**Issues with setting soil properties that are consistent with SoilTemperature’s expectations**

**No soil particle size data (Sand, Silt, Clay):**

* Clay% is used in the pedotransfer functions to estimate the soil thermal properties – it is a required input
* Many soils in APSoil and the test suit do not have this value entered in the soil descriptions and do not have enough information for even relatively simple estimation methods. Note also that there are several soil properties that are estimated, mostly invisibly to the user

*Solution:*

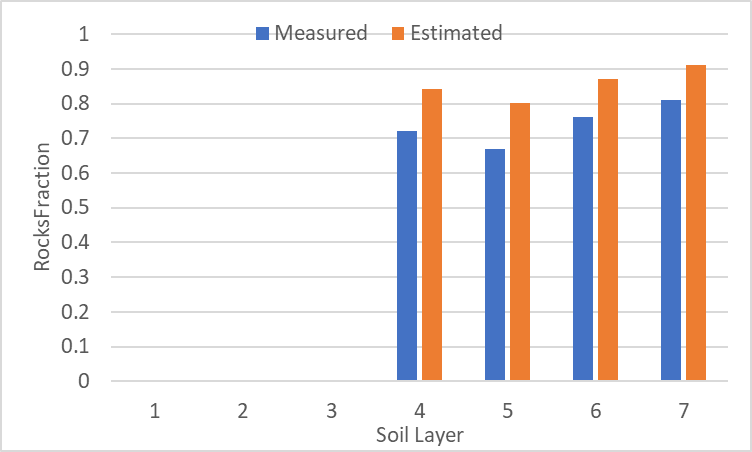
* If no Clay% data is supplied then assume the Clay% is 30% at all depths, Silt is 65% and Sand is 5%
* Insert this into the GUI, highlighting that it is an APSIM assumed value, encourage users to input more accurate data but allow the simulation to proceed as is
* User can then type over the supplied values in the GUI if they have better information – and in this case the highlighting would go away

**No Rocks% data:**

* Rocks% appears to not be pulled through from APSoil (if it even exists in that database)
* Most soils will, in reality, have a value of 0 (no rocks) but there are substantial areas of stony/rocky soil in New Zealand and internationally
* APSIM does not currently handle these very well
* The Rocks% is important for calculating the thermal properties

*Solution:*

* If Rocks% is non-blank (0 is a valid entry) then assume those values
* If Rocks% is blank then estimate the value by layer:
  + Assume rp (particle density) is 2.65 Mg /m3
  + Estimate effective total porosity (tp) as (1-bd/rp)\*0.93
  + If (1-Sat/tp) > 0.1 then take RocksFraction = (1-Sat/tp), else 0.0
* This has been tested on a range of soils and is giving sensible starting points. Below is a plot of measured and estimated Rocks% for one soil (note that this soil has no rocks in the top three layers)
* As with Clay%, show the estimated values with some highlight in the GUI and alert users to overwrite if needed



**Soil properties are structured for the fine-earth fraction but are expected to be whole-soil values**

* Soil properties in APSIM as functionally for the fine-earth fraction but the thermal properties are a function of the whole-soil.

*Solution*

* Within SoilTemperature convert the Clay%, BD and Carbon% to whole soil values before calculating the thermal properties
* This will have no effect on other models in APSIM
* Estimate whole-soil values as:
  + BD\_whole = BD+Rocks%/100\*2.65
  + Clay\_whole = (100-Rocks%)\*Clay%/100
  + OM\_whole = (100-Rocks%)\*OM%/100
* Use the above parameters to calculate the thermal conductivity parameters (L713)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| As in the GUI | | | | | |  | Whole-soil values | | |
| Depth | Clay | Rocks | BD | Sat | Carbon% |  | BD | Clay | OM |
| 0-170 | 22 | 0 | 1.2 | 0.498 | 2.9 |  | 1.2 | 22 | 2.9 |
| 170-280 | 23 | 0 | 1.35 | 0.458 | 1.2 |  | 1.35 | 23 | 1.2 |
| 280-360 | 22 | 0 | 1.42 | 0.439 | 0.67 |  | 1.42 | 22 | 0.67 |
| 360-470 | 24 | 72 | 0.389 | 0.126 | 0.92 |  | 2.297 | 6.72 | 0.2576 |
| 470-700 | 12 | 67 | 0.436 | 0.155 | 0.77 |  | 2.2115 | 3.96 | 0.2541 |
| 700-950 | 5 | 76 | 0.336 | 0.106 | 0.52 |  | 2.35 | 1.2 | 0.1248 |
| 950-1500 | 3 | 81 | 0.295 | 0.074 | 0.42 |  | 2.4415 | 0.57 | 0.0798 |

**Add soil organic matter into the thermal property calculations**

There are all sorts of issues in SPwB on the thermal properties. Instead use <https://doi.org/10.1111/ejss.12366> and the Simplified de Vries model – extended to frozen soils. Note that <https://doi.org/10.1002/saj2.20102> is an ‘update/improvement’ but the advance is relatively minor and there is no facility to include organic matter content

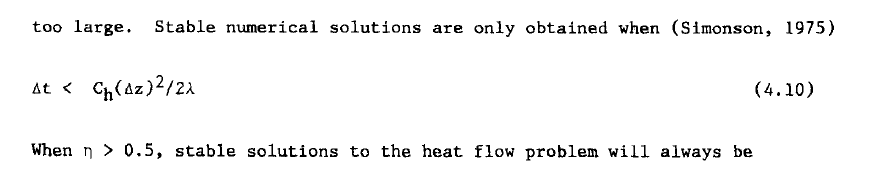
* Specific heat – volumetric fraction \* sh of the element –

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A close up of text

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