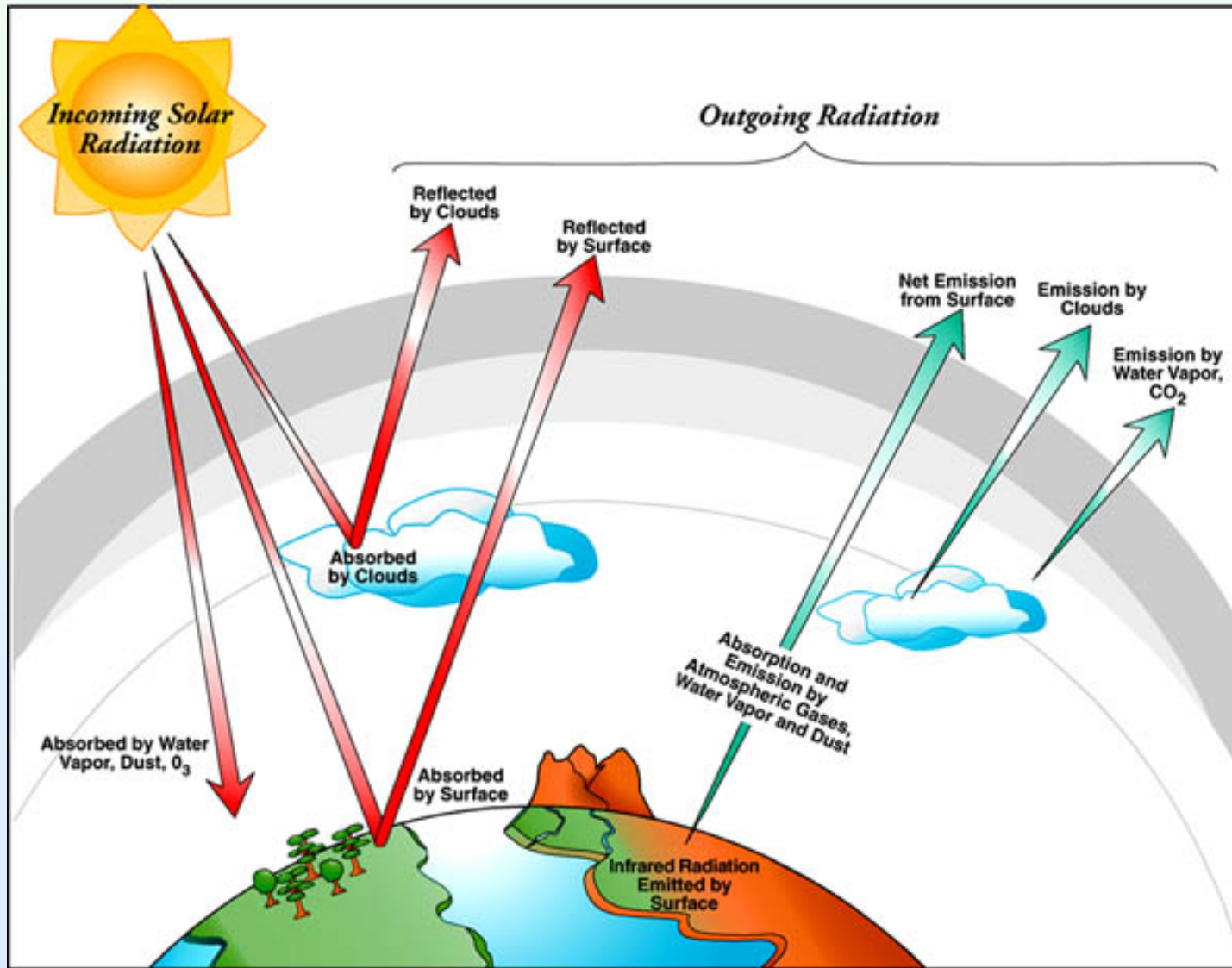


From Dimming to Brightening: Decadal Changes in Solar Radiation at Earth's Surface

Wild, M.; Gilgen, H.; Roesch, A.; Ohmura,
A.; Long, C.N.; Dutton, E.G.; Forgan, B.;
Kallis, A.; Russak, V.; and Tsvetkov, A.

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Solar Radiation at Earth's Surface



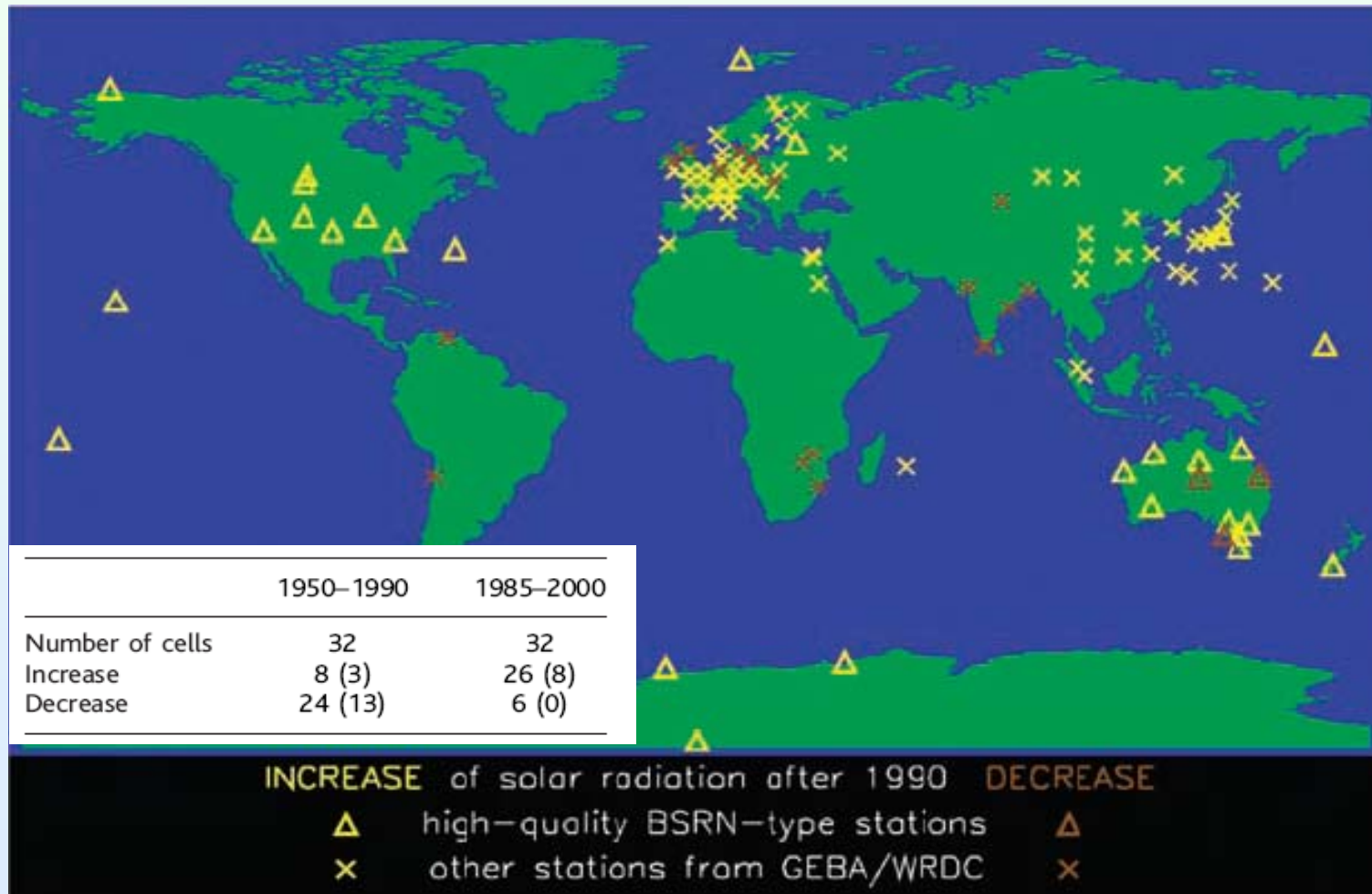
Solar Radiation at Earth's Surface

- Measurements at the surface:
 - Location of the site
 - Quality of the measurements
 - Local conditions
 - Different methods
- A general decrease (6-9 W/m²) of sunlight over land surfaces between 1960 and 1990 have been observed. This corresponds to 4% to 6% per year (dimming)

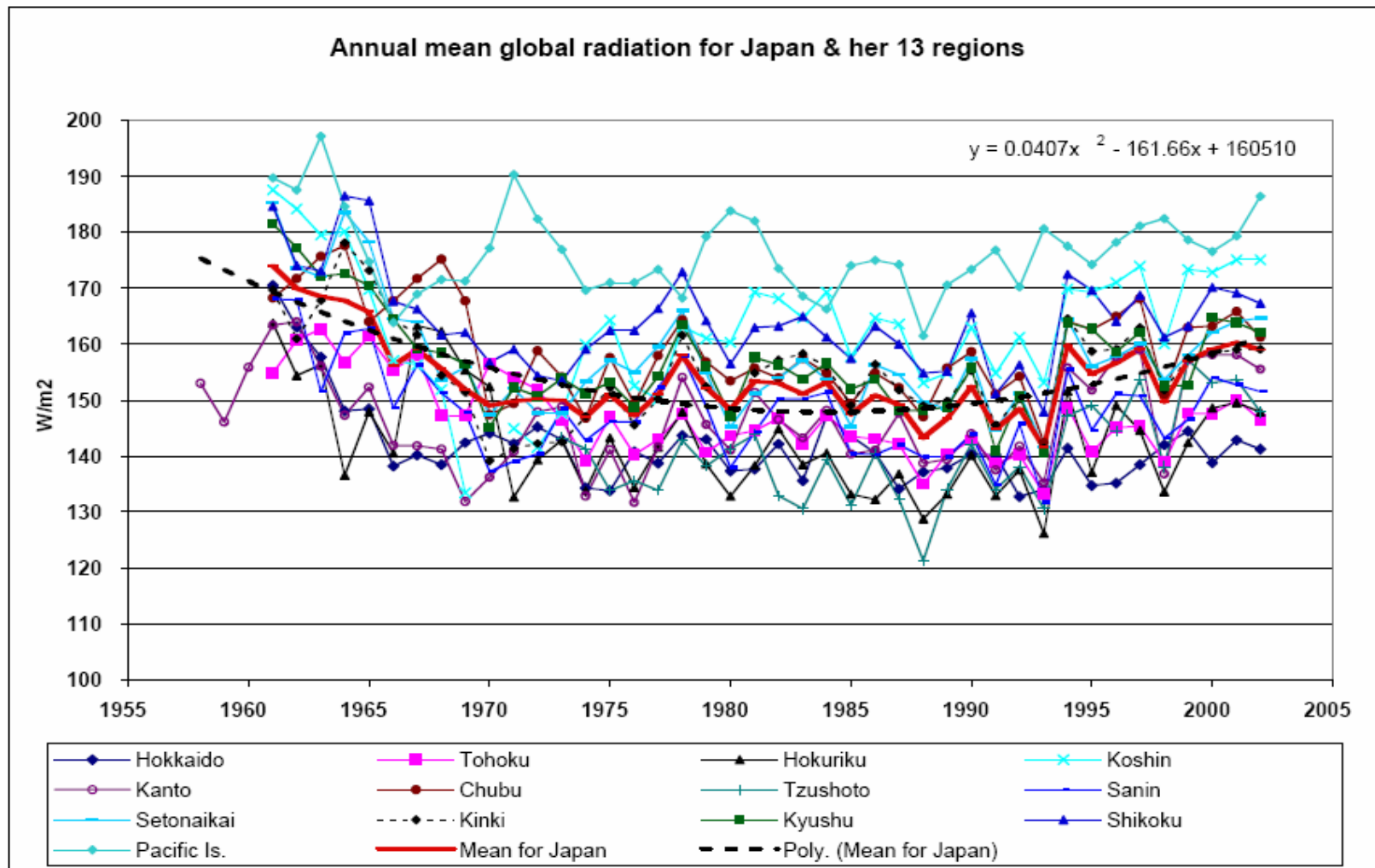
Objective

The study evaluates newly available surface observations to investigate changes in solar radiation in recent years (1990-present)

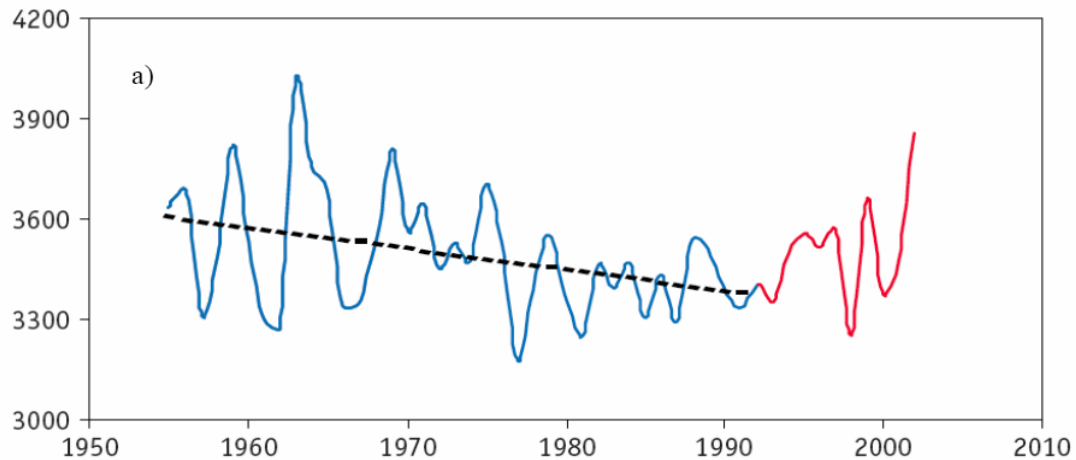
Measurement Sites



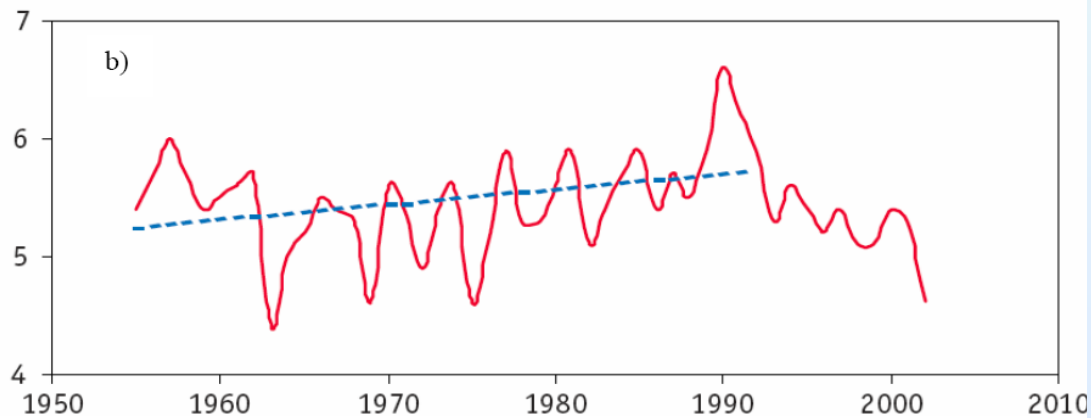
Reversal to Brightening



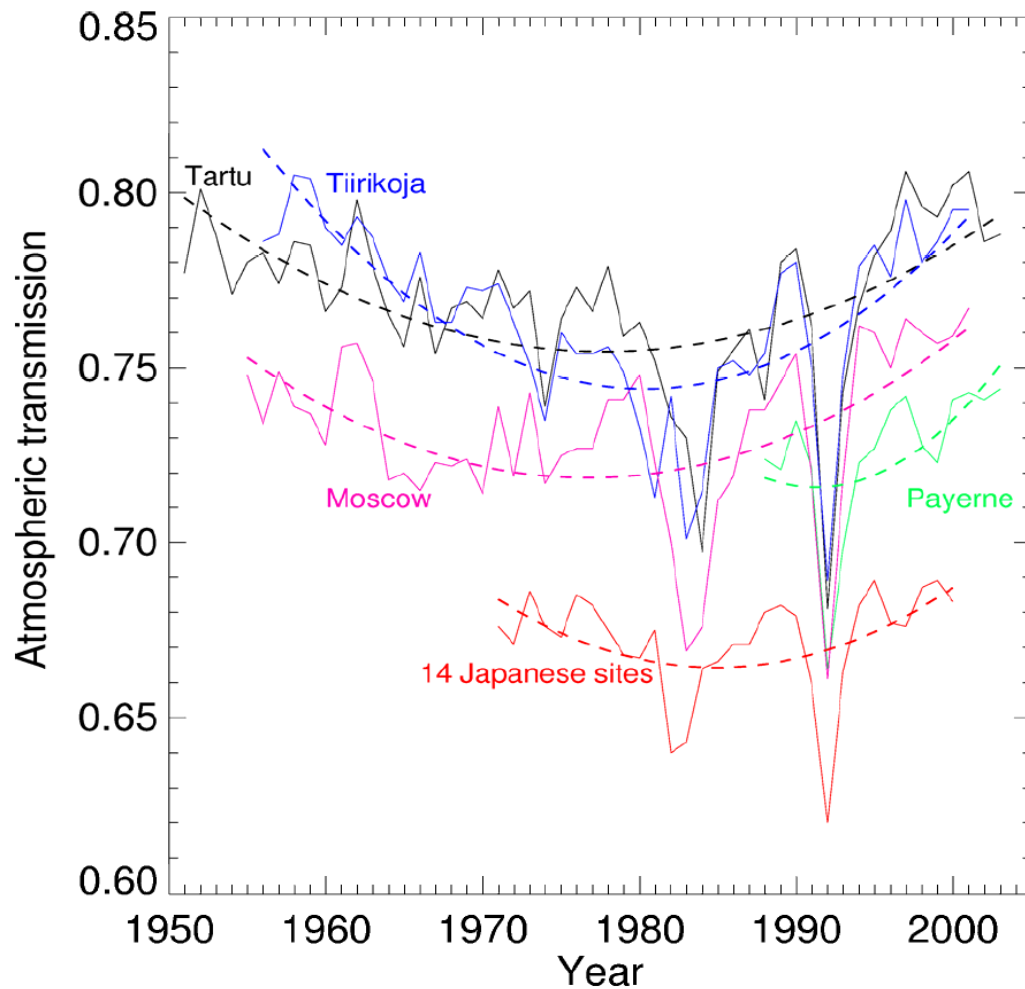
Similar Tendencies in Low Cloudiness



Annual mean solar radiation incident at the surface at Toravere (Estonia). Units MJ*m⁻²*year⁻¹



Annual mean low cloudiness at the surface at Toravere. Unit tenths of cloudiness.



This may be related to a decrease of aerosol burden due to more effective clean-air regulations and the decline in the economy with the political transition in Eastern European

Other locations

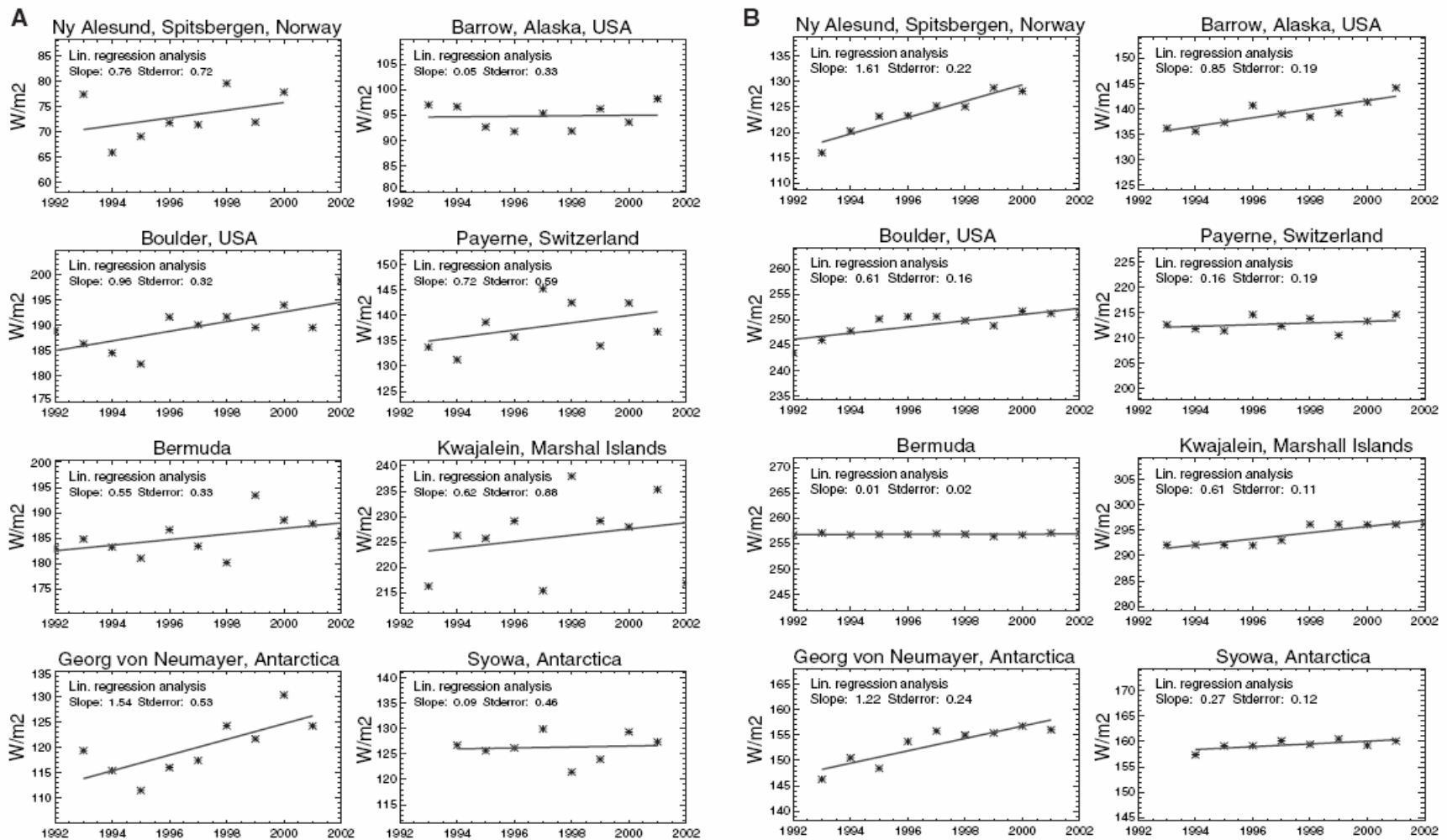


Fig. 2. Time series of annual mean surface solar radiation measured at worldwide distributed sites from BSRN. Shown are the eight longest records from BSRN covering the period 1992 to 2002 for (A) all-sky

conditions and (B) clear-sky conditions (24). Solar radiation increases at all sites under both all-sky and clear-sky conditions over this period. Units $W m^{-2}$.

Summary

- The decline of solar radiation widely reported for the period of about 1960 to 1990 did not continue in the following years. There are indications that the amount of sunlight at the surface has increased during the 1990s
- This is found under all- and clear-sky conditions, indicating that processes in both cloud-free and cloudy atmospheres contributed to the brightening during the 1990s, possibly pointing to an interplay of direct and indirect aerosol effects.

Summary

- The overall increase in the clear-sky fluxes is $0.68 \text{ W} \cdot \text{m}^{-2}$ per year, comparable to the increase under all-sky conditions. The similar changes under clear- and all-sky conditions indicate that, besides clouds, changes in the transparency of the cloud-free atmosphere also contributed to the increase in insolation.
- The decline in solar energy could have counterbalanced the enhanced greenhouse effect before the 1980, this masking of the greenhouse effect and related impacts may no longer have been effective thereafter, enabling the greenhouse signals to become more evident during the 1990s.

Possible Limitations and Future Work

- The measurement sites are concentrated around highly industrialized areas, therefore the effects can be locally more pronounced.
- Clear-sky vs. Cloudy-sky measurements only account for direct and semi-direct aerosol effects.
- More work should be devoted to the inclusion of more stations around the world, these stations should be uniformly distributed