A Cohesive SBUV(/2) Ozone Profile Dataset from 1978 to 2009

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Outline

- Description of data used and obstacles to creating a long term data set
- Description of output product
- Methodology used
- Examples of unadjusted and adjusted
- Comparisons with SAGE II and NDACC Lidar
- Future work
- Advantages and limitations

- Additional information about Reanalyses temperatures and ozone

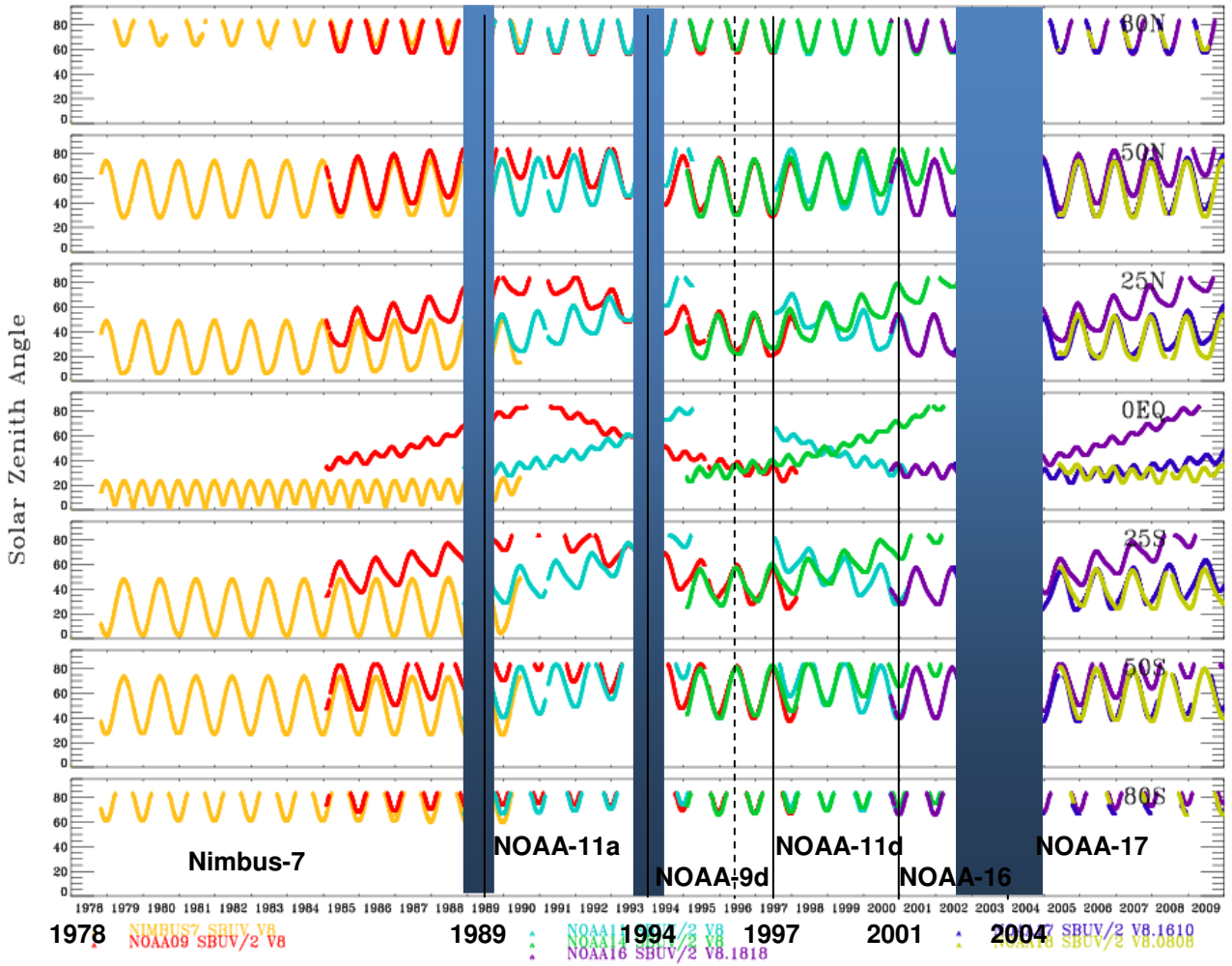
SBUV(/2) Data Description

- Solar Backscatter Ultraviolet spectrometer
- Nadir looking
- 90 obs per orbit, 14 orbits per day, sunlit side of earth
- 12 wavelengths: 252 nm – 340 nm
- Generate a TOMS like total ozone and 11 layers
  - Converted to 15 pressure mixing ratios
- Flown on Nimbus-7, NOAA-9, 11, 14, 16, 17, 18, and 19
- Heritage continued with OMPS-Mapper on NPP,J1 and J3

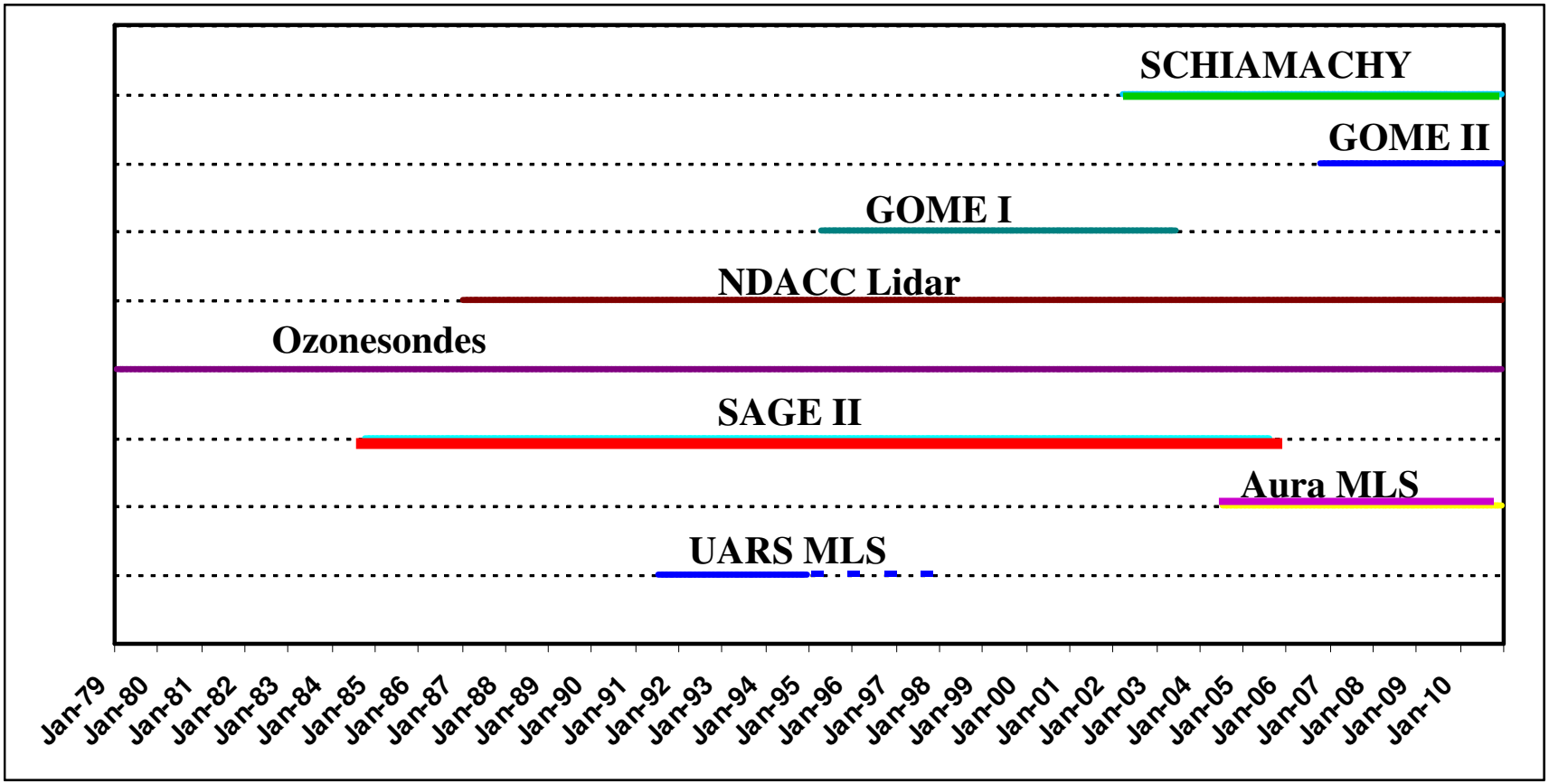
Obstacles to generating a long-term SBUV(/2) dataset

- NOAA satellites precess
- NOAA-9 put itself in safe mode May 1996. When data resumed on June 18 its characterization was changed.
- NOAA-14 noise render its profile data unusable
- Short overlap period between N11 and N16

SZA, Overlaps, Transition Times of SBUV(/2) Instruments



Time Spans of Other Ozone Profile Instruments

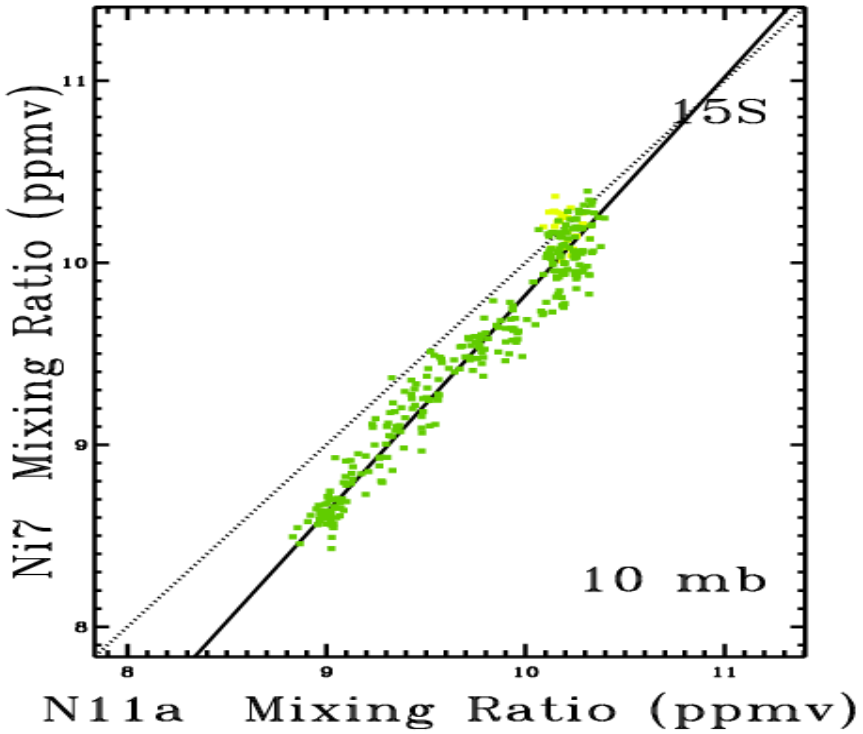


Output Product

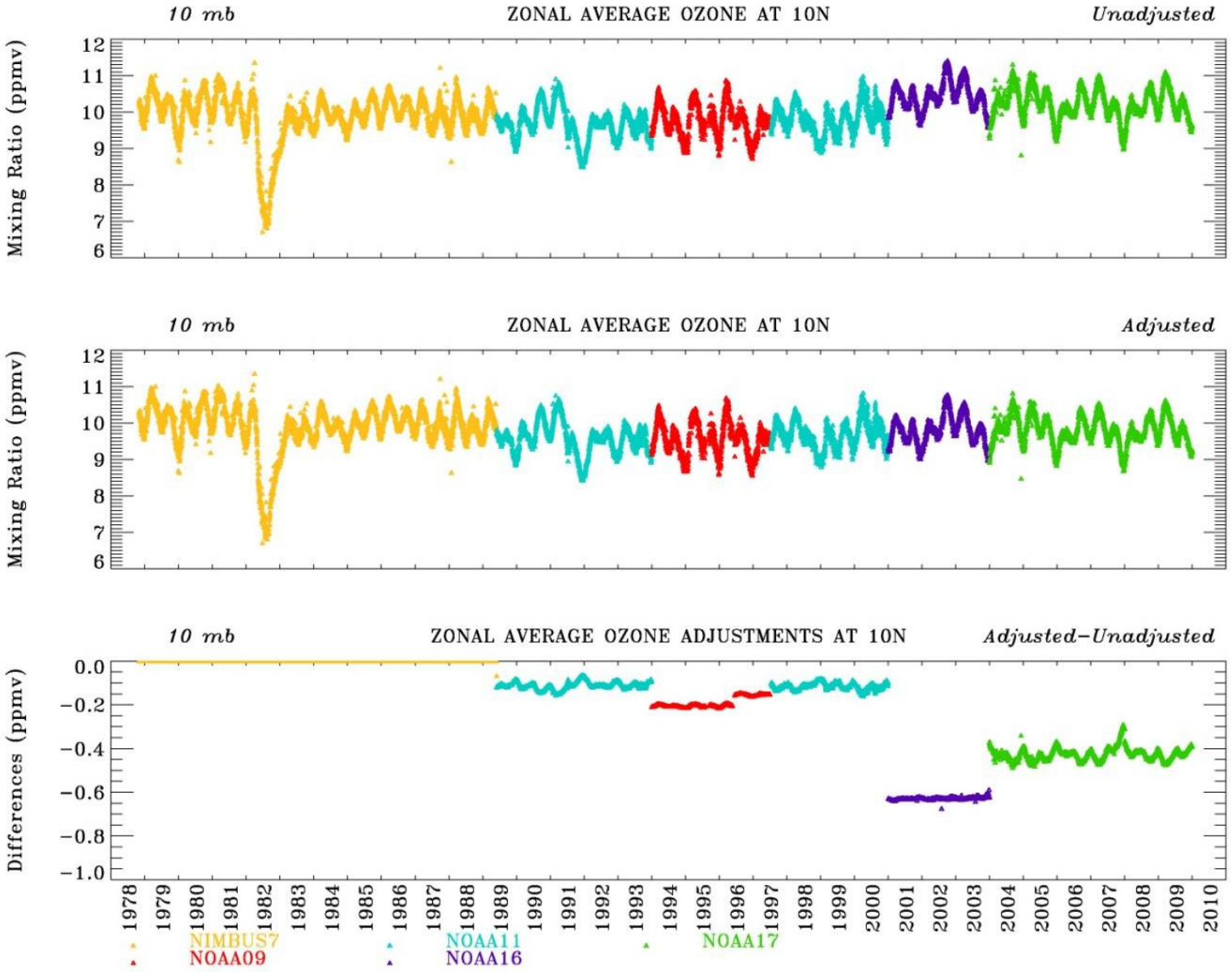
- A SBUV and SBUV/2 only data set
- Combines data from
  - Nimbus-7, NOAA-9, NOAA-11, NOAA- 16 and NOAA-17
- Extends from 1978 to 2009 (soon to add 2010)
  - Will add NOAA-18
- Daily zonal averages centered at every 5° from 80S to 80N
  - Also averaged into Monthly means
- Two products:
  - mixing ratio on pressure level and
  - layer data
- **Where to get the dataset (*final version #1*):**
  - **http://www.cpc.ncep.noaa.gov/products/stratosphere/sbuvto**

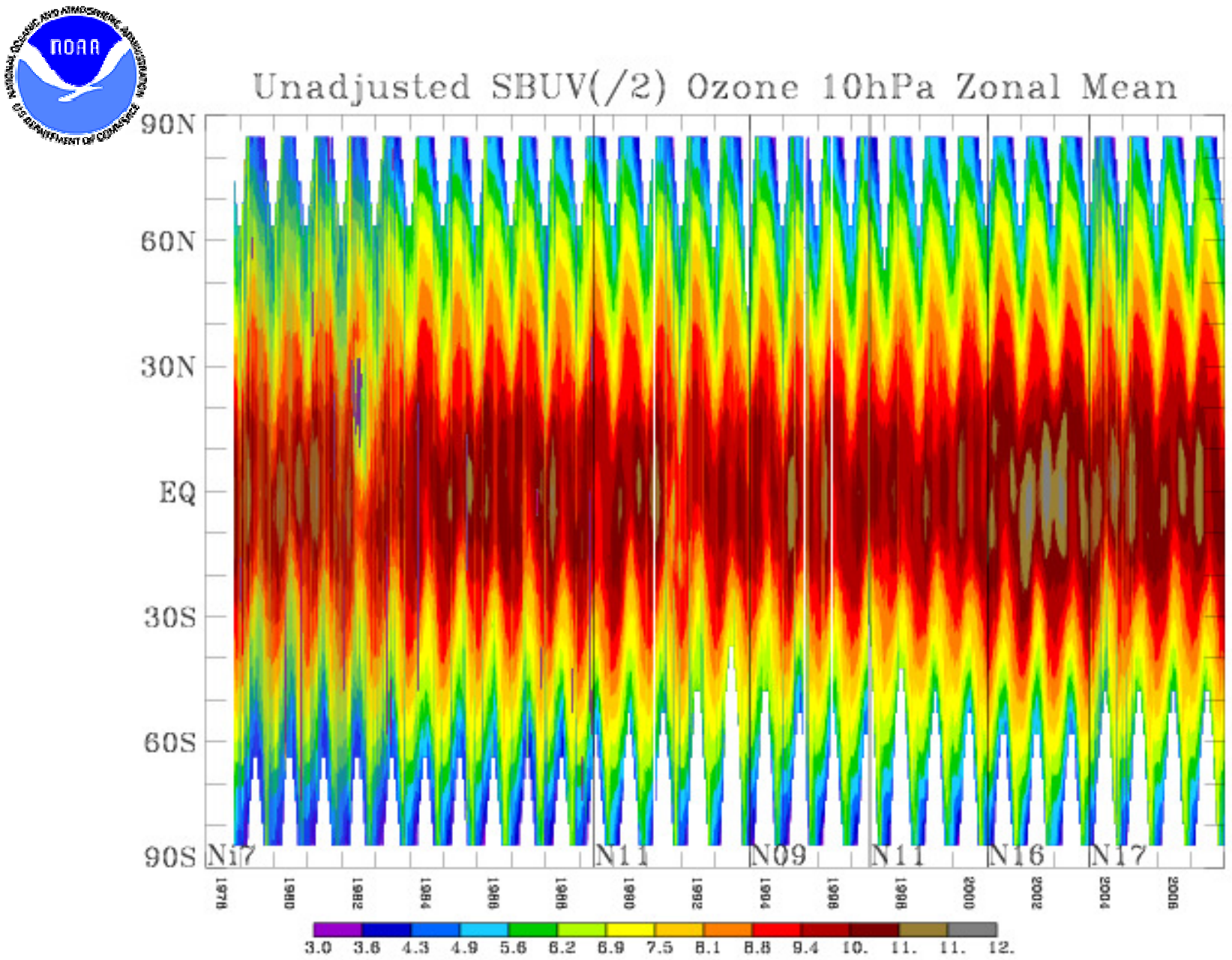
Methodology

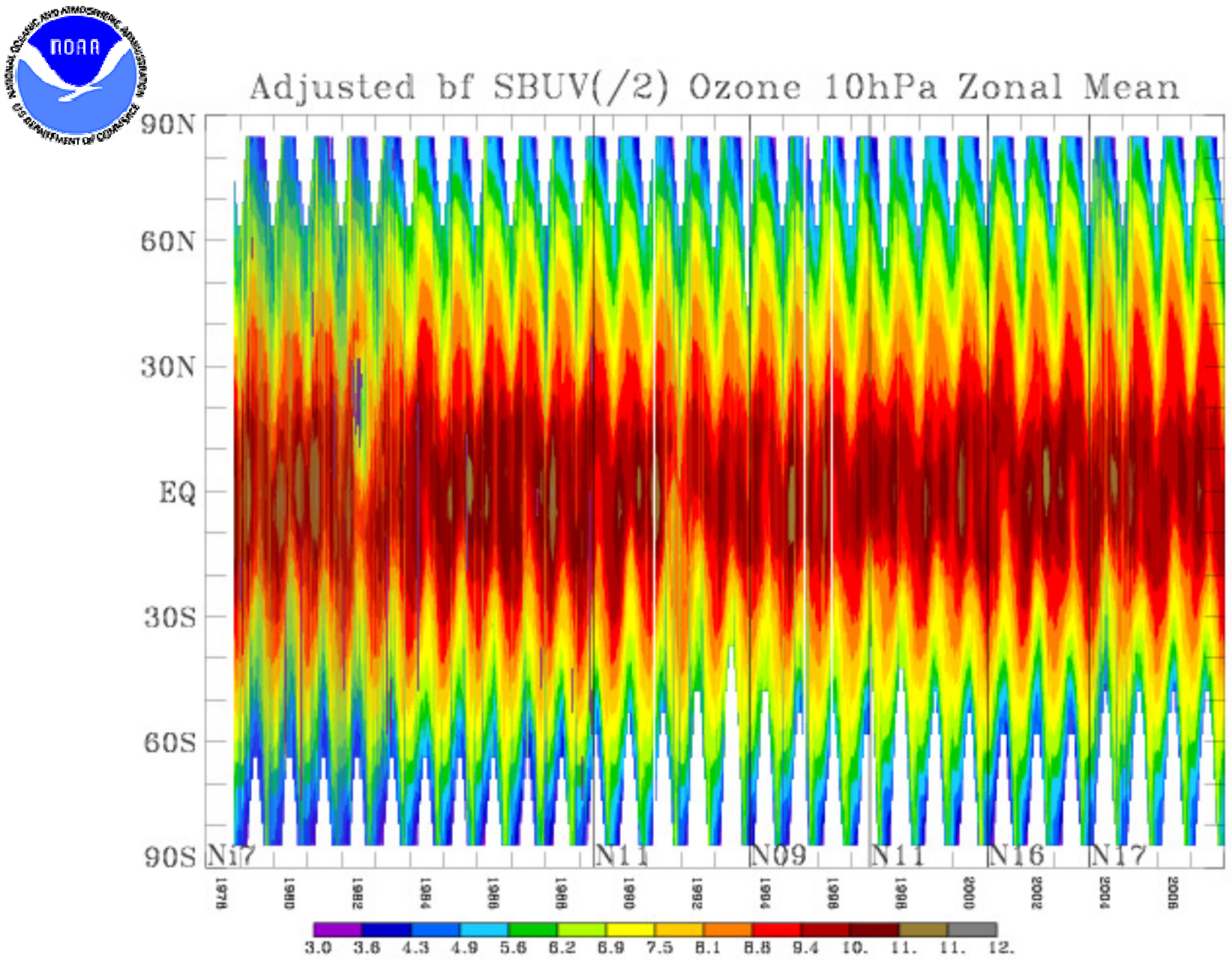
- For each zone and pressure level/layer
- Overlap periods are defined
  - Preferably 1-2 years
- Correlation, slope and bias are generated for each overlap period
- Effectively adjusts bias and annual amplitude
- When correlation coefficient is below 0.9 a bias only adjustment is made

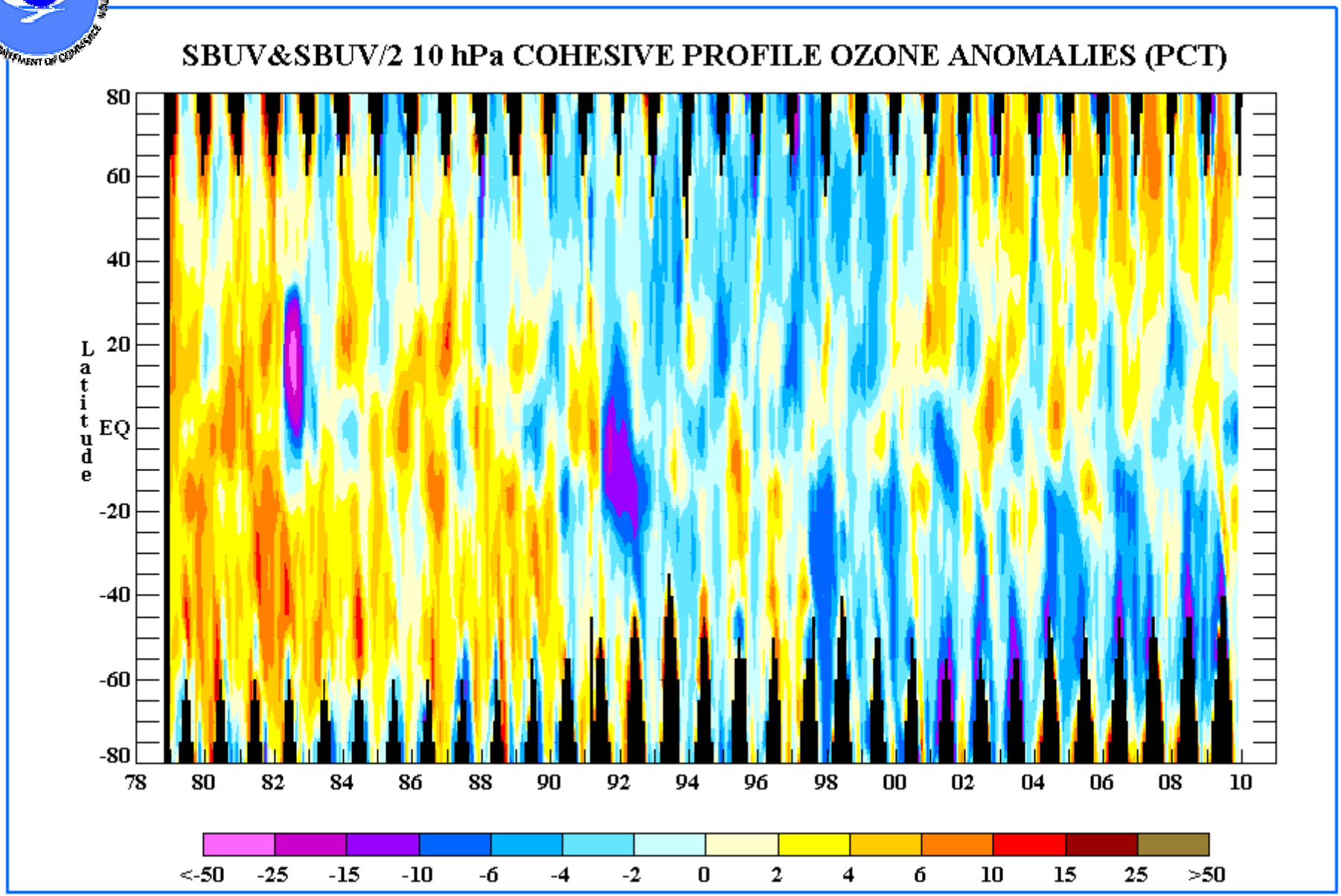


Examples of unadjusted to adjusted


10 mb
ZONAL AVERAGE OZONE AT 10N
Unadjusted
Mixing Ratio (ppmv)
12
11
10
9
8
7
6
10 mb
ZONAL AVERAGE OZONE AT 10N
Adjusted
Mixing Ratio (ppmv)
12
11
10
9
8
7
6
10 mb
ZONAL AVERAGE OZONE ADJUSTMENTS AT 10N
Adjusted−Unadjusted
Differences (ppmv)
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
1978
1979
1980
1981
1982
1983
1984
1985
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
NIMBUS7
NOAA09
NOAA11
NOAA16
NOAA17


Unadjusted SBUV(/2) Ozone 10hPa Zonal Mean
90N
60N
30N
EQ
30S
60S
90S
N17
N11
N09
N11
N16
N17
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
3.0 3.6 4.3 4.9 5.6 6.2 6.9 7.5 8.1 8.8 9.4 10. 11. 11. 12.


Adjusted bf SBUV(/2) Ozone 10hPa Zonal Mean
90N
60N
30N
EQ
30S
60S
90S
N17
N11
N09
N11
N16
N17
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
3.0 3.6 4.3 4.9 5.6 6.2 6.9 7.5 8.1 8.8 9.4 10. 11. 11. 12.


SBUV&SBUV/2 10 hPa COHESIVE PROFILE OZONE ANOMALIES (PCT)
Latitude
80
60
40
20
EQ
-20
-40
-60
-80
78
80
82
84
86
88
90
92
94
96
98
00
02
04
06
08
10
<-50
-25
-15
-10
-6
-4
-2
0
2
4
6
10
15
25
>50

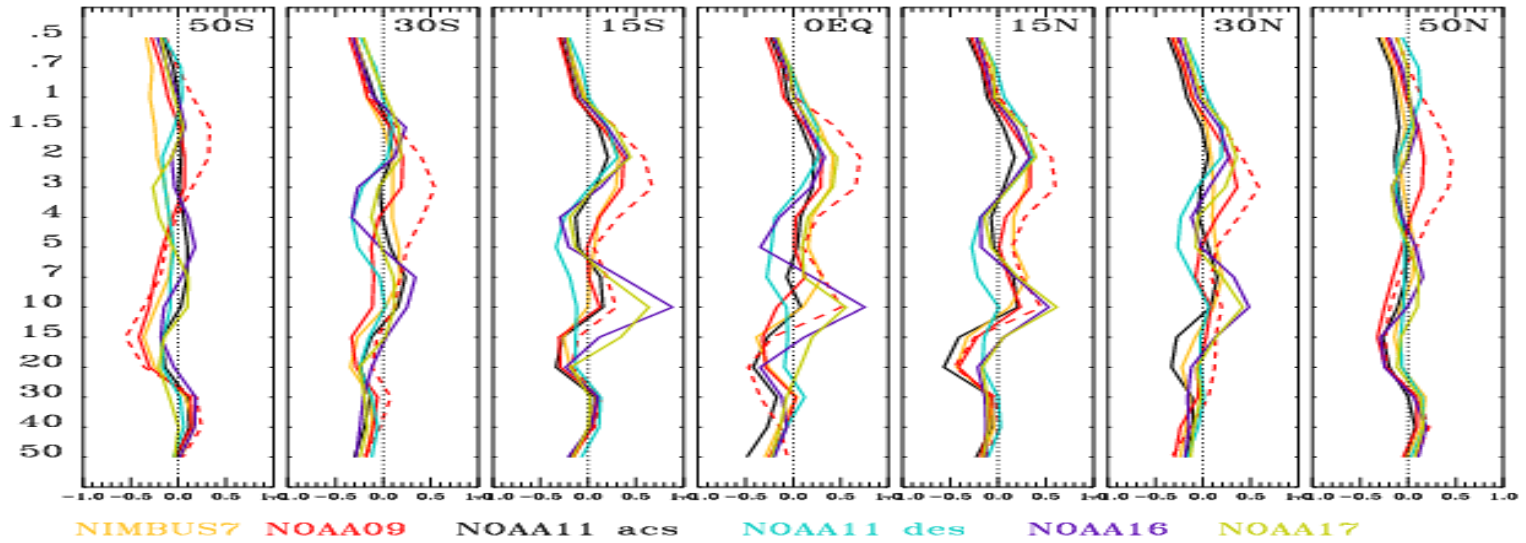
Comparisons

- **Comparison to SAGE II**
- **Comparison to Lidar (in the works)**
- **Hockey Stick Trends**

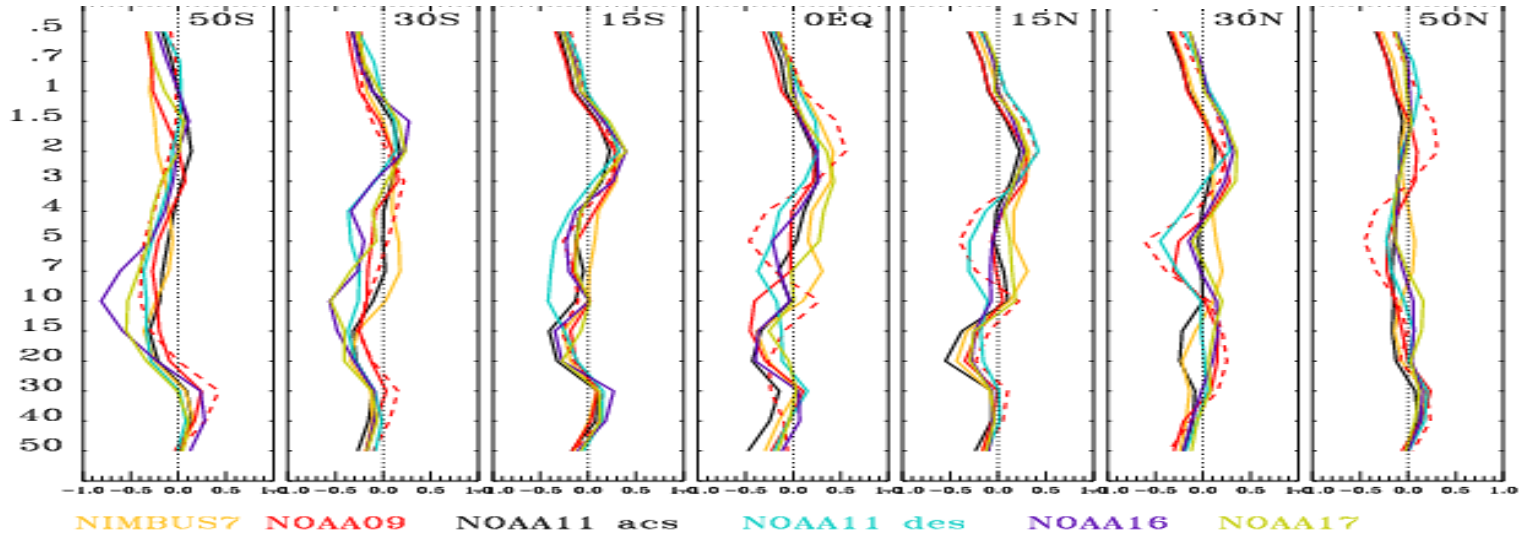
Comparisons to SAGE II

Adjusted biases more consistent from satellite to satellite.

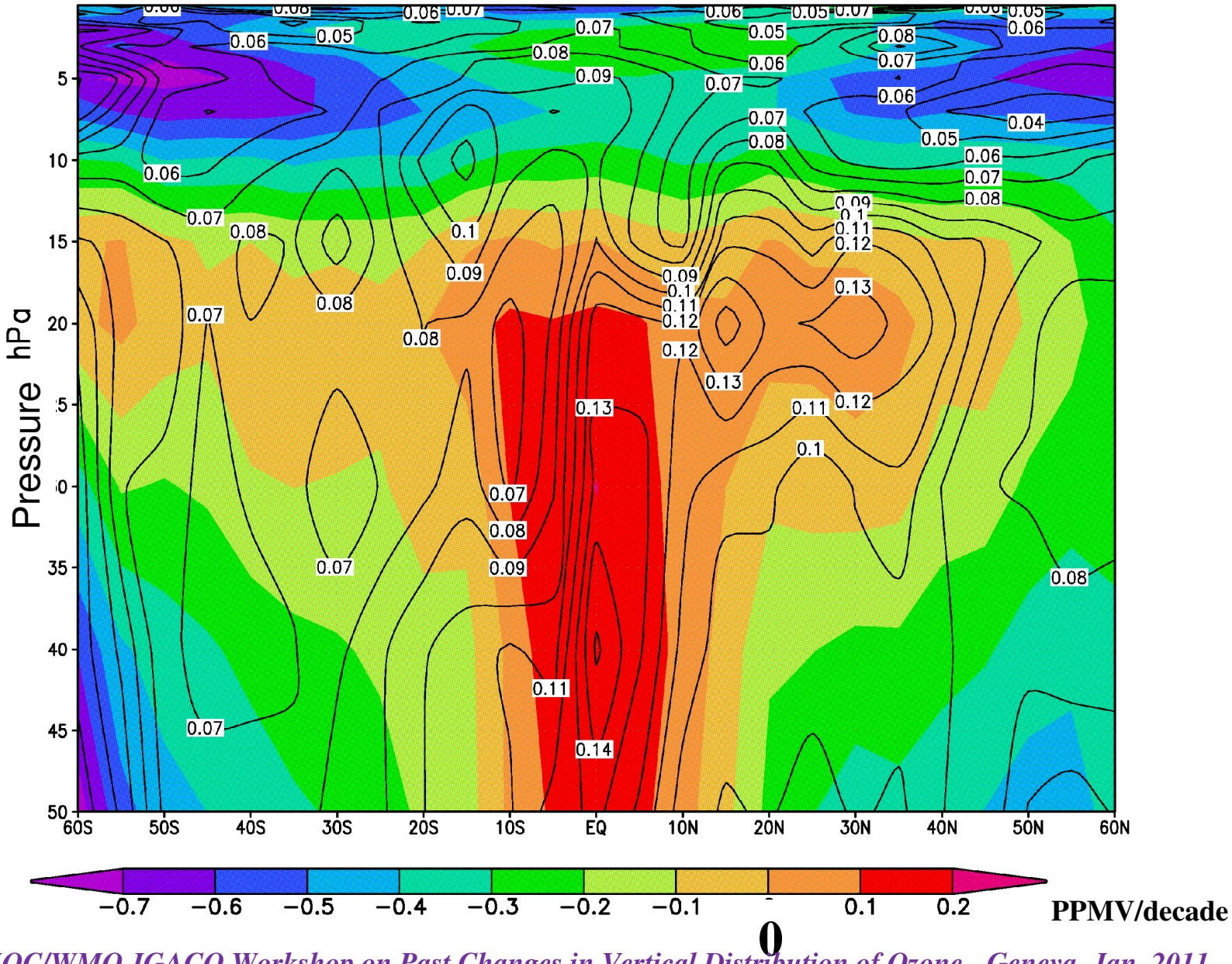
SBUV Unadjusted



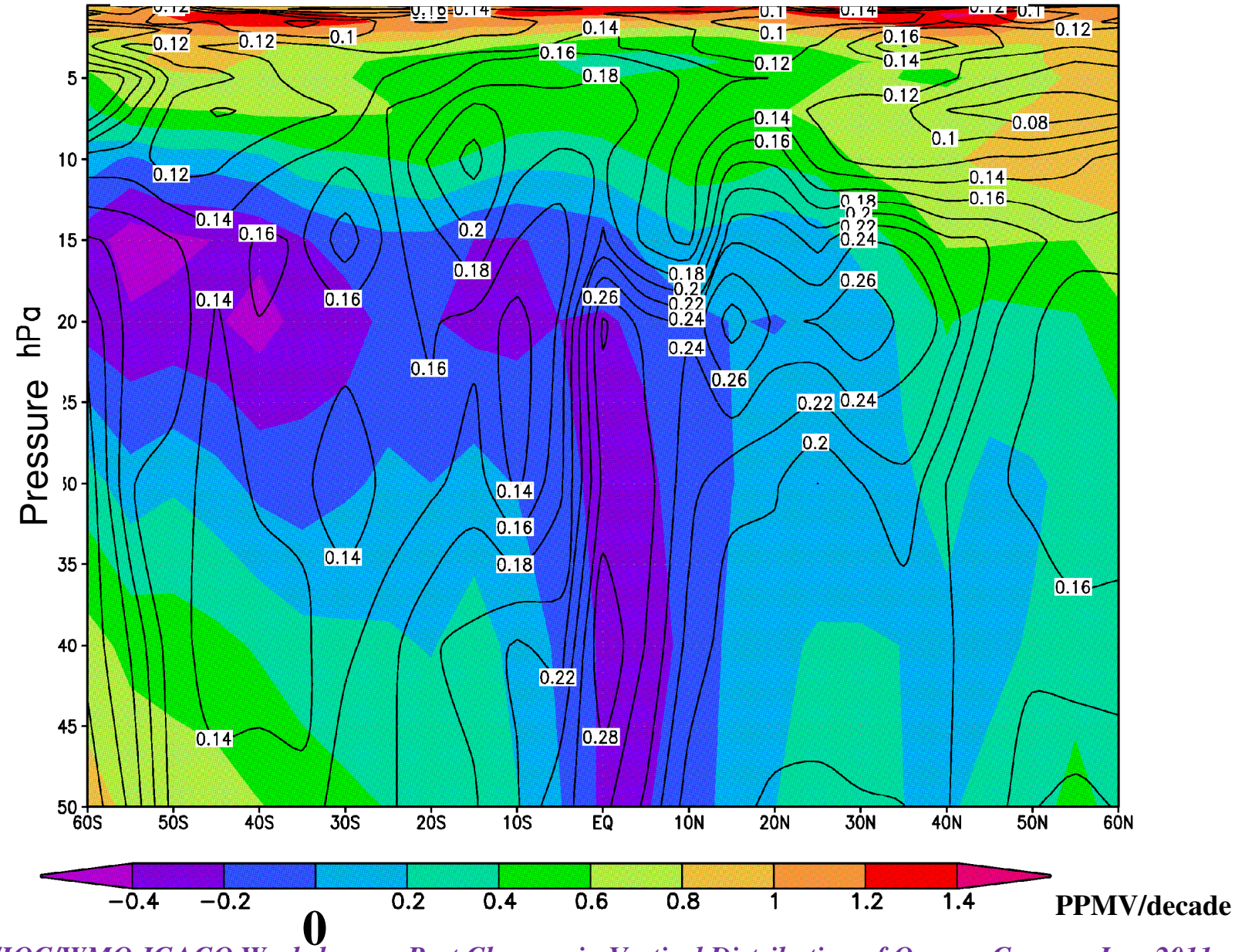
SBUV Adjusted



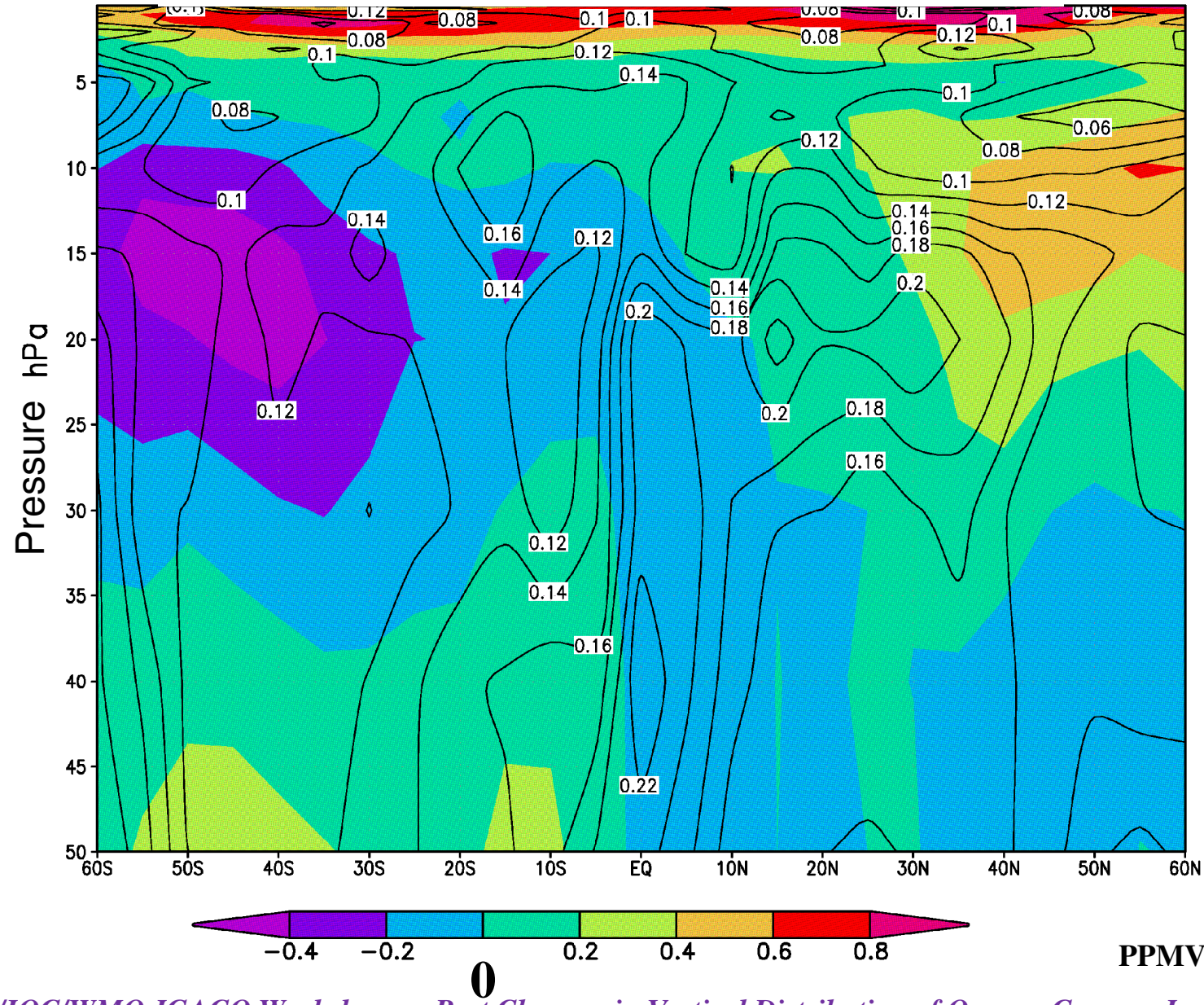
Trend and Standard Error (1979-1995)



Trend Change and Standard Error (1995)



Trend and Standard Error (1996-2009)



Advantages and Limitations

Re: PK's Good,Bad,Ugly

- Advantages:
  - Long data set
  - Viable at high SZA
  - NOAA-NASA partnership

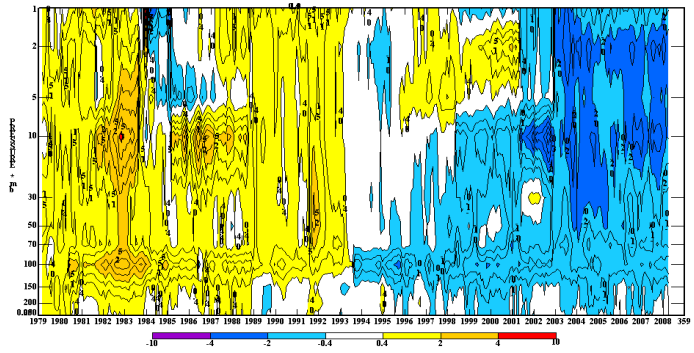
- Limitations:
  - Nadir viewing
  - Broad averaging kernals (i.e. thick layers)
    - Can not discern downward propagation of QBO
  - Precession of NOAA satellites

Reanalyses: Temperatures..Ozone..

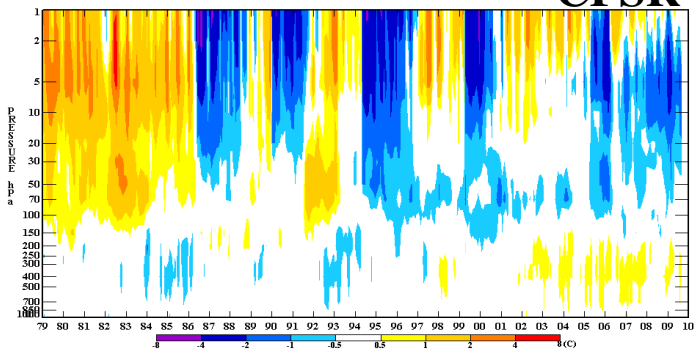
Reanalyses are not perfect

Global Temperature Anomalies

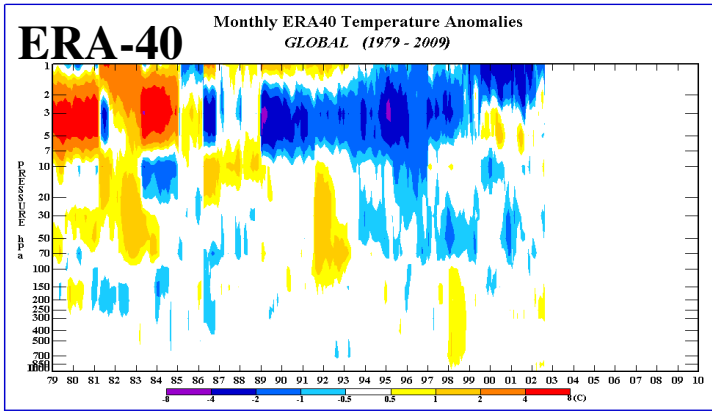
CPC



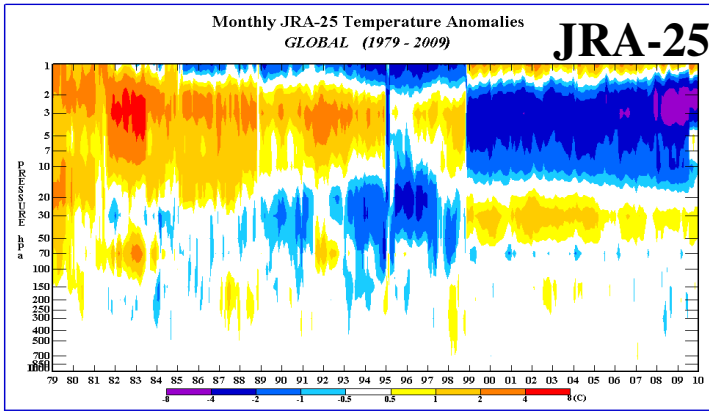
CFSR



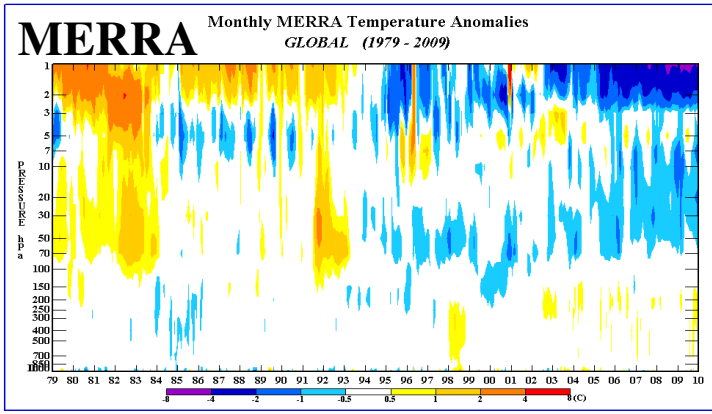
ERA-40



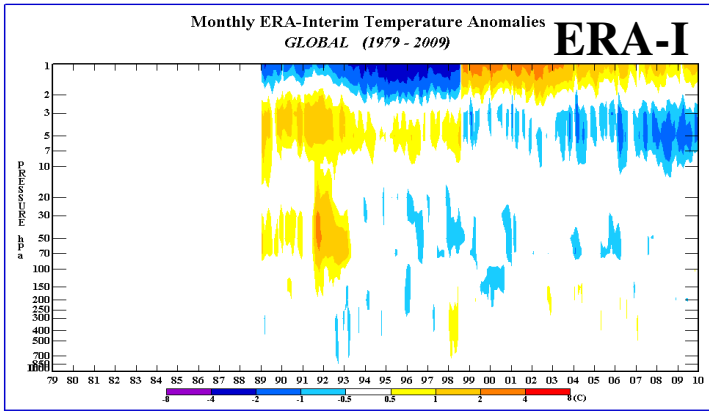
JRA-25



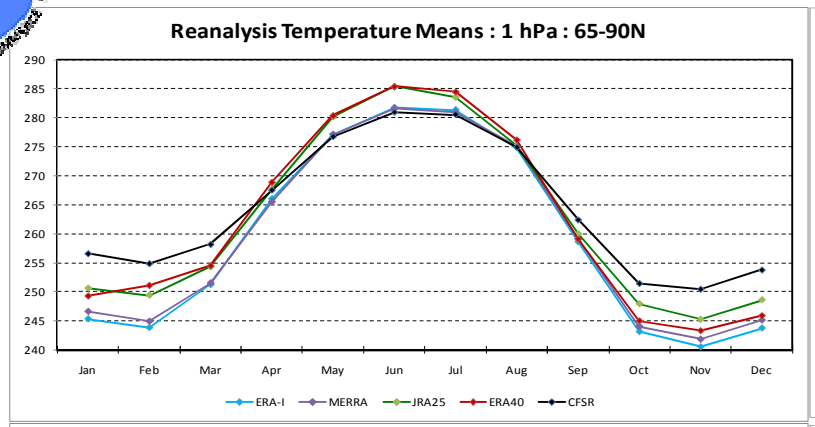
MERRA

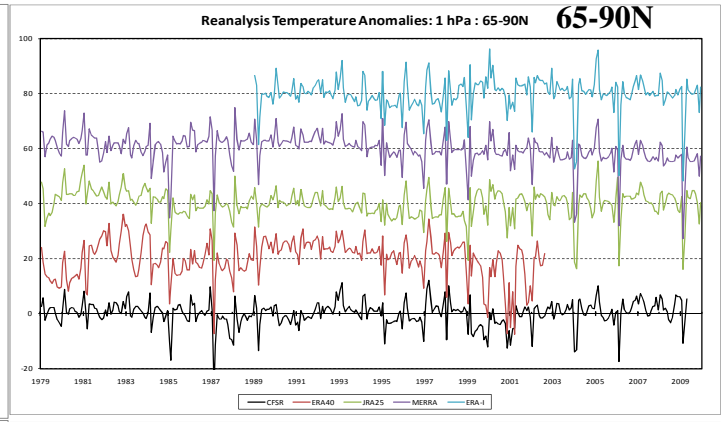


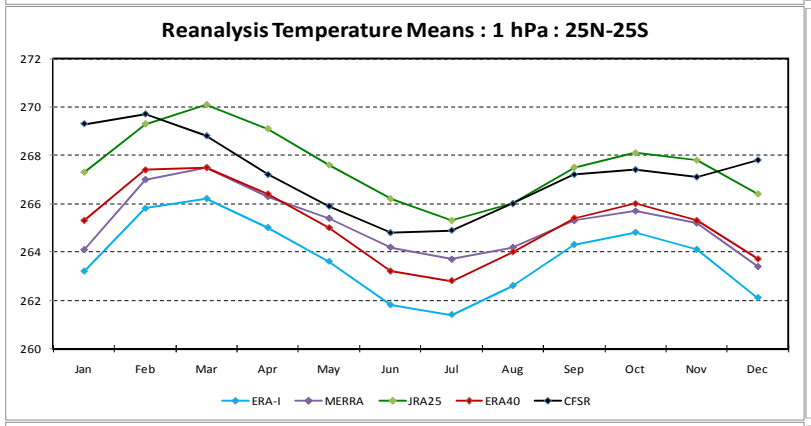
ERA-I

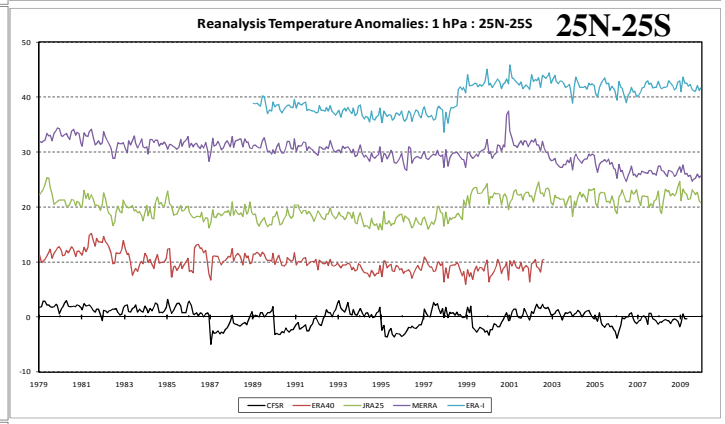


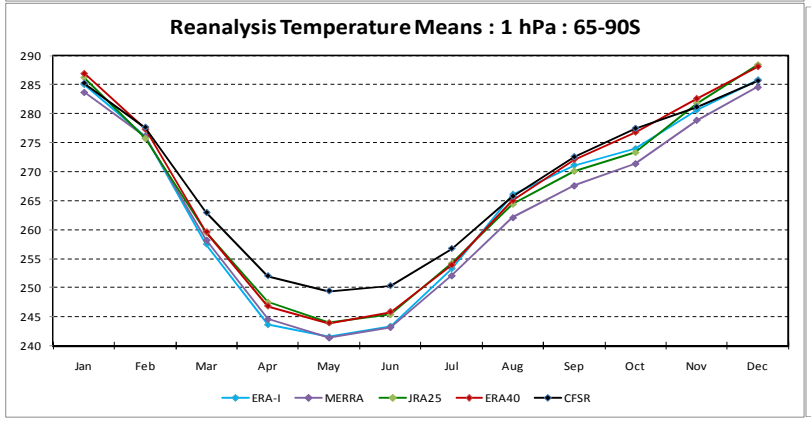
1 hPa Temperatures at Poles and Tropics: Means & Anomalies

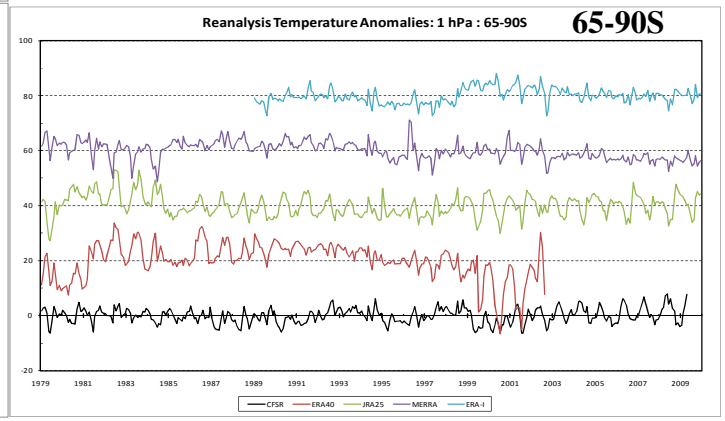












ERA-I

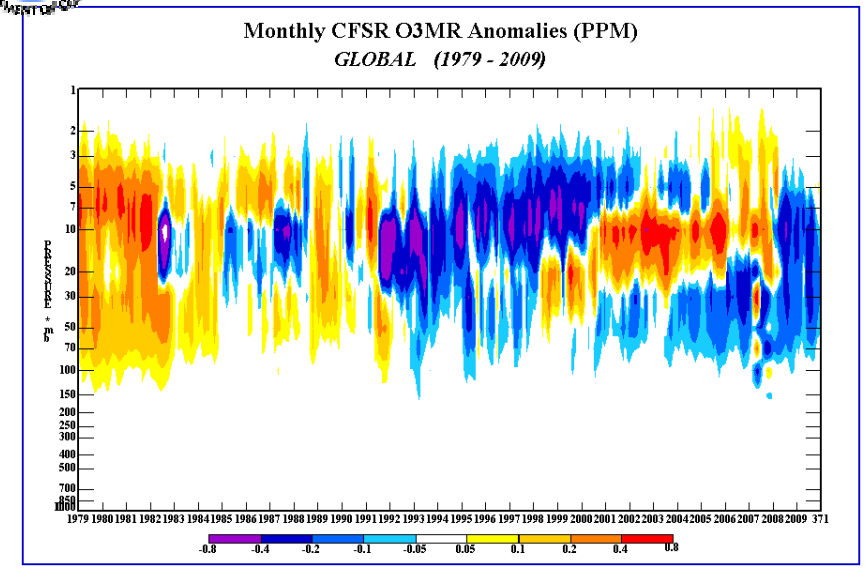
MERRA

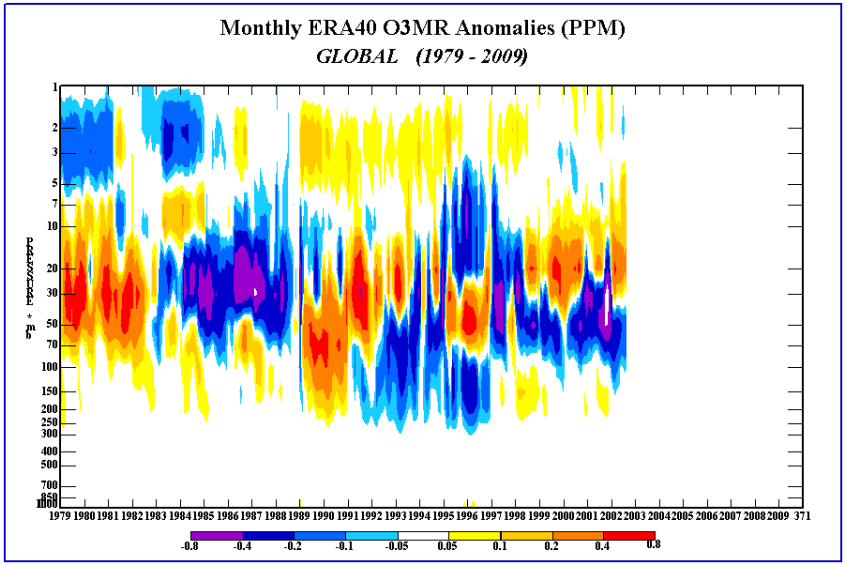
JRA-25

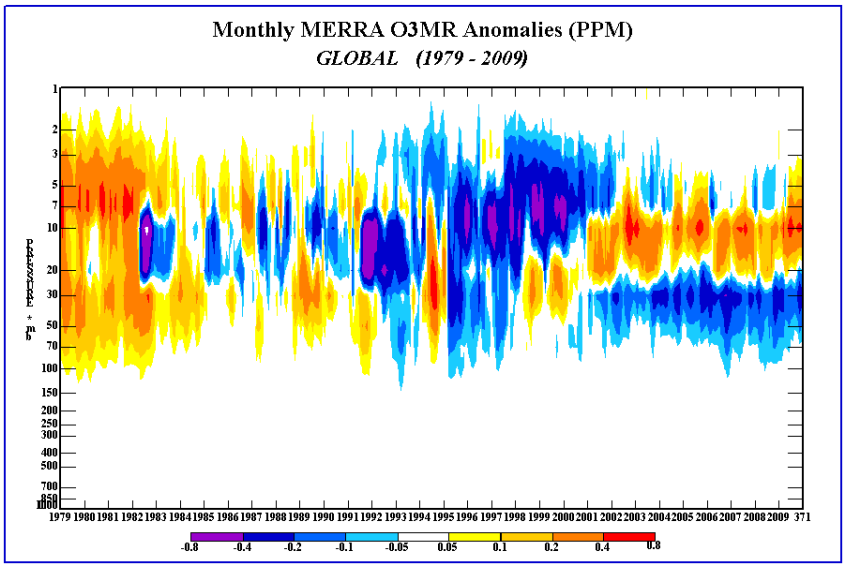
ERA-40

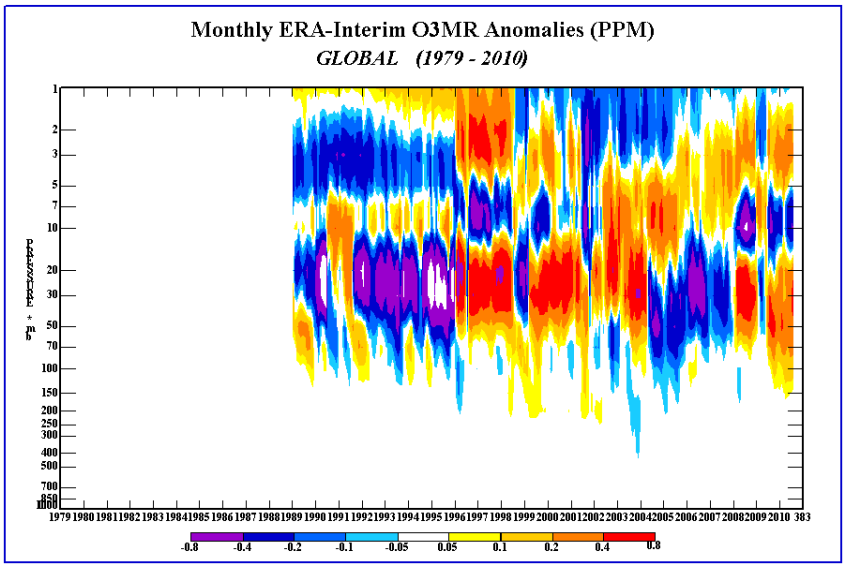
CFSR

Global Ozone Anomalies





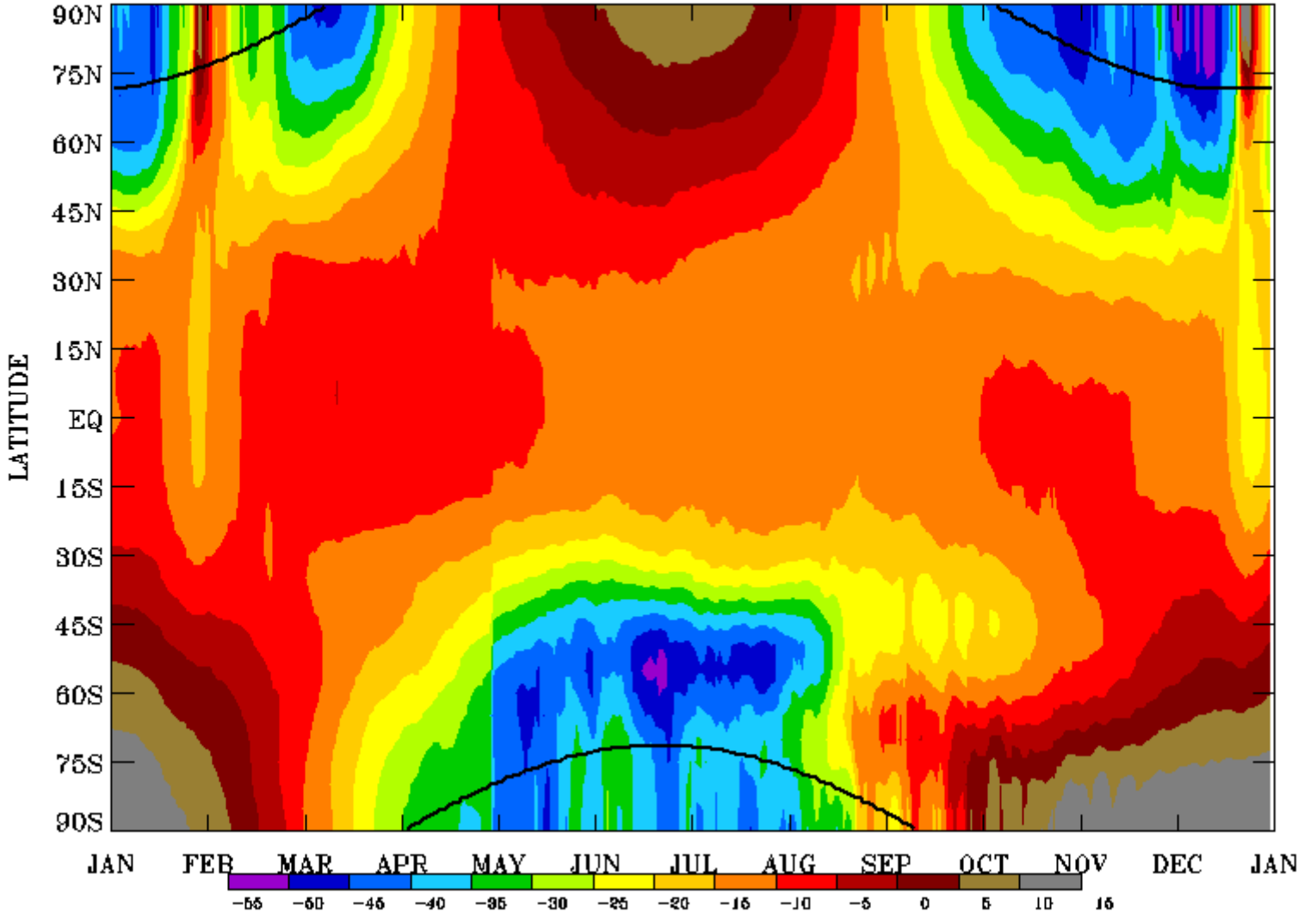




Fini

ZONAL MEAN TEMPERATURES at 02 hPa

Polar Night Occurs Poleward of Black Lines 2001 *Updated through Dec 30, 2001*



Future Work

Data availability

- Soon to be available on NOAA/CPC ftp sites

Total Ozone comparisons

- Integrate the layer dataset and compare to the NOAA Cohesive Total Ozone dataset for consistency

Living dataset

- Will be extended forward with additions of NOAA-18, 19 and OMPS

Model comparisons

- Use the "Hockey Stick" method to derive depletion and "recovery" trends

Understanding Diurnal issues and the effects on the internal trends of satellites especially NOAA 9 and NOAA 11

- Use NDACC microwave data to model diurnal characteristics of ozone
- Correct behavior as necessary of trends in satellite data

Input Data

Satellite	Data Source	Version	Available Data	Record Length in Words	Flag
Nimbus 7	NOAA/NESDIS	8 *	10/31/78 – 6/21/90	500	0
NOAA 9	NOAA/NESDIS	8.0403	2/2/85 – 12/31/90	500	100
NOAA 9	NOAA/NESDIS	8.0403	1/1/91 – 2/19/98	500	110
NOAA 11	NOAA/NESDIS	8.1506	12/01/88 – 3/31/95	500	0
NOAA 11	NOAA/NESDIS	8.1506	7/15/97 – 3/27/01	500	10 or 110
NOAA 14	NOAA/NESDIS	8 **	2/5/95 – 8/31/04	500	0 or 3
NOAA 16	NOAA/NESDIS	8.1822	10/3/00 –	2000	0 or 100
NOAA 17	NOAA/NESDIS	8.1619	7/11/02 –	2000	10
NOAA 18	NOAA/NESDIS	8.2014	6/4/05 –	2000	0

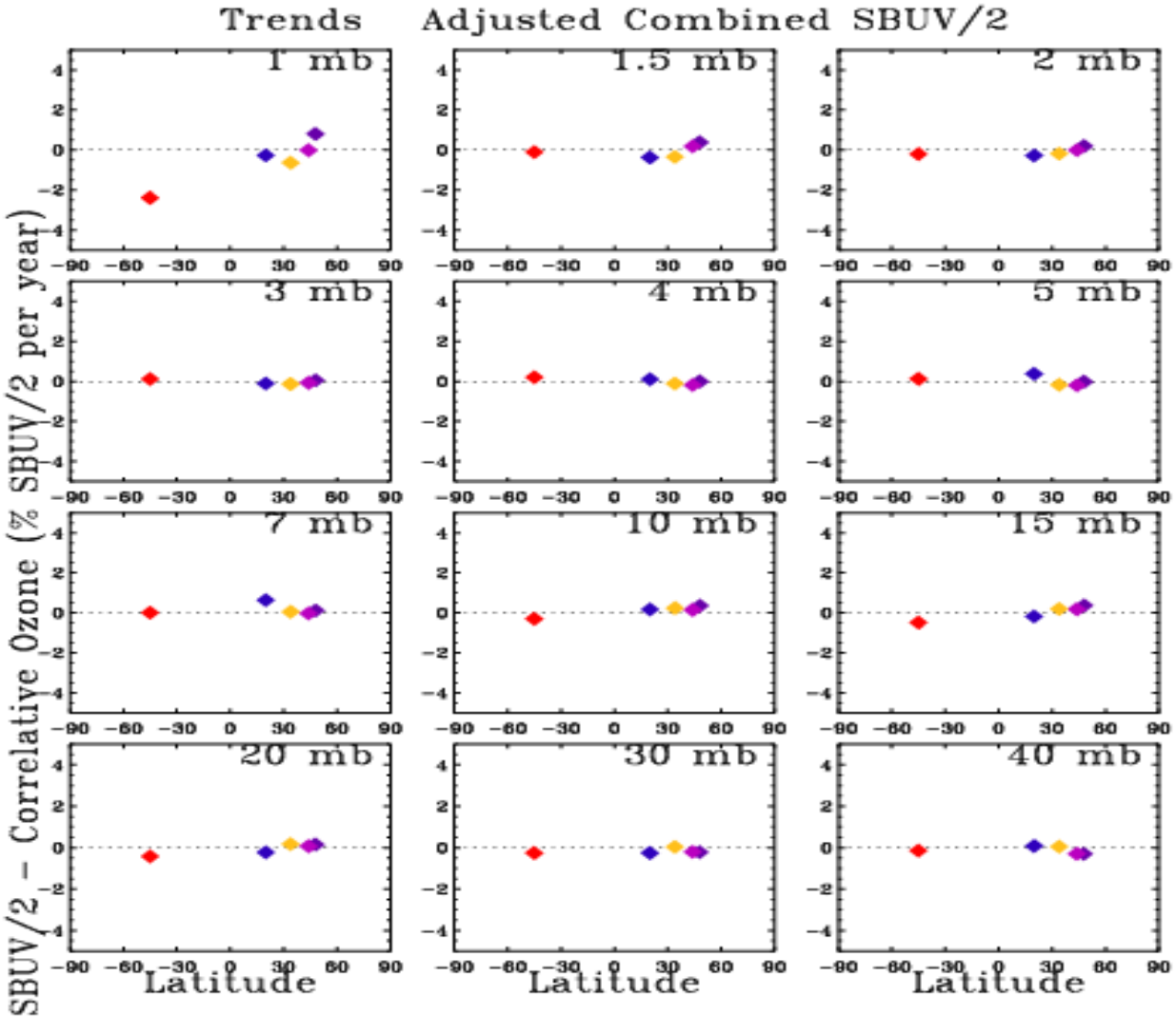
Overlaps and Adjustment Method

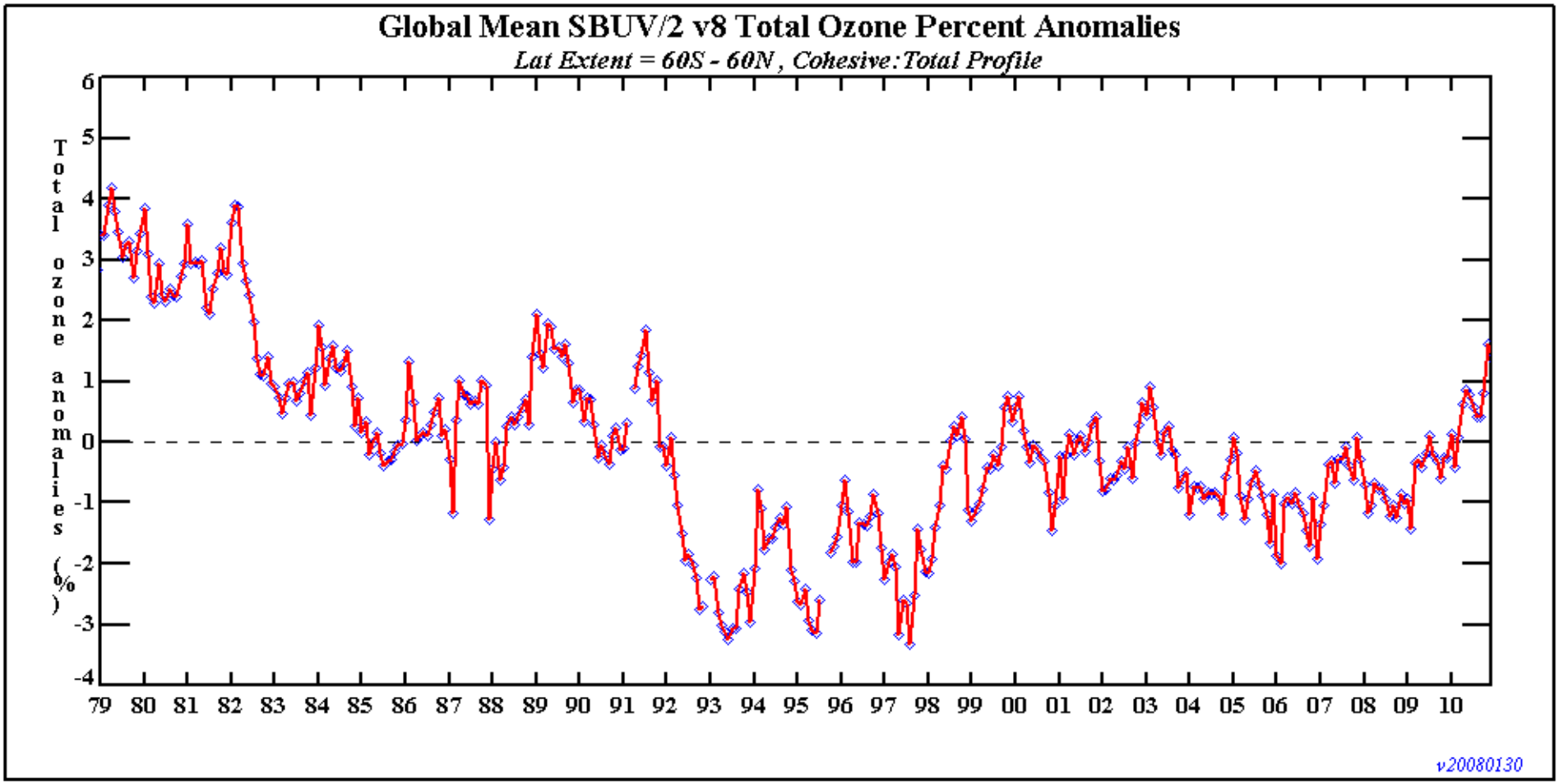
Transition	Satellite 1	Satellite 2	Overlap Dates	Overlap method
1	Nimbus 7	NOAA 11a	12/1/88 – 10/31/89	Slope and Intercept of Correlation
2	NOAA 11a	NOAA 09d	7/1/93 – 6/31/94	Slope and Intercept of Correlation
3a	NOAA 14	NOAA 11d	Various	Bias *
3b	NOAA 09d	NOAA 14	Various	Bias *
4	NOAA 11d	NOAA 16	10/3/00 – 3/27/01	Bias
5	NOAA 16	NOAA 17	7/11/02 – 12/31/05	Slope and Intercept of Correlation

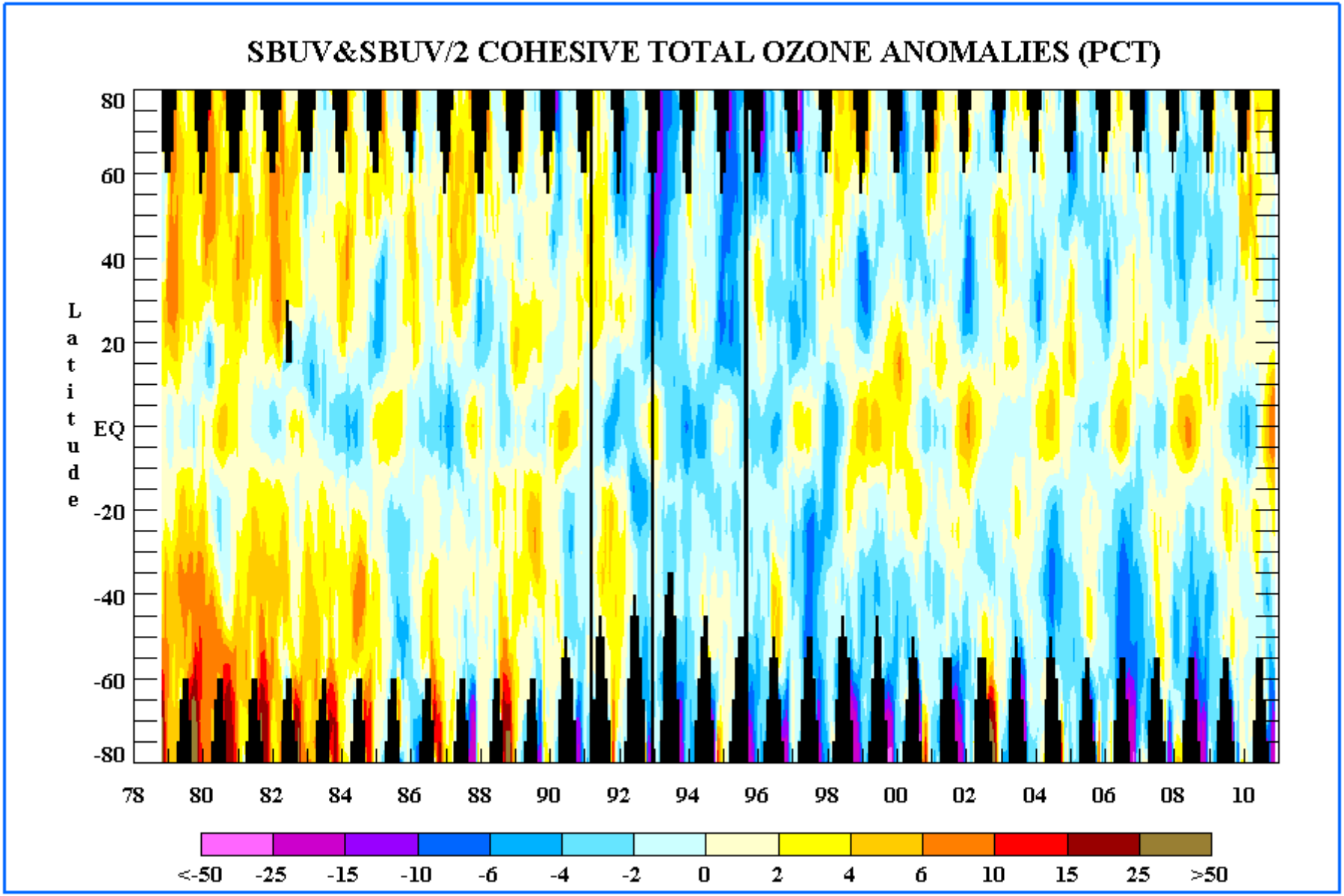
Final Period Choices

Satellite	Satellite dates	Notes
Nimbus 7	10/31/78 – 5/31/89	
NOAA 11	6/1/89 – 12/31/93	Eliminates early noisy N11 data at high levels, Northern Mid-Latitudes. See 30N 1hPa.
NOAA 9	1/1/94 – 7/14/97	
NOAA 11	7/15/97 – 12/31/00	
NOAA 16	1/1/01 – 12/31/03	
NOAA 17	1/1/04 – 12/31/09	

Differences of Trends wrt NDACC Lidar data

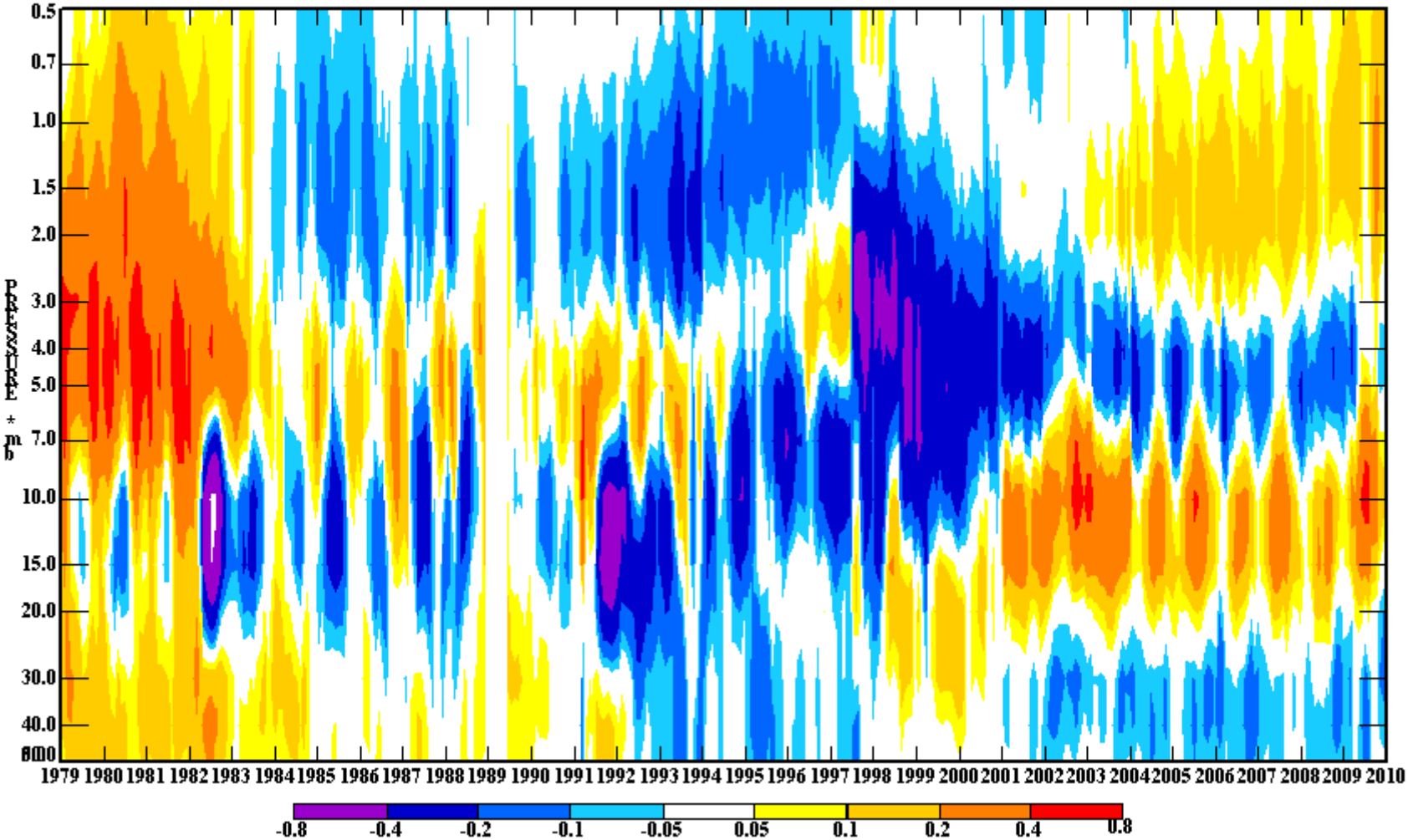



Global Mean SBUV/2 v8 Total Ozone Percent Anomalies
Lat Extent = 60S - 60N , Cohesive:Total Profile
Total ozone anomalies (%)
6
5
4
3
2
1
0
-1
-2
-3
-4
79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
v20080130


SBUV&SBUV/2 COHESIVE TOTAL OZONE ANOMALIES (PCT)
Latitude
80
60
40
20
EQ
-20
-40
-60
-80
78
80
82
84
86
88
90
92
94
96
98
00
02
04
06
08
10
<-50
-25
-15
-10
-6
-4
-2
0
2
4
6
10
15
25
>50

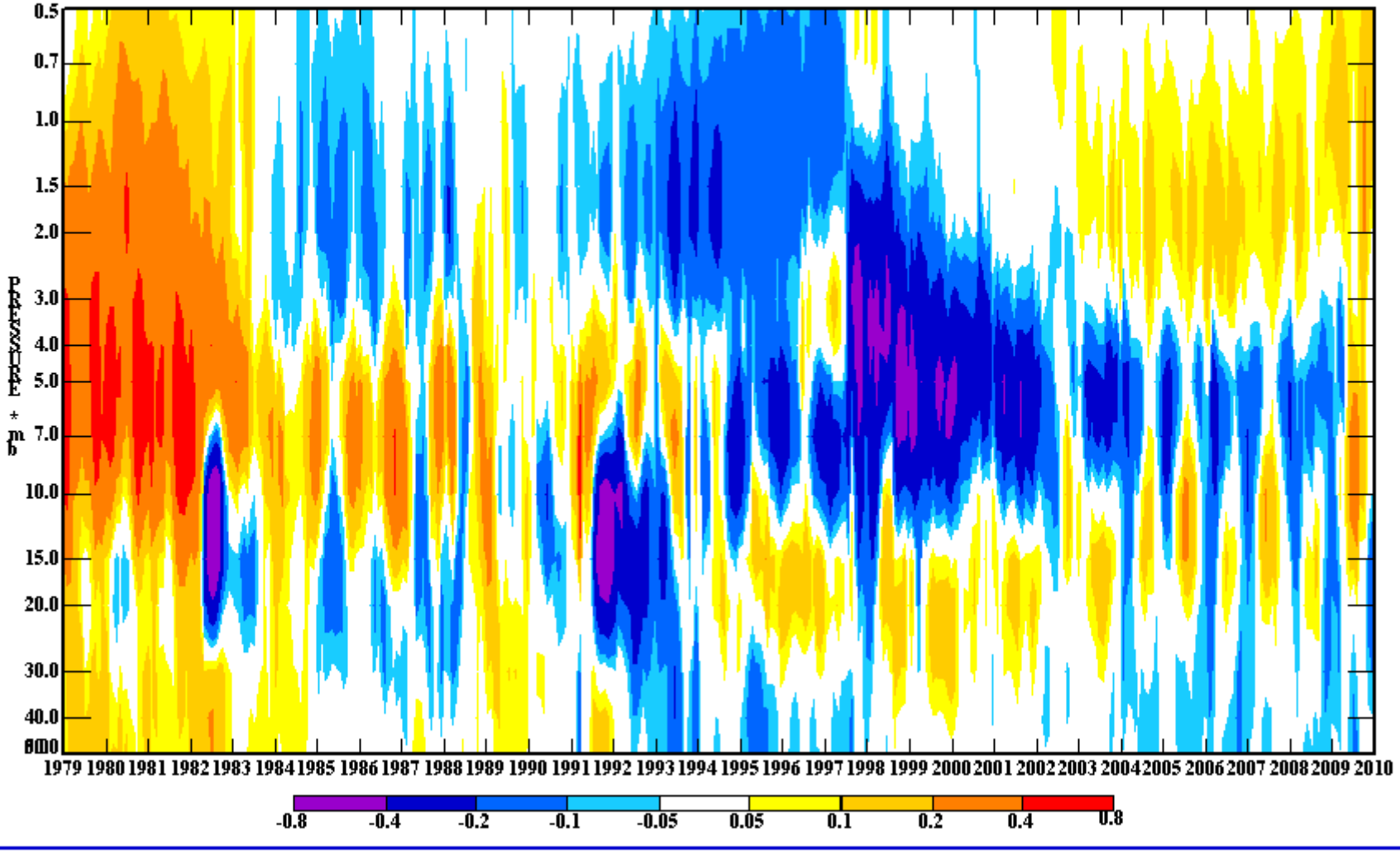
Monthly COHESIVE SBUV(/2) O3MR Anomalies (PPMV)- Unadjusted

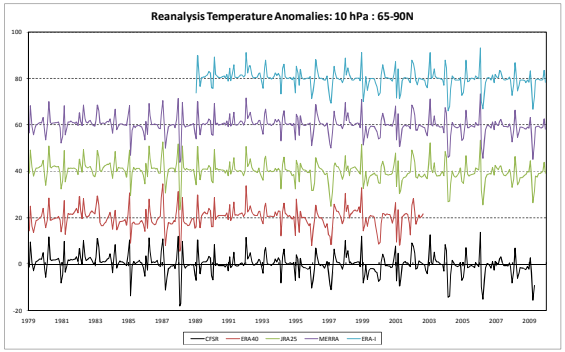
GLOBAL (1979 - 2009)

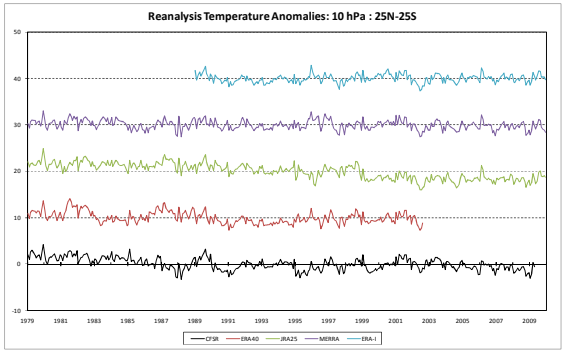


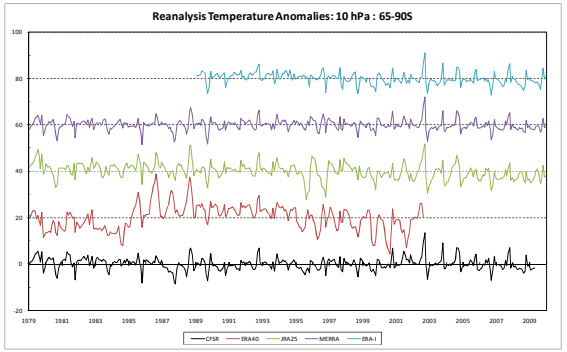
Monthly COHESIVE SBUV(/2) O3MR Anomalies (PPMV)- Adjusted

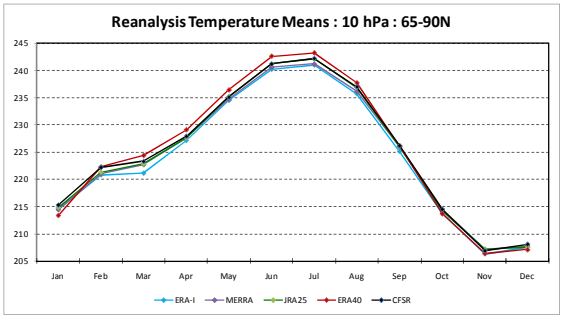
GLOBAL (1979 - 2009)

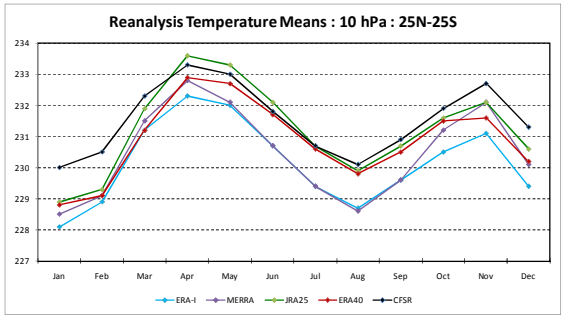


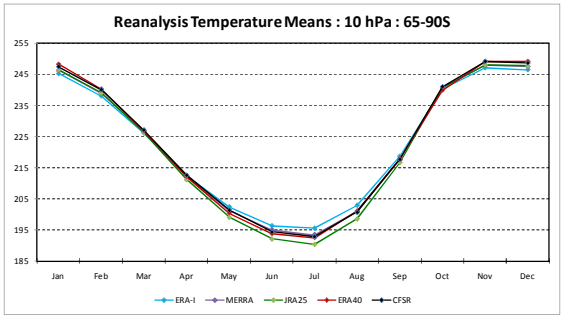

Reanalysis Temperature Anomalies: 10 hPa : 65-90N
CFSR
ERA40
JRA25
MERRA
ERA-I


Reanalysis Temperature Anomalies: 10 hPa : 25N-25S
CFSR
ERA40
JRA25
MERRA
ERA-I


Reanalysis Temperature Anomalies: 10 hPa : 65-90S
CFSR
ERA40
JRA25
MERRA
ERA-I

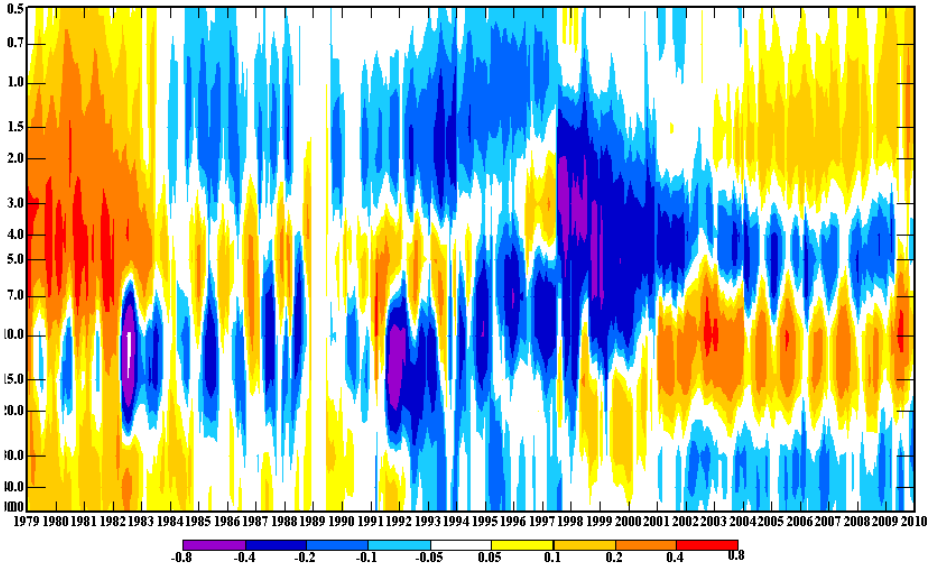

Reanalysis Temperature Means : 10 hPa : 65-90N
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
ERA-I
MERRA
JRA25
ERA40
CFSR


Reanalysis Temperature Means : 10 hPa : 25N-25S
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
ERA-I
MERRA
JRA25
ERA40
CFSR


Reanalysis Temperature Means : 10 hPa : 65-90S
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
ERA-I
MERRA
JRA25
ERA40
CFSR

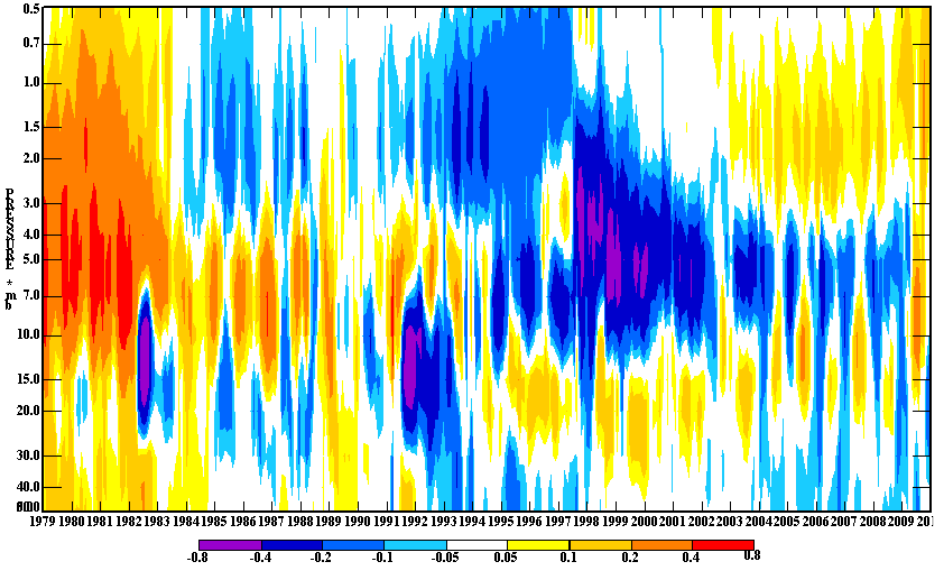
Monthly COHESIVE SBUV(/2) O3MR Anomalies (PPMV)- Unadjusted

GLOBAL (1979 - 2009)



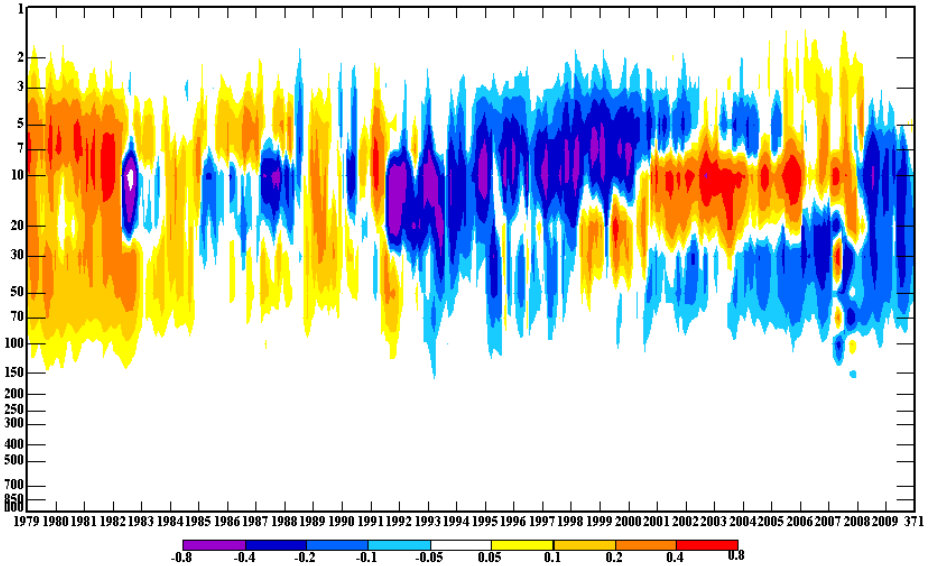
Monthly COHESIVE SBUV(/2) O3MR Anomalies (PPMV)- Adjusted

GLOBAL (1979 - 2009)



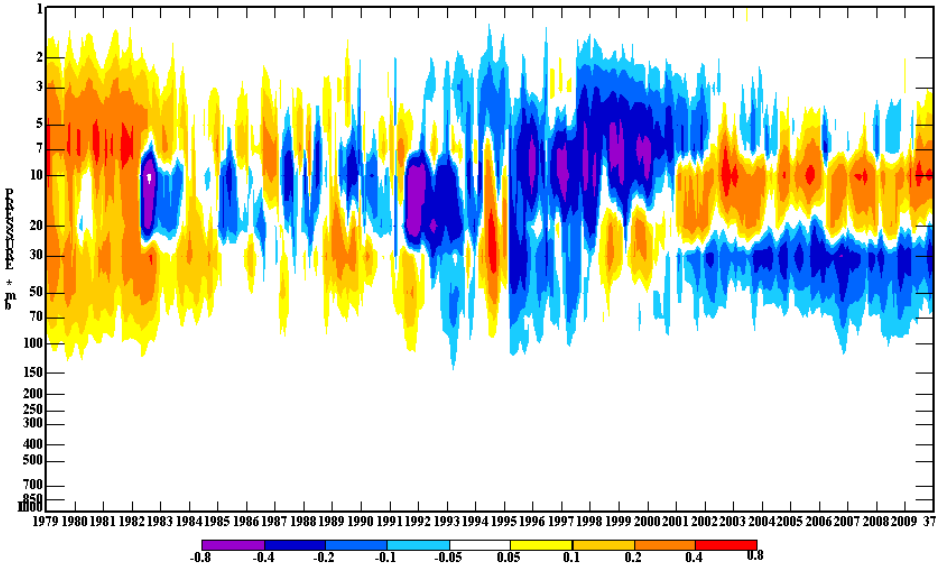
Monthly CFSR O3MR Anomalies (PPM)

GLOBAL (1979 - 2009)



Monthly MERRA O3MR Anomalies (PPM)

GLOBAL (1979 - 2009)



Special Cases

NOAA 16 Adjustment

- bias only due to short overlap period

NOAA 11 Descending Adjustment

- There is no viable overlap between NOAA 9 Descending and NOAA 11 Descending in 1997 since NOAA 9 is substantially degraded when NOAA 11 is again available
- At some levels the portion of NOAA 9 after June 1996 is offset from the rest of the data, ex: 15S at 3 hPa.
- NOAA 9 Descending has known trends
- We choose to use adjust NOAA 11 Descending with the same adjustment as NOAA 11 Ascending to avoid the retention of NOAA 9 deficits