Aircraft-based investigation of boundary-layer structures over the North Water Polynya and in summertime katabatic winds over northwest Greenland

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### AWI Polar 5

**IKAPPOS 2010**

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<table>
<thead>
<tr>
<th>Quantity</th>
<th>Sampling</th>
<th>Sensor, manufacturer</th>
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<tbody>
<tr>
<td>3D wind</td>
<td>100 Hz</td>
<td>5-hole probe, Rosemount</td>
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<tr>
<td>Air temperature</td>
<td>100 Hz</td>
<td>Pt100 open wire deiced, Rosemount</td>
</tr>
<tr>
<td>Air humidity</td>
<td>100 Hz</td>
<td>Lyman-α, Buck Research</td>
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<tr>
<td></td>
<td>100 Hz</td>
<td>Humicap HMT333, Vaisala</td>
</tr>
<tr>
<td></td>
<td>100 Hz</td>
<td>Dew point mirror 1011B, General Eastern</td>
</tr>
</tbody>
</table>

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**Heinemann et al. (2011)**

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<tr>
<th>Quantity</th>
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<tr>
<td>Position</td>
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<td>2 GPS, Trimble RTS</td>
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<td>Position/orientation</td>
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<td>INS, Honeywell LaserRef V</td>
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<tr>
<td>Height</td>
<td>100 Hz</td>
<td>Radar altimeter, Honeywell</td>
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<td>20 Hz</td>
<td>Laser altimeter PS100(E), IBEO</td>
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<td>200 Hz</td>
<td>Laser altimeter LD90-3, RIEGL</td>
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<td>Air pressure/air speed</td>
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<td>Pitot tube and static pressure sensor, Rosemount</td>
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<td>KT-15.85D, Heitronics</td>
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<td>Downward and upward</td>
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<td>radiation fluxes</td>
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<td>2 Pyrgeometer PIR, Eppley</td>
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<td>Air humidity</td>
<td>1 Hz</td>
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<td>20 Hz</td>
<td>Humicap HMT333, Vaisala</td>
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IKAPPOS 2010 (Investigation of Katabatic winds and Polynyas during Summer), June 2010

Heinemann et al. (2011)
IKAPPOS 2010 (Investigation of Katabatic winds and Polynyas during Summer)

Heinemann et al. (2011)
Mean ABL structures Humboldt glacier: Katabatic wind system under weak synoptic forcing

Early morning, non-melting surface

Potential temperature (14 June 2010, 0832–1057 UTC)
Mean ABL structures Humboldt glacier: Katabatic wind system under weak synoptic forcing
Mean ABL structures Steenstrup glacier: Katabatic wind system under strong synoptic forcing afteroom, melting surface

Wind speed (17 June 2010, 1448–1653 UTC)
NOW Polynya

Mean June 2010, GME model 10 m-wind field and constancy
Smith Sound
Visualization of flow channeling / blocking

- Strong wind
- Weak wind

Flow channeling

SBL
NOW Polynya flights – Channeling effects at Smith Sound

200km cross-section pot. temp.

NOW4 (CM1B) Potential temperature (23 June 2010, 1344–1526 UTC)
NOW Polynya flights – Shading effect of Smith Sound

NOW1 (Q1) Potential temperature (15 June 2010, 1521–1621 UTC)
NOW Polynya flights – Shading effect of Smith Sound

NOW1 (Q1) Wind speed (15 June 2010, 1521–1621 UTC)
Turbulence Spectra and multiresolution decomposition (MR)

MR cospectra (NOW3)

Sensible heat flux

Momentum flux

NOW polynya flights:
- gap scales of 500 m – 1000 m

Katabatic wind:
- gap scale 250m
Turbulent fluxes – Katabatic wind flights

Turbulent fluxes (KA1, AB, 4 km, 0.25 km highpass)

Sea ice

Glacier

Heat flux in W/m²

Distance in km

Sea ice

Glacier

Heat flux in W/m²

Distance in km

weak synoptic forcing

strong synoptic forcing
Turbulent fluxes – NOW Polynya flights

Turbulent fluxes (NOW1, AB, 4 km, 1 km highpass)

Smith Sound

NOW1: Channeling effect

Heat flux in W/m²

Distances in km

Momentum flux in N/m²
Conclusions

The IKAPPOS experiment yields a valuable data set of a fully turbulent SBL over the ice sheet (2 flights) and the North Water Polynya (NOW, 4 flights).

To our knowledge, this is the first aircraft campaign for a summertime polynya under such conditions in the Arctic.

For the NOW, gap scales of 500 m – 1000 m are found, sensible heat fluxes are around -30W/m² in the SBL.

For the katabatic wind, a gap scale of 250 m is found, sensible heat fluxes are around -5/-20W/m² for weak/strong synoptic forcing.

Strong channeling effects in Nares Strait/Smith Sound are documented (wind increase from 6 to 18m/s, LLJ at 150m) -> implications for NOW formation
References


Mean ABL structures Humboldt glacier: Katabatic wind system under weak synoptic forcing
Mean ABL structures Steenstrup glacier: Katabatic wind system under strong synoptic forcing
Turbulence Spectra and multiresolution decomposition (MR)

NOW Polynya flights: gap scales of 500 m – 1000 m
Turbulence Spectra – Fast Fourier transform (FFT)

KA flights:
- spectral intensity decreases from 40 m to 65 m
- cut-off wave length: around 250 m

NOW Polynya flights:
- spectral intensity decreases from north to south
- cut-off wave length: 500 – 1000 m
Turbulent fluxes – Katabatic wind flights

Strong synoptic forcing:
Turbulent fluxes (KA2, AB, 4 km, 0.25 km highpass)
Turbulent fluxes – Katabatic wind flights

Weak synoptic forcing:

Turbulent fluxes (KA1, AB, 4 km, 0.25 km highpass)

Strong synoptic forcing:

Turbulent fluxes (KA2, AB, 4 km, 0.25 km highpass)
Turbulent fluxes – NOW Polynya flights

Turbulent fluxes (NOW1, Q1, Q2, 4 km, 1 km highpass)

NOW1: Shading effect

Heat flux in W/m²

Momentum flux in N/m²

Distance in km

Q1a

Q1b

Q2 65 m

Q2 35 m

Q1 65 m

Q1 40 m

Q2 65 m

Q1 40 m