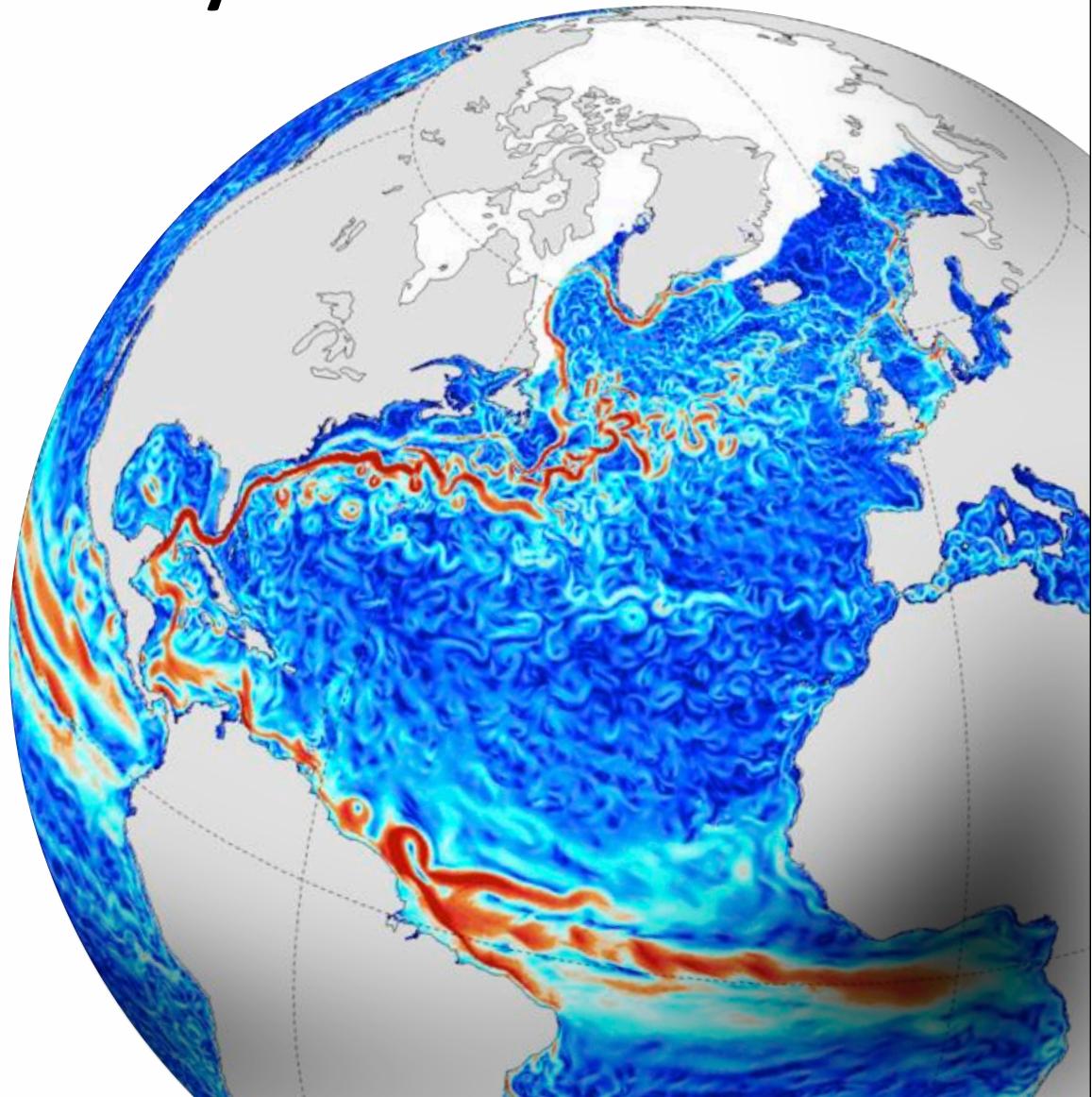


# Imprints of intrinsic low-frequency variability: Global Ocean, Atlantic, Gulf Stream

DRAKKAR

1/12° global  
NEMO simulation



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# Outline

*Intrinsic low-frequency variability (pure and forced)*

1. Shallow-water Idealized model
  - North Pacific WBC system
2. Primitive equation « realistic » OGCM
  - Global imprints and amplitudes
  - North Atlantic WBC system
3. Conclusions and perspectives



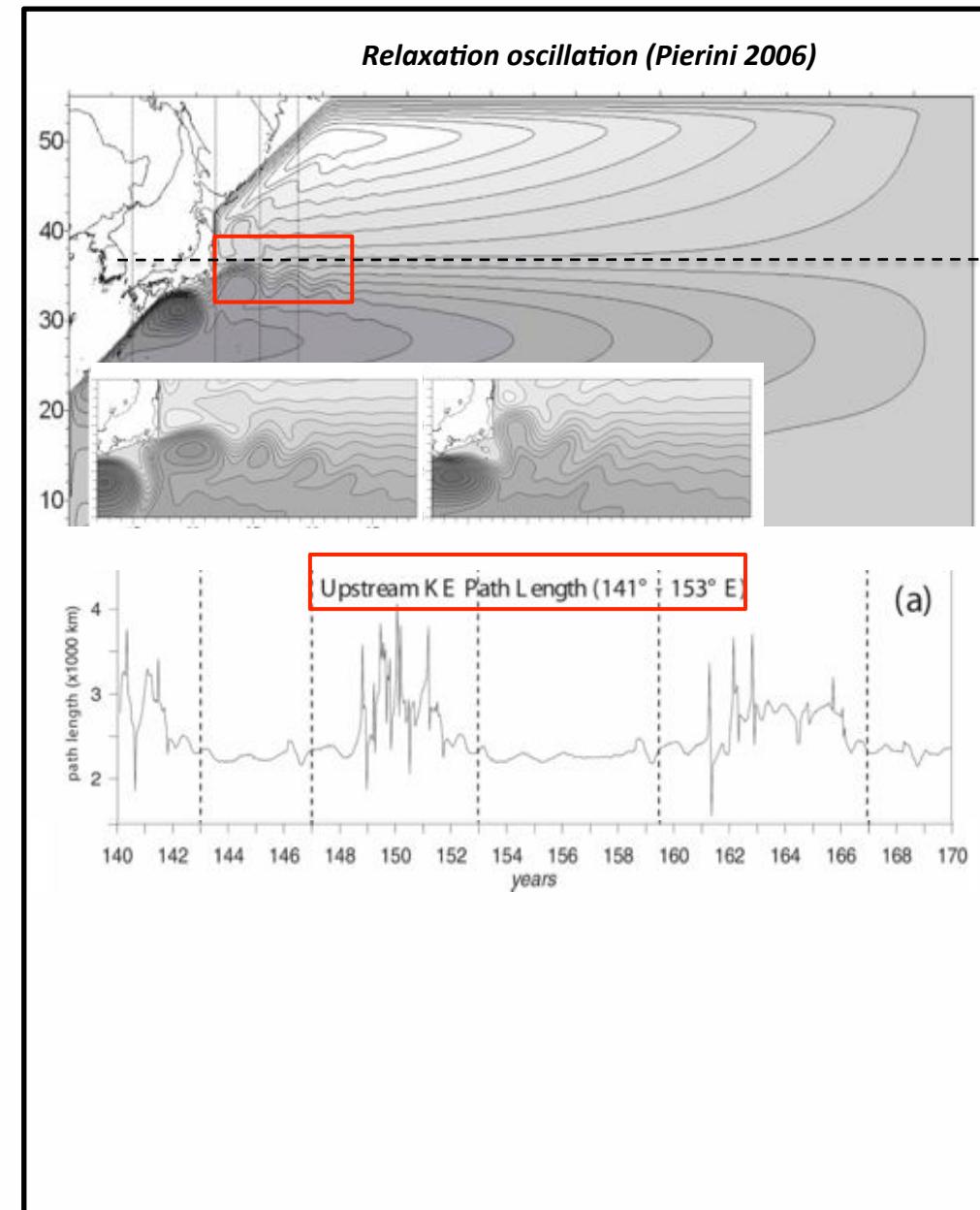
# Shallow-water models: intrinsic LF variability (pure)

North Pacific @High  $Re$  ( $u' \cdot \text{grad}(u')$ )

Constant or seasonal wind forcing

→ « Pure » intrinsic 1-10 year chaotic variability

Dijkstra & Ghil 2005; Pierini 2006; Sushama et al 2007



# Shallow-water models: intrinsic LF variability (forced)

North Pacific @High  $Re$  ( $u' \cdot \text{grad}(u')$ )

Constant or seasonal wind forcing

→ « Pure » intrinsic 1-10 year chaotic variability

Dijkstra & Ghil 2005; Pierini 2006; Sushama et al 2007

Low-frequency wind forcing (NPO-like)

→ Forced intrinsic 1-10 year chaotic variability  
(partly paced by the external forcing)

Relaxation oscillation, Pierini 2013; Crucifix 2012; Taguchi 2007

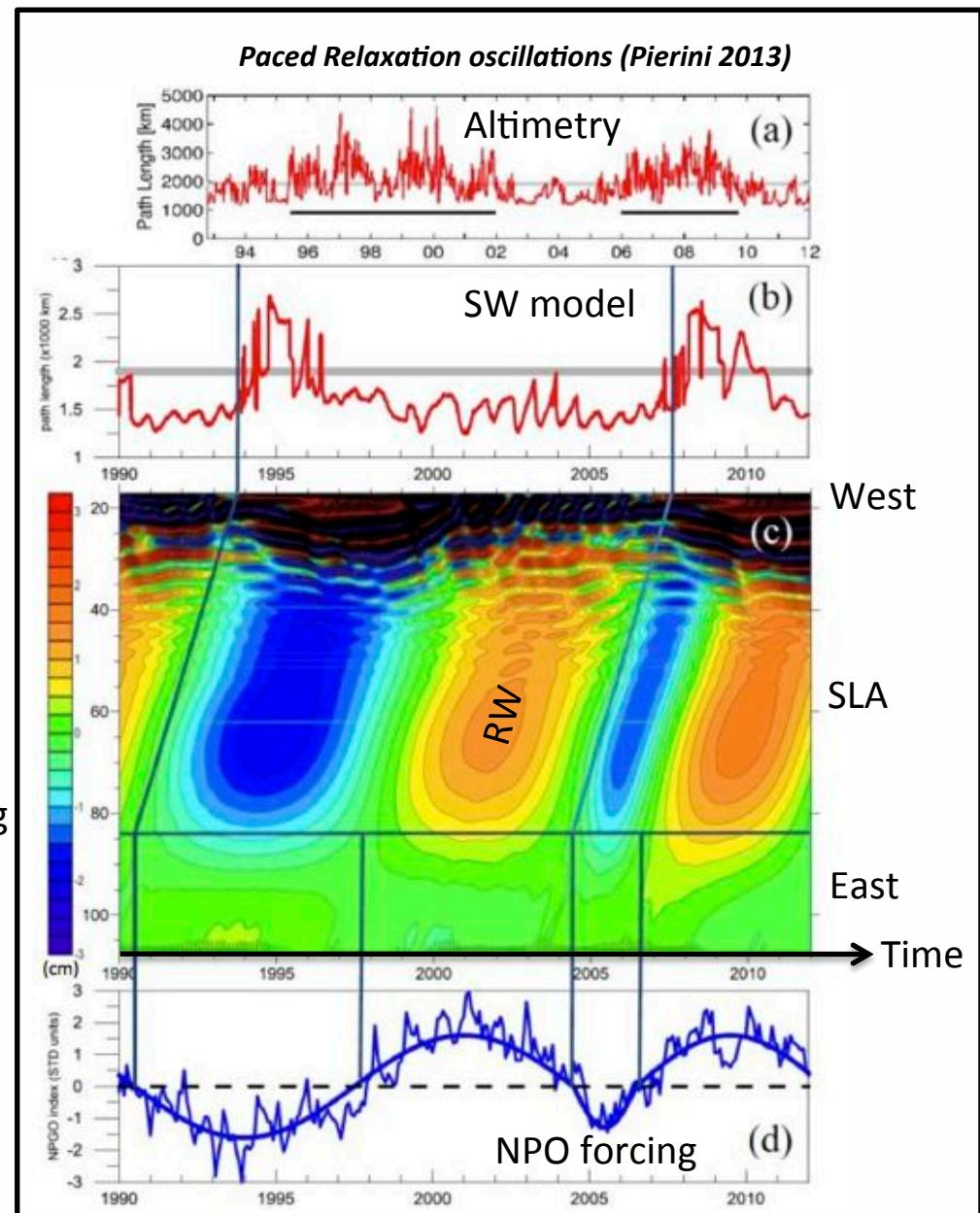
Low-frequency WBC variability :

- spatial patterns : set by intrinsic modes
- temporal evolution : partly controlled by forcing

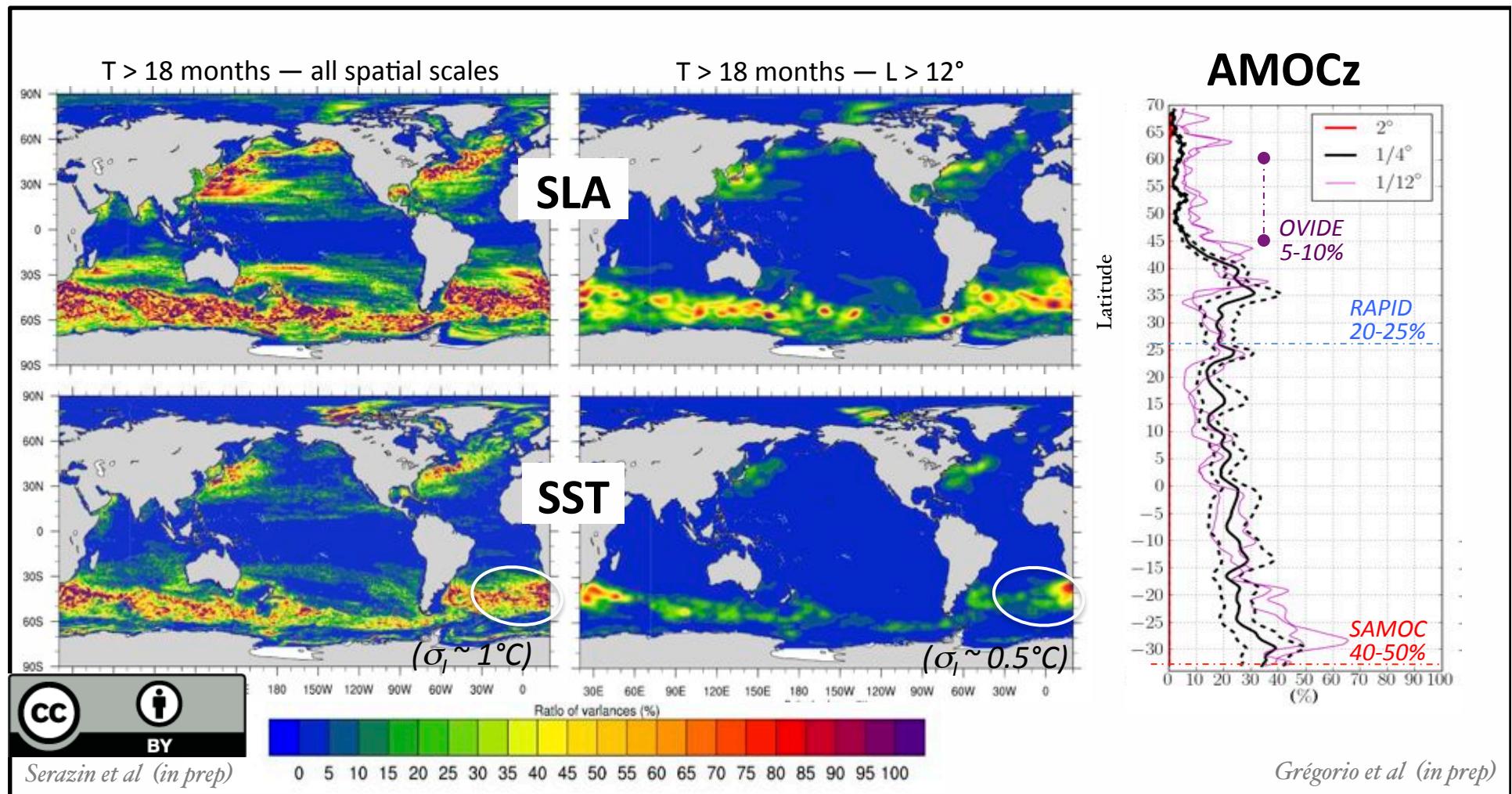
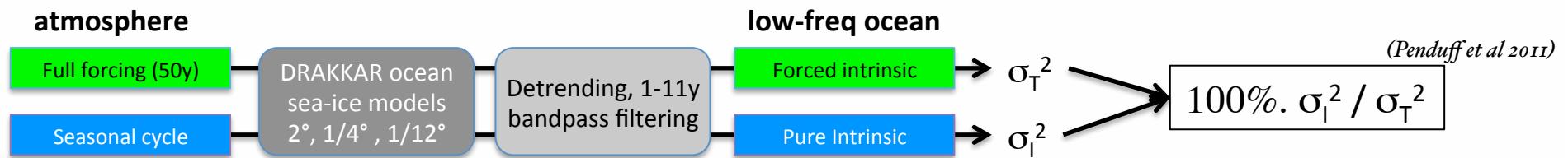
Realistic context :

Amplitude ? Other imprints ?

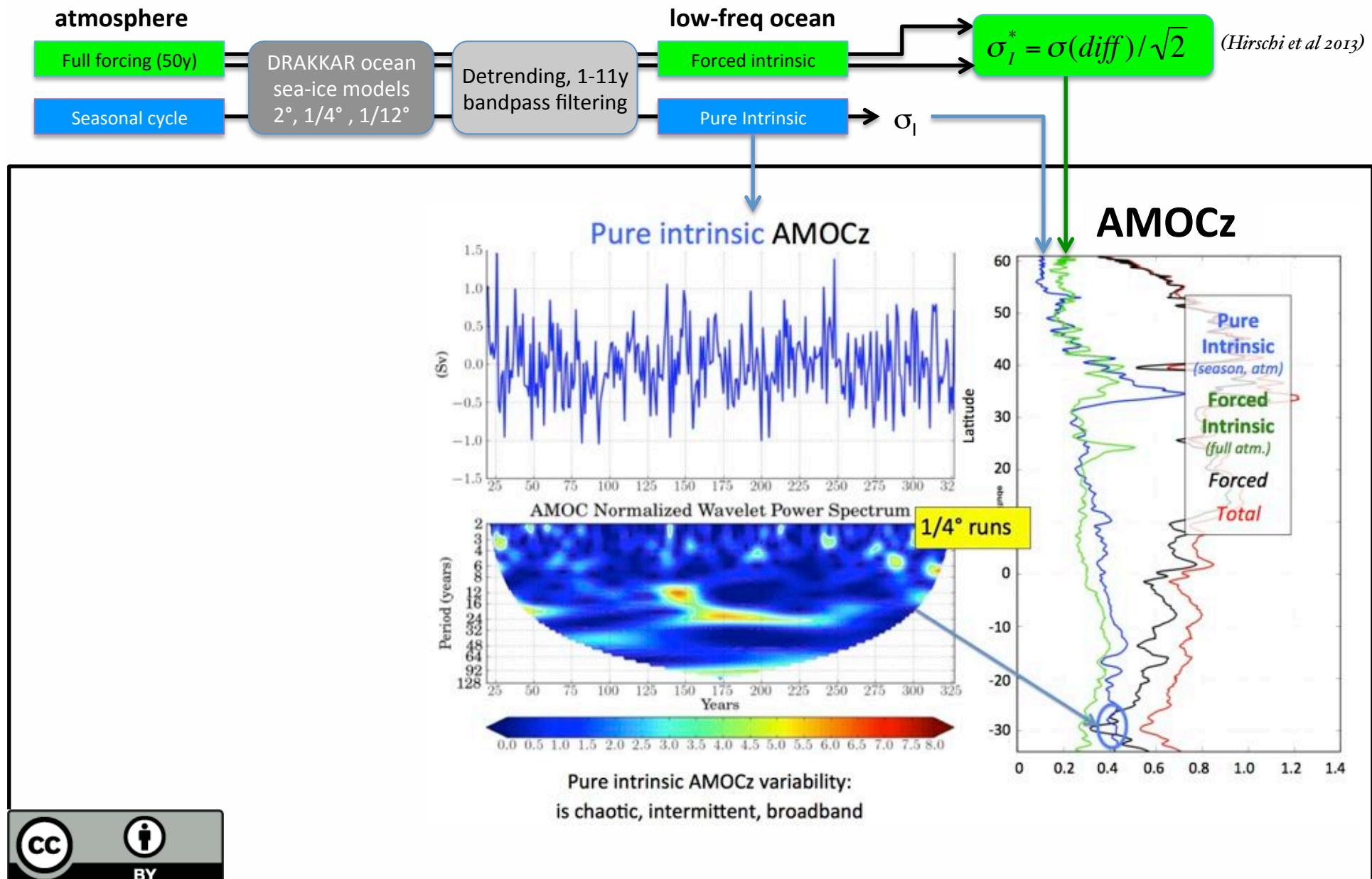
→ Eddying OGCMs



# OGCMs: intrinsic LF variability imprints & amplitudes (pure)

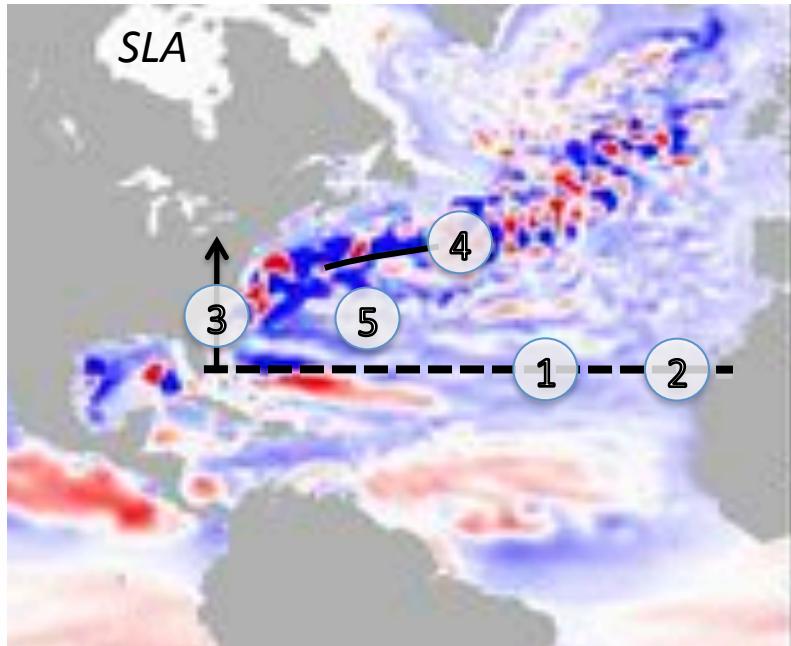


# OGCMs: intrinsic LF variability imprints & amplitudes (pure vs forced)



# N.Atl WBC : intrinsic low-freq variability

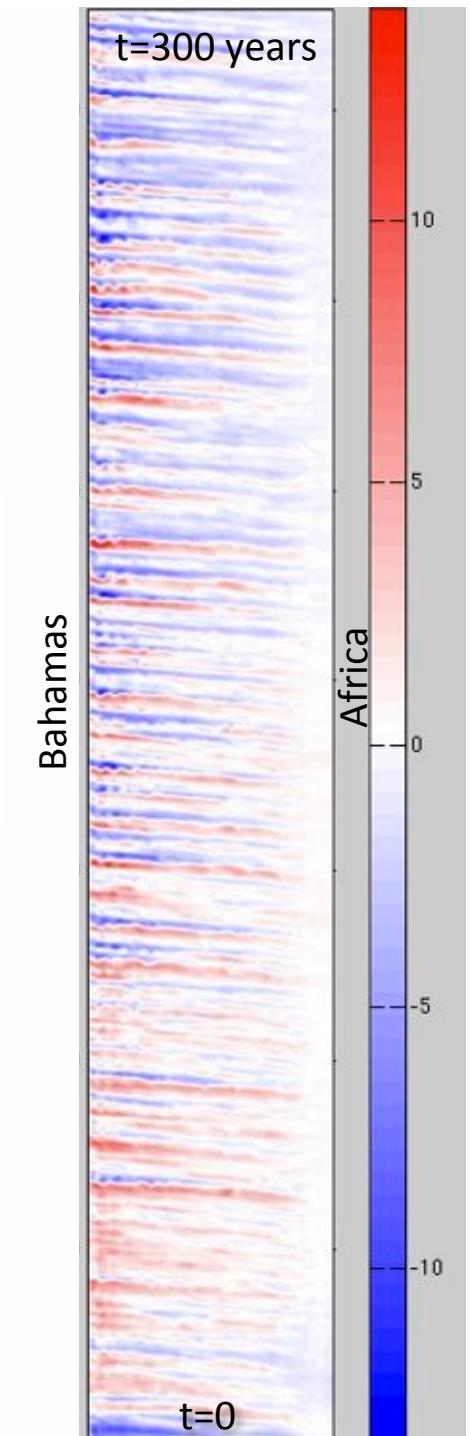
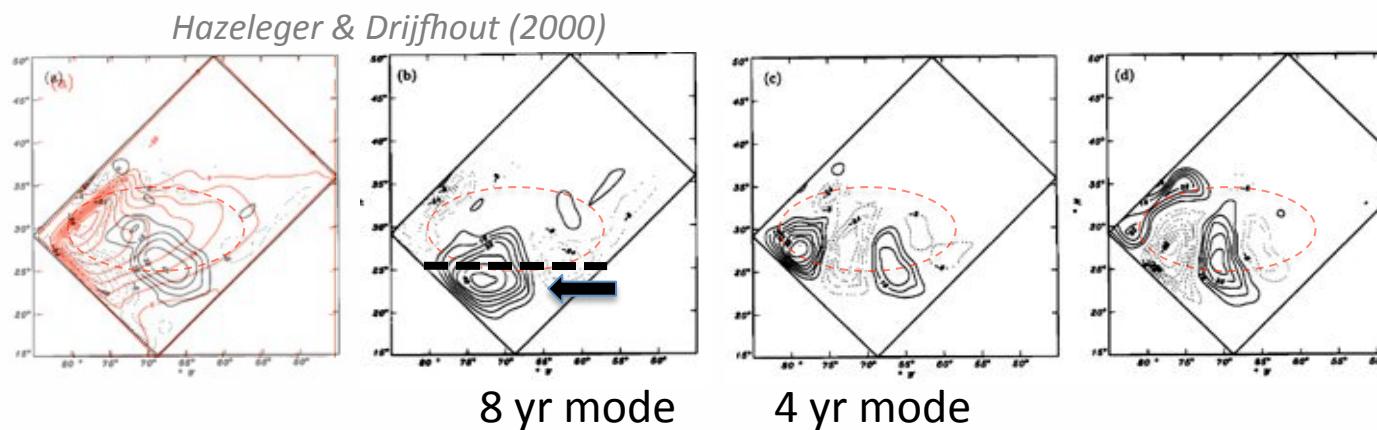
- co-varying indices
- multiple timescales



- 1) SLA @ 26.5°N
- 2) AMOC @ 26.5°N
- 3) Florida Current Transport
- 4) GS latitude
- 5) STMW<sub>vol</sub>

## N.Atl WBC : intrinsic low-freq variability

### 1) SLA @ 26.5°N (30-40% of total variance)

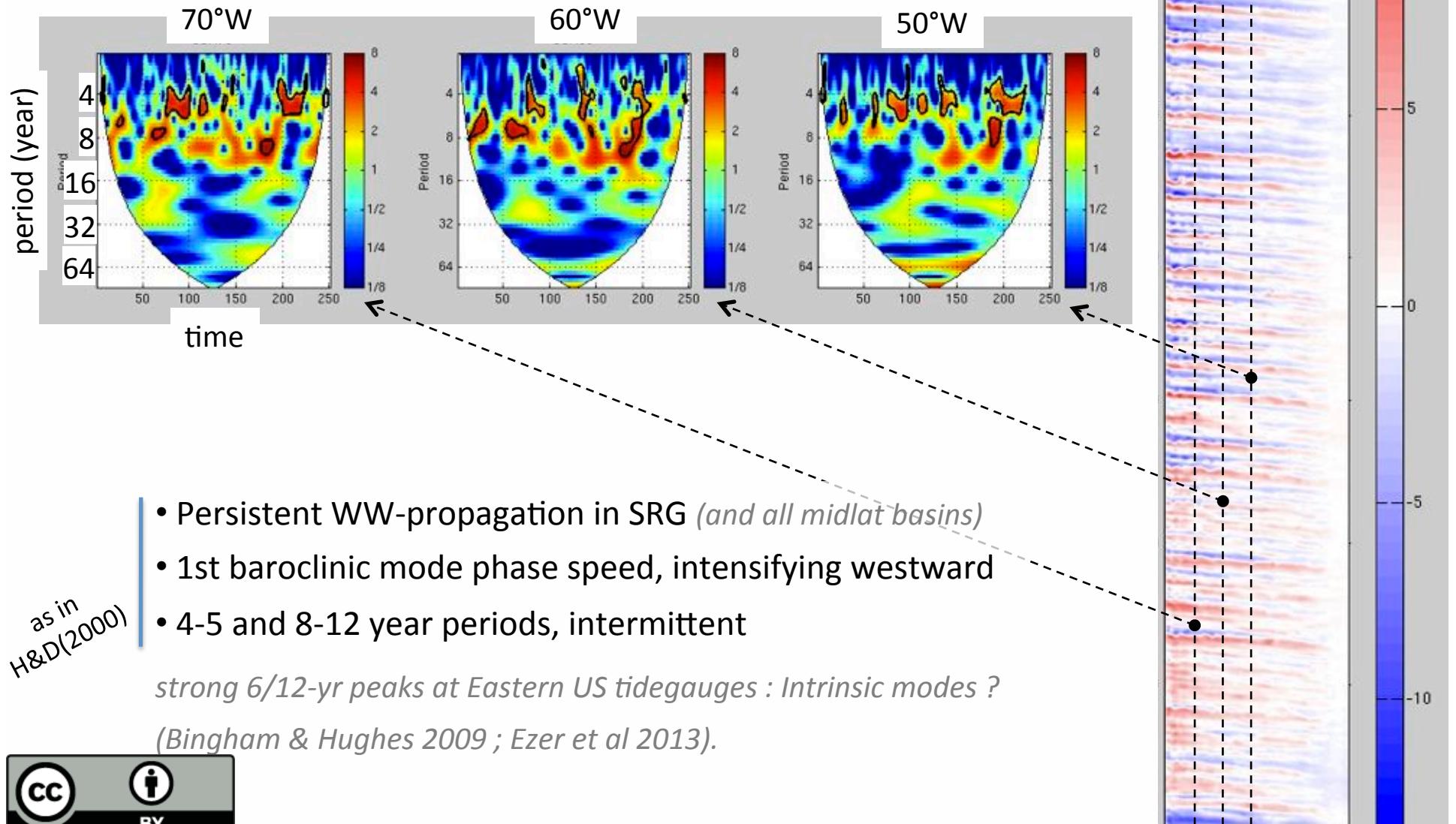


- Persistent WW-propagation in SRG (*and all midlat basins*)
- 1st baroclinic mode phase speed, intensifying westward

# N.Atl WBC : intrinsic low-freq variability

## 1) SLA @ 26.5°N (30-40% of total variance)

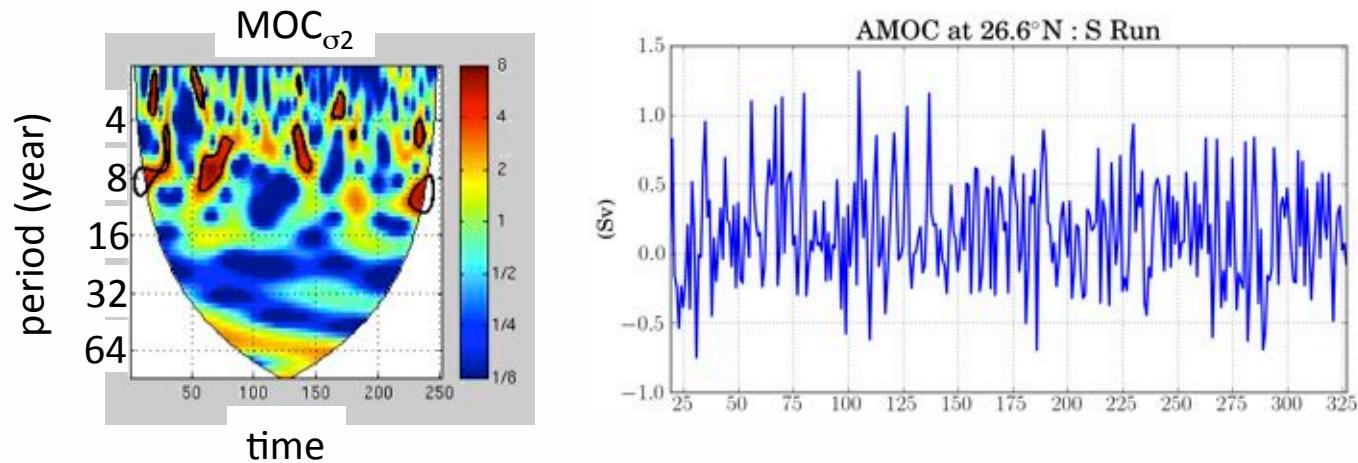
Normalized wavelet power spectra



## N.Atl WBC : intrinsic low-freq variability

### 2) MOC @ 26.5°N (35% of total variance)

Normalized wavelet power spectra

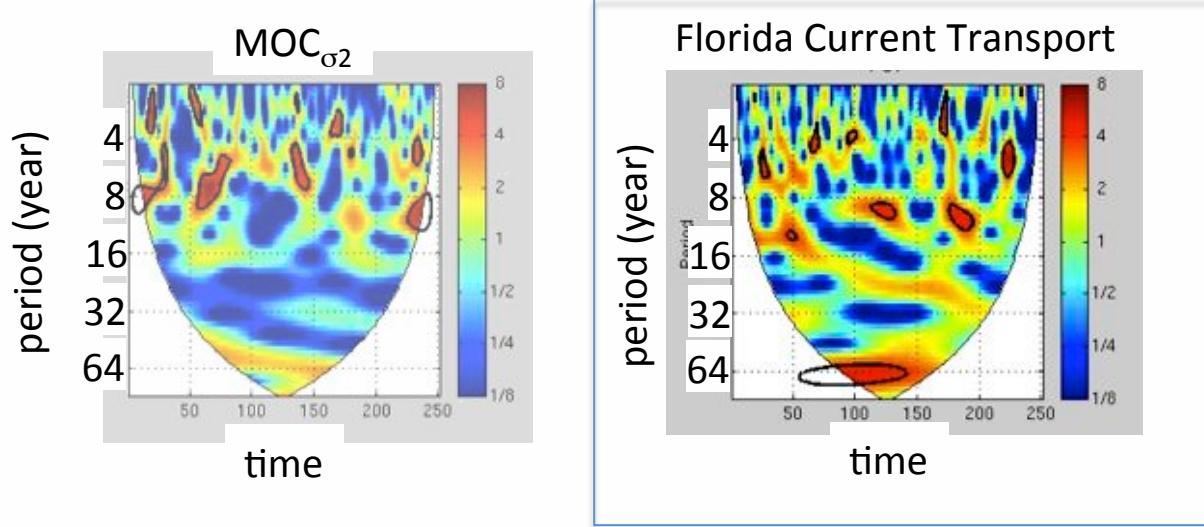


- Persistent, intermittent variability
- Most energy in 2-12 years

## N.Atl WBC : intrinsic low-freq variability

### 3) Florida Current Transport (12-20% of total variance)

Normalized wavelet power spectra

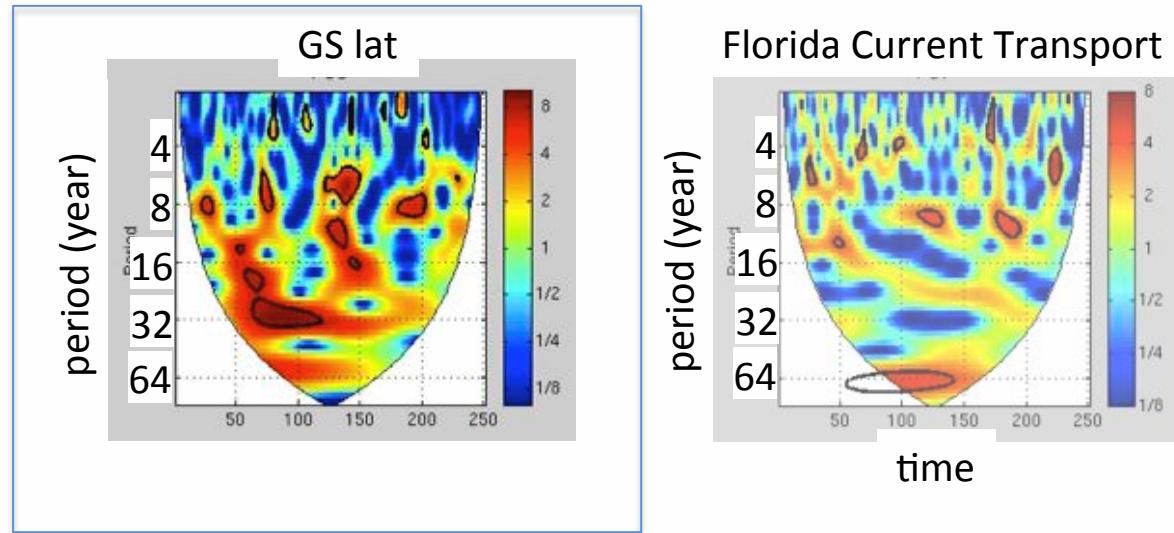


- Persistent, intermittent variability
- Most energy in 2-12 years (as MOC)
- Multidecadal intrinsic variability

## N.Atl WBC : intrinsic low-freq variability

### 4) Gulf Stream Latitude (60-70% of total variance)

Normalized wavelet power spectra

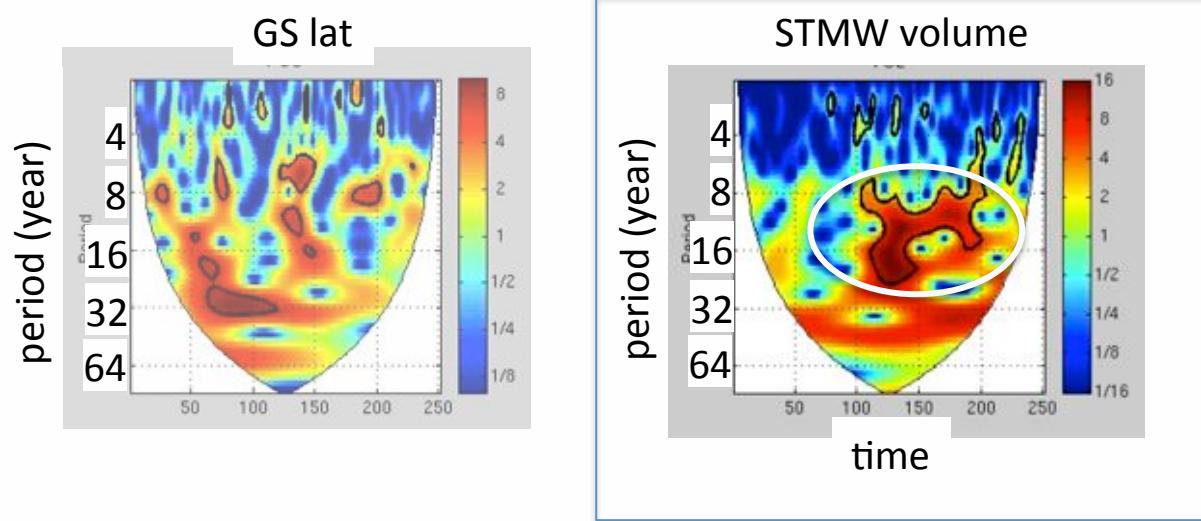


- Largely intrinsic
- Persistent, intermittent variability
- Interannual to multidecadal (*marked 6-12 year peak*)

## N.Atl WBC : intrinsic low-freq variability

### 5) Volume of STMW (PV < 1.10<sup>-11</sup>)

Normalized wavelet power spectra

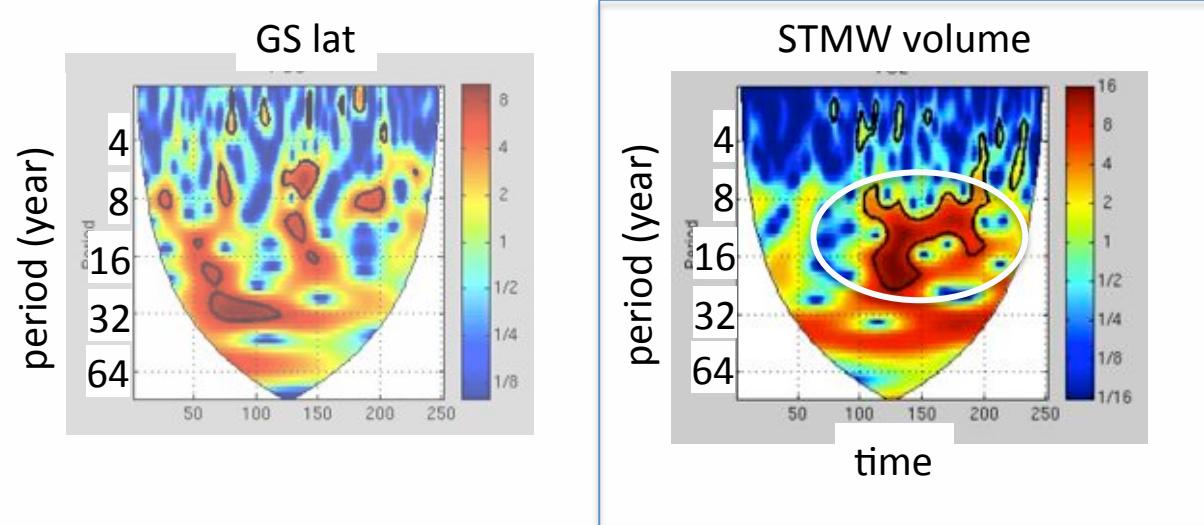


- Decadal timescales (12-14 yr peak ; Joyce et al 1996)

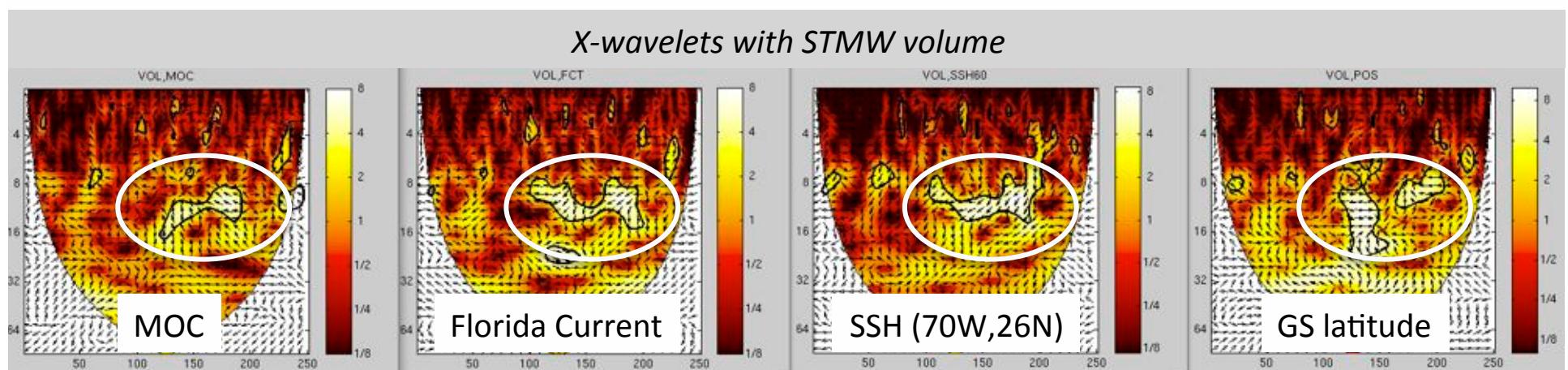
# N.Atl WBC : intrinsic low-freq variability

## 5) Volume of STMW (PV < 1.10<sup>-11</sup>)

Normalized wavelet power spectra



- Decadal timescales (12-14 yr peak ; Joyce et al 1996)
- Apparently modulating the other indices : *work in progress (phase relationships, etc)*



# Conclusions & Perspectives

## ◆ Facts

- 1/4° or 1/12°: low-freq variance is up to 100% Forced **Intrinsic** (SLA, SST, AMOC, ...)
- 2° : Forced ~ Ø
- Eddying regions : Large LF intrinsic var. and covar. (with large-scale patterns)
- Intrinsic variability : Intermittent & chaotic (seasonal or full forcing)
- Consistent with several idealized studies (multiple processes likely at work)



## ◆ Open questions

- Impact on atmosphere, biogeochemistry, climate ?
- Predictability of oceanic indices in the eddying regime ?

## ◆ Perspectives

- Probabilistic ocean studies : Ensemble hindcasts → *OCCIPUT* (ANR 2014-2017)
- Study OGCM runs with dynamicists & observationalists → *CHAOCLEAN* (OST/ST 2013-2016)

Tuesday 5:30-7pm, poster Z232 (Penduff et al)

Yellow poster zone, session OS1.8

