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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Recent variability of the solar spectral irradiance and its impact on climate modelling" *by* I. Ermolli et al.

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The text of your article completely misrepresent SRPM SSI models and the system that SRPM Solar Radiation Physical Modeling) stands for. Also some references from my papers are quoted out of context or distorted. Overall that section and your summary convey a very bad misrepresentation saying that SRPM current models are purely based on SIM and portraying the wrong picture of what SRPM really is and how is validated with ground-based high spectral-resolution data. The text of your article ignores the actual basis of SRPM model and makes it a surrogate of SIM which is a gross misrepresentation. In addition it includes no clue to the main strength of SRPM in considering full non-LTE in many species and in including a large number of atomic levels and lines as well as molecular lines and the molecular photo-dissociation opacities.

Your text also includes side comments that do not belong to the description of SRPM but are opinions of other parties that I do not believe have a solid basis. Because these opinions do not belong to the description of SRPM they should be included separately in a discussion section.

SRPM always considered an out of phase with TSI behavior in the visible, many years before SORCE was even built, and when the relevant ground-based observations were published. That behavior come from the consideration of ground-based observations around 500 nm by Topka et al 1997 (and others before and after that date), and in the IR based on observations that were described in great detail by Sanchez Cuberes et all (2000) at 1.55 microns but was also observed before by a number of authors at nearby wavelengths. Consequently, that negative behavior in the visible and IR were considered since early times in developing the SRPM non-LTE models and were referenced in my papers leading to the current models any time changes were introduced in regard to the deep photospheric regions. Those data are supplemented now by the Preminger et al paper (2011) and, before this was published, the data from San Fernando Observatory showed in meetings that displayed negative contrast of active regions at broadbands 450 nm, 600 nm and I see now at around 970 m. It is true that SIM confirms that behavior and looks at more wavelengths. Is also true that it is all more or less consistent on the out of phase behavior although quantitatively is not identical to SRPM results that are purely based on contrast images and are not absolute. It is true that the negative behavior of some SRPM models was slightly modified by considering SIM data at more wavelengths because of its greater coverage. This was done in 2009 together with the change in the temperature region and improvements in the opacity (by consideration of more species and levels) that that somewhat affected the opacities. These changes were made to still match the ground-based observations and match the Topka, and Sanchez Cuberes data on the visible and IR respectively. But not to match SIM long term trends. Moreover, the changes were made as the 2009 paper explains to match the CO lines (observed from the ground) that previous models did not explain.

Your paper contains assertions neglecting the long term changes of the non-active region related changes with the solar cycle. This is bad, since these changes are well known from both PSPTs (MLSO and OAR) although have not been published yet, escapes me why. These data shows the solar cycle variation of the network that I also see in OAR PSPT data but your paper does not mention. Moreover, at the last SORCE meeting Mark Rast looked at PSPT data showing this and other important things. The Mark Rast presentation also tends to confirm the negative behaviors at two blue and red broad bands, although PSPT data analysis was not as complete as the SFO have done on their images.

Anyway, SRPM is based on radiance data from various origins and mainly based on ground-based imaging and spectroscopic data that provides the contrast of the 7 solar features (currently are 9) at different wavelengths. Considers full non-LTE radiative transfer in 50 species and with many levels and $\sim$70,000 atomic lines, plus hundreds of thousands molecular lines included. It also goes through extensive validation with radiance observations, in addition to the irradiance data. That is the crux of SRPM, to produce a very accurate non-LTE complete spectra) and is not conveyed at all in your paper. Although SIM data brings some extra data to the models by covering the entire SSI, SRPM must go by the ground-based contrast data and the images and for this reason it does not quantitatively agree with SIM in the long term, however it does agree in rotational modulation with SIM and with TIM as well as with SOLSTICE (agree we still haven't published this comparison).

In support of the previous comment explaining when my modeling started including the negative behavior, see references to: Topka, K. P., Tarbell, T. D., & Title, A.M. 1992, ApJ, 396, 351 ". 1997, ApJ, 484, 479 Foukal, P., Little, R., Graves, J., Rabin, D., & Lynch, D. 1990, ApJ, 353, 712

In the sentence: "More recent models account for variations due to sunspots and plage. Maltby et al. (1986), Lites & Skumanich (1992), and others proposed sunspot models. Collados et al. (1994) present further work on sunspot models, and we stress that the

current models are far from definitive. Our sunspot umbra model is similar to these models in the photosphere and is extended into the upper layers as discussed in the next section. Our plage model is based in part on the results from Shine & Linksy (1974) and Lemaire et al. (1981). We modified the temperature distributions in the deep photospheric layers of our plage models, P and H, relative to the quiet Sun models. These modifications were determined in order to reproduce the center-to-limb variation and facular contrast observed at 1.6 km by Foukal et al. (1990) and the measurements by Topka, Tarbell, & Title (1992, 1997) and Wang et al. (1998). At all heights, these temperature differences are small ; however, they have significant effect on the total solar irradiance. Since photospheric radiation dominates the total radiative output of the Sun, continued improvement in photospheric models will improve the synthesis of the solar output."

In pages 489-490 of our first SSI paper of the RISE project which was the predecessor to SRPM. The paper reference is: THE ASTROPHYSICAL JOURNAL, 518:480È499, 1999 June 10 CALCULATION OF SOLAR IRRADIANCES. I. SYNTHESIS OF THE SOLAR SPECTRUM JUAN FONTENLA, ORAN R. WHITE, AND PETER A. FOX AND EUGENE H. AVRETT AND ROBERT L. KURUCZ

Further papers discussed somewhat these matters but overall did not repeat all that this paper says, and instead quoted it. These are the origin of the current set of models and it should be clear that these are non-LTE models, and applying some of their quantities to an LTE code, which also has incomplete continuum opacities, will not reproduce our results. Besides, as the opacity and species considered expanded considerably when SRPM replaced RISE around 2000 and considered much more species and levels in NLTE, and to maintain agreement with the ground-based observations, I performed some adjustments and notably in 2007 I changed very substantially the temperature minimum region in disagreement with some of my earlier coauthors for reasons explained in my 2007 paper. These things are not related to SIM SSI variations. It is quite clear that the SIM long term trends are qualitatively reproduced but not quantita-

tively reproduced by SRPM at all wavelengths. To me this prompts for examining the model assumptions and not just throwing away the observations that may not match exactly the model.

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