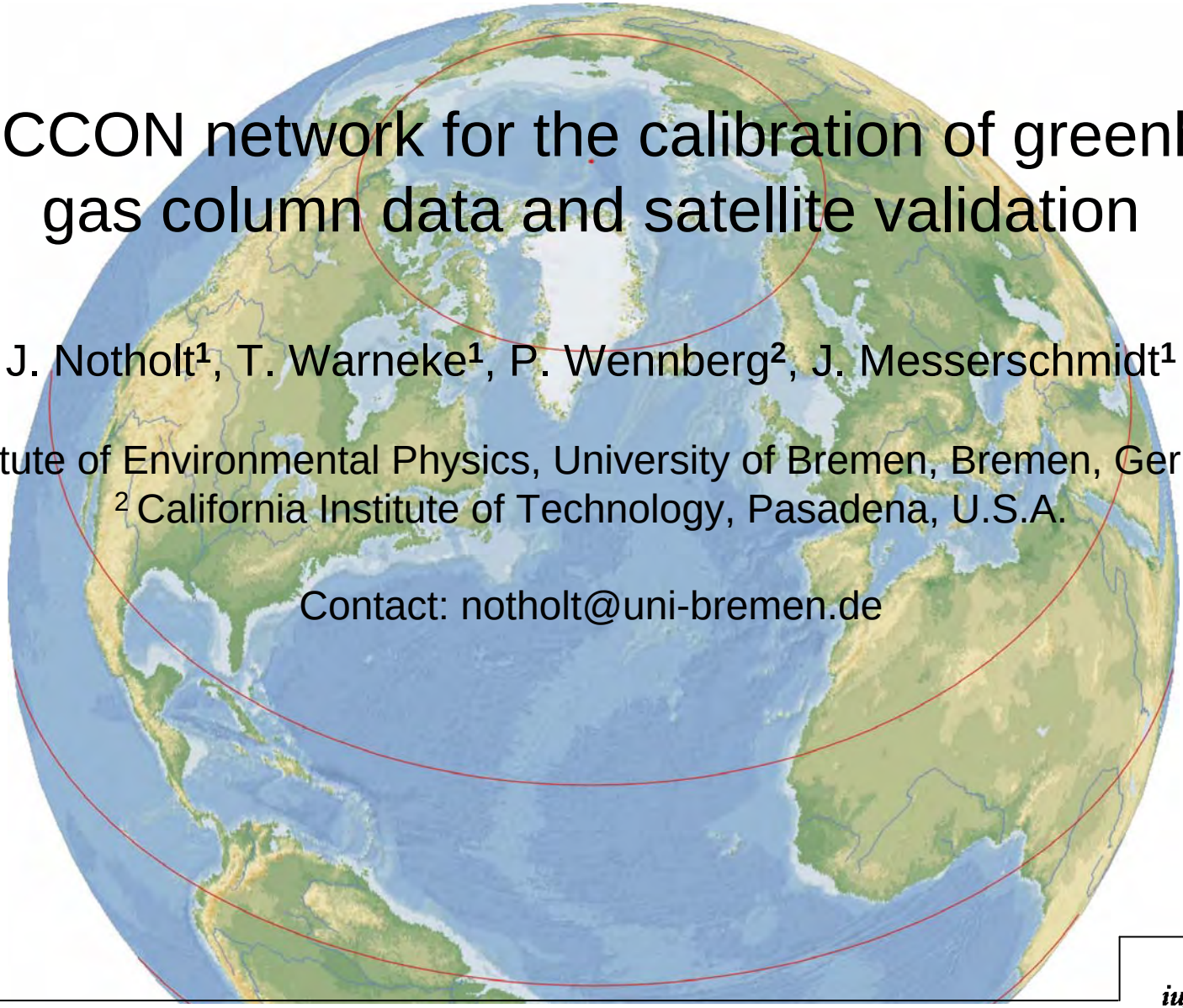
The TCCON network for the calibration of greenhouse gas column data and satellite validation



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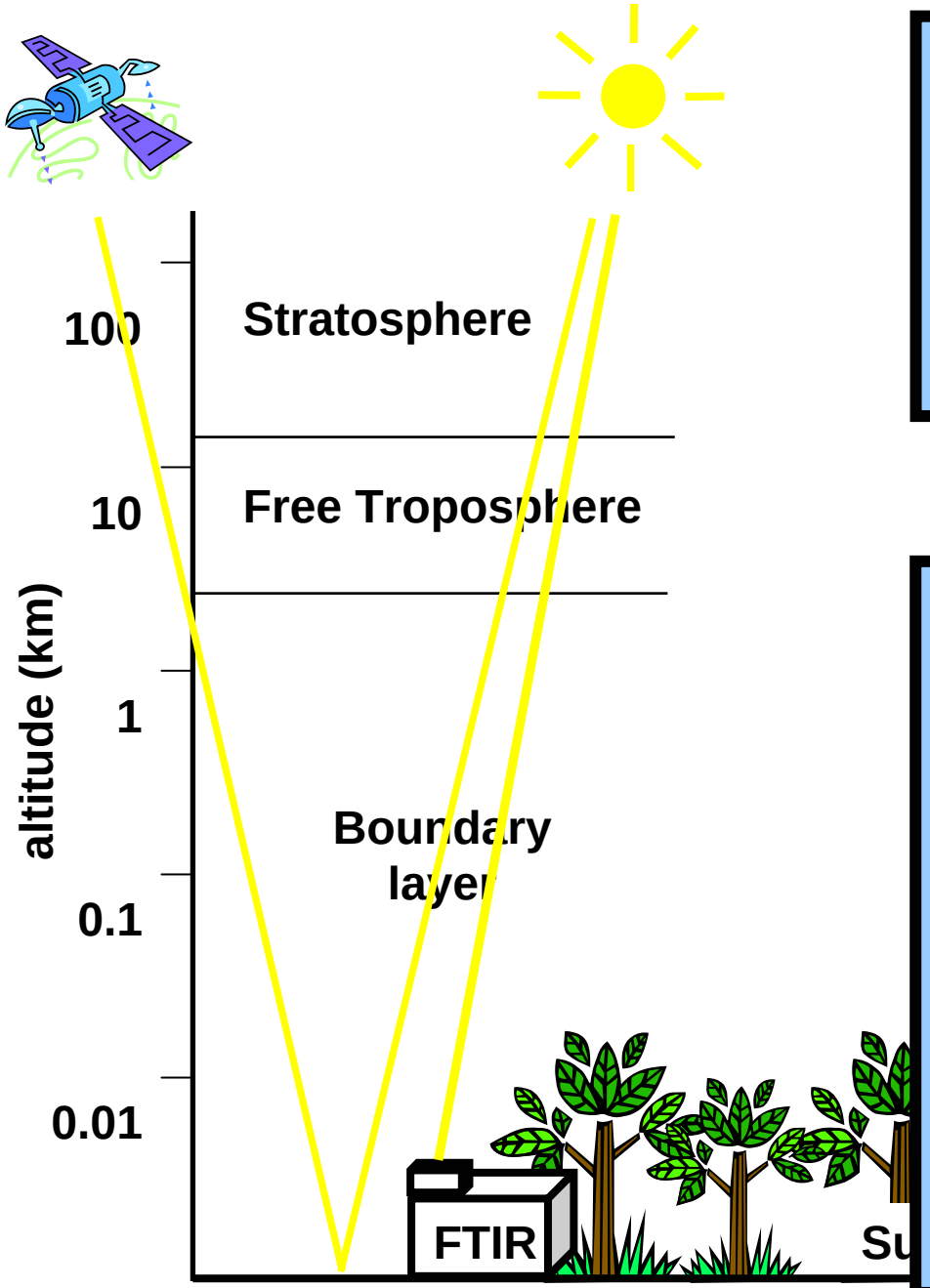


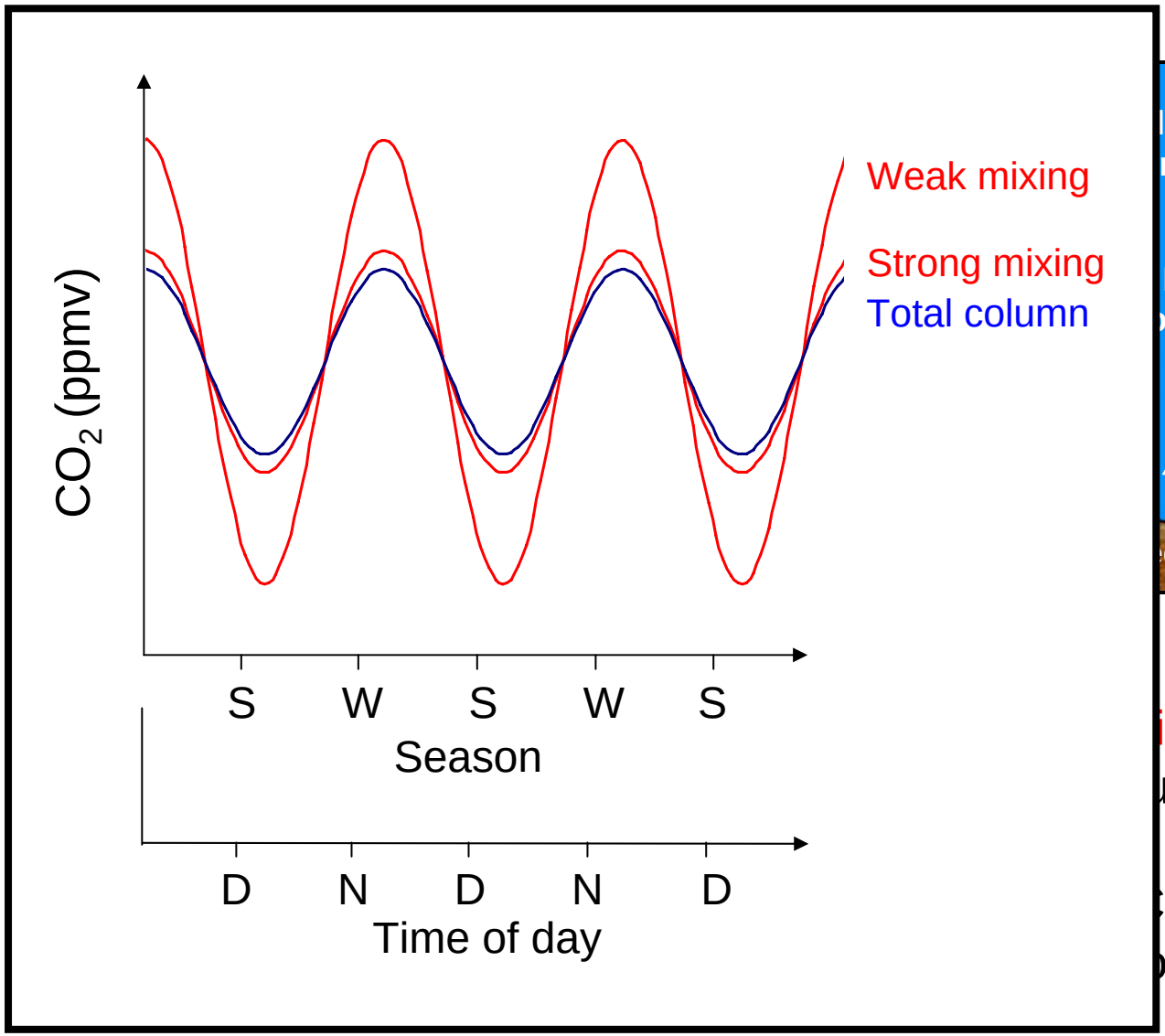
GHG in-situ network

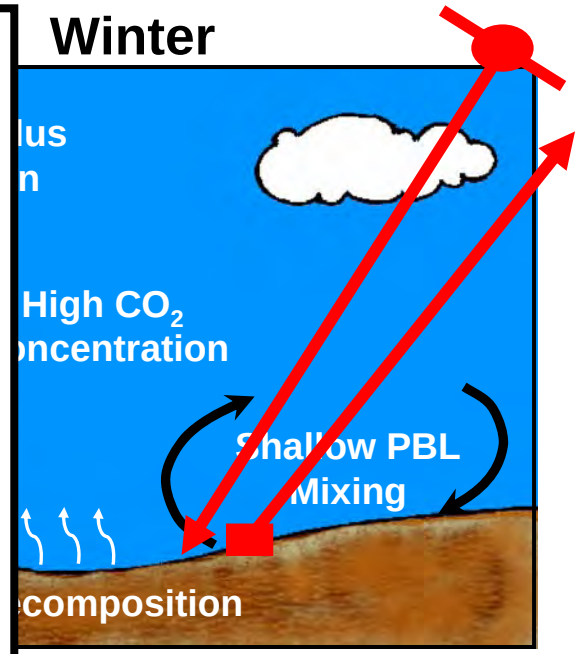
- High accuracy
- Limited spatial distribution
- Uncertainty in vertical transport has impact on the inversion

Remote sensing

- No influence by vertical transport
- Satellites provide global coverage
- Data with sufficient precision are becoming available: (SCIAMACHY, AIRS, TOVS, GOSAT)
- Ground-based network for calibration/validation has been established (TCCON)

Rectifier forcing



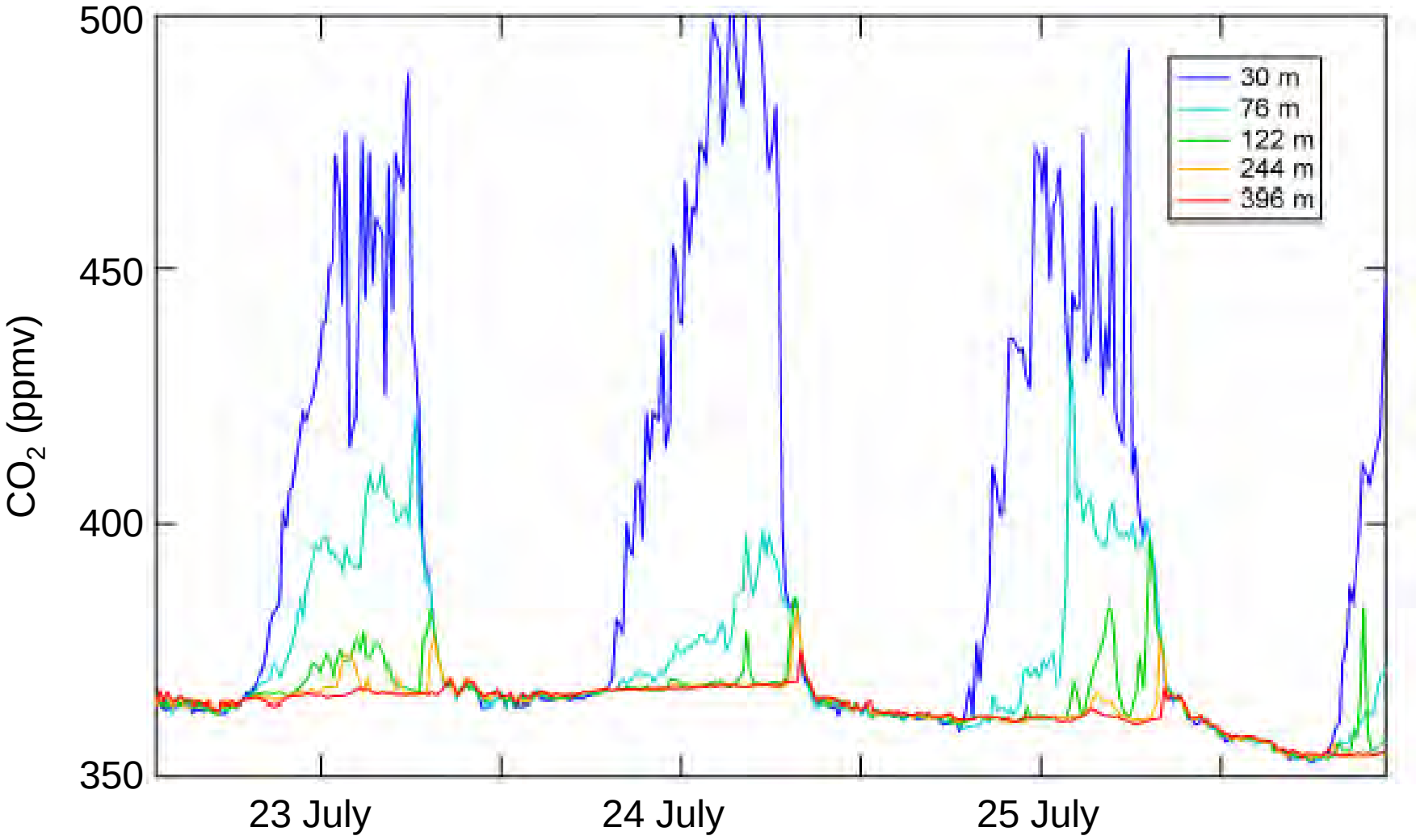


(Denning, 2002)

ion of respiration signal
urface

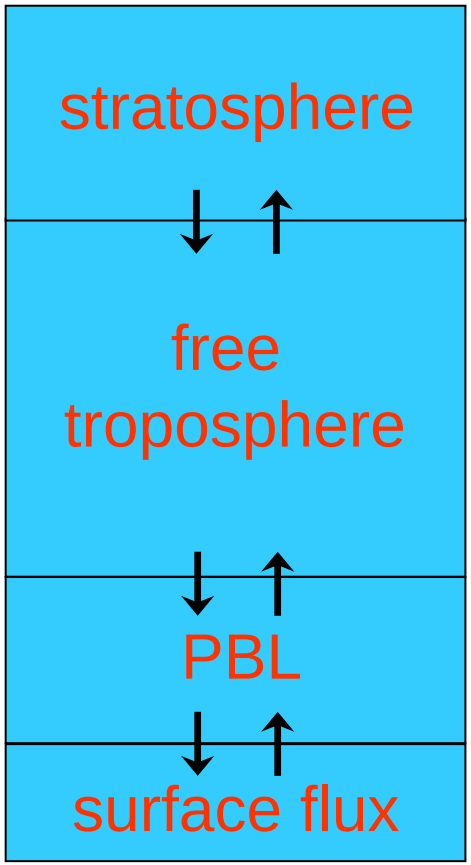
CO_2-levels in
osphere

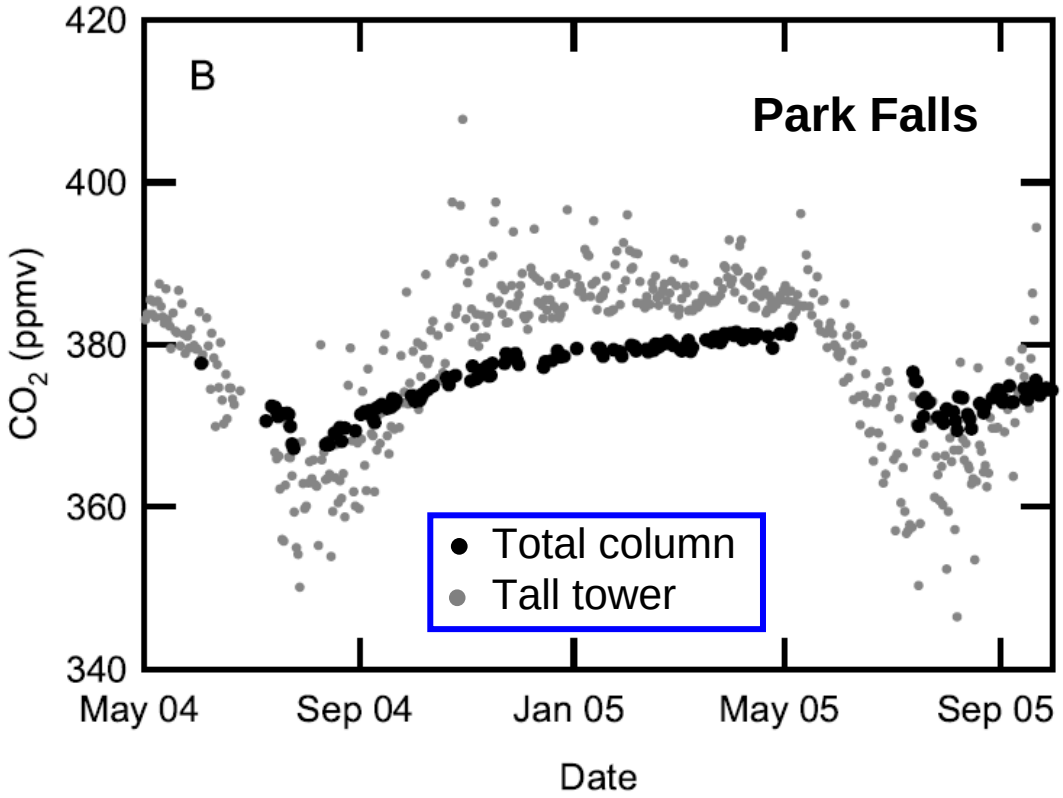
CO_2 profile at tall tower in Park Falls



(Data from http://www.esrl.noaa.gov/gmd/ccgg/towers/)

Seasonal amplitude of CO_2

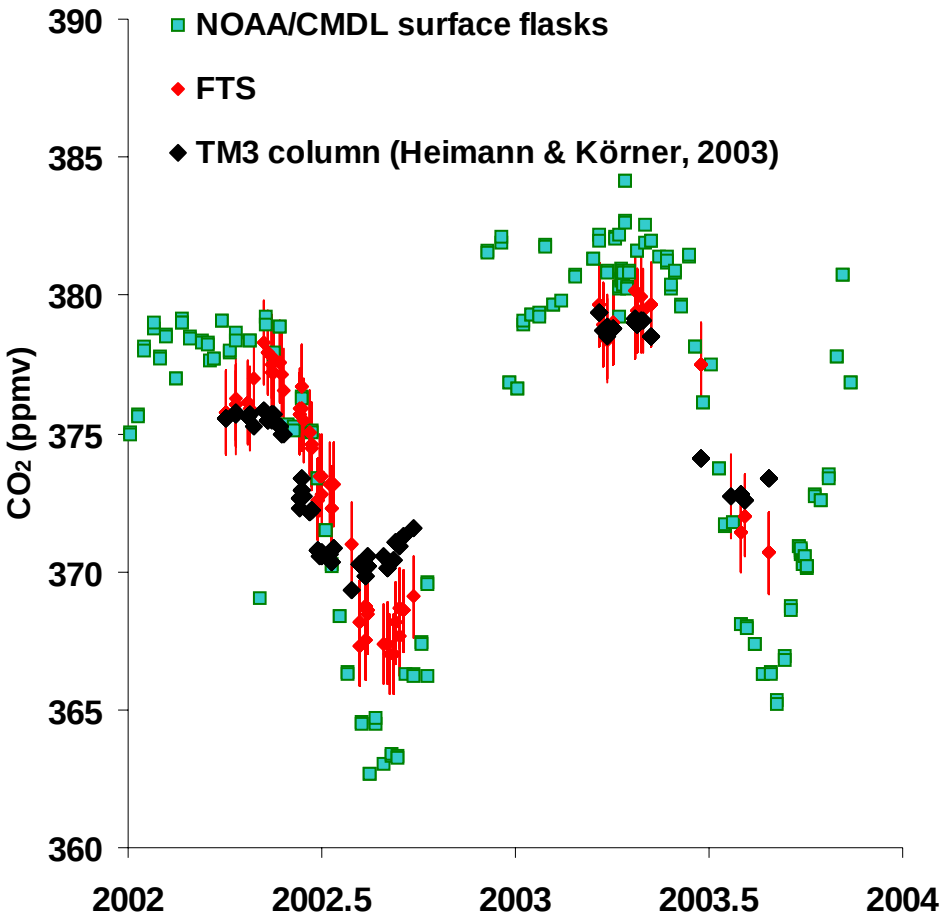




(Washenfelder et al, 2006)

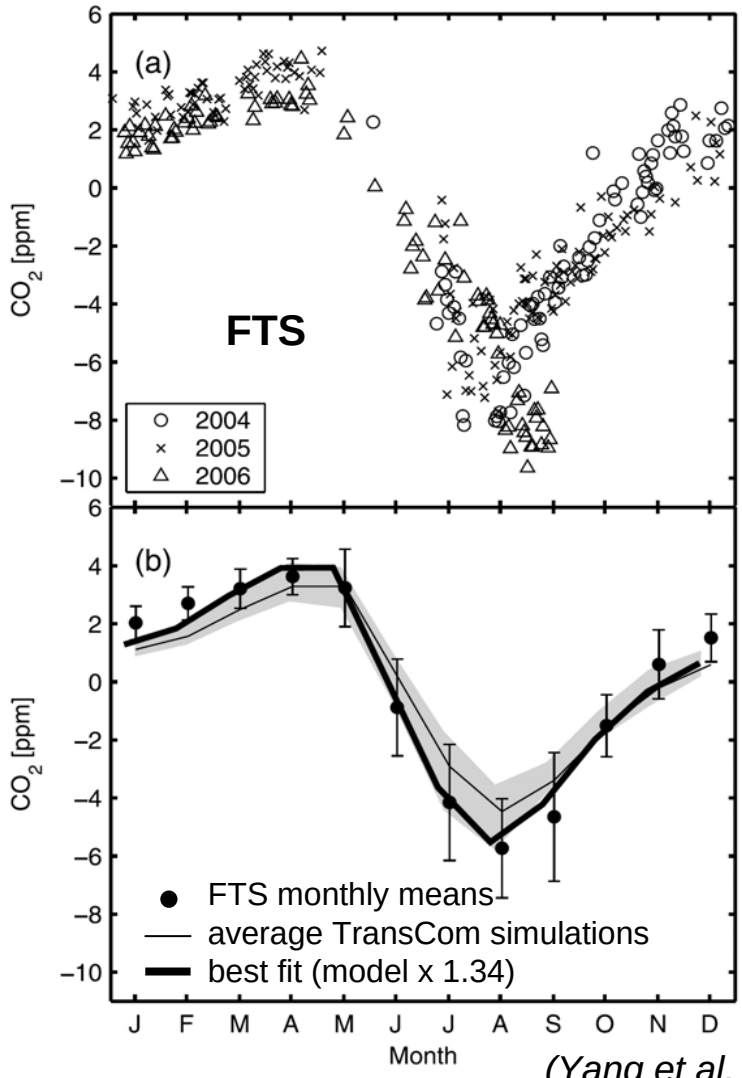
Model comparison

Ny-Ålesund, Spitsbergen, 79°N



(Warneke et al, 2005)

Park Falls, Wisconsin, 46°N



(Yang et al, 2007)

Remote sensing of CO_2 and CH_4

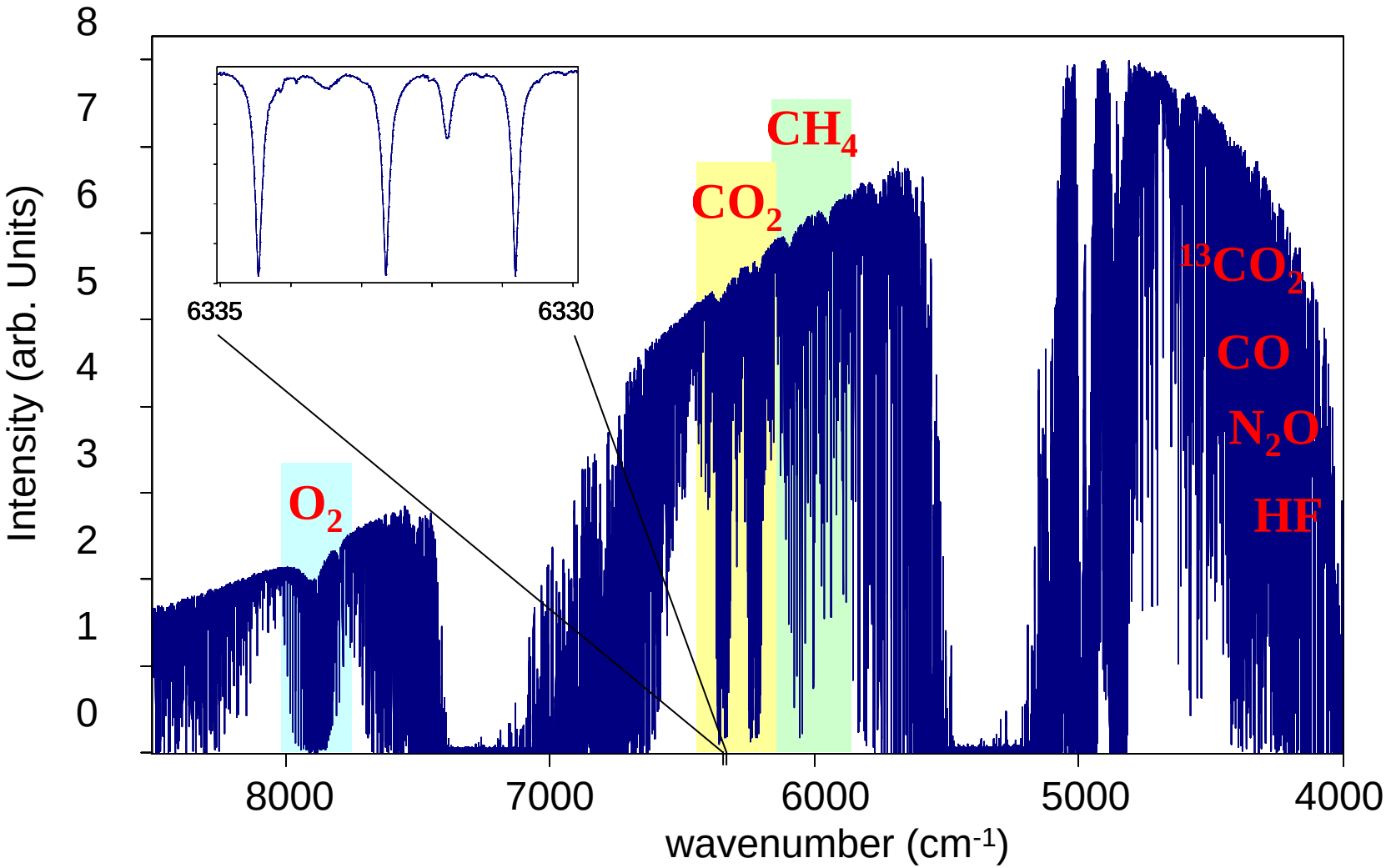
Retrieved quantity: Column averaged vmr

$$\rightarrow XCO_2 = \frac{CO_2}{O_2}$$

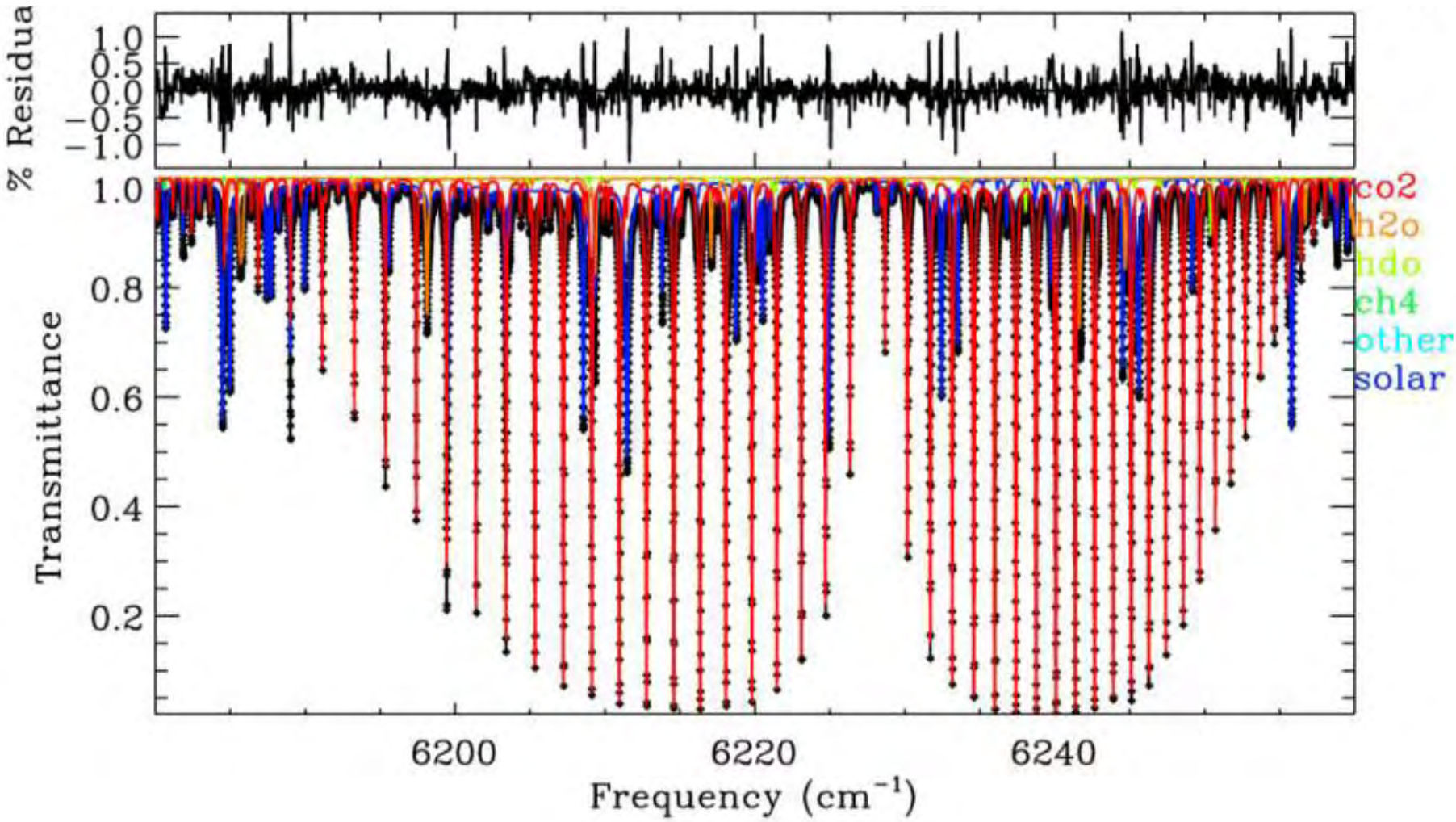
Precision

CO_2: < 0.3 %

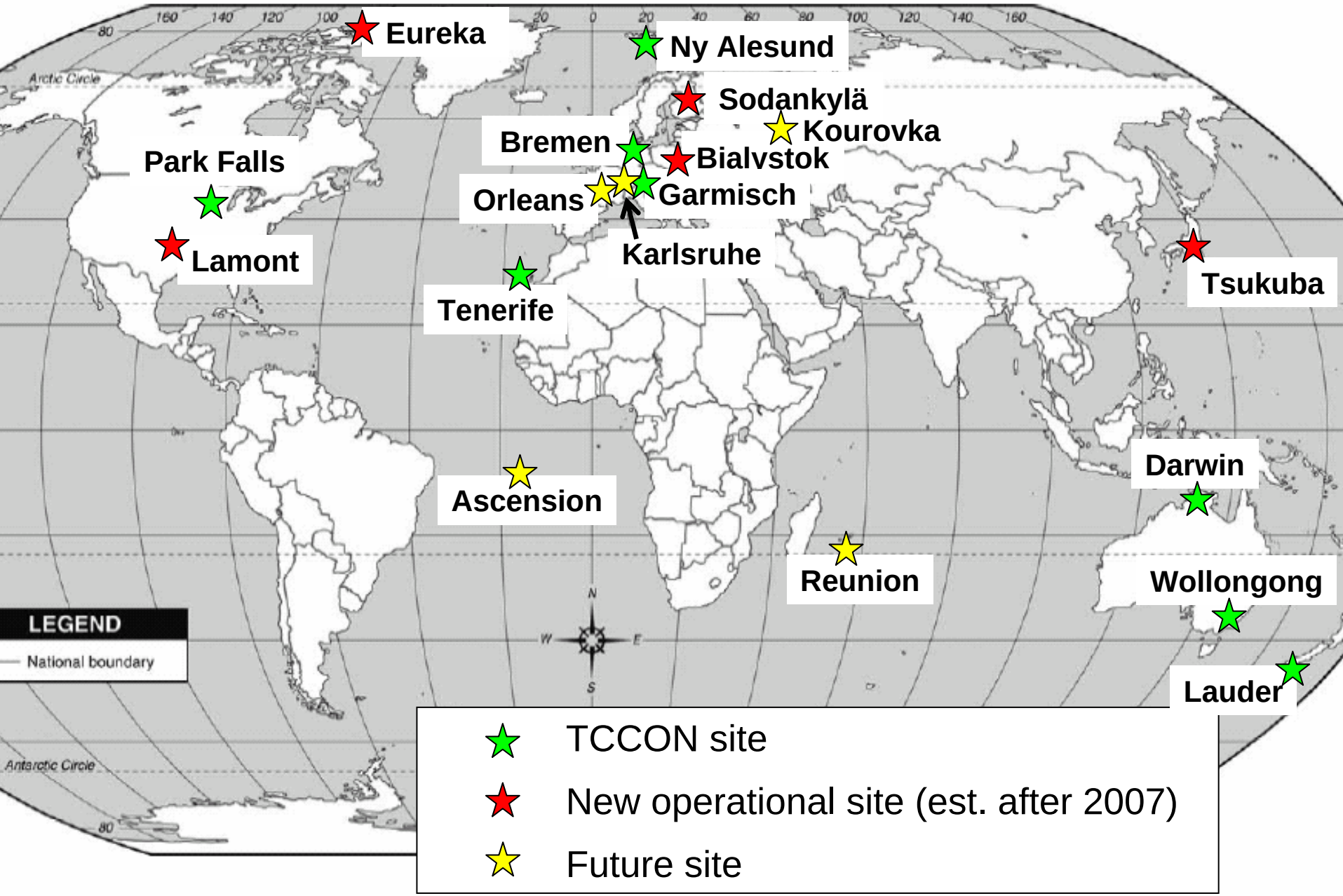
CH_4: < 0.5 %



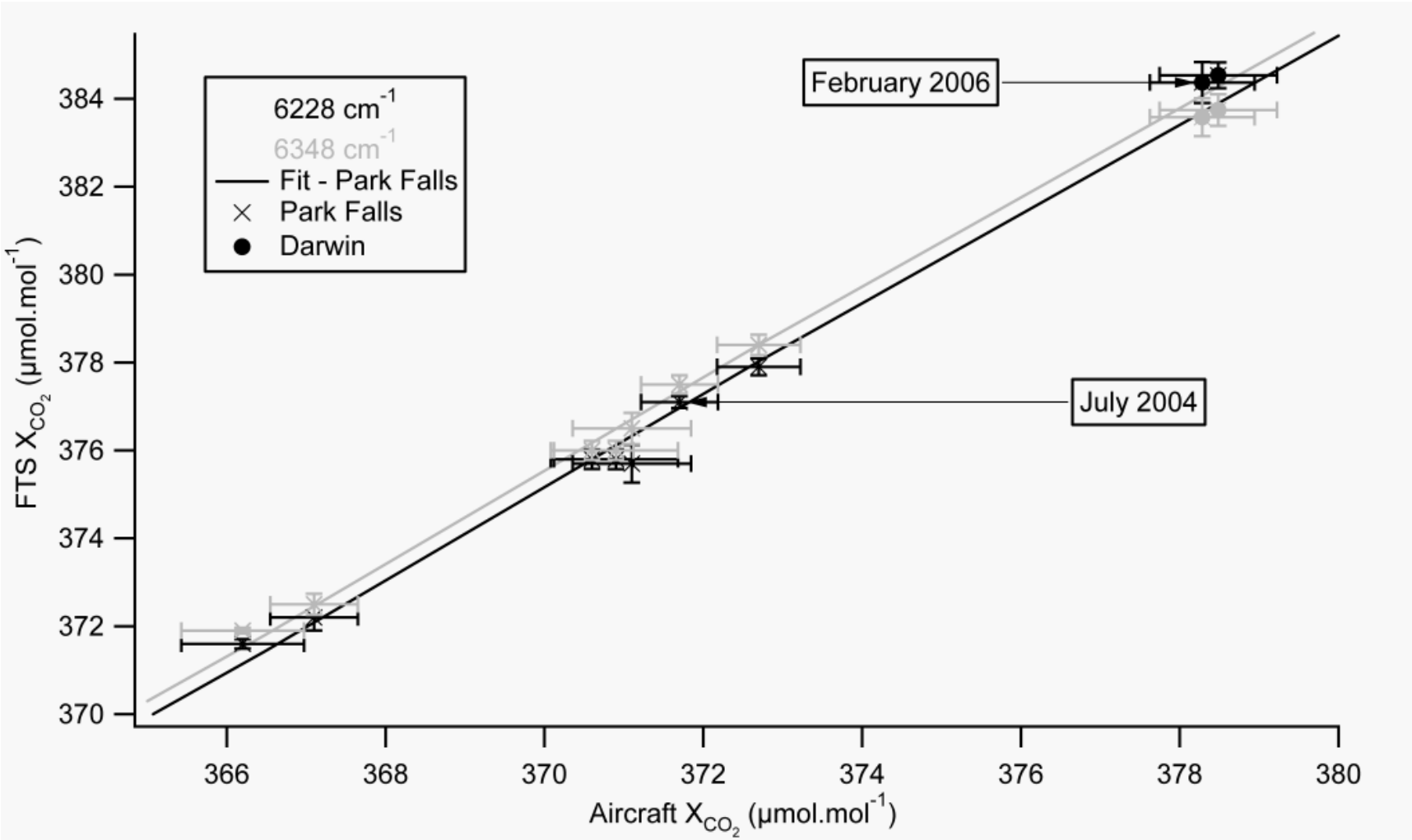
Example for CO_2



Current and future sites within the Total Carbon Column Observing Network

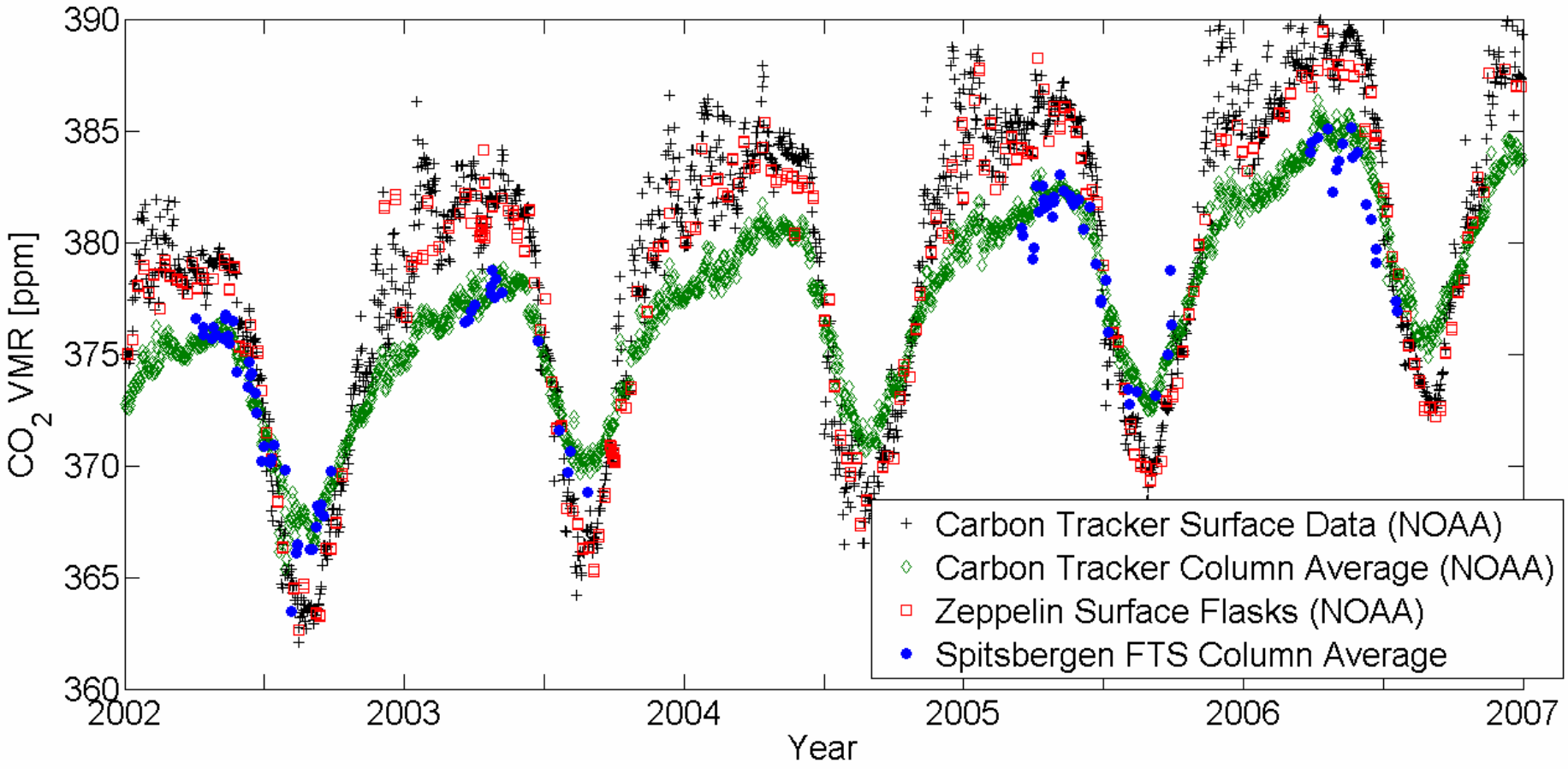


Calibration of the column measurements



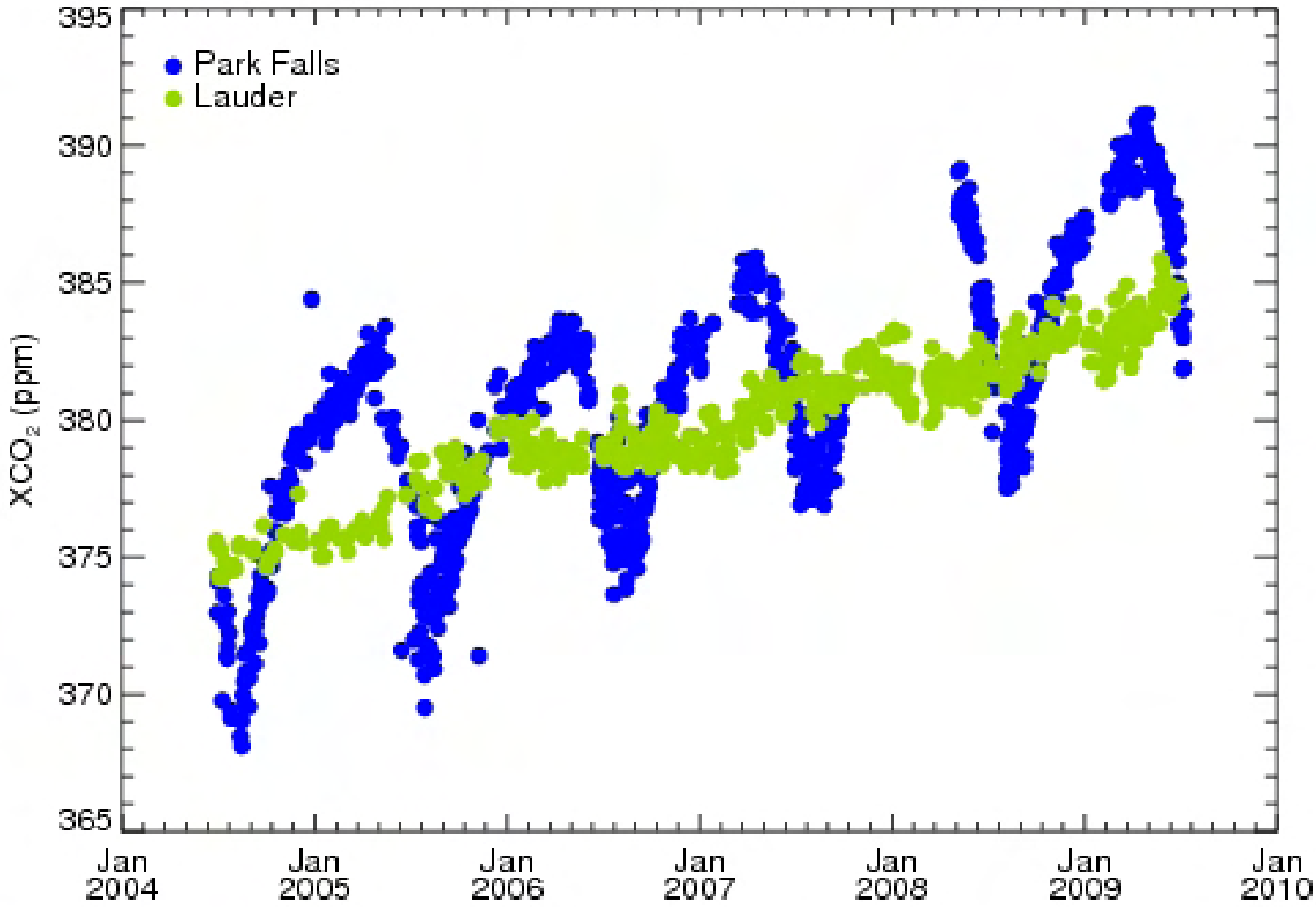
(Courtesy of N. Deutscher and D. Griffith, University of Wollongong)

Comparison with Carbon Tracker at Spitsbergen

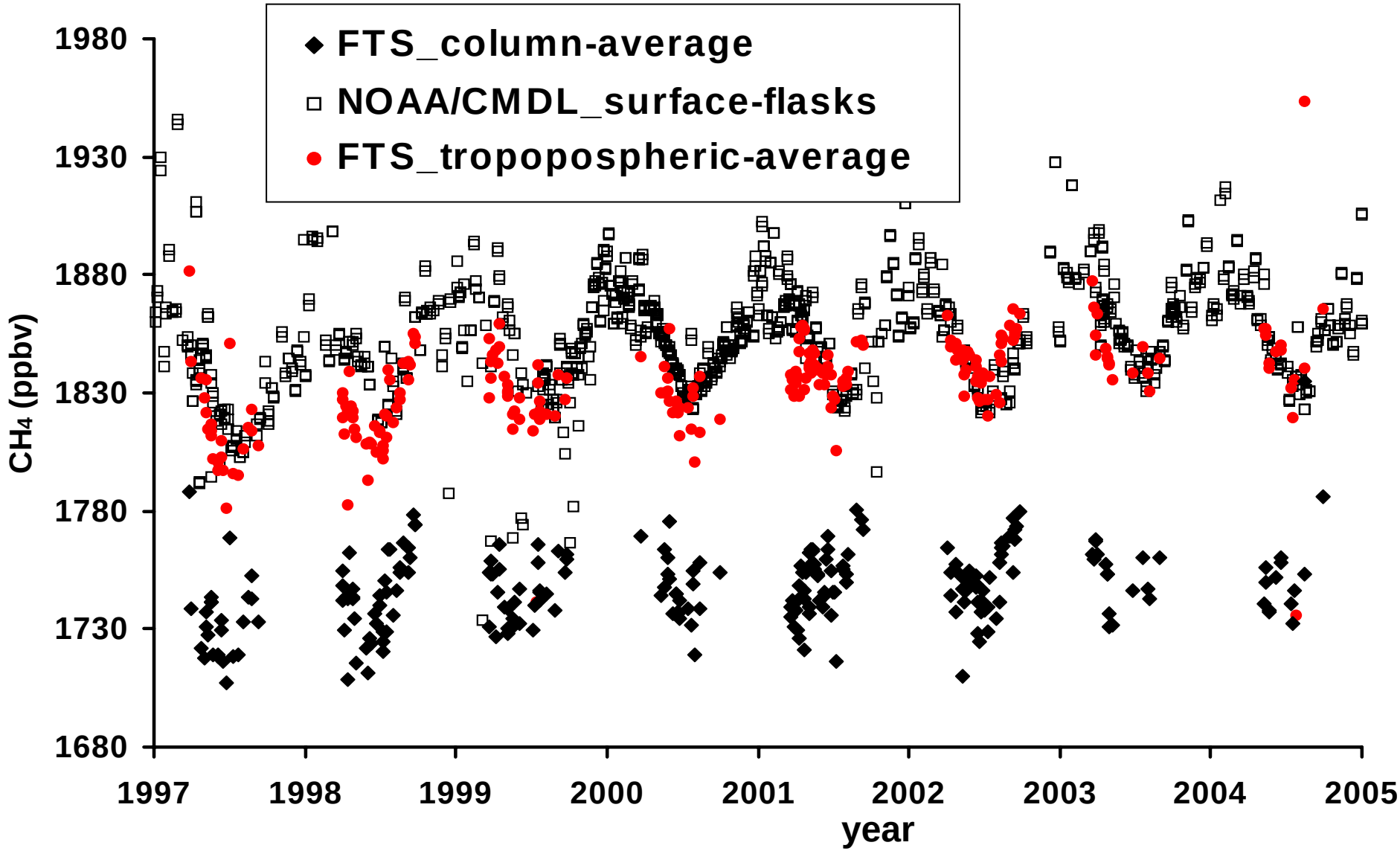


(ICDC - Posters: Macatangay et al. T4-045)

Observations of CO_2 at Park-Falls and Lauder



CH_4 at Spitsbergen – Comparison with surface *in situ* data

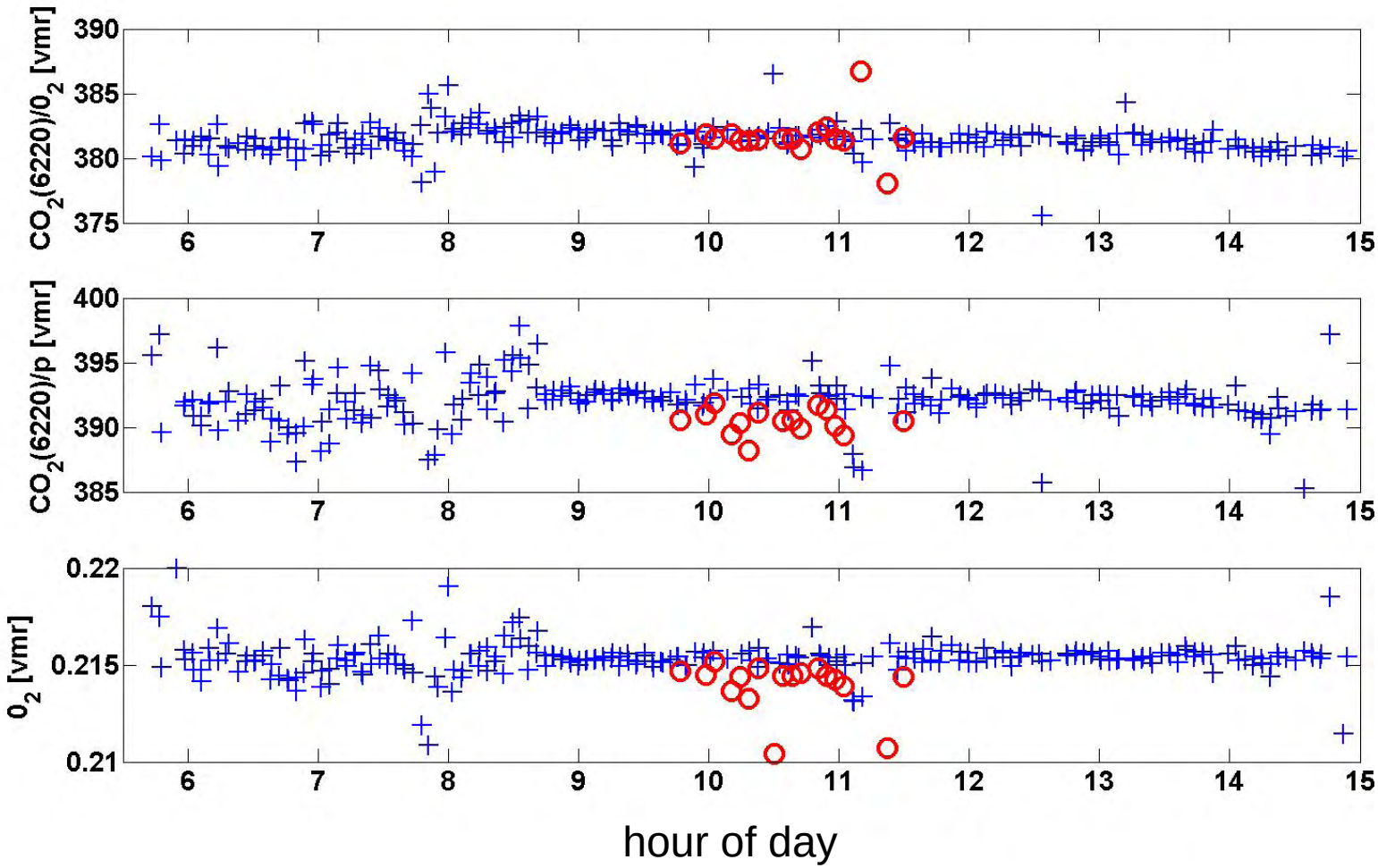


(Warneke et al, 2006)

EU-projects for integration of column data

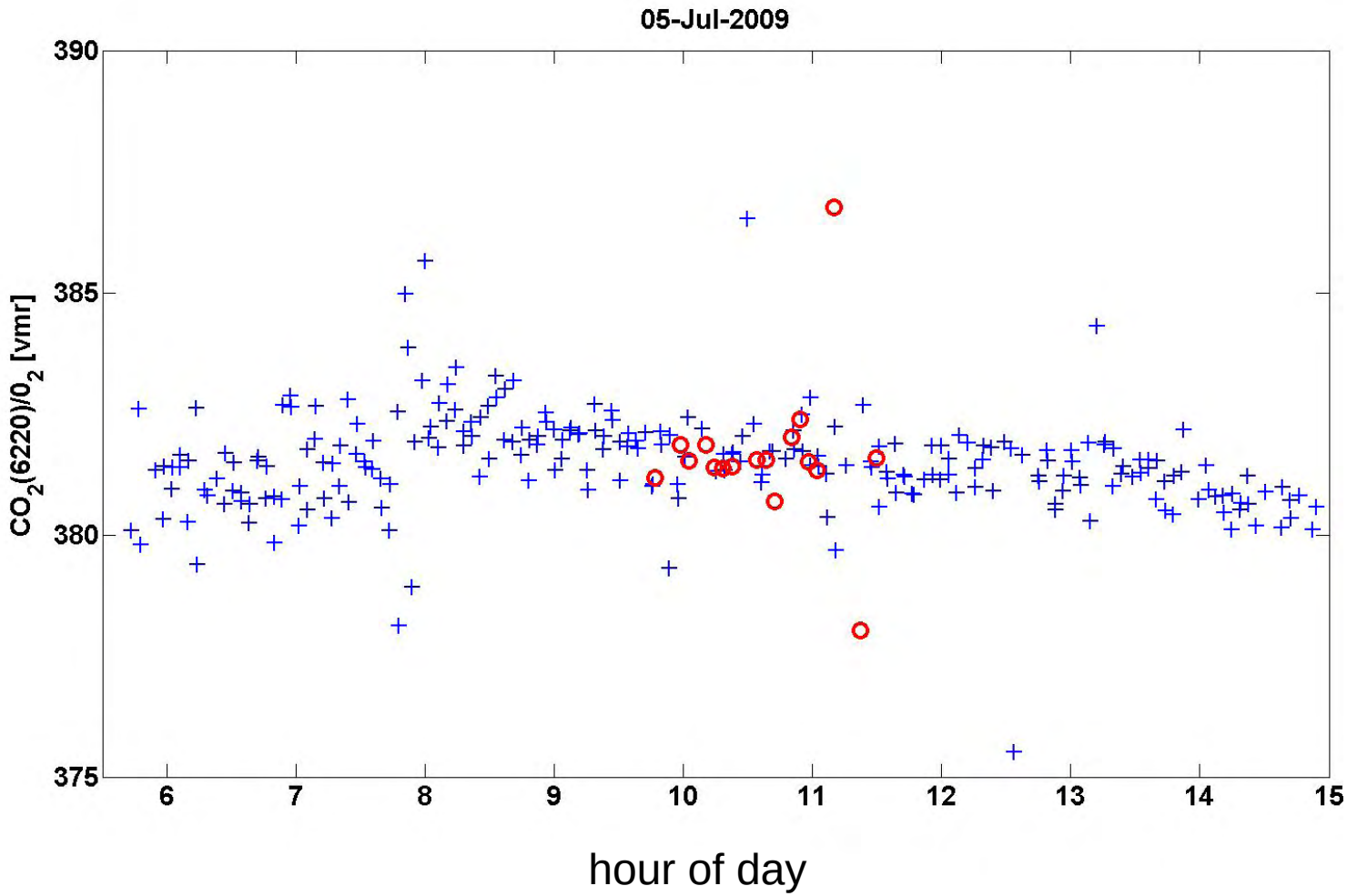
GEOMON: FTIR in Bialystok/Poland; IMECC: FTIR in Orleans/France

Instrumental intercomparison in Bremen
(5-July-2009, prelimenary data)



(ICDC - Posters: Messerschmidt et al. T4-088)

Instrumental intercomparison in Bremen
(5-July-2009, prelimenary data)



Variability (precision): < 0.25%
Comparability: < 0.25%

(ICDC - Posters: Messerschmidt et al. T4-088)

EU-projects for integration of column data

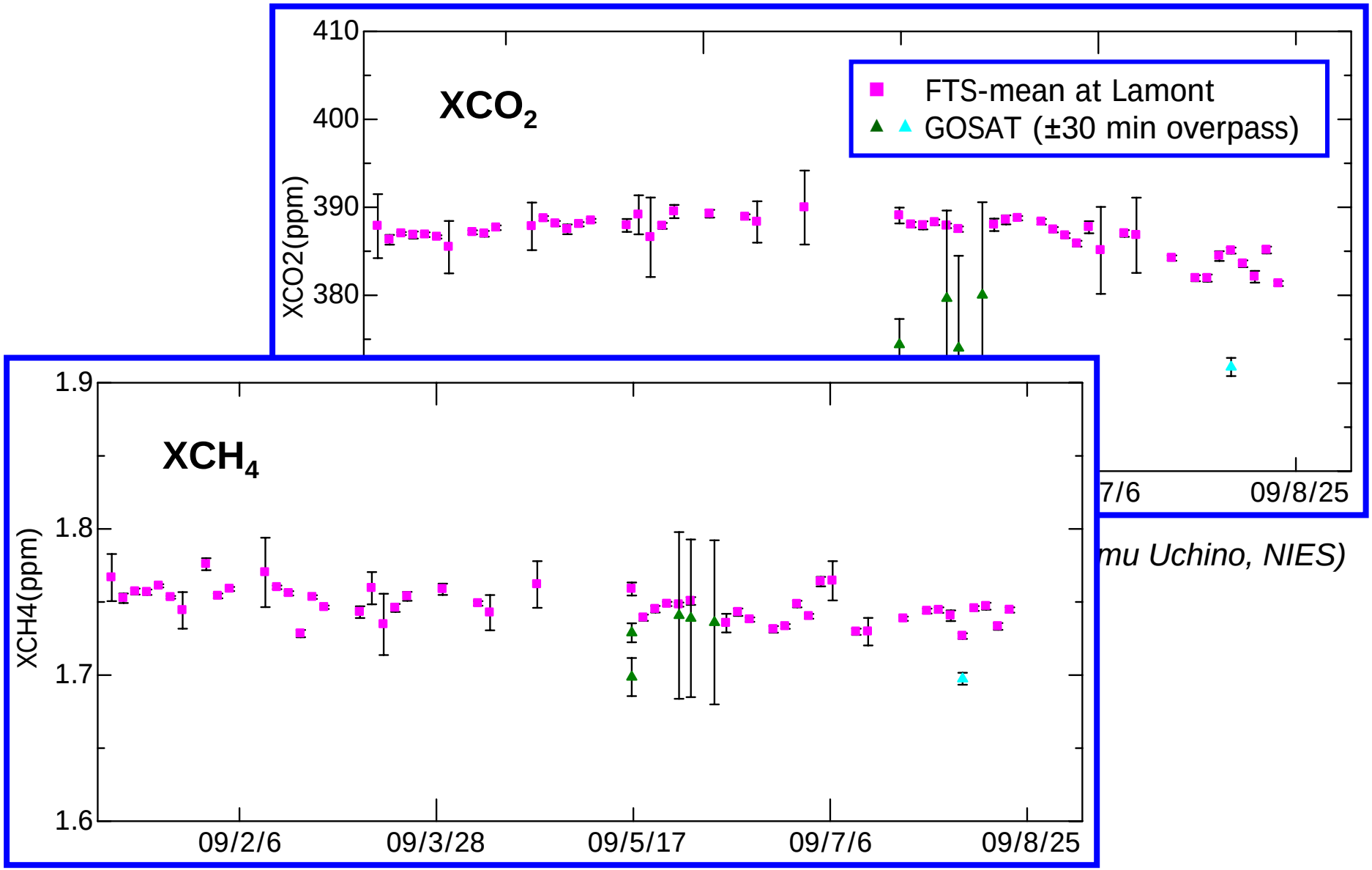
GEOMON: FTIR in Bialystok/Poland; IMECC: FTIR in Orleans/France

Satellite observations

Two-step strategy for the integration of satellite data into the existing global observing system for CO_2:

1. Calibrate the TCCON column data against the WMO standard
2. Calibrate/validate the satellite data using the TCCON network

Comparison GOSAT with ground-based FTS at Lamont (36.6N)



mu Uchino, NIES)

(courtesy of Osamu Uchino, NIES)

Conclusions

- Ground-based solar absorption spectrometry in the near-infrared has the necessary precision and accuracy for long-term monitoring of greenhouse gases
- Satellite XCO_2 data can be calibrated against the WMO standard for CO_2 using ground-based solar absorption FTIR-spectrometry as a transfer standard
- TCCON will play a vital role in the global observing system for greenhouse gases in the future
- Funding for the FTIR-observations is short-term, which is could result in discontinuous time-series in the future

Acknowledgement

- EU-projects GEOMON, IMECC
- National funding (DFG and City of Bremen)
- TCCON members (esp. P. Wennberg, D. Griffith, G.C. Toon)