

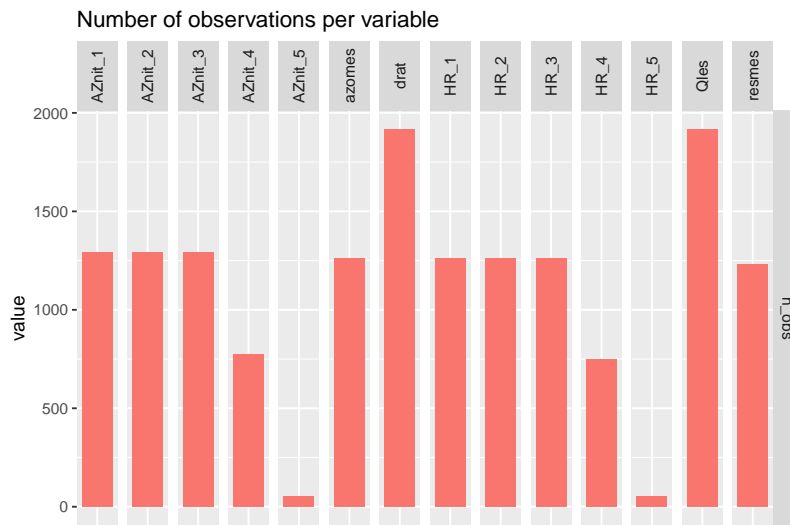
Stics Performance Evaluation Report : BareSoil

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STICS version: V10.0.0

IdeSTICS version: r1931

Number of USMs: 566



For that evaluation, we have chosen to keep the 131 usms that have been recently used to calibrate one parameter of the mineralization process (gmin1, see Clivot et al., 2017). Removing these usms would have considerably reduced the range of the explored situations while this parameter only affects the mineralization process. Performances of soil nitrogen variables simulations obtained with and without these usms will however be discussed.

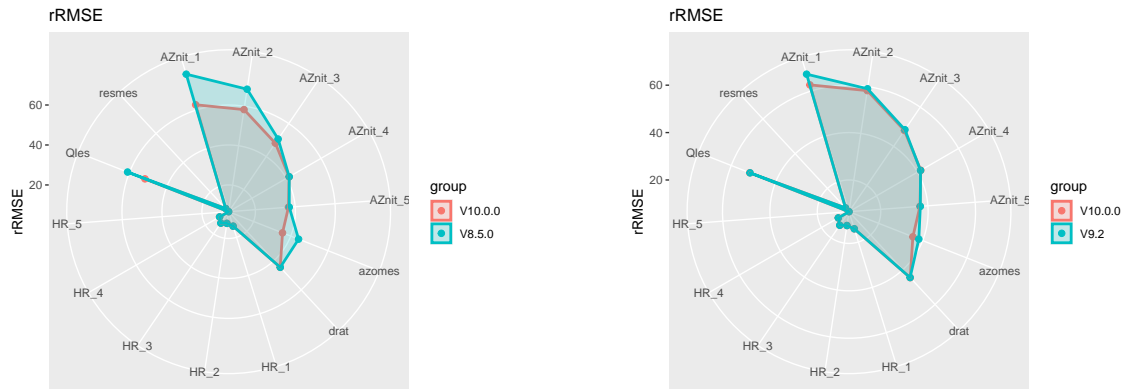
All the usms were simulated independently. In almost all these usms, specific options such as nitrification, denitrification, macroporosity, shrinkage, capillary rise, draining were not used. Activating nitrification and denitrification will probably become the default in future version, to better allow for N₂O emission simulation, and results will then be proposed with these options activated. Preliminary tests already indicate that it does not result in big changes for most variables, although nitrate simulation is slightly improved. Other options should be used with care.

The range of key soil variables or parameters in the dataset used is quite large:

- 20 to 30 cm for the surface soil layer,
- 80 to 150 cm for soil depth,
- 0.07 to 0.42 for Norg,
- 0 to 85% for CaCO₃,

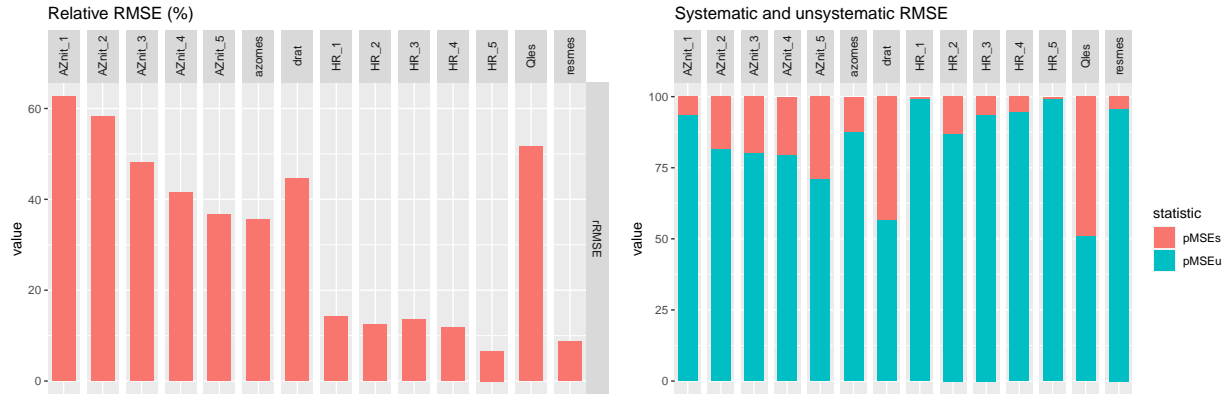
- 5.6 to 8.4 for pH,
- 1 to 1.69 for bulk density,
- 2.4 to 39.6 % for clay content,
- 0.15 to 0.31 for albedo,
- 3 to 11 mm for q_0 ,
- 12-36 % for hcc, 5-17 % for hpf.

Evolution of performances with respect to previous versions



rRMSE are slightly improved for near-surface soil nitrogen content aznit1 and for total soil nitrogen content azomes with respect to previous version V9.2, while they are very close for the other observed variables (figure on the right). Compared to results obtained with version 8.5.0 (figure on the left), rRMSE are largely improved for near-surface soil nitrogen content variables aznit1-2, for total soil nitrogen content azomes and for cumulative leached-nitrogen qles. This is mainly due to the improvement of the mineralization formalism implemented the version 9.0. Performances obtained for the other observed variables are similar for both versions.

Global analysis



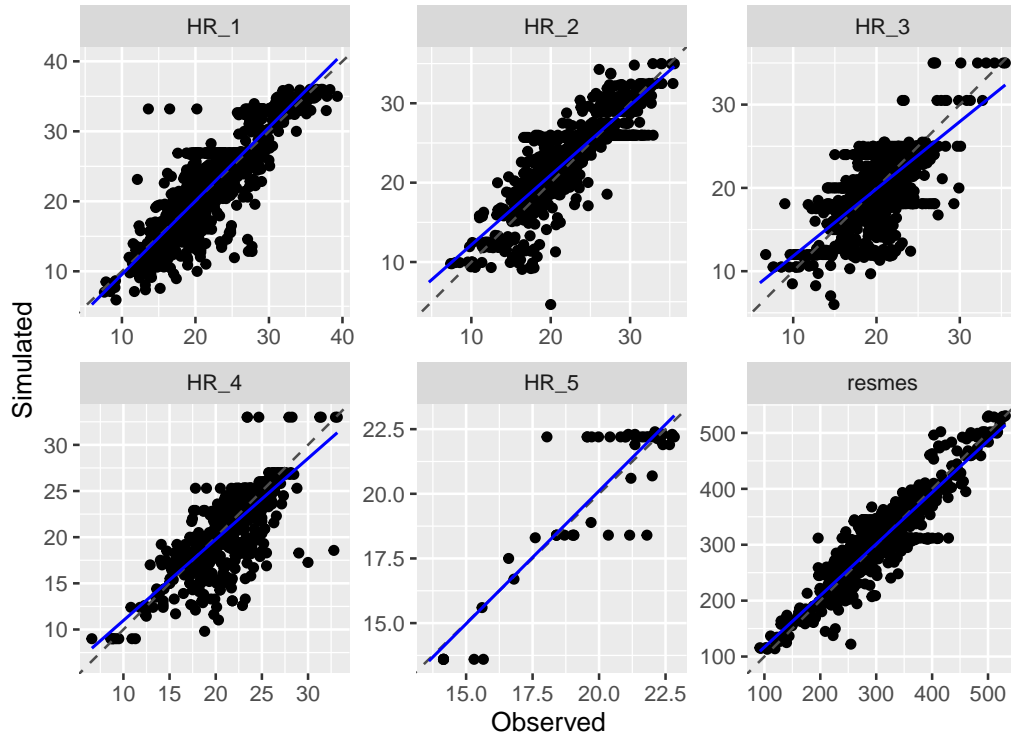
As generally expected, the model performs much better for predicting soil water content, both at soil layer scale (hr.x) and whole profile scale (resmes), than for predicting soil nitrogen content (aznit.x, azomes) and flux related variables (drat, qles). This is for part related to the higher difficulty of measuring nitrogen and fluxes variables, and also to the fact that these variables result from the interaction of numerous processes which are to be simulated accurately.

The systematic part of the error (pRMSEs) is globally much lower than the random part (pRMSEu), which indicates that bias is little present compared to dispersion error in the simulations of all variables except for qles and drat.

Soil Water Content (% ponderal; mm)

	HR_1	HR_2	HR_3	HR_4	HR_5	resmes
n_obs	1262.00	1262.00	1262.00	747.00	54.00	1230.00
mean_obs	22.47	21.29	20.25	21.36	19.92	296.02
mean_sim	22.65	22.09	20.09	20.95	20.03	297.60
CV_obs	24.18	21.17	17.33	16.98	12.88	22.45
CV_sim	28.82	21.17	19.31	19.21	14.74	22.29
RMSE	3.19	2.66	2.74	2.53	1.32	25.94
rRMSE	0.14	0.13	0.14	0.12	0.07	0.09
pMSEs	0.01	0.13	0.06	0.06	0.01	0.04
pMSEu	0.99	0.87	0.94	0.94	0.99	0.96
EF	0.66	0.65	0.39	0.51	0.73	0.85
Bias	0.18	0.80	-0.16	-0.41	0.11	1.58

- Efficiency values show slightly better performances for near surface layers (1 and 2) than for deep layers having similar number of observations (3 and 4). Their rRMSE are however quite similar.
- The presence of groups of distinct observed values with the same simulated value is related to the nature of the model: as soil water content cannot exceed field capacity, observations above field capacity are represented by the same constant value (equal to field capacity of the layer).
- Globally, simulated variability in soil water content is similar to observed variability.



Soil Mineral Nitrogen (kgN/Ha)

	AZnit_1	AZnit_2	AZnit_3	AZnit_4	AZnit_5	azomes
n_obs	1292.00	1292.00	1292.00	776.00	54.00	1260.00
mean_obs	32.70	25.19	21.52	19.44	19.81	89.53
mean_sim	35.89	25.75	19.96	18.78	17.12	91.12
CV_obs	85.16	72.82	77.25	71.71	70.99	59.07
CV_sim	85.83	69.47	77.12	66.97	74.64	56.22
RMSE	20.47	14.68	10.35	8.08	7.26	31.84
rRMSE	0.63	0.58	0.48	0.42	0.37	0.36
pMSEs	0.07	0.19	0.20	0.21	0.29	0.13
pMSEu	0.93	0.81	0.80	0.79	0.71	0.87
EF	0.46	0.36	0.61	0.66	0.73	0.64
Bias	3.19	0.57	-1.56	-0.65	-2.69	1.59

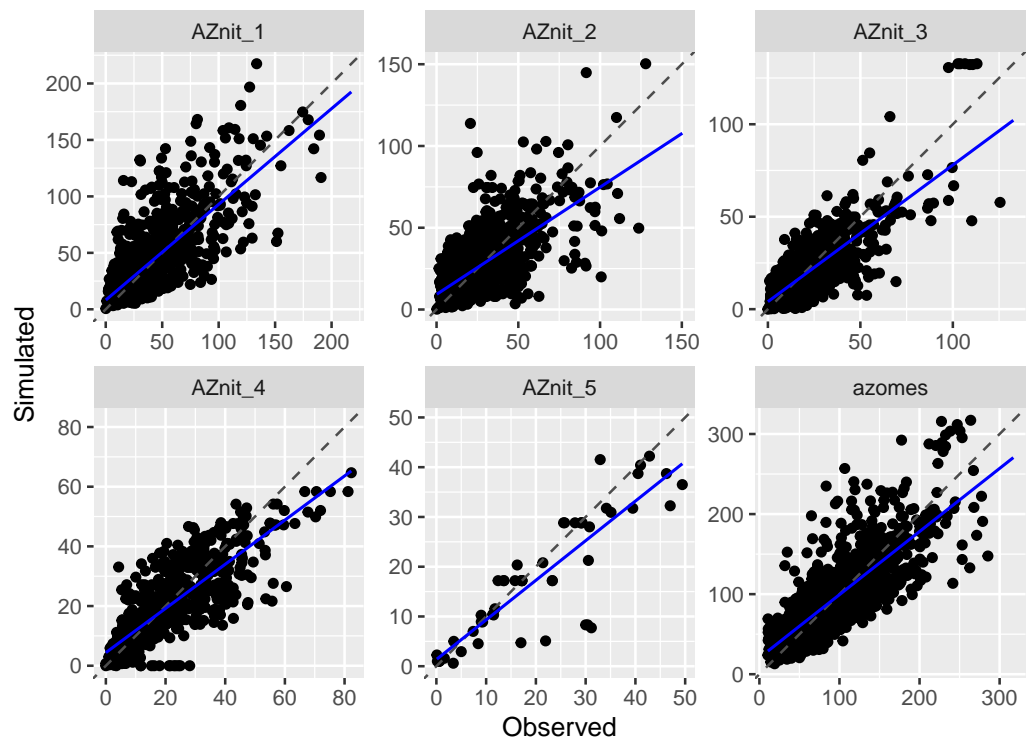
In addition to the general comments:

- Performances are better for deep layers than for near surface layers.
- Total variability of observed values is well simulated.
- Simulated values are globally underestimated, particularly for high values and deep layers (cf. relative errors and scatter plots).

Performances obtained when excluding the 131 usms used for gmin1 calibration are globally comparable to the ones obtained with the full dataset:

	AZnit_1	AZnit_2	AZnit_3	AZnit_4	AZnit_5	azomes
RMSE	15.10	14.23	7.95	4.52	2.07	22.80
rRMSE	0.71	0.81	0.64	0.52	0.37	0.43

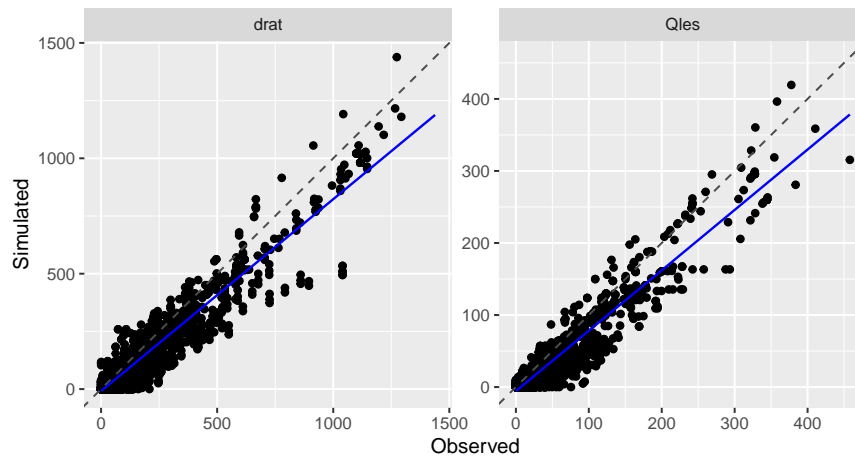
RMSEs are even lower but relative RMSEs are higher since the mean of measurements significantly decreased. These differences however reflect more the change in the structure and range of the dataset than a difference between calibration and evaluation performances. Indeed, the 131 usms used for mineralization calibration were specifically chosen on the basis of being longer than 100 days and having numerous measurements per variable (>8), and they include the large majority of observations.

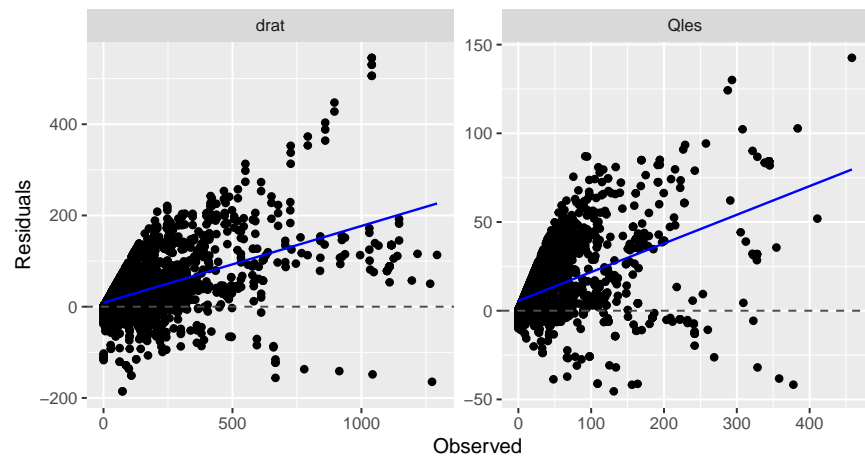


Drainage (mm/usm) and N Leaching (kgN/Ha/usm)

	Qles	drat
n_obs	1916.00	1916.00
mean_obs	47.25	189.25
mean_sim	34.00	148.65
CV_obs	141.95	120.04
CV_sim	173.07	134.07
RMSE	24.38	84.35
rRMSE	0.52	0.45
pMSEs	0.49	0.44
pMSEu	0.51	0.56
EF	0.87	0.86
Bias	-13.25	-40.60

- The systematic part of error is about half of RMSE. The global tendency is an underestimation of observed values, which seems consistent with the tendency to underestimate mineral nitrogen content.
- The total variability of observed values is correctly simulated although a bit overestimated for both variables.





Conclusion

When considering the whole dataset, the results are satisfactory both in term of performances and evolution compared to the previous STICS version. Next step will be to extend the analysis with activation of the nitrification and denitrification options which will be the default in the future.