Improving surface condition forecasting using SNOWTAM data

Anne Nuijten

Statens vegvesen
Norwegian Public Roads Administration

AVINOR

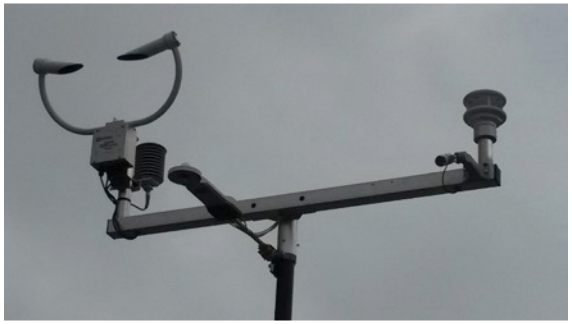
NTNU
Norwegian University of Science and Technology

SNOWTAM

- Clear & dry
- Damp
- Wet
- Rime or frost covered
- Dry snow
- Wet snow
- Slush
- Ice
- Compacted or rolled snow

Oslo Lufthavn/Liv-Runi Antonsen

1. Collection of runway and weather data

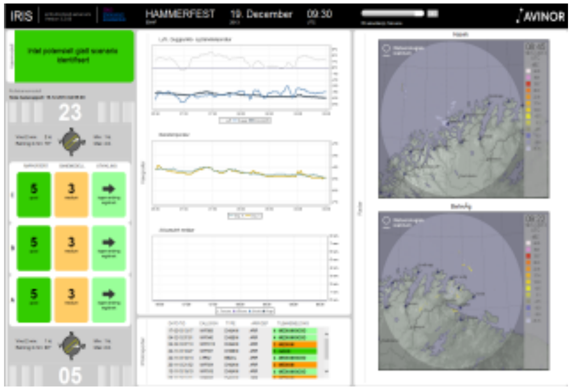


2. Prediction of the runway surface condition

- the weather model
- the runway model
- the development model

now-casting mode

3. Presentation of the results



NTNU

Surface condition prediction model

Meteorological data
- Air temperature
- Relative humidity
- Wind velocity
- Precipitation
- Shortwave radiation
- Cloud cover

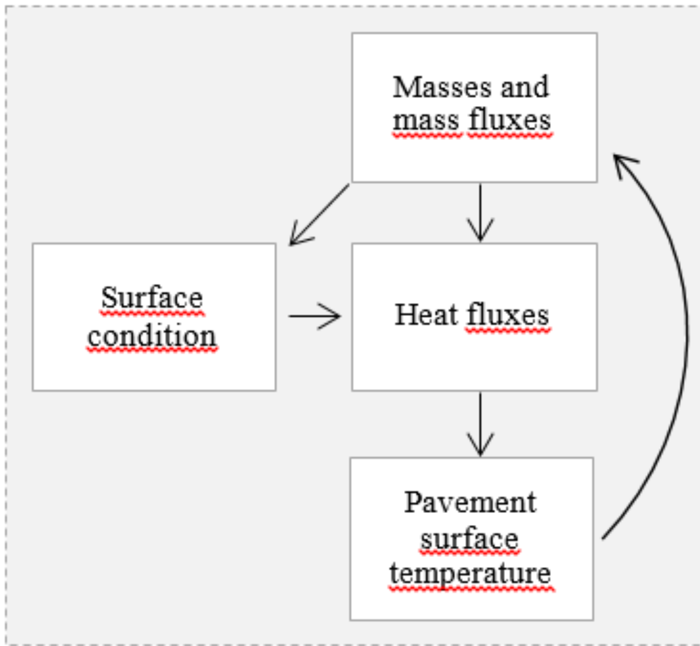
Pavement properties
- Dimensions
- Density
- Specific heat capacity
- Thermal conductivity

Traffic data
- Flight data
- Air traffic heat
- Turbulence

Observed surface condition

Chemicals

Surface and subsurface temperatures



Pavement surface temperature

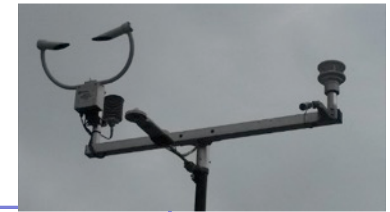
Surface condition

Mass fluxes

Water
- Rainfall
- Condensation and evaporization
- Melting
- Runoff

Ice
- Snowfall
- Sublimation and deposition
- Freezing
- Snow removal

Chemicals
- Application of chemicals
- Runoff of chemicals



RH, Ta, Tp

Freezing point

Winter maintenance measures

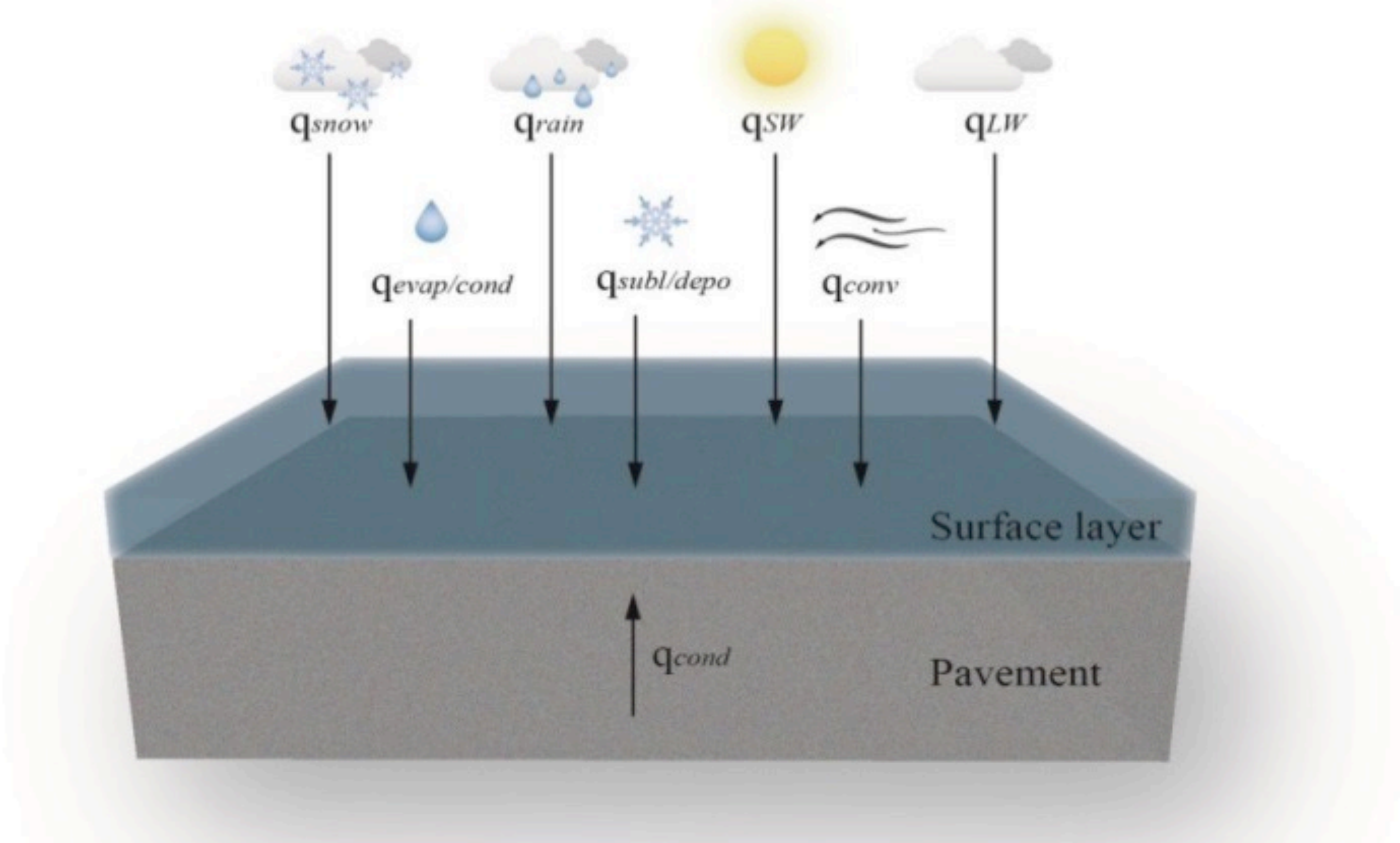
Surface conditions

Table 4. Liquid water content.

Term	*Remarks*	*Approximate Range of θ*	*Graphic Symbol*
Dry	Usually T is below 0°C, but dry snow can occur at any temperature up to 0°C. Disaggregated snow grains have little tendency to adhere to each other when pressed together, as in making a snowball.	0%	▭
Moist	T = 0°C. The water is not visible even at 10 × magnification. When lightly crushed, the snow has a distinct tendency to stick together.	< 3 %	◫
Wet	T = 0°C. The water can be recognized at 10 × magnification by its meniscus between adjacent snow grains, but water cannot be pressed out by moderately squeezing the snow in the hands. (Pendular regime)	3–8 %	▯▯
Very Wet	T = 0°C. The water can be pressed out by moderately squeezing the snow in the hands, but there is an appreciable amount of air confined within the pores. (Funicular regime)	8–15 %	▯▯▯
Slush	T = 0°C. The snow is flooded with water and contains a relatively small amount of air	> 15 %	▯▯▯▯

Colbeck, S., Akitaya, E., Armstrong, R., Gubler, H., Lafeuille, J., Lied, K., McClung, D., Morris, E., 1990. The International Classification for Seasonal Snow on the Ground. The International Commission on Snow and Ice of the International Association of Scientific Hydrology.

Heat fluxes



q_{snow}
q_{rain}
q_{SW}
q_{LW}
$q_{evap/cond}$
$q_{subl/depo}$
q_{conv}
Surface layer
q_{cond}
Pavement

The effect of air traffic

- B737-800
- Takeoff time, length and speed

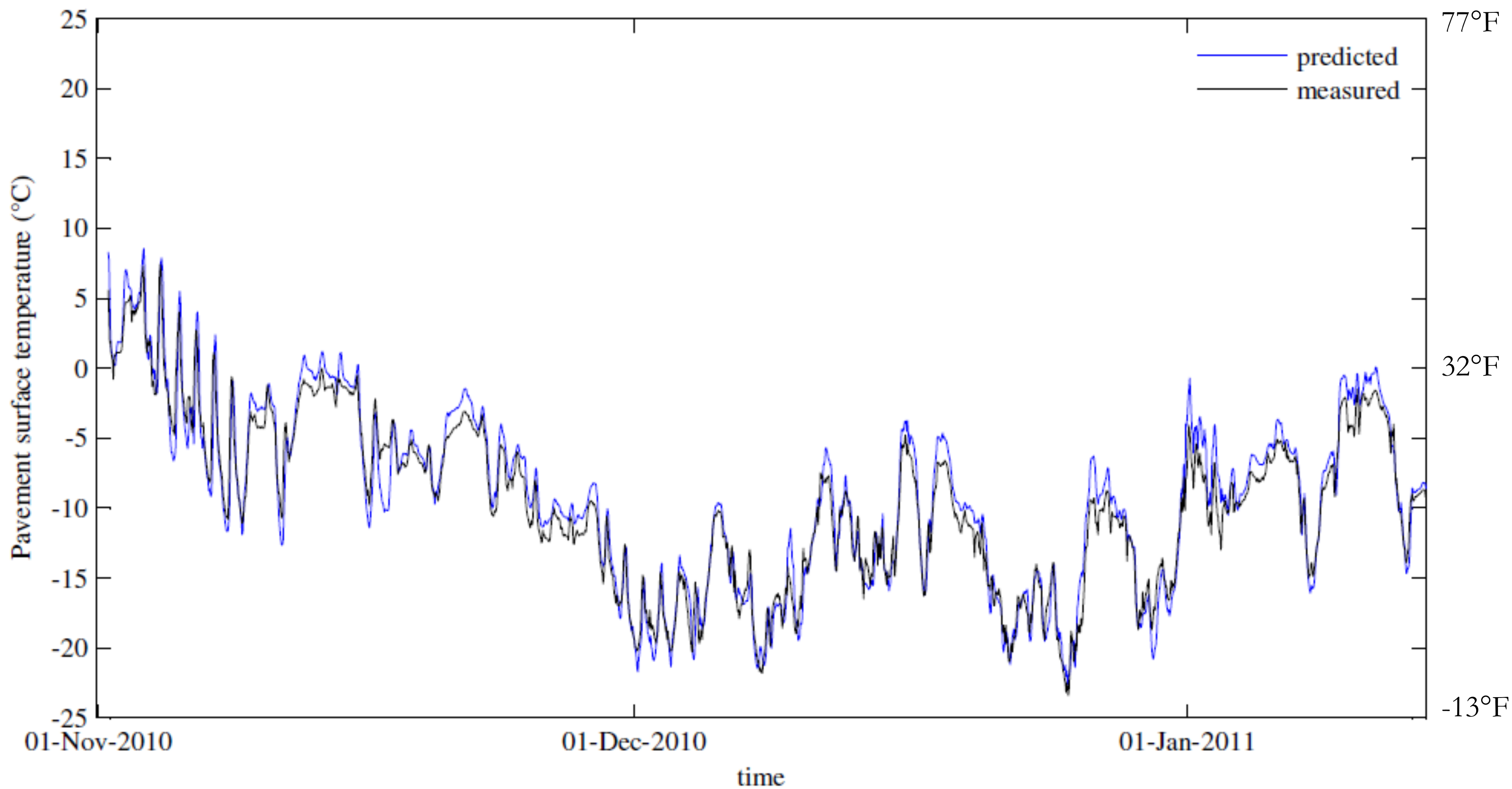
  t = 34 s, l = 1431 m, v = 77 m/s (172 mph)
- Increase in air temperature:

$$\Delta T_a = Q_{fuel} / V_a \cdot \rho_a \cdot c_{p\_a}$$

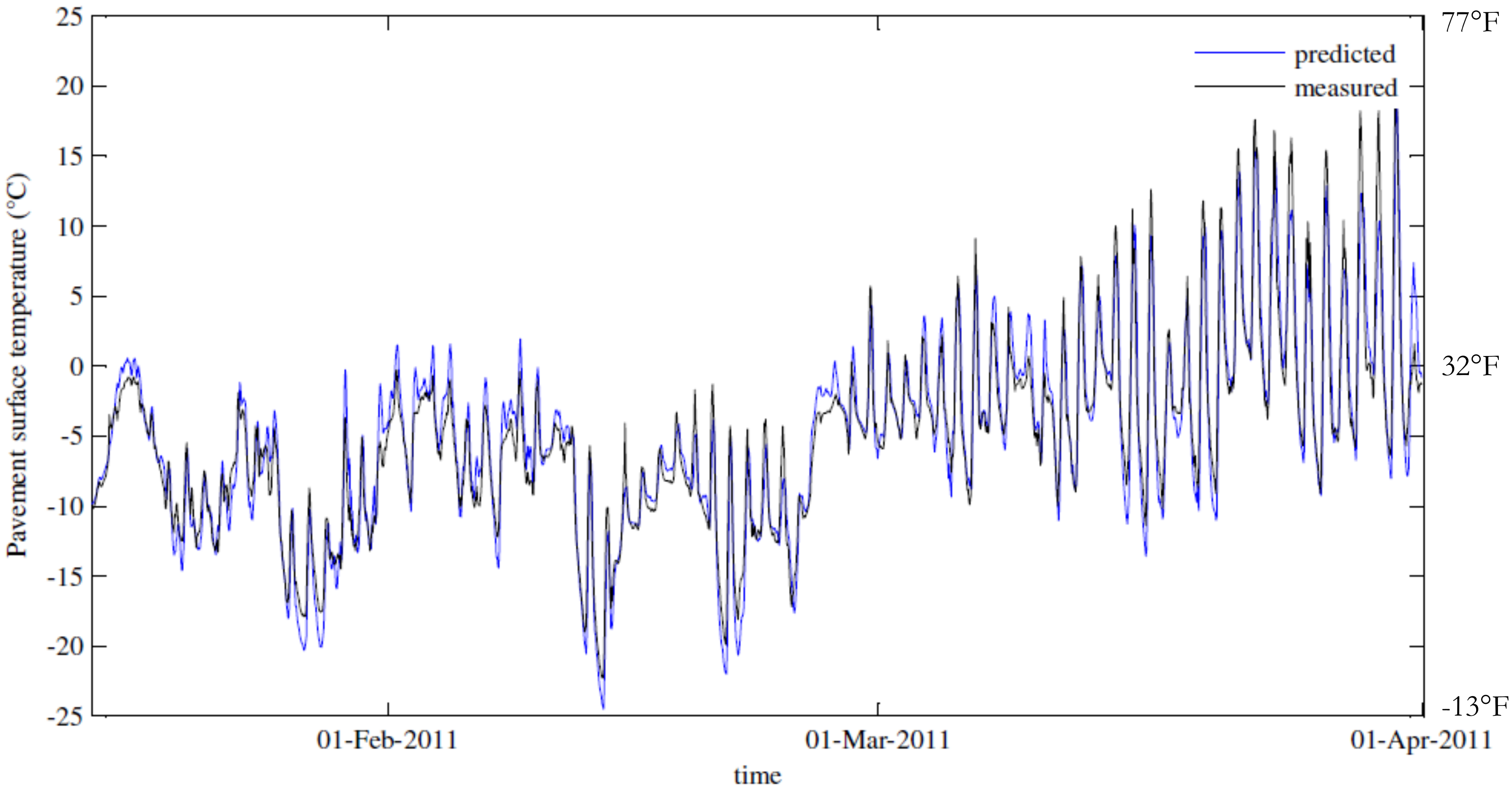
$$\Delta T_{a\ B737-800} = 5^{\circ}C$$

Case study – Oslo Gardermoen, Norway

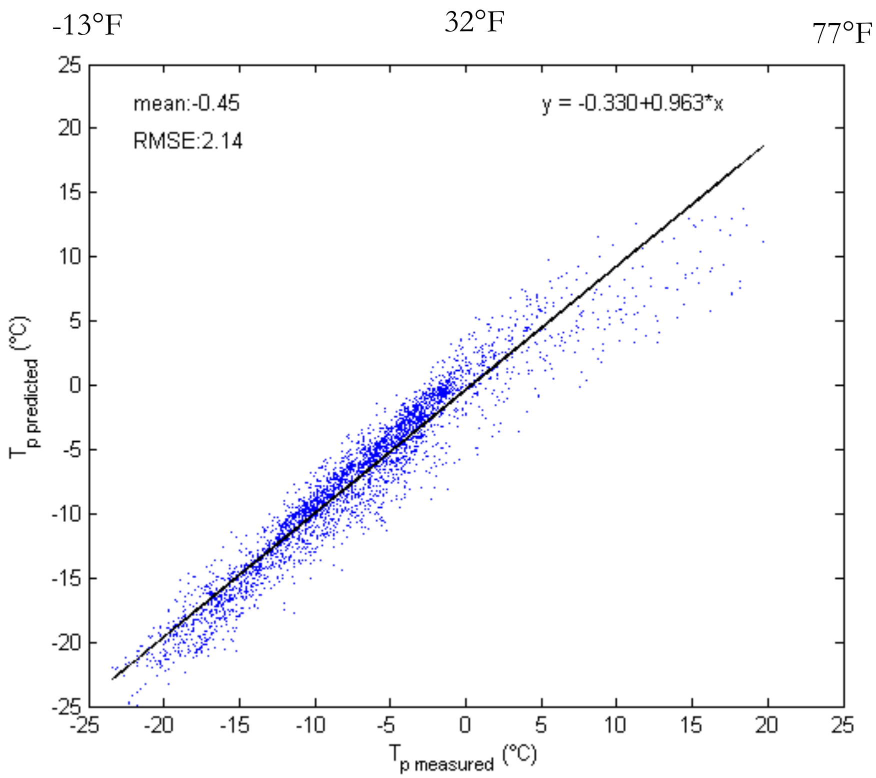
Predicted surface temperatures



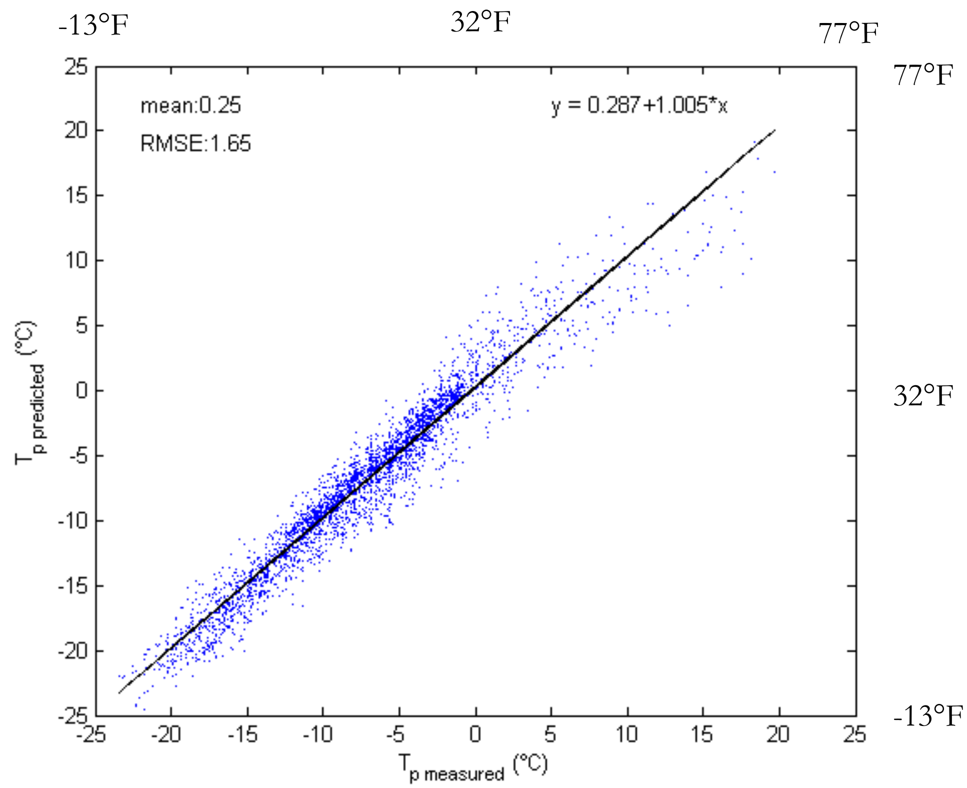
Predicted surface temperatures



Effect of using SNOWTAM data on the prediction error

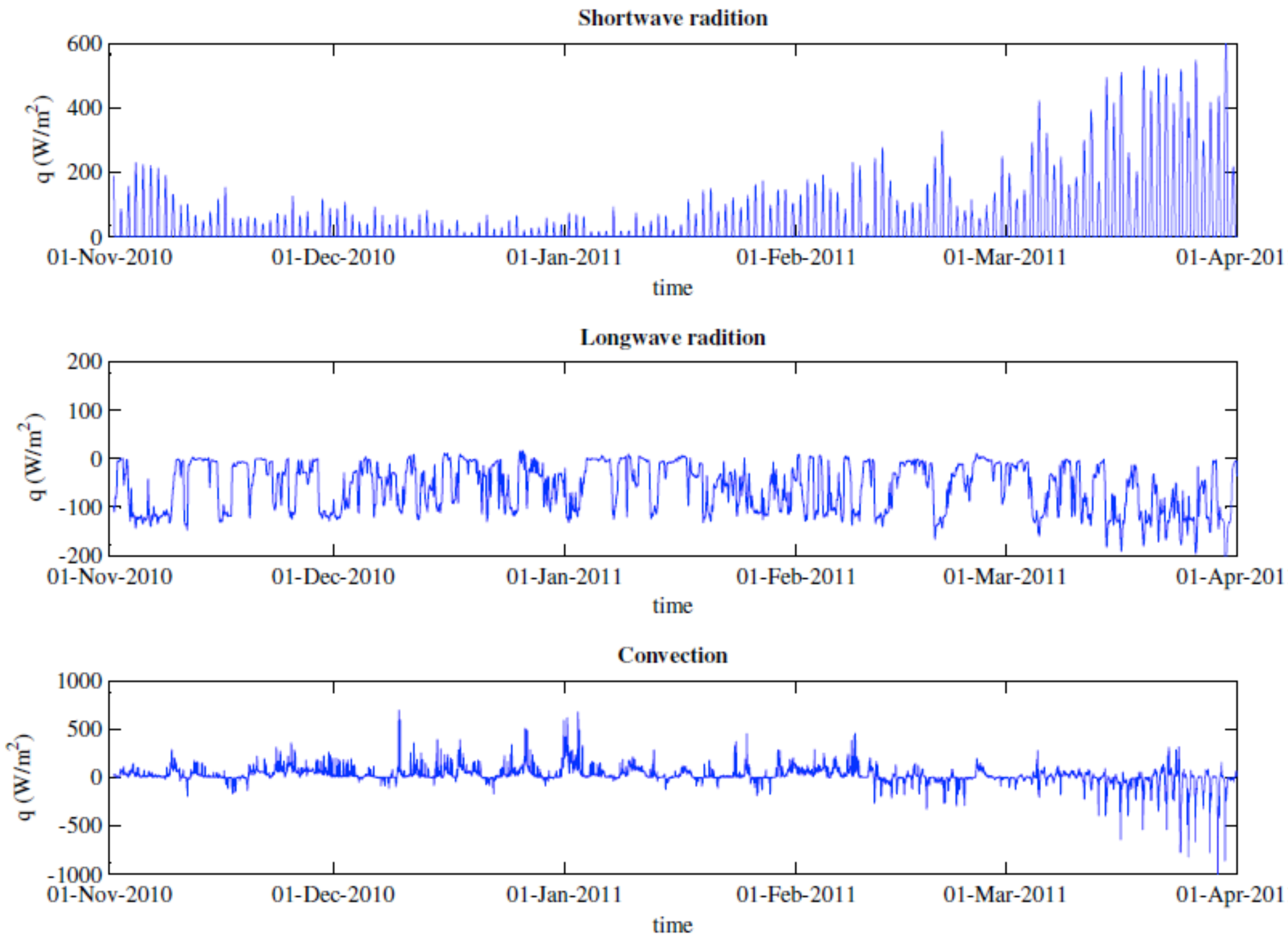


Predicted surface condition

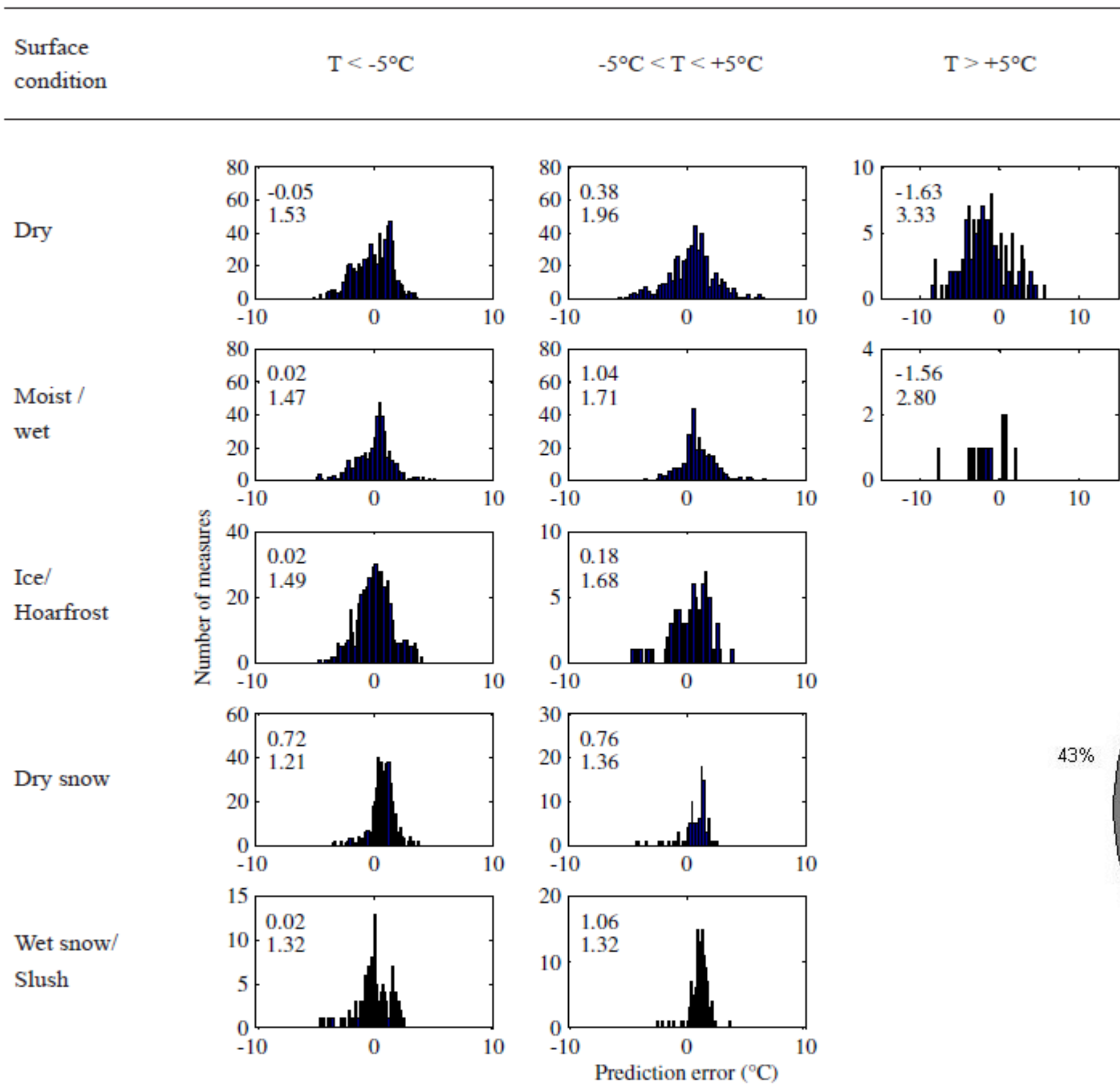


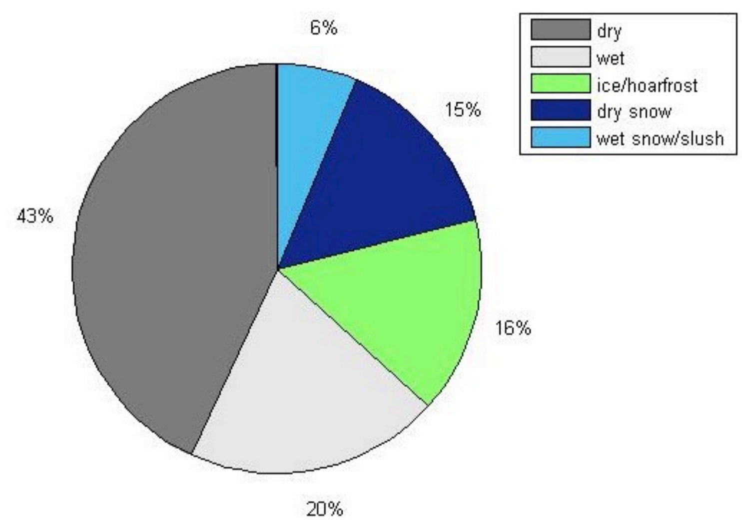
Observed surface condition (SNOWTAM)

Heat fluxes


Shortwave radition
q (W/m2)
600
400
200
0
01-Nov-2010
01-Dec-2010
01-Jan-2011
01-Feb-2011
01-Mar-2011
01-Apr-2011
time
Longwave radition
q (W/m2)
200
100
0
-100
-200
01-Nov-2010
01-Dec-2010
01-Jan-2011
01-Feb-2011
01-Mar-2011
01-Apr-2011
time
Convection
q (W/m2)
1000
500
0
-500
-1000
01-Nov-2010
01-Dec-2010
01-Jan-2011
01-Feb-2011
01-Mar-2011
01-Apr-2011
time

Prediction error





Conclusions

- Using observed surface conditions (SNOWTAM data) increases the accuracy of the predicted surface temperature with 23% for a prediction three hour ahead of time and 12% for the long term prediction.
- The prediction error is lowest for dry snow and wet snow/slush conditions, while mean errors for dry snow are relatively high


Thank you