Activities and challenges with uEMEP/EMEP modelling in Norway

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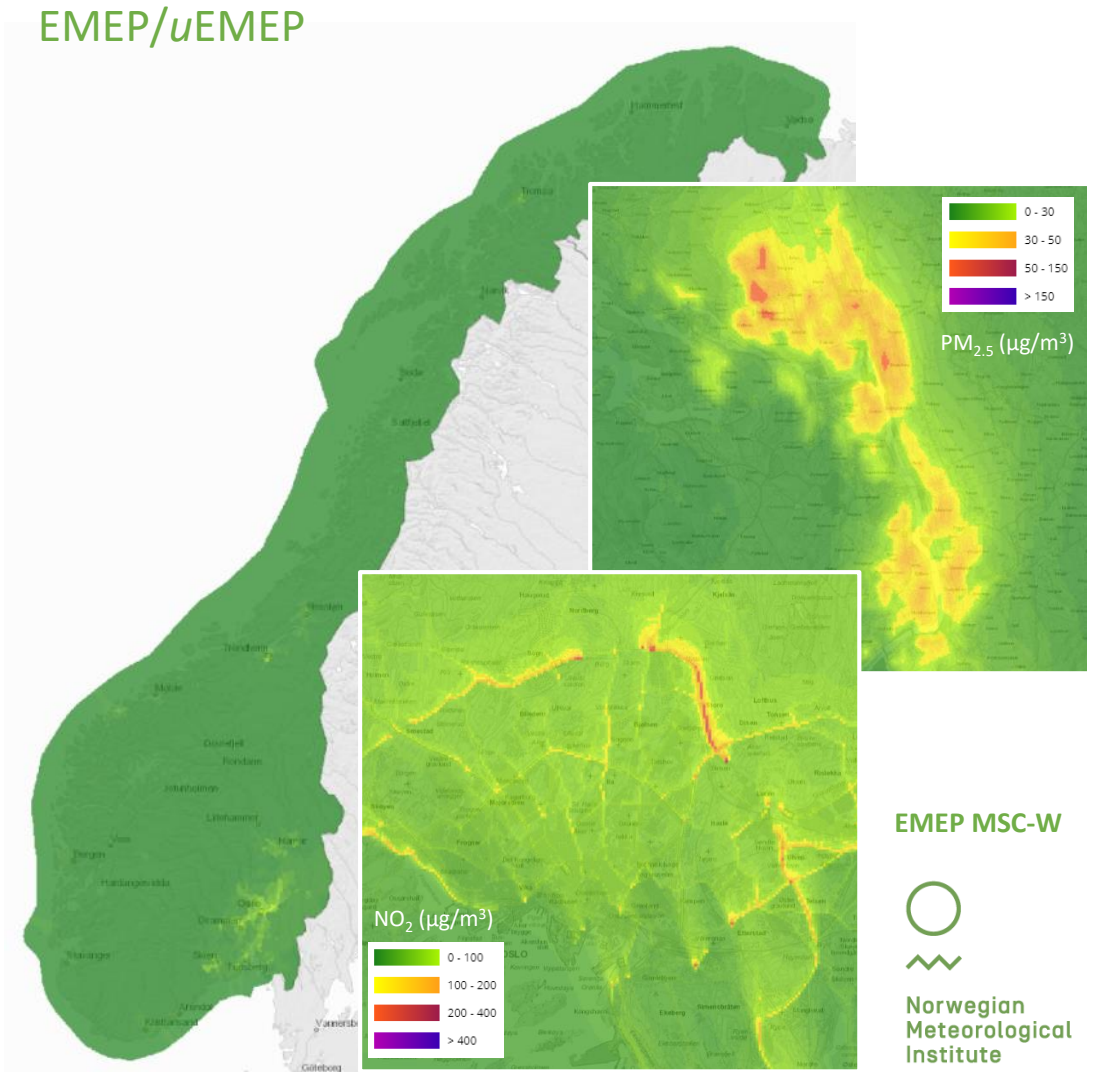

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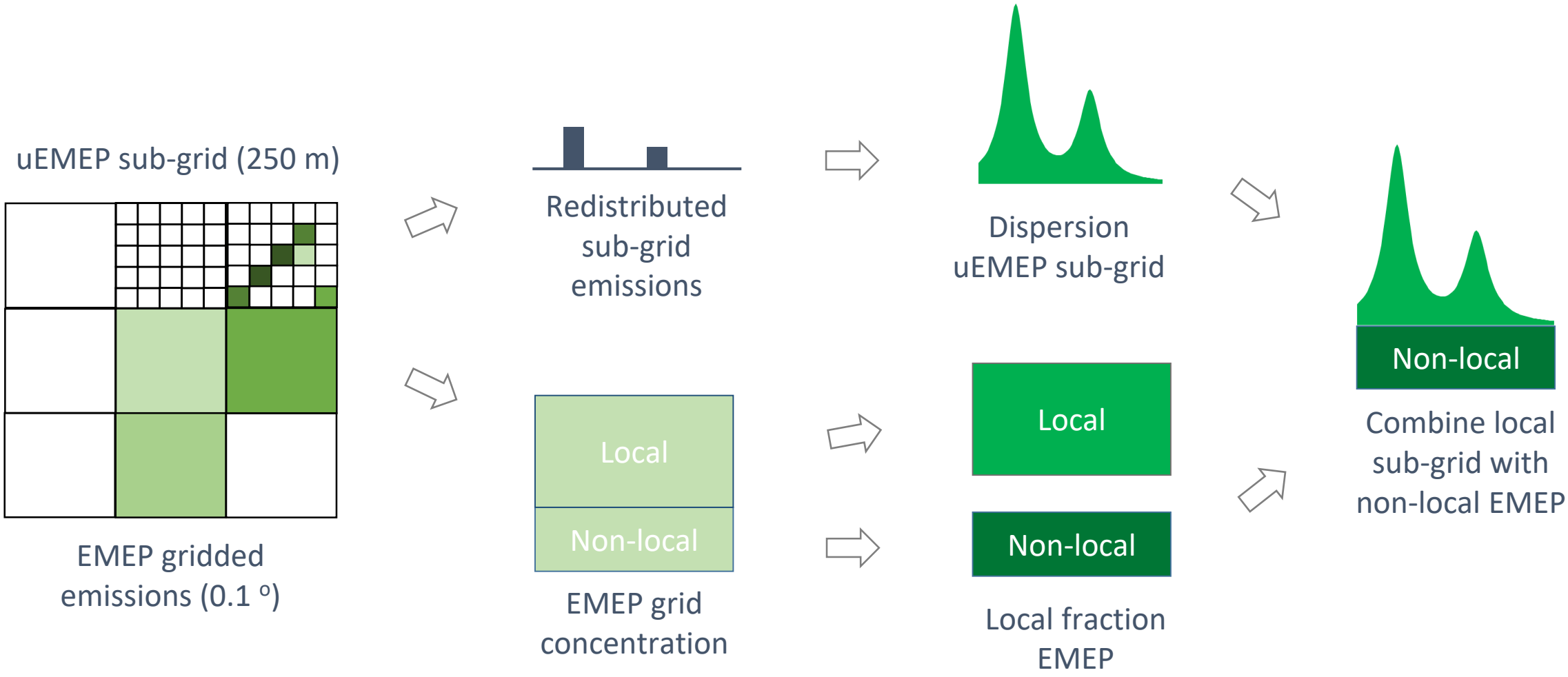
What is uEMEP?

- uEMEP (urban EMEP) is an extension of the EMEP MSC-W model used to downscale EMEP to around 100 m (*European Monitoring and Evaluation Programme Meteorological Synthesizing Centre - West*)
- It can be inserted anywhere in the EMEP domain and deals with double counting of emissions by utilizing the 'local fraction' output from EMEP
- uEMEP dispersion is calculated using a Gaussian dispersion model
- It can be run on hourly data (Norwegian forecast) or can calculate annual means using a rotationally symmetric dispersion kernel (European application)
- Emissions can be provided in two ways. Using independent sub-grid emissions (Norwegian forecast) or by redistributing EMEP gridded emissions using proxy emission data (Europe)
- Source contributions are calculated for each downscaled sector and pollutant
- Maps are made between 50 m and 250 m resolution and calculations at individual receptor points are at 25 m

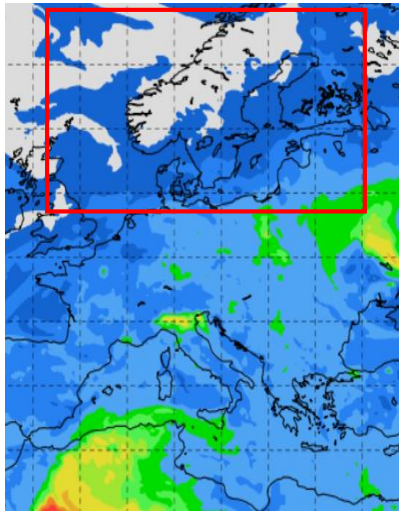
How does uEMEP downscaling work ?



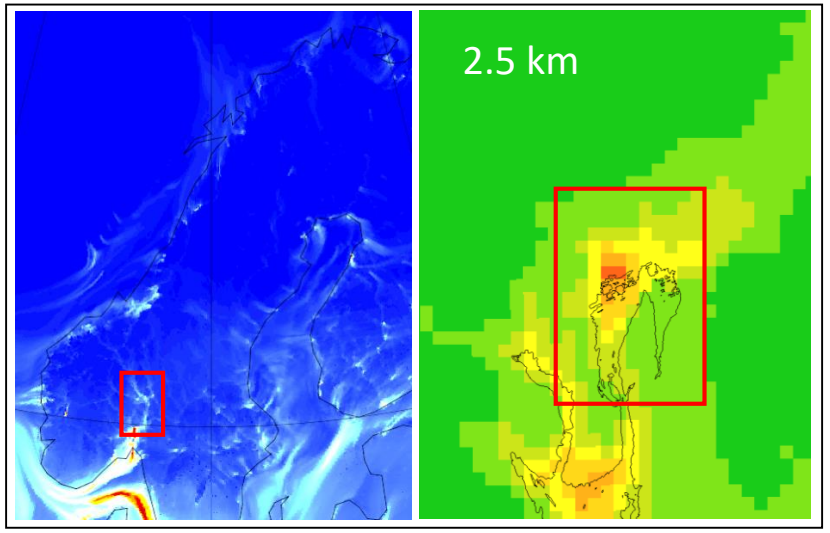
Some points

- Currently downscaled sources include traffic, residential heating, shipping and industry (off road and aviation)
- The uEMEP 'local' downscaling calculation extends over a limited region. In the Norwegian application this is ± 5 km and in the European application this is ± 0.1^{o} . The uEMEP calculations represent all sub-grid emissions within these regions
- Outside of this region, or for sectors that are not downscaled, EMEP provides the 'non-local' contribution
- Downscaling is limitted to primary emissions (NO_X is downscaled and converted to NO_2)
- The sub-grid traffic data are line sources so higher subgrid resolutions will better reflect the traffic contribution and local concentration gradients
- The sub-grid resolution of residential combustion (and other) proxy emissions is 250 m so any higher resolution calculations will not improve these contributions

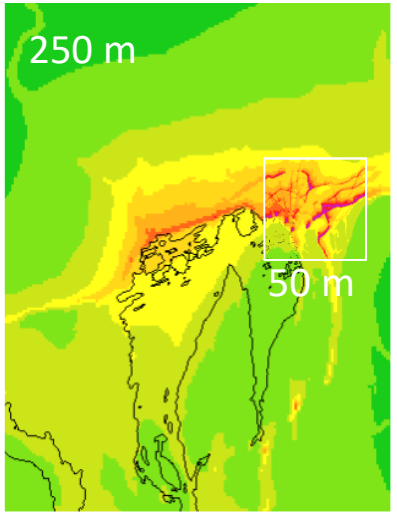
Overview of the Norwegian forecast system



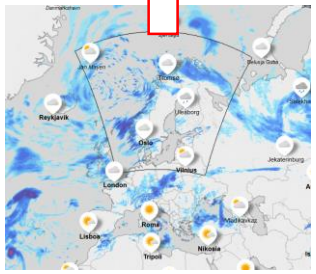
EMEP model for Europe



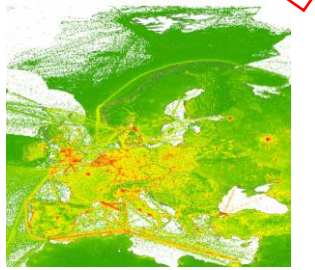
EMEP model for Norway



uEMEP

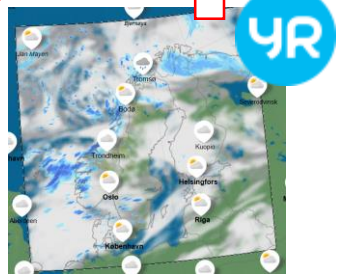


ECMWF global meteorology



EMEP European emissions

Local emissions



AROME meteorology

Activities with uEMEP: Online products in Norway

- ‘Air quality forecast service’ providing 2.5 day forecasts for all of Norway, from 250 – 50 m resolution, every 6 hours (https://luftkvalitet.miljodirektoratet.no/)
- ‘Professional user service’ provides 100 m concentration maps, exposure, source contributions and emissions for each of the 356 municipalities in Norway, 5 years (2016 - 2020) available (https://www.miljodirektoratet.no/tjenester/fagbrukertjeneste-for-luftkvalitet/)
- ‘Evaluation reports’ against observations, all years (https://met.no/prosjekter/luftkvalitet/evaluering-av-luftkvalitets-modellen/)
- ‘Mitigation calculator’ allows muncipalities to assess the impact of measures on air quality online (https://www.miljodirektoratet.no/tjenester/tiltakskalkulator-for-luftkvalitet/)
- ‘Public health profile’, publication of population weighted concentrations for each municipality as part of the general health profile provided by the Public health institute (https://www.fhi.no/hn/folkehelse/folkehelseprofil/)
- MET Norway does not carry out individual air quality planning or assessment studies at city level but the national products are available if these are considered appropriate

Activities with uEMEP: Additional activities

- Used to assist in the review of the Norwegian limit values for PM
- Provides high resolution nationwide concentration fields to the Public Health Institute for national health impact assessments
- Is being used to assist in the review of the European air quality directives
- Will be used in the review of the Gothenburg Protocol
- Will be used in support of the development of the EU Commission’s third Clean Air Outlook
- Is used in various European applications within FAIRMODE
- Ammonia modelling in The Netherlands

Applications and activities with NORTRIP

NORTRIP is a road dust emission and road weather model used widely in Norway and in other Nordic countries

- Used in all Norwegian air quality modelling applications at MET Norway, covering all roads in Norway
- Used for assessment and visualisation of road weather conditions (https://aq.met.no/roadweather/)
- Current study on model performance when using real time winter maintenance activity data in Trondheim
- Model development and application in other Nordic countries through NORDUST2 (NordFoU)
- Will be applied in a pilot study with Avinor/Sintef/NTNU for implementation at Norwegian airports (NFR)

Challenges: scientific

- High resolution emissions remain the greatest challenge
- On average, over all stations, results are generally quite good but for individual stations there can be large deviations
- We see every year the same stations giving the same bias
- Timing of road dust emissions for forecast applications remains a problem
- We see a strong ambient temperature dependence for NO_X traffic exhaust emissions, which we have assessed and corrected for
- Wood burning emissions are much improved with the MetVed model and show, on average, the correct temperature dependence based on the Heating Degree Day concept. However, large deviations can occur between stations
- Gaussian dispersion modelling does not manage stagnant low wind recirculation situations, but these are very few
- Long range episodes, despite assimilation in the EMEP model, are often not satisfactorily modelled

Challenges: technical

- The Norwegian forecast is produced every 6 hours. To provide this on time all calculations with uEMEP must be carried out within a 2 hour window. Prior to this meteorology and EMEP4EU and EMEP4NO must also be produced (not done in house)
- For Norway uEMEP calculates on around 7 million subgrids, taking emissions from a 10 x 10 km^2 window for each. This requires 200 processors be permanently available for uEMEP (in house)
- There is currently around 100 TB of uEMEP related data on the MET servers
- To be able to do all this requires sizable IT competence, well established and maintained computer facilities, operational protocols/standards and robust delivery systems (API's)
- Luckily all this is available at MET Norway

The end