The Ruisdael station Lutjewad - infrastructure developments and recent results

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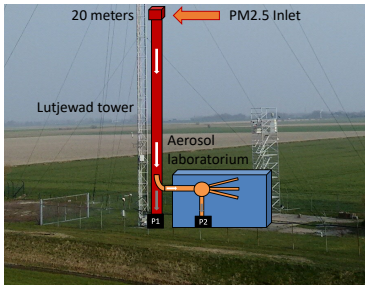
Lutjewad: Location and Facts

Facts:

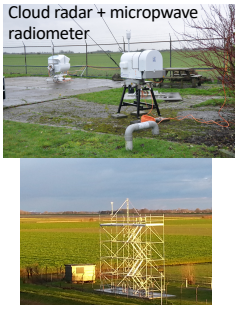
- Coastal location
- ICOS class 2 station
- 60m measurement mast
- 15+ year record of GHG measurements
- CO_2 isotopes
- O_2/N_2 record

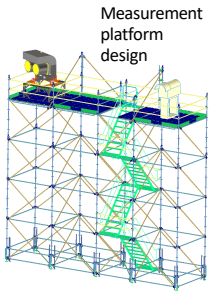
New Ruisdael Aerosol-Cloud Infrastructure



Aerosol In-situ Measurements:

- Infrastructure realized
- Instruments delivered and in final testing phase
- Measurments to begin in May 2021





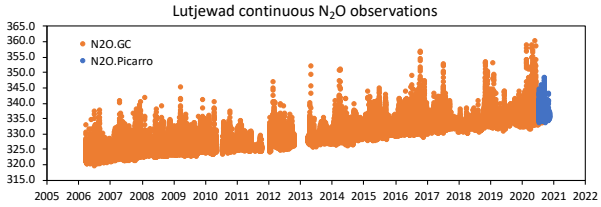
Cloud profiler:

- Delivered Dec 2020
- Measures on the ground Dec-Jan
- To be installed on a 10 m-platform in May 2021

RECENT RESEARCH HIGHLIGHT: N_2O

Methodology:

N_2O measurement methods:



Lutjewad continuous N_2O observations from May 2006 onwards. Since September 2020 the GC-system has been replaced by a Picarro Cavity Ring-Down Spectrometer (model G5310) providing high resolution and high precision observations.

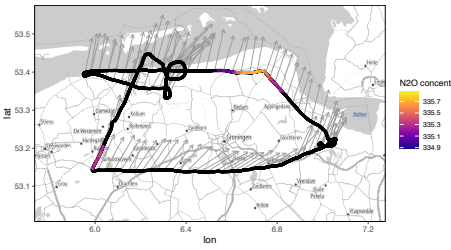
N_2O Flux determination:

Mass balance (MB) method:
Estimate fluxes from point or area sources by a Picarro Analyzer in combination with an active AirCore using the conservation of mass principle (1). The concentration within the plume of a N_2O source is compared to the N_2O concentration outside of the plume (defined as background). From this, the flux is calculated assuming constant horizontal wind, stable boundary layer (PBL) and the estimated PBL hight.

Radon tracer method (RTM):
The Radon Tracer Method (RTM) uses the correlation between the Rn-222 activity and a trace gas mole fraction in the atmosphere during stable conditions to estimate trace gas fluxes, in this case N_2O (2).

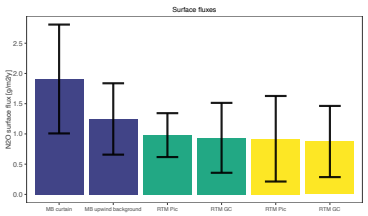
Results and Discussion:

MB approach for Groningen city plume:



- Applied to one case study (18 August 2021)
- Flight path through the Groningen city plume
- N_2O concentrations elevated downwind
- Flux estimated from concentration difference

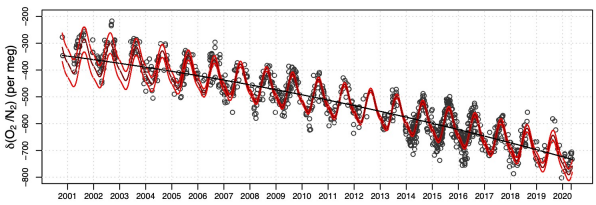
Comparison of RTM and MB methods:



- RT methods applied to various plumes Aug 2021
- MB method slightly higher estimate, but still within uncertainty range
- MB limited to a single case study, RT several plumes

blue: MB method with 2 different ways of estimating the background
green: RT method for all plumes with radon-N2O correlation coef r > 0.7
yellow: RT method for plumes with r > 0.7 for BOTH Picarro (Pic) and GC

O_2/N_2 – 20 year record



Methods

O_2 is measured with the DI-IRMS Optima at CIO, expressed in $\delta O_2/N_2$ - which is the difference between the O_2/N_2 ratio of the sample and that of a reference gas:

$$\delta O_2/N_2 = \frac{O_2/N_2(\text{sample})}{O_2/N_2(\text{ref})} - 1$$

Results

- **average trend:** -20.8 +- 0.6 per meg yr^{-1}
  seasonal amplitude: 131.8 +- 4.3 per meg
- The $\delta O_2/N_2$ record shows an increasingly more negative trend over time
- This confirms the fact that the global oxygen level is decreasing over time due to fossil-fuel burning (since O_2 is used to combust carbon to CO_2)

References:
(1) Mays, K. L., et al. (2009). Environmental Science and Technology, 43(20), 7816–7823.
(2) Wilson, S. R., et al. (1997). Journal of Atmospheric Chemistry, 26(2), 169–188.

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