

Discretisation of soil layers

Soil depths

A revised land surface model (TESSEL) was introduced in June 2000 (with Cycle23r3); This is also the model used in ERA40. At the same time the soil water units in the MARS archive changed and it was decided to change the variable names accordingly. The soil is discretized in four layers for temperature and water.

The previous major modification to the land surface model was introduced in August 1993 with Cycle 48; The land surface in ERA15 correspond to the Cycle 48 model.

Finally, before August 1993 the soil is discretized in 3 layers (Cycle 47) and only the values of temperature and water in the two top layers evolve during the forecast, while the values for the lowest layer are kept constant

The table below summarises the soil layers distribution and, for each layer, the depths of its top and bottom.

| | MARS Name | Cy 47 Top (m) | Cy 47 Bottom (m) | MARS Name | Cy 48 Top (m) | Cy 48 Bottom (m) | MARS Name | TESSEL Top (m) | TESSEL Bottom (m) |
|---|-----------|---------------|------------------|------------|---------------|------------------|------------|----------------|-------------------|
| 1 | ST/SSW | 0 | 0.07 | STL1/SW L1 | 0 | 0.07 | STL1/SWVL1 | 0 | 0.07 |
| 2 | DST/DSW | 0.07 | 0.49 | STL2/SW L2 | 0.07 | 0.21 | STL2/SWVL2 | 0.07 | 0.28 |
| 3 | CDST/CDSW | 0.49 | 0.91 | STL3/SW L3 | 0.21 | 1.00 | STL3/SWVL3 | 0.28 | 1.00 |
| 4 | - | - | - | STL4/SW L4 | 1.00 | 2.89 | STL4/SWVL4 | 1.00 | 2.89 |

Soil water units

Since the introduction of TESSEL, the MARS archived soil water (SWVL_i) have volumetric units. To convert MARS values (SWVL_i or in the following $\theta_{v,i}$) for layer *i*, with depth d_i to water θ content in the layer, the following operation should be performed:

$$\text{Water content } (\theta_i) \quad \theta_i = \theta_i * d_i; [\theta_i] = \text{m of water}$$

Before TESSEL soil water was stored in MARS with units of metres of water scaled to the depth of the top soil layer ((m of water)/0.07). The following describes the operations to convert old soil water at layer *i*, $\theta_{o,i}$ (MARS name SWLi), into other units.

$$\text{Old MARS soil water content } (\theta_{o,i}) \quad [\theta_{o,i}] = \frac{\text{m of water}}{0.07}$$

$$\text{Volumetric water content } (\theta_{v,i}) \quad \theta_{v,i} = \frac{\theta_{o,i}}{d_1}; [\theta_{v,i}] = m^3 / m^3$$

Water content (θ_i)

$$\theta_i = \frac{\theta_{o,i}}{d_1} * d_i; [\theta_i] = \text{m of water}$$

Some characteristic values (in TESSEL and cycle 48)

The maximum value of water in any layer corresponds to **saturation** (0.47 m³/m³). However, saturation can only occur during very short periods, because the model will lose water due to bottom drainage. **Field capacity** corresponds to the maximum value that the model can sustain for more than a few hours, in the absence of precipitation. The vegetated fraction of the soil evaporates at the maximum rate for soil wetness larger than **field capacity** (0.32 m³/m³) and stops evaporating below the **permanent wilting point** (0.17 m³/m³), with a continuous variation between the two extremes.