Extended and refined Multi Sensor Reanalysis (MSR) of total ozone for the period 1970-2012

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TEMIS

macc Monitoring atmospheric composition & climate

Introduction

MSR version 1:

- Total ozone data record 1979-2008
- Became available in early 2010

MSR version 2:

- Total ozone data record extended to 1970-2012
- Finished early 2014
- Several improvements as compared to version 1

MSR version 2 extension:

- Including Dobson observations before 1979

Constructing the Multi-Sensor Reanalysis of ozone

Multi Sensor Reanalysis (MSR) of ozone

Assumption:

- The ground observations are on average a good approximation for the true values.

Procedure:

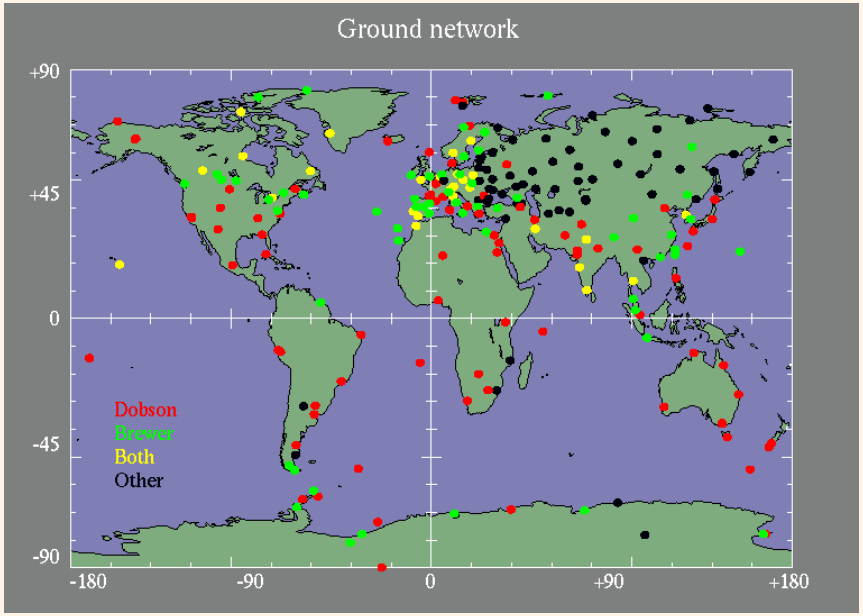
- All UV-VIS satellite data in the period 1970-2012 is used.
- Step 1 : Correct satellite data to avoid biases. The reference data that is chosen are ground data observations from reliable WOUDC stations.
- Step 2 : Satellite data is assimilated in a chemical-transport model to achieve complete global and temporal coverage.
- Multi Sensor Re-analysis (MSR2), made available at www.temis.nl
- Published in:

  R.J. van der A , Allaart, M. A. F., and Eskes, H. J.: Extended and refined multi sensor reanalysis of total ozone for the period 1970–2012, Atmos. Meas. Tech. Discuss., 2015.

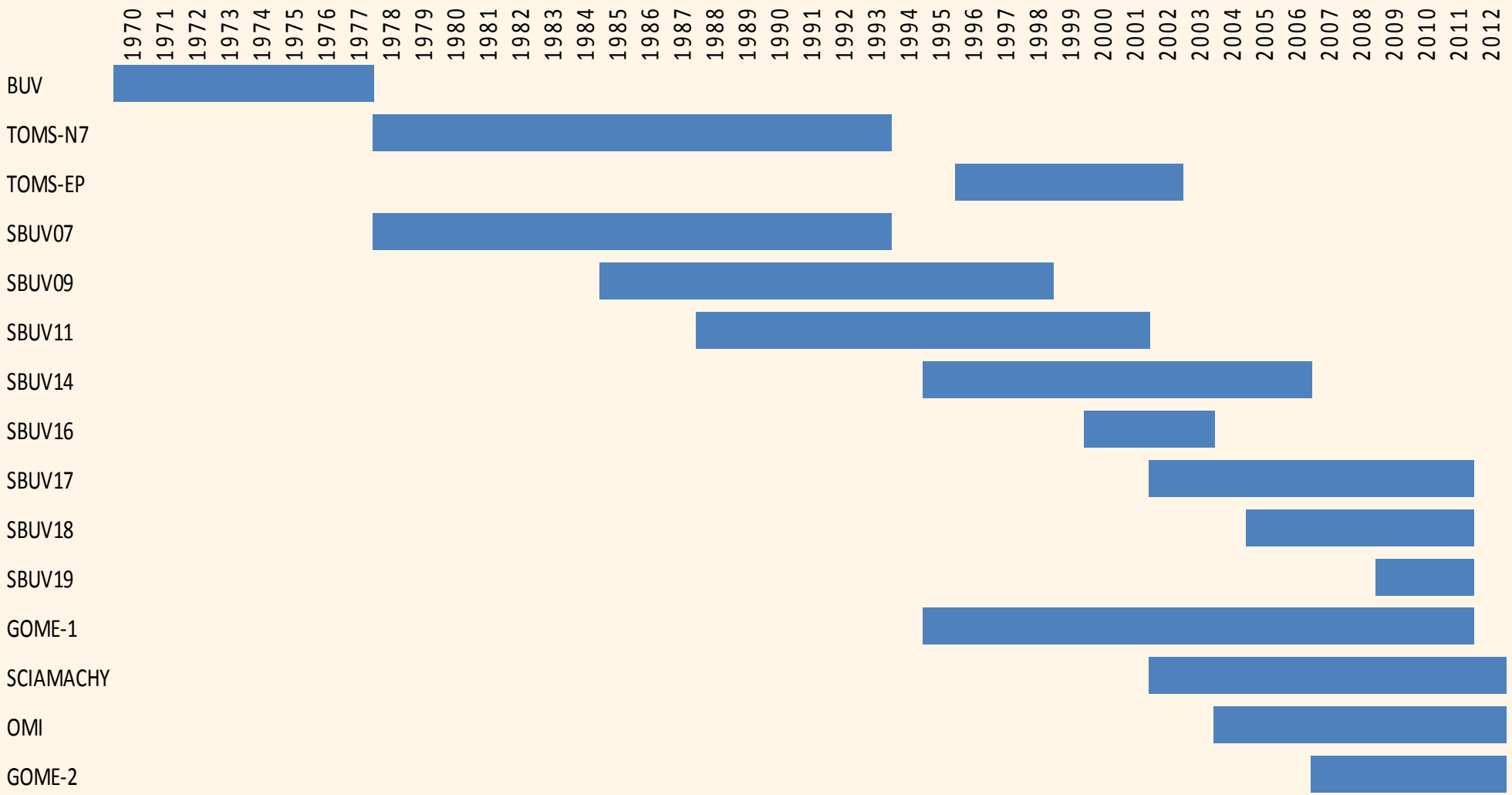
Reference data

Reference data set:

- From WOUDC 91 ground stations are selected with a long and reliable dataset (*Fioletov et al.*, 2008)
- Dobson, Brewer(3,4)–instruments
- Dobson corrected for temperature dependence (*Kerr et al.*, 2002)



Satellite instruments



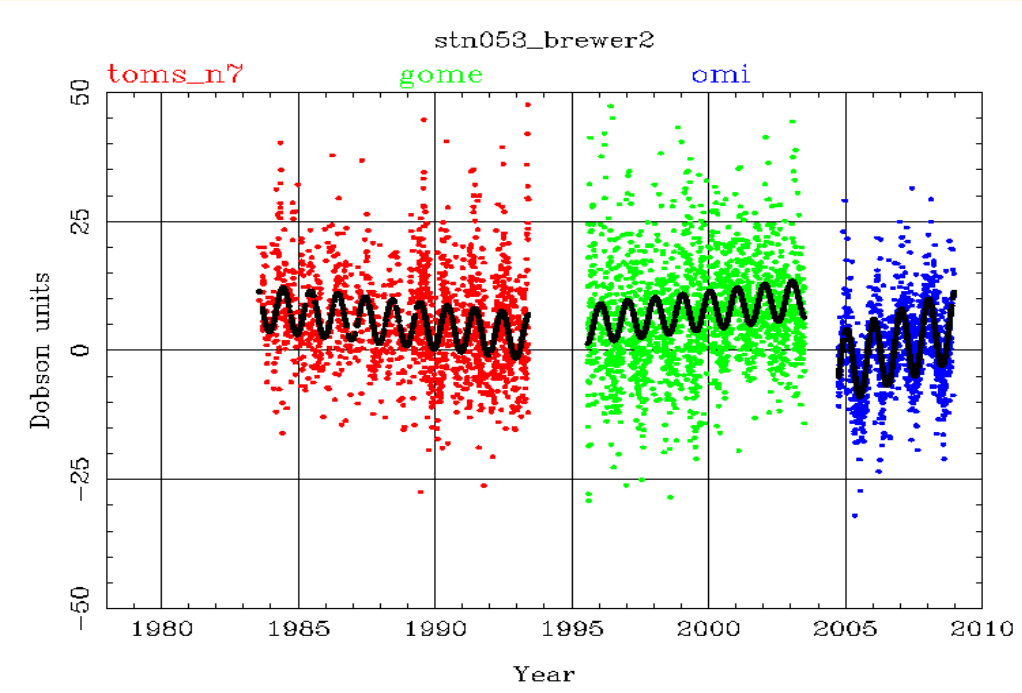
Corrections satellite data

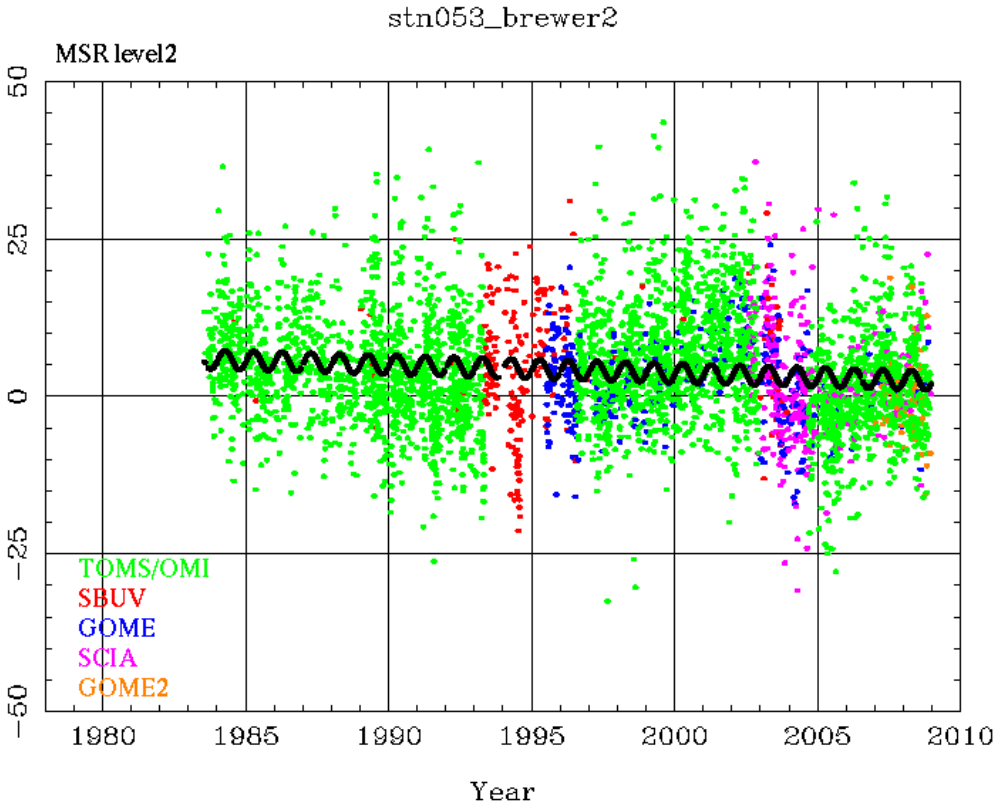
Expected dependencies of satellite data:

Parameter	Physical mechanism
Solar zenith angle	Light path
Viewing zenith angle	Scan mirror
Effective temperature	O3 cross-section
Time (trend)	Instrument degradation
Offset	Calibration

- Generate time series of the satellite data sets for all stations.
- Fit all time series as function of the 5 parameters.
- Apply corrections as function of the fit parameters to construct the Multi-Sensor Reanalysis (MSR) level 2 data

Correction of level 2 data





Satellite minus Brewer observations for the Uccle ground station

Data assimilation of the MSR level 2 data

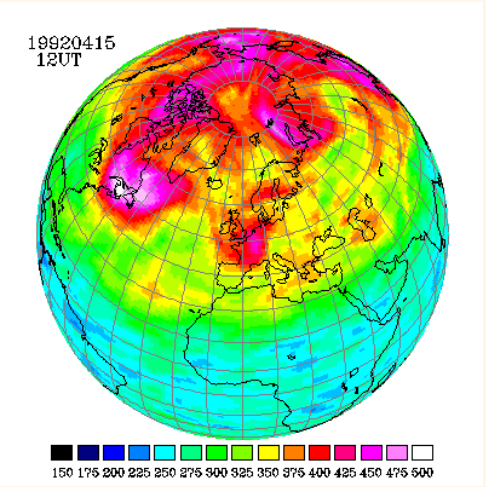
- Level 2 data is on satellite footprint. Location measured on irregular times. Regions without observations exist.

Therefore, data assimilation used to create a homogene data record

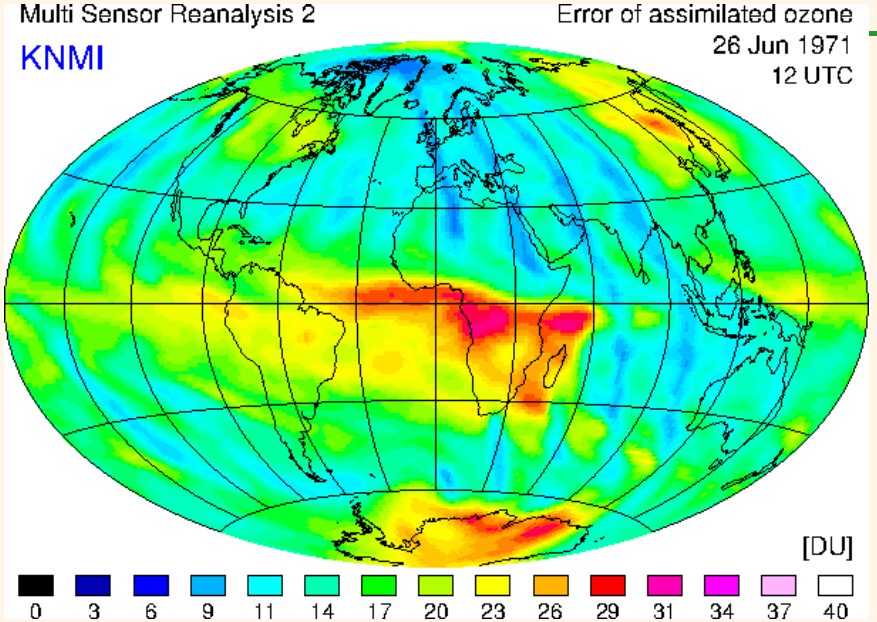
Data assimilation:

- Kalman-type data assimilation scheme using the TM model
- Meteo: ECMWF ERA-interim winds, temperatures
- Stratospheric chemistry parametrizations (Cariolle v. 2.9)
- Starting in 1970 by including BUV data. The reanalysis period is 43 years (!).

- Output:
  - Total ozone field every 6 hours
  - Spatial grid is 1 x 1 degree (resolution is 0.5 degree)
  - Daily local time ozone field at noon (for UV index)

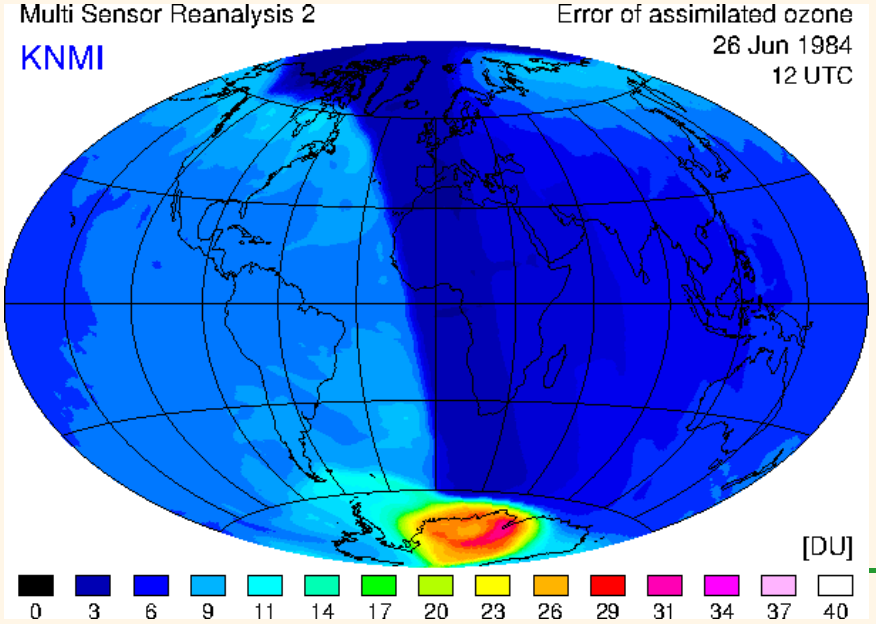


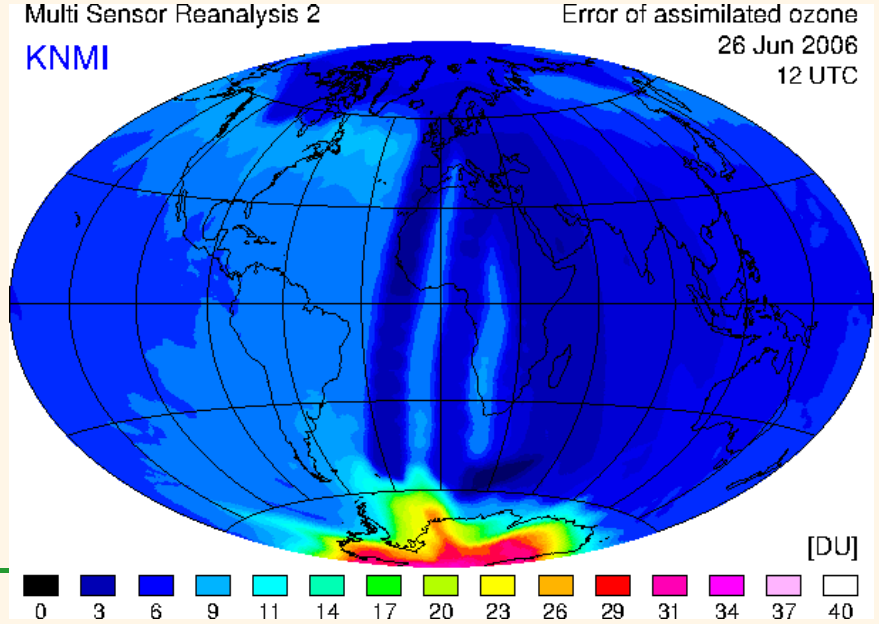
Analysis of results for the MSR version 2



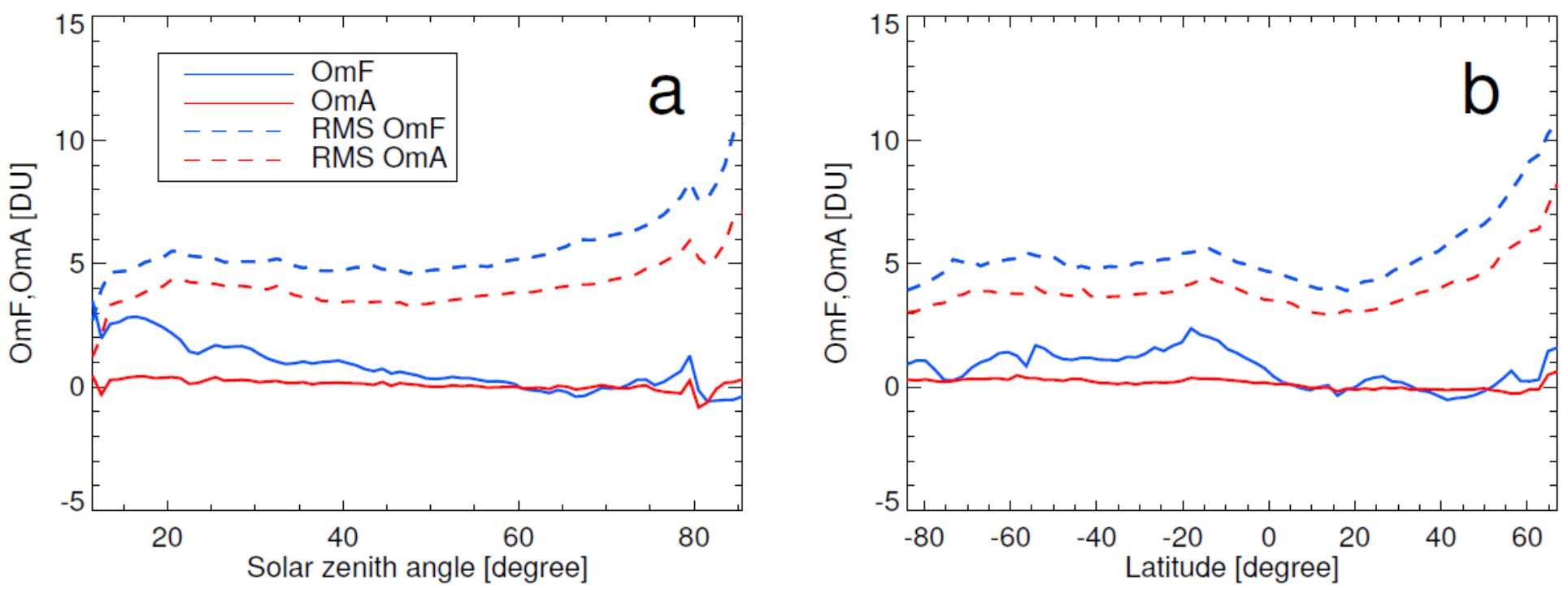
Examples of **error** fields for

- 26-06-1971 (BUV)
- 26-06-1984 (TOMS)
- 26-06-2006 (almost all sat.)



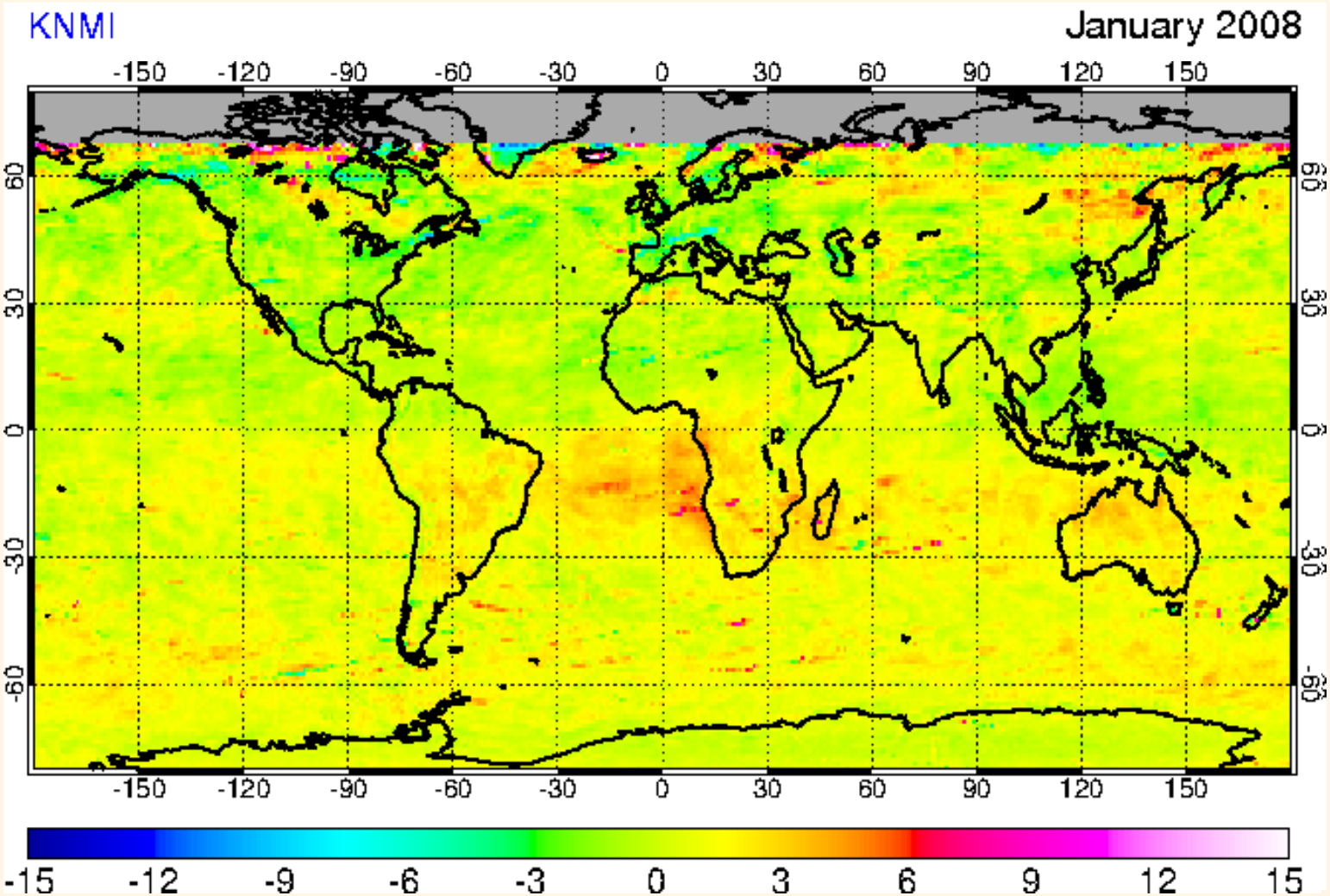


OmF, OmA as function of latitude and solar zenith angle in January 2008



OmF of the Multi-Sensor Reanalysis (MSR2)

Gridded for January 2008

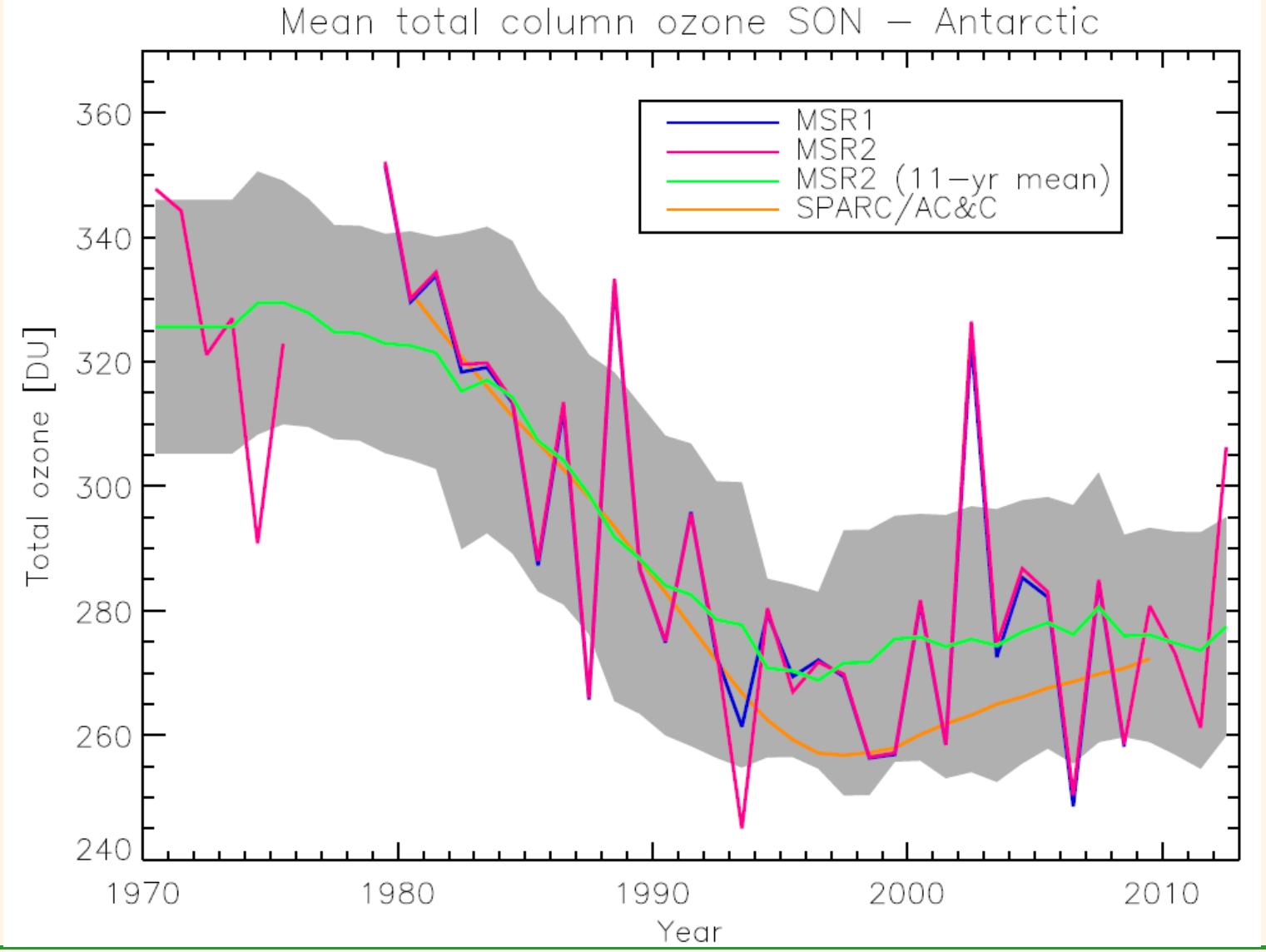


Comparison of MSR and AC&C/SPARC

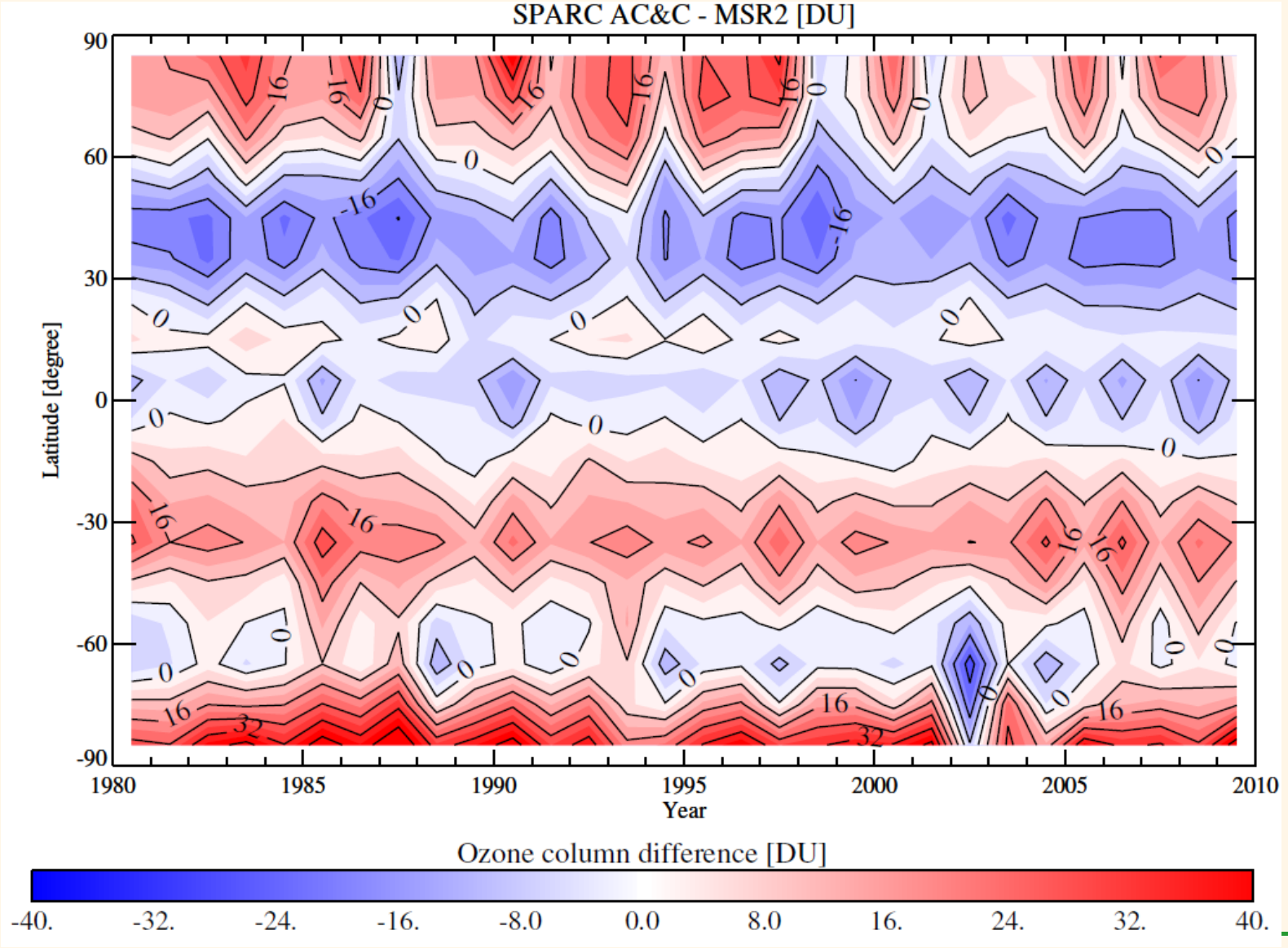
ECV ozone comparison for 1980-2010:

- Ozone satellite observations: MSR2
- Ozone database from AC&C/SPARC (for CMIP5)
  - No dynamics included
  - Zonal averaged stratosphere

Intercomparison with SPARC data over the Antarctic (Sep.-Nov.)



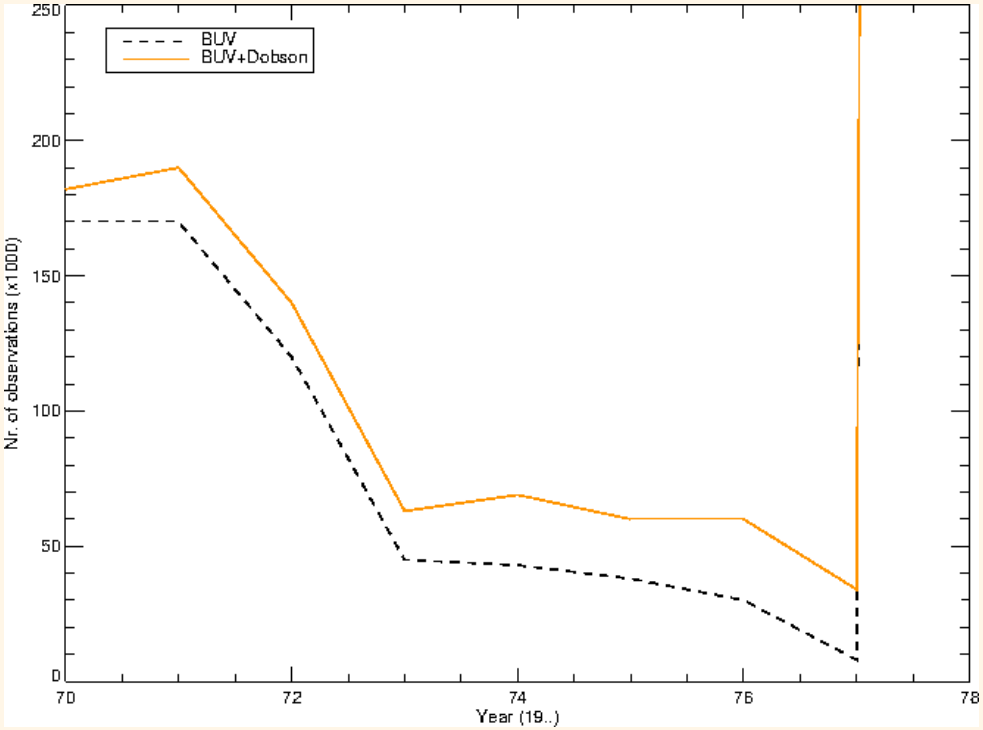
AC&C SPARC ozone versus MSR2 (annual zonal mean)

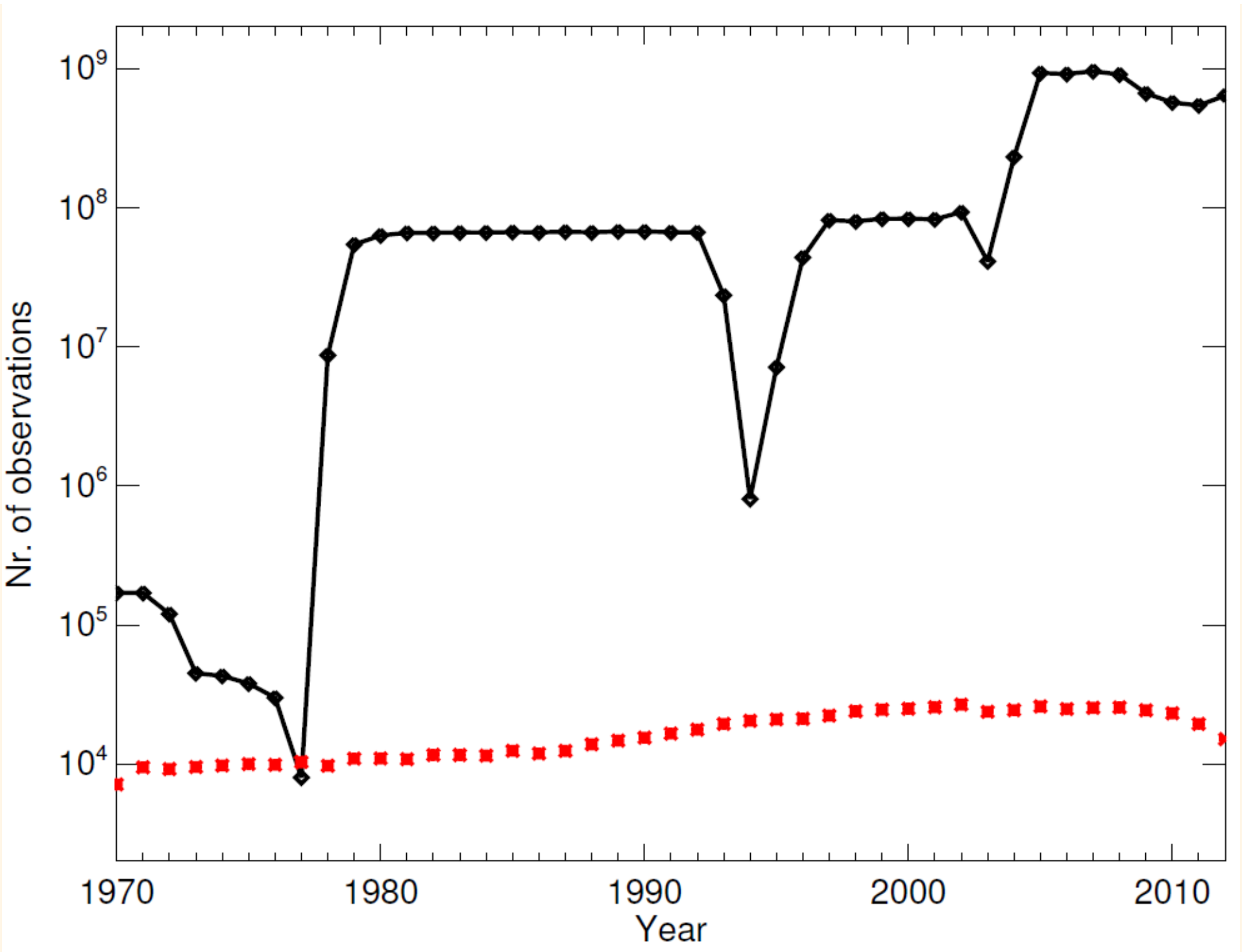


Extension of the MSR2 with ground observations

MSR2 extension

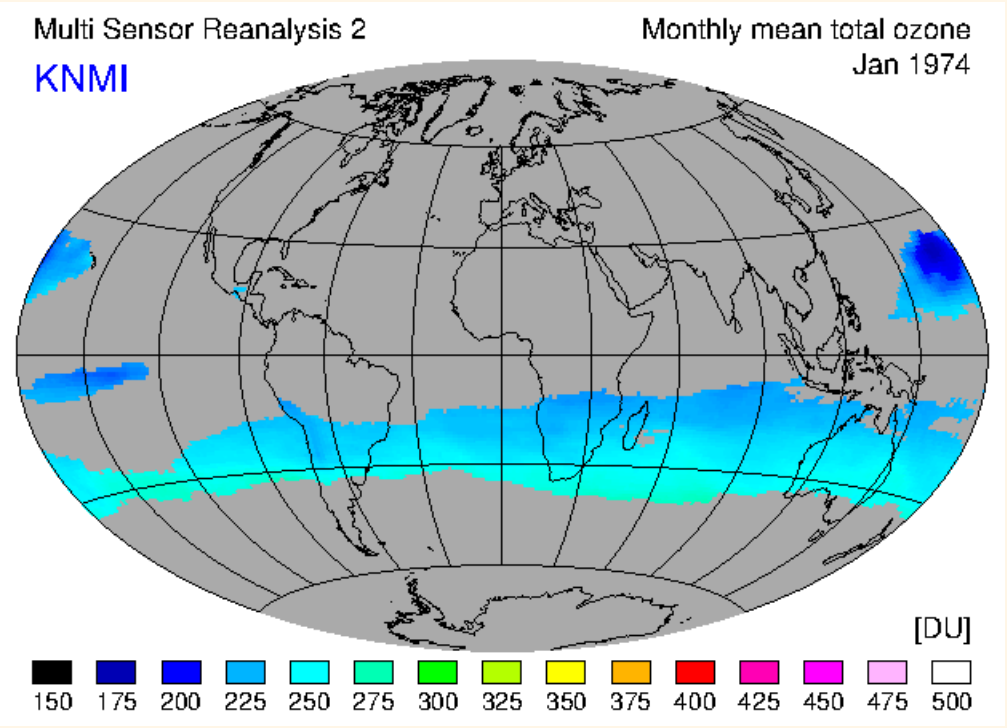
- To fill in the gaps of the period 1970-1978 ground observations are used in the data assimilation as a "19th satellite instrument".



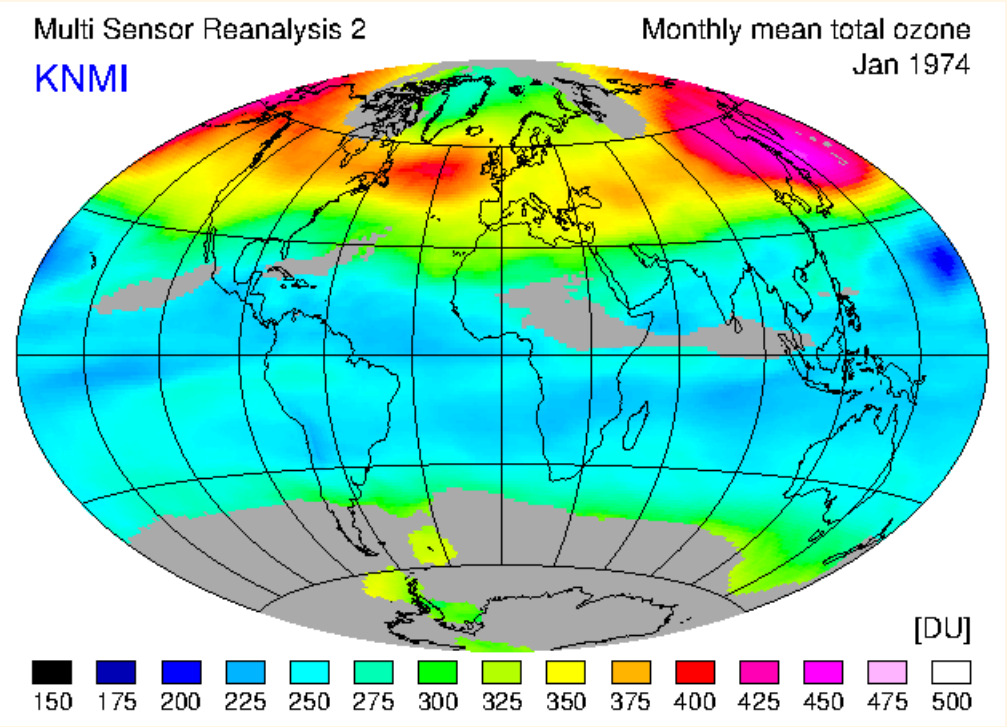

10^9
10^8
10^7
10^6
10^5
10^4
Nr. of observations
1970
1980
1990
2000
2010
Year

MSR 2 extended with Dobson ground observations

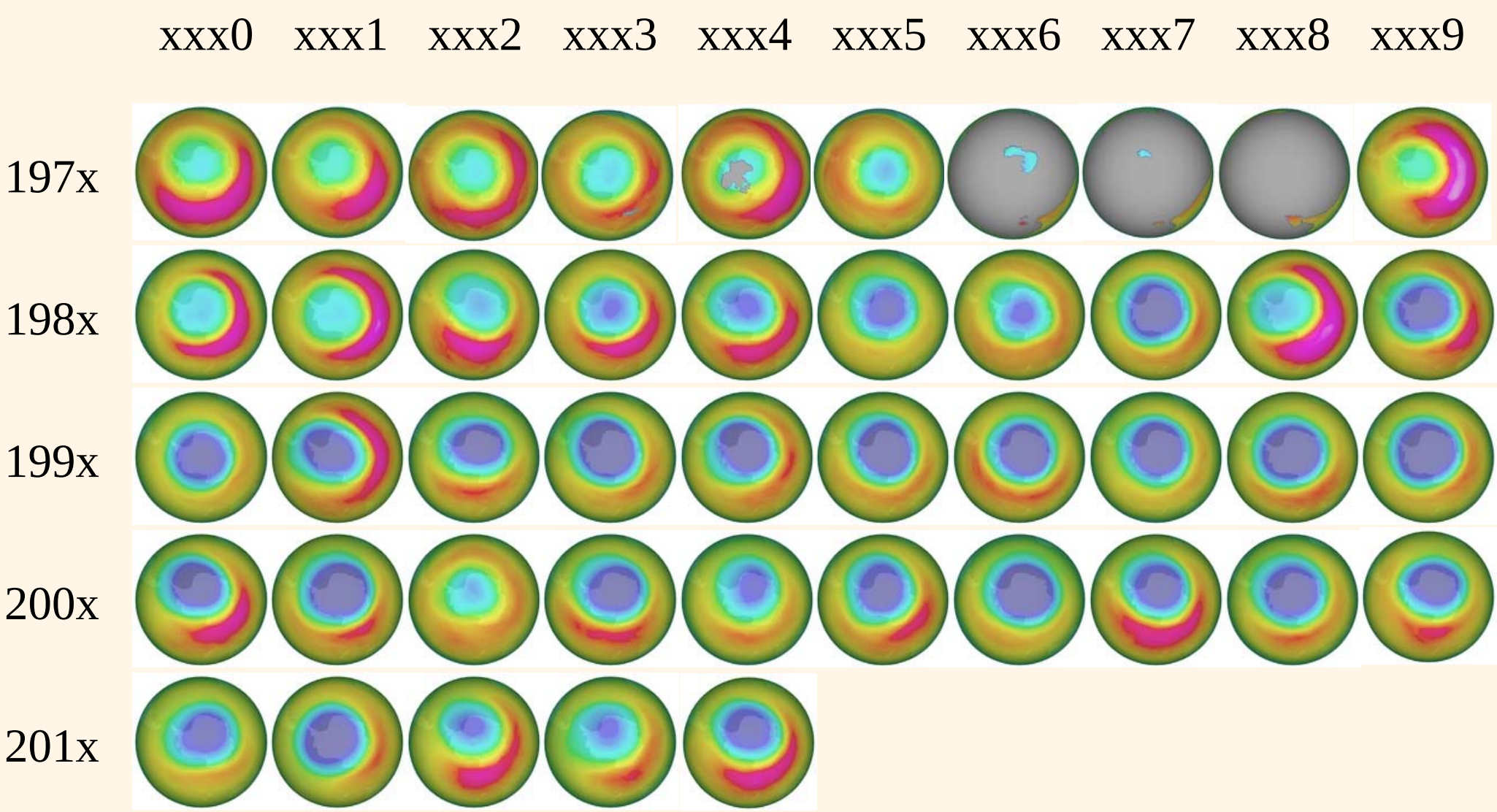
MSR2



MSR2 extended with Dobson

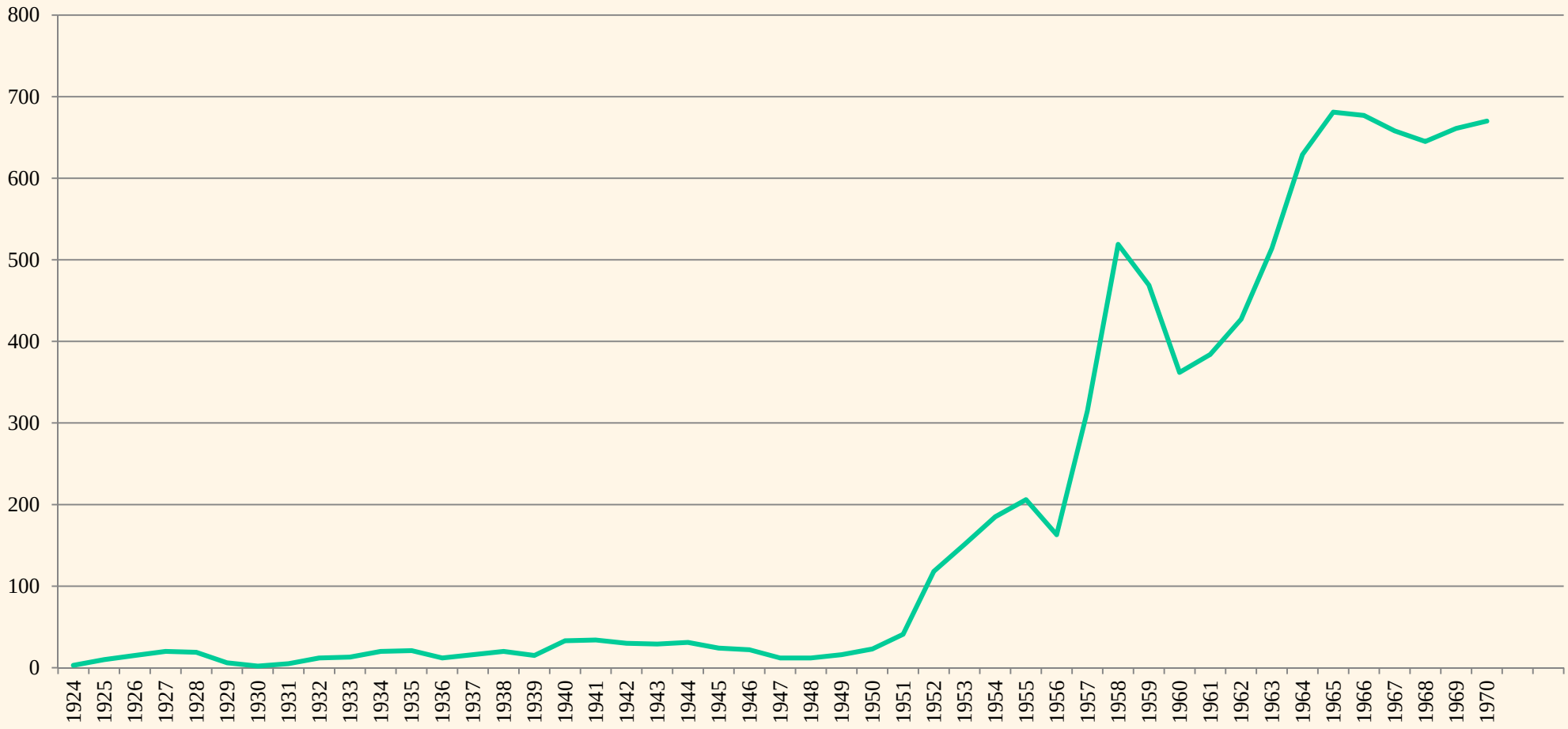


October monthly mean 1970-2012 (MSR2+)

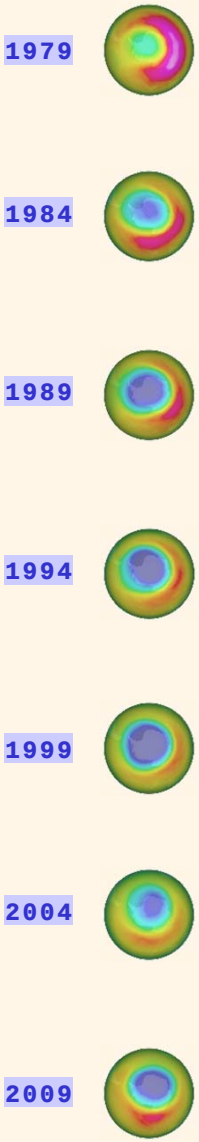


Can we go further into the past with Dobson observations ?

Number of Dobson measurements archived in WOUDC:



Summary



Multi Sensor Reanalysis (MSR2) of total ozone:

- 18 total ozone data sets from BUV, TOMS, SBUV, GOME, SCIAMACHY, OMI and GOME-2 are corrected by comparison with Brewer and Dobson data (WOUDC).
- An improved data assimilation scheme has been developed and verified by detailed OmF analysis.
- The MSR data record is extended to the period **1970-2012** on a 1x1 degree grid (0.5 degree resolution) and 6 hour time steps.
- BUV years are of less quality due to missing data (especially after 1973).
- Observations of Dobson stations in the years 1970-1978 are included in data assimilation to improve the quality for those years.

Outlook

- Can we prolong the MSR into the past by starting earlier using only Dobson observations ?