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Climate sensitivity estimated from top-of-atmosphere net radiation

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This study tries to estimate climate sensitivity using top-of-atmosphere (TOA) net radiation observations and an energy balance model. The considered time-scales generally cover from decade to century, which is directly related to the climate issue caused by atmospheric CO2 change. The significant advance of current model over previous energy balance models is that the current model targets at boundary condition problems instead of solving initial condition problems. Additionally, the system memory and deep ocean heat transport of the climate system are considered. The climate feedbacks are obtained based on the constraints of the TOA net radiation and surface temperature measurements of the present climate.
Currently, the measurements of TOA net radiation may not have high enough absolute accuracy to decide global mean ocean heat uptakes although the precision of satellite TOA radiation observations is very high. Available estimations of the radiation are mainly based on ocean heat storage observations. These estimations indicate that TOA net radiative heating to the climate system is about 0.85 W/m2. Based on this value, a positive climate feedback with a feedback coefficient ranging from –1.3 to –1.0 W/m2/K is found. The range of feedback coefficient is determined by climate system memory. The longer the memory length of climate system, the stronger the positive feedback is. The estimated time constant of the climate is large (70 $\sim$ 120 years) mainly owing to the vertical heat transport of deep ocean, implying that the system may be not in an equilibrium state under the external forcing during the industrial era. For the doubled-CO2 climate (or 3.7 W/m2 forcing), the estimated global warming would be 3.1 K if the current TOA net radiative heating is indeed 0.85 W/m2. With accurate long-term measurements of TOA radiation, the analysis method suggested here provides a great potential in the estimations of the climate sensitivity.