ANNEX 3: PERIODIC REPORT

INDIVIDUAL FELLOWSHIPS

Project n°: 221332

Project Acronym: POLICE

Project Full Name: Parameter Optimisation of a terrestrial biosphere model to Link processes to Inter annual variability of Carbon fluxes in European forest Ecosystems

Marie Curie Actions

IEF-IOF-IIF-IIFR Periodic Report

Period covered: from July 2008 to December 2008

Period number: 1

Start date of project: 1 July 2008

Project beneficiary name: Hans Verbeeck

Project beneficiary organisation name: CEA Commisariat à l'Energie Atomique

Date of preparation: June 2010

Date of submission (SESAM):

Duration: 6 months

Version: 1

DECLARATION BY THE PROJECT COORDINATOR

I Philippe Ciais, as co-ordinator of the project *POLICE*, hereby confirm that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;
- The project (tick as appropriate)[1]:

  ☐ has fully achieved its objectives and technical goals for the period;
  X has achieved most of its objectives and technical goals for the period with relatively minor deviations;

  ☐ has failed to achieve critical objectives and/or is not at all on schedule.

- The project Website (if applicable) is up to date.
- To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project and if applicable with the certificate on financial statement.
- The *beneficiary*, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section 6 (Project Management) in accordance with Article II.2.f of the *Grant agreement*.

Name of Scientist in Charge: Dr. Philippe Ciais

Date: ____/____/____

Signature of Scientist in Charge:

[1] If any of these boxes is ticked, the report should reflect these and any remedial actions taken.

1. PUBLISHABLE SUMMARY

Inter annual variations of net ecosystem carbon exchange (NEE), driven by weather and climate, are known to contribute to variation in the annual growth rate of atmospheric CO_2 globally, but little is known about the underlying processes in each region. Better ability to predict future atmospheric CO_2 levels and climate change should thus be gained by understanding the current inter annual variation in the biotic response to environmental forcing.

In this context, I assess, using a state of the art data assimilation approach, the impact of extreme climate spells, such as the summer 2003, versus the one of "normal" year-to-year climate variations on the processes which control the European carbon balance. This knowledge will be propagated into better future projections of the European carbon balance.

Overall, the scientific objectives of the project will be primarily investigated using a parameter optimisation approach. Estimation of the process-based ecosystem parameters using radiation, sensible heat, latent heat, and CO_2 exchanges at several ecosystem sites (forest) will help to improve the simulation of inter annual variations in terrestrial CO_2 fluxes and to assess the potential of the ORCHIDEE model.

The overall objectives of this proposal are threefold: (1) Optimisation of all critical parameters of ORCHIDEE and assessment of the limits of this process-based model to simulate eddy covariance measurements. (2) Identification of drivers and processes determining inter annual variations of forest carbon fluxes. (3) Improved model future projections of Europe's carbon balance, with uncertainty estimates, using the optimized parameters. As the POLICE project was only active for 6 months, only the first objective was achieved.

2. PROJECT OBJECTIVES FOR THE PERIOD

Overview of the objectives for the reporting period:
As the POLICE project was only active for 6 months, only the first objective was achieved. The progress on this objective is reported below.

Month 1-6: Objective 1: Optimisation of ORCHIDEE's parameters and assessment of the limits of the model.

Summary of previous recommendations:
Previous review: not applicable.

3. WORK PROGRESS AND ACHIEVEMENTS DURING THE PERIOD

Progress on objective 1:

The ORCHIDEE biogeochemical ecosystem model (Organizing Carbon and Hydrology In Dynamic Ecosystems) is originally developed for global applications, including the coupling with atmospheric models (Krinner et al. 2005). It is a process-driven model, which calculates fluxes between the land and the atmosphere on a 30 min time step. In this study, we applied the model in 'grid point mode' for the Tapajós km 67 site, forced by 30 min gap-filled meteorological measurements from an eddy covariance tower.
The model contains a biophysical module dealing with photosynthesis and energy balance calculations each 30 min, a carbon dynamics module dealing with the allocation of assimilates, autotrophic respiration components, foliar development, mortality and soil organic matter decomposition on a daily time step. The standard ORCHIDEE equations are given by Ducoudré et al. (1993), Krinner at al. (2005), and Santaren et al. (2007). As in most global biogeochemical models, the vegetation is classified into Plant Functional Types (PFT), with 13 different PFTs over the globe. Distinct PFTs follow the same set of governing equations, but with different parameter values, except for the calculation of the phenology, which involves a PFT specific parameterization.
We optimised model parameters by minimizing a cost function that takes into account the distance between model outputs and the corresponding observations, model and data uncertainties and prior information on parameters. Our approach is described in detail by Santaren et al. (2007) and Bacour et al. (2010). With the assumption of Gaussian errors for both the observations and the prior parameters, the optimal parameter set corresponds to the minimum of the cost function J(x) that contains both the mismatch between modelled and observed fluxes and the mismatch between prior and optimised parameters. x is the vector of unknown parameters, xb the prior parameters, H(x) the model and y de vector of observations. The covariance matrices R and Pb describe the prior uncertainties on the observations and parameters. We acknowledge that the assumption of Gaussian errors might be violated for eddy covariance data.

To minimize the cost function we used an efficient gradient-based algorithm, called L-BFGS-B (Zhu et al. 1995). This algorithm allows prescribing an upper/lower limit for each parameter. We calculate the exact derivatives of J(x) by using the Tangent Linear model of ORCHIDEE. However, the BFGS algorithm does not provide uncertainties or correlations between optimized parameters. Therefore, once the minimum is reached the posterior error-covariance matrix on the parameters Pa is calculated from the prior error covariance matrices and the Jacobian of the model at the minimum of the cost function (Santaren et al. 2007). Large absolute values of these correlations (close to 1) indicate that the observations do not provide independent information to distinguish a given pair of parameters.

Progress on researchers training:

I had several scientific training objectives in this project, although the project was terminated early, still several of thes objectives have been reached:

(1) The use of large scale ecosystem models. I have learned to use the ORCHIDEE model, one of the leading global ecosystem models in close collaboration with the scientist who developed this model and are recognised experts in the field.

(2) During this project I have learned to use, analyse and synthesise data from many sites of the global FLUXNET network.

(3) Bayesian inversion techniques, data assimilation. During this project I have been able to deepen and extend my knowledge and skills in this field.

(4) I have learned integrated approaches of large scale biogeochemical scientific problems. I have learned to integrate state of the art models, databases and techniques in a model-data integration.

These training objectives have shown to be essential for my future career and helped me to become an independent scientist.

Use of resources:

Resources during the short period of this project were used to attend 2 scientific conferences and for 1 publication.

(1) The first conference was the carboeurope-IP conference in Jena Germany (September 2008). (359,90 euro travel costs, 280,00 euro consumables)
(2) The second conference was the LBA meeting on Amazon ecosystems in Manaus (Brazil), on this last conference I presented the progress of my work on ORCHIDEE data assimilation. (1562,24 euro for plane tickets, 606,08 euro other travel costs, 182,10 euro consumables)
(3) The publication cost for a discussion paper in biogeosciences discussions.(406,98 euro)

4. ADDITIONAL INFORMATION

The project was terminated end December 2008.
Reason: Hans Verbeeck accepted a position as assistant professor at Ghent University Belgium.

5. DISSEMINATION ACTIVITIES

Executed

Publications

I contributed to several peer reviewed publications during the period July 2008- December 2008. Several of them are published, others are still in progress. (see attached list.

Oral Presentations

I presented the above described work at several scientific meetings and conferences: in Edinburgh (UK), LBA Manaus (Brazil), nacp Oak Ridge (US), ICDC8 Jena (Germany)
I contributed to several presentations: AGU, San Fransisco (US), NACP San Diego (US)

Posters

Several poster presentation at conferences and meetings: Carboeurope meeting, Jena (Germany); EGU Vienna (Austria), ICDC8 Jena (Germany)

Planned

Not relevant, project terminated early.

6. PROJECT MANAGEMENT

As I was the only person working on this project, not much management was involved. As a result, no problems have occurred.

Project website: not applicable.

Cost related to management + overheads:
3806,70 euro for overheads were used
209,37 euro were used for management

7. FINANCIAL STATEMENTS – FORM C AND SUMMARY FINANCIAL REPORT

Attachments:	**Publications_HansVerbeeck.PDF**

Date: **Signature Scientist in Charge:** _____	**Date:** **Signature Researcher:** _____