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TOA Radiative Forcing of the Alaska Wildfires in Summer 2004

G. G. Pfister, P. G. Hess, L. K. Emmons, P. J. Rasch
National Center for Atmospheric Research, Boulder, CO

In the summer of 2004 Alaska experienced a record fire season due to an extreme drought situation. Wildfires can emit large amounts of trace gases and aerosols into the atmosphere which directly or indirectly impact the Earth radiation balance. We estimated the top of the atmosphere (TOA) radiative forcing from the 2004 fires by integrating simulations with the NCAR community atmosphere model with chemistry (CAM-chem) and satellite observations of the TOA longwave and shortwave radiation fluxes. Fire emissions for carbon monoxide (CO) have been derived from an inverse modeling study using satellite observations of CO from the Measurements of Pollution in the Troposphere (MOPITT) instrument and the emissions of other trace gases have been scaled accordingly using emission ratios found in the literature.

We are comparing measured and modeled radiation fluxes for the summer of 2004 to those for the year 2000 when fire activity in the boreal zone was low. Both observations and model show a negative clear-sky forcing over the 2004 fire region averaged over June through August of -7+/-6 W m-2 and of -10+/-4 W m-2, respectively. About 2/3 of the effect is taking place in the longwave spectral range, and 1/3 in the shortwave range. Based on detailed model analysis we conclude that the longwave effect is predominantly explained by higher surface temperatures in 2004 compared to 2000 and that most of the shortwave effect is caused by scattering of solar radiation on organic carbon aerosols emitted from the fires. The cooling effect is somewhat mitigated by the positive forcing of absorbing black carbon aerosols and greenhouse gases either directly emitted (e.g. carbon dioxide) or produced (e.g. ozone) from the fires. Several model sensitivity runs have been performed to investigate the impact of uncertainties in emission ratios and emission strength of black and organic aerosols on TOA radiative forcing.