Proposal for Working Group on “Long-term Analysis of Surface SW Radiation Budget (LASR)”

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Background

• Most of anthropogenic effects on the climate change occur through radiative forcing.
• Large changes of climate due to human activity appeared for the last several decades while many of pyranometer measurements started after IGY, 1957.
• There are many evaluations on the radiative forcing at TOA but little on that at surface.
• There seems to exist long records of operational radiation (pyranometer) data that are not used for climate change study.
• Stellite-derived surface SW radiation data are available for the past two decades.
Objectives

• Collection of various types of long-term surface SW radiation data and the related data including proxy-data useful for SW calculations.

• Comprehensive evaluation of the collected data.

• Promotion of long-term analysis of surface SW radiation and the related data, focusing on their regional properties.
Why different types of surface SW radiation data?

- Independent data sets improve reliability of surface SW radiation analysis.
- Different spatial and temporal coverage compensates each other.
- Discrepancies between independent data sets suggest new findings.
Linear Trend of SW Radiation 1971-2000
(Pyranometer Measurements)
Fig. 1. Linear trend of surface SW radiation in China obtained by pyranometer data (left) and ISCCP-FD data (right).
Necessity of quality evaluations by using different types of data

• To utilize the past pyranometer data and meteorological data
• To improve state-of-the-art evaluation methods such as GEBA.
These data do not pass the criterion of GEBA.
Strategy

• Collection of surface SW radiation data
  – Search for new pyranometer and related meteorological data in the past decades.
  – Construct new data set including parameterized SW radiation.

• Evaluation of data
  – Improve GEBA?
  – Comparison among different data sets.

• Comprehensive analysis of surface SW radiation
  – Focusing on long-term and regional variations.
  – Statistical analysis?
  – Clouds, aerosols, water vapor, etc.
Parameterizations for SW radiation (1)

For clear sky condition, downward SW flux is estimated by using basic meteorological data,

\[
\frac{S_{df}}{S_{0d}} = (C_1 + 0.7 \times 10^{-m_d F_i})(1 - i_3)(1 + j_1)
\]

\[
C_1 = 0.21 - 0.2 \beta_{DUST}, \quad \beta_{DUST} < 0.3
\]
\[
= 0.15, \quad \beta_{DUST} \geq 0.3
\]

\[
F_i = 0.056 + 0.16(\beta_{DUST})^{0.5}
\]

\[
i_3 = 0.014(m_d + 7 + 2 \log_{10} w) \log_{10} w
\]

\[
j_1 = \left[0.066 + 0.34(\beta_{DUST})^{0.5}\right](\text{ref} - 0.15)
\]

\(S_{df}\): average downward SW flux on the Earth’s surface,
\(S_{0d}\): SW flux at the top of atmosphere,
\(\beta_{DUST}\): turbidity factor, \(m_d\): daily mean optical airmass,
\(w\): precipitable water, \(\text{ref}\): surface albedo
Parameterizations for SW radiation (2)

For **cloudy sky condition**, downward SW flux is estimated from sunshine duration,

\[
\frac{S_d}{S_{0d}} = a + b \frac{N}{N_0} \quad \text{for} \quad 0 < \frac{N}{N_0} \leq 1
\]

\[= c \quad \text{for} \quad \frac{N}{N_0} = 0\]

\[a = 0.179 + 0.32 \left( 1 - \frac{p_s}{1000} \right) \quad b = 0.55\]

\[c = 0.114 + 0.32 \left( 1 - \frac{p_s}{1000} \right)\]

\(S_d\): average downward SW flux on the Earth’s surface,
\(S_{0d}\): SW flux at the top of atmosphere,
\(N\): sunshine duration, \(N_0\): maximum sunshine duration.