Couplage : Interactions océan-atmosphère au sein des cyclones tropicaux

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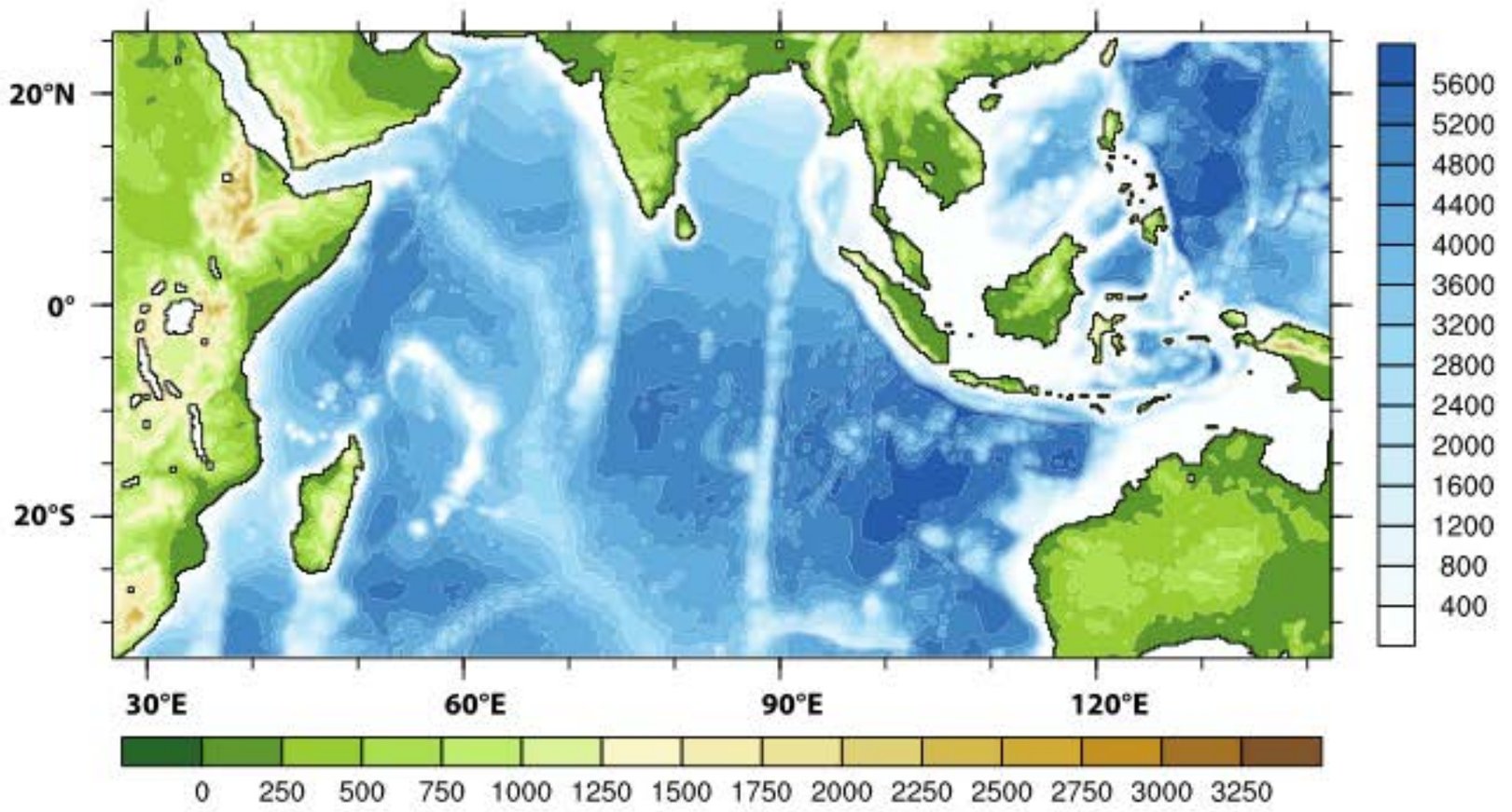
Impact of convection sheme

KF - BMJ

Configuration

NEMO-WRF 0.25°
1990 - 2009



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- WRF single-moment six-class microphysics scheme WSM6 [Hong and Lim, 2006]
- Goddard shortwave radiation scheme [Chou and Suarez, 1999]
- Rapid Radiation Transfer Model (RRTM) for longwave radiation [Mlawer et al., 1997]
- Yonsei University planetary boundary layer YSU [Noh et al., 2003]
- Monin-Obukhov surface layer param- eterization, and the four-layer Noah land surface model [Chen et al., 1996]
- drag parameterization over the ocean is based on the work of Donelan et al. [2004]

Cyclogenesis

Betts-Miller-Janjic (BMJ) scheme [Janjic´, 1994]

- moist convective adjustment scheme,
- thermodynamic profile is adjusted toward quasi-equilibrium state.
- Activation mainly determined by thermodynamics (CAPE)

Kain-Fritsch (KF) scheme [Kain, 2004]

- simulate a vertical rearrangement of mass that eliminates CAPE
- triggered based on the grid-resolved vertical motion

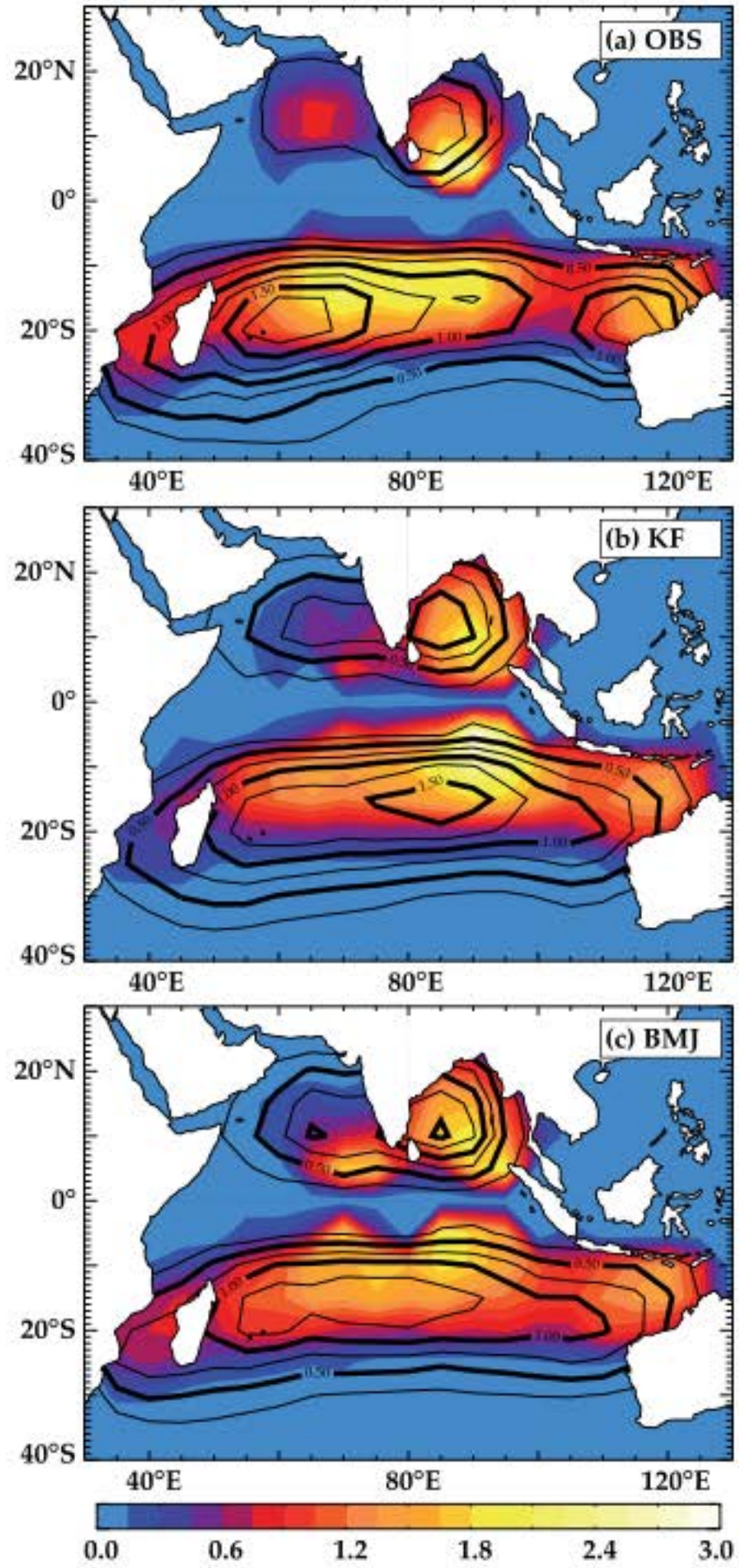

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Figure 10. Spatial distribution of cyclogenesis (color, in % of the total number of formed cyclones per 5° × 5° bins) and TC density (contour, in % per 5° × 5° bins) for (a) observations, (b) KF, and (c) BMJ experiments.

Cyclogenesis seasonal cycle

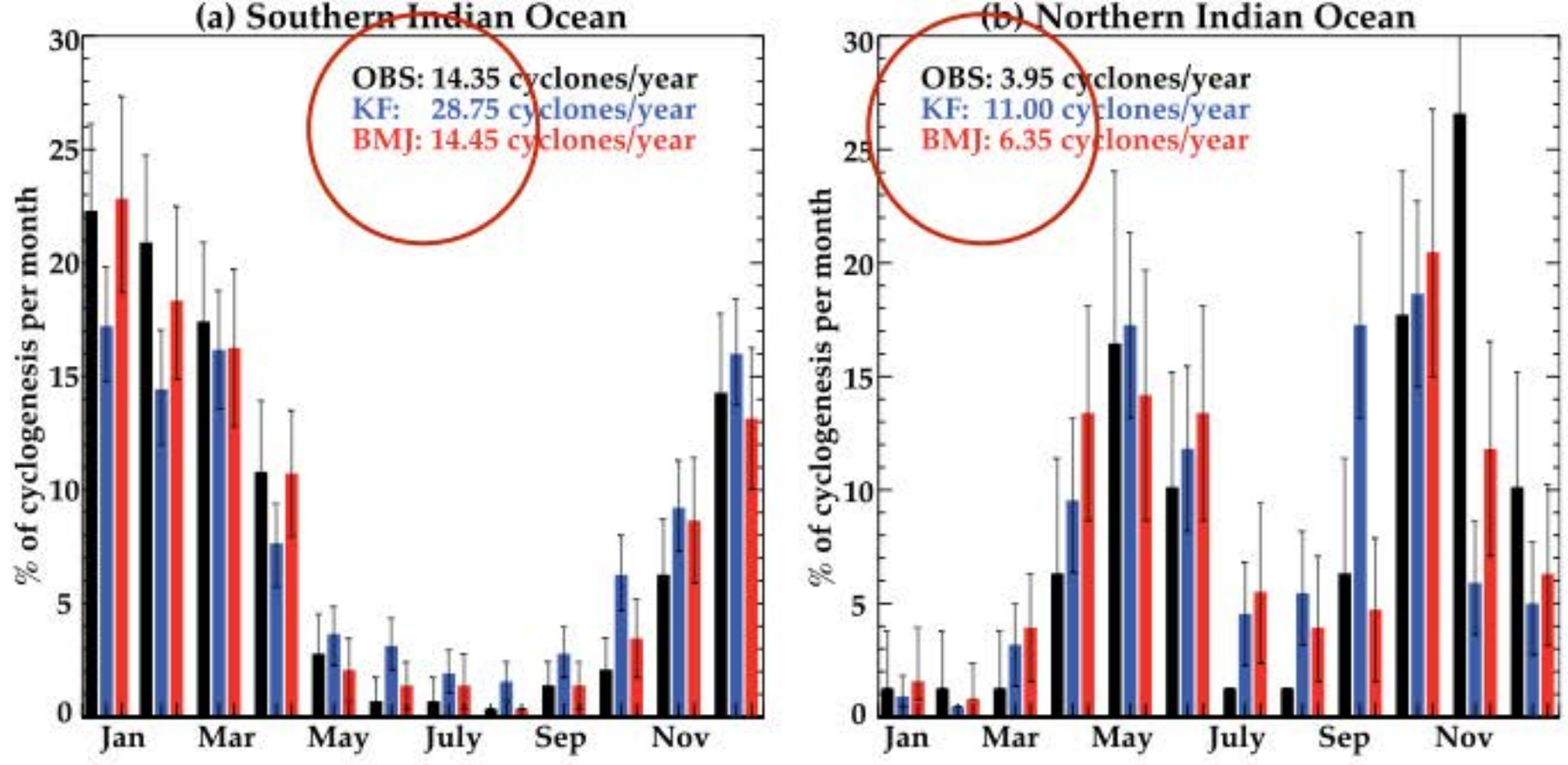

Figure 11. Seasonal cycle of relative cyclogenesis (in % of the total number of cyclones per month) for observations (black), KF (blue), and BMJ (red) experiments for (left) the southern and (right) northern Indian Ocean. The whiskers display 95% confidence interval on monthly cyclogenesis values based on a Student's *t* test.

Intensity distribution

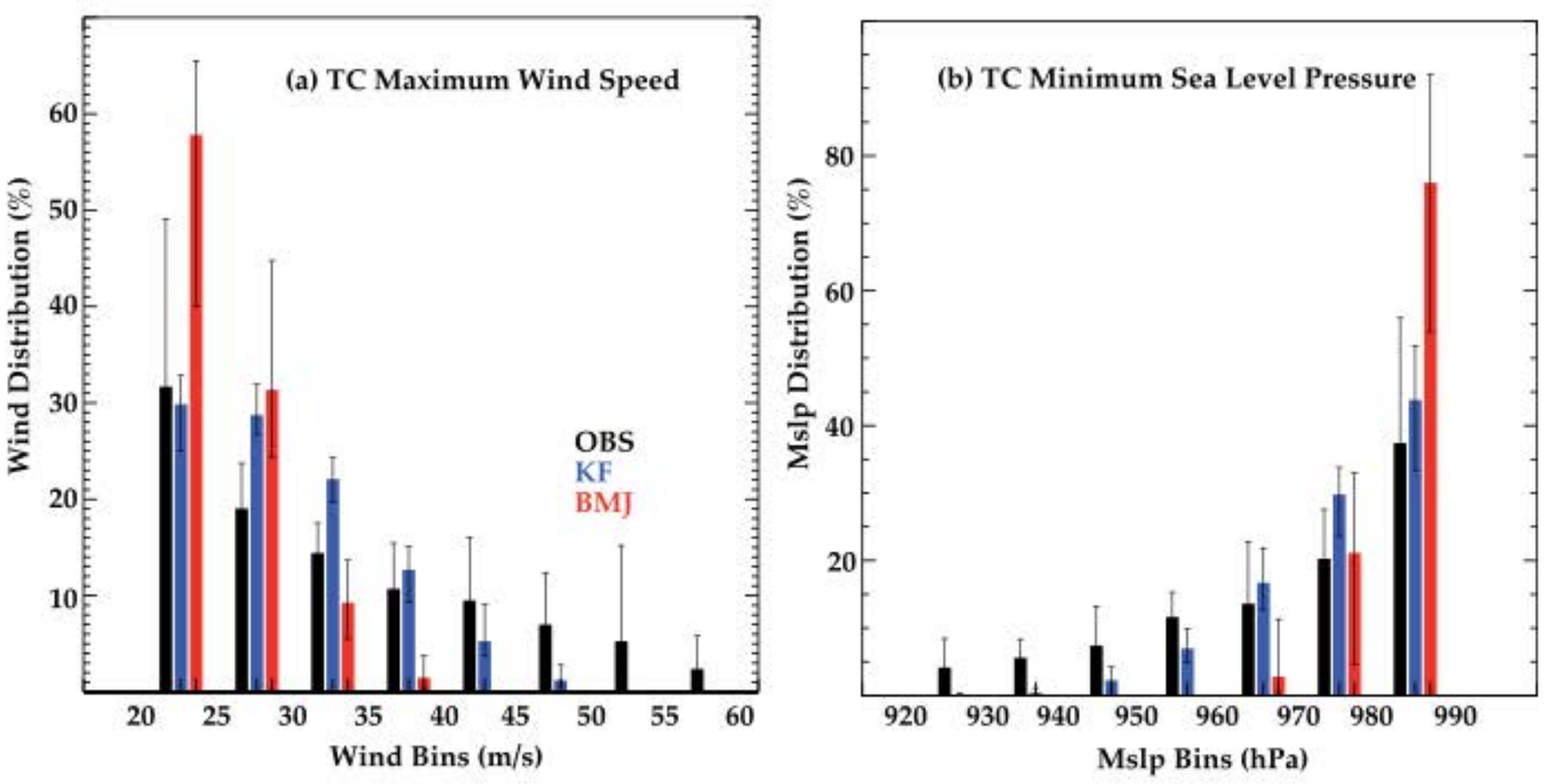

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Figure 13. (left) Maximum wind intensity and (right) minimum sea level pressure distribution in observations (black), KF (red), and BMJ (blue) simulations for all Indian Ocean TCs.

radial profile

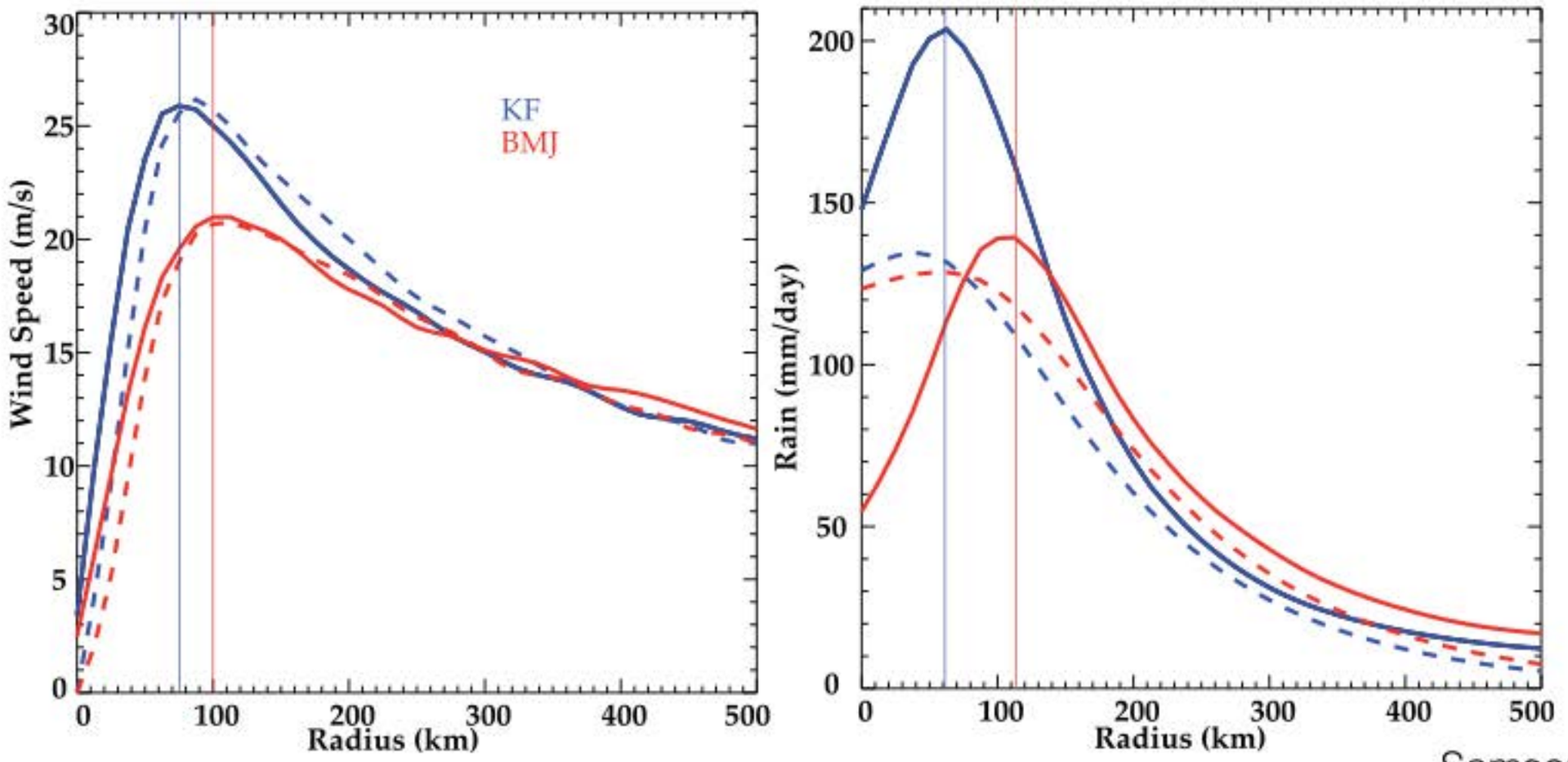

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Figure 14. (a) Composite of TCs radial wind profile as a function of the distance to the TC center directly derived from the model (plain) and reconstructed using *Willoughby et al.* [2006] formulation (dashed) for KF (blue) and BMJ (red) simulations. (b) Composite of TCs rainfall profile directly derived from the model (plain) and reconstructed using *Tuleya et al.* [2007] formulation (dashed) for KF (blue) and BMJ (red) simulations. Vertical lines indicate the wind speed and precipitation maxima for both simulations.

=> one example of the sensitivity to one parameterization

many others…

Impact of coupling

Coupled - Forced

methodology

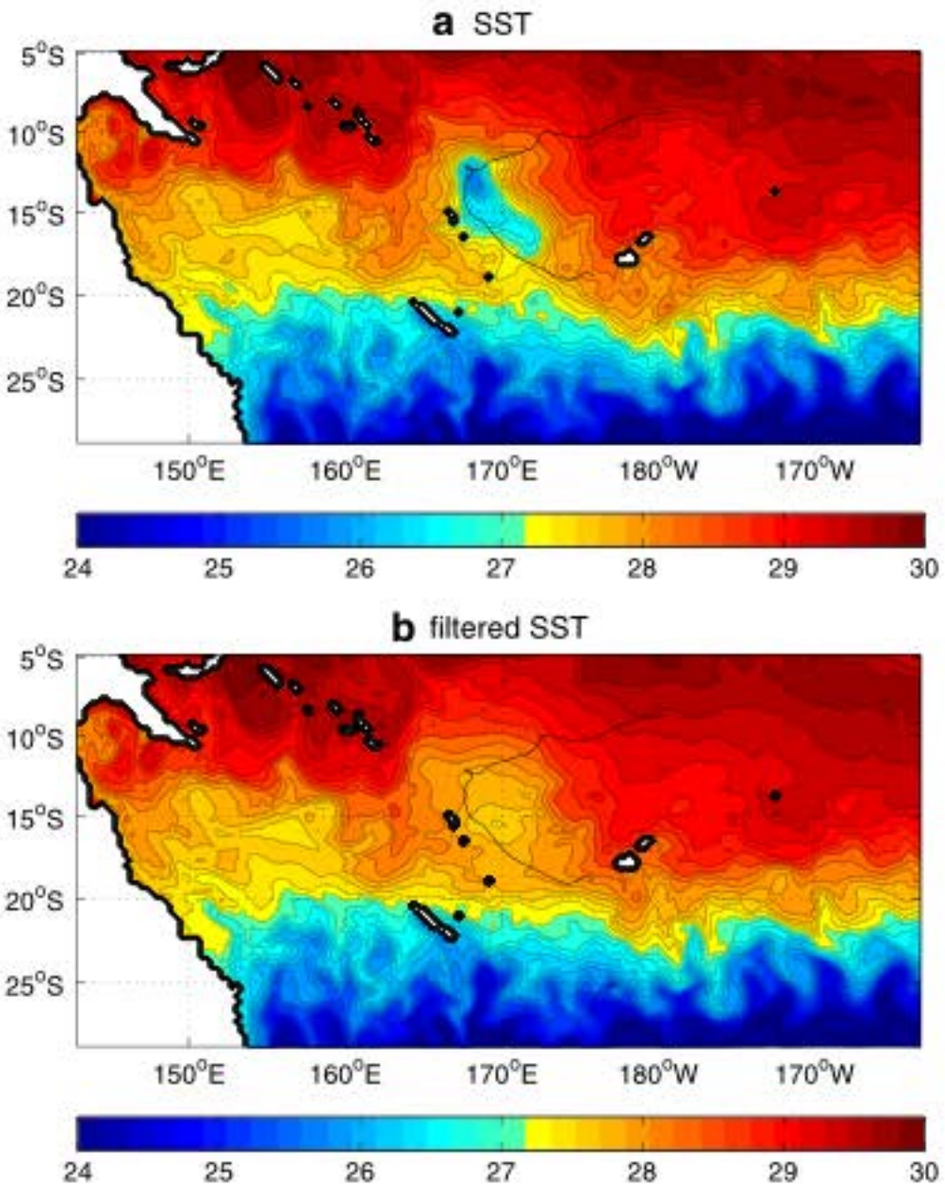

Fig. 1 Example of a TC cold wake event and its filtering procedure: **a** SST field from the coupled model (°C), **b** filtered SST field used in the forced model

WRF-ROMS 1/3°

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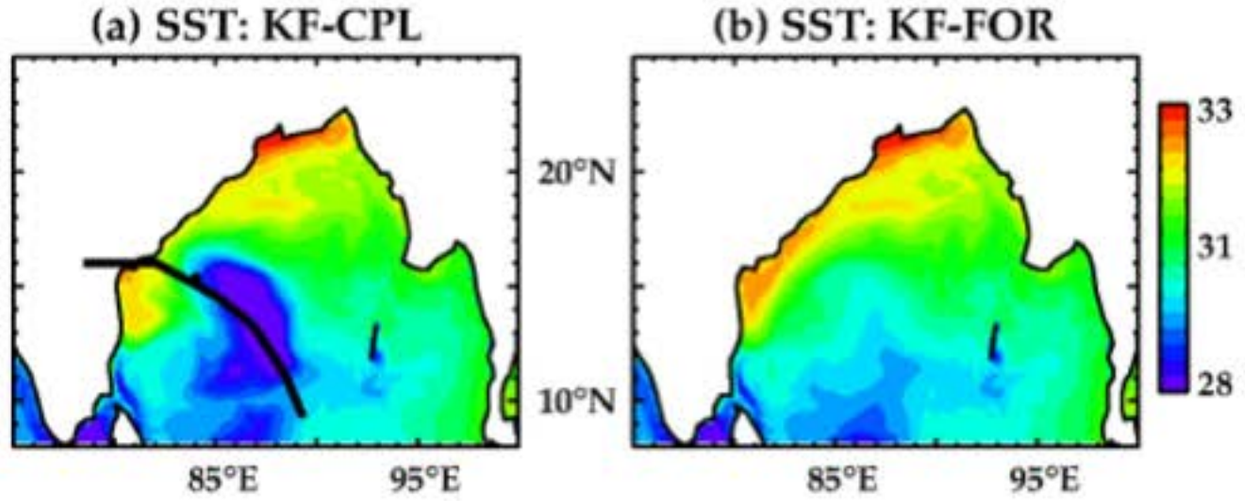

Figure 2: Sea surface temperature (°C) snapshot for the **(a)** KF-CPL and **(b)** KF-FOR simulations. The SST boundary condition of the KF-FOR simulation is obtained after filtering out (see text for details) the TC cold wake from the SST field shown in (a). The KF-CPL simulation TC track from the is shown by a black line on panel (a).

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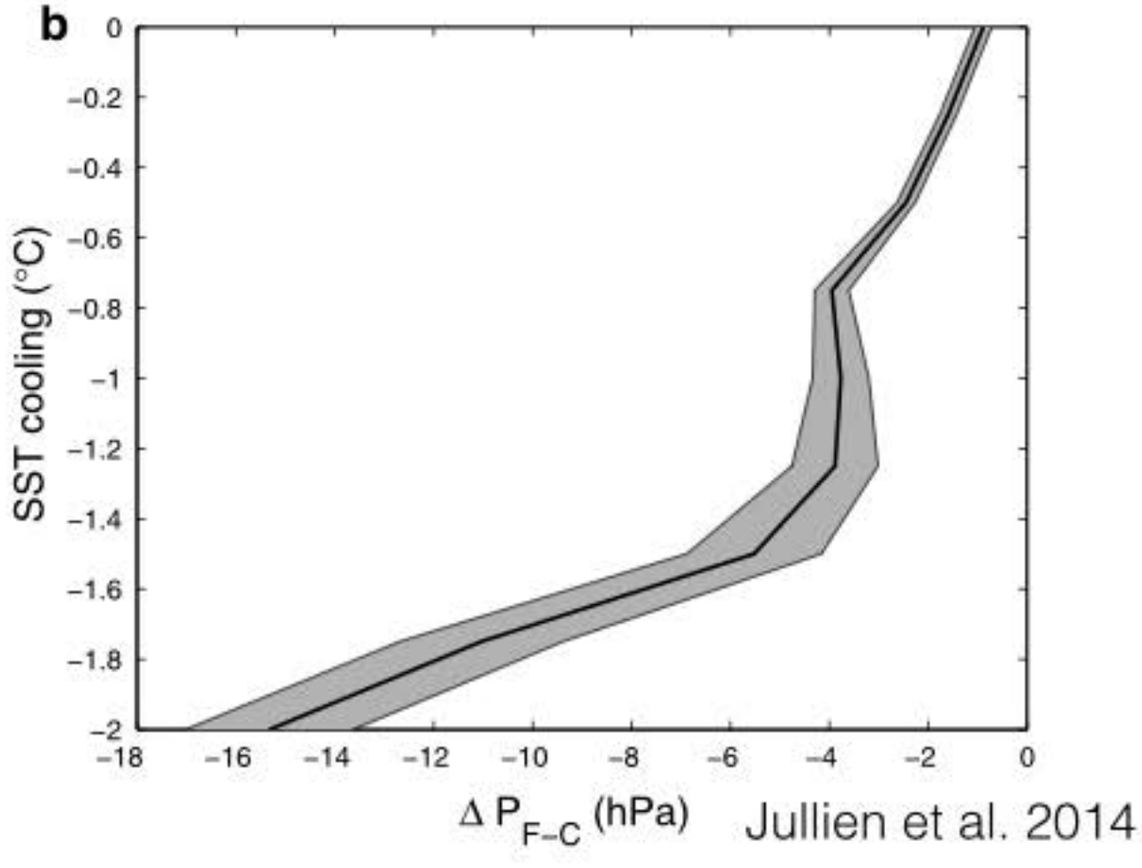

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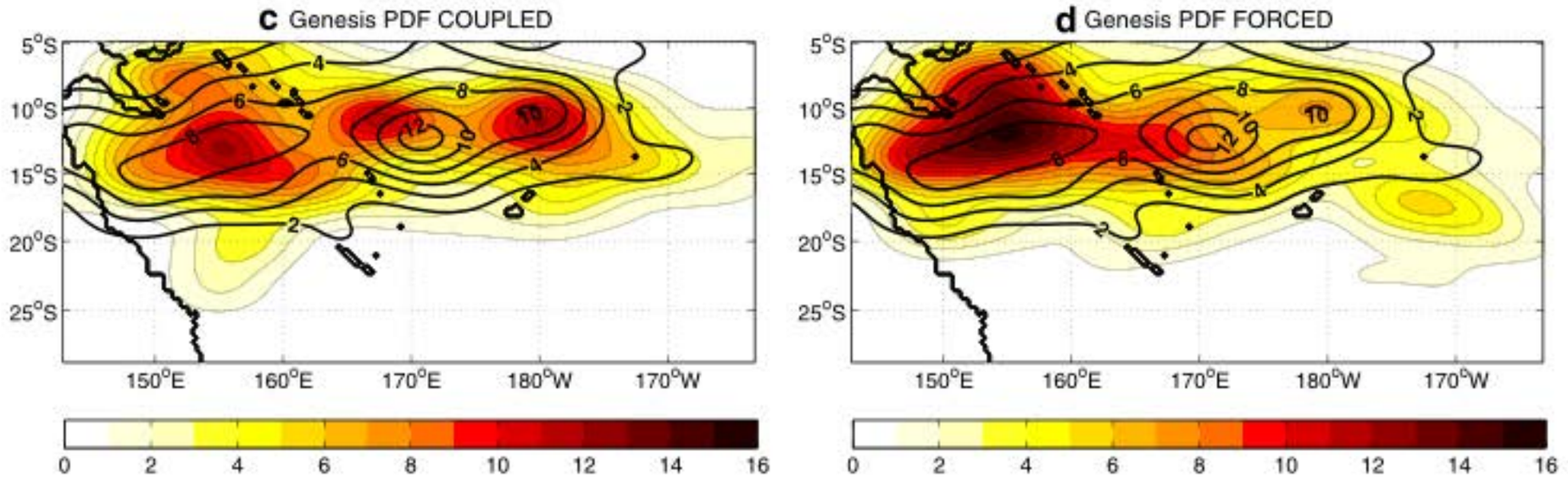
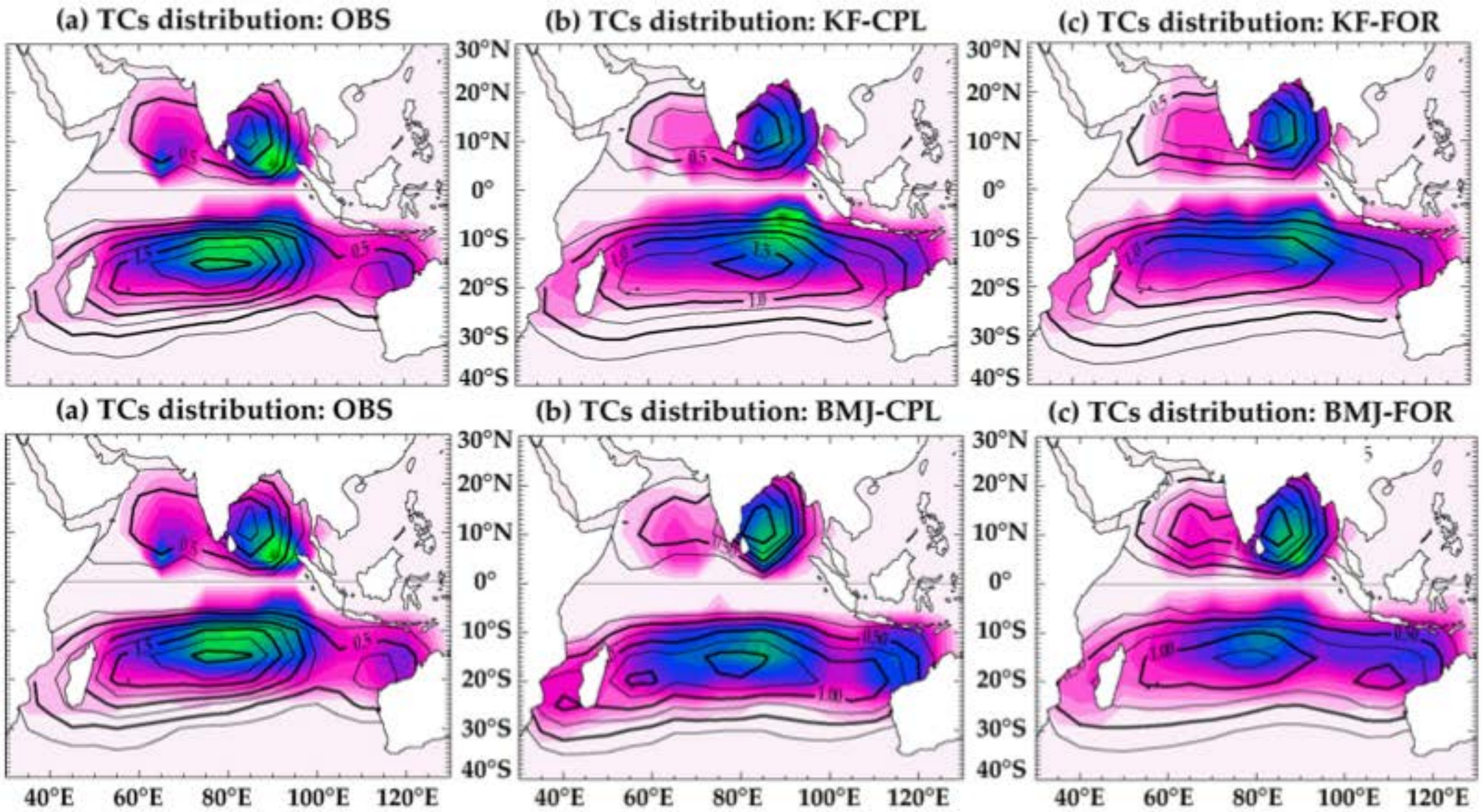
Cyclogenesis





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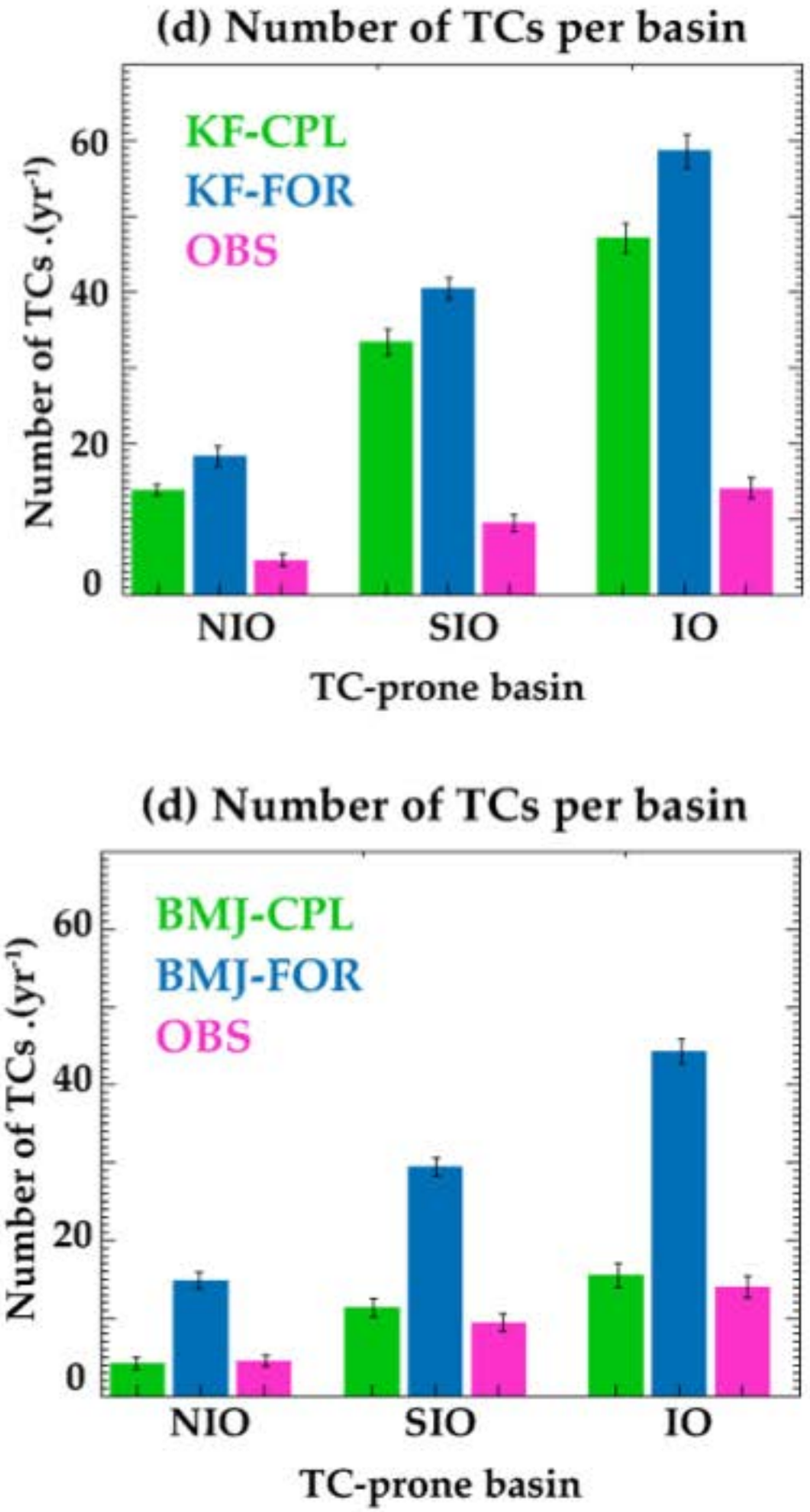

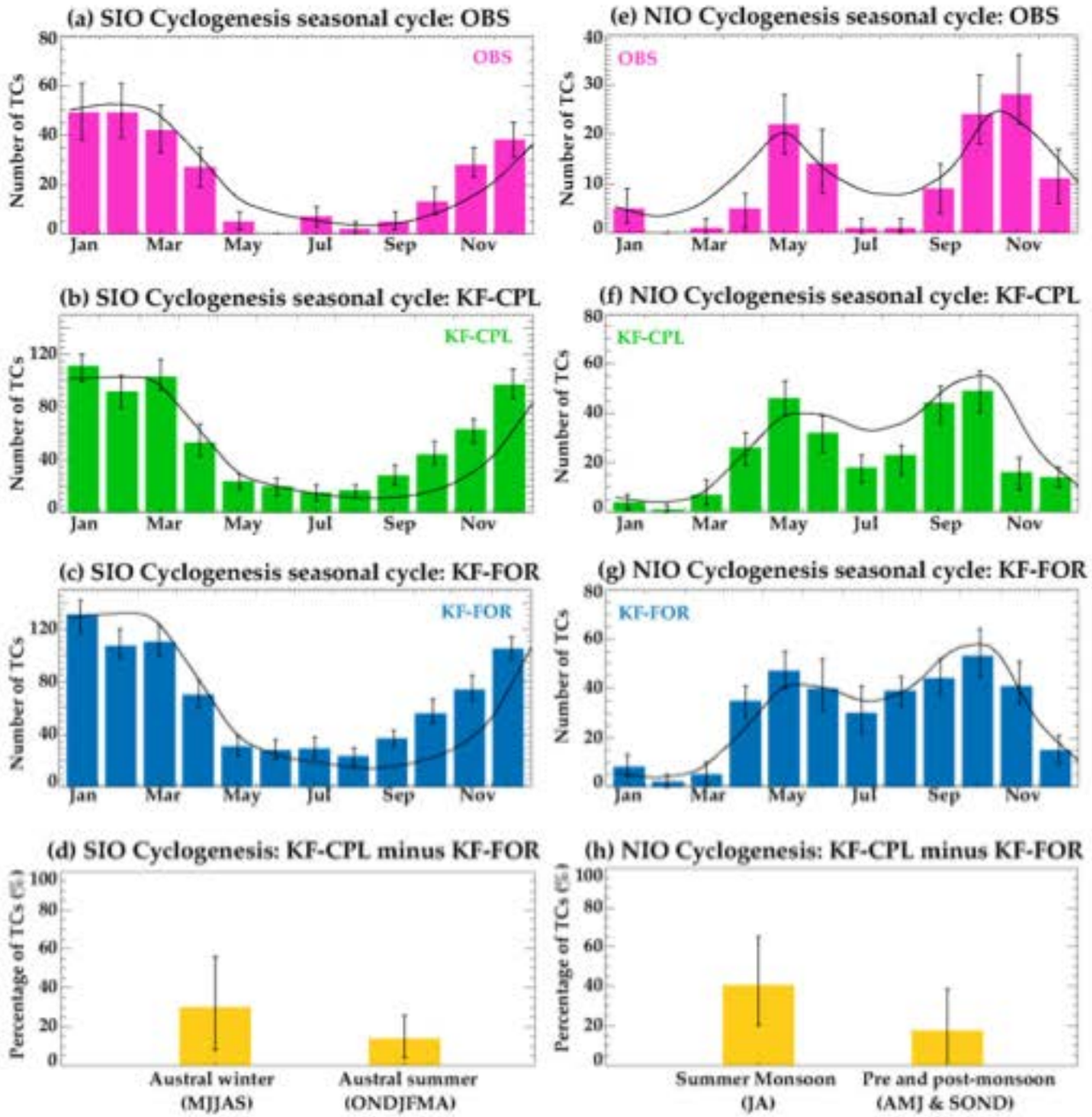

Figure 3: Histogram of the percentage of TCs occurring each calendar month in the (left column) northern and (right column) southern IO for **(a,e)** observations, **(b,f)** KF-CPL and **(c,g)** KF-FOR simulations. The monthly climatological evolution of the corresponding GPI index (northern IO: 40°E-100°E; 0°-25°N and southern IO: 30°E-130°E; 0°-25°S) is overlaid as a black curve. Reduction of the number of TCs (%) in KF-CPL relative to KF-FOR for the cyclonic and non-cyclonic seasons for **(d)** northern and **(h)** southern IO. On all panels, the whiskers display the 90% confidence interval based on a student t-test.

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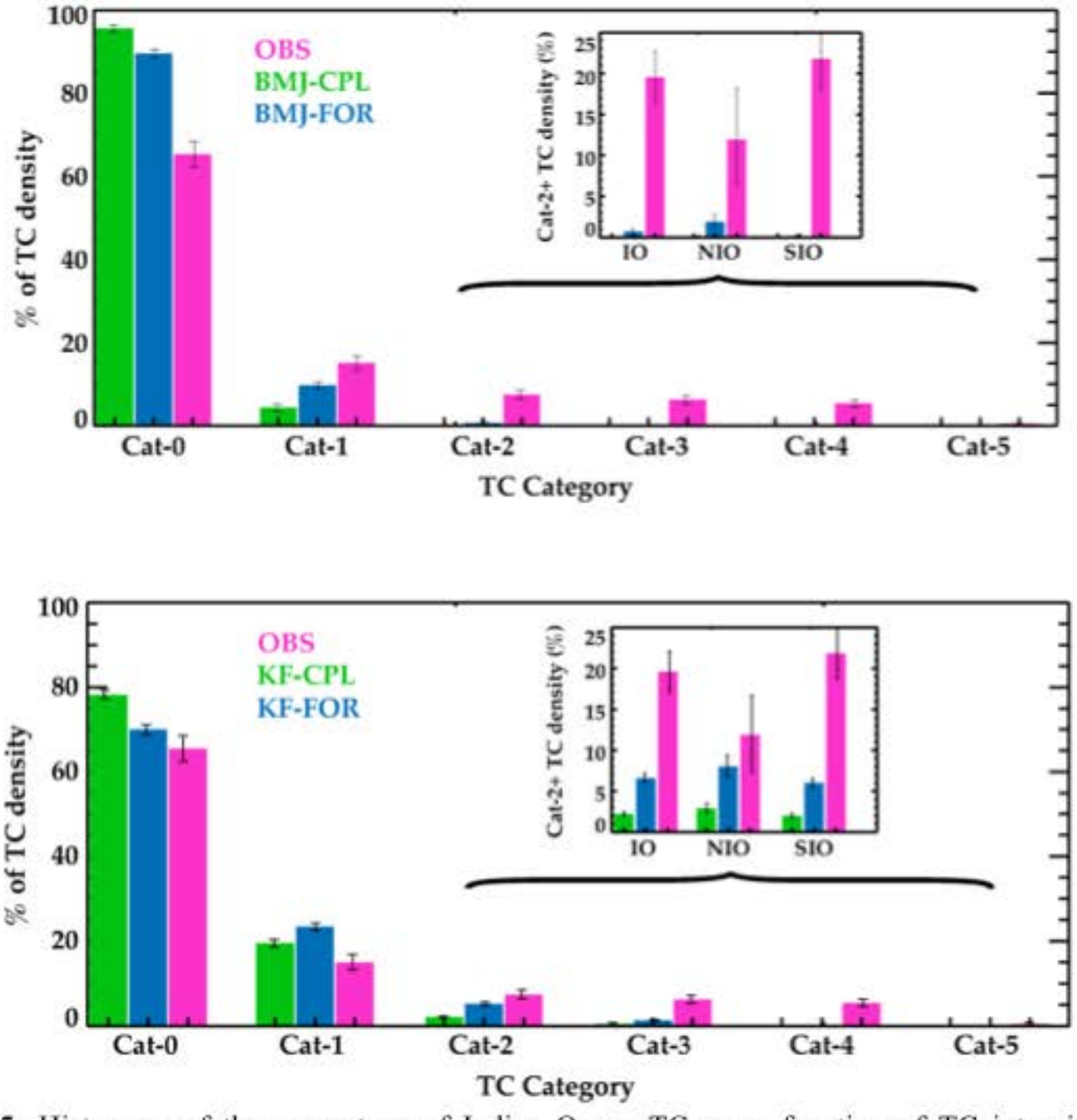

Figure 5: Histogram of the percentage of Indian Ocean TCs as a function of TC intensity, based on maximum TC wind for observations (purple), KF-CPL (green) and KF-FOR (blue) simulations. The inset indicates the percentage of intense TCs (defined as category 2 or above). The whiskers display the 90% confidence interval, computed using a Student's t-test.

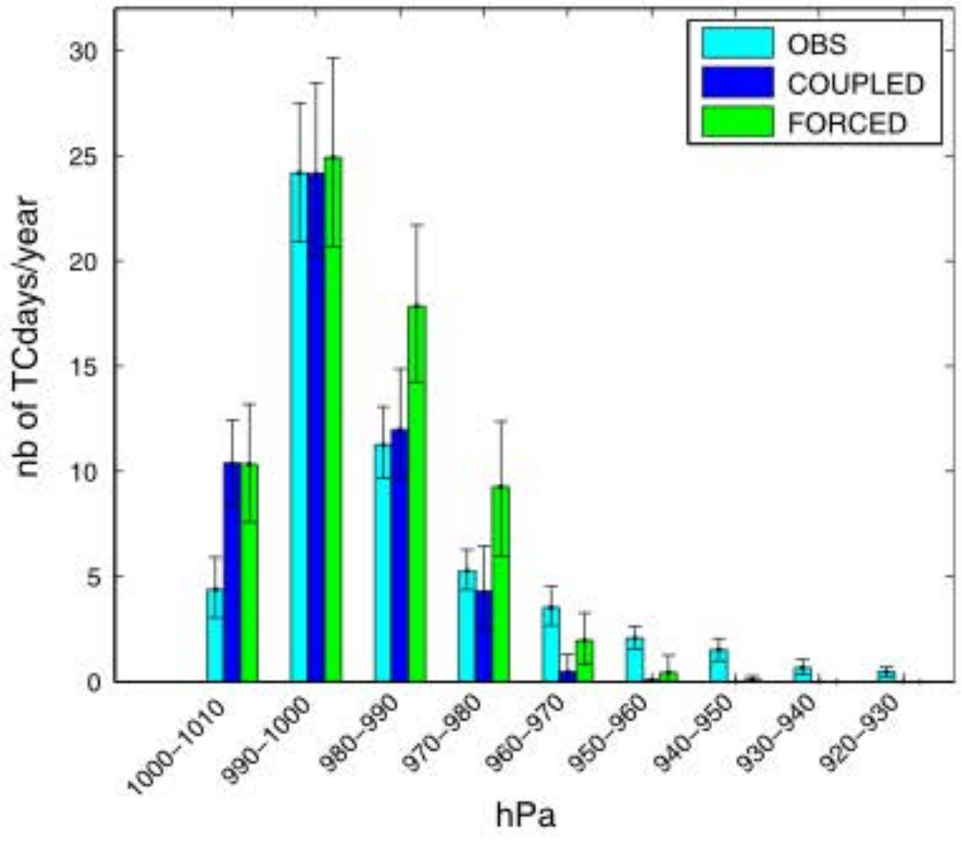

Fig. 8 Distribution of TC central pressure (in number of TC days per year) for the period 1979–1999 and from SPEArTC observations (*cyan*), the coupled model (*blue*) and the forced model (*green*). The 5–95 percentiles bootstrap *error bars* are also presented

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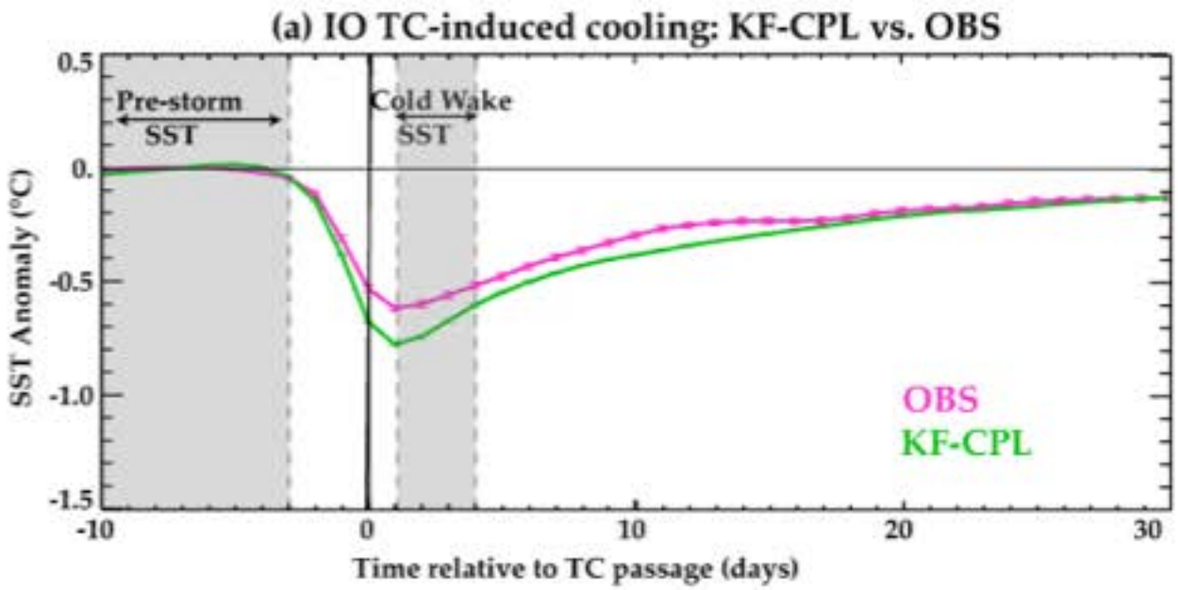

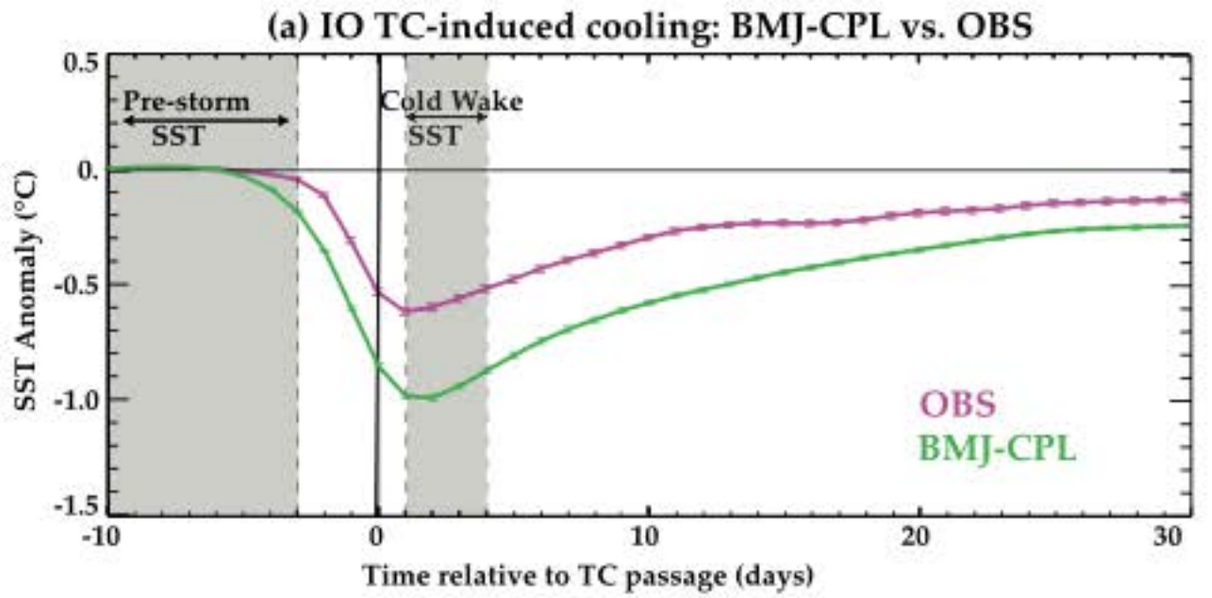

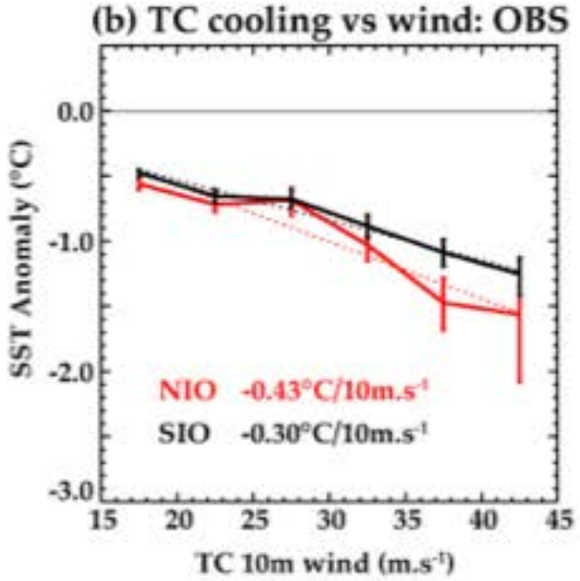

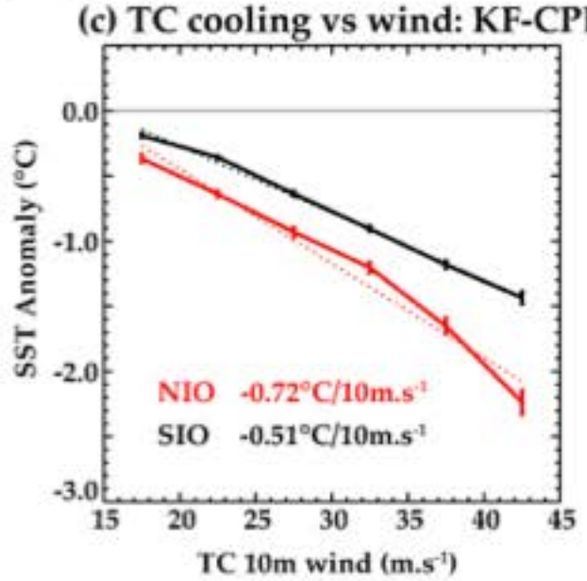

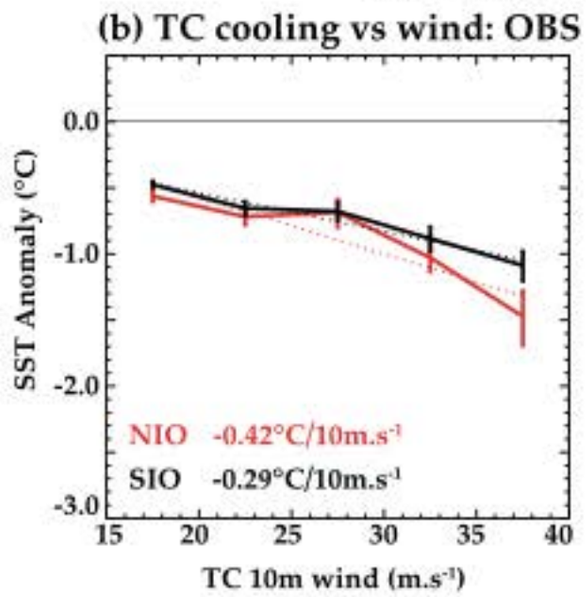

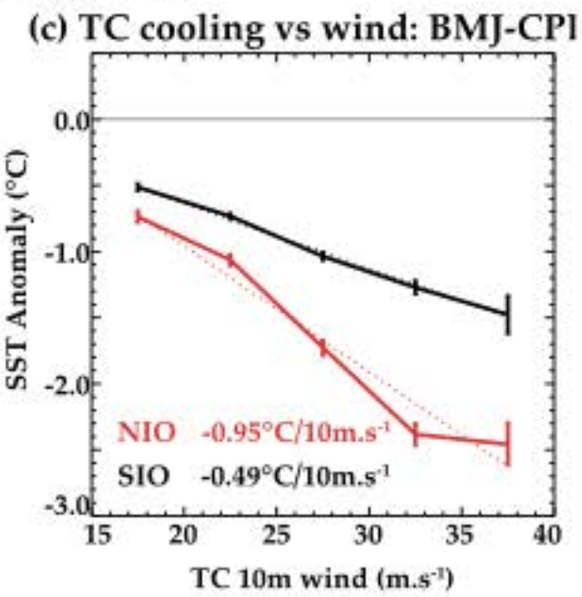

Figure 6: (a) Composite evolution of the TC-induced SST cooling within 200 km of all TC-tracks in the O (in °C) for observations (purple) and the KF-CPL experiment (green). Northern (red) and southern black) IO mean TC-induced cooling as a function of maximum wind speed for **(b)** observations and **(c)** KF-CPL. Whiskers indicate the 90% confidence level from a bootstrap method. The slope of the linear fit is also indicated as a dotted line.

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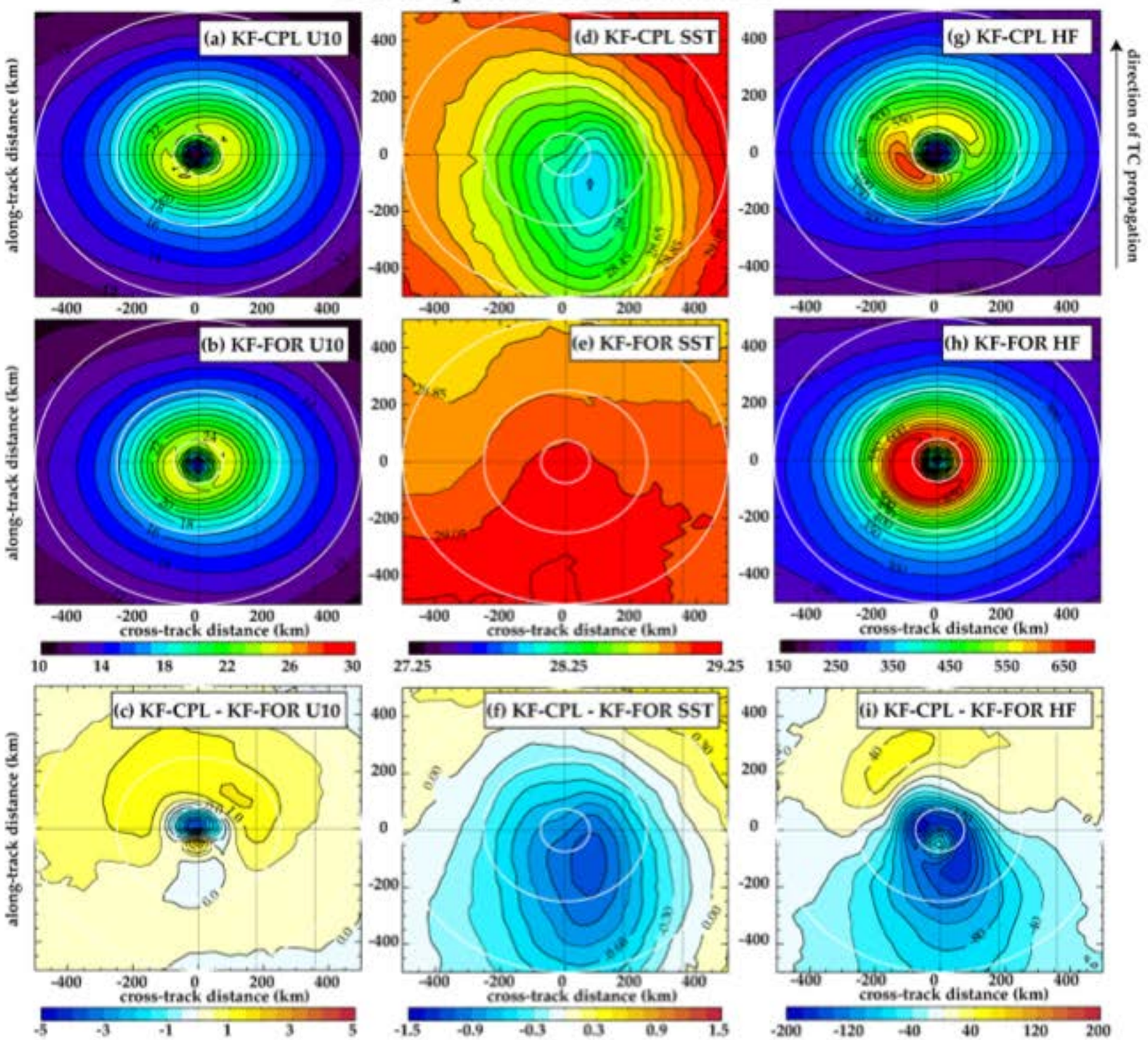

Figure 9: Same as Figure 8 for the northern IO.

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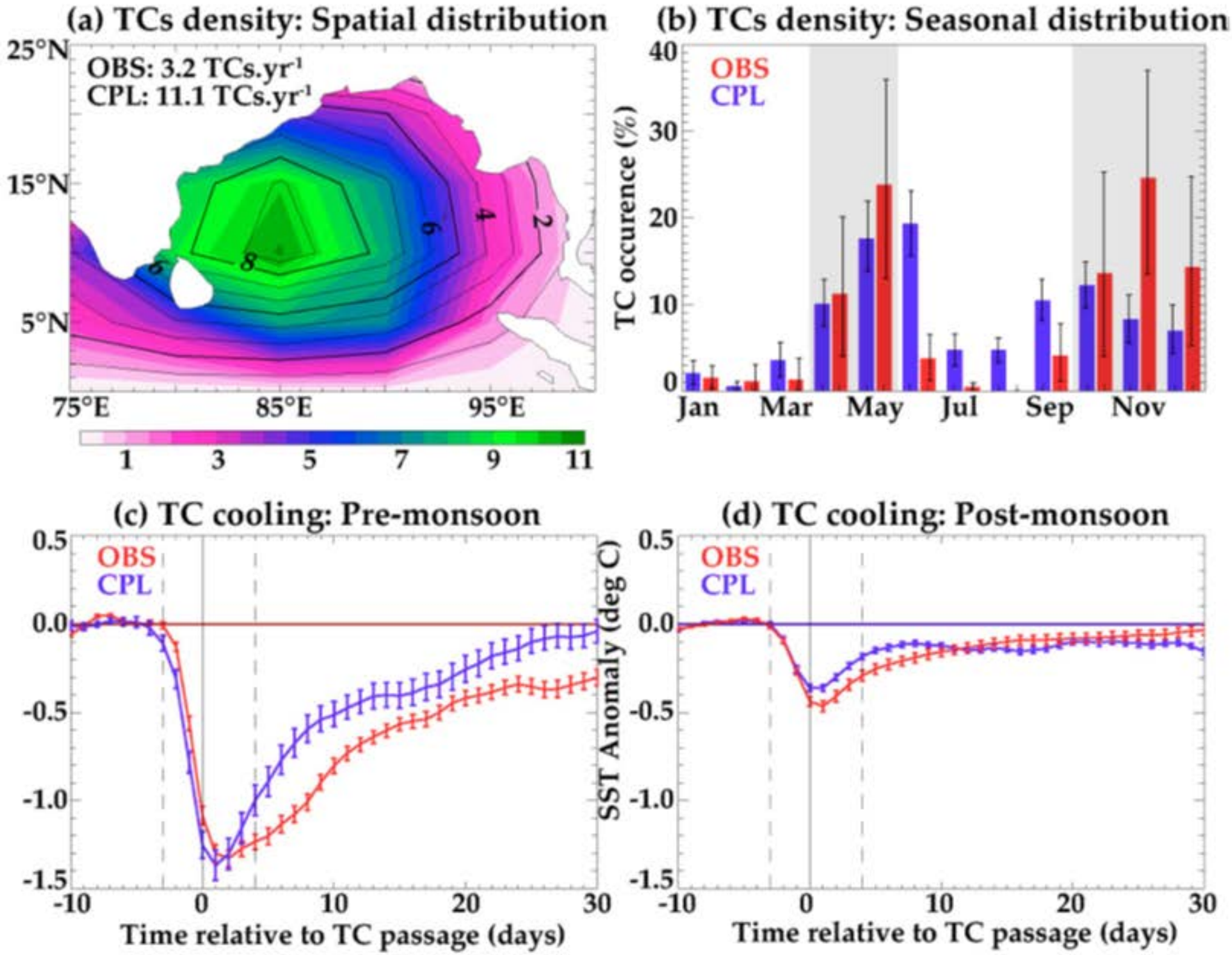
Impact oceanic statification



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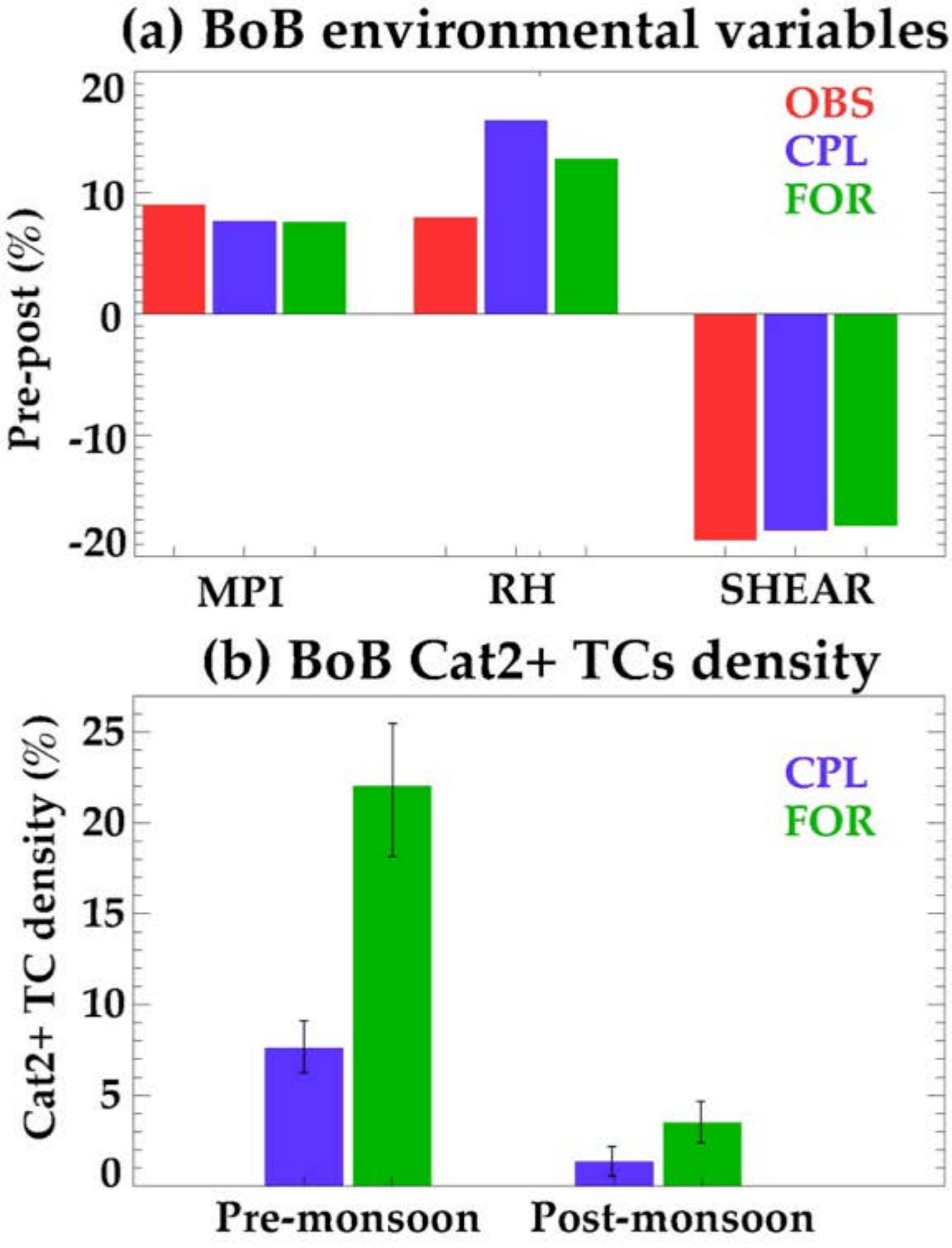

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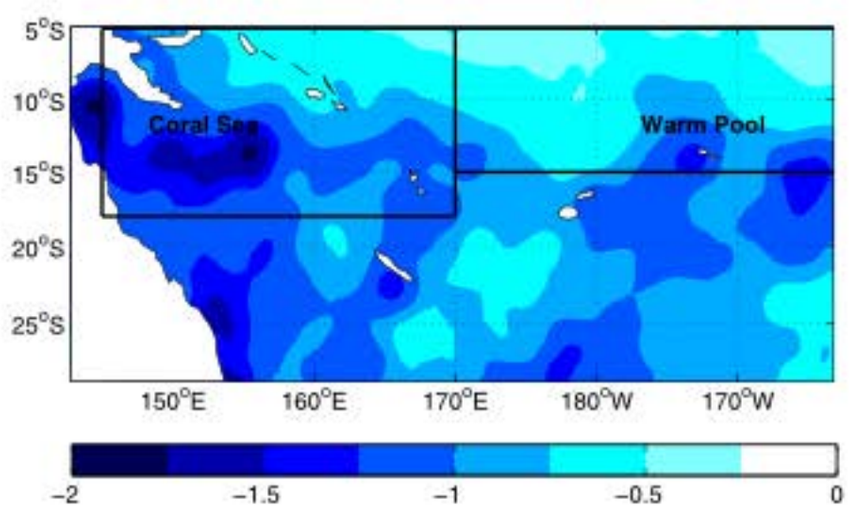
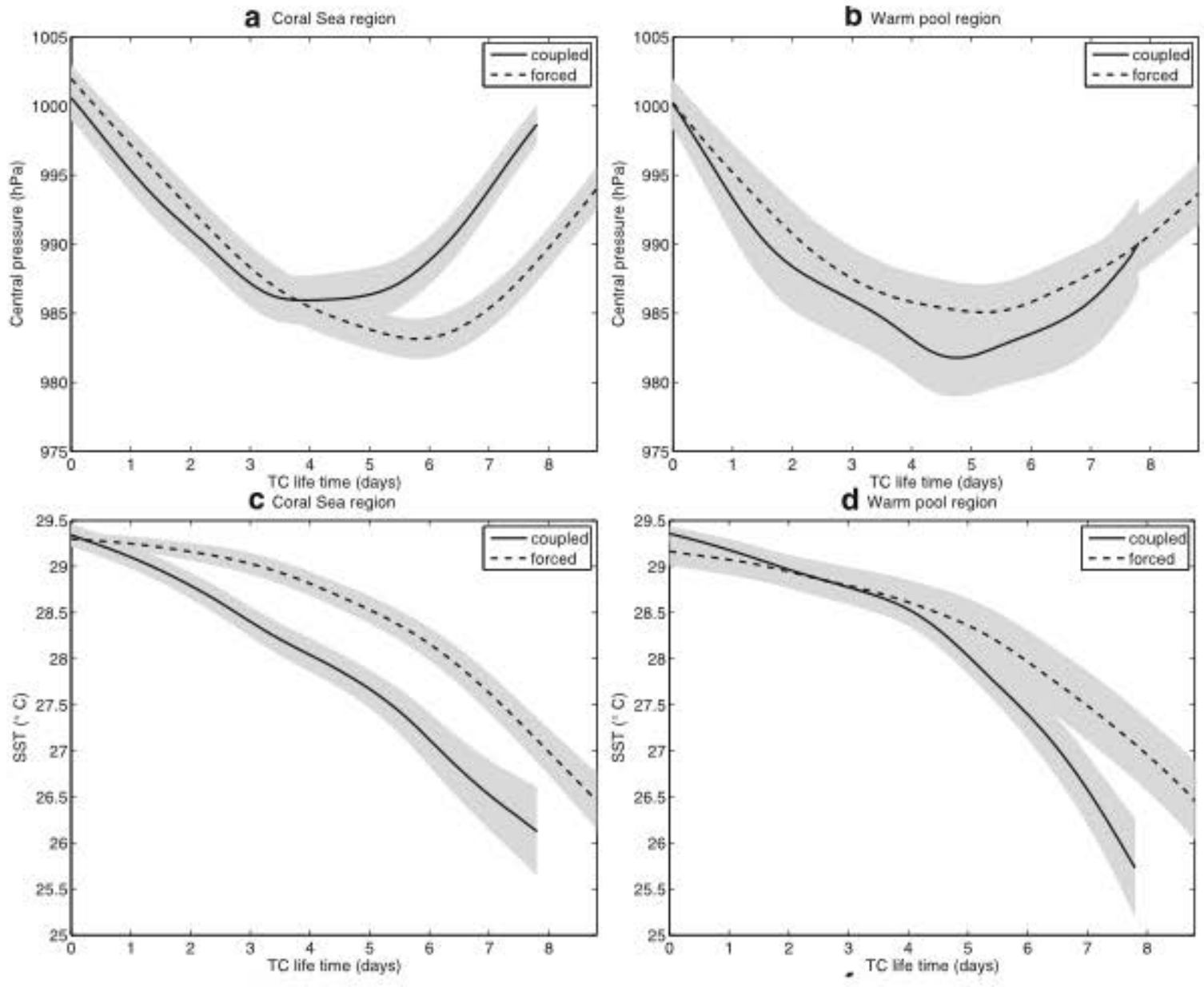


Fig. 10 Composite map of storm-induced SST cooling (°C). In the construction of this map, if two TC tracks overlap, the coolings are averaged



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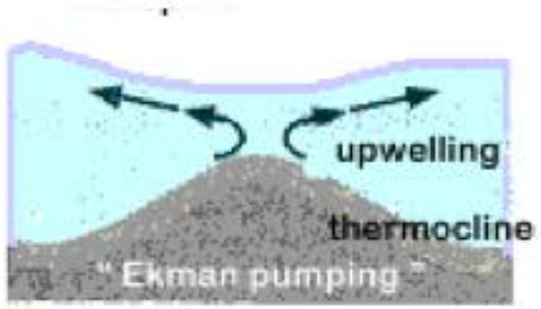
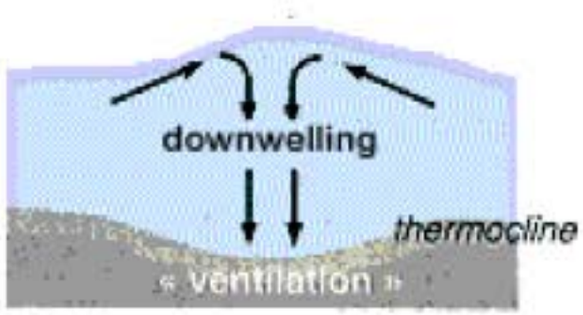
cyclonic



anticyclonic



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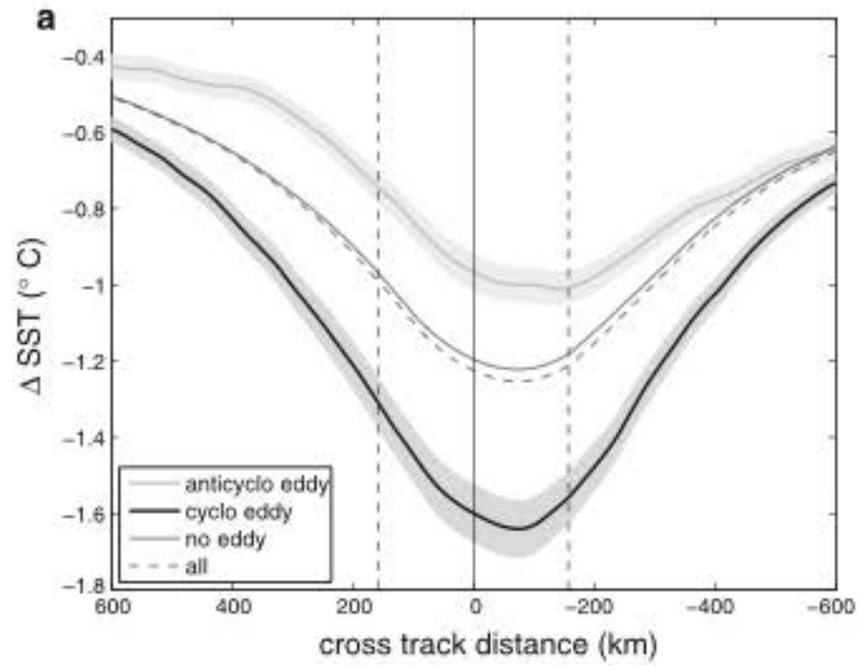
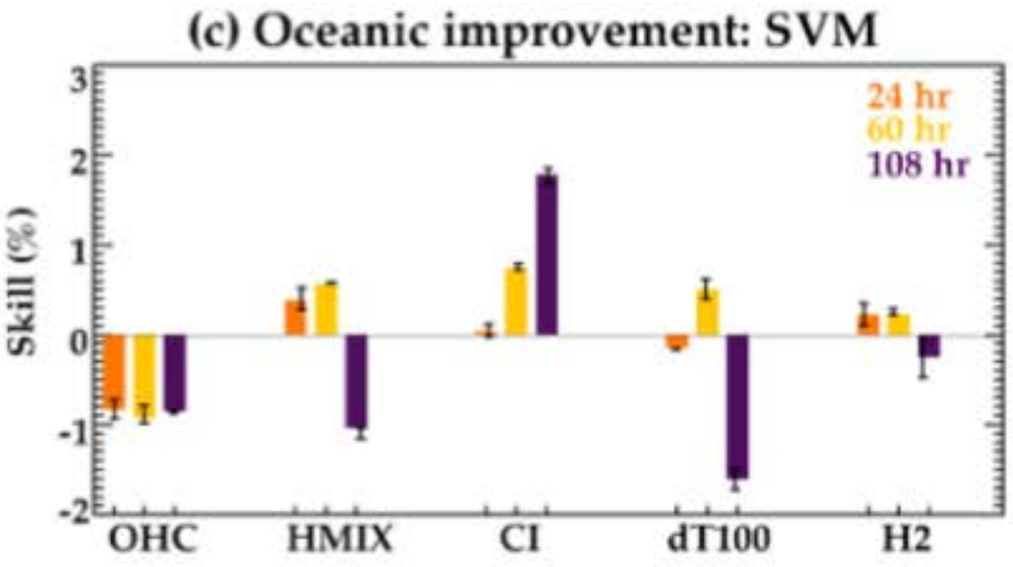
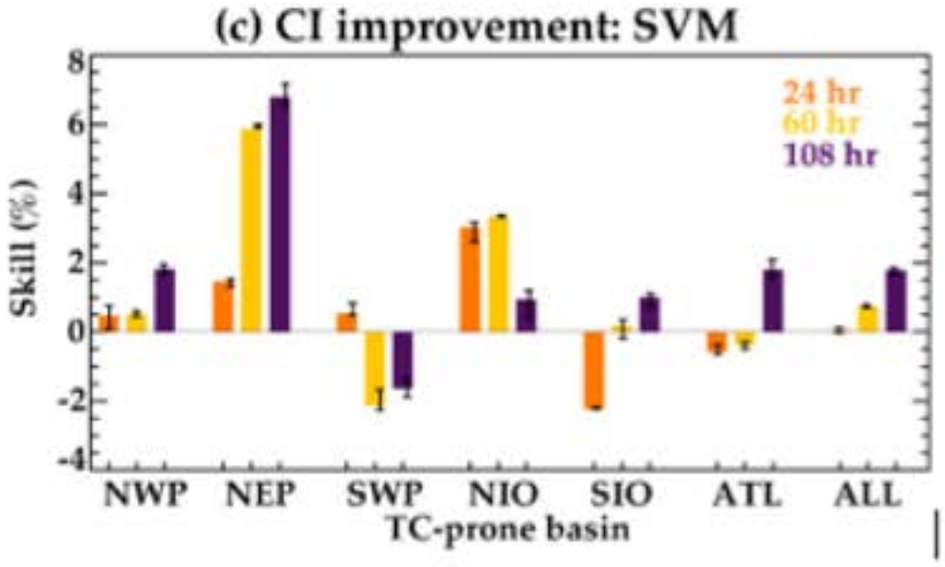
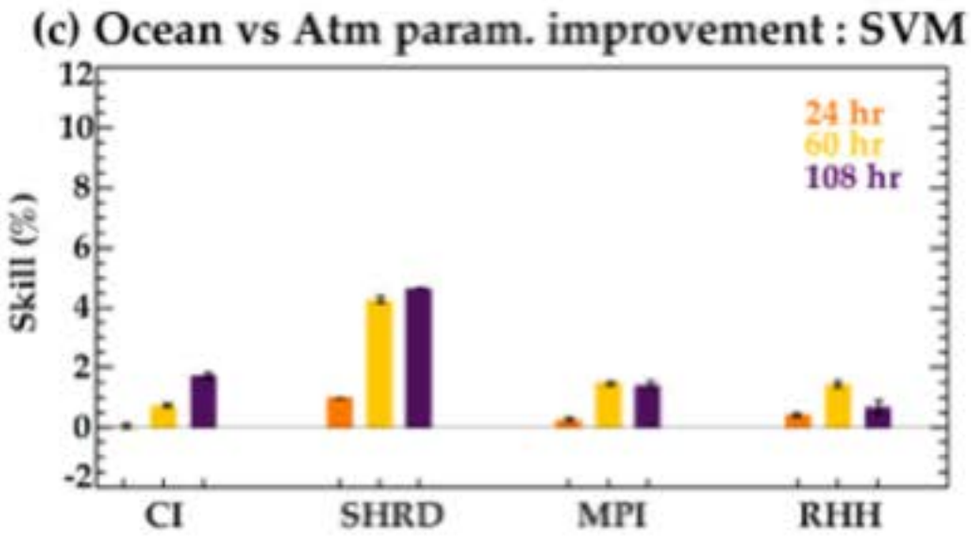


Fig. 13 Cross track composites of **a** SST cooling (°C) in the coupled model and **b** TC central pressure differences (hPa) between forced and coupled models. The results are given for all TCs (*dashed line*); TCs located over a cyclonic eddy (*bold black solid line*); TCs located over an anticyclonic eddy (*bold gray solid line*); TCs located over a neutral ocean (neither a cyclonic nor anticyclonic eddy; *thin black solid line*). The standard error of the mean (at 90 % confidence) is presented in *shades of grey*

Air-sea coupling used in Statistical models…







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conclusion

- Sensitivity of the results to parameterizations… consequences for our work???

- clear and significant impact of coupling mainly on TC intensity

- Sensitivity to ocean stratification (seasonal variations, regional variations, eddies impact…)