

# Current global and regional changes in atmospheric water vapour

Richard P. Allan

Department of Meteorology, University of Reading

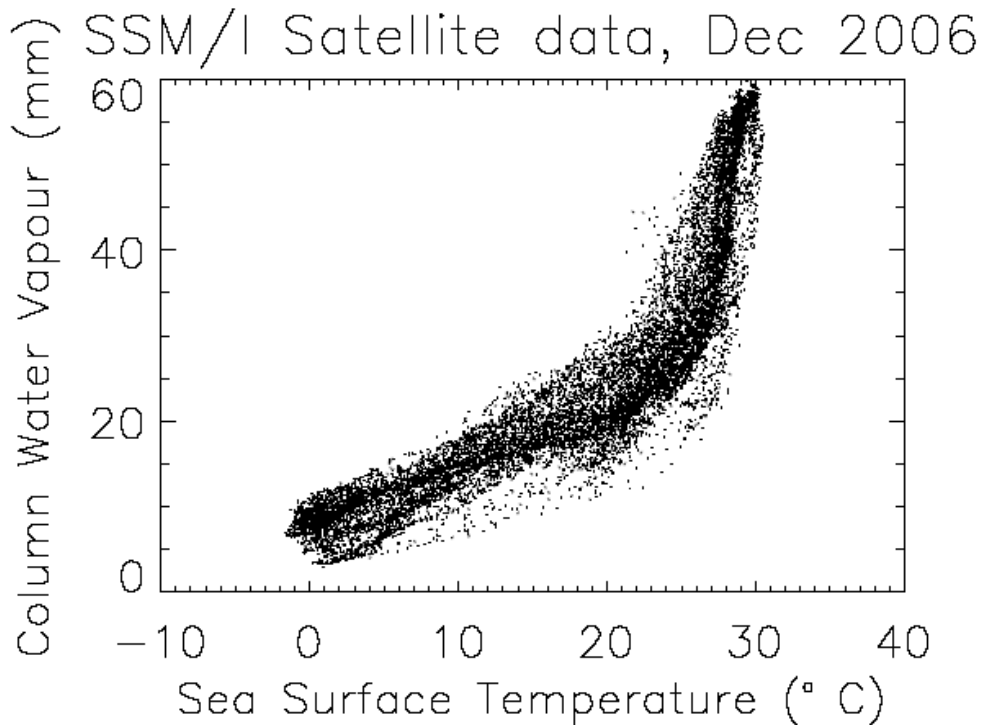
<http://www.met.reading.ac.uk/~sgs02rpa>

r.p.allan@reading.ac.uk



# Clausius-Clapeyron

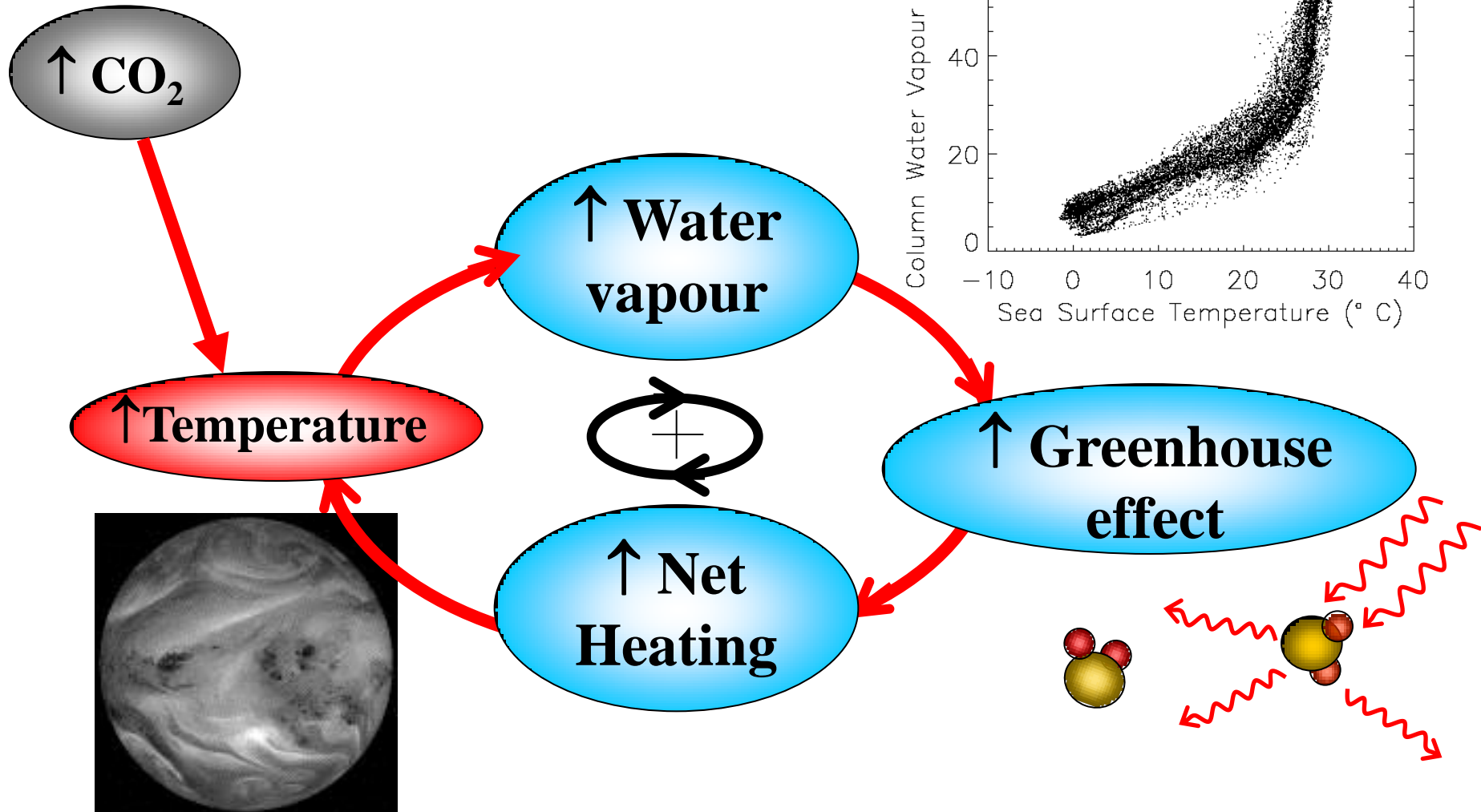
$$\frac{1}{q_s} \frac{dq_s}{dT} \approx \frac{1}{e_s} \frac{de_s}{dT} = \frac{L}{R_v T^2} = \begin{cases} 0.14 K^{-1} & T = 200 K \\ 0.07 K^{-1} & T = 273 K \\ 0.06 K^{-1} & T = 300 K \end{cases}$$



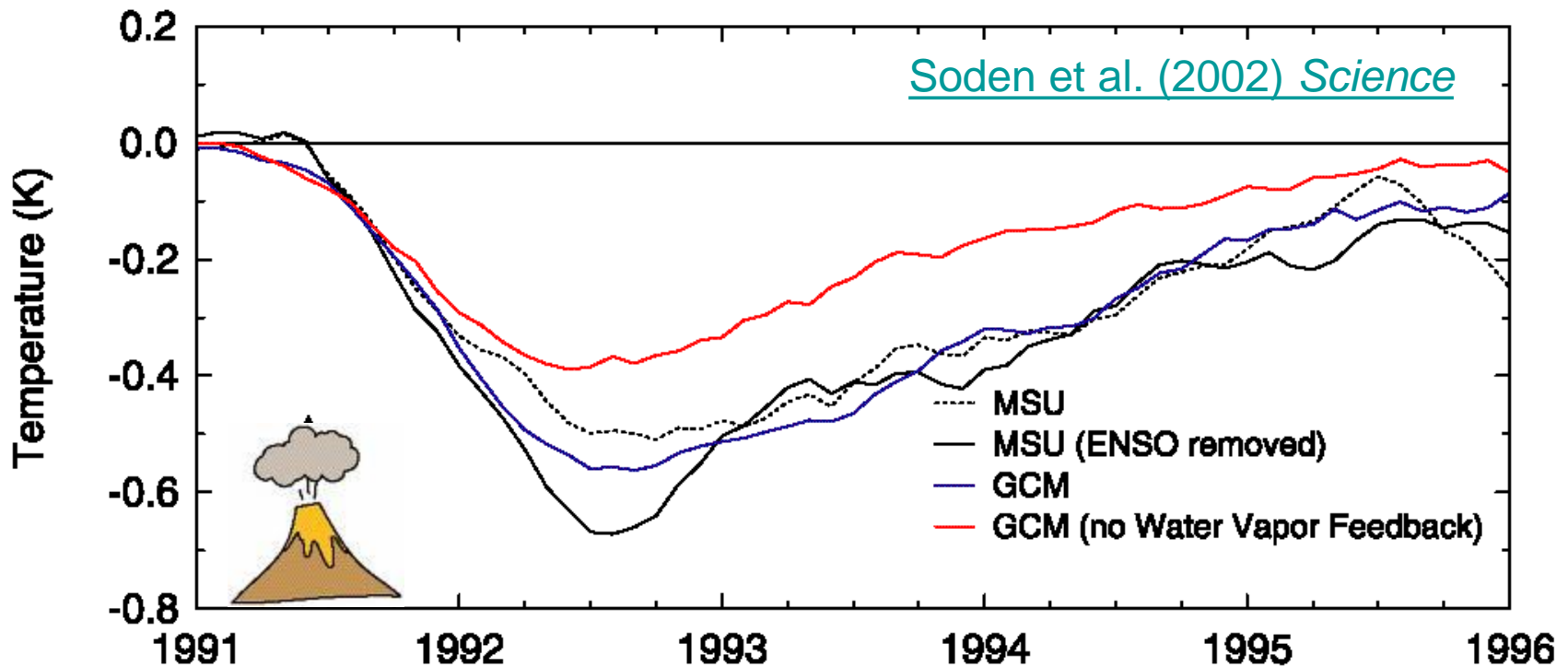
e.g. see [Allan \(2012\) Surv Geophys](#)

- Strong constraint upon low-altitude water vapour over the oceans
- Water vapour is a very forgiving climate variable!
- Land regions?
- Upper troposphere?

# Water Vapour amplifies climate change



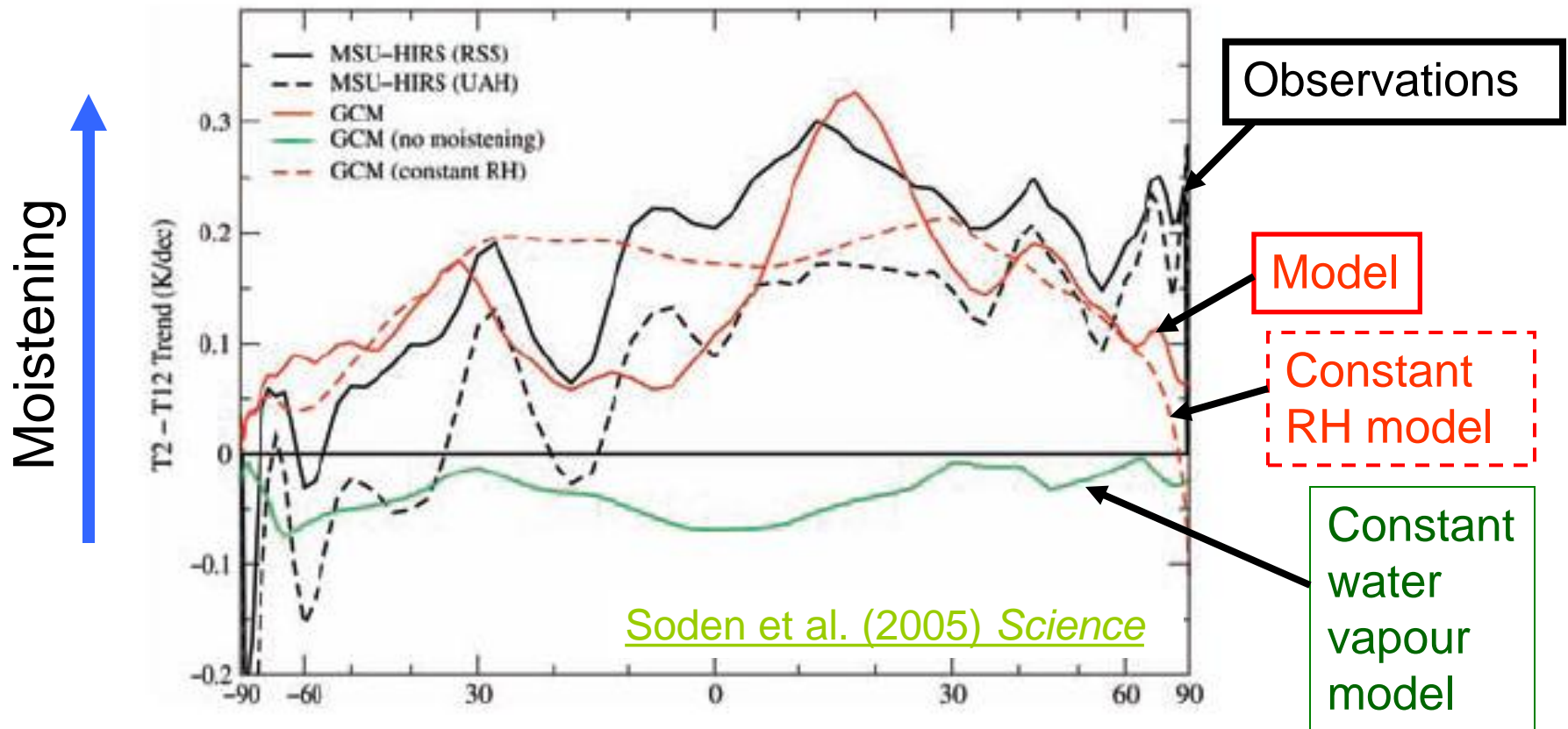
# Water vapour feedback amplified climate response to Mt. Pinatubo



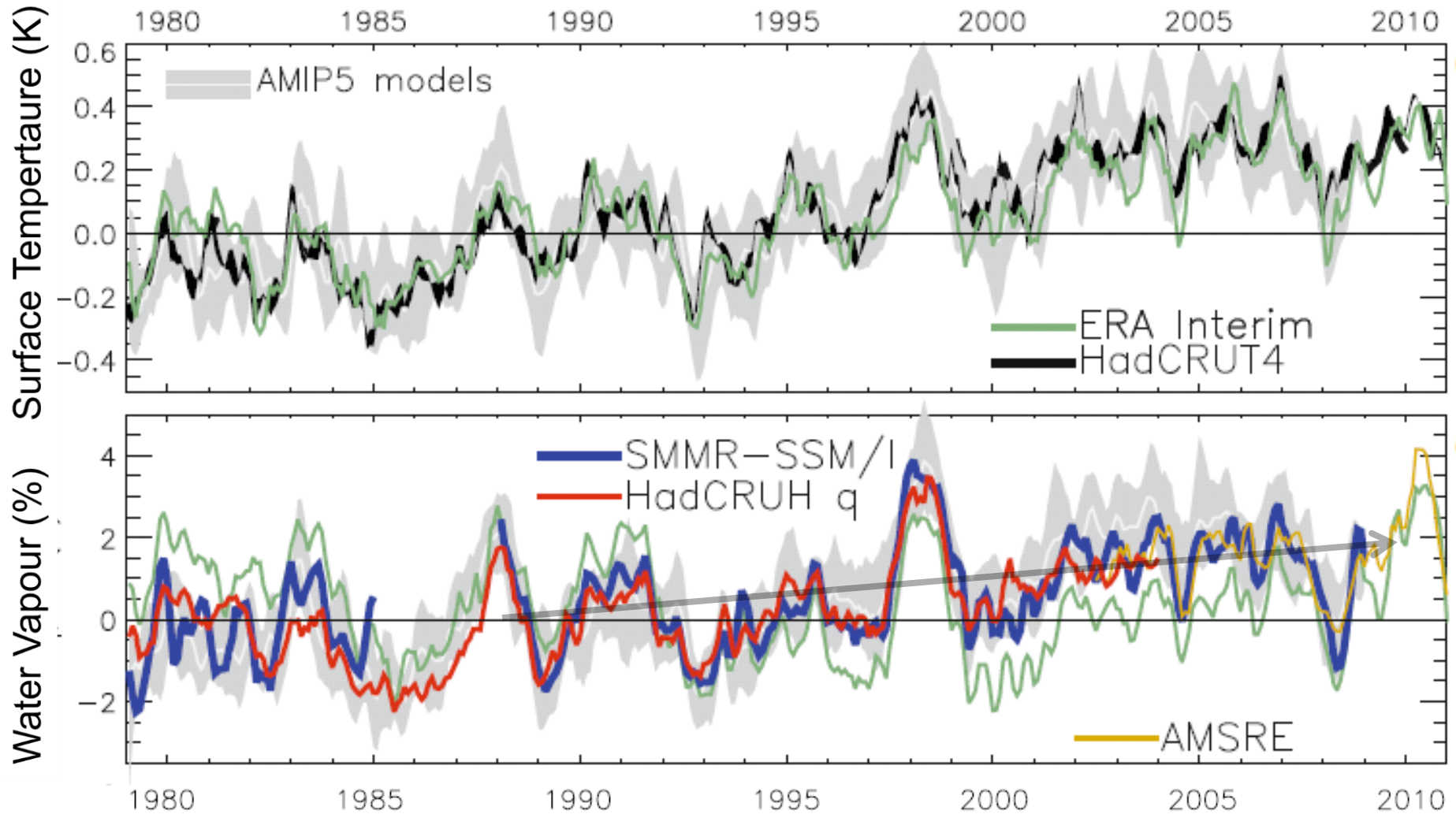
The climate model cannot simulate the magnitude of cooling following the volcanic eruption without including water vapour feedback

# Satellite data indicates increasing trends in upper tropospheric moisture

Trend in HIRS brightness temperature difference: 1983-2004



# Current global changes in water vapour

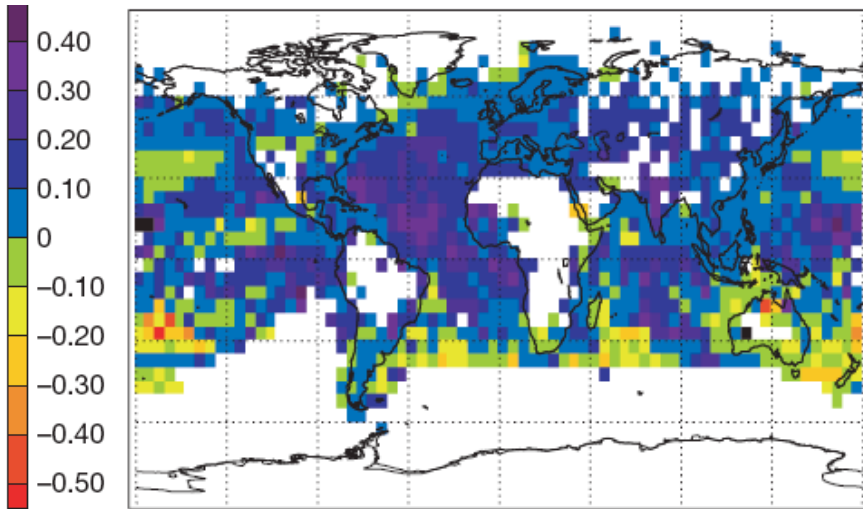


[Allan et al. \(2013\) Surv. Geophys](#)

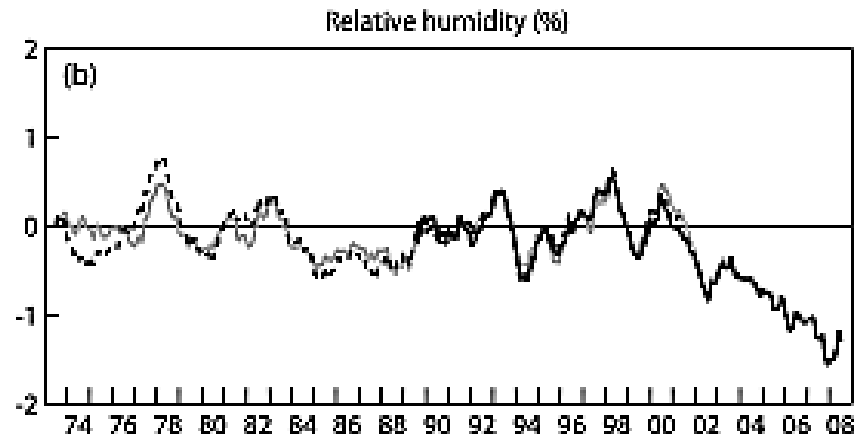
$dW/dt \sim 1\%/decade$

# Regional changes in low-level moisture

Specific humidity trend correlation (left) and relative humidity over land (right)



ERA-INTERIM --- ERA-40



[Willett et al. \(2007\) Nature](#)

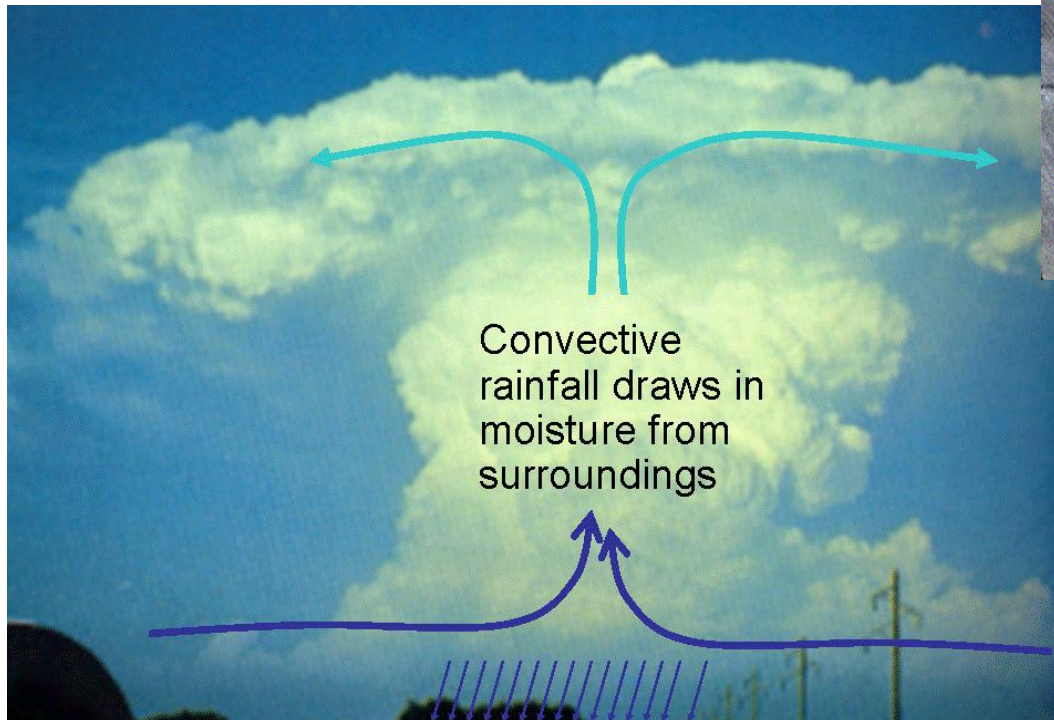
[Willett et al. \(2008\) J Clim](#)

Evidence for recent reductions in RH over land ([Simmons et al. 2009 JGR](#))?

Robust relationships globally.

Less coherent relationships regionally/over land/at higher altitudes?

# Precipitation extremes



- Large-scale rainfall events fuelled by moisture convergence  
e.g. [\*Trenberth et al. \(2003\) BAMS\*](#)
- Intensification of rainfall with global warming  
e.g. [\*Allan and Soden \(2008\) Science\*](#)

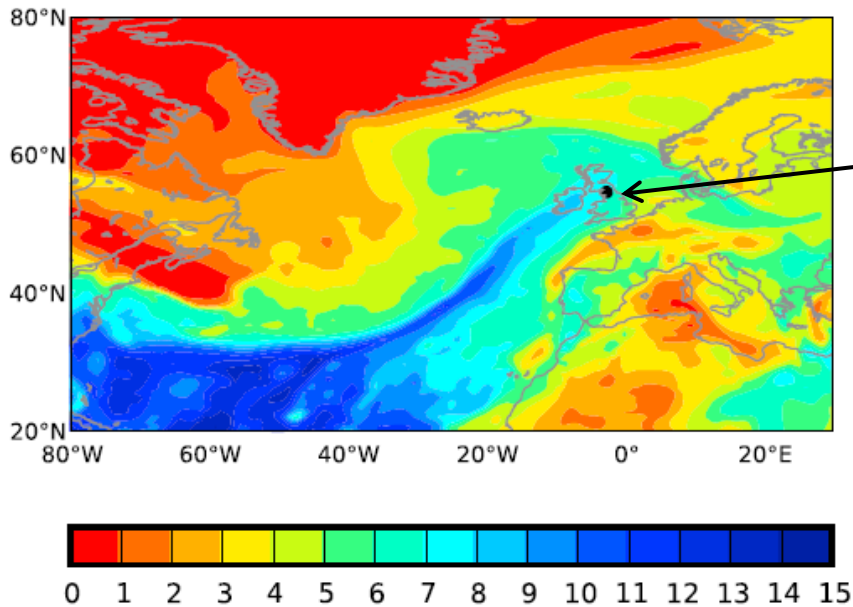


# Precipitation extremes

- Heavy rainfall requires substantial convergence of moisture
- Clausius Clapeyron is a good starting point for anticipated changes in heavy rainfall



c) Specific humidity at 900 hPa ( $\text{g kg}^{-1}$ )



[Lavers et al. \(2011\) Geophys. Res. Lett.](#)

a) Eden at Temple Sowerby hydrograph

