# A probabilistic description of the forced and intrinsic oceanic variability: SLA, SST, MOC, water masses

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## CONTEXT AND OBJECTIVES

Future climate simulators will include eddying rather than laminar oceans. **When eddies are present,** global ocean/sea-ice simulations forced by repeated annual cycles show that **an intrinsic low-frequency (LF: interannual-to-multidecadal) oceanic variability emerges spontaneously**, with a **chaotic character, and a strong (large-scale) imprint on SLA, SST, MOC, water masses**. This suggests that in coupled mode, eddying ocean models might inject low-frequency « noise » into the atmosphere/climate, but also questions the **actual constraint exerted by the atmosphere on the ocean variability**. **Ensembles of eddying ocean/sea-ice simulations** are performed and analyzed to quantify the imprint of the **atmospherically-forced and intrinsic/chaotic variabilities** on various oceanic quantities observed from space or from in-situ arrays.

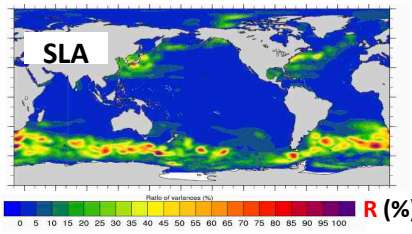
## 1 SEASONAL FORCING → ¼° NEMO RUN

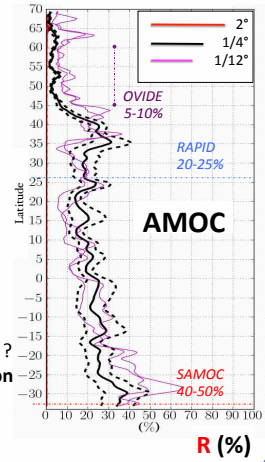
previous work

Results from the OST-ST **CHAOCEAN** project

**Intrinsic/chaotic** part (**R** in %) of the large-scale (L>1000km) interannual variance

*Penduff et al (2011), Serazin et al (2015), Gregorio et al (2015)*




Under purely seasonal forcing, **eddying** ocean models still generate a **substantial intrinsic/chaotic low-frequency large-scale oceanic variability**.

→ Does this intrinsic component remain chaotic under full forcing (with low-freq and synoptic var.) ?

→ **What is the actual constraint of the atmosphere on the ocean, and on oceanic observations ?**

→ fully-forced **ENSEMBLE** hindcasts

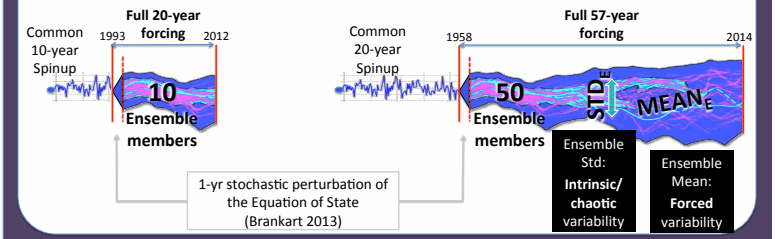
## 2 FULL FORCING → ¼° NEMO ENSEMBLE RUNS

ongoing work

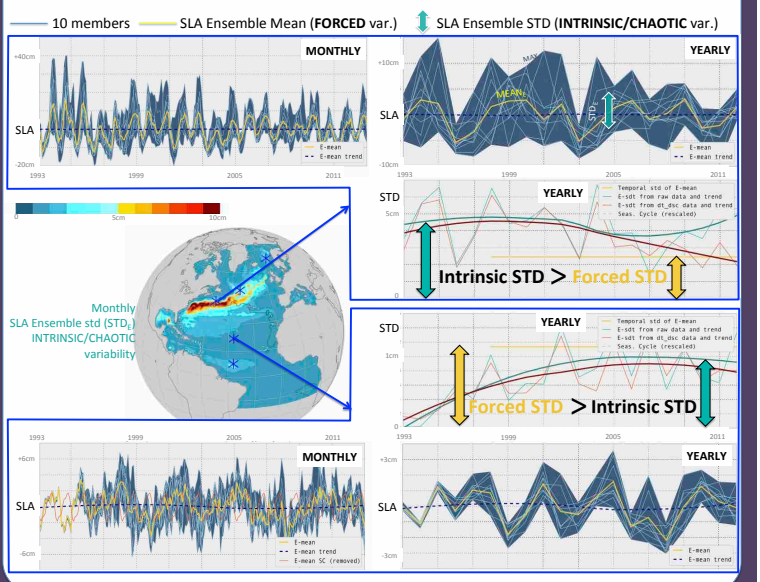
Simulation strategy (OST-ST **CHAOCEAN** and ANR/PRACE **OCCIPUT** projects)

**DONE : 10-member 20-year North Atlantic ENSEMBLE run**

**RUNNING : 50-member 57-year Global ENSEMBLE run**



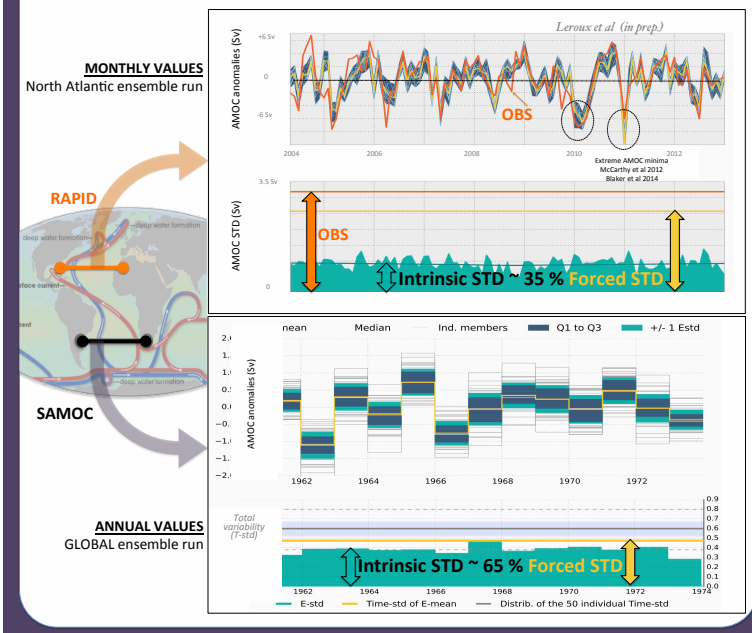

## NORTH ATLANTIC ENSEMBLE : SLA



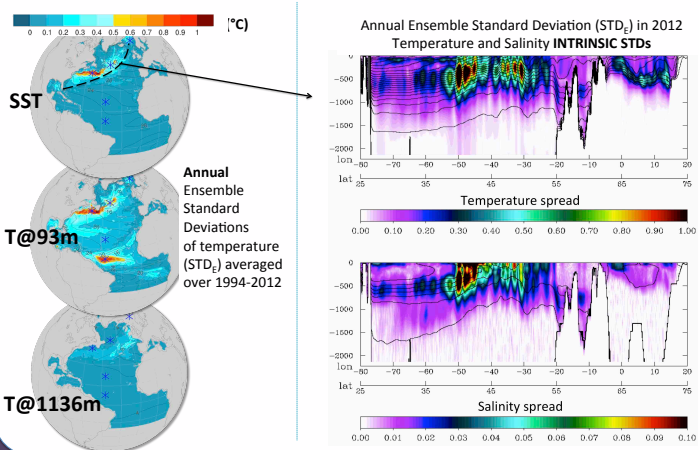

## 4 NORTH ATLANTIC & GLOBAL ENSEMBLES : AMOC

**MONTHLY VALUES**
North Atlantic ensemble run

**ANNUAL VALUES**
GLOBAL ensemble run




## 5 NORTH ATLANTIC ENSEMBLE : ANNUAL T/S




## TAKE-HOME MESSAGES

**Eddying** regime → **1-10 year** oceanic variability is **partly chaotic**.
Ensemble hindcasts with perturbed initial conditions & full forcing :

* Interannual SLA variability is **mostly chaotic** in the Gulf Stream
* **Chaotic interannual SST variability exceeds 1°C** in the Gulf Stream
* 65% of the **interannual AMOC std** at 35°S is **chaotic**

→ **PROBABILISTIC INTERPRETATIONS OF OBSERVATIONS**

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