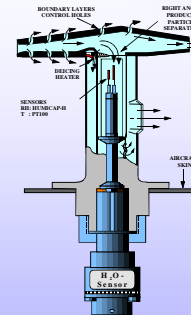


MOZAIC-Data, Particularly the Use of Water Vapor Data for UTLS-Studies and the Urgent Need for Integrated Data Sets of Ground Based, Airborne and Satellite Observations of Humidity

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Herman G.J. Smit, COST 723,
Bern, 6-7 Oct, 2003

MOZAIC: Measurement of Ozone and Water Vapor by Airbus In-Service Aircraft Passenger Aircraft as Observation Platform for Atmospheric Research

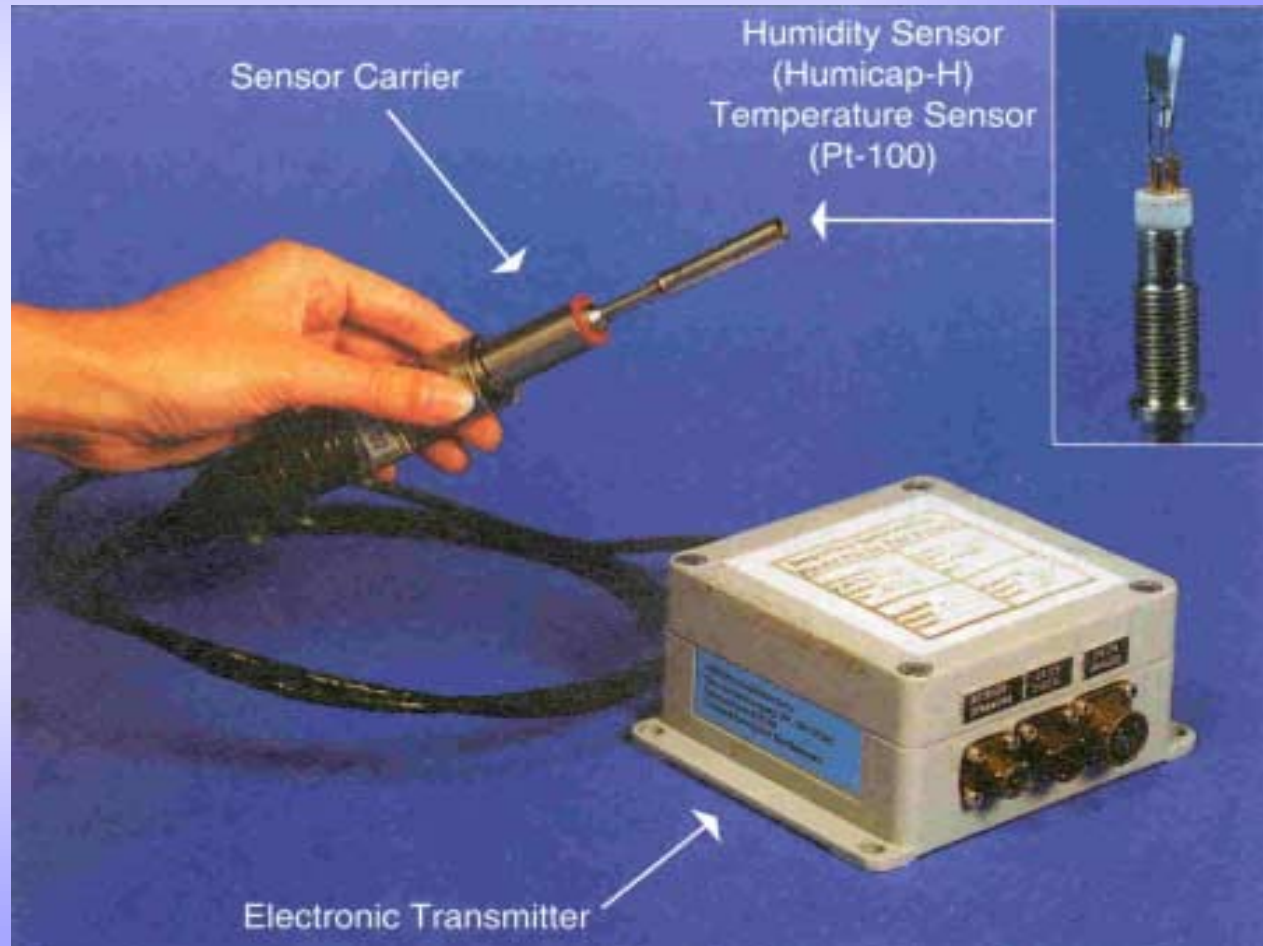
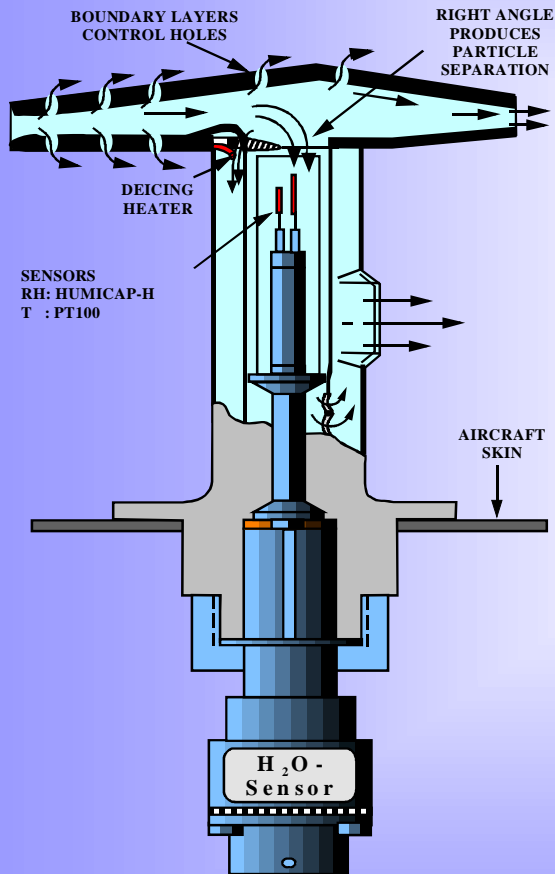


- Five Passenger A340-aircraft, operated by 4 European Airlines on scheduled flights
- Quasi continuous sampling between 0 and 12 km altitude
- 2,500 Flights per year; 175,000 hours of O₃ and H₂O data since August 1994
- CO and NO_y since 2001

MOZAIC: Aircraft Sampling Inlet



MOZAIC- Humidity Sampling Technics: Rosemount Probe and Humidity Device

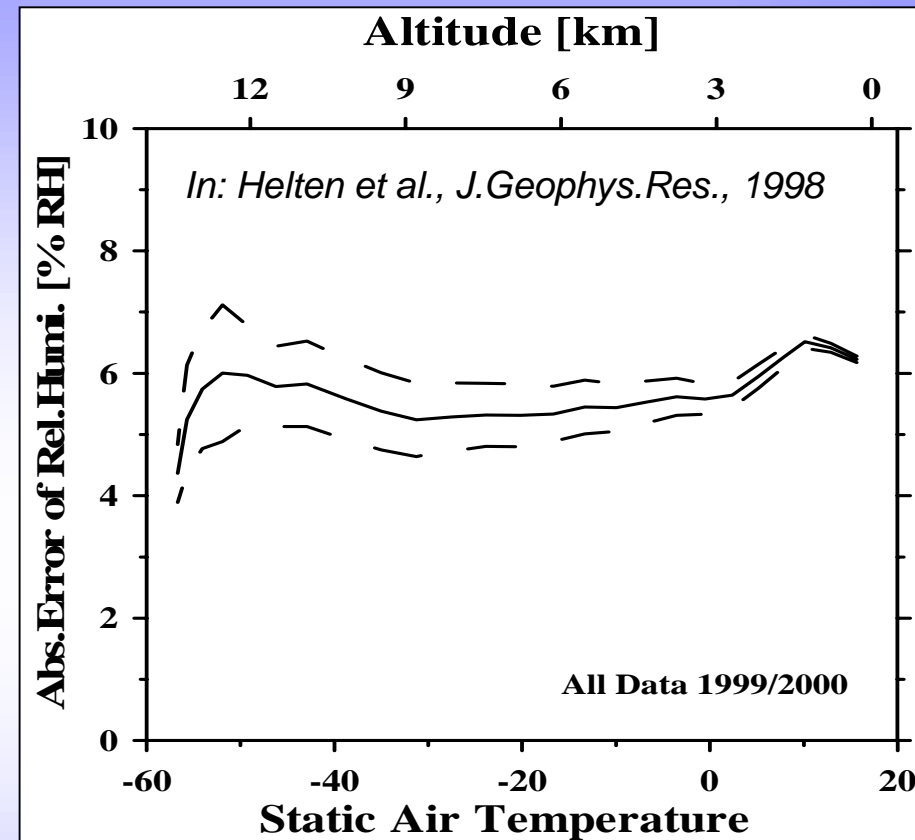


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MOZAIC Humidity Device: Performance and Quality Assurance

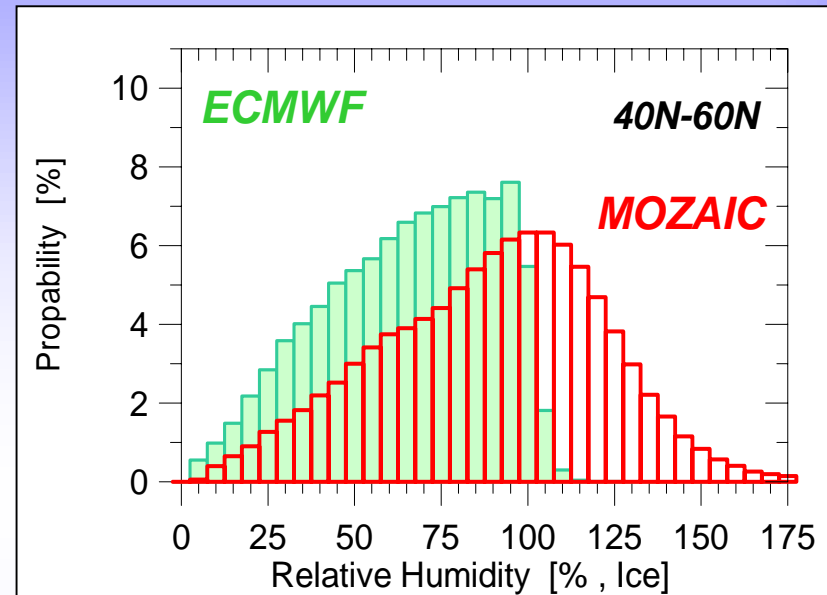
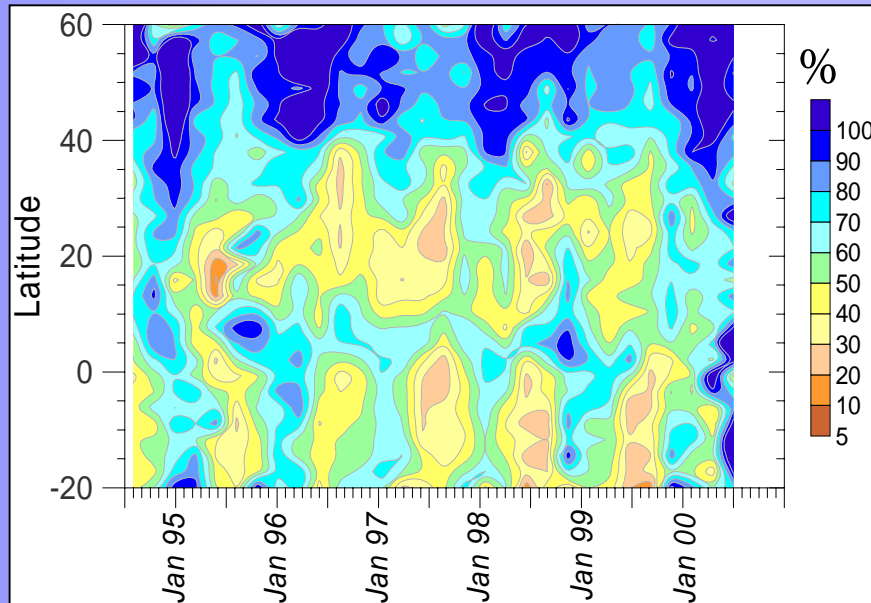


- ◆ Regular calibration (every 500 flight hours)
- ◆ In environmental simulation chamber
- ◆ Against Lyman (α)- fluorescence hygrometer
- ◆ Under realistic flight conditions of humidity, temperature and pressure



- ◆ Evaluation of two year record of pre- and post-flight calibrations
- ◆ Results agree well with in-flight inter-comparisons [Helten et al., J. Geophys. Res. 1999]

MOZAIC Relative Humidity in Upper Troposphere (UT) over North Atlantic



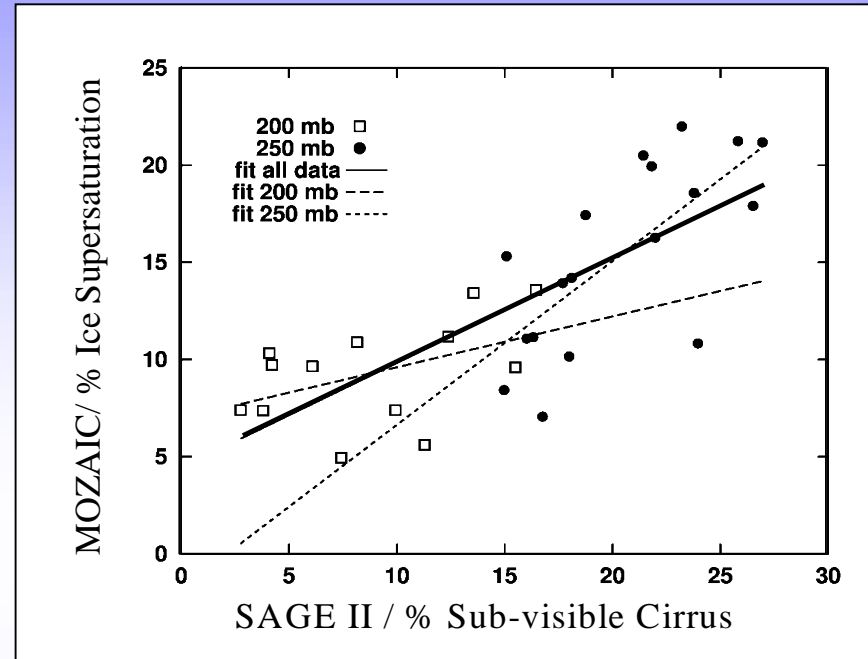
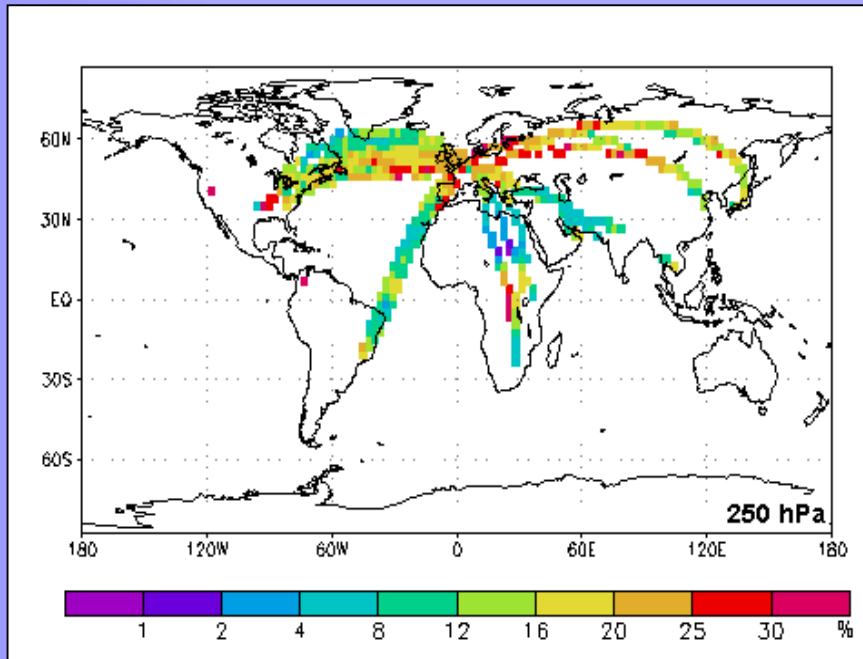
- MOZAIC provided the first climatology of humidity in the UT
- Large variability in time and space

- UT is much wetter than assumed before MOZAIC
- ECMWF does not reproduce the ice super saturation

➤ Long Term Changes ??

➤ Control of Humidity in UT??

MOZAIC: Ice Super Saturation in Upper Troposphere



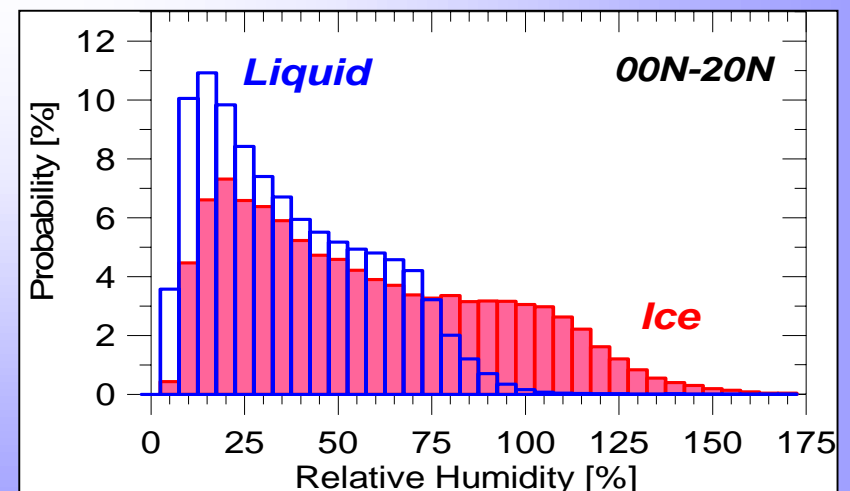
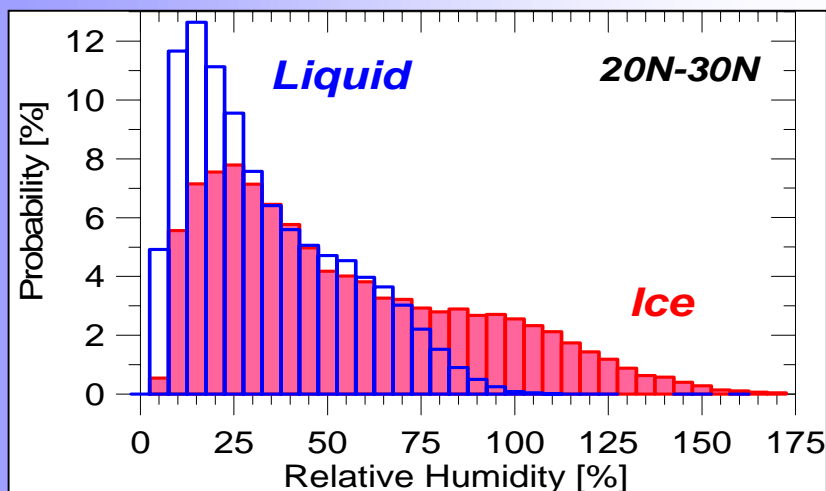
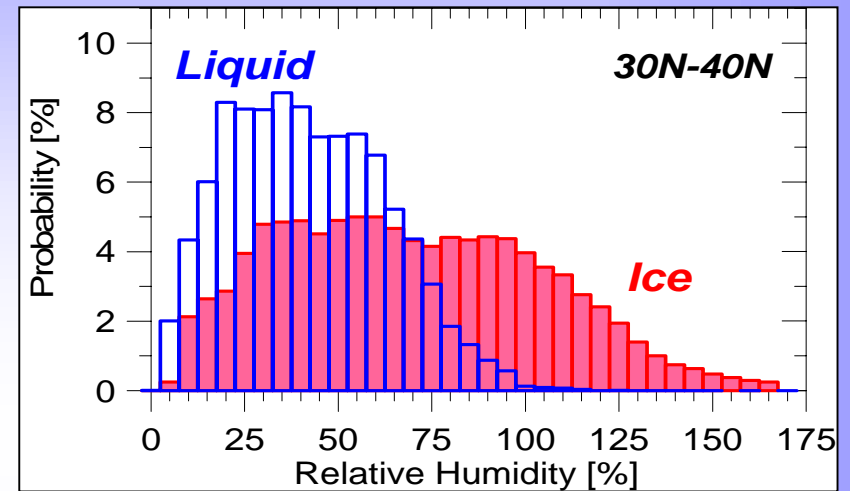
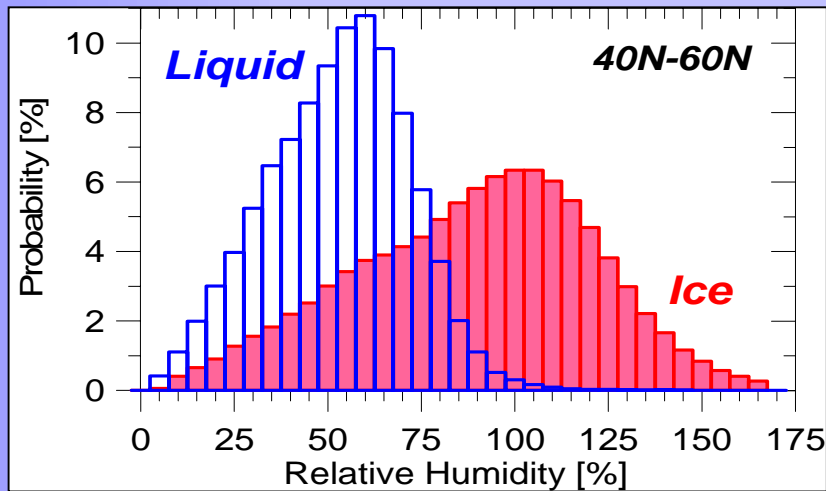
- 15-30% of the UT is ice super saturated (ISS)
- Small scale phenomena ($\Delta X < 200$ km; $\Delta Z < 2$ km)

- Strong correlation of ISS with sub-visible cirrus clouds
- Important for cirrus cloud formation and radiative balance

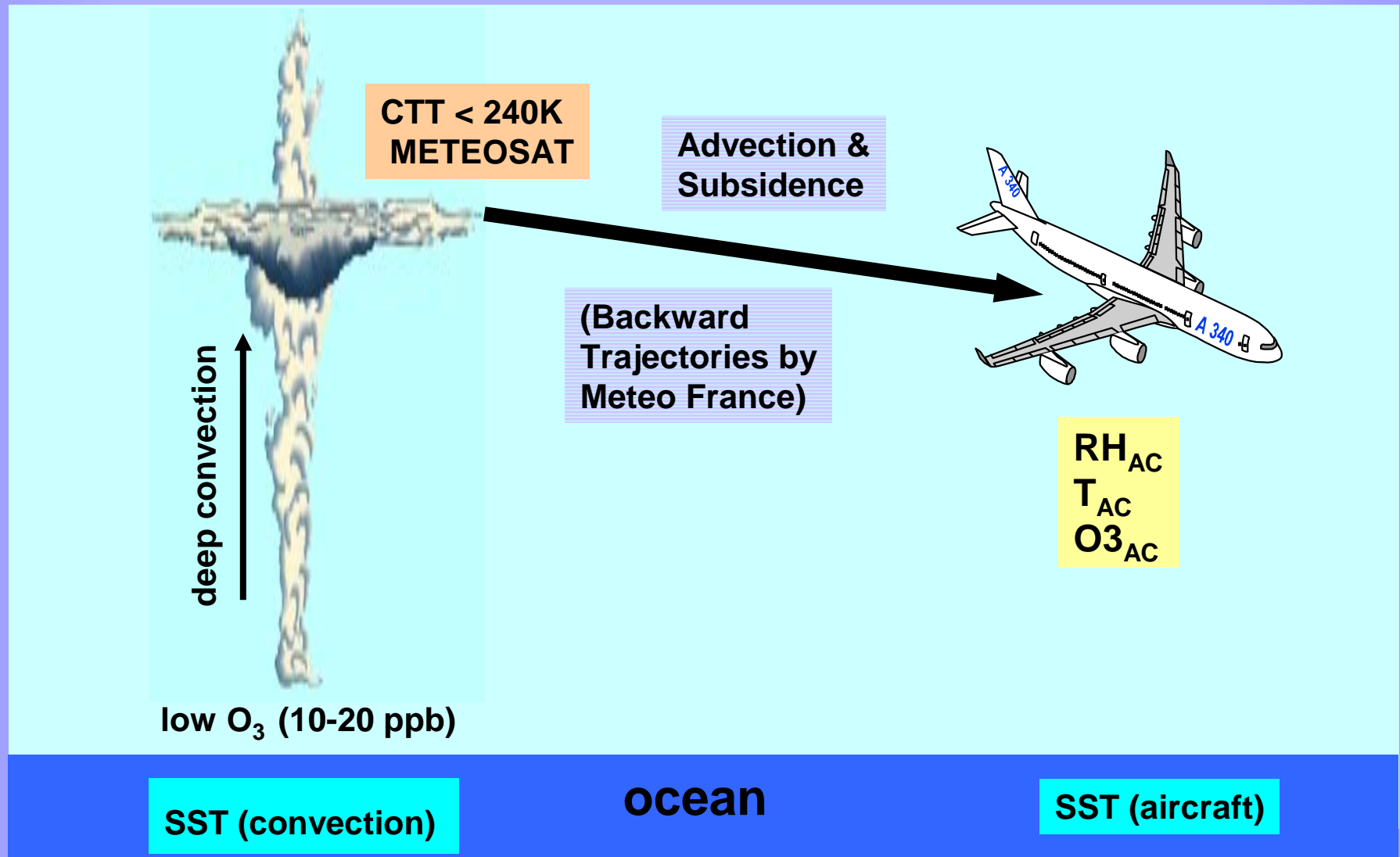
Causes of ice super-saturation and the interaction with clouds ??

MOZAIC: Distribution Relative Humidity in UT over Atlantic

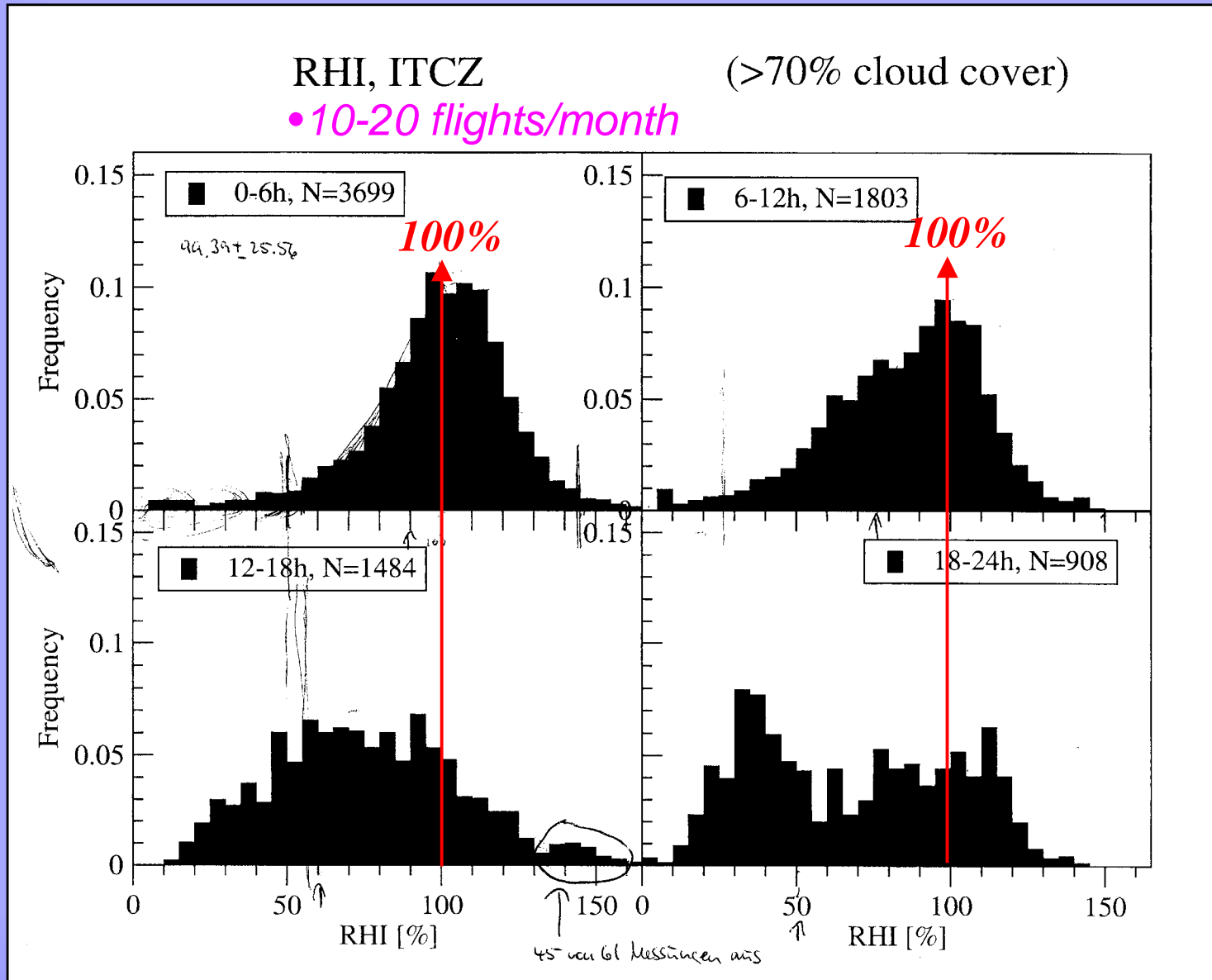
Z = 9-12 km, PV < 2.0pvu, 10W-70W, Aug 1994 - June 2000



Concept of Evolution of UTH in Cb-Outflow

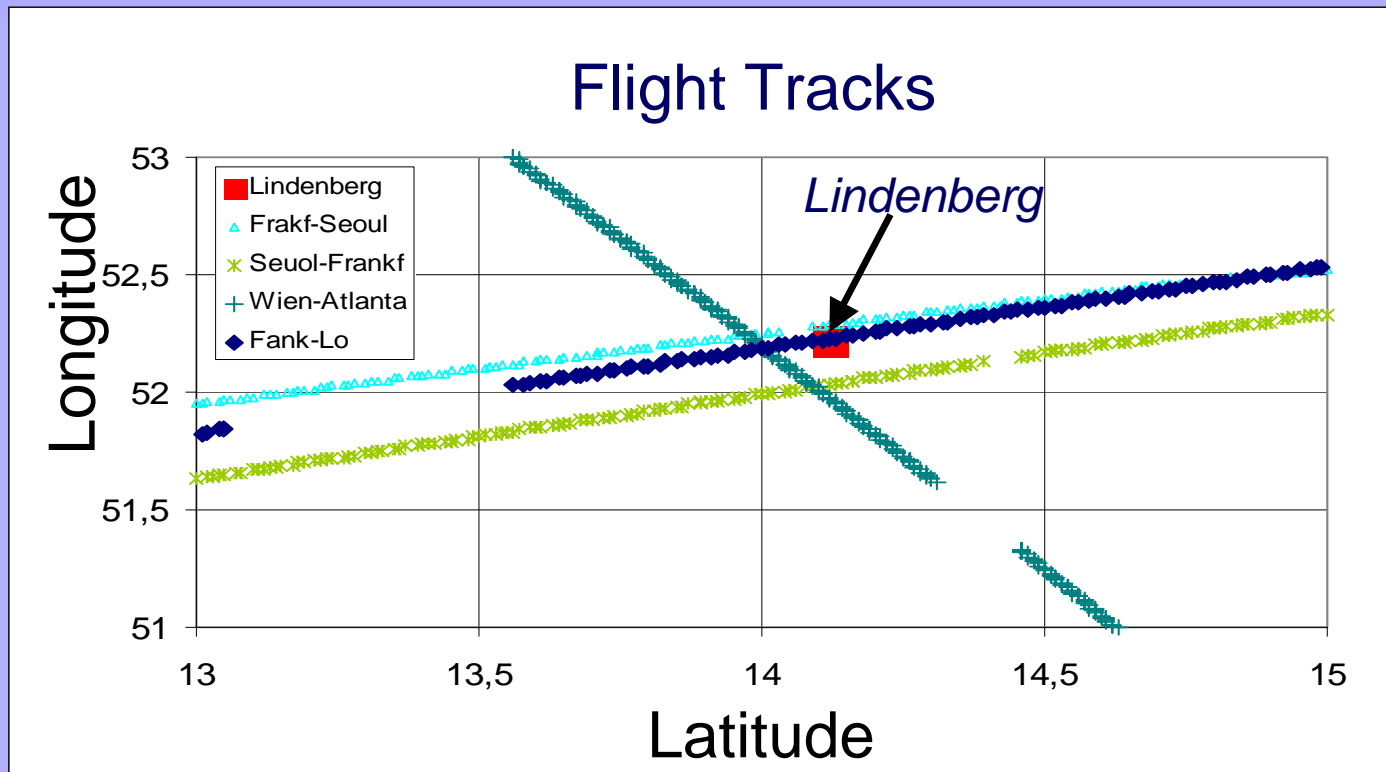


MOZAIC: Evolution RHI-distribution in outflow of Cb-Convection (1)



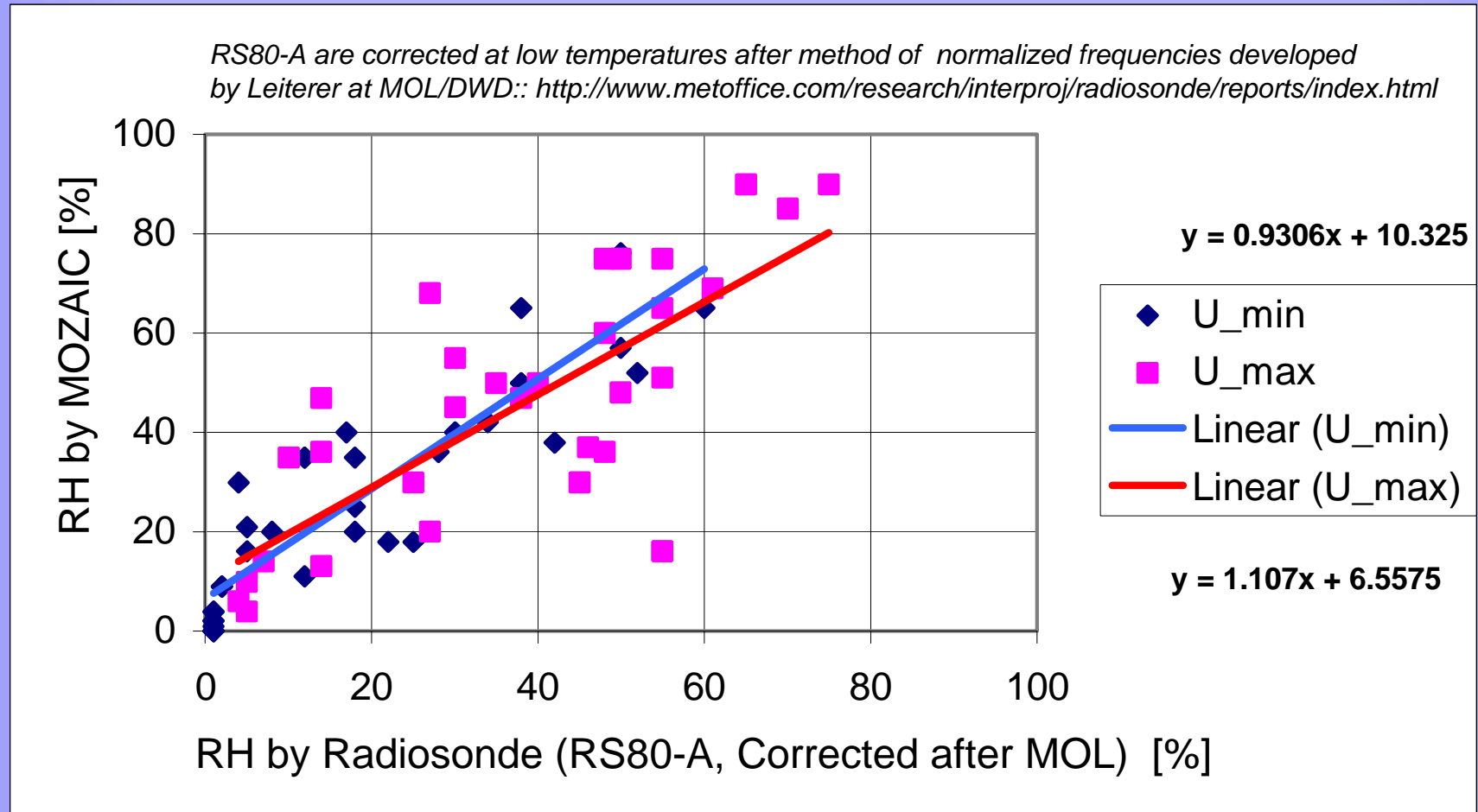
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RS80-Humicap-A: Comparison UTH with MOZAIC



- Radiosounding station Lindenberg at 14.1°E, 52.2°N
- Coincidence MOZAIC and Radiosonde
 - ❖ In time: Less than 1 hour
 - ❖ In space: 2 degree latitude and longitude
altitude range: $Z_{AC} \pm 250\text{m}$

RS80-Humicap-A: Comparison UTH with MOZAIC



Outlook: Upper Tropospheric Humidity Scientific Objectives

Seasonal variations of UTH in tropics, sub-tropics and mid-latitude & UTH control mechanisms:

- Influence of convection and subsidence on UTH
- Impact of (sub-visible) cirrus clouds on UTH-control
- Sensitivity of UTH to surface and UT-temperature
- Origin and control of ice super saturation

-
- *Scale analysis of UTH-variations*
 - *Long term changes of UTH (MOZAIC, radio sondes)*

Outlook: Integrated Network of UTH-Observations

Integration of UTH-data through validation and assimilation of:

- ❖ Satellites (e.g. ENVISAT, SAGE-III , AIRS etc.)
- ❖ Aircraft (MOZAIC + Research A/Cs)
- ❖ Radiosondes
- ❖ Groundbased (e.g.LIDAR, FTIR)

Benefits through improvement of:

- ❖ Weather analysis and forecasting (ECMWF)
- ❖ Climate: UTH-Feedback & Meso scale and Gen.Circ. Models
- ❖ UTH and its control mechanisms
- ❖ Atmospheric Chemistry: Physico-Chemical Models

MOZAIC: Acknowledgements



Lufthansa (2 AC's)



Austrian Airlines



Air France

Acknowledgement to::

- European Commission for Funding (50%)
- Airlines for no charge of:
 - ❖ Carrying MOZAIC-instruments
 - ❖ Maintenance at airports



Sabena