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A global wildfire emission and atmopsheric composition impact in 2000-2012

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A global re-analysis of 2000-2012 of main characteristics of wild-land fires and their impact on air quality is presented: (i) emission fluxes of key atmospheric pollutants; (ii) land-use-specific diurnal variations of the fire intensity; (iii) vertical distribution of the emitted plumes, (iv) atmospheric transport and transformation of the emitted species and their impact on atmospheric chemical composition and optical features.

The reanalysis is a product of application of the IS4FIRES system to the Fire Radiative Power (FRP) products of MODIS and SEVIRI, which are combined with land-use information and meteorological parameters. For the system calibration and evaluation we used MODIS AOD observations, MISR plume-top height data, and TRMM VIRS hot-spot counts. The emission fluxes are obtained by scaling FRP to PM emission with further cross-scaling to other species. The calibration distinguished between forest, grass, and mixed vegetation types.

Atmospheric transport and transformation are computed by the SILAM modelling system, which takes into account also anthropogenic and natural sources and computes gas-phase transformations and secondary aerosol formation. The model is equipped with the plume-rise algorithm developed specifically for the wild-land fires. The vertical injection profiles are based on semi-empirical formula calculating the plume top height from FRP, boundary layer height, and Brunt-Vaisala frequency.

The downside of the FRP data is its instantaneous nature. As a result, compilation of both historical and near-real-time emission inventories requires interpolation of the FRP between the satellite screenshots. This has proven complicated: low-orbit satellites provide just a few screenshots per day, whereas geostationary instruments have insufficient sensitivity and spatial resolution. However, with a help of the hot-spot counts from equatorial-orbit TRMM VIRS instrument, it was possible to obtain the diurnal variation of the fire intensity. It turned out that the regional-bulk fire intensity varies much stronger (over an order of magnitude) than the intensity-per-fire (a factor of 2-4 times). It suggests that many fires are extinguished in the late afternoon but those that continue throughout the night manifest only moderate decrease of intensity.