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THE DEVELOPMENT OF A NEW MODEL OF  
SOLAR EUV IRRADIANCE VARIABILITY

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- OVERVIEW -

The goal of this research project is the development of a new model of solar EUV irradiance variability. The model is based on combining differential emission measure distributions derived from spatially and spectrally resolved observations of active regions, coronal holes, and the quiet Sun with full-disk solar images. An initial version of this model was developed with earlier funding from NASA. The new version of the model developed with this research grant will incorporate observations from SoHO as well as updated compilations of atomic data. These improvements will make the model calculations much more accurate.

- PROGRESS TO DATE -

The work on this projects has progressed a little more slowly than anticipated, but remains fairly close to the schedule originally outlined in the grant. The major milestones achieved to date include:

- \* THE CALCULATION OF A SOLAR FLARE IRRADIANCE SPECTRUM: I used the basic elements of the model with additional observations from TRACE and GOES to estimate the solar EUV irradiance during the peak of the July 14, 2000 X6 flare. These spectra were then used by Bob Meier and collaborators at NRL in the AURIC and SAMI2 models to calculate the response of the Earth's UV thermospheric dayglow and ionosphere to the enhanced solar fluxes. The observed and modeled UV dayglow were generally consistent. The calculated response of the ionosphere was sensitive to the local dynamics, suggesting that solar flare observations may be a useful probe for understanding the detailed structure of the ionosphere. Unfortunately, there were no simultaneous ionospheric observations with which to compare. While this project was not part of the original proposal it provided a great opportunity to apply the irradiance model to interesting problems in atmospheric physics. The results from this work are presented in Meier, Warren, et al., GRL, in press, 2002. A paper on the details of the flare spectrum is in preparation.
- \* NEW ATOMIC DATA: I obtained a new set of APEC line and continua emissivities from Randall Smith at the CfA. These calculations augment the CHIANTI atomic data base with atomic models for some ionization stages of Fe with about 1000 levels. Thus the contribution of many weak emission lines can now be included in the irradiance calculations. This is important at wavelengths below 170 Angstrom.
- \* NEW THERMAL RESPONSE FOR SXT: I worked with Kathy Reeves here at the CfA to recalculate the thermal response of the Yohkoh SXT using the new APEC atomic data. The new thermal response suggests that the SXT filter ratio temperatures have been systematically underestimated in past analysis. These calculations permit the inclusion of the SXT fluxes in DEM calculations in a consistent way. The new atomic data was also used to calculate the thermal response for the Solar-B XRT.

- \* NEW DEM SOFTWARE: I worked with Paul Hamilton here at the CfA and John Mariska at NRL to develop a new, widget-based differential emission measure software package in IDL. The software greatly simplifies the calculation of DEMs.
- \* CDS/SXT/TRACE CATALOG: By combining the CDS as-run catalog with the SXT observing logs and daily SXT full-disk images I was able to generate a catalog of all existing coordinated CDS and SXT observations. This catalog greatly simplifies the identification of useful data sets. For completeness, I also included TRACE observations in this catalog.
- \* NEW ACTIVE REGION DEMS: Finally, I have combined intensities calculated from simultaneous CDS and SXT active region observations with the new APEC emissivities and the IDL software to calculate new active region differential emission measure distributions.

- WORK PLAN -

The work plan for the next year is as follows.

- \* Complete the calculation of new active region, quiet Sun, and coronal hole differential emission measures. We will need to include observations from SUMER to extend the DEM to temperatures below about  $1 \times 10^5$  K.
- \* Derive accurate relationships between the differential emission measure curves and the intensities in the SXT and BBSO full-disk images.
- \* Test the ability of the model to calculate accurately active region intensities using the synoptic CDS data.
- \* Update the intensities of optically thick line and continuum emission using SUMER and CDS observations.
- \* Compare model calculations with irradiance observations from the TIMED mission.

I request that NASA release the next year's award funds in the previously agreed-to amount of \$131,531.