Air temperature variability in and out of crevasses in the accumulation area of a maritime glacier in the Southern Alps, New Zealand

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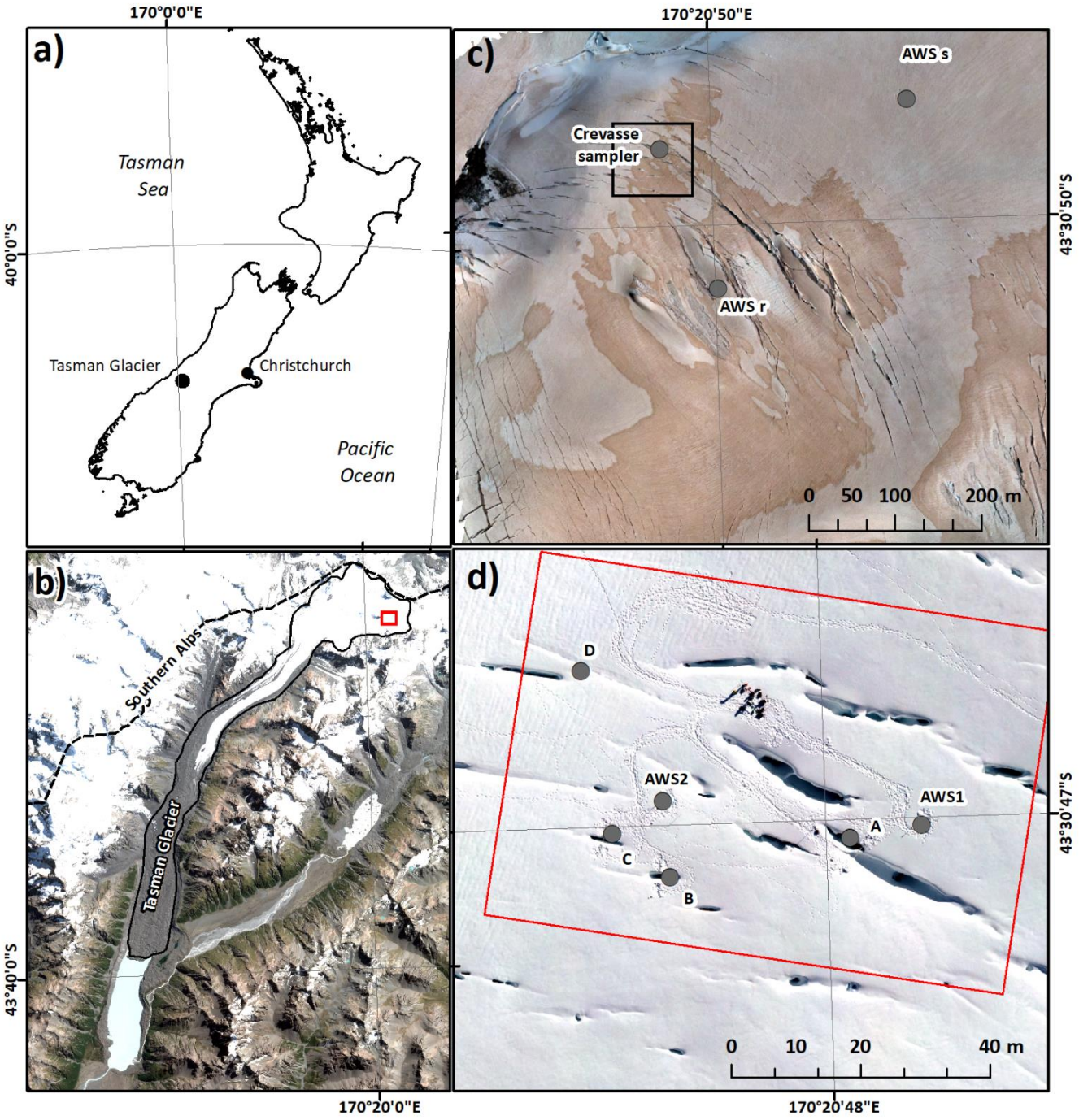
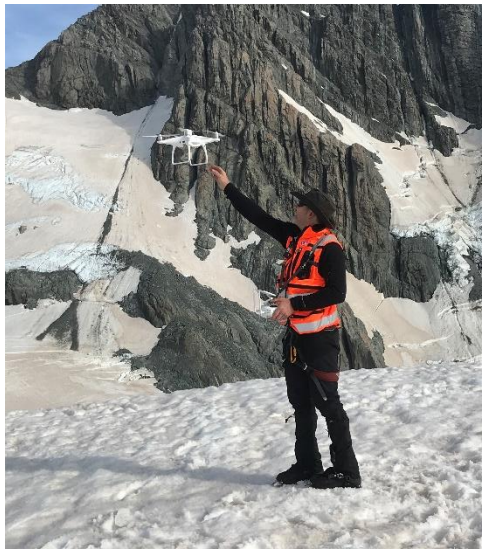
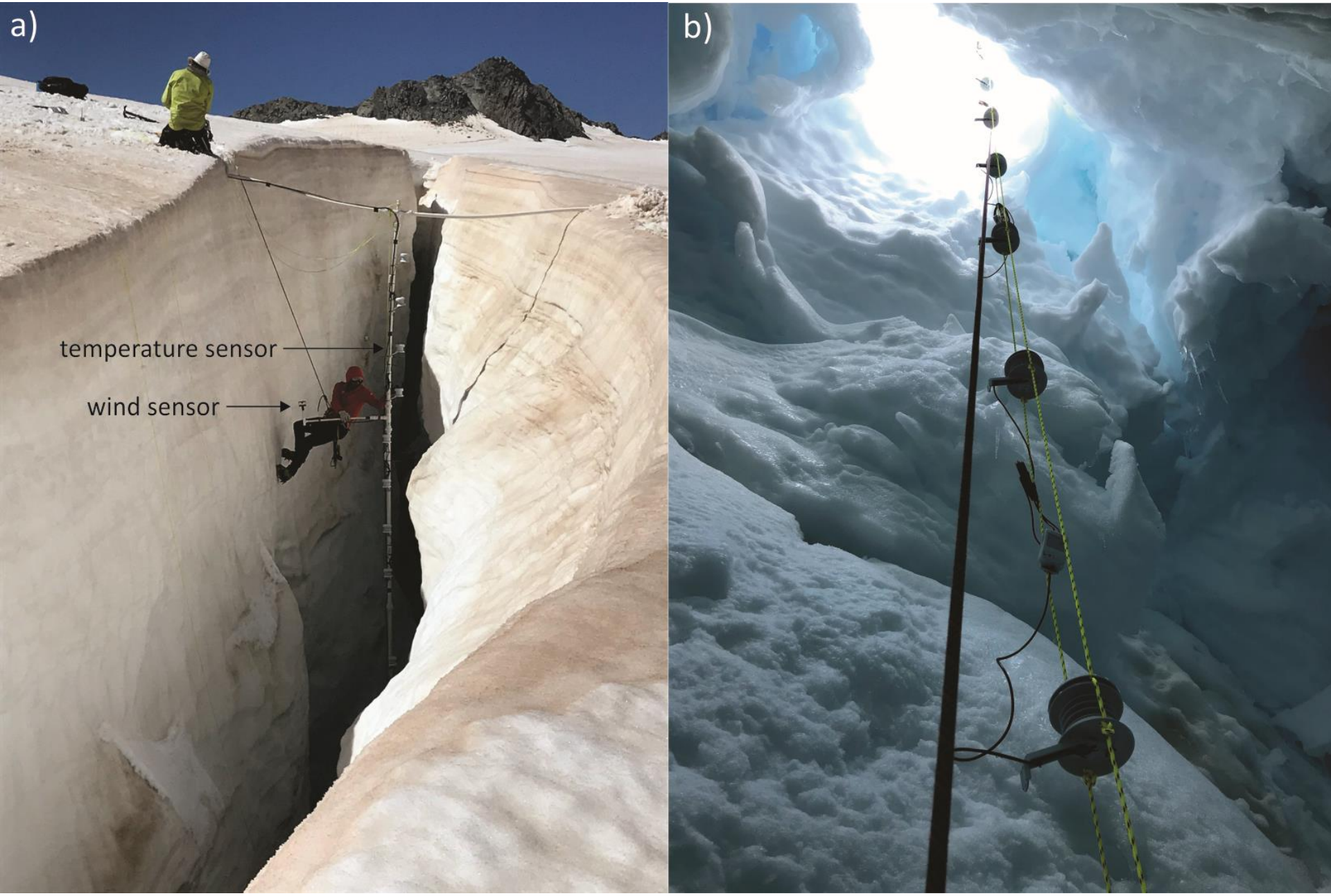
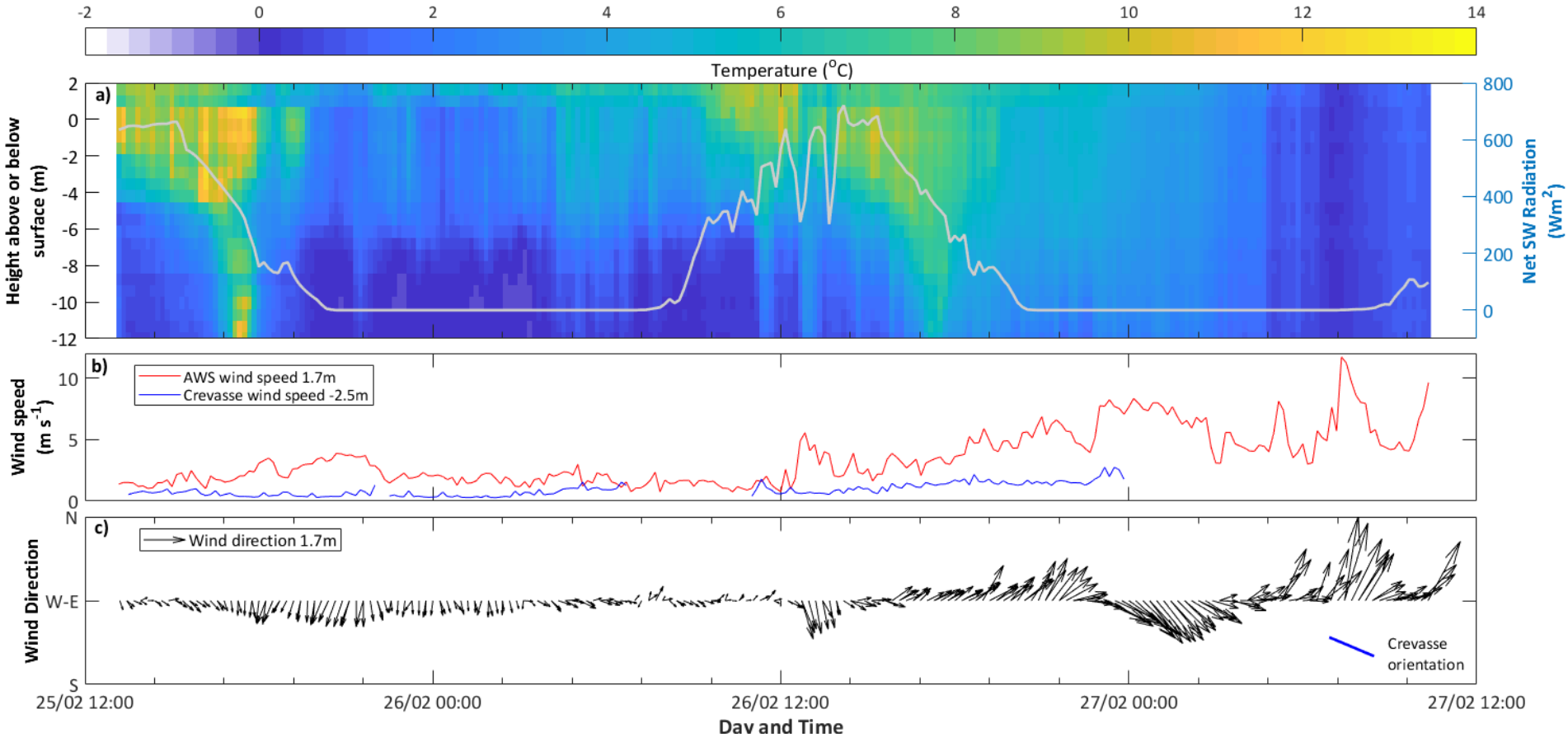
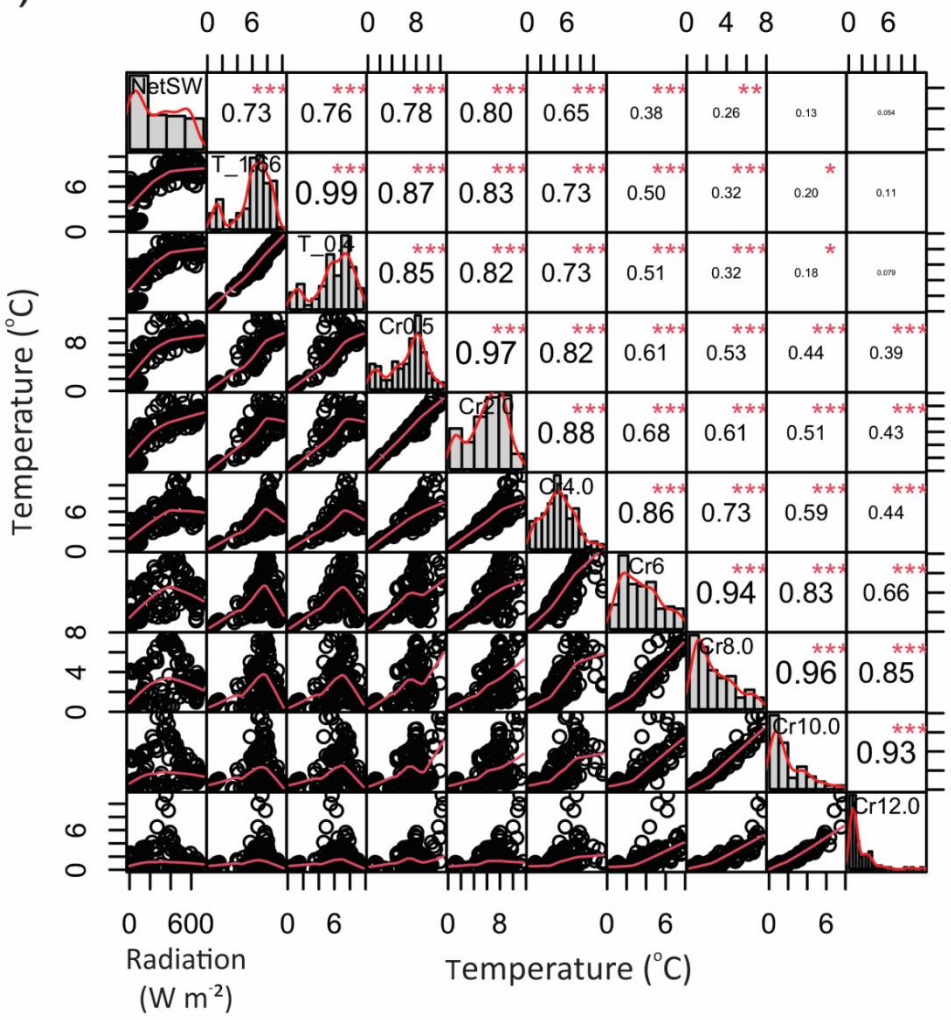

a)
170°0'0"E
40°0'0"S
Tasman Sea
Tasman Glacier
Christchurch
Pacific Ocean
b)
Southern Alps
Tasman Glacier
43°40'0"S
170°20'0"E
c)
170°20'50"E
43°30'50"S
AWS s
Crevasse sampler
AWS r
0 50 100 200 m
d)
D
AWS2
AWS1
A
C
B
43°30'47"S
170°20'48"E
0 10 20 40 m

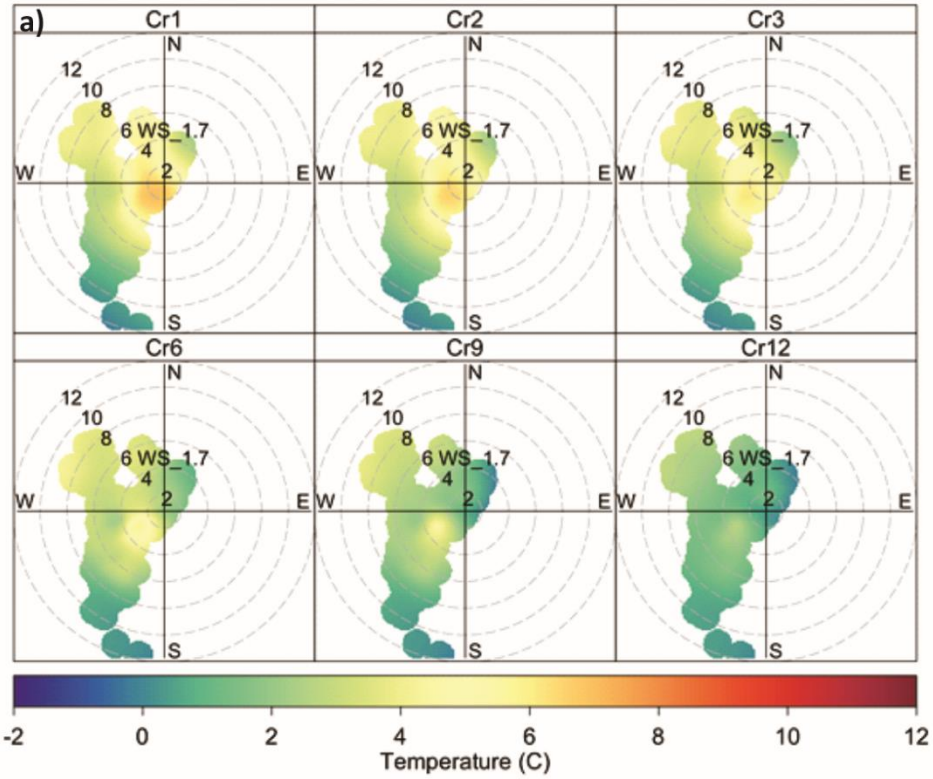


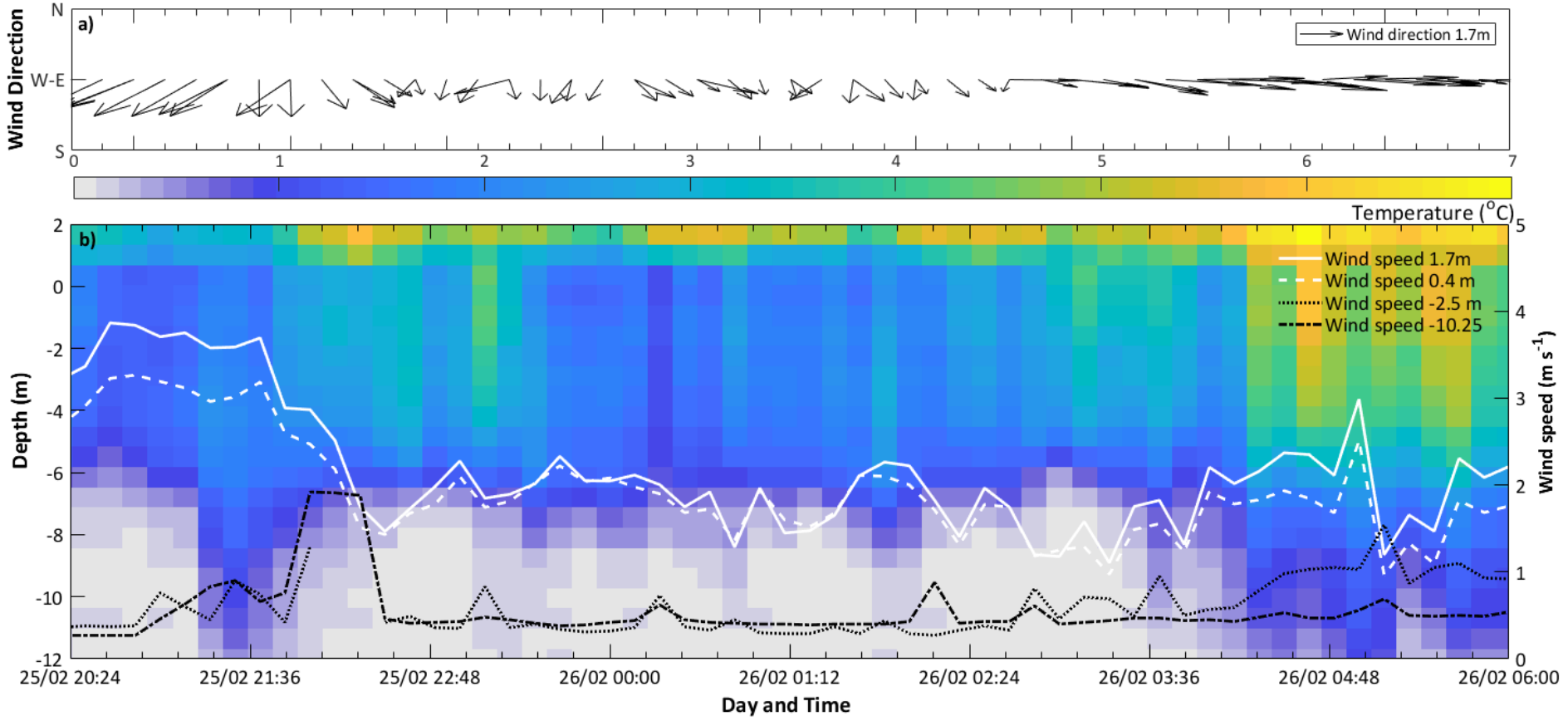

a)
temperature sensor
wind sensor
b)

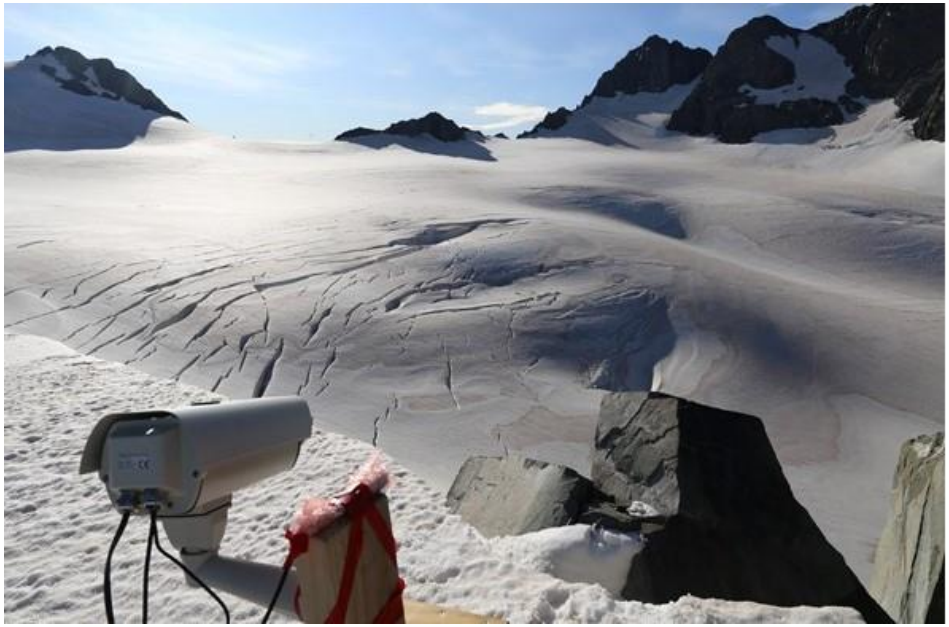

-2
0
2
4
6
8
10
12
14
Temperature (°C)
a)
Height above or below surface (m)
2
0
-2
-4
-6
-8
-10
-12
800
600
400
200
0
Net SW Radiation (Wm-2)
b)
AWS wind speed 1.7m
Crevasse wind speed -2.5m
Wind speed (m s-1)
10
5
0
c)
Wind direction 1.7m
Wind Direction
N
W-E
S
Crevasse orientation
25/02 12:00
26/02 00:00
26/02 12:00
27/02 00:00
27/02 12:00
Dav and Time

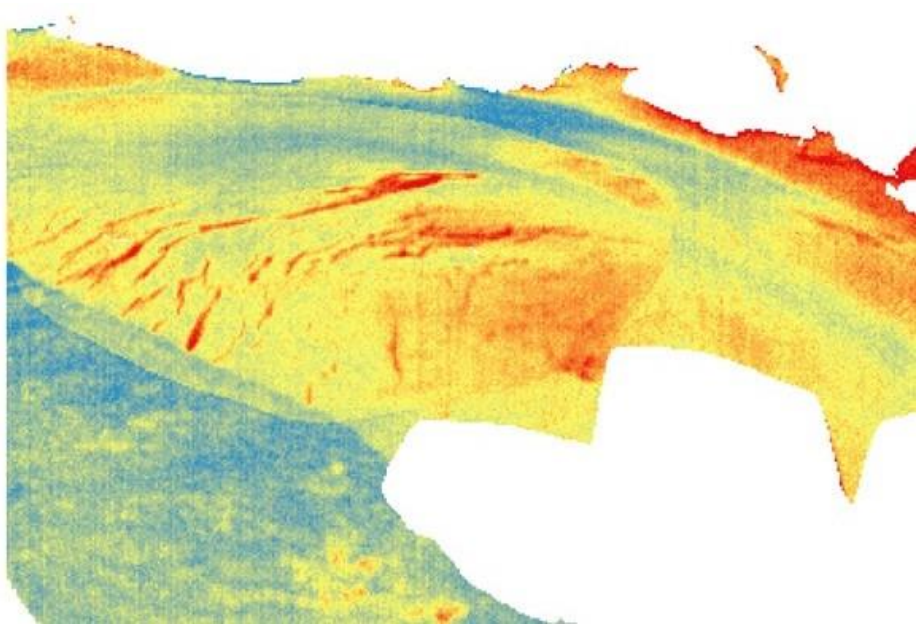
a)

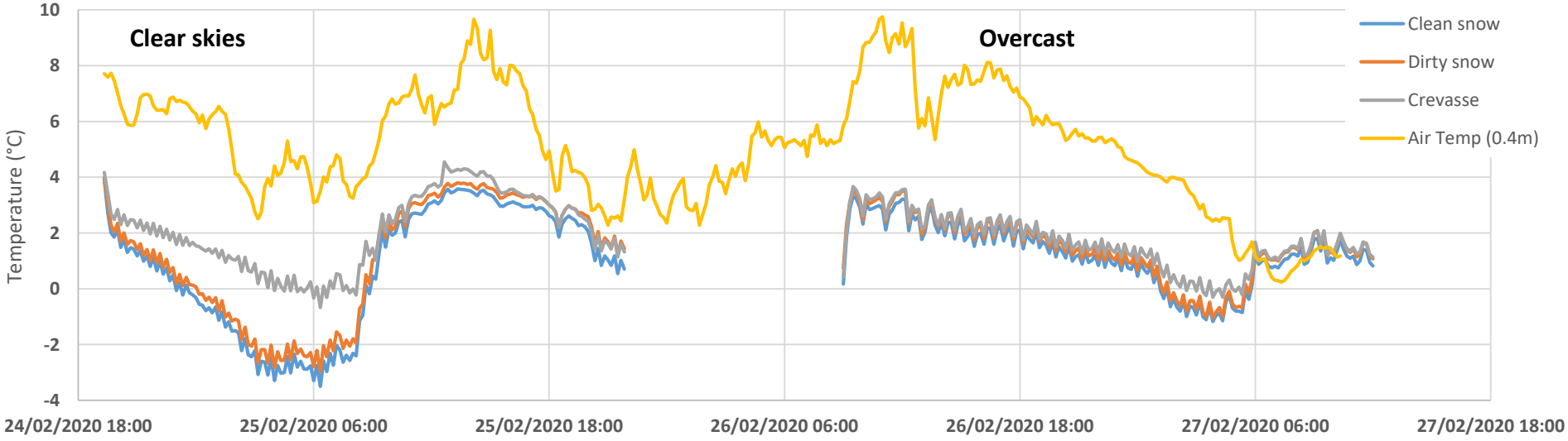

NetSW
T_1.6
T_0.4
Cr0.5
Cr2.0
Cr4.0
Cr6
Cr8.0
Cr10.0
Cr12.0
0.73 0.76 0.78 0.80 0.65 0.38 0.26 0.13
0.99 0.87 0.83 0.73 0.50 0.32 0.20
0.85 0.82 0.73 0.51 0.32 0.18
0.97 0.82 0.61 0.53 0.44 0.39
0.88 0.68 0.61 0.51 0.43
0.86 0.73 0.59 0.44
0.94 0.83 0.66
0.96 0.85
0.93
Temperature (°C)
Radiation (W m-2)
Temperature (°C)

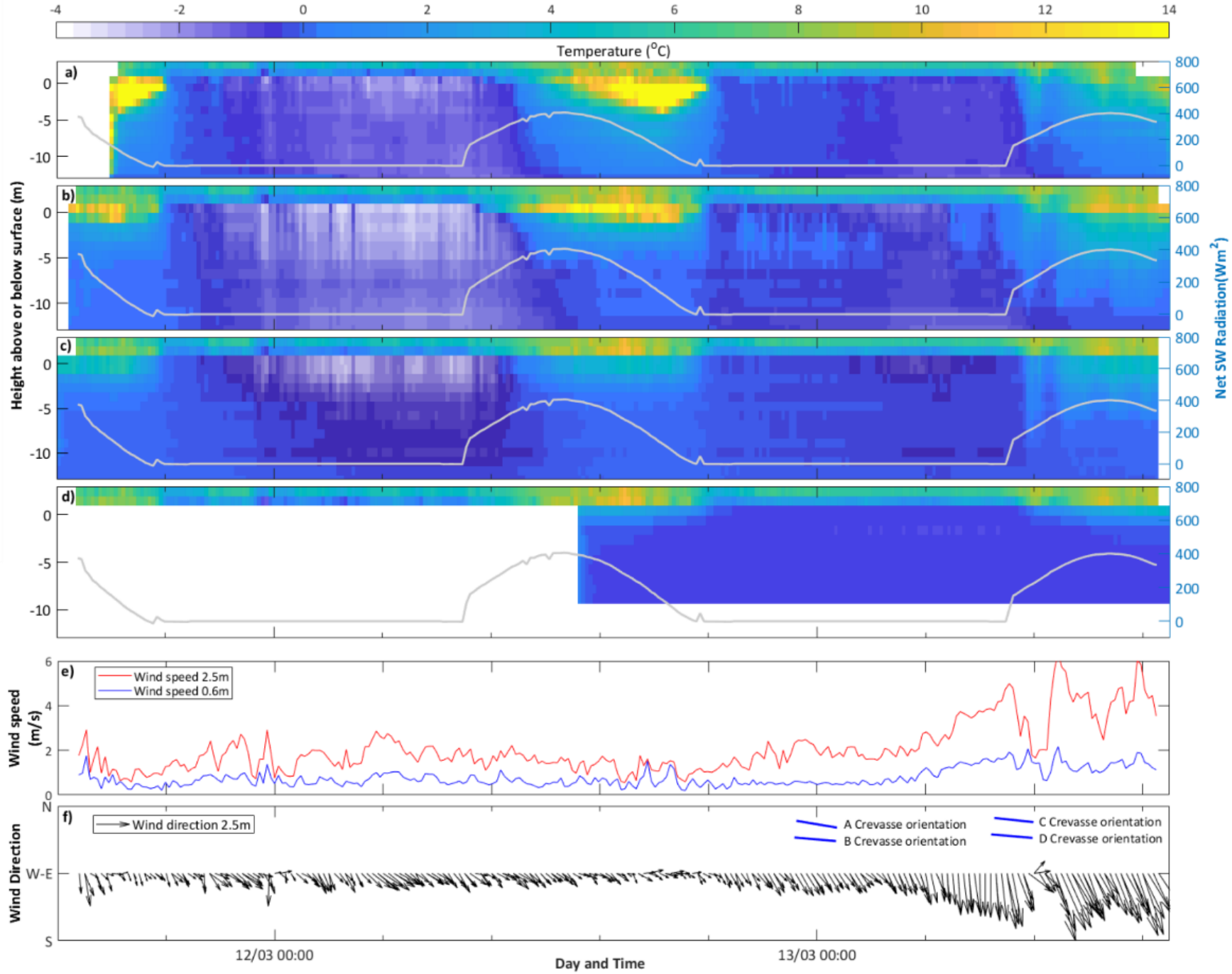

a)
Cr1
Cr2
Cr3
Cr6
Cr9
Cr12
N
S
W
E
WS_1.7
Temperature (C)

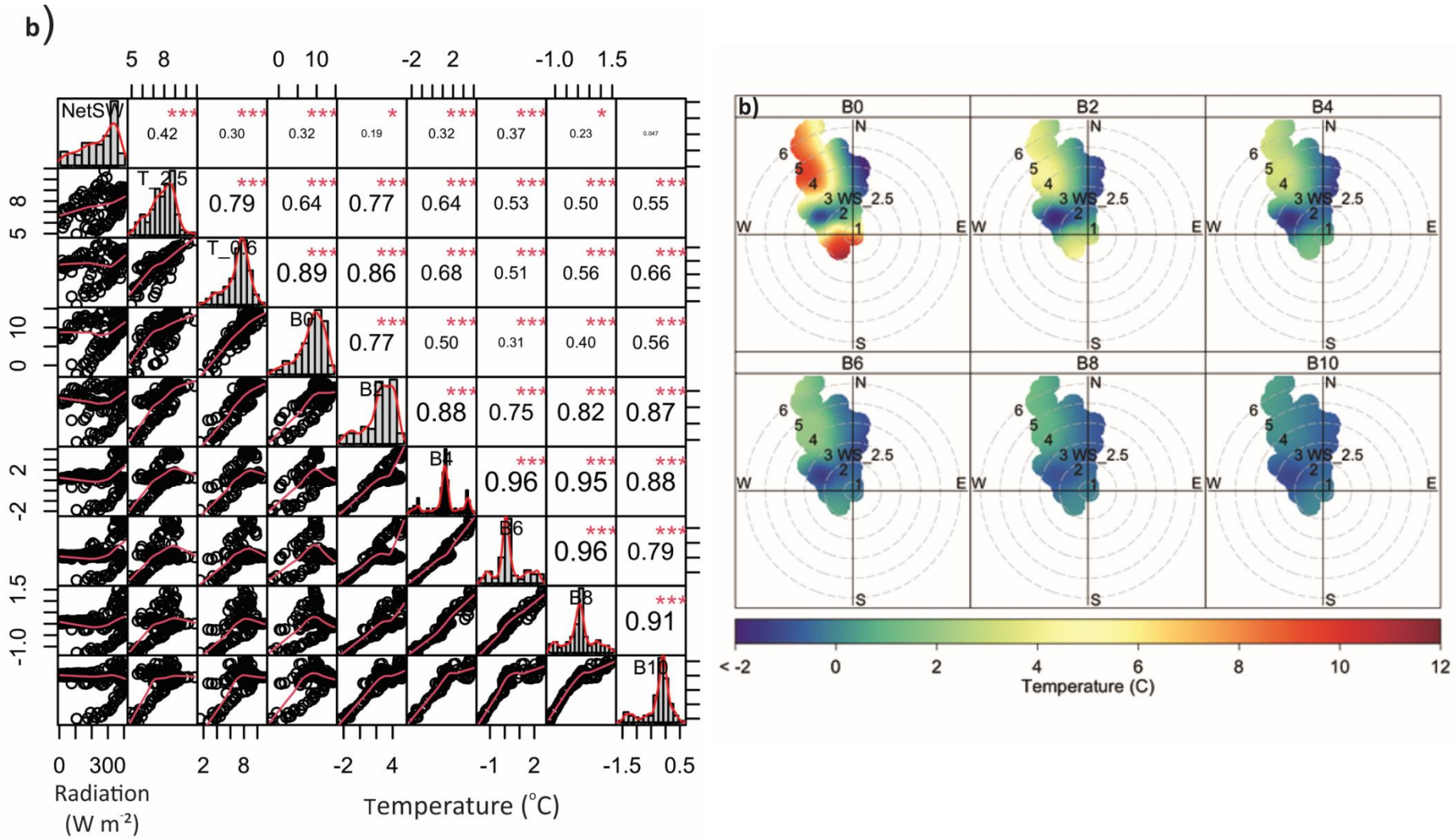

a)
Wind direction 1.7m
Wind Direction
N
W-E
S
0
1
2
3
4
5
6
7
Temperature (°C)
b)
Wind speed 1.7m
Wind speed 0.4 m
Wind speed -2.5 m
Wind speed -10.25
Depth (m)
Wind speed (m s-1)
2
0
-2
-4
-6
-8
-10
-12
5
4
3
2
1
0
25/02 20:24
25/02 21:36
25/02 22:48
26/02 00:00
26/02 01:12
26/02 02:24
26/02 03:36
26/02 04:48
26/02 06:00
Day and Time






Clear skies
Overcast
Clean snow
Dirty snow
Crevasse
Air Temp (0.4m)
Temperature (°C)
10
8
6
4
2
0
-2
-4
24/02/2020 18:00
25/02/2020 06:00
25/02/2020 18:00
26/02/2020 06:00
26/02/2020 18:00
27/02/2020 06:00
27/02/2020 18:00


Temperature (°C)
-4
-2
0
2
4
6
8
10
12
14
a)
b)
c)
d)
Height above or below surface (m)
Net SW Radiation(Wm^2)
e)
Wind speed 2.5m
Wind speed 0.6m
Wind speed (m/s)
f)
Wind direction 2.5m
A Crevasse orientation
B Crevasse orientation
C Crevasse orientation
D Crevasse orientation
Wind Direction
N
W-E
S
12/03 00:00
13/03 00:00
Day and Time


b)
NetSW
T_2.5
T_0.6
B0
B2
B4
B6
B8
B10
0.42
0.30
0.32
0.19
0.32
0.37
0.23
0.79
0.64
0.77
0.64
0.53
0.50
0.55
0.89
0.86
0.68
0.51
0.56
0.66
0.77
0.50
0.31
0.40
0.56
0.88
0.75
0.82
0.87
0.96
0.95
0.88
0.96
0.79
0.91
Radiation
(W m-2)
Temperature (°C)
b)
N
S
E
W
WS_2.5
< -2
Temperature (C)

Conclusions:

- Air temperature inside the crevasses was mostly positive and sometimes exceed surface air temperature.
- Greatest warming in widest crevasses during clear-sky conditions, but full depth warming also occurred at night.
- Net shortwave radiation heats air in the upper regions of crevasses, but turbulent sensible heat transfer most effective at depth.
- Crevasses orientated for maximum radiation retrieval & parallel to dominant wind, have the greatest potential heat storage.
- Positive feedback loop in energy balance system.

Acknowledgements

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