

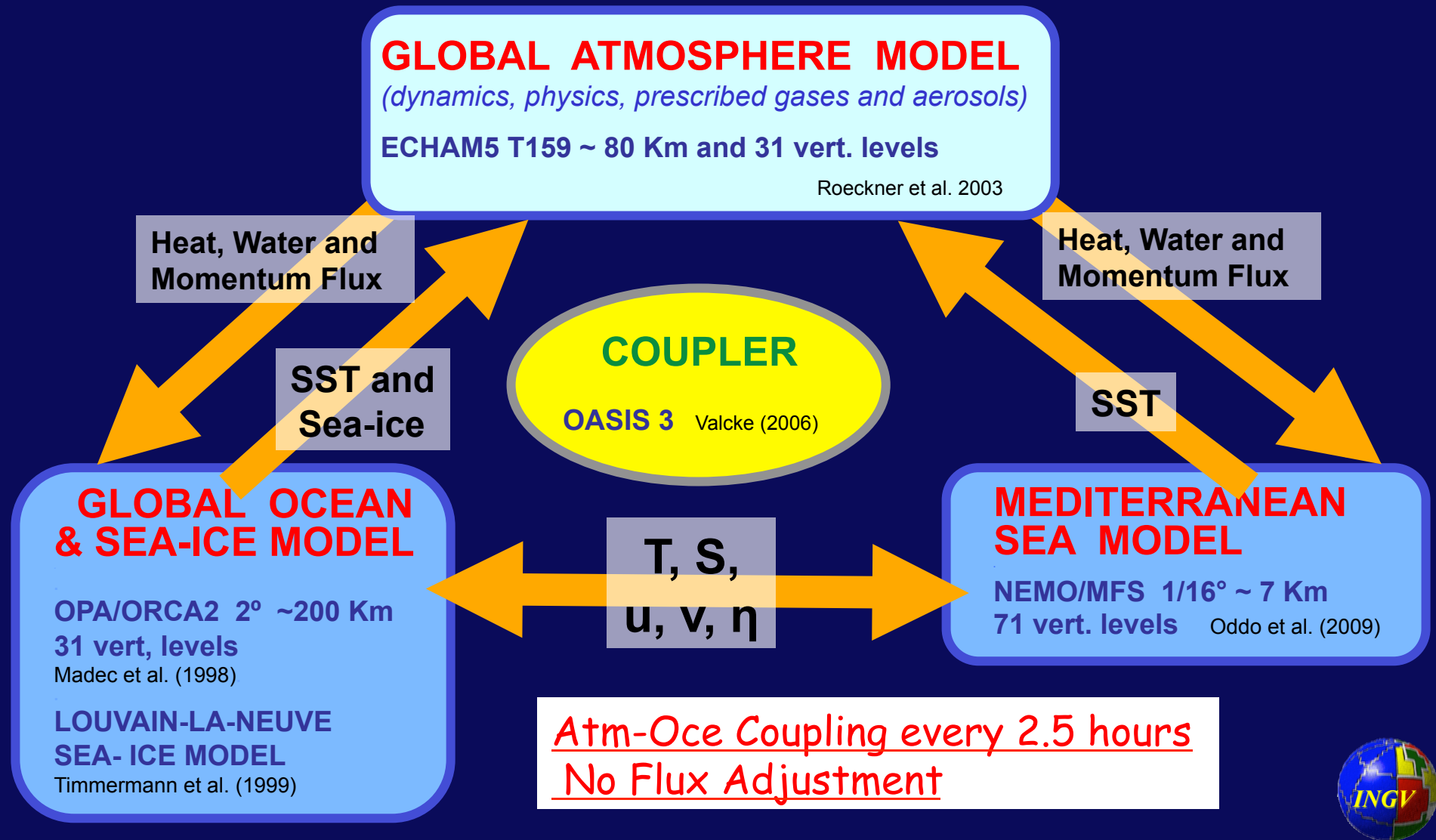


Tropical Cyclones - Ocean feedbacks: Effects on the Ocean Heat Transport as simulated by a High Resolution Coupled General Circulation Model

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- 2) CMCC - Euro Mediterranean Center for Climate Change - Bologna, Italy
- 3) MPI-M - Max Plank Institute for Meteorology – Hamburg, Germany

In this study the effect of TCs on NH Ocean Heat Transport (OHT) is investigated with a "Hurricane Resolving" High-Resolution Coupled General Circulation Model (CMCC_MED evolution of INGV-SXG [Gualdi et al. 2008]) that will be also used for CMCC CMIP5 IPCC scenario exps



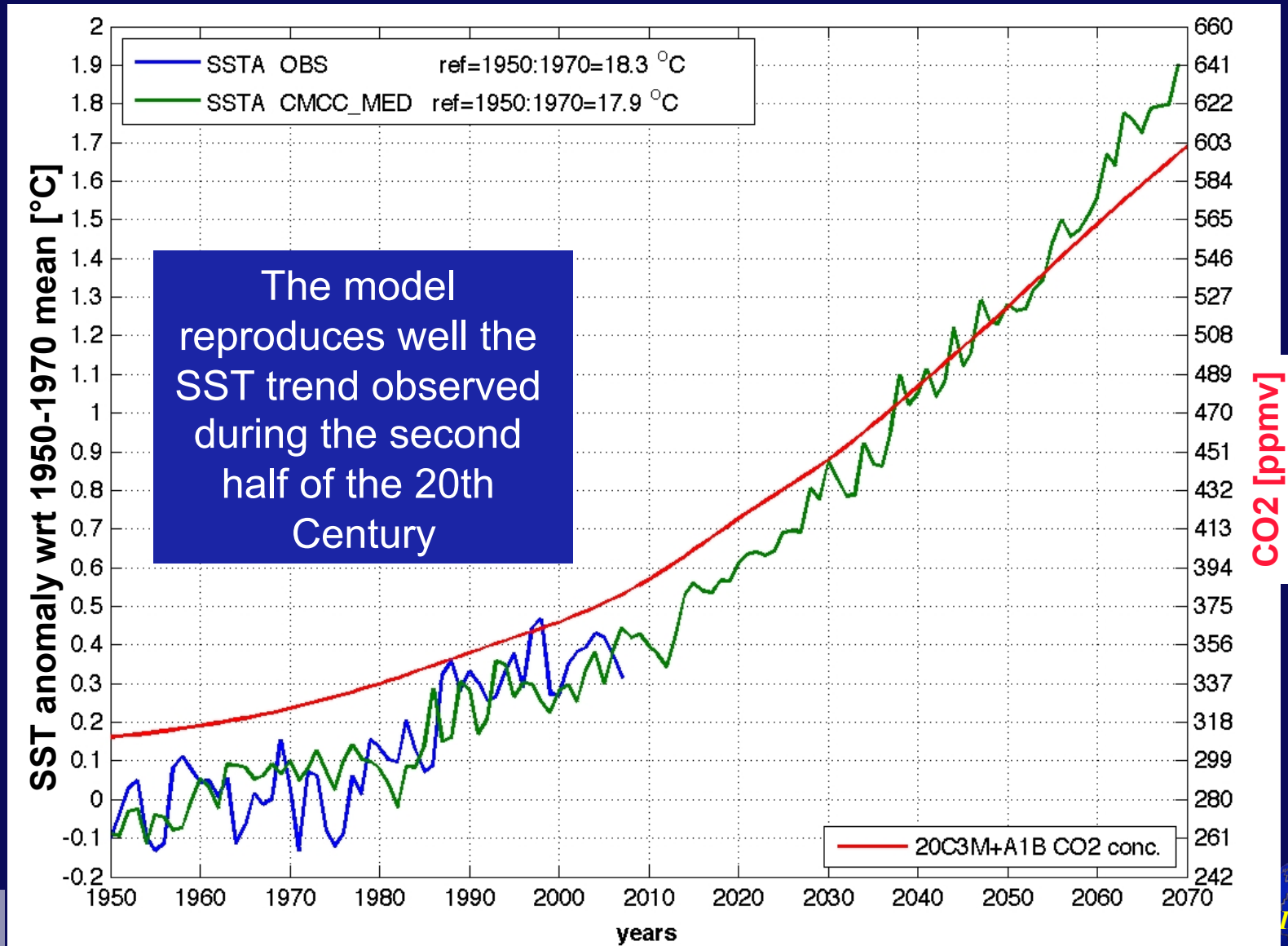
OUTLINE

1. The CMCC Climate Simulations used in this study
2. How the model represent Tropical Cyclones (TCs)
3. How simulated TCs affect the Northern Hemisphere Ocean Heat Transport (OHT)
4. TCs activity under the 21st century (A1B scenario)



The CMCC climate simulation : 20C3M and A1B scenario

Evolution of the global mean SST Anomaly from 1950 to 2069: observation vs. model

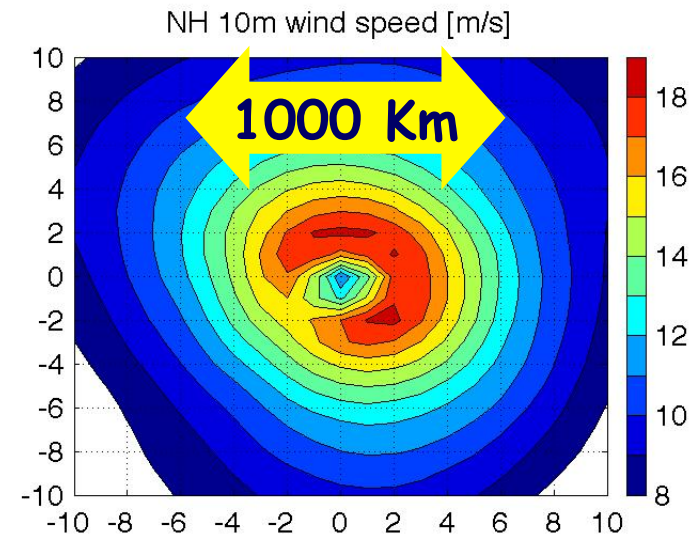
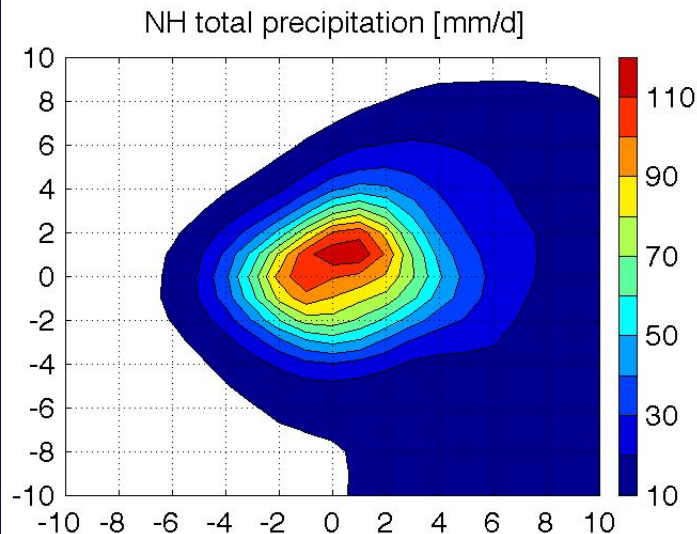


How the model represent Tropical Cyclones

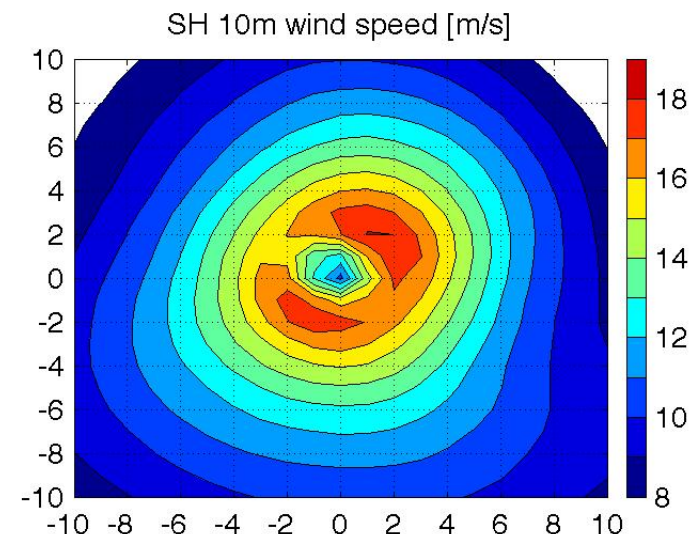
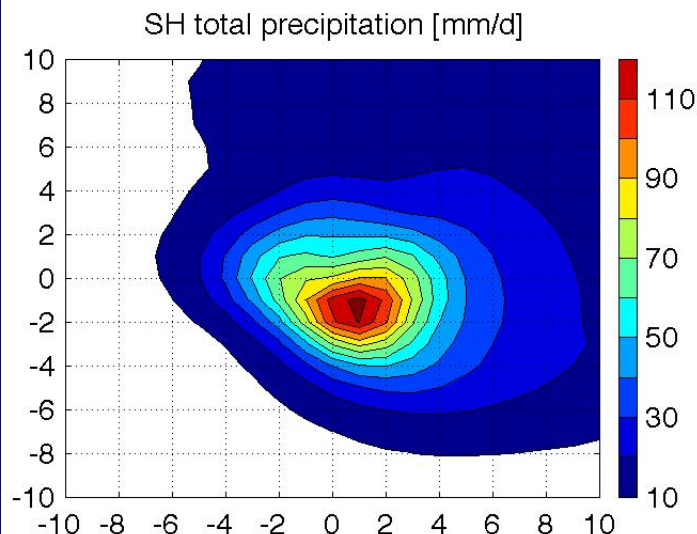
Composite of 100 hemispheric most intense simulated TCs

[TC-MIP CSIRO TCs detection method http://www.earthsci.unimelb.edu.au/~kwalsh/tcmip_index.html]

NH



SH



PRECIPITATION

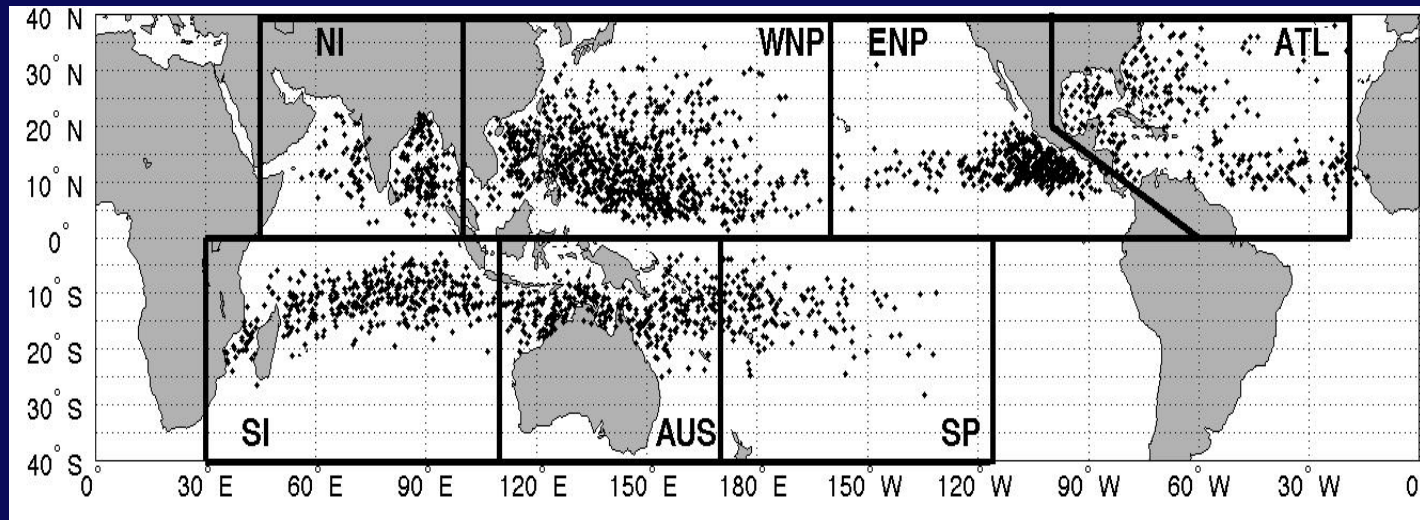
10m WIND SPEED



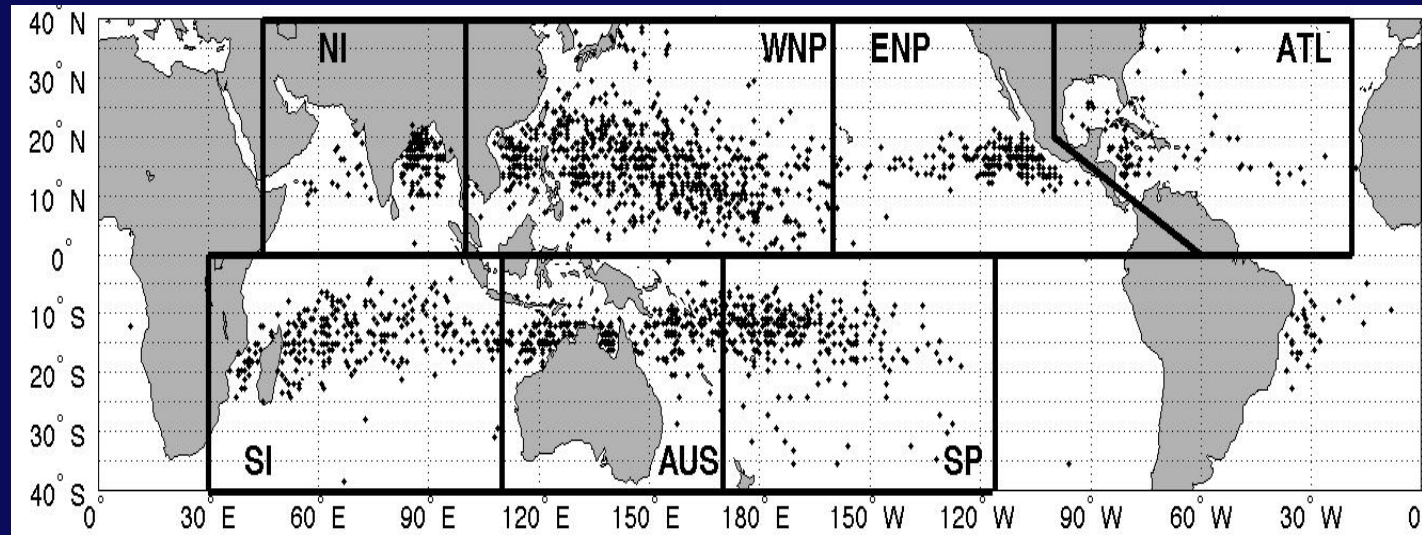
How the model represent Tropical Cyclones

TCs track starting points during 1970:1999

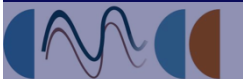
OBS



MODEL

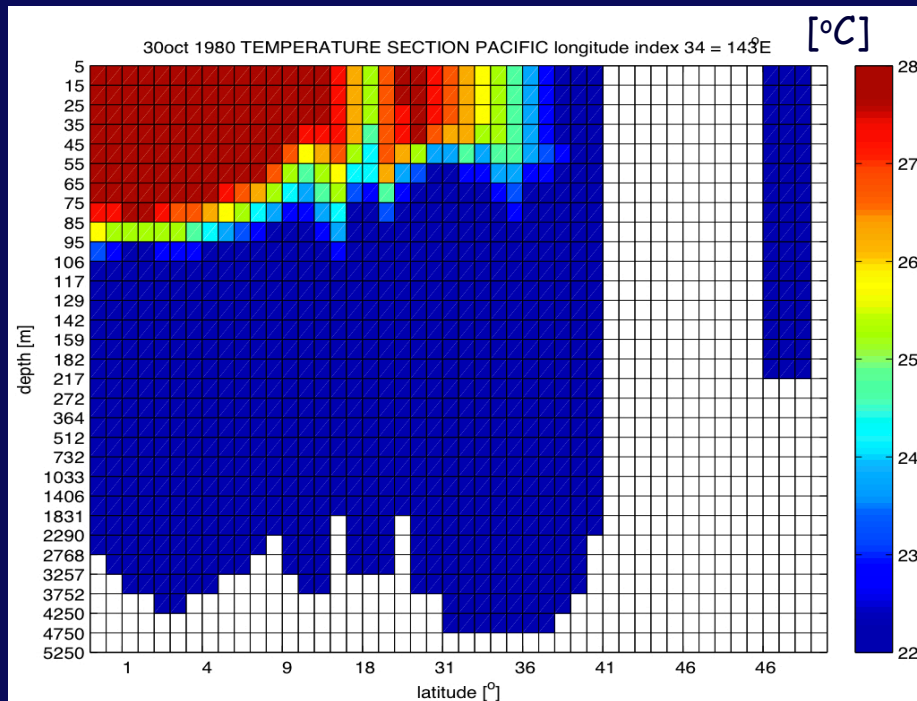
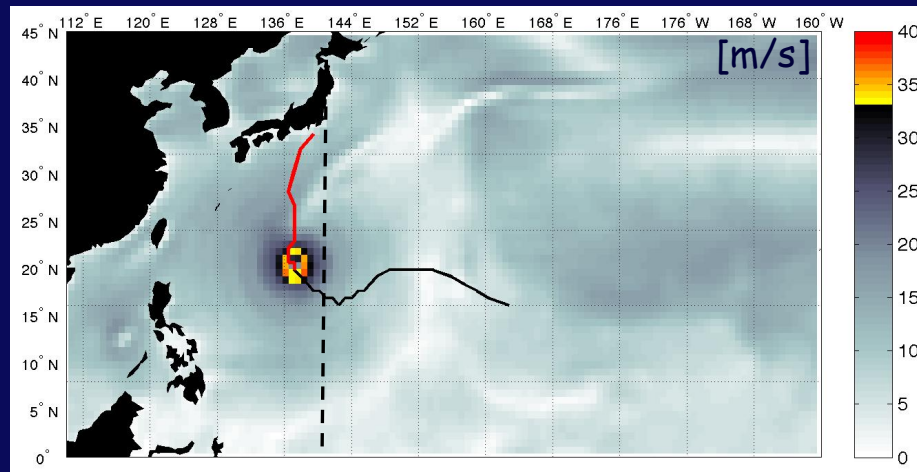


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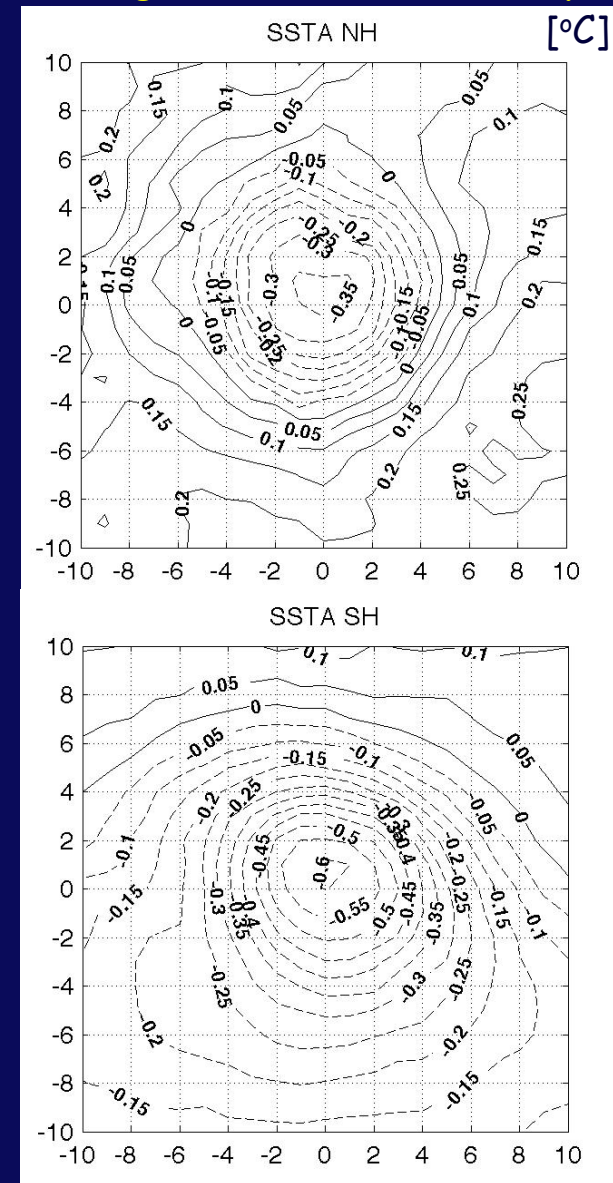


How the model represent Tropical Cyclones

Sea Surface Cooling induced by a single strong TC



Sea Surface Cooling: composite over the 100 strongest TCs in each Hemisphere



How TCs affect the Ocean Heat Transport

Previous studies:

The ocean response to moving Tropical Cyclones (TCs) has been studied through coupled numerical experiments (*) and there is evidence that the TC activity plays a role in the thermodynamic of the ocean (**).

There is therefore evidence that TCs can transfer a significant amount of heat and momentum into the ocean (***), suggesting that TCs could affect the global climate system.

Recent studies (****) indicate that the TC induced heat anomalies do not propagate under the winter thermocline, thus the annual OHT average is not affected.

(*) [Chang & Anthes 1979, Sutyrin & Khain 1979, Shade and Emanuel, 1999]

(**) [Emanuel 2001]

(***) [Emanuel 2001, Srivier and Huber 2007, Pasquero and Emanuel 2008, Liu et al., 2008]

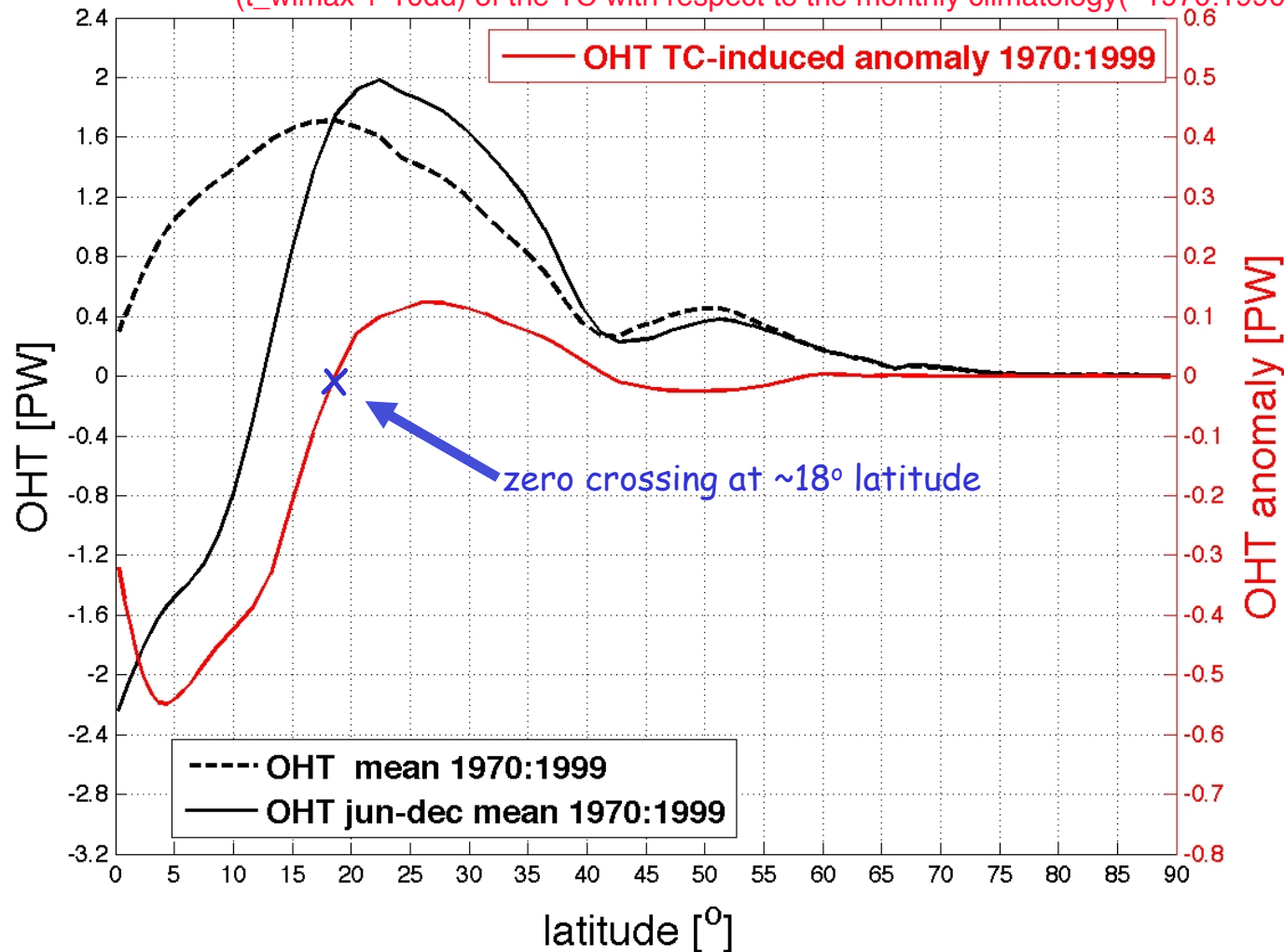
(****) [Jansen 2010]



How TCs affect the Ocean Heat Transport

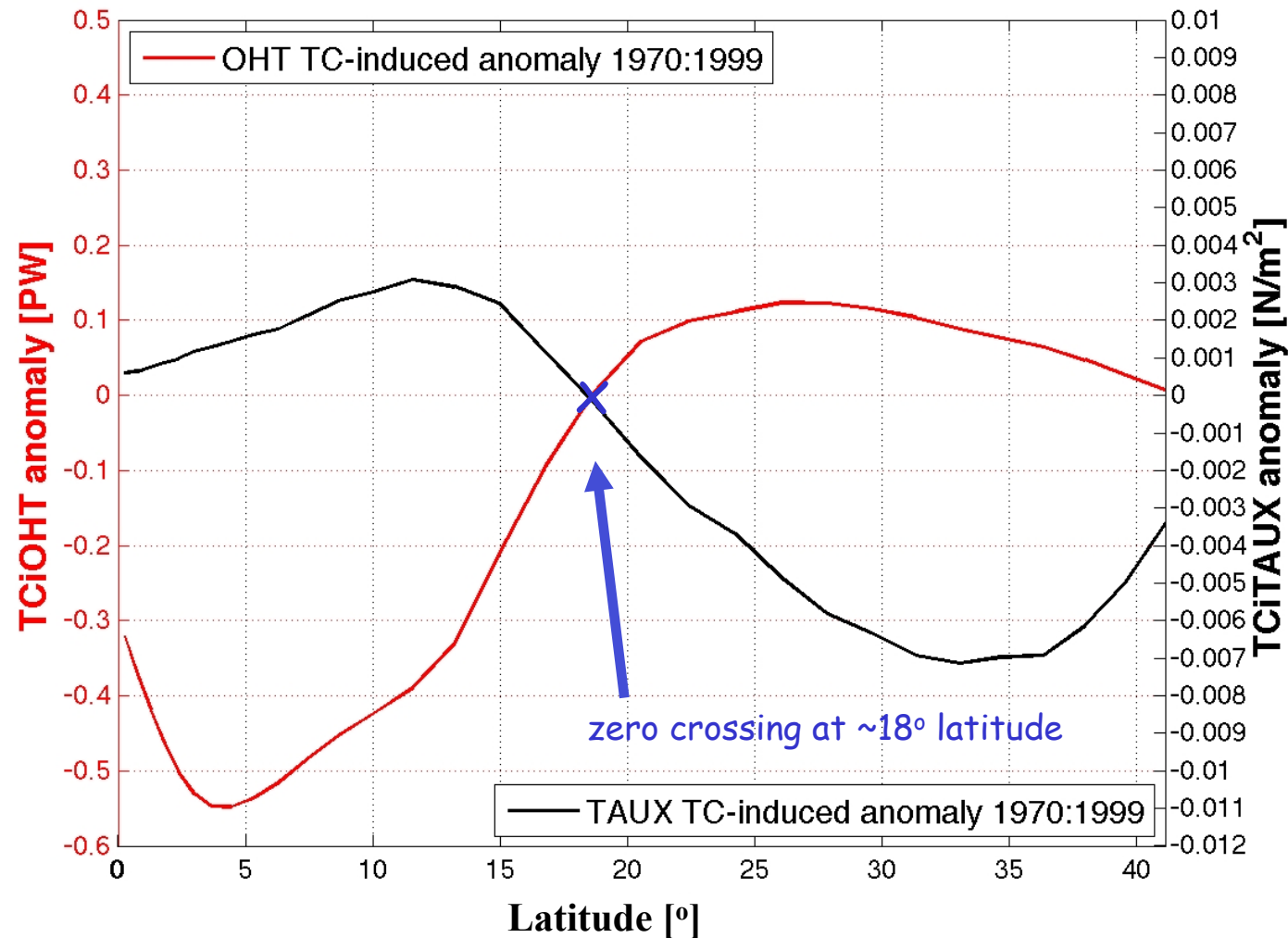
OHT as simulated by the model and TC induced OHT (TCiOHT) Anomaly

The anomalies have been computed (and averaged) for 20 days around the day of maximum intensity ($t_{wimax} \pm 10dd$) of the TC with respect to the monthly climatology (1970:1990)



How TCs affect the Ocean Heat Transport

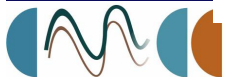
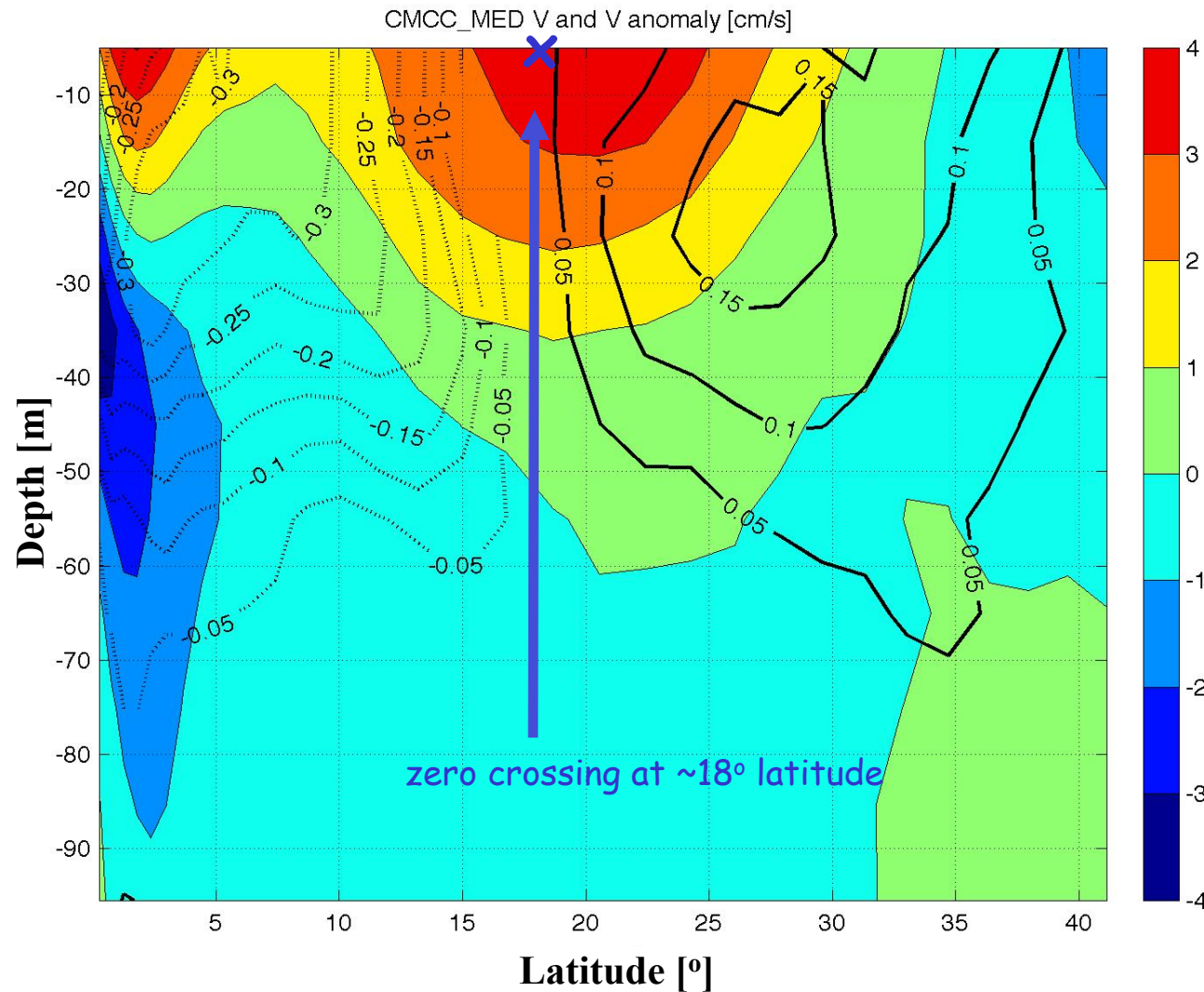
TC induced OHT (TCiOHT) and TAUX (TCiTAUX) Anomalies



How TCs affect the Ocean Heat Transport

Meridional Velocity anomaly induced by TCs:

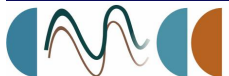
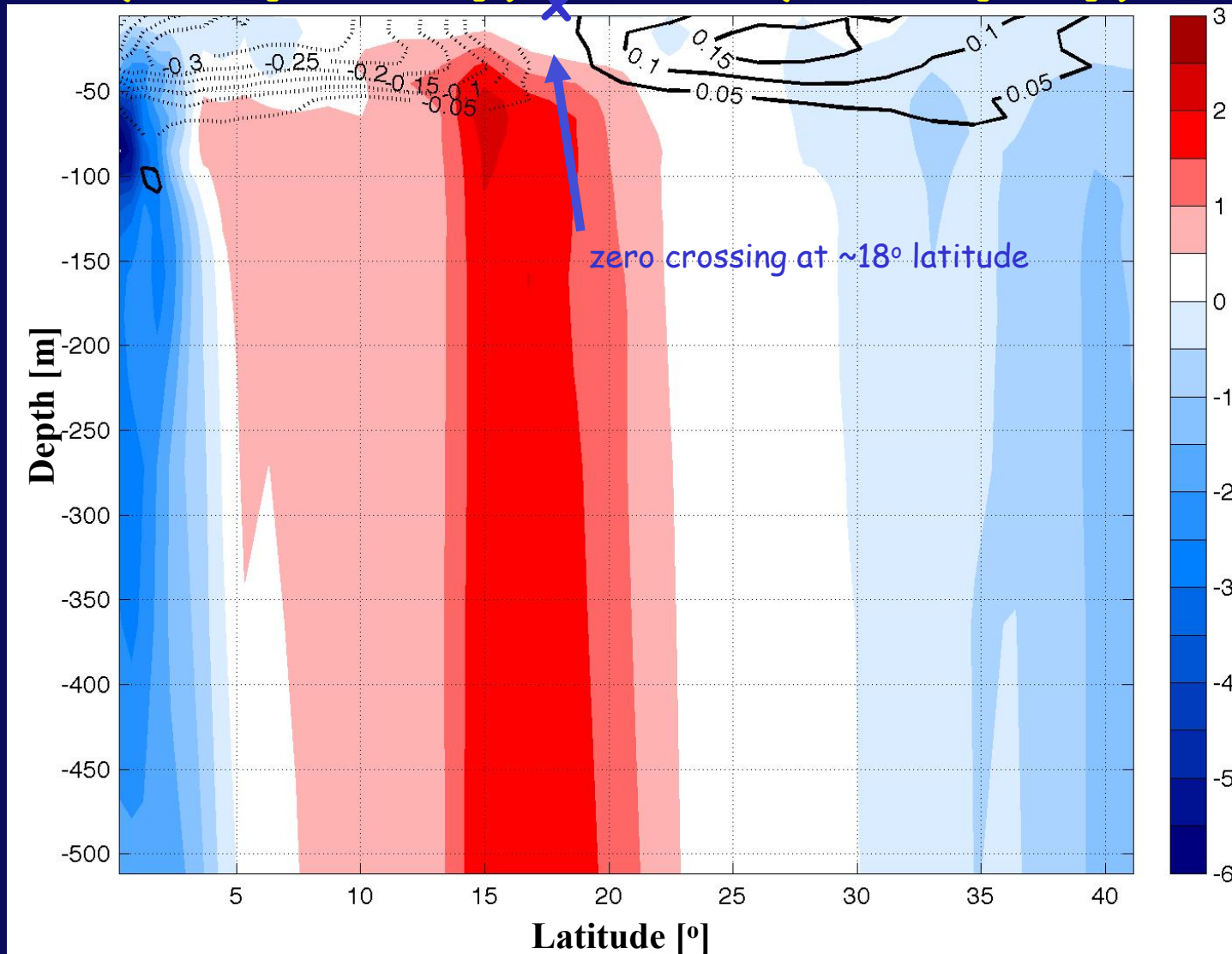
V jun-dec mean (colors [cm/s]) and V anomaly (contours [cm/s])



How TCs affect the Ocean Heat Transport

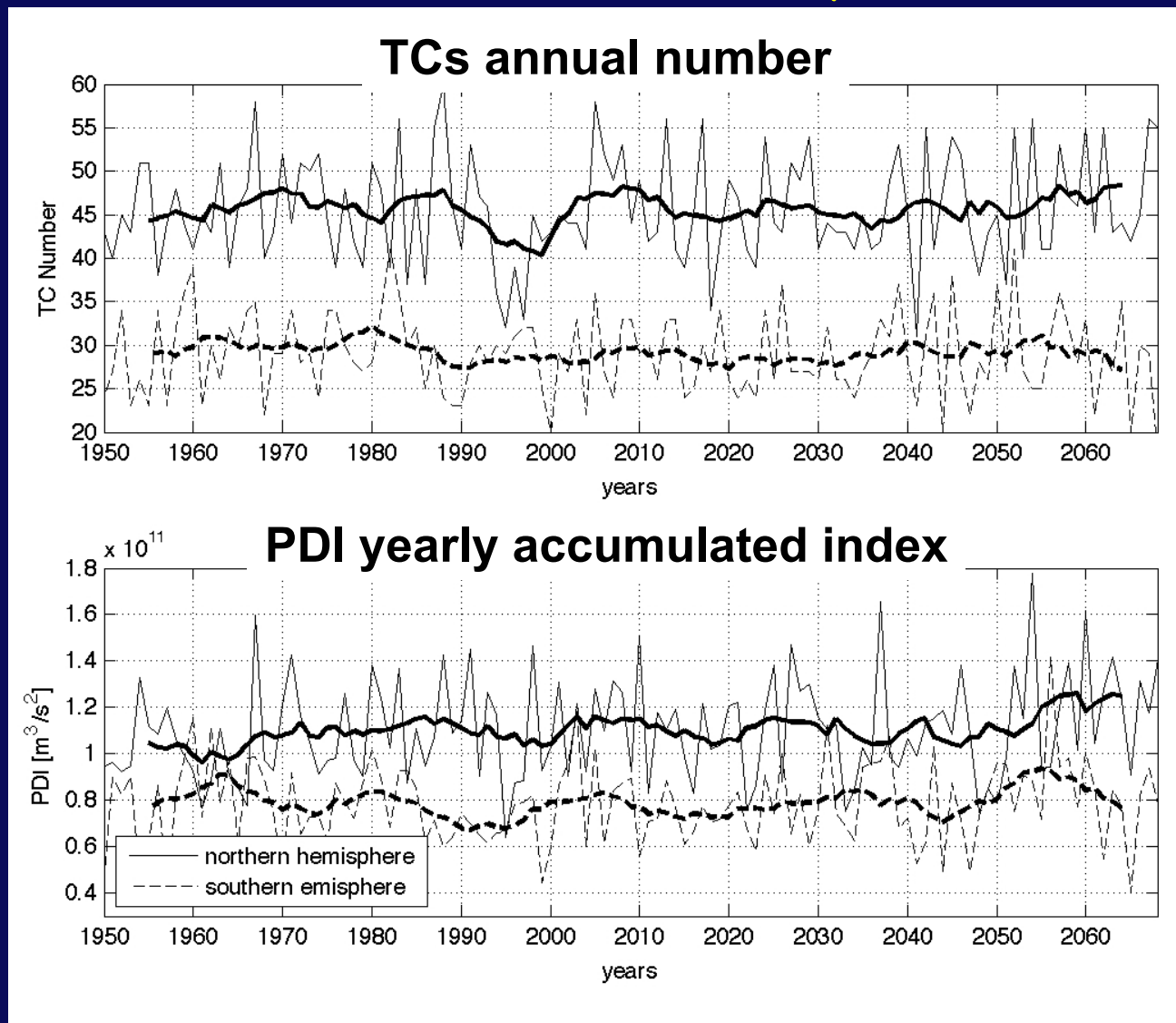
Ocean Velocity Anomalies induced by TCs:

W (colors [$1e-5\text{cm/s}$]) and V (contours [cm/s])



TCs activity under the 21st century (A1B scenario)

TCs number and Intensity (PDI)



CONCLUSIONS

The CMCC_MED (atmosphere resolution = 80Km) coupled GCM appears to simulate Tropical Cyclones (TCs) with realistic features.

TCs act reinforcing trade winds at high tropical latitudes (18°-30°N) and weaken them at low latitudes (5°-18°N).

The induced overturning cells in the ocean velocity cause a TC induced Ocean Heat Transport (TCiOHT) anomaly:

The *Poleward* OHT *out of the tropics* increases (*) but also increases the OHT *into the deep tropics* (**).

The TC activity and their effect on the OHT do not change during the 1950-2070 simulated period.

The TCiOHT anomalies are on weekly time scales and do not impact the yearly averaged large-scale meridional heat advection (***).

(*) [Emanuel, 2001]

(**) [Jansen & Ferrari, 2009]

(***) [Jansen 2010]



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THANK YOU !

REFERENCE:

Scoccimarro E., S. Gualdi, A. Bellucci, A. Sanna, P.G. Fogli, E. Manzini, M. Vichi, P. Oddo, A. Navarra (2011)
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