

In addition to the figures in this supplementary document we have a file (submitted alongside this supplementary document) which includes four additional supplementary tables. The four tables included in the file (and cited in the main manuscript) are:

Table S1. Showing model variant, institution, grid configuration and resolution (obtained from model attributes).

Table S2. ECS (K) for labelled pathways (Fig. 1), when using rtmt, cos(lat) approximation, and the Zelinka et al. (2020) ECS estimates.

Table S3. Showing model top, net radiative flux average over 150 years of the piControl for rndt, rtmt, and the difference between them, and the ECS percentage difference between estimates using rtmt and rndt.

Table S4. ECS uncertainty using a standard bootstrap approach and block bootstrap approach (using block size of 4 years).

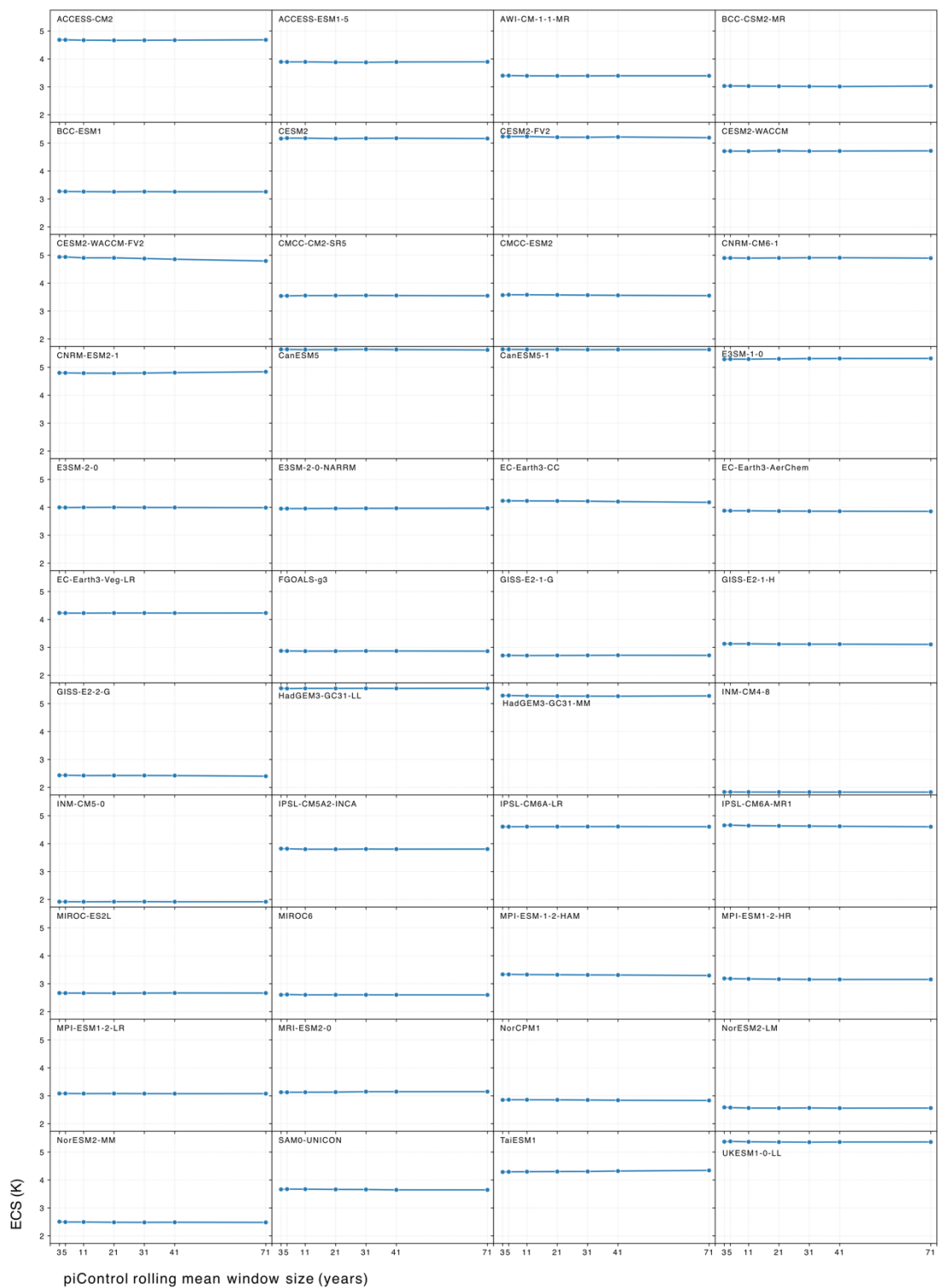
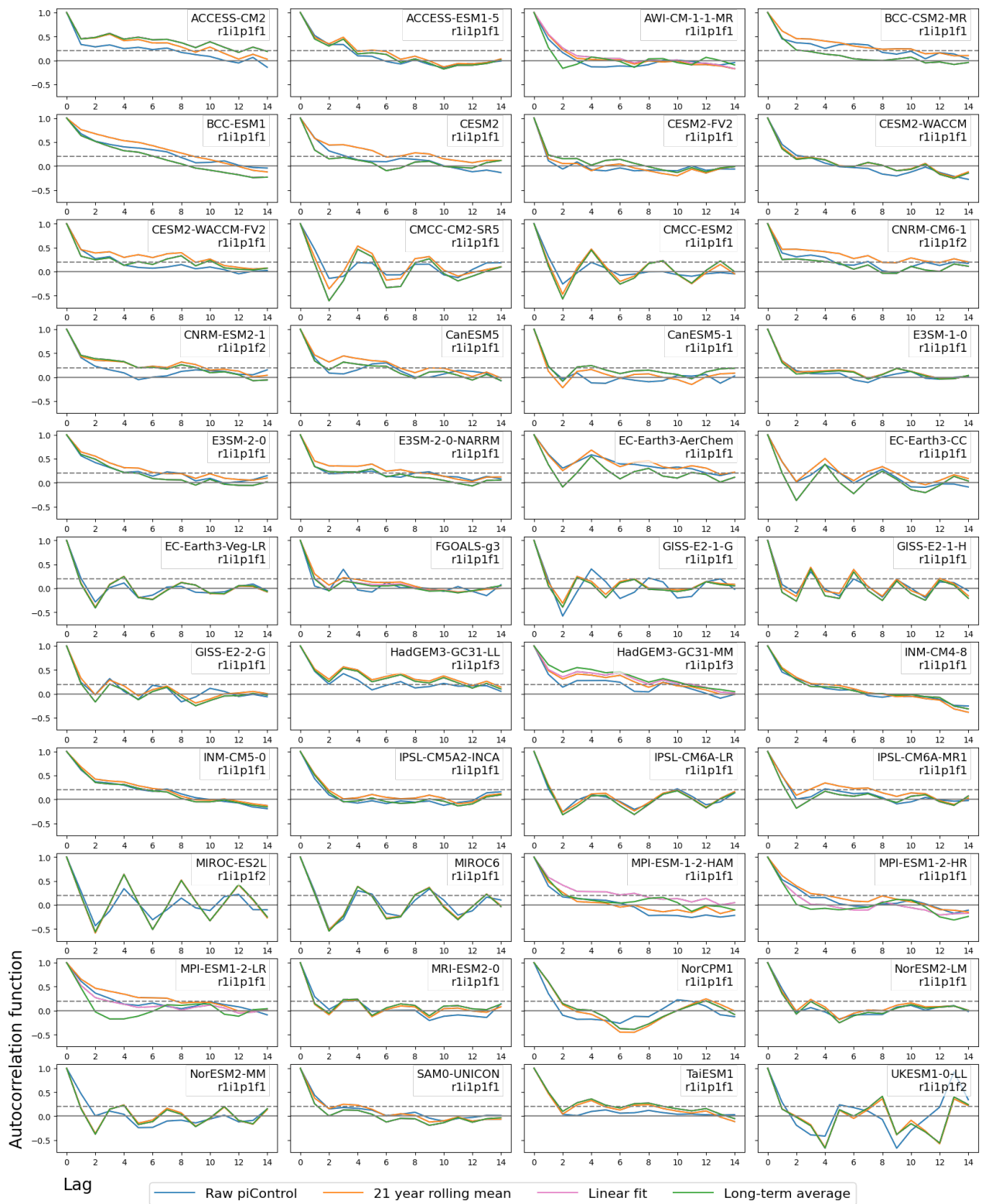


Figure S1. The ECS estimates using ordinary least squares regression calculated using different rolling mean window sizes over the piControl during the anomaly calculation.

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20 **Figure S2.** The autocorrelation function of surface air temperature anomaly timeseries comparing the four alternate anomaly methods (with global mean weighted by cell area), lags 1 to 15 years. The autocorrelation function shows the residuals calculated following the removal of a quadratic fit to years 21-150 of the anomaly between the piControl and abrupt-4xCO₂. We exclude the first 20 years of the timeseries in the interests of optimising the fit over the data to calculate the residuals. We define an autocorrelation value of less than 0.2 as representing decorrelation.

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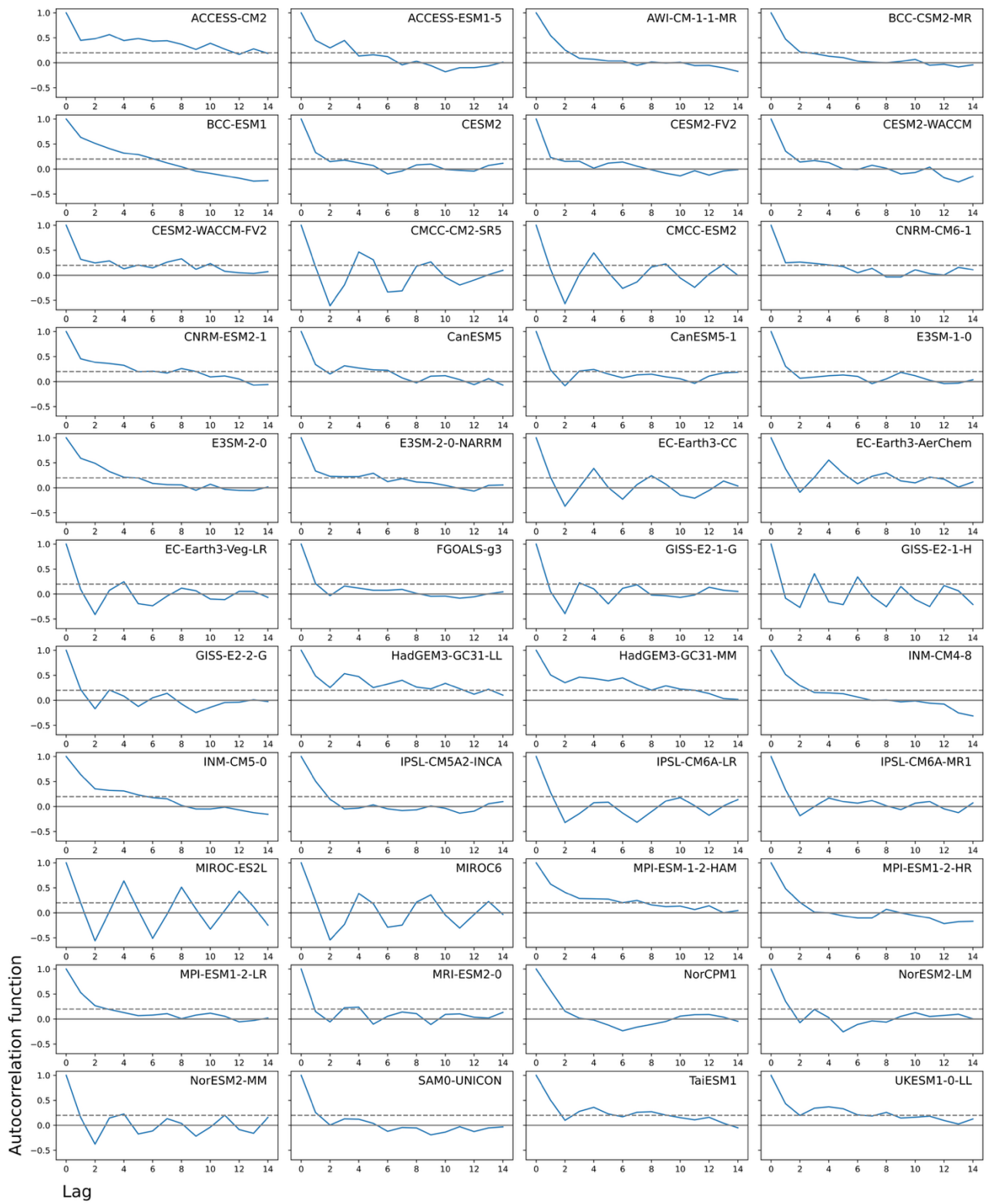


Figure S3. The autocorrelation function of abrupt-4xCO₂ surface air temperature timeseries, lags 1 to 15 years. The autocorrelation function shows the residuals calculated following the removal of a quadratic fit to years 21-150. Note that this is not showing anomalies, just the raw perturbed data. We define an autocorrelation value of less than 0.2 as representing decorrelation.

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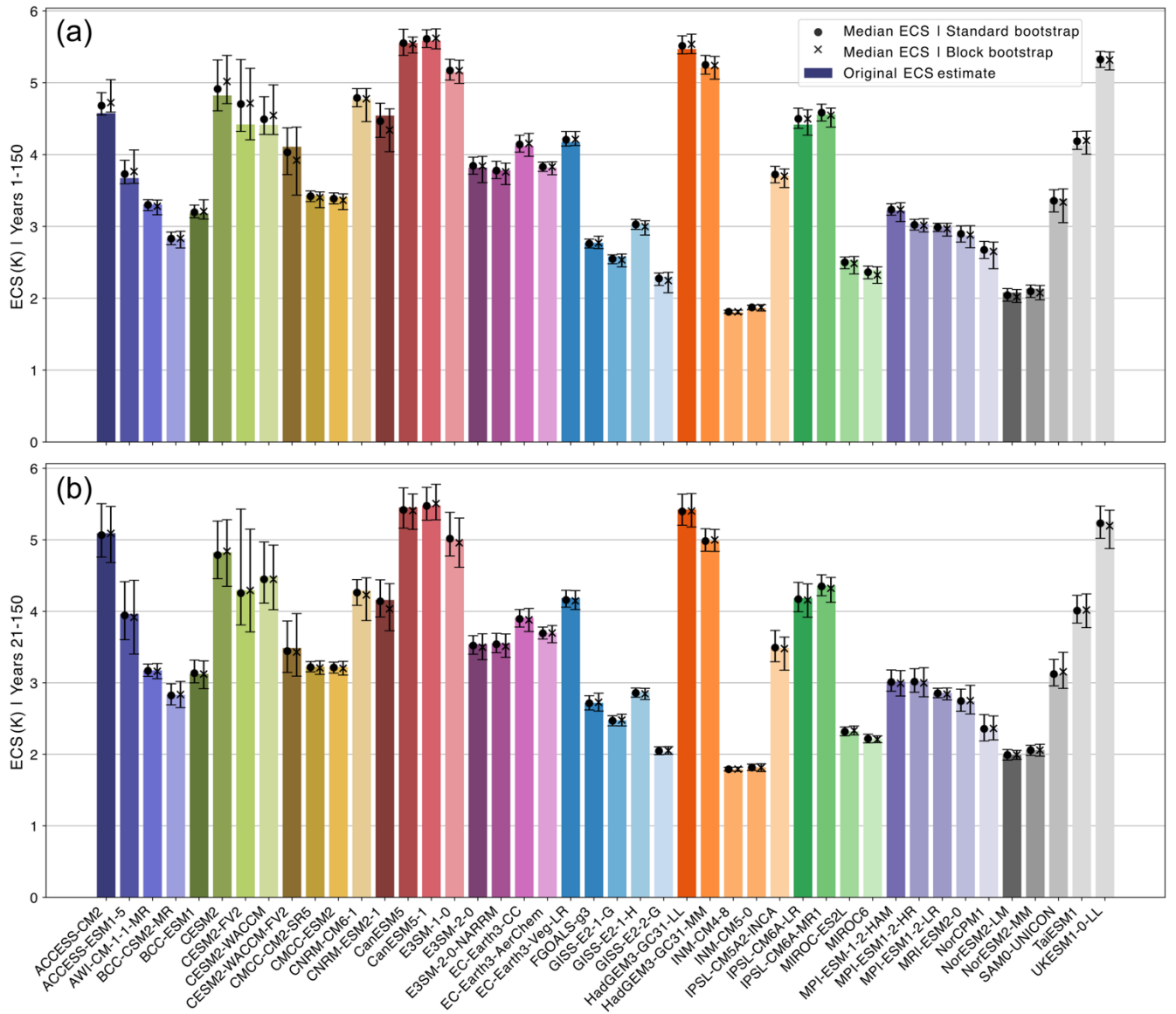


Figure S4. ECS uncertainty using a total least squares regression fit. **a)** ECS estimates for each model using the Baseline Gregory Method pathway, using years 1-150. Bars represent 95% confidence intervals, with medians calculated using a simple bootstrap (solid circle) and a moving block bootstrap with a block size of 4 (cross). **b)** The same as (a), but the ECS and bootstrap uncertainties are calculated using years 21-150 of the N and ΔT anomaly timeseries. See Methods for details on confidence interval calculations.