

Priority Task - TERRA Stand Alone (TSA)

A photograph of a layered rock formation, likely a cliff face, with a road at the bottom. The rock shows distinct horizontal strata in shades of brown and tan. A small white marker is visible on the road edge.

**COSMO General Meeting
WG3b Parallel Session
September 2016**

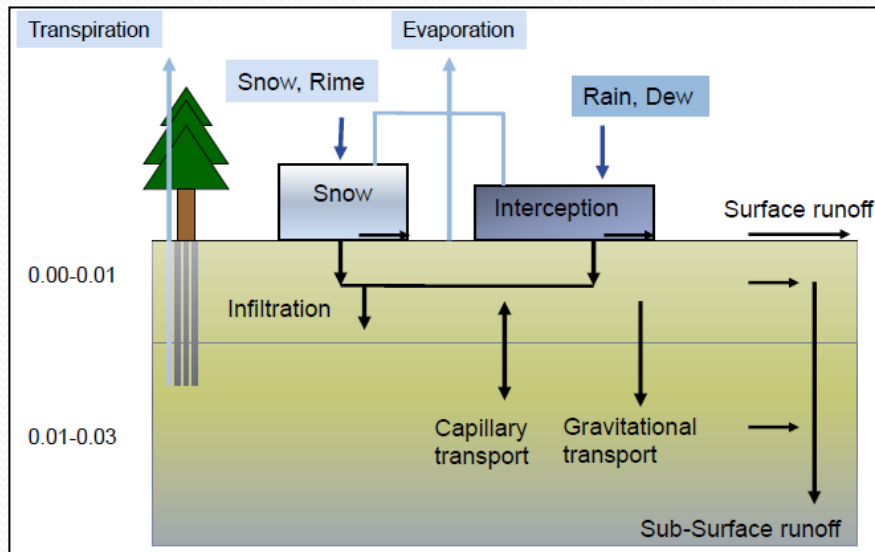
Yiftach Ziv – IMS

J.M. Bettems – Meteoswiss, WG3b; P. Khain – IMS; IMS R&D Dept.

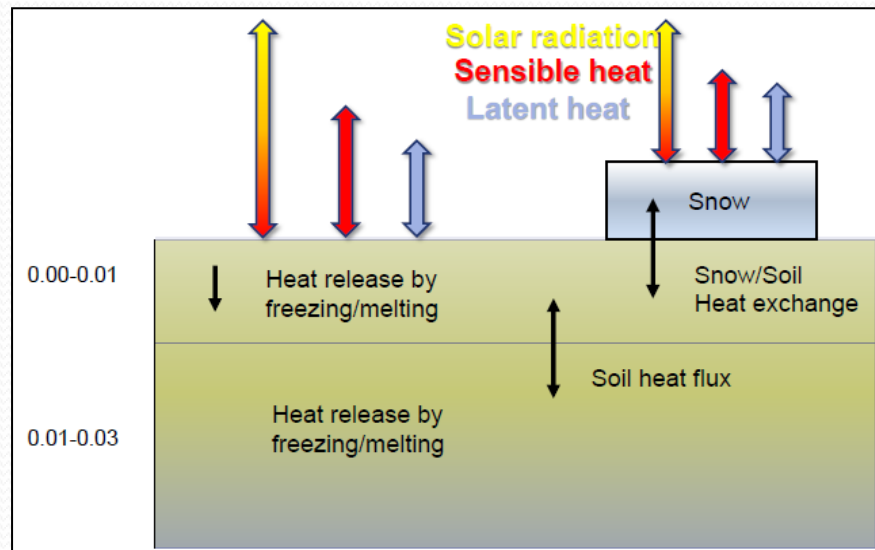
TERRA Stand Alone (TSA) – what is it?

- Decoupled version of the soil module of COSMO (TERRA)
- 1 dimensional
- Up to 7 soil layers, max depth: Temp – 21m; WC – 2.5m
- Depicts heat and moisture transfer in the soil and surface
- Utilizations:
 - Soil parameterizations
 - Efficient soil spin-up for various purposes
 - Efficient examination of soil related model issues

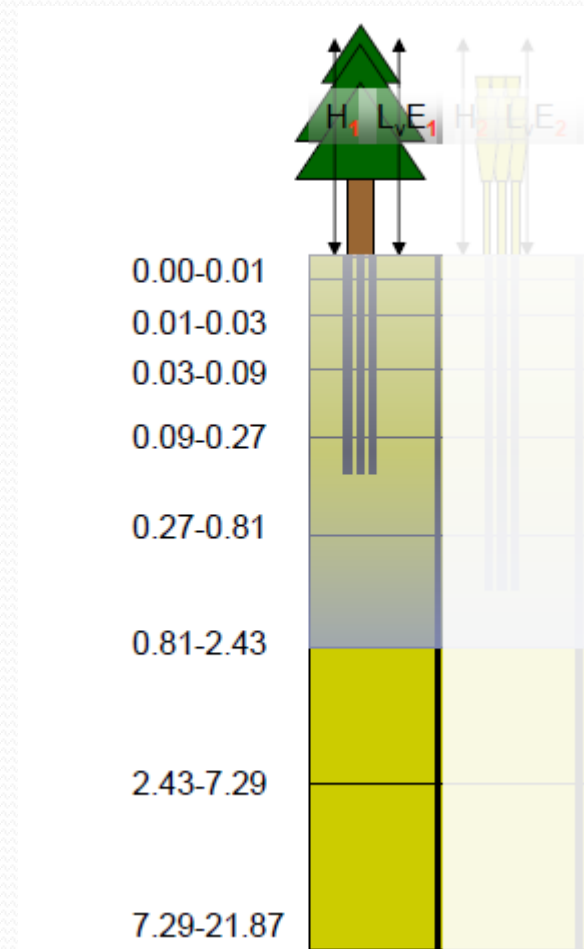
TERRA Stand Alone (TSA) – what is it?



Water Budget



Energy Budget



Priority Task - TERRA Stand Alone (TSA)

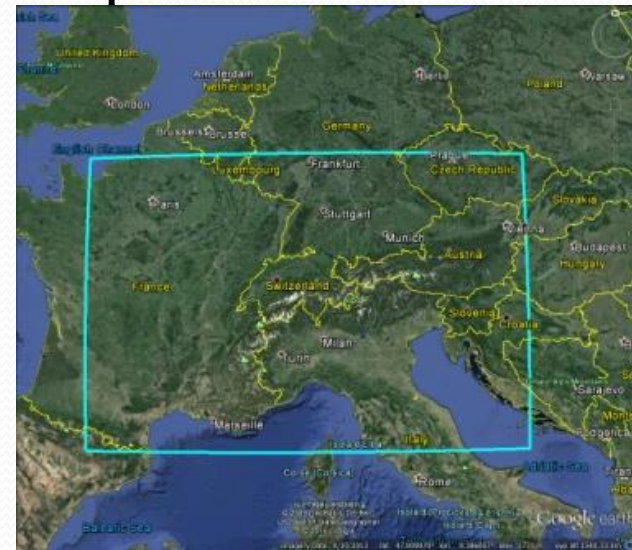
- Subtask 1
bring TSA code up to date with latest COSMO version (v5.3)
in compliance with coding standards
 - Subtask 2
Review and possible revision of TSA transfer scheme (Louis)
 - Subtask 3
Estimating Spin-Up Time of TSA
 - Subtask 4
Verification of TSA and COSMO-TERRA Vs. observations
-
- Total: 0.45 FTEs

Subtask 1 – Revision of TSA Code:

- TSA created by Felix Ament in 2003
- Last revised by Guy de Morsier in 2010 – COSMO v4.13
- Compliancy with coding standards:
 - Loops, gotos, documentation, declarations, redundant variables/modules
- Update to latest version COSMO v5.3:
 - No Blocking Structure in TERRA yet
 - Impossible to use tracers (qv)
 - Additional unique features of TSA – parameterizations, schemes, variables
 - Use of transfer coefficients and not fluxes (Louis scheme)
- External parallelization
- Available package

Subtask 3 - Estimating Spin-Up Time of TSA:

- MeteoSwiss operational domain, 2.2 km resolution
- 1 – 6 years runs all ending 01/01/2015 00z. Initialized from COSMO
- Additional 5 years run with “homogenous” soil
- COSMO analysis data as meteorological forcing
- Setting longest run available (5 years) as benchmark
- Calculating differences between various spin-up times and benchmark for each gp for each depth:
 - Temperature – regular difference [K]
 - WC – relative diff. from benchmark [%]
- Plotting PDFs of differences

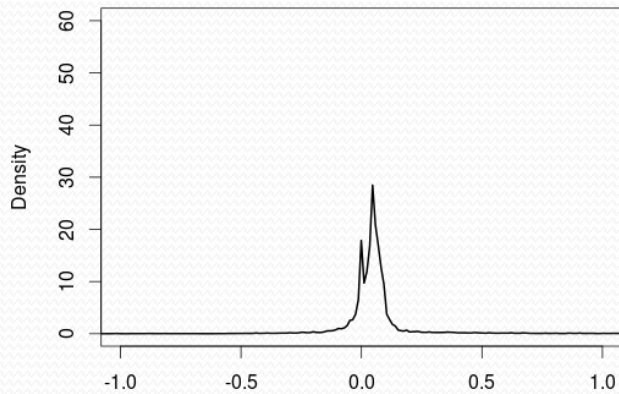


Subtask 3 - Estimating Spin-Up Time of TSA:

PDFs of Temp Difference from 5 years run

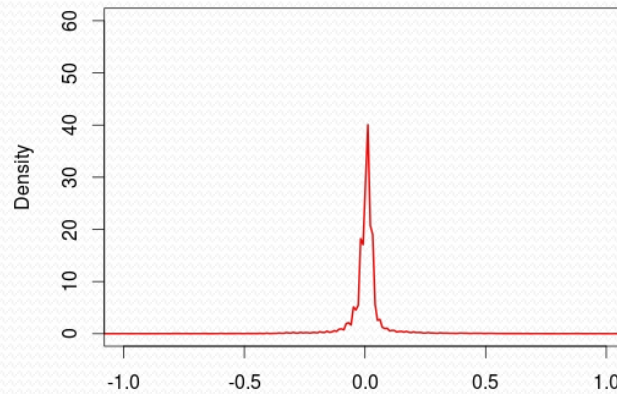
Showing results for soil type = Sandy-Loam, Depth = 54 cm

Y1



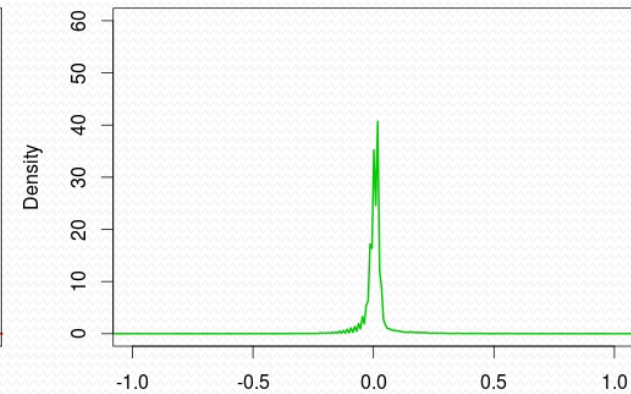
N = 21682 Bandwidth = 0.002

Y2



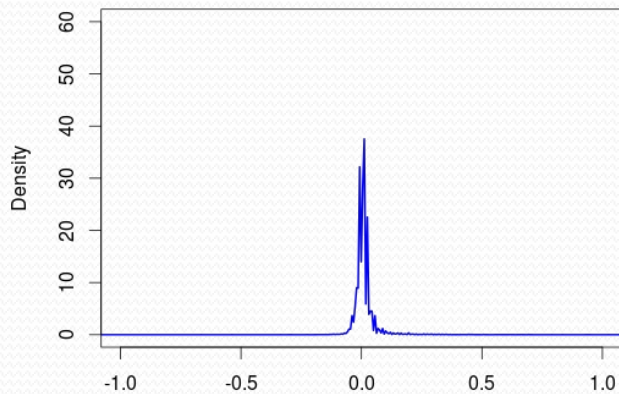
N = 21682 Bandwidth = 0.002

Y3



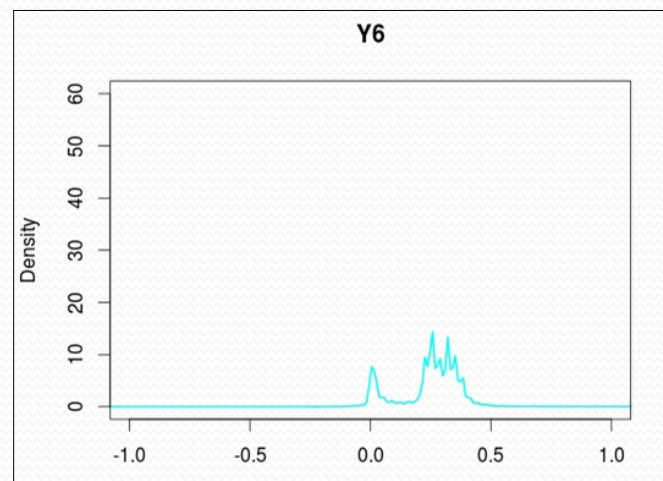
N = 21682 Bandwidth = 0.002

Y4

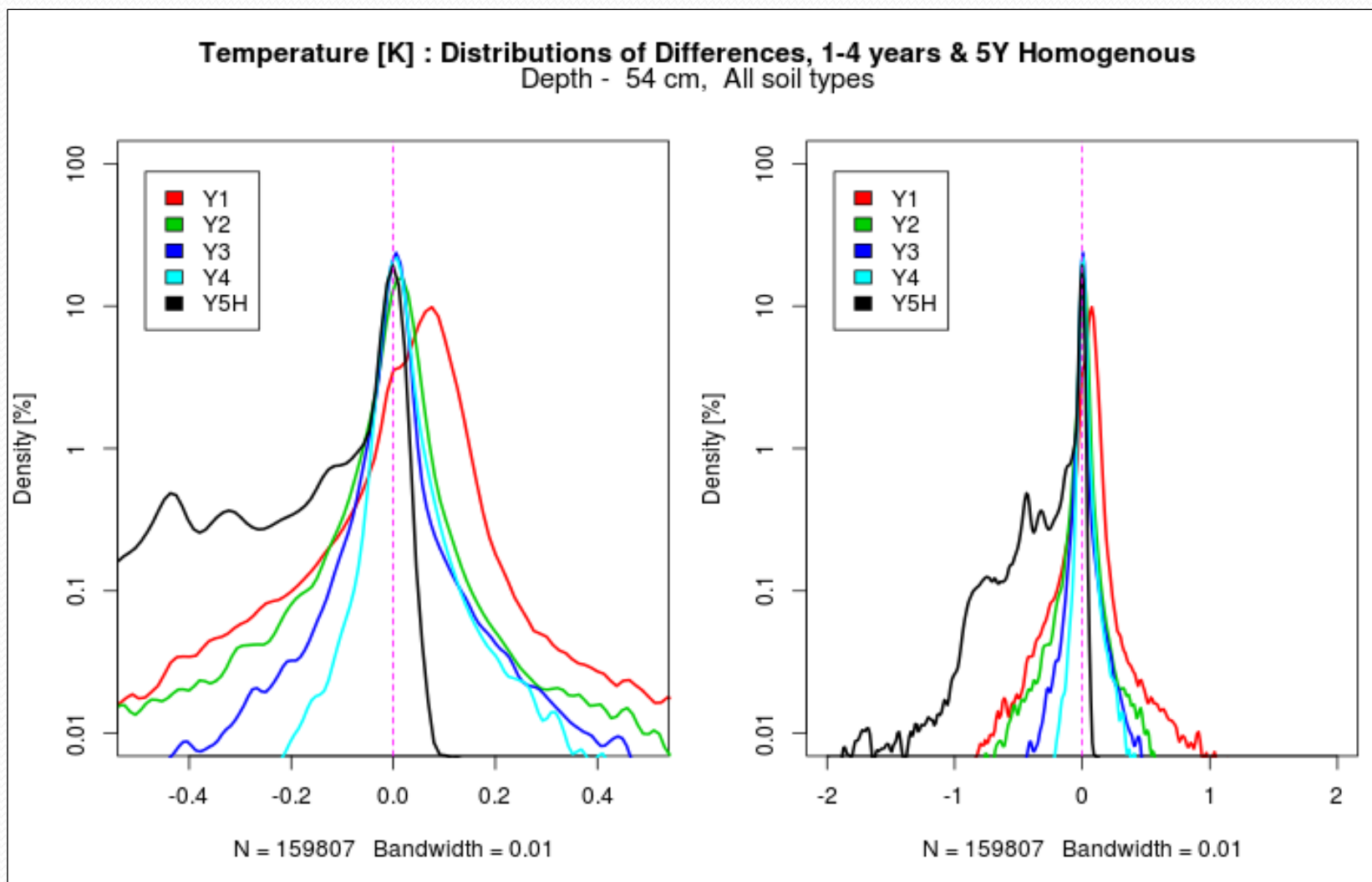


N = 21682 Bandwidth = 0.002

Y6

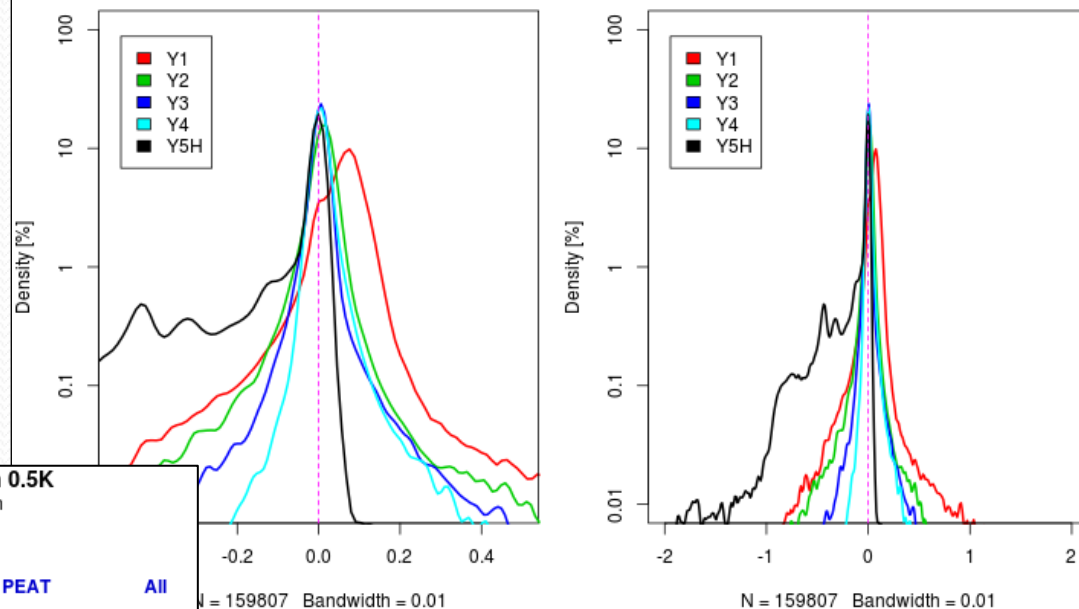


Subtask 3 – Estimating Spin-Up Time of TSA:

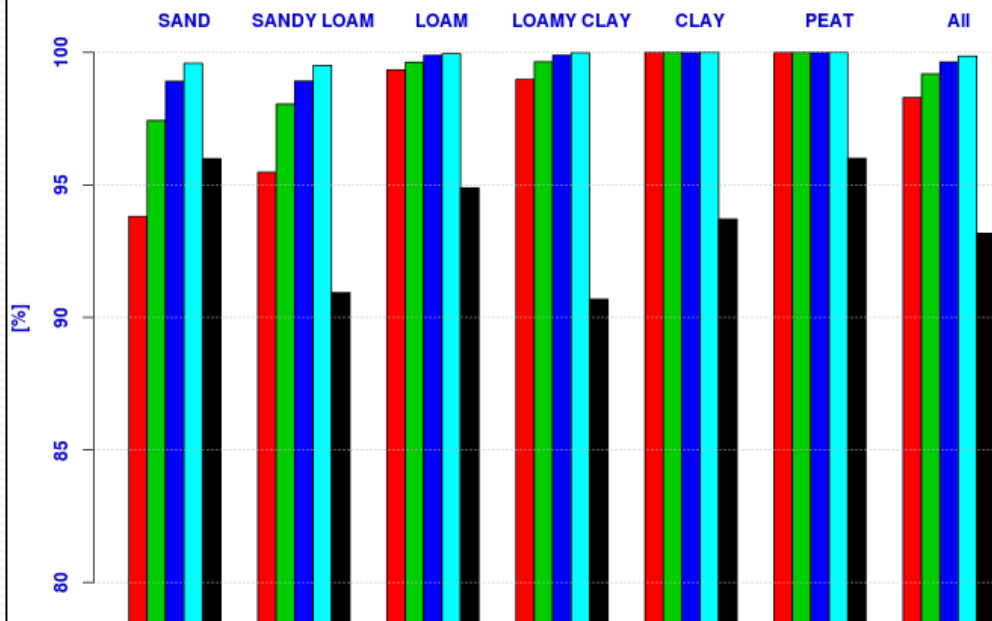


Subtask 3 – Estimating Spin-Up Time of TSA:

Temperature [K] : Distributions of Differences, 1-4 years & 5Y Homogenous
Depth - 54 cm, All soil types



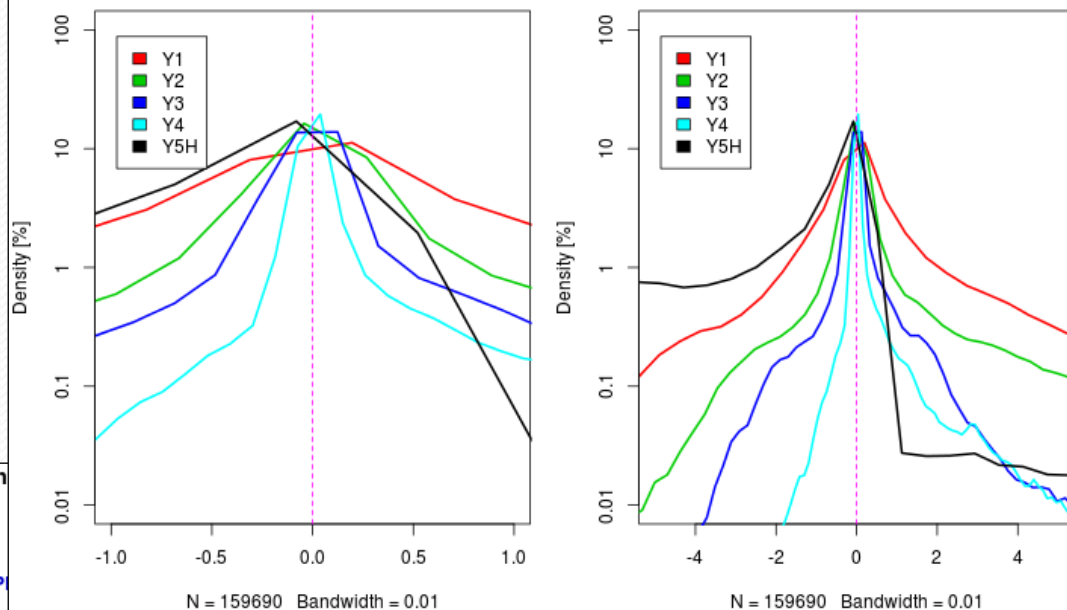
Percentage of Temperature Differences Smaller Than 0.5K
1-4 Years & 5Y-no-init (black) Runs Compared to 5 Years Run
Depth - 54cm



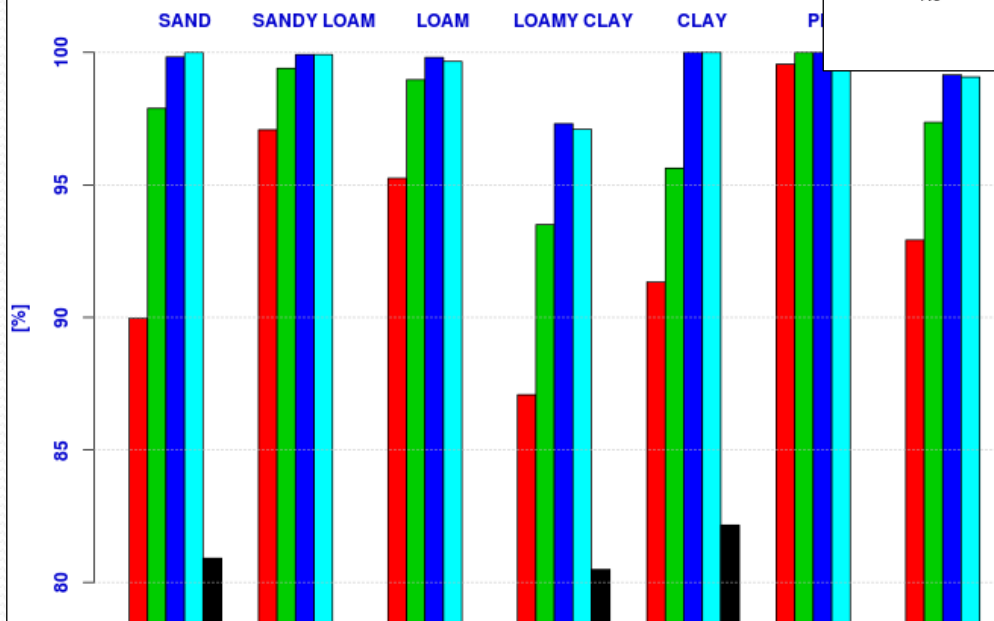
Both panels show distribution of differences between benchmark 5 years run and other runs: 1 to 4 years runs (Y1-Y4) and 5 years homogenous run (Y5H). Top panel show PDFs (logarithmic) of differences for entire domain – right insert shows differences from -2K to +2K while left insert from -0.5K to +0.5K. Right panel shows which percentage of the differences is smaller than $\pm 0.5K$ for each soil type.

Subtask 3 – Estimating Spin-Up Time of TSA:

Relative Water Content [%] : Distributions of Differences, 1-4 years & 5Y Homogenous
Depth - 54 cm, All soil types



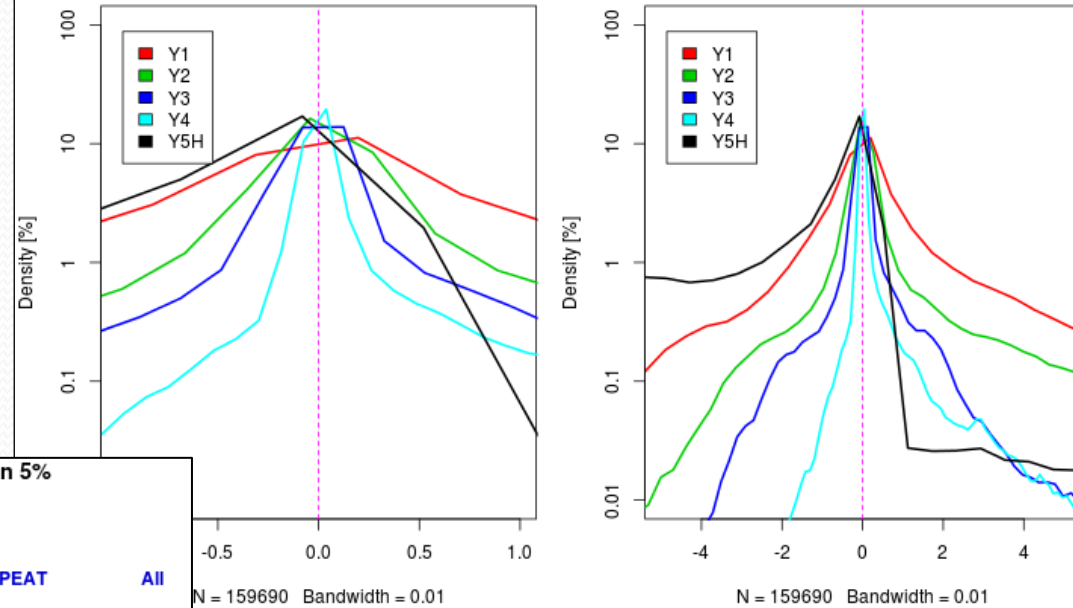
Percentage of Water Content Differences Smaller Than
1-4 Years & 5Y-no-init (black) Runs Compared to 5 Years Run
Depth - 54cm



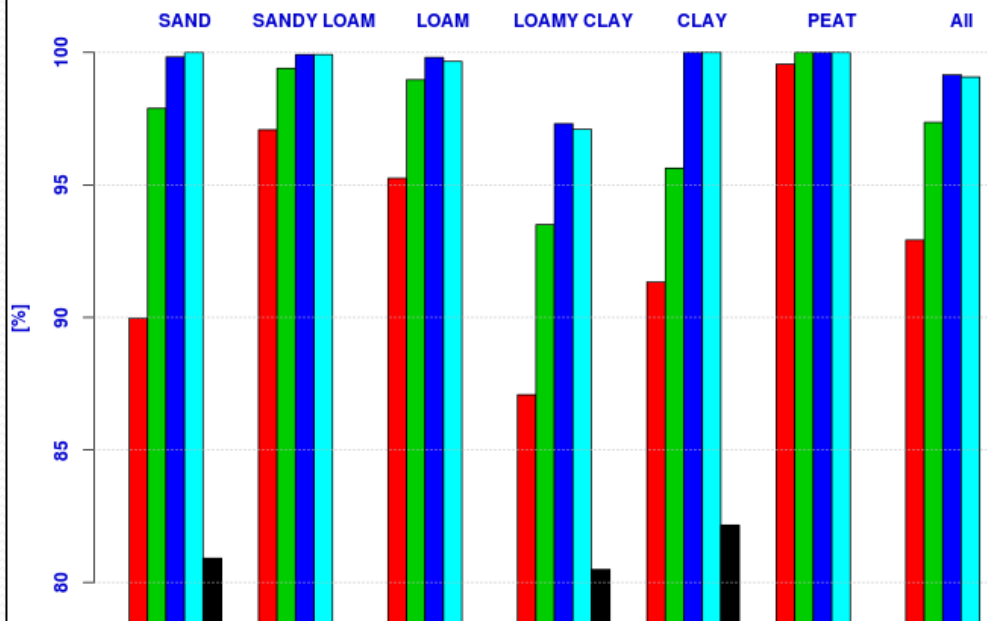
Both panels show distribution of differences between benchmark 5 years run and other runs: 1 to 4 years runs (Y1-Y4) and 5 years homogenous run (Y5H). Top panel show PDFs (logarithmic) of differences for entire domain – right figure shows differences from -5% to +5% while left figure between -1% and +1%. Bottom panel shows which percentage of the differences is smaller than $\pm 5\%$ for each soil type

Subtask 3 – Estimating Spin-Up Time of TSA:

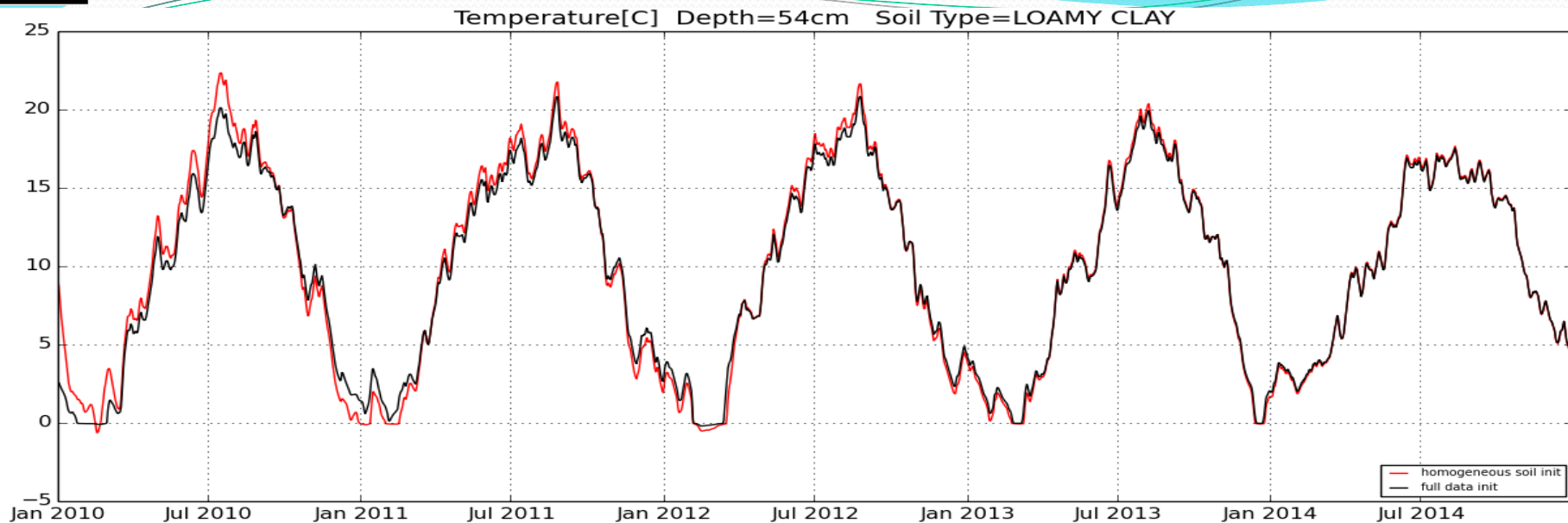
Relative Water Content [%] : Distributions of Differences, 1-4 years & 5Y Homogenous
Depth - 54 cm, All soil types



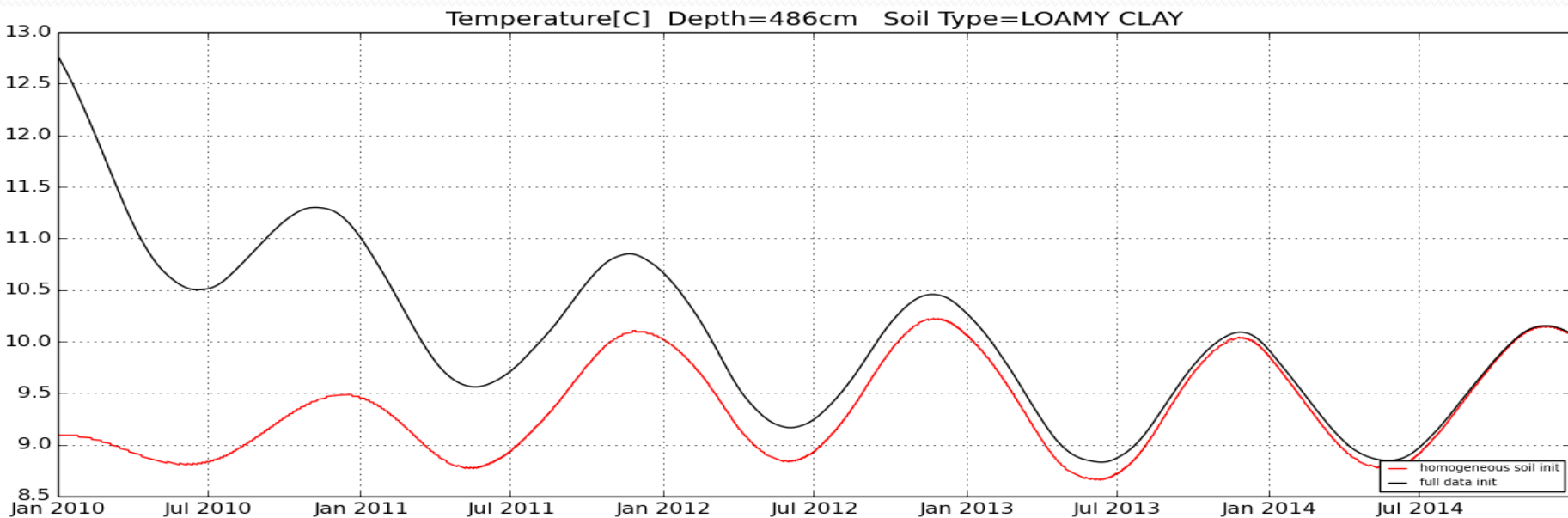
Percentage of Water Content Differences Smaller Than 5%
1-4 Years & 5Y-no-init (black) Runs Compared to 5 Years Run
Depth - 54cm

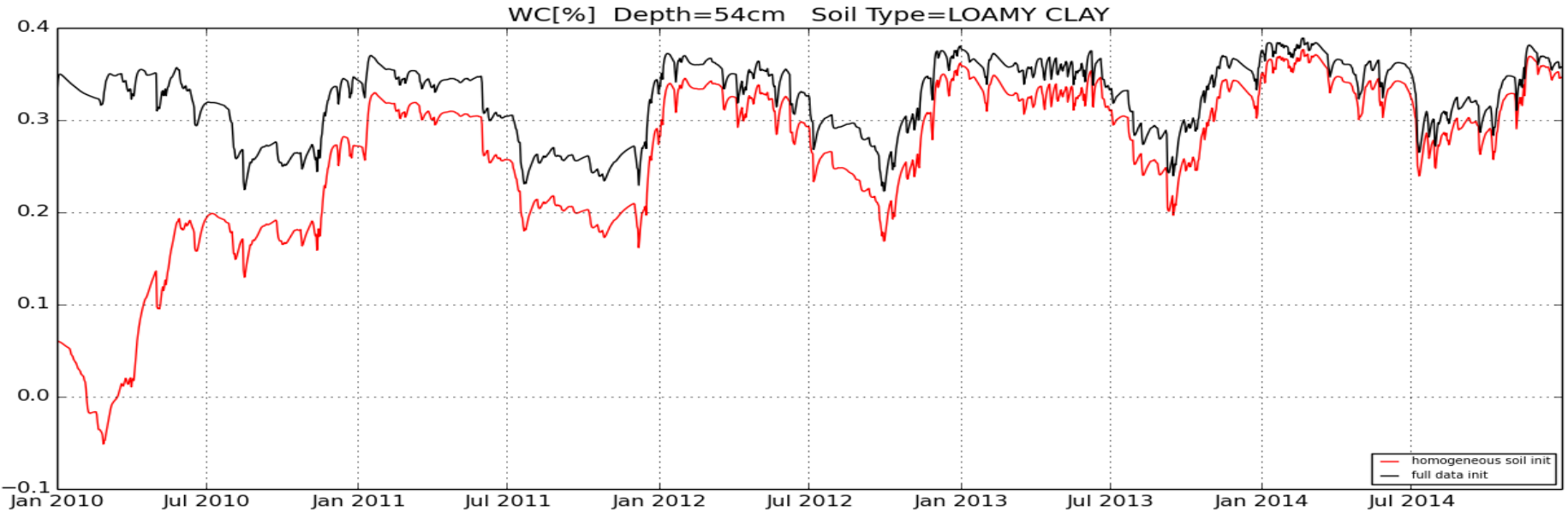


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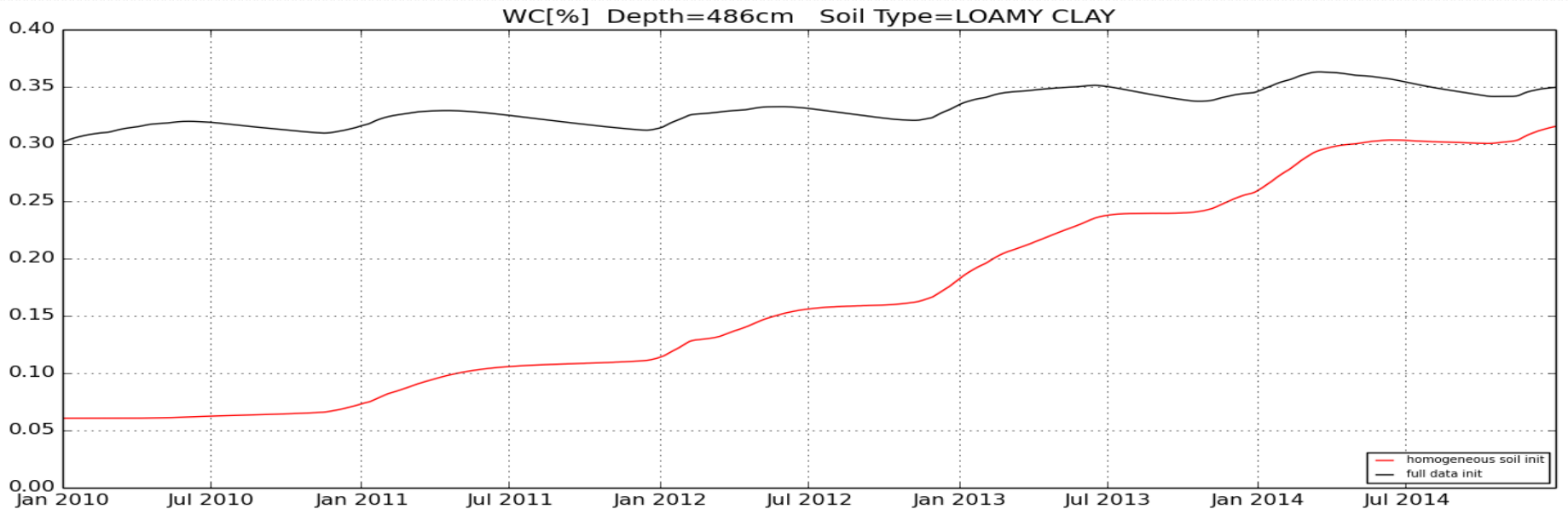


Temperature[°C], ooZ. Full initialization — Homogenous soil —





Volumetric Water Content, ooZ. Full initialization — Homogenous soil —



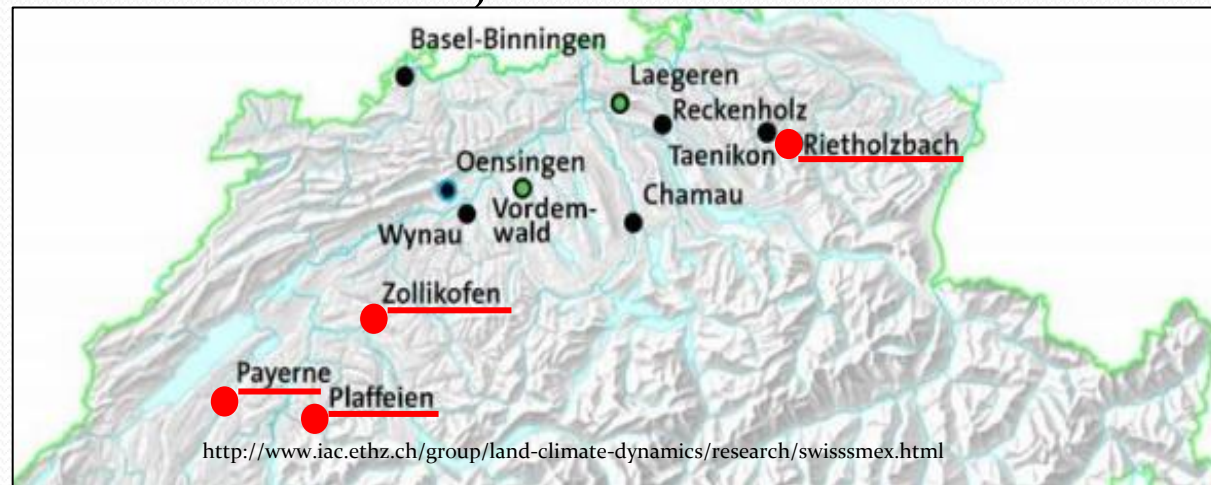
Subtask 4 - Verification of TSA Vs. observations:

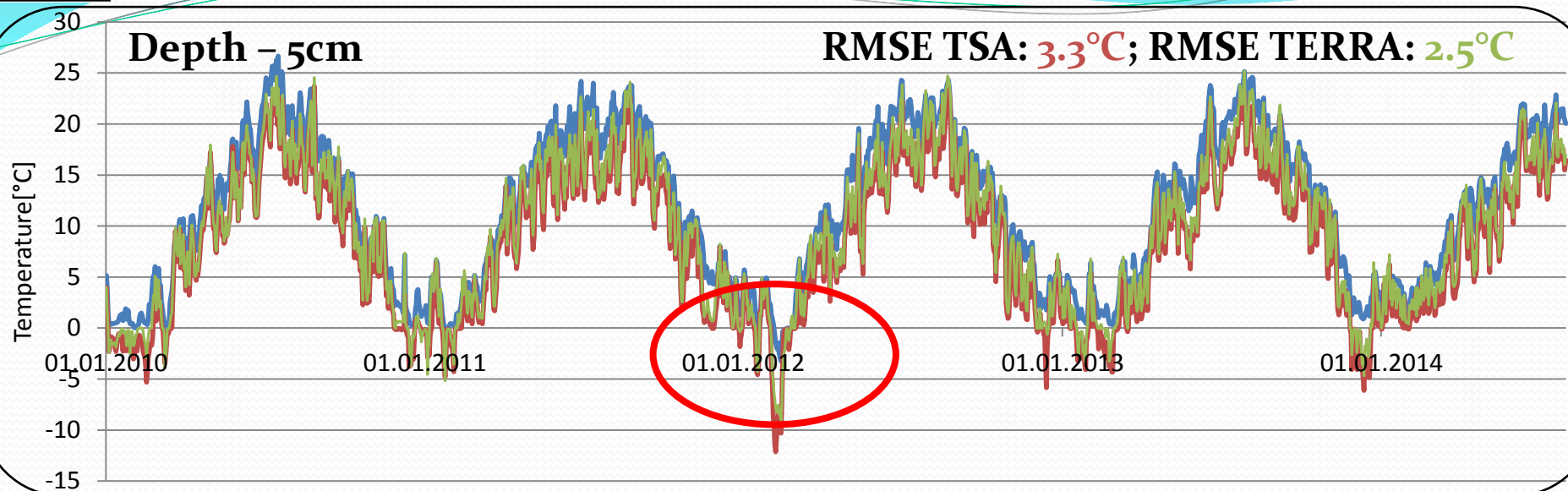
- 4 measuring stations of the SwissSMEX project (ETHZ):

- Payerne, Plaffeine, Rietholzbach, Zollikofen
- Depths [cm]: 5, 10, 30, 50, 80, 120

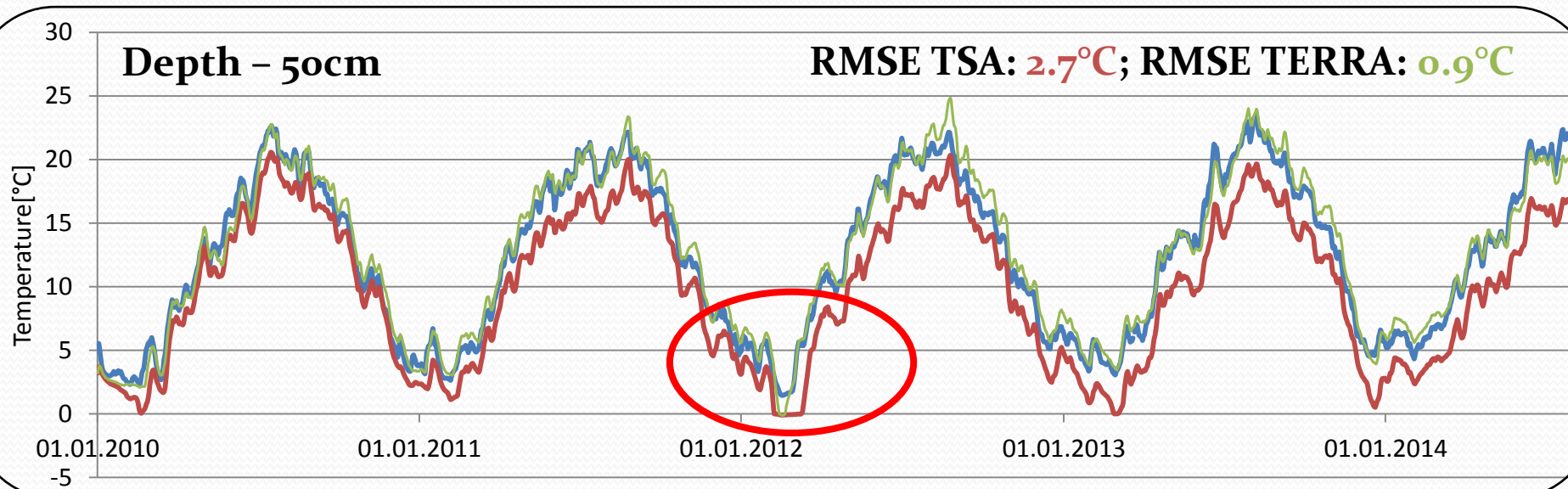


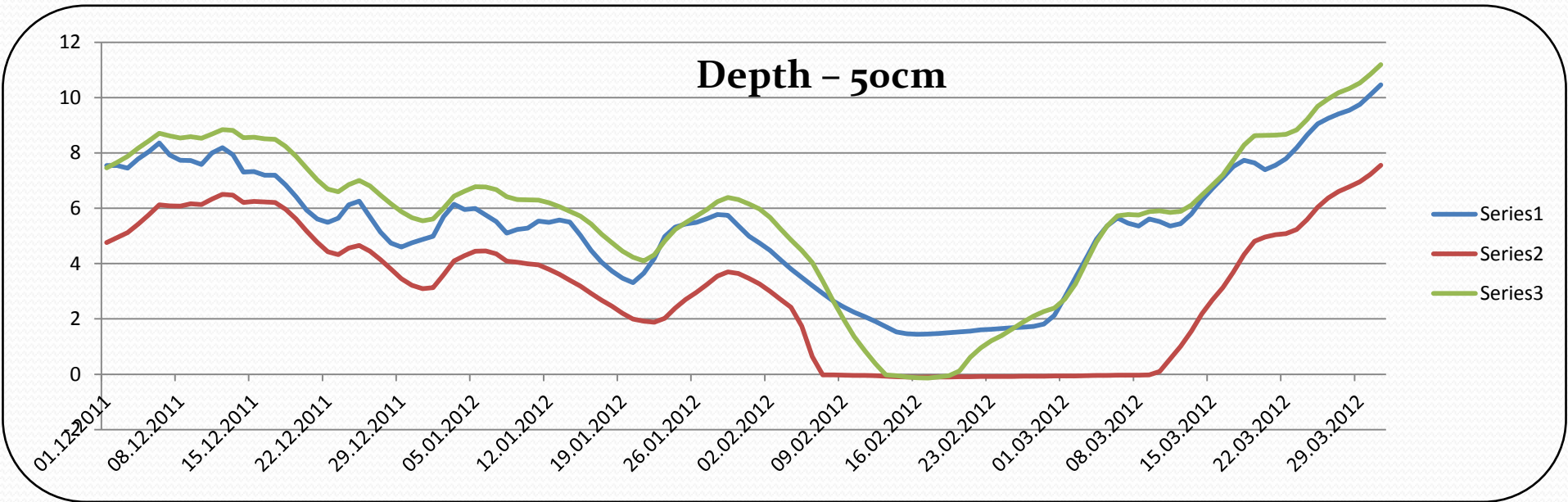
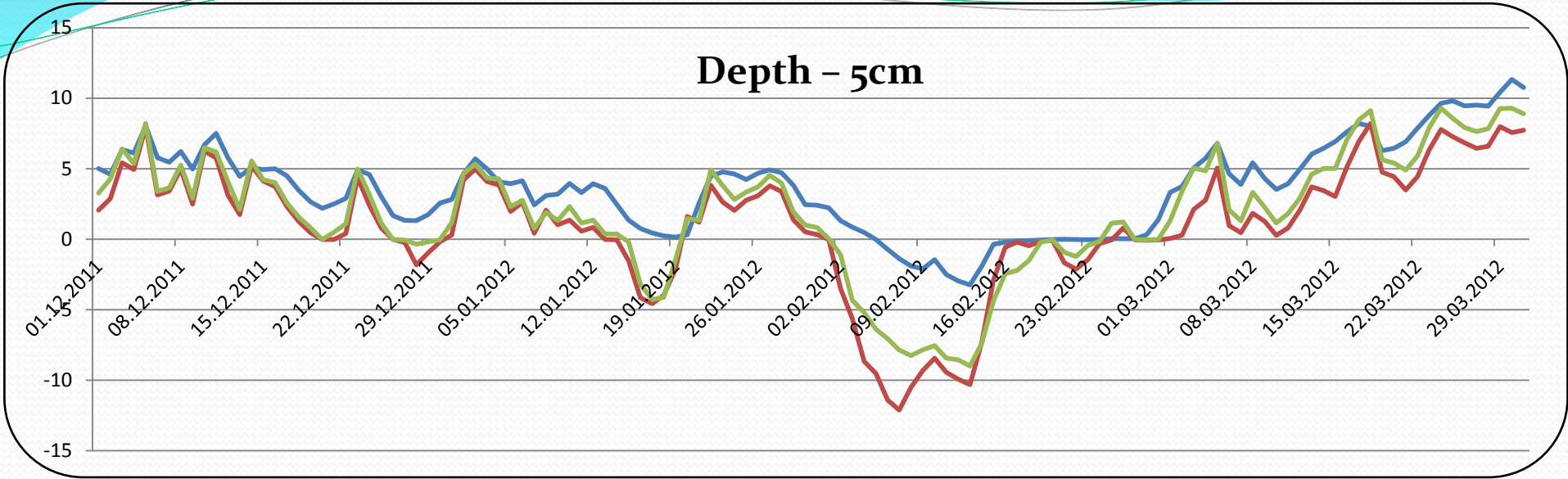
- Model middle-layers at [cm]: 1, 2, 6, 18, 54, 162, 458, 1458
- 4½ years comparison of Obs., TSA 2.2km, COSMO-TERRA 2.2km
- 2 grid points for each station – nearest, nearest with same soil type

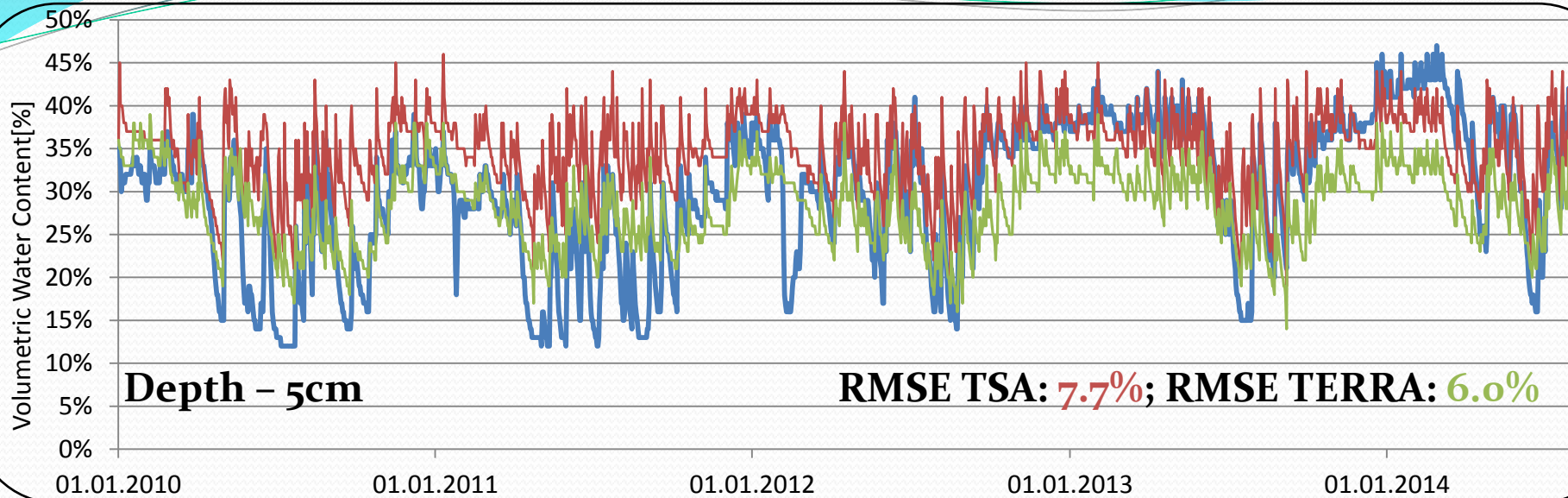




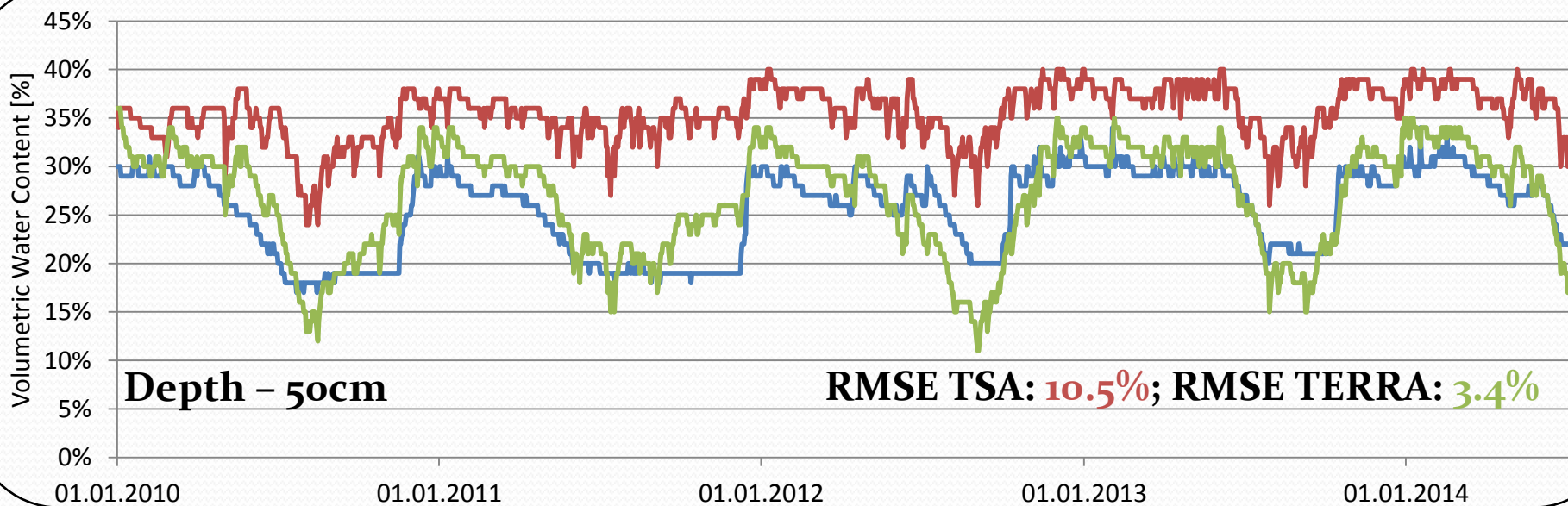
Temperature[°C], Payerne, ooZ. Observations — TSA — and TERRA — .



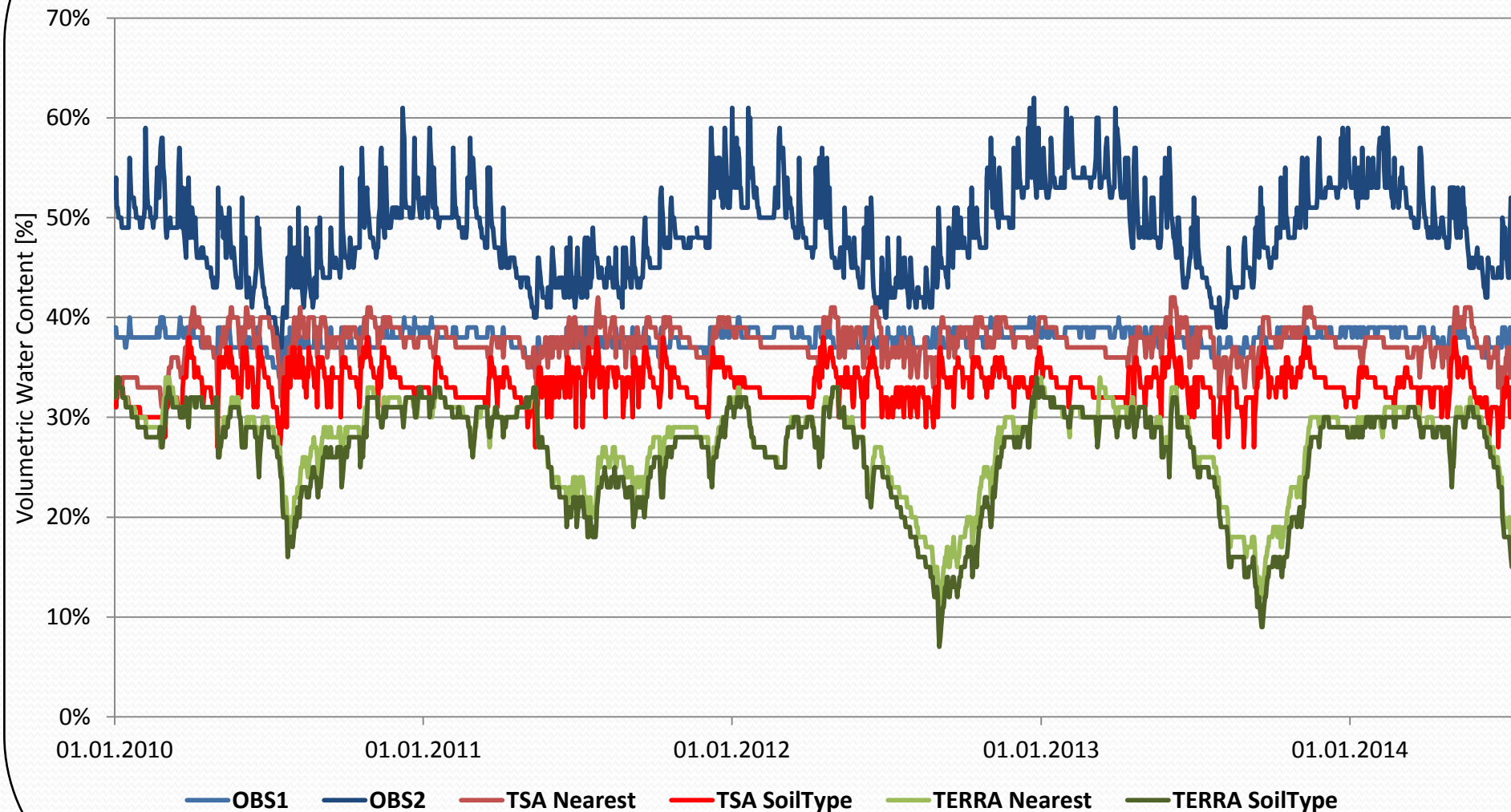




Temperature [°C], Payerne, ooZ. Observations — TSA — and TERRA — .



Volumetric Water Content [%], Rietholzbach, ooZ, 54cm



CONCLUSIONS

- TSA up to date with COSMO v5.3
- TSA adheres to coding standards
- Spin-up:
 - With soil initialized properly, spin-up time can be shortened to 3-5 years.
 - Otherwise, probably more than 7 years spin-up is needed.
 - As the soil type gets "lighter" (sand compared to clay & peat), and as depth get larger – larger differences occur more frequently.

CONCLUSIONS (continued)

- Verification:
 - In most cases, TSA and especially COSMO TERRA show reasonable agreement with soil measurements
 - Temperature predictability is better than Water Content predictability
 - High conformity between TERRA and TSA, but TERRA is always better than TSA
 - TERRA “over reacts” to weather, resulting in upper soil to be warmer at noon and colder at night.
 - Difference between nearest gp & soil-type gp are usually not significant

- Future tasks:
 - New TERRA module – tests will be conducted under PT TERRA Nova
 - (Developing stand-alone version for ICON TERRA.)

Thank You

Yiftach Ziv, IMS