

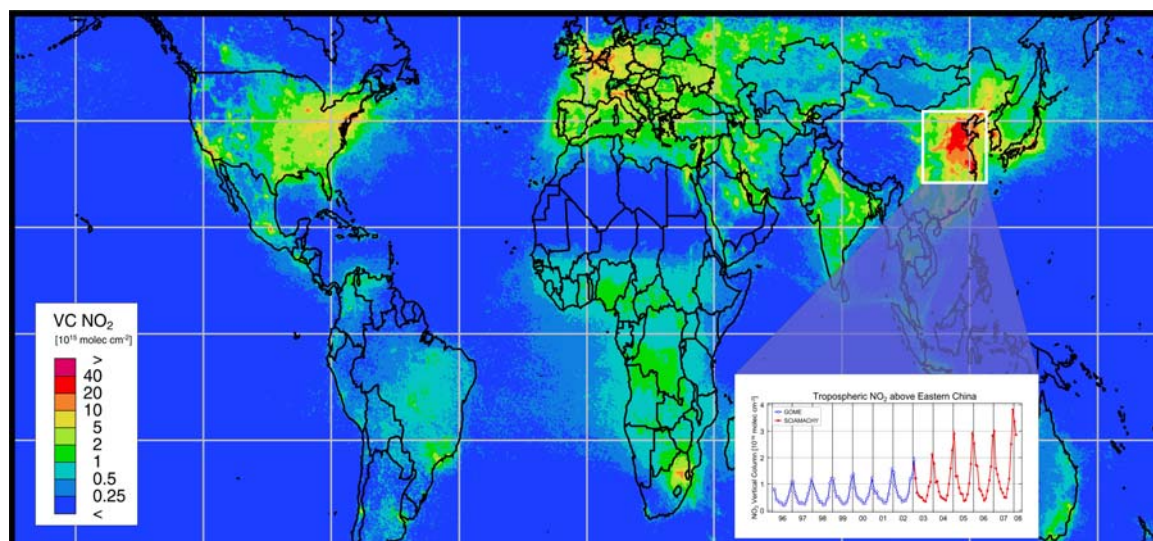
## SCIAMACHY measurements of air pollution

### The Impact of Air Pollution

Air pollution is a common problem, both in industrialised regions and in developing countries. It results from the oxidation of not only anthropogenic emissions to the atmosphere but also the combination of anthropogenic and natural emissions. A mixture of toxic chemicals comprising ozone and its precursors results, and this impacts directly on human health, agriculture, buildings and materials, and leads to loss of life and large economic losses.

Environmental laws have increasingly regulated emissions of pollutants in the industrialised countries, greatly reducing atmospheric concentrations of substances such as sulphur dioxide (SO<sub>2</sub>), which lead to acid rain in large parts of Europe and North America and to formation of London type smog. Similarly, the substances responsible for photochemical ozone smog formation have been regulated, in particular nitrogen oxides (NO<sub>x</sub>) and hydrocarbons (VOCs). However, while concentrations of these compounds have decreased over the last decade, the effects on tropospheric ozone levels were smaller than expected.

In the developing world, the situation is different. Rapid economic growth, in particular in China, combined with large population increases have strongly increased energy demand and the emission of pollutants. Environmental regulations and technology used are not always the latest standard. Over all, the efforts to reduce pollution are more than out weighted by increases in energy use.



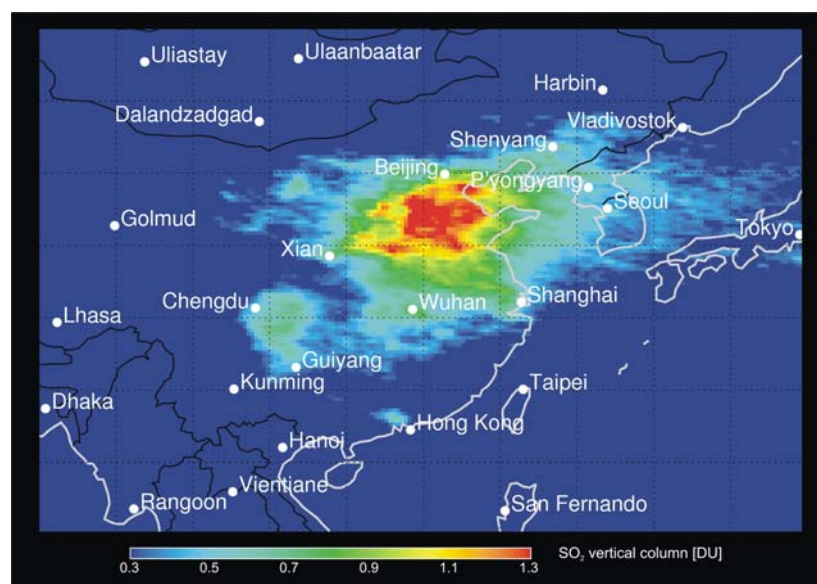
A different kind of global pollution, often producing hazardous conditions, is known as biomass burning and comes partly from the slash and burn agriculture. In the tropics biomass burning is modulated by the El Nino Southern Oscillation and results in large fires in Indonesia, South-east Asia, and Australia. The increase in large scale fires observed in boreal forests, peat bogs, and the Australian and European temperate forests in recent years, which is probably related to global climate change, is now another large source of pollution.

Satellite measurements have several advantages for monitoring of urban pollution and the results of biomass burning and fires. First of all, they provide the global view, something that no other measurement system can do. Secondly, they provide a uniform data-set, facilitating direct comparison of data from different times and places, avoiding differences between the various monitoring systems and standards currently in use in different countries. And thirdly, they have coverage in places where no network of surface stations exists, and therefore have the potential to provide data on regions otherwise not probed.

### Some SCIAMACHY results

In combination with the GOME time series, changes in concentrations of both  $\text{NO}_2$  and  $\text{SO}_2$  have been observed globally between 1996 and 2008. Over these 12 years, GOME and SCIAMACHY data documented that  $\text{NO}_2$  levels in industrialised countries have declined systematically, in particular in Europe as result of improved exhaust control. At the same time,  $\text{NO}_2$  levels in China and many mega city areas in the developing world have increased markedly as result of increasing population and economic development. The same is true for  $\text{SO}_2$ , which has been decreasing over the US but shows a strong increase over China, in both cases linked to the use of coal in power plants.

SCIAMACHY data have also been used to demonstrate the effect of new environmental regulations in the US which require power plants to use denoxification in summer and greatly reduced  $\text{NO}_2$  levels in some parts of the US. A clear  $\text{NO}_2$  signal was also found in SCIAMACHY measurements over the largest shipping routes in the Indian Ocean, highlighting the increasing impact of international shipping on air quality in the remote marine boundary layer.



In addition, SCIAMACHY data have been used to map levels of carbon monoxide ( $\text{CO}$ ), glyoxal ( $\text{CHOCHO}$ ), and formaldehyde ( $\text{HCHO}$ ). These species are generated by pollution and fire but in part also have natural sources in the biosphere. By using SCIAMACHY measurements in combination with models of atmospheric chemistry and transport, the total amounts and distributions of emissions of  $\text{NO}_x$  and other pollutants could be derived and their changes in the last decade were investigated. SCIAMACHY data have provided the opportunity and stimulus for the development of new air pollution forecast services based on satellite data.

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