

Review of Adjustments to an abrupt solar forcing in the CMIP6 abrupt-solm4p experiment,
Lange and Quaas

This paper looks in detail at the evolution of the climate system in response to an abrupt reduction in 4% incoming shortwave radiation. The authors have addressed several of the key points from previous reviews, but some minor details should be adjusted before publication.

Main Comments:

Figure 1: it appears by eye that the yearly anomalies plotted follow a gradient in color. Based on the plots I can only assume that the gradient corresponds to the year plotted, with darker years being older? This should be clarified in both the caption and potentially a colorbar added to the figure.

Lines 225-235: The authors discuss nonlinearities in the response of SW up, a departure from the linear behavior of the first decade. However, these nonlinearities do not jump out from the referenced Figure (1c). Differentiating the first 10 years of the response in the figure could remedy this.

Lines 239-246: The mechanisms behind the counteracting cloud adjustments should be discussed. Are these dominated by changes in BL clouds? Do these adjustments come from reductions in the optical thickness of such clouds, or changes in the areal coverage of clouds, and do the 4 models agree on the origin of these adjustments? As mentioned, perhaps the magnitude differs among the ensemble, but the different contributions to the cloud adjustments may be partitioned similarly across models.

Sect 3.2.1: The response in the first month of the forcing is interesting, particularly the warming over the Arctic, where it is claimed that warm, moist air intrusions drive increased cloud cover and a reduced of LW radiation emitted to space, warming the local surface temperature. However, in Figs 4b and 5b, it appears that this region is subject to an uncertain response, or that not all models simulate the warming. The authors should discuss why some of the models don't simulate this warming, because presumably all 4 models simulate a reduced meridional temperature gradient, which is put forth as the initial driver of perturbations to the polar vortex. It seems like this gets a very brief mention in line 610, but I think this should be more prominent in the text and not buried in the discussion.

Figure 8: The authors should specify the sign convention for vertical velocity (wap).

Figure 10: The different behavior of the models over time in terms of both LW and SW up is interesting, especially when comparing the timescales at which individual models seem to stabilize, whereas one model exhibits a continually decreasing SW up and increasing LW up throughout almost the entire duration of the simulation. Do the authors have insight as to this model's differing behavior?

Line 344: How do the estimates of surface RH changes in the tropics from Cao et al (2012) compare in terms of magnitude to those in this study?

Line 650: Please contextualize the Smith (2018) results by providing the percentage by which RA reduce the initial radiative forcing, if possible.

The comments from previous reviewers noting the non-negligible role of internal variability remain applicable. The discussion section has helped clarify some of the shortcomings of the relatively small ensemble used here. The justifications in the review response by the authors should perhaps be included in the main text.

Typos:

Line 28: “number of studies on the subject *have been* conducted”

Line 70: While it can be inferred that the abrupt-solm4p experiment is a simpler analogue of volcanic eruptions, the transitions between these two paragraphs should make this more explicit and clear

Line 81: “to decreased temperature of *the* troposphere...”

Lines 95-100: In reporting the results of other literature, the authors state that SW and LW effects tend to cancel each other out, with SW effects slightly stronger. The next sentence then states that SW effects dominate the overall cloud adjustments. Can the authors make clear how this is the case, when it is stated that the SW and LW tend to counteract each other and cancel?

Line 108: change development to *evolution*

Line 117: “that all rapid adjustments happen *while the global mean..*” (no comma needed)

Line 119: “while global mean surface temperature *has already begun to change*”

Line 120: “On the 120 other hand, the fixed surface temperature method (Hansen et al., 2005) or rather fixed-sea-surface temperature (SST), which is easier to implement in global climate models (Forster et al., 2016), is widely used and has the advantage of suppressing feedbacks.” Suggest moving Forster citation to the end, and remove clause about ease of implementation. It is somewhat implied in the wide use of this method that it is simple to implement.

Line 125: “or cooling cannot be simulated in *this kind of setup*”

Line 134: The meaning of the sentence leading with “Thermodynamical and dynamical” is unclear, suggest rewording.

Lin 208: “slope than in *the* long term” “developing *for* as long as a decade”

Line 218: “budget, the yearly mean”

Line 402: “indicating a reduction in the amount of longwave radiation lost to space”

Line 531: “temperature mediated”

Line 533: I’m not sure what the authors are trying to convey with the sentence leading with “This corresponds to the time”, suggest rewording to emphasize the role of high inertia components of the climate system