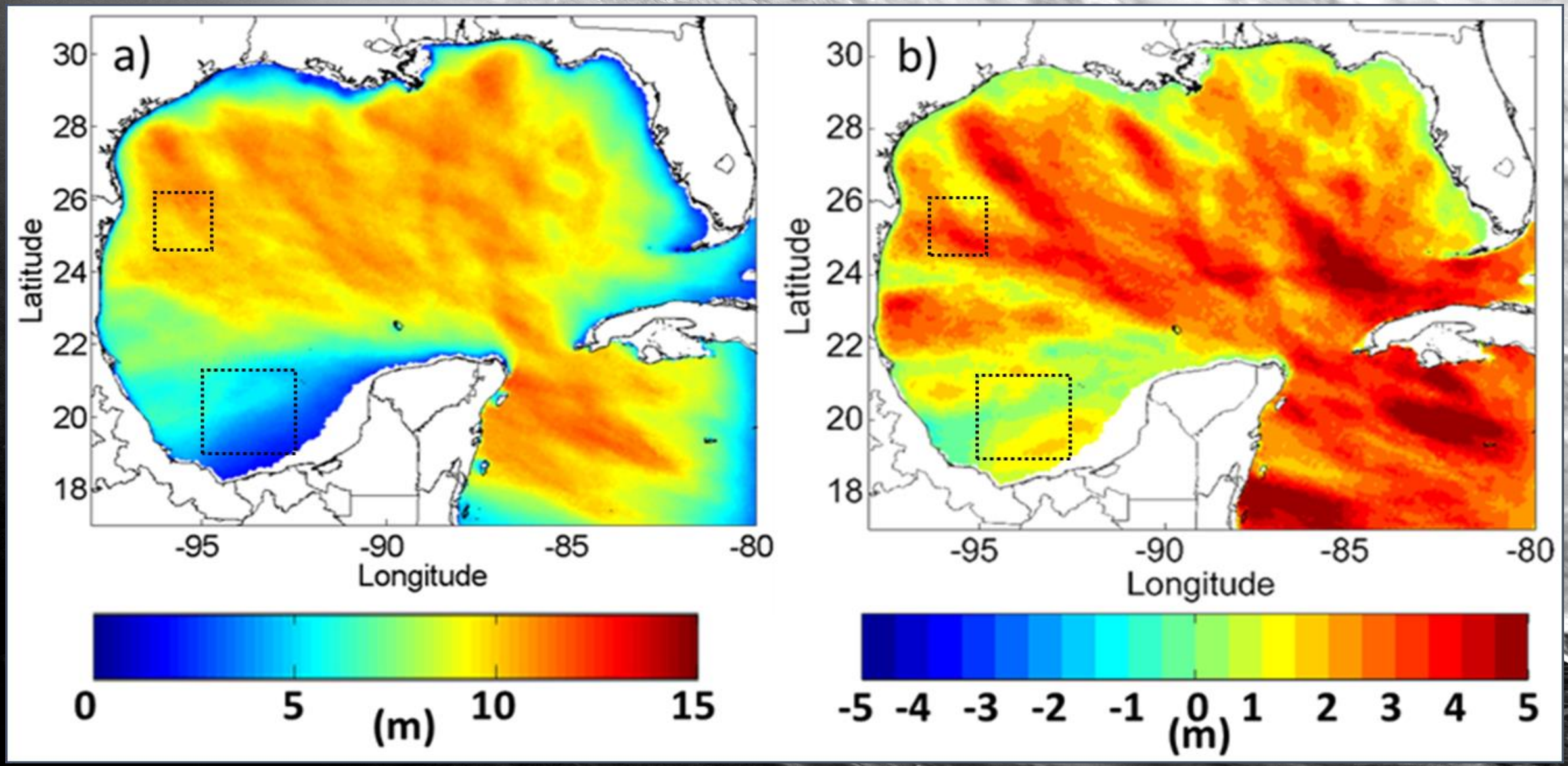
Projection 2070-2100: 99%-ile Hs

RCP 4.5 **RCP 8.5**



Hs Return Period = 100 years

Present Climate **RCP 8.5**



Main conclusions

- *Global warning results in an increasing wave power by TCs, as well as Hs in most regions of the GoM.*

- *Design of structures using the present wave climate can result in over/under design: The use of future wave climate is crucial for succesful design.*

Questions?

Thank you…