Potential misrepresentation of hydrological extremes using transient climate rather than stabilized climate given identical levels of global warming

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The Paris Agreement aims to limit global warming well below 2˚C and encourage participants to pursue effort to further limit global warming to 1.5˚C. Models combining energy–economy–environment systems have provided crucial insight to how the future could evolve and how present decisions could affect long-term global warming. However, while many scenarios attempted to limit end-of-century radiative forcing to specific levels (e.g. +1.5˚C, +2˚C), these stabilized levels of global warming were frequently temporally exceeded during the mid-21st (Fig. 1A), owning to strong reduction in greenhouse gas emissions (Fig. 1B).

Such scenarios were used extensively to identify the different options available for limiting climate change and informing international climate policy. However, since stabilized levels of global warming for the end-of-century were not always available due to time requirements for stabilizing global warming, most analysis were conducted given a 30-year period centered on the year the global temperature exceed a specific levels (Fig. 1A)[1]. While the level of global warming for this 30-year period is identical to the stabilized global warming, it is not clear if the variables used in previous analysis behave identically between the two periods, hereinafter referred to as transient and stabilized climates.

In this study, using the ISIMIP2b[2] framework which provides outputs for various global hydrological models forced by the same bias corrected GCMs in a consistent manner, we extract extreme hydrological events obtained in the two climates and assess (i) whereas a statistical difference can be detected at the global scale, and (ii) if specific regions are more susceptible to being misrepresented by using solely the transient period in an analysis.

Our results (Fig. 2) indicate that while a statistical difference in extreme discharge obtained for the transient and stabilized climates could be detected globally, the difference was generally small. Overall, on average, significant differences in low and high discharges obtained in the transient and stabilized climates were identified for 6.82 and 3.27% of the land grid cells, respectively. Note that these findings were robust to the choice of indices. The extreme discharges in central Asia and the Amazon regions were consistently highlighted by the ensemble members as behaving differently in the transient and stabilized climate given identical level of global warming. For such regions, the conclusions drawn from previous analysis using only the transient climate may not be applicable in the far future exhibiting a stabilized climate.

To better understand the reasons behind the differences among GHMs in extreme discharge behaving differently for the transient and stabilized periods, it might be important to pay close attention to processes related to snow. Last two additional GHMs are currently being processed to further increase the number of members in the ensemble.

References:

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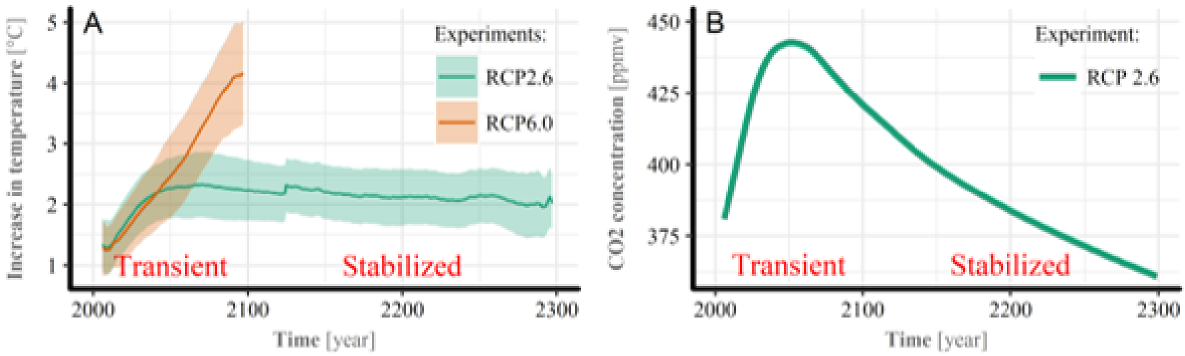

Fig. 1: Trend of (**A**) the average global temperature given by an ensemble of global circulation models (GCMs) and (**B**) the associated CO_2 emission during 2005-2300

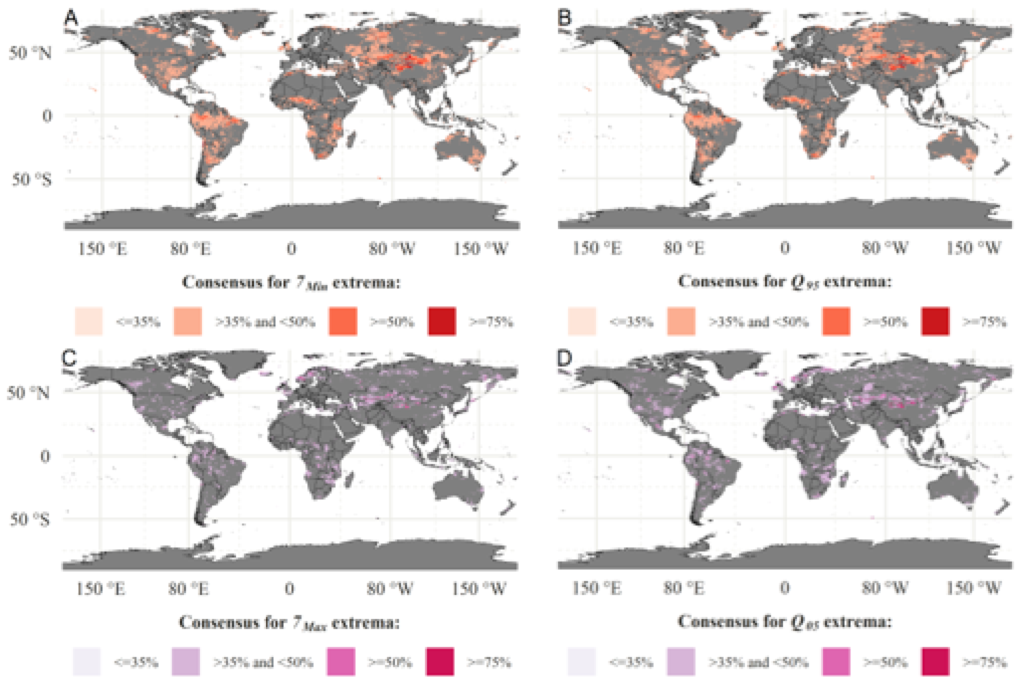

Fig. 2: Grid cells (0.5°×0.5°) where the ensemble of GCMs and GHMs indicated a consensus regarding statistical differences between (A and B) low discharge indices and (C and D) high discharge indices between the transient and stabilized climates