

5<sup>th</sup> Georgian – German School and Workshop in Basic Science  
Institute of Energy and Climate Research , Troposphere

# New Directions in Atmospheric Research

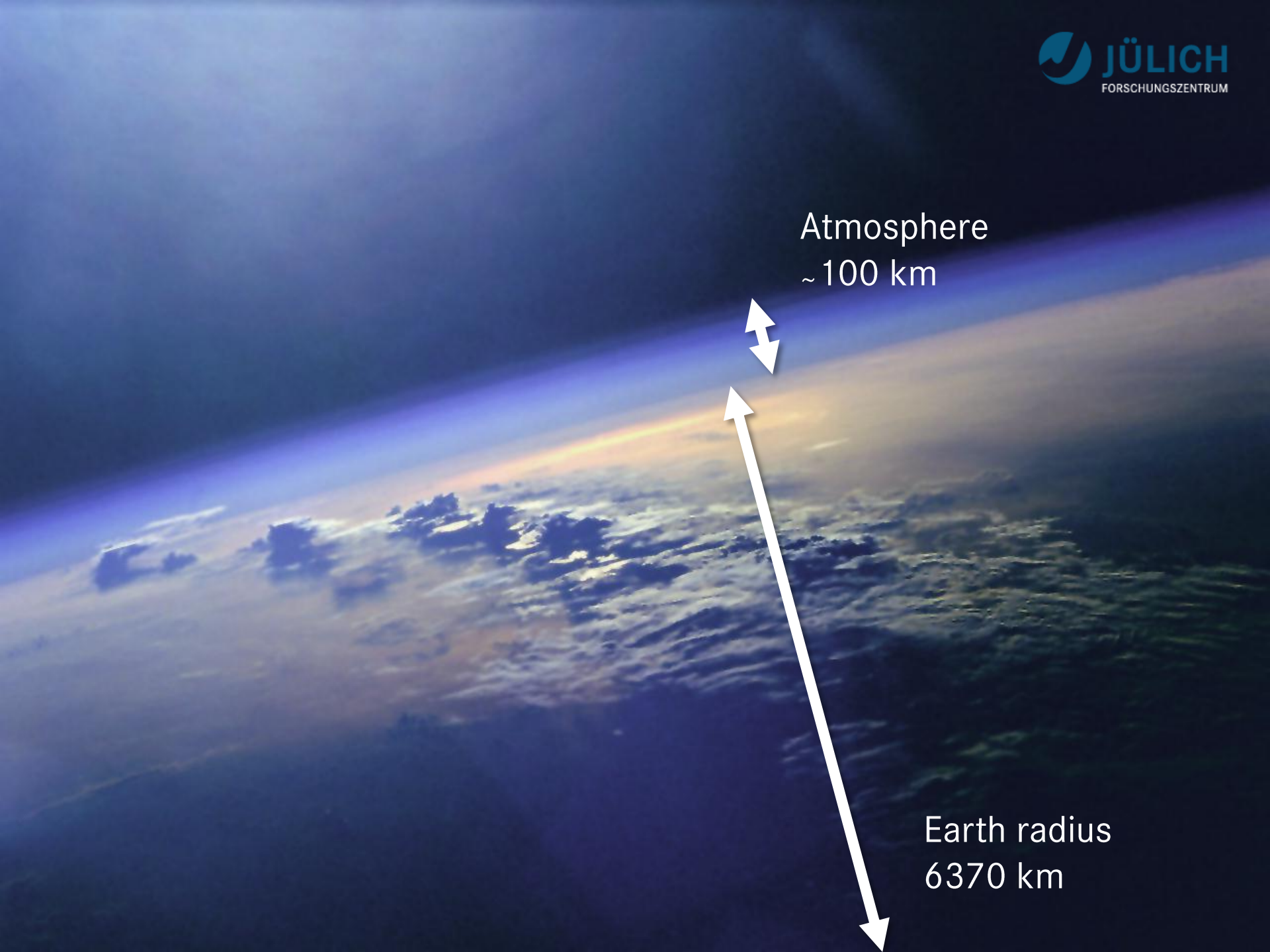
*Andreas Wahner*

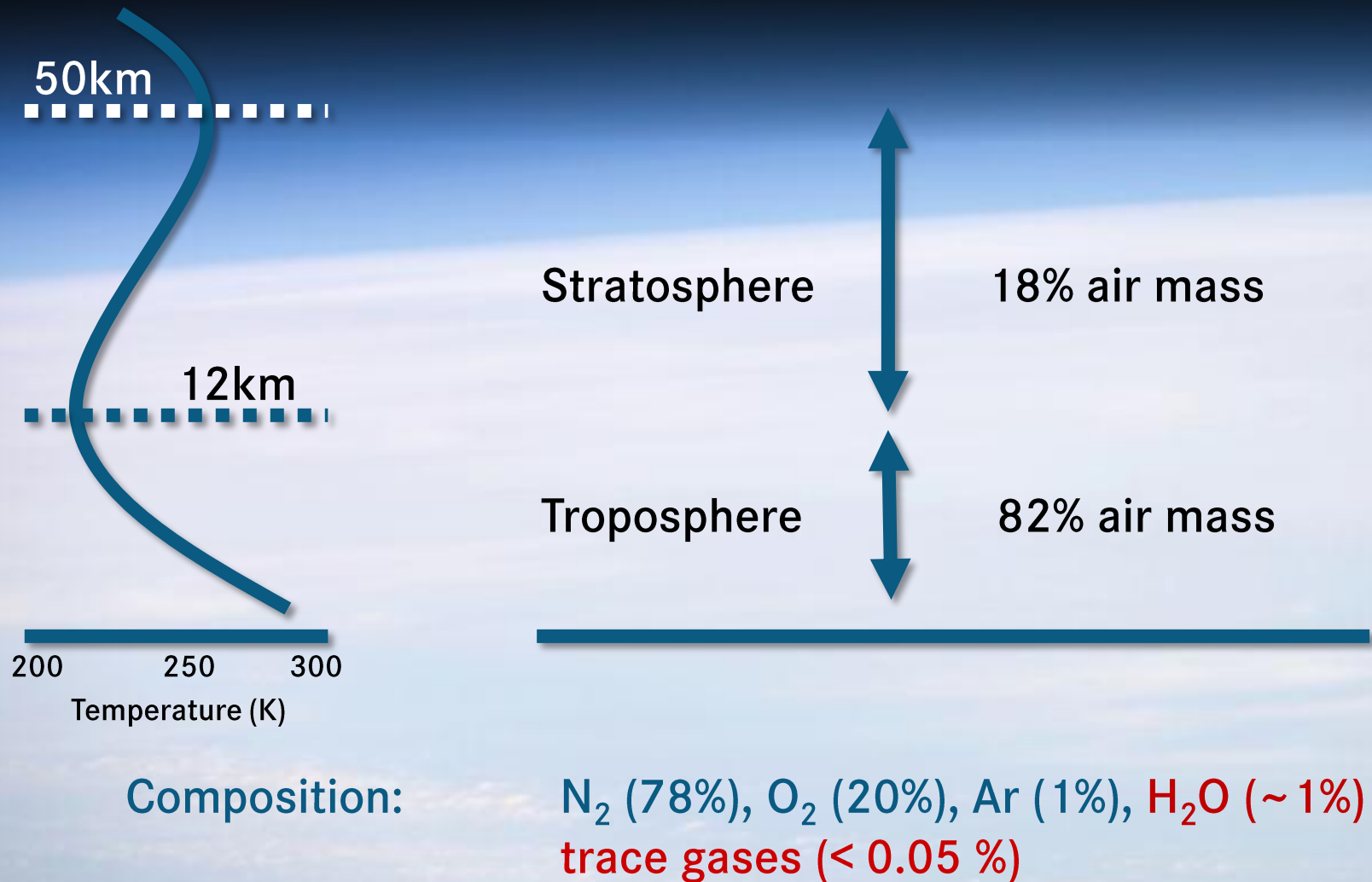
*Forschungszentrum Jülich, IEK-8: Troposphäre*



Atmosphere  
~ 100 km

Earth radius  
6370 km

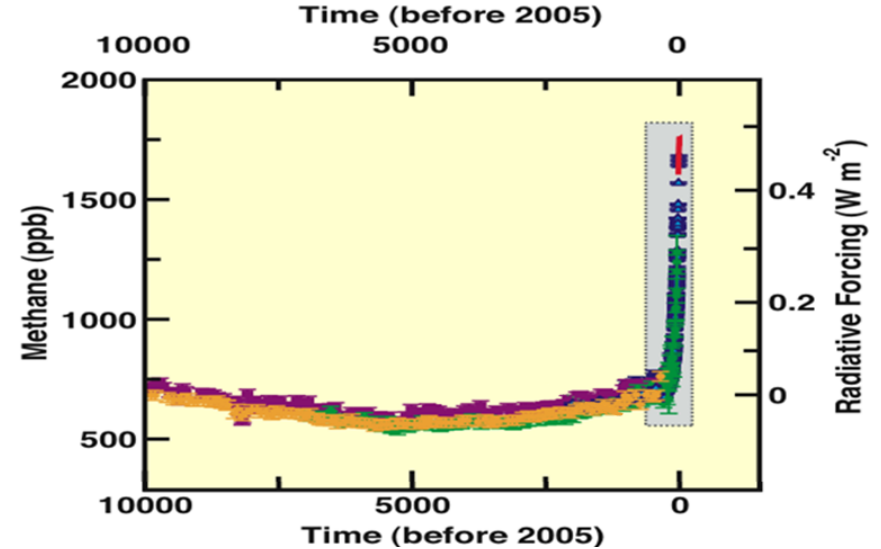
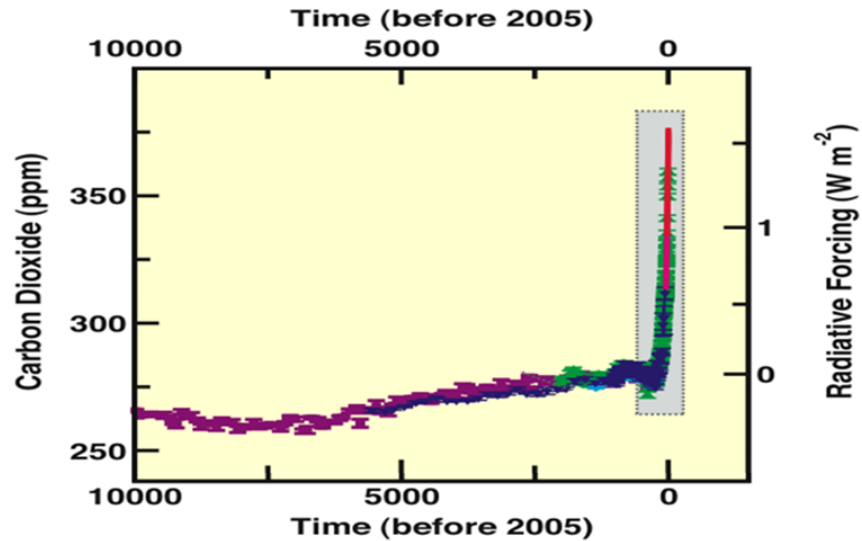




# Atmospheric Trace Gas Degradation by Oxidation

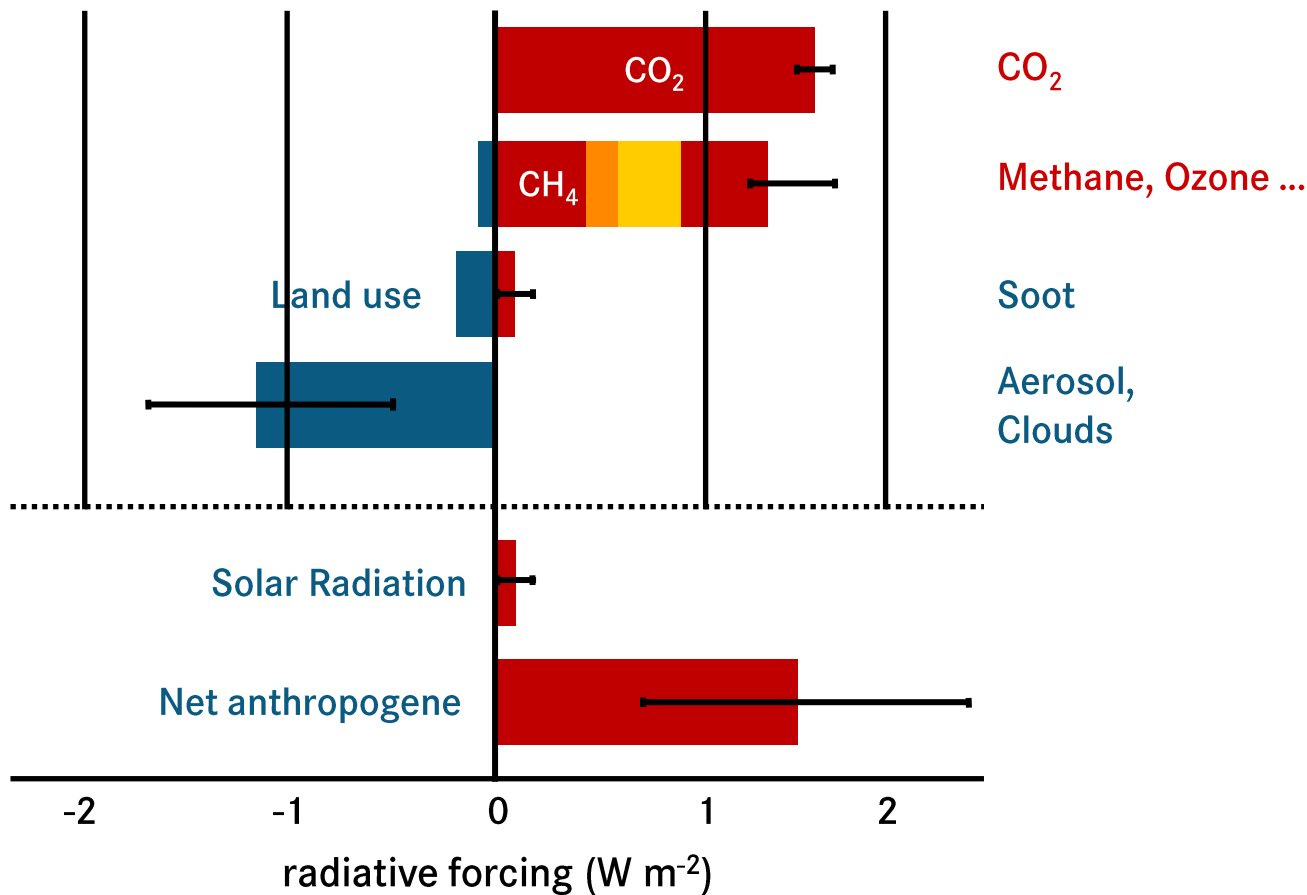
Trace Gas	Global Emission (Million Ton per Year)	Degradation by OH-radikals
CO	2800	85 %
Methan	530	90 %
Alkane	20	90 %
Isoprene	570	90 %
Terpene	140	50 %
NO <sub>2</sub>	150	50 %
SO <sub>2</sub>	300	30 %
(CH <sub>3</sub> ) <sub>2</sub> S	30	90 %
CFCI <sub>3</sub>	0,3	0 %

# Change of Greenhouse Gases



# Climate Change (1750 to 2005)

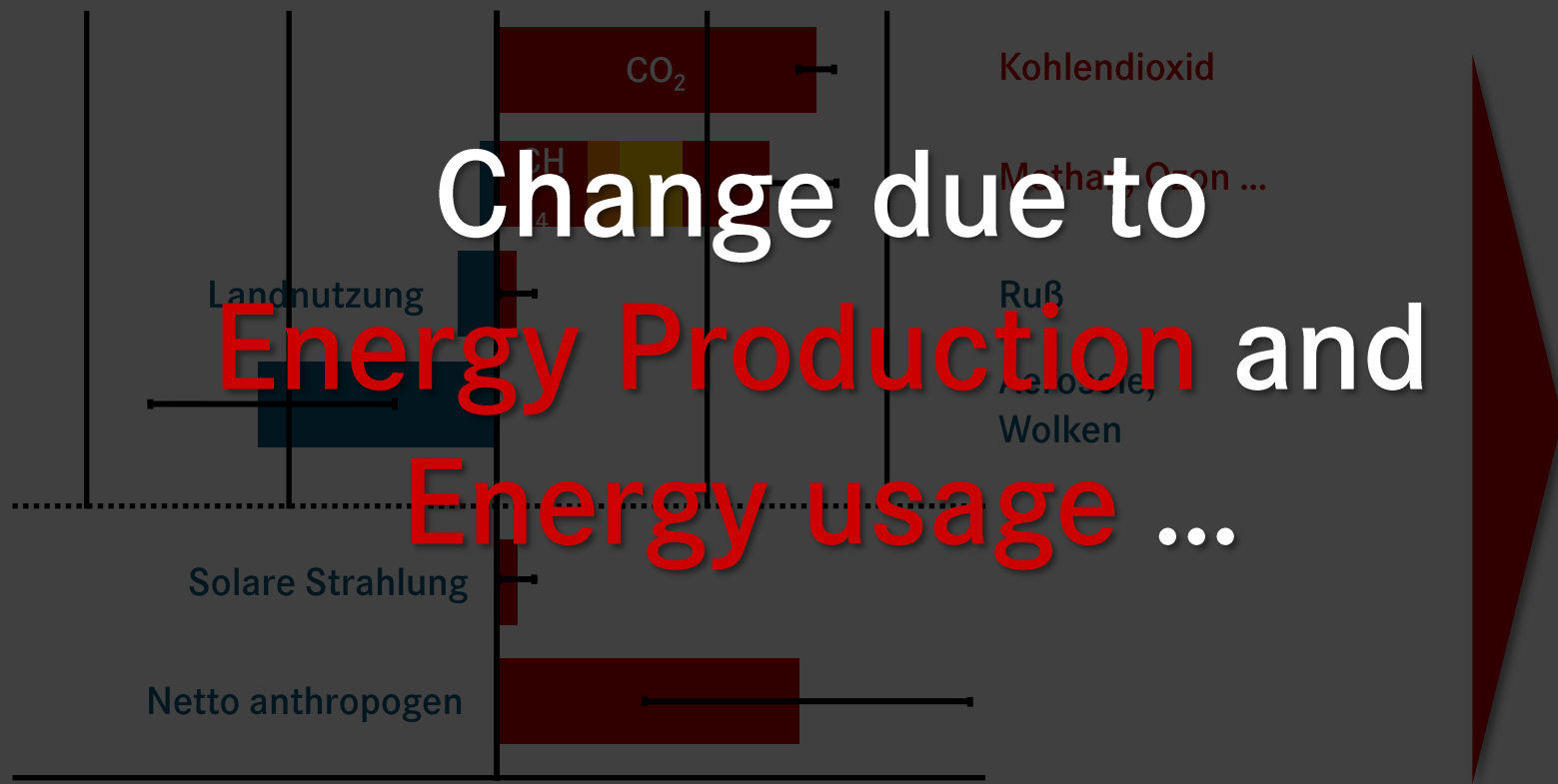
## Change of radiative forcing





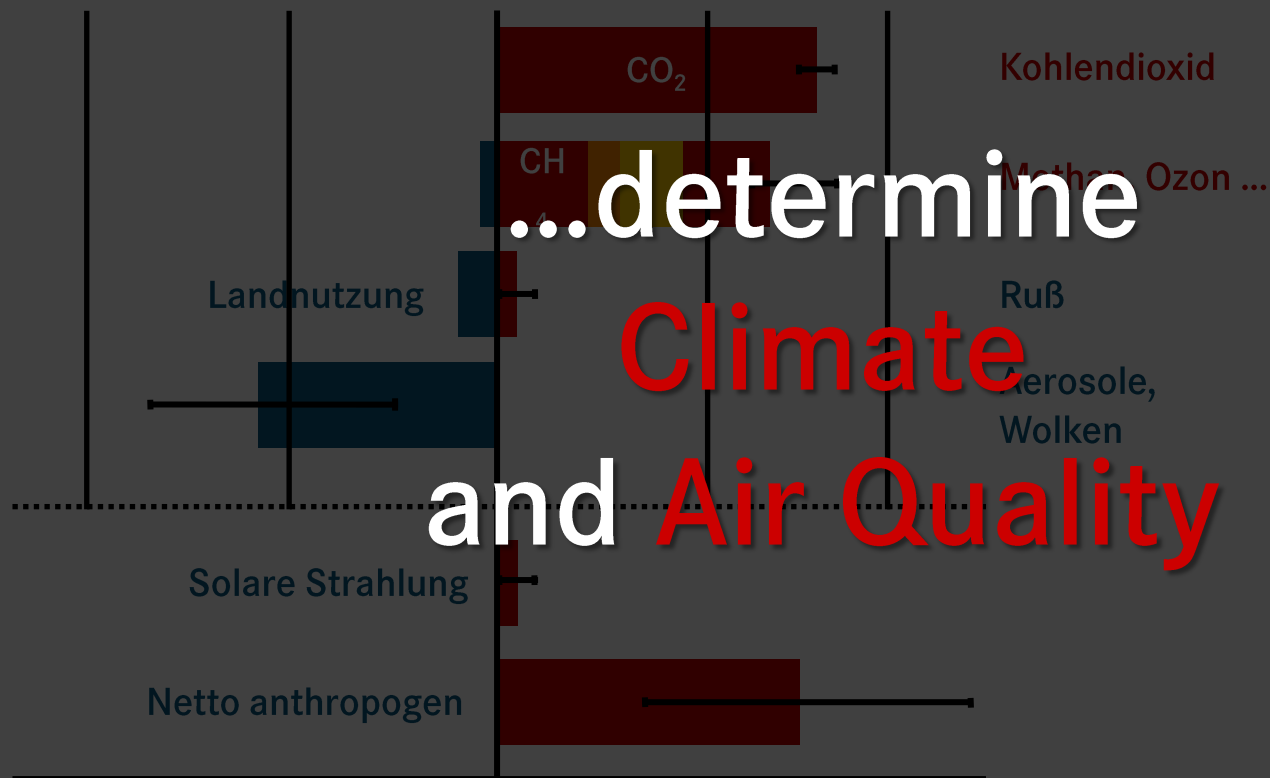
# Climate Change (1750 to 2005)

## Change of radiative forcing



# Climate Change (1750 to 2005)

## Change of radiative forcing





# Seamless Forecast of Climate Change: Basis of Mitigation and Adaption

## Chemistry-Climate- Interaction

Time scales:

Days,  
local to regional

Decades,  
regional to global

Centuries,  
global

Air Quality and Climate:  
Ozone, Aerosol, Clouds, Methane ...



longterm Climate Change:  
... Carbondioxide



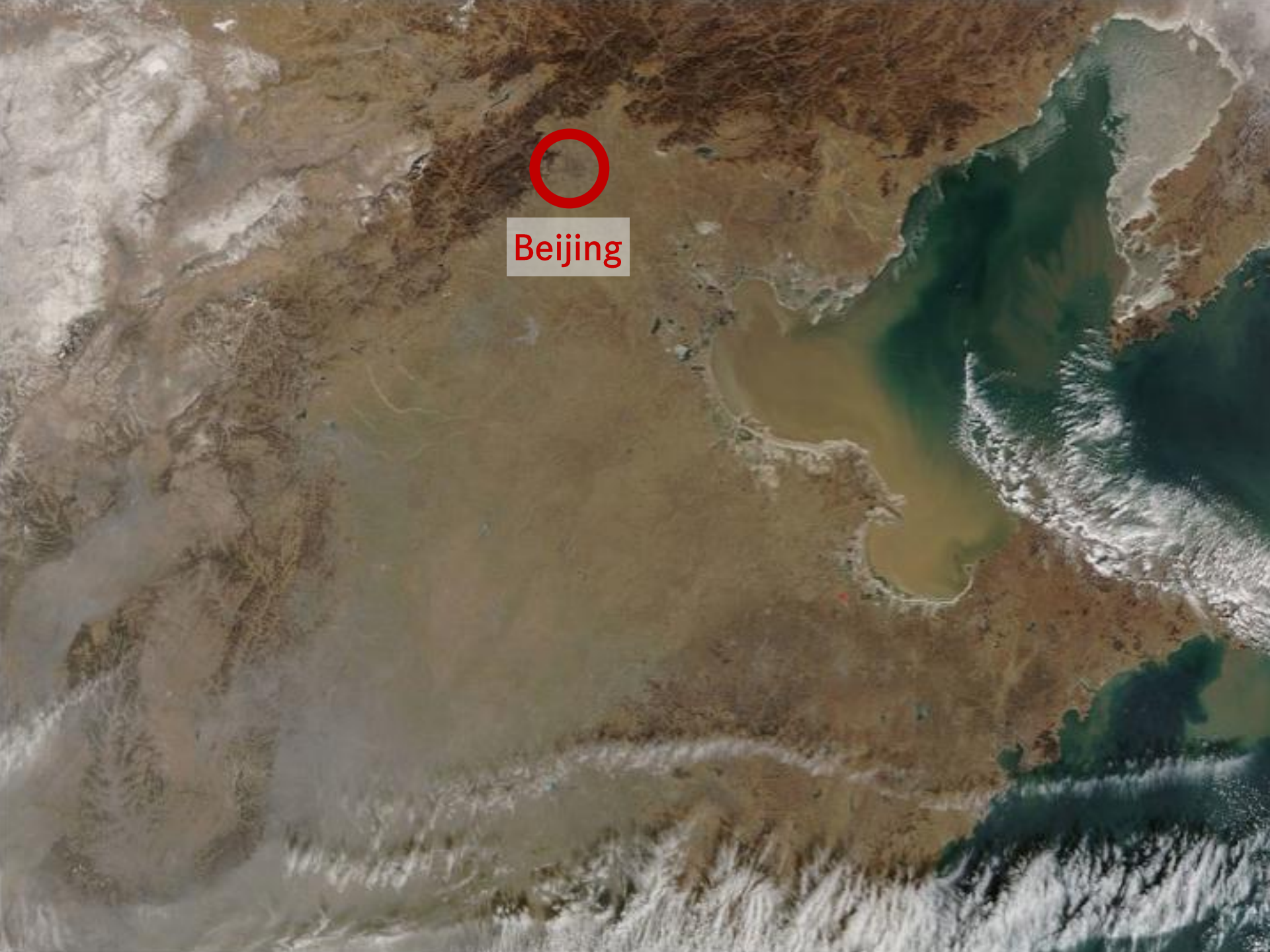
focal point:  
Mega cities > 10 million people

# Air Quality

## Violation of Limits

Guangzhou in Pearl-River-Delta, South China



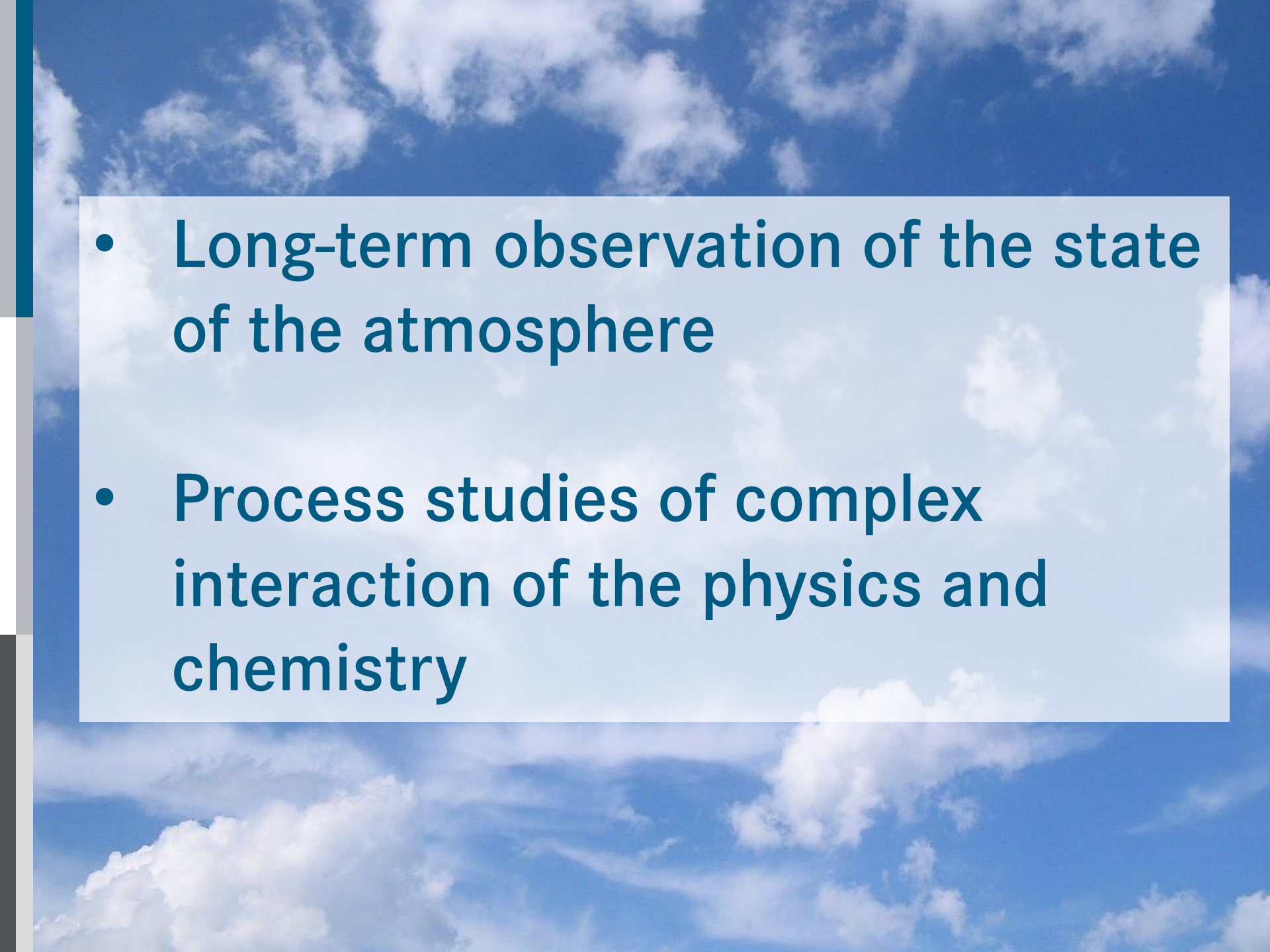


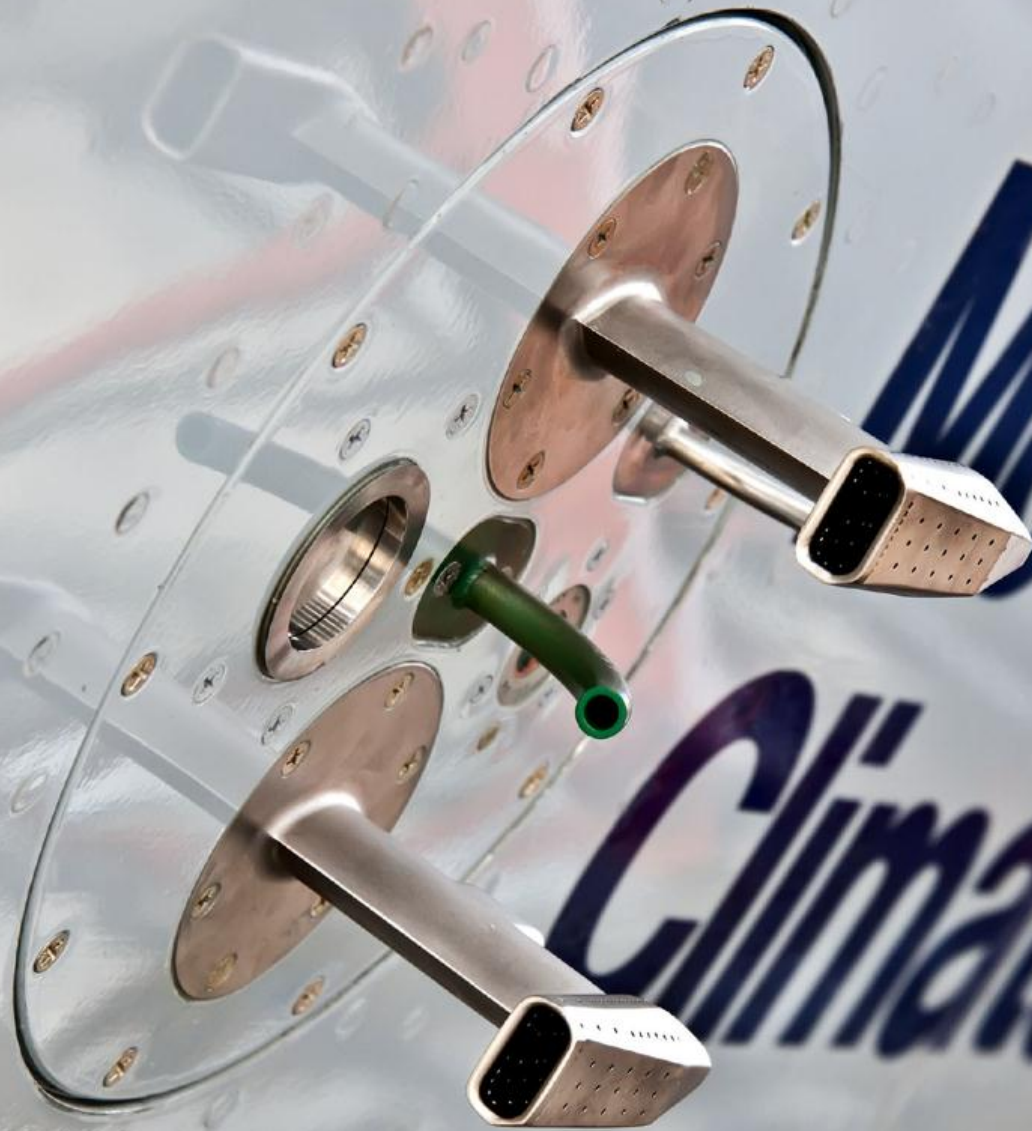
Beijing

An aerial photograph of a coastal area. The left side shows a rugged, mountainous coastline with a mix of brown and green vegetation. The right side shows a large body of water with varying shades of blue and green, indicating different depths or water types. A small red dot is visible on the coastline, marking a specific location. The text "Beijing?" is overlaid on the image, pointing towards this red dot.

Beijing?



- 
- Long-term observation of the state of the atmosphere
  - Process studies of complex interaction of the physics and chemistry



**IAGOS**

*In-service Aircraft for a Global Observing System*

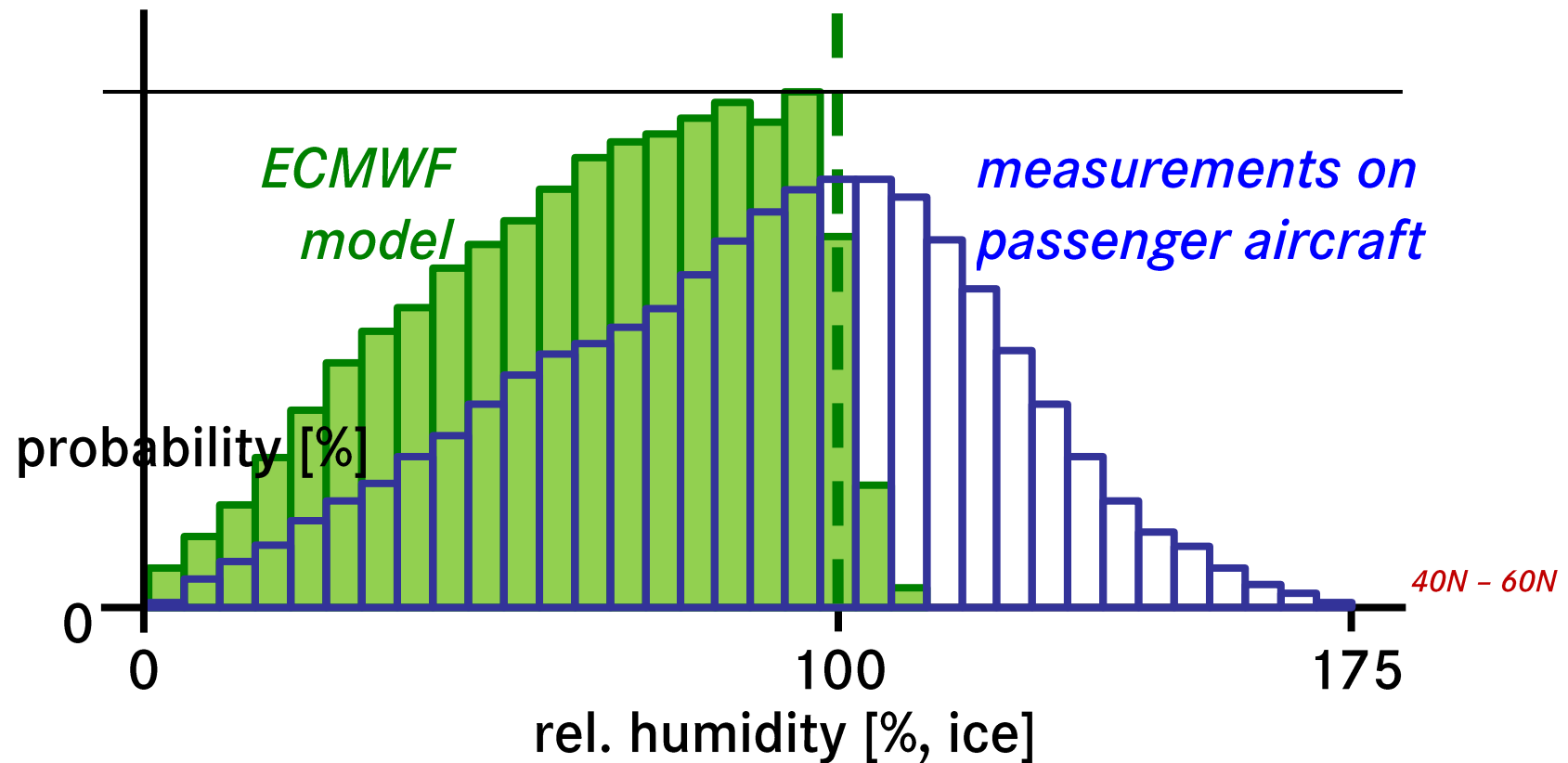
# IAGOS: Global Observation System on Passenger Aircraft

- European Research Infrastructure (up to 20 a/c)
- Long-term observation on in-service aircraft
  - atmospheric trace gases ( $\text{H}_2\text{O}$ ,  $\text{O}_3$ ,  $\text{CO}$ ,  $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{NO}_y$ ,  $\text{NO}_x$ )
  - aerosol and cloud particles
- Global scale
- Vertical profiles

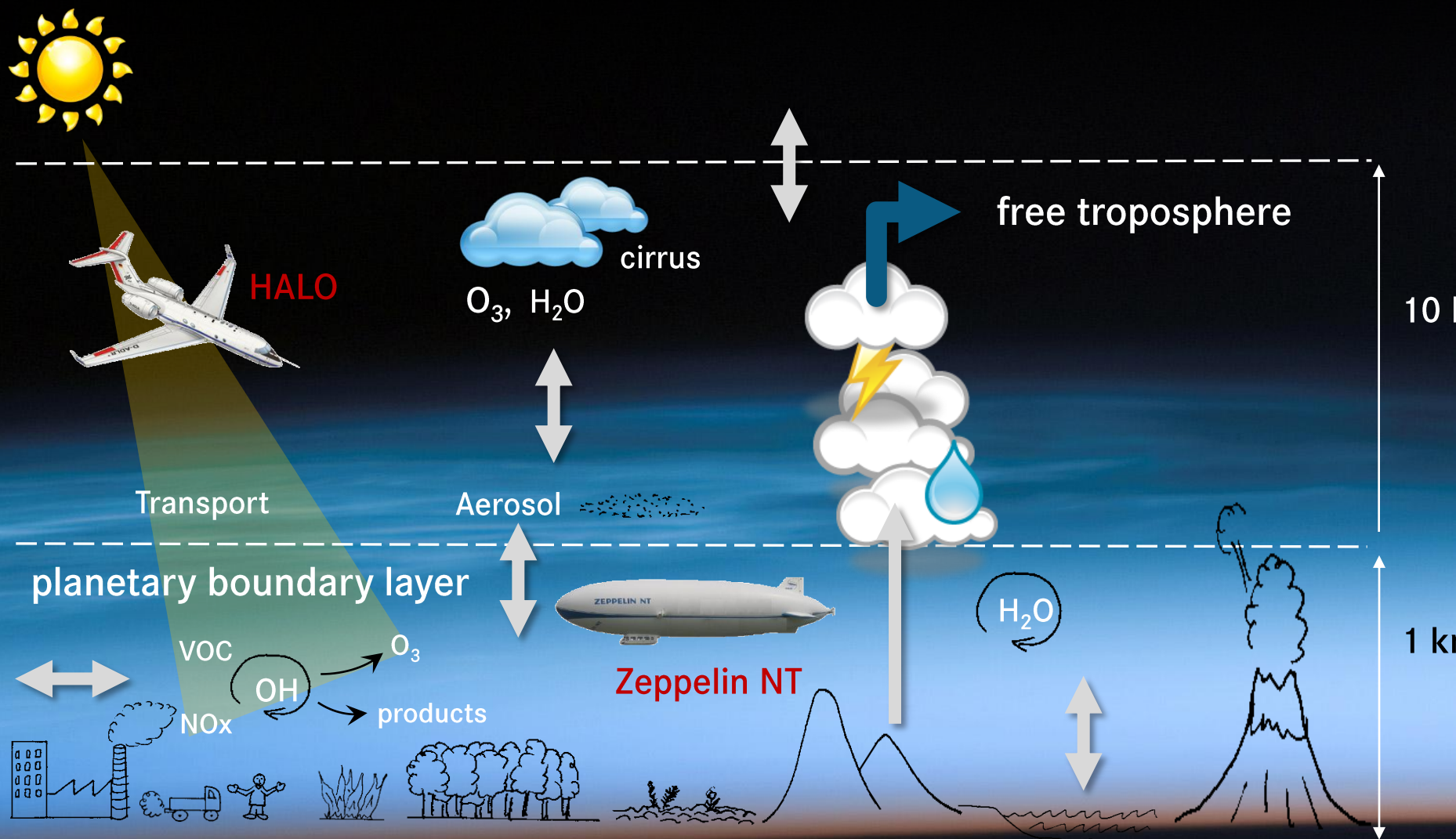




# Improvement of current weather forecast models by past observations (MOZAIC)



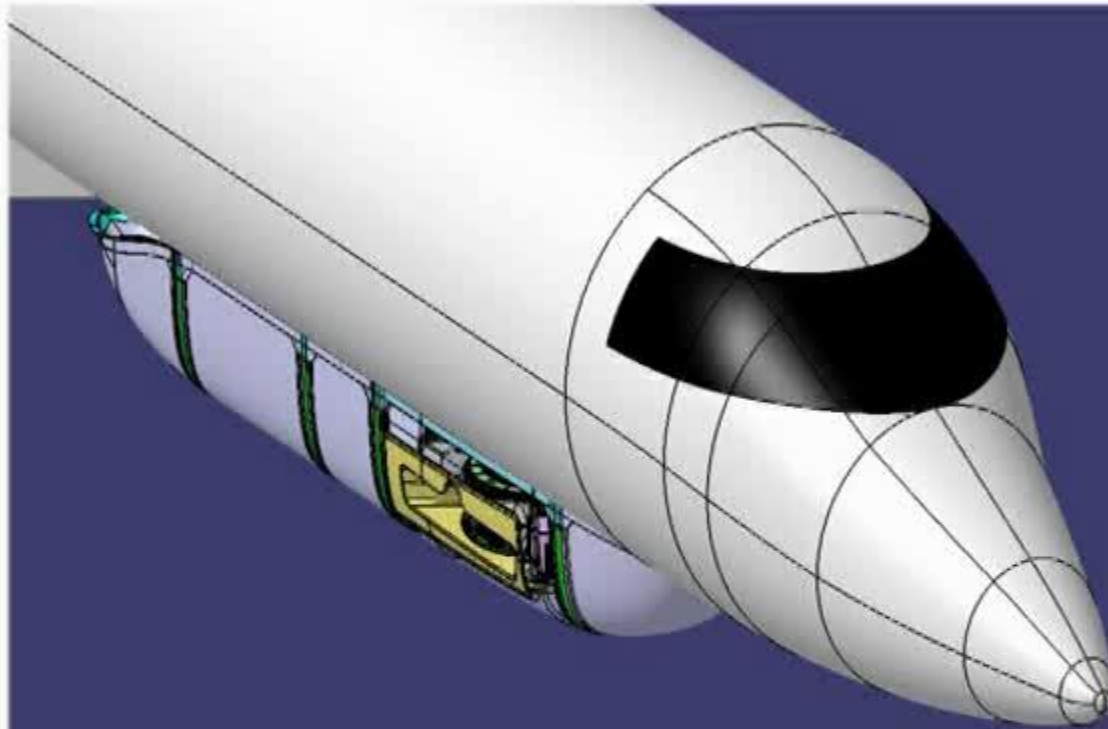
# Process Studies of Complex Interaction of the Physics and Chemistry



# HALO test flight for Bellypod and GLORIA

Wessling, April 2012



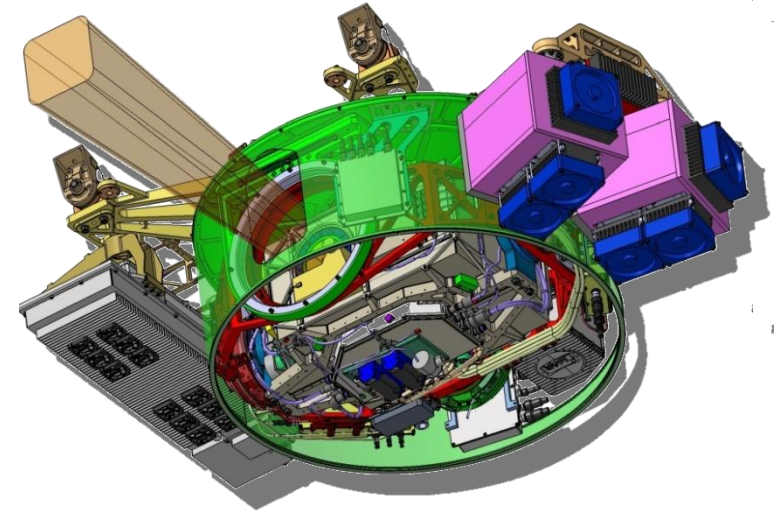


HALO  
mit GLORIA



# GLORIA onboard Geophysica

Geophysica: 20 km ceiling height

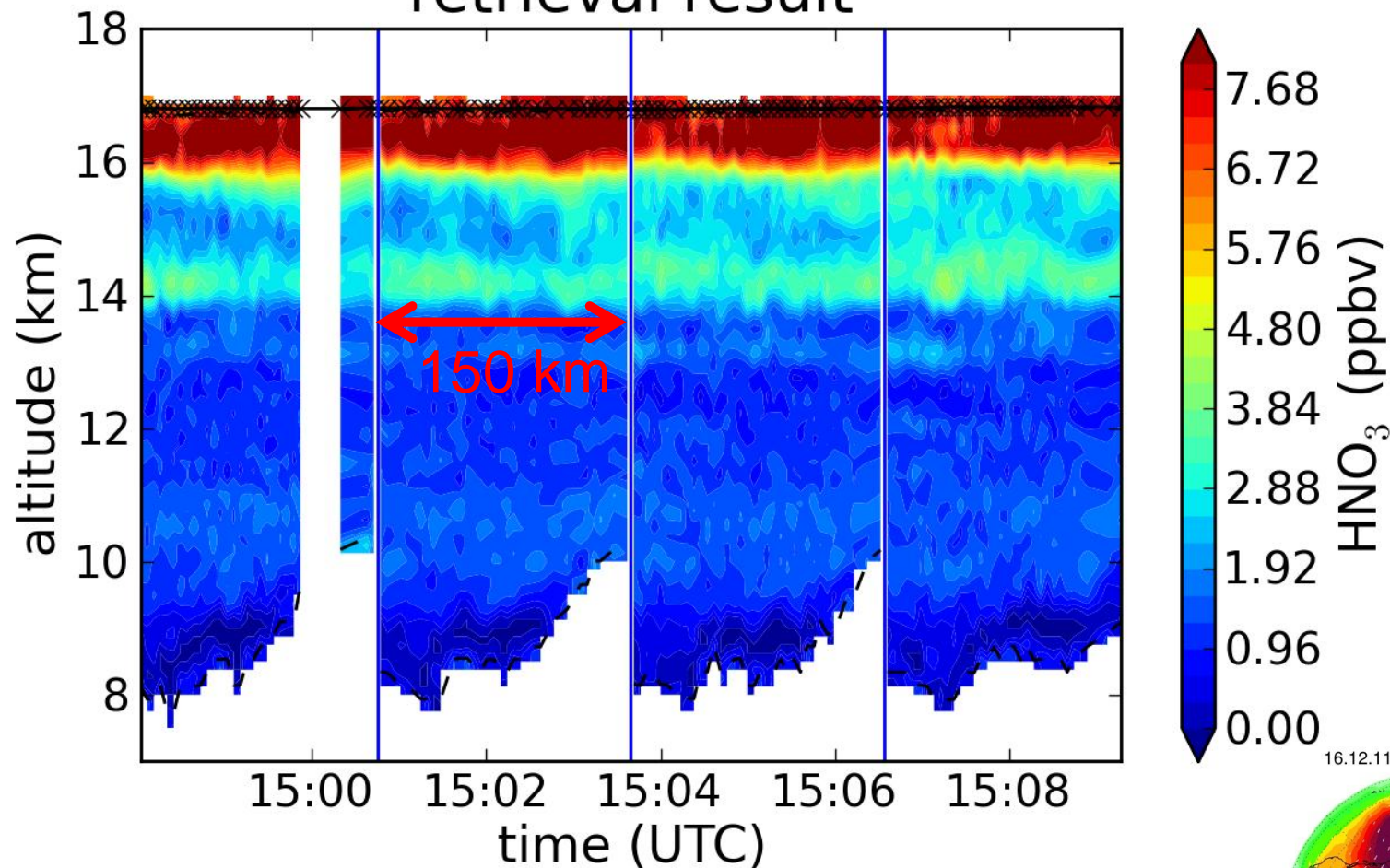


GLORIA: The first successful flights in December 2011 during Essence-11 test campaign

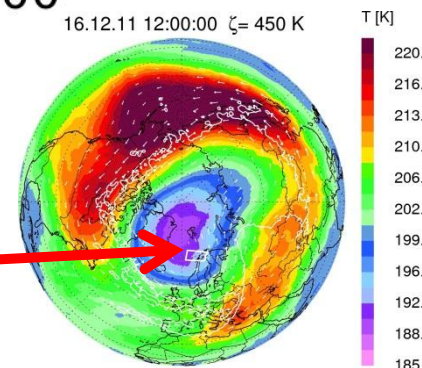
GLORIA as a limb sounder provides images

- of a large number of chemical species
- with unprecedented vertical and horizontal resolution

retrieval result



flight path inside vortex  
16.11.2011



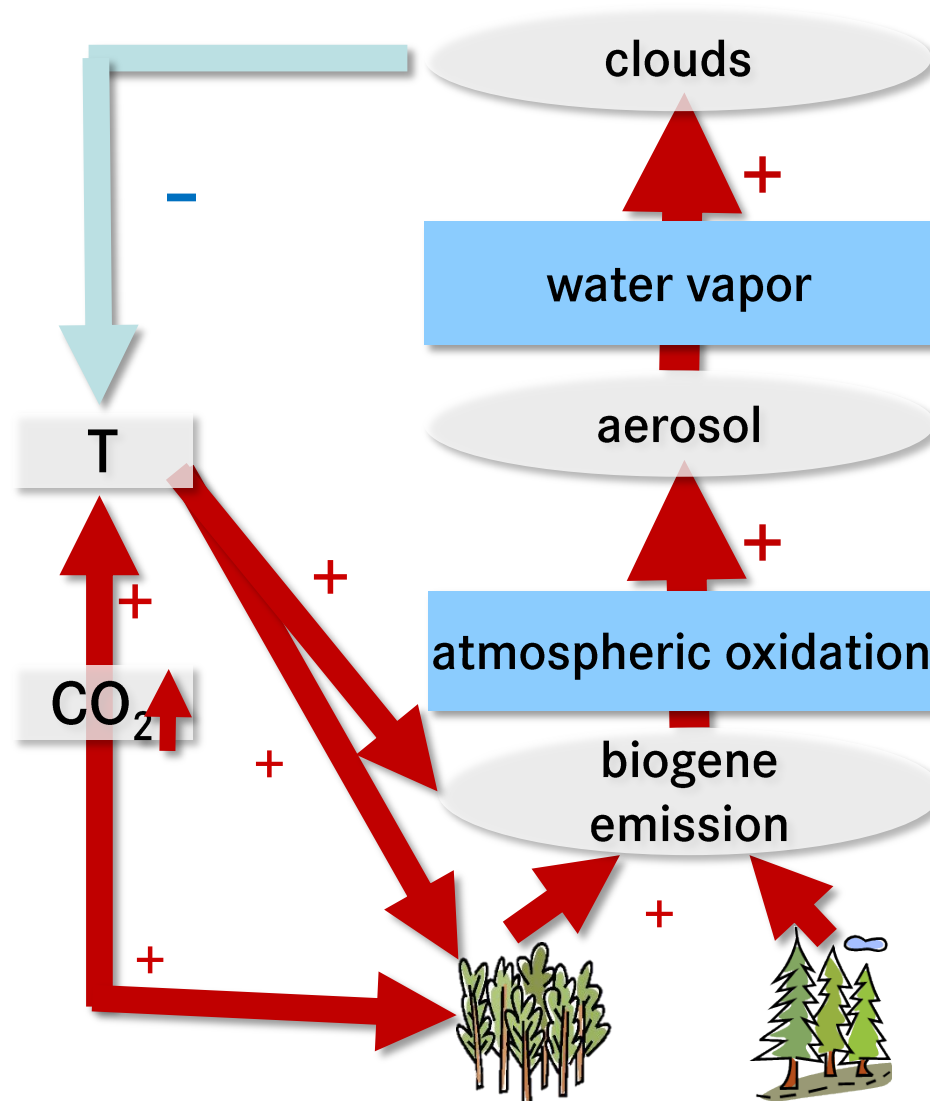


# Quantitative Experiments in Atmosphere-Simulation-Chamber

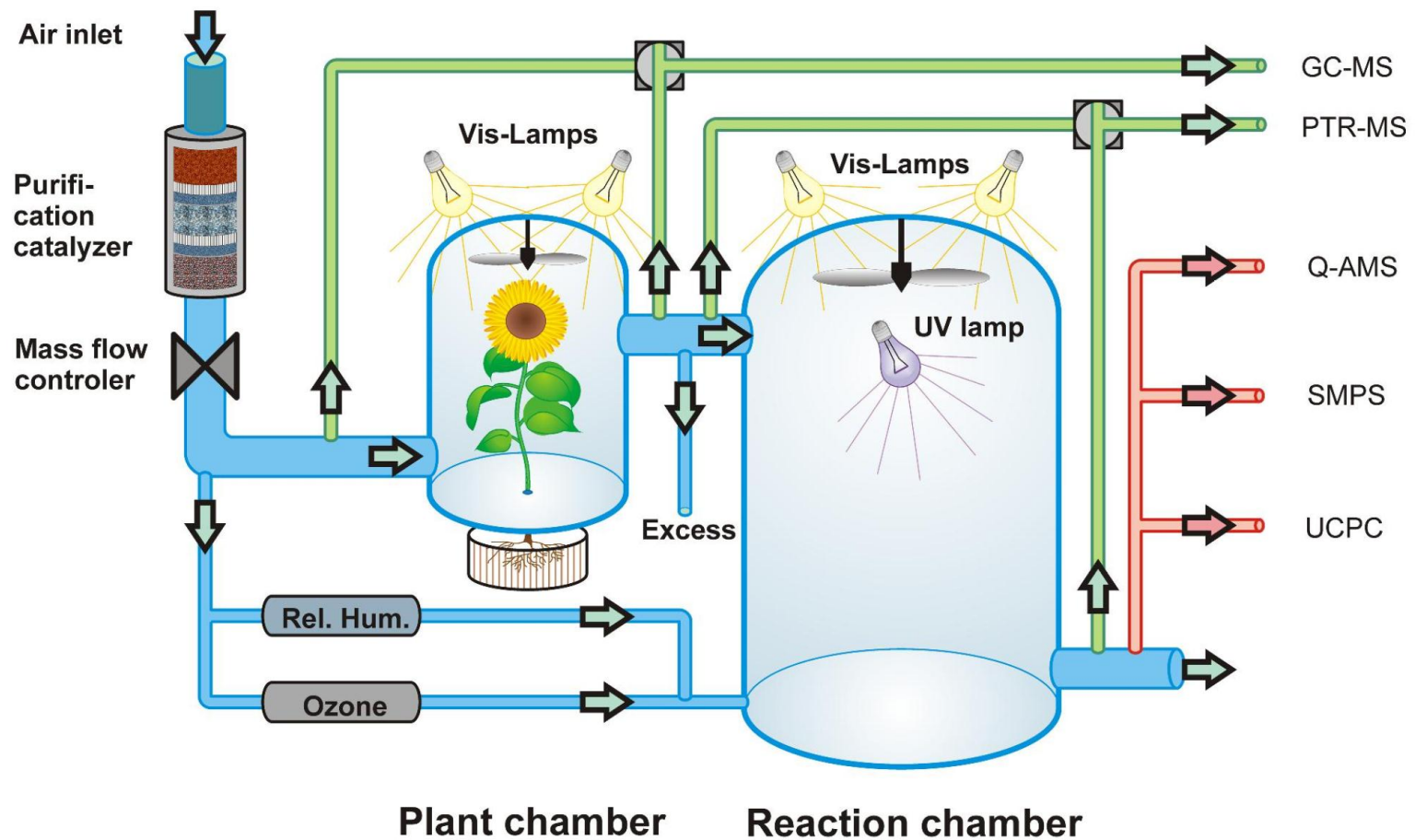




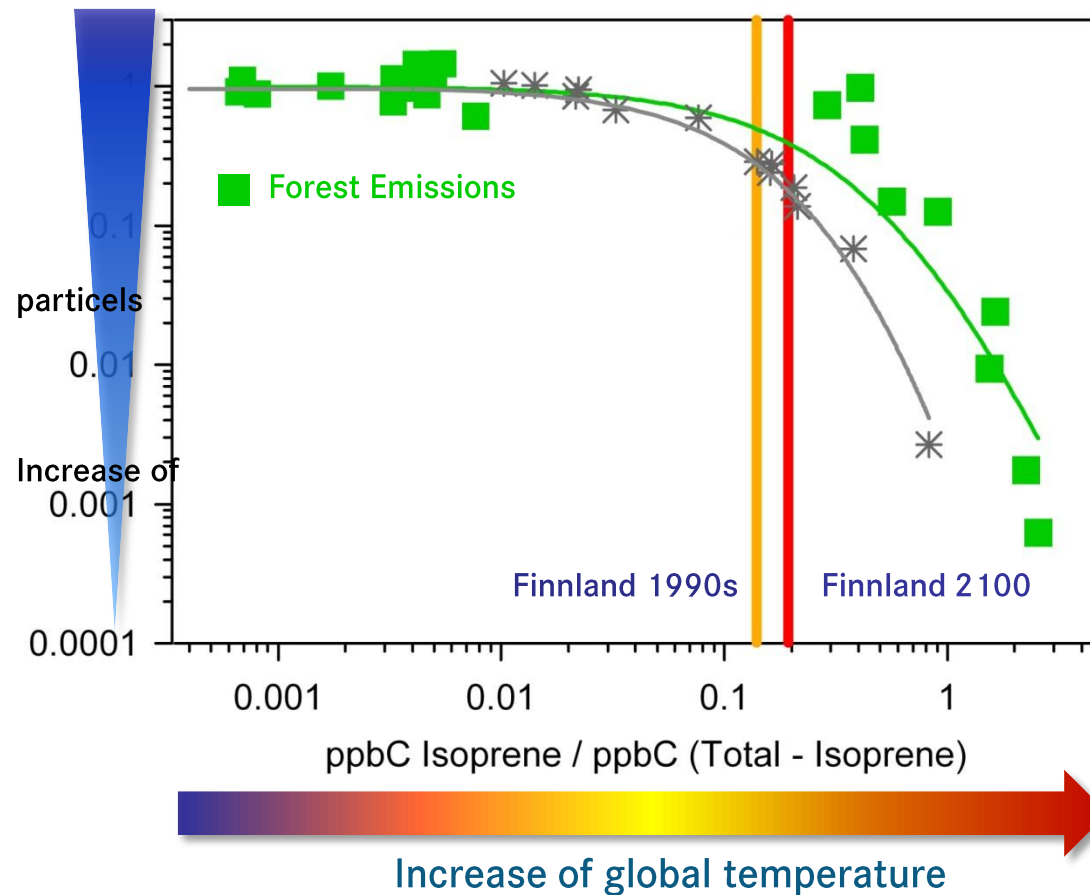
# Secondary Organic Aerosol from Biogenic Emission $\leftrightarrow$ Climate



# Plant-Aerosol-Simulation-Chamber



# Reduction of Aerosol Formation by Forest Emissions with Global Temperatur Increase



Change in Finland  
between  
1990 and 2100

→ 20% less  
aerosol

→ 12% less  
cooling than  
previously estimated

**nature**

Kiendler-Scharr et al., Nature, 2009

Kiendler-Scharr et al., ACP 2012

# Zeppelin NT ... since 2007 used for Atmospheric Measurements



$\text{HO}_x$ , MaxDOAS, j-values



T, RH, p  
3d-wind

$\text{O}_3$ ,  $\text{NO}_x$ , CO, HCHO  
HONO, VOC, Aerosol  
MaxDOAS, j-values

Top-Plattform: OH-measurement



Gondola





# EU-Project PEGASOS 2012 / 2013

(Pan-European-Gas-AeroSOI-Climate Interaction Study)

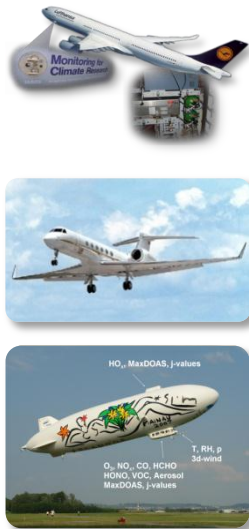


- Scientific basis for European action on emissions
- combining air quality and climate
- accounting for climate change

# Atmospheric Research (1)

- Future energy supply:  
*supply, resources, protection of nature and climate, economy*
- Impact of energy production and usage on air quality and climate

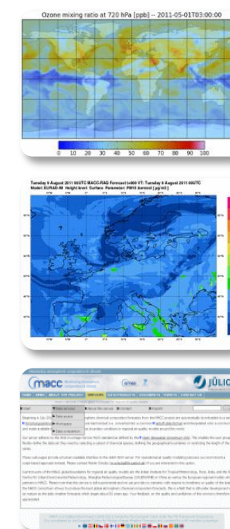
## Observation



## Simulation / Prozess Understanding



## Modell



Scientific basis for societal and political decisions:  
Energy options, mitigation- and adaption strategies