Session: B9 Oral presentation

Exploring uncertainty in stratosphere-resolving climate simulations of the Maunder minimum

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The Maunder minimum, which occurred approximately between 200-400 years ago, was a time of lower solar activity, as shown by a number of proxies for solar radiation, such as sunspot activity. It has been known for some time that a decrease in solar activity is far from being a simple lowering of total solar irradiance or TSI. Any change is actually amplified in the ultraviolet (UV) region of the solar spectrum; indeed, recent results suggest that the majority of the change in activity is concentrated in the UV, with the TSI change being very small. The pattern of the surface climate response is sensitive to the nature of the spectal distribution of solar activity variability, since a change in the UV can affect both the composition and circulation of the stratosphere, which in turn can dynamically influence winter tropospheric weather in the mid-to-high latitudes. We present simulations of a stratosphere-resolving climate model in which we conduct sensitivity studies with three important parameters: TSI, UV, and stratospheric ozone. The climatic response to TSI reduction is similar and opposite to the well-known pattern from greenhouse gas increase. However, the pattern of response to UV and stratospheric ozone reduction are markedly different: while the globally averaged radiative forcing and surface temperature change is small, a significant cooling is displayed over the northern hemisphere, particularly Europe, during winter and spring, which is dynamically influenced by stratospheric changes. The results show that the effect of solar variability on surface climate is very sensitive to the spectral nature of any solar change, and simulations of solar variability on climate need to simulate spectrally dependent radiative forcing, stratospheric composition changes, and dynamical links between stratosphere and troposphere, in order to properly represent geographical and seasonal variations in the surface and near-surface response.