



THE COUPLED ROAD WEATHER AND ROAD DUST MODELLING SYSTEM FOR AIR QUALITY FORECASTS IN NORWAY

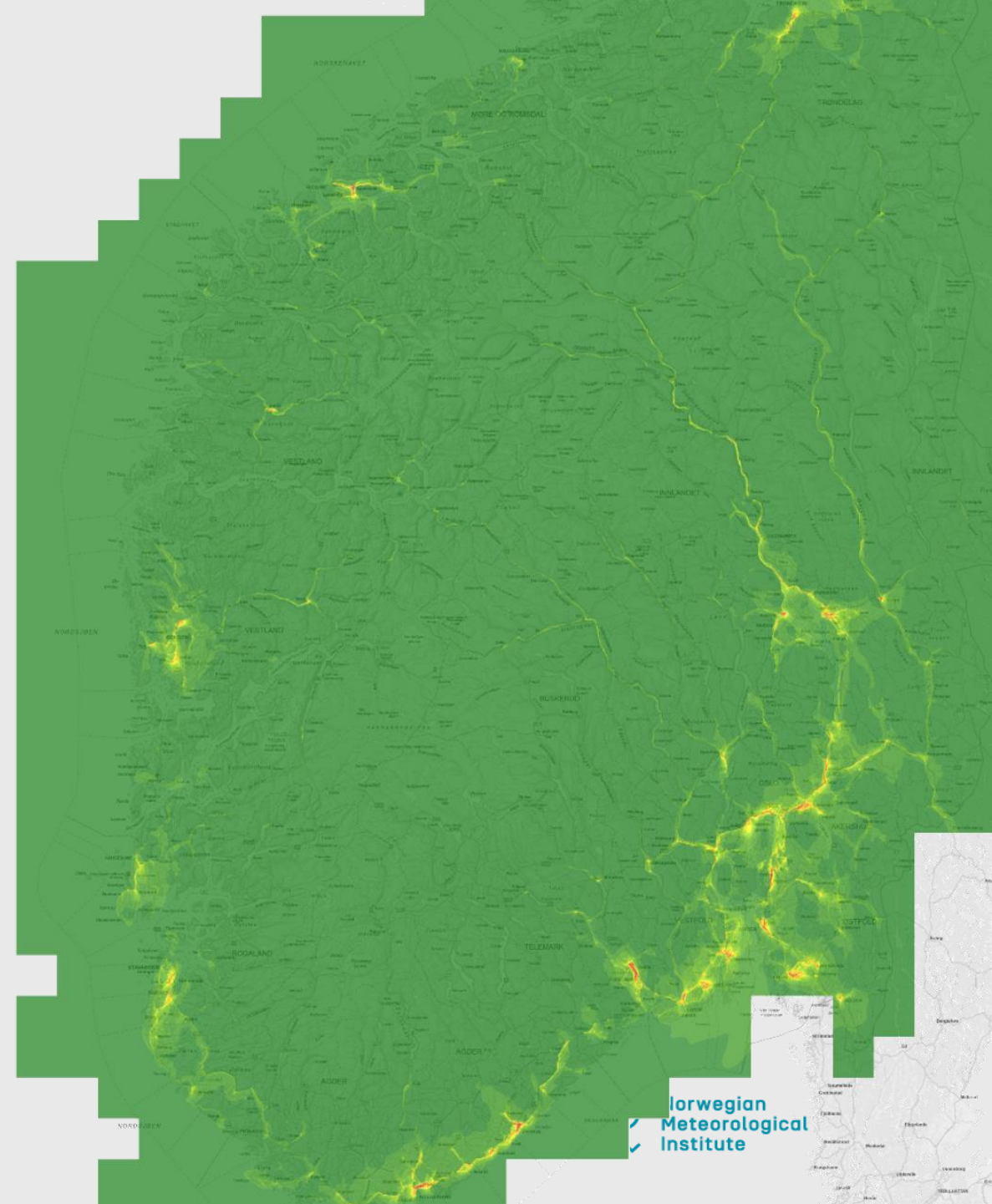
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Content

- Road dust and road weather
- The NORTRIP model
- Air quality forecasts and analysis in Norway
- Road weather modelling
- Web based exploratory tool



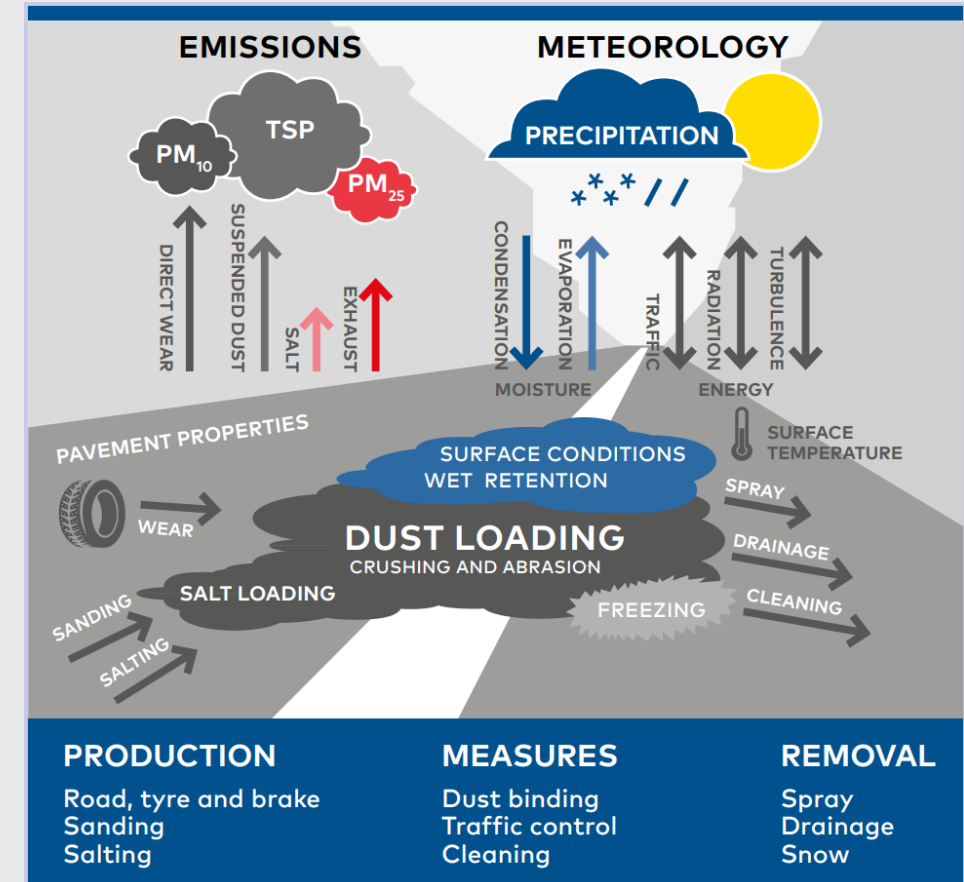
Road dust and road weather

- Road dust in Nordic countries is generated mostly through the use of studded tyres
- It is the most significant source of coarse particles (PM₁₀)
- Road wear occurs throughout the winter season, accumulating on the road under wet or snowy conditions
- Emission and suspension only occurs when the road surface becomes dry, particularly in spring
- Road weather is the controlling factor for road dust emissions so forecasting of road dust also requires road weather forecasting
- Dust binding is also carried out by the same contractors used for winter road maintenance activities

NORTRIP

NO_n-exhaust Road Transport Induced Particle emissions

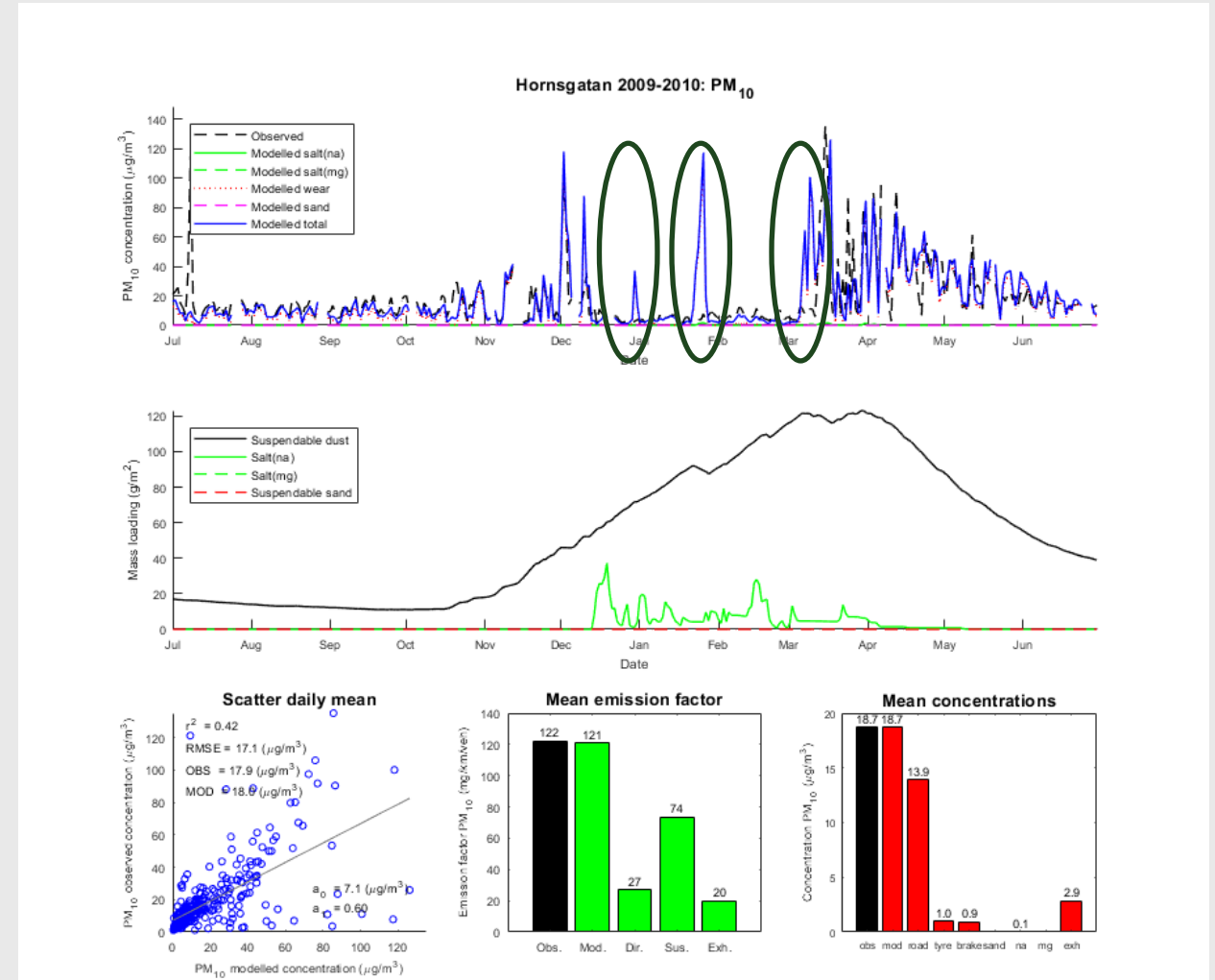
- Coupled road weather and road dust model
- Mass balance model for wear of road, tyre and brakes as well as sand and salt, includes suspension and wet removal processes
- Mass balance model for water/snow/ice including precipitation, evap/condens, spray, drainage and snow ploughing
- Energy balance model for surface temperature, evap/condens, turbulent fluxes, radiation, shading and traffic fluxes



Road dust and PM10 in the Nordic countries: Measures to reduce road dust emissions from traffic. Nordic council of Ministers NR Nr. 2016:790. DOI: <https://www.norden.org/no/node/7384>

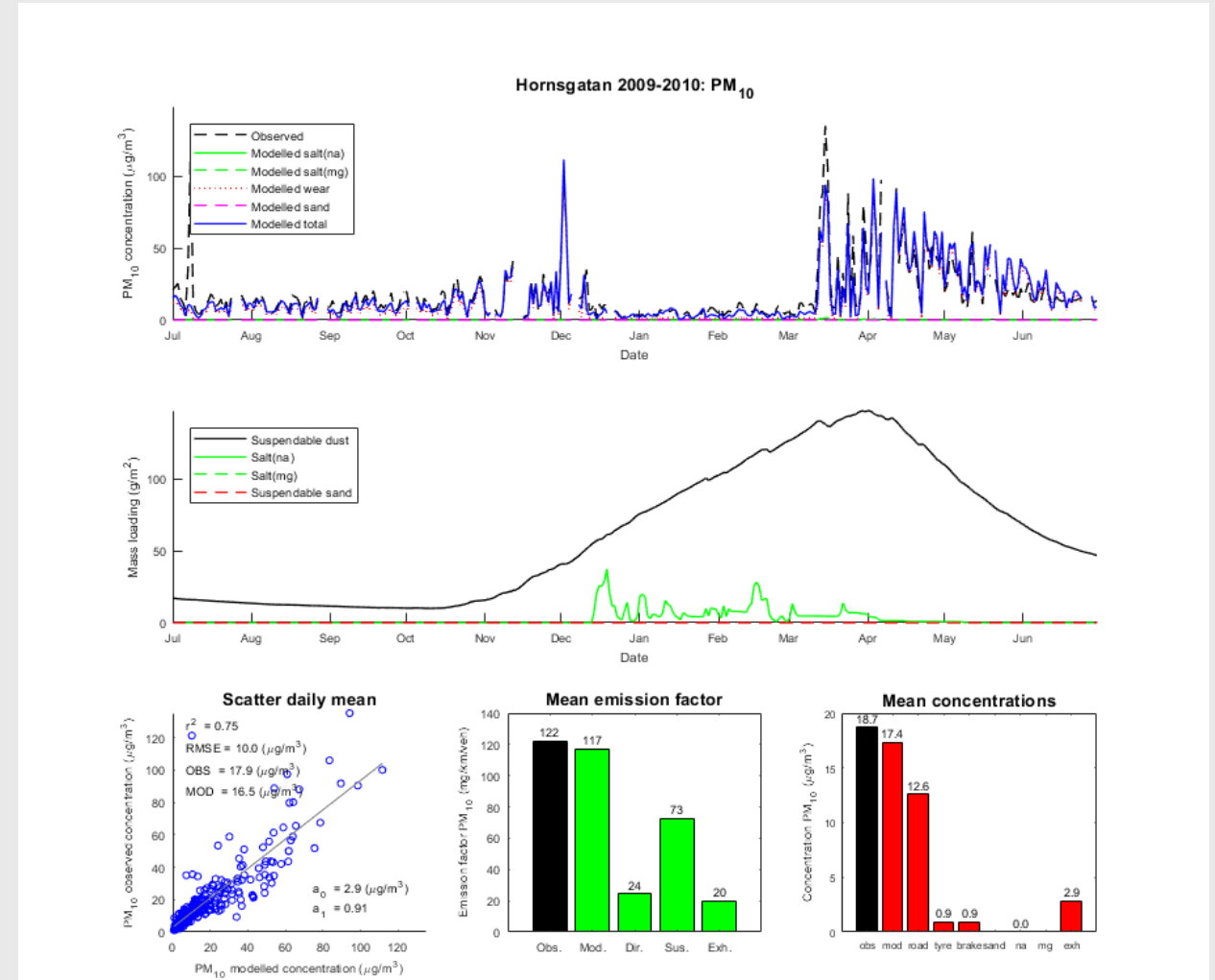
Example: modelled road moisture

- Hornsgatan, Stockholm
- Modelled road moisture controlling road dust emissions
- Accumulation of dust and salt on the road surface
- Daily mean PM_{10} concentration scatter plots $r^2=0.42$



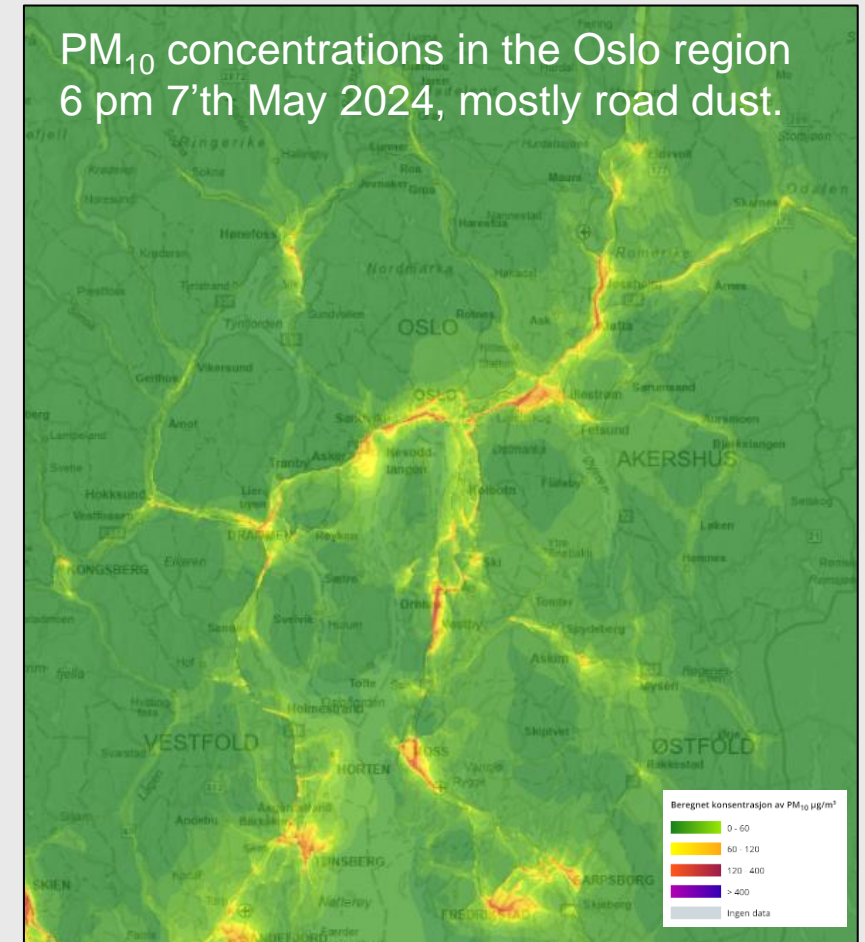
Example: observed road moisture

- Hornsgatan, Stockholm
- Observed road moisture controlling road dust emissions
- Accumulation of dust and salt on the road surface
- Daily mean PM_{10} concentration scatter plots $r^2=0.75$



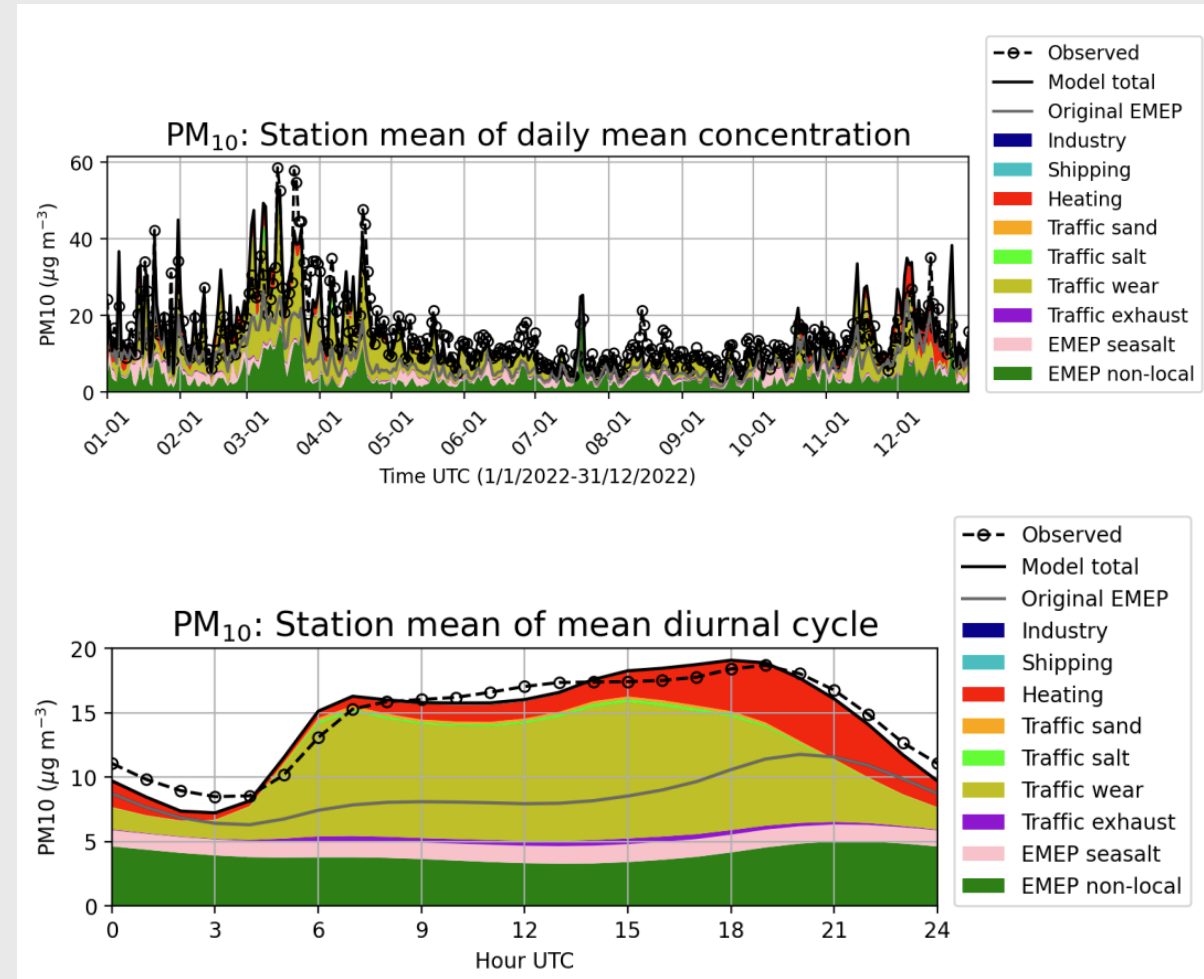
Air quality forecasts in Norway

- Operational air quality forecasts for all of Norway down to 50 m resolution.
- Forecast period is 2.5 days made every 6 hours
- Road dust emissions are the most challenging due to the road surface conditions
- <https://luftkvalitet.miljodirektoratet.no/>



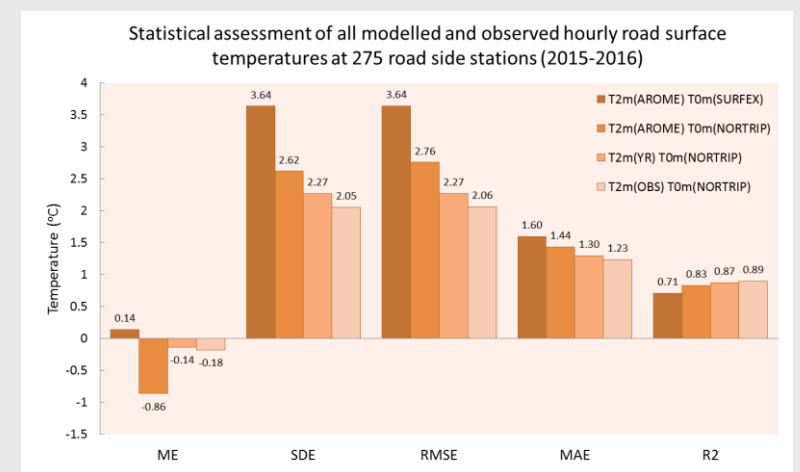
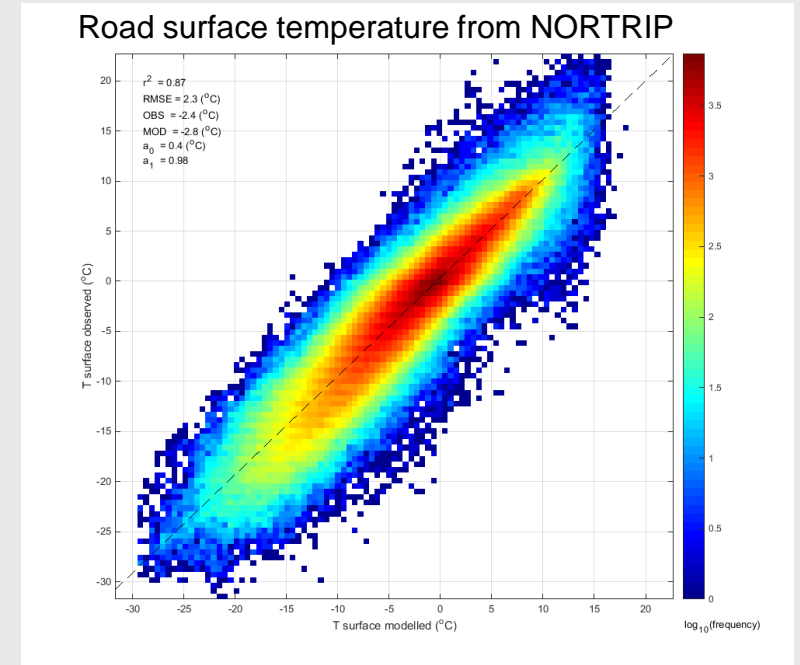
Air quality analysis in Norway

- Every year a reanalysis is carried out for all of Norway
- Comparisons are made to observed concentrations
- Daily mean concentrations of PM_{10} averaged over all stations
- Daily cycle concentrations of PM_{10} averaged over all stations
- <https://www.miljodirektoratet.no/tjenester/fagbruk-ertjeneste-for-luftkvalitet/>



Previous road weather modelling studies with NORTRIP

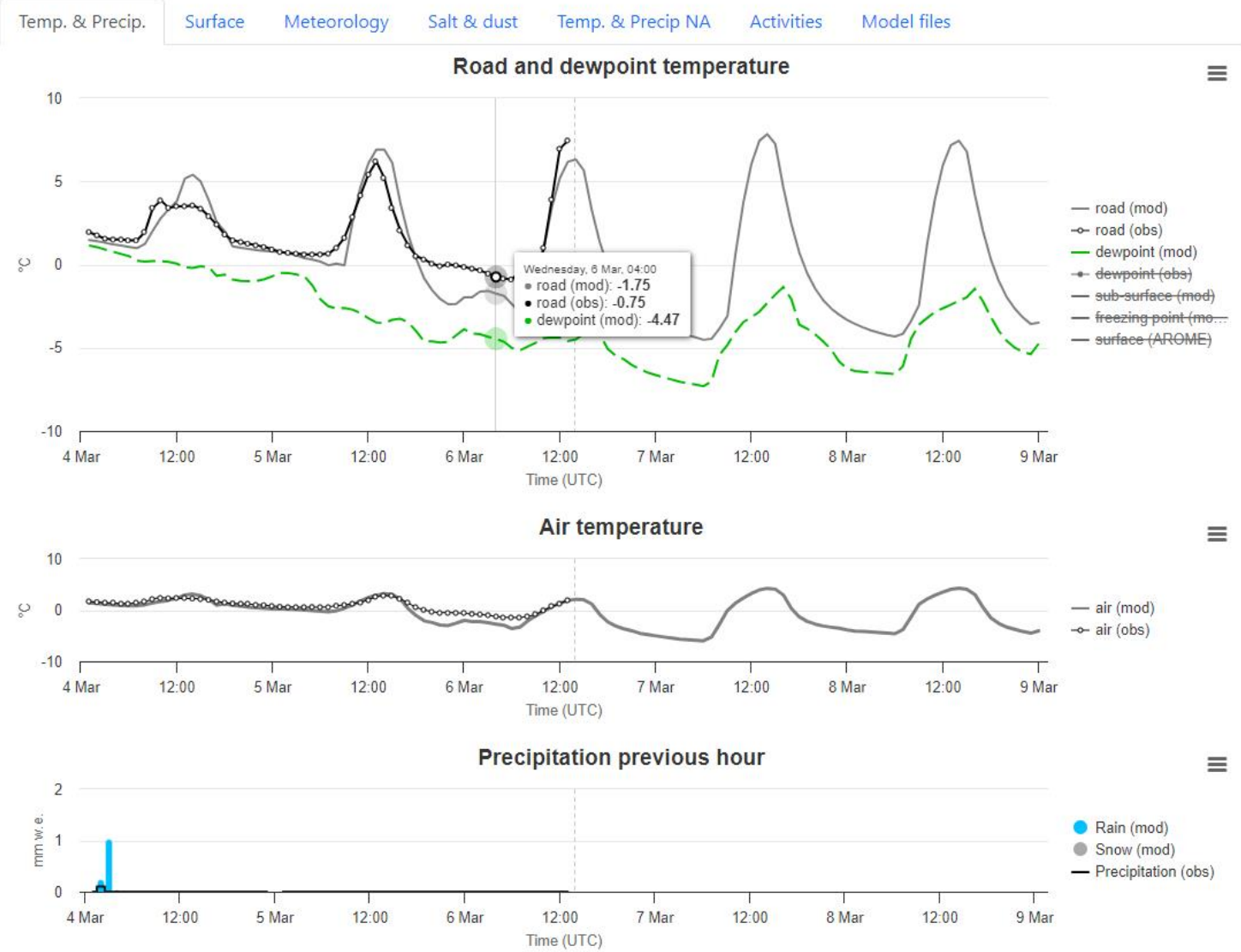
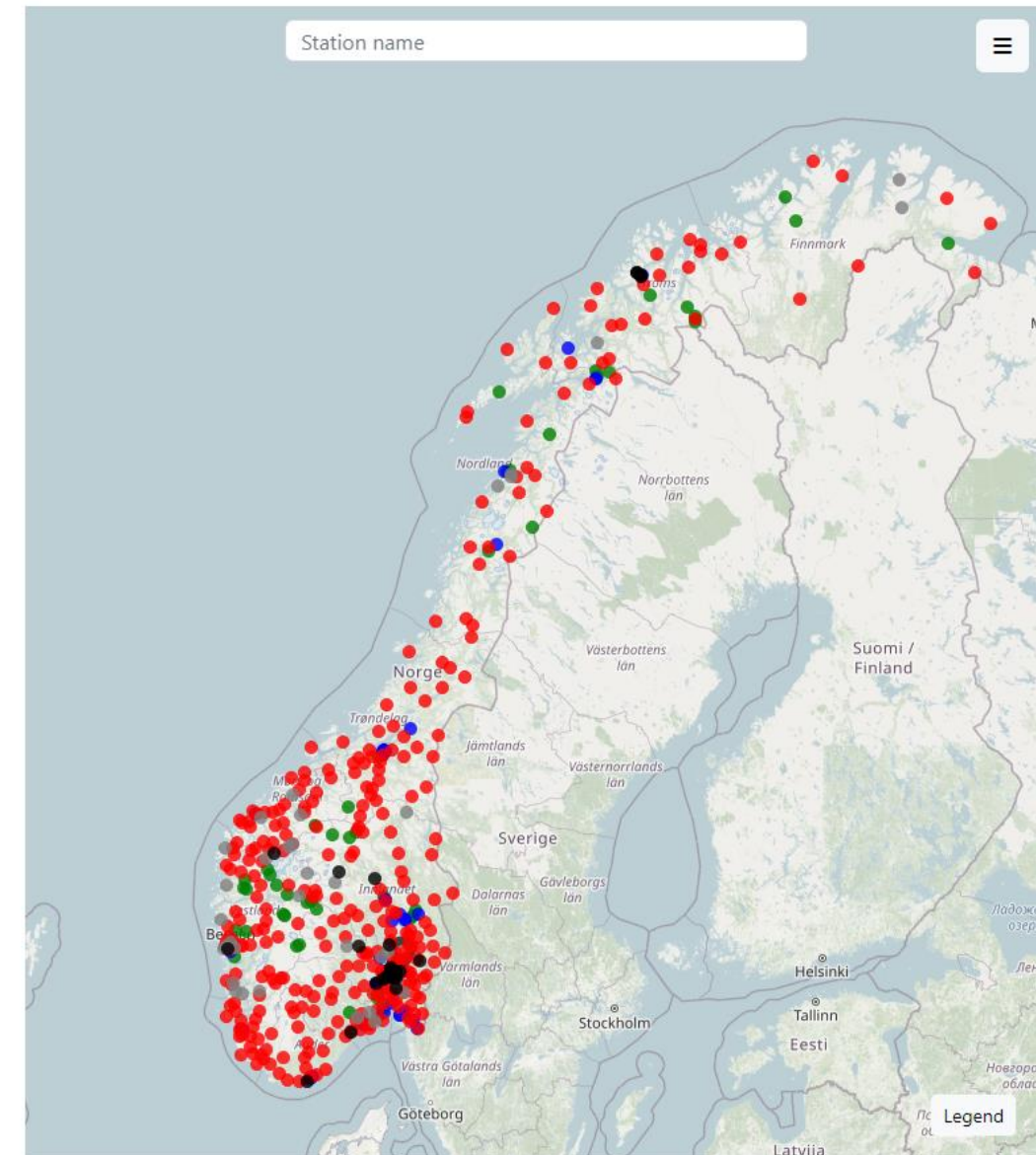
- Earlier assessment of hourly road temperature modelling at 275 sites for the winter 2015-2016, independent of observations
- Sensitivity through improvements in meteorological input
- New efforts are being put into the road weather part of the NORTRIP model as this is the most uncertain and assessment continues with the help of a new web based tool



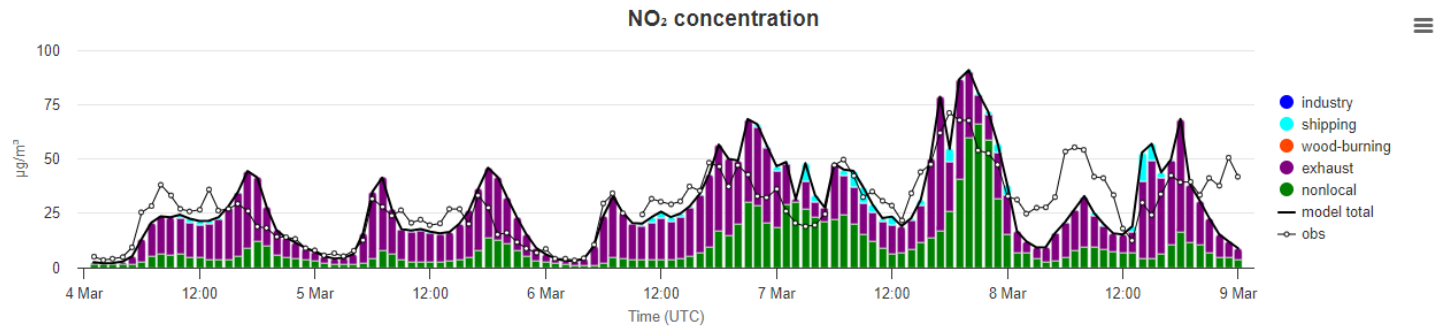
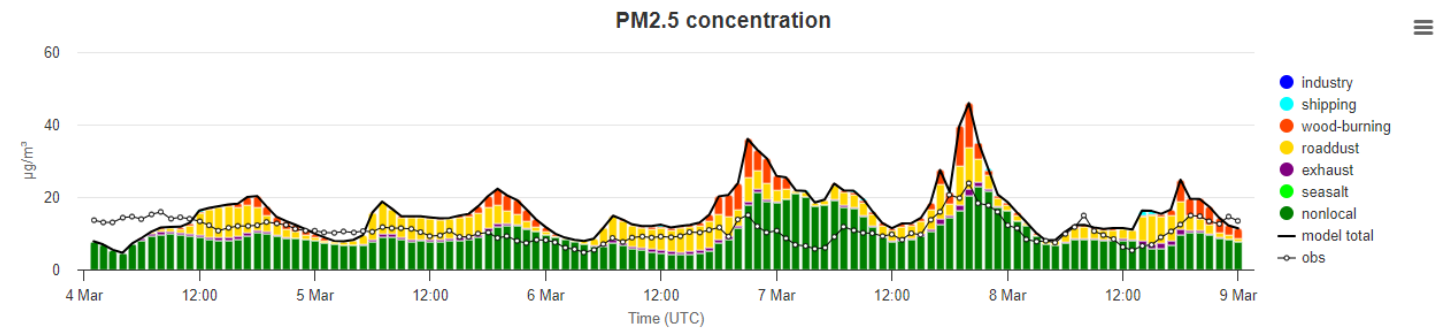
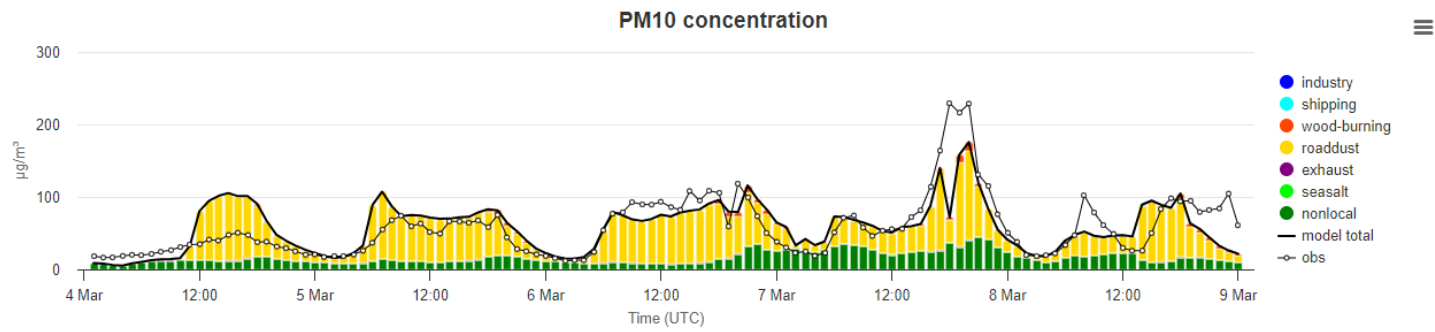
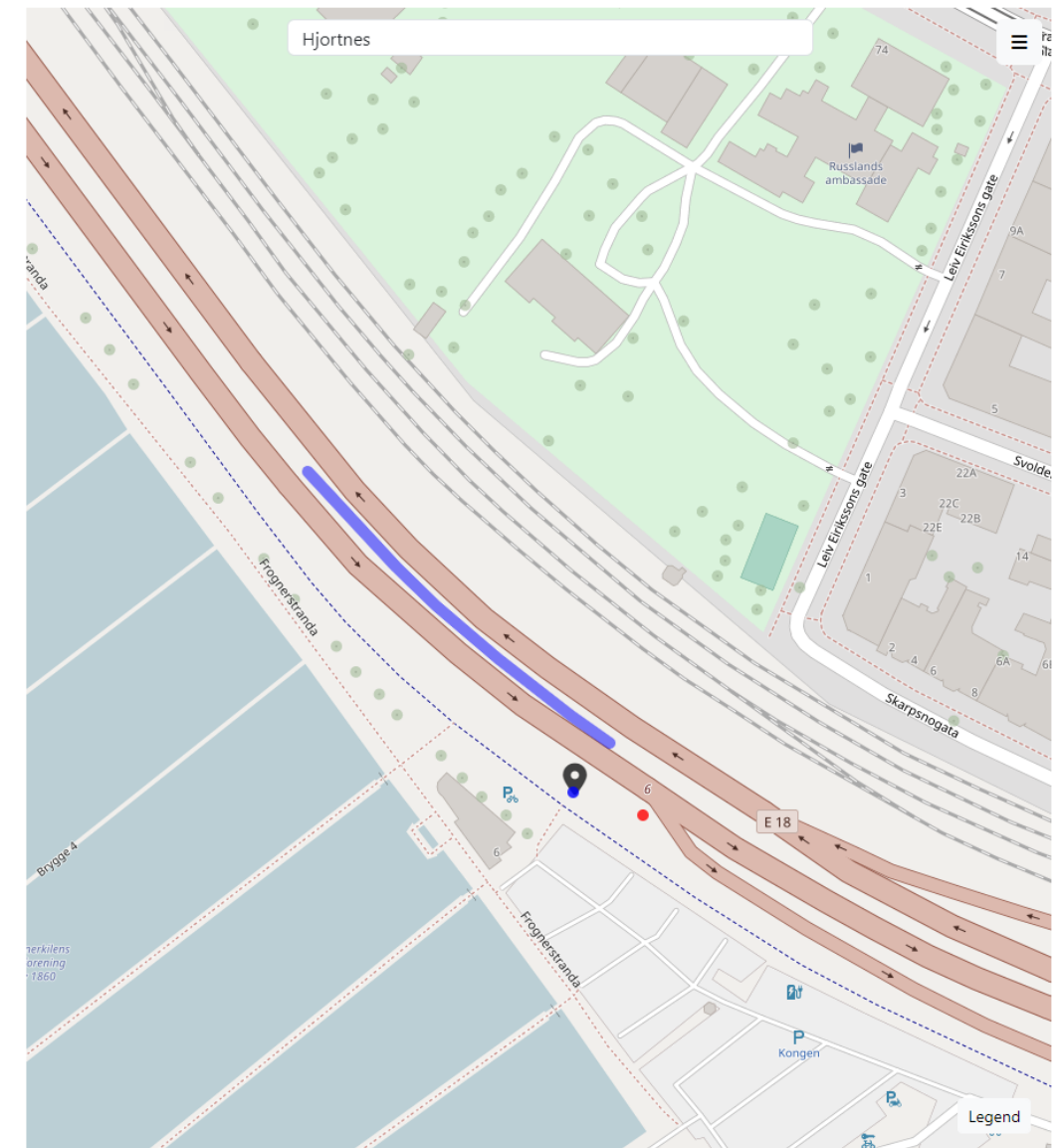
Web based exploratory tool

Parameters	Description	Observed(O)/ Modelled(M)
Traffic counts	Comparison of modelled and observed traffic at traffic counting sites	O/M
Road surface temperature	Comparison of modelled and observed road surface temperature at roadside meteorological sites	O/M
Road surface conditions	Comparison of modelled and observed (when available) road surface conditions at road side meteorological sites	O/M
Road surface energy balance	Modelled surface energy balance	M
Meteorology	Modelled and observed precipitation, air temperature, relative humidity and wind speed and direction	O/M
Air quality	Comparison of modelled and observed air quality at air quality stations including NO ₂ , PM ₁₀ , PM _{2.5} and O ₃	O/M
Surface dust and salt loading	Modelled road dust (PM ₂₀₀), sand, dust binder and salt loading	M
Road dust emissions	Emissions from each road link of PM ₁₀	M
Winter road maintenance activities	Mostly modelled but also real time data from Trondheim Municipality is available for comparison	O/M
Roadside cameras	From the Public Road Authorities	O
Street view	From Google	O

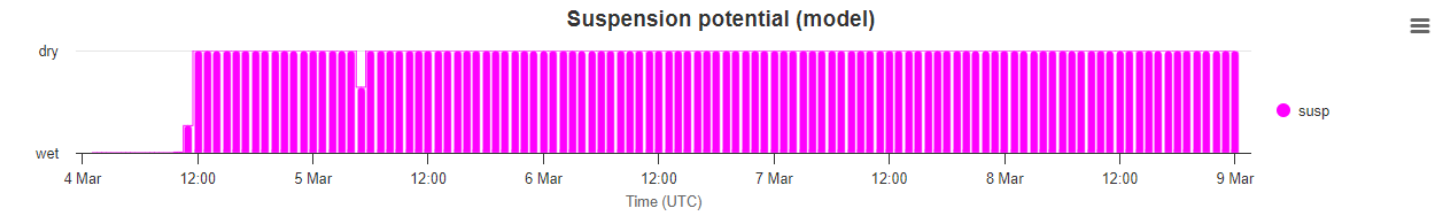
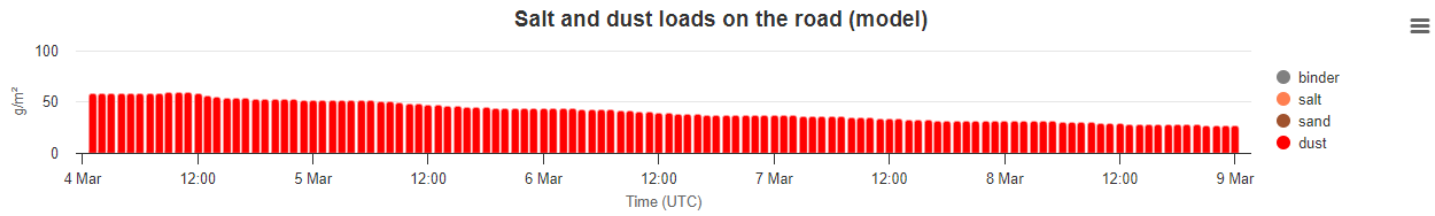
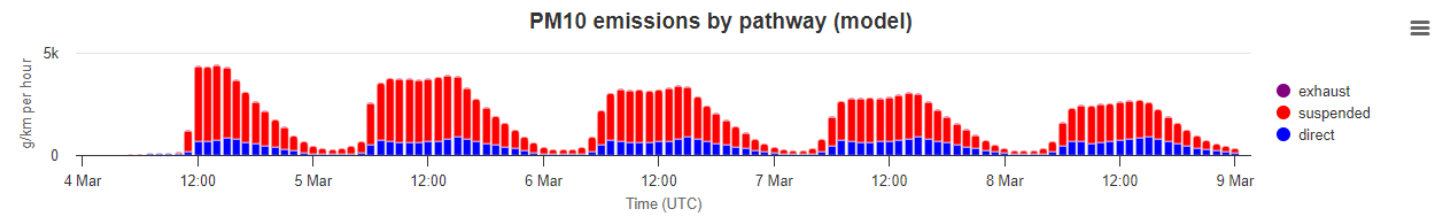
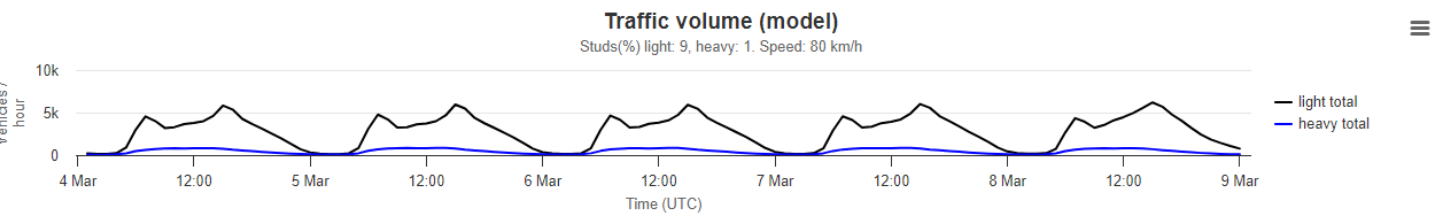
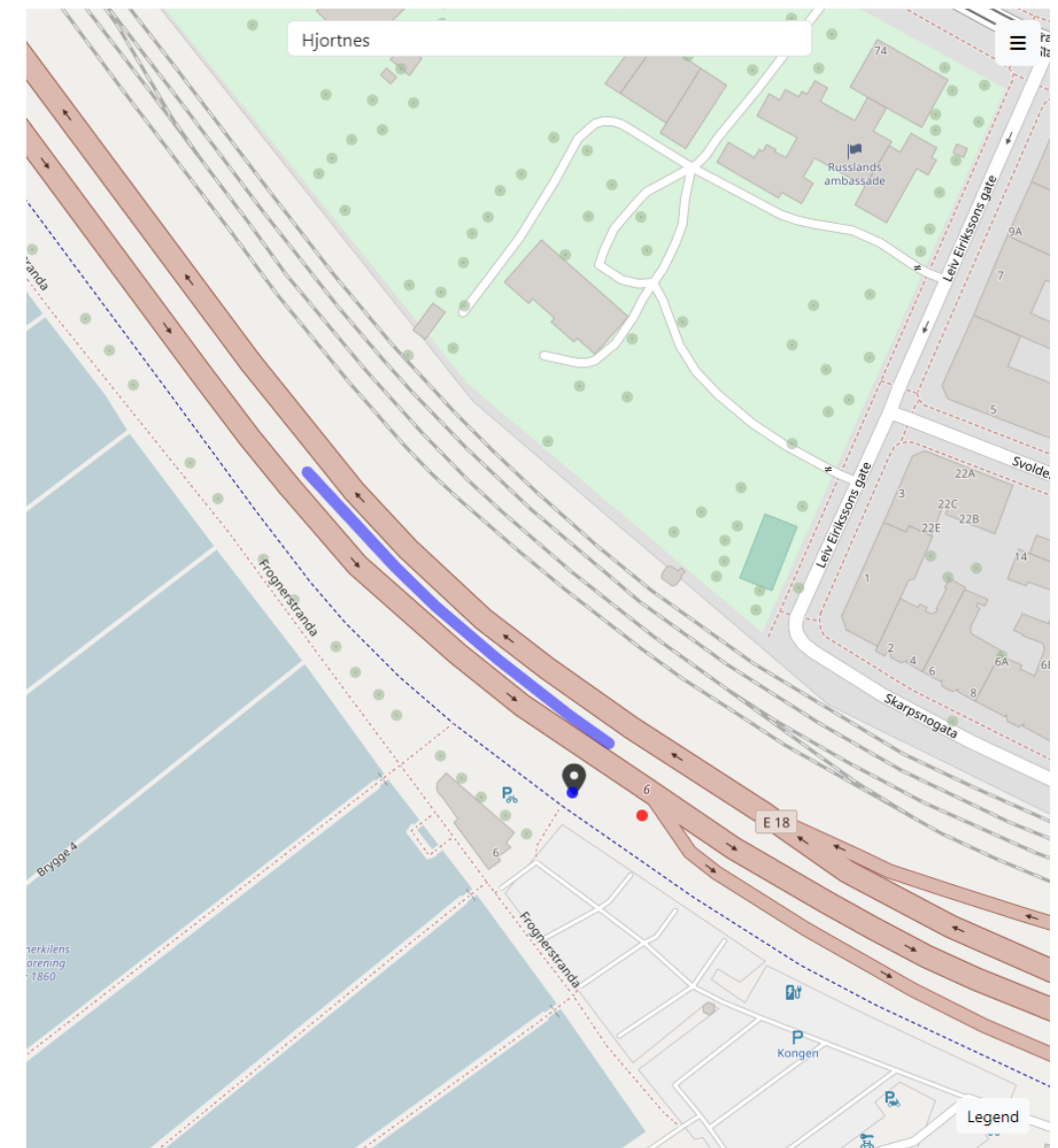
Web based exploratory tool: <https://roadweather.met.no/>



Web based exploratory tool: Air quality concentrations



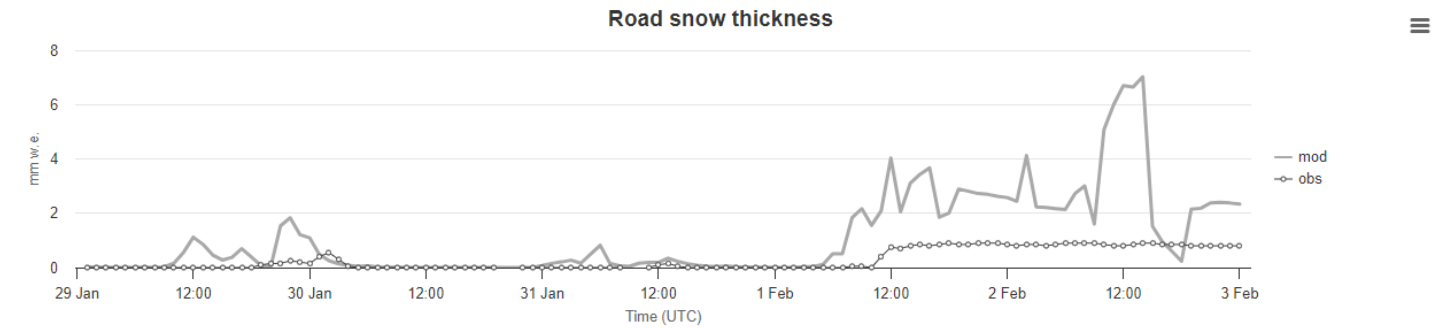
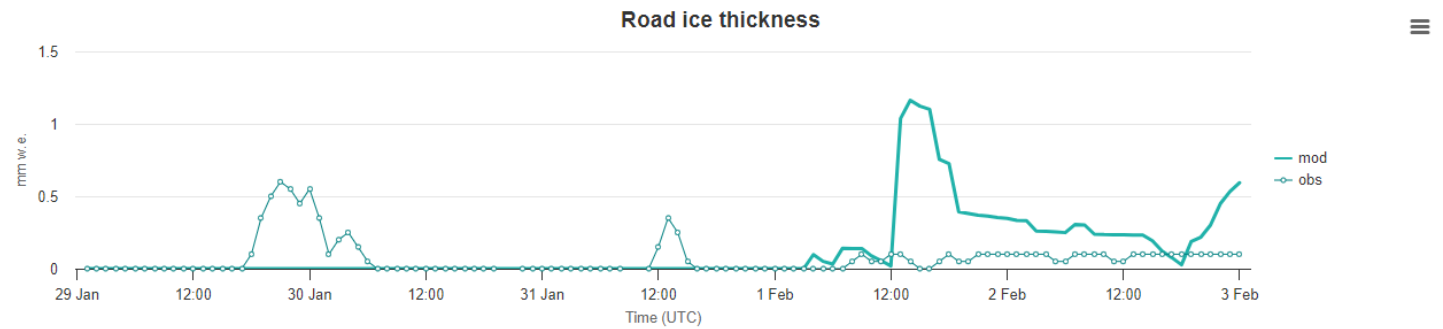
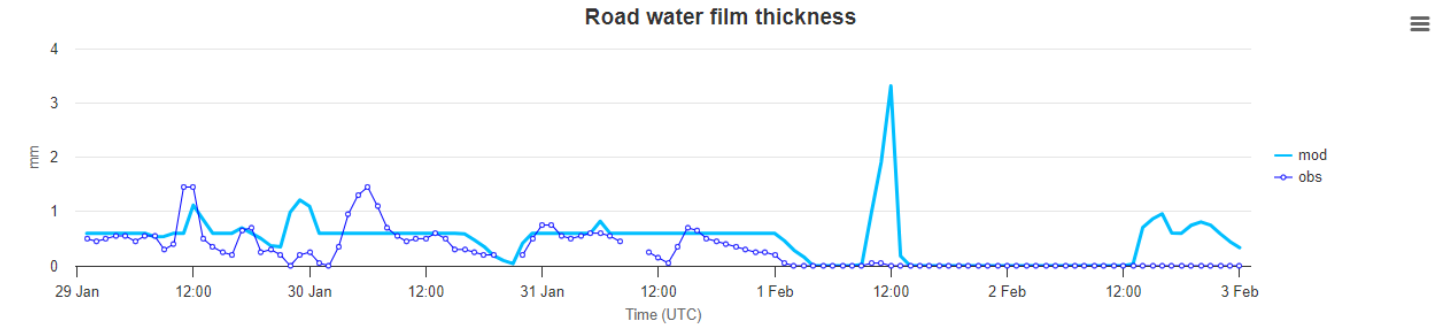
Web based exploratory tool: Emissions and dust loading



Web based exploratory tool: Surface moisture



Temp. & Precip. **Surface** Meteorology Salt & dust Temp. & Precip NA Activities Model files




Web based exploratory tool: road cameras

E6 HÅLOGALANDSBRUA

Station Name: Øyjord
ID: 3000066_1
Lat: 68.468 Lon: 17.482

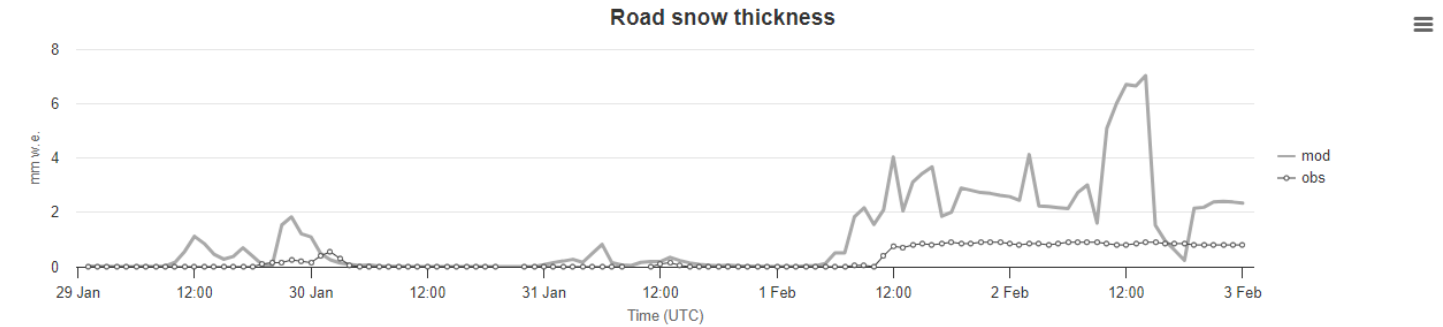
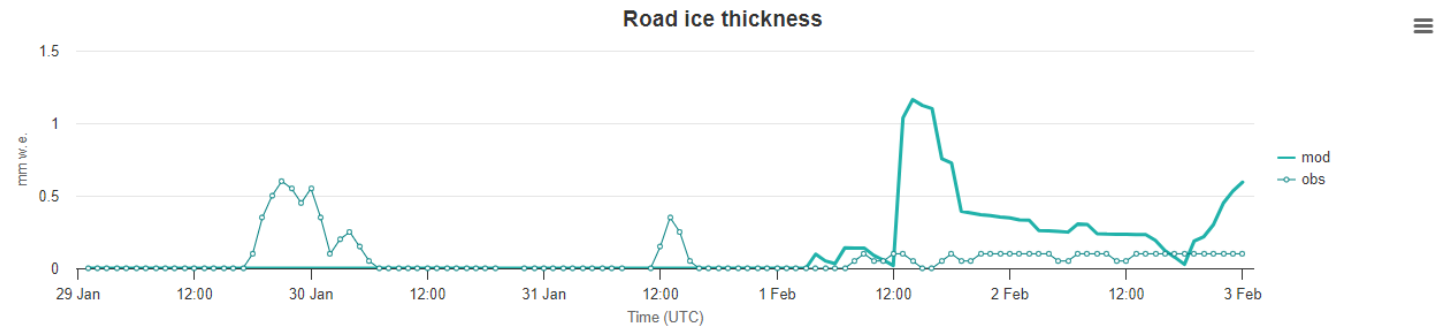
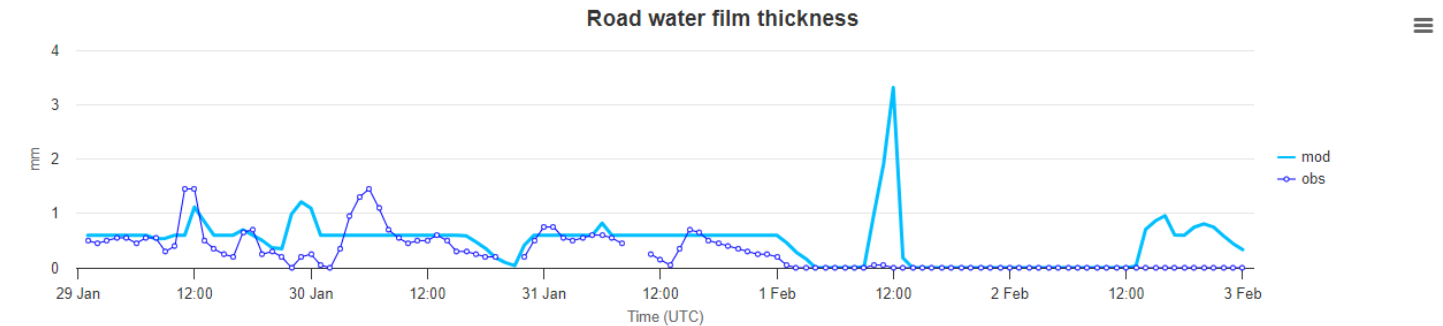
00:00 06:00 12:00 18:00 Mon Jan 29 2024



Hålogalandsbrua - Holgålåtrovri

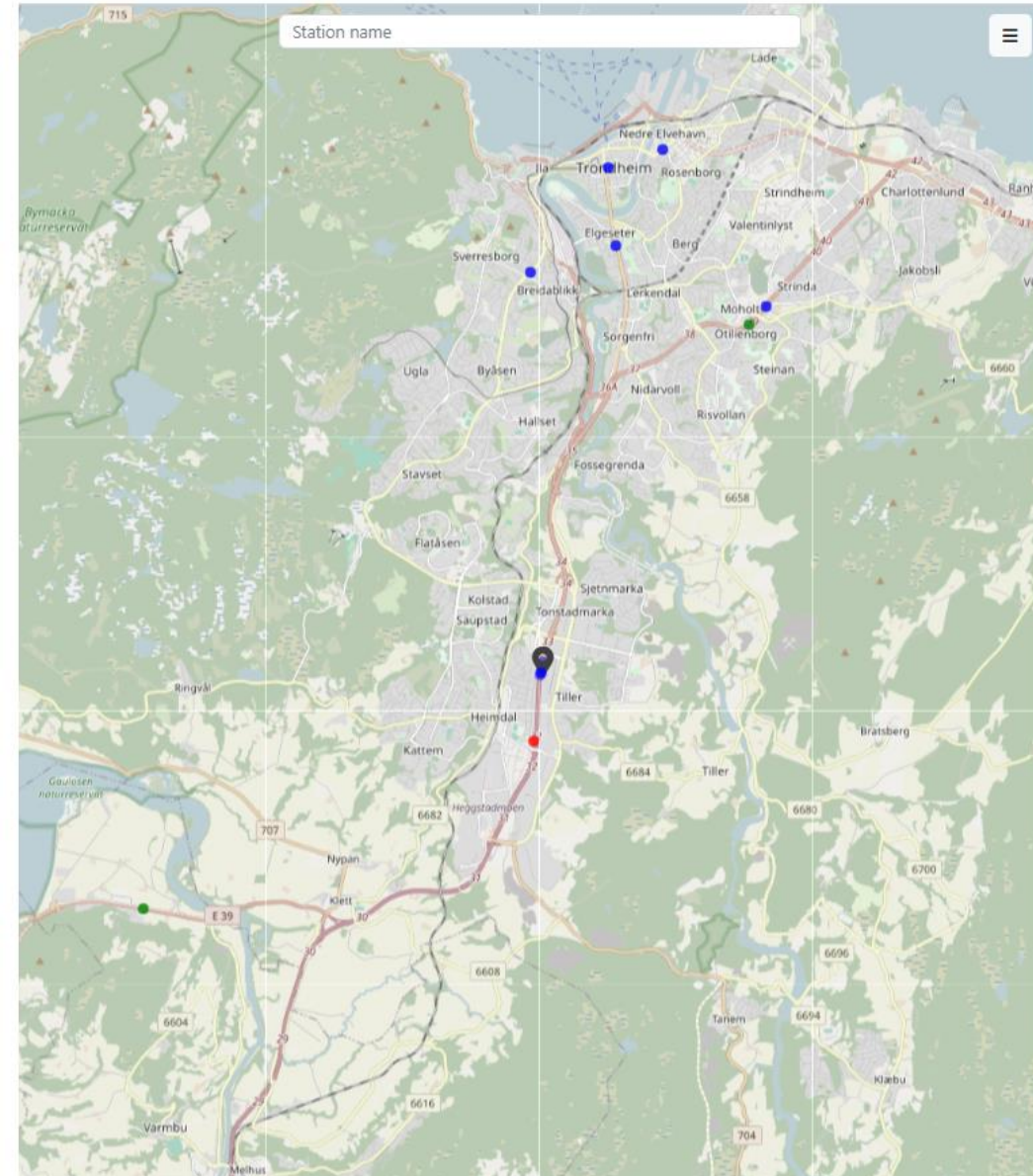
Legend

Temp. & Precip. Surface Meteorology Salt & dust Temp. & Precip NA Activities Model files

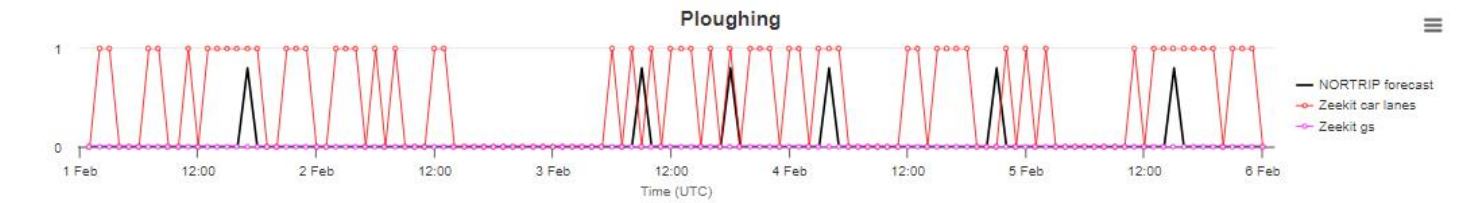
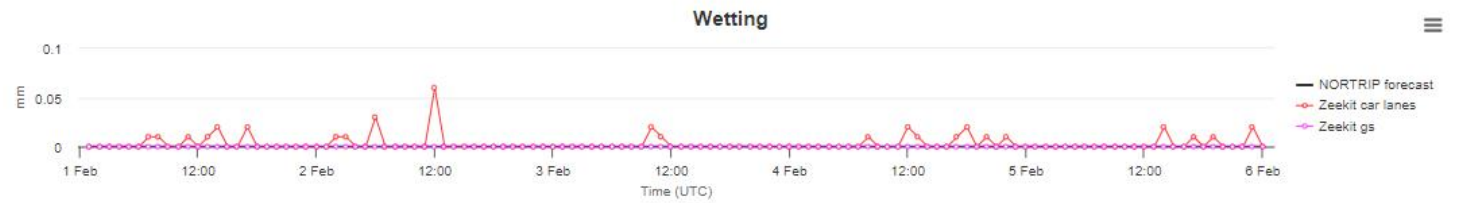
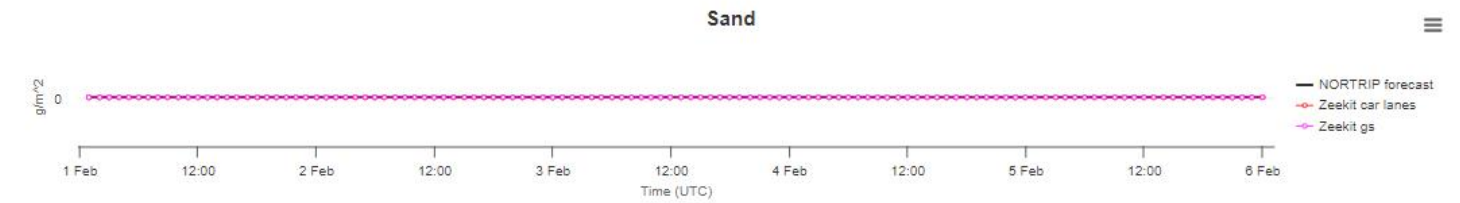
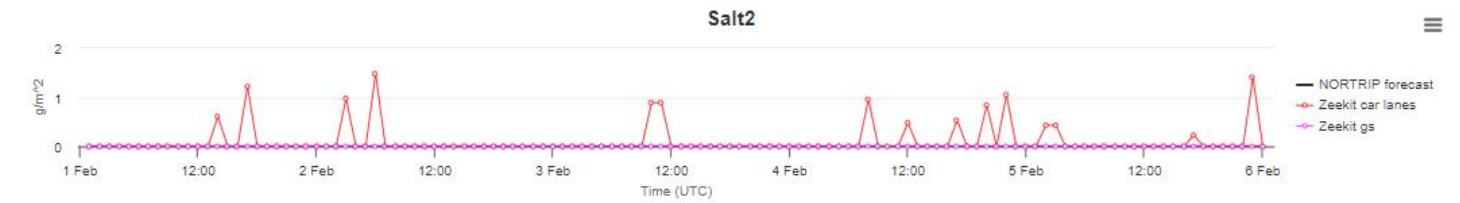
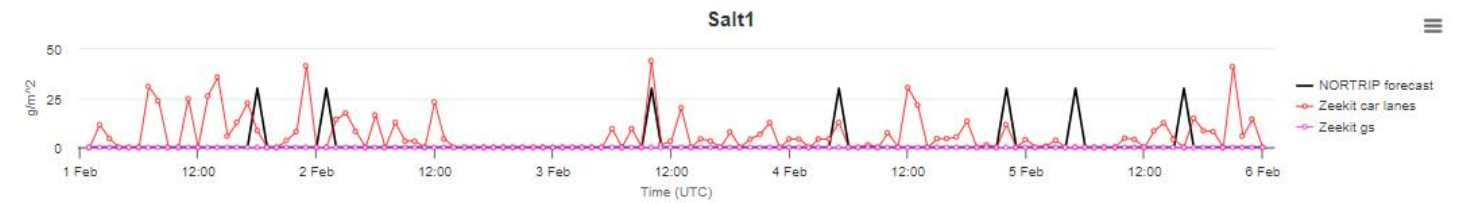


Web based exploratory tool: Winter road maintenance activities

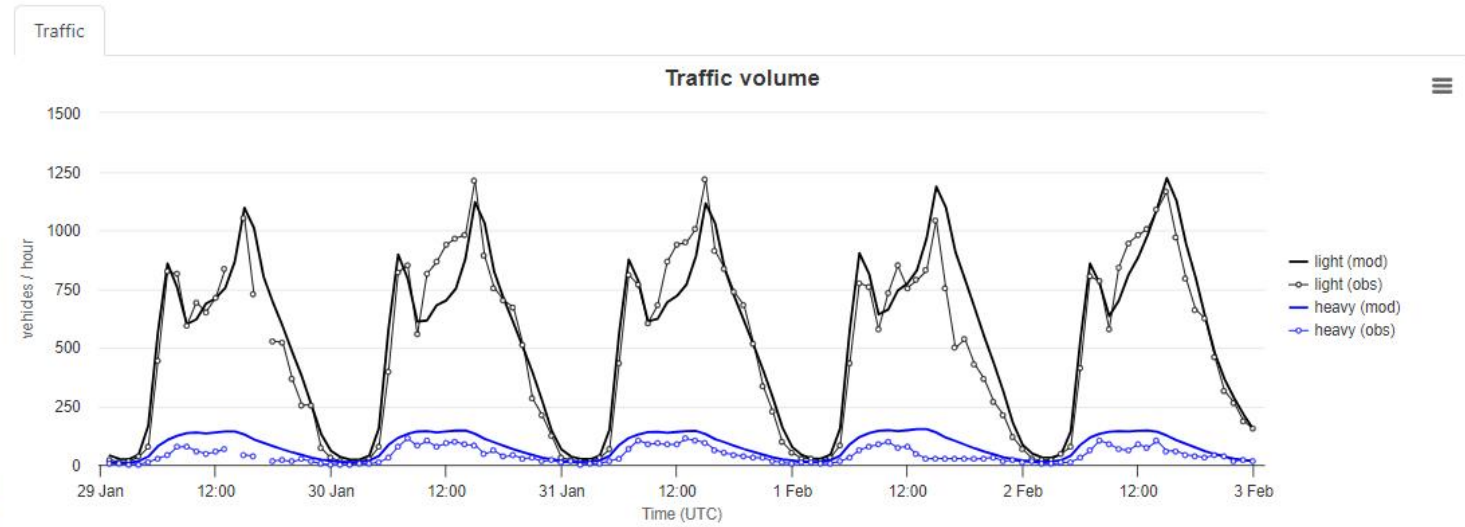
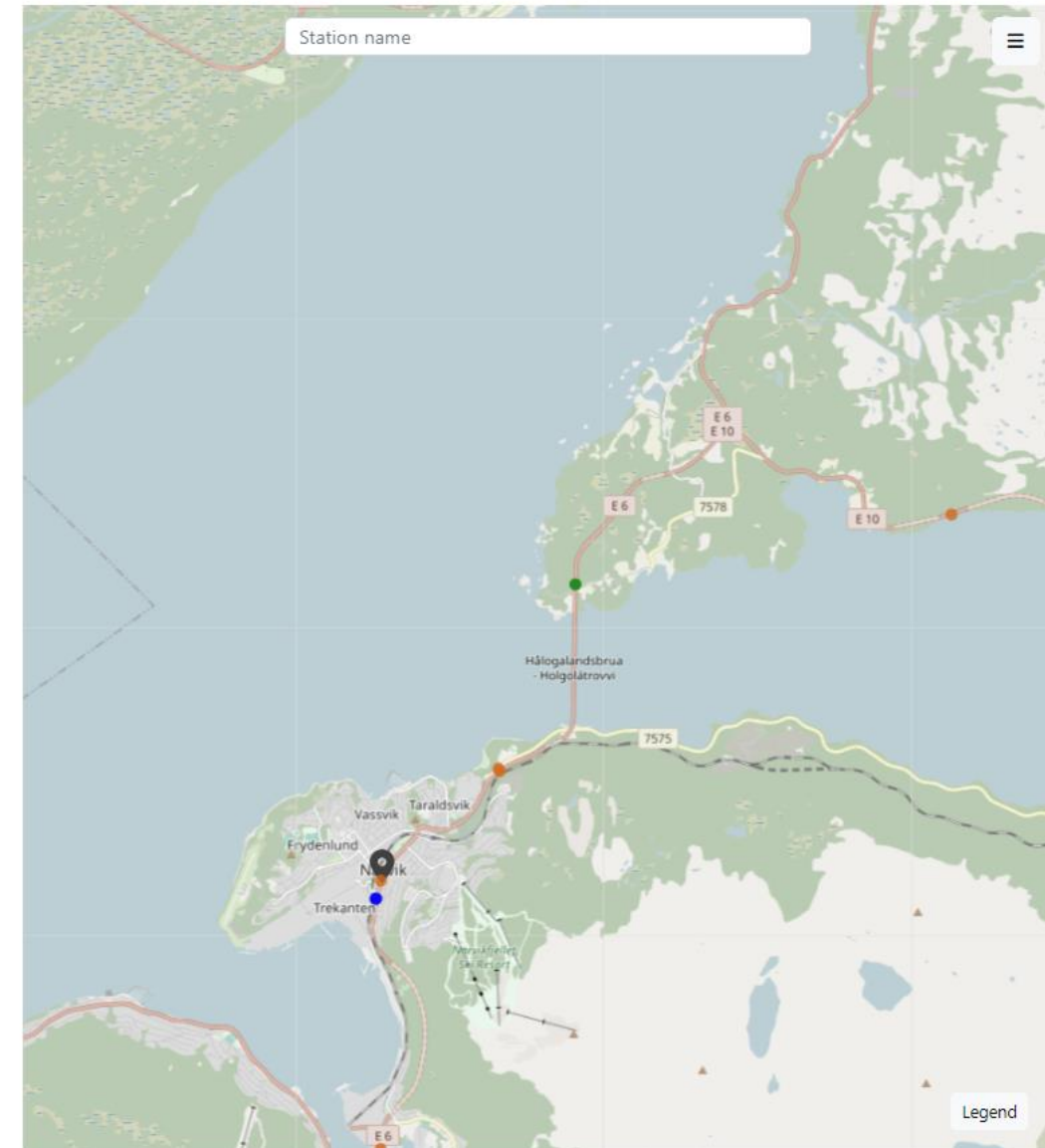
RAW Road Weather Map About



Temp. & Precip. Surface Meteorology Salt & dust Air quality Temp. & Precip NA Activities Model files



Web based exploratory tool: traffic counts



Narvik sentrum - 2024-01-29

Further developments

- Need to better inform the model through observational data
- Machine learning of cameras to recognise surface conditions
- Implementation of interpolated observed road temperatures for initialisation of forecasts
- Further implementation of real time road maintenance activities
- General improvements in model parameterisations including:
 - Melt of snow on shoulders
 - Migration of moisture and salt
 - Tunnels
 - Surface snow/ice and road wear
- Plan is to implement an operational road weather forecast in the coming 2 years