Solar variability measured by GOME and SCIAMACHY in the uv/visible/NIR spectral range

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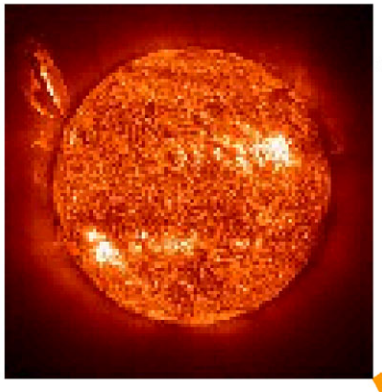
Solar variability and the atmosphere (climate)

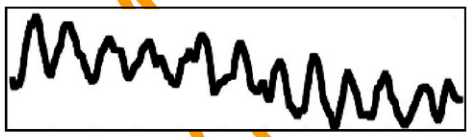


solar activity

solar irradiance

SCIAMACHY, GOME ...

solar proxies



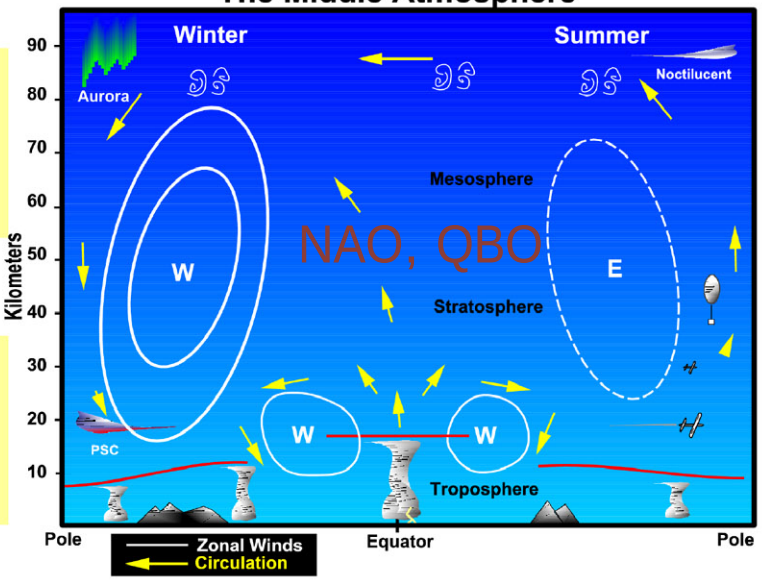
ozone and other trace gases

climate change

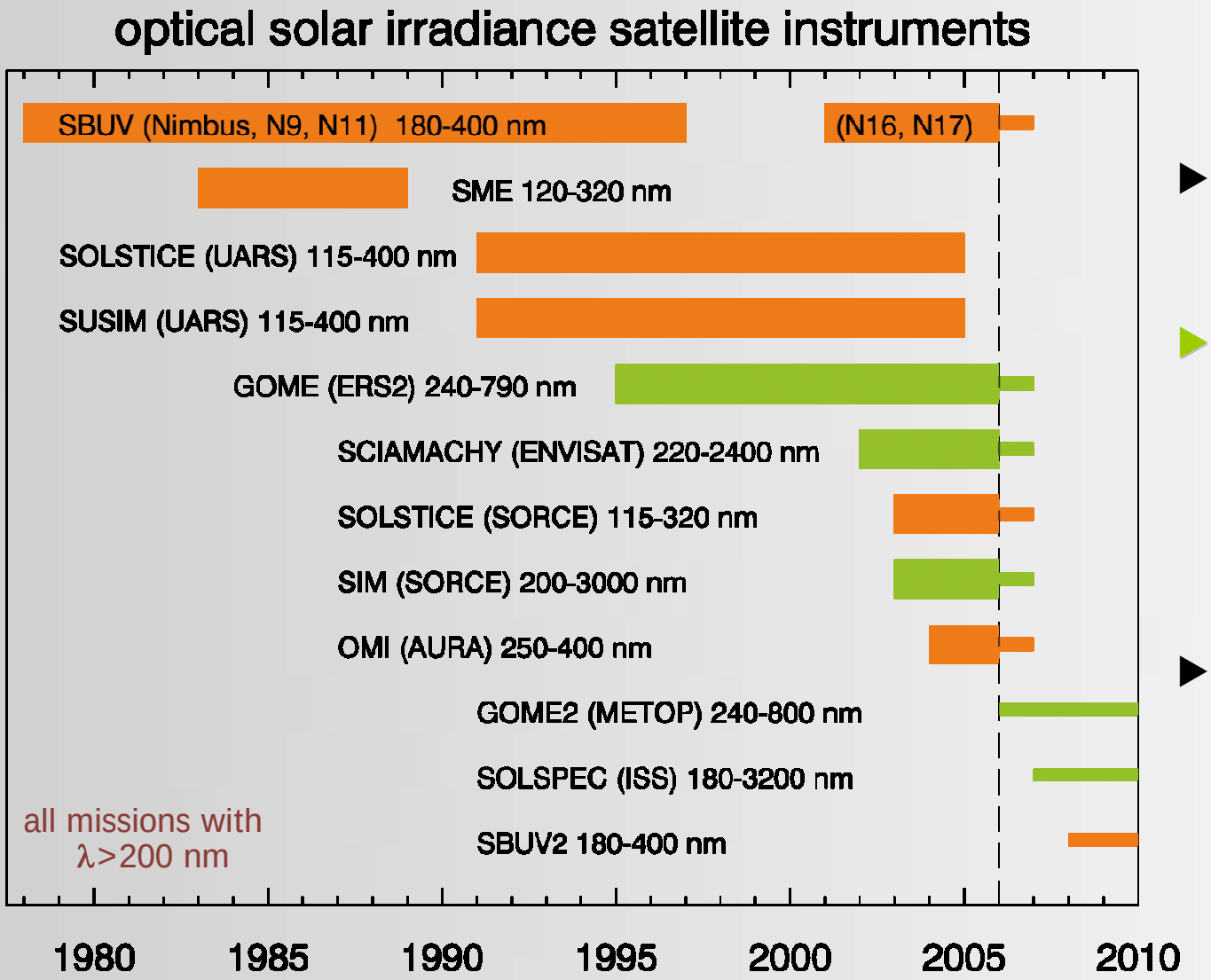
chemistry & transport

temperature & dynamics

The Middle Atmosphere

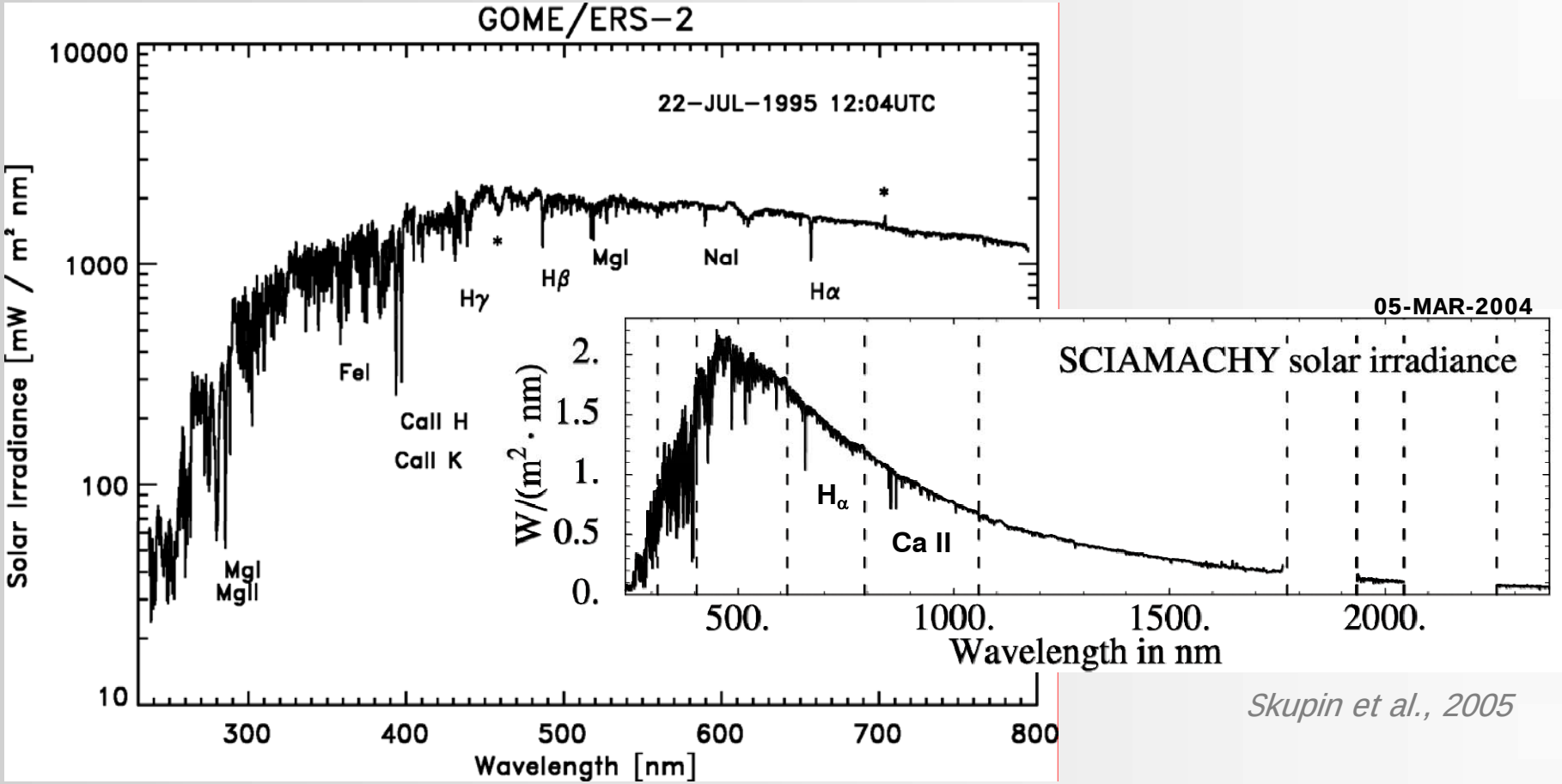


Past and future UV/Vis irradiance montoring



- UV irradiance monitoring from space since 1978
- Only few missions cover visible/NIR wavelengths
  - ➔GOME
  - ➔SCIAMACHY
  - ➔SIM
- Disadvantage of „atmospheric sounders“:
  - ➔lack of rigorous inflight calbration

GOME and SCIAMACHY solar spectrum

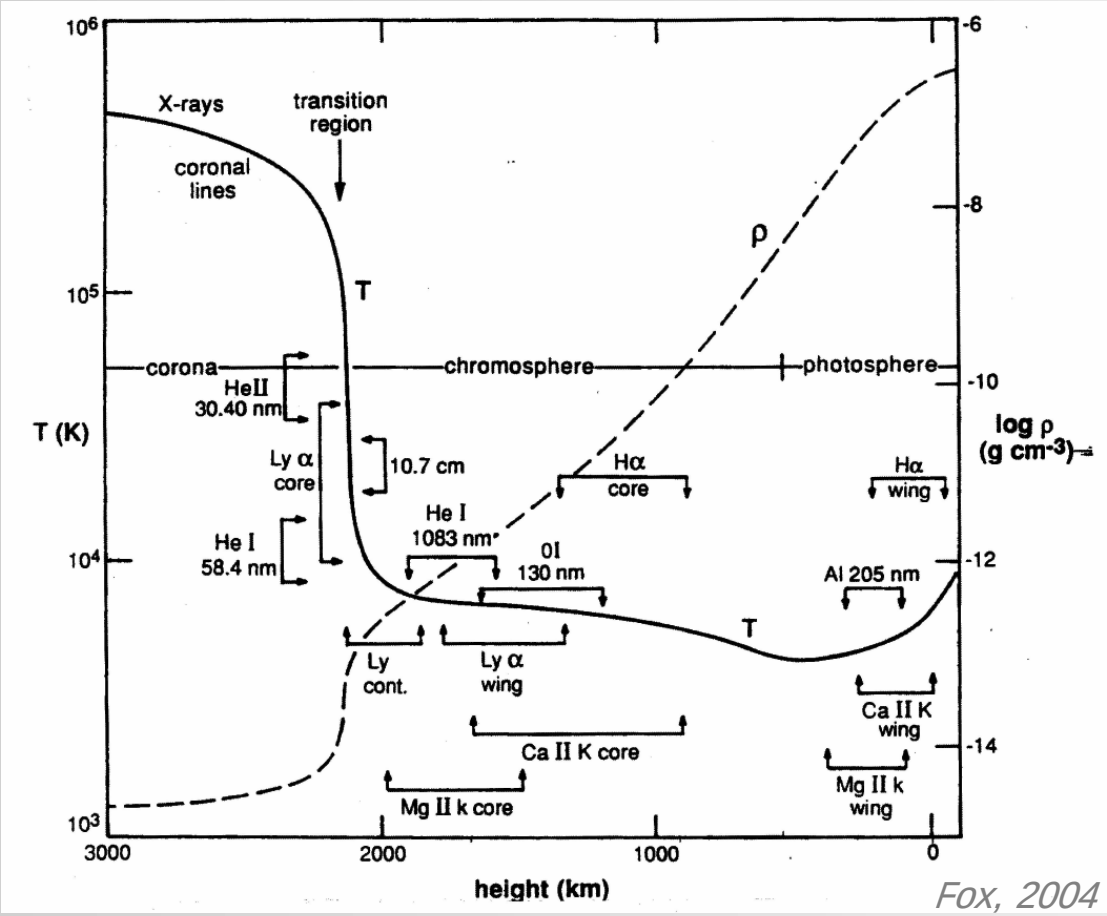


Skupin et al., 2005

Weber et al., 1998, Weber 1999

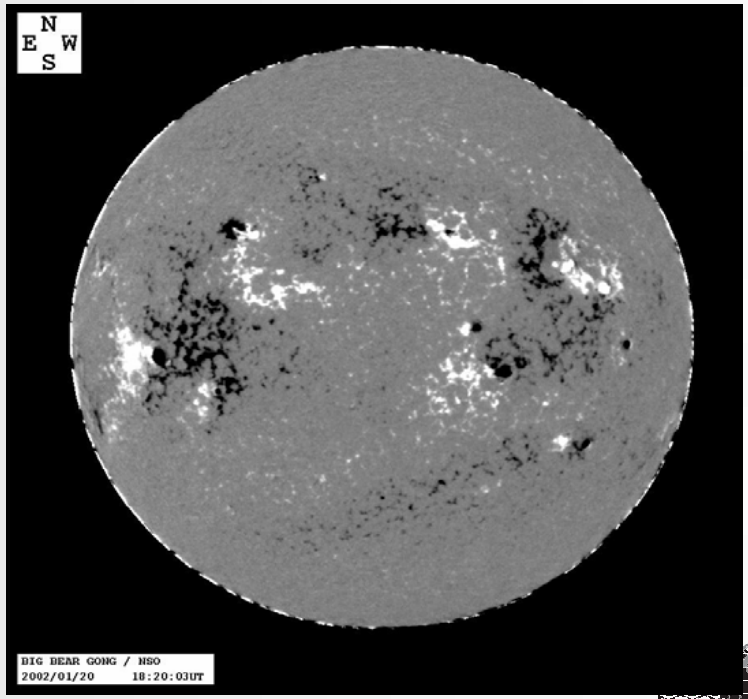
- Direct full disc solar measurements with diffuser once a day (GOME & SCIAMACHY)
- in addition uncalibrated full disc observations in „occultation“ mode (w/o diffuser) every 1.5 hrs (SCIAMACHY only)

Origin of solar variability



Fox, 2004

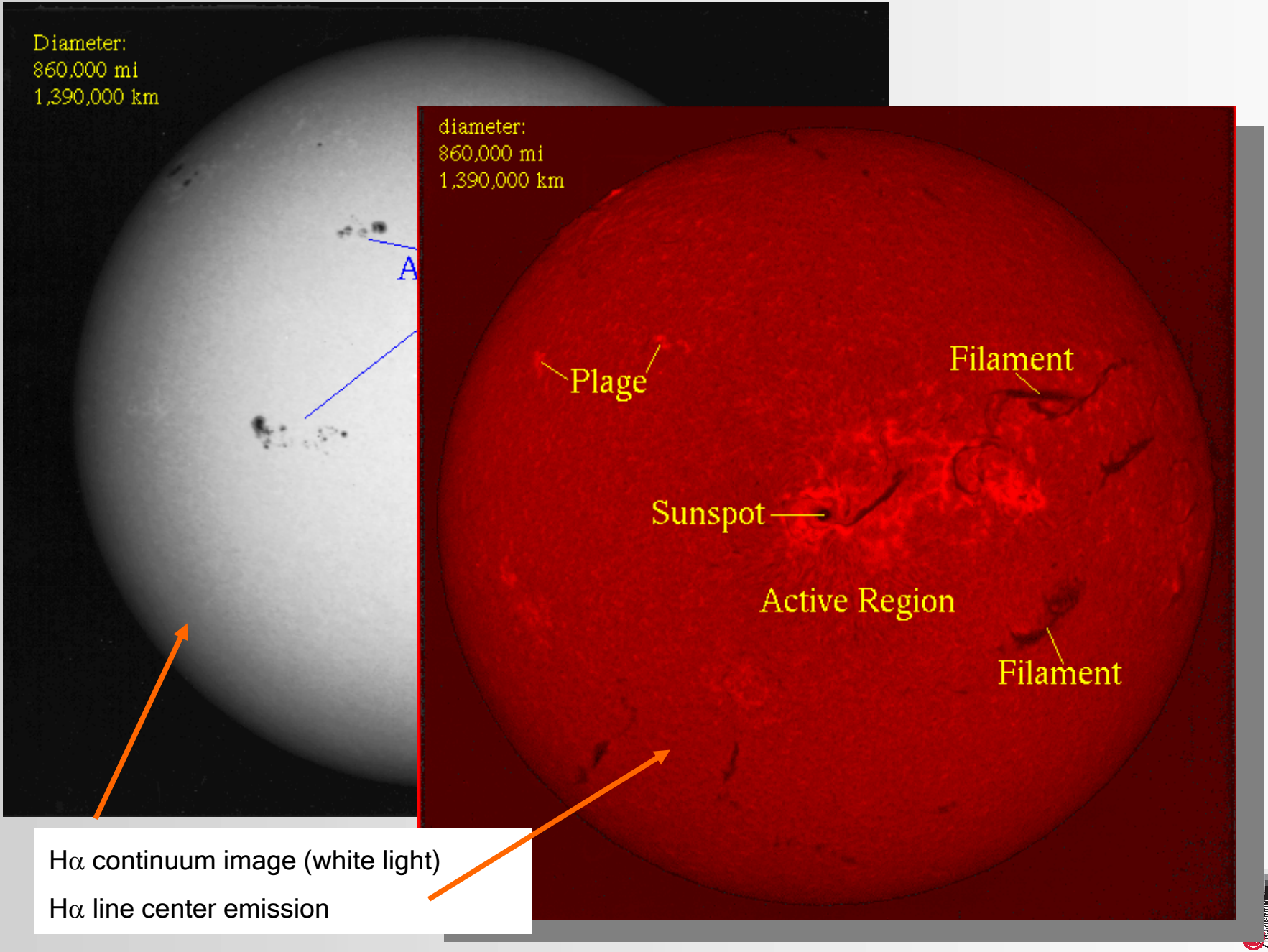
- Solar UV/vis radiation originates
  - ➔ upper photosphere
  - ➔ chromosphere
  - ➔ transition region
- Solar UV below 400 nm contributes about 30% to total solar flux (solar constant)



GONG magnetogram

- variations in received solar UV irradiance are caused by the emergence and decay of active regions as they transit the solar disk.
- Active regions contain enhanced:
  - ➔ UV brightness (faculae and plages)
  - ➔ localized enhanced magnetic fields

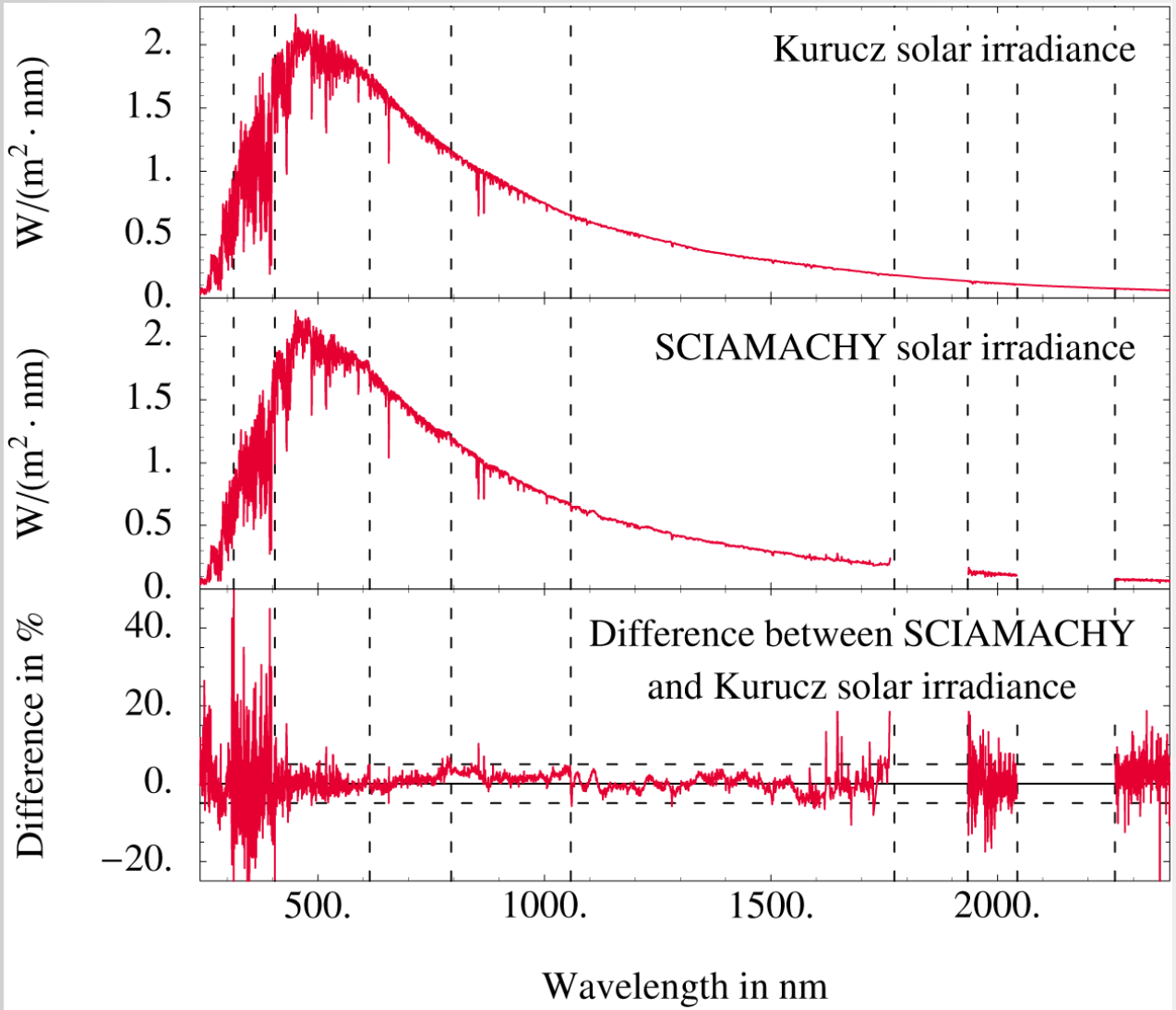
origin of irradiance variability



Hα continuum image (white light)

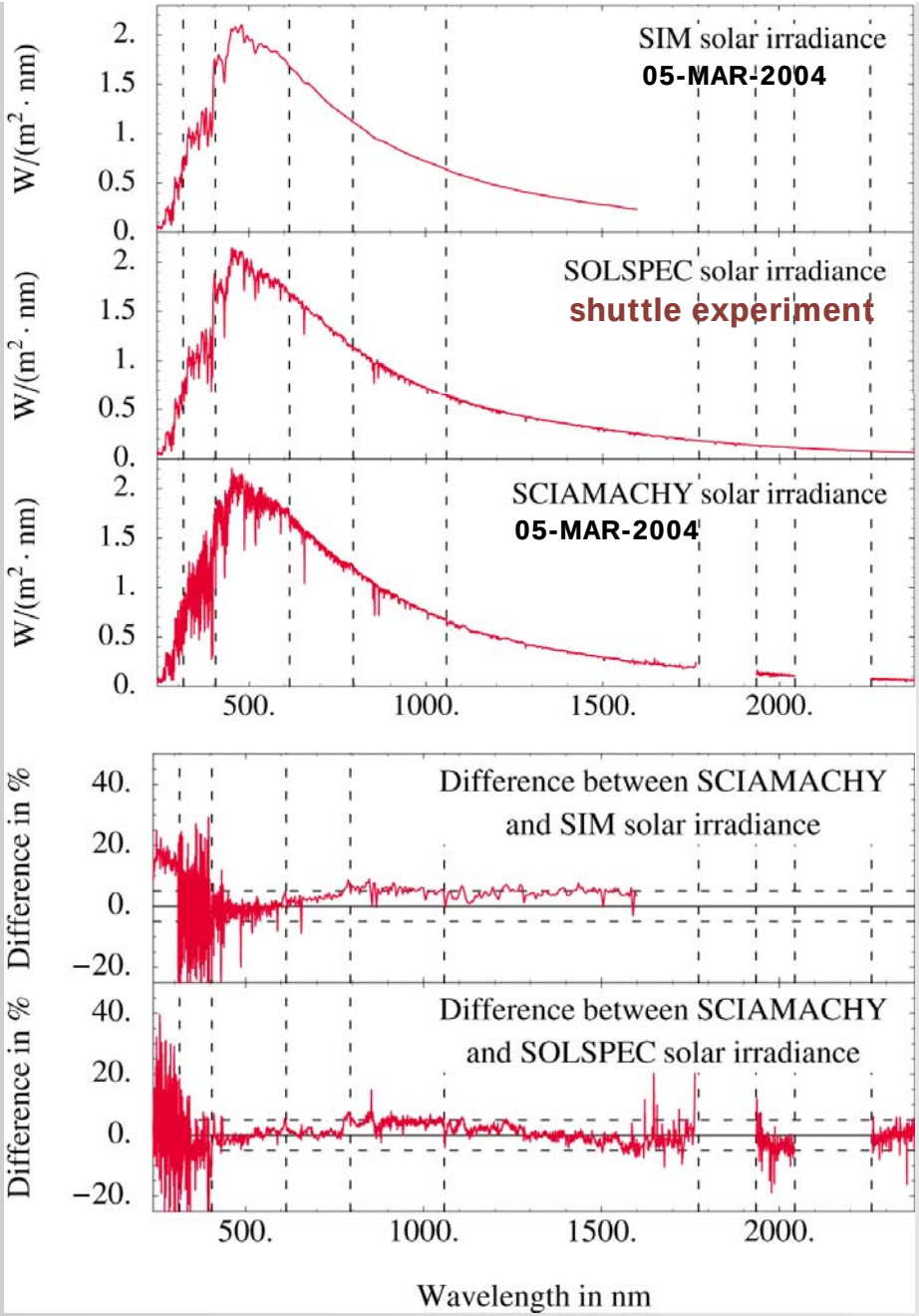
Hα line center emission

Irradiance comparison with ground data



Skupin et al., 2005

- Kurucz FTS spectrum from Kitt Peak Observatory, Arizona
- SCIA spectra calibration including etalon correction with inflight white light source (WLS) spectra referenced to ground WLS data
- good agreement to within 3% (approximately within the uncertainties of primary calibration standards)

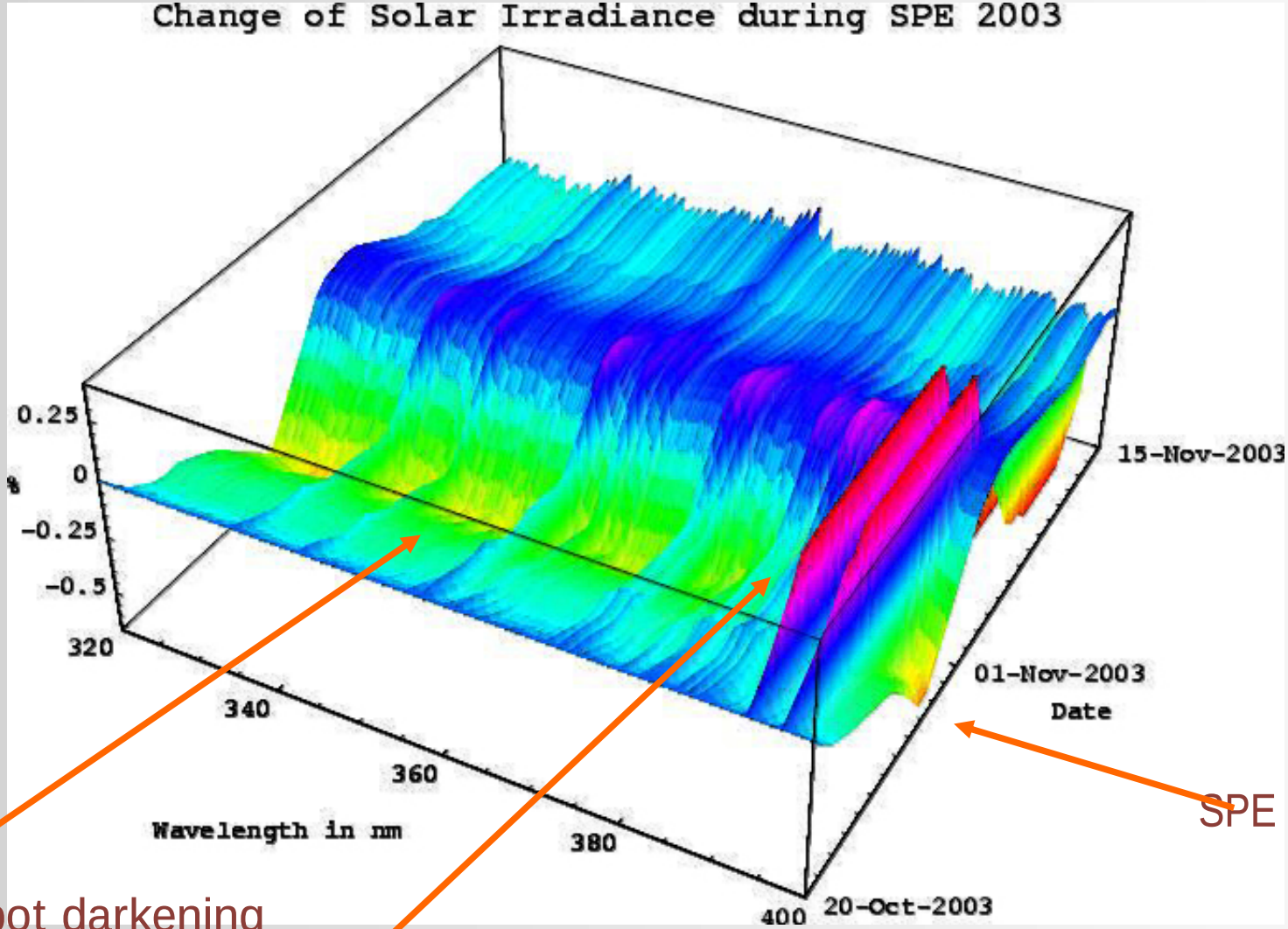


Skupin et al., 2005

Comparison with other satellites

- SIM (2003-) is the only other mission providing daily UV/vis/NIR irradiance measurements
- SCIA spectral resolution in visible (~0.5 nm) is higher than SIM's (~4-20 nm)
- SOLSPEC a shuttle experiment flown several times for brief periods (planned for ISS after 2007)
- General good agreement to within +5%
- SIM results are preliminary!
- Further improvements in SCIA lv1 calibration to be expected (reprocessed data V6)

Solar irradiance during SPE 2003: UV



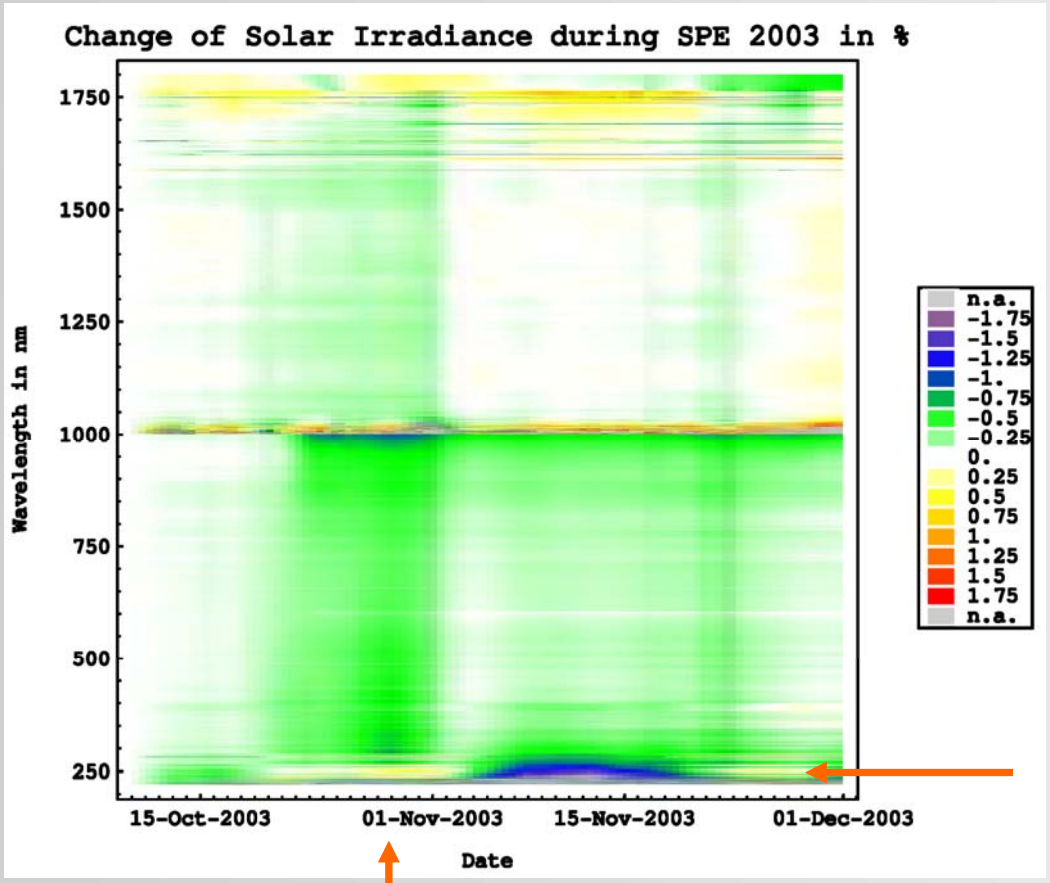
Sunspot darkening

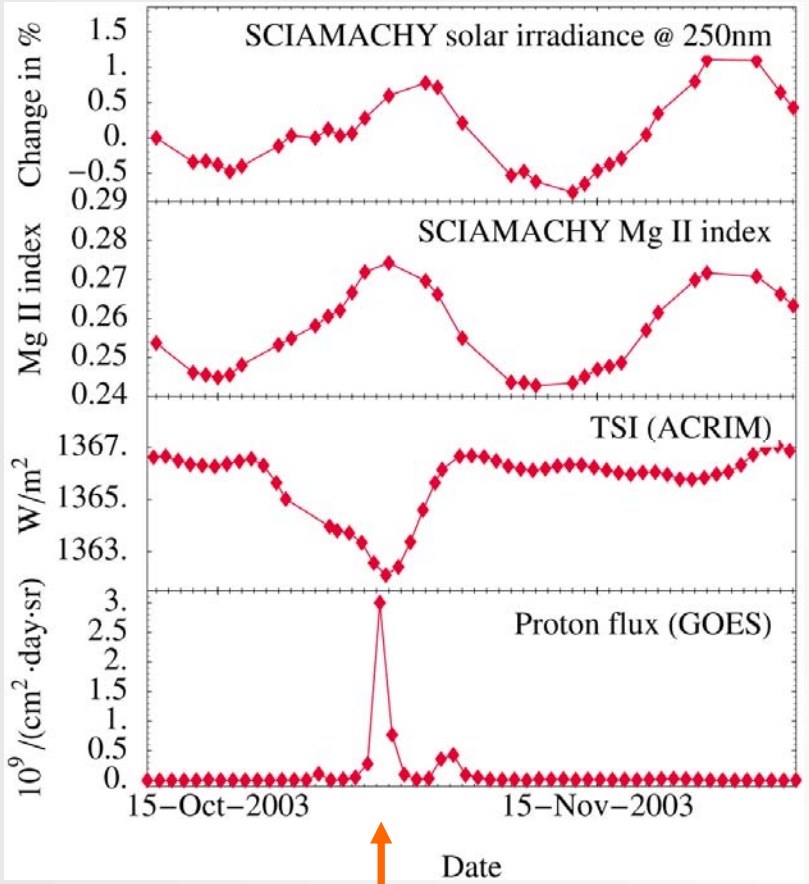
chromospheric activity
Ca II K and H line center

SPE

Solar Proton Event related
ozone loss from SCIAMACHY
(see Poster Rohen et al.)

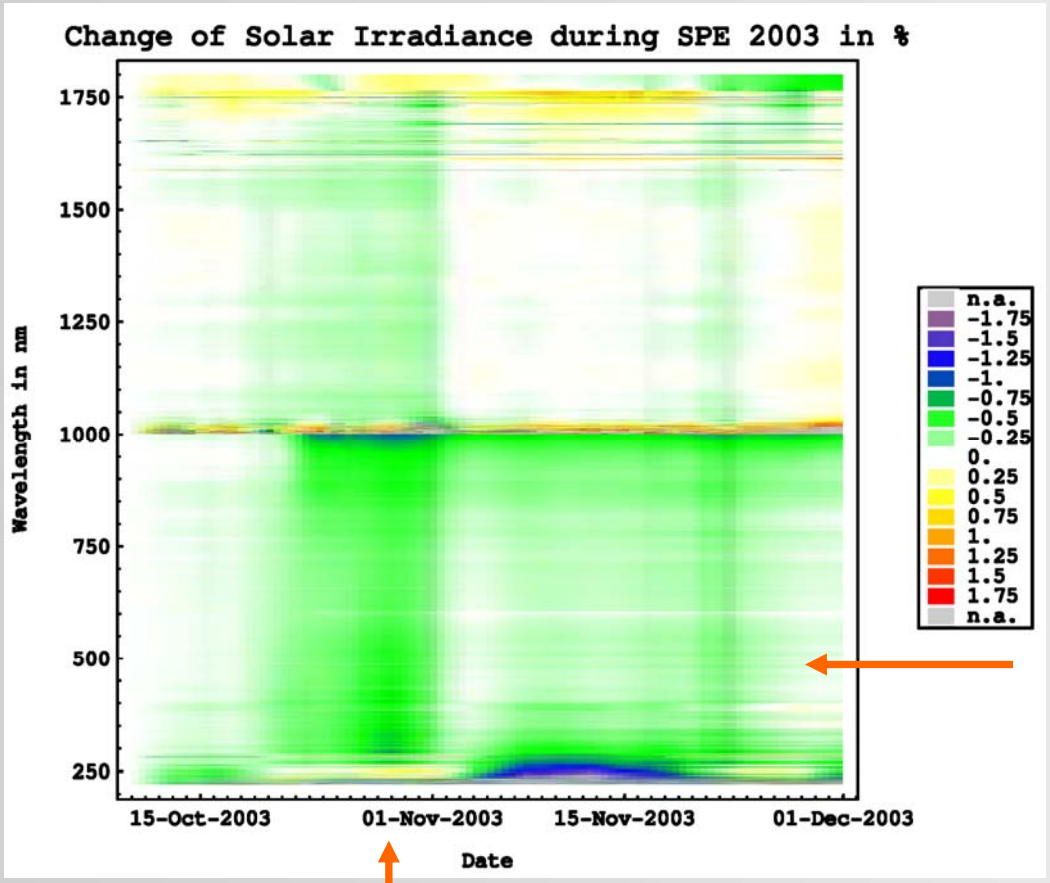
Solar irradiance during SPE 2003: UV

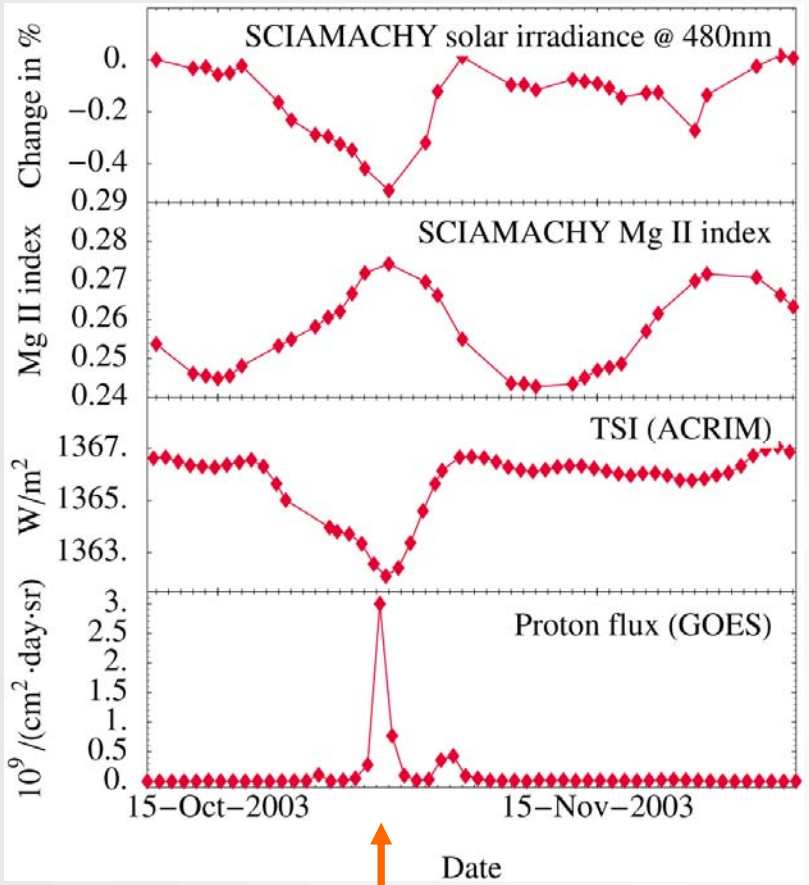




SPE

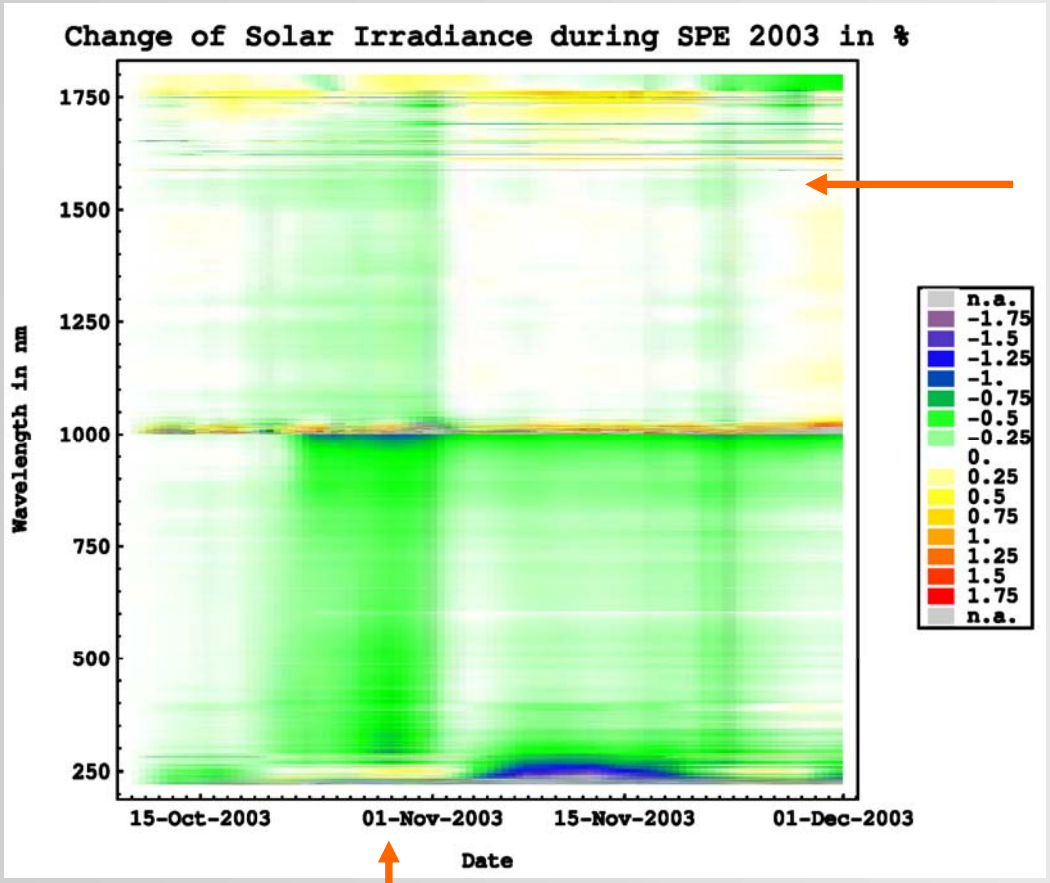
Solar irradiance during SPE 2003: VIS

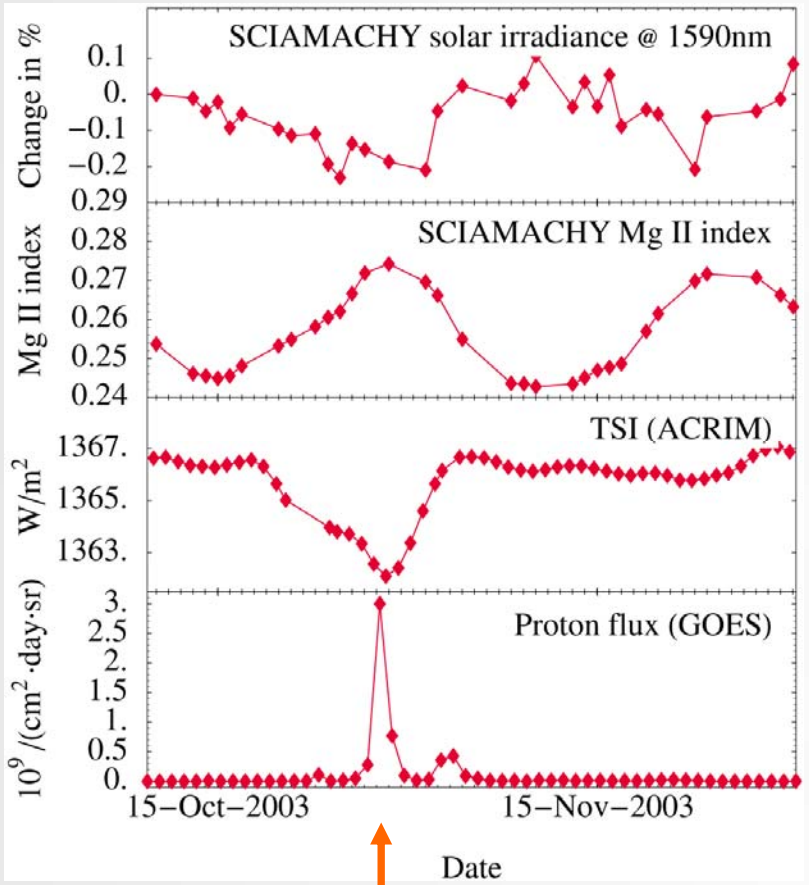




SPE

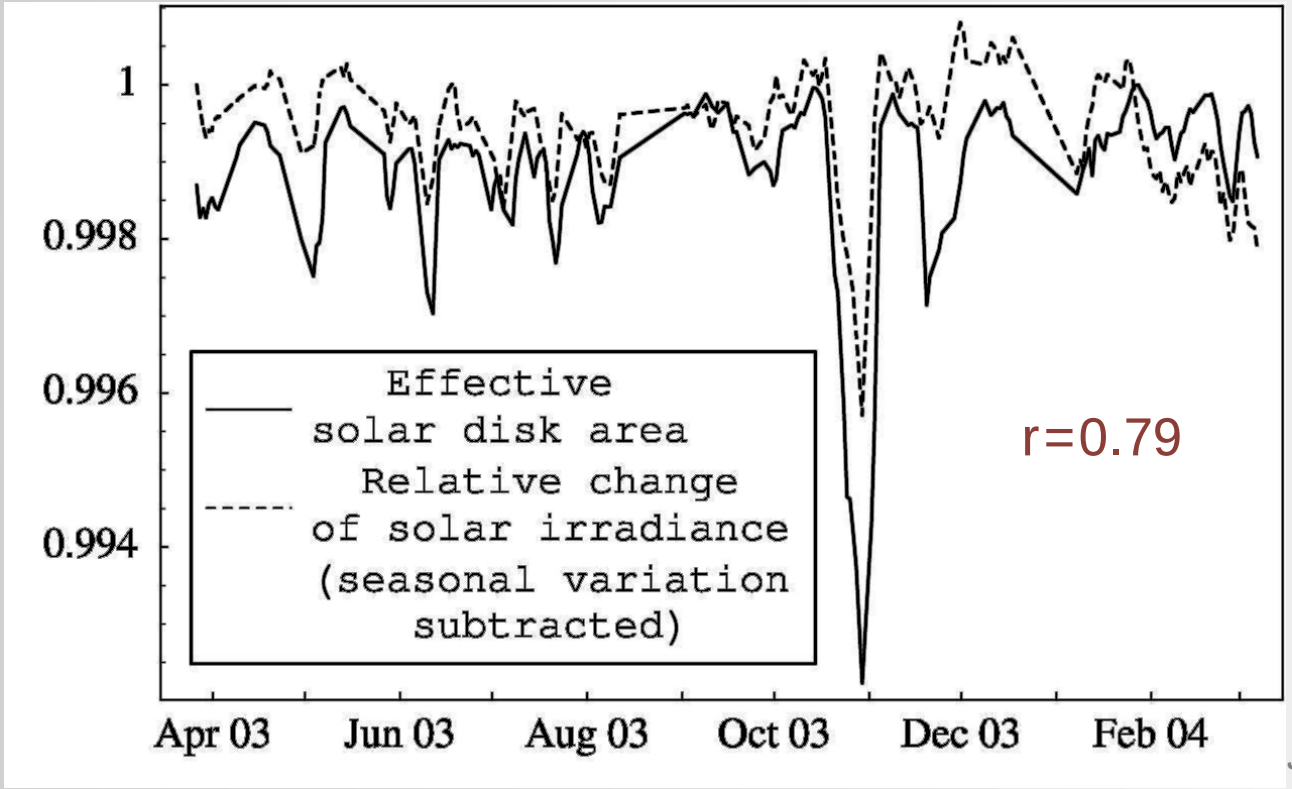
Solar irradiance during SPE 2003: NIR





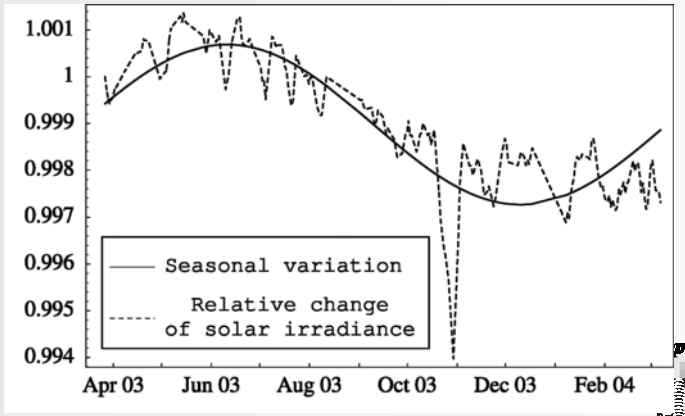
SPE

Variability in the visible range



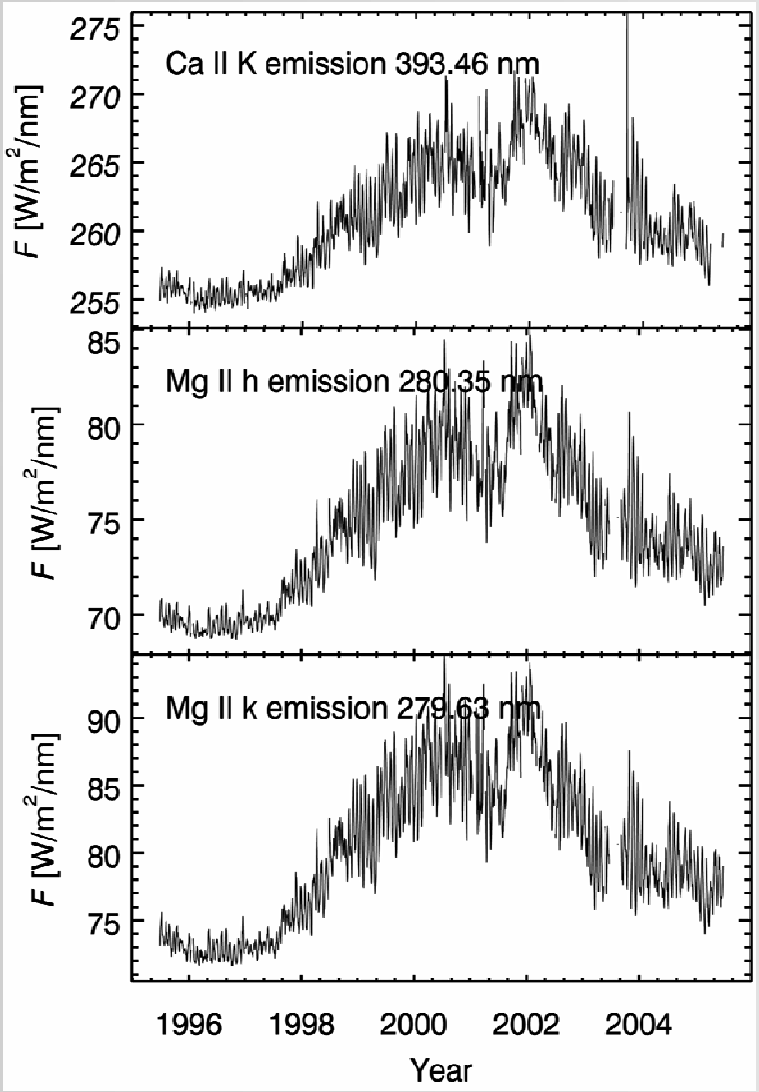
- Time series around 500 nm (maximum of solar irradiance)
- Effective solar disk area (solar disk area minus sunspot area) correlates with 500 nm irradiance

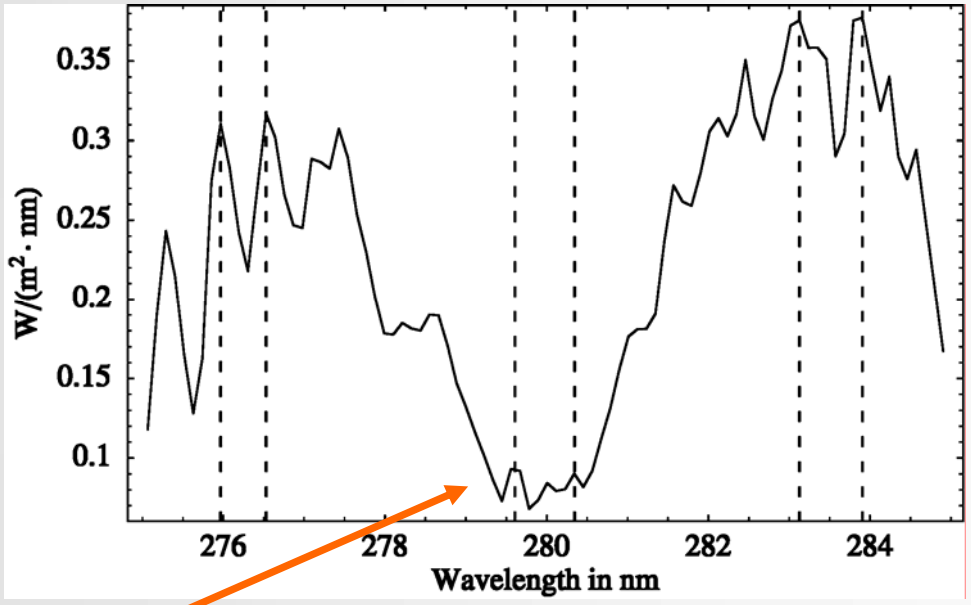
Skupin et al., 2005



Seasonal correction applied before correlating with efective sun disc area

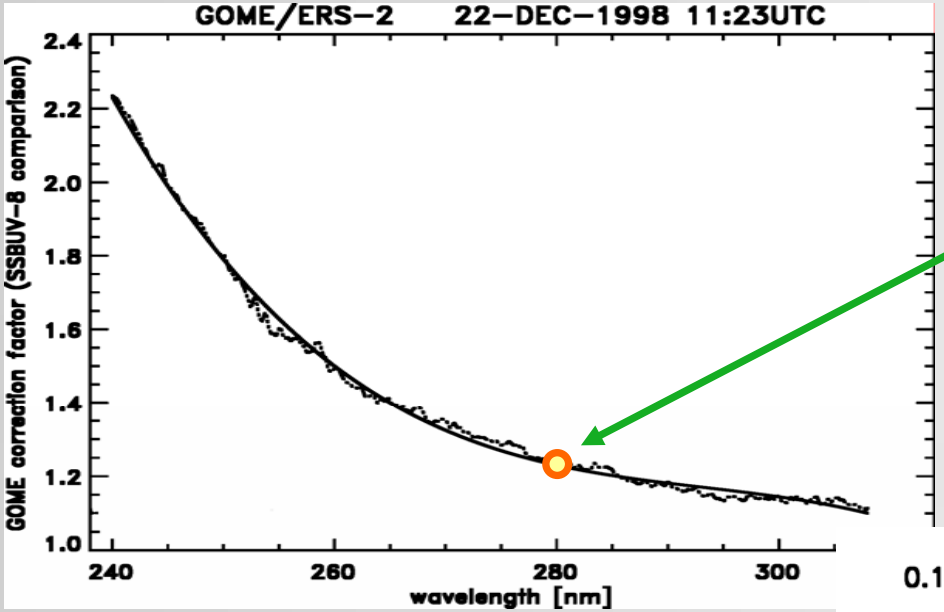
Mg II index





- UV solar activity proxy from core-to-wing ratio of Mg II line
  - ➔ insensitive to optical degradation
  - ➔ linearly correlates well with UV and EUV wavelength variations down to 30 nm (Viereck et al. 2001)
  - ➔ suitable for modelling UV solar cycle variability in chemical-transport and climate models

GOME channel 1 degradation & etalon correction

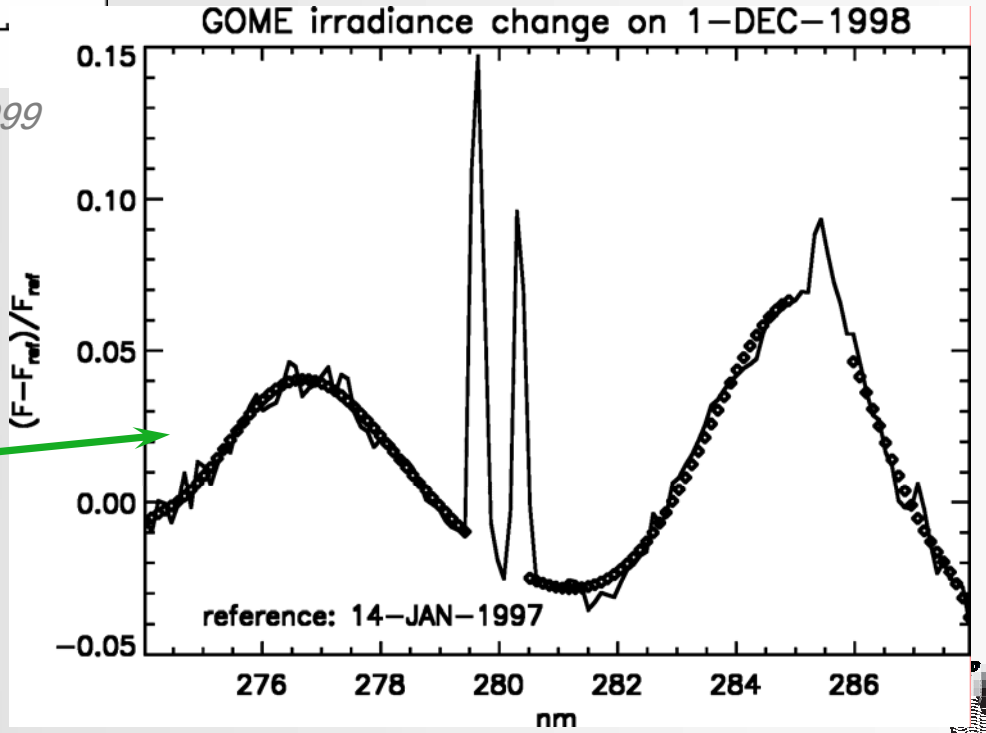


Comparison with SSBUV 1996:
GOME degradation of **20%@280 nm** by end of 1998

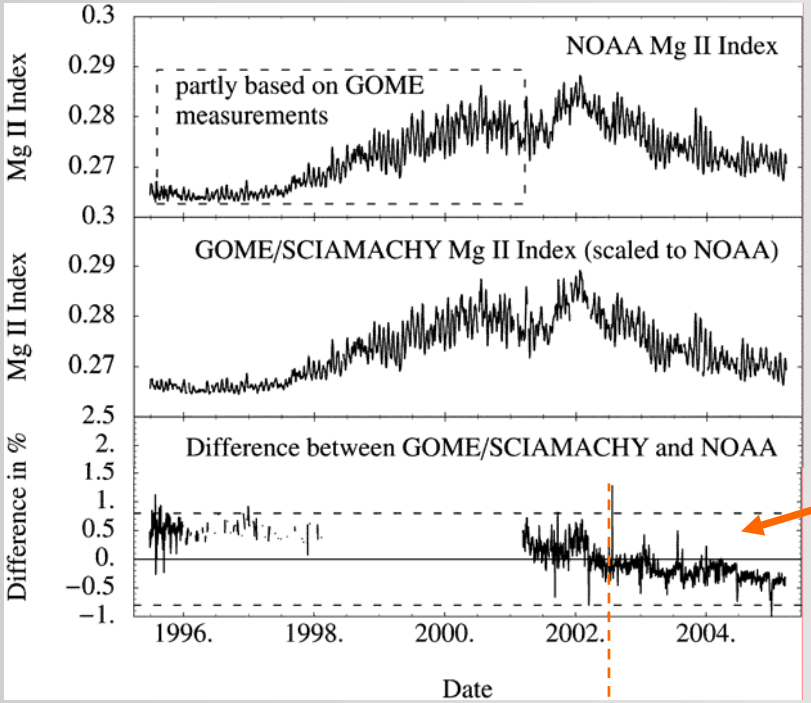
➔not important for MgII index during early period

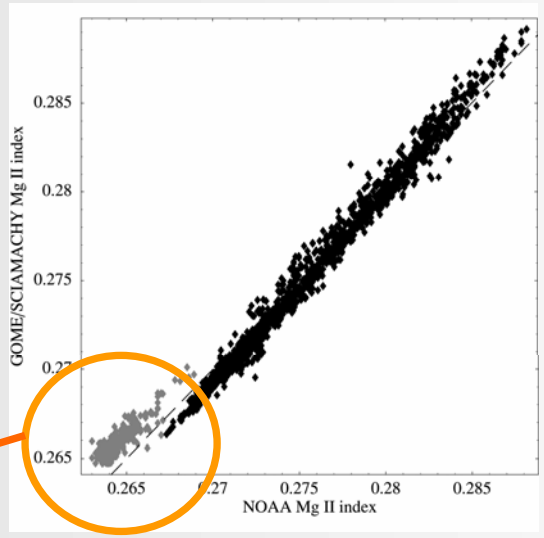
Weber 1999

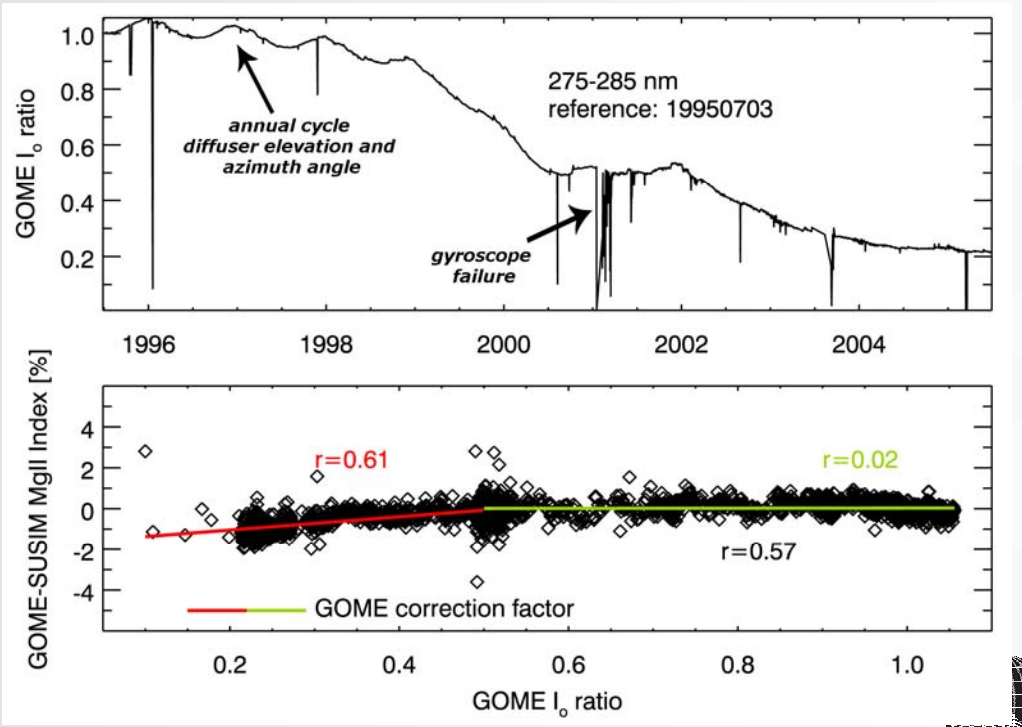
- Changing etalon patterns after detector cooler switchings lead to jumps in the MgII index
  - ➔ GOME: etalon correction by polynomial fitting to early reference data (Weber 1999)
  - ➔ SCIAMACHY: WLS source correction (Skupin et al., 2004), but etalon pattern is stable



GOME correction for SCIA overlap

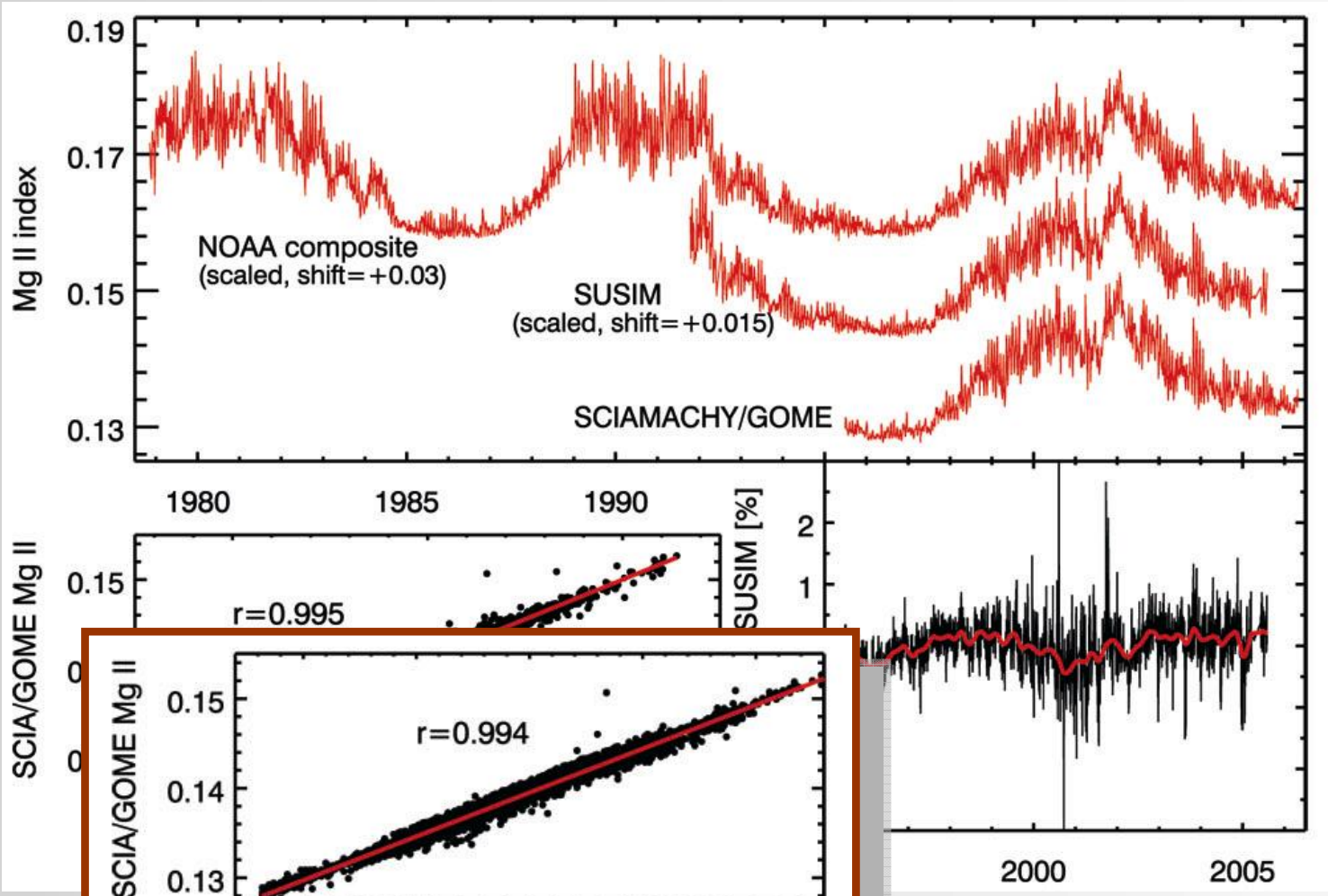




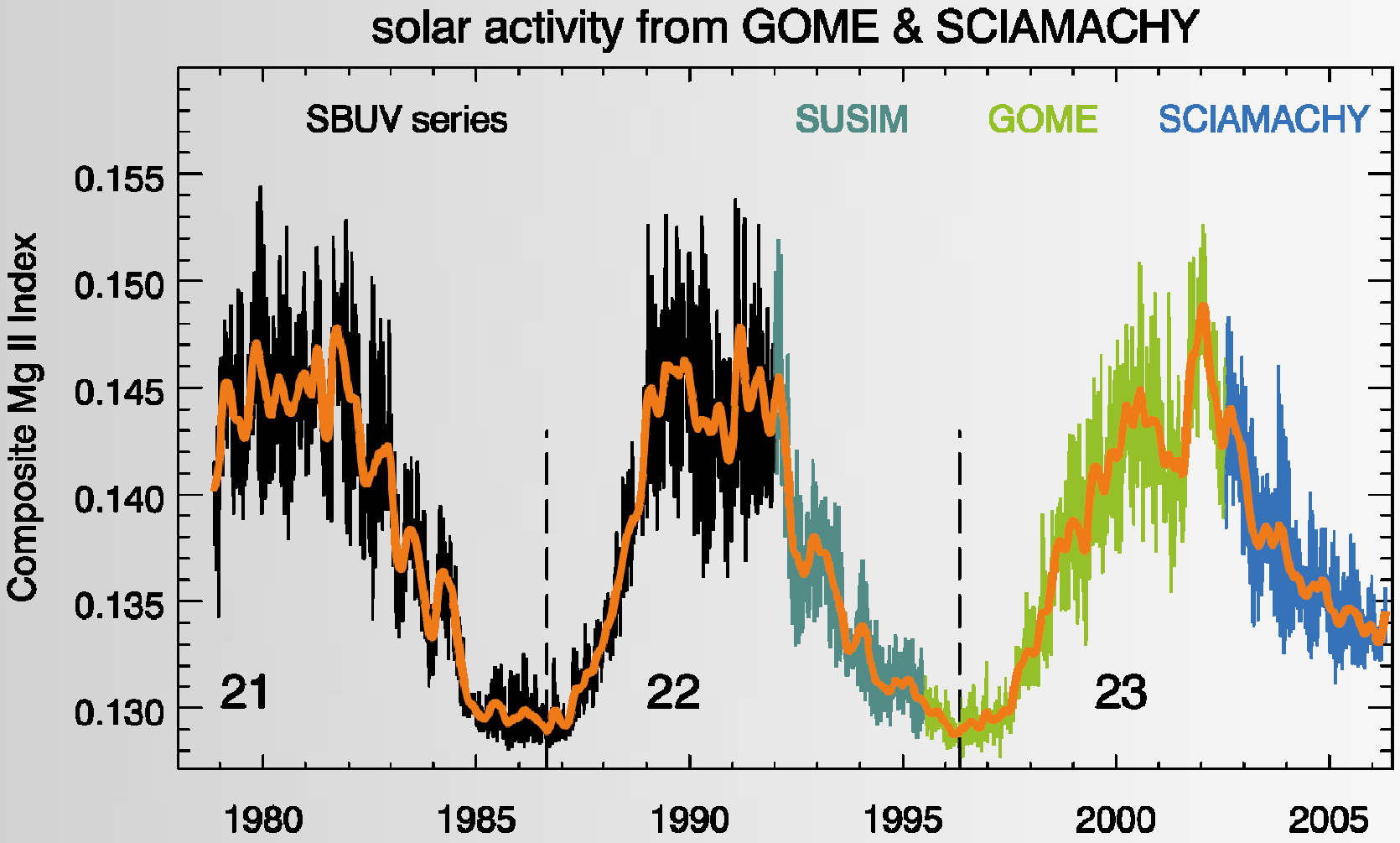


- after 2000 a degradation correction to the GOME MgII index has to be applied before joining SCIAMACHY and GOME for a composite MgII index
- after 2002 GOME data are only used for missing SCIA days

Composite Mg II index

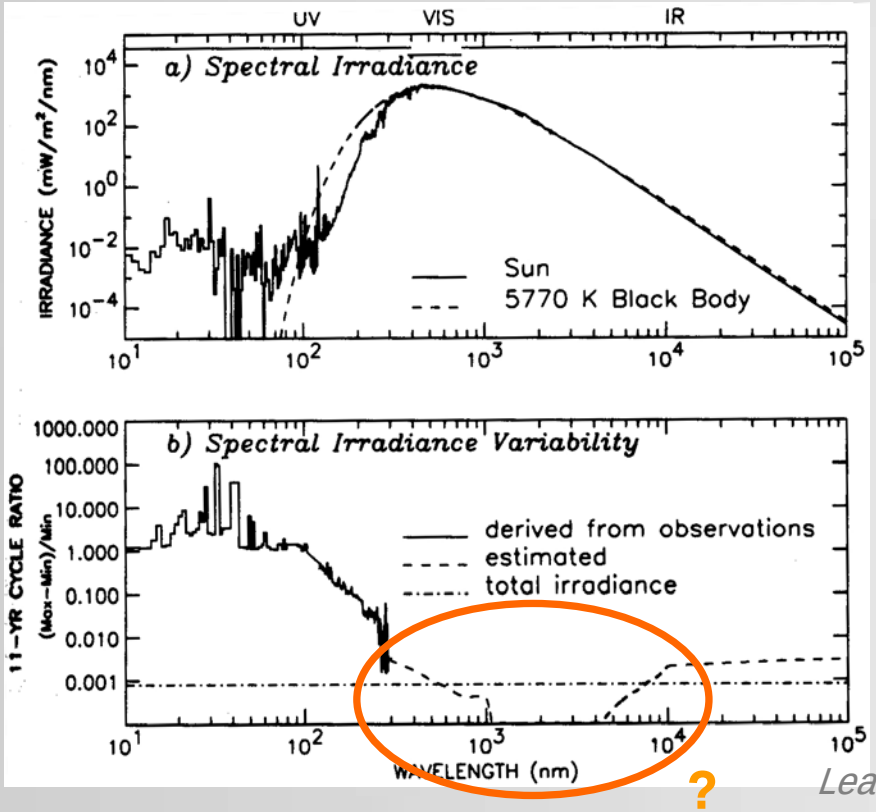


Mg II data from multiple instruments for 2 ½ solar cycles



- Solar cycle 23 compared to 22:
  - ➔ slower increase towards maximum and double peak structure

Conclusion and Outlook



Lean, 1994

Conclusion:

- SCIAMACHY and GOME provide a 10 year record of UV and vis solar irradiance data
- Solar activity proxy studies successfully continued with SCIAMACHY
- Continuity of „European“ solar record for the next decade will be provided by GOME2

Outlook (as part of national CAWSES activities):

- stronger focus on IR/visible wavelength ranges
  - ➔ large uncertainty in solar variability, but contributes 70% to total irradiance
- irradiance comparisons with empirical solar models
- study of short-term solar variability impact on ozone from the stratosphere to the mesosphere from SCIAMACHY limb data