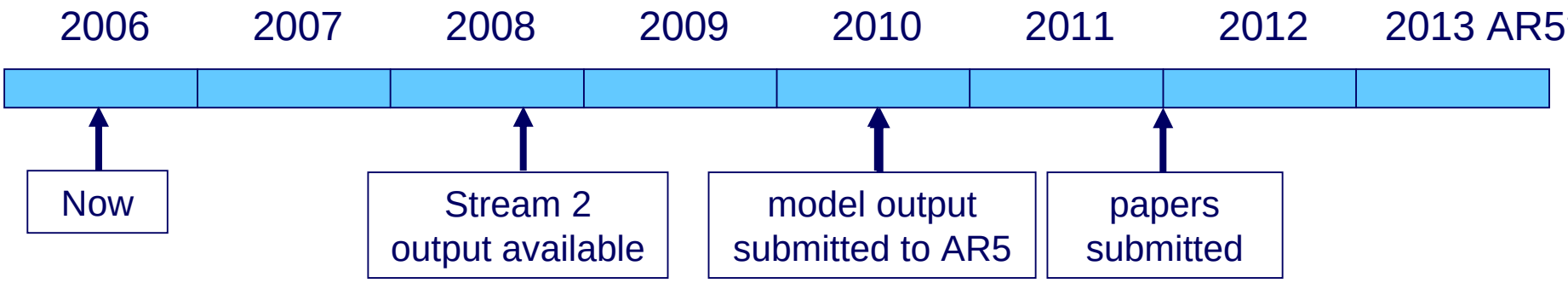
ENSEMBLES RT1/RT2A Meeting

ECMWF, 8-9th Jun 2006

ESM development at the Met Office Hadley Centre

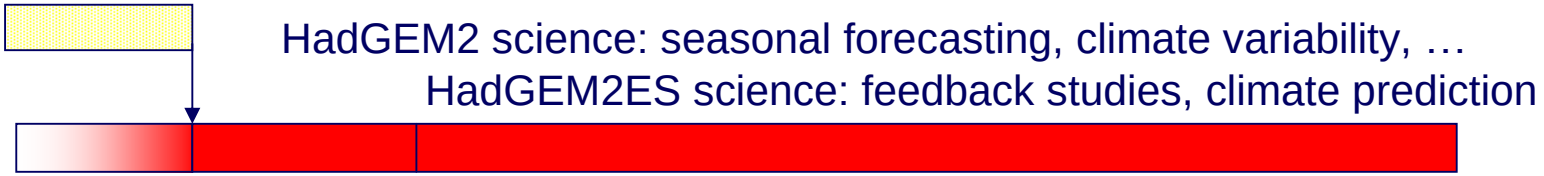
Tim Johns, and HadGEM model development teams

Model Development Timeline: HadGEM1a/GEM2/GEM2ES



HadGEM1a (physical model)

Development



Development Tuning

HadGEM2/HadGEM2ES

Supercomputing

Hadley Centre Global Environmental Model 2 (Earth System)

HadGEM2ES - Fully coupled Earth System Model

- Atmosphere, ocean, sea-ice, land surface
  - HadGEM1a
- Aerosols: Sulphate, BC, OC, dust, sea salt
  - HadGEM1a

= HadGEM2 physical model

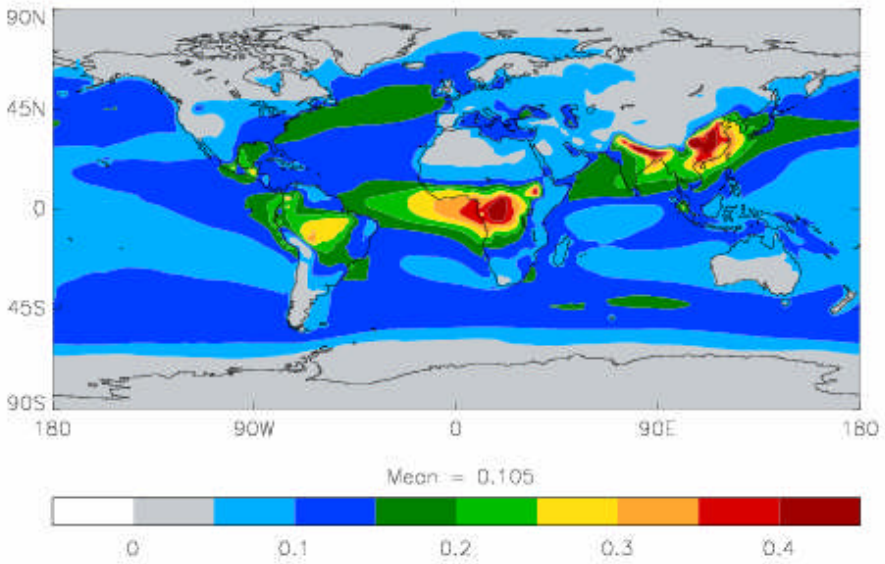
- Land ecosystems: dynamic vegetation, soil C/N
  - TRIFFID, RothC
- Ocean ecosystems: NPZD, diatoms, non-diatoms, C, N, Fe, Si
  - Diat-HadOCC, DMS
- Chemistry: trop, strat; ozone, methane, oxidants
  - UKCA

HadGEM1a compared to HadGEM1

- **Changes to convection and boundary layer:**
  - **Adaptive detrainment**
  - **W threshold for targetted diffusion**
  - **Mid-level convection (minor changes for consistency with NWP model)**
- **Aerosols**
  - **Improved aerosol parameterization for existing interactive species**
  - **Mineral dust now included**
  - **Specified biogenic aerosol climatology included**
- ***1 hour (as opposed to 3 hour) radiation calls***
- **River routing for inland basins**
- **Various bug fixes**
- **HadGEM1a model cost is currently ~20%+ more than HadGEM1 (further optimization to be done)**

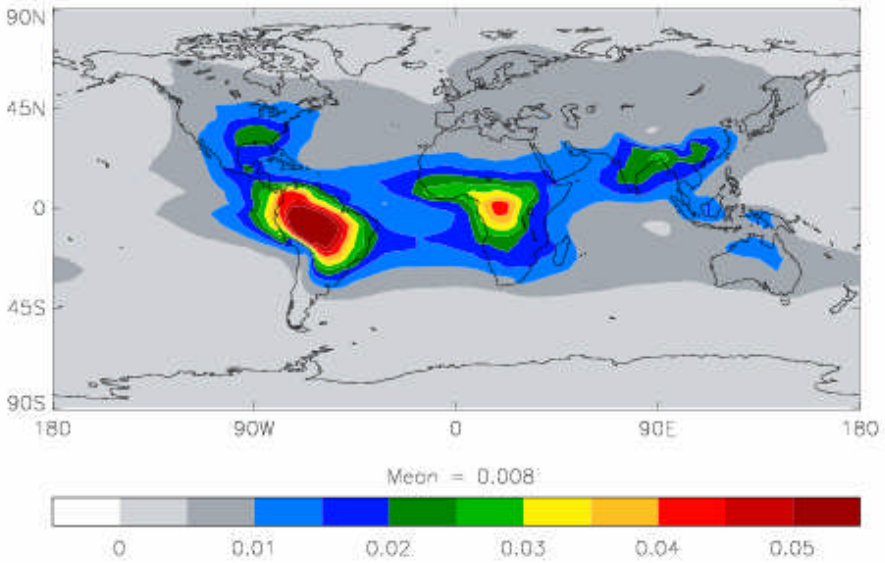
- **The main advances expected over HadGEM1 are**
  - **Improved tropical mean state, perhaps ENSO**
  - **Improved aerosols**
  - **Improved land surface biases**
- **These improvements are expected to make HadGEM1a a suitable physical basis for the HadGEM2ES model (to include couplings to carbon cycle and chemistry)**

Aerosols in HadGEM1a



Aerosol optical depth in HadGEM1a (inc. dust)

- More optically active aerosols – modelled optical depths look more realistic
- Dust is now included in HadGEM1a
- Specified biogenic aerosol climatology from STOCHEM also being tested:
  - Organic species from trees
  - Small impact (~10% in some areas) on AOD, but also act as cloud nuclei
  - Reduces the total aerosol "cooling" forcing over the 1860 to 2000 period to levels more similar to HadGEM1 (good!)

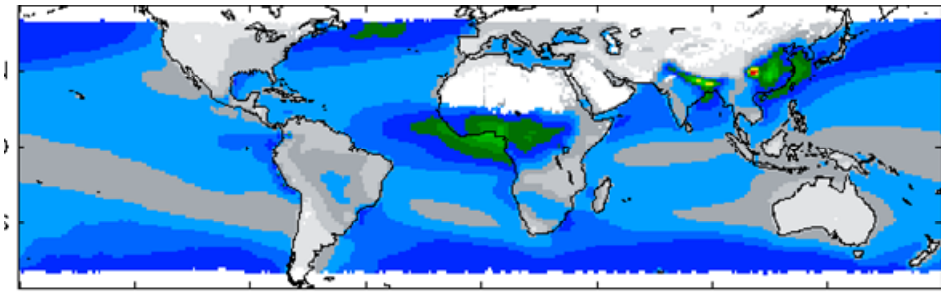


Additional aerosol optical depth from biogenic aerosols (NB note scale difference)

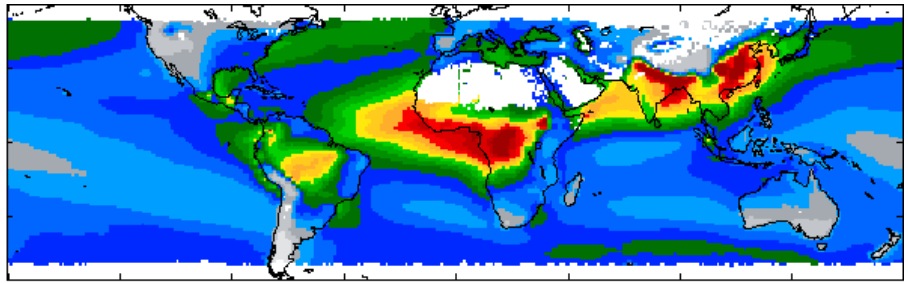
c/o Andy Jones

Impact of HadGEM1a improvements on total AOD

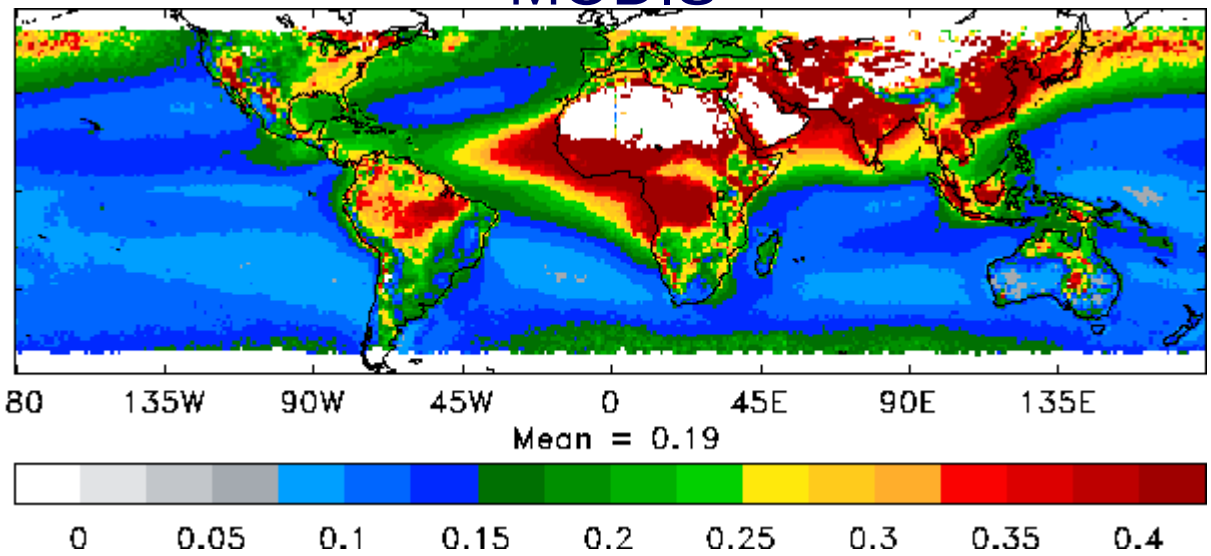
Early HadGAM1



HadGAM1a

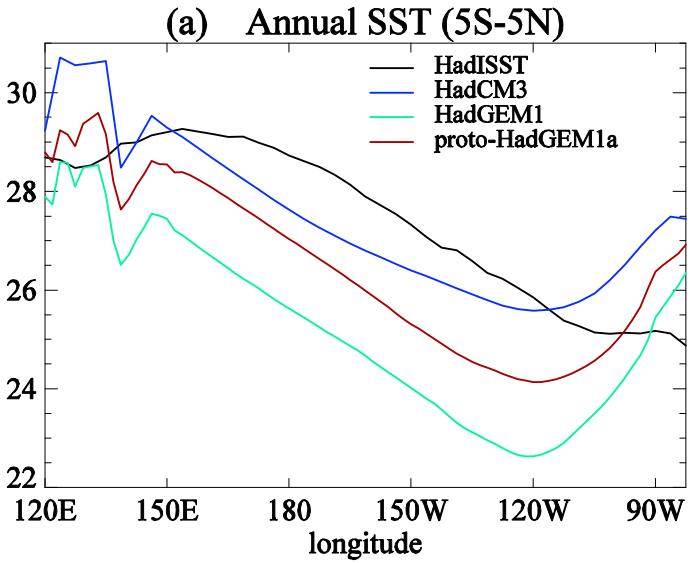


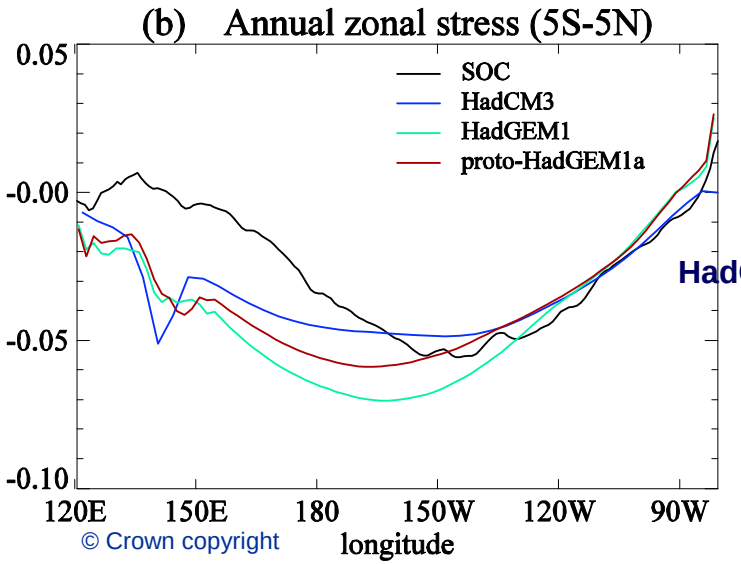
MODIS

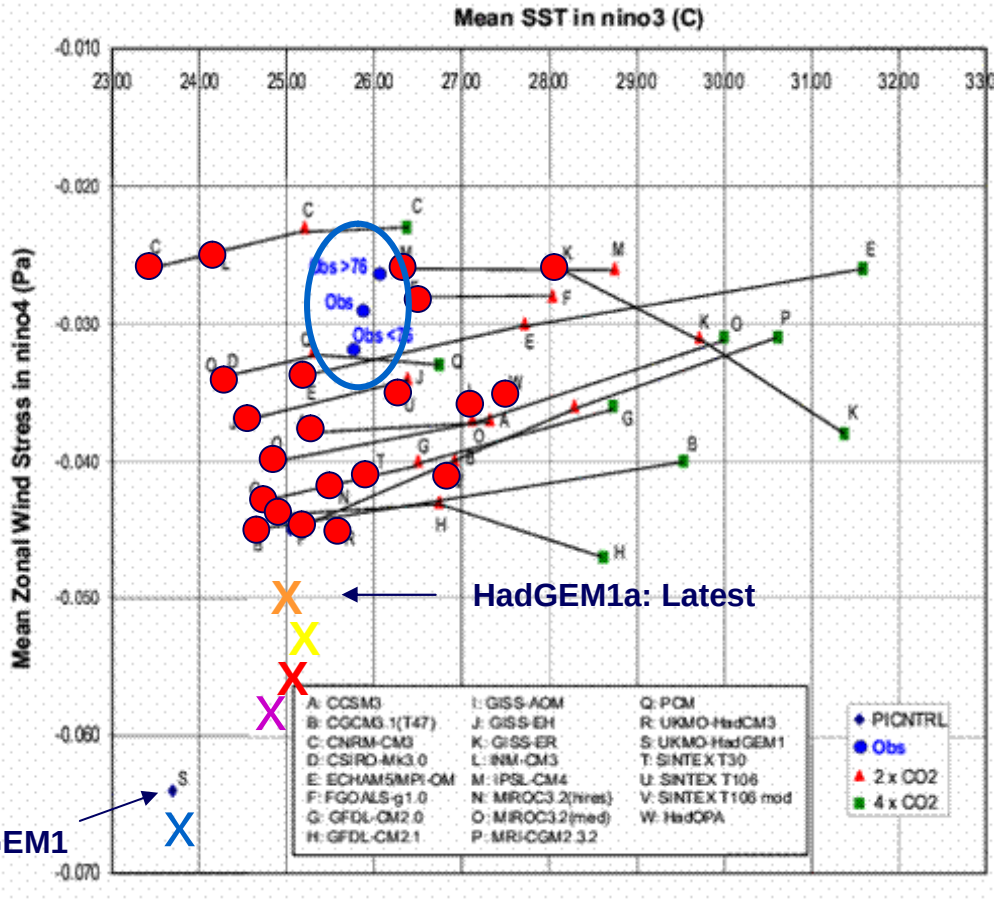


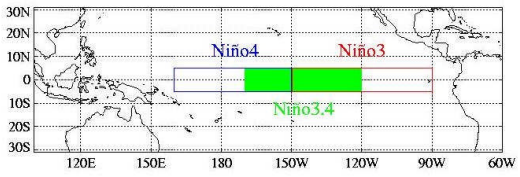
AOD increased by 55% from 0.09 to 0.14

HadGEM1a: SST and Taux

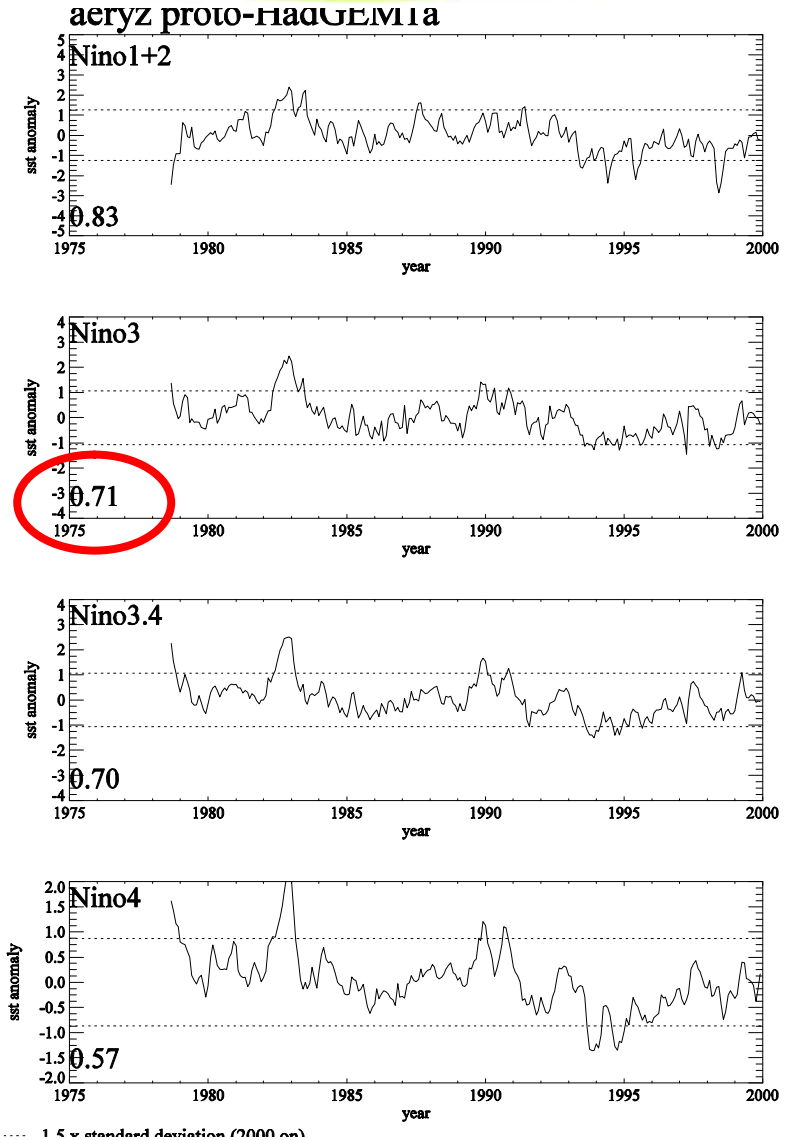








Tropical Variability: SST



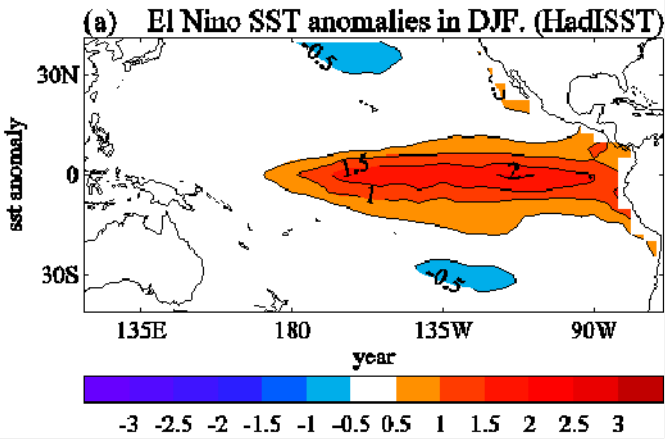
Nino 3 standard deviation

HadISST	0.8
HadCM3	0.85
HadCEM	1.12
HadGEM1	0.65
HadGEM1a	0.71

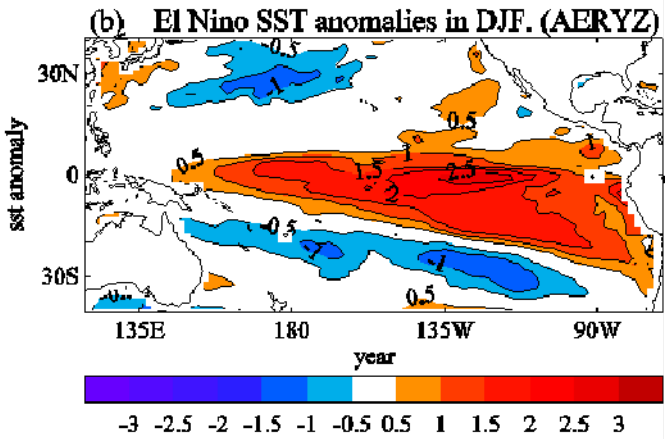
CMIP models (non-flux adjusted)	0.27 to 1.06
QUMP (Nino 3.4; flux adjusted)	0.76 to 1.19

El Nino SST anomalies: DJF

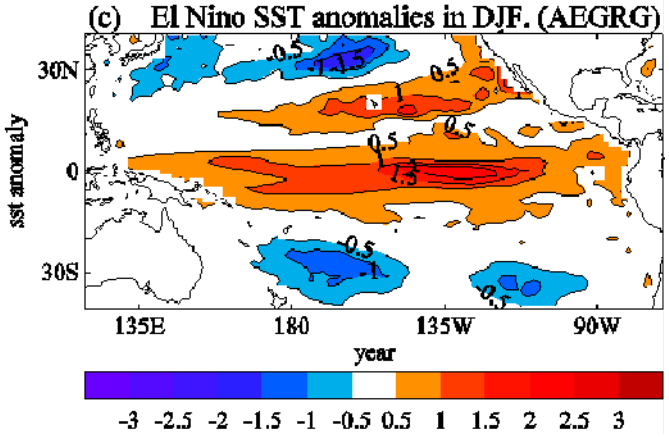
Observations: HadISST



HadGEM1a



HadGEM1



Tropical Variability: Southern Oscillation

Correlation of Niño3 SST with Southern Oscillation Index

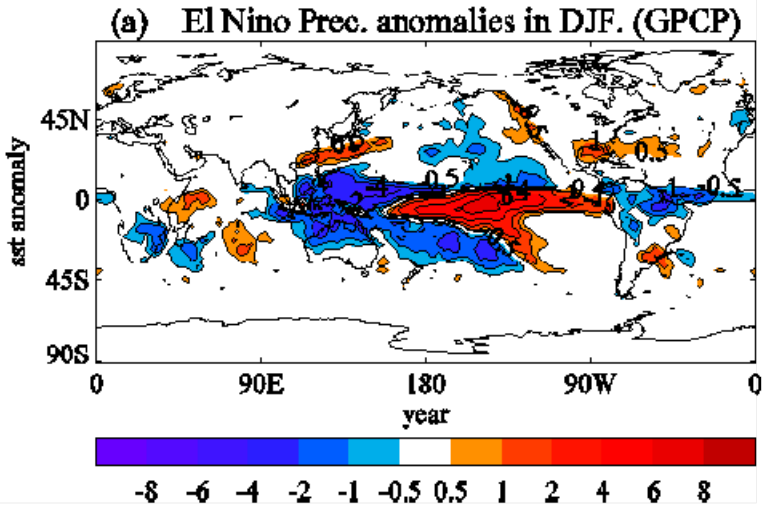
Observations	- 0.60
HadCM3	- 0.41
HadCEM	- 0.46
HadGEM1	- 0.24
HadGEM1a	- 0.35

HadGAM1 -0.61 (atmospheric model with specified SSTs)

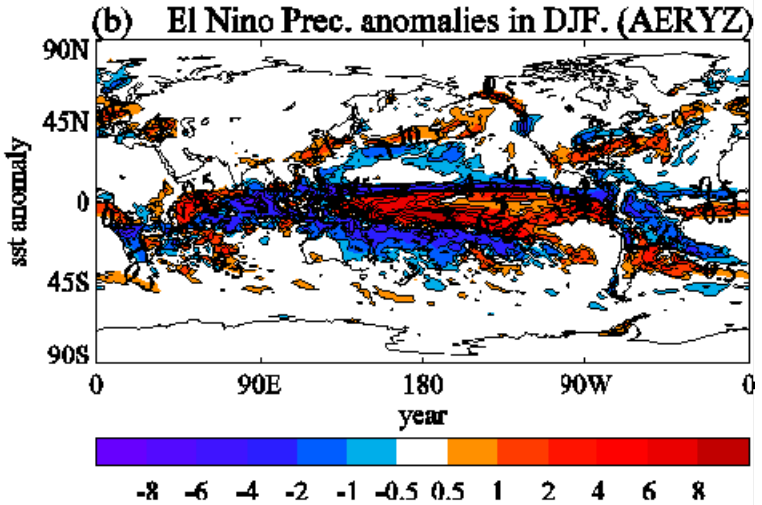
CMIP Models, non flux adjusted, range is: -0.25 to -0.5

El Nino Precipitation anomalies: DJF

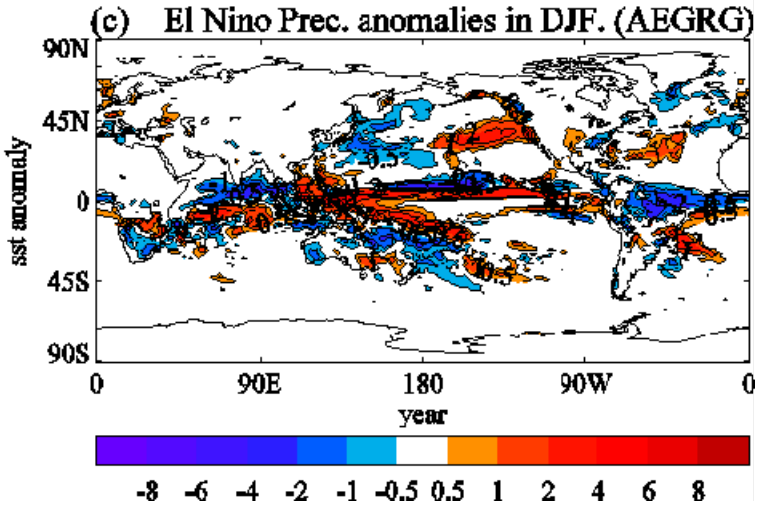
Observations: GPCP



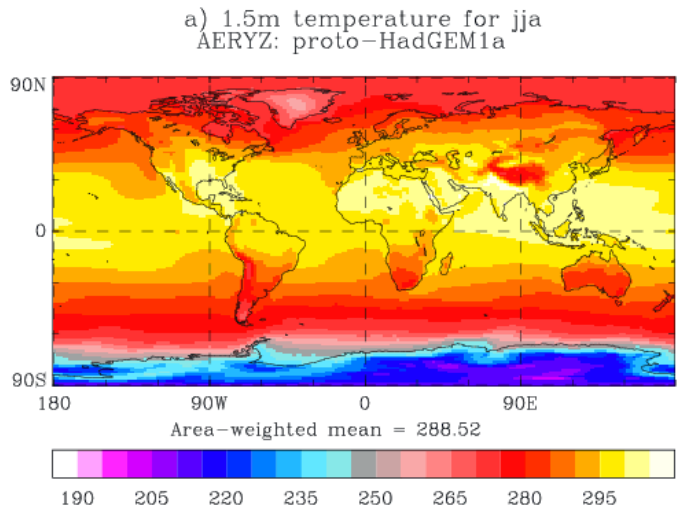
HadGEM1a

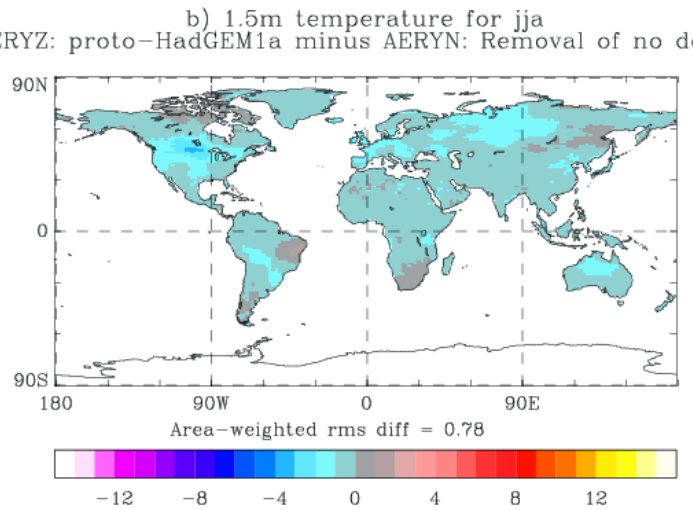


HadGEM1

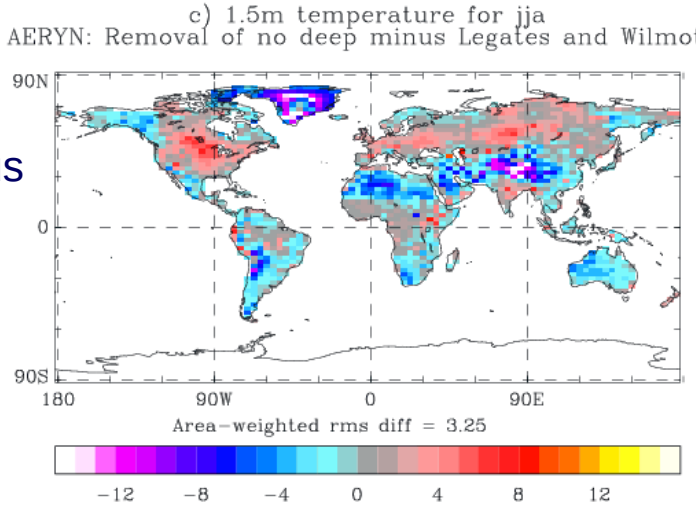


Recent HadGEM1a: JJA land surface temperature bias

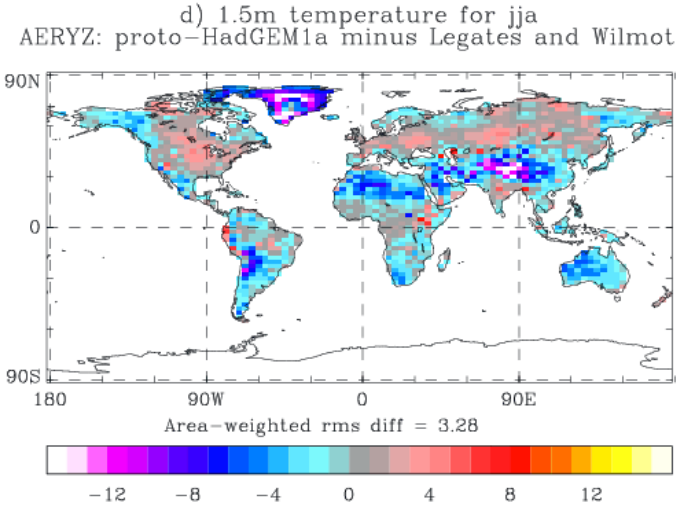




'Impact of biogenic aerosol + dust



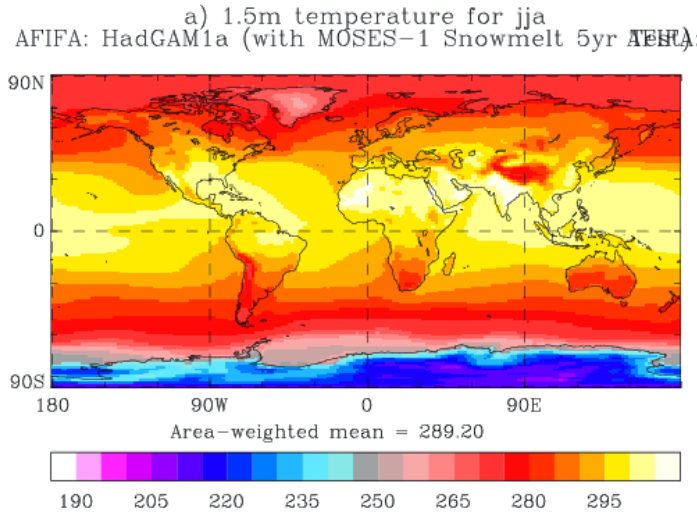
Previous - clim

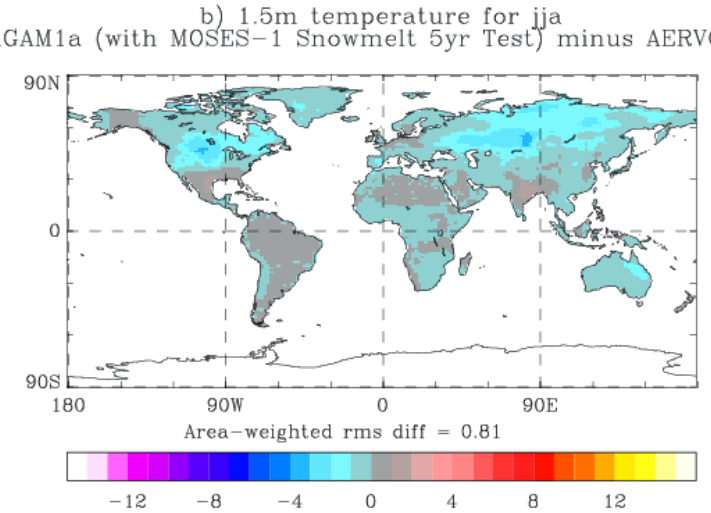


Recent - clim

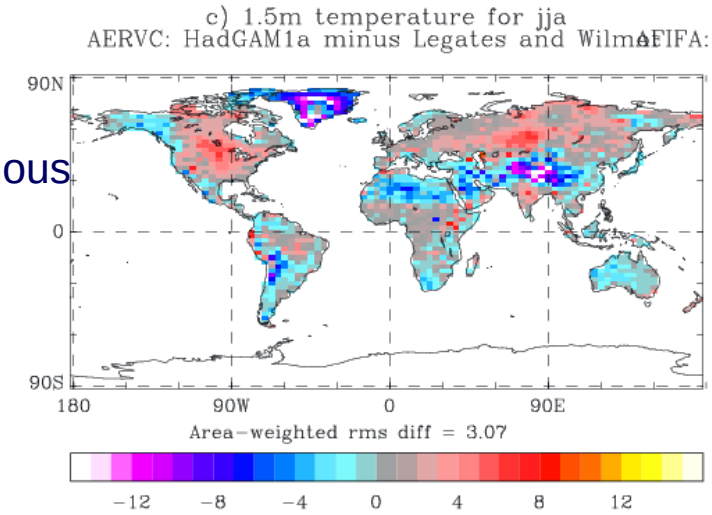
0800

Latest HadGAM1a: JJA land surface temperature bias

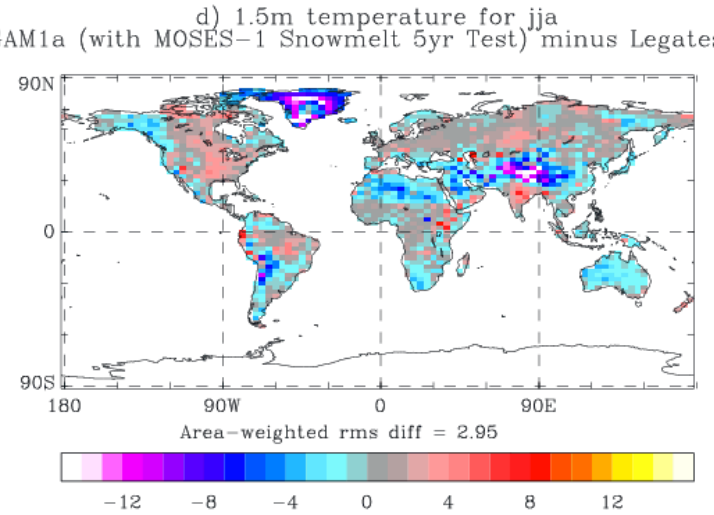




Impact of MOSES-1 snowmelt



Previous - clim



Latest - clim

0800

Summary: HadGEM model developments and Stream 2

- An improved physical model “HadGEM1a” has been developed and is being tuned now.
- HadGEM1a is expected to be a suitable physical basis for the HadGEM2 Earth System Model (“HadGEM2ES” including carbon cycle and chemistry), which is already under development.
- Ideally we would like to use the HadGEM2ES full Earth System Model for Stream 2 runs, as this would contribute to AR5 goals. However, the full model (including CC plus chemistry) is unlikely to be ready in time for ENSEMBLES (and will be too expensive on our current supercomputer). Instead, the HadGEM2 physical model (including the improvements, eg. aerosols, compared to HadGEM1) could be used (maybe including some runs with the CC, in year 4 of ENSEMBLES?).
- Note also that the HadGEM2 physical model (including aerosols) will form the basis for our improved seasonal forecast model in ENSEMBLES.

METO-HC contribution to ENSEMBLES Stream 2

A: physical system (atmos, ocean, ice)	Probably not – as HadGEM2 includes aerosols as standard
B: aerosol system (A + aerosol model)	Yes – HadGEM2 (emission scenarios to be decided)
C: carbon cycle (A + carbon cycle, with/without dyn. vegetation maps)	Possibly – if HadGEM2ES is ready in time (carbon cycle sensitivity experiments including aerosols)
D: atm. chemistry (A + atm. chemistry)	Unlikely – HADGEM2ES with chemistry may not be ready in time (and too expensive)
E: other, specify?	Possibly – other HadGEM2ES sensitivity experiments