5.117 Modeling Greenland's Climatic Response to the Presence of Biomass Burning-Based Absorbing Aerosols in the Atmosphere and Snow during the Summer of 2012.

Early Career Scientist

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Abstract:

Biomass burning events often result in the emission of particulate matter and related precursors into the atmosphere. Of these, black carbon (BC) and brown carbon are the main absorbing species. These absorbing particles can influence the regional climate by directly scattering and absorbing solar energy while suspended in the troposphere or by influencing the radiation balance at the surface after deposition through surface albedo modification. Relative impacts of these aerosols are greatest over high albedo surfaces. The Greenland Ice Sheet (GrIS), which covers most of Greenland’s surface and is characterized by high surface albedo, experienced an extensive melting episode during the summer months of 2012, indicating a significant anomaly in surface energy budget.

Here, we apply idealized climate simulations to study how Greenland surface temperature and melt are affected by elevated levels of light-absorbing particles in the atmosphere and on the ice sheet. We employ the Community Earth System Model (CESM) with prescribed sea surface temperatures and active land and atmospheric components. To achieve a more localized understanding of the climate impacts of light-absorbing aerosols, we apply the single column version of the Community Atmosphere Model (SCAM). In each configuration, we assess surface temperature and melt changes resulting from aerosol burdens with different optical depths and single scatter albedos, informed by measurements from 2011 and 2012-2014. Aerosol optical depth (AOD) can exceed 0.20, single scattering albedo (SSA; which is the ratio of aerosol light scattering to extinction), can drop below 0.90, and black carbon concentrations in snow pits can have mean peak values ranging from 4 to 15 ng/g. To assess the effect of light-absorbing aerosols at different tropospheric levels, aerosol loads are imposed at different heights in the atmosphere for the column-based simulation. We also investigate the importance of the seasonal timing of aerosol forcing for melt on Greenland.