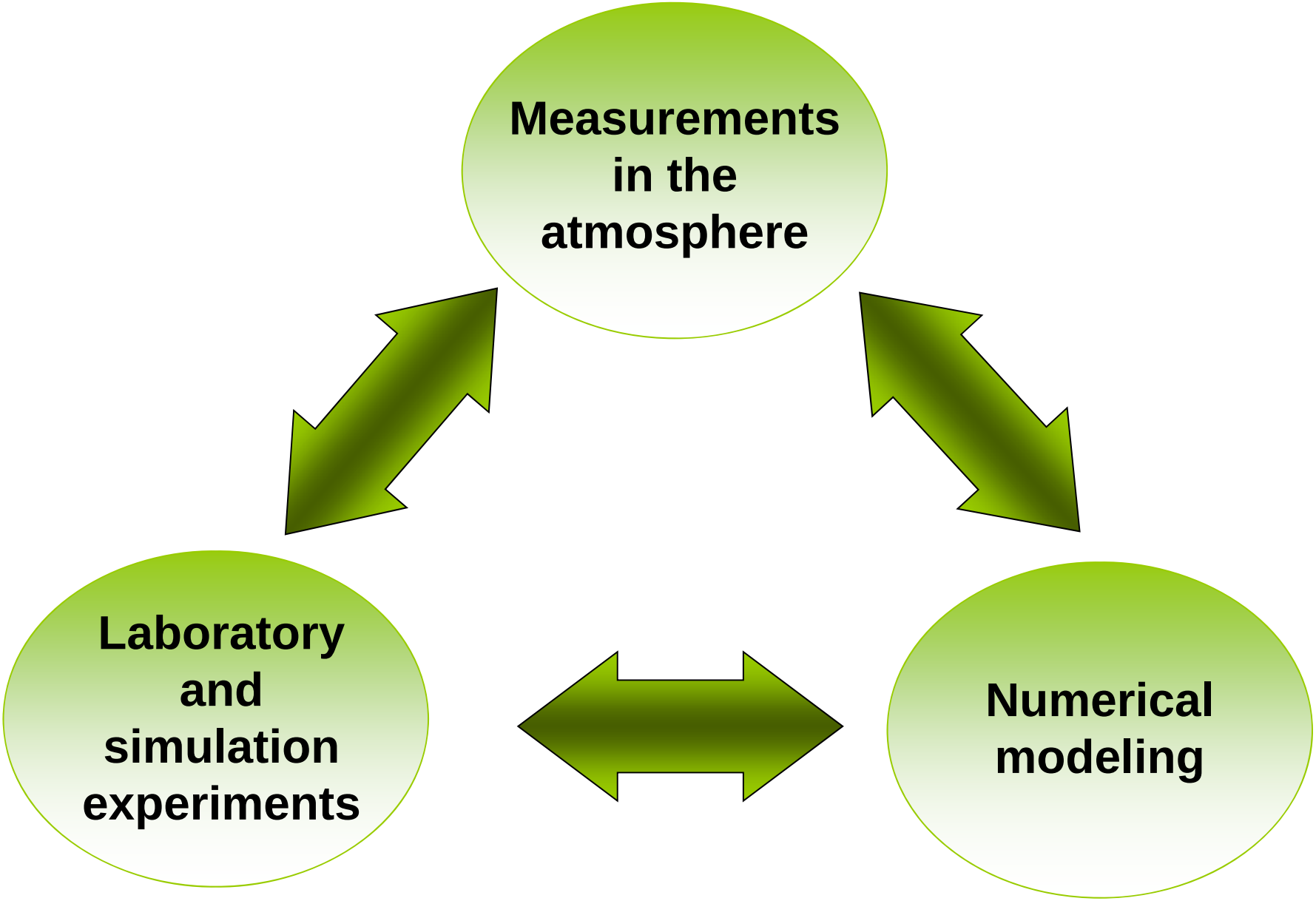
The role of HALO in the investigation of (photo)chemical processes in the atmosphere

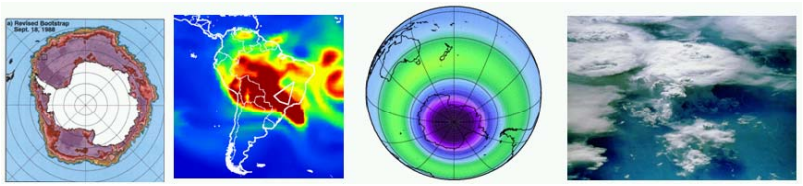
Ralf Koppmann

University of Wuppertal

Atmospheric research consists of three core areas.



Scientific Scope of HALO



… HALO will greatly increase the fraction of the global atmosphere in which fundamental physical and chemical processes can be directly observed.

… The aim is to reduce uncertainties in the understanding of crucial atmospheric processes.

- **The chemistry of the troposphere and lower stratosphere**
- **Oxidation and aerosol physical-chemical processes in the troposphere**
- **Long-range transport of pollutants that affect regional and global air quality and climate**

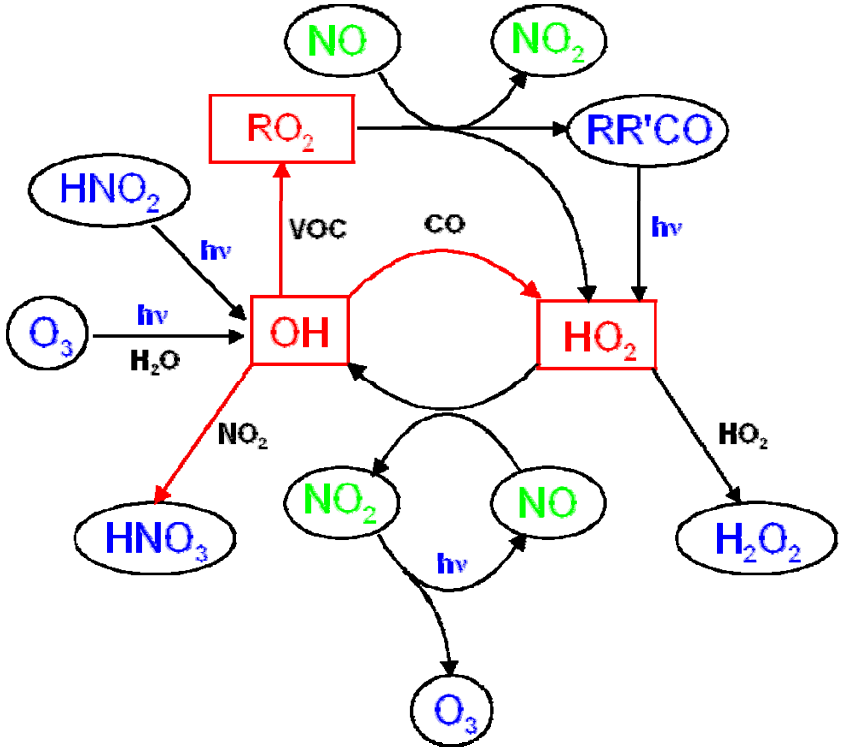
HALO is designed for 30 years of operation.

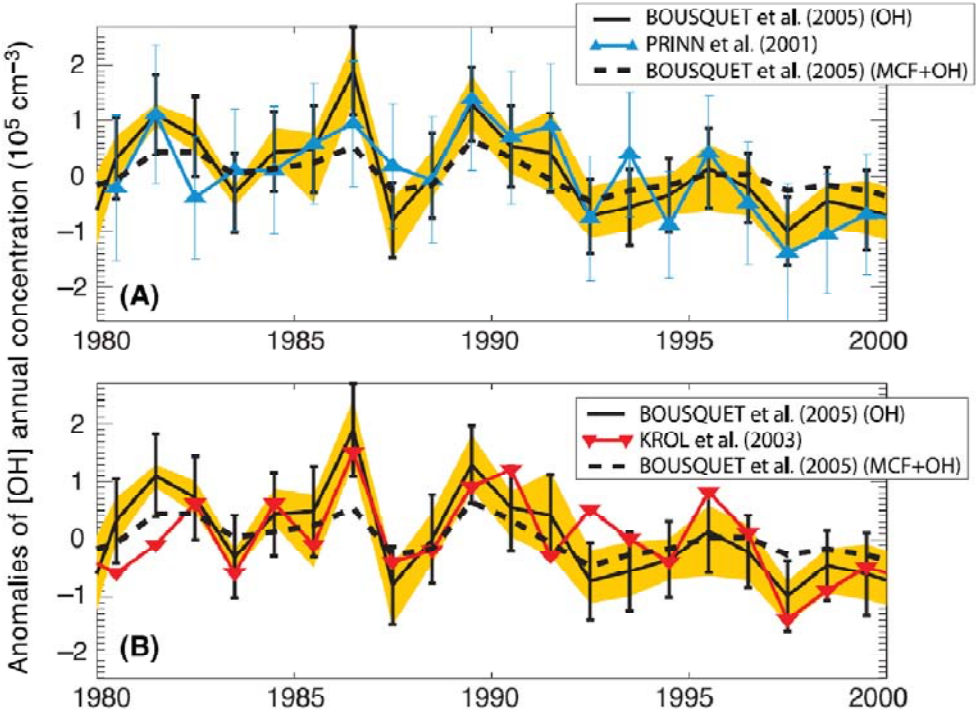
We have revealed many chemical processes in the atmosphere on a global scale, but

- **we have to deal with a changing atmosphere**
- **which gets warmer in the next decades**
- **where circulation patterns will definitively change**
- **where the biosphere will react on these changes**
- **where biomass burning areas will shift**

All this will affect atmospheric chemical processes on a gobal scale, all this requires further research.

With HALO we can measure chemical processes directly by a suite of sophisticated instruments.





3.7 Gt/yr of trace gases are removed from the atmosphere by OH

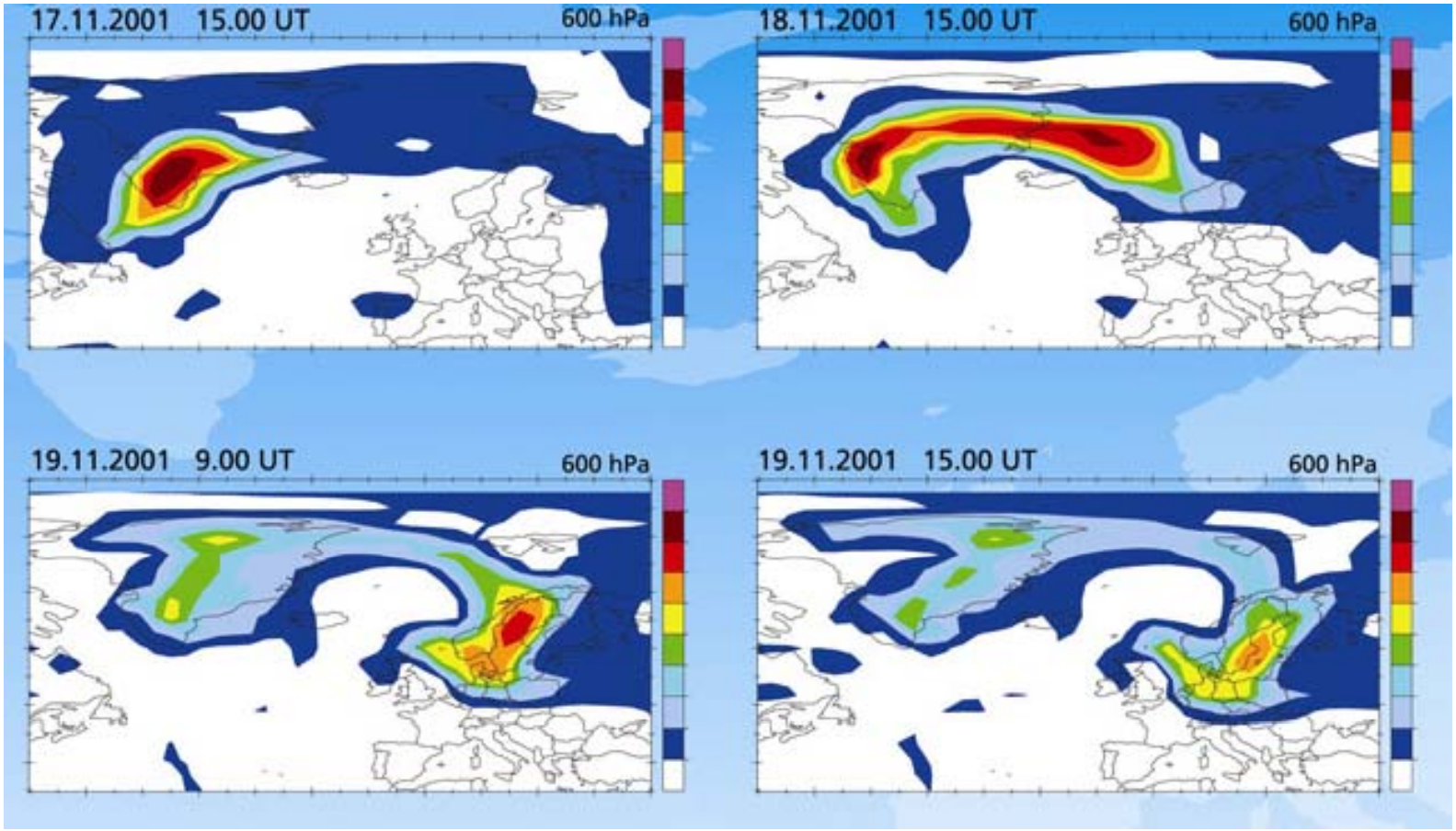
IPCC-TEAP: Changes in tropospheric OH may range from +5 % to -18 %

Is the cleansing efficiency of the atmosphere changing?

Open questions:

- Can we specify the sources and sinks of OH in a way to assess the impact of chemistry-climate changes ? (4, 7, 35, 40, 41)
- Can we quantify the influence of heterogeneous chemistry on free radical chemistry ?
- How robust are the relationships between photolysis frequencies and tropospheric OH levels ? (4)
- How do other compounds like peroxy radicals, halogen radicals, and oxygenated VOC contribute to the OH budget ? (7, 19, 20, 31, 32, 40, 41, 48, 51, 54)
- Do all these processes change with time ?
- Can we attribute any changes to climate change ?

With HALO we can conduct regional and quasi-Langrangian field experiments especially in those regions that are strongly influenced by transport and mixing.

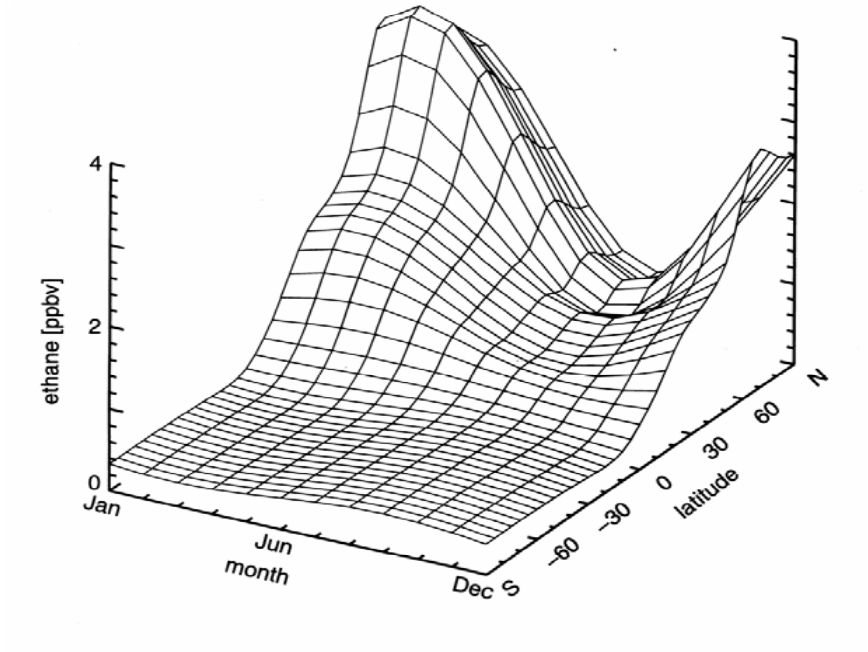


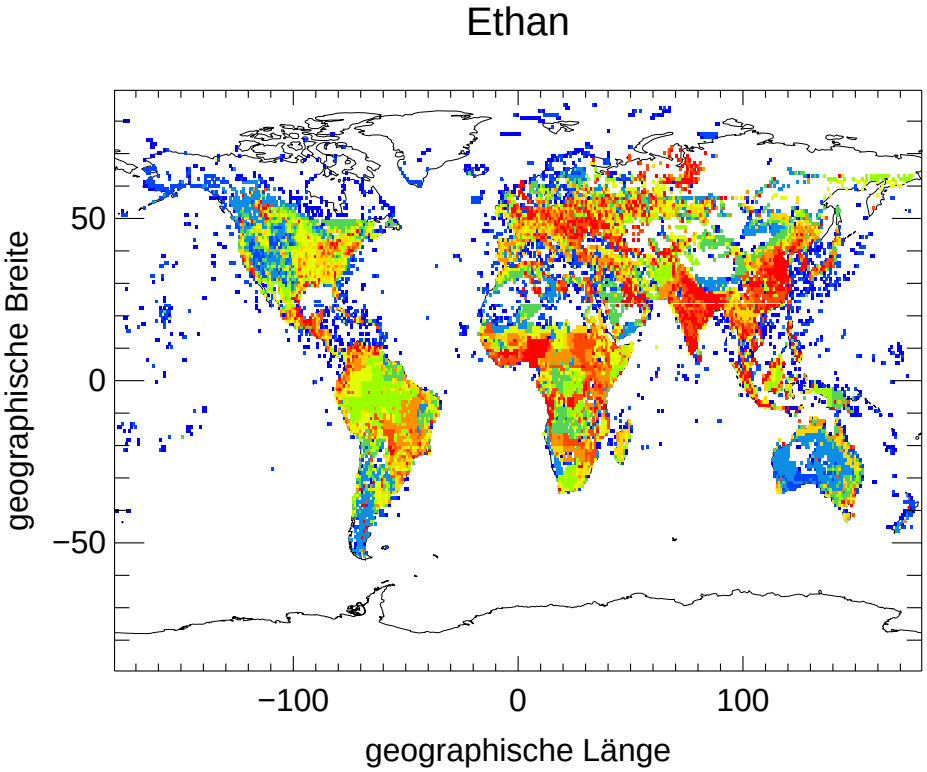
Are transport patterns and circulation systems of the atmosphere changing?

Open questions:

- How fast are trace gases transported from the PBL into the troposphere and what is their chemical transformation ?
- Can we predict the horizontal transport of pollutants and quantify their impact on the target areas ? (49)
- What are the drivers of interhemispheric exchange of air masses ?
- What are the temporal and spatial variabilities of troposphere-stratosphere exchange ? (18, 19, 20)
- Can we attribute any changes in these processes to climate change ?

With HALO we can investigate budgets of trace gases relevant for atmospheric chemistry in the troposphere and lower stratosphere.





The budget of ethane is reasonably well known.

Are the budgets of trace gases in the atmosphere changing?

Open questions:

- What determines the vertical distribution and the chemical processing of trace gases and aerosols ? (8)
- What is the impact of increased emissions of pollutants from developing regions in Asia, South America and Africa on tropospheric trace gas budgets ? (31, 32, 35)
- What controls tropospheric ozone, how and where is it produced in the troposphere ? (35)
- How do the concentration and transport of water vapour develop in the troposphere and lowermost stratosphere ? (9, 23, 45, 50)
- Can we attribute any changes in these processes to climate change ?

What are the regions of interest we can reach with HALO?

The tropical troposphere is the region

- which contains 80 % of the global OH and controls the self cleaning capacity of the atmosphere
- where interhemispheric transport and troposphere-stratosphere exchange takes place

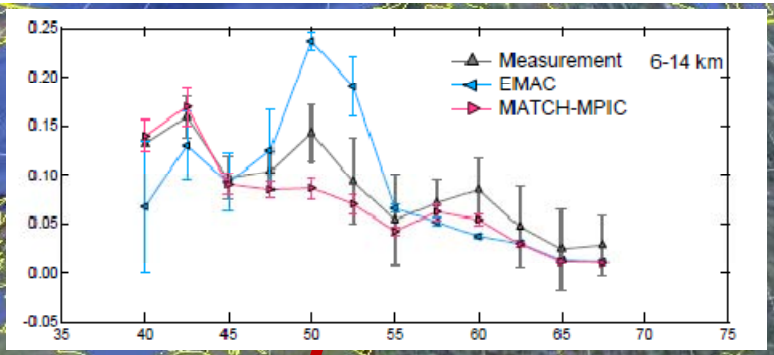
The mid-latitudes and boreal areas are regions

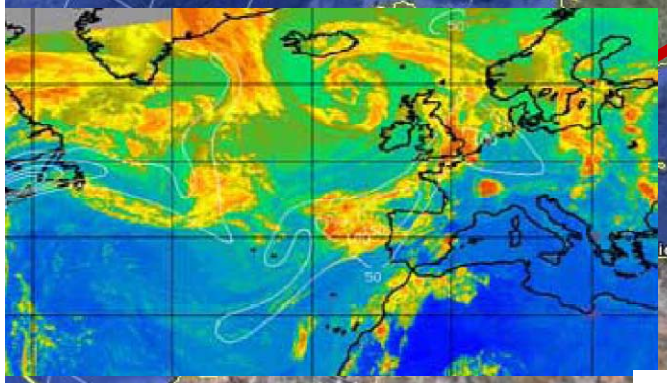
- where climate change is expected to proceed more rapidly than elsewhere
- where intercontinental transport of pollutants is an important issue

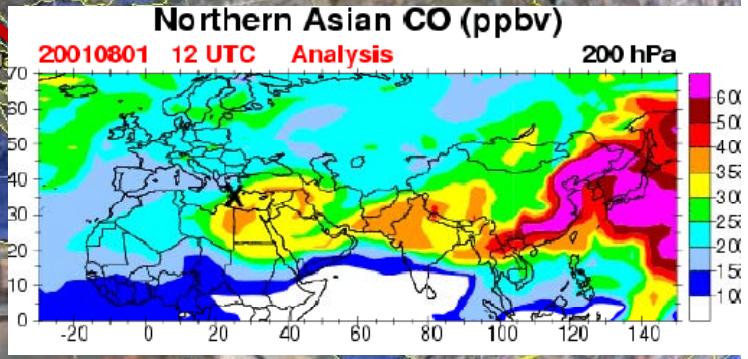
The polar areas are regions

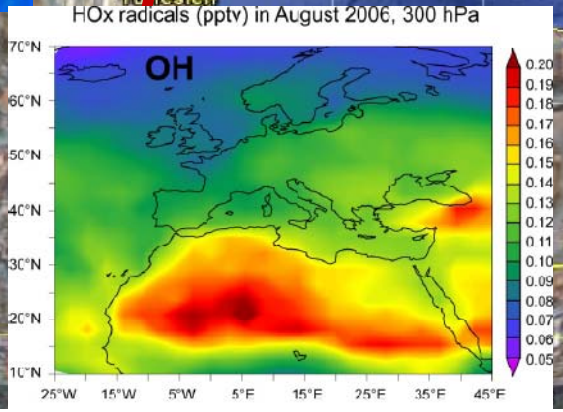
- where effects of climate change are already visible today
- where ozone chemistry is a critical issue

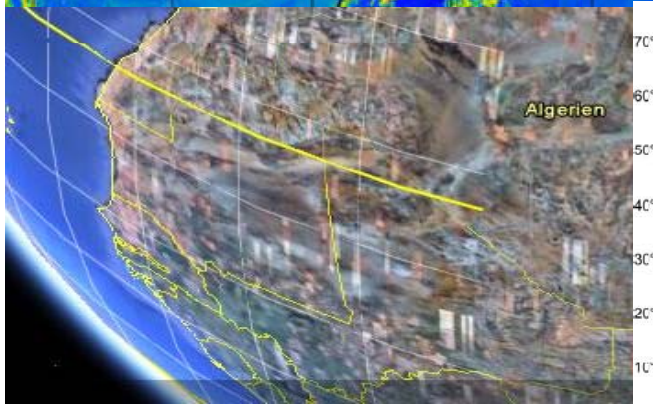
Oxidation Mechanisms Observation (OMO)

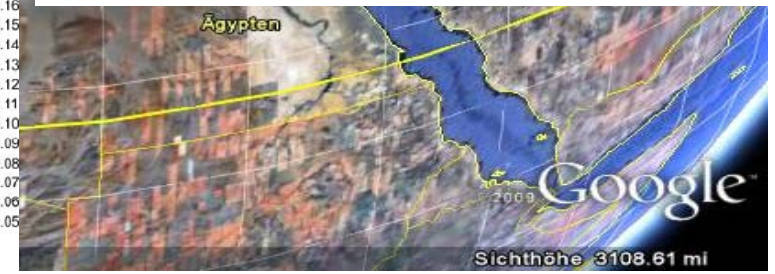












Oxidation Mechanisms Observation (OMO)

Parameter/Compound	Instrument	Funding	Institute
Photolysis frequencies	Radiometer		FZJ/Uni Mainz
OH/HO_2	AirLIF		FZJ
OH/HO_2	HORUS		MPI Mainz
RO_2	PerCEAS	SPP-1	Uni Bremen
Halogen radicals	Mini-DOAS	SPP-1	Uni Heidelberg
oxygenated VOC	fast GC-MS	SPP-1	MPI Mainz
oxygenated VOC	PTR-MS		KIT
VOC	fast GC-MS	SPP-1	FZJ
VOC	PTR-MS		MPI Mainz
Isotope ratios in VOC	MIRAH		Uni Wuppertal
NO/NO_y	Chemilum.		DLR
O_3	Photometer		KIT
HNO_3, HONO	CIMS		MPI Mainz
PAN	CIMS		DLR
H_2O_2, aldehydes	TRISTAR		MPI

Instruments are available, documents have been submitted
… waiting for certification

HALO is an indispensible platform

- to develop a fundamental understanding of processes that determine the composition of our atmosphere
- to provide the observational data base to understand the interactions between atmospheric chemical composition and climatic processes
- to predict the impact of natural and anthropogenic forcings on the chemical composition of the atmosphere