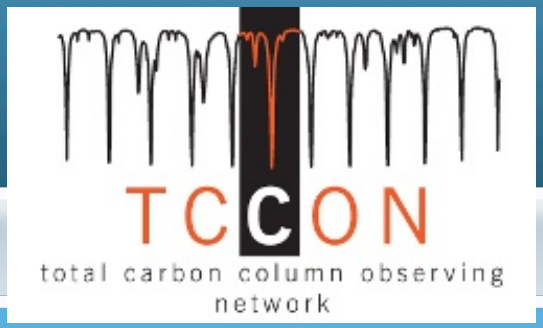
Validating GHG Satellite Data Using the Total Carbon Column Observing Network



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iup

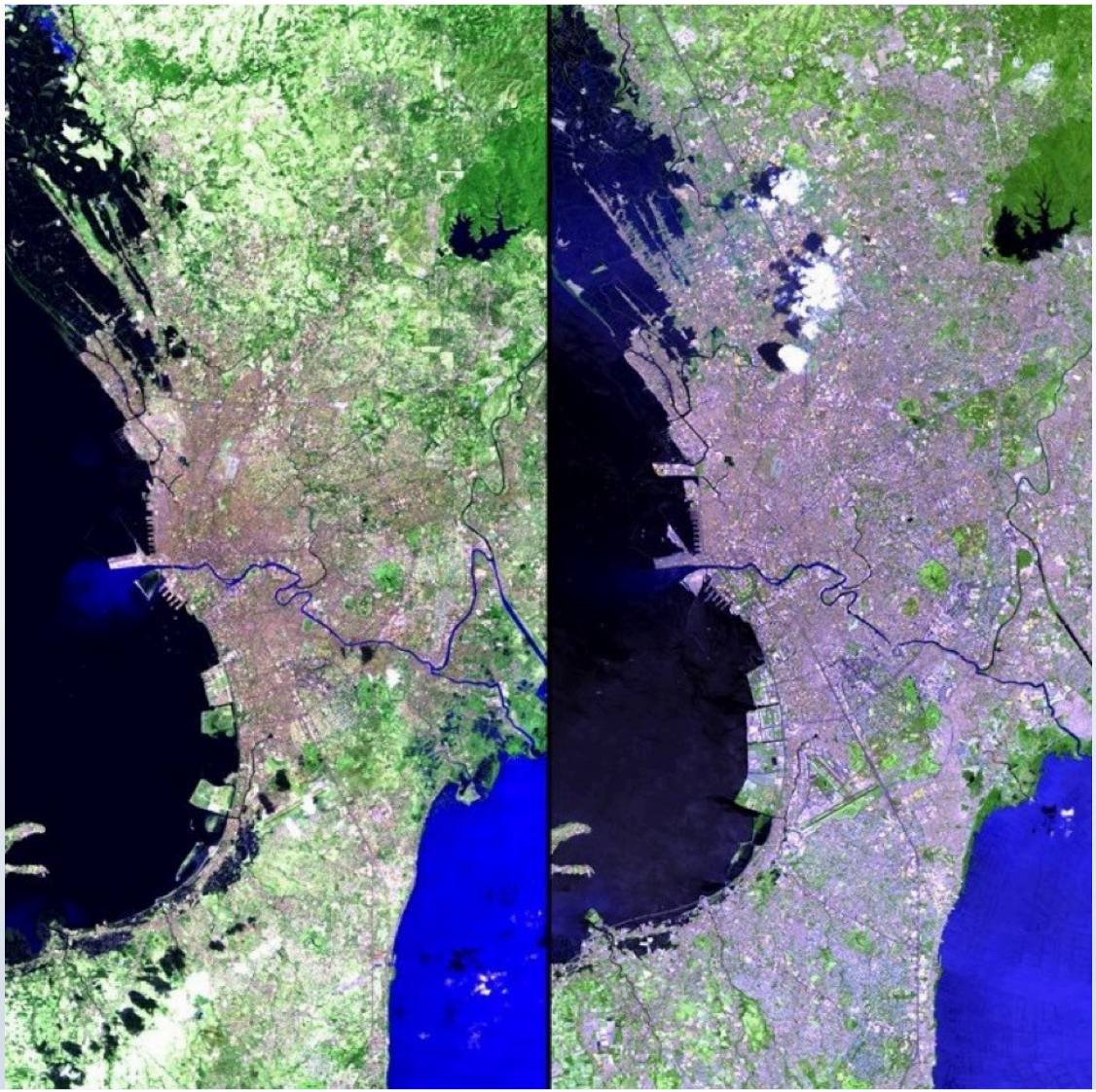
Universität Bremen*

UNIVERSITY OF WOLLONGONG

CENTRE FOR ATMOSPHERIC CHEMISTRY

INSTITUTE of ENVIRONMENTAL SCIENCE & METEOROLOGY
2003
University of the Philippines

Floods

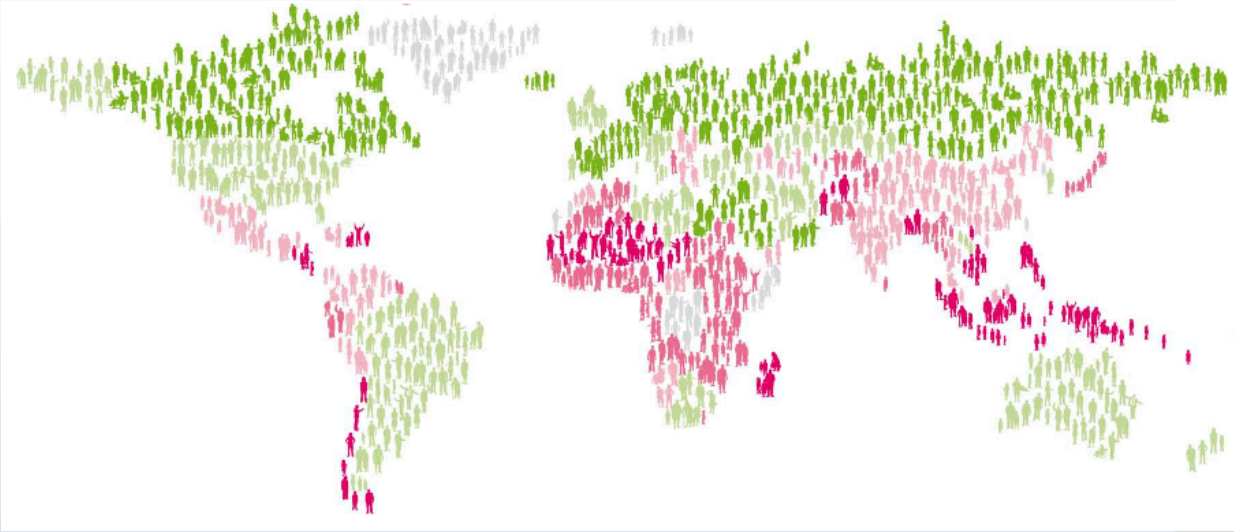


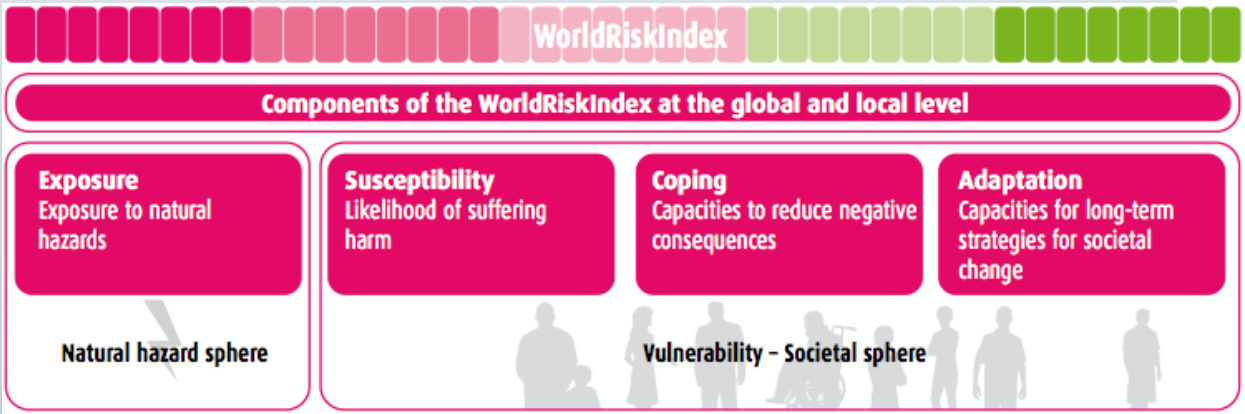
1989 2012

Rapid Urbanization

The Urban Heat Island Effect

In 2011, the Philippines ranked 3rd in the list of countries most vulnerable to climate change.

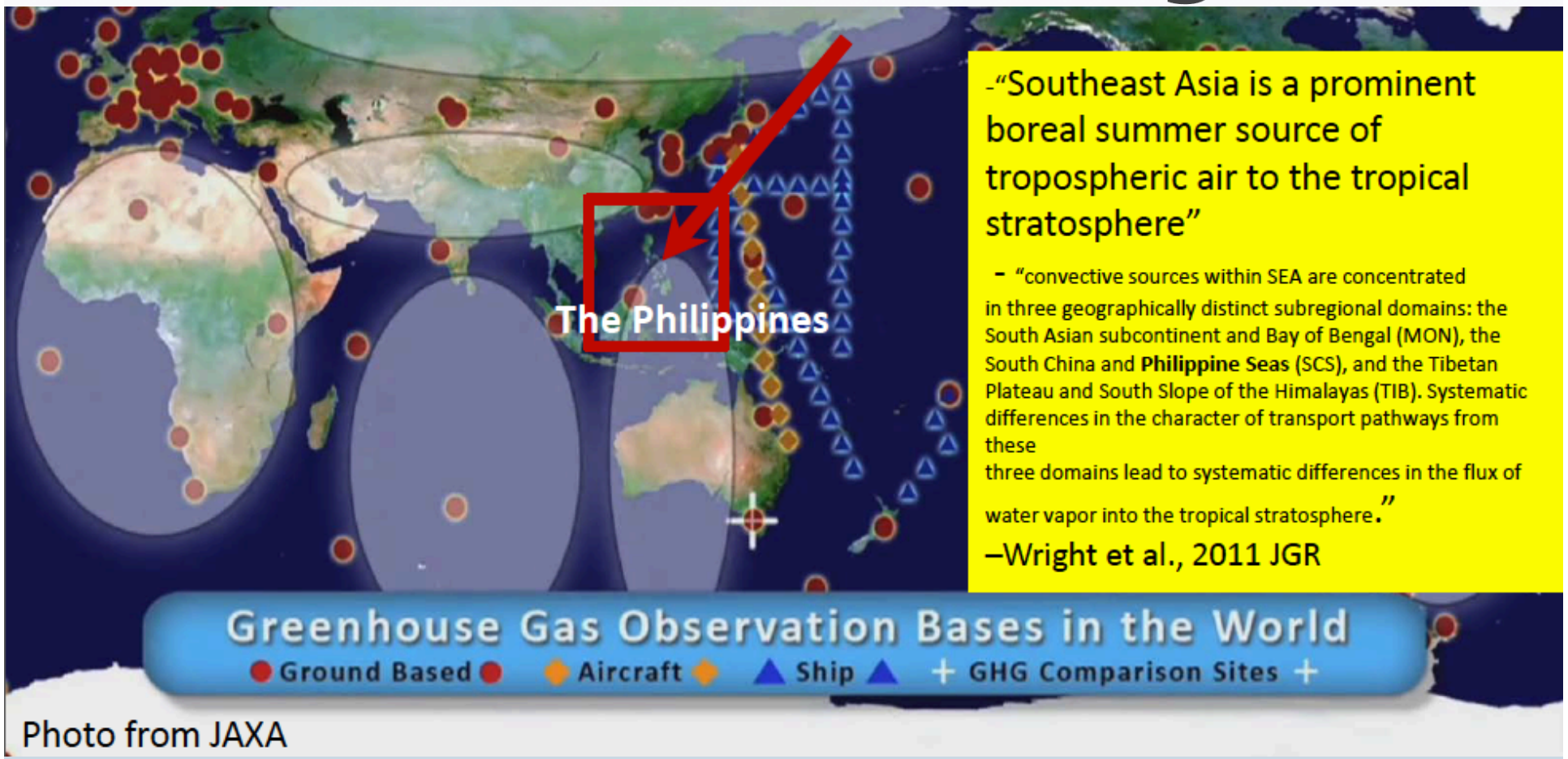




WorldRiskIndex

Rank	Country	Risk (%)
1	Vanuatu	32.00
2	Tonga	29.08
3	Philippines	24.32
4	Solomon Islands	23.51
5	Guatemala	20.88
6	Bangladesh	17.45
7	Timor-Leste	17.45
8	Costa Rica	16.74
9	Cambodia	16.58
10	El Salvador	16.49
11	Nicaragua	15.74
12	Papua New Guinea	15.45
13	Madagascar	14.46
14	Brunei Darussalam	14.08
15	Afghanistan	14.06

Importance of the Southeast Asian Region



-"Southeast Asia is a prominent boreal summer source of tropospheric air to the tropical stratosphere"

- "convective sources within SEA are concentrated in three geographically distinct subregional domains: the South Asian subcontinent and Bay of Bengal (MON), the South China and **Philippine Seas** (SCS), and the Tibetan Plateau and South Slope of the Himalayas (TIB). Systematic differences in the character of transport pathways from these three domains lead to systematic differences in the flux of water vapor into the tropical stratosphere."

–Wright et al., 2011 JGR

Photo from JAXA

The Southeast Asian Region

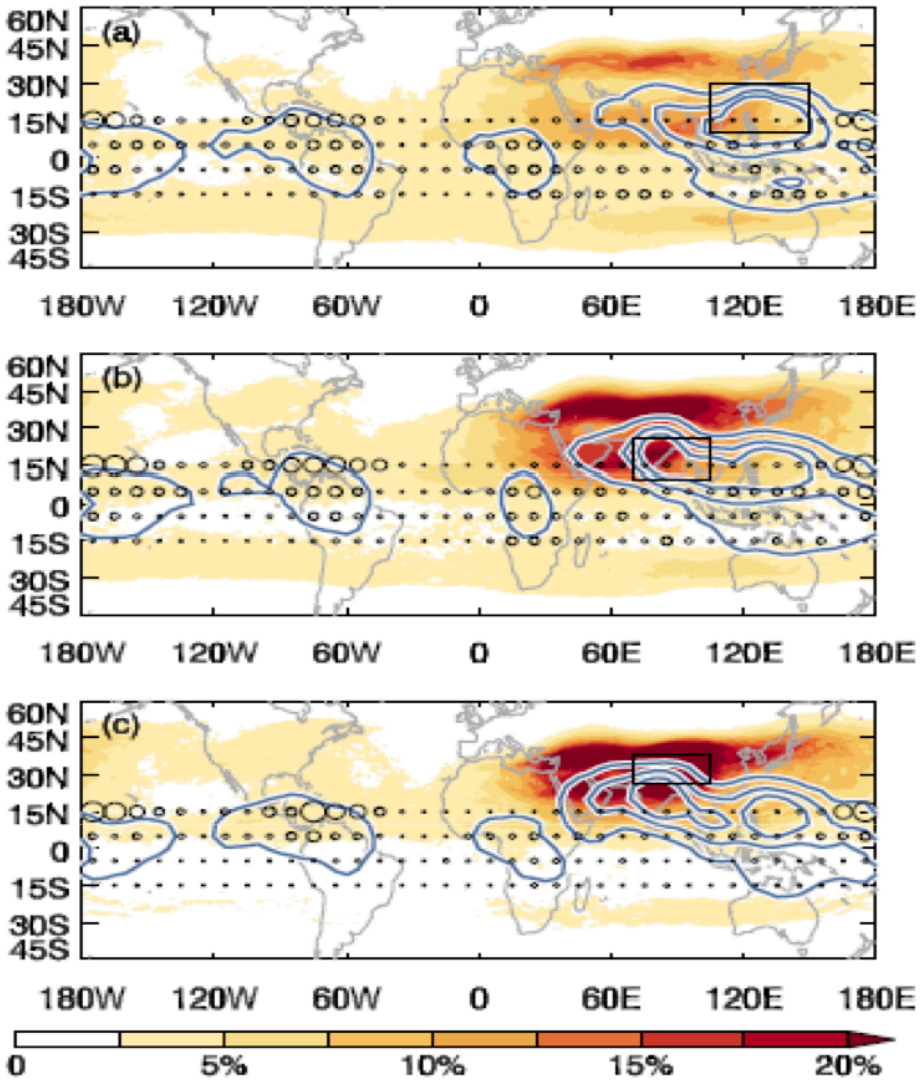


Figure 7. Preferred transport pathways (shading), distributions of LDP locations (solid blue contours), and distribution of entry to the tropical pipe (above 75 hPa; within 15°S–15°N) (black circles) for GMAO MERRA trajectories with convective sources in (a) SCS, (b) MON, and (c) TIB.

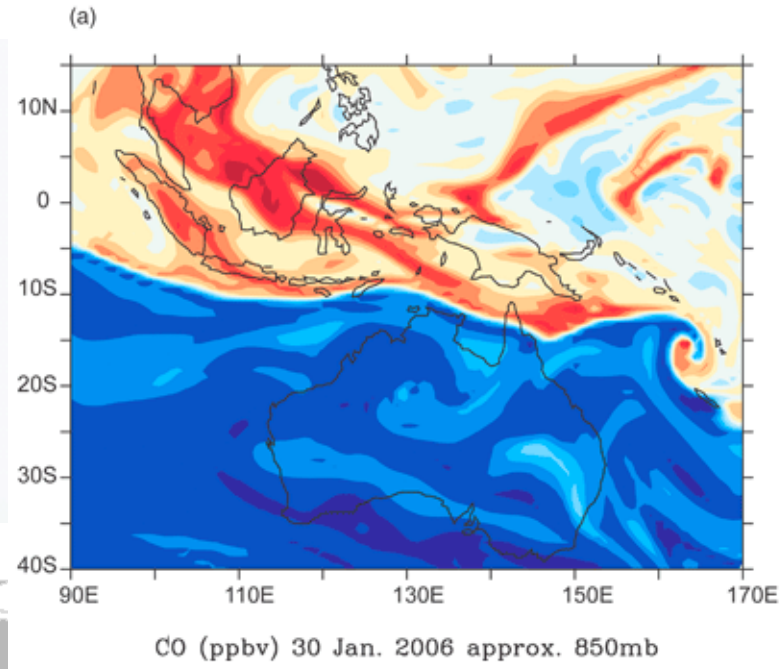
Importance of the region around Southeast Asia

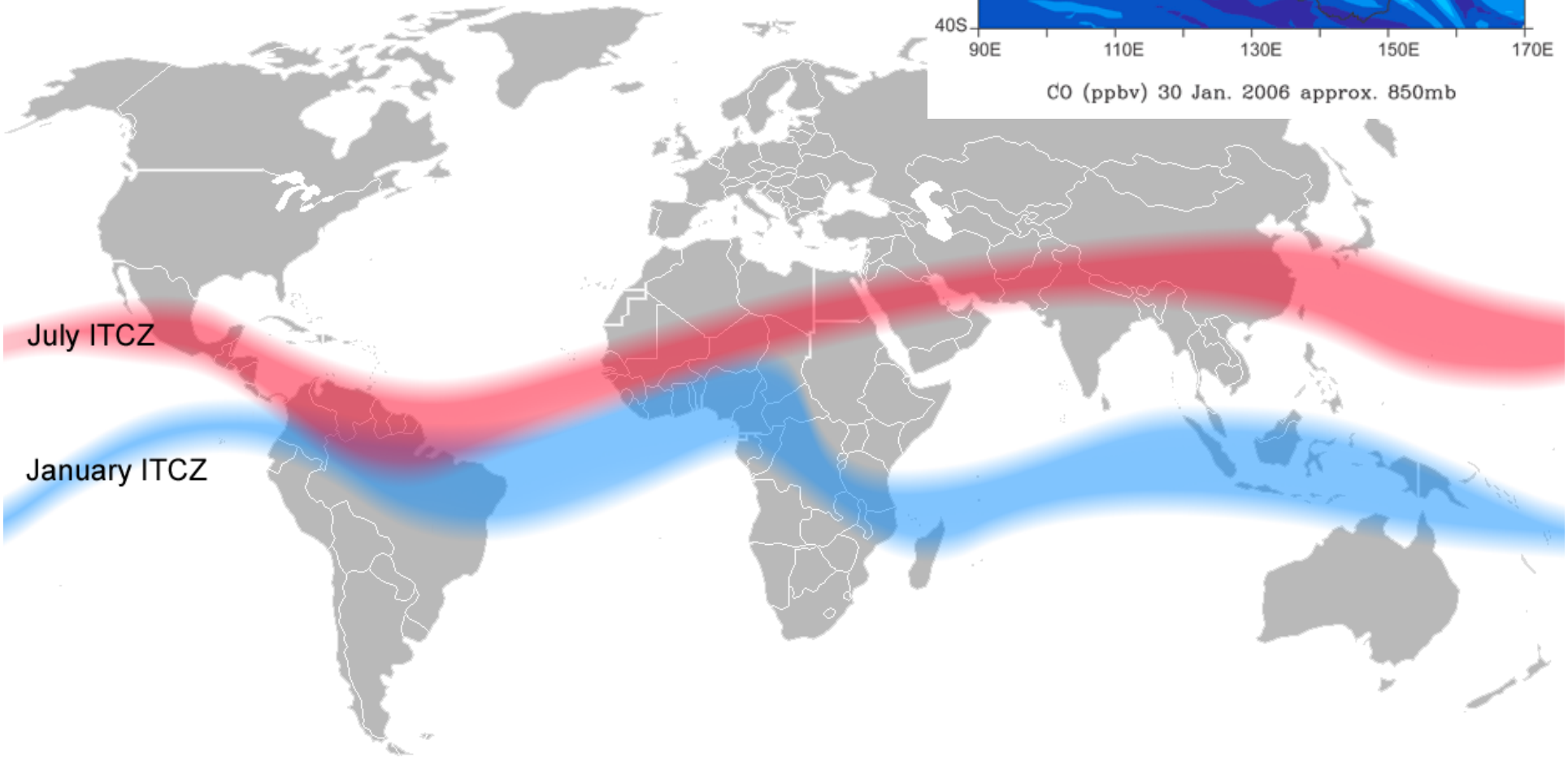
1st: SE Asia is the preeminent **tropospheric source of air** entering the tropical stratosphere during boreal summer.

2nd: temperature imprint carried by **water vapor entering the stratosphere** is disproportionately **set by conditions in the tropopause layer above Southeast Asia**.

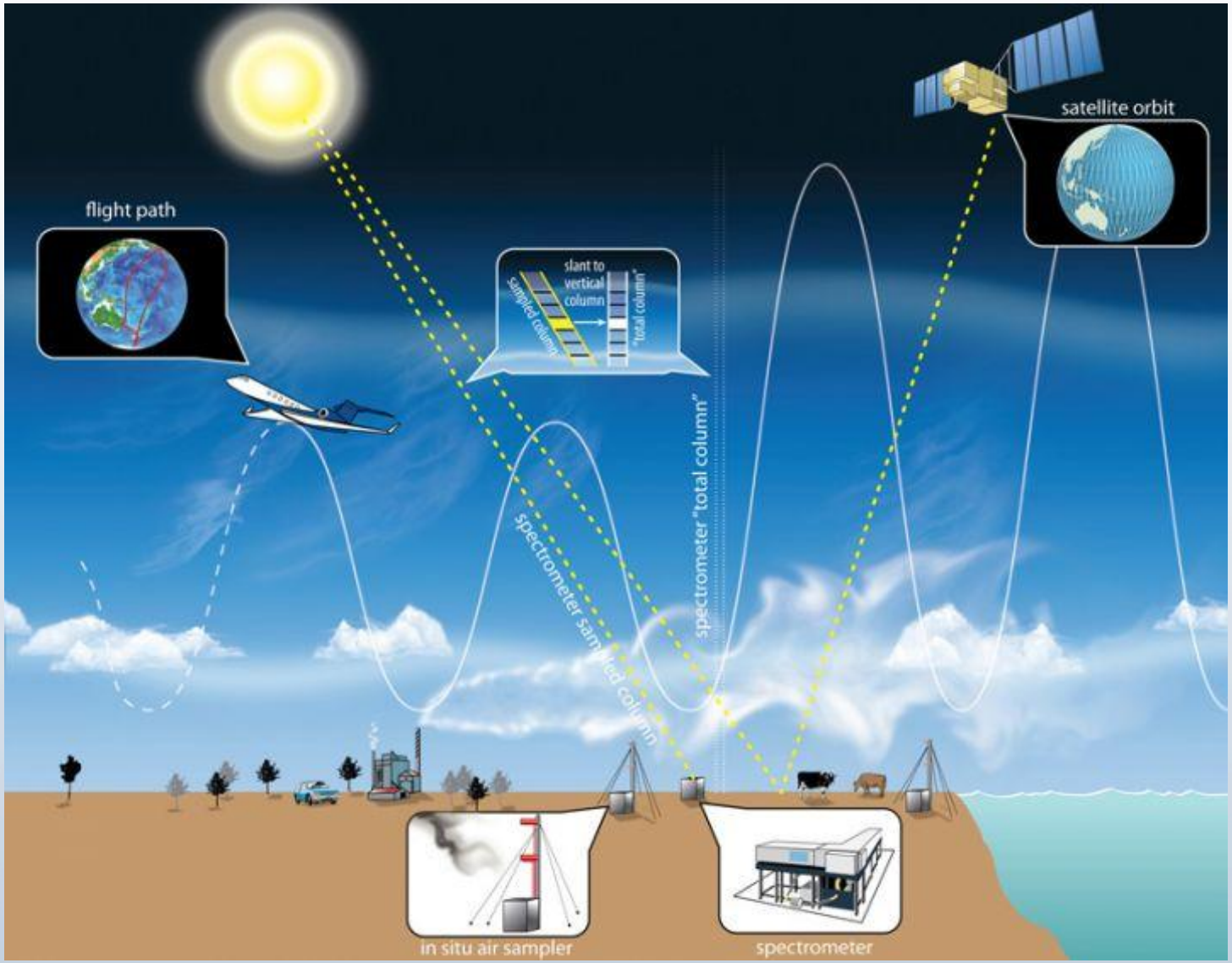
-Wright et al, 2011 (JGR)

ITCZ and the Chemical Equator

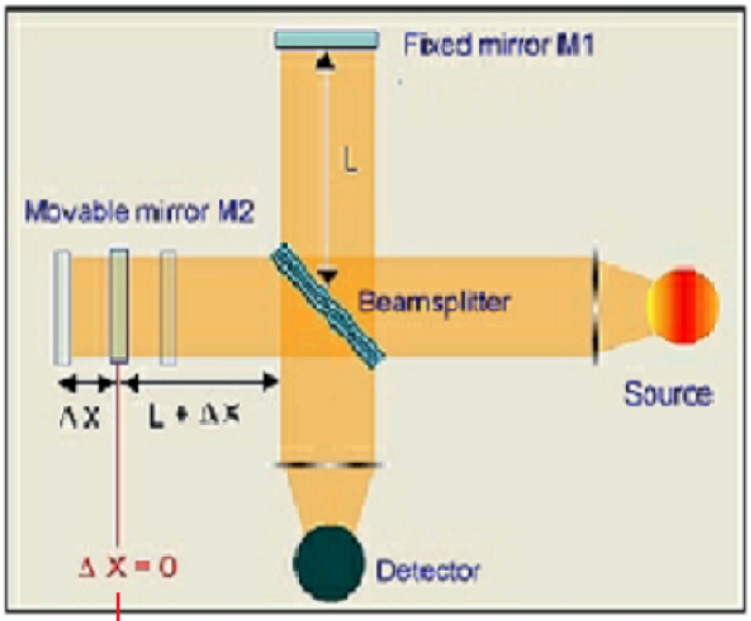


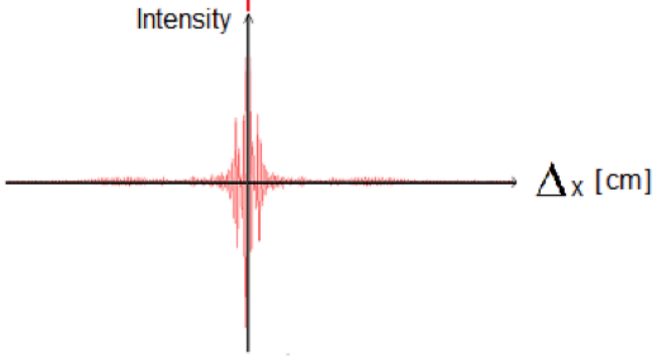


GHG Measurements



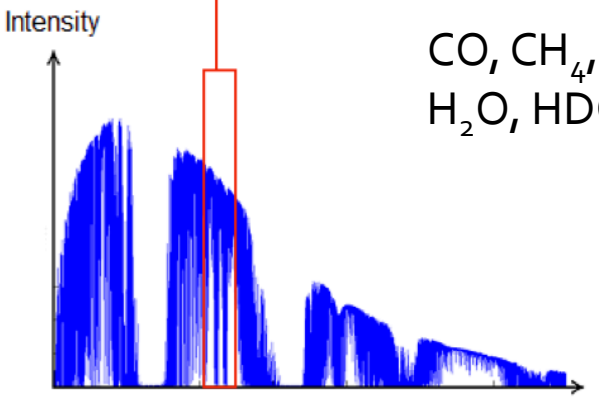
Fourier Transform Infrared (FTIR) Spectrometry





Interferogram

Fourier Transform



Spectra

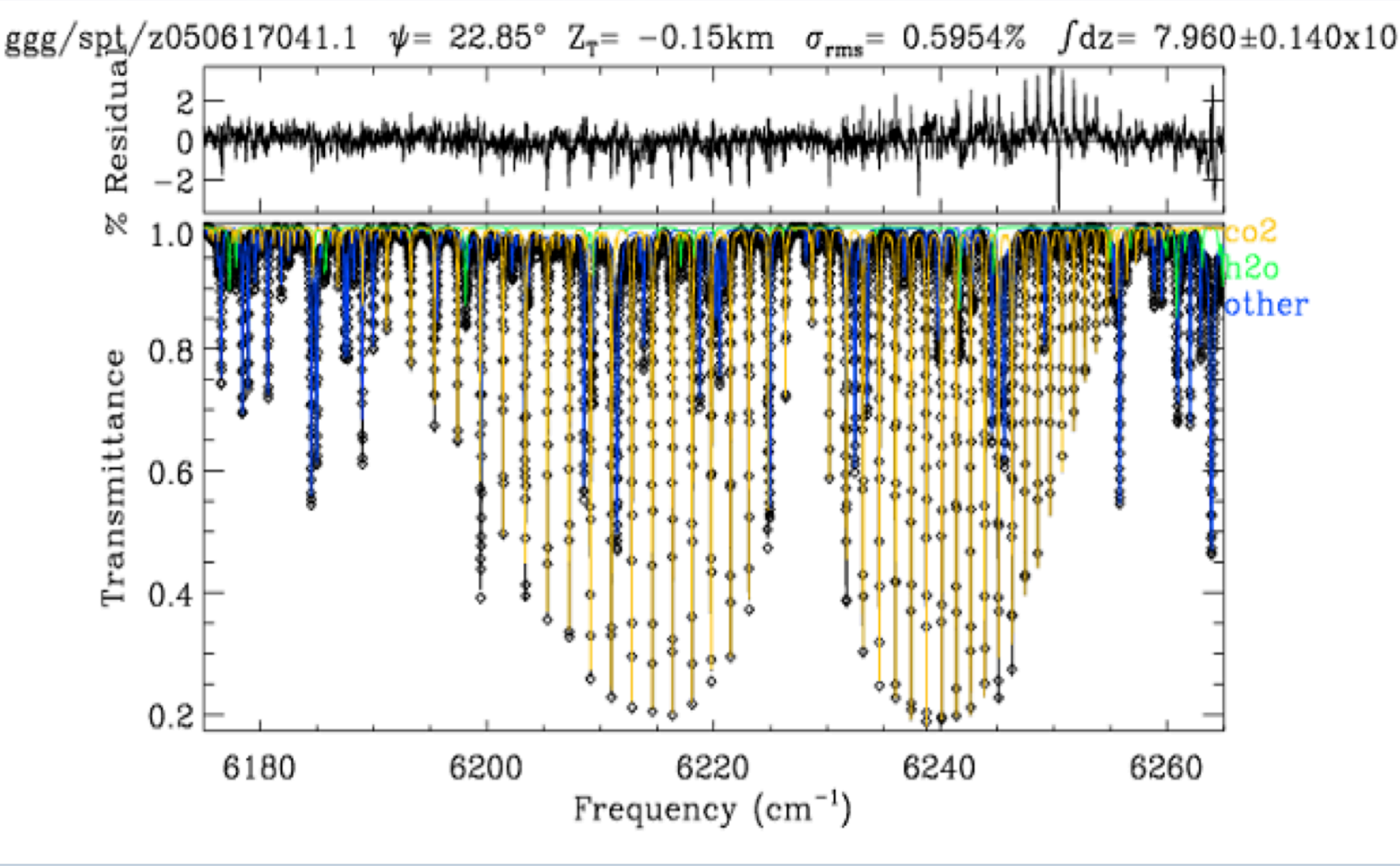
CO_2

6180 – 6260 cm^{-1}
(1.597 – 1.618 µm)
6297 – 6382 cm^{-1}
(1.567 – 1.588 µm)

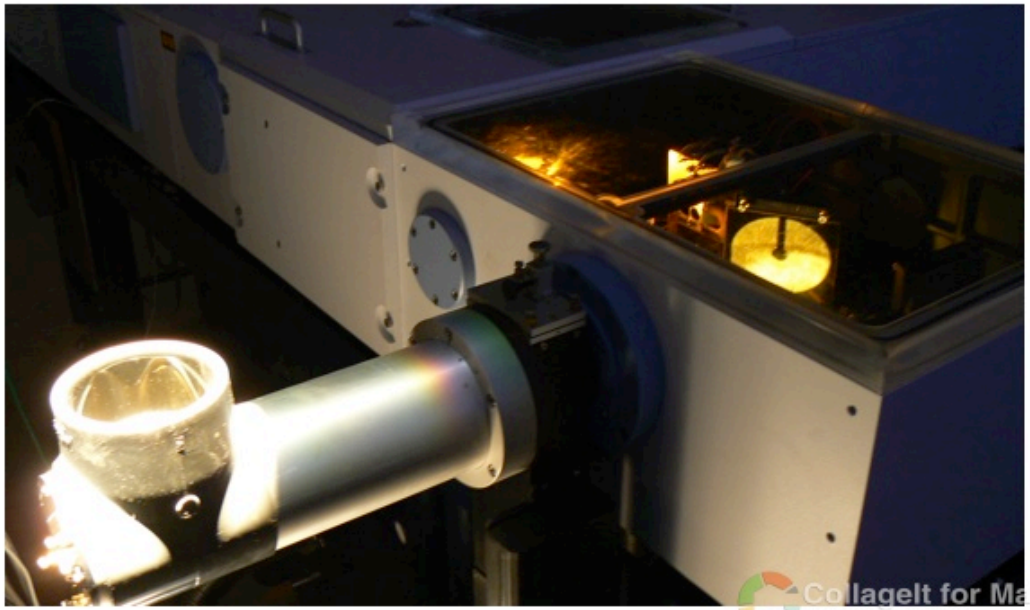
Other trace gases retrieved simultaneously:

CO, CH_4, N_2O, HF, H_2O, HDO

Retrieval / Inverse Methods



Ground-based Solar Absorption Measurements



Total Carbon Column Observing Network (TCCON)

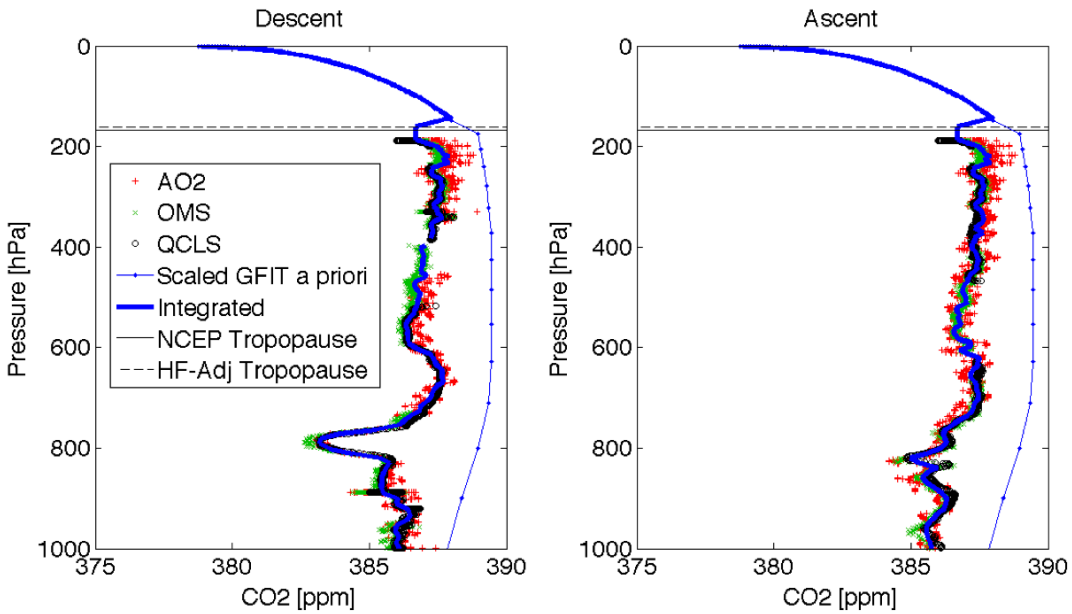
- Total Carbon Column Observing Network Has Grown Enormously in the last few years!

Calibrating TCCON Data

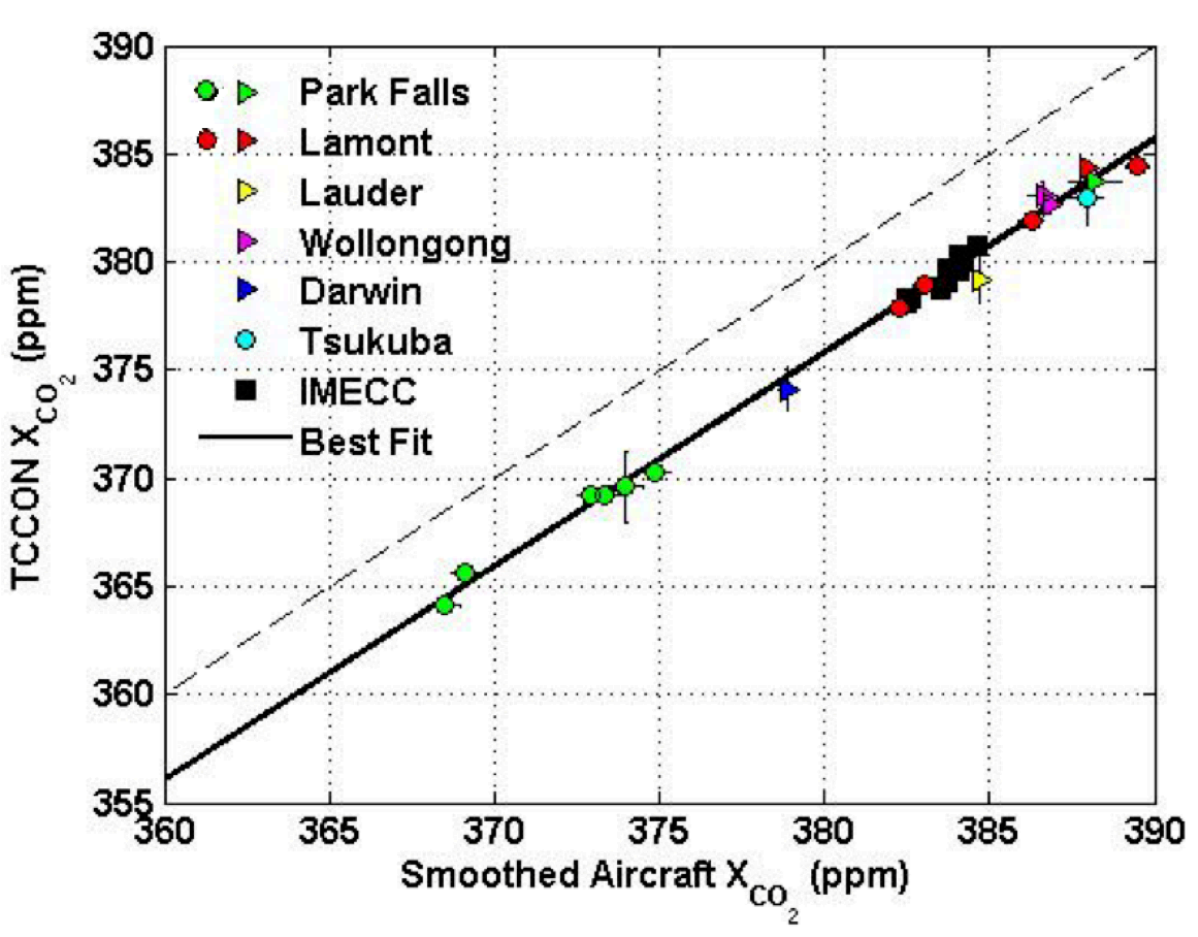
HIAPER Pole-to-Pole Project

http://hippo.ucar.edu/

HIPPO-II Overpass

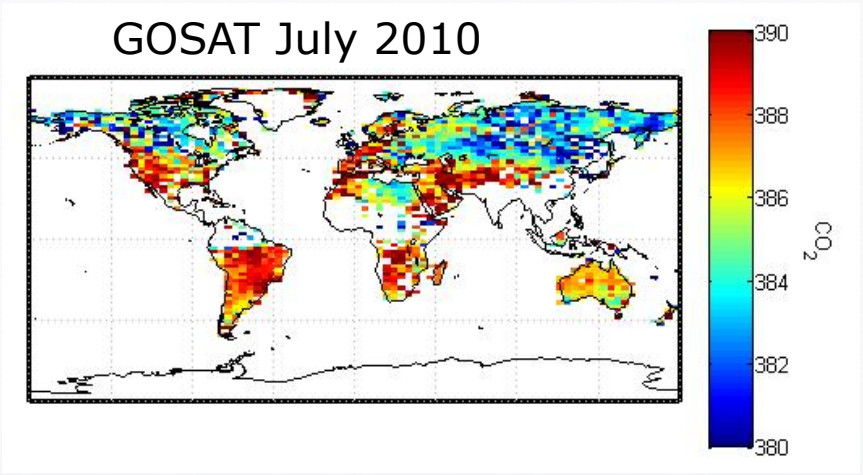


TCCON Calibration Curve



Satellite measurements of atmospheric CO_2

- Satellite measurements
  - SCIAMACHY
  - GOSAT 1 & 2
  - CARBONSAT
  - OCO-2
- Excellent global coverage
- Measure total columns of CO_2
- Poor precision and accuracy compared with the ground in situ stations but an abundance of measurements to average



SCIAMACHY

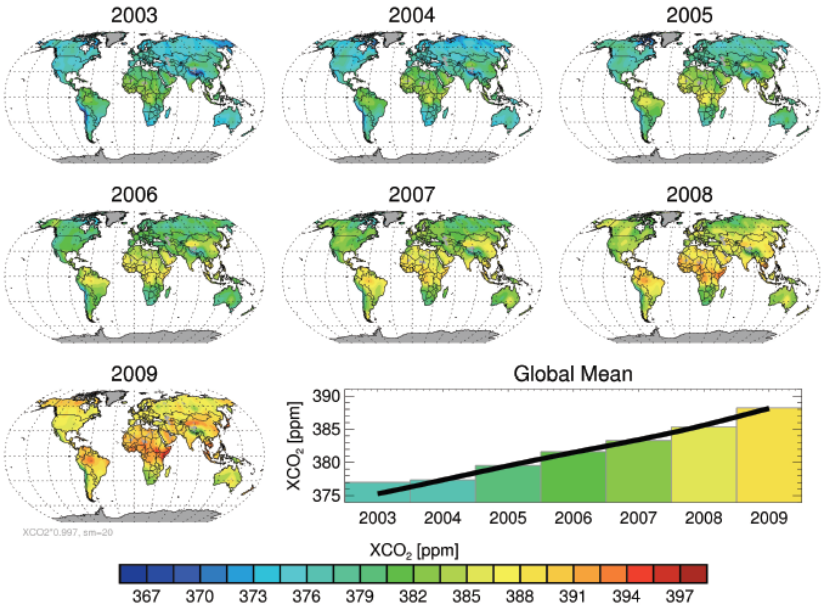
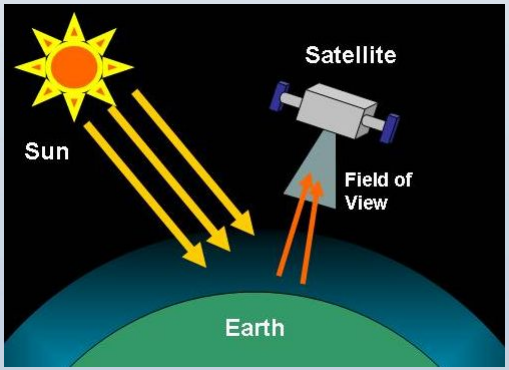


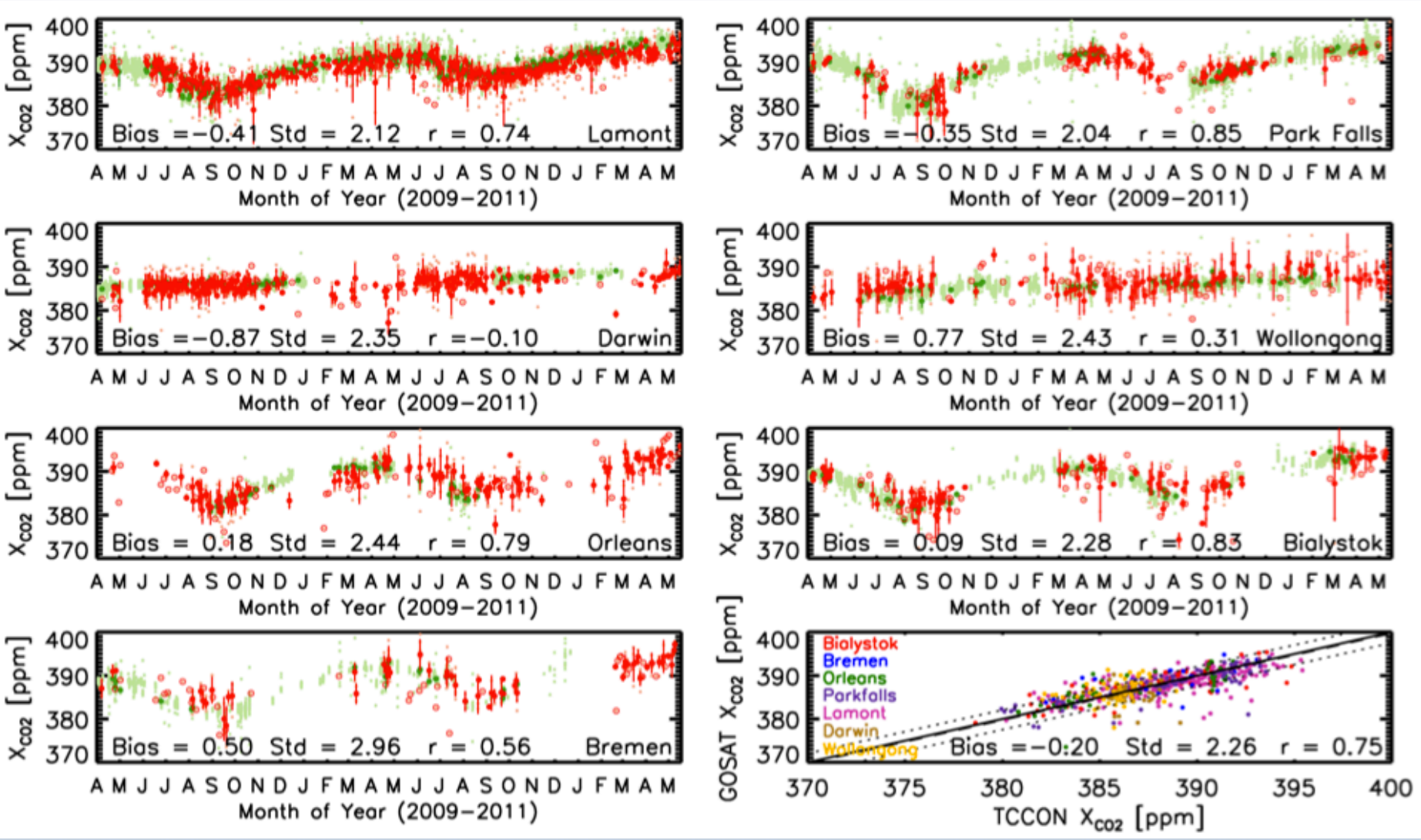
Fig. 2. Annual composite averages of quality filtered WFMDv2.1 XCO_2 for the years 2003–2009. Also shown are the corresponding global means demonstrating the steady increase of the retrieved carbon dioxide with time.

Schneising et al., ACPD, 10, 2010.



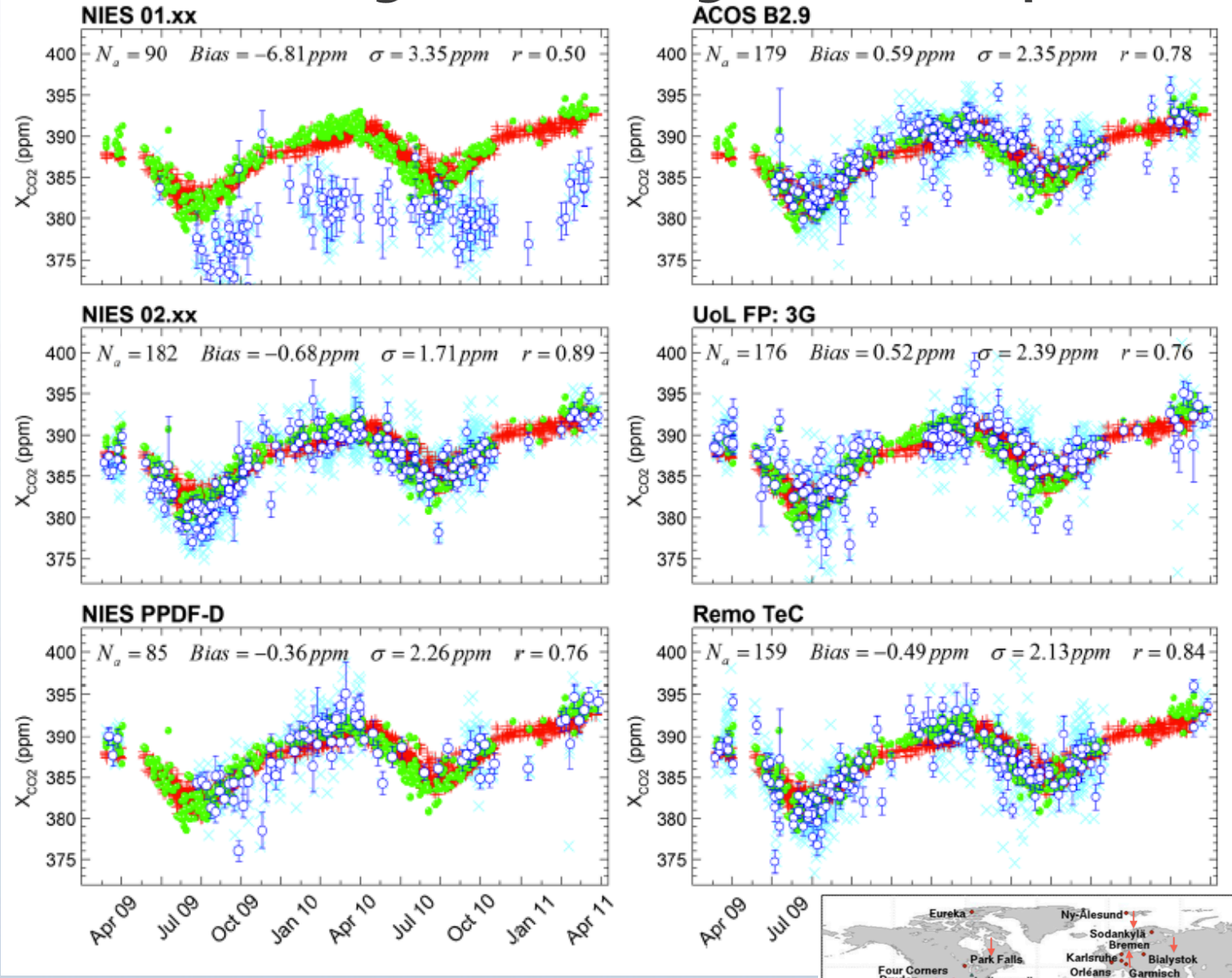
http://en.wikipedia.org/wiki/File:Nadir_Viewing_Geometry.jpg

Ground-based and Satellite Measurements



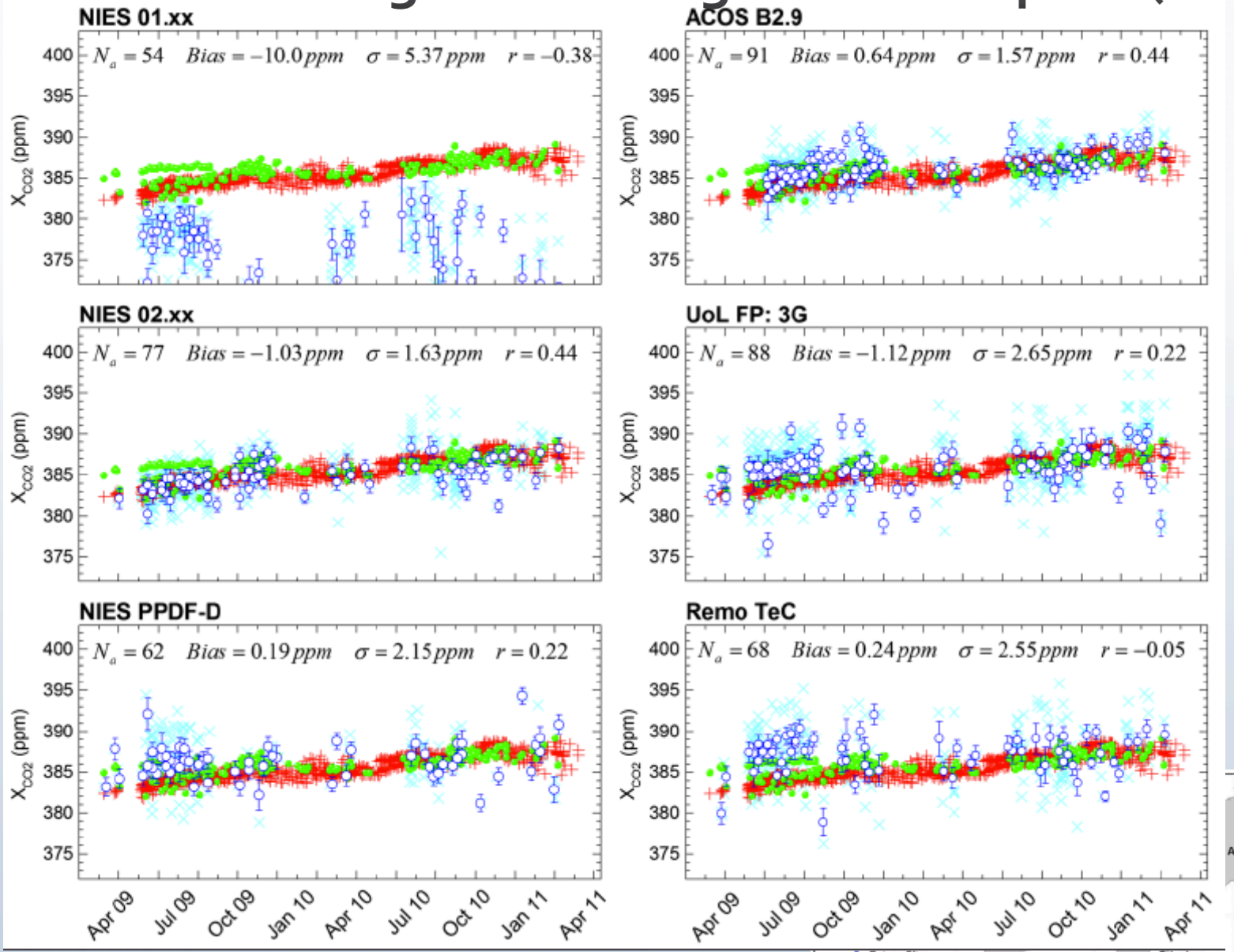
Cogan et. al, 2012

Effects of atmospheric light scattering on spectroscopic observations of greenhouse gases from space (NH)



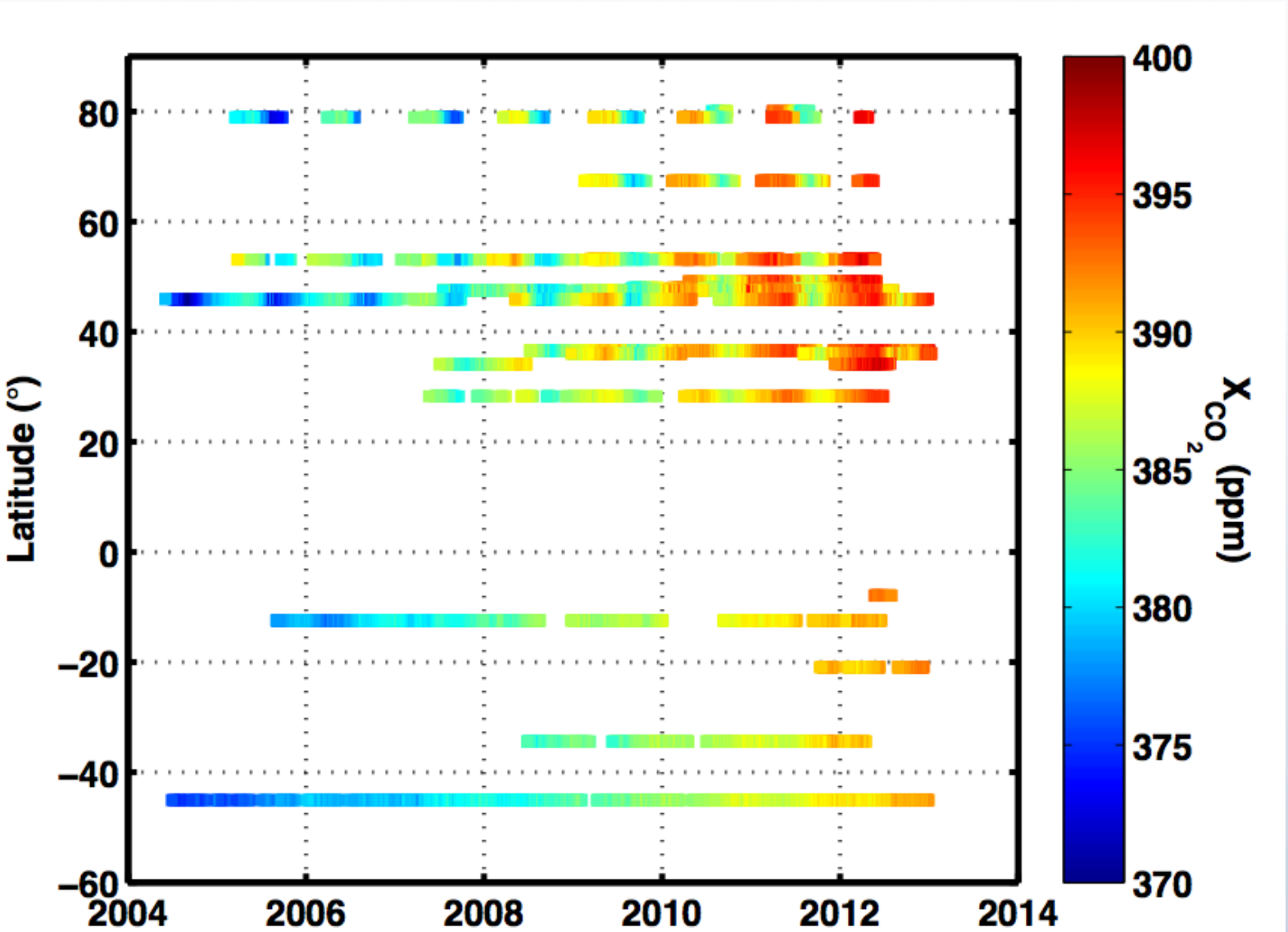
Oshchepkov et. al, 2013

Effects of atmospheric light scattering on spectroscopic observations of greenhouse gases from space (SH)

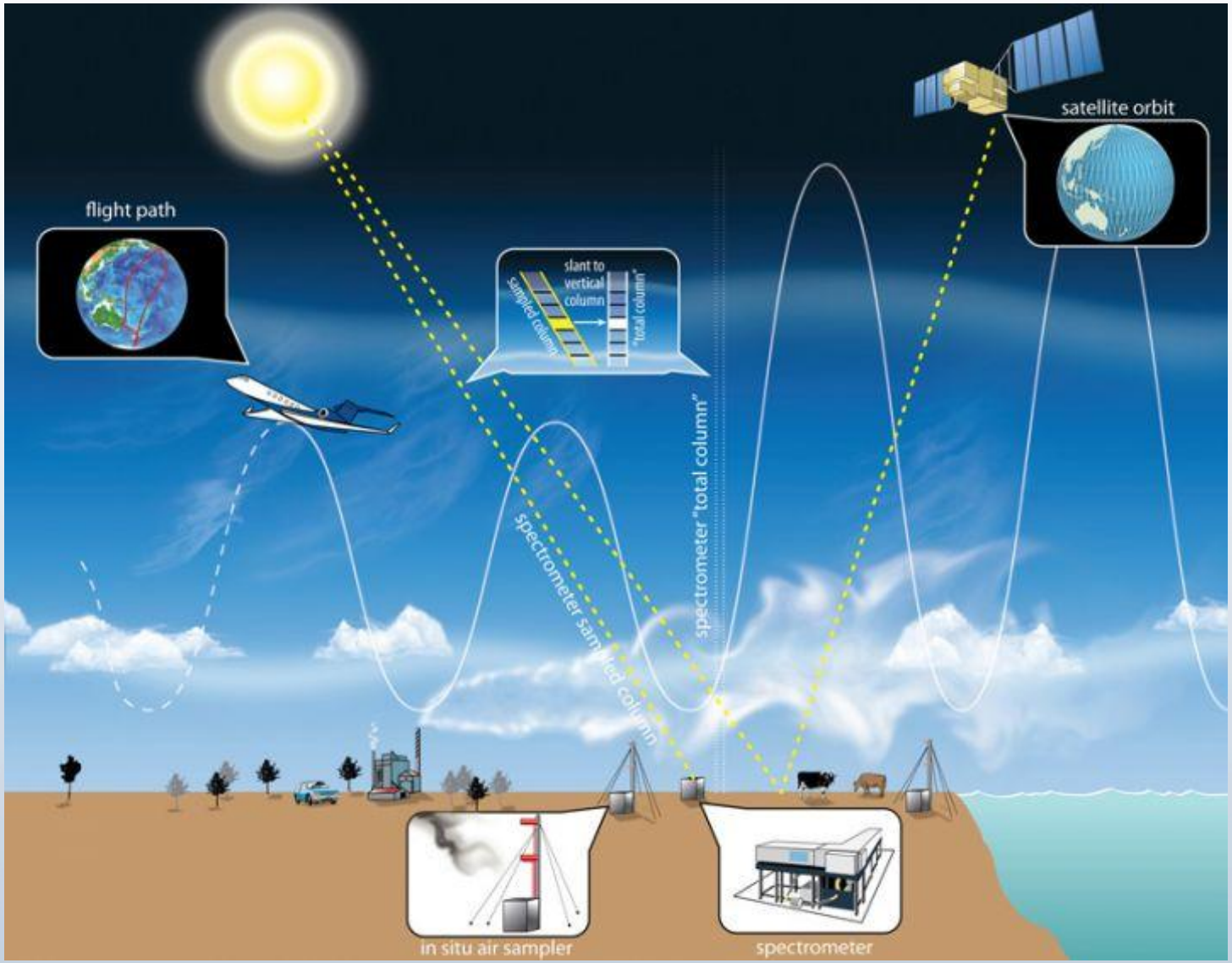


Oshchepkov et. al, 2013

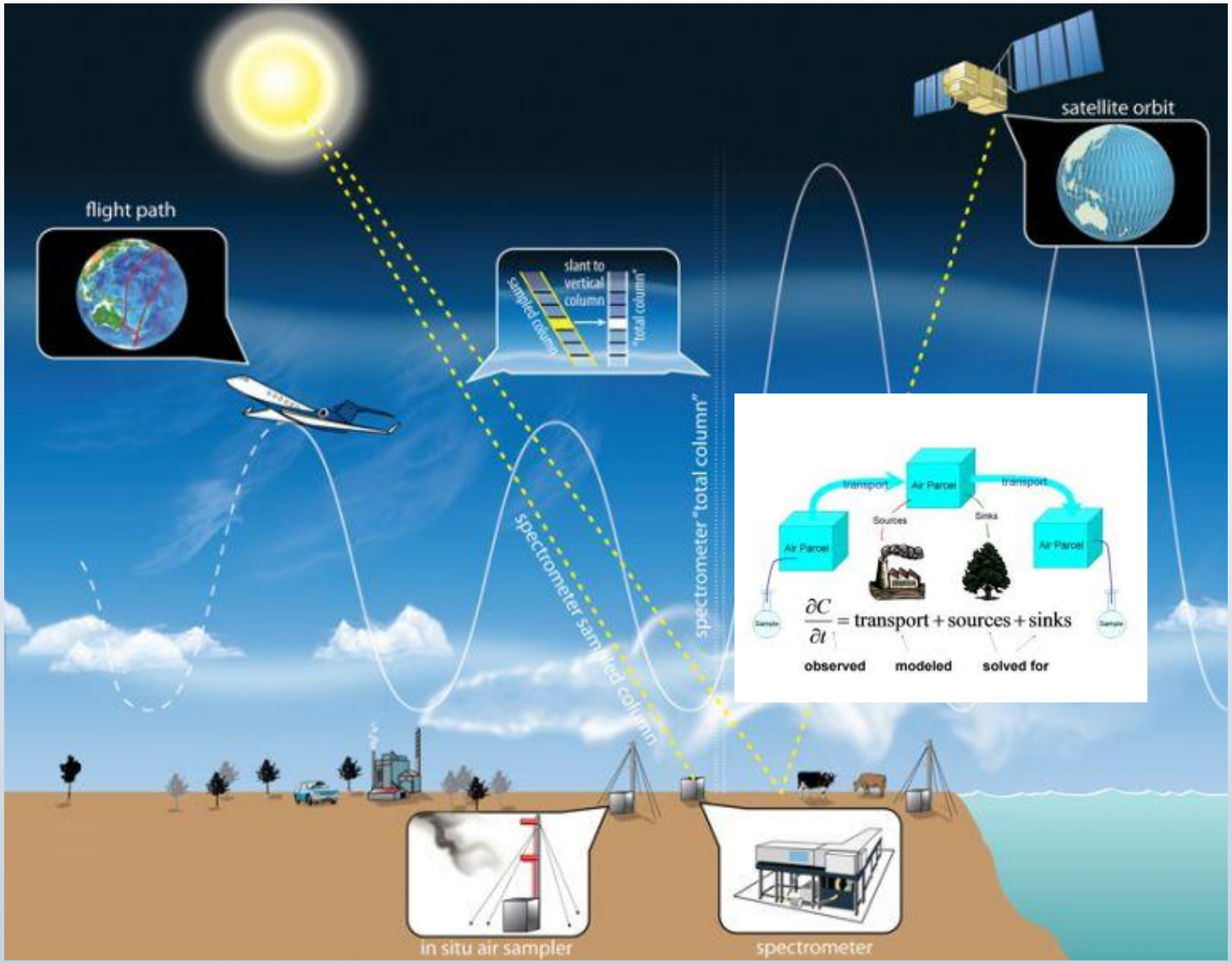
TCCON CO_2

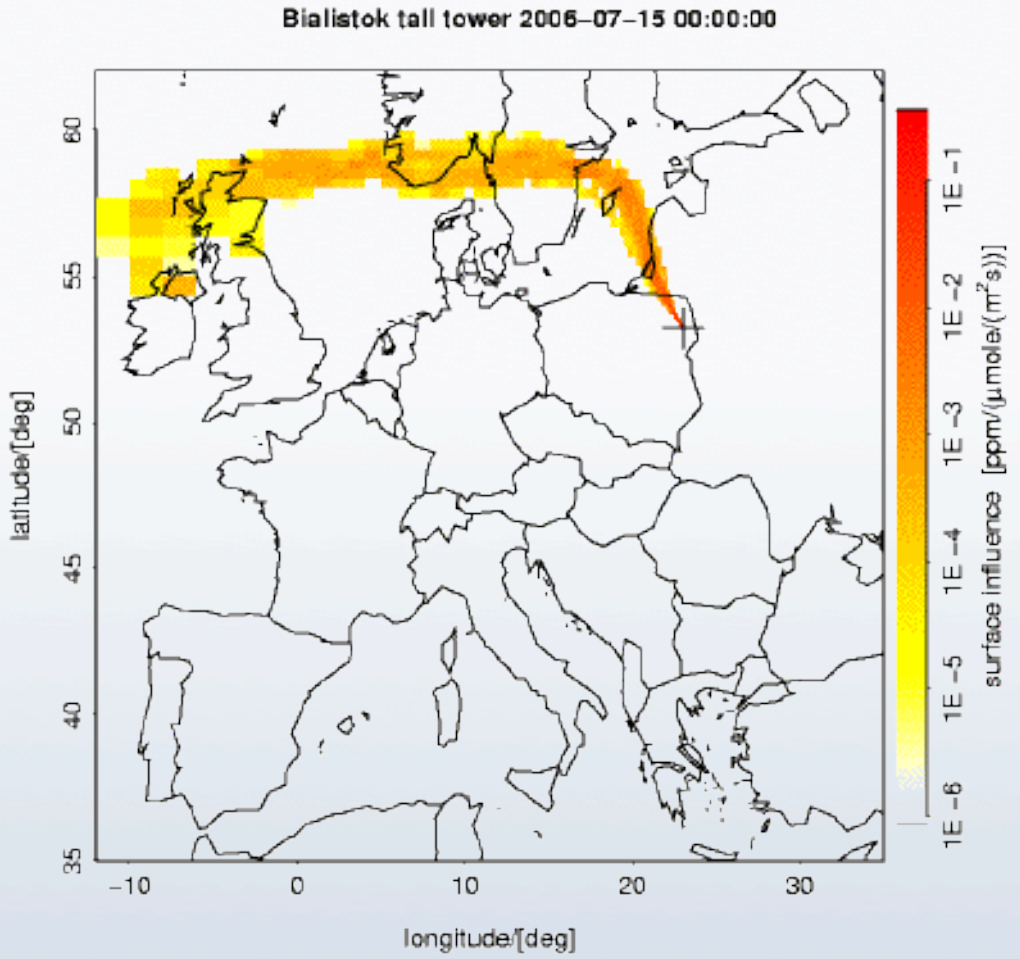

Latitude (°)
80
60
40
20
0
−20
−40
−60
2004
2006
2008
2010
2012
2014
400
395
390
385
380
375
370
X_{CO_2} (ppm)

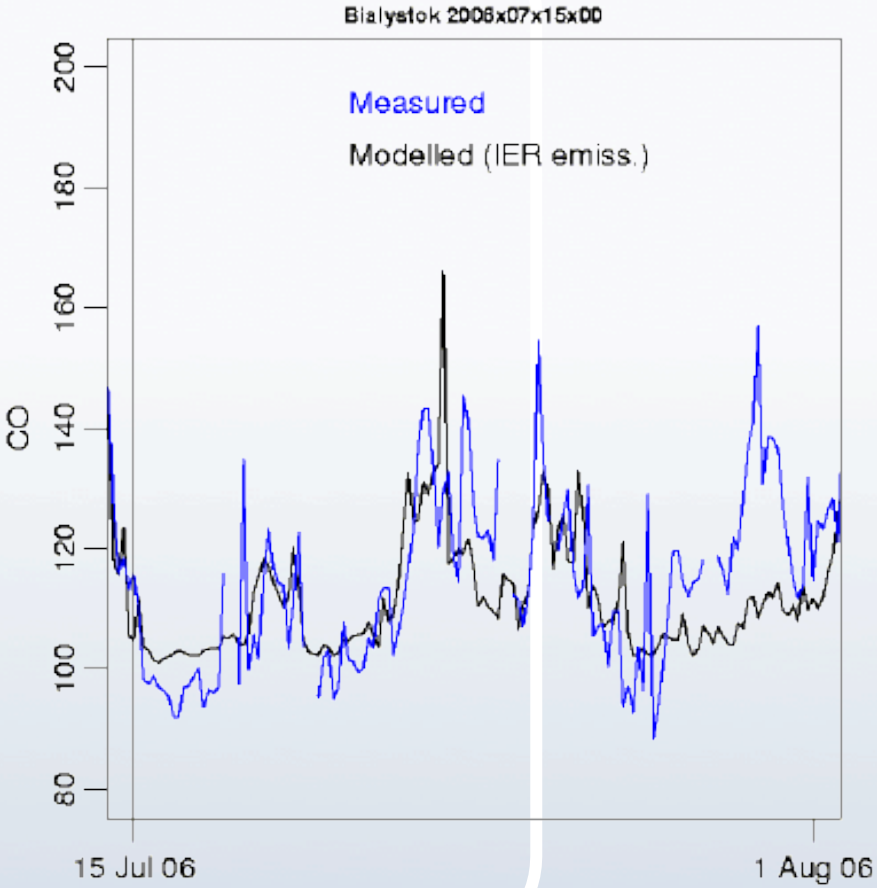
GHG Measurements



GHG Measurements + Modeling







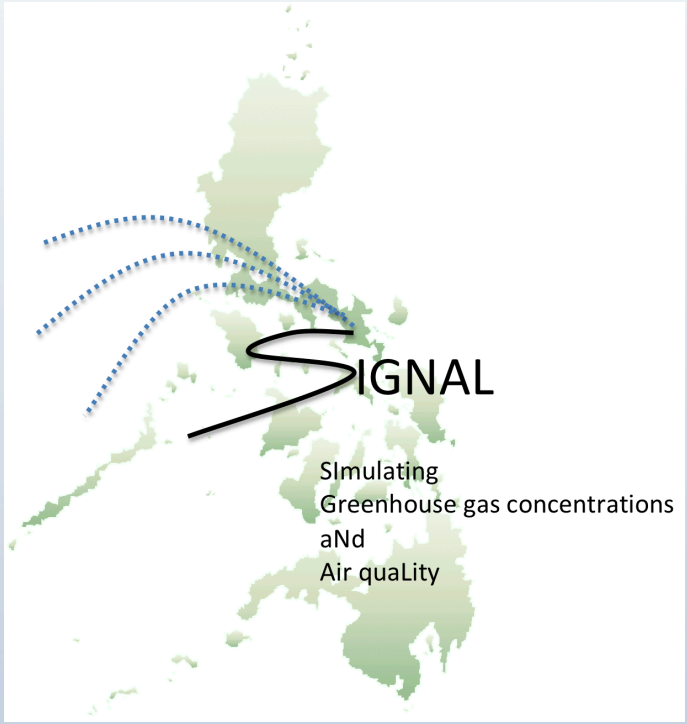
STILT

Stochastic Time-Inverted Lagrangian Transport (STILT) model: 3-Day Backtrajectories Derives and Quantifies Regions that Influence the Measurements (Footprints)

Network Planning

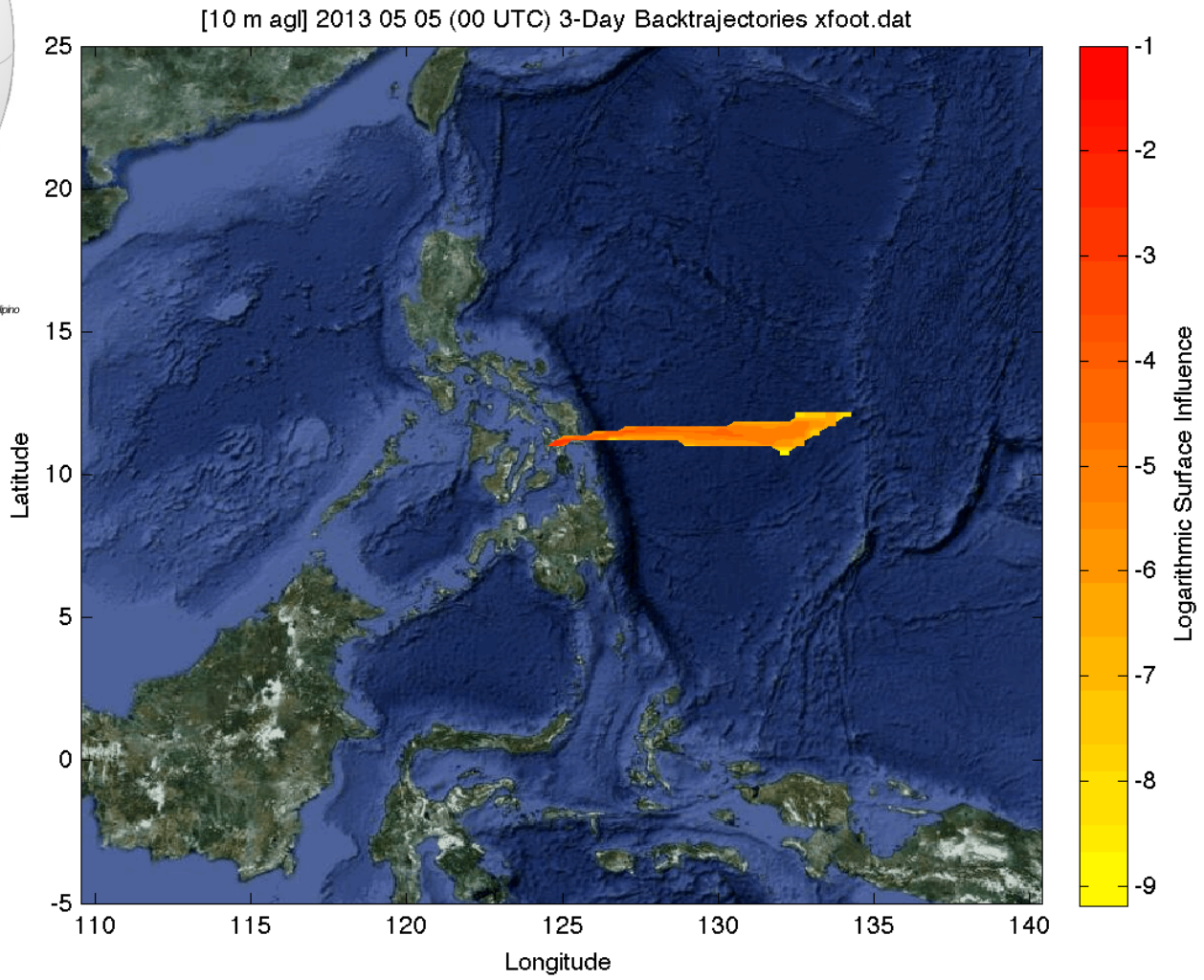
Things to Ponder when Establishing Atmospheric Measurement Networks…

- What is the optimum number of sites?
- Where should these sites be located to produce optimum data sets?

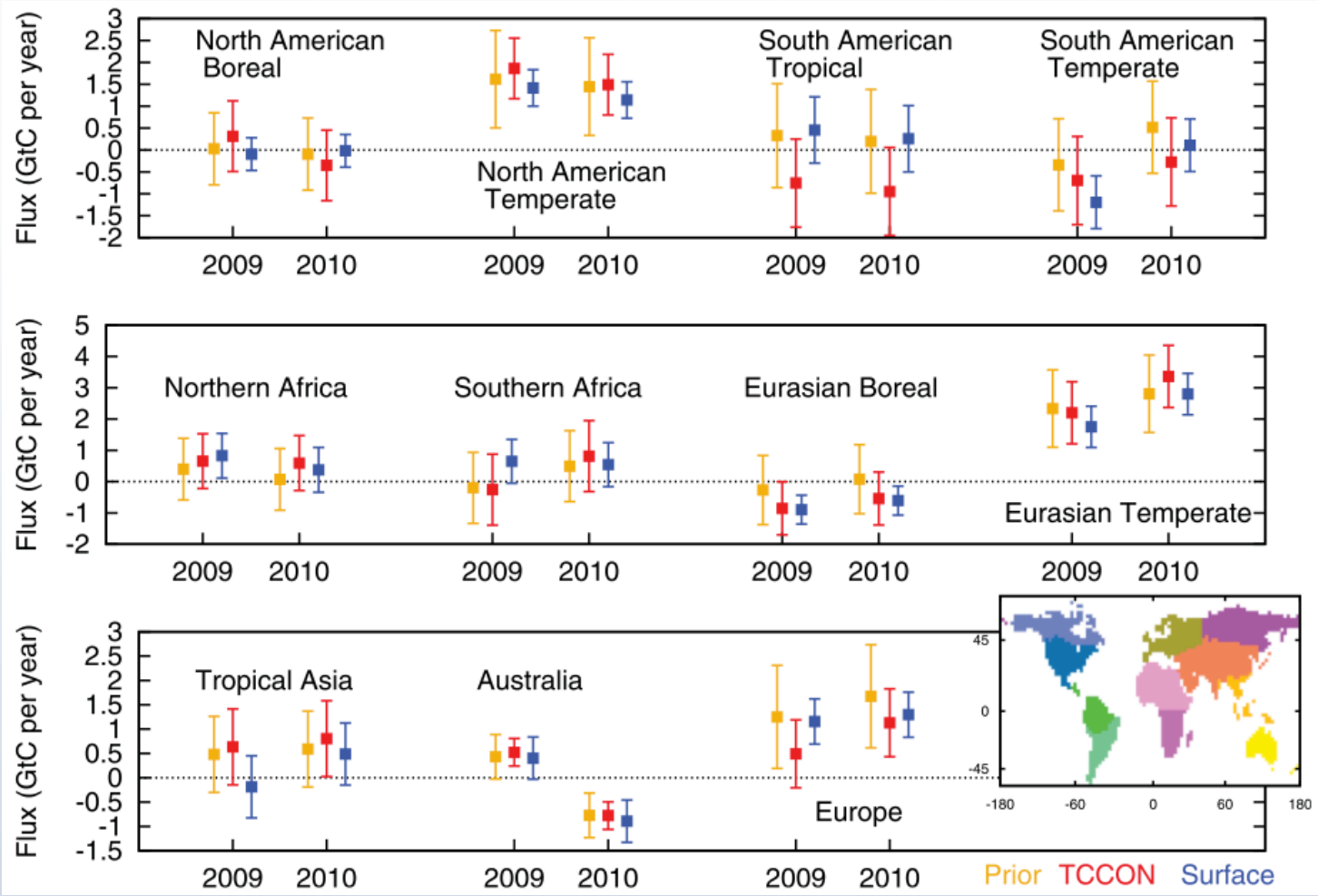


Near-Field Footprints of a Possible GHG Observation Site

Based on Jaime B. Veneracion's *Agos ng Dugong Kayumanggi: Isang Kasaysayan ng Sambayanang Pilipino*

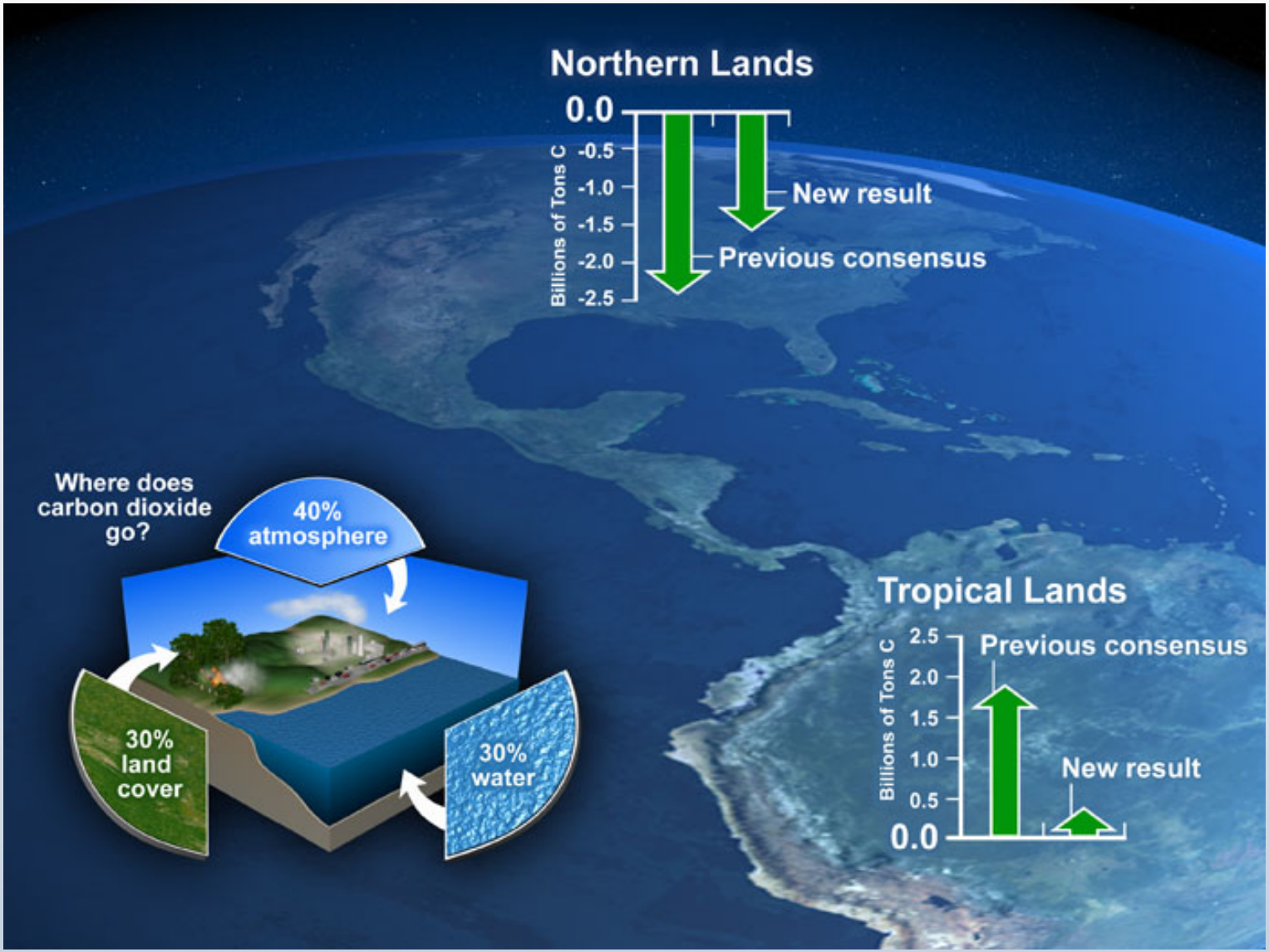


Estimating Global CO_2 Fluxes Using TCCON



"The consistency between the surface-air-sample-based and the TCCON-based inversions despite remaining flaws in transport models opens the possibility of increased accuracy and robustness of flux inversions based on the combination of both data sources and confirms the usefulness of space-borne monitoring of the CO2 column." Chevallier, F., et al. (2011), Global CO2 fluxes inferred from surface air-sample measurements and from TCCON retrievals of the CO2 column, Geophys. Res. Lett., 38, L24810, doi: 10.1029/2011GL049899.

The Missing Carbon Sink



THE END

Thank you very much to

...Dr. Isamu Morino (NIES, Japan)

...Dr. Christoph Gerbig (MPI-BGC Jena, Germany)

...and to all who contributed to this presentation!

v^_^v