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NATURAL ENVIRONMENT RESEARCH COUNCIL

Climate variability and change and the role of Earth's energy budget

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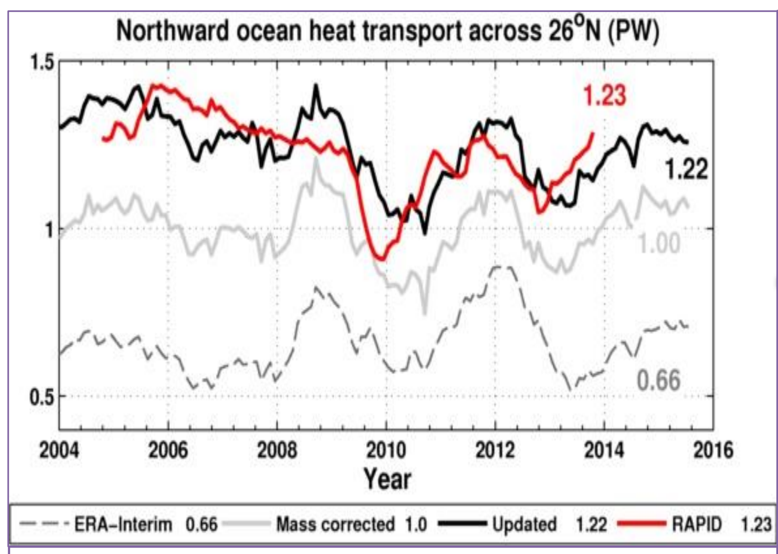
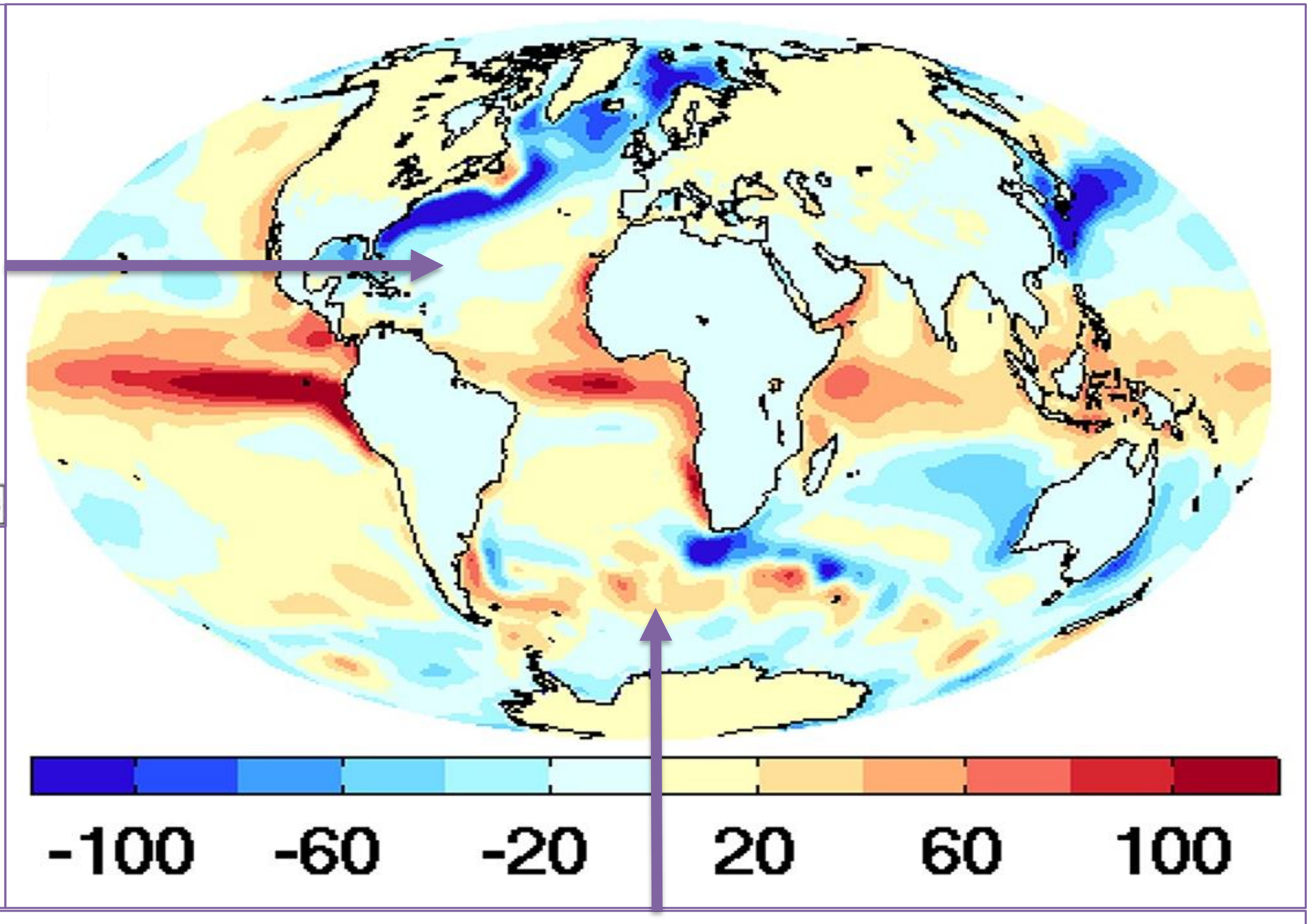
Introduction

A range of satellite products are used to monitor and assess current changes in the global energy and water cycles and evaluate climate simulations

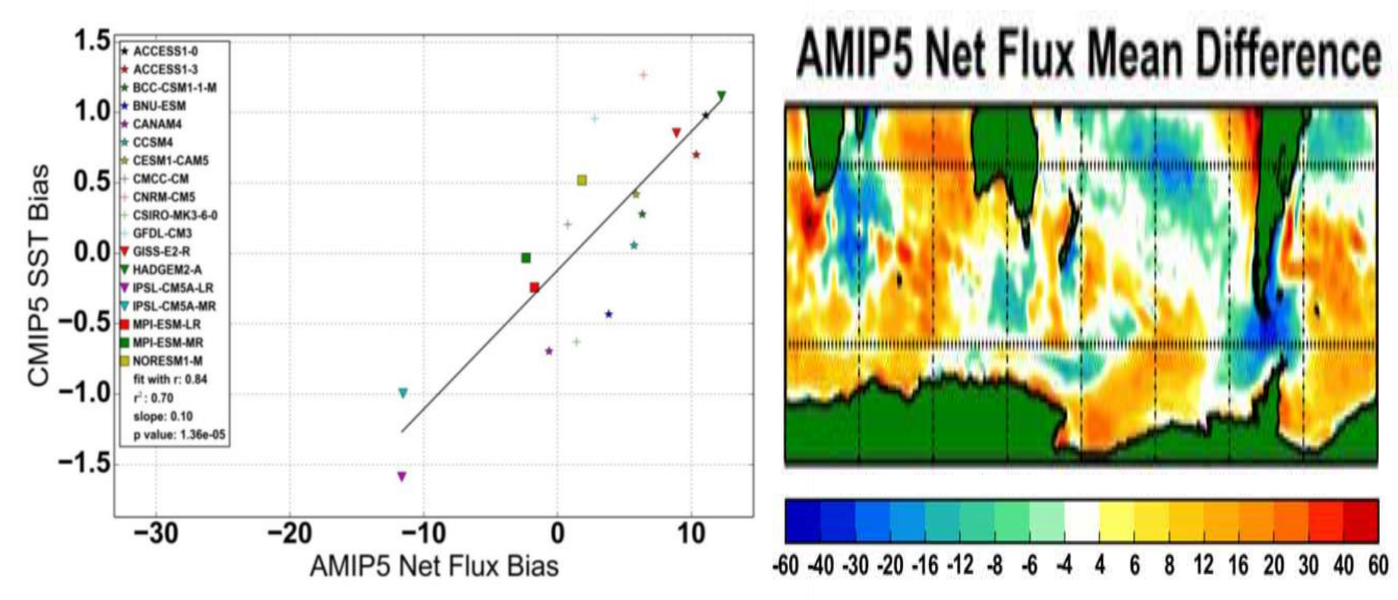
1. Atmospheric moisture increasing with surface warming at a greater rate than precipitation as expected from theory
2. Earth's radiative energy imbalance ~0.7 Wm^{-2}, varies with ENSO & volcanic eruptions with evidence of increasing trend
3. Observed Atlantic ocean heat transport captured by combined satellite/reanalysis surface energy flux product
4. Southern ocean SST bias traced to cloud deficiencies and feedbacks in combined satellite/reanalysis energy fluxes
5. Simulations capture observed aerosol cloud-brightening but overestimate limited effect on liquid water content





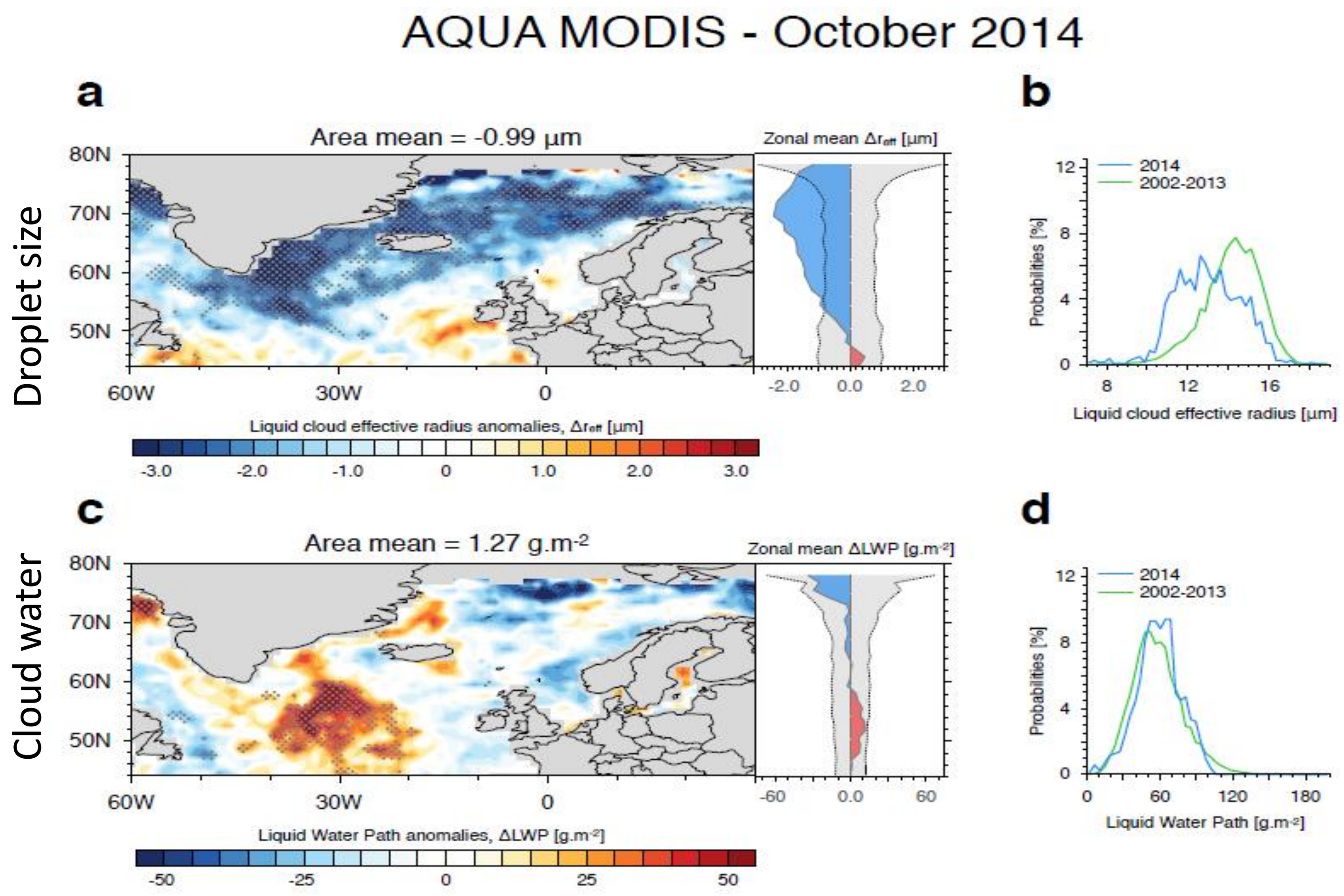
3. Atlantic heat transport

Satellite/reanalysis surface energy flux product (right, Wm^{-2}) indicates heat transport north of 1.2 PW (Liu et al., above).



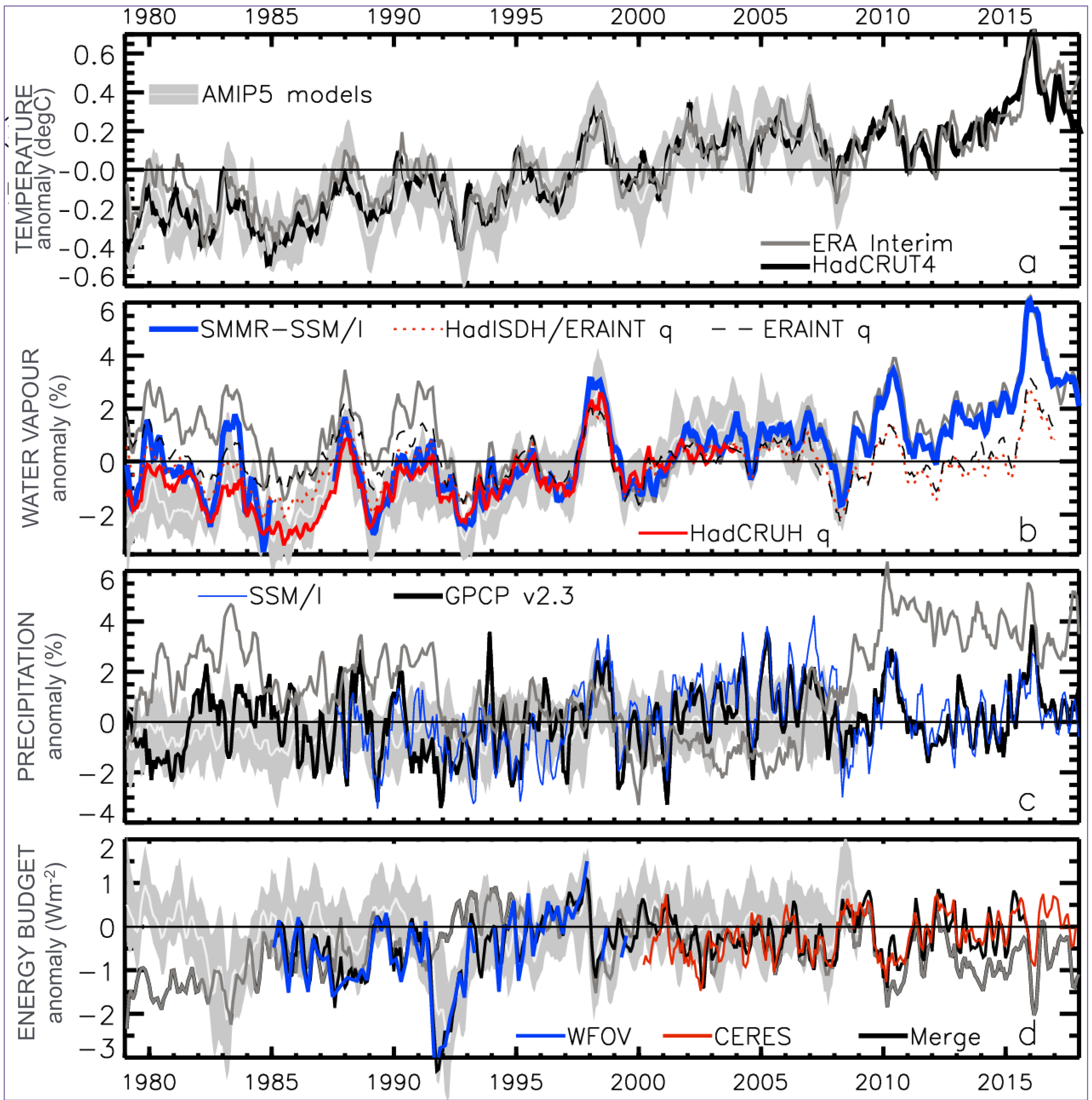
4. Southern ocean climate model biases

Comparing AMIP/CMIP simulations with satellite/reanalysis derived surface energy fluxes allows climate model biases to be traced back to the atmosphere component involving clouds and ocean/wind feedbacks (Hyder et al. 2018, above).



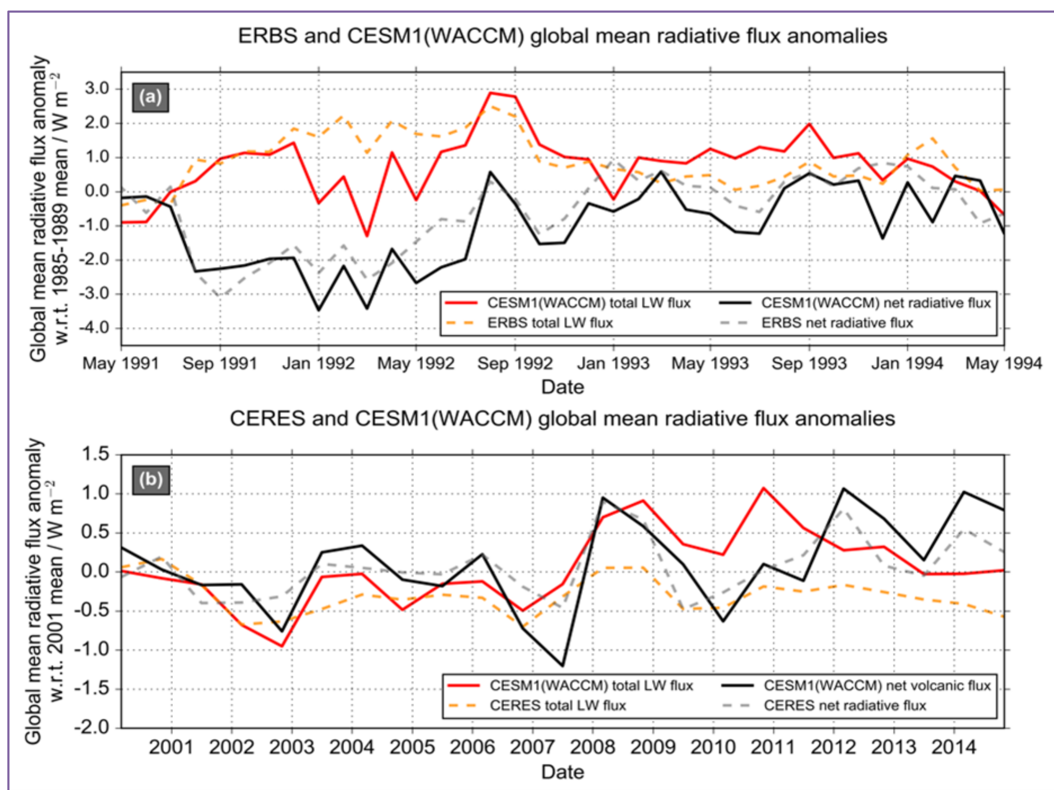
5. Small indirect aerosol-cloud water interactions?

Aqua/MODIS satellite data indicate volcanic aerosol haze brightens low altitude clouds, a cooling influence on the climate (top), but further indirect effects on cloud water are undetectable (bottom). Results can help to improve the accuracy of climate change projections of importance for policy decisions (Malavelle et al. 2017)



1. Monitoring global temperature, water vapour, precipitation & energy budget

Global mean de-seasonalised anomalies of (a) surface temperature, (b) atmospheric water vapour (column integrated, W and surface specific humidity, q), (c) precipitation and (d) net downward top of atmosphere radiative energy imbalance for a range of surface/satellite-based products & atmosphere-only simulations after Allan et al. (2014)



2. Energy budget response to volcanic eruptions

← Nudged simulations & satellite observations of Earth radiation budget response to volcanic eruptions for (a) 1991-1994 and 2000-2014 periods (Schmidt et al. 2018 JGR, in prep). Small volcanic eruptions and aerosol cloud interactions more important than previously thought.

References

Allan et al. (2014) Physically consistent responses of the global atmospheric hydrological cycle in models and observations, *Surv. Geophys.*, **35**, 533-552, doi:10.1007/s10712-012-9213-z

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Malavelle et al. (2017) Strong constraints on aerosol-cloud interactions from volcanic eruptions, *Nature*, **546**, 485–491, doi:10.1038/nature22974

Schmidt et al. (2018) Volcanic radiative forcing from 1979 to 2015, *submitted to JGR*.

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