

DRAKKAR

Barnier et al, 2006
Penduff et al, 2006
DRAKKAR Group, 2007

Thierry Penduff
CNRS, LEGI, France,
& Dpt Oceanogr., FSU, USA

LEGI	France	IFM-GEOMAR	Germany
LPO	France	NOCS	UK
LOCEAN	France	Univ. Reading	UK
Mercator	France	SIO	Russia
LSCE	France	Univ. Alberta	Canada

+
Bernard Barnier
Anne-Marie Treguier
Gurvan Madec
Julie Deshayes
Julien Le Sommer
Claus Böning
Arne Biastoch
Gilles Garric
Adrian New
Sergey Gulev
James Orr
Keith Haines
Paul Myers
Jean-Marc Molines
...

50-yr forced ocean/sea-ice simulation ensembles

NEMO (OPA9 ocean, LIM2/3 sea-ice, TOP tracer (^{14}C , CFC_{11}))

AGRIF grid refinement software (Debreu et al 2008)

- The DRAKKAR project : objectives, models, simulations, numerics
- From 2° to $1/4^\circ$ resolution : mean currents, interannual variability
- Interannual variability at $1/4^\circ$: partly intrinsic

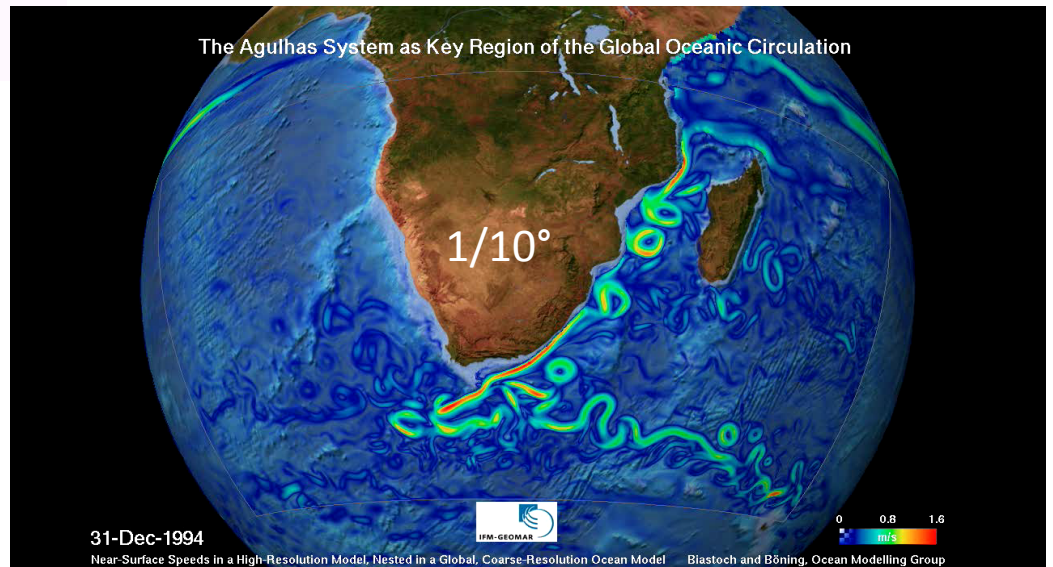
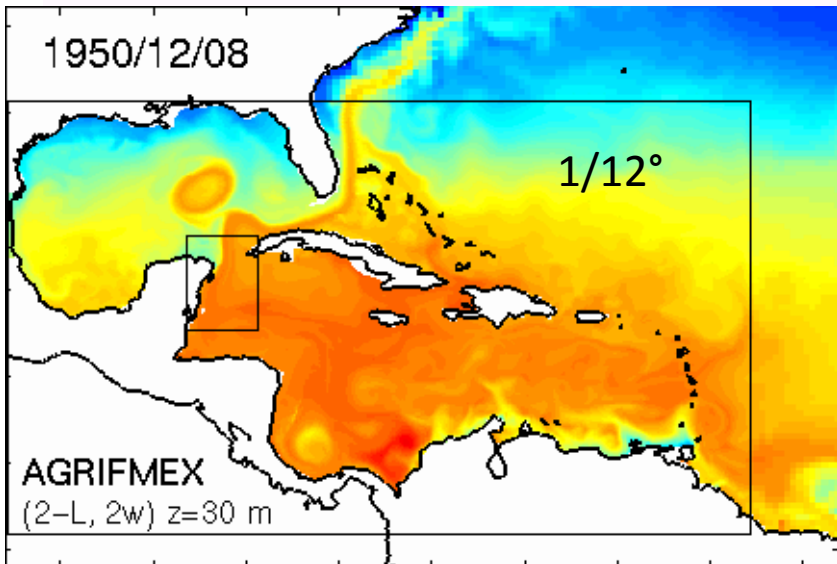
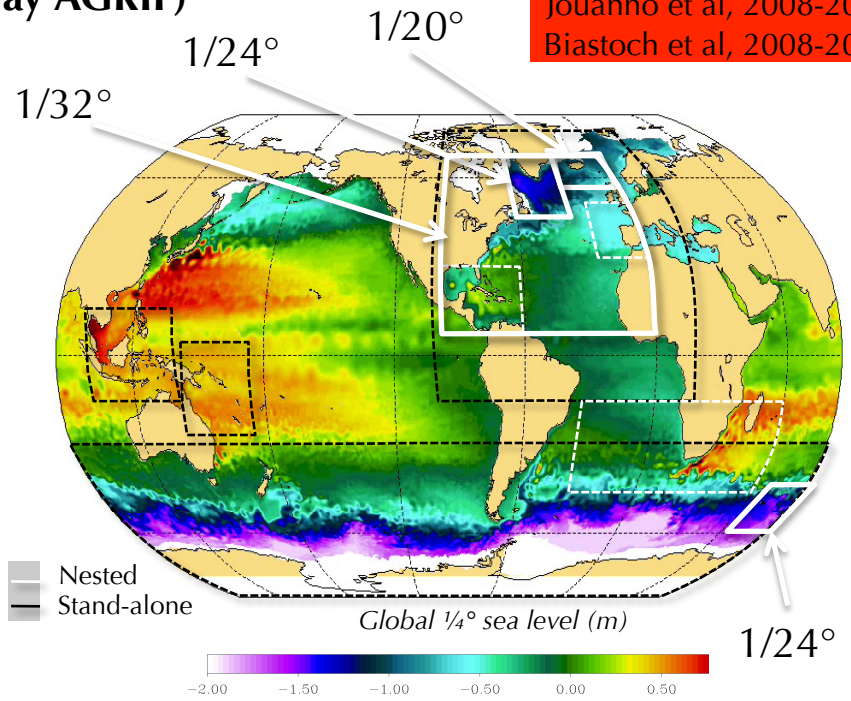
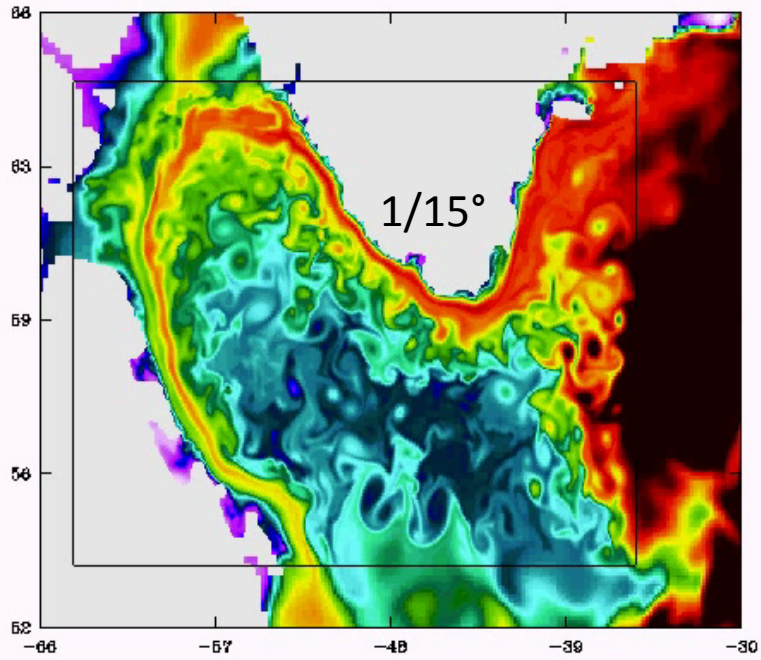
DRAKKAR objectives

Barnier et al, 2006
Penduff et al, 2006
DRAKKAR Group, 2007

Develop and improve a hierarchy of ocean/sea-ice model configurations	Build and distribute a coordinated ensemble of numerical simulations	Study variability processes in collaboration
<ul style="list-style-type: none">• Global : 2° → 1/4° → 1/12°• Regional : 1/4° → 1/12° → 1/36°• Grid refinement tools• Collab. with Mercator + HYCOM	<ul style="list-style-type: none">• Period : last 50 years• Continuous calibration of forcing• Shared simulation database• Assessment metrics	<ul style="list-style-type: none">• Eddies, scale interactions• Subpolar Atlantic• Southern Ocean• Strong link with obs.

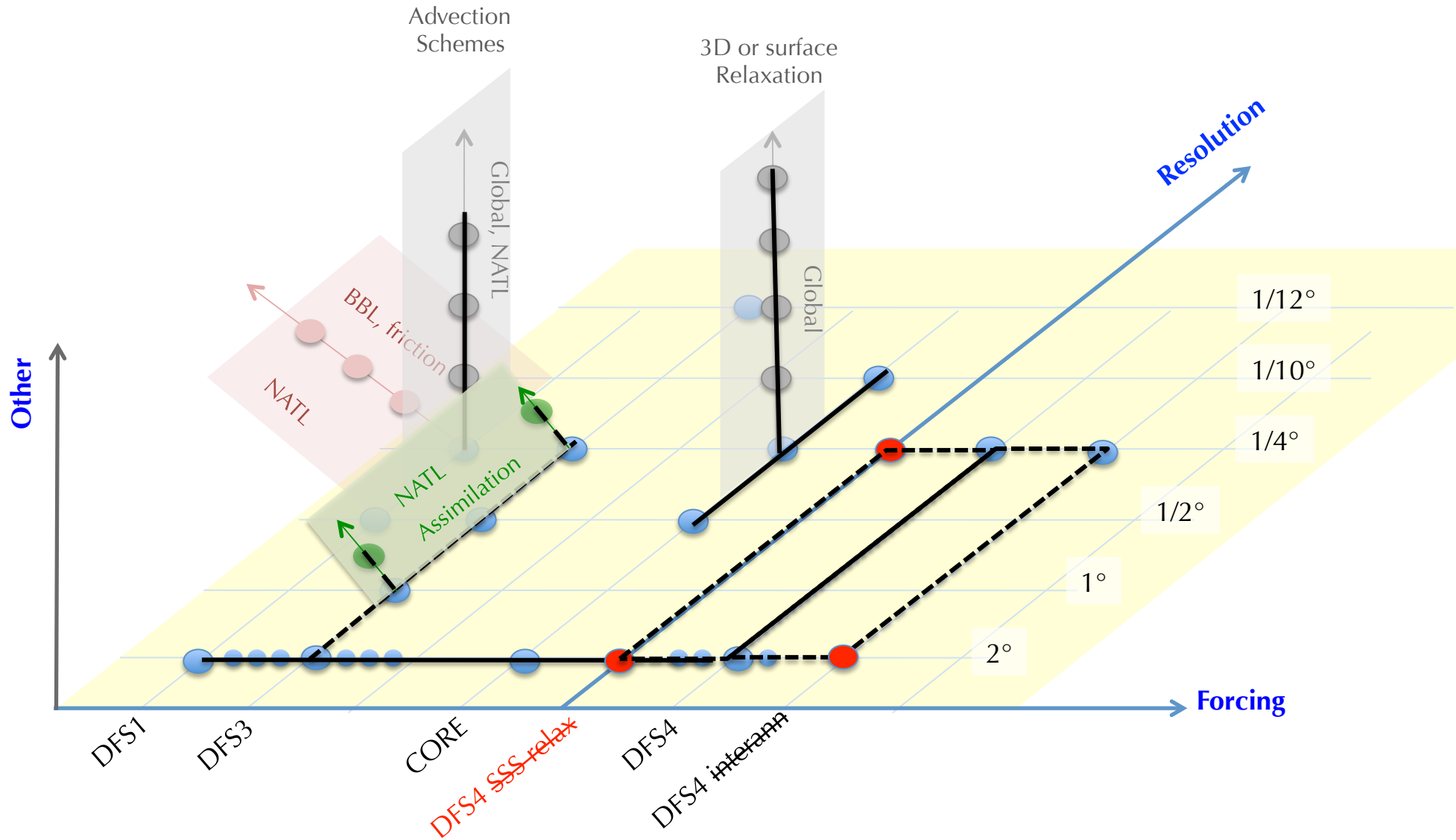
DRAKKAR configurations (global & 2-way AGRIF)

Chanut et al, 2008
 Jouanno et al, 2008-2009
 Biastoch et al, 2008-2009



Ensemble of simulations

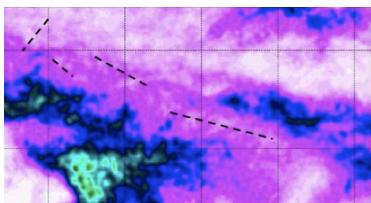
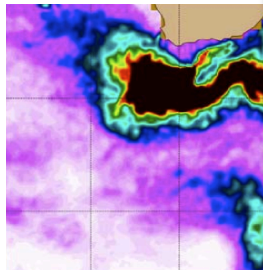
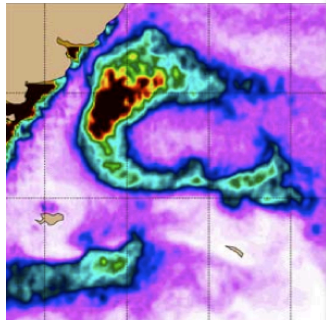
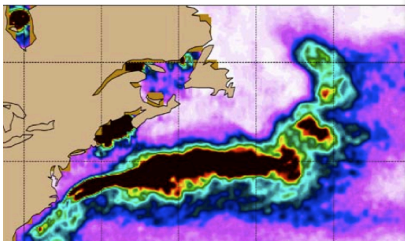
GLOBAL	NORTH ATLANTIC	SOUTHERN	+ AGRIF runs
	NATL12 (03)	.	...
ORCA025 (41)	NATL025 (19)	.	...
ORCA05 (26)	.	PERIANT05 (01)	...
ORCA1 (02)	.	.	...
ORCA2 (06)	.	.	...



Numerics: Moment. adv. scheme + partial steps ($1/4^\circ$)

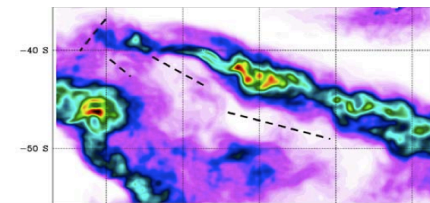
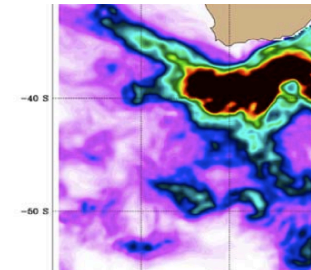
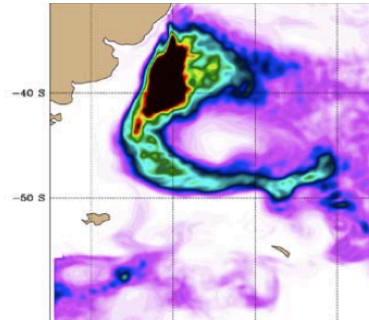
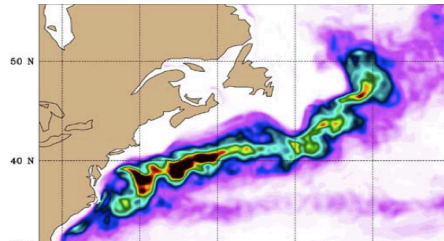
Barnier et al, 2006
Penduff et al, 2007
Le Sommer et al, 2009

AVISO
Surface EKE
Observations



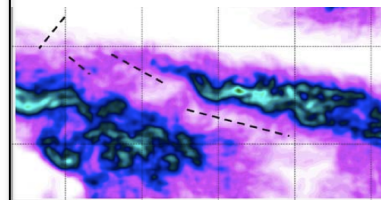
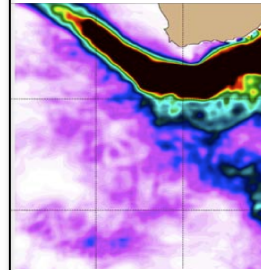
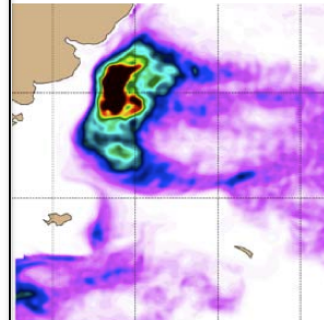
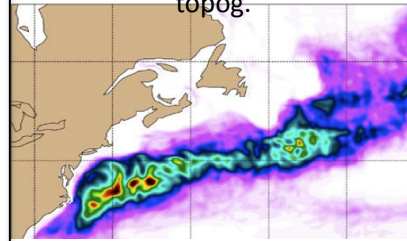
DRAKKAR SCHEMES

Energy-ensrophy-conserving
momentum advection scheme (Arakawa
& Lamb 1981) + partial steps topog.

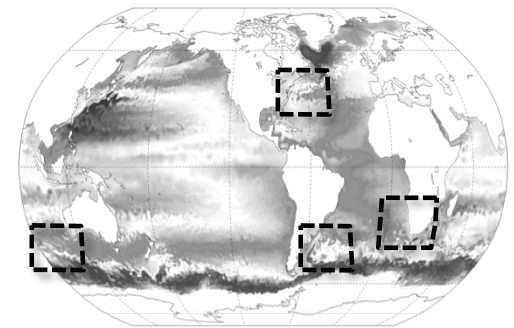


CLIPPER SCHEMES

Enstrophy-conserving
momentum advection scheme
(Sadourny 1975) + full steps
topog.

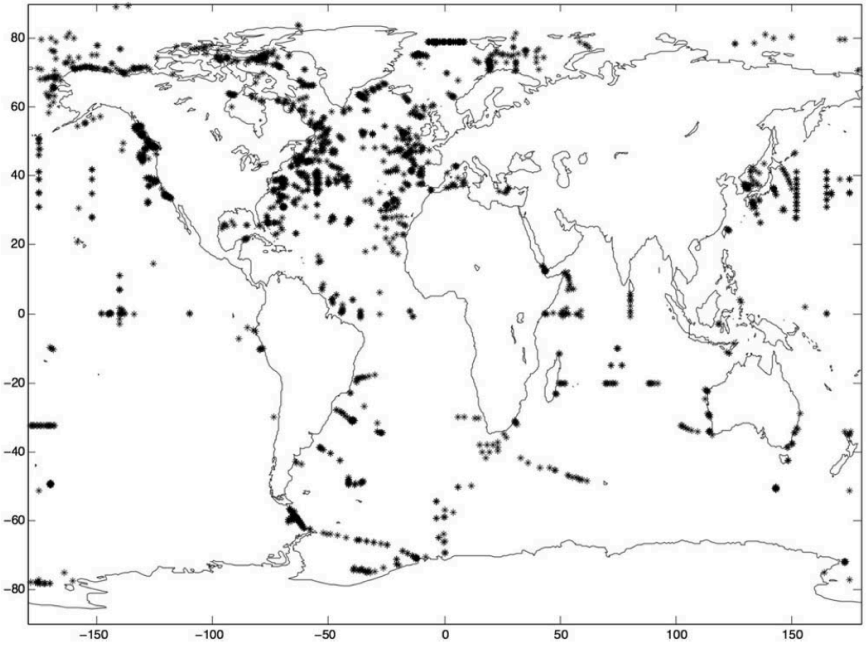


- Less bottom friction
- Enhanced eddy-topo interactions
- Stronger topostrophy
- Improved solutions

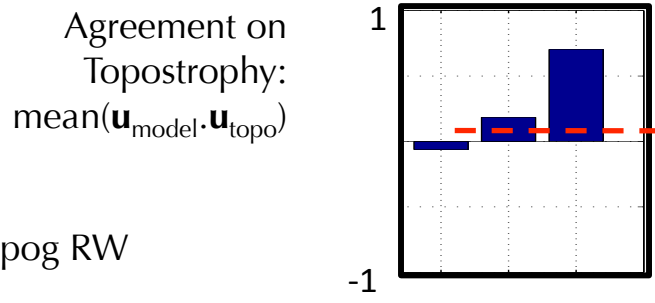
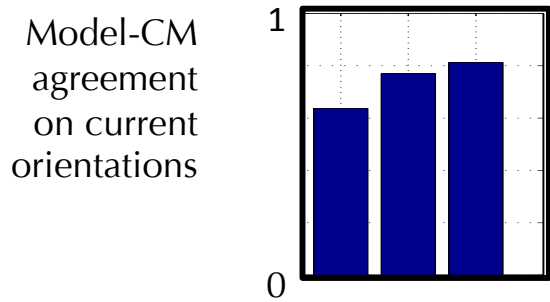
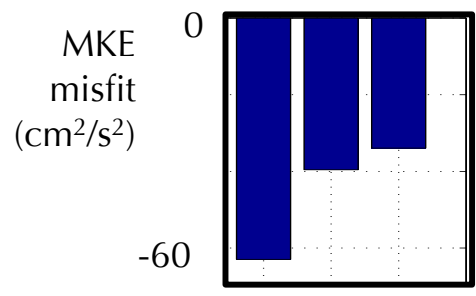


Impact of resolution on mean currents

- 17120 current meter records (Holloway, 2008)
- Mean DRAKKAR velocities collocated on CM
- Skills : Holloway and Sou (1996)



Global Models
2° 1/2° 1/4°



1/4° with
- ENS
+ Fsteps

Increasing resolution:

- Magnitudes & orientations → towards CM
- Topographic rectification → currents along along Topog RW

Impact of resolution on interann. variab (zonal averages)

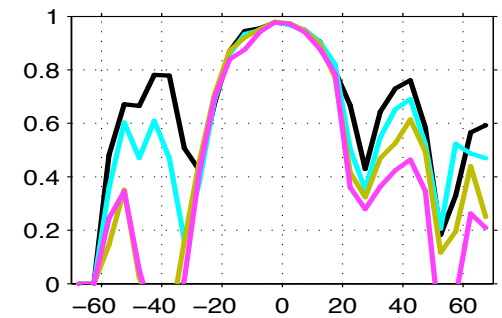
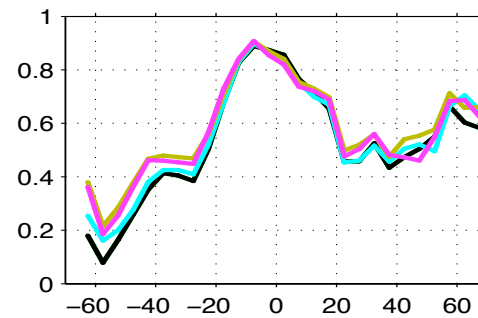
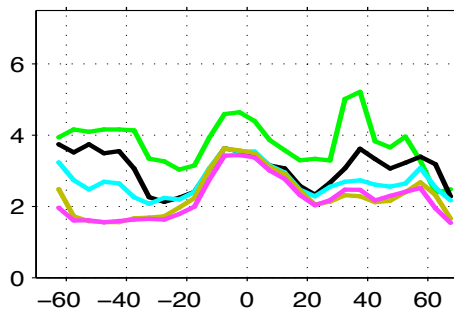
Penduff et al, 2009

SLA standard deviations (cm)
 $\sigma^A(\lambda)$ and $\sigma^m(\lambda)$

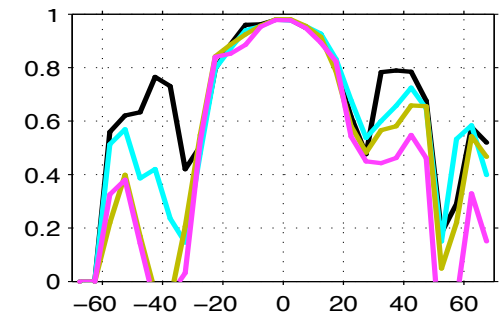
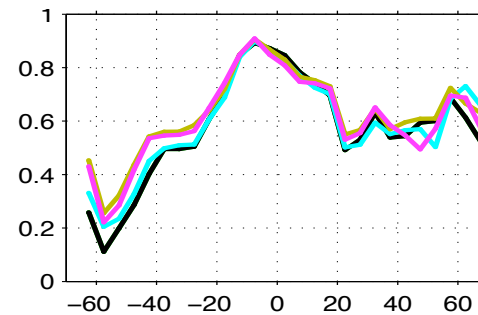
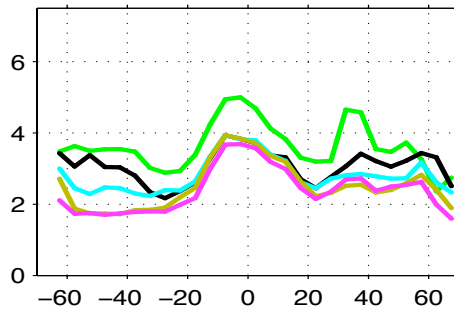
SLA temporal correlations
 $C_t^m(\lambda)$

SLA spatial correlations
 $C_s^m(\lambda)$

Interannual

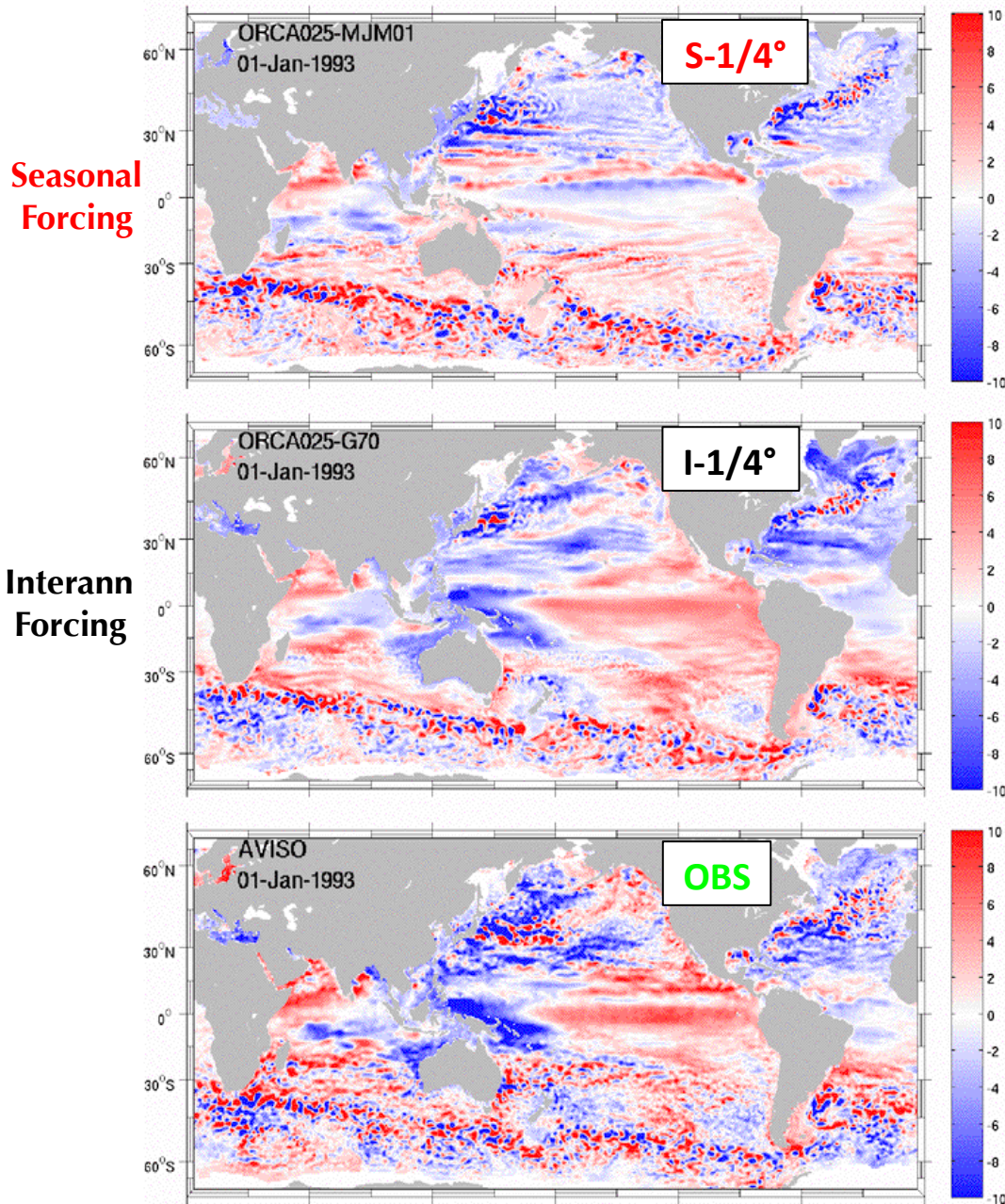


Large-scale
interannual
($L > 6^\circ$ only)

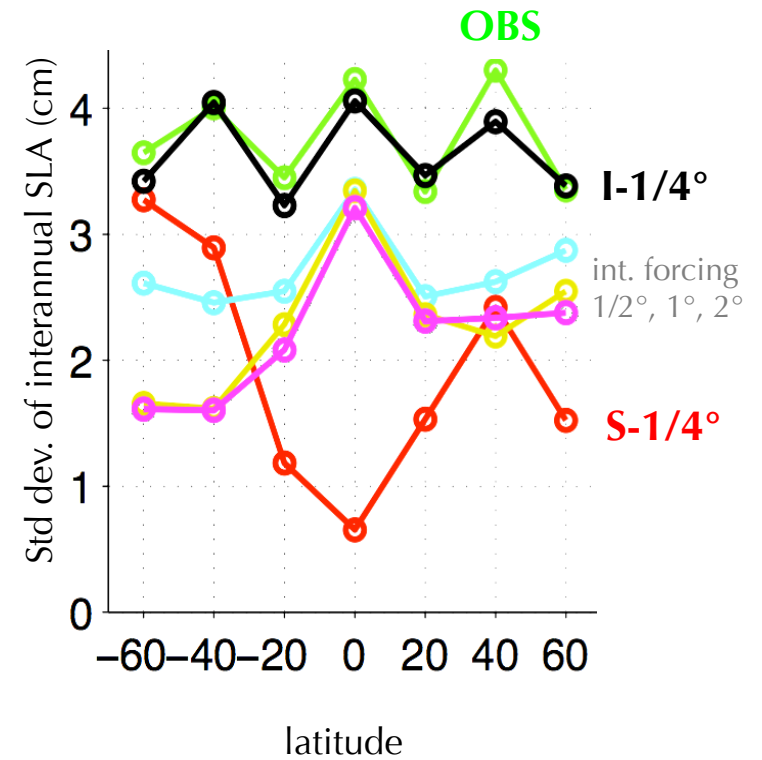


— AVISO — 1/4deg — 1/2deg — 1deg — 2deg

Interannual variability : SLA with & without interannual forcing (global 1/4°)

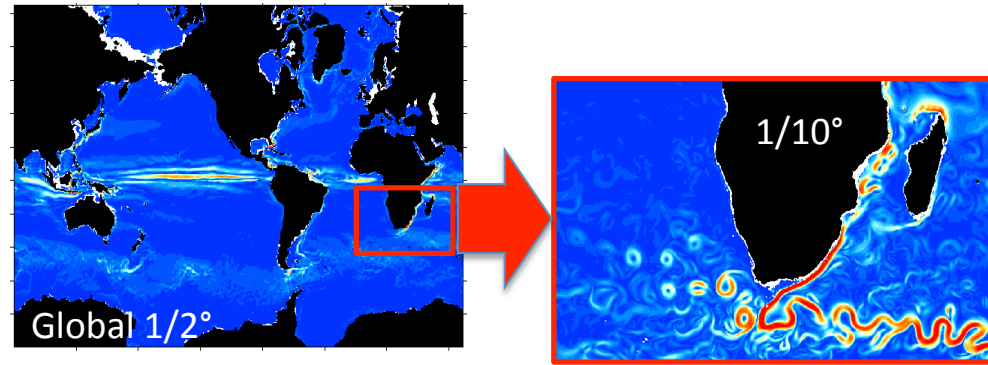


(x,y,t) collocation of model SLAs onto AVISO maps



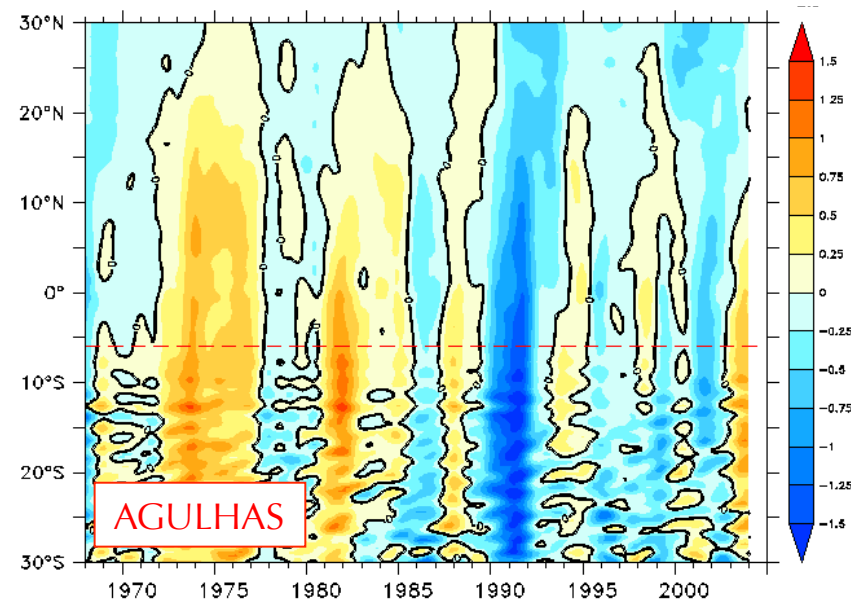
Interannual variability : AMOC with/without Agulhas eddies

Biastoch et al
Nature
2008 & 2009



Southern, turbulent origin of interannual AMOC variability

AMOC anomalies due to Agulhas mesoscale



Planned work for 2009-2011

- FORCING ERA-interim calibration/evaluation. New satellite products. Ensure continuity
- SUBMESO 1/20→1/36°. Fox Kemper (+Neptune?) at lower res. Link with biogeochemists
- Z-REFINEMENT AGRIF development + realistic implementations (Guinea Basin, overflows)
- LIM2.5 Elasto-visco-plastic rheology (continue tests at 1/12°)

- DRAK CONF MANAGER Easy updates to NEMO releases. Easy rebuild past DRAKKAR codes.
- POST PROCESSING Cdftools + Monitoring + Collocation + Statistical assessments

- STORAGE AT Hi Res Strategies for data compression, minimal loss of information.