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FMI's road weather model

Road Weather Event Week

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10 December 2019



Contents

1. Introduction
2. FMI Road weather model
3. What can go wrong?
4. Grid or point?
5. Incoming feature: probability forecast
6. Summary



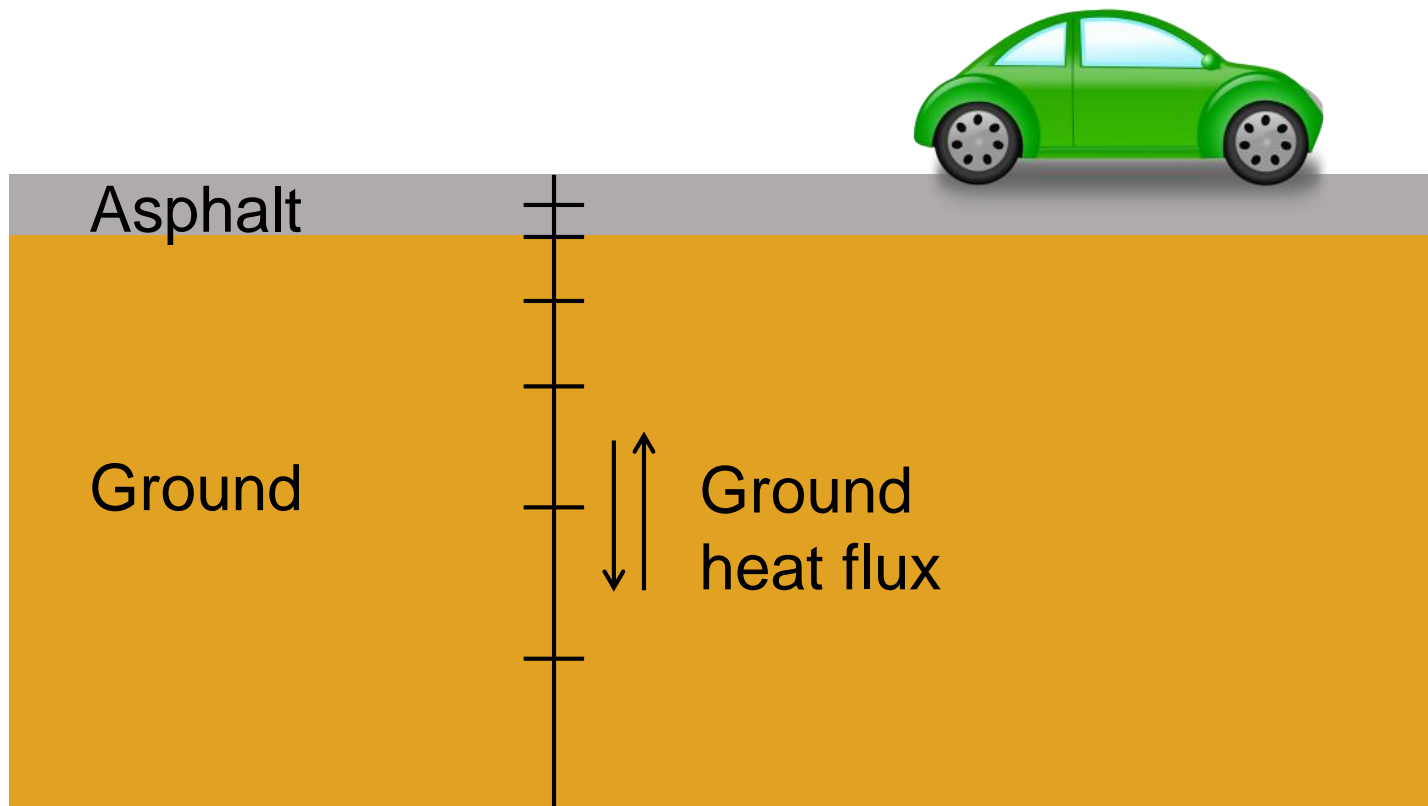
1. Introduction

- Road surface temperature modeling activities initiated already in 1979 in FMI
- Road weather model (RWM) of that time was in operational use during the early 1980s
 - Later discontinued
- The current operational RWM in FMI developed in the late 1990s
 - Operational since 2000
- Continuous development
 - Pedestrian model
 - Friction
 - Probability forecasts (incoming)



2. FMI Road weather model

- One dimensional heat balance model

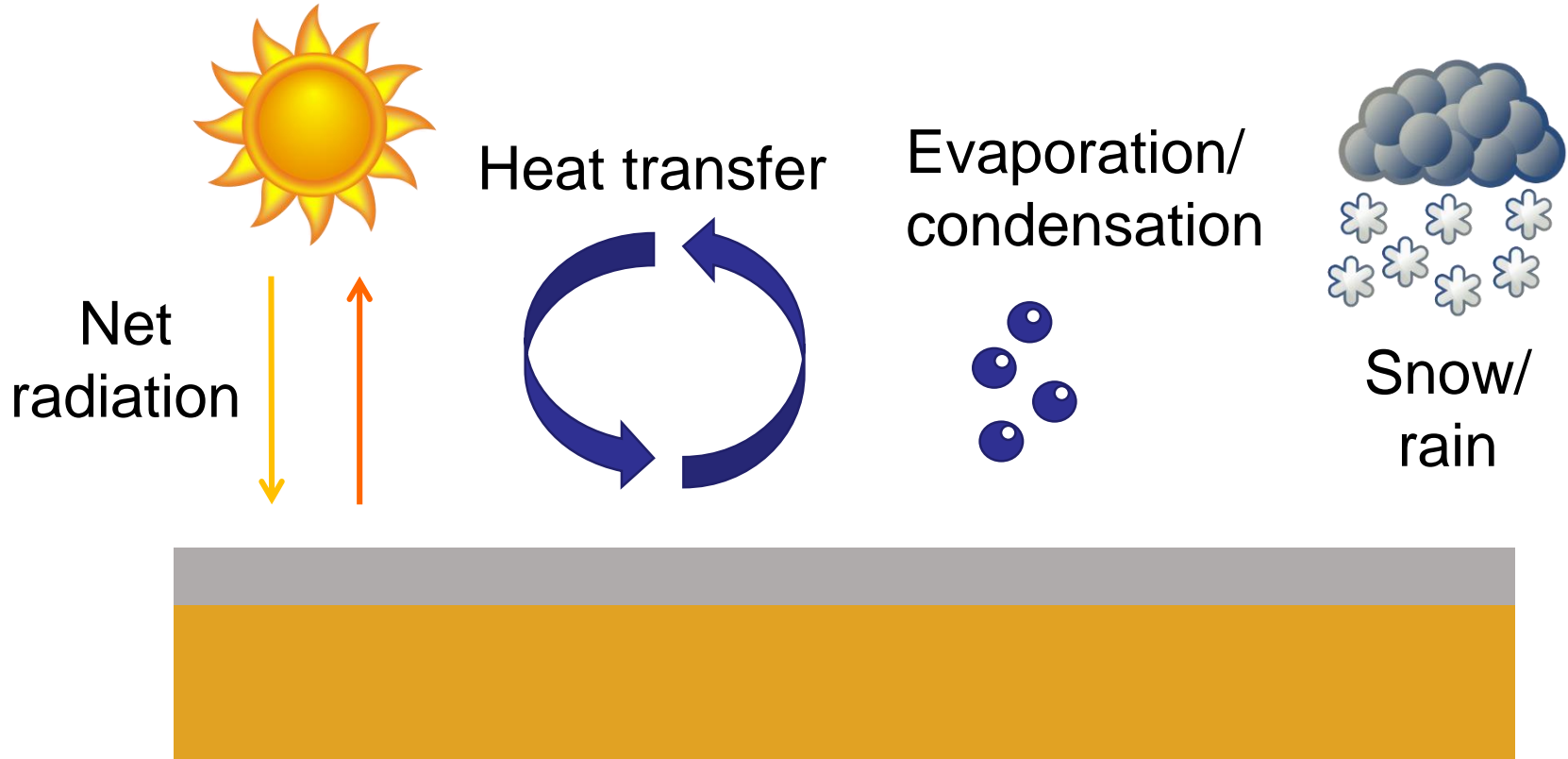


Model input:

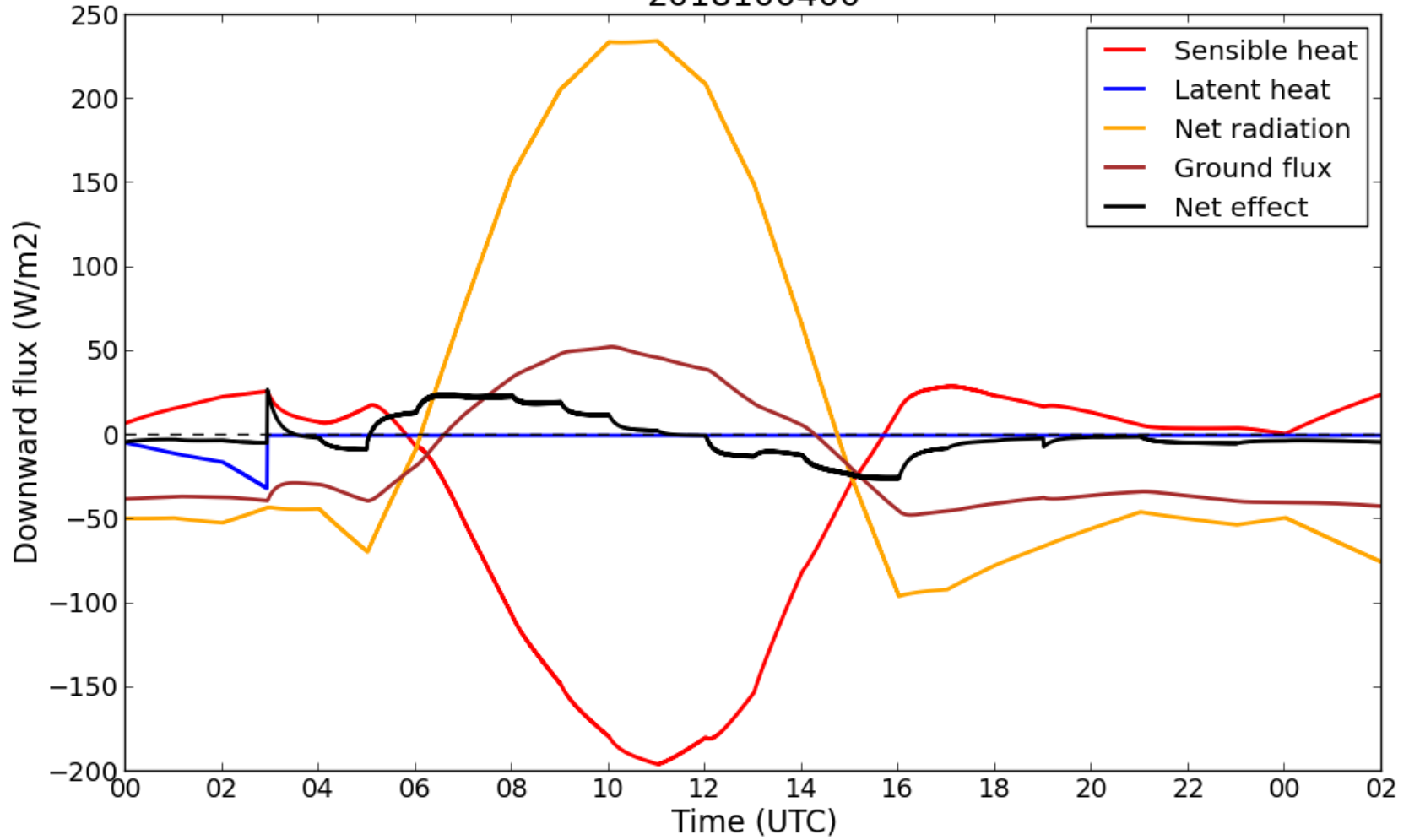
- Air temperature
- Humidity
- Wind speed
- Precipitation
- Short & long wave radiation

Optional:

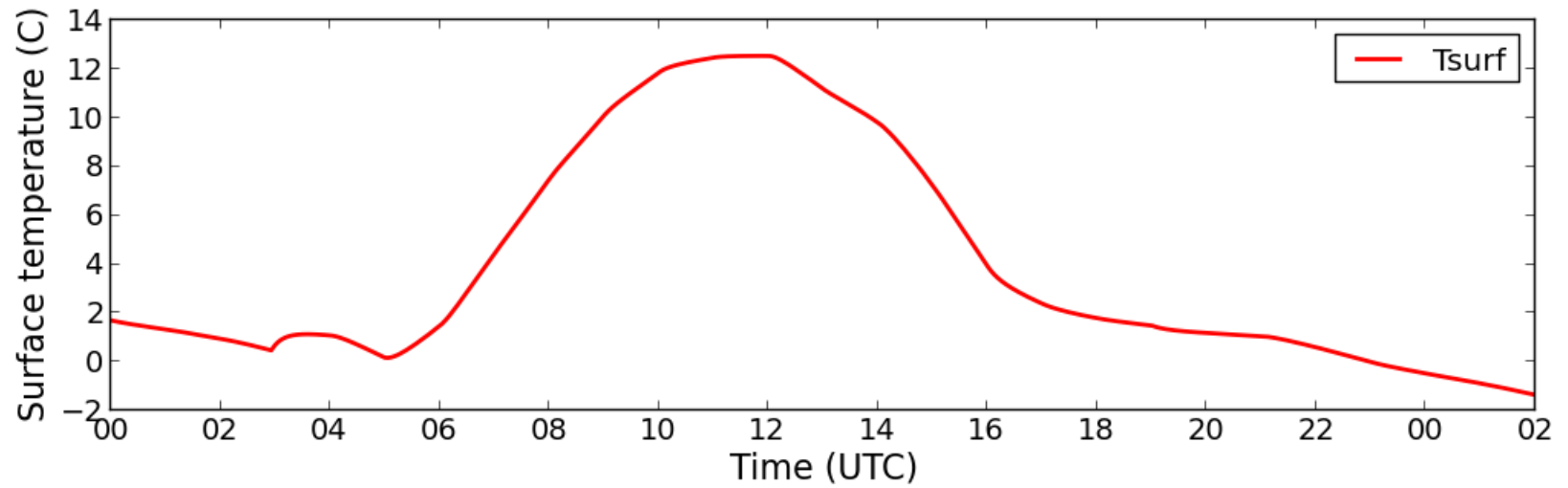
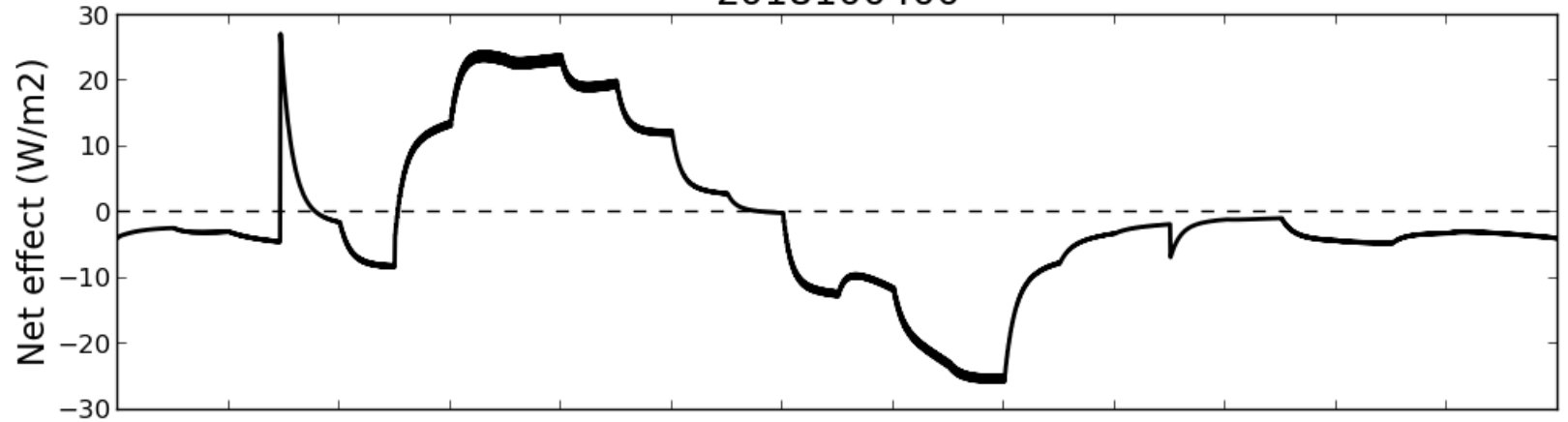
- Precipitation Phase
- Surface temperature observations



2018100400



2018100400



Example with constant cooling effect

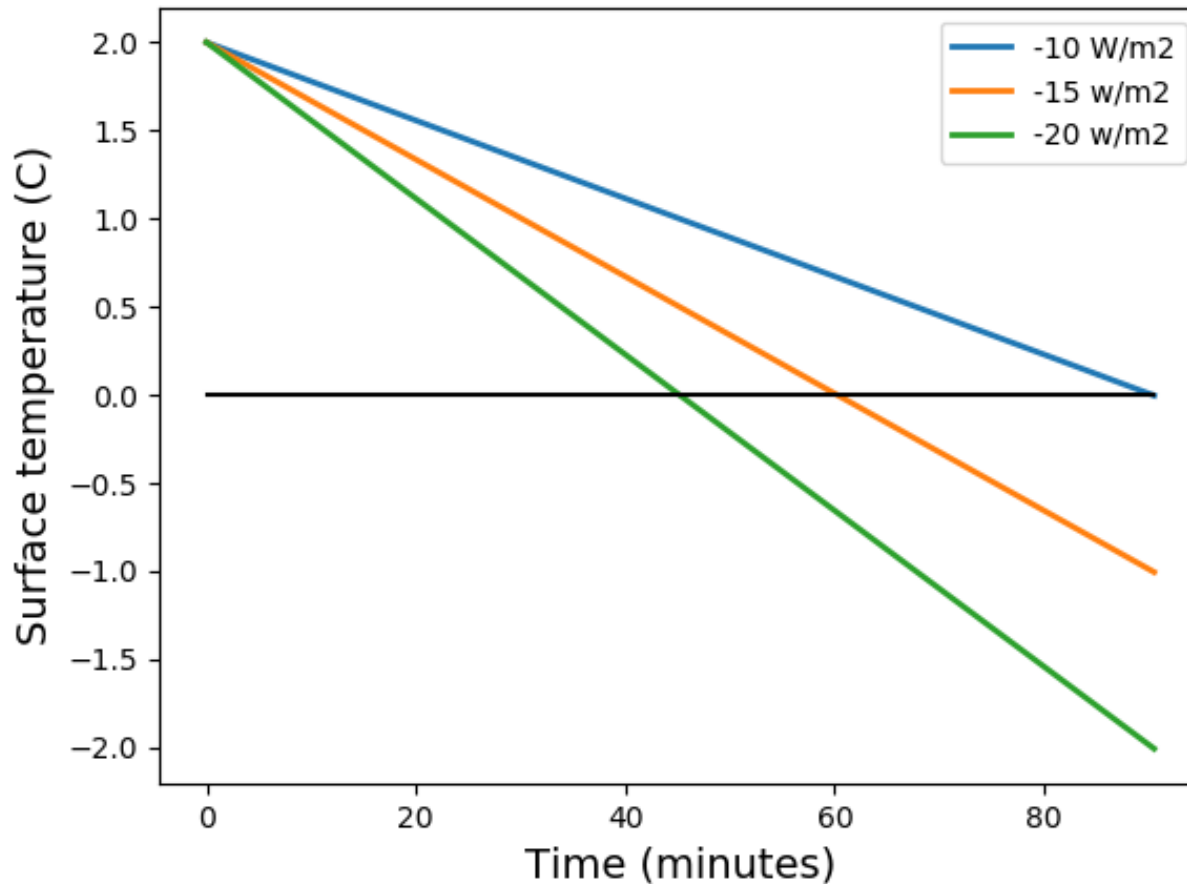
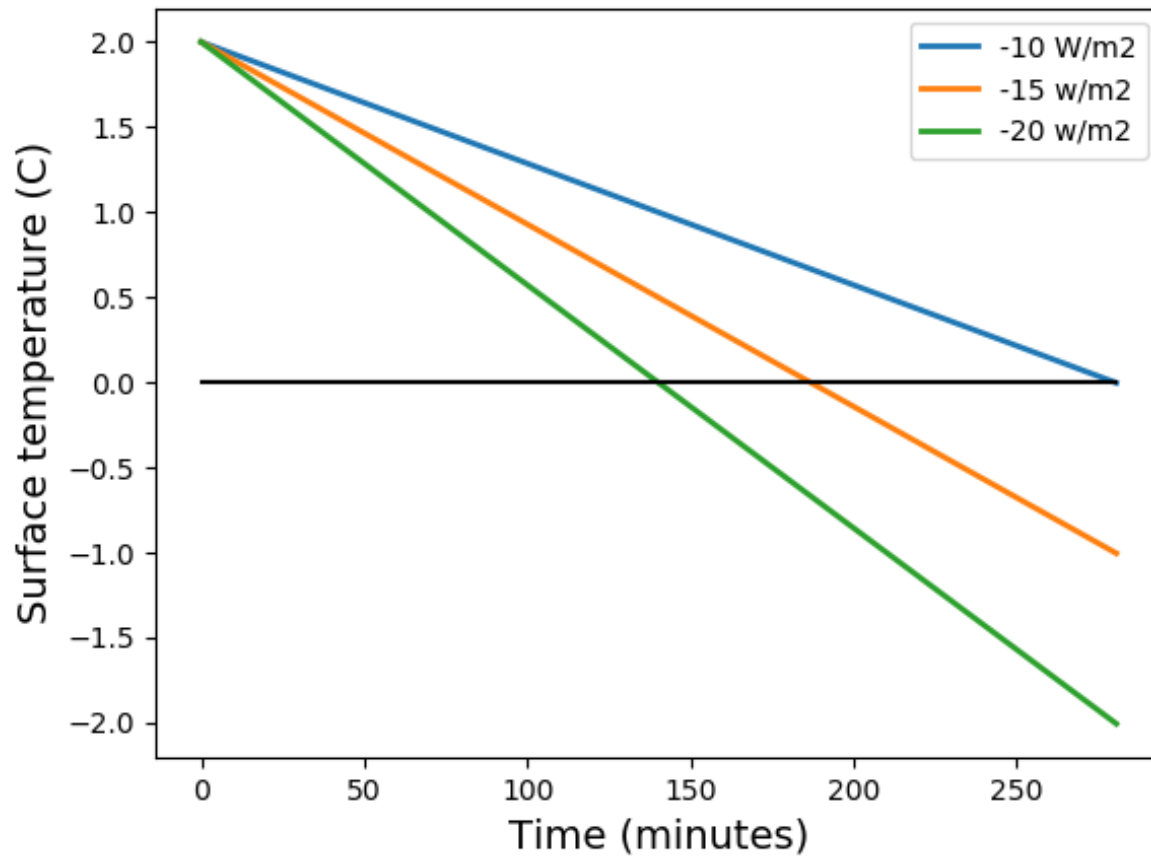


Figure shows temperature of the uppermost layer (1.5 cm), the output temperature is average of the first two layers (1.5 cm + 3.25 cm)





Same for 4.75 cm layer (1.5 cm + 3.25 cm)

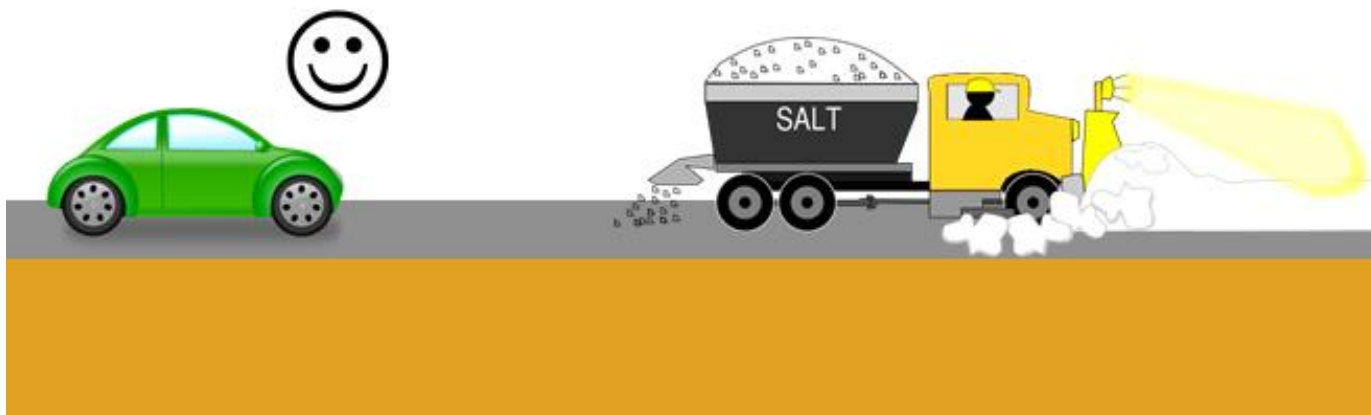
Output

Basic outcome:

- Road surface temperature
- Amounts of water, ice, snow and frost on the road

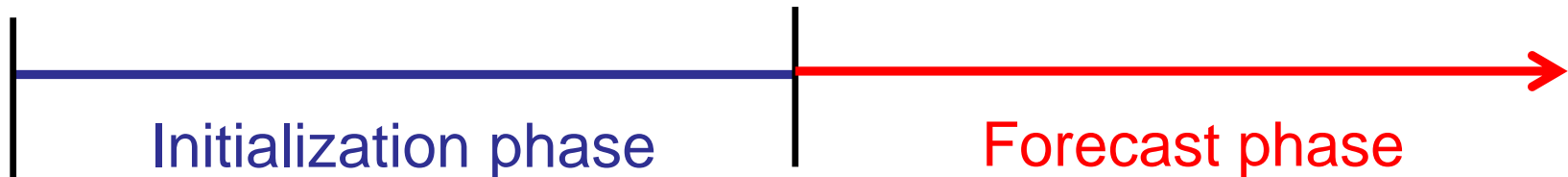
Deliverables:

- Friction coefficient
- Road condition
 - E.g. wet, icy, snowy
- Traffic Index
 - Normal, difficult, very difficult



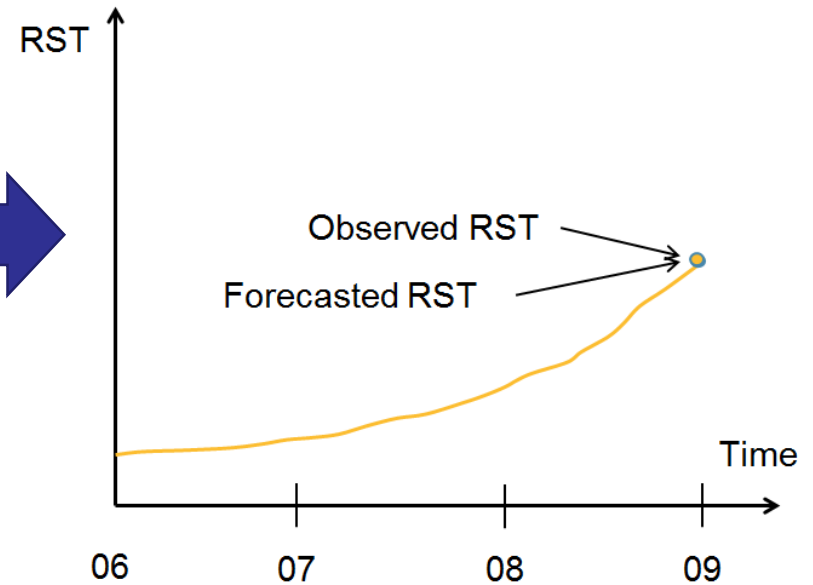
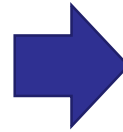
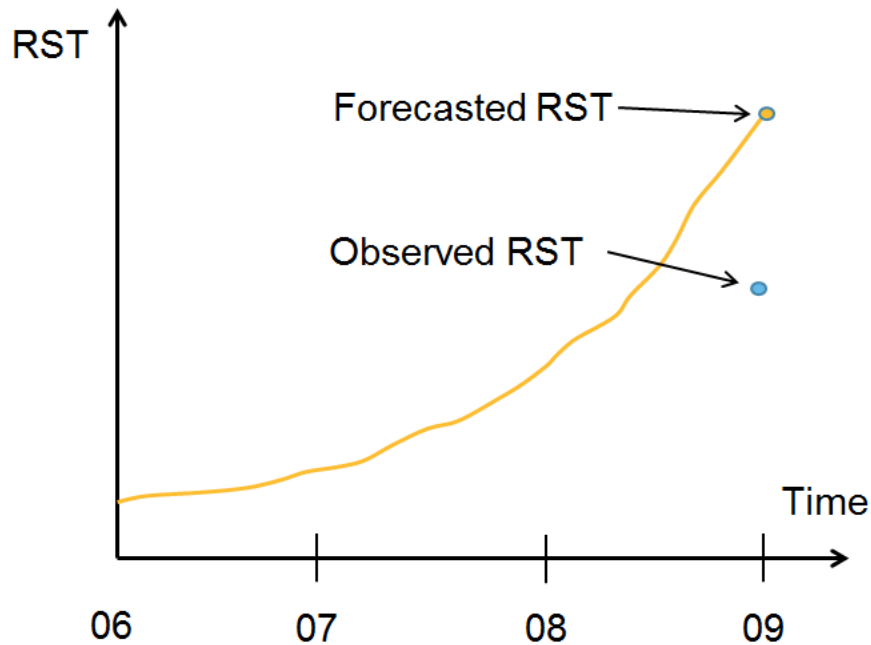
Model phases

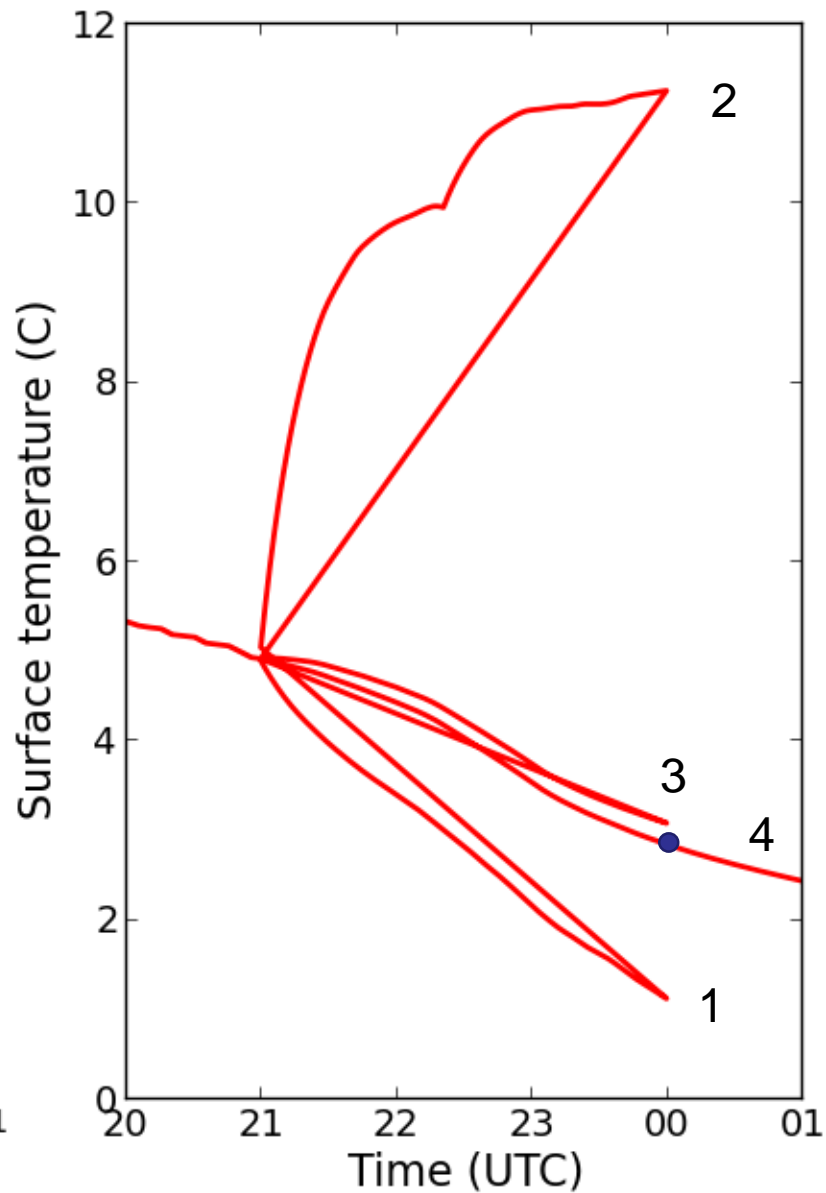
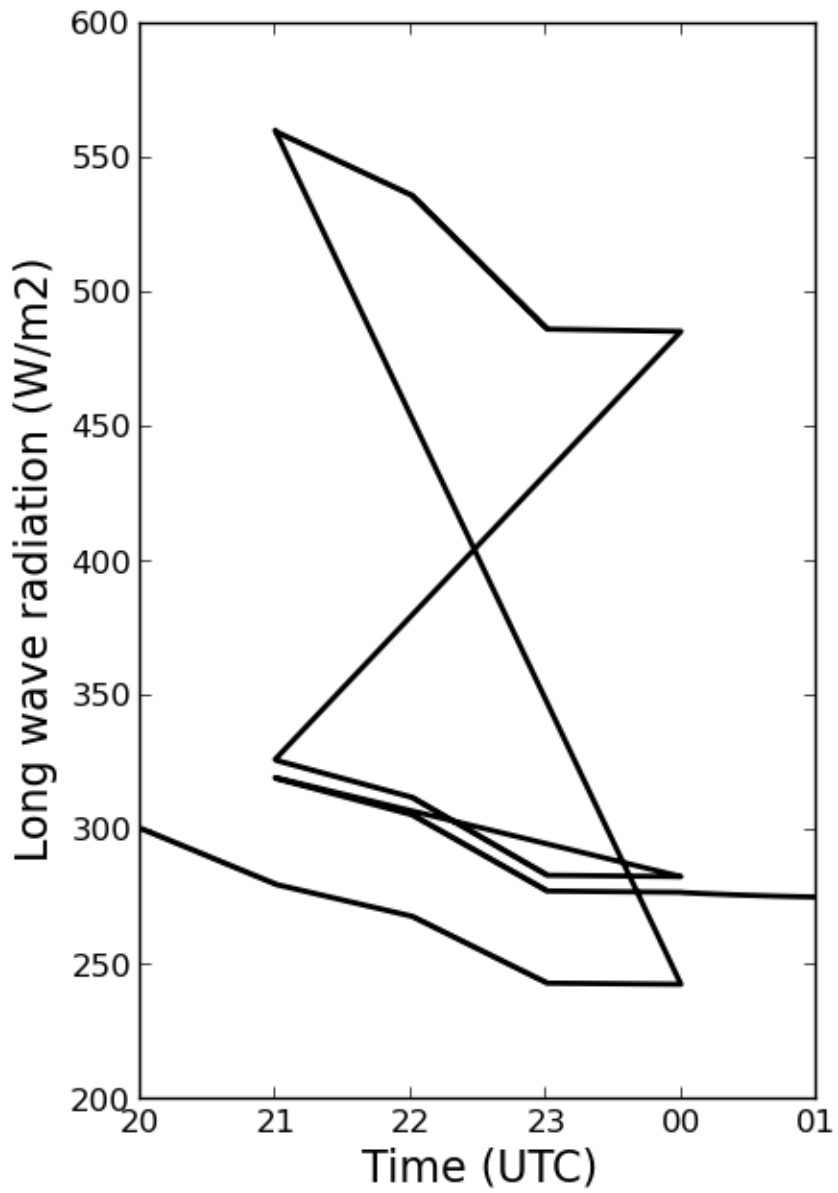
- Initialization phase
 - Atmospheric forcing from observations
- Forecast phase
 - Atmospheric forcing from numerical weather prediction model



Coupling method

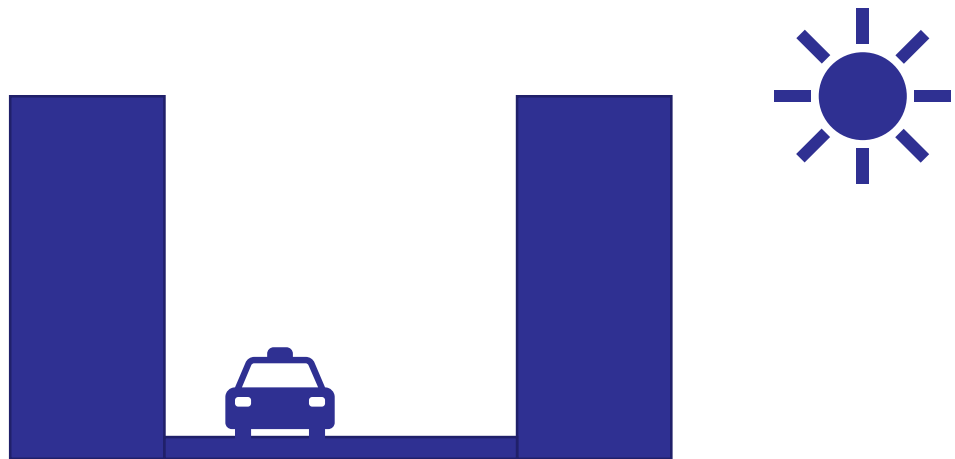
- Incoming long wave/short wave radiation flux in the model is adjusted so that forecasted road surface temperature (RST) fits to the last observed value
- Radiation correction coefficient is determined in an iterative process
- Coefficient is used in actual forecast phase
 - Approaches exponentially 1 as the forecast advances





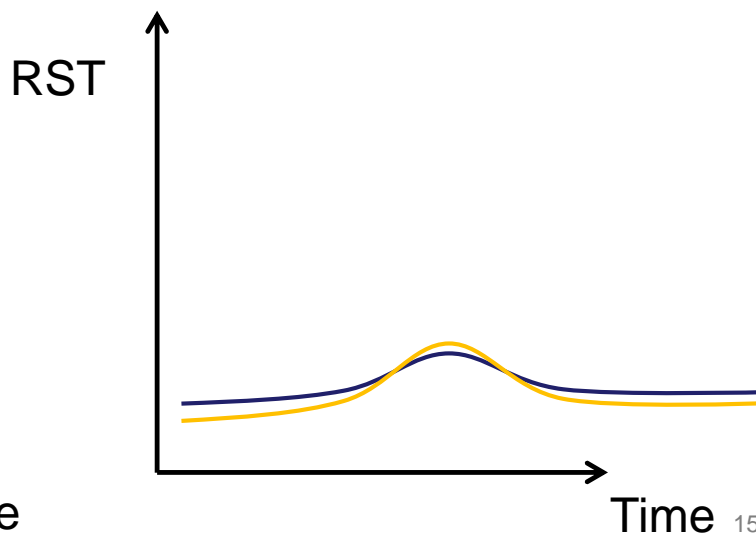
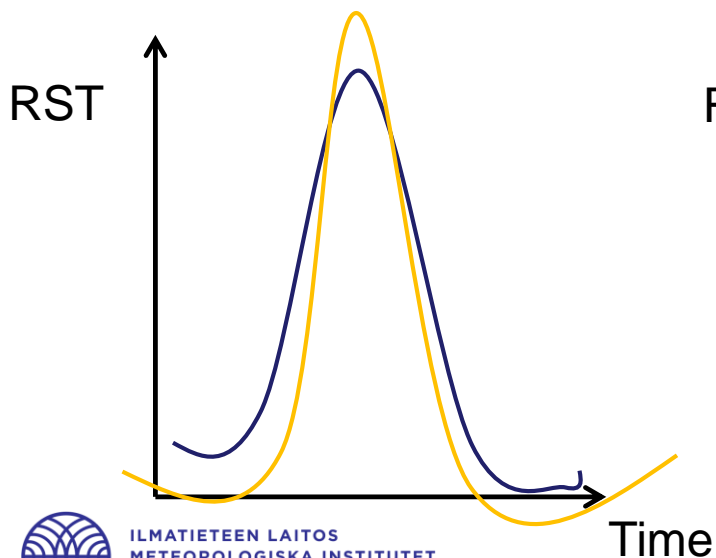
3. What can go wrong?

- RWM is very dependent of the driving forecast
 - Errors in driving forecast present themselves also in road weather forecast
- RWM excepts open surroundings
 - Does not currently take into account surrounding trees and buildings obscuring sun
 - Forecasted surface temperature can be too high during day and too low during night

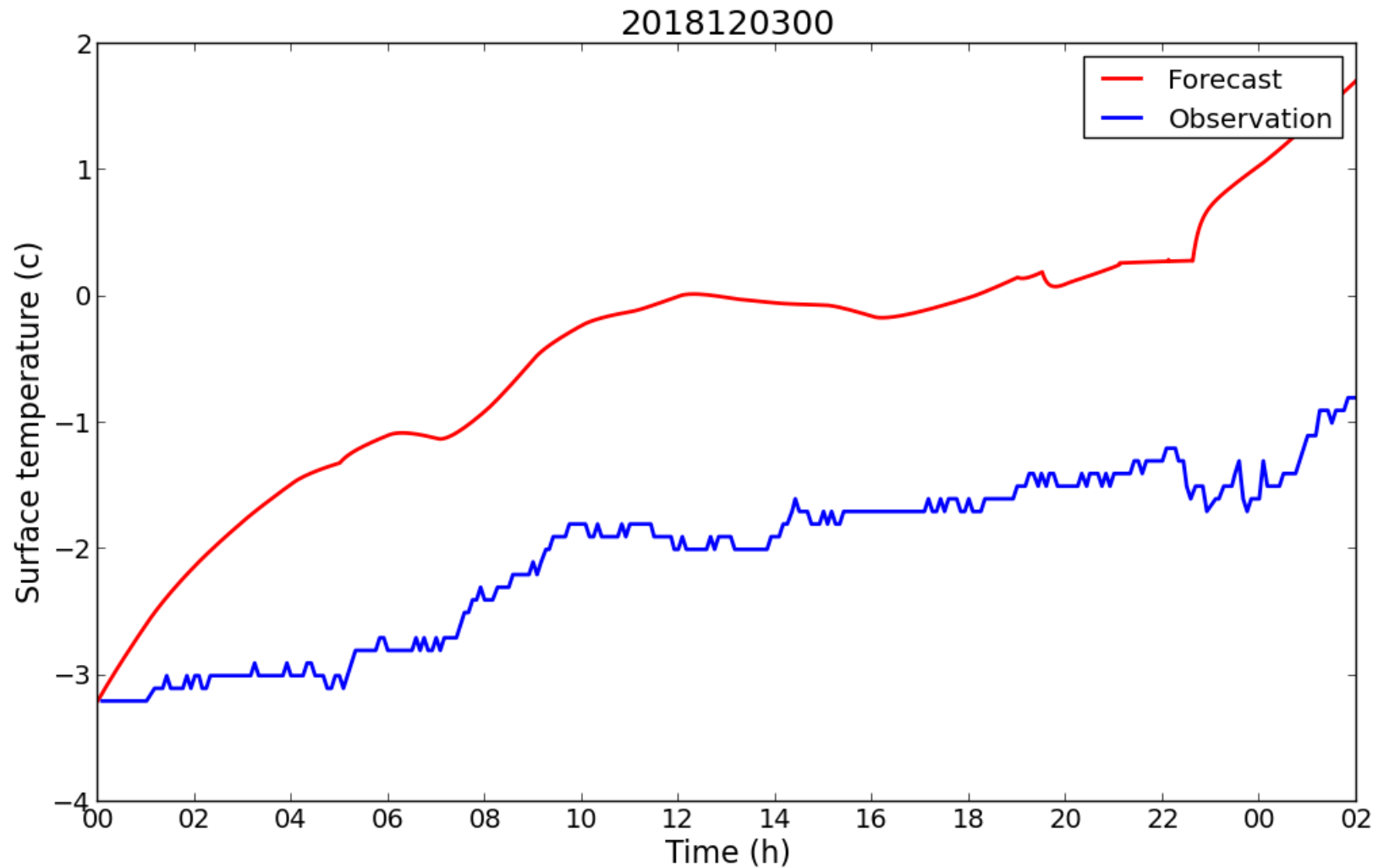


Typical errors

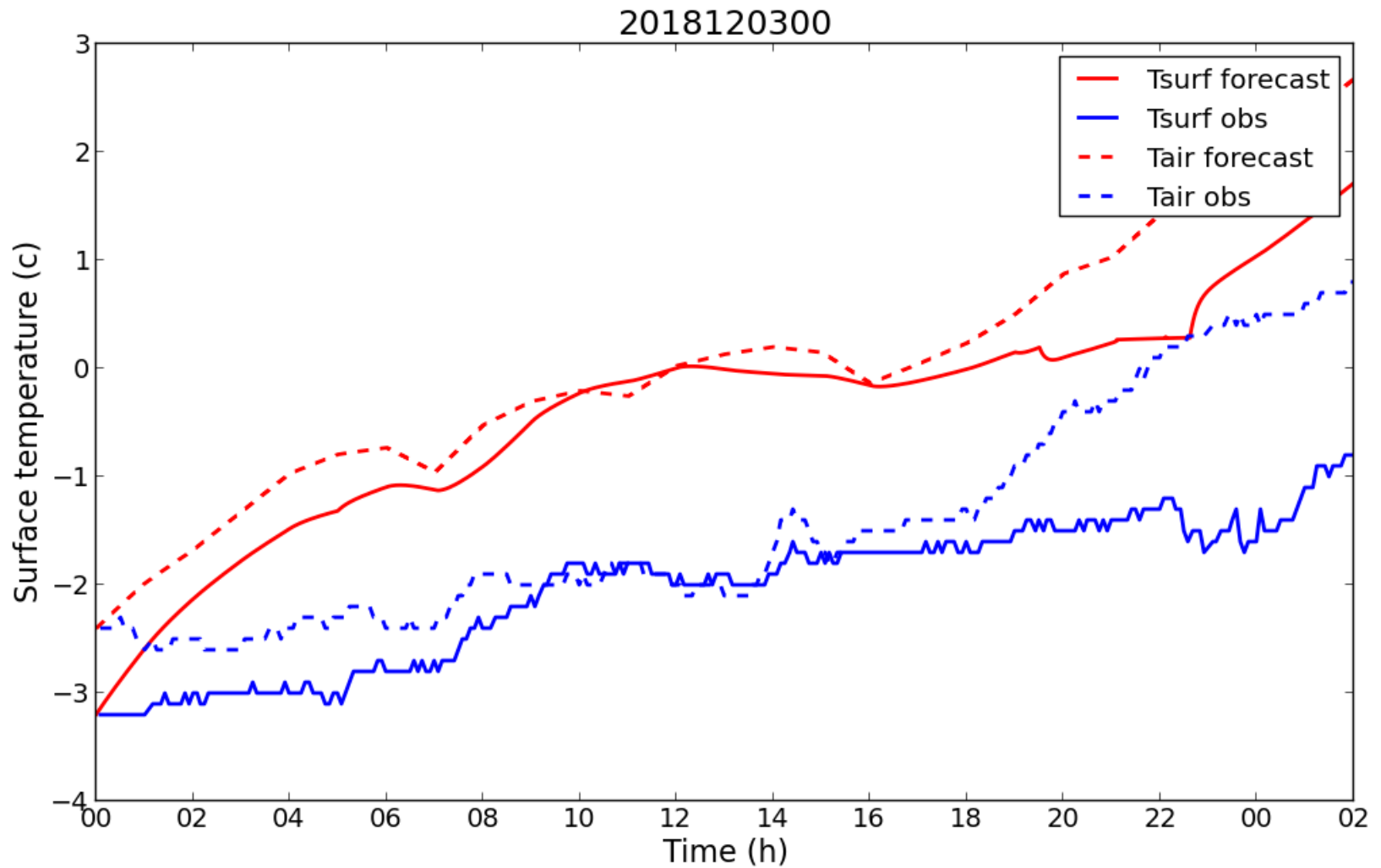
- RWM has problems in predicting daytime maximum and nighttime minimum temperatures
- Too slow cooling during evening
- Due to stronger temperature variation, errors are larger during spring than during winter



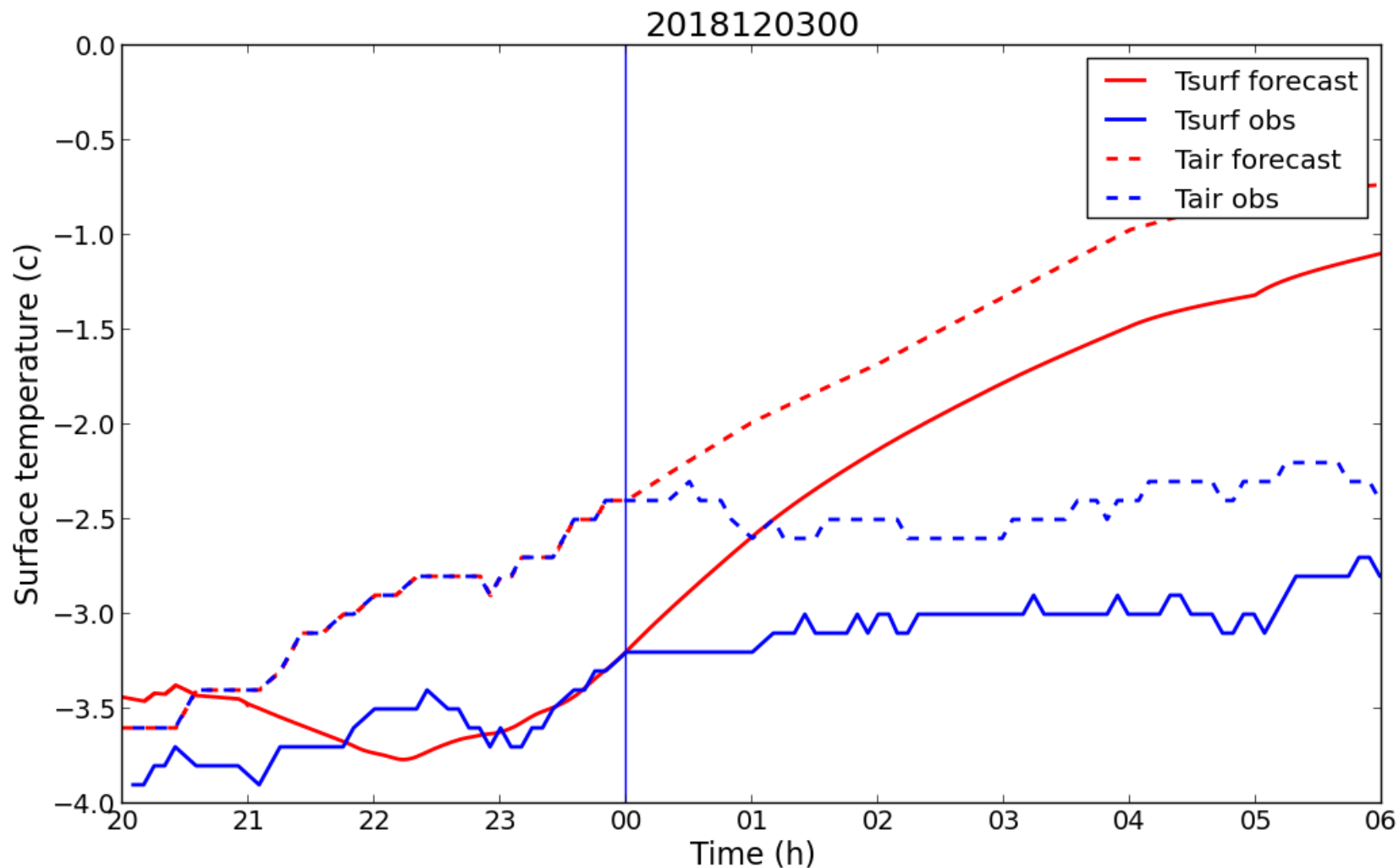
Example: forecasted surface temperature too high in December



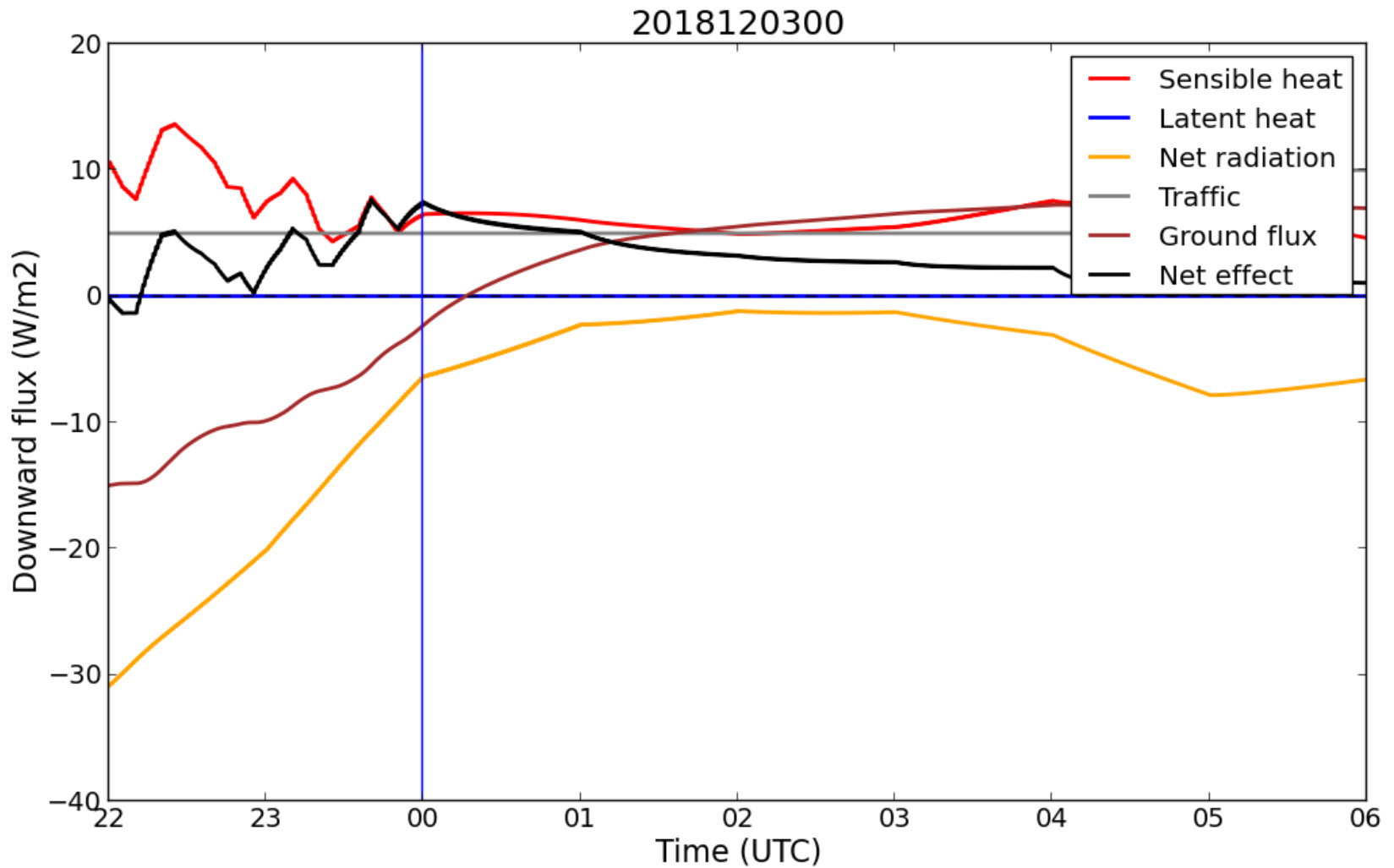
Reason 1: Forecasted air temperature too high



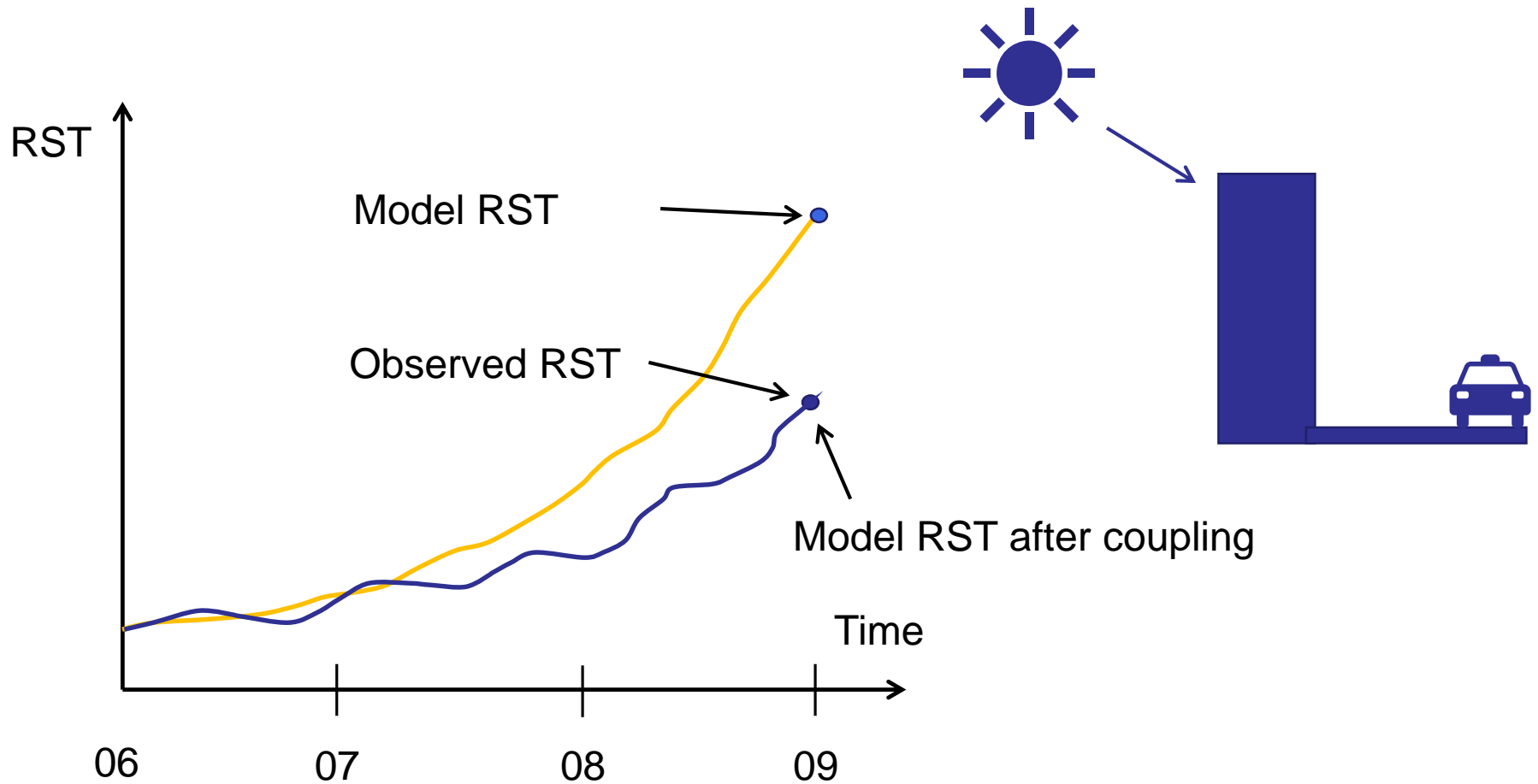
Reason 2: Coupling needed to adjust to increasing temperature during coupling phase, but at the start of forecast phase surface temperature stopped increasing

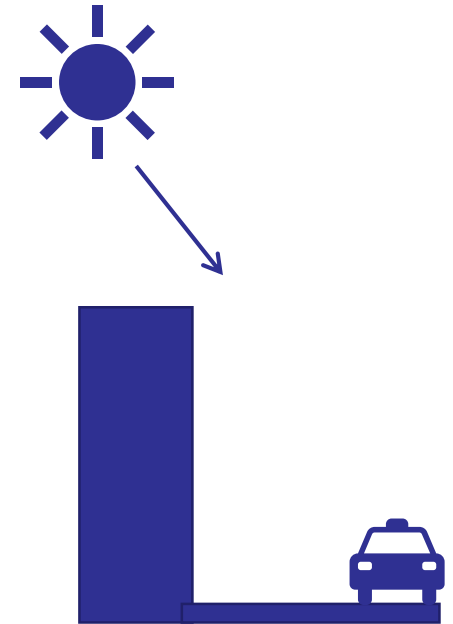
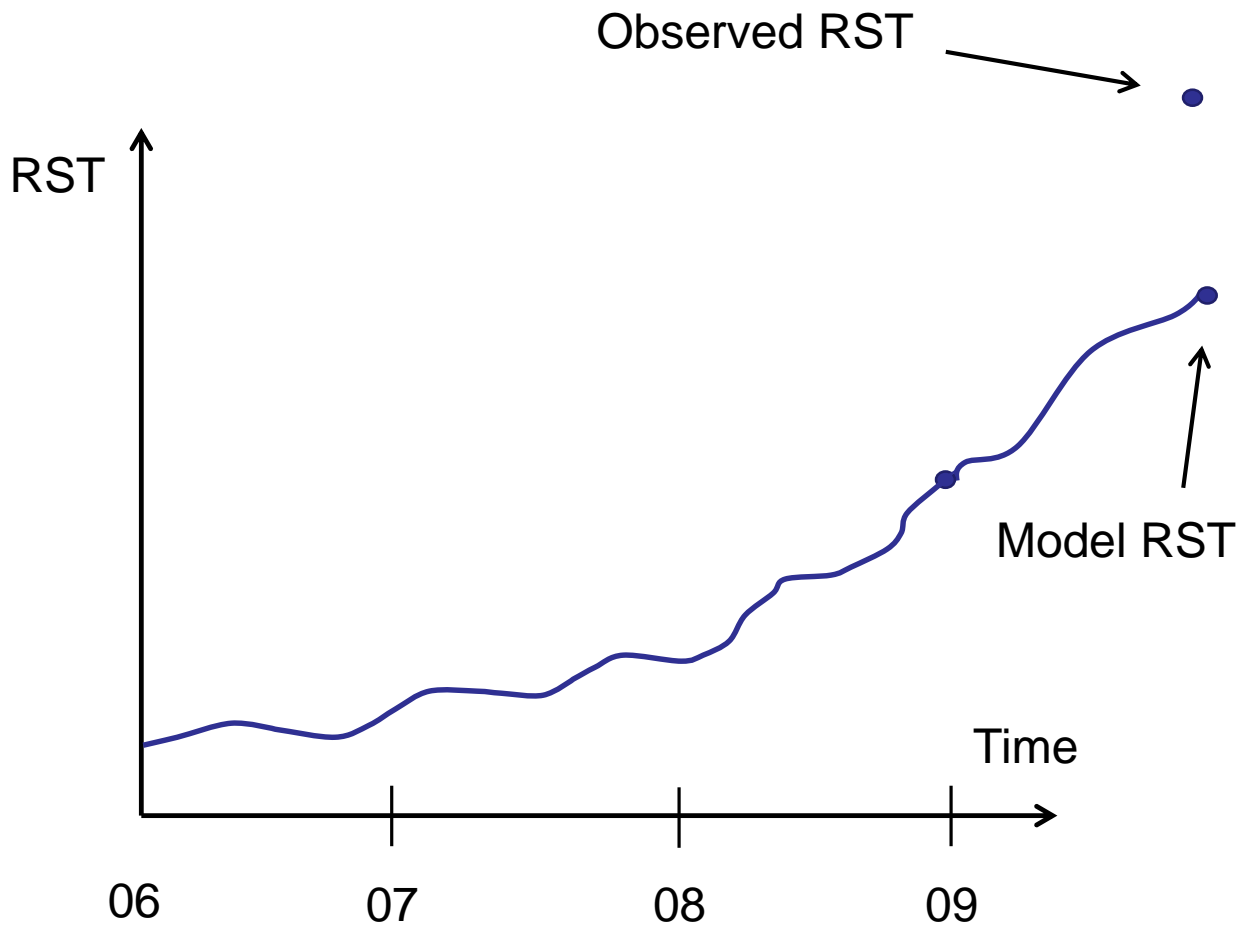


Reason 3: Increasing long wave radiation



Problem related to coupling





Rapid changes in incoming radiation after coupling period might cause error in the forecast

4. Grid or point?



FMI specific differences

Grid

- Gridded observations (LEPS (previously LAPS), kriging)
- No coupling used
 - Would be possible to use gridded observations

Point (Road weather stations)

- Road weather station observations
- Coupling

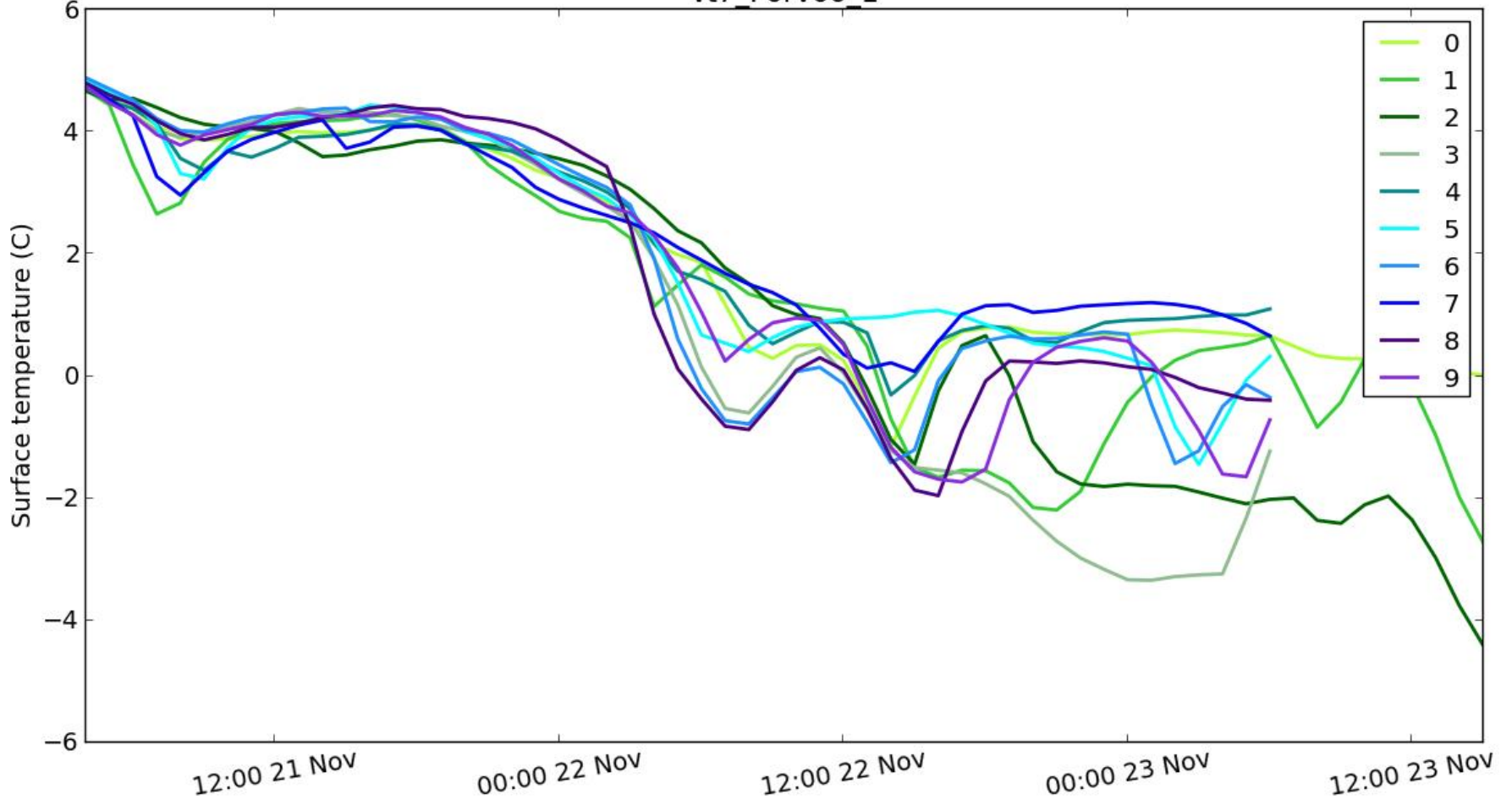
Note:

- Different setups can cause differences in the forecasts
- Model is one dimensional in both cases

5. Incoming feature: probability forecast

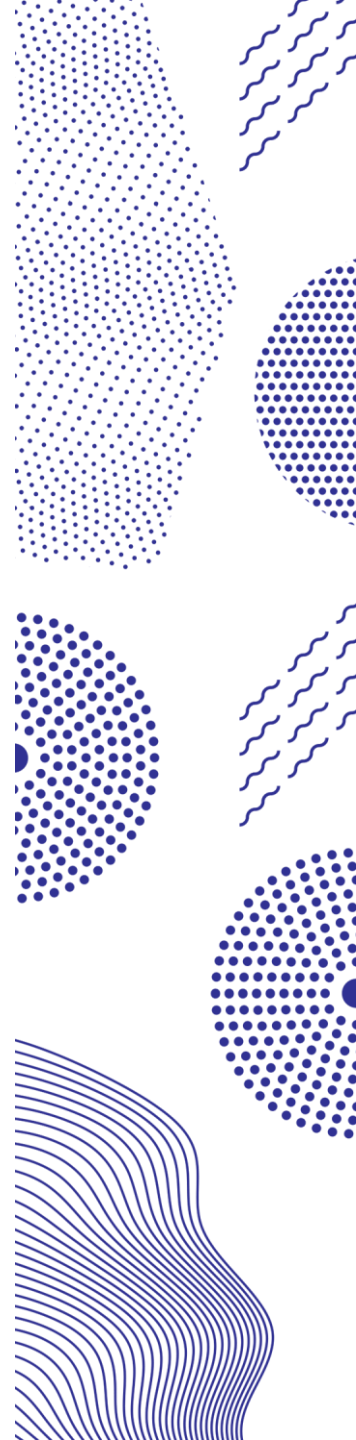
- MetCoOp = Meteorological Cooperation on Operational Numeric Weather Prediction (NWP) between FMI, MET Norway and SMHI
- 10 ensemble members run 4 times a day
- FMI started test runs with RWM by using each ensemble member as input data separately
 - Point model currently, grid version incoming

RWM Ensemble 21 Nov 2019 00 UTC
vt7_Porvoo_1



6. Summary

- Road weather model is quite sensitive to the fluxes especially during winter
 - Small variations matter!
- Coupling method tries it's best but fails if conditions change at the start of the forecast
- It's useful to know what input data the road weather model uses





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