Geophysical Research Abstracts, Vol. 7, 07664, 2005
SRef-ID: 1607-7962/gra/EGU05-A-07664


# Are arable soils of urban areas influenced by the atmospheric Suess-Effect?

**A. Guido L. B. Wiesenberg** (1), B. Michael W. I. Schmidt (2) and C. Lorenz Schwark (1)

(1) University of Cologne, Dep. of Geology and Mineralogy, Zuelpicher Str. 49a, D-50674 Cologne, Germany (guido.wiesenberg@uni-koeln.de / +49-221-4706153, lorenz.schwark@uni-koeln.de / +49-221-4702542)(2) University of Zurich-Irchel, Department of Geography, Winterthurer Str. 190, CH-8057 Zurich, Switzerland (michael.schmidt@geo.unizh.ch / +41-1-6355140)

Since the beginning of the industrial revolution fossil fuel burning led to an increase in atmospheric $CO_2$ and a depletion in atmospheric stable carbon isotopic composition ($\delta^{13}C$) (e.g. Friedli et al., 1986), the so-called Suess-effect. Plants and especially annual crop plants have been strongly affected by the atmospheric Suess-effect with respect to their biomass production and stable carbon isotopic composition as described by e.g. Zhao et al. (2001). Within larger cities massive local increases in $CO_2$-concentrations are observed (Idso et al., 2001) producing a so-called "urban dome effect". This urban dome effect should lead to enhanced carbon isotopic fraction in (crop) plants. Long-term increase of atmospheric $CO_2$ and associated stable carbon isotopic depletion of plant biomass have been detected in tree-rings. These effects have, however, not been documented in time-series of archived soil samples. In this study, a time-series of isotopic composition of archived arable soil samples covering four decades is presented. We discuss, how the atmospheric Suess-effect may influence the stable carbon isotopic composition of arable soils.

Arable soil samples were derived from the 'Eternal Rye' trial in the urban area of the city of Halle/Saale (Germany). Archived soil samples were available since 1958 for rye cropped soil. After introduction of silage-maize monoculture cropping on a part of the trial parallel samples of rye and silage-maize cropped soils were taken at twelve times since 1961 until 2004.

Wheat straw grown on the 'Eternal Rye' trial showed a large carbon isotopic depletion

of 2 per mille V-PDB in comparison to wheat straw of the same year, which was grown in a rural area near Passau (Germany). This could be related to the enhanced Suess-effect in the urban Halle area as a result of the urban $CO_2$ dome. Similar observations are expectable for rye plants of urban and rural sites. During the last four decades an isotopic depletion of wheat and rye plant biomass of approximately 2.5 per mille V-PDB could be expected, according to Zhao et al. (2001). This isotopic development must result in an isotopic depletion of approximately 0.5 per mille V-PDB in monoculture rye cropped soil, assuming an annual turnover of 0.5% of the total soil organic carbon. This depletion was observable although several ploughing modifications led to a significant admixture of isotopically enriched carbon from the subsoil.

As described by Marino & McElroy (2001) and others, maize and other C4-plants are less influenced by the atmospheric Suess-effect than C3-plants. C4-plants directly reflect the atmospheric isotopic composition with minor photosynthetic fractionation depending on the $CO_2$-concentration in the intercellular space of leaves versus that in the atmosphere. The maize cropped soil became successively isotopically enriched since introduction of maize monoculture cropping. Several ploughing modifications caused isotopic depletions in maize cropped soil.

After four decades of parallel silage-maize and rye cropping an isotopic difference of 2.0 per mille V-PDB occurs in soils of 'Eternal Rye' trial. Increases in plowing depth dilute the plowed horizon with $^{13}$C-enriched soil organic matter. If plowing depth had not been increased during the last 40 years, we would expect an isotopic difference between C3- and C4-cropped soils of 3.0 per mille V-PDB. Calculations assuming an annual turnover of 0.5% of total soil organic carbon indicate a reduction of 0.2 per mille V-PDB in isotopic difference of both soils due to the atmospheric Suess-effect. When assuming higher turnover rates, the atmospheric Suess effect will lead to an underestimation of the isotopic difference of up to 1.0 per mille V-PDB between both soils during four decades.

In contrast to previous observations in rural areas (without time-series of archived soils) this study detects a stable carbon isotopic changes in arable soils of urban areas caused by the atmospheric Suess-effect. For assessment of soil organic matter turnover rates it is thus recommended to correct for the effects of plowing modifications and atmospheric Suess-effect.

References :

Friedli, H., Lötscher, H., Oeschger, H., Siegenthaler, U., Stauffer, B., 1986. Nature 324, 237-238.

Idso, C.D., Idso, S.B., Balling, R.C. Jr., 2001. Atmospheric Environment 35, 995-

1000.

Marino, B.D., McElroy, M.B., 1991. Nature 349, 127-131.

Torn, M.S.;, Lapenis, A.G., Timofeev, A., Fischer, M.L., Babikov, B.V., Harden, J.W., 2002. Global Change Biology 8, 941-953.

Zhao, F.- J., Spiro, B., McGrath, S.P., 2001. Oecologia 128, 336-342.