30 years of Total Solar Irradiance measurements: status and outlook for the future.

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The climate on earth is driven by the radiative heat exchanges with outer space at the top of the earth's atmosphere. For the monitoring and understanding of the change of climate with time, it is therefore necessary to make long term measurements of these radiative heat exchanges, including the heat input by the incoming solar irradiance, referred to as Total Solar Irradiance (TSI).

Useable TSI measurements from space exist since the launch of Nimbus 7 in 1978. Our institute has made important contributions to these measurements with a first instrument on Spacelab in 1983, six space shuttle flights of the SOLCON instrument from 1992 to 2003, the SOVA instrument on the EUropean REtrievable CArrier (EURECA) in 1992-1993, the DIARAD/VIRGO instrument on SOHO since 1996, and recently the DIARAD/SOVIM instrument on the International Space Station. Currently we are preparing the SOVAP instrument for launch on the PICARD satellite in 2009.

The variations of the TSI with time are the most relevant for climate change on earth. The TSI measurements cover 2.5 11 year solar cycles, indicating a variation of the order of 1 W/m^2 in phase with the solar activity, and causing weak temperature variations of the order of 0.1 °C to 0.2 °C on earth. There exists some controversy whether on top of this cyclic 11 year variation, there exists a decadal long term variation of the TSI, which would have a stronger climate change impact. Recently we were able to demonstrate that for the last solar cycle 23 there exists no such long term variation. This milestone result was obtained thanks to our DIARAD/VIRGO instrument which covered the entire cycle 23 with unprecedented stability, and thanks to the objective analysis of all other available TSI measurements.

The original intent of the TSI measurements was to measure the mean value of the TSI, referred to as the Solar Constant. Ironically, after 30 years of TSI measurements, we still have a relatively large uncertainty on the value of the solar constant, particularly after the launch of the TIM instrument on SORCE in 2003. We plan to finally determine the value of the solar constant by comparing our retrieved Sova 1 radiometer with a reference cryogenic radiometer.

Although there appears to be no long term decadal TSI variation during the recent 11 year solar cycles, there are strong indications that such a long term TSI variation did exist between the Maunder minimum corresponding to the little ice age around 1700, and the modern solar maximum conditions. With the PICARD project which is currently in preparation we will try to have an indirect reconstruction of these long term TSI variation trough a correlation with solar diameter variations.

Finally, the SOVAP instrument on PICARD will contain a Bolometric Oscillation Sensor (BOS), which will resolve TSI variations at time scales smaller than those of the solar p mode variations. The BOS is developed in collaboration with the Royal Observatory of Belgium.