



# Australian Partnerships in Ice Core Sciences

## Climate modelling activities: Uncertainties in climate forcings

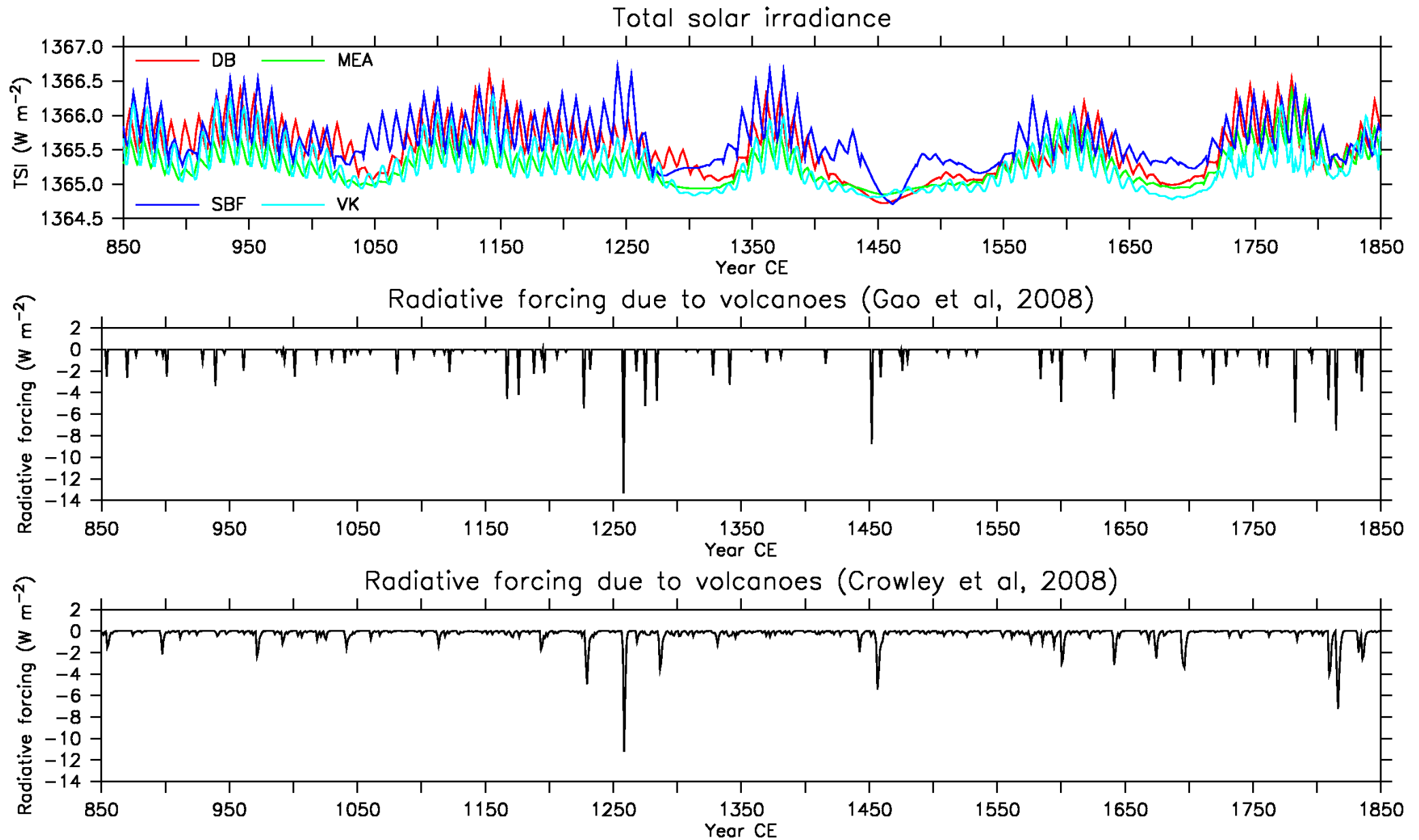
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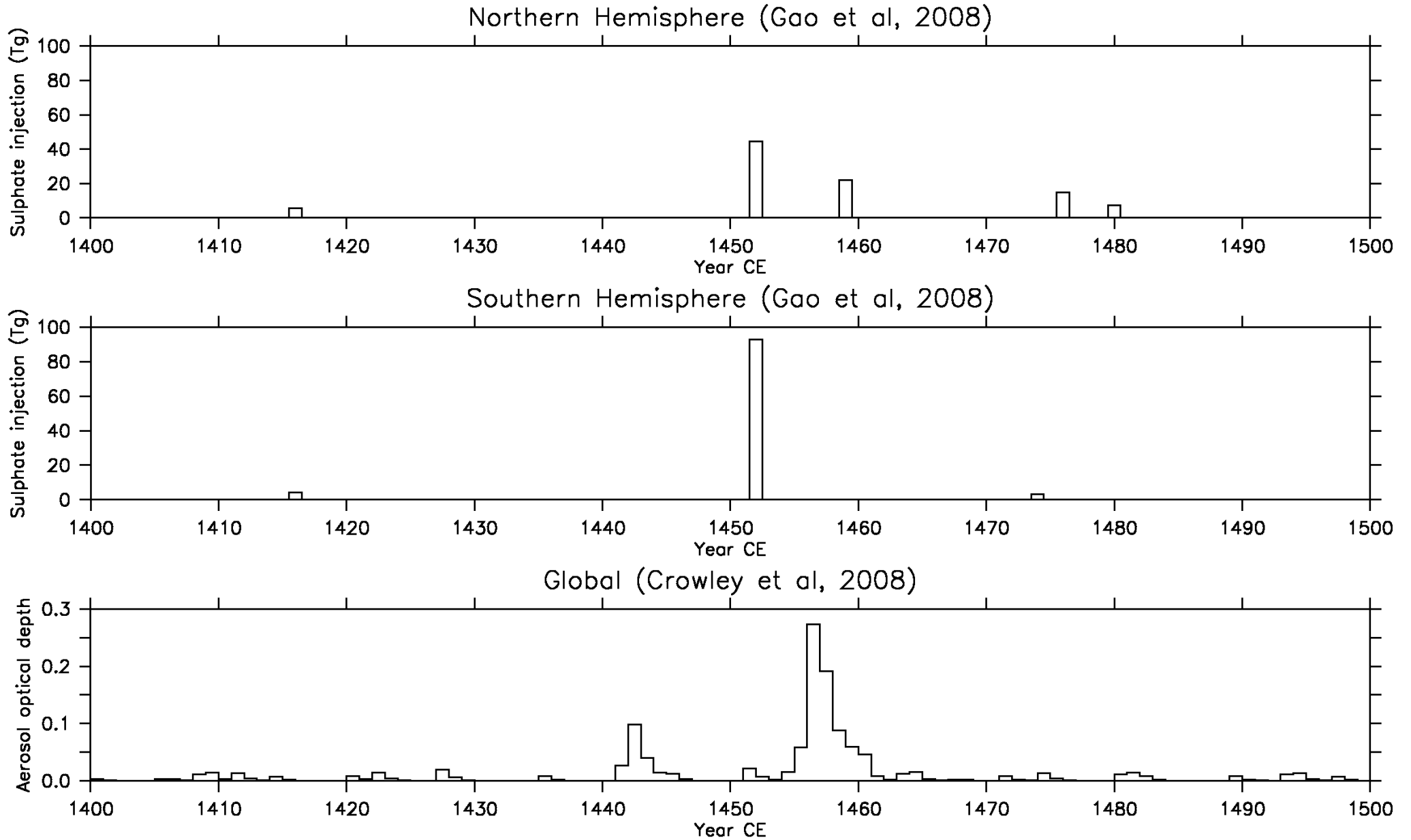
# Climate modelling and data

- The CSIRO Mk3L climate system model (Phipps et al., 2011, 2012):
  - Atmosphere-land-sea ice-ocean general circulation model
  - Multiple transient simulations of the last 2000 years
- Climate forcings:
  - Orbital changes (Berger, 1978)
  - Greenhouse gases (MacFarling Meure et al., 2006)
  - Solar irradiance (Steinhilber et al., 2009)
  - Explosive volcanism (Crowley et al., 2008; Gao et al., 2008)
- Southern Hemisphere temperature reconstruction (Mann et al., 2008):
  - Global network of 1209 annually- and decadally-resolved proxies
  - Used to reconstruct annual-mean temperature for 400–2006 CE

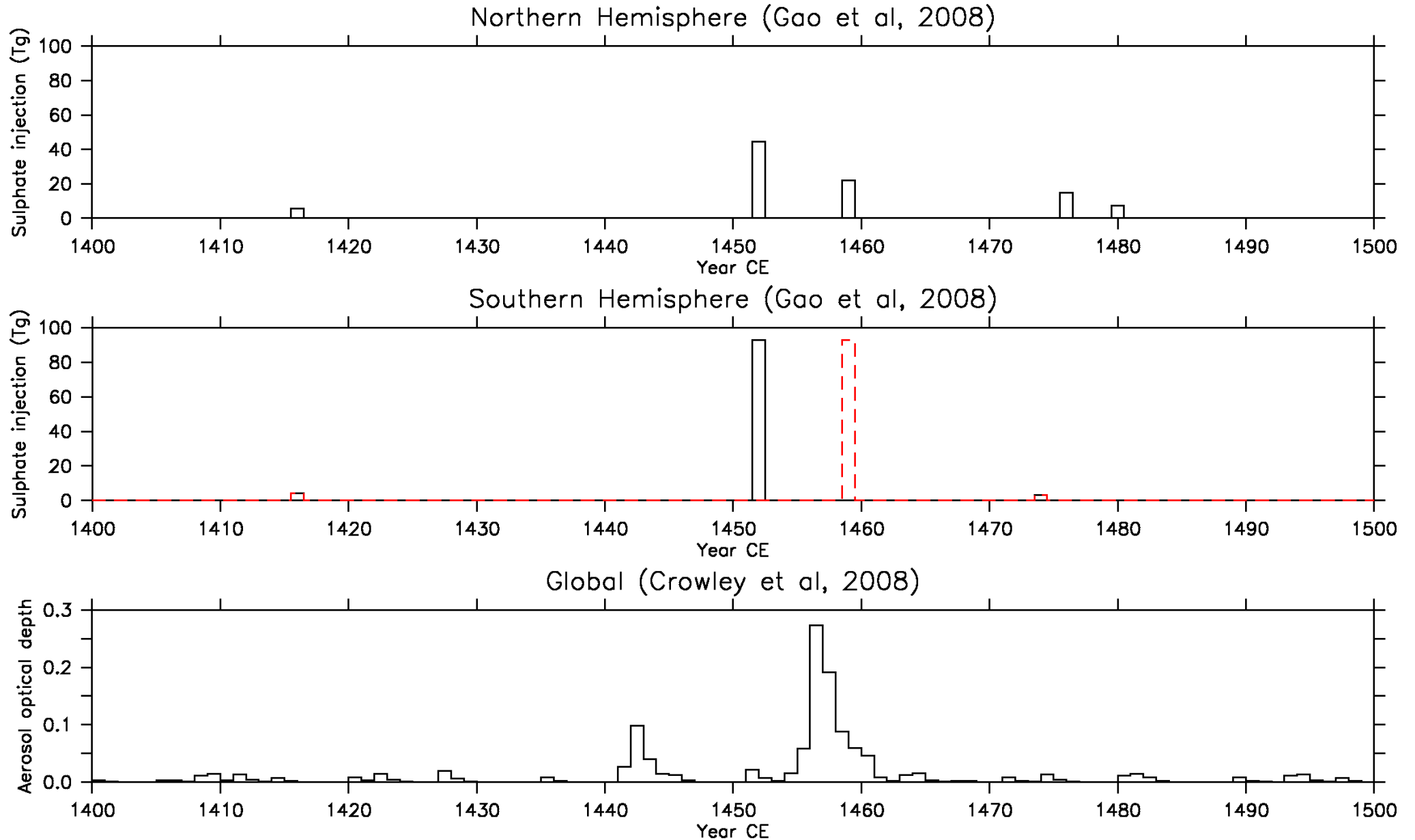
# Solar and volcanic forcing (850–1850 CE)



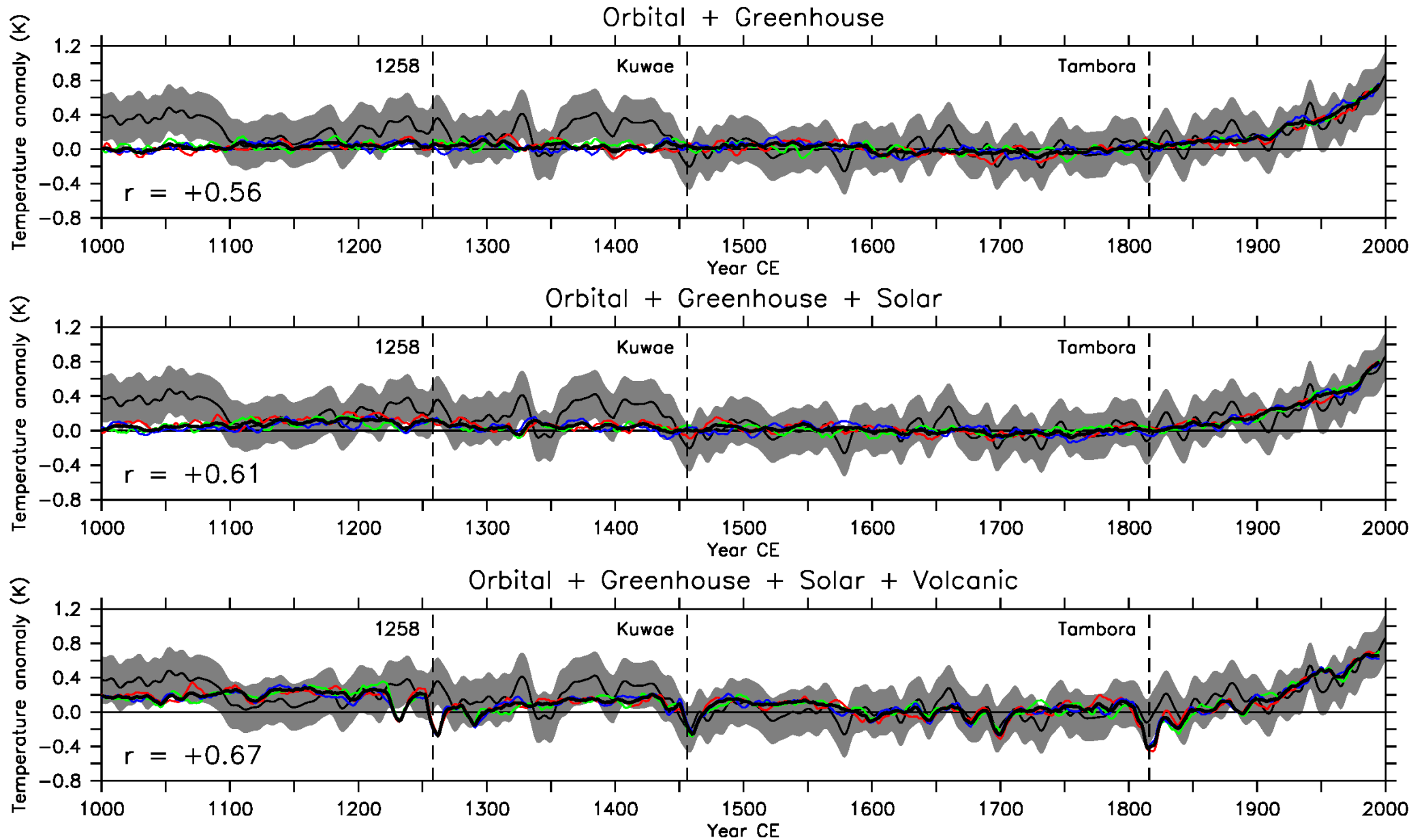
# Volcanic forcing during the 15th century



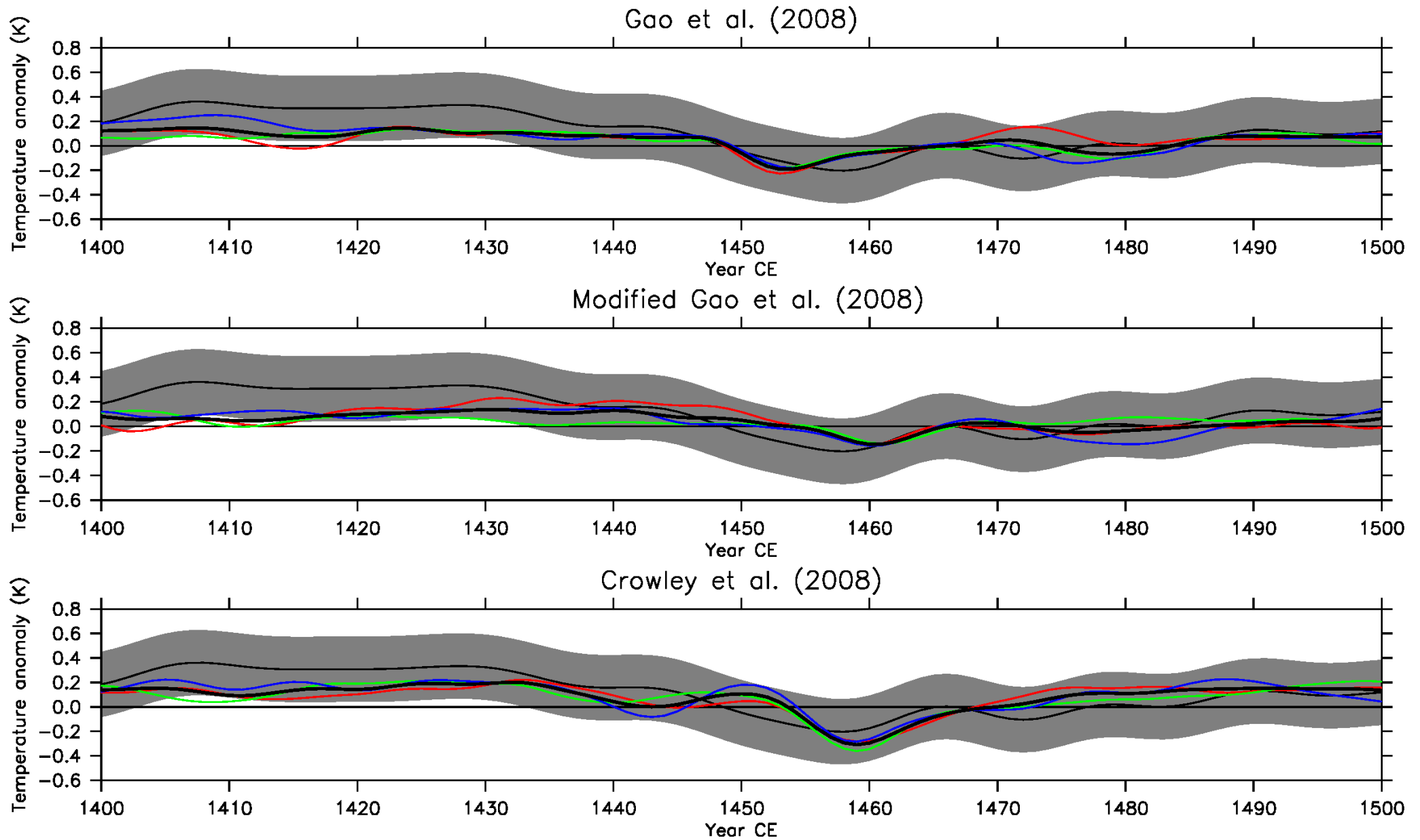
# Volcanic forcing during the 15th century



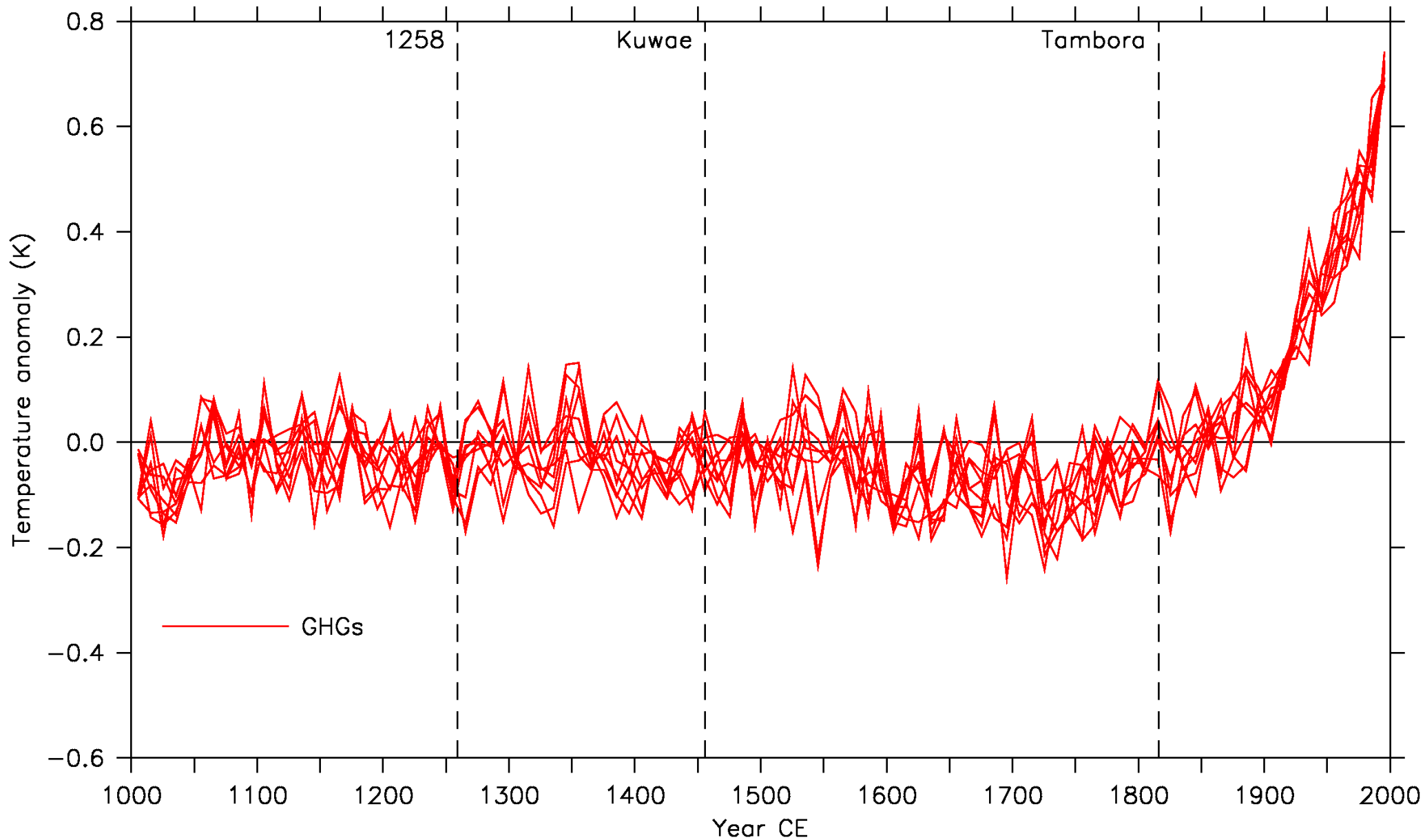
# Drivers of Southern Hemisphere temperature



# SH temperature during the 15th century

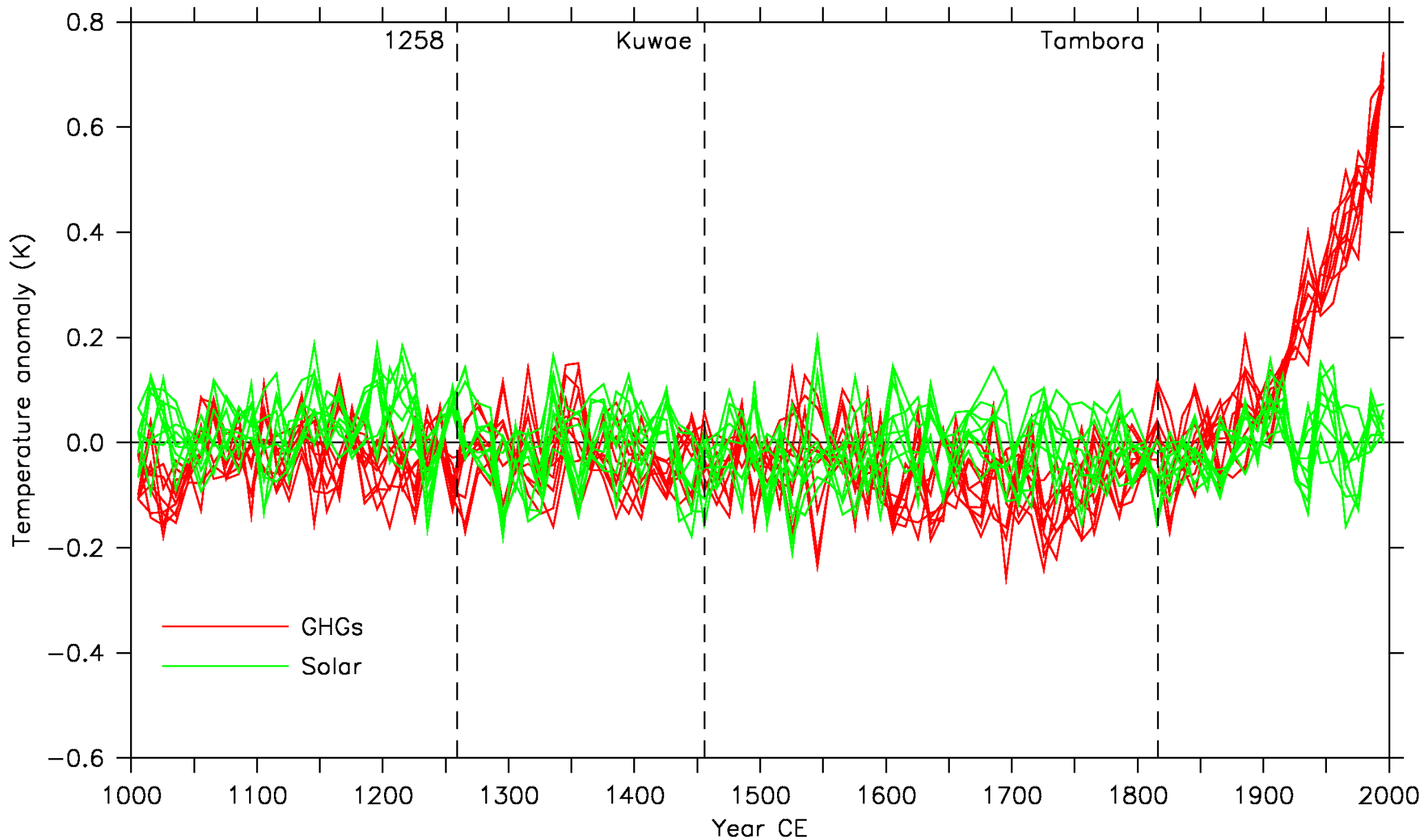


# Simulated “fingerprints” of external forcings

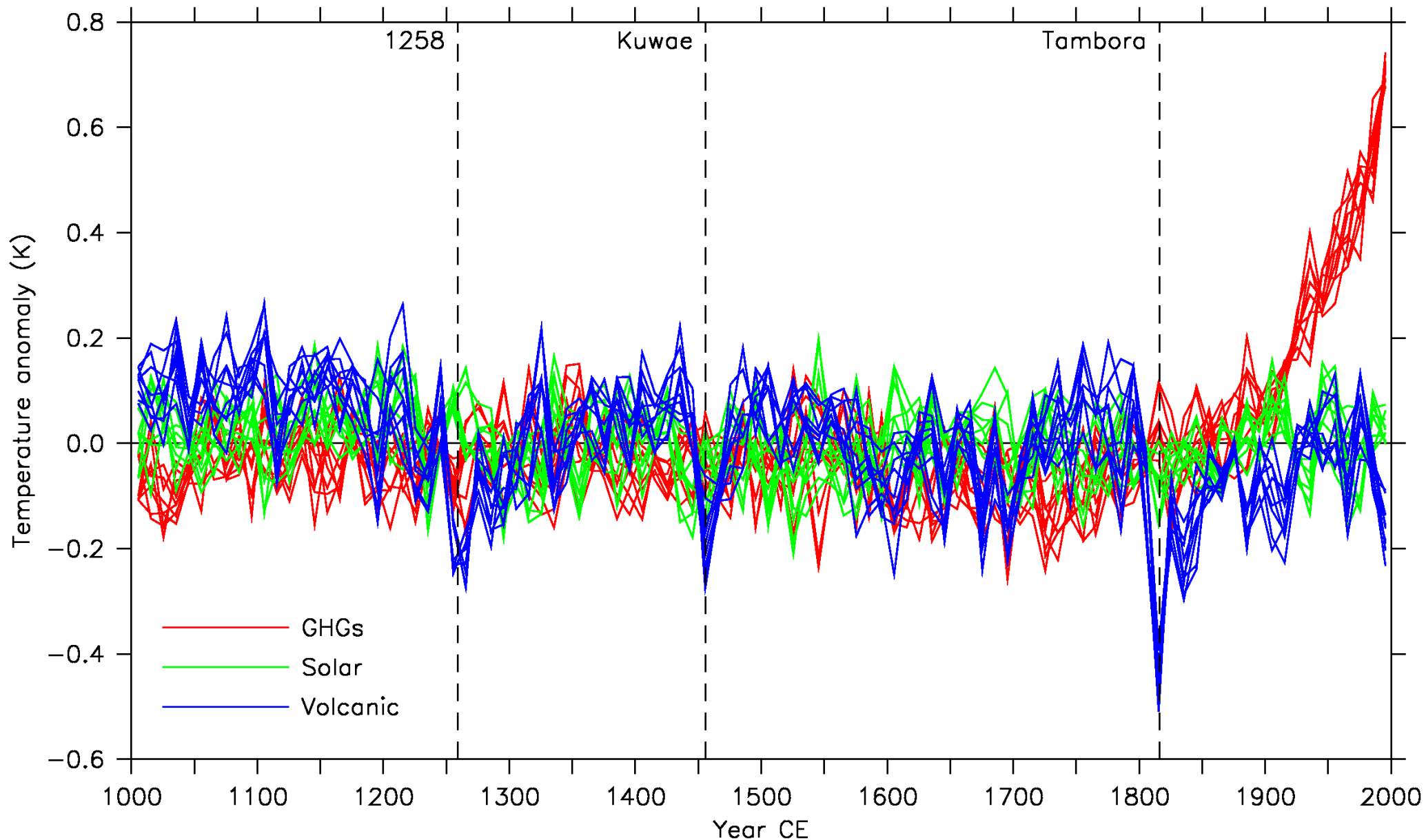




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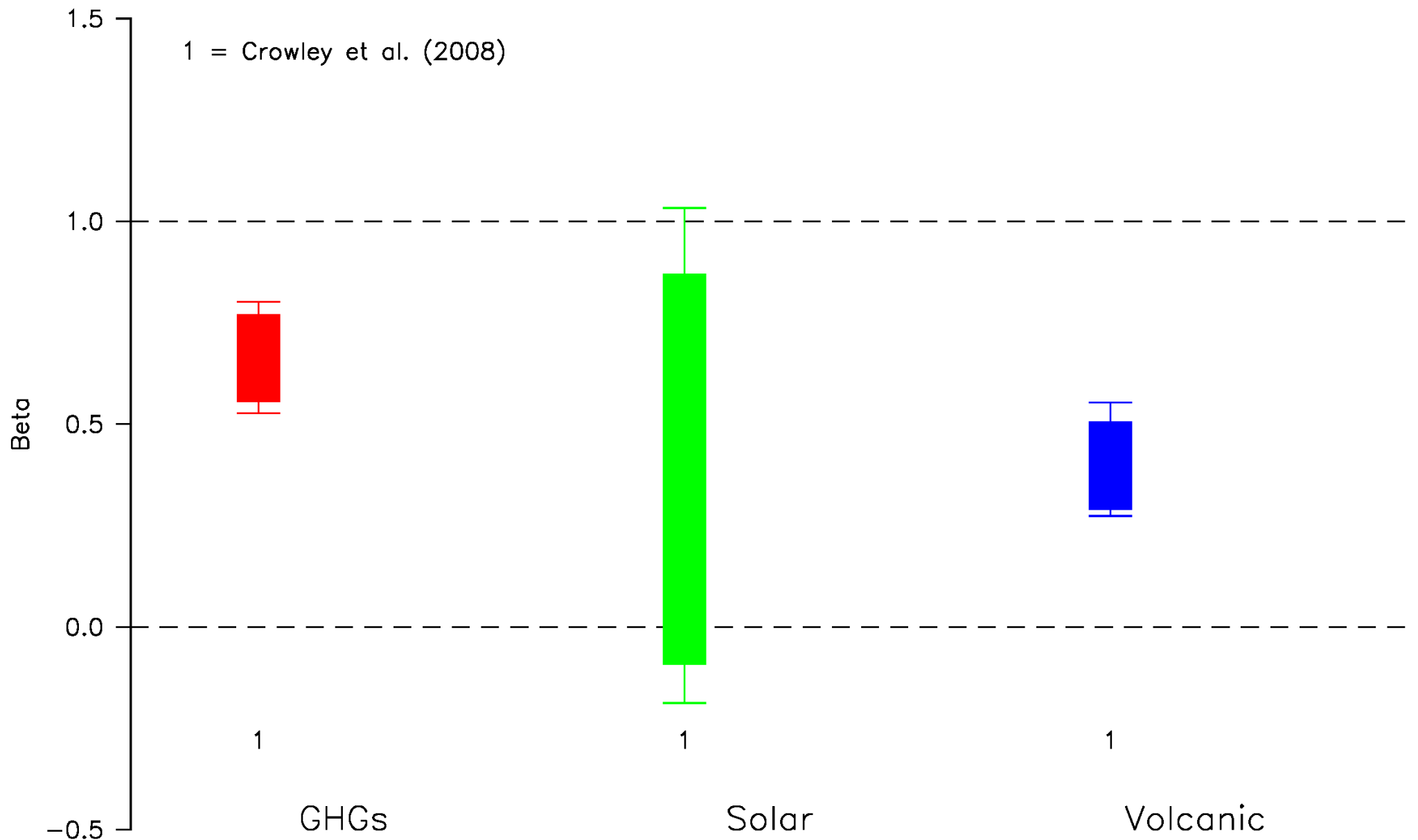


# Detection of externally-forced changes

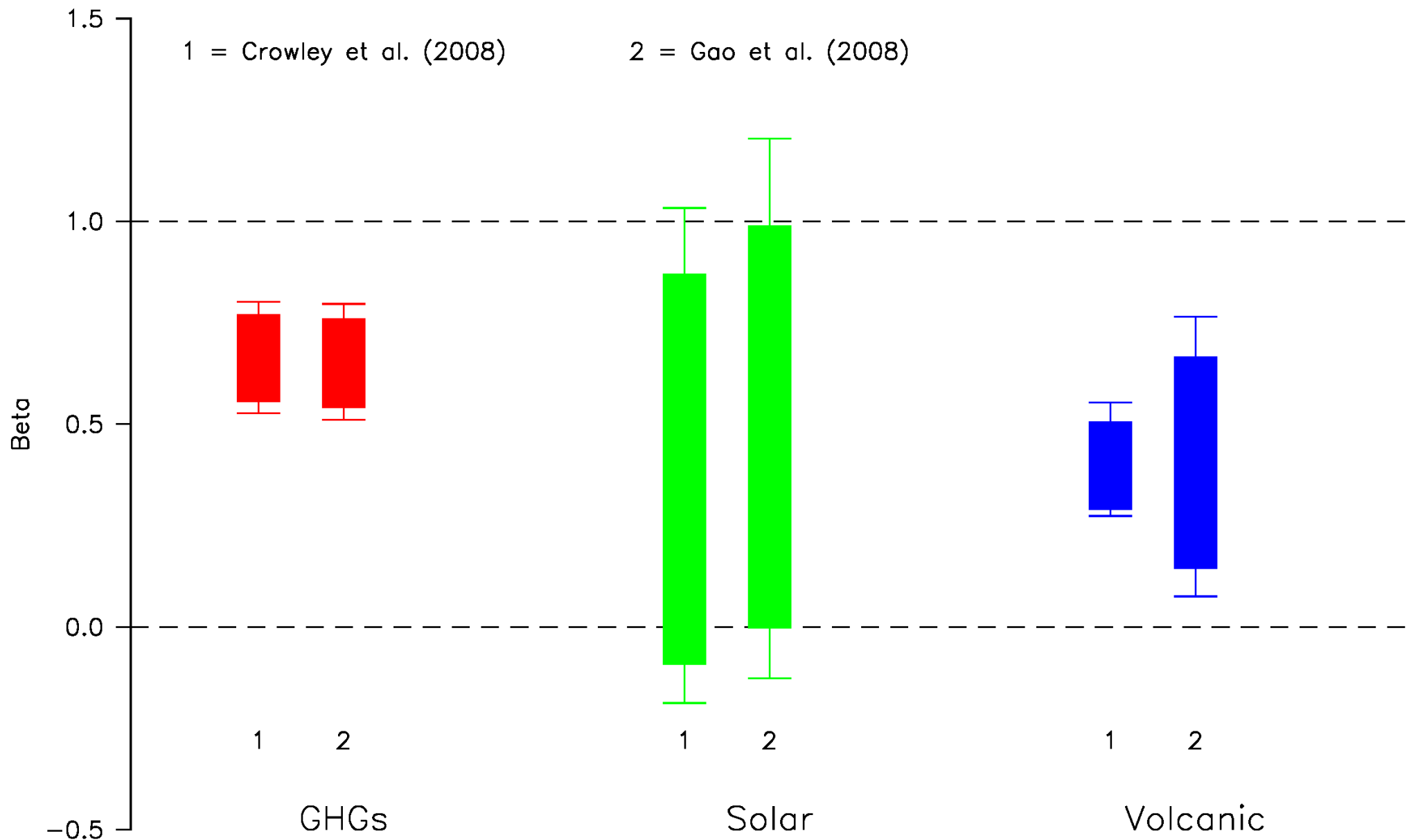
$$\Delta T = \beta_g \Delta T_g + \beta_s \Delta T_s + \beta_v \Delta T_v + \epsilon$$

- If the reconstruction and the model simulations are perfect, then  $\beta \approx 1$ .
- The external signal is detected if  $\beta > 0$ .
- $\epsilon$  will include contributions from:
  - internal climate variability
  - errors in the reconstruction
  - errors in the model simulations

# Southern Hemisphere (1001–2000 CE)



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