A comparison of the VIRGO and TIM Data

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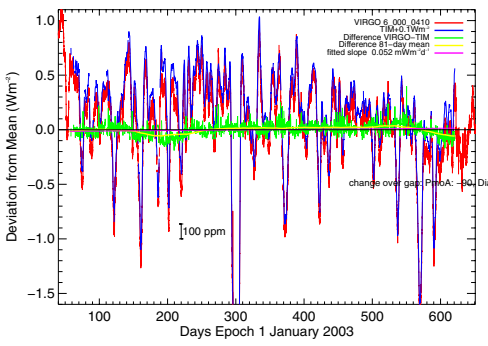

Figure 1: Shown is the comparison of the SORCE/TIM with SoHO/VIRGO as time series and as ratio. The comparison is made with the 6-hour data from the SORCE/TIM web-site.

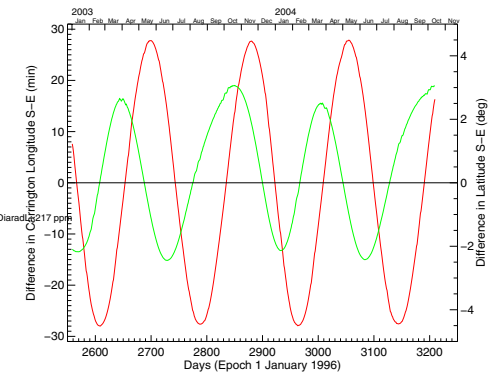

Figure 2: The two curves show the difference in the Sun’s view from SOHO and Earth. The difference in Carrington longitude translates in a difference in observation time and a positive difference means that SOHO’s observations preced those from Earth. Another interesting aspect of the different vantage points is the difference in latitude which may influence the effect of the asymmetry of the two hemispheres on the TSI observations (e.g., the one year period). The extremes of the time correction coincide also with the extremes of the halo orbit and indicate times where the data transmission from SOHO is hampered by the loss of the pointing capability of the high-gain antenna.

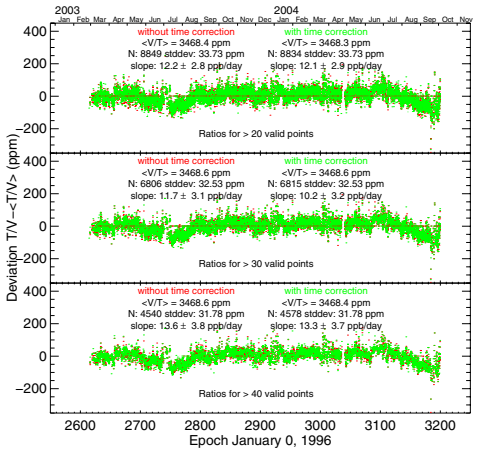

Figure 3: Comparison of the 1-hour VIRGO TSI with the individual 50 sec samples of TIM. From top to bottom the number of minimal number of values within one hour is increasing. The slight decrease of the standard deviation does indicate that the coincidence in time play some role. The correction of the observation times, however, does not seem to be very important.

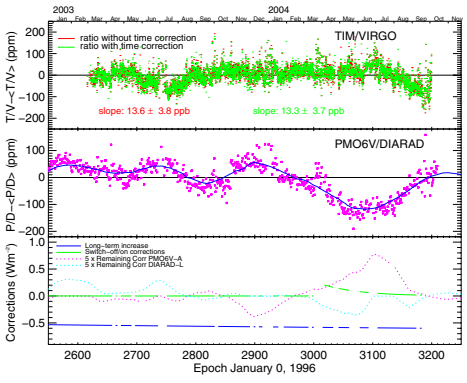

Figure 4: The top panel shows the same results as the bottom panel of Figure 3 on the same time scale as the comparison of the PMO6V-A and DIARAD-L on VIRGO and the corresponding non-exposure dependent corrections of DIARAD (bottom panel).

1 Motivation

The TIM and VIRGO total solar irradiance (TSI) data compare extremely well, after the corresponding long-term correction for TIM have been included in Version 4. This shows that the long-term corrections of both experiments seem to account for degradation properly. This was one part of the motivation. The other is the radiometry as far as the absolute value of TSI concerned, but also to get information about possible influence of the space environment on thermal radiometry.

2 Discussion of the Results

A major point is the absolute difference in the readings of 3468 ppm with TIM reading lower. As TIM had no measurements on ground before launch we do not really know where its SI value would lie. The stated absolute accuracy of 100 ppm is probably not reached as the comparison of the 4 channels in space are within 600 ppm. On the other hand PMO6V/VIRGO radiometers have traceability on ground to the World Radiometric Reference (WRR) and the transfer to space is only influenced by the non-equivalence corrections which are different at ambient air pressure and vacuum. For the PMO6V radiometer the uncertainty of this correction is of the order of 0.1% which is confirmed by the fact that in space the two PMO6V showed a difference of below 0.1% (effective 670 ppm). In terms of absolute radiometry the difference of 3468 ppm may be reduced by about 1000 ppm due to the uncertainties due to the transfer to space. The difference between the two DIARAD sensors of the order of 5 Wm^{-2} is too large to be used for this discussion.

Recent investigation of the PMO6 radiometry have shown that the influence of the heating of the precision aperture have underestimated. This has an influence on the correction for the transfer to space and for the WRR itself, as the comparison with the cryogenic radiometer have been made with aperture under-filled (flux not irradiance). However, it is not expected that this influence can explain all the remaining difference.

It is important to note that there is essentially no important trend in the ratio of both time series (Figure 3). However, this small trend of about 10 ppb/day is significant at the 4-σ level, which is only a formal statement based on statistics and does not include any possible systematic errors. There are two place were differences are obvious, around July 2003 and after August 2004. They coincide with keyhole in the SOHO data transmission due to the impossibility to move the high-gain antenna to point to the Earth at the extrem points of the halo orbit. However, there are keyholes every 6 months (see Figure 2), so there is no obvious reason why these two stick out. From the comparison between PMO6V and DIARAD in Figure 4 it seems that it may have to do with PMO6V, which is since February 1996 no longer run on its normal shuttered operation, but on 8-hour-open-6-minute-closed sequence the evaluation of which may well be influenced by the missing data during the keyholes. DIARAD should not be influenced because it is not the operation which is changed nor the pointing of SOHO, only the available data.

3 Conclusion

The comparison show that the radiometers perform very well and compare within ± 100 ppm. on a relative scale. Most important is the fact that no trend can be determined between the two time series, which means that the corrections applied for the long-term changes in the radiometers are well understood and corrected for. It should be noted that the effects in all three type of radiometers are quite different not only in magnitude, but also in terms of the materials used. This gives some confidence in the applied degradation corrections.