Implementing a algebraic method for accelerating the SPINUP in ORCHIDEE

Didier Solyga, Nicolas Vuichard

13/04/2012

Summary of the method

- The exchanges between carbon pools can be representing by a matrix
- The pools are linked by a linear differential equation of the first order
- If we accumulate the carbon matrix flux exchange during a certain period of time, we can use a algebraic method to solve the differential equation (in our case Gauss Jordan)

- For more details see :

Lardy, R., et al., A new method to determine soil organic carbon equilibrium, Environmental Modelling & Software(2011), doi:10.1016/j.envsoft.2011.05.016

Work done : first implementation

- Adaptation of the method to ORCHIDEE : 7 carbon pools and (nvm-1)*pixel (7,7) linear systems to solve

- After the first tests done after the previous meeting in September, the method is very sensitive to the biomass equilibrium

  => We can't start this method from scratch ! (the Biais was enormous 3000Y vs ~250Y for deciduous trees!)

- Decide to implement a test on the biomass fluxes (turnover_daily and bm_to_litter variables) :

  => we accumulate the biomass fluxes during a certain period of time (typically 10Y or a multiple of the forcing period in order to avoid instabilities) then we calculate the relative difference with the previous biomass fluxes . If the two differences are under a threshold chosen by the user simultaneously, we can start to accumulate the matrix fluxes and the analytic resolution. We do this test for each individual pixel independently so the resolution is asynchronous.

- A certain number of system resolutions is needed to reached the equilibrium. We solve the system periodically (the same time period as for the biomass) and we calculate the relative error on the passive pool and see if it under a threshold chosen by the user. When all the points respect this condition, the equlibrium is reached. The nbp over the forcing period is given as a diagnostic value.

Work done : first implementation (2)

- The resolution of the linear systems can be forced after a period length defined by the user in the configuration.

- Modification of the spinup script : the job stopped automatically if the equilibrium is reached.

- Choice of the threshold after calibration on a site : 0,1% for biomass, 0,01% for passive pool.

- Some spinup length for 5 years forcing period for different PFTs (IMPOSE_VEG, see https://forge.ipsl.jussieu.fr/orchidee/wiki/Branches/AccelerationSpinup for more details) :

PFT 2 (65W-5S) : 252Y
PFT 6 (7E-50N) : 302Y
PFT 7 (7E-60N) : 542Y
PFT 10(7E-50N) : 222Y
PFT 11(8W-10N) : 47Y

Second « implementation »

- the idea is to eliminate the biomass test and to start the resolution from scratch. But this time, if the relative error is greater than the relative error, we reset the matrix. We do this until the equilibrium is reached.

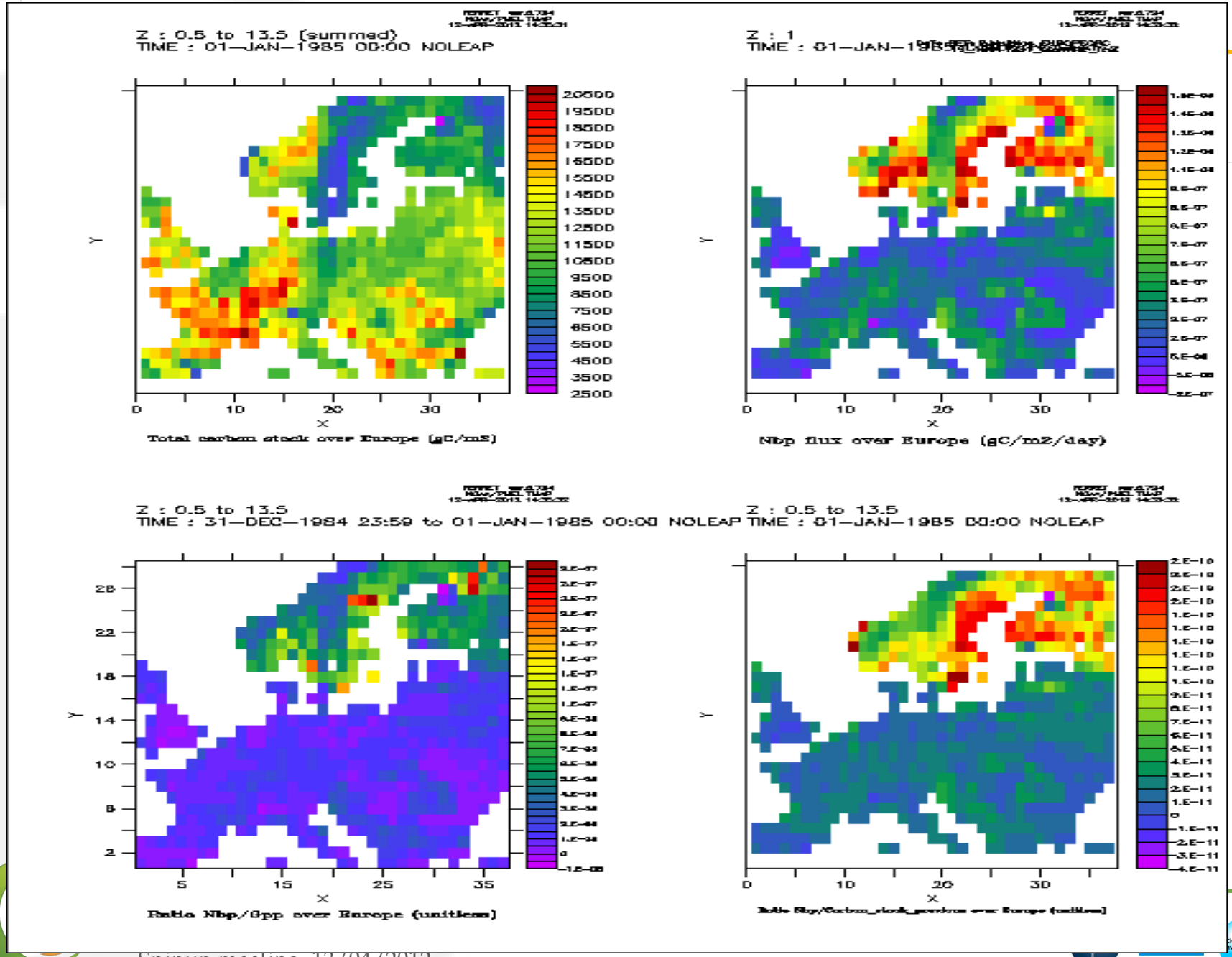
- We can simulate with the first implementation by setting a high value for the relative error on the biomass. The reset is implemented for both methods.

Tests over Europe

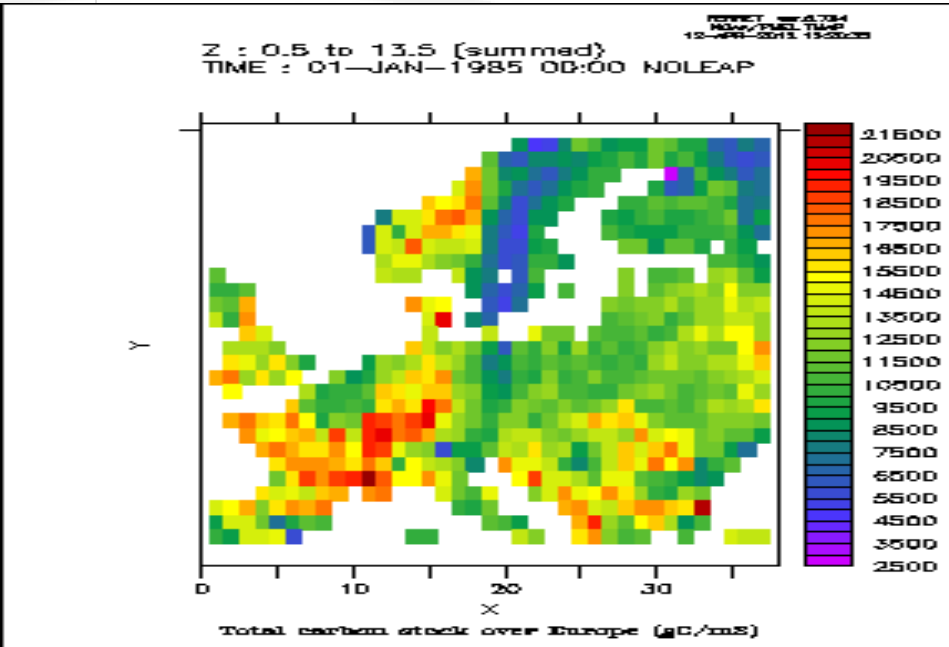
- Common setup
  - period length : 300Y (60 itérations of 5Y forcing)
  - Forcing files : Ncc modified (add noleap attribute) (1980-1984)
  - geographic coordinates : 5W-32E, 40S-68N (~ 1000 points)
- 1) First test "academic way' :
  - biomass threshold : 0,1%
  - passive pool threshold : 0,01%
  - Resolution forced after 280Y
- 2) Second test :
  - biomass threshold : 105% (so the method can start immediately)
  - passive pool threshold : 0,01%

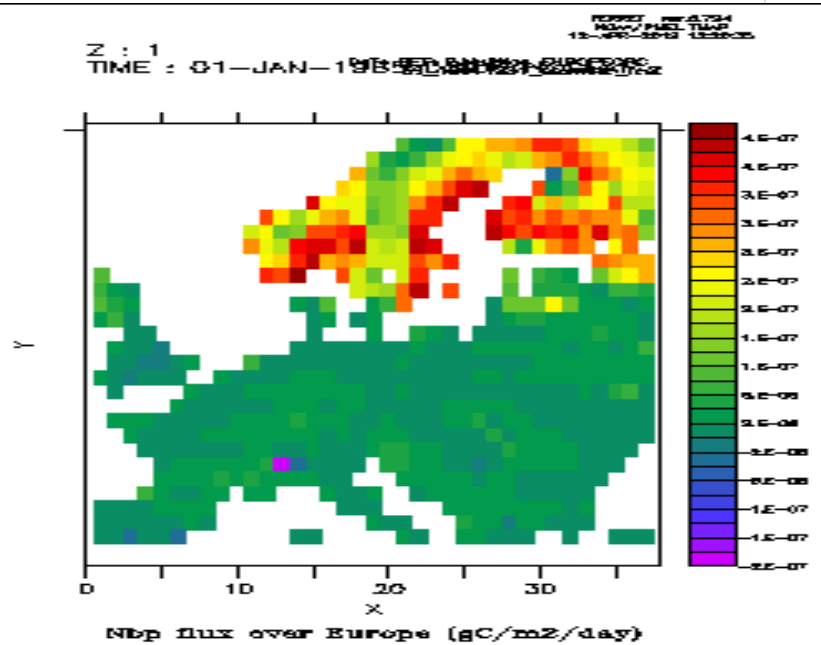
===> the final results are almost identical. The results presented after are from the "non-academic way" because we can trace the evolution of the carbon stock at different time step : 100Y, 200Y and 300Y(final results)

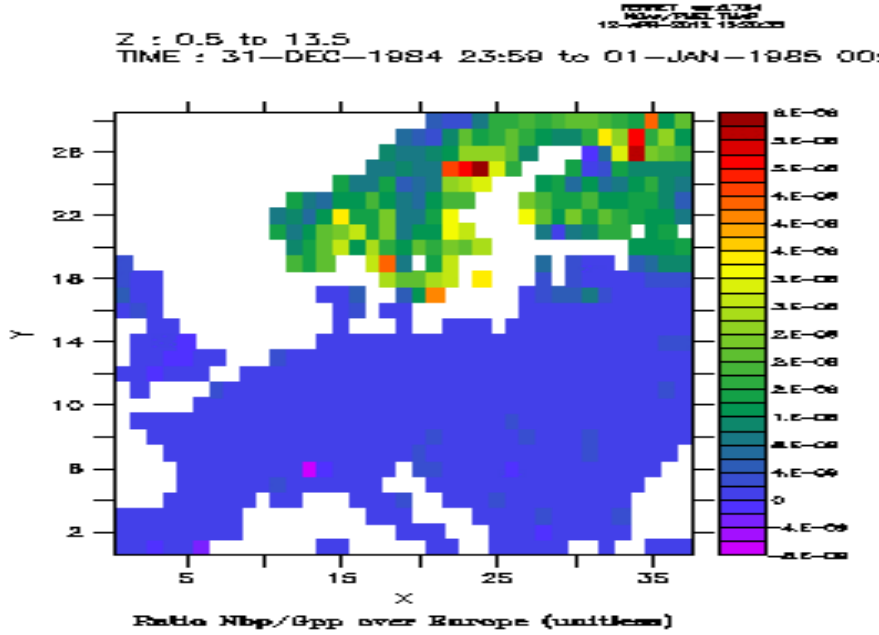
Results (100Y)

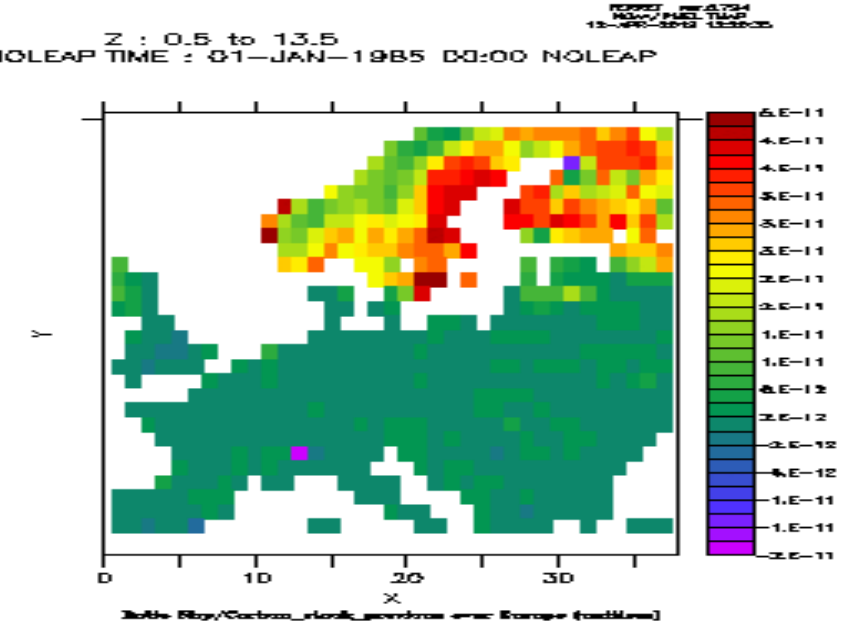


Results (200Y)

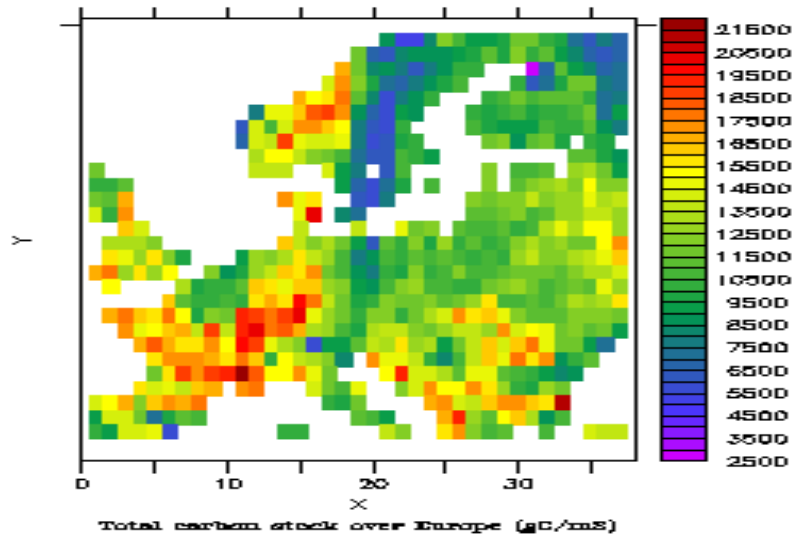


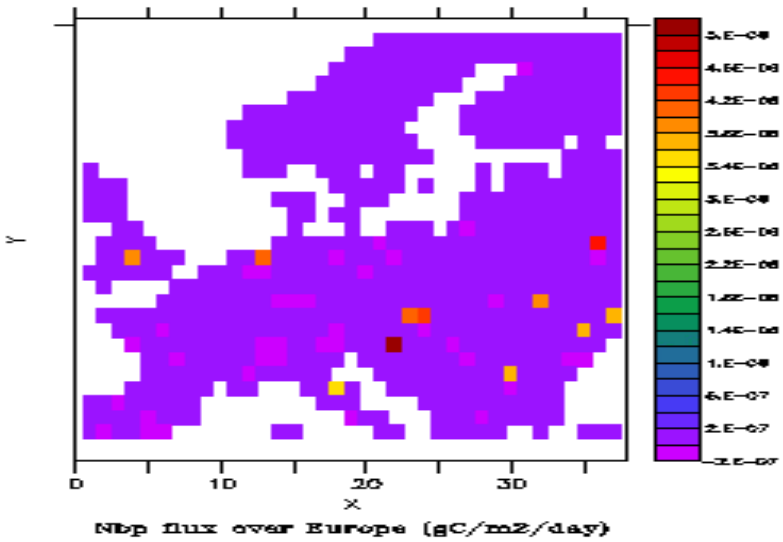


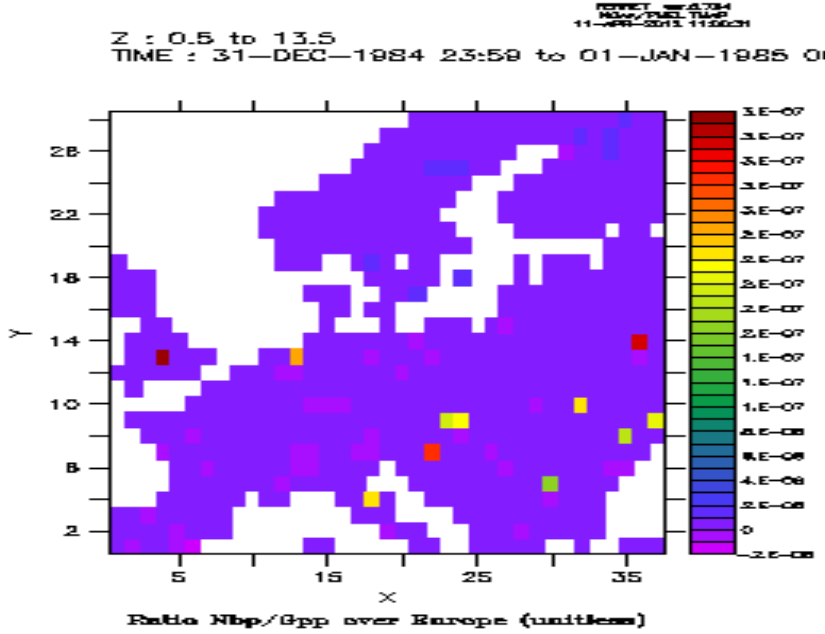


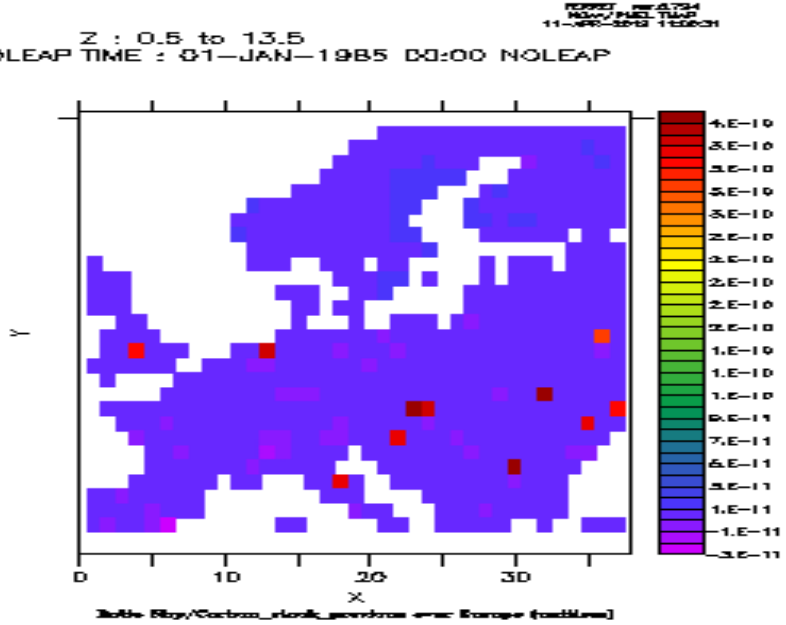


Results 300Y (Final)









Questions :

- Which implementation should we keep ?

  The "academic" one (with test on the biomass, many variables to restart, many settings parameters possible) or the other ?

- On which stopping criterion should we work ? Relative error on the passive carbon pool with a diagnostic of the nbp like now? Other ideas ?

- How do we define the equilibrium ? We should define a common methodology in order to compare the results found by teststomate and forcesoil.

ANNEX : difference between the carbon stocks