Norwegian Meteorological Institute

Modelling air pollution in Europe and the nordic countries - uncertainties and opportunities

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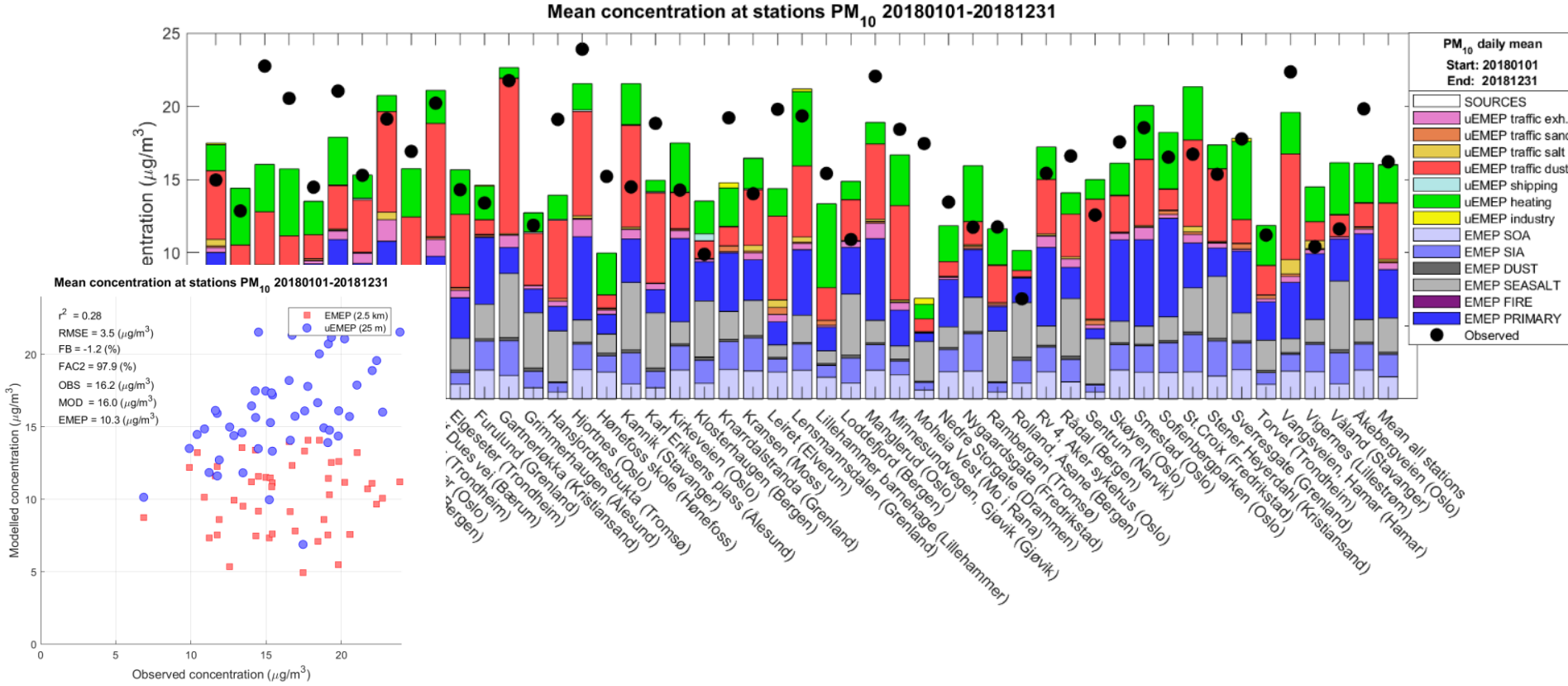
NKL workshop 19-20 November 2019, Oslo

Propagate the local/nordic competence on air quality modelling & emissions to European scale

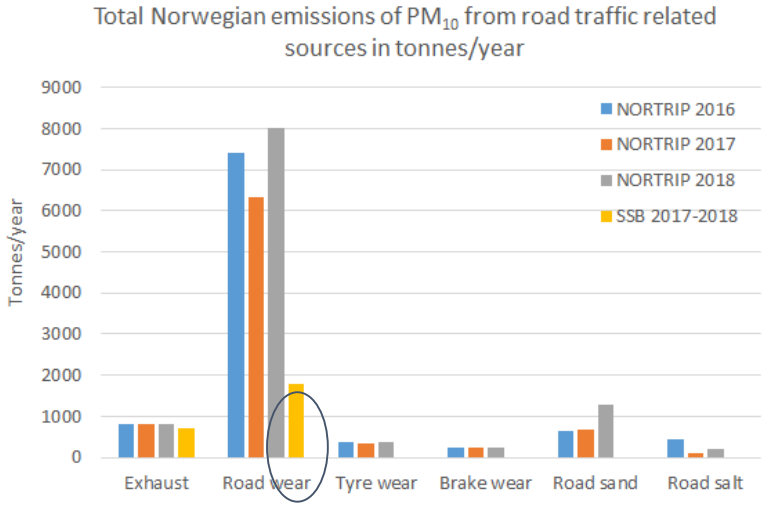
- Road dust
- Wood burning

PM_{10} in Norway

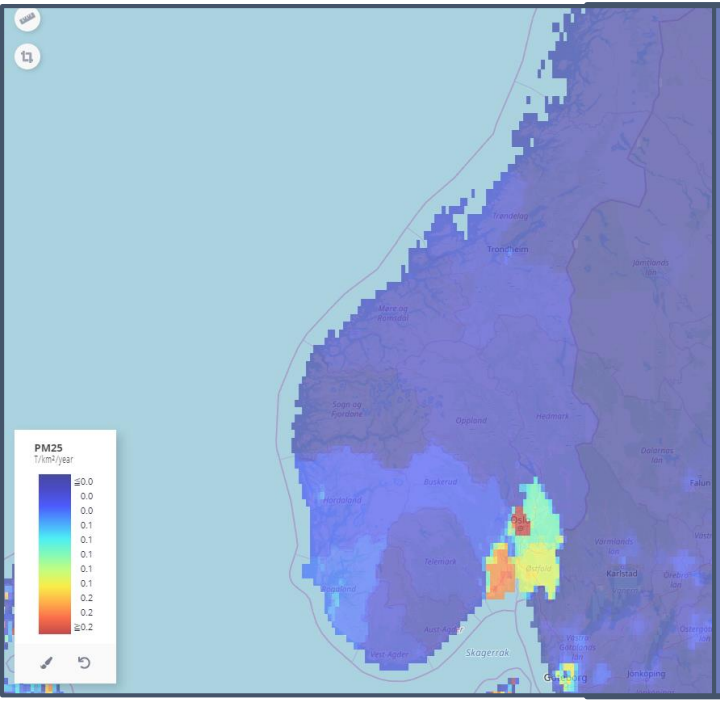


Road dust emissions in Norway

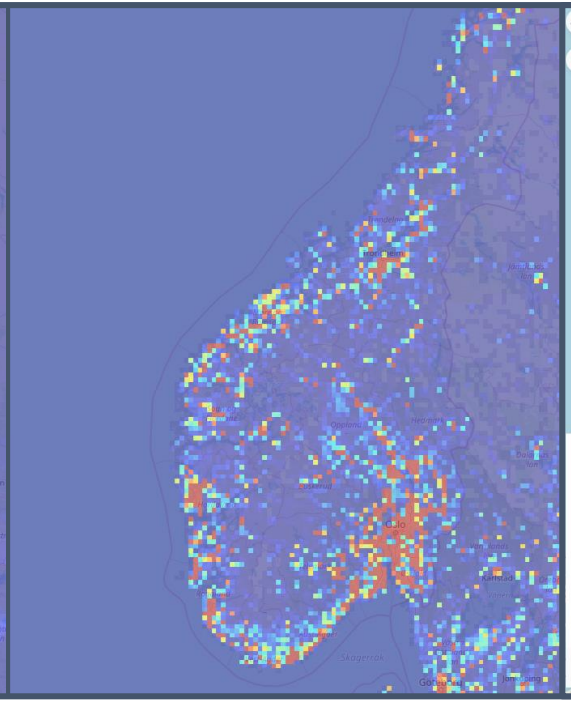
- Severe underestimation of road dust in national (EMEP) emissions
- Road dust model (s) available on road link level - needed on larger scale (meteo dependent)
- Ensure the link to international work (CLRTAP, EU), how to operationalize?



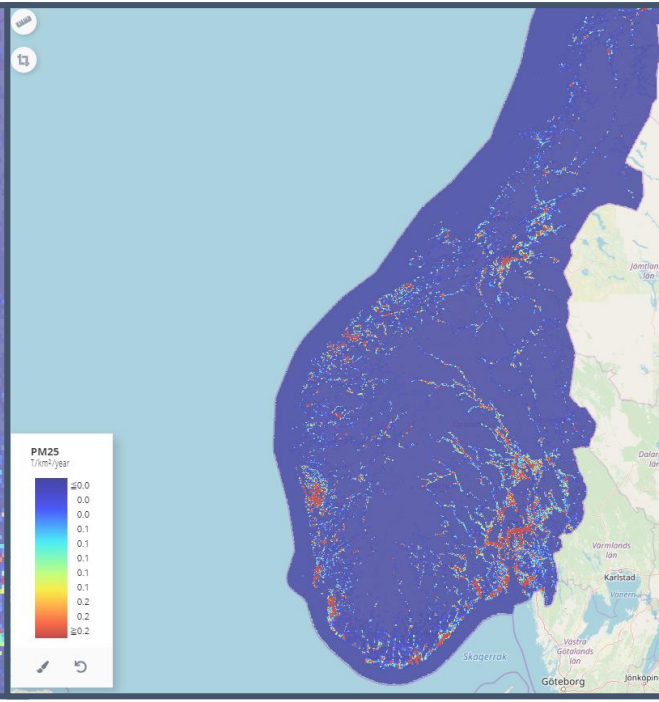
Wood burning



EMEP emissions



TNO-CAMS emissions



MetVed (NILU) emissions

What does Copernicus Atmosphere Monitoring Service (CAMS) offer?

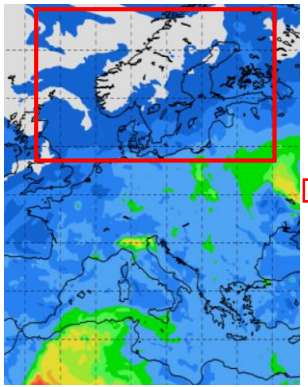
- Regional scale forecasting and **reanalysis for air quality** (concentrations, but depositions in the future)
- Different global/regional services: aerosol alert, city-SR, scenario SR
- **Downstream services, boundary conditions** (Especially valuable for e.g. forest fires, sahara dust
- **Methodology & data** (emissions incl. **condensables**, **satellite data**, data assimilation, forest fire product..)

Not offering:

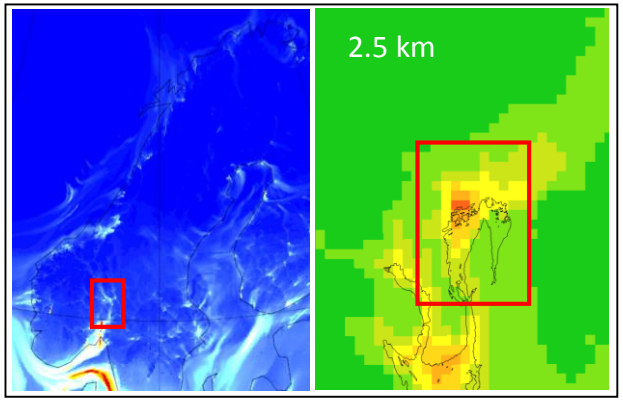
- local scale
- process understanding/research
- long term consistent trends
- cannot be used in IAM, bias correction without understanding (e.g. AOD assimilation)

Global to local scale

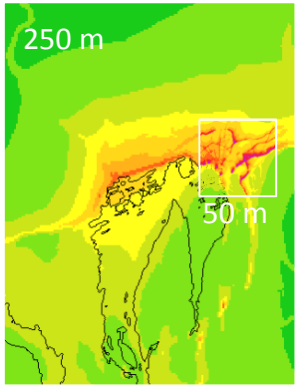
CAMS global model



CAMS models for Europe

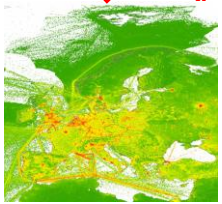


EMEP model for Norway (with local fraction)

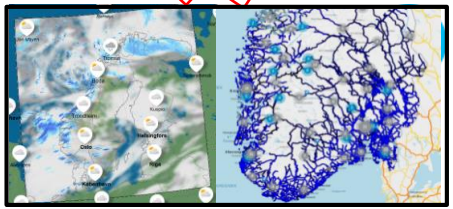


uEMEP

ECMWF global meteorology



European emissions



Local meteorology Local emissions

Monitoring of ozone effects for NEC

2-5% loss of wheat production in Norway due to ozone effects (Mills et al 2018)

AOT40: can be calculated directly on observation sites

POD: depend on soilwater, radiance, temperature etc

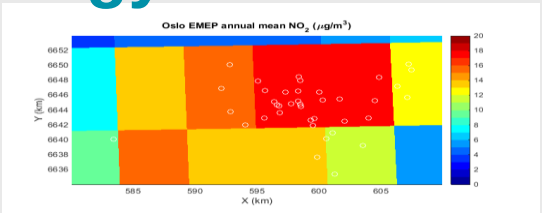
Explore 3D-Var chemical data assimilation of surface ozone for calculation of POD for all landuse in e.g. Norway

Multi-scale models/Downscaling

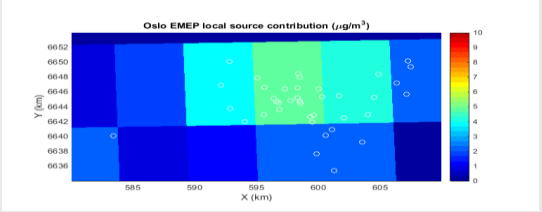
- If you want to know the LRT contribution of urban pollution you also need to know the local contribution (and vice versa)
- SHERPA-City, Vito, uEMEP
- Keep consistent through the scales
- Using fine scale emissions or proxy data (per emission sector/activity) to downscale (the local part)

The *u*EMEP Concept - a downscaling methodology

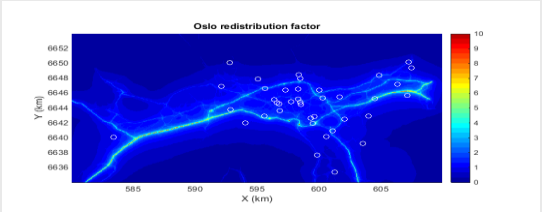
Start with coarse (0.1°x0.1°) EMEP grid:



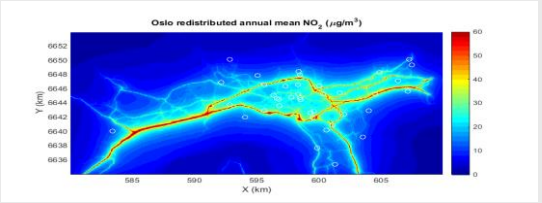
Calculate local contribution from each **sector** in each grid (The local fraction method):



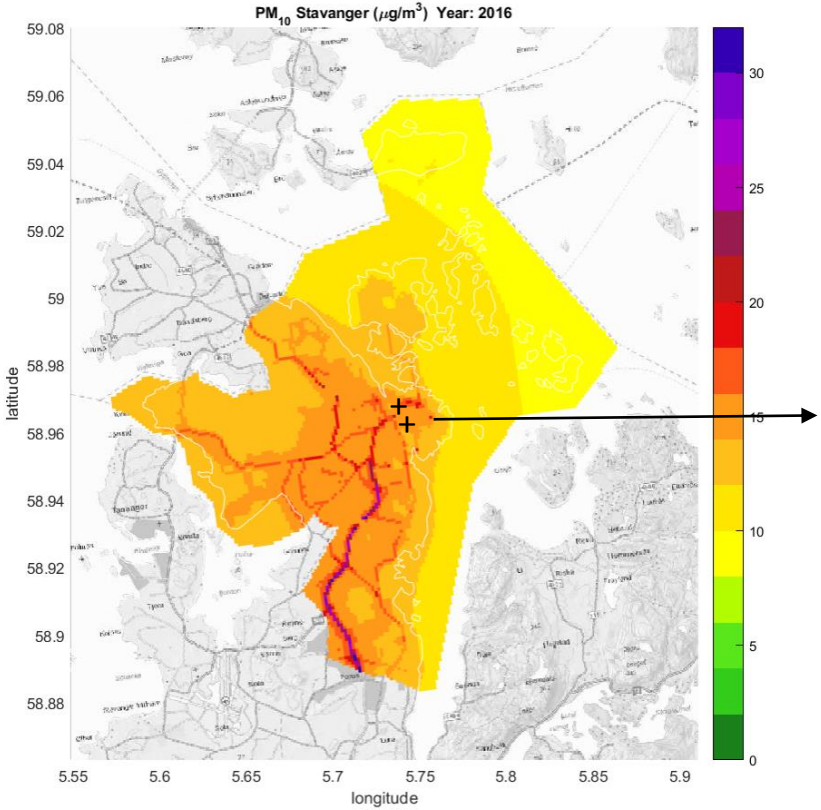
Use ‘proxy data’ (or fine scale emissions) + gaussian model to redistribute the local contribution):

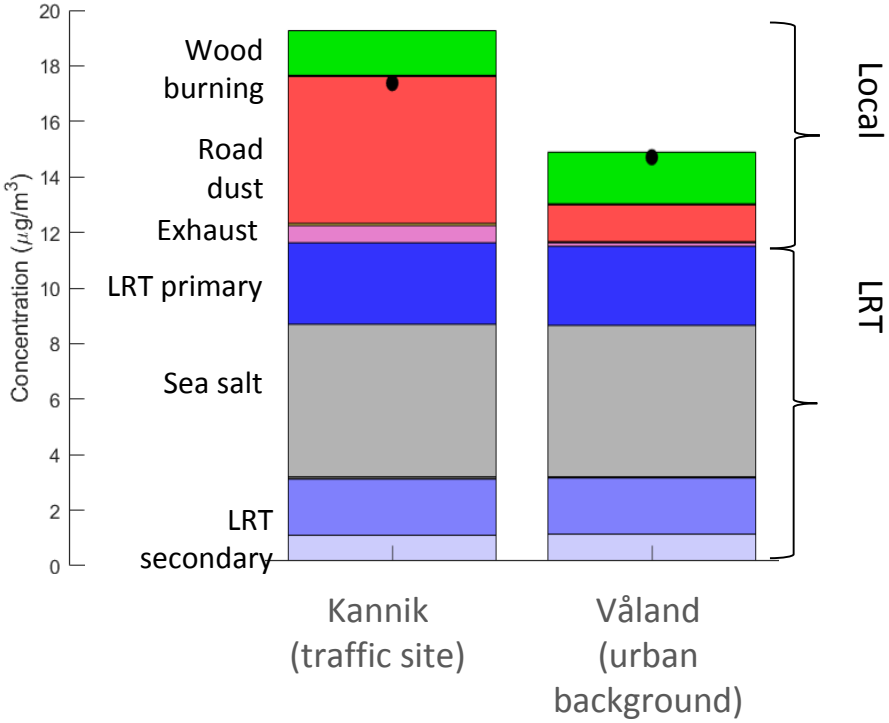


Add non-local from EMEP to the new local:



Example: sources of PM_{10} in Stavanger

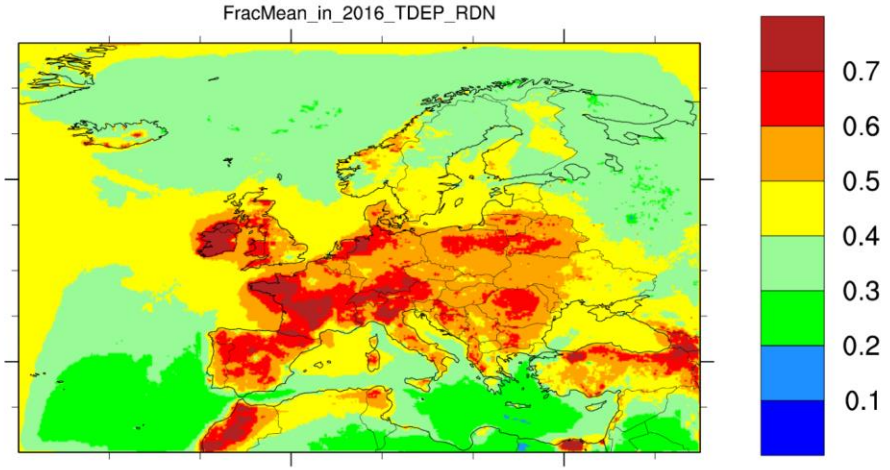




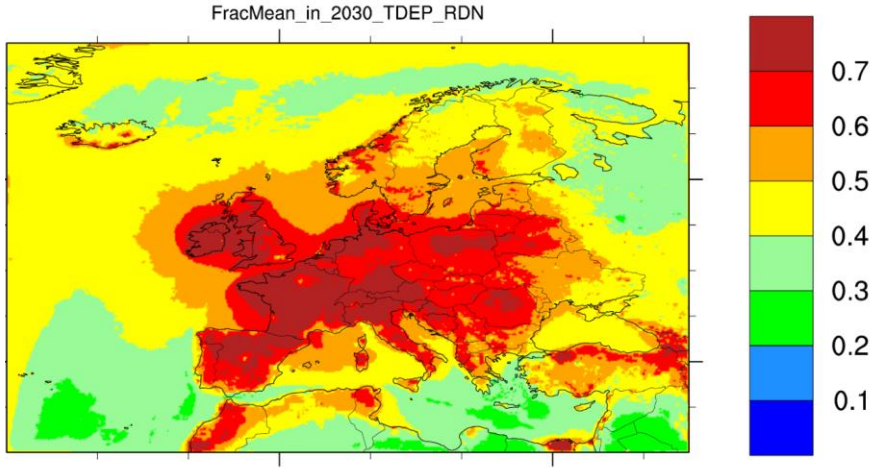
A nordic project for a pilot on an cost-effect based approach for different governance levels (based on health effects)?

N from agriculture, the largest remaining problem

Fraction of reduced N dep/total N dep



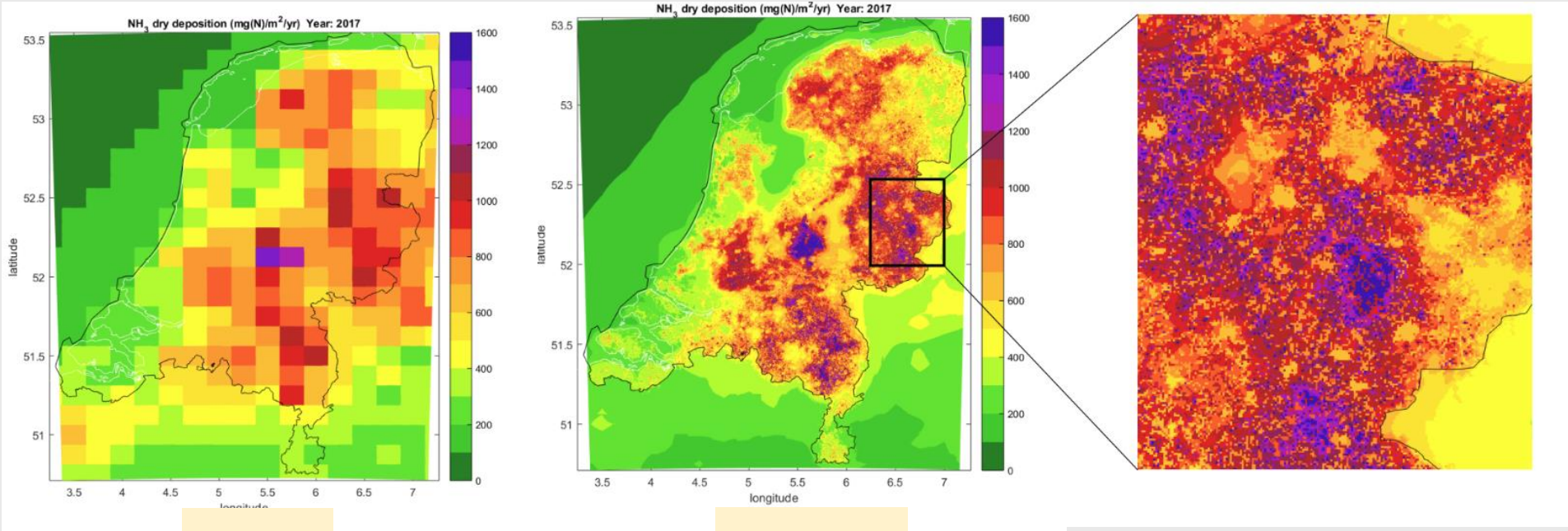
2016



2030

More than 70% of N deposition in 2030 due to ammonia emissions for large parts of Europe
How efficient will reduction of agricultural emissions be for PM reductions post NEC2030?

Multi-scale modelling for depositions



Ca 15 km

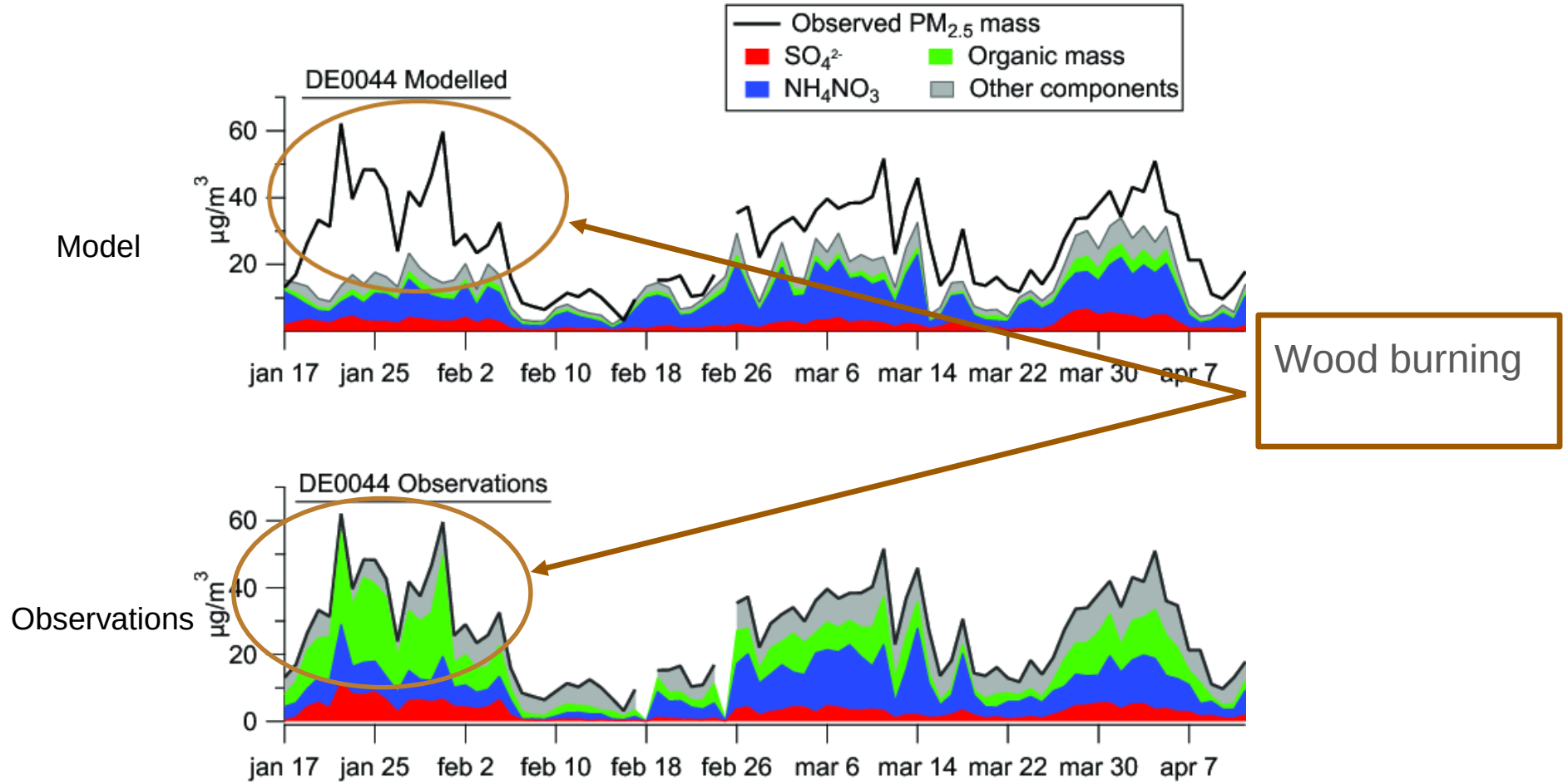
250mx250m

Better data for ecosystem effects, Natura2000, cost-effective assessment

Downscaling for Europe is possible, but needs development & detailed data

Nordic cooperation?

The ‘condensables problem’



‘Condensables’

- IIRs of 13 countries for ‘1A4bi Residential: Stationary’:
  - 3 include, 3 not include, 7 unknown/partially included

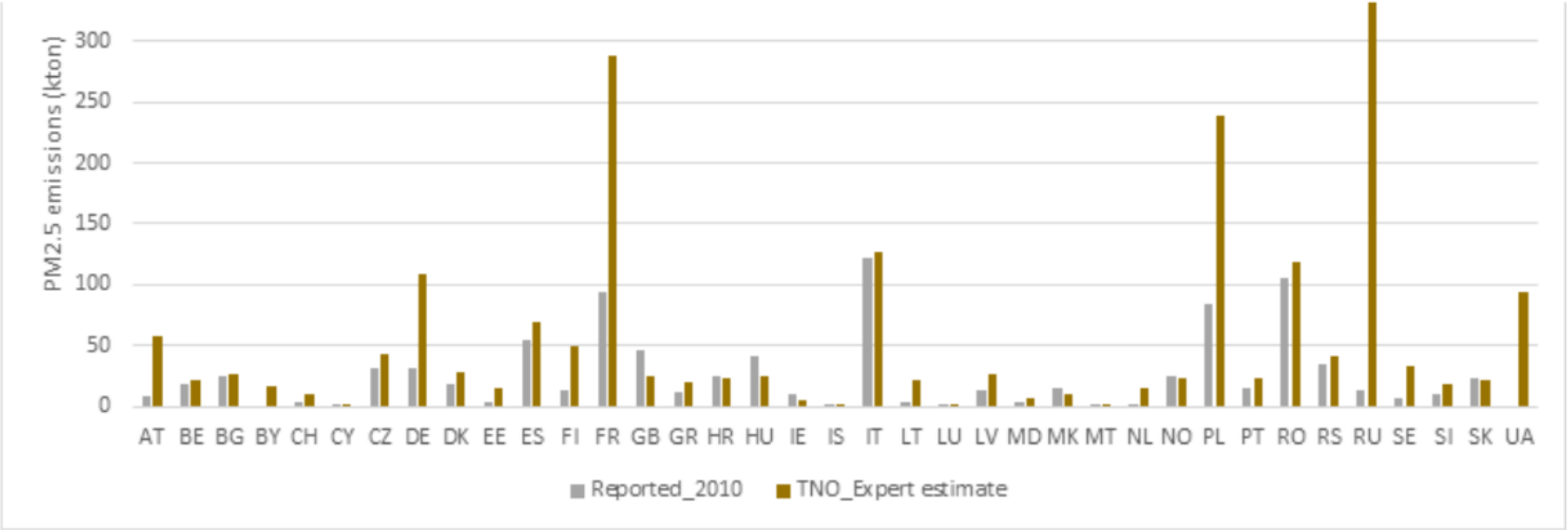
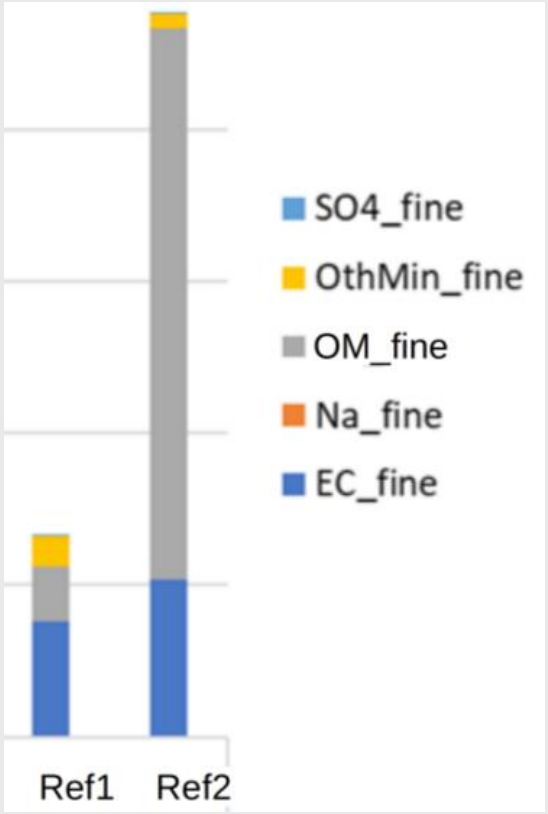
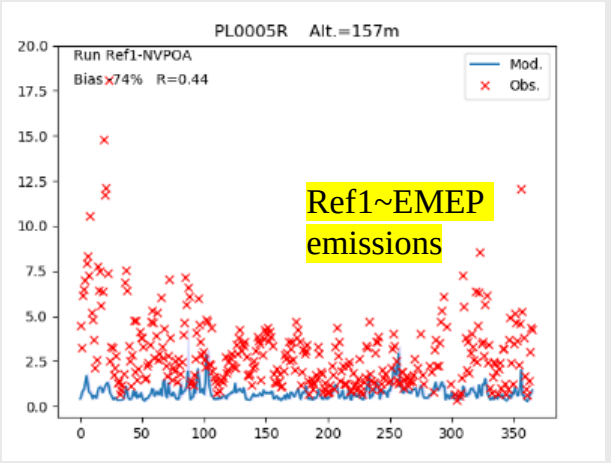
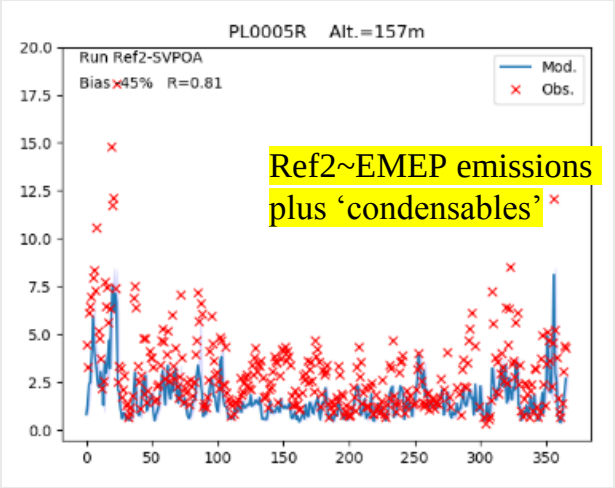


Figure 5.2: Reported $PM_{2.5}$ emissions from small-scale combustion for 2010 compared to TNO expert estimate. Updated from TFEIP/TFMM (2018).

Poland







Residential heating emissions for PL using a generic European PM split for Ref1 and source and appliance specific PM split for Ref2 (CAMS/TNO)

Workshop: How should condensables be included in PM emission inventories reported to EMEP/CLRTAP? Funding from NMR

Aims: Harmonise and improve approaches to PM inventory emissions and modelling, accounting for so-called condensable compounds.
Method: Prepare and organise a workshop to bring together experts in emission measurements, atmospheric chemistry, inventory experts and modellers to systematically consider and recommend best approaches for dealing with semi-volatile emission with regard to PM2.5. Document conclusions in report for EMEP Steering Body and relevant Task Forces under EMEP(TFEIP, TFMM, TFIAM)

To be organized March 2020. MSC-W & TFMM, TFEIP, TFIAM, CEIP, CIAM +

The EMEP/MSC-W model

	Resolution	Model	Problem
2000	150 km x 150 km	Europe	Acification Ozone Eutrophication
	50 km x 50 km	+ Unified + global	Hemispheric impact
		+ SOA + POD	Health
2015	0.1x0.1 degree		LRT and cities
2023?	~100m	+ local	Effect based protocol on health, focus areas ?
	Seamless in space and time?	+++ Earth system model?	Integrated approaches ?

The End

Models in ‘the future’

- Computer power will not continue to grow with the same speed as before
- Multi-scale models
- Coupled `problems’ (reactive nitrogen cycle, climate, biodiversity, the water cycle ...)
  - Earth system models
  - Coupling of the most important processes, photosynthesis-based flux-response models, dry dep (coupling to climate)
- Machine learning, big data, low cost monitors

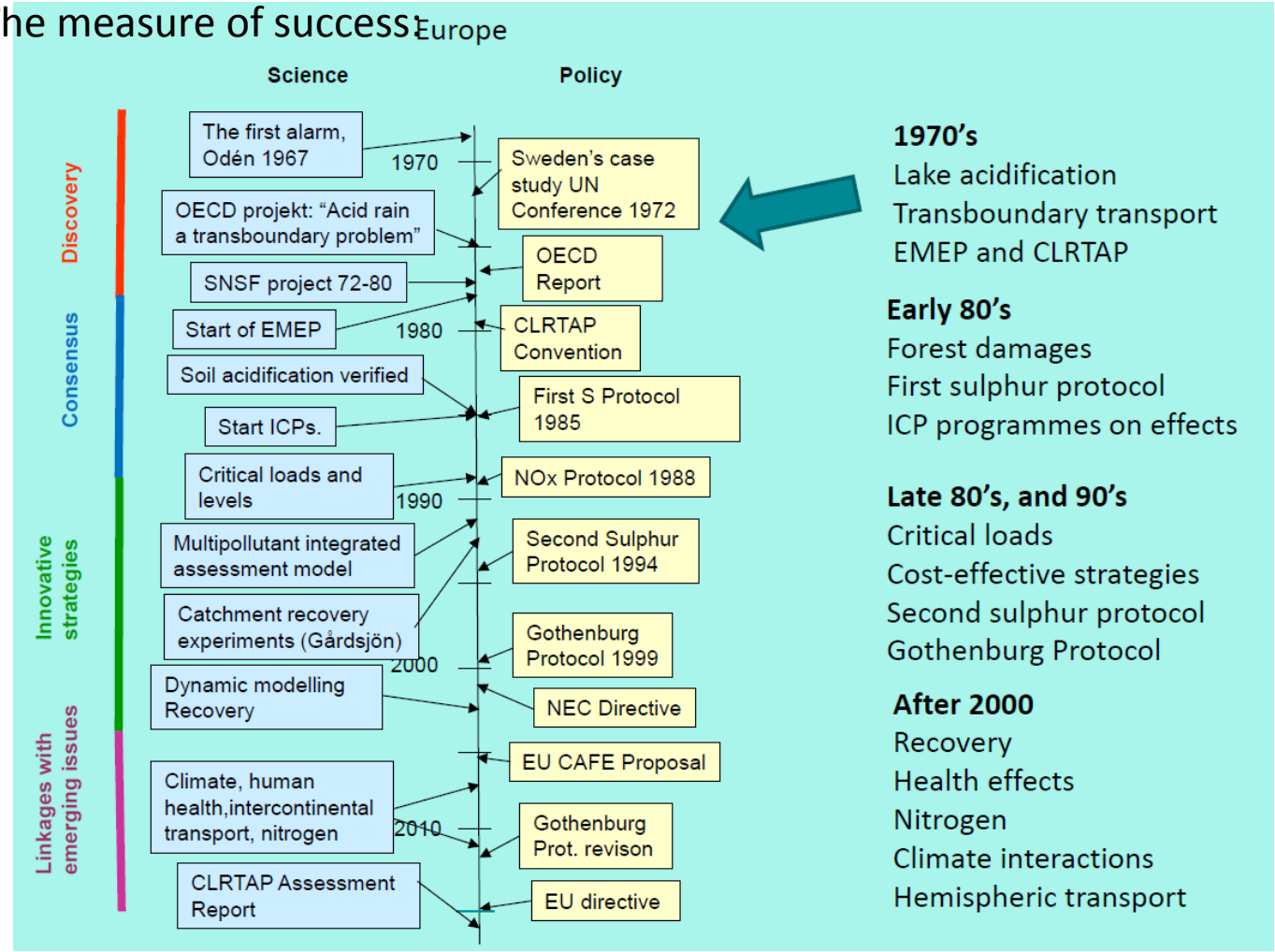
BC/OC source attribution and emission evaluation

(Measurements will become available, and together with modelling they can evaluate sources and emission estimates, gridding)

Metans rolle for O3 trender (og dermed effekter på vegetasjon)

Utvide varsling til MetCoop området

The measure of success: Europe

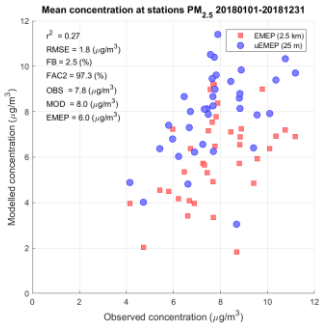


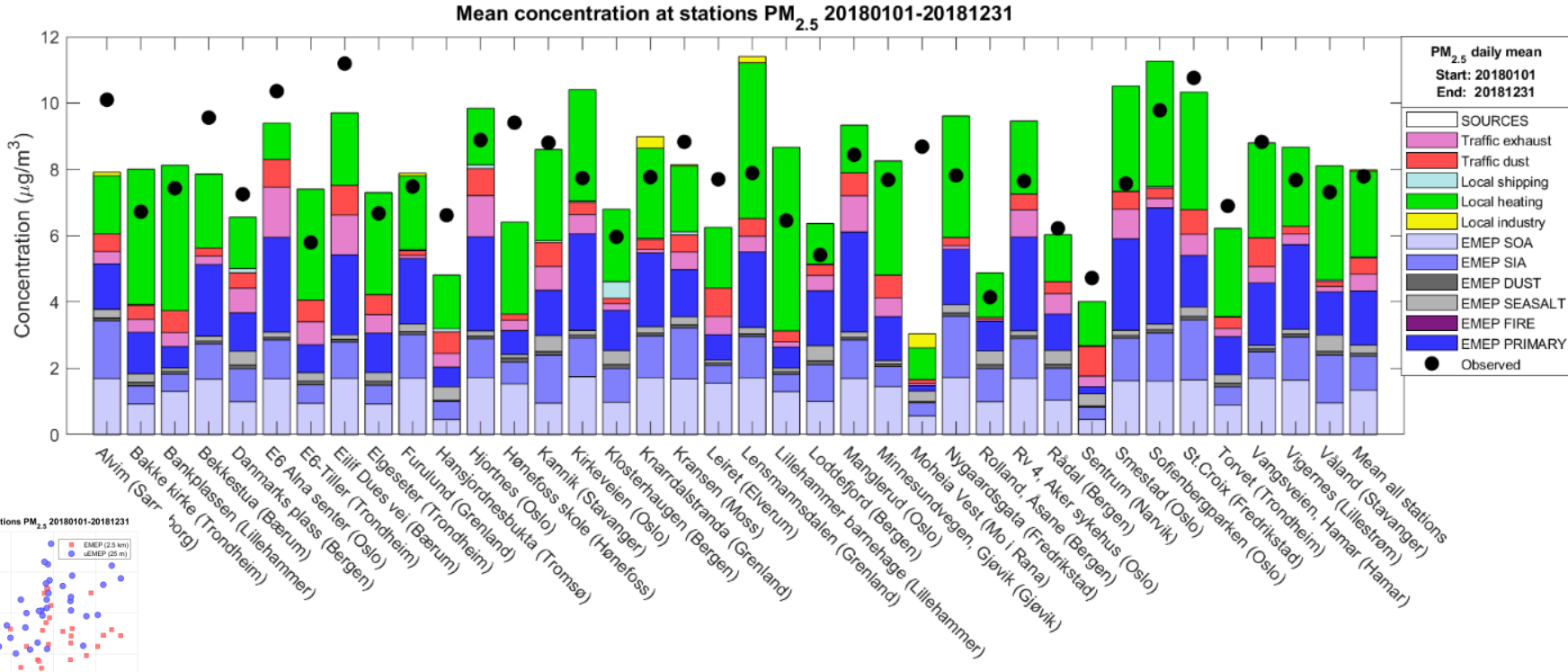
1970's
Lake acidification
Transboundary transport
EMEP and CLRTAP

Early 80's
Forest damages
First sulphur protocol
ICP programmes on effects

Late 80's, and 90's
Critical loads
Cost-effective strategies
Second sulphur protocol
Gothenburg Protocol

After 2000
Recovery
Health effects
Nitrogen
Climate interactions
Hemispheric transport


Mean concentration at stations PM2.5 20180101-20181231
r2 = 0.27
RMSE = 1.8 (μg/m3)
FB = 2.5 (%)
FAC2 = 97.3 (%)
OBS = 7.8 (μg/m3)
MOD = 8.0 (μg/m3)
EMEP = 6.0 (μg/m3)
EMEP (2.5 km)
uEMEP (25 m)
Modelled concentration (μg/m3)
Observed concentration (μg/m3)


Mean concentration at stations PM2.5 20180101-20181231
Concentration (μg/m3)
PM2.5 daily mean
Start: 20180101
End: 20181231
SOURCES
Traffic exhaust
Traffic dust
Local shipping
Local heating
Local industry
EMEP SOA
EMEP SIA
EMEP DUST
EMEP SEASALT
EMEP FIRE
EMEP PRIMARY
Observed
Alvim (Sarpsborg)
Bakke kirke (Trondheim)
Bankplassen (Lillehammer)
Bekkestua (Bærum)
Danmarks plass (Bergen)
E6 Alna senter (Oslo)
E6-Tiller (Trondheim)
Eilif Dues vei (Bærum)
Elgeseter (Trondheim)
Furulund (Grenland)
Hansjordnesbukta (Tromsø)
Hjortnes (Oslo)
Hønefoss skole (Hønefoss)
Kannik (Stavanger)
Kirkeveien (Oslo)
Klosterhaugen (Bergen)
Knarrdalstranda (Grenland)
Kransen (Moss)
Leiret (Elverum)
Lensmannsdalen (Grenland)
Lillehammer barnehage (Lillehammer)
Loddefjord (Bergen)
Manglerud (Oslo)
Minnesundvegen, Gjøvik (Gjøvik)
Moholia Vest (Mo i Rana)
Nygaardsgata (Fredrikstad)
Rolland, Åsane (Bergen)
Rv 4, Aker sykehus (Oslo)
Rådal (Bergen)
Sentrum (Narvik)
Smestad (Oslo)
Sofienbergparken (Oslo)
St.Croix (Fredrikstad)
Torvet (Trondheim)
Vangsveien, Hamar (Hamar)
Vigernes (Lillestrøm)
Våland (Stavanger)
Mean all stations

Better modelling for air quality in nordic countries (European perspective) - major uncertainties

REGIONAL SKALA:

-SOA summertime, BVOC (landuse from satelittes)

-Hva med ozone? Særlig i fremtiden