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The Impact of Soil Moisture Content on Net Carbon Sequestration

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Carbon emission and fixation fluxes are key variables to guide climate change stake holders in the process of selecting durable energy production solutions.. To develop Kyoto Protocol support tools, a robust decision framework is offered by expert systems based on earth observation (EO). Firstly, estimates of vegetation carbon fixation using a minimum of meteorological and additional data are required. The core module of this type of expert systems is a Monteith based production efficiency model C-Fix. This model estimates gross primary productivity (GPP), net primary productivity (NPP) and net ecosystem productivity (NEP) for various spatial scales.

Continental scale carbon sequestration studies are dominated by temperature effects that suggest a positive feedback of increased ecosystem respiration to global warming. Though the strong coupling between carbon assimilation and water availability is a longstanding acquisition, the effect of short term water limitation, i.e. soil moisture, on continental scale carbon sequestration has not been properly investigated. We assessed the effect of soil moisture on the NEP of ecosystems using the ERS Scatterometer derived Soil Water Index as a water limiting factor in the C-Fix model that assimilates satellite based fAPAR data computed from NOAA/AVHRR and VGT NDVI imagery. C-Fix is optimized with data of 1998 for nine EUROFLUX sites and has been run for the year 1997 to produce Net ecosystem carbon uptake for Europe. World Meteorological Organization (WMO) meteorological datasets were used. The

inclusion of soil moisture content (SMC) as a short term water limitation factor in the C-Fix algorithm was validated at EUROFLUX sites. SMC leads to a decreased (increased) NEP depending on whether soil respiration is increased (or decreased) or gross primary productivity is decreased or both.With short term water limitation, NEP reduces with more than 20% compared to the long term water limitation results.

Using remote sensing data and assessing the fully water limited NEP, less than 30% of all European countries (more than 70% of the European continental surface area) is capable of recapturing their anthropogenic CO2 emissions of 1997. Including soil moisture as short term water limitation factor some ecosystems revert from a net carbon source to a net sink and vice versa. Hence soil moisture singles out as a quite important determinant for carbon sequestration and proves to have a strong impact on carbon sequestration spatial patterns. A European Net Biome Productivity of 229 ± 109 Tg C is estimated, constituting only a mere 5.5% of European anthropogenic CO2 emissions for 1997.

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