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RESEARCH FOR GRAND CHALLENGES

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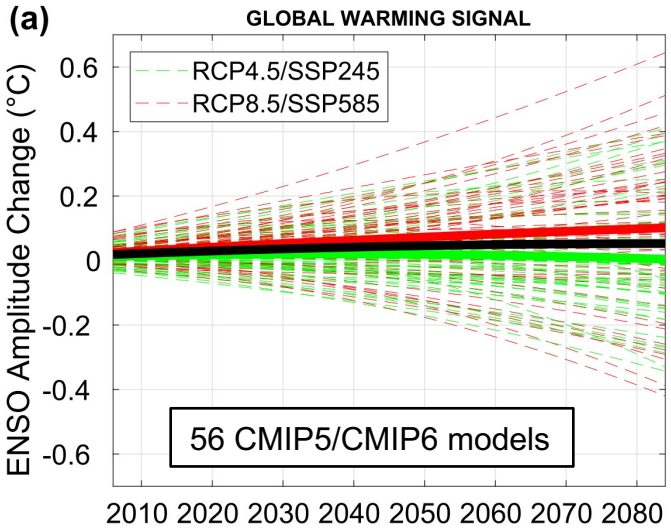
ENSO Atmospheric Feedbacks under Global Warming and their Relation to Mean-state Changes

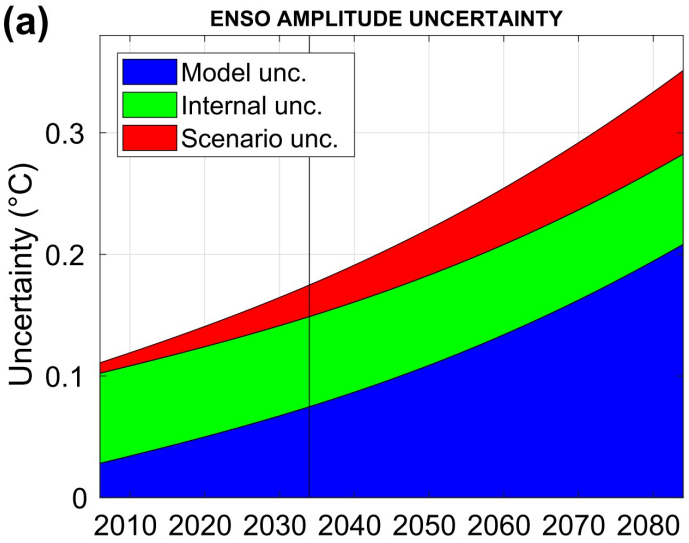
Tobias Bayr and Mojib Latif

EGU 2022

Motivation

ENSO amplitude change under global warming is still uncertain…





Beobide et al. (2021)

… mostly due to model uncertainties!

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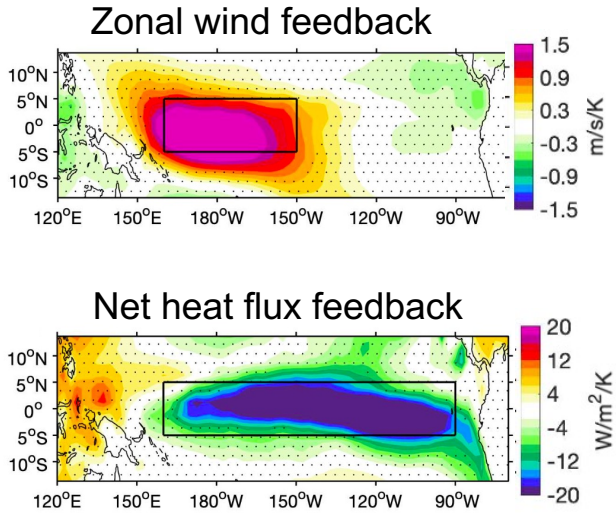
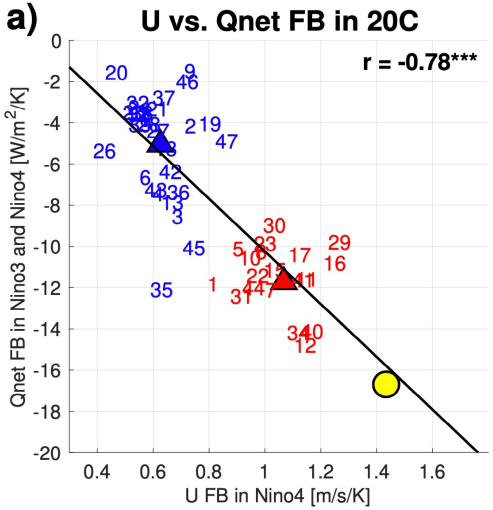
ENSO atmospheric feedbacks in 20C



Regression with SST in Niño3.4 in ERA Interim



ERA Interim

CMIP5

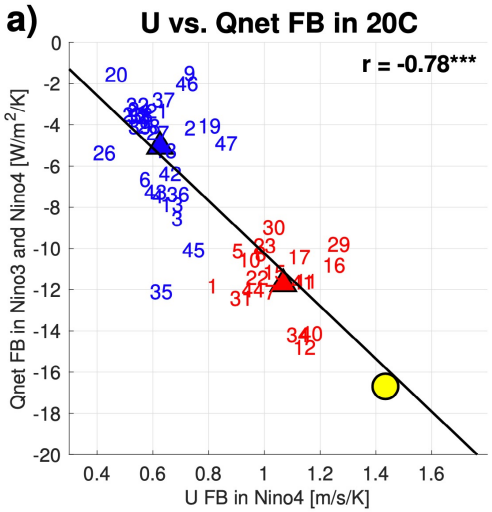
1: ACCESS1-0
2: ACCESS1-3
3: BCC-CSM1-1
4: BCC-CSM1-1-M
5: BNU-ESM
6: CanESM2
7: CESM1-BGC*
8: CESM1-CAM5*
9: CMCC-CESM
10: CMCC-CM
11: CMCC-CMS
12: CNRM-CM5
13: GFDL-CM3
14: GFDL-ESM2G
15: GFDL-ESM2M
16: GISS-E2-R
17: GISS-E2-R-CC
18: HadGEM2-CC
19: INM-CM4
20: IPSL-CM5A-LR
21: IPSL-CM5A-MR
22: IPSL-CM5B-LR
23: MIROC5
24: MIROC-ESM
25: MIROC-ESM-CHEM
26: MPI-ESM-LR
27: MPI-ESM-MR
28: MRI-CGCM3
29: NorESM1-M
30: NorESM1-ME*

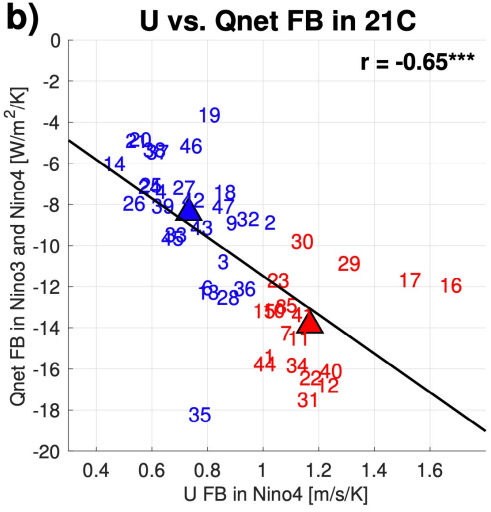
CMIP6

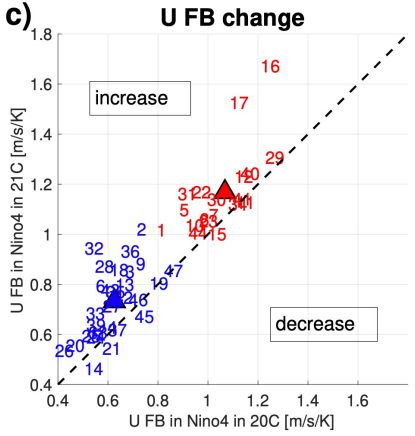
31: ACCESS-CM2
32: ACCESS-ESM1-5
33: BCC-CSM2-MR
34: FGOALS-f3-L
35: FGOALS-g3*
36: GFDL-ESM4
37: INM-CM4-8
38: INM-CM5-0
39: IPSL-CM6A-LR
40: KACE-1-0-G
41: MIROC6
42: MPI-ESM1-2-HR
43: MPI-ESM1-2-LR
44: MRI-ESM2-0
45: NESM3
46: NorESM2-LM*
47: NorESM2-MM*

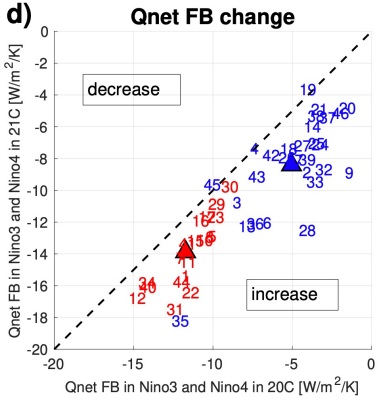
Both feedbacks are strongly underestimated in 2/3 of the CMIP models, showing an error compensation

ENSO atmospheric feedback changes in 21C









Both feedback strengths increase!

(stronger forcing and stronger damping)

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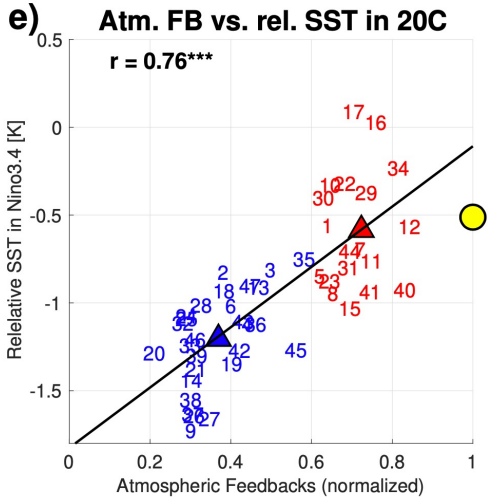
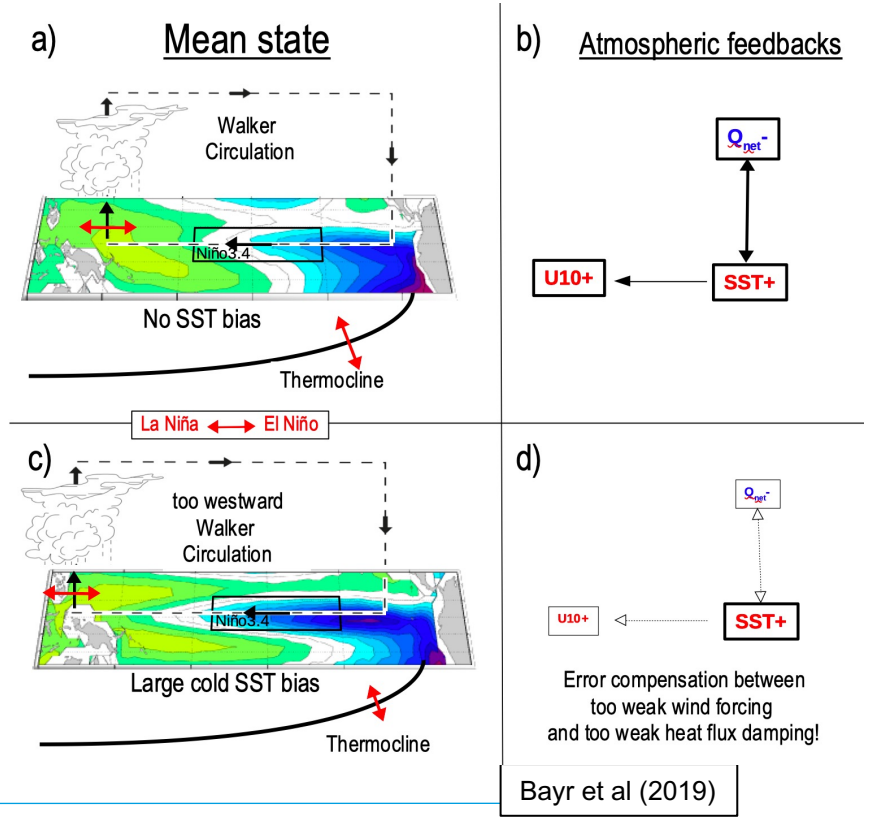
Mean state and feedback strength in 20C



Position of the rising branch of the Walker Circulation determines both feedback strengths!



Bayr et al (2019)

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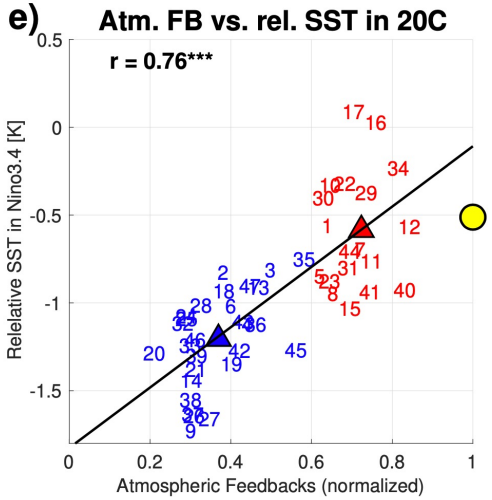
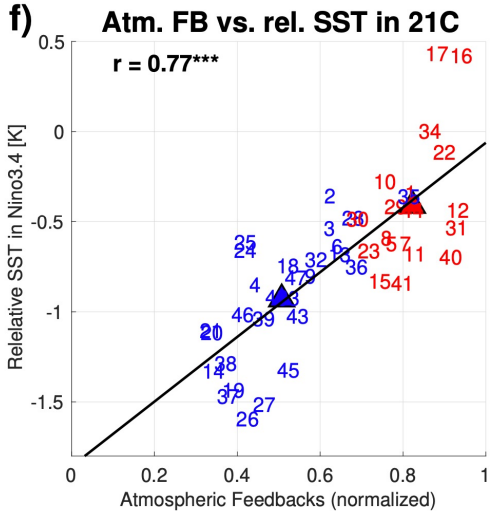
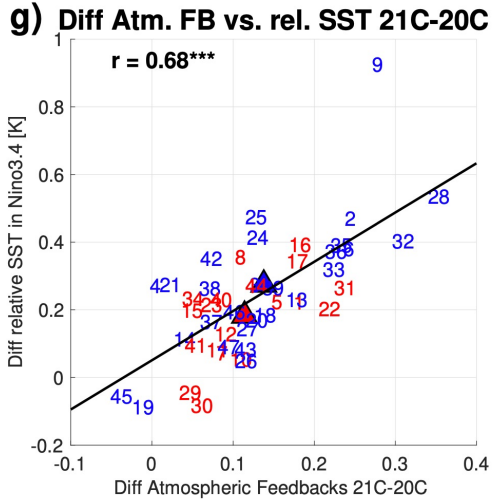
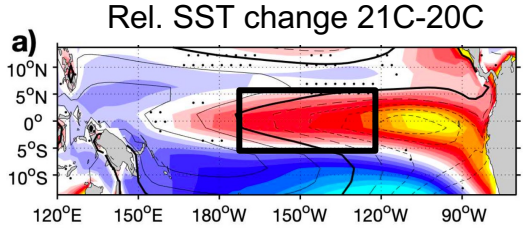
What causes the feedback strengthening?







The relative warming in the Nino3.4 region determines how much the rising branch of the Walker Circulation shifts to the east



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Conclusion

- Both atmospheric feedbacks strengthen under global warming
- The relative warming of SST in Niño3.4 determines the strengthening, as it shifts the Walker Circulation to the east
- Climate models with stronger atmospheric feedbacks have more realistic ENSO dynamics and asymmetry

Paper is hopefully published soon:
Bayr and Latif (2022): ENSO Atmospheric Feedbacks under Global Warming and their Relation to Mean-state Changes, Submitted to Climate Dynamics

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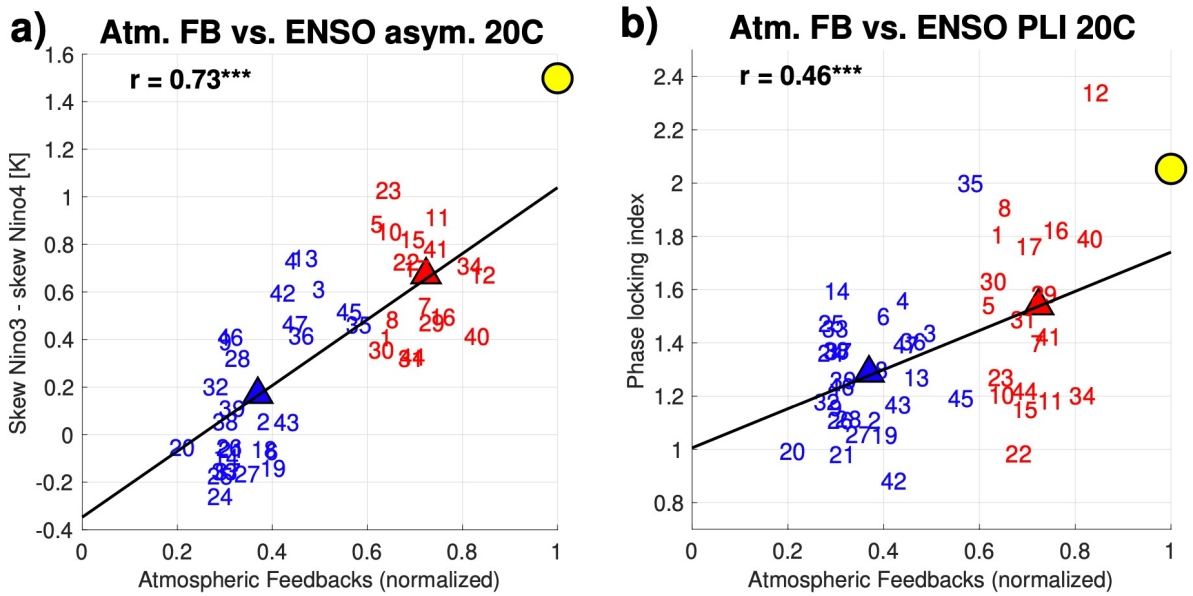
Thanks for your attention

References

- Beobide-Arsuaga G, Bayr T, Reintges A, Latif M (2021) Uncertainty of ENSO-amplitude projections in CMIP5 and CMIP6 models. Clim Dyn 56:3875–3888. https://doi.org/10.1007/s00382-021-05673-4
- Bayr T, Wengel C, Latif M, et al (2019) Error compensation of ENSO atmospheric feedbacks in climate models and its influence on simulated ENSO dynamics. Clim Dyn 53:155–172. https://doi.org/10.1007/s00382-018-4575-7
- **Bayr and Latif (2022): ENSO Atmospheric Feedbacks under Global Warming and their Relation to Mean-state Changes, Submitted to Climate Dynamics**

Strong vs. weak feedbacks
Which projections should we trust more?



Models with stronger atmospheric feedbacks simulate
the ENSO dynamics, asymmetry and phase locking more realistically!

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