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A New Globally Constrained Dataset of Fire Aerosols, based on measurements ofaerosol height, aerosol optical depth and total column trace gas measurements using Remote Sensing and Models

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Due to changes in economics, technology, population, agriculture, and climate, there have been significant changes in terms of fires around the, and their impacts on air pollution, climate, and society. In specific, we are interested to know more about how these effects play out, from source to sink, on the atmospheric loadings and associated impacts of aerosols and some specific co-emitted trace gasses. Fires produce plumes of aerosols which are first lofted to a significant height, and then advected near and far to impact the larger atmosphere. We know from measurements that the absolute magnitude of smoke from fires is currently vastly underestimated. In this paper, we demonstrate a new database of emissions, formed in a uniform way, using 4 different remotely sensed measurements, coupled with three types of models. We then work to demonstrate what has worked well and why, as well as outline what still needs to be improved.
We combine existing measurements of NO_2 columns, AOD, CO, vertical distribution, with models at Global Scale, Mesoscale, and plume scale, into a single product. This product yields a spatially and temporally variable distribution of the emissions from global fires of aerosols and some trace gasses. Furthermore, we draw a set of relationships based on the physics and chemistry: making a connection from the emissions amounts and the heat tsources to the ultimate vertical structure and magnitude . The point is not only to be able to force a model to match the measurements, but to build a system through which we can mode deeply understand and constrain these relationships. This will slowly allow us to understand to the point where we can improve the model predictions analytically, as well as to perform massive uncertainty calculations. Given the changes occurring over the past decade, this is essential.
We draw three conclusions. First, that the total underestimate of BC emissions is more than 40 percent to 70 percent of the present total global emissions, a more than doublig in magnitude. Second, that there are significant missing sources with a time scale from 3 to 6 weeks in duration, annually occurring in mountainous regions of Africa and Asia which are not present in existing databases. Thirdly, we demonstrate that a larger fraction of total emissions is lofted high up, and hence the impact on the atmosphere is larger than presently assumed.
We make some initial conclusions in terms of these relationships over Africa, Southeast Asia, and the High Arctic, and show that they are different in each of these critical areas. We then try to explain a bit as to why this is the case, and build towards a more comprehensive and physically based relationship for future work.