

# Which part of the low-frequency sea-level variability is purely due to intrinsic ocean processes ?

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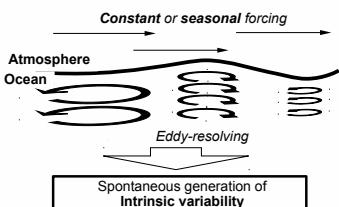
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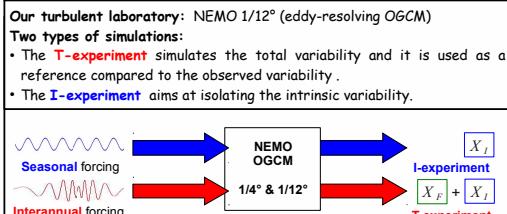
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## Intrinsic variability



## Experimental strategy



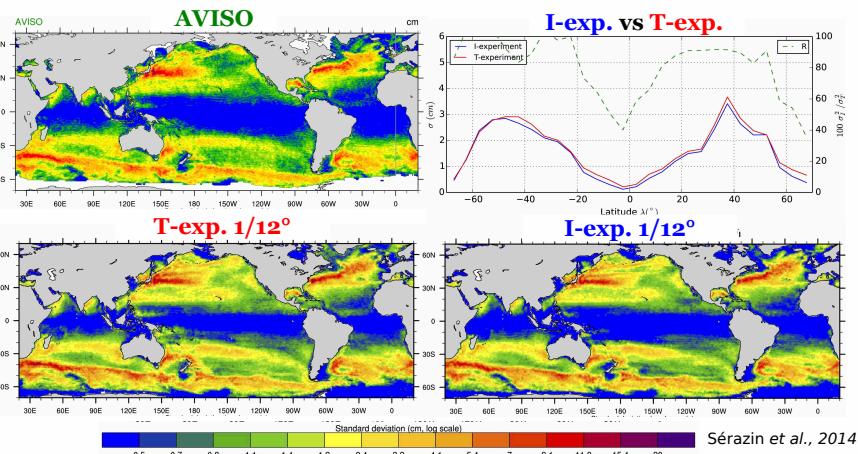
## Western Boundary Currents: Kuroshio case

EOF decomposition of the zonal jets into 2 modes ( $10^{\circ} \times 10^{\circ}$  box):

- Mode 1: Displacement of the SSH gradient ↔ Jet displacement
- Mode 2: Increase/decrease of the SSH gradient ↔ Jet intensification/weakening
- **AVISO ↔ T-exp.:**
- NEMO 1/12° is able to reproduce the main jet meridional modes
- **T-exp. ↔ I-exp.:**
- Jet meridional modes of variability are shaped by oceanic processes

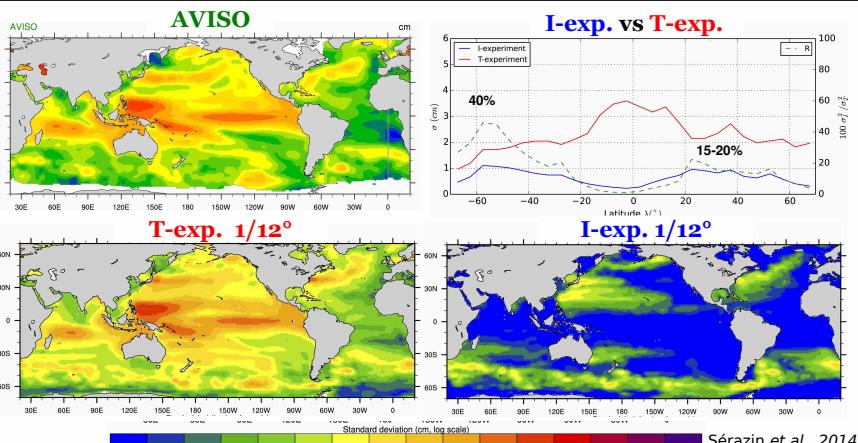
## Small-scale (<6°) interannual-to-decadal (1.5-20 ans) SLA variability

- **AVISO:** mesoscale activity imprint LF SLA variability, concentrated at midlatitudes
- **AVISO ↔ T-exp.:** NEMO 1/12° reproduces with accuracy the LF SS variability
- **T-exp. ↔ I-exp.:** the ocean generates similar LF SS variability with or without LF and synoptic atmospheric variability
- **Summary:** The observed small-scale interannual-to-decadal SLA variability is largely **intrinsic**: it spontaneously emerge from oceanic non-linearities → stochastic oceanic component



## Large-scale (>12°) interannual-to-decadal (1.5-20 ans) SLA variability

- **AVISO:** LS variability is substantial over the global ocean and particularly large at low latitudes (e.g. Niño, IOD)
- **AVISO ↔ T-exp.:** NEMO 1/12° reproduces with accuracy the LS LF variability
- **T-exp. ↔ I-exp.:** LF LS variability is mainly induced by LF and synoptic atmospheric forcing except in eddy-active regions
- **Summary:** The observed large-scale interannual-to-decadal SLA variability is mainly related to the oceanic response of low-frequency and synoptic atmospheric forcing but it is partly **intrinsic** in eddy-active regions.



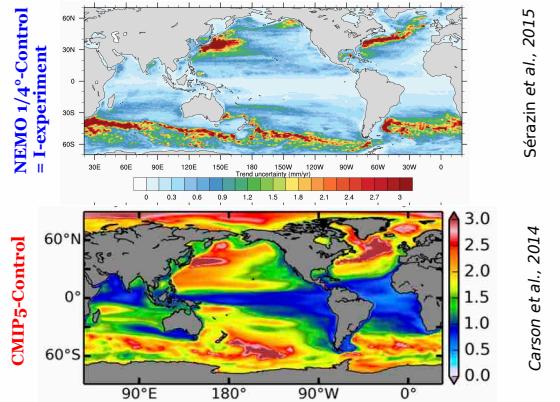
## Multi-decadal (>20 ans) SLA variability

Zonal mean of SLA multi-decadal standard deviation

**CMIP5-Control**  
**NEMO 1/4°-Control**

Coupled internal variability without oceanic intrinsic variability  
Oceanic intrinsic variability only

Uncertainty on 20-yr regional sea level trends induced by truncation of multi-decadal internal variability



## MESSAGE OF THIS POSTER

- NEMO 1/12° vs AVISO: very good accuracy (e.g. spatial scales, WBC modes of variability)
- LF small-scale (<6°) SLA variability: **intrinsic** (i.e. spontaneously generated by oceanic non-linearities)
- LF large-scale (>12°) SLA variability: linked to **atmospheric variability** except in **eddy-active regions**
- **WBC modes of variability:** spatial structure shaped by **nonlinear oceanic processes** but potentially excited by the **external forcing**
- **Multi-decadal SLA variability:** I-exp. ~ CMIP5 at midlatitudes → probable underestimation of internal climate variability due to the coarse ocean resolution ; **intrinsic** oceanic variability → additional uncertainty on the estimate of regional sea level trends.

## References:

- Carson M., A. Köhl, D. Stammer, 2014: The Impact of Regional Multidecadal and Century-Scale Internal Climate Variability on Sea Level Trends in CMIP5 Models. *J. Climate*, 28, 853–861.  
 Séزان, G., T. Penduff, L. Terray, S. Grégorio, B. Barnier, J.-M. Molines, 2014: Intrinsic Variability of SeaLevel from Global 1/12° Ocean Simulations: Spatiotemporal scales. *J. Climate*, 28, 4279–4292.  
 Séزان, G., B. Meyssignac, T. Penduff, L. Terray, B. Barnier, J.-M. Molines, 2015: Quantifying uncertainties on regional sea-level trend induced by multi-decadal oceanic intrinsic variability. In preparation for *JGR*.