Characterizing Solar Spectral Irradiance Variability with Synthetic Models and their Applicability to LWS Science Goals

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Outline

• Characterizing solar activity
• Irradiance models, synthesis
• Spectral variability
• Toward LWS goals
Characterizing solar activity

- Separate irradiance signal into components/structures
- Identify surface components that contribute differently to irradiance/radiance
- Associate semi-empirical models of the solar atmosphere with components
- Use detailed radiative transfer
- Account for detailed center to limb variations
- Convolve spectra with measured instrument profiles
- Compare with observations in absolute units (where possible)
Structures

• A – faint cell interior/ network
• C – average cell center quiet Sun
• E – average network
• F – bright network/ faculae
• H – average plage
• P – bright plage
• S – sunspot umbra
Intensity structures (PSPT CaIIK)
Disk-averaged solar activity

- Mg II index
- Ca K plage index
- F10/E10
- $\Sigma_K/\Sigma_R$
- Use for spectral irradiance not just total
Irradiance Models, synthesis

- Physics-based models (absolute units)
  - Intensity – $I(\lambda,t) = \sum_{\text{structures}} \sum_{\text{disk}} I_{\text{structure}}(\lambda,\mu)$
  - $I_{\text{structure}}(\lambda,\mu) = \text{Integral} \left( S(\tau) \exp(-\tau/\mu) \, d\tau/\mu \right)$

- Non-LTE radiative transfer, multi-level atoms, molecules, ionization, continuum and line-by-line, using variable spectral resolution, for any disk position

- Source function calculations – some PRD, some CRD, some “net radiative bracket” (see Fontenla et al. 1999 for details)
Lyman-α model and Lemaire obs
UV 285-290nm model and ATLAS3/SUSIM (full res)
UV 285-290nm model and ATLAS3/SUSIM (0.15nm res)
UV 300-310nm model and ATLAS3/SUSIM (full res)
UV 300-310nm model and ATLAS3/SUSIM (0.15nm res)
Mg II and F10 - “Summed” irradiance
Mg II and F10 - “UV” band irradiance
Mg II and F10 - visible band irradiance
Toward LWS goals

- Quantify EUV/UV (and visible/near-IR) variability with detailed decompositions of solar images (magnetic and intensity)
- Develop relation to disk-averaged measures of solar activity available over many decades
- Correlate with banded irradiances
- Continue to improve accuracy of radiance spectra (atomic and molecular physics and data)
- Develop a set of spectral variability models covering decadal and century timescales