→ THE EARTH OBSERVATION HANDBOOK
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http://www.eohandbook.com/eohb2012/sat_earth_obs_atmos_chem.html

Atmospheric Chemistry Instruments

Description

‘Atmospheric chemistry instruments’ is used here to describe a range of different types of instruments that use various techniques and different parts of the electromagnetic spectrum to undertake measurements of the atmosphere’s composition. Each atmospheric gas is characterised by its ‘absorption’ and ‘emission’ spectra, which describe how the molecules respond to, or signal their presence through the emission of, different frequencies of radiation. Remote sensing instruments exploit these ‘signatures’ to provide information on atmospheric composition, using measurements over a range of wavelengths, between UV and microwave.

Atmospheric absorption tends to be dominated by water vapour, carbon dioxide, and ozone, with smaller contributions from methane and other trace gases. Relatively broadband instruments can be used for measurements of the dominant gases, but high spectral resolution sensors are needed to make measurements of other species, since they produce weaker signals, and these must be discriminated from the signals from more abundant gases.

The instruments are typically operated in either:

— nadir-viewing mode: looking directly down to measure the radiation emitted or scattered in a small solid angle centred around a measurement point on the Earth, with resulting high spatial resolution in the horizontal direction, but limited vertical resolution; or

— limb-viewing mode: scanning of positions beyond the horizon to observe paths through the atmosphere at a range of altitudes – providing high vertical resolution (a few km) but limited horizontal resolution (tens of km at best) and particularly useful for studying the middle atmosphere.

Emission or absorption spectra can be studied in limb-viewing mode. One approach – known as occultation – uses known astronomical bodies (such as the Sun and stars) as well characterised target sources, and measures the effect of the Earth’s atmosphere on the radiation reaching the satellite to determine atmospheric composition.

Current & planned instruments

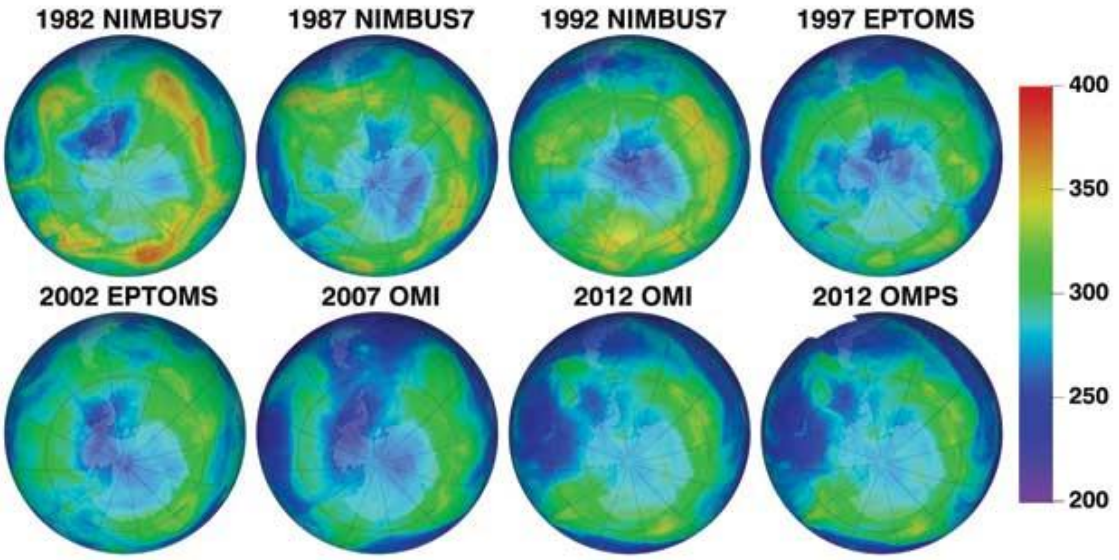
ACE-FTS	PCW PHEMOS - Atmospheric
CO Sensor (ASCENDS)	SAGE-III
FTS	SBUV/2
GAMI	SCIAMACHY
GEMS	SMILES
GOME-2	SMR
GOMOS	Spectrometer (OCO-2)
HiRDLS	TANSO-FTS
IPDA LIDAR	TES
IR Spectrometer (GACM)	TGSP
LiV HYSI	UV Spectrometer (GACM)
Mach-Zehnder Microinterferometer	UVAS
MAESTRO	UVN (Sentinel-4)
Microwave limb sounder (GACM)	UVNS (Sentinel-5 precursor)
MIPAS	UVNS (Sentinel-5)
MOPITT	TANSO-FTS
OMI	TOU/SBUS
OMPS	TRSR
OMS	TSU
OSIRIS	

Applications

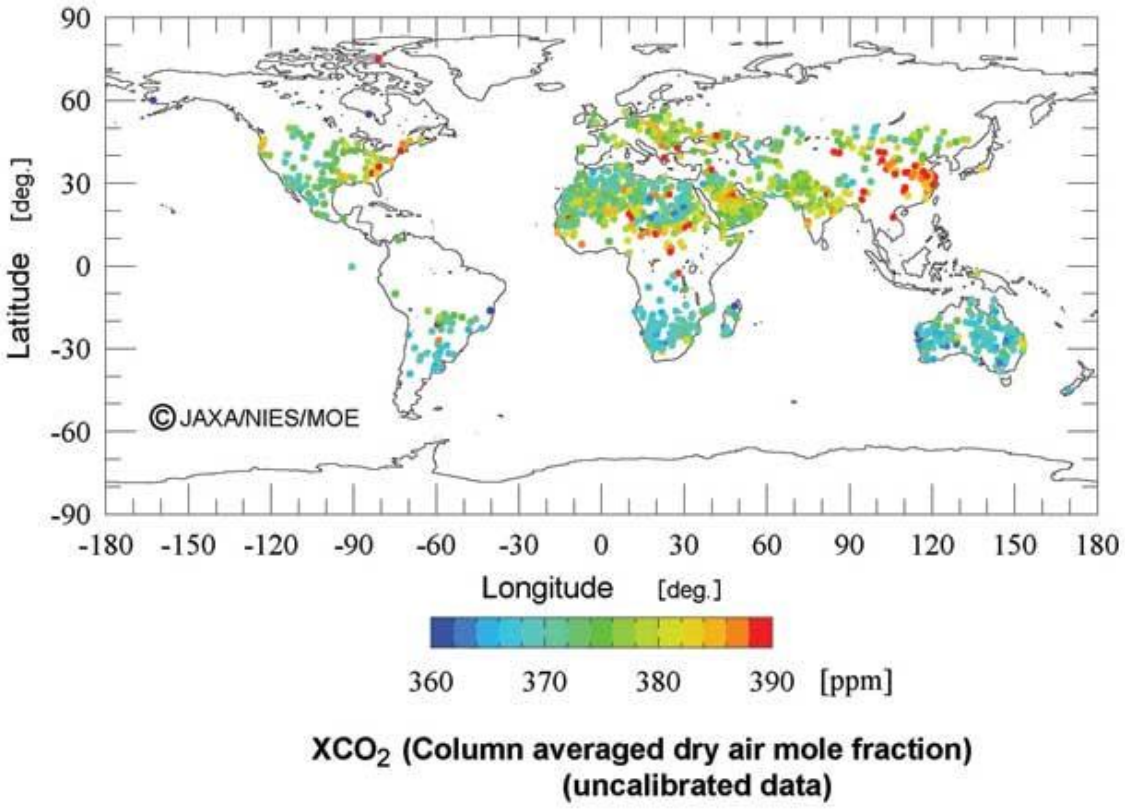
The earliest atmospheric chemistry instruments were deployed to measure the stratospheric ozone content, and help understanding of stratospheric ozone depletion after this phenomenon was discovered. They succeeded in producing startling and convincing evidence of the growth of the Antarctic ozone hole. Many of the current and planned instruments continue to provide more sophisticated and accurate information on ozone chemistry in the atmosphere, including data related to gases and radicals which impact on the ozone cycle.

Agencies are addressing the need for sustained measurements of other key atmospheric constituents including CO2, CO and CH4. Research missions are also planned periodically to allow detailed examination of the complex details of atmospheric chemistry and the possibility that such details might be changing. The capability to provide a global picture of the atmosphere, and how it is changing on a daily, seasonal and geographical basis, is ensuring demand for these instruments in a wide range of applications. These include: pollution monitoring; climatology, including studies of the carbon cycle and support to policy-making processes such as the Kyoto Protocol; volcanic eruption monitoring; and operational meteorology.

The trend towards improved measurement resolutions and accuracies, profiling measurements (rather than total column measurements), and extended capability in the Upper Troposphere/Lower Stratosphere (UTLS) will further extend the value of these instruments in the coming years for monitoring air quality and modelling atmospheric processes.



The long heritage of ozone measurements from space.



Global CO2 product from GOSAT

Further Information

ACE-FTS: www.ace.uwaterloo.ca
FY-3: www.nsmc.cma.gov.cn/newsite/NSMC_EN/Channels/100097.html
GOMOS/MIPAS/SCIAMACHY: envisat.esa.int/instruments/index.html
GOSAT: www.jaxa.jp/projects/sat/gosat/index_e.html
IASI: smsc.cnes.fr/IASI/
HIRDLS/MLS/OMI/TES: http://aura.gsfc.nasa.gov/instruments/
MERLIN: www.dlr.de/pa/en/desktopdefault.aspx/tabid-2342/6725_read-26662/
OCO: oco.jpl.nasa.gov/
OMPS: npp.gsfc.nasa.gov/omps.html, www.nesdis.noaa.gov/jpss/
Sentinels: www.esa.int/esaLP/SEM097EH1TF_LPgmes_0.html