Sensitivity of the AMOC
to freshwater anomalies in the South Atlantic

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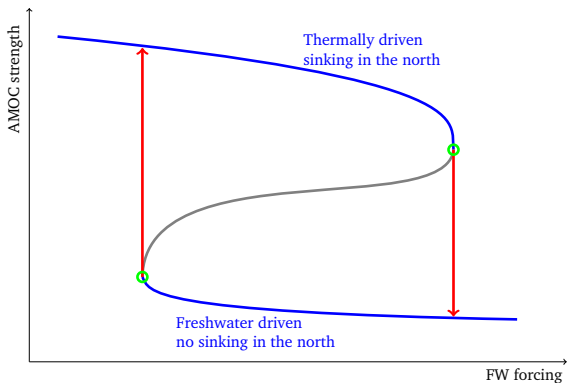Utrecht University
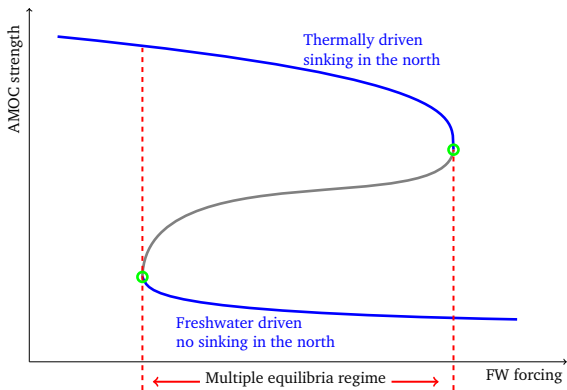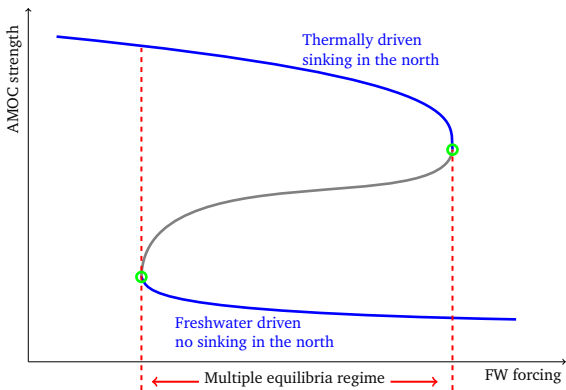
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EGU 2012
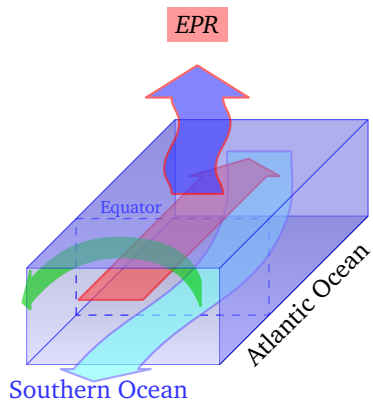
Hysteresis of the AMOC

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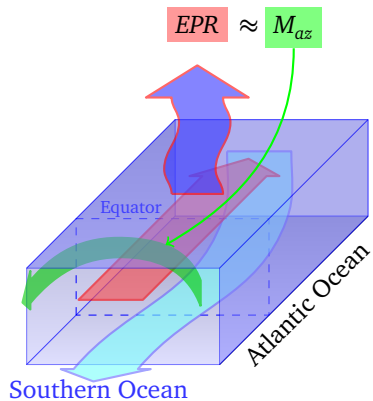
Hysteresis of the AMOC

How is the multiple equilibria regime modified by changes in the freshwater budget of the Atlantic Ocean?
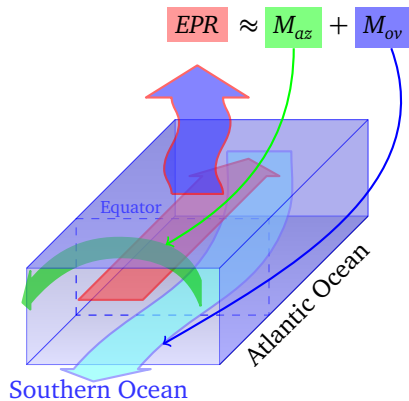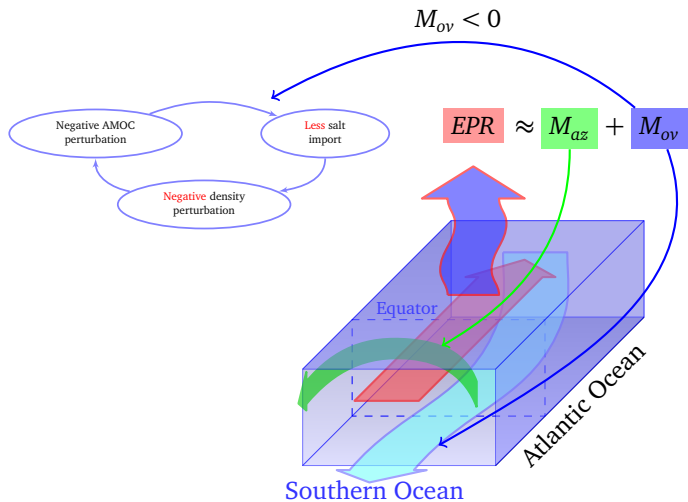
Freshwater budget and salt–advection feedback

Freshwater budget and salt–advection feedback

$$EPR \approx M_{az}$$

Equator

Atlantic Ocean

Southern Ocean

Freshwater budget and salt–advection feedback

Freshwater budget and salt–advection feedback

$M_{ov} < 0$

Negative AMOC perturbation

Less salt import

Negative density perturbation

$EPR \approx M_{az} + M_{ov}$

Equator

Atlantic Ocean

Southern Ocean

Freshwater budget and salt–advection feedback

Biases in freshwater budget representation

$EPR \approx M_{az} + M_{ov}$

1. Tropical cloud cover underestimation
   - excessive evaporation
2. Agulhas leakage misrepresentation
3. eddy activity...

Biases in freshwater budget representation

What is the impact of these biases?
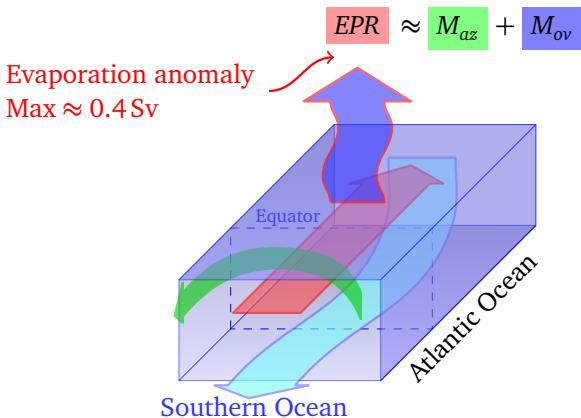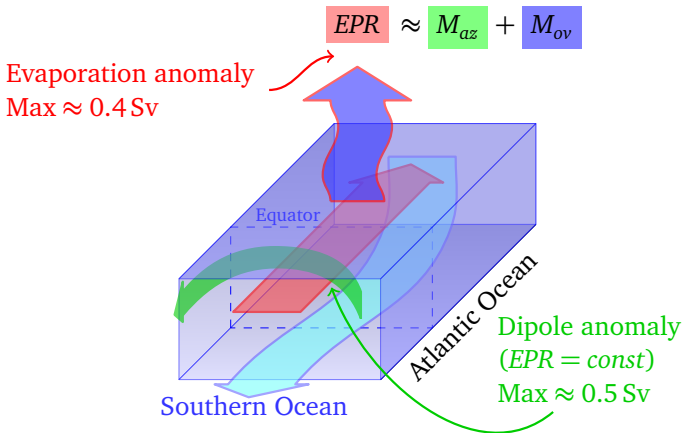

1. Tropical cloud cover underestimation
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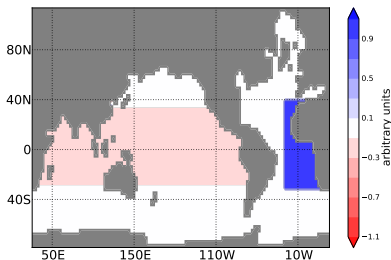
Represent freshwater biases as two anomaly patterns
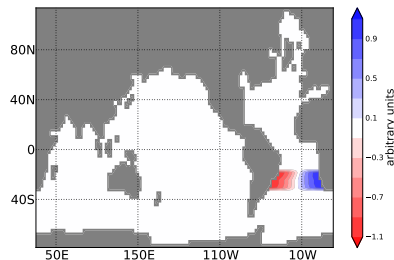
Represent freshwater biases as two anomaly patterns

$$EPR \approx M_{az} + M_{ov}$$

Evaporation anomaly
Max $\approx 0.4\,\mathrm{Sv}$

Equator

Atlantic Ocean

Dipole anomaly
($EPR = const$)
Max $\approx 0.5\,\mathrm{Sv}$

Southern Ocean

The model used: SPEEDO EMIC

- Primitive equations
- Resolution $3° \times 3°$
- Atmospheric model including feedbacks on long time scales

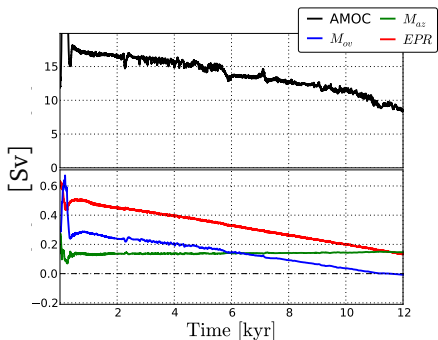*Evaporation anomaly*   *Dipole anomaly*

Both are applied at the surface.

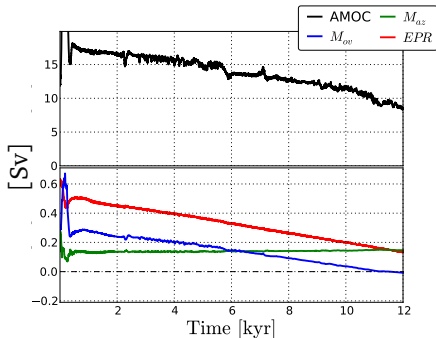*Cimatoribus et al, Clim. Dyn. 2012*

Sensitivity of AMOC stability

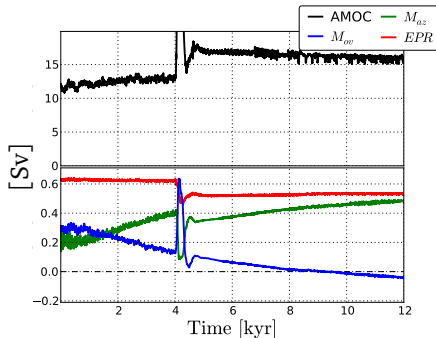Decrease evaporation
No dipole anomaly

Sensitivity of AMOC stability

Decrease evaporation
No dipole anomaly

Increase dipole anomaly
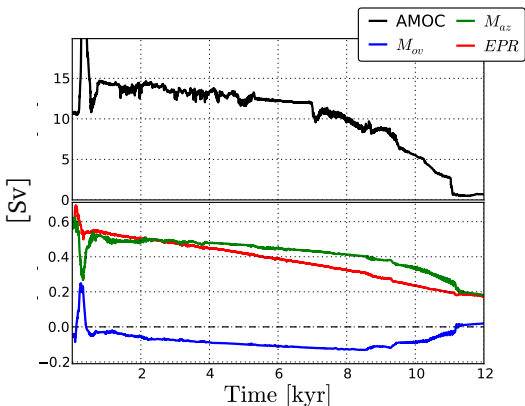No change in net evaporation

Sensitivity of AMOC stability

Decrease net evaporation

with dipole anomaly applied

Conclusions

Biases in freshwater fluxes = biases in AMOC stability

1. Basin–scale freshwater budget controls the AMOC stability
   - In particular freshwater transport from the Southern Ocean into the Atlantic Basin
2. Careful assessment (and improvement) of model biases is needed
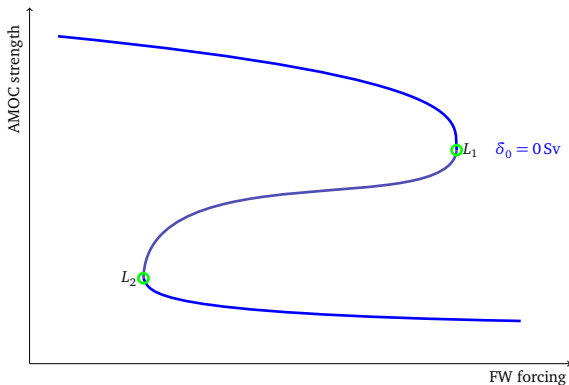   - Need for measurements (SAMOC)!

Thanks for listening!

Cimatoribus, A. *et al.*, Clim. Dyn. (2012) *In press*
Sensitivity of the Atlantic meridional overturning circulation to South
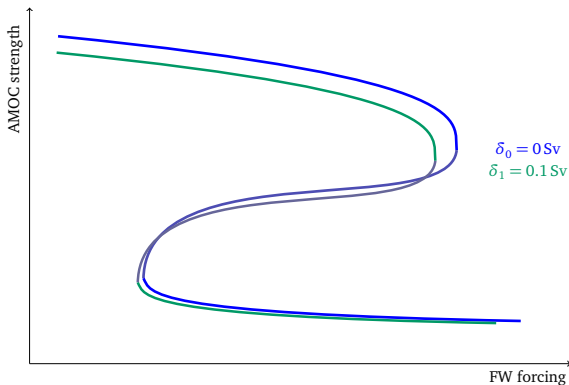Atlantic freshwater anomalies
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Assess systematically the AMOC stability for different dipole strengths

The whole picture (THCM)

Assess systematically the AMOC stability for different dipole strengths
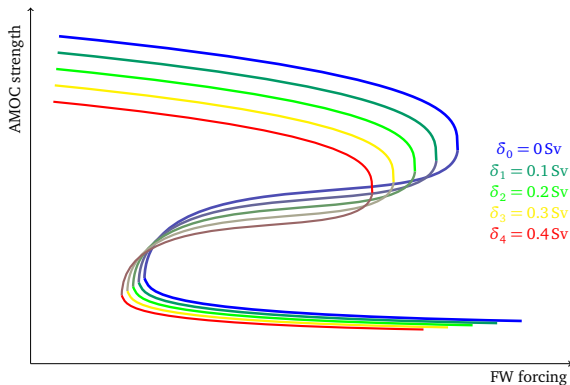

$\delta_0 = 0\,\mathrm{Sv}$
$\delta_1 = 0.1\,\mathrm{Sv}$

The whole picture (THCM)

Assess systematically the AMOC stability for different dipole strengths

Assess systematically the AMOC stability for different dipole strengths