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Dangerous human-made interference with climate: a GISS modelE study

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Abstract. We investigate the issue of "dangerous human-made interference with climate" using simulations with GISS modelE driven by measured or estimated forcings for 1880–2003 and extended to 2100 for IPCC greenhouse gas scenarios as well as the "alternative" scenario of Hansen and Sato (2004). Identification of "dangerous" effects is partly subjective, but we find evidence that added global warming of more than 1°C above the level in 2000 has effects that may be highly disruptive. The alternative scenario, with peak added forcing ~1.5 W/m^2 in 2100, keeps further global warming under 1°C if climate sensitivity is ~3°C or less for doubled CO_2. The alternative scenario keeps mean regional seasonal warming within 2σ (standard deviations) of 20th century variability, but other scenarios yield regional changes of 5–10σ, i.e. mean conditions outside the range of local experience. We conclude that a CO_2 level exceeding about 450 ppm is "dangerous", but reduction of non-CO_2 forcings can provide modest relief on the CO_2 constraint. We discuss three specific sub-global topics: Arctic climate change, tropical storm intensification, and ice sheet stability. We suggest that Arctic climate change has been driven as much by pollutants (O_3, its precursor CH_4, and soot) as by CO_2, offering hope that dual efforts to reduce pollutants and slow CO_2 growth could minimize Arctic change. Simulated recent ocean warming in the region of Atlantic hurricane formation is comparable to

observations, suggesting that greenhouse gases (GHGs) may have contributed to a trend toward greater hurricane intensities. Increasing GHGs cause significant warming in our model in submarine regions of ice shelves and shallow methane hydrates, raising concern about the potential for accelerating sea level rise and future positive feedback from methane release. Growth of non-CO_2 forcings has slowed in recent years, but CO_2 emissions are now surging well above the alternative scenario. Prompt actions to slow CO_2 emissions and decrease non-CO_2 forcings are required to achieve the low forcing of the alternative scenario.

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