Ruisdael observatory

ROTTERDAM

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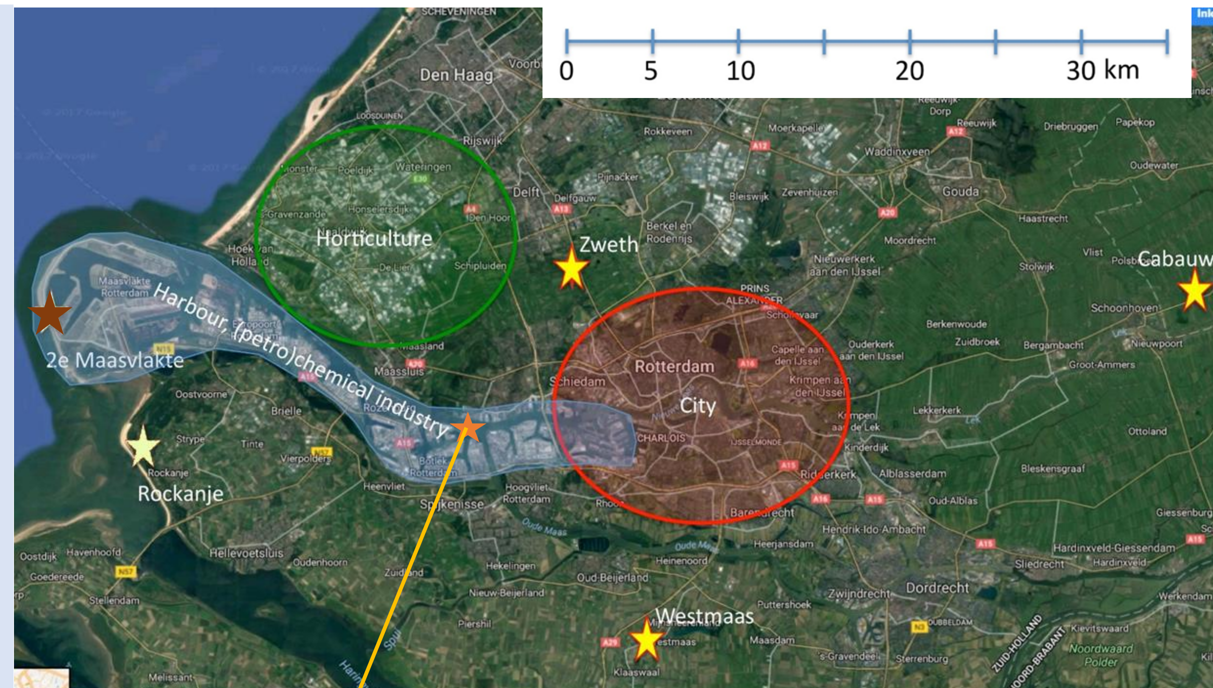
The greater Rotterdam area or Rijnmond area is the ideal test bed for innovative methods to observe and quantify anthropogenic impact on atmospheric composition in a highly industrialized and urbanized environment. Three distinctly different source areas and activities are present in this area: the port with petrochemical industry, power plants and shipping activities, the city area with intense traffic, and the horticulture area Westland, with large natural gas combustion emissions. Three permanent stations are foreseen (yellow stars), while the Cabauw site functions as a 4th Eastern background site. Multiple Ruisdael partners will cooperate and contribute to construct an extremely valuable dataset for innovative science. Here we provides an impression of the currently ongoing developments as of 2019



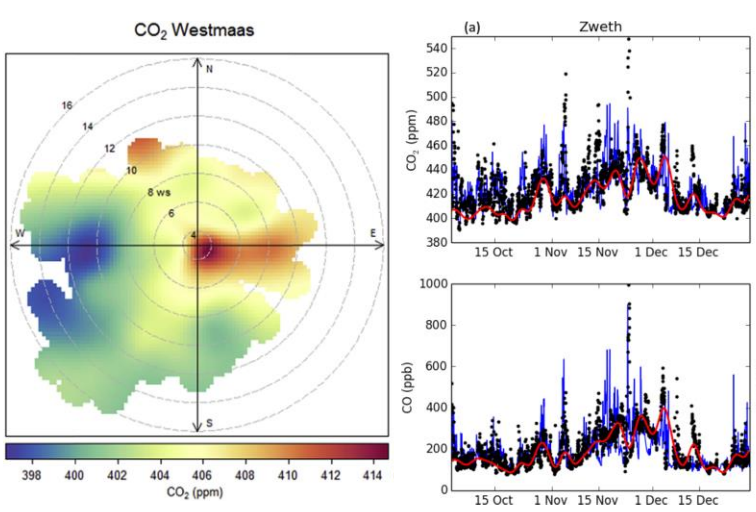


Figure 1. Continuous monitoring of CO_2, CO and CH_4 will be done by TNO and RUG at the three Rotterdam sites. Pre-Ruisdael observatory data are available for 2 stations. The figure shows the median CO_2 mole fraction observed at Westmaas as a function of wind direction (left) and time series of modelled (WRF-Chem) and observed CO_2 and CO mixing ratios at Zweth for 2014.

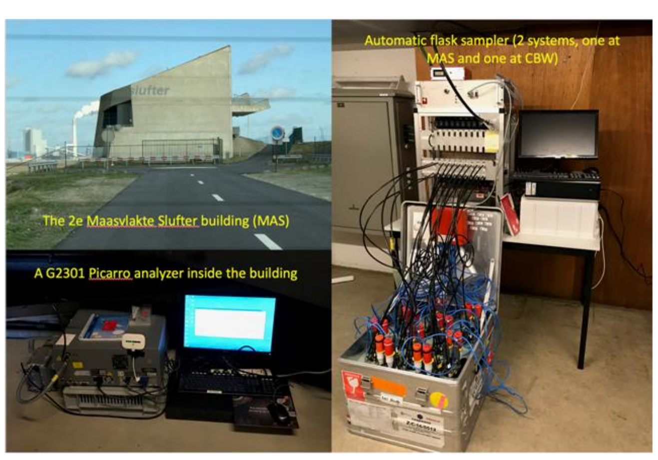


Figure 2. RUG installed equipment to measure radiocarbon (14C) on the 2e Maasvlakte site. (brown star in overview). Radiocarbon (14C) is an important tracer for quantifying fossil fuel CO2 emissions (FFCO2). Therefore, by analyzing air samples before and after they pass through a city area (in this case, Rotterdam), the observed differences in 14C levels can be used to calculate the amount of FFCO2 from that city.

Figure 3. At one Rotterdam site RUG & WUR will perform Atmospheric O_2 measurements which provides additional information on CO_2 emissions from fossil fuel combustion, as the oxidative ratio (O_2/CO_2 ratio) is different for each type of fuel. The oxidative ratio for the global average fossil fuel mix is around 1.4, whereas this ratio is much higher for natural gas (1.95). Atmospheric O_2 will therefore allow to attribute the emissions to specific source categories. The figures shows the instrumental set-up which is currently tested in Finland.

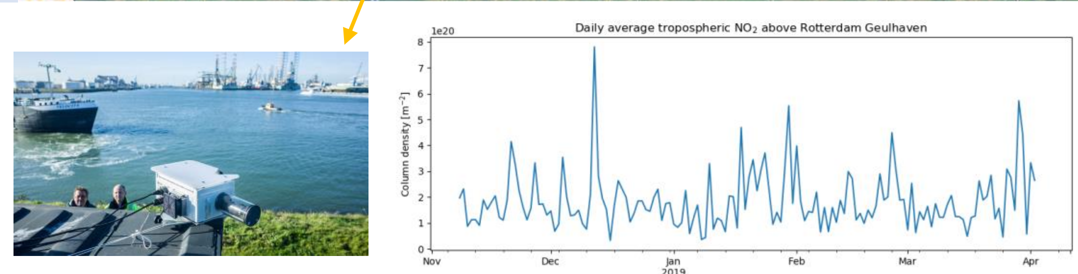


Figure 4. Since Nov 2018, KNMI measures tropospheric NO2 with a MAXDOAS instrument in Rotterdam, at DCMR station Geulhaven. The measurements are performed every 5-15 minutes during daytime. They serve as a validation source for satellite measurements (e.g. TROPOMI), and regional air-quality models (e.g. CAMS, LOTOS-EUROS).

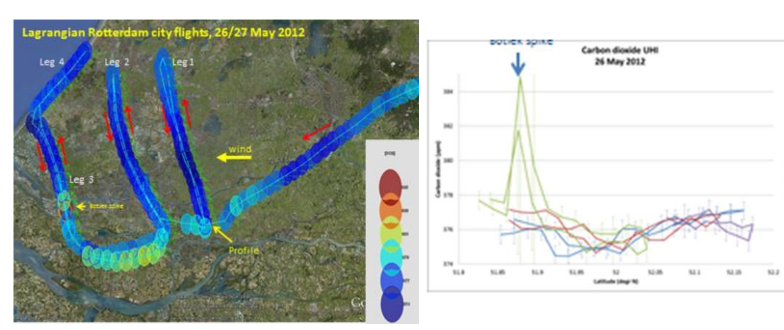


Figure 5. Observations by WUR aircraft were made over Rotterdam. (Note the Botlek CO_2 – spike, see graph). New flights under Ruisdael will be discussed to complement the observations at Ruisdael stations.

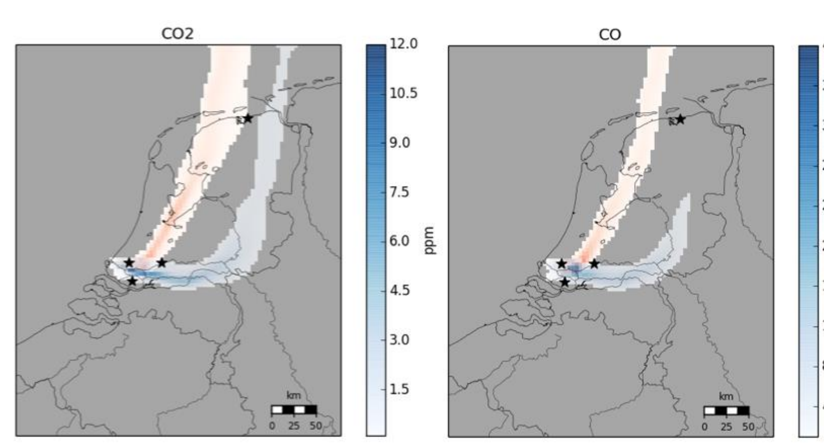


Figure 6. Together with high resolution simulations of transport in the atmosphere, 'inverse modeling' allows us to find the combination of sources, sinks, and emission ratios that optimally reproduces observed CO, CO_2, Δ14C , and NOx. Model teams at WUR, TNO and others aim to separate the impact of different sectors (such as traffic, power production, or ship transport) on the regional budget of greenhouse gases and air pollution. The figure shows the dispersion of a plume from the Rijnmond on Oct 21, 2014 at 12pm (red) and two hours later (blue) as calculated with the WRF-CHEM transport model at a highest resolution of 1x1 km. Stars indicate the Ruisdael "Rotterdam" measurement sites and the Ruisdael background monitoring sites (Cabauw, Lutjewad).

Outlook: To characterize urban pollution we will also monitor NO_2 and Black carbon next to CO_2, CO, CH_4. Moreover additional data will be available from the DCMR and RIVM air quality monitoring stations. One station will be extended with an Aerosol Chemical Speciation Monitor (ACSM) by UU to get a grip on the composition, and sources of local PM2.5 pollution. TUD will operate high resolution weather radar, surface rainfall equipment, and eddy covariance observations to better understand the water balance in urban areas. Stations are expected to be fully operational in 2020 and additional efforts will be made to integrate the workflows, data handling and sharing.

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