# WRF sensitivity to infiltration using urban parametrizations and LCZs

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## 1 Introduction

We would like to test the sensitivity of the WRF (v4.3.1) model to the infiltration in the urban environtment. For that reason, we set-up an experiment over the Metropolitan Area of Buenos Aires (AMBA, in Spanish) at 1 km horizontal resolution with the representation of the *'Local Climate Zones'* (LCZs Stewart and Oke, 2012) and the use of the BEP (Martilli et al., 2002) + BEM (Salamanca and Martilli, 2010) urban canopy schemes.

We are intersted in the sensitivity to infiltration within the urban environtment. So, we need to find how land moisture is simulated within the urban scheme.

## 2 Land representation and dynamics in WRF

WRF model uses a series of tables to infer the type of use at each grid cell. There are multipe potential different classifications to be used. The paramters of the *'landuse'* categories are provided in an static table called `LANDUSE.TBL` which is readed at the beginning of the simulation by `phys/module_physics_init.F`. See an example of values in table 1. The different values correspond to different global datasets (OLD, USGS, MODIFIED_IGBP_MODIS_NOAH, SiB, MODIS, SSIB, NLCD40) each one with different amount of available categories. How ever all of them provide the same parameters for each category (with values for winter and summer) being provided in table 3

The values of this table and the ones from `SOILPARM.TBL` (read by each land scheme, see its content in 4), `VEGPARM.TBL` (read by each land scheme, see its content in 5) and `GENPARM.TBL` (read by each land scheme, see its content in 6) are readed and their values are used to compute the dynamics of the soil.

## 3 urban representation in WRF

Since WRF v4.3, urban representation in WRF add extra complexity by the use of LCZs, taken values from the *'The World Urban Database and Access Portal Tools'* (WUDAPT, `https://www.wudapt.org/` Ching et al., 2018). This added 11 new landuse types and it was prepared only for the Noah land schemes. There is a python-based tool to prepare urban LCZs classifications to be directly ingested into the `geo_em.d[nn].nc` domain files called w2w prepared by Matthias Demuzere (Ruhr-University Bochum, Germany). Since WRF v4.3.1 WRF provides pre-processed global data that can be directly be used without the need of the w2w tool. For the use of the LCZs a new file with multiple parameters is added to the WRF suite called `URBPARM_LCZ.TBL`. Exists a previous version for the representation of the urban environment called `URBPARM.TBL`.

`URBPARM_LCZ.TBL` file has more than 135 values specific for the morphological representation of the urban environtment. When using the WUDAPT data into the generation of the domains (`geogrid.exe`), in the files `geo_em.d[nn].nc` appears a new variable with 131 values at each grid point called `URB_PARAM` (the unique documentation of all the values seems to be this document from the NUDAPT data-base, see table ??). These variable gets its values from the `NUDAPT` data-base, but it only has values for Northamerica. Therefore is left empty (zero). When the model runs, if a certain parameter of the variable `URB_PARAM` has zero value, it takes the value from `URBPARM_LCZ.TBL`. From all these values the 6 most important ones are: 'LP_URB2D' (90), 'MH_URB2D' (91), 'STDH_URB2D' (92), 'HGT_URB2D' (93),

Table 1: Summer values for MODIFIED_IGBP_MODIS_NOAH landuse categories

| **number** | **ALBD** | **SLMO** | **SFEM** | **SFZ0** | **THERIN** | **SCFX** | **SFHC** | **description** |
|---|---|---|---|---|---|---|---|---|
| 1 | 12. | .30 | .95 | 50. | 4. | 3.33 | 29.2e5 | Evergreen Needleleaf Forest |
| 2 | 12. | .50 | .95 | 50. | 5. | 1.67 | 29.2e5 | Evergreen Broadleaf Forest |
| 3 | 14. | .30 | .94 | 50. | 4. | 2.86 | 25.0e5 | Deciduous Needleleaf Forest |
| 4 | 16. | .30 | .93 | 50. | 4. | 2.63 | 25.0e5 | Deciduous Broadleaf Forest |
| 5 | 13. | .30 | .97 | 50. | 4. | 2.11 | 41.8e5 | Mixed Forests |
| 6 | 22. | .10 | .93 | 5. | 3. | 1.56 | 20.8e5 | Closed Shrublands |
| 7 | 20. | .15 | .95 | 6. | 3. | 2.14 | 20.8e5 | Open Shrublands |
| 8 | 22. | .10 | .93 | 5. | 3. | 1.56 | 20.8e5 | Woody Savannas |
| 9 | 20. | .15 | .92 | 15. | 3. | 2.00 | 25.0e5 | Savannas |
| 10 | 19. | .15 | .96 | 12. | 3. | 2.37 | 20.8e5 | Grasslands |
| 11 | 14. | .42 | .95 | 30. | 5.5 | 1.32 | 35.5e5 | Permanent wetlands |
| 12 | 17. | .30 | .985 | 15. | 4. | 2.71 | 25.0e5 | Croplands |
| 13 | 15. | .10 | .88 | 80. | 3. | 1.67 | 18.9e5 | Urban and Built-Up |
| 14 | 18. | .25 | .98 | 14. | 4. | 2.56 | 25.0e5 | cropland/natural vegetation mosaic |
| 15 | 55. | .95 | .95 | 0.1 | 5. | 0. | 9.0e25 | Snow and Ice |
| 16 | 25. | .02 | .90 | 1. | 2. | 0.81 | 12.0e5 | Barren or Sparsely Vegetated |
| 17 | 8. | 1.0 | .98 | 0.01 | 6. | 0. | 9.0e25 | Water |
| 18 | 15. | .50 | .93 | 30. | 5. | 2.67 | 9.0e25 | Wooded Tundra |
| 19 | 15. | .50 | .92 | 15. | 5. | 2.67 | 9.0e25 | Mixed Tundra |
| 20 | 25. | .02 | .90 | 10. | 2. | 1.60 | 12.0e5 | Barren Tundra |
| 21 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 22 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 23 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 24 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 25 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 26 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 27 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 28 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 29 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 30 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 31 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 32 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 33 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 34 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 35 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 36 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 37 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 38 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 39 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 40 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 41 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 42 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 43 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 44 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 45 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 46 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 47 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 48 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 49 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |
| 50 | 15. | .02 | .88 | 80. | 3. | 1.67 | 18.9e5 | Unassigned |

Table 2: Continuation of 1

| number | ALBD | SLMO | SFEM | SFZ0 | THERIN | SCFX | SFHC | description |
|---|---|---|---|---|---|---|---|---|
| 51 | 10. | .10 | .97 | 80. | 3. | 1.67 | 18.9e5 | LCZ_1 |
| 52 | 10. | .10 | .97 | 80. | 3. | 1.67 | 18.9e5 | LCZ_2 |
| 53 | 10. | .10 | .97 | 80. | 3. | 1.67 | 18.9e5 | LCZ_3 |
| 54 | 10. | .10 | .97 | 80. | 3. | 1.67 | 18.9e5 | LCZ_4 |
| 55 | 10. | .10 | .97 | 80. | 3. | 1.67 | 18.9e5 | LCZ_5 |
| 56 | 10. | .10 | .97 | 80. | 3. | 1.67 | 18.9e5 | LCZ_6 |
| 57 | 10. | .10 | .97 | 80. | 3. | 1.67 | 18.9e5 | LCZ_7 |
| 58 | 10. | .10 | .97 | 80. | 3. | 1.67 | 18.9e5 | LCZ_8 |
| 59 | 10. | .10 | .97 | 80. | 3. | 1.67 | 18.9e5 | LCZ_9 |
| 60 | 10. | .10 | .97 | 80. | 3. | 1.67 | 18.9e5 | LCZ_10 |
| 61 | 10. | .10 | .97 | 80. | 3. | 1.67 | 18.9e5 | LCZ_11 |

Table 3: Description (as from `phys/module_physics_init.F`) of the variables provided within `LANDUSE.TBL`

| Acronym | meaning |
|---|---|
| ALBD | Surface albedo |
| SLMO | Moisture availability |
| SFEM | Emissivity |
| SFZ0 | Roughness length |
| THERIN | Thermal inertia (only used in SLAB) |
| SFHC | Soil heat capacity (not used) |
| SCFX | Snow cover effect (dependent on SNOWC) |

Table 4: Meaning of the entries in the `SOILPARM.TBL` as are provided from NoahMP web page

| Acronym | meaning |
|---|---|
| BB | B parameter [units??] (Any more descriptive documentation?) |
| DRYSMC | Dry soil moisture threshold at which direct evaporation from top soil layer ends [volumetric fraction] |
| F11 | Soil thermal diffusivity/conductivity coefficient [units??] (Unused in Noah LSM?) |
| MAXSMC | Saturation soil moisture content (i.e., porosity) [volumetric fraction] |
| REFSMC | Reference soil moisture (field capacity), where transpiration begins to stress [volumetric fraction] |
| SATPSI | Saturation soil matric potential [units??] |
| SATDK | Saturation soil conductivity [units??] |
| SATDW | Saturation soil diffusivity [units??] |
| WLTSMC | Wilting point soil moisture [volumetric fraction] |
| QTZ | Soil quartz content [units??] |
| BVIC | |
| AXAJ | |
| BXAJ | |
| XXAJ | |
| BDVIC | |
| BBVIC | |
| GDVIC | |

Table 5: Description of the content of `VEGPARM.TBL` as it is commented in `phys/module_sf_rucslm.F`

| **Acronym** | **meaning** |
|---|---|
| ALBBCK | SFC albedo (in percentage) |
| Z0 | Roughness length (m) |
| LEMI | Emissivity |
| PC | Plant coefficient for transpiration function |
| SHDFAC | Green vegetation fraction (in percentage) |
| CMXTBL | MAX CNPY Capacity (m) |
| RSMIN | Mimimum stomatal resistance (s m-1) |
| RSMAX | Max. stomatal resistance (s m-1) |
| RGL | Parameters used in radiation stress function |
| HS | Parameter used in vapor pressure deficit function |
| TOPT | Optimum transpiration air temperature. (K) |
| CMCMAX | Maximum canopy water capacity |
| CFACTR | Parameter used in the canopy inteception calculation |
| SNUP | Threshold snow depth (in water equivalent m) that implies 100% snow cover |
| LAI | Leaf area index (dimensionless) |
| MAXALB | Upper bound on maximum albedo over deep snow |

Table 6: Meaning of the content of `GENPARM.TBL` as it is provided in NoahMP web page

| **Acronym** | **meaning** |
|---|---|
| SLOPE_DATA | Linear reservoir coefficient (function of slope type?) [units??] |
| SBETA_DATA | Parameter used to calculate vegetation effect on soil heat [units??] |
| FXEXP_DAT | Soil evaporation exponent used in DEVAP [units??] |
| CSOIL_DATA | Soil heat capacity [J m-3 K-1] |
| SALP_DATA | Shape parameter of distribution function of snow cover[units??] |
| REFDK_DATA | Parameter in the surface runoff parameterization [units??] |
| REFKDT_DATA | Parameter in the surface runoff parameterization [units??] |
| FRZK_DATA | Frozen ground parameter [units??] |
| ZBOT_DATA | Depth [m] of lower boundary soil temperature |
| CZIL_DATA | Parameter used in the calculation of the roughness length for heat [units??] |
| SMLOW_DATA | Soil moisture wilt, soil moisture reference parameter [units??] |
| SMHIGH_DATA | Soil moisture wilt, soil moisture reference parameter [units??] |

Table 7: Decription of the content of the `URB_PARAM` 3-dimensional variable as it appears in NUDAPT_44_Documentation

| description | Acronym | indices |
|---|---|---|
| Frontal Area Density at 0° | FAD0_URB2D | 1-15 |
| Frontal Area Density at 135° | FAD135_URB2D | 16-30 |
| Frontal Area Density at 45° | FAD45_URB2D | 31-45 |
| Frontal Area Density at 90° | FAD90_URB2D | 46-60 |
| Plan Area Density | PAD_URB2D | 61-75 |
| Roof Area Density | RAD_URB2D | 76-90 |
| Plan Area Fraction | LF_URB2D | 91 |
| Mean Building Height | MH_URB2D | 92 |
| Standard Deviation of Building Height | STDH_URB2D | 93 |
| Area Weighted Mean Building Height | HGT_URB2D | 94 |
| Building Surface to Plan Area Ratio | LF_URB2D | 95 |
| Frontal Area Index | LF_URB2D | 96-99 |
| Complete Aspect Ratio | CAR_URB2D | 100 |
| Height to Width Ratio | H2W_URB2D | 101 |
| Sky View Factor | SVF_URB2D | 102 |
| Grimmond and Oke (1999) Roughness Length | ZOS_URB2D | 103 |
| Grimmond and Oke (1999) Displacement Height | ZDS_URB2D | 104 |
| Raupach (1994) Roughness Length | ZOR_URB2D | 105,107,109,111 |
| Raupach (1994) Displacement Height | ZDR_URB2D | 106,108,110,112 |
| Macdonald et al. (1998) Roughness Length | ZOM_URB2D | 113-116 |
| Macdonald et al. (1998) Displacement Height | ZDM_URB2D | 117 |
| Distribution of Building Heights | HI_URB2D | 118-132 |

'LB_URB2D' (94), 'LF_URB2D' (95), ( # 97, 98, 99, for all 4 directions –> Can only extract one if perpendicular E/N orientation) and 'HI_URB2D' (117)

### 3.1 NoahMP

The *'Noah-Multiparameterization Land Surface Model'* (https://ral.ucar.edu/model/noah-multiparameterization-land-surface-model-noah-mp-lsm#noah-mp%C2%AE2 Niu et al., 2011) is a highly complex land scheme with multiple capabilities one of each, to be coupled to WRF's urban schemes.

Since WRF v4.3 Noah-MP code is provided separately from WRF's code. Alos it is using its own parameter tables located at specific folder `phys/noamp/` (when it is downloaded properly). Now, Noah-MP is using new file called `MPTABLE.TBL` which is being read as a namelist.

### 3.2 urban schemes

WRF has 4 different ways to take into account the representation of the urban grid-cell. Accordingly to the value of the `namelst.input` parameter `urban_scheme`:

- `urban_scheme=0`: The most simple one, when no specific urban scheme is activated Noah and Noah-MP land models use a bulk scheme to represent impact of the urban grid point into the atmosphere.
- `urban_scheme=1`: The first urban scheme is a bulk approximation (Chen et al., 2011). It does not vertically splits the urban canopy in multiple layers. Because of that, one needs to locate the first vertical layer of the atmosphere above the urban canopy.
- `urban_scheme=2`: This uses the 3-dimensional representation of the urban canopy known as BEP (Martilli et al., 2002)

Table 8: Hard coded morphological values for soil moisture, specific for urban grid points found in `phys/module_sf_noahlsm.F`. NOTE: there are some discrepancies regarding hard coded values for urban grid points found in `phys/module_sf_urban.F` module (see table 9) used only for the 'green roof'

| Acronym | value | description |
|---|---|---|
| SHDFAC | 0.05 | Vegetated area fraction |
| RSMIN | 400 | Minimum stomatal resistance (`VEGPARM.TBL`) |
| SMCMAX | 0.45 | Saturated soil moisture (seems to be MAXSMC from `SOILPARM.TBL`) |
| SMCREF | 0.42 | Reference soil moisture (seems to be REFSMC from `SOILPARM.TBL`) |
| SMCWLT | 0.40 | Wilting point (seems to be WLTSMC from `SOILPARM.TBL`) |
| SMCDRY | 0.40 | Residual soil moisture (seems to be DRYSMC from `SOILPARM.TBL`) |
| DF1 | 3.24 | thermal diffusivity |
| CSOIL[a] | 3.0E6 | soil heat capacity (from `GENPARM.TBL`) |

[a]in subroutine `HRT, NOPAC`

- `urban_scheme=3`: This introduces the anthropogenic effects in the urban grid cell being called BEM (Salamanca and Martilli, 2010)

Each one provides different accuracies and complexities with a variety of impacts in the evolution of the atmosphere (see for example Luque et al., 2023)

# 4 Sensitivity to infiltration

Moisture land fluxes are computed in `phys/module_sf_noahlsm.F` by subroutine `SFLX`. At the beginning of this subroutine (line #433), one encounters a hard coded declaration of some parameters (see table 8) for the urban grid points (by the value `VEGTYP==is_urban`). The calculation in soil of the 'soil water diffusivity' (WDF) and the 'soil hydraulic conductivity' (WCND) is computed by subroutine `WDFCND` and the driven equations are provided in 1 (for simplification the part taking into account frozen soil is removed)

$$
\begin{aligned}
& \begin{cases} FACTR1 = 0.05/SMC_{max} \\ FACTR2 = \frac{SMC}{SMC_{max}} \\ FACTR1 = MIN(FACTR1, FACTR2) \end{cases} \\
WDF &= DW_{sat} FACTR2^{\beta+2} \\
WCND &= DK_{sat} FACTR2^{2\beta+3}
\end{aligned} \tag{1}
$$

$SMC$: water content of the soil layer, $SMC_{max}$ (`SMCMAX`), $DW_{sat}$ (`DWSAT`), $DK_{sat}$ (`DKSAT`), $\beta$ (`BEXP`) are different parameters depending on `VEGPARM.TBL`, `SOILPARM.TBL` and `GENPARM.TBL` tables

Runoff is computed in subroutine `SRT` from `phys/module_sf_noahlsm.F` as shown in equation 2

$$
\begin{aligned}
& \begin{cases} RHSCT = SHDFACpr - EC \\ EXCESS = CMC + TRHSCT \\ EXCESS > CMC_{max} \rightarrow drip = EXCESS - CMC_{max} \end{cases} \\
PC_{drp} &= (1. - SHDFAC)pr + drip/\delta t
\end{aligned} \tag{2}
$$

$$
\begin{aligned}
PC_{drp} \quad &\neq \quad 0 \begin{cases}
SMC_{av} = SMC_{max} - SMC_{wlt} \\
D_{max}(1) = -Z_{soil}(1) SMC_{av} \\
D_{ice} = -Z_{soil}(1) S_{ice}(1) \\
D_{max}(1) = D_{max}(1) \left(1.0 - \frac{S_{H2O}A(1) + S_{ice}(1) - SMC_{wlt}}{SMC_{ac}}\right) \\
VAL = (1. - e^{-K_{DT}\delta 1}) \\
DDT = DD * VAL \\
PX = PCP_{drp} \delta t \\
INF_{max} = \frac{PX * \frac{DDT}{PX+DDT}}{\delta t} \\
\mathcal{F}_{frz} = 1. \\
INF_{max} = INF_{max} \mathcal{F}_{frz} \\
MXSMC = S_{H2O}A(1) \\
WDFCND(WDF, WCND, MXSMC, SMC_{max}, \beta, DK_{sat}, DW_{sat}, SICE_{max}) \\
INF_{max} = max\left(INF_{max}, WCND\right) \\
INF_{max} = min\left(INF_{max}, \frac{PX}{\delta t}\right)
\end{cases} \\
PC_{drp} \quad &> \quad INF_{max} \rightarrow runoff = PC_{drp} - INF_{max}
\end{aligned}
$$

being $pr$: precipitation, $EXCESS$: increase of soil moisture content ($CMC$) by precipitation, $EC$: canopy evaporation, $PC_{drp}$: combination of precipitation and drip that goes into soil, $S_{H2O}$: soil liquid content, $Z_{soil}$: depth of the soil layer, $S_{ICE}$: soil iced content, $\mathcal{F}_{frz}$: fractional impermeable (frozen) area (see eq. 7 in Niu and Yang, 2006) is modified only by the ice content in the soil (not included to simplify).

So, the impact of the values in the urban soil type is double: in the water capacity of the grid cell and its runoff.

Whereas the specific urban dynamics is computed by `phys/module_sf_urban.F` and the subroutine `urban`. Within the subroutine `urban` in `phys/module_sf_urban.F`, there is also the use of `SMFLX` subroutine, but only for the green roof.

There are also different parameters that seem to control infiltration in the pavements directly from the tables.

- `PORIMP`: Porosity of pavement materials on impervious surface (roof, wall, road, in `URBPARM_LCZ.TBL`). Is being used only in `urban_scheme=1` and impervious scheme `IMP_SCHEME=2`

- `DENGIMP`: Maximum water-holding depth of pavement materials on impervious surface [m] (roof, wall, road, in `URBPARM_LCZ.TBL`). Is being used only in `urban_scheme=1`

In the light of all that has been described, it seems that to proceed with a sensitivity on infiltration within the urban grid cells, it is necessary to modify the hard coded values found in `phys/module_sf_noahlsm.F`. This could be done in a more complex way by incorporating some of these parameters in the `URBPARM_LCZ.TBL` file and be able to set them up for each LCZ without the need of extra compilation. In doing that we could perform sensitivity tests without recompilation and providing a different permeability for each LCZ.

# 5 Conclusion

It seems that the way to perform sensitivity tests in urban environment to infiltration is related to modify certain hard coded values specific for urban grid points (the same for all LCZs) which will directly affect the infiltration and the runoff. In the study of (Alexander et al., 2024) the saturated hydraulic conductivity (`SATDK` or `SATDW`?) to a $1.76 \times 10^{-4} ms^{-1}$, leaving the rest to the same as soil type 'sand'. One must keep in mind, that a too porous soil, will drain too fast the water and would produce at the end too dry and warm soils.

The infiltration computed in the urban scheme is only used for the *green roofs*.

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Table 9: Hard coded parameters in the `phys/module_sf_urban.F` module

| **Acronym** | **value** | **description** |
|---|---|---|
| SHDFAC | 0.80 | Vegetated area fraction of green roof vegetation |
| ALBV | 0.20 | green roof albedo |
| EPSV | 0.93 | green roof emissivity |
| LAI | 1.50 | leaf area index on green roof |
| CMCMAX | 0.5e-3 | Maximum canopy interception capacity (seems to be CMCMAX from `VEGPARM.TBL`) |
| SMCREF | 0.329 | Reference soil moisture (seems to be REFSMC from `SOILPARM.TBL`) |
| SMCDRY | 0.066 | Residual soil moisture (seems to be DRYSMC from `SOILPARM.TBL`) |
| SMCWLT | 0.084 | Wilting point (seems to be WLTSMC from `SOILPARM.TBL`) |
| SMCMAX | 0.439 | Saturated soil moisture (seems to be MAXSMC from `SOILPARM.TBL`) |
| RSMAX | 5000 | Maximum stomatal resistance (`VEGPARM.TBL`) |
| RSMIN | 100 | Minimum stomatal resistance (`VEGPARM.TBL`) |
| RGL | 100 | Radiation limit where photosynthesis begins (`VEGPARM.TBL`) |
| CFACTR | 0.5 | Parameter used in the canopy interception calculation (`VEGPARM.TBL`) |
| DWSAT | 0.143e-4 | Saturated soil conductivity (seems to be SATDK from `SOILPARM.TBL`) |
| DKSAT | 3.38e-6 | Saturated soil diffusivity (seems to be SATDW from `SOILPARM.TBL`) |
| BEXP | 5.25 | B parameter in soil hydraulic calculation |
| FXEXP | 2.0 | Parameter for computing direct soil evaporation (`GENPARM.TBL`) |
| ZBOT | -2.0 | Depth [m] of lower boundary soil temperature |
| QUARTZ | 0.40 | As soil quartz content ? (`SOILPARM.TBL`) |
| CSOIL | 2.0e+6 | Soil heat capacity [J m-3 K-1] (`GENPARM.TBL`) |
| HS | 36 | parameter used in vapor pressure deficit function (`VEGPARM.TBL`) |
| NROOT | 2 | Root depth layer of green roof |
| NGR | 4 | Layer of green roof |

# References


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