South Pole Ozonesonde and Dobson Spectrophotometer Measurements: 2012 Ozone Hole

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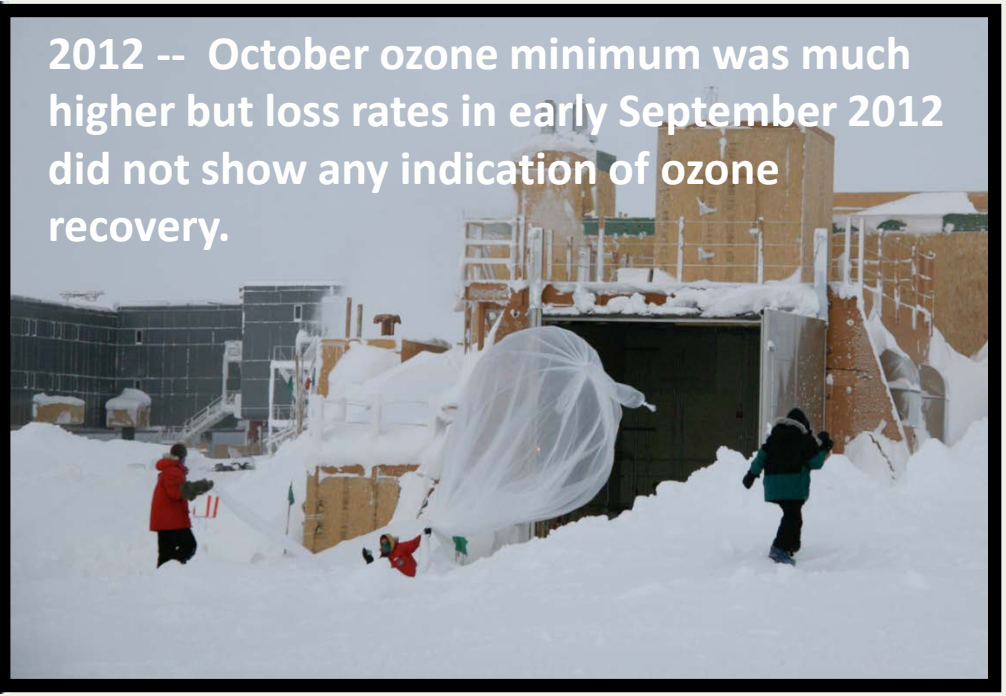
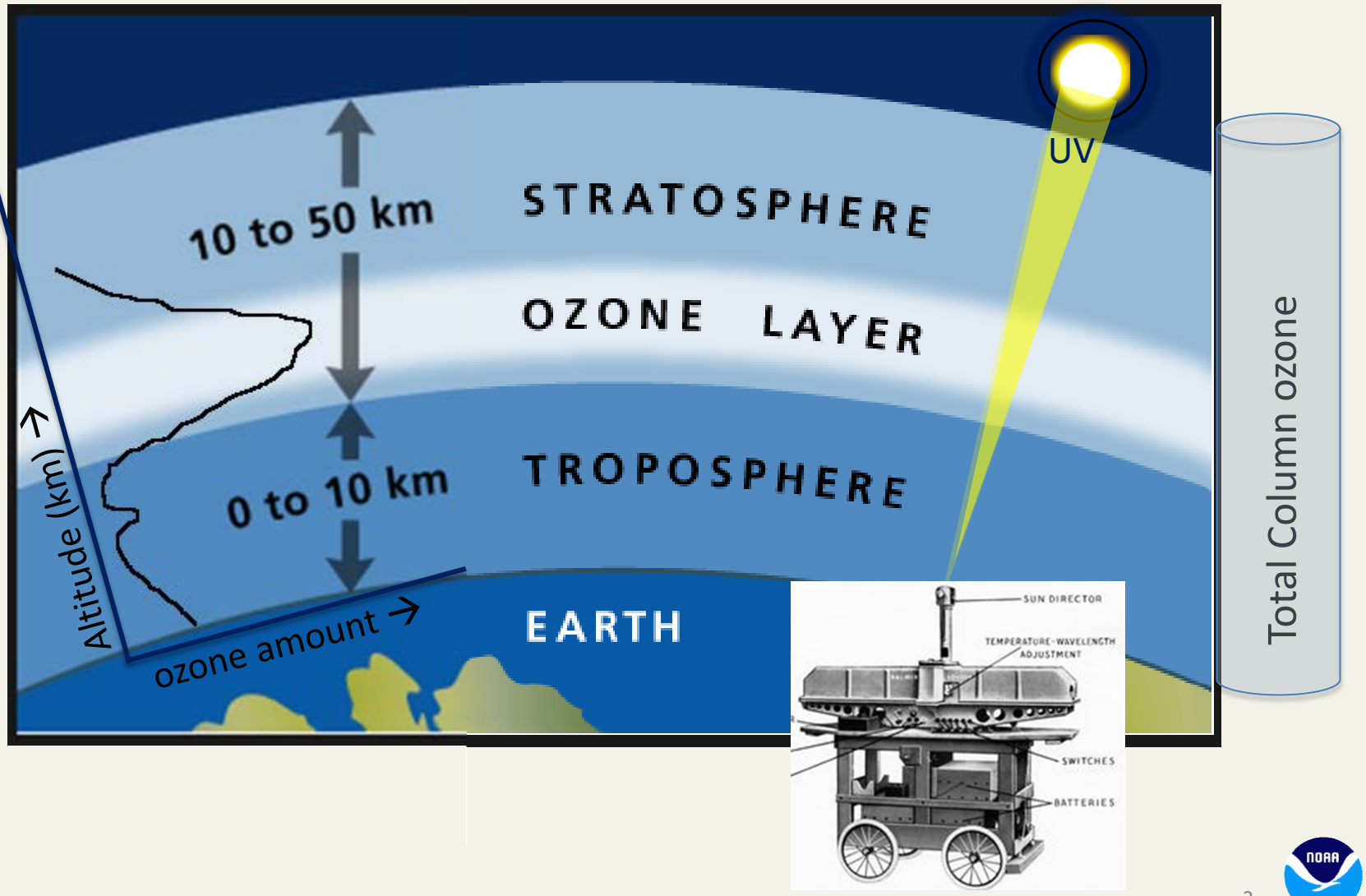


NOAA GMD measures stratospheric ozone at South Pole from:

1. Ground-based Dobson spectrophotometer: *51 years 1962-2012*
2. Balloon-borne ozonesondes: *27 years 1986-2012*

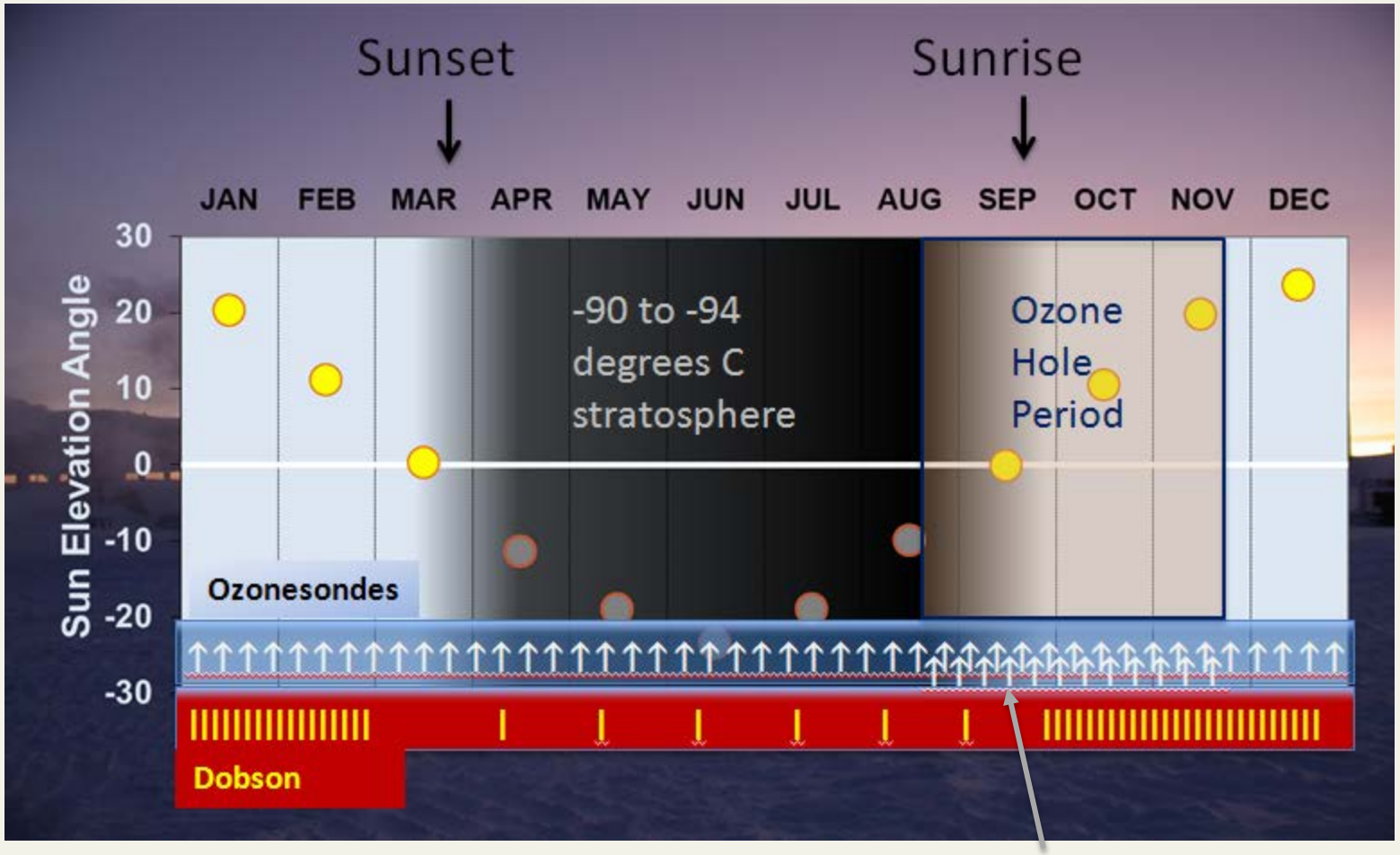


- The Ground-based Dobson spectrophotometer and balloon-borne ozonesondes - a good combination for tracking stratospheric ozone.
- Dobson measures total column ozone as the view of the sun passes by the ARO Dobson room windows.

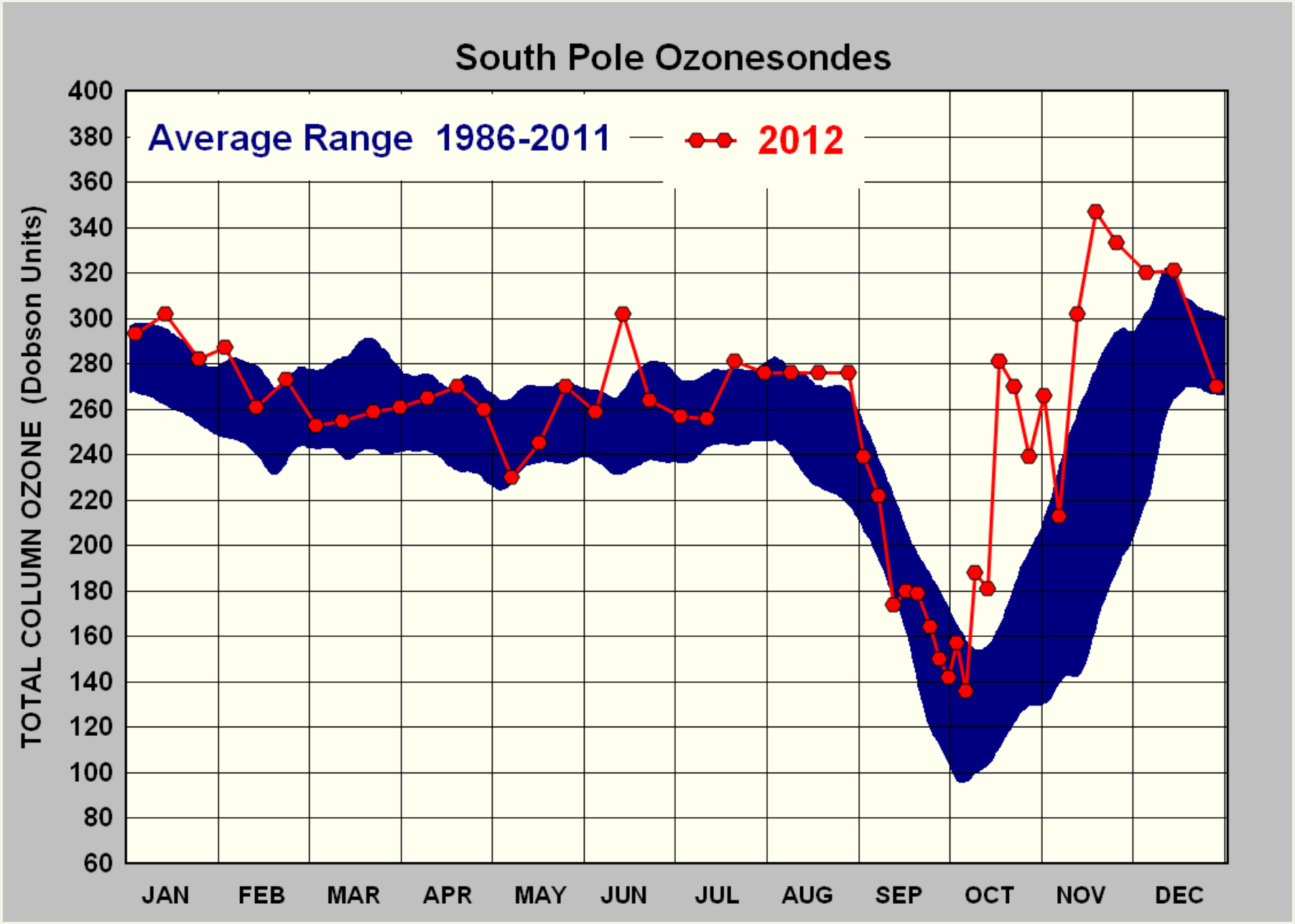
Dobson Spectrophotometer at Atmospheric Research Observatory (ARO)

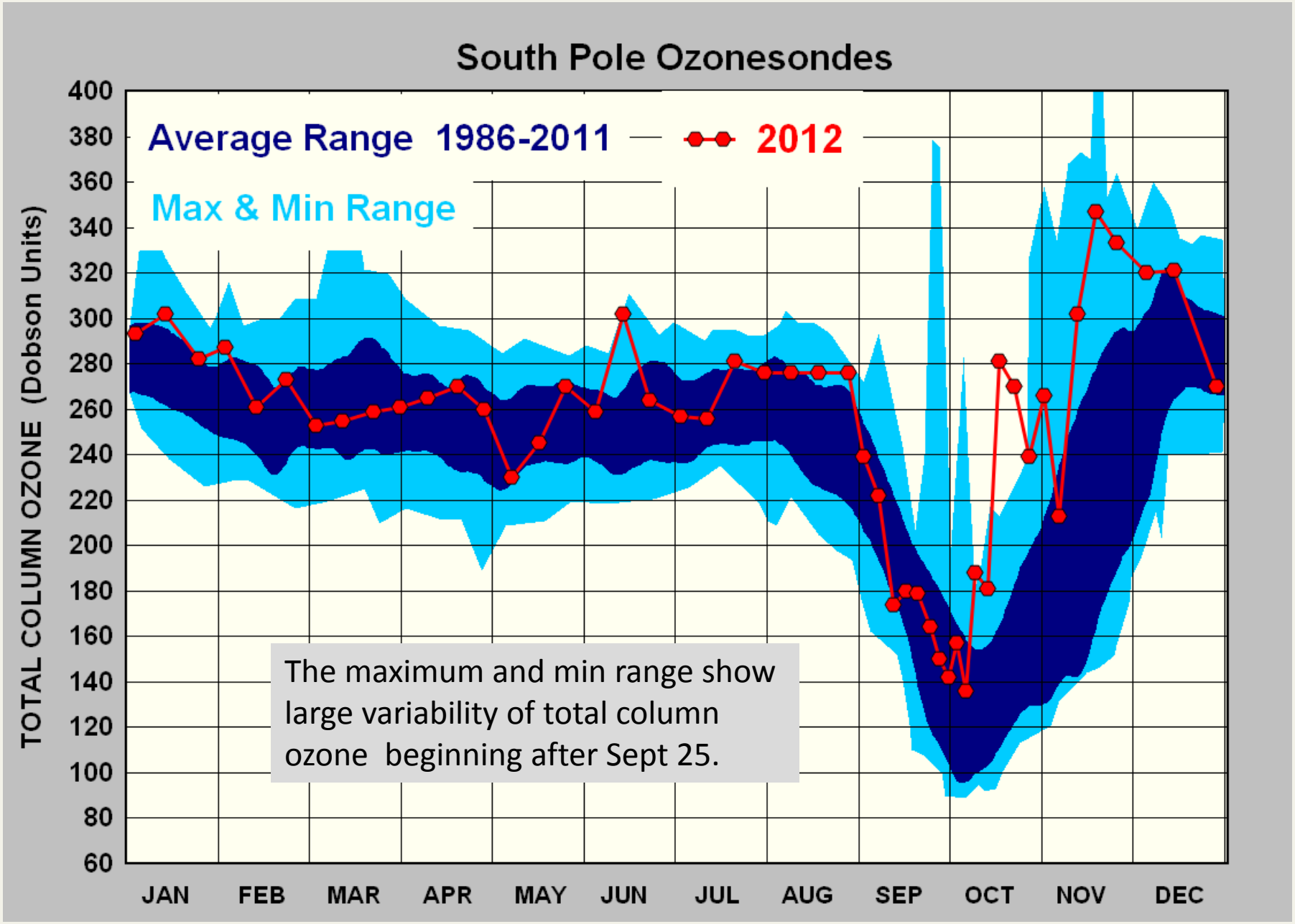
Ozonesonde launch at Balloon Inflation Facility (BIF)

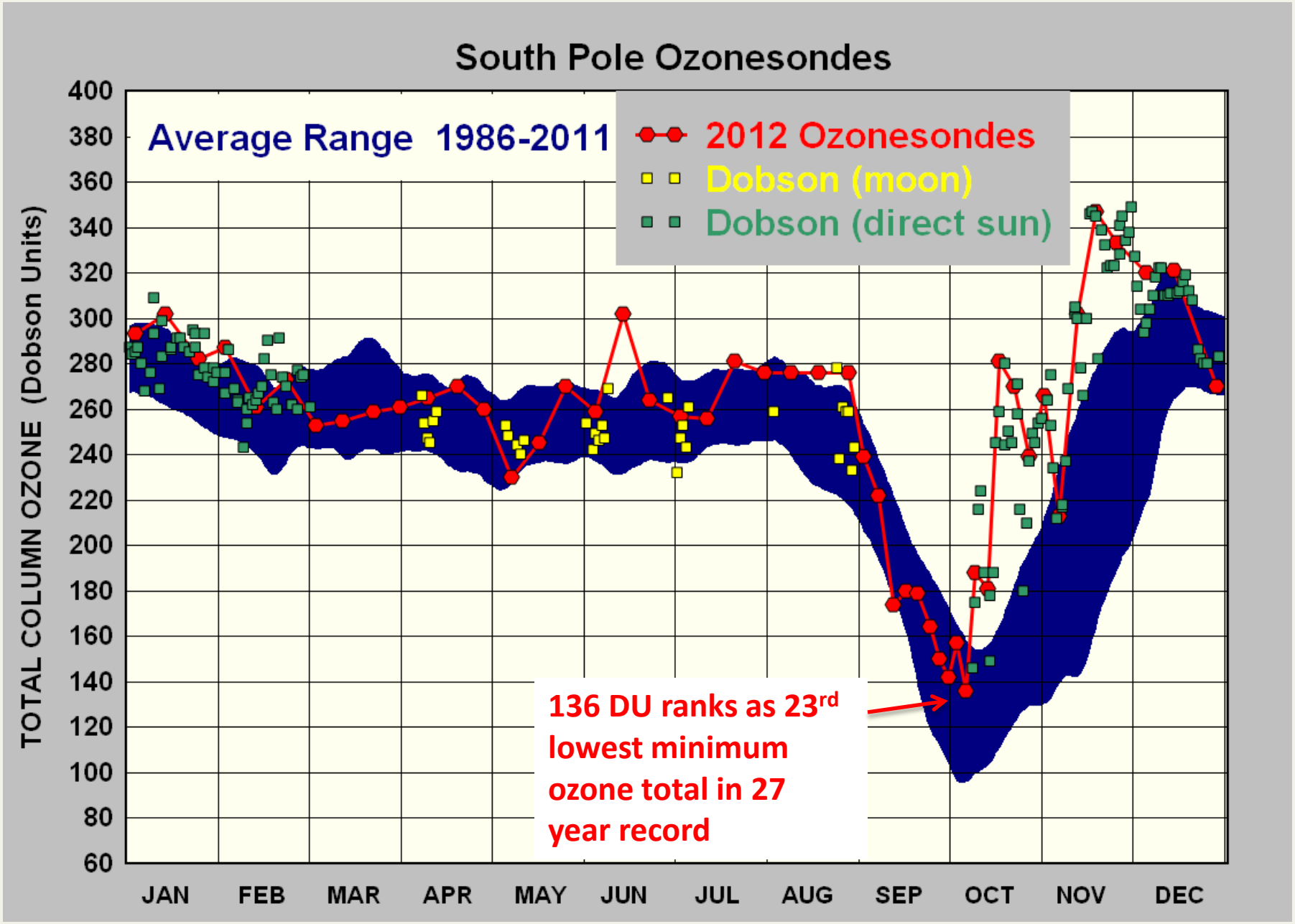
Summary of South Pole Sun Elevation Angle and Corresponding Ozone Measurements.



Increased frequency of ozonesonde launches during ozone hole period.

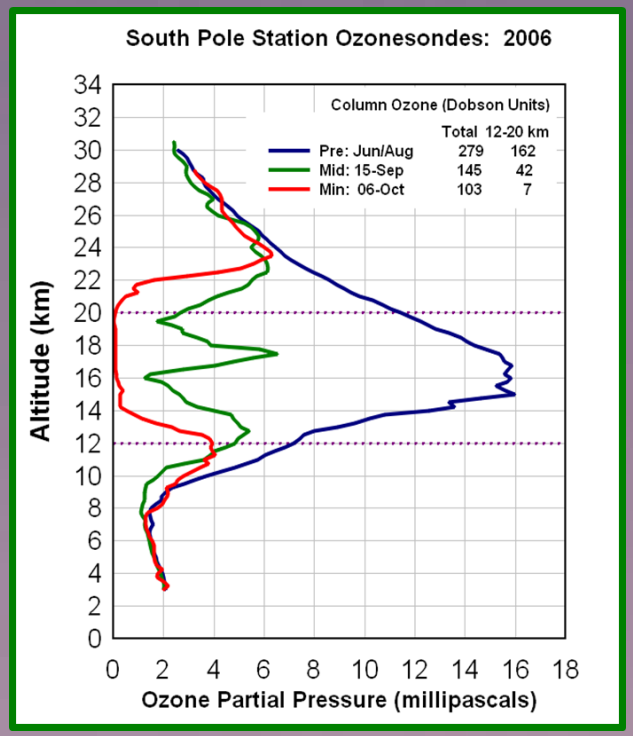

South Pole Ozonesondes
Average Range 1986-2011
2012
TOTAL COLUMN OZONE (Dobson Units)
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

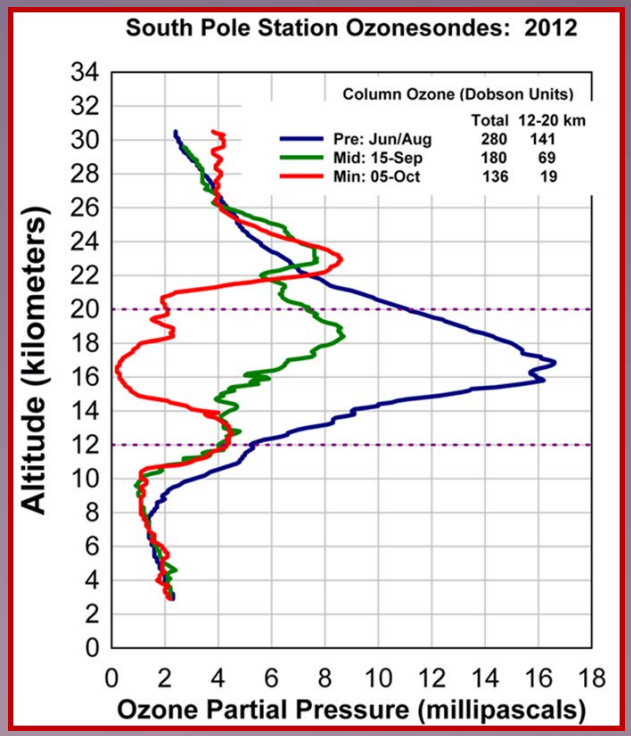

South Pole Ozonesondes
Average Range 1986-2011
2012
Max & Min Range
TOTAL COLUMN OZONE (Dobson Units)
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
The maximum and min range show large variability of total column ozone beginning after Sept 25.

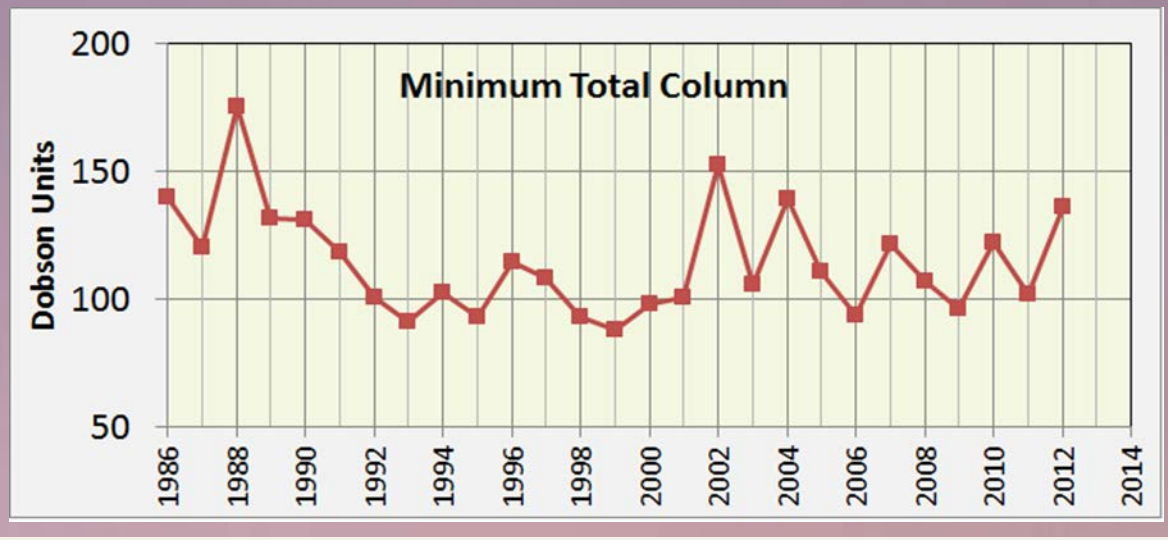

South Pole Ozonesondes
Average Range 1986-2011
2012 Ozonesondes
Dobson (moon)
Dobson (direct sun)
TOTAL COLUMN OZONE (Dobson Units)
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
136 DU ranks as 23rd lowest minimum ozone total in 27 year record

2006 Ozonesonde Profiles 2012

RANK	MIN (DU)	YEAR	DATE
1	89	1993	6-Oct
2	90	1999	29-Sep
3	93	1995	5-Oct
4	93	2006	9-Oct
5	95	1998	5-Oct
6	98	2000	29-Sep
7	98	2009	25-Sep
8	100	1992	11-Oct
9	100	2001	28-Sep
10	102	1994	5-Oct
11	102	2011	9-Oct
12	106	2003	26-Sep
13	107	2008	28-Sep
14	110	2005	28-Sep
15	114	1987	9-Oct
16	114	1996	6-Oct
17	117	1997	8-Oct
18	122	2010	30-Sep
19	125	2007	8-Oct
20	129	1991	7-Oct
21	130	1990	7-Oct
22	131	1989	9-Oct
23	136	2012	5-Oct
24	138	2004	4-Oct
25	140	1986	7-Oct
26	152	2002	21-Oct
27	190	1988	10-Oct







2006 Ozonesonde Profiles 2012

RANK	MIN (DU)	YEAR	DATE
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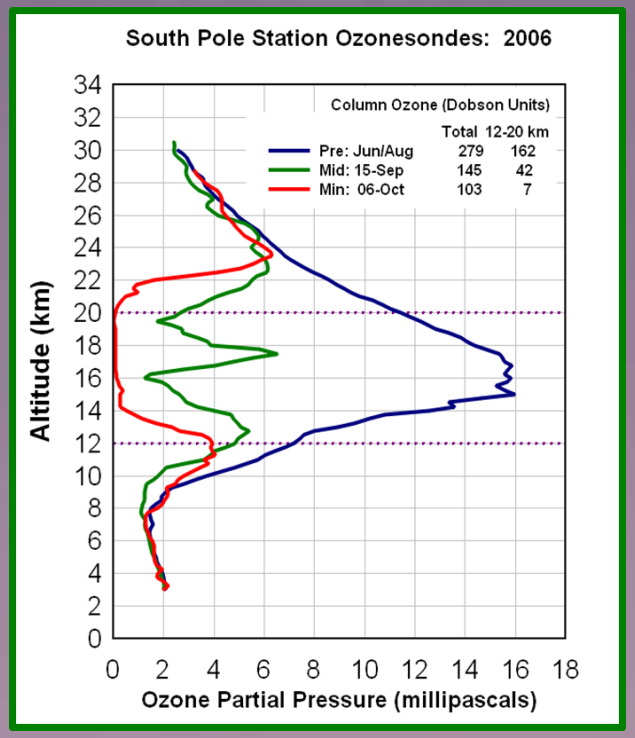
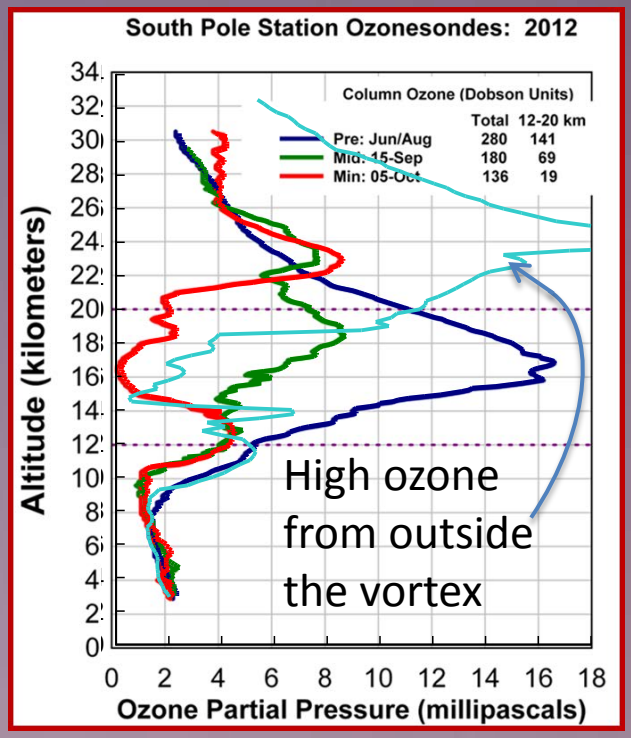
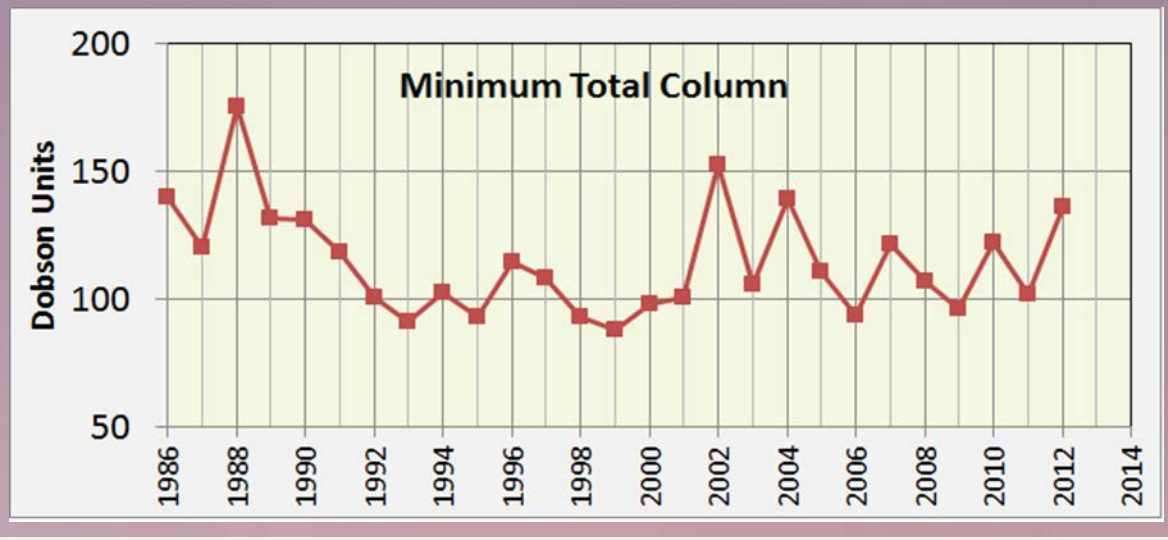
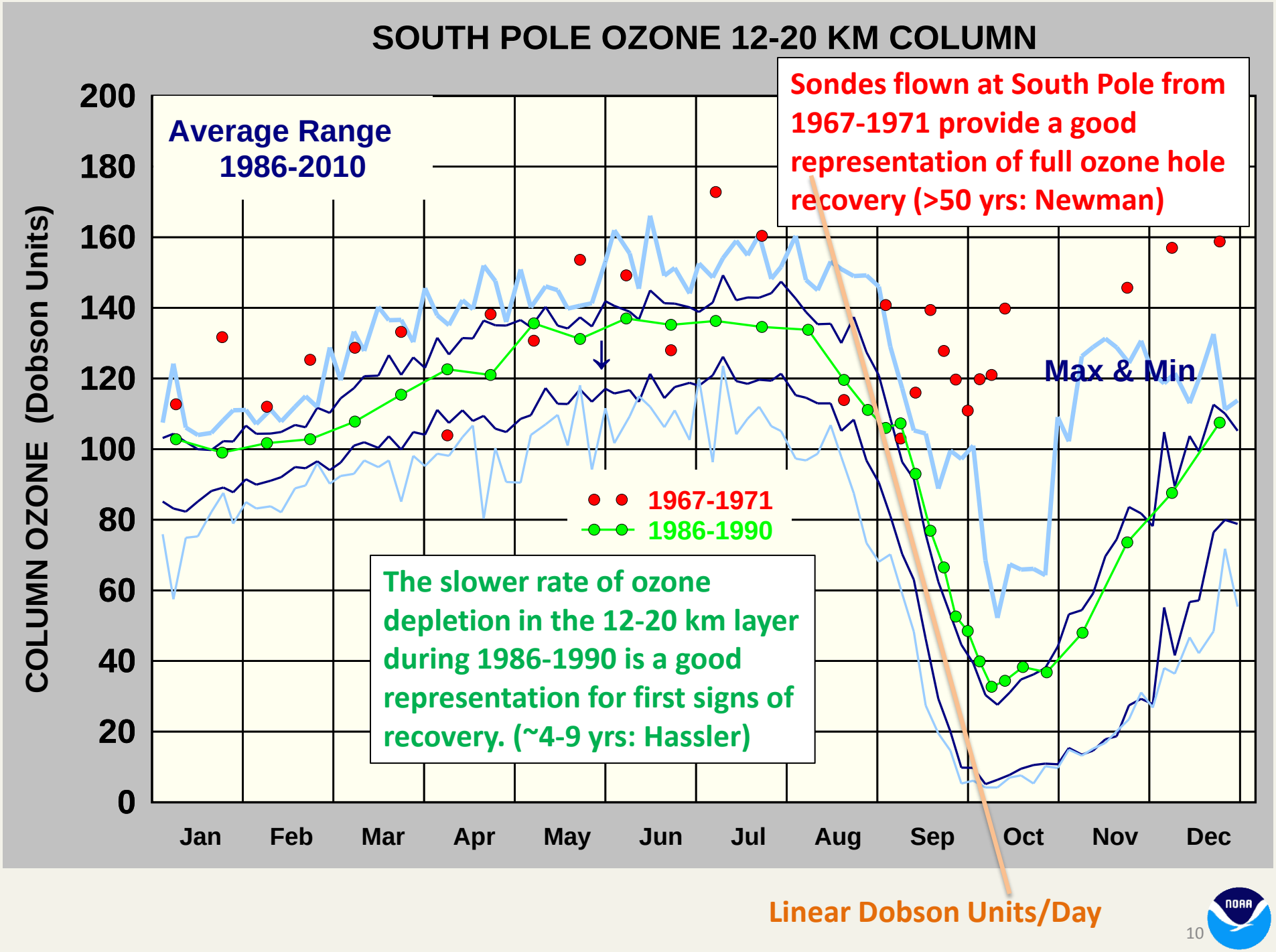
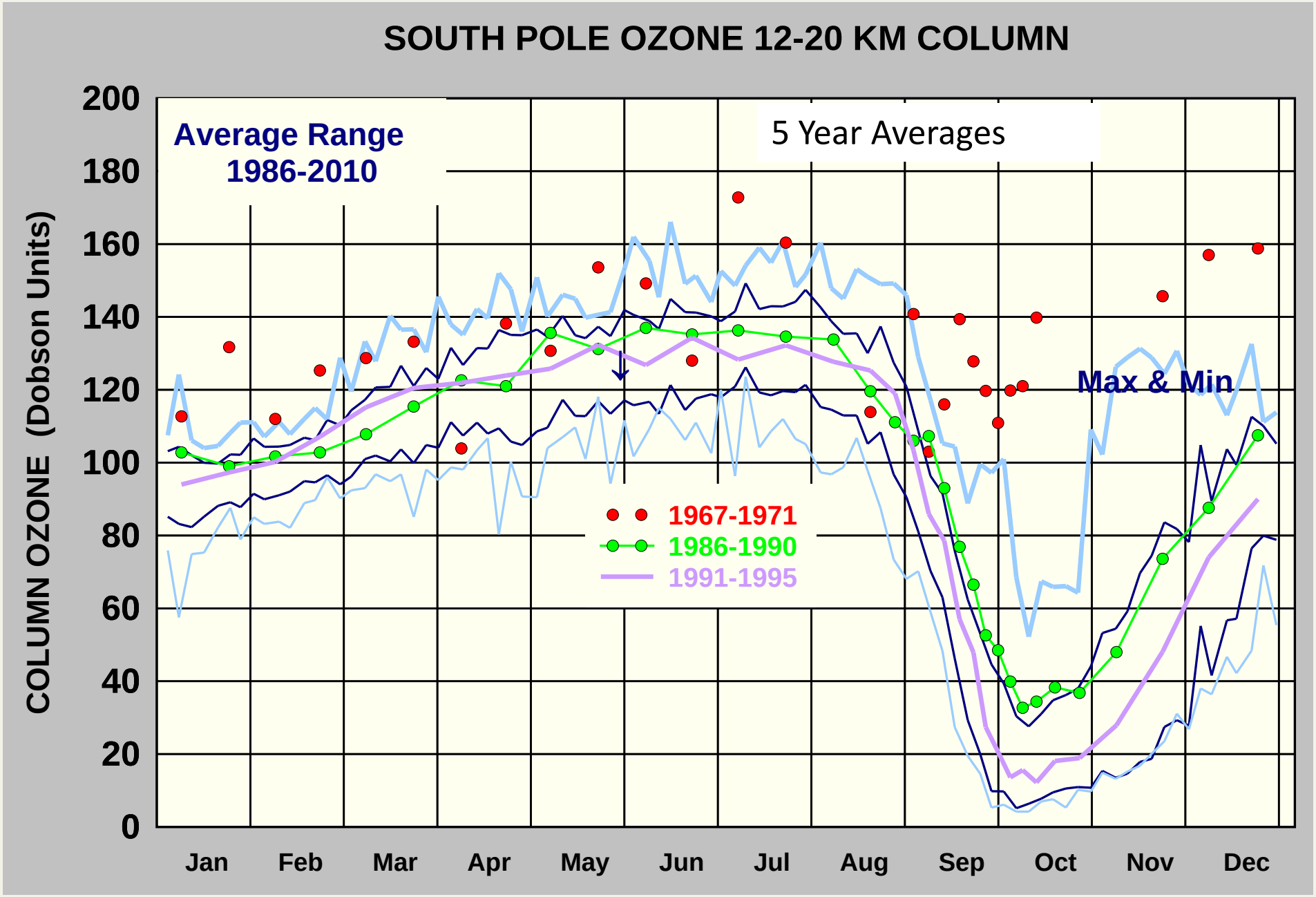
2	90	1999	29-Sep
3	93	1995	5-Oct
4	93	2006	9-Oct
5	95	1998	5-Oct
6	98	2000	29-Sep
7	98	2009	25-Sep
8	100	1992	11-Oct
9	100	2001	28-Sep
10	102	1994	5-Oct
11	102	2011	9-Oct
12	106	2003	26-Sep
13	107	2008	28-Sep
14	110	2005	28-Sep
15	114	1987	9-Oct
16	114	1996	6-Oct
17	117	1997	8-Oct
18	122	2010	30-Sep
19	125	2007	8-Oct
20	129	1991	7-Oct
21	130	1990	7-Oct
22	131	1989	9-Oct
23	136	2012	5-Oct
24	138	2004	4-Oct
25	140	1986	7-Oct
26	152	2002	21-Oct
27	190	1988	10-Oct

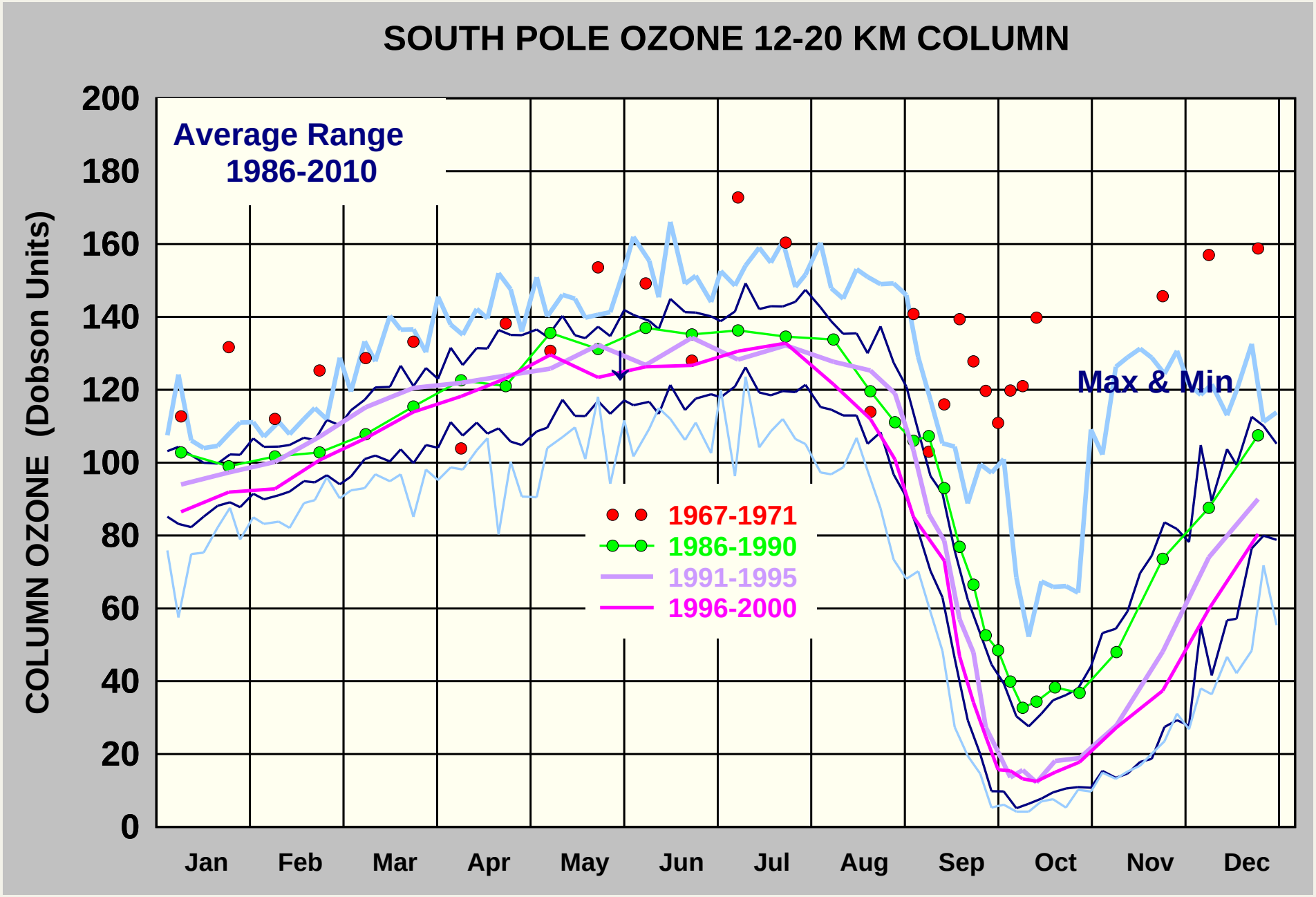


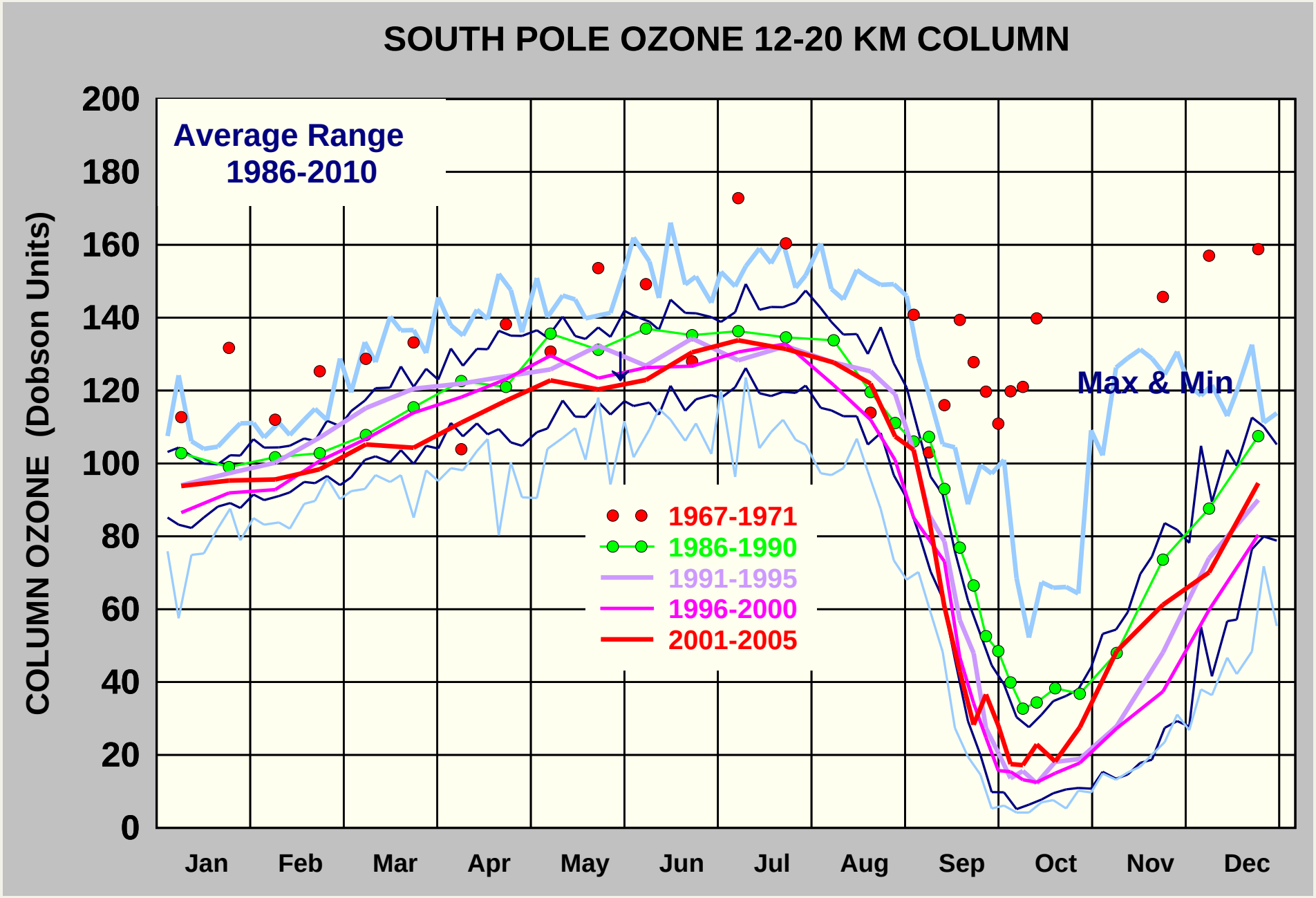


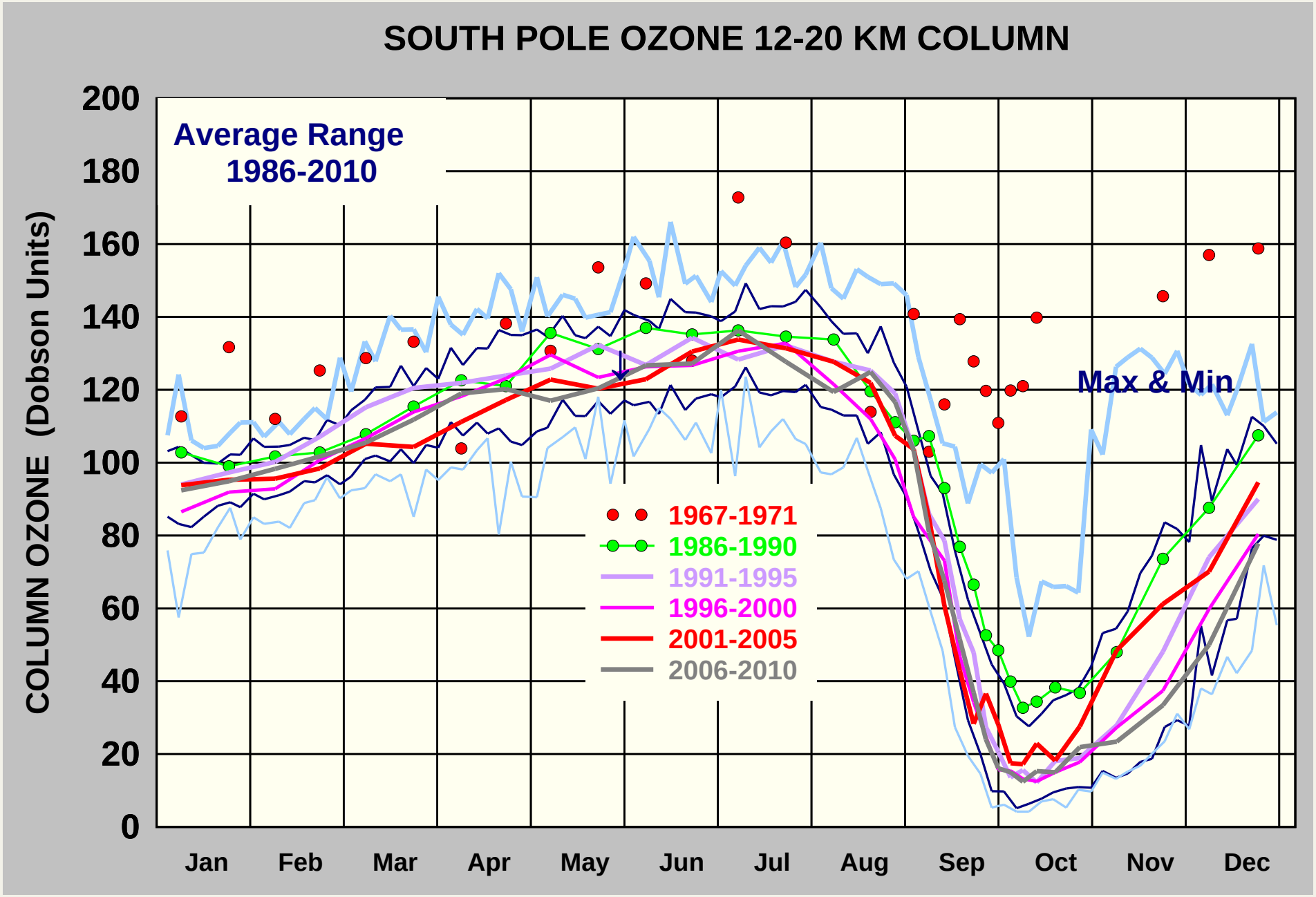


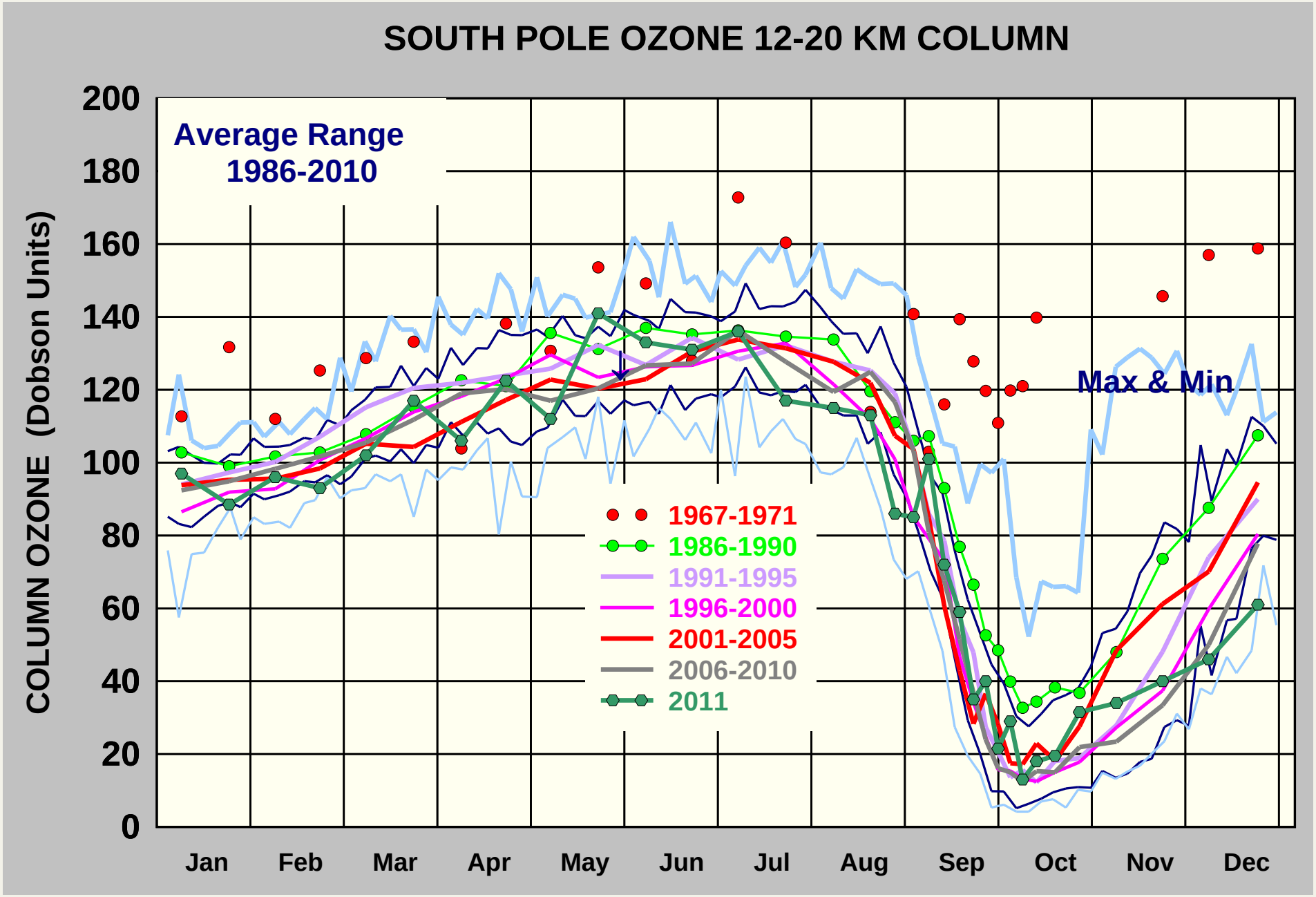

SOUTH POLE OZONE 12-20 KM COLUMN
Sondes flown at South Pole from 1967-1971 provide a good representation of full ozone hole recovery (>50 yrs: Newman)
Average Range 1986-2010
Max & Min
1967-1971
1986-1990
The slower rate of ozone depletion in the 12-20 km layer during 1986-1990 is a good representation for first signs of recovery. (~4-9 yrs: Hassler)
Linear Dobson Units/Day
COLUMN OZONE (Dobson Units)
200
180
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

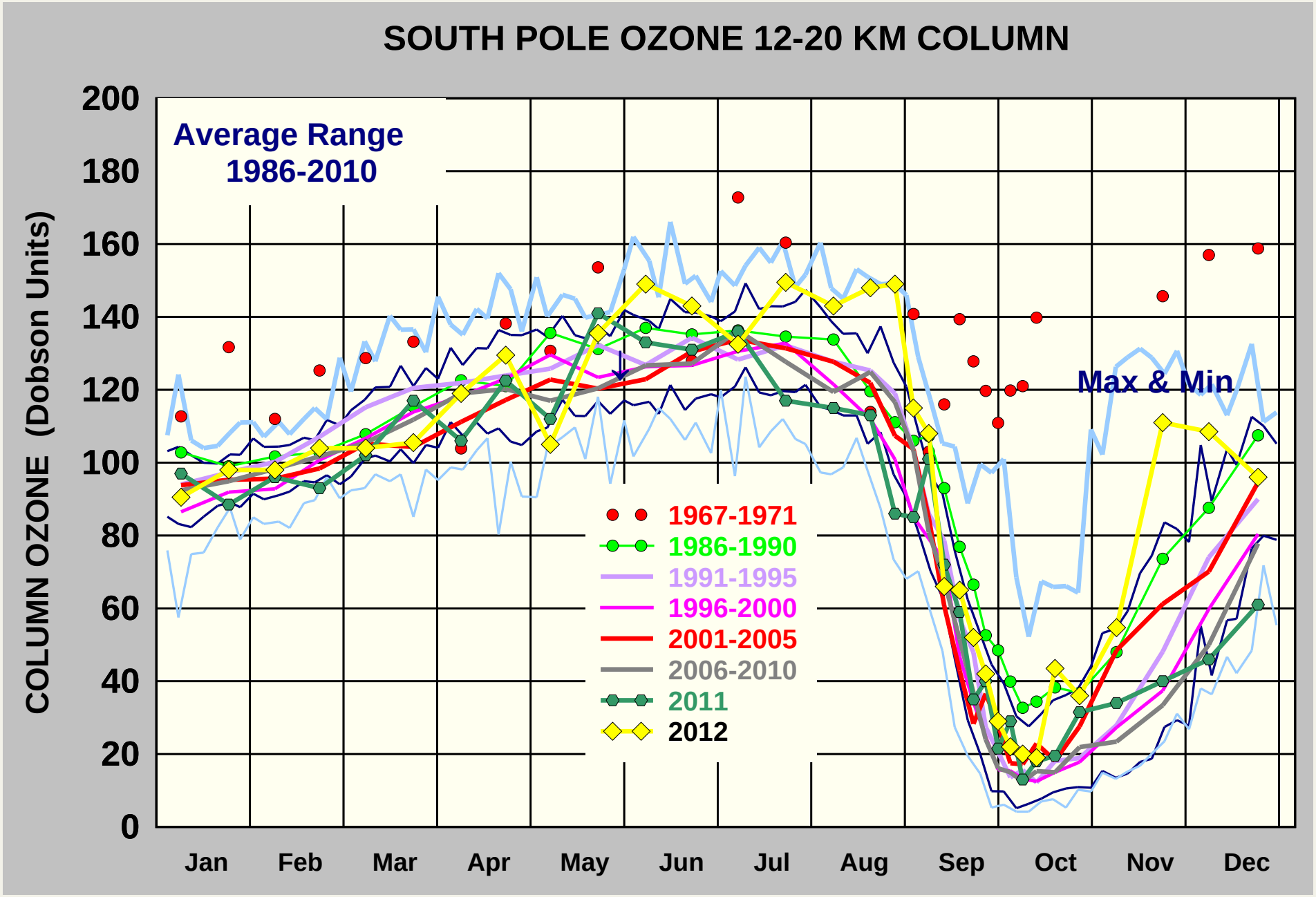

SOUTH POLE OZONE 12-20 KM COLUMN
COLUMN OZONE (Dobson Units)
200
180
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Average Range
1986-2010
5 Year Averages
Max & Min
1967-1971
1986-1990
1991-1995

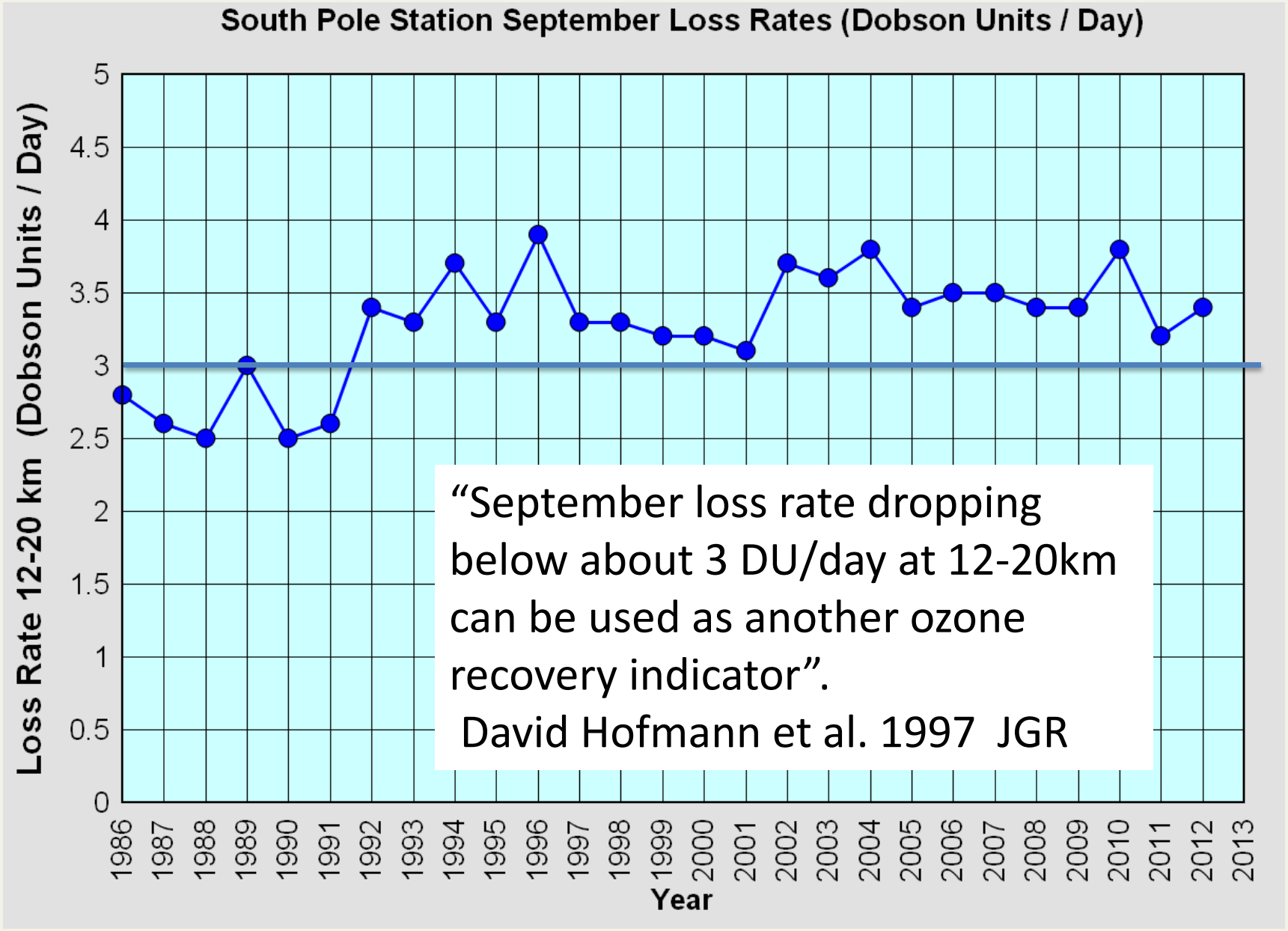

SOUTH POLE OZONE 12-20 KM COLUMN
COLUMN OZONE (Dobson Units)
200
180
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Average Range
1986-2010
Max & Min
1967-1971
1986-1990
1991-1995
1996-2000


SOUTH POLE OZONE 12-20 KM COLUMN
COLUMN OZONE (Dobson Units)
200
180
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Average Range
1986-2010
Max & Min
1967-1971
1986-1990
1991-1995
1996-2000
2001-2005


SOUTH POLE OZONE 12-20 KM COLUMN
COLUMN OZONE (Dobson Units)
200
180
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Average Range
1986-2010
Max & Min
1967-1971
1986-1990
1991-1995
1996-2000
2001-2005
2006-2010


SOUTH POLE OZONE 12-20 KM COLUMN
Average Range
1986-2010
Max & Min
1967-1971
1986-1990
1991-1995
1996-2000
2001-2005
2006-2010
2011
COLUMN OZONE (Dobson Units)
200
180
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


SOUTH POLE OZONE 12-20 KM COLUMN
COLUMN OZONE (Dobson Units)
200
180
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Average Range
1986-2010
Max & Min
1967-1971
1986-1990
1991-1995
1996-2000
2001-2005
2006-2010
2011
2012


South Pole Station September Loss Rates (Dobson Units / Day)
Loss Rate 12-20 km (Dobson Units / Day)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year
"September loss rate dropping below about 3 DU/day at 12-20km can be used as another ozone recovery indicator".
David Hofmann et al. 1997 JGR

Summary

GMD monitors stratospheric ozone at South Pole Station:

-- Ground based Dobson Spectrophotometer observations (*51 year record*).
-- Balloon-borne ozonesonde profiles (*27 year record*).

- Total column minimum ranked at #23 in 27 year record for ozonesondes.

- 12-20 km layer reduces influence of dynamics and shows the depletion rate remains in typical 3.2 to 3.8 DU per day range.

- When do we expect first signs of recovery at South Pole?

*"Assuming a lineal relationship between ozone loss rate and Equivalent Effective Stratospheric Chlorine - a reduction of the ozone loss rate at South Pole station will be detectable in **2017-2021 period** " Hassler et al., (2011).*