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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global streamflow and flood response to stratospheric aerosol geoengineering" *by* Liren Wei et al.

Anonymous Referee #2

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Summary ———-

The authors present a suite of simulations from six GCMs that participated in GeoMIP, under two scenarios: RCP4.5 and an SRM scenario from GeoMIP (G4). The authors note that this is the first study to assess how SRM might affect global-scale streamflow. The authors compare the two scenarios to demonstrate what effect SRM might have compared with a non-SRM scenario in a mid-emissions (RCP4.5) future, in terms of high and low flows, mean flow, and return period flows.

General comments ——————

Lines 76-80: "Under the Geoengineering Model Intercomparison Project (GeoMIP; Robock et al., 2011; Kravitz et al., 2011, 2012, 2013a), G4 experiment a constant

5Tg per year of SO_2 is introduced into the lower tropical stratosphere of climate models during the period of 2020-2069, while greenhouse gas forcing is defined by the RCP4.5 scenario". It would be helpful to readers if a little more information could be said about G4, to provide some context to the results. For example, how does the injection affect the timeseries of global-mean temperature (a graph showing global-mean temperature would be quite informative here, or at least a statement of the magnitude of global cooling achieved by G4 relative to RCP4.5).

Lines 61-62: "River flood models such as CaMa-Flood (Yamazaki et al., 2011) are important tools for simulating flood hazard." Yes they are, but CaMa-Flood is better described as a "river routing model" as opposed to a "river flood model". The latter implies that hydrological processes are included explicitly but they are not, since routing models take the outputs of hydrological models or climate models and route them through a network.

Lines 64-66: "The high-resolution models have contributed to better simulation of river discharge (Yamazaki et al., 2009; Yamazaki et al., 2013 and Mateo et al., 2017)". This is a fair point and it is worth noting that 'offline' (i.e. separate from the hydrological model) routing models, such as CaMa-Flood specifically, have resulted in better agreement between simulated and observed discharge, compared with when the native hydrological model routing methods are used (see Zhao et al., 2017).

Line 79: "while greenhouse gas forcing is defined by the RCP4.5". I appreciate that this scenario can be used with G4 but it is worth noting in the Discussion section, that the general conclusions drawn from this research are based upon these specific scenarios, i.e. G4 and RCP4.5. There are three other emissions scenarios under the RCPs (2.6, 6 and 8.5), which means the simulated offsetting (or otherwise) effects of SRM, particularly in terms of magnitude, could be different if the underlying emissions scenario was different (i.e. RCP2.6, 6 or 8.5).

Table 1: Several of the GCMs include multiple runs for a single scenario, e.g. 3 runs for

the CanESM-2 historical scenario. Can the authors please explain what this means? Is it a perturbed parameter ensemble of three members, or something else?

Table 1. In Section 2.1 the authors also need to explain how the multiple runs in this table were dealt with. Was an ensemble mean used where there were three runs for one GCM, or were the calculations performed for each of the three runs in turn? From lines 159-160 it appears as though the runs were averaged, but it would be helpful to clarify this in Section 2.1.

Line 148: “an adaptive time step approach was applied in simulation”. Can the authors please explain in detail what this means in practical terms? I had presumed that CaMa-Flood was run at daily temporal resolution for all GCMs, but this text suggests that this is not the case.

Line 150: “to the fine resolution hydrological model”. I made this point earlier – CaMa-Flood is not a hydrological model, it's a routing model.

Section 2.4. and Figure 4: the authors calculate 30, 50 and 100-year return period levels of flows and then calculate the average across all GCMs. This approach is reasonable but in applying this method the authors overlook two important uncertainties that could influence the results significantly: 1) climate model uncertainty (from using several GCMs); and 2) statistical uncertainty introduced by calculating extreme flows for return periods that are longer than the period used to calculate them (40 years). It is known that climate model uncertainty can result in return period flows that vary more between GCMs than they do between warming scenarios, and that the range in return period flows across GCMs can be significant (Gosling et al., 2017). The authors may therefore like to consider presenting the range across all GCMs (as opposed to just the ensemble median).

Lines 399-402: “Under the G4 experiment, some recent studies (Jones et al., 2018; Sonntag et al., 2018) have pointed out that the increased P–E (difference between precipitation and evaporation) in northern Asia caused by global warming could be partly

counteracted by solar geoengineering.” It is perhaps also worth noting that the way in which evapotranspiration is estimated is quite important, as this can vary significantly between different models (Wartenburger et al., 2018).

Lines 425-427: “The CaMa-Flood river routing model also does not consider anthropogenic effects on rivers (e.g. dams), so the results presented here are for a hypothetical natural condition.” This is true but can the authors explain how this may have affected their results? Would the differences be smaller or lager if human impacts were included? This could lead on to an interesting discussion on the relative value of using runoff direct from GCMs compared with inputting precipitation and other variables from GCMs into hydrological models that include human impacts. Recent work with hydrological models shows that including dams etc. within them improves their representation of river flows compared with excluding dams (Veldkamp et al., 2018; Zaherpour et al., 2018), but also that the way human impacts such as dams are presented is quite important (Masaki et al., 2017) – so, does this mean that we should be using hydrological models that include human impacts to assess changes in the hydrological cycle with SRM, or is it reasonable to use naturalised runoff direct from GCMs instead? Clearly there is no straightforward answer but the Discussion chapter could be enhanced by considering this important issue.

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