Comparing Solar Cycle dependence of TEC and Solar 30.4nm EUV flux

Andrew Jones[1]

Abstract:

As part of the calibration check for SEM I looked at the comparison between the global TEC and the 30.4nm flux as measured by SEM. Using the V3.0 calibration coefficients there was a significant discrepancy between the 2 curves, however using modified calibration fits, the curves show good agreement, though there still seems to be some discrepancy between the curves.

Introduction:

I have used the CODE Bernese ION files available from: “ftp.unibe.ch/aiub/CODE” as the source for the TEC data. The files have TEC maps described as a set of spherical harmonics. I have used the $\imath$ =0 (global) TEC mode.

For the EUV data I have used a ‘corrected’ version of the SOHO-SEM 26–34nm (henceforth referred to as 30.4nm) fluxes. These have a better (though still approximate) degradation model than the data available on the website. We are working to get a fully corrected data set available on the web.

Results:

A plot of the global ($\imath$=0) TEC and 30.4nm data is shown in . I have removed the 1AU correction that is normally applied to the published SEM data.

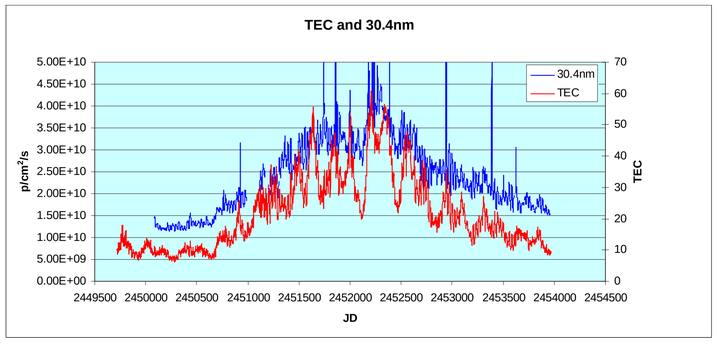

Figure 1 : Daily averages of Global TEC and SEM 26–34nm channels

To look at the correlation between the TEC and 30.4nm I plotted one against the other.

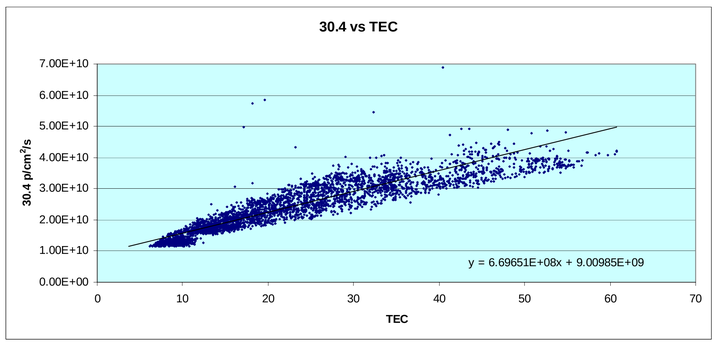

Figure 2 : 30.4nm flux vs. TEC

Figure 2 shows some interesting features. Obviously the flares stand out from the EUV part of the picture. There is also something “strange” happening down at the low end as if something has “bottomed out” in the flux. It may be from the way I handle incomplete data sets due to drop outs etc.

I used a linear fit from the correlation graph to fit the TEC data to the EUV data (is this TEC_{euv} ? — TEC scaled to photon units) shows very good agreement in long-term trends.

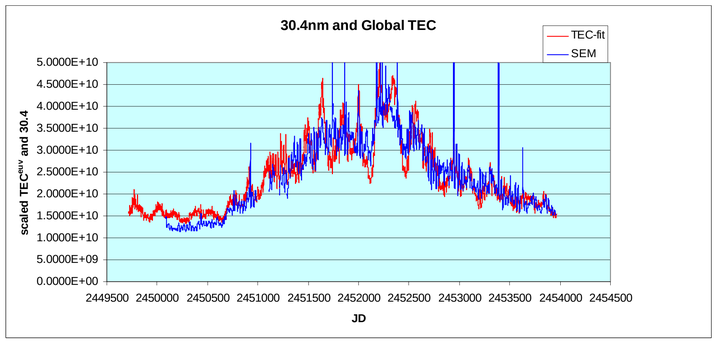

Figure 3: TEC fitted by linear fit.

As the next step I have plotted the residuals (Scaled, fitted TEC in 30.4nm flux units) :

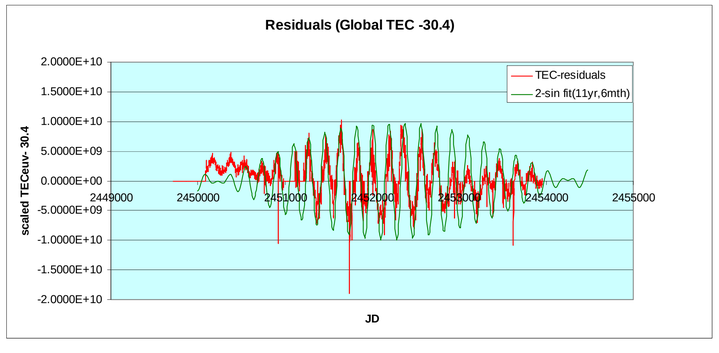

Figure 4: Residuals: TEC_{euv} - 30.4

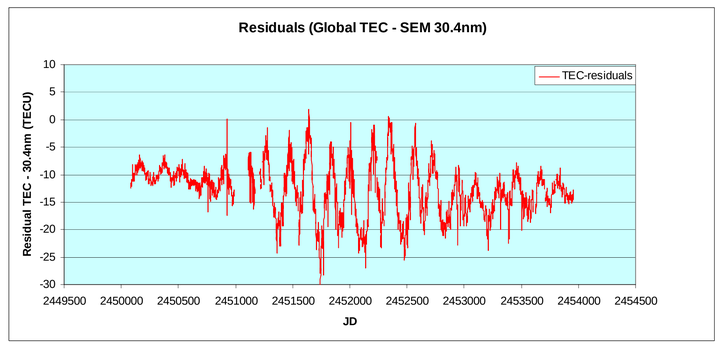

Figure 5: Residuals as Figure 4 but in TECU

The plot shows a clear 6-month periodicity. This is probably a signature of the middle atmosphere semi-annual oscillation (SAO). It also shows a systematic decrease that is probably due to my simplistic modeling the SEM degradation.

An identical analysis this time using the SEM 0-order channel yields very similar results.

A filter using higher degree modes isolating the sub-solar point would be interesting.

Though it looks like it is probably a reasonable assumption that we can explain the long-term trends in TEC with this simple approach, the same is not true under flare conditions, where the TEC response does not scale nicely with EUV flux. The mechanism for these effects are also under investigation.

Acknowledgements:

This work was supported under NASA grant NNG05WC09G

SOHO is a project of international cooperation between ESA and NASA.

All the TEC data came from the Center for Orbit Determination in Europe (CODE) at the Astronomical Institute of the University of Bern, part of the International GPS Service (IGS).

[1] Space Sciences Center, University of Southern California, Los Angeles, CA 90089-1341