What could we learn about climate sensitivity from variability in the surface temperature record?

James Annan¹, Julia Hargreaves¹, Thorsten Mauritsen², and Bjorn Stevens³
¹BlueSkiesResearch.org.uk, Settle, United Kingdom of Great Britain and Northern Ireland (jdannan@blueskiesresearch.org.uk)
²Dept of Meteorology, Stockholm University
³The Max Planck Institute for Meteorology, Hamburg

We examine what can be learnt about climate sensitivity from variability in the surface air temperature record over the instrumental period, from around 1880 to the present. While many previous studies have used the trend in the time series to constrain equilibrium climate sensitivity, it has recently been argued that temporal variability may also be a powerful constraint. We explore this question in the context of a simple widely used energy balance model of the climate system. We consider two recently-proposed summary measures of variability and also show how the full information content can be optimally used in this idealised scenario. We find that the constraint provided by variability is inherently skewed and its power is inversely related to the sensitivity itself, discriminating most strongly between low sensitivity values and weakening substantially for higher values. As a result of this, is only when the sensitivity is very low that the variability can provide a tight constraint. Our results support the analysis of variability as a potentially useful tool in helping to constrain equilibrium climate sensitivity, but suggest caution in the interpretation of precise results.