A possibility to recover the past Solar Constant (TSI) with the Moon

Atsumu Ohmura¹, Konrad Steffen²

¹Institute for Atmospheric and Climate Science, E.T.H., Zurich Switzerland
²CIRES, University of Colorado, Boulder
Rational to measure long-term TSI variability

The sun is the only energy source for the earth, and the solar constant (TSI) is one of the most important climatic factors.

TSI definitely influenced the earth’s climate in the past, but unfortunately we don’t know how much.
TSI variability and sunspot numbers

ACRIM Composite Total Solar Irradiance (TSI)

Trend between successive solar cycle minima: + 0.05 %/decade

Greenwich Sunspot Number
The direct measurement of TSI has been available since late 1978.
Owing to too many sensors involved and the calibration uncertainty, we have diverse proposals of its trend, as figure shows.
There are a number of efforts to reconstruct TSI, based on sunspot numbers, and temperature proxy values.

It is therefore necessary to recover the lost TSI.
The proposal was made during the Radiation Panel Meeting (GEWEX) in August 2002 in Zurich.

The method is based on the fact that the Lunar surface is in a state of radiative equilibrium between the absorbed solar radiation and the thermal emission.

The lunar surface temperature is determined by TSI.

By measuring the temperature profile and inverting the temperature to the surface temperature, one can recover the lost TSI of the past, and the albedo and emissivity can be assumed almost constant.

The ideal site will be near the Lunar Equator (large absolute flux and better resolution for TSI) and a spot with a thick lunar dust layer (easier to bore and heat conductivity is small; longer history in a short core). 100 m will do to reach 1600 AD, containing the Maunder and Dalton minima.
How to recover the lost TSI of the past on the Moon

\[ 4\pi r^2 \varepsilon \sigma T^4 = (1 - a) S \pi r^2 \]

\[ T = \left[ \frac{(1 - a)S}{4\varepsilon \sigma} \right]^{1/4} \]

\( T_i \) can be measured and inverted to obtain \( T \), thus \( S \) as a function of time.

\[ S = \frac{4\varepsilon \sigma T^4}{1 - a} \]