FINE-SCALE INTEGRAL MONITORING OF THE CARBON CYCLE: LOW COST, HIGH RESOLUTION MONITORING OF CO_2 WITHIN A DUTCH AND EUROPEAN NETWORK

Bart Kruijt[1], Jan Elbers[1], Ronald Hutjes[1], Eddy Moors[1], Martina Schmidt[2], Claire Carouge[2], Cor Jacobs[1]

[1] *Wageningen University and Research Centre,Alterra/WU, PO Box 47, 6711 AA, Wageningen, Netherlands; bart.kruijt@wur.nl;*
[2] *Laboratoire des Sciences du Climat et de l'Environnement, Gif sur Yvette,- France*

ABSTRACT

We report on the set-up of and first experiences with a medium-precision CO_2 concentration monitoring network in Europe, linked to existing flux towers. The system is to be embedded in an integral GHG monitoring system to be developed for the Netherlands and into the CABOEUROPE effort to quantify the European carbon balance. The proof of concept has not been fully satisfactory as yet, but work continues.

REGIONAL MONITORING

Inverse methods for quantification of a regional greenhouse gas balance use measured time series of a particular mixing ratio at one or more sites, together with transport and diffusion information from an atmospheric model. Prior estimates of source/sink distributions must be provided to the inverse computation scheme and these are then improved towards values more in agreement with the observed concentration fields. This method sofar has been used mostly at large, continental to global scales, but in principle can be used at smaller scales too, and hence could provide a tool to verify the emissions at roughly national and perhaps sub-national levels.

The challenges, however, of developing a verification tool at these relative small scales are large and in part of a different nature than those developed for continental to global scales. These have to do with the very large variability of fluxes in landscapes exhibiting e.g., cities and forests, covariance of fluxes and atmospheric PBL dynamics and the resulting problems of representativity and aggregation of data. Therefore, at these scales it is imperative to make use of all of the constraints provided/imposed by different data streams, by process knowledge of ecosystem behaviour (natural and man made) and of atmospheric dynamics as embodied in state-of-the-art models.

Several initiatives have recently been taken to set up monitoring systems at such high resolution, attempting to overcome the complexity by applying a strong multiple-constraint approach. In Europe, the CARBOEUROPE integrated project is hosting a coordinated effort to link flux and ecosystem observations, atmospheric monitoring, modelling and integral data and model synthesis. In the Netherlands, through the BSIK community programmes, a broadly similar approach is being adopted, yet at even higher resolution (Fig. 1).

Integrated observations and modelling of Greenhouse Gas budgets at the national level

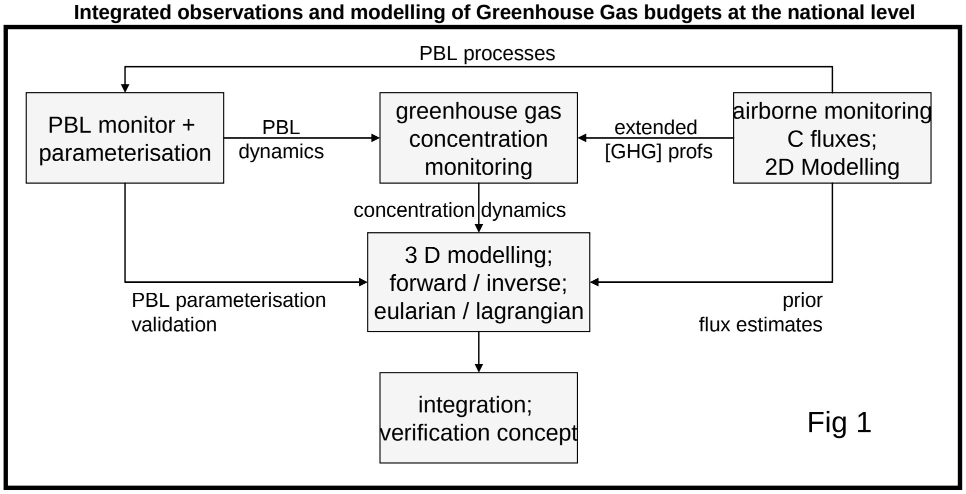

Fig 1

HIGH-DENSITY CONCENTRATION MONITORING

One important challenge in such a scheme is to increase the density of measurements of unbiased spatial CO_2 concentration gradients, closer to the land surface. Even with the high concentration variability near the surface, exchange inferred from such gradients is very sensitive to bias. We are designing and testing a system that is simple enough to be installed on any flux or meteorological observation tower, but accurate enough to be at least used as ancilliary data in an inverstion network.

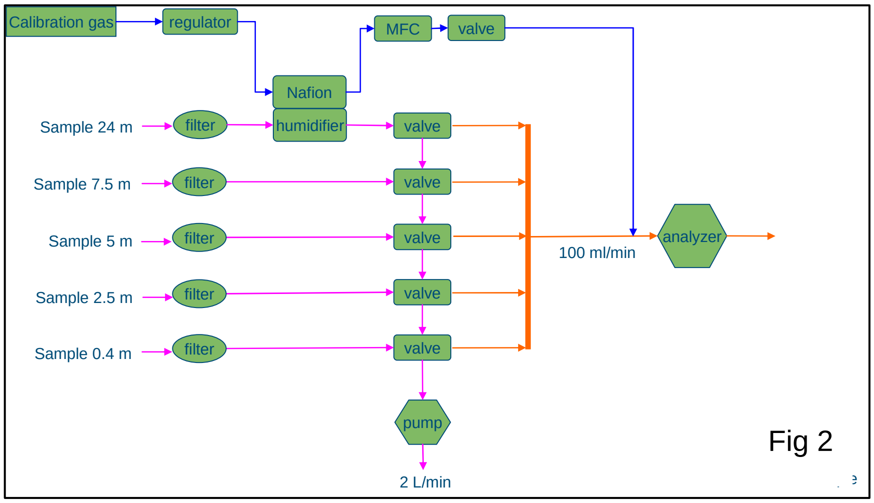

Fig 2

We based the measurement system on an exisiting set-up for routine measurements of CO_2 gradients into the vegetation, along flux towers. Such a system typically constists of a set of tubes, pumps, valves and a logging system, with at its core a low-cost IRGA. The CIRAS-SC of PP Systems (Herts, Hitchin, UK) is an example of such an analyser, and among its specified features are medium precision (0.5 ppm) and high stability resulting from temperature and zero control. We added to this system an automatic, frequent calibration module using high-specification standard gas. Because these gradient systems usually also need to measure water vapour concentrations, drying the sample air is not an option. Instead, to avoid transient humidity in the cell, we are humidifying the calibration gas using an inverted Nafion 'dryer'. The system is illustrated in Fig. 2.

The raw output of the CIRAS analyser needs to be corrected in several ways. First, there is a temperature dependence, second, the dilution by humidity is accounted for and, third, the calibration needs to be applied. The system has been tested through comparison with flask samples, analysed at LSCE, France. As shown in figure 3, the comparison is not satisfactory yet. The mean deviation between corrected measurements and flask observations is about 3 ppm. One explanation may be a non-perfect match between sampling time of IRGA and flasks. Also, the flask data were variable, and it is possible that there were problems in sampling the air.

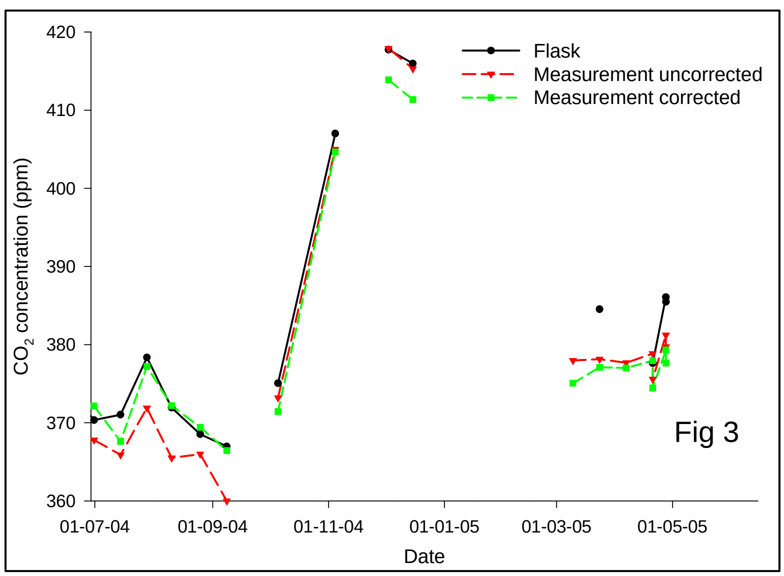

Fig 3

CONCLUSIONS

The system improves on the status quo, which is one of very infrequent calibration. Proof of satisfactory precision has still to be given, though. In the mean time, we plan the installation of the system on various flux towers in Europe, hopefully contributing to the monitoring network in the long run.