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Identification of Solar Cycle 23 Minimum from Solar UV Measurements: NOAA-9 and NOAA-11 SBUV/2, UARS SUSIM, UARS SOLSTICE

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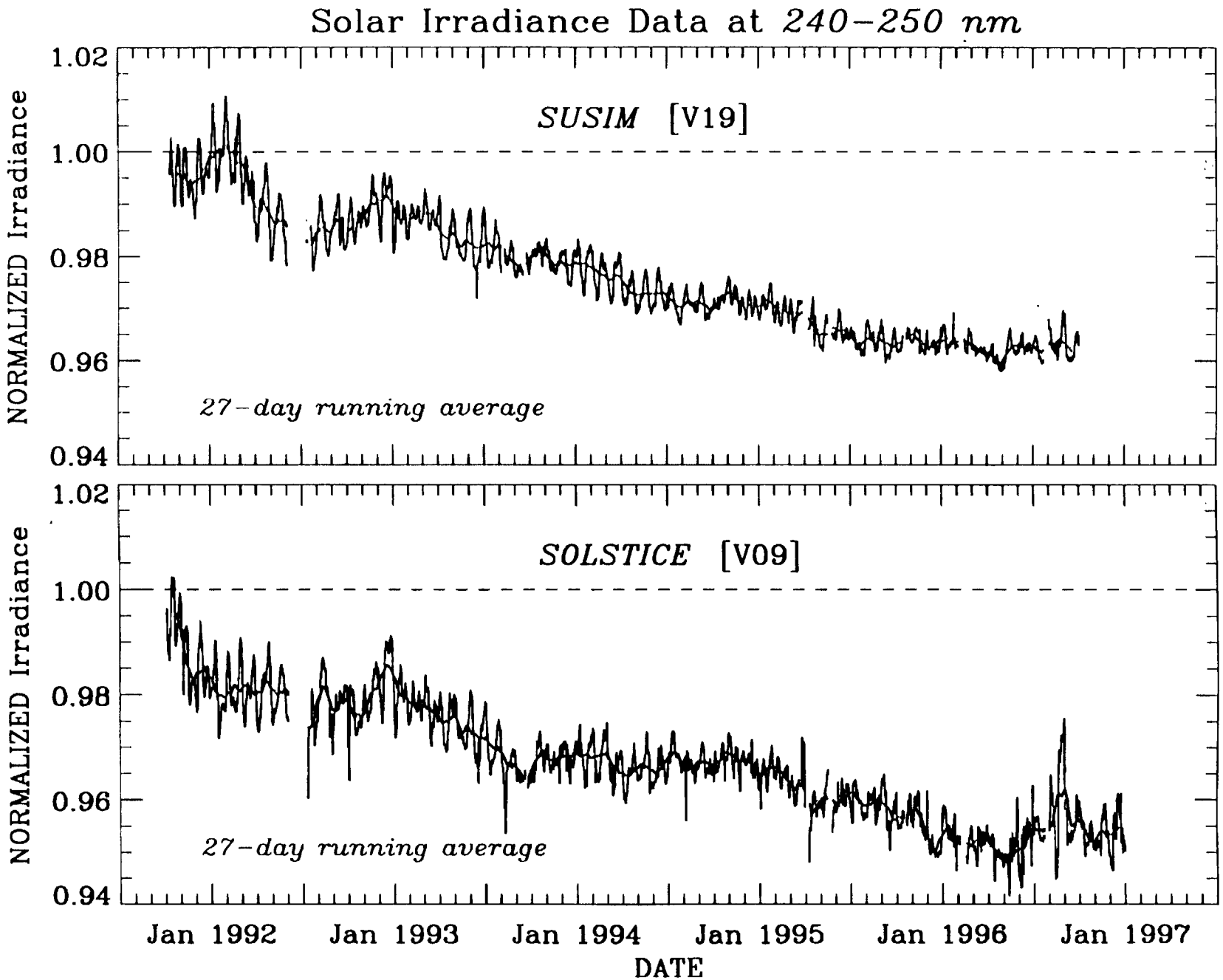
Solar Spectral UV Data for Cycle 22

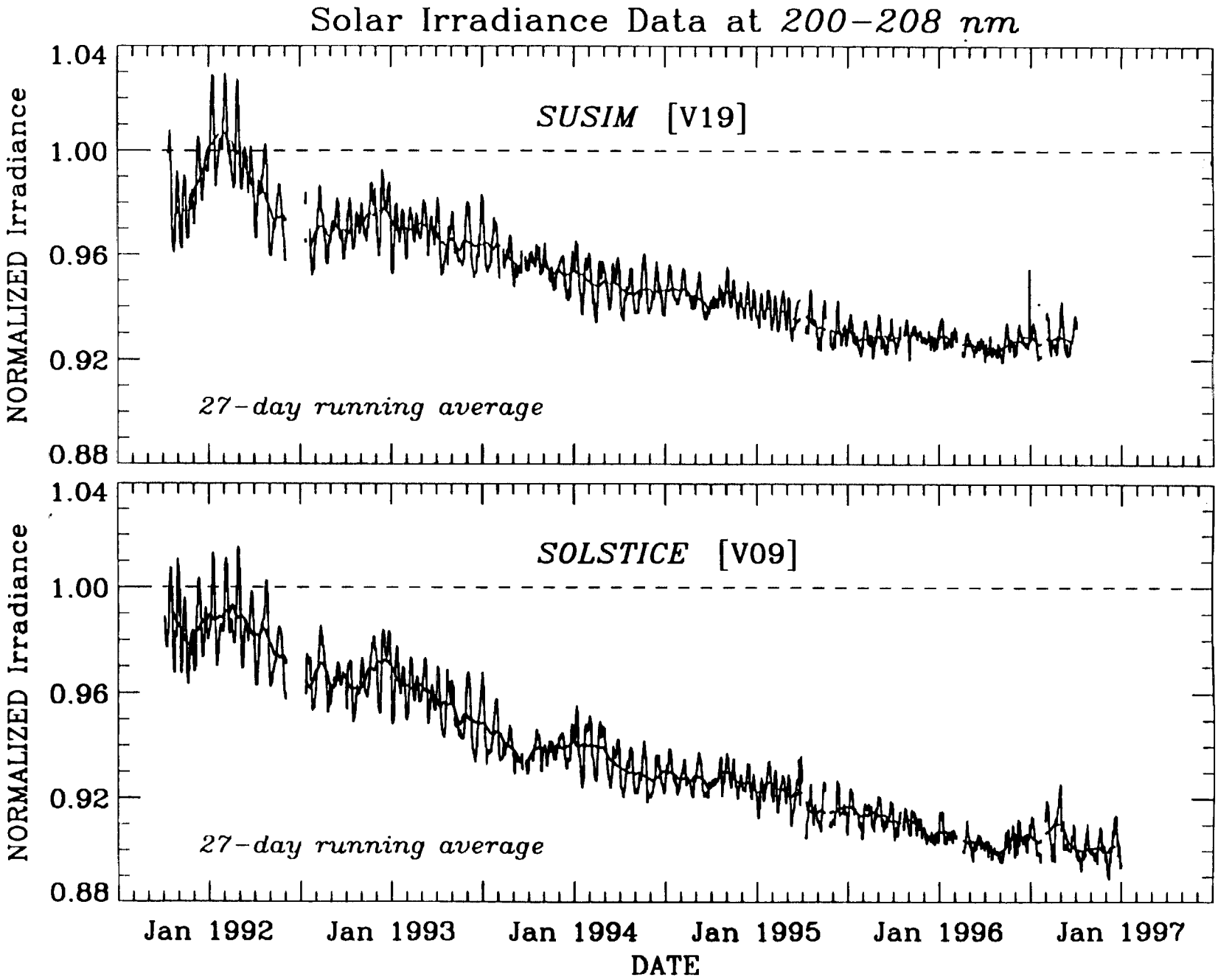
- **NOAA-9 SBUV/2**, *March 1985 – May 1997*
  - Long-term absolute calibration not yet available
  - Mg II index data continue through November 1997

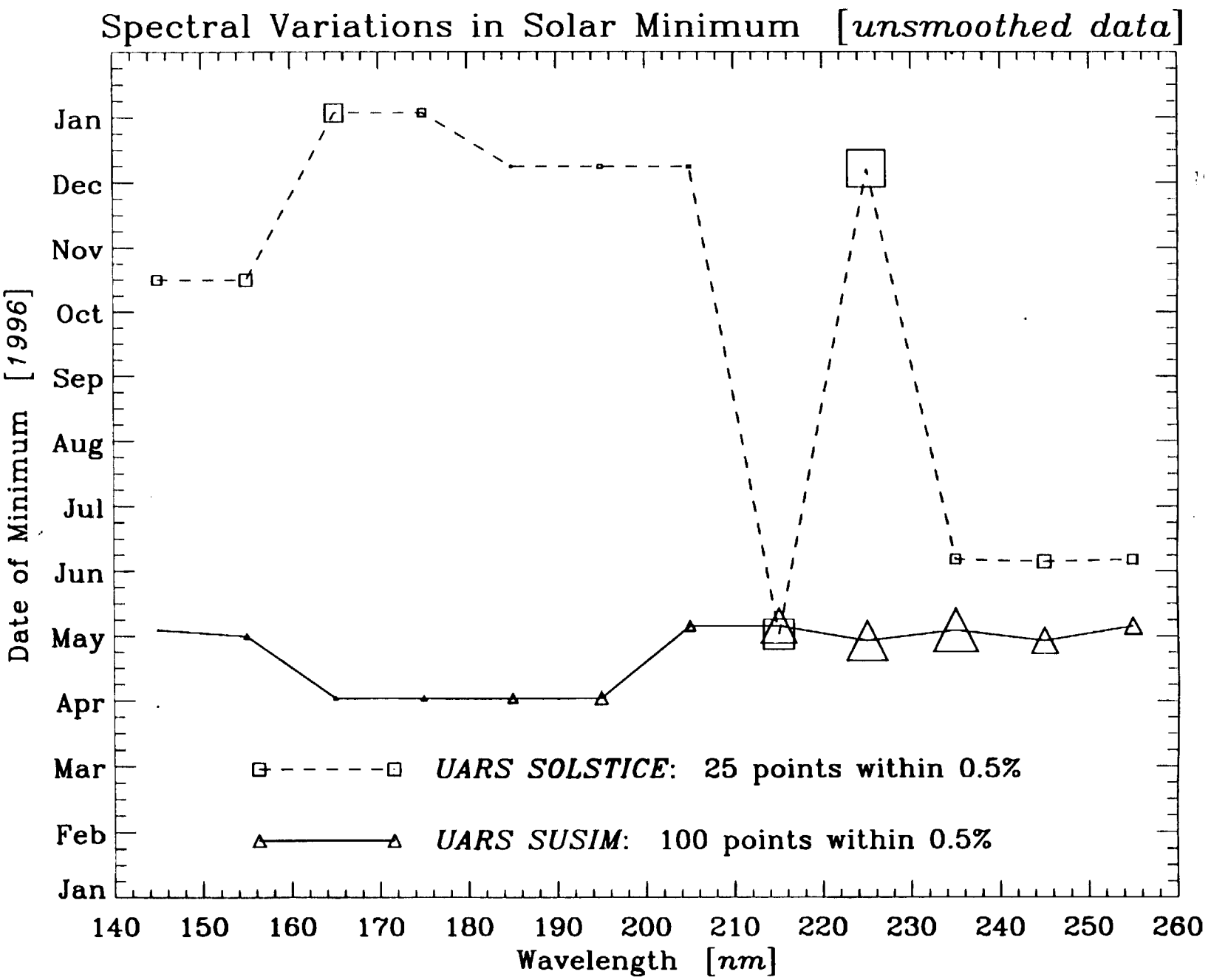
- **NOAA-11 SBUV/2**, *February 1989 – October 1994*
  - Long-term calibration *via* SSBUV coincidences
  - Data do not reach solar minimum, but overlap UARS data during 1991-1994

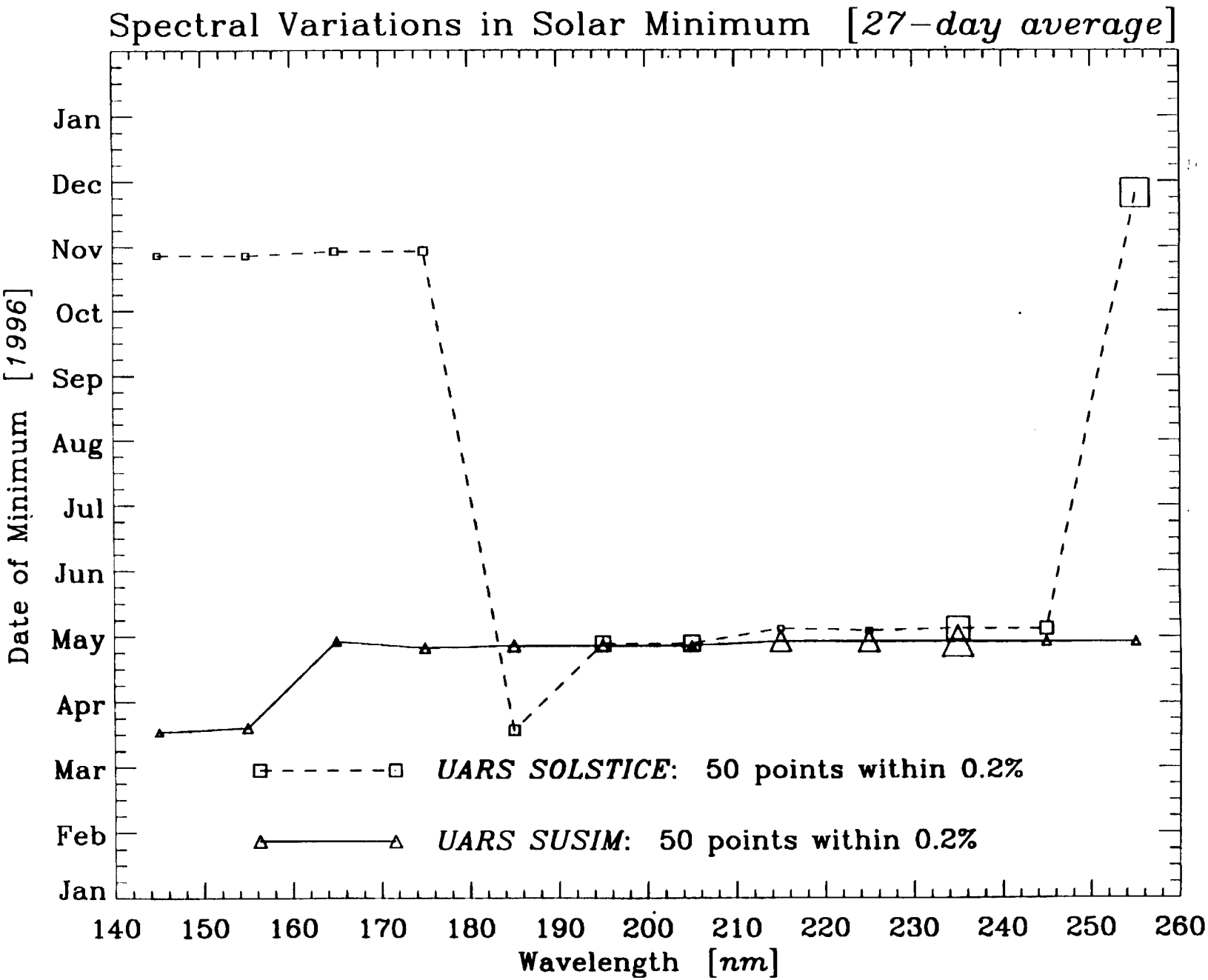
- **UARS SUSIM**, *October 1991 – September 1996* [V19]
  - Long-term calibration *via* on-board calibration system
  - Currently operational

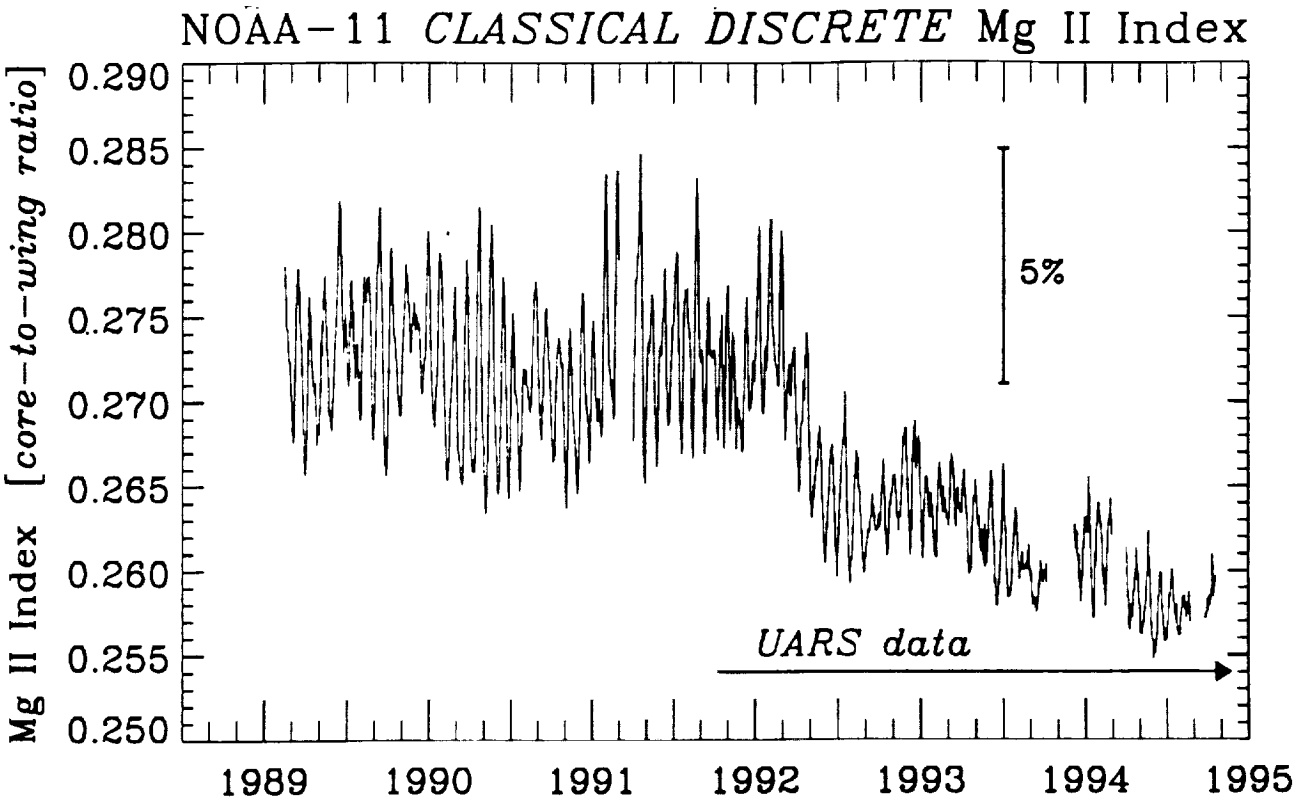
- **UARS SOLSTICE**, *October 1991 – December 1996* [V09]
  - Long-term calibration *via* on-board calibration system
  - Currently operational

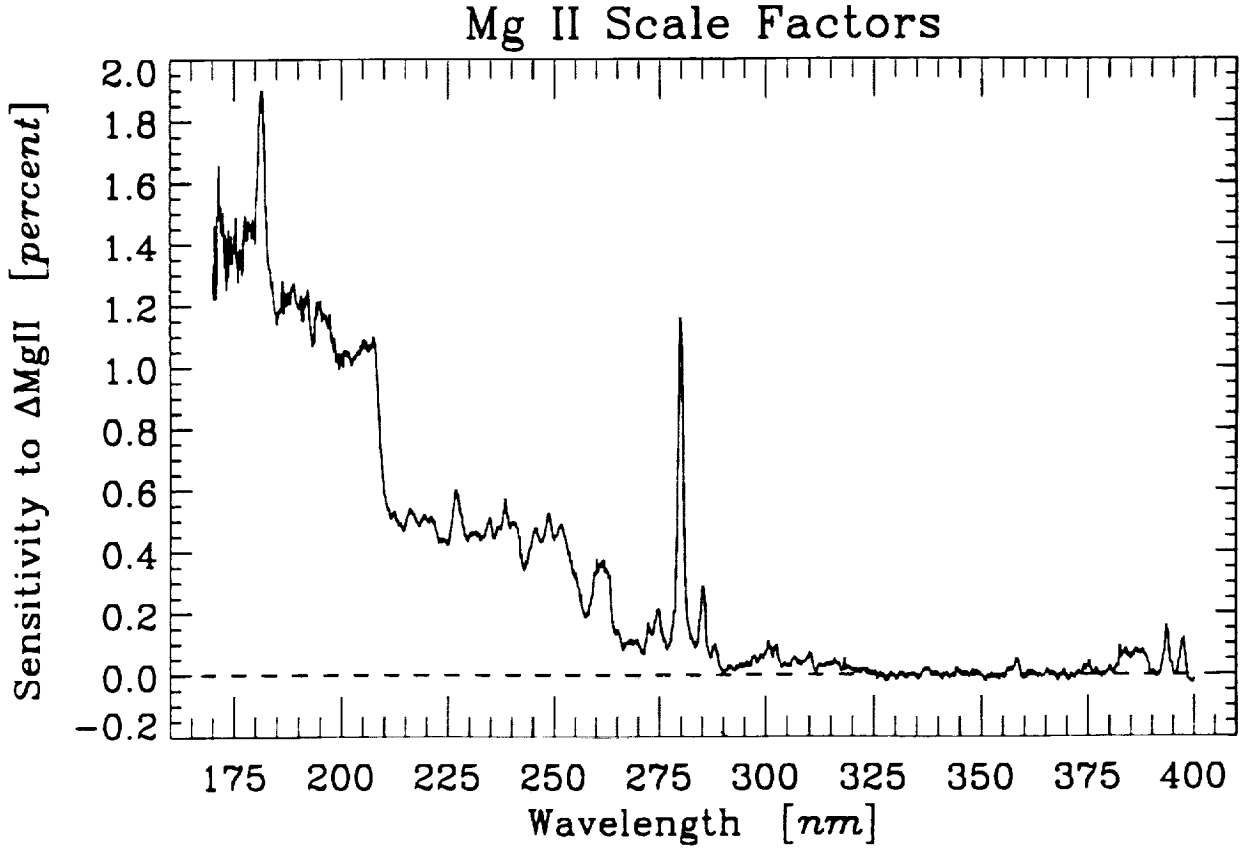

Solar Irradiance Data at 240–250 nm
SUSIM [V19]
27-day running average
SOLSTICE [V09]
27-day running average
NORMALIZED Irradiance
1.02
1.00
0.98
0.96
0.94
Jan 1992
Jan 1993
Jan 1994
Jan 1995
Jan 1996
Jan 1997
DATE

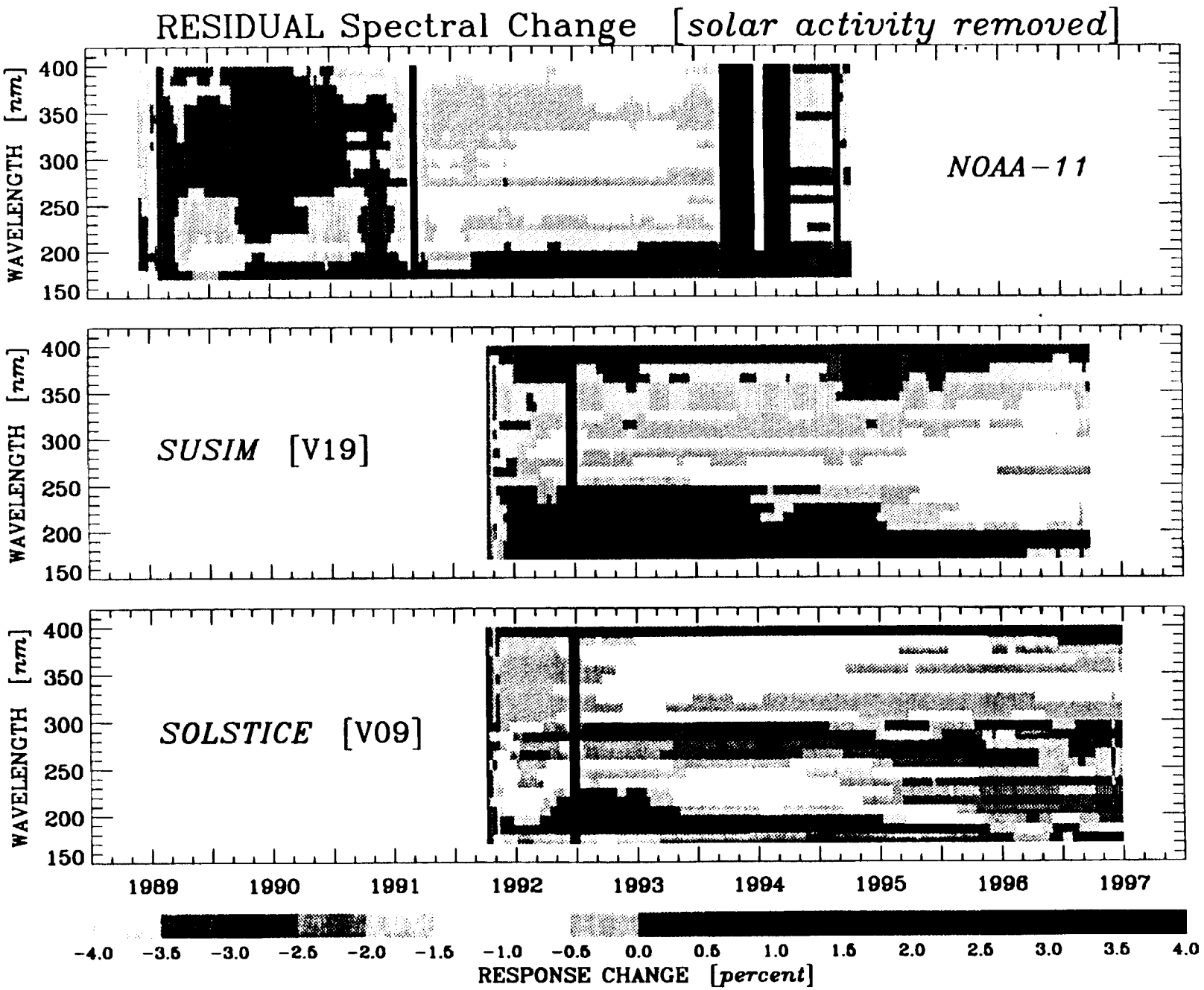

Solar Irradiance Data at 200–208 nm
SUSIM [V19]
27-day running average
SOLSTICE [V09]
27-day running average
NORMALIZED Irradiance
NORMALIZED Irradiance
1.04
1.00
0.96
0.92
0.88
Jan 1992
Jan 1993
Jan 1994
Jan 1995
Jan 1996
Jan 1997
DATE

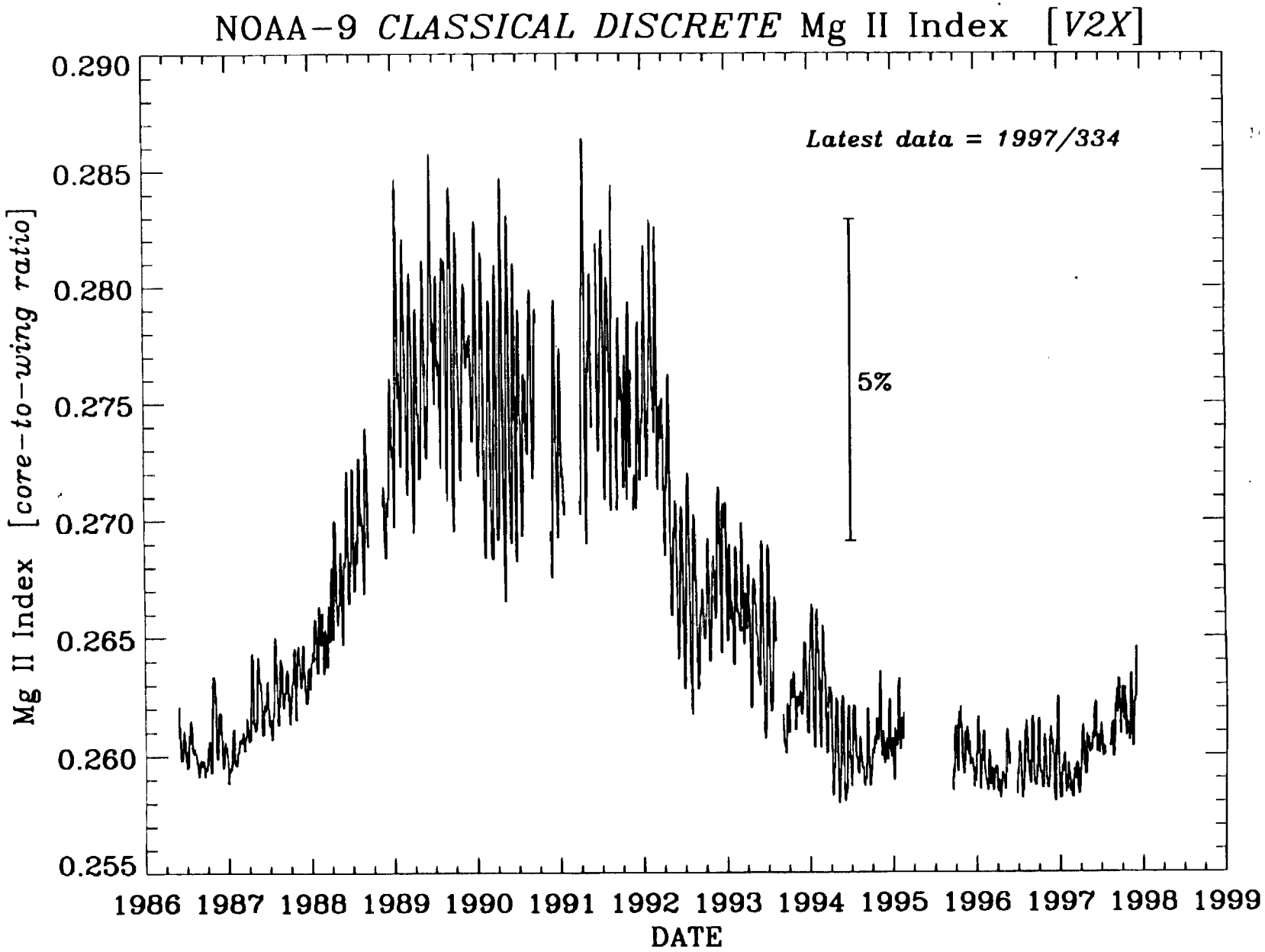

Spectral Variations in Solar Minimum [unsmoothed data]
Date of Minimum [1996]
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
UARS SOLSTICE: 25 points within 0.5%
UARS SUSIM: 100 points within 0.5%
140
150
160
170
180
190
200
210
220
230
240
250
260
Wavelength [nm]

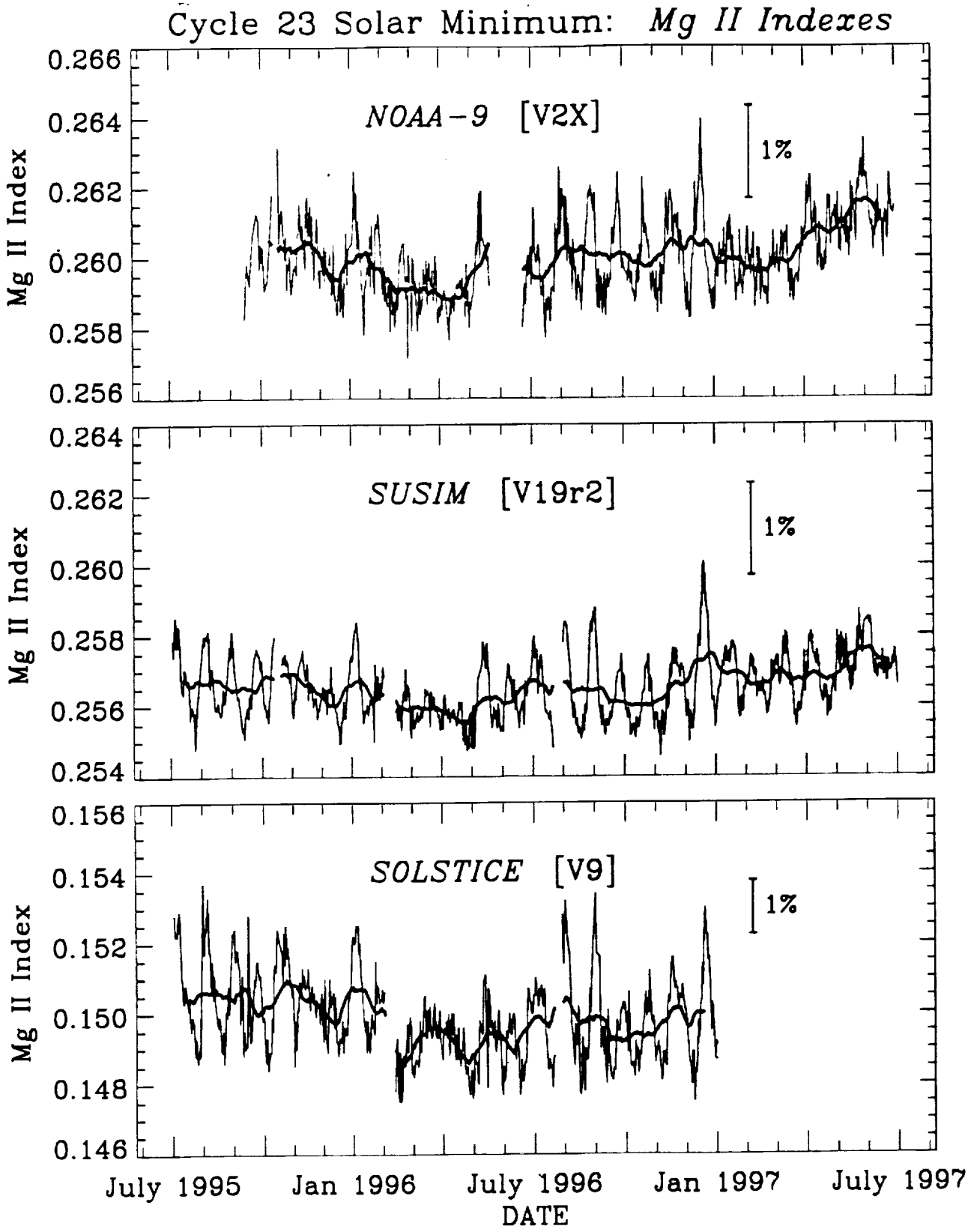

Spectral Variations in Solar Minimum [27-day average]
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
Date of Minimum [1996]
UARS SOLSTICE: 50 points within 0.2%
UARS SUSIM: 50 points within 0.2%
140
150
160
170
180
190
200
210
220
230
240
250
260
Wavelength [nm]


NOAA−11 CLASSICAL DISCRETE Mg II Index
Mg II Index [core−to−wing ratio]
0.290
0.285
0.280
0.275
0.270
0.265
0.260
0.255
0.250
5%
UARS data
1989
1990
1991
1992
1993
1994
1995


Mg II Scale Factors
Sensitivity to ΔMgII [percent]
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
175
200
225
250
275
300
325
350
375
400
Wavelength [nm]


RESIDUAL Spectral Change [solar activity removed]
WAVELENGTH [nm]
400
350
300
250
200
150
NOAA-11
SUSIM [V19]
SOLSTICE [V09]
1989
1990
1991
1992
1993
1994
1995
1996
1997
-4.0
-3.5
-3.0
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
RESPONSE CHANGE [percent]


NOAA-9 CLASSICAL DISCRETE Mg II Index [V2X]
Latest data = 1997/334
5%
Mg II Index [core-to-wing ratio]
0.290
0.285
0.280
0.275
0.270
0.265
0.260
0.255
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
DATE


Cycle 23 Solar Minimum: Mg II Indexes
NOAA-9 [V2X]
SUSIM [V19r2]
SOLSTICE [V9]
1%
Mg II Index
0.266
0.264
0.262
0.260
0.258
0.256
0.254
0.156
0.154
0.152
0.150
0.148
0.146
July 1995
Jan 1996
July 1996
Jan 1997
July 1997
DATE

Conclusions

- Determination of solar minimum date from daily spectral irradiance data sensitive to noise, long-term calibration.

- Minimum date for smoothed time series more consistent spectrally (late April 1996 for SUSIM, SOLSTICE between 190-250 nm). Many points fall within small range of minimum value.

- Mg II index less sensitive to calibration error. Minimum date based on daily values also impacted by noise. Smoothed Mg II time series from NOAA-9, SUSIM, SOLSTICE agree on minimum date for Cycle 22 within 1-2 weeks (late April 1996).

- NOAA-9, NOAA-11 SBUV/2 data available on-line at

http://ssbuv.gsfc.nasa.gov/solar.html