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Seasonal climate changes from anthropogenic sulfur emissions simulated with CLIMBER-2

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The climate of the Earth system during the last 1000 years was influenced by natural and anthropogenic factors, such as changes in solar irradiance, volcanic activity, land-use, greenhouse gas concentrations, and tropospheric aerosol burden. The influence of aerosols is often ignored in the estimations of the historical global-scale climate changes, but in the last century sulfate aerosols play a growing role in the regional and seasonal climate changes. We therefore have compiled the regionally and annually varying sulfur emission data from 1850 until 2000. By extending the radiation transfer scheme of the coupled atmosphere-ocean-vegetation model CLIMBER-2 we estimated the regional and seasonal climate changes induced by the sulfate aerosol burden. The simulated changes of the radiative forcing and the surface air temperature show reasonable patterns. The strongest response is obtained over the Northern Hemisphere land areas and is found larger in summer than in winter. In our case, the considerably enhanced cooling during the northern summer period follows from changes in the radiation fluxes rather than from a seasonally varying sulfate burden or from effects of relative humidity. The contribution of the anthropogenic sulfur burden to climate changes is discussed in relation to climate changes from the other natural and anthropogenic factors for the last 1000 years.