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Aerosol and cloud effects on solar brightening and the recent rapid warming

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During the second part of the last century, surface air temperature evolution in the northern hemisphere exhibited a fairly stable first phase with no temperature increase until 1980, and a subsequent steep rise during a second phase by the end of the century. The rapid temperature increase of 1˚C over mainland Europe since 1980 is considerably larger than expected from anthropogenic greenhouse warming. Here we present aerosol optical depth measurements from six specific locations and surface irradiance measurements from a large number of radiation sites in Northern Germany and Switzerland showing a substantial decline in aerosol concentration over Europe, which has led to a statistically significant increase of solar irradiance under cloud-free skies. The measurements explain solar brightening and show that the direct aerosol effect has about a five times larger climate forcing impact on the observed warming than the indirect aerosol and other cloud effects have. First order estimates indicate that direct and indirect aerosol forcing combined may have produced about 50 percent of the rapid warming since the 1980s.