

Package ‘Porous’

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Type Package

Title Dual porosity SOC decomposition model (draft)

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Author Lorenzo Menichetti

Maintainer Lorenzo Menichetti <Lorenzo.Menichetti@slu.se>

Description This package contains a draft version of the dual porosity SOC decomposition model developed by Meurer and Jarvis. The model is being actively developed.

Original description in: Meurer, Katharina Hildegard Elisabeth, Claire Chenu, Elsa Coucheney, Anke Marianne Herrmann, Thomas Keller, Thomas Kätterer, David Nimblad Svensson, and Nicholas Jarvis. “Modelling Dynamic Interactions between Soil Structure and the Storage and Turnover of Soil Organic Matter.” Biogeosciences 17, no. 20 (October 19, 2020): 5025–42. <https://doi.org/10.5194/bg-17-5025-2020>.

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Suggests knitr,
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R topics documented:

| | |
|-----------------|---|
| Delta_z | 2 |
| f_som | 3 |
| f_text_mic_func | 4 |
| gamma_b | 5 |
| Msm | 6 |
| phi_mat | 6 |
| phi_mic | 7 |
| pore_frac | 8 |
| Porous | 9 |

| | |
|------------------------------|----|
| Porous_test | 11 |
| Porous_test_min | 13 |
| run_Porous | 14 |
| run_Porous_deSolve | 15 |

| | |
|--------------|-----------|
| Index | 18 |
|--------------|-----------|

| | |
|---------|---|
| Delta_z | <i>Variation of the thickness of soil layer</i> |
|---------|---|

Description

This function calculates the variation of the thickness of soil layer as a function of organic matter. The parameter f_{agg} should be estimated from data on the relationship between bulk density (or its inverse, the specific volume) and soil organic matter content (see eq. 19 and fig. 4 in Meurer et al., 2020; from this data and other studies, a good average value of f_{agg} should be around 3, which is the default value)

Usage

```
Delta_z(
  f_agg = f_agg,
  Delta_z_min,
  My_mic,
  Mo_mic,
  My_mes,
  Mo_mes,
  phi_mac,
  gamma_o
)
```

Arguments

| | |
|-------------|---|
| f_agg | an aggregation factor (m ³ pore space m ⁻³ organic matter) defined as the slope of the linear relationship assumed between the volume of aggregation pore space V_{agg} , and the volume of organic matter V_{so} (dimensionless) |
| Delta_z_min | minimal soil thickness if no organic matter was present (cm) |
| My_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| My_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| phi_mac | macroporosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |

Value

one single value

| | |
|-------|----------------------|
| f_som | Soil C concentration |
|-------|----------------------|

Description

This function calculates the soil C concentration. It relies on [Msm](#) to calculate the mineral mass.

Usage

f_som(My_mic, Mo_mic, My_mes, Mo_mes, Delta_z_min, phi_min, gamma_m)

Arguments

| | |
|-------------|---|
| My_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| My_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| Delta_z_min | minimal soil thickness if no organic matter was present (cm) |
| phi_min | minimal porosity, ($\frac{cm^3\ of\ water}{cm^3\ of\ soil}$) |

Value

one single value

See Also

[Msm](#)

| | |
|-----------------|---------------------------------|
| f_text_mic_func | <i>Proportion of micropores</i> |
|-----------------|---------------------------------|

Description

This function calculates the proportion of the textural pore space that comprises micropores. It is used in [pore_frac](#). This parameter was intended in the original paper (Meurer et al., 2020) as user defined, but its estimation has been developed further by N. Jarvis (personal communication). The method for its estimation is based on a Brooks-Corey soil water retention model:

$$f_{mic_{text}} = \left(\frac{\psi_{mes\backslash mac}}{\psi_{mic\backslash mes}} \right)^{\lambda_{mat(t)}}$$

where $\psi_{mes\backslash mac}$ is the pressure head defining the largest mesopore (set to -0.3) and $\psi_{mic\backslash mes}$ is the pressure head defining the largest micropore (set to -0.6). The parameter $\lambda_{mat(t)}$ is in turn estimated as:

$$\lambda_{mat(t)} = \frac{\log\left(\frac{\theta_w}{\phi_{min}}\right)}{\log\left(\frac{\psi_{mes\backslash mac}}{\psi_w}\right)}$$

where ψ_w is the wilting point pressure head (set to -150 m) and θ_w is estimated from a pedotransfer function:

$$\theta_w = 0.004 + 0.5 \cdot f_{clay}$$

where f_{clay} is the soil clay content ($kg\ kg^{-1}$).

Usage

```
f_text_mic_func(clay, phi_min)
```

Arguments

| | |
|---------|--|
| clay | fraction of clay content (dimensionless, between 0 and 1) |
| phi_min | minimal porosity, ($\frac{cm^3\ of\ water}{cm^3\ of\ soil}$) |

Value

one single value

| | |
|---------|-------------------|
| gamma_b | Soil bulk density |
|---------|-------------------|

Description

This function calculates the soil bulk density. It relies on [Msm](#) to calculate the mineral mass.

Usage

```
gamma_b(  
  My_mic,  
  Mo_mic,  
  My_mes,  
  Mo_mes,  
  Delta_z_min,  
  phi_min,  
  gamma_o,  
  gamma_m,  
  f_agg,  
  phi_mac  
)
```

Arguments

| | |
|-------------|---|
| My_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| My_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| Delta_z_min | minimal soil thickness if no organic matter was present (cm) |
| phi_min | minimal porosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |
| f_agg | an aggregation factor (m3 pore space m-3 organic matter) defined as the slope of the linear relationship assumed between the volume of aggregation pore space V_{agg} , and the volume of organic matter V_{so} (dimensionless) |
| phi_mac | macroporosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |

Value

one single value

See Also

[Msm](#)

| | |
|-----|---------------------|
| Msm | <i>Mineral mass</i> |
|-----|---------------------|

Description

This function calculates the mineral mass

Usage

```
Msm(Delta_z_min, phi_min, gamma_m)
```

Arguments

Delta_z_min minimal soil thickness if no organic matter was present (cm)

Value

one single value

See Also

[Delta_z_min](#), [gamma_b](#), [f_som](#)

| | |
|---------|------------------------|
| phi_mat | <i>Matrix porosity</i> |
|---------|------------------------|

Description

This function calculates the matrix porosity ϕ_{mac} based on the variation of organic matter in the soil. It is used in [pore_frac](#) to calculate mesoporosity $\phi_{mes} = \phi_{mat} - \phi_{mic}$

Usage

```
phi_mat(  
  My_mic,  
  Mo_mic,  
  My_mes,  
  Mo_mes,  
  gamma_o,  
  f_agg,  
  Delta_z_min,  
  phi_min,  
  phi_mac  
)
```

Arguments

| | |
|-------------|---|
| My_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| My_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| f_agg | an aggregation factor (m ³ pore space m ⁻³ organic matter) defined as the slope of the linear relationship assumed between the volume of aggregation pore space V_{agg} , and the volume of organic matter V_{so} (dimensionless) |
| Delta_z_min | minimal soil thickness if no organic matter was present (cm) |
| phi_min | minimal porosity, ($\frac{cm^3\ of\ water}{cm^3\ of\ soil}$) |
| phi_mac | macroporosity, ($\frac{cm^3\ of\ water}{cm^3\ of\ soil}$) |

Value

one single value

| | |
|---------|----------------------|
| phi_mic | <i>Microporosity</i> |
|---------|----------------------|

Description

This function calculates the microporosity ϕ_{mic} based on the variation of organic matter in the soil. It is used in [pore_frac](#)

Usage

```
phi_mic(
  My_mic,
  Mo_mic,
  My_mes,
  Mo_mes,
  gamma_o,
  f_agg = f_agg,
  clay,
  Delta_z_min,
  phi_min,
  phi_mac,
  f_text_mic
)
```

Arguments

| | |
|-------------|---|
| My_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| My_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| f_agg | an aggregation factor (m ³ pore space m ⁻³ organic matter) defined as the slope of the linear relationship assumed between the volume of aggregation pore space V_{agg} , and the volume of organic matter V_{so} (dimensionless) |
| clay | fraction of clay content (dimensionless, between 0 and 1) |
| Delta_z_min | minimal soil thickness if no organic matter was present (cm) |
| phi_min | minimal porosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |
| phi_mac | macroporosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |

Value

one single value

pore_frac

The main accessory function of the model

Description

This function calculates the proportion of inputs in each of the two young pools depending on the organic matter content

Usage

```
pore_frac(
  phi_mac,
  clay,
  Delta_z_min,
  gamma_o,
  My_mic,
  Mo_mic,
  My_mes,
  Mo_mes,
  phi_min,
  f_text_mic = NULL,
  f_agg
)
```


Arguments

| | |
|-------------|---|
| phi_mac | macroporosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |
| clay | fraction of clay content (dimensionless, between 0 and 1) |
| Delta_z_min | minimal soil thickness if no organic matter was present (cm) |
| My_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mic | One of the four model pools (they are all summed up in this function for calculating the total) |
| My_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| Mo_mes | One of the four model pools (they are all summed up in this function for calculating the total) |
| phi_min | minimal porosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |

Value

two values, the proportion of input in the mesopore and micropore Y pools

See Also

[phi_mic](#), [phi_mat](#), [f_som](#)

| | |
|--------|---|
| Porous | <i>The SOC decomposition model **STILL TESTING; NOT YET WORKING, use the deSolve function instead**</i> |
|--------|---|

Description

This function implements with the SoilR model development framework the dual porosity model described in Meurer et al. (2020). This function provides just the model definition, that needs then to be run with specific SoilR functions. A more comfortable wrapper for doing this automatically is provided in the package ([run_Porous](#)). The model is an evolution of a two-pool linear SOC model, with two pools (young and old material) running in parallel for micro- and mesopores. While aboveground inputs are rooted in the mesopores, root inputs are distributed between micro and mesopores depending on porosity, which is in turn influenced by organic matter. This makes the model nonlinear, although it still behaves similarly to a linear model within a reasonable calibration range. The model is described by a series of four equations:

$$\begin{aligned}
 \frac{dM_{Y(mes)}}{dt} &= I_m + \left(\frac{\phi_{mes}}{\phi_{mes} + \phi_{mic}} \right) \cdot I_r - k_Y \cdot M_{Y(mes)} + T_Y \\
 \frac{dM_{O(mes)}}{dt} &= (\epsilon \cdot k_Y \cdot M_{Y(mes)}) - ((1 - \epsilon) \cdot k_O \cdot M_{O(mes)}) + T_O \\
 \frac{dM_{Y(mic)}}{dt} &= \left(\frac{\phi_{mic}}{\phi_{mes} + \phi_{mic}} \right) \cdot I_r - k_Y \cdot F_{prot} \cdot M_{Y(mes)} - T_Y \\
 \frac{dM_{O(mic)}}{dt} &= (\epsilon \cdot k_Y \cdot F_{prot} \cdot M_{Y(mes)}) - ((1 - \epsilon) \cdot k_O \cdot F_{prot} \cdot M_{O(mes)}) - T_O
 \end{aligned}$$

Please refer to the original paper for more details.

The terms T_Y and T_O are calculated in the original paper as $k_{mix} \cdot \frac{(My_{mic} - My_{mes})}{2}$ and $k_{mix} \cdot \frac{(Mo_{mic} - Mo_{mes})}{2}$, but in a later model development the term 2 disappeared and are now calculated as $T_Y = k_{mix} \cdot (My_{mic} - My_{mes})$ and $T_O = k_{mix} \cdot (Mo_{mic} - Mo_{mes})$.

The two porosity terms, $\phi_{mes} = f(M_{Y(mes)}, M_{O(mes)}, M_{Y(mic)}, M_{O(mic)})$ and $\phi_{mic} = f(M_{Y(mic)}, M_{O(mic)})$, are dependent on the variation of the different C pools and everything is variable over time, introducing a nonlinearity in the system and defining the biggest peculiarity of this model.

After substituting the terms $\left(\frac{\phi_{mes}(t)}{\phi_{mes}(t) + \phi_{mic}(t)}\right) = \varphi_{mes}$ and $\left(\frac{\phi_{mic}(t)}{\phi_{mes}(t) + \phi_{mic}(t)}\right) = \varphi_{mic}$, The model can be rewritten in matrix form as :

$$I_m(t) + I_r(t) \cdot N(C, t) + A(t) \cdot P(t) \cdot C(t)$$

The model is implemented with the SoilR package but it is relying on a more conventional ODE definition (not its matrix form).

Usage

```
Porous(
  ky,
  ko,
  kmix,
  e,
  Im,
  Ir,
  F_prot,
  phi_mac,
  phi_min,
  clay,
  Delta_z_min,
  gamma_o,
  proportion = NULL,
  f_text_mic = NULL,
  f_agg
)
```

Arguments

| | |
|---------|--|
| ky | decomposition constant of the Young pool <i>frac1year</i> |
| ko | decomposition constant of the Old pool <i>frac1year</i> |
| kmix | mixing rate <i>frac1year</i> |
| e | efficiency, which is the transfer term between the pools and corresponds to the term h in the ICBM model in Kätterer et al. (2001) (dimensionless) |
| F_prot | protection provided by the micropore space (dimensionless) |
| phi_mac | macroporosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |

| | |
|-------------|---|
| phi_min | minimal porosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |
| clay | fraction of clay content (dimensionless, between 0 and 1) |
| Delta_z_min | minimal soil thickness if no organic matter was present (cm) |
| proportion | this is a linearization term to make the proportion of the inputs between micro- and mesopores constant. If NULL (or not specified, since default is NULL) then the model is running as nonlinear, as in the original paper. If specified (must be between 0 and 1) then the model is linearized adopting this value as fixed proportion of inputs from roots going into the mesopore space (and its reciprocal into the micropore) |
| f_agg | an aggregation factor (m ³ pore space m ⁻³ organic matter) defined as the slope of the linear relationship assumed between the volume of aggregation pore space V_{agg} , and the volume of organic matter V_{s_o} (dimensionless) |

Value

two values, the proportion (between 0 and 1) of input in the mesopore and micropore Y pools

References

Meurer, Katharina Hildegard Elisabeth, Claire Chenu, Elsa Coucheney, Anke Marianne Herrmann, Thomas Keller, Thomas Kätterer, David Nimblad Svensson, and Nicholas Jarvis. “Modelling Dynamic Interactions between Soil Structure and the Storage and Turnover of Soil Organic Matter.” *Biogeosciences* 17, no. 20 (October 19, 2020): 5025–42. <https://doi.org/10.5194/bg-17-5025-2020>.
 Kätterer, Thomas, and Olof Andrén. “The ICBM Family of Analytically Solved Models of Soil Carbon, Nitrogen and Microbial Biomass Dynamics — Descriptions and Application Examples.” *Ecological Modelling* 136, no. 2–3 (January 2001): 191–207. [https://doi.org/10.1016/S0304-3800\(00\)00420-8](https://doi.org/10.1016/S0304-3800(00)00420-8).

See Also

[run_Porous](#)

Porous_test

The SOC decomposition model

Description

Purely for testing purposes

Usage

```
Porous_test(
  ky,
  ko,
  kmix,
  e,
```

```

    Im,
    Ir,
    F_prot,
    phi_mac,
    phi_min,
    clay,
    Delta_z_min,
    gamma_o,
    proportion = NULL,
    f_text_mic = NULL,
    f_agg
)

```

Arguments

| | |
|-------------|---|
| ky | decomposition constant of the Young pool <i>frac1year</i> |
| ko | decomposition constant of the Old pool <i>frac1year</i> |
| kmix | mixing rate <i>frac1year</i> |
| e | efficiency, which is the transfer term between the pools and corresponds to the term h in the ICBM model in Kätterer et al. (2001) (dimensionless) |
| F_prot | protection provided by the micropore space (dimensionless) |
| phi_mac | macroporosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |
| phi_min | minimal porosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |
| clay | fraction of clay content (dimensionless, between 0 and 1) |
| Delta_z_min | minimal soil thickness if no organic matter was present (cm) |
| proportion | this is a linearization term to make the proportion of the inputs between micro- and mesopores constant. If NULL (or not specified, since default is NULL) then the model is running as nonlinear, as in the original paper. If specified (must be between 0 and 1) then the model is linearized adopting this value as fixed proportion of inputs from roots going into the mesopore space (and its reciprocal into the micropore) |
| f_agg | an aggregation factor (m ³ pore space m ⁻³ organic matter) defined as the slope of the linear relationship assumed between the volume of aggregation pore space V_{agg} , and the volume of organic matter V_{s_o} (dimensionless) |

Value

two values, the proportion (between 0 and 1) of input in the mesopore and micropore Y pools

References

Meurer, Katharina Hildegard Elisabeth, Claire Chenu, Elsa Coucheney, Anke Marianne Herrmann, Thomas Keller, Thomas Kätterer, David Nimblad Svensson, and Nicholas Jarvis. “Modelling Dynamic Interactions between Soil Structure and the Storage and Turnover of Soil Organic Matter.” *Biogeosciences* 17, no. 20 (October 19, 2020): 5025–42. <https://doi.org/10.5194/bg-17-5025-2020>.
 Kätterer, Thomas, and Olof Andrén. “The ICBM Family of Analytically Solved Models of Soil

Carbon, Nitrogen and Microbial Biomass Dynamics — Descriptions and Application Examples.” Ecological Modelling 136, no. 2–3 (January 2001): 191–207. [https://doi.org/10.1016/S0304-3800\(00\)00420-8](https://doi.org/10.1016/S0304-3800(00)00420-8).

See Also

[run_Porous](#)

| | |
|-----------------|------------------------------------|
| Porous_test_min | <i>Purely for testing purposes</i> |
|-----------------|------------------------------------|

Description

Purely for testing purposes

Usage

```
Porous_test_min(ky, ko, e, Im, Ir, F_prot, proportion)
```

Arguments

| | |
|------------|---|
| ky | decomposition constant of the Young pool <i>frac1year</i> |
| ko | decomposition constant of the Old pool <i>frac1year</i> |
| e | efficiency, which is the transfer term between the pools and corresponds to the term h in the ICBM model in Kätterer et al. (2001) (dimensionless) |
| F_prot | protection provided by the micropore space (dimensionless) |
| proportion | this is a linearization term to make the proportion of the inputs between micro- and mesopores constant. If NULL (or not specified, since default is NULL) then the model is running as nonlinear, as in the original paper. If specified (must be between 0 and 1) then the model is linearized adopting this value as fixed proportion of inputs from roots going into the mesopore space (and its reciprocal into the micropore) |
| kmix | mixing rate <i>frac1year</i> |

Value

two values, the proportion (between 0 and 1) of input in the mesopore and micropore Y pools

References

Meurer, Katharina Hildegard Elisabeth, Claire Chenu, Elsa Coucheney, Anke Marianne Herrmann, Thomas Keller, Thomas Kätterer, David Nimblad Svensson, and Nicholas Jarvis. “Modelling Dynamic Interactions between Soil Structure and the Storage and Turnover of Soil Organic Matter.” Biogeosciences 17, no. 20 (October 19, 2020): 5025–42. <https://doi.org/10.5194/bg-17-5025-2020>.
 Kätterer, Thomas, and Olof Andrén. “The ICBM Family of Analytically Solved Models of Soil Carbon, Nitrogen and Microbial Biomass Dynamics — Descriptions and Application Examples.” Ecological Modelling 136, no. 2–3 (January 2001): 191–207. [https://doi.org/10.1016/S0304-3800\(00\)00420-8](https://doi.org/10.1016/S0304-3800(00)00420-8).

See Also[run_Porous](#)

| | |
|------------|--|
| run_Porous | <i>Run Porous **STILL TESTING; NOT YET WORKING, use the deSolve function instead**</i> |
|------------|--|

Description

This function is a wrapper for running the main model [Porous](#), which is a wrapper for the dual porosity decomposition model (equations 1 to 6) described in Meurer et al. (2020) implemented in ‘SoilR’. It then feeds the simulated SOC stocks to the functions [gamma_b](#) and [f_som](#) to calculate the variation of bulk density and C concentrations

Usage

```
run_Porous(
  ky,
  ko,
  kmix,
  e,
  Im,
  Ir,
  F_prot,
  phi_mac,
  phi_min,
  clay,
  Delta_z_min,
  gamma_o,
  gamma_m,
  proportion = NULL,
  f_text_mic = NULL,
  f_agg,
  init,
  sim_length,
  sim_steps
)
```

Arguments

| | |
|------|--|
| ky | decomposition constant of the Young pool <i>frac1year</i> |
| ko | decomposition constant of the Old pool <i>frac1year</i> |
| kmix | mixing rate <i>frac1year</i> |
| e | efficiency, which is the transfer term between the pools and corresponds to the term h in the ICBM model in Kätterer et al. (2001) (dimensionless) |

| | |
|-------------|---|
| F_prot | protection provided by the micropore space (dimensionless) |
| phi_mac | macroporosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |
| phi_min | minimal porosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |
| clay | fraction of clay content (dimensionless, between 0 and 1) |
| Delta_z_min | minimal soil thickness if no organic matter was present (cm) |
| proportion | this is a linearization term to make the proportion of the inputs between micro- and mesopores constant. If NULL (or not specified, since default is NULL) then the model is running as nonlinear, as in the original paper. If specified (must be between 0 and 1) then the model is linearized adopting this value as fixed proportion of inputs from roots going into the mesopore space (and its reciprocal into the micropore) |
| f_agg | an aggregation factor (m ³ pore space m ⁻³ organic matter) defined as the slope of the linear relationship assumed between the volume of aggregation pore space V_{agg} , and the volume of organic matter V_{s_o} (dimensionless) |
| sim_steps | steps of the simulation (fraction of one year) |
| sim_lenght | length of the simulation (years) |

Value

a data frame with the simulation of C stocks for each of the four pools, soil respiration for each of the four pools, bulk density variation and SOC concentration.

See Also

[Porous](#), [gamma_b](#), [f_som](#)

| | |
|--------------------|---|
| run_Porous_deSolve | <i>The SOC decomposition model implemented as an system of differential equations with the deSolve package.</i> |
|--------------------|---|

Description

This function implements the dual porosity model described in Meurer et al. (2020). The model is the same as in [run_Porous](#) and [Porous](#) but it is implemented differently, directly as a wrapper of the system of equations within the deSolve package. This implementation was designed during the development of the package, as a more transparent way of running the model and check for errors, but it does run correctly and is perfectly usable. This command relies on the same functions than [Porous](#) to calculate the partitioning of the inputs between meso- and micropores. This version currently do not provide separately the respiration fluxes but only the soil C stocks.

Usage

```
run_Porous_deSolve(
  ky,
  ko,
  kmix,
  e,
  Im,
  Ir,
  F_prot,
  phi_mac,
  phi_min,
  clay,
  Delta_z_min,
  gamma_o,
  gamma_m,
  proportion = NULL,
  f_text_mic = NULL,
  f_agg,
  init,
  sim_length,
  sim_steps,
  constant = FALSE
)
```

Arguments

| | |
|-------------|---|
| ky | decomposition constant of the Young pool <i>frac1year</i> |
| ko | decomposition constant of the Old pool <i>frac1year</i> |
| kmix | mixing rate <i>frac1year</i> |
| e | efficiency, which is the transfer term between the pools and corresponds to the term h in the ICBM model in Kätterer et al. (2001) (dimensionless) |
| F_prot | protection provided by the micropore space (dimensionless) |
| phi_mac | macroporosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |
| phi_min | minimal porosity, ($\frac{cm^3 of water}{cm^3 of soil}$) |
| clay | fraction of clay content (dimensionless, between 0 and 1) |
| Delta_z_min | minimal soil thickness if no organic matter was present (cm) |
| proportion | this is a linearization term to make the proportion of the inputs between micro- and mesopores constant. If NULL (or not specified, since default is NULL) then the model is running as nonlinear, as in the original paper. If specified (must be between 0 and 1) then the model is linearized adopting this value as fixed proportion of inputs from roots going into the mesopore space (and its reciprocal into the micropore) |
| f_agg | an aggregation factor (m ³ pore space m ⁻³ organic matter) defined as the slope of the linear relationship assumed between the volume of aggregation pore space V_{agg} , and the volume of organic matter V_{s_o} (dimensionless) |

constant boolean, if TRUE then the solver run in constant input mode, otherwise in variable input mode. Default is FALSE.

Details

The model is an evolution of a two-pool linear SOC model, with two pools (young and old material) running in parallel for micro- and mesopores. While aboveground inputs are rooted in the mesopores, root inputs are distributed between micro and mesopores depending on porosity, which is in turn influenced by organic matter. This makes the model nonlinear, although it still behaves similarly to a linear model within a reasonable calibration range. The model is described by a series of four equations:

$$\begin{aligned}\frac{dM_{Y(mes)}}{dt} &= I_m + \left(\frac{\phi_{mes}}{\phi_{mes} + \phi_{mic}} \right) \cdot I_r - k_Y \cdot M_{Y(mes)} + T_Y \\ \frac{dM_{O(mes)}}{dt} &= (\epsilon \cdot k_Y \cdot M_{Y(mes)}) - ((1 - \epsilon) \cdot k_O \cdot M_{O(mes)}) + T_O \\ \frac{dM_{Y(mic)}}{dt} &= \left(\frac{\phi_{mic}}{\phi_{mes} + \phi_{mic}} \right) \cdot I_r - k_Y \cdot F_{prot} \cdot M_{Y(mes)} - T_Y \\ \frac{dM_{O(mic)}}{dt} &= (\epsilon \cdot k_Y \cdot F_{prot} \cdot M_{Y(mes)}) - ((1 - \epsilon) \cdot k_O \cdot F_{prot} \cdot M_{O(mes)}) - T_O\end{aligned}$$

Please refer to the original paper for more details.

The terms T_Y and T_O are calculated in the original paper as $k_{mix} \cdot \frac{(My_{mic} - My_{mes})}{2}$ and $k_{mix} \cdot \frac{(Mo_{mic} - Mo_{mes})}{2}$, but in a later model development the term 2 disappeared and are now calculated as $T_Y = k_{mix} \cdot (My_{mic} - My_{mes})$ and $T_O = k_{mix} \cdot (Mo_{mic} - Mo_{mes})$.

The two porosity terms, $\phi_{mes} = f(M_{Y(mes)}, M_{O(mes)}, M_{Y(mic)}, M_{O(mic)})$ and $\phi_{mic} = f(M_{Y(mic)}, M_{O(mic)})$, are dependent on the variation of the different C pools and everything is variable over time, introducing a nonlinearity in the system and defining the biggest peculiarity of this model.

Value

two values, the proportion (between 0 and 1) of input in the mesopore and micropore Y pools

References

Meurer, Katharina Hildegard Elisabeth, Claire Chenu, Elsa Coucheney, Anke Marianne Herrmann, Thomas Keller, Thomas Kätterer, David Nimblad Svensson, and Nicholas Jarvis. “Modelling Dynamic Interactions between Soil Structure and the Storage and Turnover of Soil Organic Matter.” *Biogeosciences* 17, no. 20 (October 19, 2020): 5025–42. <https://doi.org/10.5194/bg-17-5025-2020>.
Kätterer, Thomas, and Olof Andrén. “The ICBM Family of Analytically Solved Models of Soil Carbon, Nitrogen and Microbial Biomass Dynamics — Descriptions and Application Examples.” *Ecological Modelling* 136, no. 2–3 (January 2001): 191–207. [https://doi.org/10.1016/S0304-3800\(00\)00420-8](https://doi.org/10.1016/S0304-3800(00)00420-8).

See Also

[run_Porous](#)

Index

Delta_z, [2](#)

Delta_z_min, [6](#)

f_som, [3](#), [6](#), [9](#), [14](#), [15](#)

f_text_mic_func, [4](#)

gamma_b, [5](#), [6](#), [14](#), [15](#)

Msm, [3](#), [5](#), [6](#)

phi_mat, [6](#), [9](#)

phi_mic, [7](#), [9](#)

pore_frac, [4](#), [6](#), [7](#), [8](#)

Porous, [9](#), [14](#), [15](#)

Porous_test, [11](#)

Porous_test_min, [13](#)

run_Porous, [9](#), [11](#), [13](#), [14](#), [14](#), [15](#), [17](#)

run_Porous_deSolve, [15](#)