# InGOS kickoff meeting 21+22 November 2011

# Registered talks and posters

# Posters

1. Ralf Kiese:

GHG measurements on lysimeters within an in-situ climate change experiment using a QCL system- Ralf Kiese, Benjamin Wolf, Eugenio Diaz-Pines, Klaus Butterbach-Bahl

1. Eiko Nemitz:

Concentrations and fluxes of methane above London - Eiko Nemitz & Carole Helfter

Spanish contribution to the observation of N2O and CH4 to InGOS

1. Emma Huertas:

Spanish contribution to the observation of N2O and CH4 to InGOS - Mercedes de la Paz, Emma I. Huertas and Fiz F. Pérez

1. Sacco te Lintel Hekkert:

QCL-based photoacoustic trace gas detectors for environmental detection of NH3 and N2O - S. te Lintel Hekkert, R.Zijlmans

1. Iain Robinson:

An adaptable lidar for vertical profile measurement of greenhouse gases - Iain Robinson, Jim Jack and John B. Moncrieff

1. Dave Lowry:

Carbon isotopes of methane from source emissions and atmospheric background - an InGOS TNA analytical service (WP11) - Lowry, D., Fisher, R., Lanoisellé, M., Nisbet, E.G.

1. Ronald Hutjes:

Eddy covariance observations of wetland methane fluxes using open path WM spectroscopy - Elbers, Naipaul, Kruijt, Hutjes

1. The InGOS consortium

InGOS – Integrated non-CO2 Greenhouse gas Observing System (PDF)

1. Fiz Perez:

Nitrous oxide and methane in the equatorial Atlantic Ocean - de la Paz et al. (PDF)

1. Alex Vermeulen, Arjan Hensen, Elena Popa, Bart Verheggen, Pim van den Bulk, Piet Jongejan

Greenhouse Gas Observations at Cabauw Tall Tower 1992-2010 (PDF)

1. de la Paz, Mercedes, Barnes Jonathan,Upstill‐Goddard, Robert, Fajar, Noelia, Pelegrí, J.Luis.,

Ríos, Aida .F. , Pérez, Fiz F

Nitrous oxide and methane in the equatorial Atlantic Ocean (PDF)

1. Bill Sturges

Weybourne Atmospheric Observatory TNA (PDF)

1. J. Bielewski , D. Limanówka1, J. Rosiek2, I. Śliwka

Long term measurements of CFCs and SF6 in air of Southern Poland.

1. Lowry, D., Fisher, R., Lanoisellé, M., Zazzeri, G., Nisbet, E.G.

Access to megacity and near background air sampling

15. Peltola, I. Mammarella\*, S. Haapanala and T. Vesala

Intercomparison of four methane gas analyzers suitable for eddy covariance measurements

1. Hella van Asperen, Thosten Warneke

The use of FTIR-spectrometry for quantifying greenhouse gas fluxes between the biosphere and the atmosphere

# Plenary talks

Ronald Hutjes:

Prospects for airborne measurments of methane fluxes - Hutjes, Lindroth, Elbers, Vellinga, Oechel

Herman Bange:

Nitrous oxide and methane in the ocean - Hermann W. Bange, Emma I. Huertas, Truls Johannessen, and Andrew J. Watson

Ray Weiss:

Developing a global network for the measurement of non-CO2 greenhouse gases: The AGAGE experience – Ray Weiss et al.

Ed Dlugokencky:

Recent trends in CH4, N2O and SF6 - Ed Dlugokencky et al.

Peter Bergamaschi:

Top-down estimates of European CH4 and N2O emissions based on 5 different inverse models - Peter Bergamaschi et al.

# WP Talks

Ingeborg Levin - NA2: tbd

Martina Schmidt – NA3: Overview

Emanuele Reggiani - NA6: Observing ocean –atmosphere carbon fluxes: the marine component of the Integrated Carbon Observing System (ICOS) and what is the potential implementing non–CO2 gasses as well (InGOS) - Johannessen Truls, Watson Andrew, Huertas Emma, Hermann Bange and Marine ICOS team

Lynn Hazan- SA1: The InGOS data center

Aasmund Fahre Vik - SA1: introduction to the SA1 activity on halocarbons

Alex Vermeulen – JRA1: Overview

Hartmut Boesch - JRA2: Space-based CH4 Retrievals from GOSAT - Hartmut Boesch, Robert Parker, Austin Cogan, Paul Palmer

Thorsten Warneke - JRA2: Integration of in-situ data with remote sensing - T. Warneke, T. Blumenstock, H. Boesch, F. Hase, E. Kyrö, M. De Maziere, J. Notholt, M. Schneider, R. Sussmann

Dave Lowry – JRA4/SA: Carbon isotopes of methane from source emissions and atmospheric background - an InGOS TNA analytical service (WP11) - Lowry, D., Fisher, R., Lanoisellé, M., Nisbet, E.G.

Lukas Emenegger - JRA4: Isotopes: Getting ready for atmospheric monitoring? Lukas Emenegger, T. Röckmann

Willi Brand - JRA4: CH4 Isotope measurement and data compatibility across laboratories

Johannes Laube - JRA5: tbd

Arnoud Frumau – JRA6: Eddy flux observations of N2O and CH4 at CBW 60m, link with concentration profiles

# Agenda of parallel session NA4:

**Data assurance halocarbon measurements**

09:00 Introduction, objectives and tasks proposed in NA4 (**O’Doherty**)

09:15-0945 Introduction of each halocarbon measurement site, with a focus on current measurements, and calibration (4-5 slides):

Mace Head (**O’Doherty**)

Jungfraujoch (**Reimann standin?**)

Cabauw (**ECN person?**)

Weybourne (**Sturges/Oram**)

GUF (**GUF person?**)

Ny Ålesund (**NILU person?**)

Mt Cimone (**Maione**)

Others?

09:45 Central data base (**Kjetil Tørseth**)

10:00 General discussion and next steps (**all**)

# Agenda of parallel session JRA1:

11:00-11:10 Overview JRA1 (Alex Vermeulen)

11:10-11:30 Experiences with the Wollongong FTIR – Samuel Hammer

11:30-12:15 Presentation and discussion on the tasks of JRA1:

**Task 13.1**: To evaluate the benefits of FTIR in situ observation in comparison to other techniques - Alex Vermeulen

**Task 13.2**: Combine the FTIR-analyzer with micrometeorological techniques for multi-species - Thorsten Warneke

atmosphere-biosphere exchange flux measurements

**Task 13.3**: To evaluate the benefits of new optical analyzers - Martina Schmidt

**Task 13.4**: To evaluate the possibilities for DIAL techniques in the tall tower network - John Moncrieff

**Task 13.5:** Low cost high precision GC technique for multi-component analysis - Bill Sturges

12:15-12:30 Wrap-up and appointments

# Agenda of parallel session JRA3:

9:00-9:05 Overview JRA3 (Peter Bergamaschi)

9:05-9:25 Task 15.1/15.2: Modeling of CH4/N2O (Peter Bergamaschi)

9:25-9:40 Task 15.3: Model validation (Ute Karstens)

9:40-9:45 Task 15.4: Link to remote sensing (Peter Bergamaschi)

9:45-10:00 Task 15.5: Modeling of halocarbons (Dominik Brunner)

10:00-10:15 Task 15.6:Modeling of δ13CH4 (Sander Houweling)

10:15-10:30 Task 15.7: Network analysis and optimization (Philippe Bousquet)

# Agenda of parallel session JRA6:

11.00 - 11.10 Overview of JRA6 (Ivan Mammarella)

Short presentation on JRA6 tasks (3-4 slides):

 Task 18.1 (Arjan Hensen)

 Task 18.2 (Ivan Mammarella)

 Task 18.3 (Anders Lindroth)

 Task 18.4 (Timo Vesala)

Other presentations:

Arnoud Frumau – JRA6: Eddy flux observations of N2O and CH4 at CBW

60m, link with concentration profiles

Discussion and next steps (All)

# Poster abstracts

**Poster 1**

**GHG measurements on lysimeters within an in-situ climate change experiment using a QCL system**

Ralf Kiese1 Benjamin Wolf, Eugenio Diaz-Pines, Klaus Butterbach-Bahl

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Within a in-situ global change experiment grassland soil monoliths were transplanted along a natural gradient in temperature and precipitation and are now operated at three lysimeter stations at three different altitudes: Graswang860m, 1600mm, 5°C; Rottenbuch 750m, 1400mm, 6.5°C and Fendt 600m, 1030mm, 8.2°C. Lysimeters have the dimension of 1m2 and 1.4m height. At the Rottenbuch site 12 Lysimeters are operated. Beside hydrological parameters (water balance and soil moisture measurements) we also measure GHG exchange via an automatic measuring system. The system consists of an automatic robot setting one chamber alternatively to the 12 lysimeter positions. GHG exchange i.e. CO2, N2O, CH4 and H2O is measured with a QCL system in high temporal resolution allowing minimizing closer times and bias on the water cycle. We will present the technical setup and first measuring results of the GHG exchange of grassland ecosystems with the atmosphere.

**Poster 2**

**Concentrations and fluxes of methane over London.**

Eiko Nemitz1 and Carole Helfter

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Long-term flux measurements have been installed on the BT Tower, 190 m above central London, for CO2, CO, O3, NO and NO2 within the UK ClearfLo project. This site has previously been used for long-term flux measurements of CO2 and campaign based measurements of volatile organic compounds and aerosols (Helfter et al., 2010; Langford et al., 2010; Martin et al., 2009).

InGOS is making use of this infrastructure by adding a fast response high-precision cavity ring down analyser (Picarro G2301-f) to the setup. The analyser has started to measure concentrations and fluxes above London, providing the first urban flux measurement of methane fluxes above an urban environment. First results will be presented.

The installation will be expanded by measuring concentrations gradients below the flux measurement height to quantify storage effects above the city. In addition, during campaigns the CH4 flux measurements at 190 m will be complemented by CH4 and N2O flux measurements at a lower height, from a roof-top tower.

References:

Helfter, C., Famulari, D., Phillips, G. J., Barlow, J. F., Wood, C. R., Grimmond, C. S. B., and Nemitz, E.: Controls of carbon dioxide concentrations and fluxes above central London, *Atmos. Chem. Phys*., **11**, 1913-1928, doi:10.5194/acp-11-1913-2011, 2011.

Langford, B., Nemitz, E., House, E., Phillips, G. J., Famulari, D., Davison, B., Hopkins, J. R., Lewis, A. C., and Hewitt, C. N.: Fluxes and concentrations of volatile organic compounds above central London, UK, *Atmos. Chem. Phys*., **10**, 627-645, doi:10.5194/acp-10-627-2010, 2010.

Martin, C. L., Longley, I. D., Dorsey, J. R., Thomas, R. M., Gallagher, M. W., & Nemitz, E. : Ultrafine particle fluxes above four major European cities. *Atmospheric Environment*, **43**(31), 4714-4721, 2009.

**Poster 4**

**QCL-based photoacoustic trace gas detectors for environmental detection of NH3 and N2O**

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Photoacoustic (PA) spectroscopy is a well known tool for extremely sensitive trace gas detection1. The absorbed energy of the laser photons is transformed from internal ro-vibrational into translational energy by collisions of neighbouring molecules resulting in a pressure increase. By periodically switching on and off the laser a pressure wave is created and its amplitude is detected by a microphone. Since PA is a background free technique (i.e. if there is no absorption, there is no signal), PA is extremely sensitive.

The PA signal scales linear with the laser power, therefore, in the past, PA was used in combination with strong laser sources like the CO2 lasers1 and laboratory OPO systems2 that can deliver from several Watts up till several tens of Watts of laser power. The developments on the QC lasers are going fast and nowadays there are QC lasers with laser powers up to 100 or 200 mW.

In a collaborative effort, Synspec and Sensor Sense have developed QC laser-based photoacoustic detectors for the detection of NH3 and N2O with sub ppbv detection limits. The detectors are compact, robust and fully automated with an integrated software allowing 24/7 measurements with a minimum on maintenance. These detectors are since recently applied in environmental monitoring. As example, monitoring of NH3 emission during a campaign in the south of the Netherlands is shown. It illustrates the sensitivity and speed of the instrument for NH3 monitoring, a difficult compound to measure because of the well known sticking effect.

References:

1. F.J.M. Harren, G. Cotti, J. Oomens and S. te Lintel Hekkert: “Photoacoustic Spectroscopy in Trace Gas Monitoring”, Encyclopedia of Analytical Chemistry, R.A. Meyers (Ed.) 2203-2226 (2000).
2. M.M.J.W. Van Herpen, S. Li, S.E. Bisson and F.J.M. Harren: ”Photo acoustic trace gas detection of ethane using a continuously tunable, continuous-wave optical parametric oscillator based on periodically poled lithium niobate”, Appl. Phys. Lett. **81**, 1157-1159 (2002).

**Poster 5**

**An adaptable lidar for vertical profile measurement of greenhouse gases**

Iain Robinson1, Jim Jack and John B. Moncrieff

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Measurements of the vertical profile of CH4 and N2O concentrations are required to develop and validate models of greenhouse gas cycles and to determine fluxes in order to identify sources. Satellite-based spectroscopic measurements provide global coverage, however the data are column-averaged. They therefore provide very limited information on the vertical profile, particularly in the boundary layer where sources reside. Aircraft sampling provides direct measurement of concentration variation with height, but is too costly for routine monitoring.

Lidar [1] provides the ability to measure the vertical profile from the ground. In contrast to passive techniques its use is not dependent on suitable weather or illumination conditions. We present here the first tests of a lidar instrument being developed at the University of Edinburgh for monitoring of aerosols and greenhouse gases. The lidar consists of a pulsed laser diode with a wavelength of 1550 nm and a custom-built 38 cm Newtonian telescope to collect the returned light, which is detected by a fast InGaAs photodiode. Initial testing of the lidar demonstrates that it can achieve a range resolution of 0.3 m. The custom-designed set-up is very flexible and can readily be adapted to specific measurement requirements. Our aim is to develop a laser source for the instrument to detect CH4 using the differential absorption lidar [2] technique.

References:

[1] U. Wandinger. Introduction to Lidar. In C. Weitkamp (ed.) *Lidar: Range-Resolved Optical Remote Sensing of the Atmosphere,* 2005. [10.1007/b106786](http://dx.doi.org/10.1007/b106786)

[2] M. Uchiumi, N. J. Vasa, M. Fujiwara, S. Yokoyama, M. Maeda, and O. Uchino. Development of DIAL for CO2 and CH4 in the atmosphere. *Proceedings of SPIE*, 2003. [10.1117/12.466107](http://dx.doi.org/10.1117/12.466107)

**Poster 11**

**Spanish contribution to the observation of N2O and CH4 to InGOS**

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The contribution of the Spanish CSIC to the Integrated non-CO2 Greenhouse has Observing Systems (InGOS) aim to increase the knowledge about temporal variability and controlling mechanism of N2O and CH4 in the North Atlantic Ocean. Time-series observations form a critical element of oceanography. New interdisciplinary efforts in marine biogeochemistry are based on time series to build a better, though still poorly resolved, picture of lower-frequency ocean variability, the climate processes that drive variability, and the implications for greenhouse gases dynamics, and climate feedbacks.

The time series station GIFT (Gibraltar Fixed Time Series), located in the meeting point between Mediterranean Sea and Atlantic Ocean will be a valuable contribution to InGOS. The Strait of Gibraltar is an ocean location where permanent and long term monitoring is fully justified. This interest is not only due to the variety of processes occurring within the Strait itself, but also for its importance as a control point for evaluate the content and exchange of N2O and CH4 in the Mediterranean and Atlantic water masses that meet there. Other biogeochemical parameters such as inorganic carbon and nutrients has been measured since 2005 in the GIFT station, and will be highly useful for understanding the biogeochemical processes affecting the N2O and CH4.

Secondly, the OVIDE repeated hydrography section, which connects the Portuguese coast with Greenland, will be also monitored for vertical distribution of N2O and CH4 along this south-north section. The resulting database is highly interest in the study of the decadal variability of the meridional overturning circulation (MOC) and the uptake capacity of greenhouse gases in the North Atlantic Ocean. Next cruise along this section is planed the next summer 2012 under the umbrella of the CATARINA project, which is part of a decadal experiment that started in 1997 and has been sampled every two year. This cruise embraces the different activities, giving multidisciplinary consistency to this project and producing a valuable data base for N2O and CH4 as well as for ancillary biogeochemical measurements that provide the perfect framework to resolve the controlling mechanism of the N2O and CH4 variability in the North Atlantic ocean. The N2O and CH4 in seawater will be analytically determined using the gas chromatographic technique. The measurement device is based in the system developed by Upstill-Goddard et al (1996) and has been optimised during the last year in the Oceanography Department of IIM-CSIC for oceanic measurements.

References:

Upstill-Goddard, R.C, Rees, A.P. and Owens, N.J.P. Simultaneous high-precision measurements of methane and nitrous oxide in water and seawater by single-phase equilibration gas chromatography. Deep Sea Research 1996, 43, 1669-1682

Poster 13

Long term measurements of CFCs and SF6 in air of Southern Poland.

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The concentrations of chlorofluorocarbons (CFCs) and sulphur hexafluoride (SF6) in the atmosphere are on the ppt level. As radiatively active gases they influence the depletion of the Earth’s ozone layer and increase of the greenhouse effect. The decisions of the Vienna Convention (1985) and of the Montreal Protocol (1987) limited the world production level of CFCs in the year 1989 at least 35% after 2004, 90% after 2015 and total reduction after year 2030.

The measurements of CFCs and SF6 in air are usually conducted at the so-called clean stations, i.e., at places situated far from the urban areas. Such clean station in Europe is Mace Head station (Ireland) participated in AGAGE program since 1987 [1]. In central Europe such measurements have been carried out in densely populated urban area of Krakow since 1997. The chlorofluorocarbons measured in Krakow are the result of the superposition of the concentration of these compounds typical for this part of Europe and the local, incidental concentration fluctuations. Very interesting is diminishing frequency of the seasonal variability of CFCs concentration pollution events after the date of 1.07.2002 when the Montreal Protocol legislations were implemented in Poland (The Journal of Laws No. 52). This suggests that the most observed sources of CFCs has been localized to the territory of Poland (the wind and air mass movements have still the same statistical character in Krakow region, as before legislation implementation) [2].

 This work presents a general view of environmental pollution of Krakow air by selected halocarbons i.e., freons F-11 (CFCl3), F-12 (CF2Cl2), F-113 (CCl2FCClF2), chloroform (CHCl3), 1,1,1-trichloroetane (CH3CCl3), carbon tetrachloride (CCl4) and SF6 in the years 1997-2011.

*The authors wish to acknowledge Prof. R. Weiss from Scripts Oceanography Institute (CA, USA) for preparing of the CFC’s primary standard and Dr M. Maiss from Max-Planck Institute (Germany) for SF6 calibration. The authors also thanks prof Kazimierz Rozanski from AGH University of Science and Technology for help. This work was accomplished, as part of grants N N305 0528 34 and N N305 4009 39 from the KBN, the Ministry of Science and Higher Education.*

References:

[1] Prinn R.G. et al*., A history of chemically and radiatively important gases in air deduced from*

 *ALE/GAGE/AGAGE.* J.Geophys.Res. 105(D14), pp 17751 – 17792, 2000*.*

[2] Śliwka I., et al*., Long-Term Measurements of CFCs and SF6 Concentration in Air,*

 Polish J. of Eviron. Stud. Vol. 19, No. 4, 811-815, 2010.

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Poster 14

**Access to megacity and near background air sampling**

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The greenhouse gas laboratory (GGLES) at RHUL is situated 32 Km WSW of London city centre on the first hill since Belgium. During summer the mixing ratios of carbon gases are close to (and sometimes lower than) those observed at Mace Head when the wind is from the Atlantic sector. When winds are low and air moves from the city there are significant build-ups of greenhouse gases under the nocturnal inversion.

The site has continuous measurement of CO2 and CH4 by Picarro CRDS and CO and H2 by Peak Performer. Additionally there is the capability to make continuous measurement of 13C of CO2 or CH4 to high precision. The laboratory has a CRDS dedicated to Tedlar bag, tank, flask and cylinder measurements of CO2 and CH4 with spare capacity for more campaign measurements and will be made available for those without such instrumentation who wish to make measurements and is available for training purposes. The station can also offer training in the analysis of carbon isotopes of atmospheric gases.

The suburban setting makes RHUL an ideal site for testing the capabilities of new instrumentation under a variety of atmospheric conditions and at a range of carbon gas concentrations. It offers a rare opportunity for testing of field based isotopic equipment that aims to run continuously as the lab instruments have the capability, for simultaneous quasi-continuous isotopic measurement of 13C of CO2 or CH4 in ambient air, currently unique in Europe.

**Poster 15**

**Intercomparison of four methane gas analyzers suitable for eddy covariance measurements**

O. Peltola, I. Mammarella\*, S. Haapanala and T. Vesala

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 Methane fluxes were measured simultaneously with four gas analysers capable of measuring gas concentration with high sampling frequency. The measurement system operated about six months between March and August 2010. The aim of the campaign was to evaluate functionality, data quality and overall performance of the gas analysers and to provide an instrumentation recommendation for the European Research Infrastructure ICOS (Integrated Carbon Observation System). Four methane gas analyzers and one sonic anemometer (USA-1, METEK, Germany) were used to acquire four methane flux estimates. One of the participating analyzers, TGA-100A (Campbell Scientific Inc., USA), was rather old, while the three other ones, RMT-200 (Los Gatos Research, USA), G1301-f (Picarro Inc., USA) and LI-7700 (LI-COR Biosciences, USA), were new state-of-the-art instruments.

Methane fluxes obtained from RMT-200 and G1301-f agree remarkably well throughout the measurement campaign, while fluxes determined using TGA-100A and LI-7700 showed more scattering and not as good agreement with the first two instruments.

Random error analysis revealed that the precision of RMT-200 was the highest and that G1301-f and LI-7700 had difficulties in measuring small fluxes as accurately as high fluxes. Also magnitude of instrumental noise and different corrections were estimated. LI-7700 measurements were highly sensitive to water vapor and temperature fluctuations and the corresponding corrections had a major impact on the final fluxes.

**Poster 16**

**The use of FTIR-spectrometry for quantifying greenhouse gas fluxes between the biosphere and the atmosphere**

Hella van Asperen, Thorsten Warneke

University of Bremen

Fluxes between the biosphere and atmosphere of these gases are not all well known, especially not for remote areas. Nowadays, most flux data is derived from atmospheric measurements using inverse modelling and usually obtained for only one gas species at the time. Fourier Transform InfraRed (FTIR) spectrometry has the advantage of being able to measure gas concentration of different gases simultaneously. Furthermore, it is possible to apply FTIR-spectrometry to different measurement techniques, such as the Eddy Flux correlation methods or the flux chamber method. In combination with suitable software, FTIR is suitable for independently executing measurements for longer time periods with minimum maintenance. Besides, because of the mobility of the FTIR-spectrometer, it is possible to quantify greenhouse gas fluxes in remote areas. Research areas still have to be determined.Plenary sessions

**Developing a global network for the measurement of non-CO2 greenhouse gases: The AGAGE experience**

Ray F. Weiss1

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The Advanced Global Atmospheric Gases Experiment (AGAGE) has evolved, beginning in the late 1970s with a focus on CFCs and other stratospheric ozone depleting substances (ODSs), into a global network measuring over 40 non-CO2 GHGs, including all non-CO2 GHGs and ODSs regulated under the Kyoto and Montreal Protocols. Whole air injections are analyzed with multi-detector custom gas chromatographs (GC-MDs), mainly for the CFCs, N2O and CH4. Other species, including PFCs, SF6, HCFCs, HFCs, chloro- and bromo-carbons, SO2F2 and NF3, as well as CFCs, are measured by the AGAGE “Medusa” instrument using cryogenic preconcentration and capillary gas chromatography with mass-spectrometry (GC-MS). This instrumentation is fully automated for unattended operation at remote field stations as well as at central laboratories. Calibrations are by AGAGE ambient-level primary gravimetric standards, but interim calibrations from other sources are also used, including relative calibration scales based on stored whole air samples that can be used to begin trend measurements before primary calibrations are available. Instrument operation and data acquisition, processing, and exchange are all handled by custom software making extensive use of the Internet. AGAGE is highly collaborative measurement and modeling effort, with strong and regular working meetings and close interactions with other international colleagues and programs.

References:

R. G. Prinn, R. F. Weiss, P. J. Fraser, P. G. Simmonds, D. M. Cunnold, F. N. Alyea, S. O’Doherty, P. Salameh, B. R. Miller, J. Huang, R. H. J. Wang, D. E. Hartley, C. Harth, L. P. Steele, G. Sturrock, P. M. Midgley and A. McCulloch, A history of chemically and radiatively important gases in air deduced from ALE/GAGE/AGAGE, *J. Geophys. Res.*, **105**, 17,751-17,792, 2000.

B. R. Miller, R. F. Weiss, P. K. Salameh, T. Tanhua, B. R. Greally, J. Mühle, and P. G. Simmonds, Medusa: a sample preconcentration and GC/MS detector system for in situ measurements of atmospheric trace halocarbons, hydrocarbons and sulfur compounds, *Anal. Chem.*, **80**, 1536-1545, 2008.

# Parallel sessions

**NA6 Harmonisation and QA of NCGHG measurements in the ocean**

**Observing ocean –atmosphere carbon fluxes: the marine component of the Integrated Carbon Observing System (ICOS) and what is the potential implementing none – CO2 gasses as well (InGOS)**

Johannessen Truls1, Watson Andrew, Huertas Emma, Hermann Bange and Marine ICOS team

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The oceans are important sinks for the greenhouse gases produced by human activity – for example, on millennial time scales they will take up most of the carbon dioxide we are releasing to the atmosphere. In response to global climate change, uptake or release of these gases will change with time. It is important therefore to have some way of tracking ocean-atmosphere fluxes, to know how the Earth system as a whole, and the marine part of it in particular, is responding to anthropogenic activities. ICOS is the European component of what will become a global in-situ observational network for the monitoring of fluxes of greenhouse gases (principally carbon dioxide, methane and nitrous oxide) between the atmosphere and both land and ocean. It is one of the projects listed in the roadmap for ESFRI (European Strategic Forum for Research Infrastructures). The marine component of ICOS will be made up of regular surface observations from voluntary observing ships using automated instruments, time series sites at which observations through the water column can be made, and support for global observations of the marine carbon inventory. In recent years projects such as CARBO-OCEAN and CARBOCHANGE, supported by EU FP6 and FP7, have shown that it is possible to define with good space and time resolution the basin-wide fluxes of CO2 between atmosphere and ocean in the North Atlantic using an observational network like that envisaged for ICOS. This flux is more variable than previously believed, and undergoes decadal changes of quite large magnitude. What added value will implementing none – CO2 gasses to this network as well (InGOS).

**Nitrous oxide and methane in the ocean**

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The ocean is a major source for atmospheric N2O; whereas oceanic emissions play only a minor role for the atmospheric budget of CH4. The major issues impacting the quality of oceanic emissions estimates for N2O and CH4 may be summarised as follows: 1) Limited database: Large parts of the open and coastal oceans have little to no spatial data coverage and 2) Seasonal and interannual variability: The concentrations of dissolved N2O and CH4 and their seasonal variability reflect the imprint of seasonally varying biology (i.e. nitrification/denitrification and methanogenesis) on an underlying hydrographic regime (e.g. coastal upwelling, mixing etc.) which also varies seasonally. Both gases thus show considerable temporal variability in the surface ocean. To this end InGOS WP6 was initiated to improve, harmonize and integrate oceanic measurements of N2O and CH4 in different open ocean and coastal regions. The objectives of WP6 include (i) intercomparison exercise of different analytical methods (Gas Chromatograph (GC) versus Off-Axis Integrated Cavity Output Spectrometer (OA-ICOS) in the laboratory and during field campaigns and (ii) Establishment a network of oceanic N2O and CH4 concentration measurements in different oceanic regions (open ocean, coastal, coastal upwelling) by using different platforms such as VOS lines, repeated hydrographic sections as well as open ocean and coastal time series stations. WP6 is a joint effort of IFM-GEOMAR (Kiel, Germany), CSIC (Vigo and Cadiz, Spain), UEA (Norwich, UK), and University of Bergen (Norway).

**Paralle session JRA2 Integration of in-situ data with remote sensing**

**JRA2: Integration of in-situ data with remote sensing**

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Remote sensing measurements of the methane column averaged volume mixing ratio (XCH4) have significantly contributed to the understanding of the atmospheric methane distribution over the last six years. It is expected that the quality of the remotely sensed XCH4 will continue to improve and that it will become increasingly important for constraining CH4 fluxes. Ground-based remotely sensed XCH4 measurements are performed within the Total Carbon Column Observing Network (TCCON), which became part of the Global Atmosphere Watch (GAW) programme of the World Meteorological Organization (WMO) in 2009 (Wunch et al., 2010).

The TCCON measurements are vital for the calibration and validation of the satellite methane and add complementary information to the in situ measurements. Despite its importance the European part of TCCON (TCCON-Europe) is currently not part of ICOS. In this JRA we will work towards a harmonized and calibrated dataset of ground-based remotely sensed XCH4 with well characterized uncertainties for the TCCON-observations at proposed ICOS atmospheric sites and will assess the value of the integration of TCCON-Europe into ICOS. The established dataset will be used for the validation of models as well as satellites.

**Space-based CH4 Retrievals from GOSAT**

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The Japanese Greenhouse Gases Observing SATellite (GOSAT) satellite is the first dedicated space-based greenhouse gas mission that provides global observations of total column CO2 and CH4 from high-resolution shortwave infrared measurements which aim at improving our knowledge of the surface fluxes on regional scales. We retrieve the dry air mole fraction of CH4 from GOSAT observations using the NASA OCO full physics retrieval algorithm and we will soon have a global two year CH4 dataset.

To assess the performance of our retrieval, we have validated the GOSAT CH4 columns against CH4 column retrievals from ground-based Fourier Transform Spectrometers at six sites of the Total Carbon Column Observing Network (TCCON). We find that biases between the TCCON and GOSAT retrievals are less than 1% with a station-to-station variation of 0.6%. We also find a very high level of consistency between the GOSAT CH4 retrievals and model calculations of GEOS-Chem global transport model with correlation coefficients close to unity for features such as the north-south gradient or seasonal cycle over regions without significant sources (such as northern Africa). In contrast, clear differences in the magnitude of the seasonal patterns are observed over known source regions (such as the Amazon) where the emission inventories are highly uncertain. These can be investigated further using an inverse model to quantify the corresponding flux estimates.

References:

Parker, R., Boesch, H. Cogan, A., Fraser, A., Feng, L., Palmer, P., Messerschmidt, J., Deutscher, N. Griffith, D., Notholt, J., Wennberg, P., and Wunch, W., Methane observations from the Greenhouse Gases Observing SATellite: Comparison to ground‐based TCCON data and model calculations, Geophys. Res. Lett., 38, L15807, doi:10.1029/2011GL047871, 2011

**Parallel session JRA4+SA Isotopes**

**Carbon isotopes of methane from source emissions and atmospheric background - an InGOS TNA analytical service (WP11)**

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The greenhouse gas laboratory (GGLES) at RHUL has two CRDS instruments and two Trace Gas / IsoPrime mass spectrometer systems for the measurement respectively of mixing ratios and 13C of CH4 (and CO2). The 13C of CH4 can be measured in as little as 75cc of air to a precision averaging 0.04‰ (1 on triplicate analyses). The system is set up primarily to measure the 13C of 1 to 10 ppm CH4 in air, but measurements of methane fluxes from sources are also regularly made by sample dilution. Each analysis takes less than 20 minutes.

In addition to the west London (EGH) time series, over the last 4 years we have maintained time series for stations in the Atlantic (East Falkland, Ascension Island), at UK coastal sites (Weybourne, Barra), in the Arctic (Alert, Pallas, Zeppelin) with less frequent sampling from Cyprus, Hong Kong and South Africa. Campaign samples at background stations and in source regions have been analysed from Canada (East Trout Lake, Sable Island, forest fires), Finland (wetland), Spitsbergen and surrounding seas (hydrates, wetland), Siberia (Kytalyk, N. Siberian shelf), Suriname and Cote d”Ivoire.

For InGOS we will offer up to 180 days of analysis in daily units. Each day consists of 15 analyses of unknowns, plus standards for calibration purposes. We recommend that each sample be analysed in triplicate to achieve good precision. While the focus will be a better understanding of methane sources and their contribution to background station measurements within Europe we welcome proposals for measurement of samples from monitoring stations and flux campaigns further afield.