

The Ocean Mixing – SST – Cloud Feedback in the Tropical Atlantic

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Royal Netherlands
Meteorological Institute



SST - SSR

ocean mixing -
SST

Unravelling the
feedback

Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Correlation between SST and surface fluxes

monthly reanalysis data

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Deppenmeier

SST - SSR

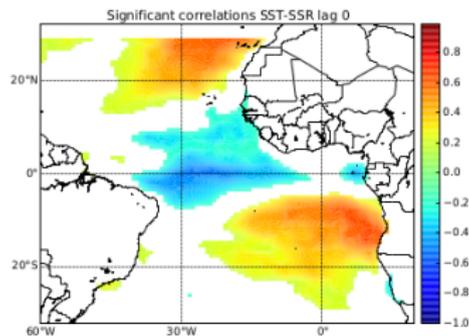
ocean mixing -
SST

Unravelling the
feedback

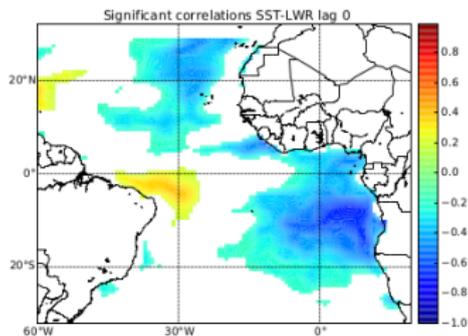
Conclusion

Supplementary
material

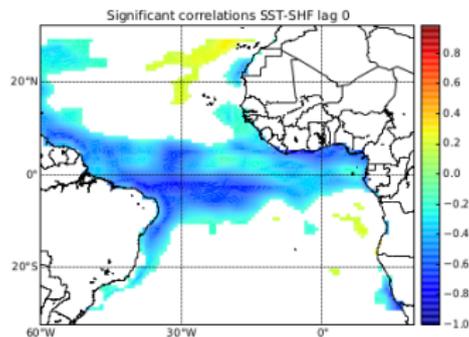
The data
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MXL
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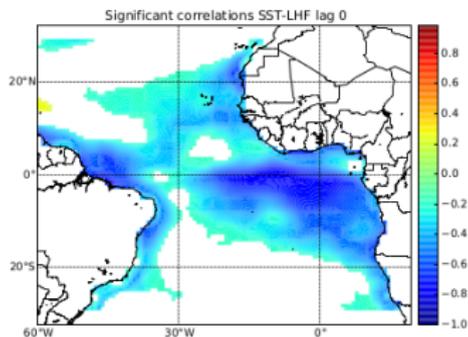
(a) Short wave down



(b) Long wave



(c) Sensible heat



(d) Latent heat

TropFlux, Kumar et al 2012



Correlation between SST and surface fluxes

monthly reanalysis data

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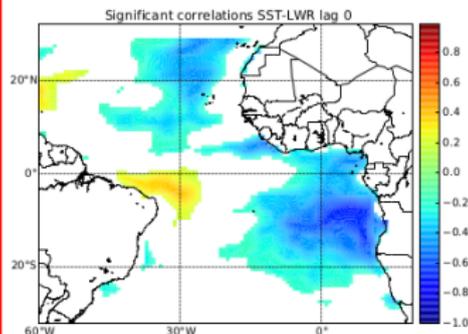
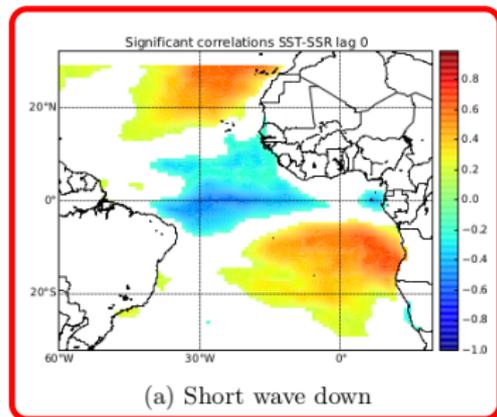
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feedback

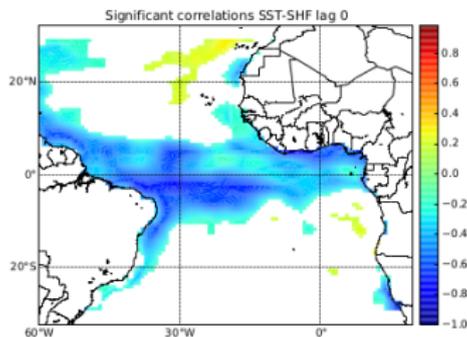
Conclusion

Supplementary
material

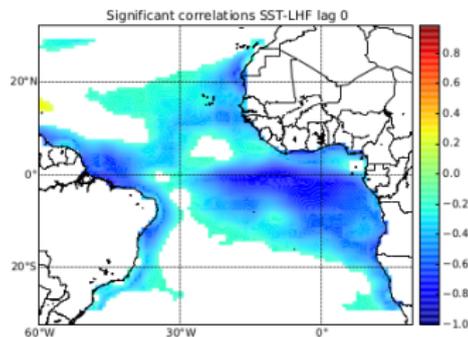
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MXL
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(b) Long wave



(c) Sensible heat



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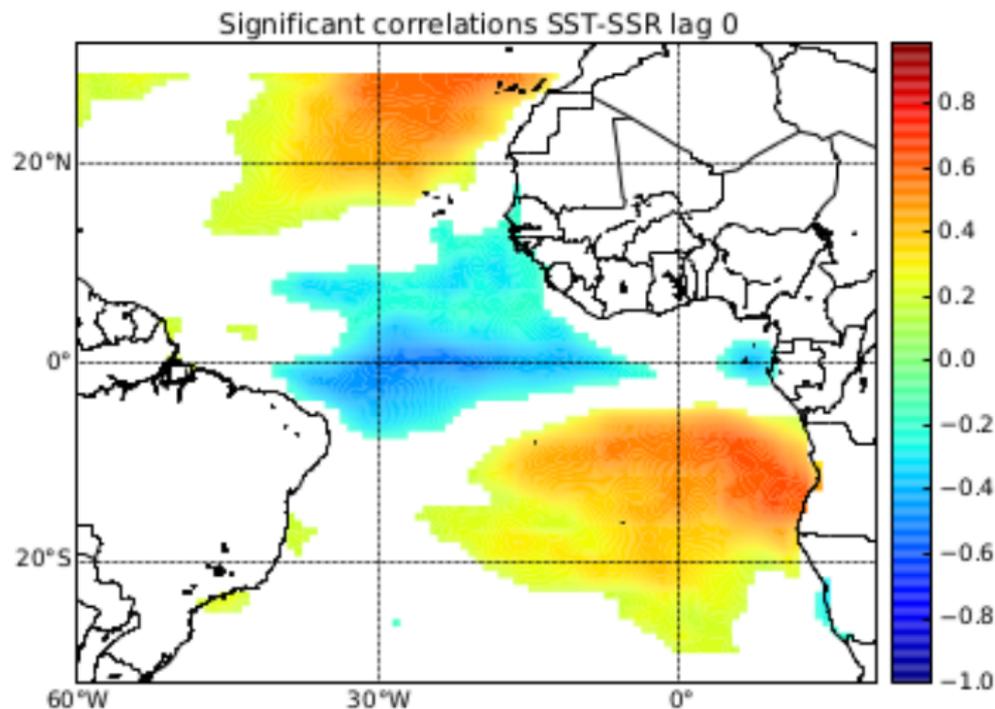
TropFlux, Kumar et al 2012



Correlation between SST and surface fluxes

monthly

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(a) Short wave down

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Unravelling the
feedback

Conclusion

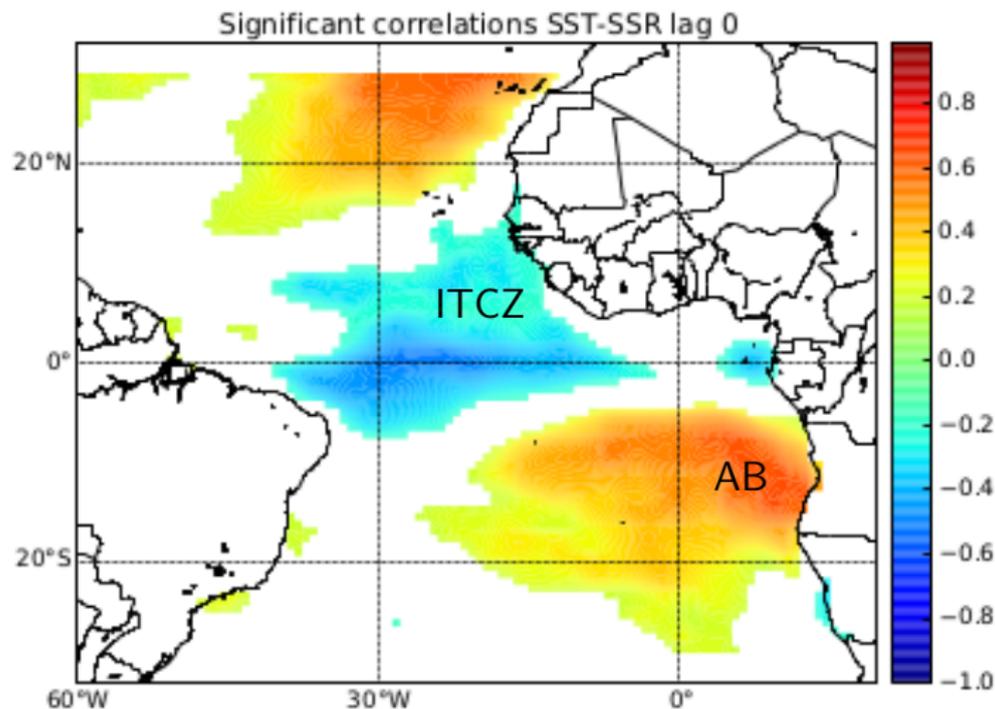
Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

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monthly

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(a) Short wave down

SST - SSR

ocean mixing -
SST

Unravelling the
feedback

Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Correlation SST - SSR

daily

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SST - SSR

ocean mixing -
SST

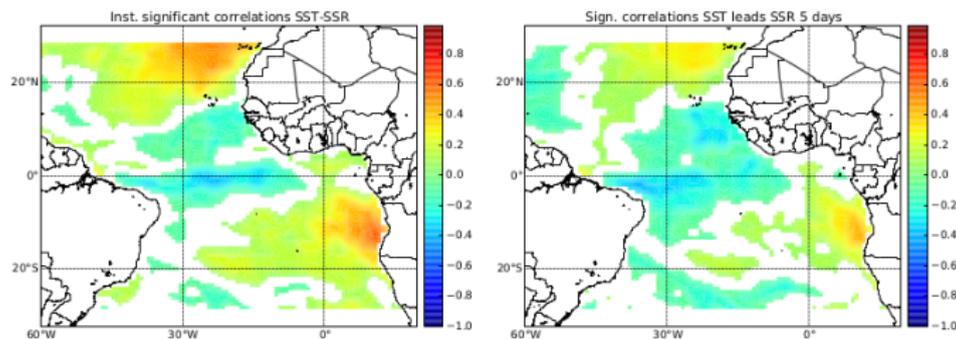
Unravelling the
feedback

Conclusion

Supplementary
material

The data
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MXL
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Figure 1: Tropflux 5 day running mean correlations



instantaneous correlation

5 days lag

Correlation SST - SSR

daily

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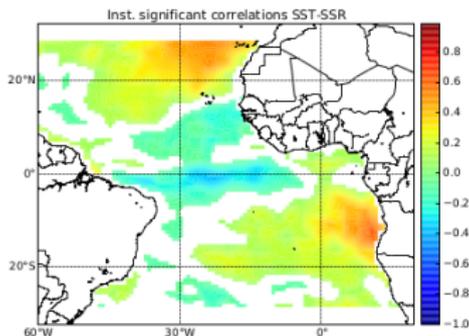
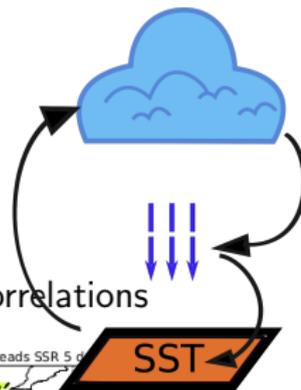
Unravelling the
feedback

Conclusion

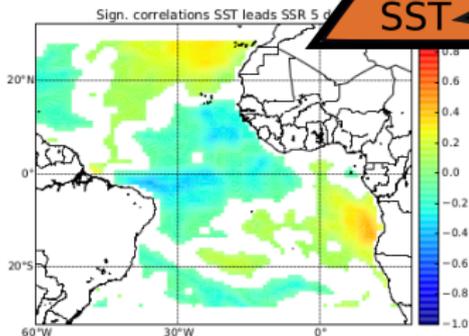
Supplementary
material

The data
EC-Earth SST-SSR
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Figure 1: Tropflux 5 day running mean correlations



instantaneous correlation

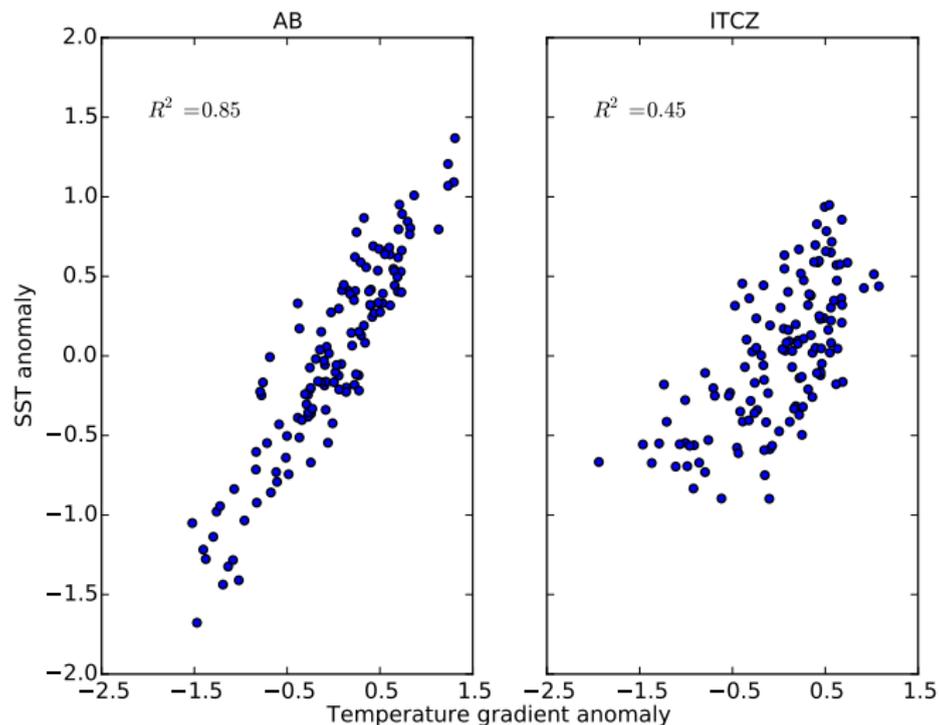


5 days lag

Ocean mixing - SST

Data from ORAS4, Balmaseda et al 2013

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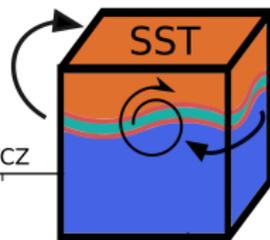
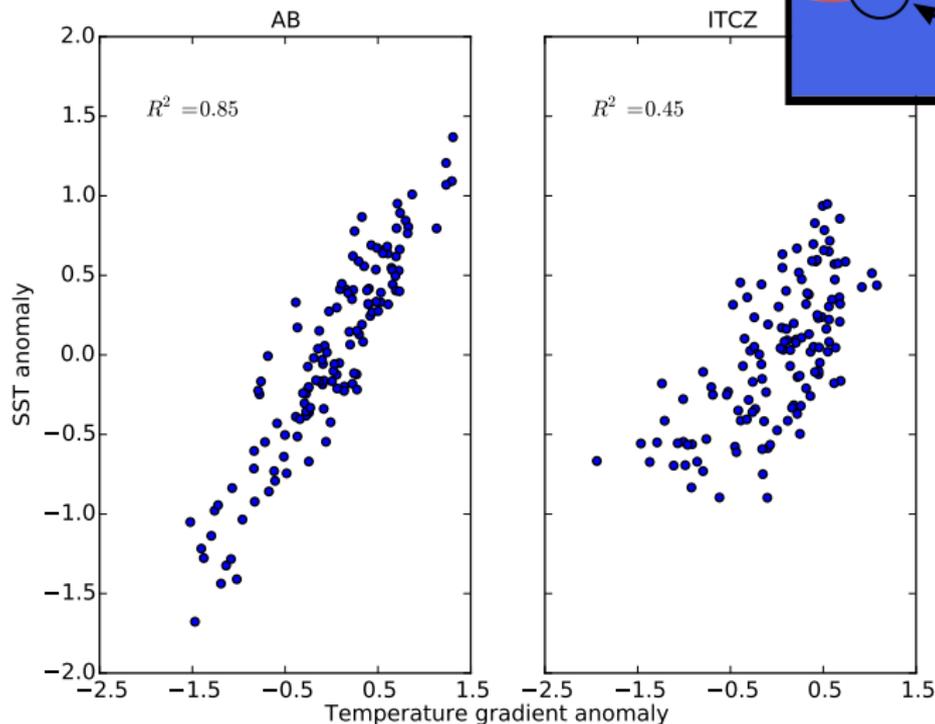
Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Ocean mixing - SST

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ocean mixing -
SST

Unravelling the
feedback

Conclusion

Supplementary
material

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Can we explain GCM SST biases

with the SST - cloud cover and/or the SST - ocean mixing processes?

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SST

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feedback

Conclusion

Supplementary
material

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- ▶ Construct heat budget for model and reanalysis
- ▶ Compare to to each other
- ▶ Identify important processes
- ▶ Find model errors

GCM: EC-Earth3.1 (Nemo ORCA1L46, IFS T255, OASIS3, LIM3)
3D initialised hindcasts 1st of May - 31st of August 2000-2009, 5 members

Reanalysis: ORAS4 (Balmaseda et al 2013), TropFlux (Kumar et al 2013)

SST bias

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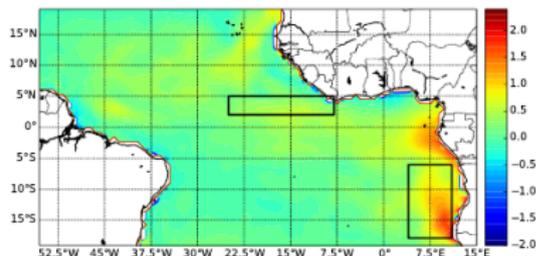
Unravelling the
feedback

Conclusion

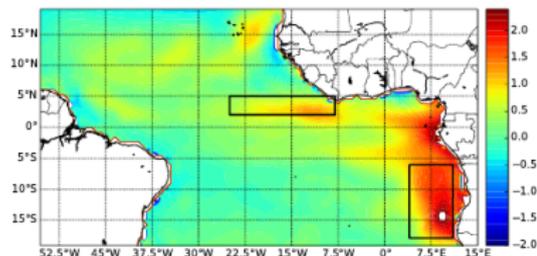
Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

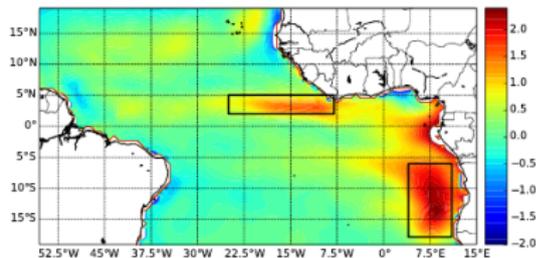
(a) May



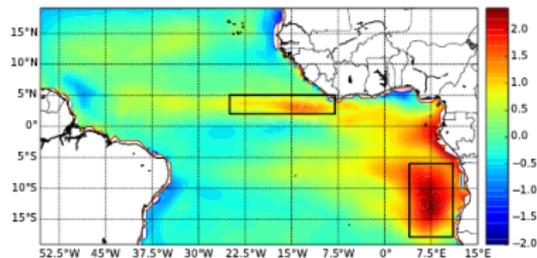
(b) June



(c) July



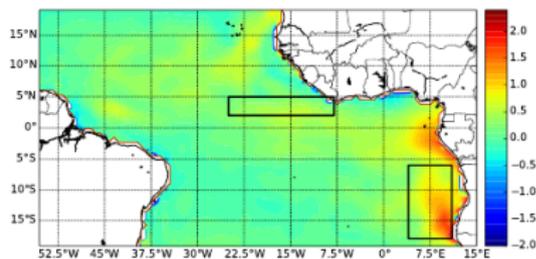
(d) August



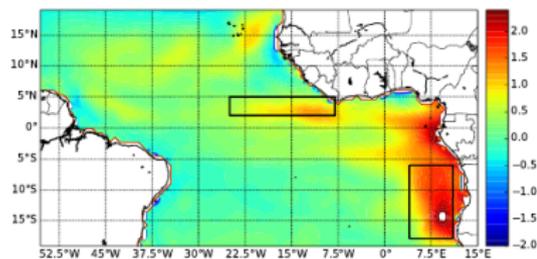
SST bias

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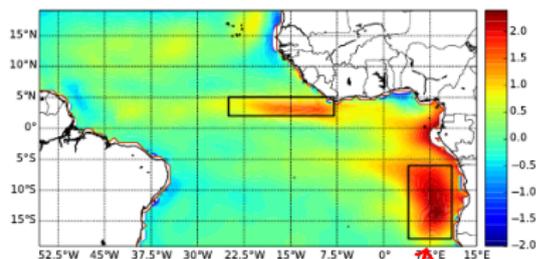
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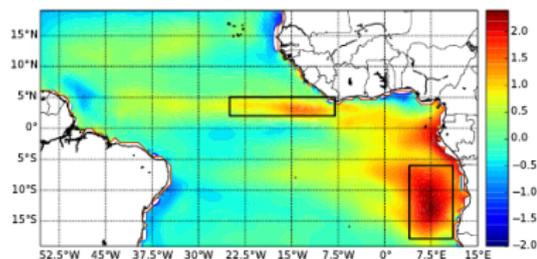
(b) June



(c) July



(d) August



AB box

SST - SSR

ocean mixing -
SST

Unravelling the
feedback

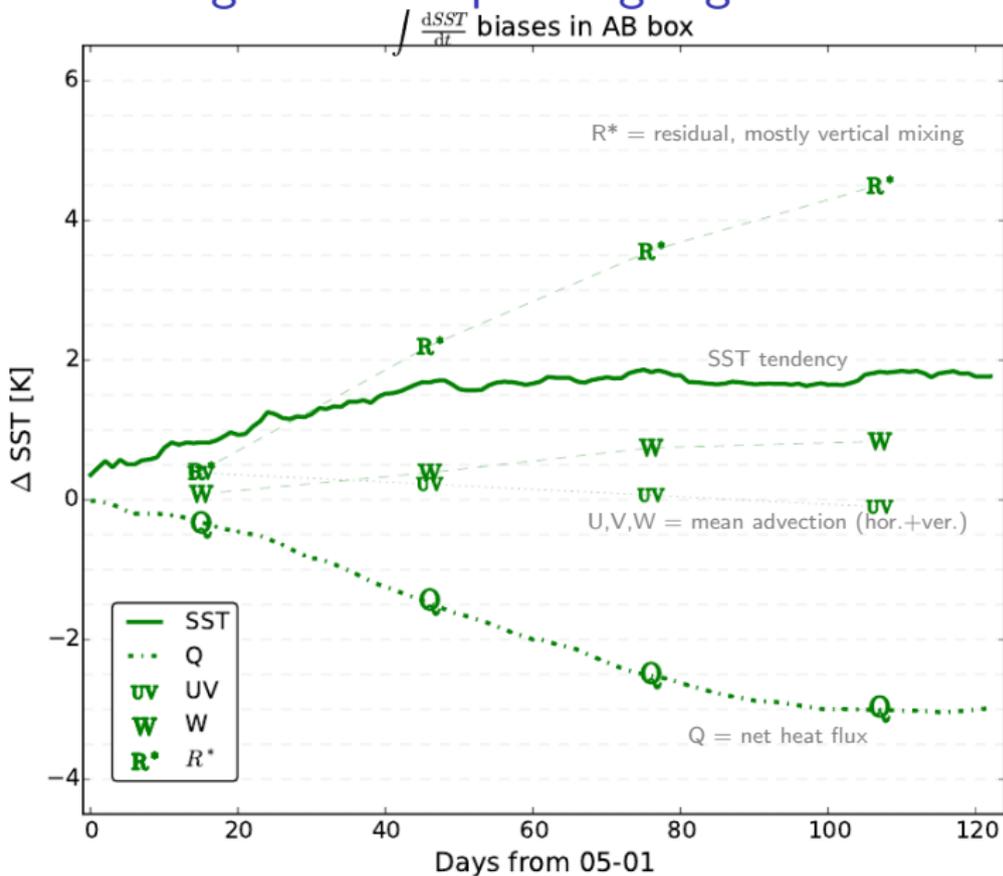
Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Heat budget in the upwelling region

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SST - SSR

ocean mixing -
SST

Unravelling the
feedback

Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

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SST - SSR

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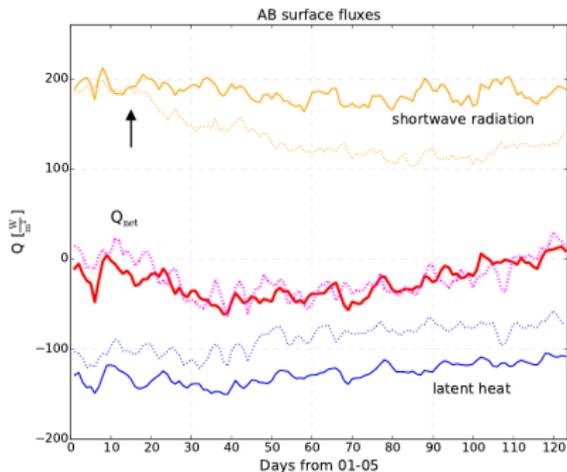
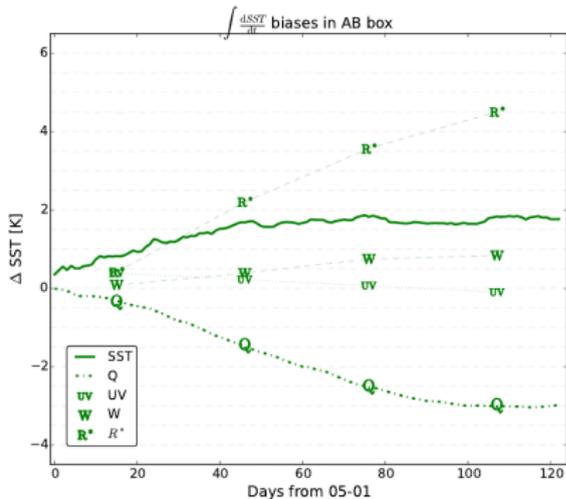
Unravelling the
feedback

Conclusion

Supplementary
material

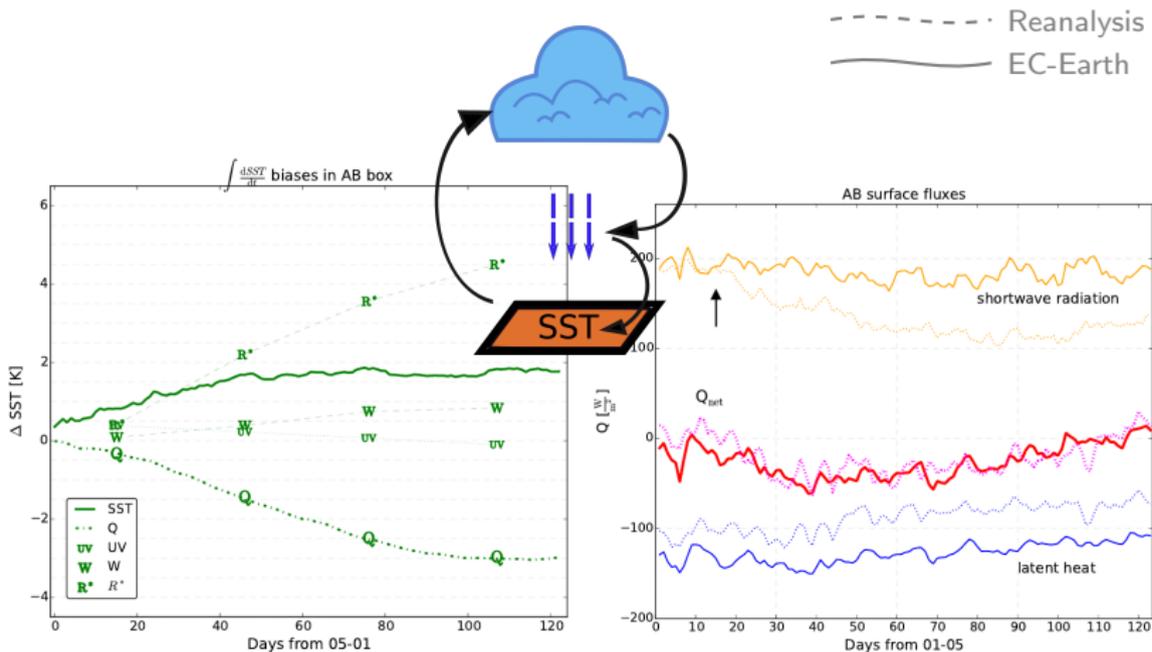
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--- Reanalysis
— EC-Earth



Heat budget in the upwelling region

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SST - SSR

ocean mixing -
SST

Unravelling the
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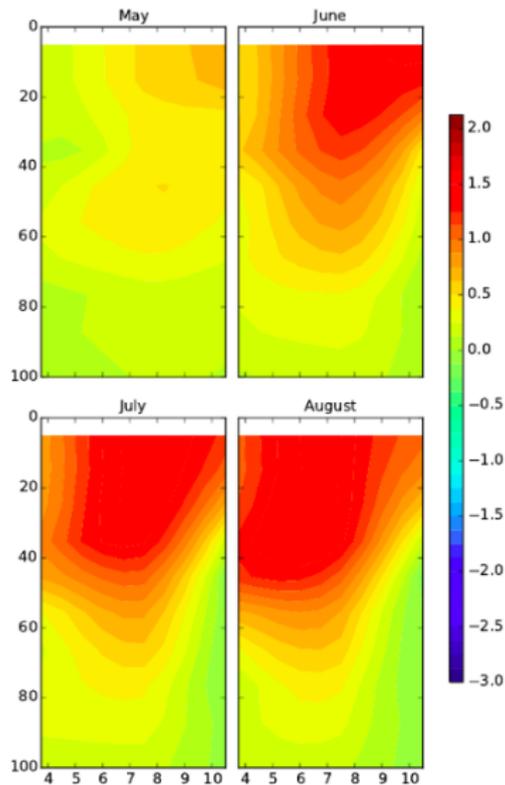
Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

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SST - SSR

ocean mixing -
SST

Unravelling the
feedback

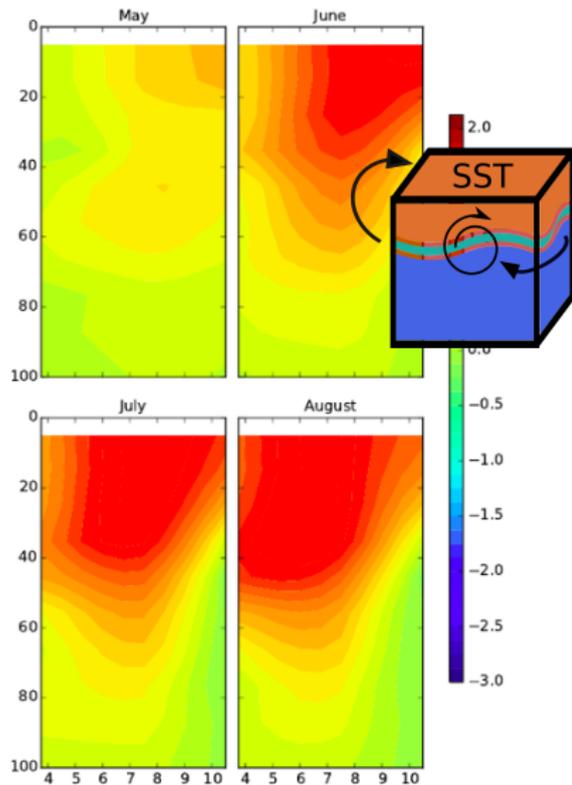
Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Heat budget in the upwelling region

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SST - SSR

ocean mixing -
SST

Unravelling the
feedback

Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Mechanism Angola Benguela upwelling region

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SST - SSR

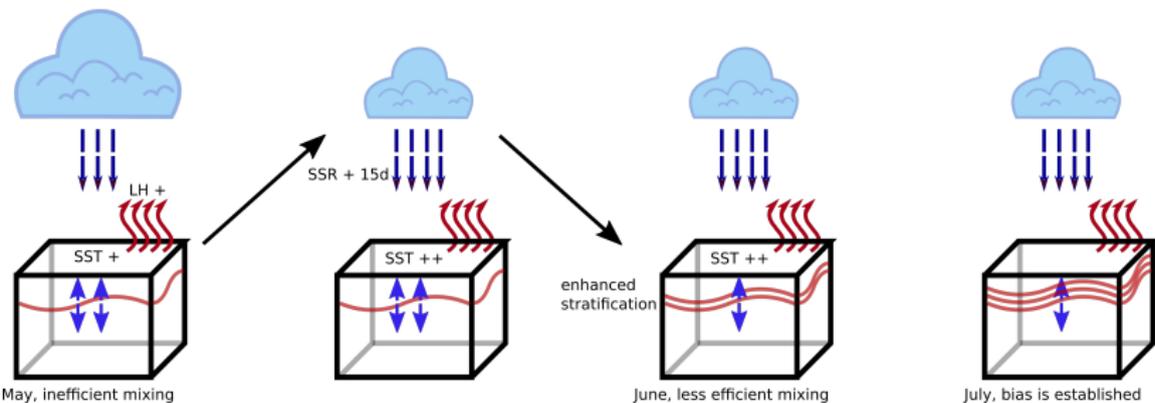
ocean mixing -
SST

Unravelling the
feedback

Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5



SST bias

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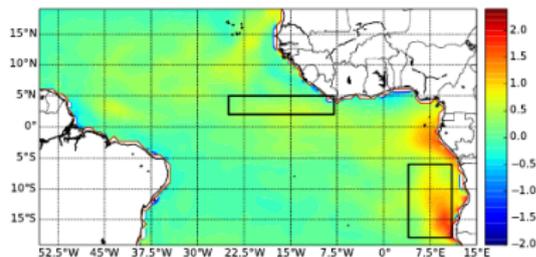
Unravelling the
feedback

Conclusion

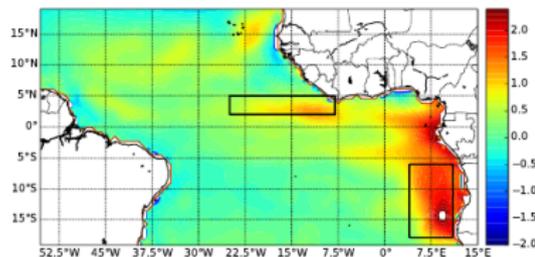
Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

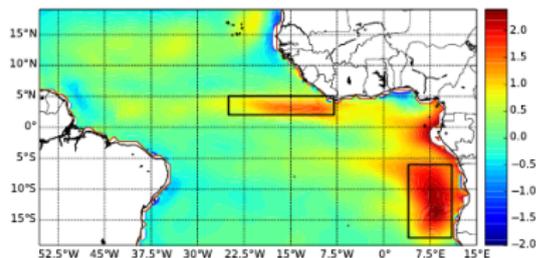
(a) May



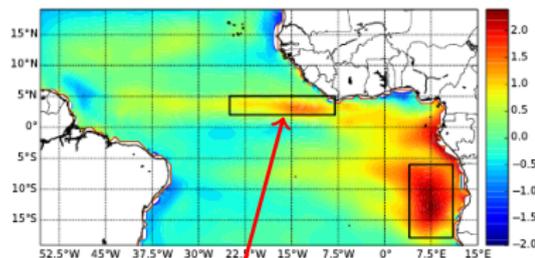
(b) June



(c) July



(d) August



ITCZ box

Heat budget underneath ITCZ

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SST - SSR

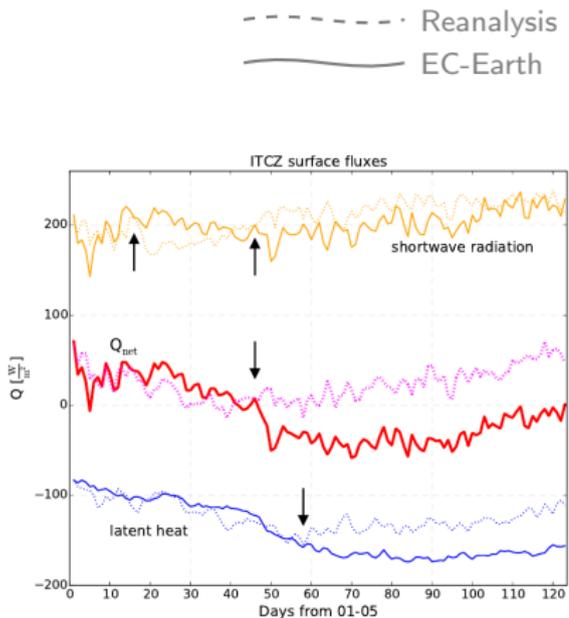
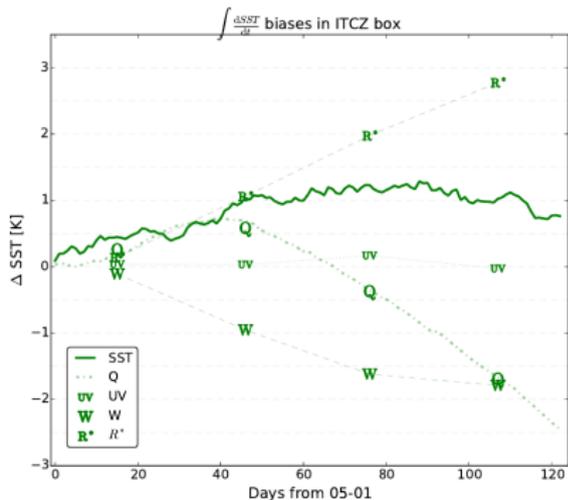
ocean mixing -
SST

Unravelling the
feedback

Conclusion

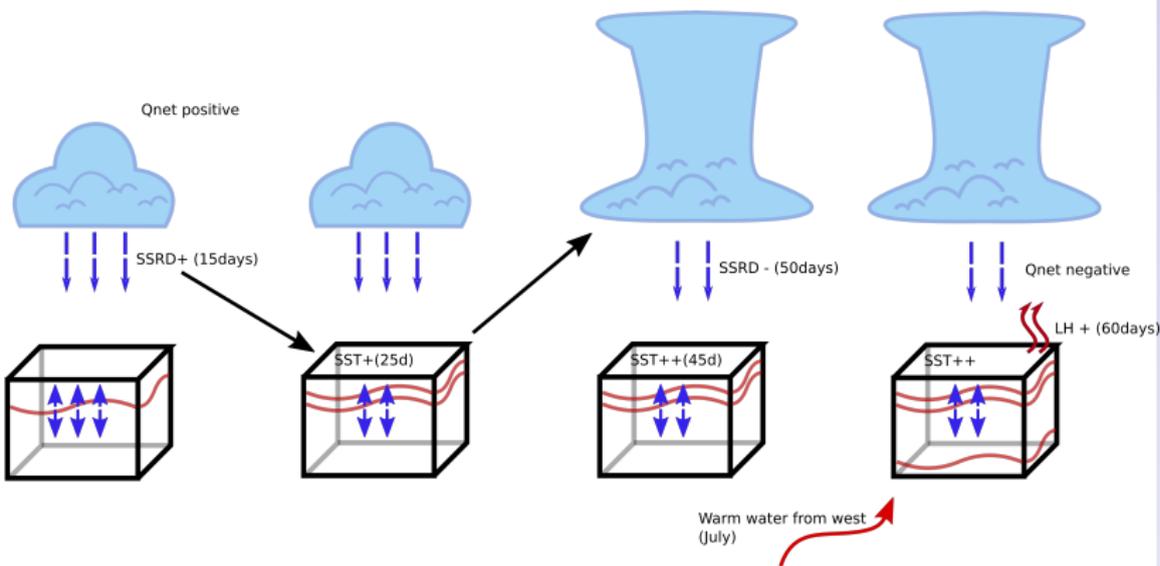
Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5



Mechanism ITCZ region

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ocean mixing -
SST

Unravelling the
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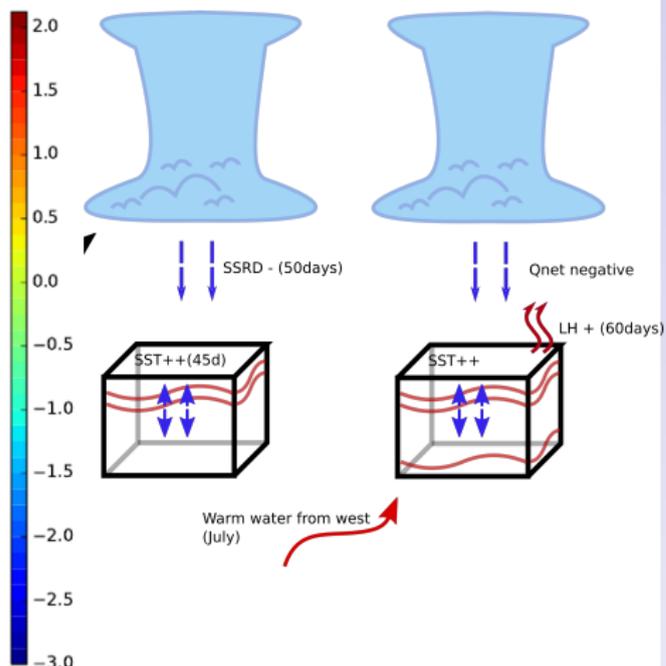
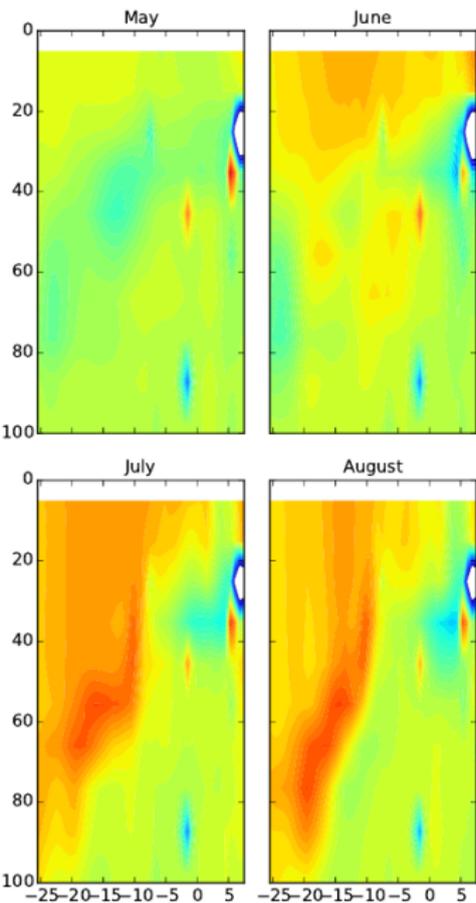
Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Mechanism ITCZ region

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SST - SSR

ocean mixing -
SST

Unravelling the
feedback

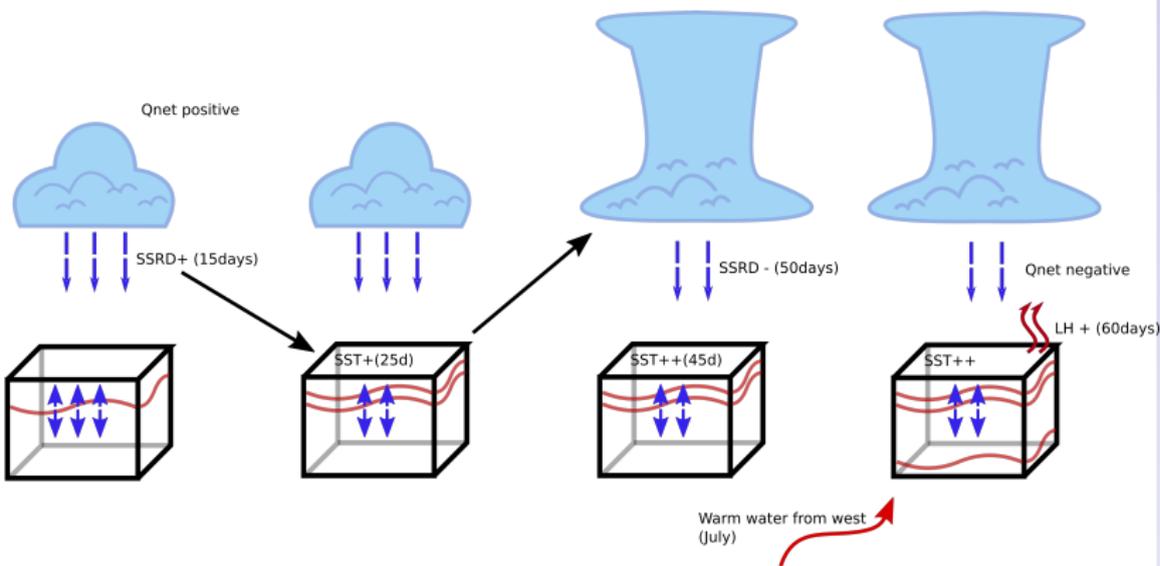
Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Mechanism ITCZ region

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Deppenmeier



SST - SSR

ocean mixing -
SST

Unravelling the
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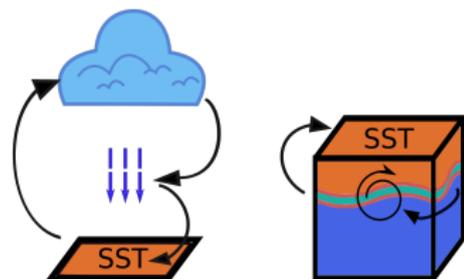
Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Conclusion

- ▶ SST - SSR feedback works differently depending on the region.
- ▶ Ocean vertical mixing is mainly responsible.
- ▶ Initialised hindcasts are a good tool to unravel processes.



SST - SSR

ocean mixing -
SST

Unravelling the
feedback

Conclusion

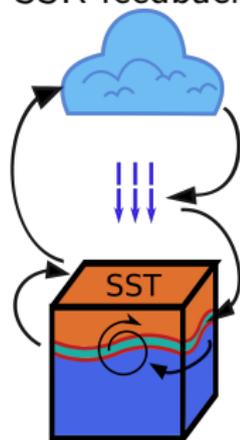
Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Conclusion

- ▶ SST - SSR feedback works differently depending on the region.
- ▶ Ocean vertical mixing is mainly responsible.
- ▶ Initialised hindcasts are a good tool to unravel processes.
- ▶ There is actually an ocean mixing - SST - SSR feedback that influences the bias development.

Thank you for your attention!



SST - SSR

ocean mixing -
SST

Unravelling the
feedback

Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Supplementary Material

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SST - SSR

ocean mixing -
SST

Unravelling the
feedback

Conclusion

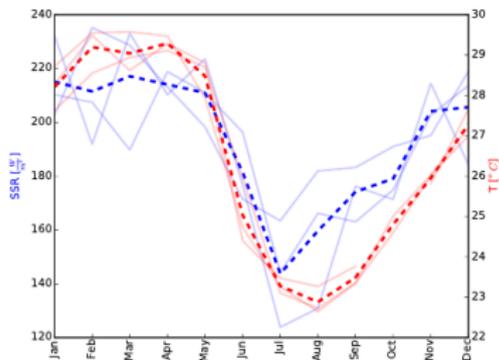
**Supplementary
material**

The data
EC-Earth SST-SSR
MXL
CMIP5

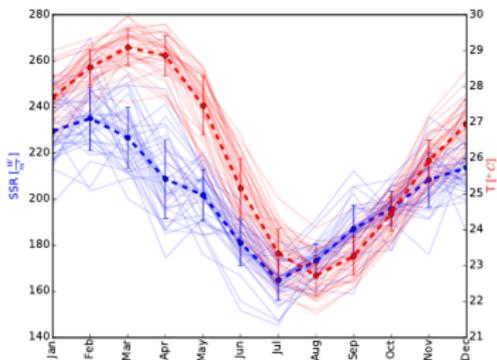
The good, the bad, and the ugly

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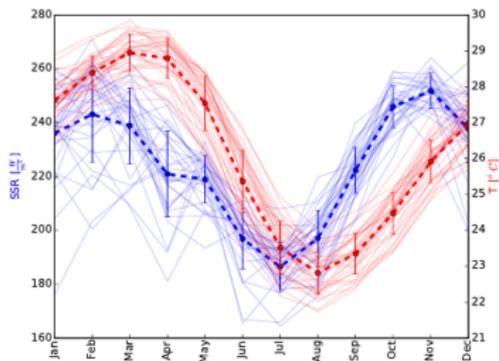
(a) PIRATA buoy



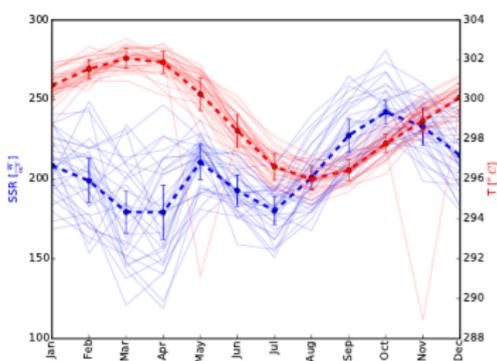
(b) Tropflux



(c) ERAInt



(d) MERRA2



SST - SSR

ocean mixing -
SST

Unravelling the
feedback

Conclusion

Supplementary
material

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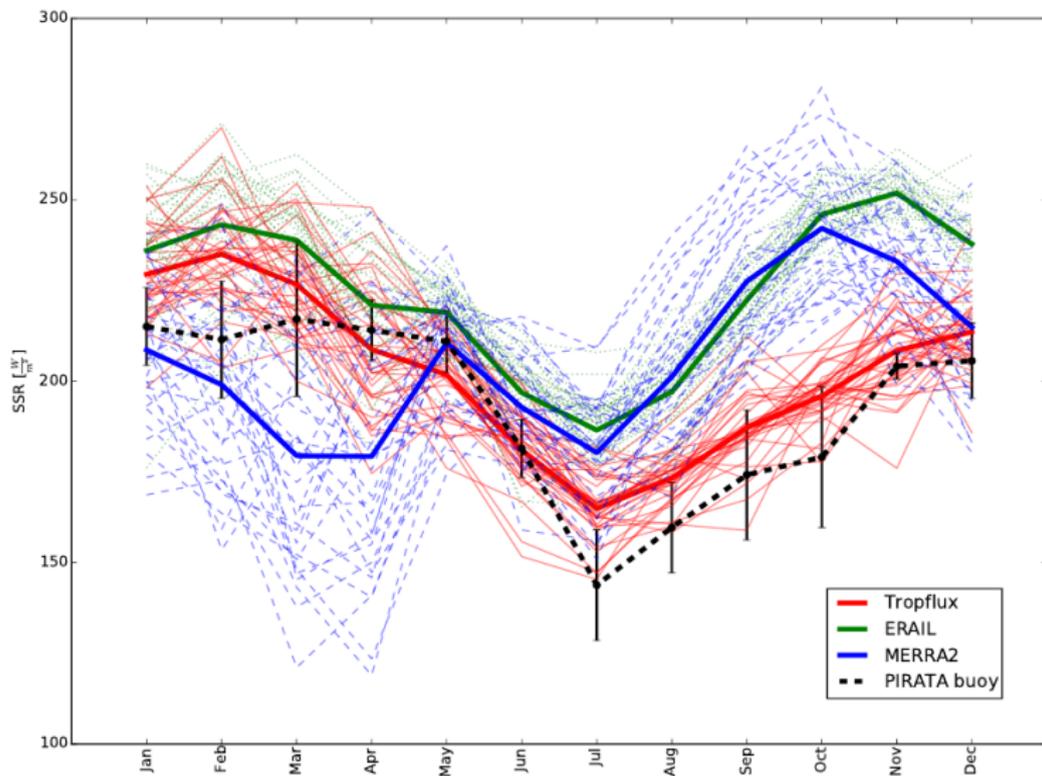
EC-Earth SST-SSR

MXL

CMIP5

The good, the bad, and the ugly

Anna-Lena
Deppenmeier



SST - SSR

ocean mixing -
SST

Unravelling the
feedback

Conclusion

Supplementary
material

The data

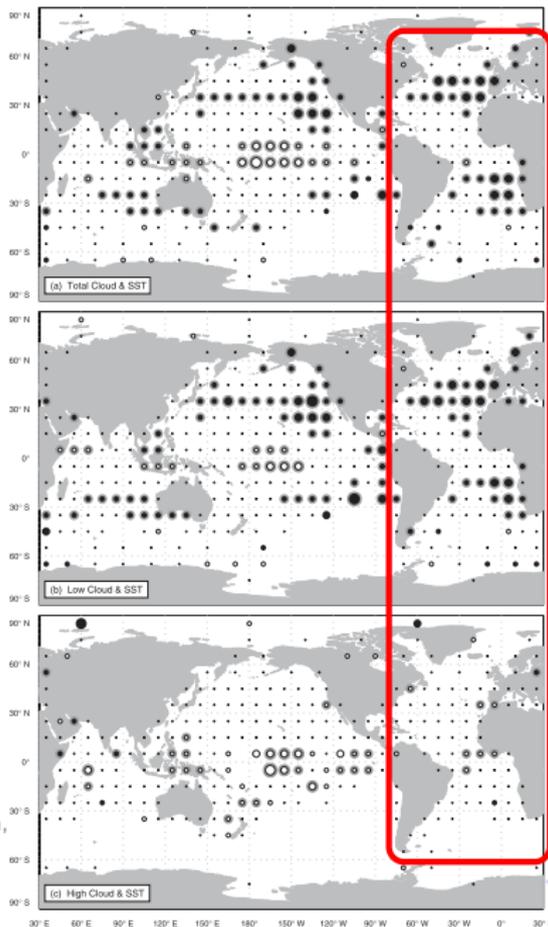
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MXL

CMIP5

SST – cloud cover correlation

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total cloud cover

low cloud cover

high cloud cover

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ocean mixing -
SST

Unravelling the
feedback

Conclusion

Supplementary
material

The data

EC-Earth SST-SSR

MXL

CMIP5

Eastman, Warren and Hahn,

JClim 2011



SST - SSR

ocean mixing -
SST

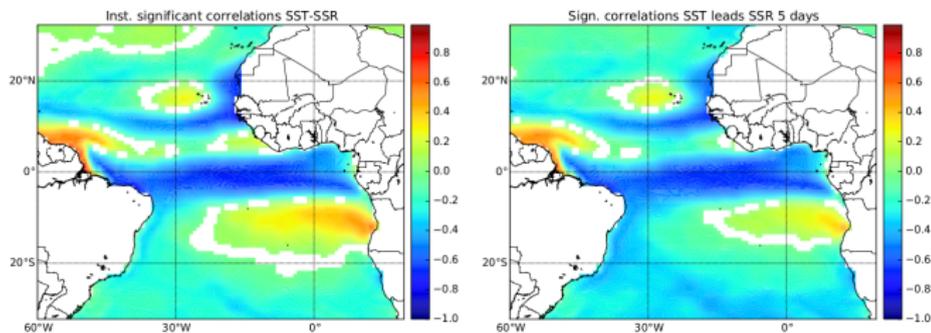
Unravelling the
feedback

Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

Figure 2: EC-Earth



Mixed layer depths acc. to $T > SST-0.1$

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SST

Unravelling the
feedback

Conclusion

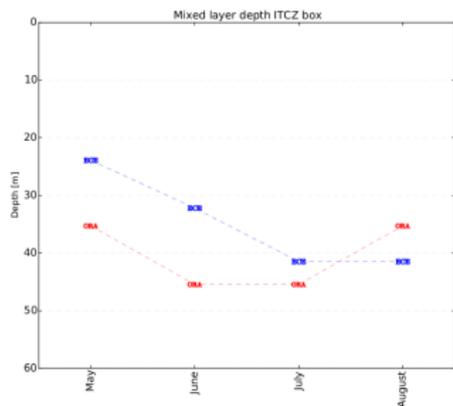
Supplementary
material

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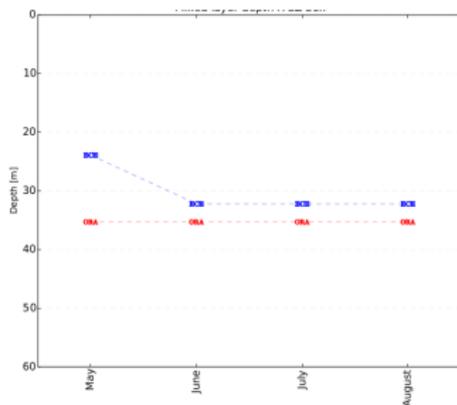
MXL

CMIP5

ITCZ box

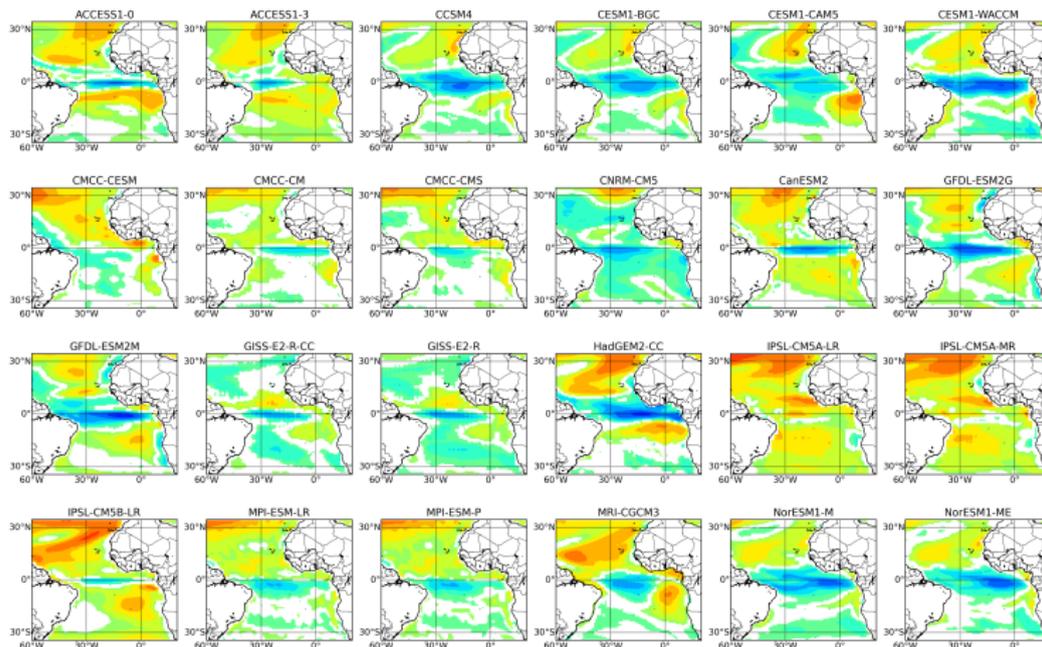


AB box



SST - SSR correlation in CMIP5

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SST - SSR

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SST

Unravelling the
feedback

Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

SST bias in CMIP5

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SST - SSR

ocean mixing -
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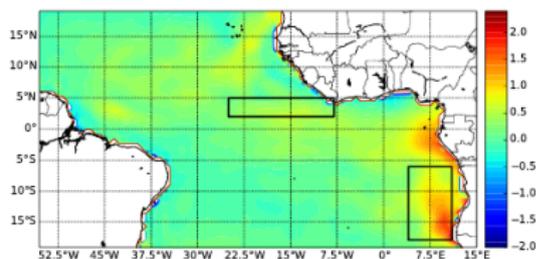
Unravelling the
feedback

Conclusion

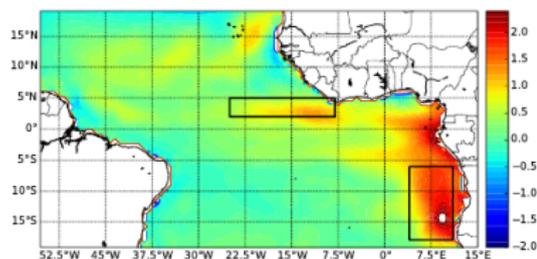
Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

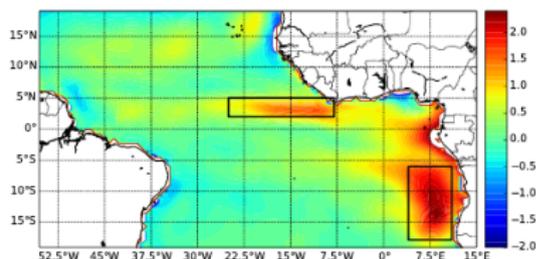
(a) May



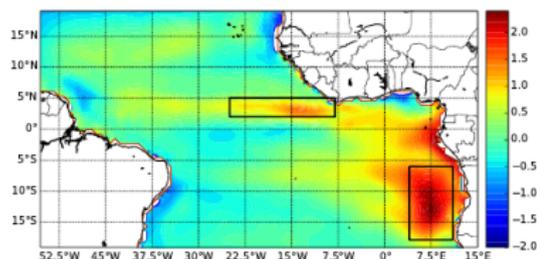
(b) June



(c) July

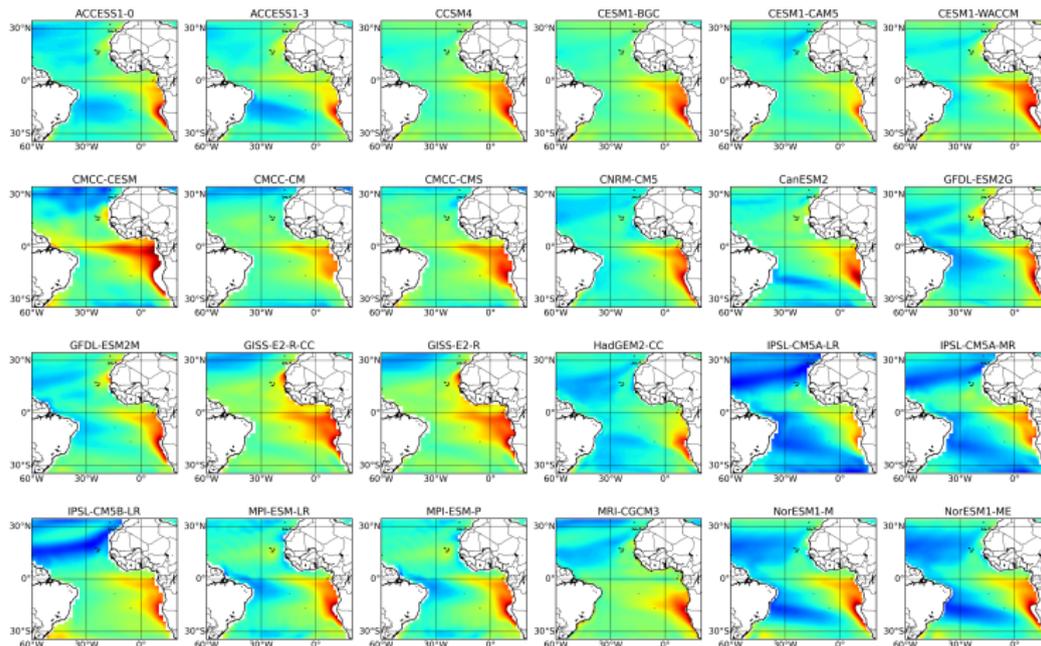


(d) August



SST bias in CMIP5

Anna-Lena
Deppenmeier



SST - SSR

ocean mixing -
SST

Unravelling the
feedback

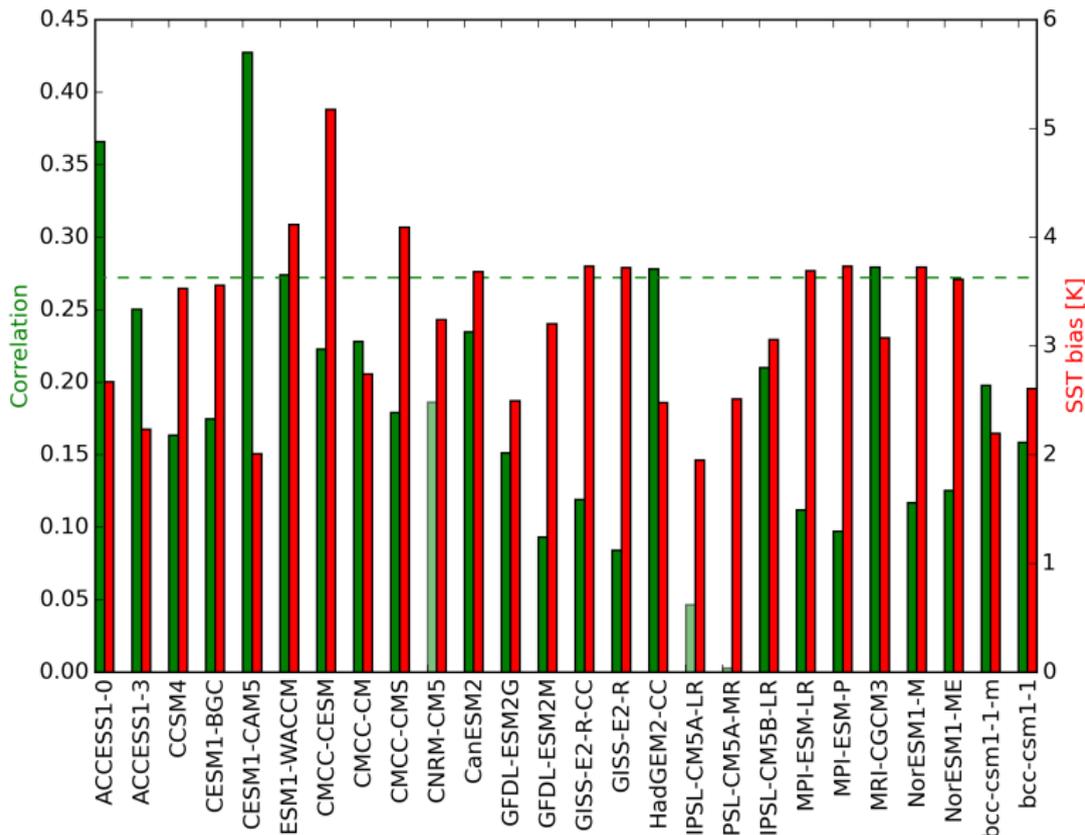
Conclusion

Supplementary
material

The data
EC-Earth SST-SSR
MXL
CMIP5

For the AB region

the bias should be larger



SST - SSR

ocean mixing -
SST

Unravelling the
feedback

Conclusion

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material

The data
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MXL
CMIP5