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Dimming over the Oceans: Transient Anthropogenic Aerosol Plumes in the 20th Century

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Anthropogenic aerosols reduce incoming surface solar radiation (SSR), but the magnitude of this effect for reducing sea surface temperature (SST) is still debated. Using simulations from the global climate model ECHAM5 with the Hamburg Aerosol Module (HAM) and prescribed SSTs, we quantify anthropogenic aerosol dimming over sea surfaces by comparing ensembles, which only differ in anthropogenic aerosol emissions. We isolate the anthropogenic aerosol effect on SSR with sufficiently large ensemble sizes to provide statistically significant results. The following simulation results are obtained: Dimming plumes extend from their source regions with clear seasonality. The latter is predominantly shaped by atmospheric circulation, while interdecadal changes follow the gradual increase in anthropogenic aerosol emissions. Comparing the 1990s with the 1870s, on average, 9.4% (clearsky SSR) or 15.4% (allsky SSR) of the entire ocean surface was affected by anthropogenic aerosol dimming larger than -4 W m^{-2} (annual mean). Comparing the same time periods, global average anthropogenic dimming over oceans is -2.3 W $m^{-2}$and -3.4 W m^{-2} for clearsky and allsky SSR, respectively. Surface dimming is hemispherically asymmetrical with stronger Northern Hemispheric dimming by 2.3 W m^{-2} and 4.5 W m^{-2} for clearsky and allsky SSR, respectively. Zonal average clearsky dimming reaches its maximum (5.5 W m^{-2}) near the Equator. Allsky dimming peaks at 40°N (-8 W m^{-2}) and is regionally larger than clearsky dimming. Regionally, surface dimming can go beyond -20 W m^{-2} (clearsky) and -40 W m^{-2} (allsky). Results are a contribution towards better quantifying spatially heterogeneous and time-dependent anthropogenic dimming effects on SSTs.