

faculty of science and engineering

$\delta O_2/N_2$ and CO_2 flask measurements from the Netherlands, Ireland, and Antarctica

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1. The stations

- Flask measurements are taken from 3 atmospheric stations (Fig. 1):
 - Lutjewad (LUT) on the north coast of the Netherlands. Operated by Center for Isotope Research (CIO) of the University of Groningen, and is part of the European Integrated Carbon Observation System (ICOS).
 - Mace Head (MHD) -on the west coast of Ireland, operated by ICOS.
 - Halley VI (HAL) on the Brunt Ice Shelf, Antarctica, operated by the British Antarctic Survey (BAS).



Fig.1: Station locations

2. Sample collection and analysis

- Flask samples are collected on a regular schedule and transported to the laboratory at the CIO for analyses of several gas species and their isotopes (e.g. CO₂, ¹⁴C, ¹³C, CO, CH₄, δO₂/N₂).
- At LUT station, an automated flask sampling system (Fig. 2) is used to operate a 2-stage drying apparatus and control the temperature, air flow and pressure.
- For δO₂/N₂ analysis, the CIO employs a Micromass Optima Dual Inlet IRMS (Fig. 3) accompanied by a horizontal rack to store standard and reference cylinders (Fig. 4), both situated in a climate-controlled laboratory room.

Fig.3: Micromass Optima Dual Inlet IRMS

Fig.4: Cylinder storage rack

3. CIO data quality

 The CIO maintains several reference cylinders which are used to connect the flask δO₂/N₂ measurements to the international Scripps scale. Fig. 5 shows the measurements of the reference cylinders and Fig. 6 shows the measurements of the Scripps standard cylinders at CIO over the years.

Fig.6: Scripps international standard cylinders

4. Results

- Fig. 7 and 8 show the δO₂/N₂, CO₂, and APO trends and seasonal variabilities from flasks collected at LUT and MHD stations, respectively (the results are from Charlotte van Leeuwen (2015)).
- We are currently working on extending these records to 2020, along with flasks from HAL.

Fig.7: $\delta O_2/N_2$ and CO_2 (top panel) and APO (bottom panel) measurements at LUT station from 2000 to 2015

Fig.8: $\delta O_2/N_2$ and CO_2 (top panel) and APO (bottom panel) measurements at MHD station from 1999 to 2014

5. Planning

- Along with extending the flask measurements, we are also working with and improving our continuous coupled $\delta O_2/N_2 \& CO_2$ measurement systems.
- Details of the works pertaining to the continuous systems and the campaigns involving them will be presented by Ingrid Luijkx next week.