

What are the Patterns of Climate Change that Threaten the Amazon Biome?

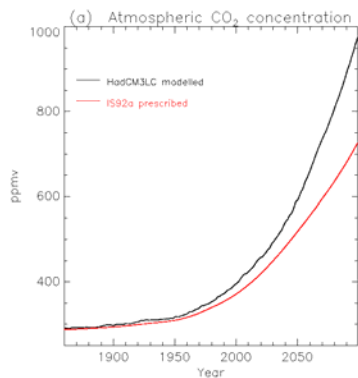
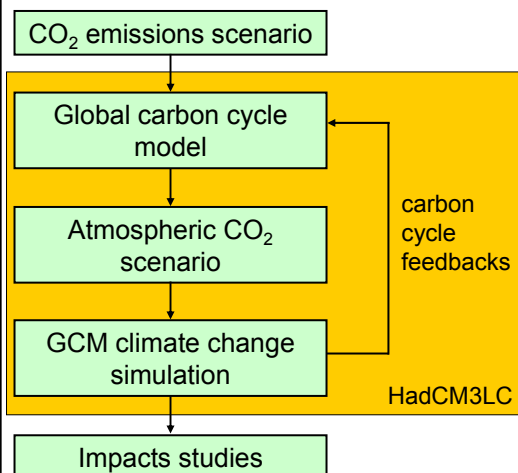
Phil Harris¹, Peter Cox², Chris Huntingford¹

¹ Centre for Ecology and Hydrology, Wallingford

² School of Engineering, Computer Science and Mathematics, University of Exeter



Coupled climate-carbon cycle modelling

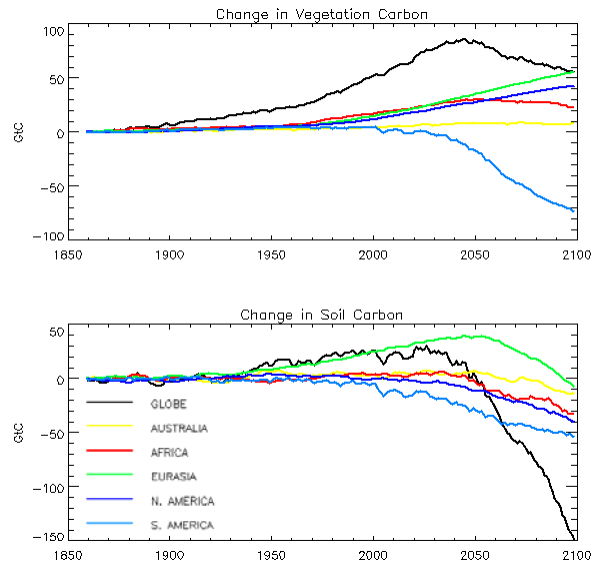


Hadley Centre model, HadCM3LC
Following Cox *et al.* (2000)

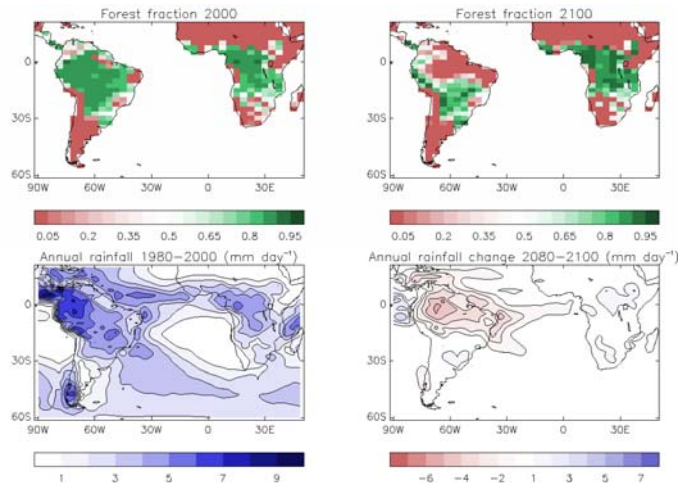


Terrestrial carbon reservoir

- Global loss of 145 GtC (8%) from terrestrial reservoir
- Amazon basin loss of 72 GtC (80%)



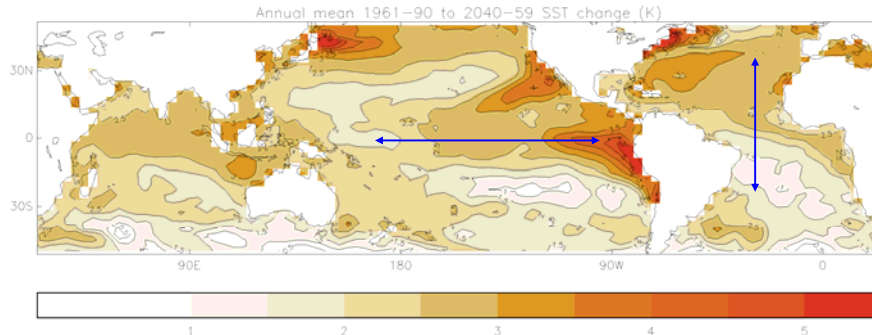
From C. Jones, Met Office



- Corresponds to loss of Amazon forest
- Betts et al (2004) estimate that climate-carbon cycle feedbacks enhance drying by 40%
- What forces the drying without feedbacks?



HadCM3LC sea surface temperature (SST) change



1. Global mean SST warming
 2. "El Niño-like" Pacific SST change (east-west gradient)
 3. North-South gradient in Atlantic SST change
- Use atmosphere model (HadAM3) to assess response to the SST changes



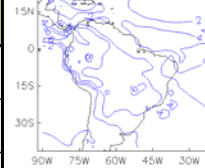
SST forcing: annual mean results

Experiment	Rainfall (mm day ⁻¹)	1.5m T (°C)	Top 3m SMC (mm)	NPP (Mg ha ⁻¹ yr ⁻¹)
Control	5.34	25.3	913	12.2
HadCM3LC	-1.39	+4.7	-78	-4.4
Mean warming + gradients	-1.11	+5.4	-91	-6.3

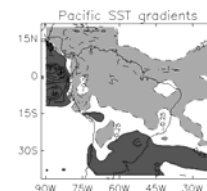
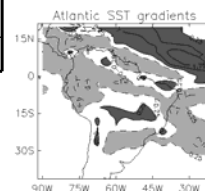
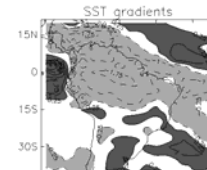
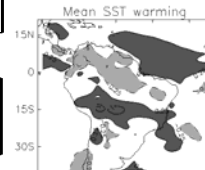
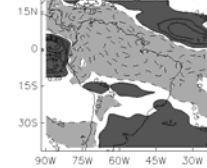
Mean warming only	+0.01	+3.5	-12	-2.8
Gradients only	-1.16	+1.8	-92	-3.6

ATL gradients	-0.33	+0.5	-24	-1.1
PAC gradients	-0.58	+1.0	-43	-1.6

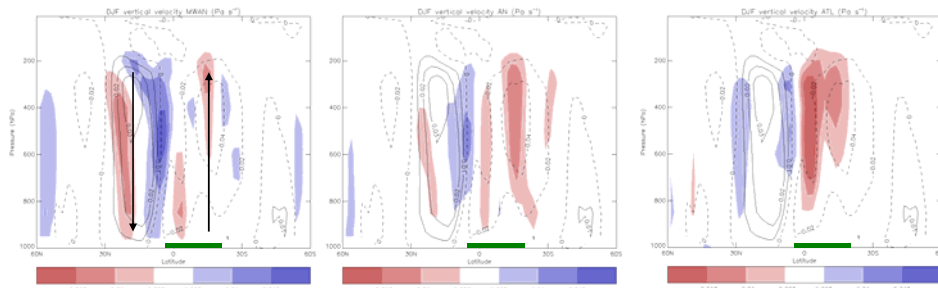
HadAM3 annual rainfall (mm/day)



Future (2040-59)

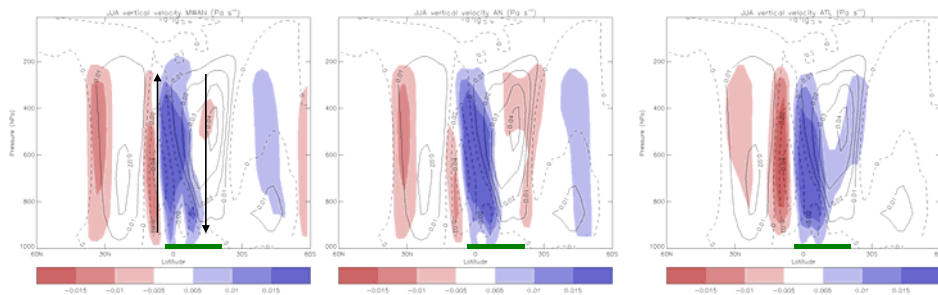


Wet season (DJF): Hadley cell (70-50W)



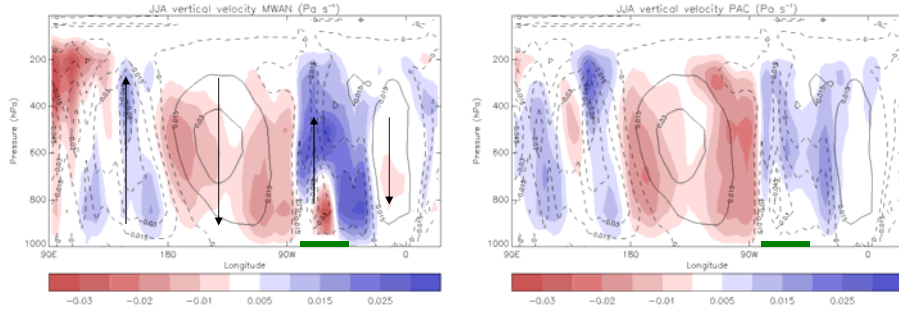
- Atlantic SST gradient strengthens Atlantic Hadley cell and South American monsoon
- Pacific SST gradient inhibits enhanced convection over equatorial Amazon through Walker cell weakening

Dry season (JJA): Hadley cell (70-50W)



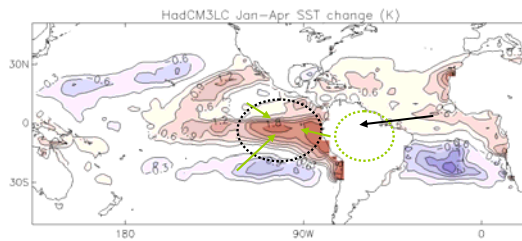
- Atlantic SST gradient change strengthen Atlantic ITCZ
- Inhibits convection over equatorial Amazon

Dry season (JJA): Walker cell (7S-7N)



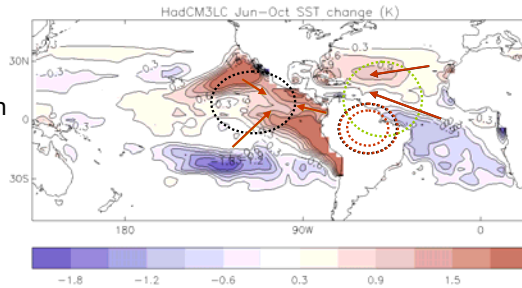
- Pacific SST gradient change weakens Walker cells
- Inhibits deep convection over equatorial Amazon and Atlantic

Monsoon season



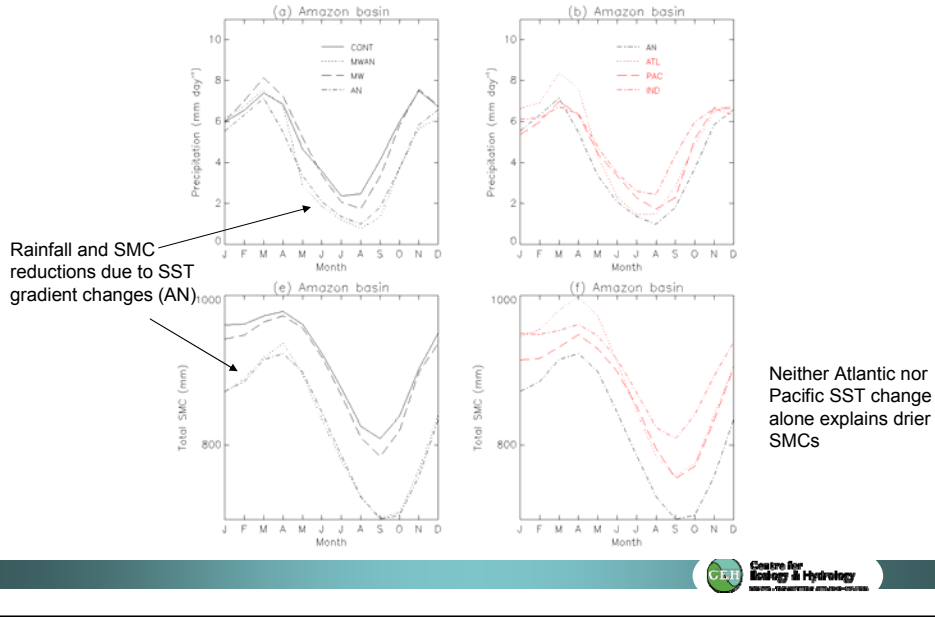
- Atlantic SST anomalies
- Pacific SST anomalies
- Net effect

Dry season

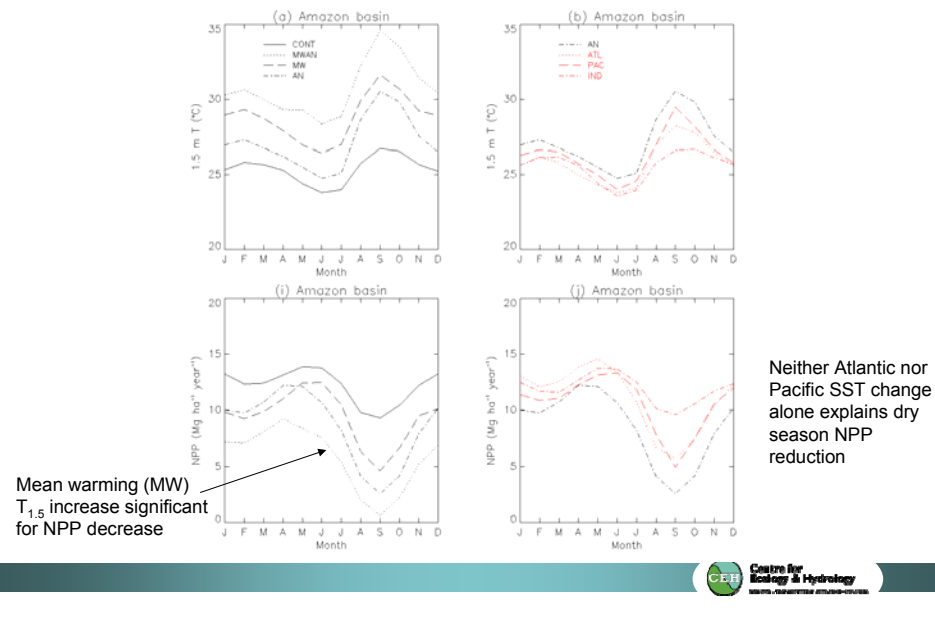


Reduced Rainfall

Amazon basin climate in HadAM3: rainfall and soil moisture

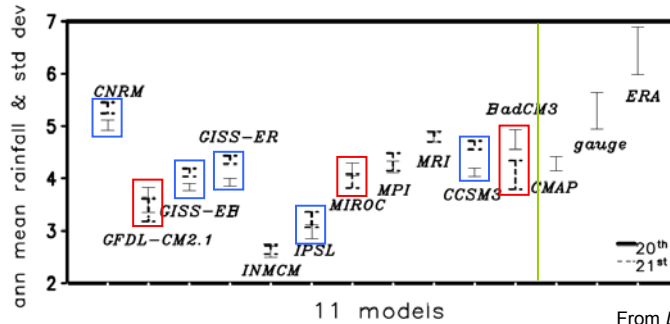


Amazon basin climate in HadAM3: $T_{1.5}$ and NPP



Amazon climate change in other GCMs

- This is one model only
- IPCC AR4 models exhibit great differences in Amazon rainfall response (Boulanger et al, 2006; Li et al, 2006)
- P increase (5 models), little change (3 models), decrease (3 models)



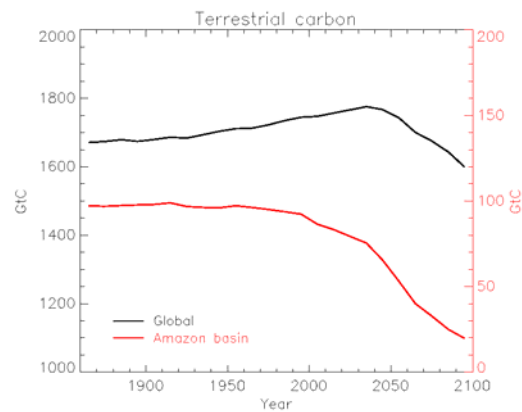
Summary

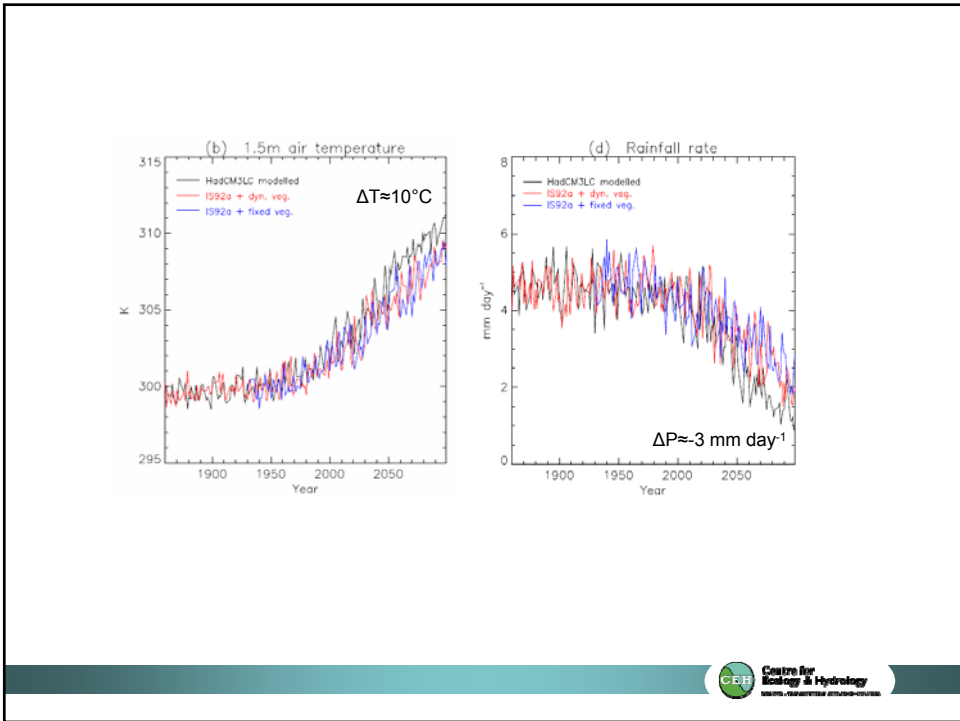
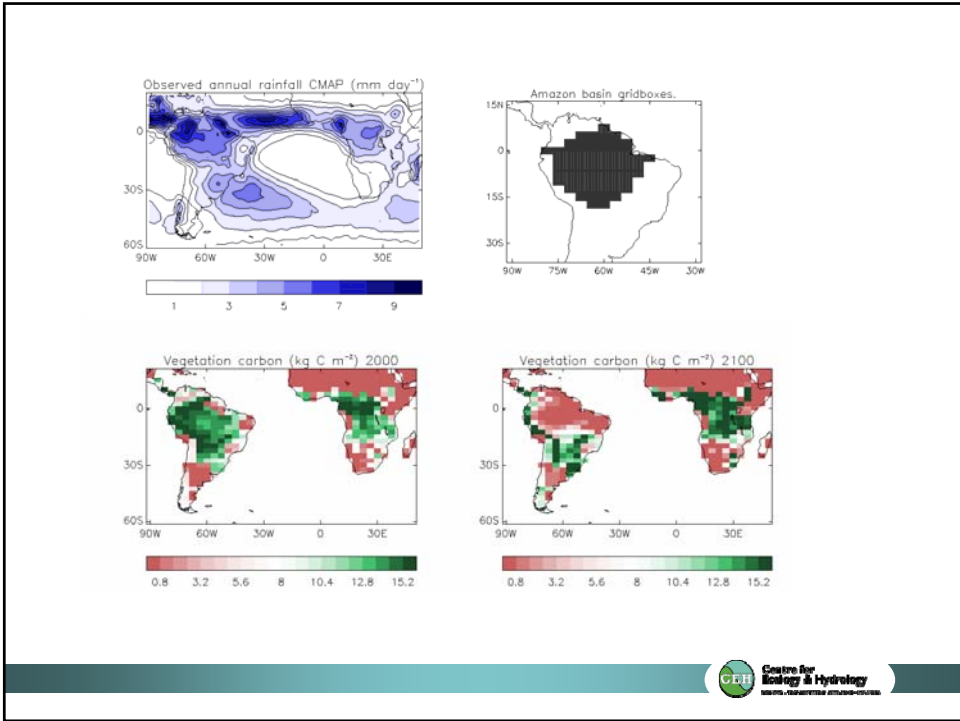
- Strength of rainfall and NPP reductions require the presence of
 1. Mean warming of the tropics
 2. Atlantic north-south SST gradient change
 3. Pacific east-west SST gradient change
- Reasonably well-understood atmosphere response
- But reasons for HadCM3LC SST change uncertain - different models produce different patterns
- Dynamic vegetation models are a further source of uncertainty



References

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MOSES temperature response

