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# TOPOCLIMATIC CONDITIONS IN THE SUMMER SEASONS IN THE OSCAR II LAND (NW SPITSBERGEN) IN THE PERIOD 2005-2009

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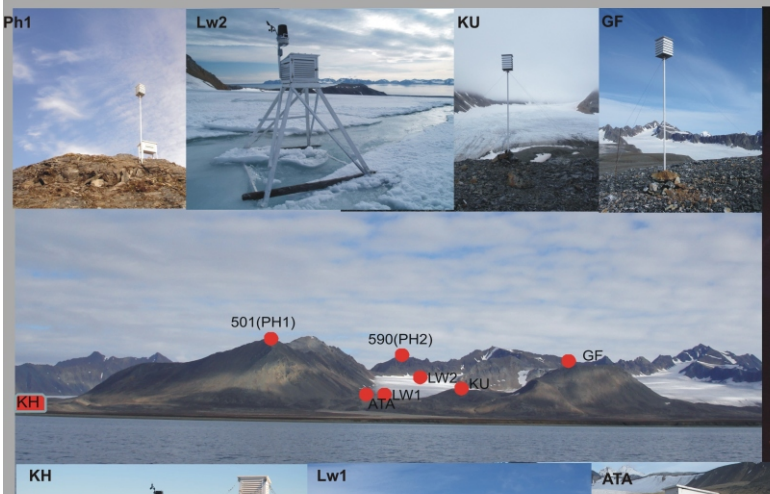
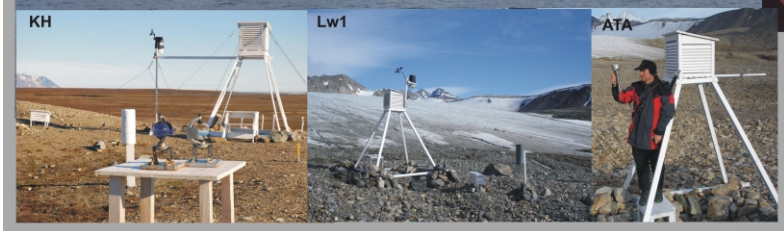
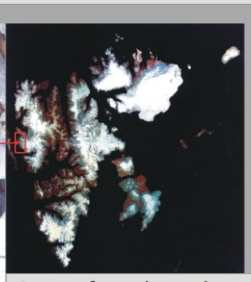
Meteorological conditions on the Kaffioyra region (Oscar II Land, NW Spitsbergen) show significant spatial differentiation due to large-scale denivelation, slope aspect, diverse ground properties and local air circulation. Topoclimatic research on the Kaffioyra were carried out since 1977.







## Area of study and methodology

There are many physiographic units in the study area: sea shore of the Forlandsundet, tundra on the Kaffiøyra, moraines, glaciers and mountain ridges. The meteorological measurement points (4 automatic weather stations and 4 electronic devices measuring temperature and humidity, 2 m a.g.l.) were located on the Kaffiøyra Plain (main station 78°41'N, 11°51'E, 11 m a.s.l.), on the Waldemar Glacier area and on the mountains: Grøfjellet and Prins Heinrichfjella.


Meteorological stands used in this study

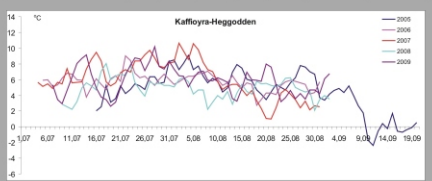
| | Stand | Latitude | Longitude | Hight (m asl.) |
|---|---|---|---|---|
| KH | Kaffiøyra-Heggodden | 78°41'34" N | 11°51'39" E | 11,5 |
| ATA | ATA | 78°40'31" N | 11°59'30" E | 137,0 |
| LW1 | Lodowiec Waldemara-1 | 78°40'31" N | 12°00'01" E | 130,0 |
| LW2 | Lodowiec Waldemara-2 | 78°40'59" N | 12°05'15" E | 375,0 |
| LA | Lodowiec Aavatsmarka | 78°57'46" N | 11°57'46" E | 130,0 |
| KU | Kuven | 78°40'53" N | 12°00'53" E | 193,0 |
| GF | Gråfjellet | 78°30'59" N | 12°00'33" E | 345,0 |
| PH1 | Prins Heinrichfjella-1 | 78°40'51" N | 11°59'28" E | 501,0 |
| PH2 | Prins Heinrichfjella-2 | 78°41'01" N | 12°06'25" E | 590,0 |

# Meteorological conditions

The analysed summer seasons (July 21st-Augist 31th) had variable weather conditions (2005-2009). The average level of cloudiness, 8.6 (scale 0-10), was significant. Mean sunshine duration reached 158,2 hours. The analysed seasons were warmer (5.4°C) then the mean value in the years 1975-2009 (4.8°C). Owing to dominance of maritime masses, the air on Oscar II Land shows a significant level of saturation with the water vapour (mean relative humidity at the Kaffioyra station was 88%). Wind velocity in the vicinity of Kaffioyra Station is strongly dependent on the barometric situation in the Svalbard area and the influence of local factors, mainly orography (mean velocity 4.2 m/s).

Mean values of selected meteorological elements on the Kaffioyra-Heggodden during summer seasons (21.07-31.08), 2005-2009

| Element | 2005 | 2006 | 2007 | 2008 | 2009 | 2005-2009 | 1975-2009 |
|---|---|---|---|---|---|---|---|
| Wind [m/s] | 3,8 | 5,0 | 3,7 | 5,4 | 3,1 | 4,2 | 4,3 |
| Cloudiness [0-10] | 9,1 | 8,3 | 8,7 | 8,9 | 7,9 | 8,6 | 8,4 |
| Sunshine duration [h] | 149,4 | 158,0 | 132,0 | 131,7 | 220,0 | 158,2 | 162,9 |
| Max. air temp. [°C] | 12,1 | 11,9 | 13,9 | 12,4 | 13,0 | 13,9 | 18,9 |
| Mean air temp. [°C] | 5,8 | 5,2 | 5,5 | 4,5 | 6,1 | 5,4 | 4,8 |
| Min. air temp. [°C] | 1,4 | 1,0 | -1,3 | -0,8 | 0,9 | -1,3 | -4,2 |
| Relative air humid. [%] | 87,0 | 91,0 | 85,0 | 88,0 | 87,0 | 87,6 | 88,5 |
| Precipitation [mm] | 49,9 | 25,1 | 12,3 | 22,2 | 13,0 | 24,5 | 42,6 |




Course of mean air temperature at the Kaffioyra-Heggodden station during summer seasons 2005-2009

# Concluding remarks

The analysed five seasons (2005-2009) had changeable weather conditions dependent on types of barometric situations. The highest air temperatures were recorded on the coast and on the marginal zone of the Waldemar Glacier. On the glaciated area air temperature is decreasing with the altitude and growing coverage by snow. The largest temperature lapse-rate is recorded at the transitional area between the glacier and its marginal zone. Growing altitude lowers air temperature on the mountain ridges, but inversions are recorded quite frequently in the region. Relative air humidity is high due to low temperature and large frequency of occurrence of maritime air masses. The highest mean relative air humidity was recorded on the coast and on the firn field of the Waldemar Glacier as well as on the mountain ridges. The course of the relative humidity is significantly influenced by föhn winds. Wind directions and velocity in the study area are strongly dependent on the synoptic situation and influence of local factors, mainly orography. Wind regime in the Waldemar Glacier significantly differ from that observed in the Kaffiøyra (here tunnel effect is observed as a consequence of the narrow Forlandsundet, neighbouring to the abovementioned plain), mainly due to the presence of the katabatic winds.

**Acknowledgments** - this research was founded by grants obtained from:
- the State Committee for Scientific Research: 113/IPY/2007/01 pt.: „Struktura przestrzenna pola temperatury powietrza jako podstawa do rozpoznania mechanizmów funkcjonowania ekosystemów na obszarze Zachodniego Spitsbergenu"
- Polish-Norwegian Research Found – project: "Arctic Climate and environments of the Nordic Seas and the Svalbard – Greenland Area - AWAKE"

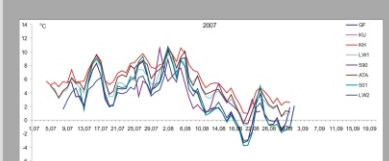
# Topoclimatic conditions

## Air temperature

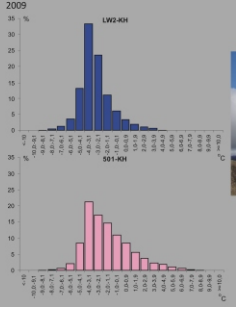
Spatial differentiation of the air temperatures on the Oscar II Land is significantly influenced by altitude, the terrain characteristics (beach, tundra, moraine, rocks, snow and ice, etc.), exposure and local air circulation. The highest mean temperature was recorded at KH (5.8°C) and at the rocky mountain (KU 5,6 °C), and moraine of the Waldemar Glacier (ATA 5,1°C). Much lower temperatures were recorded on the forefield of the Glacier (LW1 4.5°C) which was often affected by katabatic winds, and on the firn field (LW2 2,9°C). Growing altitude lowers air temperature to 4.0°C at 340 m asl. (GF) and 3.6°C on PH2 (590 m asl.). Temperature lapse-rate in the relation to the sea shore (KH) is 0.53°C/100 m for ATA and 1.02°C/100 m for LW1. On the forefield of the Waldemar Glacier the differences between the moraine (ATA) and the glaciated area (LW1) grow during the day owing to more intense heating above the morainic ground. The laps rate on the Waldemar Glacier (between LW2 and LW1) is 0.67°C/100 m. In the mountain area vertical gradients can be much steeper (GF 0.53°C/100 m, PH1 0,33°C/100 m, and PH2 0,38°C/100 m). However, inversions and non-adiabatic gradient of the air are common in the region. During individual types of weather, air temperature differences and lapse-rates may be even higher (see histograms).

Mean air temperature in the Kaffiøyra region in the years 2005-2009

| Stand | 11-20.07 | 21-31.07 | 1-10.08 | 11-20.08 | 21-31.08 | 21.07-31.08 |
|---|---|---|---|---|---|---|
| KH | 5,3 | 6,8 | 6,6 | 5,0 | 4,6 | 5,8 |
| ATA | 5,5 | 6,5 | 5,8 | 4,1 | 3,9 | 5,1 |
| LW1 | 5,2 | 5,7 | 5,1 | 3,7 | 3,6 | 4,5 |
| LW2 | 3,3 | 4,1 | 3,7 | 1,8 | 2,1 | 2,9 |
| KU | 6,0 | 6,5 | 4,3 | 4,6 | 4,8 | 5,6 |
| GF | 5,1 | 5,6 | 4,9 | 2,2 | 2,6 | 4,0 |
| 501(PH1) | 5,1 | 6,3 | 5,4 | 2,1 | 2,9 | 4,2 |
| 590(PH2) | 4,1 | 5,5 | 4,9 | 0,9 | 0,9 | 3,6 |




Course of mean air temperature at the Kaffiøyra region during summer seasons 2005-2009



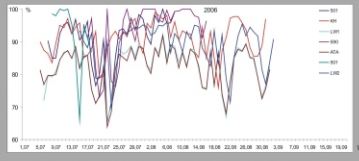

Histograms of the difference of mean daily air temperature between topoclimatic stands and KH in the summer seasons 2005-2009

## Relative air humidity

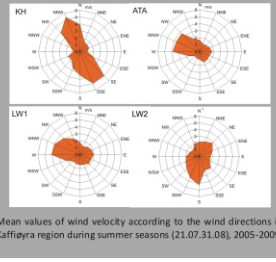
Owing to dominance of fresh maritime masses, the air on the Oscar II Land shows a significant level of saturation with the water vapour. During the study period, mean relative humidity at the KH was 88%. The values for the Waldemar Glacier forefield were lower (ATA 80%, LW1 81%). Increasing altitude and falling temperature bring an increase in relative air humidity, e.g. LW2 84%; GF 91% and PH2 92%. The course of the relative humidity shows extended periods of reduced values. A relatively low humidity (daily mean 60-70%) was associated with föhn processes.

Mean values od relative air humidity in the Kaffiøyra region in the years 2005-2009

| Stand | 11-20.07 | 21-31.07 | 1-10.08 | 11-20.08 | 21-31.08 | 21.07-31.08 |
|---|---|---|---|---|---|---|
| KH | 87 | 87 | 89 | 86 | 88 | 88 |
| ATA | 77 | 79 | 81 | 81 | 80 | 80 |
| LW1 | 77 | 81 | 83 | 82 | 80 | 81 |
| LW2 | 80 | 83 | 83 | 86 | 82 | 84 |
| GF | 85 | 89 | 91 | 94 | 91 | 91 |
| KU | 83 | 84 | 95 | 89 | 80 | 88 |
| 590 | 79 | 87 | 88 | 98 | 94 | 92 |



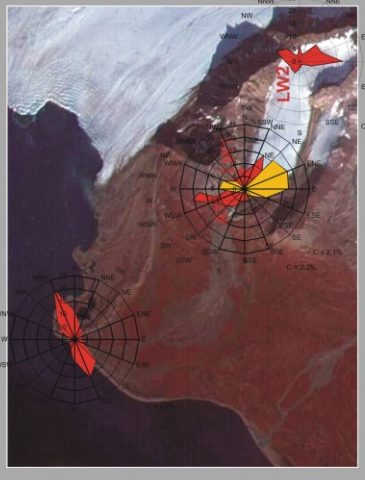

Course of relative air humidity in the Kaffiøyra region stations during summer seasons 2005-2009




Mean values of wind velocity according to the wind directions in the Kaffiøyra region during summer seasons (21.07.31.08), 2005-2009

## Wind direction

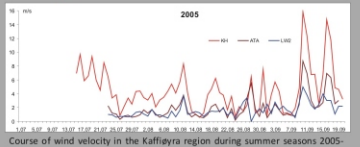
Wind direction and velocity on the Oscar II Land is strongly dependent on the development of the barometric situation in the area of the Svalbard and the influence of local factors, mainly orography. Föhn winds are a very frequent phenomenon there, which is the result of movement of air masses over the hills. Tunnel phenomena are observed in narrow Forlandsundet. At the Kaffiøyra NNW (20,0%), SSE (15,1%) and SE (11,3%) winds predominated. The wind regime at the Waldemar Glacier is quite different, katabatic winds parallel to the course of the glacier prevail: ATA (ENE 17,8%, N 16,8%, ENE 17,8%); LW1 (NE 25,5%, ENE 18,4%); LW (17,1%).




## Wind velocity

Mean values of wind velocity in the Kaffiøyra region in the years 2005-2009

| Stand | 11-20.07 | 21-31.07 | 1-10.08 | 11-20.08 | 21-31.08 | 21.07-31.08 |
|---|---|---|---|---|---|---|
| KH | 5,9 | 3,7 | 3,6 | 4,2 | 3,4 | 3,7 |
| ATA | 2,6 | 1,7 | 2,0 | 2,1 | 1,7 | 1,9 |
| LW1 | 2,7 | 2,2 | 2,2 | 2,4 | 1,7 | 2,1 |
| LW2 | 2,0 | 1,9 | 2,0 | 2,0 | 1,6 | 1,8 |




Course of wind velocity in the Kaffiøyra region during summer seasons 2005-2009

Wind velocity also shows significant variation. At the Kaffiøyra the mean wind velocity was 3.7 m/s, whereas at the Waldemar Glacier values of wind velocity were lower than that at the sea shore (ATA 1.9 m/s; LW1 2,1 m/s; LW2 1,8 m/s). At the Kaffiøyra the strongest winds were recorded in respect of NNW winds (5.4 m/s), i.e. those parallel with the course of the Forlandsundet. However on the Waldemar Glacier are the largest mean values of wind velocity were recorded from different directions: ATA - WNW and NW (3.6 m/s); LW1 - WNW (4.1 m/s) and LW2 - S (4.2 m/s).