UK activity towards CMIP5

Catherine Senior

Presentation to WGCM15, Boulder, October 21st, 2011

Simulations for CMIP5: UK

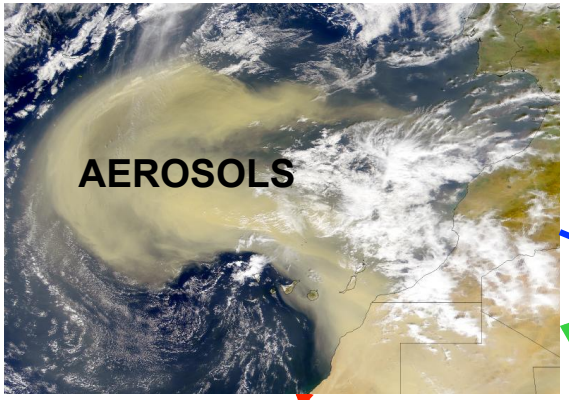
Timescale	Model	Institute
Decadal	HadCM3 HiGEM	MOHC NCAS-Climate/JWCRP
Centennial	HadGEM2-ES (HadGEM2-CC with enhanced vertical resolution) *HadGEM2-AO*	MOHC MOHC *KMA*

Project Co-ordinators: Chris Jones, Mat Collins

Met Office
Hadley Centre

Radiation, cloud μφ,

Greenhouse Effect



HadGEM2-ES

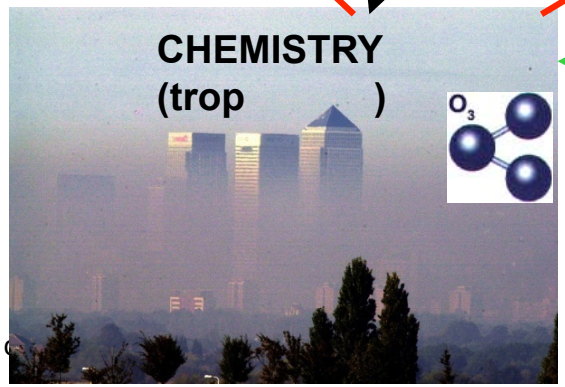
SO_4^{2-}, formation

DMS, dust, emissions

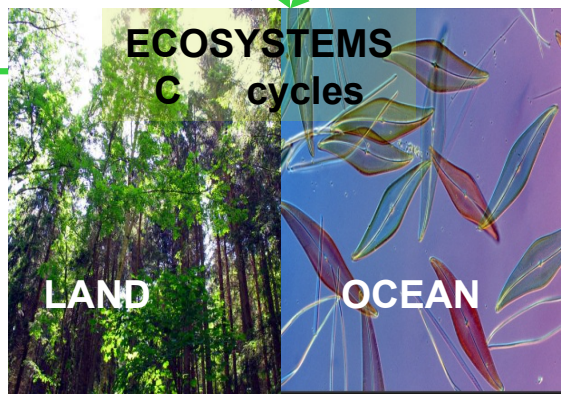
Iron, deposition

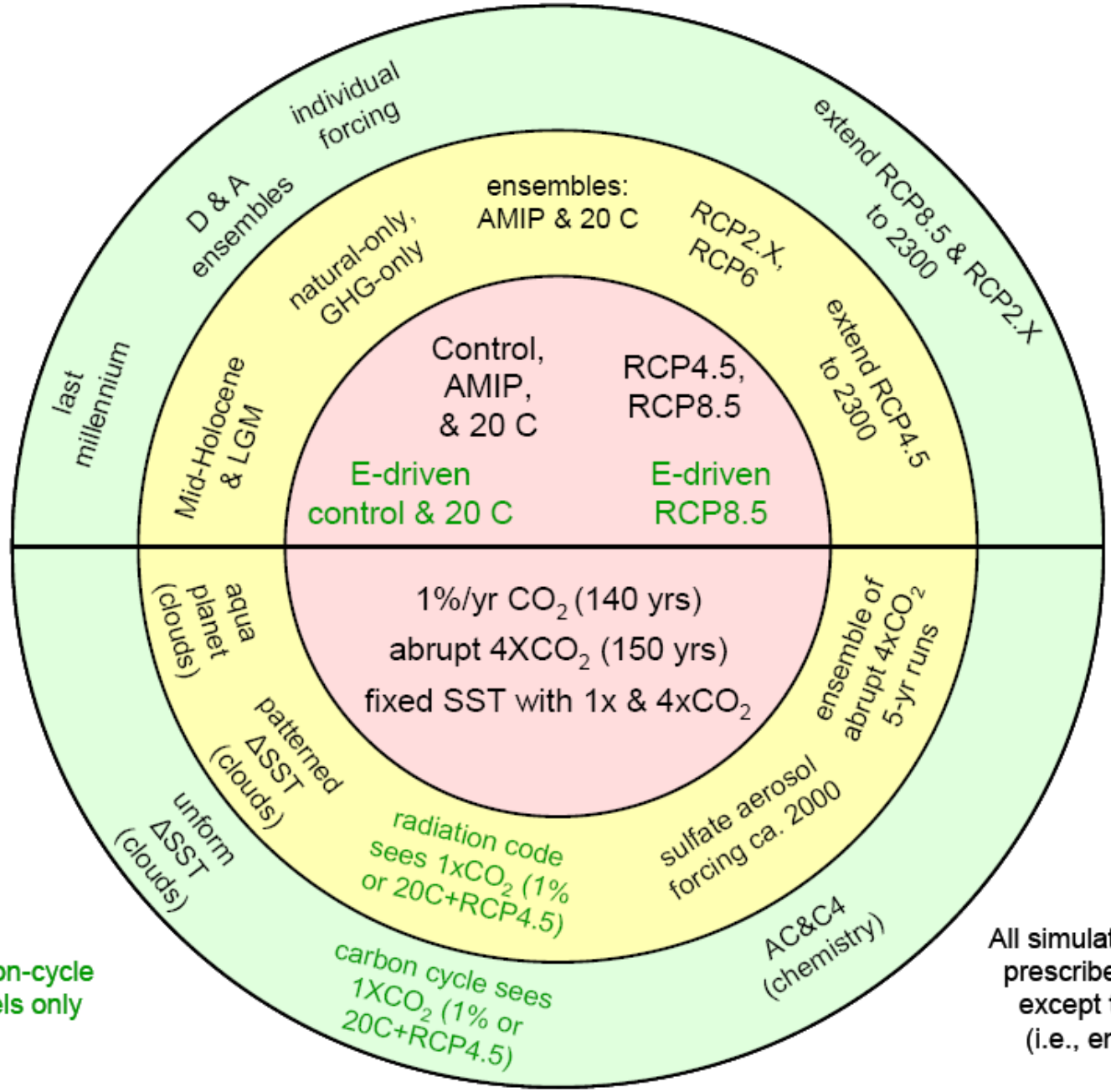
CO_2,

CH_4, trop O_3



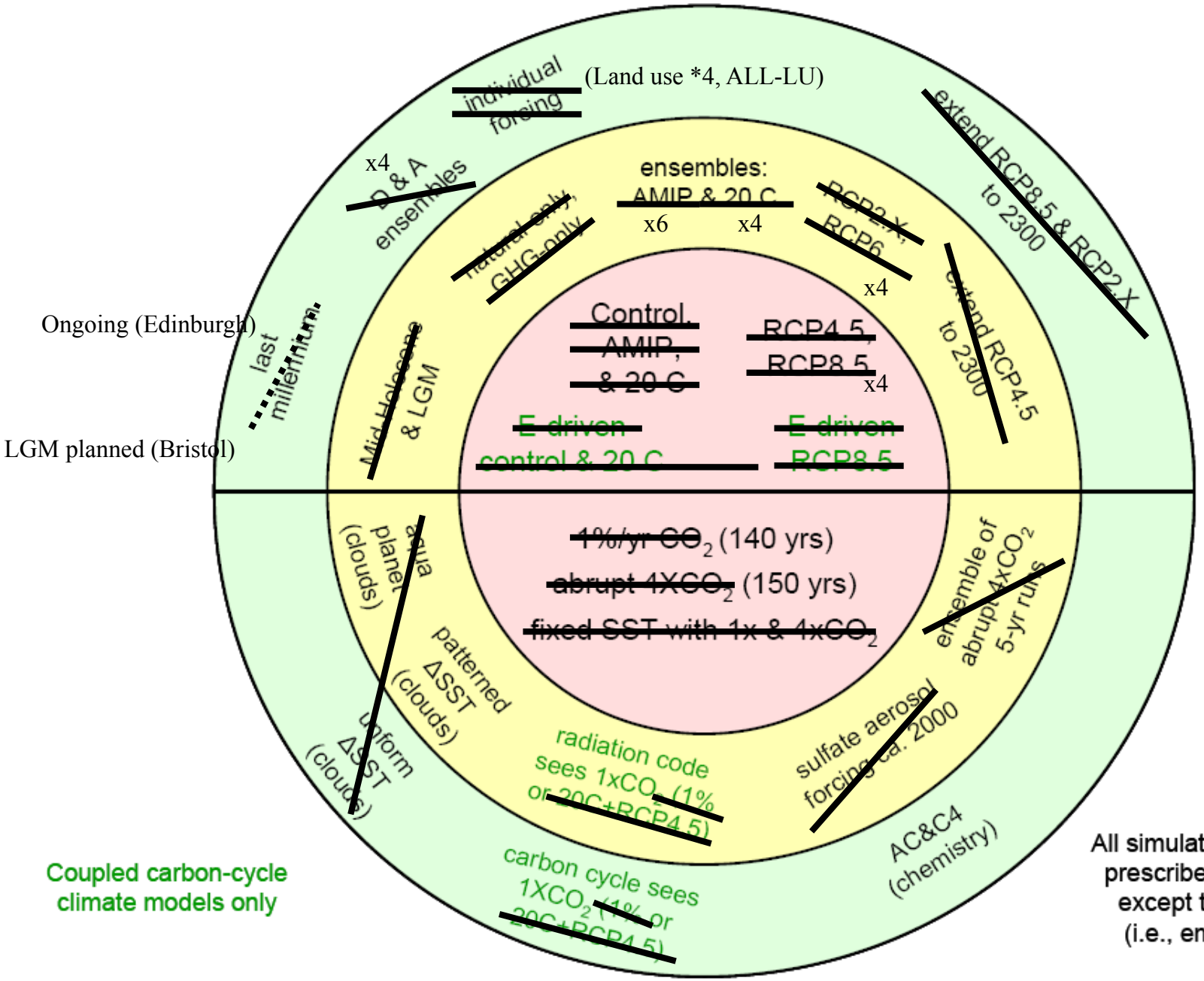
Wetland CH_4, dry dep, stomatal uptake,





Coupled carbon-cycle climate models only

All simulations are forced by prescribed concentrations except those "E-driven" (i.e., emission-driven).


Ongoing (Edinburgh)
LGM planned (Bristol)
individual forcing
(Land use *4, ALL-LU)
extend RCP8.5 & RCP2.X to 2300
x4
D & A ensembles
ensembles:
AMIP & 20 C
x6
x4
natural only, GHG-only
RCP2.X, RCP6
x4
last millennium
Mid-Holocene & LGM
Control, AMIP, & 20 C
RCP4.5, RCP8.5
x4
extend RCP4.5 to 2300
E-driven control & 20 C
E-driven RCP8.5
1%/yr CO2 (140 yrs)
abrupt 4XCO2 (150 yrs)
fixed SST with 1x & 4xCO2
aqua planet (clouds)
patterned ΔSST (clouds)
uniform ΔSST (clouds)
radiation code sees 1xCO2 (1% or 20C+RCP4.5)
carbon cycle sees 1XCO2 (1% or 20C+RCP4.5)
ensemble of abrupt 4xCO2 5-yr runs
sulfate aerosol forcing ca. 2000
AC&C4 (chemistry)
Coupled carbon-cycle climate models only
All simulations are forced by prescribed concentrations except those "E-driven" (i.e., emission-driven).

Run status

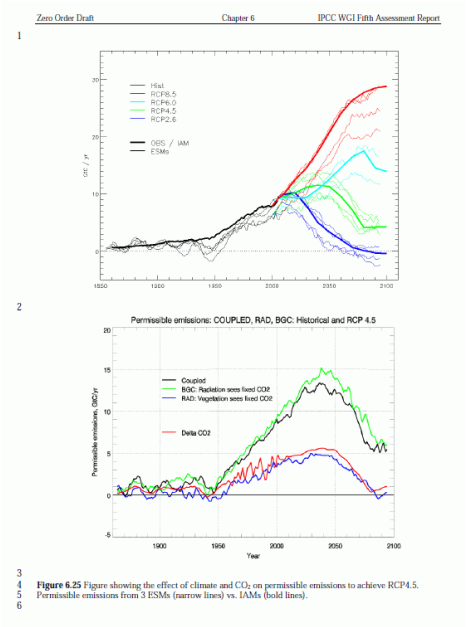
- All planned CMIP5 runs done
  - Incl. 4 ensemble members of HIST, NAT, GHG, LU-only and all RCPs
- Carbon cycle E-driven runs
  - Plus RCP3PD extra
- Palaeo runs
  - Mid-Holocene – MOHC
  - Last Millennium – Edinburgh (on MONSooN) – ongoing (until 2013!)
  - LGM – planned at Bristol
- HiTOP(L60 runs) – RCP4.5 and 8.5
- GEOMIP runs ongoing
- Alternative LU scenarios for RCP4.5
- Extended chemistry runs with vegetation isoprene emissions
- “loop cutting” BGC feedback runs

category	#	Experiment	No. Years	Model	Data Vol (Gb)	Delivery Status	Est. Completion	Notes
Decadal Prediction Experiments								
core	1.1	10 yr hindcast ensembles	3 x 10 x 10	HadCM3	375	complete		
core	1.2	30 yr hindcast ensembles	3 x 3 x 10	HadCM3	306	complete		
tier 1	1.1-E	extended 10 year ensemble	7 x 10 x 10	HadCM3	875	complete		
tier 1	1.2-E	extended 10 year ensemble	7 x 3 x 10	HadCM3	714	complete		
tier 1	1.1-I	additional ensembles with different start dates	10x10x10	HadCM3		[0%]	15/02/2012	simulations still running
Baseline Simulations								
core	3.1	Pre-Industrial Control	500	HadGEM2-ES	1607	complete		
core	3.2	Historical	150	HadGEM2-ES	1606	complete		
core	3.2	Historical ensemble	10 x 150	HadCM3	824	complete		
core	3.3	AMIP	140	HadGEM-A	1427	complete		
tier 1	3.2-E	Historical Ensemble	3 x 150	HadGEM2-ES	674	complete		
tier 1	3.3-E	AMIP Ensemble	5 x 30	HadGEM-A	1315	complete		
other	3.2	Historical [60 level atmosphere]	150	HadGEM2-CC		[10%]	15/10/2011	simulation complete
Future Climate Projections								
core	4.1	RCP4.5	95	HadGEM2-ES	3155	complete		
core	4.2	RCP8.5	95	HadGEM2-ES	2908	complete		
other	4.2	RCP4.5 ensemble	10 x 30	HadCM3	169	complete		
tier 1	4.3	RCP2.6	95	HadGEM2-ES	520	complete		
tier 1	4.4	RCP6.0	95	HadGEM2-ES	520	complete		
other	4.1	RCP45 [60 level atmosphere]	95	HadGEM2-CC		[0%]	15/11/2011	simulation complete
other	4.1-E	RCP45 ensemble	3 x95	HadGEM2-ES		[0%]	15/12/2011	*ditto*
other	4.2	RCP85 [60 level atmosphere]	95	HadGEM2-CC		[0%]	15/11/2011	*ditto*
other	4.2-E	RCP85 ensemble	3 x95	HadGEM2-ES		[0%]	*ditto*	*ditto*
other	4.3-E	RCP26 ensemble	3 x95	HadGEM2-ES		[0%]	*ditto*	*ditto*
other	4.4-E	RCP60 ensemble	3 x95	HadGEM2-ES		[0%]	*ditto*	simulations complete - data transfer underway
Additional Coupled Carbon Simulations								
core	5.1	Pre-Industrial Control	250	HadGEM2-ES		[0%]	30/10/2011	simulation complete
core	5.2	Historical	150	HadGEM2-ES		[0%]	*ditto*	*ditto*
core	5.3	RCP85	95	HadGEM2-ES		[0%]	*ditto*	*ditto*
tier 1	5.4-1	carbon/climate feedback 1	140	HadGEM2-ES	248	complete		
tier 1	5.4-2	carbon/climate feedback 2	250	HadGEM2-ES	443	complete		
tier 2	5.5-1	carbon/climate components 1	140	HadGEM2-ES	65	[25%]	15/10/2011	simulation complete - data transfer underway
tier 2	5.5-2	carbon/climate components 1	250	HadGEM2-ES	126	[25%]	*ditto*	*ditto*
Diagnostic Experiments for Understanding the long-term Simulations								
core	6.1	idealised 1%/yr run	140	HadGEM-A	116	complete		
core	6.2a	SST baseline run	30	HadGEM-A	306	complete		
core	6.2b	Hansen - fast response run	30	HadGEM-A	306	complete		
core	6.3	Gregory - slow response run	140	HadGEM-A	117	complete		

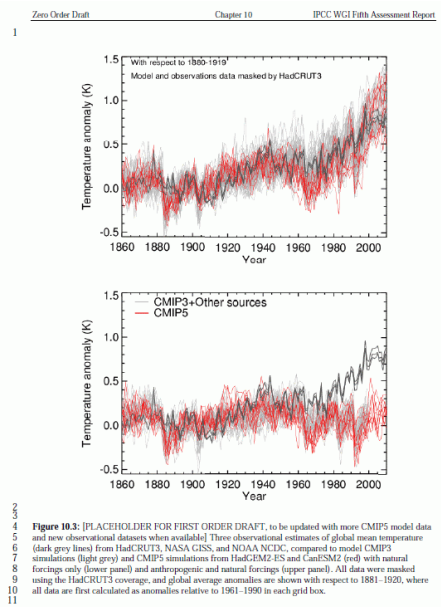
Science feeding into AR5 draft chapters

Project to co-ordinate HadGEM2-ES / CMIP-5 Analysis and Model Publication

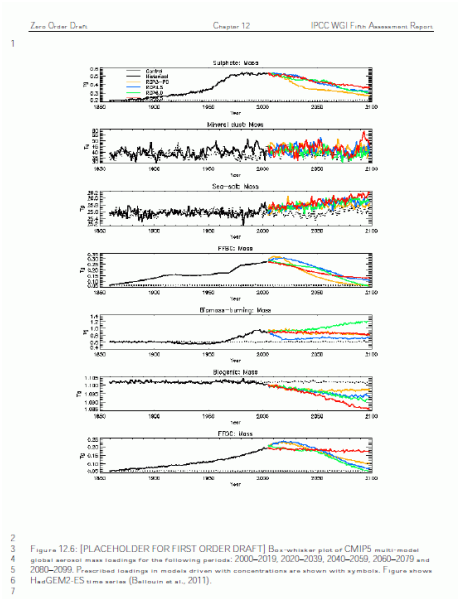
Over 100 separate suggested analysis topics. Work in progress on a combination of bottom-up science ideas and top-down coordination



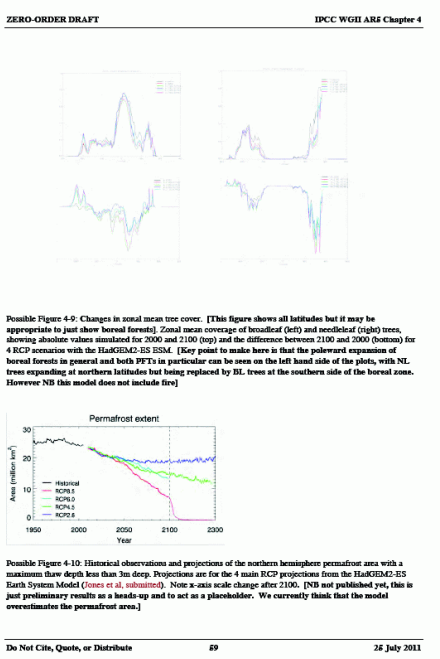
WG1, Ch6



WG1, Ch10

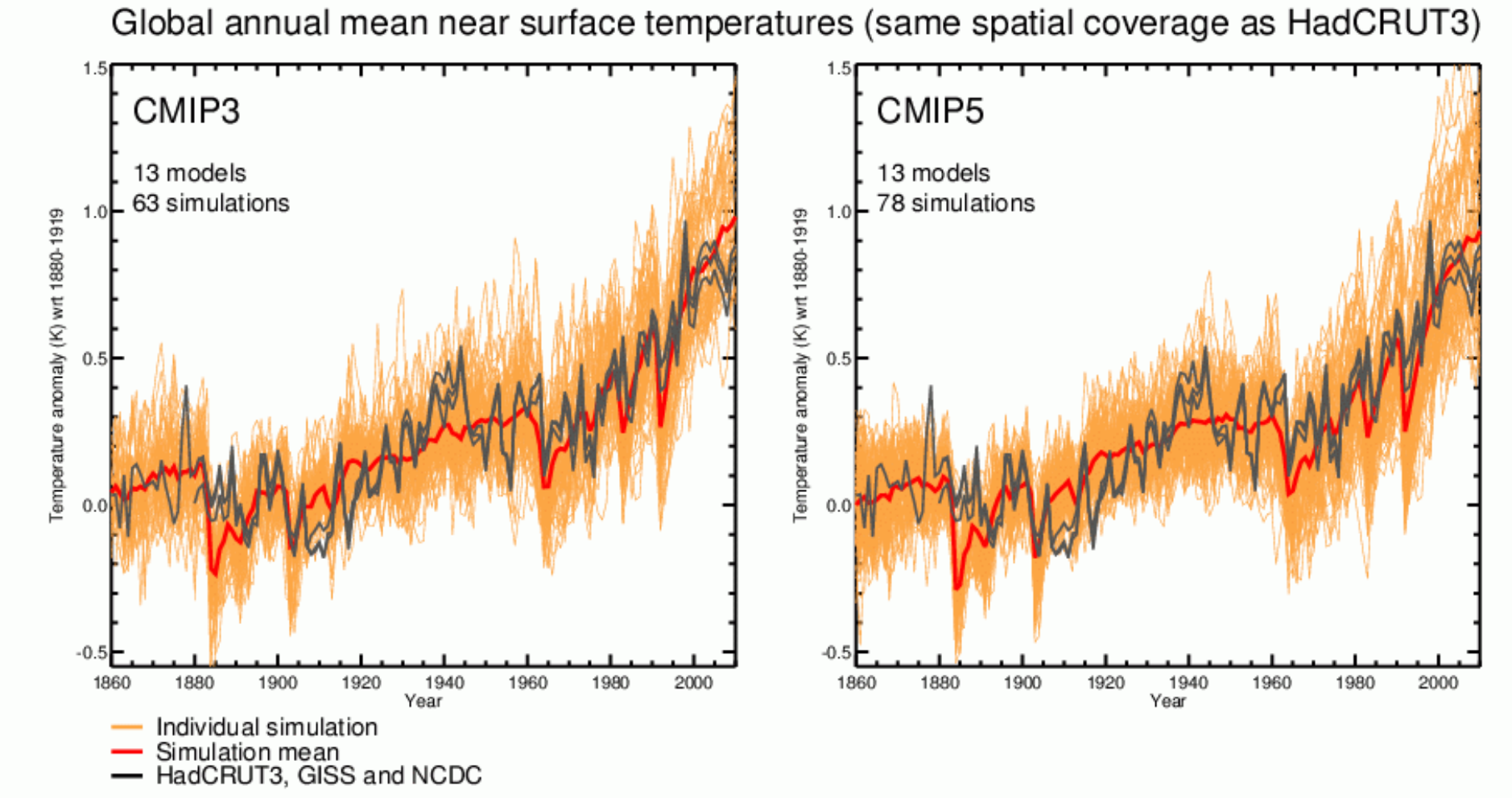


WG1, Ch12



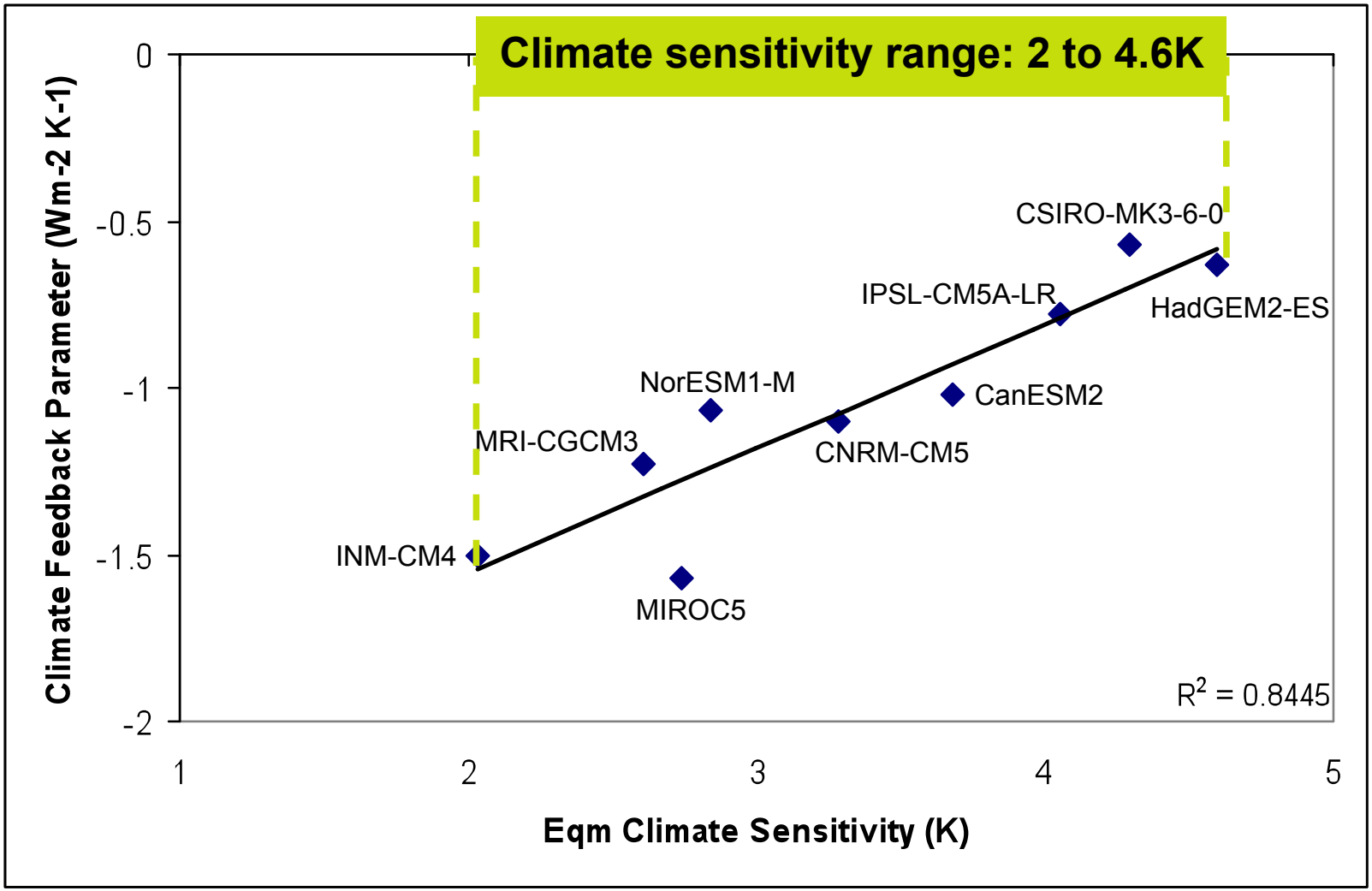
WG2, Ch4

Temperature anomalies CMIP5 v CMIP3



Gareth Jones

Equilibrium Climate Sensitivity: CMIP5

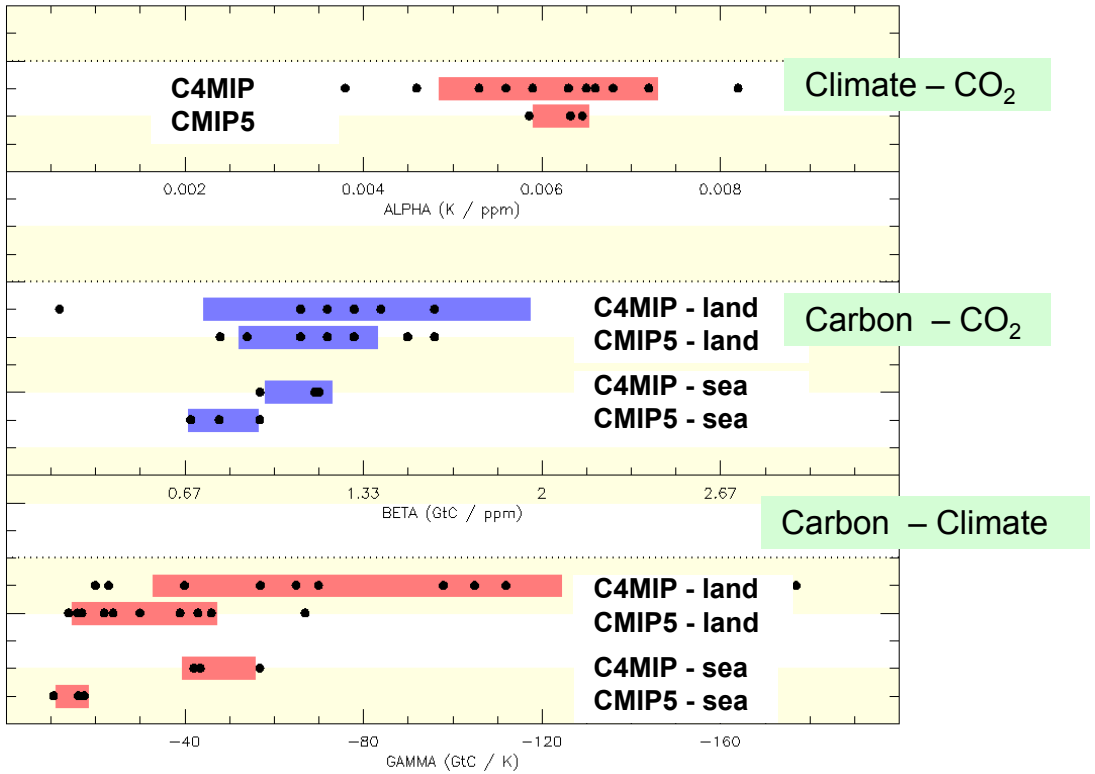


Tim Andrews, Karl Taylor, Jonathan Gregory et al

Carbon Cycle Feedback: HadGEM2-ES vs HadCM3/ CMIP5 vs C4MIP

- HadGEM2-ES has a weaker climate-carbon feedback than HadCM3. No single reason, but
  - greater land differences than ocean
  - No Amazon dieback
  - Stronger high-lat carbon uptake
  - Sensitivity to parameters/tuning
  - Larger carbon cycle-CO_2 feedback

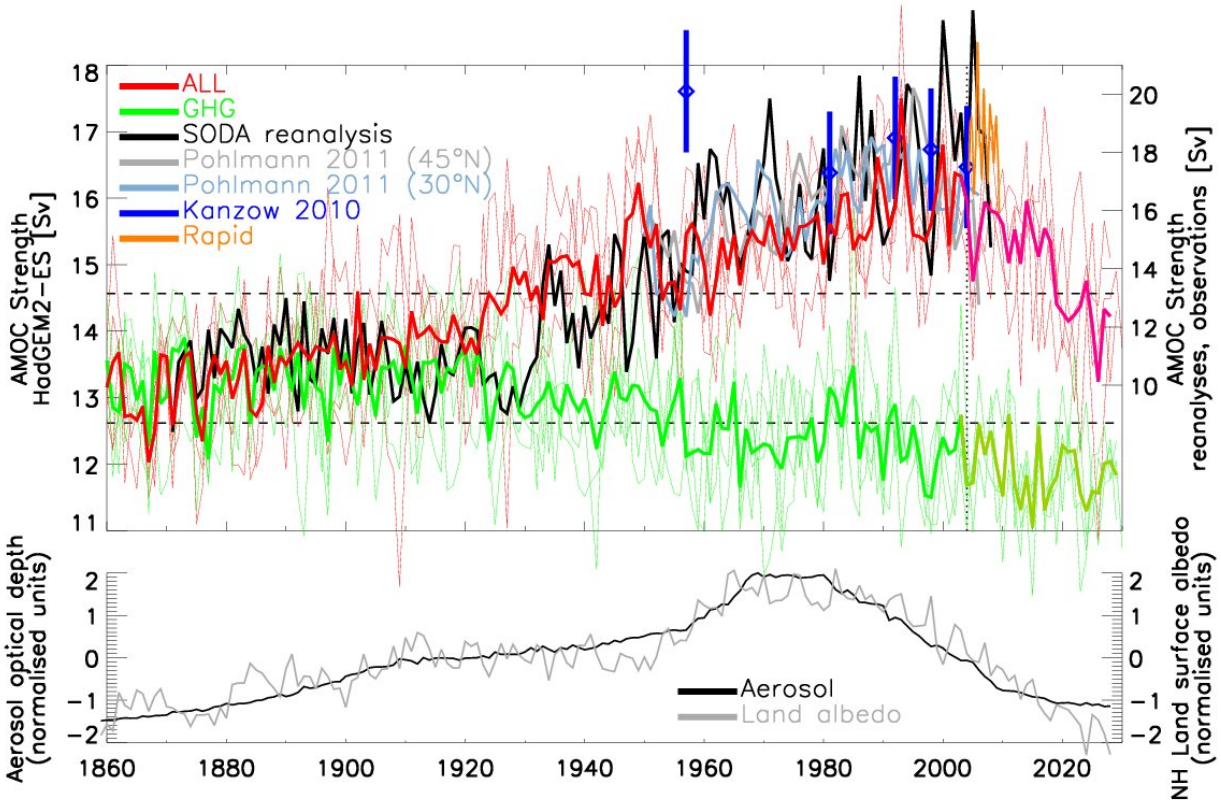
- No evidence that CMIP5 is systematically different from C4MIP but…
  - only 3 CMIP5 models
  - different scenario
  - can't say anything yet on model spread



Chris Jones

Increasing MOC through the 20th Century – and rapid decline in the 21st?

HadGEM2-ES 20th Century simulations



- Possible link to aerosol forcing driving changes in atmospheric circulation
- Anticyclonic anomaly in Beaufort Sea traps fresh water in Arctic
- Cyclonic anomaly in North Atlantic strengthens subpolar gyre, preconditioning convection
- Fresh water accumulates in Arctic during 20th Century and is released to North Atlantic in 21st Century

Menary et al. 2011 subm.

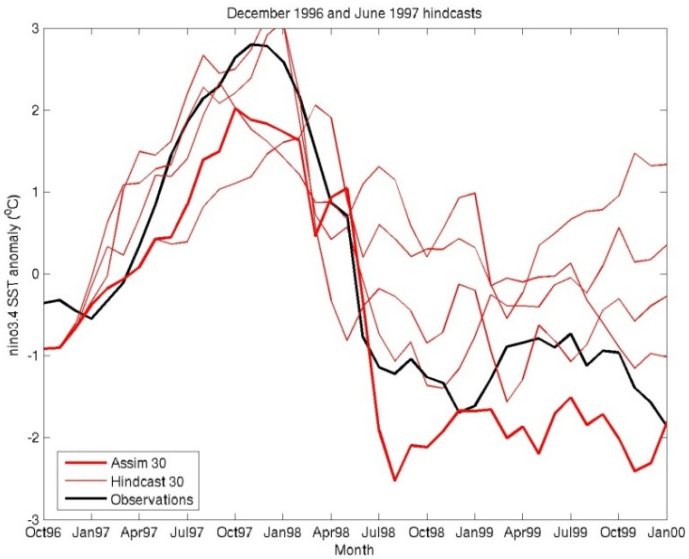
Decadal Prediction Experiments: HiGEM

Len Shaffrey NCAS-Climate

HiGEM is a higher resolution version of the Met Office coupled climate model, HadGEM1

Atmos: 1.25° x 0.86° (90km) Ocean: 1/3° x 1/3°

Century-length integrations of HiGEM have been performed (Shaffrey et al. 2009, *J. Climate*).



Dec 1996 and June 1997 HiGEM test hindcasts. Nino3.4 SST anomalies from obs (black), the assimilation run (thick red) and 4 HiGEM hindcasts (thin red)

- About 2/3 of the way through hindcast experiments. Hope to complete these by end of October
- Starting uploading of data to CMIP5 database next month, hope to complete by December
- Studying role of resolution on measures of forecast skill

Decadal Prediction Experiments: HadCM3 DePreSys

- 10 free-running transient experiments 1860-2035 with initial conditions from HadCM3 control
- One anomaly assimilation run from 1960-2009
- 10-year hindcasts from 1960, 1965, … 2005 – 10 members each generated by initial SST perturbations (Expt 1.1)
- 30-year hindcasts from 1960, 1980, 2005 – 10 member ensembles (Expt 1.2)
- Additional ensemble members
- Expt 1.5 with alternative full-field initialization
- Output completed and all data at BADC

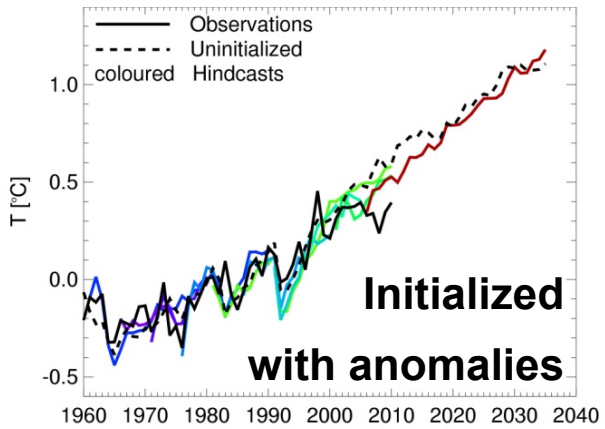
Holger Pohlman, MOHC

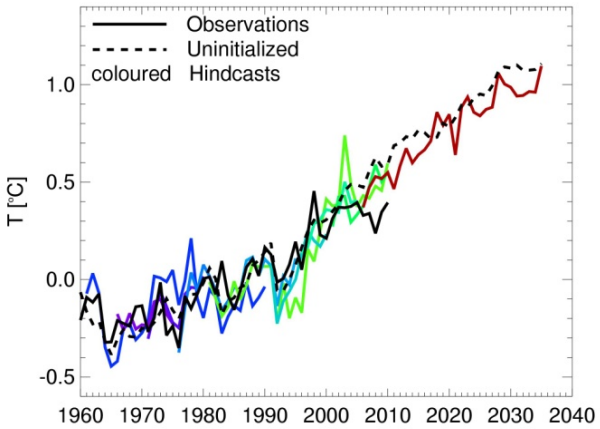
Prediction skill of global mean T: two methods of Initialisation

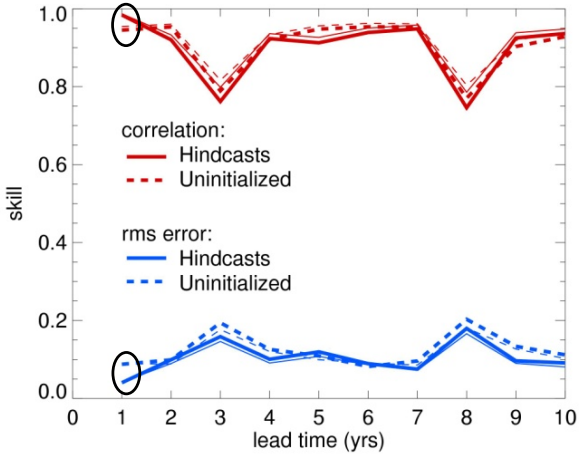
DePreSys CMIP5:

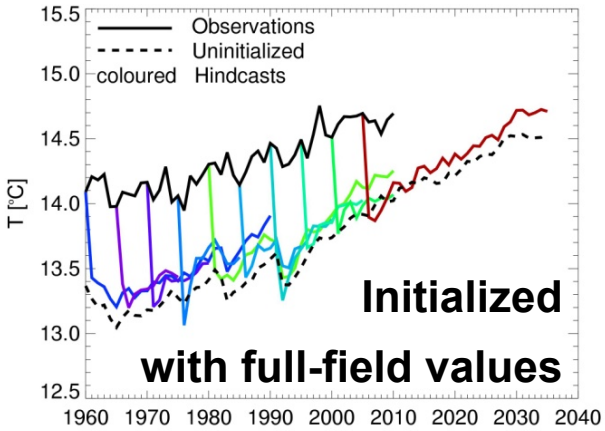
Bias corrected:

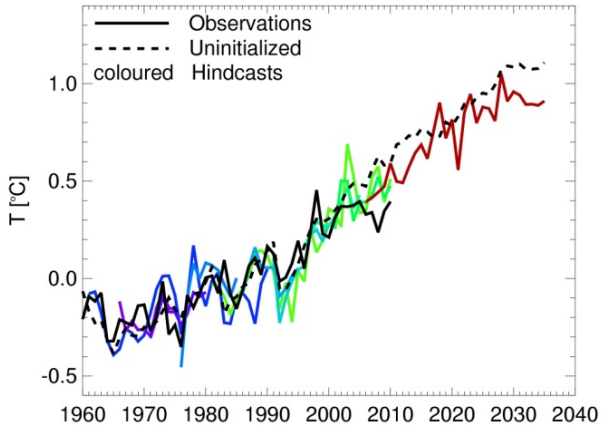
Skill:

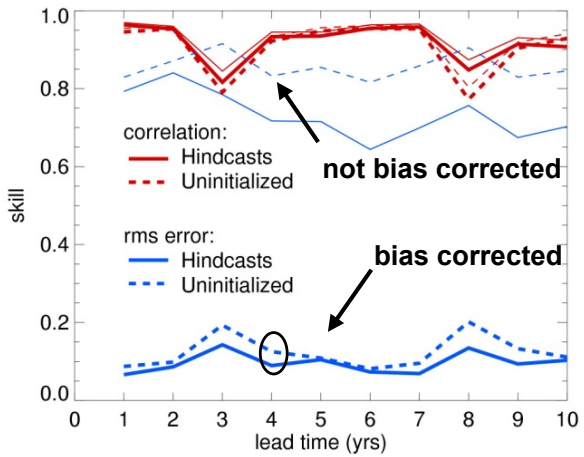












H. Pohlmann & D. Smith, paper in preparation

Summary

- More than 10,000 HadGEM2-ES simulated years completed. All runs complete
- Delivered 20TB of data and counting (42 times more data than for CMIP3)
- A lot of analysis for AR5 ongoing – feeding directly in 1st order draft.
  - CMIP5 models reproduce the observed T* but with greater spread than CMIP3. Aerosol forcing differences?
  - HadGEM2-ES carbon-cycle feedback is weaker than HadCM3. No evidence for systematic difference CMIP5/CMIP3
  - Range of climate sensitivity unlikely to be less than CMIP3
  - 20th century MOC increase arising from salinity anomaly
- Decadal simulations complete with HadCM3 and progressing with HiGEM
  - No difference in skill in full-field or anomaly initialisation

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20th Century climate: HadGEM2-ES

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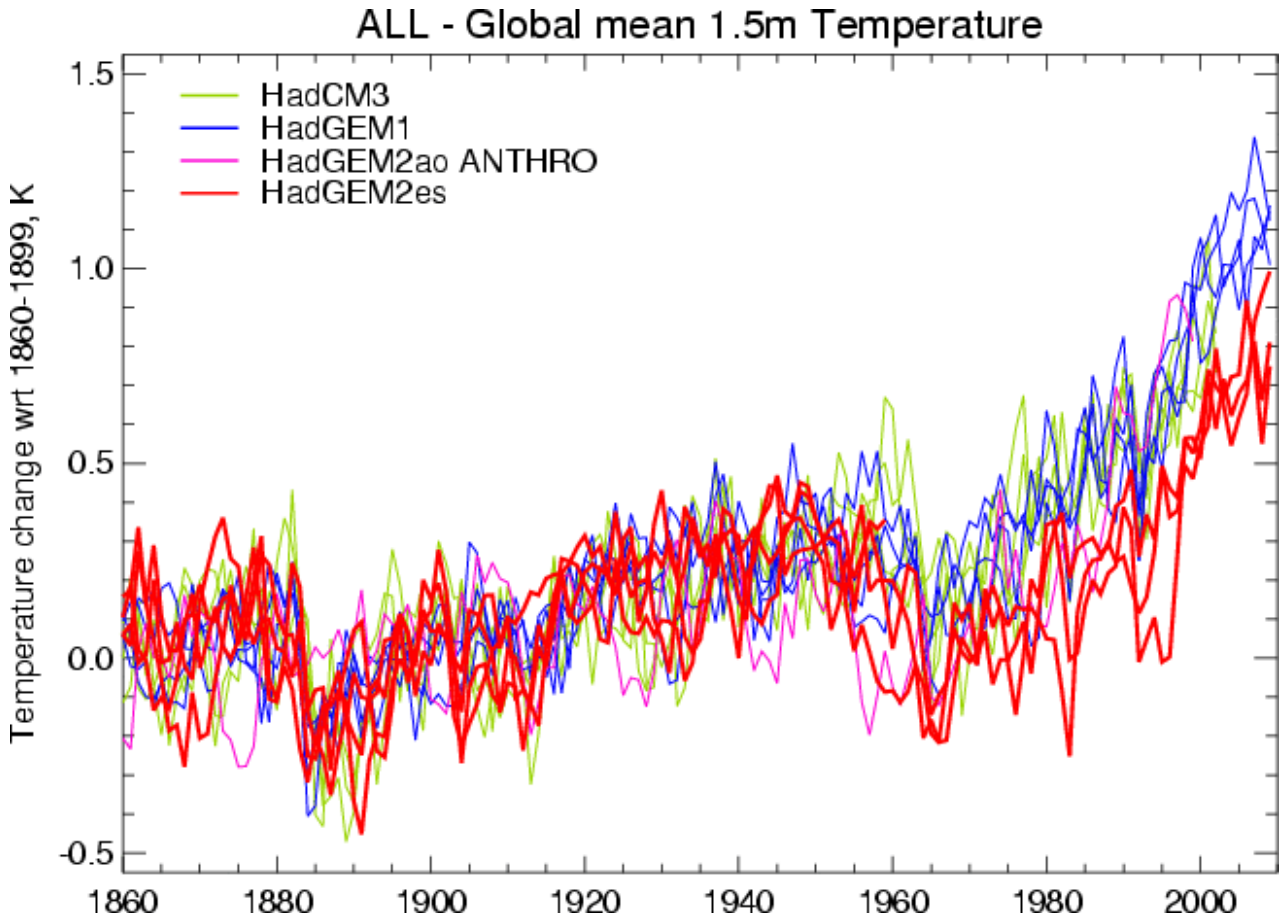
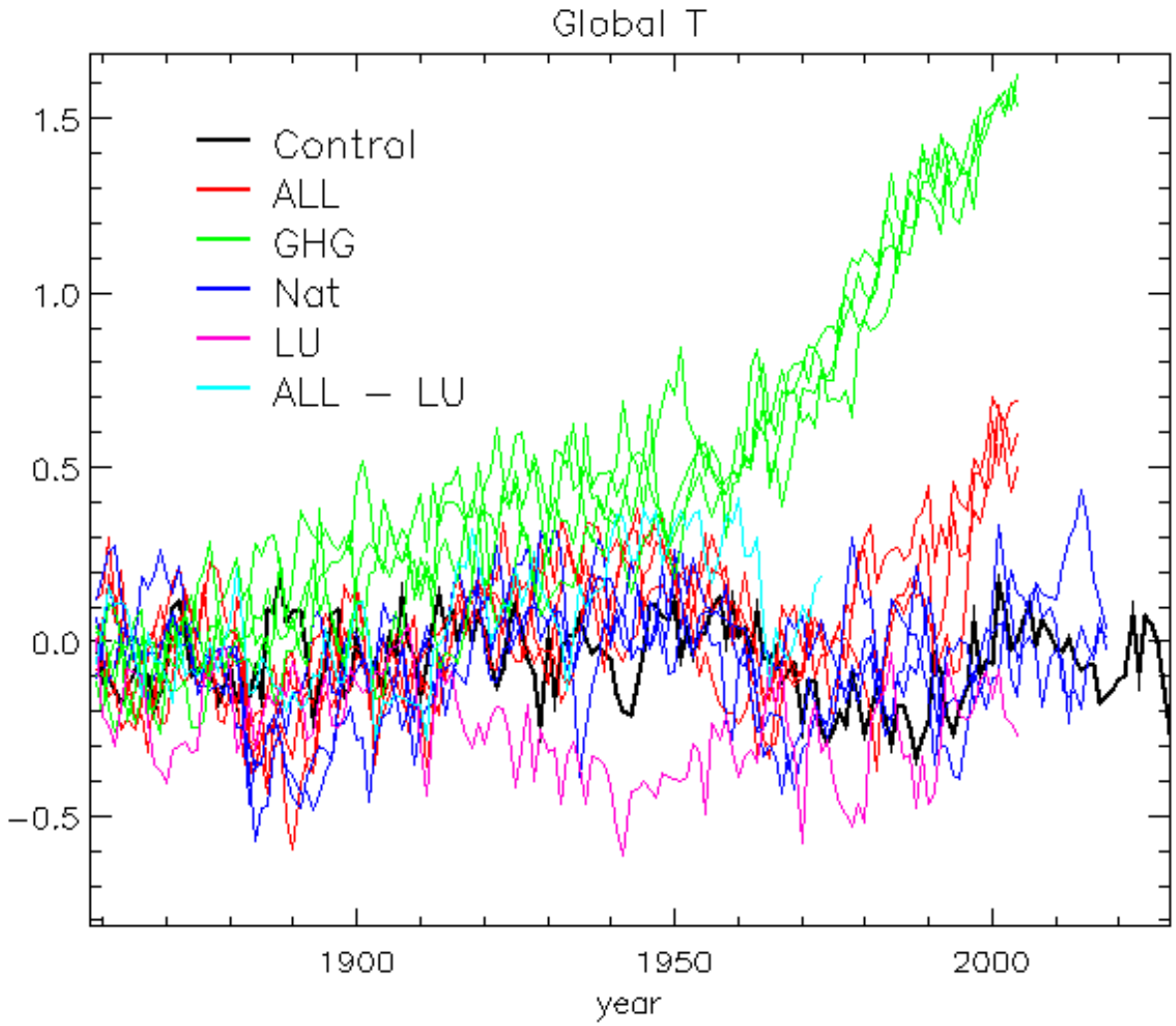


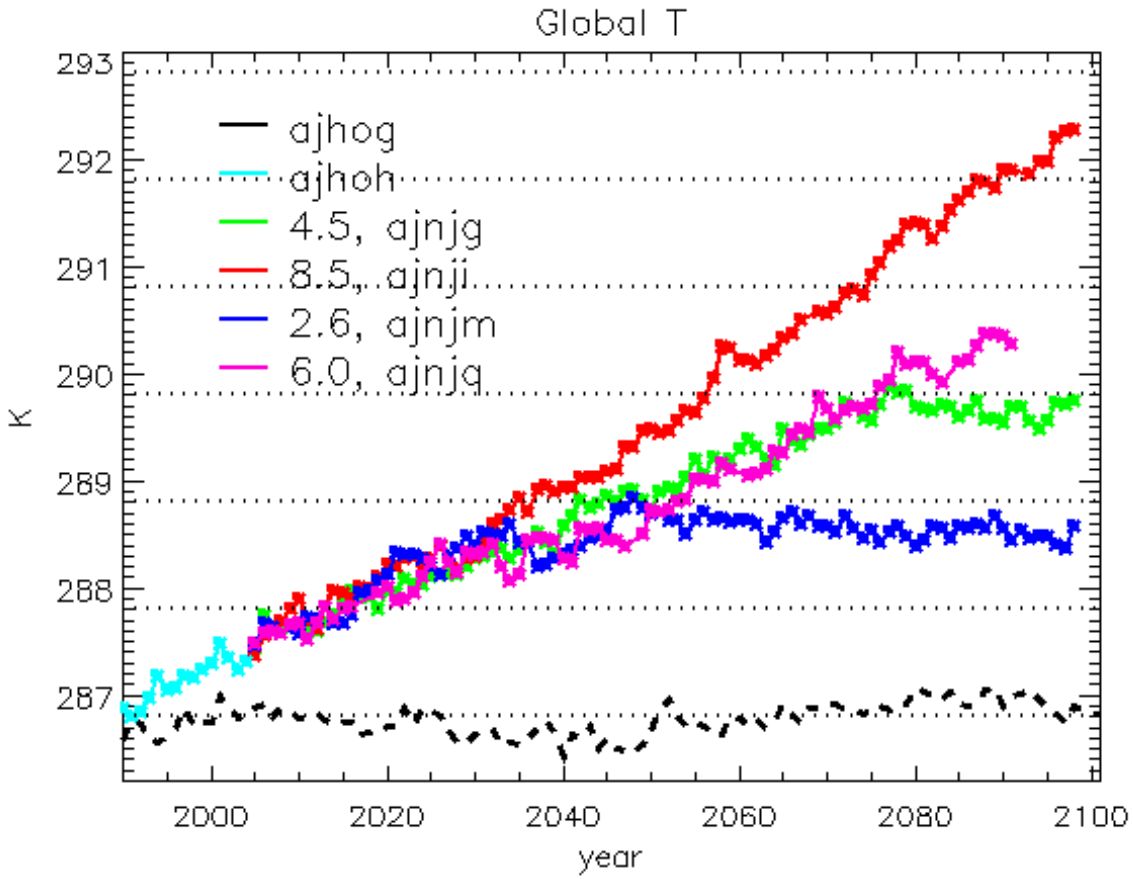
Detection and Attribution ensembles: HadGEM2-ES

- 4 members each of GHG and NAT
- Big signal is GHG warming vs “ALL”.
- Land-use interesting too



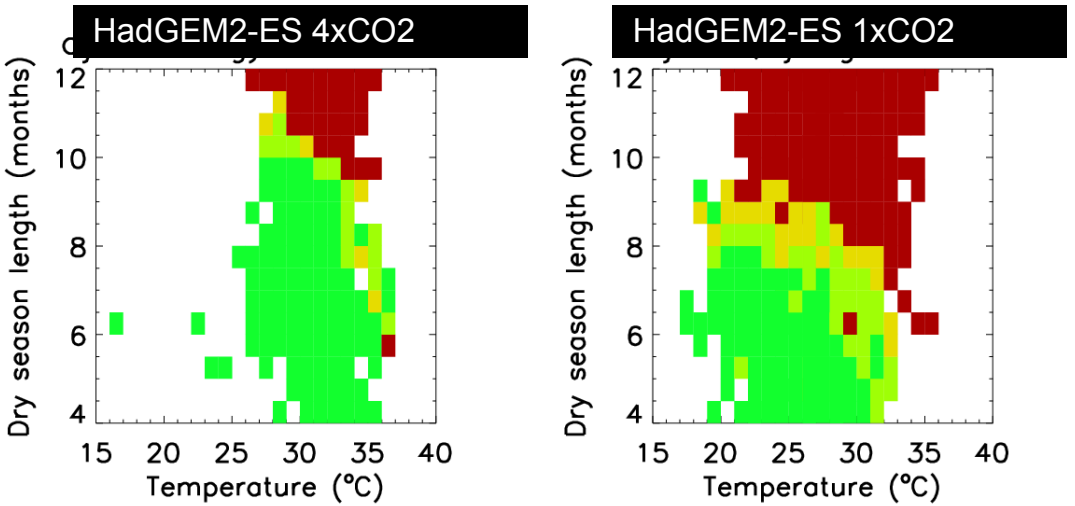
RCPs: HadGEM2-ES

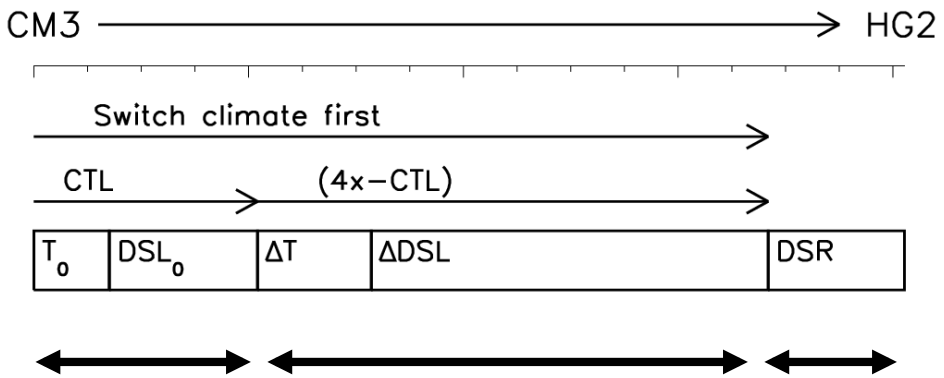
- All 4 RCPs finished to 2100
- RCP2.6 avoids 2 degrees. (Shows slight cooling by 2100)
- RCP8.5 reaches 5.5 degrees



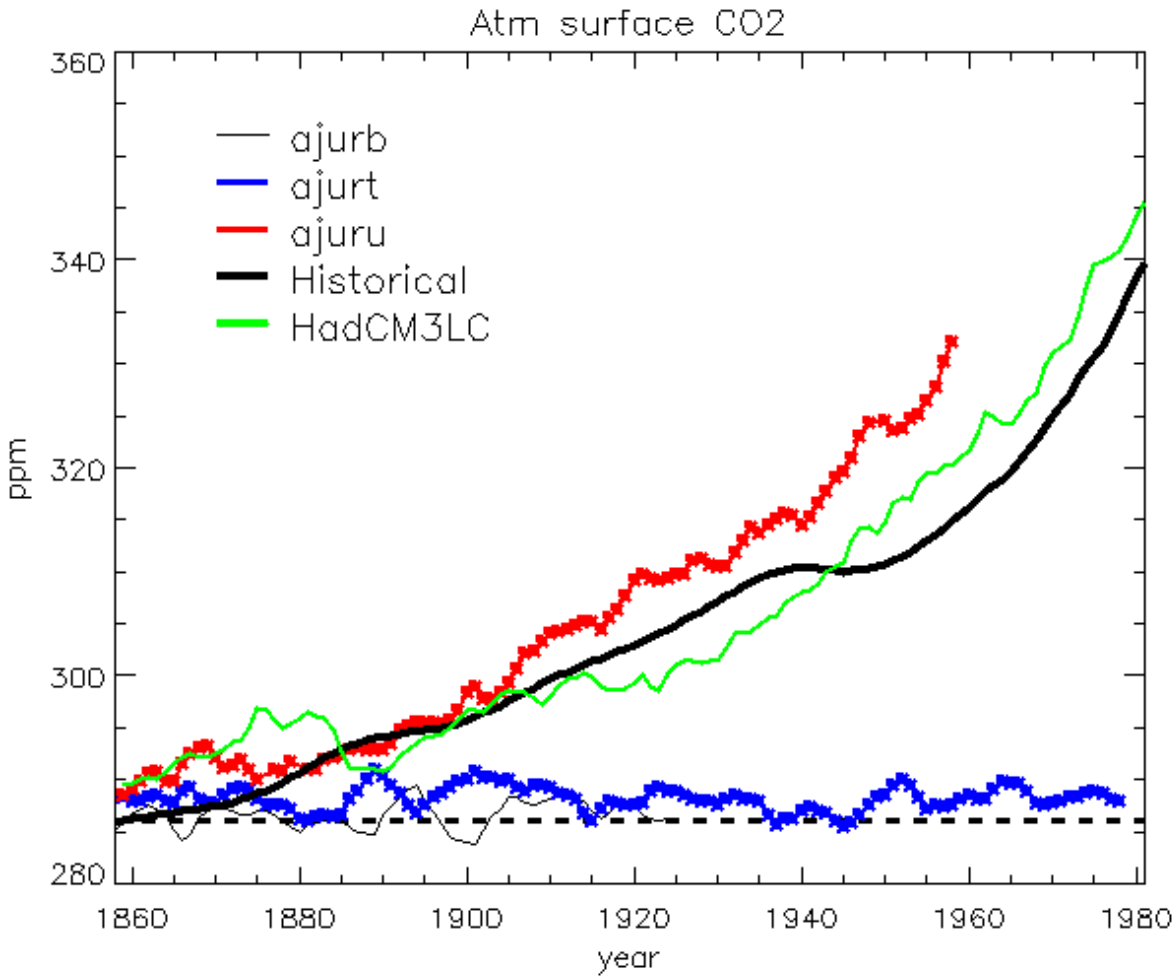
HadGEM2-ES: No Amazon dieback

- Define “dry season resilience”, DSR
  - Fn of T, dry-season length, and CO2
- Allows:
  - Determine where forest near threshold
  - Quantify what causes dieback

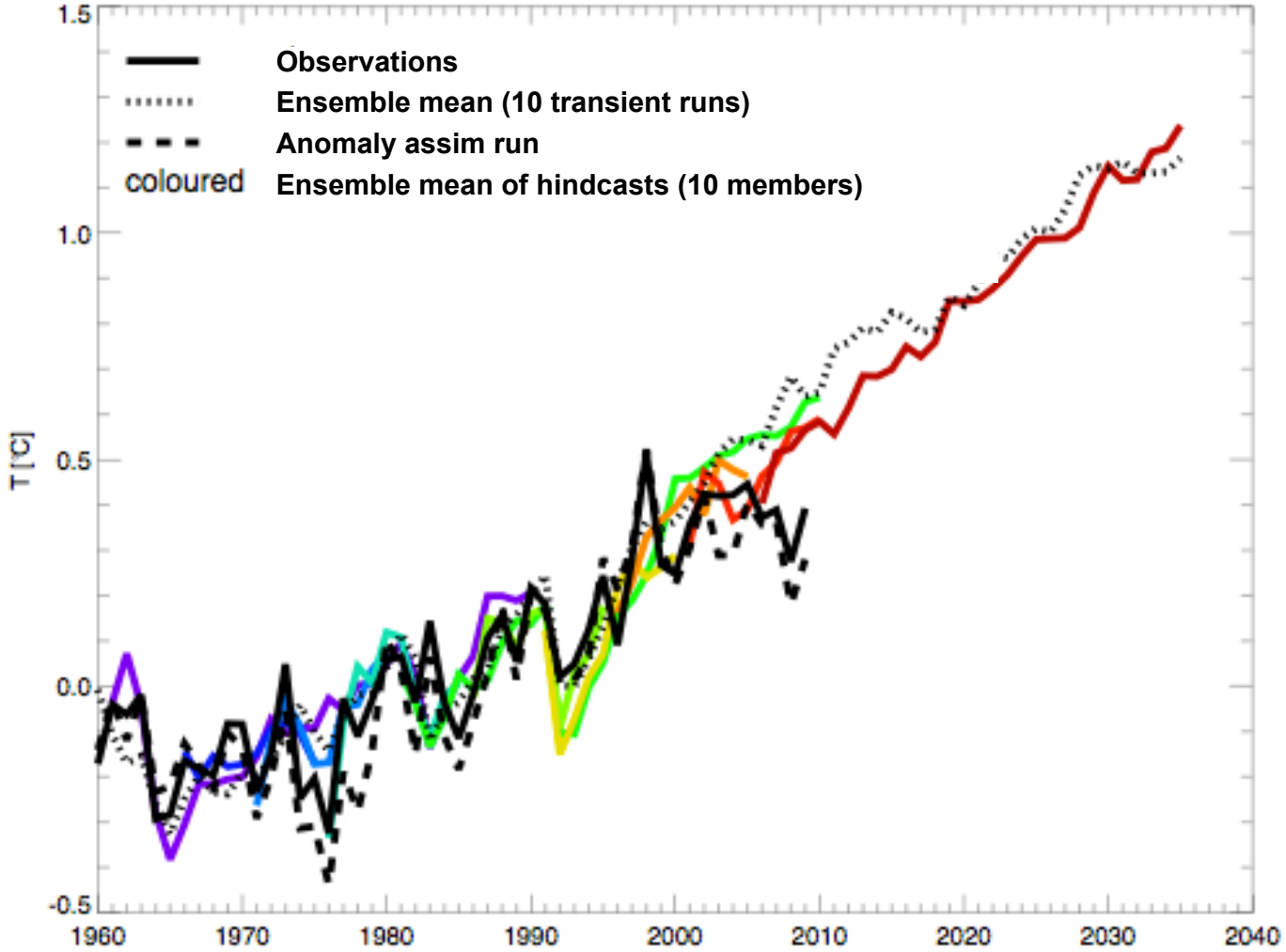




Emissions driven runs: HadGEM2-ES



Decadal prediction: HadCM3 Global Mean Temperature



Holger Pohlman, MOHC

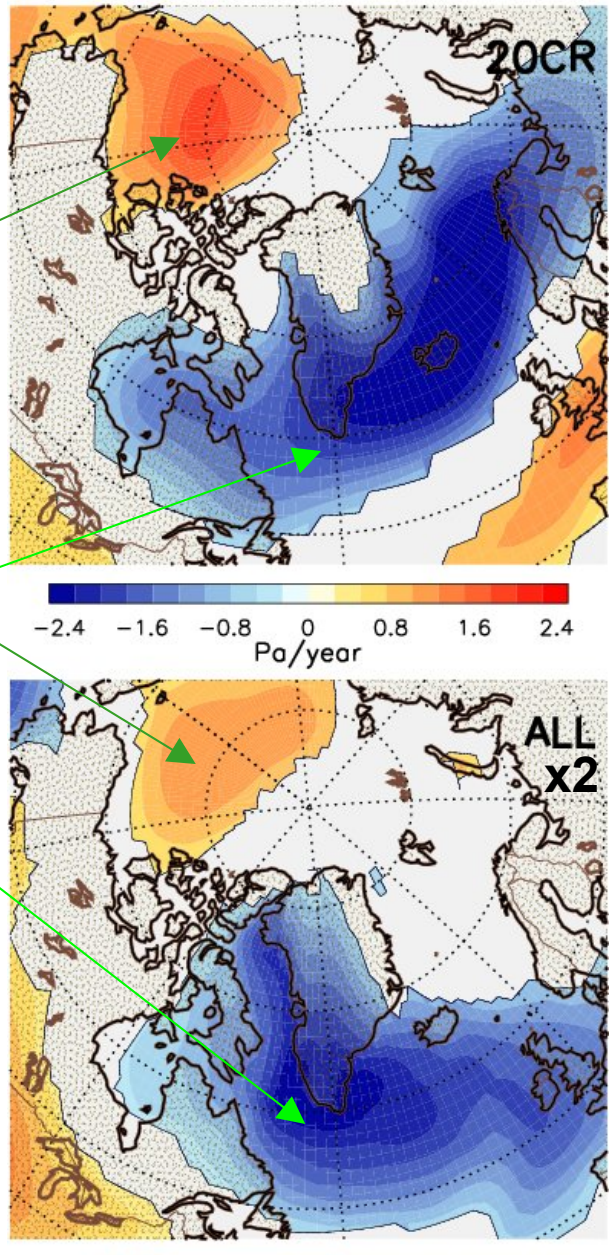
Arctic circulation response in 20th Century

1871-2000 MSLP trend: reanalysis

Anticyclonic anomaly in Beaufort Sea traps fresh water in Arctic

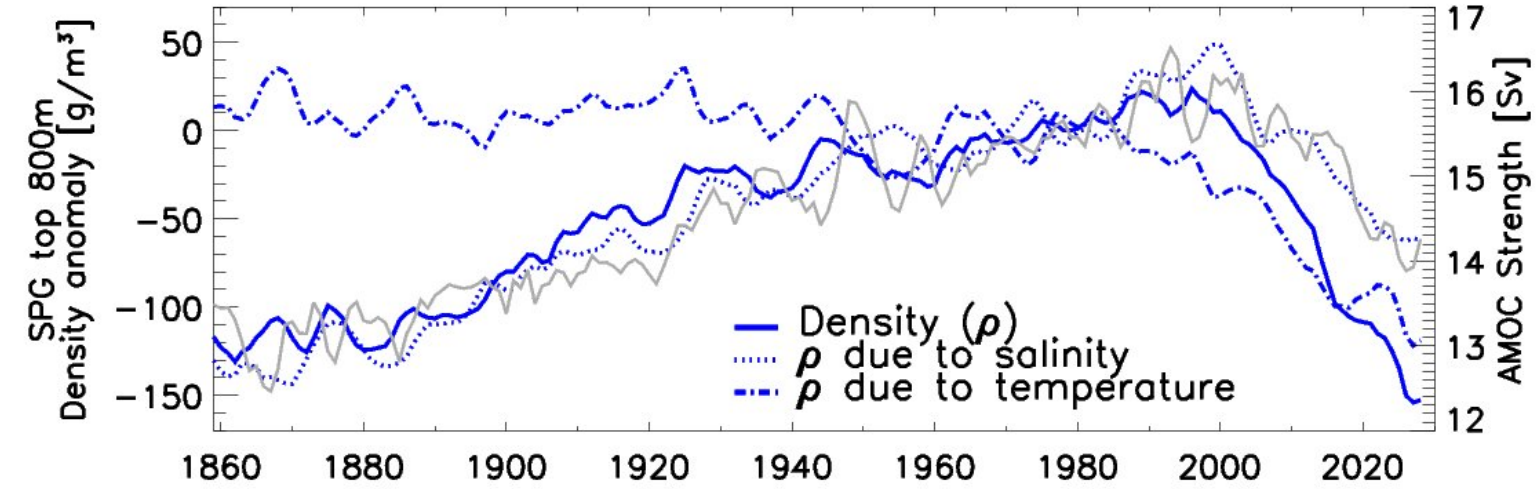
Cyclonic anomaly in North Atlantic strengthens subpolar gyre, preconditioning convection

1871-2000 MSLP trend: all forcings ensemble mean (note lower amplitude)

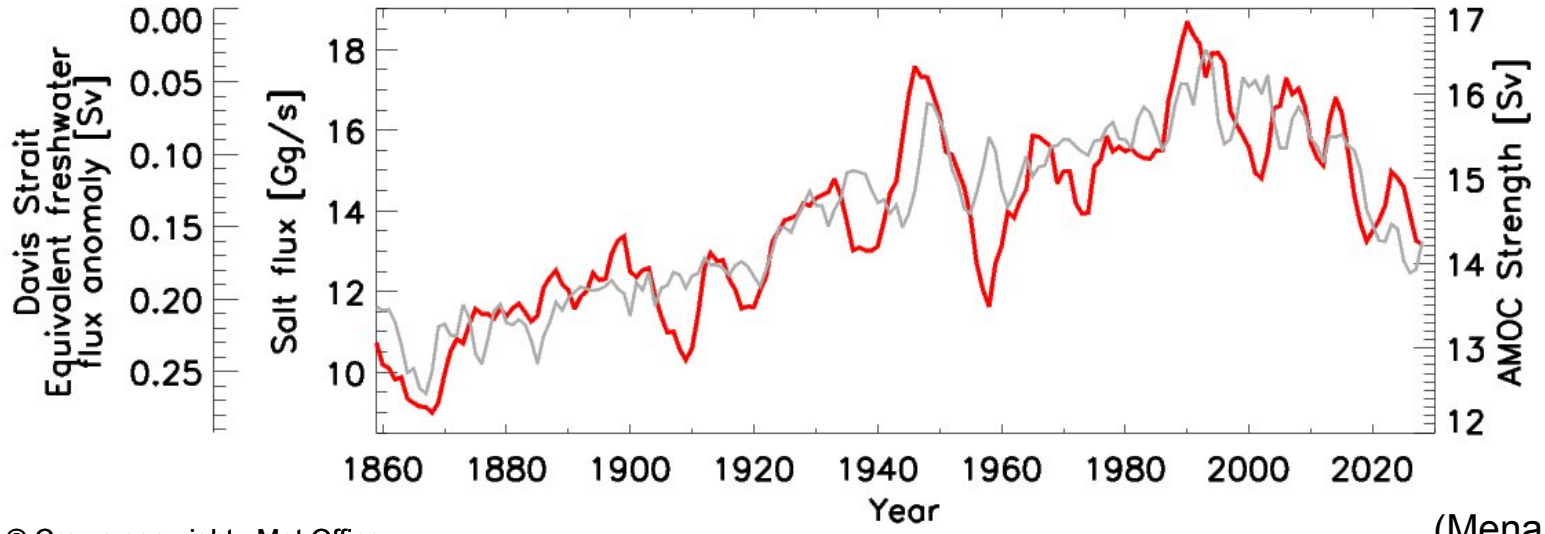


(Menary et al. 2011 subm.)

Fresh water accumulates in Arctic during 20th Century and is released to North Atlantic in 21st Century



Subpolar North Atlantic density



Salt flux through Davis Strait (red)

MOC (grey)

(Menary et al. 2011 subm.)