

Abstract

This project has been undertaken in order to better estimate the Greenhouse Gas (GHG) emissions of N_2O from the agricultural sector of Ireland. The Intergovernmental Panel on Climate Change (IPCC) has prescribed limits on national GHG emissions and provides methods for their estimation. It is currently estimated that N_2O emissions are responsible for ~15% of the national GHG emissions. This estimate is currently obtained through the crude IPCC 'Tier I' method and it may be an overestimate. The Irish agricultural sector therefore requires: (i) an accurate nationally, representative N_2O emissions inventory avoiding possible overestimation by Tier I method; (ii) environmental and agronomically sound mitigation options for N_2O emissions; (iii) an examination of the effects of possible future changes in land use and management practices on N_2O emissions. Emissions from eight agricultural sites in the south west of Ireland will be analysed. On one site N_2O emissions are detected by using the eddy covariance technique and on all eight agricultural sites gas samples are taken in 1 hr periods by means of gas flux monitoring chambers. Soil temperatures, moisture content and rainfall are continuously recorded at all sites. Soil samples are also taken at various depths to determine and classify the soil with regards to bulk density, total carbon/nitrogen content and other parameters. The gas samples are returned to the laboratory and analysed using a gas chromatograph for N_2O concentrations. Natural and artificial fertiliser applications are also monitored and the emissions from the different soil types may demonstrate a relationship between the amount and type of fertiliser applied to the soil, the soil conditions and the N_2O emissions from the soil.

Introduction

N_2O emissions will be measured at eight agricultural grassland sites over a period of 2 years. The seven satellite sites will be targeted by week-long closed chamber measurement campaigns once per month from April to October (the months of peak N_2O emissions from Irish soils). Less frequent measurements will be made during autumn and winter to provide background emission levels. The campaigns will be timed in order to observe the effects of the addition of synthetic N fertiliser and animal slurry. The main site will be at Dripsey (Co. Cork). Emissions will be continuously measured at this site using existing eddy covariance instrumentation and closed chambers. The seven satellite sites will be spatially dispersed throughout the south-western region to represent the most prevalent soil properties and management practices. This approach will capture the temporal variability of emissions at the main site whilst also capturing small-scale spatial variability at the main site, and regional scale variability between the satellite sites. The emissions and meteorological data gathered will be combined with existing national soils data from other studies to model N_2O emissions at measurement sites and upscale the modelled emissions to the national scale and predict changes in N_2O emissions under various scenarios.

Methods

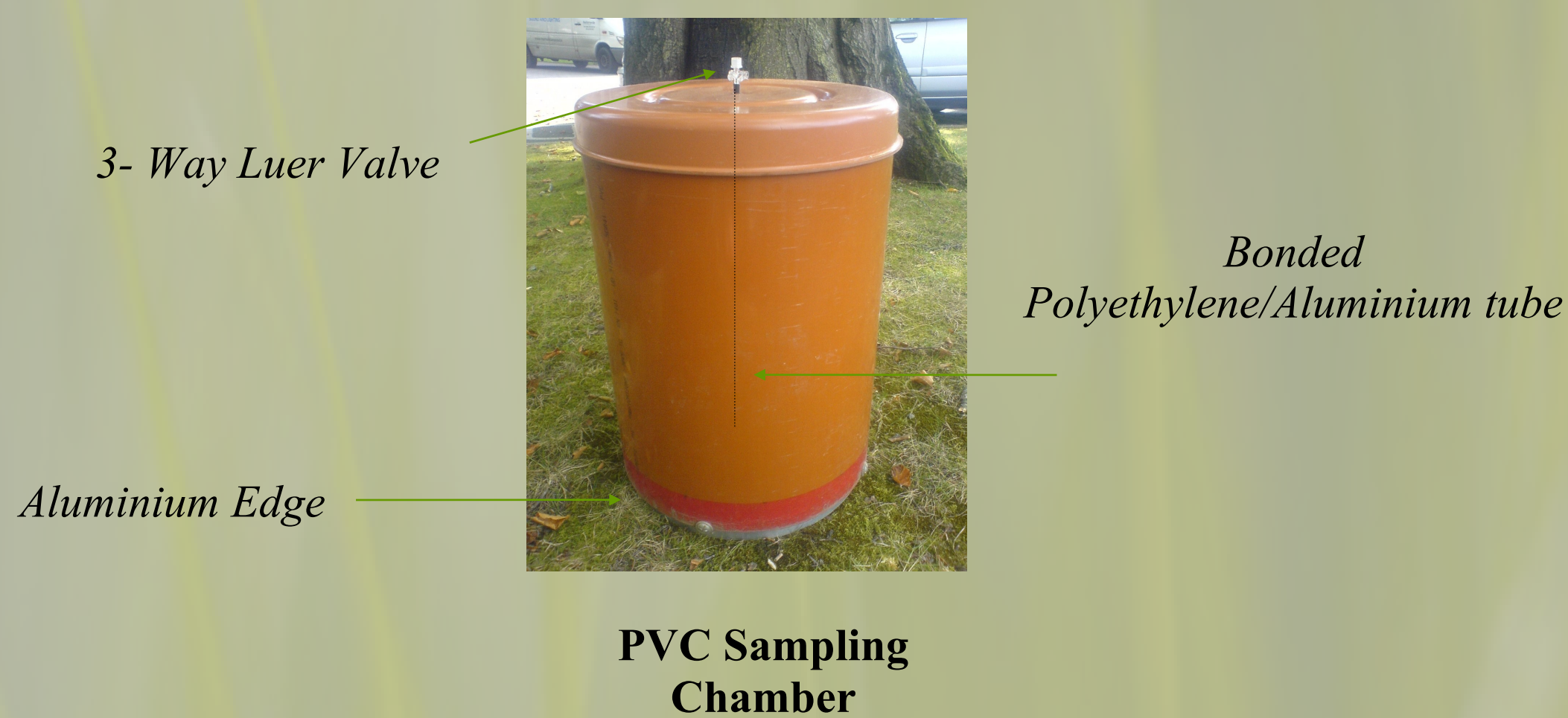
In order to determine the N_2O emissions from the grassland sites, the tried and tested gas sampling chamber method is being employed.

Procedure

- 8 gas chambers and 1 control gas chamber are placed on each site with luer valves shut
- Initial ambient gas samples are taken with a 100 ml glass syringe
- Soil temperature and moisture are recorded
- 2 gas samples are taken from each chamber after 1 hour
- Soil temperature and moisture are again recorded
- Vials are labelled with site name, chamber number, sample number and date and time
- On day of sampling, the 27 vials are then processed through the gas chromatograph for chemical analysis

Chamber Design

The gas sampling chambers used in this project are manufactured from Polyvinyl Chloride Pipe (PVC). They have a diameter of 300 mm and a height 450 mm. At the base there is an aluminium edge hugging the internal circumference of each chamber and it is used to penetrate the soil and provide an airtight seal during sampling.



Sampling Method

The initial ambient gas sample is taken by simply withdrawing the plunger of the syringe while the barrel is exposed to ambient atmospheric conditions. A 25 gauge needle is then fixed onto the syringe and the ambient sample is injected into a vial and the vial is labelled according.

After the 1 hour incubation period, 2 samples are then taken from each chamber. On this occasion a luer valve is fixed on the syringe and is coupled with the shut luer valve on the top of each chamber. The valve on the chamber is then opened and the plunger of the syringe is withdrawn to a volume of 40 ml. Both luer valves are then shut and uncoupled. The needle is then fixed to the syringe as before and the sample is injected into a vial.



Gas Extraction from Sampling Chamber

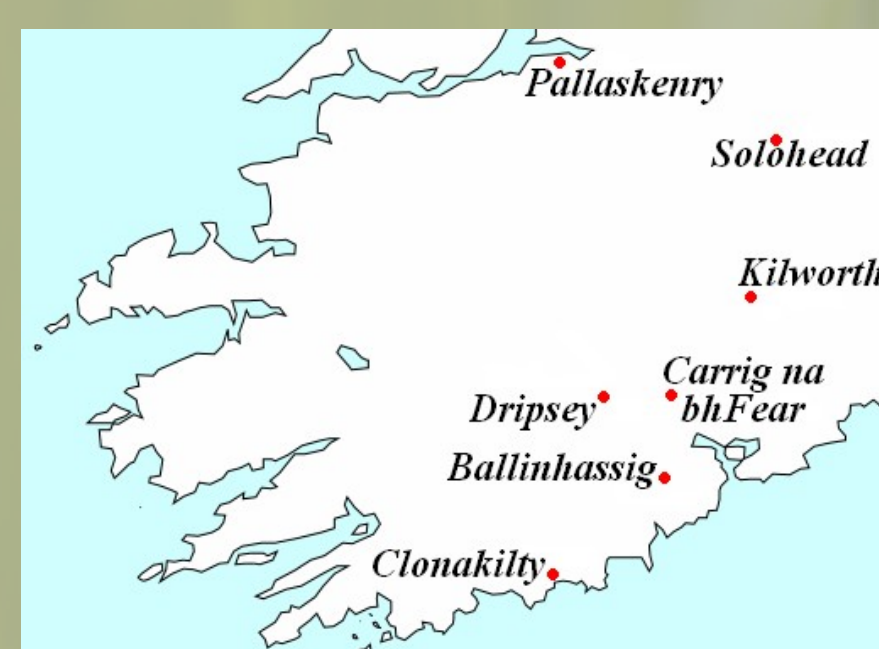


These photos show the formation used for the chambers during the sampling. Chambers are placed at 4 metre intervals.

Sites

Eight sites are being analysed for soil emissions in this project. These sites are :

- Pallaskenry, Co. Limerick
- Solohead x 2, Co. Tipperary
- Kilworth, Dripsey, Carrig na bhFear, Ballinhassig and Clonakilty, all in Co.Cork.



Map of 8 Sites Within Munster

Soils

Soil analysis is being carried out on all 8 sites. This analysis comprises of the determination and detection of :

- Bulk density
- Texture (Sand/Silt/Clay)
- Organic matter
- Organic carbon
- Available nitrogen as nitrate (NO_3^-) and ammonium (NH_4^+), pH, exchange capacity, sulphur, total phosphorus.

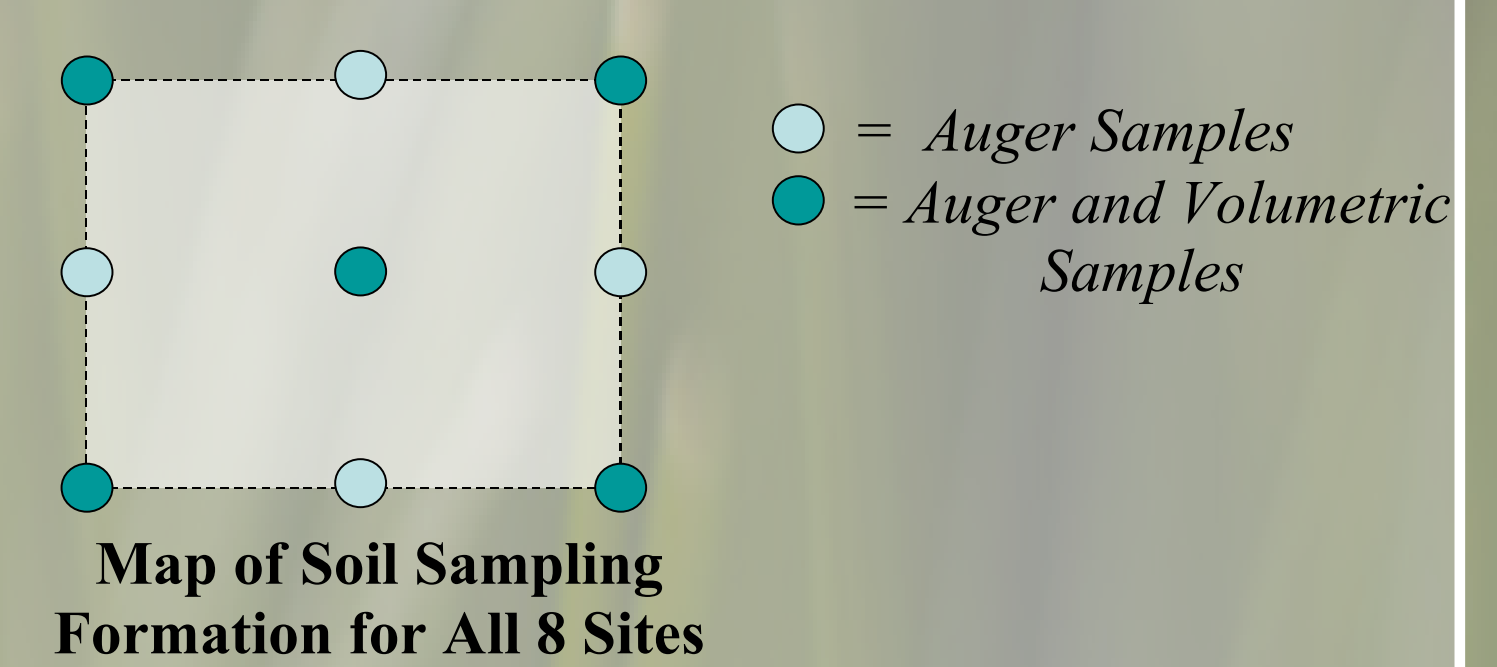
The formation of the soil sampling plots are in 20 by 20 metre configurations with 9 sampling points.



Solohead



Clonakilty



For the required soil analysis to be carried out, two methods for obtaining soil are employed in the field.

Augers are used to get soil samples are three different depths; 0 – 10cm, 10 – 25cm and 25 – 50cm. Volumetric samples are also taken at similar depths.

Each of the eight sites have a met station. These met stations record:

- Rainfall
- Soil Temperature
- Soil Moisture Content



Site Met Stations



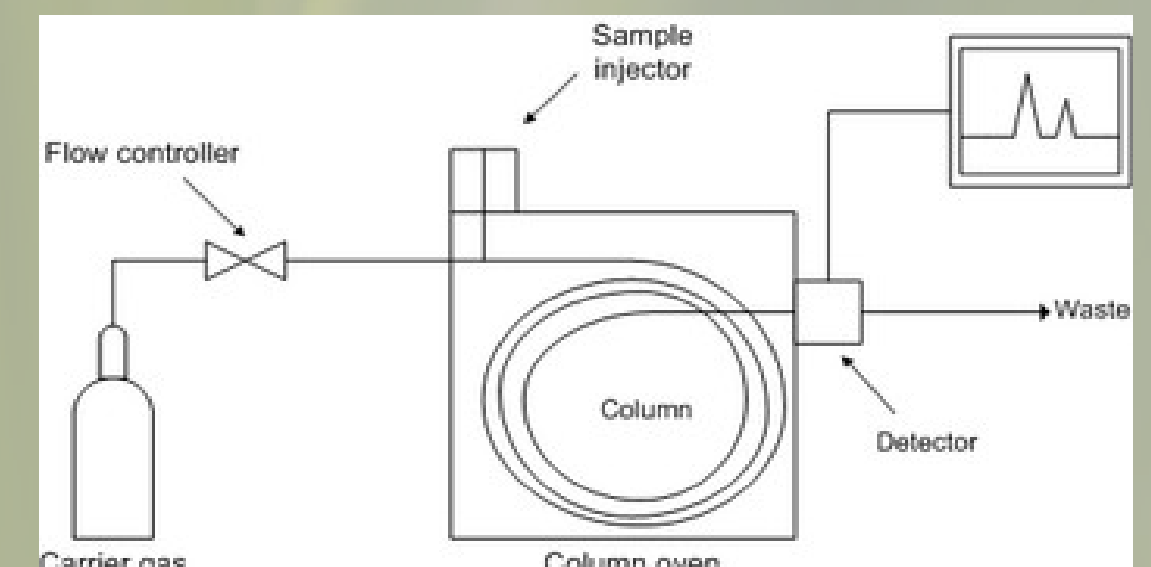
Dripsey Met Station

Dripsey being the main site records the previous parameters as well as having more varied and advanced instrumentation measuring:

- Three-dimensional wind speeds
- N_2O concentrations using eddy covariance technique

Gas Chromatograph

The Gas Chromatograph is a chemical analysis instrument for separation and detection of chemicals in a liquid or gas sample. A gas chromatograph uses a tube known as the *column*, which has a carrier gas flowing through it at all times. Different chemical constituents of a sample pass through the column at different rates depending on their various chemical and physical properties and their interaction with the column filling. As the chemicals exit the end of the column, they are detected and identified electronically. The function of the column is to separate different components, causing each one to exit the column at a different time (*retention time*) and this retention time is used to determine what the chemical is. Other parameters that can be used to alter the order or time of retention are the carrier gas flow rate and temperature.



Gas Chromatograph Diagram

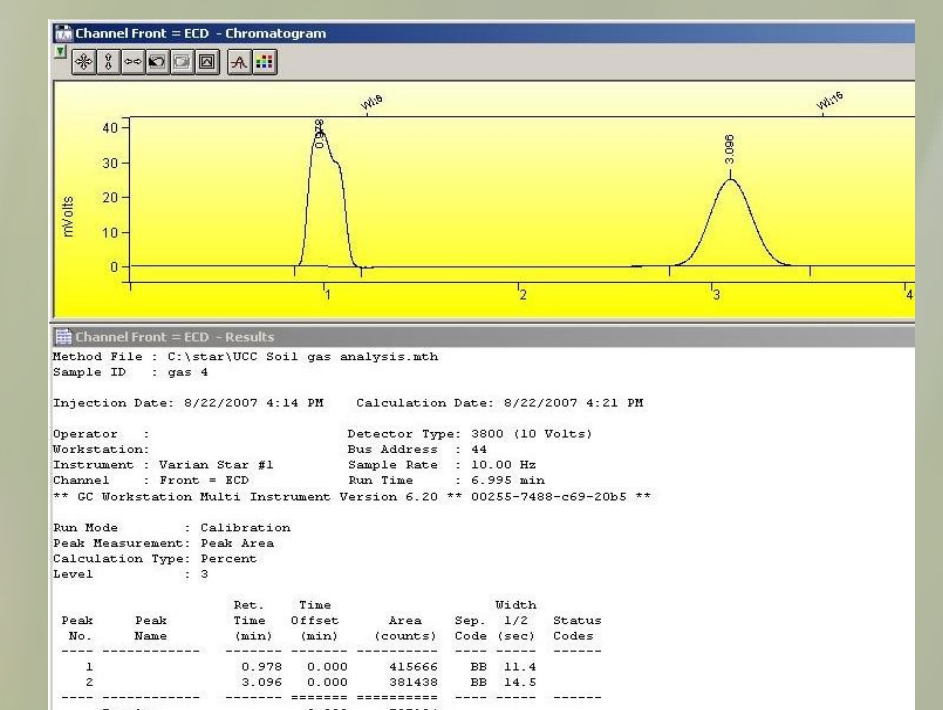


Gas Chromatograph with CombiPal Auto Sampler



Gas Sample Vials

The vials in use are made from Borosilicate Glass to a volume of 12 ml and are pre-evacuated. They are supplied with a white Exetainer cap which accommodates the septum for needle access.



Gas Chromatograph Detector Output Graph

Graph displays retention time on x-axis and detector voltage on the y-axis which represents the different components of the sample and their concentrations respectively.

Results

August N_2O Fluxes

Site	Date	No. of Chamber Sampled	Average Flux ($ng\ N_2O\ m^{-2}\ s^{-1}$)
Dripsey	08/08/2007	1	28
Ballinhassig	10/08/2007	1	-18.2
Pallaskenry	13/08/2007	1	20
Clonakilty	16/08/2007	5	182

Initial flux results calculated from the concentration values obtained from the gas chromatograph averaged from the chamber samples.

Acknowledgements:

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References:

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