



Supplement of

Causes of uncertainties in the representation of the Arabian Sea oxygen minimum zone in CMIP5 models

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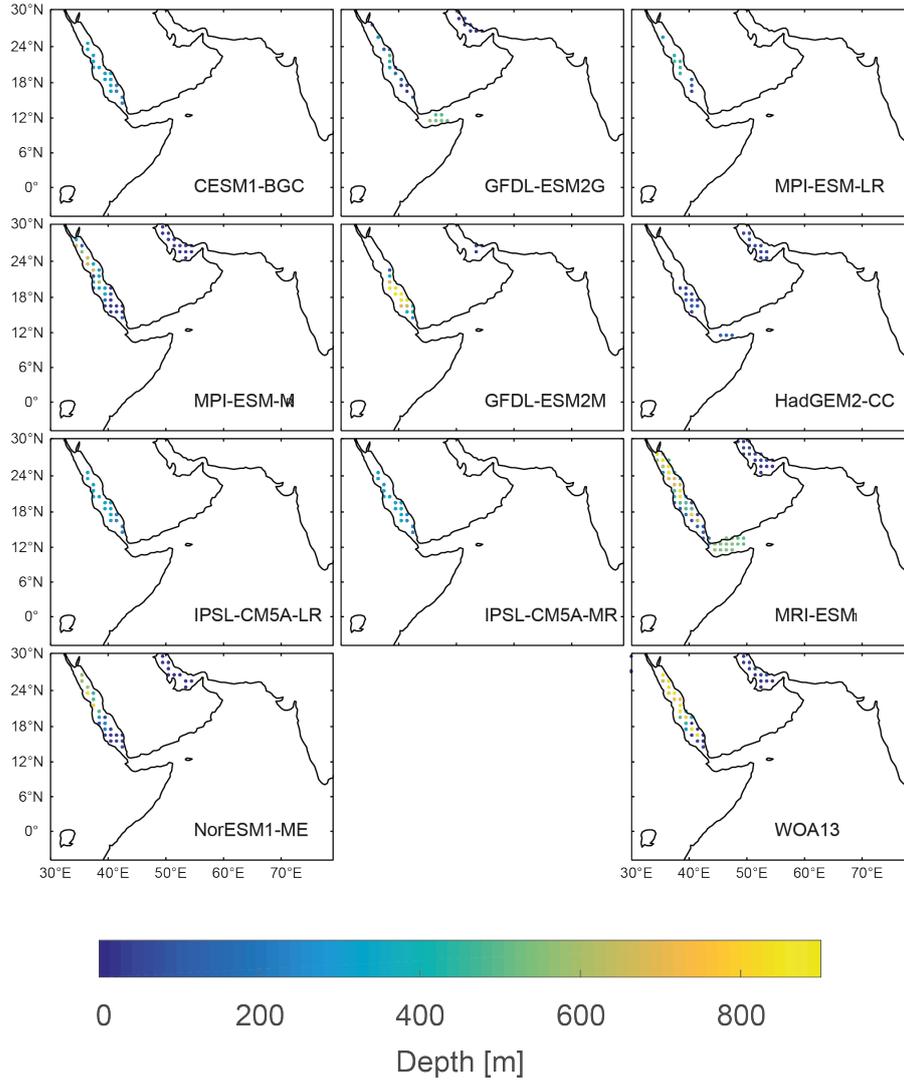


Figure S1. Water mass formation regions of Red Sea and Persian Gulf Water in CMIP5 models and observations (WOA13). The colors indicate the deepest depth at each grid point, where the respective water mass properties are found.

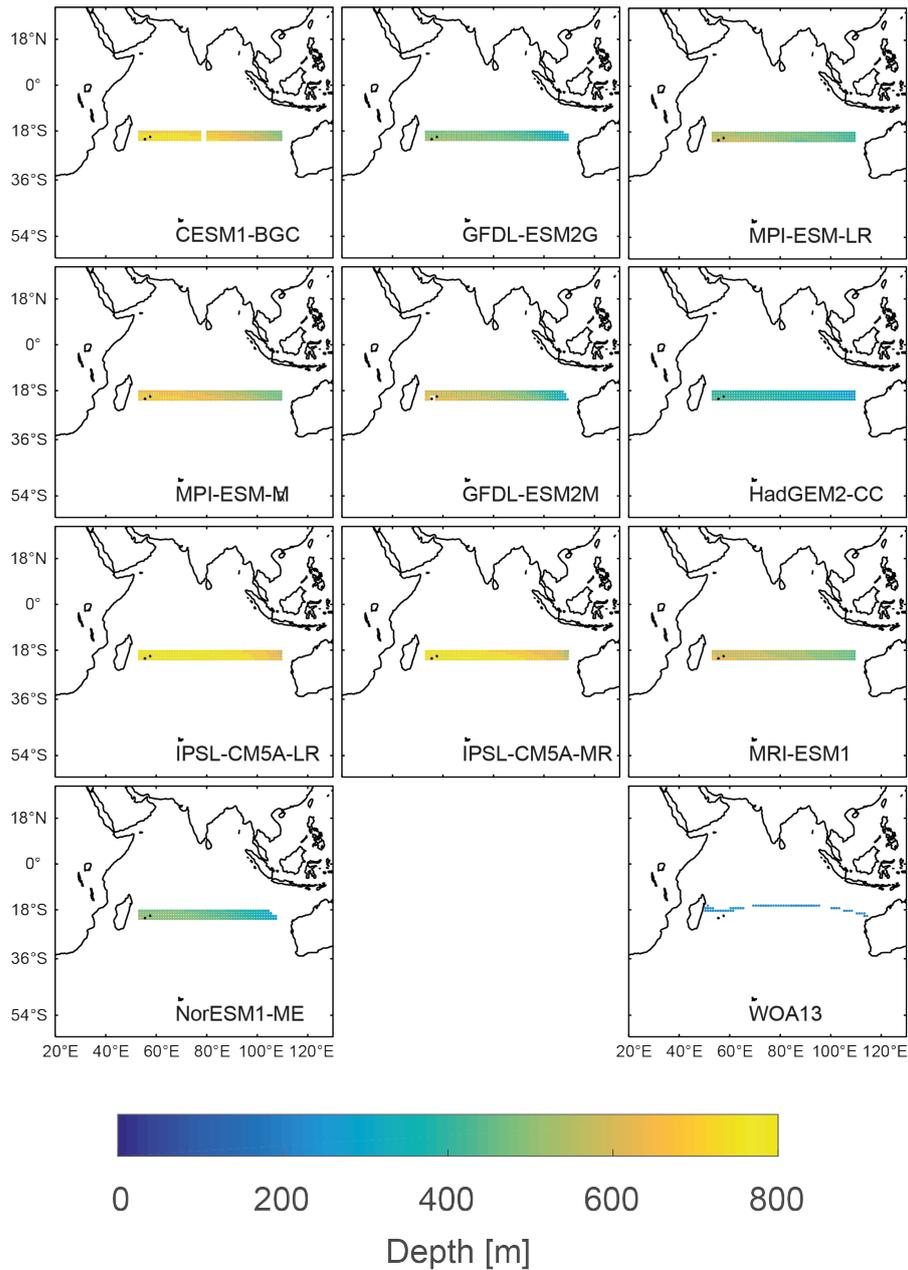


Figure S2. Water mass formation regions of Indian Central Water in CMIP5 models and observations (WOA13). The colors indicate the deepest depth at each grid point, where the respective water mass properties are found.

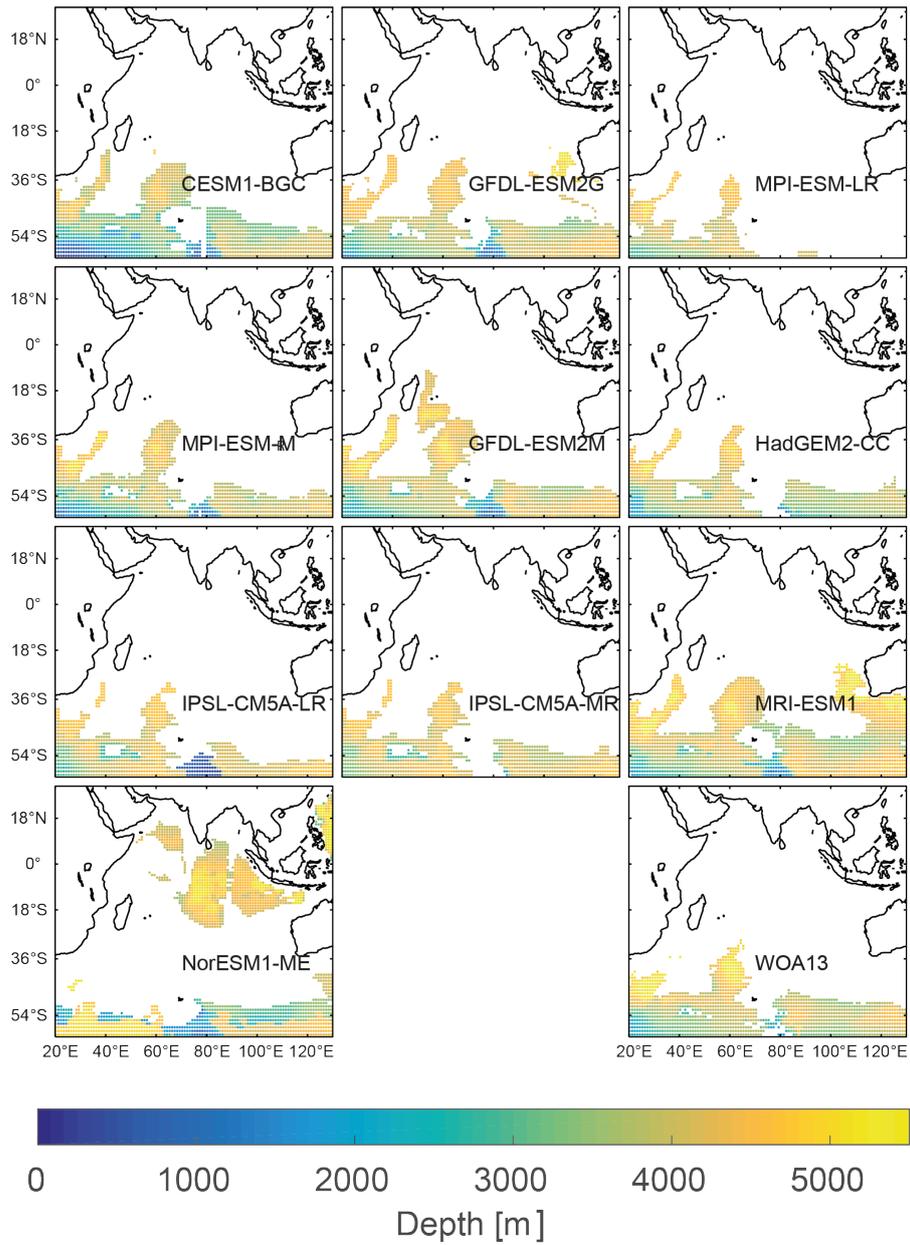


Figure S3. Water mass formation regions of Indian Ocean Deep Water in CMIP5 models and observations (WOA13). The colors indicate the deepest depth at each grid point, where the respective water mass properties are found.

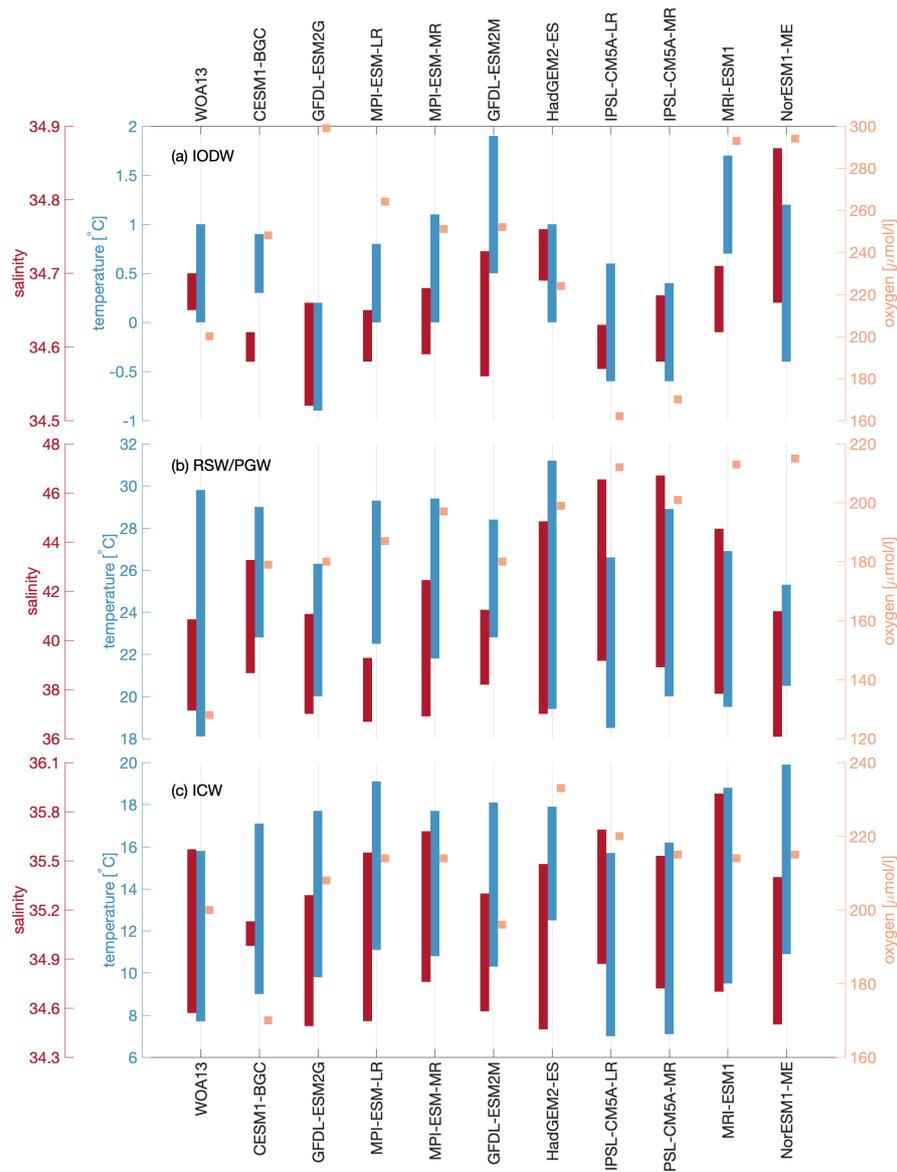


Figure S4. Overview of water mass characteristics in observations and the CMIP5 models. Temperature and salinity values are given as upper and lower limits of the water masses. Oxygen is given as mean values. The exact values can be found in Table 2.

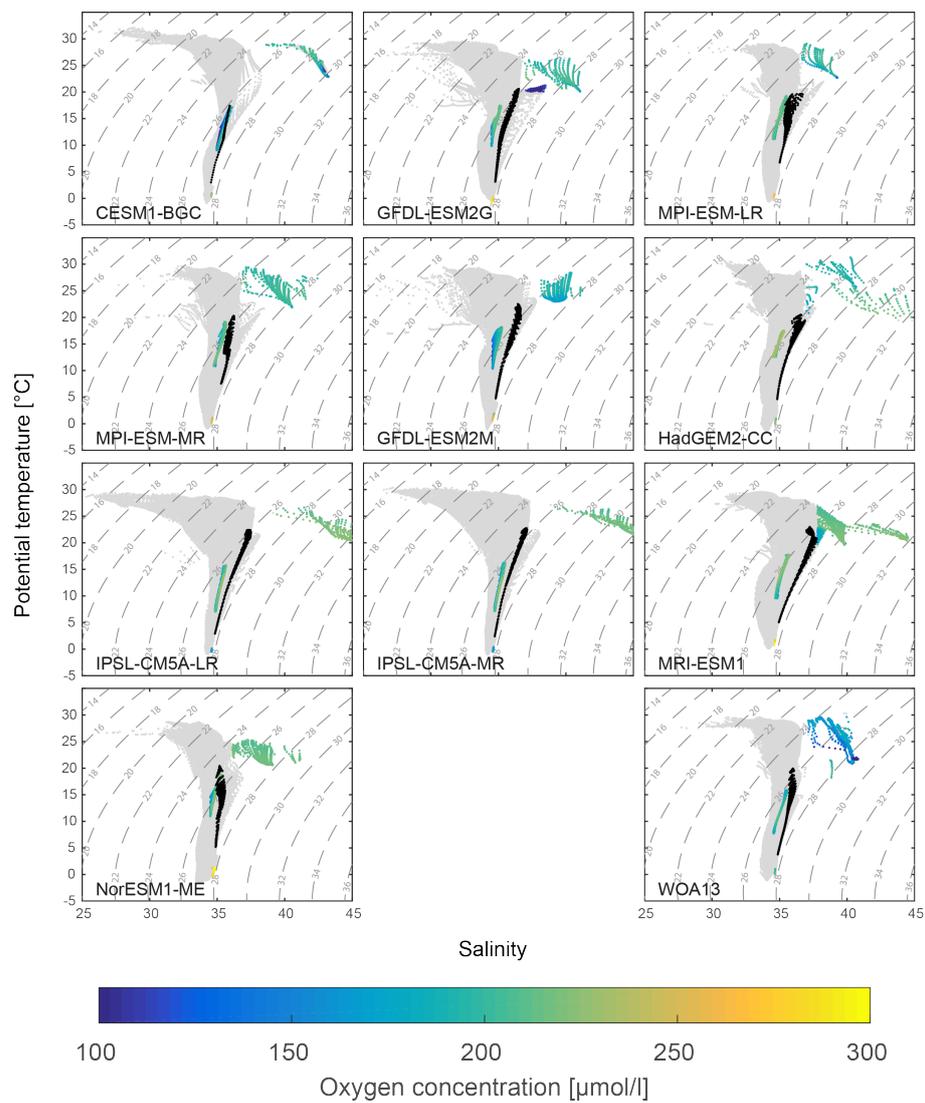


Figure S5. TS diagrams for the Indian Ocean (grey) for CMIP5 models and observations (WOA13). The color shading indicates the oxygen concentration of RSW and PGW, ICW and IODW. In black are the values in the ASOMZ.

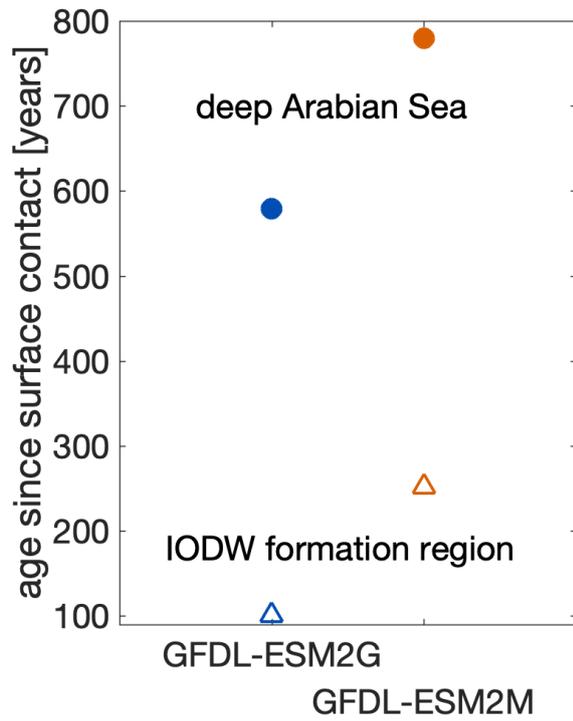


Figure S6. Modelled ideal age in the formation region of IODW (triangles) and below the bottom of the ASOMZ deeper than 1800 m depth in the AS (circles). The colors mark the oxygen clusters as described in Fig. 5.

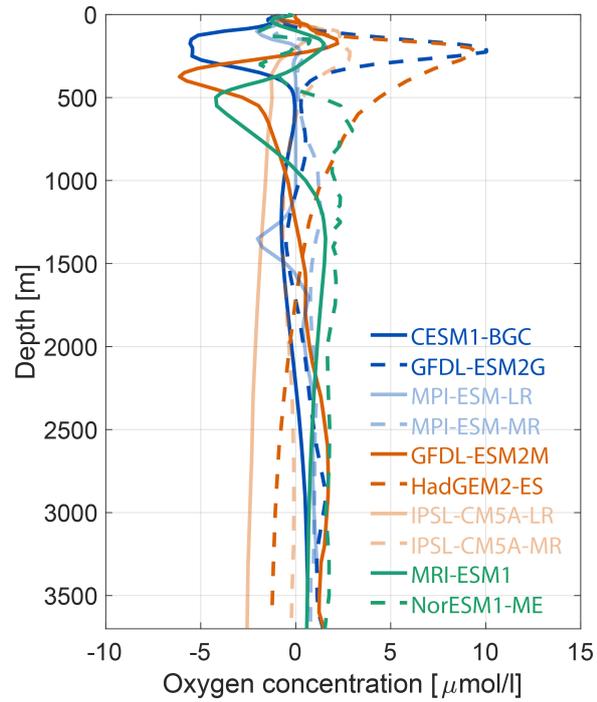


Figure S7. Difference of the averaged vertical oxygen concentration profiles from 1999-1950 minus 1949-1900 in the box between 16° and 22° N, 61° and 67° E in the Arabian Sea (see Fig. 1). Blue coloured models belong to oxygen cluster *HIGH*, red to cluster *MEDIUM* and green to clusters *LOW1* and *LOW2*.

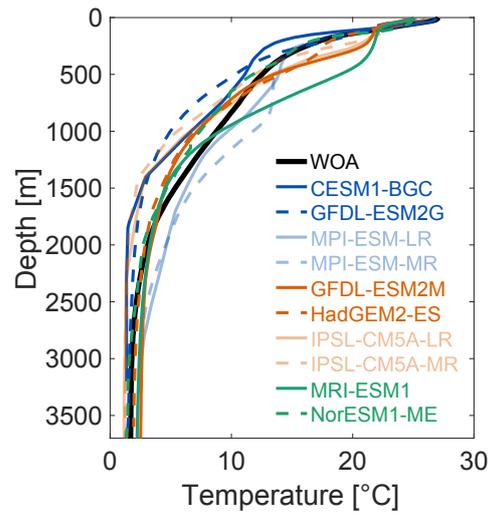


Figure S8. Averaged vertical temperature profiles in the box between 16 and 22 °N, 61 and 67 °E in the Arabian Sea (see Fig. 1) for CMIP5 models (colored) and observational data (black). Blue coloured models belong to oxygen cluster *HIGH*, red to cluster *MEDIUM* and green to clusters *LOW1* and *LOW2*.

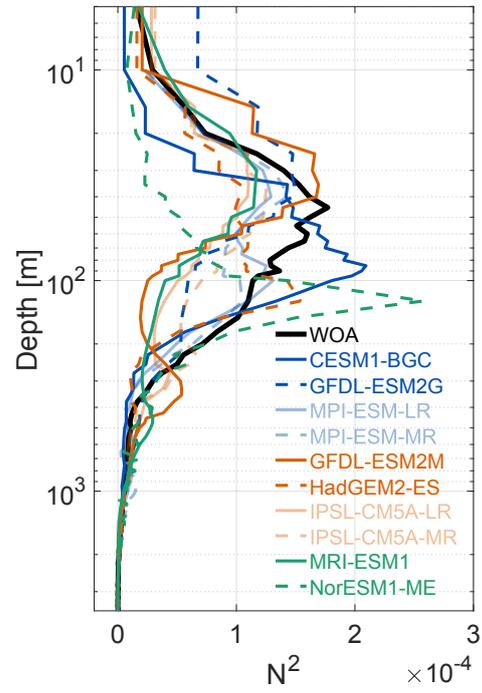


Figure S9. Averaged brunt väisälä frequency squared in the box between 16 and 22 °N, 61 and 67 °E (see Fig. 1) in the Arabian Sea for CMIP5 models (colored) and observational data (black). Blue coloured models belong to oxygen cluster *HIGH*, red to cluster *MEDIUM* and green to clusters *LOW1* and *LOW2*.

Table S1. Oxygen solubility and deviations of the oxygen solubility in the models from the observations (WOA13) for the upper 10 m of the ASOMZ region, the formation region of IODW and the upper 10 m of the formation region of RSW/PGW.

	ASOMZ		IODW		RSW/PGW	
	Solubility [$\mu\text{mol/l}$]	Deviation WOA [%]	Solubility [$\mu\text{mol/l}$]	Deviation WOA [%]	Solubility [$\mu\text{mol/l}$]	Deviation WOA [%]
WOA13	202.3		357.7		198.0	
CESM-BGC	202.5	0.1	324.5	-9.3	194.0	-2.0
GFDL-ESM2G	209.4	3.5	339.3	-5.1	205.4	3.7
MPI-ESM-LR	208.7	3.2	321.9	-10.0	197.4	-0.3
MPI-ESM-MR	205.8	1.7	320.6	-10.4	198.0	0.0
GFDL-ESM2M	209.0	3.3	321.9	-10.0	200.0	1.0
HadGEM2-CC	211.8	4.7	326.1	-8.8	197.2	-0.4
IPSL-CM5A-LR	207.8	2.7	327.6	-8.4	203.2	2.6
IPSL-CM5A-MR	205.1	1.4	332.2	-7.1	200.4	1.2
MRI-ESM1	209.6	3.6	341.5	-4.5	207.2	4.6
NorESM1-ME	210.6	4.1	335.2	-6.3	211.3	6.7