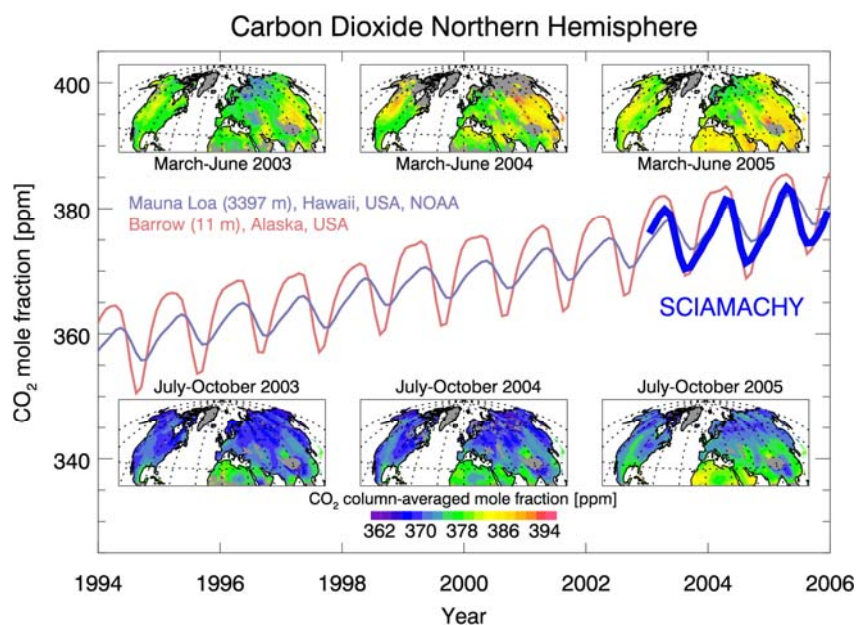


SCIAMACHY observations of the greenhouse gases Carbon Dioxide and Methane

Greenhouse Gas Emissions and Climate Change

Global climate change is the most urgent environmental problem of our time (see IPCC and OECD reports). It results from the release of long lived gases such as Carbon Dioxide, Methane, Nitrous Oxide, Chlorofluorocarbons, and also the generation of short lived greenhouse constituents such as tropospheric Ozone. The two most important greenhouse gases, whose atmospheric loading has been very significantly influenced by anthropogenic activity since pre-industrial times, are Carbon Dioxide (CO₂) and Methane (CH₄). The global mean surface concentrations of CO₂ and CH₄ are well known, both for present day conditions and for the unperturbed pre-industrial “natural” conditions. However, the reliable prediction of future greenhouse gas levels is very challenging because of an inadequate knowledge of their regional sources and sinks and in particular feedback in response to global climate change. In order to assess accurately the impact of global climate change both realistic estimates of future anthropogenic emissions of greenhouse gases and a thorough understanding of the sources and sinks and their response to a warmer climate are required.



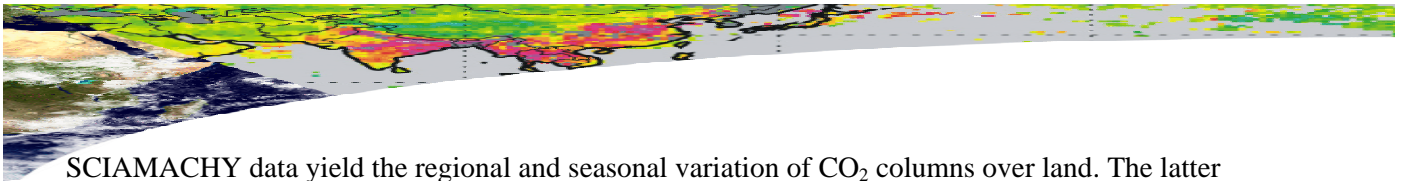
The need to determine greenhouse gas distributions from space

The surface fluxes of the greenhouse gases can be inferred from the spatial and temporal fluctuations in the atmospheric column amounts. However, for the long lived CO₂ and CH₄ these variations are small and superimposed on a large atmospheric background modulated by natural processes. The current surface based monitoring network for greenhouse gases provides accurate measurements, but is very sparse. In large parts of the globe, in particular in the tropics, there are no measurements. Instruments retrieving the greenhouse gas amounts based on satellite platforms orbiting the Earth have an advantage over conventional ground-based stations: They provide global coverage. However, the required accuracy of the greenhouse gases retrieved from space based measurements is a scientific and technological challenge. One of the objectives of SCIAMACHY has been to beat this challenge.

Greenhouse Gas Data from SCIAMACHY

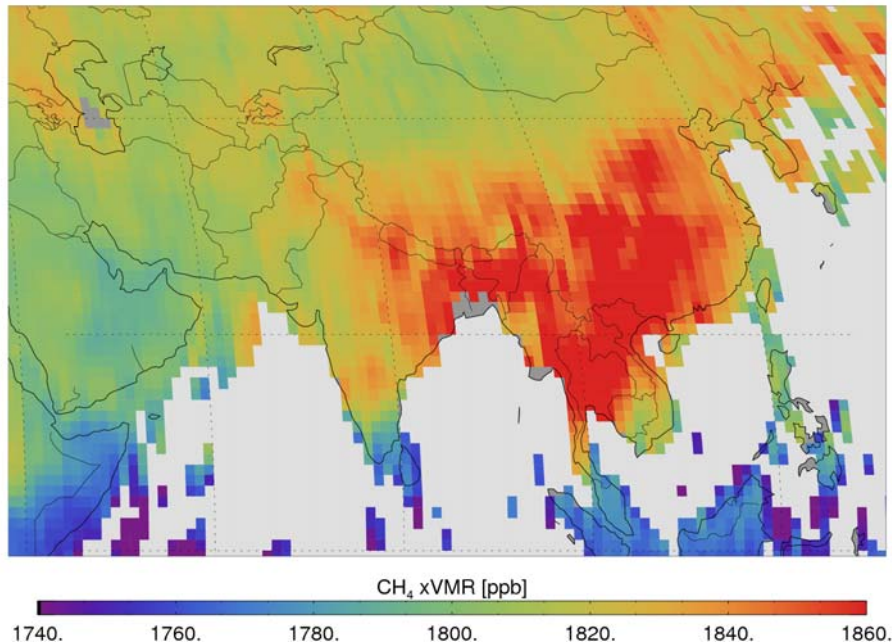
SCIAMACHY is the first, and so far only, satellite instrument capable of measuring the column of the greenhouse gases of CO₂ and CH₄ from the top of the atmosphere down to the Earth's surface, where the source and sink signal is largest. CO₂ contributes significantly more to global climate change than CH₄. However, the regional and temporal variations in the column amounts of CO₂, which result from anthropogenic activity and natural phenomena, are smaller than those in CH₄ making their accurate measurements from space more ambitious.

For CO₂ the variations observable by SCIAMACHY are relevant for the derivation of the patterns of the terrestrial regional sources and sinks, one key issue in the carbon cycle. It has now been shown that



SCIAMACHY data yield the regional and seasonal variation of CO₂ columns over land. The latter exhibits a seasonal cycle comprising the growing season of plants and trees in summer and the decomposition of foliage during autumn to early spring. This is superimposed on a weak (about 0.5% per year) steady increase, attributed to the emissions from the burning of fossil fuels and to a lesser extent biomass burning. Current research aims at constraining the surface fluxes using the SCIAMACHY CO₂ column data. These efforts focus mainly on the biological feedbacks to anthropogenic emissions, which are far more uncertain than the anthropogenic emissions themselves. In addition, the capability of SCIAMACHY to detect anthropogenic CO₂ emissions is currently under investigation.

Methane as seen from SCIAMACHY, rice emission peak season Aug-Oct 2004



For CH₄, SCIAMACHY has provided the first high quality maps of its global amount showing regions of enhanced concentration, for example those over Asia are attributed to result from rice production, livestock farming, and coal mining in China and India. While measurements in most regions were roughly consistent with modelled distributions, the enhanced amounts of CH₄ observed by SCIAMACHY over tropical regions were surprising. In the meantime, aircraft and some ground based measurements have confirmed the presence of high CH₄ concentrations above the Amazon rain forest, which were significantly under-predicted by atmospheric models. These findings, achieved by analysis of SCIAMACHY observations, point to a gap in our understanding of CH₄ sources in the tropics and is currently under investigation by the atmospheric research community.

The measurements by SCIAMACHY of the solar short wave infrared radiation and the retrieval of CO₂ and CH₄ amounts have also facilitated the preparations for the upcoming dedicated Carbon Dioxide missions Orbiting Carbon Observatory (OCO) of NASA and the Greenhouse gas Observing SATellite (GOSAT) of Japan, both planned for launch in late 2008. These research missions will run in parallel to SCIAMACHY in the period 2009 to 2014. As we enter the next phase of the anthropocene, further and improved European missions to measure the greenhouse gases are required to fill the data gap between the end of SCIAMACHY on ENVISAT and the European operational meteorological missions, which are planned for the decade beginning in 2020. In the longer-term, greenhouse gas monitoring from space will provide a unique component and an objective verification of greenhouse gas emission reporting within the framework of the UNFCCC convention on sustainable development and climate change (the Kyoto protocol) and subsequent international agreements on environmental policy.

SCIAMACHY constitutes a joint contribution from Germany, the Netherlands and Belgium.