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Regional-scale correlation between CO_2 fire emissions, burned areas, and mid-tropospheric CO_2 diurnal variations retrieved from MetOp-A/ATOVS observations (2007-2011) over southern Africa.

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Inferred from the Advanced TIROS Operational Vertical Sounder (ATOVS) flying onboard the MetOp-A platform, mid-tropospheric CO_2 columns are retrieved from evening (21:30 LST) and morning (09:30 LST) observations over the tropic for the period July 2007 - December 2011, using a non linear inference scheme based on neural networks initially designed for TOVS instruments onboard the NOAA platforms (Chédin et al. 2003),

We find that the difference between evening and morning CO_2 columns, hereafter referred to as Daily Tropospheric Excess (DTE), increases up to several ppm over regions affected by biomass fires, confirming the results obtained from TOVS observations onboard the NOAA10 platform over 1987-1991. The physical mechanism linking DTE with fire emissions comes from the diurnal cycle of fire emissions associated with enhanced convection: hot convective fire plumes injects CO_2 into the troposphere during the afternoon peak of fire activity, which is seen by the satellite evening passing; it is then diluted by large scale atmospheric transport, before the next satellite morning passing.

The CO_2 DTE shows monthly, seasonal and annual spatial patterns similar to fire products, such as CO_2 emissions from the Global Fire Emission Database (GFEDv3) and burned areas from the MODIS instrument for ten regions of southern Africa with contrasted vegetation cover. Across these regions, a high positive correlation is found between DTE and CO_2 emission ($R^2 \sim 0.8$). There is also a good agreement in terms of seasonal variability north of 14S. South of 14S, the seasonal increase of the CO_2 difference during the early fire season starts earlier and rises up more rapidly than in either GFEDv3 or MODIS burned areas. This misfit could come from limitations in current burned area detection algorithms owing in particular to their difficulty in detecting small fires associated with small burnt scars.