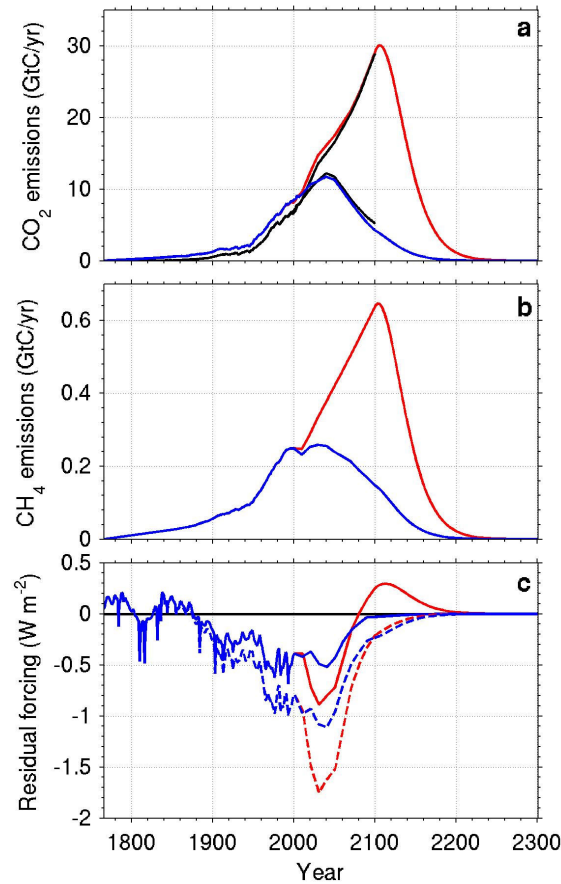
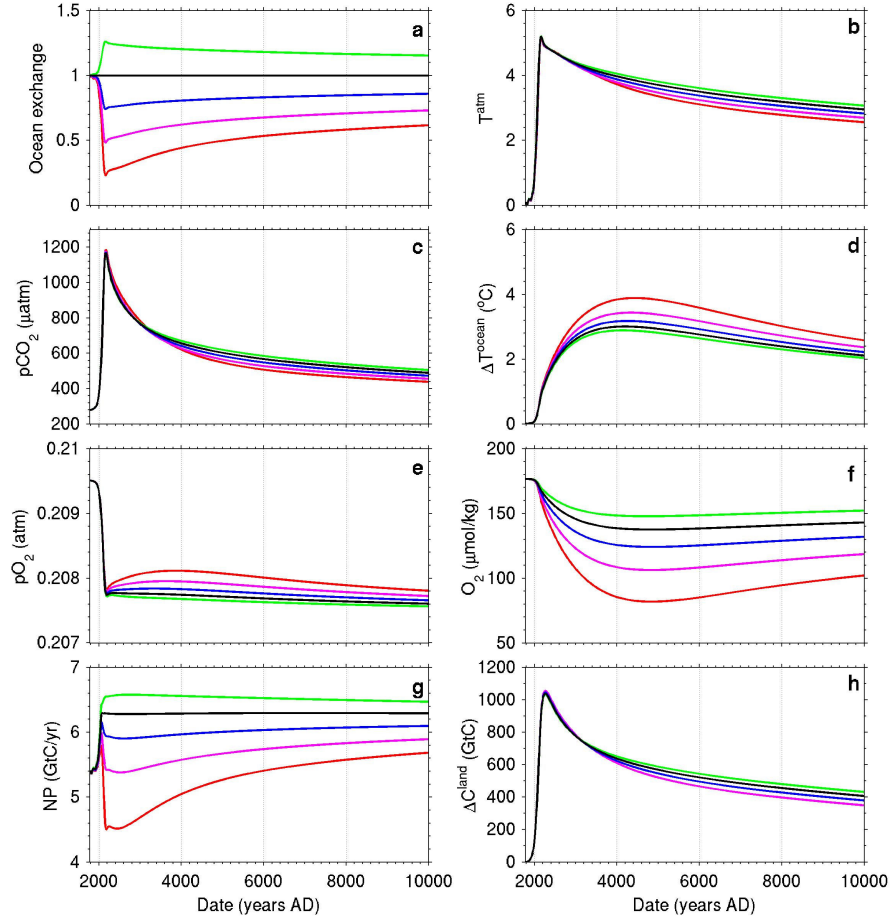




Supplementary Figure 1 | Projection forcing details. **a**, The black line from 1765 to 2004 AD shows fossil fuel CO₂ emissions¹². In this interval, the blue line above this line shows the sum of land use change and fossil fuel CO₂ emissions. Land use change emissions for 1860 to 1950 AD are from ref. 13. Linear interpolation from an assumed zero value at 1765 AD have been used prior to 1860 AD. For 1950-1980 AD, values from ref. 13 were multiplied by a factor varying linearly from 1 to 0.73 over this period and, for 1980 to 2000 AD, were multiplied by 0.73 to yield mean values of about 1.4 and 1.6 GtC yr⁻¹ for the 1980's and 1990's, respectively¹⁰. The black lines from 2004 to 2100 AD show CO₂ emissions from fossil fuel burning for Illustrative Marker SRES scenarios²⁷ B1 and A2. Blue and red lines between 2000 and 2100 AD show total land use change and fossil fuel emissions for the B1 and A2 scenarios²⁷, but with use of observed fossil fuel emissions until 2004 AD¹². After 2100 AD, both scenarios for total CO₂ emissions are extrapolated using polynomial functions such as to tail off by the late 21st or early 22nd centuries. **b**, The blue line from 1765 to 2000 AD shows anthropogenic CH₄ emissions. Values from 1860 to 1994 AD are from ref. 14 minus a constant value of 0.04 Gt(CH₄) yr⁻¹, our estimate for anthropogenic, pre-industrial emissions included in our land biosphere emissions⁹. Linear interpolation from a zero value at 1765 AD has been used prior to 1860 AD. Values for 1995 to 2000 AD were assigned the “corrected” 1994 value. Blue and red lines between 2000 and 2100 AD show anthropogenic CH₄ emissions for the B1 and A2 scenarios²⁷. After 2100 AD, these scenarios are extrapolated as described above. For simplicity, we take anthropogenic N₂O emissions for the projections (not shown) to be proportional to those of CH₄ (in units mol s⁻¹) with a proportionality constant of 0.007, determined by model fit to N₂O observations. **c**, The solid blue line until 2000 AD shows residual radiative forcing calculated from results in ref. 11 by subtracting radiative forcing due to CO₂, CH₄, and N₂O from

total radiative forcing that includes the effects of major and minor greenhouse gases, aerosols and solar radiation changes. Solid blue and red lines between 2000 and 2100 AD show the residual radiative forcings for the B1 and A2 scenarios²⁷ with 3.0°C climate sensitivity. Dashed blue and red lines show modified residual forcings for the B1 and A2 scenarios with 4.8°C climate sensitivity whereby the (negative) indirect aerosol part of these forcings has been enhanced by 50% (see text). After 2100 AD, these scenarios are extrapolated as described above.



Supplementary Figure 2 | Atmosphere and ocean property evolutions for the A2 scenario projection with 3.0°C climate sensitivity and varying ocean overturning and convection. Green, blue, violet and red lines are for projections with values of 0.05, -0.05, -0.10 and -0.15, respectively, for the parameter B that relates model ocean deep overturning and high latitude convection changes to atmospheric temperature changes (see equation 1 and accompanying text). The black lines are for the projection with constant, pre-industrial ocean exchange. **a**, Deep ocean overturning and high latitude convection scaled by pre-industrial values. **b**, Mean atmosphere temperature change relative to the pre-industrial climate state. **c**, Partial pressure of atmospheric CO_2 . **d**, Mean ocean temperature change relative to the pre-industrial state. **e**, Partial pressure of atmospheric O_2 . **f**, Mean ocean dissolved oxygen concentrations. **g**, Total ocean new production. **h**, Land biosphere carbon stock change relative to the pre-industrial level.