Supplementary Material for:
Improvements and persistent biases in the southeast tropical Atlantic in CMIP models

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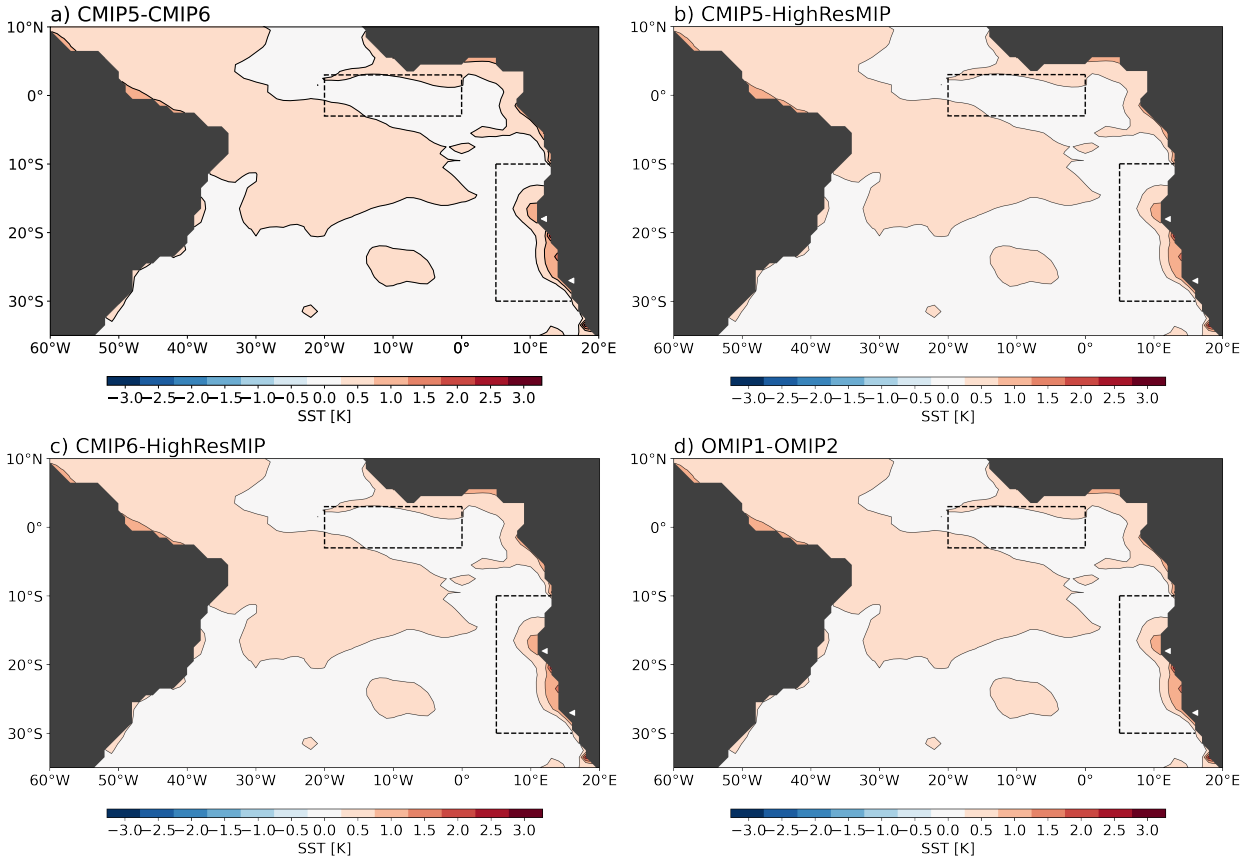
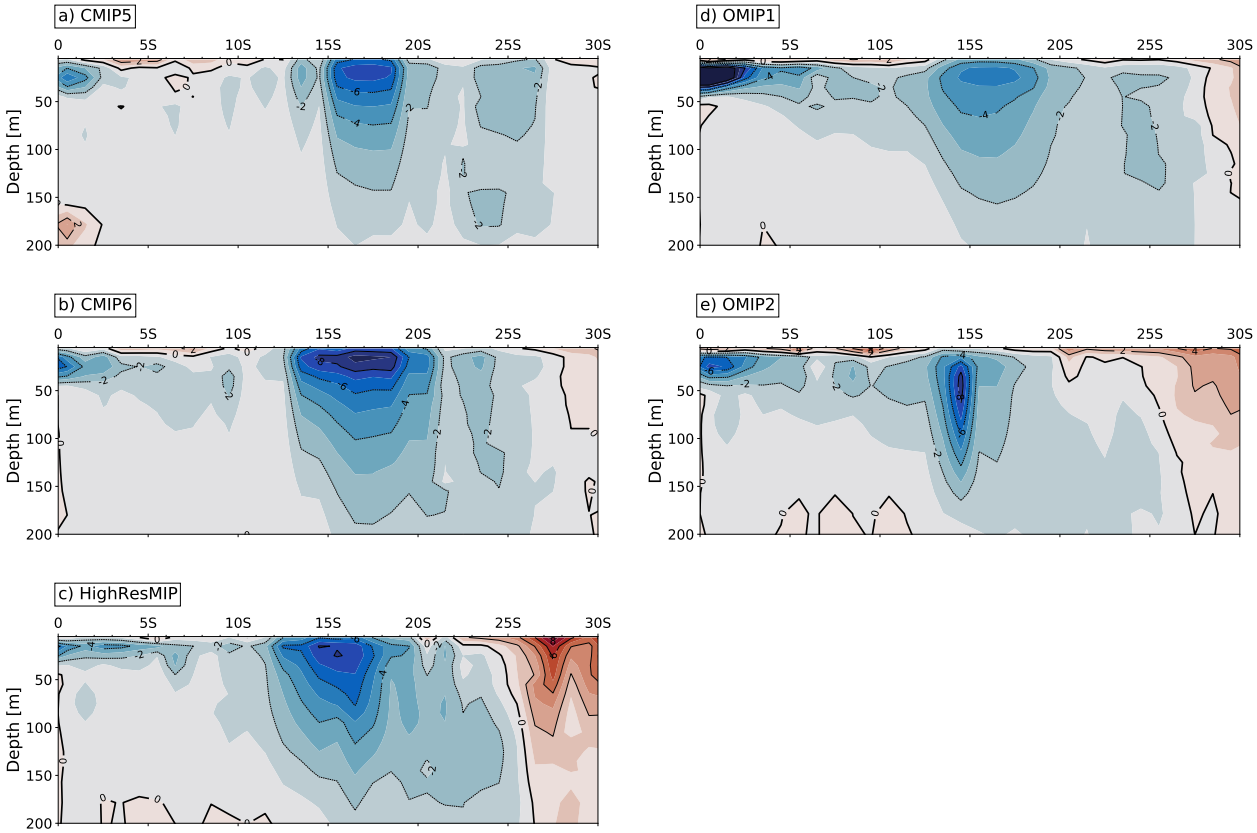
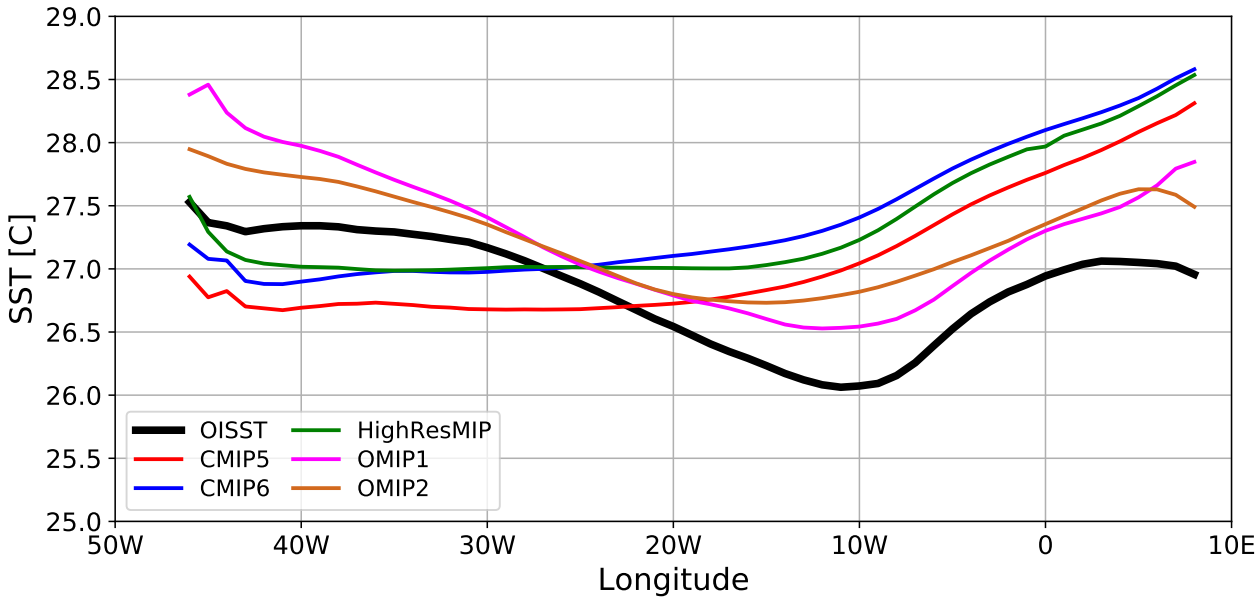


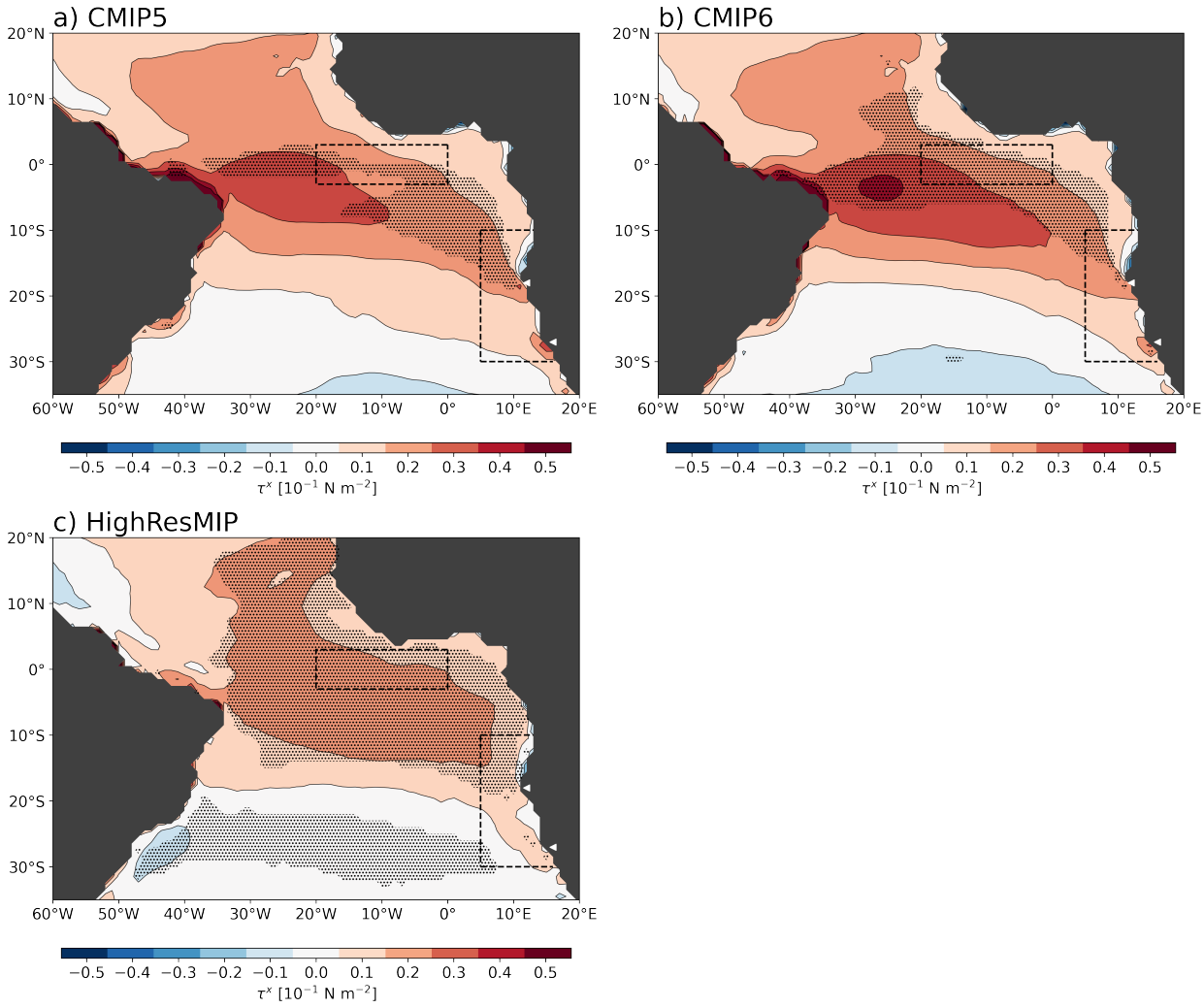
Supplementary Figure 1: **Difference in time-mean SST between MMMs.** Time-mean MMM SST difference for a) CMIP5 - CMIP6, b) CMIP5 - HighResMIP, c) CMIP6-HighResMIP and d) OMIP1-OMIP2. Every contour represents a 0.5 °C SST change. The dashed black boxes highlight the ATL3 (5°S - 5°S, 10°W - 0°E) and SETA (10°S - 30°S, 5°E - 20°E) regions. The white triangles by the coast show the location of Cape Frio (17°S - 18°S) and Lüderitz (26°S - 27°S).



Supplementary Figure 2: **Alongshore meridional currents.** Annual-mean alongshore subsurface meridional current profile (in cm s^{-1}, zonally averaged over a 2° wide band along the coast) in CMIP5, CMIP6, HighResMIP, OMIP1 and OMIP2 MMMs. Contour interval is 2 cm s^{-1}. Negative (positive) values are for poleward (equatorward) currents.



Supplementary Figure 3: **Equatorial SST zonal gradients.** Time-mean SST zonal gradient averaged between 2°S-2°N. The black line represents the observed SST in the equatorial ocean from OISST. Note the reversed zonal gradient in all CMIP MMMs west of 10°W.



Supplementary Figure 4: **MMM biases in the zonal component of wind stress.** Biases in the zonal component of wind stress (τ^x) for (a) CMIP5, (b) CMIP6 and (c) HighResMIP MMM. The dashed black boxes highlight the ATL3 and SETA regions. The white triangles by the coast show the location of Cape Frio (17°S - 18°S) and Lüderitz (26°S - 27°S). Black dots show regions where all models in each MMM agree on the sign of the bias.

Supplementary Table 1: Models used in this study from the CMIP5 archive, together with their atmospheric and oceanic resolution.

	CMIP5	
Model	**Atmosphere**	**Ocean**
1. ACCESS1.0	192×144×85	360×384×60
2. ACCESS1.3	320×160×46	360×232×40
3. BCC-CSM1.1	320×160×31	360×200×50
4. CCSM4	384×192×95	802×404×40
5. CNRM-CM5	288×192×32	320×384×60
6. CNRM-CM5-2	288×192×32	320×384×60
7. EC-Earth	128×64×49	361×290×45
8. FGOALS-s2	144×143×79	362×332×75
9. FGOALS-g2	256×128×81	360×256×63
10. GFDL-CM3	∼360×180∼72	60km (30)×60
11. GFDL-CM2.1	512×256×91	362×292×75
12. HadGEM2-AO	512×256×91	362×292×75
13. MPI-ESM-MR	360×180×33	1440×1080×75
14. MRI-CGCM3	360×180×32	360×218×30
15. NorESM-M	192×288×26	320×384×60

Supplementary Table 2: Models used in this study from the CMIP6 archive, together with their atmospheric and oceanic resolution.

	CMIP6	
Model	**Atmosphere**	**Ocean**
1. ACCESS-CM2	192×144×85	360×384×60
2. BCC-CSM2-MR	320×160×46	360×232×40
3. CAMS-CSM1-0	320×160×31	360×200×50
4. CESM2	288×192×32	320×384×60
5. CanESM5	128×64×49	361×290×45
6. E3SM-1-0	∼360×180∼72	60km (30)×60
7. EC-Earth3	512×256×91	362×292×75
8. EC-Earth3-Veg	512×256×91	362×292×75
9. FGOALS-f3-L	360×180×32	360×218×30
10. FIO-ESM- 2-0	192×288×26	320×384×60
11. GFDL-CM4	360×180×33	1440×1080×75
12. IPSL-CM6A-LR	144×143×79	362×332×75
13. MIROC6	256×128×81	360×256×63
14. MPI-ESM1-2-HR	384×192×95	802×404×40
15. NESM3	192×96×47	362×292×46
16. NorCPM1	144×96×26	320×384×53
17. SAMO-UNICON	288×192×30	320×384×60

Supplementary Table 3: Models used in this study from the HighResMIP archive, together with their atmospheric and oceanic resolution.

	HighResMIP	
Model	**Atmosphere**	**Ocean**
1. AWI	384×192×95	1306775 wet nodes×46
2. BCC-CSM2-HR	800×400×56	360×232×40
3. CESM1-CAM5-SE-HR	777602 cells×30	3600×2400×62
4. CESM1-CAM5-SE-LR	48602 cells×30	320×384×62
5. CMCC-CM2-VHR4	1152×768×26	1442×1051×50
6. CMCC-CM2-HR4	288×192×26	1442×1051×50
7. CNRM-CM6-1-HR	T359×91	1442×1050×75
8. EC-EARTH3P-HR	1024×512×91	1442×1921×75
9. EC-EARTH3P	512×256×91	362×292×75
10. ECMWF-IFS-HR	1600×800×91	1442×1021×75
11. ECMWF-IFS-MR	800×400×91	1442×1021×75
12. HadGEM3-GC31-HM	1024×768×85	1440×1205×75
13. INM-CM5-H	540×360×73	2160×1440×40
14. MPI-ESM1-2-HR	384×192×95	802×404×40
15. MPI-ESM1-2-XR	768×384×95	802×404×40

Supplementary Table 4: Models used in this study from the OMIP1 archive. OMIP1 models are forced with the CORE.v2 atmospheric state.

OMIP1	
Model	**Ocean**
1. CMCC-CM2-SR5	362×292×50
2. CMCC-ESM2	362×292×50
3. FGOALS-f3-L	360×218×30
4. GFDL-CM4	1440×1080×75
5. IPSL-CM6A-LR	362×332×75
6. MIROC6	360×256×63
7. MRI-ESM2-0	360×364×61
8. NorESM2-LM	360×384×70

Supplementary Table 5: Models used in this study from the OMIP2 archive. OMIP2 models are forced with the JRA55-do surface atmospheric dataset.

OMIP2	
Model	**Ocean**
1. CESM2	320×384×60
1. CMCC-CM2-HR4	1442×1051×50
2. CMCC-CM2-SR5	362×292×50
1. CNRM-CM6-1	362×294×75
3. EC-EARTH3	362×292×75
4. FGOALS-f3-H	3600×2302×55
5. FGOALS-f3-L	360×218×30
6. MIROC6	360×256×63
7. MRI-ESM2-0	360×364×61
8. NorESM2-LM	360×384×70
9. CESM2	320×384×60
10. CNRM-CM6-1	362×294×75