# Daisy Newsletter no. 25

## 1 The Daisy code, v. 6.09

This new version is released on all platforms. On top of the additions mentioned in the last newsletter, there are a number of important changes since last full release.

**Important:** There has been a change in exact time, the calculation of short term (hourly) extra-terrestrial radiation is called. This should improve the match between observed and simulated radiation, but may affect your calculation of evapotranspiration.

If temperature is below 0 °C, all precipitation is assumed to be in the form of snow. Previously, the cut off was -2 °C.

Three new hydraulic models were added: M_vGBS, hypweb and M_BivG. The first model (M_vGBS) is a generalised model framework accounting for the capillary and non-capillary part of soil water. This model offers a better description of the dry range of the water retention and conductivity curves, compared with traditional approaches (Mualem-van Genuchten approach). The model is described in Weber et al. (2019) and Streck and Weber (2020). The second model is a 2-step pedotransfer function for the M_vGBS model (Weber et al. 2020). M_BivG is the bimodal van_Genuchten retention curve model with Mualem theory presented by Durner (1994).

In connection with work on a new mulch module, a range of changes were implemented. However, the module itself is under testing and only some of the consequences to the code will be mentioned here.

As flagged in the last issue that there had been some changes regarding chemicals. 'base' is a new base class for chemicals. The sub-class 'FOCUS' generally follows recommendations for pesticide simulations recommended by FOCUS [link]. 'default' model still exists and use traditional PLF for abiotic factors. Other defined base classes are 'nutrient' (for C and N), a 'C', 'N', 'MIN' (mineral nitrogen), 'NO3', 'NH4', 'DON' and 'DOC' (dissolved organic nitrogen and carbon). However, DON/DOC are generated by the experimental 'mulch' module and not fully supported yet. The base classes are useful for logging:

("Soil chemical" (chemical MIN))

will log all mineral nitrogen in the soil.

**Important:** As parameterizations in chemistry-base.dai and chemistry.dai were updated, any personal parameterisation based on these will require updating.

Michaelis Menten kinetics can now be specified for biological degradation of pesticides with the 'decompose_SMB_KM' parameter. It can be scaled with 'SMB_ref'.

The temperature effect on pesticide turnover can now be scaled with 'T_ref'.

A new 'default_h' function has been added under SoilWater. It is used for the soil surface if no other value is specified. The rest of the profile will then be in hydrostatic equilibrium with that value.

Find all news items here.

Durner, W. (1994). Hydraulic conductivity estimation for soils with heterogeneous pore structure. *Water Resources Research*, **30** (2), 211– 223. https://doi.org/10.1029/93WR02676.

Weber, T. K. D., Durner, W., Streck, T., & Diamantopoulos, E. (2019). A modular framework for modelling unsaturated soil hydraulic properties over the full moisture range. *Water Resources*

*Research*, **55**, 4994– 5011. https://doi.org/10.1029/2018WR024584.

Weber, T.K.D., Finkel, M., Gonçalves, M. da C., Vereecken, H., Diamantopoulos, E. (2020). Pedotransfer function for the Brunswick Soil Hydraulic Property Model and comparison to the van Genuchten-Mualem Model. Water Resources Research 56 (9) e2019WR026820. https://doi.org/10.1029/2019WR026820.

Streck, T and Weber, T.K.D. (2020). Analytical expressions for noncapillary soil water retention based on popular capillary retention models. Vadose Zone Journal, 19 (1) e20042. https://doi.org/10.1002/vzj2.20042.

## 2 Courses

We expect the next Daisy PhD-course to run in the last week of August 2021 (30.8-3.9 2021) provided the Covid-19 situation is under control. The present prognosis for Denmark is that all interested will have received a vaccine sometime in August.

A second MSc course on "Modelling Soil-Plant-Atmosphere" systems will take place in block 1 (September 2021).

## 3 Events

On-line monthly lunch meetings took place in January and February. Saghar Motarjemi (DCE, AU) presented her simulations based on 10 years of N-leaching data from one of the pesticide monitoring sites in Denmark and Jeanne Vuaille (PLEN, UCPH) presented the new mulch module implemented in Daisy. Next meeting will be on the 24$^{th}$ of March, where Finn Plauborg, DCE, AU will present a study of irrigation and fertigation in potato.

Events are now announced on the homepage and if you are interested, please join.

## 4 Recent articles where Daisy has been used

*Andrade et al. (2021)* compared four agricultural models (PEF, SALCA, Daisy and Animo) with different complexity levels and test their suitability and sensitivity in LCA. The model performance was evaluated according to their potential feasibility to be used in estimating nitrogen emissions in LCA using an adapted version of the criteria proposed by the United Nations Framework Convention on Climate Change (UNFCCC), and other relevant studies, to judge their suitability in LCA. Finally, a full LCA-study on nitrogen emissions from a case study of irrigated maize in Spain was carried out using the selected models.

According to the set of criteria, the models scored, from best to worst: Daisy (77%), SALCA (74%), Animo (72%) and PEF (70%). For the case study, estimated emissions agreed to literature data for the irrigated corn crop in Spain and the Mediterranean, except $N_2O$ emissions, which showed differences of up to 56%. They concluded that Daisy could be a suitable model to estimate emissions when fertilizer application is relevant for the environmental study. In addition, and due to LCA urgently needing a solid methodology to estimate nitrogen emissions, mechanistic models such as Daisy could be used to estimate default values for different archetype scenarios.

*Holbak et al. (2021)* presents a comprehensive description of the water and solute transport in biopores implemented in Daisy as well as a validation of the approach on a laboratory experiment. Daisy was able to simulate the observed pulses of flow in biopores observed in the laboratory. Scenario simulations illustrate how biopore flow will influence transport of bromide to drains depending on whether the pores are present or not, and whether they end in the matrix or are connected to drain pipes.

This article is the most comprehensive documentation so far of the preferential flow processes included in Daisy.

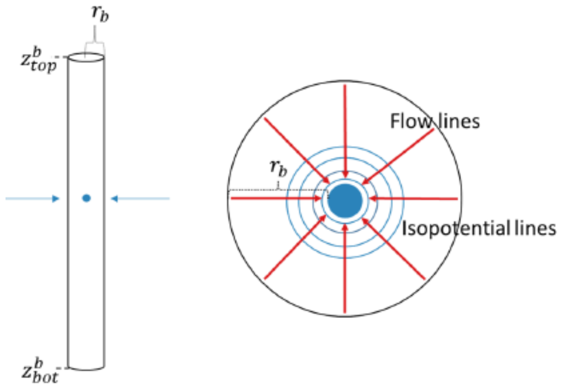


*Figure 1. Conceptual description of the Daisy biopore.*

Laub et al. (2021) only use the organic matter model of Daisy, build into an expert system, where HYDRUS takes care of water simulations. The major lessons to be learned here is that

- They are using an infra-red method to classify SOM2 and SOM1 pools based on aliphatic or phenolic compounds, thus improving the basis for model initialisation, which is always a difficult issue.
- They find a link between temperature sensitivity of microbial enzymes and observed breakdown and thus argue for the need of assigning different temperature sensitivities to different pools.
- However, laboratory findings were not directly applicable to field conditions.

When interpreting their results, Daisy users should be aware that they modify the SOM model a little, letting the SMB2-pool produce SOM2 and SOM 1, based on that the transition from SOM2 to SOM1 takes place without microbial interaction. This is not correct, as breakdown is facilitated by the SMB1-pool. Also, the temperature function in Daisy appears to be slightly differently implanted in their system (in Daisy linear from 0-20 degrees, while in their system it is 0-10 degrees, according to the text).

*Machholdt et al. (2021)* quantifies the impact of future climate on yield risk of winter wheat for two common soil types of Eastern Denmark, using Daisy to simulate arable, conventional cropping systems differing with respect to three main management factors: cropping sequence, usage of catch crops and cereal straw management. The results showed that the future yield risk of wheat does not necessarily increase under climate change mainly due to lower water stress in the projections; rather, it depends on appropriate management and each CS design. Cropping systems characterized by straw removal and no catch crop within the rotation, showed increased wheat yield risk in the future. In contrast, cropping systems including catch crops and straw incorporation maintained their capacity and resulted in a decreasing yield risk over time. Higher soil organic matter content, higher net nitrogen mineralization rate and higher soil organic nitrogen content were the main underlying causes for these positive effects. These cropping systems had a better N recycling and, at the same time, reduced nitrate leaching.

The *Petersen and Abrahamsen (2021)* -reference is a report (English) describing effects of compaction observed in a 10-year experiment with different degrees of compaction. Compaction resulted in some measurable differences in bulk density and yields tended to be lower on compacted soil in the years after compaction but the effects were generally not statistically significant in the individual years. Simulations of compaction effects now and in the future indicated that the treatments increased denitrification and reduced harvested N, and different assumptions concerning root growth in compacted soil affected outcome. An increased heterogeneity due to compaction led to increased water stress. This effect was more severe in future climate.

*Figure 2. Water standing in compacted wheel tracks in spring.*

## 5 Other articles

*Biswas et al. (2021)* provides a summary of attempts to combine crop models with satellite data. The contribution is part of a book called "Geospatial technologies for crops and soils" available on the internet. The link is provided.

*Farina et al. (2021)* evaluated SOC simulated from an ensemble of 26 process-based C models (Daisy not included, but its OM-sub-model was) by comparing simulations to experimental data from seven long-term bare fallow (vegetation-free) plots at six sites: Denmark (two sites), France, Russia, Sweden and the United Kingdom. The decay of SOC in these plots has been monitored for decades since the last inputs of plant material, providing the opportunity to test decomposition without the continuous input of new organic material. The models were run independently over multi-year simulation periods (from 28 to 80 years) in a blind test with no calibration (Bln) and with the following three calibration scenarios, each providing different levels of information and/or allowing different levels of model fitting: (a) calibrating decomposition parameters separately at each experimental site (Spe); (b) using a generic, knowledge-based, parameterization applicable in the Central European region (Gen); and (c) using a combination of both (a) and (b) strategies (Mix). On average across sites, Gen proved adequate in describing changes in SOC, indicating sufficiently reliable SOC estimates. Mix and Spe-simulations provided only marginal gains in accuracy, but modellers would need to apply more knowledge and a greater calibration effort than in Gen, thereby limiting the wider applicability of models.

*Jensen et al (2021)* described the influence of groundwater in the root zone on yield and development of winter wheat and spring barley. It is not a modelling article, but Daisy has been used to extend records of groundwater measurements.

## 6 References

### *6.1 Daisy*

Andrade, E.P., Bonmati, A., Esteller, L.J., Montemayor, E., and Vallejo, A.A. (2021). Performance and environmental accounting of nutrient cycling models to estimate nitrogen emissions in agriculture and their sensitivity in life cycle assessment. The International Journal of Life Cycle Assessment. https://doi.org/10.1007/s11367-021-01867-4

Holbak, M., Abrahamsen, P., Hansen, S. and Diamantopoulos, E. (2021). A physically based model for preferential water flow and solute transport in drained agricultural fields. Water Resources Research, e2020WR027954. https://doi.org/10.1029/2020WR027954.

Laub, M., Ali, R.S., Demyan, M.S., Nkwain, Y.F., Poll, C., Högy, P., Poyda, A., Ingwersen, J., Blagodatsky, S., Kandeler, E. and Cadisch, G. (2021). Modeling temperature sensitivity of soil organic matter decomposition: Splitting the pools. Soil Biology and Biochemistry 153, 108108. https://doi.org/10.1016/j.soilbio.2020.108108

Macholdt, J., Gyldengren, J.G., Diamantopoulos, E., and Styczen, M. E. (2021). How will future climate depending agronomic management impact the yield risk of wheat cropping systems? A regional case study of Eastern Denmark. The Journal of Agricultural Science 1–16. https://doi.org/10.1017/S0021859620001045.

Petersen, C.T. and Abrahamsen, P., (2021). Predicting effects of soil compaction on crop yield and nitrogen dynamics. Dept. of Plant and Environmental Sciences, University of Copenhagen. 45 p. https://daisy.ku.dk/about-daisy/projects/commit/Simulating_compaction_effects_final.pdf.

### *6.2 Other articles of general interest*

Biswal, A., Chakraborty, A. and Murthy, C.S. (2021) Spatialization of crop growth simulation model using remote sensing. In (Eds.) Mitran, T., Meena, R.S. and Chakraborty, A. (2020). Geospatial Technologies for Crops and Soils. Springer Nature Singapore Pte Ltd. https://doi.org/10.1007/978-981-15-6864-0. pp. 153-199. https://link.springer.com/chapter/10.1007/978-981-15-6864-0_4

Farina, R, Sándor, R, Abdalla, M, et al. (2021). Ensemble modelling, uncertainty and robust predictions of organic carbon in long-term bare-fallow soils.*Glob Change Biol*. 2021; 27: 904–928. https://doi.org/10.1111/gcb.15441.

Jensen, K.J.S., Hansen, S., Styczen, M.E., Holbak, M., Jensen, S.M and Petersen, C.T. (2021). Yield and development of winter wheat (*Triticum aestivum* L.) and spring barley (*Hordeum vulgare*) in field experiments with variable weather and drainage conditions. European Journal of Agronomy 122, 126075. https://doi.org/10.1016/j.eja.2020.126075.