Combined impact of global warming and CCN number on precipitation from mid-latitude convective clouds

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Introduction

Observations show that the rate of heating in the atmosphere due to human pollution varies with latitude and height. The largest warming of the troposphere for mid-latitudes is found at about 300mb [1]. As this tendency in the vertical distribution of heat is projected to continue, the thermodynamical structure of the troposphere will change [2].

Aerosol pollution is known to cause the formation of smaller cloud droplets, thus suppressing the conversion of cloud to rain water [3,4]. However, aerosol impact on precipitation in a changing atmosphere is difficult for qualitative evaluation [2].

Model Simulations

A case study was modeled using RAMS v.6.0 model [5], which is 3D, nonhydrostatic cloud resolving model, that includes a two moment bulk microphysics scheme with 7 hydrometeor categories. The simulations were initiated with rawinsonde sounding data from Sofia, Bulgaria on 14.07.2006 and a warm moist bubble was used to trigger convection. Two single clouds were modeled – a large and a small cumulus. Simulated in-cloud characteristics and precipitation are compared for simulations with different CCN concentrations (clean and polluted air) and modified soundings in the range of expected temperature increase.

Discussion of Results

The results show that global warming acts to suppress convection at lower levels, so that the small cloud develops slower and produces less precipitation. For the big cloud both precipitation rate and total rainfall volume increase. The CCN impact on precipitation for both clouds is weaker compared to present day conditions.

[1] Santer *et al*. (2003) *J. Geoph. Res.* **108**. [2] ICCP(2007) *Cambridge University Press*, 921. [3] Levin & Cotton (2007) *WMO/IUGG IAPSAG.* [4] Rosenfeld *et al*. (2008) *Science* **321**, 1309-1313. [5] Pielke *et al*. (1992) *Meteorol. Atmos. Phys.* **49**, 69-91.

Temperature differences between the hemispheres drive ice-age climate variability

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The ice ages have traditionally been viewed as a phenomenon driven by the insolation over the ice sheets in the Northern Hemisphere. Since the discovery of ice-age CO_2 variations in Antarctica thirty years ago, however, much of the focus has shifted to the greenhouse effect from atmospheric CO_2 and the south. The missing piece is an understanding of the CO_2 mechanism and the way it is related to the insolation variations in the north. Ice-age climate variations are described here in terms of two centers of action, the traditional one in the north and a new one in the south. The southern center drives the temperature variability in Antarctica and atmospheric CO_2. The northern center activates the southern center via the temperature contrast between the hemispheres. Individual ice ages come to an end when the temperature difference between the hemispheres is flattened and they start up when the north-south temperature difference is greatest. This form of north-south communication is actually very familiar, as it is readily observed during the Younger Dryas interval 13,000 years ago and in the various “millennial-scale events” over the last 90,000 years.