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Increase in Temperature and Radiation at the Arctic BSRN Station Ny-Ålesund (79°N, 12°E)

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The Arctic Baseline Surface Radiation Network (BSRN) station Ny-Ålesund (79°N, 12°E), Svalbard, operates surface radiation measurements since 1992, complemented with surface and upper air meteorology that build the 20 year base of our study. Obviously, the radiation budget in the Arctic region has a large seasonal variation, attributed to polar day and polar night. The Arctic climate is further modulated by the presence of atmospheric aerosols that affect the distribution of radiant energy passing through the atmosphere. Aerosols may affect the surface–atmosphere radiation balance directly by interactions with solar and terrestrial radiation, and indirectly by providing condensation nuclei for the formation of cloud particles.

Following the general Arctic warming, the annual mean surface temperature in Ny-Ålesund has increased during the last two decades, with +1.35 K per decade. Remarkably, during the period of observation the Ny-Ålesund annual mean radiation budget has become positive, with a significant increase of + 4.2 Wm-2 per decade. The largest contribution was found for the summer months. Looking at the shortwave radiation budget, the annual mean global radiation has not significantly changed, while an increase is found for the summer months (about 10 Wm-2 per decade) and a decrease is found for springtime (about -6.5 Wm-2 per decade), indicating a change in cloud coverage with more clouds during spring and less clouds during summer. The upwelling shortwave radiation decreased slightly during summer, but decreased largely during the springtime period. This decrease in reflected shortwave radiation is related to changes in the albedo: in the Arctic tundra environment of Ny-Ålesund, the rising temperature leads to an earlier onset of snow melt and thus less snow coverage. Generally, the longwave radiation budget is affected by three atmospheric components: clouds, water vapour and temperature. As for the upwelling longwave radiation, an increase is observed in the annual mean with the largest contribution found for the winter months, most likely due to the general warming. By far the strongest changes are found in the downwelling thermal radiation during polar night. An increase of about 14 Wm-2 per decade indicates changes in the Arctic humidity or cloud coverage during wintertime, with clouds being either larger in volume or modified in composition.

Although the largest changes in the total radiation budget are found during the summer months, the longwave radiation changes during wintertime seem to have more impact on the Ny-Ålesund climate, as the largest temperature increase is also observed for the winter months. The vertical temperature structure as found from surface and radiosonde measurements indicates a decrease in the planetary boundary layer stability throughout all months. For the winter period, this reduction in stability implies a shift away from the typical Arctic inversion situation and consequently a change in cloud coverage. Further analysis will include more meteorological parameters, and a comparison with ERA Interim model analysis.