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

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Universität Trier

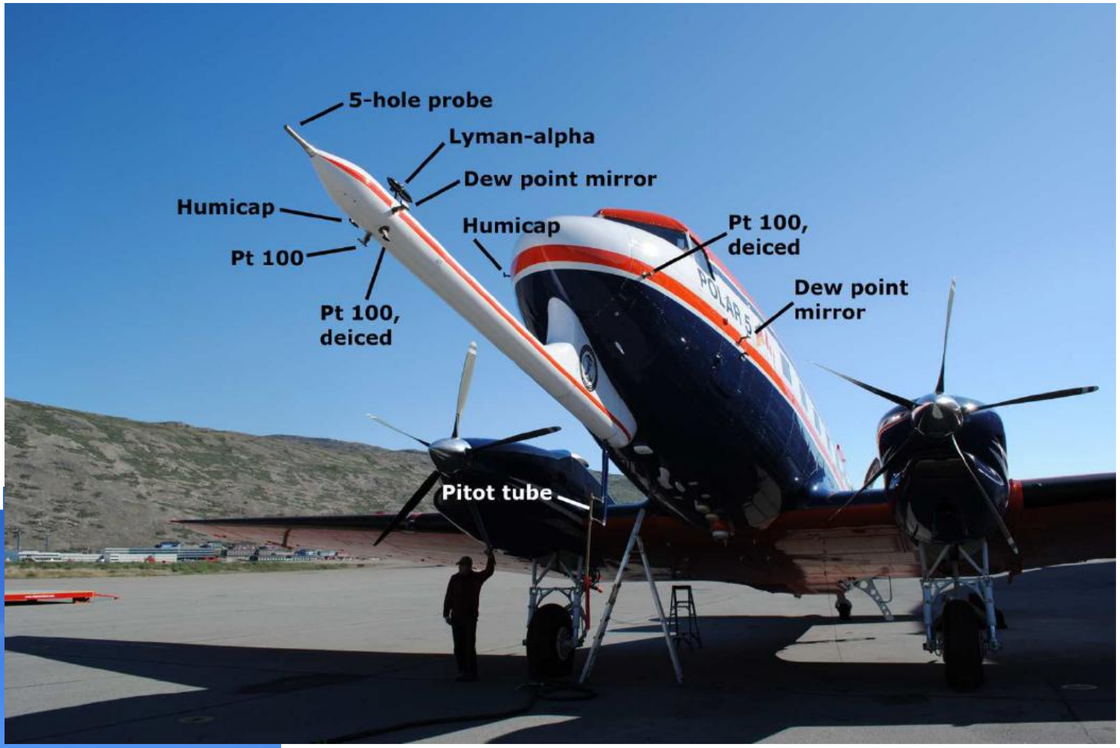
IPY 2012 CONFERENCE MONTRÉAL

DFG Deutsche Forschungsgemeinschaft

IKAPOS 2010

AWI Polar 5

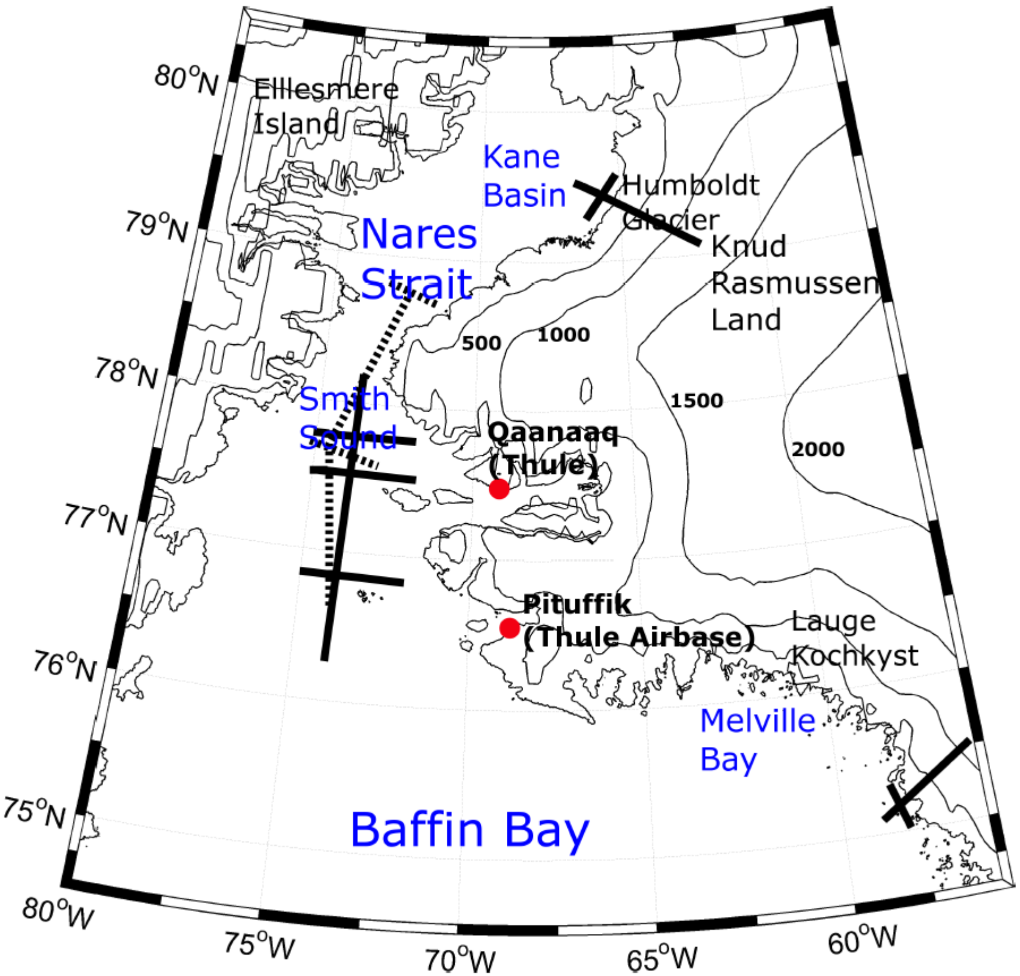
Quantity	Sampling	Sensor, manufacturer
3D wind	100 Hz	5-hole probe, Rosemount
Air temperature	100 Hz	Pt100 open wire deiced, Rosemount
	100 Hz	Pt100 open wire, Rosemount
Air humidity	100 Hz	Lyman-α , Buck Research
	100 Hz	Humicap HMT333, Vaisala
	100 Hz	Dew point mirror 1011B, General Eastern

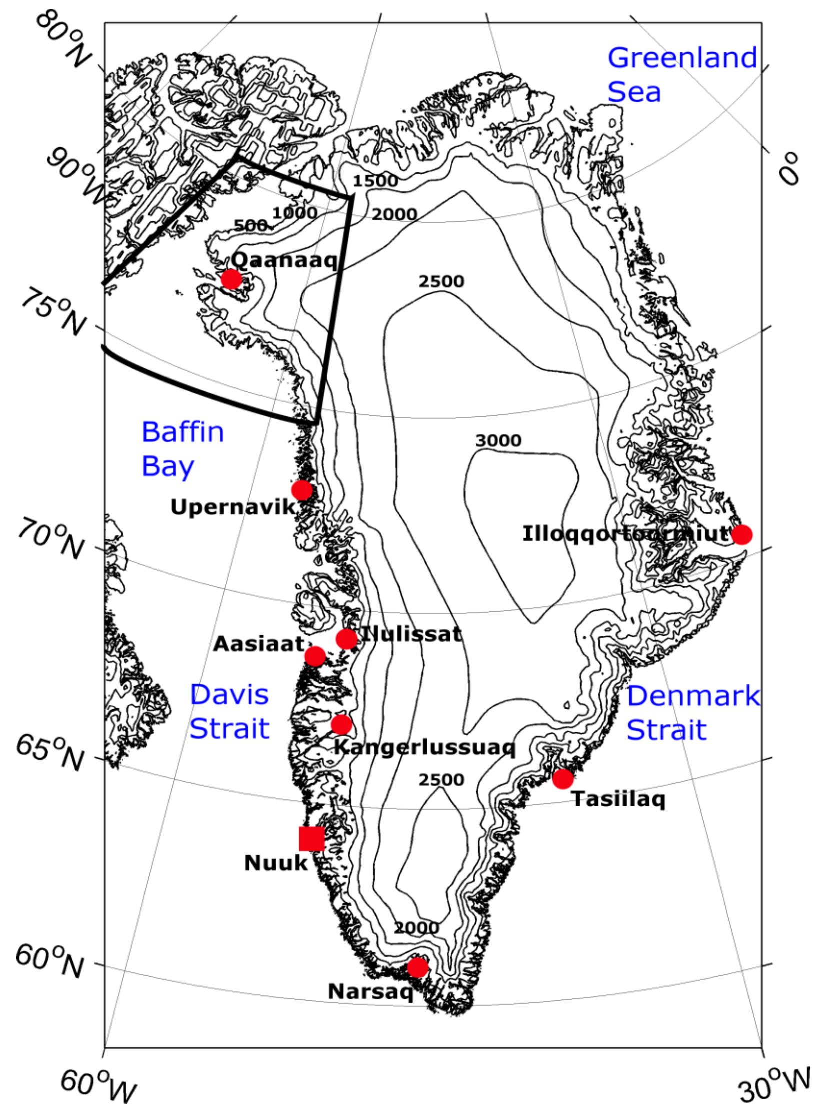


Heinemann et al. (2011)

Quantity	Sampling	Sensor, manufacturer
Position	1 Hz	2 GPS, Trimble RTS
Position/orientation	50 Hz	INS, Honeywell Laseref V
Height	100 Hz	Radar altimeter, Honeywell
	20 Hz	Laser altimeter PS100(E), IBEO
	200 Hz	Laser altimeter LD90-3, RIEGL
Air pressure/air speed	20 Hz	Pitot tube and static pressure sensor, Rosemount
Surface temperature	20 Hz	KT-15.85D, Heitronics
Downward and upward radiation fluxes	20 Hz	2 Pyranometer PSP, Eppley
		2 Pyrgeometer PIR, Eppley
Air temperature	20 Hz	Pt100 open wire deiced, Rosemount
Air humidity	1 Hz	Dew point mirror CR-2, Buck Research Instruments
	20 Hz	Humicap HMT333, Vaisala

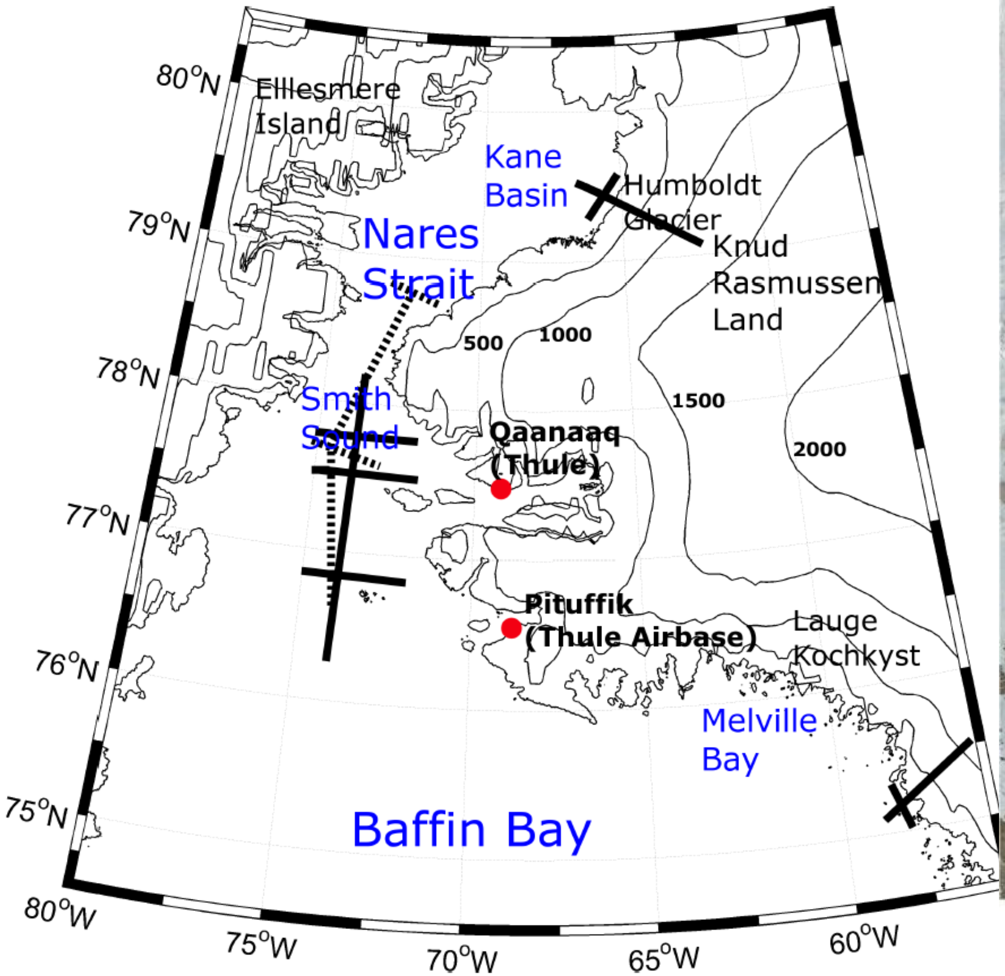
IKAPOS 2010 (**I**nvestigation of **Ka**tabatic winds and **Po**lynyas during **S**ummer), **June 2010**

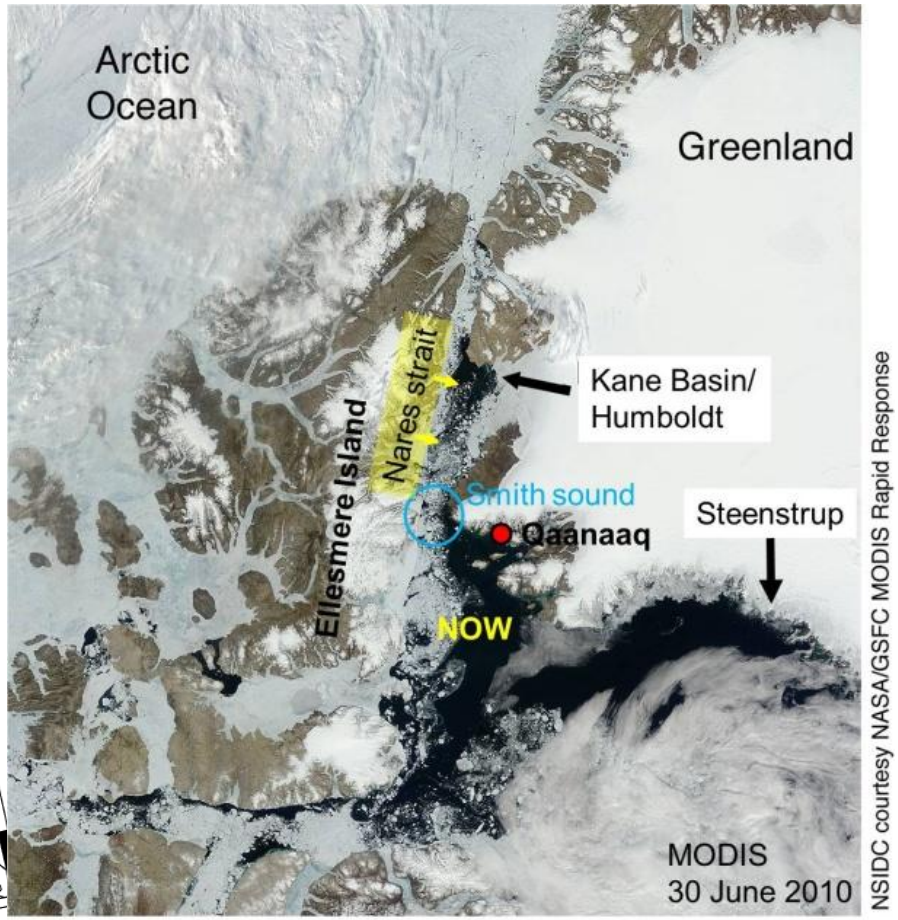




Heinemann et al. (2011)

IKAPOS 2010 (**I**nvestigation of **Ka**tabatic winds and **Po**lynyas during **S**ummer)

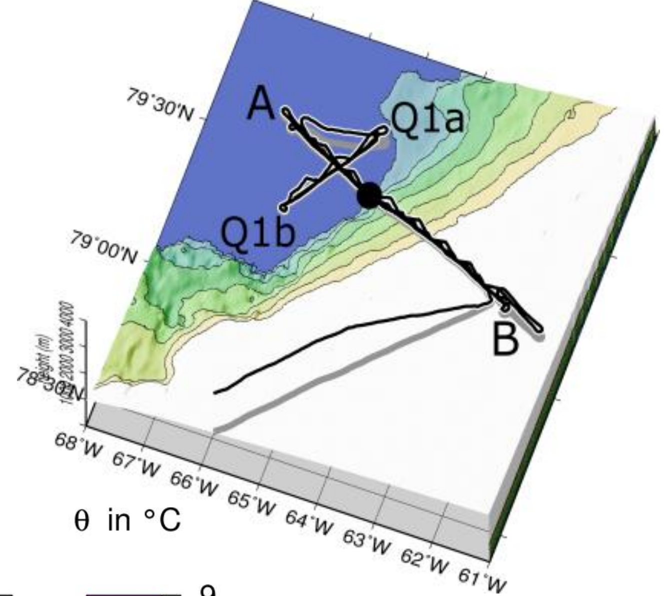


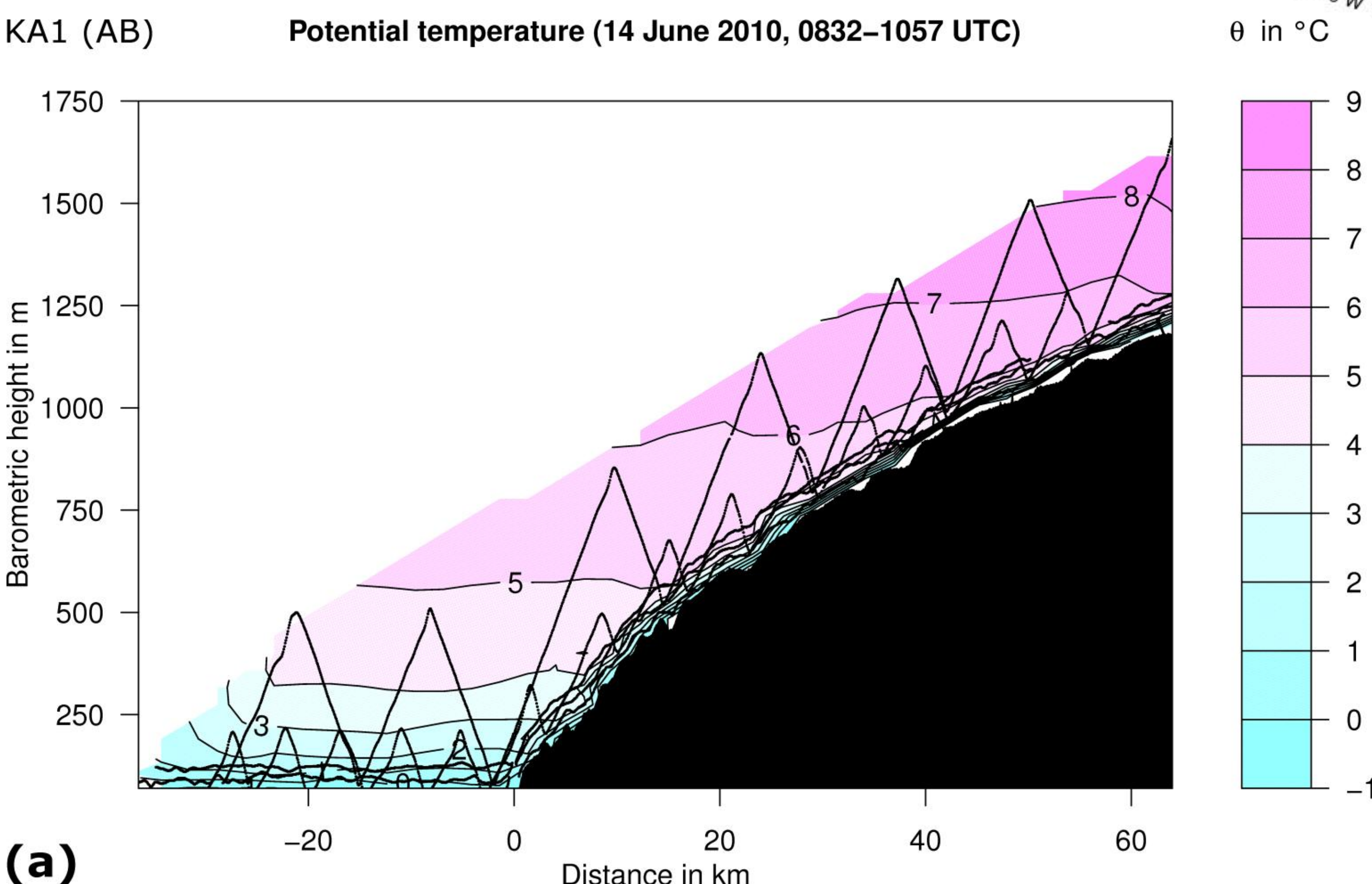


Heinemann et al. (2011)

Mean ABL structures Humboldt glacier: Katabatic wind system under weak synoptic forcing

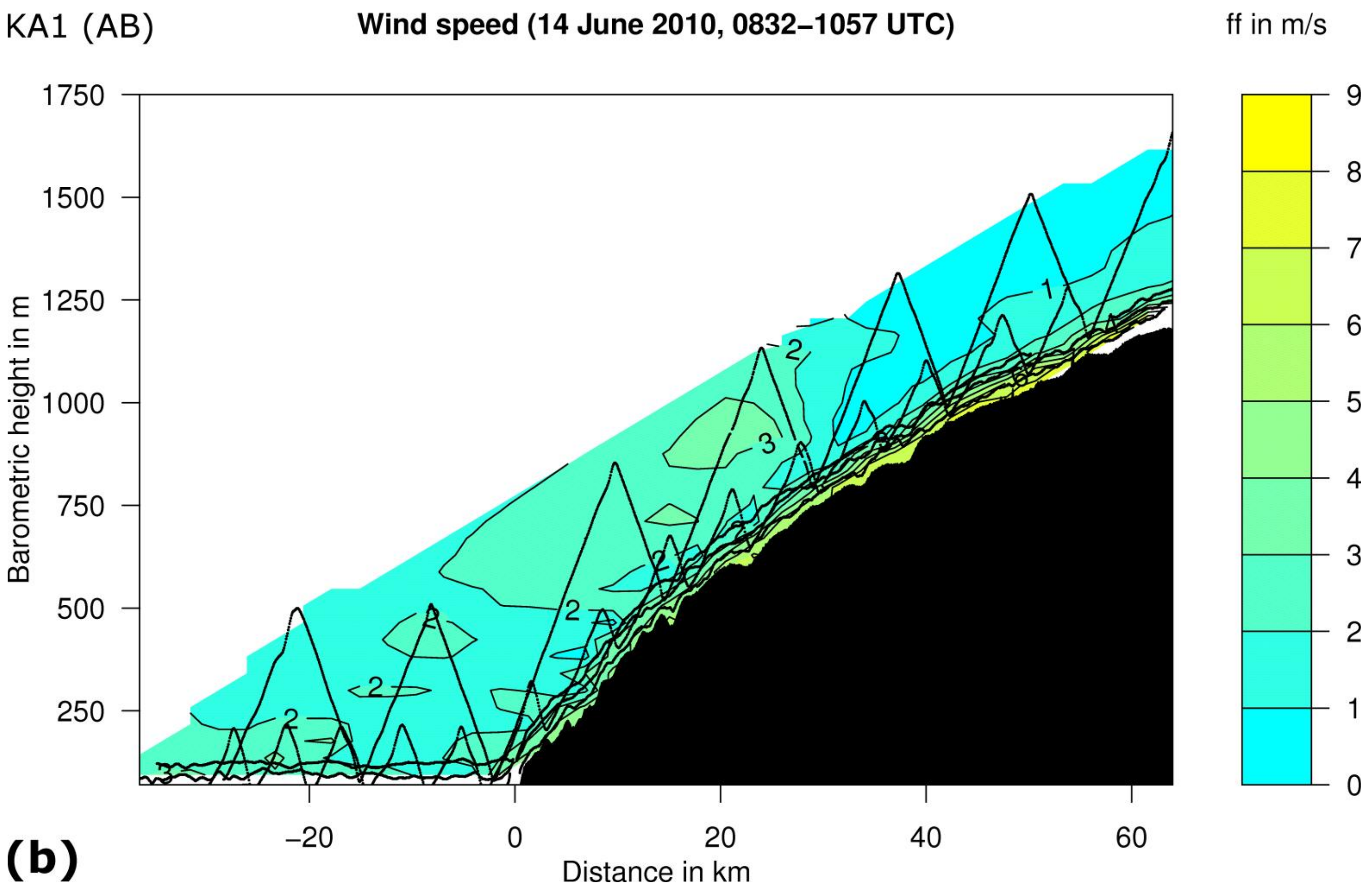
Early morning, non-melting surface





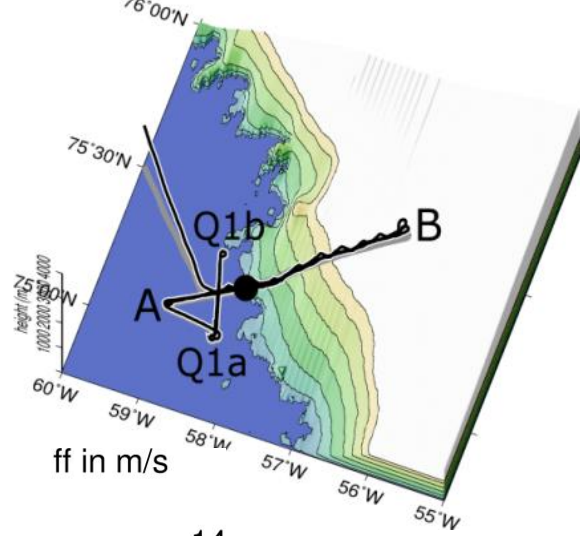
(a)

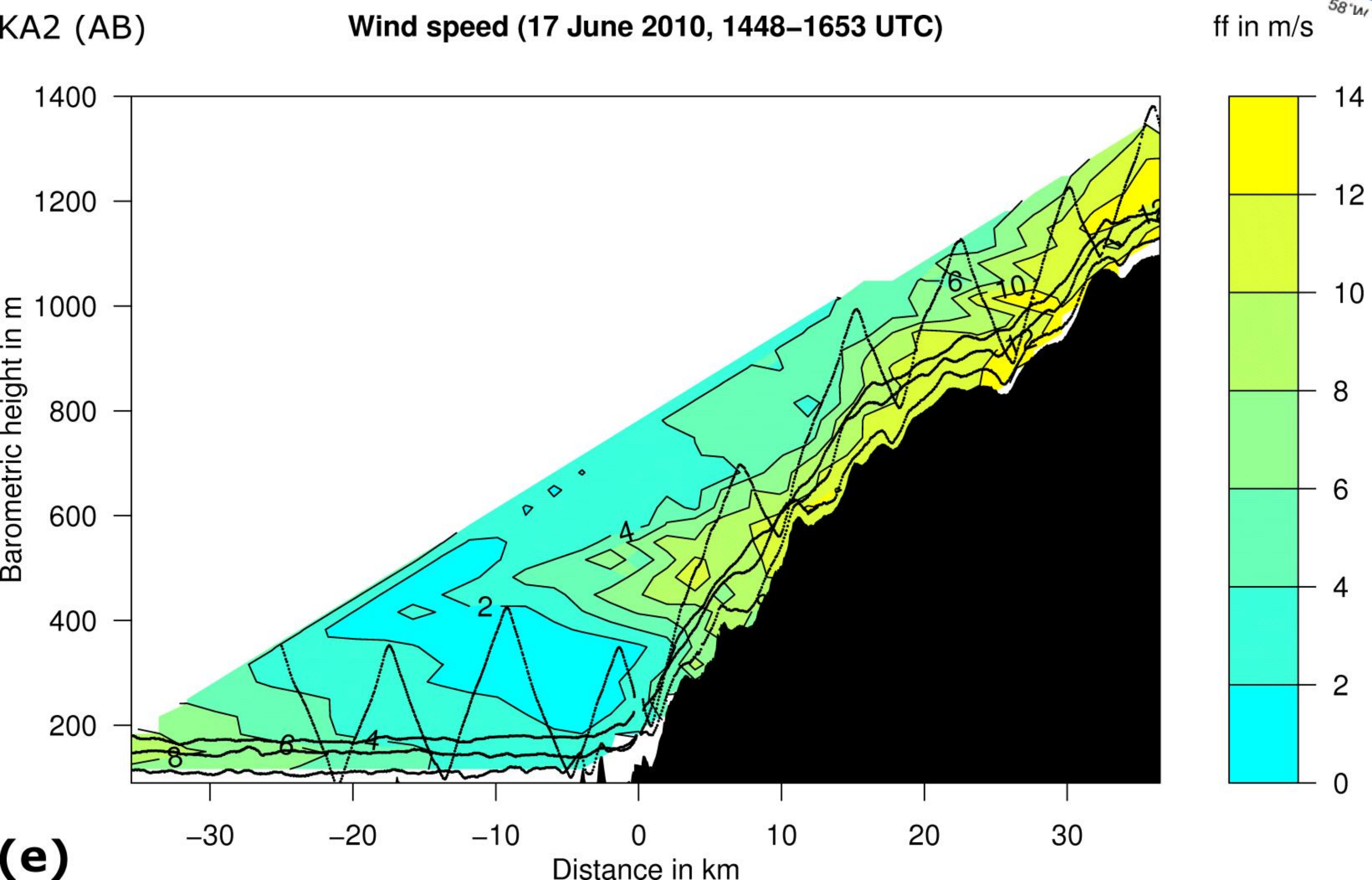
Mean ABL structures Humboldt glacier:
Katabatic wind system under weak synoptic forcing



Mean ABL structures Steenstrup glacier: Katabatic wind system under strong synoptic forcing

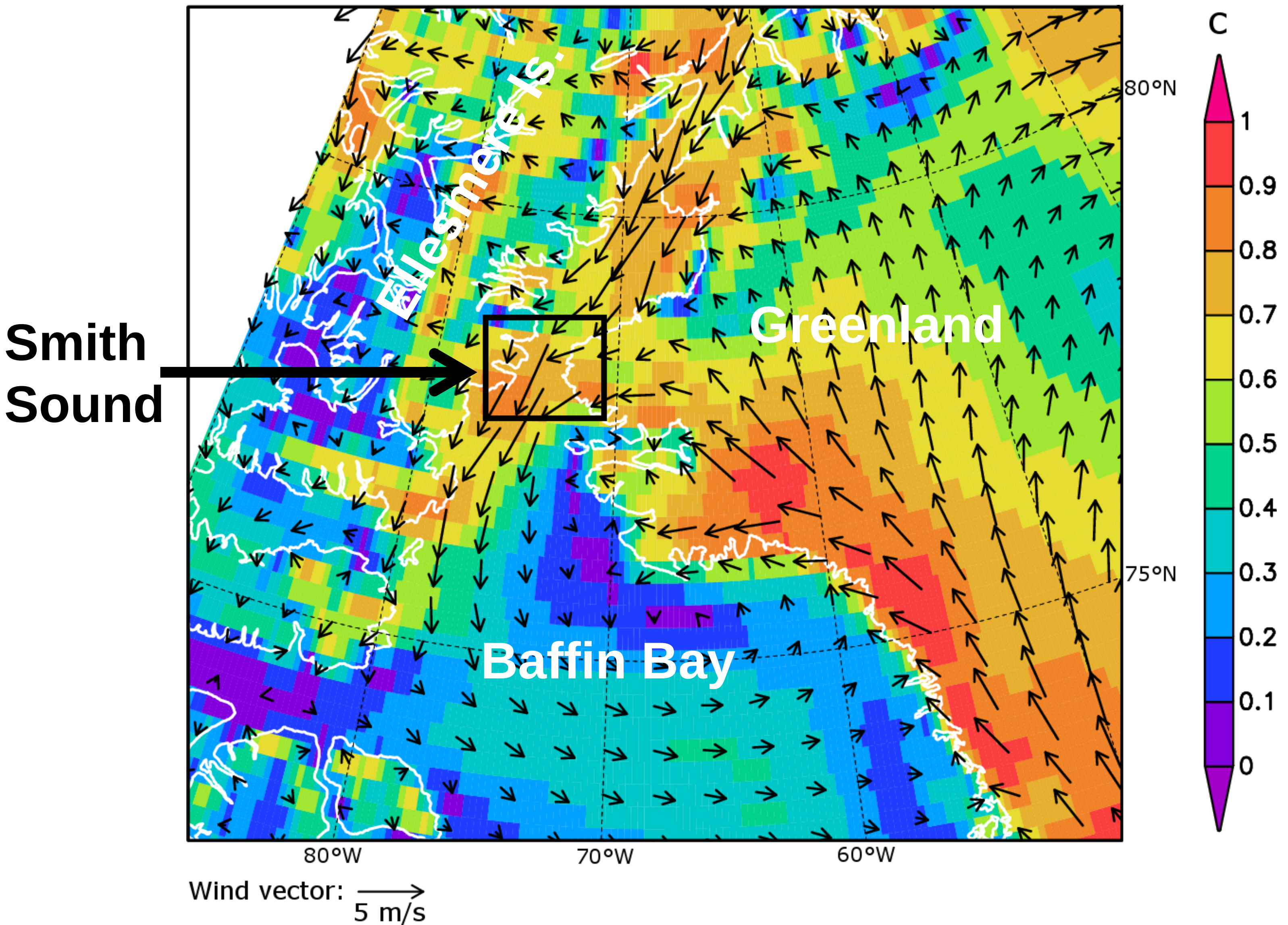
afternoon, melting surface





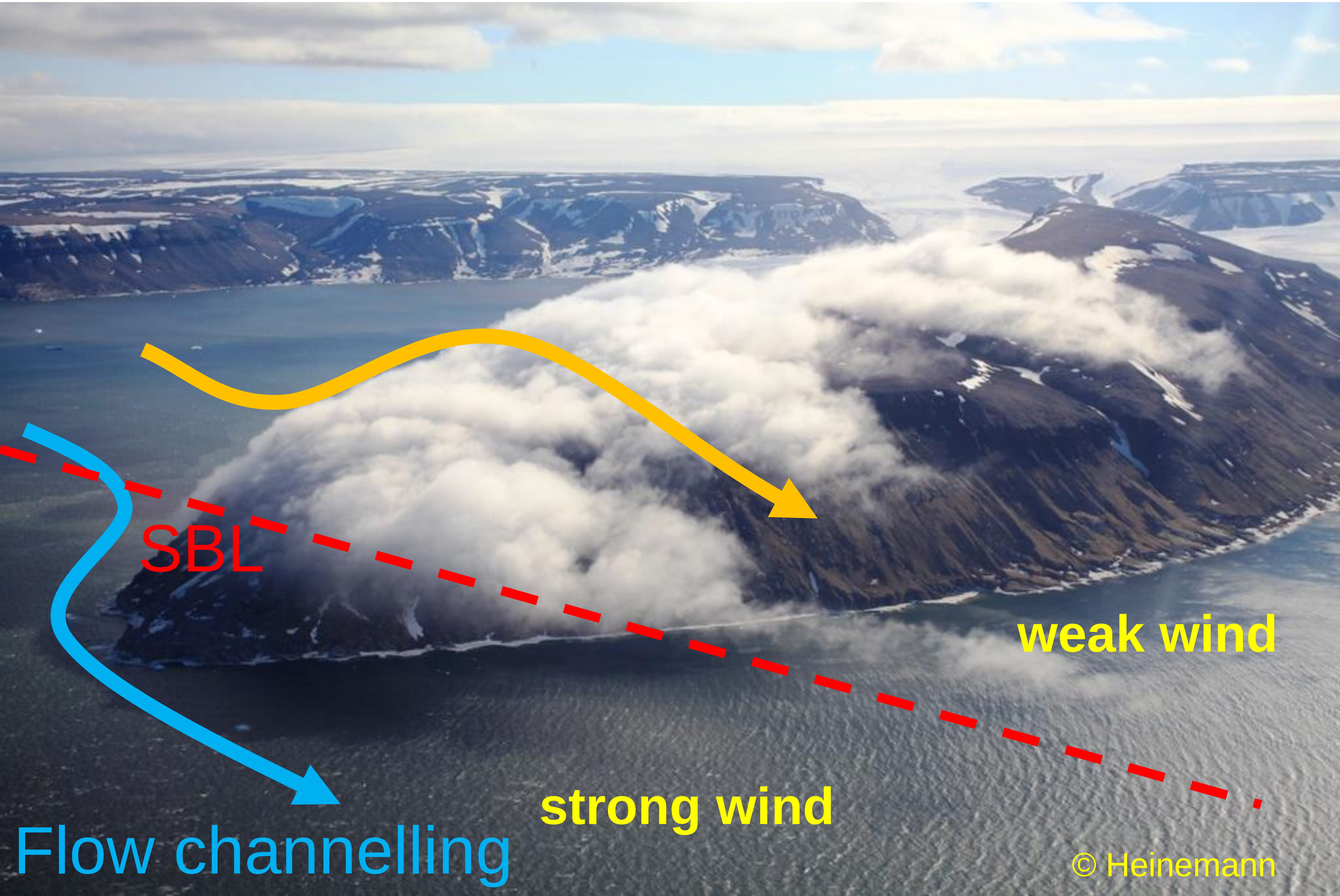
NOW Polynya

Mean June 2010, GME model 10 m-wind field and constancy

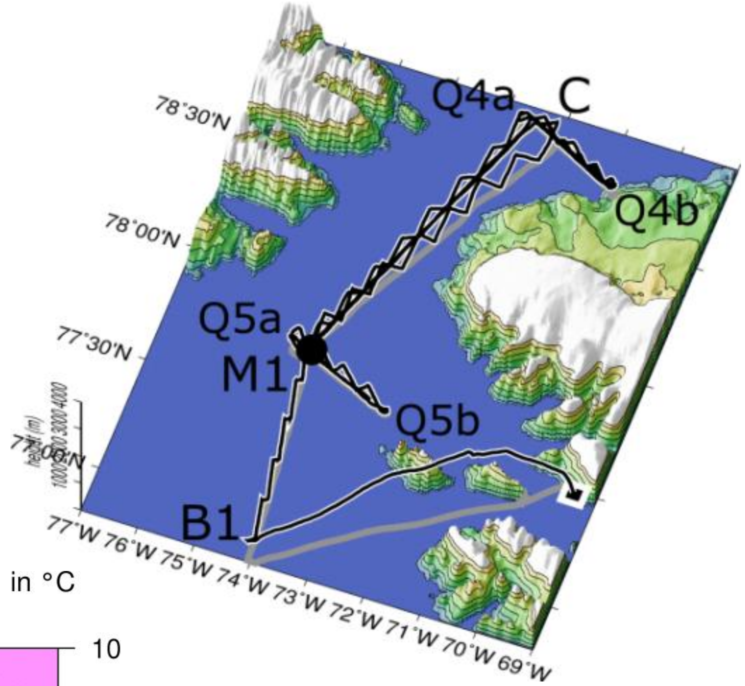


Smith Sound

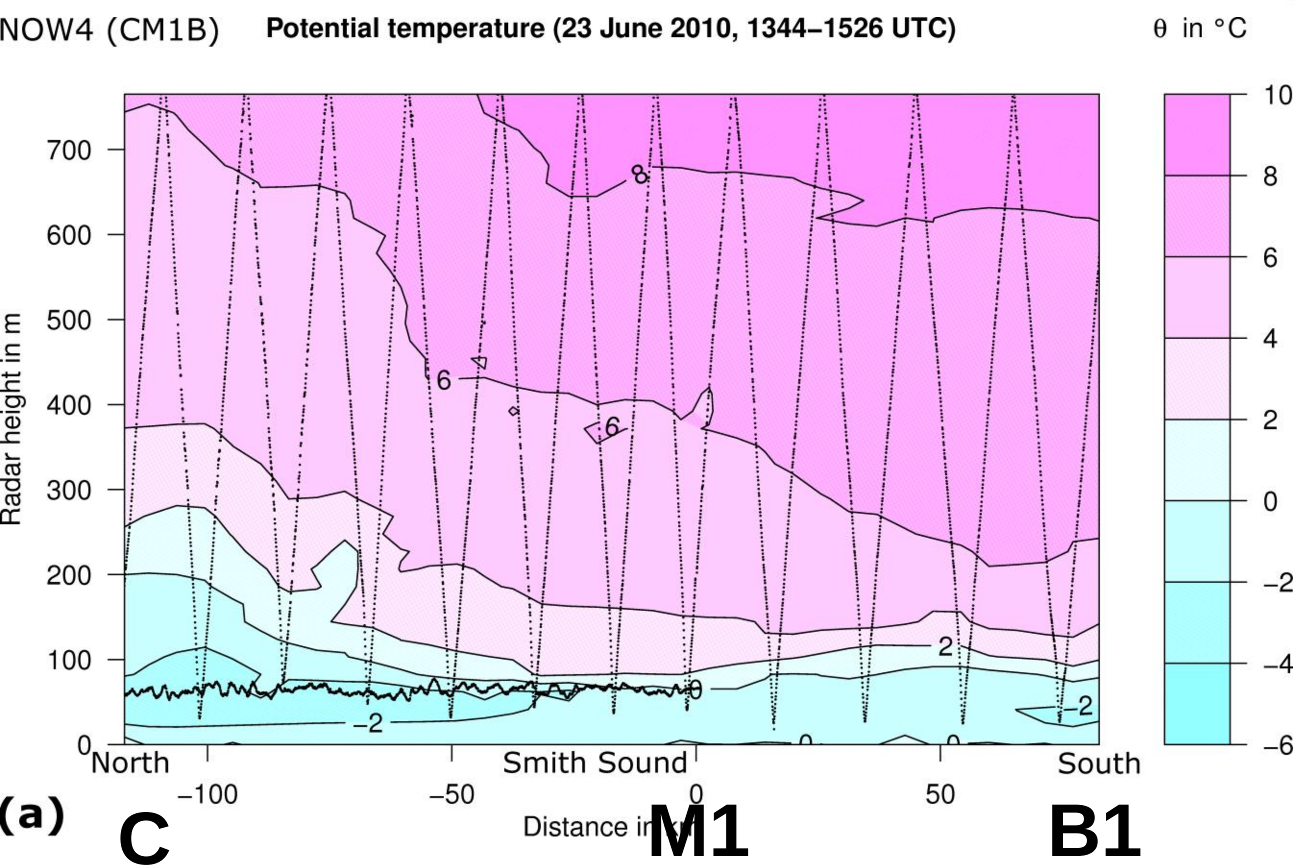
Visualization of flow channeling / blocking

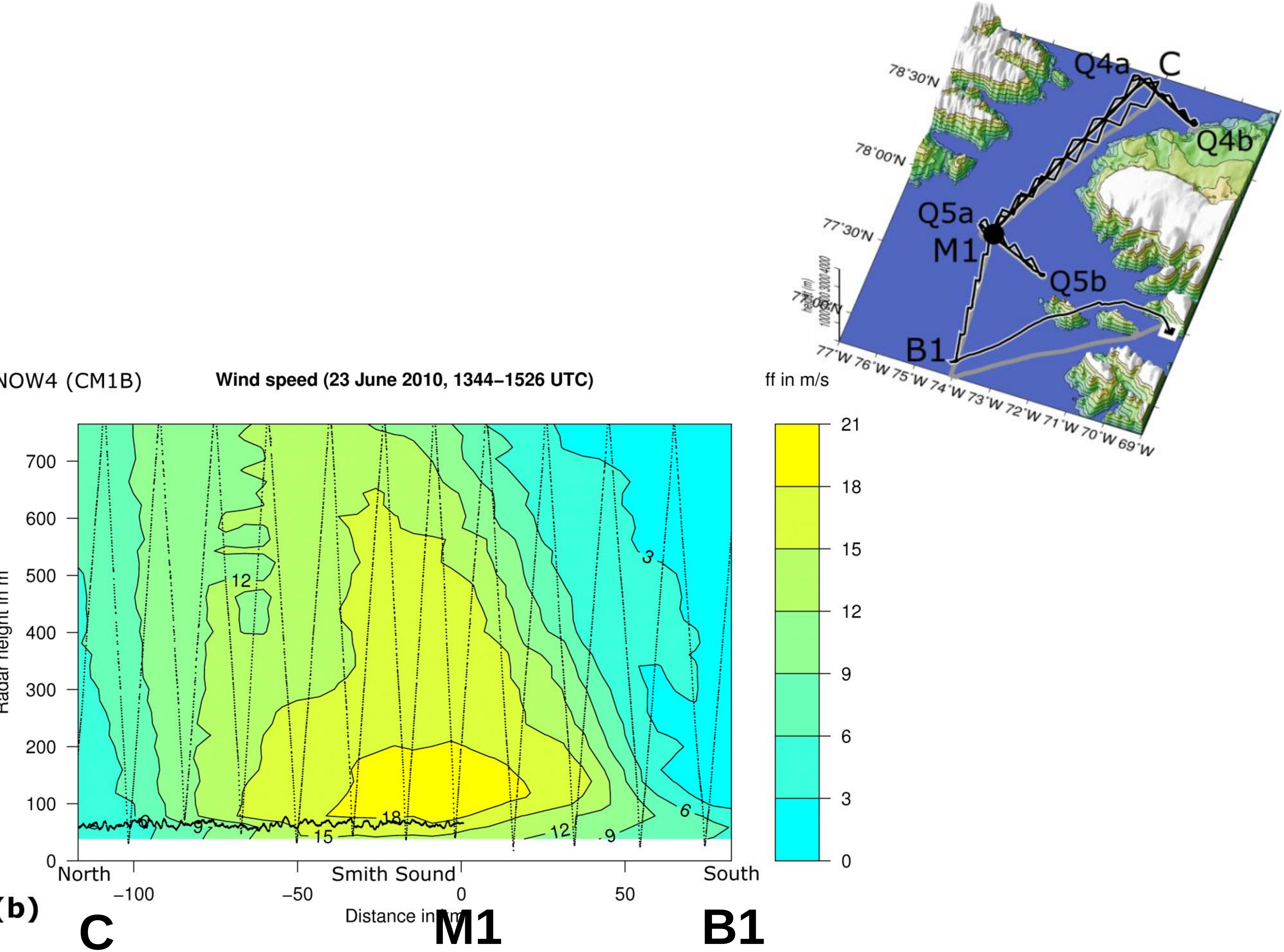


NOW Polynya flights – Channeling effects at Smith Sound



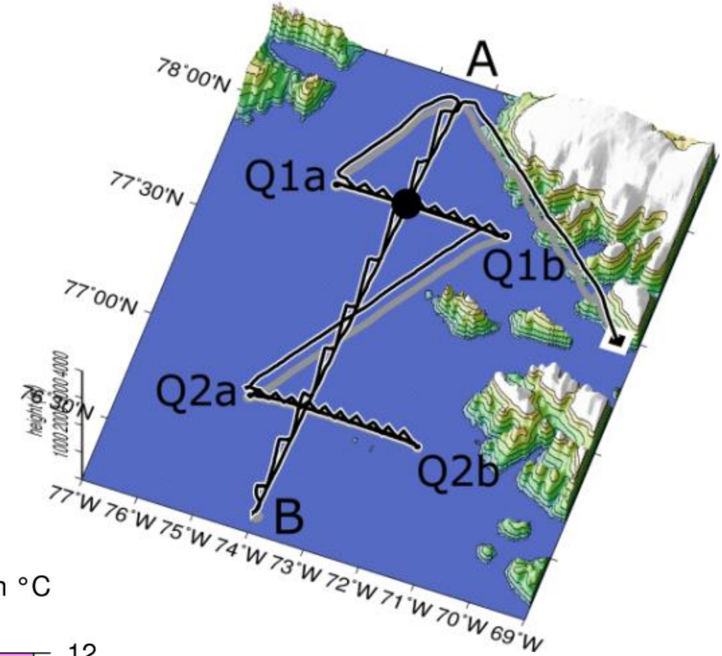
200km cross-section pot. temp.

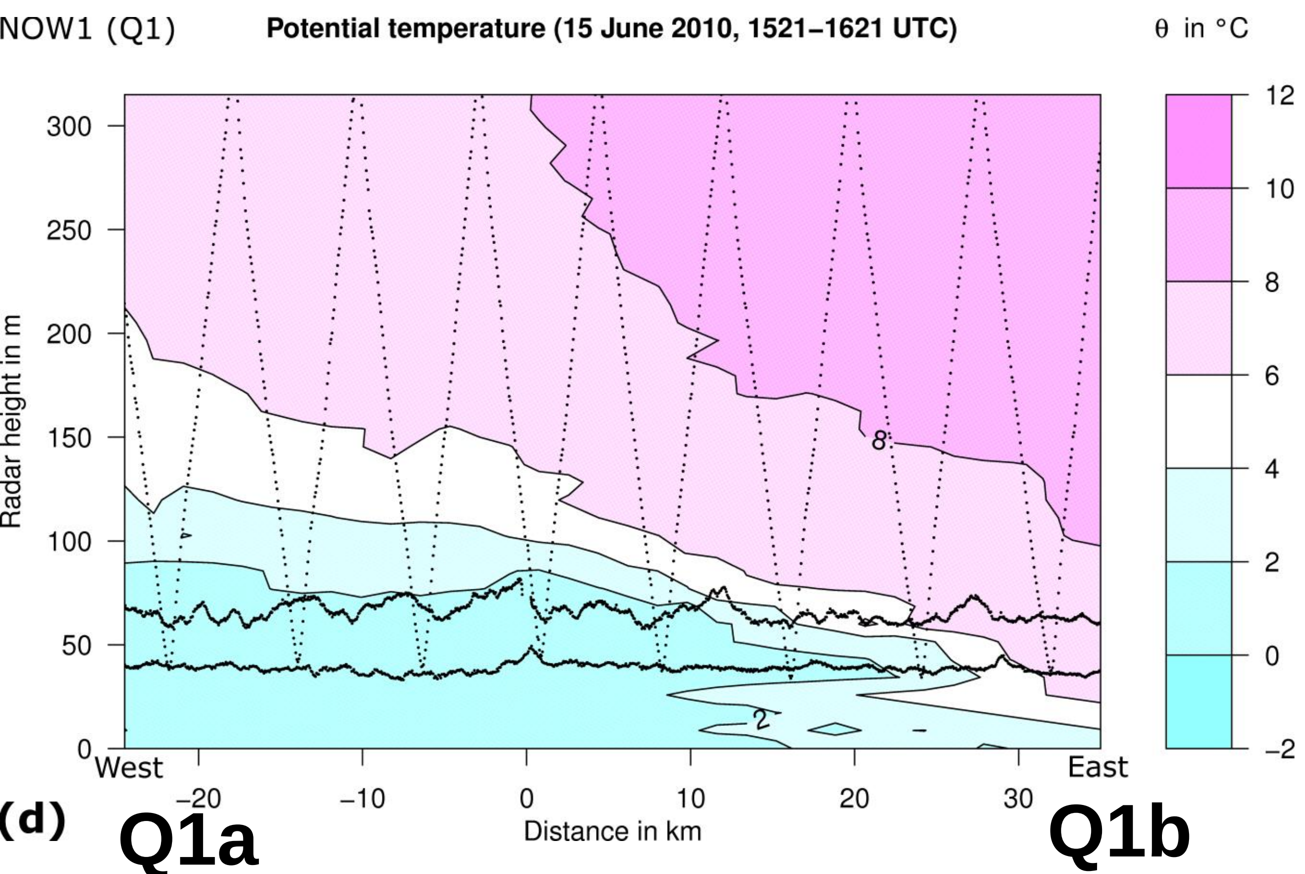




Q4a
C
Q4b
78°30'N
78°00'N
77°30'N
77°00'N
Q5a
M1
Q5b
B1
77°W 76°W 75°W 74°W 73°W 72°W 71°W 70°W 69°W
NOW4 (CM1B)
Wind speed (23 June 2010, 1344–1526 UTC)
ff in m/s
Radar height in m
North
Smith Sound
South
Distance in km
(b)
C
M1
B1

NOW Polynya flights – Shading effect of Smith Sound





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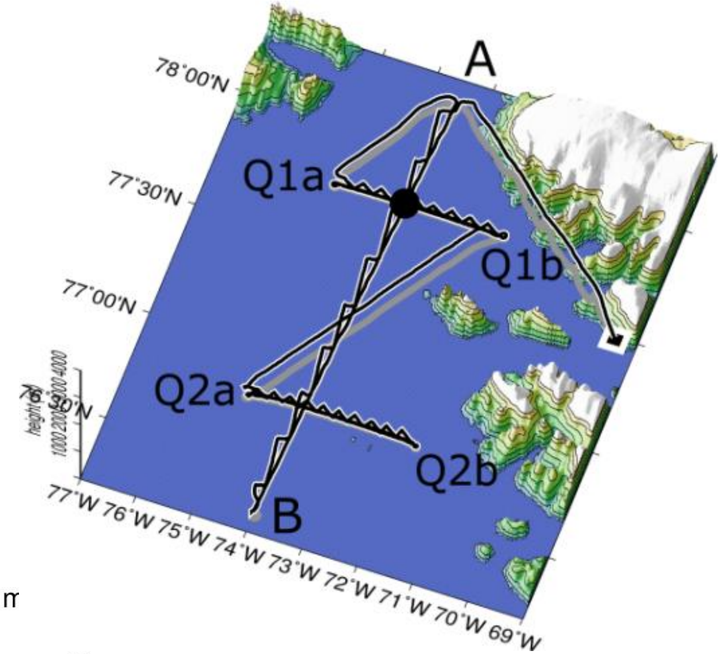
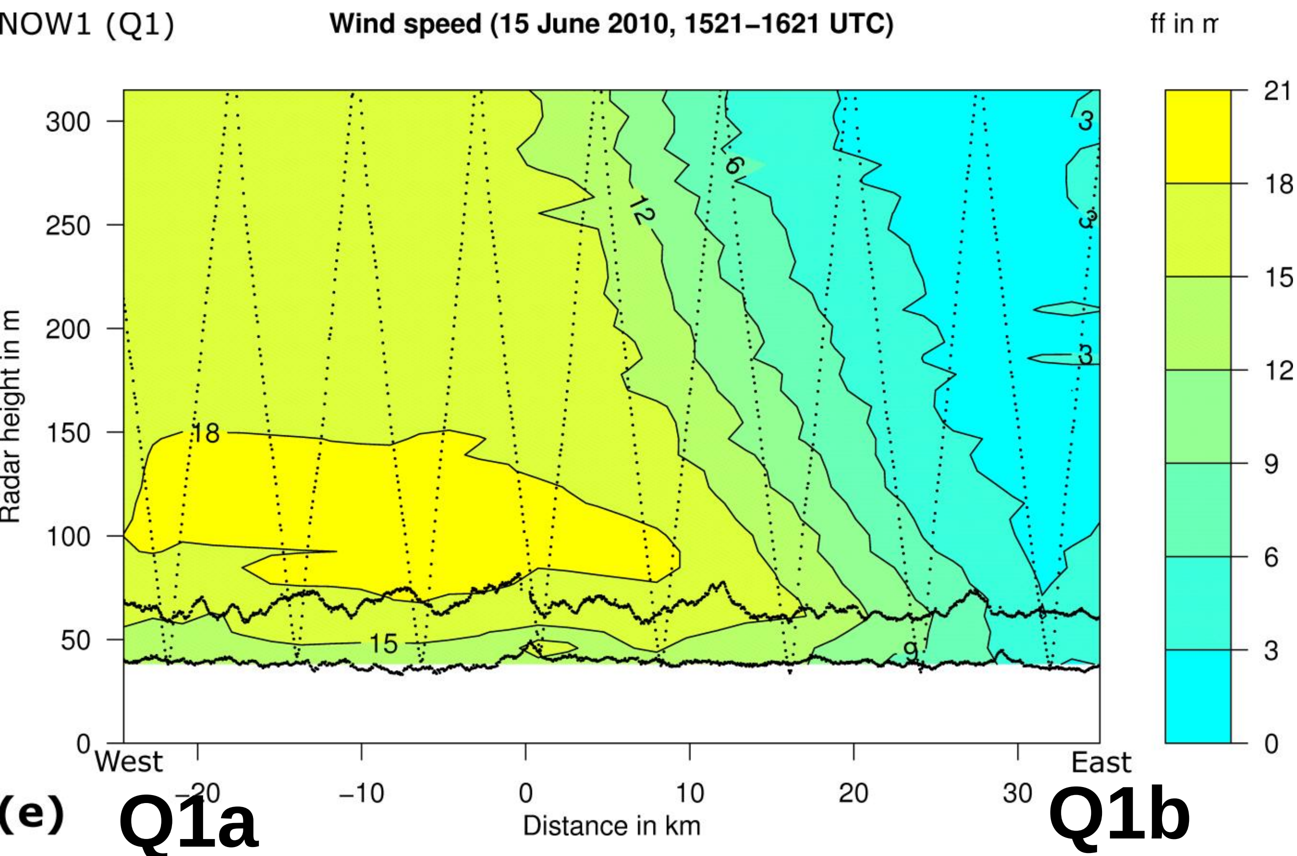
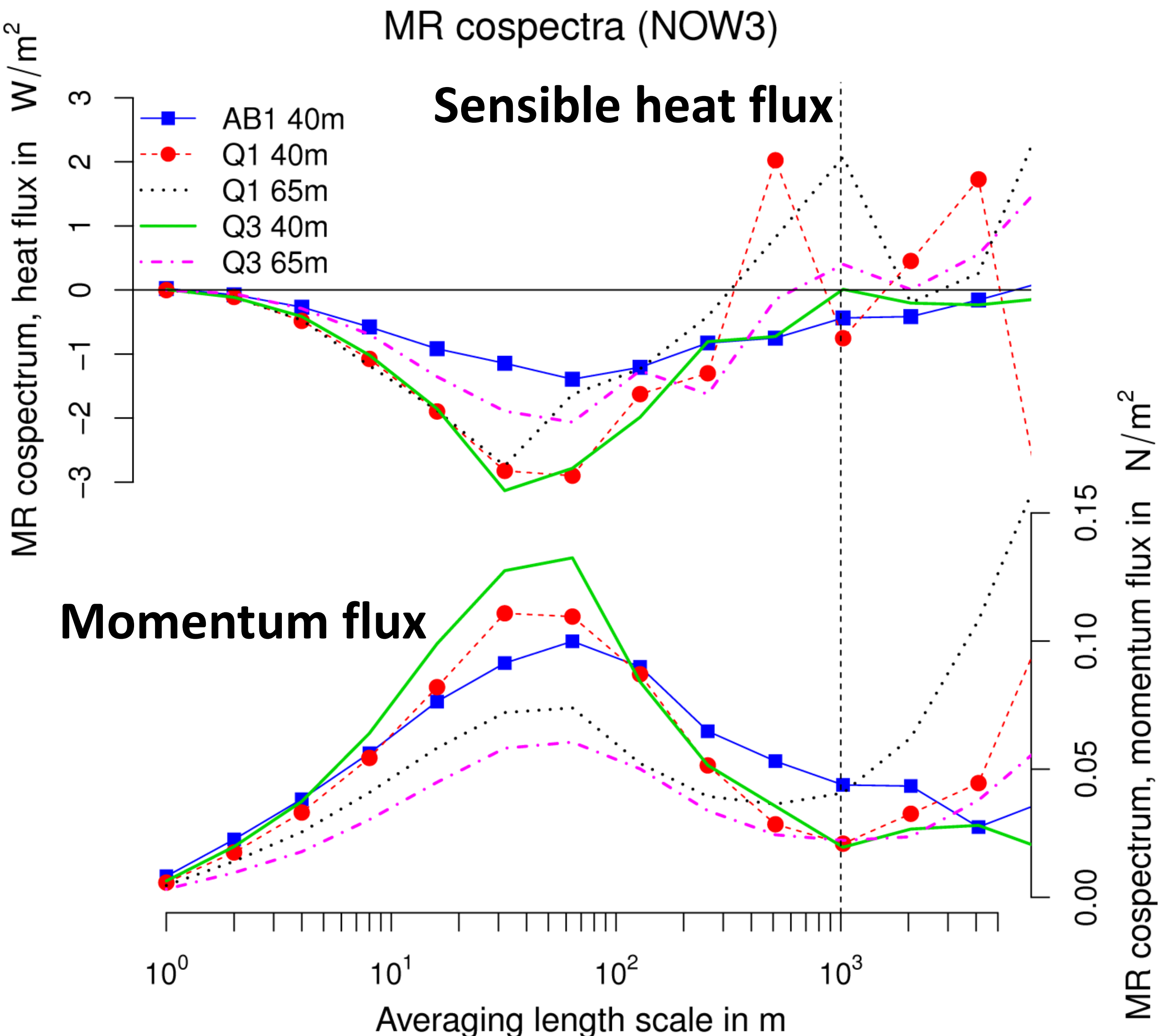




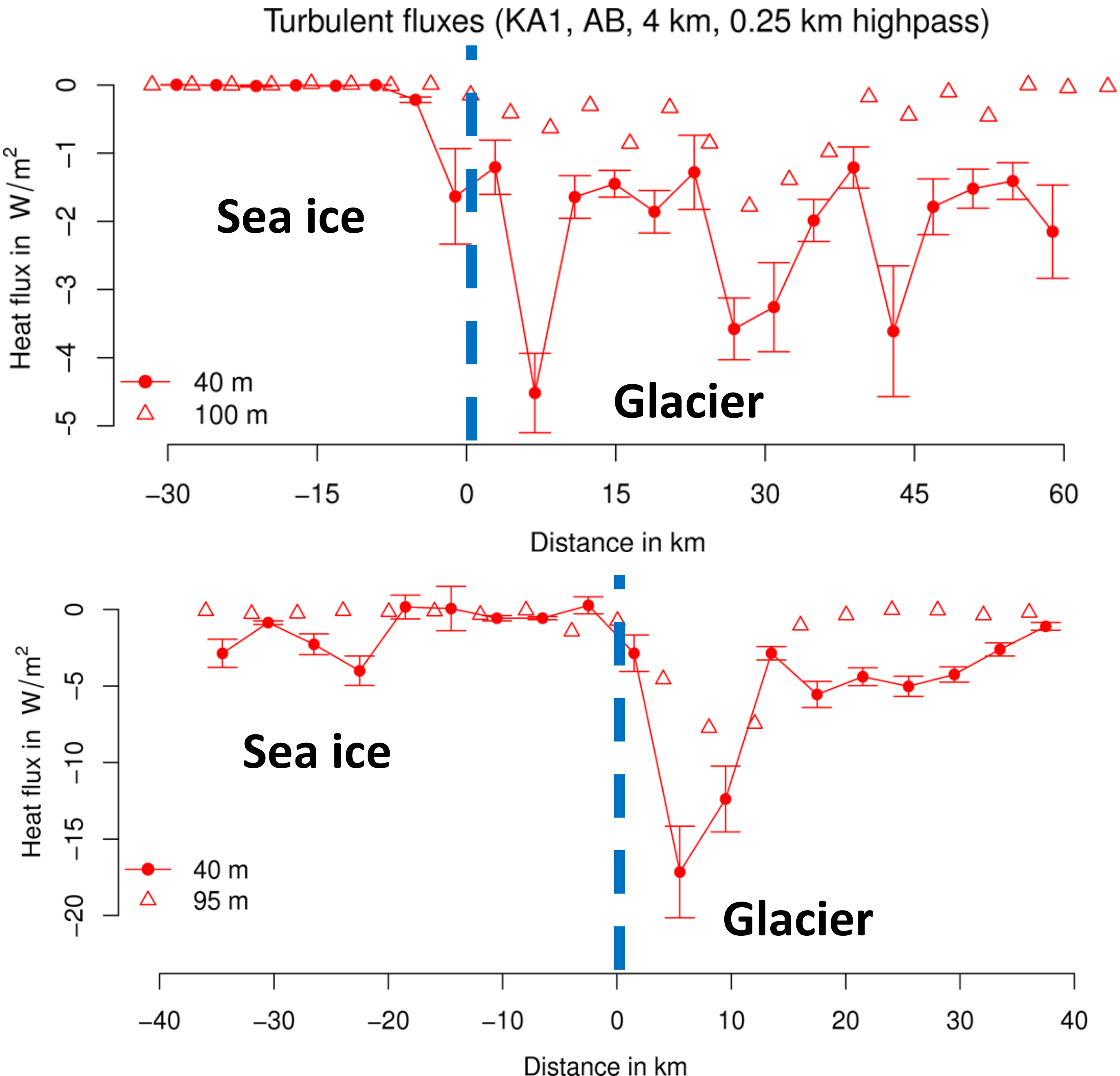
Turbulence Spectra and multiresolution decomposition (MR)



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

Katabatic wind: gap scale 250m

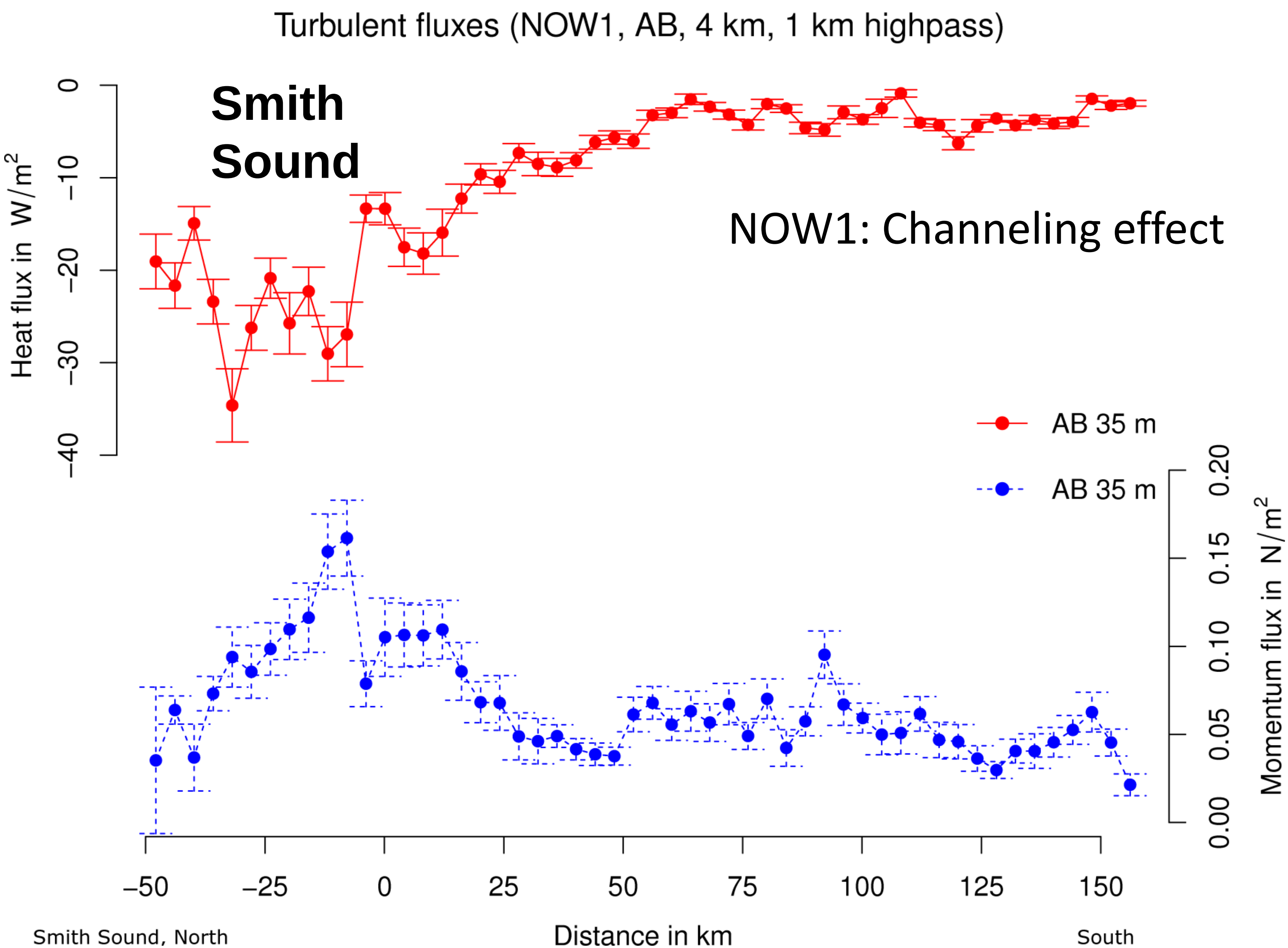
Turbulent fluxes – Katabatic wind flights



weak synoptic forcing

strong synoptic forcing

Turbulent fluxes – NOW Polynya flights



Conclusions

The IKAPOS 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.

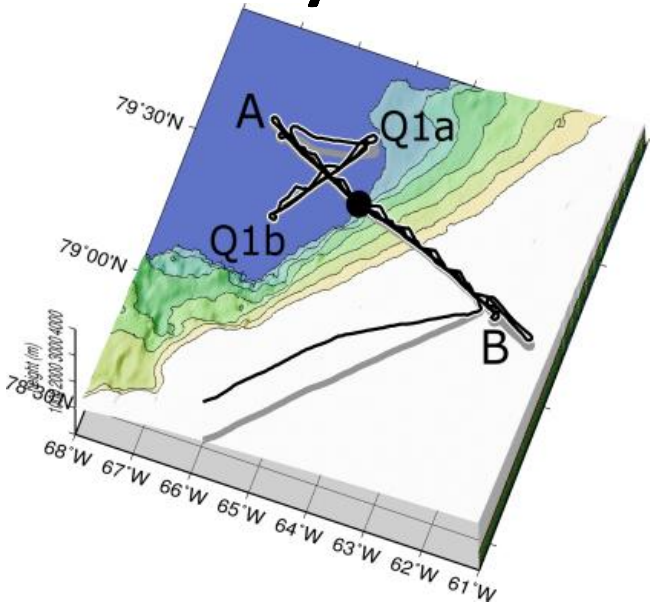
Strong channeling effects in Nares Strait/Smith Sound are documented (wind increase from 6 to 18m/s, LLJ at 150m)-> implications for NOW formation

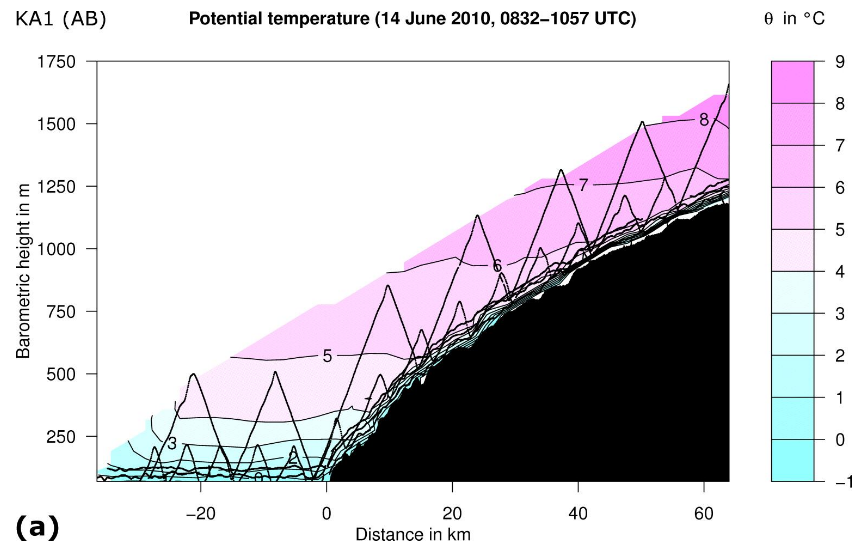
References

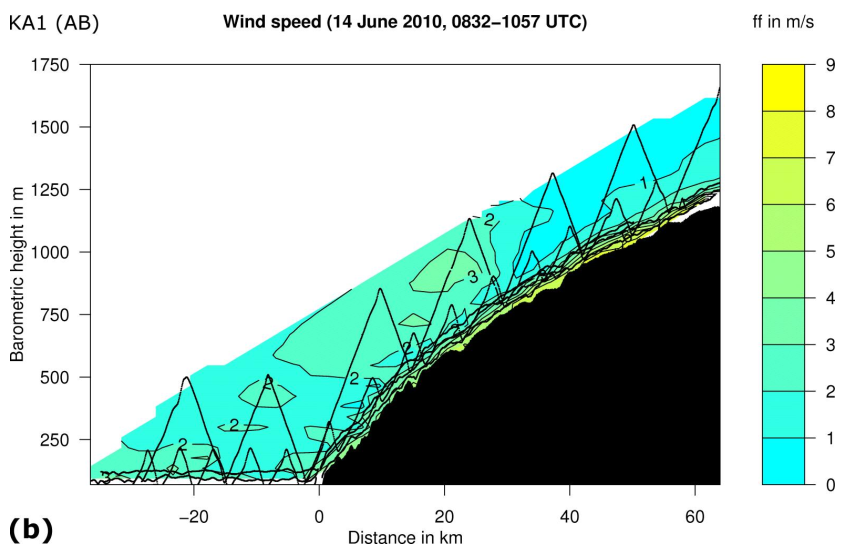
Heinemann, G., Ernsdorf, T., Drüe, C., 2011: Investigation of Katabatic winds and Polynyas during Summer - KAPOS, Field Phase Report. Reports on Polar and Marine Research 633, Alfred-Wegener-Institute for Polar and Marine Research, Bremerhaven, Germany, 116pp. http://epic-reports.awi.de/3792/

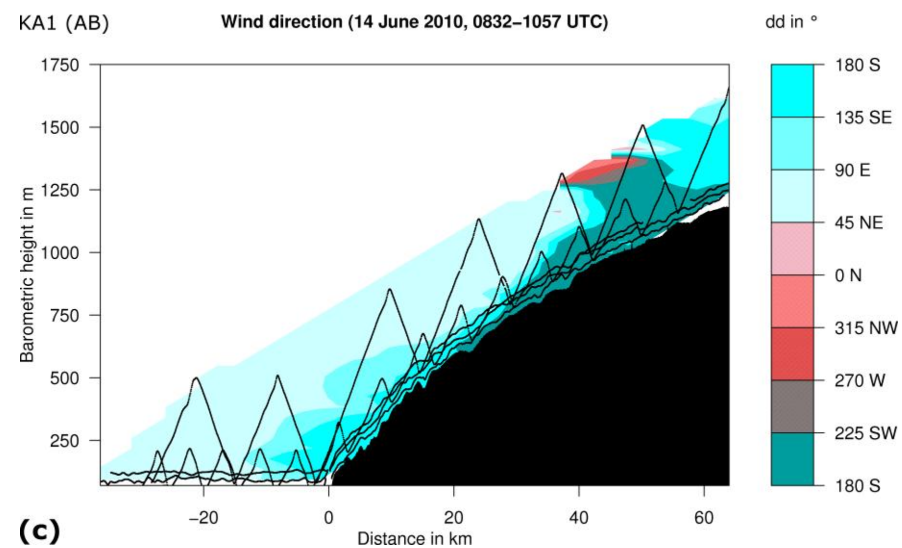
Drüe, C., Heinemann, G., 2012: A practical in-flight calibration scheme for aircraft turbulence sensors. J. Atmos. Oceanic Technol., in preparation.

Mean ABL structures Humboldt glacier:
Katabatic wind system under weak synoptic forcing









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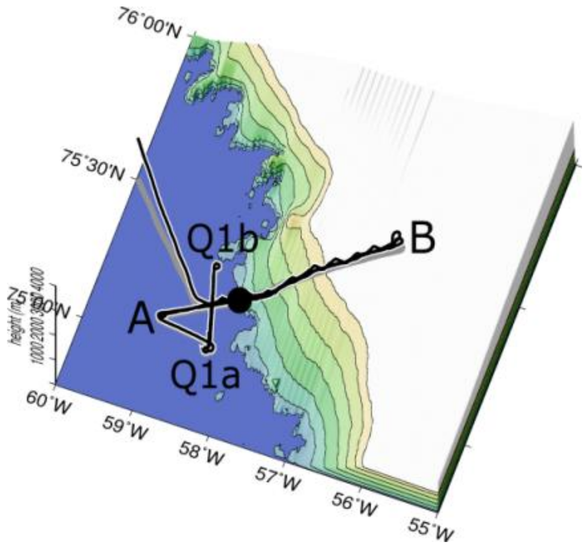

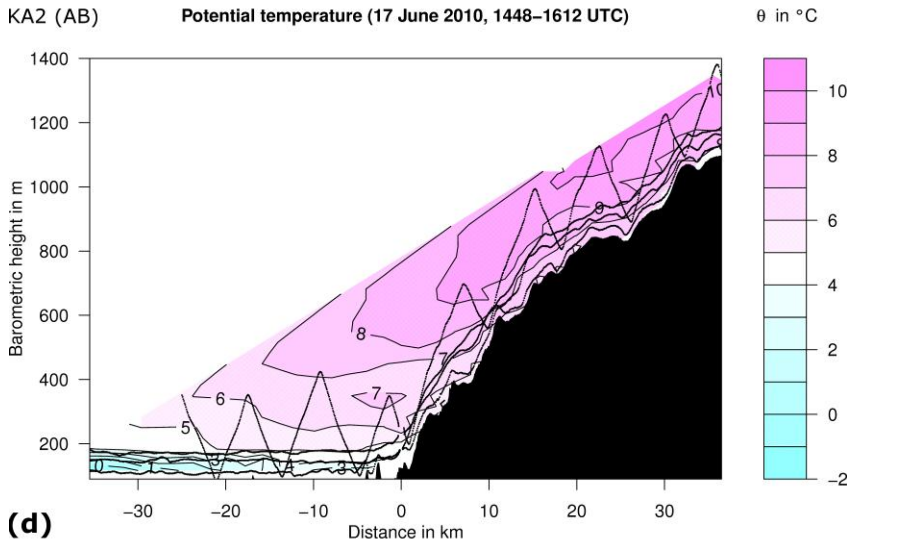

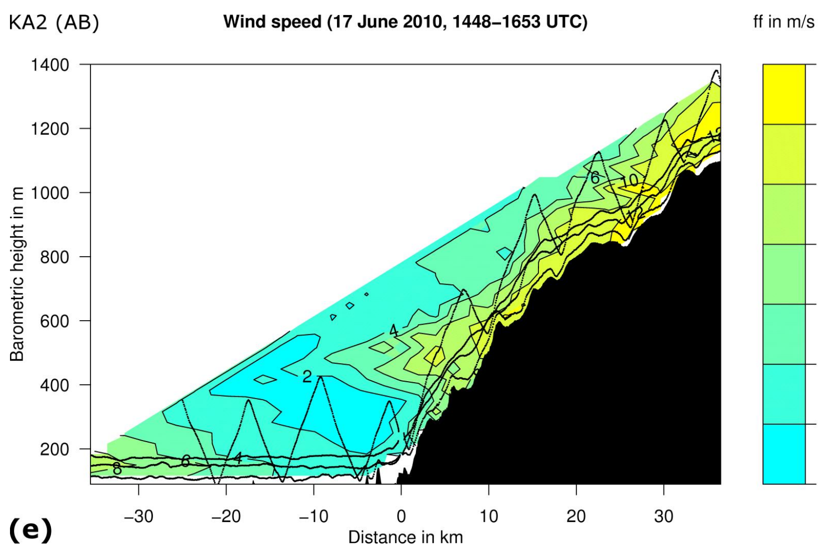

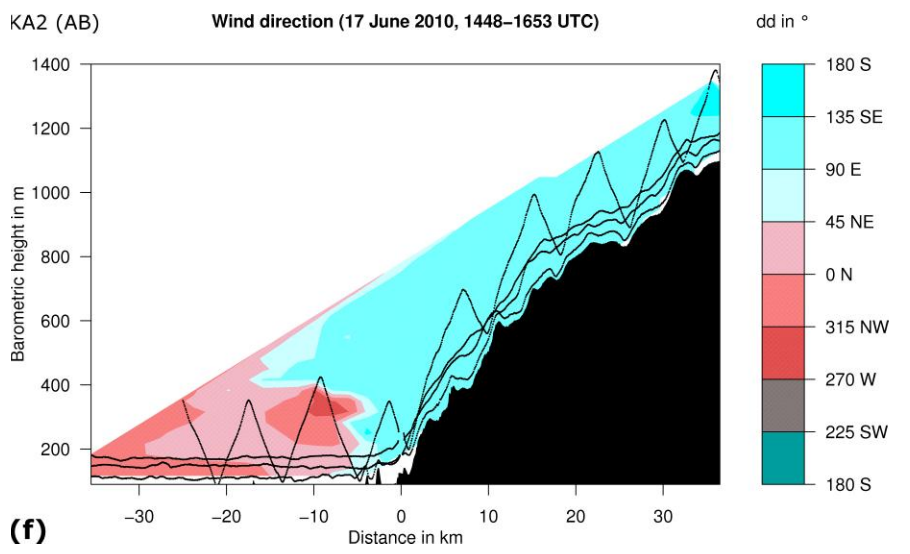

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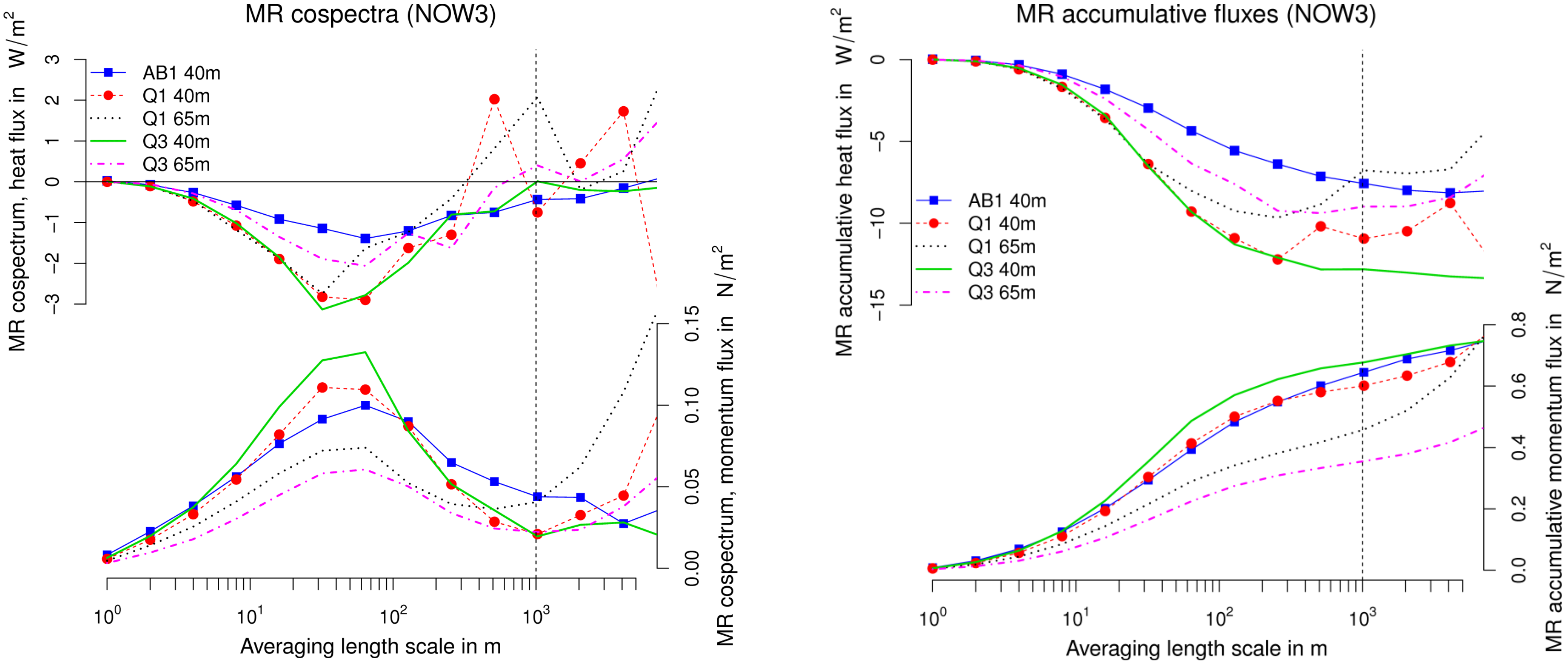
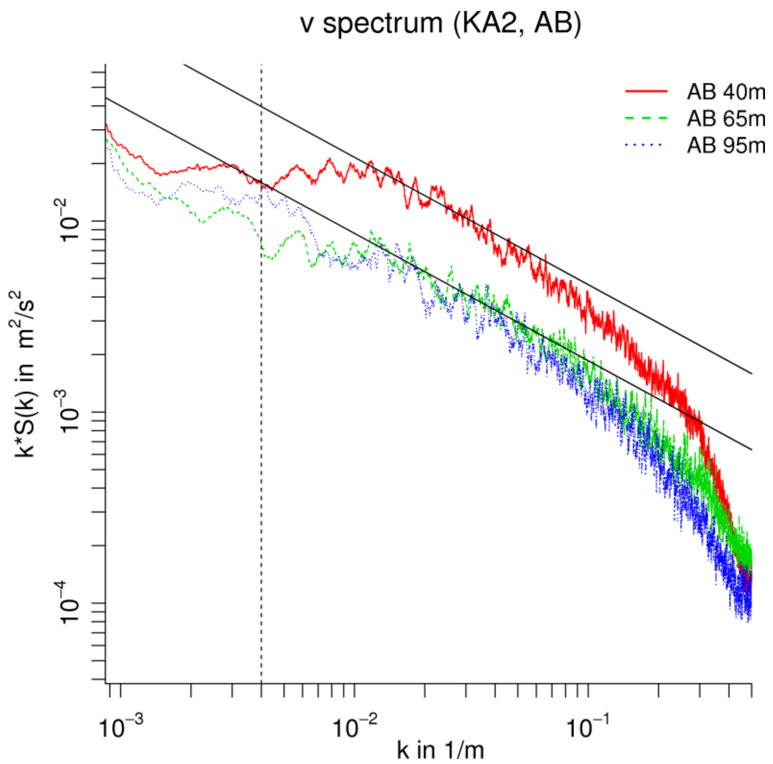
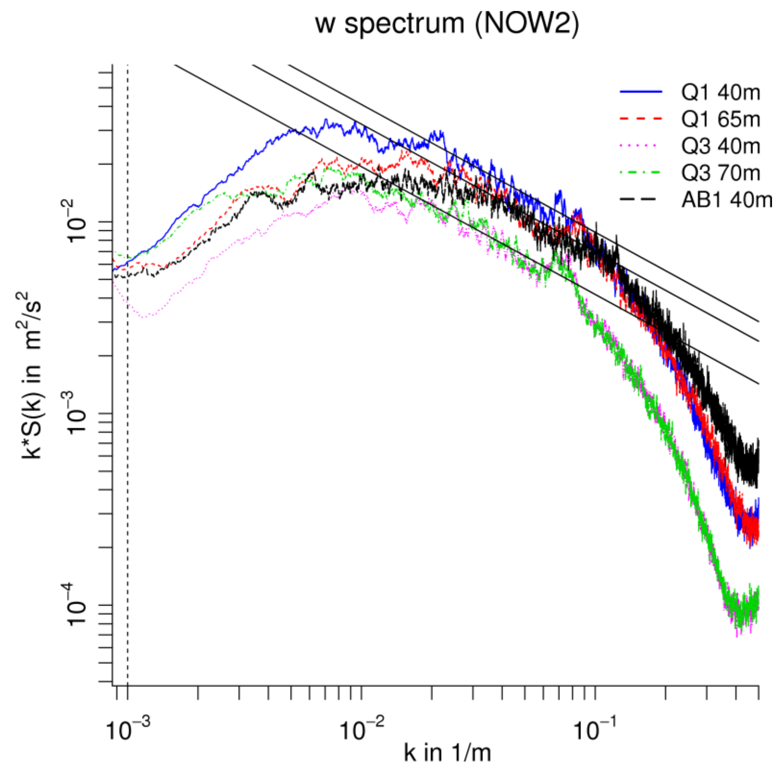


NOW Polynya flights: gap scales of 500 m – 1000 m

Turbulence Spectra – Fast Fourier transform (FFT)



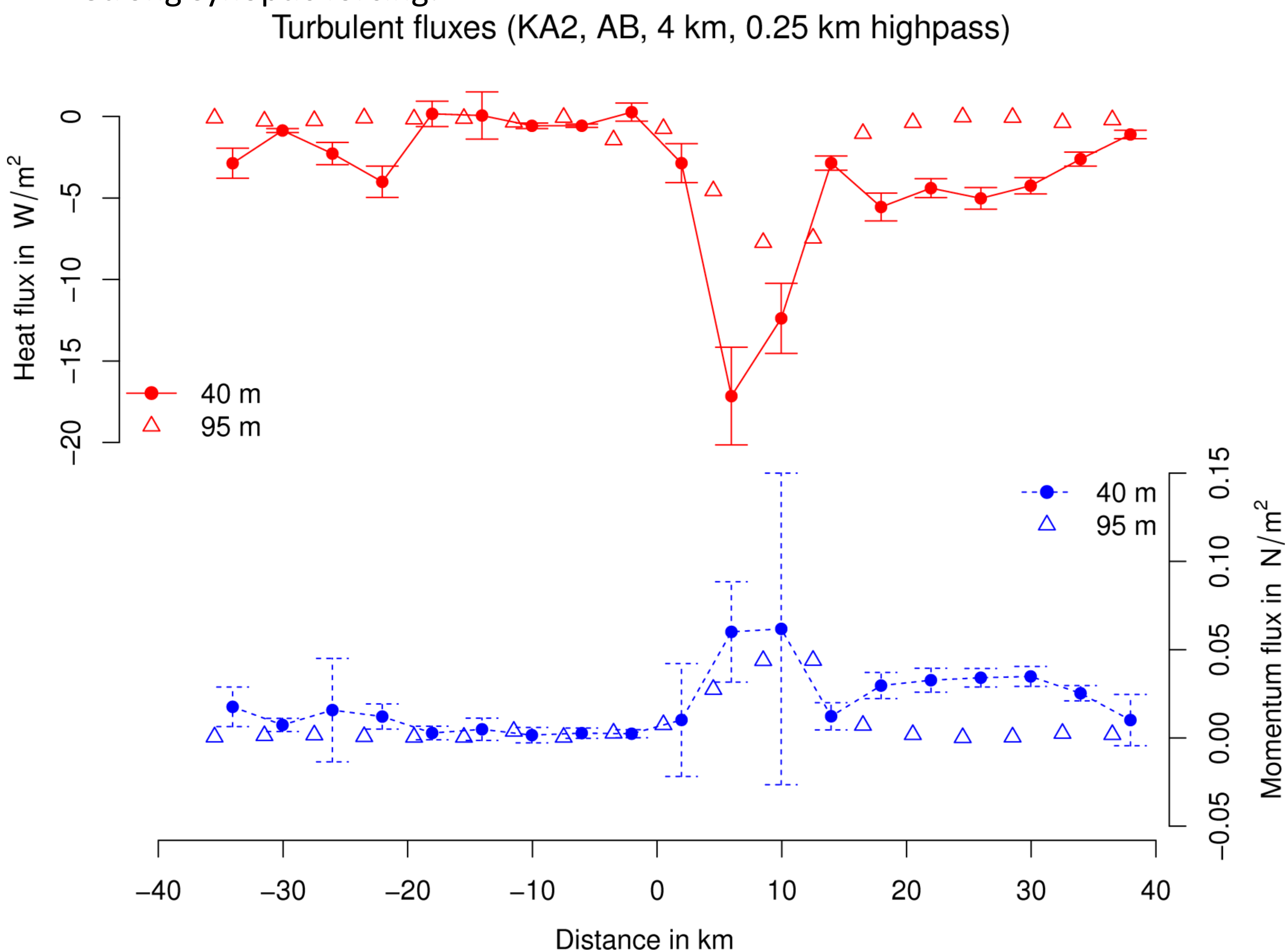


KA flights:
- spectral intensity decreases from 40 m to 65 m
- cut-off wave length: around 250 m

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

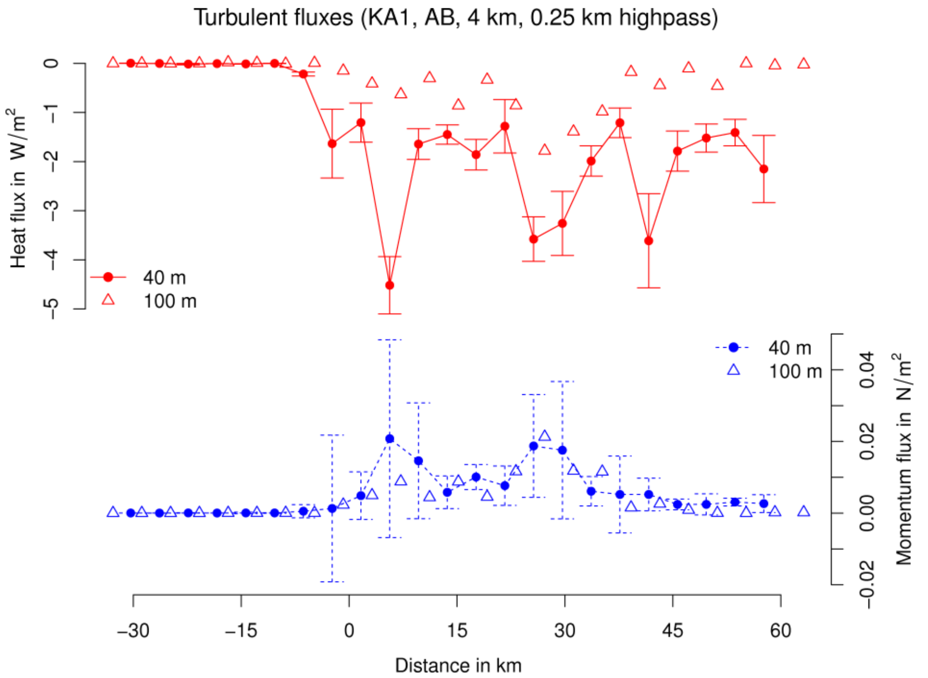
Turbulent fluxes – Katabatic wind flights

Strong synoptic forcing:

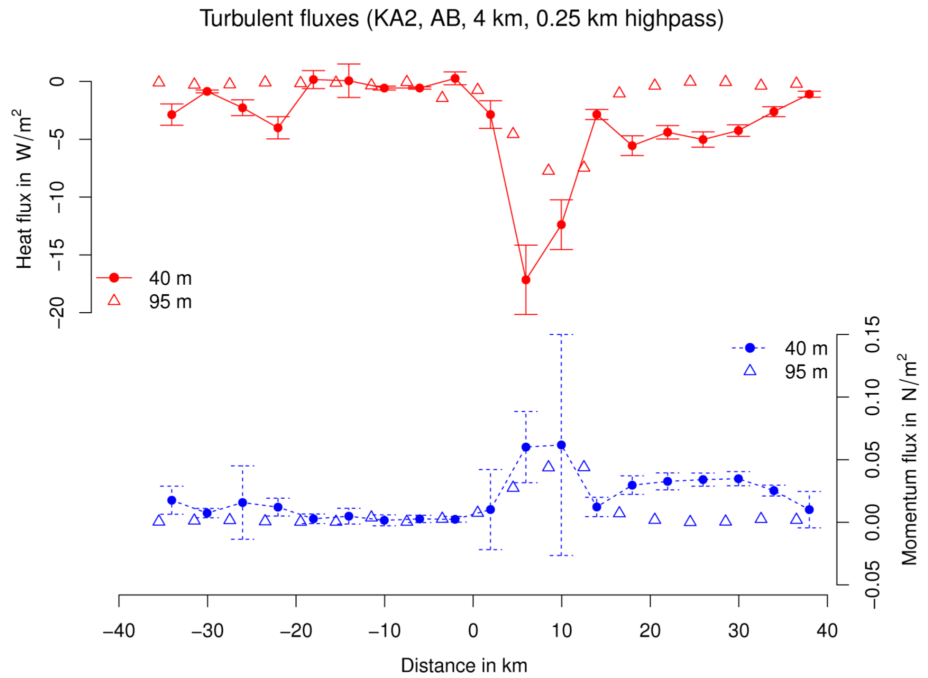


Turbulent fluxes – Katabatic wind flights

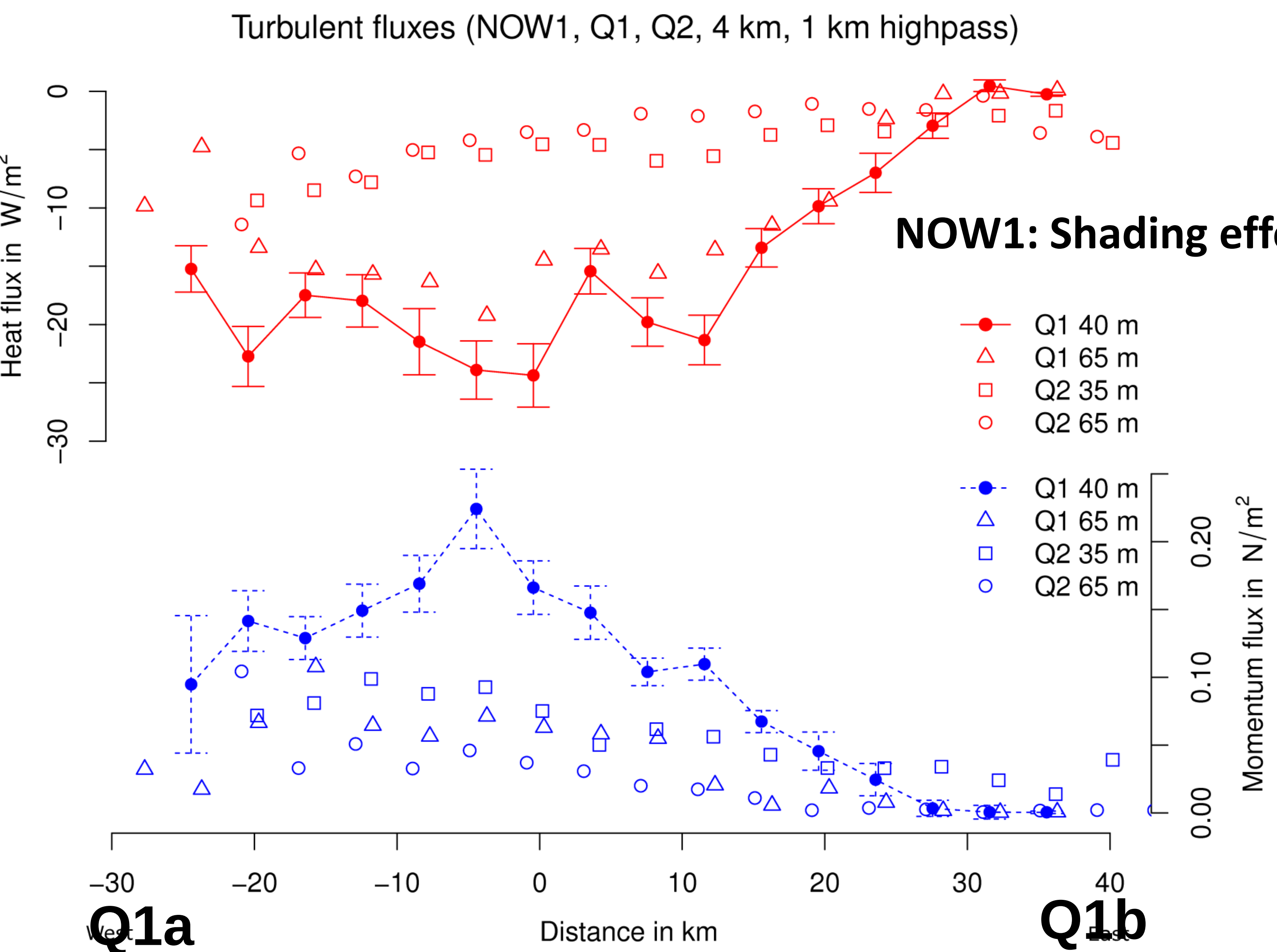
Weak synoptic forcing:



Strong synoptic forcing:



Turbulent fluxes – NOW Polynya flights



NOW1: Shading effect

Q1a

Q1b