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Bipolar Intercomparison of Long-Term Solar Radiation Measurements from two BSRN Stations

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Instrumentation

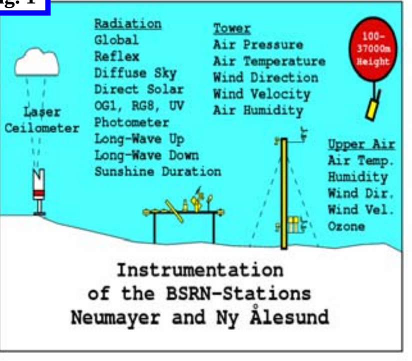
The Alfred-Wegener-Institute for Polar and Marine Resarch runs the BSRN-station Neumayer (70º39'S, 8º15'W, Antarctica) and together with the Norsk Polarinstitut the BSRN-station Ny Ålesund (78º56'N, 11º57'E, Spitzbergen). Both stations are equipped with identical instruments, see Fig.1, 2 and 3.

The radiation sensors are ventilated artificially and get inspected several times a day. Active solar trackers (2AP SCI-TEC/Kipp & Zonen) are used to point automated working photometers (Schulz&Partner, Germany) and a pyrheliometer (NIP, Eppley, USA) towards the sun. Additionally, the trackers shades pyranometers (CM11, SCI-TEC/Kipp & Zonen, Canada) and a pyrgeometers (PIR, Eppley, USA, modified at Davos).

Minute-by-minute averaged radiation fluxes are obtained by using data logger (CR7, Campell Scientific, USA). Additionally, synoptic weather observations as well as daily upper air soundings and weekly ozone soundings are available from both stations. On-line visualization and validation of the data are performed by workstations (SUN, USA).

The continuous measurements started at Neumayer in 1982 and at Ny Ålesund in 1992. More information and on-line data are available via http://www.awi-bremerhaven.de/MET.

Fig. 1



Environment of the Stations

Neumayer is situated on the Ekstrøm Ice Shelf at a distance of about 10 km from the shore line. The Ekstrøm Ice Shelf has a homogeneous, flat surface sloping gently upward to the south. The surface is always covered with snow which forms occasionally sastrugies up to 1 m height.

Ny Ålesund is situated directly on the shore line of the Kongsfjorden, surrounded by mountains with heights up to 700 m. The ground is snow-free from about midsummer to early winter.

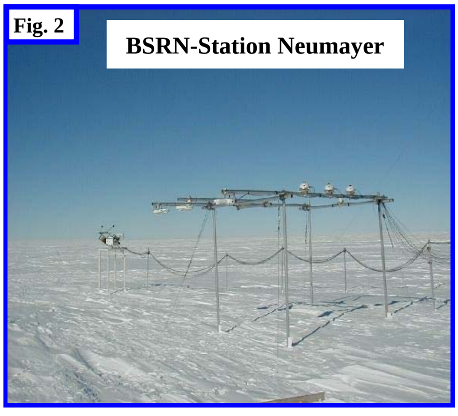
Annual Averaged Surface Radiation Fluxes

Neumayer receives more global radiation K⇓ than Ny Ålesund. Nevertheless, due to the very high annually averaged albedo the short-wave radiation budget K* is smaller at Neumayer, see Fig. 4 and 5.

Since Ny Ålesund is stronger influenced from the ocean, the temperatures as well as all long-wave fluxes L ⇓, L⇑ are higher compared with Neumayer.

The short-wave energy gains get compensated to a remarkable extend by the long-wave losses. At Ny Ålesund the total radiation budget Q* is close to zero, at Neumayer slightly negative.

Fig. 2



Annual Cycle of the Daily Averaged Sunshine Duration

Fig. 6 and 8 depict the mean annual cycle of daily averaged sunshine duration from Neumayer and Ny-Ålesund as well as the extraterrestrial sunshine duration calculated after Iqbal (1983) and the relative sunshine duration (measured versus extraterrestrial sunshine duration). For a better bipolar intercomparison, the data are presented as a function of days after midwinter.

At Neumayer the relative sunshine duration is rather constant throughout the year. At Ny-Ålesund the relative sunshine duration reaches maximum values during spring. Significantly less clear sky cases exist during summer and autumn.

Daily Averaged Sunshine Duration and Cloud Cover

Additionally, the averaged cloud free amount calculated from the visual observed total cloud amounts at noon is shown in Fig. 6 and 8.

The data analysis show a rather good correlation between the daily averaged relative sunshine duration and the daily averaged cloud free amount calculated from the visual observed total cloud amounts. The relative sunshine durations slightly exceeds the results from the visual observations in most cases since thin transparent cirrus clouds have no influence on the sunshine measurements. Within these limits the relative sunshine duration – which can be measured easily - can be taken as a good proxy for hardly available cloud cover observations.

Cloud Forcing of the Global Radiation

To quantify the mean radiative forcing from partly cloud covered skies the mean daily averaged relative global radiation versus the mean daily averaged relative sunshine duration is presented in Fig. 7. The relative sunshine duration can be taken as a proxy for the cloud free amount.

The most striking result of Fig. 7 is the rather linear dependence between the weakening of the global radiation and the increasing cloud amounts. Only very overcast days deviate from this linear behaviour. As lower the cloud amount (higher the relative sunshine duration) as smaller standard deviation in the relative global radiation are obtained.

The dataset from Ny-Ålesund has been subdivided to distinguish between snow-covered surfaces (data from April and May) and snow free surfaces (data from July and August). The low albedo (about 15%) of the snow-free dataset leads to the lowest mean relative global radiation and the highest relative short-wave cloud forcing values.

Although the data from the snow-covered period from Ny-Ålesund are closest to the values from Neumayer they still differ significantly. The lower large area albedo and the aerosol laden air during spring in the Arctic must be taken as explanation.

Fig. 3

Fig. 4

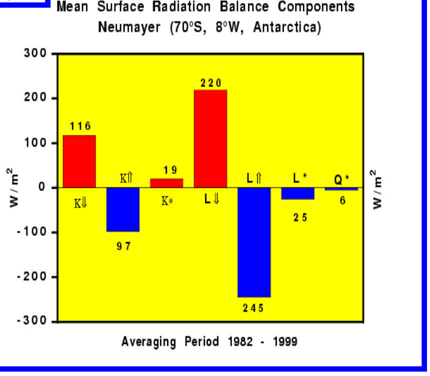


Fig. 5

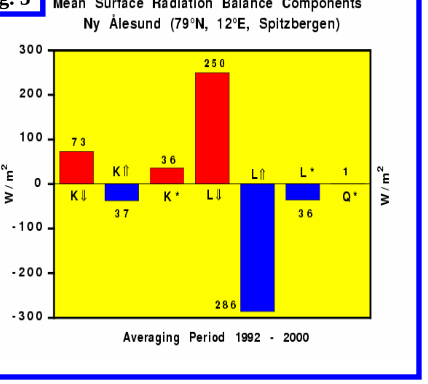


Fig. 6 Annual Cycle of the Sunshine Duration from Neumayer

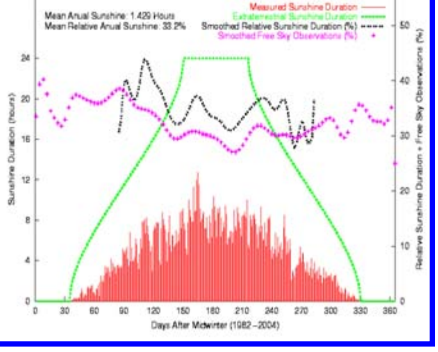
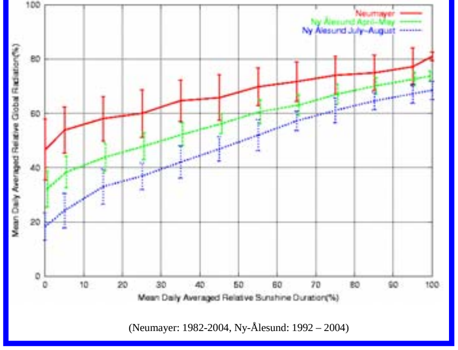


Fig. 7 Cloud Forcing of the Global Radiation



(Neumayer: 1982-2004, Ny-Ålesund: 1992 – 2004)

Fig. 8 Annual Cycle of the Sunshine Duration from Ny-Ålesund