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Observations of long-lived trace gases in the upper troposphere and stratosphere

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Trace gases with atmospheric lifetimes ranging from a century to several millennia include certain chlorofluorocarbons (e.g. CFC-13, CFC-115, CFC-216ba, CFC-216ca) as well as many highly fluorinated species such as sulphur hexafluoride (SF₆), hexafluoroethane (C₂F₆), octafluorocyclobutane (c-C₄F₈) and trifluoromethane (HFC-23 or CHF₃). These compounds are all very potent greenhouse gases with the chlorofluorocarbons being also of importance for stratospheric ozone depletion, especially on longer timescales. The abundances of some of them continue to increase in the atmosphere. We here present measurements of a selection of these gases on air samples collected in the upper troposphere during passenger aircraft flights since 2009, notably including several interhemispheric flights. These observations were made as part of the CARIBIC project and we compare these distributions with concentration trends of these species in the troposphere. We also combine the results with stratospheric data obtained from samples collected during high-altitude aircraft and balloon campaigns and explore the compatibility of their stratospheric distributions with their atmospheric lifetimes. Finally we assess the suitability of several species as tracers of transport in the stratosphere in terms of their inertness, tropospheric growth rates and measurement precisions.