6 Conclusions and the need to create referenced TSI and SSI indices

"A plausible simulation of the global energy balance is a first-order requirement for a credible climate model.", (Wild, 2020). Since the determination of EEI requires an accuracy of ≈0.1 W m^{-2} or 7*10^-3 %, TSI, TOR and SOR instruments must meet this high performance in space and be calibrated correspondingly. This assumes the availability of simulating TSI and TOR radiation sources with an accuracy of 0.1 W m−2, which is not possible. Neither the Sun, with a spectral composition of regions with 6000 K to a maximum of 200 million K, nor the Earth, with temperatures from -80 K to +60 K and reflected solar radiation in the VUV to infrared spectral range, can be simulated in the laboratory or in space. If the effects of permanent degradation are also taken into account, the dilemma of the impossibility of determining the EEI with the required accuracy becomes more understandable.

A reasonable approach is to derive annual changes in SOR data from SORACES in the spectral region from 200 to 1100 nm. Using data from DARA instruments and deriving reference SSI(t) data from a SOLACER instrument, a stability close to 5 mW m^{-2} $year^{-1}$ over a solar cycle or more is expected. With regularly updating the efficiency of the SORACES spectrometers, the degradation will be compensated. 80 PMT channels provide TOR spectra with a cadence of 1 s^{-1}. The instrument also enables the determination of the global green Earth coverage and its annual changes by measuring chlorophyll absorption from 350 nm to 490 nm and 620 nm to 690 nm and green backscatter from 500 nm to 600 nm. With the high sensitivity, the mapping of the Earth would also allow to track annual local changes in green coverage to verify the effectiveness of various climate policies such as climate protection actions. With the numerous repeated measurements of the areas over a period of the year, similar influences of the respective cloud cover are assumed. They can be recorded by evaluating the measured with selected model spectra. With a rigorous operational schedule for collecting high data rates with high statistics from SORACES, we expect optimal accuracies for annual and local changes in SOR(t) for data <1100 nm.

A great advantage of this development is the ability to test the expected SOR data (Table 1) from the ground and from balloons, collect the AI data pool before launch and create reference SSI(t) data also from ground measurements. It is intended to use these data for SSI(t)-related instruments in space and for climate modeling.

In principle, a similar instrument TORACES should be investigated by extending the wavelength range >1100nm. For example, increasing the detection area of BOS sensors (Zhu et al., 2015) from 1 cm to 5 cm diameter could provide a factor of 25 to increase sensitivity. A stable Black Body radiator at a medium Earth temperature in space should be developed for as radiation reference radiation source and contribute to further improvements in space. While SORACES could provide shortwave TOR-SW data, TORACES with the reference radiation source should provide longwave data TOR-LW. However, implementing such a tool, important as it is for climatology, is still to be investigated.

It is proposed to operate two SOLACER instruments, in space and on the ground, to simultaneously derive SSI(t) data. Ultimately, a SOLACER instrument with its two radiometers should be able to determine permanent SSI(t) reference data from the ground and correct the atmospheric absorption by comparison with the SSI(t) data in orbit.

Our approach for creating TSI and SSI indices like the reference meter in Paris is considered an important requirement for future research in climatology. It suggests the development of a climate satellite with the following payload: A TSI and a TOR instrument, SOLACER, SORACES, instruments from CERES, ERBE, CLARREO and/ other programs.