Session: B12 Oral presentation

Climate response to carbon dioxide and solar forcing: sensitivity to forcing and sensitivity to forcing-induced temperature change

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One core issue in global climate change is to understand how climate system responds to imposed forcing, such as greenhouse gas forcing due to man-made carbon dioxide and natural forcing due to solar variability. The response of climate system to climate forcing occurs over different time scales. Over the timescale of days to months before significant surface temperature change occurs, the atmosphere adjusts rapidly to the imposed forcing and causes changes in climatic fields such as precipitation and cloud. Over a time scale of years to decades when surface temperature change becomes significant, atmosphere responds directly to the change in surface temperature. We perform ensemble Hadley Center climate model simulations to investigate climate response over different time scales to three types of forcings: CO2-radiative forcing associated with its greenhouse effect, CO2-physiological forcing associated with its effect on plant stomata, and solar forcing. For each type of forcing, we analyze the magnitude and pattern of the forcing-induced climate change and temperature-induced climate change. Our results show that as for the part of climate change associated with rapid atmospheric adjustment to the imposed forcing, pronounced differences are found between these three forcings. In contrast, as for the part of climate change associated with surface temperature change, strong similarities are found between these forcings. Our results also show that, within the magnitude of forcings considered, total climate response can be approximated reasonably well by the linear combination of forcing-induced response and temperature-induced response. Physical mechanisms responsible for the different climate responses to different types of forcings and the implication of this study will be discussed.