Climate-relevant imprints and observational implications of the oceanic intrinsic variability: lessons from the OCCIPUT Large Ensemble

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Climate-relevant imprints and observational implications of the chaotic/intrinsic ocean variability: lessons from the OCCIPUT oceanic Ensemble.

The OCCIPUT Ensemble: 50 turbulent ocean hindcasts

- NEMO global ocean model
- Resolution $\frac{1}{4}^\circ$ — 1960-2015
- 50 members with:
  - Same ERA-Interim atm. forcing
  - Slight initial perturbations

Penduff et al., 2018
Bessières et al., 2017

Slight intrinsic perturbations
Same

- In the presence of mesoscale, the ocean spontaneously generates a strong low-frequency chaotic/intrinsic ocean variability (LFCIV). It locally competes with the atmospheric forcing in driving the interannual-to-multidecadal variability of key ocean climate indices (OHC$_0$-700m, AMOC, MHT, etc.).
- Much weaker or absent in coarse-resolution ocean models used in most IPCC-class climate simulators, this strong LFCIV, might impact the atmosphere in coupled models with turbulent oceans.
- Over large regions, the LFCIV adds a random component to local 20/30-year trends of OHC and sea level, hindering their unambiguous attribution to [atmospheric+anthropogenic] drivers.
- Ensemble model statistics can be used to attenuate the signature of LFCIV in observational datasets (via filters or Machine Learning), and unveil the deterministic response of the real ocean to the atmosphere.

Take-home messages

**Interannual variability of Ocean Heat Content (0-700m)**

LFCIV imprint on OHC$_0$-700: 
- up to basin scales (and multiple decades)
- dominates forced variability in regions within contours

Sérazin et al., 2017
Penduff et al., 2018

- [atmospheric + anthropogenic drivers] $\Rightarrow$ Forced OHC trends $T_F$ (colors)
- LFCIV $\Rightarrow$ Random OHC trends $T_R$

In regions where $|T_r| < 2T_F$ (green shading)

OHC trends can NOT be surely attributed (95% confidence) to [atmospheric + anthropogenic drivers]

SL trend observed by altimetry

Estimation: Forced observed SL trend

Sérazin et al., 2017
Close et al., in rev

- In many regions, $\alpha_\text{C} > \alpha_\text{F}$ on space scales [110-800km], over all time scales
- Filtering out scales [110-800km] $\Rightarrow$ estimation of Forced observed trends
- Currently developing an estimator based on Machine Learning (CNN)


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**References**

- Penduff et al., 2016: Ensemble model statistics can be used to attenuate the signature of LFCIV in observational datasets (via filters or Machine Learning), and unveil the deterministic response of the real ocean to the atmosphere.
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