TNO innovation for life

AUTOMATED GENERATION OF AN AERMOD DISPERSION MODEL

B. KELLY

WHAT IS AERMOD

- American Meterorological Society/EPA Regulatory MODel (AERMOD)
- Steady State Gaussian plume model which models concentrations from dispersion of any primary pollutant
- Written in FORTRAN, runs on Windows & Linux
- .exe file that can be controlled without the need for manual GUI inputs
- Current and still being developed and open access
- Best known for its plume model but in recent years used more and more for roads

Control (CO)
Name of run, roughness, model period, pollutants

Source (SO)
Coordinates, emissions rate, release height etc..

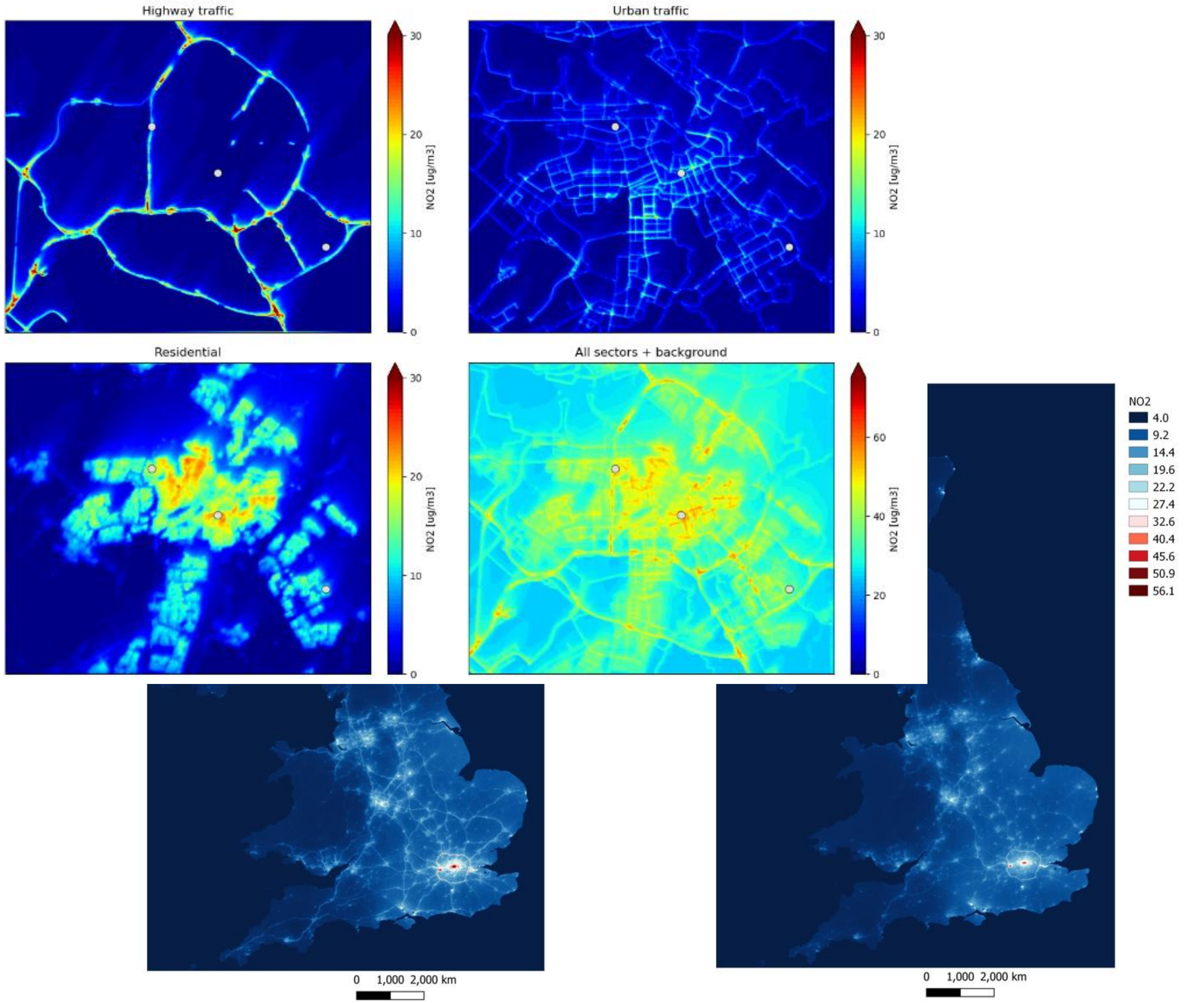
Receptor (RE)
Coordinates of receptor points/grid

Meteo (ME)
Meteorological inputs

Output (OU)
Concentrations for each receptor or grid coordinate

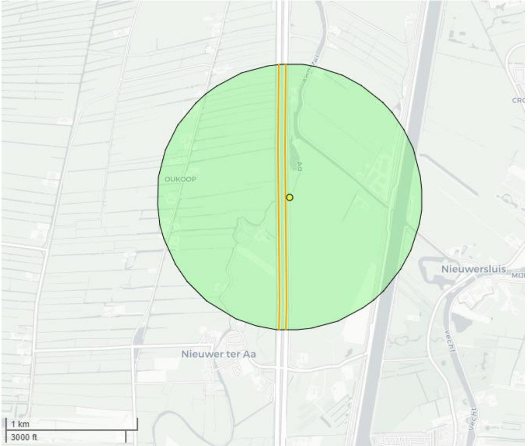
AERMOD AS ROAD MODEL

- Riccardo RAPID AIR model
- KNMI used to model Amsterdam

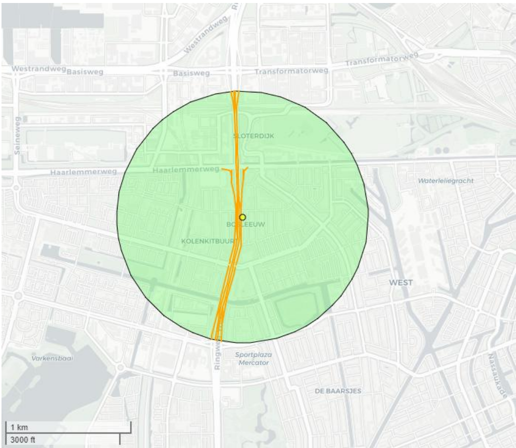


EXAMPLE SITES

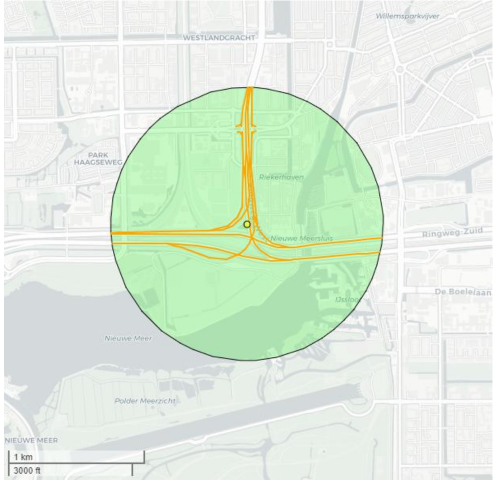
EXAMPLE SITES



EINSTEINWEG A10



BREUKELEN-SNELWEG A2

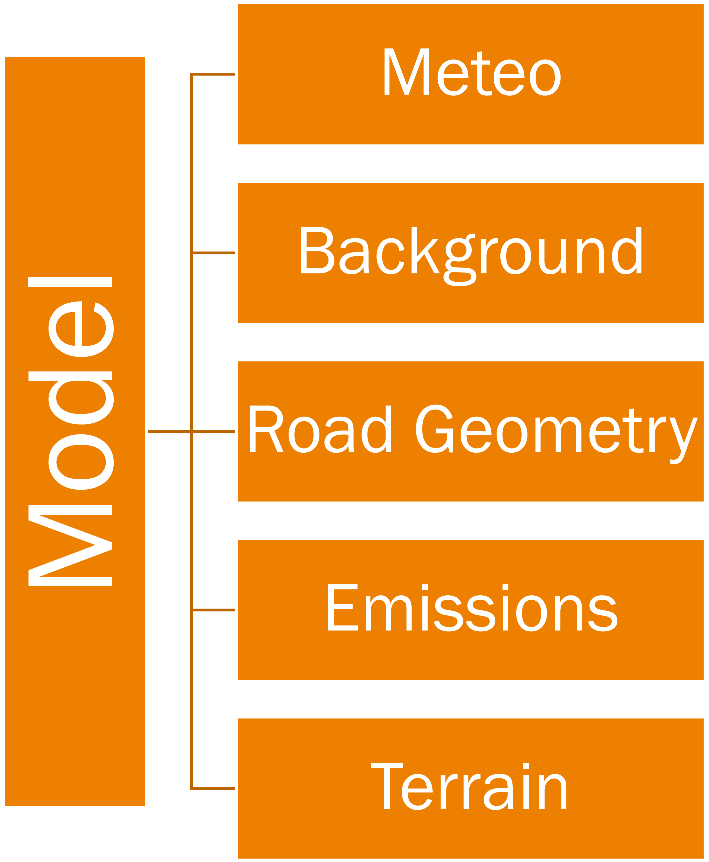


AMSTERDAM ZUID A10

TNO innovation for life

MODEL INPUTS

- For this model 5km resolution LE outputs were used for the background concentrations
- Meteo data from the LE inputs used
- Emissions from NDW
- Road geometry from OSM
- Terrain from PDOK – Digital Terrain Model (DTM) and Digital Surface model (DSM)



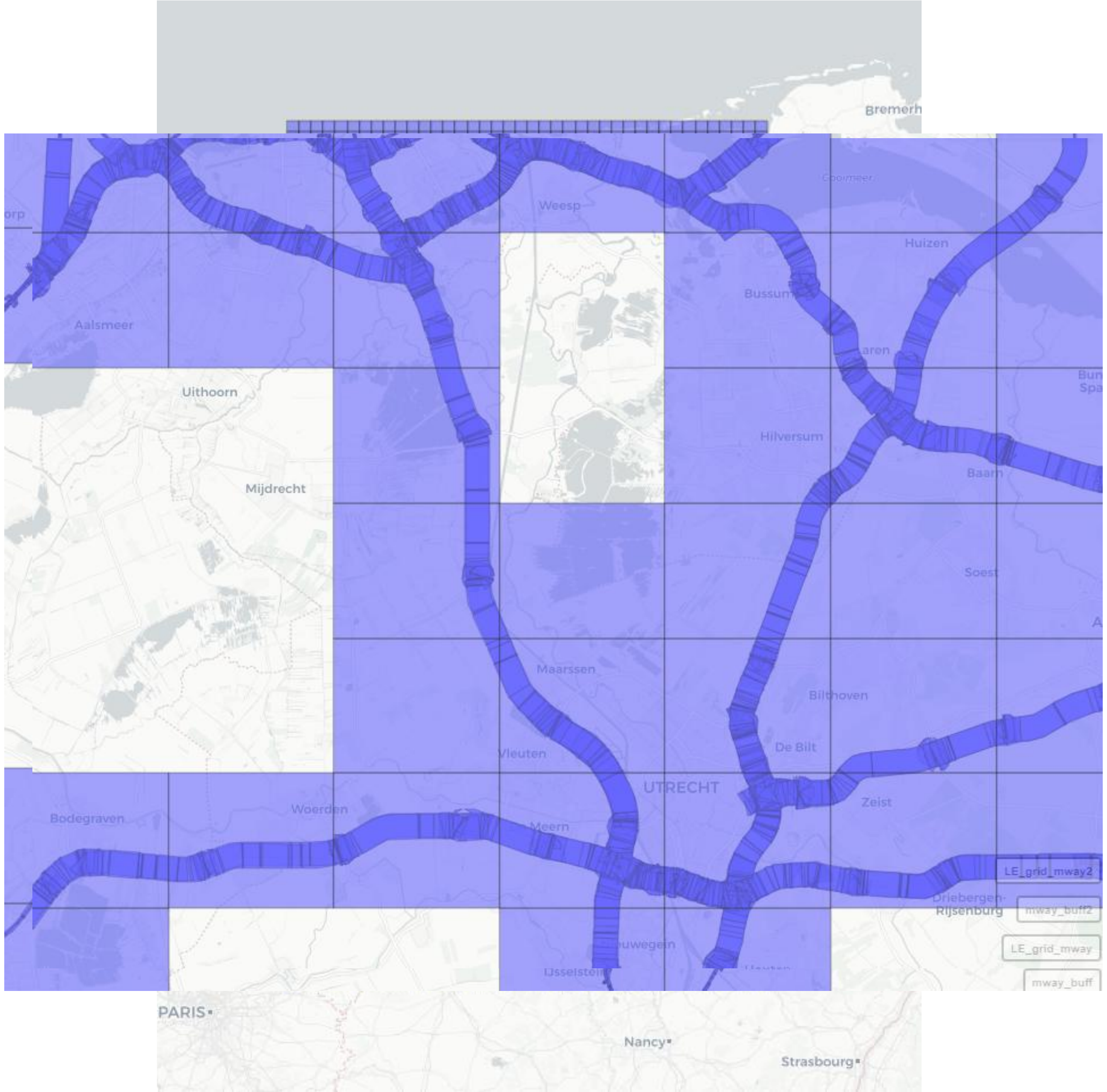
MODEL SETUP

- For a single receptor a full year run takes a few seconds
- Multiple receptors e.g. grid for a contour plot exponentially longer
- Only modelling road sources, wasted resources to model
  - Model generation script is run which processes model_setup.txt
  - Generates model files for each sub area
  - Model files then:

    - import the emissions, terrain and meteo

    - execute the model

    - preprocess output e.g. to a raster file/plots



TNO innovation for life

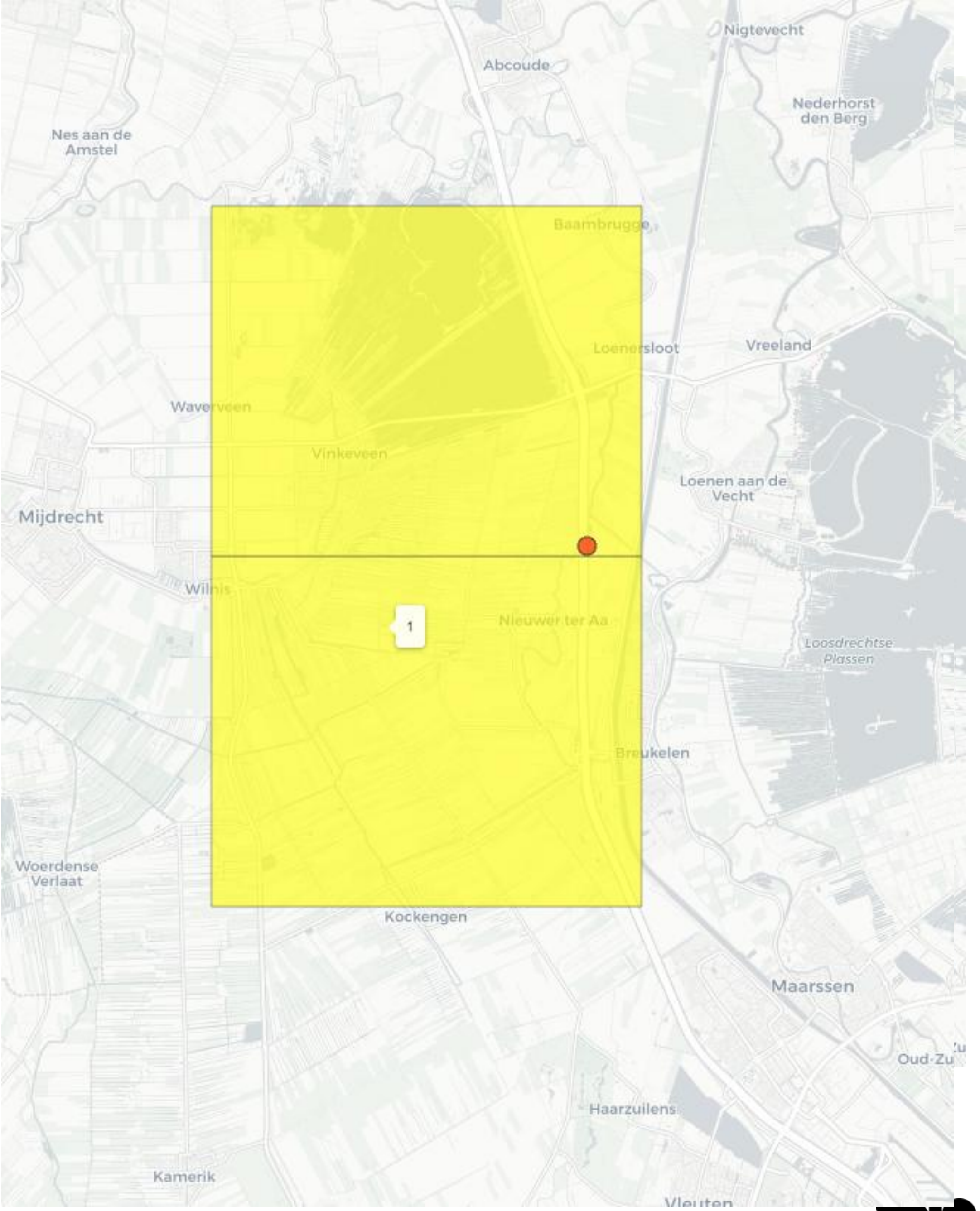
MODEL INPUTS

- Modelled period
- Modelled area
- Pollutant to be modelled
- Use buildings as receptors
- Roughness factor: manual, LOTOS EUROS, auto
- Resolution of output contour plot
- Where to be applied – whole country lecvel or local

- Meteo data
- Background concentrations
- Road geometry
- Emissions
- Surface (DSM) and ground terrain (DTM) files
- Roughness (LE, auto based on land use, population or terrain)
- Buildings

MODEL SETUP
A2 BREUKLEN SNELWEG

- Two main model outputs
  - Concentrations at receptor points
  - Concentrations over the modelled area (contour plot)
- Running contour outputs for the full domain area (yellow areas) means a lot of points calculated that are not impacted
- In this case a 50x50 grid means 2,500 points calculated for each model
- Took approx. 7 hours

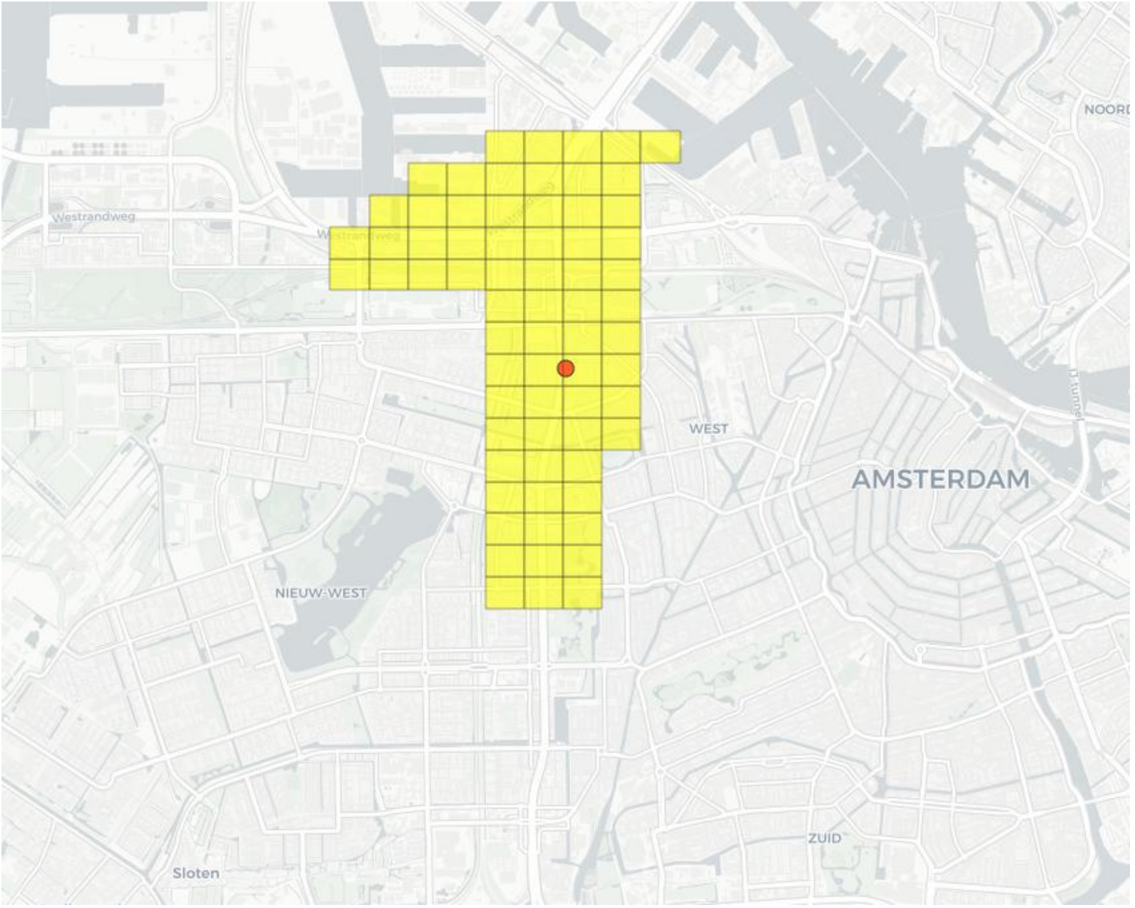


MODEL SETUP
A10 AMSTERDAM

- To speed up model run model is split into seperate models and run on the HPC

For this model

- A 2km radius around site
- 400m buffer from road
- 69 seperate models all running in parrellel
- Higher resolution possible



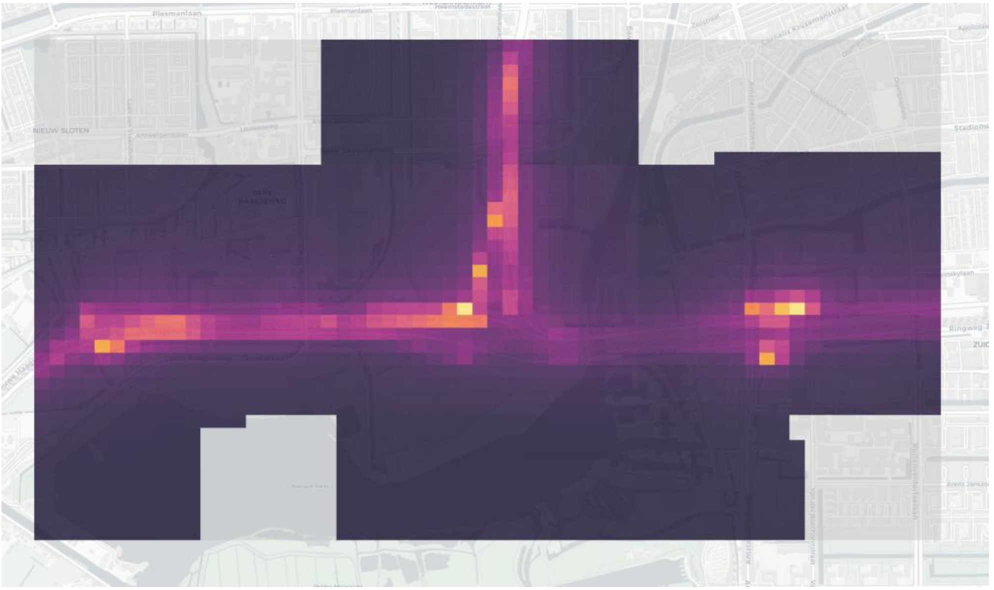
MODEL SETUP
ROAD GEOMETRY

- Line strings imported from OSM
- Emissions from NDW
- Terrain possible using PDOK data
- 0.5m Digital Surface Model (DSM) terrain used

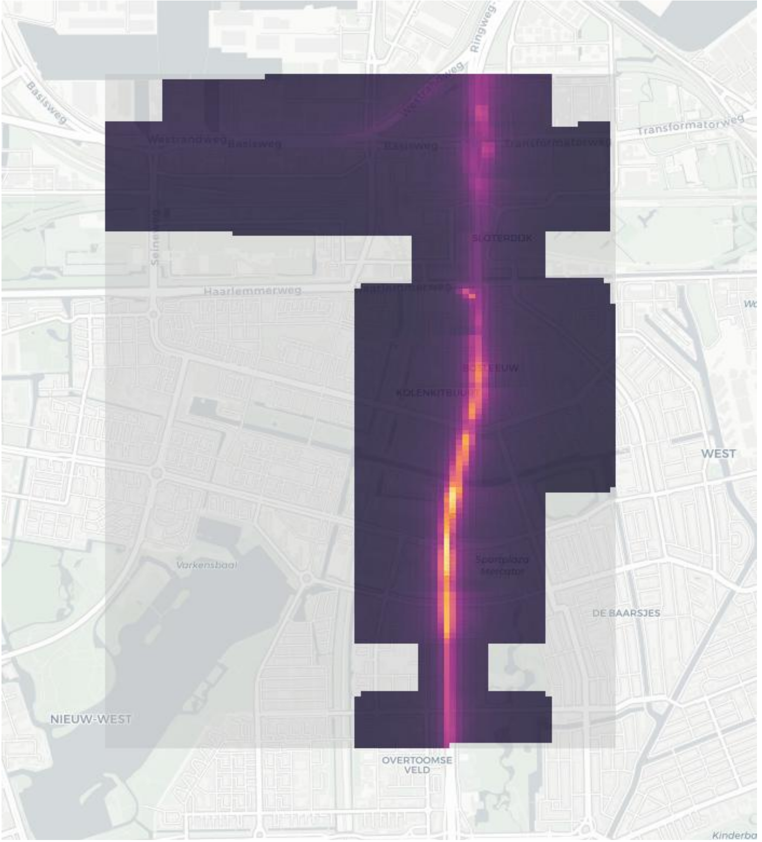
RECEPTORS

- Generated from OSM building inputs
- Heights can be determined using Terrain

RESULTS

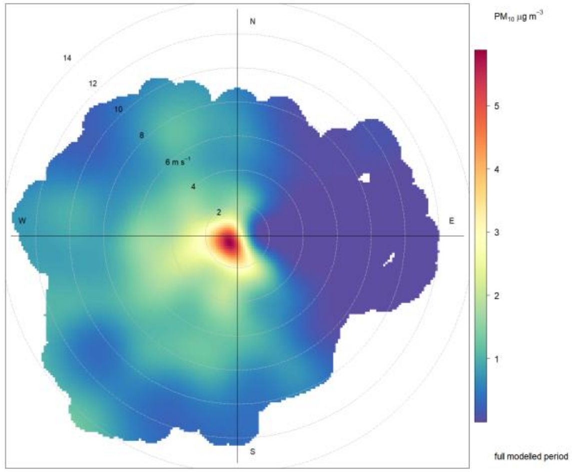


Amsterdam Zuid

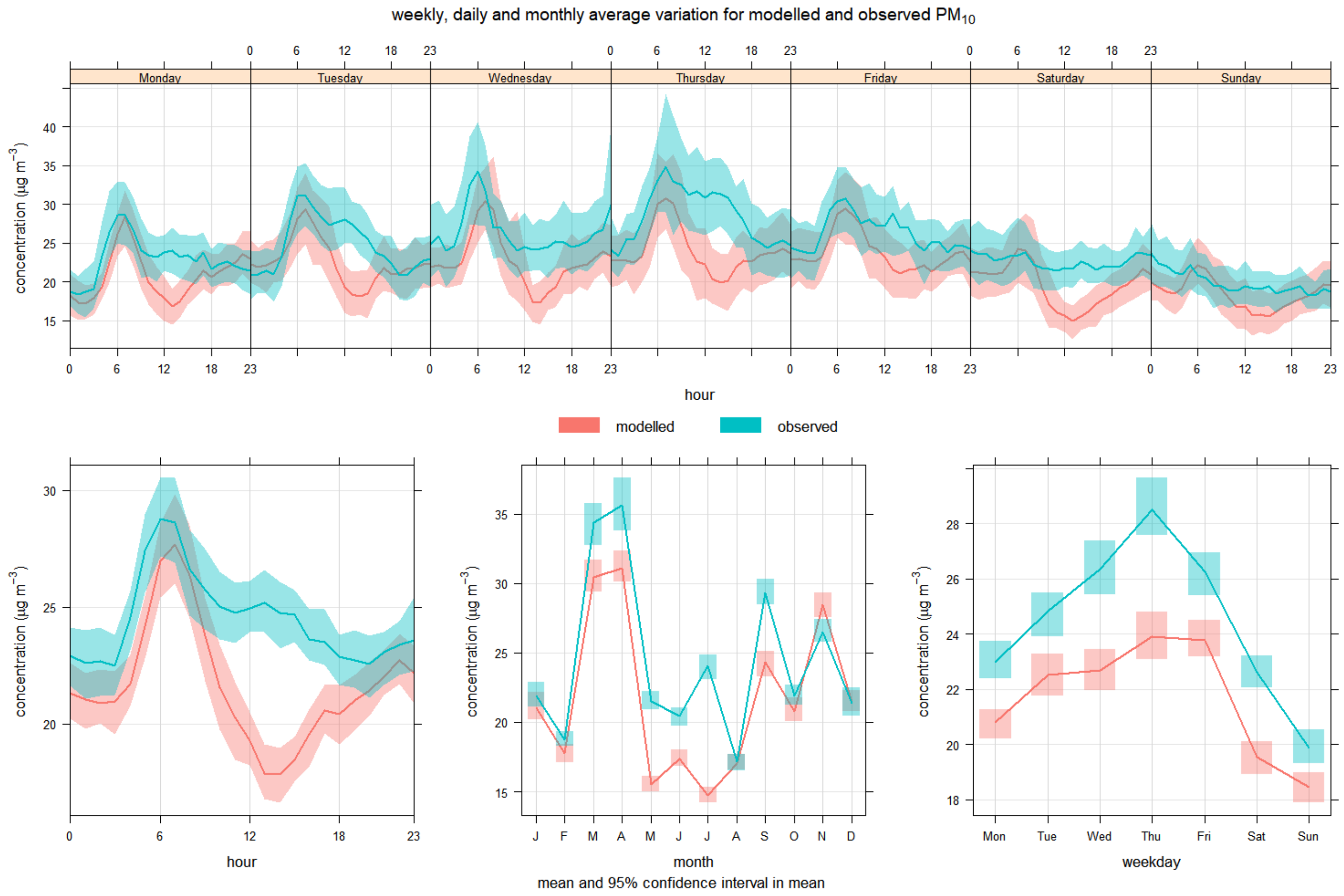


Einsteinweg

RESULTS



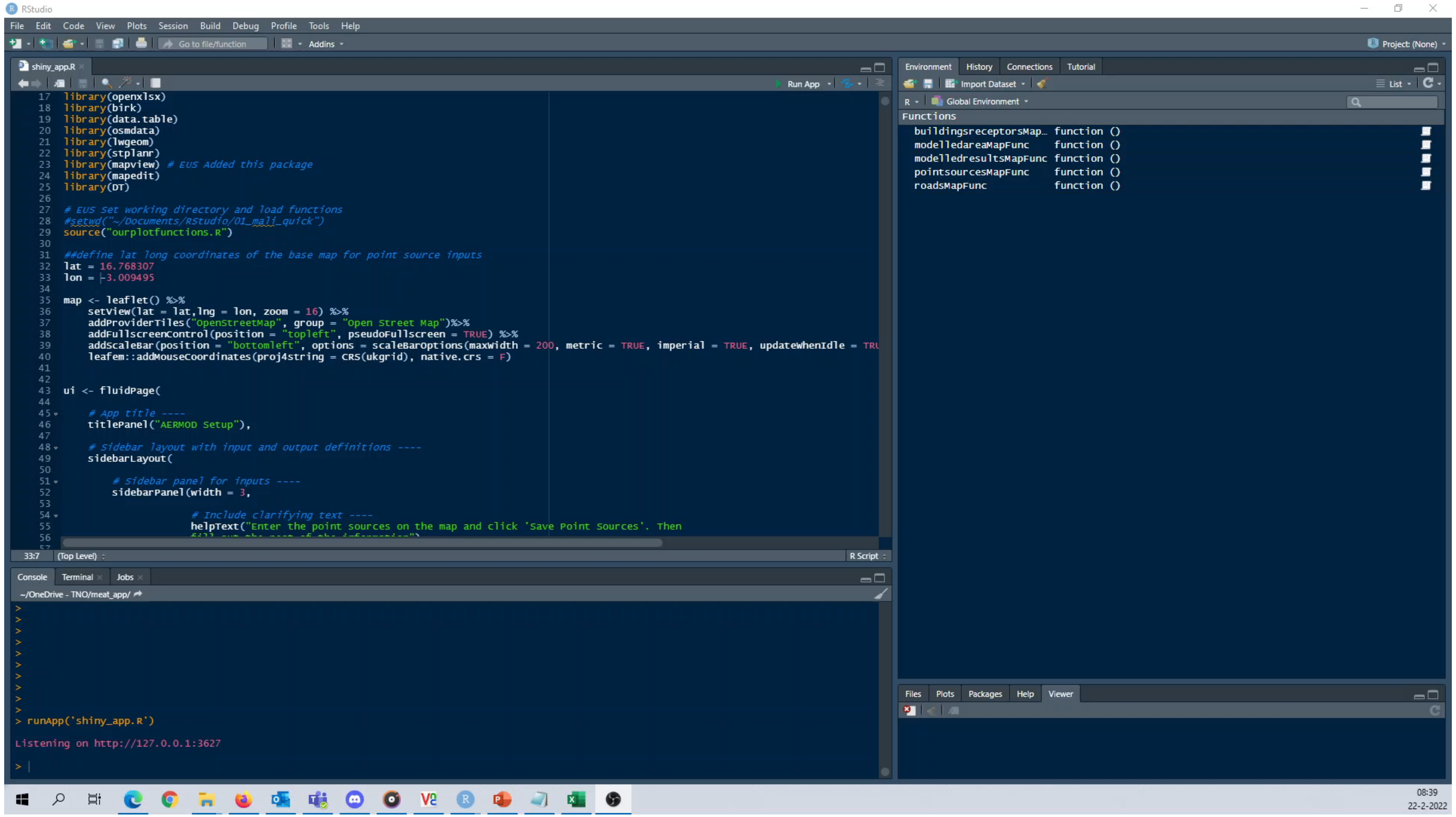
Polar Plot at receptor



Time variation plot at receptor

MODEL INPUTS

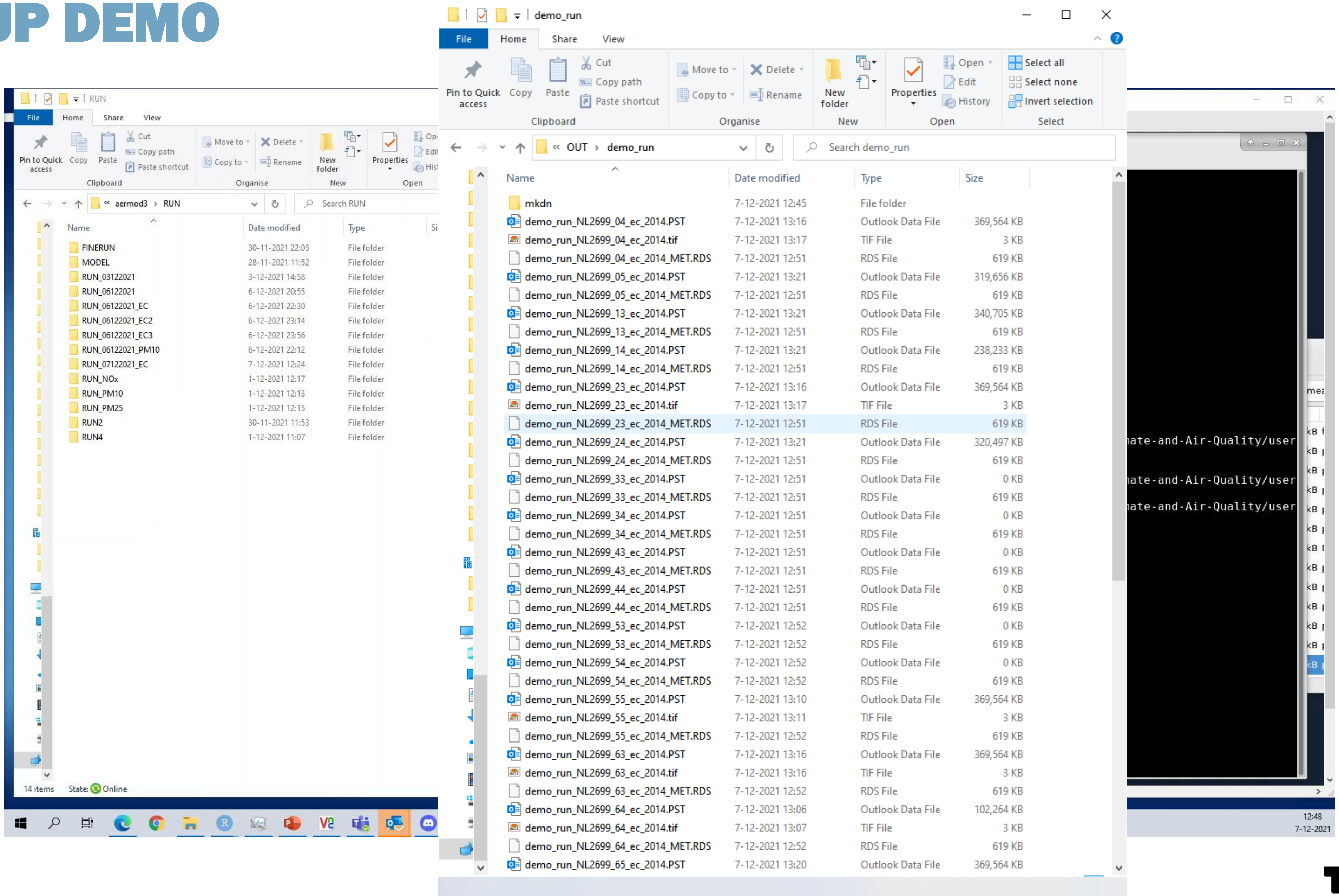
GUI



STREET CANYONS

› MODEL INPUTS

SETUP DEMO



innovation for life

METEO & BACKGROUND

- LE background concentrations basis for final concentrations
- Meteo data taken from LE
  - sensible heat flux (W/m2)
  - surface friction velocity (m/s)
  - convective velocity scale (m/s)
  - lapse rate above mixing height (K/m)
  - boundary layer height
  - equilibrium height of stable boundary layer
  - convective mixing height (m)
  - mechanical mixing height (m)
  - Monin-Obukhov length (m)
  - surface roughness length (m)
  - wind speed (m/s)
  - wind direction (degrees)
  - wind speed (m/s)
  - standard deviation of wind direction
  - reference wind height (m)
  - Ambient temperature (K)
  - delta T
  - precipitation (mm)
  - snowfall (mm)
  - relative humidity (%)
  - surface pressure (mb)
  - sky cover in tenths

MODEL SETUP

- Know what the model can do, but how realistic is it to model large areas and how long will it take. A key element of this work was to show how a model implementation can be setup that can model large areas quickly in parallel
- The user doesn’t have to input any data, it uses uniform datasets
  - PDOK terrain data (available for whole of NL)
  - open street map (available for the globe) which have had hourly emissions calculated
  - Height and gradient of road included
  - Open street map buildings base height and roof height known. Receptors can be generated for front of building
  - R implementation connects with R markdown to automatically generate plots and results

  - LE meteo (global)
  - For stacks if emissions, chimney heights are known can be modelled with actual height above ground.

STREET CANYONS

- Uses road geometry and lidar data to determine where the biggest change in height is at roadside and what that height is
- Smaller the line string of the road the better surrounding geometry can be considered.

TERRAIN USING DSM

- Using DSM (digital Surface Model) and the Raster R package an estimate can be made of the roughness of a specific area
- The finer the resolution the model is split up, the more repesentative of surrounding roughness