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Angularly-resolved measurements of light scattering by smoke from wildfires during FIREX-AQ

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The open burning of biomass fuels is an important source of aerosols because they contribute significantly to the pre-industrial radiative forcing budget and they are a large source of aerosol in the modern era that is anticipated to increase due to climate change. However, the optical properties of smoke have been shown to be complex and variable, which in turn complicates a) the retrieval of aerosol properties using remote measurements and b) the estimation of the direct radiative forcing caused by smoke.

During the FIREX-AQ aircraft campaign, we measured the angular distribution of light (i.e. scattering phase function) scattered by smoke *in situ* using the NOAA Laser Imaging Nephelometer. We then used collocated measurements of the particle size distribution and literature values of the complex refractive indices to calculate expected phase functions using Mie theory. When comparing the measured versus calculated phase functions, we see there is more backscattered light in the measurements.

This enhanced backscatter has two important repercussions. First, when the measured phase function is used with an open source algorithm (GRASP) to retrieve the particle mode size, we find that the algorithm tends to undersize the particles by about 10%. Second, when the enhanced backscatter is included in a simple radiative transfer model, we observe an additional 20% cooling effect from fresh smoke.