

The Global Warming Hiatus

John C. Fyfe

Canadian Centre for Climate
Modelling and Analysis



Environment
Canada

Environnement
Canada

Canada 

Three Topics

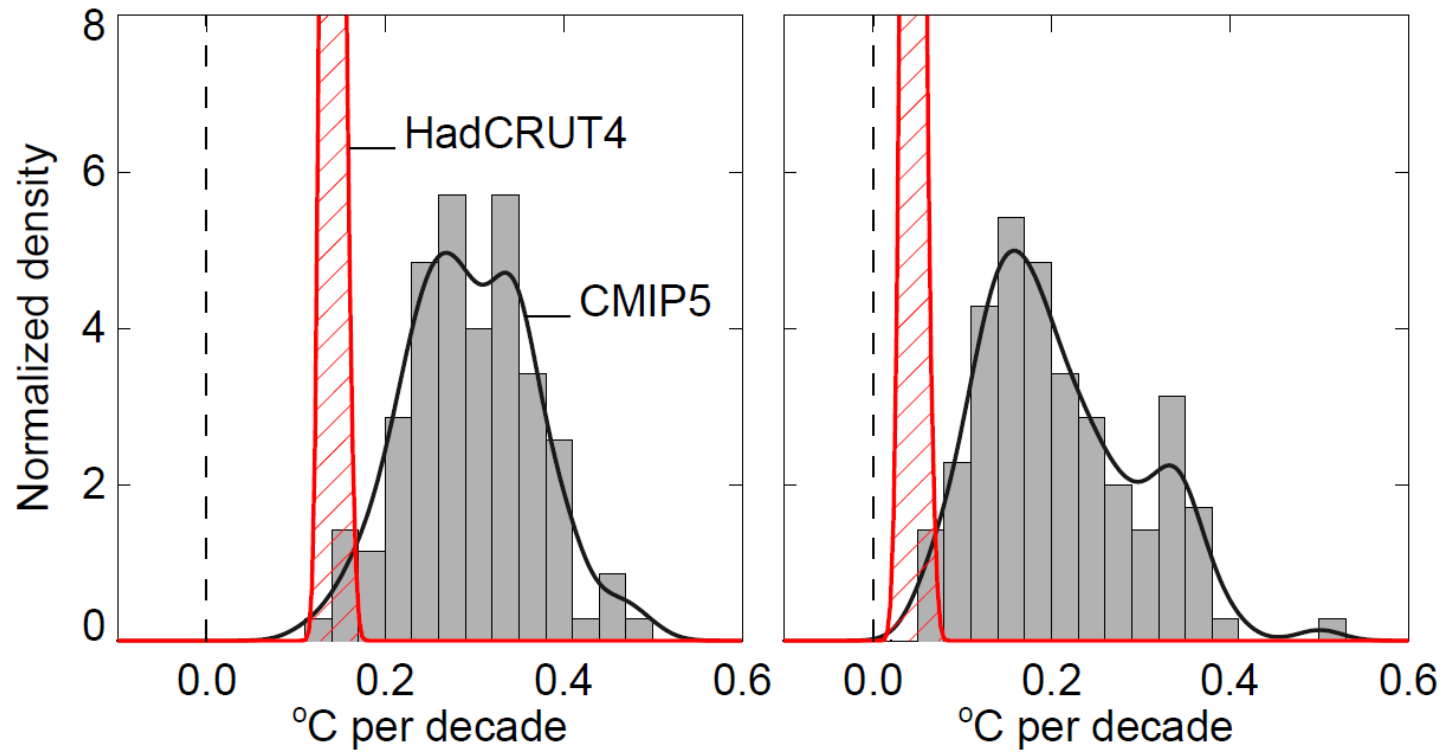
1. Observed verses CMIP5 trends
2. Role of volcanic forcing
3. Role of SST and wind variability

Many Collaborators

Nathan Gillett, Francis Zwiers,
Ben Santer, Jason Cole, Jana
Sillmann, Markus Donat, Oleg
Saenko and Neil Swart

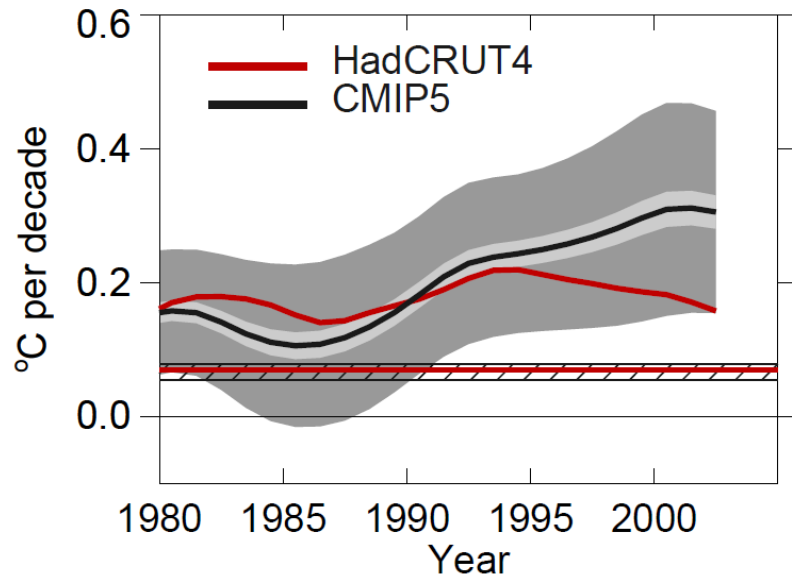
1993-2012

1998-2012

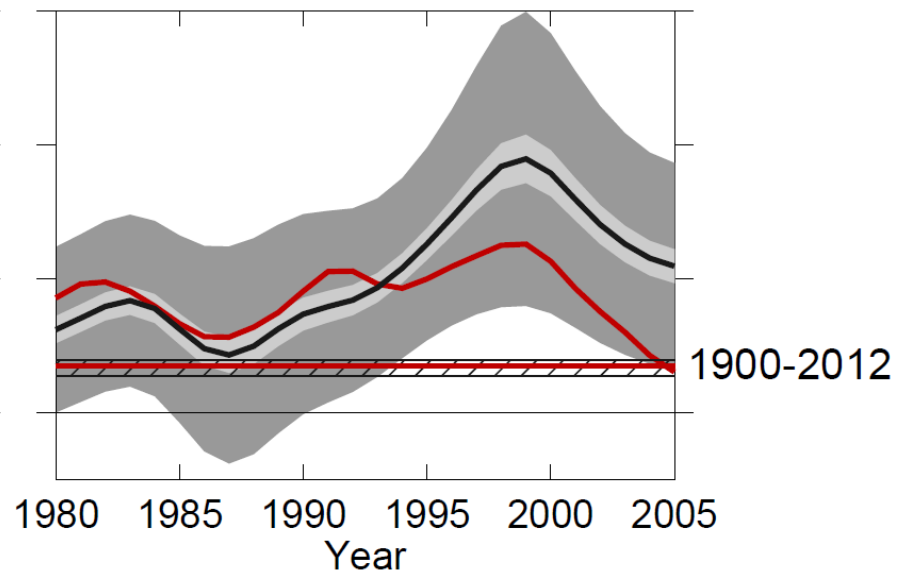


Fyfe *et al.* (*Nature Clim. Change*, 2013)

20-year trends



15-year trends



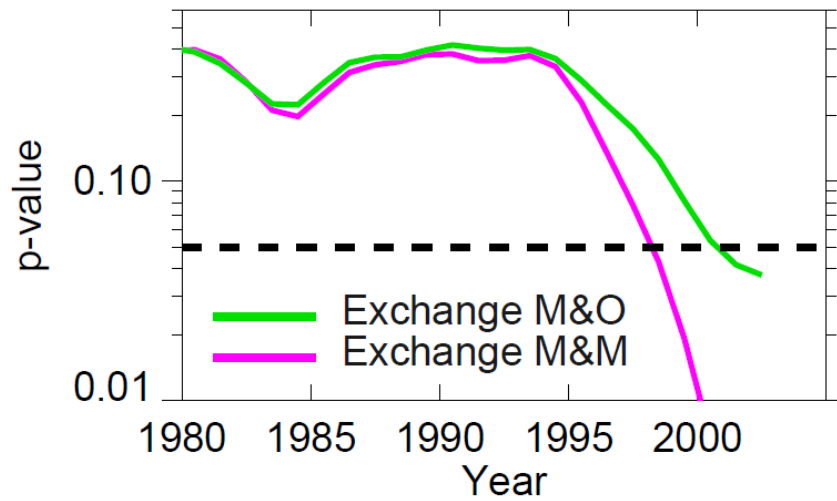
Null hypothesis

Observed and model mean trends are equal

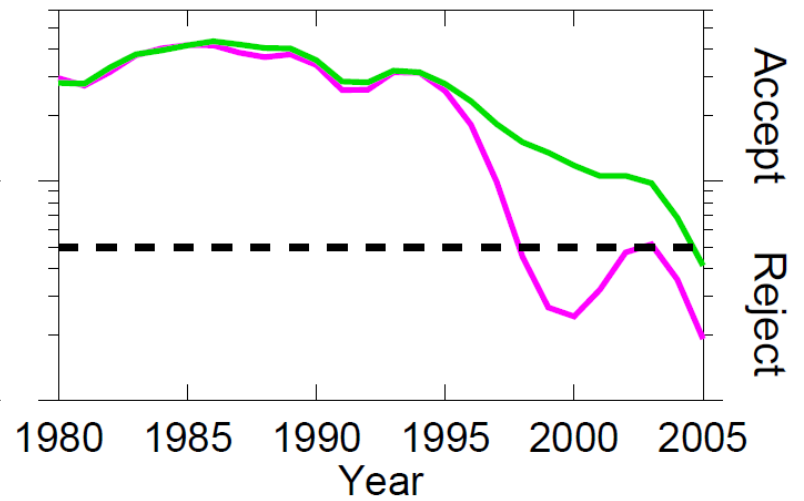
Assuming either

- 1) Models and observations exchange
- 2) Models exchange

20-year p -values



15-year p -values



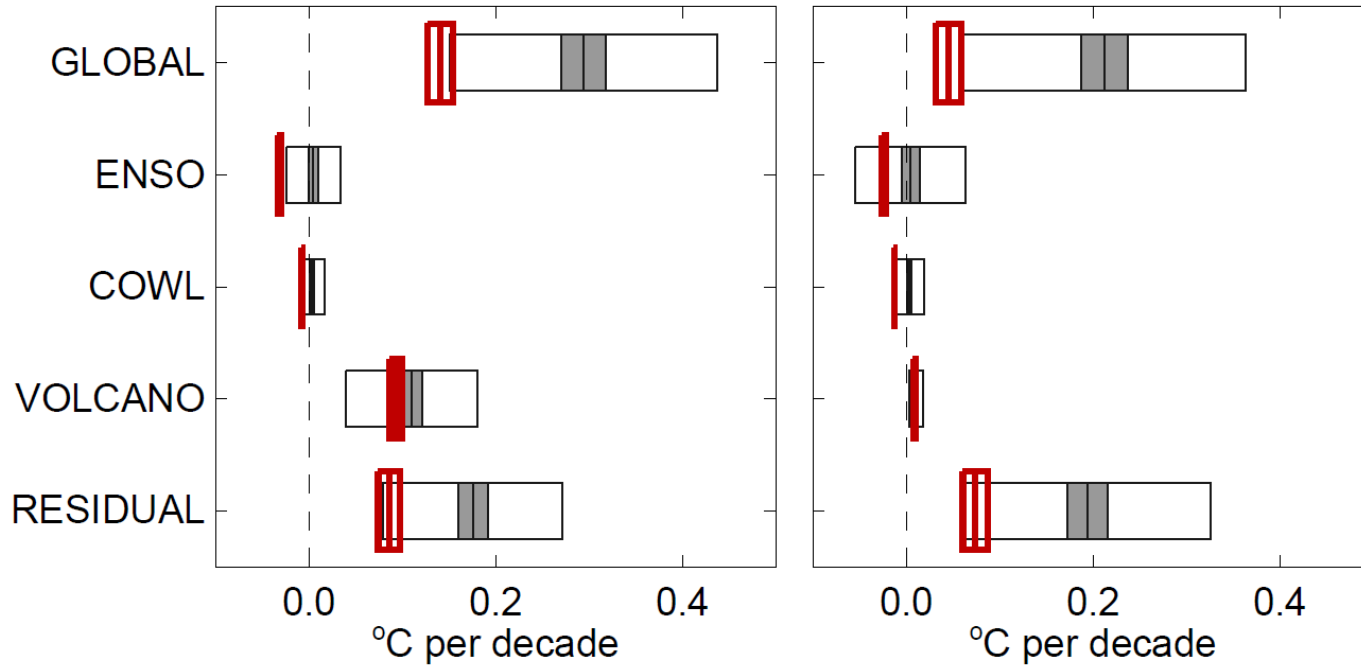
Known signals of natural variability

$$\begin{aligned} T_{global}(t) = & c + \alpha t \\ & + \mu \hat{T}_{enso}(t) \\ & + \nu \hat{T}_{cowl}(t) \\ & + \xi \hat{T}_{volcano}(t) + \varepsilon(t) \end{aligned}$$

Thompson *et al.* (*Nature*, 2008)

20-year trends

15-year trends



Fyfe *et al.* (*Nature Clim. Change*, 2013)

Conclusion

Recent observed warming is less than model mean warming

Due to combined errors in

Model response, external forcing and internal variability

<http://www.nytimes.com/>

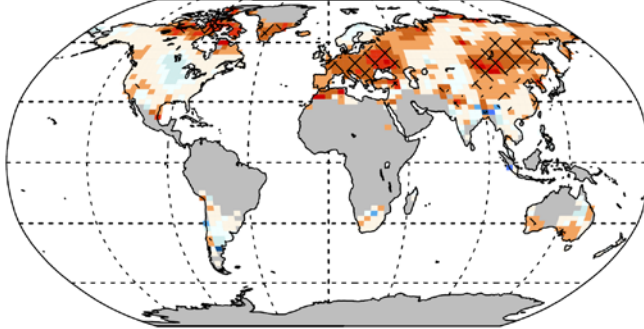
“For Zwiers to acknowledge this is like hearing the Archbishop of Canterbury question the divinity of Christ”

Warmest day

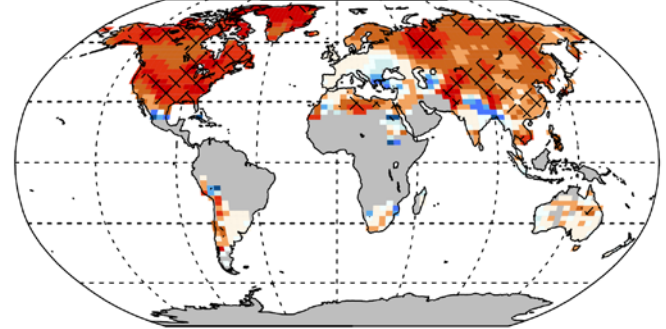
Coldest night

40-years

HadEX2 trend 1971-2010

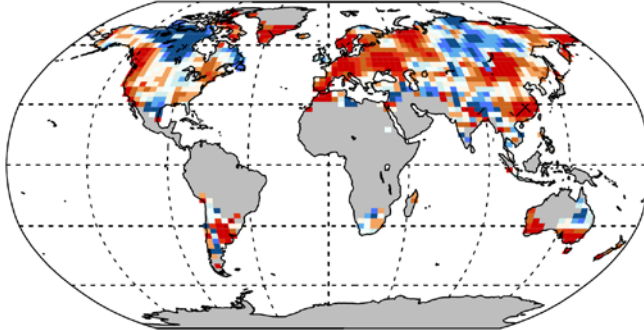


HadEX2 trend 1971-2010

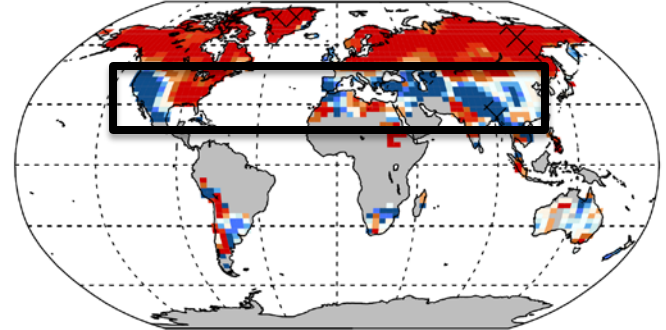


15-years

HadEX2 trend 1996-2010



HadEX2 trend 1996-2010



-1 -0.75 -0.5 -0.25 0 0.25 0.5 0.75 1

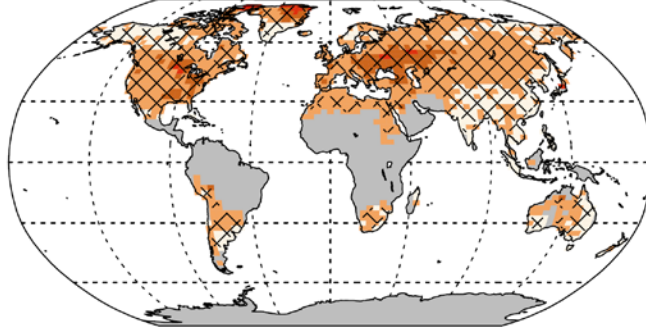
[°C / decade]

Warmest day

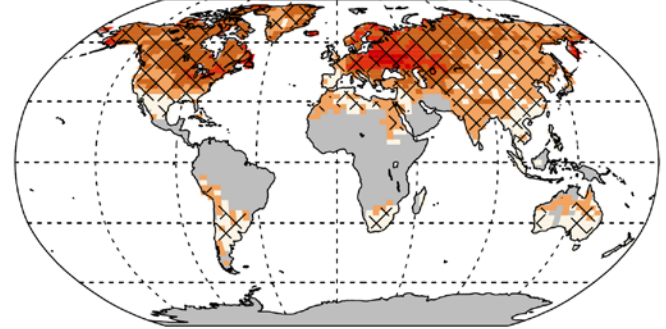
Coldest night

40-years

CMIP5 median trend 1971-2010

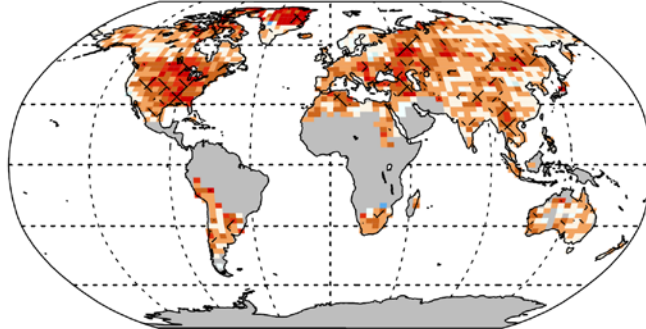


CMIP5 median trend 1971-2010

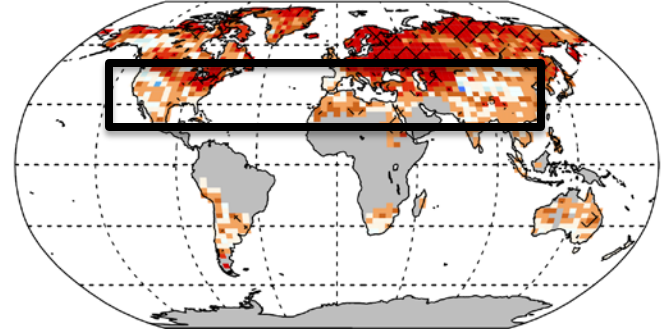


15-years

CMIP5 median trend 1996-2010

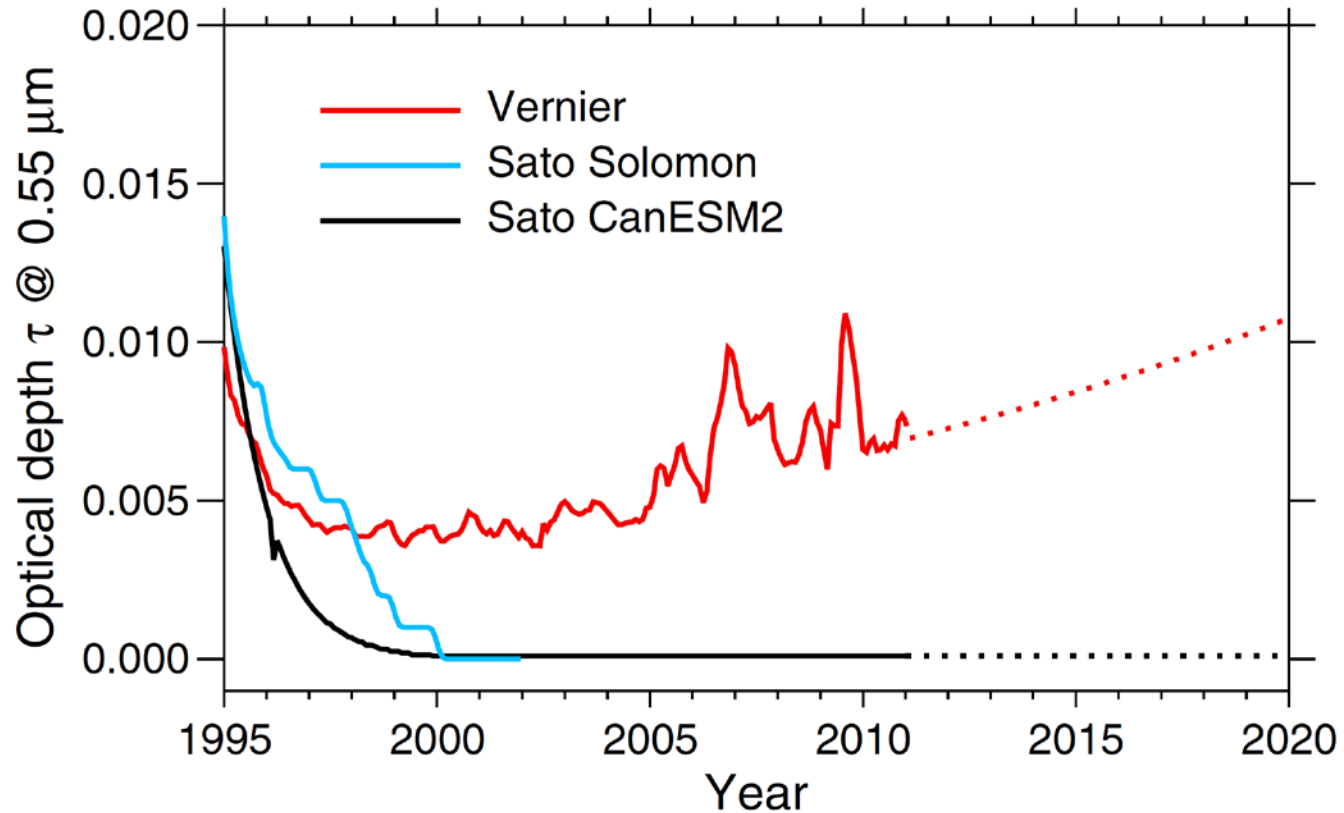


CMIP5 median trend 1996-2010



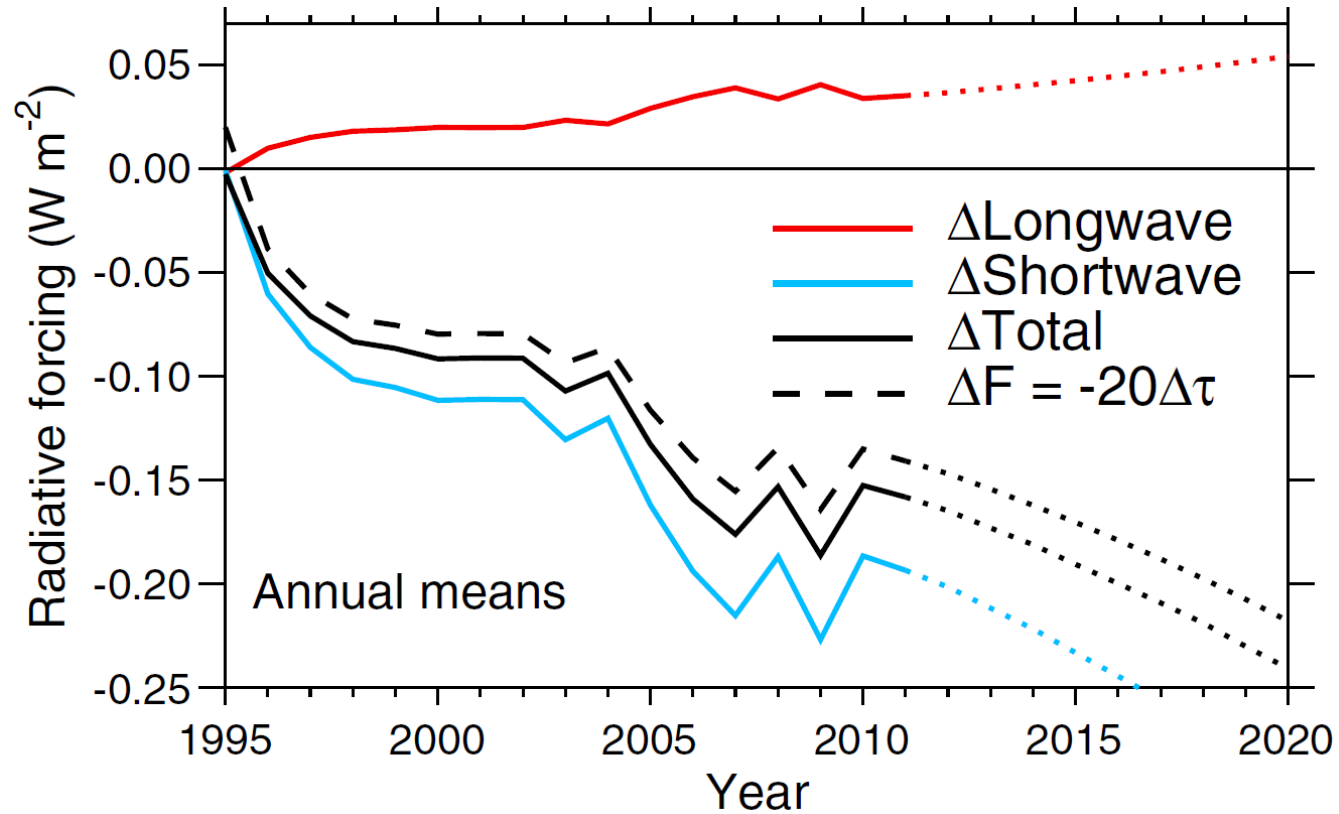
Sillmann *et al.* (*Environ. Res. Lett.*, 2014)

Stratospheric aerosol change

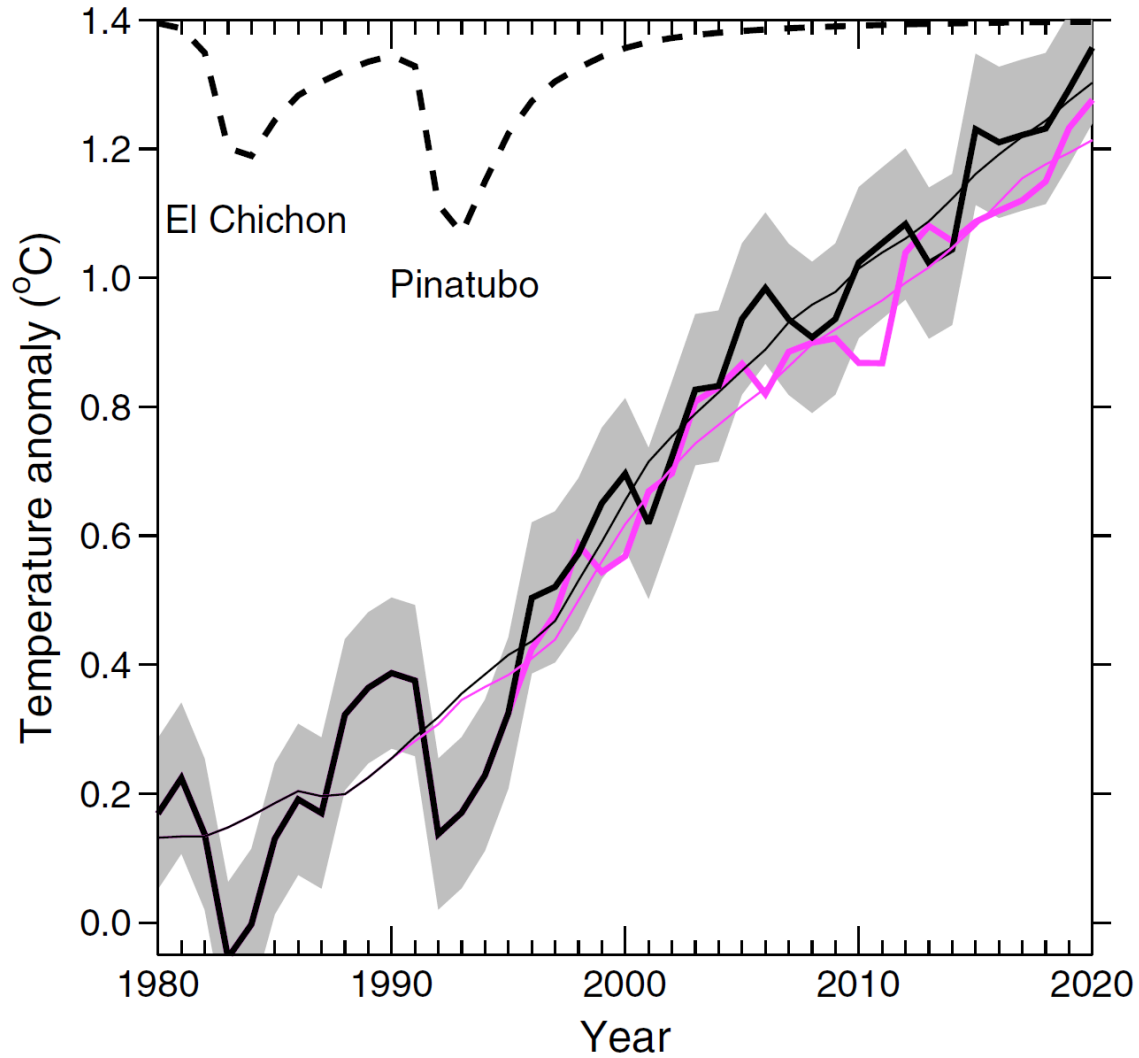


Fyfe *et al.* (*Geophys. Res. Lett.*, 2013)

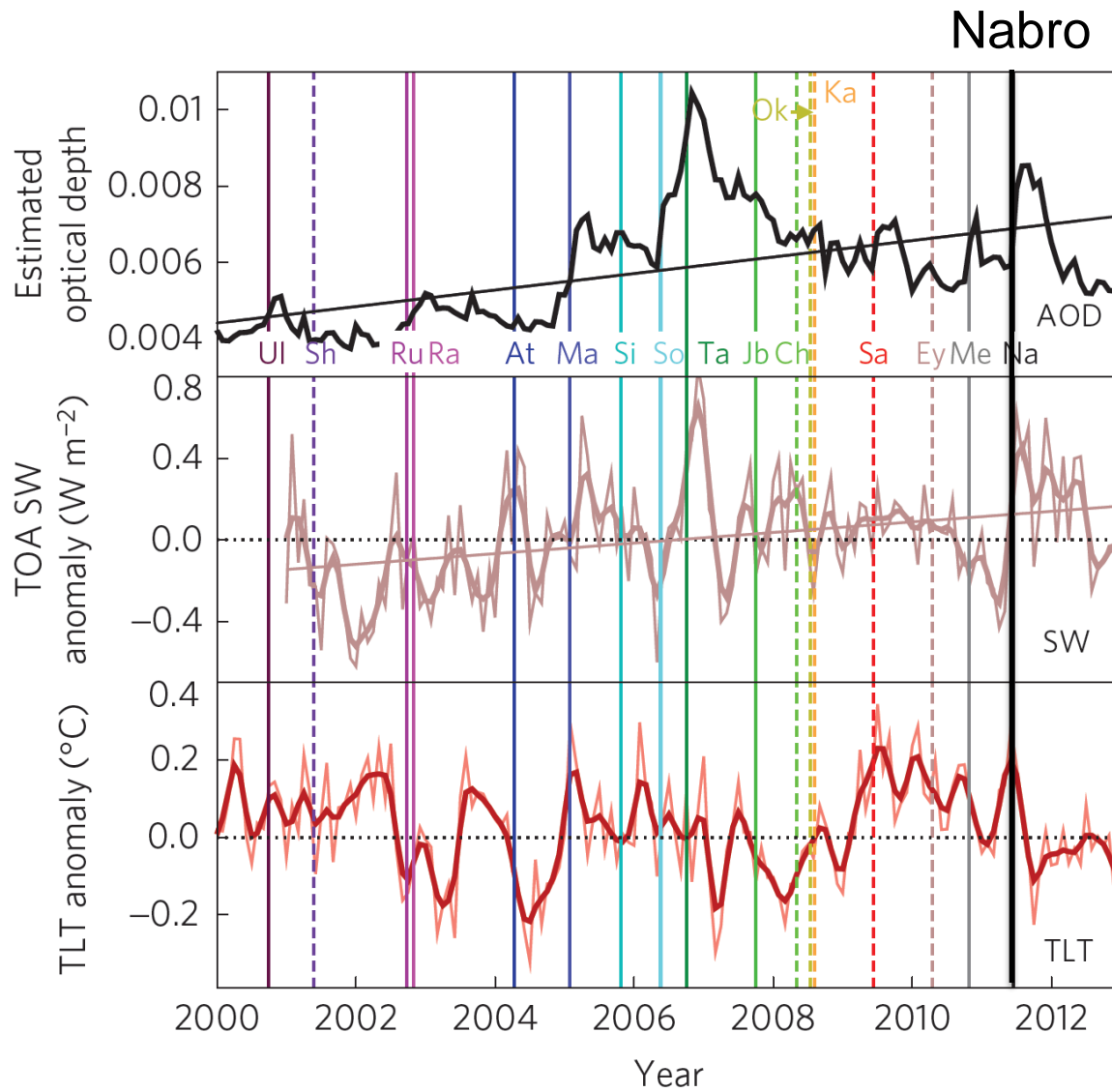
Radiative forcing change



Fyfe *et al.* (*Geophys. Res. Lett.*, 2013)

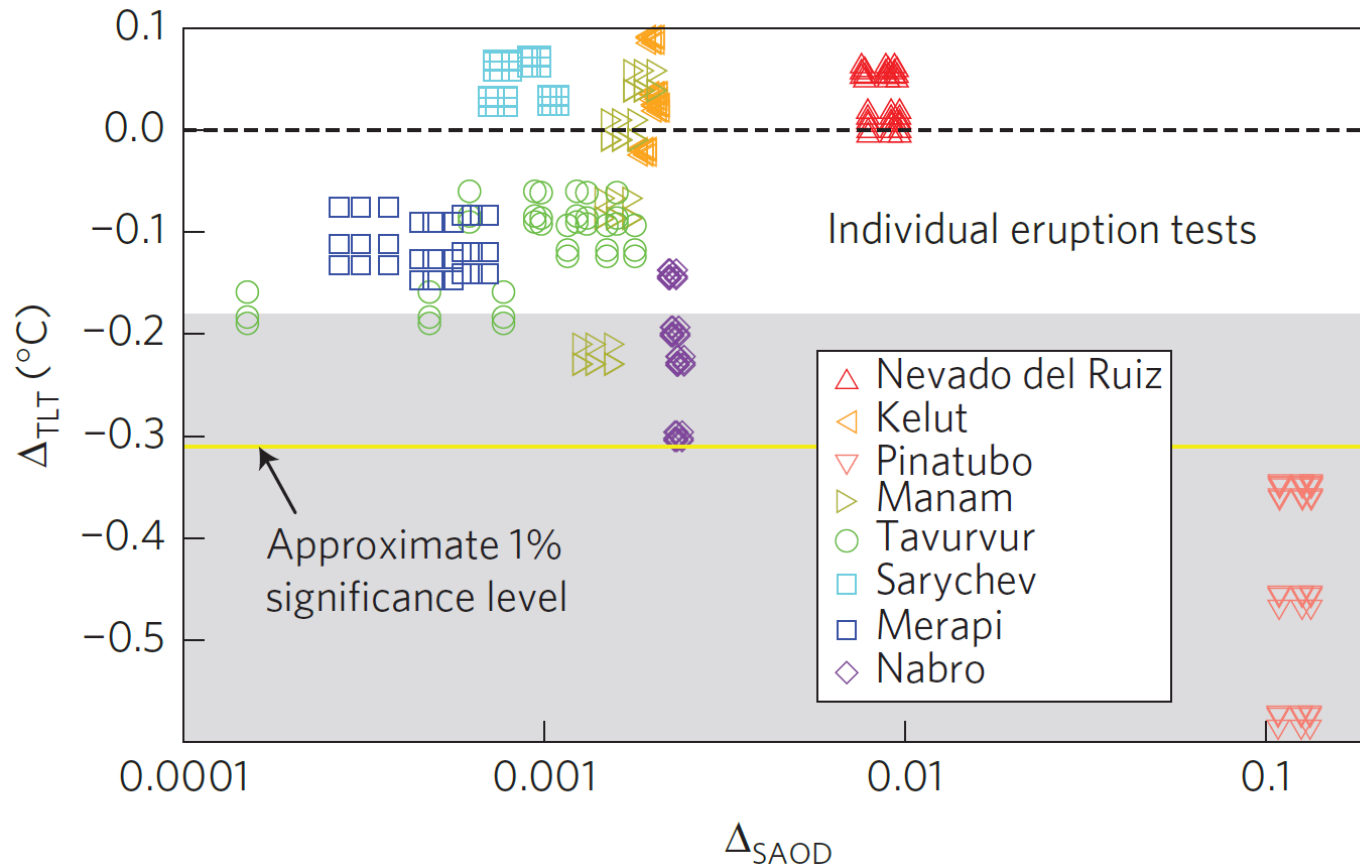


Fyfe *et al.* (*Geophys. Res. Lett.*, 2013)



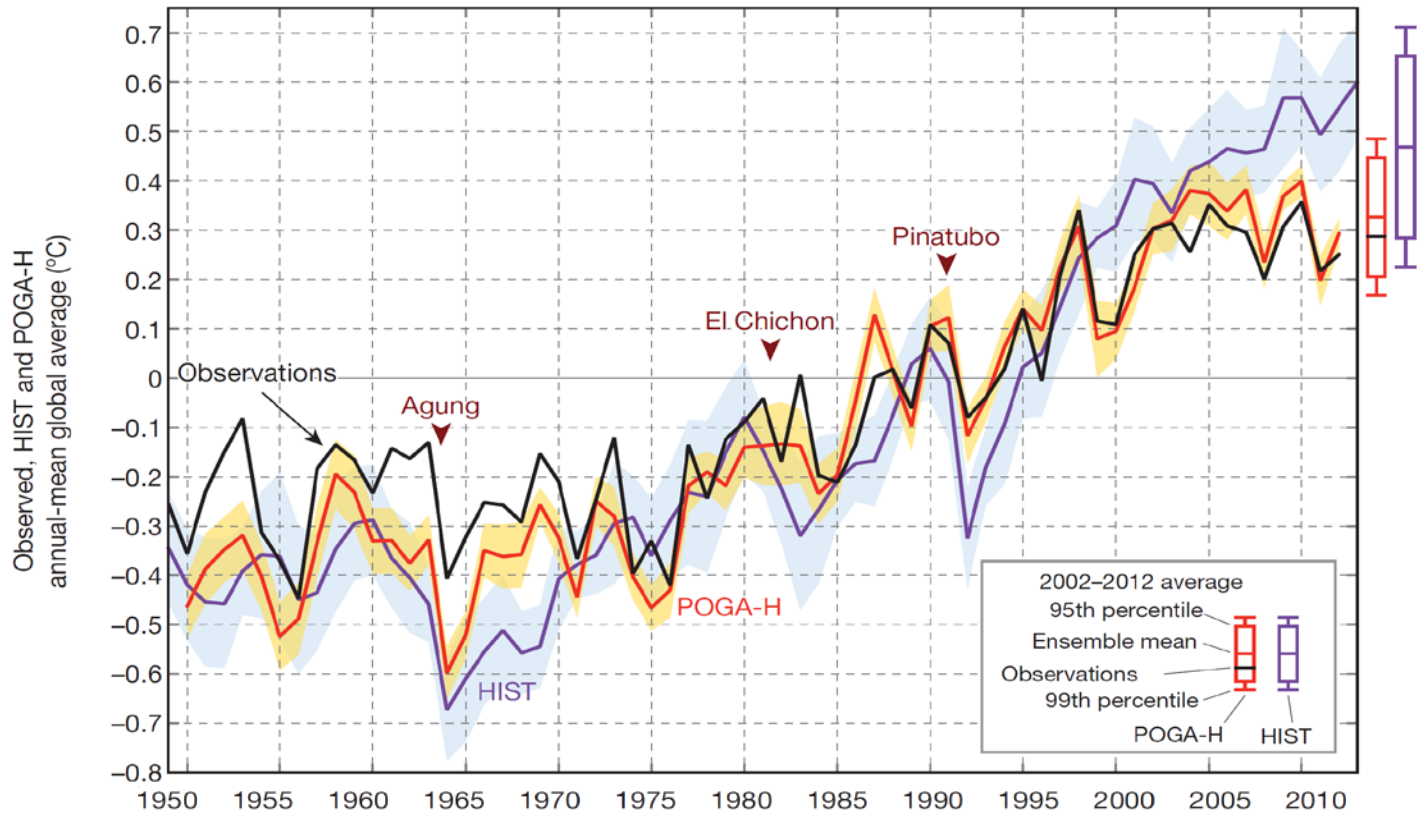
Santer *et al.* (*Nature Geosci.*, 2014)

Volcanic impact on tropical temperature



Santer *et al.* (*Nature Geosci.*, 2014)

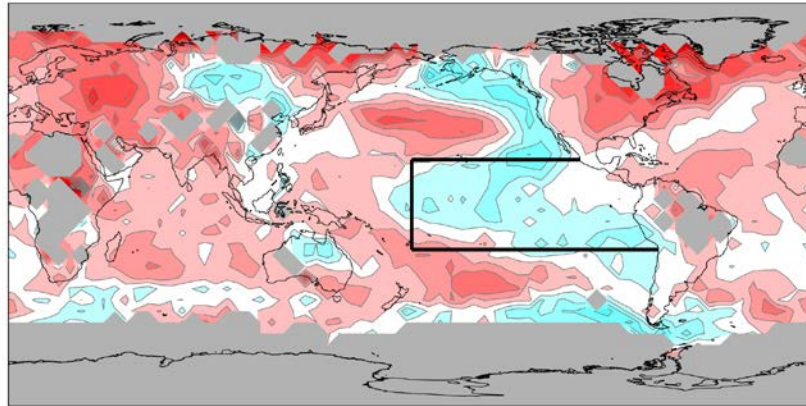
Global mean surface temperature



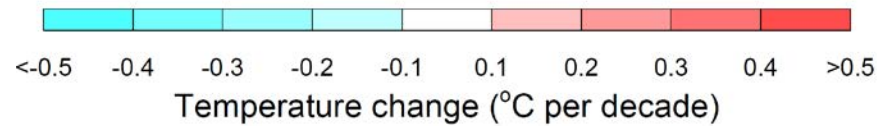
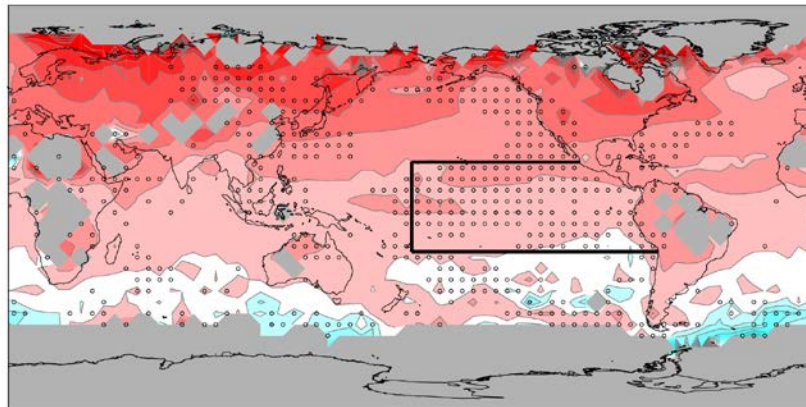
Kosaka & Xie (*Nature*, 2013)

1993-2012

HadCRUT4

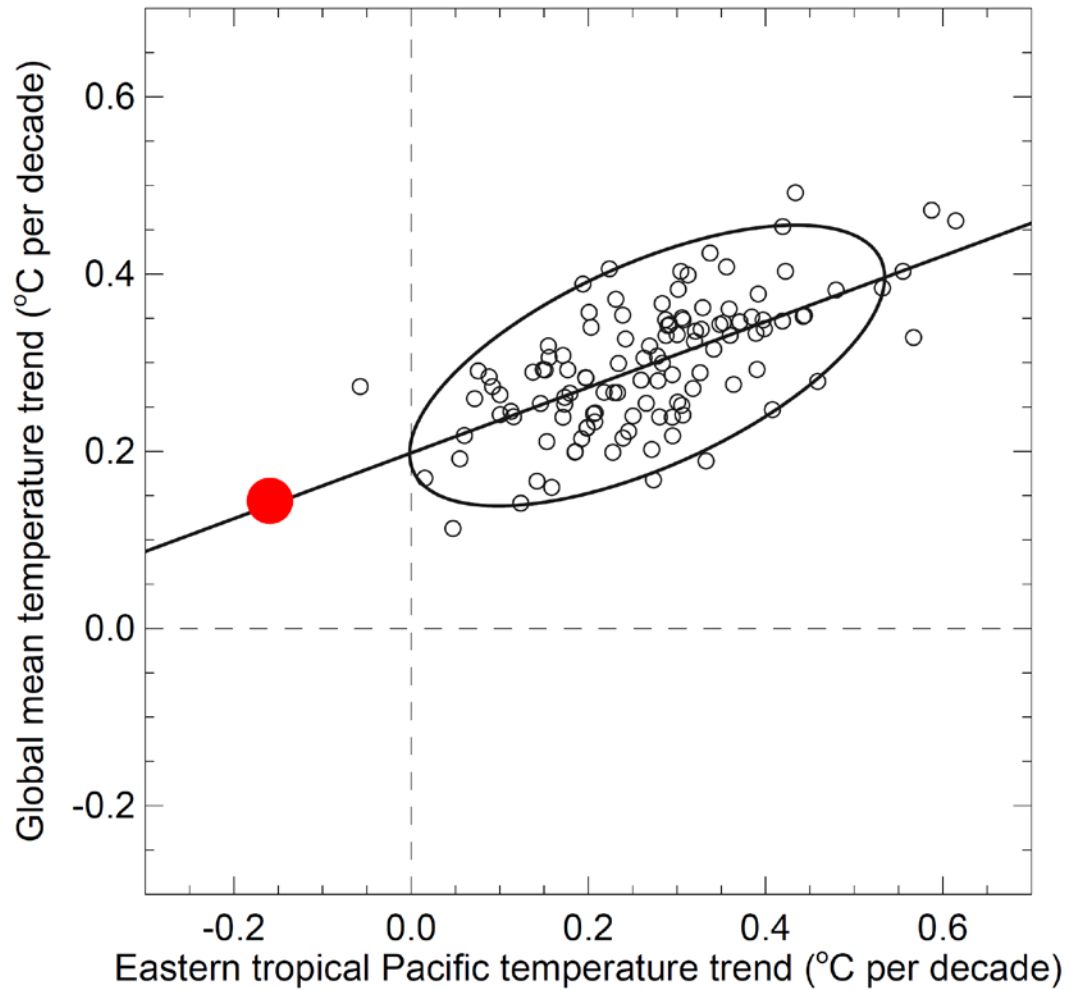


CMIP5

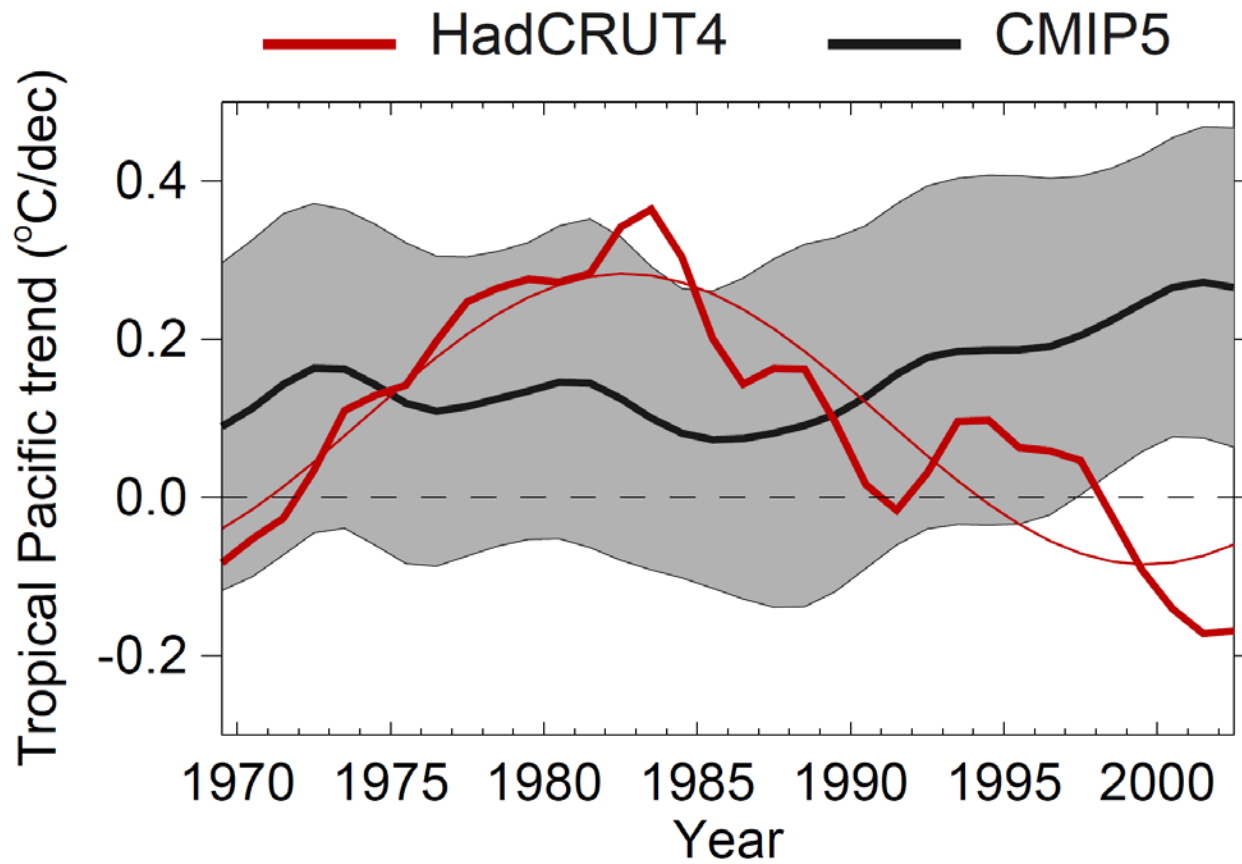


Fyfe & Gillett (*Nature Clim. Change*, 2014)

1993-2012

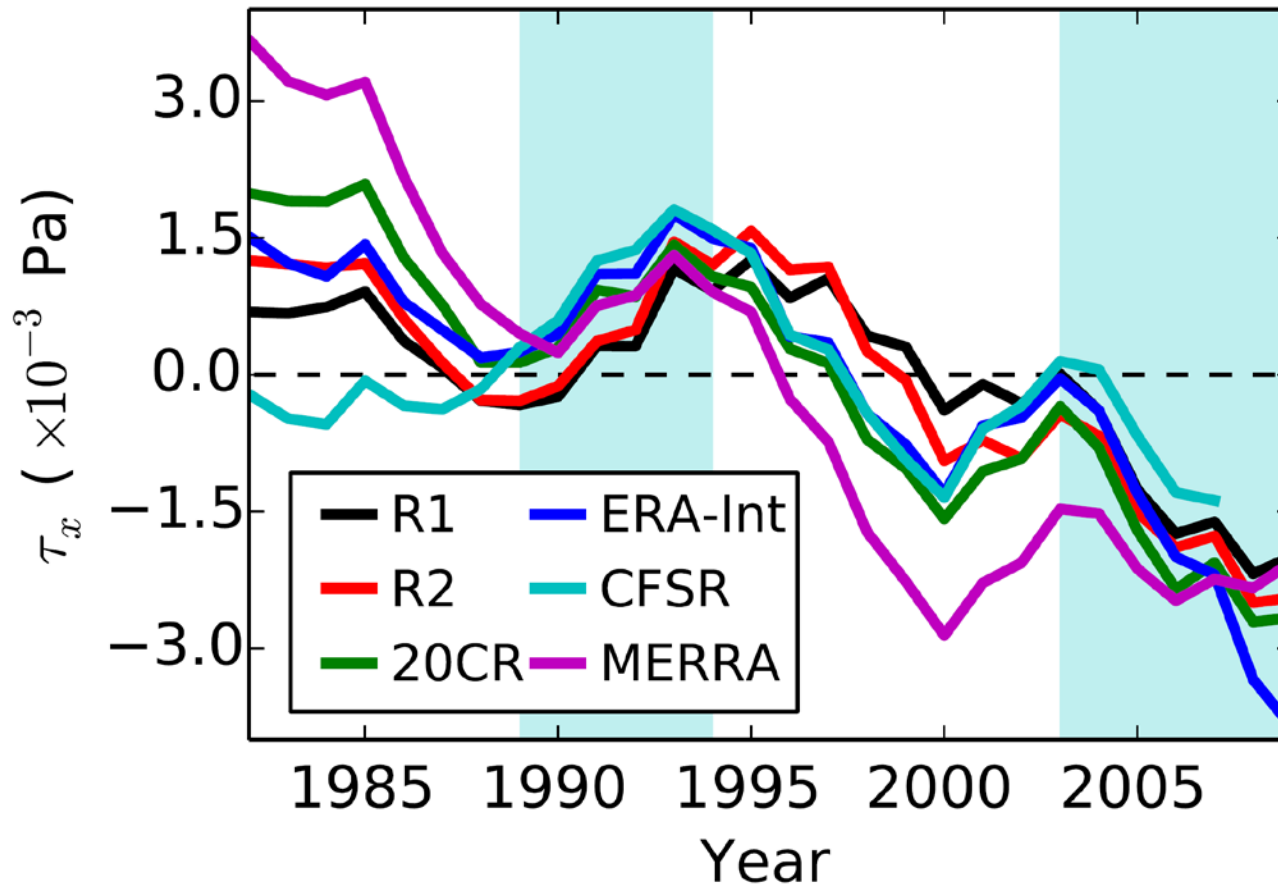


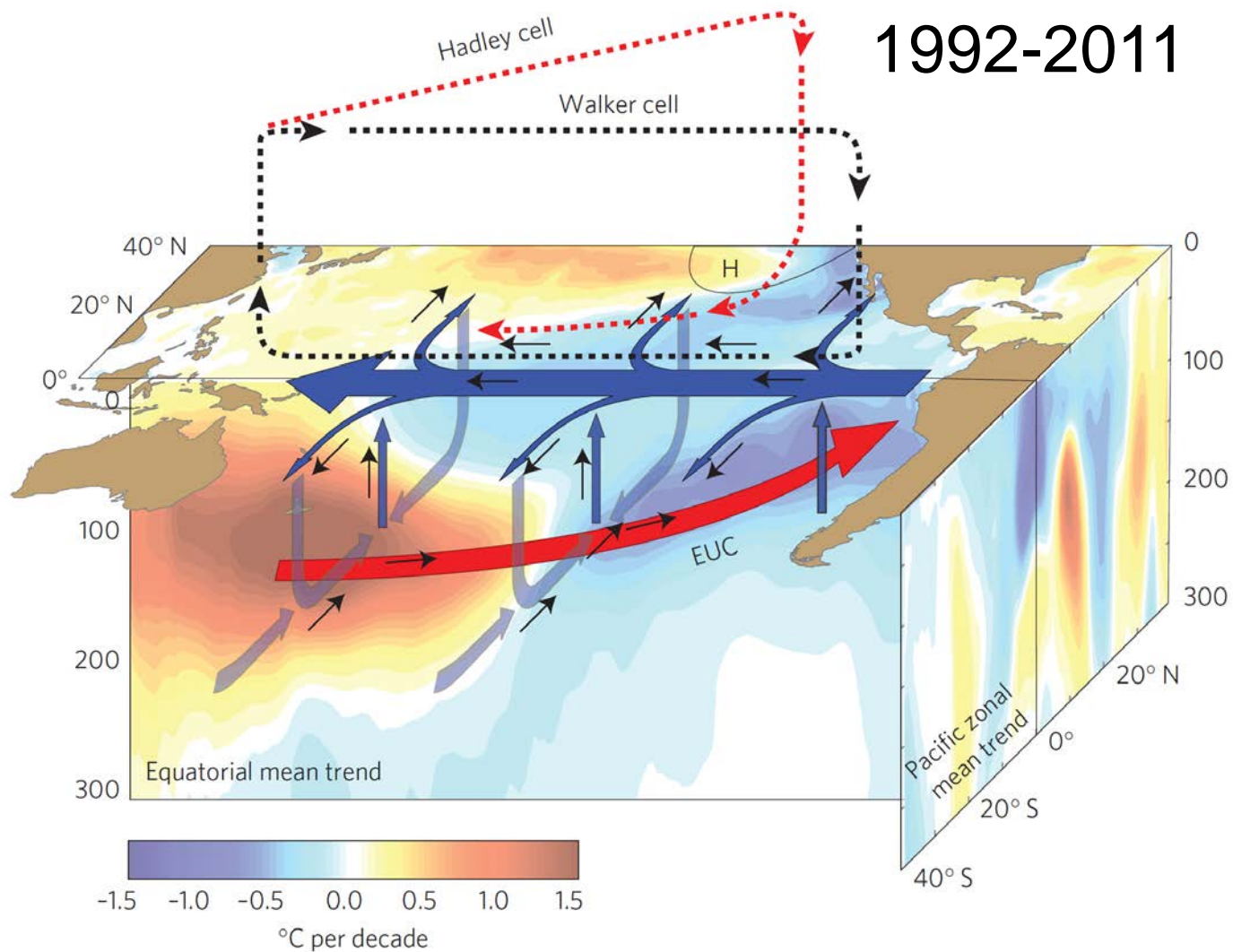
Fyfe & Gillett (*Nature Clim. Change*, 2014)



Fyfe & Gillett (*Nature Clim. Change*, 2014)

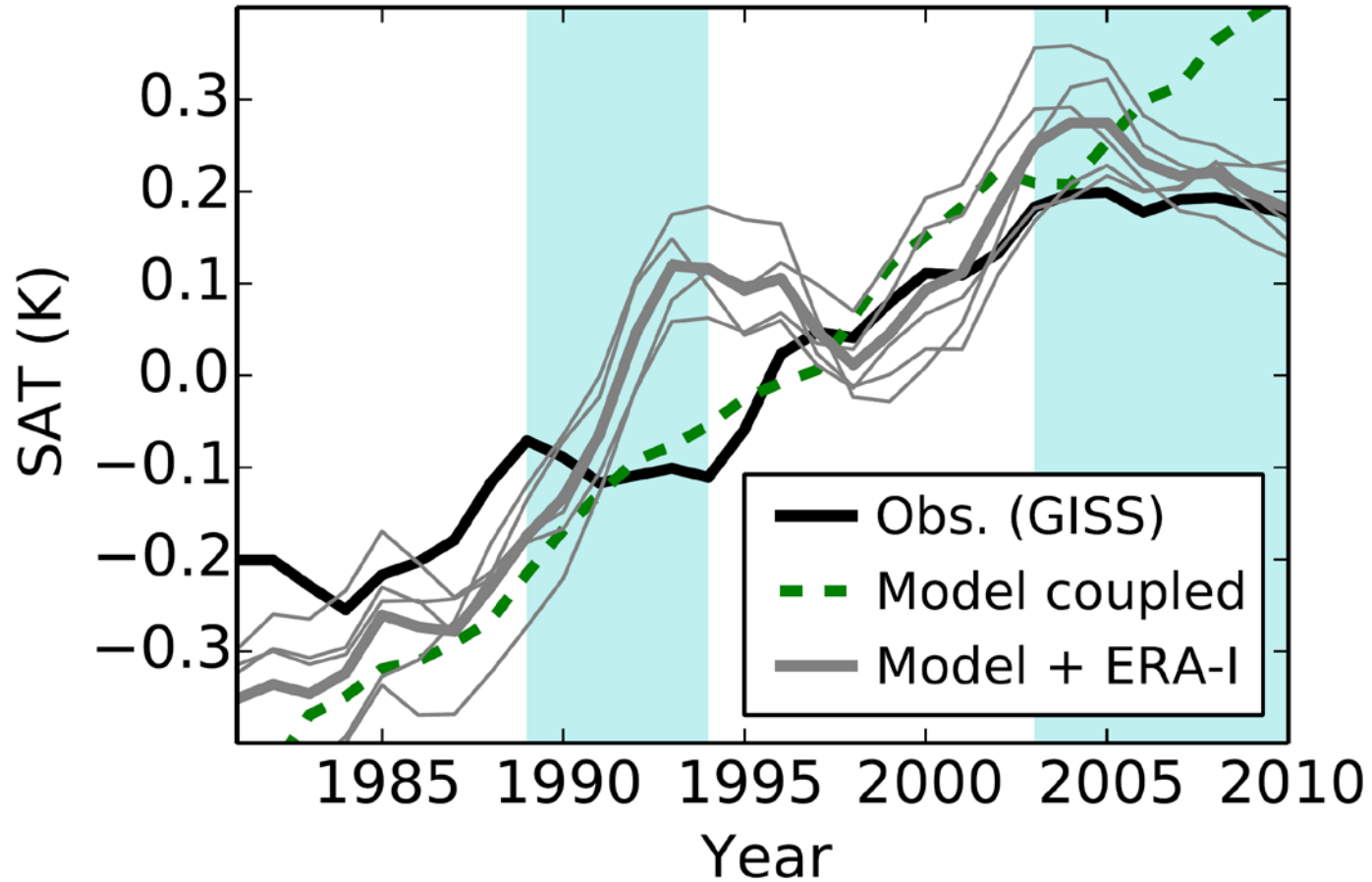
Tropical surface zonal wind stress





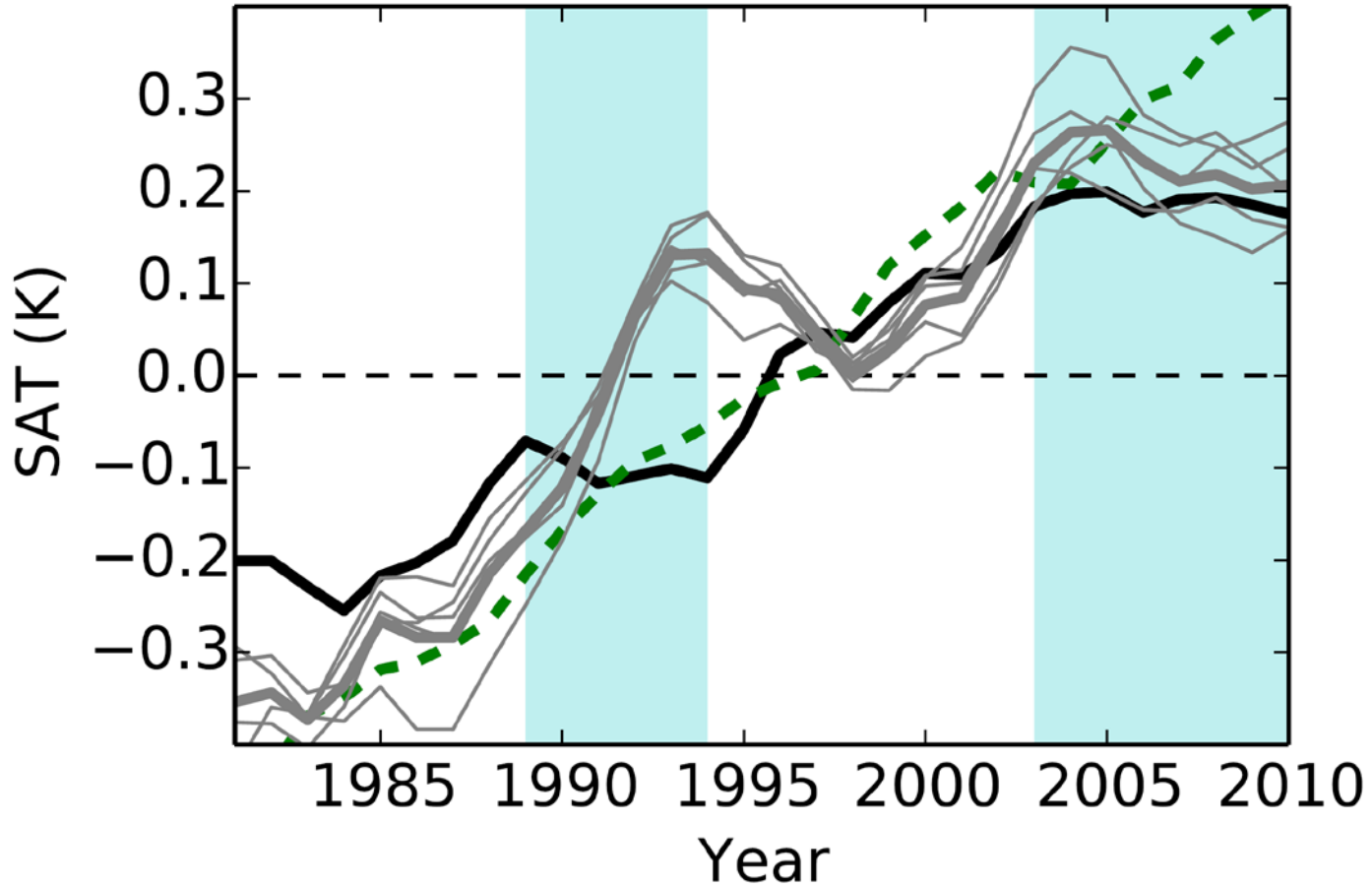
England *et al.* (*Nature Clim. Change*, 2014)

Global mean surface temperature



Saenko *et al.* (in revision)

Global mean surface temperature



Saenko *et al.* (in revision)

The Global Warming Hiatus

John C. Fyfe

Canadian Centre for Climate
Modelling and Analysis



Environment
Canada

Environnement
Canada

Canada 