Spectral Solar Irradiance Modelling: where now and where next?

> Yvonne Unruh Imperial College London

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- Spectral solar irradiance: what do we know?
- Tests of SSI models
 - Long-term inconsistencies?
 - Short term uncertainties
- SSI from magneto-convection simulations
- Conclusions

State of Affairs?



What are the problems?

Measurements:

- Lack of continuous measurements
- Insufficient overlap between different instruments
- Calibration once instruments are in space / degradation corrections

Models:

- What produces the irradiance variations? (Can we just extrapolate from rotational → cyclic → secular variability?)
- What are best / sufficient tracers?
- Uncertainties in contrasts:
 - spectral synthesis
 - model atmospheres

Tests of Contrast Calculations

SATIRE:

- continuum images \rightarrow spot coverage
- magnetograms → facular filling coverage dent
- emergent contrasts
 - Currently not feature dependent, though scaled according to magnetic field of features

Time

 (cf Shapiro et al; Fontenla et al; Ermolli et al for different approaches)

Tests of Contrast Calculations



Tests of Contrast Calculations











SATIRE – SIM: in detail



+ SATIRE ▲ SORCE/SIM

During May 2004 – reasonably active time



SATIRE – SIM: in detail



During May 2004 – reasonably active time



+ SATIRE ▲ SORCE/SIM

SATIRE – SIM: in detail

2008 – much more quiet time

Early



spots and faculae: cycle vars



spots and faculae: cycle vars



MURaM

Magnetoconvection simulations: 288 x 288 x 100 points corresponding to 6 x 6 x 1.4 Mm mean vertical magnetic flux: 0, 50, 200 & 400 G

vertical velocity



Temperature

vertical mag flux

↑9 km/s



see Vögler et al 2005, A&A 429,

From MURaM to disk-centre intensities 1:



From MURaM to diskcentre intensities 2:

G-band images for different mean mag fluxes





Individual features



Individual features







Average limb-behaviour



Average limb-behaviour



S A R Ε + Μ U R A Μ

Conclusions

- Excellent agreement between models and observations on rotational timescale
- some (small) uncertainties in UV and NIR
- Are starting to understand cycle variations; SIM long-term trends seem unlikely starting with magnetically induced changes
- Magneto-convection simulations allow the calculation of ab-initio contrasts
 - dependence of spectral shape on magnetic flux
 - Initial results are encouraging, but also some surprises... not straightforward!

SATIRE background Unruh et al 1999, A&A 345, 635 Fligge et al 2000, A&A 353, 380 **Reconstructions** (cyclical and shorter timescales) Krivova et al 2003, A&A 399, L1 Wenzler et al 2006, A&A 460, 583 Unruh et al 2008, A&A 486, 311 Long-term reconstructions Krivova et al 2007, A&A 467, 335 (and refs therein) MURaM background

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