Propagation of wave signals along the western boundary and their link to ocean overturning in the North Atlantic

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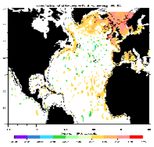
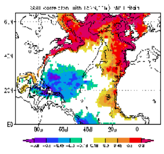
1. How changes in the high latitude forcing communicate over the ocean?

Downstream response at lower latitudes along the western boundary involving:

- **rapid response: wave propagation against the sidewalls and along the equator – Kelvin waves, coastal trapped waves (Huthnance, 1978, JPO; Kawase, 1987; Johnson & Marshall, 2002, JPO)**
- **an intermediate response involving changes in local circulation**
- **slower response: advection along western boundary and evolution of dense water masses**



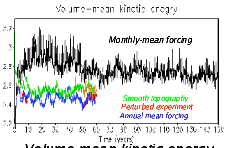
Correlation of altimetry (Hughes & Meredith)



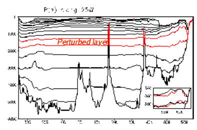
Model SSH correlation

2. Model Studies

Model simulations carried out using a 16 layer isopycnic model (MICOM).



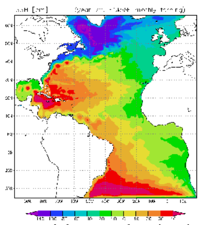
Volume mean kinetic energy



Model density interfaces along 25ºW.

Resolution is 0.23º (26 km at the equator & 13km at 60ºN). Model initialised from Levitus and run for 150 years, forced by ECMWF monthly-mean winds and surface fluxes. Parallel run is performed, forced by annual mean forcing, and a twin experiment involving extra thermohaline forcing is run from year 50. The twin perturbation experiments is run for 10 years, with deep interface raised 50m per 5 days over the northern relaxation zone.

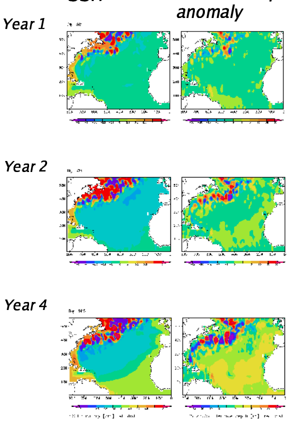
Advection is monitored by a transient model tracer, released in the Labrador Sea, when the perturbed buoyancy forcing starts.



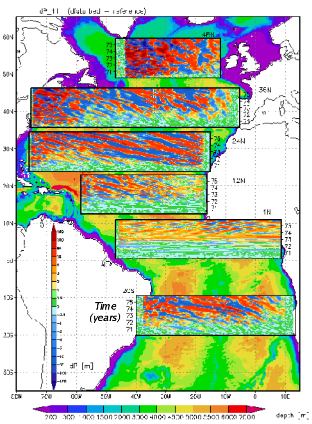
Model Sea-surface height

3. Propagation of wave signals anomalies in the model

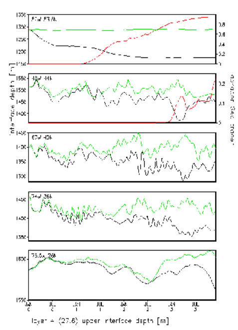
Model snapshots of: SSH, Interface depth anomaly



Hovmoeller diagrams of Interface depth anomaly



Propagation of signals along the western boundary

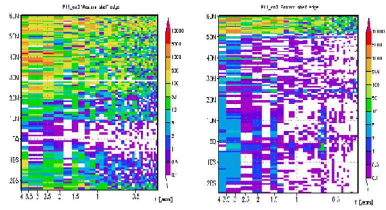


--- default; --- perturbed run; --- tracer signal.

- **there is a rapid spreading along the western boundary**
- **a slower spreading along the eastern boundary, generating Rossby waves**
- **the SSH and isopycnal height anomalies appear related, but with SSH signals on a slightly broader scale.**

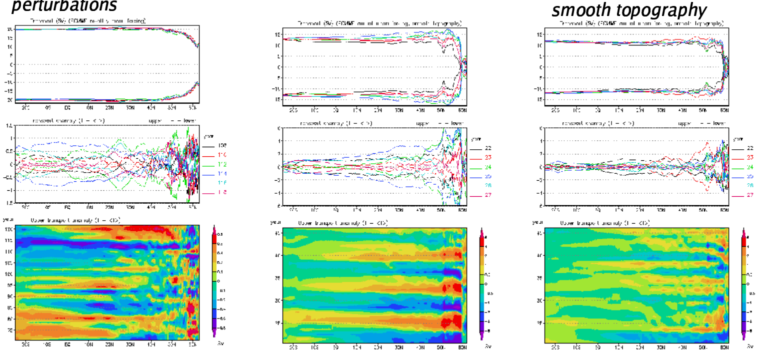
4. Spectral changes in boundary waves

Pressure time series spectral analysis



- **higher frequency waves possibly filtered by the boundary current**
- **waves modified by the topography and stratification**
- **interaction with incoming Rossby waves**
- **lower frequencies and amplitudes along eastern boundary and low latitudes**

5. How do the waves affect the overturning variability



- **transport variations of 1 –2 Sv in mid-latitudes and 2 – 4 Sv at high latitudes**
- **fast changes in the overturning (few years after the high latitude perturbation)**
- **longer term transport oscillations**

6. Conclusions

- **Boundary wave propagation on time scale of months to years**
- **Connected to interior via equatorial Kelvin waves and basin-wide Rossby waves**
- **High frequency boundary waves are possibly filtered by the western boundary current**
- **Waves modified by the topography and stratification**
- **Wave signals associated with changes in basin-wide overturning of typically 1 – 3 Sv, occurring prior any deep advective signal**

Poster available on-line: www.liv.ac.uk/~vassilr/rapid