2nd CLIVAR Ocean Model Development Panel Meeting
« Extended meeting on forcing ocean-ice climate models »

Experiments with JRA-55 forcing dataset in NEMO global eddying configurations

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cnrs

NEMO

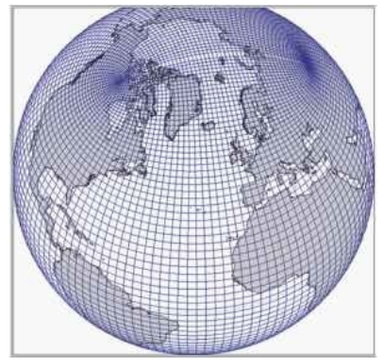
DRAKKAR

Outline

1. Model set-up, experiments and diagnostics
2. Sensitivity tests with JRA-55 forcing dataset at 0.5° resolution
3. Sensitivity tests with JRA-55 forcing dataset at 0.25° resolution
4. Wrap-up and conclusions

DRAKKAR model set-up

Two NEMO model configurations



	ORCA05.L46	ORCA025.L75
code version	NEMO v. 3.5	NEMO v.3.5
sea-ice model	LIM2	LIM2
horizontal grid	ORCA	ORCA
resolution	0.5° (cosine lat)	0.25° (cosine lat)
vertical grid	z-levels, 46	z-levels, 75
lateral closures (tracers)	iso, no GM	iso, no GM
lateral closures (momentum)	biharm	biharm
vertical closures	TKE, EVD	TKE, EVD
salinity restoring	intermediate	intermediate
bulk formulae	CORE	CORE

DRAKKAR standard global configurations (as of 2014)

ORCA025.L75 will be used in several ESMs for CMIP6

Five model experiments

- Two ORCA05 experiments

ORCA05-JRA	sensitivity experiment (JRA, absolute winds)
ORCA05-DFS	reference experiment (DFS5.2, absolute winds)

over period **1958-2012**, no spin-up, one pass

- Three ORCA025 experiments

ORCAO25-JRA1	sensitivity experiment (JRA, relative winds)
ORCA025-JRA2	sensitivity experiment (JRA, absolute winds)
ORCA025-DFS	reference experiment (DFS5.2, absolute winds)

- **DFS** : DFS5.2, ERA-i + corrections (Brodeau et al. 2010, Dussin et al. 2014)
- **JRA** : JRA-55, corrected data as distributed in Mar. 2015 (v0.2)

Approach and diagnostics

Question : order zero difference between runs forced by JRA vs DFS ?

Focus on standard metrics for OGCM sensitivity studies

- global trends (temp, sal, ssh)
- mean circulation patterns (gyre, equatorial)
- sea-ice (concentration, thickness)
- air-sea fluxes and mixed layers
- overturning

plots based on DRAKKAR monitoring system
mostly showing averages over 2000-2007

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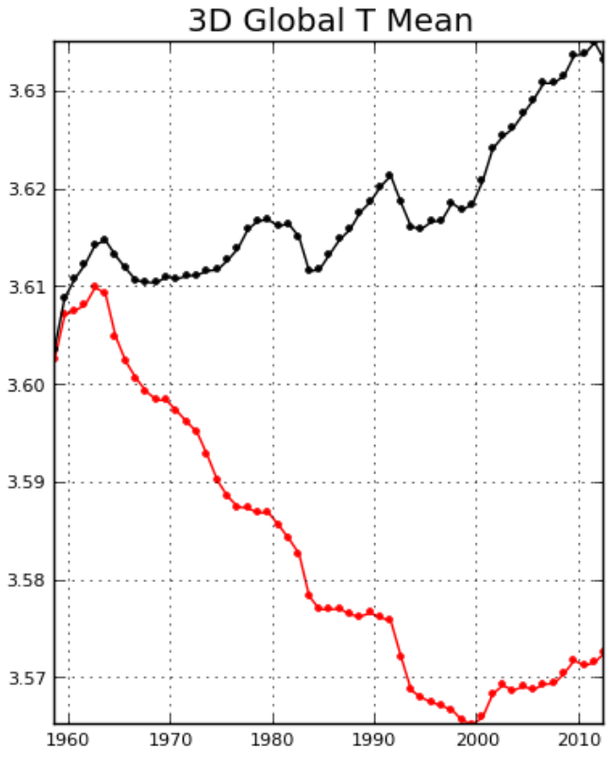
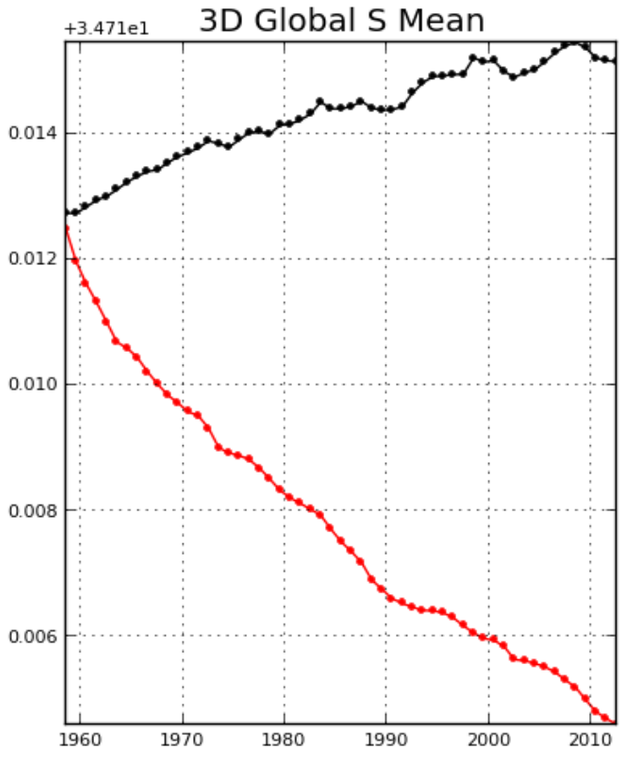
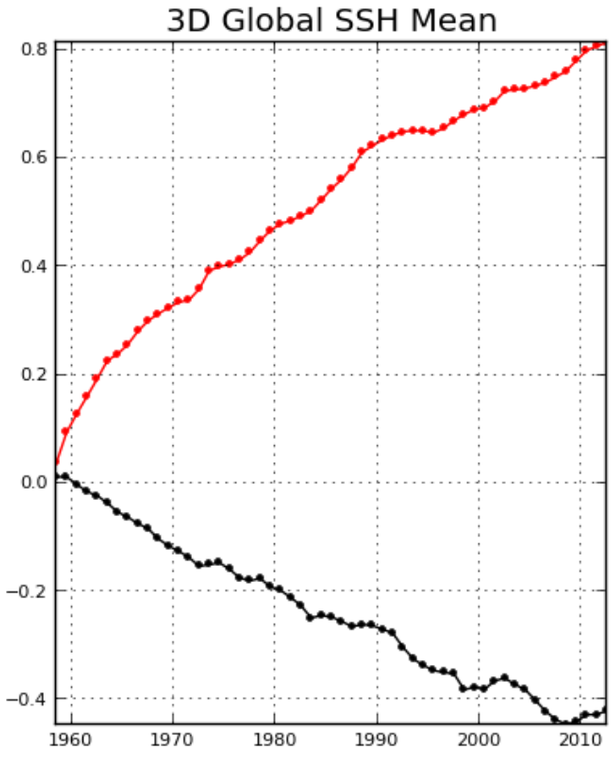
Sensitivity experiment with JRA at 0.5° resolution

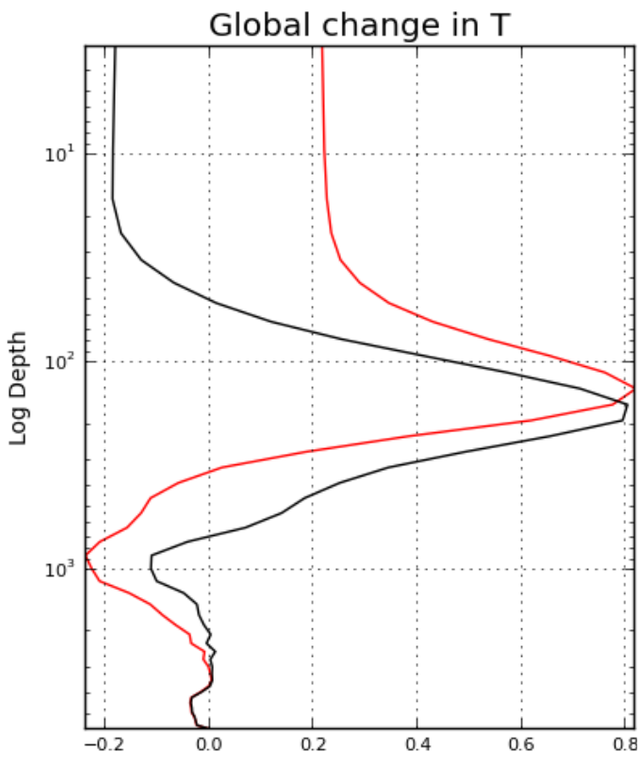
GLOBAL TRENDS IN ORCA05

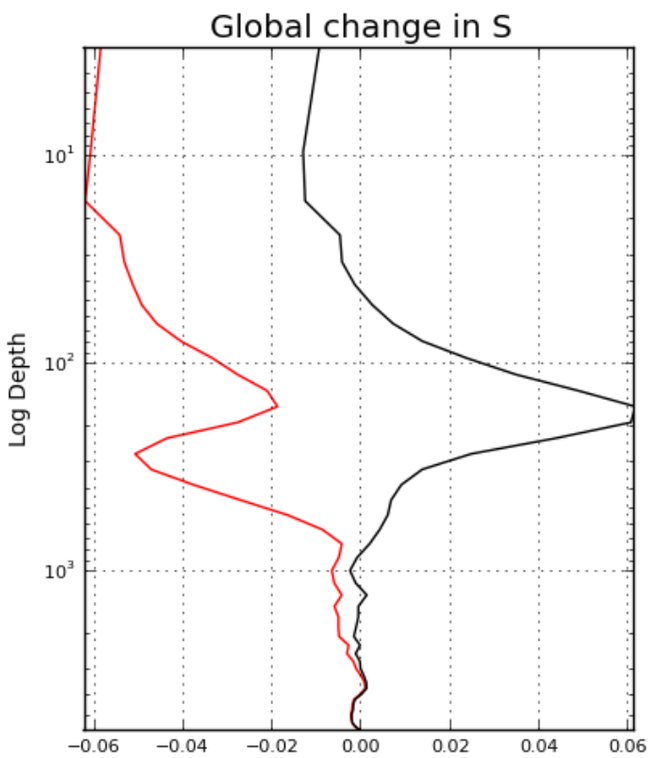
Sensitivity experiment with JRA at 0.5° resolution











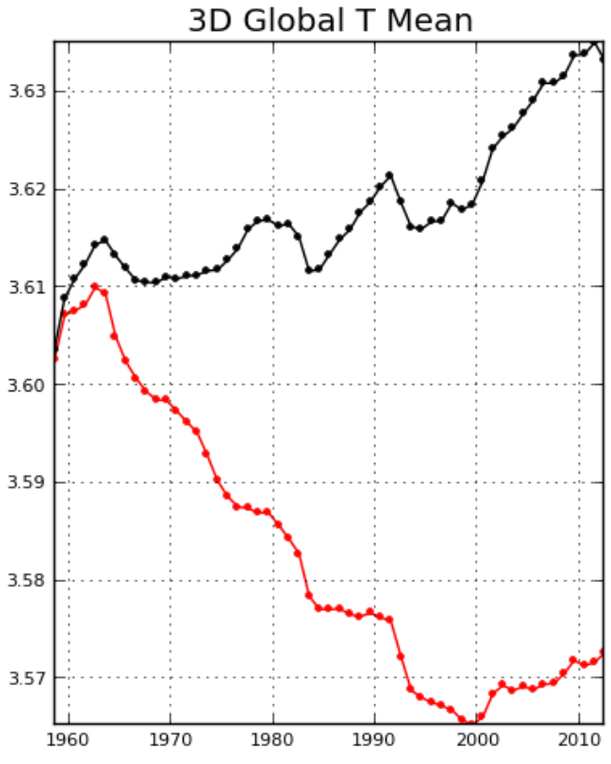
JRA : red

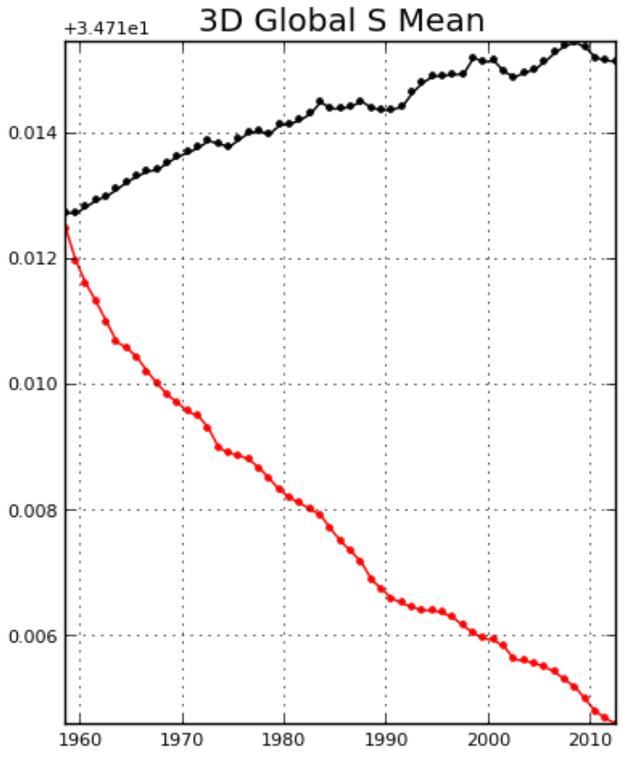
DFS : black

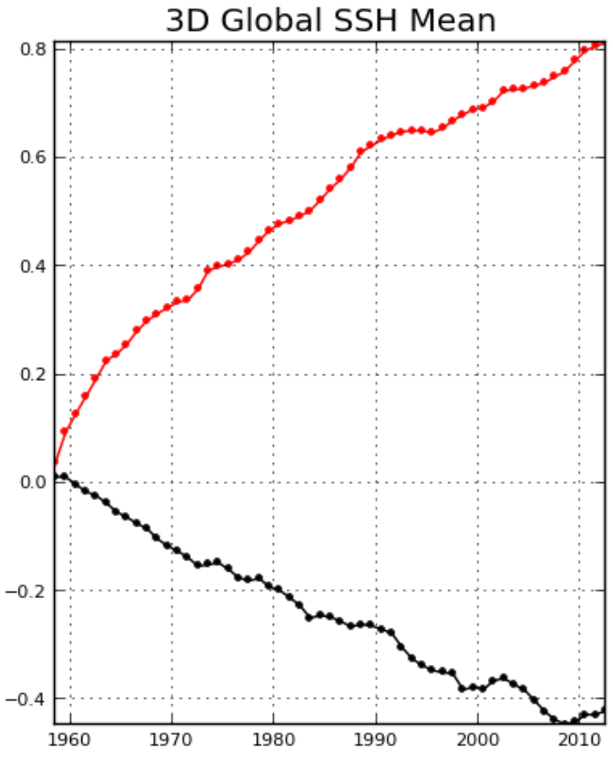
cooling, freshening

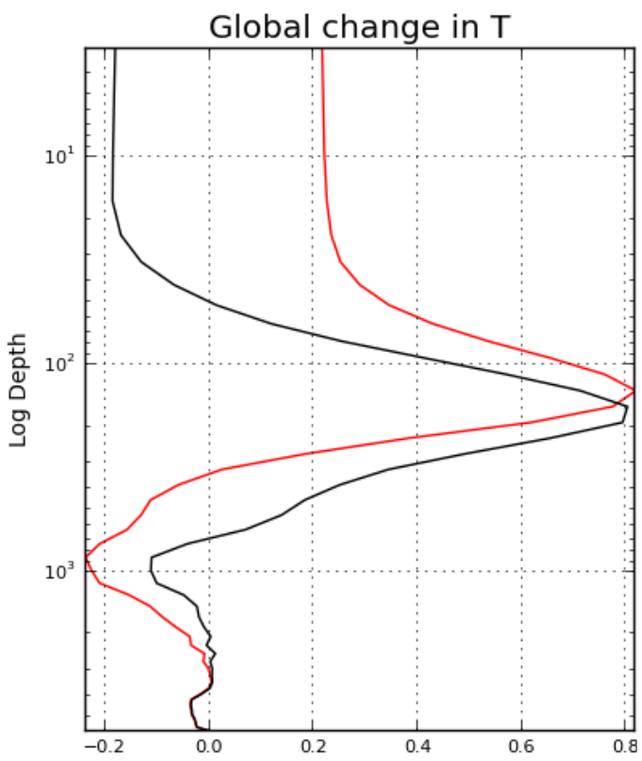
<u>Global trends</u>

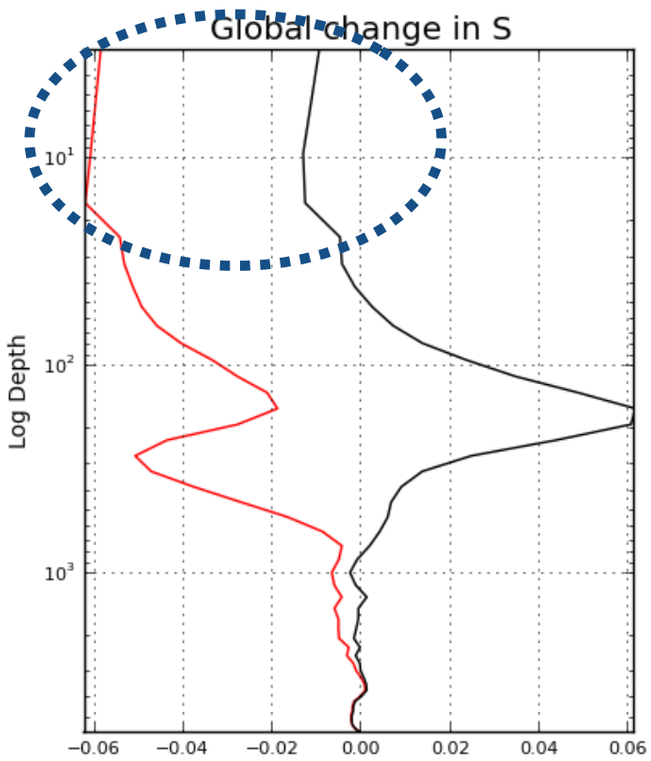
Sensitivity experiment with JRA at 0.5° resolution











JRA : red

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cooling, freshening

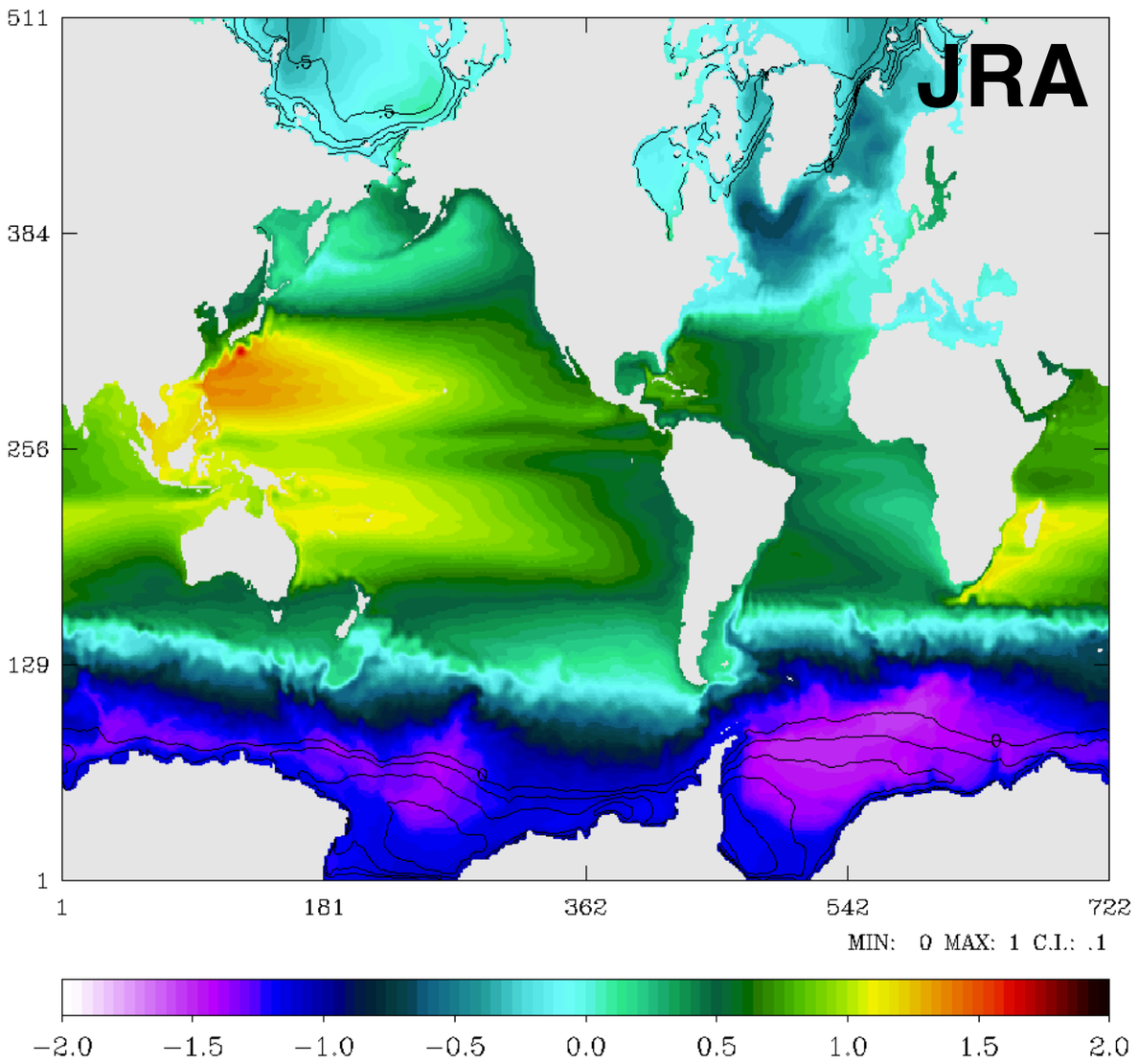
<u>Global trends</u>

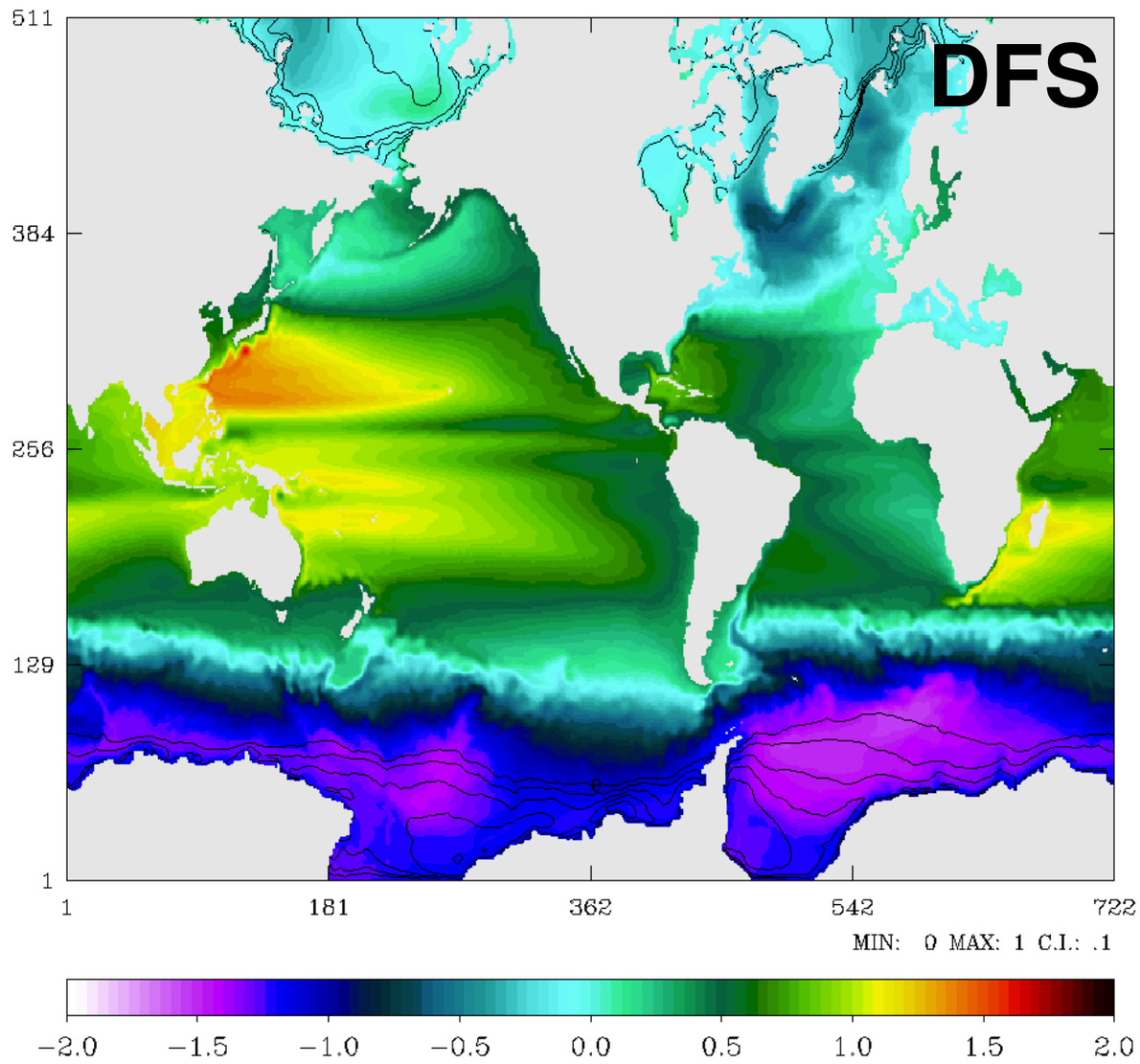
Sensitivity experiment with JRA at 0.5° resolution

MEAN CIRCULATION IN ORCA05

Sensitivity experiment with JRA at 0.5° resolution

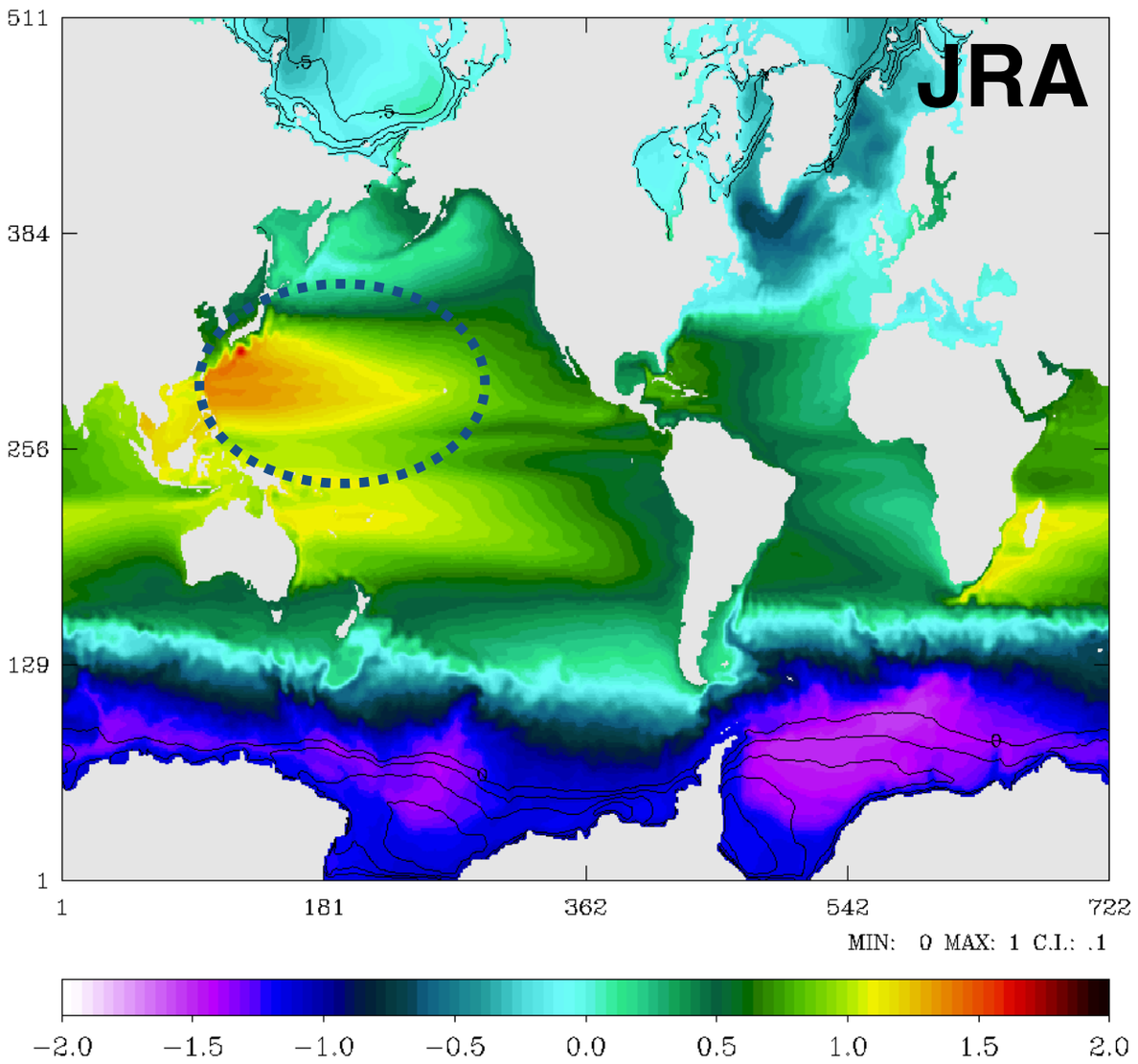
Mean sea surface height

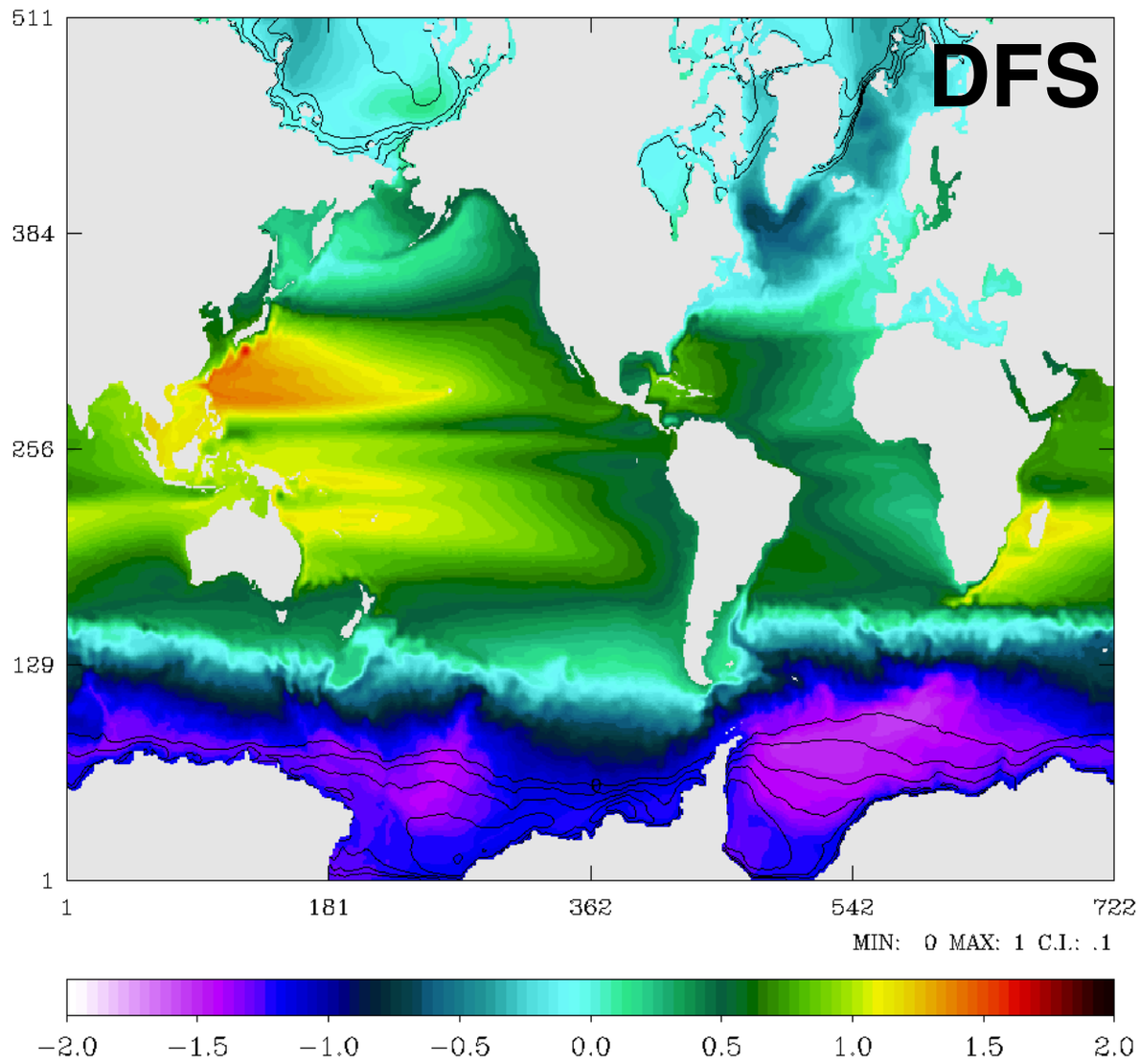




Sensitivity experiment with JRA at 0.5° resolution

Mean sea surface height

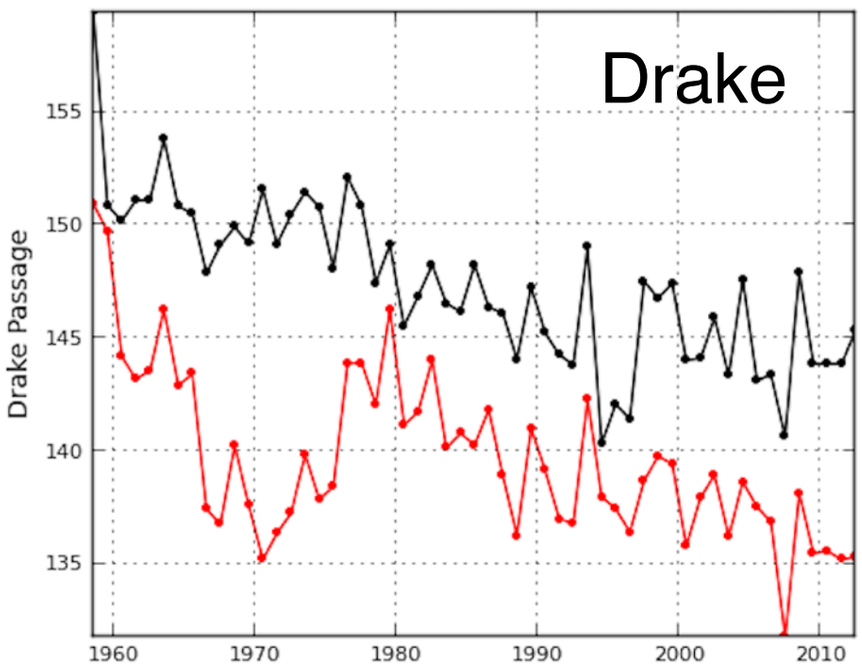


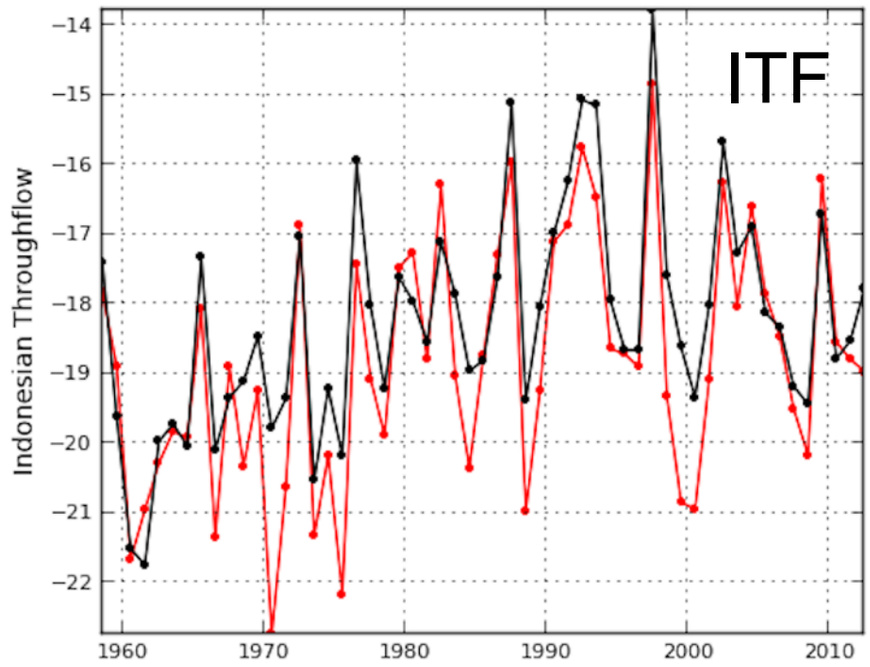


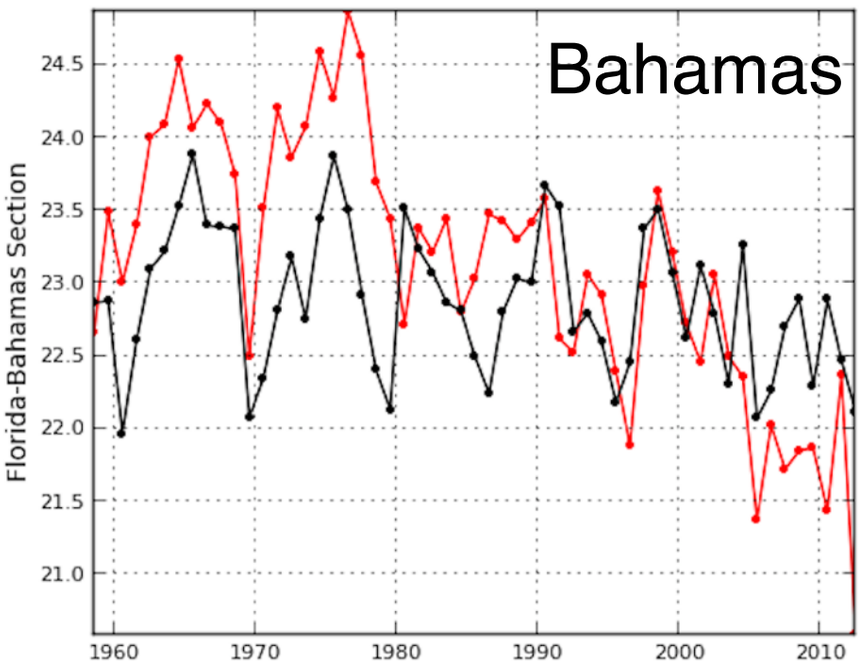
Sensitivity experiment with JRA at 0.5° resolution

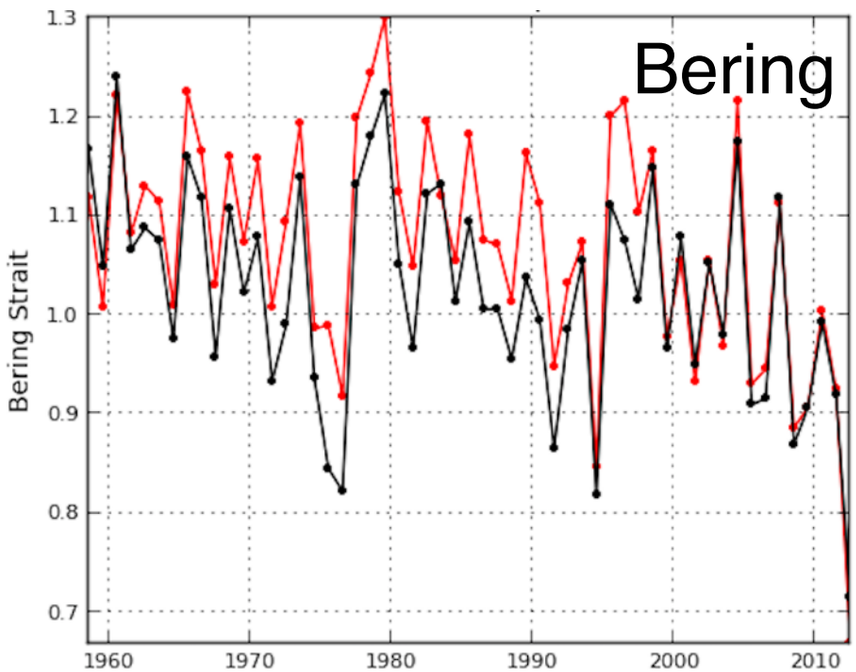
Barotropic transport

JRA : red
DFS : black









Sensitivity experiment with JRA at 0.5° resolution

Barotropic transport

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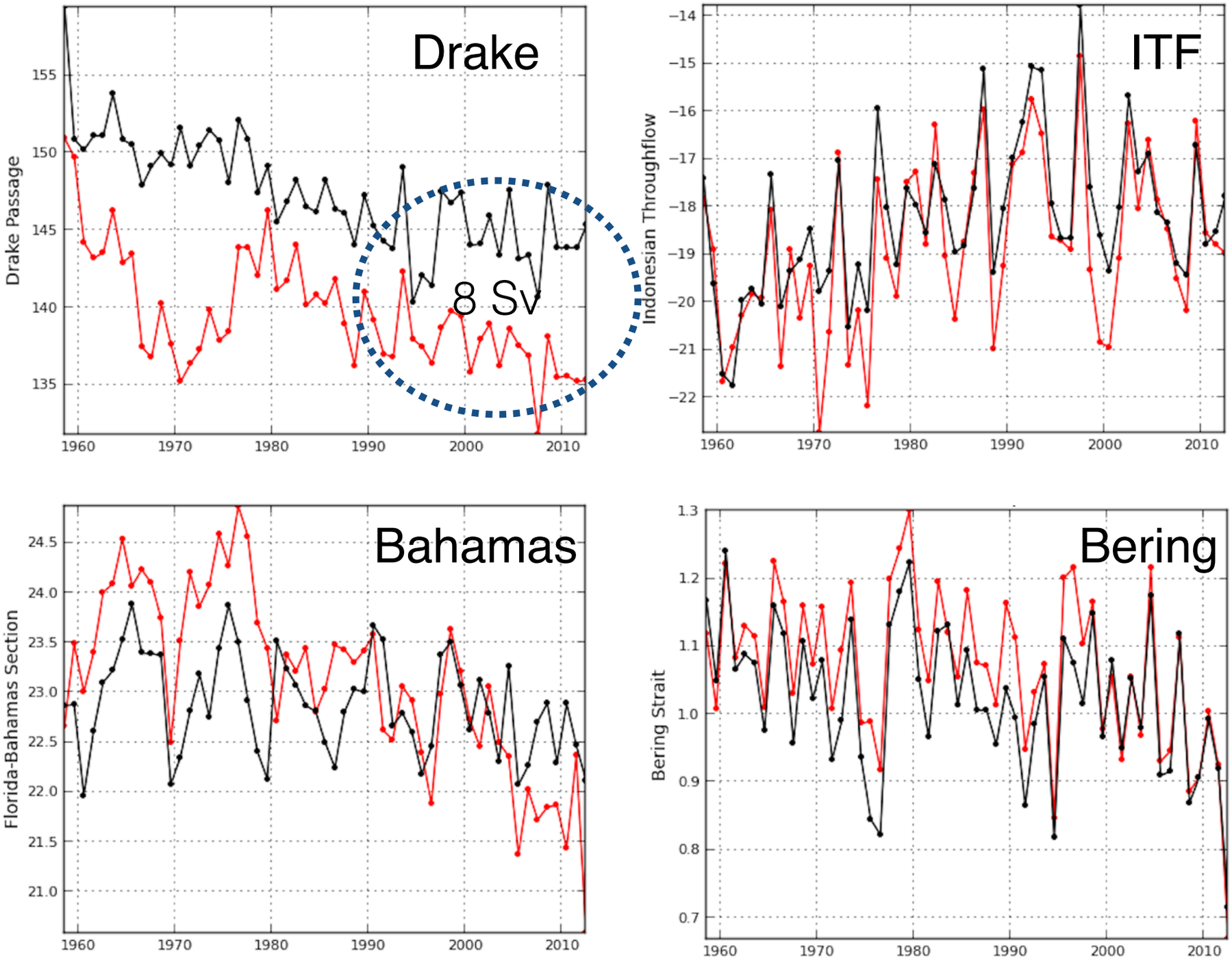
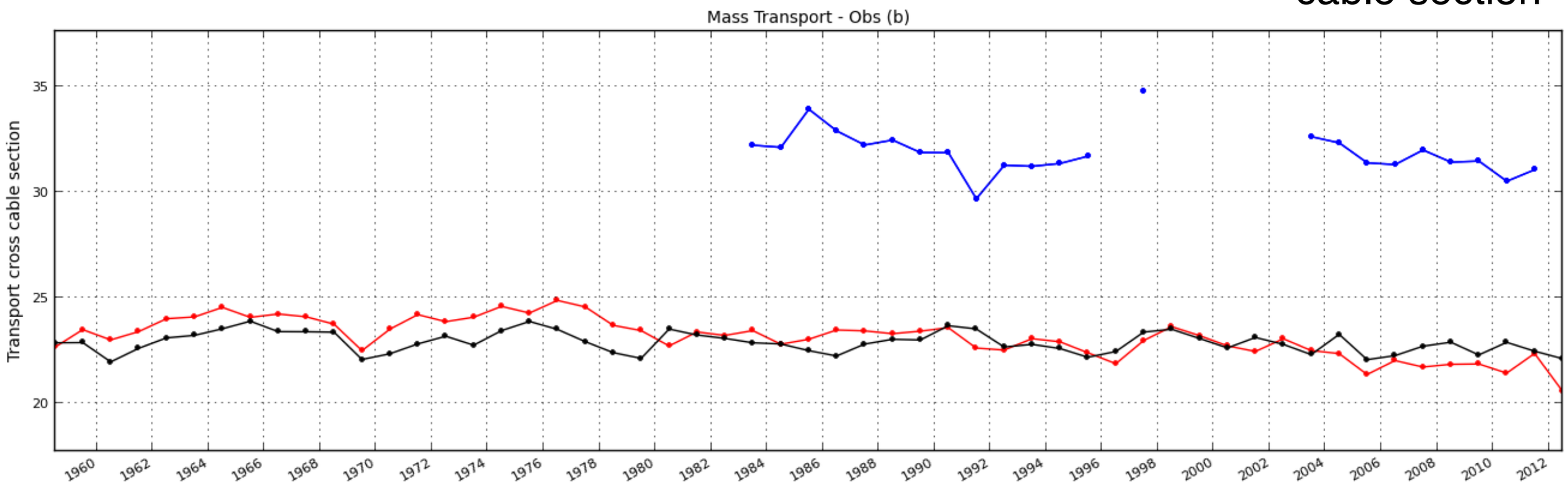
DFS : black



Sensitivity experiment with JRA at 0.5° resolution

Barotropic transport

cable section



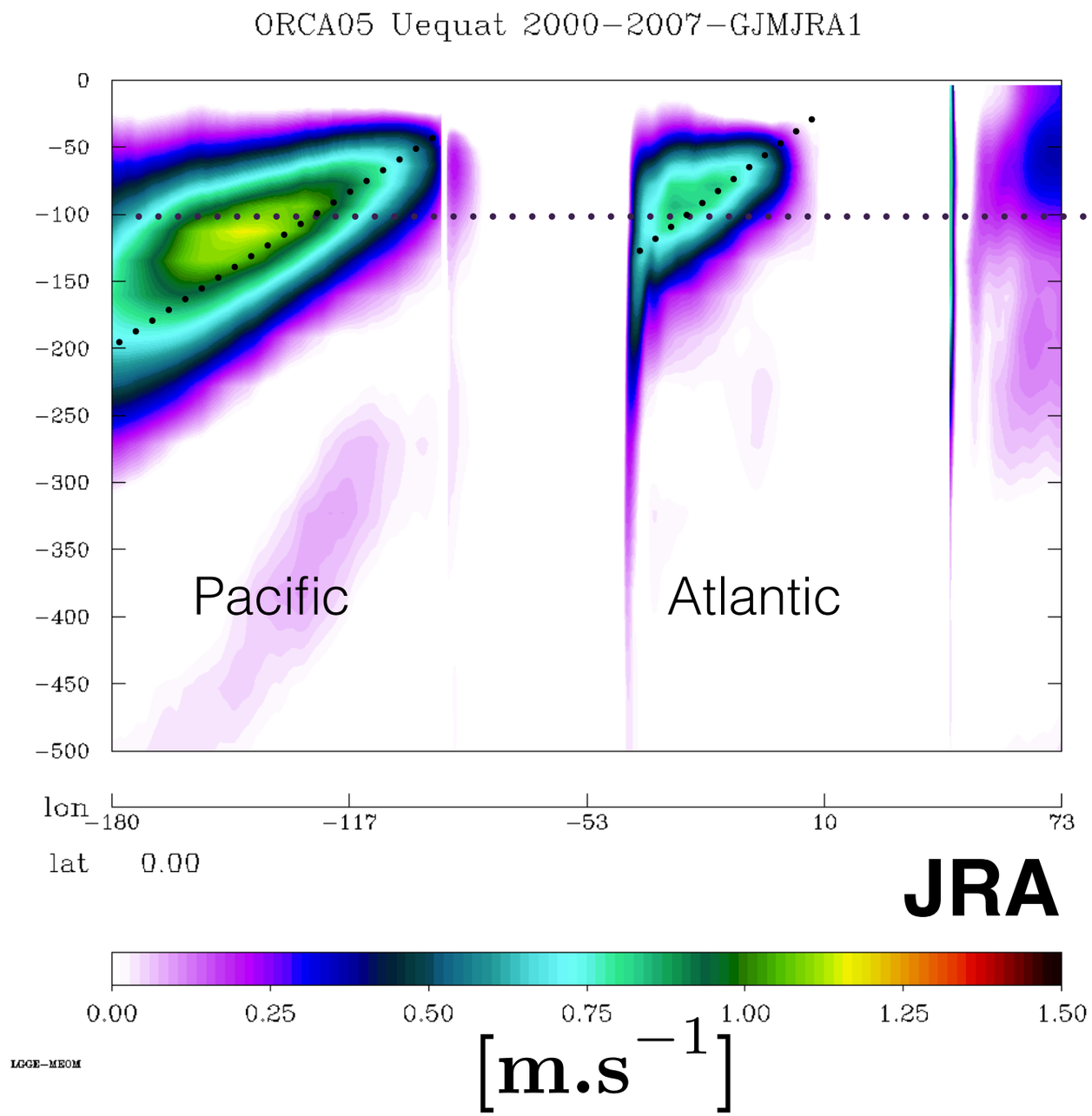
JRA : red

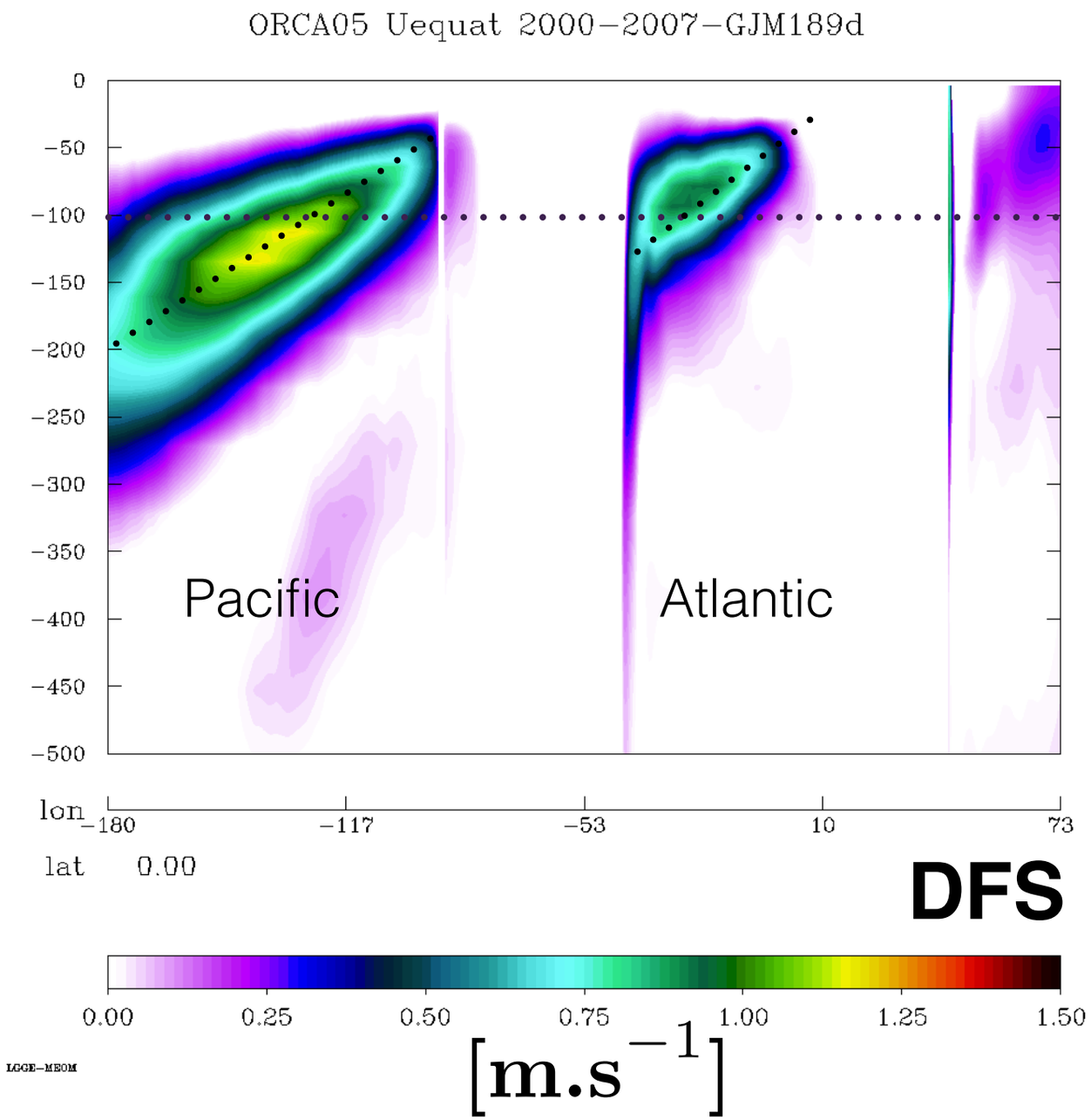
DFS : black

OBS : blue

Sensitivity experiment with JRA at 0.5° resolution

Mean zonal equatorial currents





Sensitivity experiment with JRA at 0.5° resolution

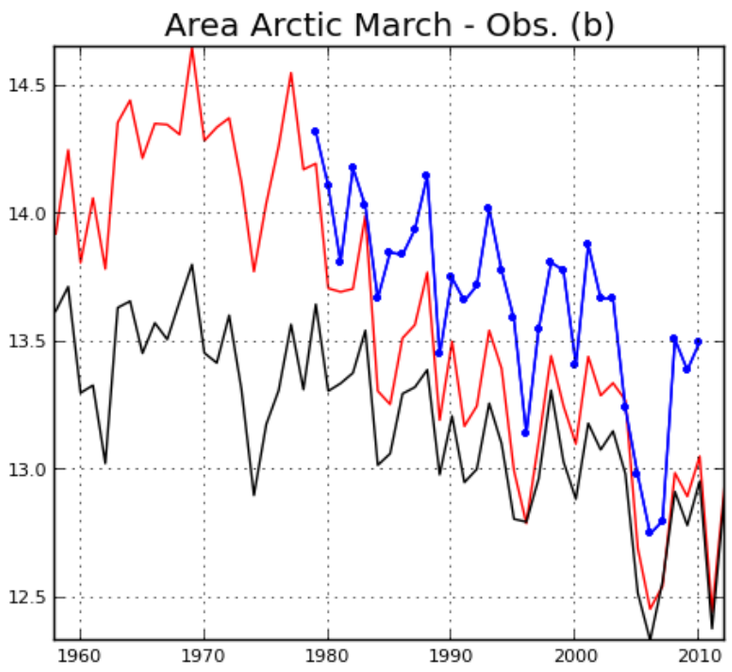
SEA ICE IN ORCA05

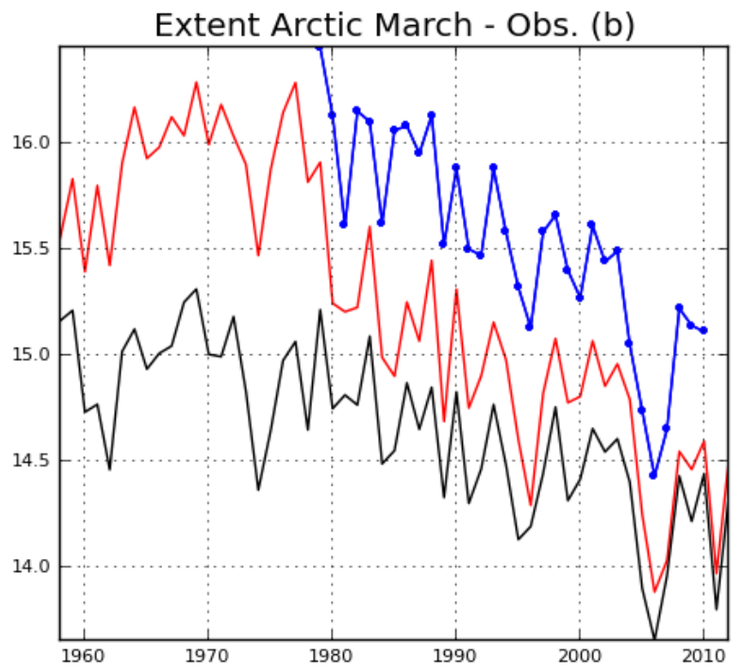
Sensitivity experiment with JRA at 0.5° resolution

Sea ice extent and sea ice area

ARCTIC

Max





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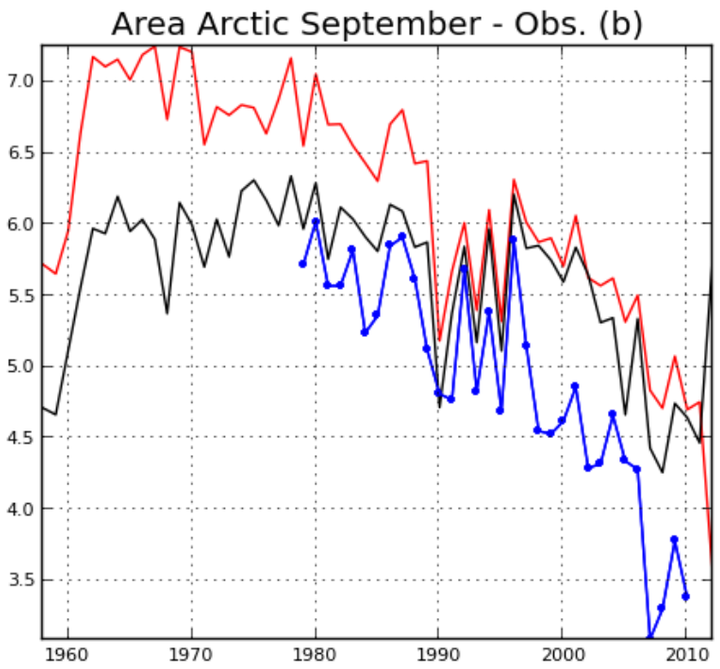
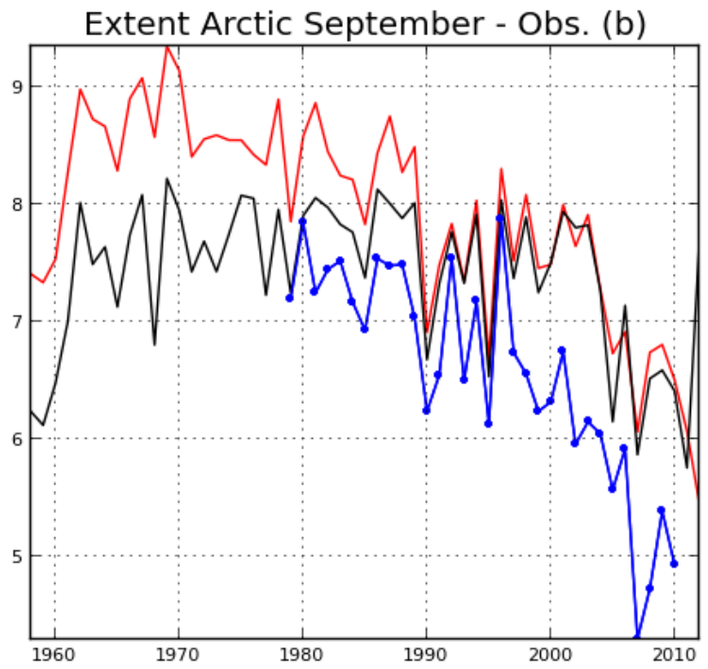
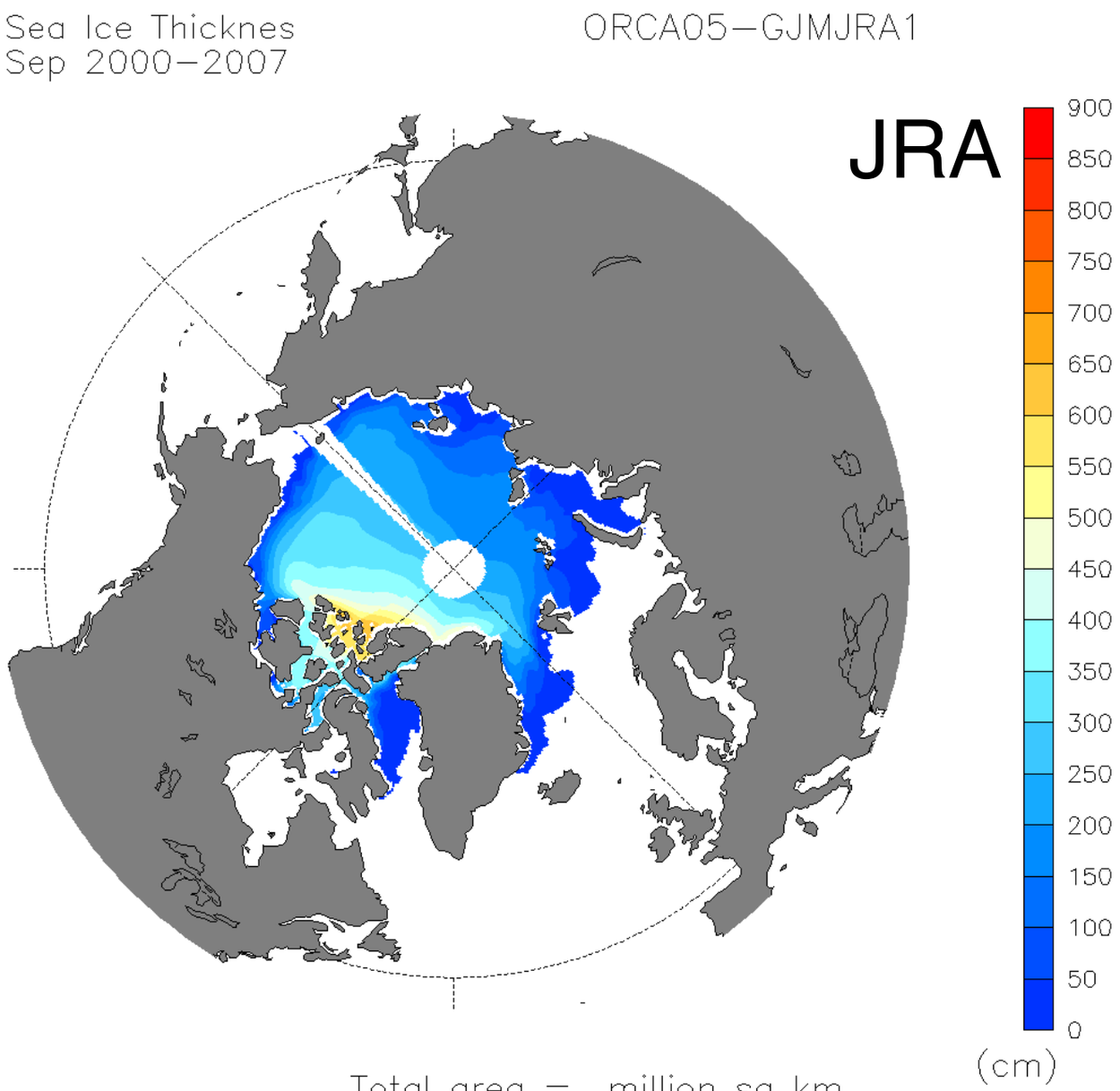


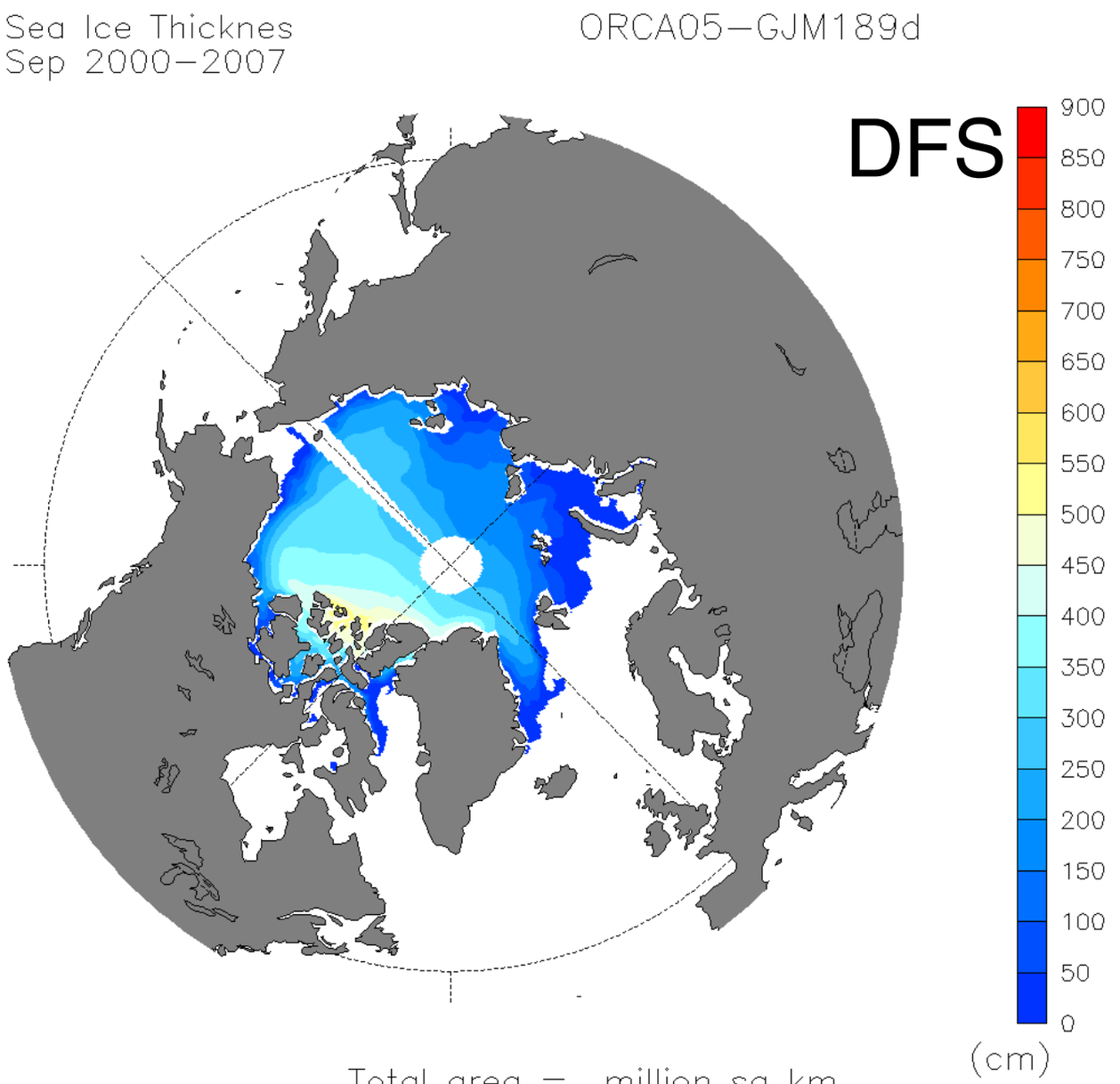


Sensitivity experiment with JRA at 0.5° resolution

Sea ice thickness (September)

ARCTIC





Sensitivity experiment with JRA at 0.5° resolution

Sea ice thickness (September)

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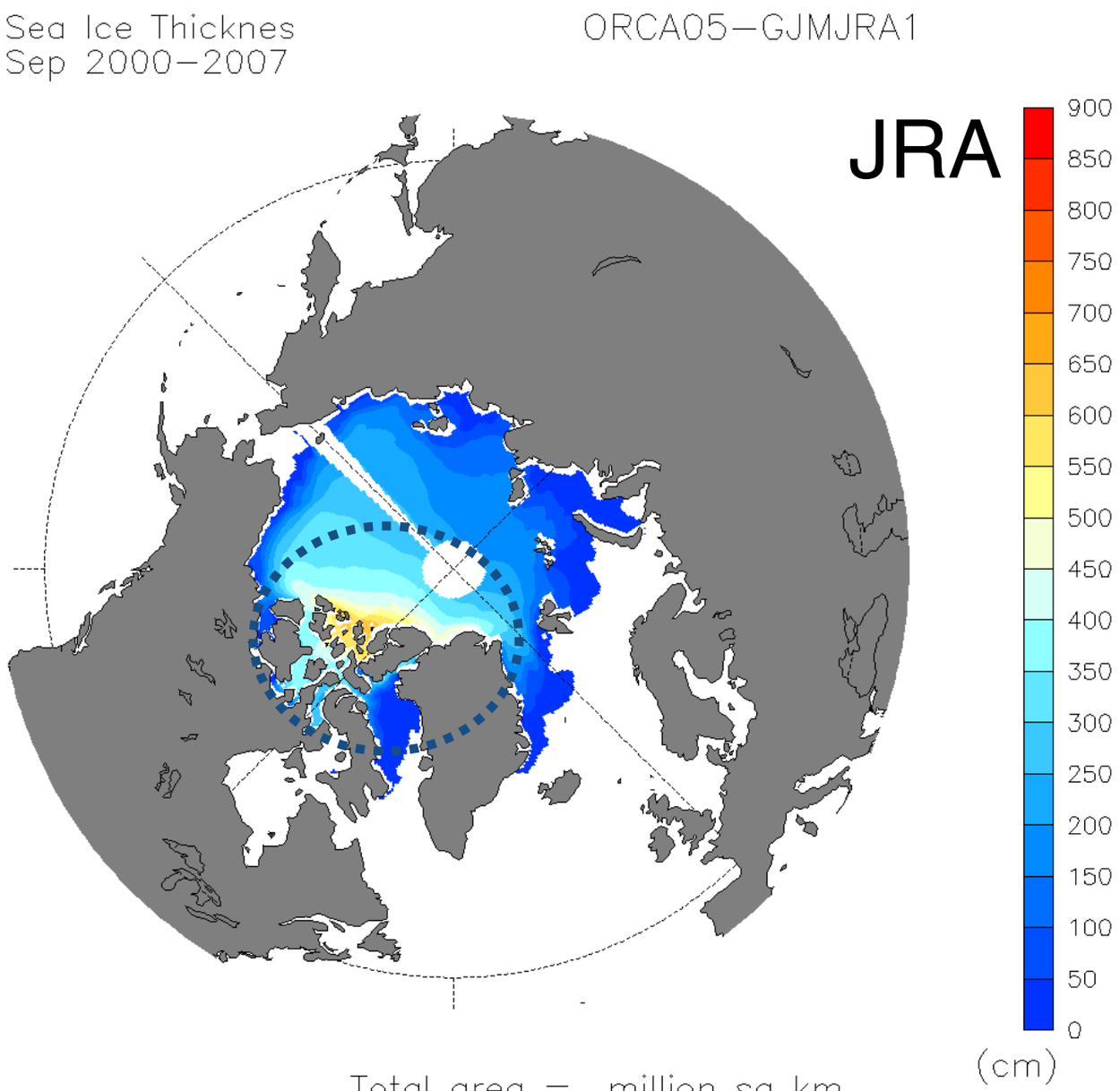
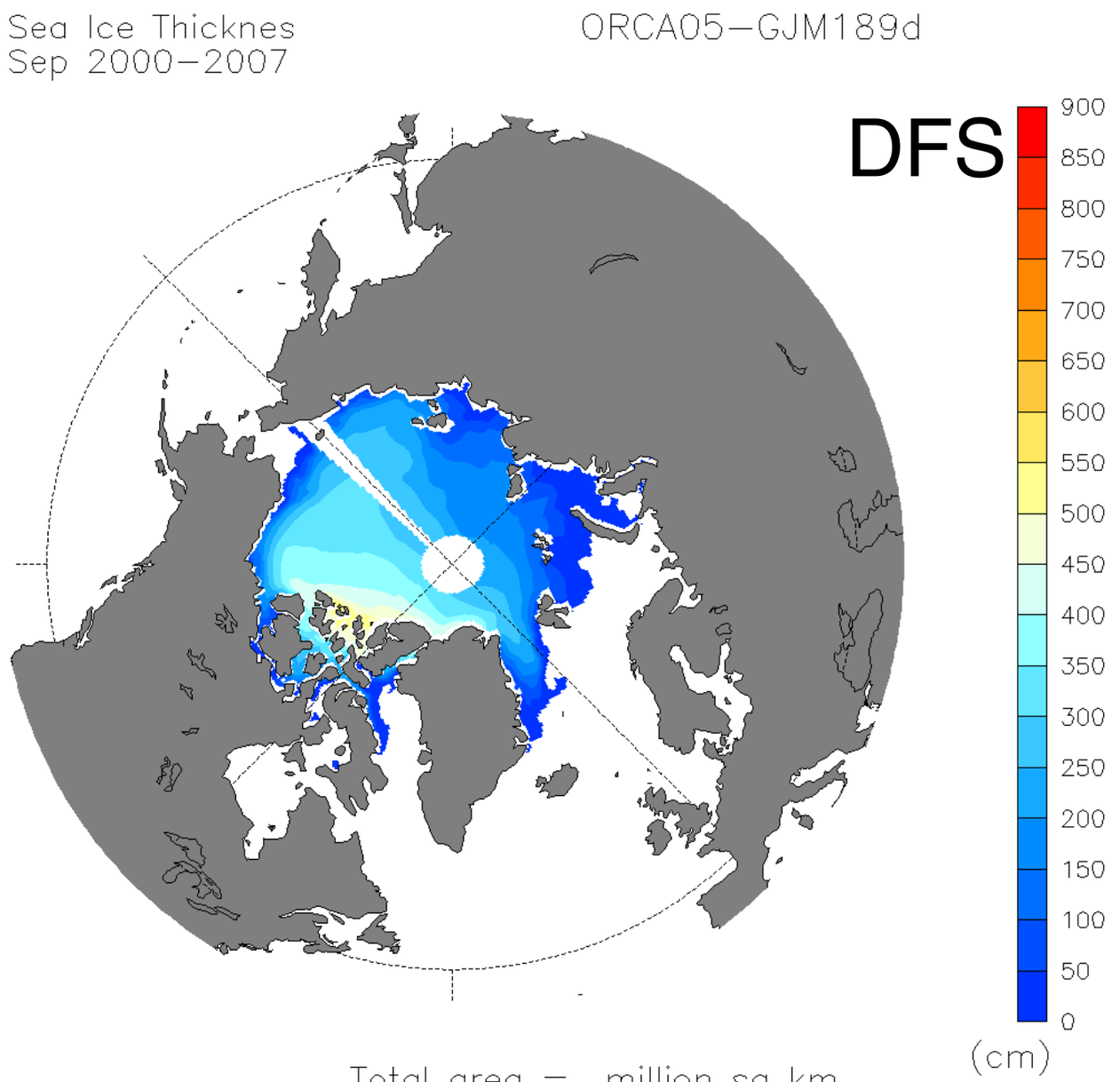
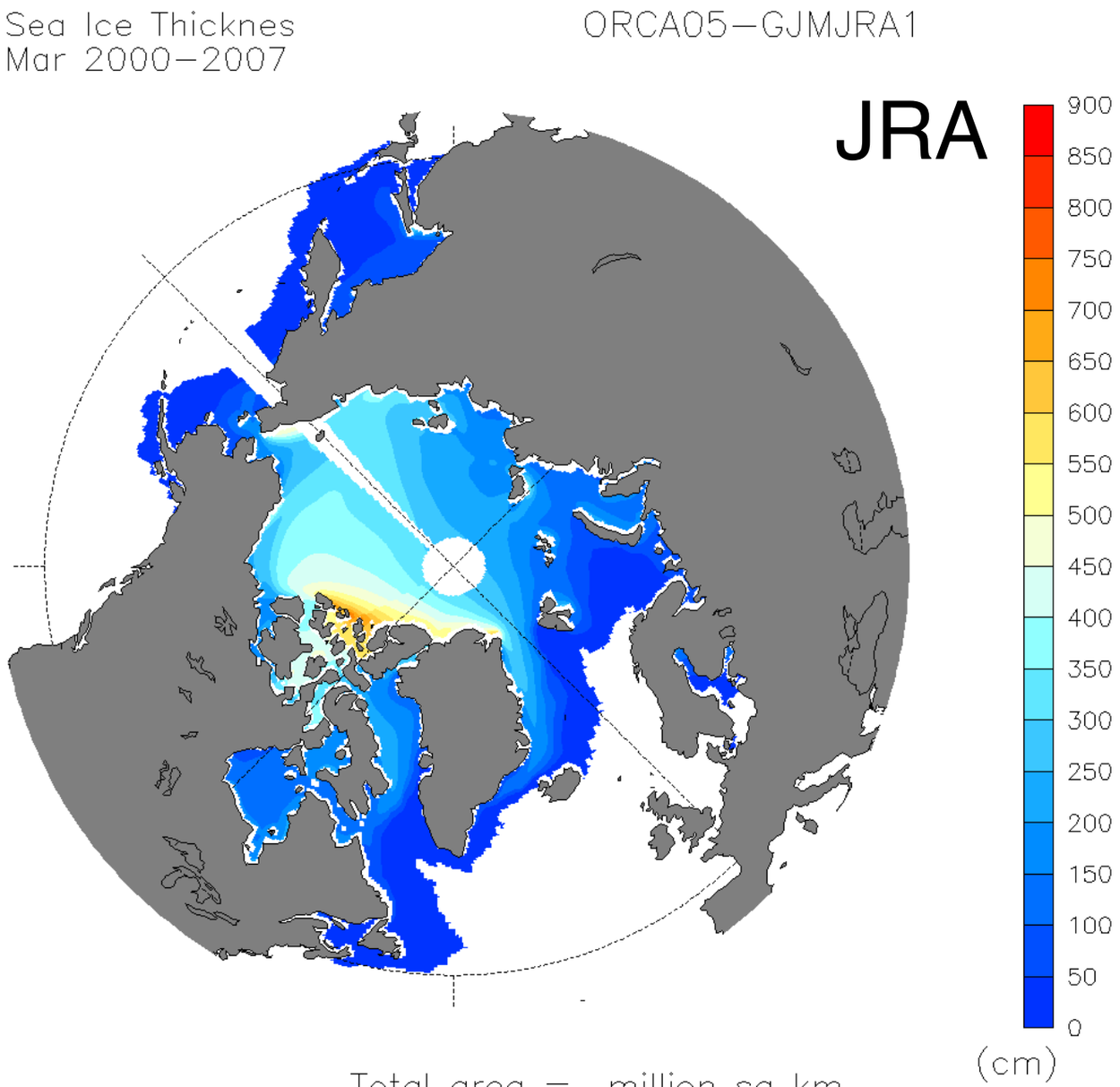


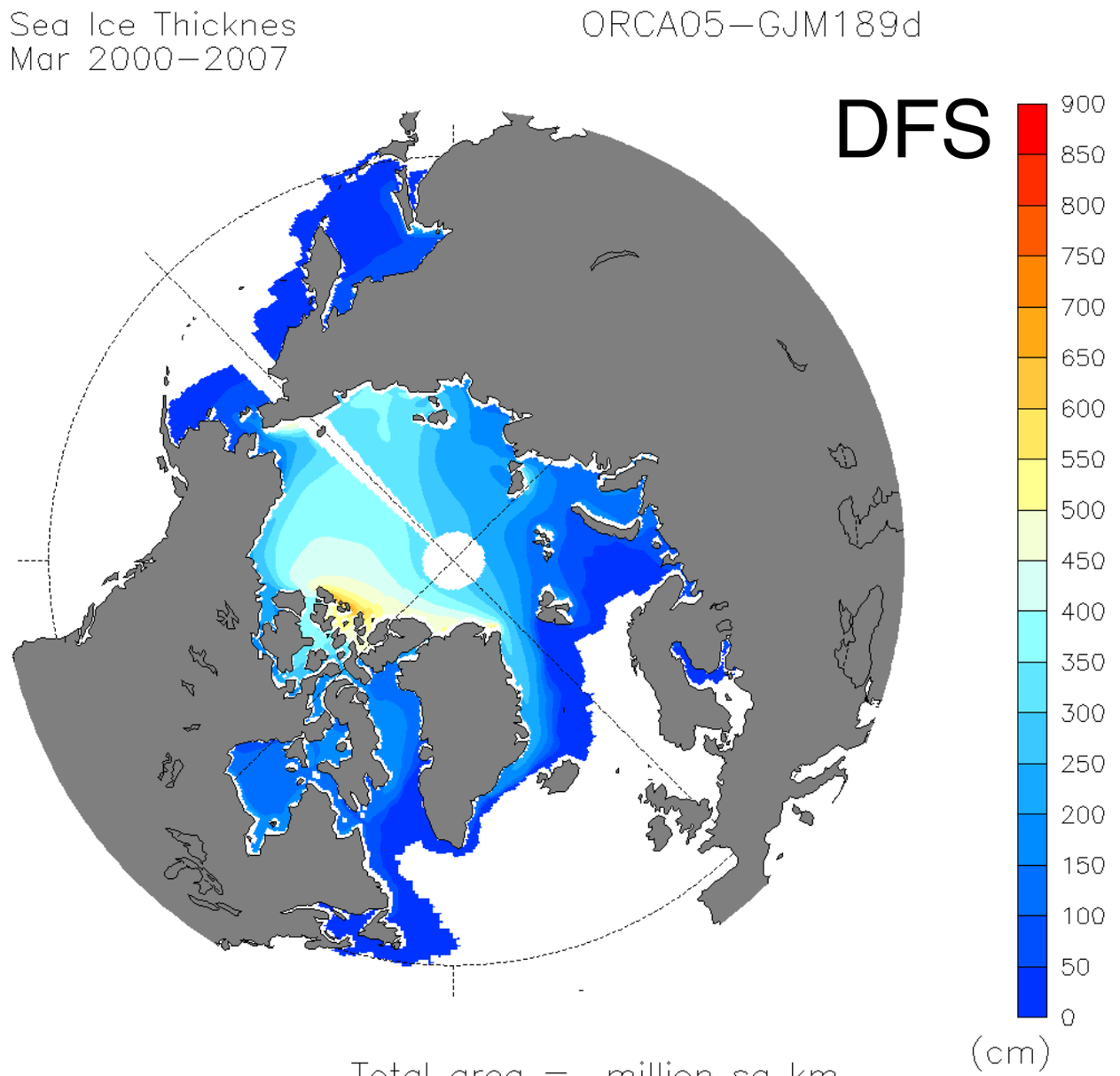


Sensitivity experiment with JRA at 0.5° resolution

Sea ice thickness (March)

ARCTIC





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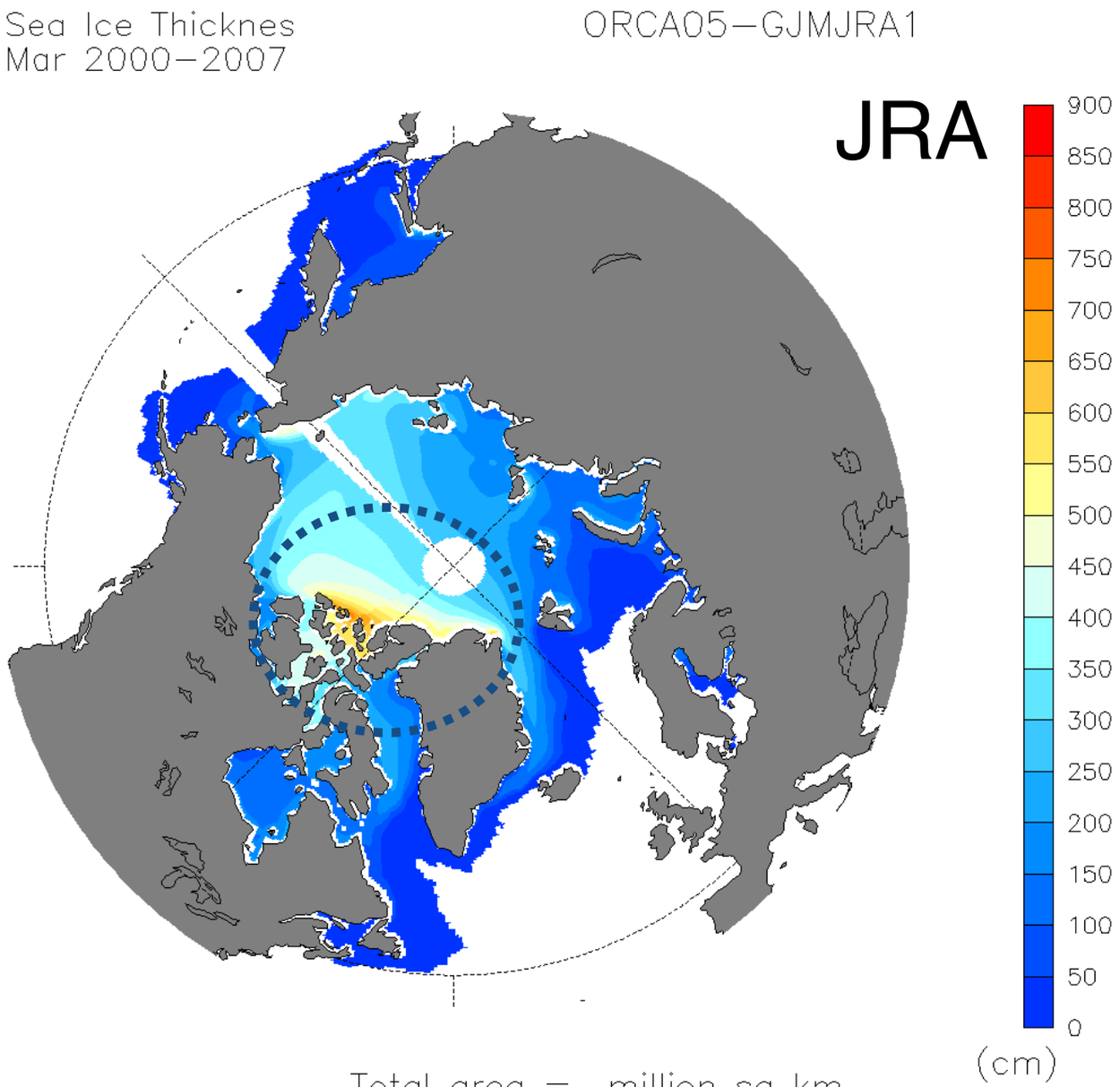
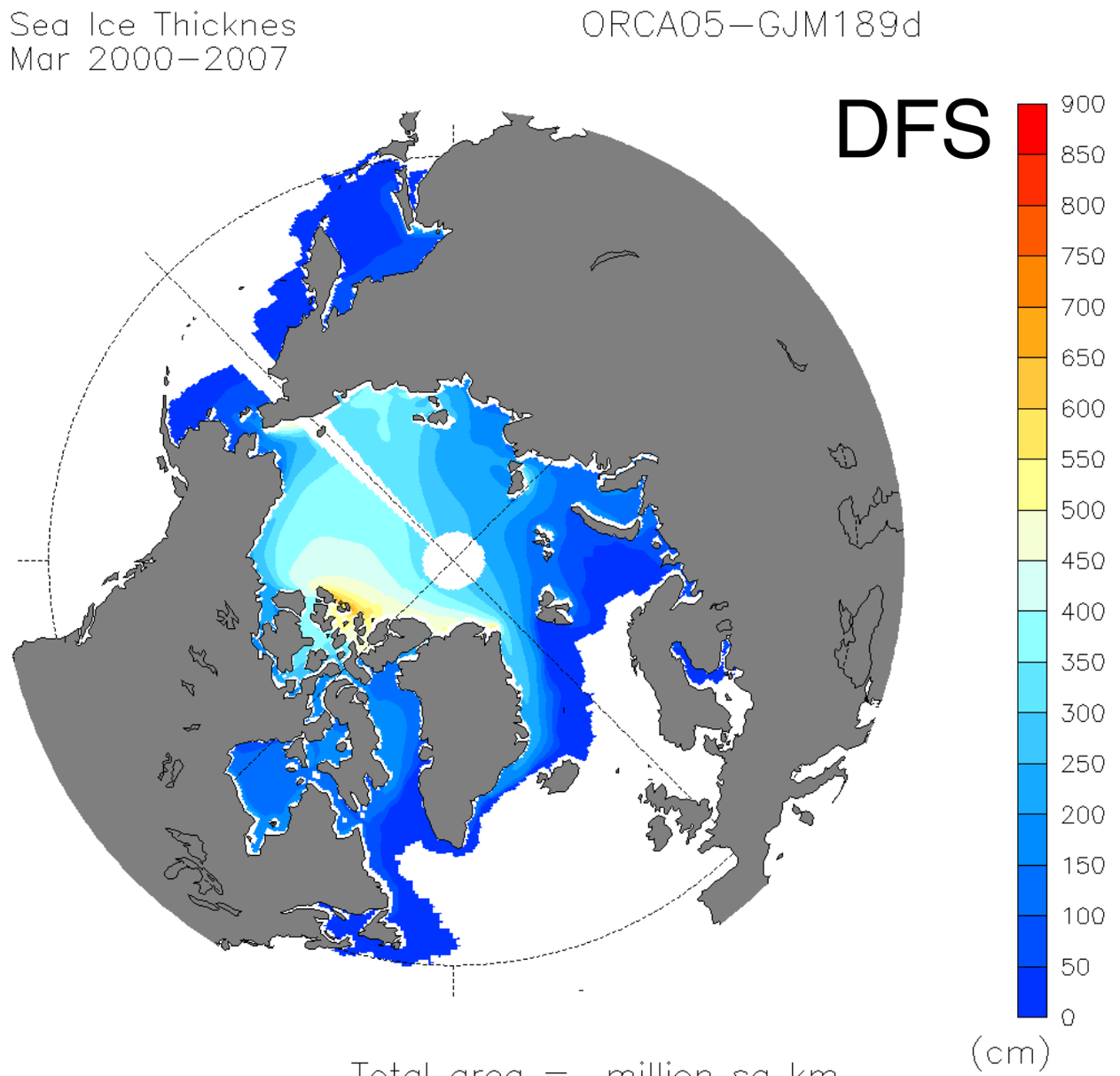


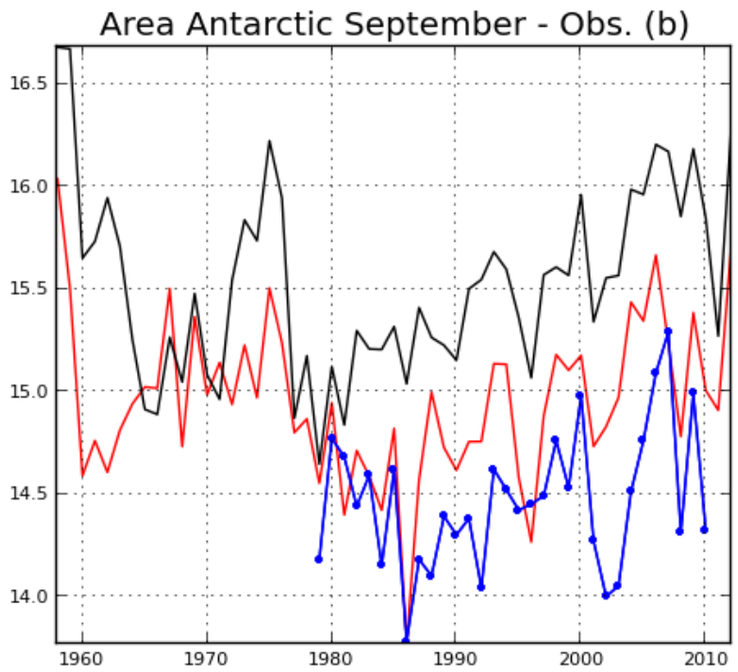


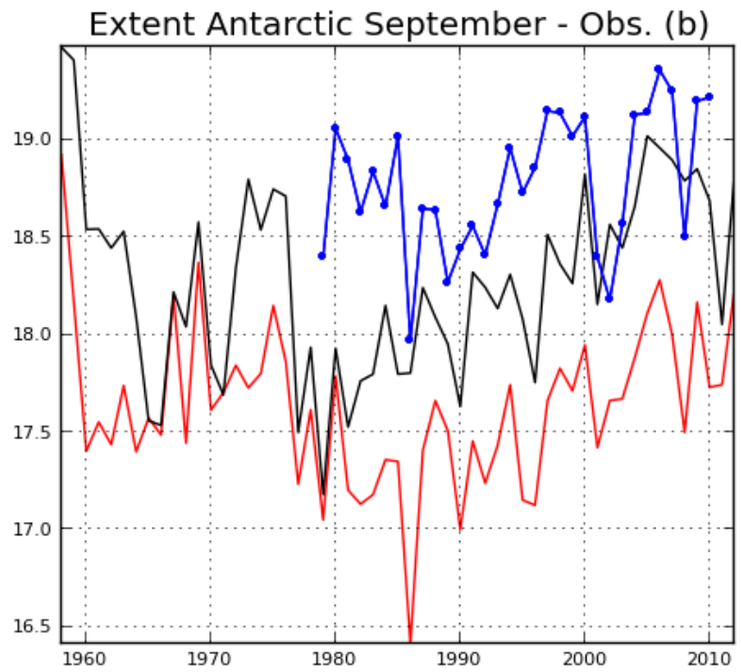
Sensitivity experiment with JRA at 0.5° resolution

Sea ice extent and sea ice area (Antarctic)

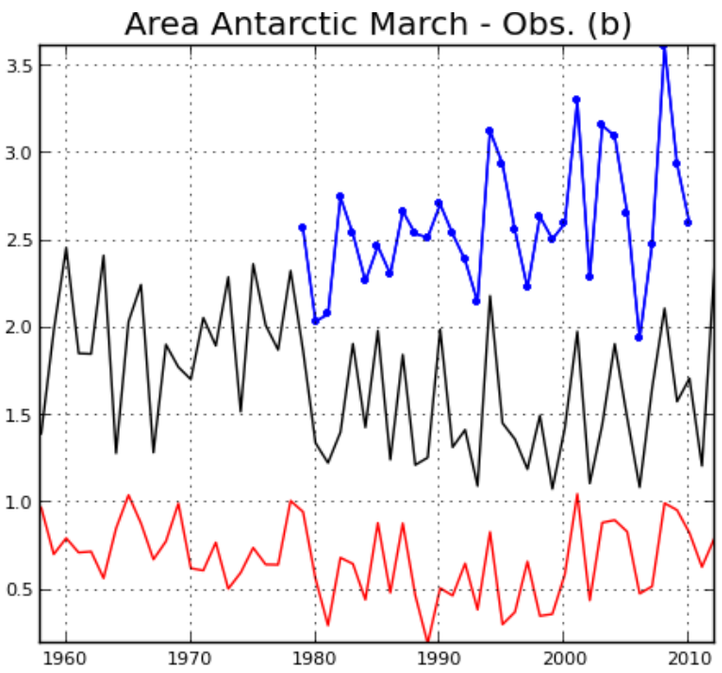
ANTARCTIC

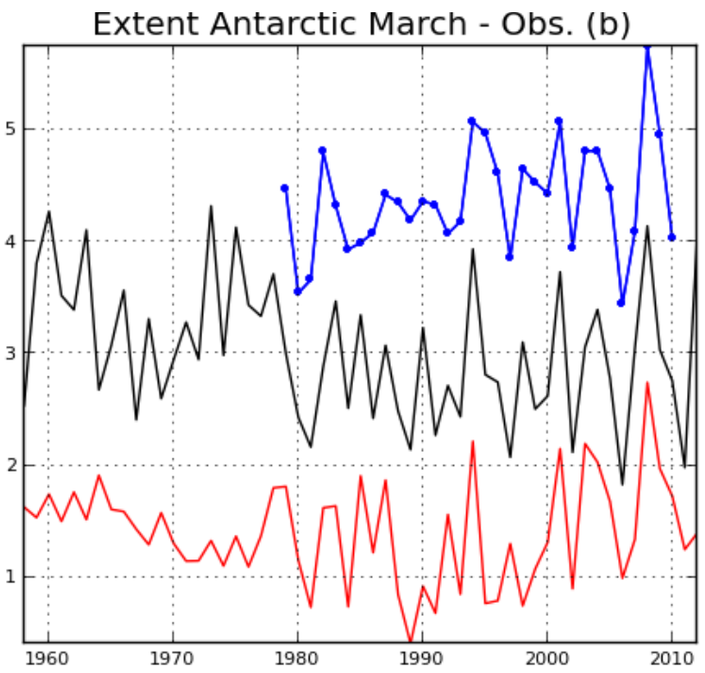
Max





Min



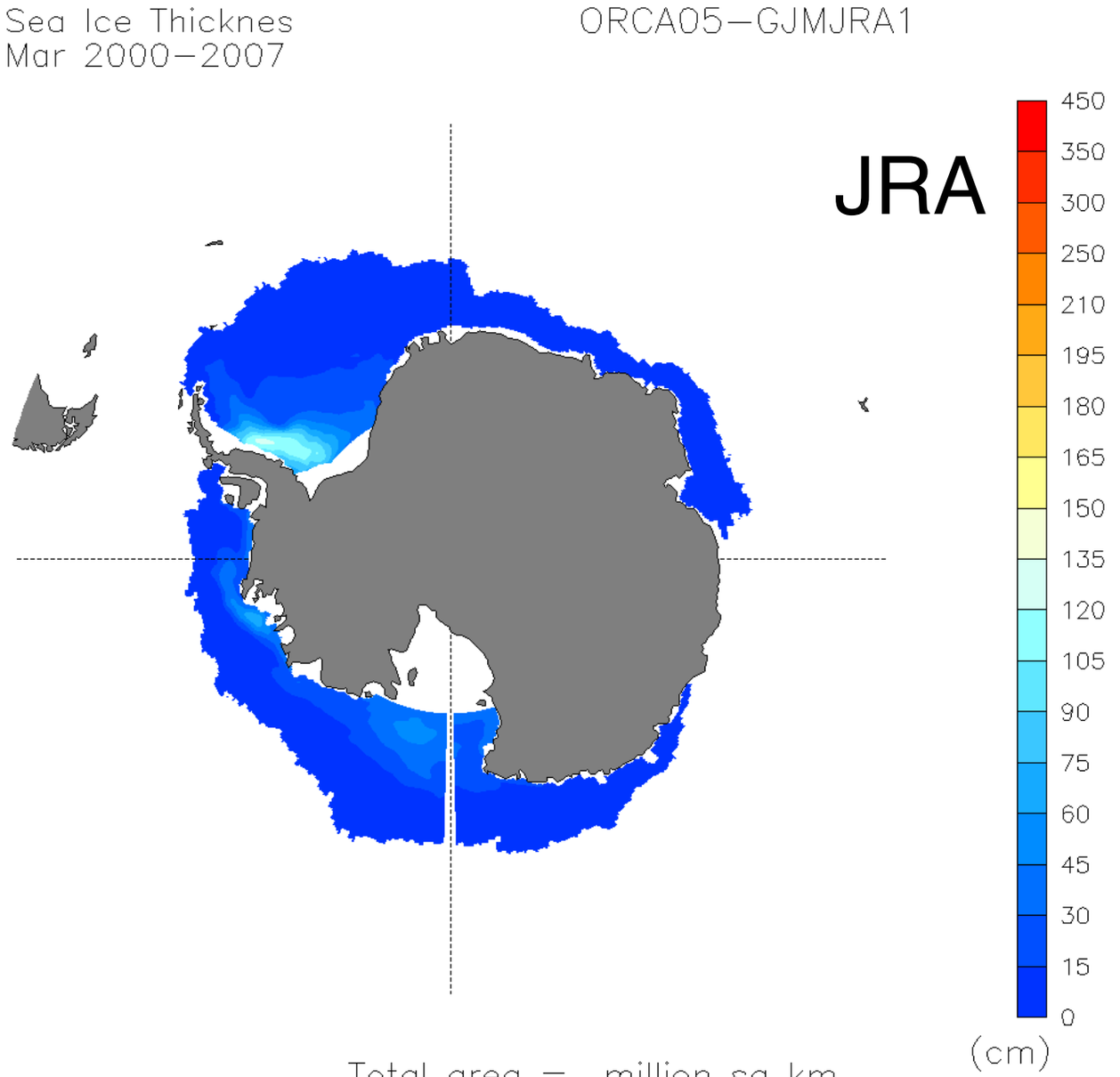


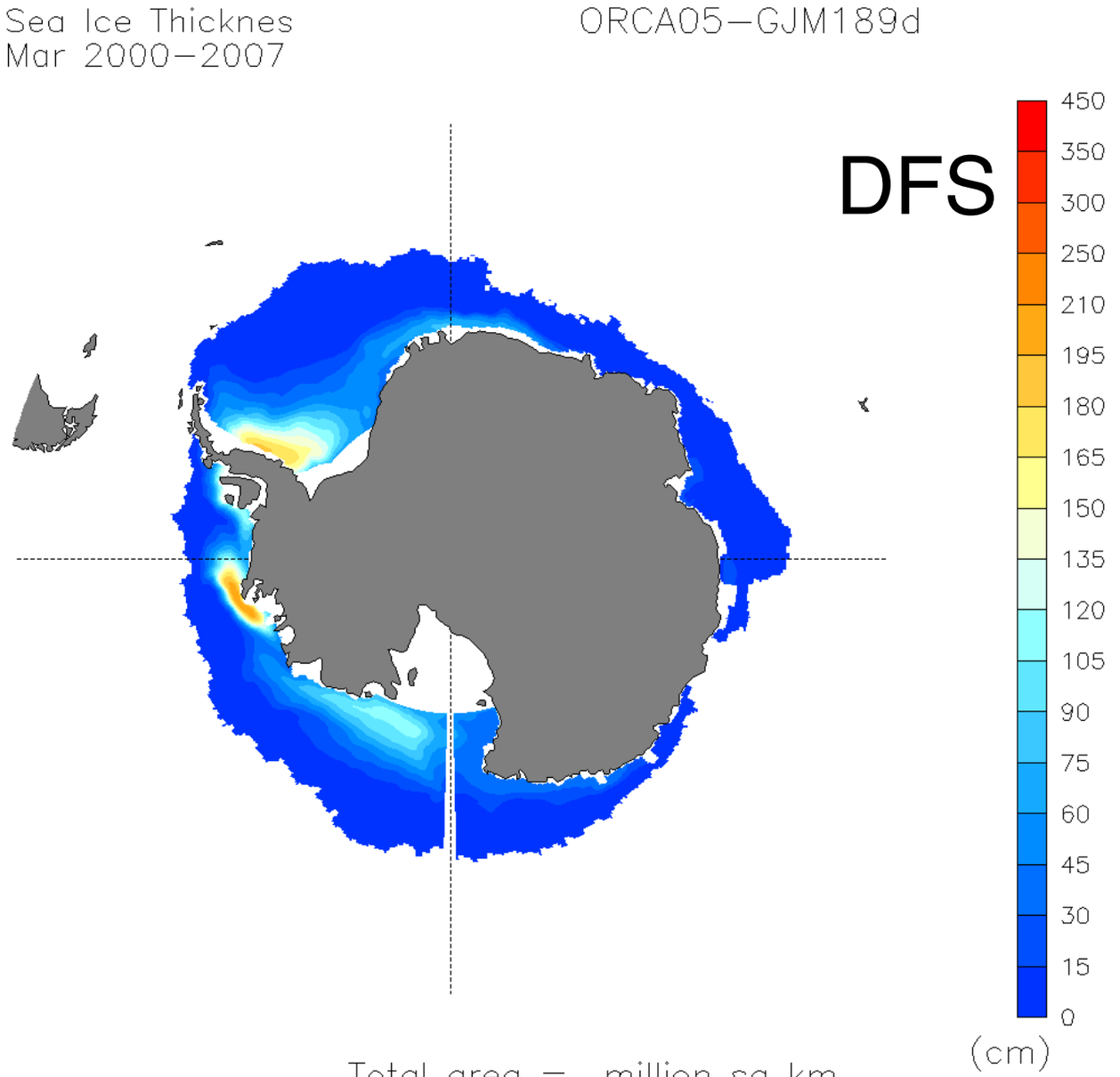
JRA : red
DFS : black
OBS : blue

Sensitivity experiment with JRA at 0.5° resolution

Sea ice thickness (March)

ANTARCTIC

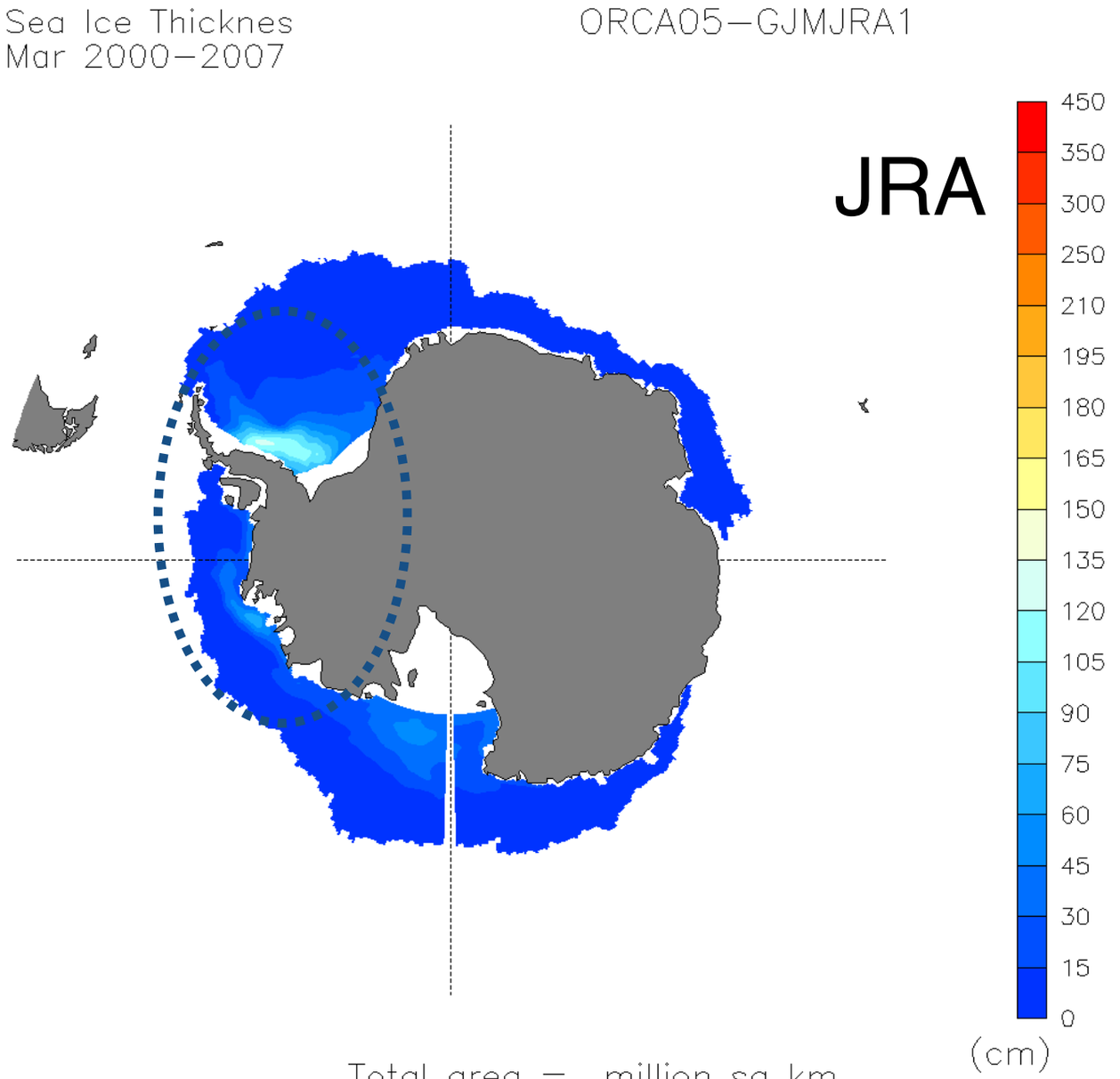


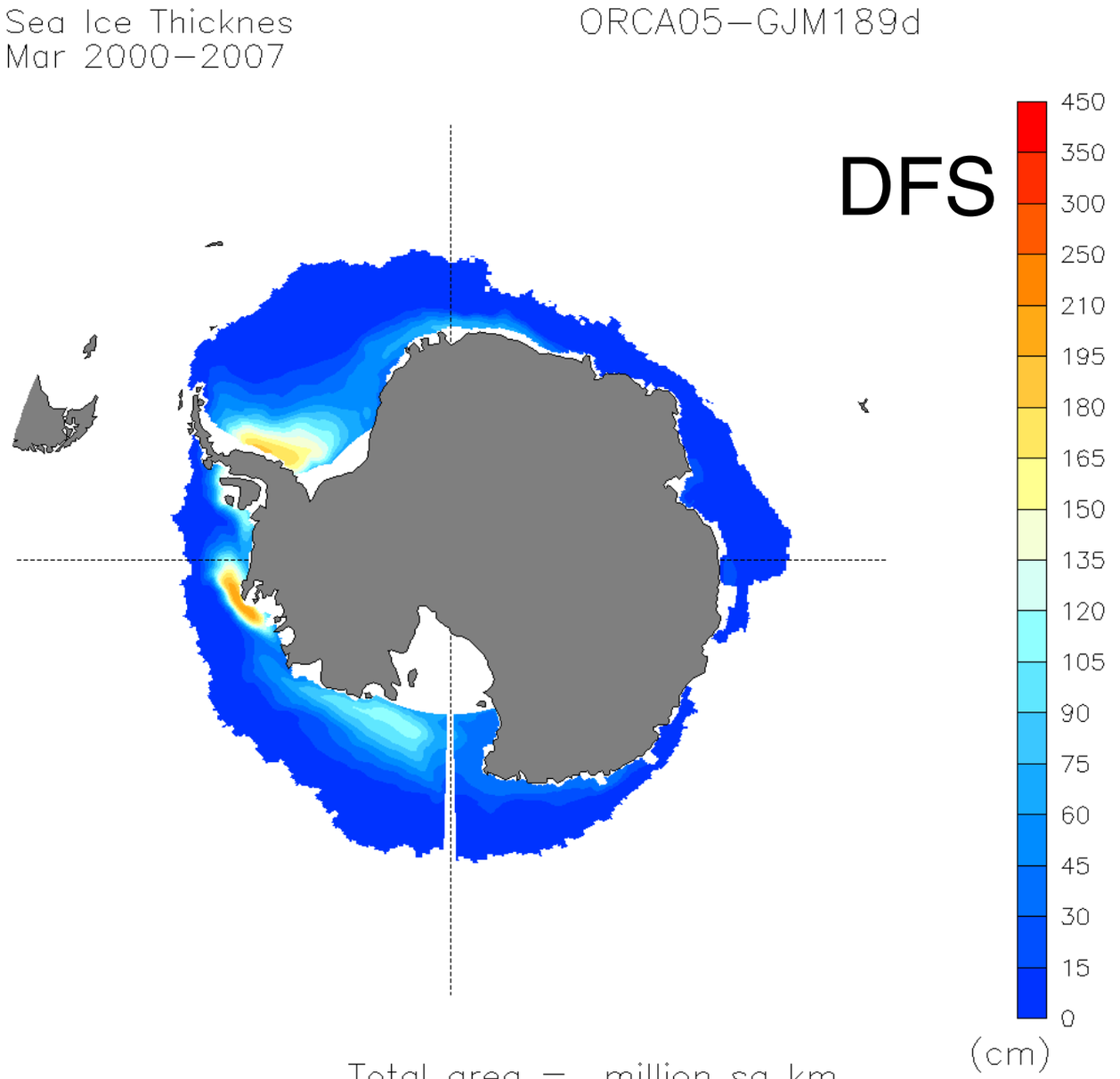


Sensitivity experiment with JRA at 0.5° resolution

Sea ice thickness (March)

ANTARCTIC



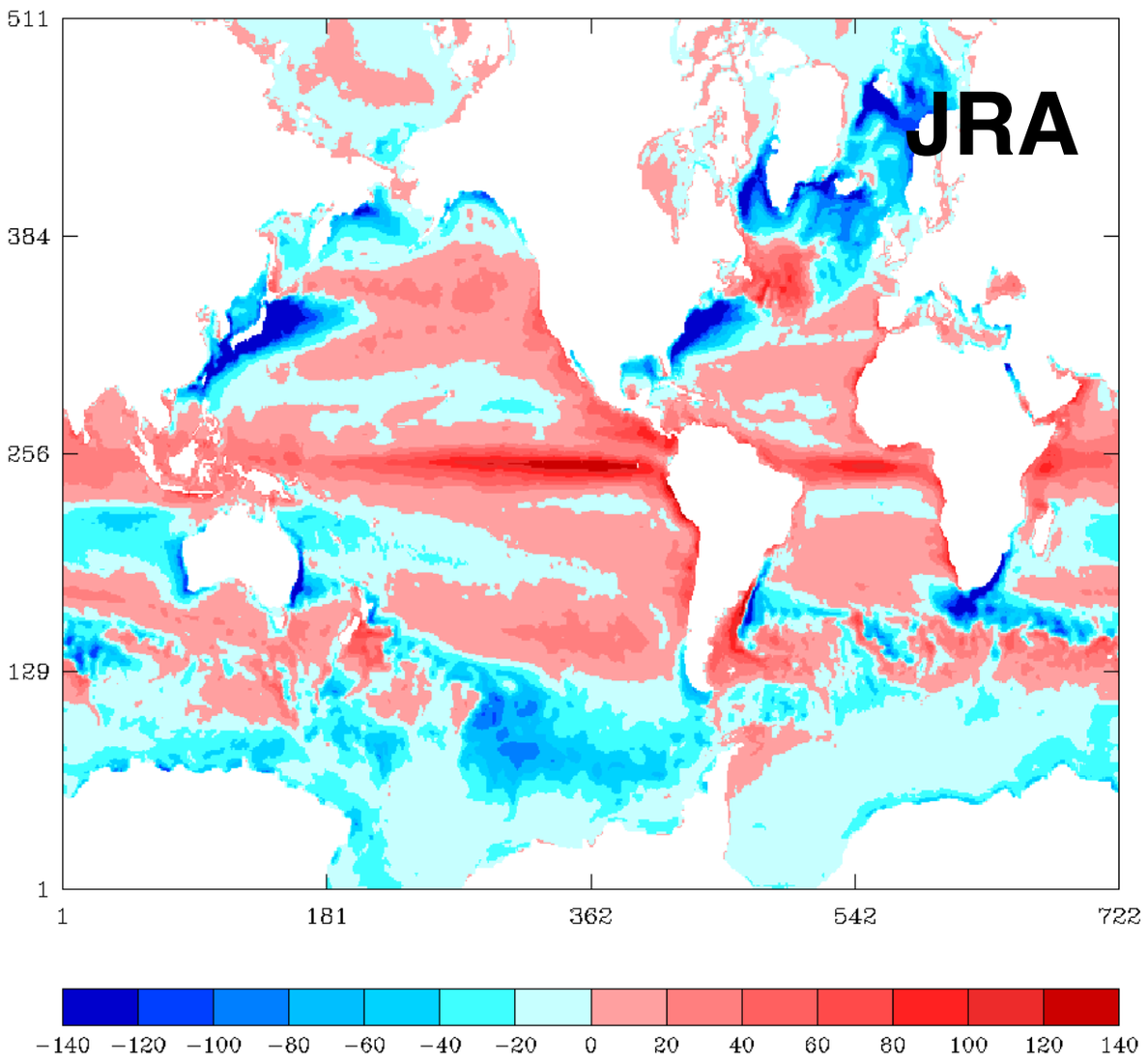


Sensitivity experiment with JRA at 0.5° resolution

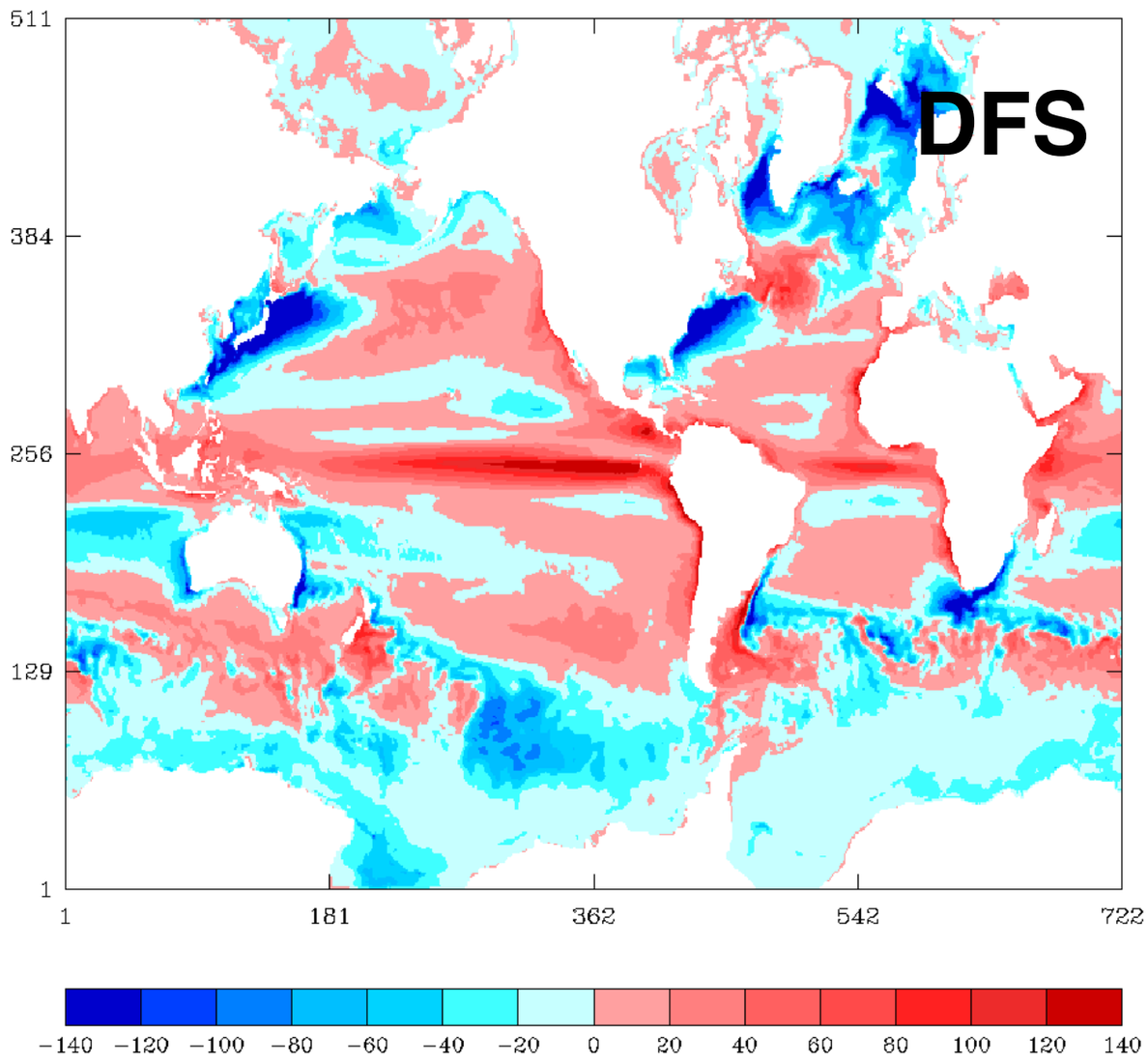
AIR-SEA FLUXES AND MIXED LAYER IN ORCA05

Sensitivity experiment with JRA at 0.5° resolution

Net heat flux



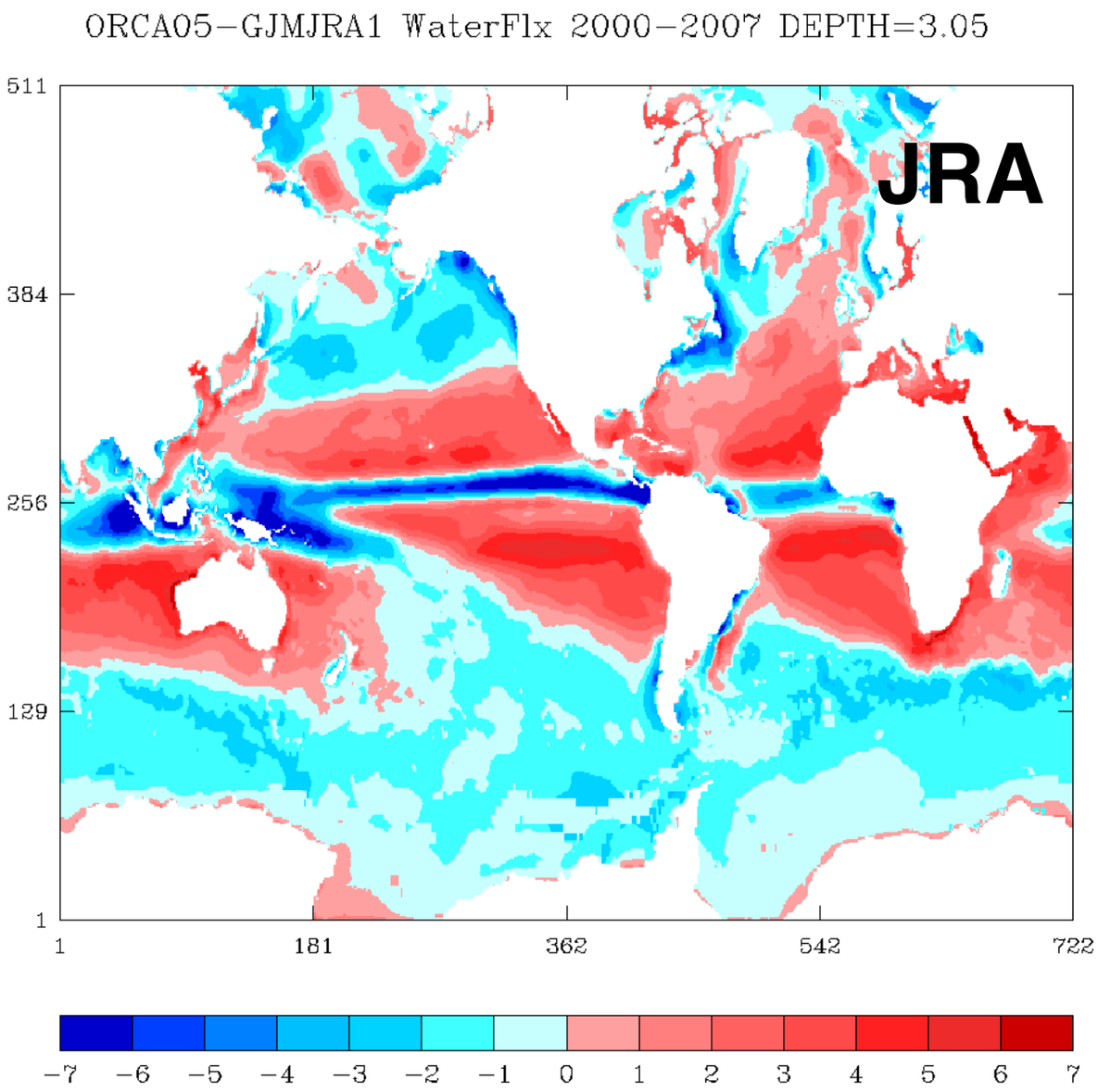
$[W.m^{-2}]$



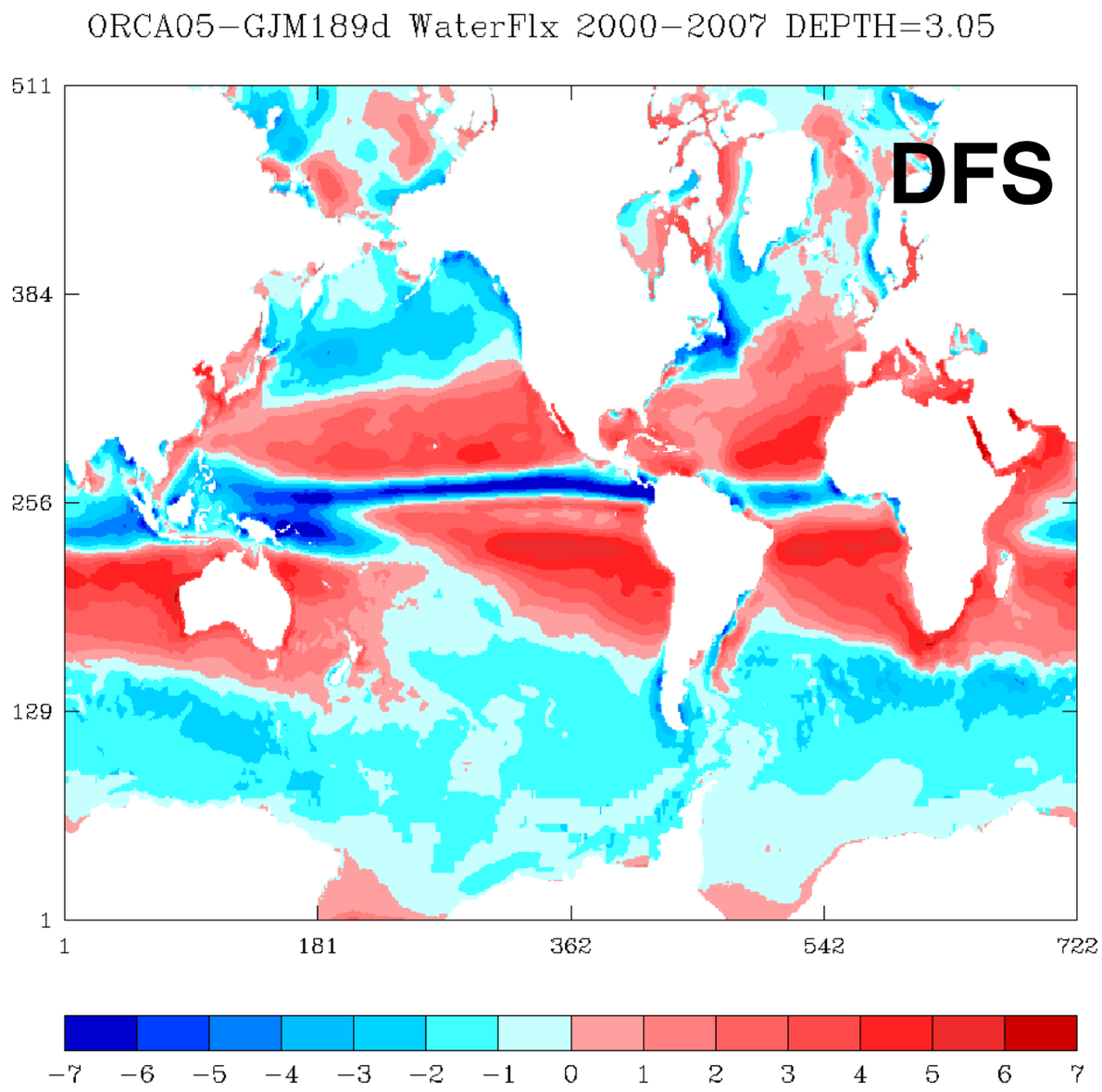
$[W.m^{-2}]$

JRA versus DFS5.2 in ORCA05

Freshwater flux



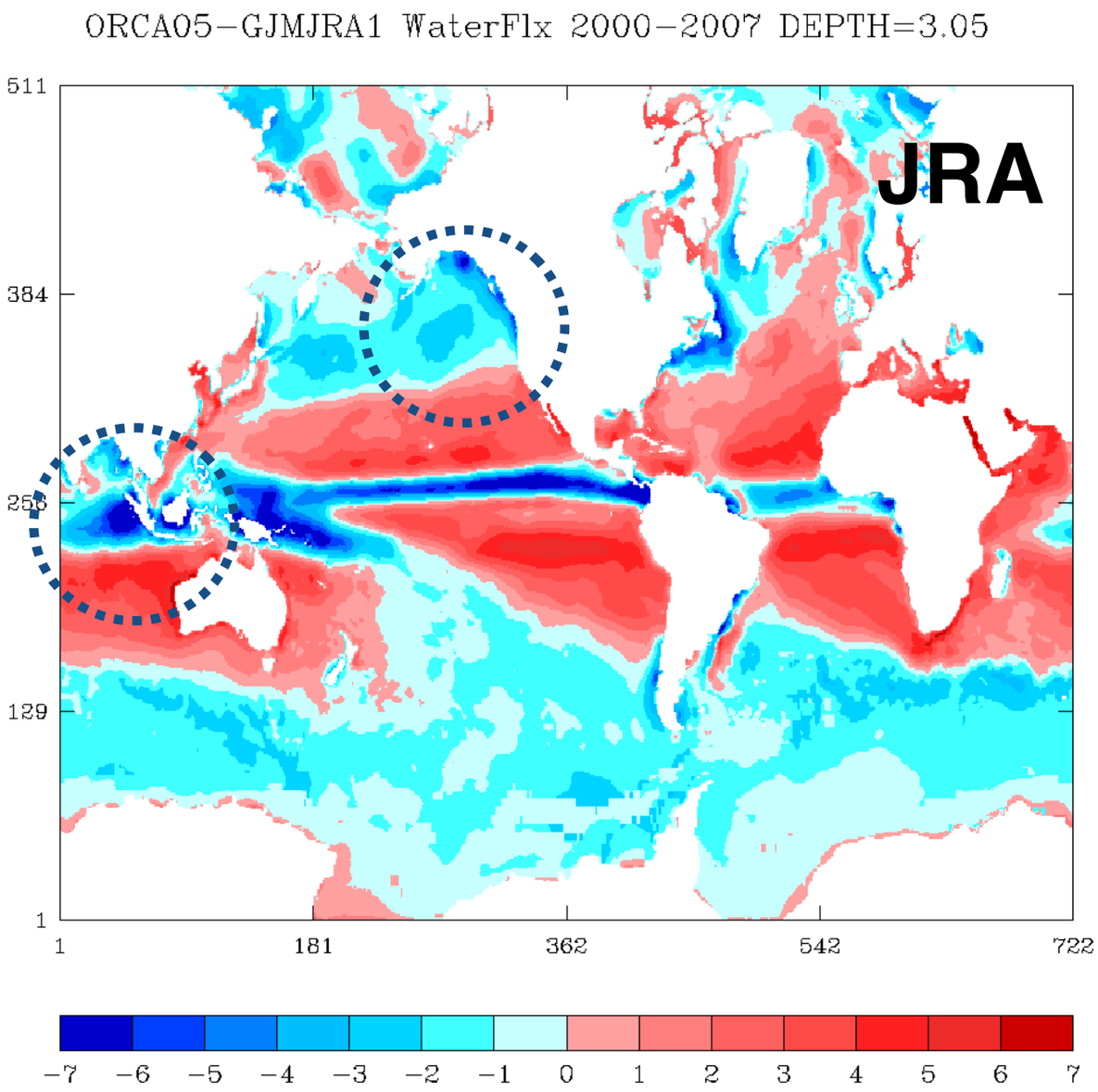
$[mm.d^{-1}]$



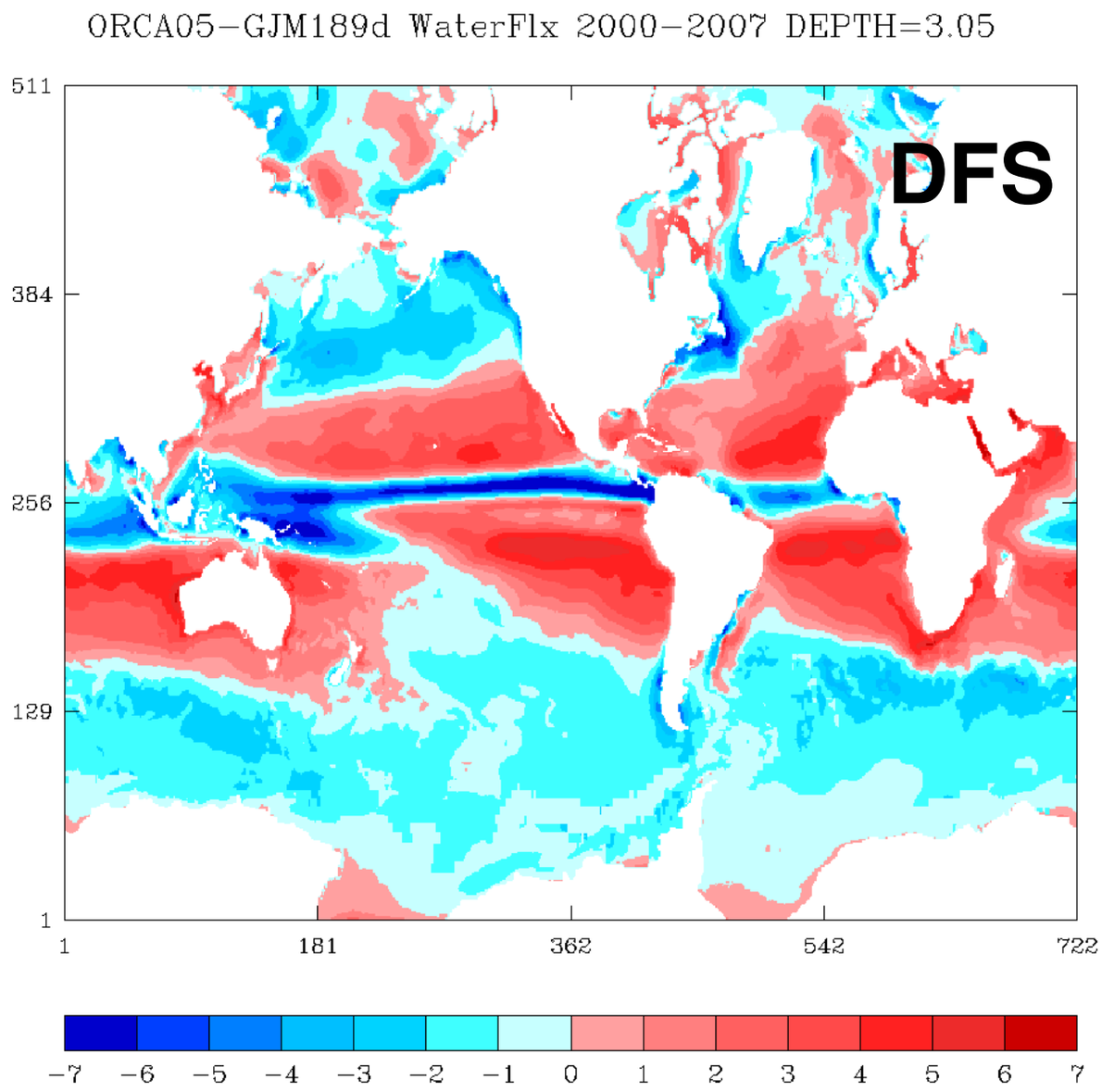
$[mm.d^{-1}]$

JRA versus DFS5.2 in ORCA05

Freshwater flux



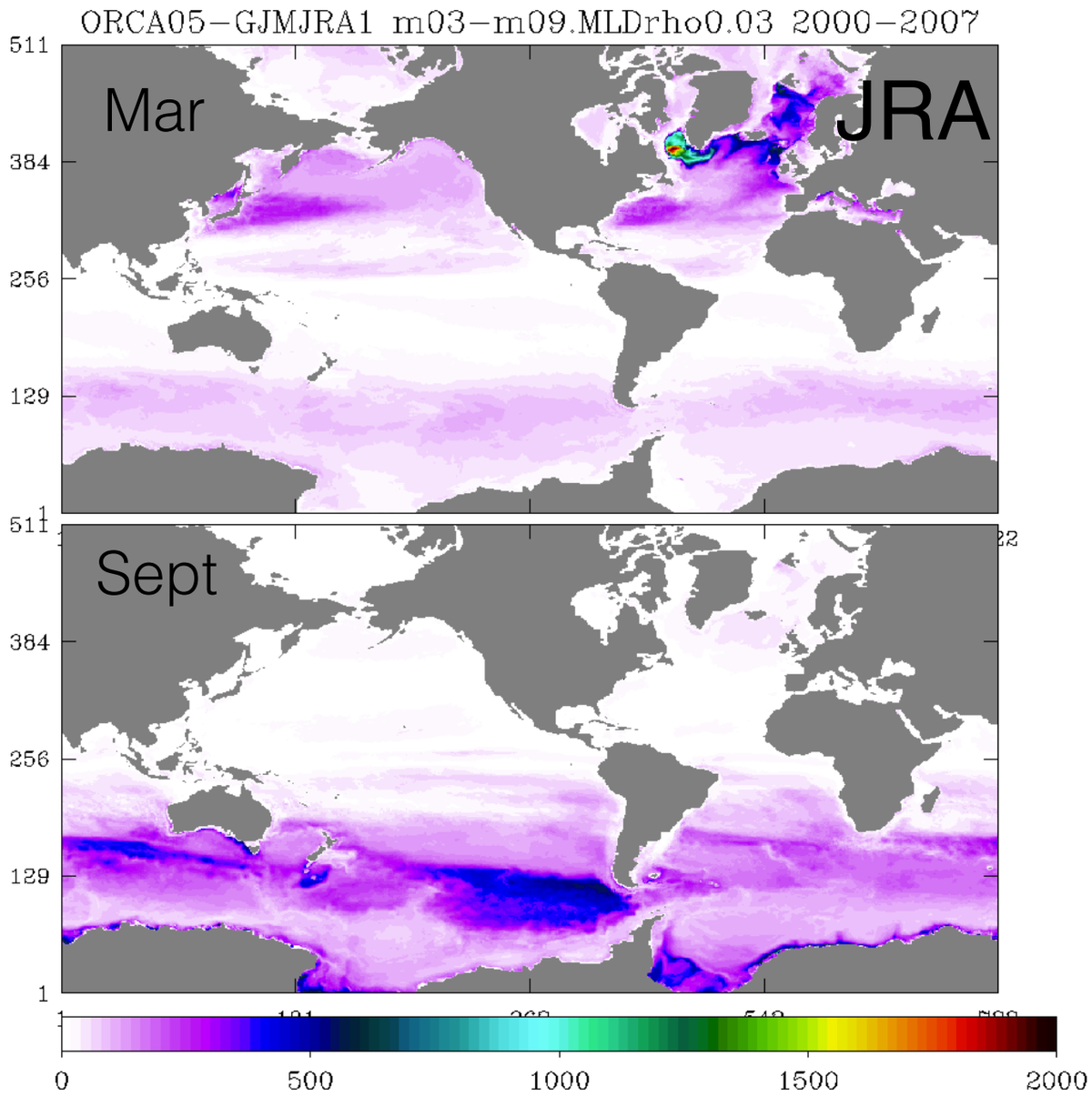
$[mm.d^{-1}]$



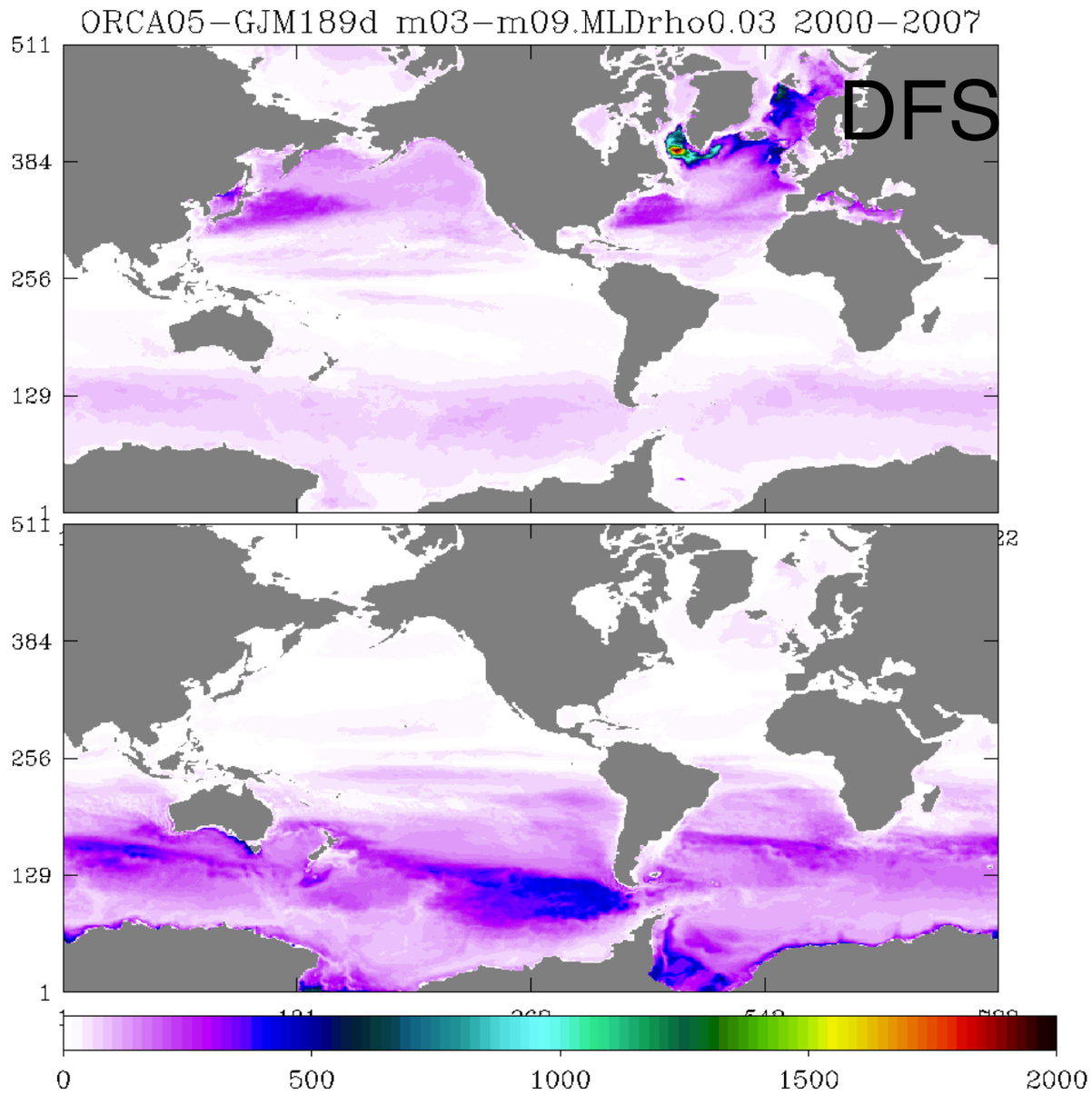
$[mm.d^{-1}]$

Sensitivity experiment with JRA at 0.5° resolution

Mixed layer depth



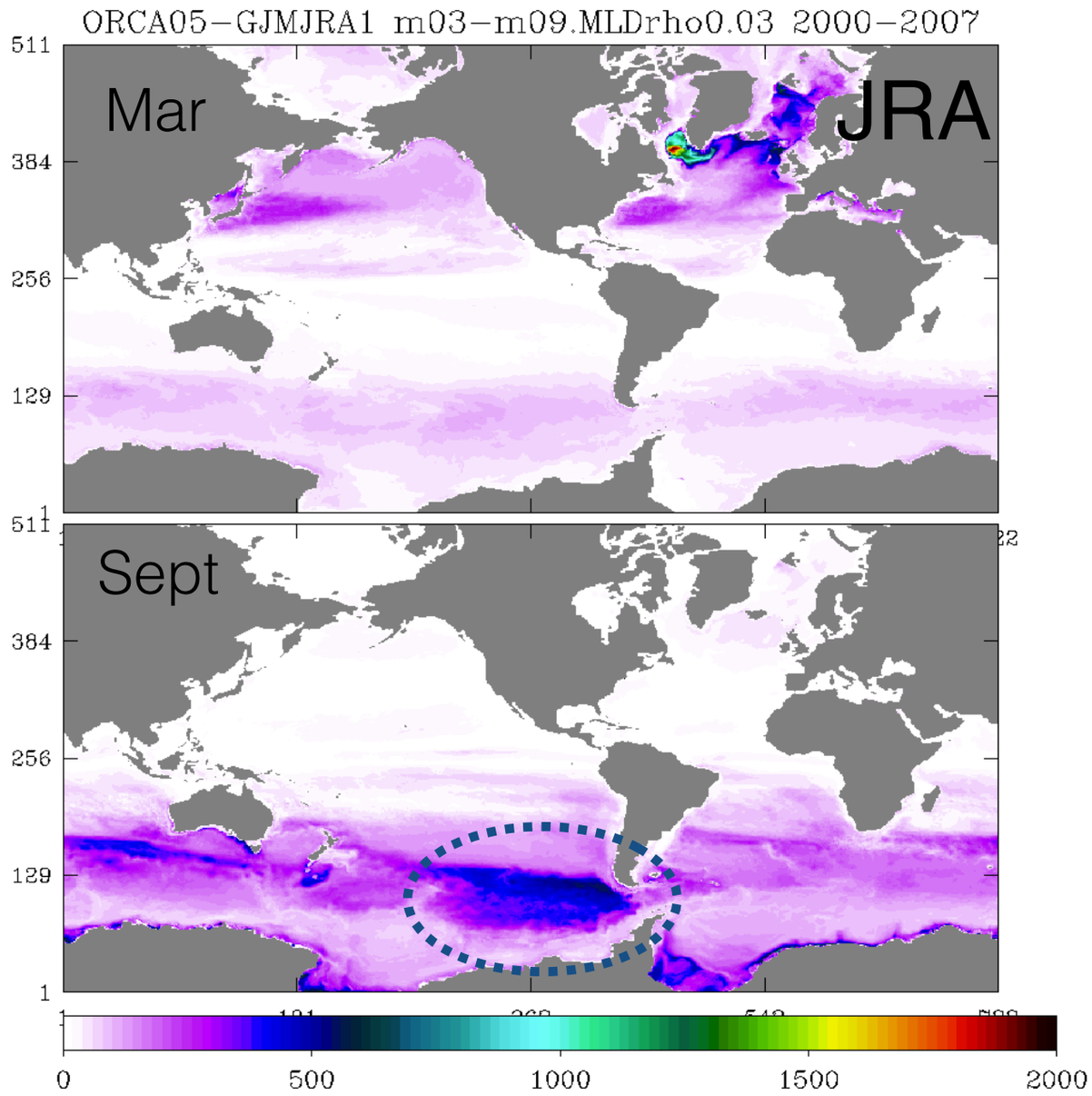
[m]



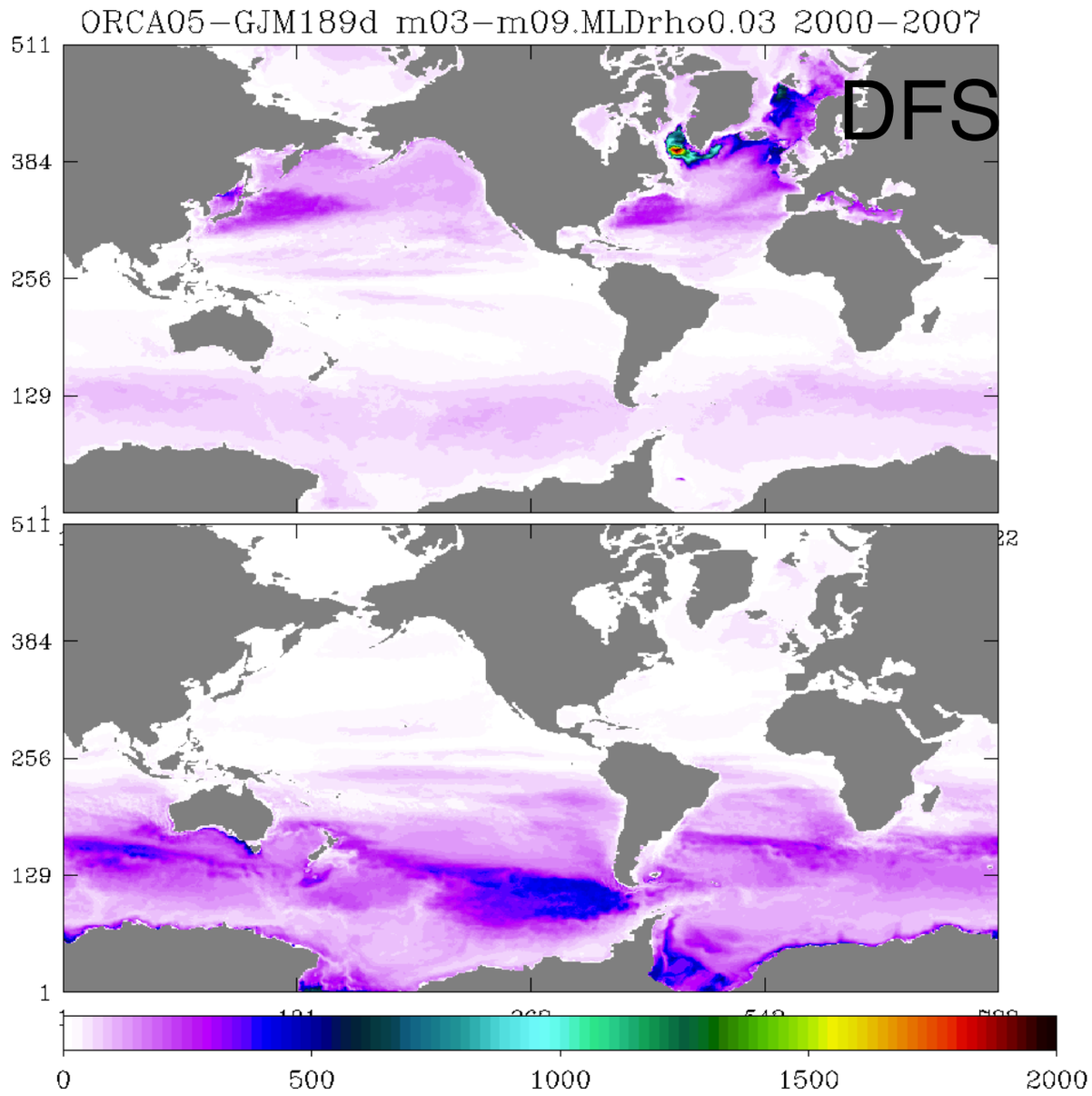
[m]

Sensitivity experiment with JRA at 0.5° resolution

Mixed layer depth



[m]



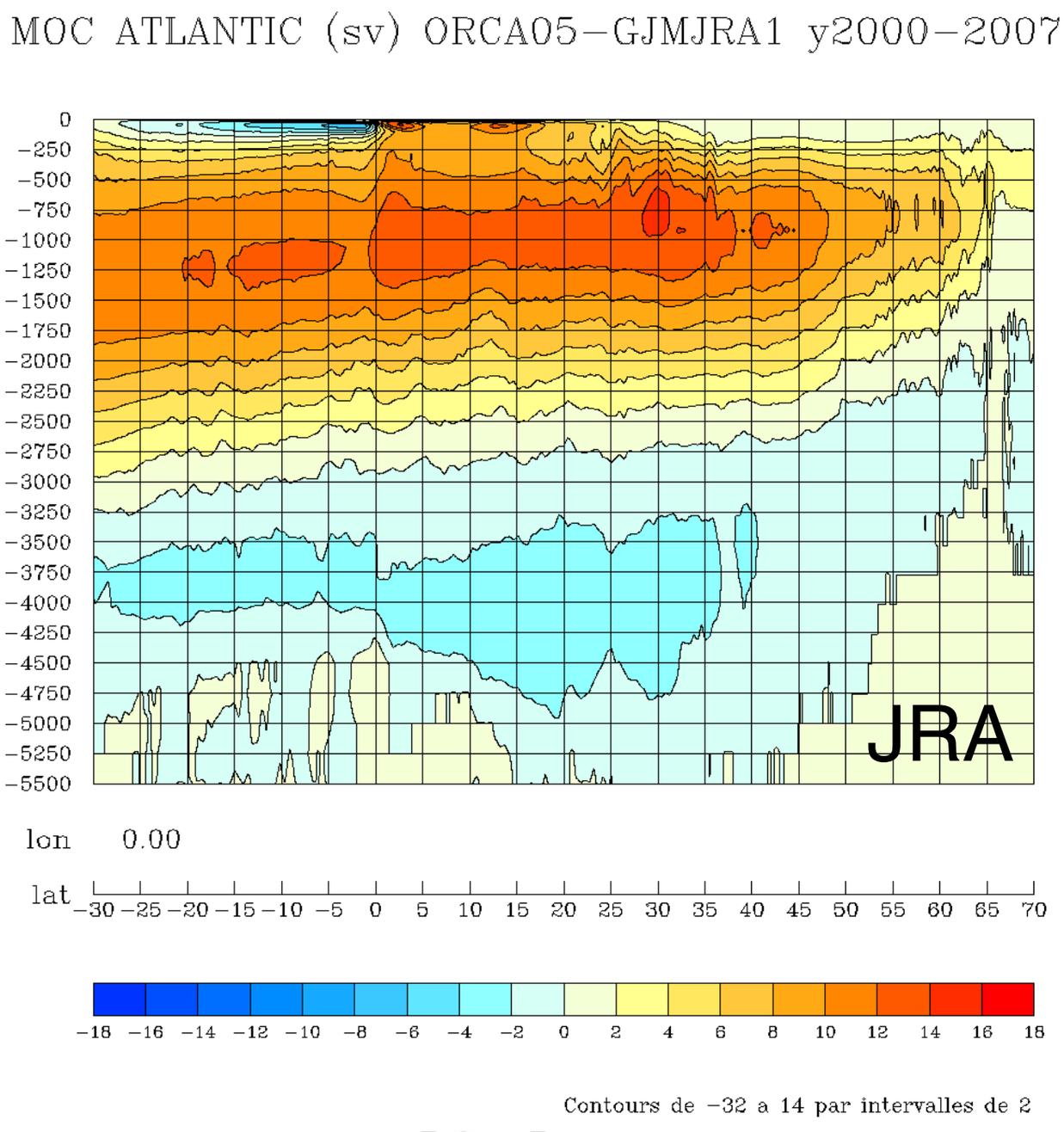
[m]

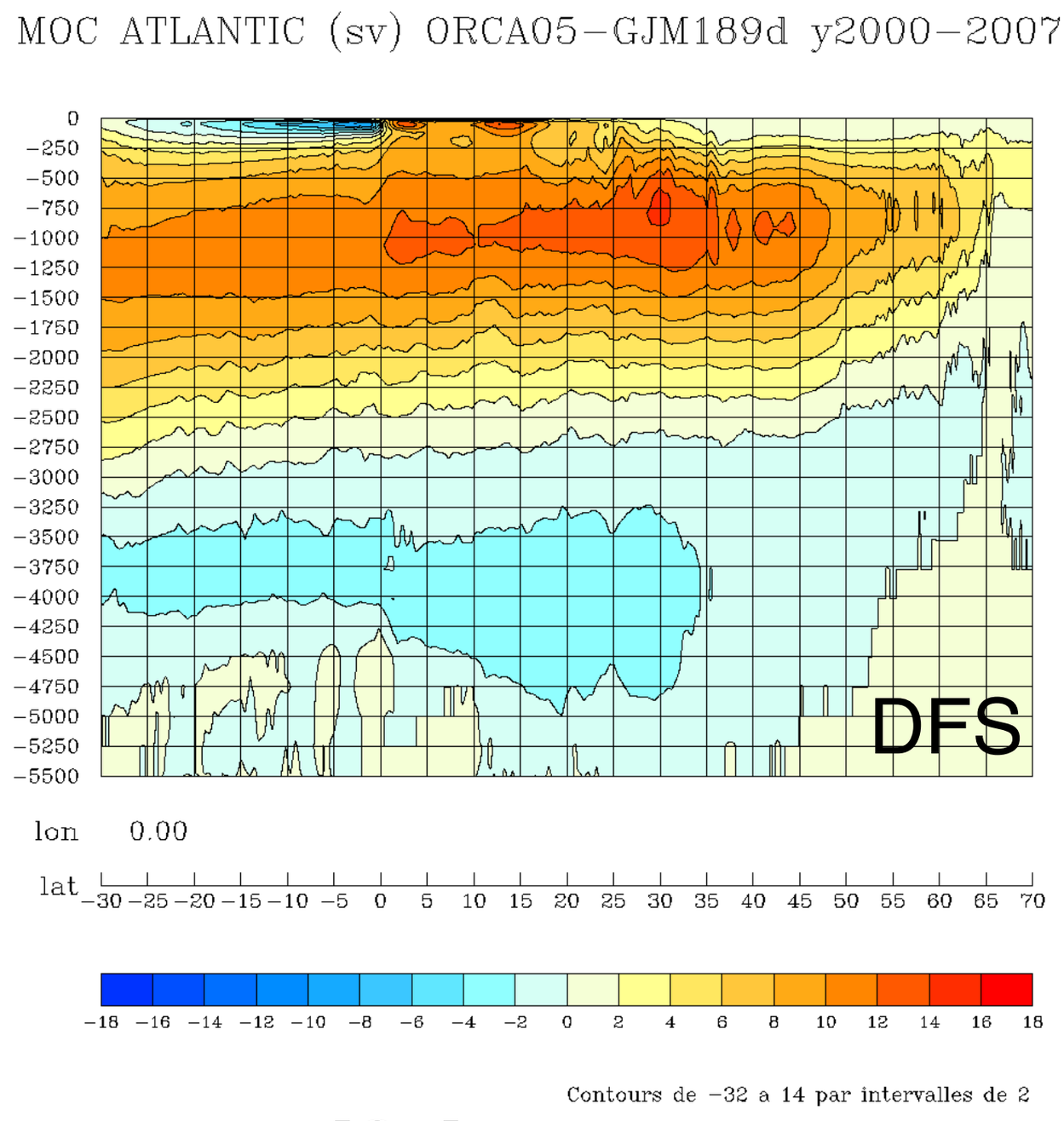
Sensitivity experiment with JRA at 0.5° resolution

OVERTURNING IN ORCA05

Sensitivity experiment with JRA at 0.5° resolution

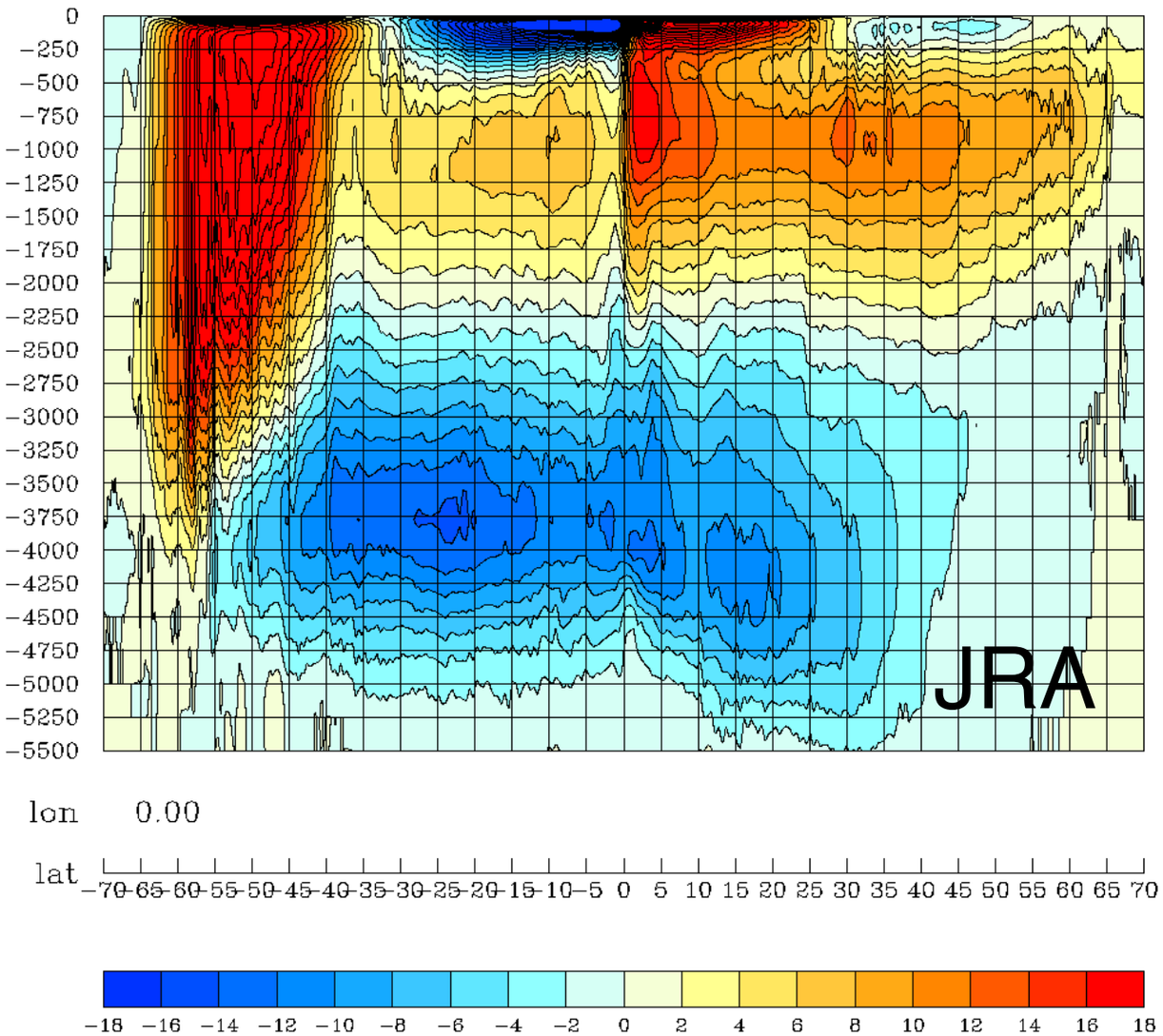
Mean overturning stream function (Atlantic)

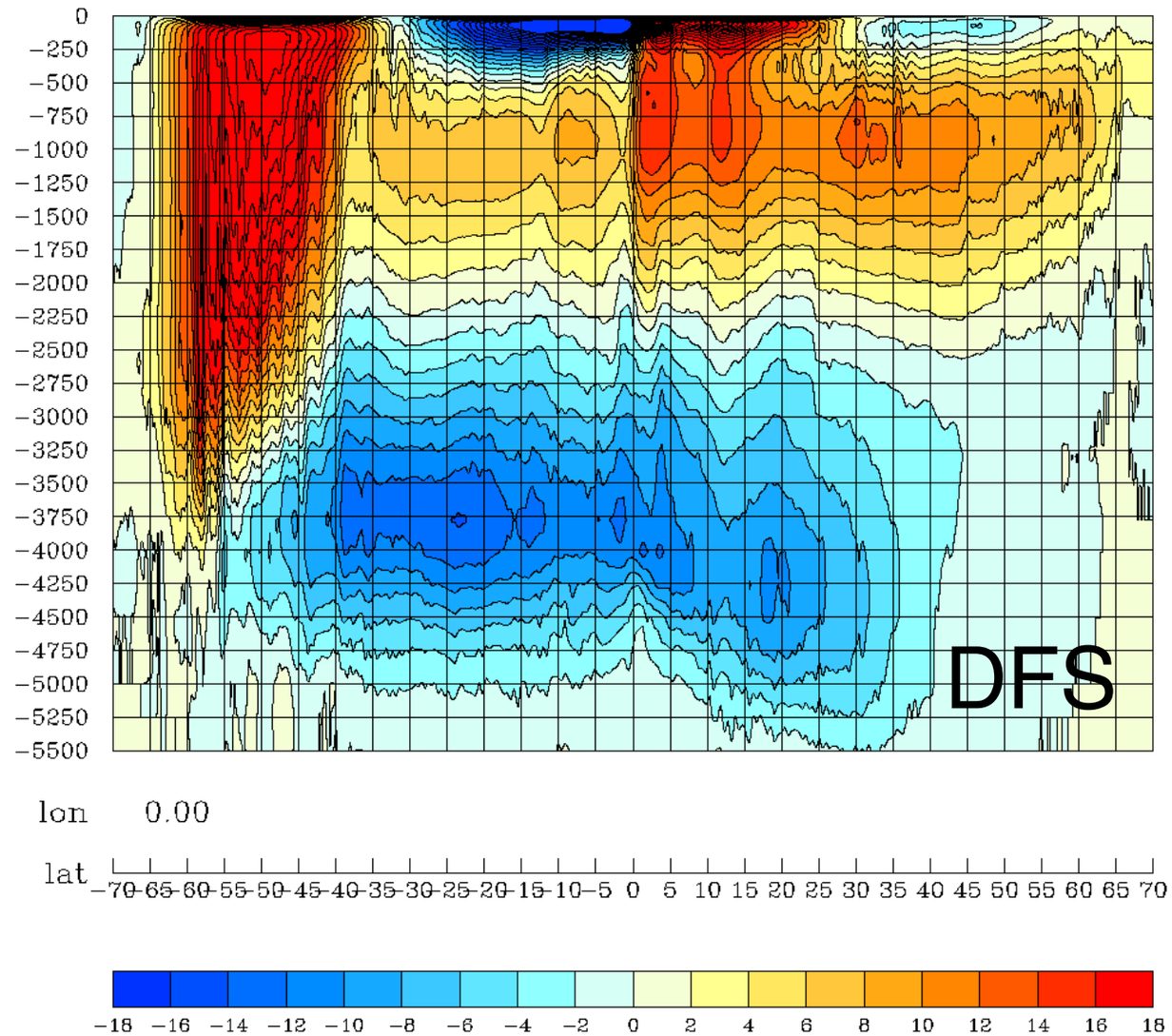




Sensitivity experiment with JRA at 0.5° resolution

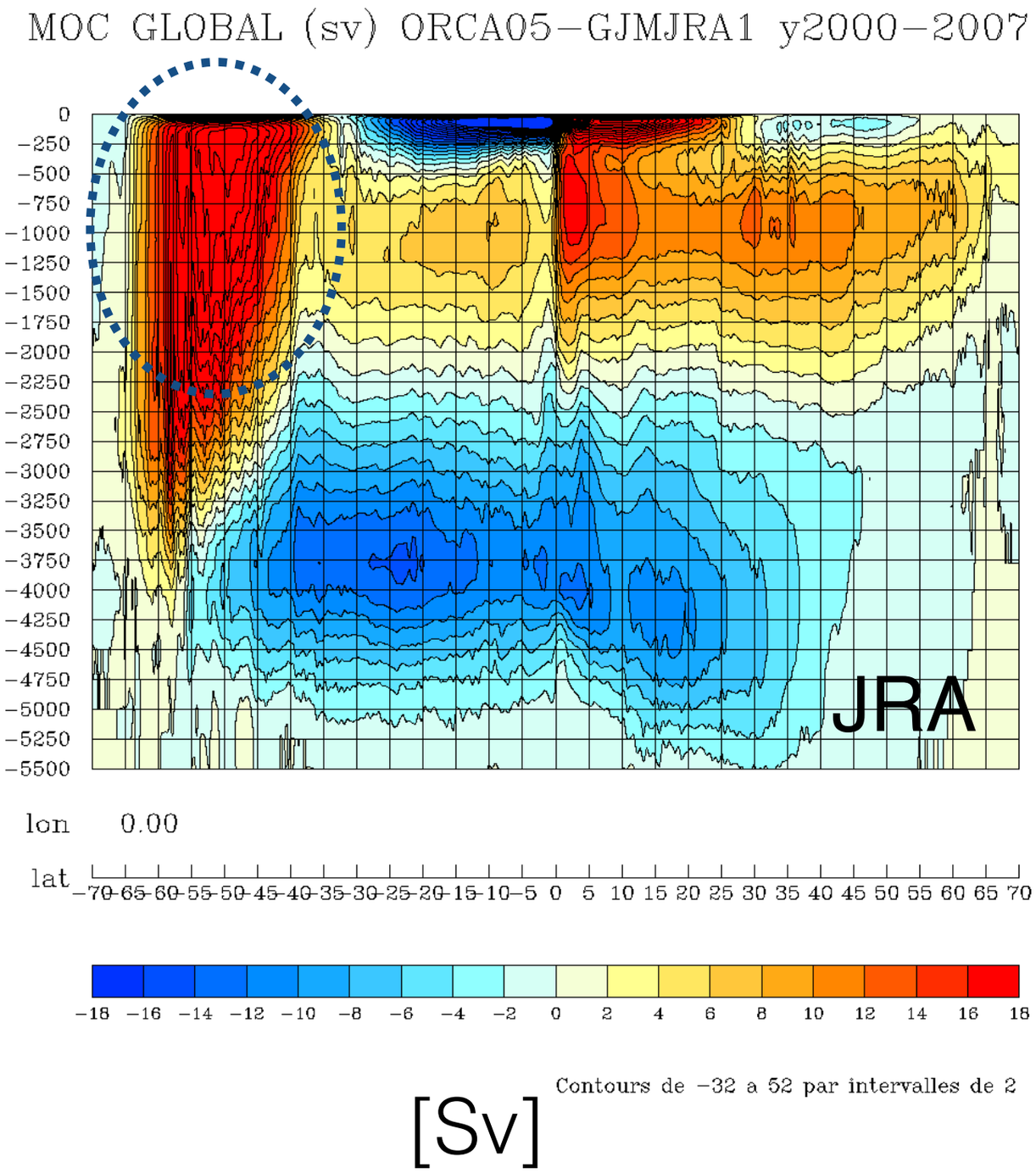
Mean overturning stream function (Global)

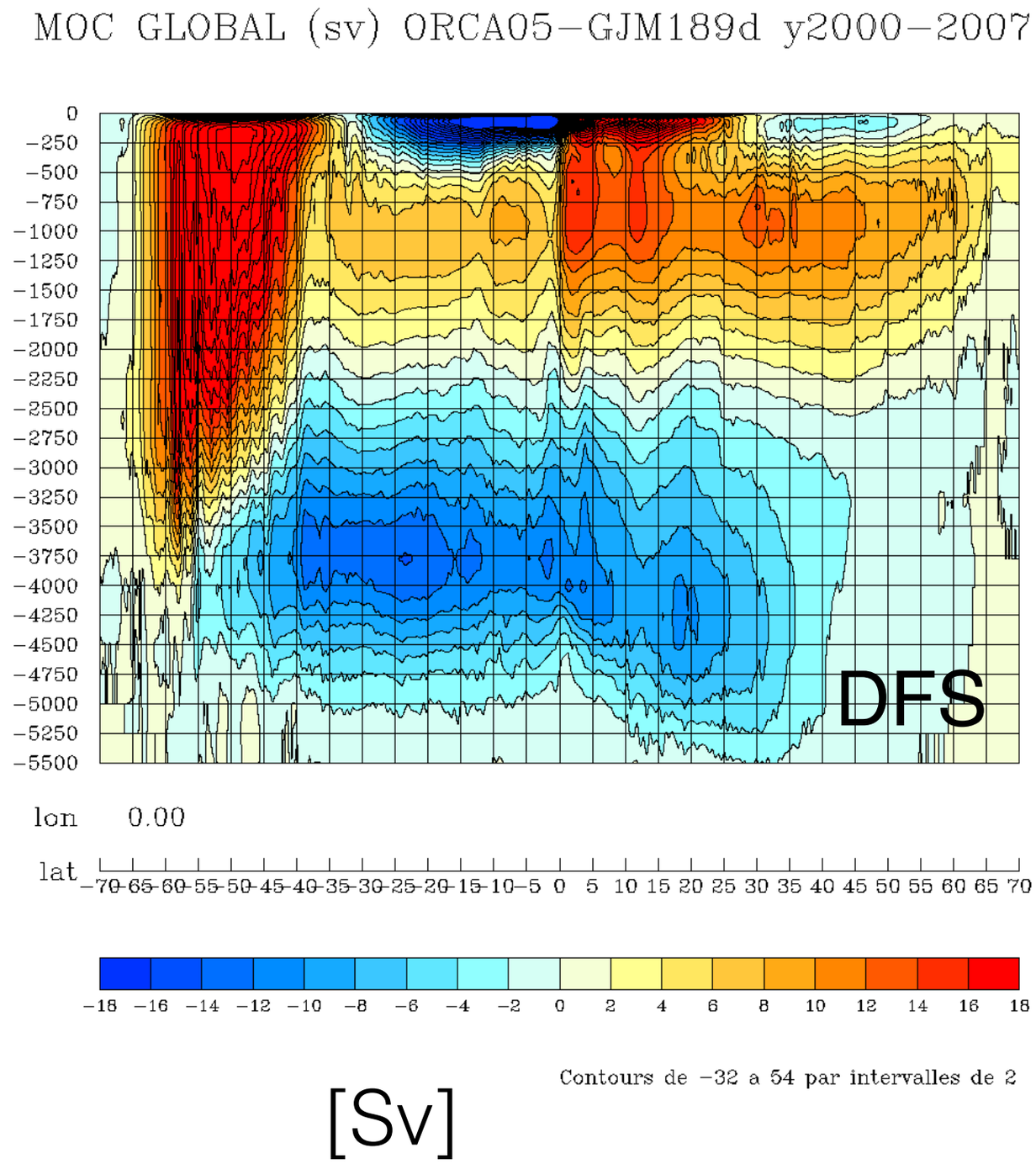




Sensitivity experiment with JRA at 0.5° resolution

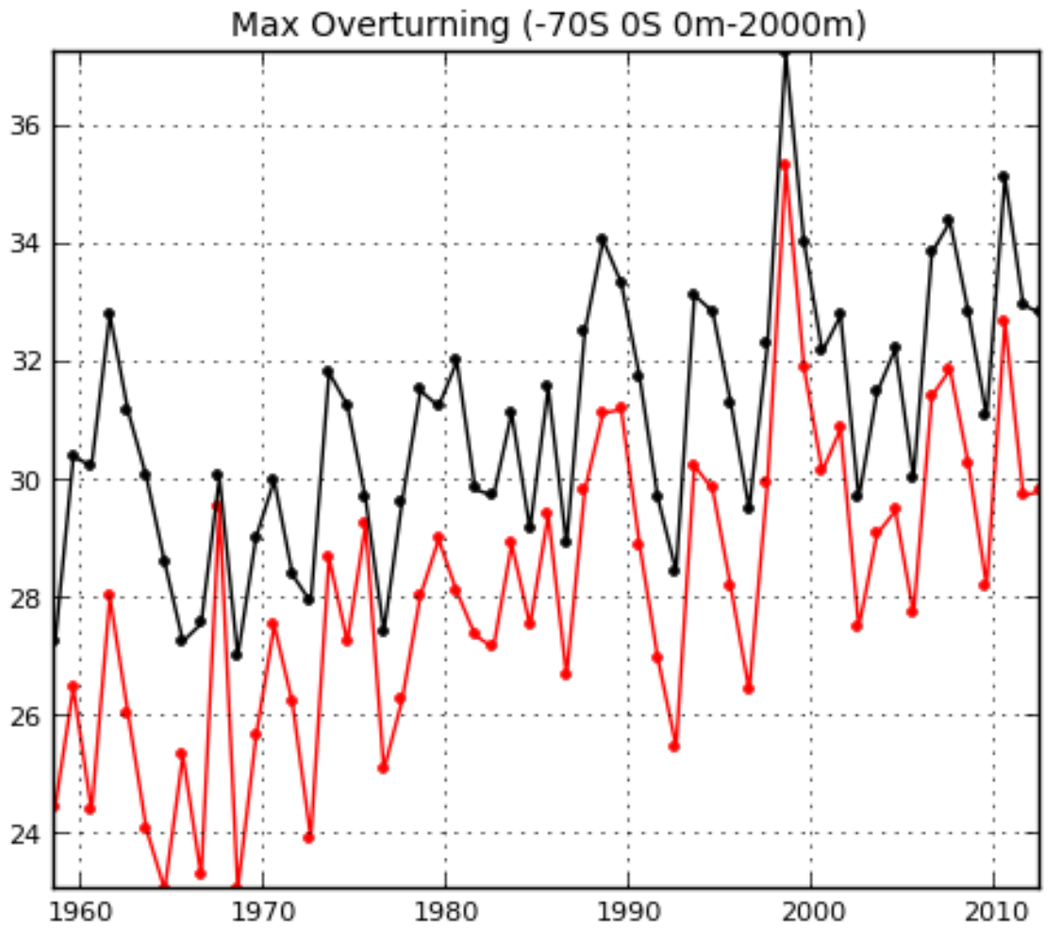
Mean overturning stream function (Global)

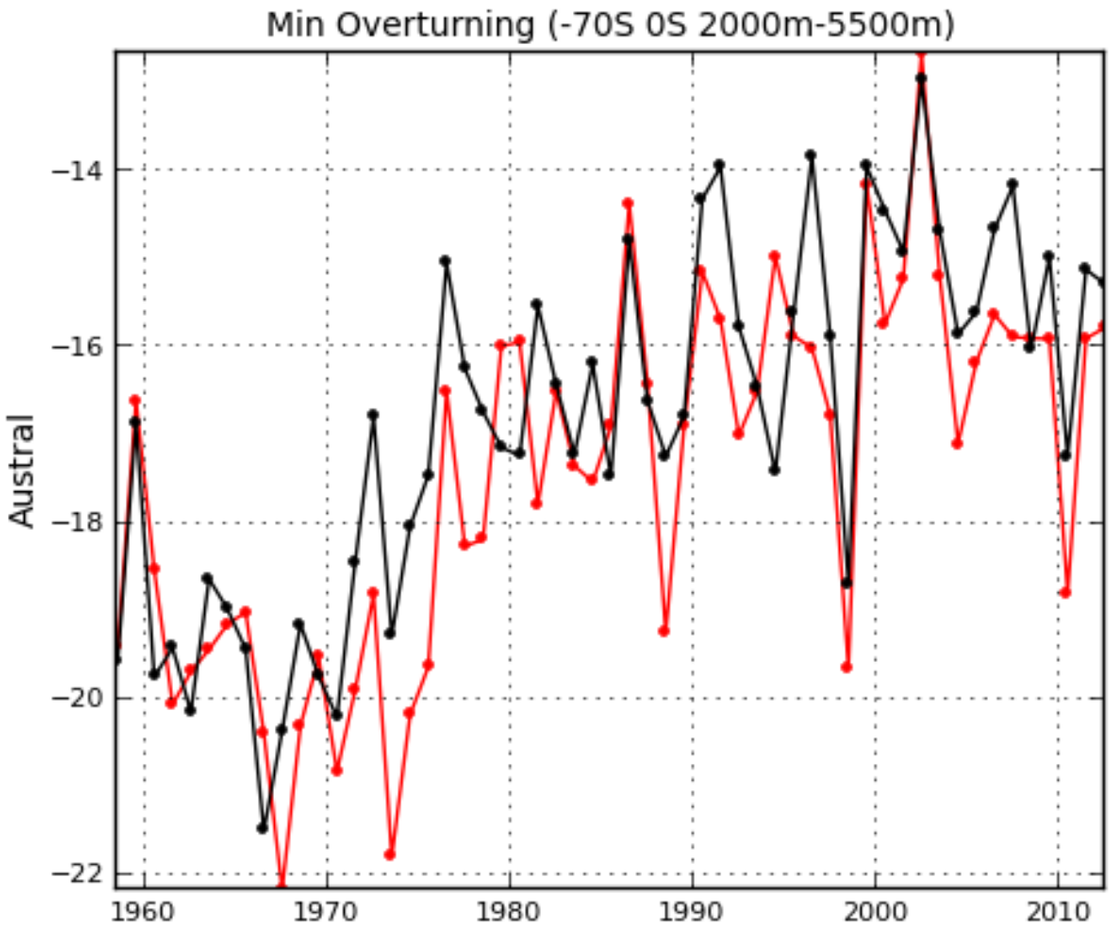




Sensitivity experiment with JRA at 0.5° resolution

Southern Ocean overturning stream (pressure coordinate)



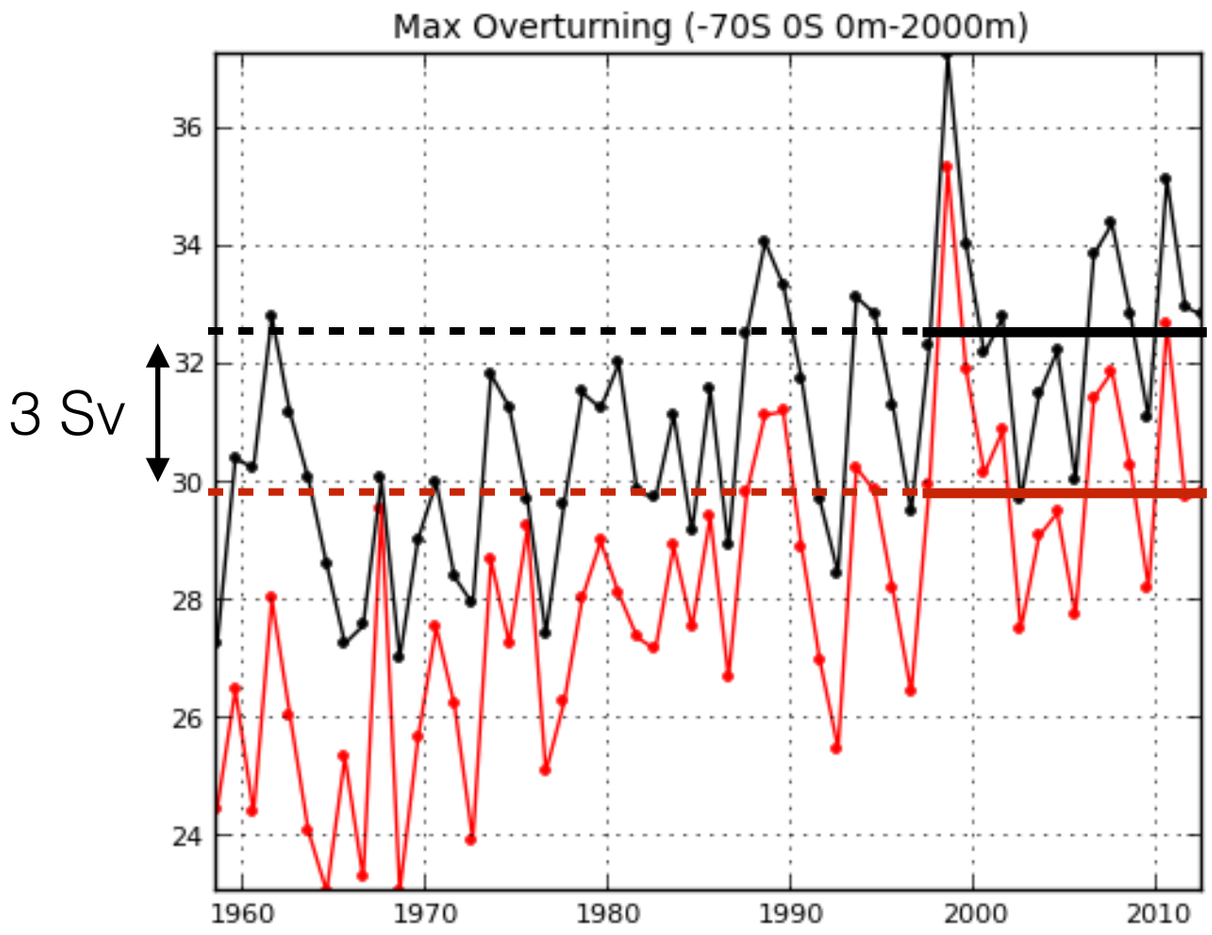


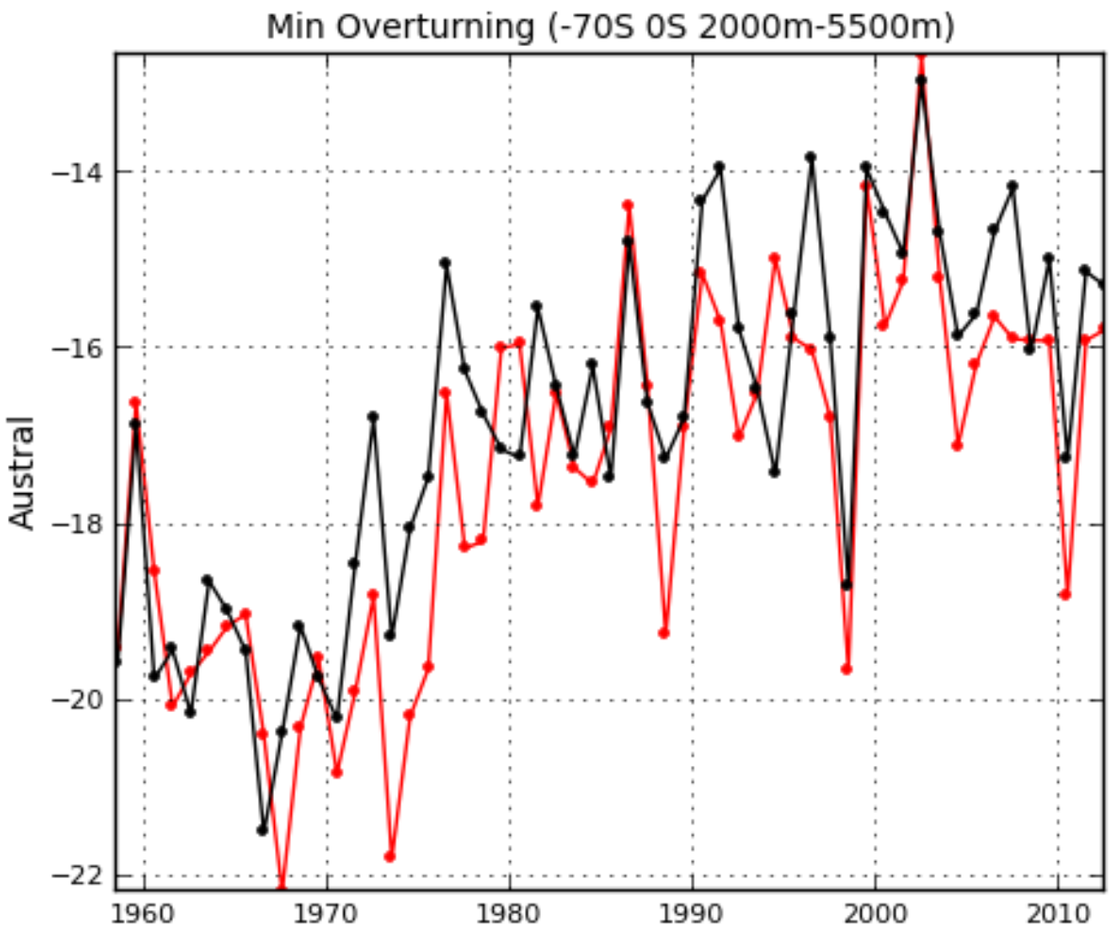
JRA : red

DFS : black

Sensitivity experiment with JRA at 0.5° resolution

Southern Ocean overturning stream (pressure coordinate)





JRA : red

DFS : black

Sensitivity experiment with JRA at 0.5° resolution

Overall, the two **simulations are very similar**, except for

- **mean circulation patterns**
  - slightly contracted subtropical gyre in the north pacific
  - weaker Drake passage transport
  - slightly shallower / less energetic equatorial jets (cf winds)
- **sea-ice**
  - weaker antarctic summer sea-ice extent (cf previous talk)
  - thinner antarctic summer sea-ice
  - slightly thicker arctic sea ice (all-year)
- **mixed layers**
  - deeper winter mixed layers in the Southern Ocean
- **overturning**
  - weaker upper cell overturning in the SO

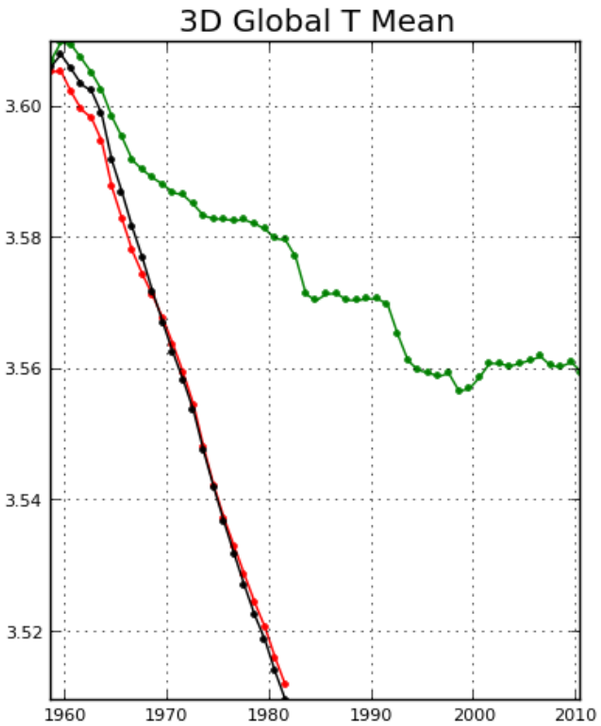
Outline

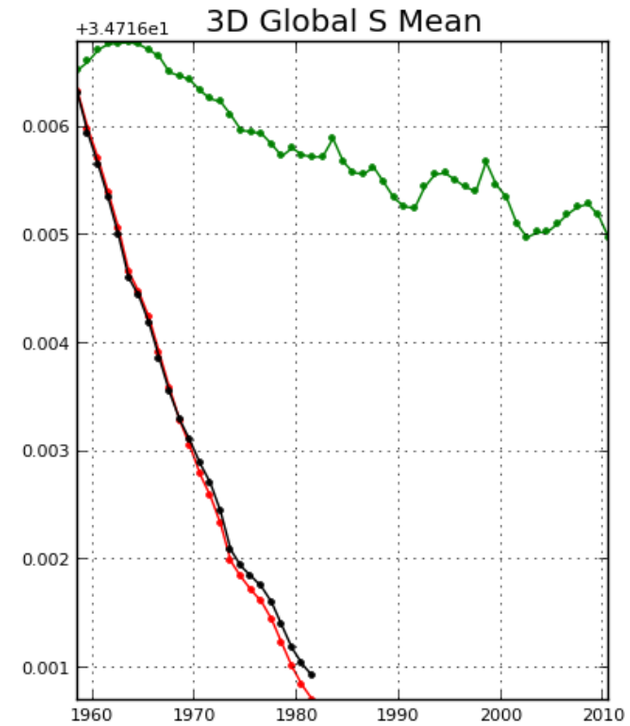
1. Model set-up, experiments and diagnostics
2. Sensitivity tests with JRA-55 forcing dataset at 0.5° resolution
3. Sensitivity tests with JRA-55 forcing dataset at 0.25° resolution
4. Wrap-up and conclusions

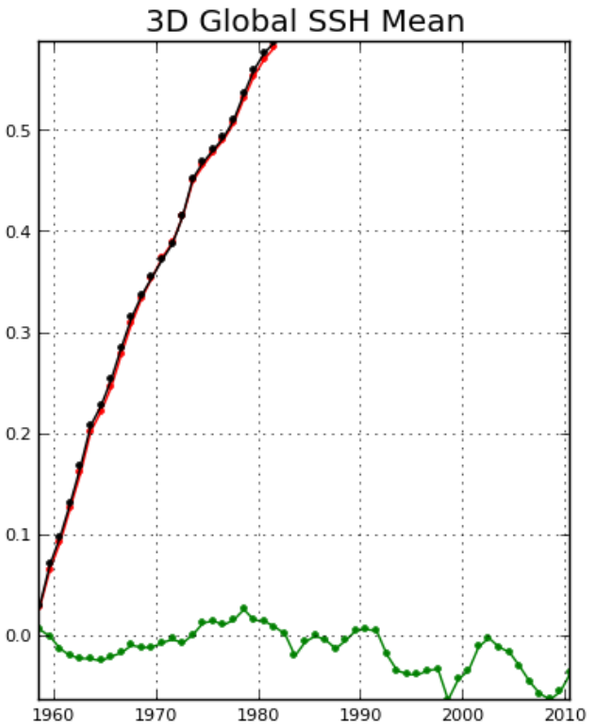
Sensitivity experiment with JRA at 0.25° resolution

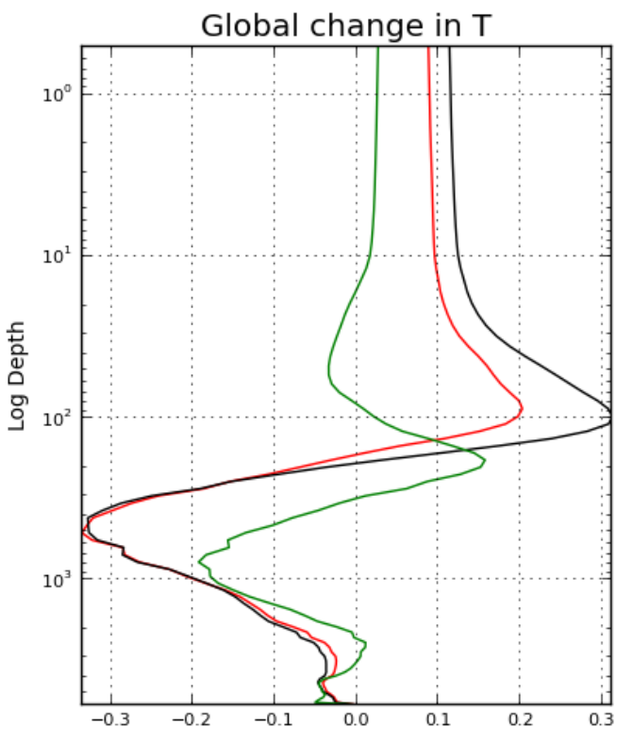
GLOBAL TRENDS IN ORCA025

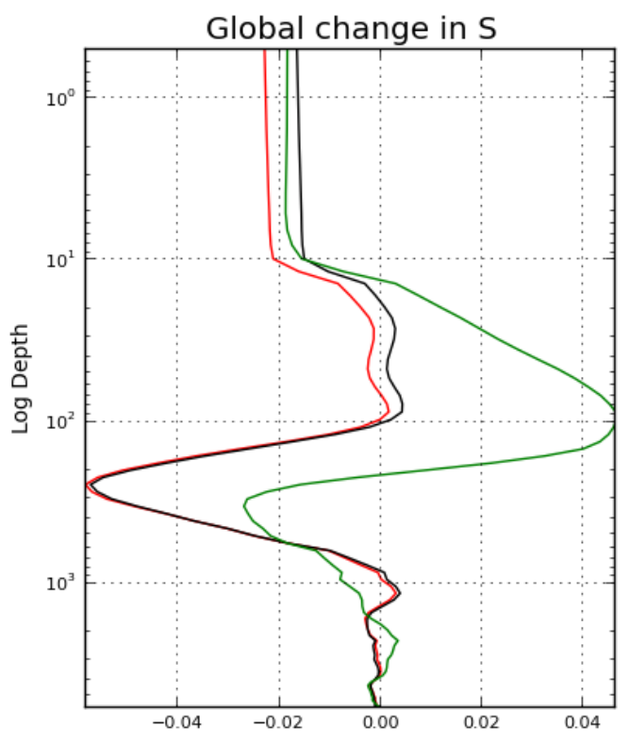
Sensitivity experiment with JRA at 0.25° resolution











JRA1 (abs) : black
JRA2 (rel) : red
DFS : green

cooling, freshening

<u>Global trends</u>

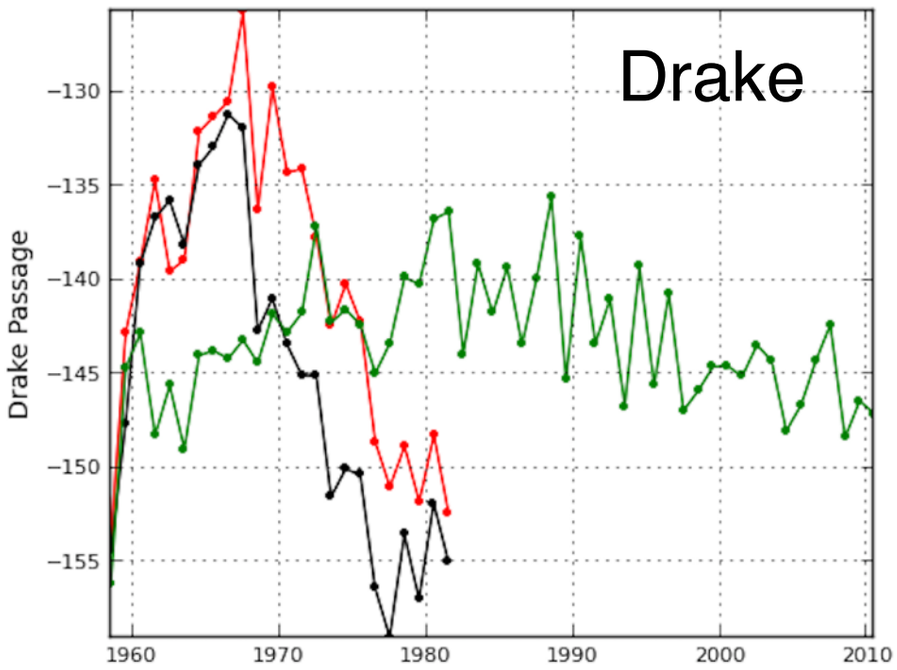
Sensitivity experiment with JRA at 0.25° resolution

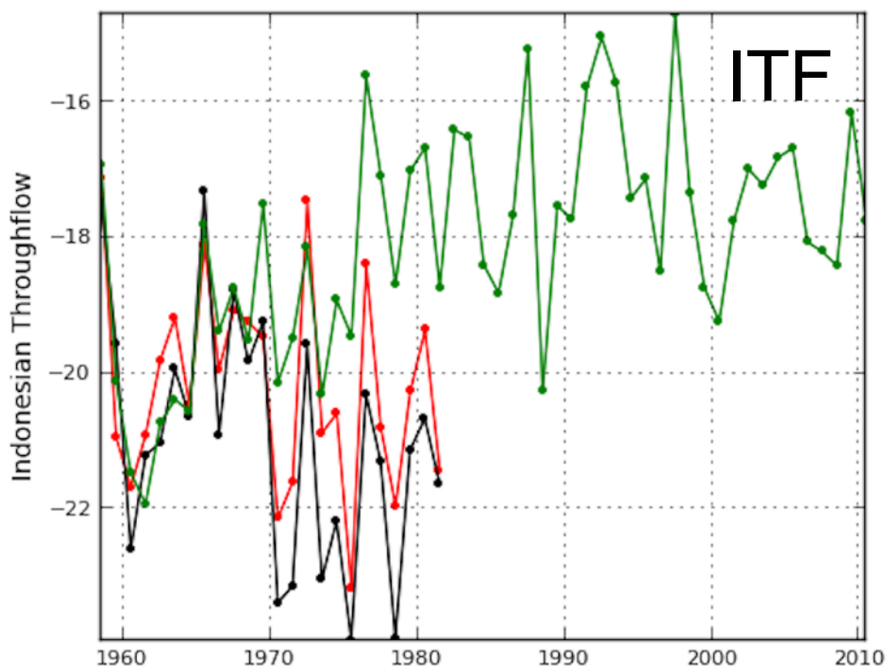
TRANSPORTS IN ORCA025

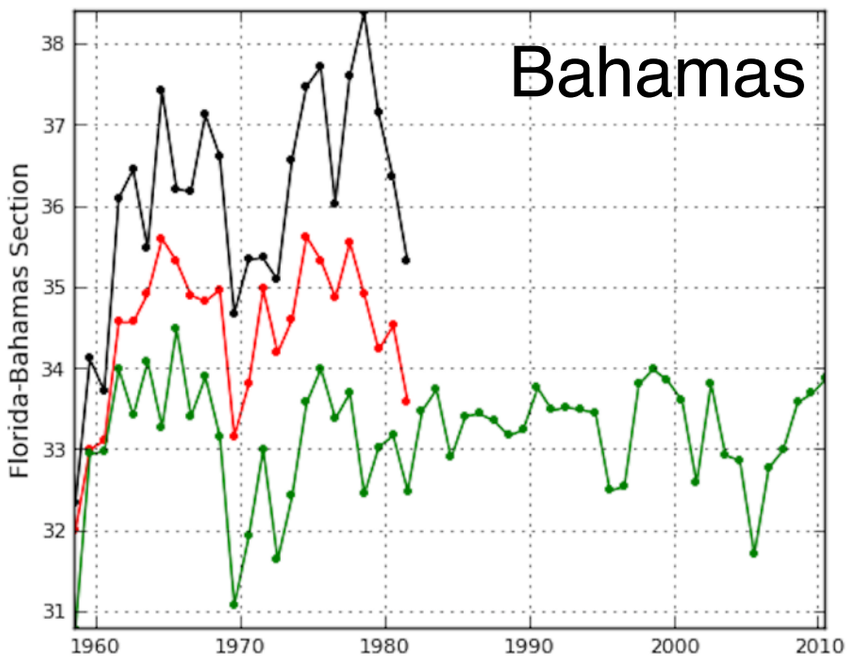
Sensitivity experiment with JRA at 0.25° resolution

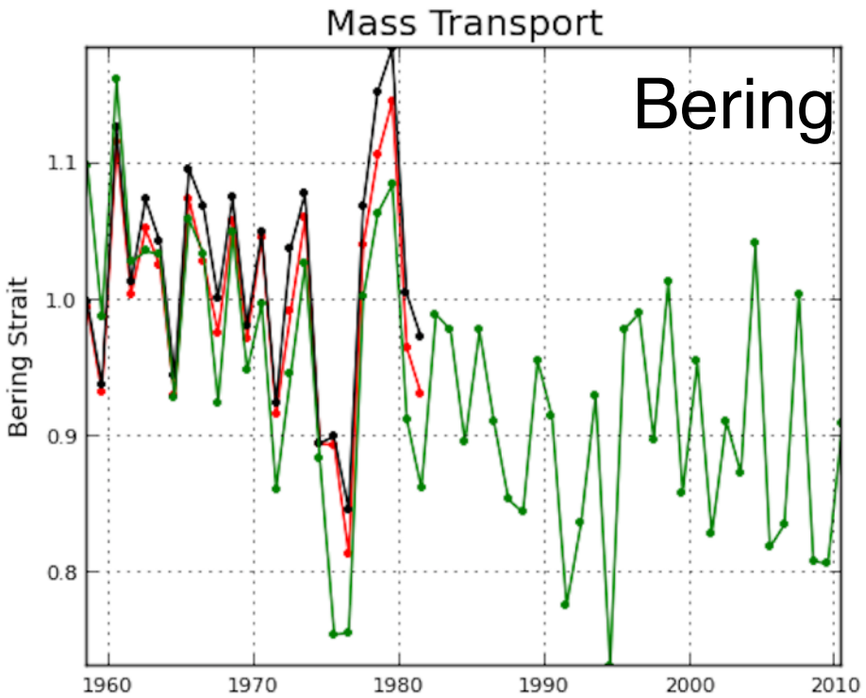
Barotropic transport

JRA1 (abs) : black
JRA2 (rel) : red
DFS : green





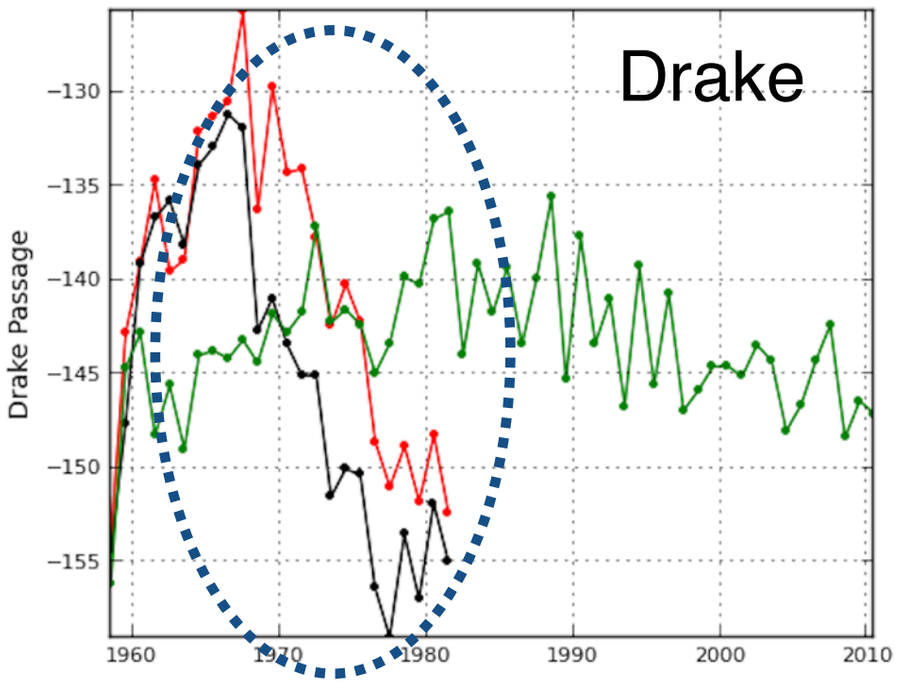


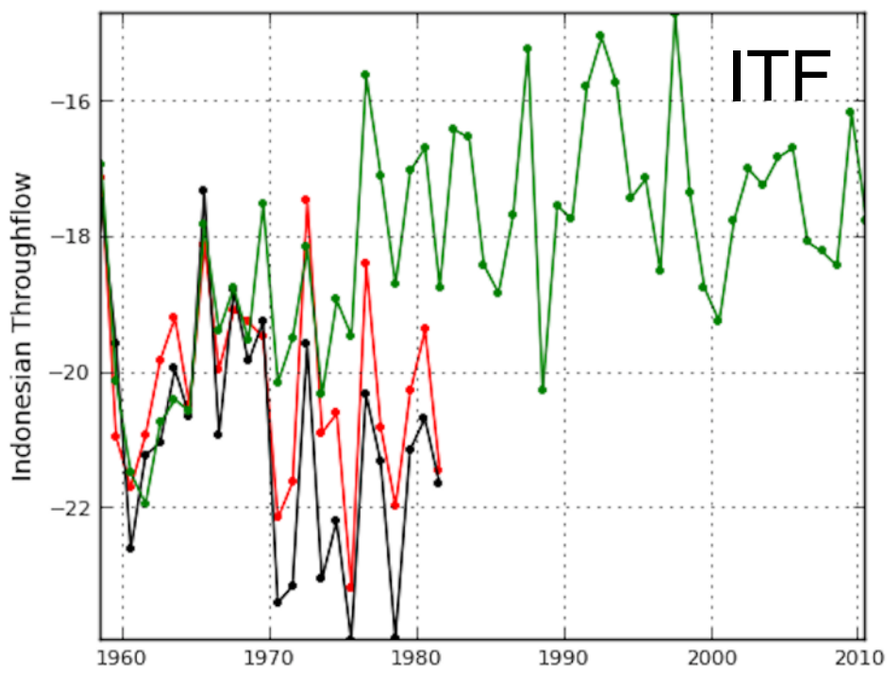


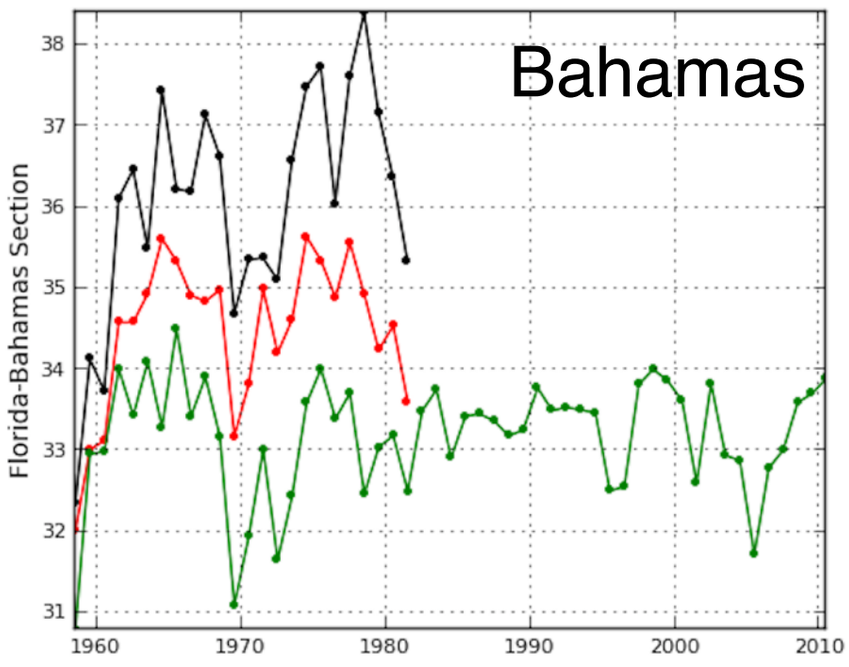
Sensitivity experiment with JRA at 0.25° resolution

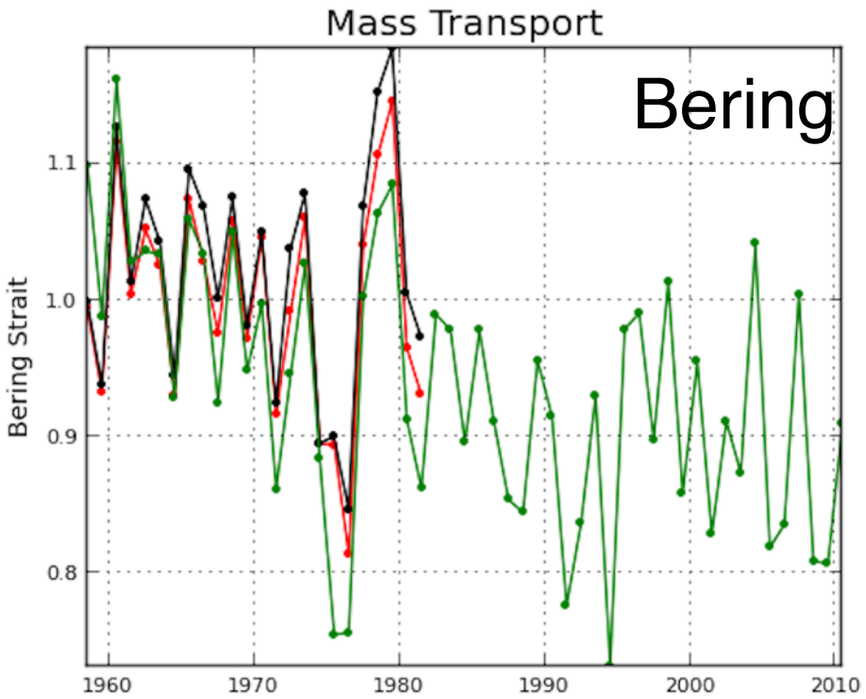
Barotropic transport

JRA1 (abs) : black
JRA2 (rel) : red
DFS : green





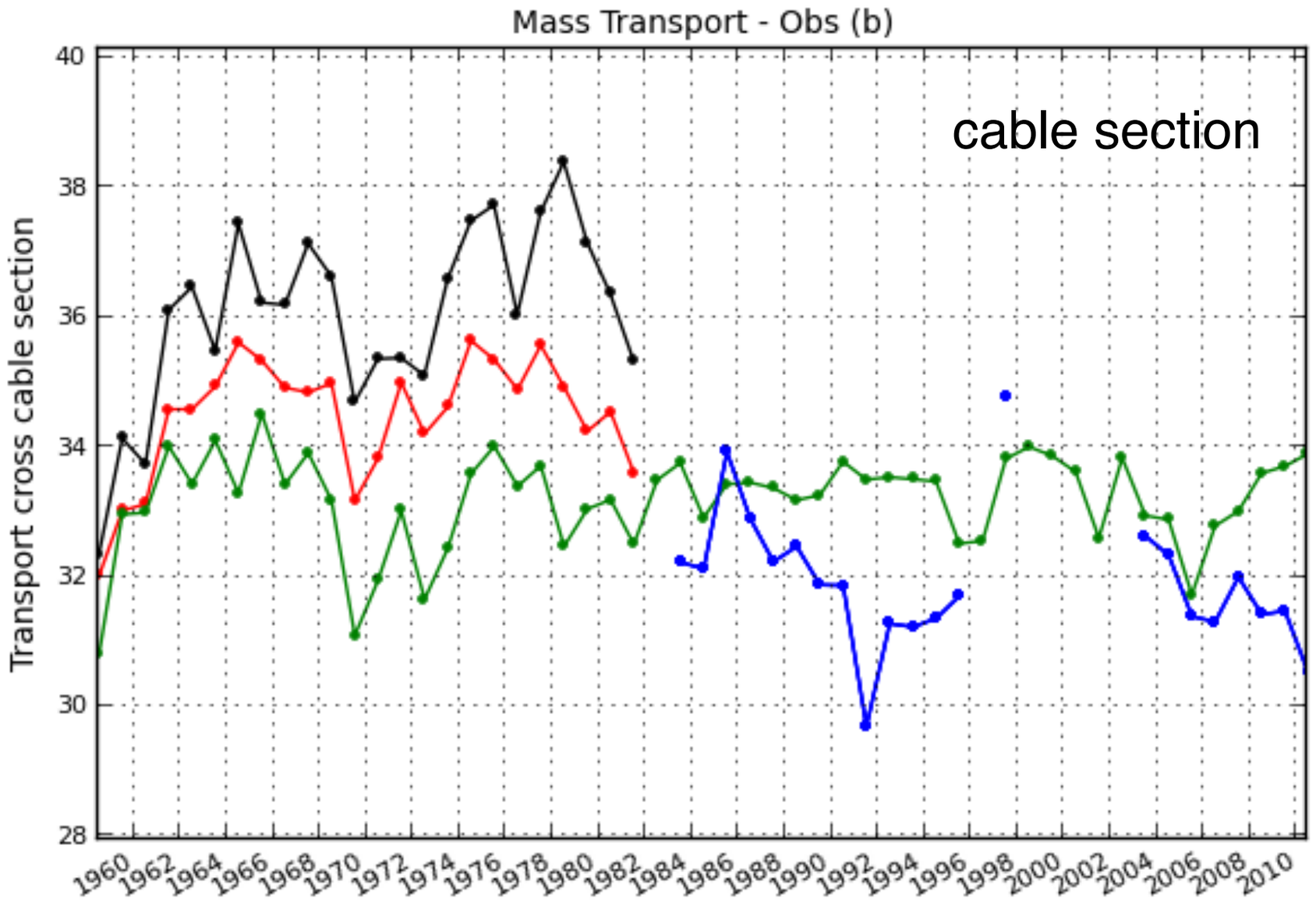




Sensitivity experiment with JRA at 0.25° resolution

Barotropic transport

JRA1 (abs) : black
JRA2 (rel) : red
DFS : green
OBS : blue

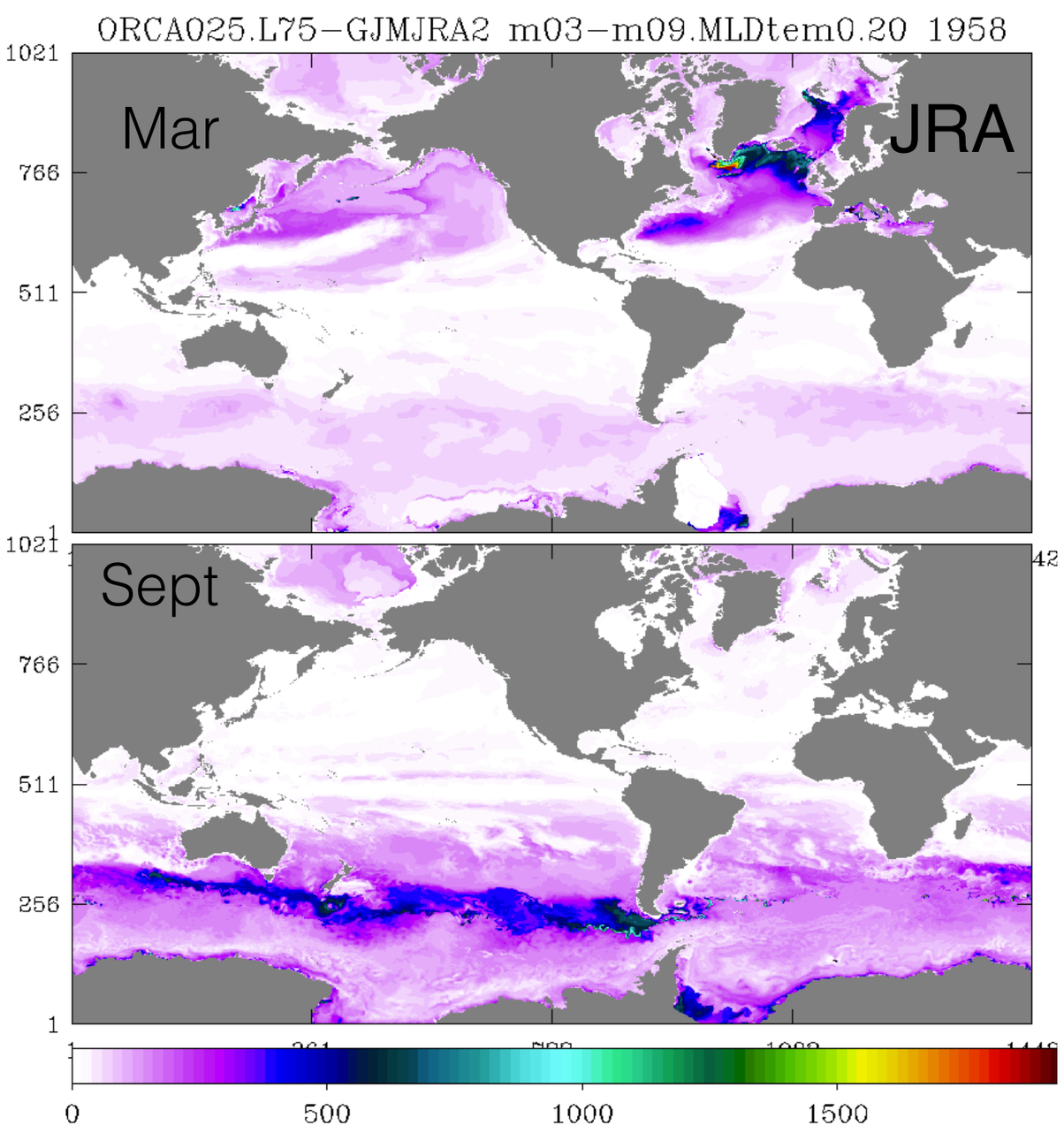


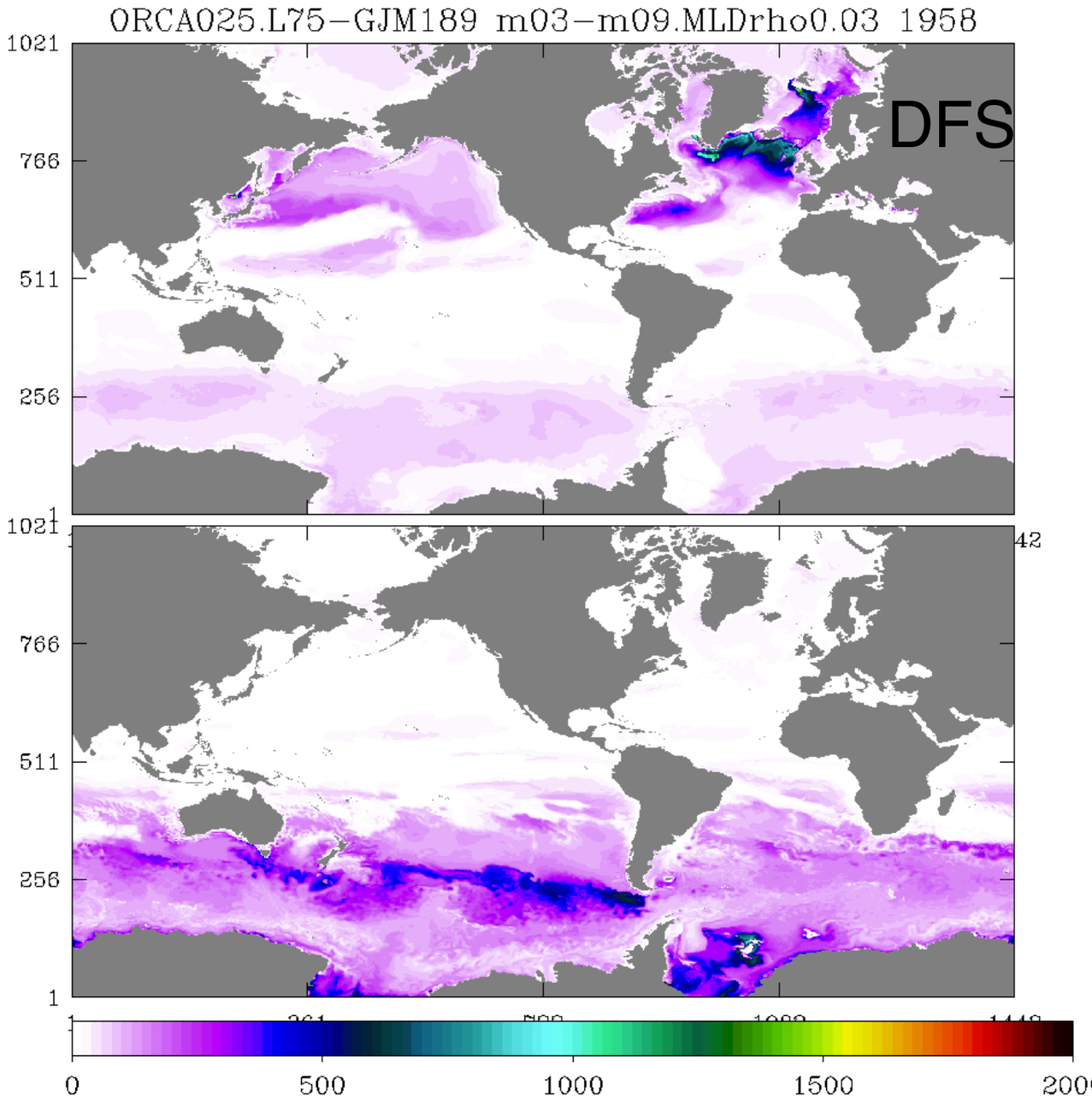
Sensitivity experiment with JRA at 0.25° resolution

MIXED LAYER IN ORCA025

Sensitivity experiment with JRA at 0.25° resolution

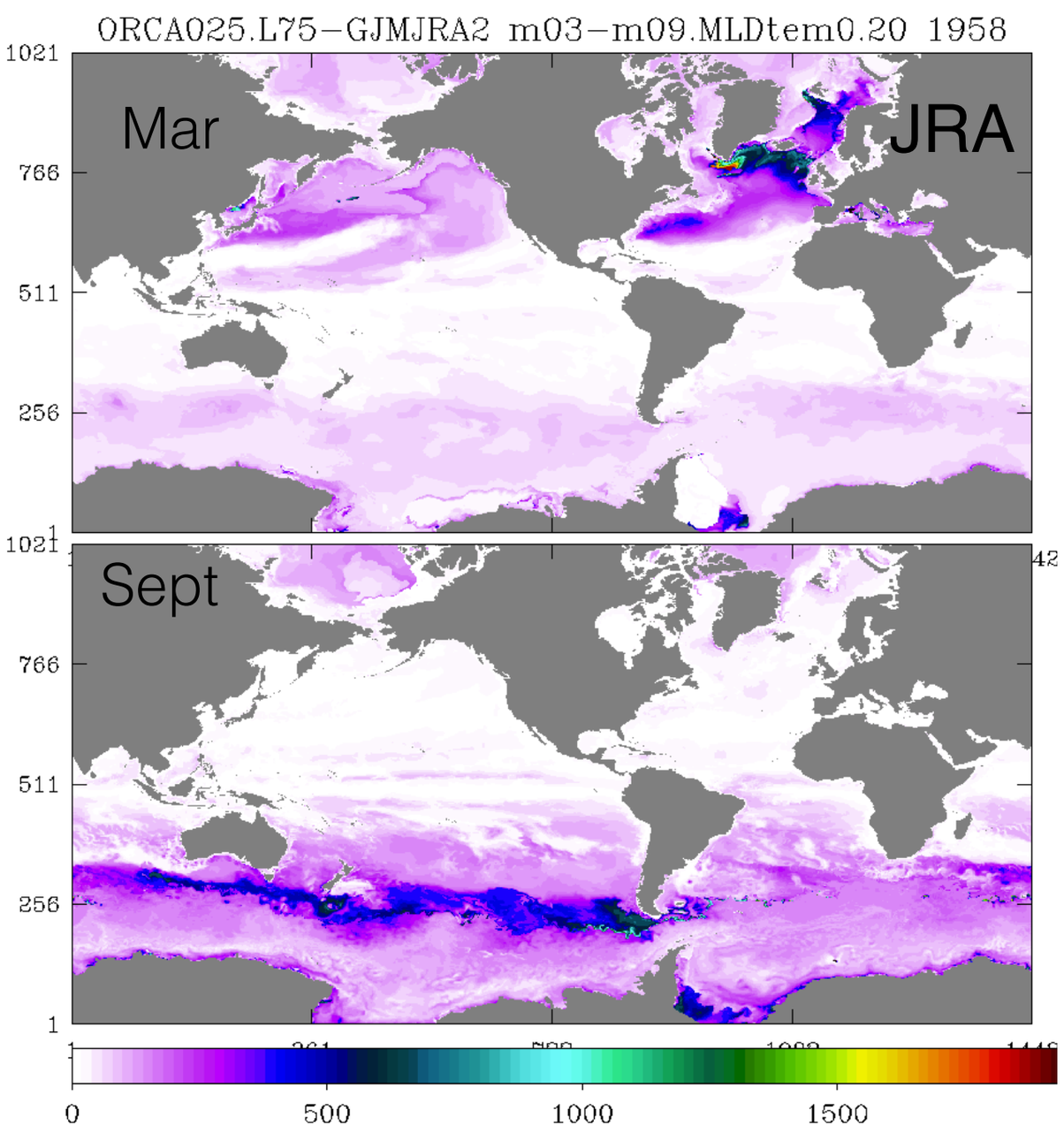
Mixed layer depth

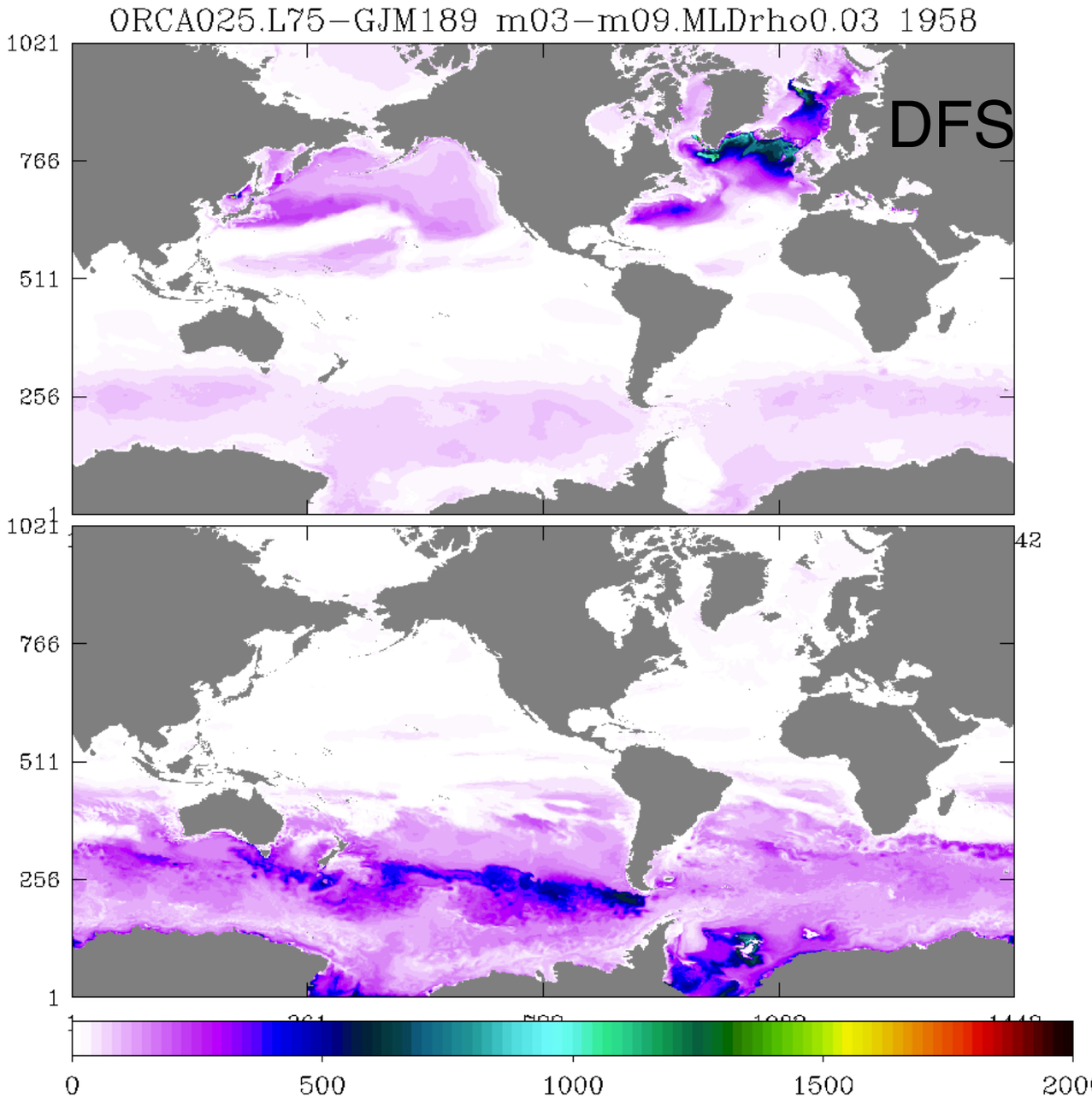




Sensitivity experiment with JRA at 0.25° resolution

Mixed layer depth





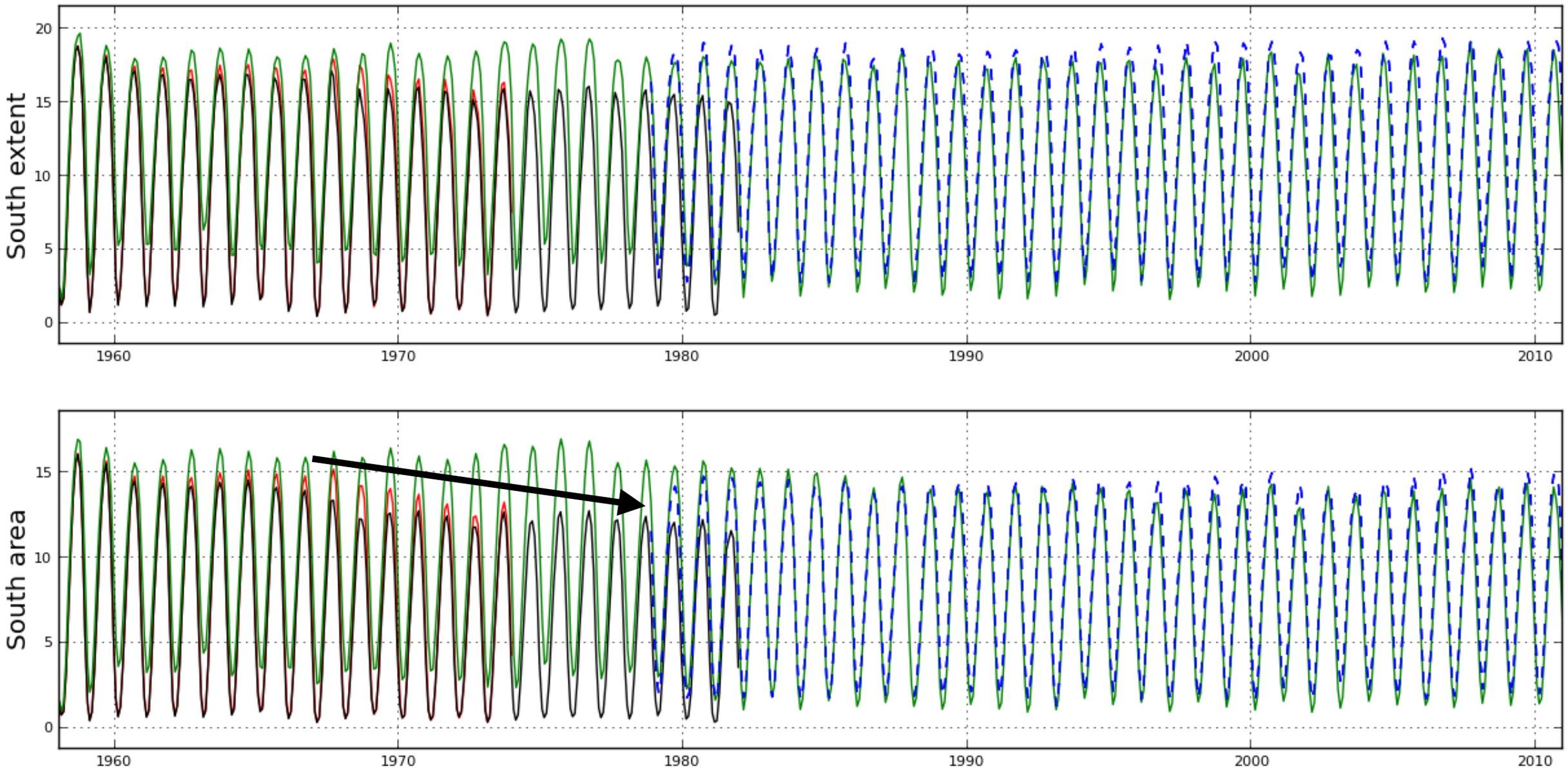
Sensitivity experiment with JRA at 0.25° resolution

SEA ICE IN ORCA025

Sensitivity experiment with JRA at 0.25° resolution

Antarctic sea ice extent and area

JRA1 (abs) : black
JRA2 (rel) : red
DFS : green
OBS : blue

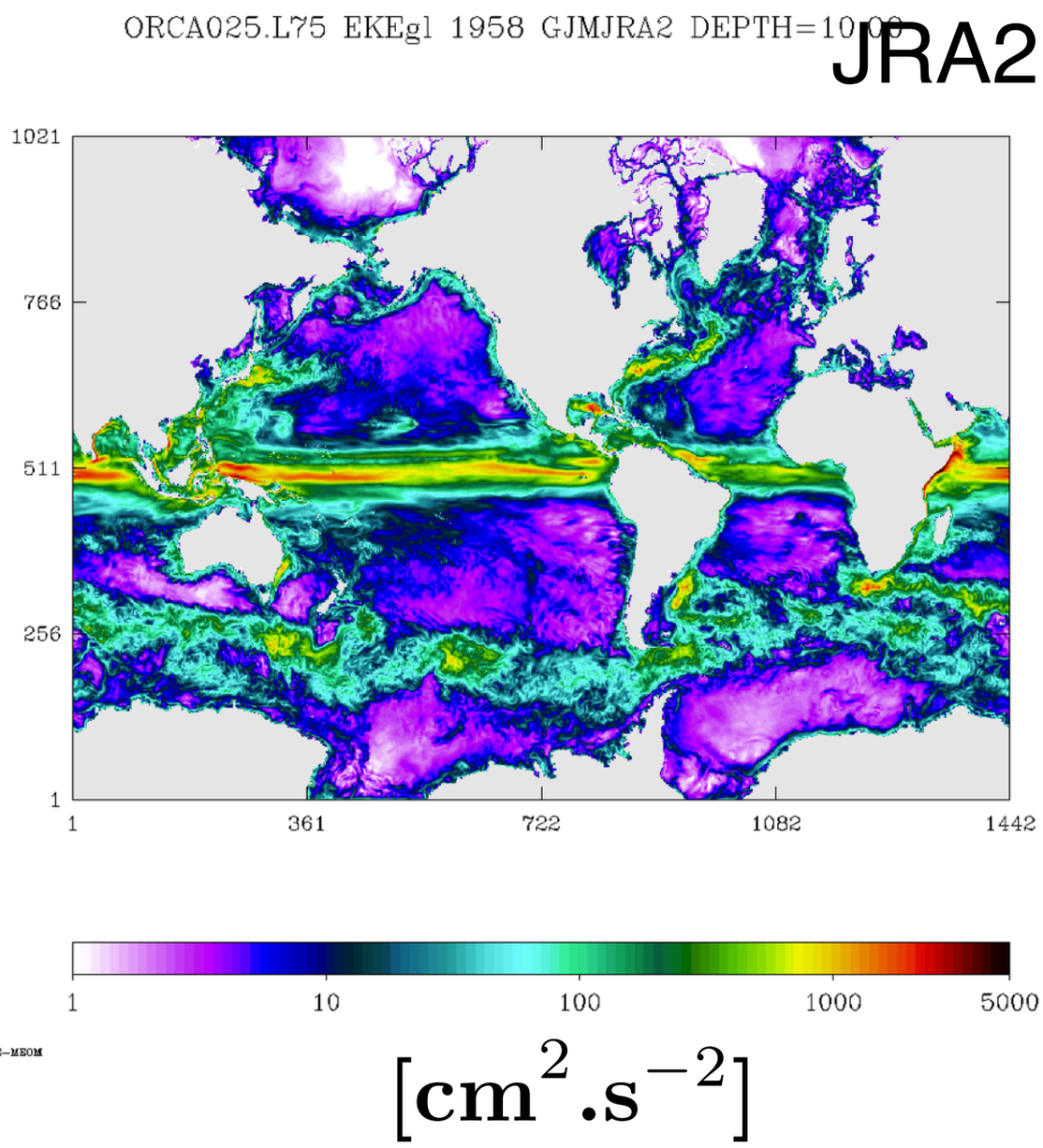


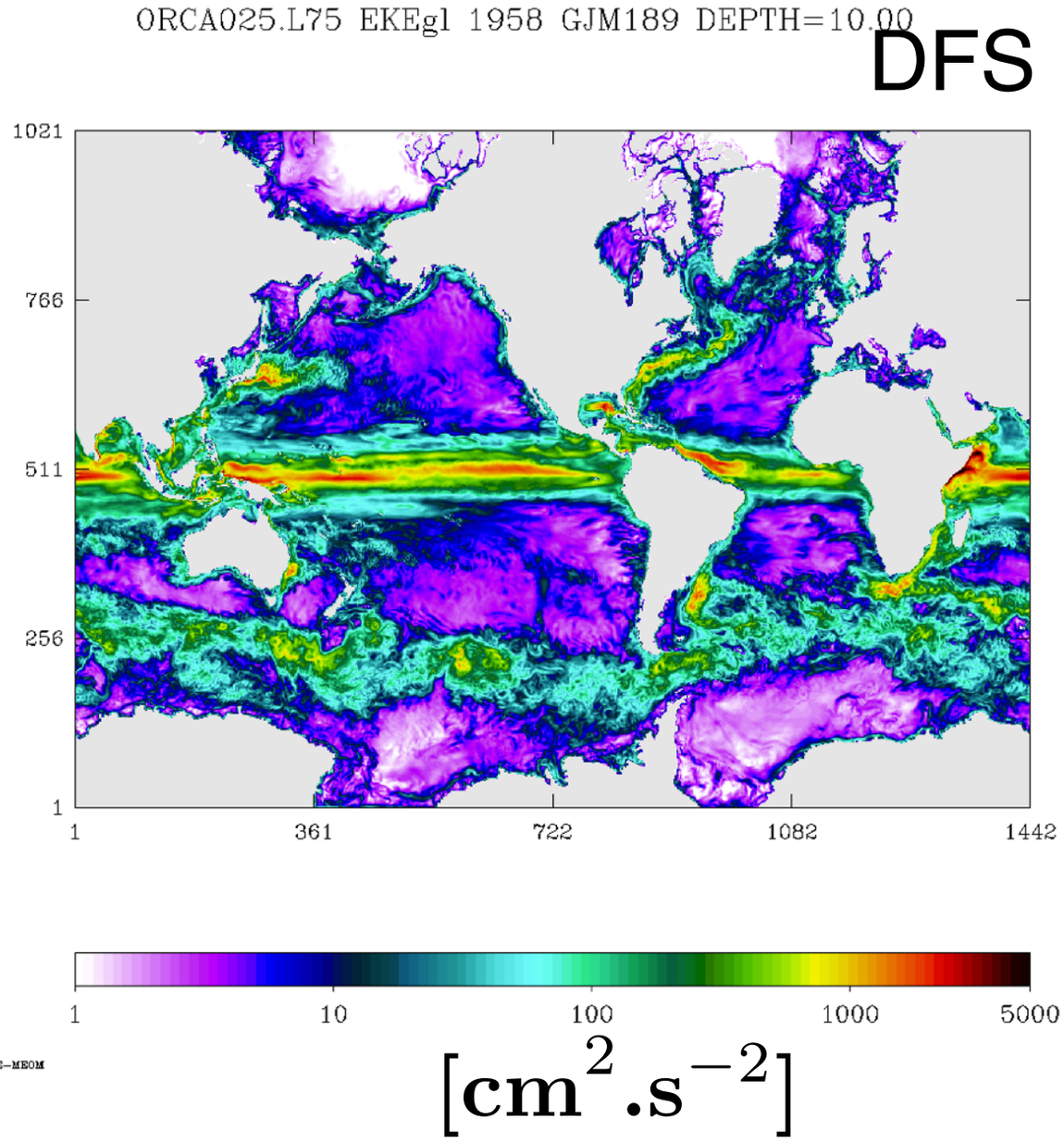
Sensitivity experiment with JRA at 0.25° resolution

EDDY KINETIC ENERGY IN ORCA025

Sensitivity experiment with JRA at 0.25° resolution

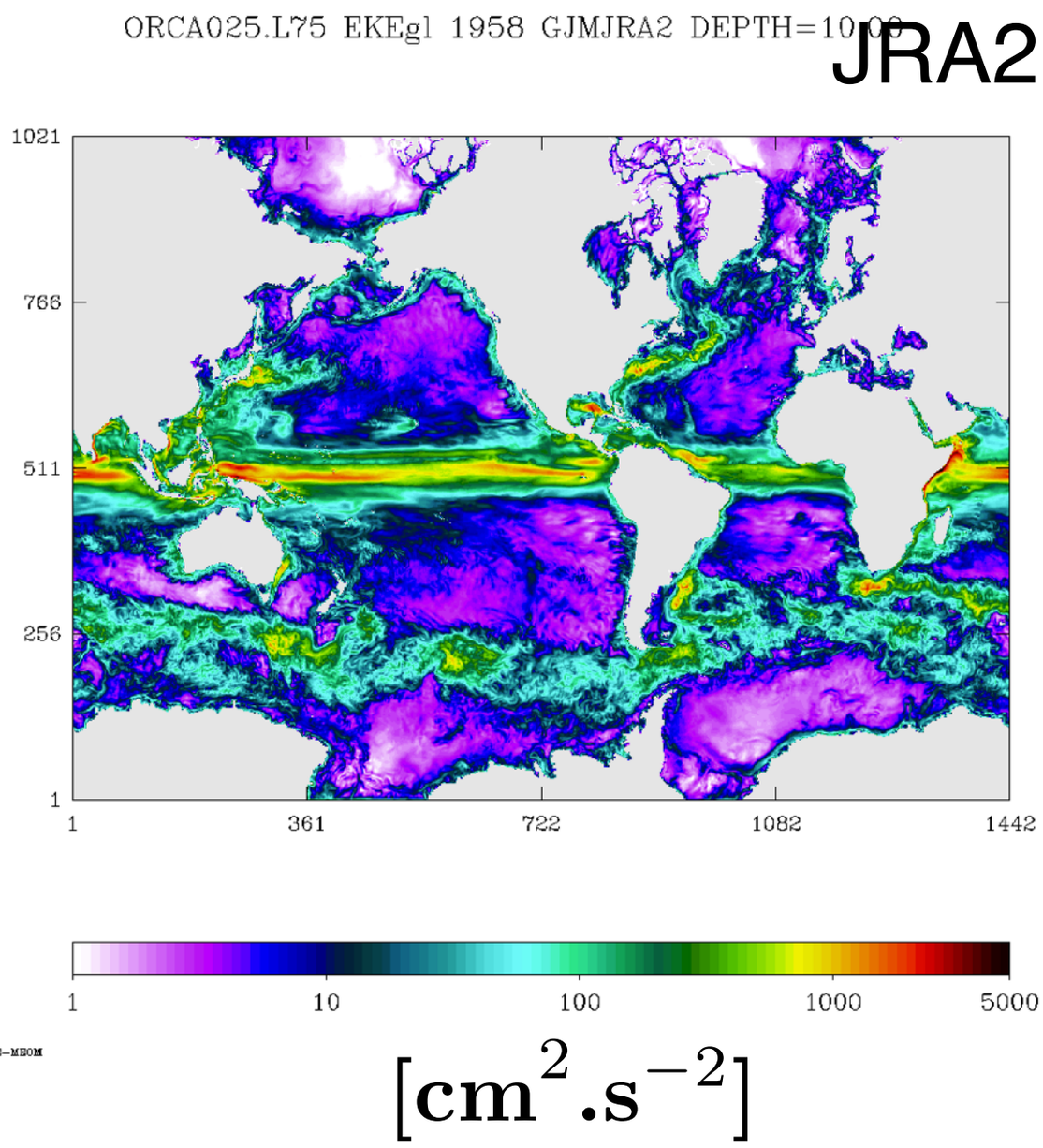
Surface eddy kinetic energy

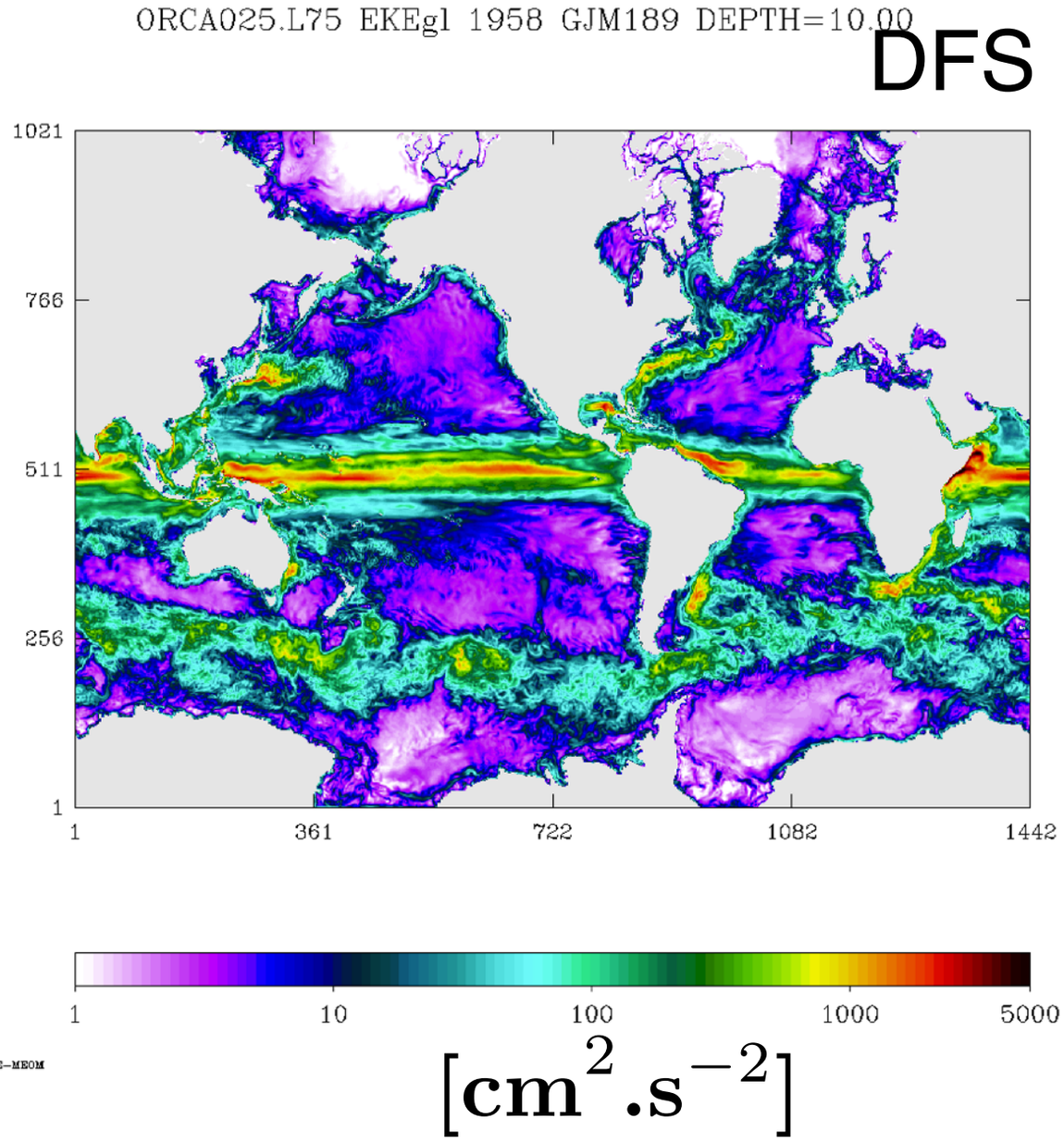




Sensitivity experiment with JRA at 0.25° resolution

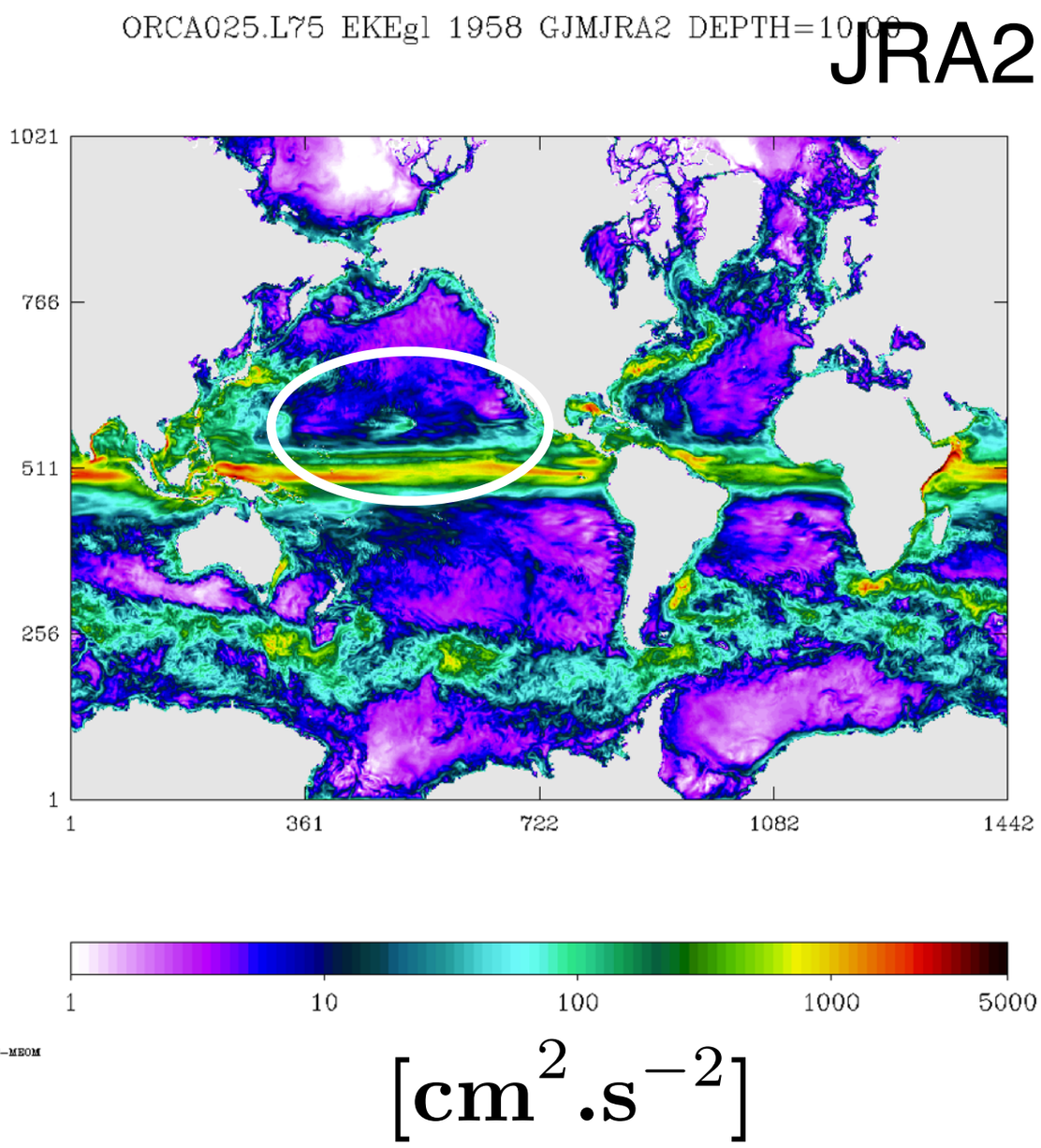
Surface eddy kinetic energy

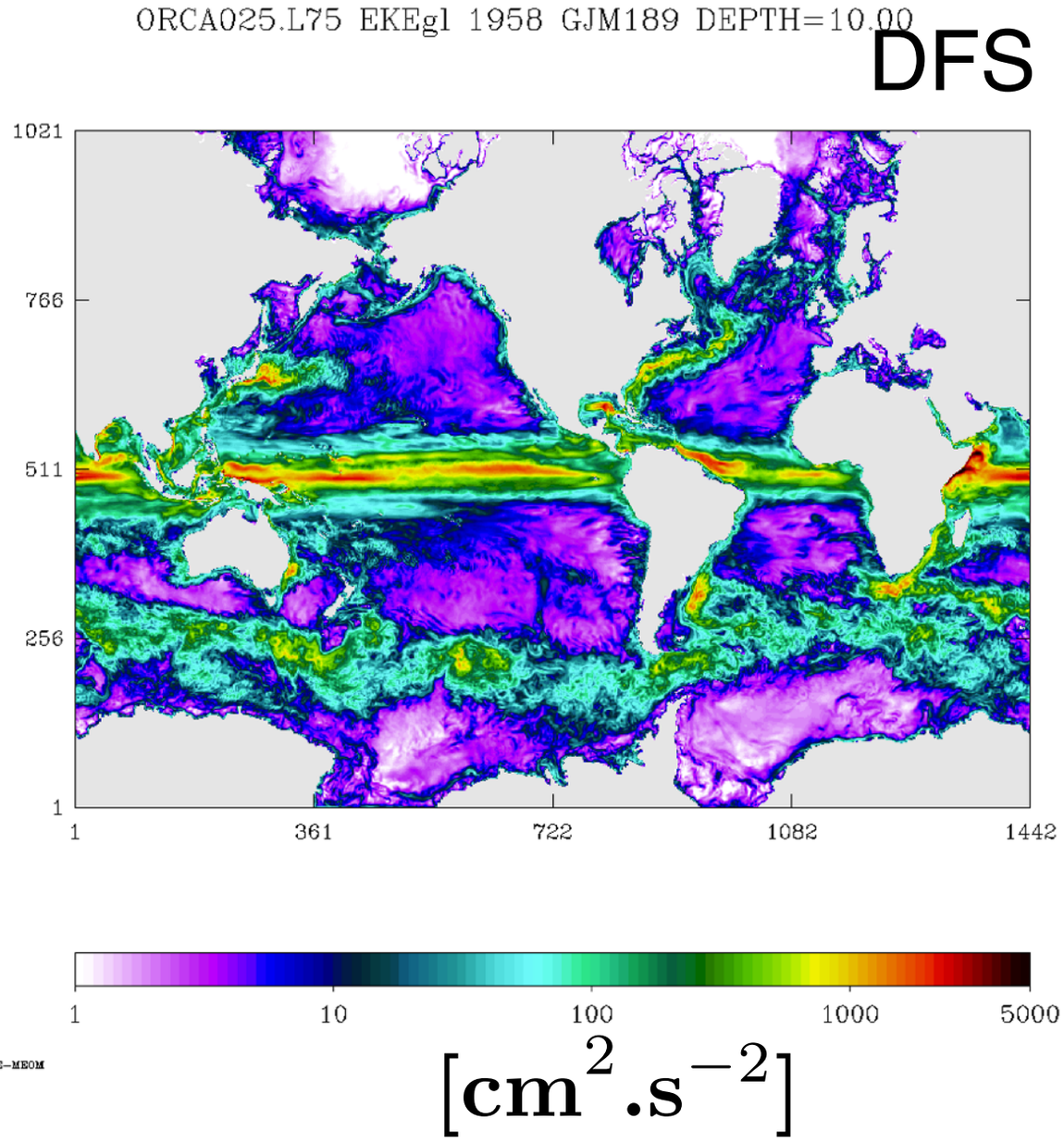




Sensitivity experiment with JRA at 0.25° resolution

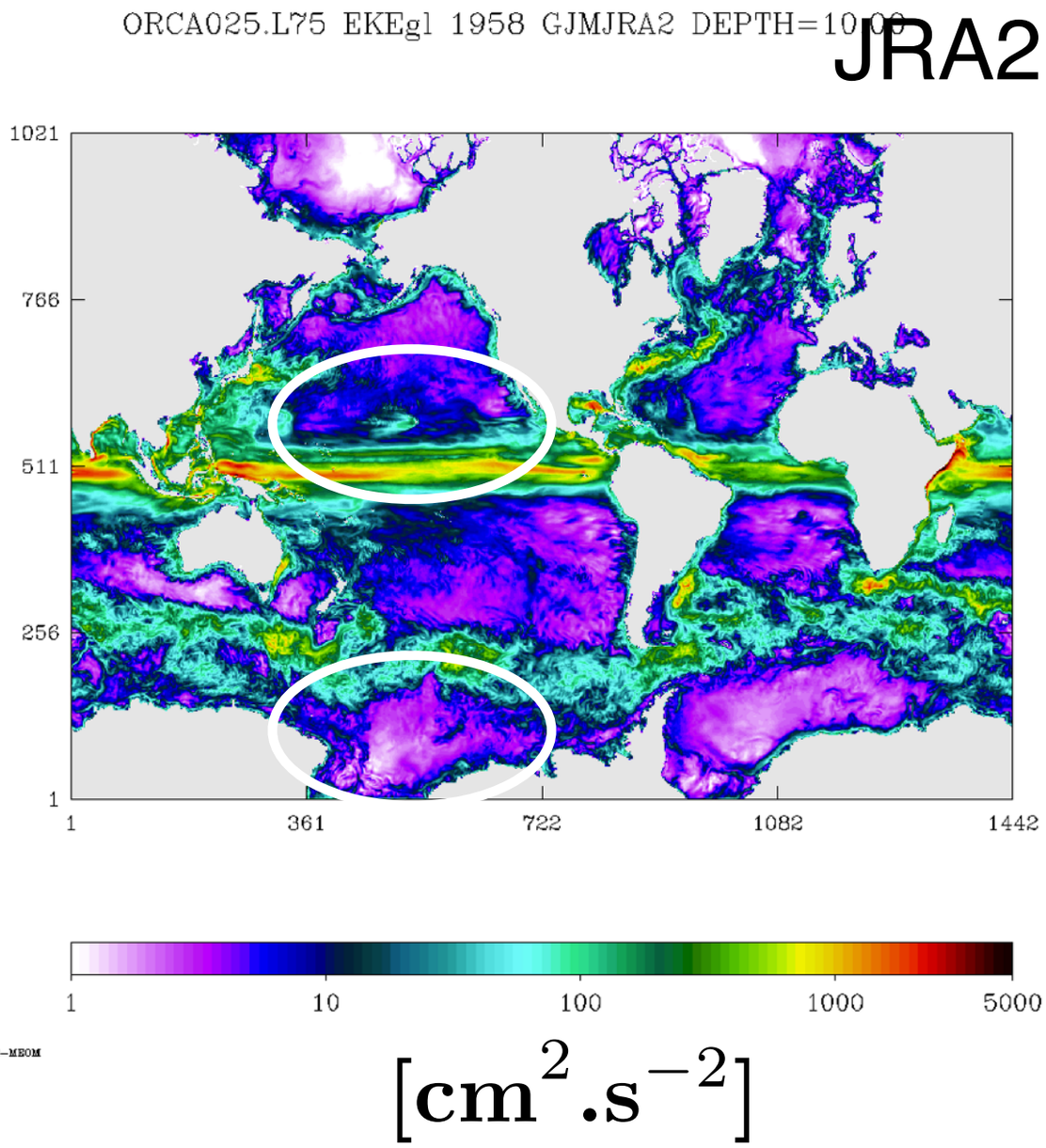
Surface eddy kinetic energy

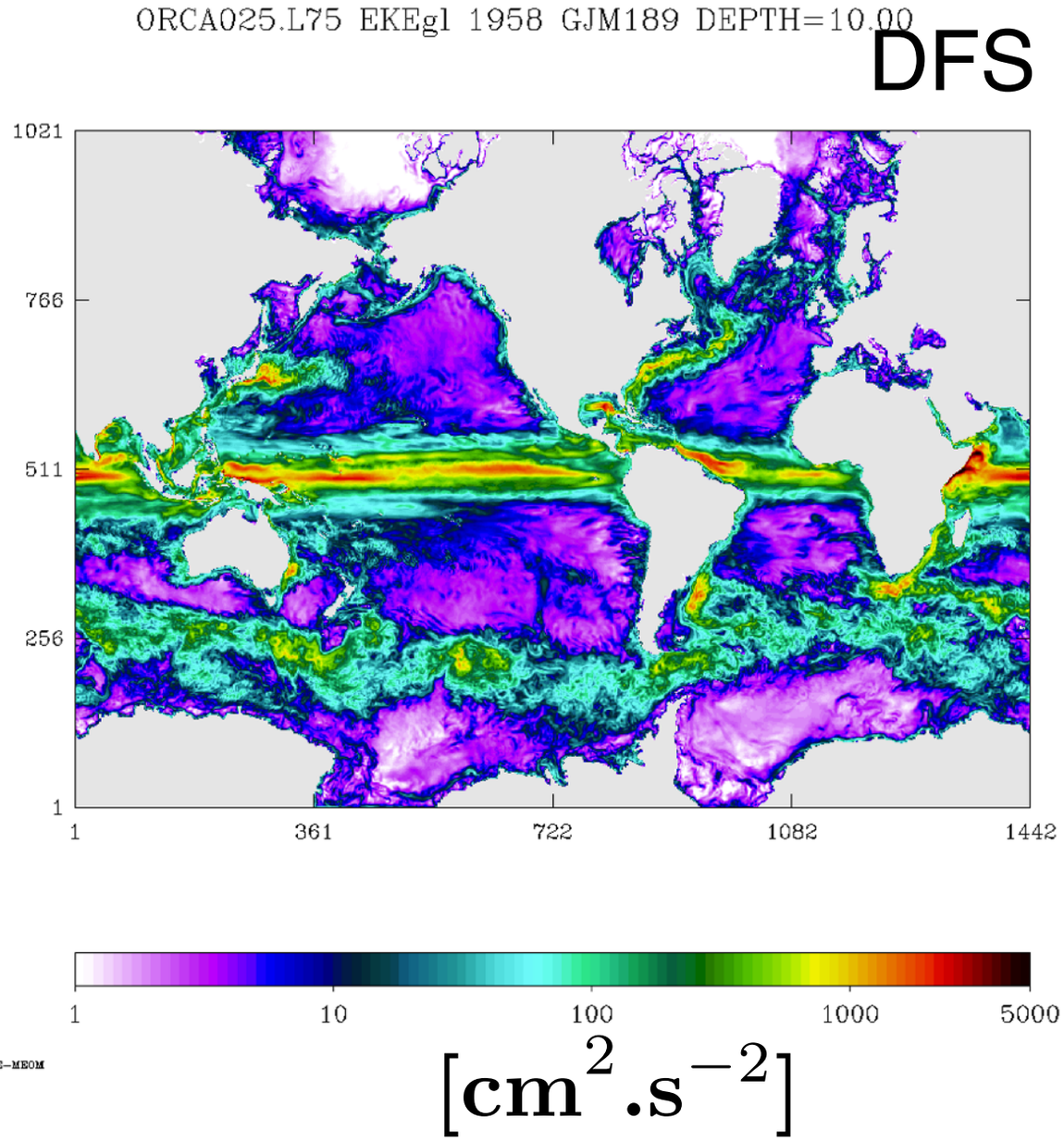




Sensitivity experiment with JRA at 0.25° resolution

Surface eddy kinetic energy





Outline

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Wrap-up and conclusions

Forcing ocean/sea-ice models with JRA-55 (corrected v0.2) ?

- sensitivity to forcing depend on model configuration (resolution)
- trends not discussed here but could possibly affect multi-pass runs
- at coarse resolution, JRA-55 forced model solution is « ok »

at 0.5° resolution,

DFS and JRA lead **very similar simulations**, except for

- Southern Ocean : DP transport, mld, overturning, sea ice
- slightly less energetic pacific ST gyre and equatorial circulation

at 0.25° resolution,

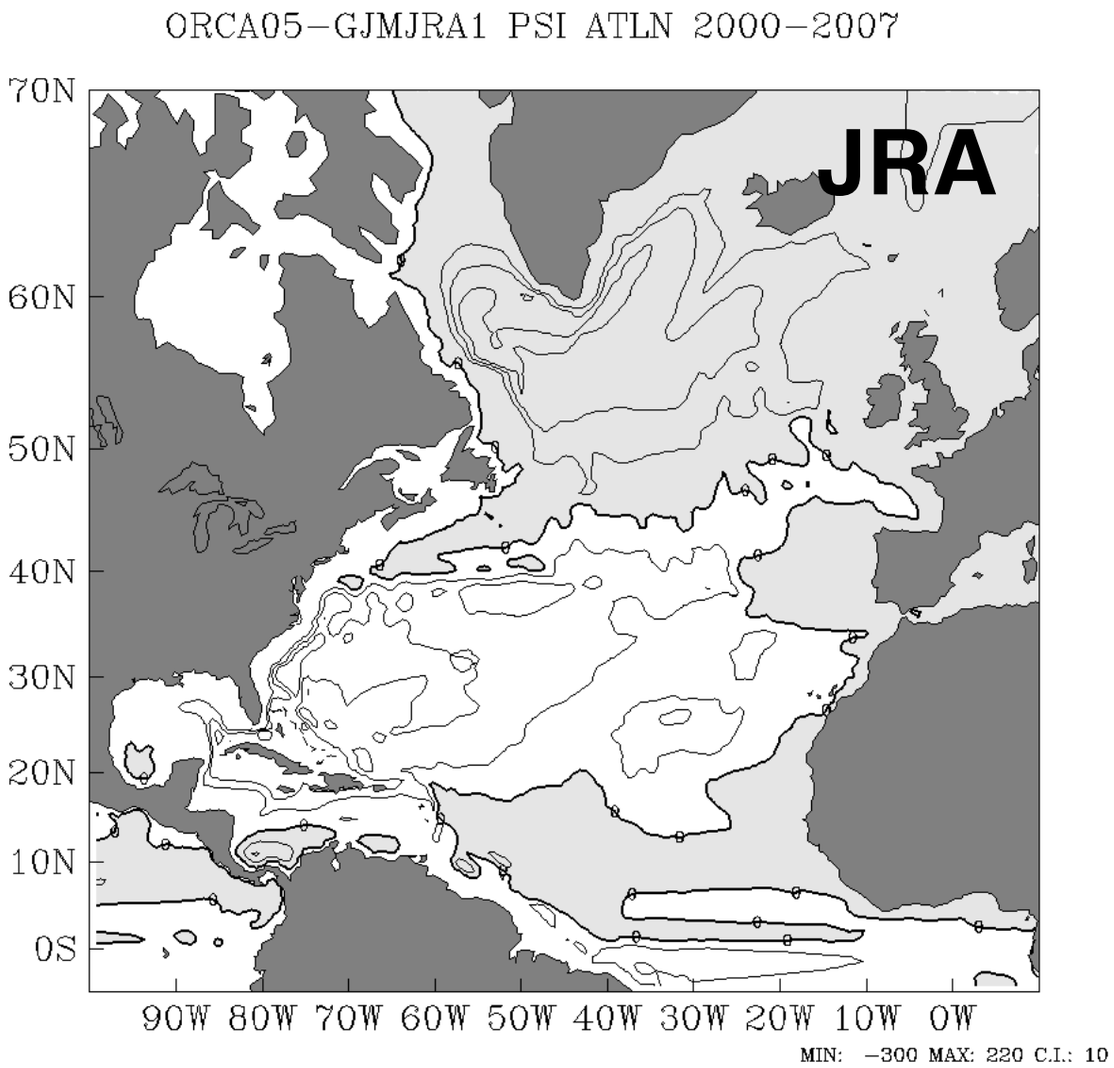
DFS and JRA lead **different model solutions**

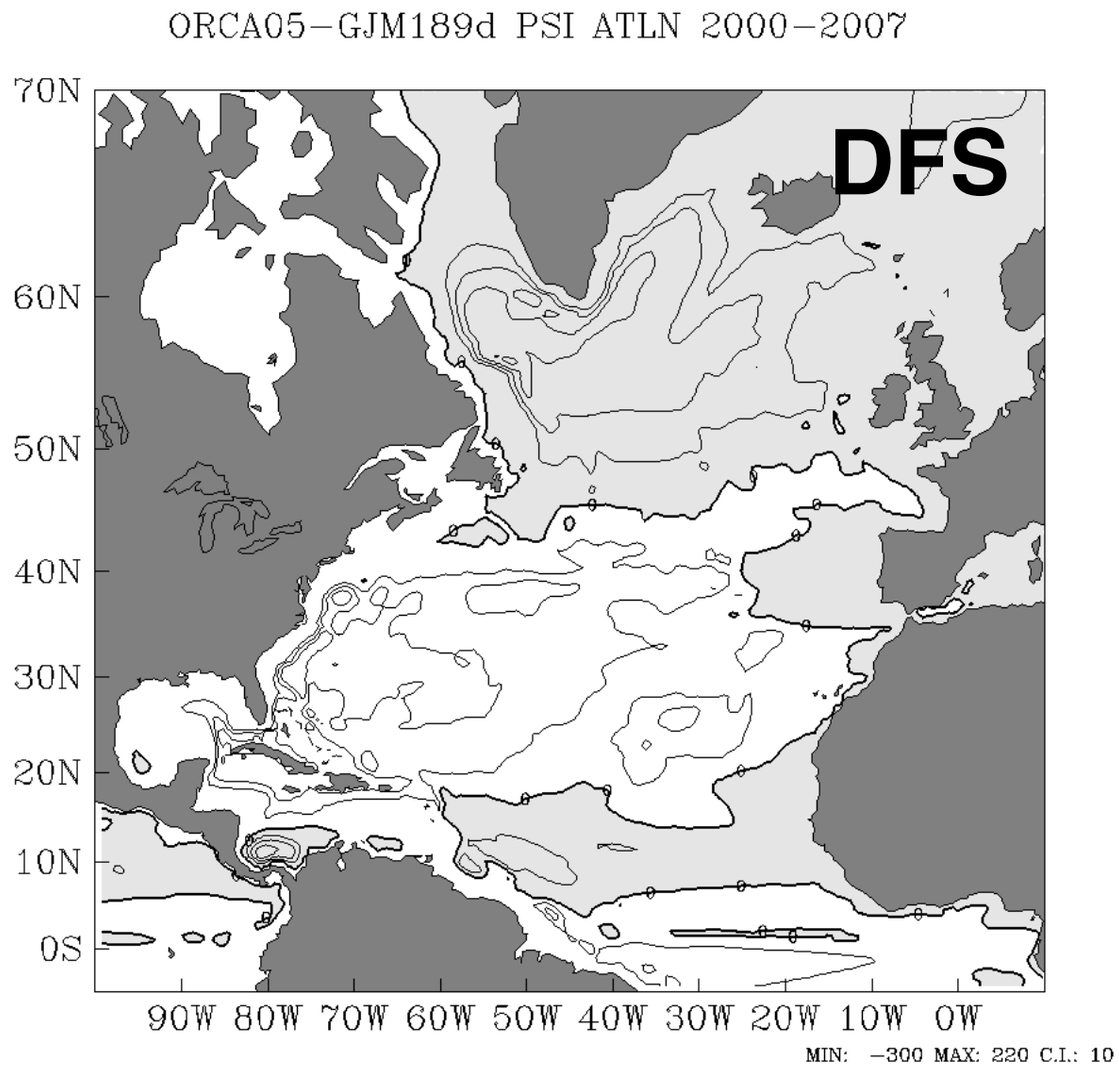
- spurious polynia in the Admunsen and the Ross seas
- possibly due to (eddy) heat advection from the boundary current
- possibly associated with surface winds (?).
- depend on the period (cf Claus Boning's results in Kiel)

EXTRA MATERIAL

Sensitivity experiment with JRA at 0.5° resolution

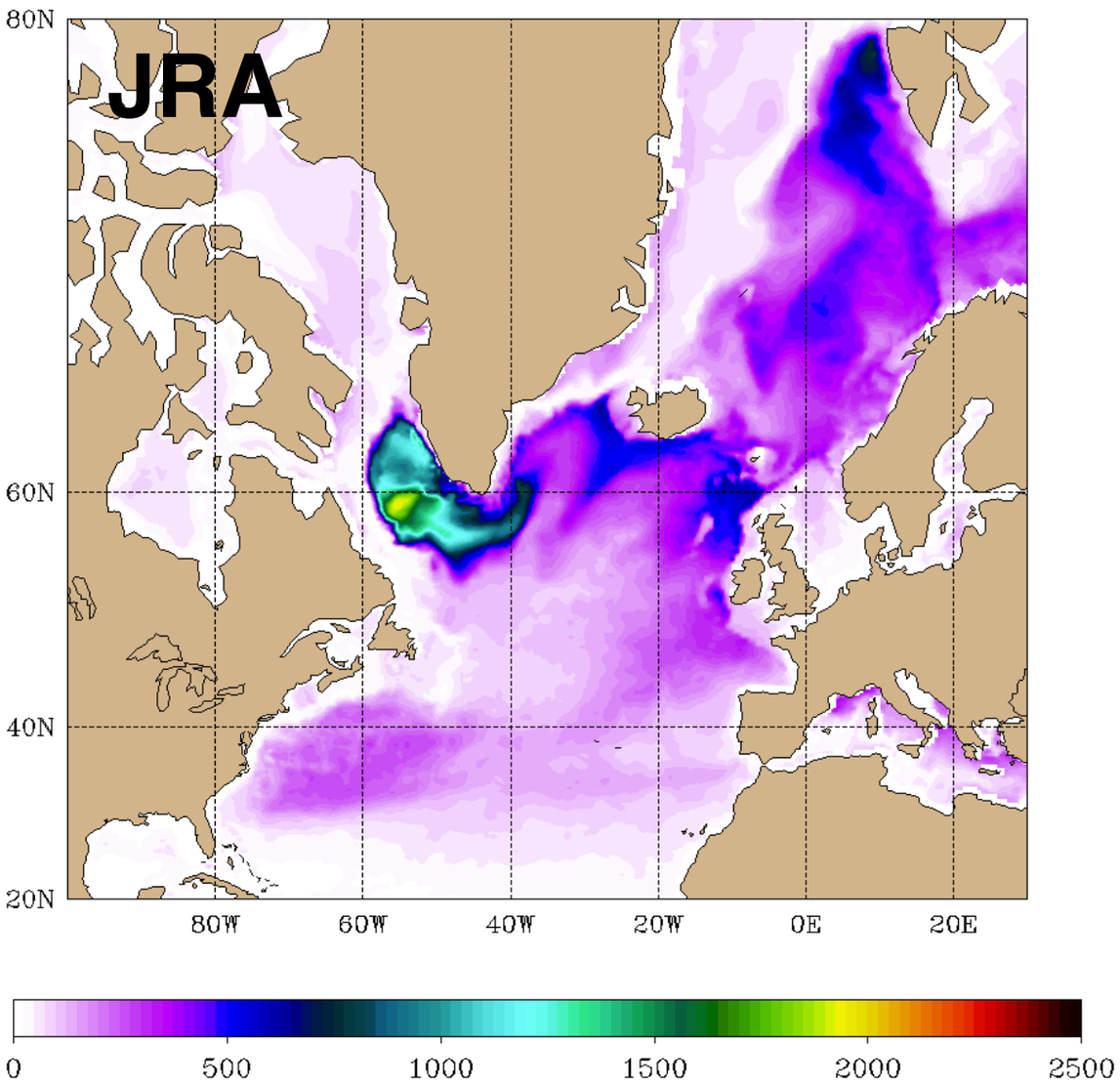
Barotropic stream-function

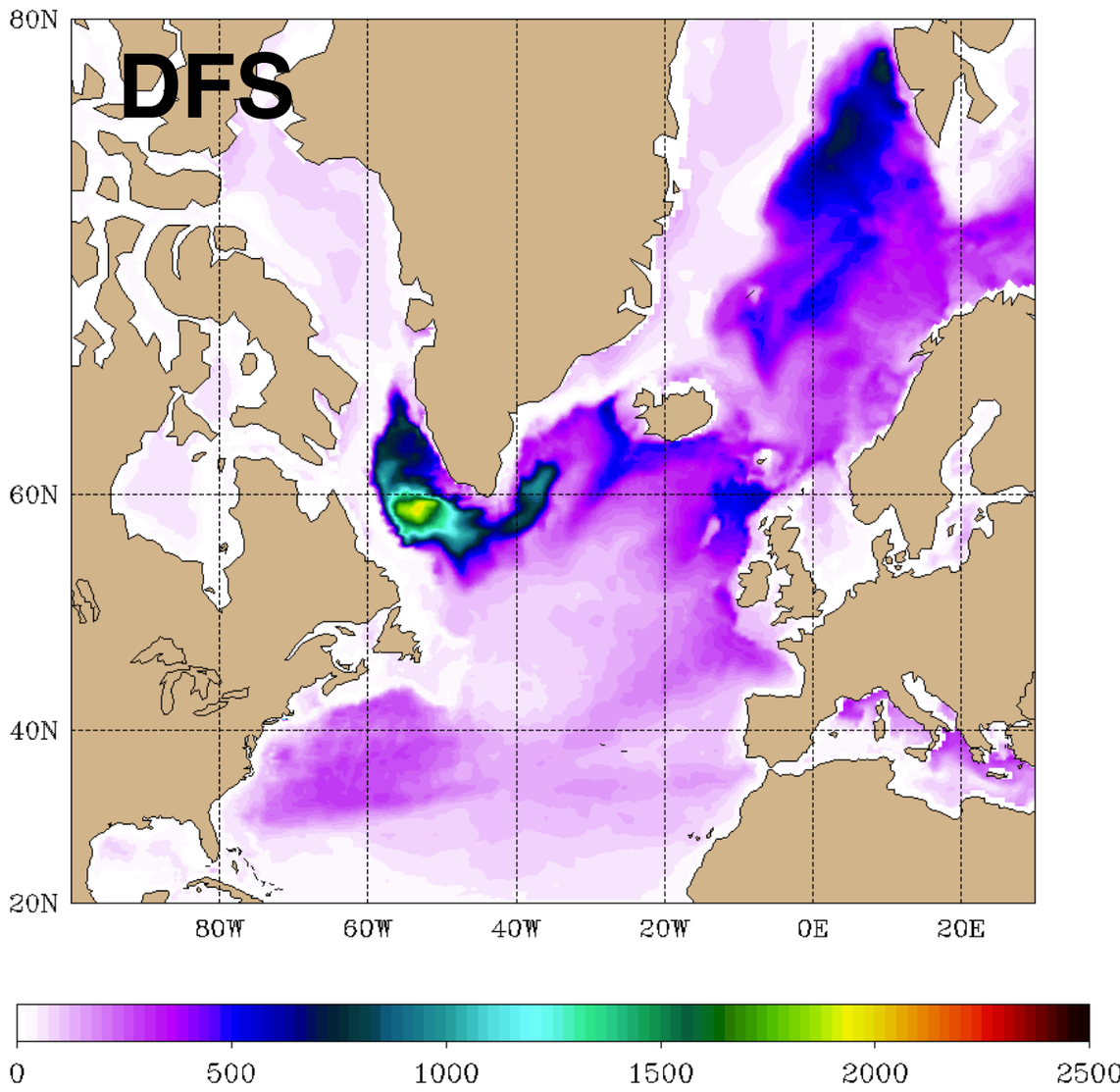




Sensitivity experiment with JRA at 0.5° resolution

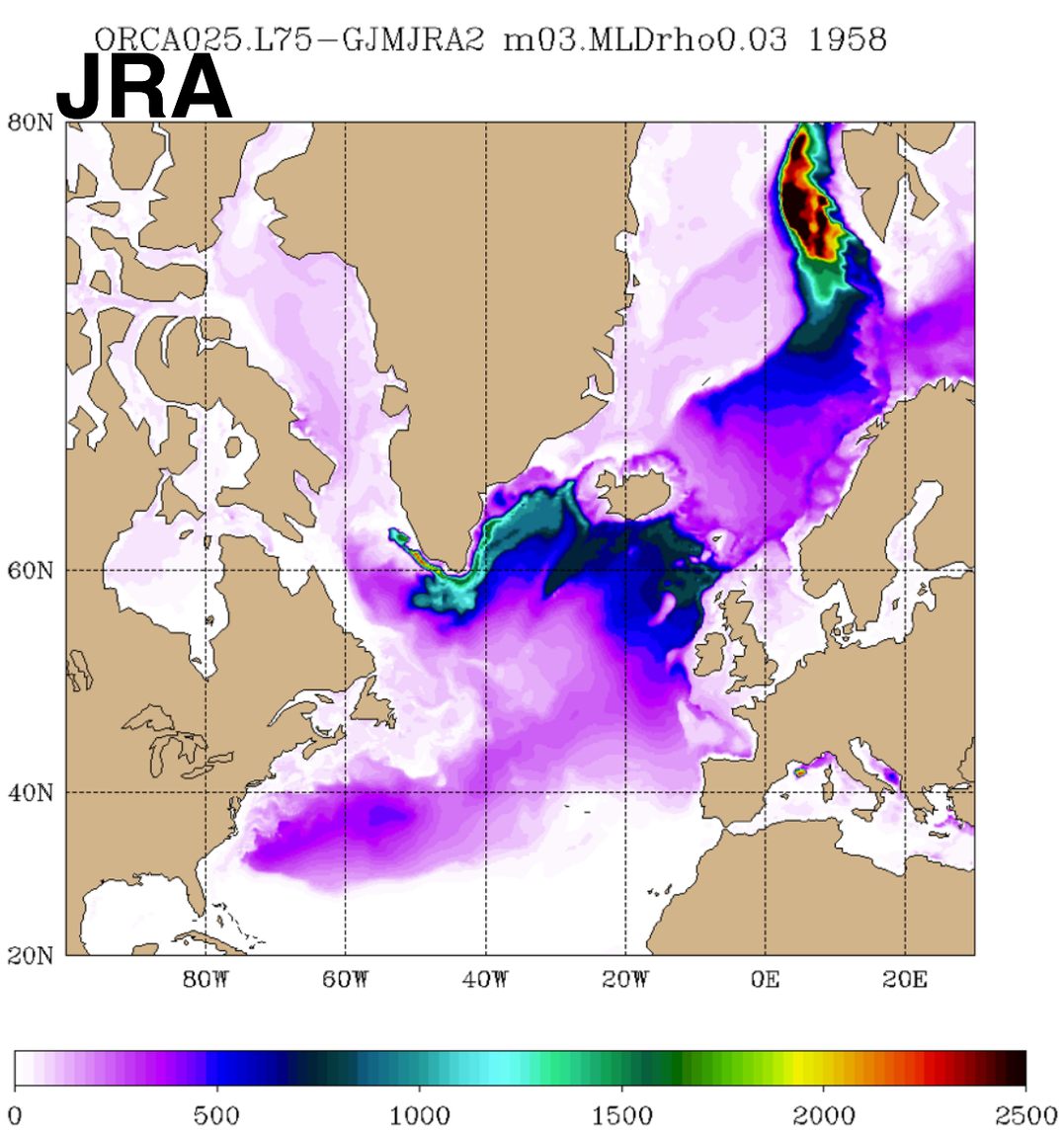
Mixed layer depth

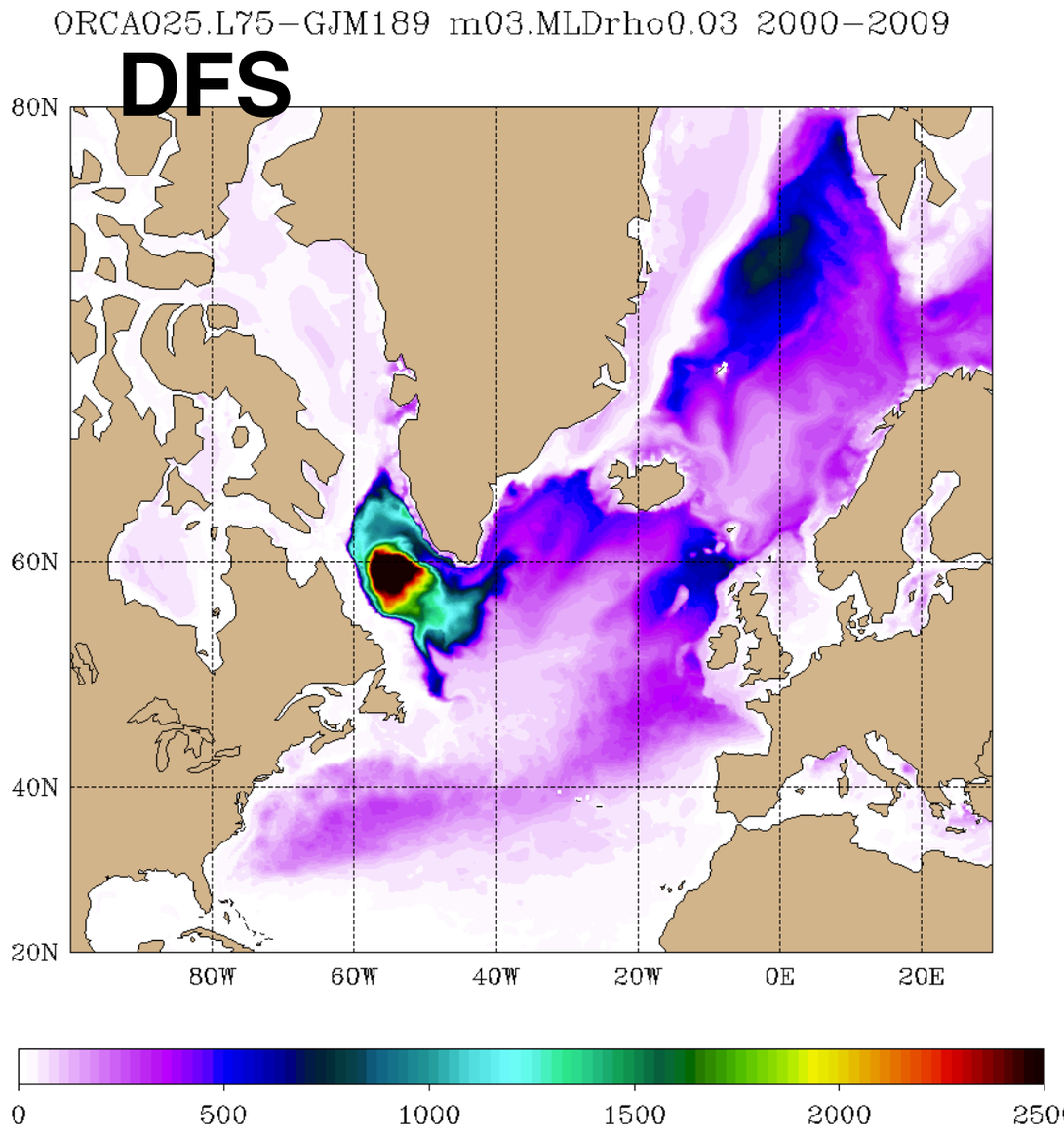




Sensitivity experiment with JRA at 0.25° resolution

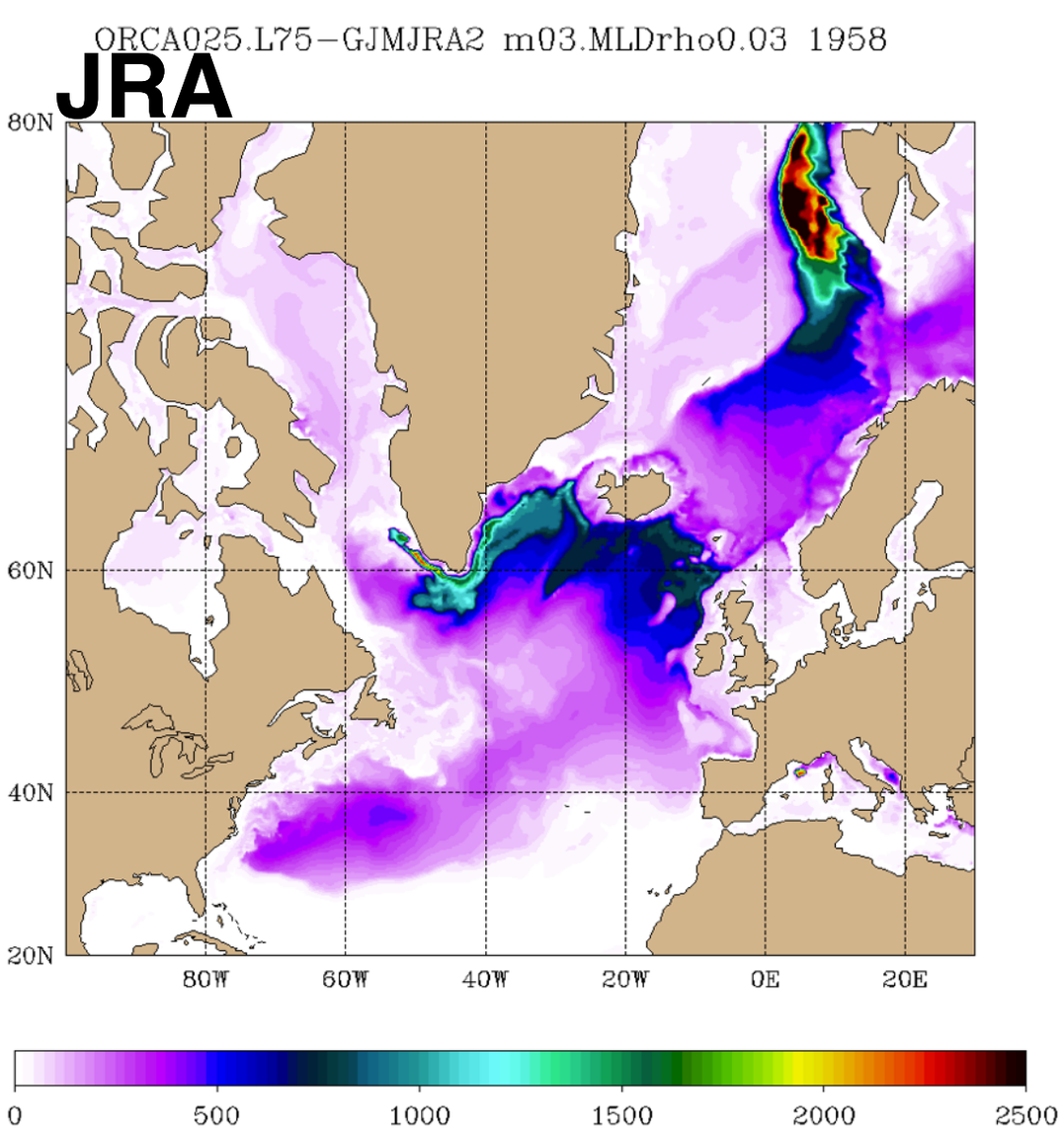
Mixed layer depth

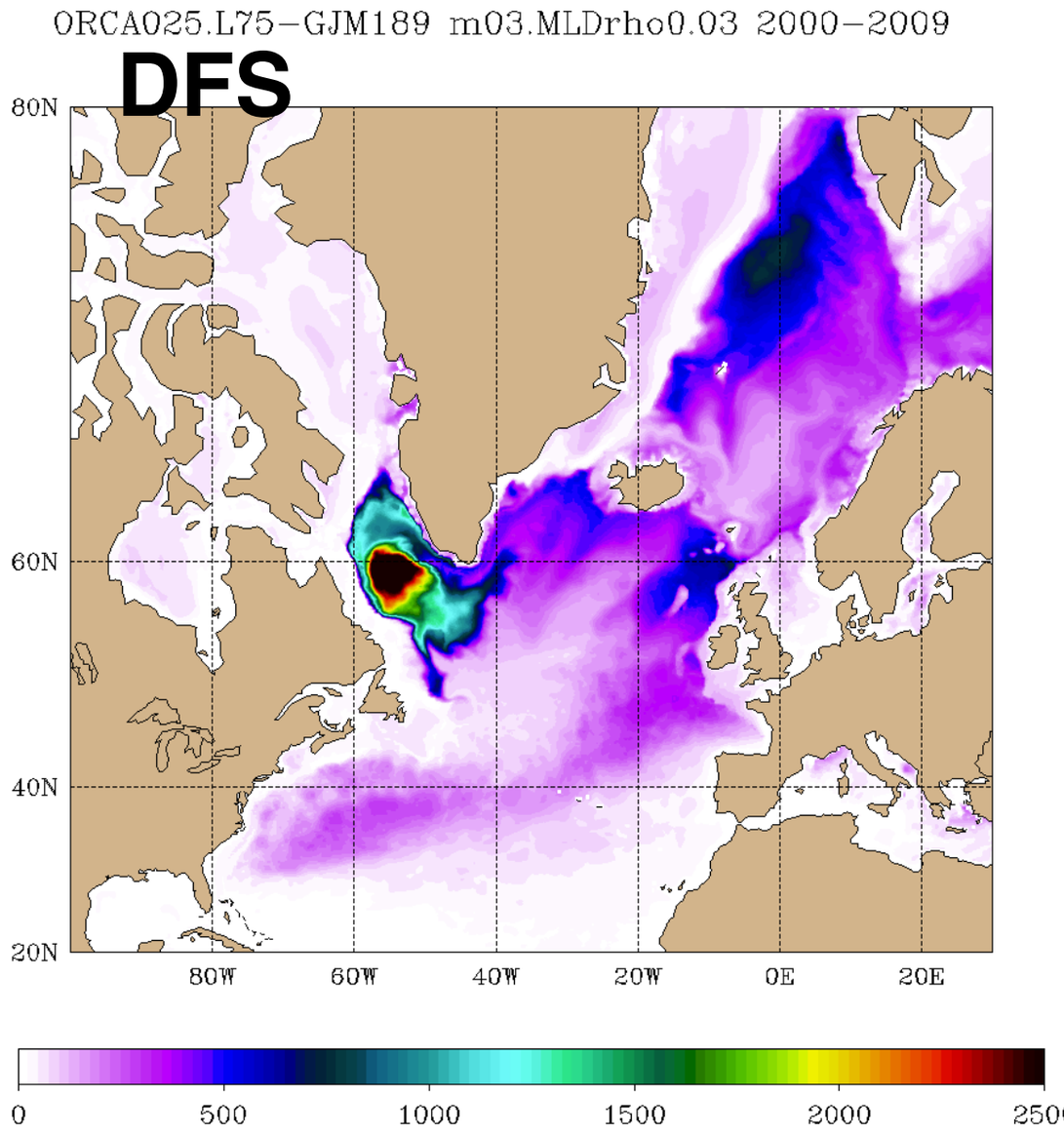




Sensitivity experiment with JRA at 0.25° resolution

Mixed layer depth

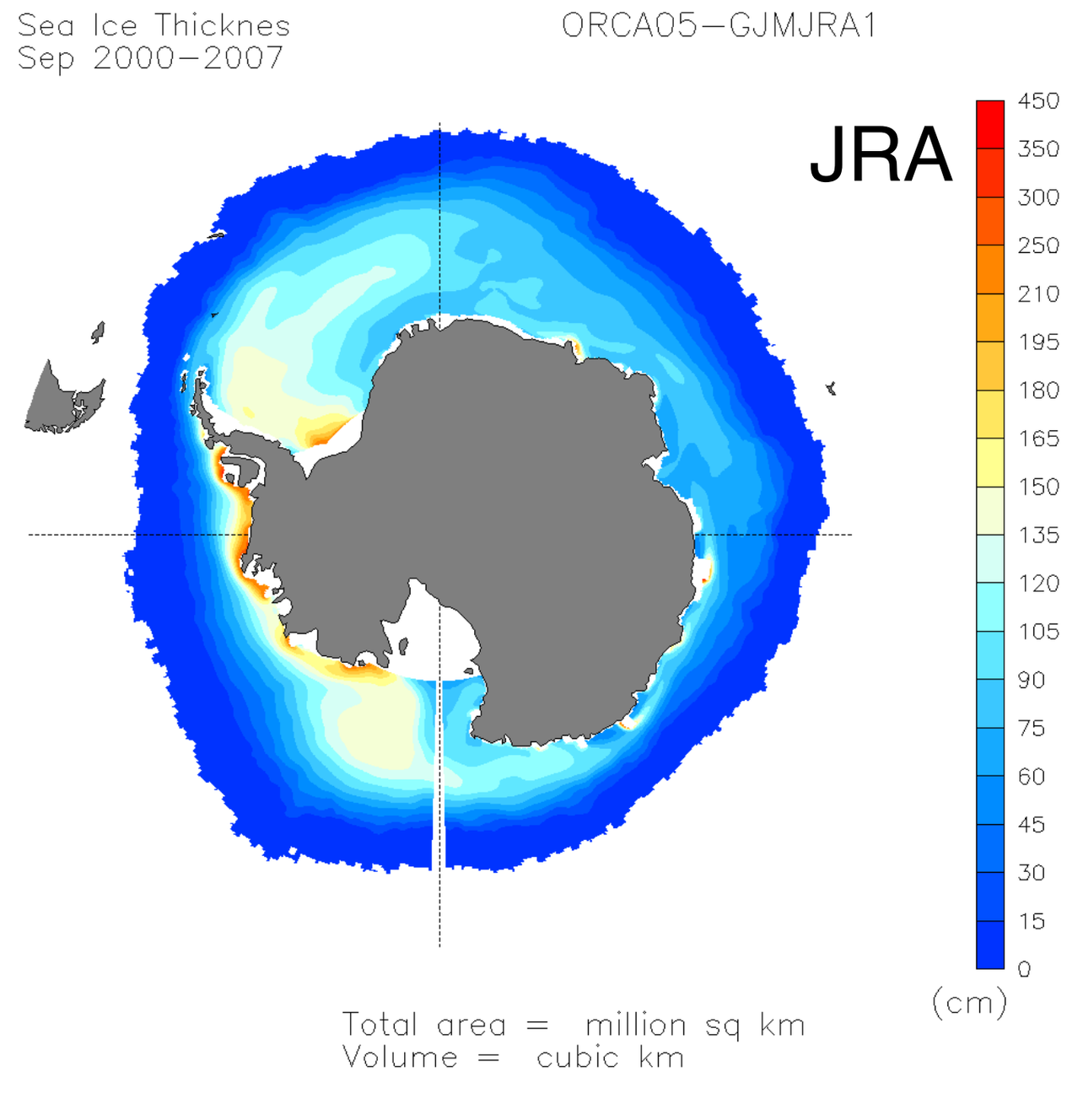


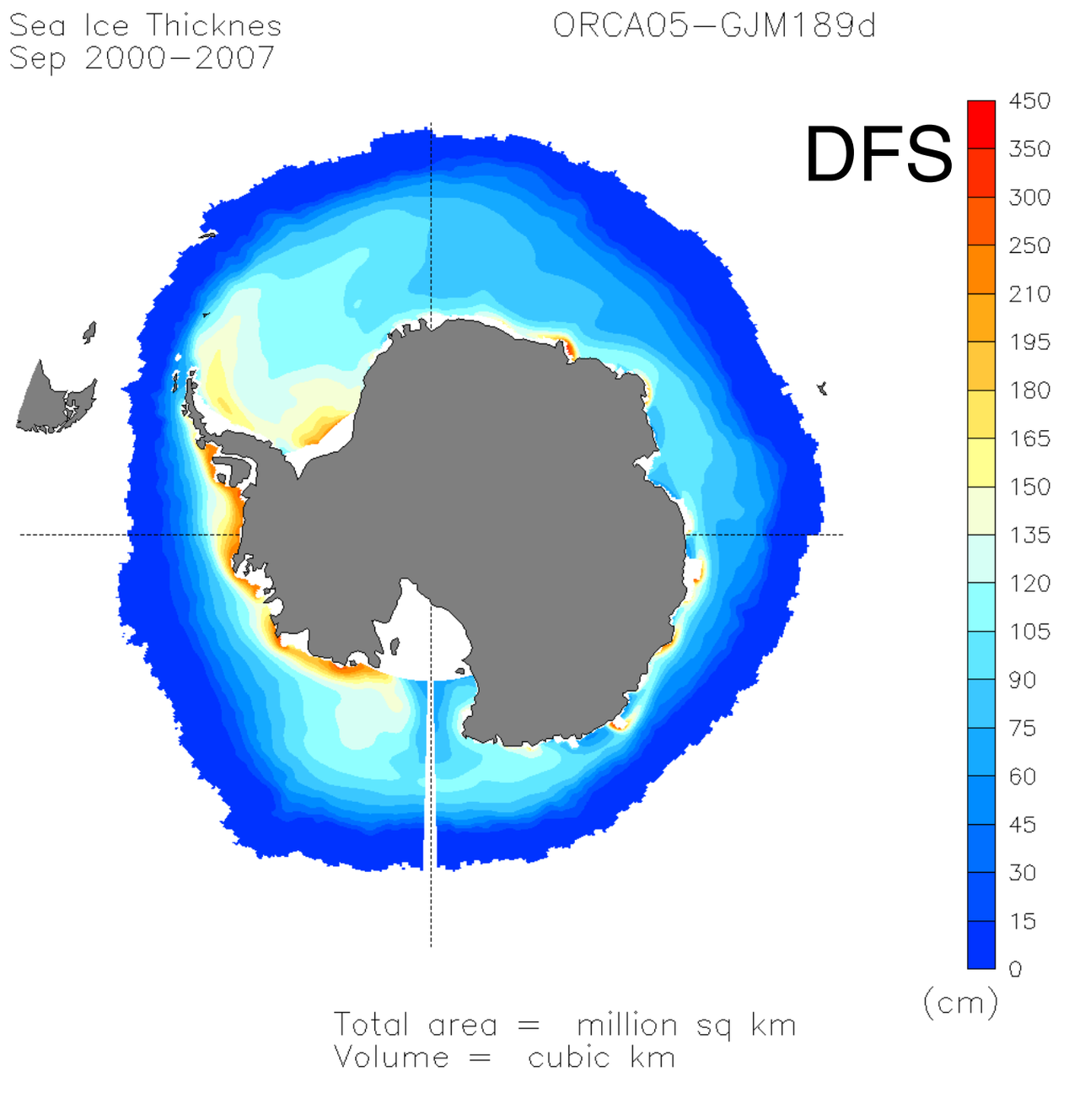


Sensitivity experiment with JRA at 0.5° resolution

Sea ice thickness (September)

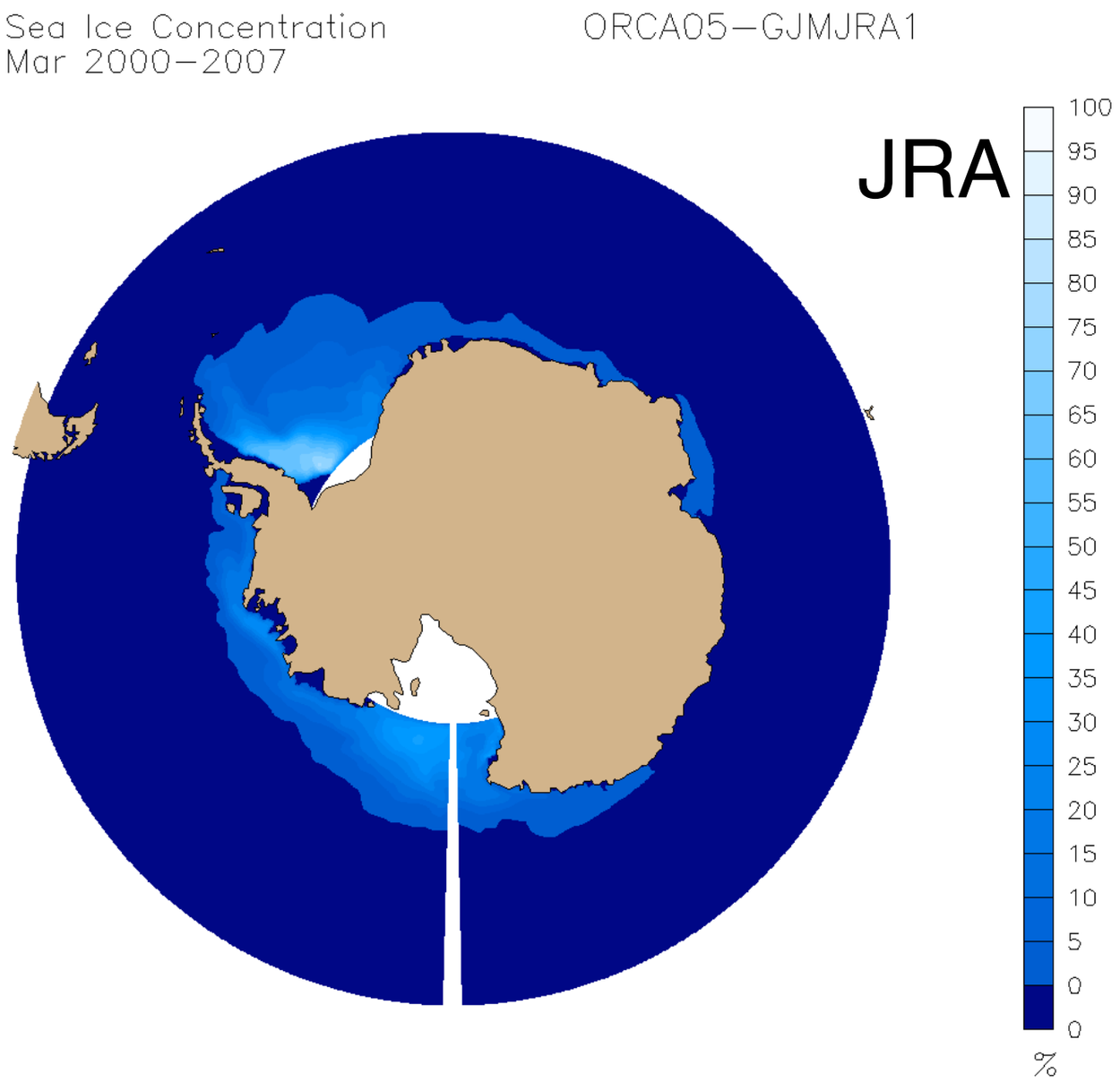
ANTARCTIC

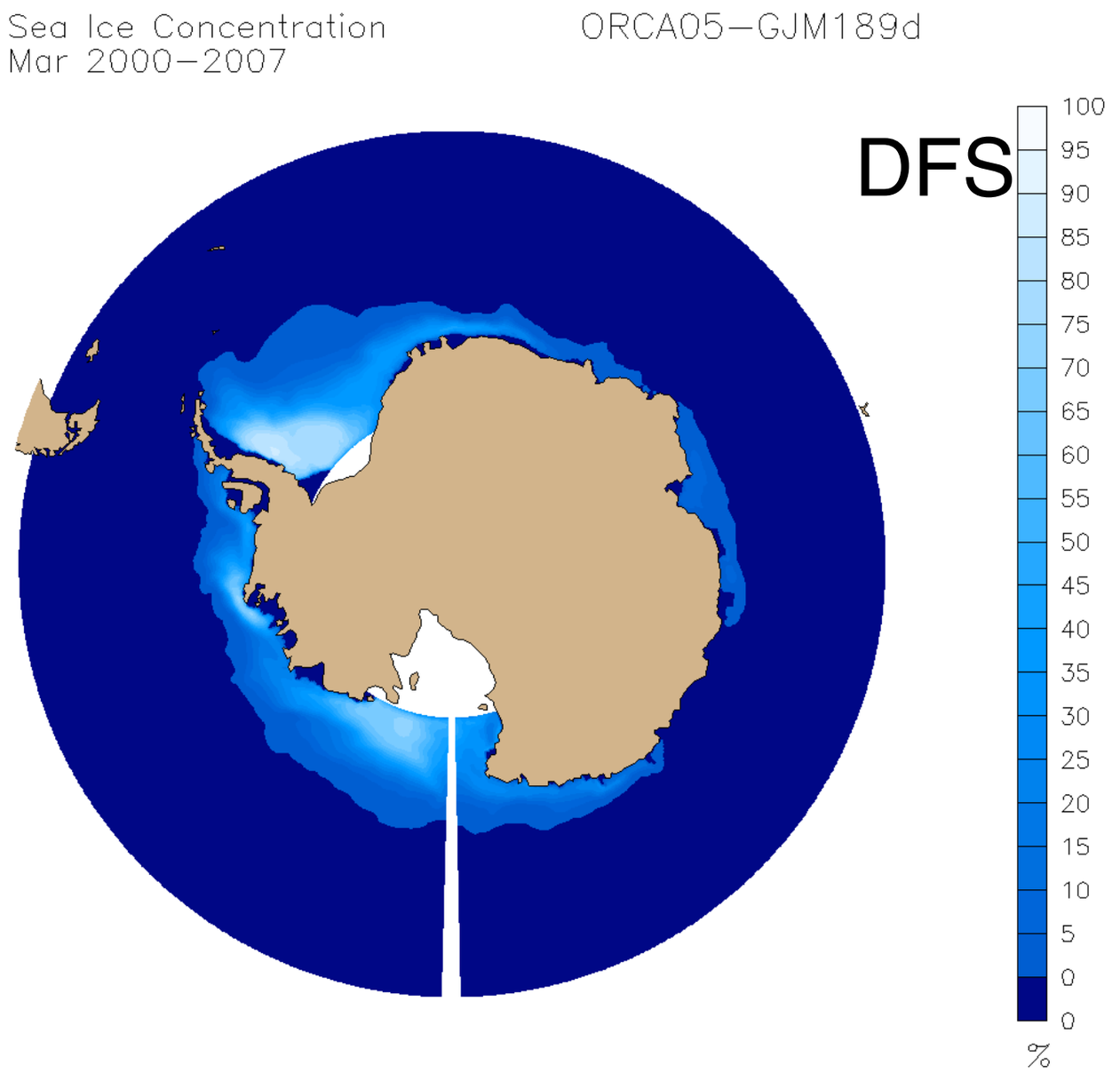




Sensitivity experiment with JRA at 0.5° resolution

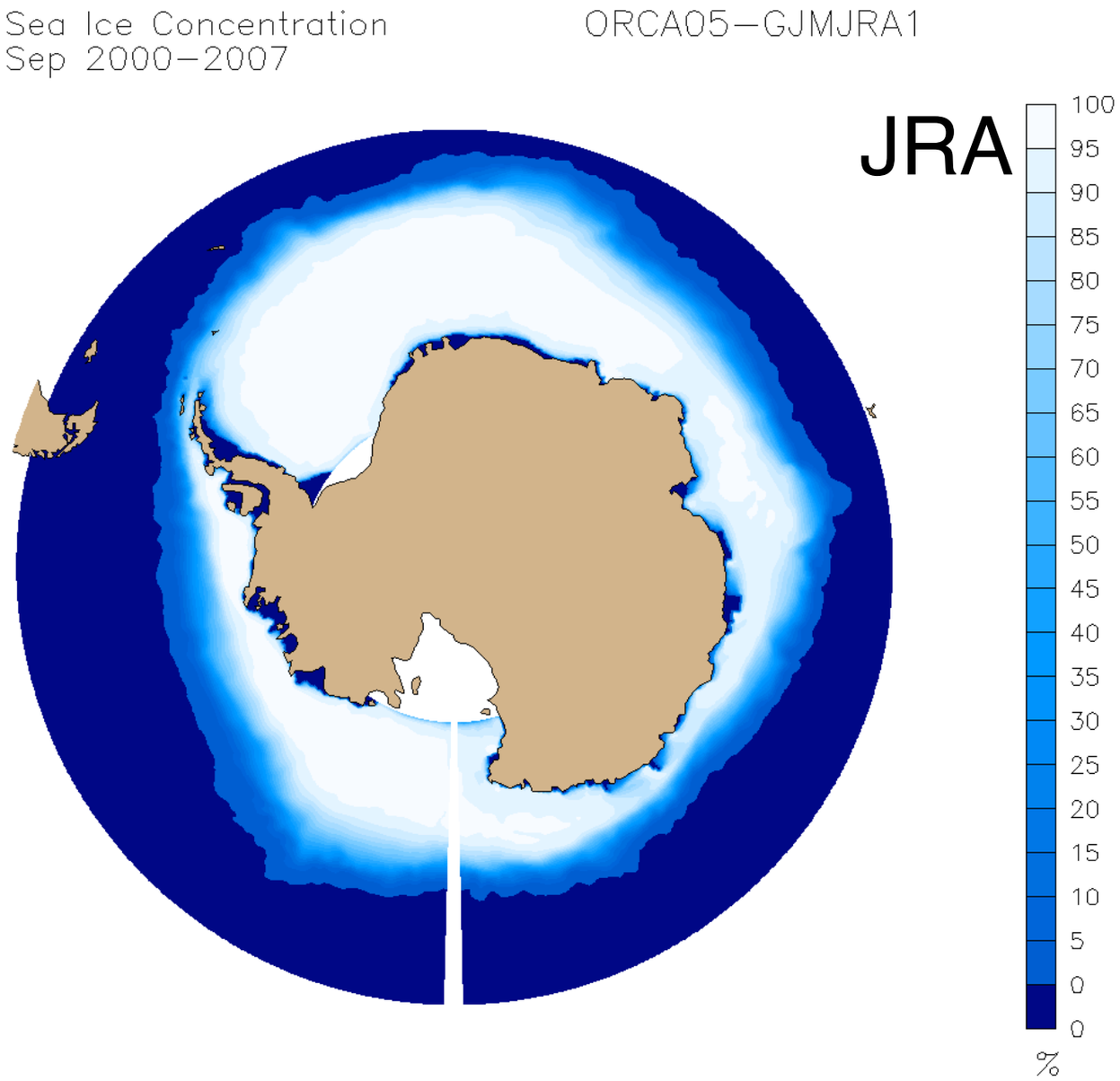
Sea ice concentration (March)

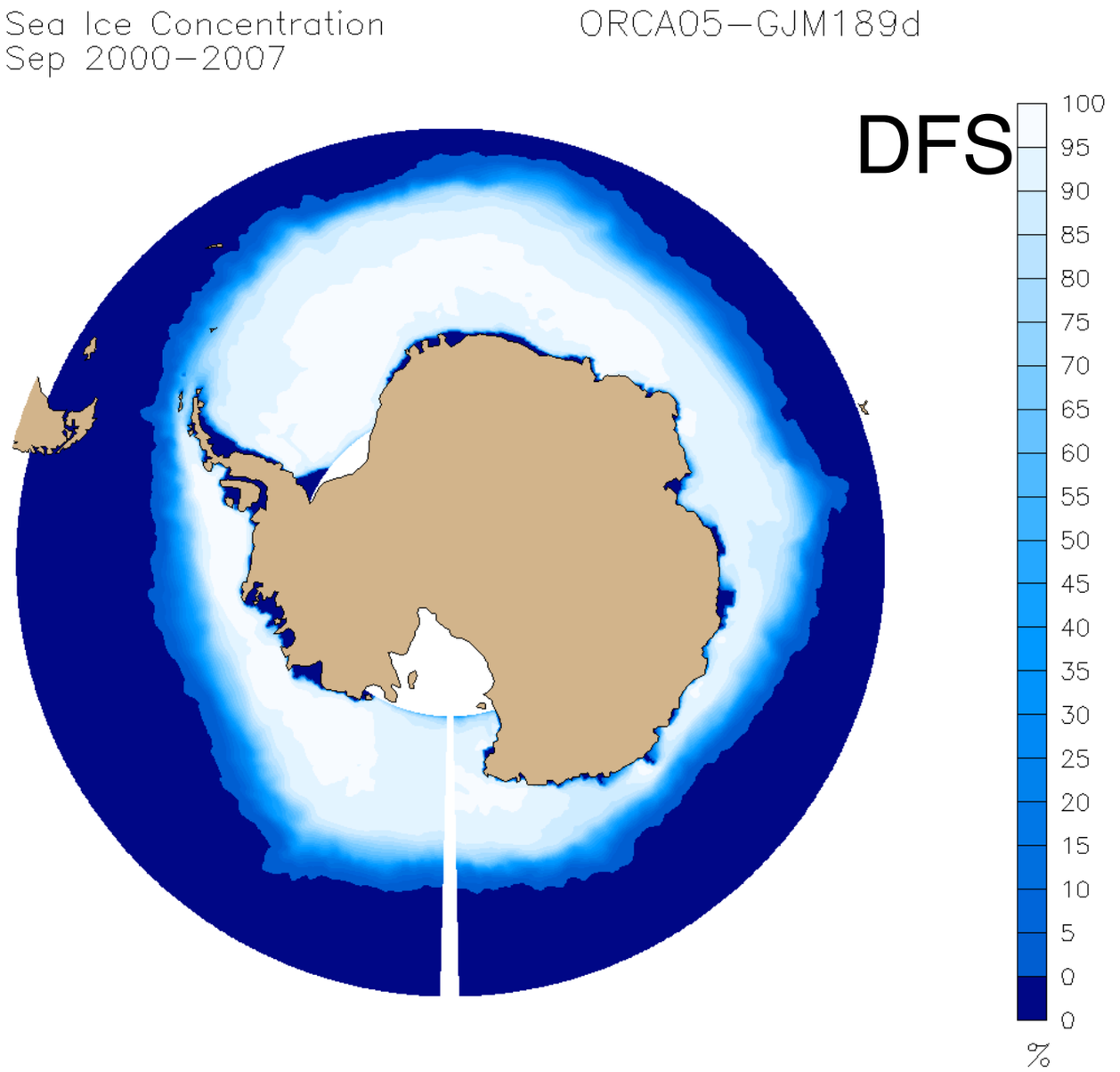




Sensitivity experiment with JRA at 0.5° resolution

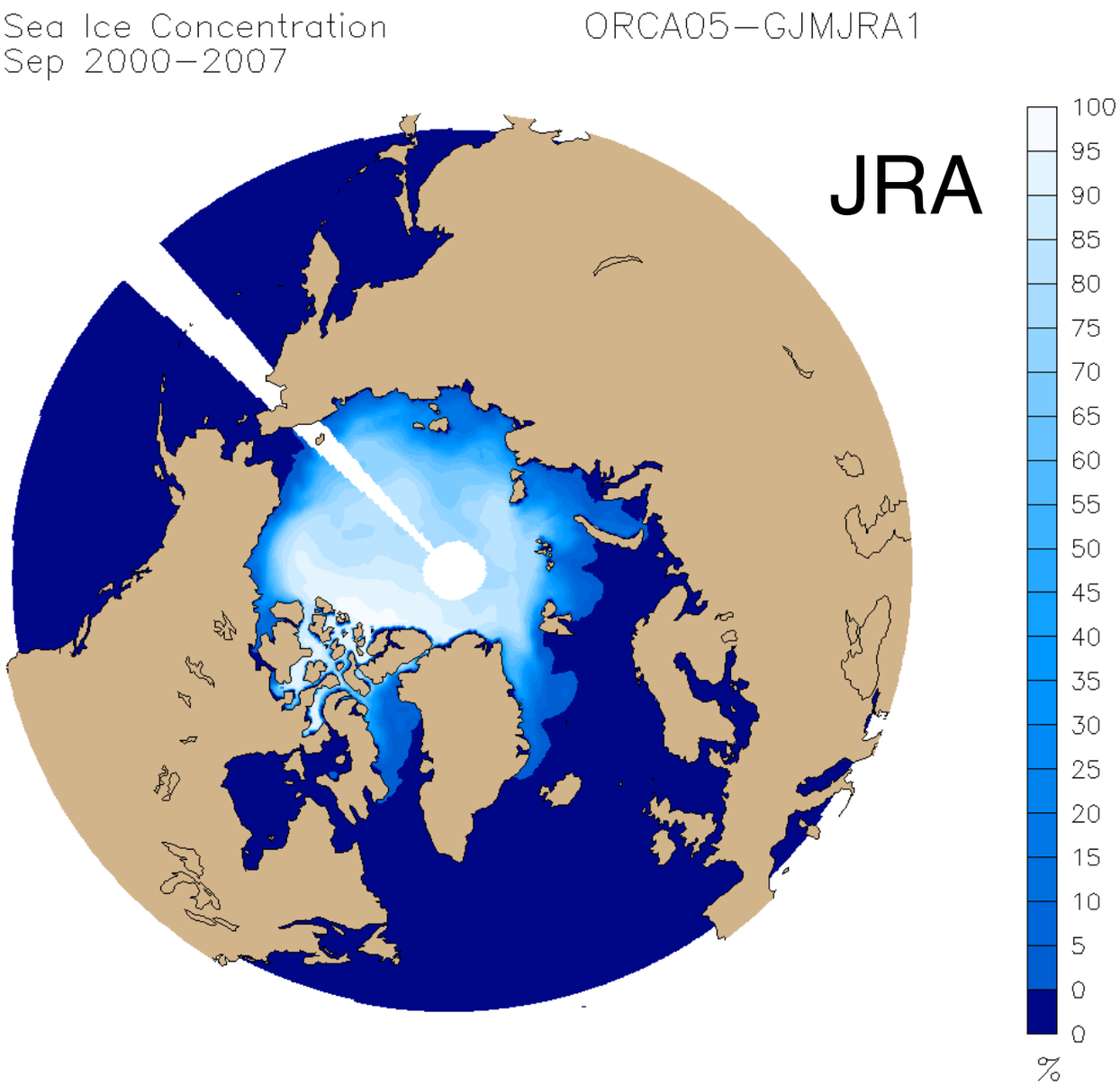
Sea ice concentration (September)

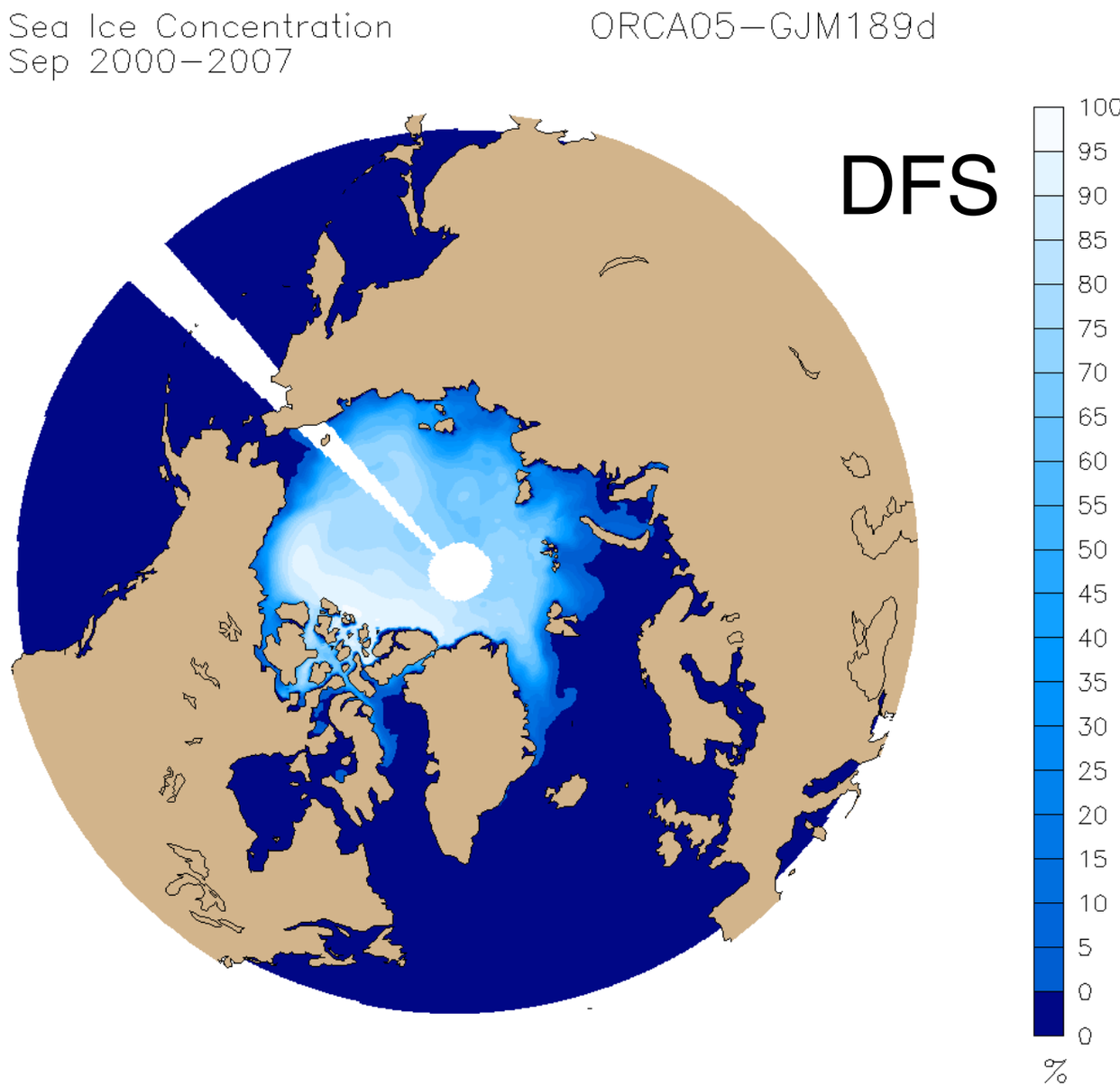




Sensitivity experiment with JRA at 0.5° resolution

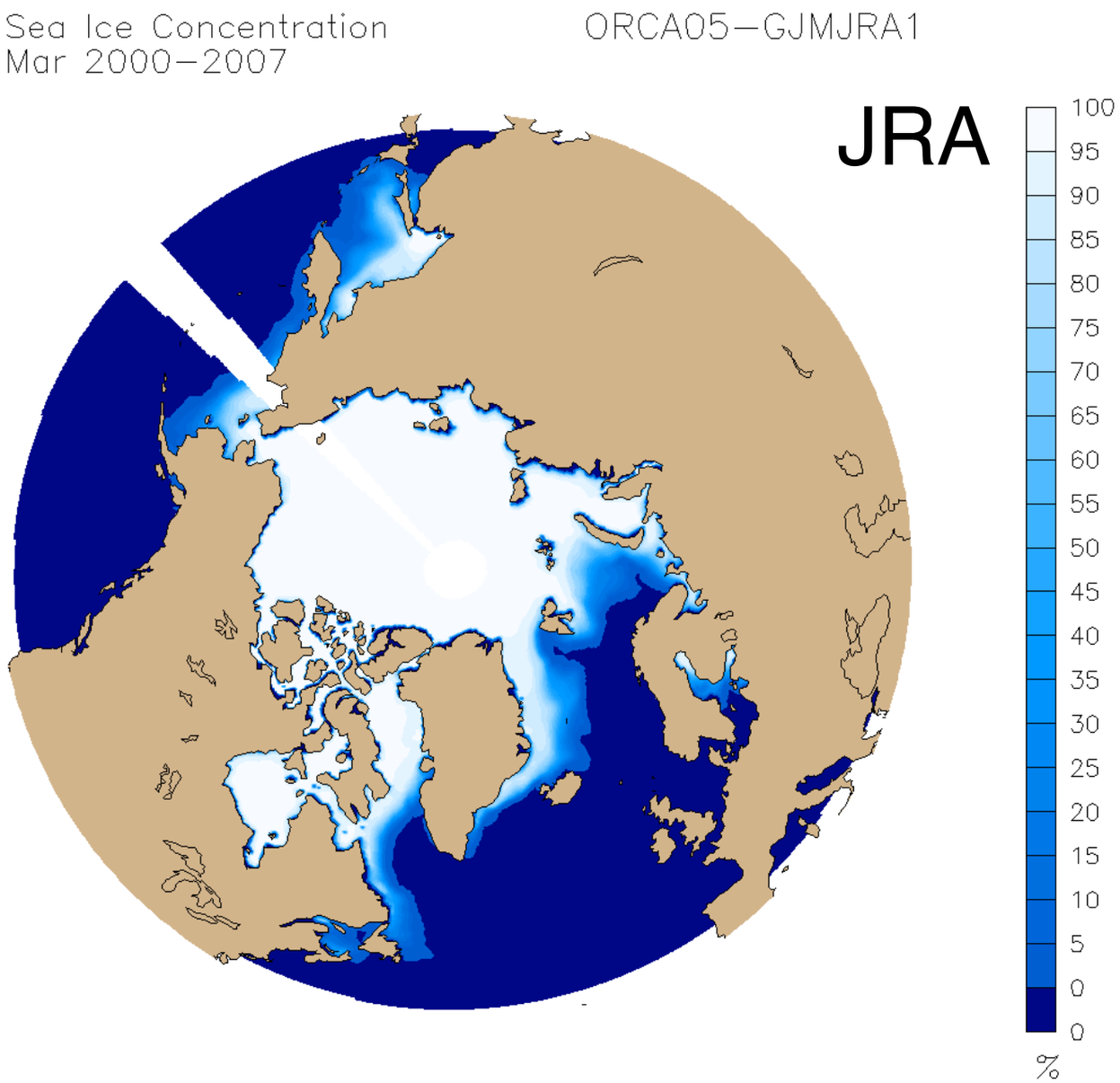
Sea ice concentration (September)

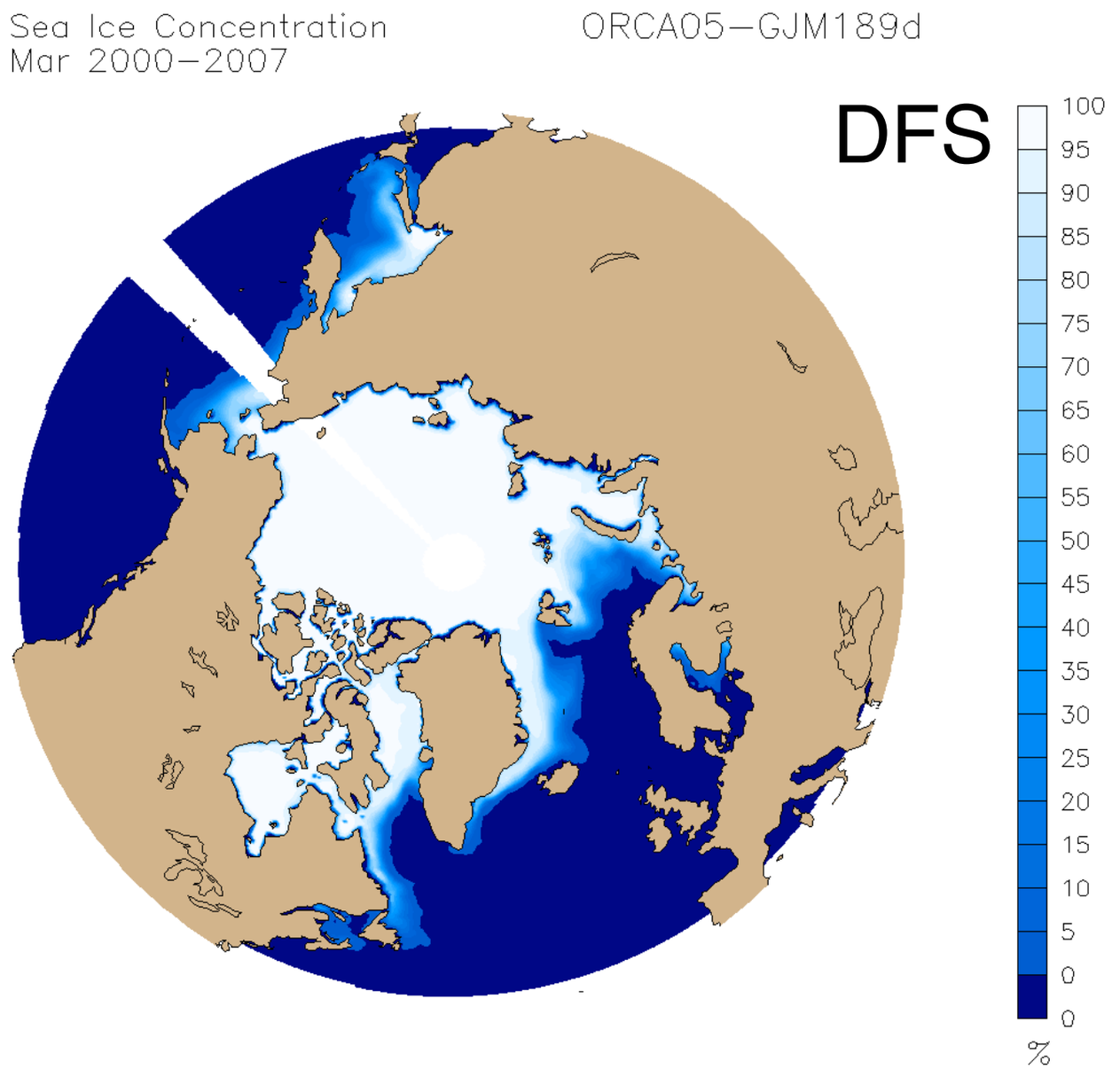




Sensitivity experiment with JRA at 0.5° resolution

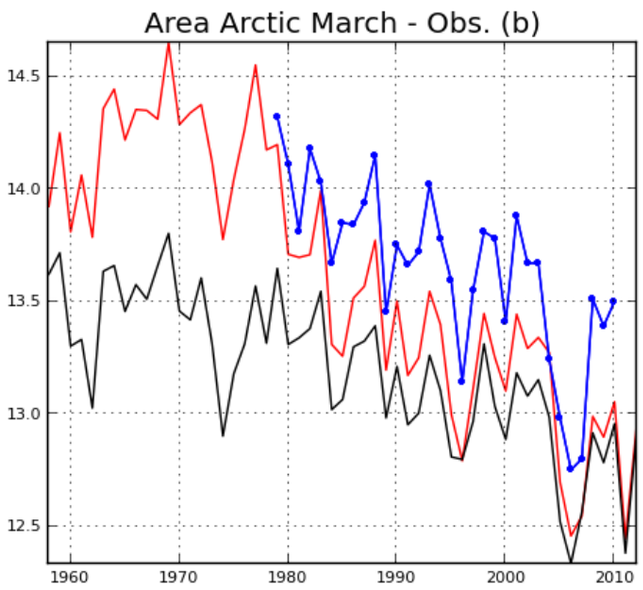
Sea ice concentration (March)

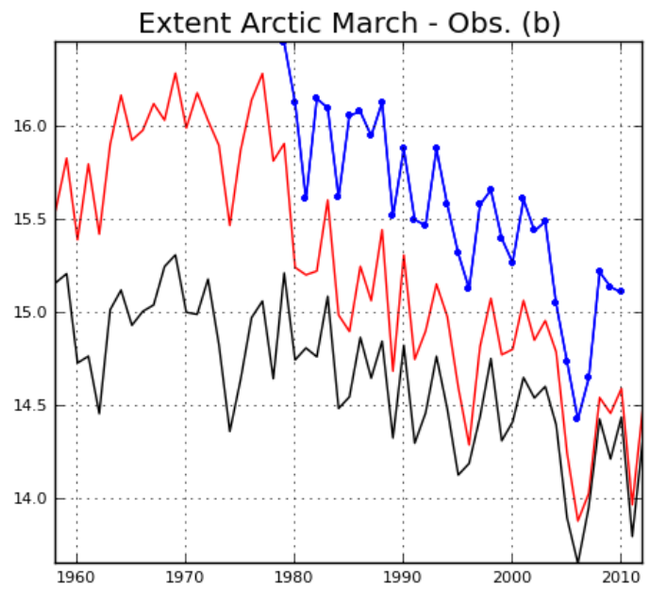


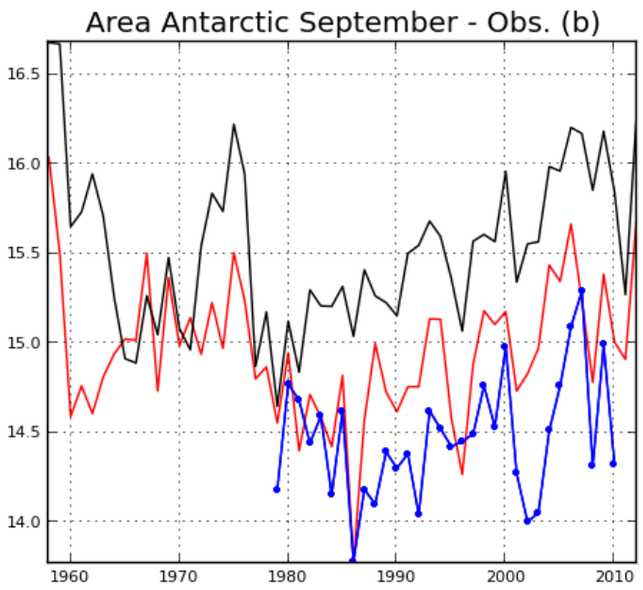


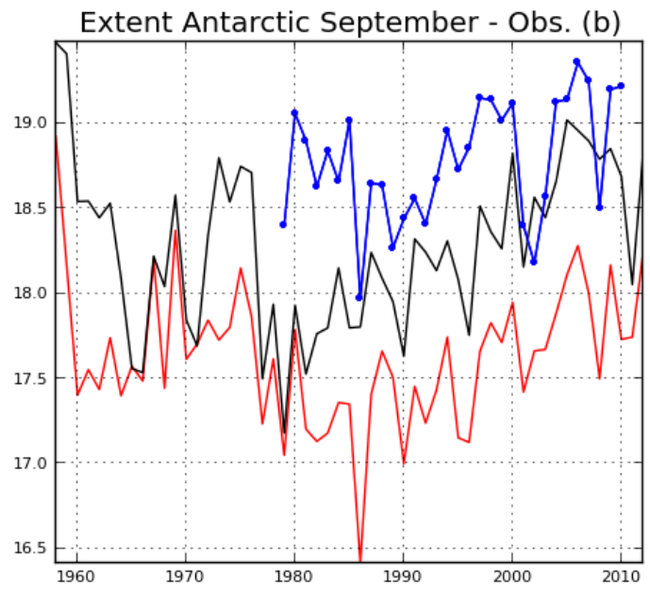
Sensitivity experiment with JRA at 0.5° resolution

Sea ice extent and sea ice area (maximum)









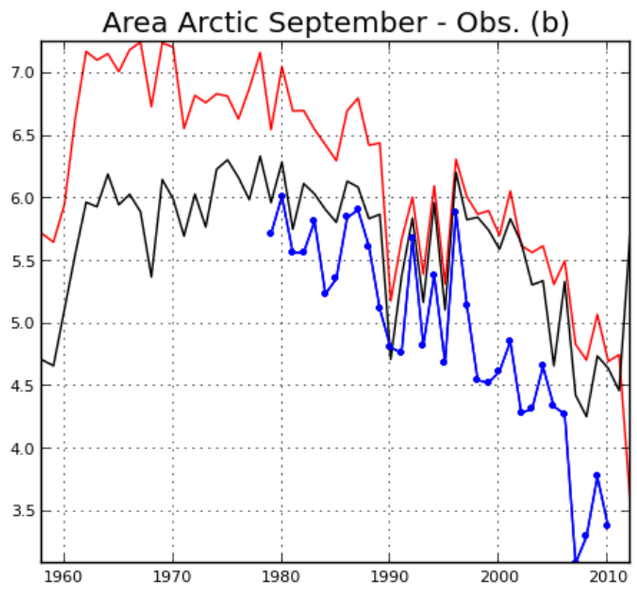
JRA : red

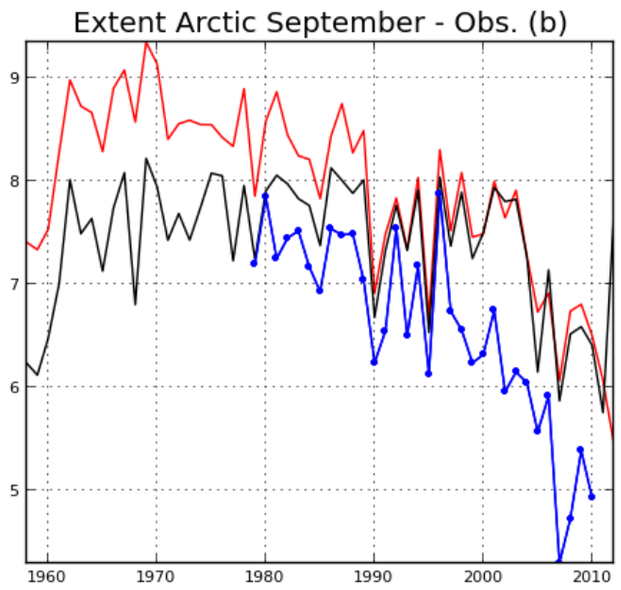
DFS : black

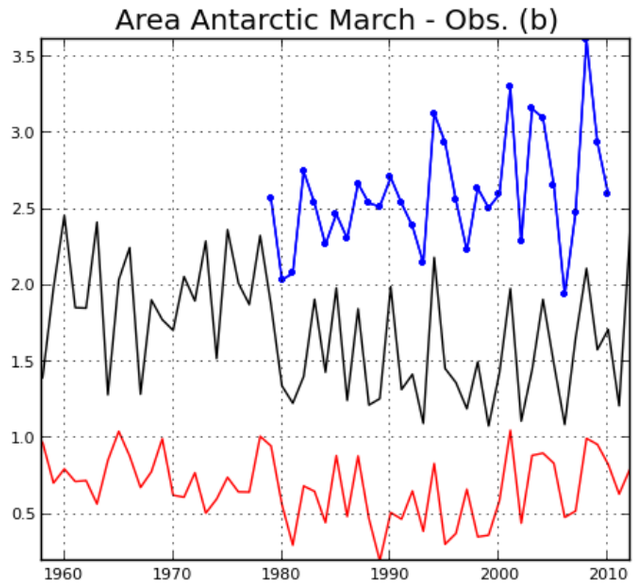
OBS : blue

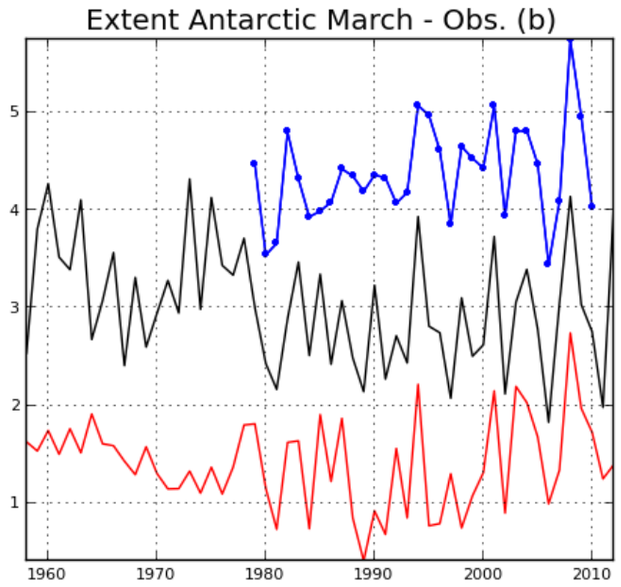
Sensitivity experiment with JRA at 0.5° resolution

Sea ice extent and sea ice area (minimum)









JRA : red
DFS : black
OBS : blue