

# Intercontinental transport – processes and observations

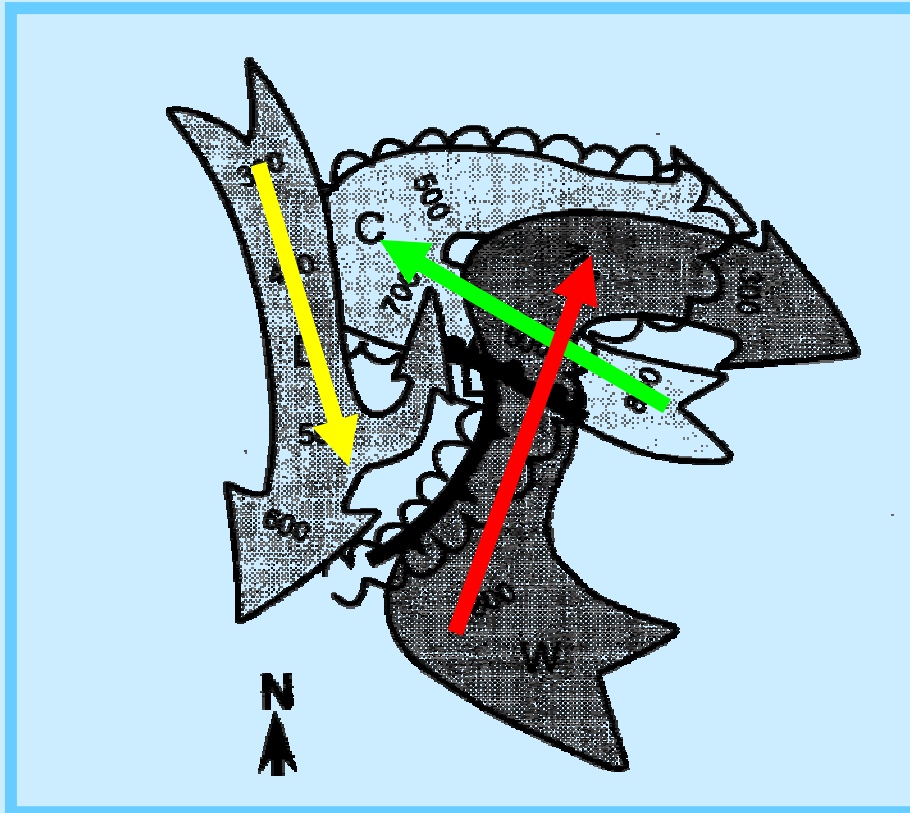
**Andreas Stohl**



**Norsk institutt for luftforskning**



# Quasi-Lagrangian Cyclone Model



**Dry Airstream**  
Descending air stream

**Cold Conveyor Belt**  
Moderately ascending air stream

**Warm Conveyor Belt**  
Rapid ascent ahead of the cold front

Cooper (2001)  
after Carlson (1980)

# A 15-year climatology of WCBs

Stohl et al. (2001): *J. Geophys. Res.* **106**, 7263-7279

Eckhardt et al. (2004): *J. Climate* **17**, 218-237

## ECMWF

ERA 15, 1979-1993, 1°x1° Resolution, 31 levels

## FLEXTRA

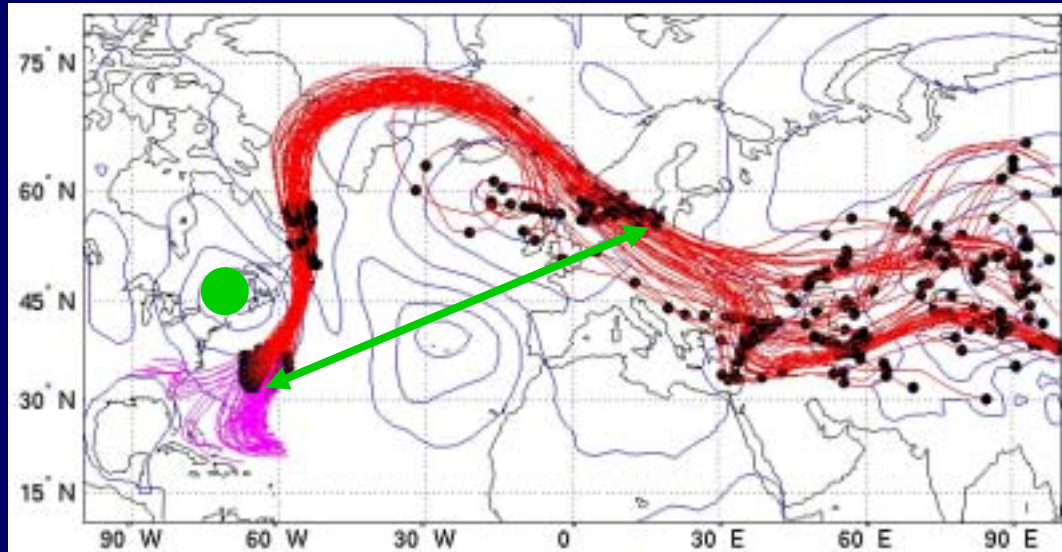
Lagrangian trajectory model

6-day forward trajectories

starting daily on a 1°x1° grid

365 million trajectories in total

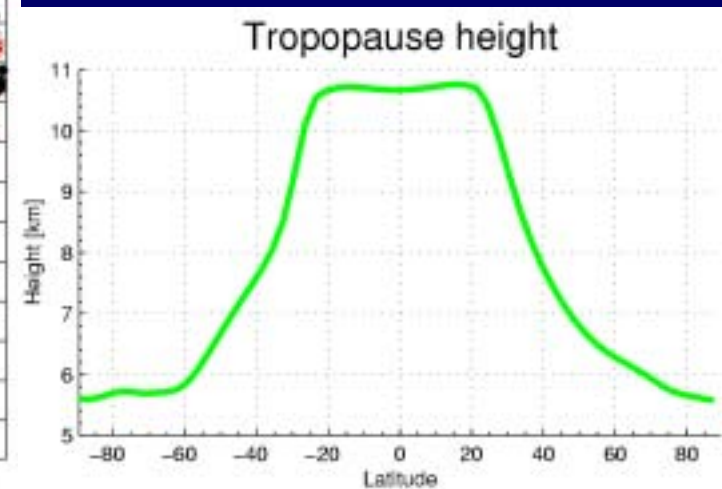
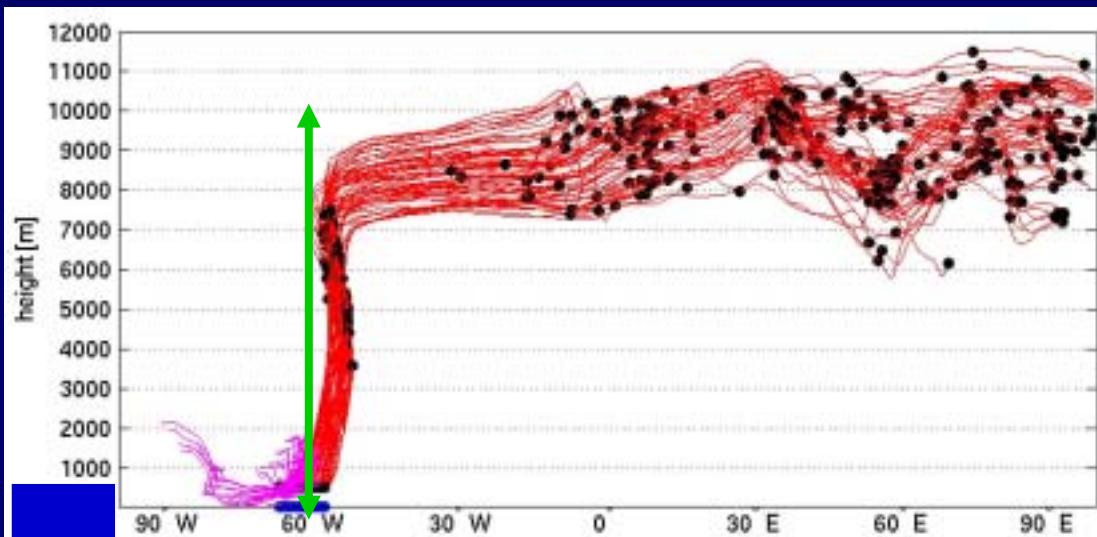
# Trajectory definition of a WCB



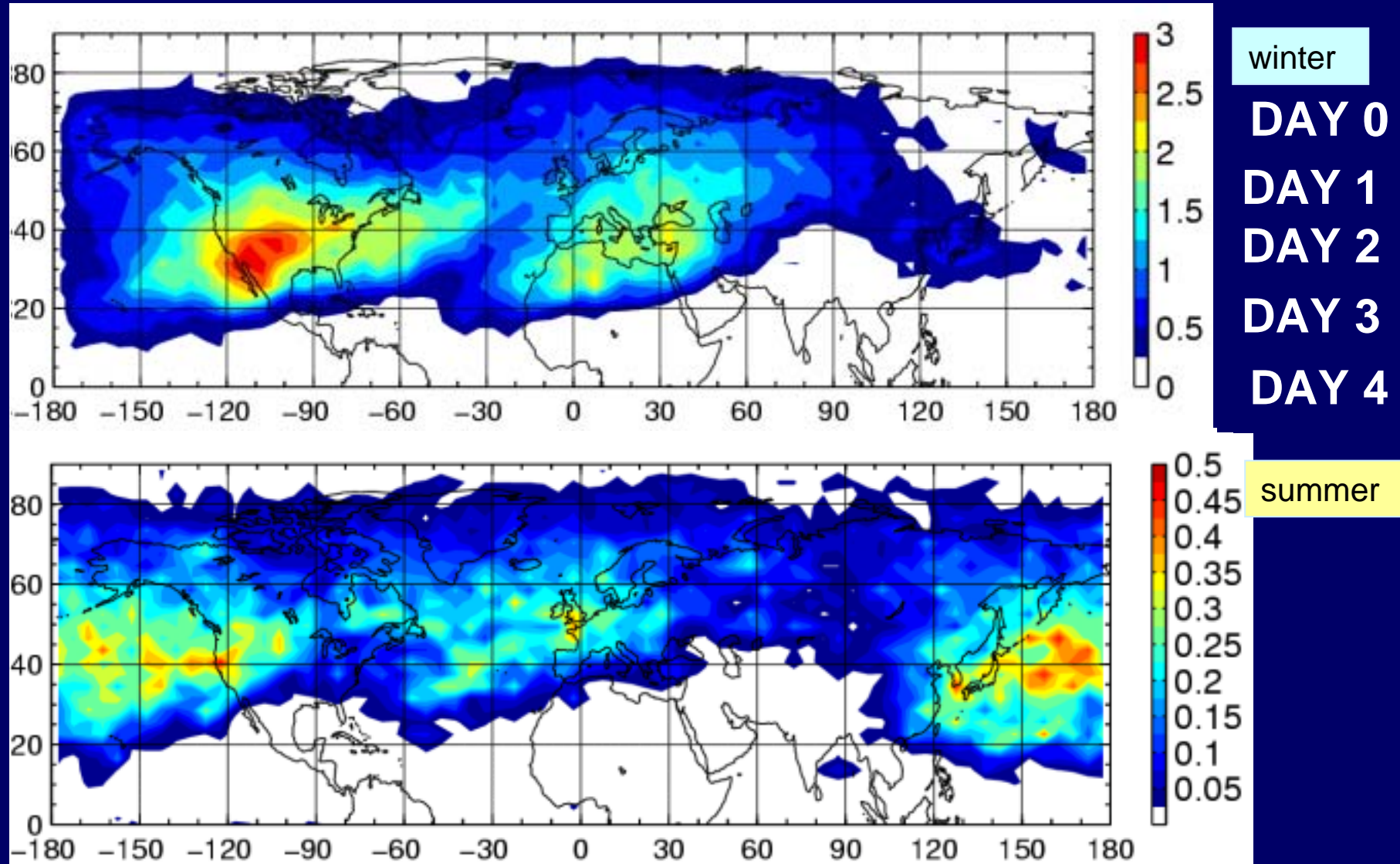
south of a cyclone

moves pole- and eastward

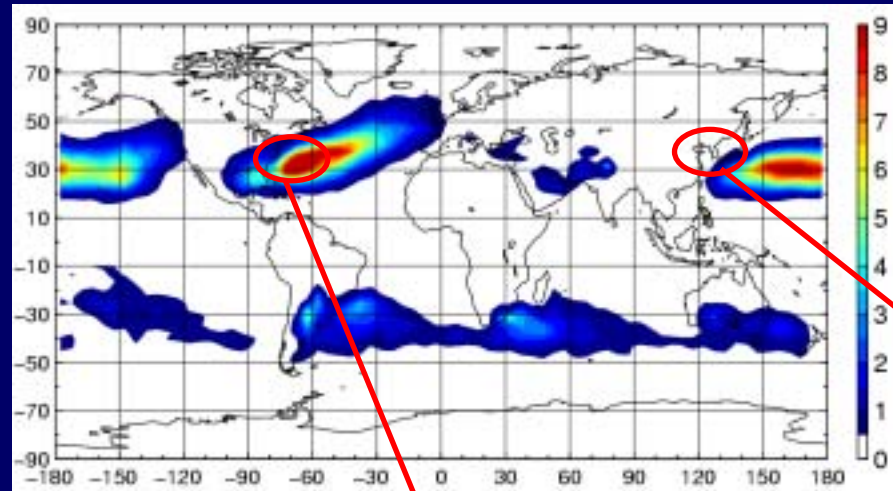
strong ascent



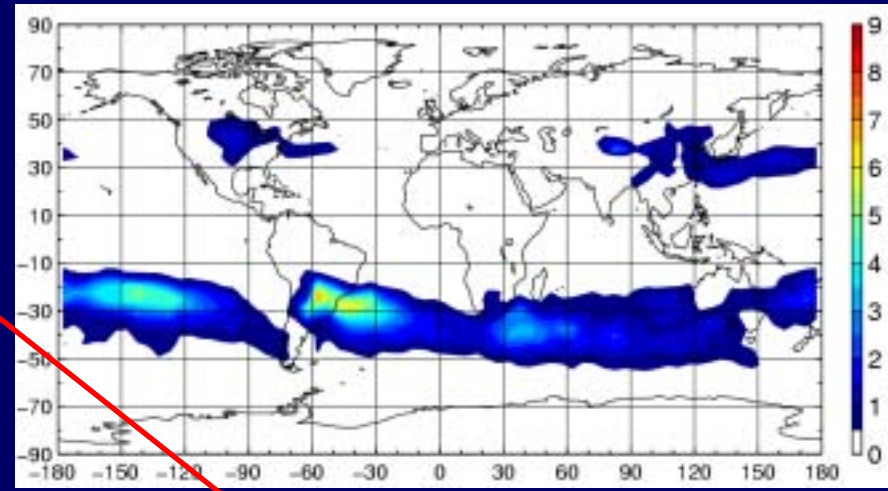
# Transport within WCBs (Eckhardt et al. 2004)



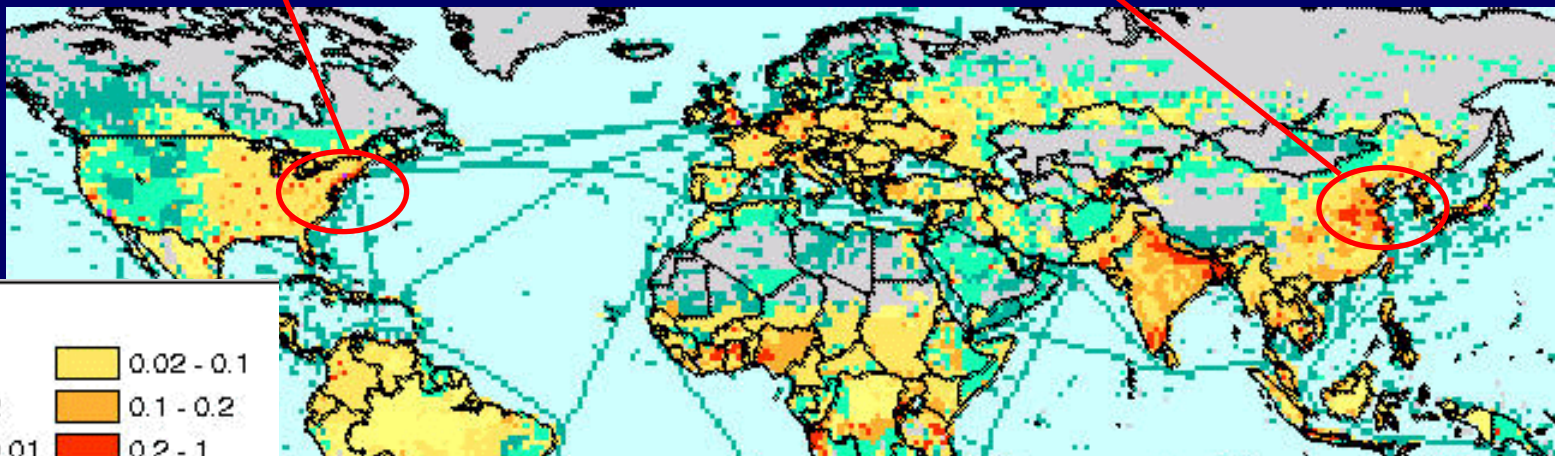
# WCBs & Pollutant emissions



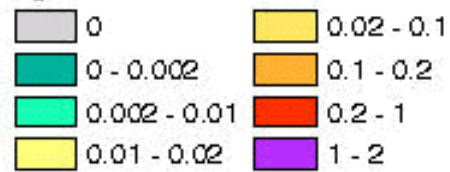
Dec., Jan., Feb.



June, July, Aug.



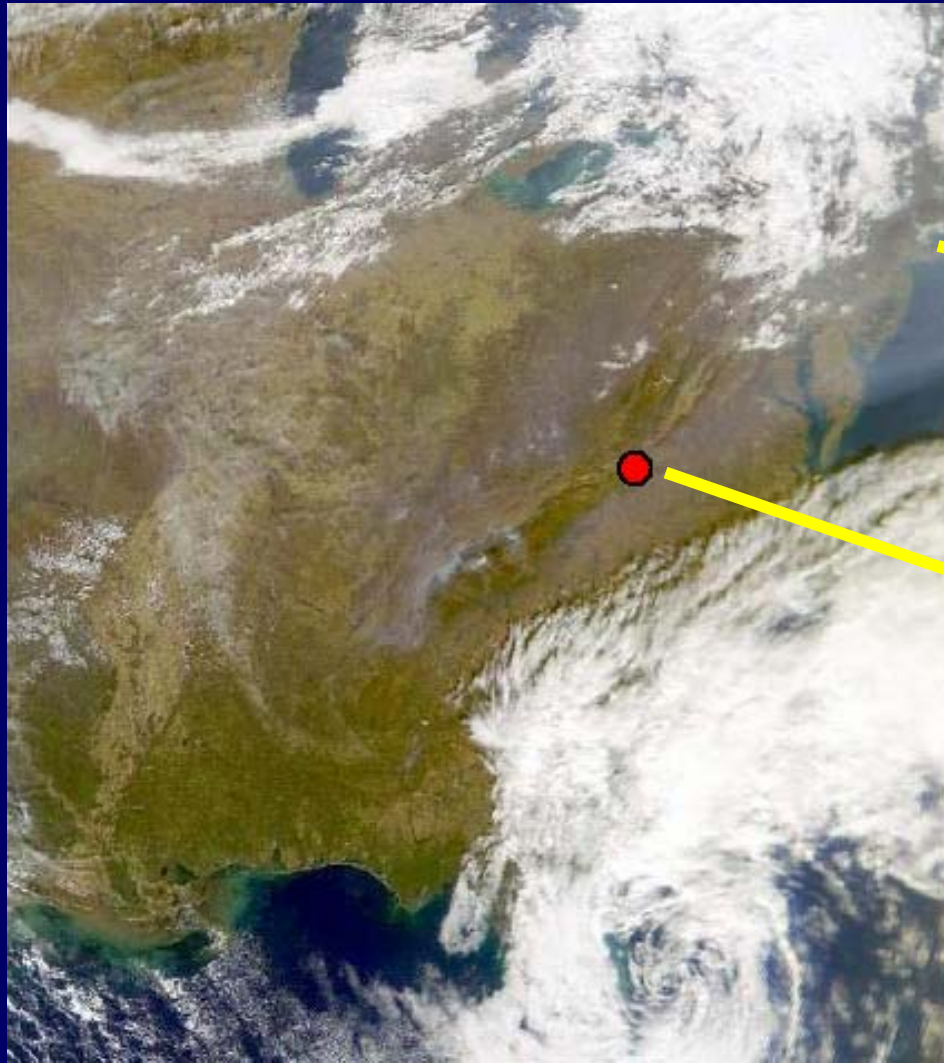
Tg CO-C / cell



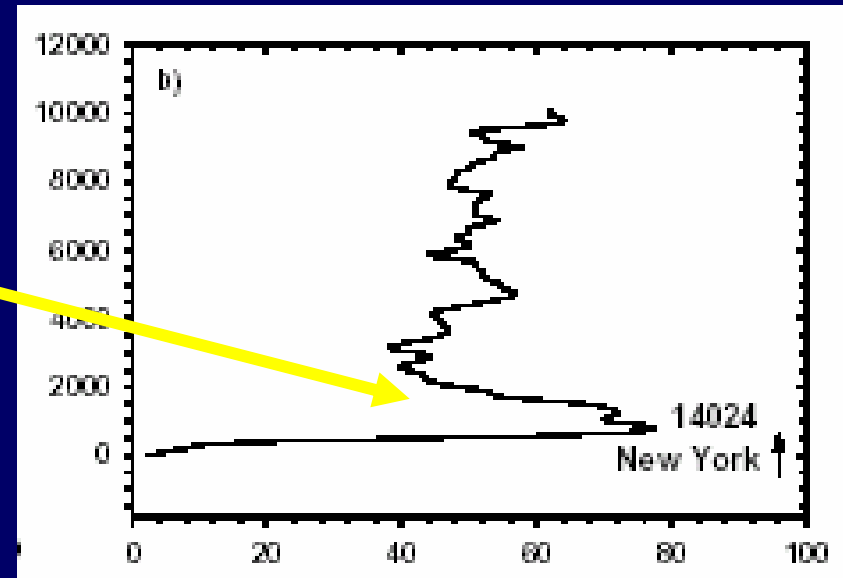
# North American pollution plume observed during CONTRACE

Stohl et al., JGR, 108, 4370, 2003

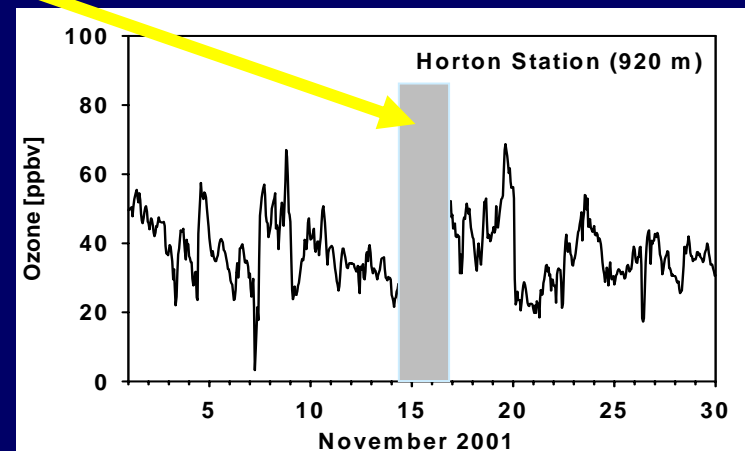
Huntrieser et al., JGR, 110, DO1305, doi: 10.1029/2004JD005045



SeaWifs image on 15 November



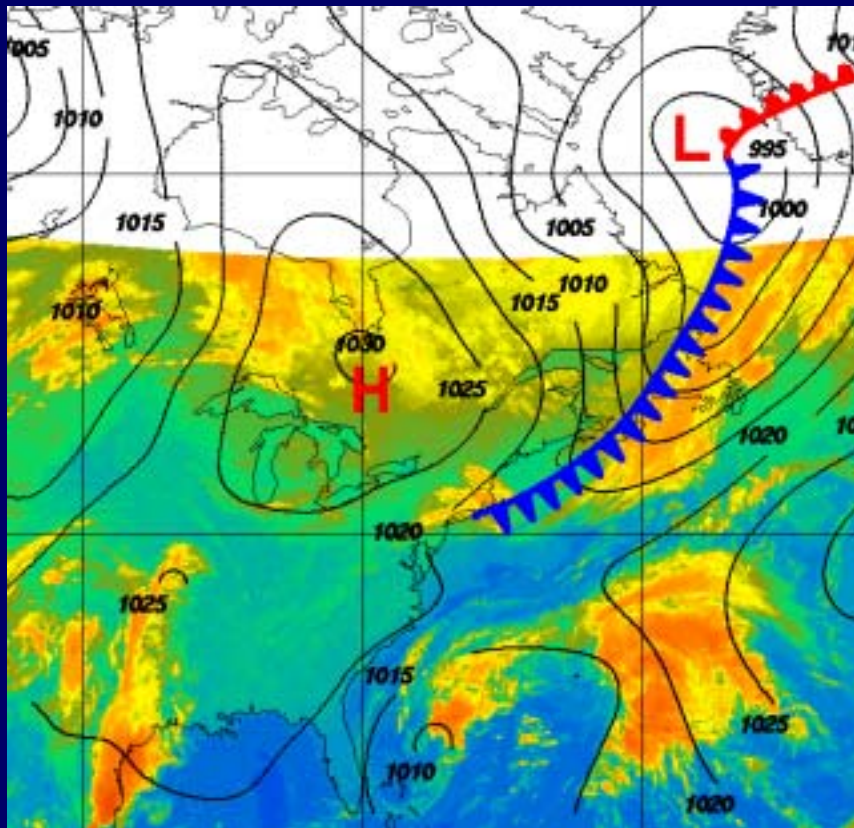
Ozone from MOZAIC ascent



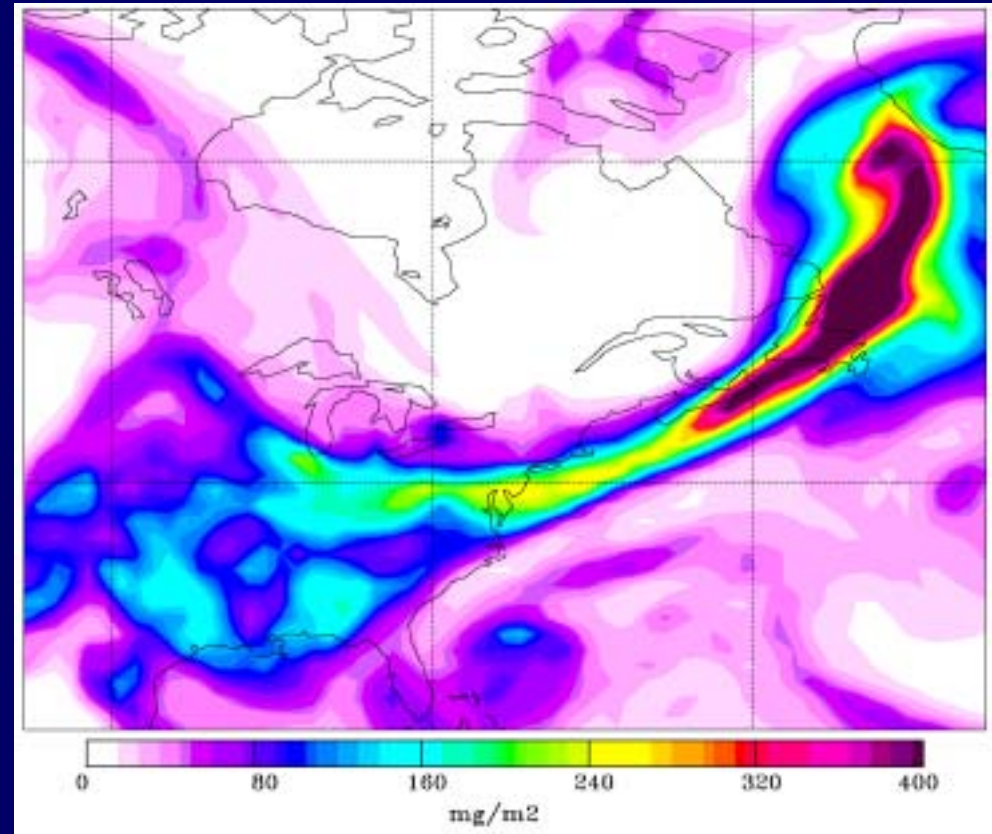
Ozone at Horton station

17 November 2001: Cold front pushes pollution to the Atlantic  
Tracer plume and clouds are aligned in WCB  
Lifting to free troposphere

GOES-East IR satellite image



FLEXPART total column of CO tracer

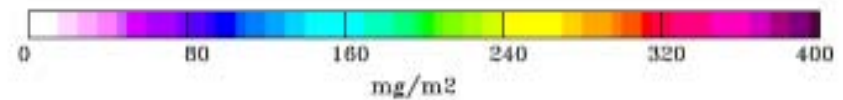
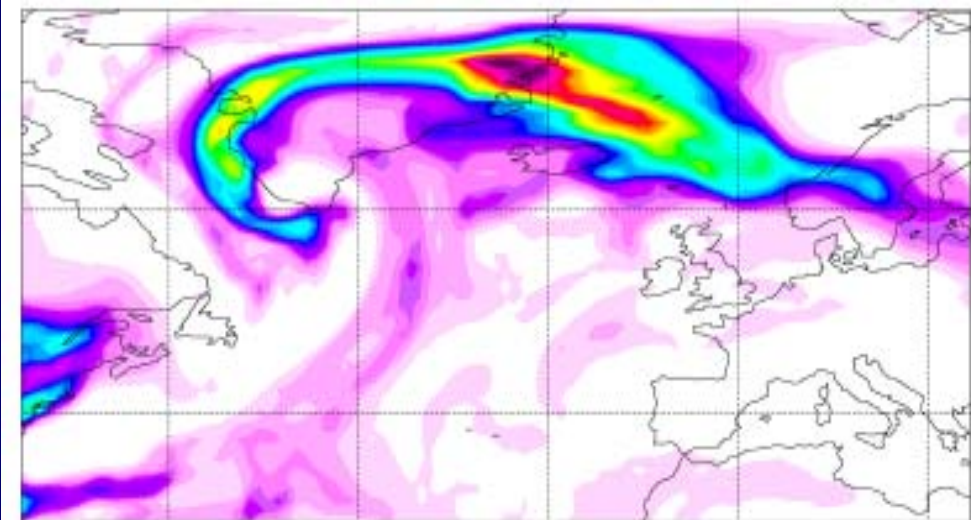
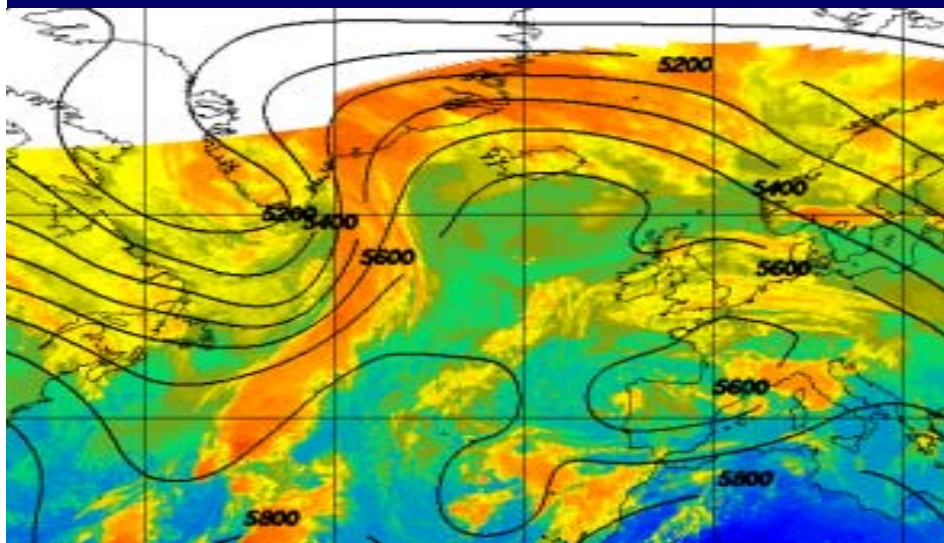




18 November 2001: Pollution plume in the WCB outflow  
in the upper troposphere

METEOSAT + GOES-East

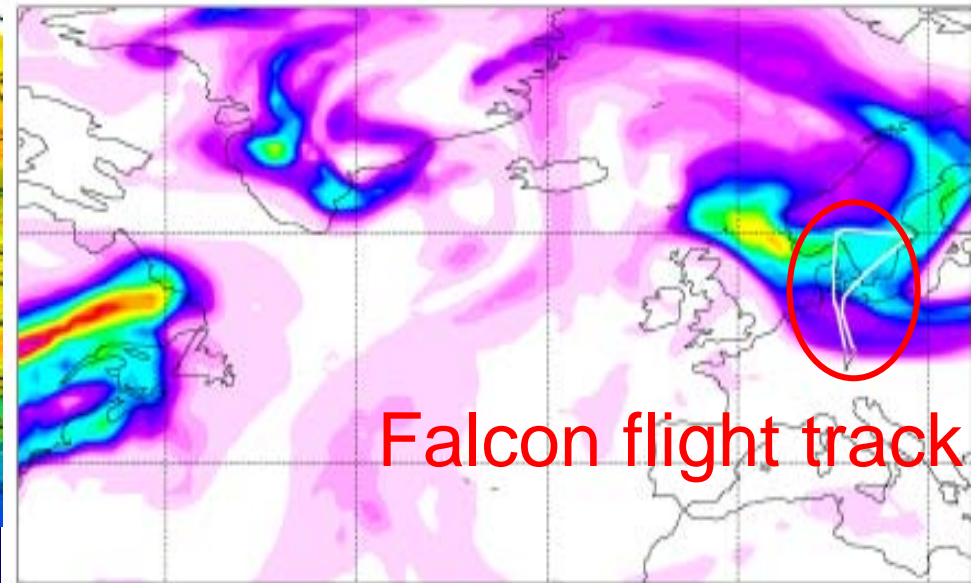
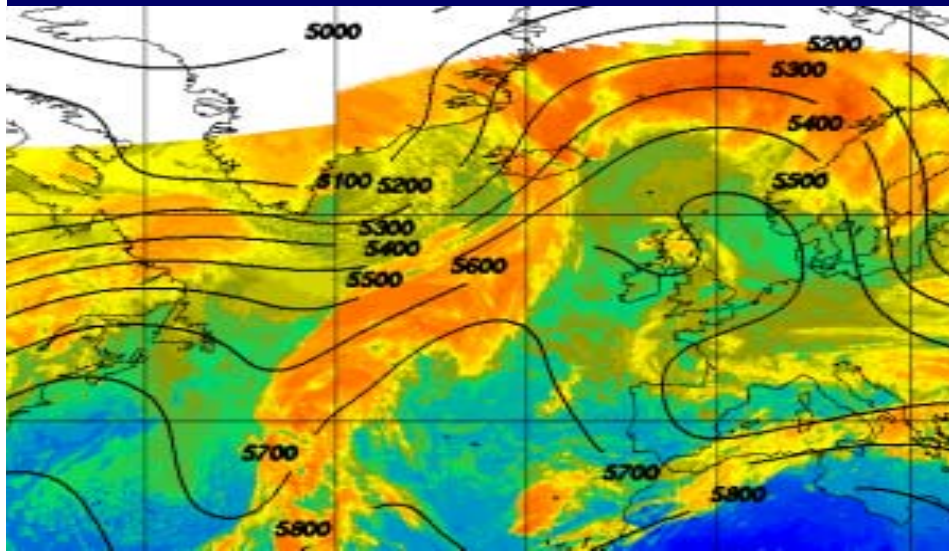
FLEXPART total column of CO tracer



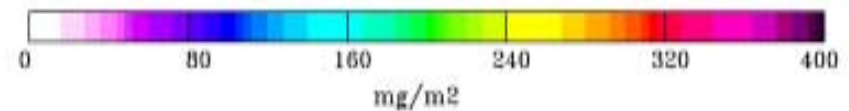
# 19 November 2001: Pollution plume arrives over Europe

METEOSAT + GOES-East

FLEXPART total column of CO tracer



Falcon flight track

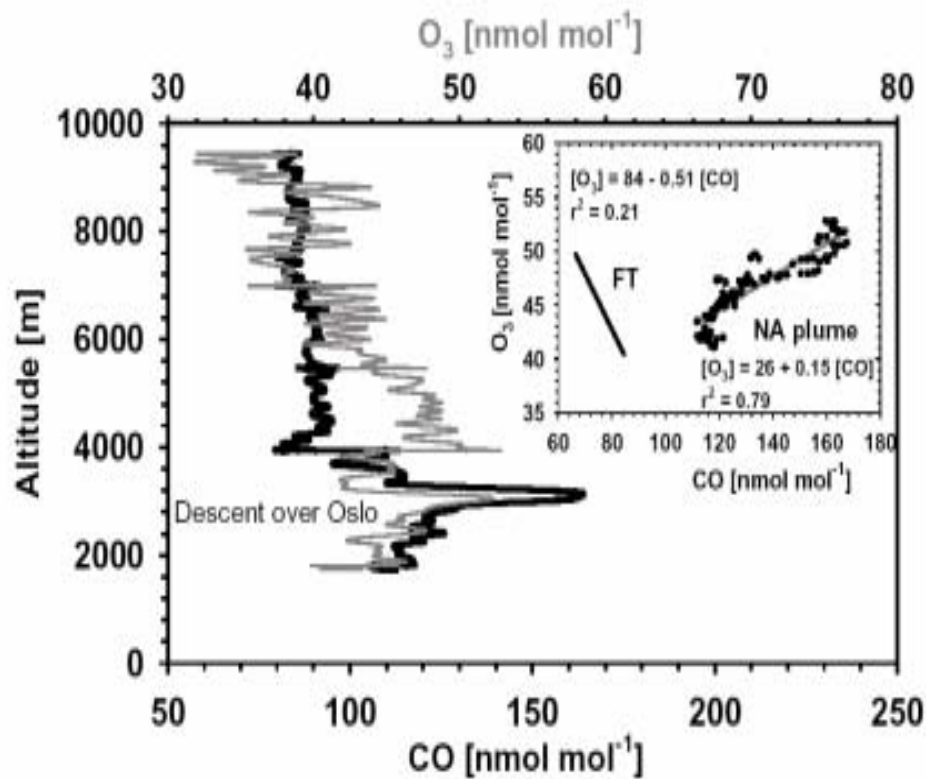


# Descent over Oslo

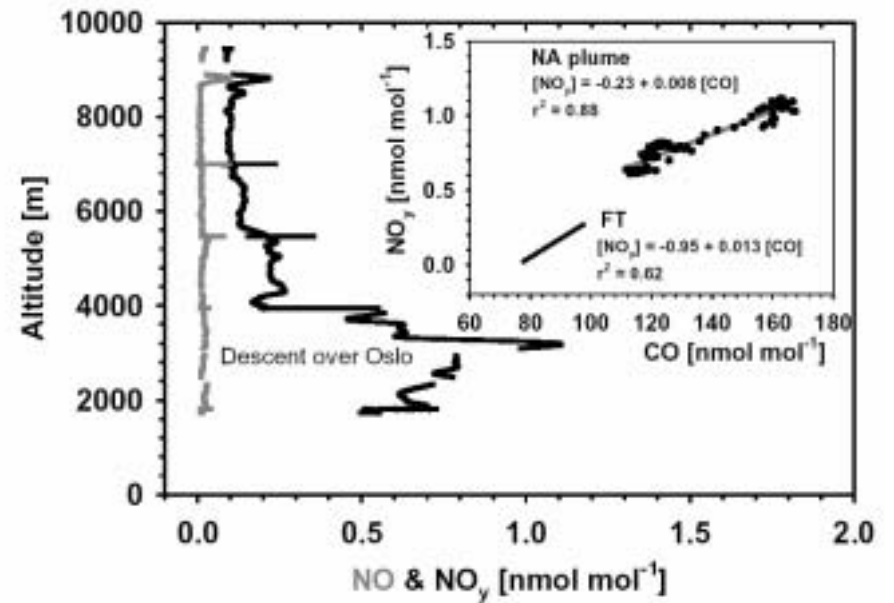
NO and NO<sub>y</sub>

CO and O<sub>3</sub>

a)

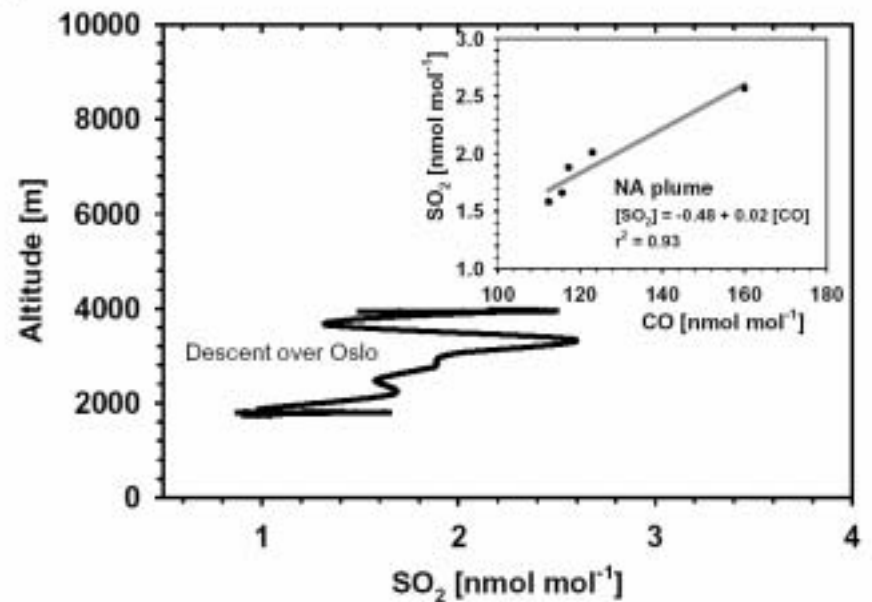


b)

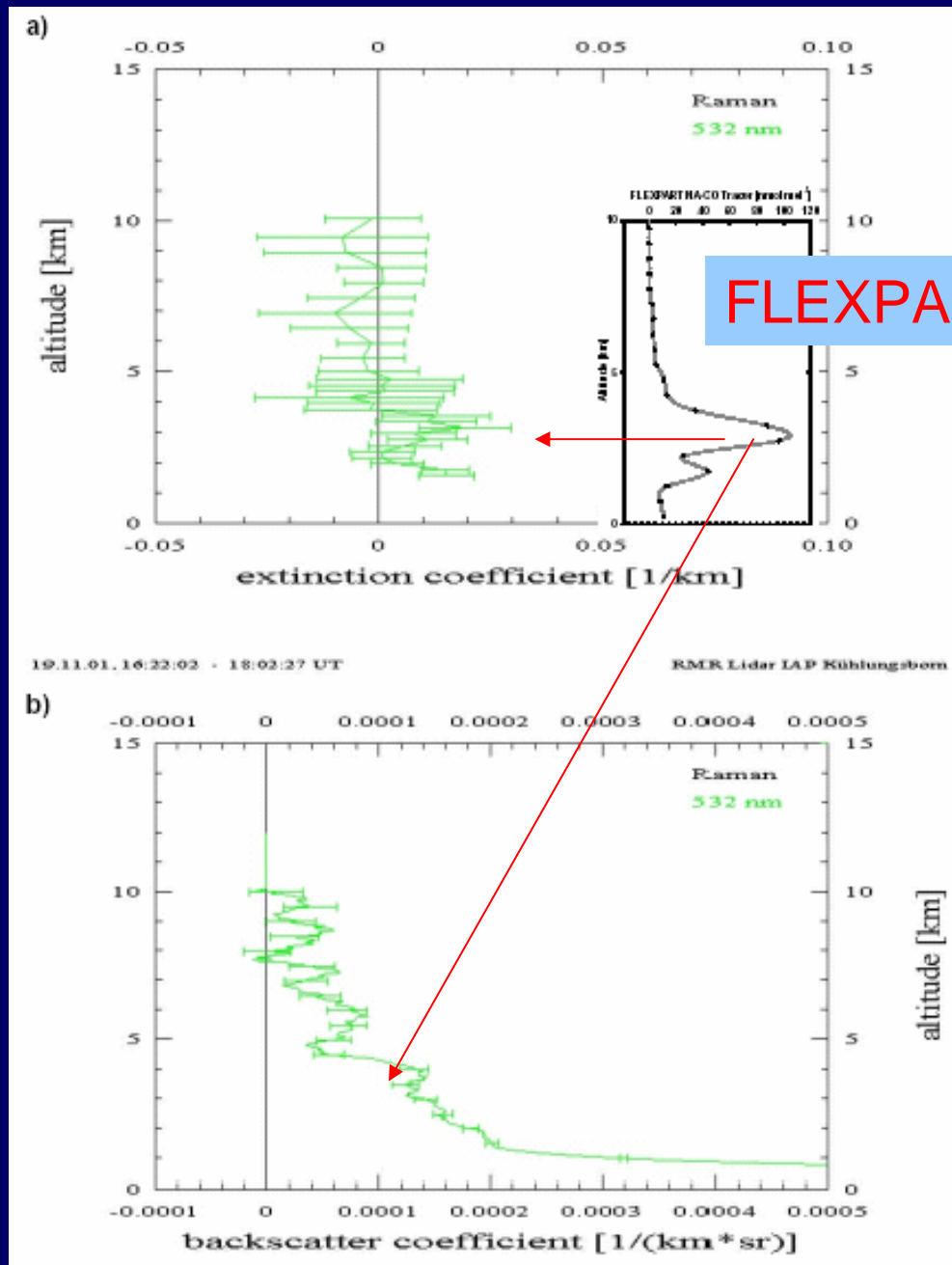


SO<sub>2</sub>

c)



# Aerosol lidar measurements in Kühlungsborn, Northern Germany

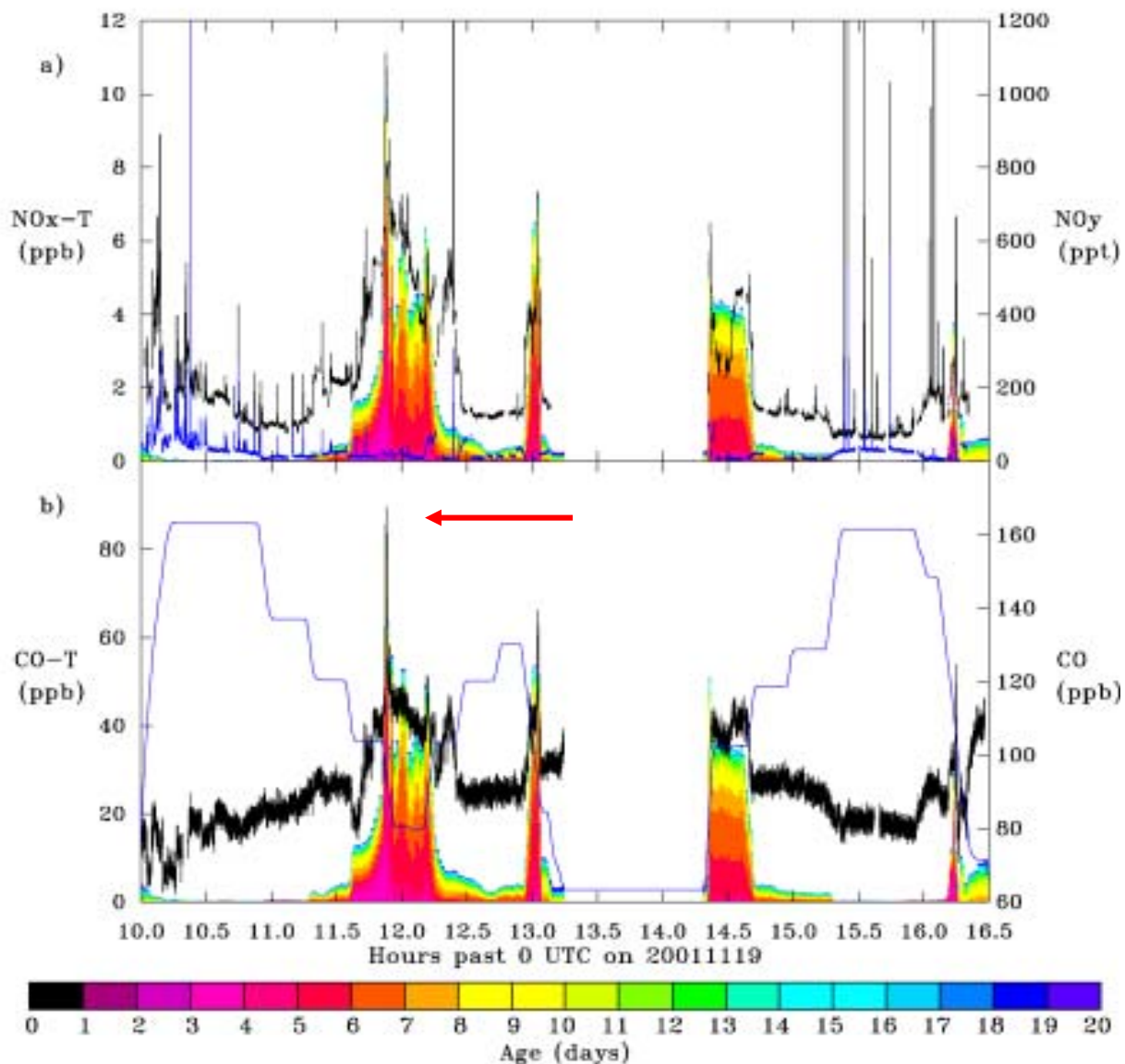


FLEXPART CO tracer

# North American CO and NO<sub>y</sub> along flight track from 600 backward simulations

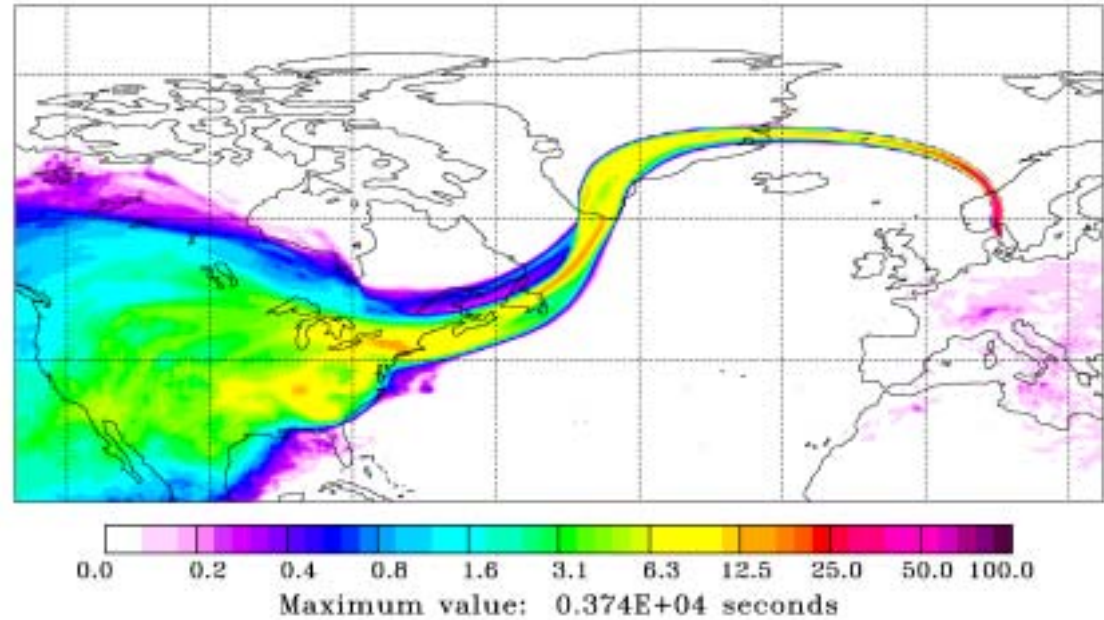
EDGAR N. Am. NO<sub>x</sub>  
+ measured NO<sub>y</sub> (black)  
+ measured NO

EDGAR N. Am. CO  
+ measured CO (black)  
+ aircraft altitude

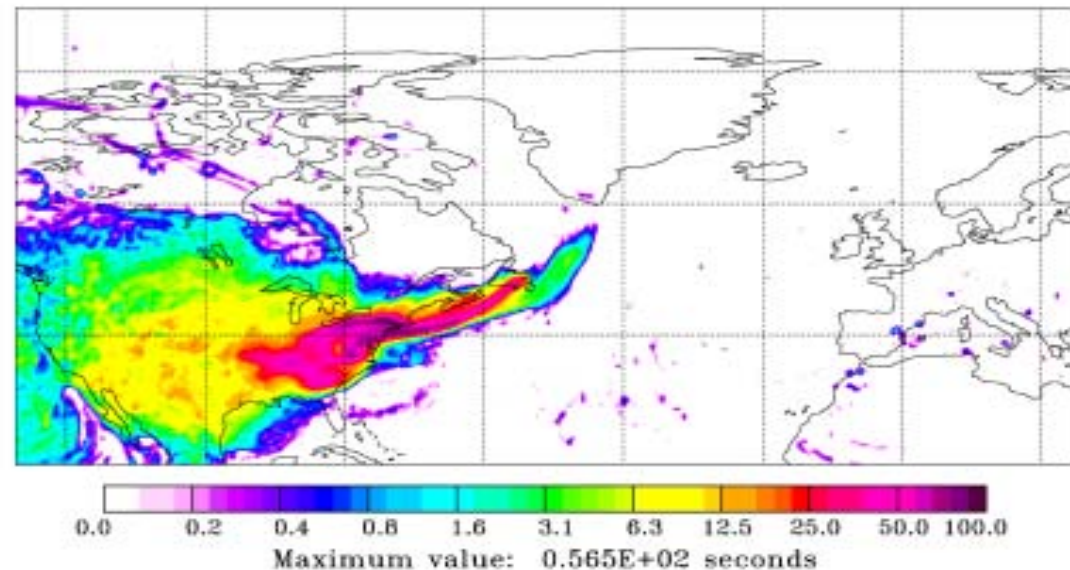


# FLEXPART backward simulation for peak at 11:53 UTC 27 second interval

Emission sensitivity in  
whole atmospheric column

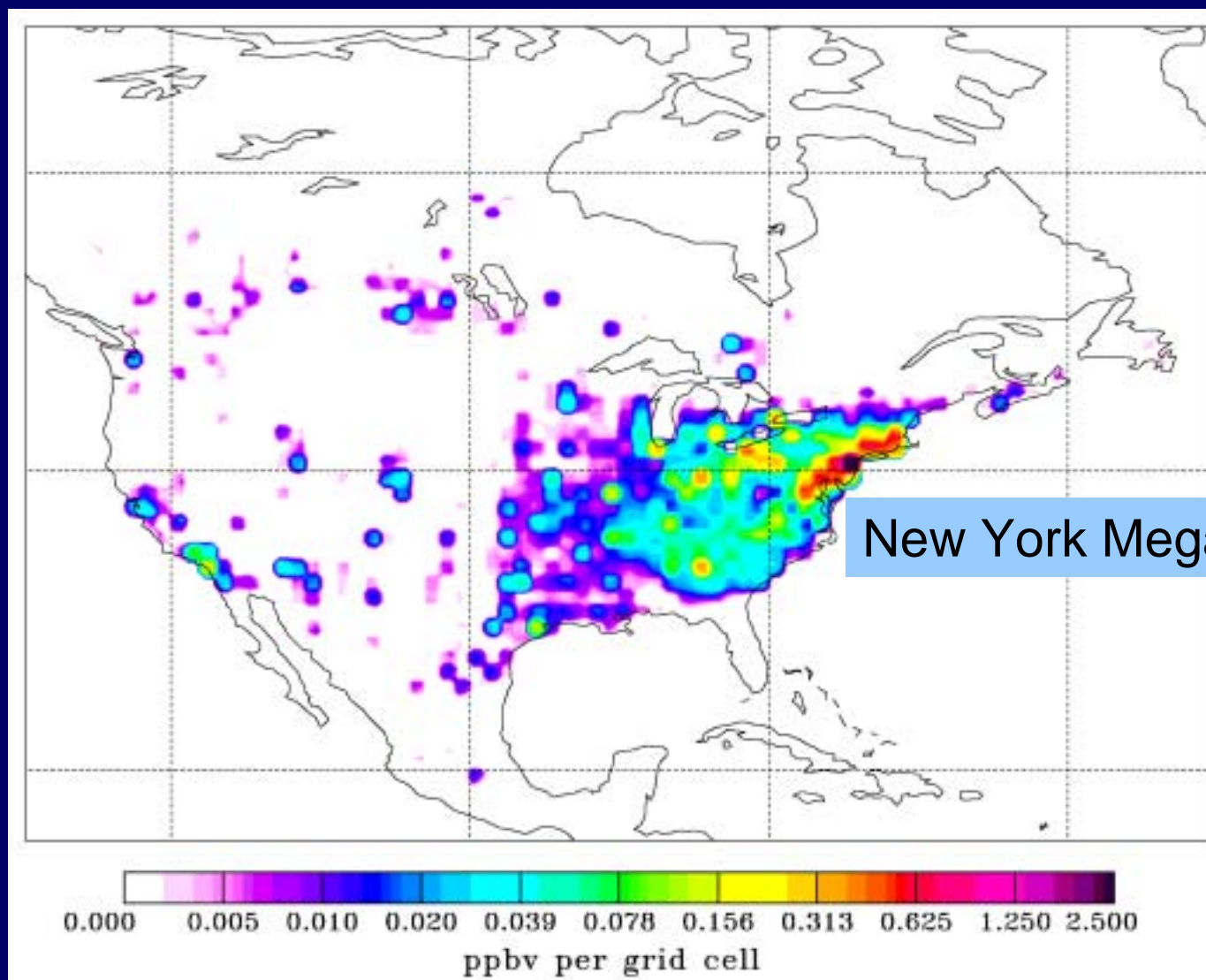


Emission sensitivity  
in footprint



# FLEXPART backward simulations for peak at 11:53 UTC

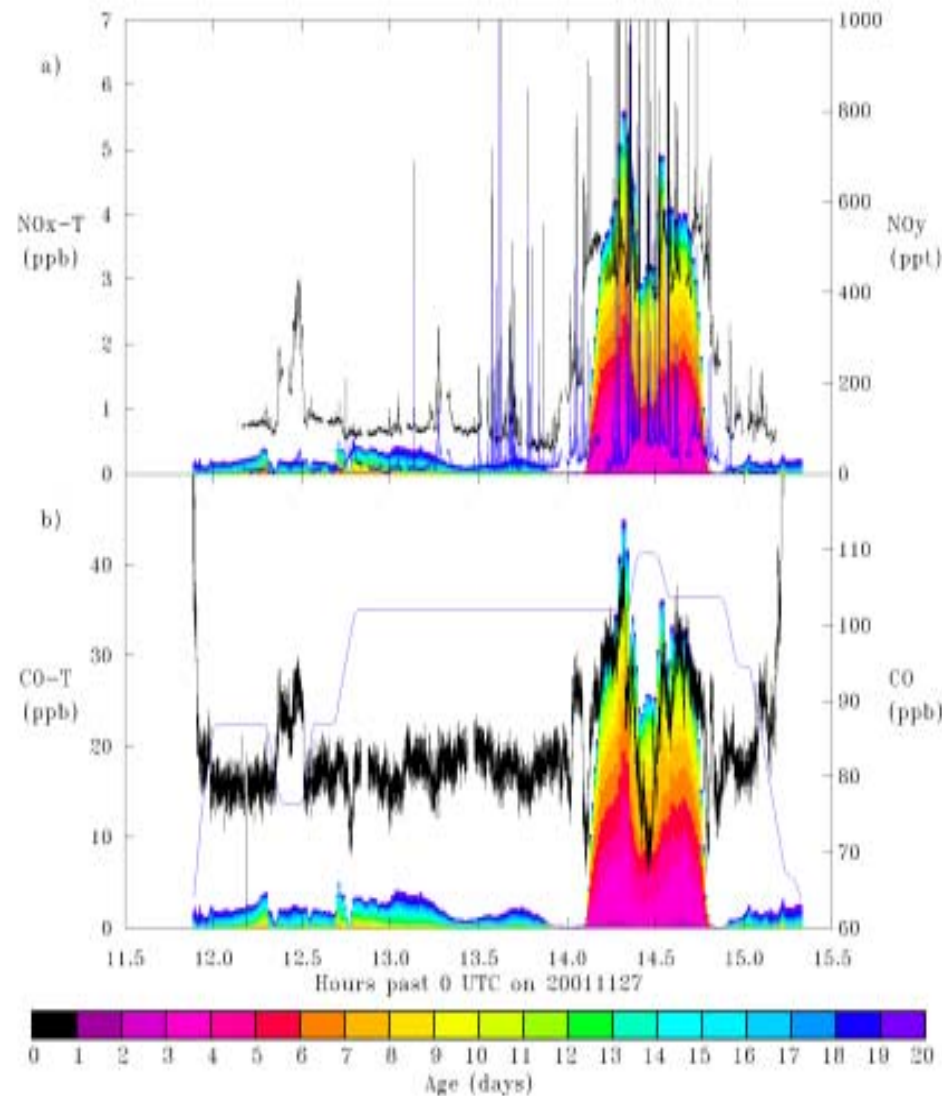
Source contribution (ppbv per grid cell)



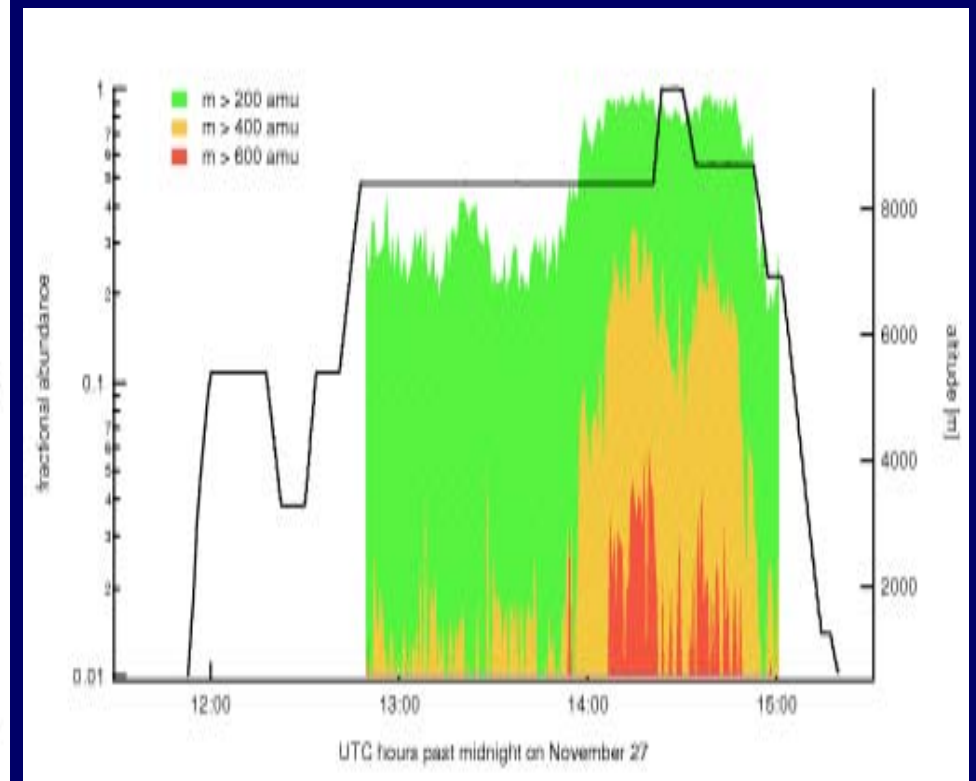
New York Megacity plume

And another five days later...

...yet another plume from North America



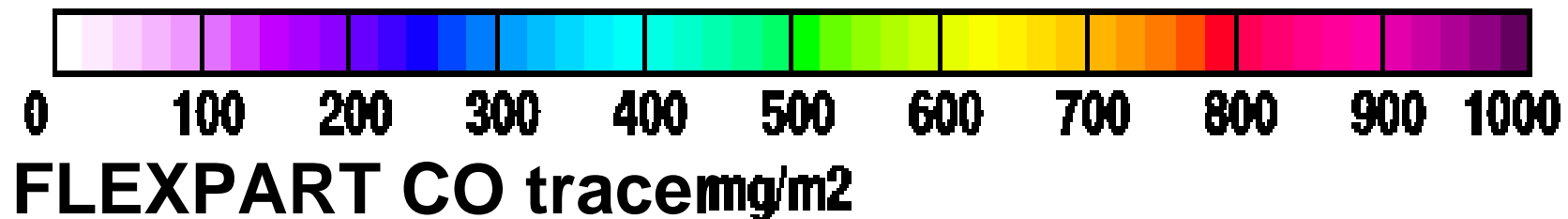
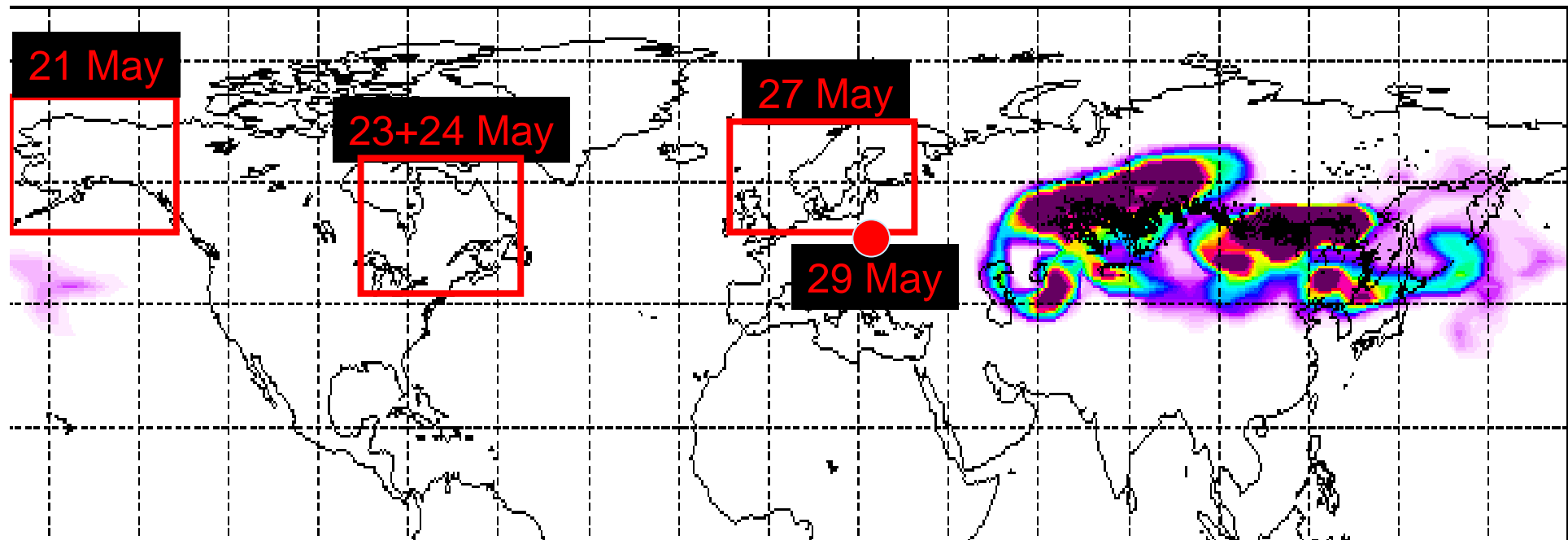
New particle formation in plumes:  
Large ions with different mass  
units (red = largest ions)





# Siberian fire plumes travel around the world

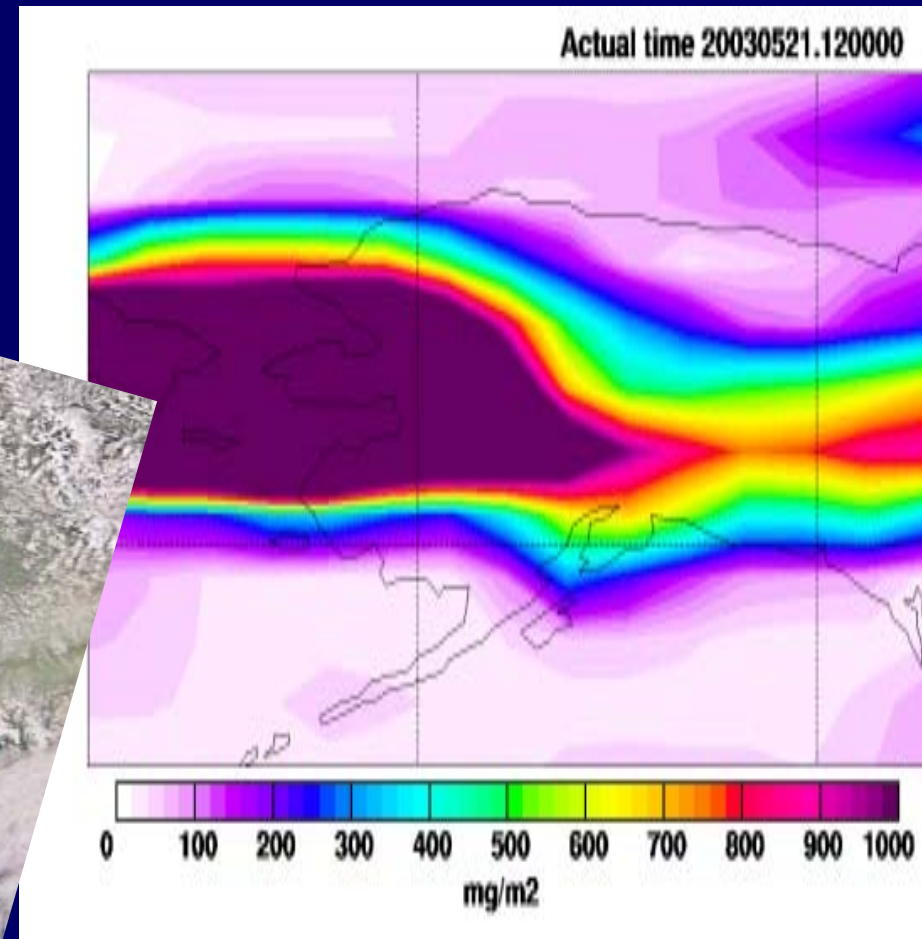
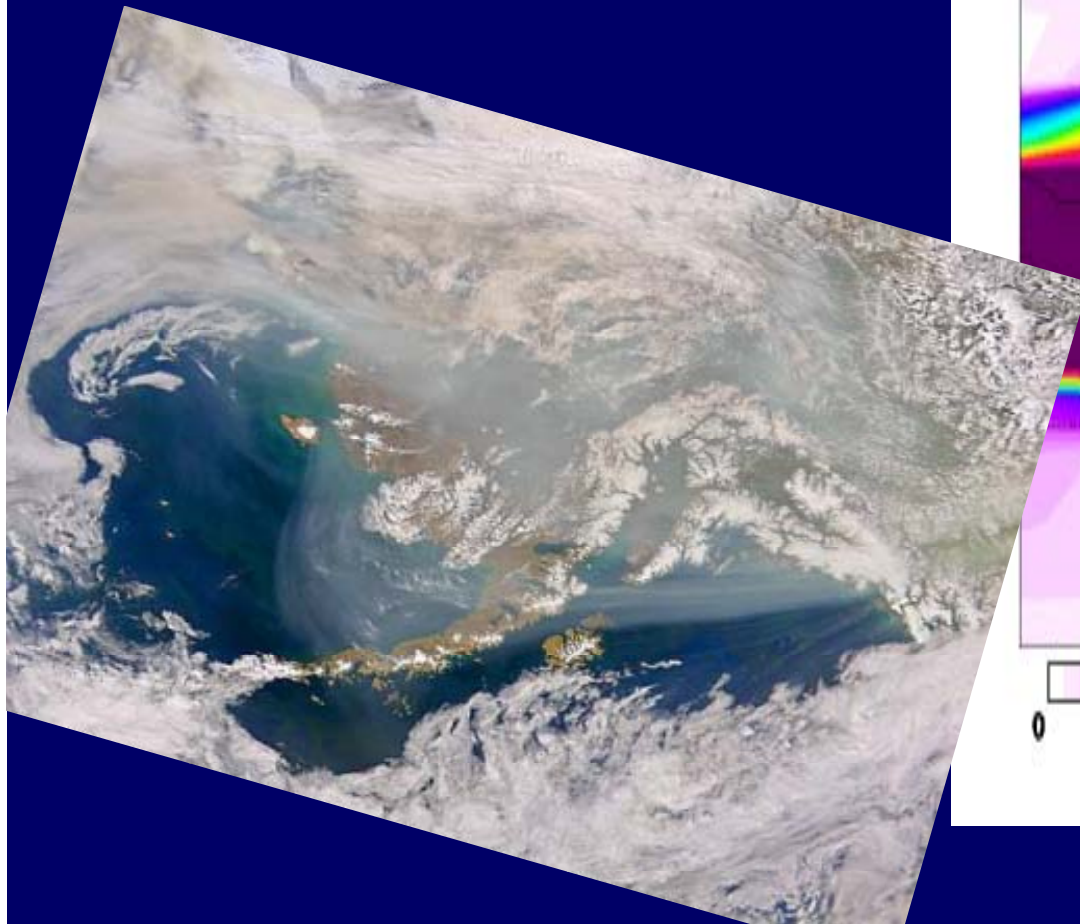
Actual time 20030515. 0



# Siberian fire plumes travel around the world

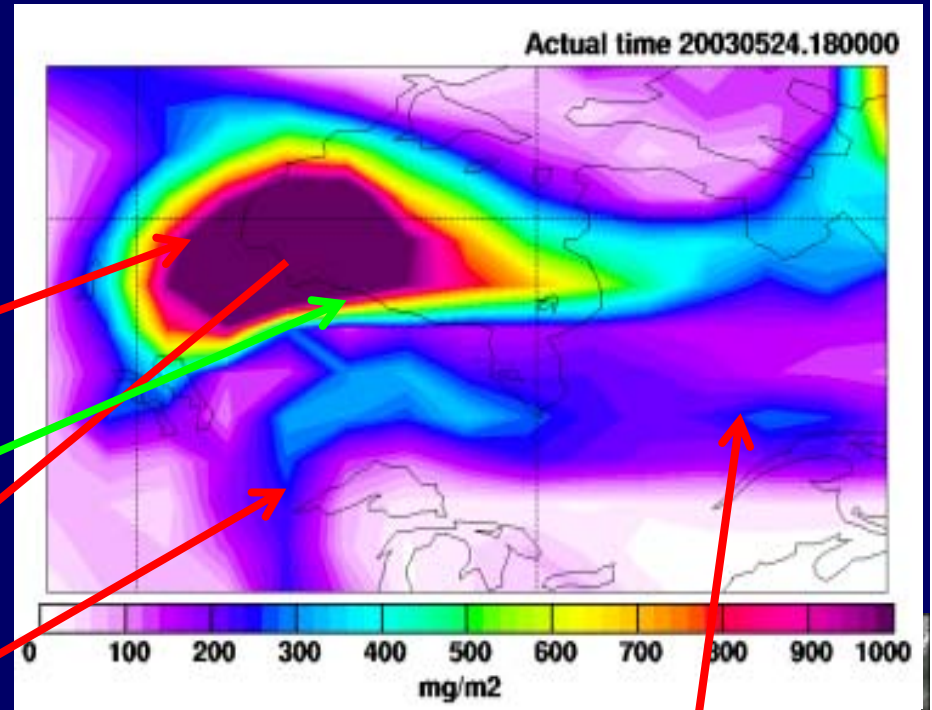
SeaWiFS image on 21 May

FLEXPART Siberian forest fire tracer on 21 May

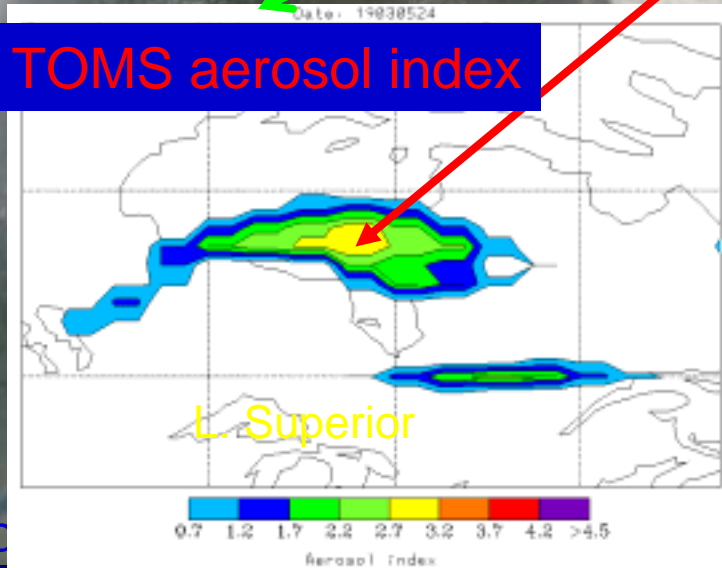


# Siberian fire plumes travel around the world

MODIS images on 23+24 May



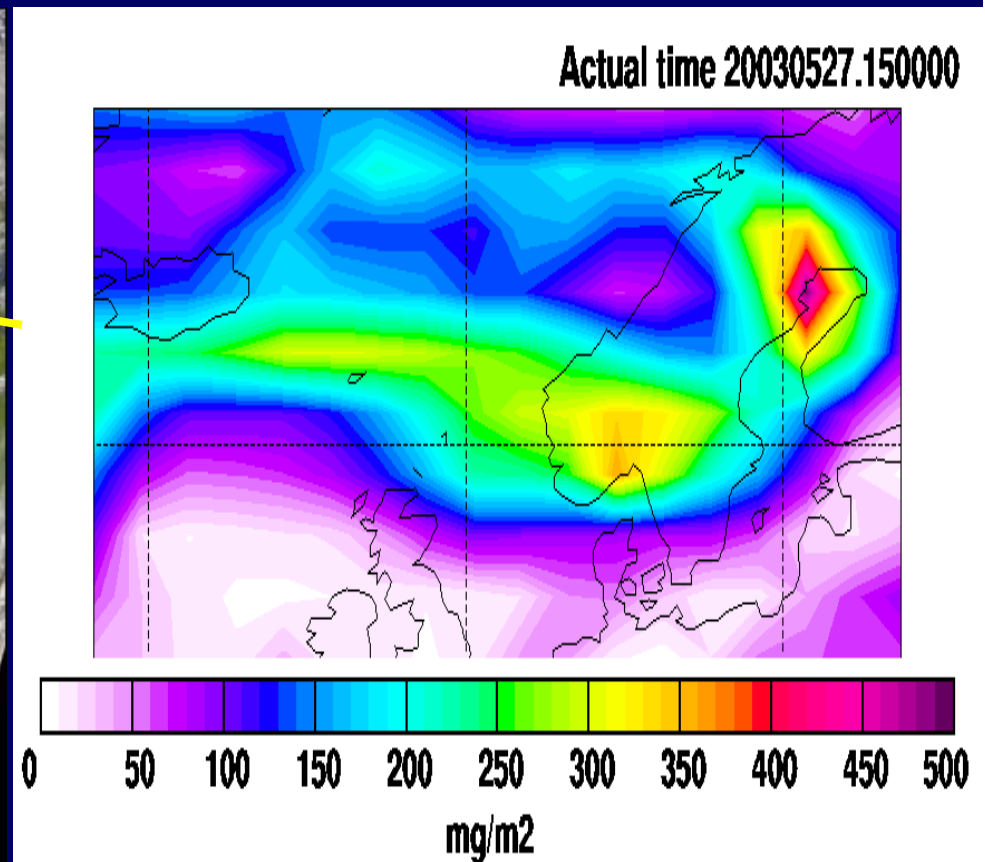
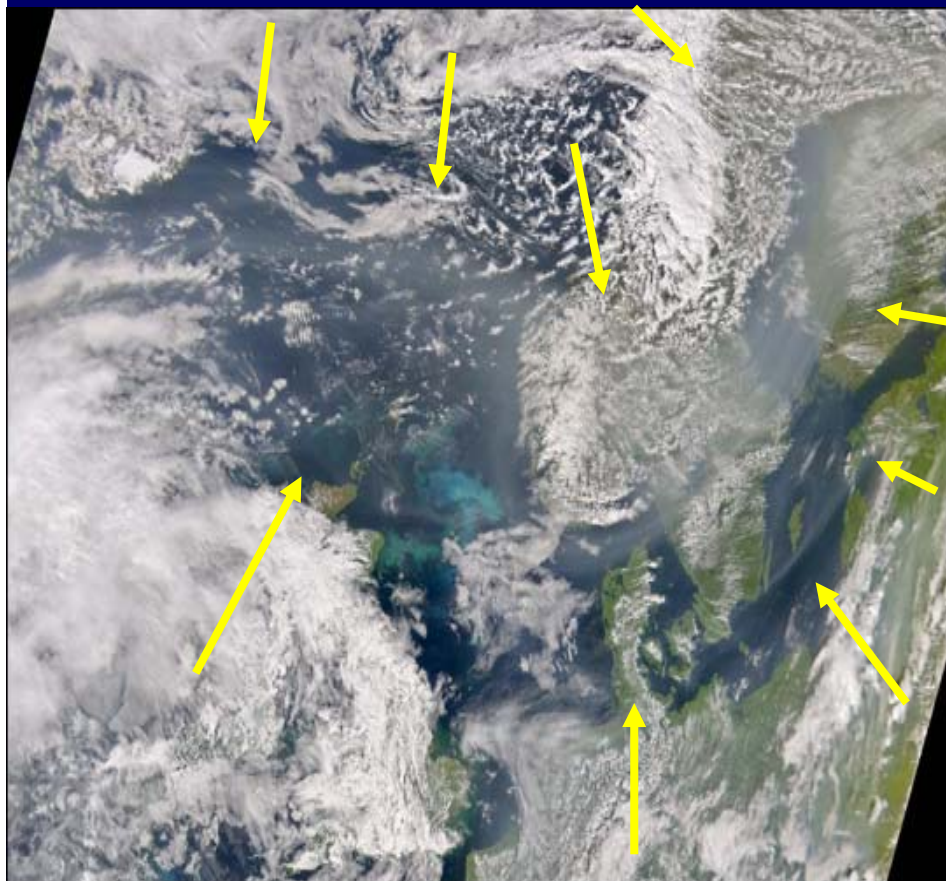
TOMS aerosol index



# Siberian fire plumes travel around the world

SeaWiFS image on 27 May

FLEXPART Siberian forest fire tracer on 27 May



# The International Polar Year

A large, fluffy polar bear cub is the central focus of the image. It is sitting on a snowy surface, looking directly at the camera with a calm expression. The bear's fur is a mix of light and dark brown tones, appearing very soft and thick. Its front paws are visible, resting on the snow. The background is a bright, overexposed snowy landscape, creating a high-contrast scene.

An Expression of Intent for Research on  
the Atmospheric Composition in the  
Arctic

# IPY History

First International Polar Year (1882–1883)

50 years later

Second International Polar Year (1932–1933)

25 years later

The International Geophysical Year (1957–58)

50 years later

Third International Polar Year (2007–2008)

# Atmospheric research during the IPY

36 EoIs were clustered into

“Clouds, aerosols and atmospheric chemistry (incl ozone depletion and anthropogenic impacts)”

6 of these activities were identified as “potential core” projects and the activity leaders were asked to structure the cluster

ATMOPOL: Set up a monitoring network/legacy

AICI: Concerted study of unusual chemical processes in polar regions

SYNSCOPE: Contaminant deposition network using bioindicators and passive samplers

AOD: Aerosols and radiation

P03L: Stratosphere

POLARCAT: Transport of pollution into and out of the Arctic

# POLARCAT

## Polar Study using Aircraft, Remote Sensing, Surface Measurements and Models, of Climate, Chemistry, Aerosols, and Transport

Two multi-aircraft campaigns are planned for winter/spring 2007/8 and summer 2008, several smaller ones also

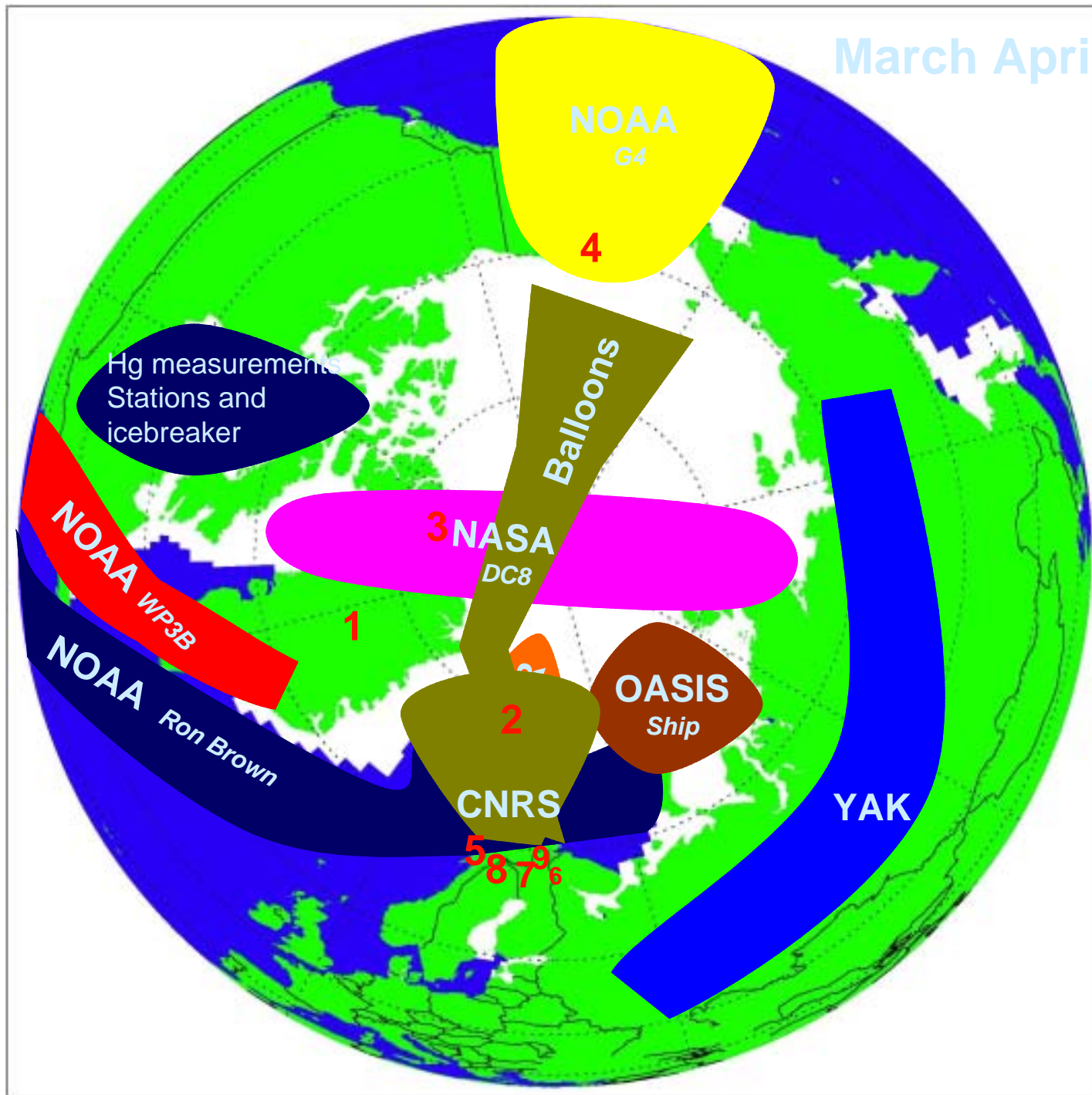
Summer campaign will focus on the transport of pollution from boreal forest fires to the Arctic troposphere and stratosphere

Winter/spring campaign will target transport of anthropogenic pollution, in particular from Eurasia, to the Arctic

Study the processes responsible for long-range transport of trace gases and aerosols into/out of the Arctic region



March April 2008



Summer 2008

