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Origins and seasonality of greenhouse gases over the South Atlantic Ocean

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The Total Carbon Column Observing Network (TCCON) has become the reference network for all total-column observations of greenhouse gases (GHGs) like CO_2, CH_4, CO, N_2O and others. Within TCCON, the Max Planck Institute for Biogeochemistry (MPI-BGC) has been operating a Fourier-Transform Spectrometer (FTS) on Ascension Island (8°S, 14°W) since May 2012. This is currently the only TCCON station covering the South Atlantic Ocean. So far, the measurements span more than two complete seasonal cycles.

Due to its location in the southern trade wind zone, the station is downwind from Africa most of the time. A detailed trajectory analysis shows that different parts of the total atmospheric column typically have different origins. Air in the Planetary Boundary Layer (PBL) typically comes from the deep southern Atlantic Ocean and had only little GHG exchange with land surfaces. However, air in the free troposphere above the PBL usually comes from tropical and southern Africa and sometimes also from South America.

A detailed analysis allowed us to separate the total column of CH_4 into a tropospheric and stratospheric part. Together with independent flask measurements from the surface, the effects of the different origins of air parcels can be seen in the PBL, the free troposphere and the stratosphere. For example, there are striking differences in seasonality for CH_4 between the PBL and the free troposphere. Unlike over typical land stations, trace gas concentrations in the free troposphere above Ascension Island seem to be generally much higher than near the surface. Above the PBL, there is a whole layer of GHGs transported from Africa which shows land seasonal effects and biomass burning signals. This layer remains undetectable for surface observations.