HARMO22
10 – 13 June 2024, Pärnu, Estonia

Application of SILAM model on Airviro platform

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SILAM, on Airviro!

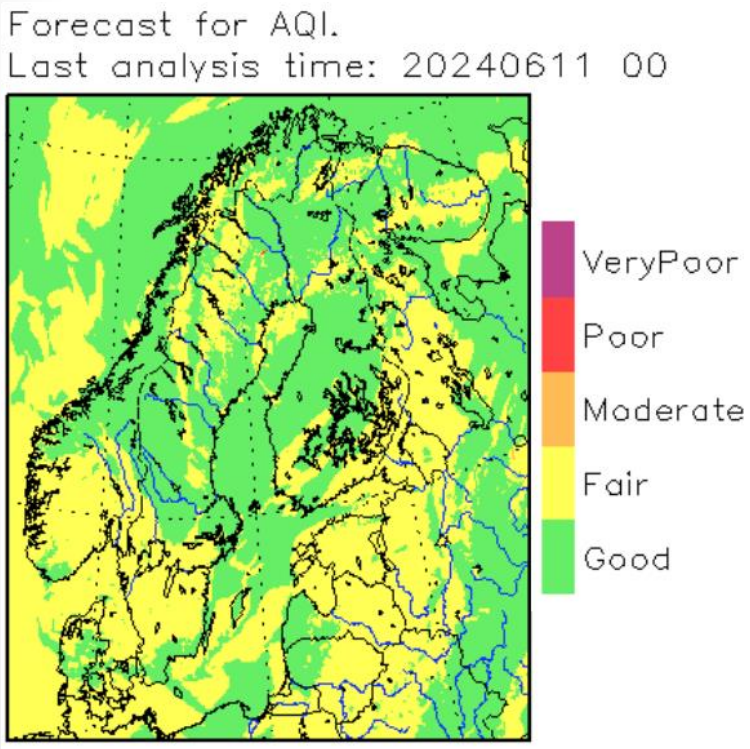
System for Integrated modeLling of Atmospheric coMposition

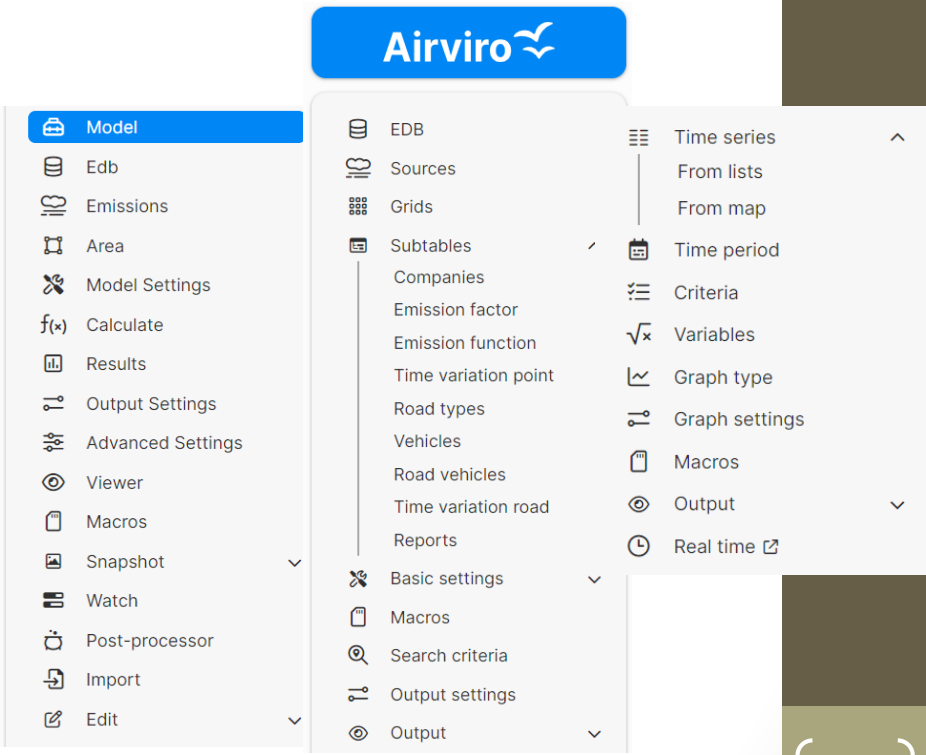
- atmospheric chemistry-transport model, developed by FMI

+

Airviro – integrated software platform for air quality management

- for time series, emissions and dispersion, by Apertum AB





- Pilot project at EERC to join them.

Aim of study: validating the model in Estonian domain after setup.

Model timeseries comparison with measurements at stations.

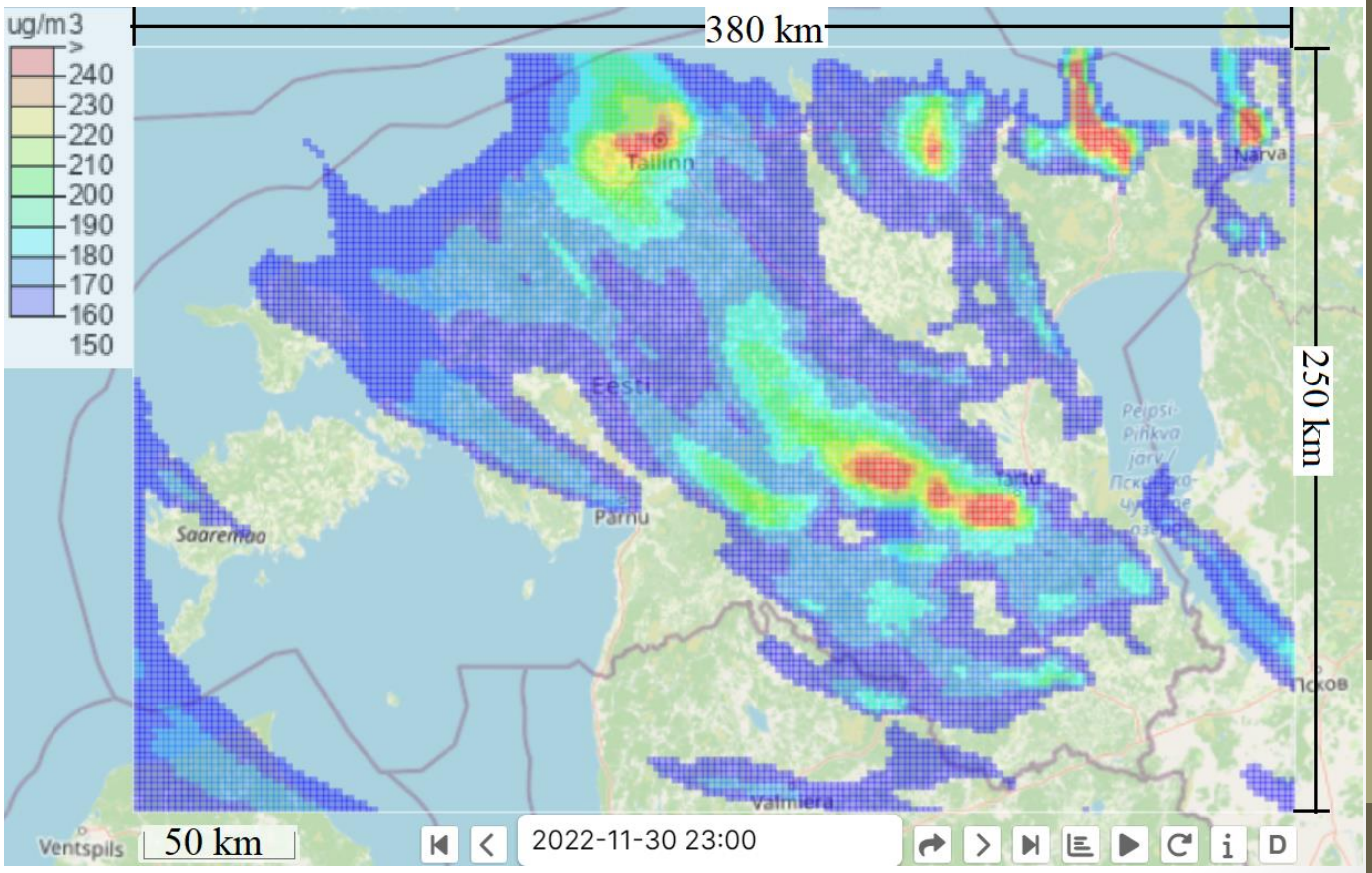
Modelling setup

- Period 01.10.2022 – 30.09.2023 (full year)
- 2 km resolution
- 11 vertical layers, bottom one: 20 m
- 2 minute time step

FMI SILAM boundary fields

CAMS-REG-AP v5.1 + Estonian OSIS NO_x

ECMWF meteorological fields



Domain example (CO hourly average concentration).

Modelling setup

- „Full chemistry“ setup
- Validation run for NO_x, O_3, $PM_{2.5}$ and CO
- Time series comparison at stations

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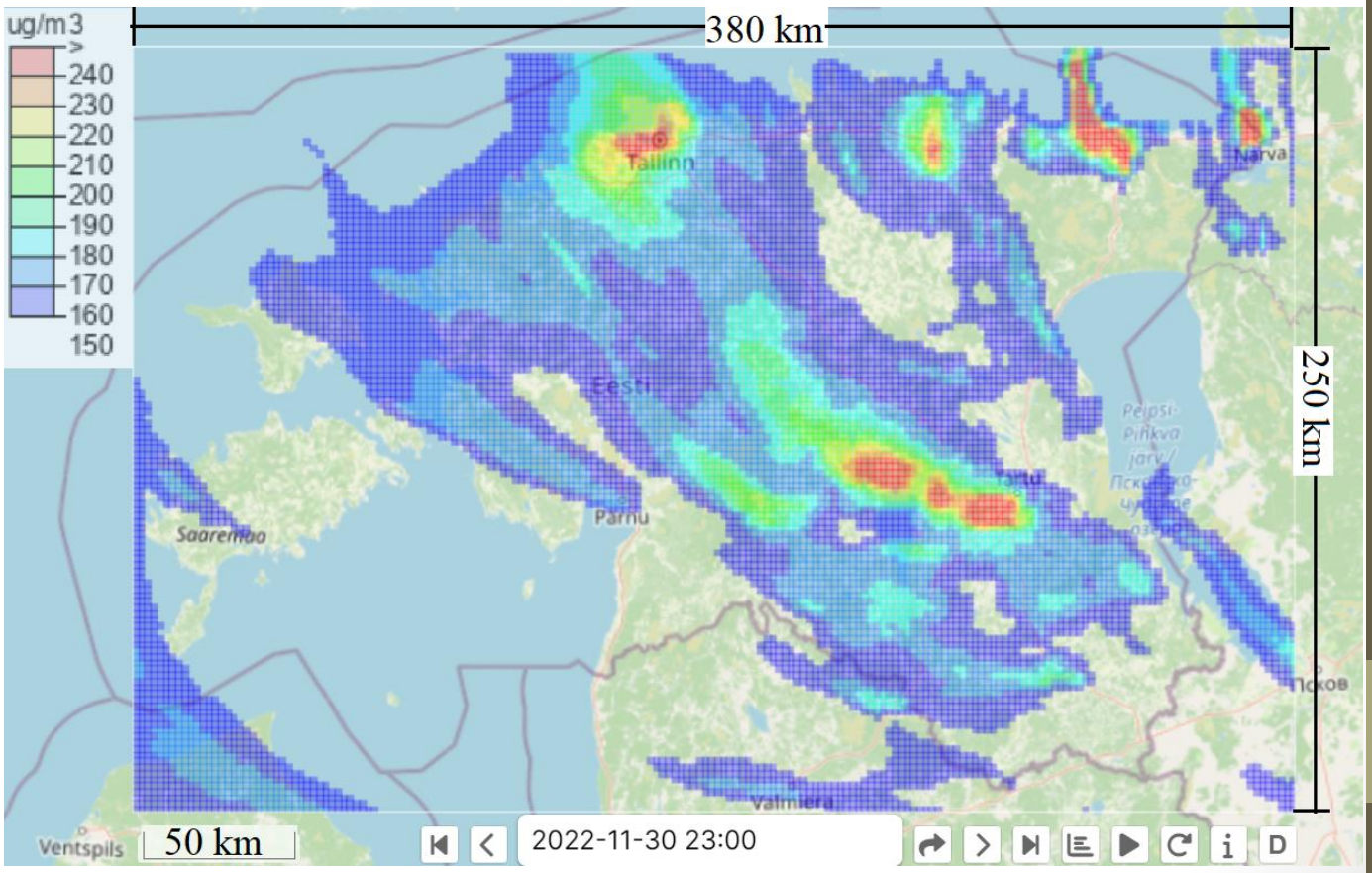

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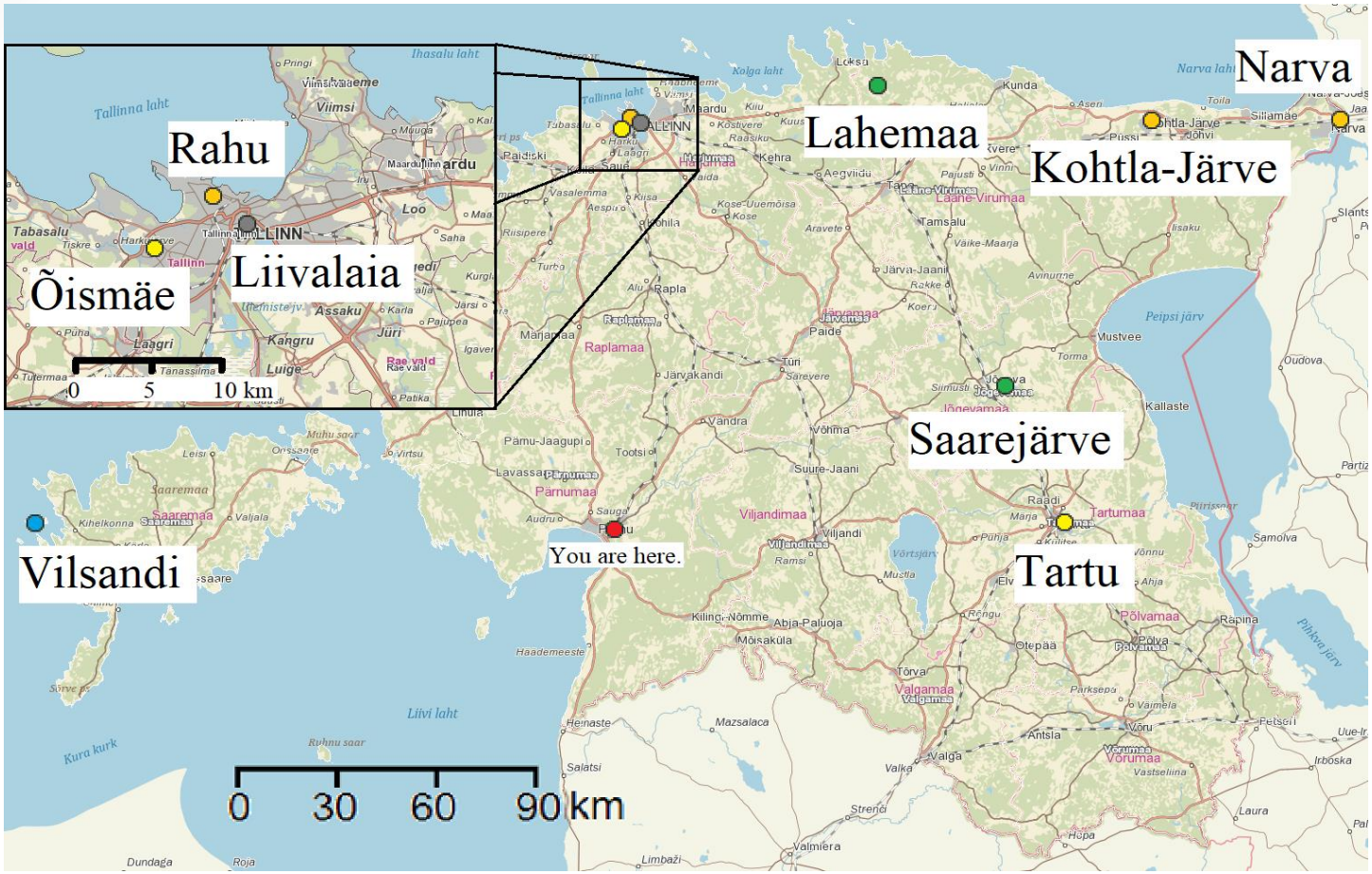
Monitoring stations



Urban-industrial, urban background, street, rural background and rural maritime monitoring stations used for timeseries validation. Our location marked in red.

Statistical procedure (recommended by HARMO initiative)

Linear correlation coefficient *R*

$$R = \frac{\overline{(C_p - \overline{C_p})(C_o - \overline{C_o})}}{\sigma_{C_o}\,\sigma_{C_p}}$$

Fractional bias *FB*

- Symmetrical measure of over- and underestimation

$$FB = \frac{(\overline{C_o} - \overline{C_p})}{0.5(\overline{C_o} + \overline{C_p})}$$

FB	±0.4	±0.67	±1	±1.2
missed by	1.5x	2x	3x	4x

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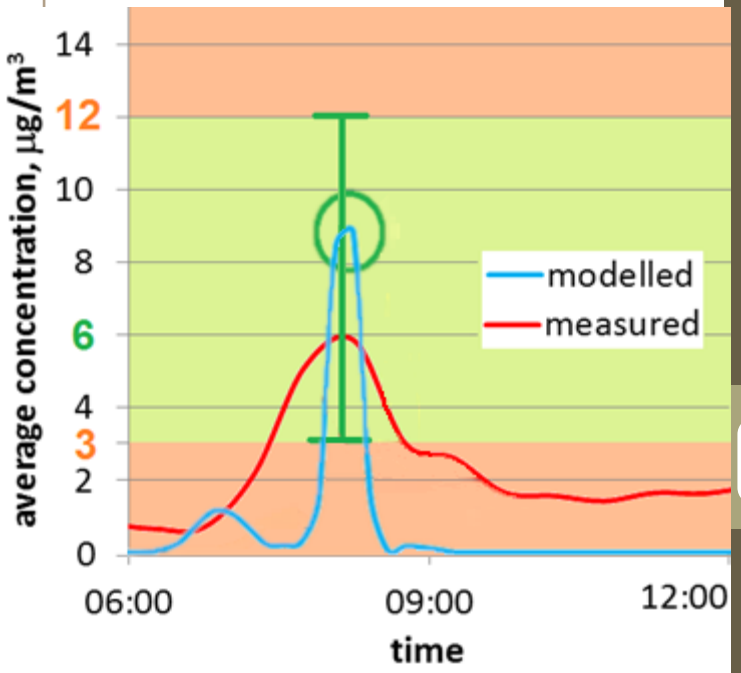
Fraction in factor two *FA2*

- How much modelled data differs less than two times.

Modelled peak maximum should not differ more than two times from the measured peak maximum.



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Statistics applied to concentration…

- …annual average daily course
- …hourly values, hourly values with daily course removed
- …daily averages, maxima and minima

Results: NO_2

	hourly FB	hourly FA2	hourly R
best	-0.77, 2x overestimation	0.41, urban & rural background	0.65, Tallinn background
worst	-1.25, 4x overestimation	0.09, Tallinn background	0.1, urban industrial

- R = 0.5-0.6 (urban), 0.4-0.5 (rural)
- Similar for daily course and daily course removed

$\Rightarrow$ SILAM predicts both quasi-periodical daily pattern and longer time scale changes

- European domain run: moderate overestimation only in rural background.

Results: NO

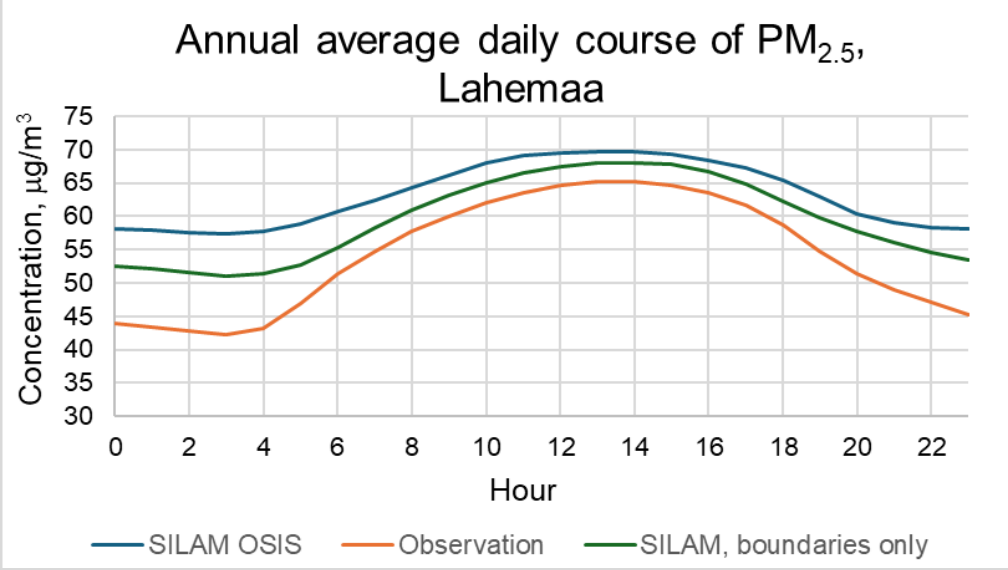
- Urban modelled NO fraction bigger than measured
  - Measured 20%, modelled nearly 50%

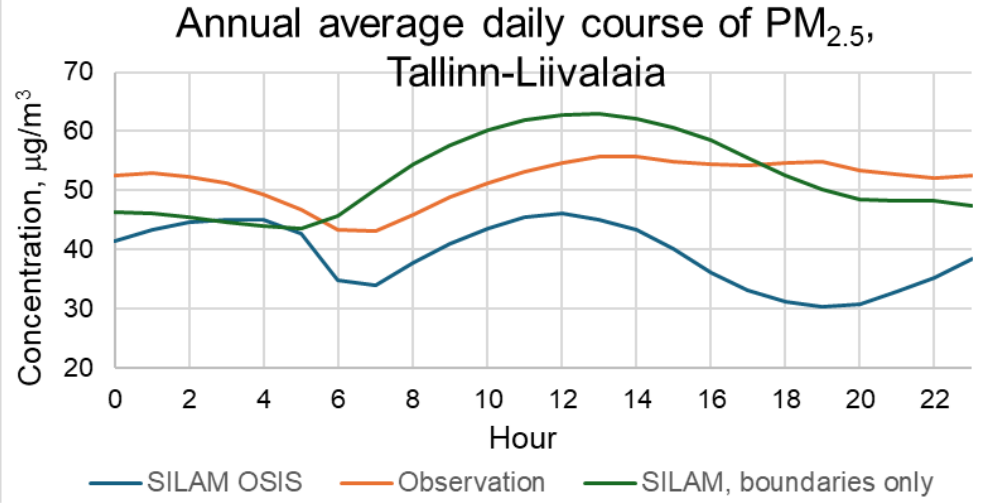
$\Rightarrow$ is even more overestimated in urban stations

- European domain run: hourly values underestimated

Results: O_3

- Despite NOx, at most only 30% overestimated
- Hourly FA2 > 0.5 except Tallinn
- Tallinn daily course - silam has two maxima, R near zero
- Other stations daily course R near perfect, FA2 = 1
- Daily maxima FB < 0.12
- European domain run: also highly accurate, less problems with daily course, better results in Tallinn.





	hourly R	daily average R
rural	0.57-0.68	0.74-0.82 (+Narva, Tartu)
other	0.43-0.54	0.65-0.66

Results: CO

- Underestimated by factor 1.5 or less
- Not measured in rural Saarejärve, Vilsandi

	R	FA2
hourly	0.48-0.70	> 0.94 (Tartu 0.76)
daily course	0.44-0.75 (Narva 0.9)	1

- Similar results with daily course removed
- daily minima and averages agree better than hourly

$\Rightarrow$ sub-daily peaks and lows modelled not with perfect timing

- European domain run similar; Kohtla järve R better.

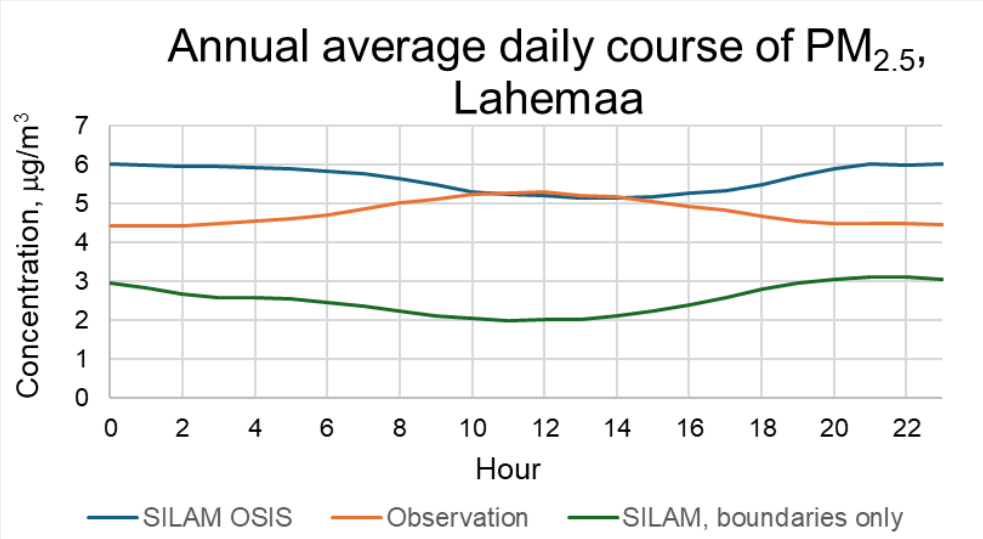
Results: PM2.5

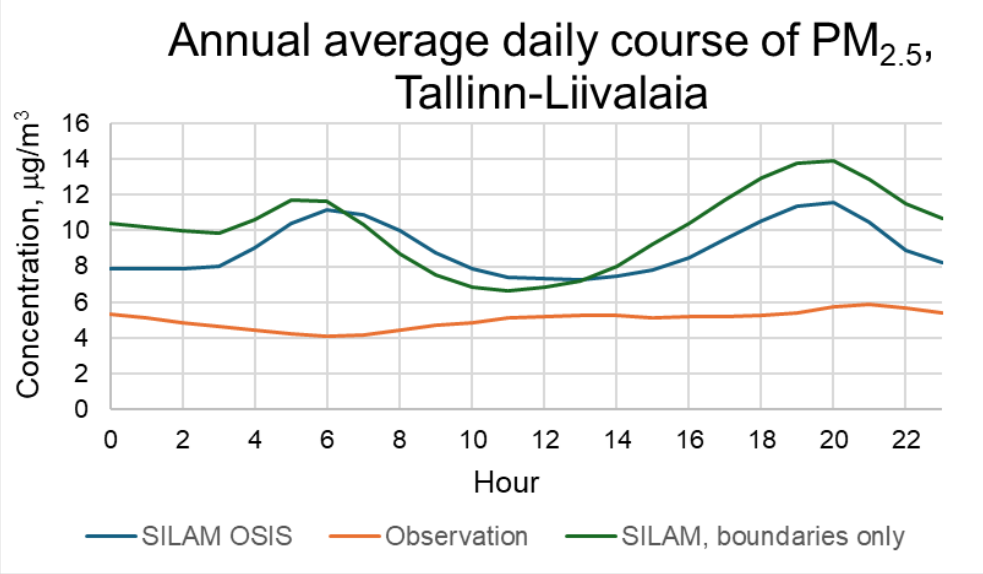
- Hourly values overestimated 15-80%, biggest in Tallinn
- All but Narva: FA2 a bit over 0.5

station type	daily course R
rural	-0.91
industrial	-0.50
rural	-0.45

hourly R	daily average R
0.38-0.62	0.59-0.73

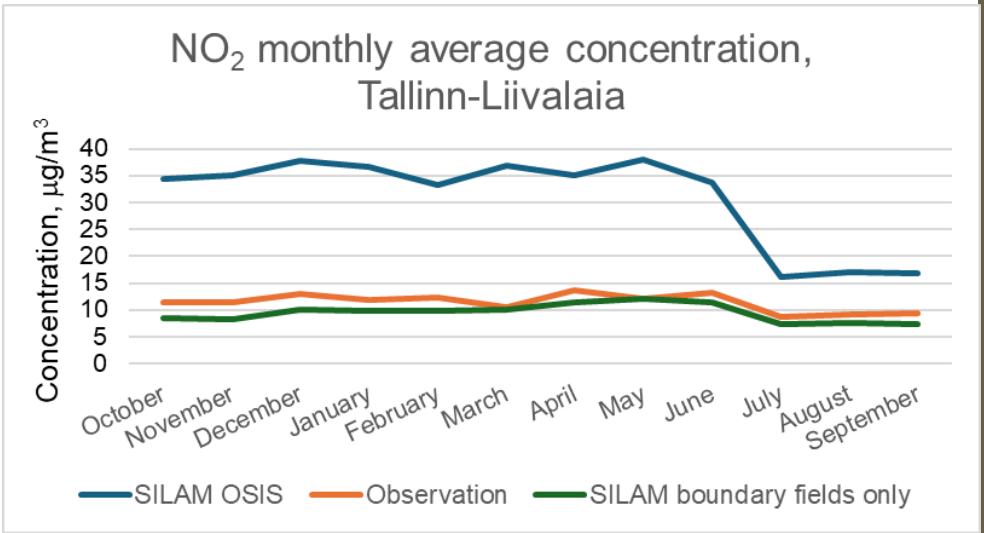
European domain run: similar, including negative R

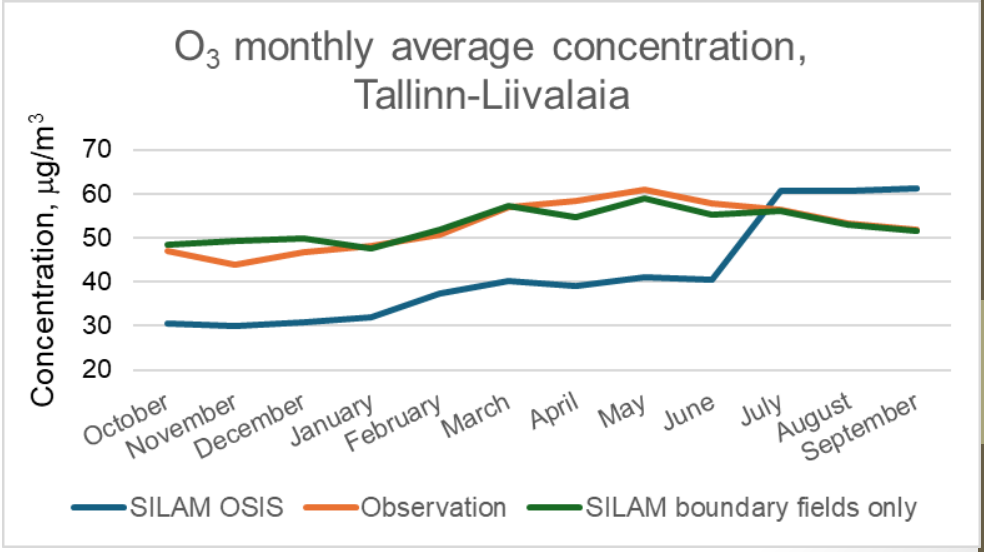




Results: yearly performance

- CO performs best
- NO_2 still highly overestimated but well correlated
- Predicted NO_2 minimum and O_3 maximum in jul-sept
- Seasonal O_3 and NO_2 changes are actually smoother





Future plans

- Check emissions and model input: only NO_x that came from the national inventory is highly overestimated.
- Continue with validation excercises: full year runs after making a change
- Find out reasons for strange PM2.5 daily course (look at components of PM)

Conclusions

NO_X highly overestimated, although yearly and daily courses and intermediate range weather-related patterns reproduced reasonably well.

SILAM has been validated extensively. Input source data bias?

Despite NO_X, O_3 predicted rather accurately.

In general, CO (originating mostly from heating) reproduced best.

$PM_{2.5}$ moderate overestimation, inadequate daily course.

Acknowledgements

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Thank you!

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