Intrinsic variability in the global eddying ocean at interannual timescales: sea-level, sea-surface temperature, overturning

T. Penduff[1,2], M. Juza[1], B. Barnier[1], J. Zika[1], W.K. Dewar[2], A.M. Treguier[3], J.M. Molines[1], N. Audiffren[4], B. Deremble[2]

(1) LEGI/CNRS, Grenoble, France. (2): EOAS Dpt/FSU; Tallahassee, USA.
(3) LPO/CNRS, Brest, France; (4): CINES, Montpellier, France.

Contact: Thierry.Penduff@hmg.inpg.fr

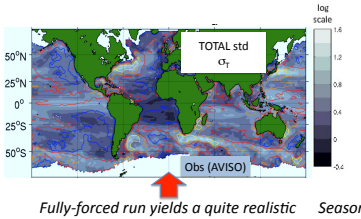
Idealized studies (e.g. Dijkstra and Ghil 2005; Berloff et al 2007) show that high Reynolds number flows undergo an **intrinsic interannual variability** (with constant forcing)
Regional evidence of this behavior has been **reported in a few realistic OGCM simulations** (e.g. *Hall et al 2004; Biastoch et al 2008; Taguchi et al 2007*). **No global analysis yet**.

WHAT IS THE IMPRINT/MAGNITUDE OF **INTRINSIC INTERANNUAL VARIABILITY IN A GLOBAL EDDYING OGCM ?** (SEA-LEVEL, SEA-SURFACE TEMPERATURE, OVERTURNING, TRANSPORTS)

[1] We perform multi-decadal global 1/4° *DRAKKAR* ocean simulations with
- a climatological seasonal cycle → **intrinsic** interannual variability
- a full atmospheric reanalysis → **total** interannual variability (**forced + intrinsic**)

[2] We compare the interannual standard deviations of these variables with/without internnual forcing
- Climatological (resp. fully-forced) run gives intrinsic and total standard deviations: $\sigma_I(x,y)$ and $\sigma_T(x,y)$
- The Fraction (%) of the interannual variance that is intrinsic is simply = 100% . $[\sigma_I(x,y) / \sigma_T(x,y)]^2$

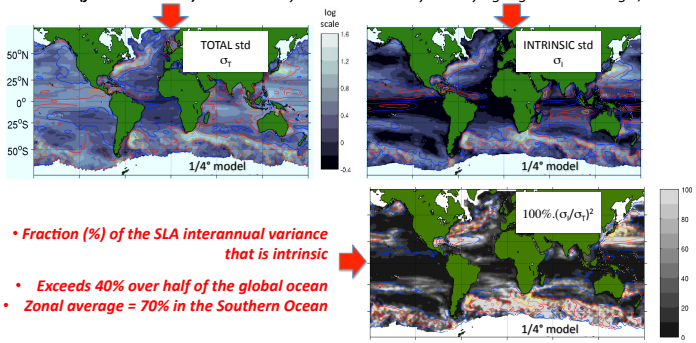
Intrinsic interannual variability of **SEA-LEVEL** (*Penduff et al, J. Clim. 2011*)



Color shadings show the interannual standard deviation of SLA (cm, log scale)
Note : intrinsic SLA variability is almost absent in 2° IPCC-like model.

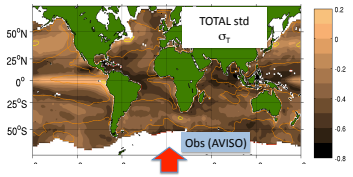
Fully-forced run yields a quite realistic ***total (forced+intrinsic)*** *SLA variability*

Seasonally-forced run reveals a ***large intrinsic interannual*** *variability in eddying regions and along +/- 25°*



- ***Fraction (%) of the SLA interannual variance that is intrinsic***
- ***Exceeds 40% over half of the global ocean***
- ***Zonal average = 70% in the Southern Ocean***

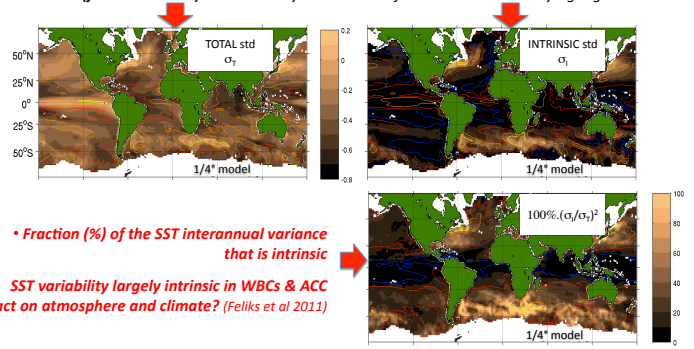
Instrinsic interannual variability of **SEA-SURFACE TEMPERATURE**



Color shadings show the interannual standard deviation of SST (°C, log scale)
Note : bulk formulae exert a negative feedback on SSTs via latent and sensible heat fluxes, and might damp the intrinsic variability

Fully-forced run yields a quite realistic ***total (forced+intrinsic)*** *SST variability*

SST and SSH ***intrinsic*** *interannual variabilities found in the same eddying regions*

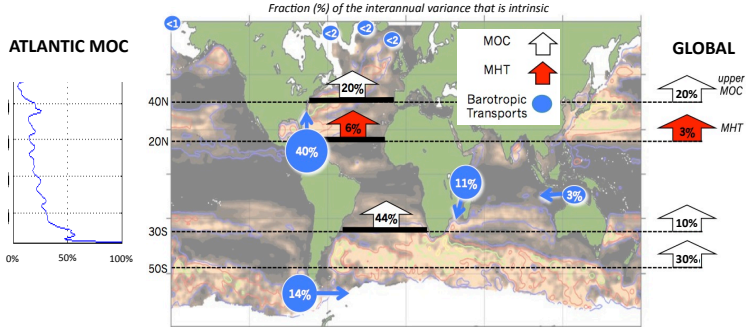


- ***Fraction (%) of the SST interannual variance that is intrinsic***
- ***SST variability largely intrinsic in WBCs & ACC***
- ***Impact on atmosphere and climate?*** *(Feliks et al 2011)*

Intrinsic interannual variability of the **MOC and TRANSPORTS**

Work in progress

Fraction (%) of the interannual variance that is intrinsic



- ***Large intrinsic AMOC variability due to Agulhas eddies (Biastoch et al, 2008)***
- ***Secondary maximum around 40°N***
- ***Florida Current transport variability is 40% intrinsic***
- ***14% at Drake passage***
- ***Global MOC variability is: 30% intrinsic at 45°S 20% intrinsic at 40°N***

Conclusions — Perspectives

- **Our 2° (IPCC-like) ocean model is devoid of intrinsic interannual variability**
- **Our 1/4° ocean model generates intrinsic interannual variability under seasonal forcing**
  - **→ Strong impact on SLA and SST in eddying regions (as in idealized models)**
  - **→ Strong impact on Atlantic MOC around 30°S — significant impact around the Gulf Stream**

- **4D modes ? Timescales ? Dynamics of intrinsic variability ? Interaction with forcing ?**
- **Imprint of intrinsic variability on observational datasets ? On climate predictibility ?**
- **Atmospheric impact of ocean-driven interannual SST variability ?**

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