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THE ROLE OF CMIP IN CLIMATE RESEARCH FOR POLICY SUPPORT

Examples focusing on the changing water cycle and global warming hiatus

Richard Allan

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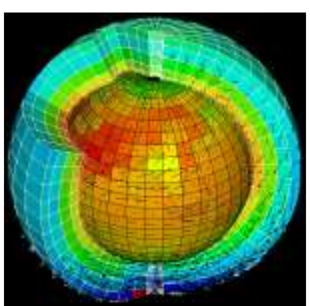
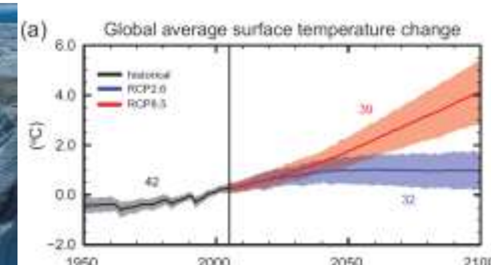
CMIP: THE COUPLED MODEL INTER-COMPARISON PROJECT

- CMIP provides a framework for coordinated climate change experiments using comprehensive global simulations
- CMIP provides a multi-model context for:

1. Assessing the mechanisms responsible for model differences in poorly understood feedbacks associated with the carbon cycle and with clouds
2. Examining climate predictability and exploring the ability of models to predict climate on decadal time scales, and, more generally
3. Determining why similarly forced models produce a range of responses

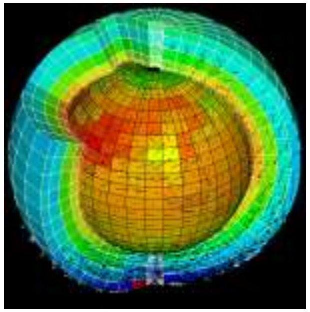


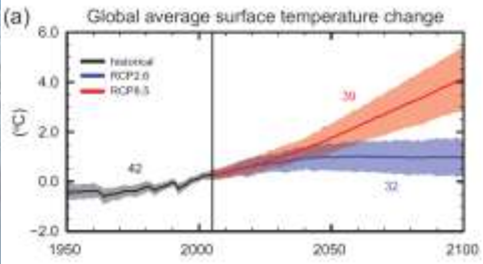




CMIP5: THE COUPLED MODEL INTER-COMPARISON PROJECT #5

- CMIP5 promotes standard set of model simulations in order to:
  - evaluate how realistic the models are in simulating the recent past
  - provide projections of future climate change on two time scales, near term (out to about 2035) and long term (out to 2100 and beyond)
  - understand some of the factors responsible for differences in model projections, including quantifying some key feedbacks such as those involving clouds and the carbon cycle





EXPERIMENTS…

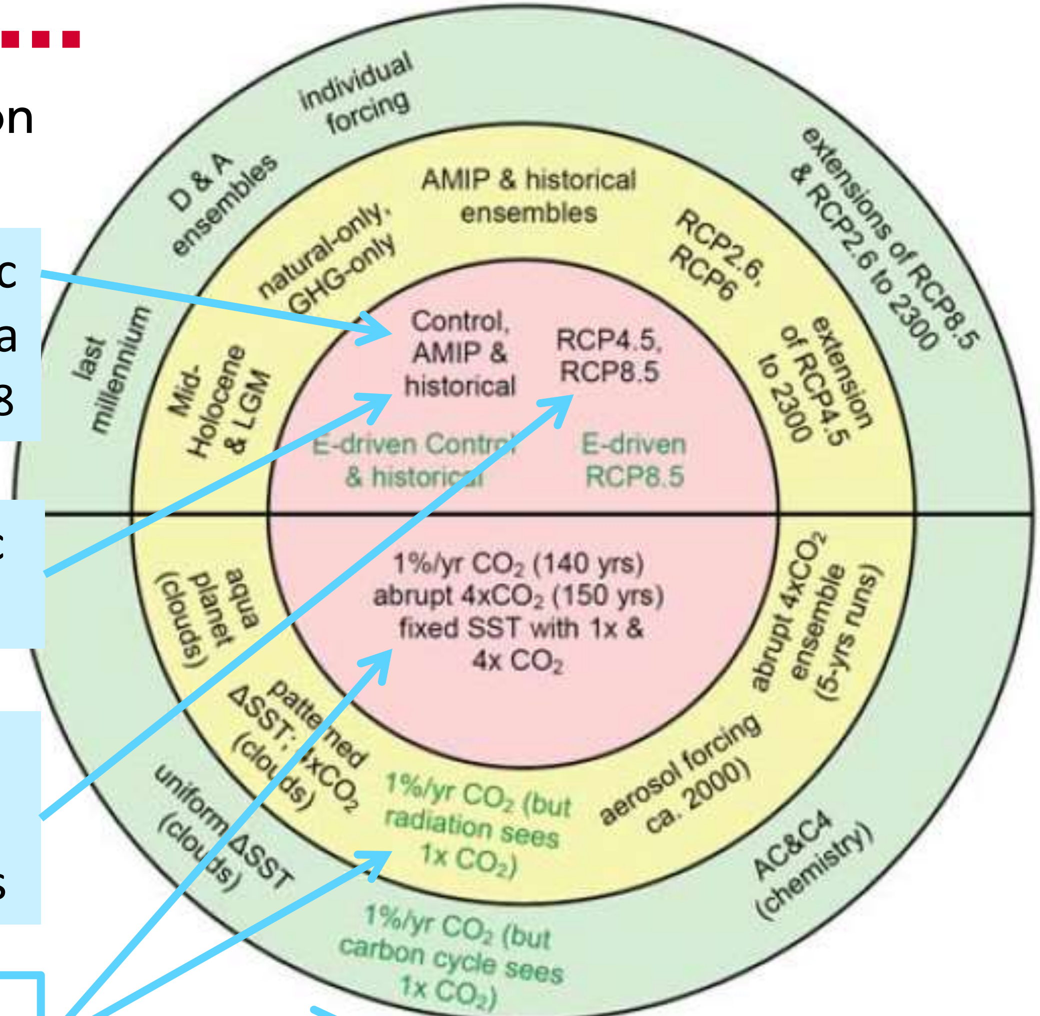
Coupled Model Intercomparison Project Phase 5: CMIP5

AMIP: Atmosphere-only; realistic past sea surface temperature/sea ice & radiative forcings 1979-2008

Historical: fully coupled, realistic radiative forcing 1850-2005

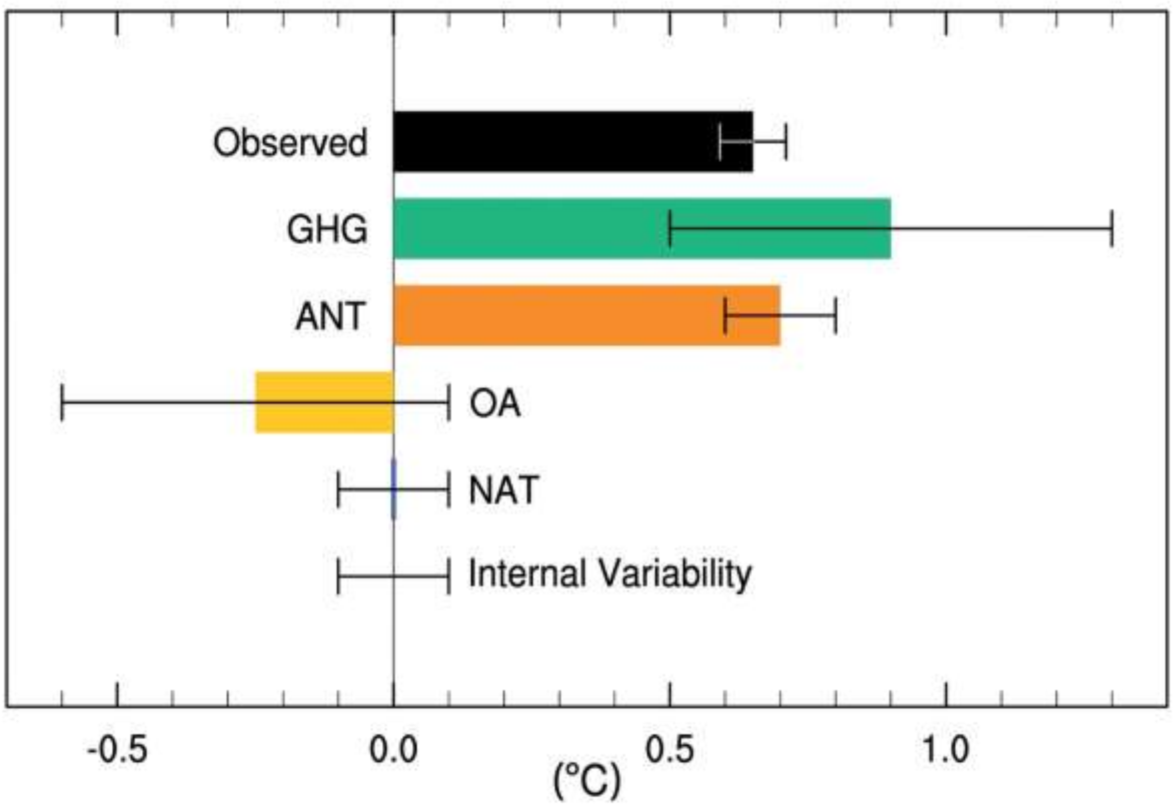
RCPs: fully coupled projections >2005 driven by representative concentration pathway scenarios

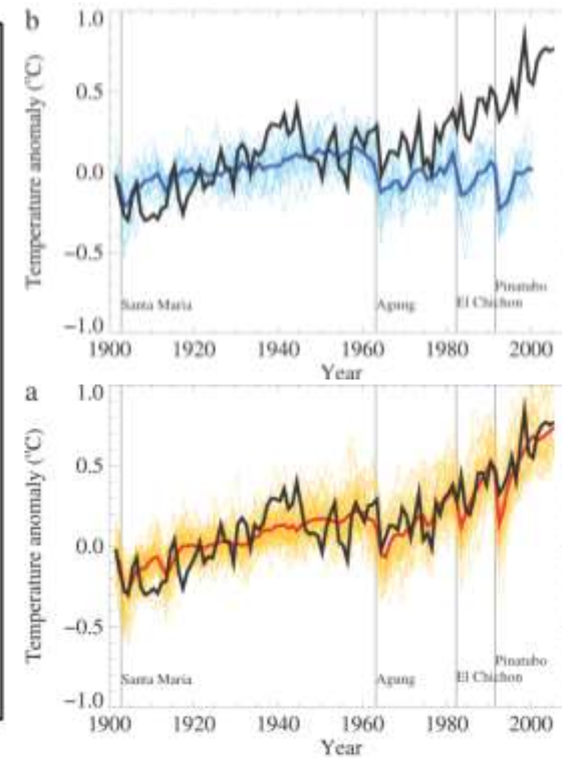
Many other flavours & idealised experiments (e.g. 1%/yr CO_2)



IPCC (2013) Fig. 9.1 (see also Table 9.1)

DETECTION & ATTRIBUTION





IPCC (2013) WG1 Fig. 10.5 (see also IPCC updates for schools)

IPCC: FUTURE PROJECTIONS

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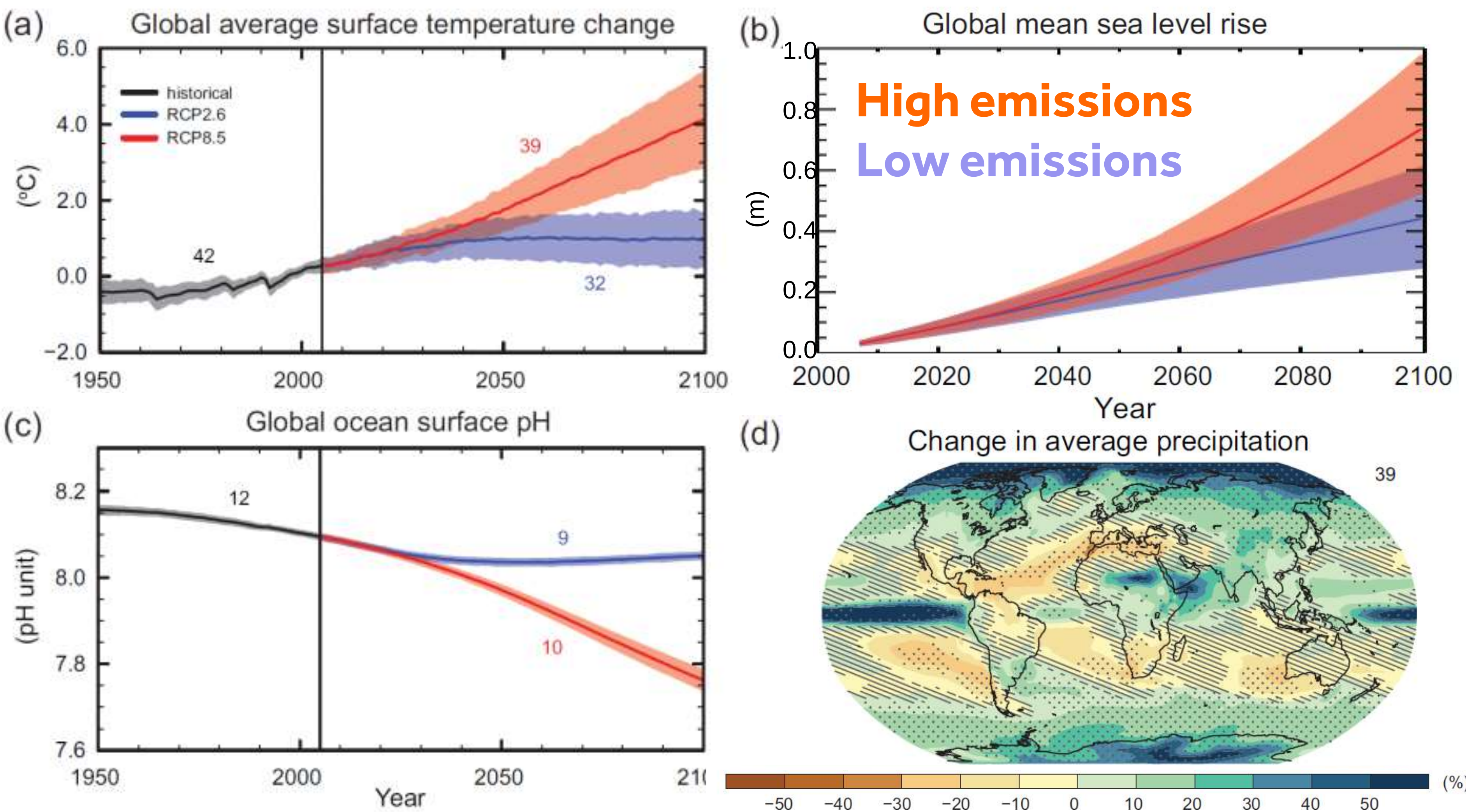
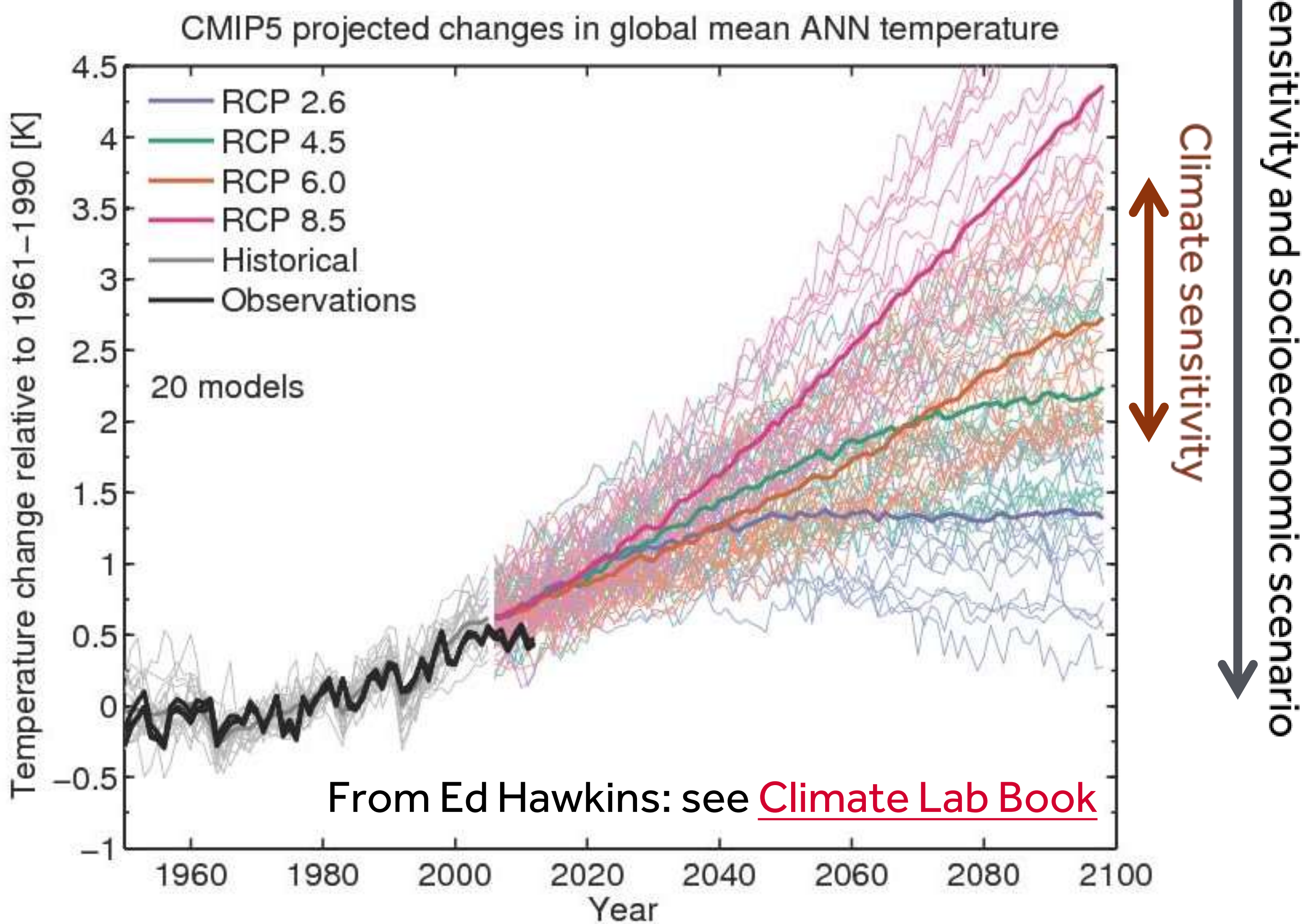


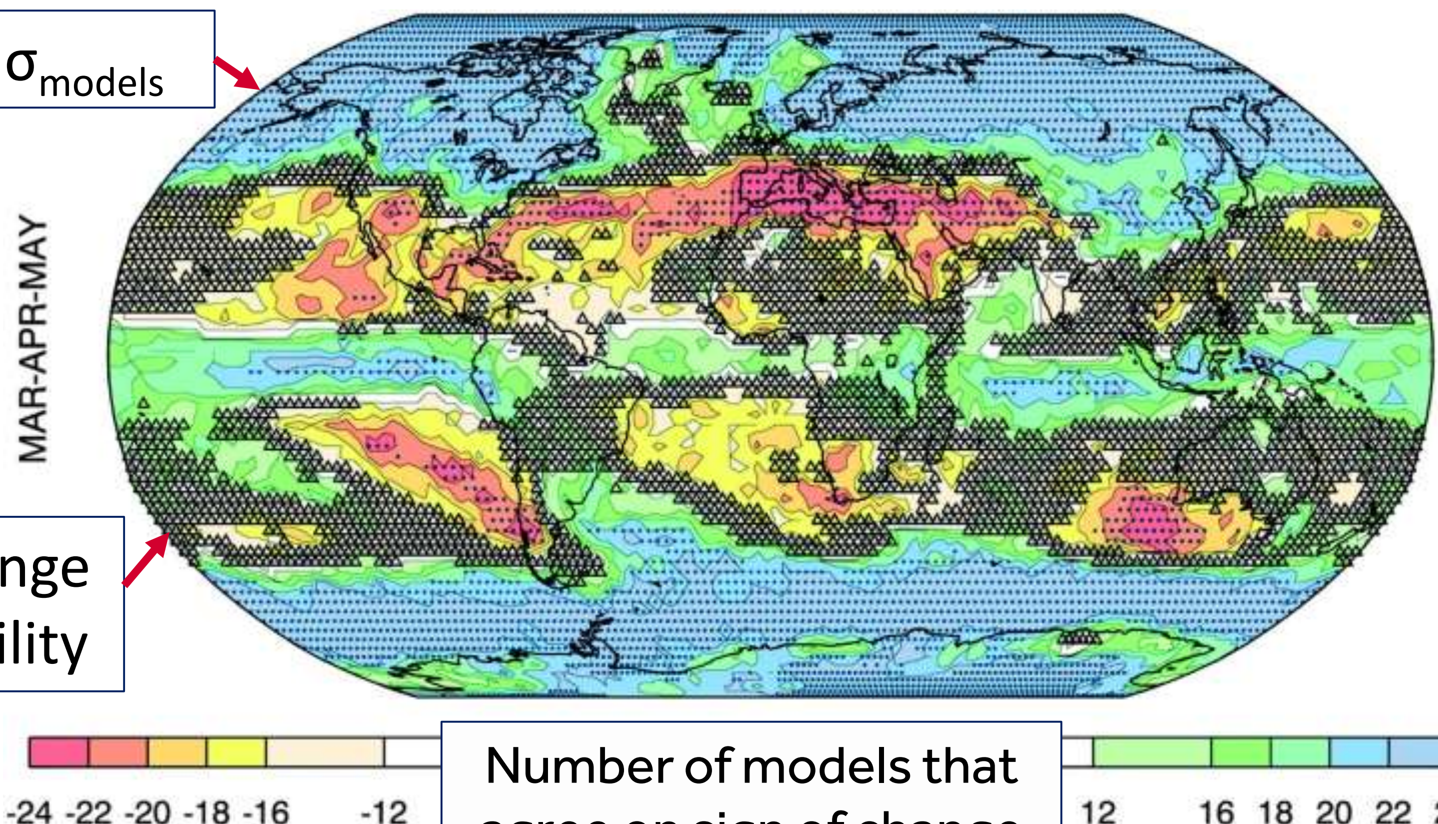
IPCC (2013) WG1 Summary for Policy Makers

UNCERTAINTY RANGES



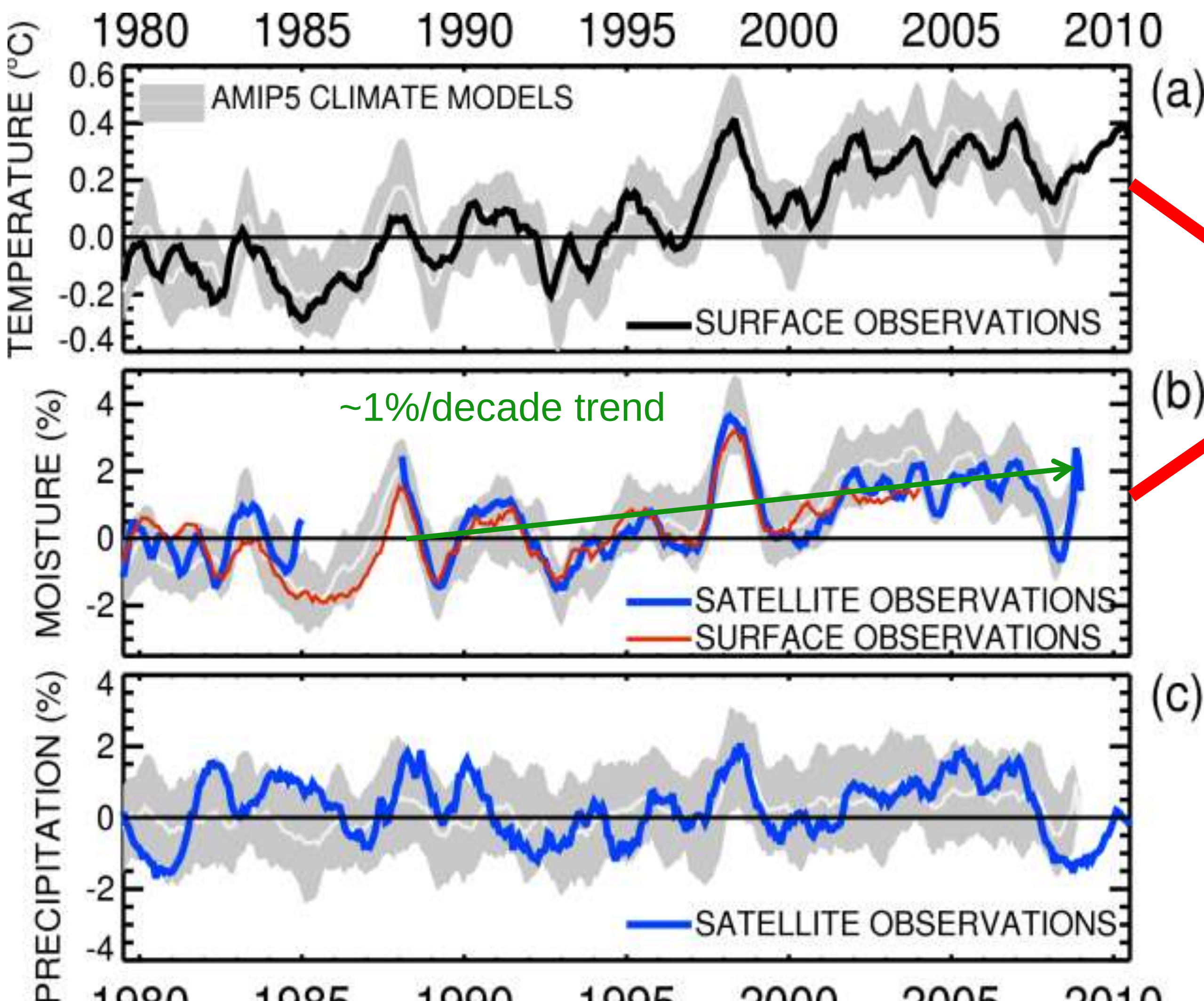
From Ed Hawkins: see Climate Lab Book

CHANGING PRECIPITATION:
WHERE IS BIG/SMALL CHANGE ROBUST?



[Power, et al. (2012) J. Climate]()

CURRENT CHANGES IN THE GLOBAL WATER CYCLE



Co-variation:
dW/dTs ~ 7%/°C

Adapted from:
Allan et al. (2014)
Surv. Geophys

CONTRASTING TRENDS IN TROPICAL PRECIPITATION

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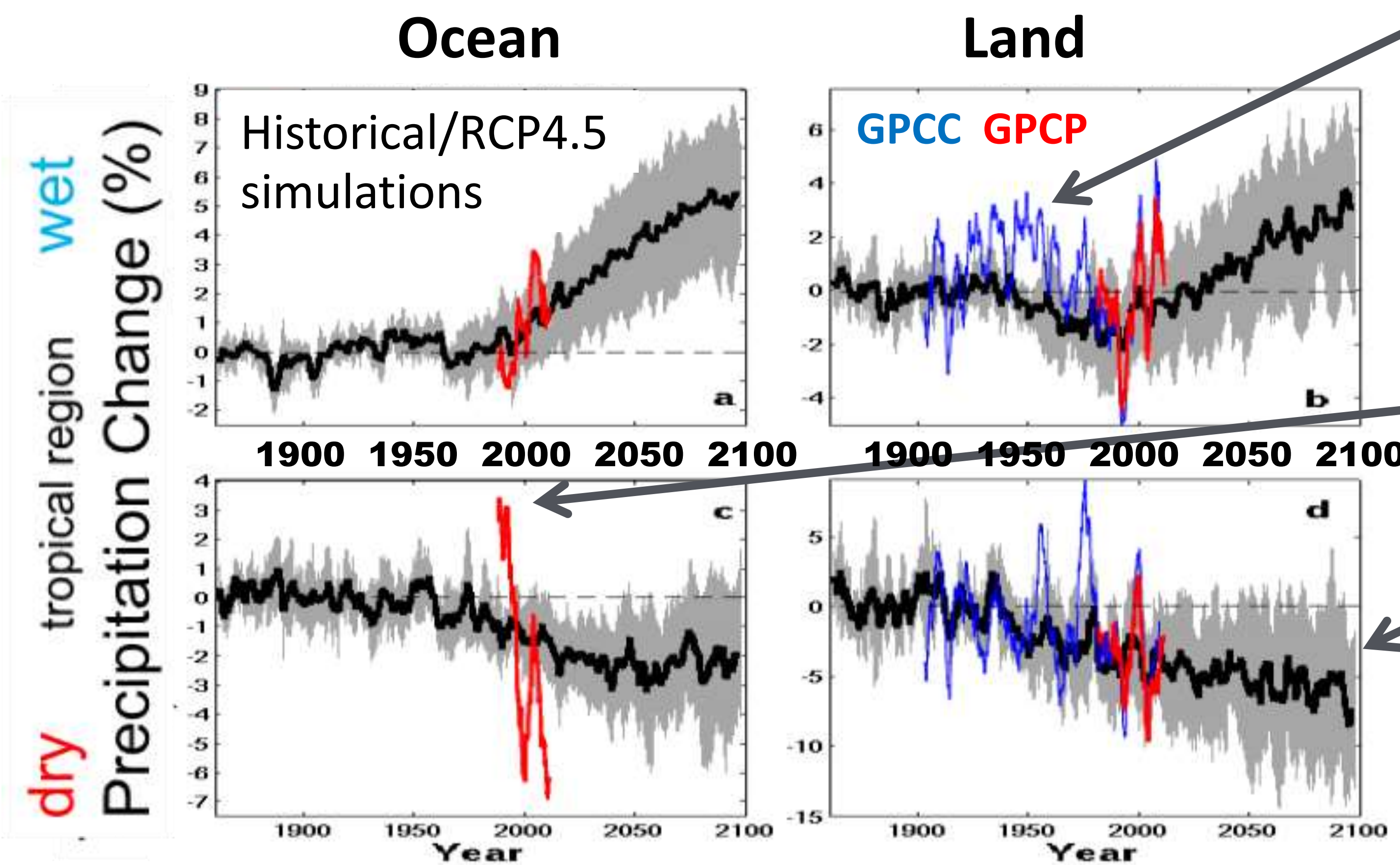
Changing water cycle



Discrepancy: wet tropical land

$$\frac{dP}{dT} \approx \alpha(P - \beta E)$$

Pre 1988 GPCP observations over ocean don't use microwave data

Robust drying of dry tropical land

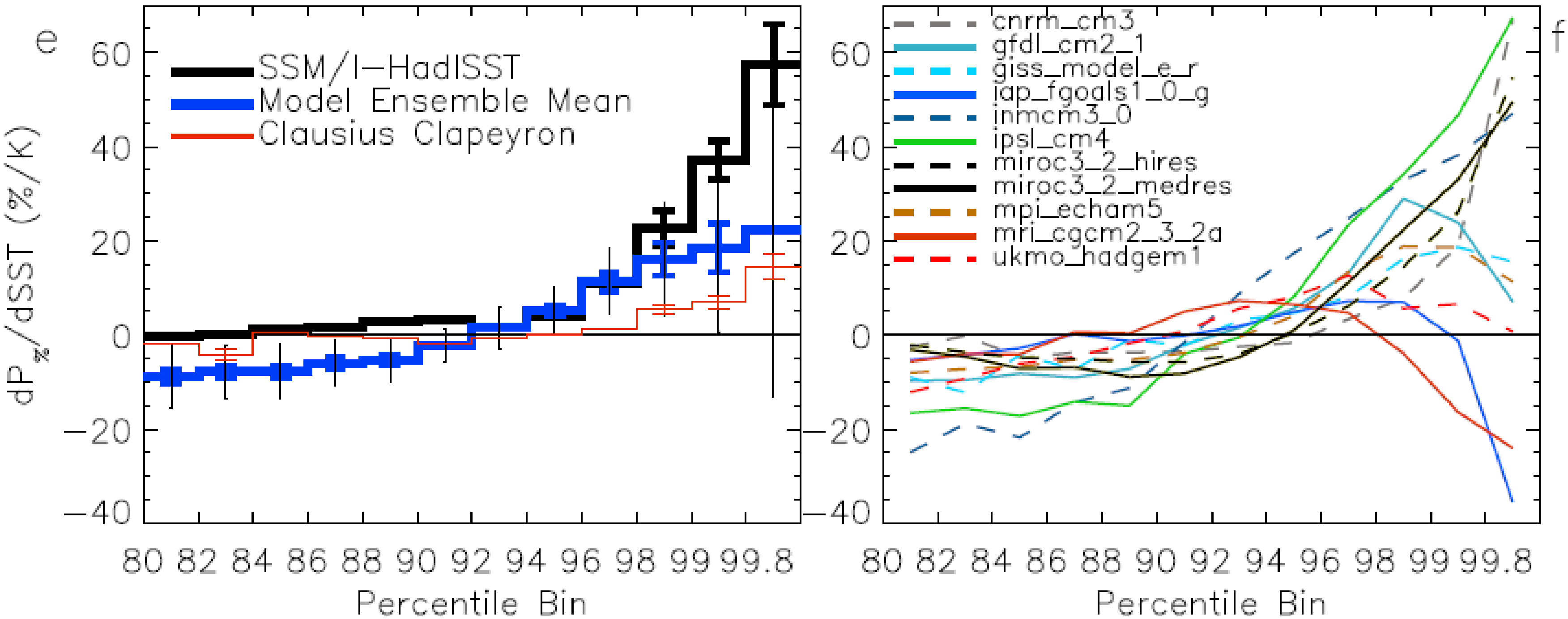
30% wettest gridpoints vs 70% driest each month

Liu and Allan (2013) ERL

See also Chadwick et al. (2013) J Clim; Greve et al. (2014) Nature Geosci.

EVALUATING RESPONSE OF EXTREME PRECIPITATION

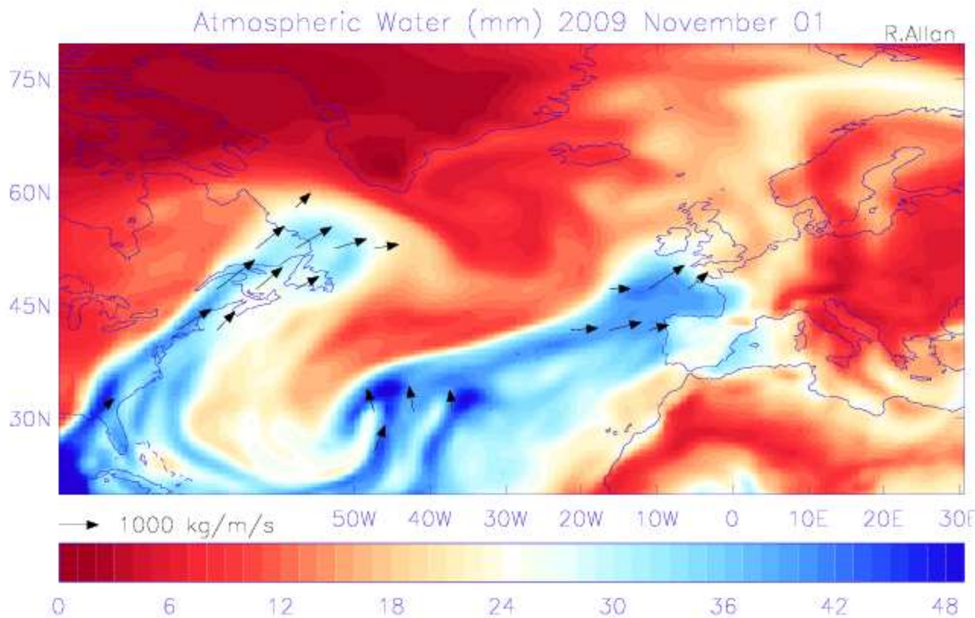
- Increase in intense rainfall with tropical ocean warming
- SSM/I satellite observations at upper range of models

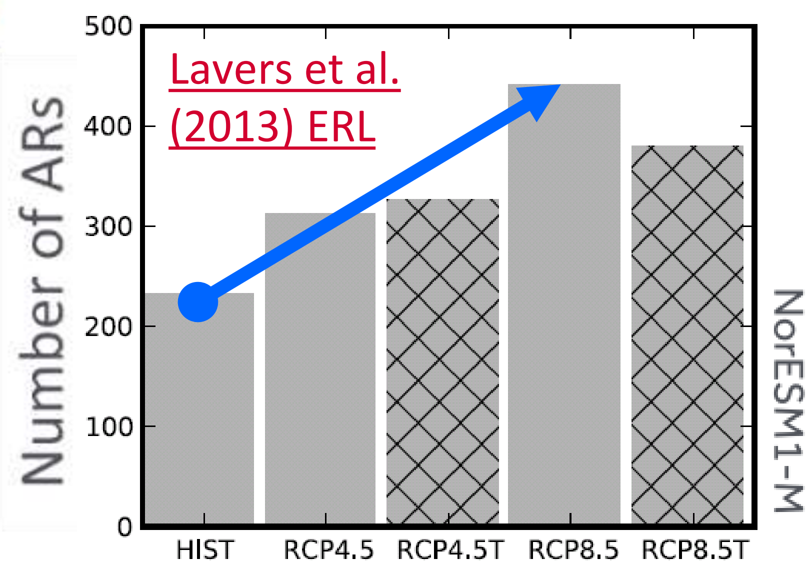


Allan et al. (2010) ERL; Allan and Soden (2008) Science

WATER VAPOUR AND MID-LATITUDE FLOODING

- UK winter flooding linked to strong moisture transport events
  - Cumbria November 2009 (Lavers et al. 2011 GRL)
  - "Atmospheric Rivers" (ARs) in warm conveyor



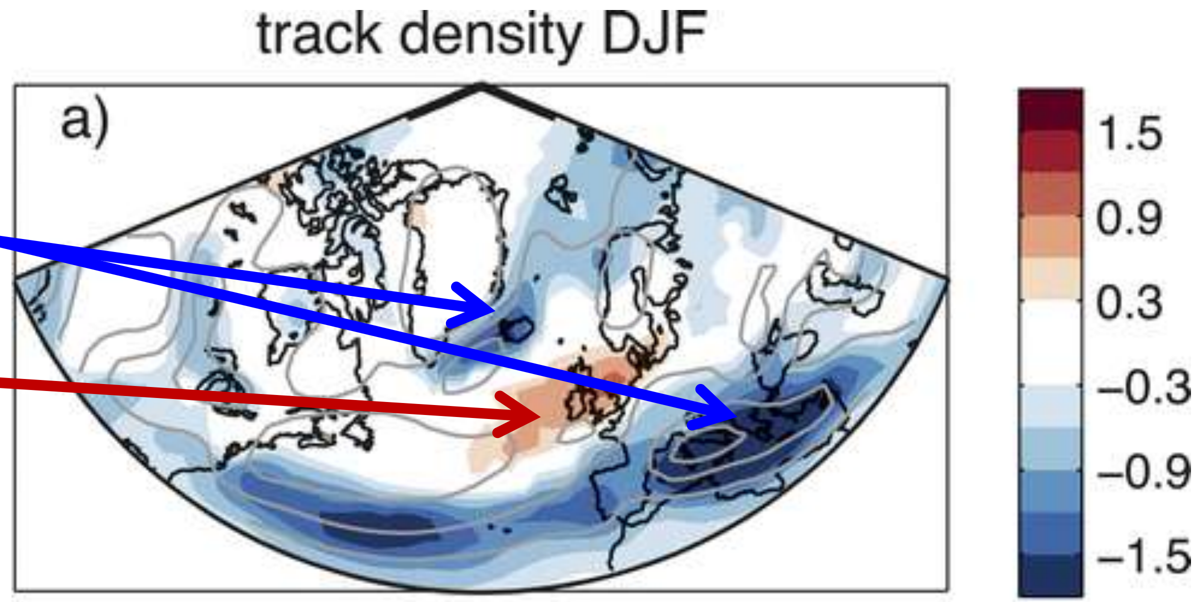


- Future increase in moisture explains most (but not all) of intensification of AR events
  - Confident in the mechanisms and physics involved

PROJECTED CHANGES IN STORMS

Fewer storms over Mediterranean and Iceland.
<u>UK: Little signal.</u>

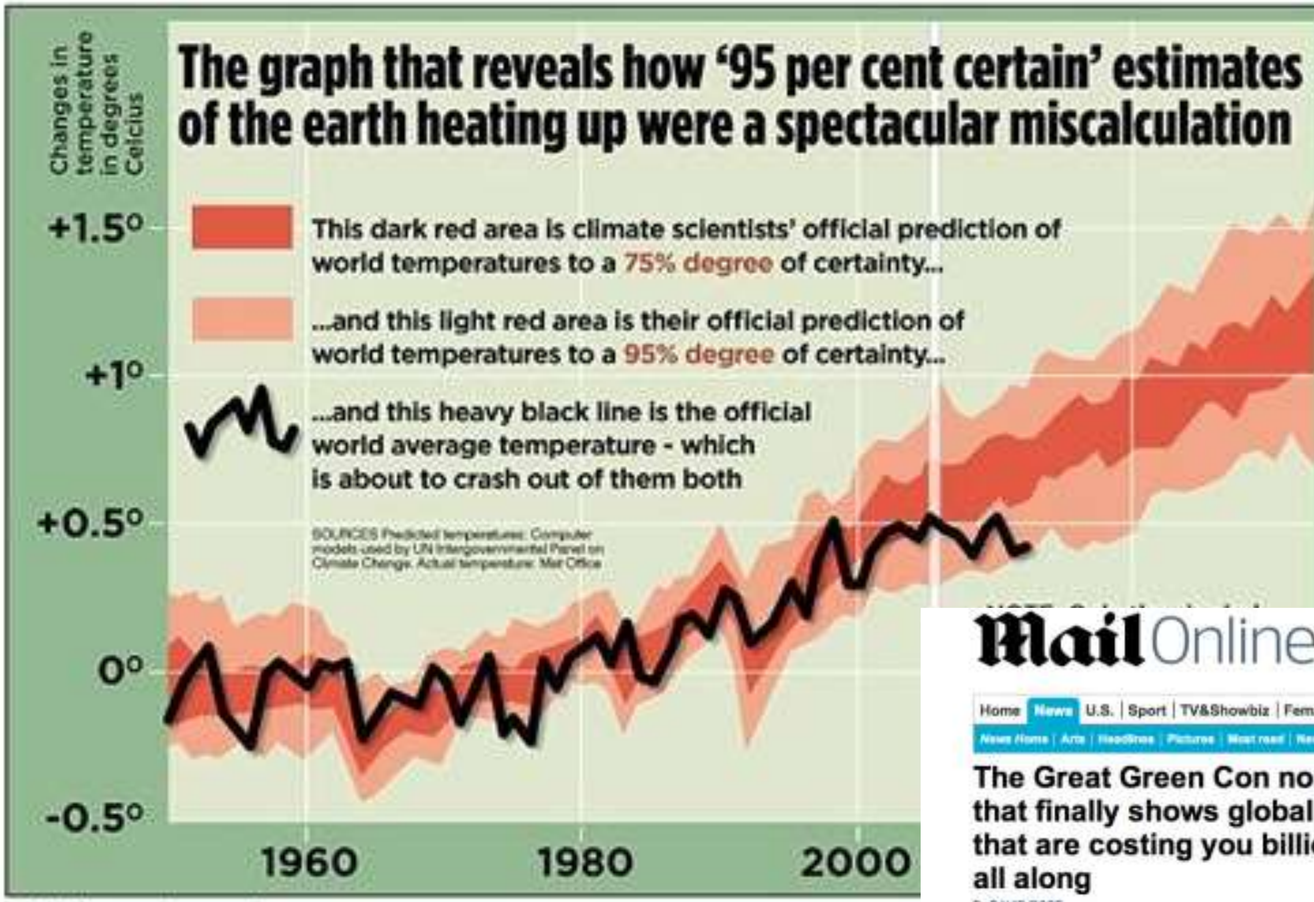
Robust signal: more extreme precipitation from all storms.



Zappa et al. 2013 J. Clim.

Changes in storm frequency (2070-2100 minus 1980-2005) from CMIP5 high-range emissions scenario.

HAS GLOBAL WARMING STOPPED?



[Mail on Sunday 16th March 2013](#)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The Great Green Con no. 1: The hard proof that finally shows global warming forecasts that are costing you billions were WRONG all along

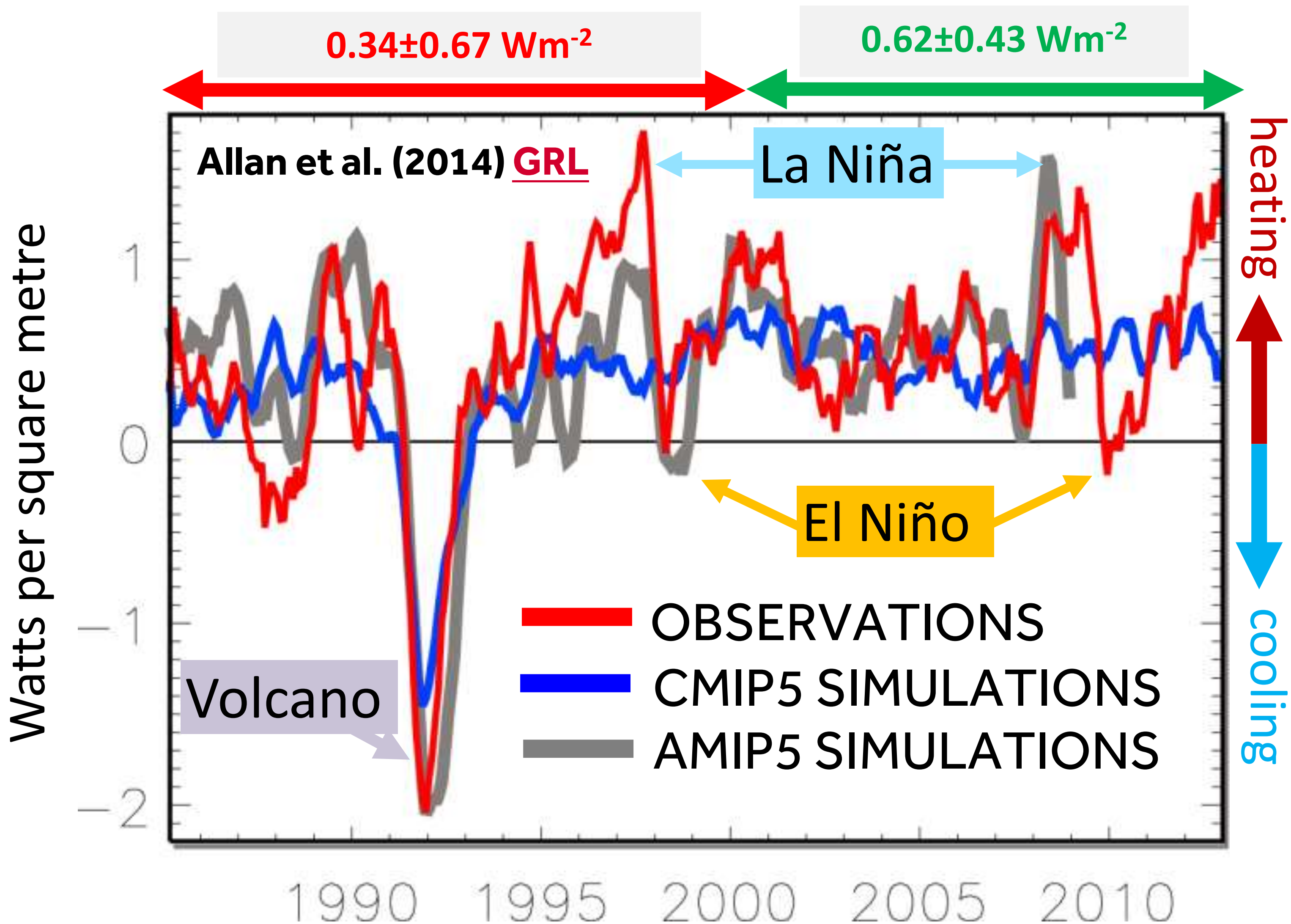
By DAVID ROSE

PUBLISHED: 23:37, 16 March 2013 | UPDATED: 13:41, 18 March 2013

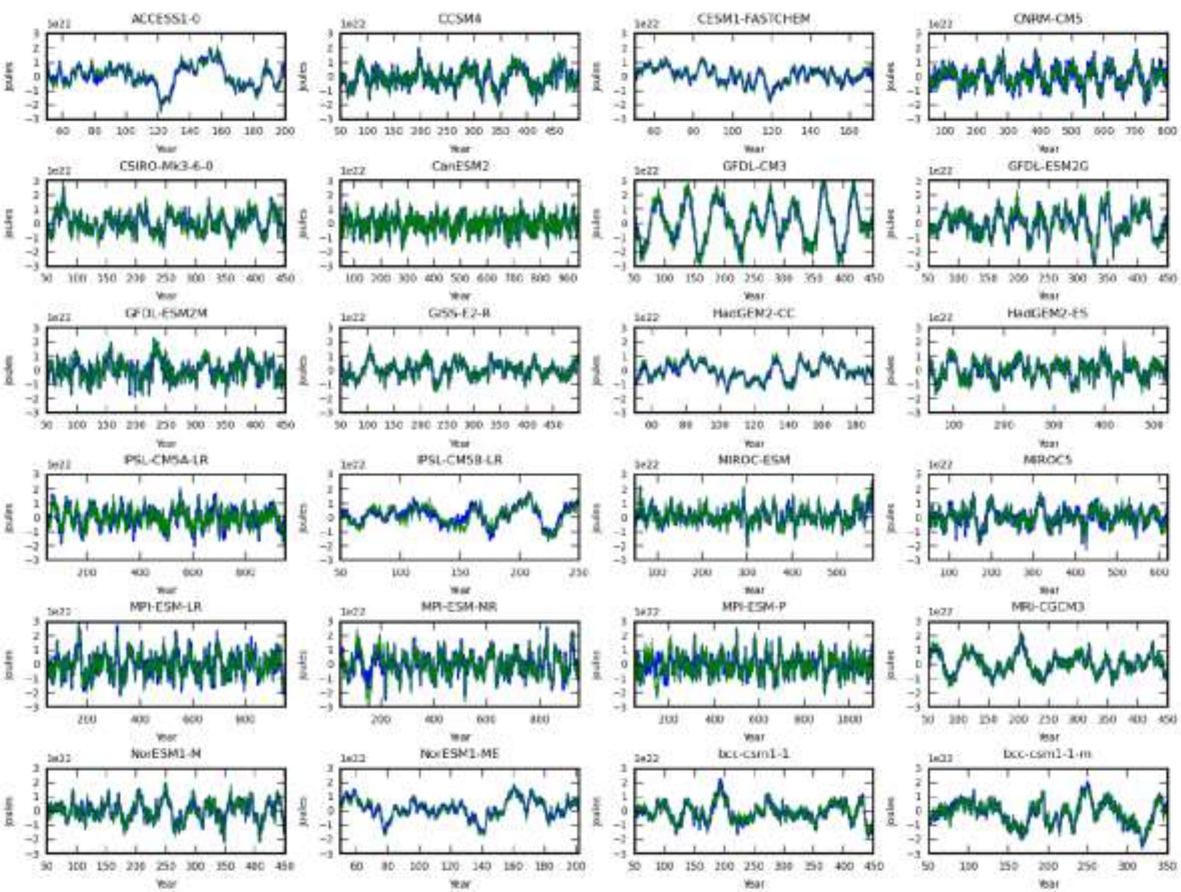
Comments (737) | Share | +1 | 60 | Tweet | 13

No, the world ISN'T getting warmer (as you may have noticed). Now we reveal the official data that's making scientists suddenly change their minds about climate doom. So will eco-funded MPs stop waging a green crusade with your money? Well... what do YOU think?

EARTH CONTINUES TO HEAT UP



UNFORCED VARIABILITY IN EARTH'S ENERGY BUDGET

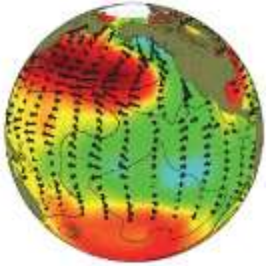


- Diverse range of unforced variability in CMIP5 pre-industrial control simulations
- **Left:** variations in total energy content of Earth's climate system across CMIP5 simulations

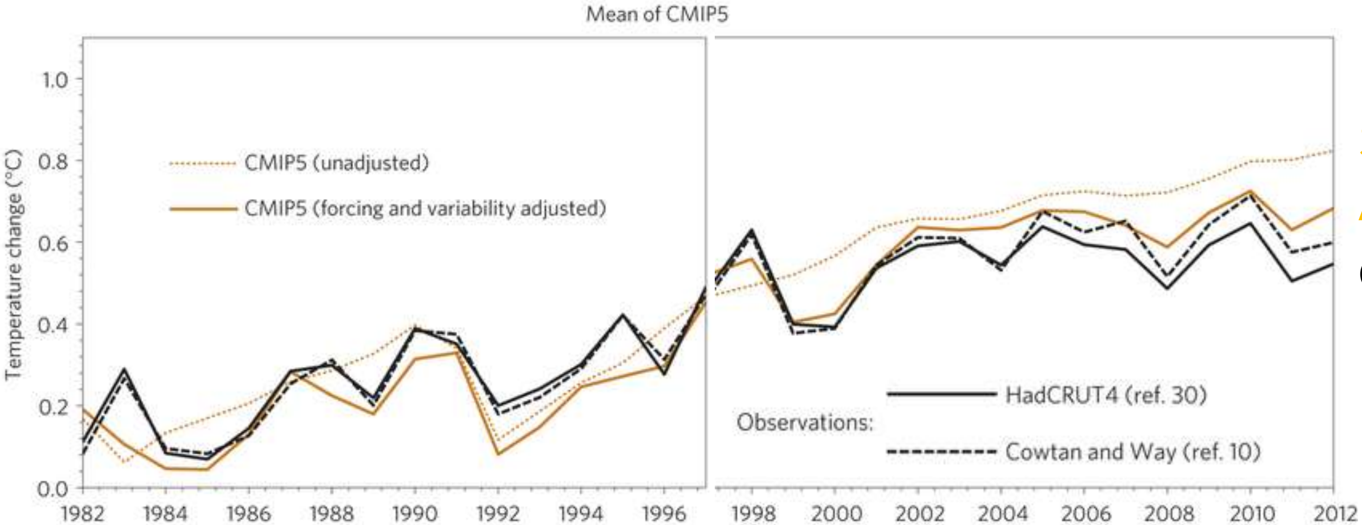
Palmer & McNeall (2014) ERL

LIMITLESS **POTENTIAL** | LIMITLESS **OPPORTUNITIES** | LIMITLESS **IMPACT**

WHAT EXPLAINS THE HIATUS?



- Declining solar forcing (e.g. Hansen et al. 2013 PLOSONE) , more small volcanos (e.g. Ridley et al. 2014 GRL) & more La Niñas/cold NH land in winter vs late 1990s appear to explain:
  - Slowing in surface warming (e.g. Foster & Rahmstorf 2012)
  - Slower surface warming compared with coupled simulations (e.g. Risbey et al. 2014 ; Huber & Knutti 2014)



Simulations

Adjusted Simulations

Observations

Huber & Knutti 2014

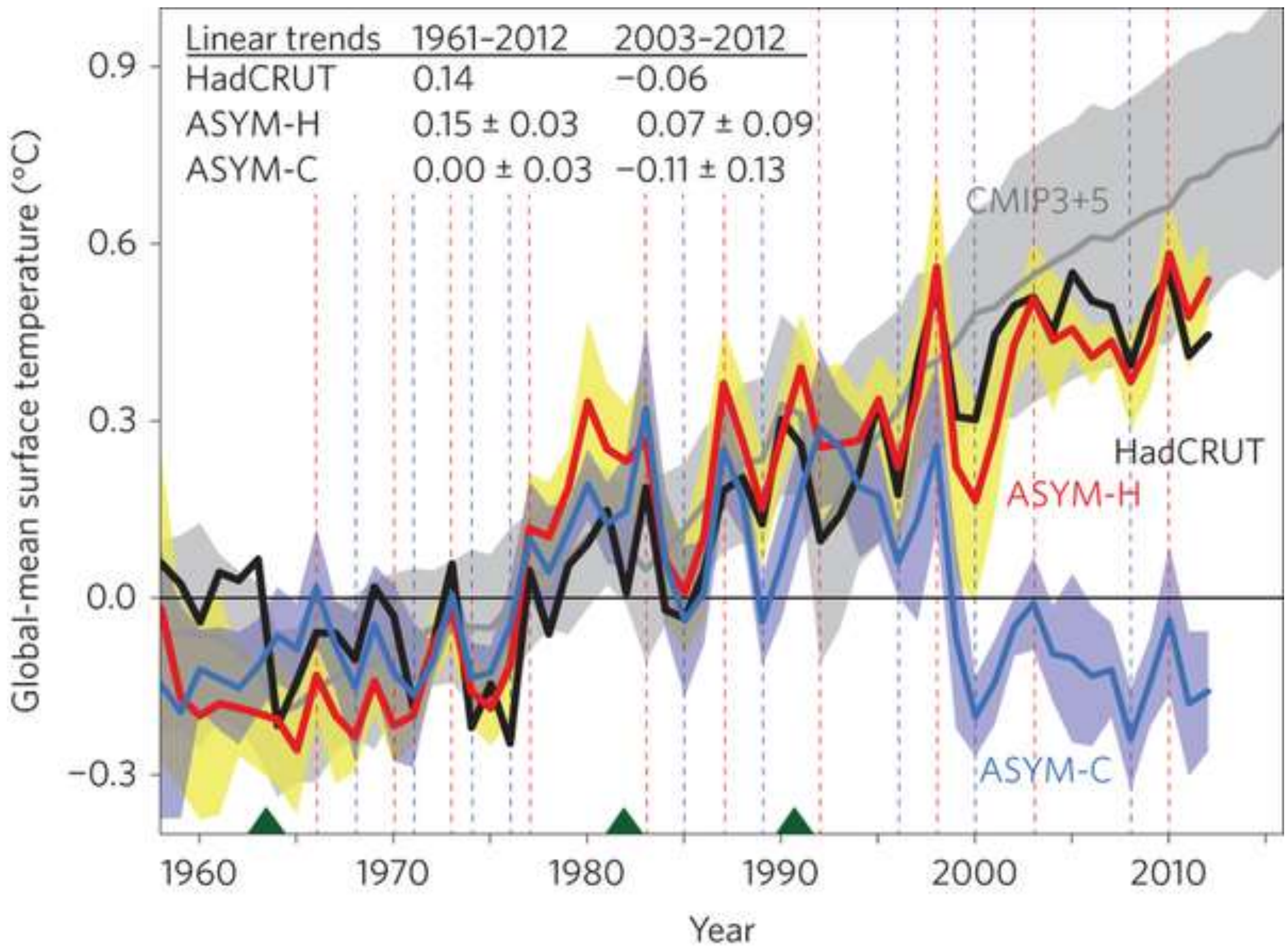
PATHWAYS TO POLICYMAKERS

- IPCC
  - Literature; Contributing and Lead authors
- DECC/EA – face to face meetings/web-based info
- Media
  - Press briefings/media events (e.g. Science Media Centre)
  - Planned or reactionary interaction
- Public Engagement
  - Stakeholder meetings (CWC program; Walker Institute Flooding conference)
  - Schools events, local interest groups?

CONCLUSIONS

- The CMIP5 database offers a huge resource to support policy advice through climate research
  - e.g. changing water cycle, global warming “hiatus”
- Combining with a robust physical basis and verifying with observations is a vital step in providing useful advice
- The IPCC is vital in collating, distilling and driving research that is policy relevant
- Clearly the analysis of comprehensive climate models is only one component of providing sound policy-relevant advice

ROLE OF PACIFIC TRADE WINDS IN HIATUS



Watanabe et al. (2014) Nature Climate Change:

- Prescribe observed changes in Pacific trade winds
- Estimate Internal variability contributes ~+0.11-0.13°C in 1980s/90s and -0.11°C in 2000s
- Is it all internal or is there a forced component?

Global context: changing water cycle

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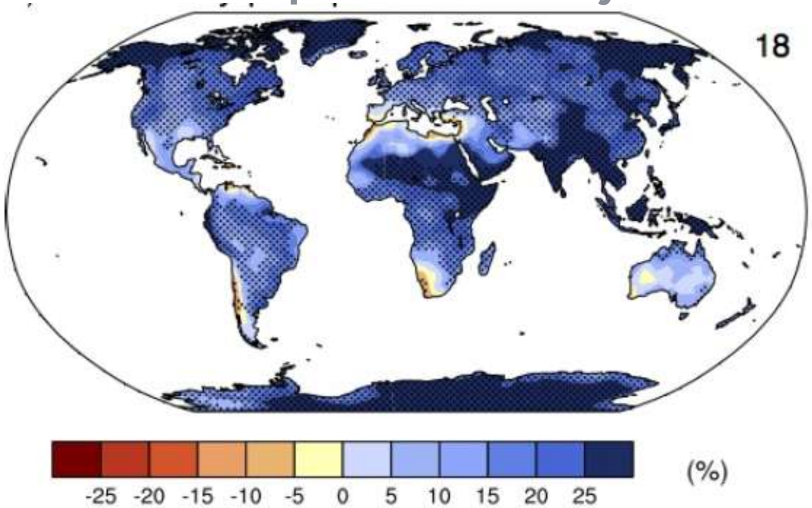
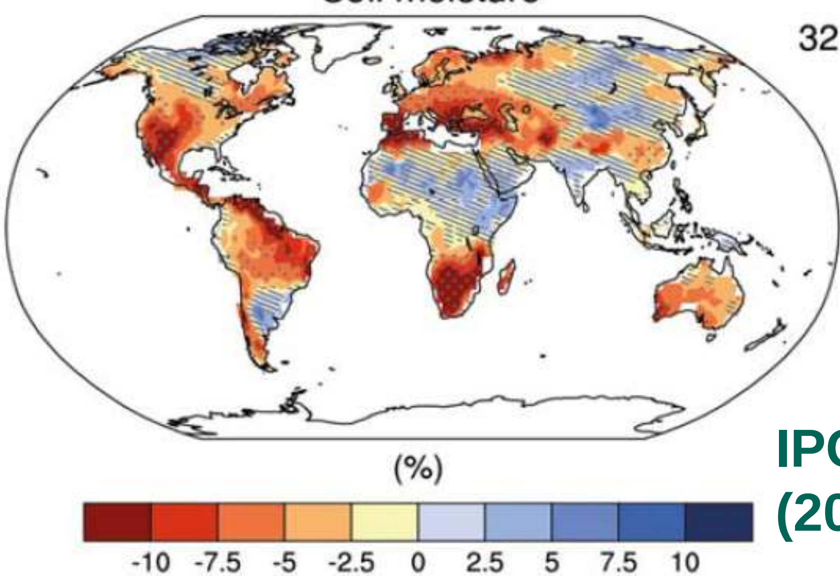
- Increased Precipitation
- More Intense Rainfall
- More droughts
- Wet regions get wetter, dry regions get drier?

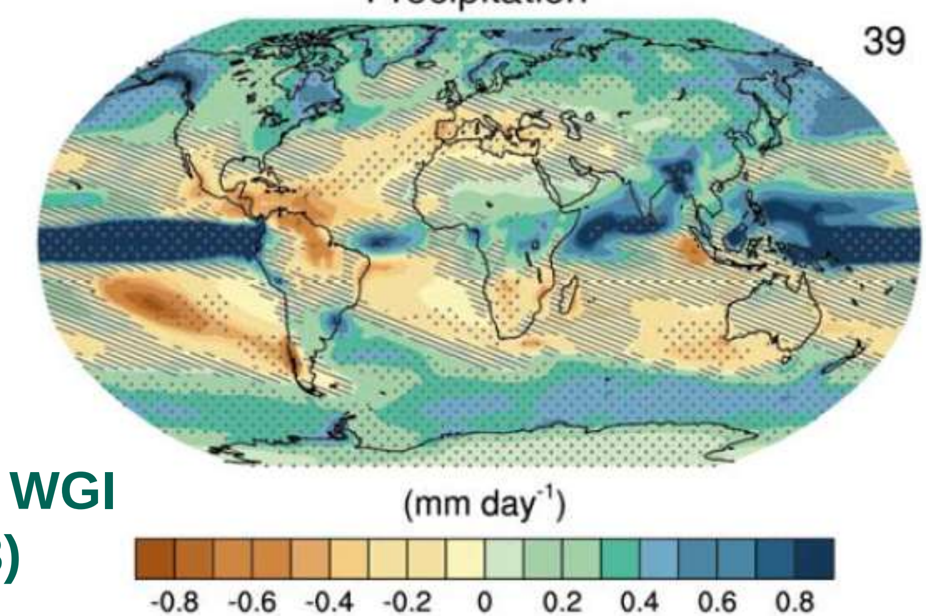
Precipitation intensity



Soil moisture

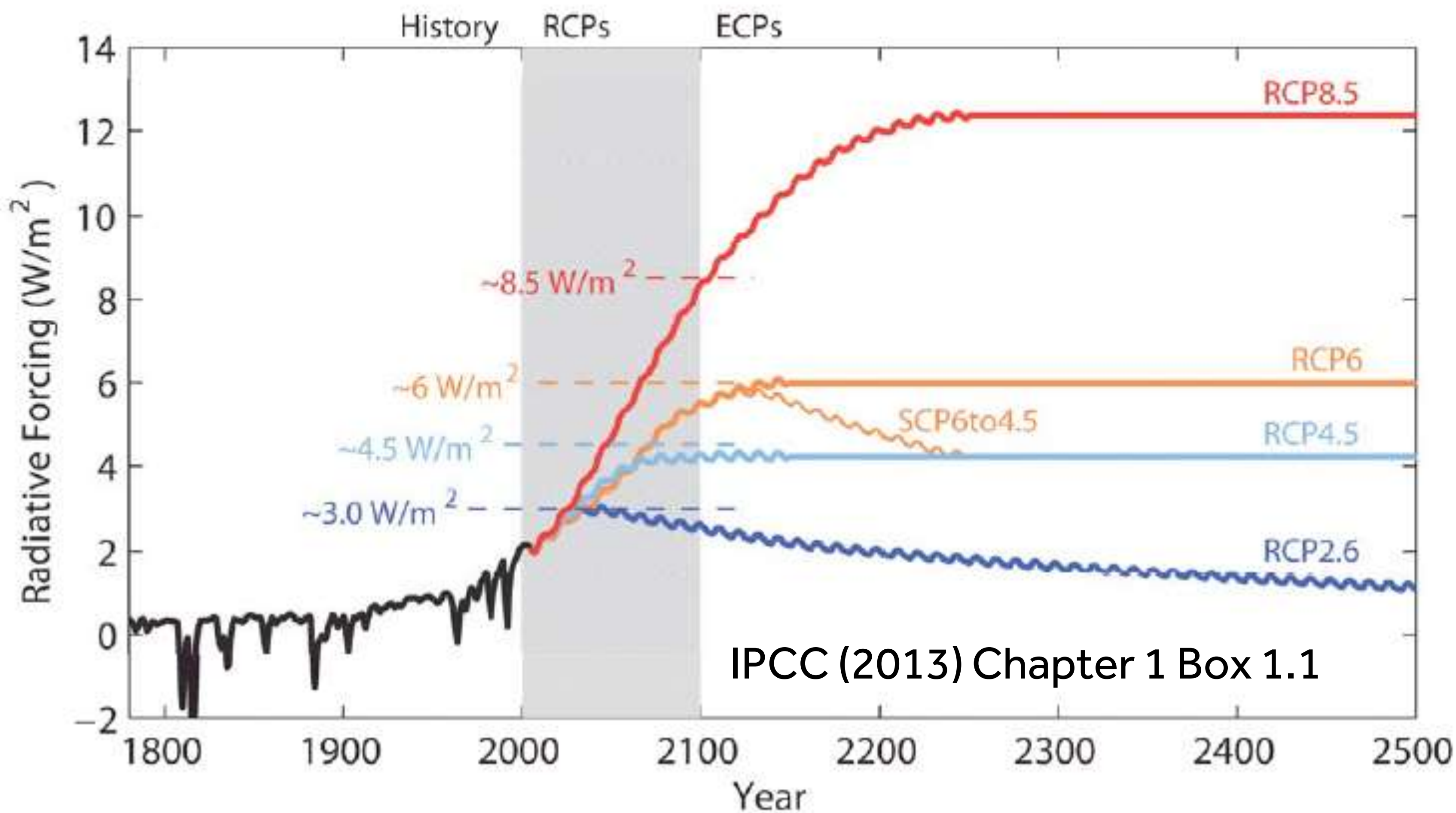


Precipitation



IPCC WGI (2013)

Experiments with Climate Models



Historical and **Future** scenarios

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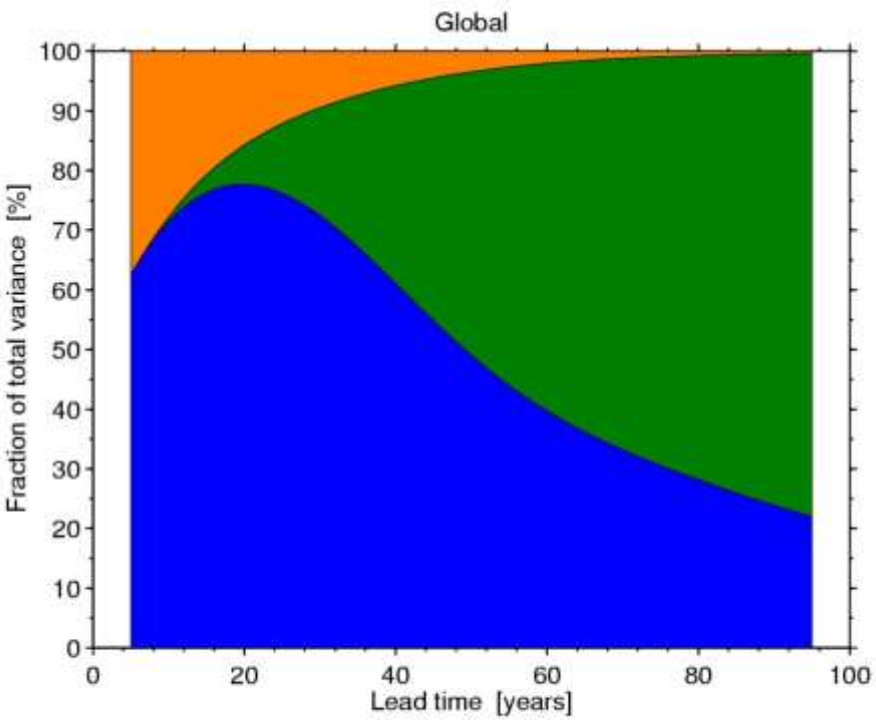
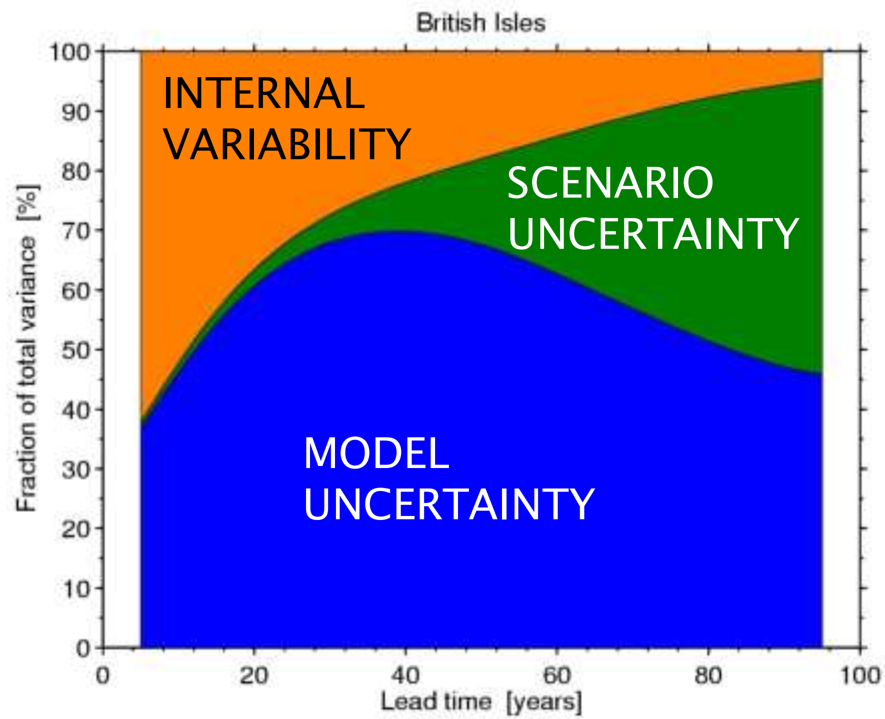
PREDICTABILITY OF CLIMATE:
SURFACE AIR TEMPERATURE



Global, decadal mean



British Isles, decadal mean

Ed Hawkins, NCAS Climate; see IPCC (2013) Fig. 11.8 & FAQ 1.1

INTERANNUAL CHANGES IN PRECIPITATION OVER LAND

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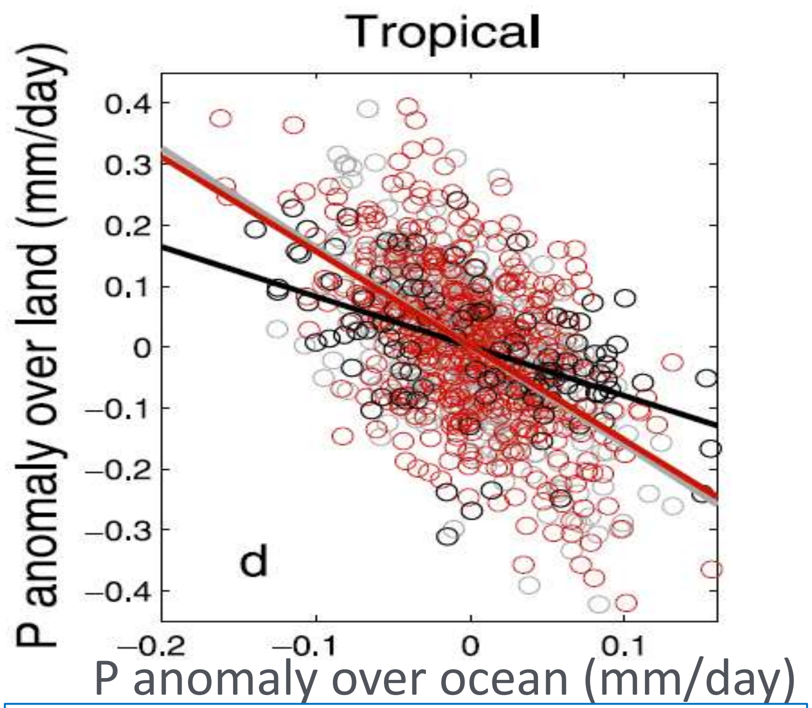
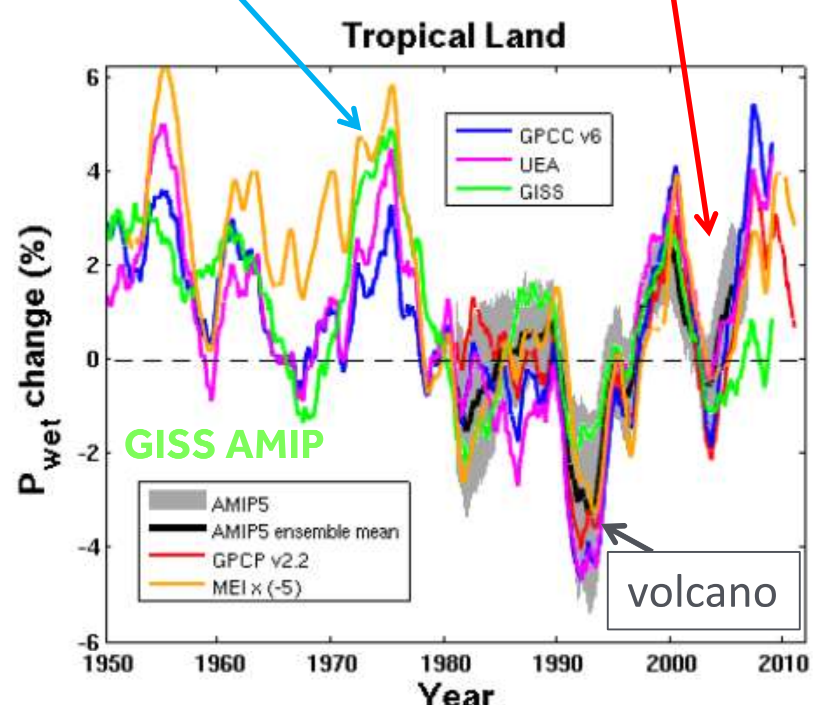
NERC SCIENCE OF THE ENVIRONMENT

Changing water cycle



Land and ocean rainfall anti-correlated on interannual time-scale (above)

Interannual-decadal changes in continental rainfall dominated by: La Niña (more rain) & El Niño (less rain)



Liu, Allan, Huffman (2012) GRL

Liu & Allan (2013) ERL