IAGOS - CARIBIC - Nitrogen oxides measurements

H. Ziereis, G. Stratmann, P. Stock, S. Matthes, P. Jöckel, K. Gottschaldt

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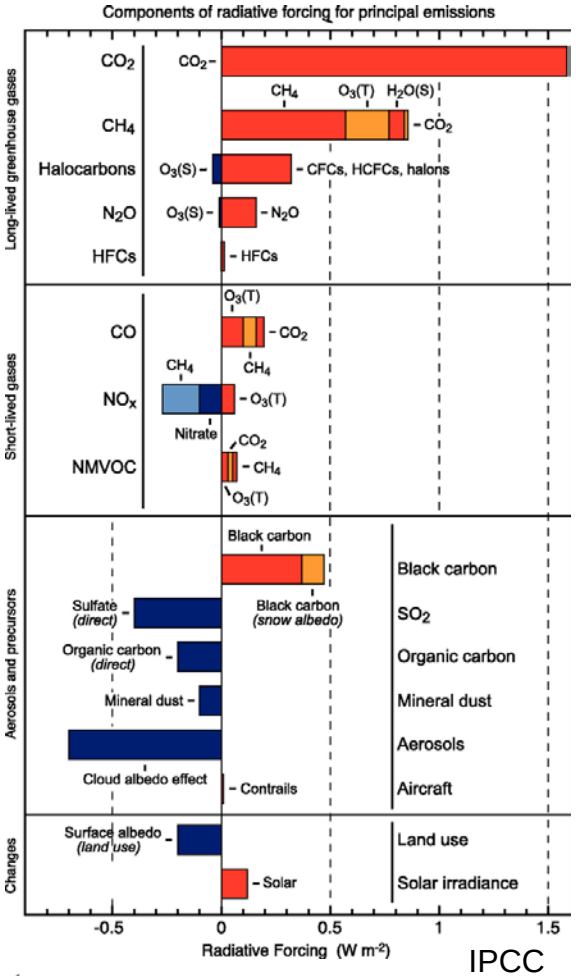
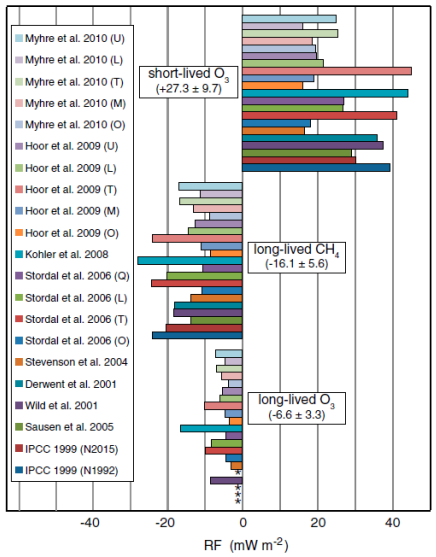
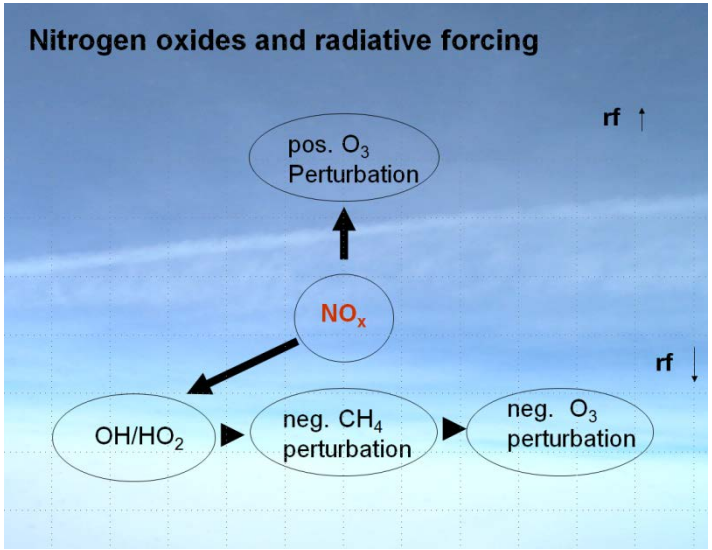
Radiative Forcing
Nitrogen oxides impact on O_3 and CH_4



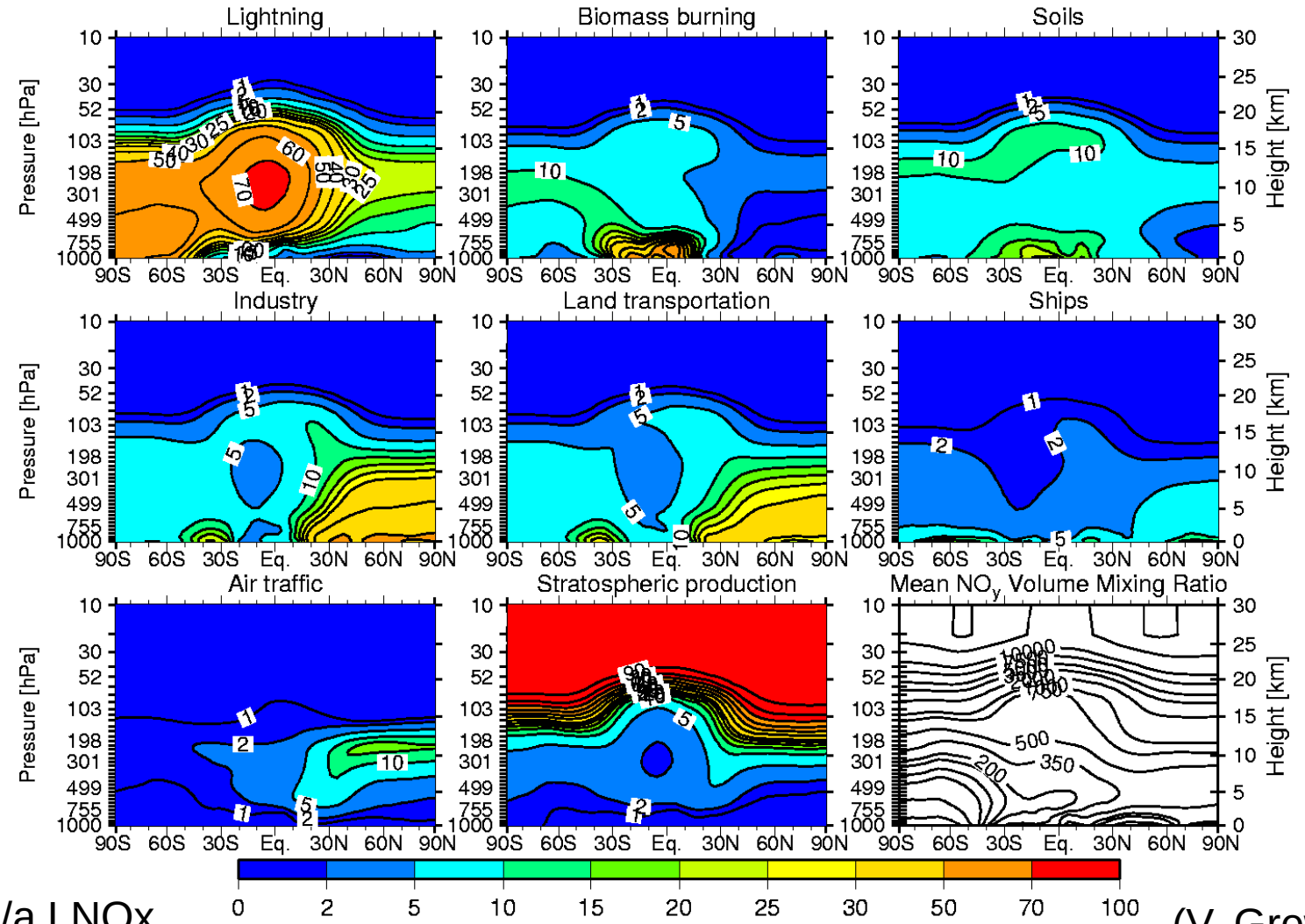
IPCC



Holmes et al., 2011



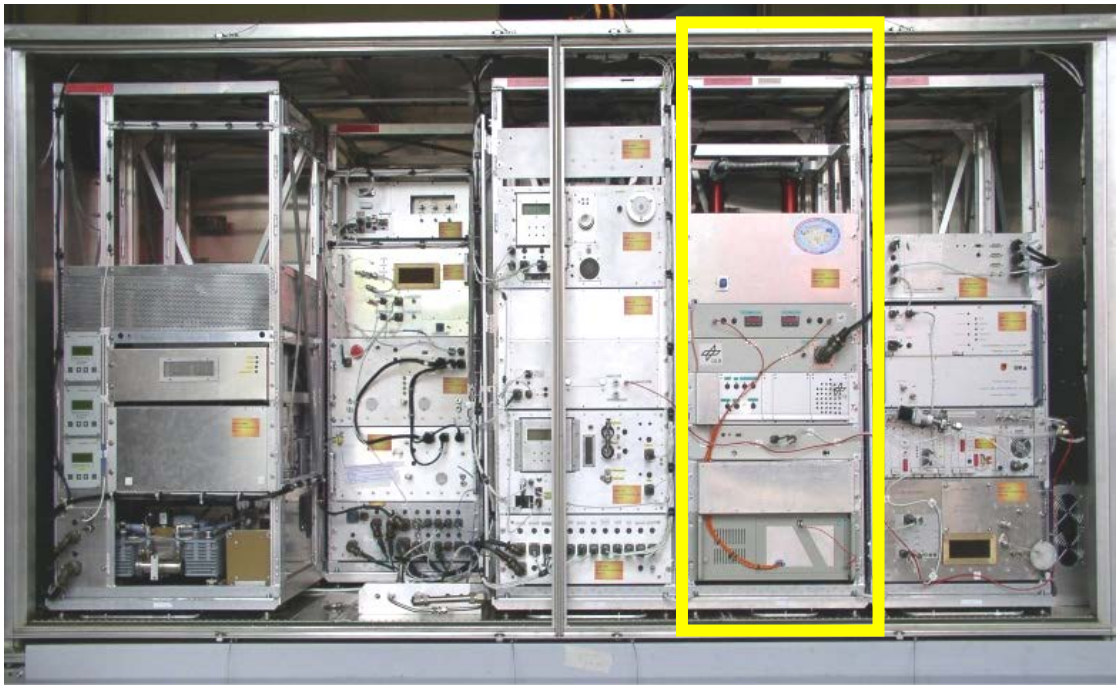
Sources that control the NO_y distribution



for 5 Tg/a LNOx

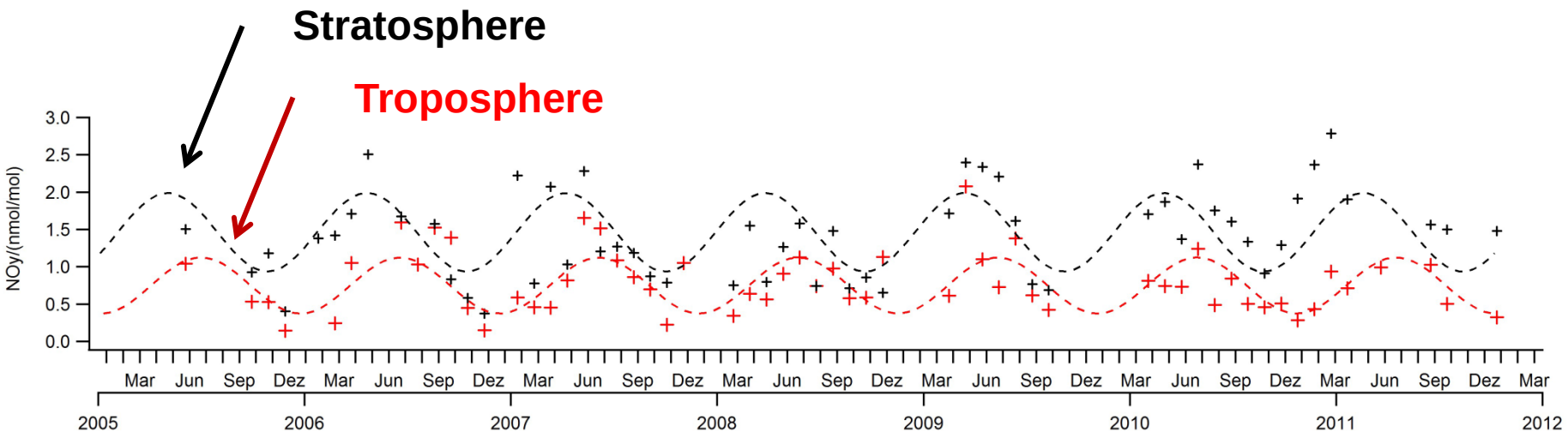
(V. Grewe, 2007)

Measurement of NO, (NO_2), NO_y since 2002 (CARIBIC-1)



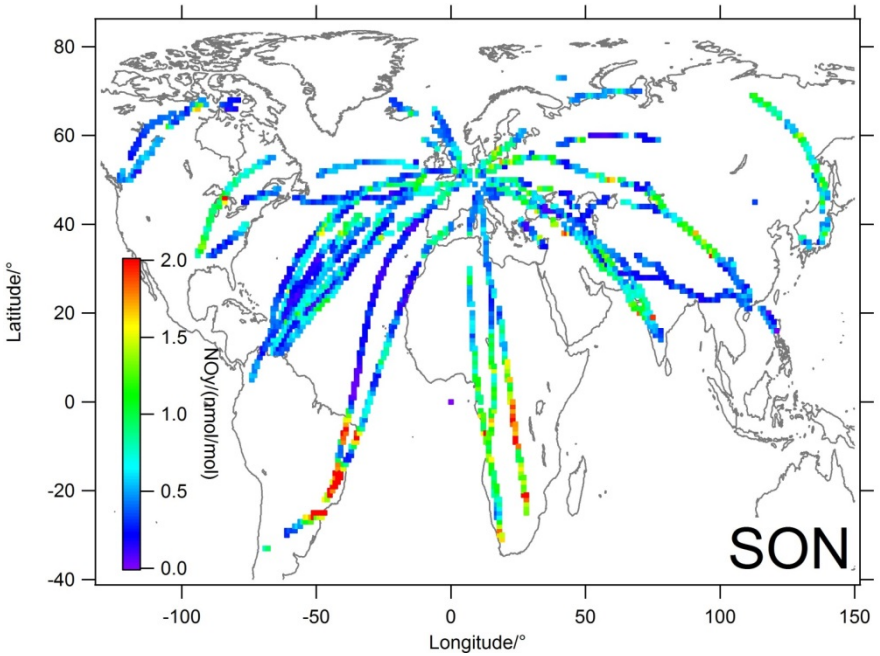
Similar instruments are operated on board of other research aircraft:
HALO, Geophysica, D-CMET

IAGOS-CARIBIC NO_y seasonality



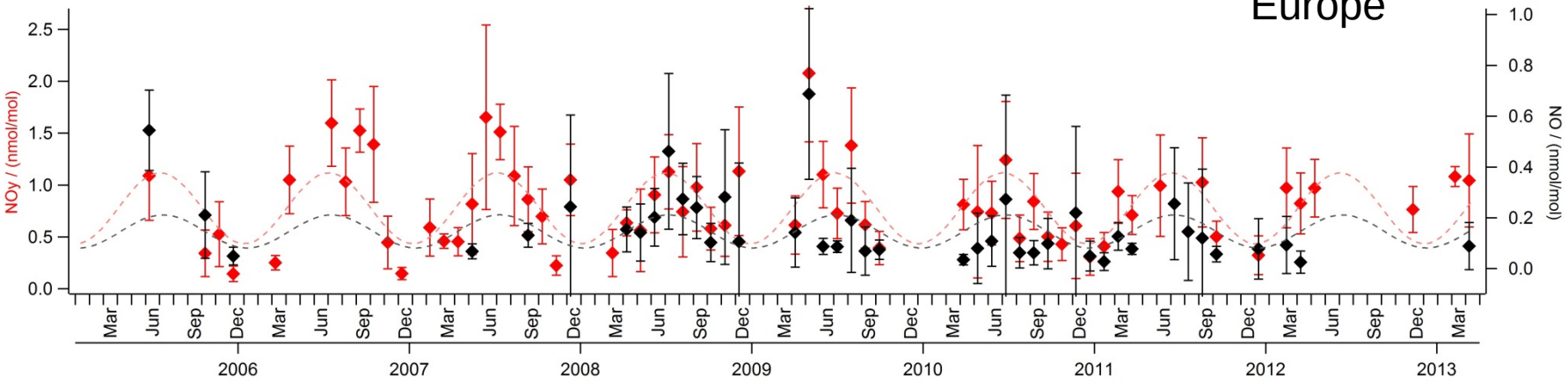
Seasonality in the UTLS over Europe

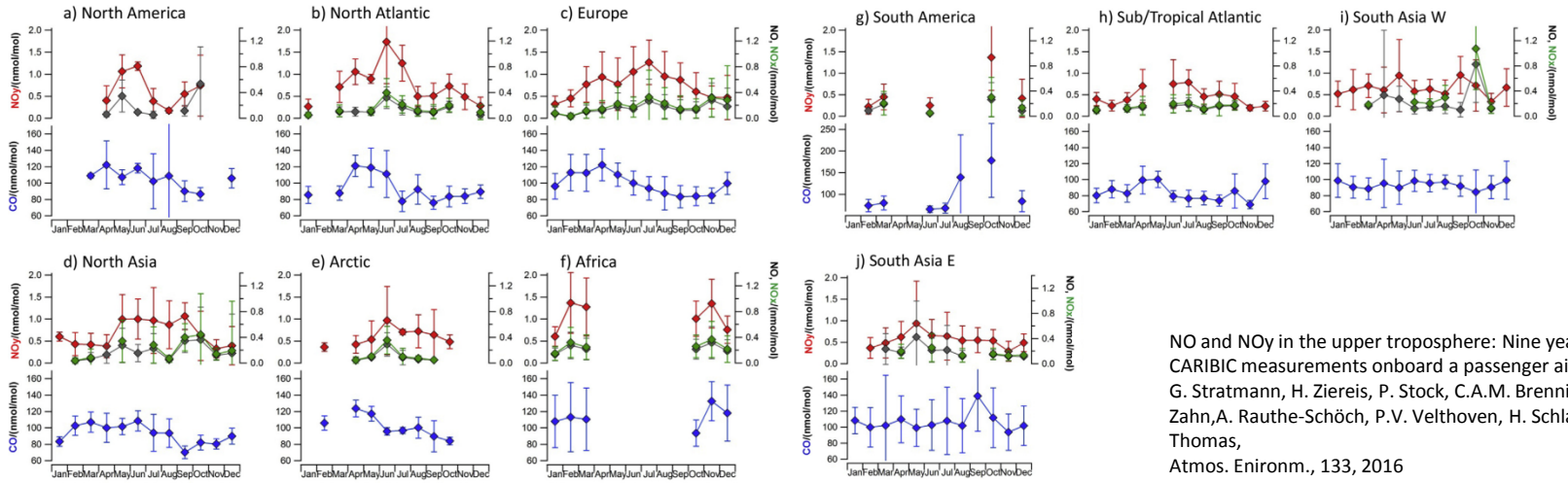
Lowermost stratosphere - maximum in spring
Upper troposphere – maximum in summer



IAGOS-CARIBIC NO_y

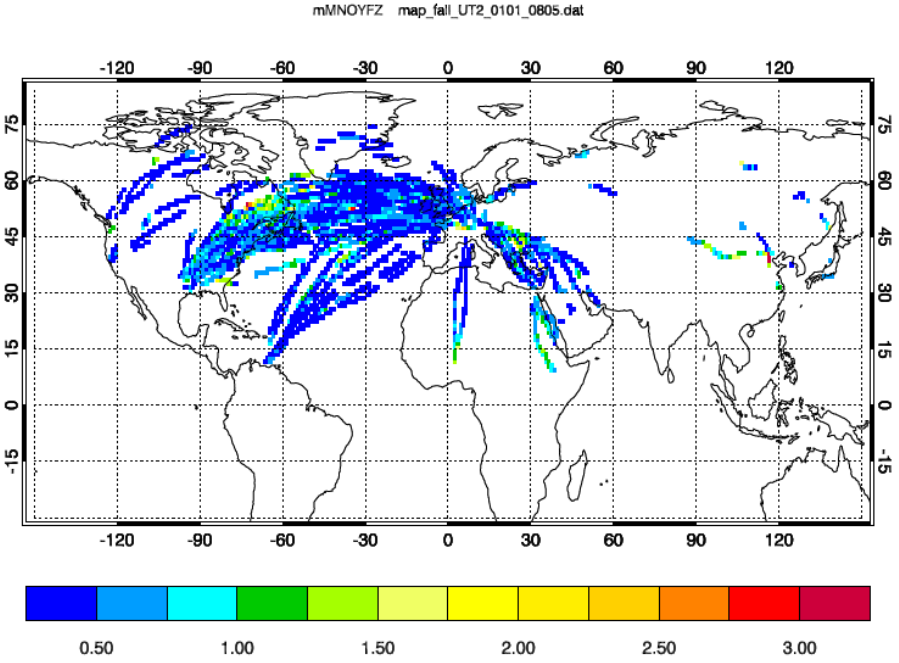
NO: 0.14/0.19/0.13/0.13 ppbv
NOy: 0.82/1.07/0.70/0.42 ppbv

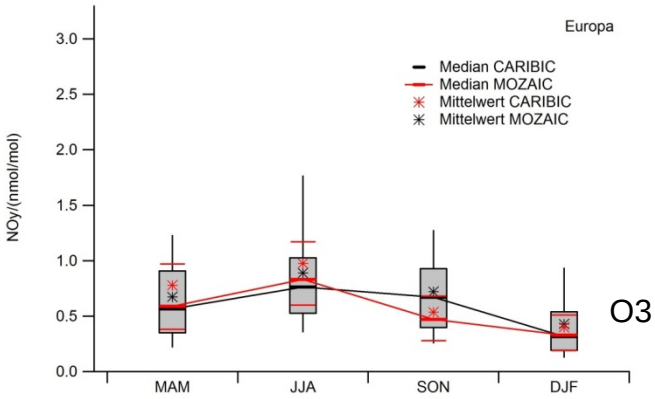




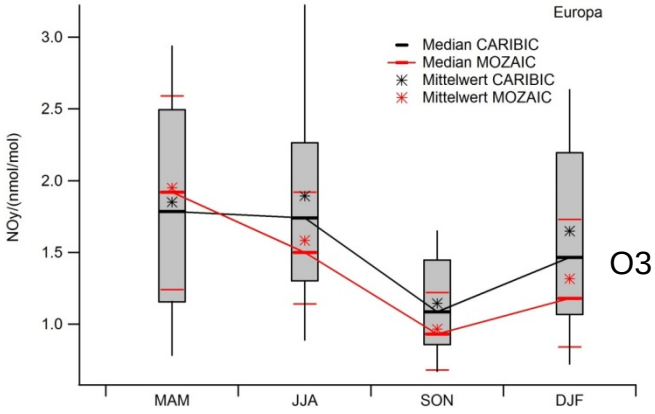
NO and NOy in the upper troposphere: Nine years of CARIBIC measurements onboard a passenger aircraft
G. Stratmann, H. Ziereis, P. Stock, C.A.M. Brenninkmeijer, A. Zahn,A. Rauthe-Schöch, P.V. Velthoven, H. Schlager, A. Volz-Thomas,
Atmos. Environm., 133, 2016

MOZAIC - CARIBIC



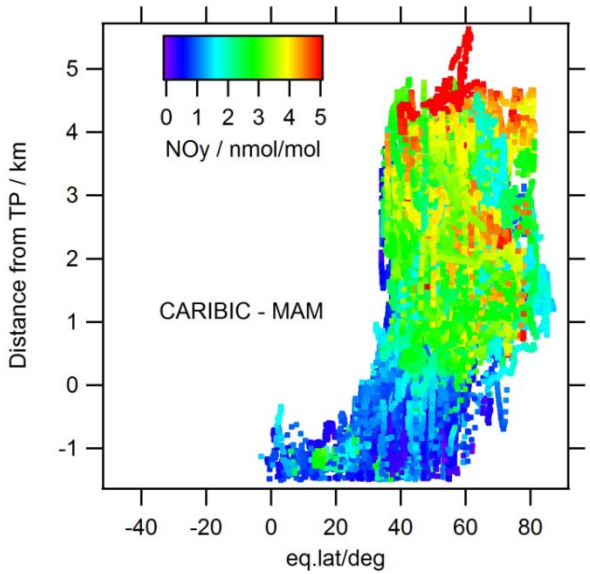


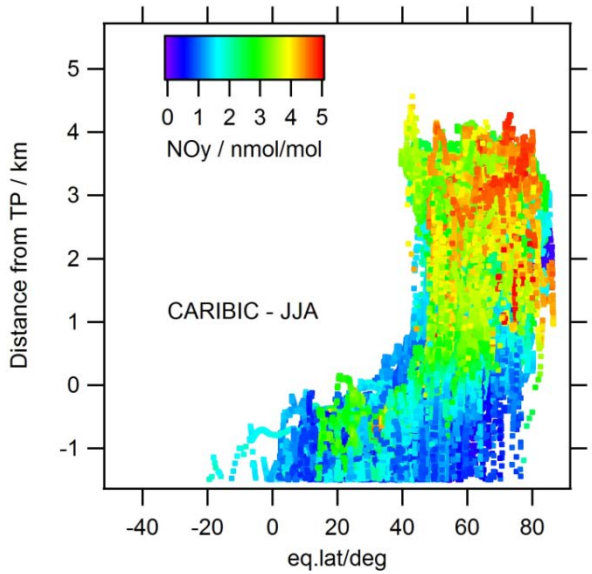
O3 < 100 ppbv

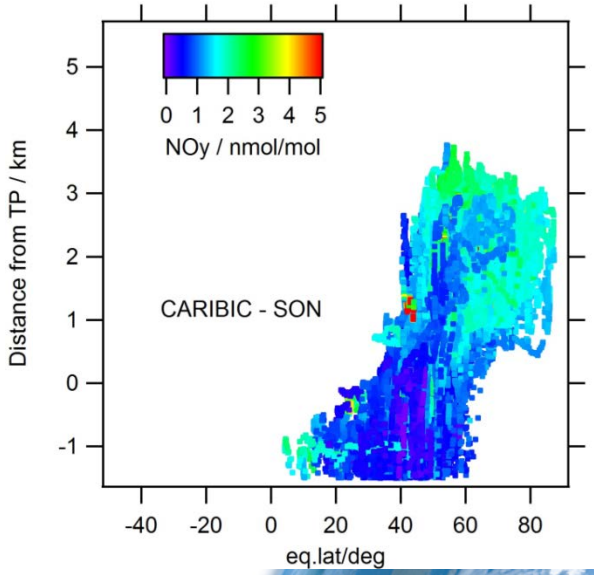


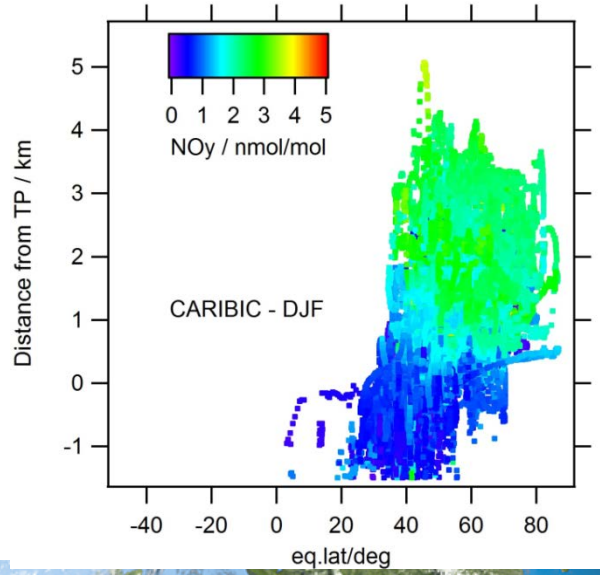
O3 > 100 ppbv

Structure and seasonality of UTLS NO_y

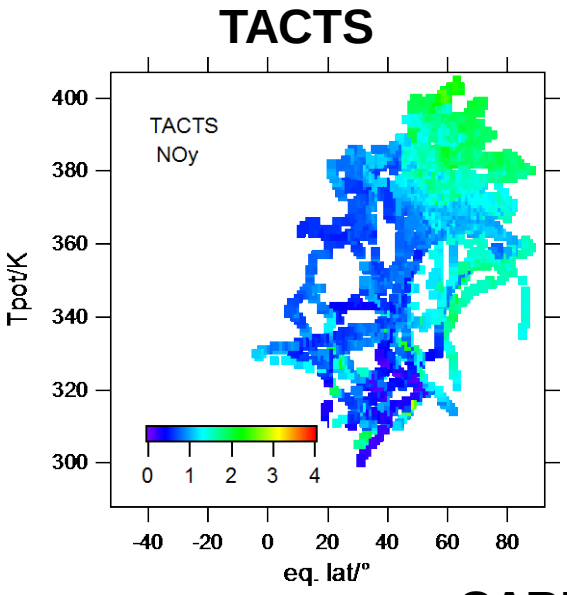


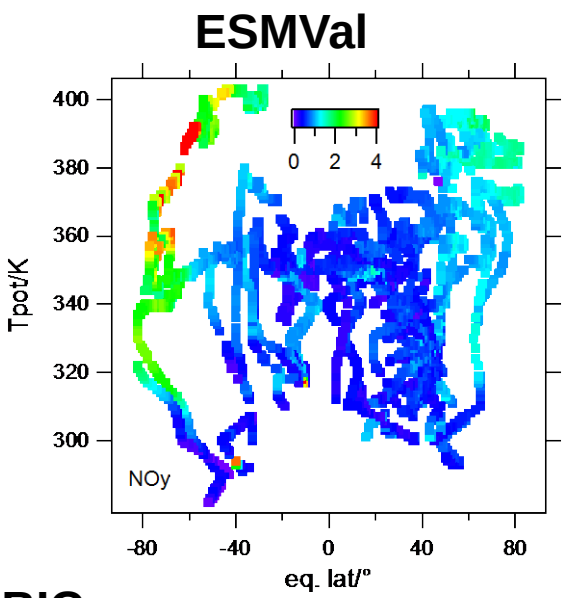




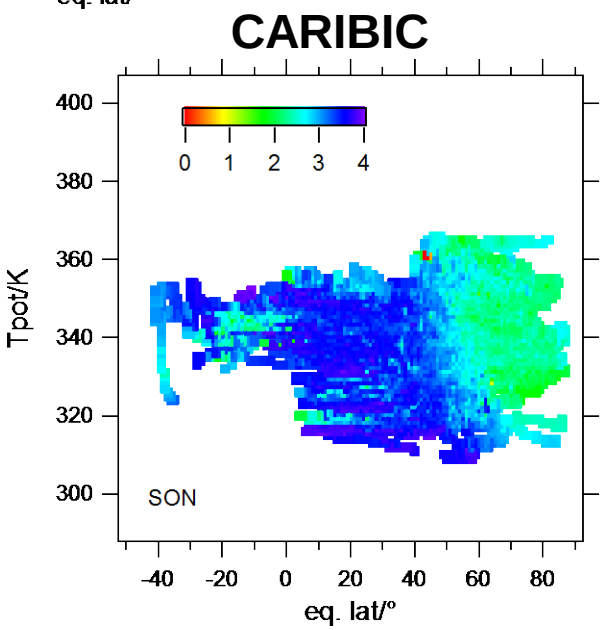


IAGOS and research aircraft – measurements complement each other



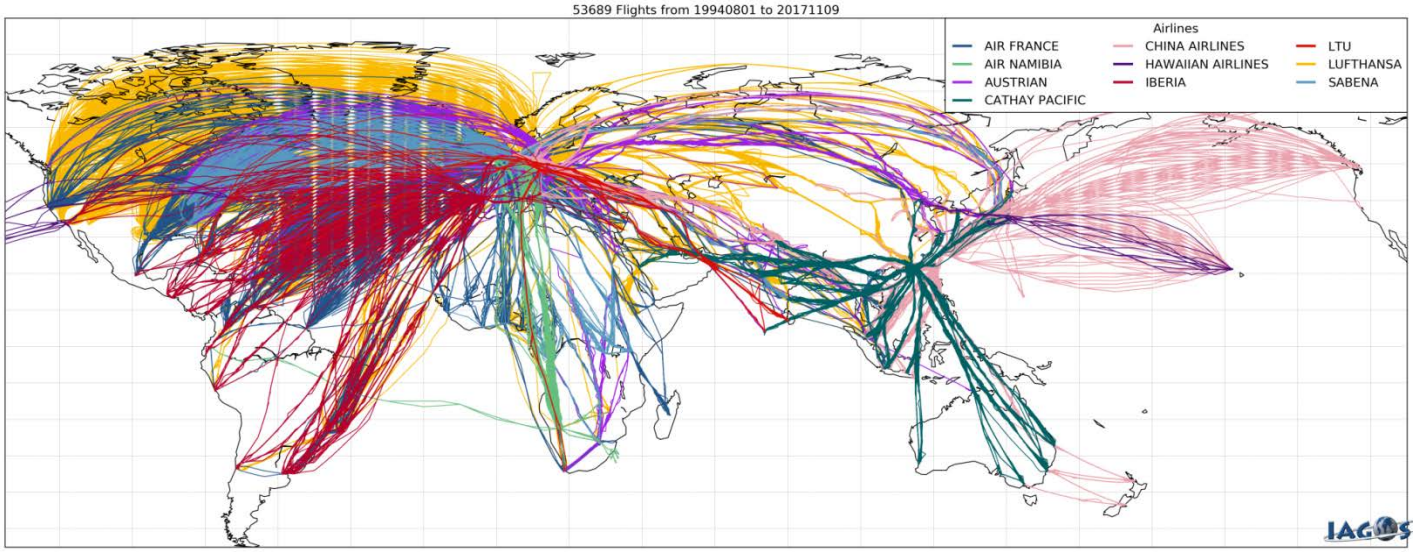


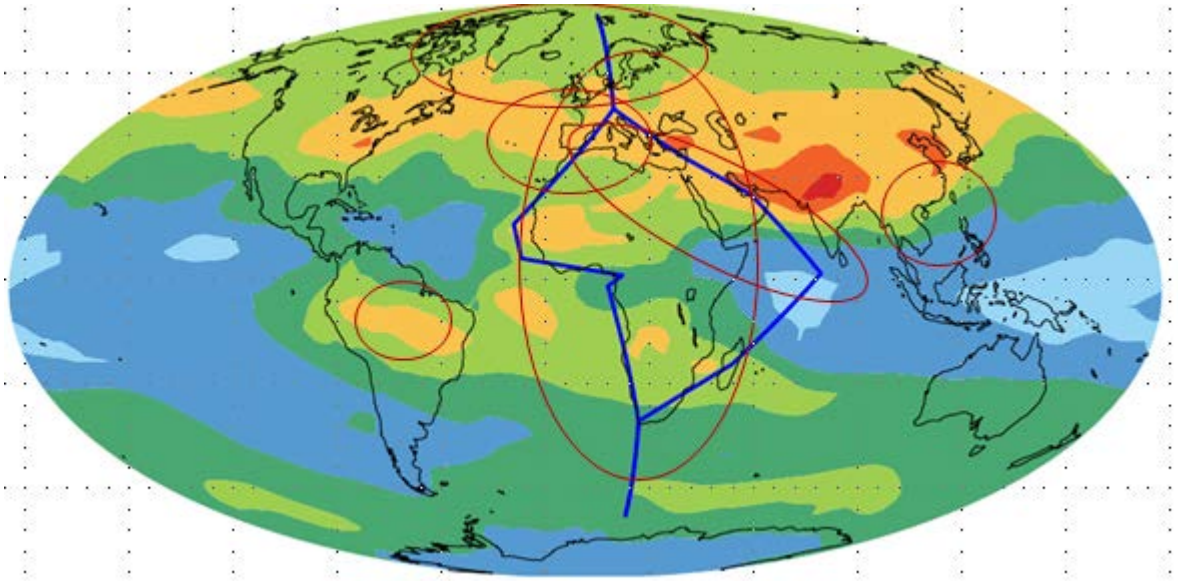
Research - aircraft: HALO



IAGOS- CARIBIC: A340-600

IAGOS and research aircraft – measurements complement each other





HALO missions

TACTS
ESMVal
OMO
ACRIDICO
PGS
EMERGE
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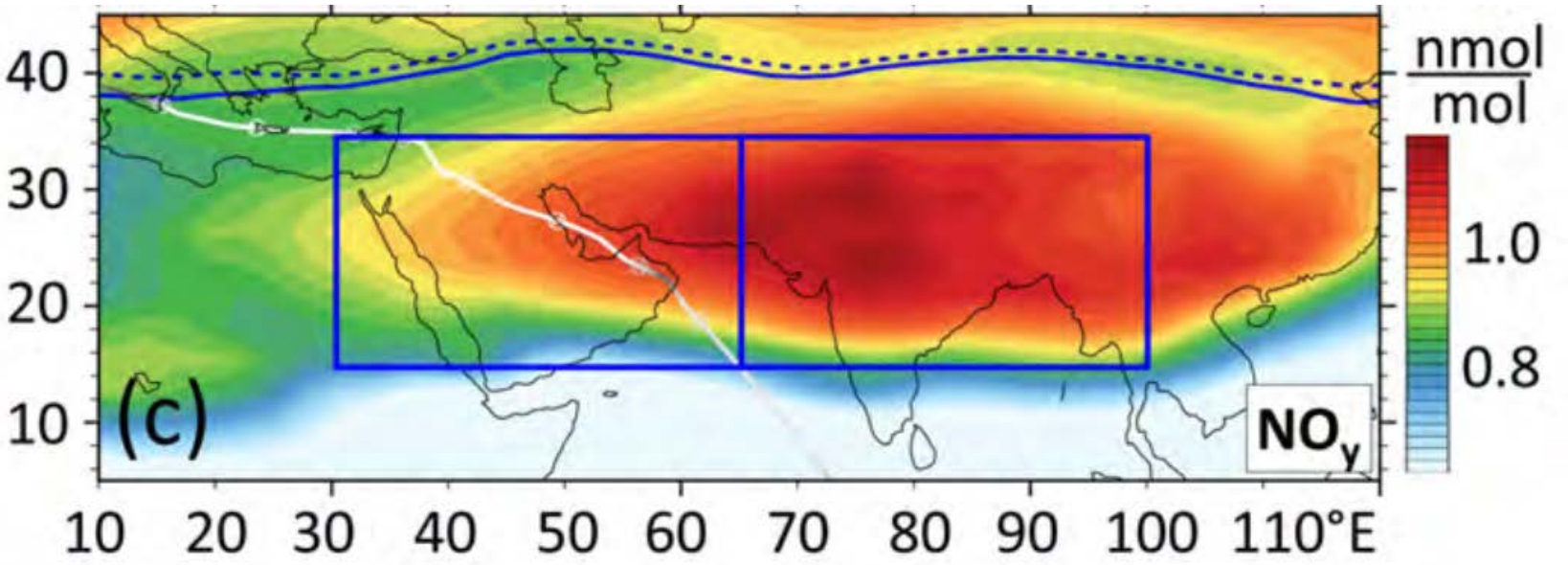
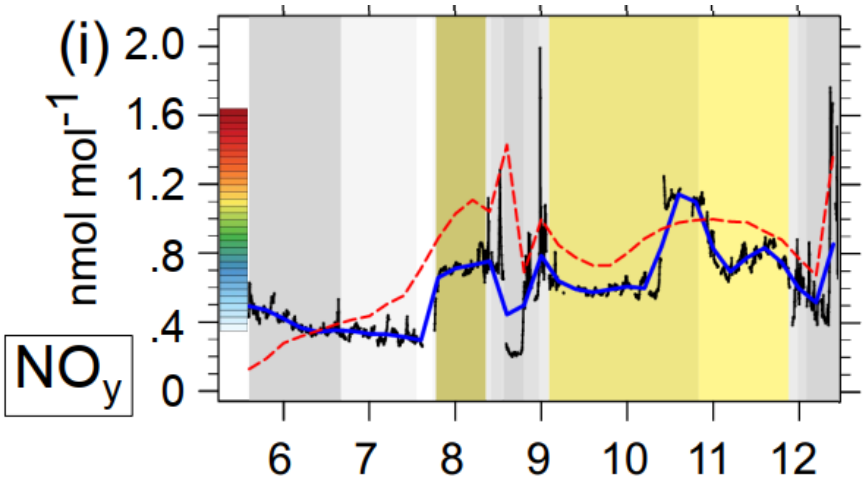
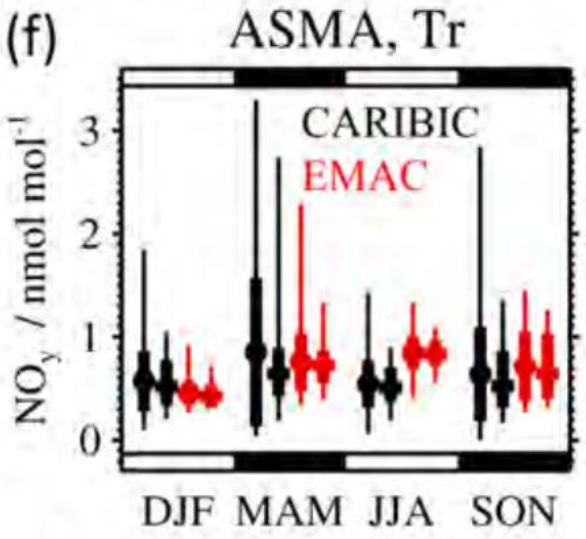
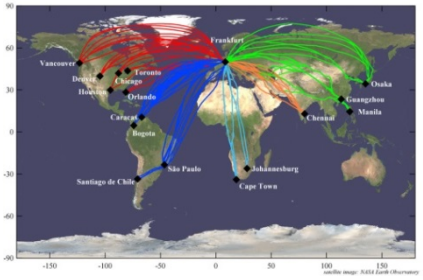
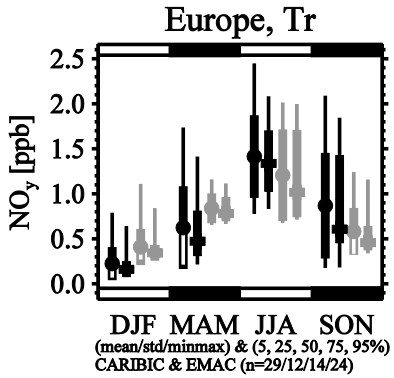
ASIAN summer monsoon: Research aircraft – model simulation - IAGOS

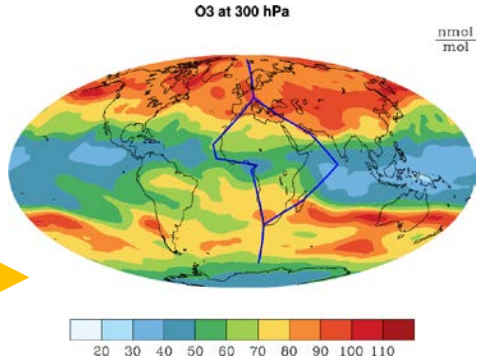


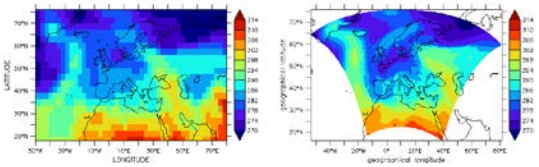


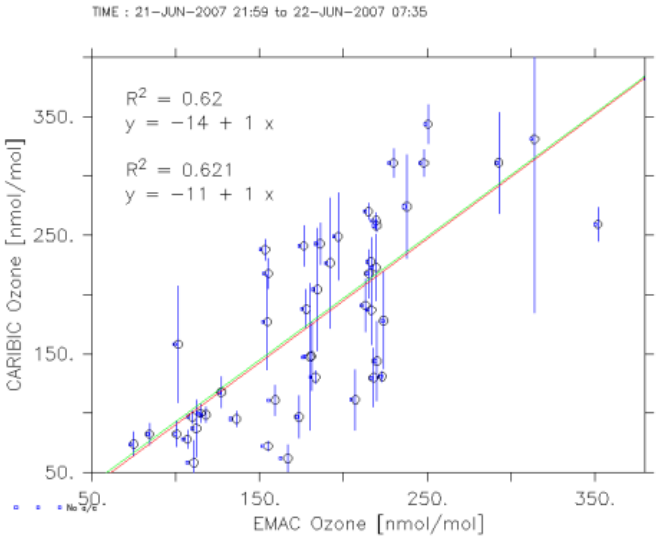










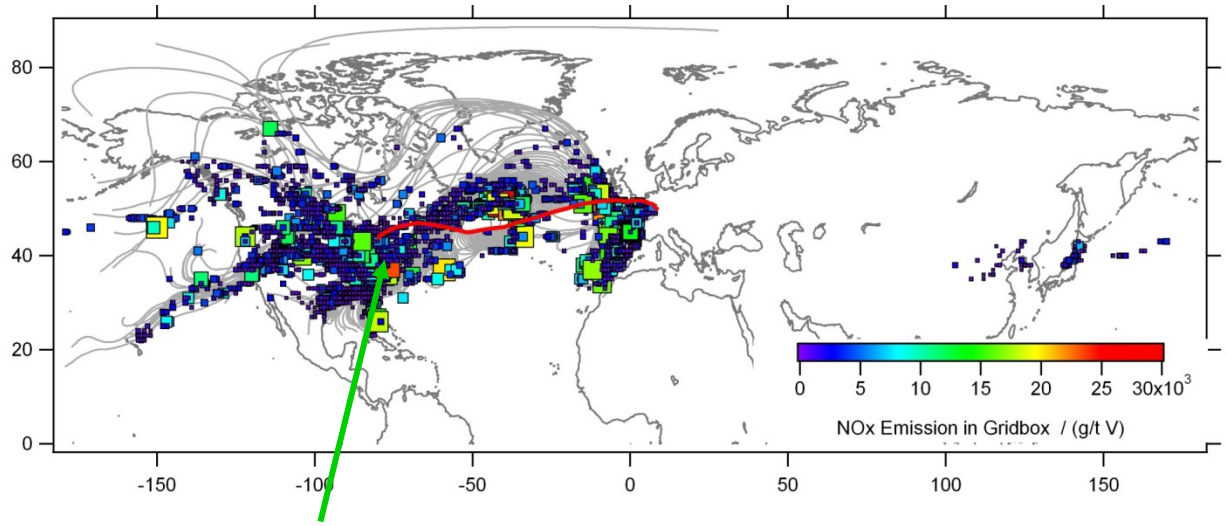


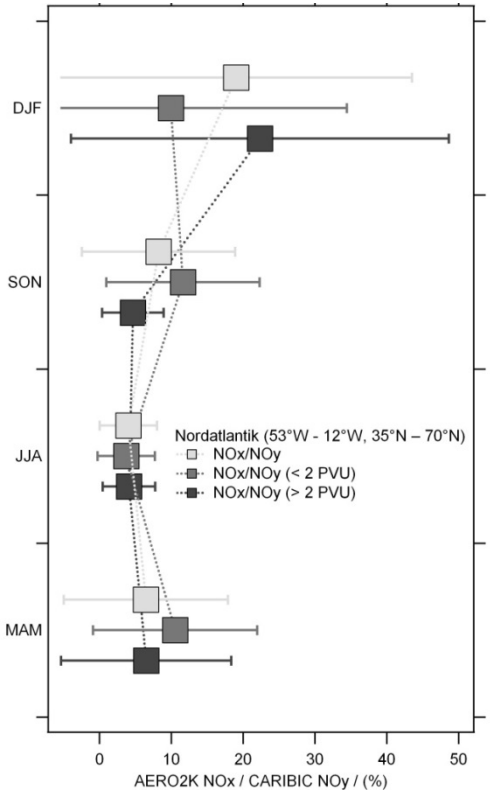
Measurement of trace species
e.g. NO, NOy, O3, CO, …
Research aircraft: HALO, Falcon,
Civil aircraft: IAGOS

ECHAM/MECO(n)

Atmospheric Chemistry model (EMAC). Numerical chemistry and climate simulation system.

Aircraft emissions: Observations – AERO2K





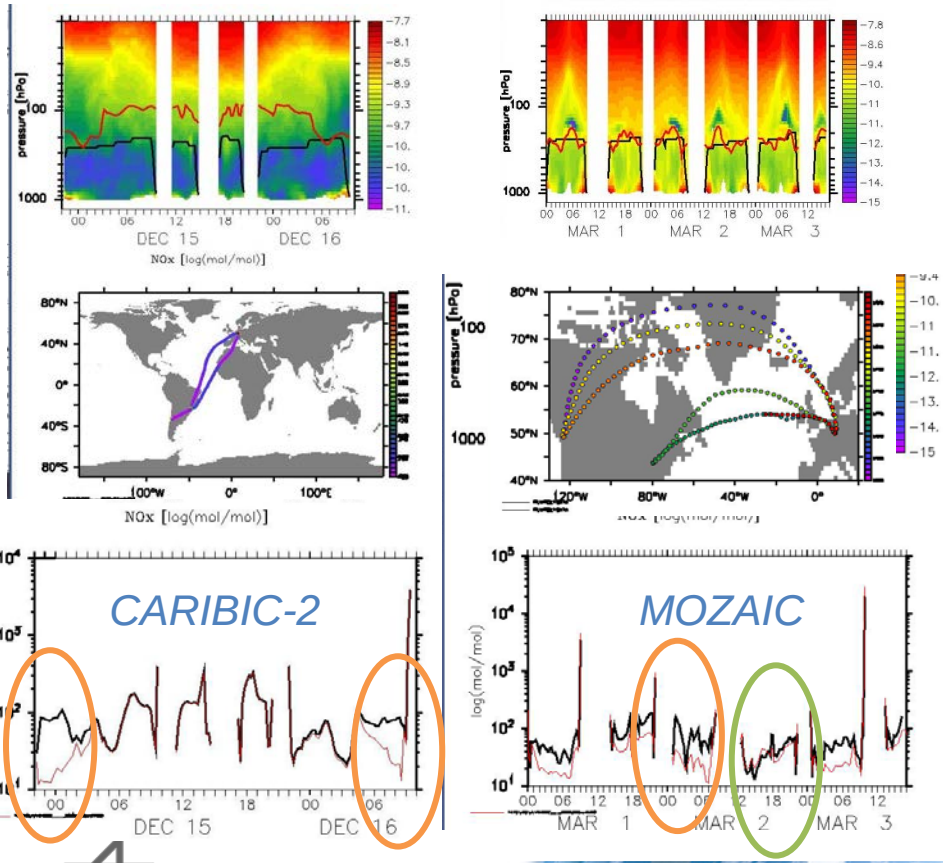
Emitted NO_x per grid cell per hour

CARIBIC flight: September 2007 Frankfurt - Toronto

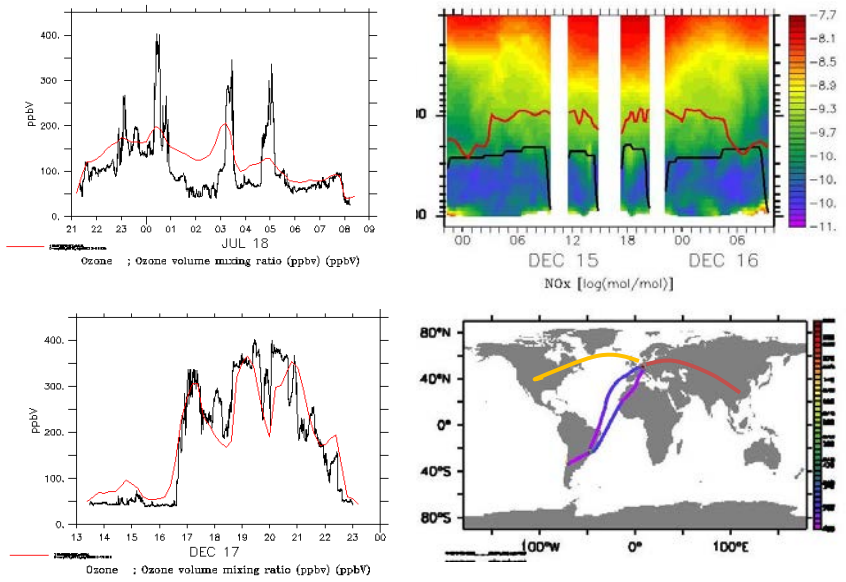
Observations vs. Model simulations

Classification of regions with different burden of aircraft emissions
Analysis of IAGOS-CARIBIC data and model EMAC model simulations

Model sensitivity scenarios



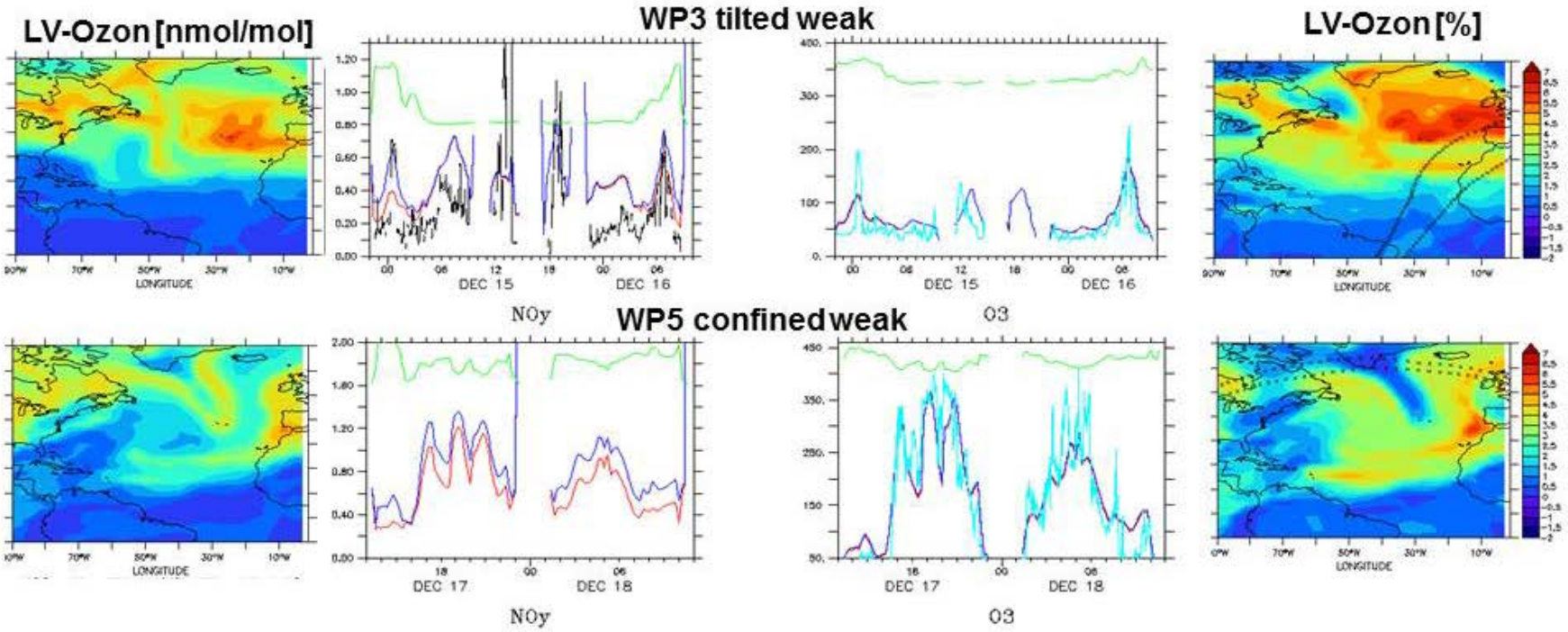
IAGOS vs. EMAC



EMAC2 (REACT4C Scenarien), CARIBIC-2 *(Ozon Andreas Zahn, KIT) vs. EMAC2*

Contribution of air traffic emissions to atmospheric ozone in the NAFC
Model simulation and IAGOS / CARIBIC observations

Analysis of different weather patterns



DLR

Summary

- Nitrogen oxides observations since 2002
- One of the longest continuous time series in the UTLS
- Seasonal and regional differences
- Structure and seasonality of the UTLS
- Comparison with MOZAIC

- **IAGOS vs. research aircraft – mutual supplementation**
- **Observation vs. model simulation – comparison, validation, development**