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SBUV/2 Long-Term Measurements of Solar Spectral Variability

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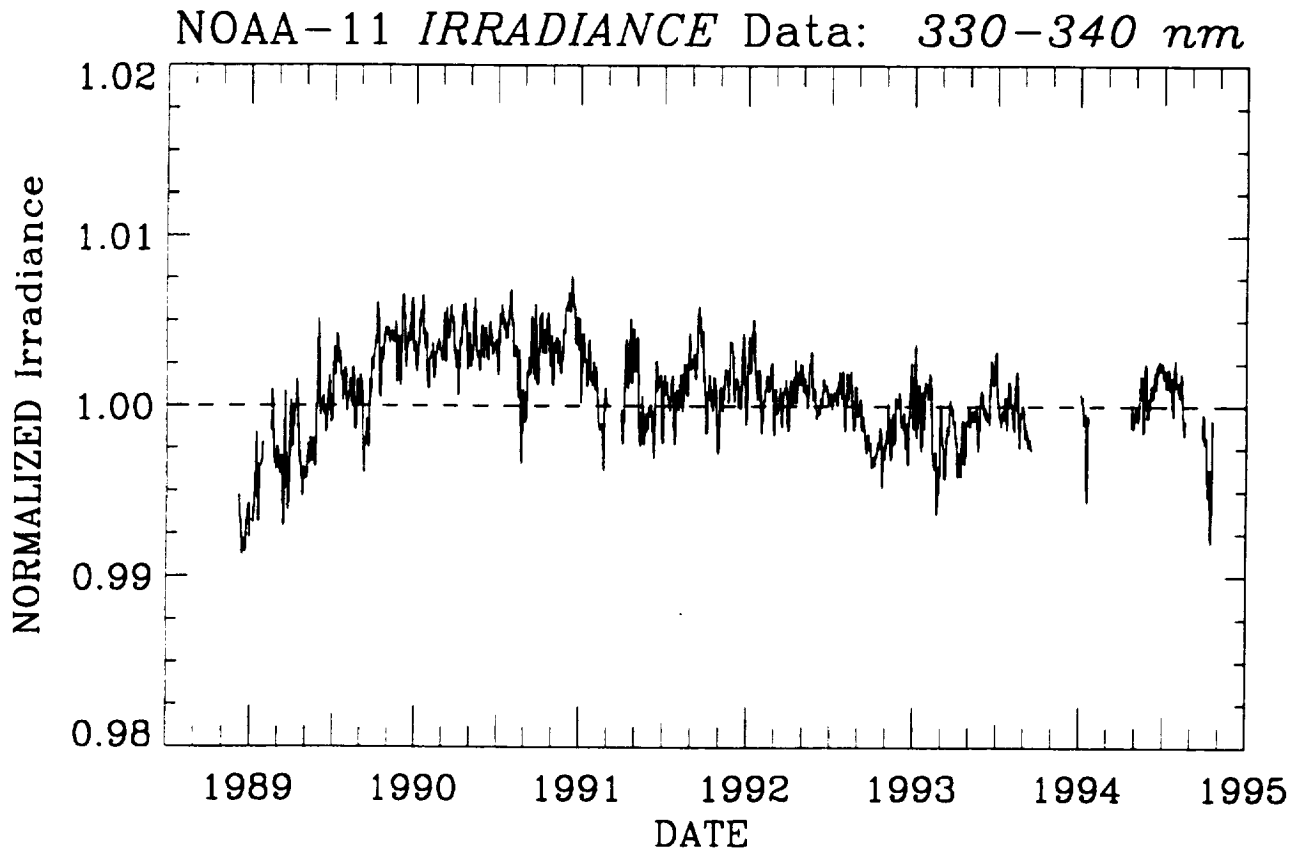
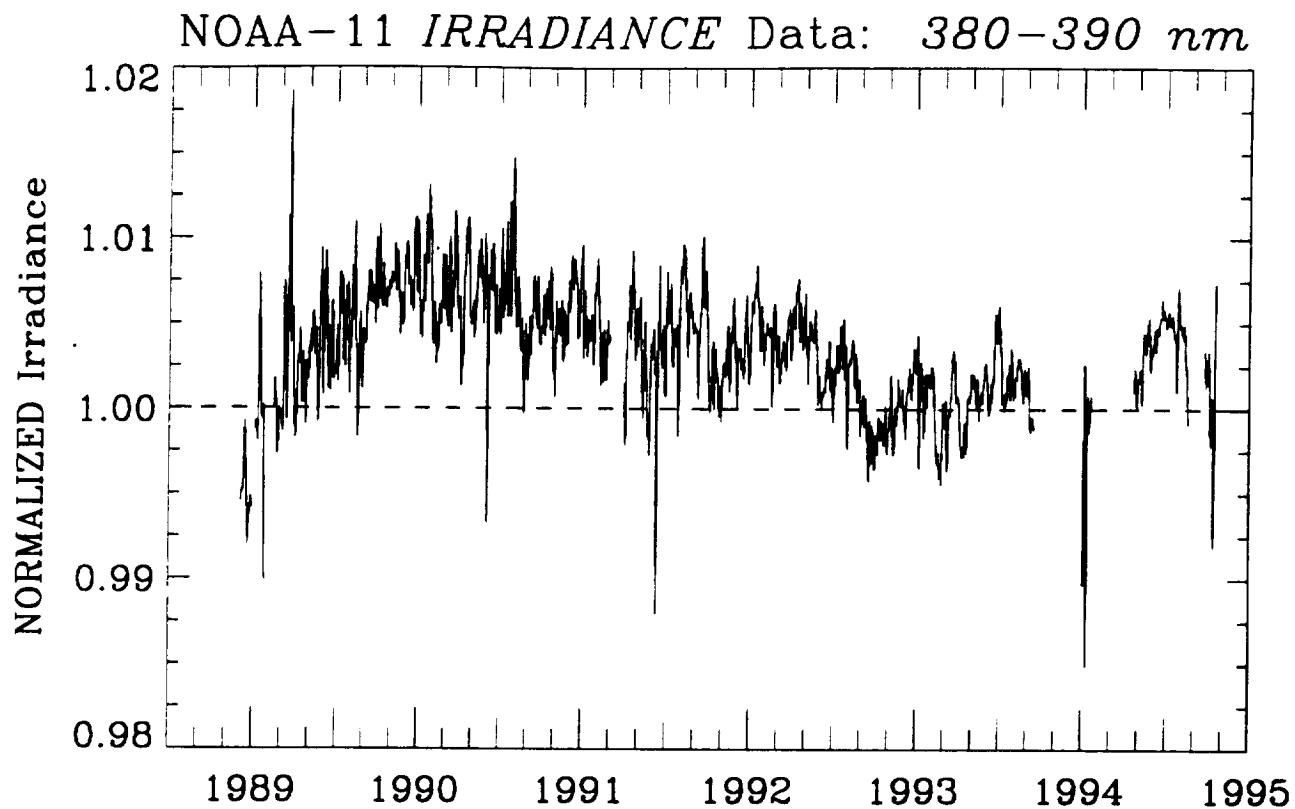
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The NOAA-11 SBUV/2 spectral solar data have been corrected for long-term instrument changes to produce a 5.5 year data record during solar cycle 22 (December 1988 - October 1994). Residual drifts in the data at long wavelengths are $\pm 1\%$ or less. At 200-205 nm, where solar variations drive stratospheric photochemistry, these data indicate long-term solar changes of 5-7% from the maximum of Cycle 22 in April 1991 through the end of the NOAA-11 data record. Comparisons of NOAA-11 data with UARS SUSIM and SOLSTICE for the period October 1991 - October 1994, when all 3 instruments were operating simultaneously, show that the observed long-term variations in 200-205 nm irradiance agree to within 2%. This result is consistent with predictions from the Mg II proxy index.

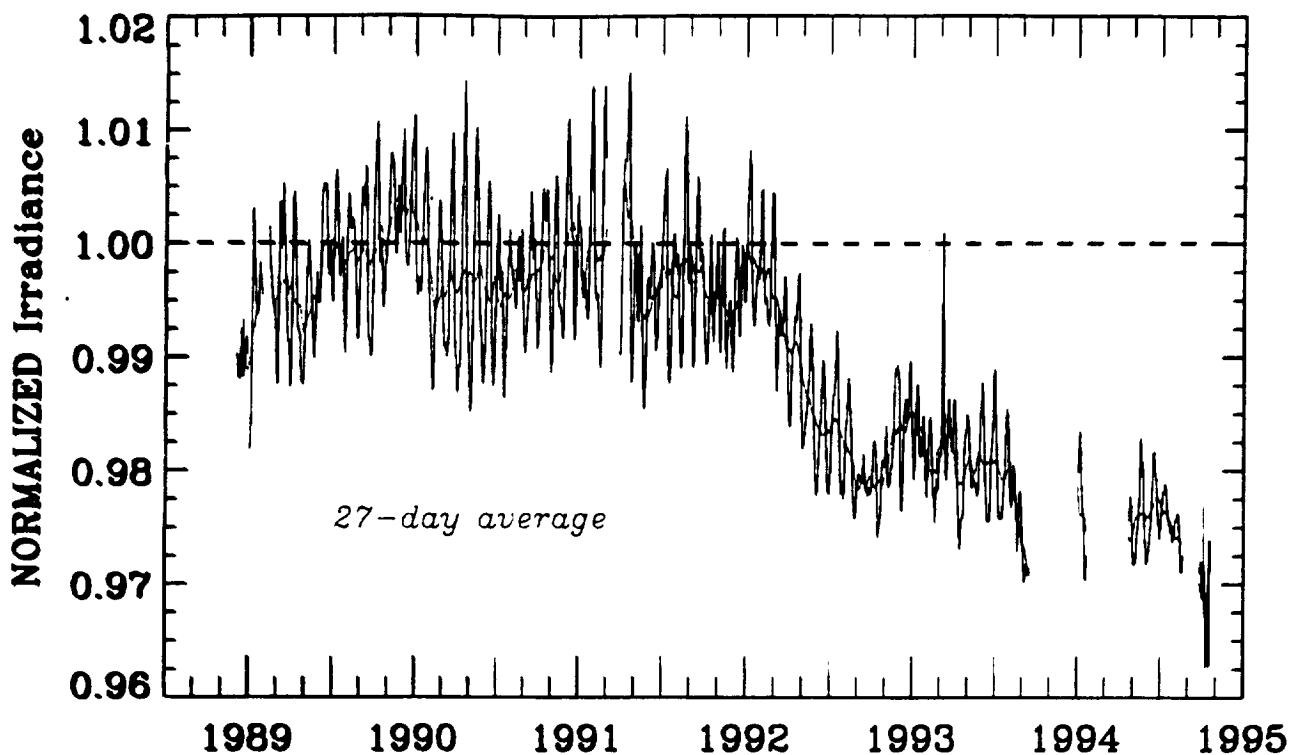
The SBUV/2 instruments represent a valuable resource for long-term solar UV activity studies because of their overlapping data records. In addition to the NOAA-11 data presented here, the NOAA-9 SBUV/2 instrument began taking data in March 1985 and is still operating, providing a complete record of Cycle 22 behavior from a single instrument. Three additional SBUV/2 instruments are scheduled to be launched between 1997 and 2003, which should permit full coverage of solar cycle 23.

- ▶ Daily measurements made over 160-405 nm wavelength region from December 1988 to October 1994
- ▶ On-board calibration system corrects for diffuser reflectivity change only
- ▶ Coincident observations with SSBUV flights used to characterize long-term instrument throughput changes as functions of time, wavelength
- ▶ NOAA-11 irradiance data show long-term drift $\leq 1\%$ for $\lambda > 300$ nm; This is consistent with expectation of little/no solar activity, indicates accuracy of corrections
- ▶ Shorter wavelengths show regular rotational modulation (up to 5-6% at 200-208 nm, 2-3% at 240-250 nm) during maximum and decline of Cycle 22; Periods of 13-day variability in Fall 1991, late 1992 also present

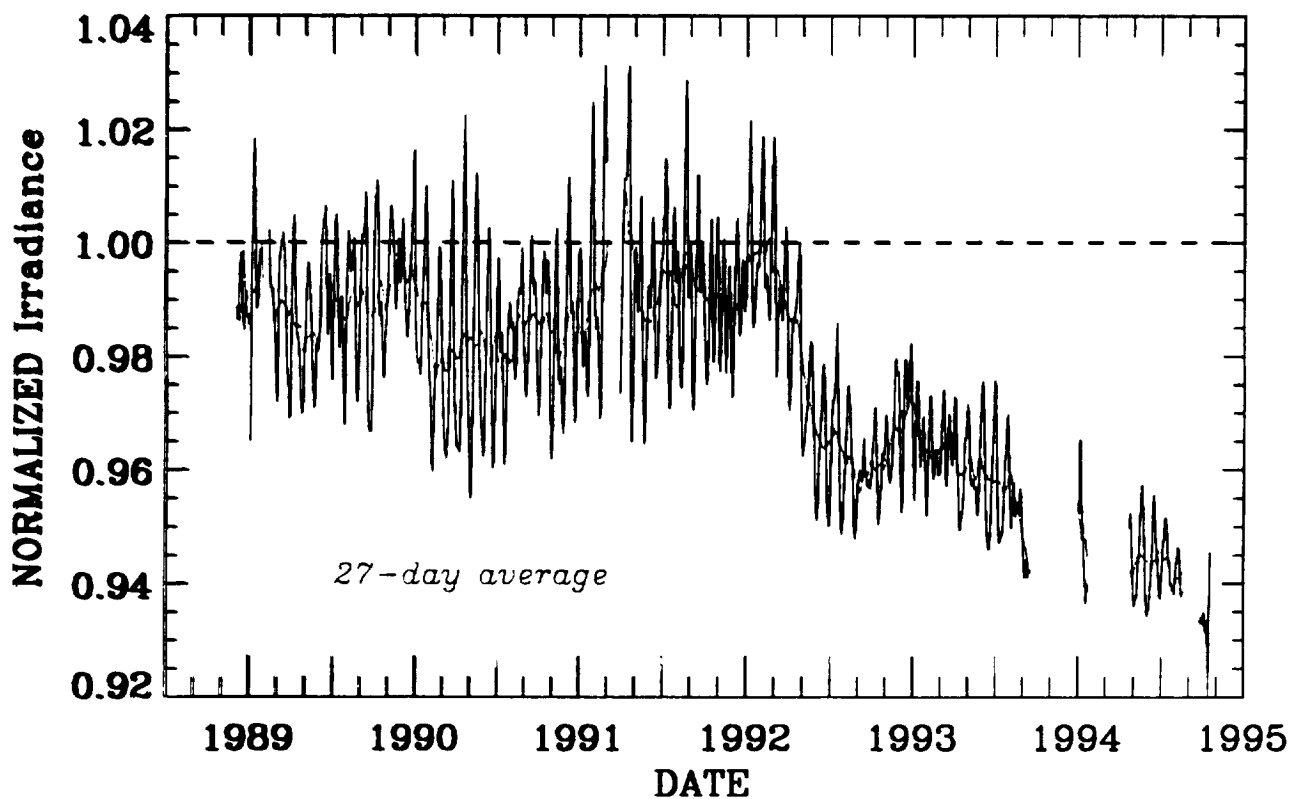
NOAA-11 Solar Irradiance Results



NOAA-11 IRRADIANCE Data: 240-250 nm

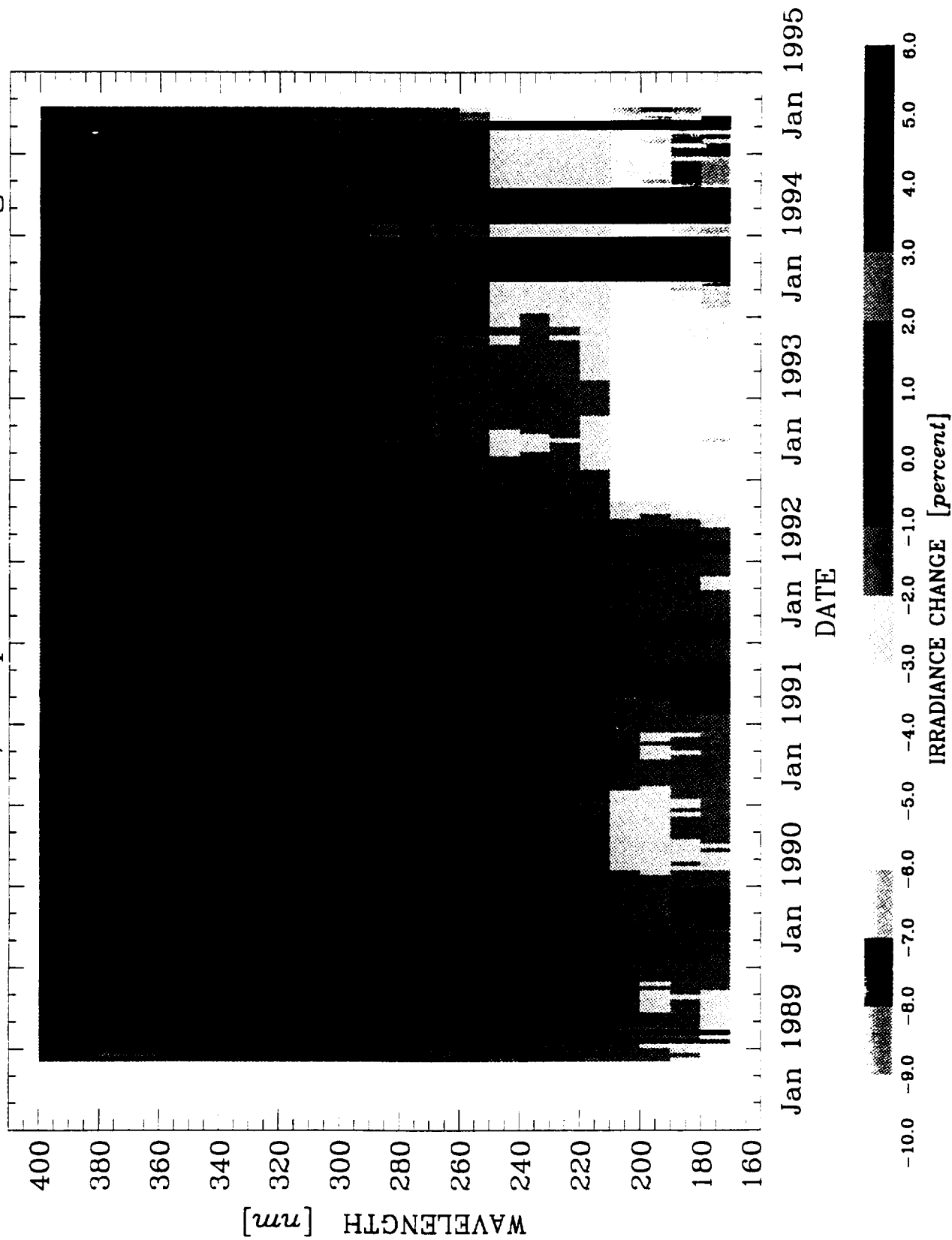


NOAA-11 IRRADIANCE Data: 200-208 nm

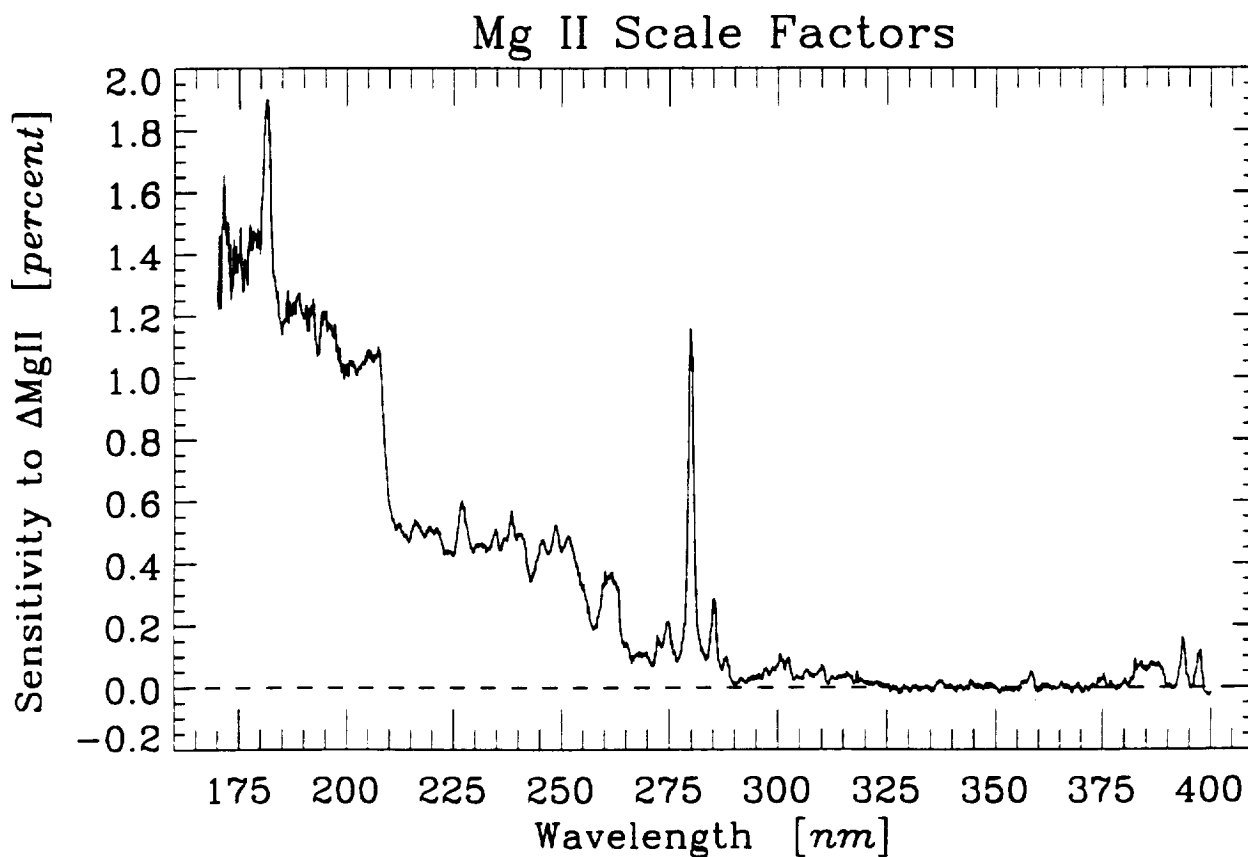
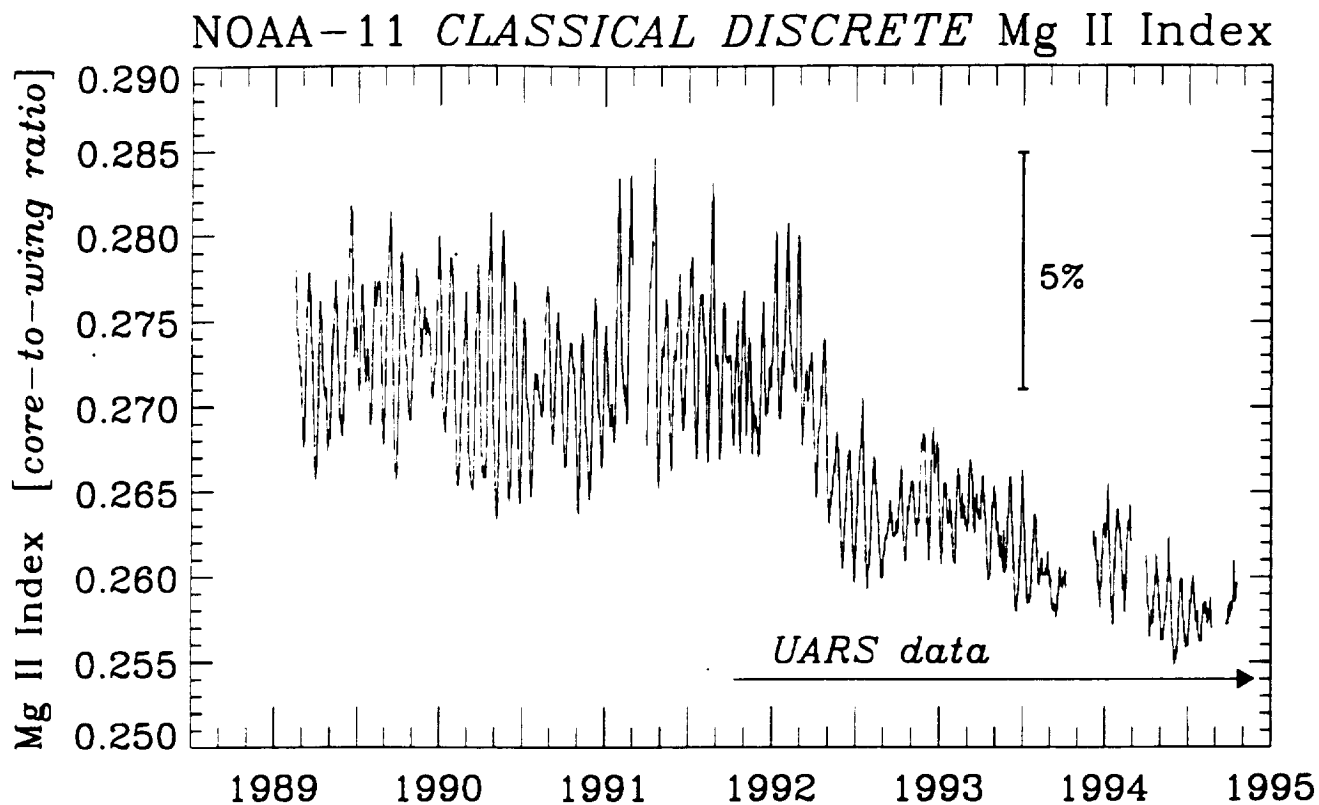


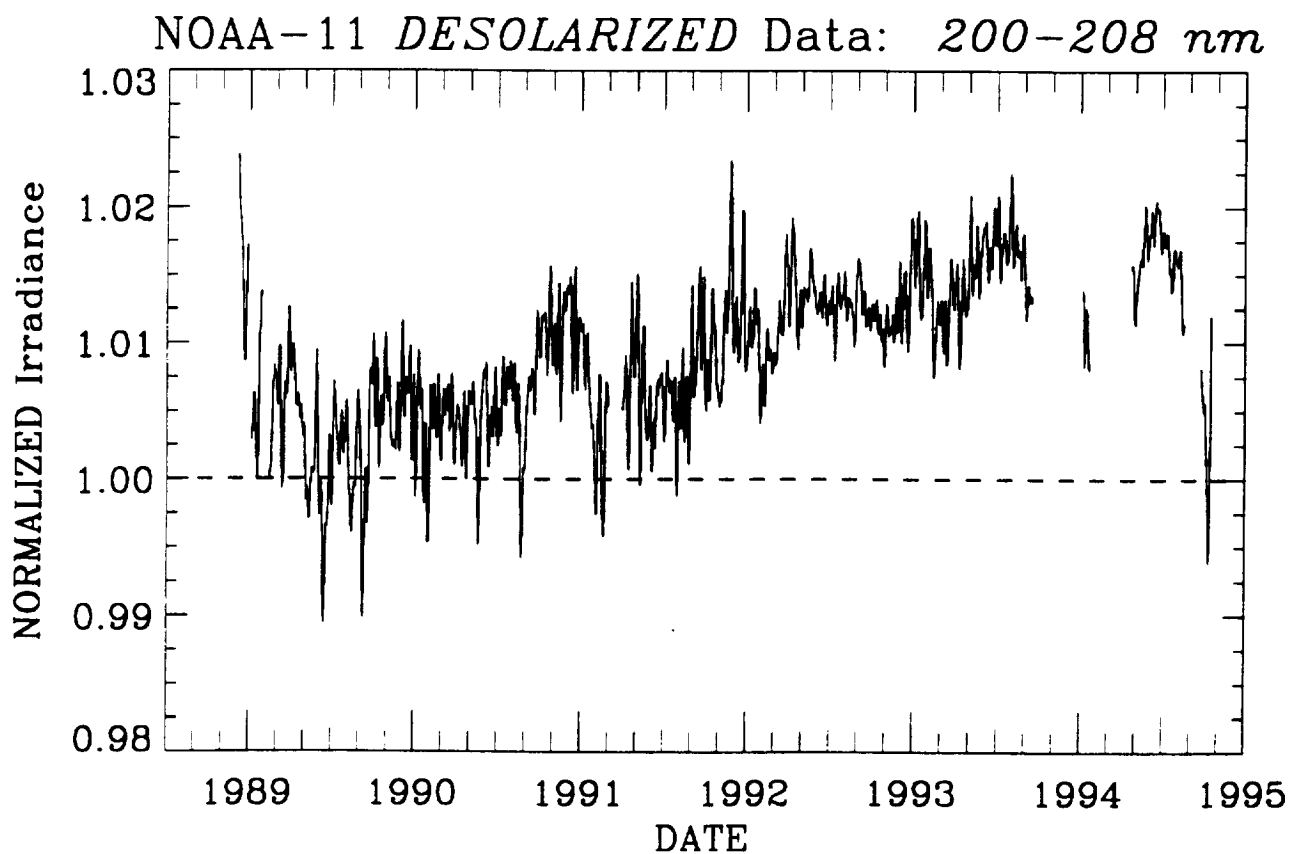
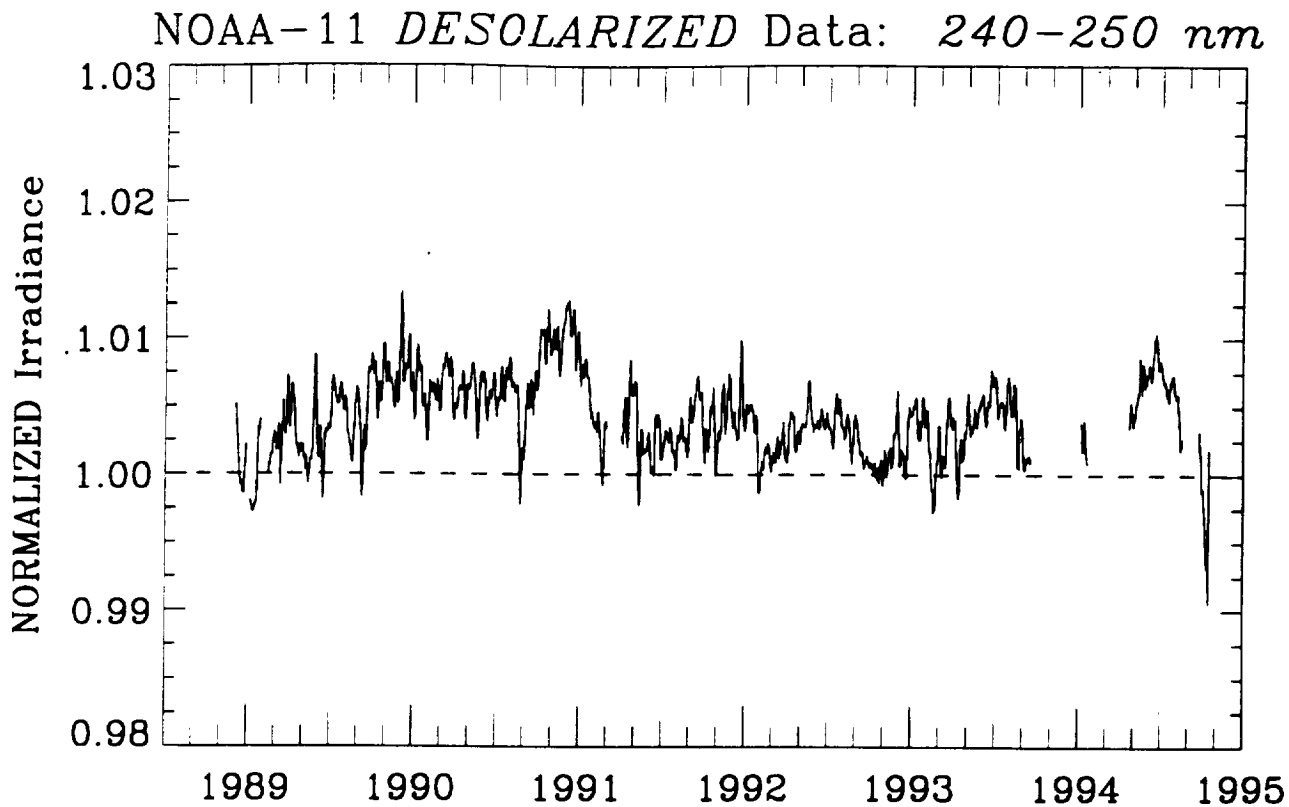
- ▶ Plot of all data in 10 nm bands (81-day average) shows $\Delta F < \pm 1\%$ [*darker green*] for $\lambda > 270$ nm, more long-term change shortward of Mg edge at 210-250 nm [*lighter green*], largest change below Al edge at $\lambda < 210$ nm [*yellow, orange*]; End of Cycle 22 maximum in Spring 1992 visible at $\lambda < 270$ nm
- ▶ Long-term changes at short wavelengths determined from smoothed data are approximately 6% at 200-208 nm, 3-3.5% at 240-250 nm; *How can we evaluate instrument drift at these wavelengths?*

NOAA-11 SBUV/2 Spectral Irradiance Change



- ▶ Solar irradiance variations modeled using NOAA-11 Mg II index, scale factors; NOAA-11 Mg II agrees with NOAA-9 Mg II, SUSIM Mg II to within 1% during overlap periods
- ▶ "Desolarized" NOAA-11 irradiance data has long-term drift of +2% at 200-208 nm, < 1% at 240-250 nm
- ▶ If (Mg II + scale factor) result is correct for long-term change, $\Delta F_{\text{solar}} \approx -(6-7)\%$ at 200-208 nm, $-(3-4)\%$ at 240-250 nm during 1989-1994; *Compare with other instruments for validation*

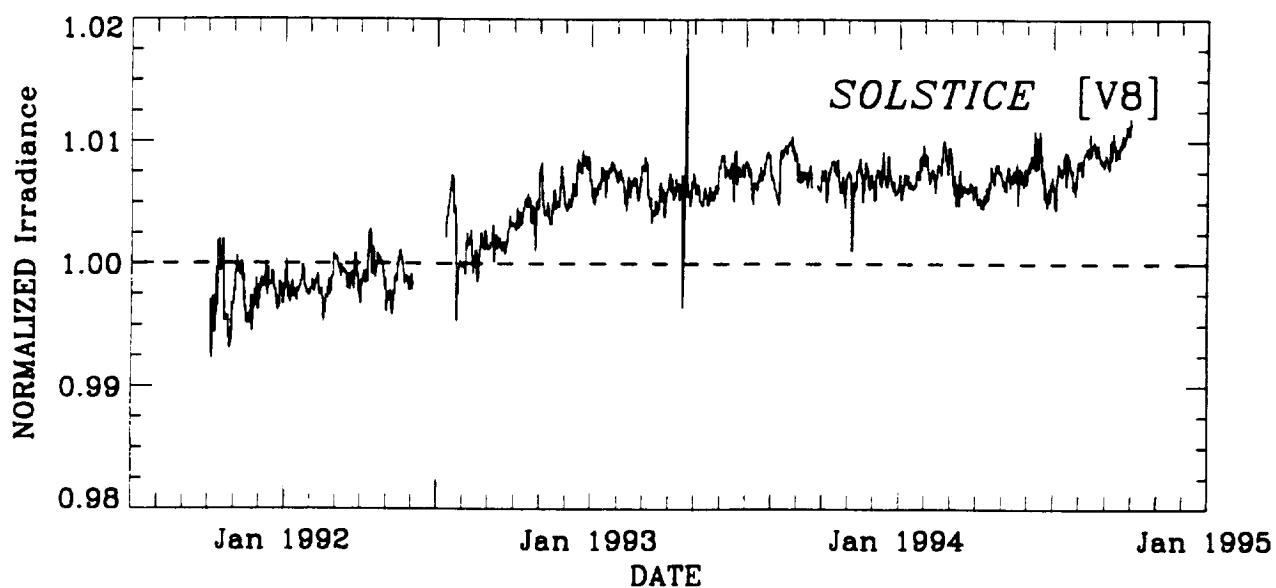
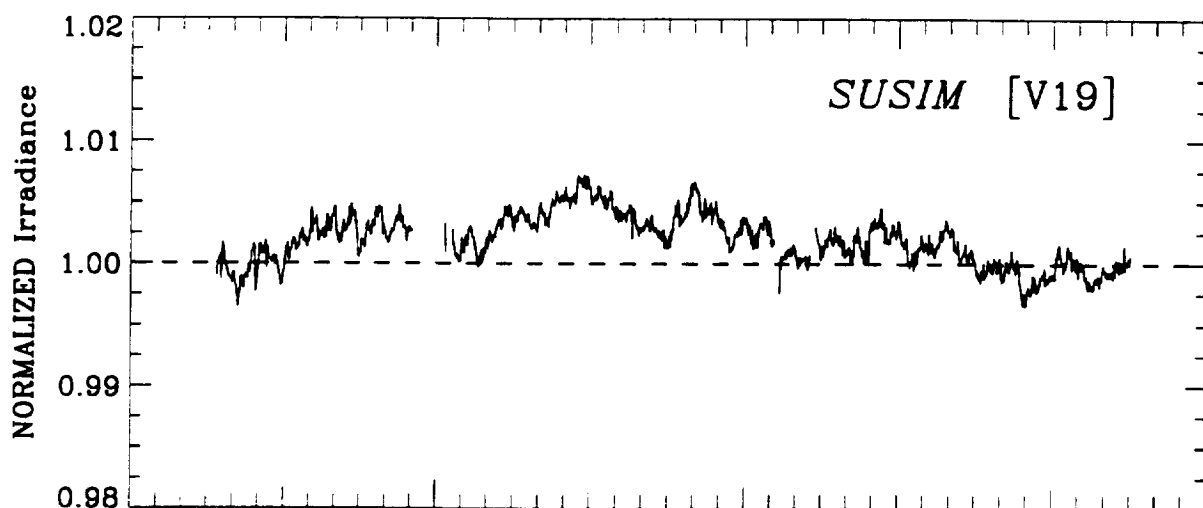
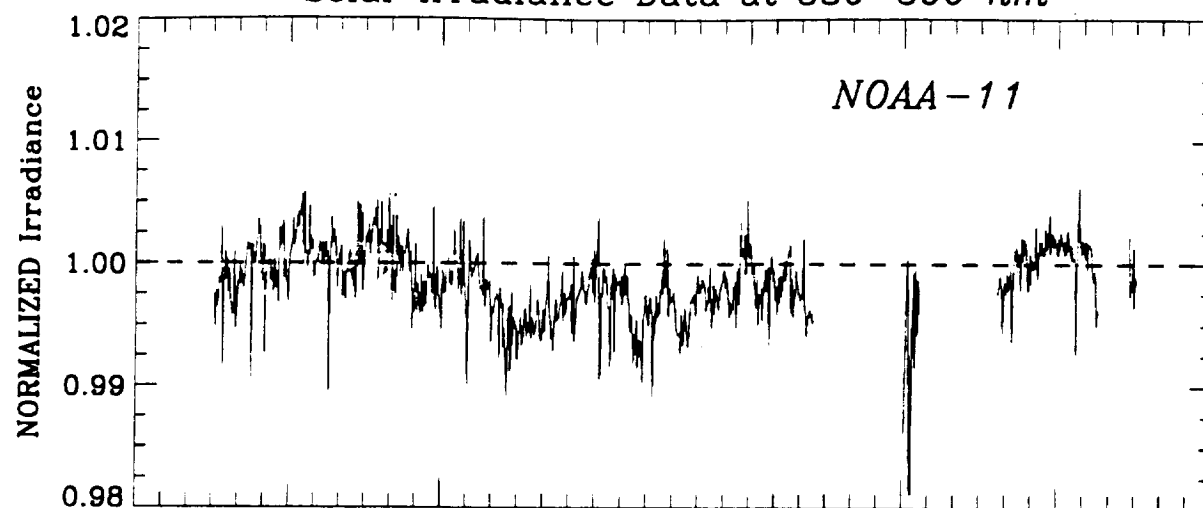




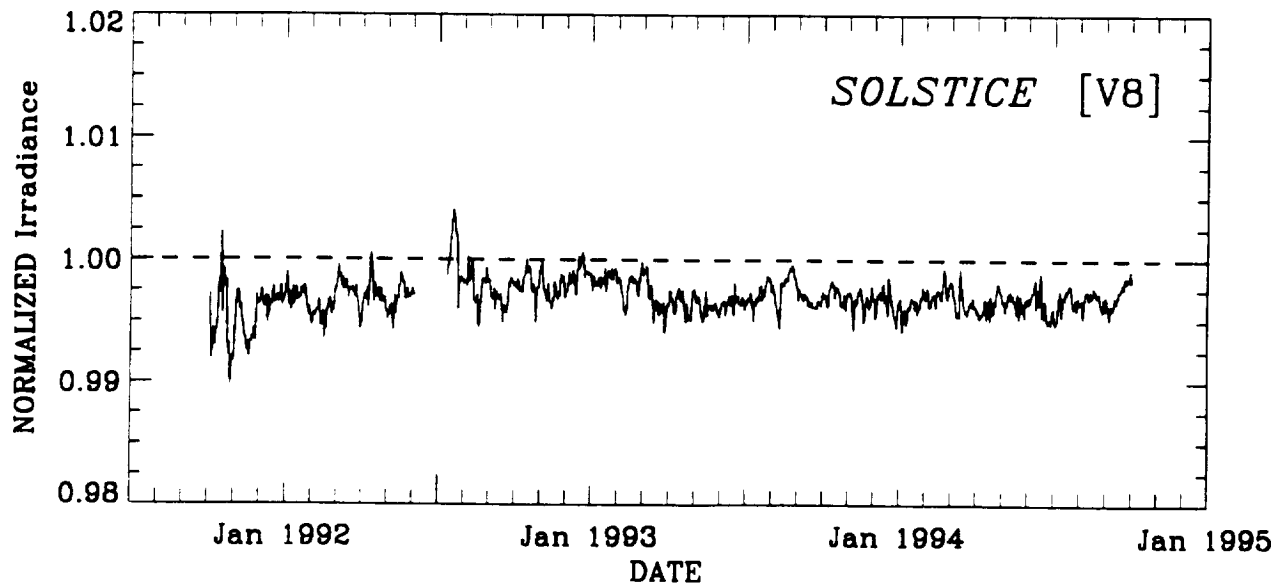
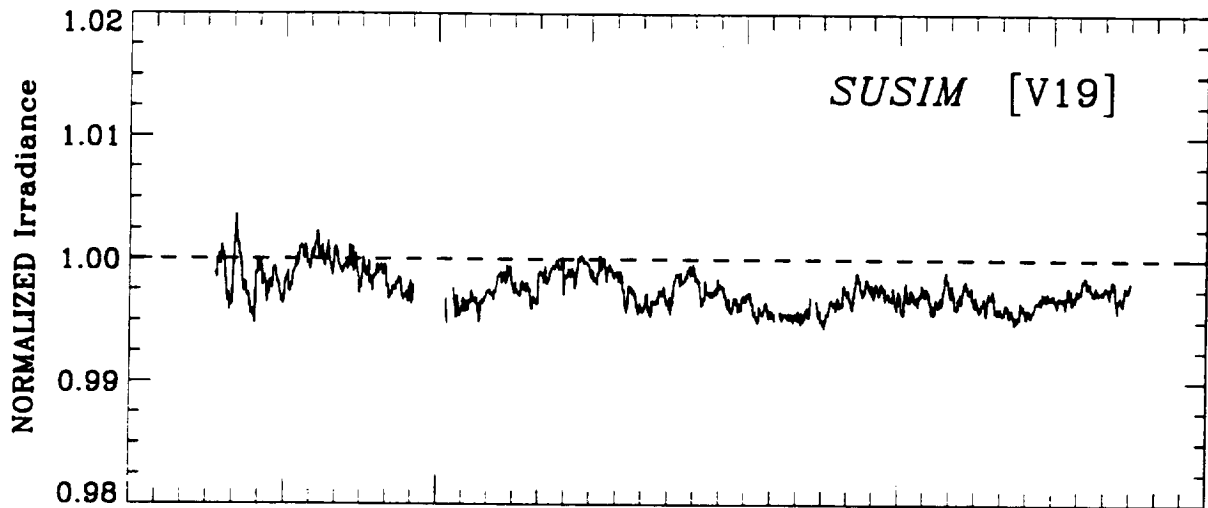
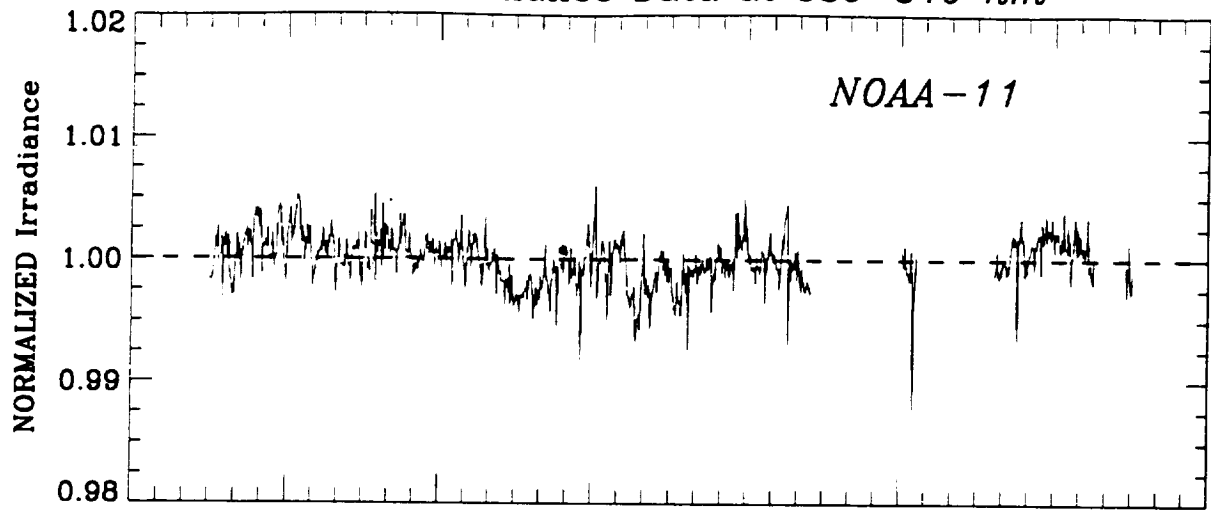
- ▶ NOAA-11 data overlap UARS solar instruments (SUSIM, SOLSTICE) during Oct 1991 - Oct 1994; Results shown here use SUSIM V19 data, SOLSTICE V8 data
- ▶ Long wavelengths ($\lambda > 300$ nm) generally have $\Delta F < \pm 1\%$; Raw data at short wavelengths ($\lambda < 260$ nm) show similar rotational activity, long-term decrease
- ▶ Evaluate drift at short wavelengths by removing predicted solar change from all data; Results good to 1-2% for selected bands; No indication of long-term bias in Mg II-based solar change values

Comparisons with UARS Irradiances

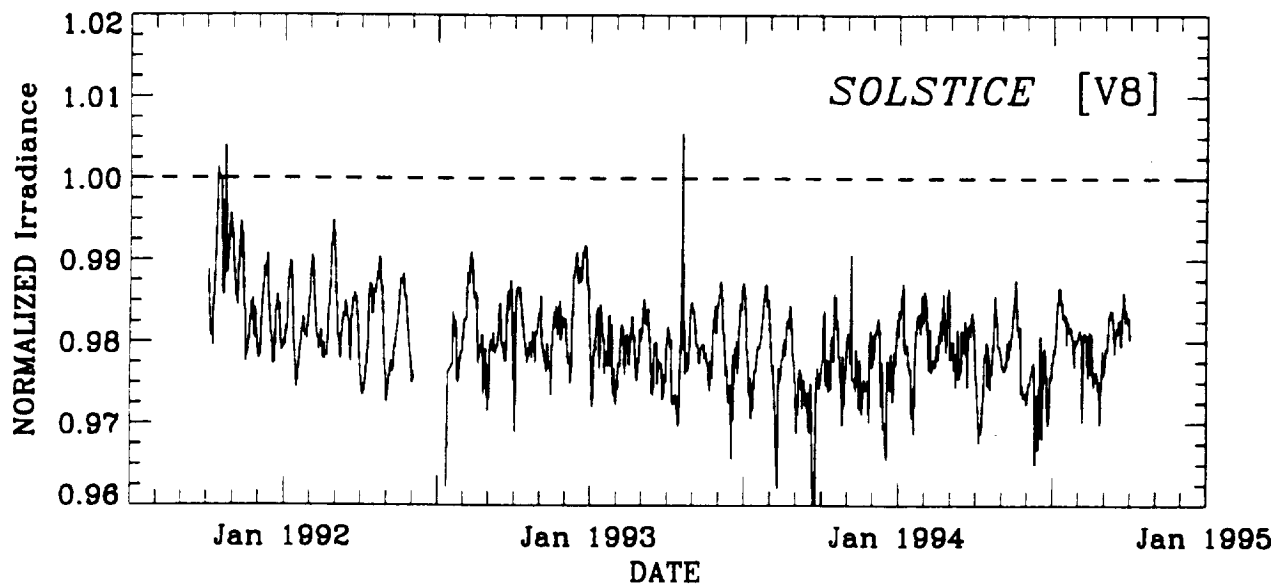
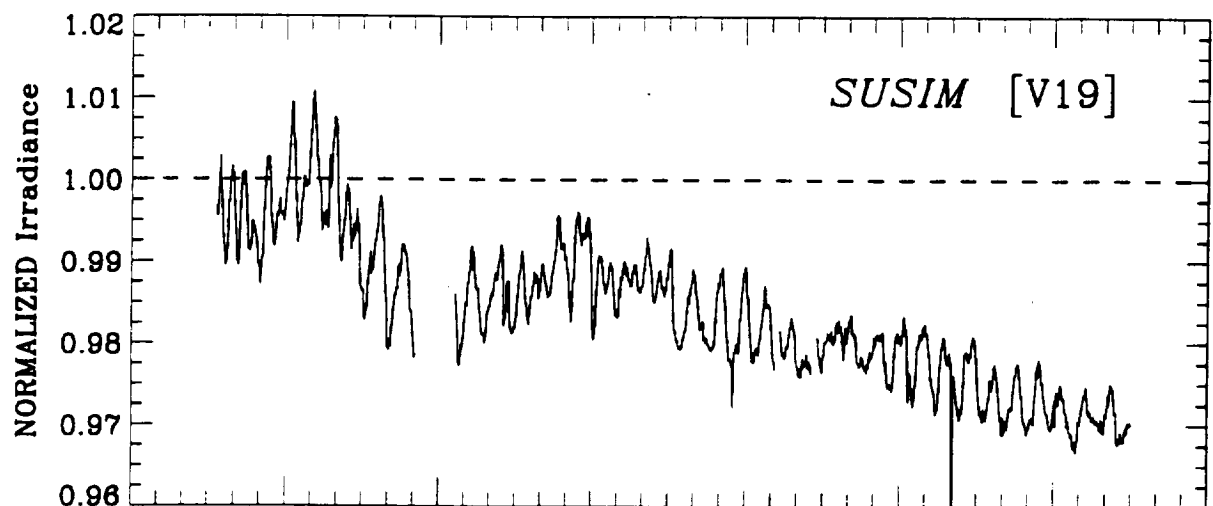
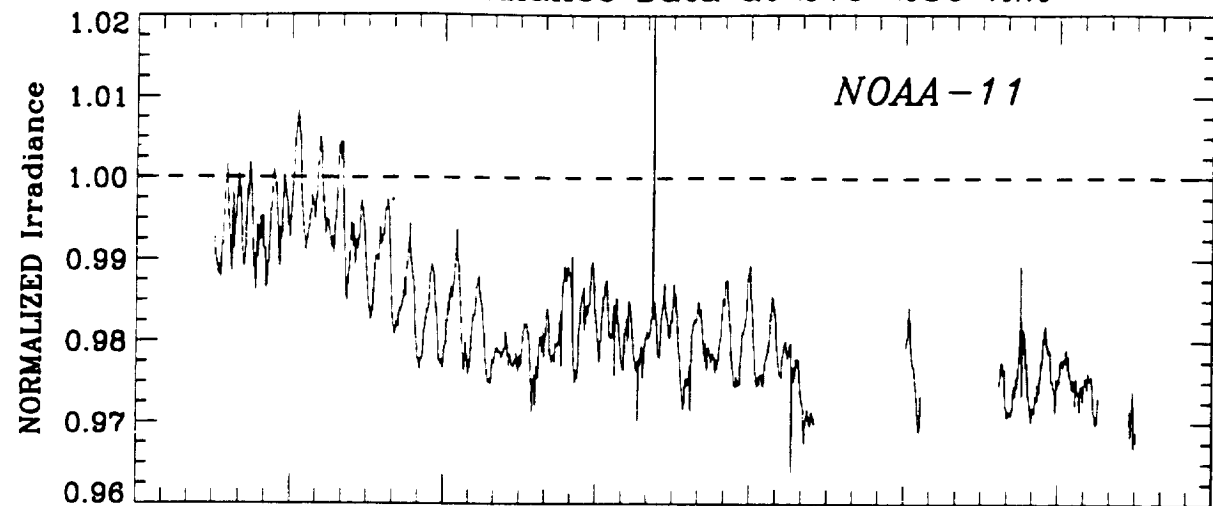
Solar Irradiance Data at 380-390 nm



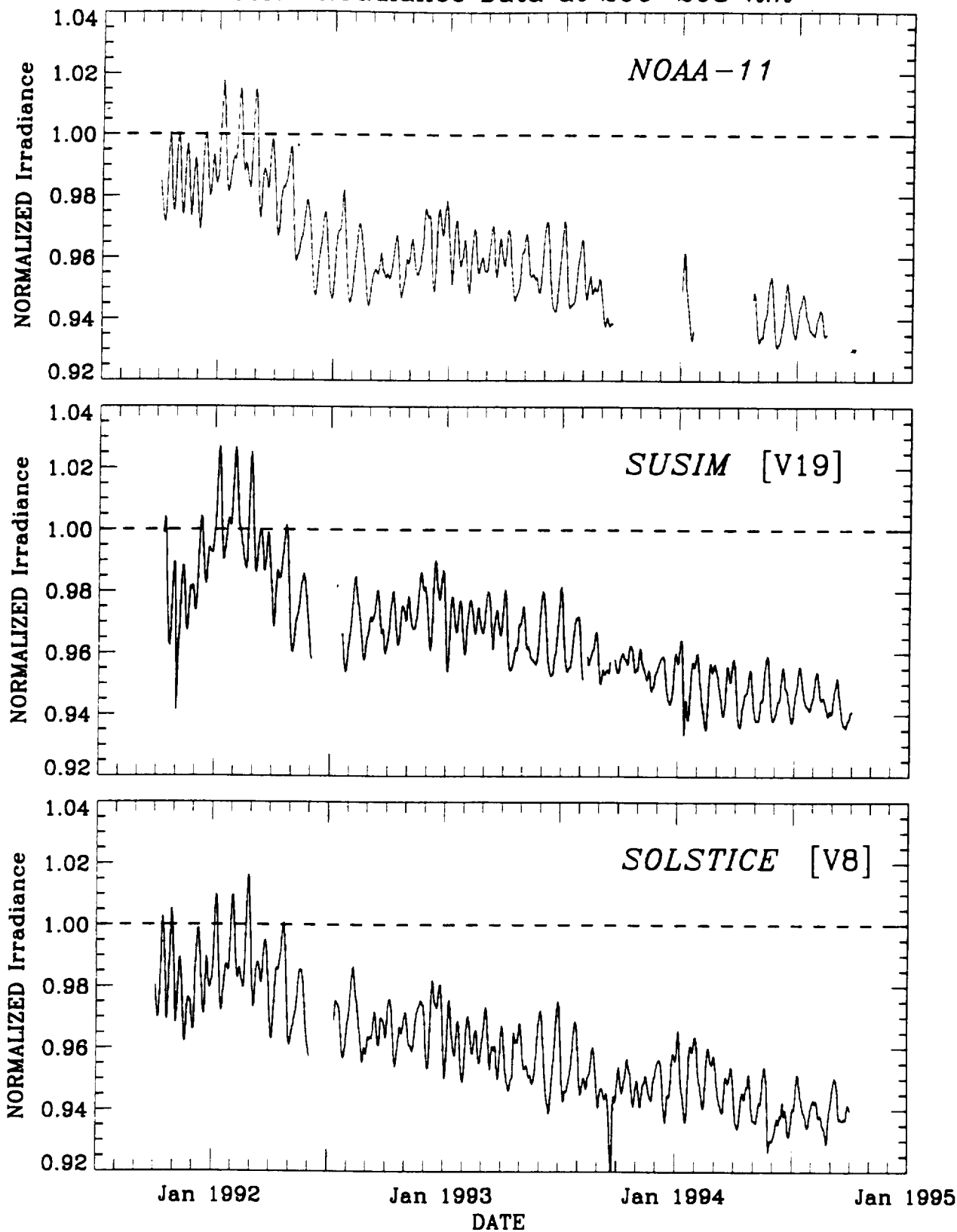
Solar Irradiance Data at 330-340 nm



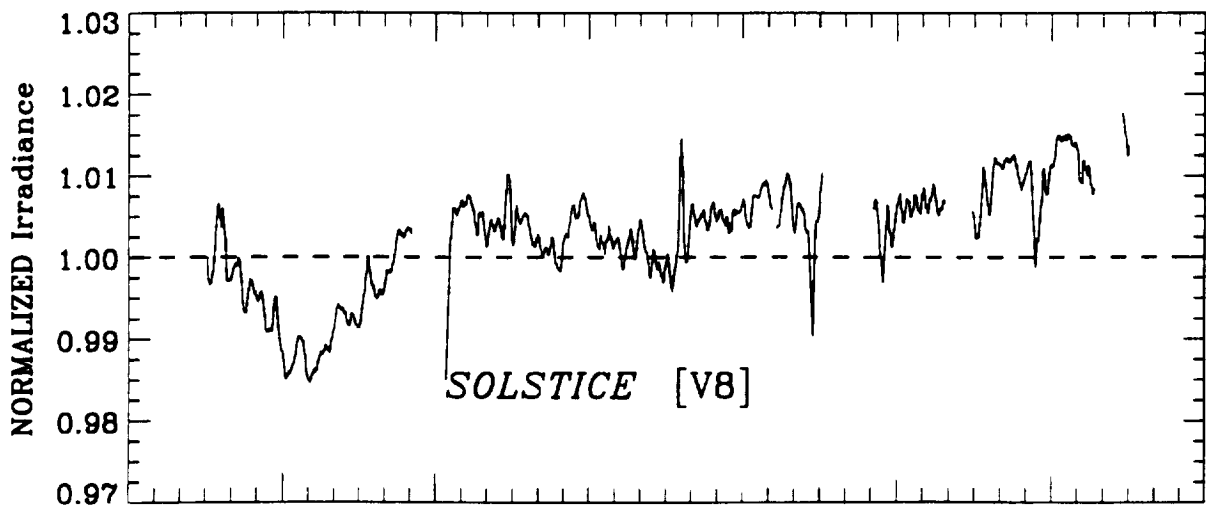
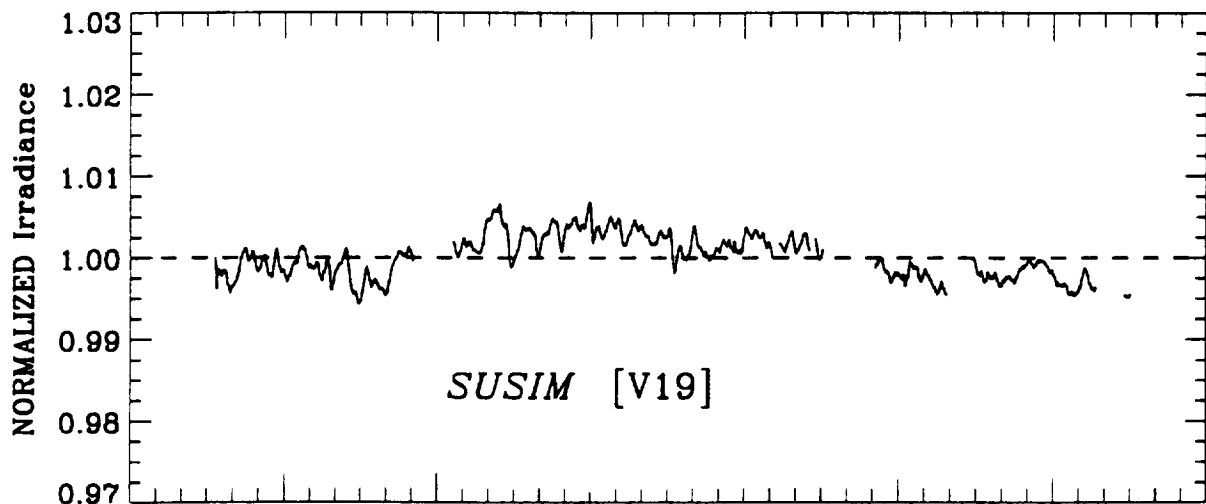
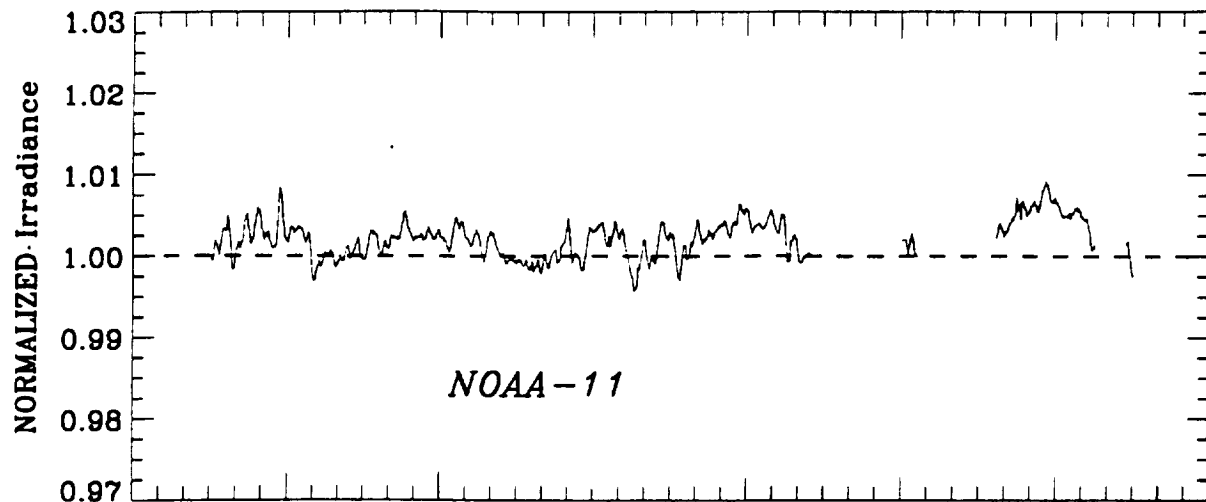
Solar Irradiance Data at 240-250 nm



Solar Irradiance Data at 200–208 nm



Irradiance Data at 240-250 nm
PREDICTED SOLAR CHANGE Removed



Jan 1992

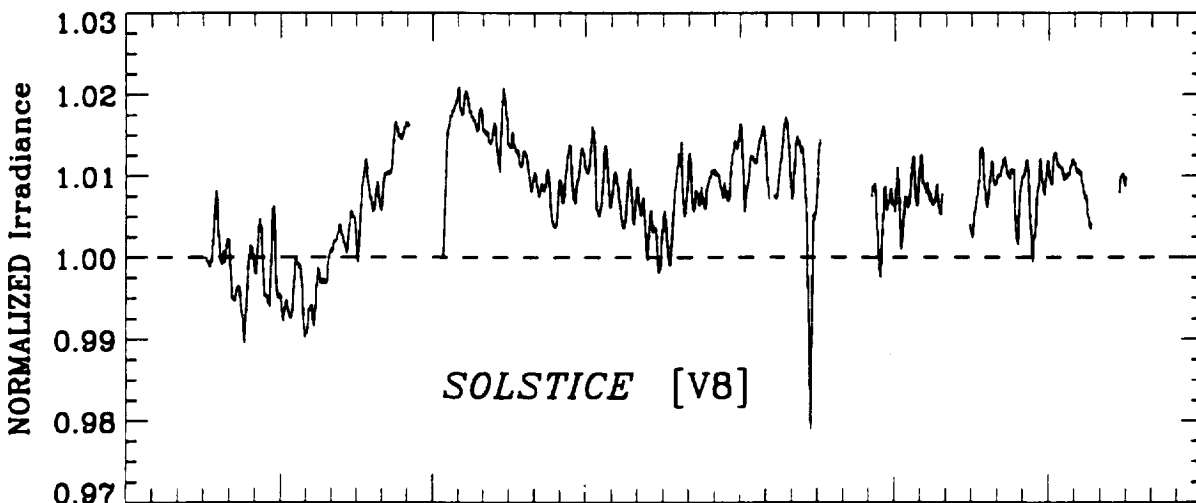
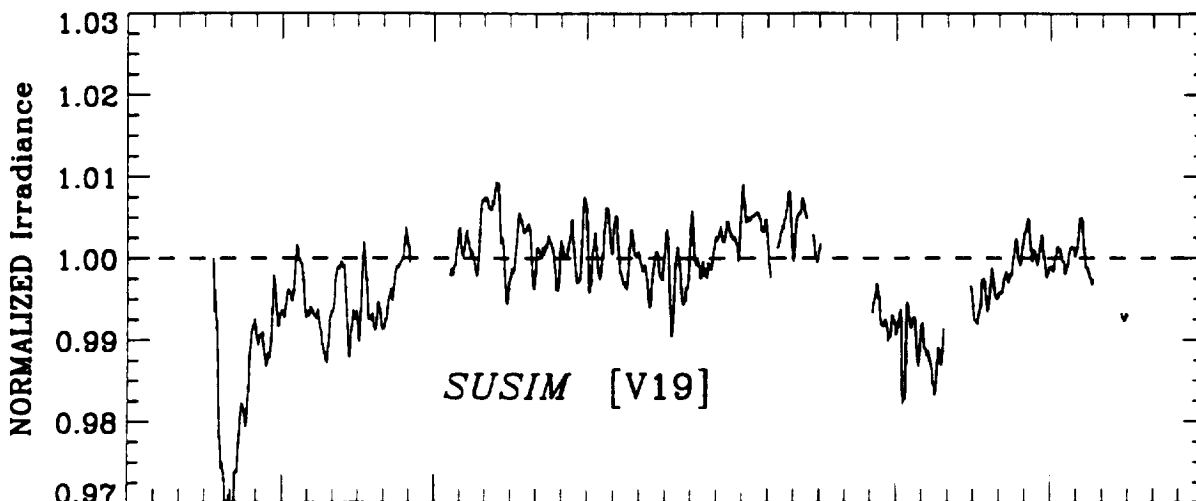
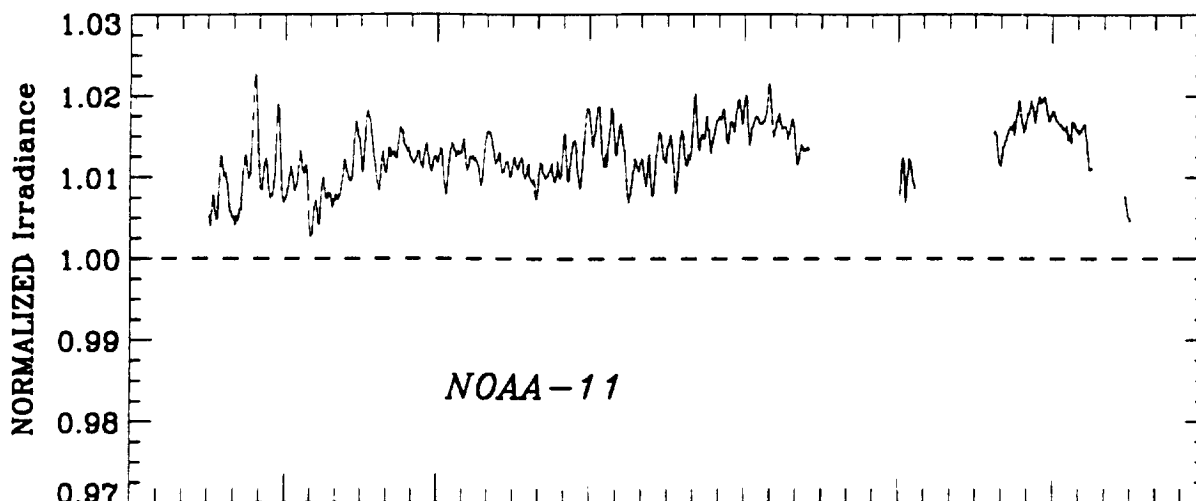
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Jan 1994

Jan 1995

DATE

Irradiance Data at 200-208 nm
PREDICTED SOLAR CHANGE Removed



Jan 1992

Jan 1993

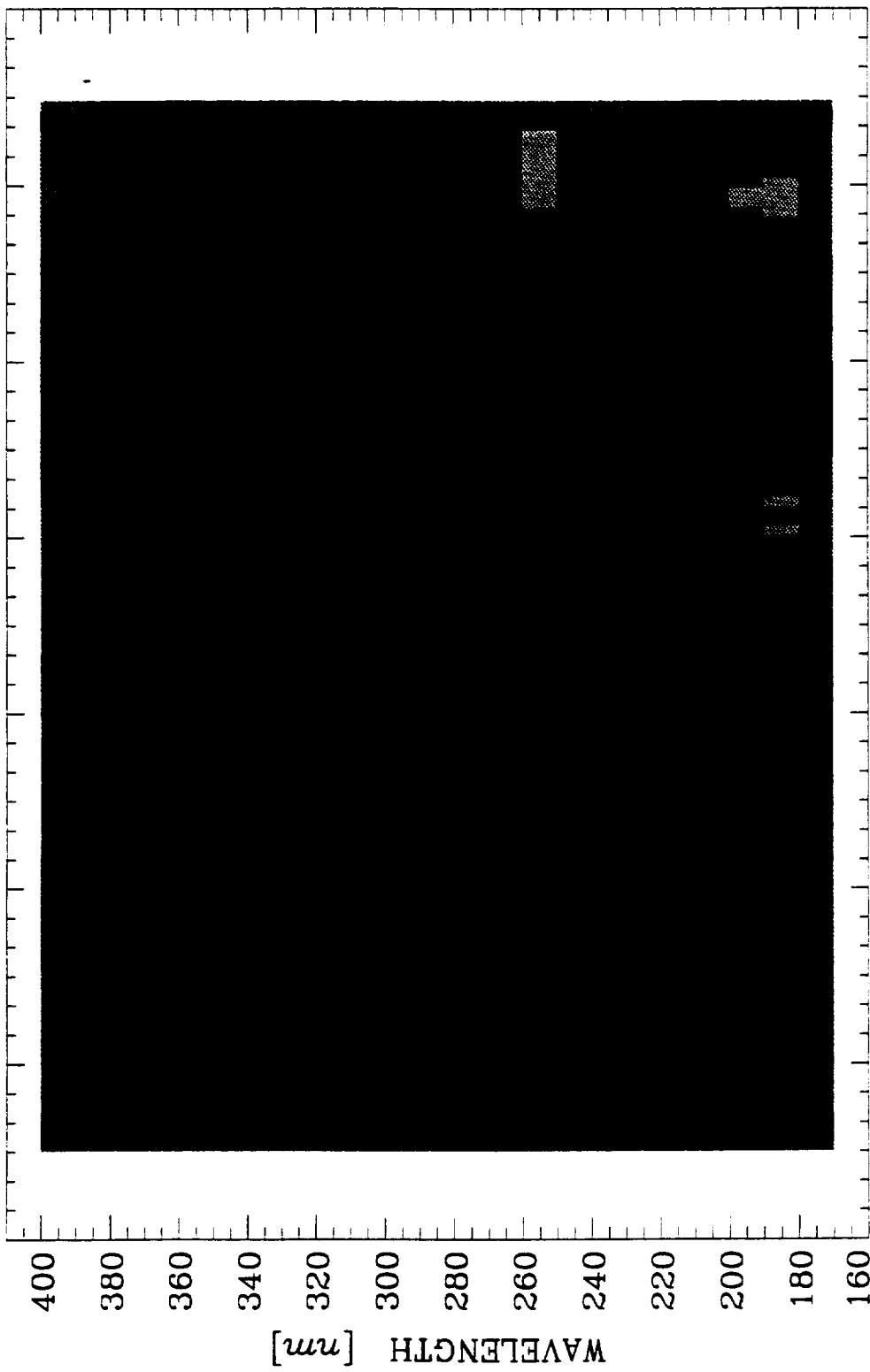
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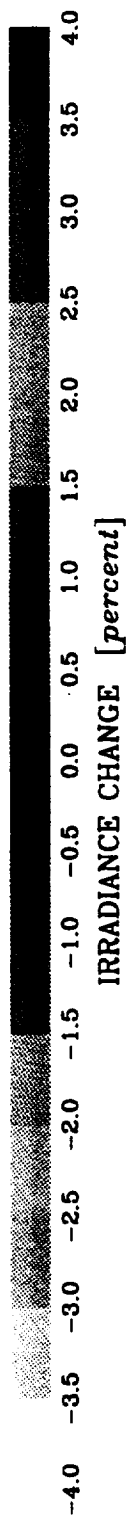
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- ▶ For full comparison, remove predicted solar change from all 10 nm bands and plot together
- **NOAA-11** data mostly within $\pm 1\%$ range, with drift of +1-2% at $\lambda < 200$ nm [*light green*]; These data represent later part of NOAA-11 data record
- **SUSIM** data fall in $\pm 1\%$ range, except for early dip at $\lambda < 230$ nm [*yellow*] and additional drift at 170-190 nm
- **SOLSTICE** data good to $\sim 1\%$ at 300-380, 220-260 nm; Drifts of -2% or more present in 260-300 nm region, particularly 290 nm [*yellow*]; Data for $\lambda < 210$ nm have positive drift, reaching $\Delta F = 3-4\%$ at 180-190 nm [*blue*]

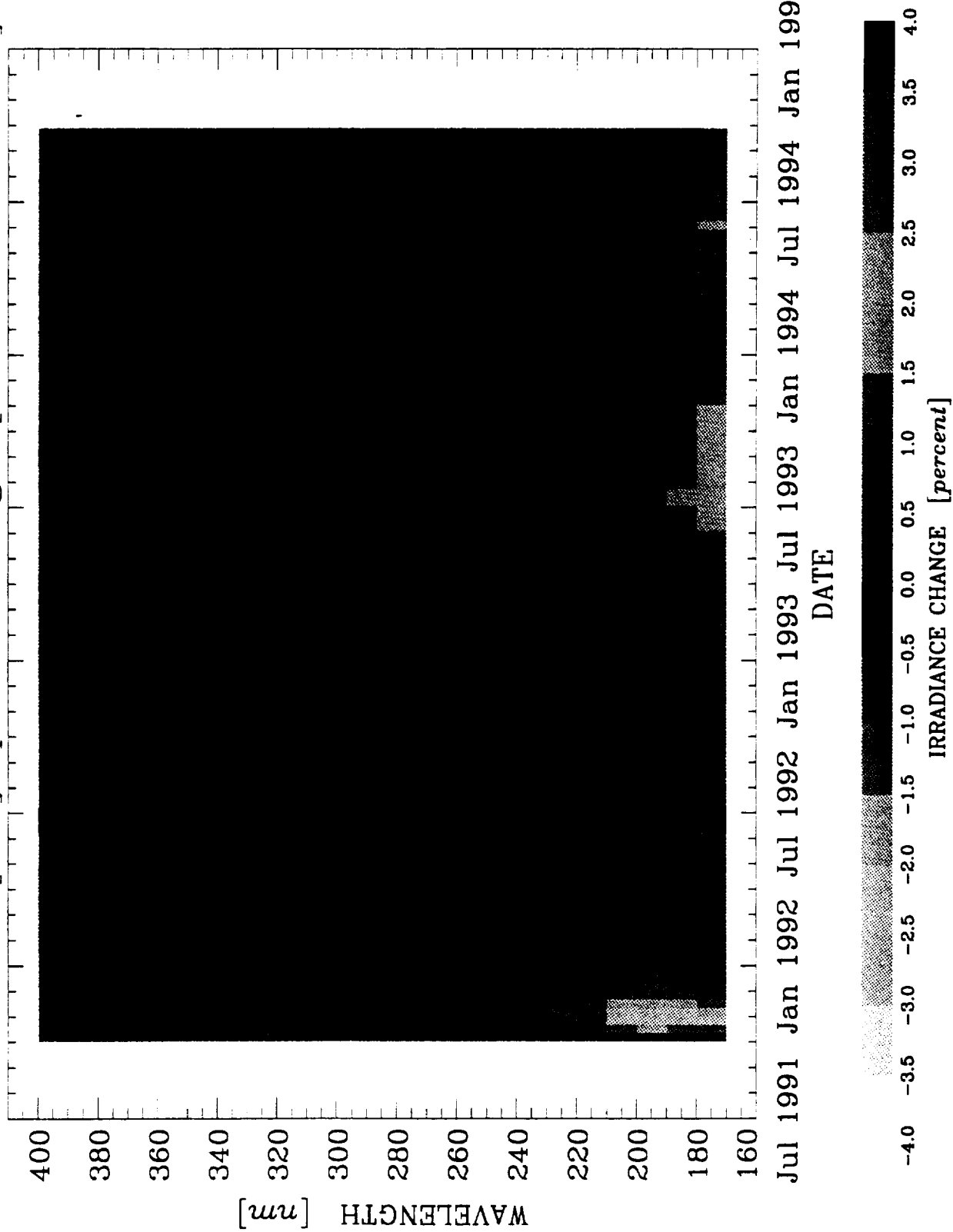
NOAA-11 SBUV/2 Spectral Change [DESOLARIZED DATA]



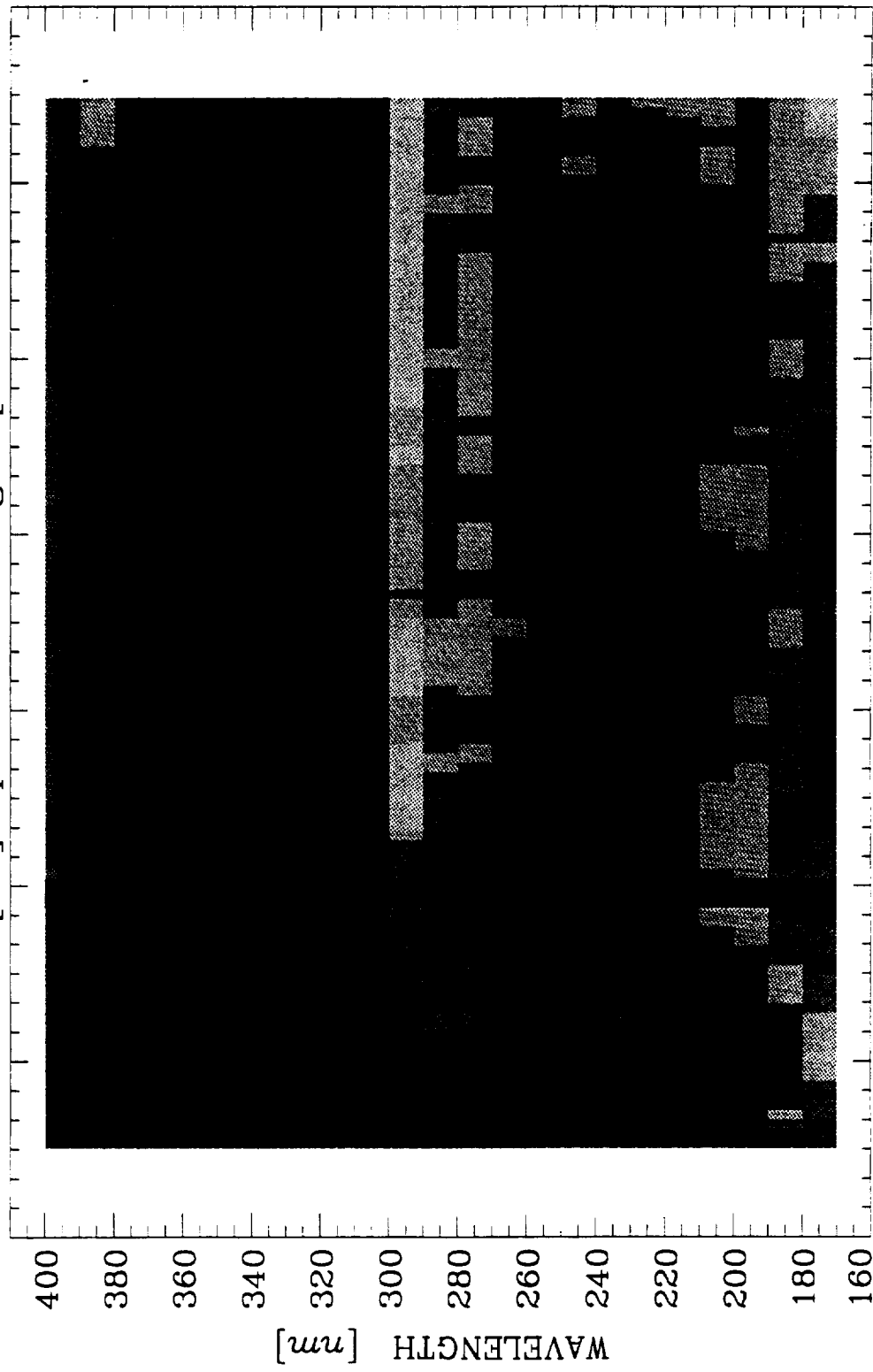
Jul 1991 Jan 1992 Jul 1992 Jan 1993 Jul 1993 Jan 1994 Jul 1994 Jan 1995



UARS SUSIM [V19] Spectral Change [DESOLARIZED DATA]



UARS SOLSTICE [V8] Spectral Change [DESOLARIZED DATA]



- ▶ NOAA-11 solar spectral irradiance data [170-400 nm, December 1988 - October 1994] have been processed with full corrections based on SSBUV coincident data
- ▶ Results have long-term accuracy of $\pm 1\%$ at most wavelengths; Solar change from late 1989 (maximum of Cycle 22) to October 1994 (close to minimum) $\approx -(6-7)\%$ at 200-208 nm, $-(3-4)\%$ at 240-250 nm
- ▶ Comparisons with coincident UARS data during 1991-1994 show that NOAA-11 irradiance data have comparable long-term accuracy, representation of short-term variations
- ▶ NOAA-11, NOAA-9 discrete Mg II index data and Mg II scale factors now available at anonymous FTP site [*ssbuv.gsfc.nasa.gov*]; **NOAA-11 spectral irradiance data will be available on-line in Summer 1997**

CONCLUSIONS

Solar UV Data: CYCLES 21-22

