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Chemical weather forecasting of smoke events: lessons on predictability from NASA's GEOS modeling system

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Global weather models are expanding to include increasingly complex representations of trace gas and aerosol chemistry and schemes that estimate fire emissions in near-real time. Here, we report on the skill of forecasting smoke events by the Goddard Earth Observing System (GEOS) modeling system, a state of the art Earth system model developed and maintained by NASA's Global Modeling and Assimilation Office. GEOS routinely operates from 14-25 km and produces 10-day forecasts of five types of aerosols, CO, and CO2, which are used to support NASA field campaigns and missions. Fire emissions are estimated using a scheme based on fire radiative power observations and projected to persist at the same levels for the duration of the forecast. Smoke forecast skill is estimated by comparing aerosol optical depth (AOD) forecasts at different lead times with GEOS AOD analyses based on assimilation of MODIS observations. While forecast skill varies substantially by region, our preliminary analysis shows that skillful smoke forecasts are currently possible over many populated areas. Improving the realism of fire emission forecasts beyond the persistence model would complement the inherent meteorological skill, helping to further improve forecast quality. We also introduce a new GMAO effort which uses a complex tropospheric chemistry model to forecast ozone mixing ratios and discuss implications for prediction of future fire-related air quality events.