Surface prediction modelling, the effect of a changing snow layer on the thermal balance

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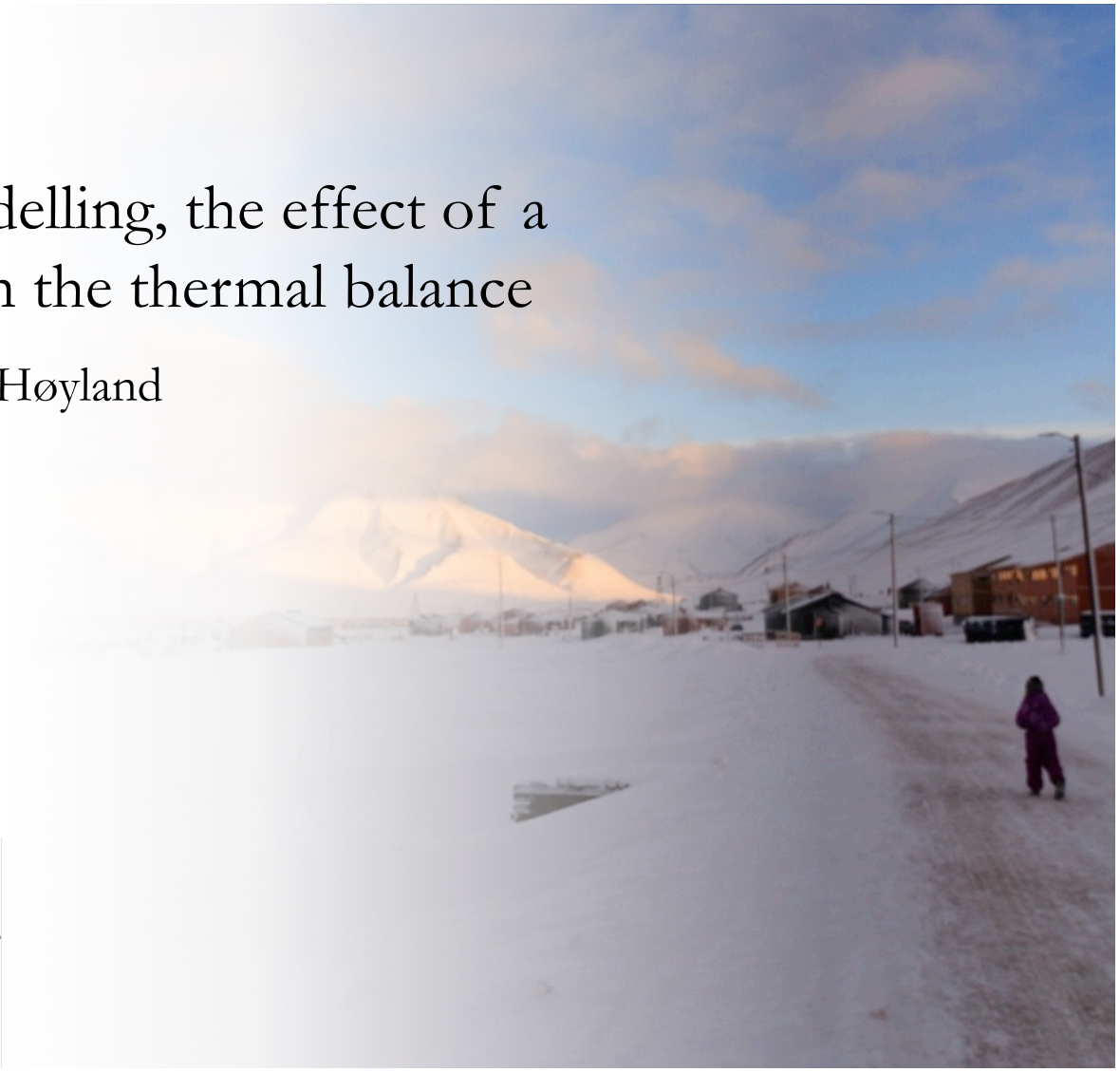

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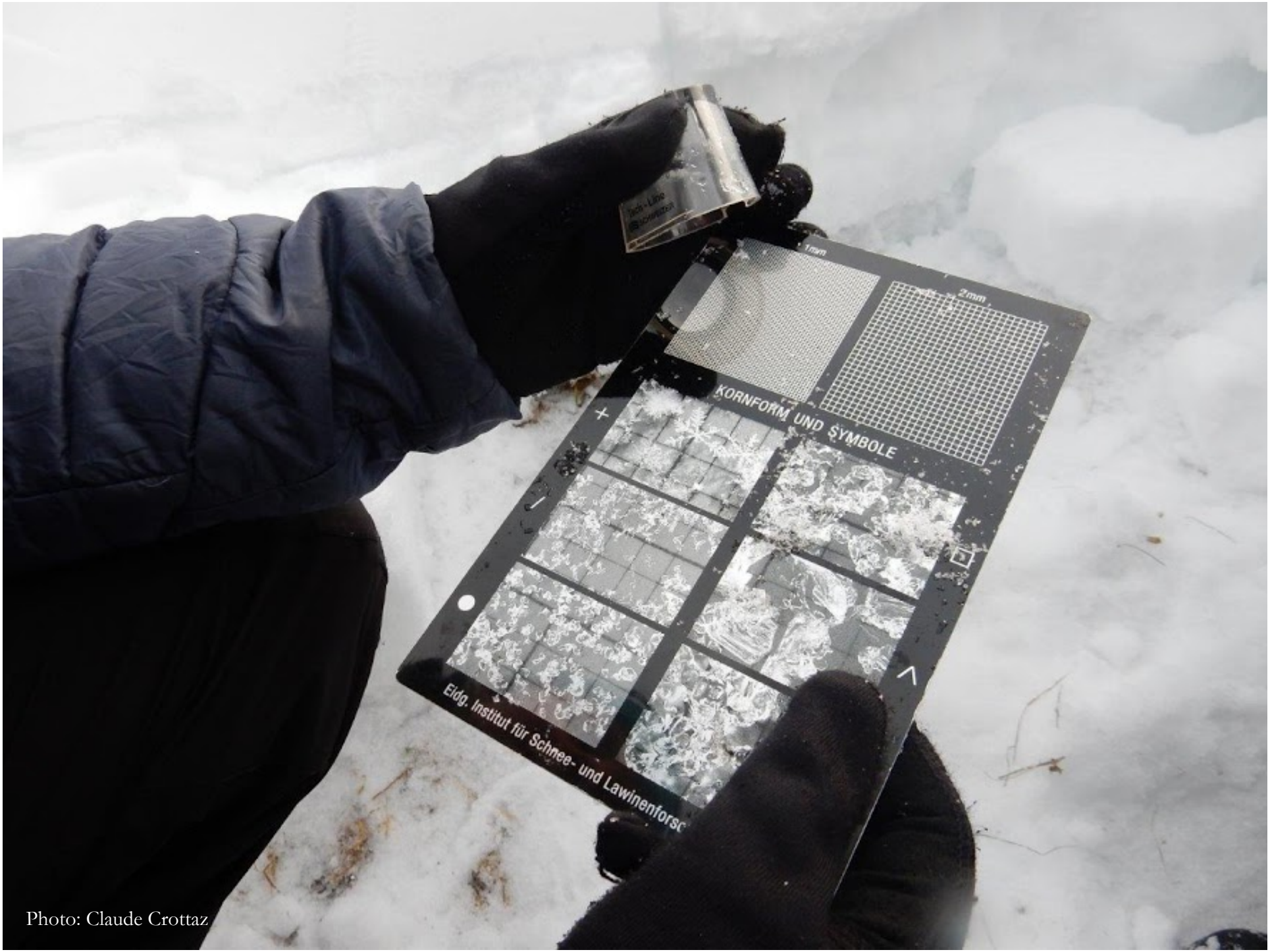


Photo: Claude Crottaz

Snow properties

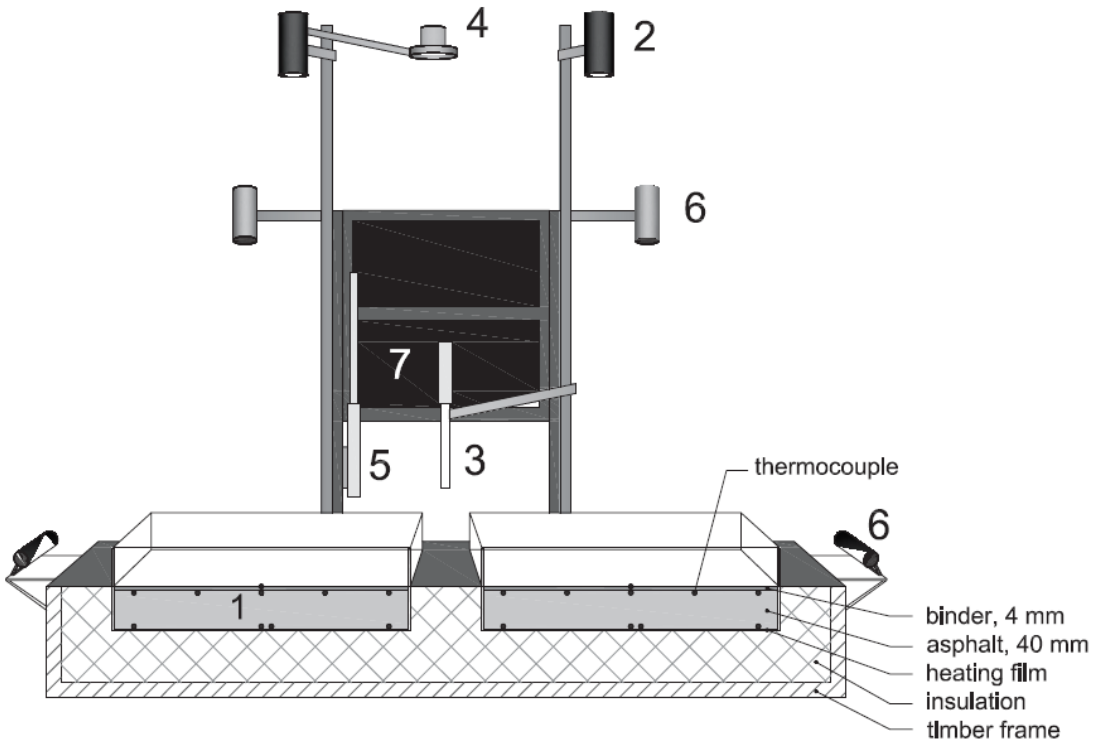
$\rho = 50 – 100$ kg/m³

$k = 0.05 - 0.25$ W/m·K

$\rho = 999.8$ kg/m³

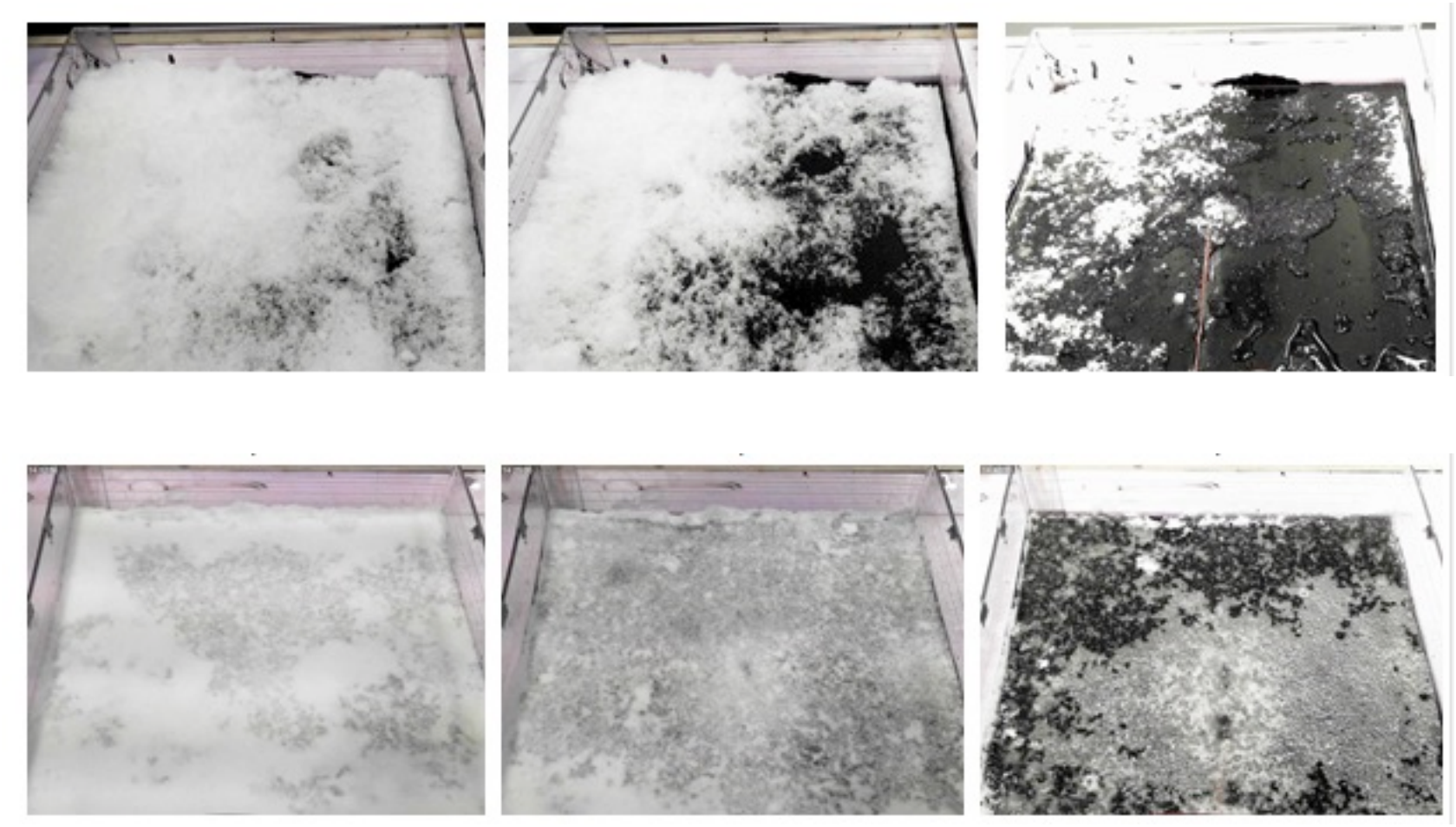
$k = 0.58$ W/m·K

Experimental setup



Nr.	Measured data
1	Slab temperature
2	Surface temperature
3	Air temperature and relative humidity
4	Incoming longwave radiation
5	Wind speed and logger
6	Photos
7	Data logger temperatures, RH and LW radiation
8	Data logger Watt and temperature heating films

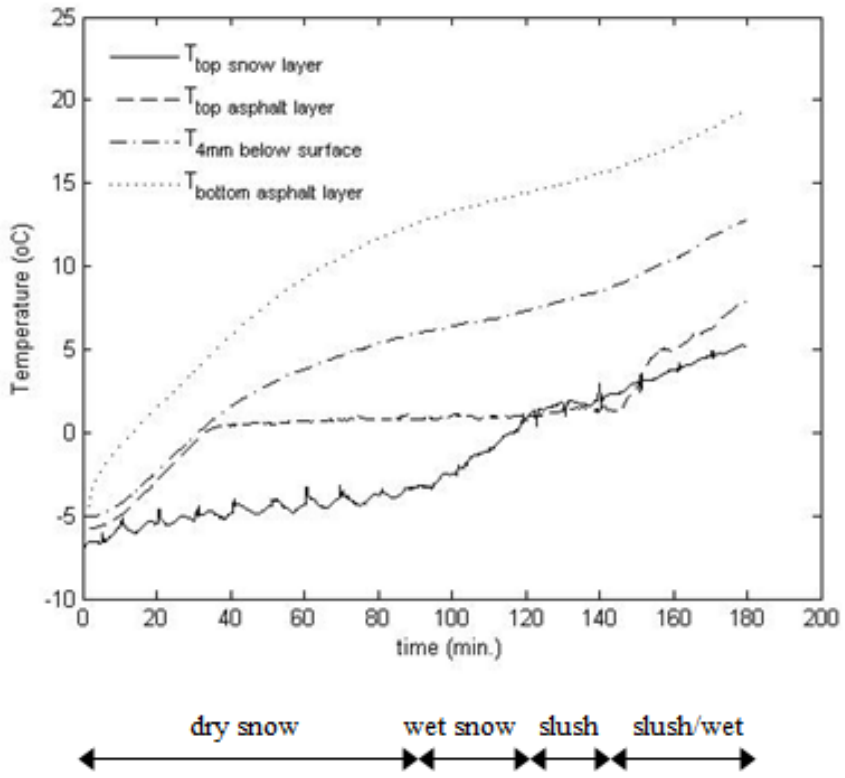
Uncompressed and compressed snow



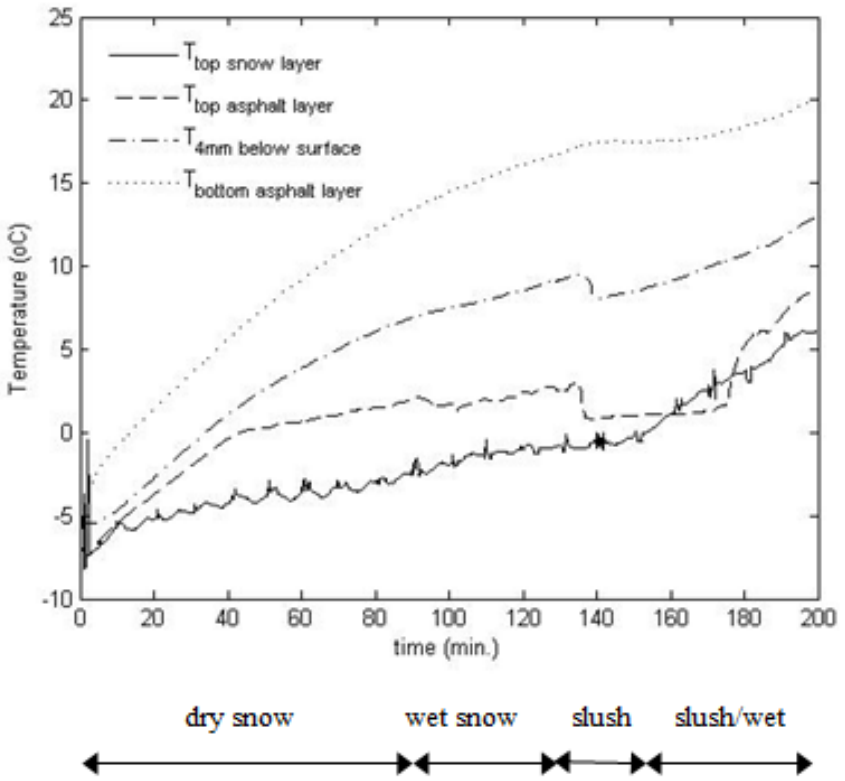
Snow melting process

Temperatures

Uncompressed



Compressed



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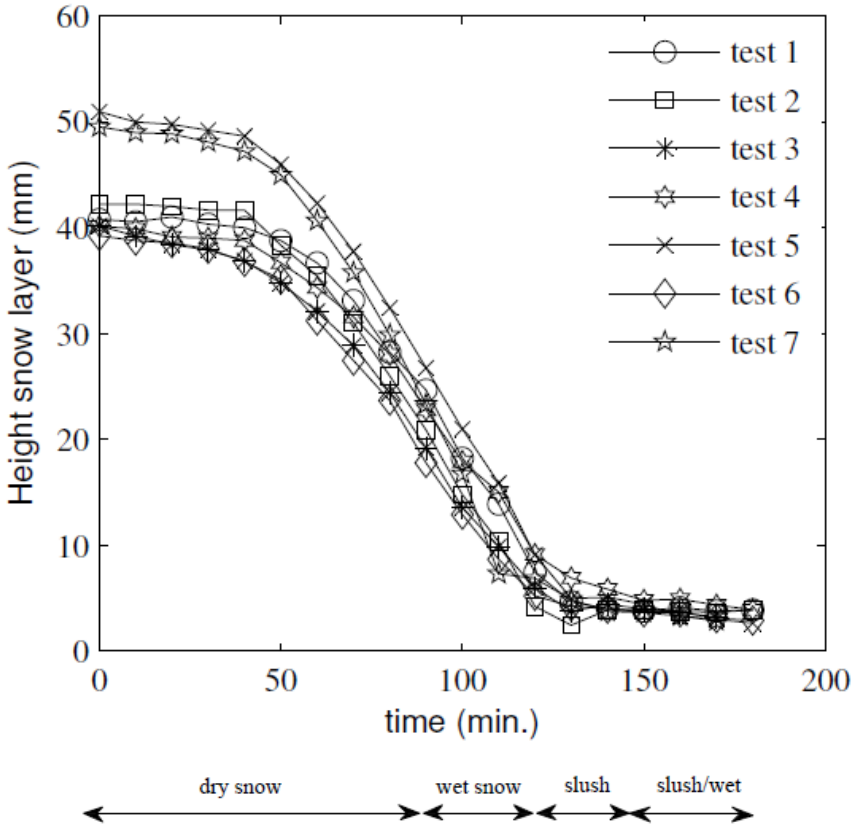
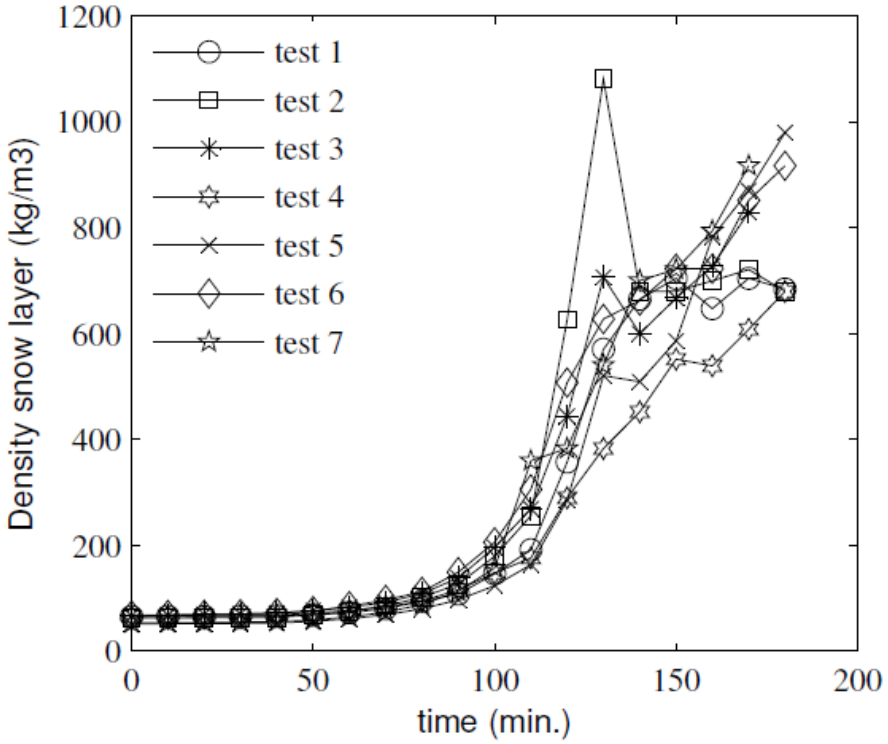
Height and density change





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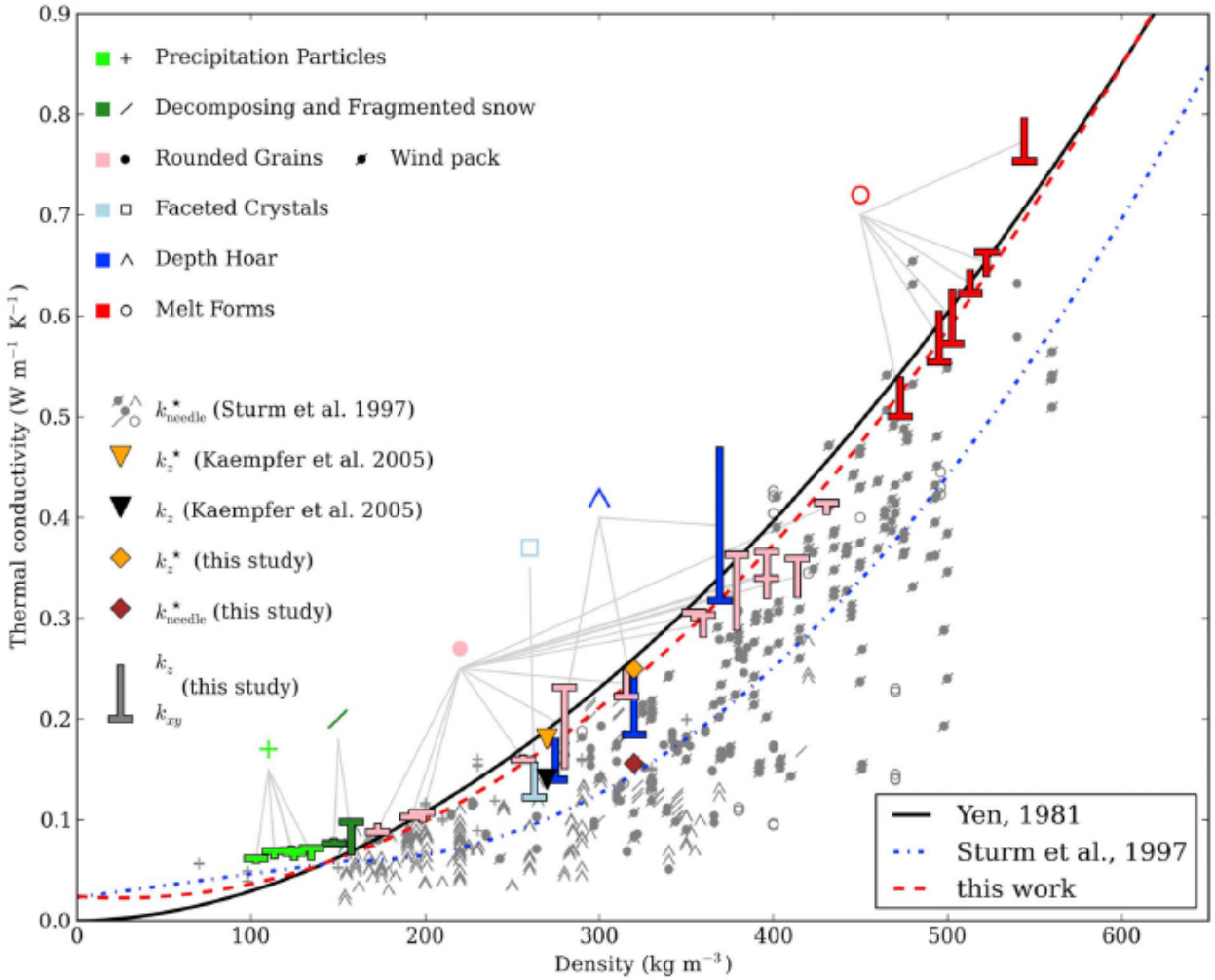
Thermal conductivity

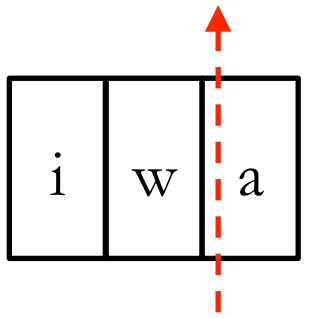


N. Calonne, F. Flin, S. Morin, B. Lesaffre, S. Rolland du Roscoat, C. Geingreau, Numerical and experimental investigations of the effective thermal conductivity of snow. Geophys. Res. Lett., **38** (2011)

Thermal conductivity

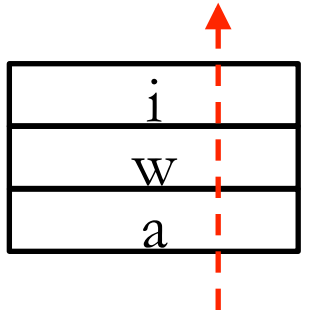
Parallel system

$$\lambda_s = \lambda_i \cdot \theta_i + \lambda_w \cdot \theta_w + \lambda_a \cdot \theta_a$$



Series system

$$\lambda_s = \frac{1}{\left(\frac{\theta_i}{\lambda_i} + \frac{\theta_w}{\lambda_w} + \frac{\theta_a}{\lambda_a}\right)}$$



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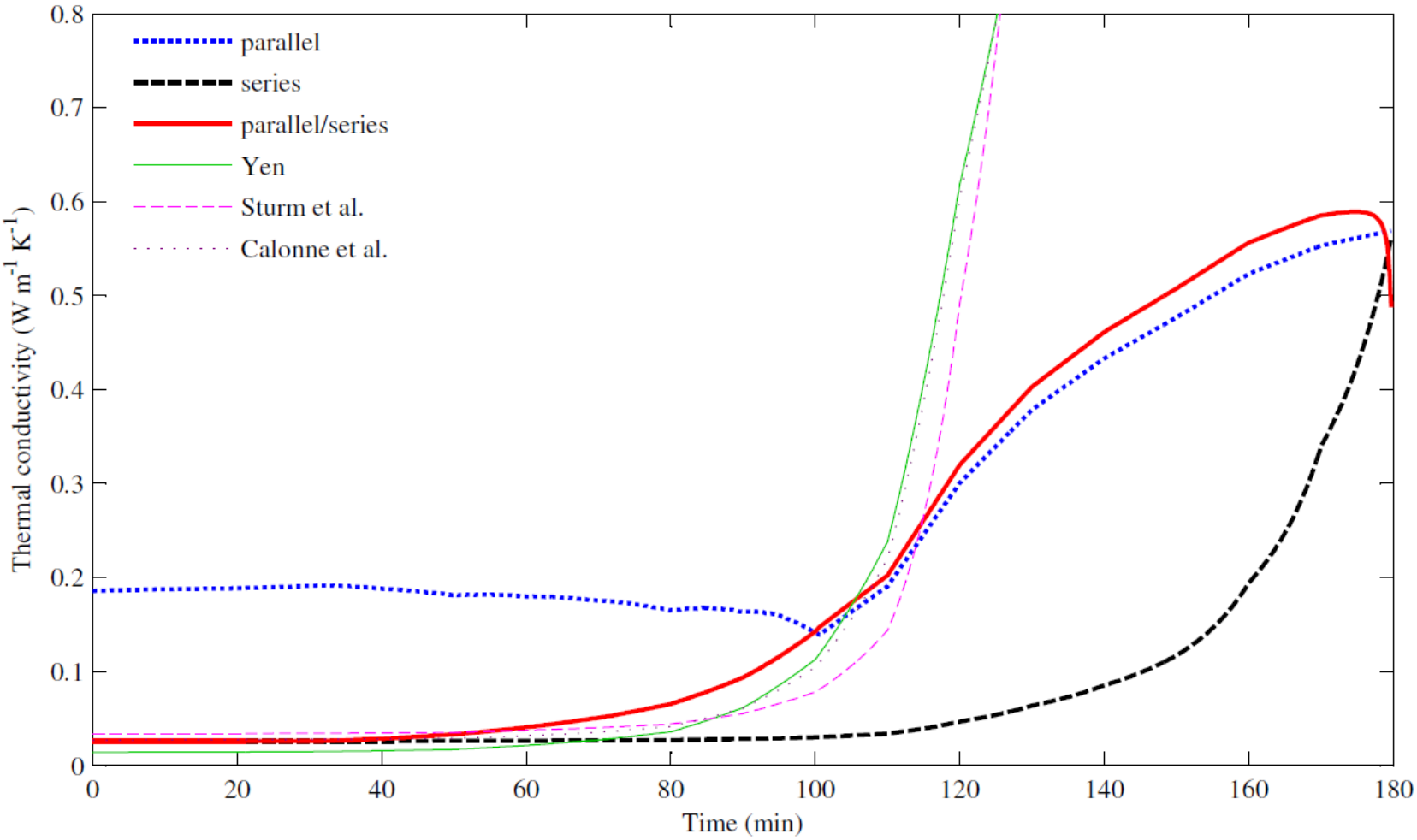
Thermal conductivity



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Effect of compression on the melting process

- Due to compression the density increases which gives a lower permeability and higher capilary forces.
- The snow can absorb the melt-water further into the snow so air gaps can form between the snow and pavement surface.
- Air gaps reduce the thermal conductivity significantly.
- The stronger snow would contribute to maintaining these air pockets.


Thank you