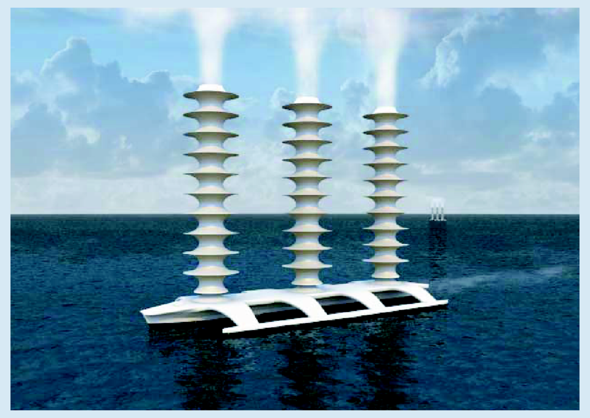
TESTING SEA SALT INJECTIONS INTO MARINE SC AS A GEOENGINEERING OPTION

Andreas Muhlbauer, Thomas P. Ackerman and Robert Wood
University of Washington, Seattle, WA
Contact: Andreas Muhlbauer, University of Washington, Seattle, WA, andreasm@atmos.washington.edu

Introduction

Marine stratocumulus (Sc) clouds reflect most of the incoming shortwave radiation back to space thereby cooling the Earth's atmosphere. Hence, deliberate modifications of the Sc cloud albedo have been suggested as a geoengineering option to slow down or even offset the increase in global mean temperature due to emissions of anthropogenic greenhouse gases (Lenton and Vaughan, 2009).



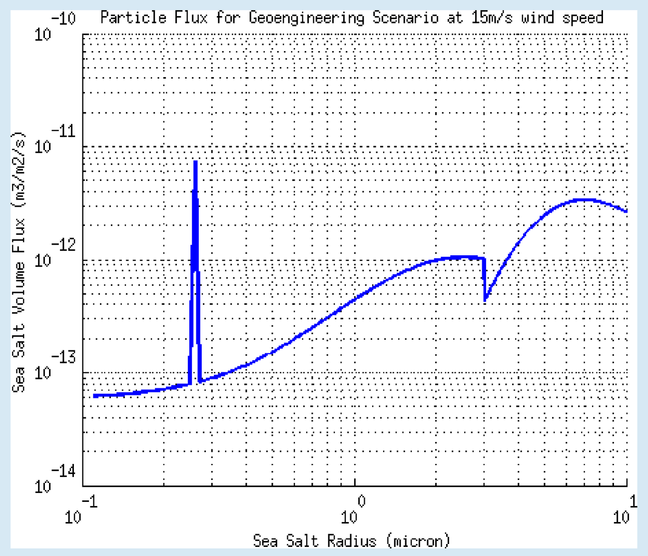
A geoengineering proposal by Latham (1990) suggests to modify the albedo of marine Sc clouds by controlled emissions of sea salt aerosols from a fleet of unmanned wind-powered vessels (Salter et al., 2008).

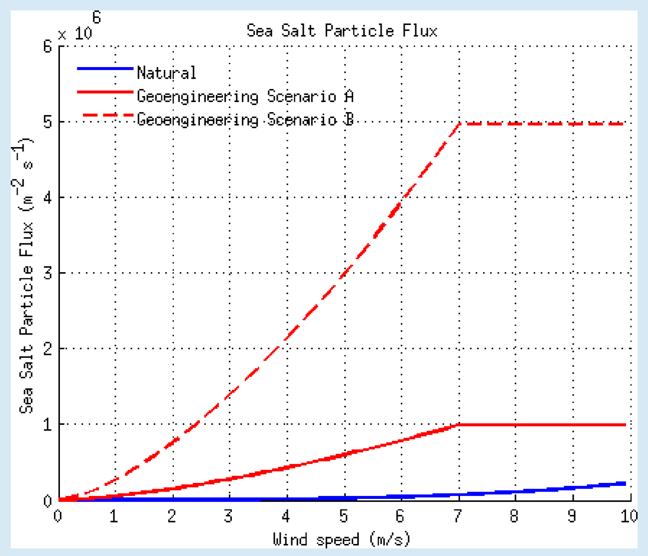
So far, numerical studies testing this particular geoengineering approach have been conducted only on the global scale (Rasch et al., 2009; Korhonen et al., 2010) thereby neglecting potential effects on the mesoscale. This contribution is the first attempt to test this particular geoengineering proposal with a regional scale model. Our region of interest in the Southeast Pacific (SEP) region and the western part of South America.

Setup of the Numerical Model

- Simulations are performed with the UW version of the COSMO model
- Model is driven in forecast mode for a period of 1 month (Oct 15-Nov 15, 2008)
- Grid spacing: 1.0 degree with 60 vertical levels (SLEVE coordinates)
- Initial/boundary conditions provided by ECMWF analyses (1.0 degree, 6 h updates)
- Numerics: 3rd order Runge-Kutta, 4th order positive-definite advection, time step 40 s
- Parameterizations: Radiation (Ritter and Geleyn, 1992), convection (Park and Bretherton, 2009), turbulence, cloud-microphysics (Morrison et al., 2005), aerosol-microphyscs (Vignati et al., 2004)

Sea Salt Emission Functions



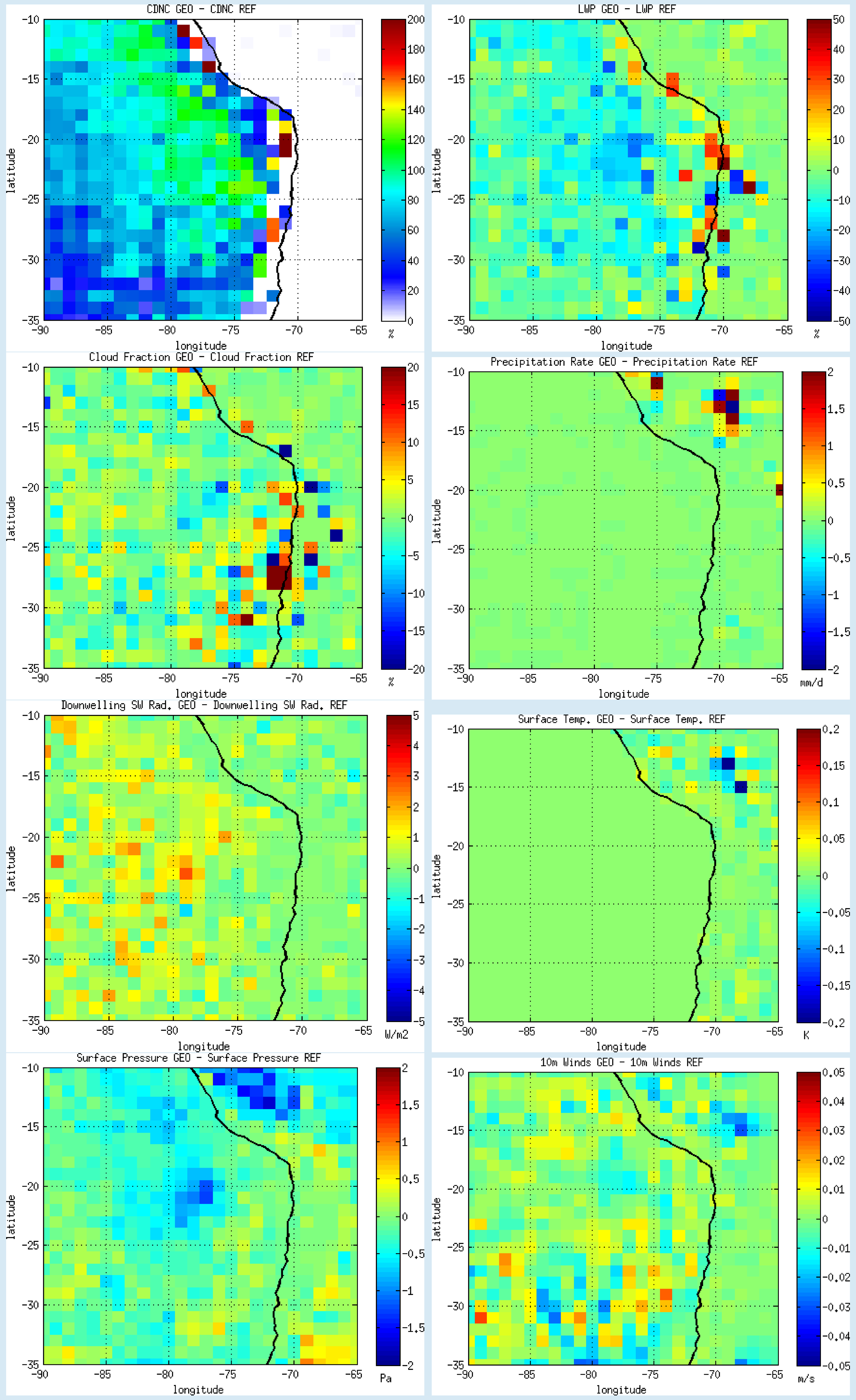


- Natural sea spray emission fluxes are derived from Monahan (1986) and Andreas (1998). This yields natural particle fluxes that are roughly a factor 10 lower than those assumed by Korhonen et al. (2010)
- Geoengineering particle fluxes are taken from Korhonen et al. (2010) for both geoengineering scenarios. The maximum spraying efficiency of the vessels is assumed at wind speeds of 7 m s^{-1}. Geoengineering scenario B has five-fold particle flux than scenario A.
- Typical background aerosol number concentrations for marine conditions are taken from Seinfeld and Pandis (1998)

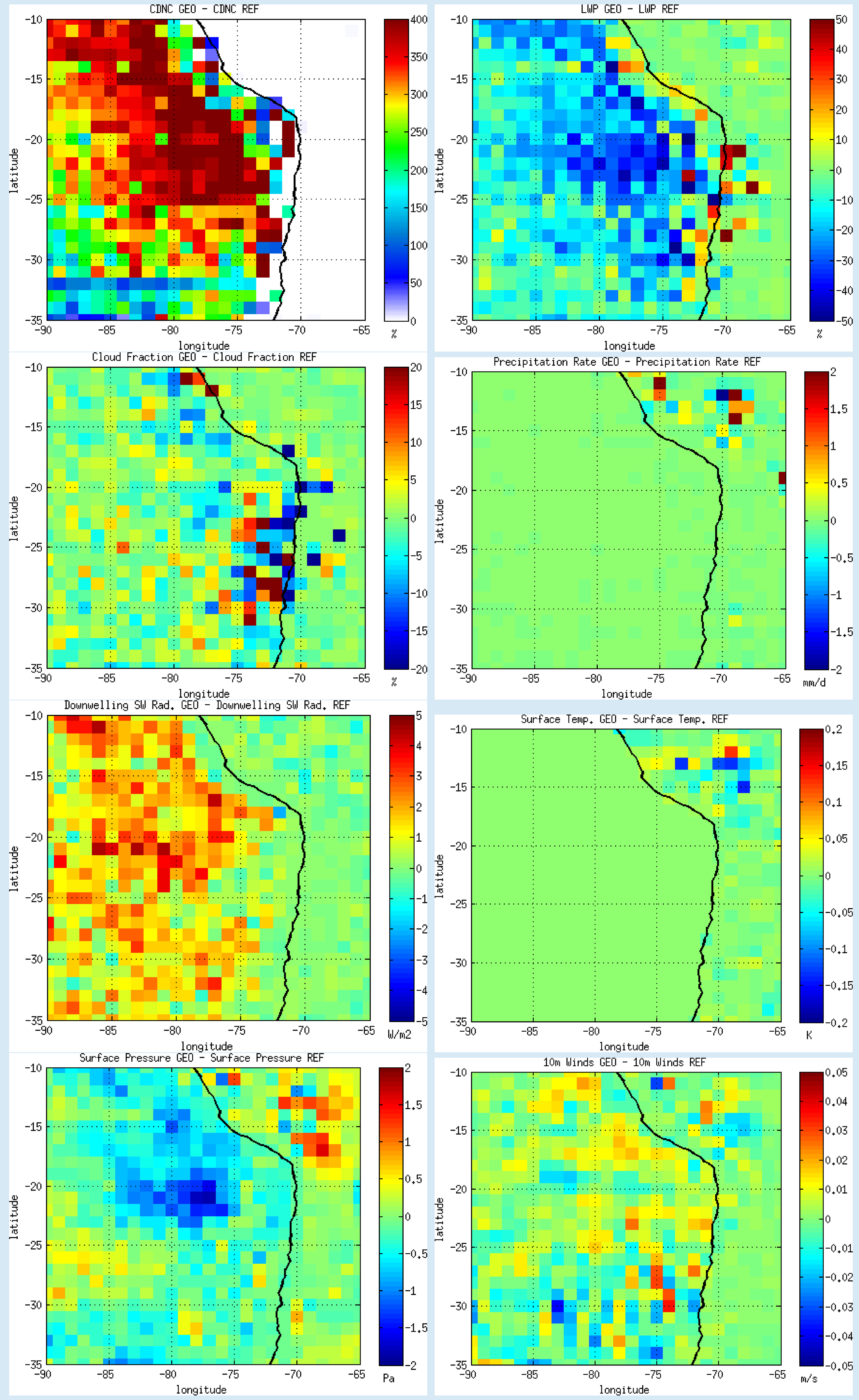
Results

	Geoengineering Scenario A	Geoengineering Scenario B
Δ CDNC	+30 % (+20 %)	+126 % (+163 %)
Δ LWP	-1.5 %	-4 %
Δ CF	< 1 %	< 1 %
Δ PRECIP.	< 1 %	< 1 %
Δ RAD.	+0.13 W m^{-2}	+0.4 W m^{-2}

Geoengineering Simulations (A-Scenario)



Geoengineering Simulations (B-Scenario)



Results (continued)

- Cloud droplet number concentrations (CDNCs) at Sc cloud top increase in both geoengineering scenarios. The magnitude of change is similar to the CDNC change reported by Korhonen et al. (2010) for the SEP region.
- Liquid water path (LWP) is decreased in both scenarios whereas cloud fraction is virtually unchanged.
- Precipitation is unchanged on average. However, there are regional inhomogeneities and patterns of decreasing precipitation over ocean and an increasing precipitation over land. This emphasizes the risk of potential side-effects of geoengineering on the regional scale.
- Changes in large-scale dynamics and near surface winds are small, which suggests that feedbacks of geoengineering on the natural sea salt production are small.

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