

# Supporting Information for “The role of ocean mesoscale in air-sea CO<sub>2</sub> exchange: a global perspective”

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## Computation of air-sea CO<sub>2</sub> and relative vorticity

The air-sea CO<sub>2</sub> flux is computed in the model and observation-based dataset as follows:

$$\text{CO}_2 \text{ flux} = k \times K_o \times (p\text{CO}_{2o} - p\text{CO}_{2a}), \quad (1)$$

where  $K_o$  is the solubility of carbon in seawater,  $k$  denotes the gas transfer velocity (Wanninkhof, 2014), and  $p\text{CO}_{2o}$  and  $p\text{CO}_{2a}$  are partial pressure of CO<sub>2</sub> in the ocean surface and atmosphere, respectively.

Ocean surface relative vorticity ( $\zeta$ ) is computed from model output as follows:

$$\zeta = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}, \quad (2)$$

where  $u$  and  $v$  are zonal (east-west,  $x$ -direction) and meridional (north-south,  $y$ -direction) components of sea surface velocity, and the gradients are computed between adjacent model grid cells.

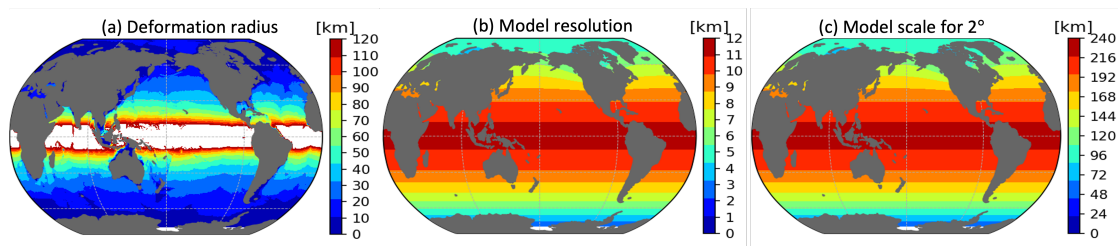
## References

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Geographical variability of the first baroclinic Rossby radius of deformation. *Journal of Physical Oceanography*, 28(3), 433–460.

Landschützer, P., Gruber, N., & Bakker, D. (2020). An observation-based global monthly gridded sea surface pCO<sub>2</sub> and air-sea CO<sub>2</sub> flux product from 1982 onward and its monthly climatology. *NCEI Accession*, 160558.

Wanninkhof, R. (2014). Relationship between wind speed and gas exchange over the ocean revisited. *Limnology and Oceanography: Methods*, 12(6), 351–362.



**Figure S1.** (a) Theoretical Rossby radius of deformation based on the WKB approximation (Chelton et al., 1998); (b) Horizontal resolution in POP-BGC-HR; (c) Spatial scales corresponding to  $2^\circ$  in POP-BGC-HR.

**Table S1.** Summary of dataset and model resolutions and temporal coverage.

Data source	Spatial resolution	Temporal resolution	Time period
observation-based $p\text{CO}_2$ and $\text{CO}_2$ flux (Landschützer et al., 2020)	$1^\circ$	monthly	1982-2000
POP-BGC-HR	nominal $0.1^\circ$	monthly	1982-2000
Satellite sea surface height	$0.25^\circ$	long-term mean	1993-2017