FTIR measurements indicate global impacts of air quality measures

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Fourier-Transform Infra-Red (FTIR) spectrometers form part of the Network for the Detection of Atmospheric Composition Change (NDACC). Historically, a lot of attention has been paid to compounds associated with ozone depletion in the stratosphere. However, the FTIR network is also extremely relevant for studies of tropospheric air pollution. Two such pollutants are ethane (C_2H_6) and carbon monoxide (CO); both are important ozone precursors in the troposphere. In the Southern Hemisphere, they are predominantly produced by biomass burning (Watson et al., 1990), but in the Northern Hemisphere human activities add considerably to their emissions, e.g. associated with fossil fuel usage. At several Northern-Hemisphere locations, downward trends have recently been reported for both compounds (Angelbratt et al., 2011; Aydin et al., 2011), reflecting the implementation of measures to improve regional air quality. By contrast, hydrogen cyanide (HCN) is thought to be nearly exclusively produced by biomass burning (Li et al., 2000). All three compounds are represented in the mid-infrared spectrum.

The National Institute of Water and Atmospheric Research (NIWA) operates the two southernmost FTIR instruments in the NDACC network. Unlike their Northern-Hemisphere counterparts, the NIWA FTIR instruments sample background air representative of the relatively clean southern mid- and high latitudes (Morgenstern et al., 2012). In a recent study, Zeng et al. (2012) analysed 13 years of FTIR measurements made at the Lauder, New Zealand, and Arrival Heights, Antarctica, sites. Tropospheric partial columns of all three species (CO, C_2H_6 , and HCN) were found to decline between 1997 and 2009, with ethane exhibiting the largest relative decrease of around 2.5%/year . Partly, the negative trends were associated with 1997-1998, the start of the records, dominated by an anomalously strong El Niño event causing major wildfires in Indonesia. However, even if only a shorter period excluding this El Niño event is analysed, significant negative trends ensue. Zeng et al. (2012) compare the measurements to results from chemistry-climate model (CCM) simulations (Figure 1). In one set of simulations, emissions of anthropogenic pollutants are assumed to be annually periodic and only the biomass burning emissions are interannually varying according to observations (van der Werf et al., 2010). In this simulation, generally realistic amounts of the three pollutants are found, and the interannual variability is mostly captured at both locations, but the model does not correctly reproduce the observed trends in C_2H_6 and CO. Only when negative linear trends are imposed on the anthropogenic part of the emissions of CO and C_2H_6 (of -35% for C_2H_6 and -26% for CO over 1997-2009), do the modelled and measured trends for these species agree. There is no such disagreement for HCN which does not have a major anthropogenic component. In further sensitivity experiments, the authors establish that reductions in the Northern Hemisphere cause this effect because anthropogenic emissions in the Southern Hemisphere are relatively minor. The assumed emission trends for C_2H_6 and CO are in agreement with the recent literature.

The results are interesting in that the timescale of mixing between the two hemispheres is considerably longer than the atmospheric lifetimes of CO and ethane. One could have expected this to preclude these reductions in emissions to have global

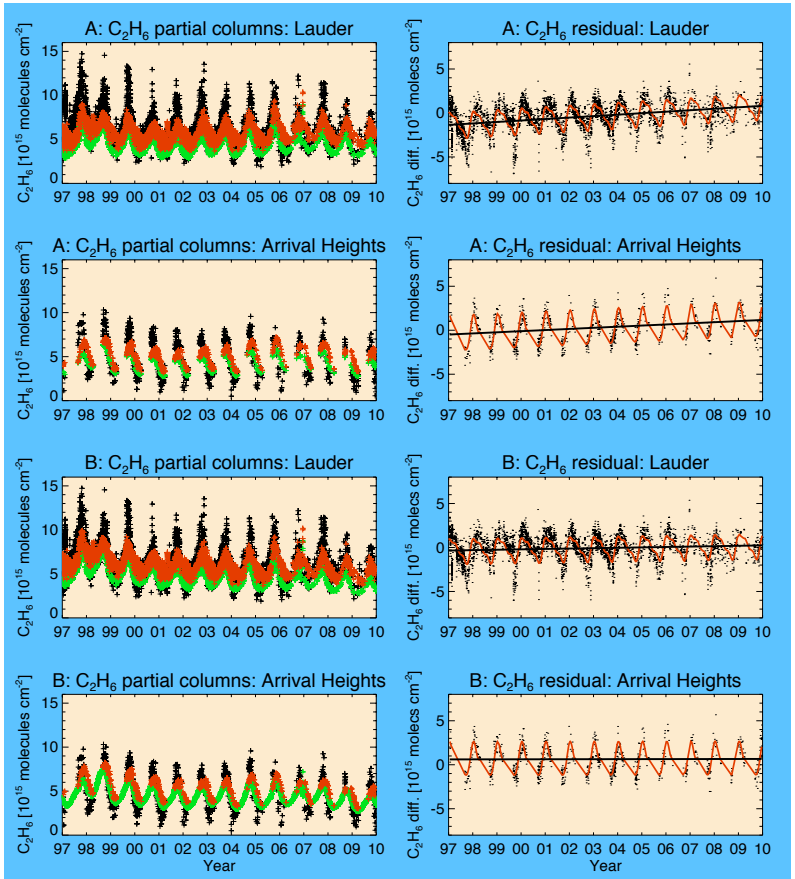

Figure : (left) Tropospheric partial columns of C_2H_6 at Lauder and Arrival heights. Black: FTIR observations. Green: CCM results. Red: CCM results after folding with averaging kernels and a-priori data. (right) Residual (model - observation). Red: Regression fit. Thick solid line: Linear trend. Panels marked "A" indicate a model simulation not accounting for reductions in industrial emissions of ethane, "B" indicate a model simulation that does. Note that residual trends for B are insignificant (from Zeng et al., 2012).

impacts. The NDACC FTIR measurements, combined with a CCM, suggest otherwise. The results exemplify the value of making long-term measurements of atmospheric composition in remote parts of our planet.

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