South Pole Station Ozonesondes: 2017 Shows Less Severe Ozone Loss

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- **Ozonesondes: 32 consecutive years.**
  - **1986-2017: 1,930 ozonesonde launches**
  - **1967-1971: 65 ozonesondes (no ozone hole)**
- **Dobson Spectrophotometer: 54 years**
  - **1964-2017: Daily Total Column Ozone**

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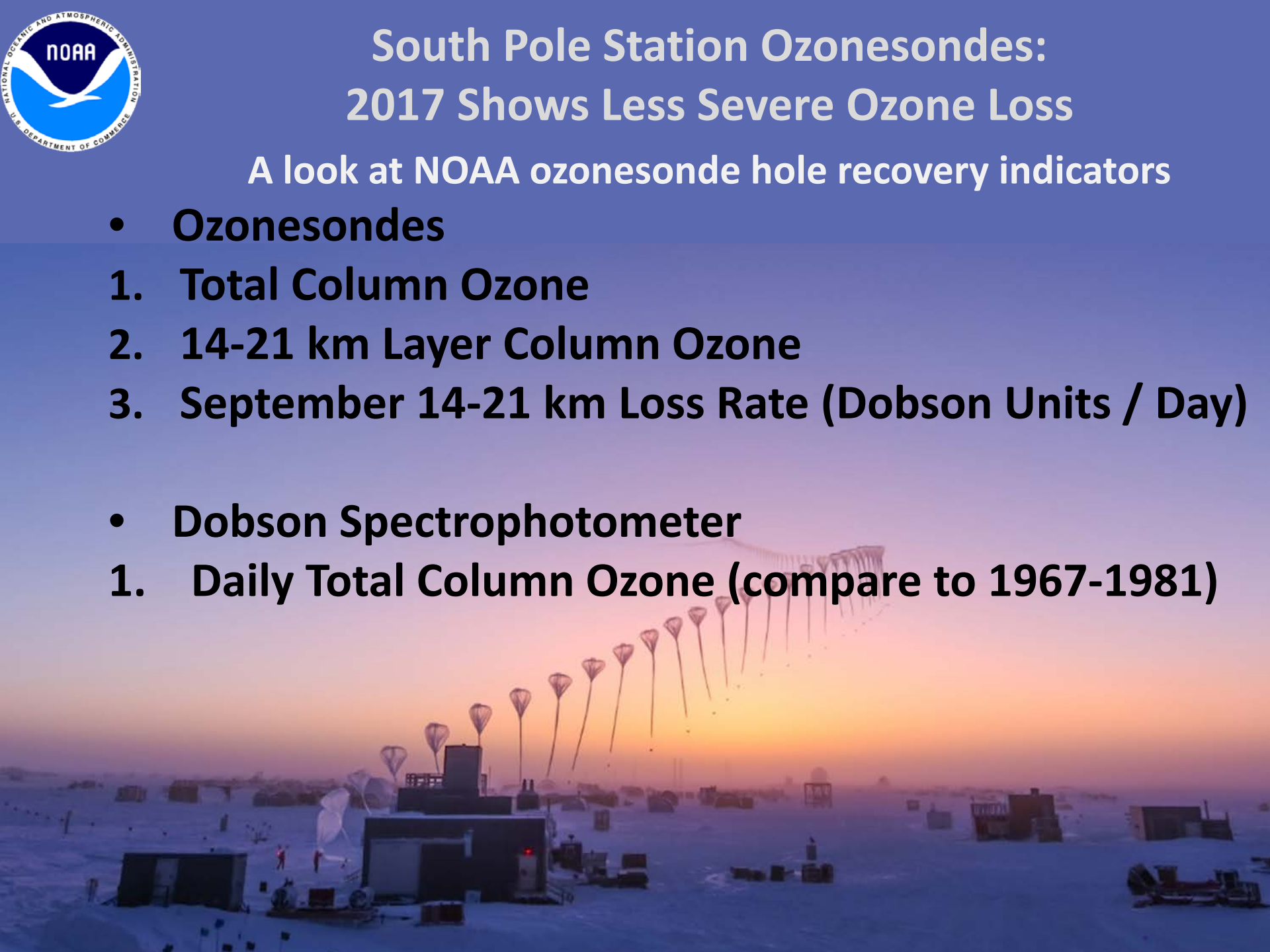
A look at NOAA ozonesonde hole recovery indicators

- **Ozonesondes**

1. **Total Column Ozone**
2. **14-21 km Layer Column Ozone**
3. **September 14-21 km Loss Rate (Dobson Units / Day)**

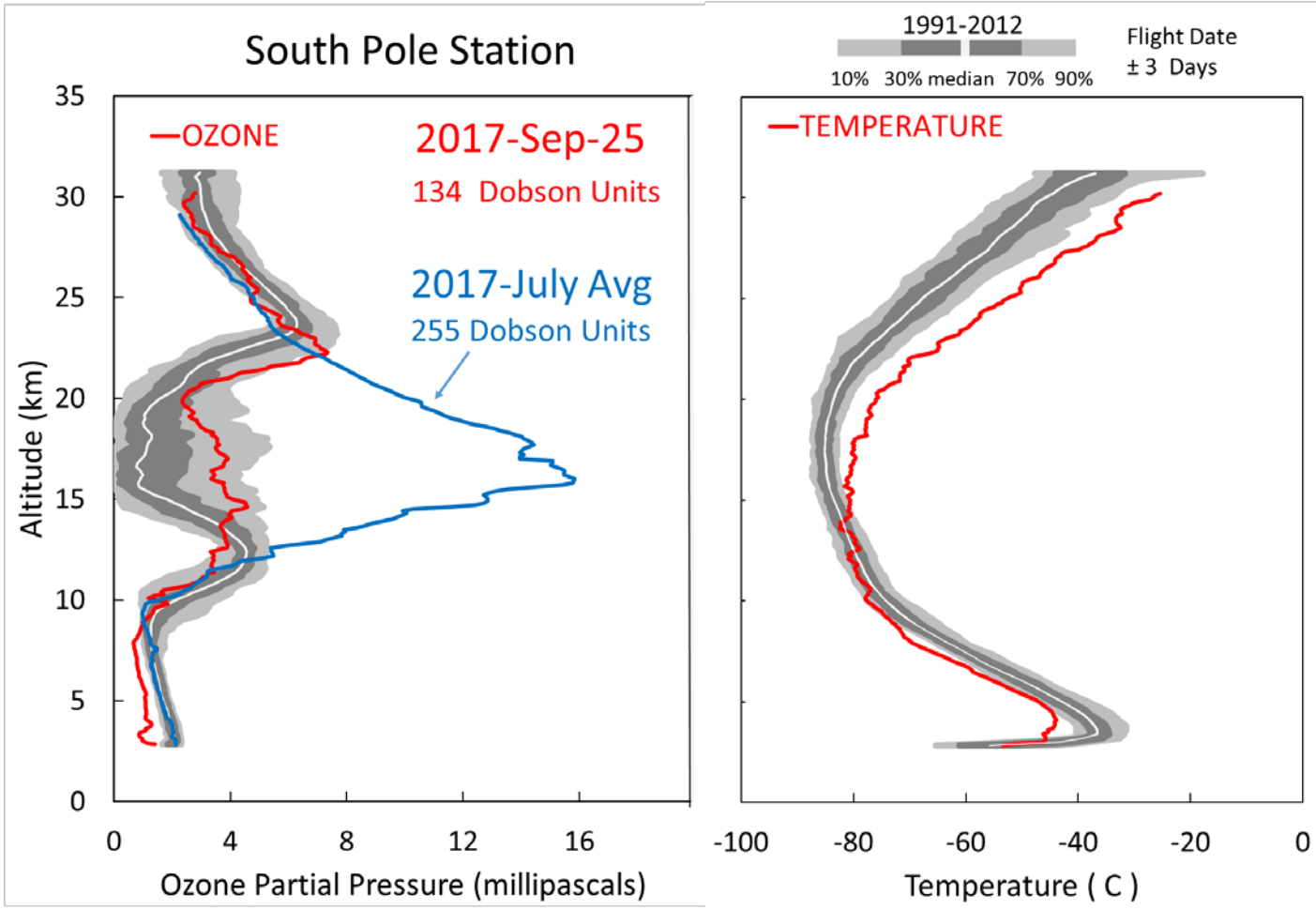
- **Dobson Spectrophotometer**

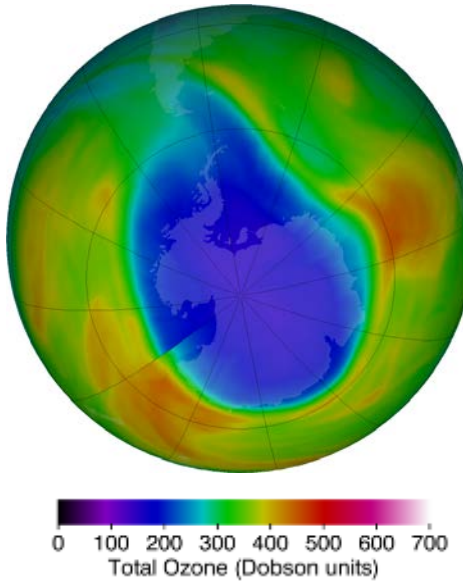
1. **Daily Total Column Ozone (compare to 1967-1981)**



South Pole Station Ozonesondes:

Minimum Ozonesonde (Total Ozone) Profile 2017

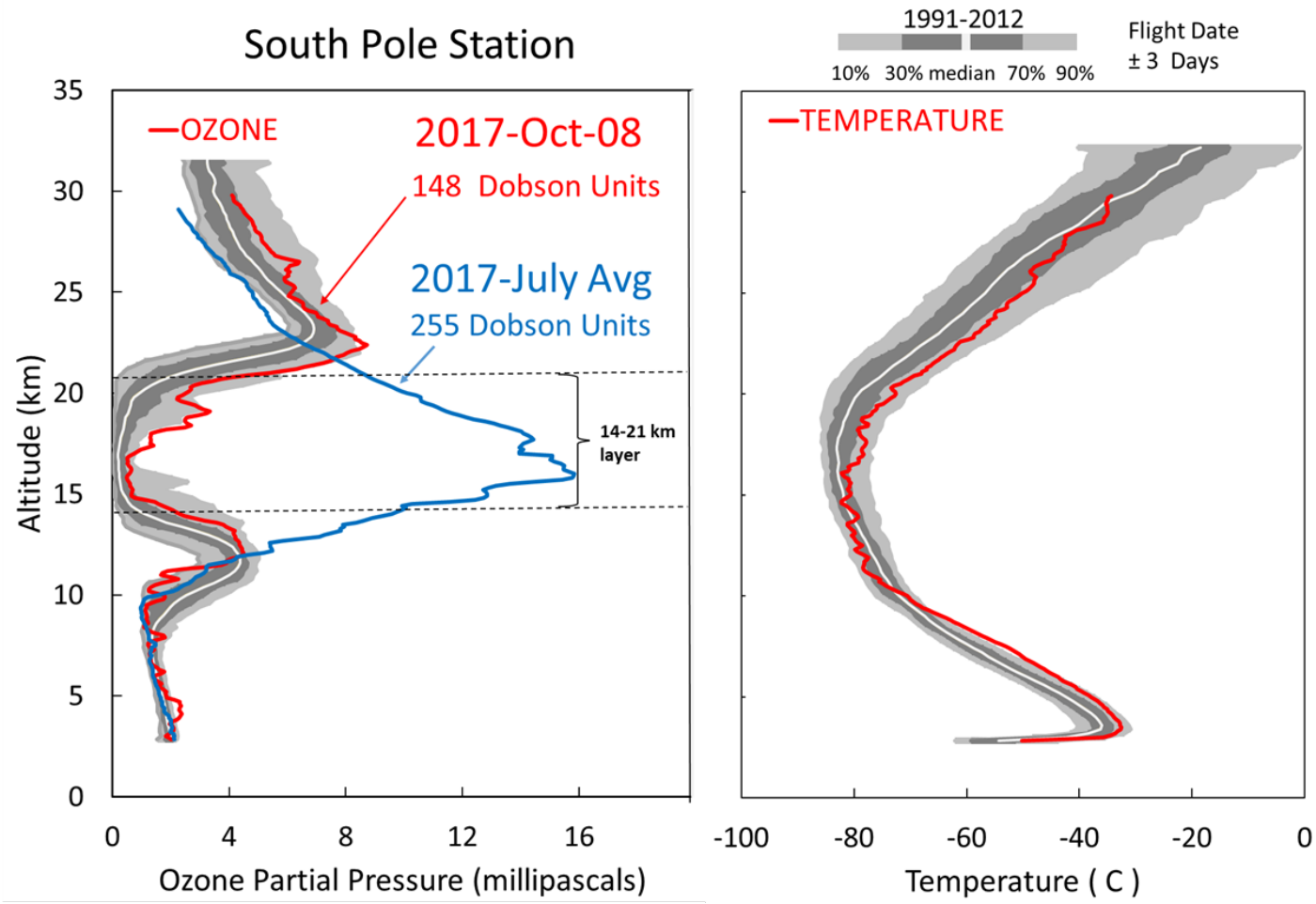


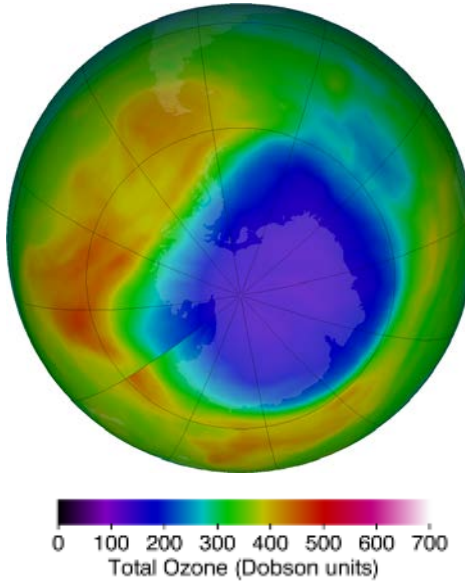


25 Sep 2017 NASA image

South Pole Station Ozonesondes:

Minimum Ozonesonde (14-21 km column) Profile

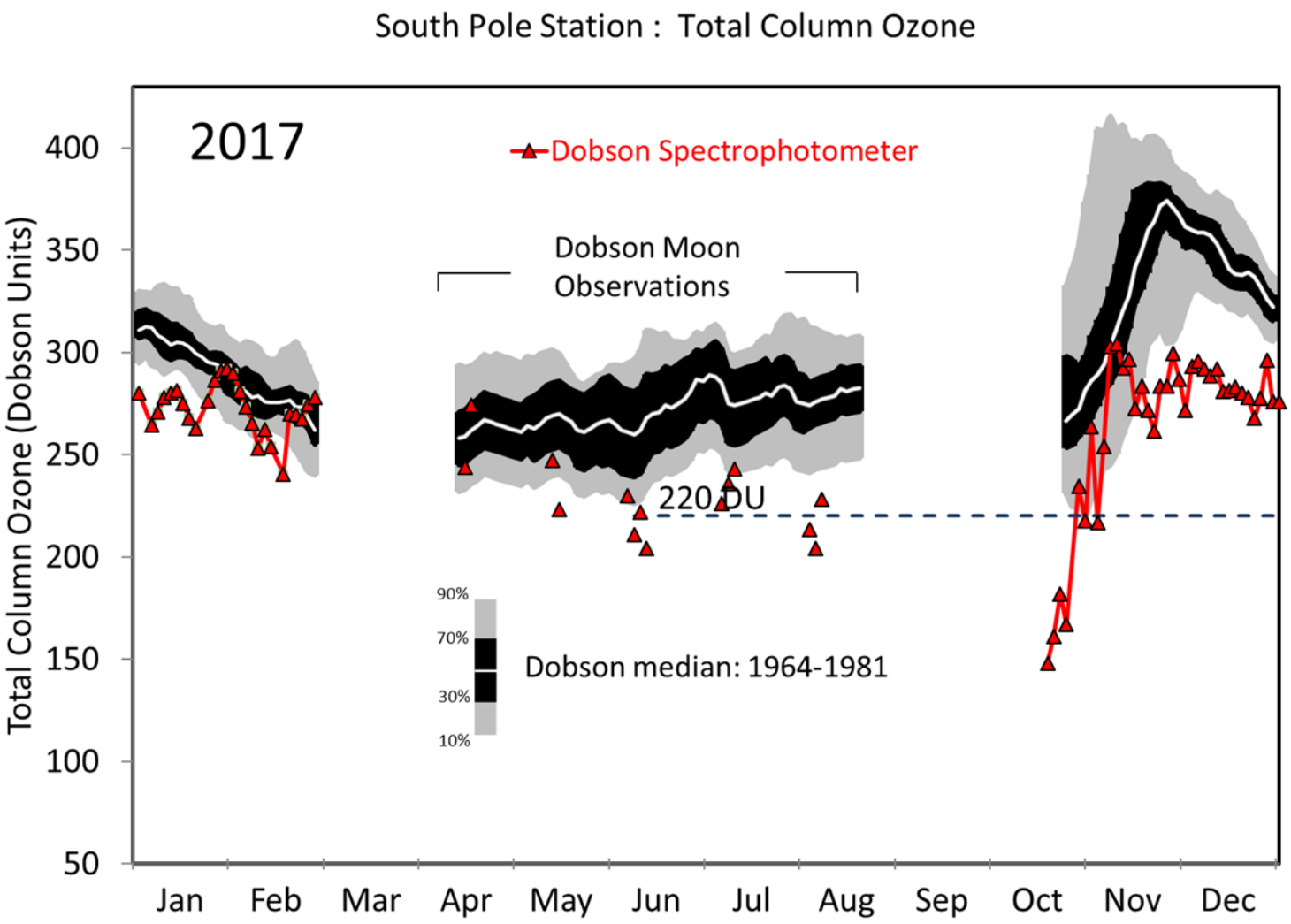




08 Oct 2017 NASA image

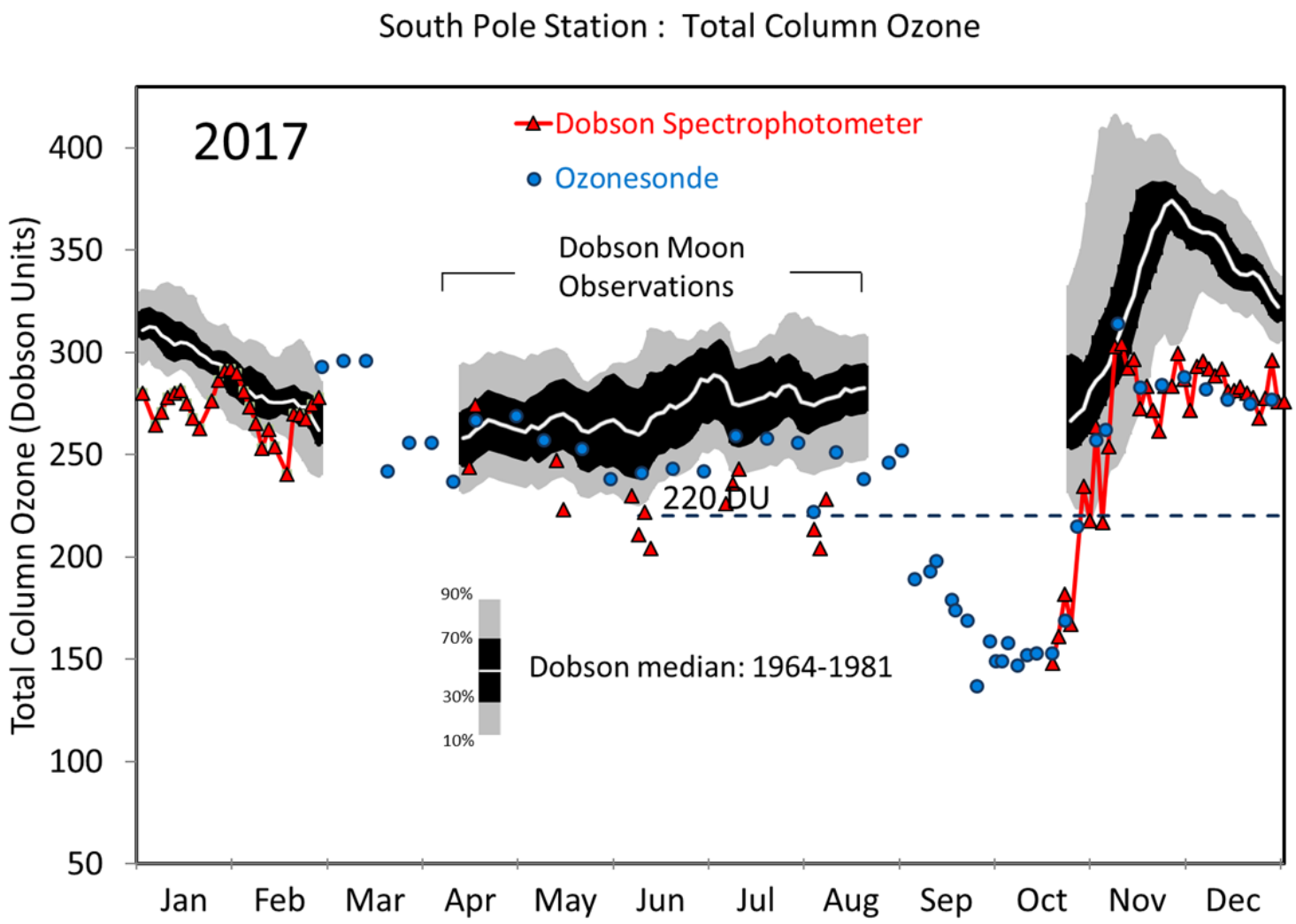
South Pole Dobson:

Dobson Spectrophotometer (Total Column)



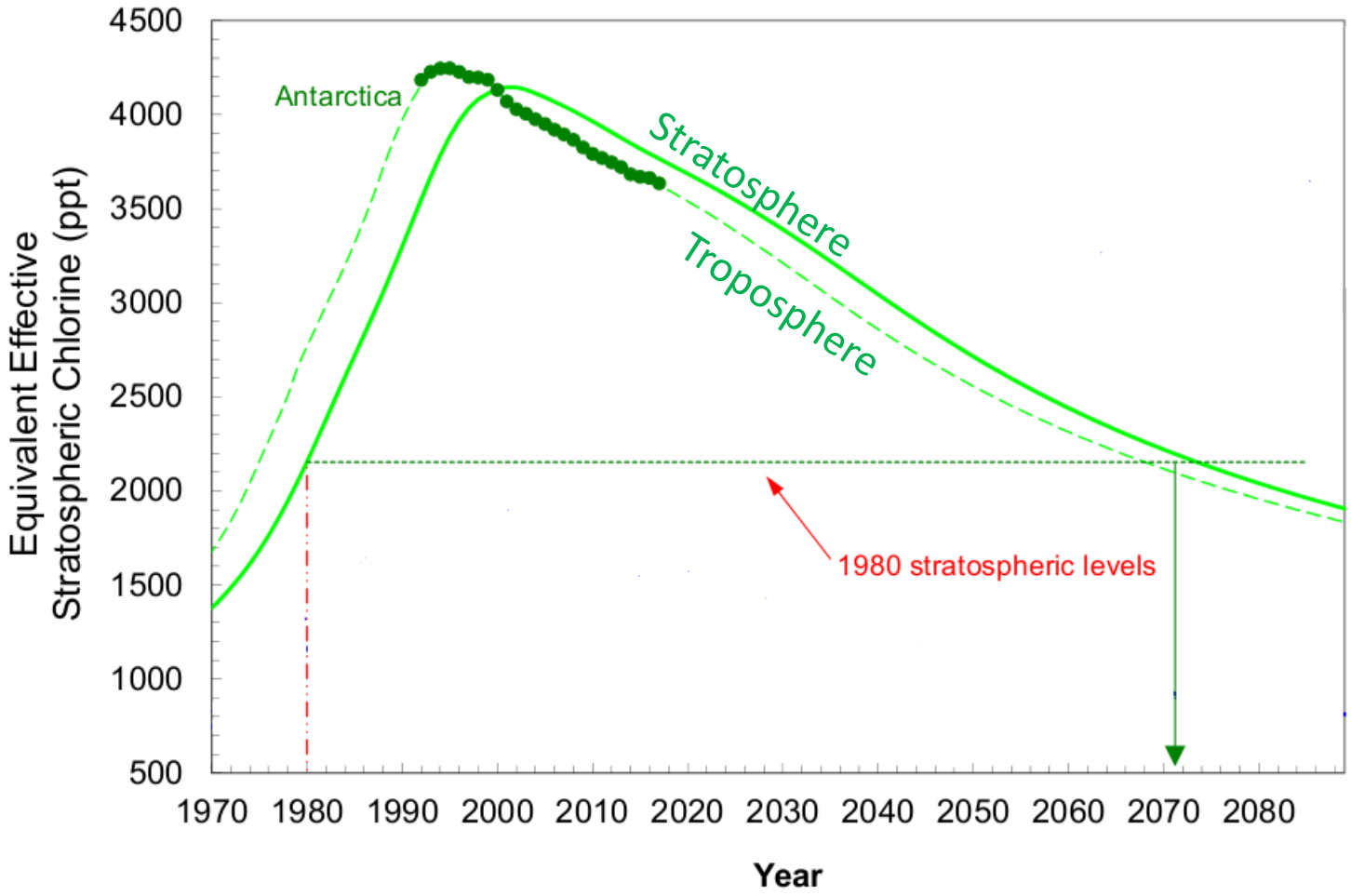
South Pole Dobson:

Dobson Spectrophotometer & Ozonesonde (Total Column)



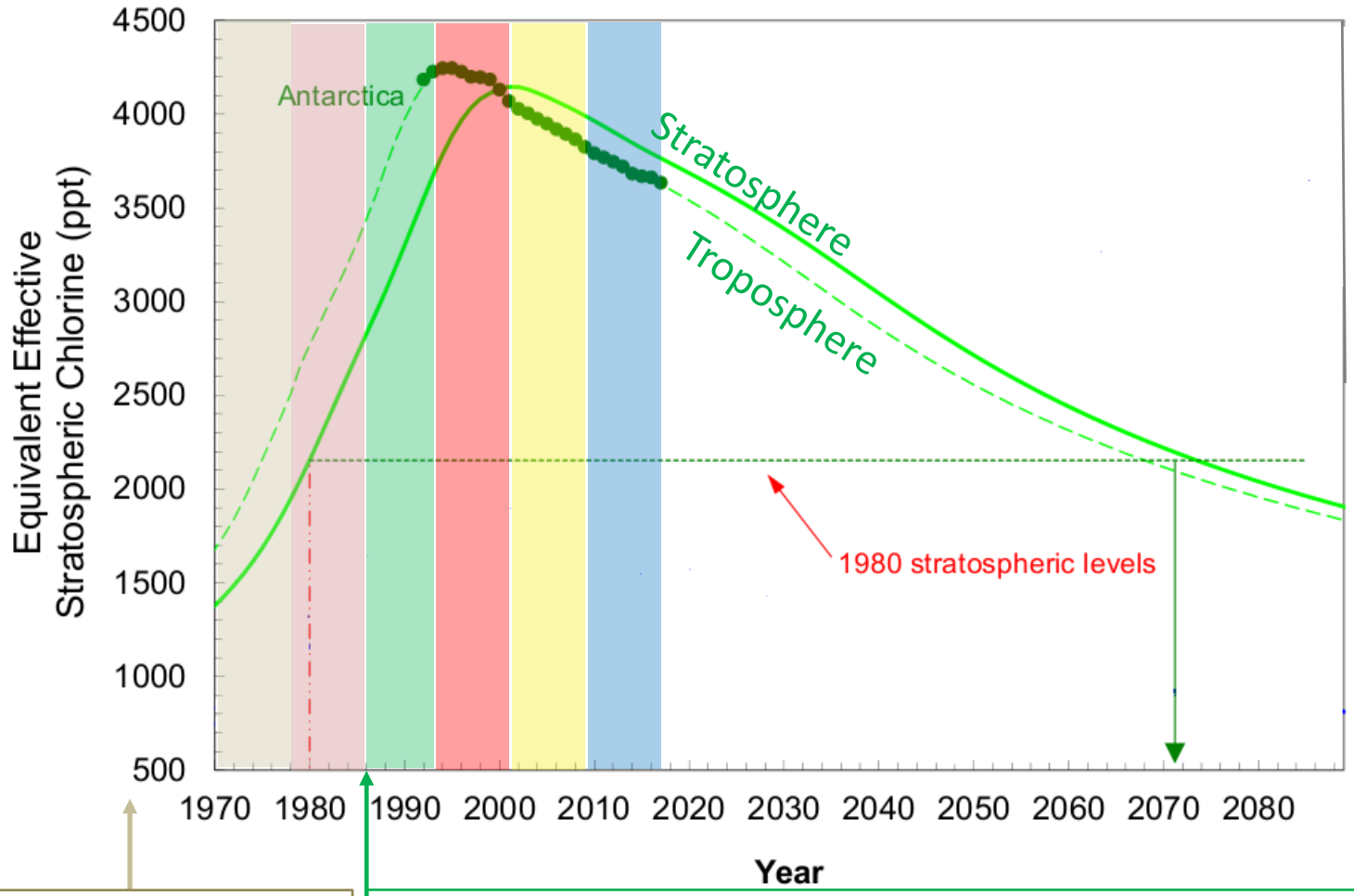
The NOAA Ozone Depleting Gas Index based on Equivalent Effective Stratospheric Chlorine : Guiding Recovery of the Ozone Layer (Montzka, et al.)

Ozone depletion depends on stratospheric chlorine & meteorological / temperature conditions of polar vortex.



Tracking South Pole Ozone Observations binned in 8 year intervals (median values) to compare with Equivalent Effective Stratospheric Chlorine

Ozone depletion depends on stratospheric chlorine & meteorological / temperature conditions of polar vortex.



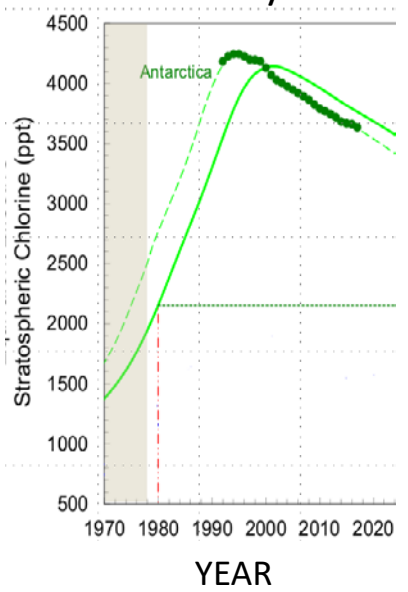
South Pole Dobson begins

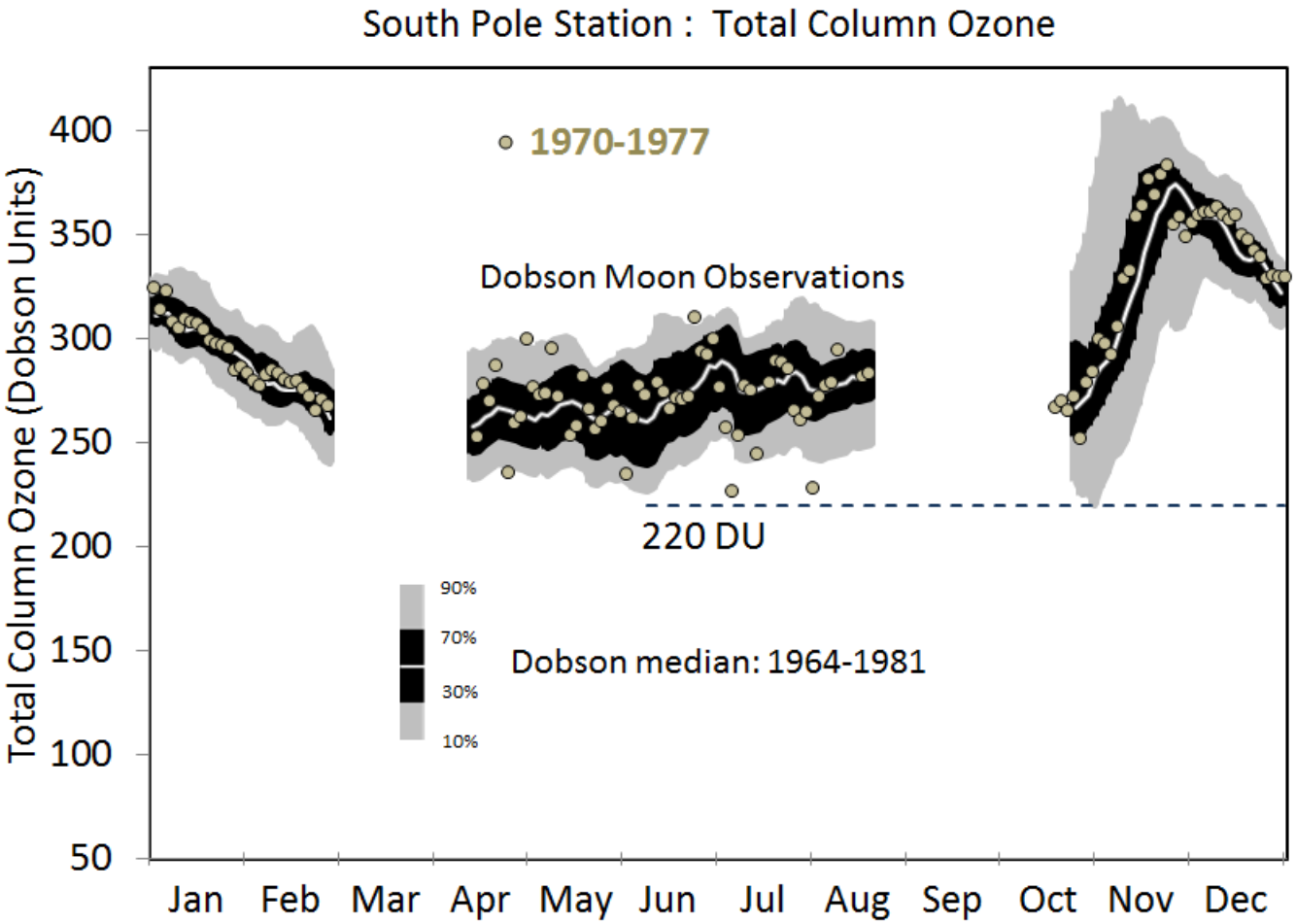
South Pole Ozonesonde observations begin 1986

1985 Farman paper, Montreal Protocol originally signed 1987

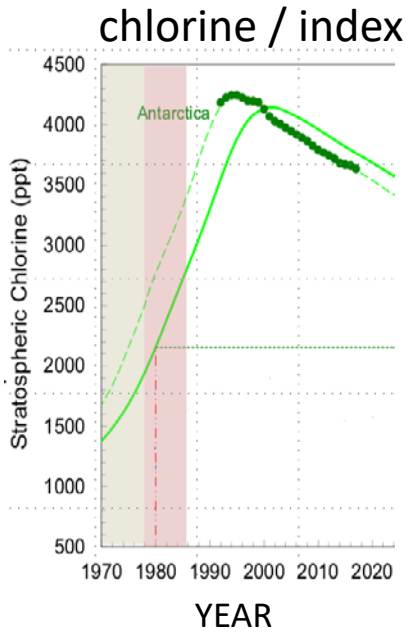
Dobson Spectrophotometer

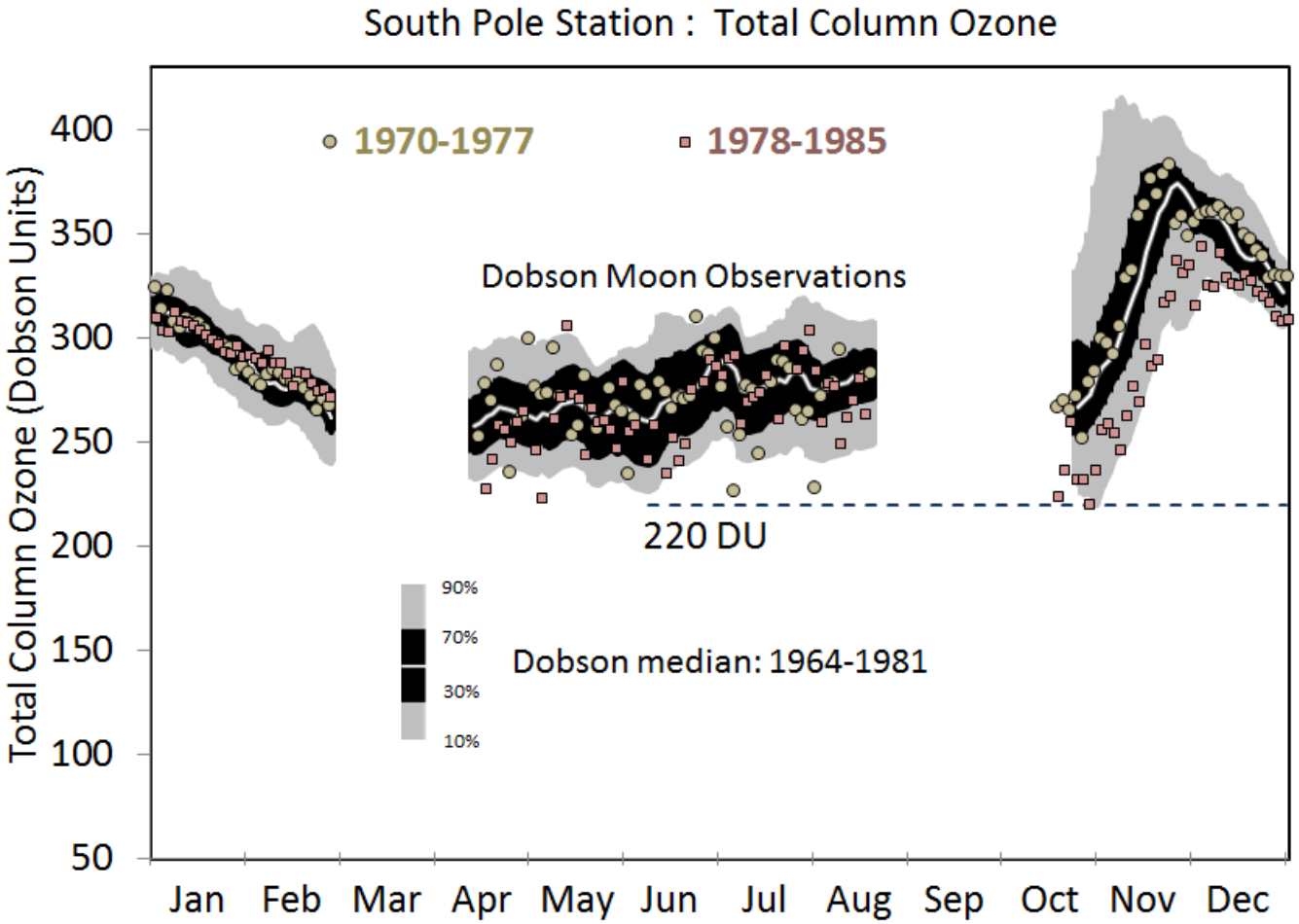
chlorine / index





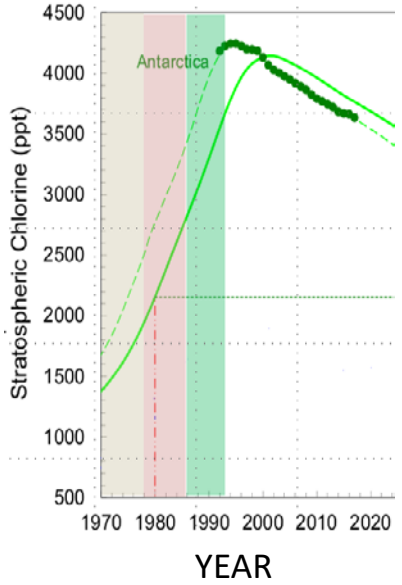
Dobson Spectrophotometer



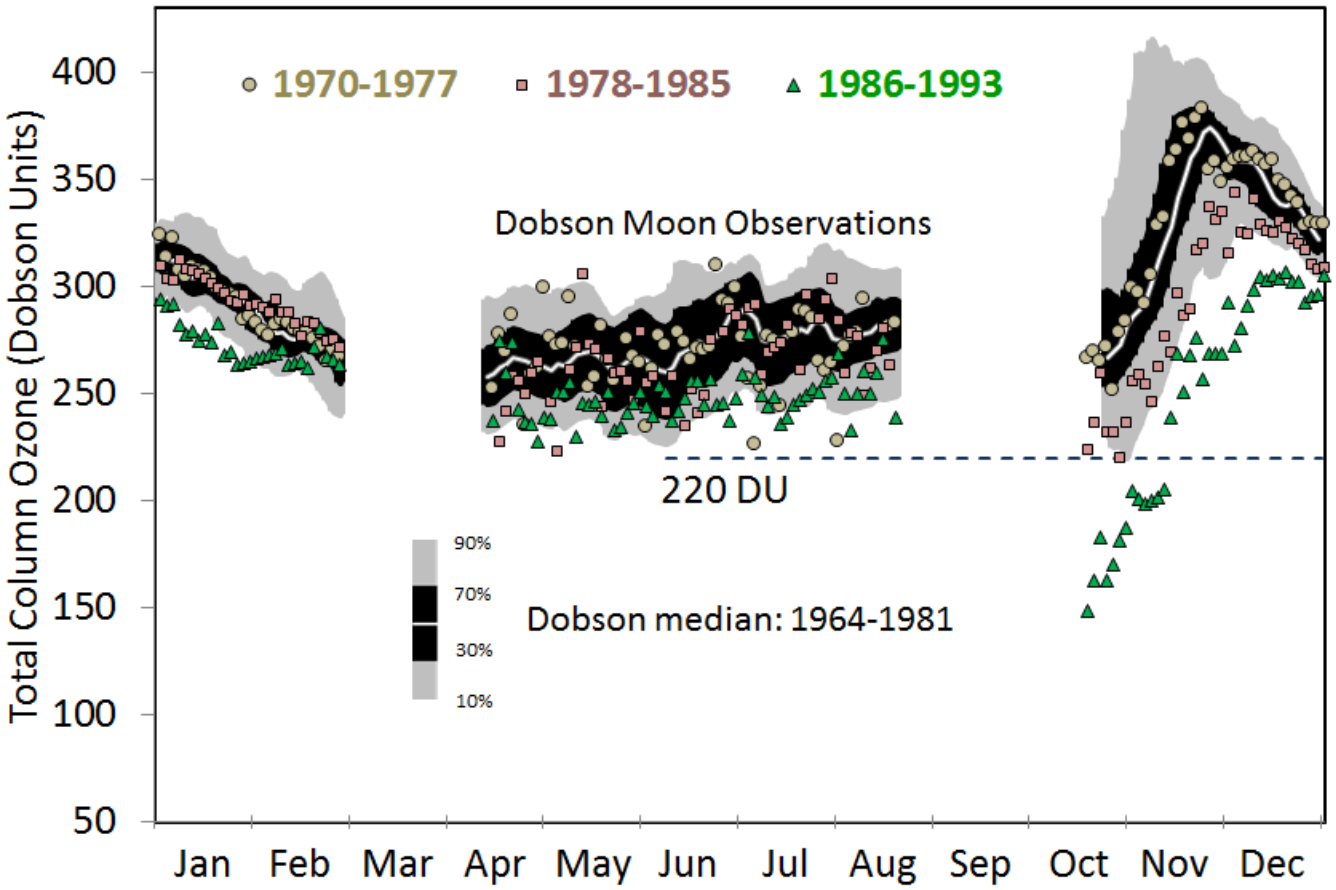


Dobson Spectrophotometer

chlorine / index

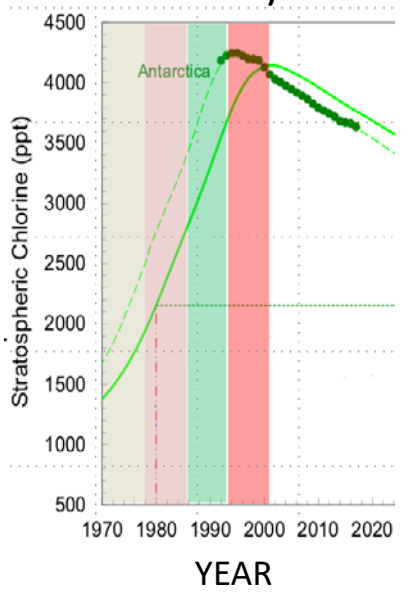


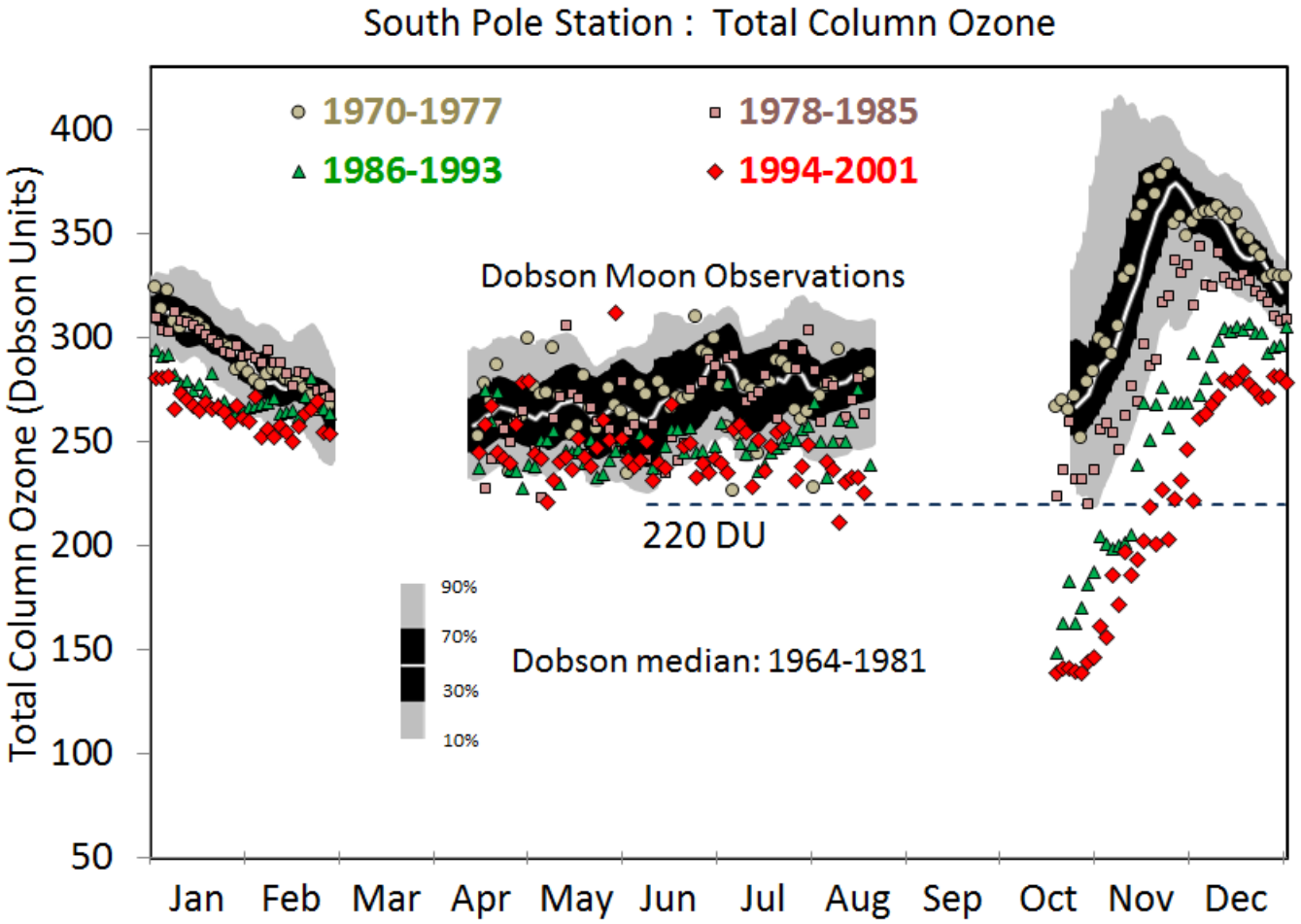
South Pole Station : Total Column Ozone



Dobson Spectrophotometer

chlorine / index





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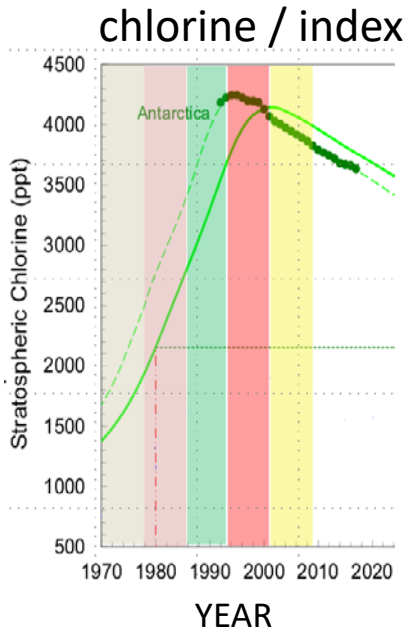
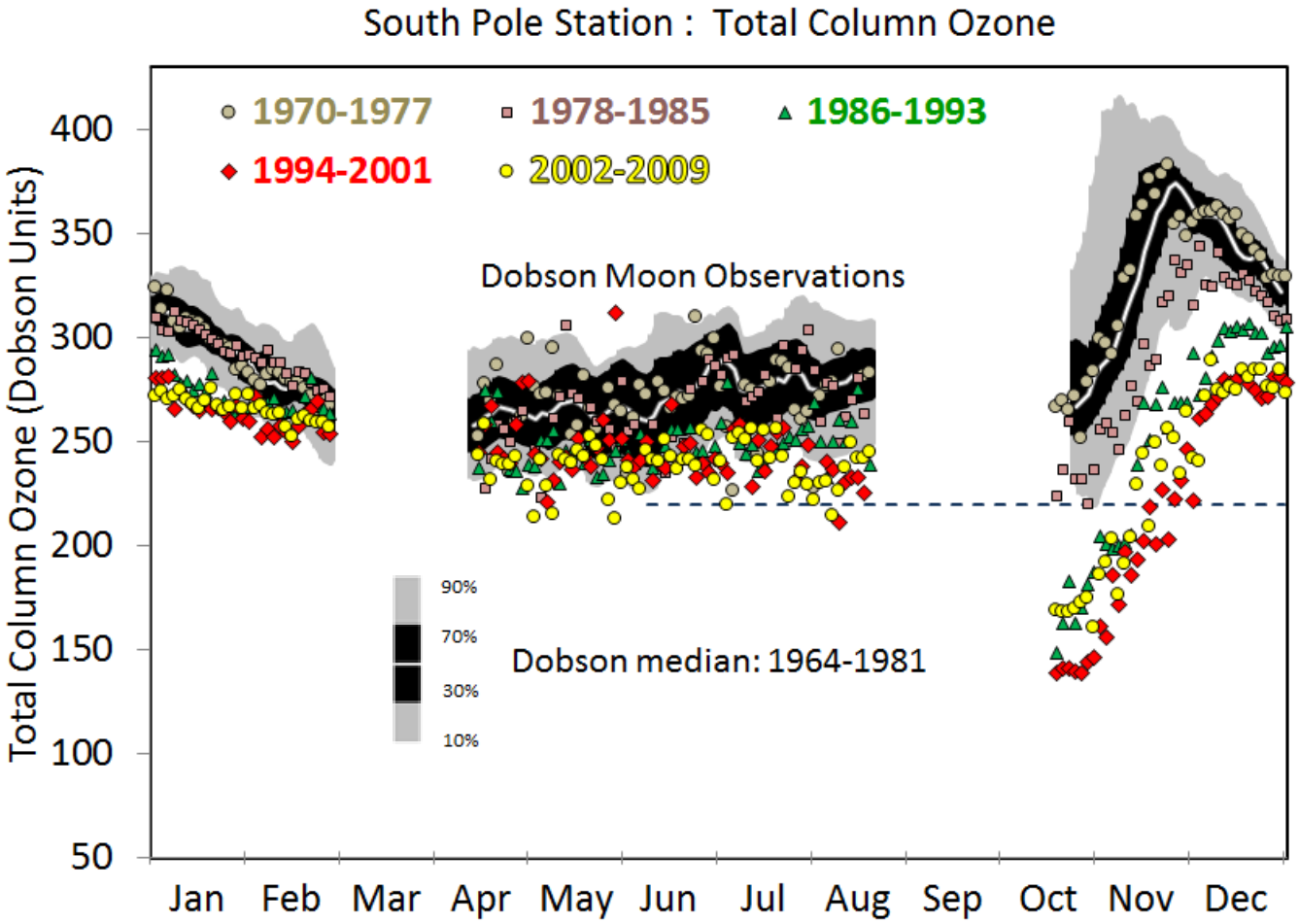
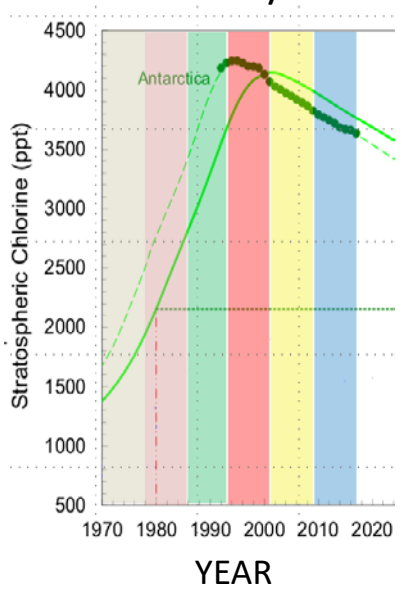
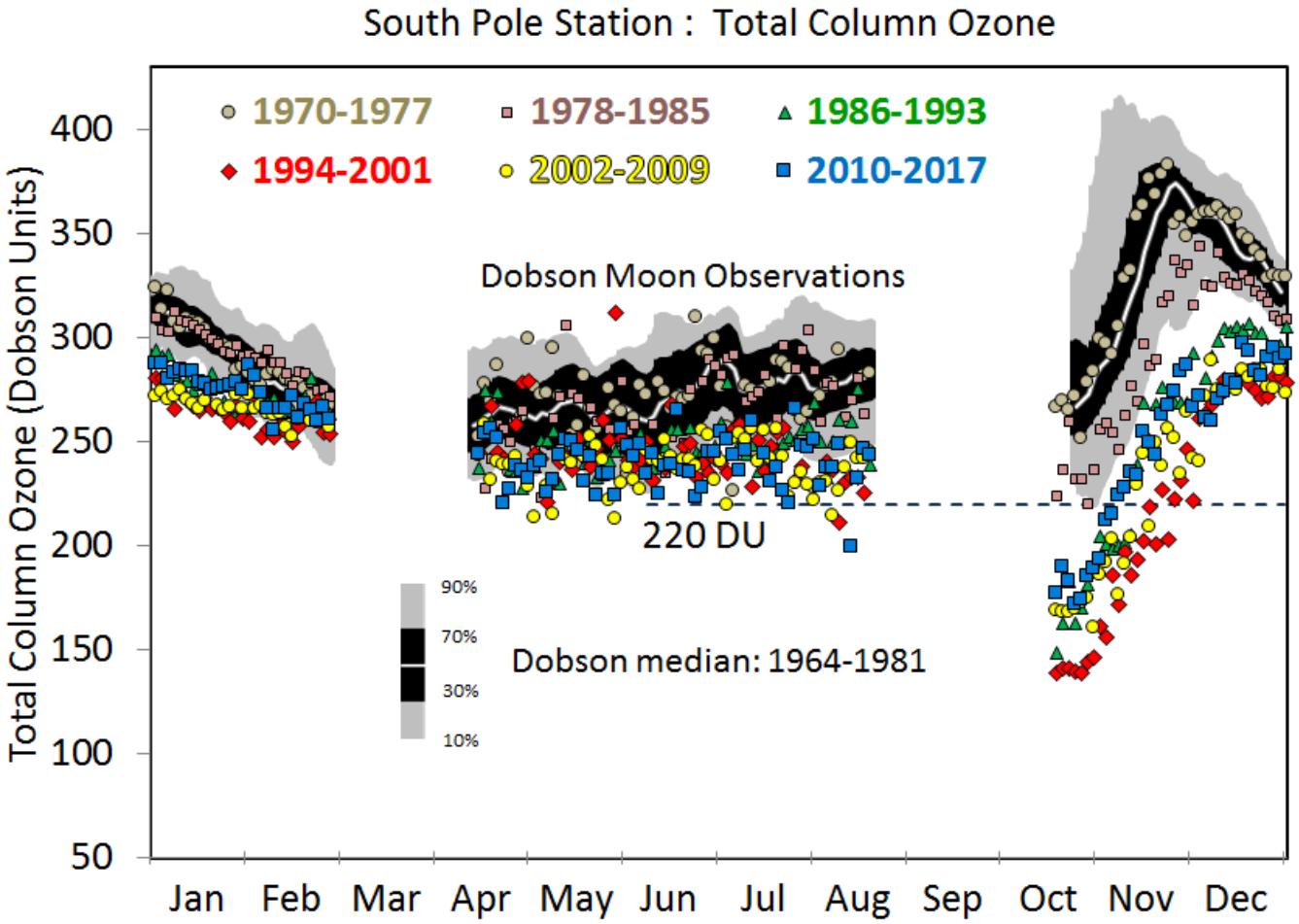




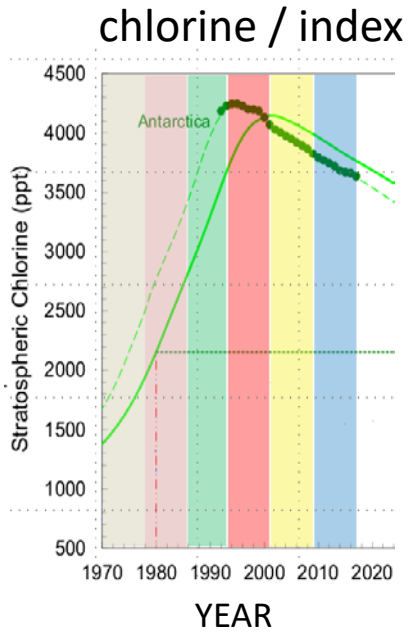
Dobson Spectrophotometer

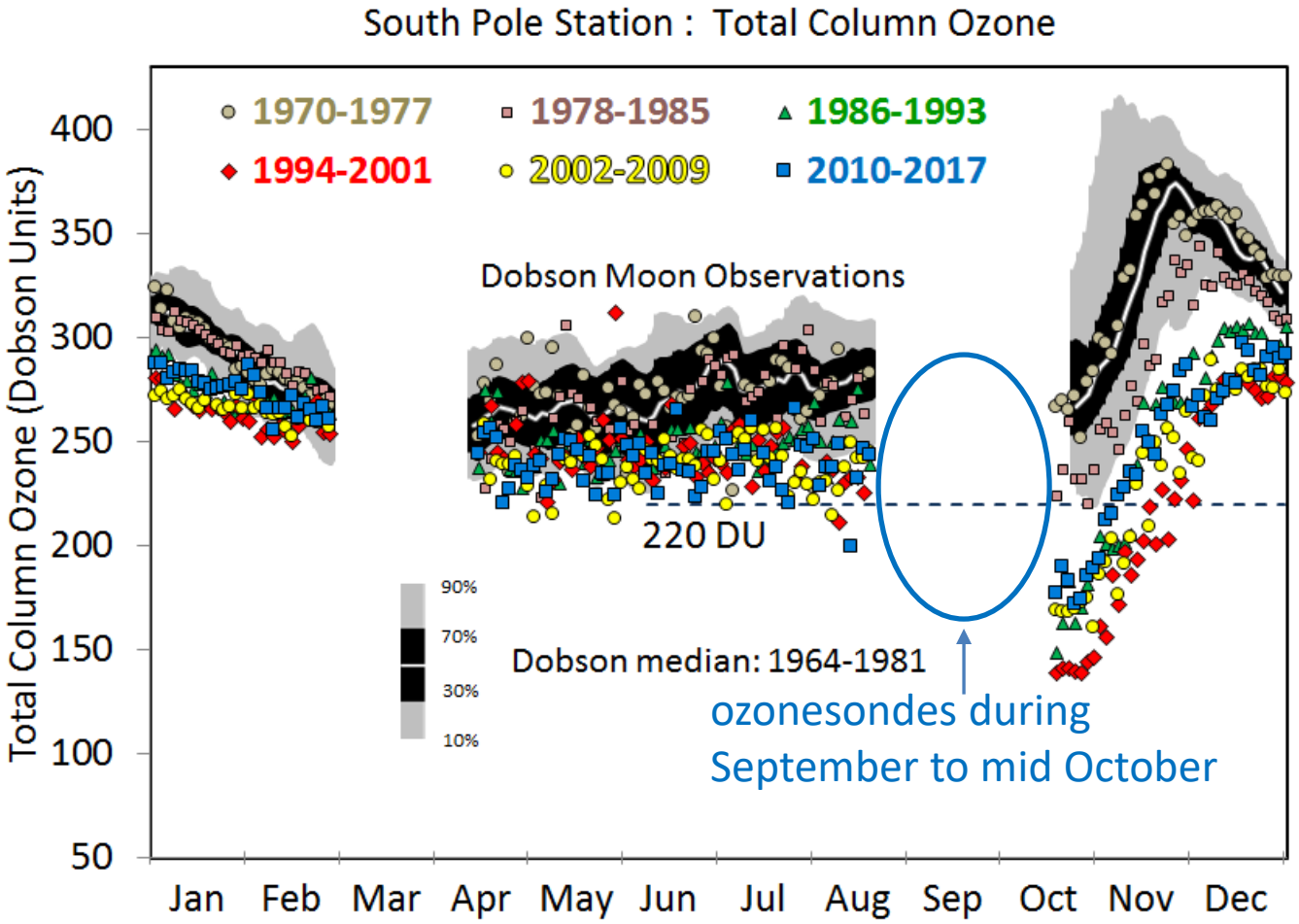
chlorine / index





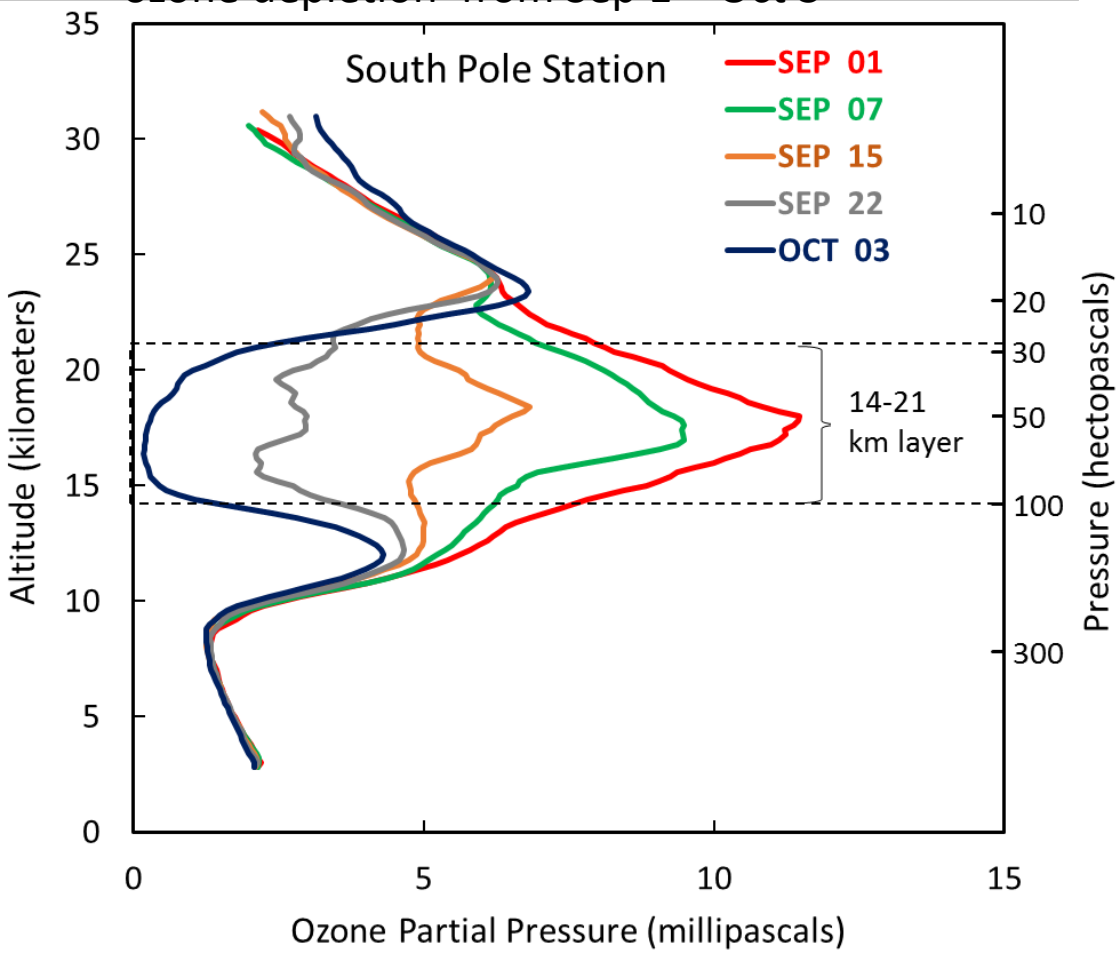
Dobson Spectrophotometer





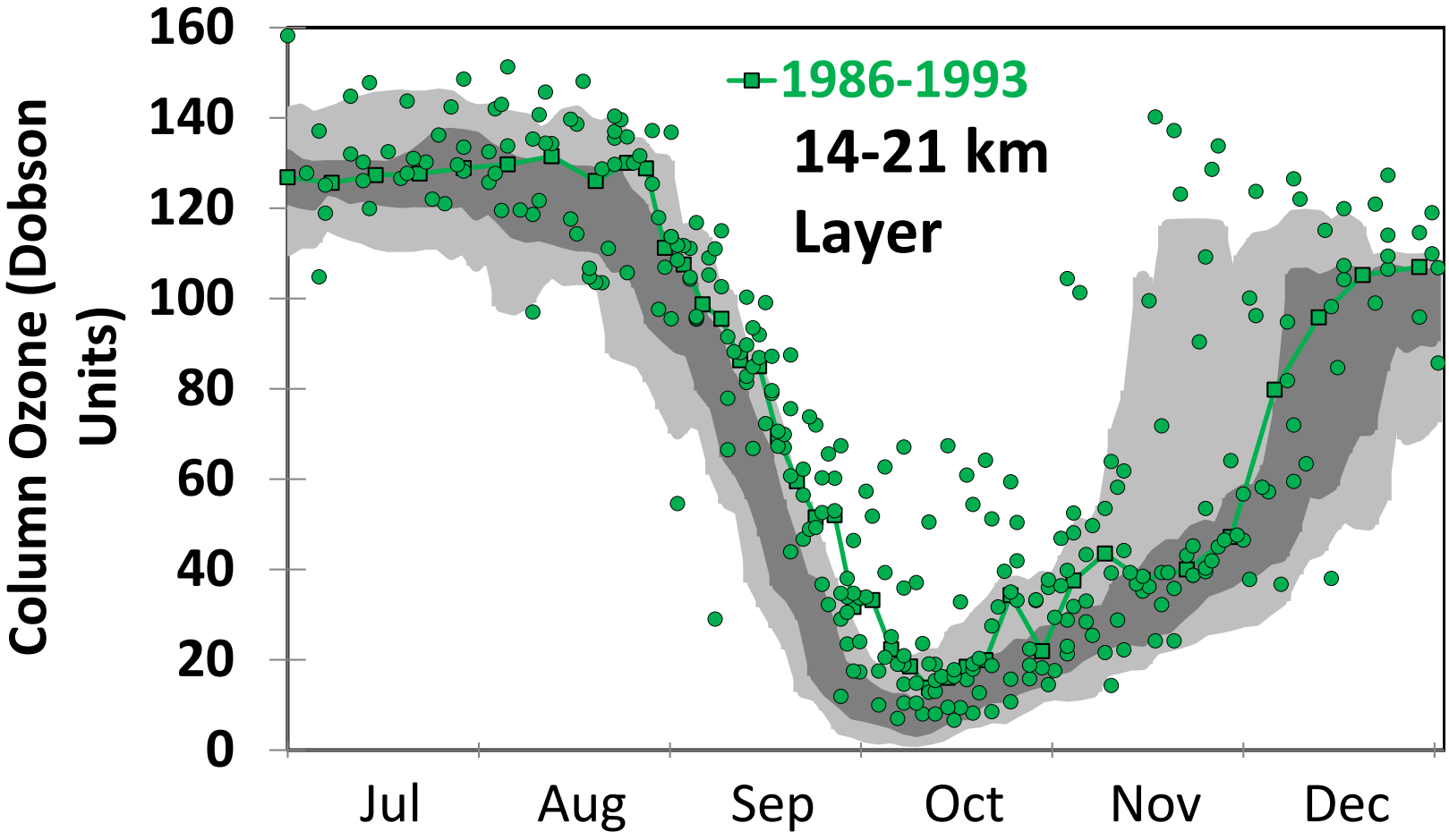
South Pole Station Ozonesondes 14-21 km Layer

1991 – 2014 median weekly profiles during rapid ozone depletion from Sep 1 – Oct 3

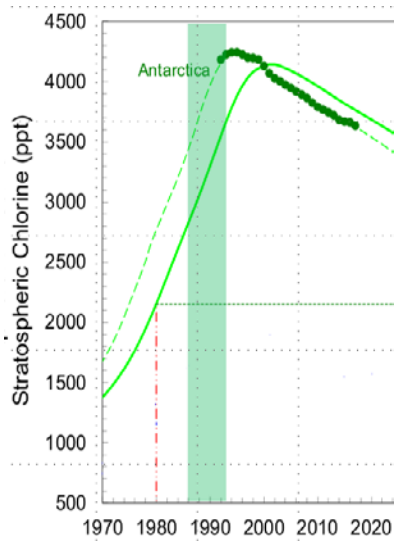


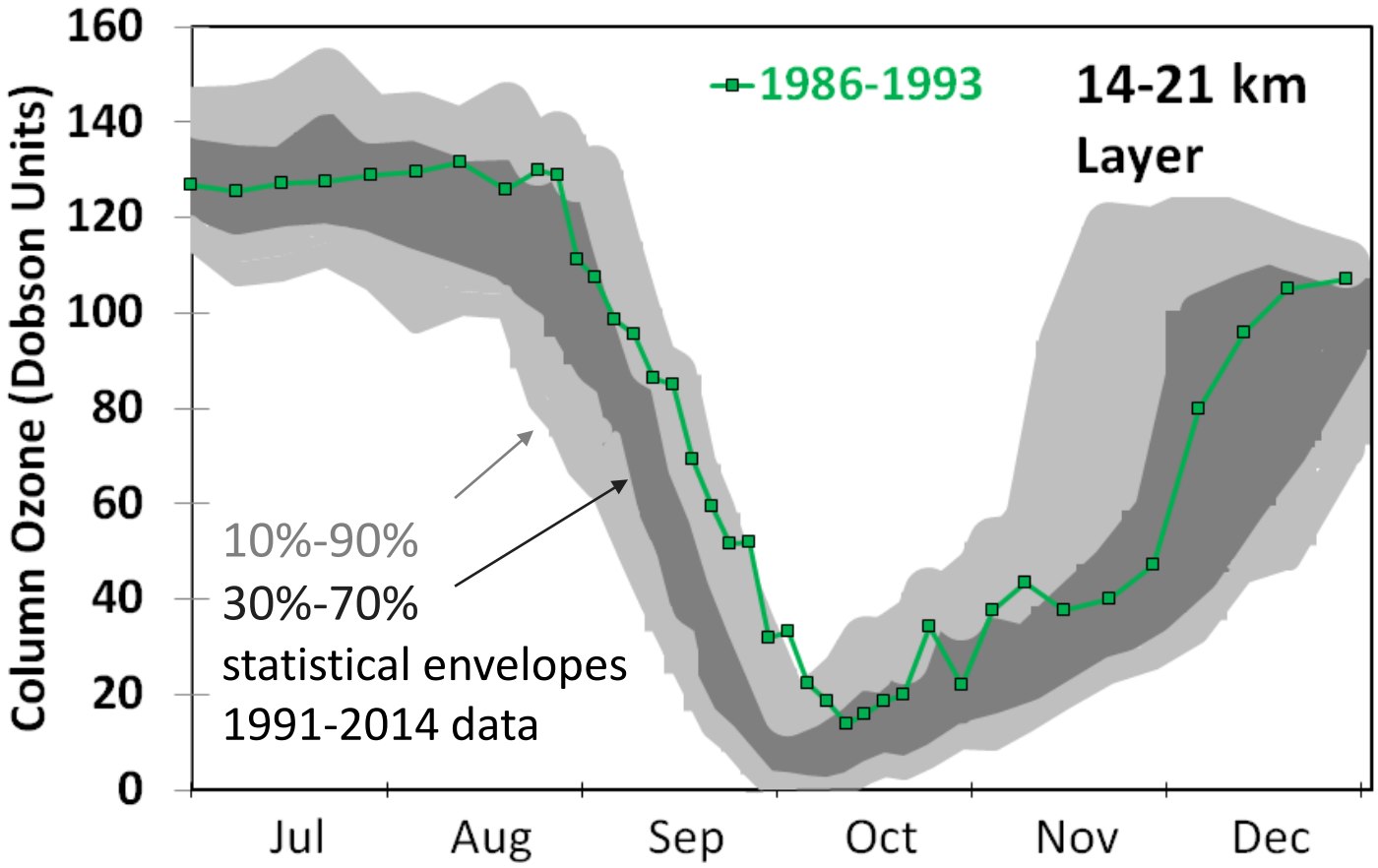
Ozonesonde

14-21 km column ozone (balloon flights) from 1986-1993 July-December and median line

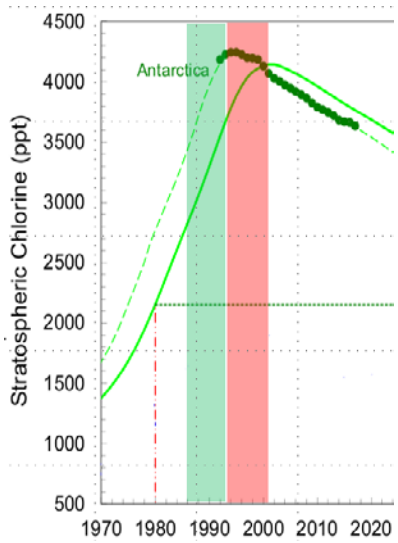


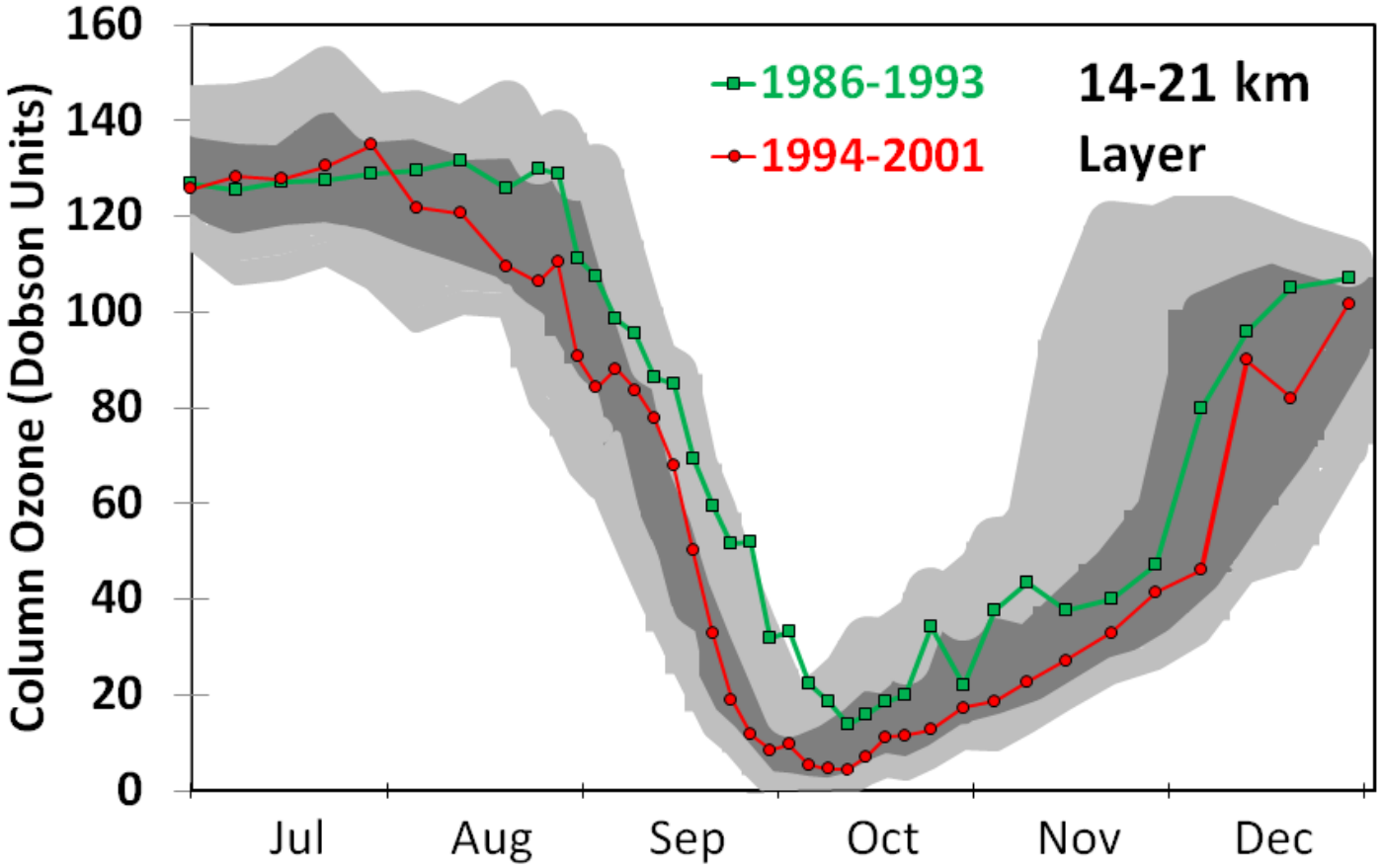
Ozonesondes





Ozonesondes





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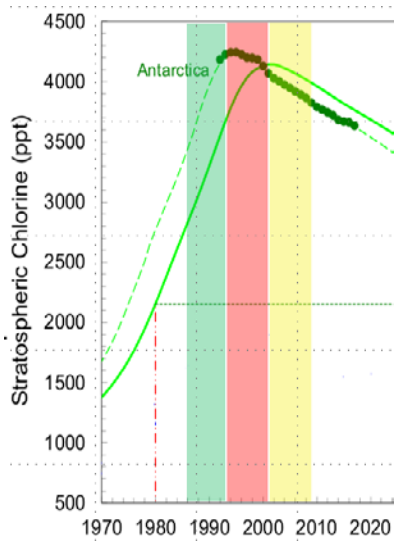
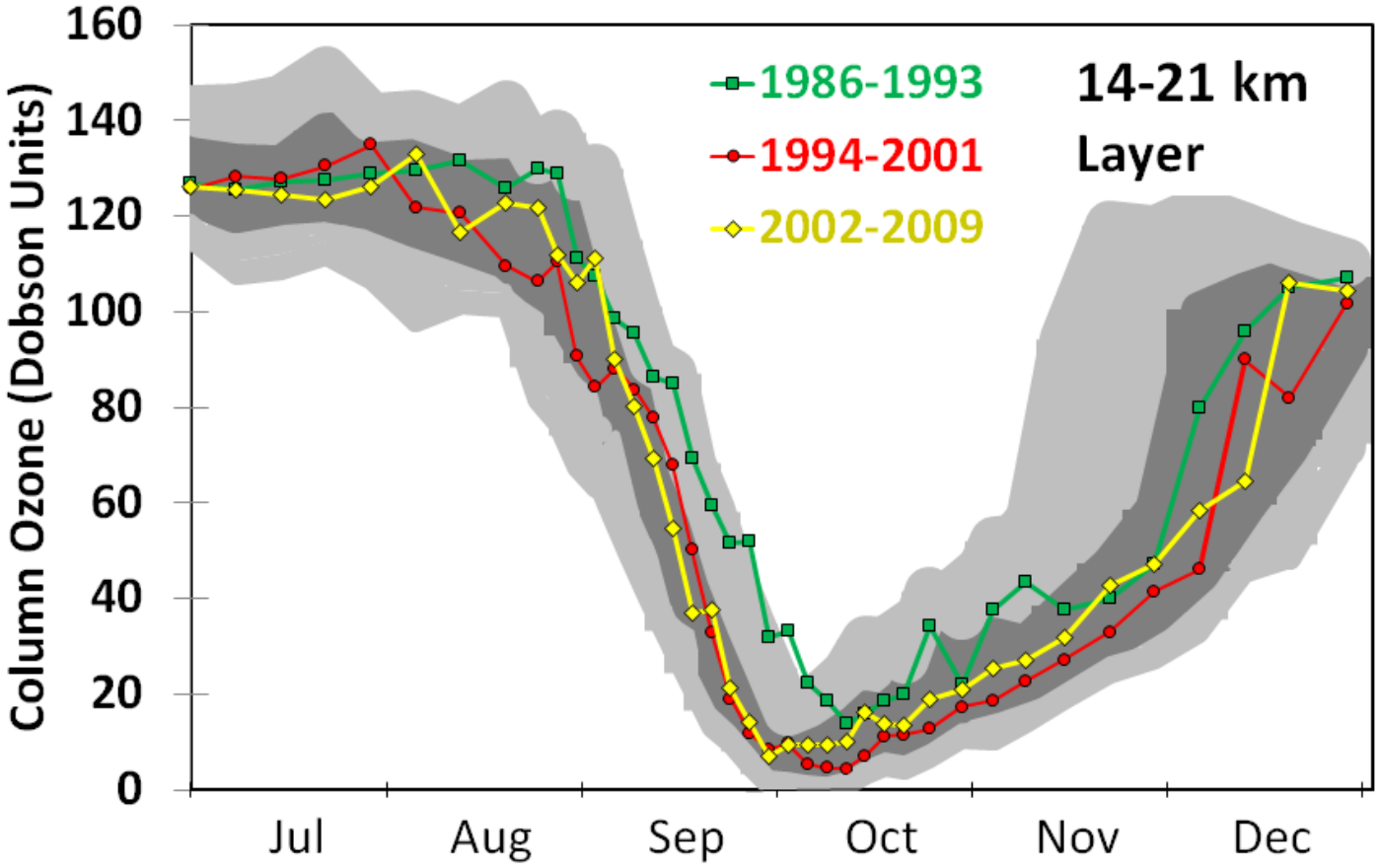
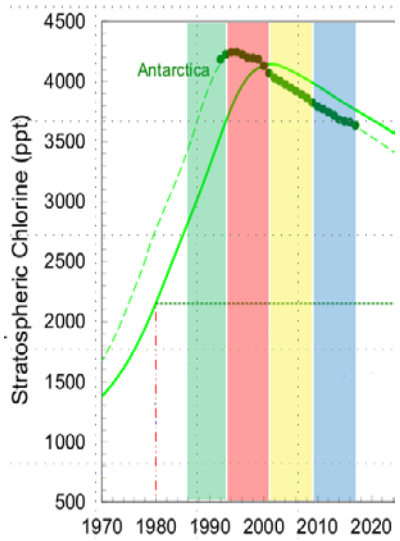
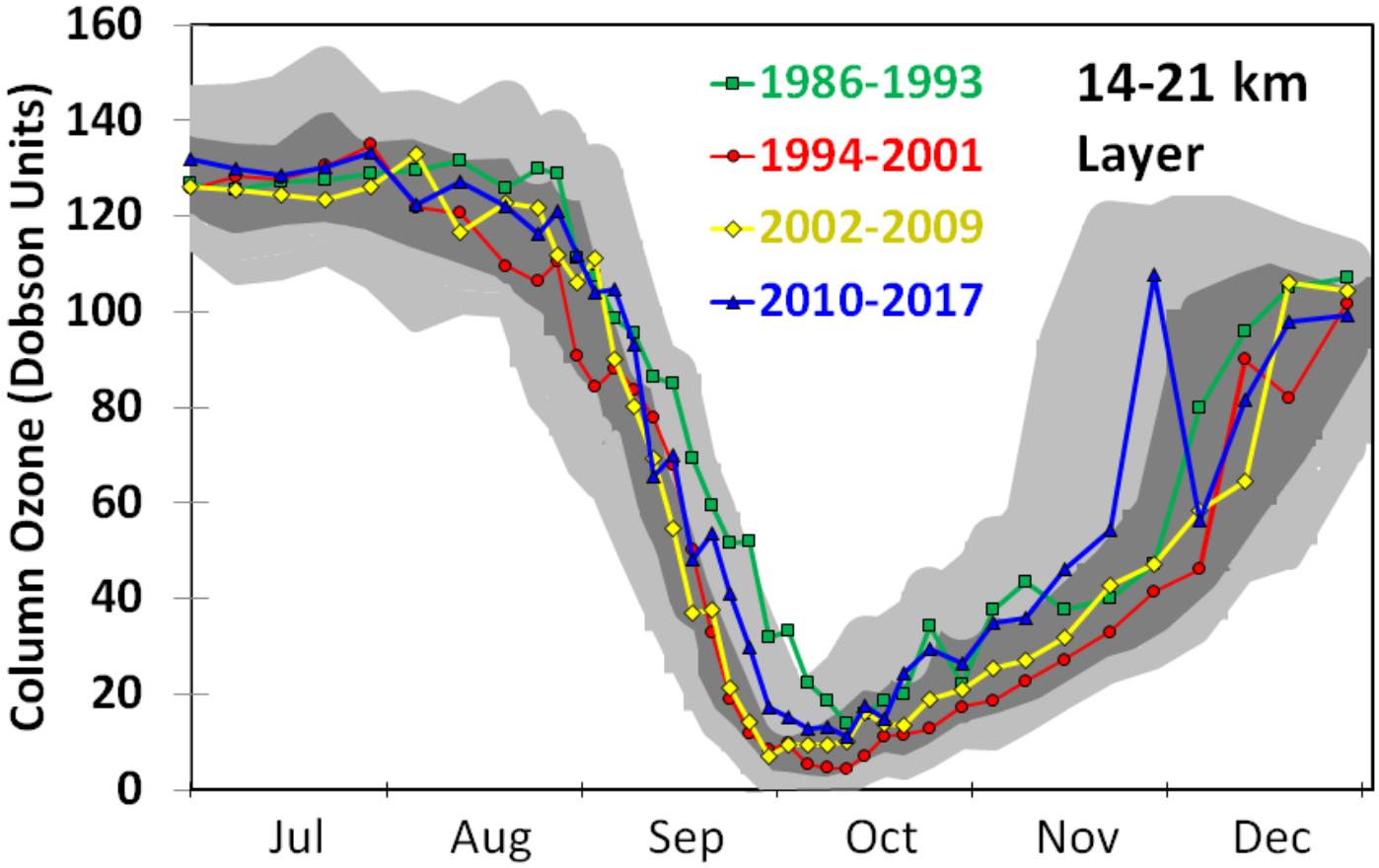




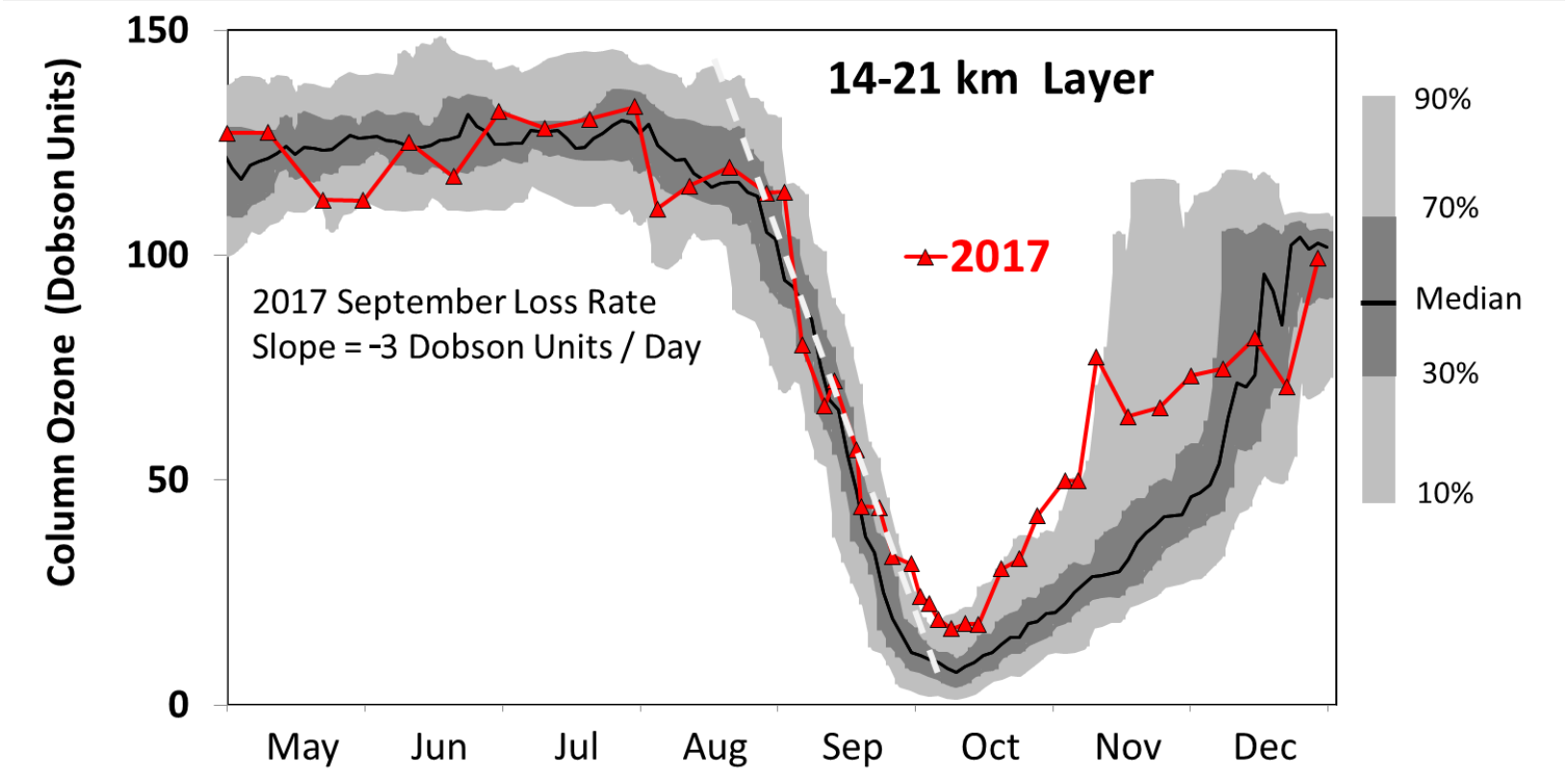
Ozonesondes





Stratospheric Ozone Recovery:

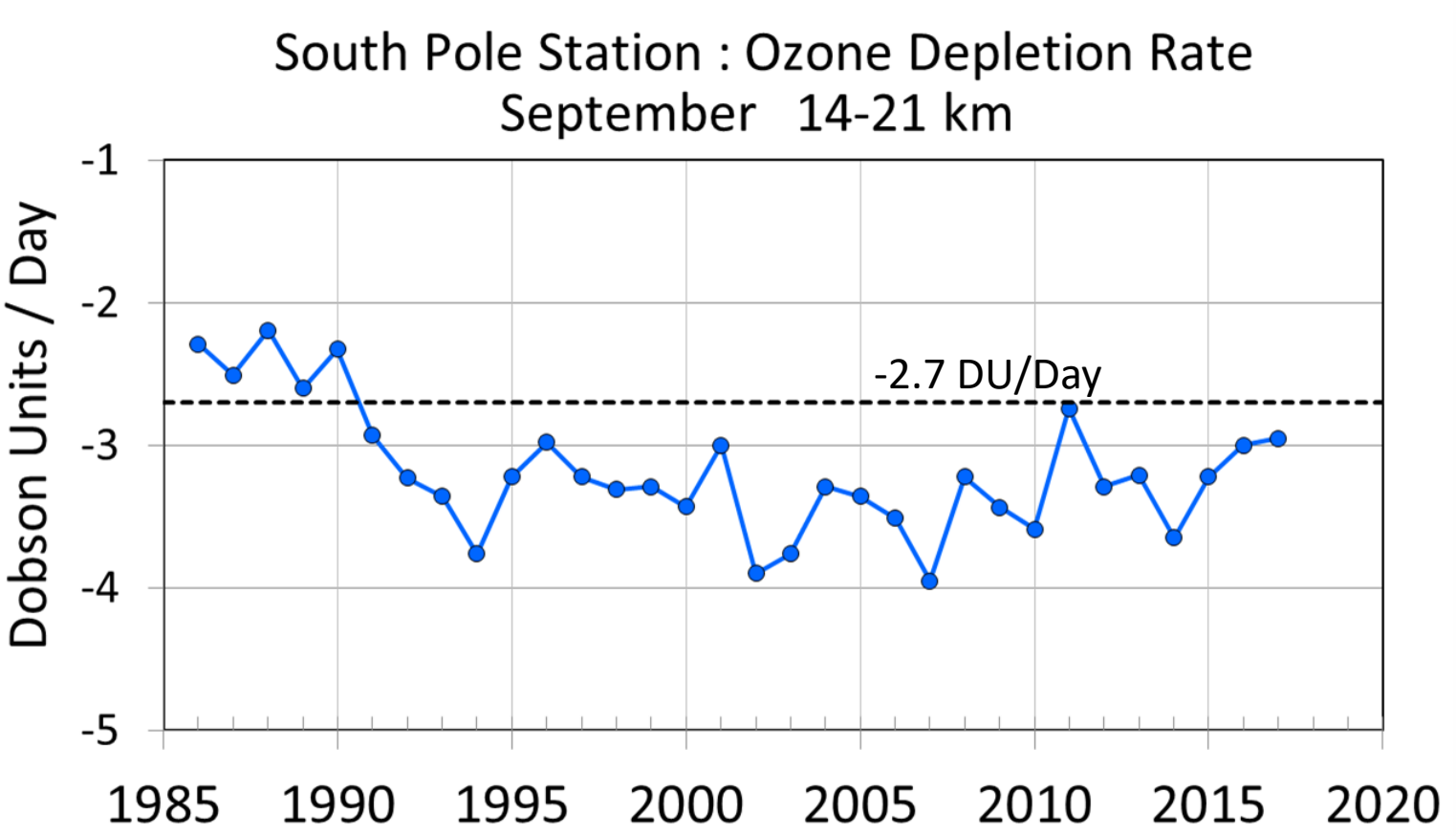
➢ September Ozone Depletion Rate in 14-21 km Layer



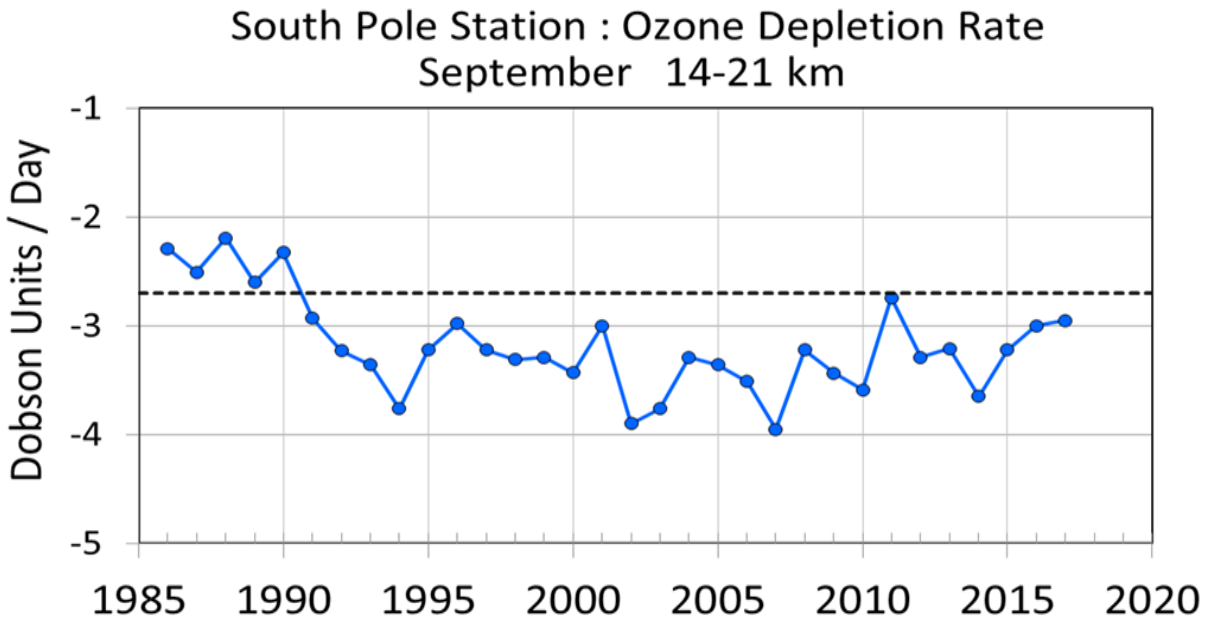
Stratospheric Ozone Recovery:

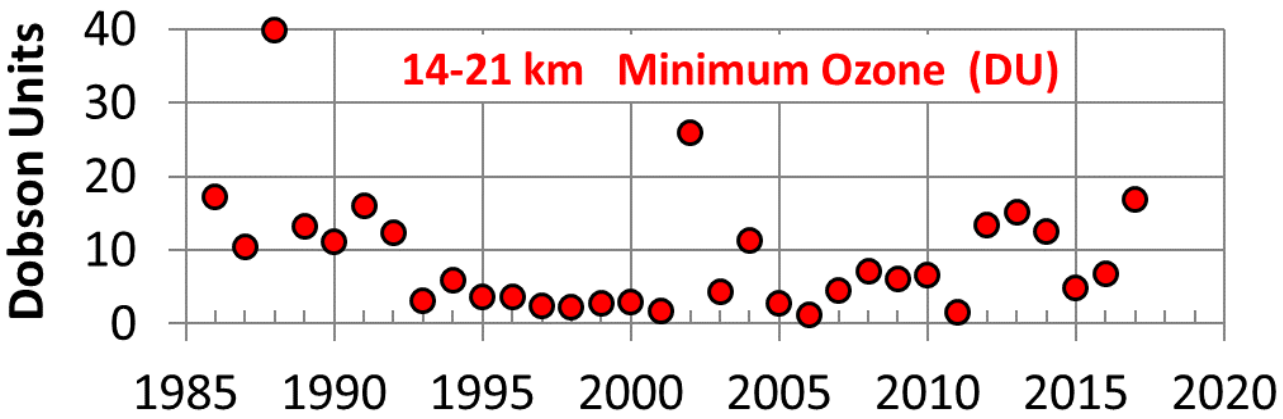
➢ September Ozone Depletion Rate in 14-21 km Layer

"September loss rate rising above the -2.7 DU/day at 14-21km can be used as another ozone recovery indicator". David Hofmann et al. 1997 JGR



Summary of 14-21 km Minimum Ozone 1986-2017 Ranking
Last 4 years in red text





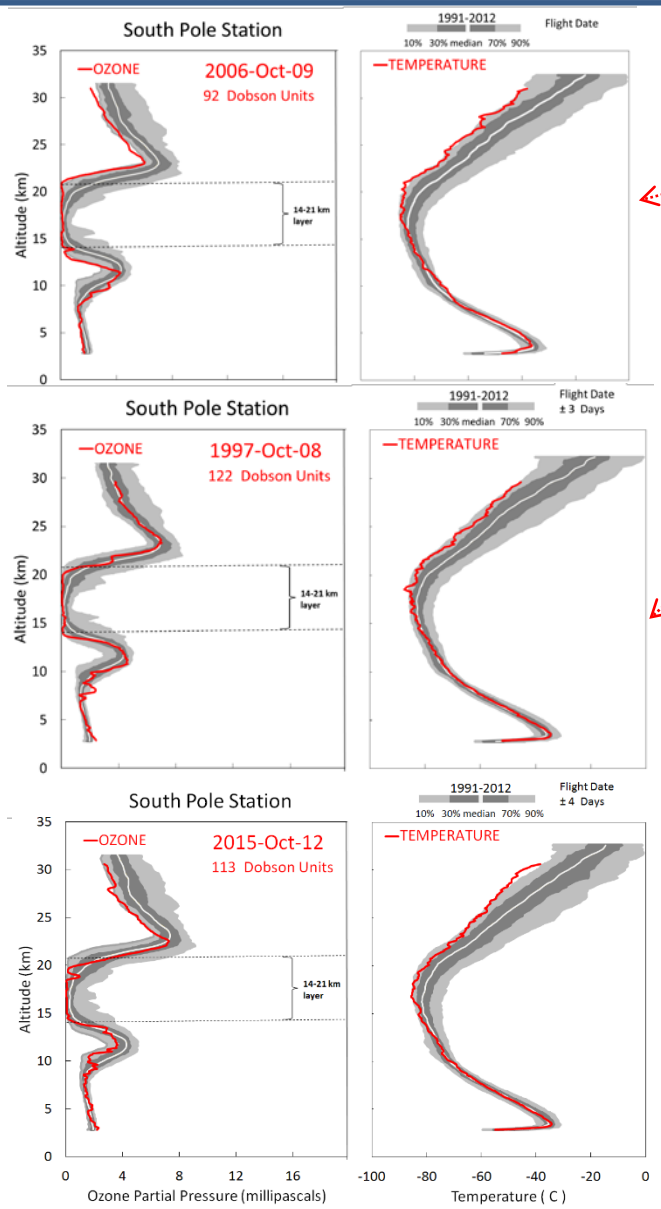
Min **14-21 KM** Column Lowest to Highest			
RANK	**MIN (DU)**	**YEAR**	**DATE**
1	1.2	2006	9-Oct
2	1.6	2011	9-Oct
3	1.8	2001	4-Oct
4	2.3	1998	5-Oct
5	2.4	1997	8-Oct
6	2.7	1999	29-Sep
7	2.7	2005	28-Sep
8	2.9	2000	11-Oct
9	3.1	1993	12-Oct
10	3.6	1996	8-Oct
11	3.7	1995	11-Oct
12	4.4	2003	26-Sep
13	4.5	2007	29-Sep
14	4.9	2015	12-Oct
15	5.9	1994	5-Oct
16	6.1	2009	29-Sep
17	6.6	2010	2-Oct
18	6.7	2016	5-Oct
19	7.2	2008	5-Oct
20	10.4	1987	9-Oct
21	11.1	1990	10-Oct
22	11.3	2004	16-Oct
23	12.4	1992	11-Oct
24	12.5	2014	8-Oct
25	13.3	1989	9-Oct
26	13.4	2012	5-Oct
27	15.2	2013	29-Sep
28	16.0	1991	15-Oct
29	16.9	2017	3-Oct
30	17.2	1986	7-Oct
31	25.9	2002	8-Oct
32	39.9	1988	10-Oct

SUMMARY of 14-21 km Minimum Ozone 1986-2017 Ranking compare similar cold, stable vortex conditions

2006

1997

2015



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29	16.9	2017	3-Oct
30	17.2	1986	7-Oct
31	25.9	2002	8-Oct
32	39.9	1988	10-Oct

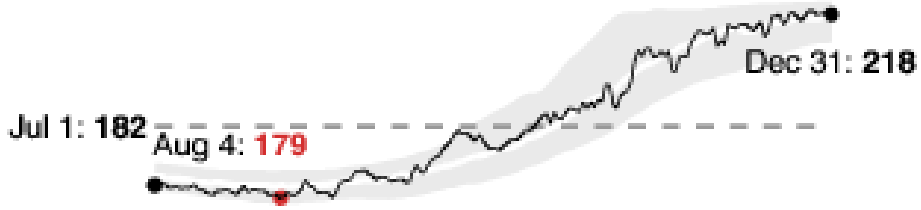
SUMMARY

- 2017: Weak ozone depletion due to early stratosphere warming in mid September and a weak vortex.
- 1994-2001: the most severe ozone depletion years which was just prior to the peak in the Antarctic Effective Stratospheric Chlorine peak /ozone depleting gas index (ODGI).
- 2002-2009 and 2010-2017: Dobson& Ozonesondes show upward trends as ODGI index declines.
- 14-21 km September depletion rate is also on upward trend in the last 10 years.
- Ozone is trending upward, but it will be interesting to see if severe ozone depletion (broad zero ozone layer) returns with a very cold, stable vortex similar to 1997, 2006, 2015.

2017 Season

Ozone hole area (millions of km^2)

Minimum ozone (Dobson Units)



Minimum stratospheric temperature (K)