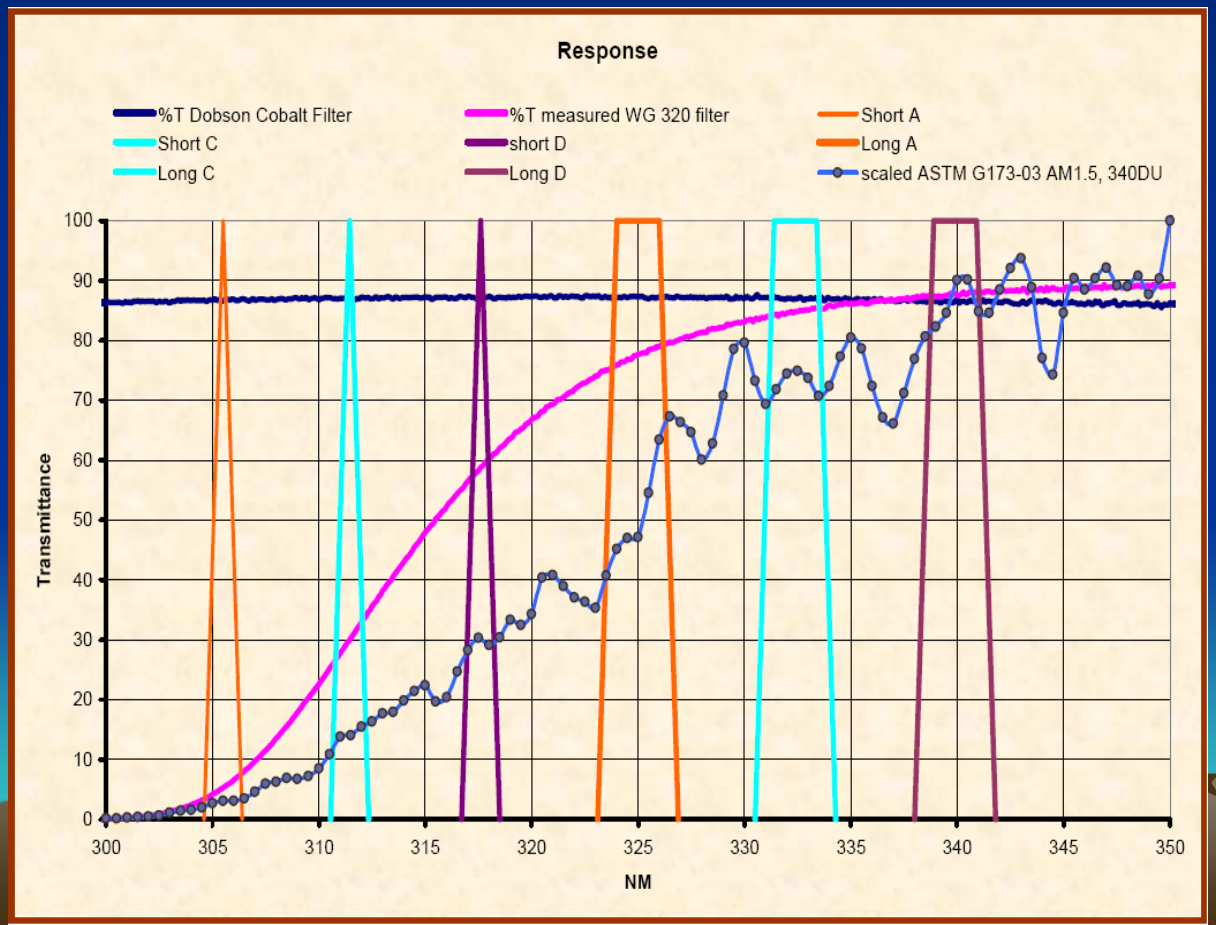
The short-term and long-term stratospheric and tropospheric ozone variability available from zenith sky measurements.

Irina Petropavlovskikh (ESRL/CIRES, Boulder, CO)
S. J. Oltmans, R. Evans, D. Quincy, G. McConville
(NOAA/ESRL/GMD, Boulder)
P. Disterhoft, K. Lantz, P. Kiedron (ESRL/CIRES, Boulder, CO)
V. Fioletov and E. Hare (Environment Canada, Canada)
L. Flynn, M. DeLand, (NOAA/NESDIS, Silver Springs, MD)
P.K. Bhartia, R. McPeters, J. Herman (NASA/Goddard, Greenbelt, MD)

Dobson – work-horse of ozone network since 1930s

- Measurements of total ozone column by Dobson network for over 40 years (15 stations at ESRL/GMD + world calibration standard)



Sir G.M.B. Dobson

Götz, H. Dütch, C.Mateer, W. Komhyr, R. Bojkov, J. DeLuisi, B. Evans, D. Quincy, G.McConville, and many others

Walshaw, C. D., "G.M.B. Dobson – The man and his work, Planet. Space Sci., 37, pp.1485-1507, 1989.

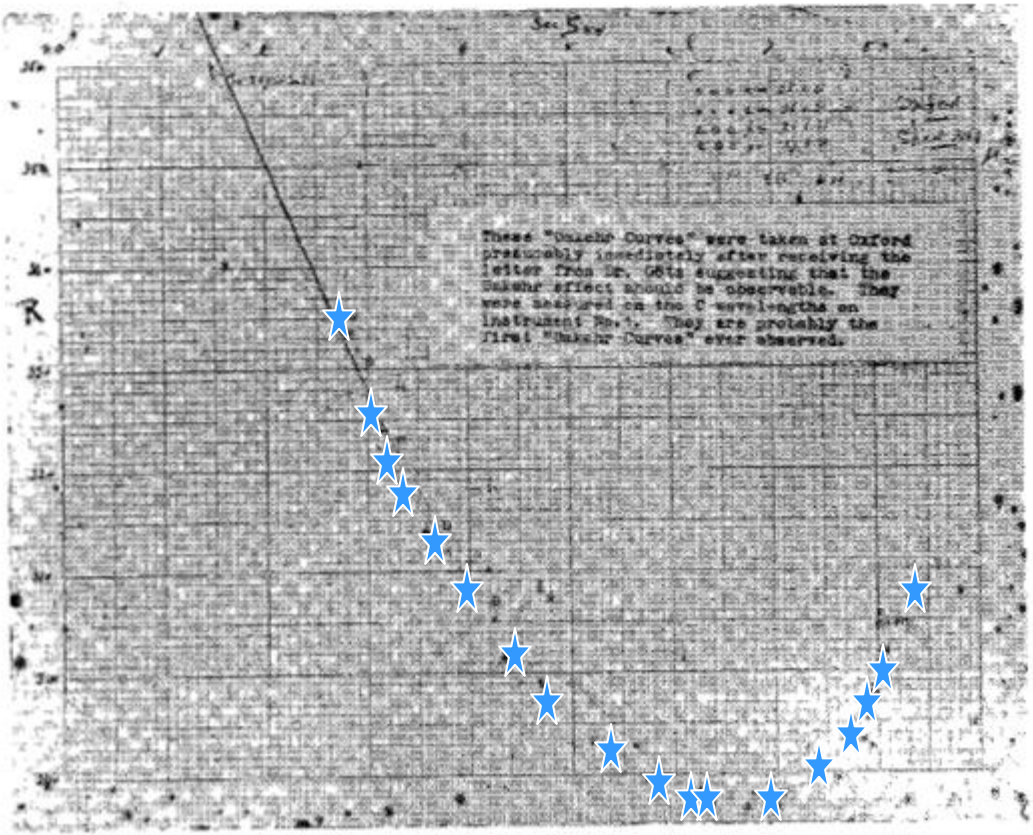


FIG. 6. DOBSON'S FIRST UMKEHR OBSERVATIONS, 25–27 JANUARY 1931.
The typed comment is his. Only a minimum of enhancement has been used on a xerox print of the original graph.

"These "Umkehr Curves" were taken at Oxford presumable immediately after receiving the letter from Dr. Götz suggesting that the Umkehr effect should be observable. They were measured on the C wavelengths on instrument Db 1. They are probably the first "Umkehr" curve ever observed." - G.M.D. Dobson

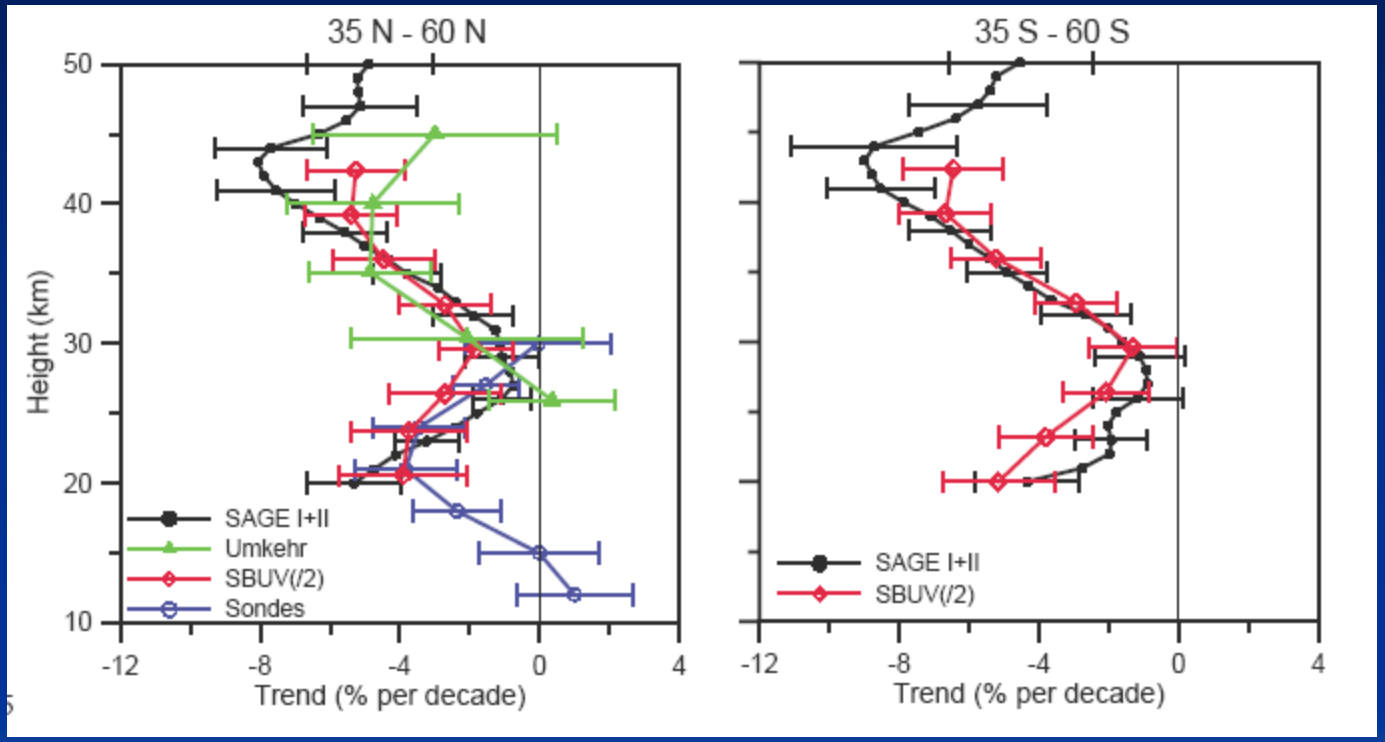
Why do we continue taking and looking at Umkehr data?

- Well-maintained and self-consistent record
- Long historical record (back to 1957, some even earlier)
  - Satellites start measurements only in 1970s
- Calibration: Ratio vs. Absolute (tropospheric aerosols, albedo)
  - Satellites are hard to calibrate
- Stratospheric aerosol interference – large errors, but a short-lived effect (~6 months)
  - The same problem for satellites and other instruments
- Umkehr data provide reliable information in layer 8 (40-45 km)
  - Sonde data do not reach 40-km altitude
  - New methods have shorter records and limited coverage

Main points addressed in the talk

- *UMK04 ozone profile retrieval algorithm was designed in 2004 to reduce effect of a priori on trends and inter-annual variability (Petropavlovskikh et al., 2005)*
- An assessment of the Umkehr ozone profile data.
- Capabilities and limitations.
- Studies of tropospheric ozone variability and comparisons with ozone sounding data.
- Natural and instrument variability.
- Questions addressed - change in the seasonal cycle, trends, correlation
- The impact of the retrieval algorithm on the derived trends.
- Comparisons with SBUV satellite profiles (V8, Bhartia 2004).

Vertical profile ozone trends Northern vs Southern Hemisphere



Vertical profile of ozone trends over the northern and southern middle latitudes estimated from ozone sonde, Umkehr, SAGE I+II, and SBUV (/2) data for the period of 1979-2004. The trends were estimated using regression to an EESC curve and converted to %/decade using the variation of EESC with time in the 1980s. The 2σ bars are shown.

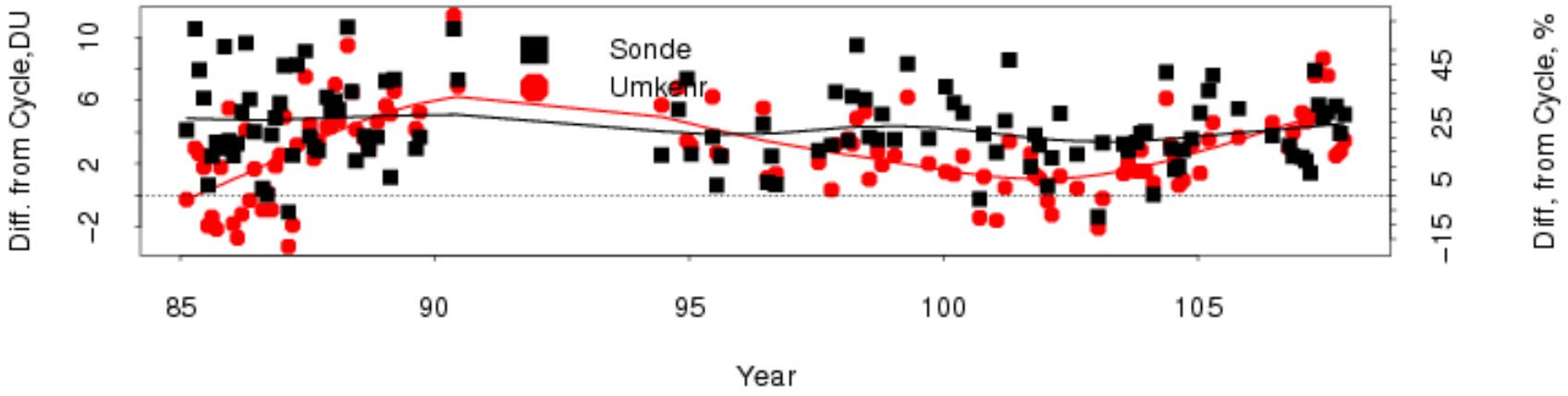
Scientific Assessment of Ozone Depletion 2006, WMO Rep 50, Chapter 3

Variability – seasonal cycle, long-term, and partial correlation

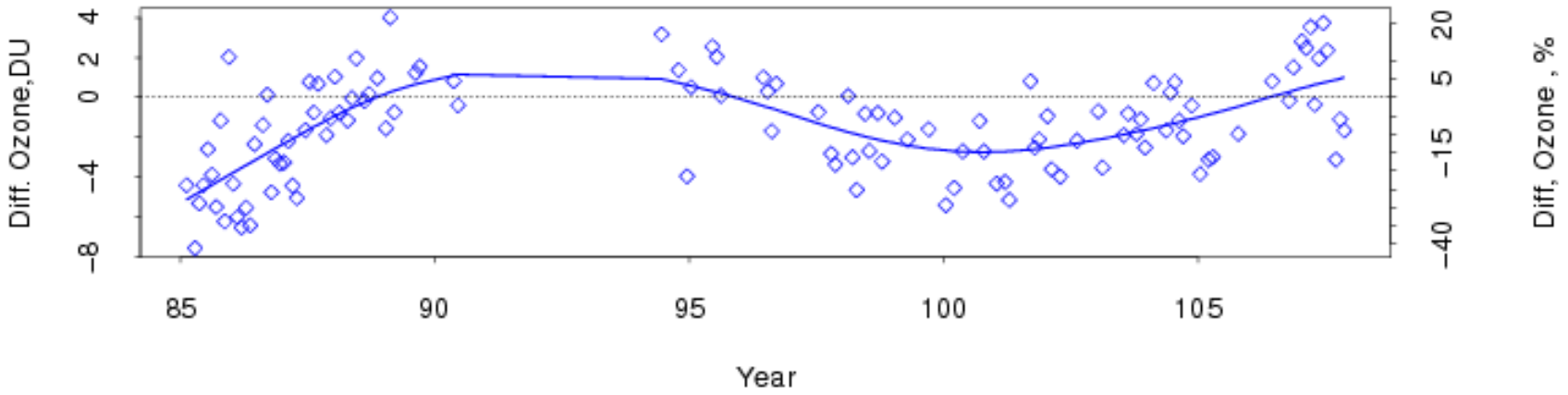
- Troposphere: Umkehr vs. ozone sounding – Boulder (US), and MLO stations (US)
- Stratosphere: SBUV V.8 vs. Umkehr overpass –Arosa (47 N, Switzerland), OHP (44 N, France), Boulder (40 N, US), MLO (19 N, US), Lauder (45 S, New Zealand) stations

MLO/Hillo ozone below 250 hPs, Dobson and sonde, <2-day

1985-2007 linear trend %/decade: Umkehr (-0.03+/-0.05) and sonde (-0.06 +/-0.03)

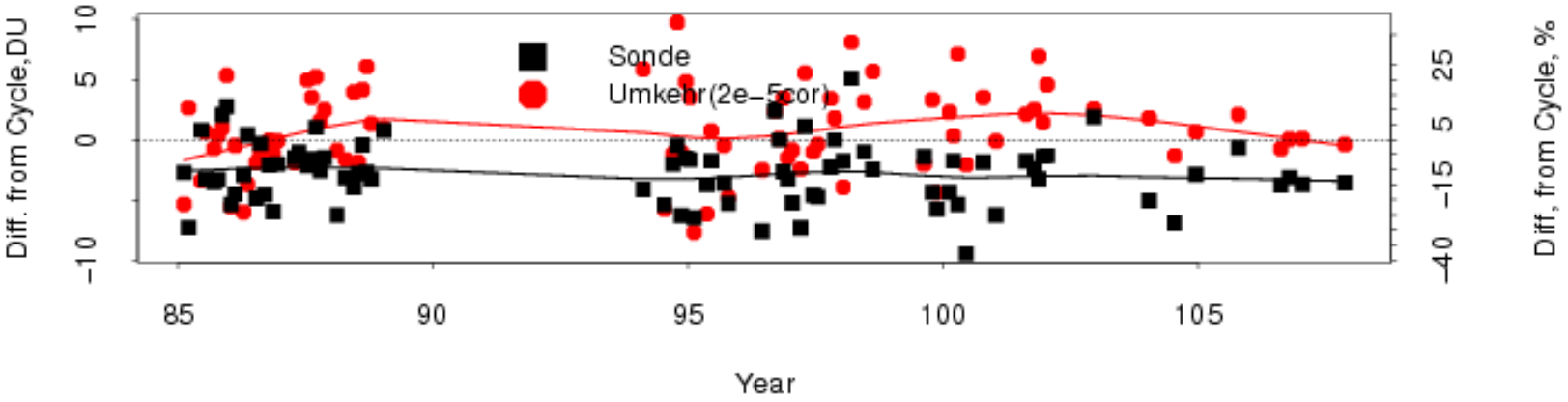


Relative difference between Umkehr and sonde in layer 1 (0.04%/decade)

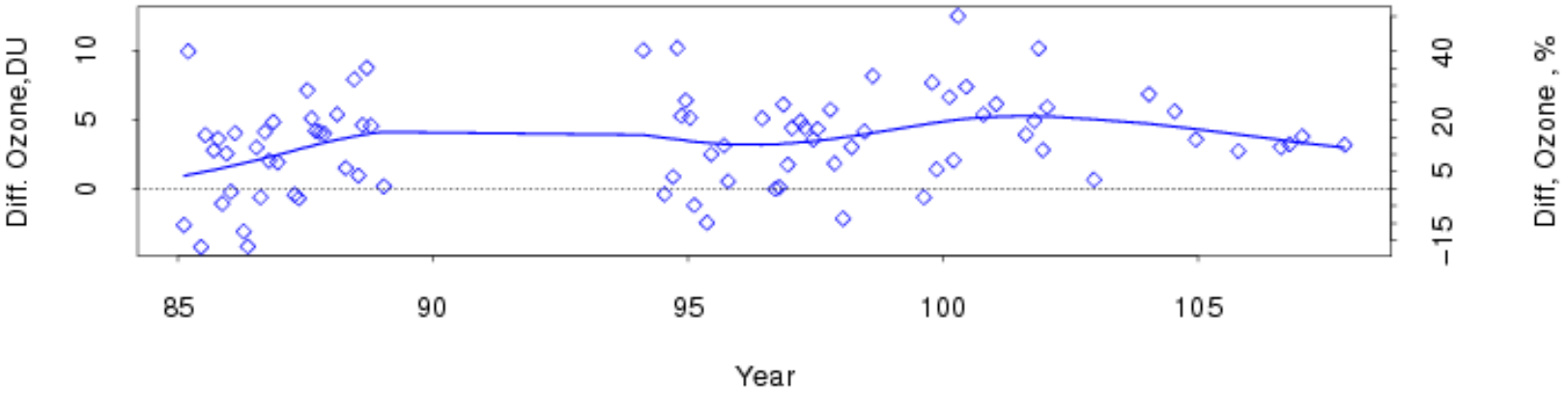


Boulder ozone below 250 hPs, Dobson and sonde, <2-day

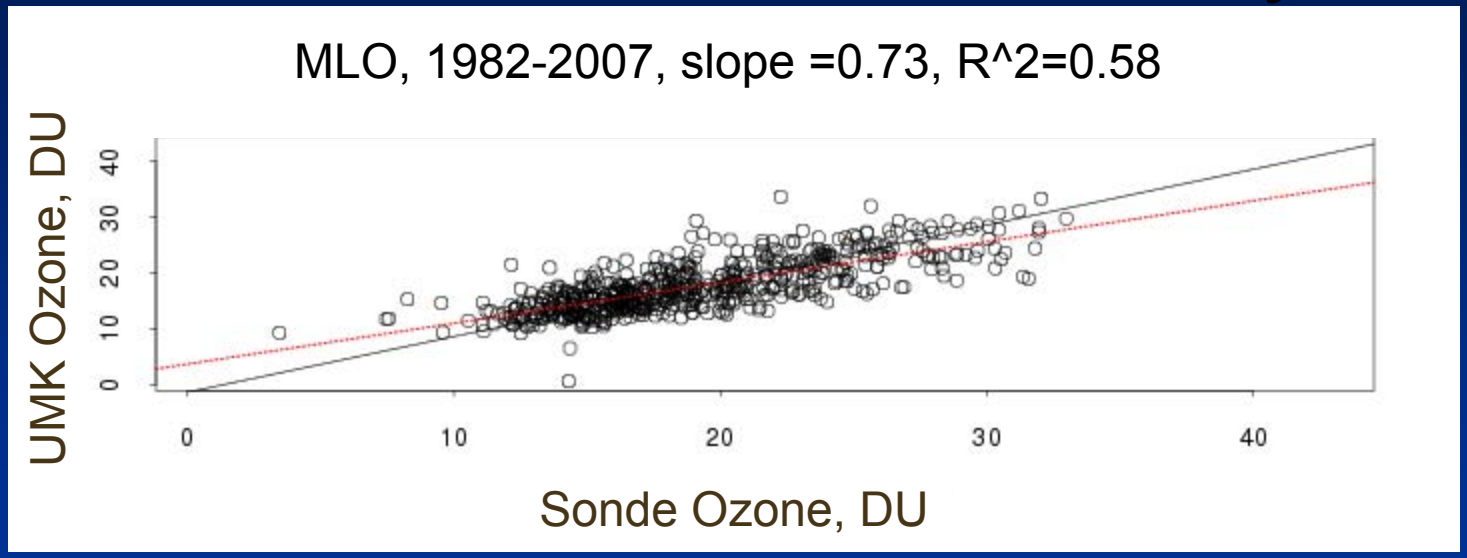
1985-2007 linear trend %/decade: Umkehr (0.07+/-0.03) and sonde (-0.05 +/-0.02)

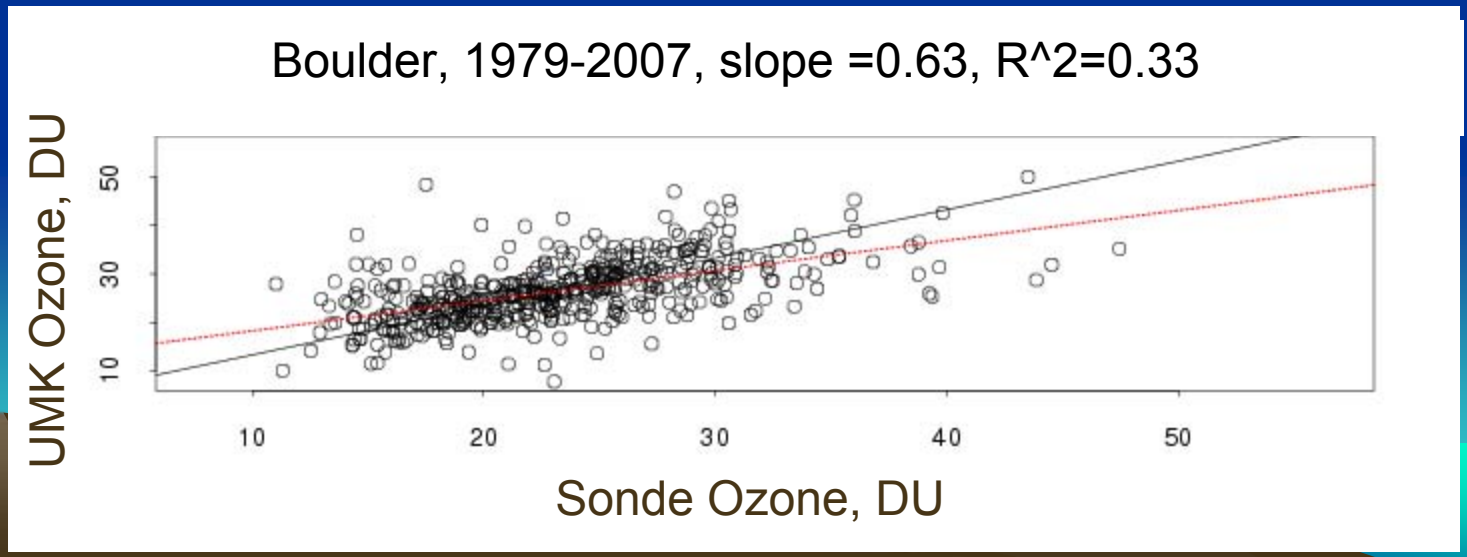


Relative difference between Umkehr and sonde in layer 1 (0.1%/decade)



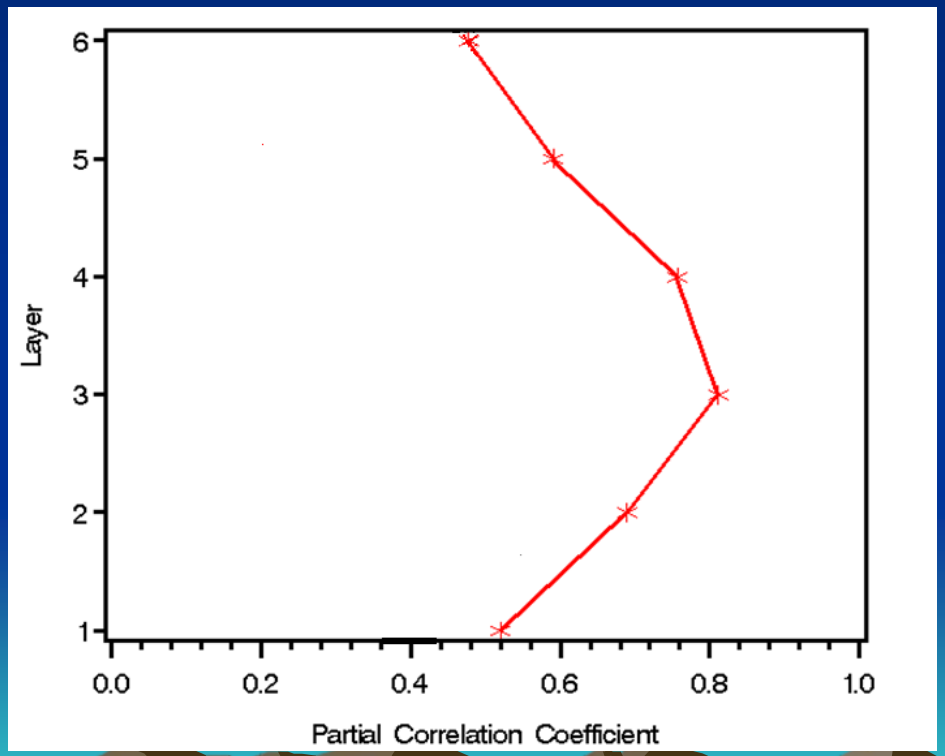
Tropospheric ozone below 250 hPs, Dobson and sonde, <2-day



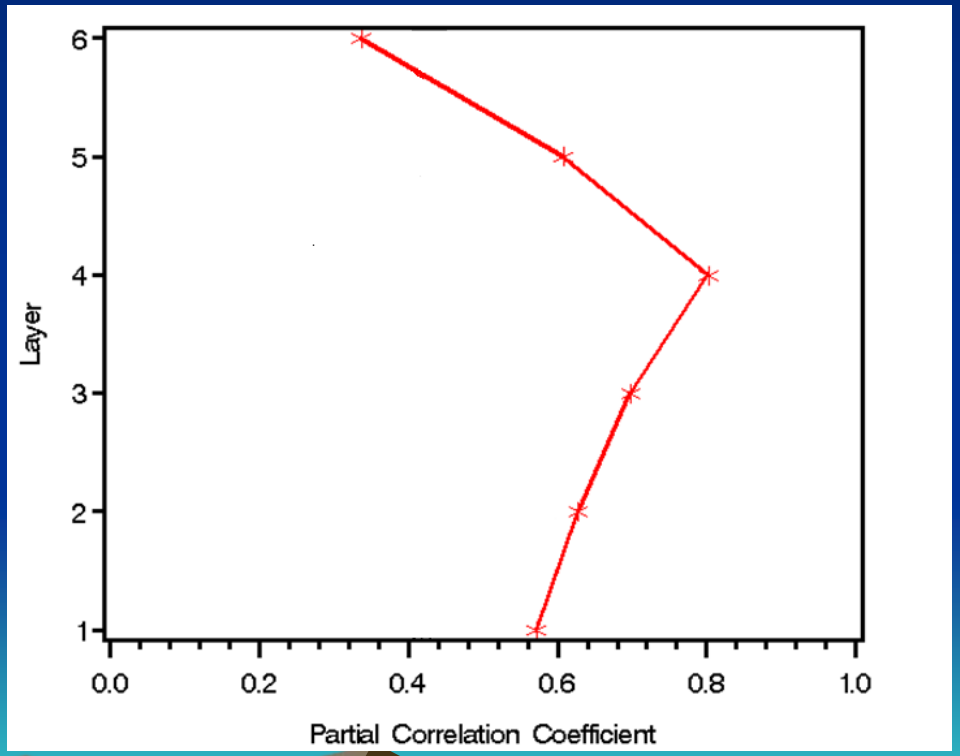


Correlation between sonde and Dobson (in excess of climatology)

Boulder (1985-2005)

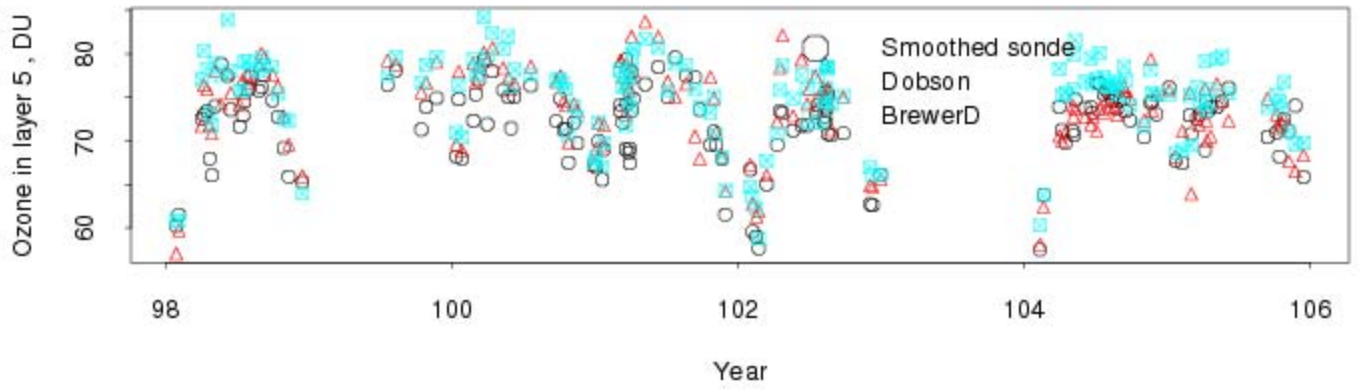


MLO (1985-2005)

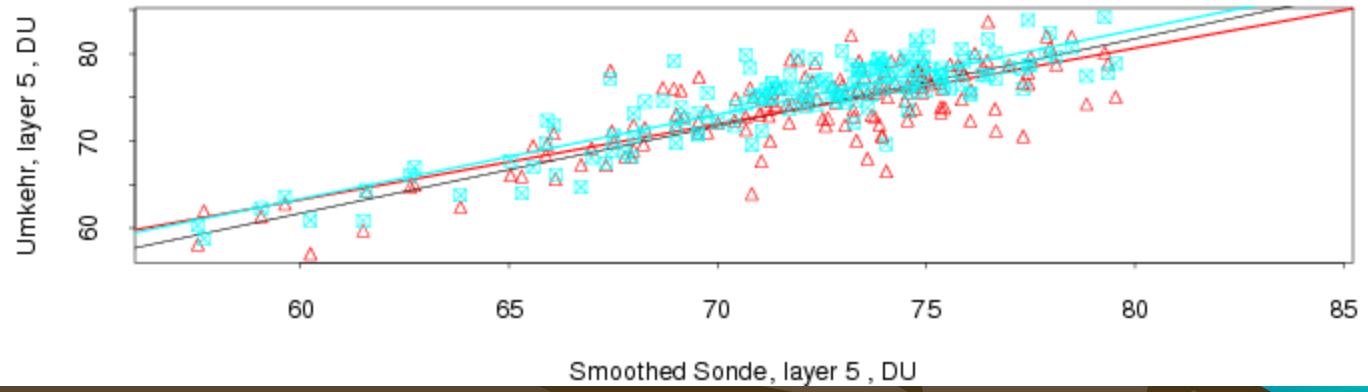


MLO/Hilo ozone 16-32 hPa (25-30 km) Dobson, Brewer and sonde (1998-2005)

trend %/decade: Dobson (-1.1+/-0.3), Br(-0.5+/-0.2) and sonde (-0.3 +/-0.02)



Slope: Db=0.87 (0.62), Br=0.97 (0.76)



NEUBrew Network - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://esrl.noaa.gov/gmd/grad/neubrew/

capture the screen

Channels Calendar Download Instant Message People Radio RealPlayer WebMail Yellow Pages

NEUBrew Network | Print screen - Wikipedia, the fre...

U.S. Department of Commerce | National Oceanic & Atmospheric Administration | NOAA Research

Earth System Research Laboratory
Global Monitoring Division

Search ESRL:

FAQs | People | Publications

Global Monitoring Division | About | Research | Outreach | Media Center

NEUBrew Home

About Brewer MKIV
NEUBrew Contacts
Calibration/Characterization
DOY Calendar

Stations

TMTF, CO
MRS, CO
Houston, TX
Bondville, IL
Raleigh, NC
Ft. Peck, MT

Data Files

Brewer Raw Data
Products (QC'ed)

Displays

Brewer Raw Data Displays
Product Displays

Documents

Publications

NEUBrew

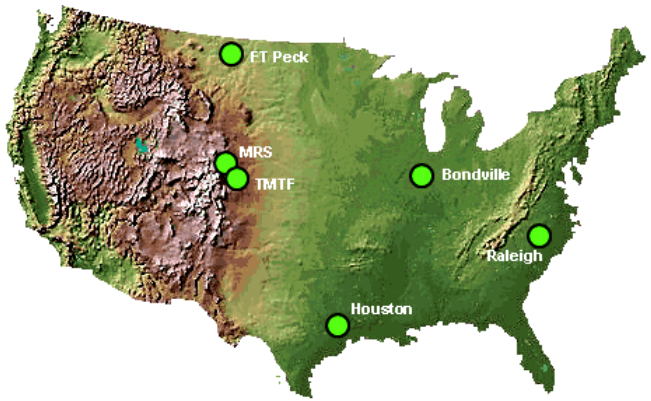
NOAA-EPA Brewer Spectrophotometer UV and Ozone Network

The NOAA/EPA Brewer Spectrophotometer Network consists of six stations located in the western, central and eastern United States. Brewer instruments provide daily Ultra-Violet (UV) Radiation and Total-Column Ozone measurements. Many Brewers are co-located at NOAA SURFRAD stations equipped with Total Surface Radiation Budget instrumentation, and Total Sky Imagers.

Brewer Deployments:

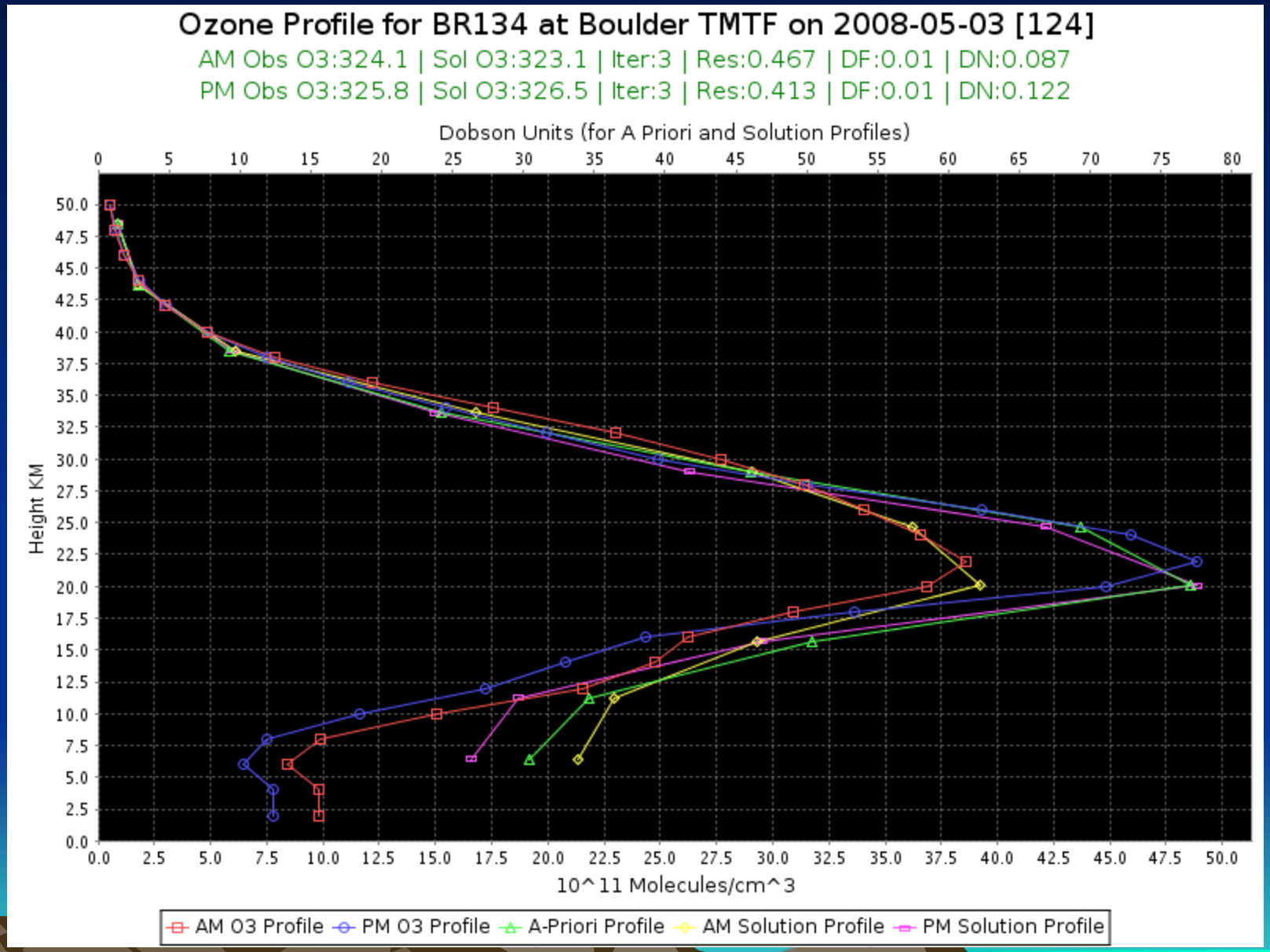
TMTF, CO	July 1, 2006
Houston, TX	July 24, 2006
MRS, CO	Oct 25, 2006
Bondville, IL	Sep 25, 2006
Raleigh, NC	Oct 13, 2006
Ft. Peck, MT	Nov 07, 2006

Thu, 24 May 2007 20:00:23 UTC - DOY [144]

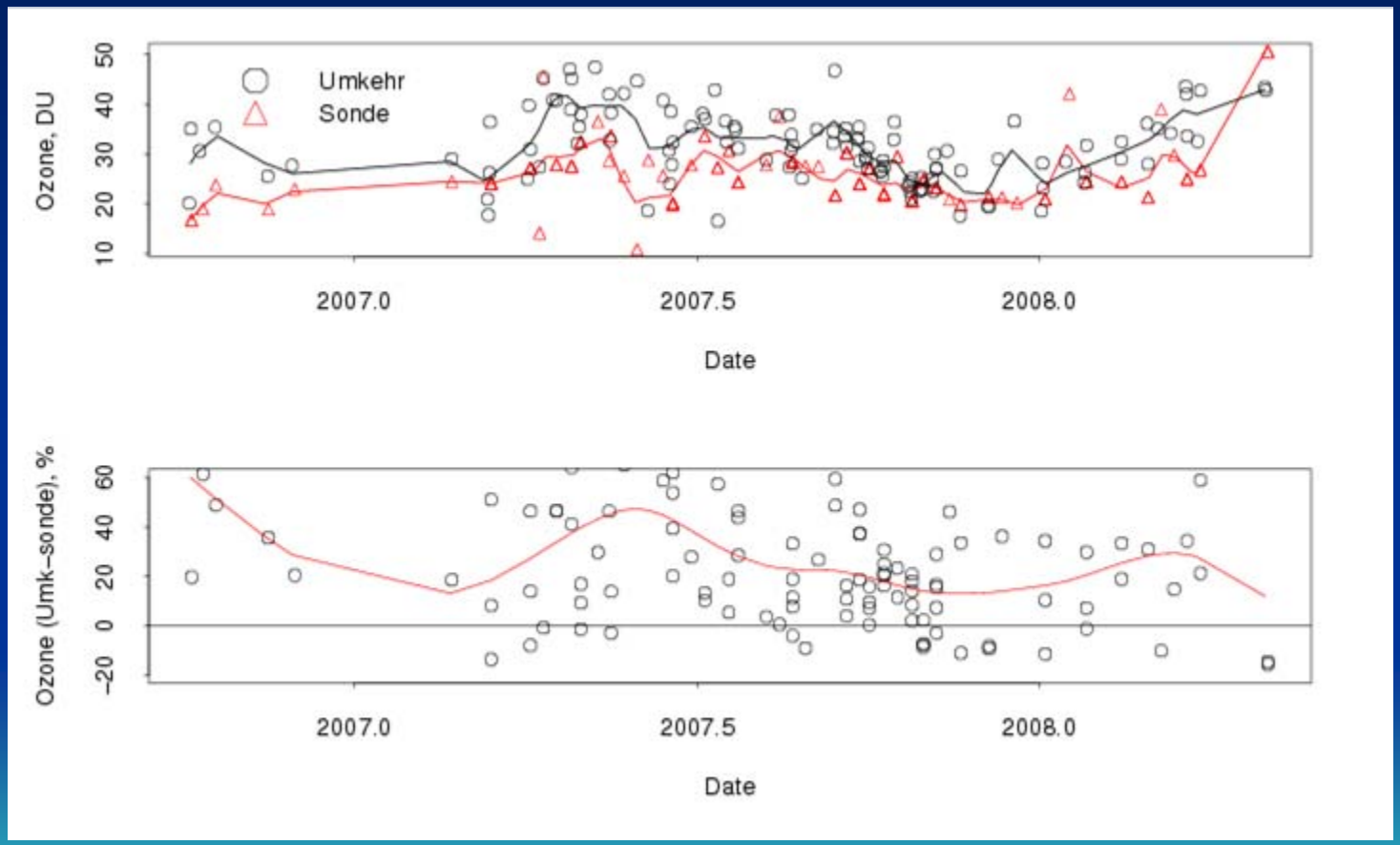


Brewer Network Stations

http://www.doc.gov/


Ozone Profile for BR134 at Boulder TMTF on 2008-05-03 [124]
AM Obs O3:324.1 | Sol O3:323.1 | Iter:3 | Res:0.467 | DF:0.01 | DN:0.087
PM Obs O3:325.8 | Sol O3:326.5 | Iter:3 | Res:0.413 | DF:0.01 | DN:0.122
Dobson Units (for A Priori and Solution Profiles)
Height KM
10^11 Molecules/cm^3
AM O3 Profile
PM O3 Profile
A-Priori Profile
AM Solution Profile
PM Solution Profile

Boulder Brewer data (NEUBrew) Troposphere, Sept 2006 – May 2008



Sampling:

Brewer – daily, multiple TO

Sounding - weekly

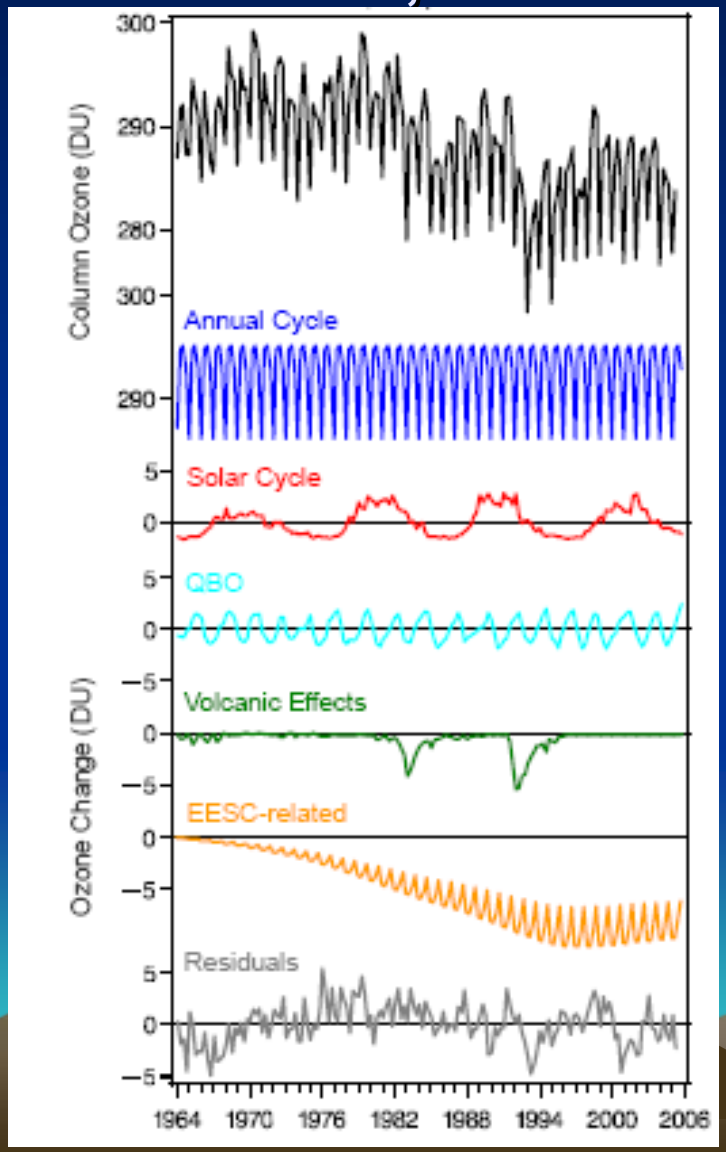
Limitations:

Brewer – clouds, vertical resolution

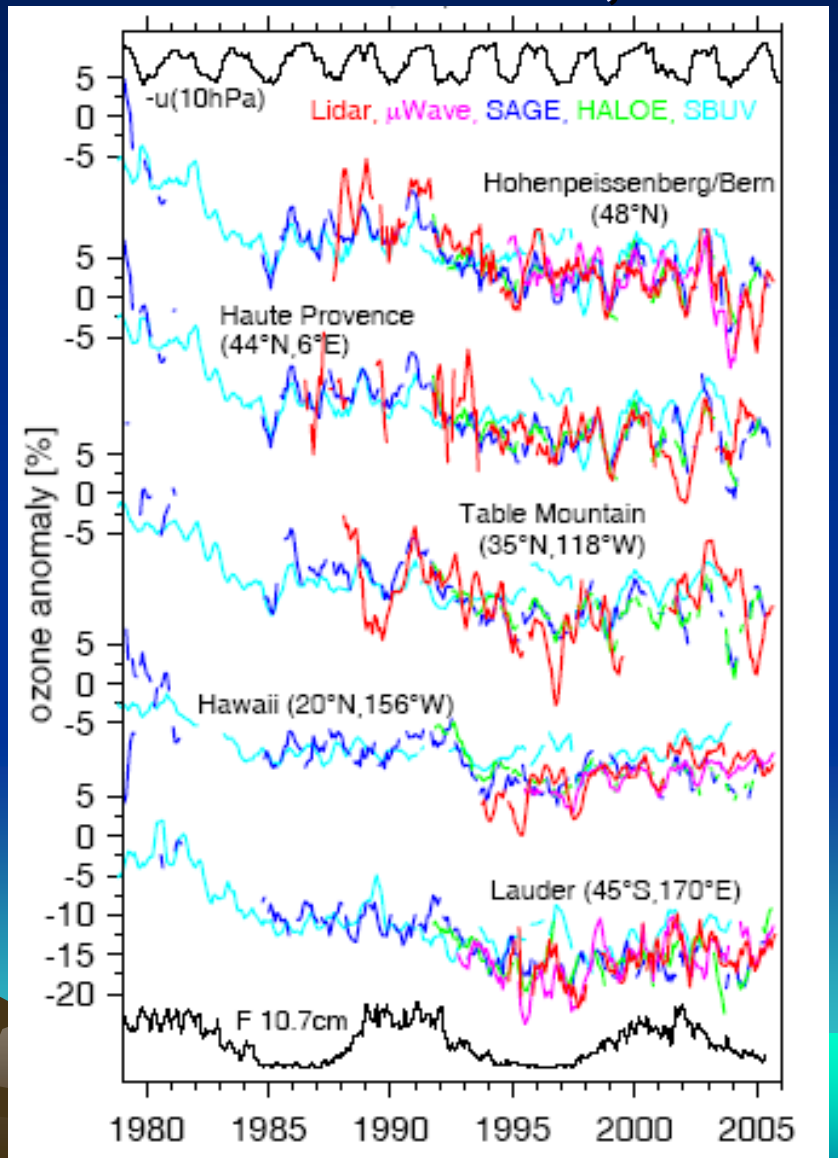
Sounding - sampling

Autoregressive trend model

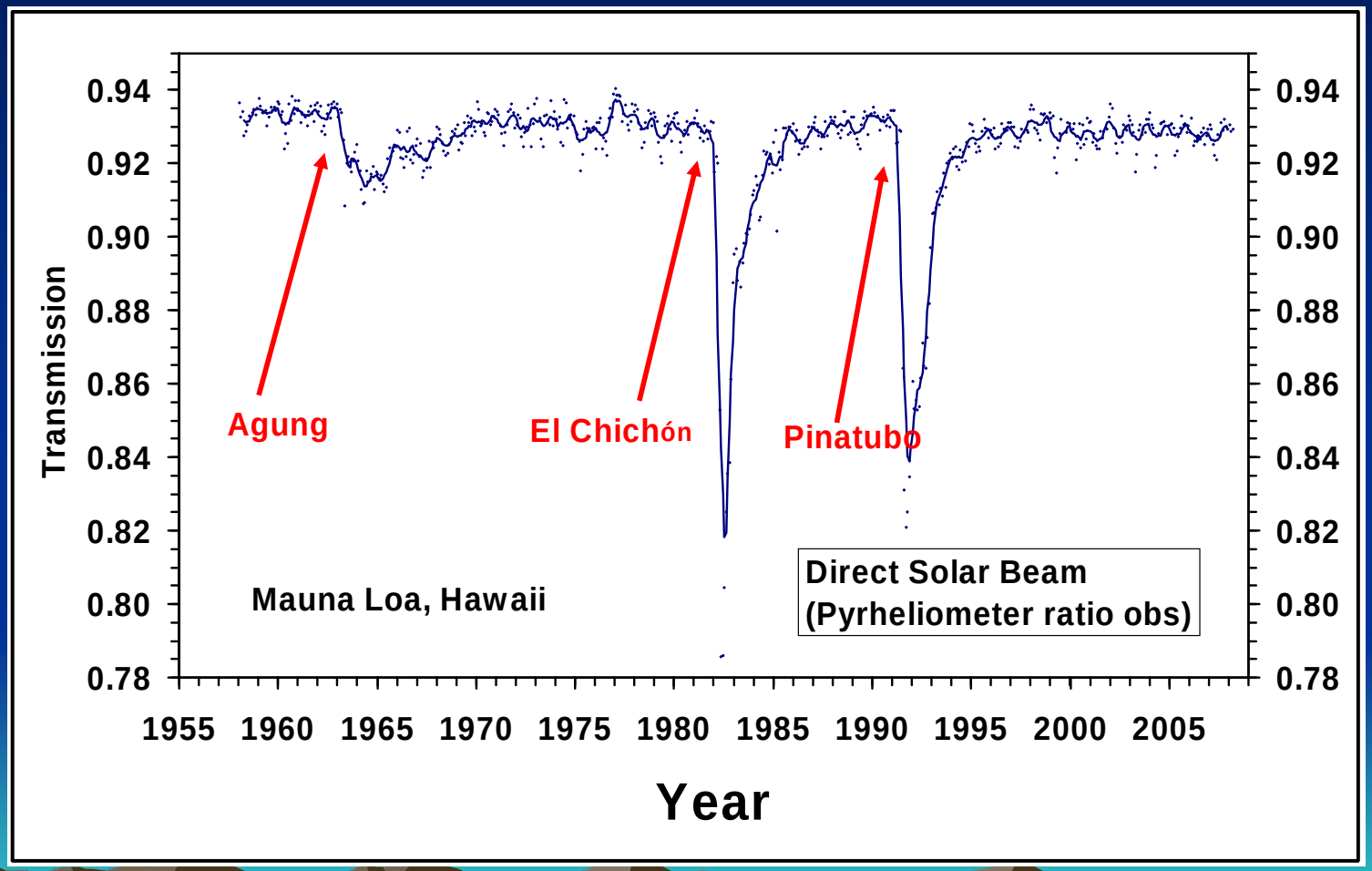
WMO, 2007



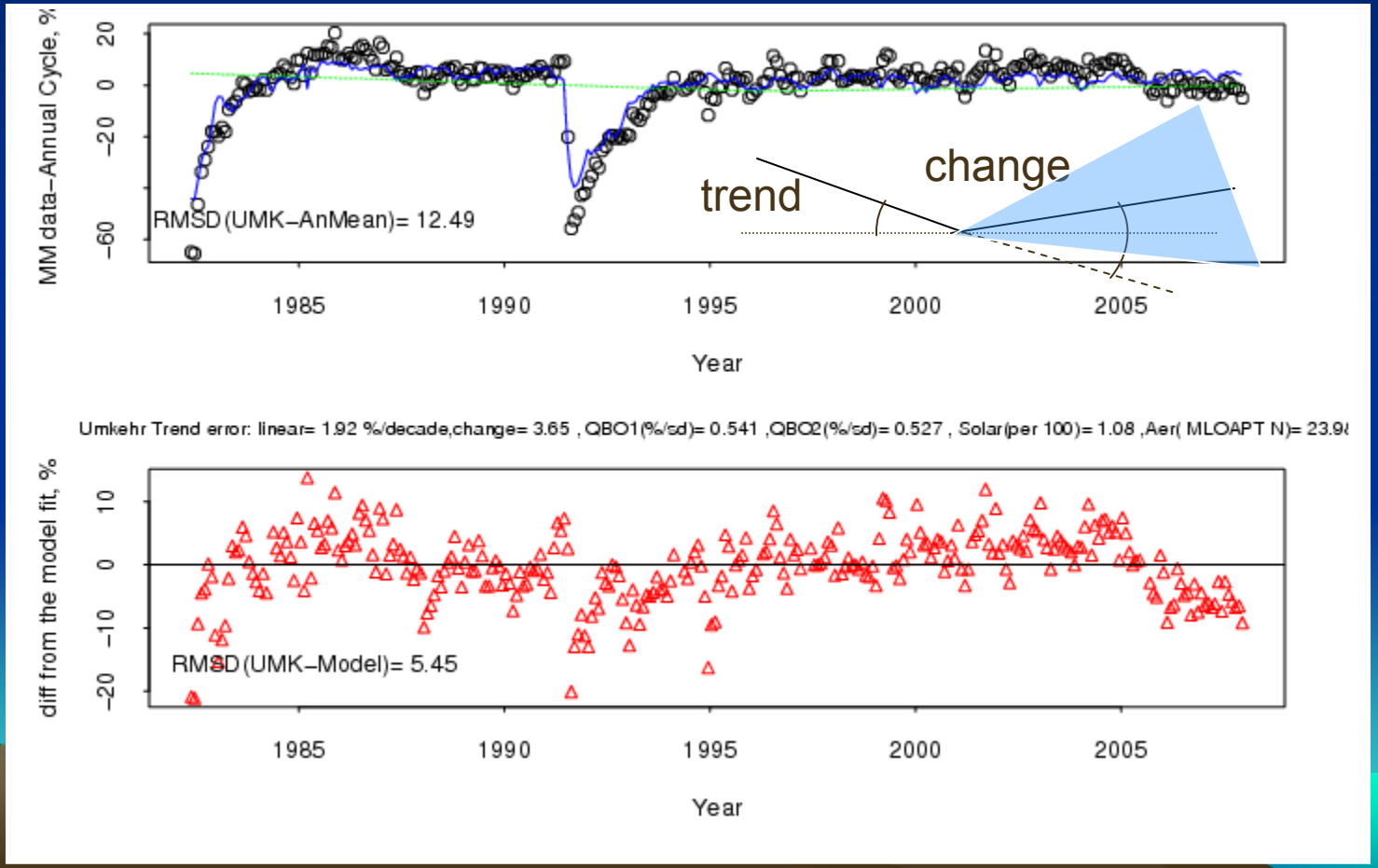
Steinbrecht et al., 2006



MLO monthly averages from Pyrheliometer ratio observations (courtesy of GMD/GRAD)



MLO 1982-2007 Umkehr ozone, Layer 8 (1-2 hPa) Model fit (aerosol, QBO [0.4%/sd/ -0.1%/sd], Solar [-0.9%/100F], trend[-5%/dec], change[7%/dec]

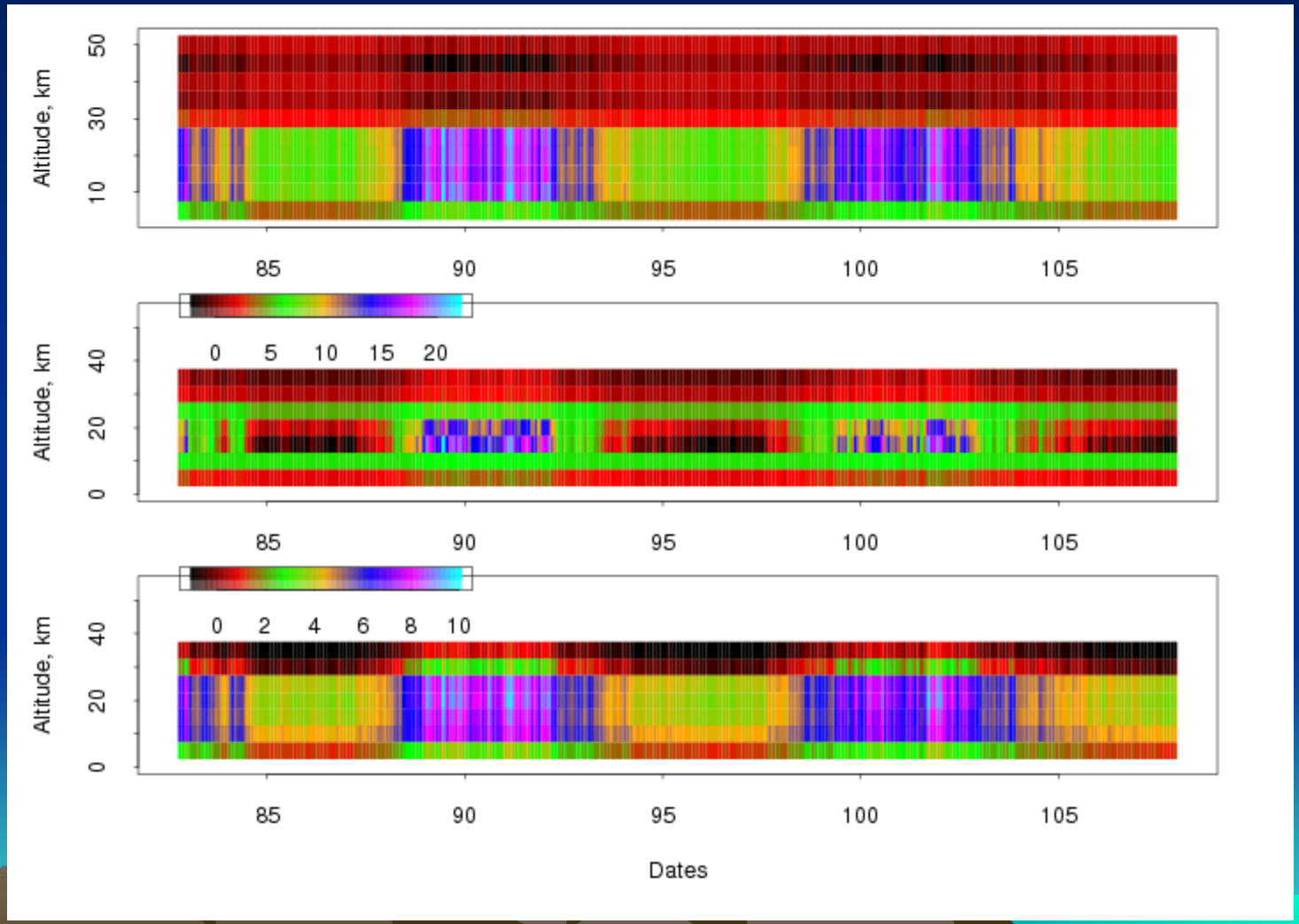


MLO, Solar signal in ozone profile, Dobson and sonde, coincidence<2-day

Umkehr

Sonde

AK*sonde

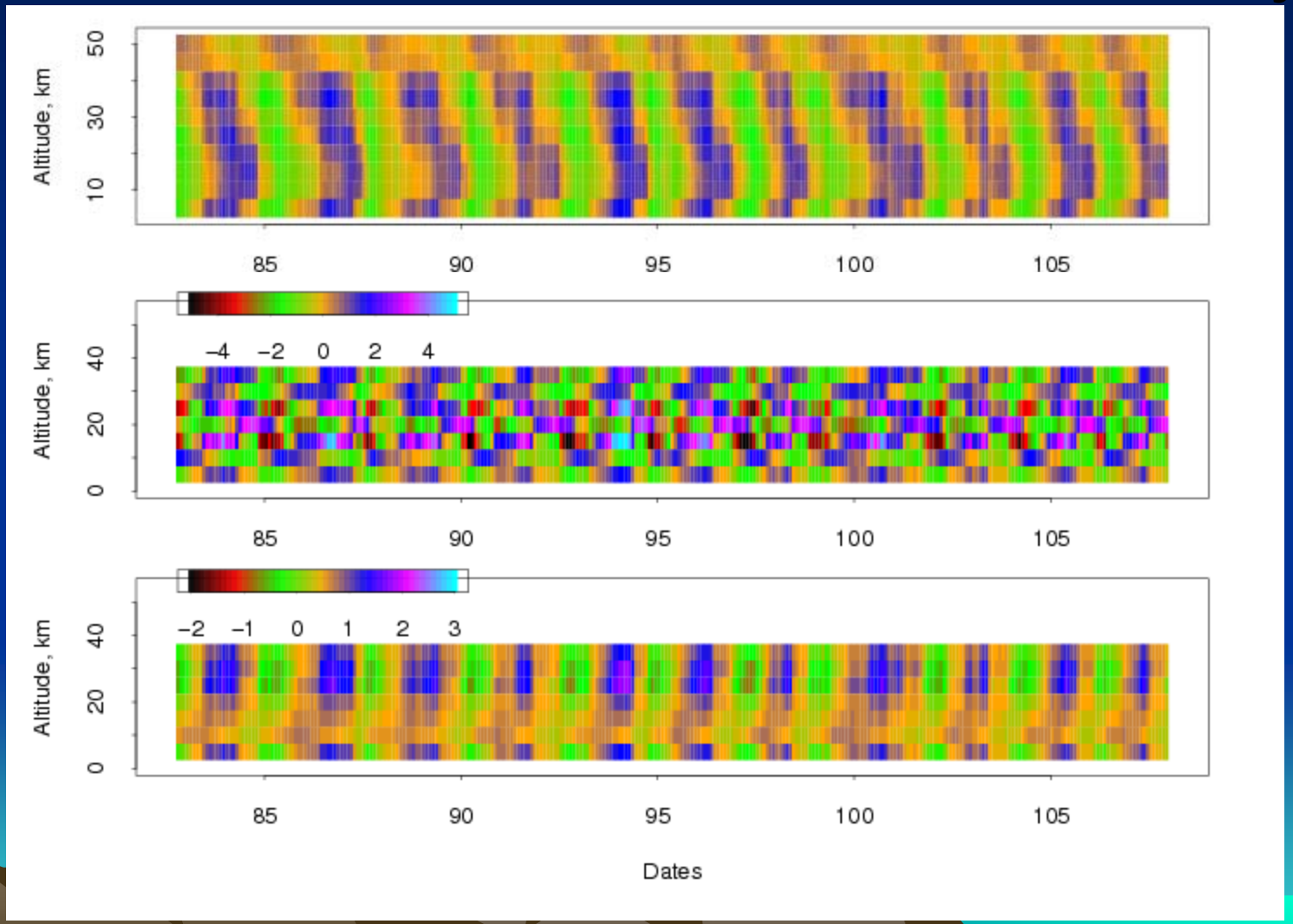


MLO, QBO signal in ozone profile, Dobson and sonde, coincidence <2-day

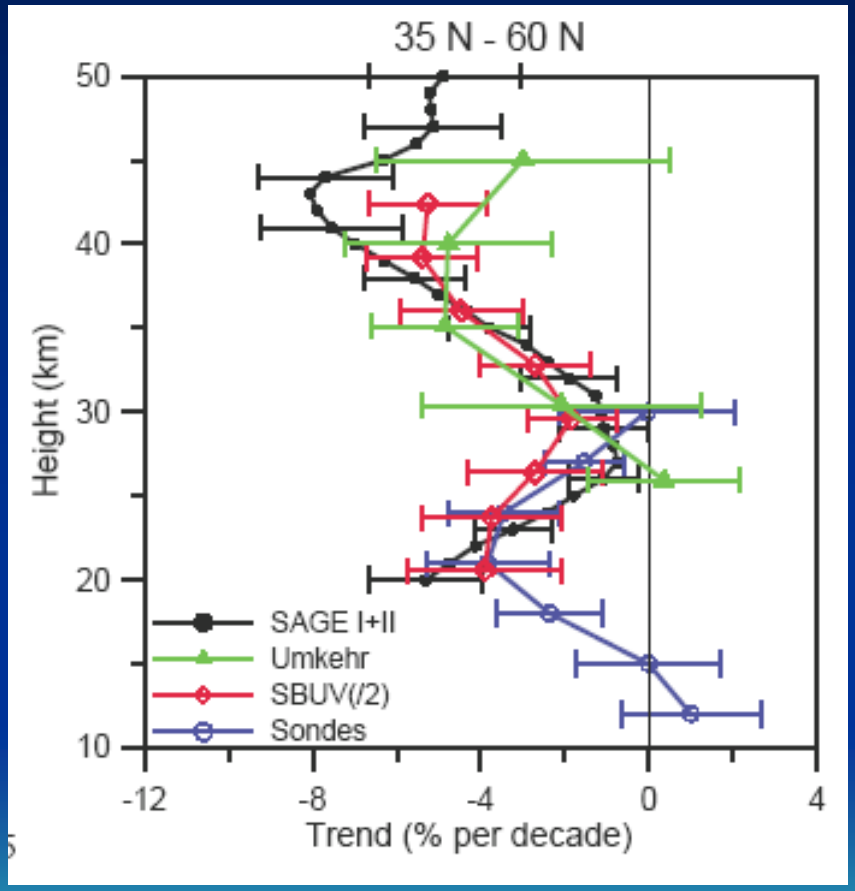
Umkehr

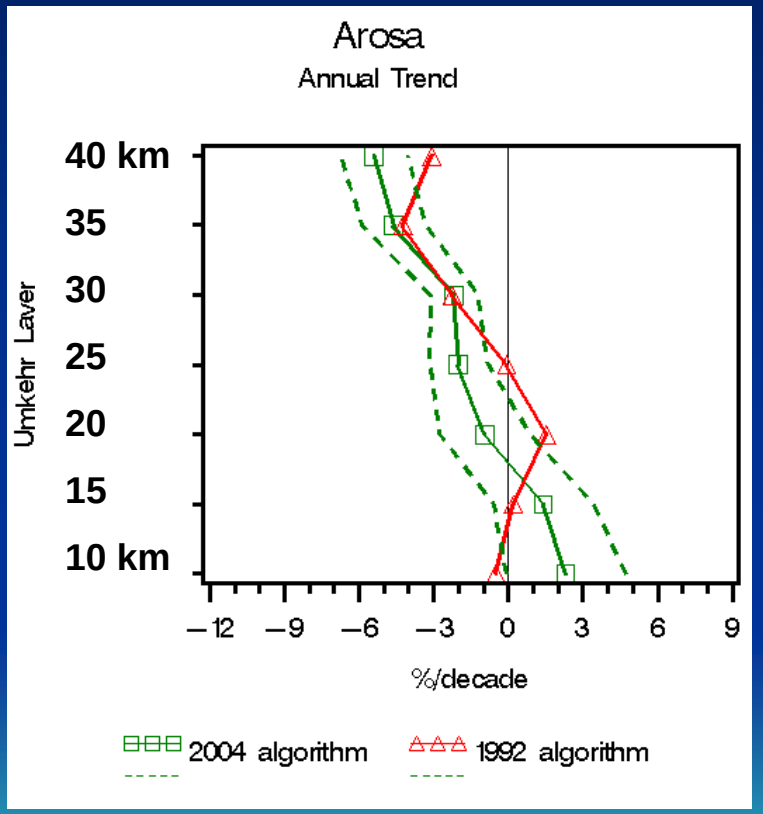
Sonde

AK*sonde



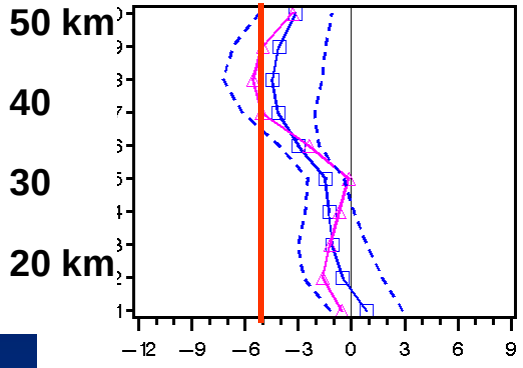
Algorithm and tropospheric ozone



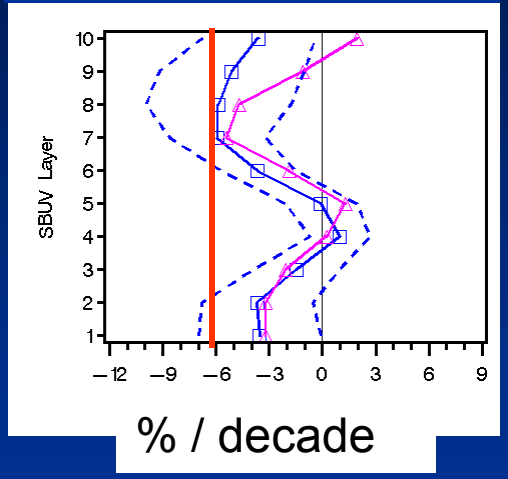


Latitude/altitude trend distribution (SBUV overpass)

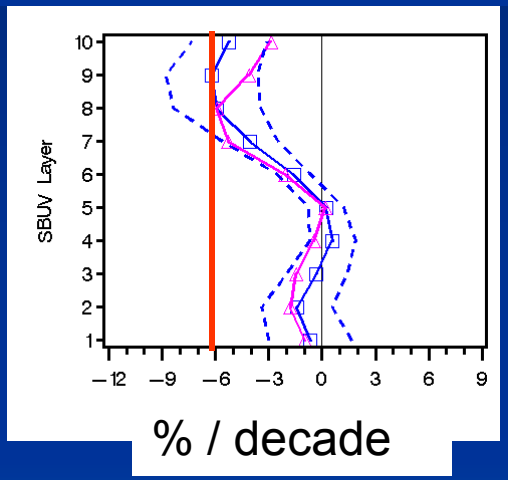
Arosa, 47N, 1979-2006



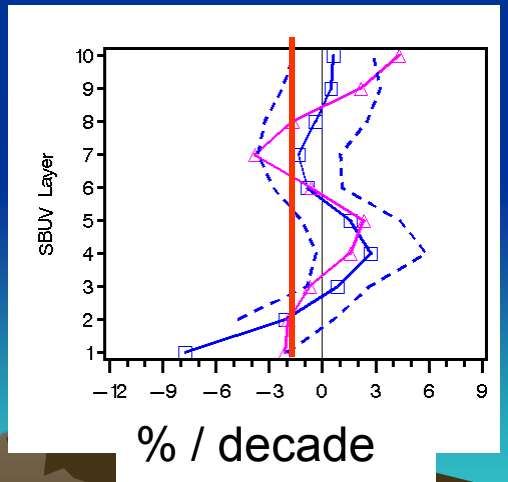
OHP, 44 N, 1982-2006



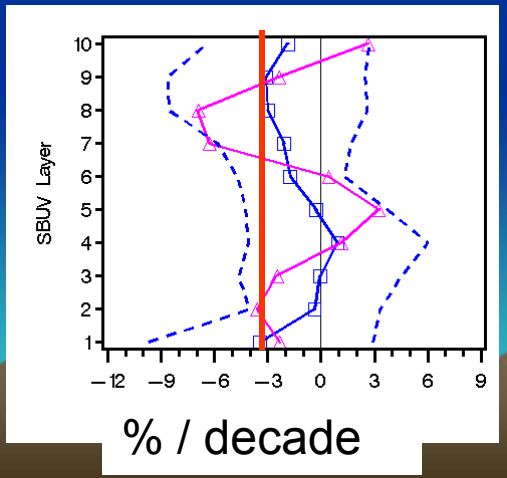
Boulder, 40N, 1979-2006



MLO, 19N, 1982-2006



Lauder, 45S, 1986-2006



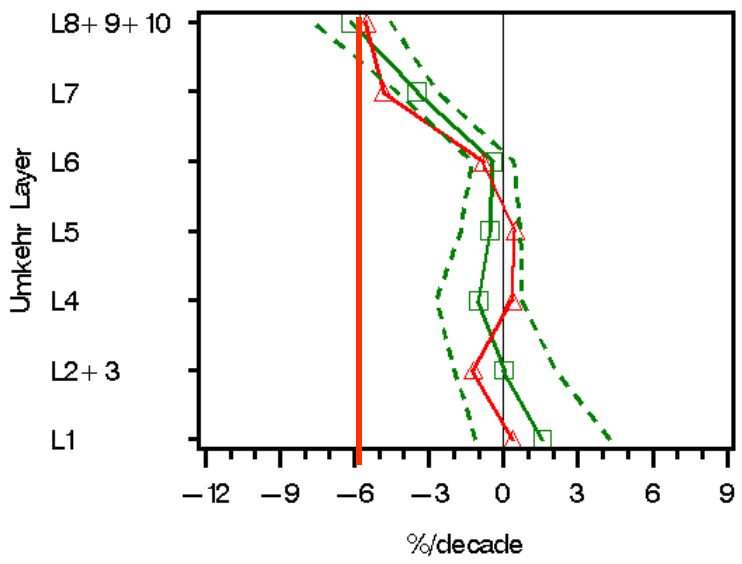
UMK04

SBUV V8

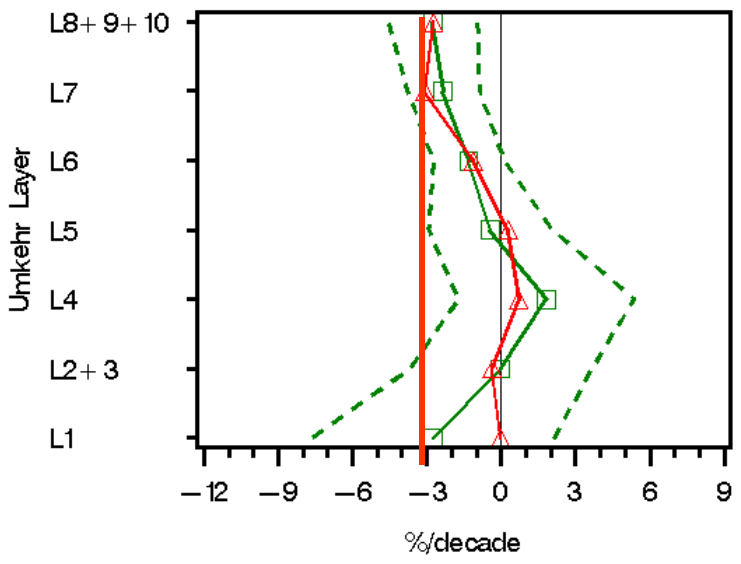
Error bars

Change the beginning of record

Boulder, 40N, **1979**-2006



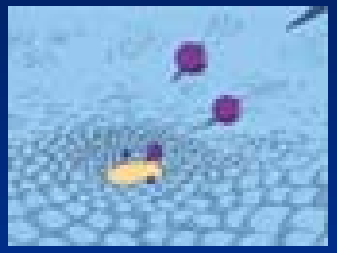
Boulder, 40N, **1986**-2006



Conclusions

- Umkehr retrieved ozone profile time series are valuable assets in determining ozone inter-annual variability and trends in both stratosphere and troposphere.
- Quality assured Umkehr data show no significant differences in stratospheric ozone trends among stations in northern middle latitudes.
- Trend differences found in stratospheric ozone depletion over Lauder, NZ (southern hemisphere compared to the Northern hemisphere) are most likely related to the starting date of the record.
- Upper tropospheric ozone appears to be increasing over Northern latitudes.
- Long-term Umkehr data records provide ground-truth for homogenized SBUV and TOMS satellite data records
- Work on Brewer ozone profile retrieval is undergoing, new data sets are available for 6 NEUBrew sites.
- Extended data set will be available for future satellite mission validation and ozone recovery analysis.

Ozzy Ozone Video
http://www.unep.org/Ozoneaction

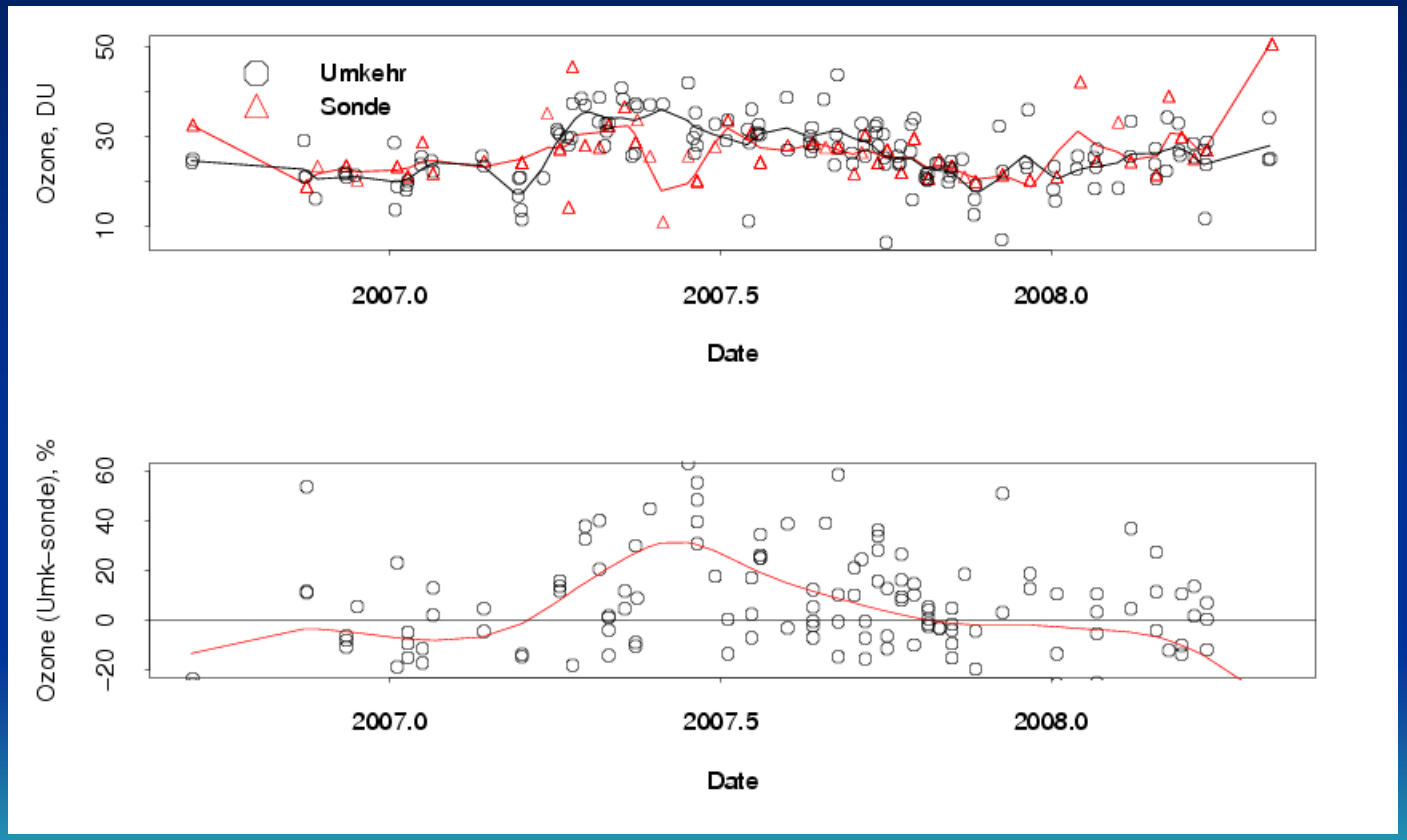




In this video, Ozzy Ozone and Alberta the Albatross take a voyage of discovery to find out exactly who and what is attacking the ozone layer and how children can play an important role in making a difference.

Thank you all

Boulder Brewer data (NEUBrew) Troposphere, Sept 2006 – May 2008



Sampling:

Brewer – daily, multiple TO

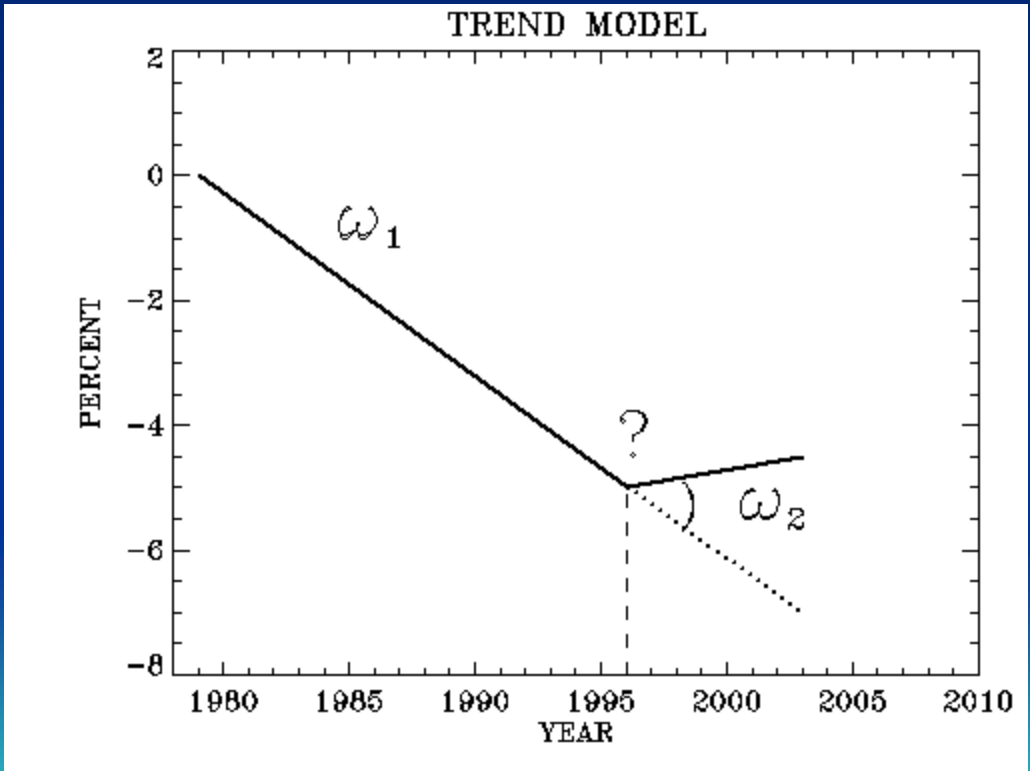
Sounding - weekly

Limitations:

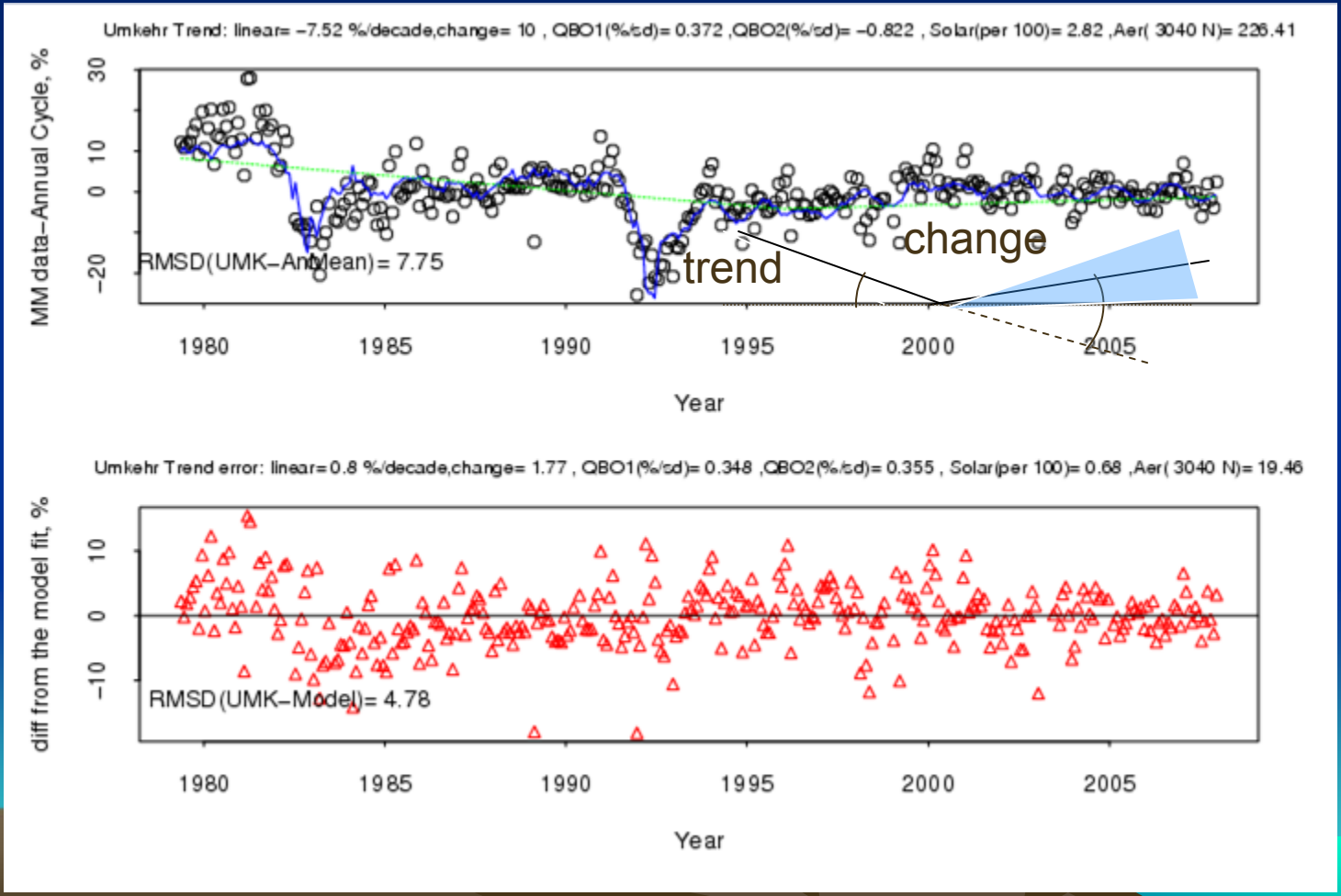
Brewer – clouds, vertical resolution

Sounding - sampling

$$Y_t = \mu + S_t + \omega_1 X_{1t} + \omega_2 X_{2t} + \gamma_1 Z_{1,t} + \gamma_2 Z_{2,t-k} + N_t,\ 0 < t \leq T$$ *(Reinsel et al., 2004)*



Boulder 1979-2007 Umkehr ozone, Layer 8 (1-2 hPa) Model fit (aerosol error, QBO [0.4%/sd/ -0.8%/sd], Solar [2.8%/100F], trend[-7%/dec], change[10%/dec]



Effect of the algorithm retrieval (effect of the a priori)