Appendix A: SMAP products information and sampling scheme

Table A1
Types of information levels of the products generated by the SMAP mission

SMAP Data Product Levels	Description
Level 0	Level 0 data products contain unprocessed instrumental information
Level 1	Level 1 contains geolocated and calibrated brightness temperature information adjusted for local vegetation and topography conditions; additionally, it includes the covariates used to solve the tau-omega model (O'Neill et al., 2020).
Level 2	Level 2 data products contain soil moisture estimates based on the fusion of radiometer data for the ascending (6:00 p.m.) and descending (6:00 a.m.) orbits (Liu et al., 2020).
Level 3	Level 3 data products contain average soil moisture estimates based on radiometer data for both orbits, representing a daily average (Liu et al., 2020).
Level 4	Level 4 data products contain derived scientific products such as root zone soil moisture or soil carbon dioxide flux, which are currently under development and scientific validation.

Source: NASA (2014). SMAP Handbook Soil Moisture Active Passive. Jet Propulsion Laboratory California Institute of Technology.

Table A2
Proposed soil moisture monitoring scheme for the validation of the SMAP product.

Target universe ⋆	Surface horizon of the soil at the validation site (a pixel from the SMAP soil moisture product), from May 2021 to July 2022
Target variable	Volumetric soil moisture content ($cm^3\ cm^{-3}$) at a depth of five centimeters
Measurement frequency	Daily measurements
Physical measurement support	Measurement volume of the ThetaProbe ML3 capacitance sensor (60·30 mm diameter).
Measurement method	Electromagnetic measurement of soil moisture using the ThetaProbe ML3 capacitance sensor (Cooper, 2016; Gaskin & Miller, 1996).
Measurement time	Approximately at 7:00 in the morning.
Measurement point density	One sampling point per pixel of the SMAP product.
Data collection protocols	Geolocation of the sampling location with Garmin GPSMAP 66sr GPS (accuracy of 1.5 - 2 m), observation of precipitation conditions, and recording in a previously printed notebook.

⋆ Terminology based on de Gruijter et al. (2006).

Appendix B: Validation plots between SMAP soil moisture observation and predictions at 9 km of spatial resolution

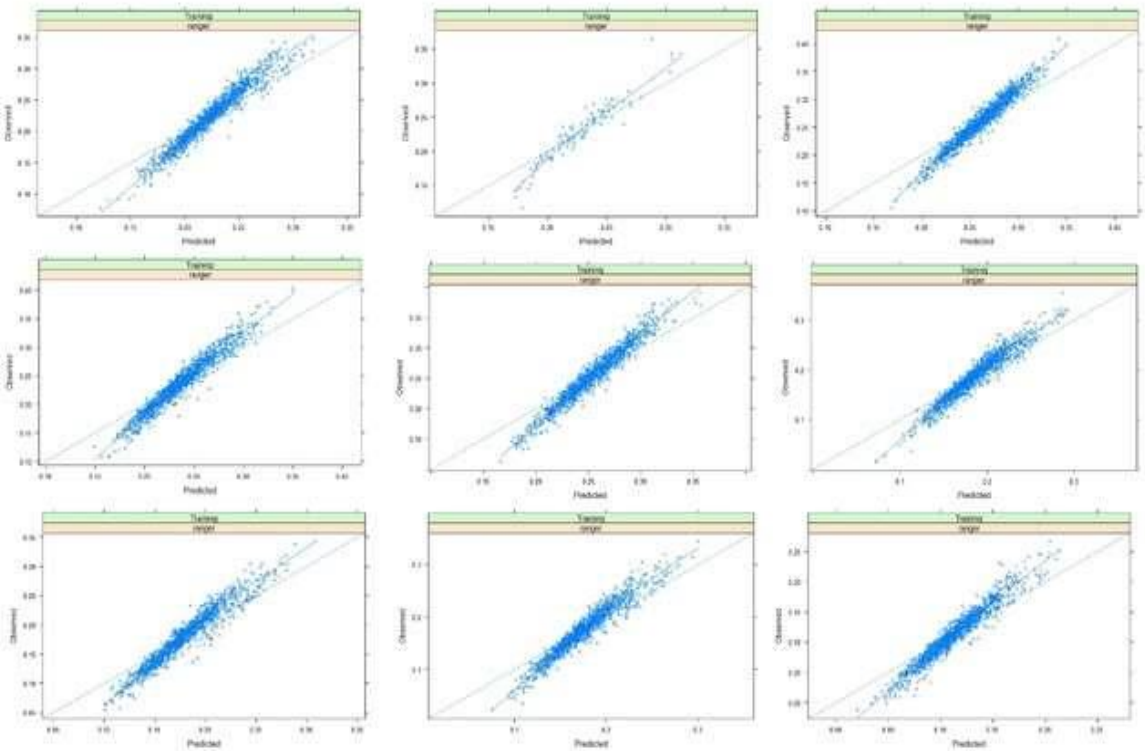


Figure B1. First nine validation plots between SMAP soil moisture observation and predictions at 9 km of spatial resolution. The comparison is made pixel wise using 10 fold cross validation. For the first 9 random forest models.

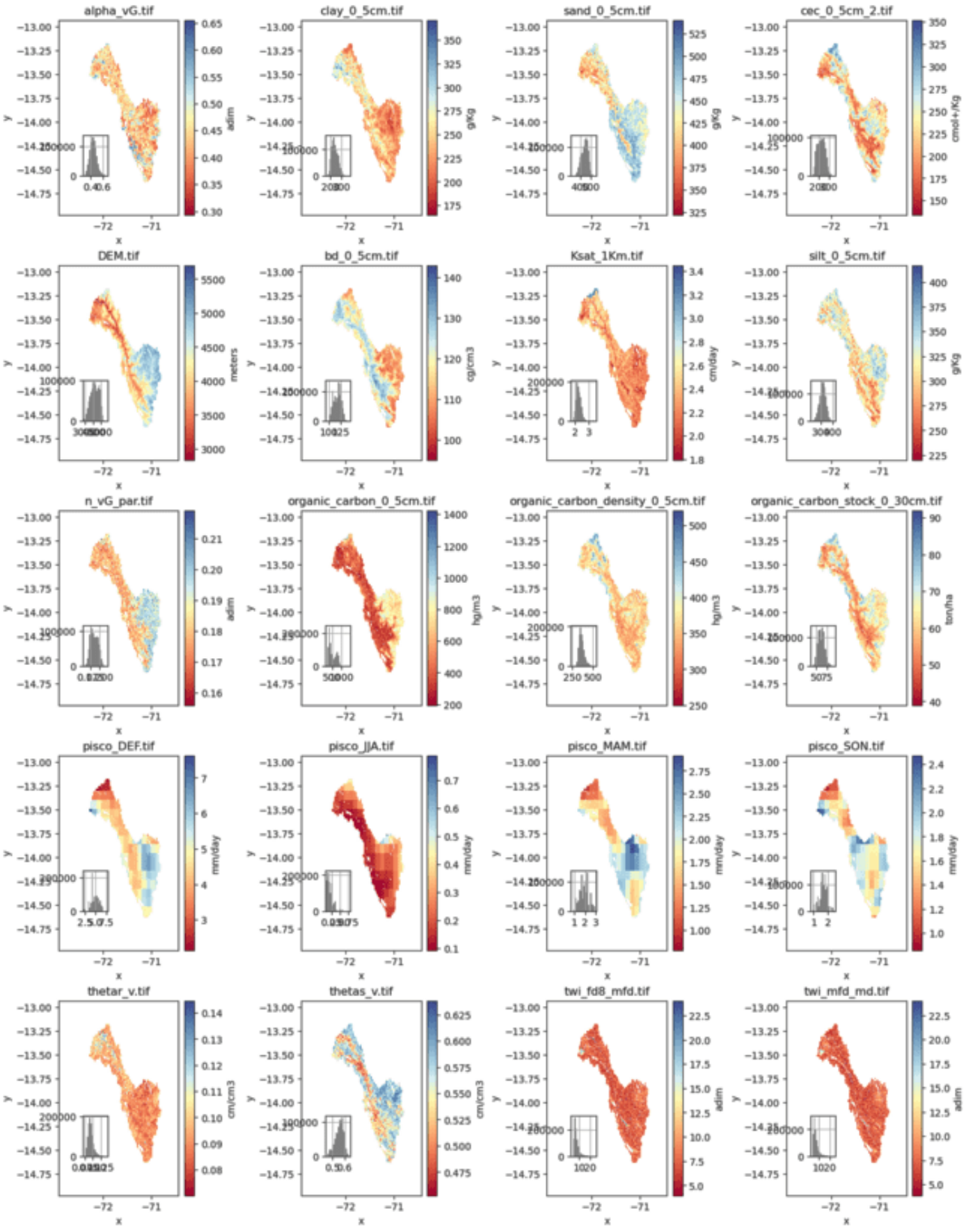
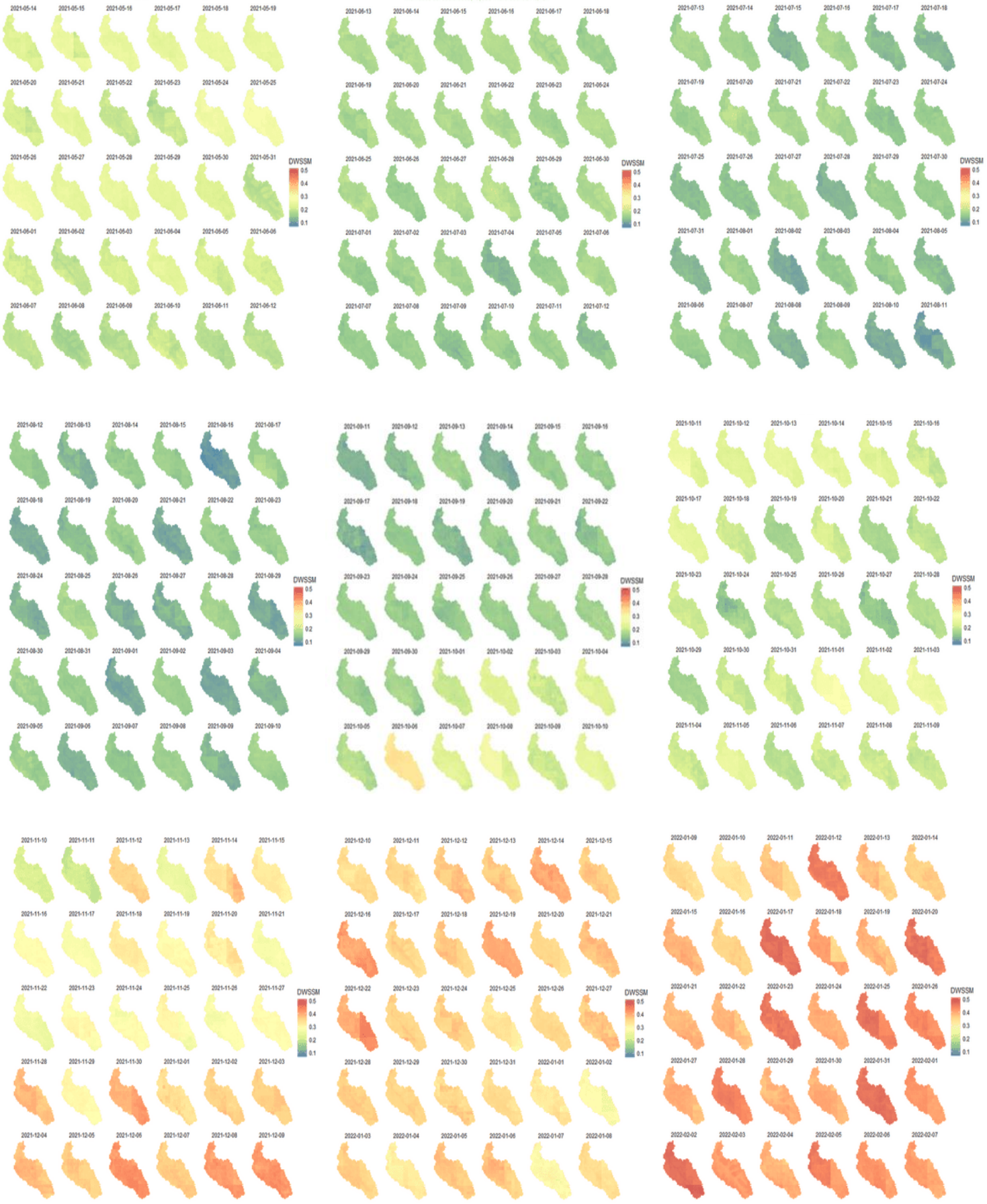


Figure S1. Maps of predictive covariates used for the downscaling approach. Inset shows the respective histogram for each covariate.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2021-05-20 2021-05-21 2021-05-22 2021-05-23 2021-05-24 2021-05-25
2021-05-26 2021-05-27 2021-05-28 2021-05-29 2021-05-30 2021-05-31
2021-06-01 2021-06-02 2021-06-03 2021-06-04 2021-06-05 2021-06-06
2021-06-07 2021-06-08 2021-06-09 2021-06-10 2021-06-11 2021-06-12
2021-06-13 2021-06-14 2021-06-15 2021-06-16 2021-06-17 2021-06-18
2021-06-19 2021-06-20 2021-06-21 2021-06-22 2021-06-23 2021-06-24
2021-06-25 2021-06-26 2021-06-27 2021-06-28 2021-06-29 2021-06-30
2021-07-01 2021-07-02 2021-07-03 2021-07-04 2021-07-05 2021-07-06
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0.3
0.2
0.1

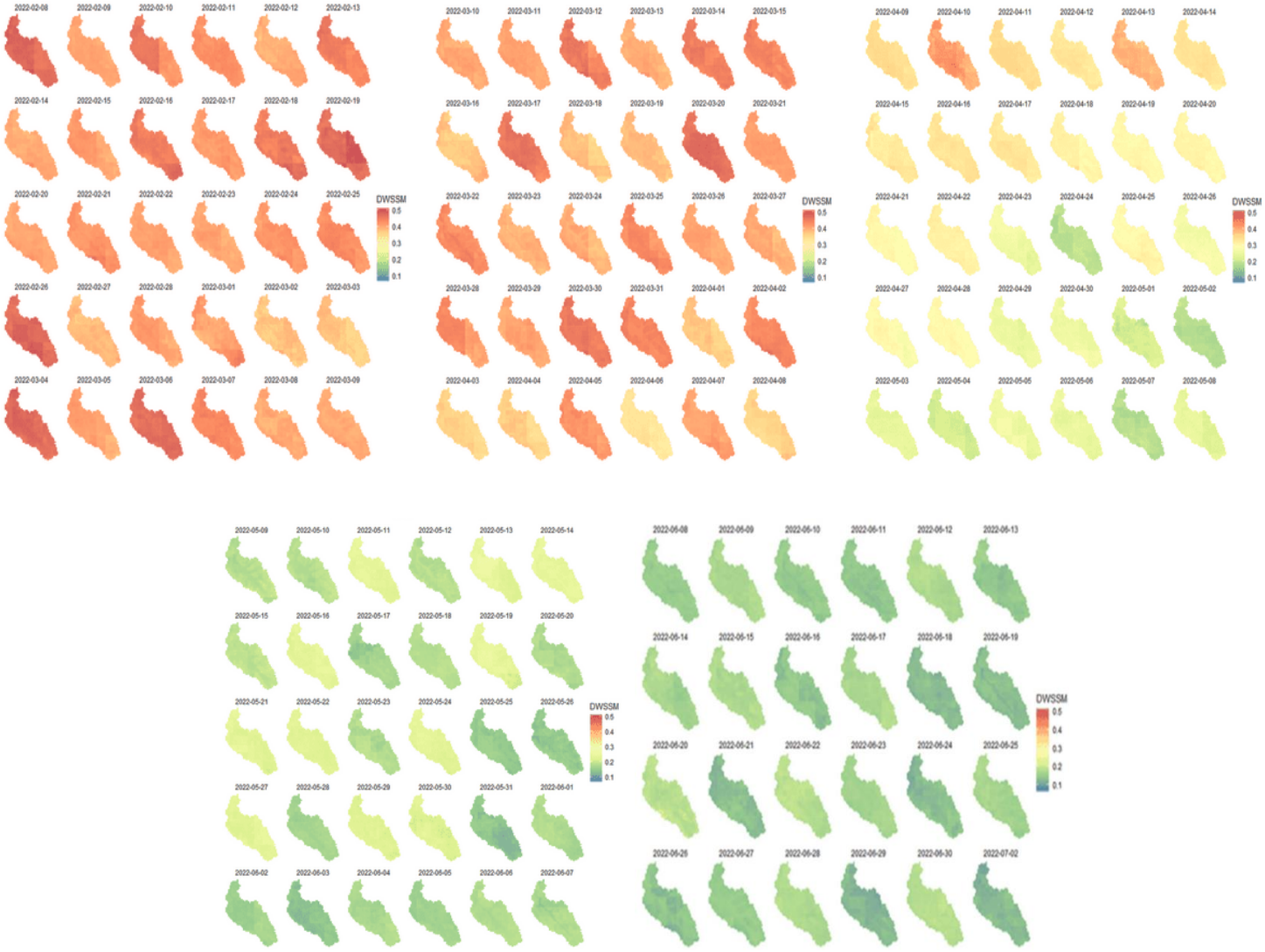

Figure S2. Downscaled Soil Moisture Maps. Maps at a 100 m spatial resolution for the K'ayra watershed, from 05/14/2021 to 07/06/2022, units are in $cm^3\ cm^{-3}$.

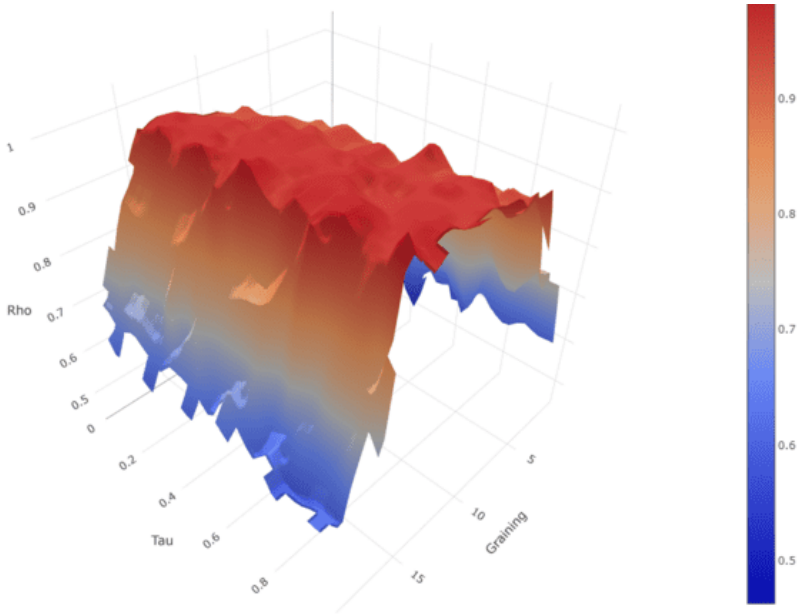

Figure S3. Multiscale Quantile Correlation Coefficient (MQCC) beetwen DWS (the downscaled soil moisture product at a spatial resolution of 100 m) and OBS (soil moisture observed in the field through daily monitoring using the ThetaProbe ML3 sensor) . The axis names area defeied based on equation 3 and its description.