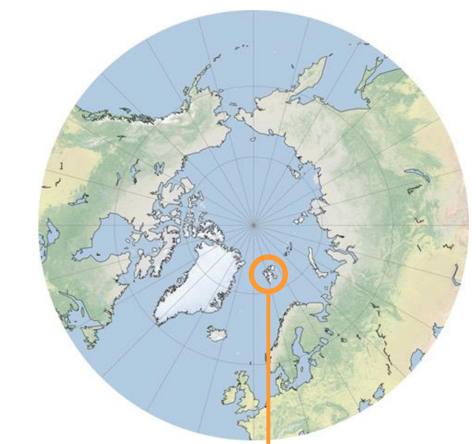
Long-Term Changes in Temperature and Radiation at the Arctic Station Ny-Ålesund (79°N, 12°E)



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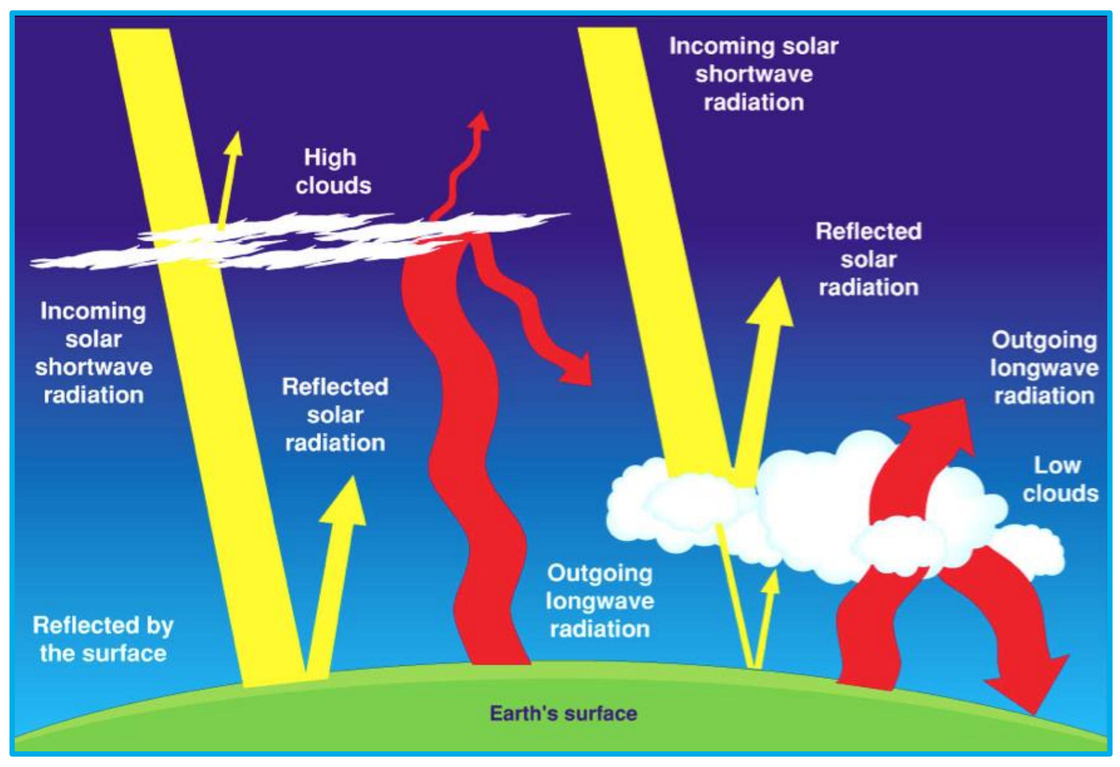
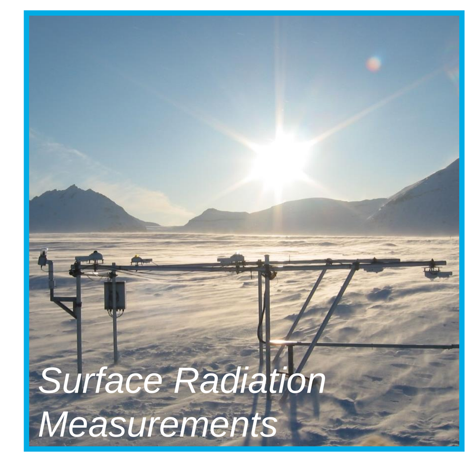
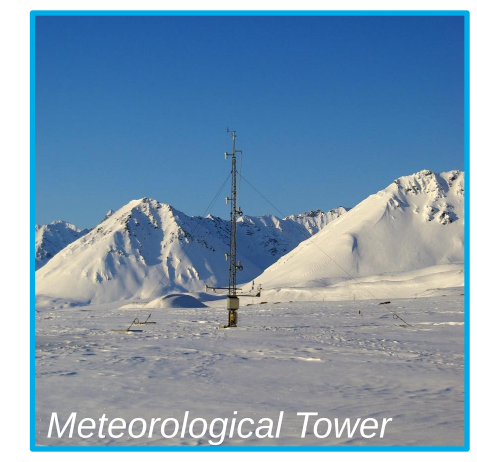
The radiation budget of the Earth-atmosphere system plays a fundamental role in determining the thermal conditions and the circulation of the atmosphere and the ocean, shaping the main characteristics of the Earth's climate. The irradiances at the Earth's surface are especially important in understanding the climate processes, since the Earth's surface transforms approximately 60% of the solar radiation absorbed by the planet.







At Ny-Ålesund (78.9°N, 11.9°E), Svalbard, surface radiation measurements of up- and downward short- and longwave radiation are operated since August 1992 in the frame of the *Baseline Surface Radiation Network* (BSRN), complemented with surface and upper air meteorology since August 1993. The long-term observations enable the detection of changes in the complex Arctic environment.

Surface Radiation Budget ⇩SW + ⇩LW - ⇧SW - ⇧LW

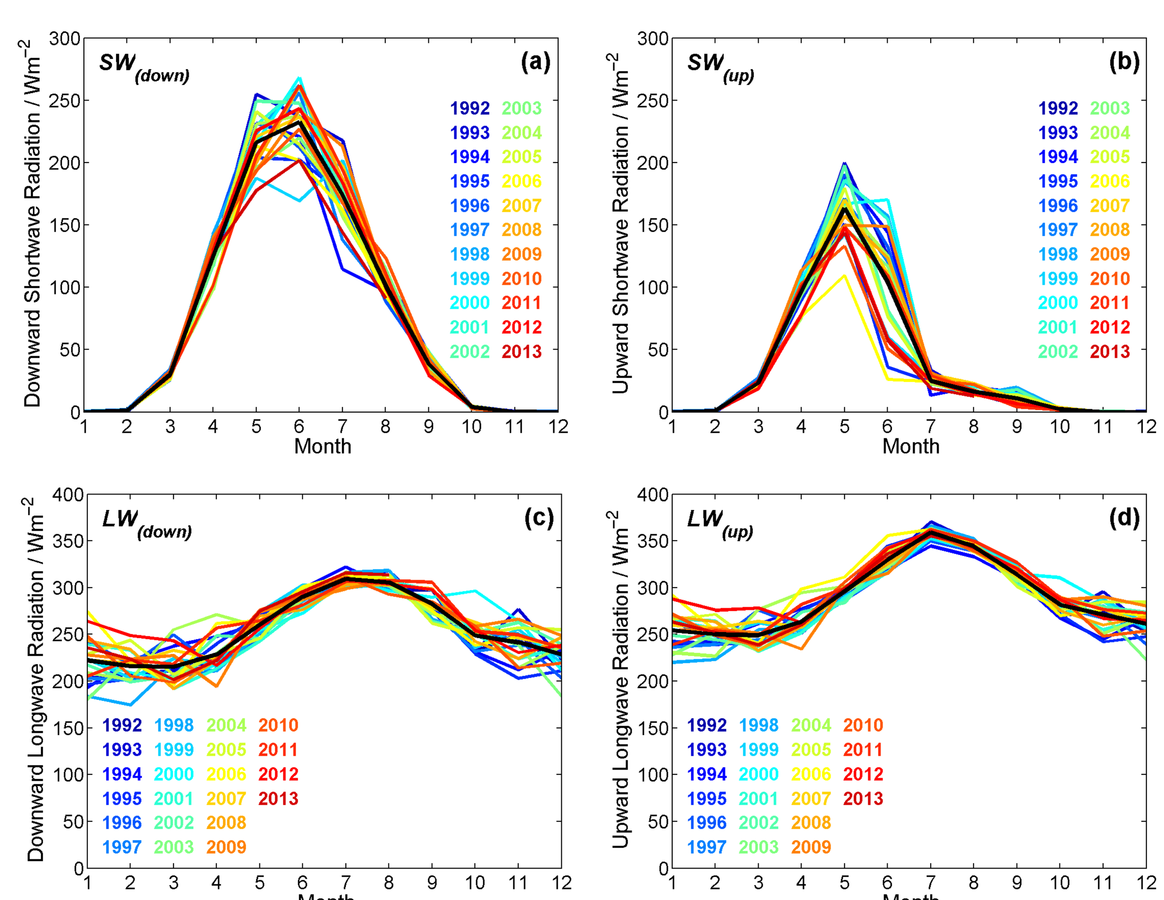


Fig 1 Ny-Ålesund monthly mean values (*color-coded for all years of observation, black for overall mean*) for global shortwave radiation SW_{down} (a), reflected shortwave radiation SW_{up} (b), downward longwave radiation LW_{down} (c), and upward radiation LW_{up} (d), respectively

…and its Change over Time

Net Radiation Budget

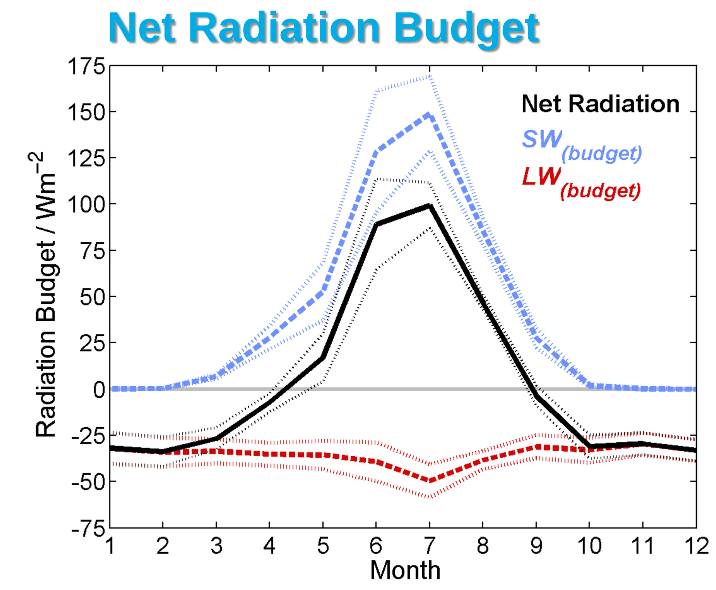


Fig. 2: Average monthly mean values of shortwave, longwave, and net radiation budget (*red, blue and black lines, respectively*) each +/- 1 δ of monthly means (*colored dotted lines, respectively*)

Increase in Net Radiation Budget

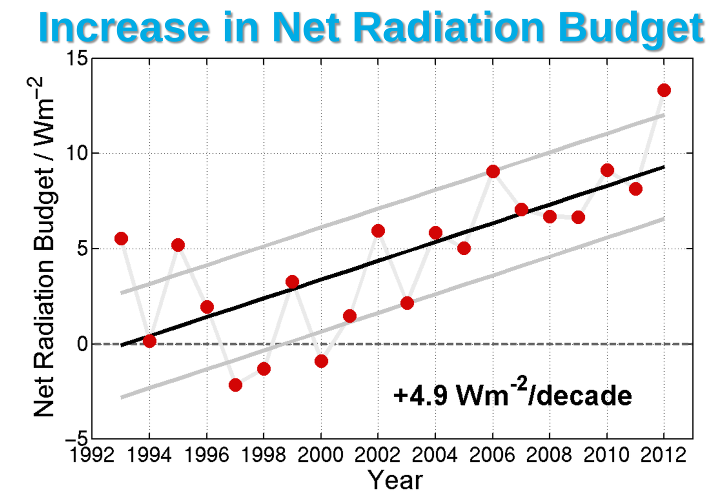


Fig. 3: Ny-Ålesund annual mean net radiation budget Q_{net} (*red dots*), with the linear regression (*black line*) ± 1 δ (*grey lines*) indicating an increase of + 4.9 ± 2.9 Wm^{-2} per decade.

Seasonal Dependence

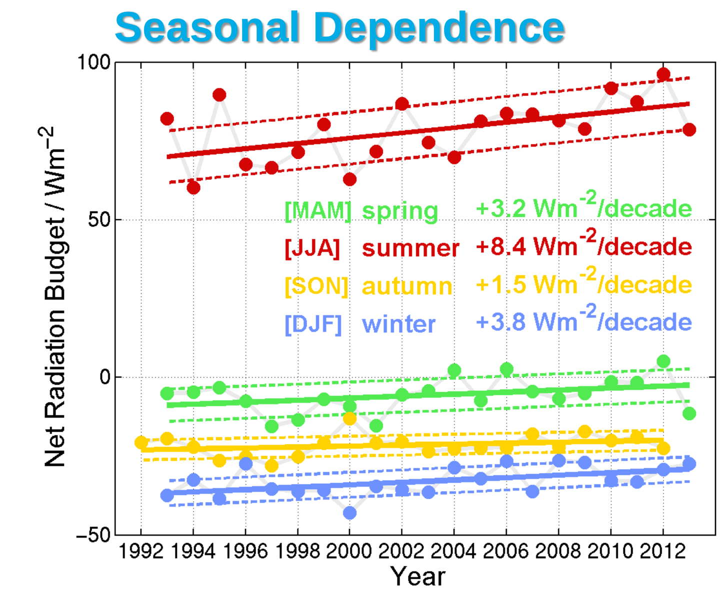


Fig. 4: As Fig.3 , but for the seasonal mean net radiation budget (Mar-Apr-May, *green*), summer (Jun-Jul-Aug, *red*), autumn (Sep-Oct-Nov, *yellow*), and winter (Dec-Jan-Feb, *blue*).

Atmosphere ⟷ Surface

Albedo (Reflectivity ⇧SW / ⇩SW)

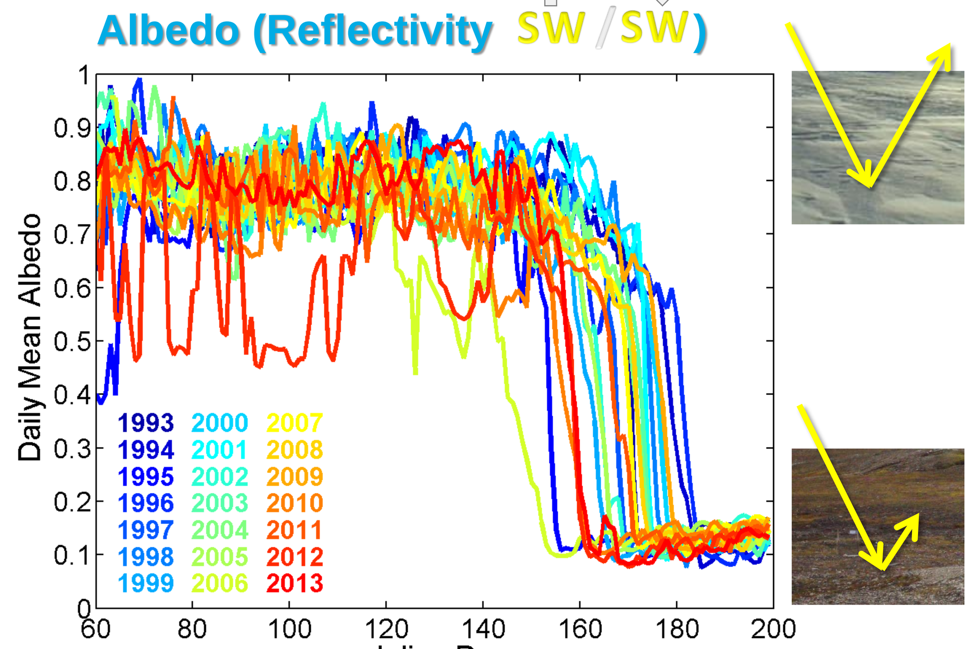


Fig. 8: Daily mean albedo SW_{down}/SW_{up} at the Ny-Ålesund BSRN radiation sensor set-up, on Julian days for all observation years 1993 to 2013 (color-coded)

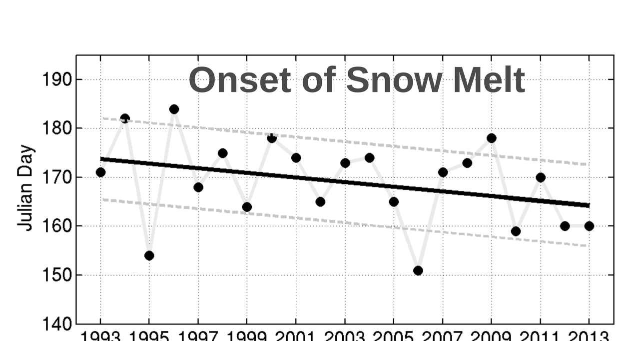


Fig. 9: First day of each year 1993 to 2013 assumed to have a predominantly snow-free surface (daily mean albedo < 0.2).

Surface Air Temperature

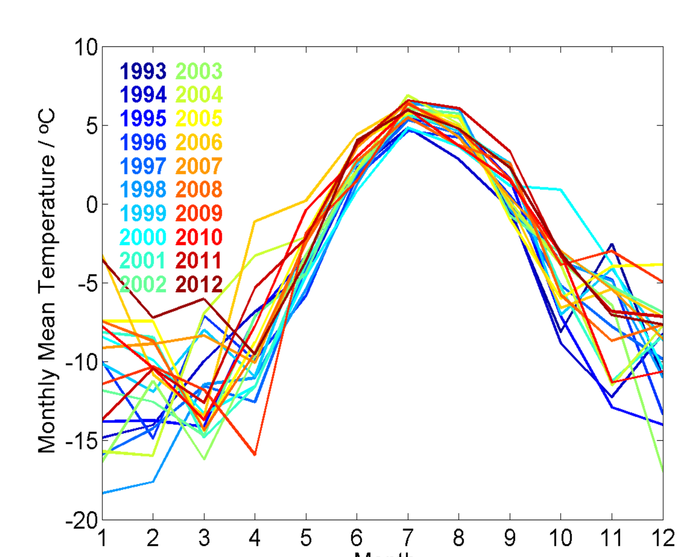


Fig. 5: Ny-Ålesund monthly mean surface air temperature, colour-coded for the different years of the observation period.

…and its Change over Time

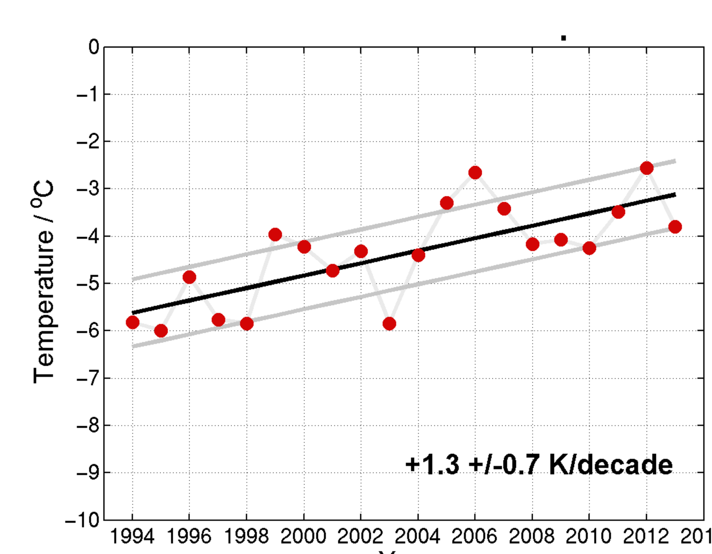


Fig. 6: Ny-Ålesund annual mean surface air temperature (*red dots*), with the linear regression (*black line*) ± 1 δ (*grey lines*) indicating an increase of + 1.3 ± 0.7 K per decade.

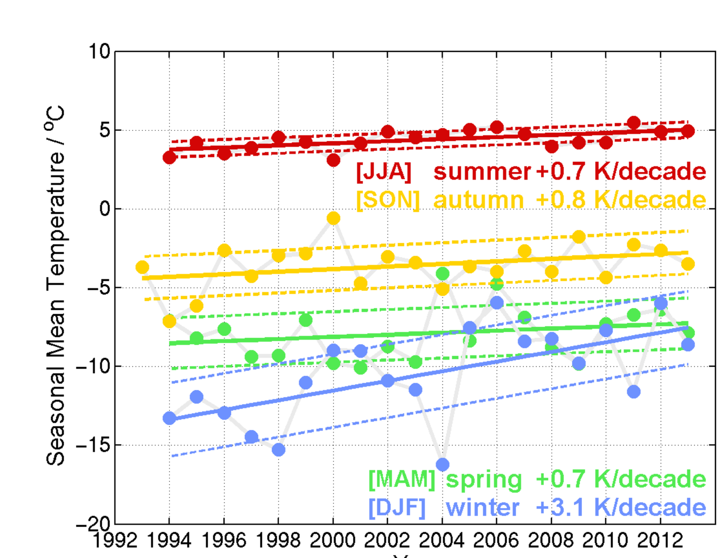


Fig. 7: As Fig.5 , but for the seasonal mean temperature spring (Mar-Apr-May, *green*), summer (Jun-Jul-Aug, *red*), autumn (Sep-Oct-Nov, *yellow*), and winter (Dec-Jan-Feb, *blue*).

- Increase in longwave radiation largest in winter, potentially related to changes in cloud cover or humidity.
- The observed warming is accompanied by changes in the Svalbard environment.
- The onset of snow melt is found to occur earlier by about one week over the 20 year observation period.
- As terrestrial ecology is most active during the snow-free season, the prolongation of the warm season's duration has a strong impact on the Svalbard tundra ecosystem.

more details →
Maturilli M, Herber A, König-Langlo G: 'Surface Radiation Climatology for Ny-Ålesund, Svalbard (78.9°N), Basic Observations for Trend Detection', submitted to Theoretical and Applied Climatology (2014)

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