Network for the Detection of Atmospheric Composition Change:

Tracking Changes in the Earth's Atmosphere

Michael J. Kurylo & Geir O. Braathen

On behalf of the NDACC Science Team and the NDACC Steering Committee

What is the NDACC?

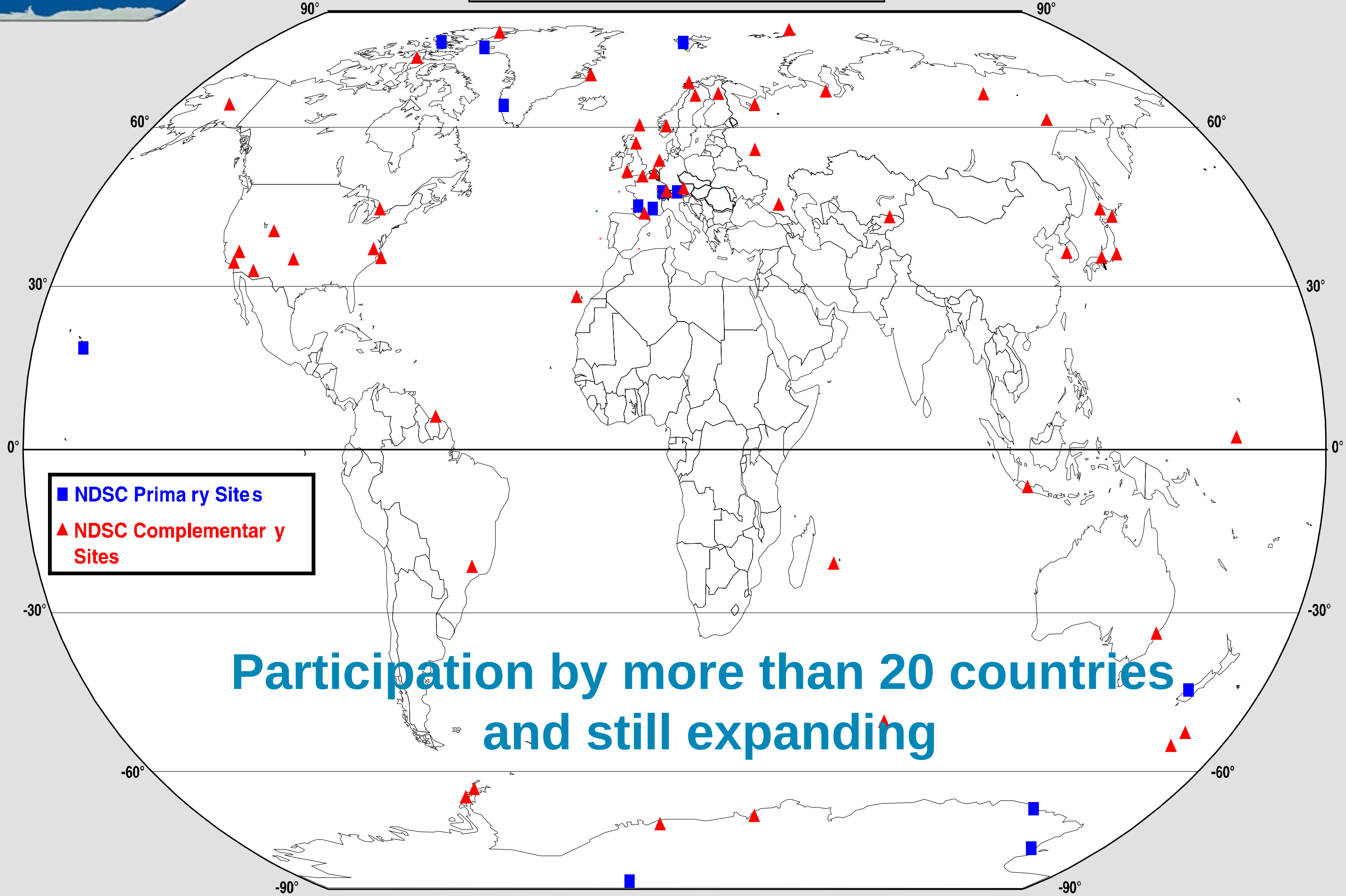
- ***A set of more than 70 high-quality, remote-sensing research sites for***
  - *observing and understanding the physical / chemical state of the stratosphere and upper troposphere*
  - *assessing the impact of stratospheric changes on the underlying troposphere and on global climate*

What is the NDACC?

- ***A major component of the international atmospheric research effort formulated to***
  - *document and understand naturally-occurring and human-induced stratospheric and tropospheric changes*
  - *further our capability to forecast the future state of the atmosphere*

NDSC

NDACC Sites



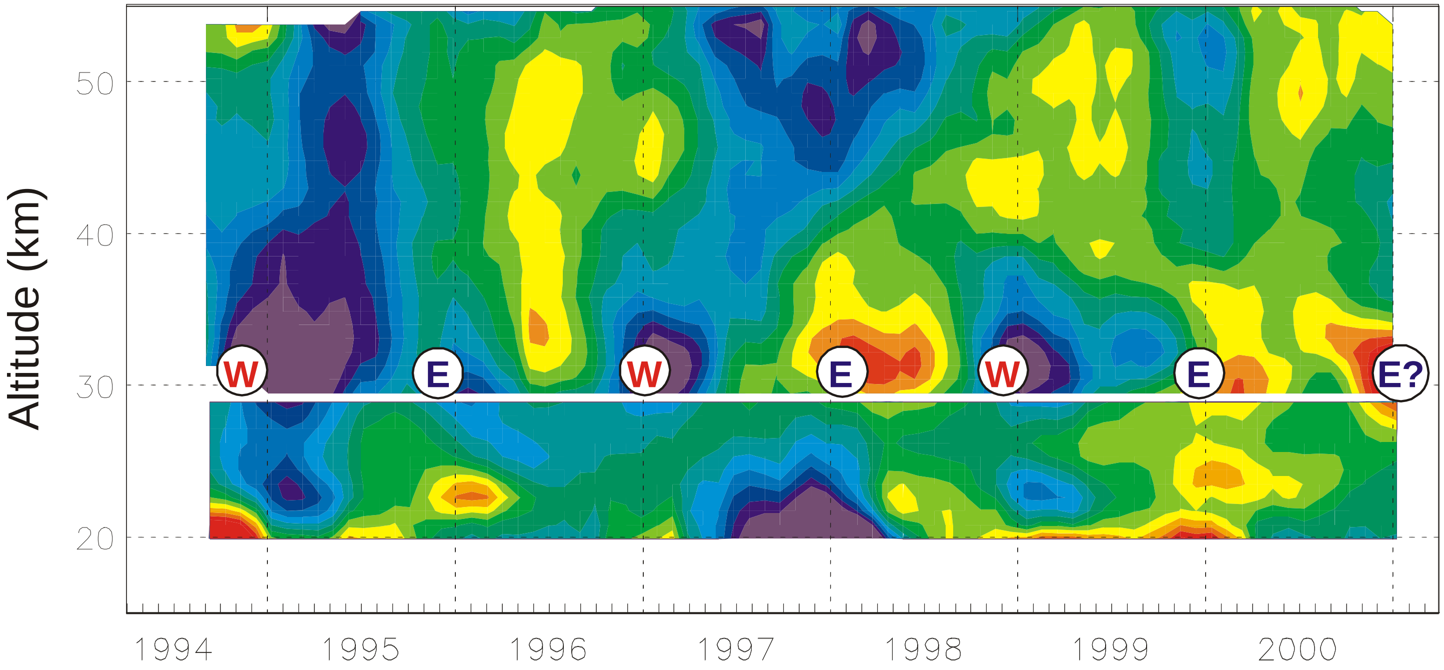
Participation by more than 20 countries and still expanding

NDACC priorities

- study the temporal and spatial variability of atmospheric composition and structure
- detecting trends in overall atmospheric composition and understanding their impacts on the stratosphere and troposphere,
- establishing links between climate change and atmospheric composition,
- calibrating and validating space-based measurements of the atmosphere,
- supporting process-focused scientific field campaigns, and
- testing and improving theoretical models of the atmosphere.

Goals of the NDACC

1. To study the temporal and spatial variability of atmospheric composition and structure



Ozone QBO at Mauna Loa, Hawaii

1) **W and E indicate the phase & altitude of the maximum amplitude of the equatorial QBO winds. O_3 color contour range is +/-15% (from purple to red)**
2) **The O_3 QBO is clearly observed at 24, 30, and 45 km, including the QBO phase change in 2000/01.**
3) **The QBO at 24 km is hidden by the strong ENSO signature in 1997/98**

Goals of the NDACC

2. *To provide early detection and subsequent long-term monitoring of changes in the chemical and physical state of the stratosphere and upper troposphere; to provide the means to discern and understand the causes of such changes*

Upper Stratosphere Ozone Trends
(NDACC Lidar Working Group)

- **Multiple instruments / stations**
- **Similar upper stratospheric ozone anomalies**
- **Recently higher O_3 values may indicate recovery**
- **Should become clearer by 2008 (after solar min.)**

Hohenpeissenberg (48°N, 11°E)
(QBO, solar-cycle removed)

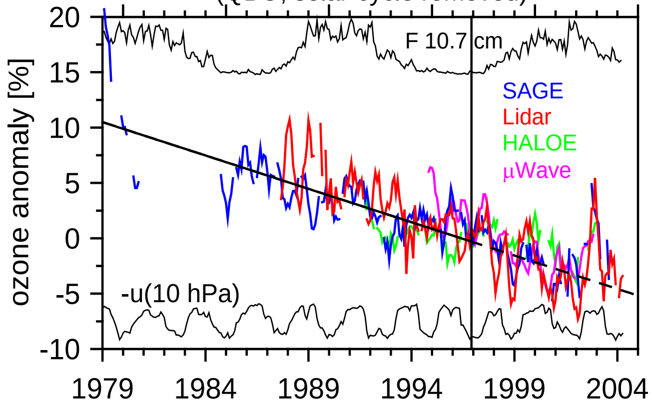
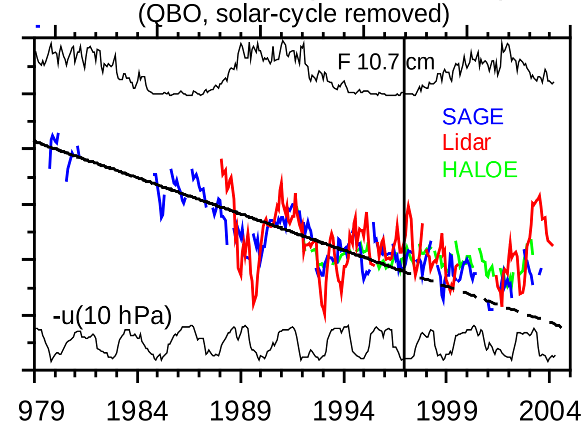
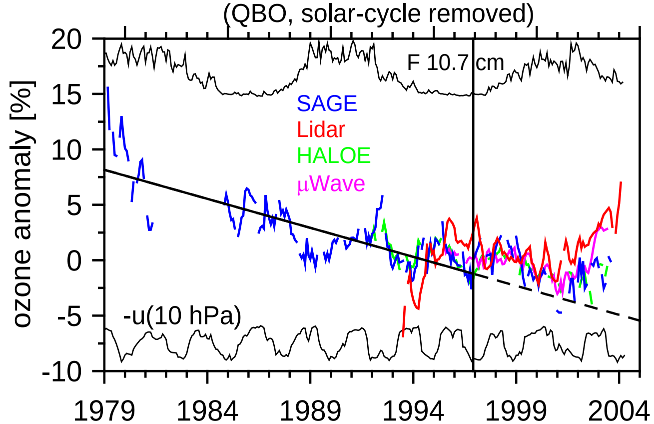


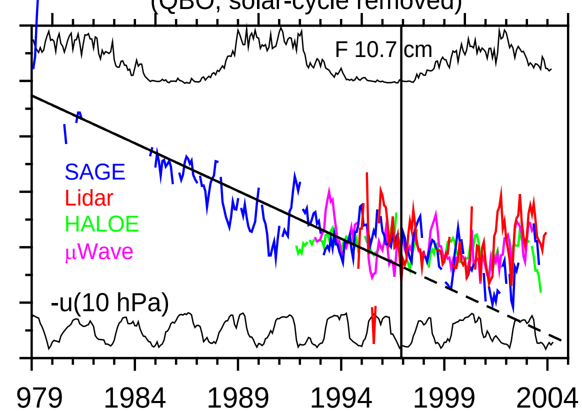
Table Mountain (35°N, -118°E)
(QBO, solar-cycle removed)



Hawaii (20°N, 156°E)
(QBO, solar-cycle removed)

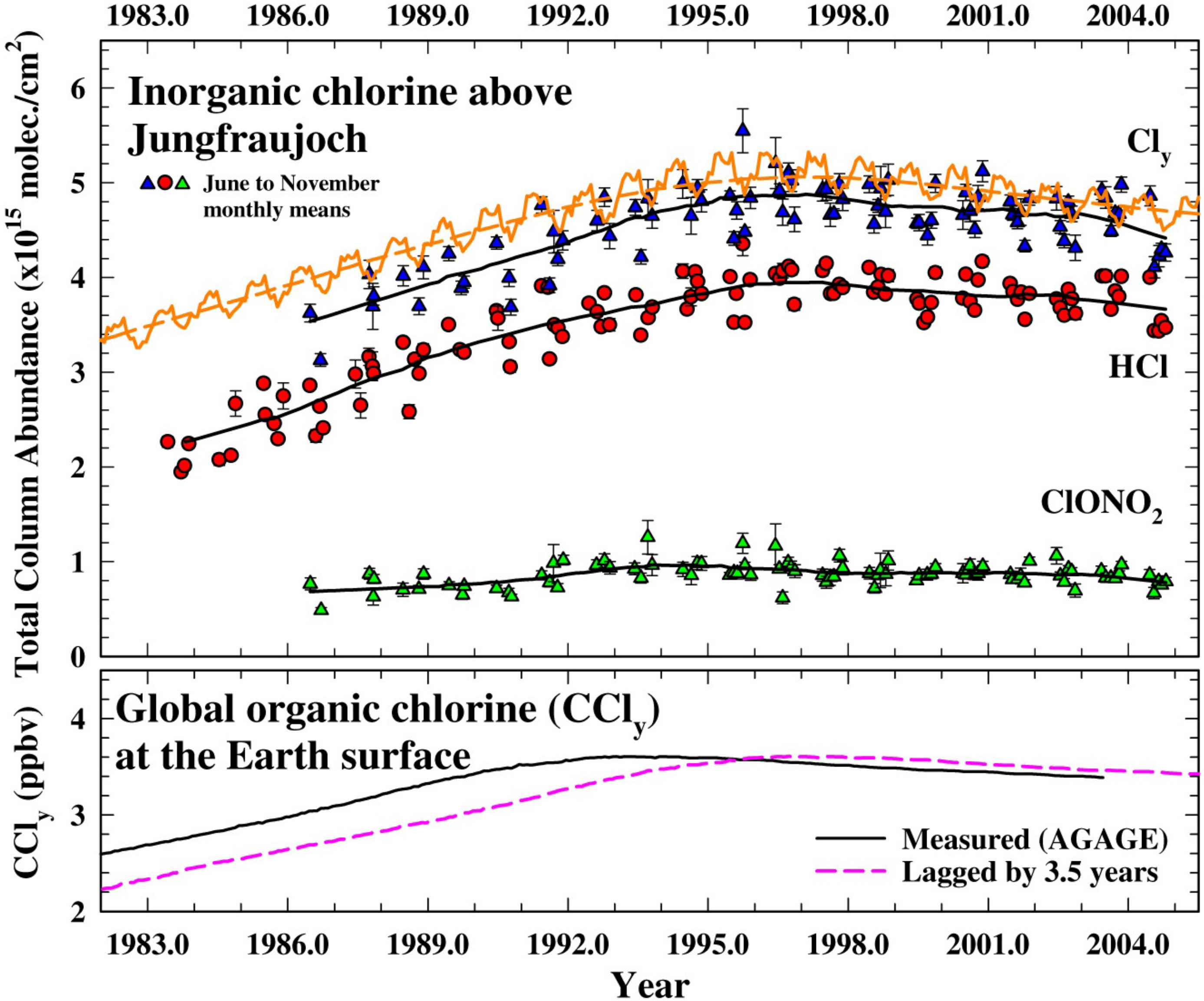


Lauder (44°S, 170°E)
(QBO, solar-cycle removed)



FTIR Column Measurements at Jungfraujoch

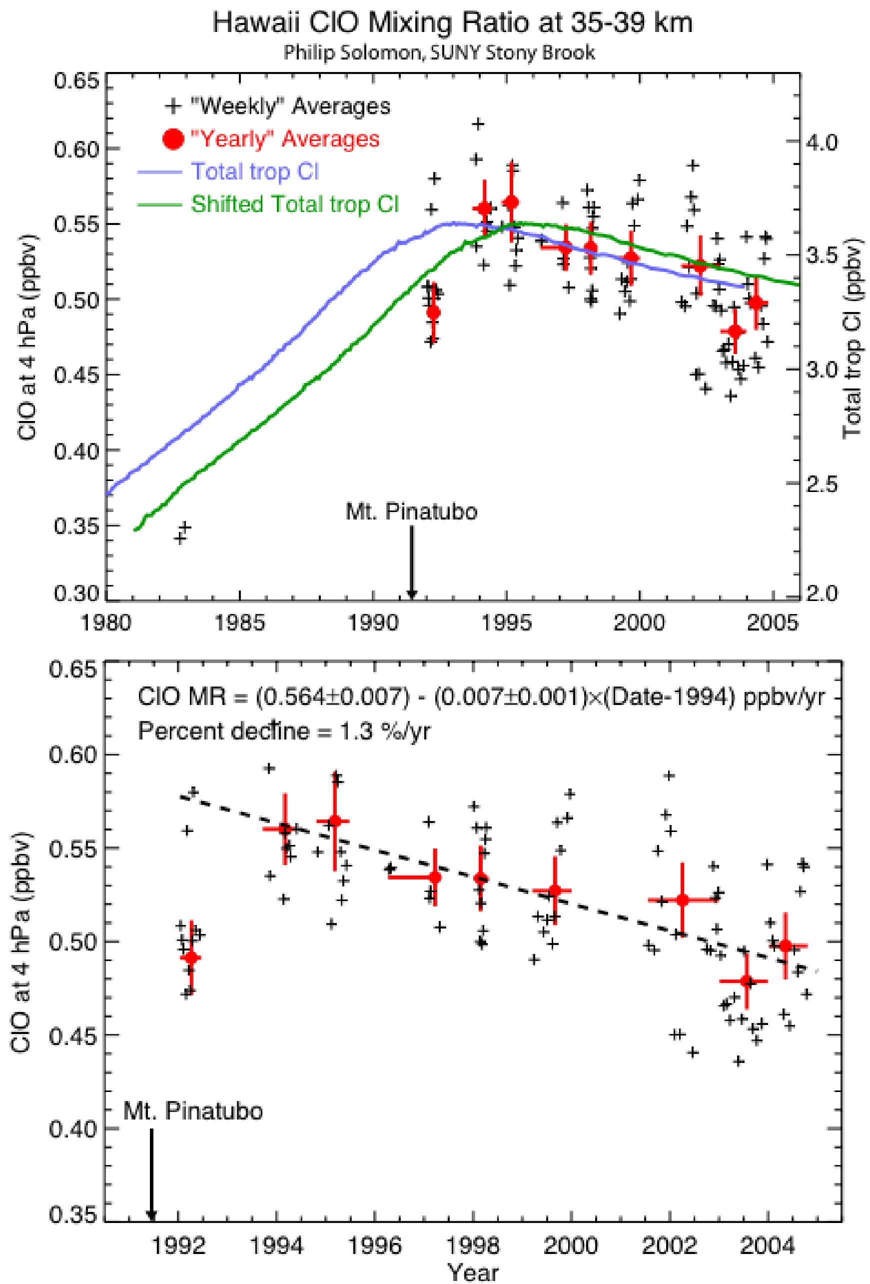
HCl, $ClONO_2$, and derived Cl_y (R. Zander & E. Mahieu) compared to model predictions (M. Chipperfield) and to surface CCl_y measurements (R. Prinn)



inorg_Cl_2004

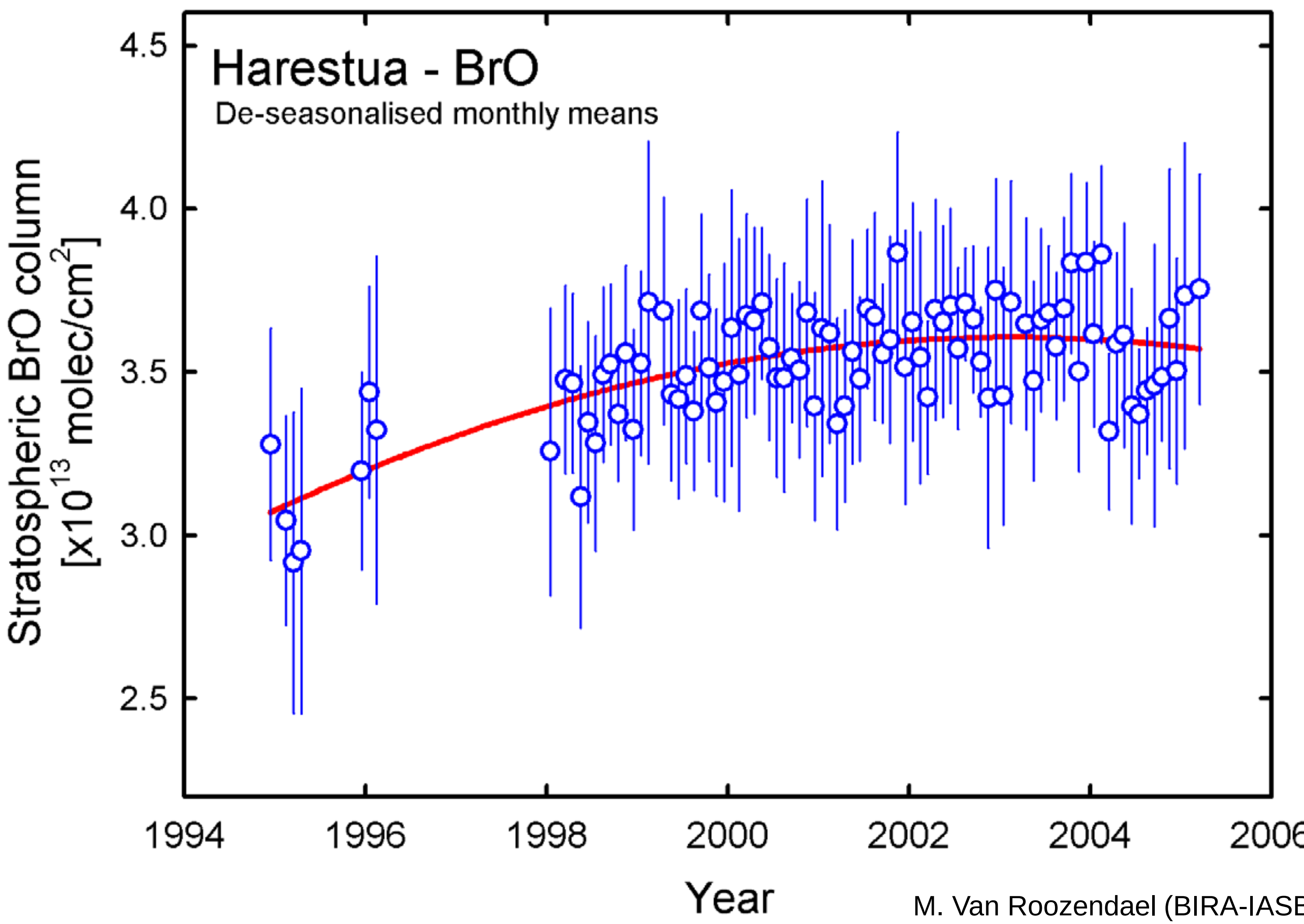
ULg-GIRPAS / 08-Nov-2004

Long-term Record of Stratospheric ClO Derived from Microwave Measurements at Mauna Kea, Hawaii.



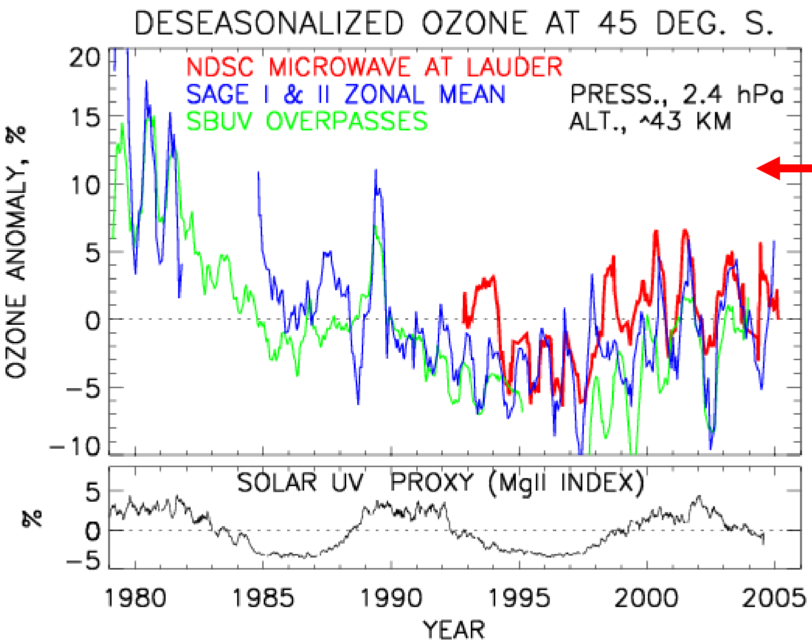
P. Solomon & J. Barrett (SUNY)

Evolution of Stratospheric BrO Derived from UV-Visible Measurements at Harestua, Norway



M. Van Roozendael (BIRA-IASB)

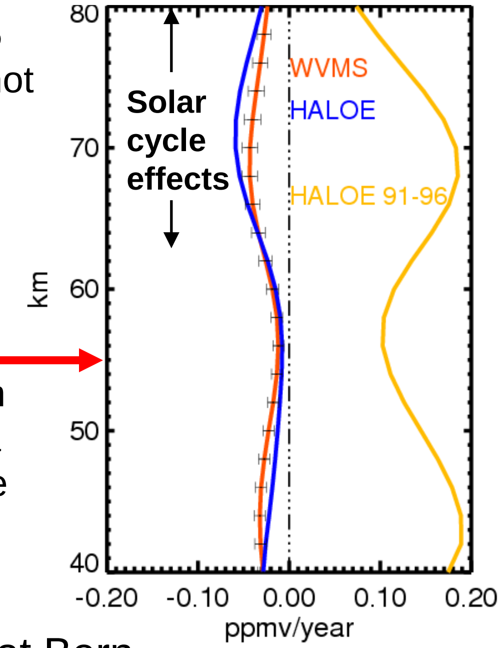
NDACC Microwave Measurements: Long-term Record of O_3 & H_2O



•Ground-based O_3 measurements from Lauder are consistent with SAGE and SBUV. The 1979-1996 upper stratospheric O_3 decline is not continuing. The effect of the solar cycle complicates any analysis.

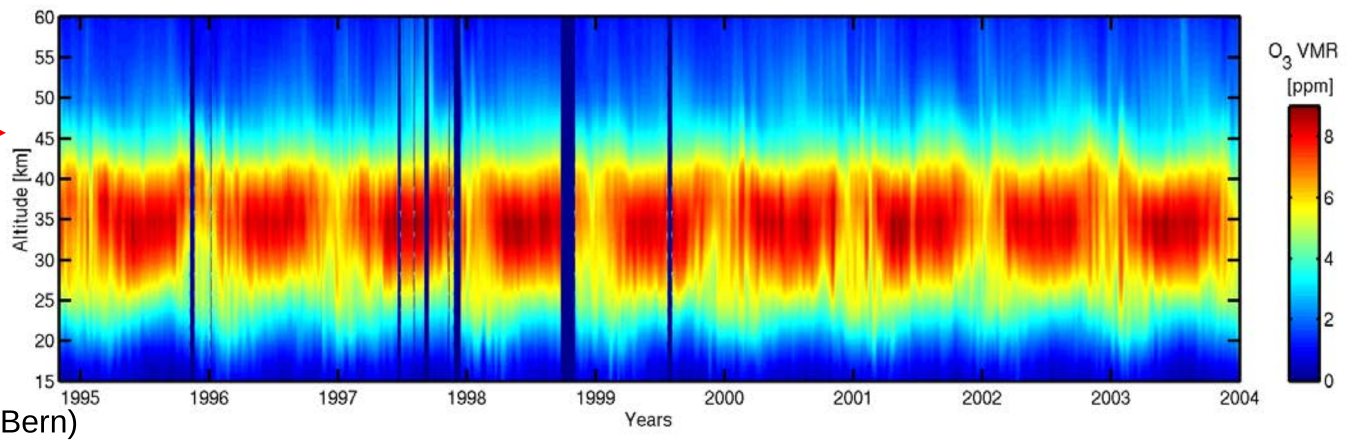
•Ground-based H_2O trends from Mauna Loa are consistent with HALOE from (1996-2005). The increase which was observed from 1991-1996 is not continuing. Data below ~60km is not affected by the solar cycle.

H_2O trend at Mauna Loa 1996-2005



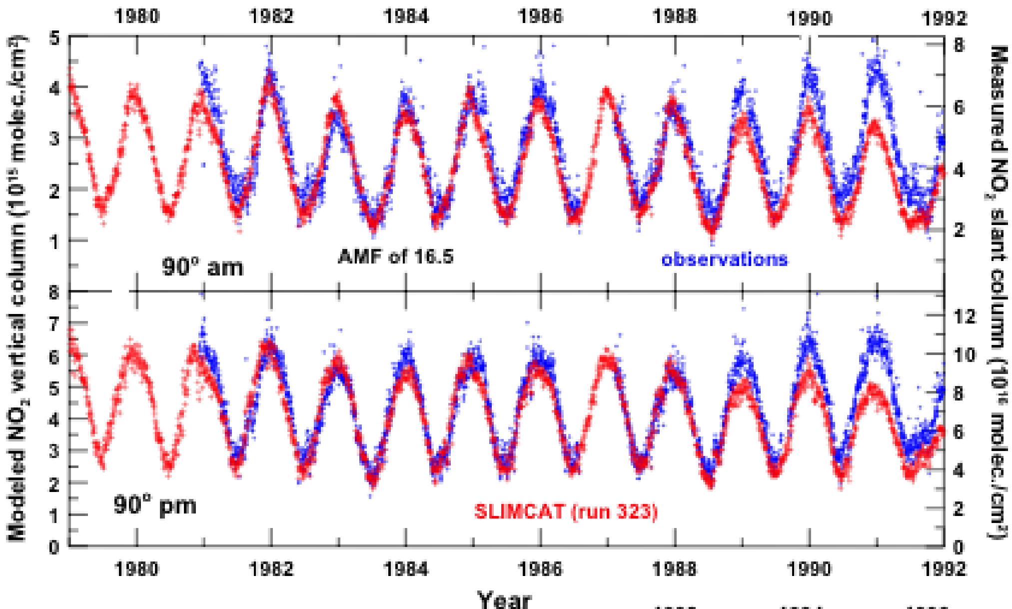
•Ground-based O_3 measurements at Bern since 1994 show the strong seasonal variation of mid-latitude ozone.

GROMOS measurements of O_3 at Bern



G. Nedoluha (NRL) & N. Kampfer (U. Bern)

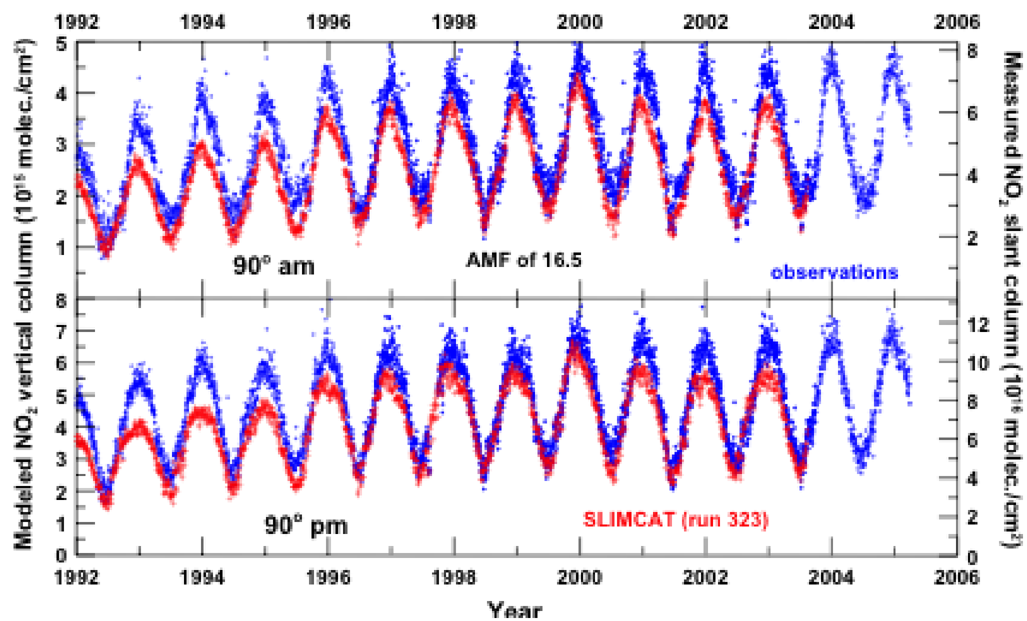
NDSC NO_2 Time Series, Lauder (45.0°S, 169.7°E), New Zealand



Stratospheric Nitrogen Dioxide columns have been measured since December 1980 using the Twilight Zenith UV/Vis Spectroscopic Technique.

Observations (blue) were made at solar zenith angle = 90° AM and 90° PM, when the air-mass factor (calculated) = 16.5.

Example application of these measurements is this comparison with SLIMCAT Standard Model Run 323 (M. Chipperfield)



NO_2 trend using 19 parameter regression analysis:

A.M. $= +6.2 \pm 1.8$ % decade^{-1}

P.M. $= +5.7 \pm 1.1$% decade^{-1}

Thanks to: K. Kreher, P. Johnston, B.Liley, R. McKenzie & A. Thomas

Goals of the NDACC

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3. ***To establish links between changes in stratospheric O_3, UV radiation at the ground, tropospheric chemistry, and climate***

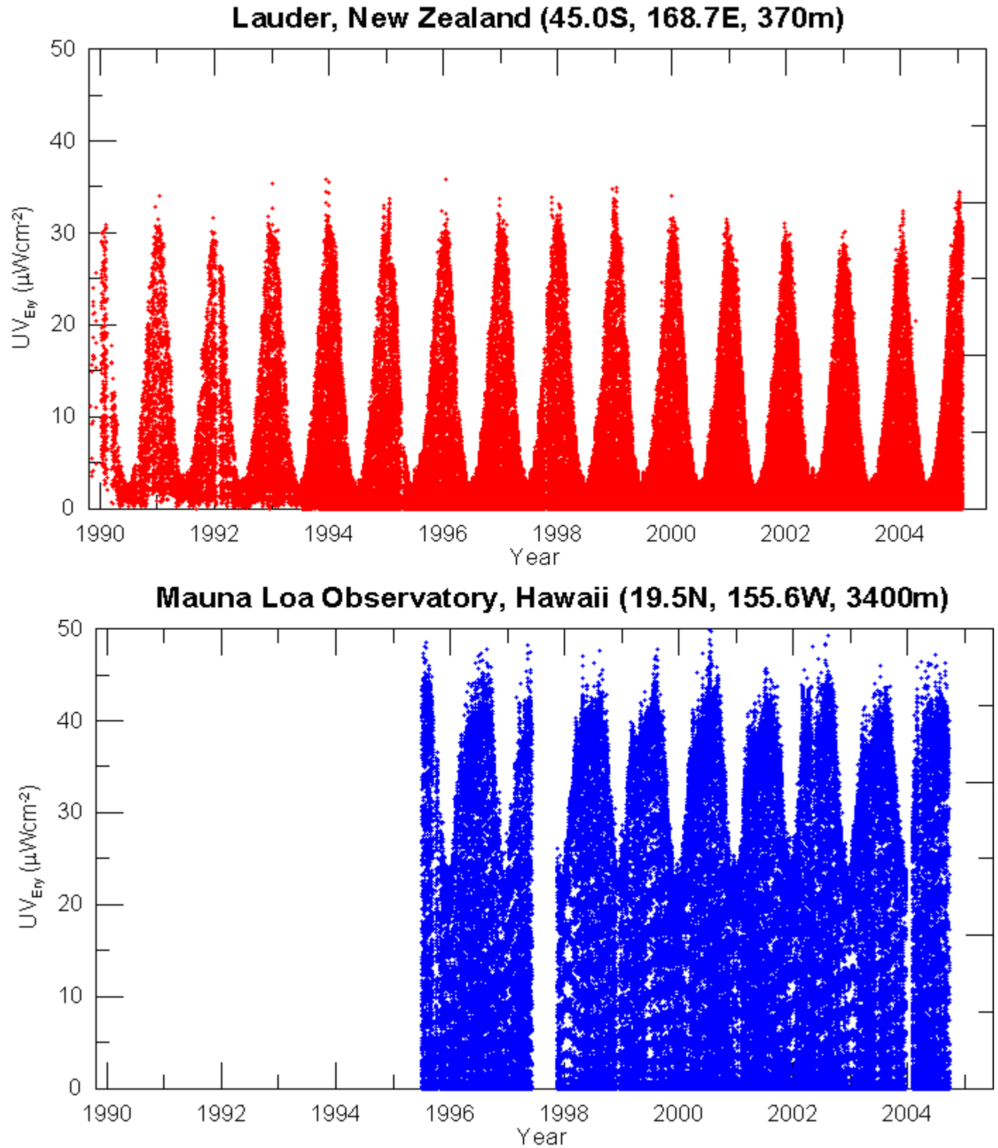


Fig 2. Erythemally-weighted UV. Data continuity is excellent at both sites Peak values are much greater at MLO, and seasonal variability is greater at Lauder

UVEryPlot.grf
February 24, 2005

NIWA
Taihoro Nukurangi

R. McKenzie

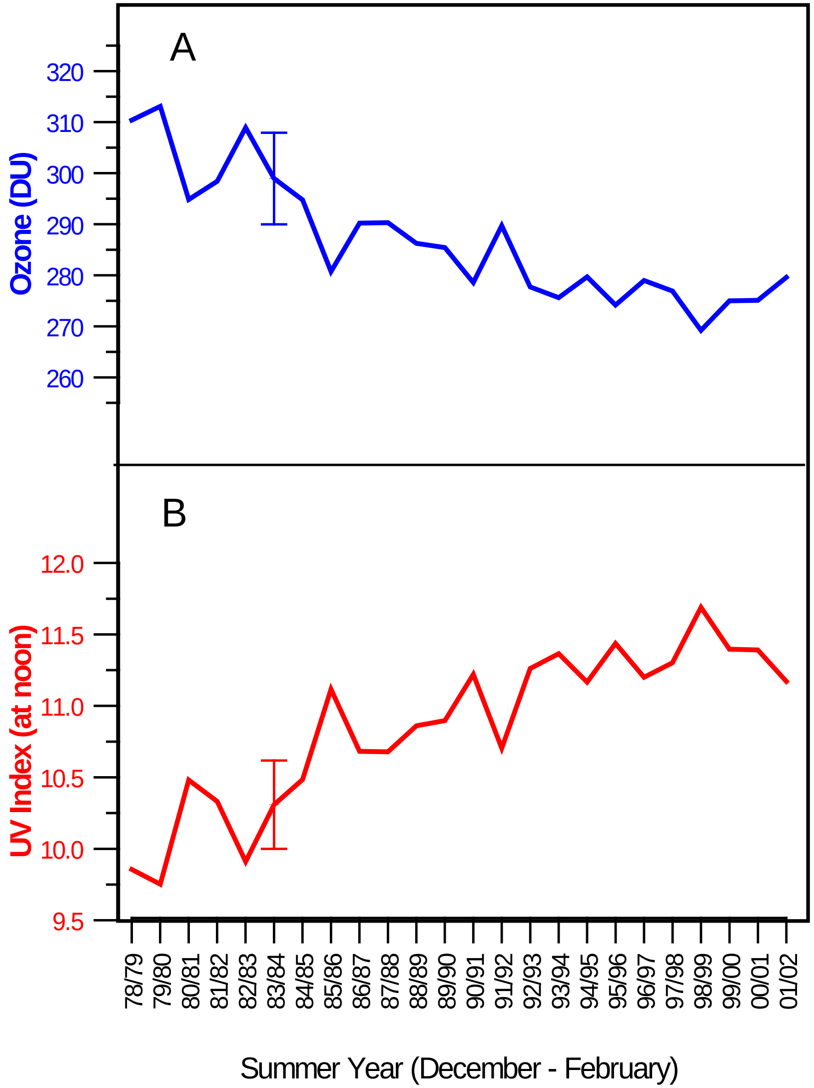
NDSC

NIWA
Taihoro Nukurangi

Mean Summer Ozone and Estimated UV Index
Lauder, New Zealand

Long term decrease in ozone has been responsible for 12-15% increase in the maximum summertime UV Index over Lauder, NZ.

Approximately half of the ozone depletion at mid-southern latitudes has been due to the export of ozone-poor air from Antarctica.



Update of McKenzie, Connor, and Bodeker, *Science*, *1999*, *285*, 1709-1711

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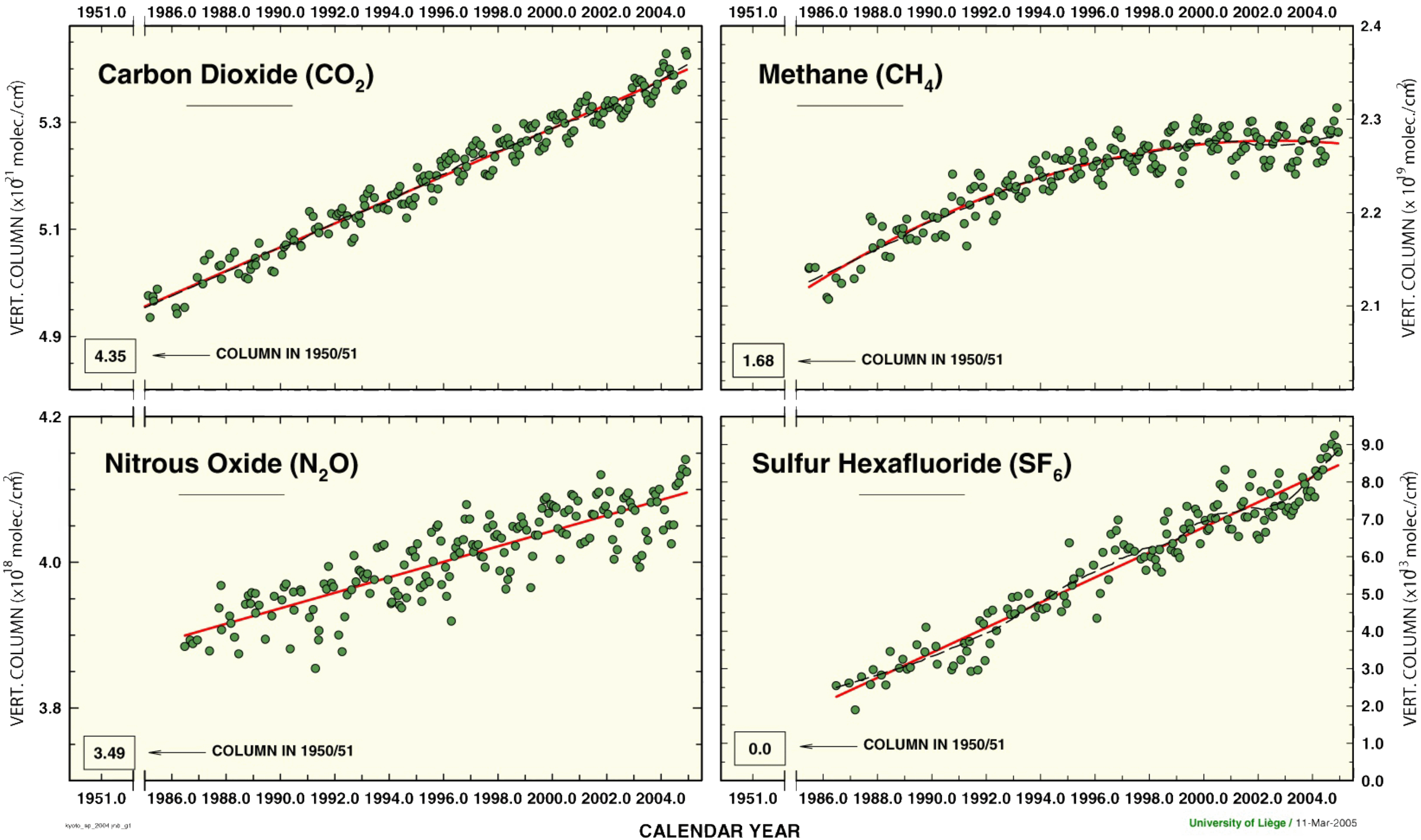
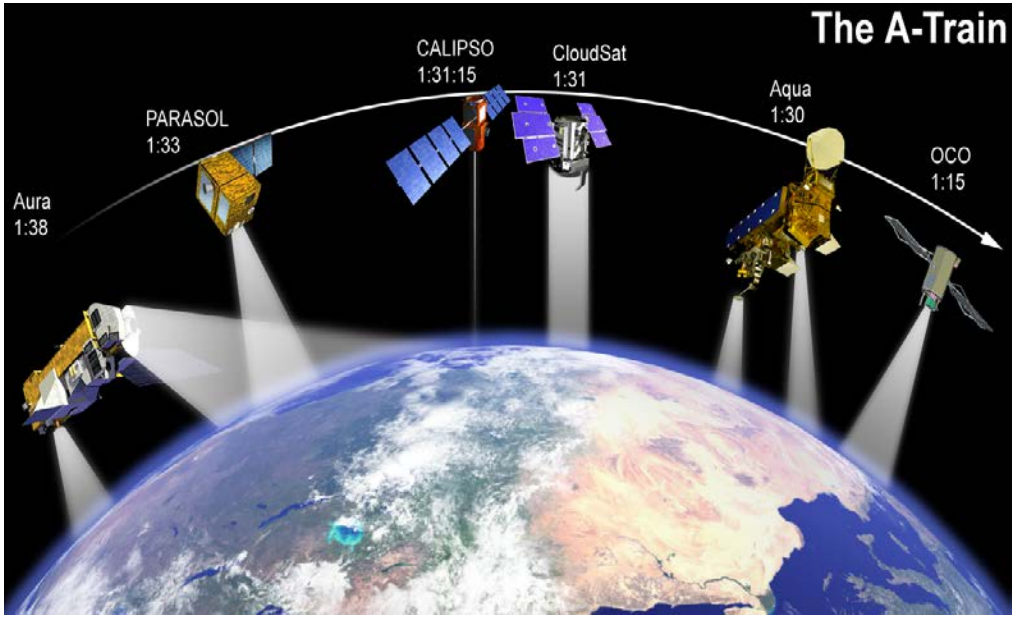
KYOTO-PROTOCOL RELATED MEASUREMENTS AT THE JUNGFRAUJOCH



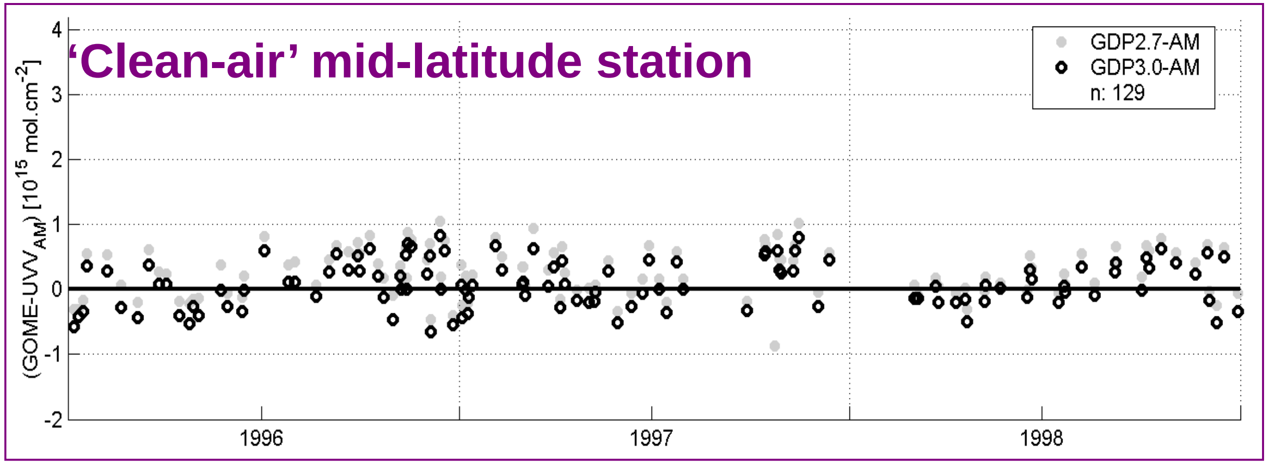
R. Zander & E. Mahieu (U. Liege)

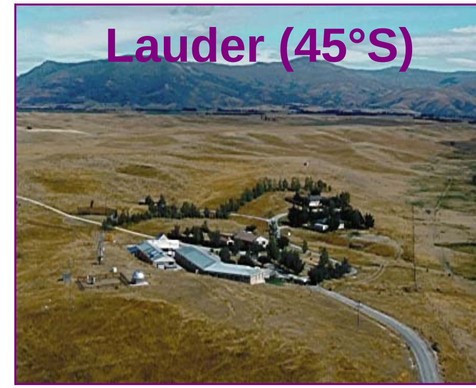
Goals of the NDACC

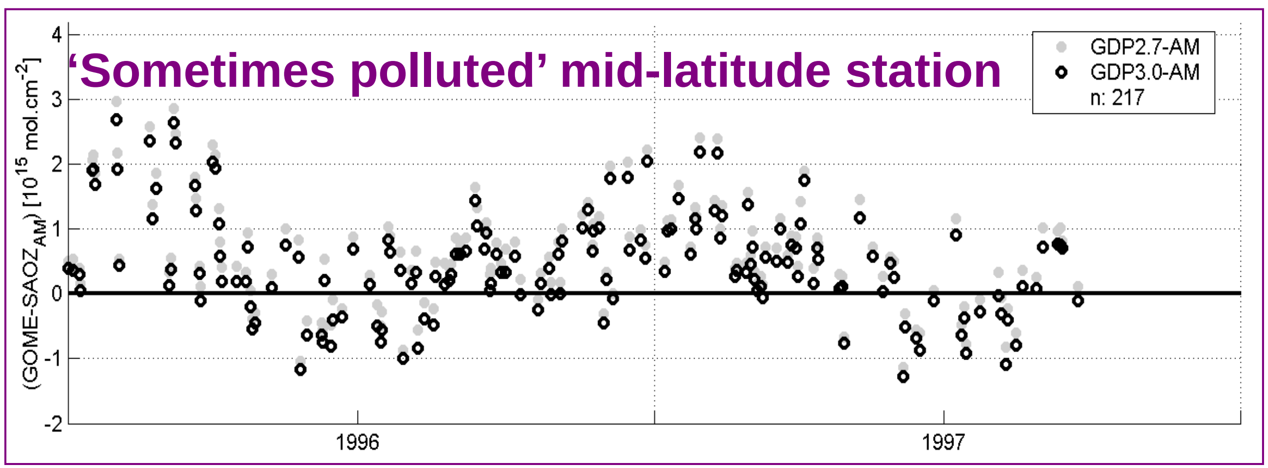
4. ***To provide independent validations, calibrations, and complementary data for space-based sensors of the atmosphere***
   - *Rigorous time control*
   - *Long time series*



GOME vs. NDACC UV-Visible NO_2 Column

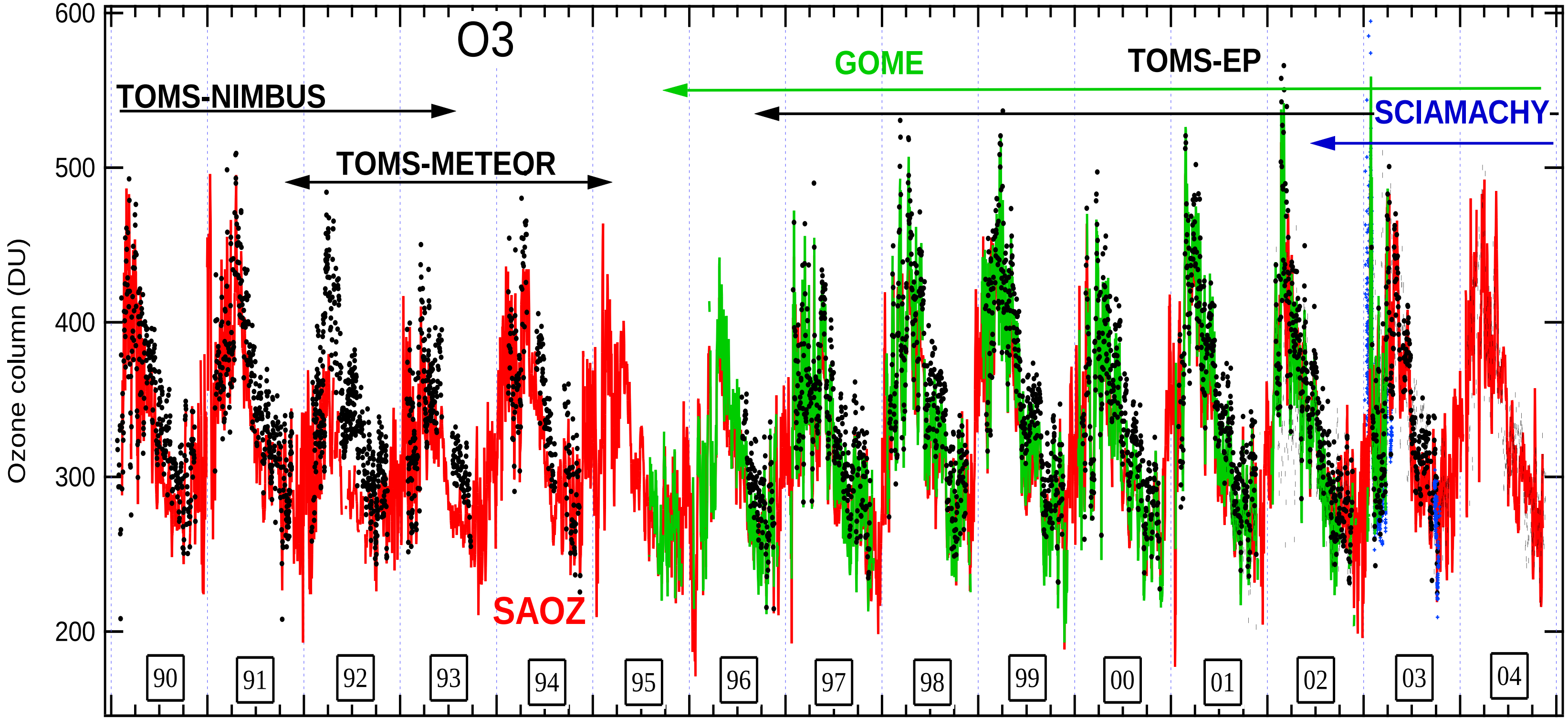






J.-C. Lambert et al., ESA ERSE TN, 2002

SAOZ UV-Visible Measurements:
Sodankylä, Finland



F. Goutail (CNRS) and E. Kyrö (FMI)

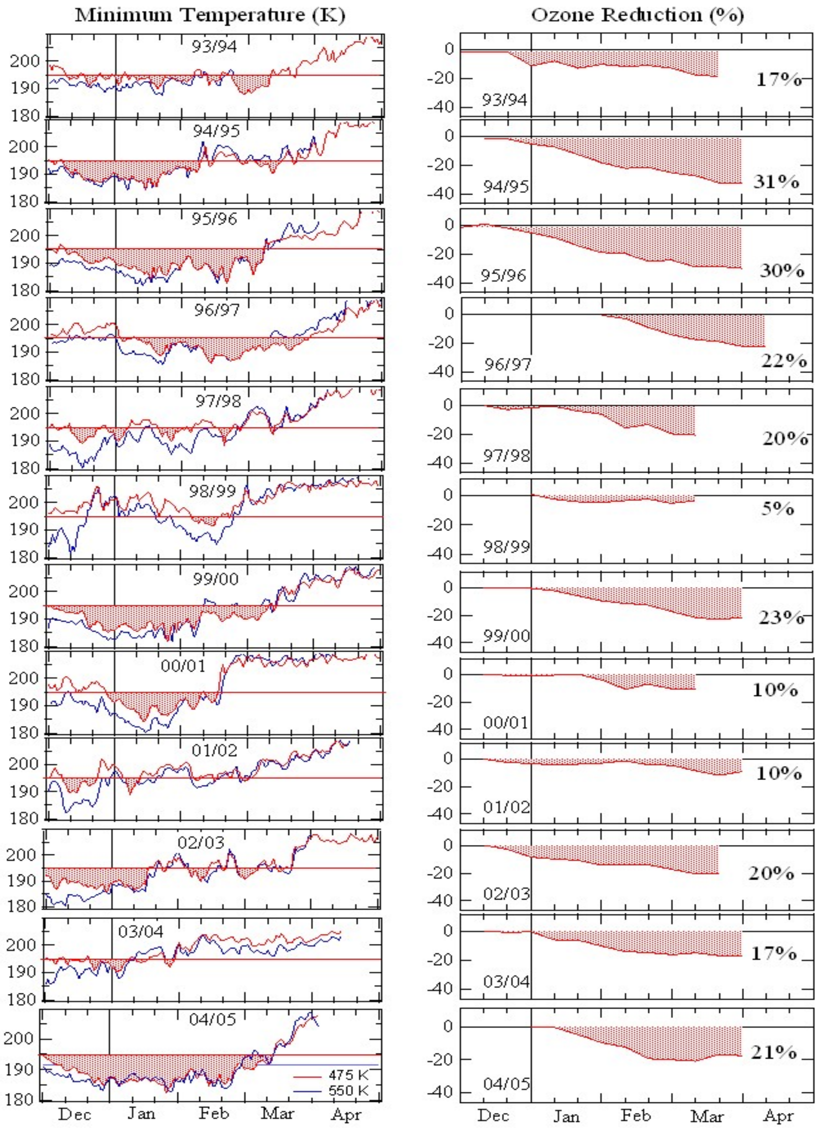
Long-term validation is crucial!

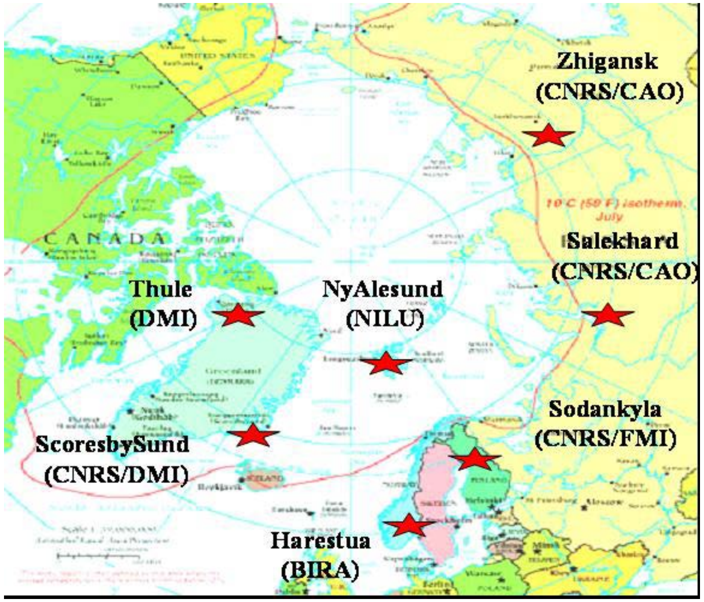
Goals of the NDACC

5. To support process-specific field campaigns occurring at various latitudes and seasons

Arctic Ozone Loss

SAOZ UV-Visible Network



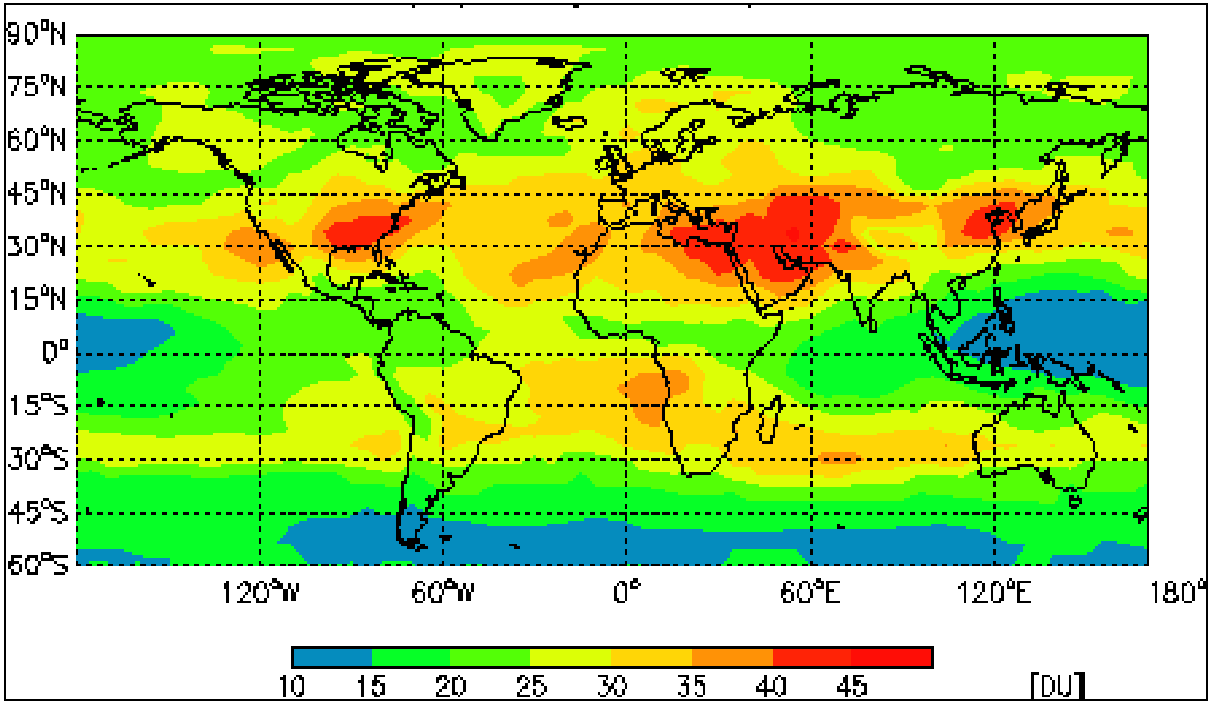


Winter 04/05: 21%
(0.5% per day from January 10 through late February)

F. Goutail, J. P. Pommereau + SAOZ team

Goals of the NDACC

6. ***To provide verified data for testing and improving multidimensional chemistry and transport models of the stratosphere and troposphere***



Enhanced Ozone and Aerosols

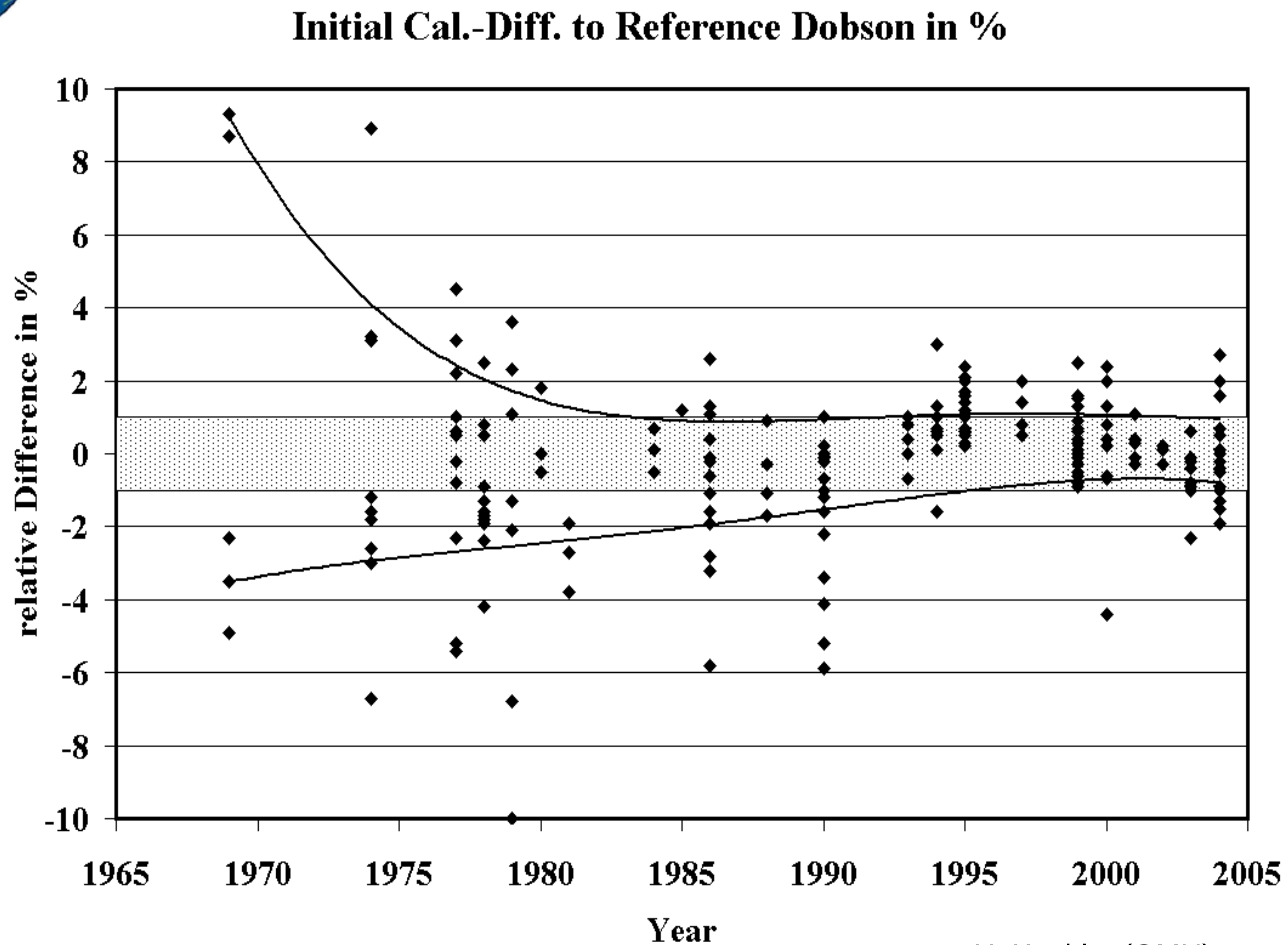
Global Model Simulation of
Tropospheric Ozone Columns

Quality Control

A Commitment to Data Quality

- *Investigators subscribe to a protocol designed to ensure that archived data are of as high a quality as possible within the constraints of measurement technology and retrieval theory*
- *Validation is a continuing process*
  - *Instruments and data analysis methods are evaluated prior to NDACC acceptance and are continuously monitored throughout their use.*
  - *Formal intercomparisons are used to evaluate algorithms and instruments.*

Dobson / Brewer Working Group



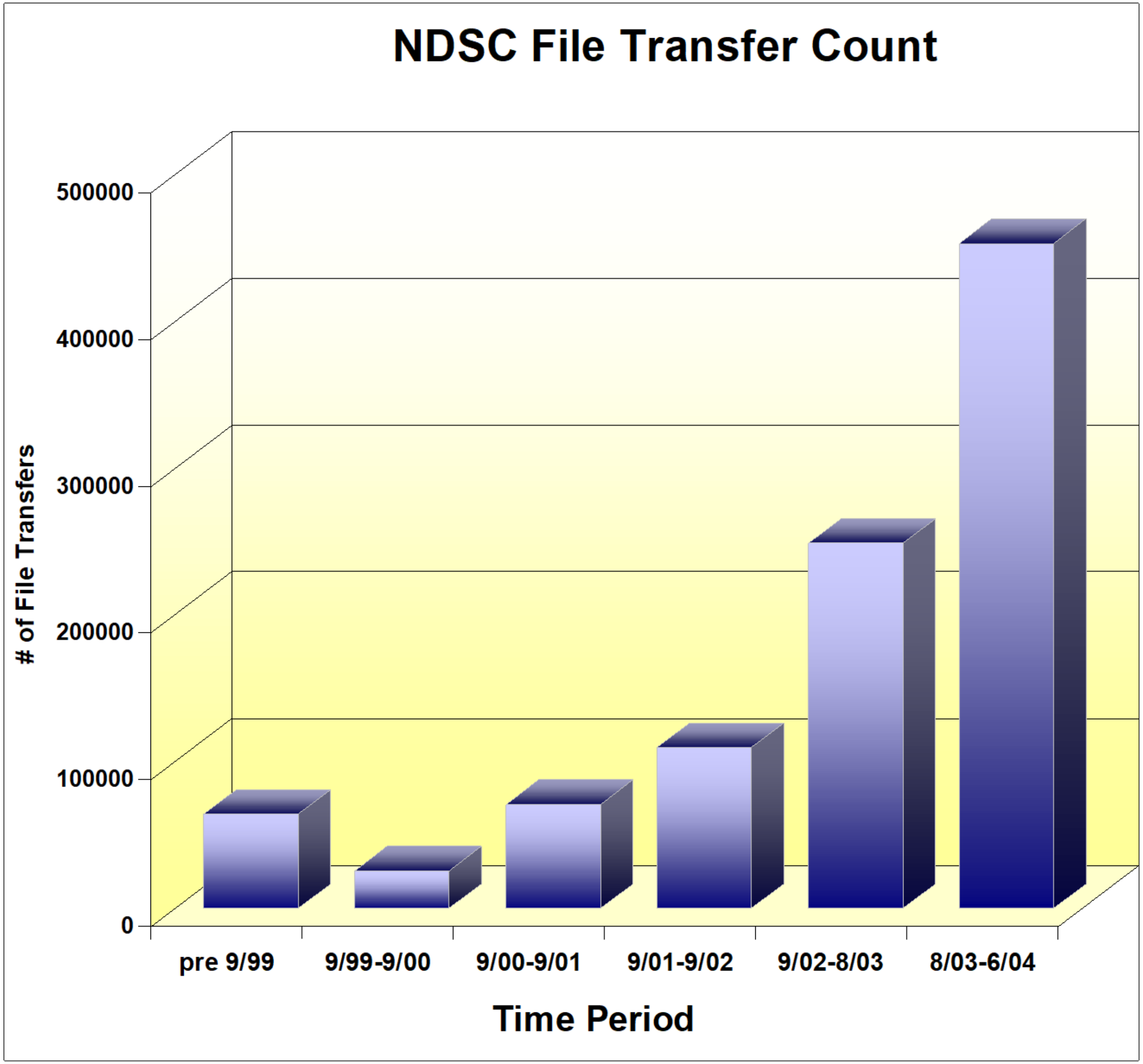
U. Koehler (OMH)

Improvement of the data quality of the Dobson network during the past 35 years.

Data Archiving and Availability

- *Data must be submitted to the central archive within one year of the measurement*
- *All data are available via anonymous ftp within two years of measurement*
- *Many NDACC investigators have agreed to make their data publicly available regularly on a shorter timescale (in some cases, immediately upon archiving).*
- *The use of any NDACC data prior to its being made publicly available (i.e., for field campaigns, satellite validation, etc.) is possible via collaborative arrangement with the appropriate PI(s).*

NDACC Data Host Facility



~ 30,000 files in data base

~ 500,000 file transfers per year

J. Wild & R. Lin (NOAA)

Measurement Contributions to GAW and IGACO

- Stratospheric temperatures
- Total ozone
- Ozone profiles
- Compounds related to ozone loss
  - ClO, OClO, BrO, HCl, HBr, $ClONO_2$, CFC etc.
- Greenhouse gases and water vapor
- Stratospheric aerosols and PSCs
- UV radiation

Future Developments

- Water vapor in the UTLS
  - Raman Lidars
  - Balloon soundings
  - Discrepancy between balloon sondes and

  HALOE data: 5-10% increase per decade from from balloon sondes (15-28 km).
- Closer collaboration with other networks such as SHADOZ
- Establishment of more stations in the tropics
- Provision of data in near-real-time

For Additional Information

- ***http://www.ndacc.org***
  - *The web page is continually being updated*
  - *Comments and suggestions are welcome*
- ***New brochure published 2001***
- ***New informational leaflet published November 2005***
- ***Annual newsletters now available***