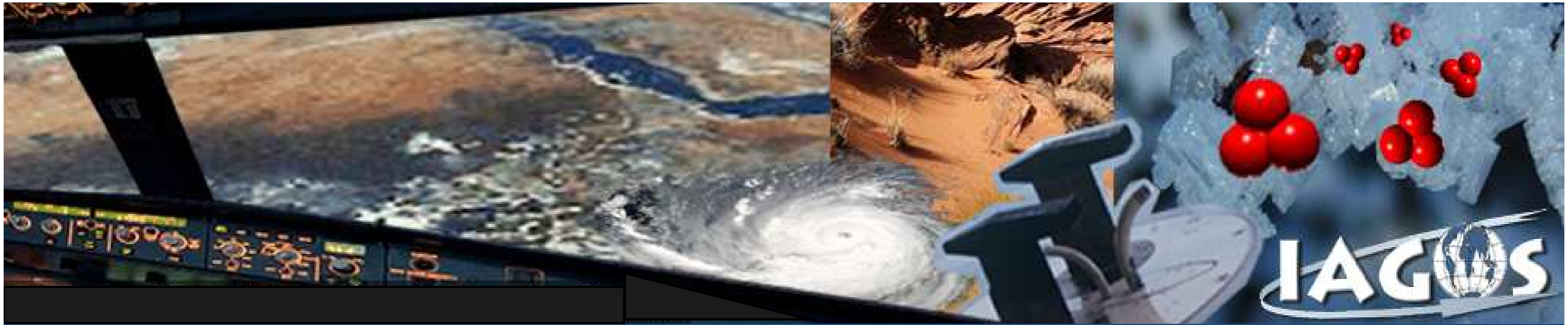


Civil Aviation Monitors

Air Quality and Climate

MOZAIC – IAGOS

Jean-Pierre Cammas, CNRS et Université de Toulouse, France

Andreas Volz-Thomas, ICG-2, Research Centre Jülich, Germany

mozaic.aero.obs-mip.fr/web/ **www.iagos.org**

Plan

- **The european program MOZAIC (1994-2009): Measurement of Ozone, Water Vapor, Carbon Monoxide, Nitrogen Oxide by Airbus In-Service Aircraft**
- **IAGOS-ERI: a long-lasting research infrastructure project taking over MOZAIC (In-service Aircraft for a Global Observing System – European Research Infrastructure)**
- **Some results:**
  - Relative humidity in the upper troposphere
  - Ozone and carbon monoxide tendencies
  - Long-range transport of biomass fire plumes and LiNOx plumes
  - Air quality: the european summer-2003 heat wave,
  - Validation of global chemistry-transport models: GMES Atmospheric Service

MOZAIC European Program

Measurement of Ozone, Water Vapor, Carbon Monoxide, Nitrogen Oxide by Airbus In-Service Aircraft

Why ? **Comprehensive and continuous observations are needed to contribute to the assessment of climate change**

- **Ozone and water vapor in the tropopause region have a key role in climate**
- **Large natural variability in space and time**

The general aim of MOZAIC is to collect data to:

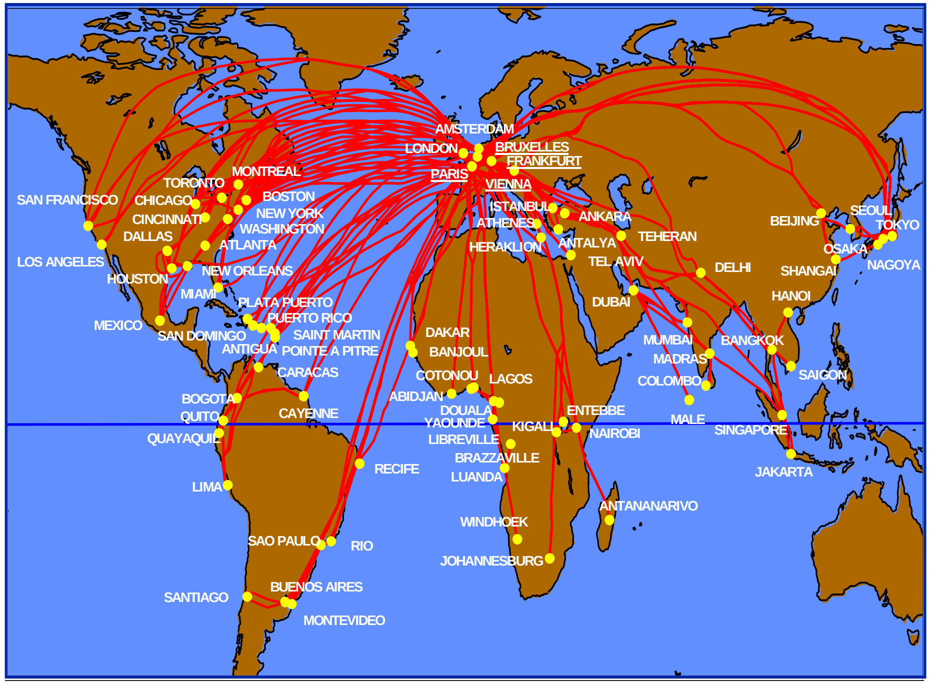
- ♦ **Assess the long term tendencies of the atmospheric composition**
- ♦ **Better understand the atmospheric processes: transport, mixing, chemistry, ...**
- ♦ **Improve model results for the budgets of ozone and water vapor**
- ♦ **Assess the aircraft impact on the atmosphere**
- ♦ **Contribute to monitor the regional air quality**

Passenger aircraft are a very powerful observing platform

MOZAIC 1994-2009

Measurements of Ozone, Water Vapour, Carbon Monoxide and Nitrogen Oxides by Airbus In-service Aircraft

http://mozaic.aero.obs-mip.fr/web/



Launched by european research institutes with the support from Airbus

Instruments deployed on 5 Airbus A340 aircraft by Lufthansa, Air France, Austrian, Sabena, Air Namibia

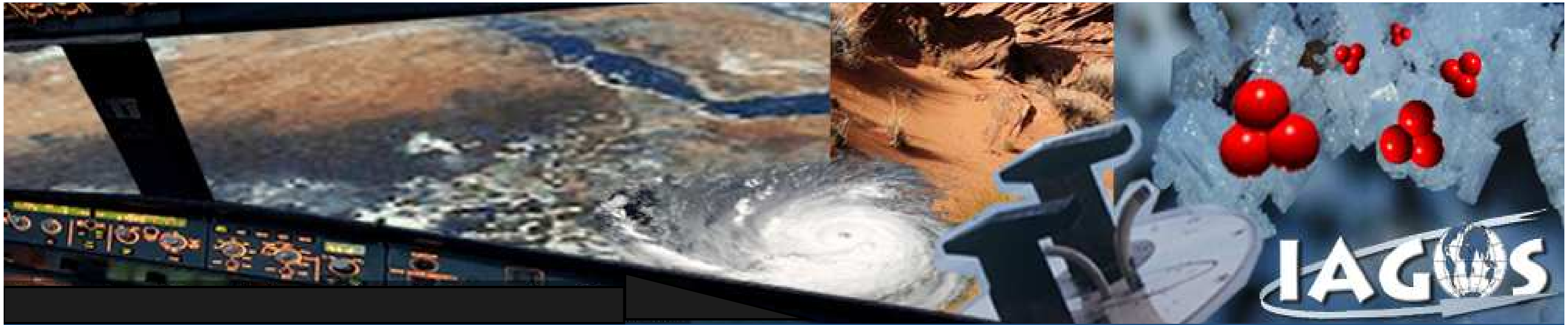
Measurements: O_3, CO, H_2O, NO_y, and meteorological parameters

2500 longhaul flights per year
5000 vertical profiles per year

>30000 flights since 1994
Data base open for scientific research
Hundreds of international users
>150 peer-reviewed papers using MOZAIC data
Still 3 aircraft flying MOZAIC instruments

cnrs dépasser les frontières
Université de Toulouse
JÜLICH FORSCHUNGSZENTRUM

IAGOS



In-service Aircraft for a Global Observing System

www.iagos.org

- **Longterm Observations for Climate Change and Air Quality from a Fleet of Passenger Aircraft**
- **16 Partners**
  - Scientific institutions (D, F, UK)
  - Aviation industry and aerospace
  - Meteorological services
  - Funding Agencies
- **Users**
  - Scientific community
  - Validation of models and satellite data
  - GMES-Atmospheric Service

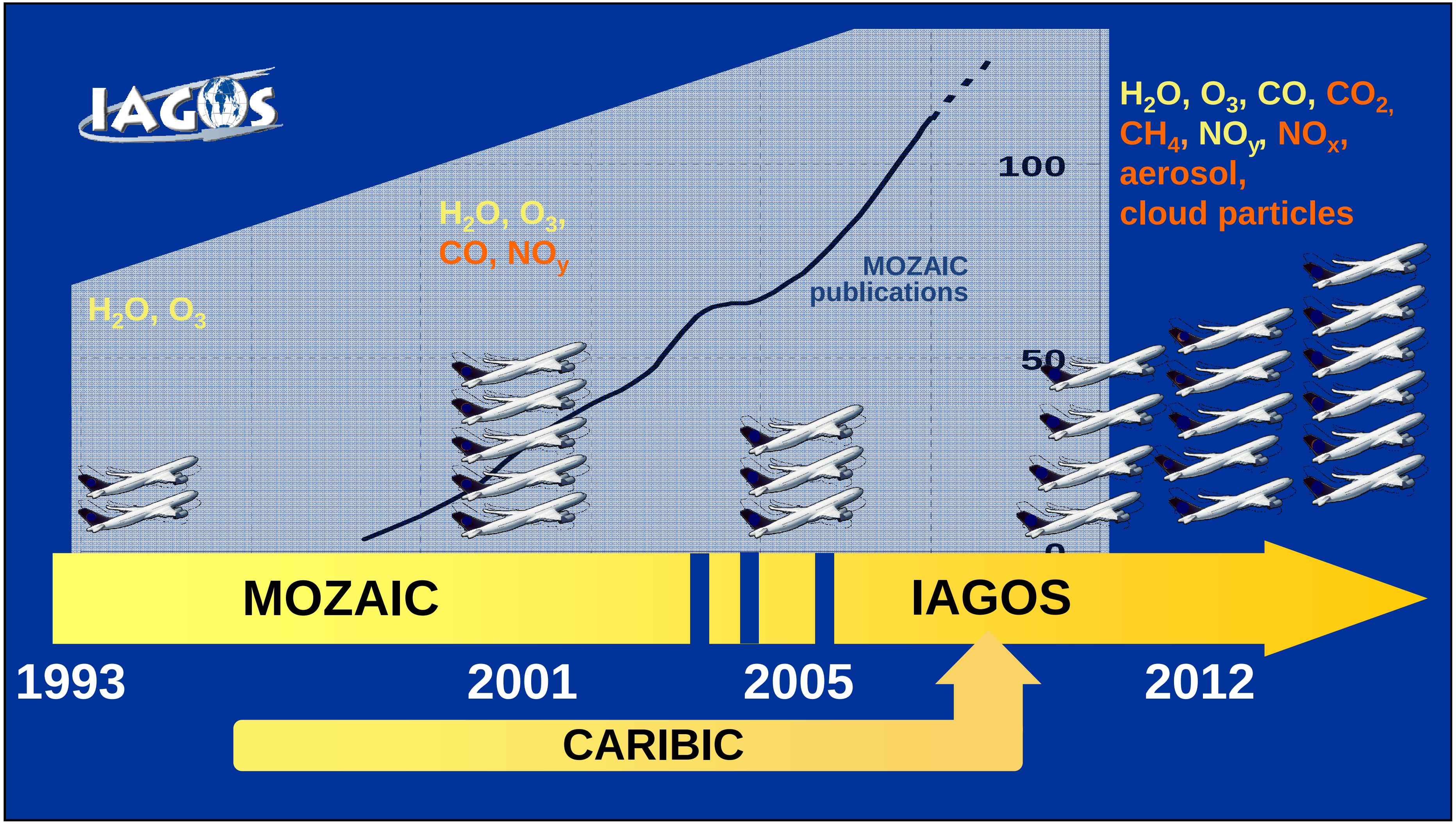
Lufthansa Airbus A340-300

Foto: Gerd Rebenich / Lufthansa DR 120-13-C 291
Nur für redaktionelle Zwecke / For editorial purposes only

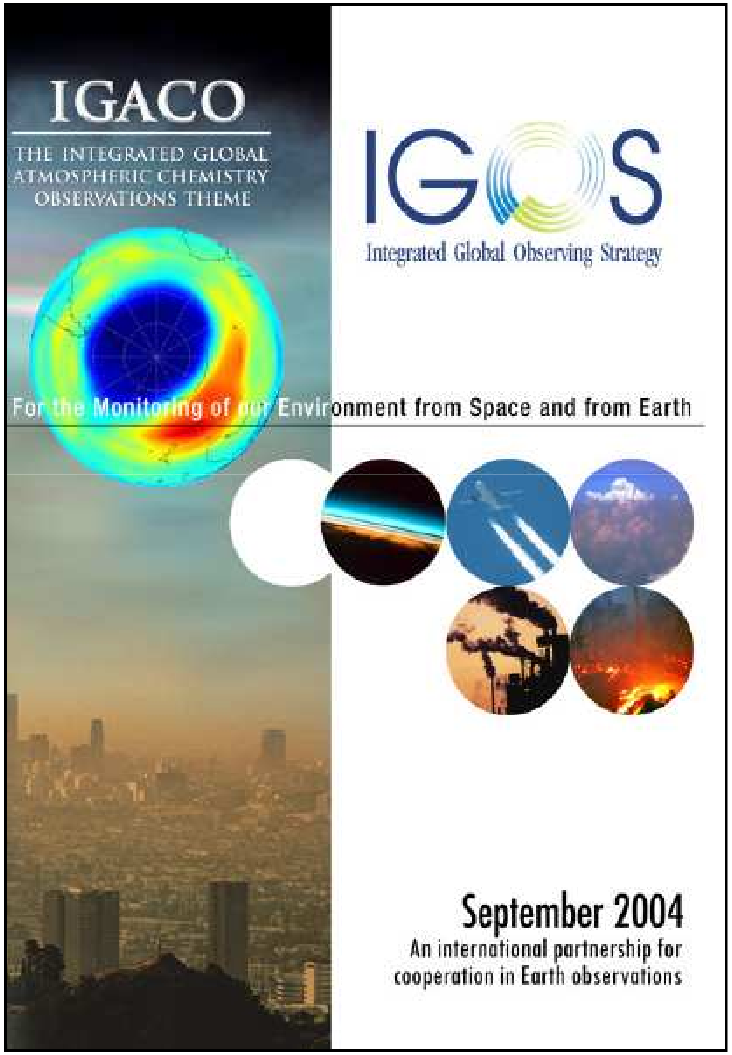
The Aim of IAGOS

- **Build a long-lasting infrastructure for monitoring the atmosphere from 20 longhaul in-service aircraft on a global scale.**
- **Provide information for monitoring of climate change and global air quality, including impact of aviation.**
  - Ozone, H_2O, CO, NOx, NOy, CO_2, CH_4, aerosol, cloud particles
- **Specific goals:**
  - Develop the necessary instrumentation
  - Obtain aeronautic certification for instruments and aircraft modification
  - Data transfer, database, quality assurance
  - Find partners (airlines and research institutes) for collaboration
  - Find funding for instruments and operation
  - Serve as a cluster for international cooperation

From MOZAIC to IAGOS

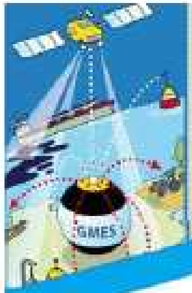


IAGOS will form a cornerstone of IGACO/GEOSS and of the European GMES initiative



Variables defined by IGACO IAGOS

Variables (priority 1)	Air Quality	Oxidation Capacity	Climate	Strat. O_3 Depletion
O_3	✓	✓	✓	✓
CO	✓	✓		
UV-A, UV-B	✓	✓		
H_2O	✓	✓	✓	✓
HCHO	✓	✓		
C_2H_6	✓	✓		
NO_x, HNO_3	✓	✓	✓	✓
SO_2	✓	✓	✓	✓
Halocarbons				✓
aerosol opt. properties	✓		✓	✓
CO_2			✓	
CH_4		✓	✓	✓



EUROPEAN COMMISSION

GMES Bureau

Objectives

GMES is a joint initiative of the European Commission and ESA.
Its objective is to provide information for policy-makers, particularly in relation to environment and security.

EARTH OBSERVING SYSTEMS

Solutions →

← Needs (policy driven)

PUBLIC POLICIES (Environment & Security)

Space Agencies / Operators
In-situ Observing systems operators
Scientific Community
EO Value Adding Industry

National Governments and Agencies
European Union Institutions
Inter-Governmental Organisations (IGOs)
Non Governmental Organisations (NGOs)

2005-2009 Design Study for Research Infrastructures

- New design of the MOZAIC instrumentation
- Near-real time data transmission (6h-1day)
- STC for Airbus A340
- First A340s to be equipped: Lufthansa (November 2009)
- Development of new instruments: cloud probe, aerosol, NOx, $CO_{2,}$ CH_4
- Establishing of cooperation with airlines & institutes: SH, Pacific

2008-2012 Preparatory Phase for New Infrastructures

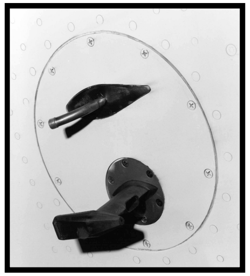
- A340s to be equipped in 2010: China Airlines (Taiwan) and Air France
- Legal structure of IAGOS and longterm funding
- Integration into GMES and IGACO
- Extension of STC to A330
- Certification of new instruments (aerosol, $CO_{2,}$ CH_4)
- Realtime data transmission (<3h)

The IAGOS Team

- A. Volz-Thomas, H. Smit, H.W. Pätz, K. Thomas, *ICG-2, FZ-Jülich*
- J.-P. Cammas, P. Nédélec, *Laboratoire d'Aérologie, CNRS, Toulouse*
- F. Karcher, Y. Lemaître, *CNRM, Météo-France, Toulouse*
- R. L. Jones, M.I. Mead, *University of Cambridge*
- M. Gallagher, *University of Manchester*
- A. Petzold, H. Schlager, *IPA, DLR Oberpfaffenhofen*
- Y. Allouche, *AIRBUS Toulouse*
- T. Gill, *British Airways*
- A. Waibel, *Deutsche Lufthansa*
- C. Gerbig, *MPI-BGC, Jena*
- M. Hermann, *IFT Leipzig*
- H. Franke, *Enviscope, Frankfurt*
- L. Barrie, H. Pümpel, *WMO*
- T. Henshaw, *NERC*
- M. Paulin, *CNES, Toulouse*

MOZAIC INSTRUMENTATION

INSTRUMENTATION BELOW THE COCKPIT
O3/CO/H2O/NOy/DAS



PITOT TUBES ON THE AIRCRAFT FUSELAGE

Ozone Instrument validation: MOZAIC + ozone sounding at Hohenpeissenberg (48°N, 11°E)

MOZAIC O3 instrument: improved version of commercial dual-beam UV absorption instrument (Thermo-Electron, model 49-103),

Accuracy ± 2 ppbv / precision ± 2% / response time 4 sec

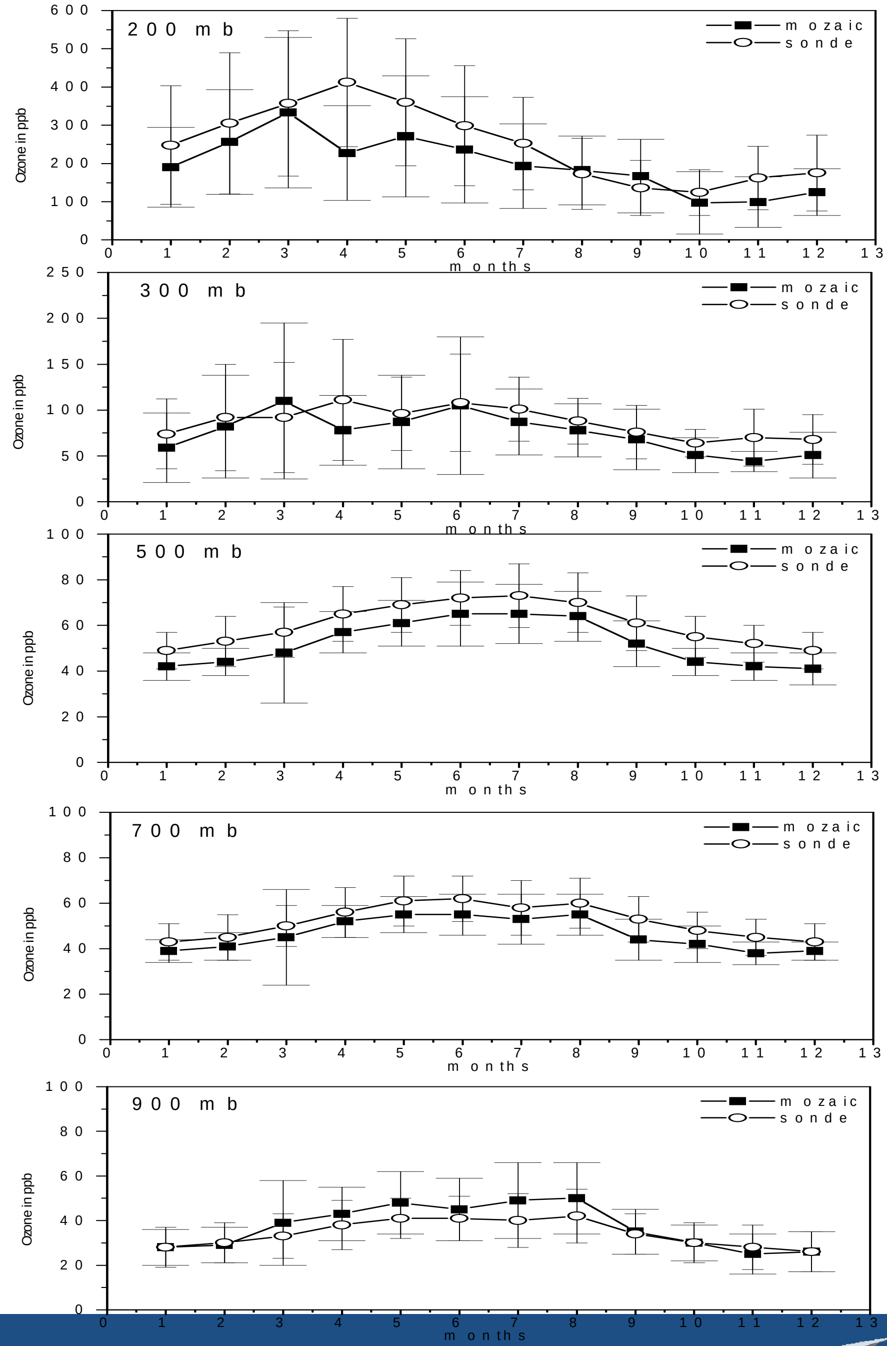
Sensor replacement & pre- and post-calibration in laboratory every C-check of aicraft.

Aeronautical certification: Airbus

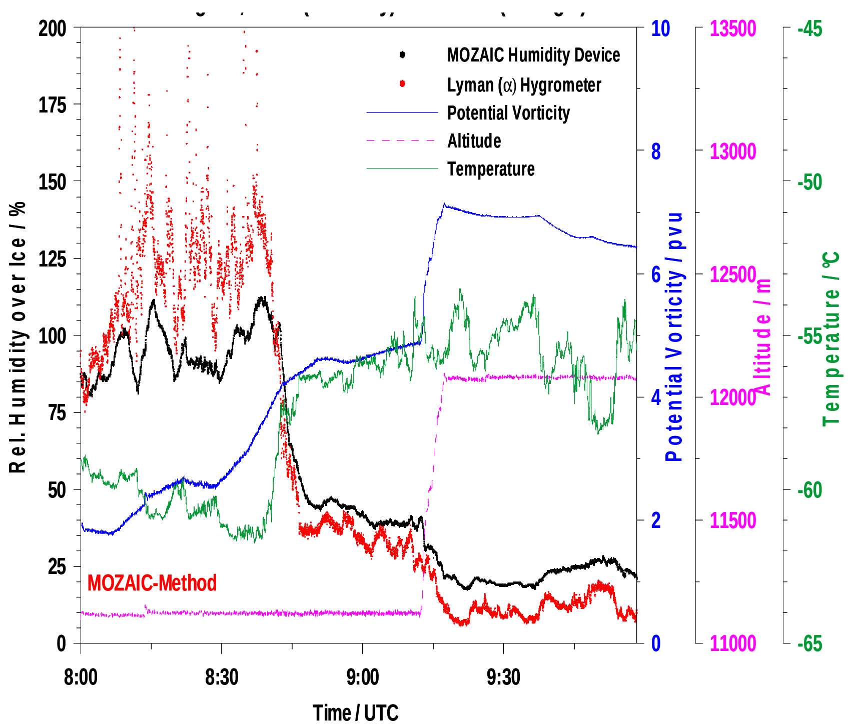
Marenco et al., JGR, 1998

Seasonal variations of ozone monthly averages for the Hohenpeissenberg sounding station [1980-93] compared with MOZAIC data over Frankfurt [Sept 1994-Aug 1996] at 5 standard pressure levels. Standard deviations are plotted as error bars with large cap for MOZAIC and small cap for Hohenpeissenberg.

Thouret et al., JGR, 1998



Instrument validation: MOZAIC H2O measurements



In-flight comparison of relative humidity over ice (RHI) measured by MOZAIC (black curve) and Lyman(α) hygrometer (red curve) at cruise altitude (pink curve) of Learjet research aircraft during SPURT mission at 28 April 2003.

Helten et al., 1999

Potential vorticity (blue curve) obtained from ECMWF analyses along the flight track.

The comparison provides experimental evidence that the phenomena of ice super saturation observed by MOZAIC are real and not caused by the evaporation of hydrometeors.

MOZAIC RH instrument: capacitive RH sensor (Humicap-H) mounted in a Rosemount Probe system

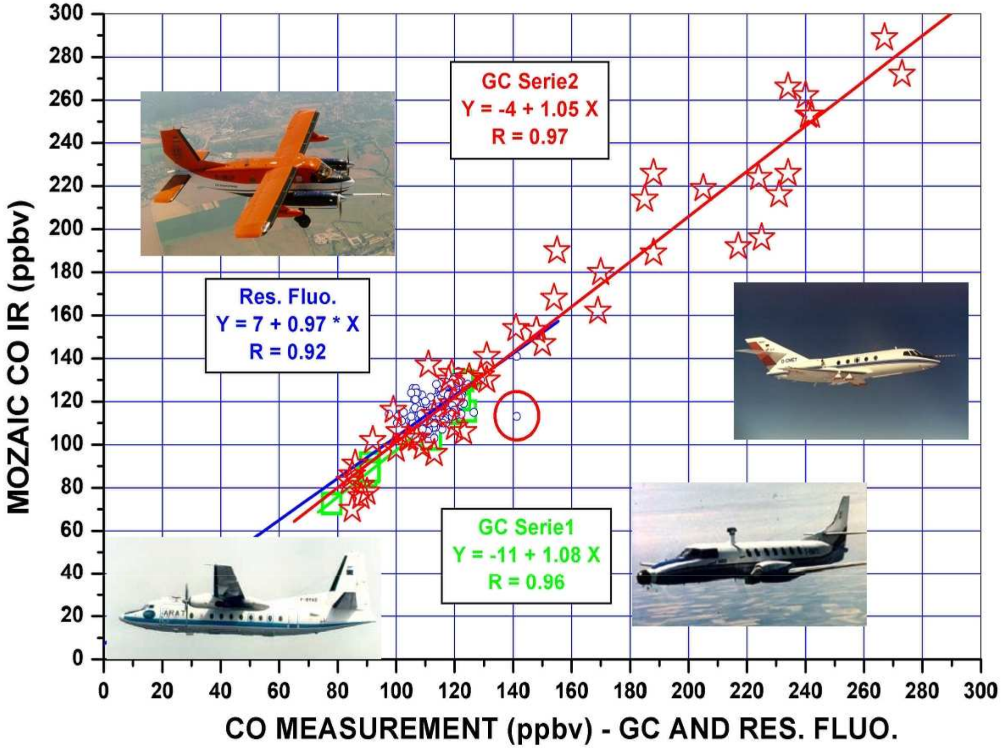
Accuracy < 10%, precision ± 7%, response time depending on temperature (sec at ground to 2 minutes at cruise altitude)

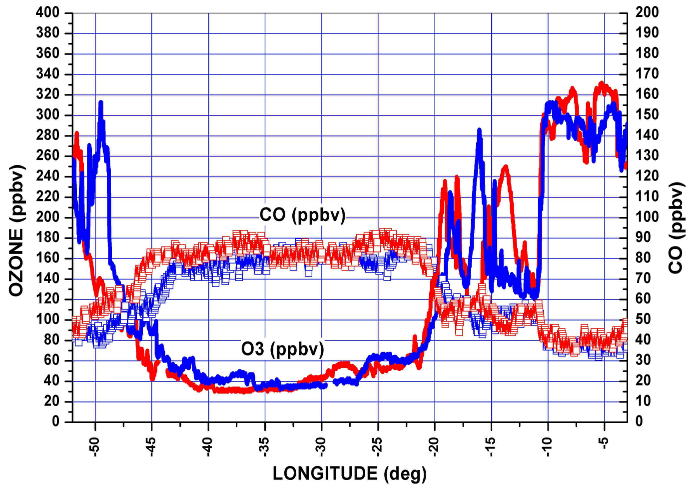
Sensor replacement & pre- and post-calibration in laboratory every C-check of aicraft.

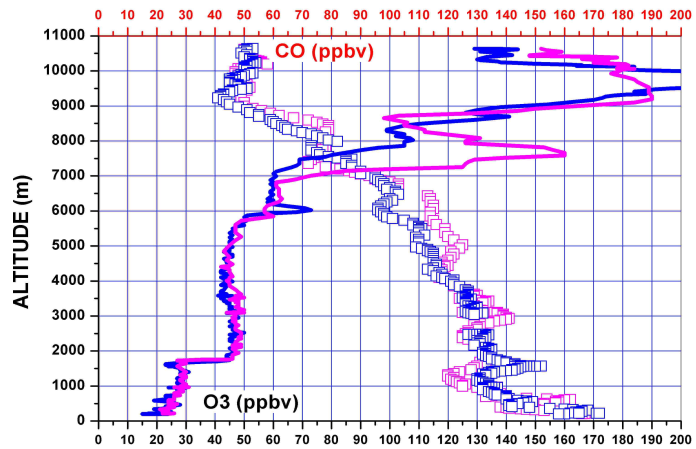
Aeronautical certification: Airbus

Helten et al., JGR, 1998

Instrument validation: MOZAIC CO measurements







MOZAIC CO instrument: improved version of commercial IR gaz filter correlation model (48CTL, Thermo Environmental Instruments)

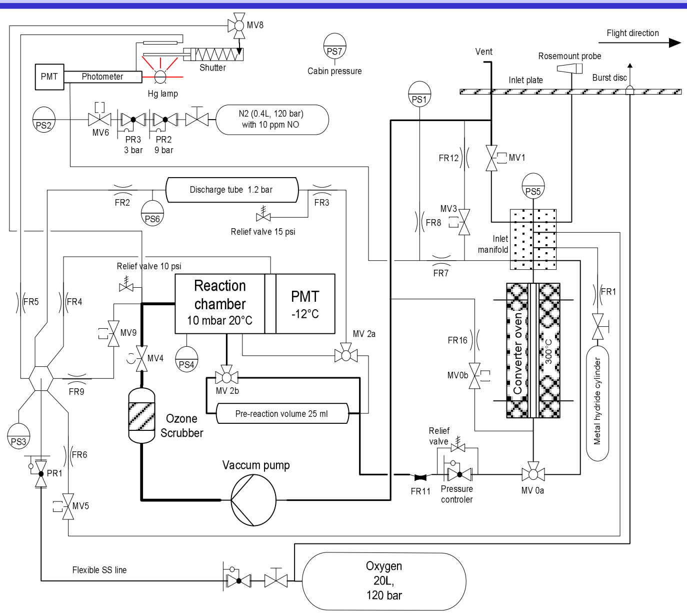
Accuracy ± 5 ppbv, precision ± 5%, detection limit 10 ppbv, response time 30 sec. Sensor replacement & pre- and post-calibration in laboratory every C-check of aicraft.

Aeronautical certifcation: Airbus

Nédélec et al., Atmos. Chemistry & Physics, 2003

Comparison of time series of O3 and CO for two co-located MOZAIC aircraft during cruise phase (top) and landing phase (bottom)

Instrument validation: MOZAIC NOy measurements



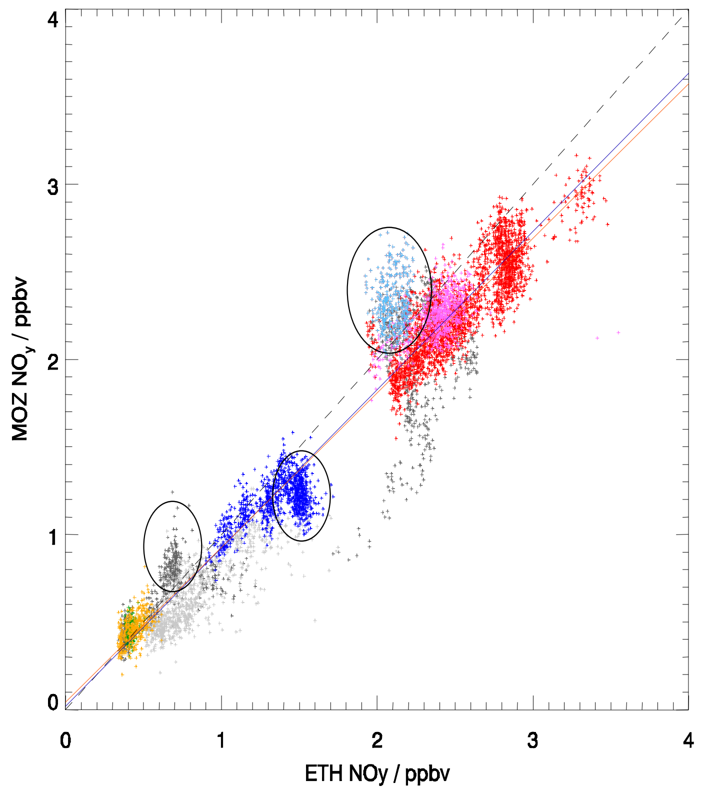
MOZAIC NOy instrument: detection of NO by chemiluminescence with O3 in combination with catalytic conversion of the other NOy compounds to NO at 300°C on a gold surface in the presence of H2.

Sensitivity of 0.3-0.5 cps/ppt gives a detection limit of better than 30-50 ppt for an integration time of 4s, and 150-300 ppt at the maximum resolution of the instrument (10Hz).

Designed for unattended operation during 400-800 flight hours. Total weight 50 kg, including calibration system, compressed gases, mounting, and safety measures.

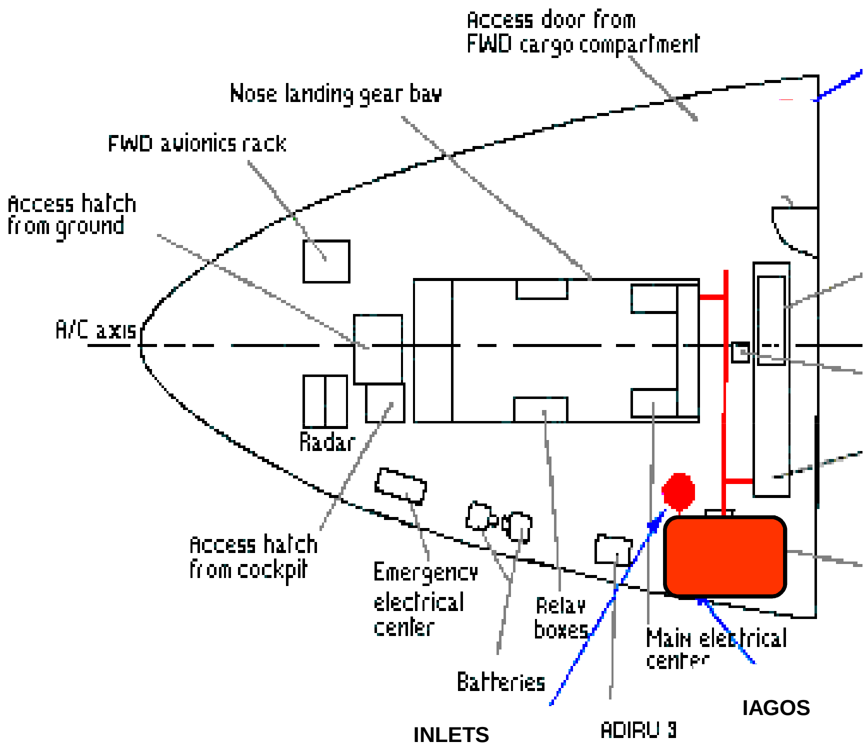
Aeronautical certification: Lufthansa technics

Volz-Thomas et al., (ACP, 2005)



Quality assurance: Scatter plot of the NOy data from the comparison flight in April 2004 obtained by the MOZAIC and ETHZ instrument. The encircled data are from times after calibrations of the ETHZ (light blue and gray points) and MOZAIC (dark blue points) instrument. ***Pätz et al., (ACP, 2006)***

IAGOS instrumentation



Package 1 (72 kg)
Basic & mandatory system

O_3
CO
Relative humidity
Cloud droplets and ice crystals
Meteorological parameters
Data acquisition and transmission

Package 2 (50 kg)
Optional extra

NO_y
or (NO_x = NO + NO_2)
or Aerosol (>2012 ?)
or CO_2 + CH_4 (>2012 ?)

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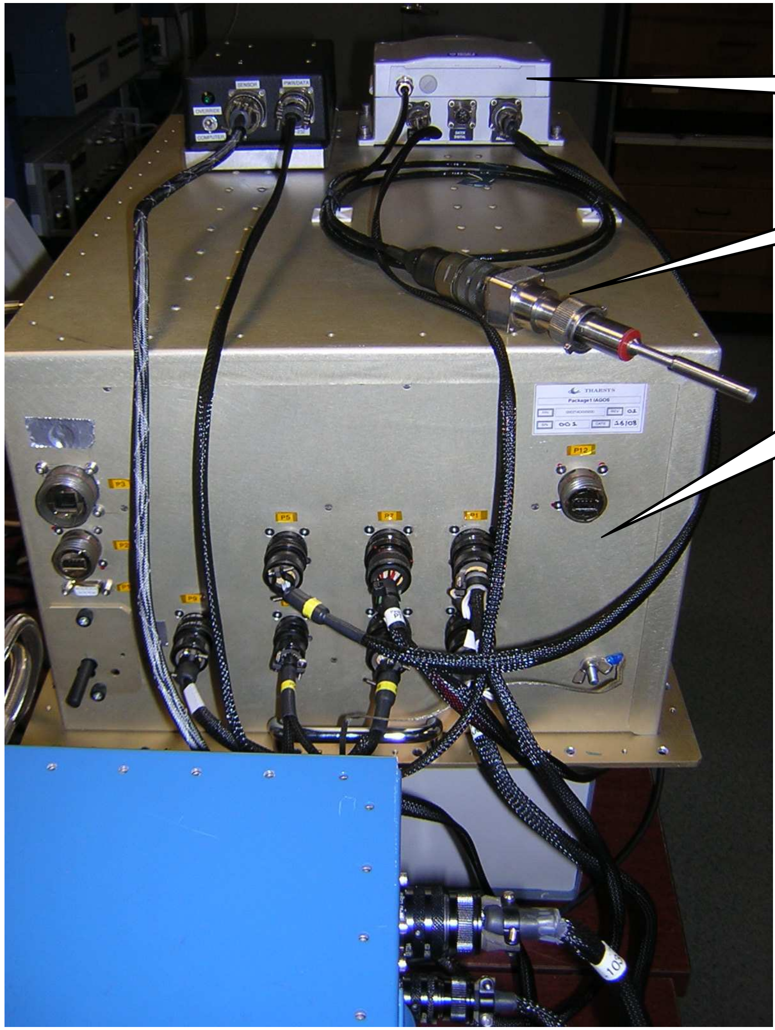
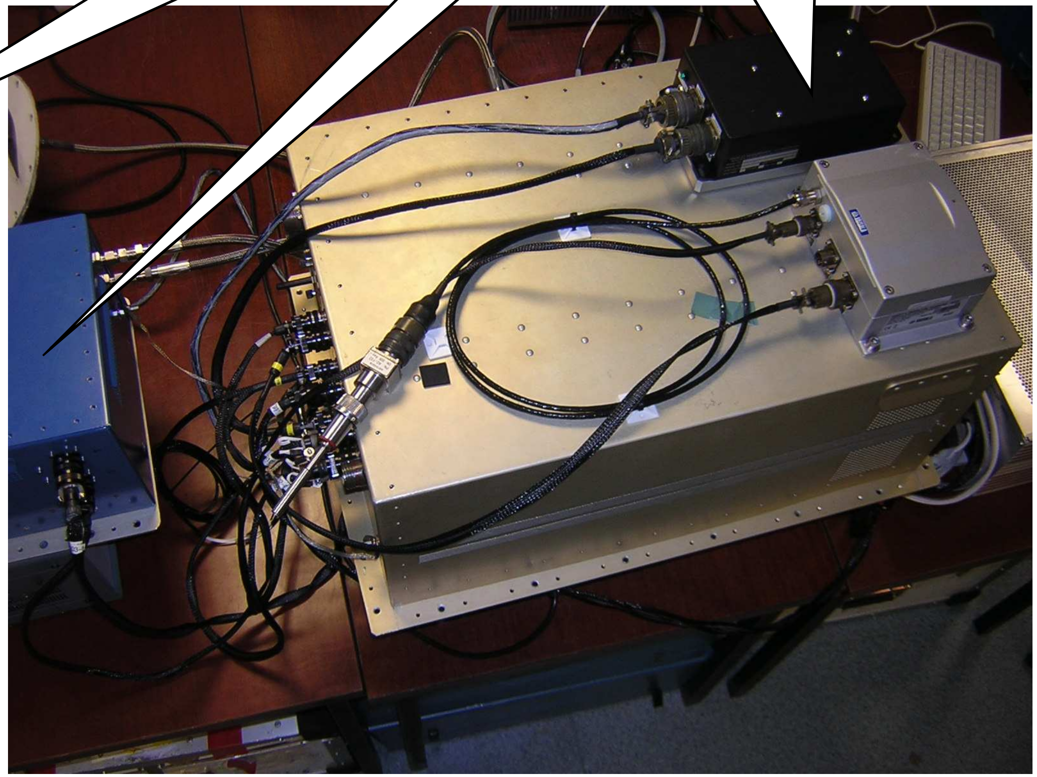
IAGOS Package 1 (CNRS)





Status of airlines in IAGOS

Lufthansa: MOZAIC partner since 1994, IAGOS A340 in 2009, transport free of charge

Air France: MOZAIC partner since 1994, IAGOS A340 in 2010, transport free of charge

China Airlines: MoU for IAGOS signed in 2008, IAGOS A340 in 2010, transport free of charge

Air Namibia: MoU for MOZAIC signed in 2005, MOZAIC A340 since 2006

Cathay Pacific: Interest expressed since 2006, IAGOS A330 in 2012 (?), transport free of charge

South African Airways, Iberia, Qantas, Philippine Airlines: Interest expressed since 2006

Aeronautical guarantors: Airbus, EASA (Cival Aviation Authority)

Plan

- **How civil aviation can monitor climate and regional air quality ?**
- **The european program MOZAIC (1994-2009): Measurement of Ozone, Water Vapor, Carbon Monoxide, Nitrogen Oxide by Airbus In-Service Aircraft**
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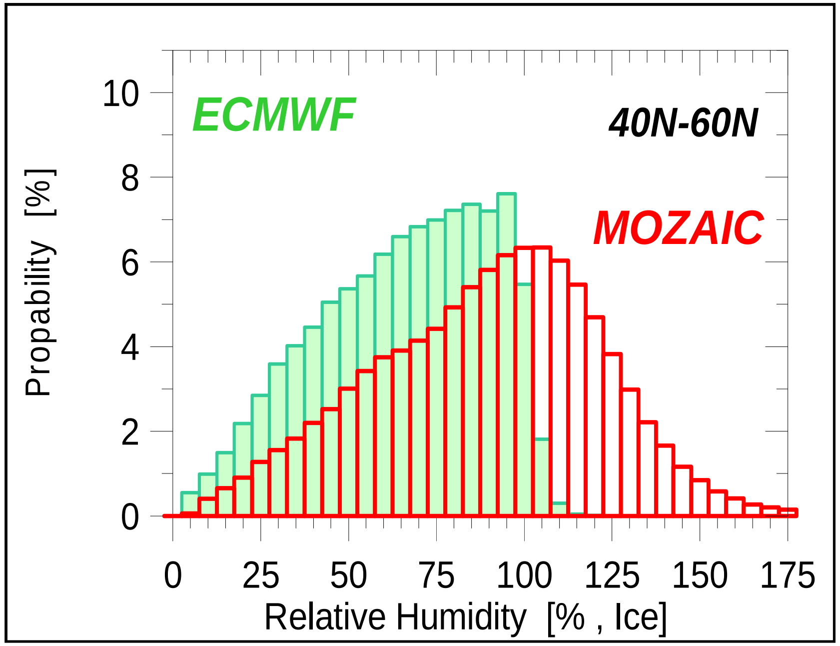
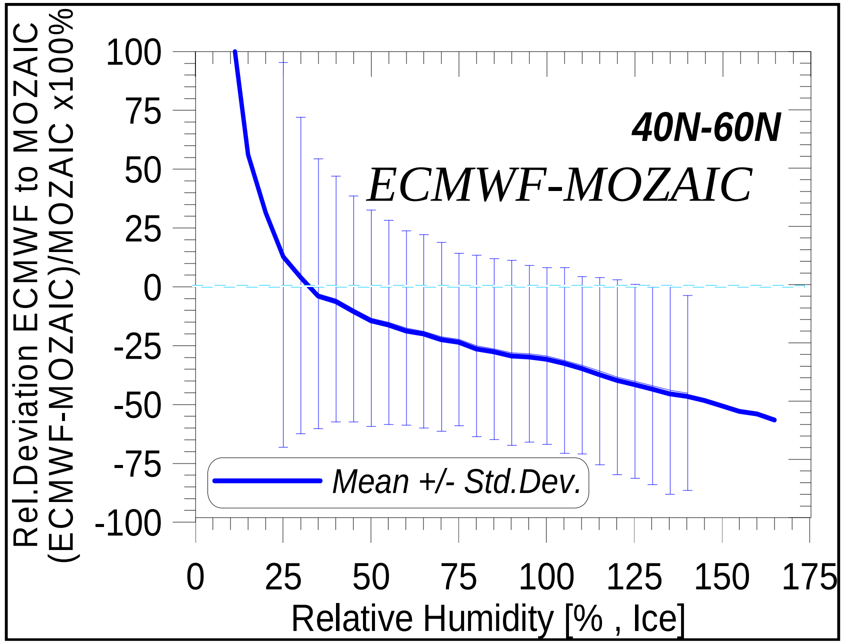
- **Some results:**
  - Relative humidity in the upper troposphere
  - Ozone and carbon monoxide tendencies in the upper troposphere
  - Long-range transport of biomass fire plumes and LiNOx plumes
  - Air quality: the european summer-2003 heat wave,
  - Validation of global chemistry-transport models: GMES Atmospheric Service

MOZAIC Relative Humidity in UT over North Atlantic: comparison with ECMWF





- MOZAIC provided the first climatology of UTH
- UT is much wetter than assumed before MOZAIC
- ECMWF does not reproduce ice super saturation

Gierens et al., 1997, 1998, 1999, 2004 ; Spichtinger et al., 2002, 2003

Plan

- **How civil aviation can monitor climate and regional air quality ?**
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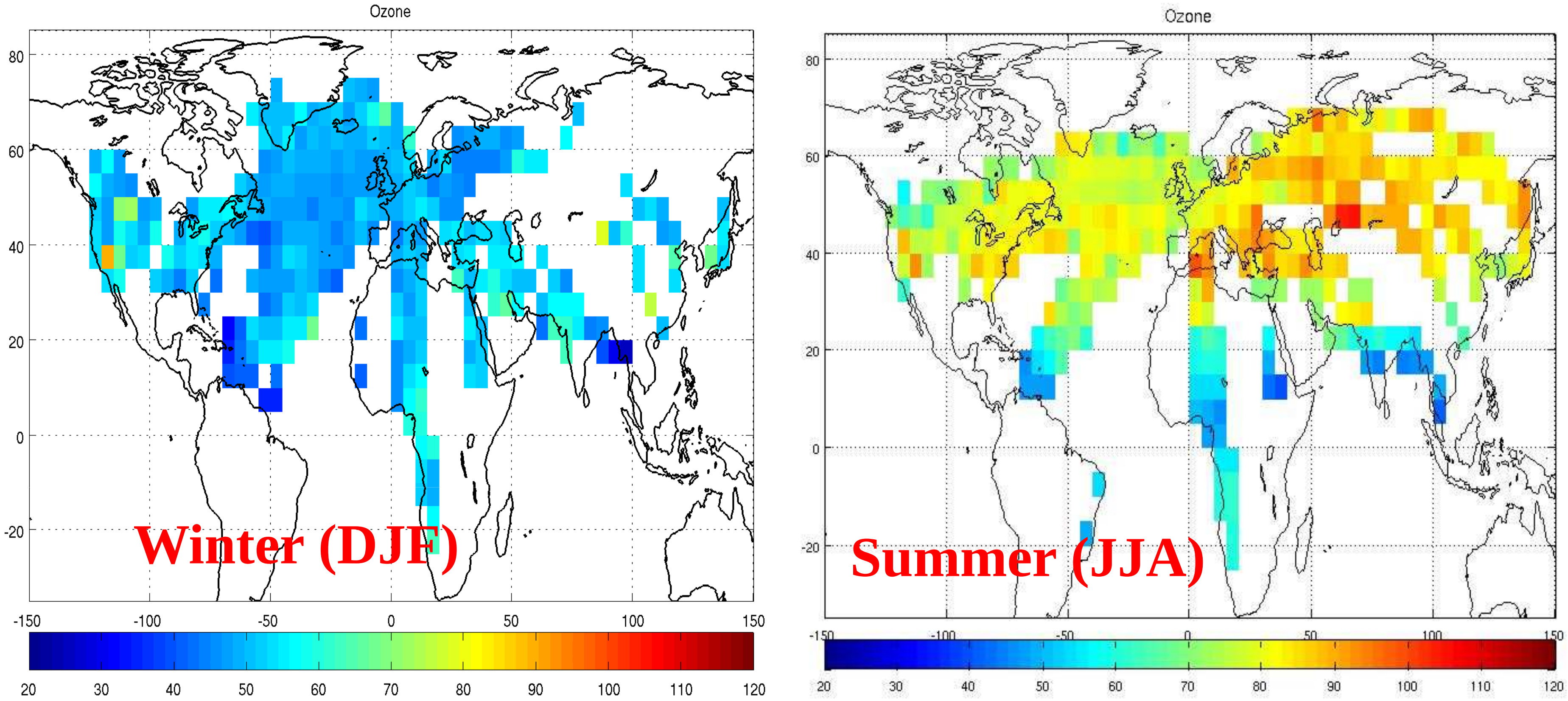
O3 in the Upper Troposphere

Climatology: 1994 - 2004



- O3 : summer maximum in the UT
- Higher concentrations of both O3 and CO in the eastern hemisphere
- The Black Sea region is characterized by an O3 maximum and a CO minimum (strong stratospheric influence ?)

Thouret et al., 2006

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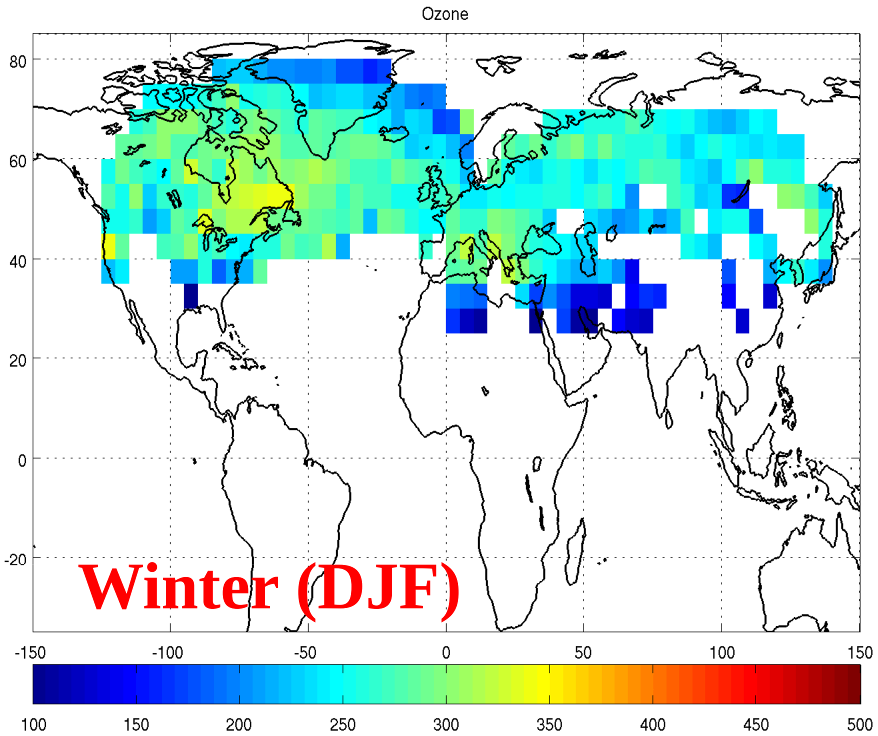
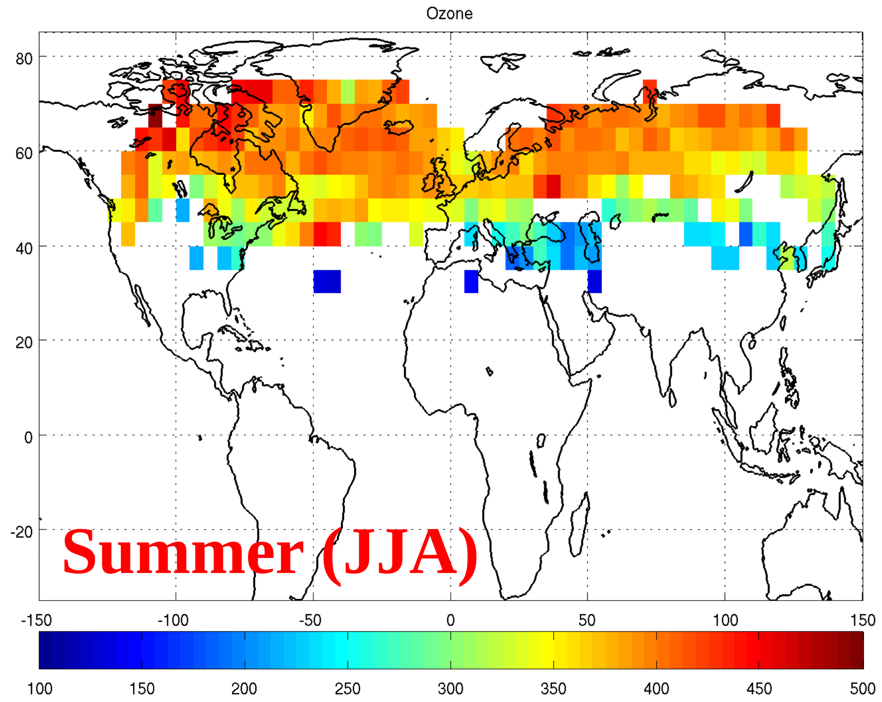
O3 in the Lower Stratosphere

Climatology: 1994 - 2004

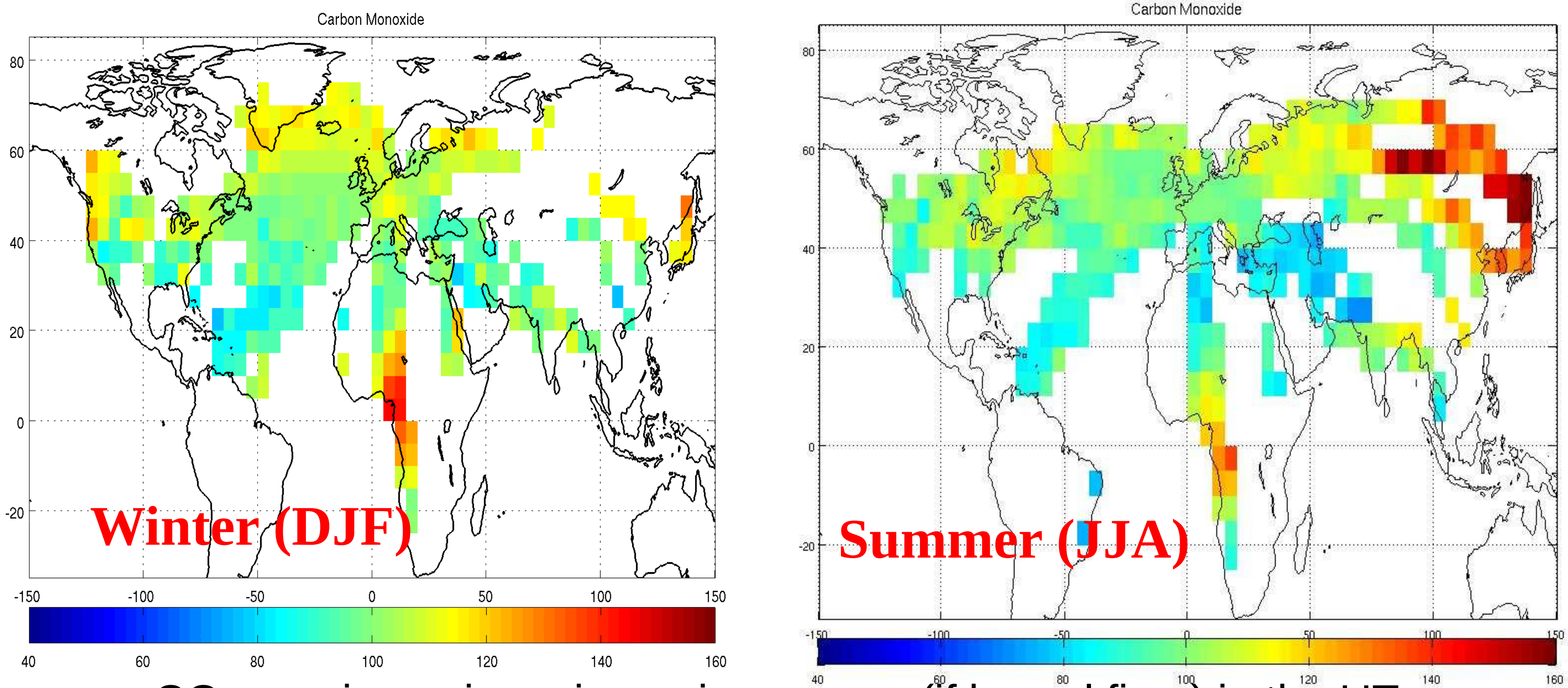




Spring maximum in the LS

Thouret et al., 2006

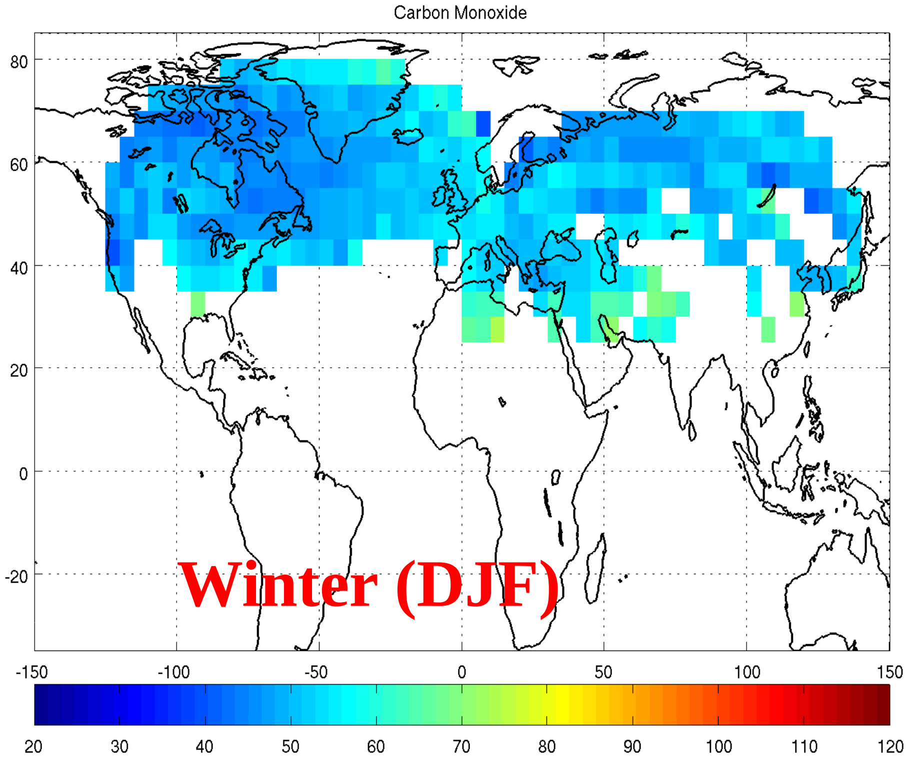
CO in the Upper Troposphere

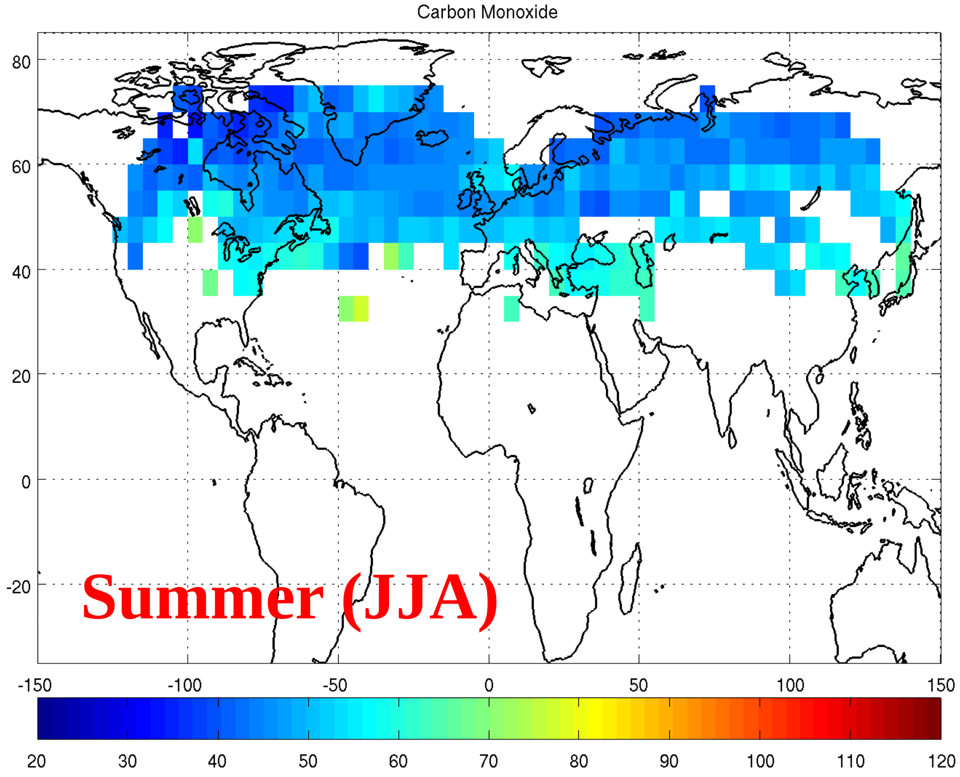


- CO : maximum in spring or in summer (if boreal fires) in the UT
- Higher concentrations of both O3 and CO in the eastern hemisphere
- The Black Sea region is characterized by an O3 maximum and a CO minimum (strong stratospheric influence)
- CO maxima over burning regions (West Africa in DJF, Central Africa in JJA)

Thouret et al.

CO in the Lower Stratosphere

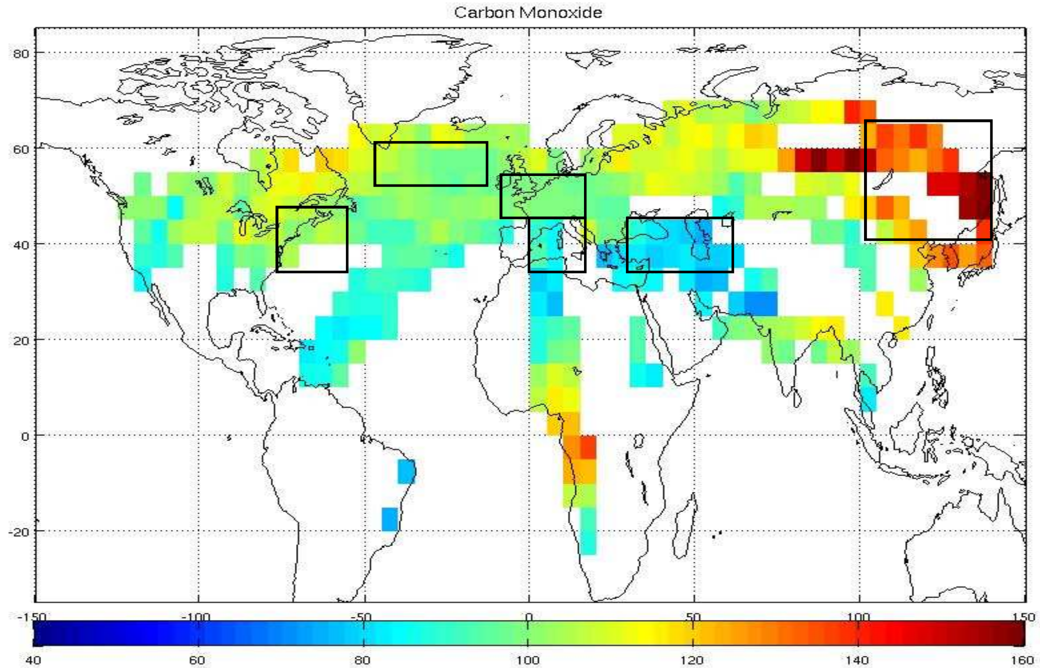




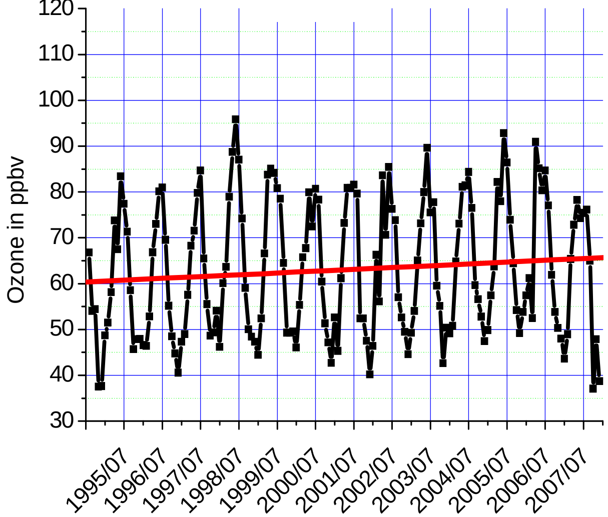
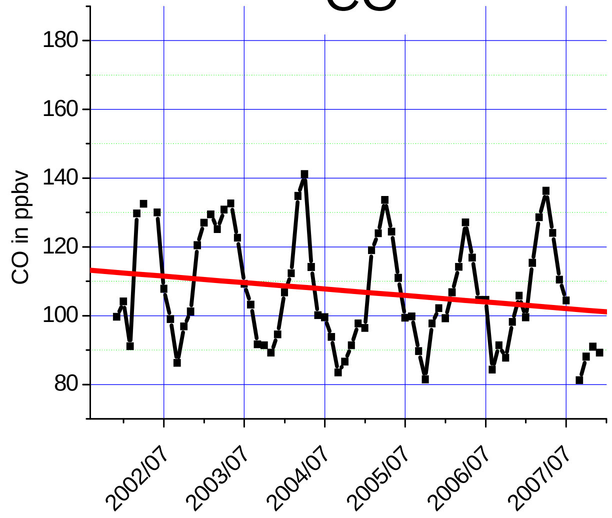
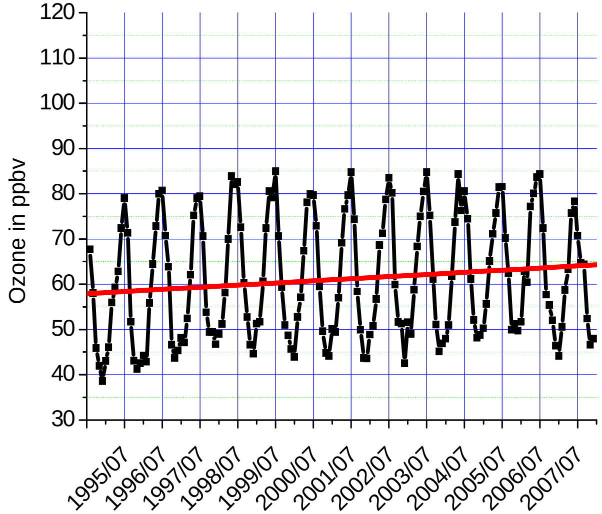
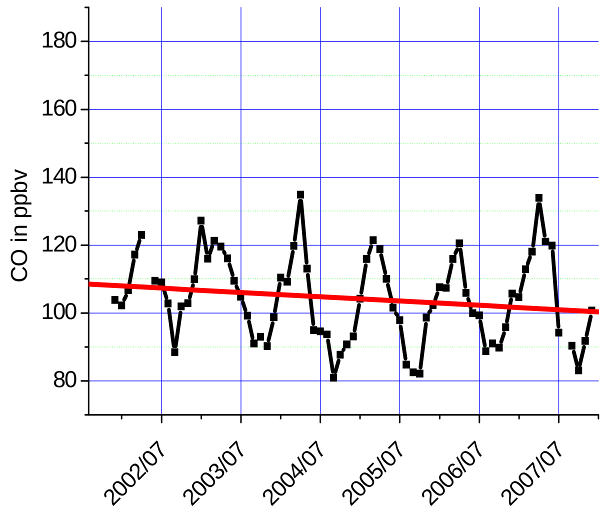
– no real seasonal cycle in the LS

Thouret et al.

Regions quite well documented to assess the interannual variabilities and first decennal trends



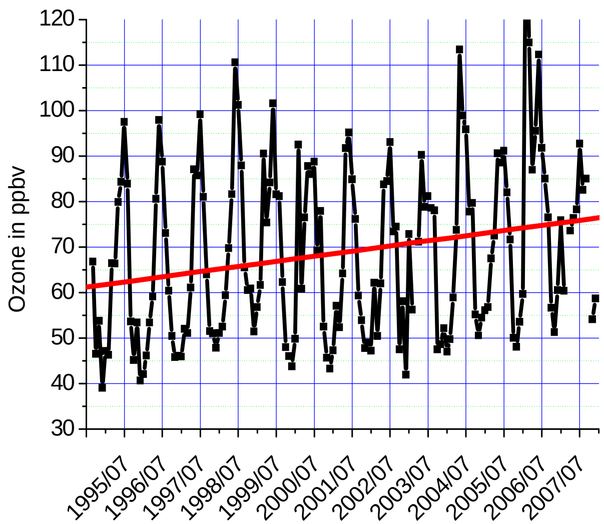
	Latitude range	Longitude range	Number of flights
1- US east	35°N - 50°N	90°W - 60°W	14 412 (5 203)
2 North Atlantic	50°N – 60°N	50°W – 20°W	10 703 (3 300)
3- EU west	45°N – 55°N	15°W – 15°E	22 935 (8 216)
4- West. Medit.	35°N – 45°N	5°W – 15°E	6 298 (2 657)
5- Black Sea	35°N – 45°N	25°E – 55°E	9 323 (3 097)
6- East Asia	40°N – 65°N	100°E – 140°E	5 472 (1 596)

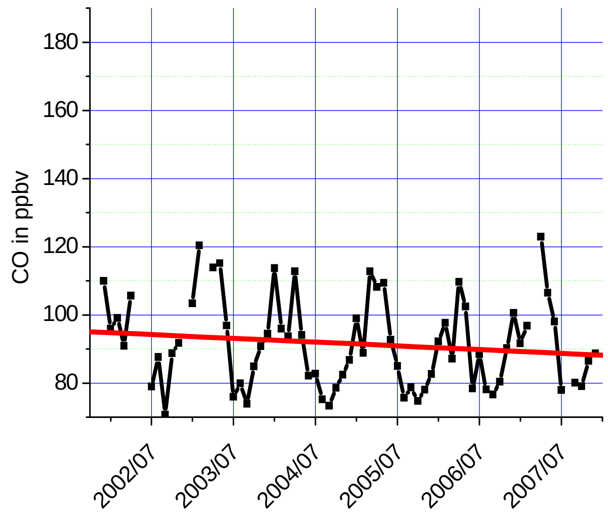
	O3	CO
USA East		
EU west		

Thouret et al.

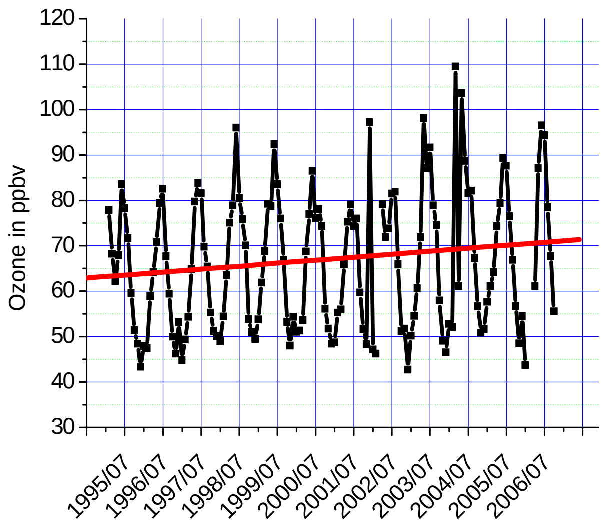
O3 | CO

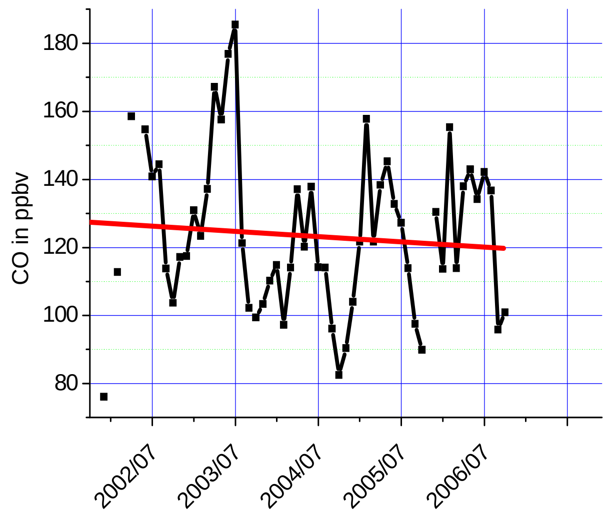
Black sea





East Asia





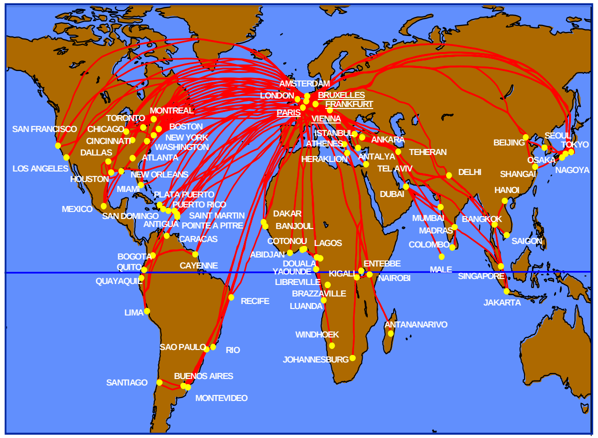
Thouret et al.

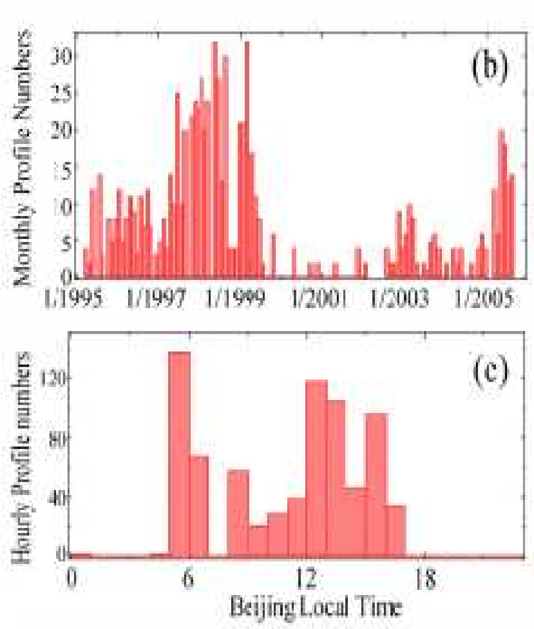
Interannual variabilities and first decennal trends over selected regions

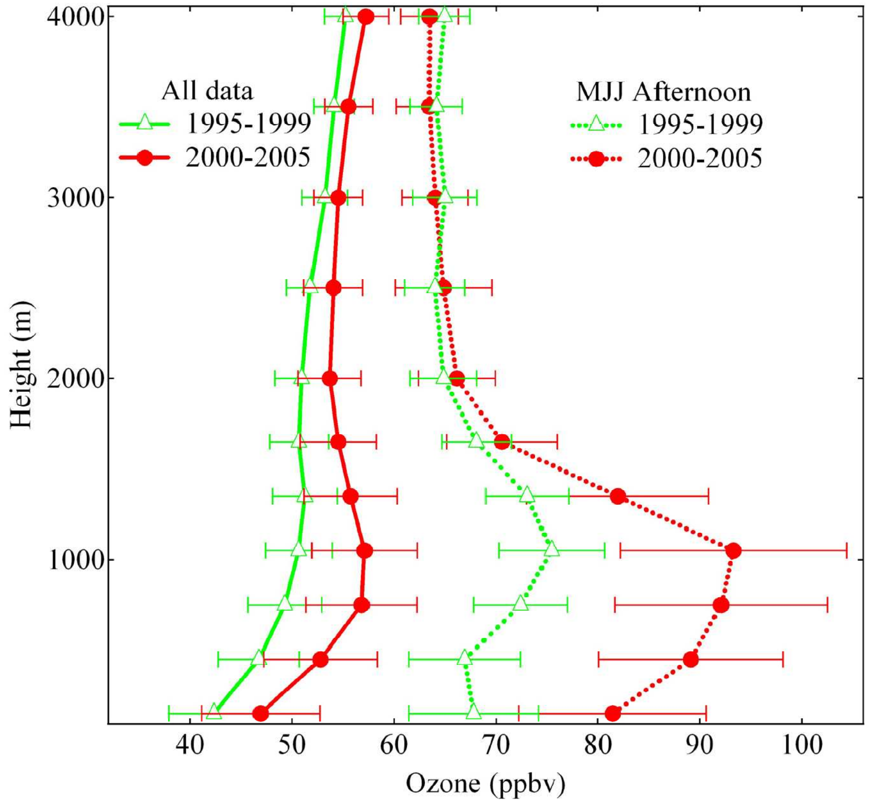
- **O3**
  - General increase in the UT : ~1%/yr
  - Largest increase over the Western Medit. and Black Sea
  - No significant signal in the LS
  - 1998-1999 anomalies still characterize the time series (influence of the strong El-Nino in 1997)
- **CO in the UT**
  - General decrease (even over Asia) : ~ -1%/yr
  - Largest decrease over USA East
  - Positive anomalies: 2002 (global, biomass burning), over Asia in 2003 and over Med West in 2007

Thouret et al.

Tropospheric ozone climatology over Beijing





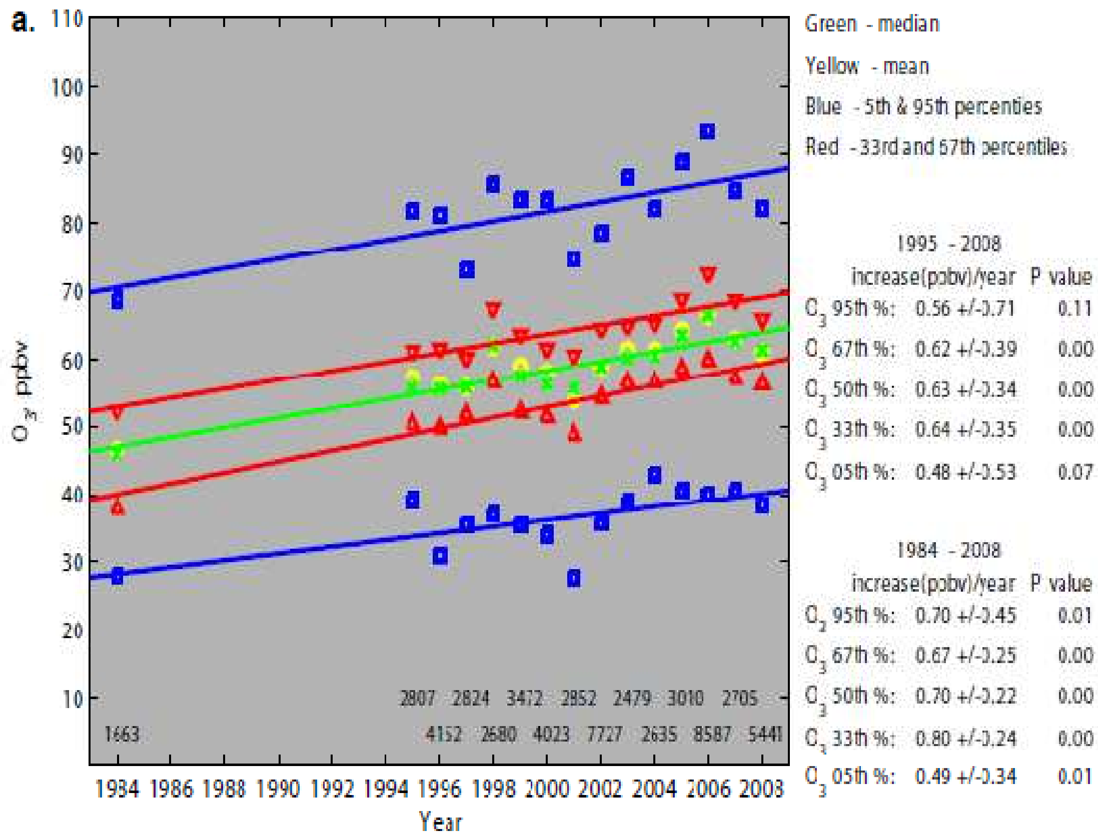


Comparisons of mean profiles O3 profiles in the lower troposphere over Beijing 1995-1999 and 2000-2005. The solid lines are annual mean values, and the dashed lines on the right hand side represent the data collected in summer afternoons at local times 15h-16h in May-June-July

Ding et al., ACP, 2008

Increasing ozone above western North America during springtime

Cooper et al., 2009, in revision



Median ozone values have a significant rate of increase of 0.63 ± 0.34 ppbv year-1.

Similar values are found for the 33rd and 67th percentiles while rates for the 95th and 5th percentiles are not significant

Plan

- How civil aviation can monitor climate and regional air quality ?
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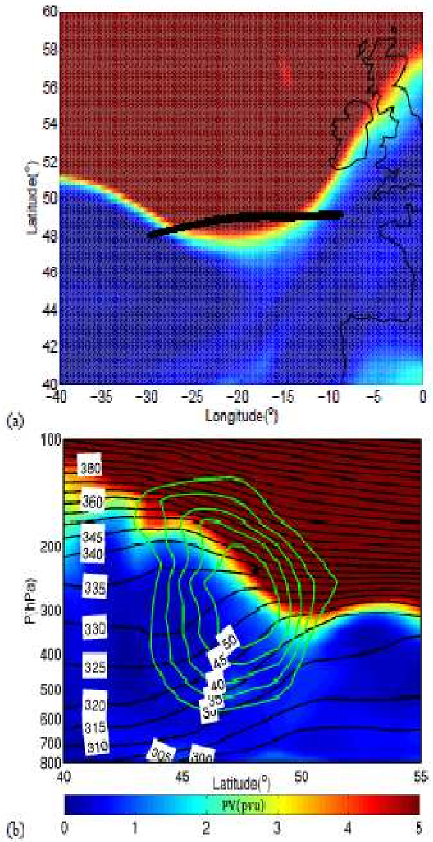
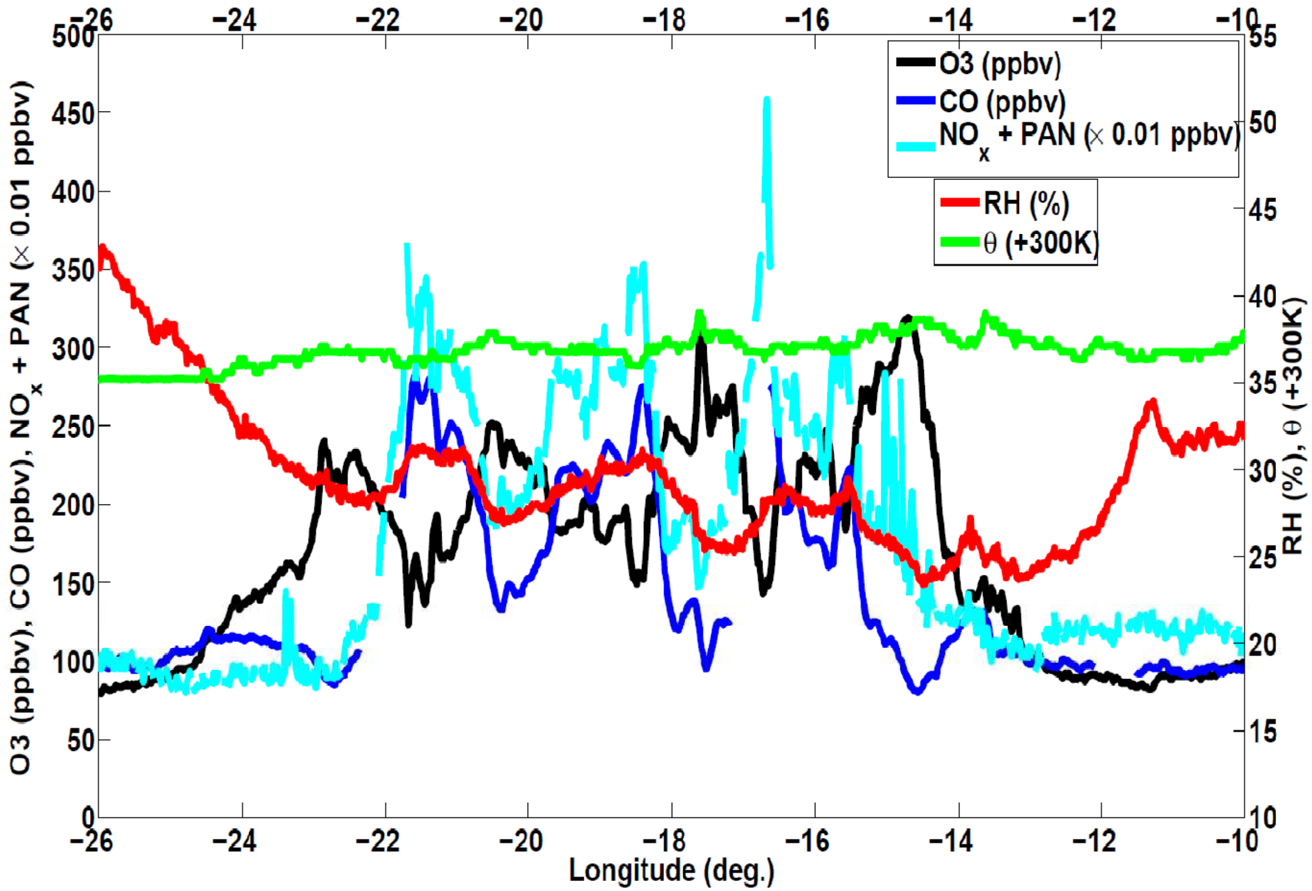
Injection in the lower stratosphere of biomass fire emissions followed by long-range transport: a MOZAIC case study

Cammas et al., ACP, 2009





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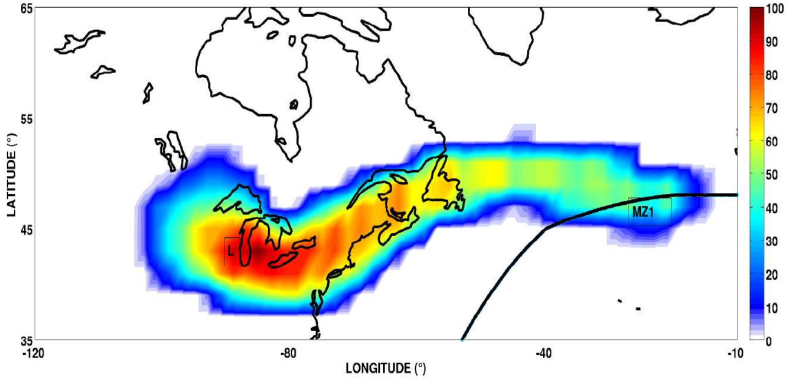
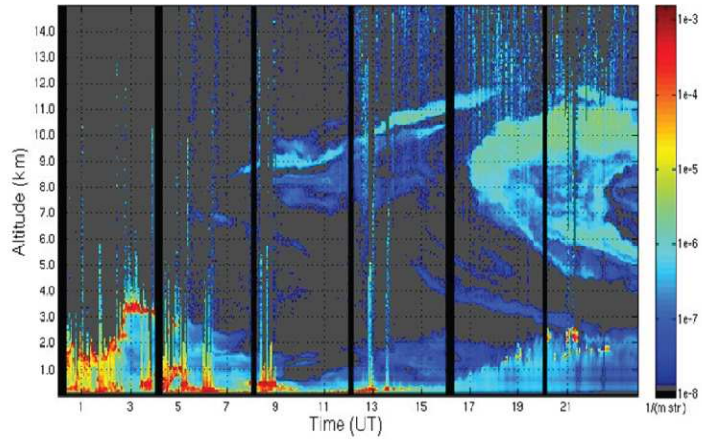
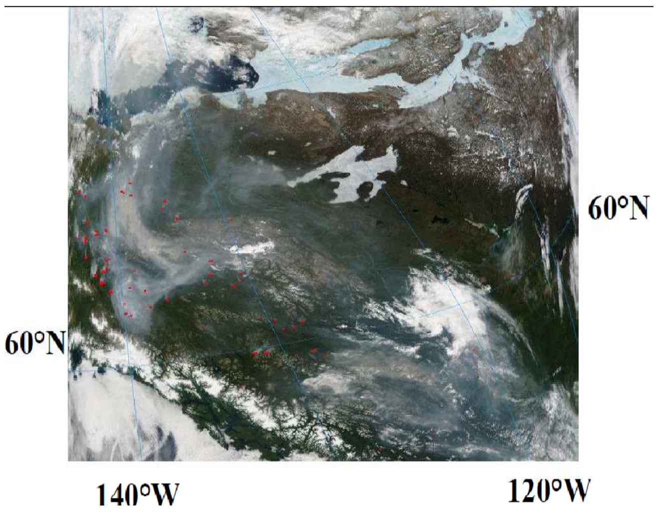


Backwards trajectories from the measurements along the flight track: residence times from Flexpart calculations



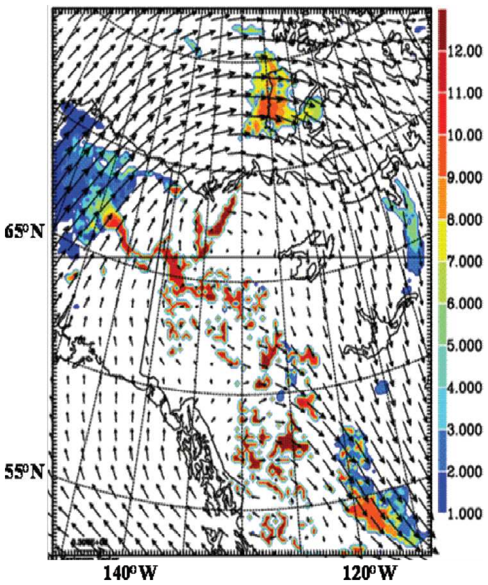
Lidar observations at Madison (University of Wiscousin): aerosol backscatter cross-section



MODIS image, June 24, 2004

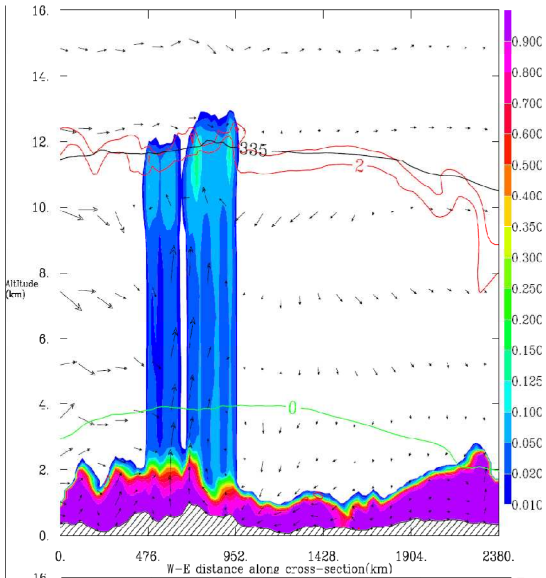
Injection in the lower stratosphere of biomass fire emissions followed by long-range transport: a MOZAIC case study

Cammas et al., ACP, 2009

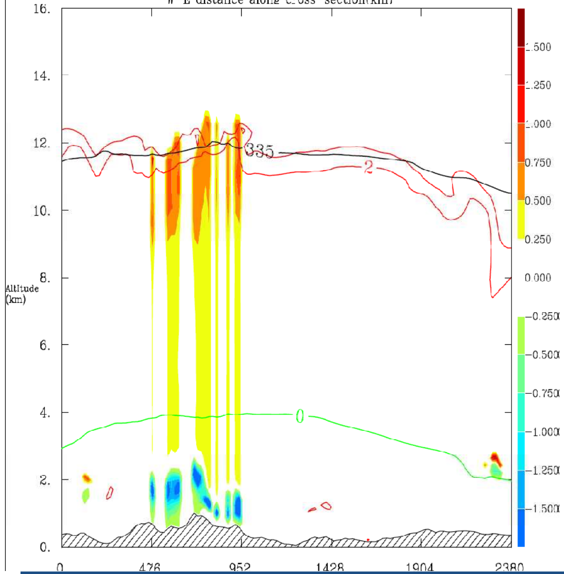


Meso-scale model simulation (Meso-NH):

Height of convective cloud tops (km)



Vertical cross-section: boundary layer tracer concentration (%)



Vertical cross-section: Indicator of the characteristic time for convective mass fluxes to exchange air at the root and the top of updraft and downdraft

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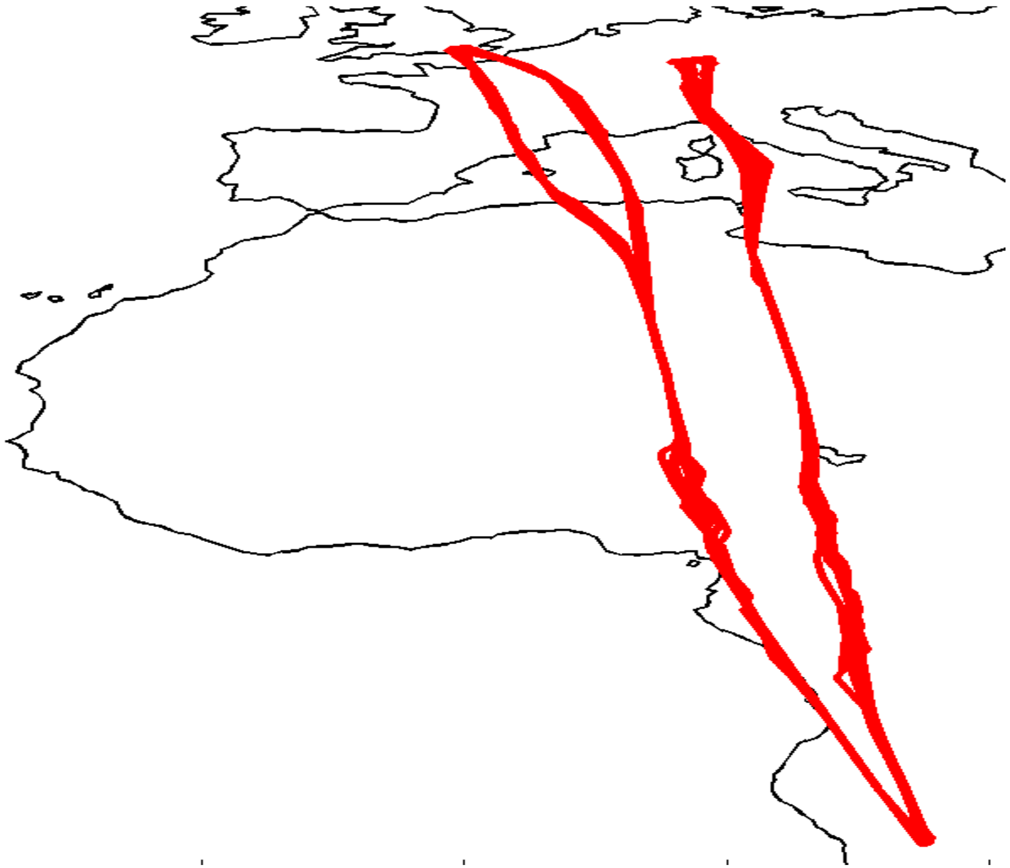
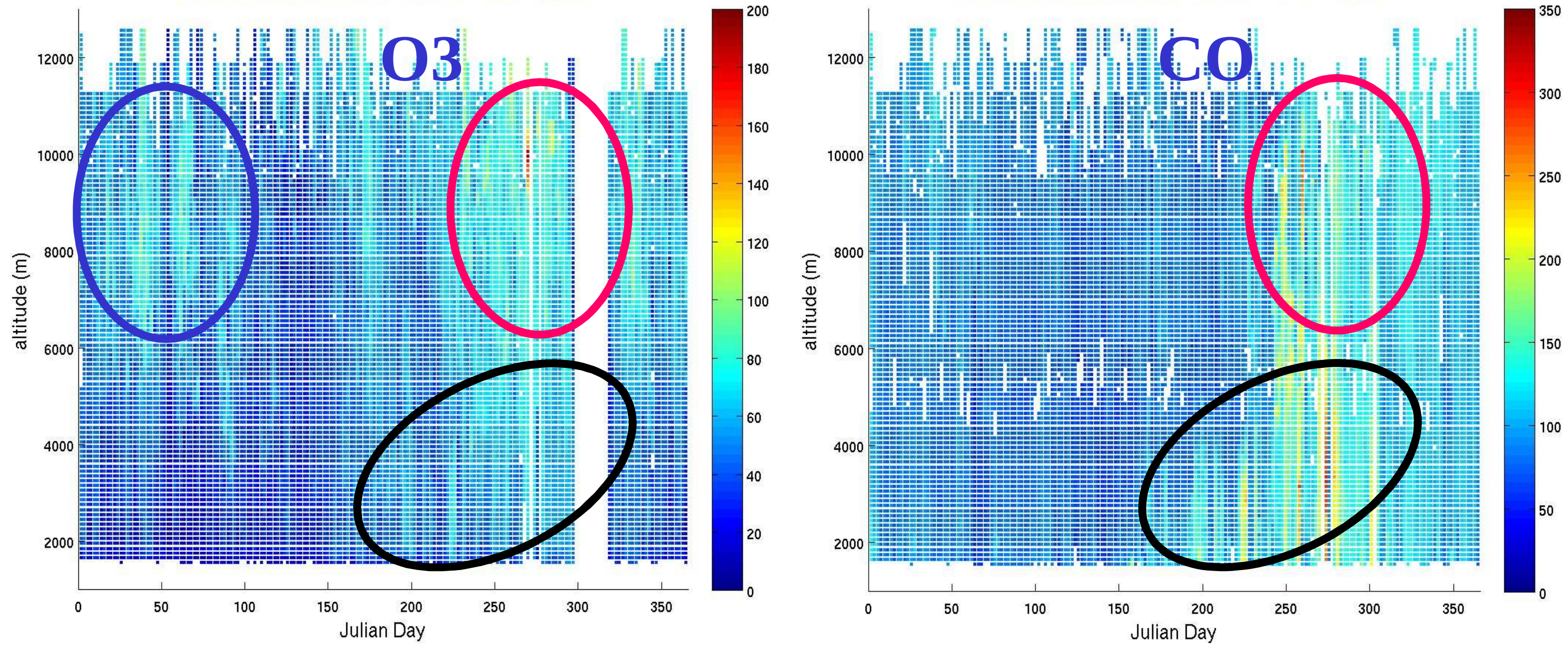
MOZAIC over Africa

Air Namibia is operating a MOZAIC-equipped aircraft since January 2006 with flights every day between Windhoek and Frankfurt or London



Main processes involved in the tropospheric ozone budget over austral Africa: work in progress

Time series of vertical profiles – Windhoek, 2006



Lower troposphere: moderate O3 production in CO plumes during spring : transport of biomass burning plumes from over austral Africa

Upper troposphere: strong O3 production in CO plumes during spring: transport of biomass burning plumes from over South America and embedded stratospheric ozone-rich intrusions

Moderate to strong O3 production associated with plumes enriched with lightning-NOx emissions by convective clouds over Austral Africa and/or South America

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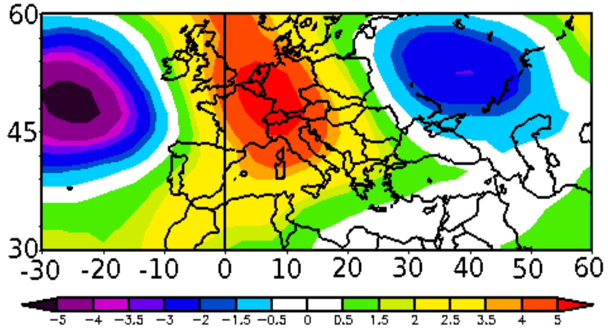
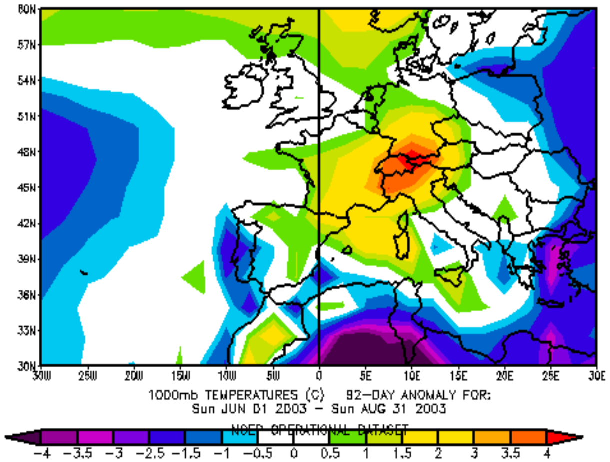
European heat wave during summer 2003

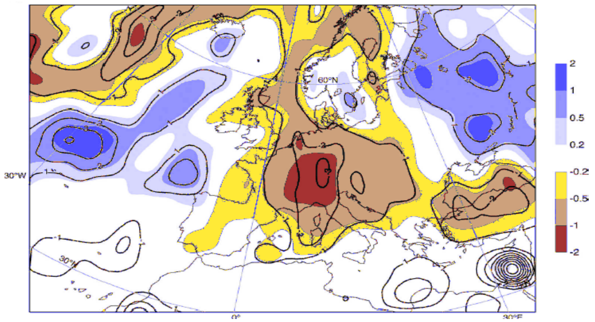
500hPa geopotentiel anomaly JJA (dam)



Surface temperature anomaly JJA (°C)



Precipitation anomaly JJA (mm/day)



Factors favorable for ozone pollution (e.g., Vautard et al., 2005 ; Solberg et al., 2008 ; Tressol et al., 2008):

- anticyclonic blocking: increased temperature, increased solar radiation, extended residence time of air parcels in the Planetary Boundary Layer

- deficit of precipitation and increased biogenic emissions

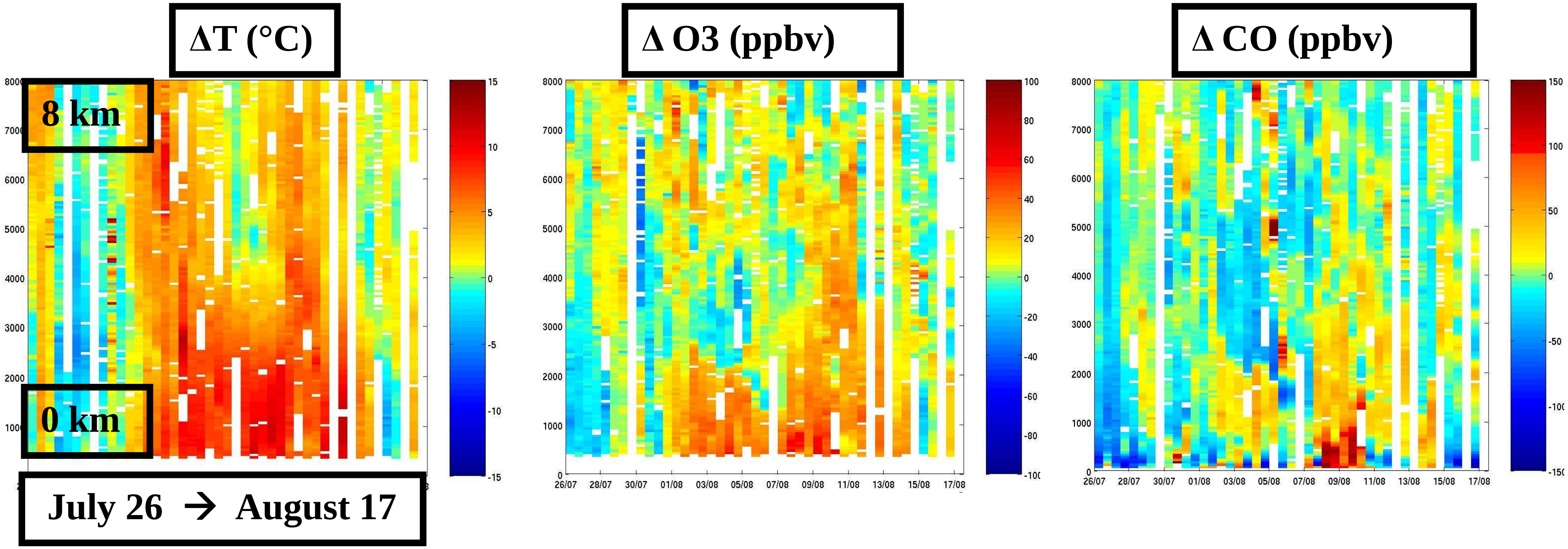
- less efficient dry ozone deposition

- strong development of the PBL (positive feedback between the deficit of precipitation, soil water loss and cloud cover)

European heat wave during summer 2003

MOZAIC provided data from aircraft based in Frankfurt (3), Paris (1), and Vienna (1)

Frankfurt observations of anomalies (Tressol et al., ACP, 2008)

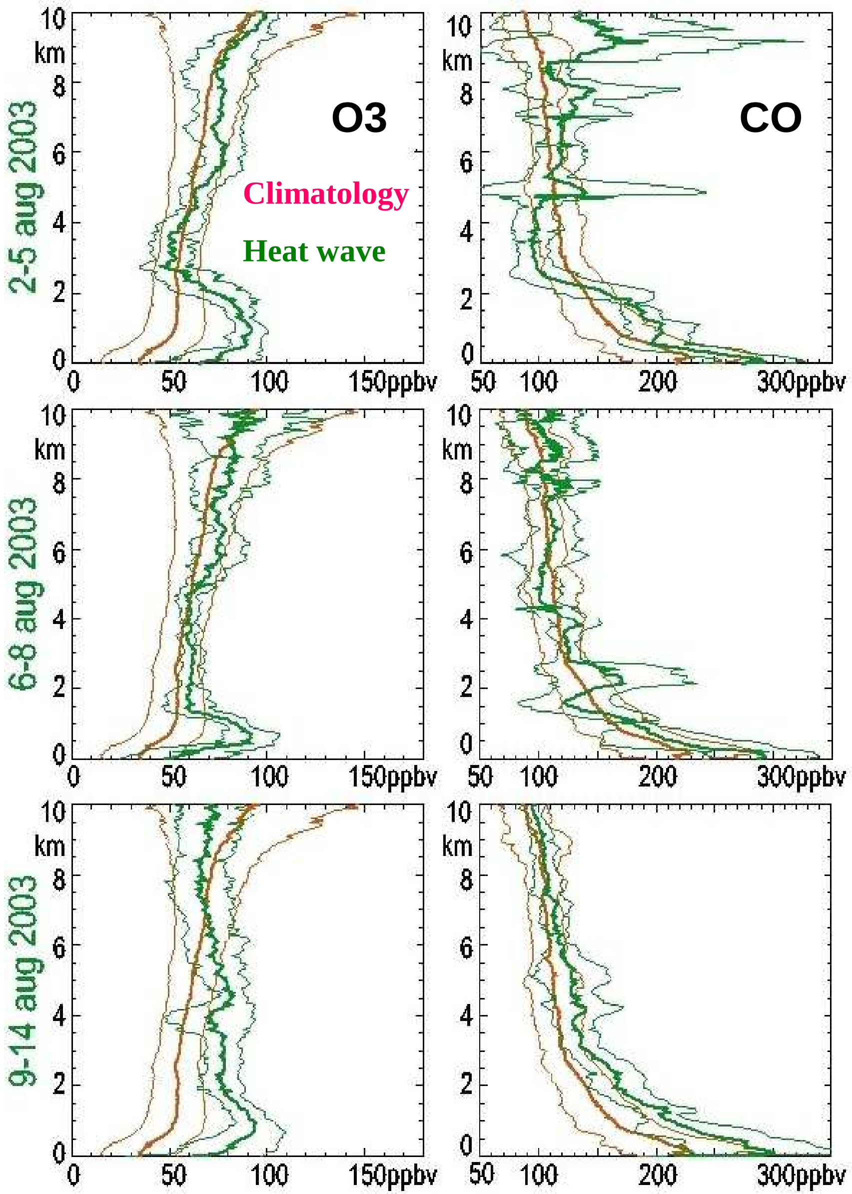


Regional air quality monitoring with MOZAIC:

In Frankfurt and Paris, large anomalies of ozone (ΔO3 > 60 ppbv) and carbon monoxide (ΔCO > 100 ppbv) were lying inside the Planetary Boundary Layer.

In Vienna, anomalies were only observed when the heat wave disperses eastwards

European heat wave during summer 2003



Regional Air Quality monitoring in Frankfurt with MOZAIC:

-Intensities of O3 and CO anomalies exceed the standard deviation of the climatology

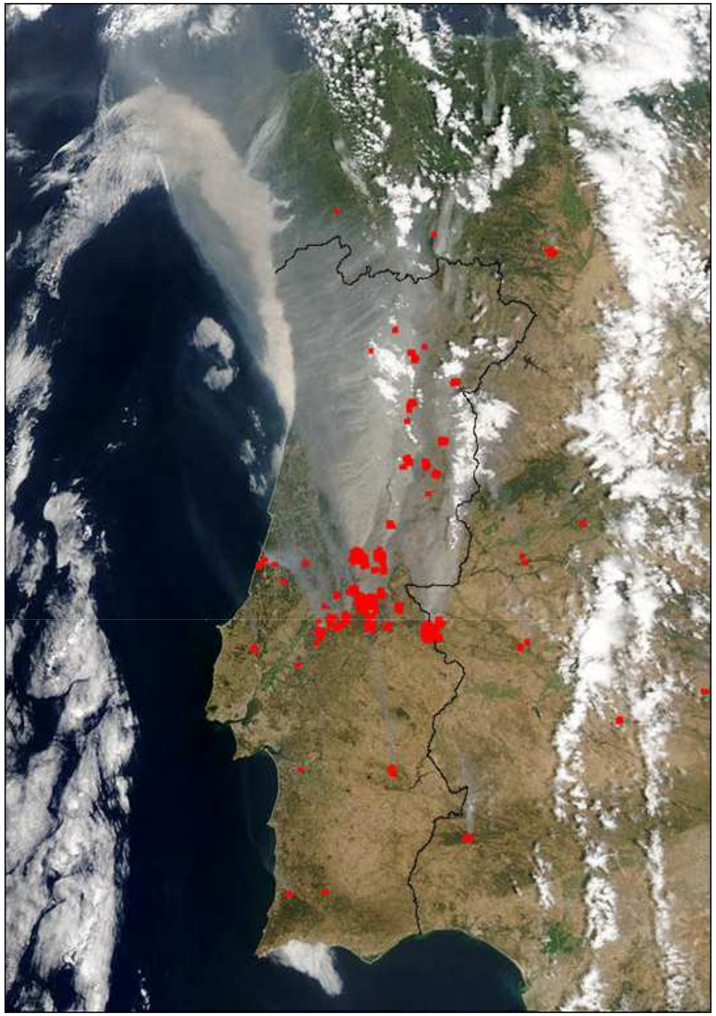
- thickness of O3 and CO anomalies are as large as the height of the PBL and follow the modifications of height of the PBL (e.g. lower thickness during the passage of a weak surface low)

- many plumes of biomass fires coming from Portugal, at first in the upper troposphere, then descending in the middle to lower troposphere, and finishing down into the PBL

Impact of plumes of biomass fire on the regional air quality over Frankfurt ?

(Tressol et al., ACP, 2008)

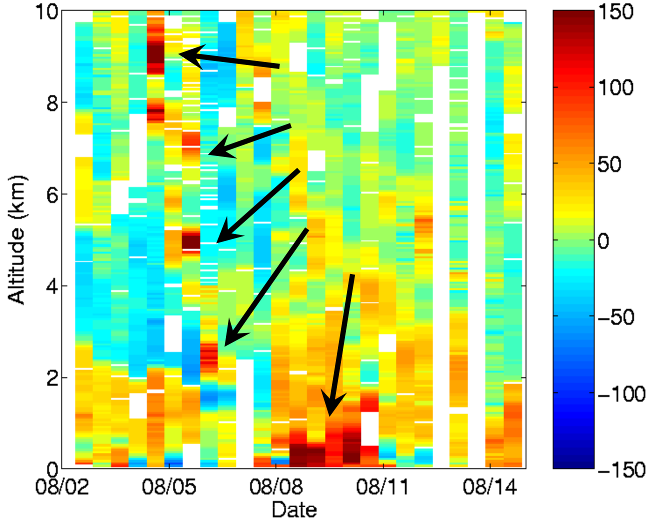
European heat wave during summer 2003



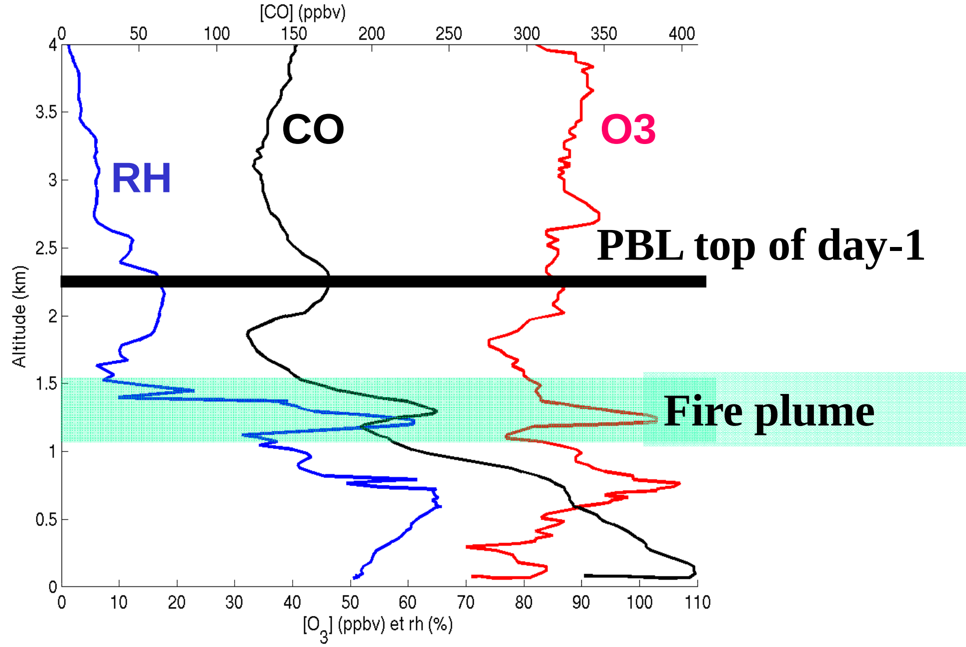
MODIS image over Portugal during the heat wave.

CO emissions by biomass fires over Portugal from July 29 to August 15 have exceeded 1.63 Tg. Biomass fire plumes have spreaded over most western Europe

European heat wave during summer 2003



Anomalies of CO in the MOZAIC times series over Frankfurt



MOZAIC profile over Frankfurt, 2003/08/10, early morning

- Plumes of biomass fires coming from Portugal arrived first in the upper troposphere over Frankfurt, then descend in the middle to lower troposphere, and finish down to mix into the Planetary Boundary Layer

- Problem: Up-to-date global chemistry transport models are in their first faltering steps to provide such informations to initialize and to run regional air quality models (boundary limits).

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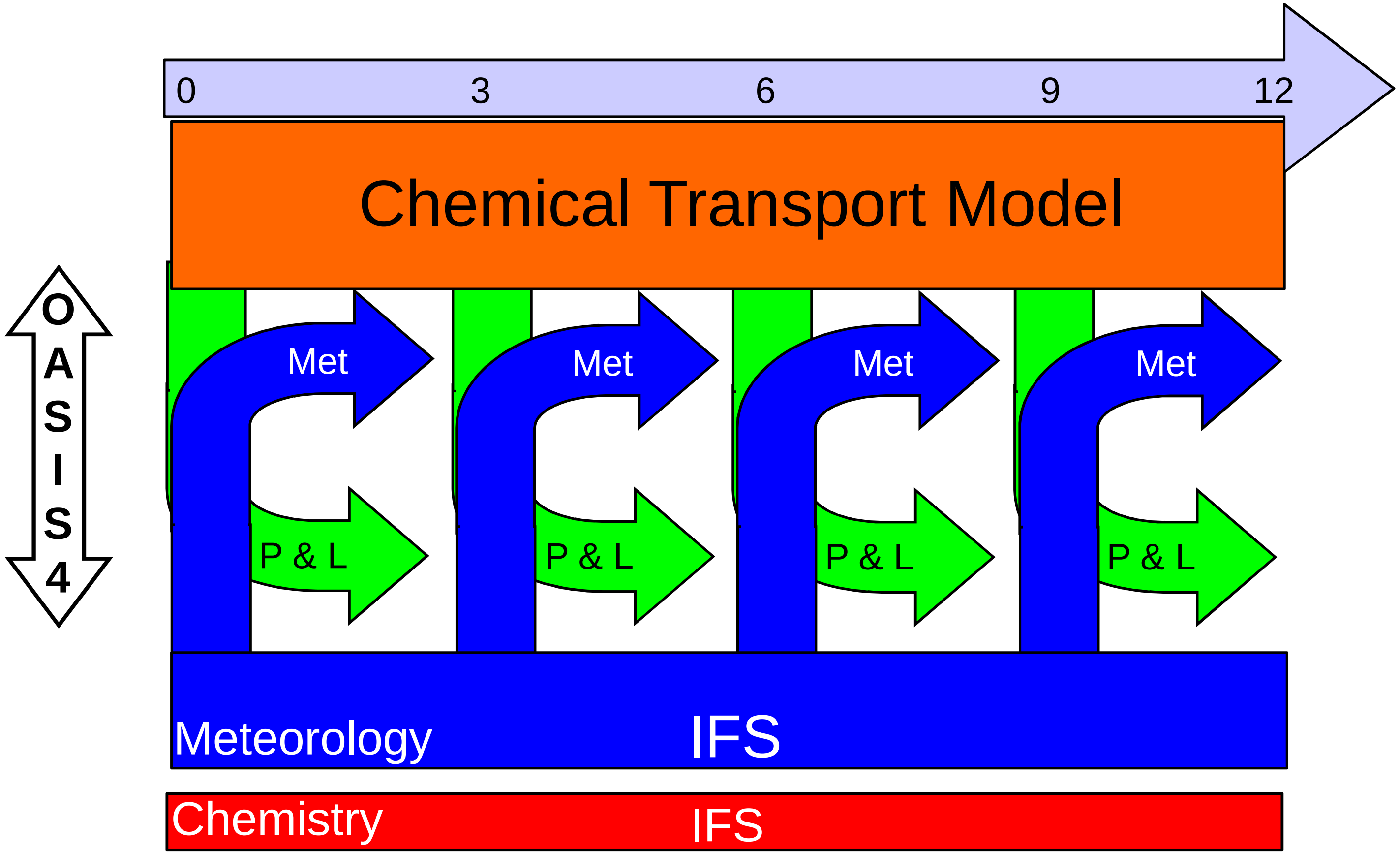
GEMS

Global and regional Earth-system Monitoring using Satellite and in-situ data

An EC FP6 Integrated Project, developing:

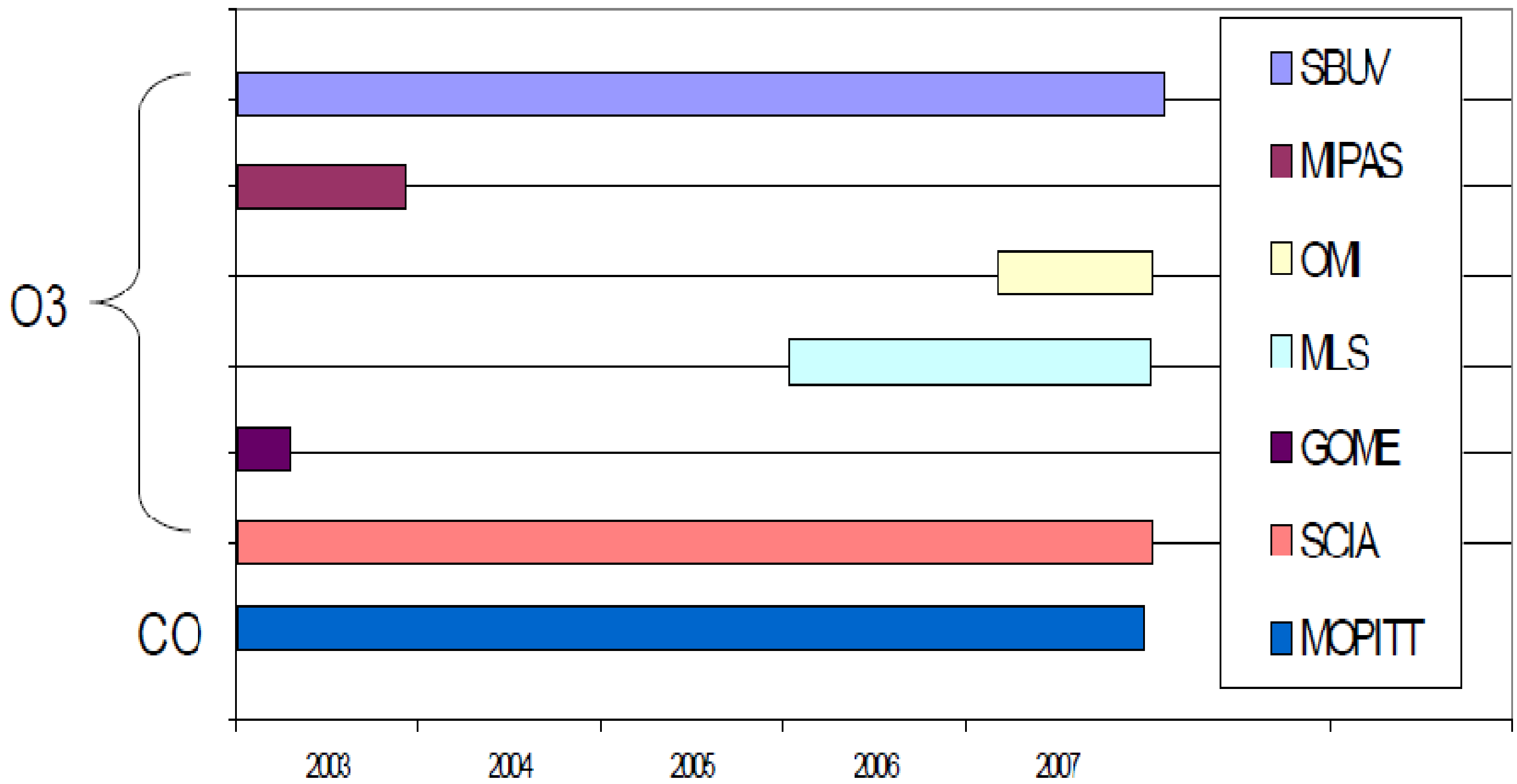
- global modelling and data assimilation for greenhouse gases, reactive gases and aerosols
- a global production system, including surface-flux estimation
- collaborative regional modelling, data assimilation and forecasting of air quality for the European domain

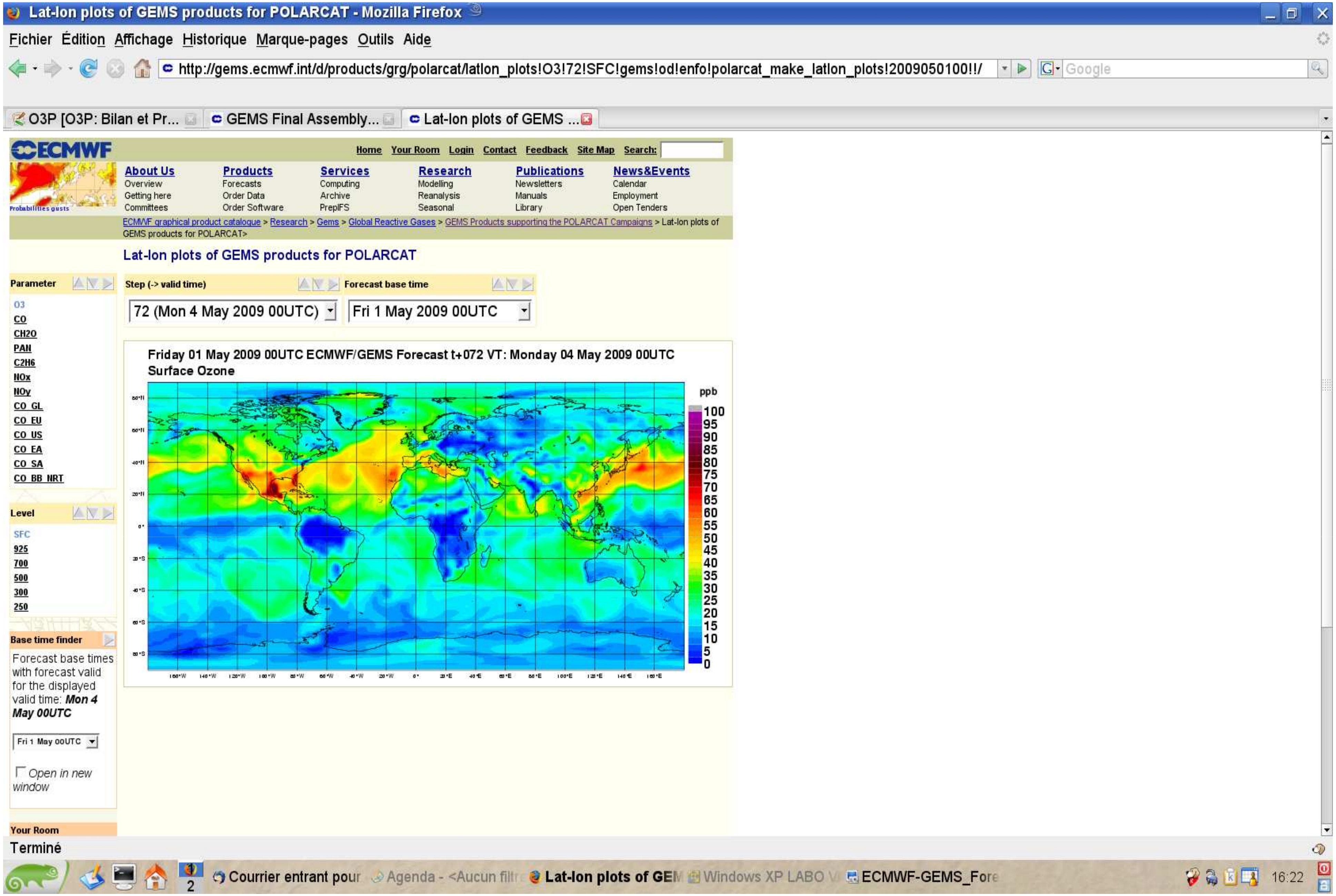
Development of a coupled reactive-gas forecasting system with 4D-Var assimilation of satellite products



3 CTMs: MOZART, TM5 and MOCAGE
MOZART chosen for data assimilation with coupled system

O3 and CO satellite data assimilation in GEMS-GRG Reanalysis 2003-2007




Lat-lon plots of GEMS products for POLARCAT - Mozilla Firefox
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GEMS Final Assembly...
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ECMWF graphical product catalogue > Research > Gems > Global Reactive Gases > GEMS Products supporting the POLARCAT Campaigns > Lat-lon plots of GEMS products for POLARCAT>
Lat-lon plots of GEMS products for POLARCAT
Parameter
O3
CO
CH2O
PAN
C2H6
NOx
NOy
CO_GL
CO_EU
CO_US
CO_EA
CO_SA
CO_BB_NRT
Step (-> valid time)
72 (Mon 4 May 2009 00UTC)
Forecast base time
Fri 1 May 2009 00UTC
Friday 01 May 2009 00UTC ECMWF/GEMS Forecast t+072 VT: Monday 04 May 2009 00UTC
Surface Ozone
ppb
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90
85
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75
70
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Level
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Base time finder
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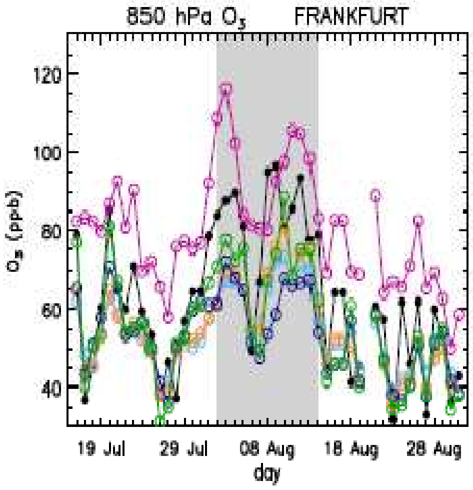
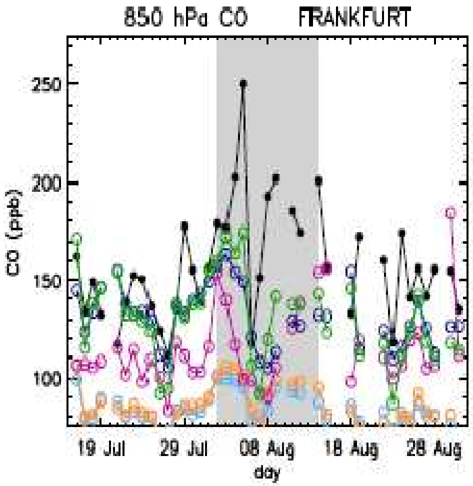
European heat wave during summer 2003
Ordonez et al., ACPD, 2009

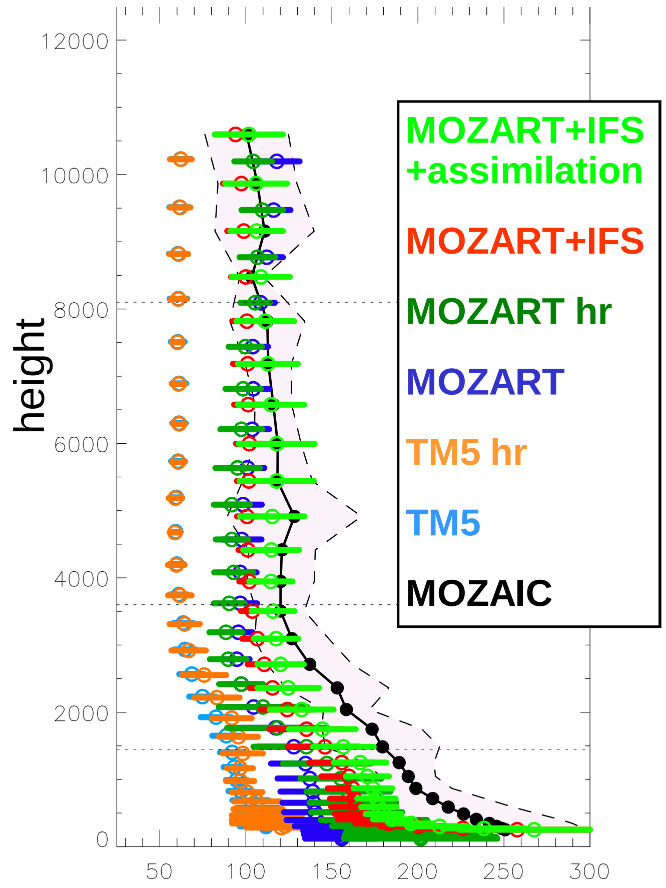




CTMs only vs MOZAIC

- MOCAGE
- MOZART hr
- MOZART
- TM5 hr
- TM5

CTMs + coupled system vs MOZAIC



GEMS

The 2003 summer heat wave is not yet matched by up-to-date global chemistry transport models. To take into account the impact of the long-range transport of pollution on regional air quality, routine aircraft data and progresses in data assimilation are needed.

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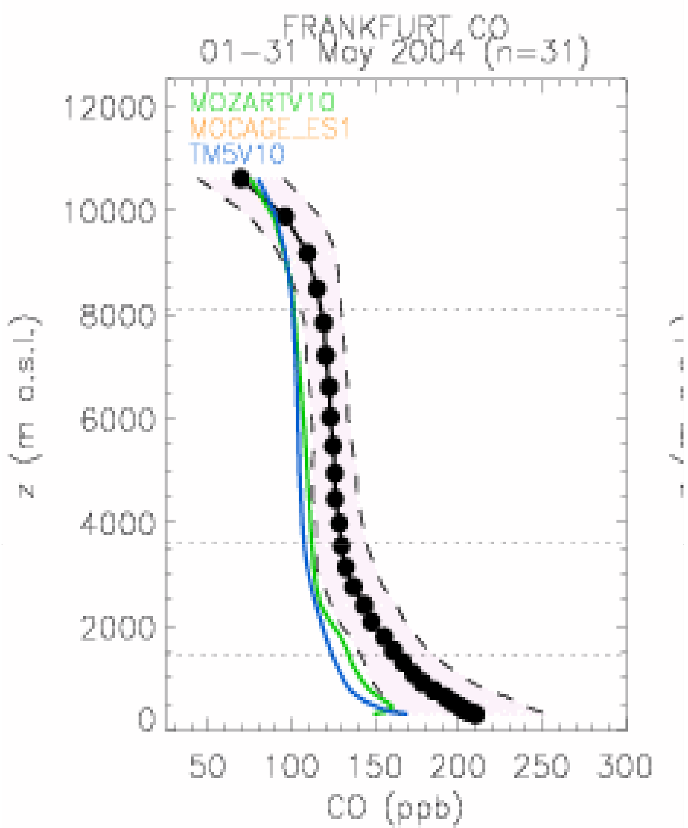
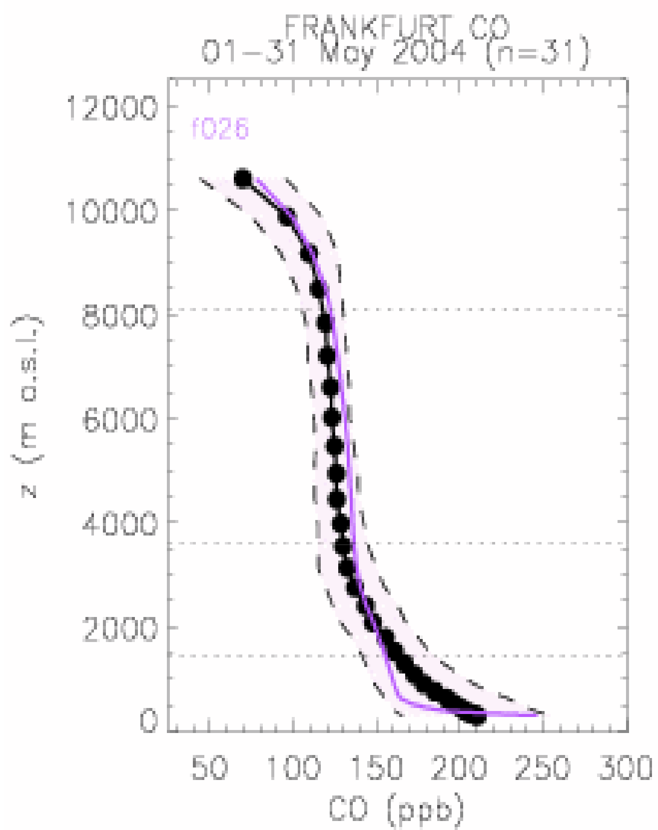
IAGOS

FRANKFURT May 2004 – MOZAIC CO profiles

CTMs



IFS coupled system

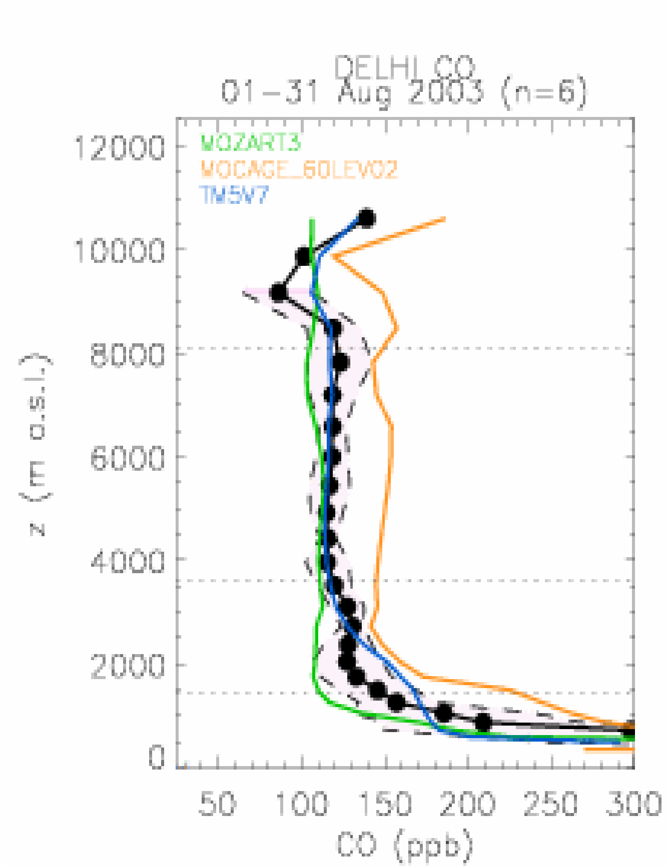


Assimilation for May 2004 of MOPITT tropospheric CO columns improves fit of tropospheric CO profiles to MOZAIC data in Frankfurt

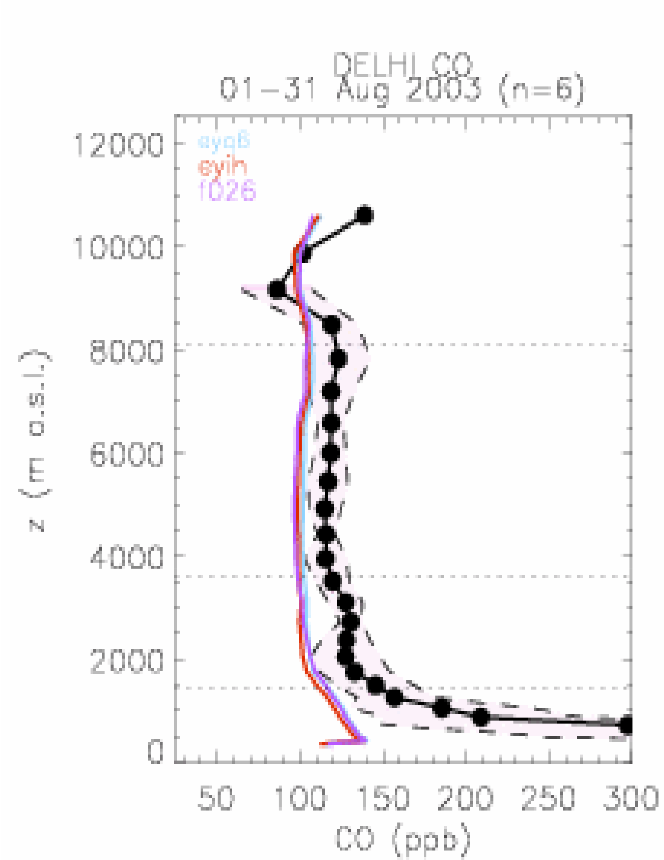
cnrs Université de Toulouse JÜLICH FORSCHUNGSZENTRUM IAGOS

DEHLI August 2003 – MOZAIC CO profiles

CTMs



IFS coupled system



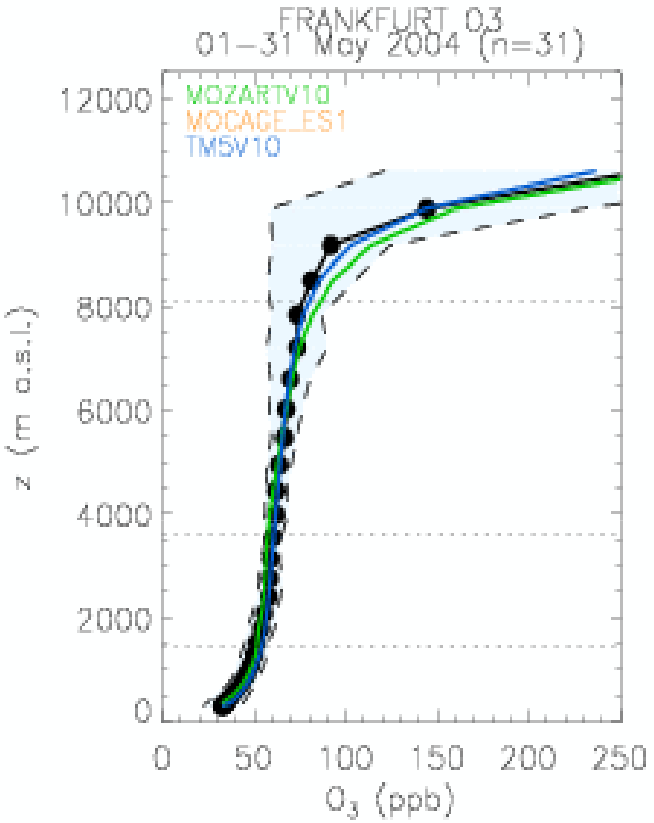
Assimilation for August 2003 of MOPITT tropospheric CO columns does not improve fit of tropospheric CO profiles to MOZAIC data in Dehli

Université de Toulouse

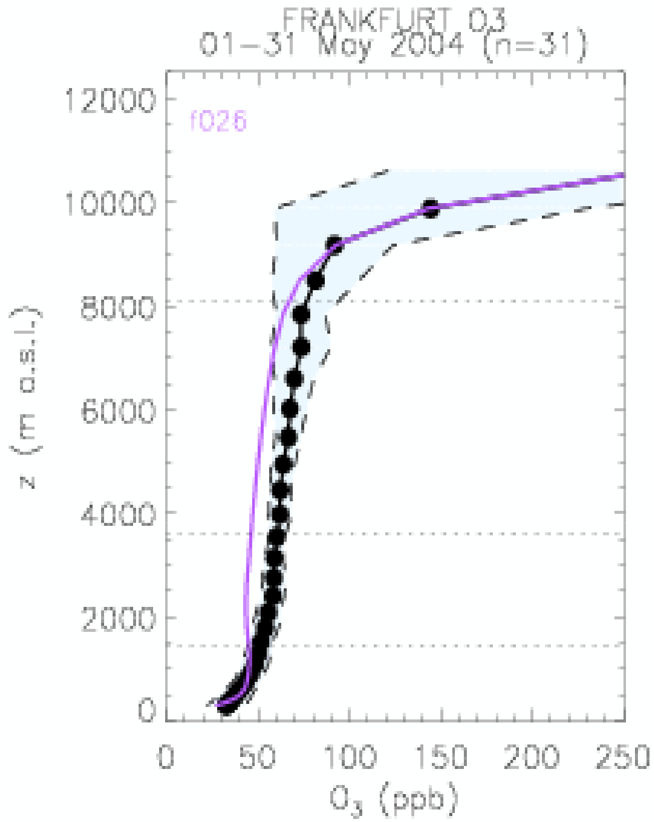
JÜLICH FORSCHUNGSZENTRUM

FRANKFURT May 2004 – MOZAIC O3 profiles

CTMs



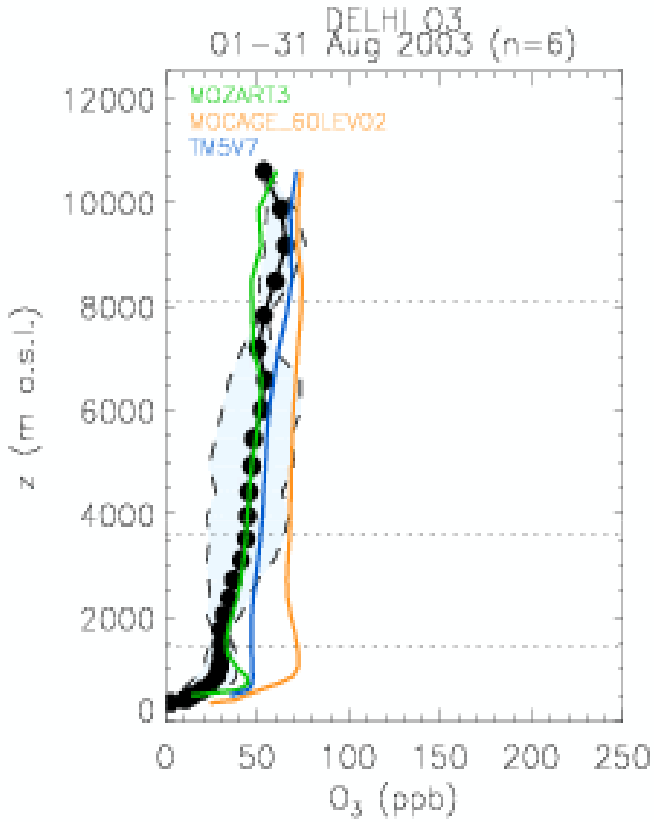
IFS coupled system



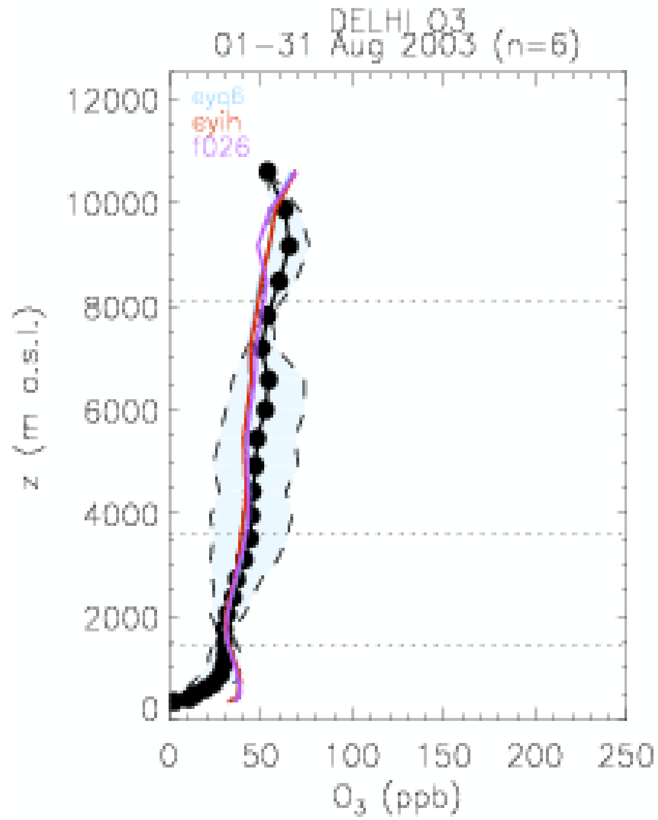
Assimilation for May 2004 of O3 satellite retrievals (SCIAMACHY, MIPAS, SBUV, and GOME) does not improve fit of tropospheric O3 profiles to MOZAIC data in Frankfurt

DEHLI August 2003 – MOZAIC O3 profiles

CTMs



IFS coupled system



Assimilation for August 2003 of O3 satellite retrievals (SCIAMACHY, MIPAS, SBUV, and GOME) improves fit of tropospheric O3 profiles to MOZAIC data in Dehli

Conclusions

Civil aviation is an excellent, cost effective platform for air quality and climate research by providing high quality observations throughout the atmosphere, on a scale and in numbers impossible to achieve using research aircraft, and where other measurement methods (e.g., satellites) have technical limitations.

The success of MOZAIC (1994-2009) has grown on the value of such in-service aircraft data. Although it is a climate-minded program, applications to regional air quality are numerous because of the sparsity of existing regular observations and of the impact of long-range transport of the pollution.

IAGOS is taking over MOZAIC, with the perspective to become a long-lasting infrastructure for monitoring the atmosphere. A better equipment will be available for monitoring the climate regional air quality (backscatter cloud probe, aerosols, greenhouse gases). IAGOS is looking forward to a successful cooperation with Airlines and the scientific community.

Technology transfer from IAGOS to other infrastructures would be valuable (mountain stations, high speed trains, …).

How can I access to the MOZAIC-IAGOS data base?

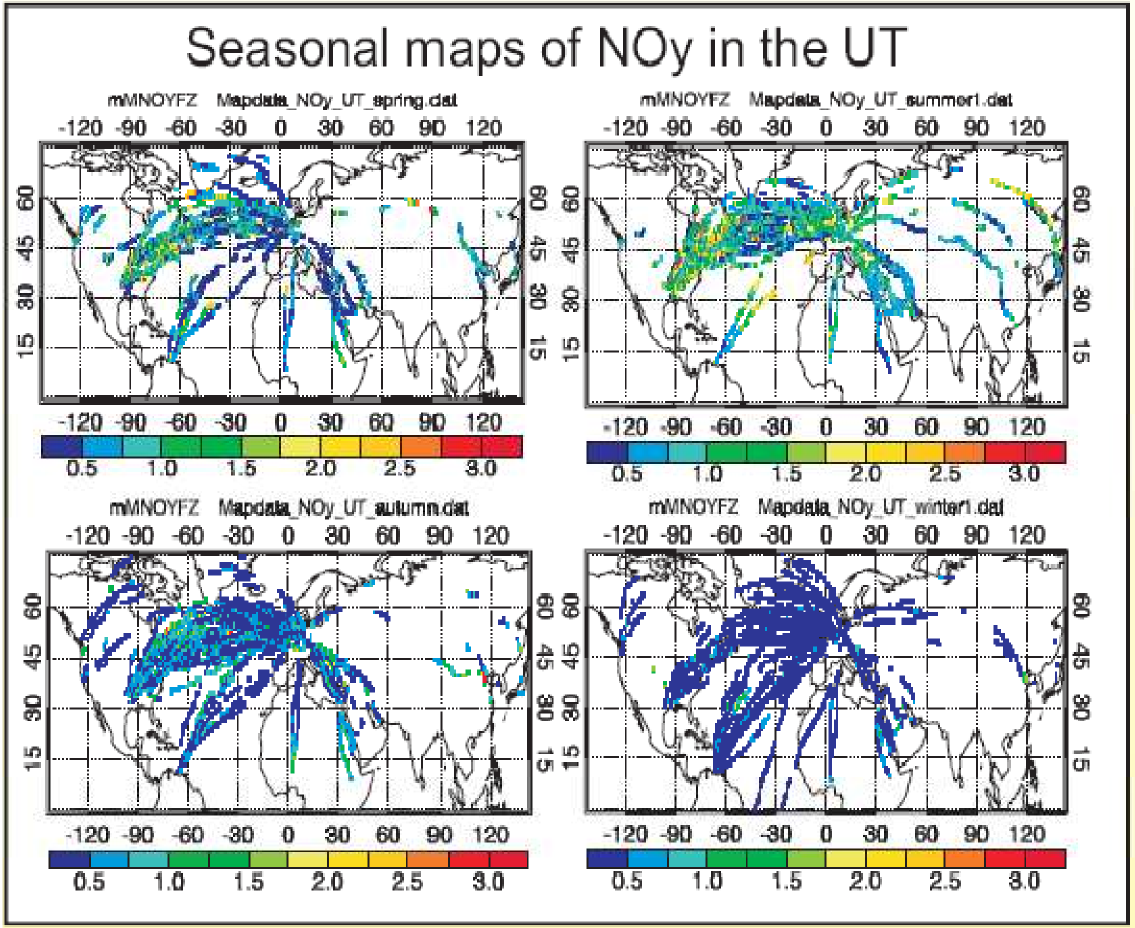
1) Describe your project using MOZAIC-IAGOS data and fill in the form available at:
   http://mozaic.aero.obs-mip.fr/web/features/database/access.html

2) Sign the data protocol with co-authorship offered to the PIs

3) Get access to the web interface with login/password at:
   http://mozaic.aero.obs-mip.fr/extract/

The MOZAIC data base is supported by ETHER (Thematic Action Centre from CNES and INSU-CNRS)
http://davis.ipsl.jussieu.fr/

MOZAIC NOy measurements in the UT



Uplift of PBL-polluted air by deep convection & warm conveyor belts ; Lightning contribution (LiNOx)

Volz-Thomas et al., 2009 (in preparation)