Peyto Glacier: revisiting the 25 m HRU

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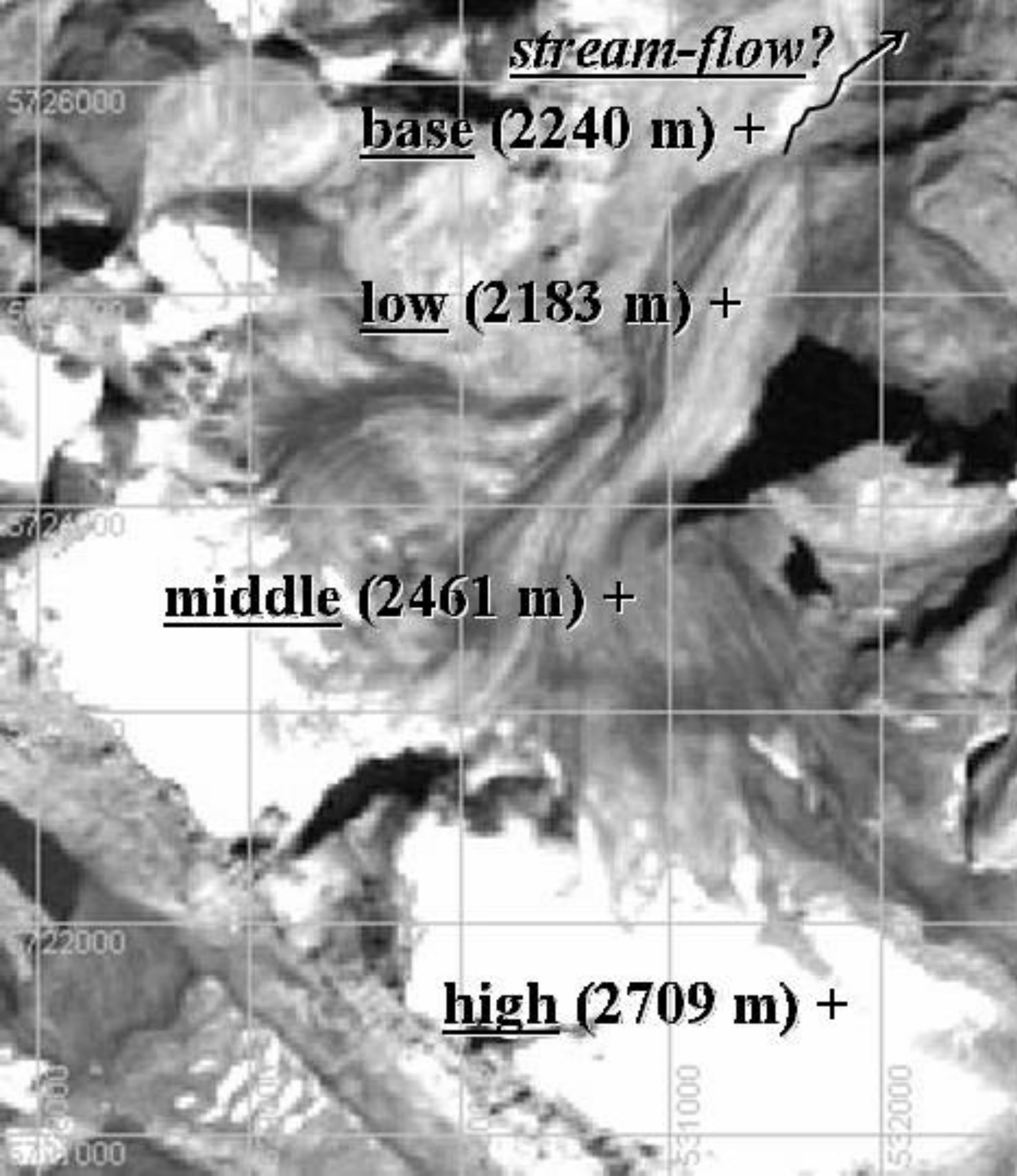


AWS Status

- Point ***process*** investigation
- Spatial distribution tools (DEM, trigonometry, ***parameterization***)
- Distributed modelling and ***prediction***
- Base AWS/RCM forcing

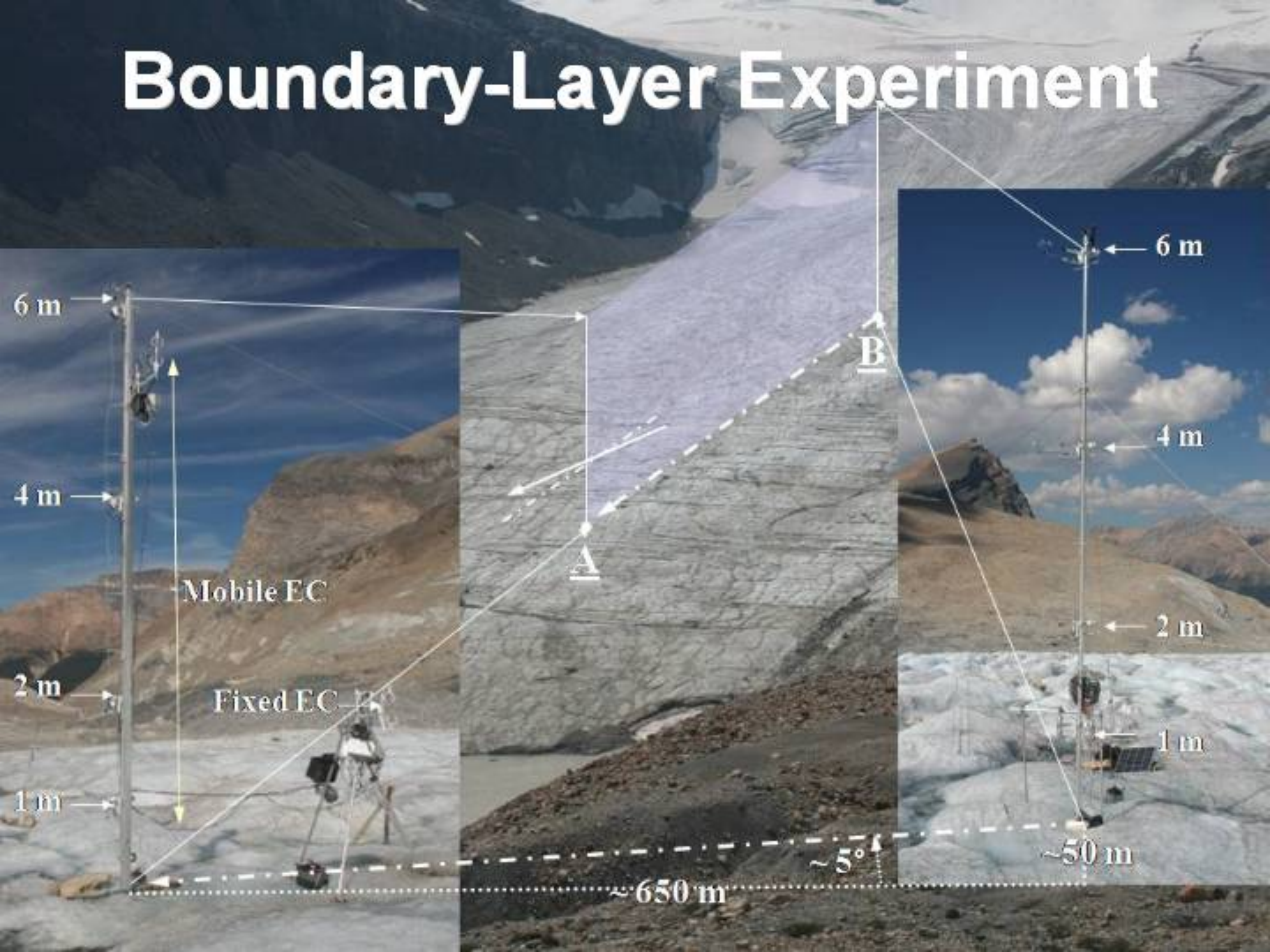
Point *process* investigation

- ***<u>1st Hypothesis</u>:*** due to the heat flow barrier of the glacier wind speed maximum, air adjacent to the surface cools as it accelerates down glacier. *<u>Boundary-Layer Experiment</u>*

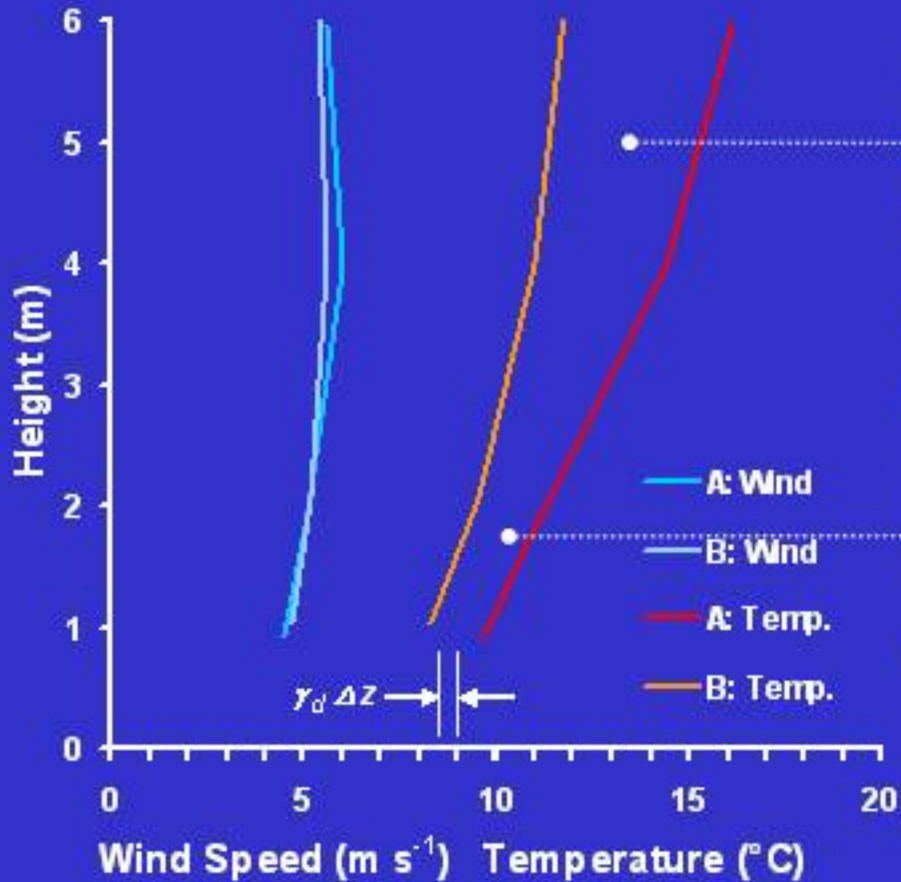
- ***<u>2nd Hypothesis</u>:*** in accordance with the 1st hypothesis, eddy correlation data will show no turbulent heat flux at the maximum wind speed height. *<u>Boundary-Layer Experiment</u>*

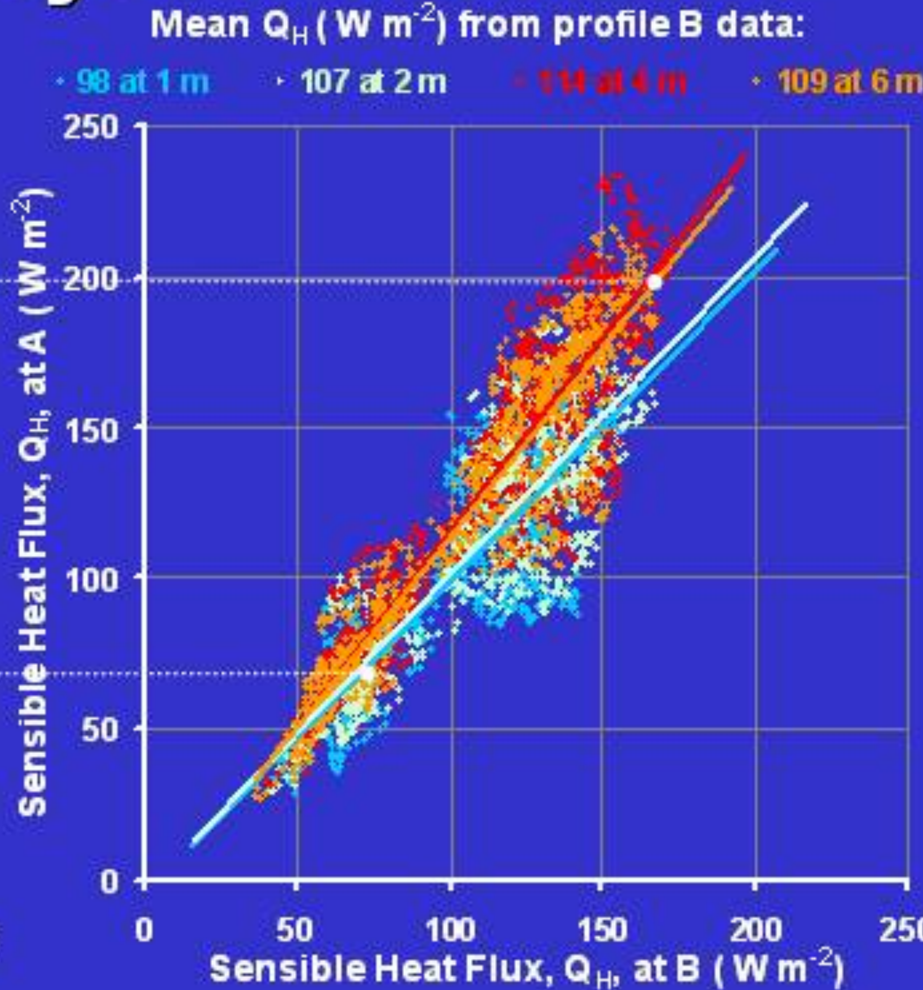
- ***<u>3rd Hypothesis</u>:*** due to weathering crust development, there is significant diurnal delay in melt-water flow response at the glacier surface. *<u>Microbasin Experiment</u>*

Boundary-Layer Experiment



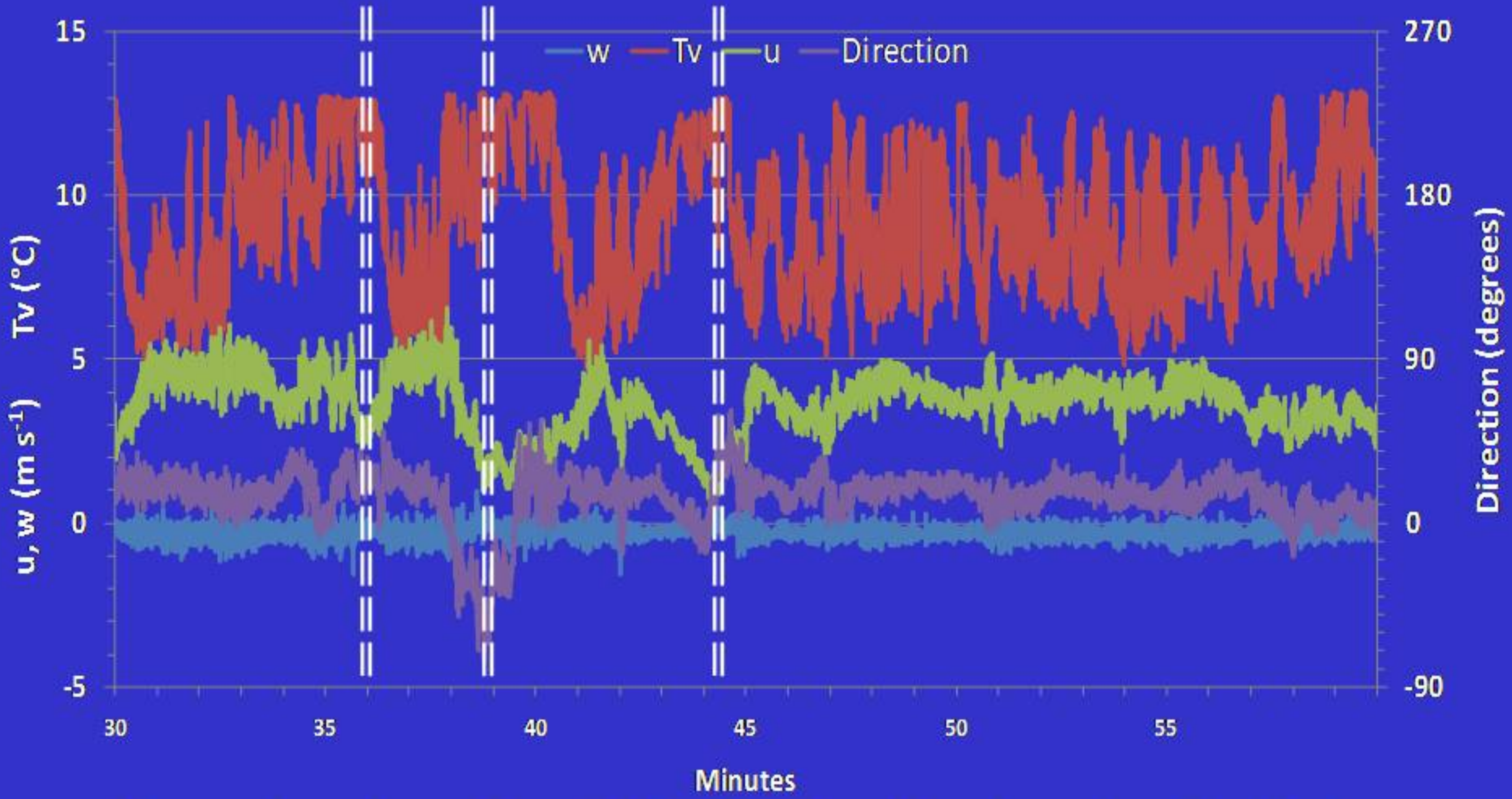
Boundary-Layer Results 1





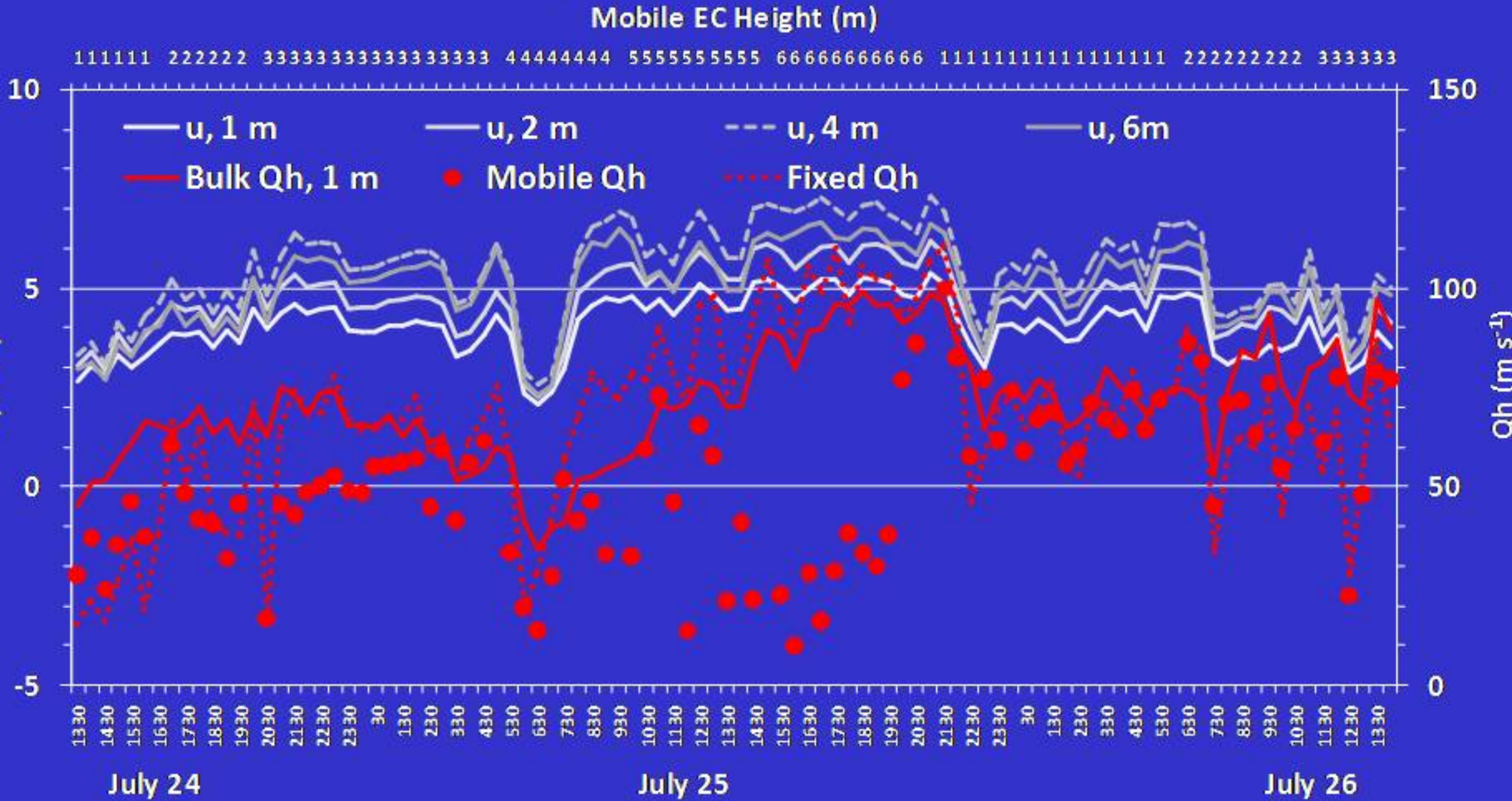
→ warming and modest acceleration adjacent to the surface despite classic theoretical implication of no heat flow across the 4 m wind speed maximum

Boundary-Layer Results 2



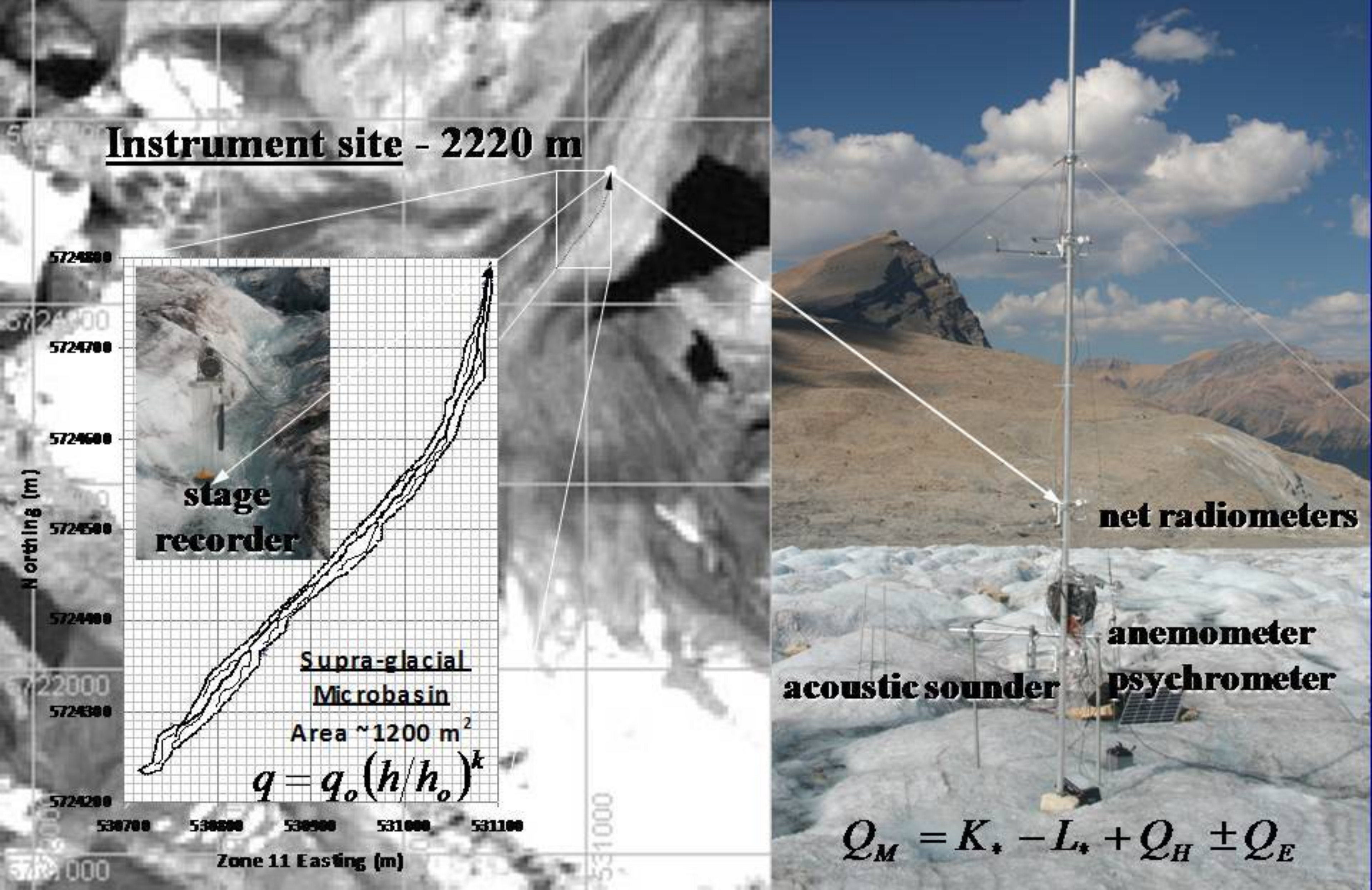
→ boundary-layer instability (broken lines) marked by high temperature, weak wind and directional disturbance: possible intermittent barrier collapse as a heat flow agent?

Boundary-Layer Results 3



→ vertical flux divergence that shows mobile *Qh* < fixed *Qh* above 4 m, but still > 0: likelihood of a leaky barrier rather than a barrier collapse heat flow mechanism

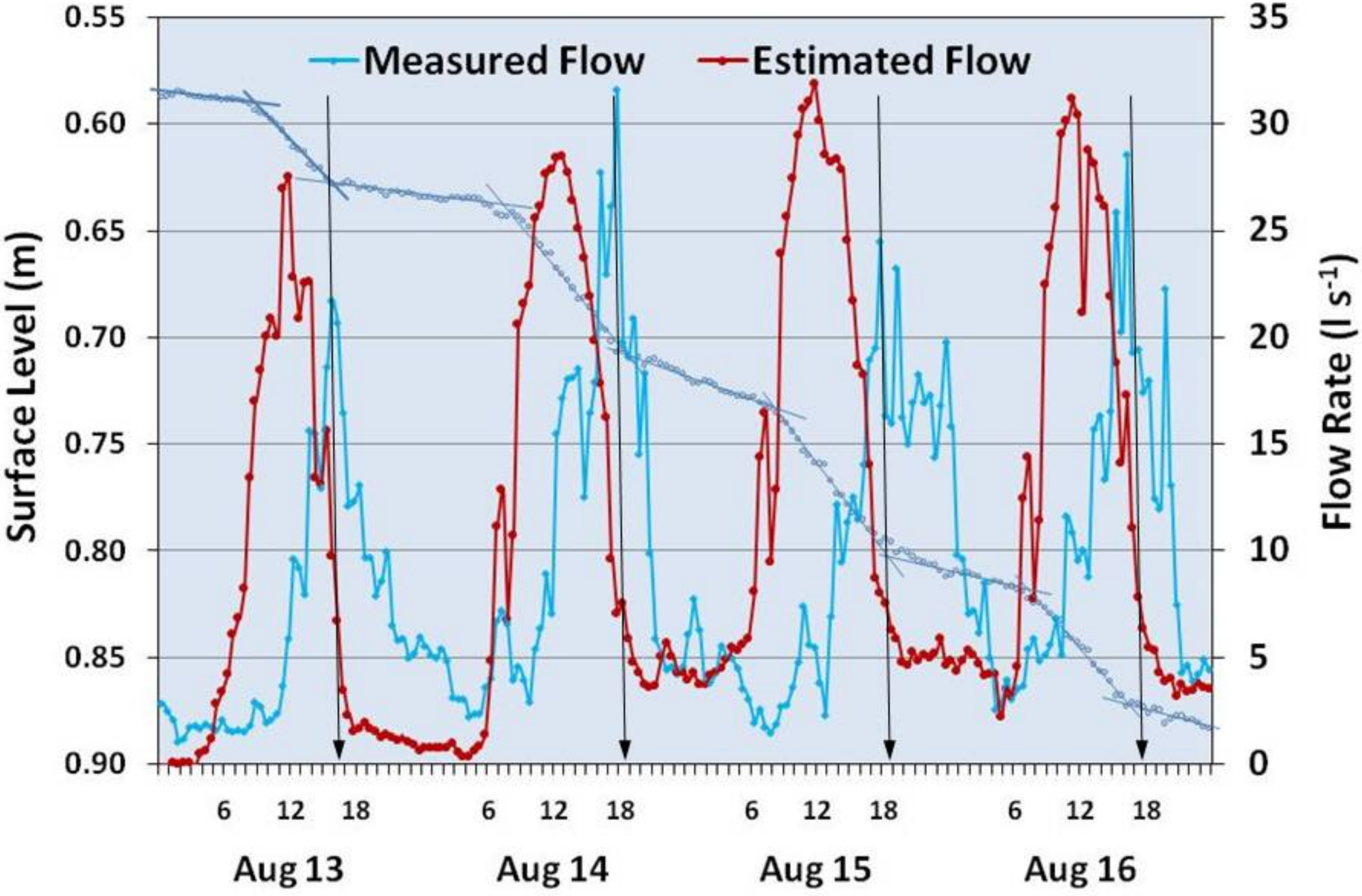
Microbasin Experiment



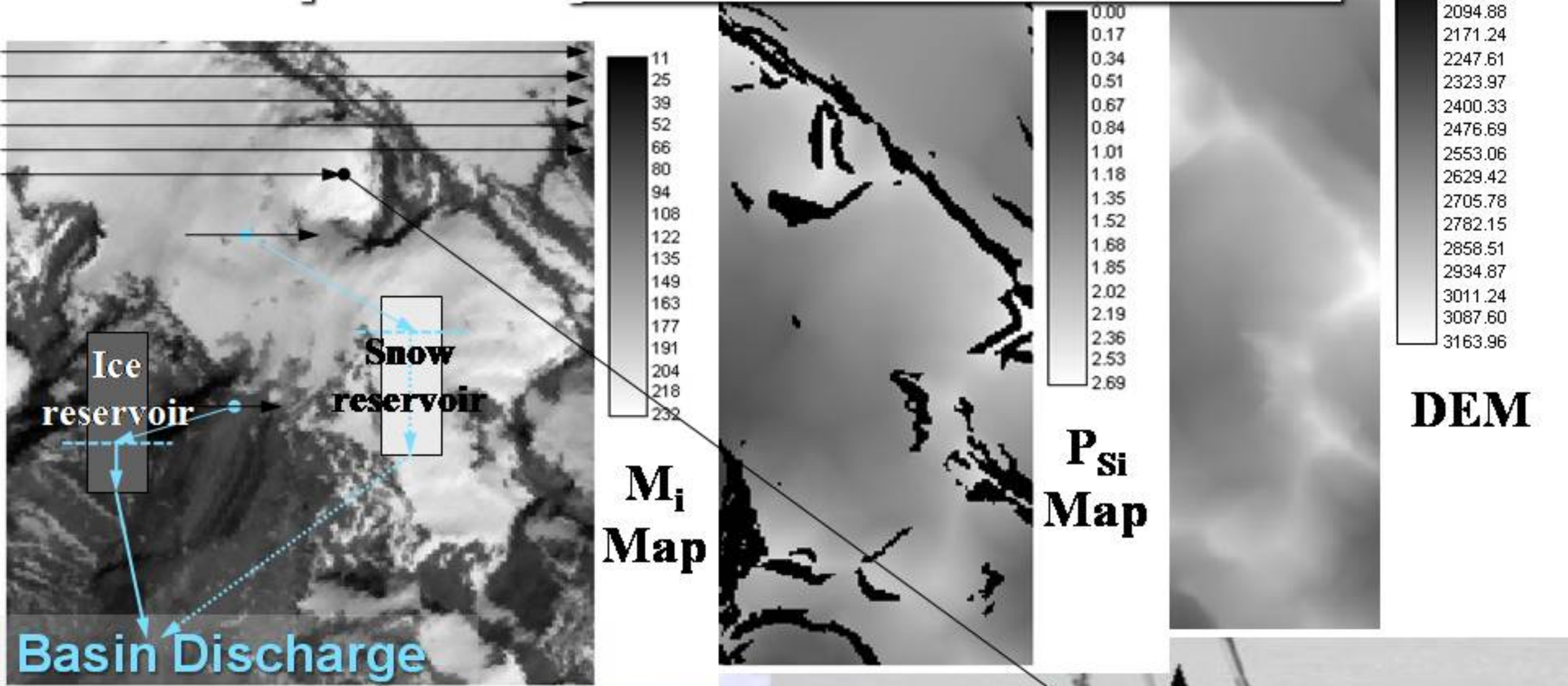
Microbasin Results 1

Date	$q_{measured}$ ($l\ s^{-1}$)	$q_{estimated}$ ($l\ s^{-1}$)	$q_{meas.}/q_{est.}$	K^*/Q_M
Jul-25	8.5	9.9	0.86	0.97
Aug-05	7.5	8.7	0.86	1.08
Aug-06	8.9	11.1	0.81	0.90
Aug-07	10.3	12.8	0.81	0.69
Aug-13	6.6	7.7	0.86	0.90
Aug-14	10.2	11.2	0.91	0.79
Aug-15	9.5	13.3	0.71	0.67
Aug-16	10.1	11.9	0.85	0.70
Aug-23	6.6	5.6	1.18	0.91
Aug-24	7.1	10.4	0.68	0.66
Aug-25	5.1	5.5	0.93	0.75

Microbasin Results 2

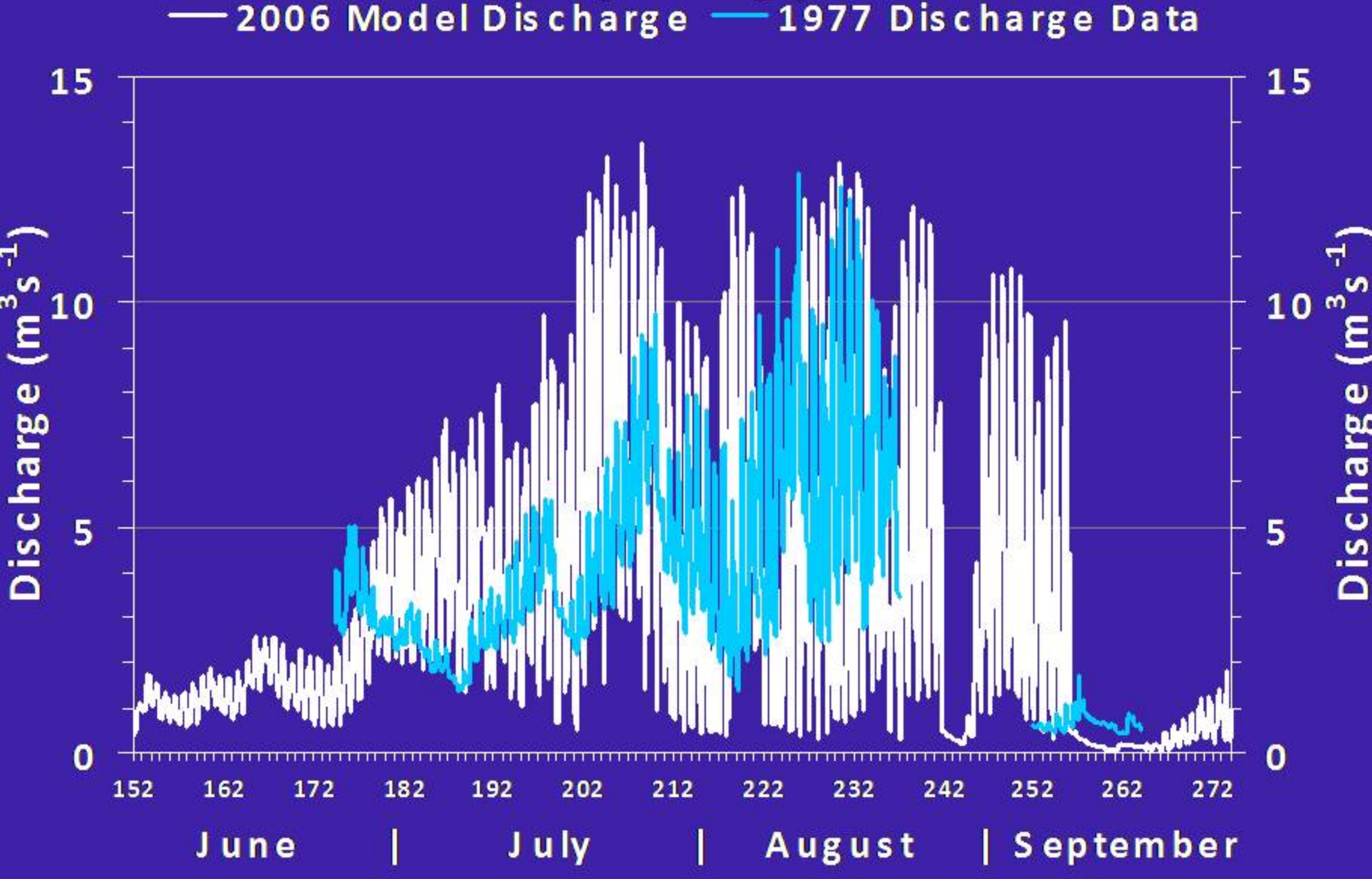


Spatial *parameterization*

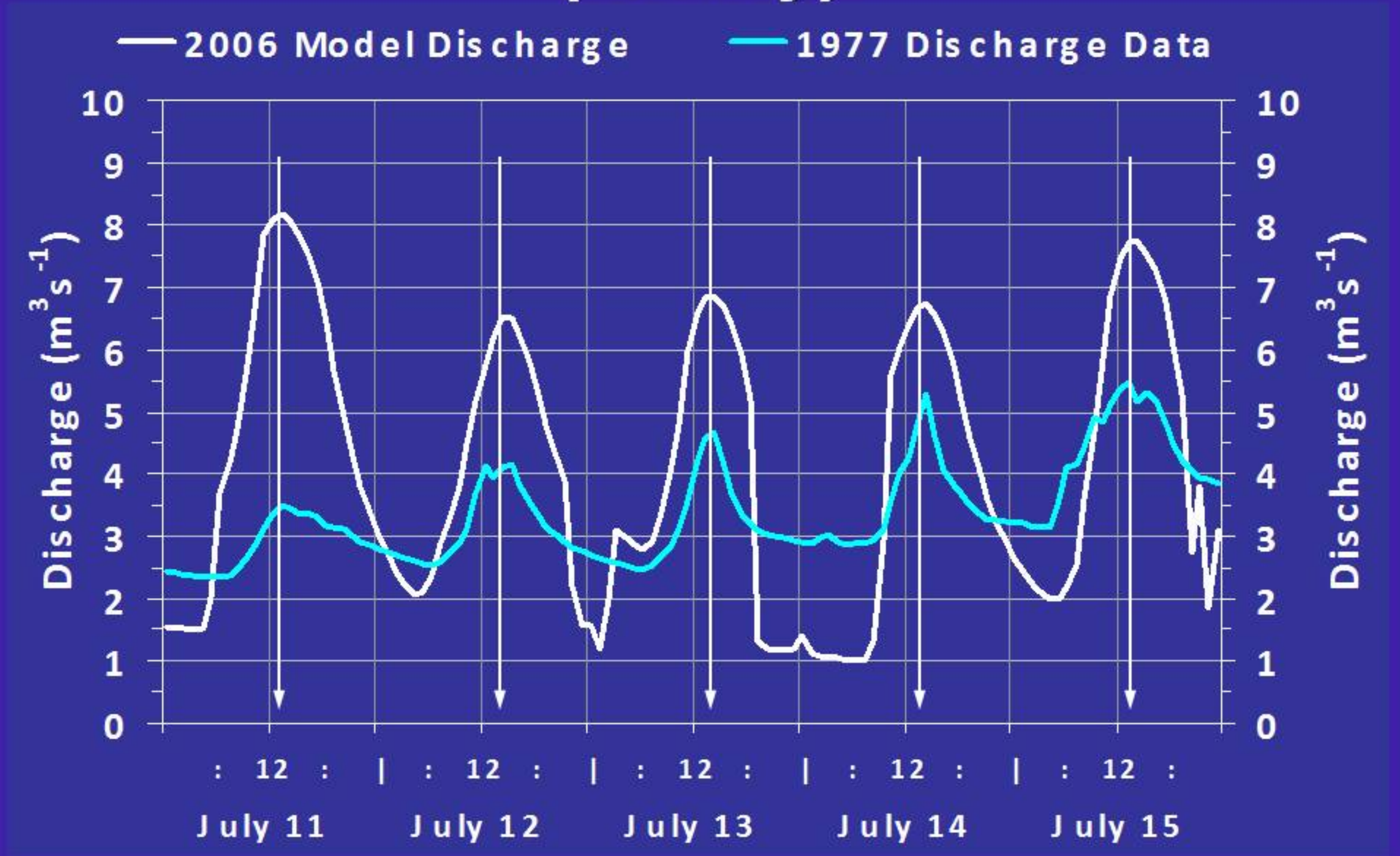


$$\rightarrow \left\{ P_S + \frac{K\downarrow(1-\alpha_S) + L_* + Q_H + Q_E}{L_f} \right\}_i = \delta M_i$$

Basin Discharge ***prediction*** (daily)



Basin Discharge *prediction* (hourly)



Conclusions & Outlook

- ***1st Hypothesis***: warming adjacent to the surface, with modest wind speed acceleration due to downward air flow across the barrier of the local wind speed maximum, possibly due to intermittent barrier collapse.
- ***2nd Hypothesis***: persistent downward sensible heat flux across the local wind maximum, suggesting a 'leaky barrier' rather than a 'barrier collapse' model of glacier boundary-layer flow and the need for caution in the use of a coordinate rotation scheme for flux estimates.
- ***3rd Hypothesis***: delay in the surface runoff response of a glacier ice surface, a delay of 4 to 6 hours in fact, which conflicts with basin discharge prediction.
- ***Streamflow from an ungauged basin:*** a spatially distributed modelling approach, based on 25 m HRUs that have snow or ice responses, may be the best that can be done for now.

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