Soil wetness index calculation

The EFAS soil moisture is currently modelled in three layers representing top, medium and bottom. Further, the soil moisture is divided into fractions of forest \((f)\), irrigation \((i)\) and other \((o)\). The fractions of each soil type do not necessarily add up to 1 for each pixel since they represent the soil area that is not water for each grid. The soil moisture that is shown on the EFAS web page is the mean soil moisture calculated from the forest \((f)\) and other \((o)\) fraction for the two top layers \((1\text{ and }2)\). On the web, the soil moisture is calculated as the average relative soil moisture in the top two layers, also known as the soil wetness index. However, in MARS and CDS the three layers are stored as individual layers. This is more flexible and allows the user to extract the information that is needed.

The soil moisture that is stored in MARS and CDS is the "volumetric soil water content", which is defined as the ratio between the volume of water and the total volume of the soil, including all particles, vegetation, water and air. The soil moisture shown on the EFAS-IS is actually the soil wetness index, calculated as an average over the whole forecast period.

To calculate the Soil Moisture product \((SM)\) shown on EFAS-IS, you will need a number of static files that are not directly available from MARS or CDS. SM on EFAS-IS is the mean SM for the two upper layers. The below formulas calculate SM for each point.

You will need to derive the soil depth for each layer. The soil depth that comes out of the EFAS archive is the cumulative depth from the top of the surface to the bottom of each layer.

In order to calculate soil wetness, you need the below static maps. Note that the formulas below are for the gridded fields of all variables.

**Wilting point**

is defined as the minimal amount of water in the soil that the plant requires not to wilt. If the soil water content decreases to this or any lower point a plant wilts and can no longer recover its turgidity when placed in a saturated atmosphere for 12 hours.

Wilting point for each layer:

- \(thmin1.nc\)
- \(thmin2.nc\)
- \(thmin3.nc\)

**Field capacity**

is the amount of soil moisture or water content held in the soil after excess water has drained away and the rate of downward movement has decreased.

Field capacity for each layer:

- \(thmax1.nc\)
- \(thmax2.nc\)
- \(thmax3.nc\)

1. **Calculate the individual soil depth for layer 1 and 2**

   From CDS you will retrieve the depth from the surface of the soil to the bottom of that layer. To get the layer thickness of the second layer, we need to subtract the top layer:
   
   \[ sd1 = \text{Soil depth of layer 1} \]
   
   \[ sd2 = \text{Soil depth of layer 2} - \text{Soil depth of layer 1} \]

   where \(sd1\) and \(sd2\) are the thickness of layer 1 and 2 respectively.

2. **Calculate the mean wilting point and field capacity for layer 1 and 2**

   Wilting point: \(thmin = (thmin1 \cdot sd1 + thmin2 \cdot sd2)/(sd1 + sd2)\)

   Field capacity: \(thmax = (thmax1 \cdot sd1 + thmax2 \cdot sd2)/(sd1 + sd2)\)

3. **Calculate the mean soil moisture for layer 1 and 2**

   The mean soil moisture is calculated as the mean of all forecast steps in the 10-day forecast driven by ECMWF's high-resolution forecast:

   \[ smtot = (\text{mean(vsw1)} \cdot sd1 + \text{mean(vsw2)} \cdot sd2)/(sd1 + sd2) \]

   where the mean soil moisture is calculated over the 10-day forecast. vsw1 and vsw2 are the soil moisture that is stored in the EFAS archive for layer 1 and 2.

4. **Finally, calculate the soil wetness index**

   \[ SM = (smtot - thmin)/(thmax - thmin) \]