CODIGO PONENCIA : 20112016NYKUSA
TITULO PONENCIA :
CATEGORIA PONENCIA : Póster
CLASIFICACION TEMATICA : Ambientes de regiones polares
AUTOR PRINCIPAL : Kejna Marek
ORGANIZACION : Nicolaus Copernicus University Dep of Climatology
PAIS : Polonia / Poland

SPATIAL DIFFERENTIATION OF RADIATION BALANCE IN THE KAFFIØYRA REGION (SVALBARD, ARCTIC) IN THE SUMMER SEASON 2010

Kejna Marek, Przybylak Rajmund, Araźny Andrzej
Department of Climatology, Institute of Geography, Nicolas Copernicus University
Gagarina 9, 87-100 Toruń, Poland
marek.kejna@umk.pl

Between 16 July and 31 August 2010 topoclimatic research was carried out in the area of Kaffiøyra (NW Spitsbergen, Svalbard, Arctic). The local climate heavily relies on the Earth's radiation balance (Q*). The radiation balance consists of net short wave radiation (K*) and net long wave radiation (L*), and in the whole spectrum it is described by the following equations:

$$Q^* = K^* + L^*; \quad K^* = K{\downarrow} - K{\uparrow}; \quad L^* = L{\downarrow} - L{\uparrow}$$

$$Q^* = (K{\downarrow} - K{\uparrow}) + (L{\downarrow} - L{\uparrow})$$

where:
Q* – radiation balance,
K* – net shortwave radiation,
L* – net longwave radiation,
K↓ – shortwave solar radiation (direct and diffuse),
K↑ – reflected shortwave solar radiation,
L↓ – longwave atmosphere radiation,
L↑ – longwave surface radiation.

Measurements of Q* were carried out at three stations with different bases: KH on the glacial moraine of the Aavatsmark (11 m a.s.l.), LW1 – on the terminal moraine of the Waldemar Glacier (130 m a.s.l.), and LW2 – on the firn field of the Waldemar (375 m a.s.l.). A Kipp&Zonen CNR 4 Net Radiometer was used to measure and register – minute by minute – the short wave radiation balance (K*), which is the difference between solar radiation K↓; and reflected solar radiation (K↑), and the long wave radiation balance (L*), which is the difference between downward long wave atmospheric radiation (L↓;) and upward long wave radiation (L↑).

In the studied period the maximum intensity of K↓ reached 709.4 $W.m^{-2}$ at KH, 882.1 $W.m^{-2}$ at LW1 and 836.2 $W.m^{-2}$ at LW2. The mean diurnal sums of K↓ ranged from 11.04 $MJ.m^{-2}$ at KH to 10.46 $MJ.m^{-2}$ at LW1 and 10.60 $MJ.m^{-2}$ at LW2. The K↓ cycle was marked by a strong influence of cloudiness, since the dispersed radiation was several times lower due to the lack of direct solar radiation. The surface albedo varied, reaching between 13% (LW1) and 15% (KH) on the moraines, and up to 61% (LW2) on the firn field. Thus the lowest value of K* +4.31 $MJ.m^{-2}$, was registered at LW2, whereas it was doubled on the moraines: KH +9.50 $MJ.m^{-2}$ and LW1 +9.09 $MJ.m^{-2}$.

The components of the long wave balance are mostly affected by surface temperatures and cloudiness. The flux of L↓ coming from the atmosphere does not reveal any significant differences between individual stations: KH – 27.26 $MJ.m^{-2}$, LW1 – 27.47 $MJ.m^{-2}$ and LW2 – 27.37 $MJ.m^{-2}$in 24h. The Earth's surface (L↑) was losing, on average:, 30.31 $MJ.m^{-2}$, 29.88 MJ.m^{-2}and 30.10 MJ.m^{-2}, respectively, and the mean daily values of L* were negative: KH -3.05 MJ.m^{-2}, LW1 -2.42 MJ.m^{-2} and LW2 -2.42 MJ.m^{-2}. The Earth's surface balance (Q*) was the most favourable on moraine bases: LW1 +6.67 MJ.m^{-2}, KH +6.45 MJ.m^{-2}, whereas the snow-covered firn field received the smallest amount of energy: LW2 +1.58 MJ.m^{-2}.

In spite of the polar day, the diurnal cycle of the radiation balance components appears symmetrical with regard to the solar noon, related to the elevation of the sun over the horizon and the temperature of the surface and of the atmosphere. The flux of K↓; reached its peaks during midday hours with the following mean values: KH – 278.7 W.m^{-2}, LW1 – 275.9 W.m^{-2}, and LW2 – 295.2 W.m^{-2}. At the time of lower culmination of the sun the values of K* were falling to zero. The balance of long wave radiation (L*) was negative and reached its highest values around midday hours (KH -50.0 MJ.m^{-2}, LW1 -40.1 MJ.m^{-2} and LW2 -47.5 MJ.m^{-2}). Q* was the highest in midday hours, when it was 2.5 times higher for moraine bases (KH +194.8 MJ.m^{-2} and LW1 +201.5 MJ.m^{-2}) than for snow and glacial surfaces (LW2 +79.1 MJ.m^{-2}). At low elevation of the sun Q* became negative: KH -6.8 MJ.m^{-2}, LW1 -5.4 MJ.m^{-2} and LW2 -19.4(KH +194.8 MJ.m^{-2} and LW1 +201.5 MJ.m^{-2}.

On individual days the diurnal cycle of the components of Q* was affected not only by the elevation of the sun, but also by the atmospheric state and the presence of clouds, in particular. For example, on 27 and 28 July 2010 a different weather occurred. On the first of the days the sky was completely overcast with St and Sc clouds and no sunshine was observed. On the following day it cleared up with partial cloudiness (Cu, Ac, Ci), and the sunshine duration reached 16.2 h. On 27 July a slight influx of K↓ was registered (mean intensity 68.6 W.m^{-2}, diurnal sum 5.92 MJ.m^{-2}), K* was 5.14 MJ.m^{-2}, and L* -0.84 MJ.m^{-2} due to the total cloudiness, which supported substantial downward atmospheric radiation (L↓; 339.3 W.m^{-2}). On the other hand, on 28 July, when the amount of cloudiness was moderate, the maximum intensity of K↓ was 668.7 W.m-2. In 24 hours the total radiation that reached the surface amounted to 22.04 MJ.m^{-2}, and K* increased to 18.90 MJ.m^{-2}. L* was negative (-5.26 MJ.m^{-2}) due to substantial radial emittance of the ground (L↑; 352,0 W.m^{-2}) and some downward atmospheric radiation (L↓ 291.1 W.m^{-2}). However, the overall radiation balance was three times higher than on 27 July and amounted to 13.65 MJ.m^{-2}. In the studied period, the individual components of Q* were decreasing in value, as a result of the lower and lower elevation of the sun over the horizon and the ending of the polar day.

The radiation balance affects the surface and air temperatures, and it influences the courses of other meteorological elements.

This research was founded by the Polish-Norwegian Research Fund - grant PNRF-22-AI-1/07 "Arctic Climate and environments of the Nordic Seas and the Svalbard-Greenland Area-AWAKE".