Flux-anomaly-forced model intercomparison project (FAFMIP)

Steering committee: Jonathan Gregory (U Reading and Met Office), Stephen Griffies (GFDL), Detlef Stammer (U Hamburg), Oleg Saenko (CCCma), Johann Jungclaus (MPI)

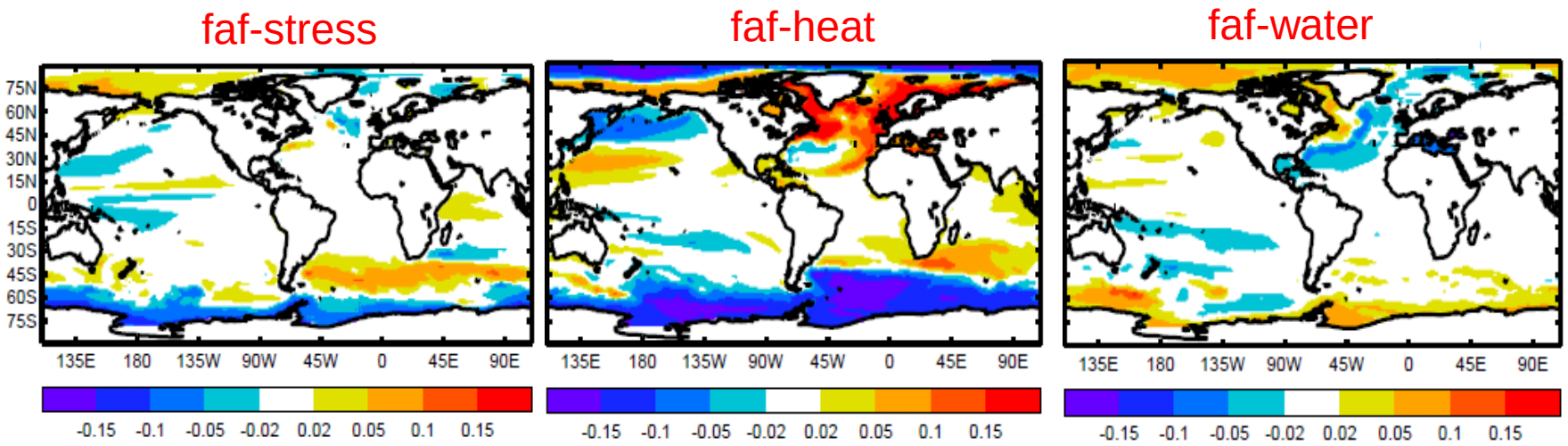
The goal is to account for the spread in simulated ocean response to changes in surface fluxes resulting from CO_2 forcing, particularly the uncertainties in global ocean heat uptake and geographical patterns of sea-level change due to ocean density and circulation change.

Ten CMIP6 groups intend to participate. We held our first meeting at GFDL on 17-18 July 2017, attended by almost all groups and a few other people having related interests. We discussed the timeline of CMIP6 experiments and relevant scientific results already obtained.

Pre-CMIP6 FAFMIP results

FAFMIP design was tested by five groups using pre-CMIP6 AOGCMs. It requires 3x70 years of integration in tier-1, for experiments with perturbed surface fluxes of momentum (faf-stress), heat (faf-heat) and freshwater (faf-water). Some results are described by Gregory et al. (2016, GMD).

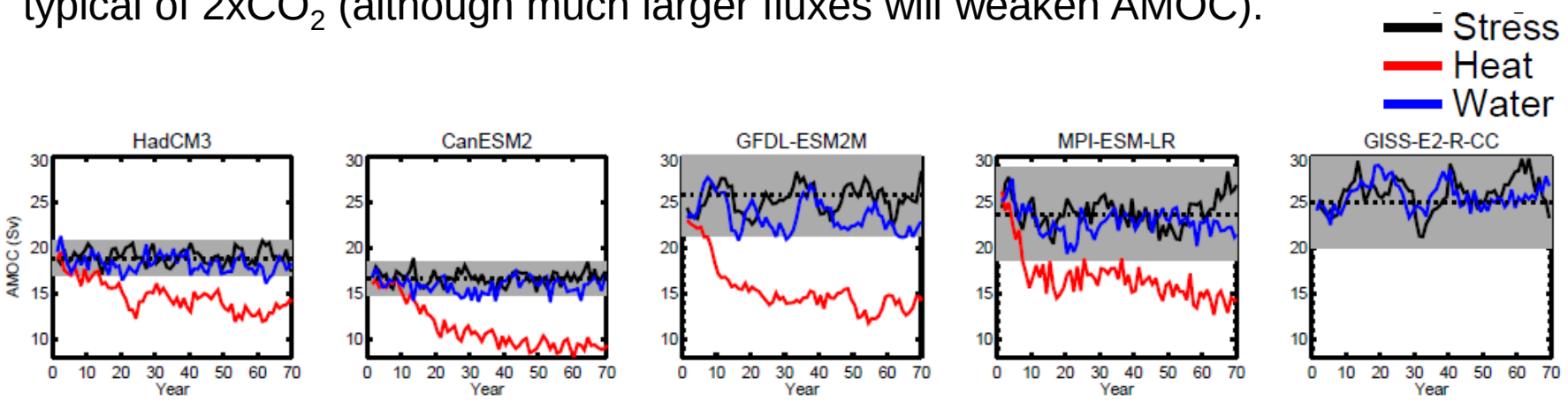
For instance, model-mean dynamic sea-level change $\Delta\zeta$ (m) (change relative to global mean) is affected by windstress change in Southern Ocean, and heat flux change in Southern Ocean, N Pacific and especially N Atlantic because of AMOC.



Issue for CMIP panel: FAFMIP participants and steering committee would like to include FAFMIP results from pre-CMIP6 models in the CMIP6 archive (CanESM2, GFDL-ESM2M, HadCM3 and HadGEM2-ES). They don't have CMIP6 historical runs, but we don't need those for FAFMIP. Is this OK?

Experimental design

AMOC weakens only because of heat flux change, not from freshwater flux change typical of 2xCO_2 (although much larger fluxes will weaken AMOC).



The faf-heat experiments show that there is a strong positive feedback on AMOC weakening, whereby the reduced northward advection of heat causes a cooling tendency in the North Atlantic, and an anomalous increase in the surface heat flux. The added heat in that region is thus twice as big as we intended in faf-heat, and the AMOC weakening likewise doubled. Further tests with HadCM3 and CanESM2 show that the AMOC is sensitive to anomalous heat input *only* in the North Atlantic, nowhere else! If we halve the faf-heat input in that region, we get what we wanted, due to the feedback; this is being tested in MPI-ESM-LR and MIROC6 too.

Issue for CMIP panel: If the tests show what we expect, we will change the design of tier-1 faf-heat accordingly (writing another GMD paper) and relegate the original design to tier 2.

Summary of CMIP6 FAFMIP status reported by participating centres

Center and/or model, who	Ocean horizontal levels	FAFMIP when
ACCESS-CM2, Marsland	MOM 1°→1/3° tripolar z*	Before June 2018
CCCma CanESM2	1.4° lon x 0.93° lat 40 z	Completed
CCCma CanESM5, Saenko	ORCA1→1/3° tripolar 46 z	Late 2017/Early 2018
CNRM-CM6-1, Salas	ORCA1→1/3° tripolar 75 z	Early 2018
GFDL, Winton	MOM5 1°→1/3° tripolar 50 z	Last quarter 2017
GISS, Romanou		
IPSL-CM6-LR, Swingedouw	ORCA1→1/3° tripolar 75 z	Winter 2017
MIROC6, Suzuki	COCO4.9, 1° tripolar 63 z	Nearly completed
MPI-ESM1.2-LR, Jungclaus	MPIOM1.65 1.5° 40 z	Start summer 2017
MPI-ESM1.2-HR, Jungclaus	ditto 0.4° tripolar 40 z	ditto
MRI-ESM, Ishii		
NCAR CESM, Hu		
UK HadGEM3-lr, Gregory	ORCA1→1/3° tripolar 75 z	Winter 2017
UK HadGEM3-hr, Gregory	ORCA 1/4° tripolar 75 z	By summer 2018