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Turnover time determinations on a molecular level: traditional C3-/C4-crop change experiments as the ultimate choice?

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During the last decades C_3-/C_4- crop change experiments have been frequently used to determine turnover rates and turnover times for bulk carbon and on a molecular level. Therein, the natural isotopic difference between C_3- and C_4-grasses is commonly used as isotopic tracer for turnover determinations. These experiments use the crop change from one grass to another due to the physiological similarities of these grasses. Therefore, steady state conditions in terms of biomass input into soil are assumed for both plants. However, the change from forest to C_4-grassland systems is used for the same purposes in numerous studies using the same formulas based on the calculations by Balesdent & Mariotti (1996).

On a molecular level these experiments were used for turnover determinations for numerous substances or substance classes including lignin (e.g. Heim & Schmidt, 2007), phospholipid fatty acids (Kramer & Gleixner, 2006) or free extractable lipids (Wiesenberg et al., 2004, 2007). Commonly, turnover determinations of plant or microbially derived components are main objectives of these studies. However, contribution from fossil sources like dust or soot may have an effect on turnover times (e.g. Rethemeyer et al., 2004). Therefore, a differentiation of recent and fossil sources is required to determine realistic turnover times of the recent biomass in the plant-soil-microorganism system and to avoid any misinterpretation.

As recently described (e.g. Rommerskirchen et al., 2006, Wiesenberg & Schwark, 2006), the quality of C_3- and C_4-biomass differs and thus, contribution of soil is dif-

ferent for C_3- and C_4-plants despite of physical similarities, potentially resulting in different decomposition rates and hence different turnover times depending on the degradability of distinct biomass.

With an example of free extractable lipids, a variety of problems and potential solutions are discussed, which might occur during turnover time determinations on a molecular level. In addition to the traditional, problematic C_3-/C_4-crop change experiments, results from FACE (free air carbon dioxide enrichment) experiments are discussed as a potential alternative to the traditional approach using isotopic labelling under elevated atmospheric CO_2 concentration. However, these experiments are not free of problems, which are also discussed in this presentation, but provide the possibility to determine turnover times on a molecular level. This is possible, because identical plants are grown under elevated and ambient CO_2 concentration receiving a different isotopic label due to the added atmospheric CO_2. This isotopic signal facilitates turnover time determinations on a molecular level as frequently published, recently (e.g. Heim & Schmidt, 2007, Wiesenberg et al., 2007). Advantages and disadvantages of both methodologies are discussed in this presentation giving potential solutions to problems occurring within both experimental approaches.

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