geotopbricks

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Who am I?

- Environmental engineer with hydraulic and hydrological background (more deterministic and physicall-based than statics!)
- Some skills in programming and a R entusiast which I use to work with hydro-climatic data.
- Find me as @ecor on GitHub
- I'm self-employed and freelancer as www.rendena100.eu .
- Author of several R-packages and p

Who are the other authors?

- Hydrologist „, BLA
- Author of several packages, including `geotop`,...

Hydrology

Scientific study of the movement, distribution, and quality of water on Earth water cycle, water resources and environmental watershed sustainability.

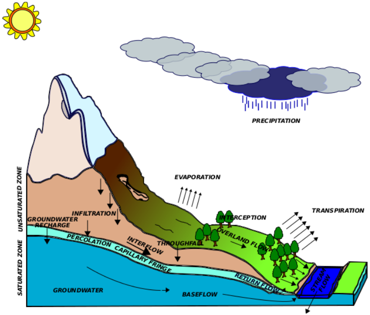


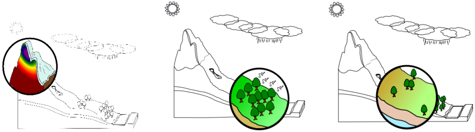
Figure 1: image

Soil Water Balance

GEOtop Hydrological Model

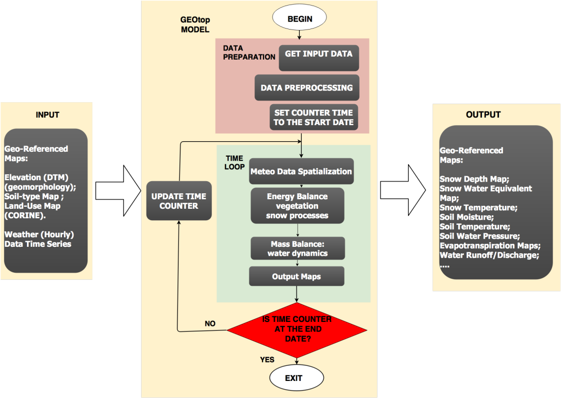
GEOtop is an integrated hydrological model that simulates:

- water flow in the soil $\rightarrow$ Richards' eq (sub) + Kinematic eq (sur)
- energy exchange with the atmosphere $\rightarrow$ full integration of equation



Hydrological Model

- Input: meteo data, elevations, soil parameters
- Output: snow cover, soil temperature, soil moisture



##

GEOtop model}%{Optional Subtitle

Water and energy budgets can be activated :

GEOtop external extensions

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GEOtop

placeholder

GEOtop configuration File (geotop.inpts)

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GEOtop configuration File (geotop.inpts)

A GEOtop simulation is organized in a set of files within a directory. This directory contains:

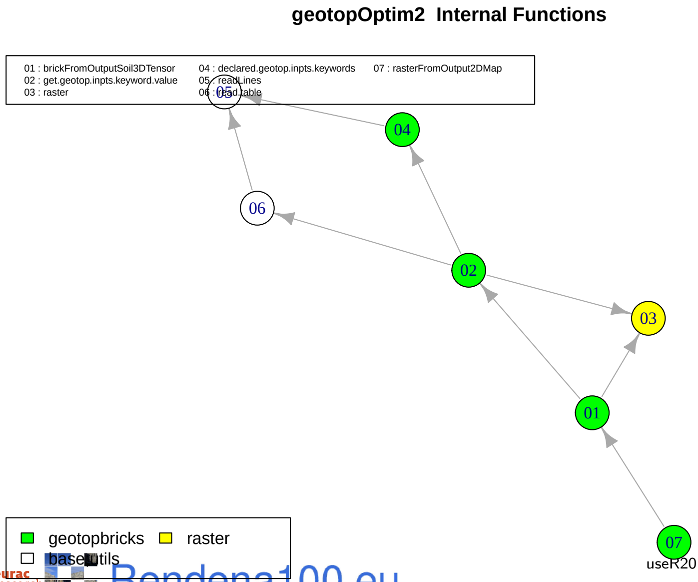
-**input files** (meteorological forcings, topography, land-use, soil-type maps, initial conditions); **target information** (which results are requested) ; - **observations**. Allthese information are written in a file called `geotop.inpts`, which is a list of **keyword-value** pairs:

```
InitDateDDMMYYYYhhmm      =    09/04/2014 18:00
EndDateDDMMYYYYhhmm       =    01/01/2016 00:00
[...]
MeteoFile                 =    "meteoB2_irr"
PointOutputFile           =    "tabs/point"
```

Simulation of soil water budget in an alpine site

GOtop is applied to estimate soil water content in two soil columns below two hydro-meteorological stations (B2 and P2) located in Val Mazia/Match, Malles Venosta/Mals Vinschgau, in South Tyrol, Italy (LOng Term Reasearch Ecological Area, [http://lter.eurac.edu/en]).

Geotopbricks Graph



Simulation of soil water budget in an alpine site

Here is the directory containing files of B2 point simulation:

```
library(geotopbricks)

## SET GEOTOP WORKING DIRECTORY
wpath_B2 <- "resources/simulation/Matsch_B2_Ref_007"
##writeLines(list.files(wpath_B2))
```

Getting simulation input data

Meteorological variable time series are imported and saved as 'meteo' variable (class 'zoo'). This variable is retrieved through the GEOtop keyword **MeteoFile** :

```
tz <- "Etc/GMT-1"
meteo <- get.geotop.inpts.keyword.value(
  "MeteoFile",
  wpath=wpath_B2,
  data.frame=TRUE,
  tz=tz)
class(meteo)
```

```
## [1] "zoo"
```

Verifying that import of simulation input data has succeed

Meteorological time series once imported are available in the R environment:

```r
head(meteo[12:14,c("Iprec","WindSp","WindDir")])
```

```
##                     Iprec WindSp WindDir
## 2009-10-02 11:00:00     0   3.63  339.75
## 2009-10-02 12:00:00     0   2.75  328.48
## 2009-10-02 13:00:00     0   2.74  311.28
```

```r
head(meteo[12:14,c("RelHum","AirT","Swglobal")])
```

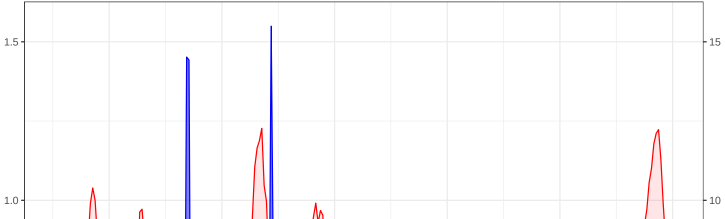
```
##                     RelHum  AirT Swglobal
## 2009-10-02 11:00:00  31.45 12.38   396.02
## 2009-10-02 12:00:00  30.50 13.12   500.07
## 2009-10-02 13:00:00  30.20 13.96   564.02
```

Plotting

```
##
## Attaching package: 'lubridate'

## The following object is masked from 'package:igraph':
##
##     %--%

## The following object is masked from 'package:base':
##
##     date
```



Getting output simulation data

Soil Water Content Profile:

```
tz <- "Etc/GMT-1"
SWC_B2  <- get.geotop.inpts.keyword.value(
  "SoilLiqContentProfileFile",
  wpath = wpath_B2,
  data.frame = TRUE,
  date_field = "Date12.DDMMYYYYhhmm.",
  tz = tz,
  zlayer.formatter = "z%04d"
)
help(get.geotop.inpts.keyword.value) ## for more details!
```

P2

The same for P2:

```
wpath_P2 <- "resources/simulation/Matsch_P2_Ref_007"
SWC_P2  <- get.geotop.inpts.keyword.value(
  "SoilLiqContentProfileFile",
  wpath = wpath_P2,
  data.frame = TRUE,
  date_field = "Date12.DDMMYYYYhhmm.",
  tz = "Etc/GMT-1",
  zlayer.formatter = "z%04d")
```

Data Reformatting

```
class(SWC_B2)
```

```
## [1] "zoo"
```

```
SWC_B2 <- cbind(time=as.POSIXct(index(SWC_B2)),as.data.fran
SWC_P2 <- cbind(time=as.POSIXct(index(SWC_P2)),as.data.fran
class(SWC_B2)
```

```
## [1] "data.frame"
```

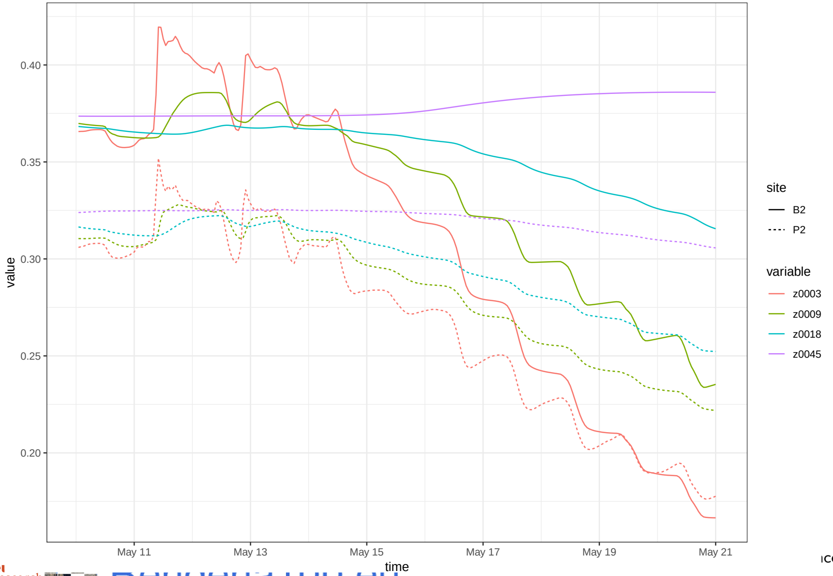
```
names(SWC_B2)
```

```
##  [1] "time"  "z0001" "z0002" "z0003" "z0004" "z0006" "z0
##  [9] "z0018" "z0023" "z0028" "z0035" "z0045" "z0055" "z0
## [17] "z0093"
```



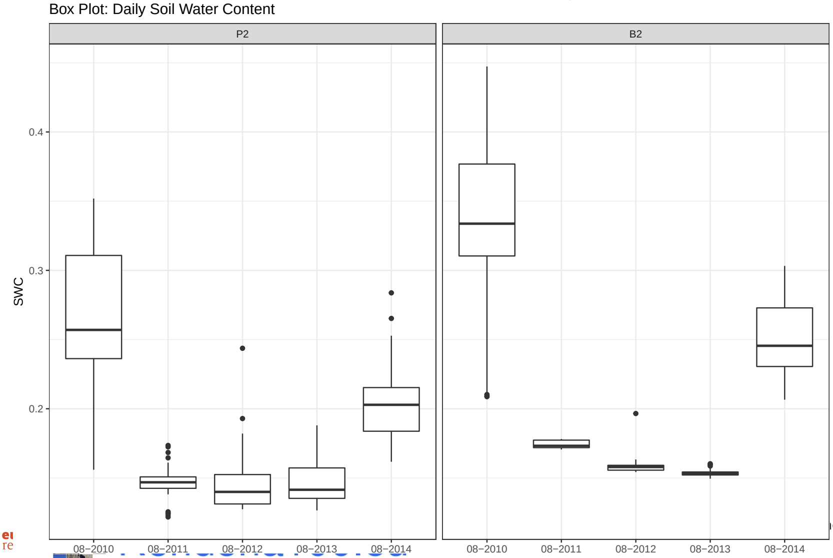
```
###knitr::kable(head(SWC_B2))
```

Output Visualization



Analysis (soil Mooisture Distribution)

Soil Water Content Distributio at a 18 cm depth



And Precipitation:

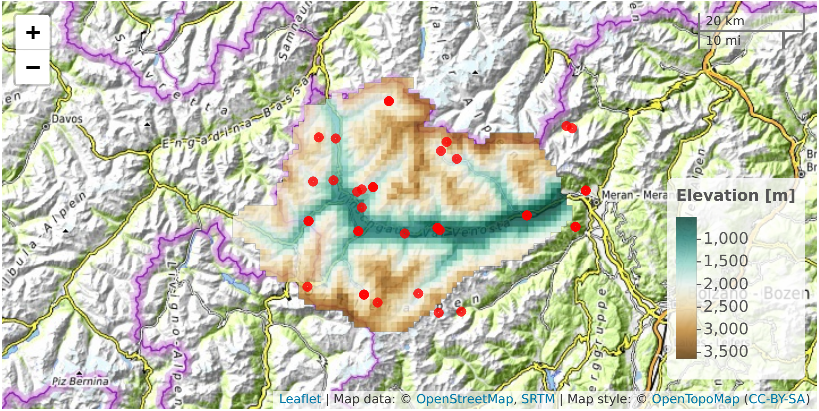
?

3D Spatially Distributed Distribution (Vinschgau - Upper Adige River Basin - Alps - I/CH/A)

```
wpath_3D <- 'resources/simulation/Vinschgau_test_3D_002'
basin <- get.geotop.inpts.keyword.value("LandCoverMapFile",
                 wpath=wpath_3D,raster=TRUE)
basin
```

```
## class       : RasterLayer
## dimensions  : 48, 63, 3024  (nrow, ncol, ncell)
## resolution  : 1000, 1000  (x, y)
## extent      : 598166, 661166, 5145386, 5193386  (xmin, x
## coord. ref. : +proj=utm +zone=32 +ellps=WGS84 +datum=WGS
## data source : in memory
## names       : layer
## values      : 1, 11  (min, max)
```

3D Spatially Distributed Distribution (Input Geospatial Map)



LOREM IPSUM

The results show than B2 is able to hold more water than P2. This depends on soil and land properties. Compared with input precipitation results,soil water behaviour for the different months is related to precipitation amount (depth and number of rainy days). Interestingly, in August 2014 soil water content is higher than in August 2012, in which precipitaion is higher. However, in August 2014 the daily precipitation distribution is the least wide with the lowest variability (interquantile range) and two extreme events. (Precipitation time series in B2 and P2 are equal due to their short distance!)

Hydrological models are solvers of the differantial equations of water flows and water thermodynamics in the Earth associated to heat transfers between Earth and the low atmosphere. They are a simplification of a real-world system useful to understand, predict, manage water resources. "integrated"

Conclusion

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- getting your data in the right shape (e.g. `tidyverse`, `recipes`)
- getting your data in the right shape (e.g. `tidyverse`, `recipes`)
- lorem ipsum

Interested?

www.geotop.org

Thank you for your attention! / Merci pour votre attention!

Addendum

LOREM IPSUM