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.

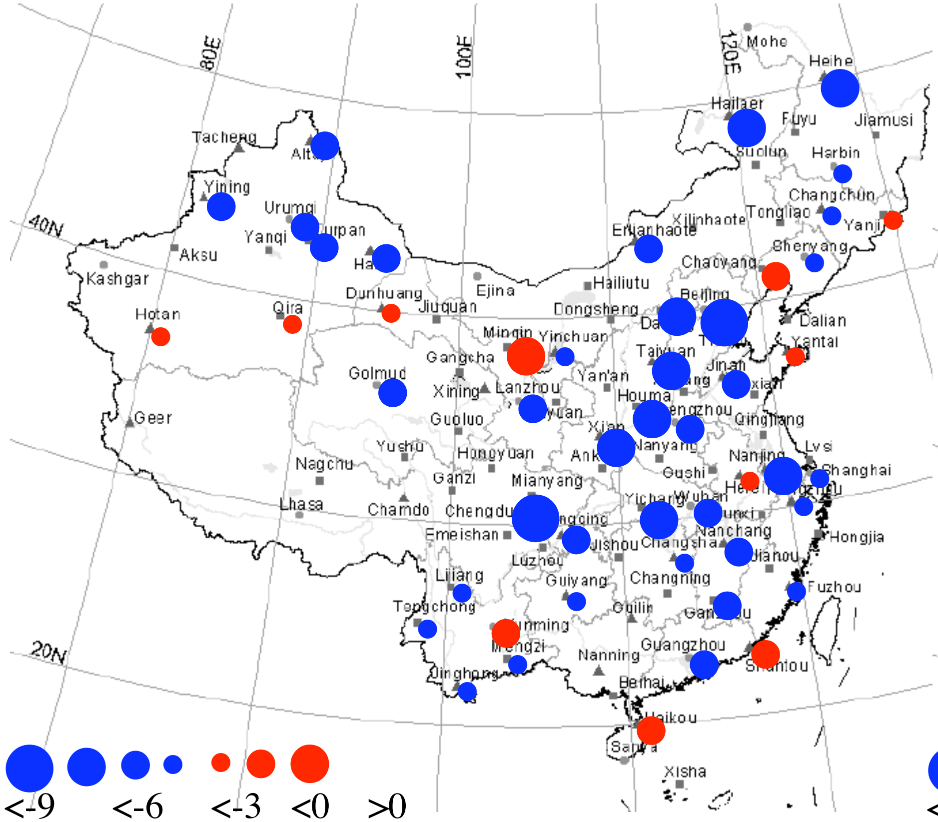
Objectives

- 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?

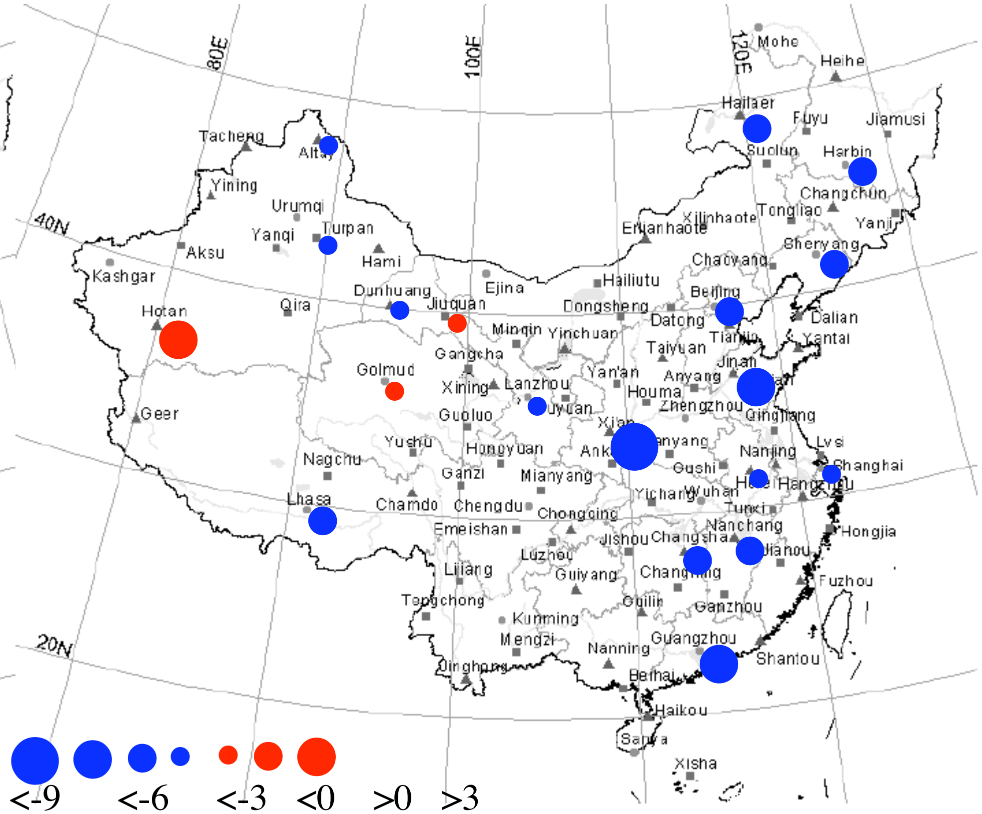
- Independent data sets Improve reliability of surface SW radiation analysis.
- Different spatial and temporal coverage compensates each other.
- Discrepancies between independent data sets suggest new findings.

Linear Trend of SW Radiation 1971-2000
(Pyranometer Measurements)



<-9 <-6 <-3 <0 >0 >3 >6 (W/m2/decade)

Linear Trend of SW Radiation 1971-2000
(Parameterization Method)



<-9 <-6 <-3 <0 >0 >3 >6 (W/m2/decade)

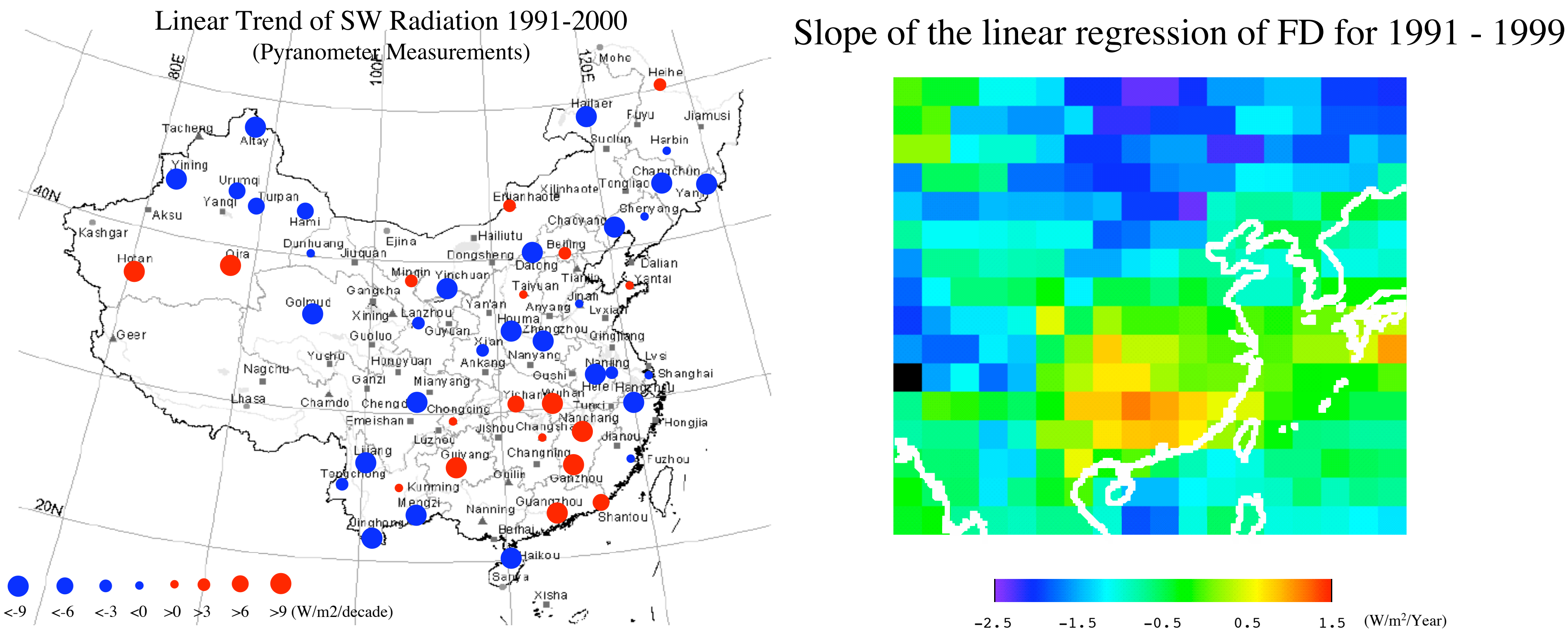
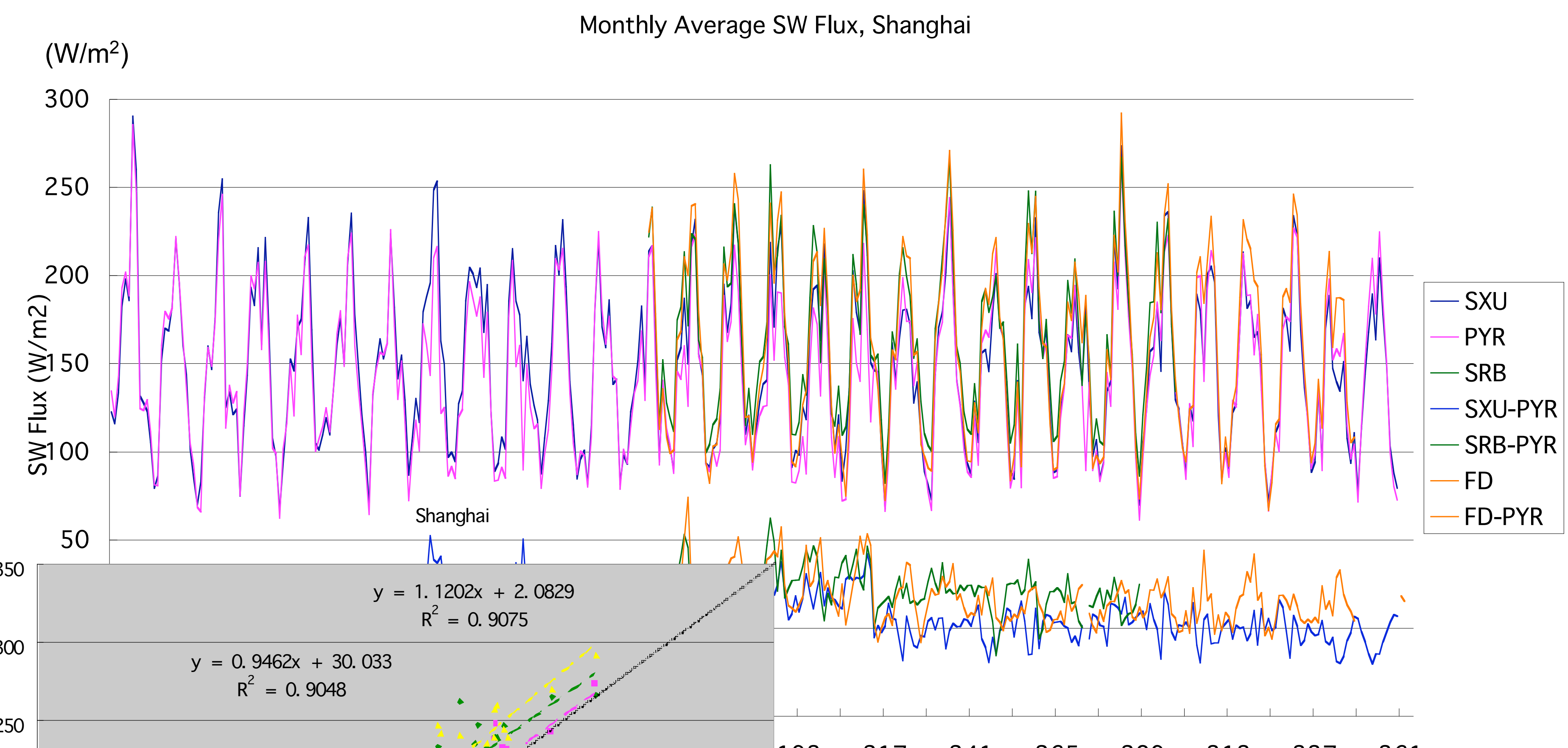
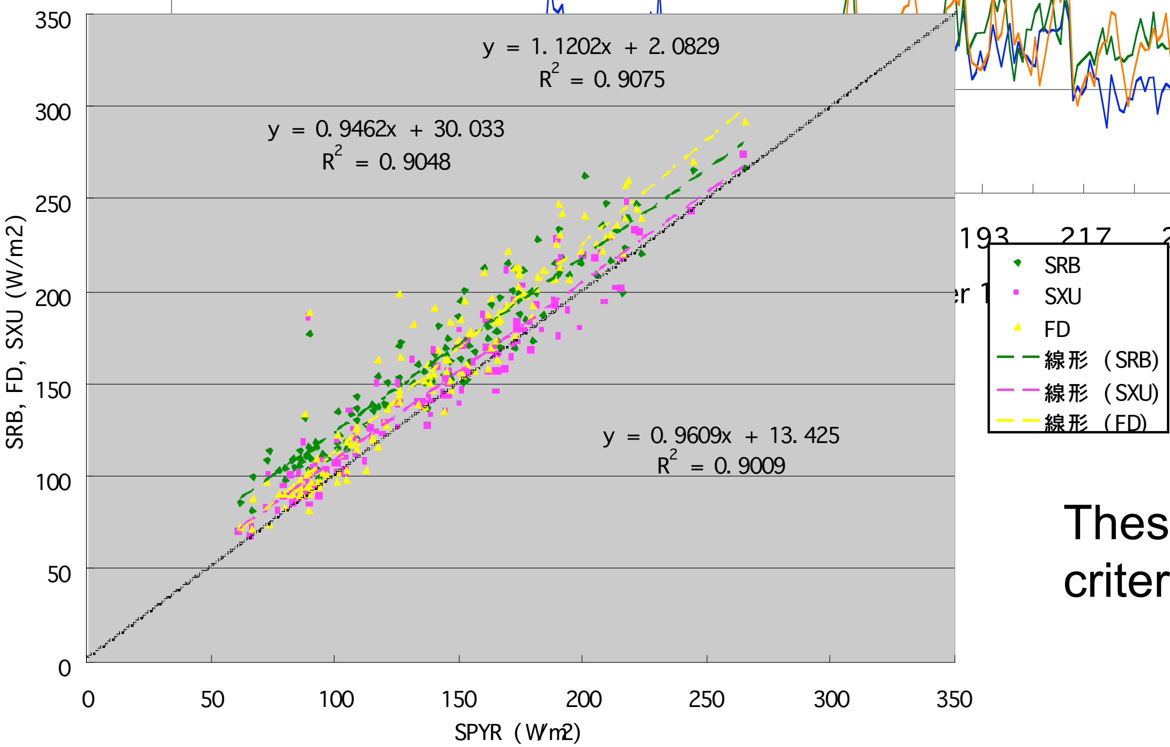


Fig. 1. Linear trend of surface SW radiation in China obtained by pyranometer data (left) and ISCCP-FD data (right).

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,

$$\frac{S_{df}}{S_{0d}} = (C_1 + 0.7 \times 10^{-m_d F_1})(1 - i_3)(1 + j_1)$$

$$C_1 = 0.21 - 0.2\beta_{DUST}, \qquad \beta_{DUST} < 0.3$$

$$= 0.15, \qquad \beta_{DUST} \geq 0.3$$

$$F_1 = 0.056 + 0.16(\beta_{DUST})^{0.5}$$

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

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

S_{df}: average downward SW flux on the Earth’s surface,
S_{0d}: SW flux at the top of atmosphere,
β_{DUST}: turbidity factor, m_d: daily mean optical airmass,
w: precipitable water, ref: surface albedo

Parameterizations for SW radiation (2)

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

$$\frac{S_d}{S_{0d}} = a + b\frac{N}{N_0} \qquad \text{for} \qquad 0 < \frac{N}{N_0} \le 1$$

$$= c \qquad \text{for} \qquad \frac{N}{N_0} = 0$$

$$a = 0.179 + 0.32\left(1 - \frac{p_s}{1000}\right) \qquad b = 0.55$$

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

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.