Effect on the Earth system of realizing a 1.5 ˚C warming climate target after overshooting to the 2 ˚C level

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An Earth system model (ESM) was used to investigate the effect of reaching the target of 1.5 ˚C warming (relative to preindustrial levels) after overshooting to the 2 ˚C level with respect to selected global environment indicators. Two scenarios were compared that diverged after reaching the 2 ˚C level: one stayed at the 2 ˚C level, and the other cooled to the 1.5 ˚C level. Unlike the internationally coordinated model intercomparison projects, the scenarios were developed for a specific climatic model with emissions and land use scenarios consistent with socioeconomic projections from an integrated assessment model. The ESM output resulted in delayed realization of the 1.5 ˚C and 2 ˚C targets expected for 2100. The cumulativeCO2 emissions for 2010–2100 (2300) were 358 (−53) GtCO2 in the 2 ˚C scenario and−337 (−936) GtCO2 in the 1.5 ˚C scenario. We examined the effect of overshooting on commonly used indicators related to surface air temperature, sea surface temperature and total ocean heat uptake. Global vegetation productivity at 2100 showed around a 5%increase in the 2 ˚C scenario without overshooting compared with the 1.5 ˚C scenario with overshooting, considered to be caused by more precipitation and strongerCO2 fertilization. A considerable difference was found between the two scenarios in terms of Arctic sea ice, whereas both scenarios indicated few corals would survive past the 21st century. The difference in steric sea level rise, reflecting total cumulative ocean heat uptake, between the two scenarios was <2 cm in 2100, and around 9 cm in 2300 in the Pacific Island region. A large overshoot may reduce the eventual difference between targets (i.e. 1.5 ˚C in contrast to 2 ˚C), particularly in terms of the indicators related to total ocean heat uptake, and to sensitive biological thresholds.

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