Supporting information

1 TM5-GFEDV3 Comparison to MOPITT V5

We use version 5 of the MOPITT thermal infrared (TIR) level 2 product. MOPITT is a gas-filter correlation radiometer on board the Terra satellite that measures thermal emission near 4.7 μm at a resolution of 22 km x 22 km. The local equator crossing time is 10:30/22:30, and global coverage is achieved in 3 days. CO vertical profiles of volume mixing ratio on a fixed pressure grid are retrieved with an optimal estimation technique (Deeter et al., 2010; Rodgers, 2000) for cloud-free scenes. A monthly climatology of the MOZART model provides the a priori vertical profile. The MOPITT instrument has the highest vertical sensitivity in the mid-troposphere, but also provides some boundary layer information (Deeter et al., 2007; Kar et al., 2008). As the Degrees of Freedom for signal is typically 1.5 (Deeter et al., 2004), we use the measured CO total column derived by integrating the CO vertical profile. Validation of version 5 data with respect to NOAA aircraft in situ CO profiles shows a mean bias of 0.06×10^{18} molecules/cm^2 with no clear geographical or time dependencies in the bias (Deeter et al., 2013; Worden et al., 2013).

As nighttime observations are less accurate (Yurganov et al., 2010), nighttime data were rejected. We only selected retrievals with DFS>1.0 to minimize the influence of the a priori. Finally, a first order correction for the geolocation bias was made by following the latitude/longitude bias correction recommendations in Table 1 of the MOPITT geolocation bias documentation (http://web3.acd.ucar.edu/mopitt/GeolocationBiasReport.pdf).

The satellite observations were gridded to 1° x 1°, where grid cell averages were taken only when MOPITT had enough valid observations to fill 30% of the grid cell. Following the recommendations in (Deeter et al., 2011), the MOPITT data were weighted by the Observation Quality Index (OQI; see the MOPITT v5 Users Guide http://www.acd.ucar.edu/mopitt/v5_users_guide_beta.pdf) during averaging to give more weight to observations with less geophysical noise.

2 References

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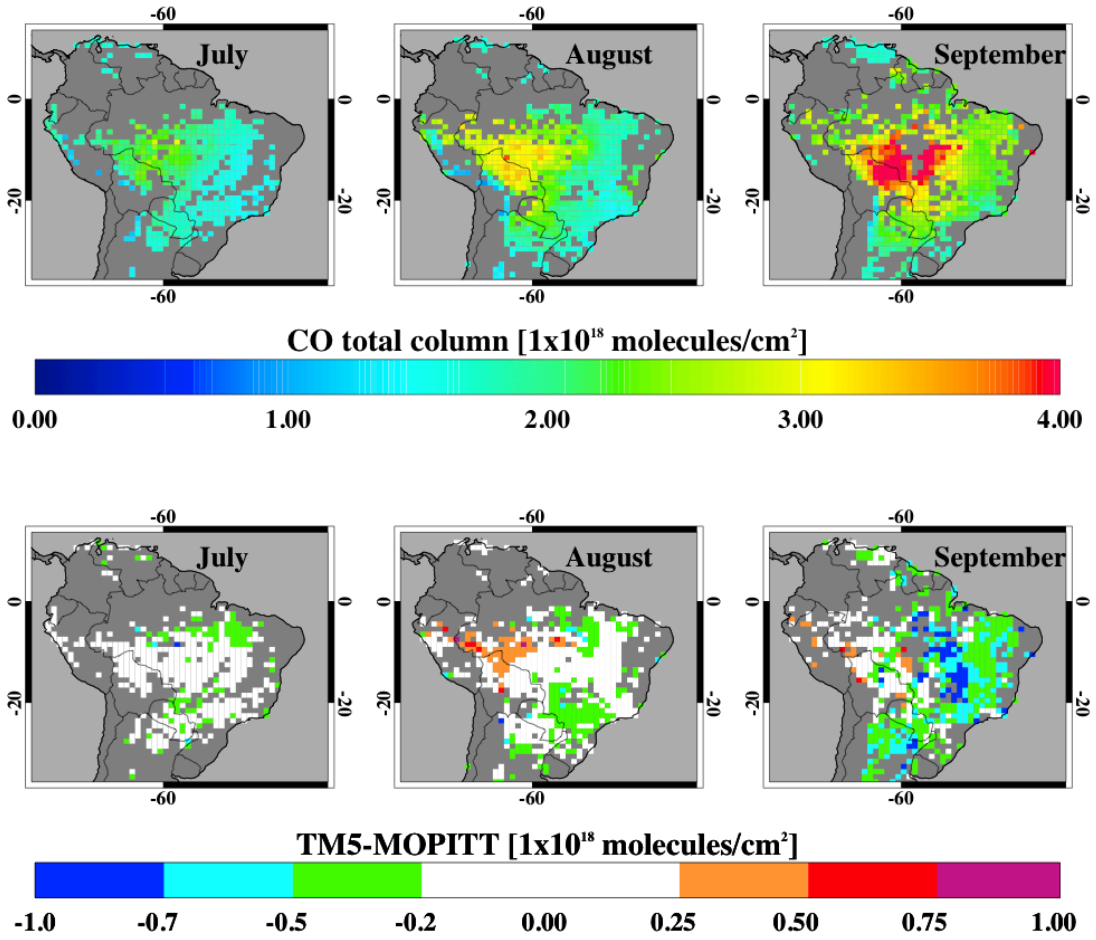

Figure S1. Comparison of monthly average MOPITT observed (top row) and TM5 simulated CO total columns. Only grid cells that have fire emissions as indicated by GFED v3 are considered in the monthly averages. Satellite observations were re-gridded to 1°x1° on a daily basis, where grid cell averages were taken only when the satellite had enough valid observations to cover 30% of the grid cell. In the bottom row is the TM5 bias. Positive values indicate that the TM5 simulated CO total column is higher that the MOPITT observation. The simulated vertical profiles have been transformed with the MOPITT a priori profile and averaging kernel according to the strategy described in Section 3.

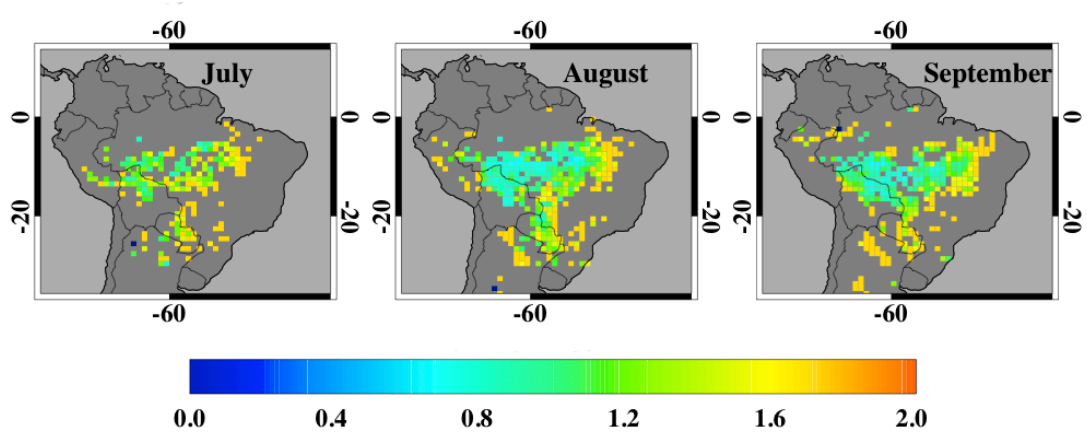

Figure S2. Monthly β sensitivity values (Eq. 2) calculated with the approach described in section 4. We only consider grid cells where fire NO_x emissions dominate over other emission sectors. Briefly, we calculate the change in TM5 modeled NO_2 tropospheric columns after increasing the bottom up fire NO_x emissions by 15%. From these NO_2 tropospheric column changes, we calculated daily β values that were then averaged to monthly values if multiple days of burning occur in a grid cell

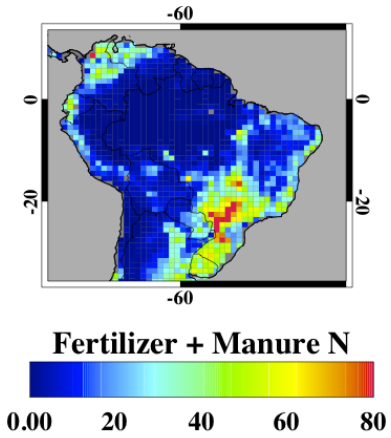

Figure S3. Fertilizer and manure nitrogen availability from Potter et al. (2010); units are kg/ha.

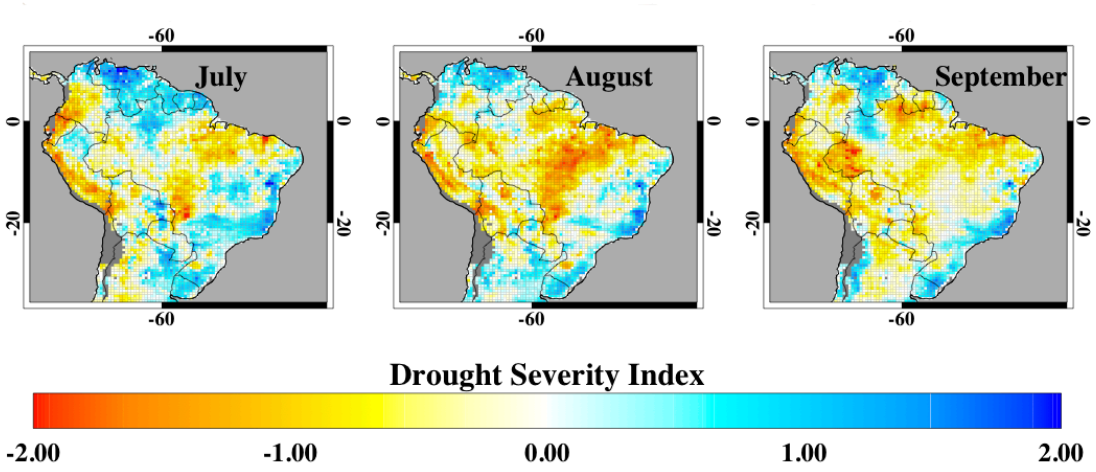

Figure S4. Drought severity index (DSI). Values less than zero indicate drier than normal conditions, and values greater than zero indicate wetter than normal conditions.