

Figure S1. The dominant USGS landcover classes in the Tucson Basin.

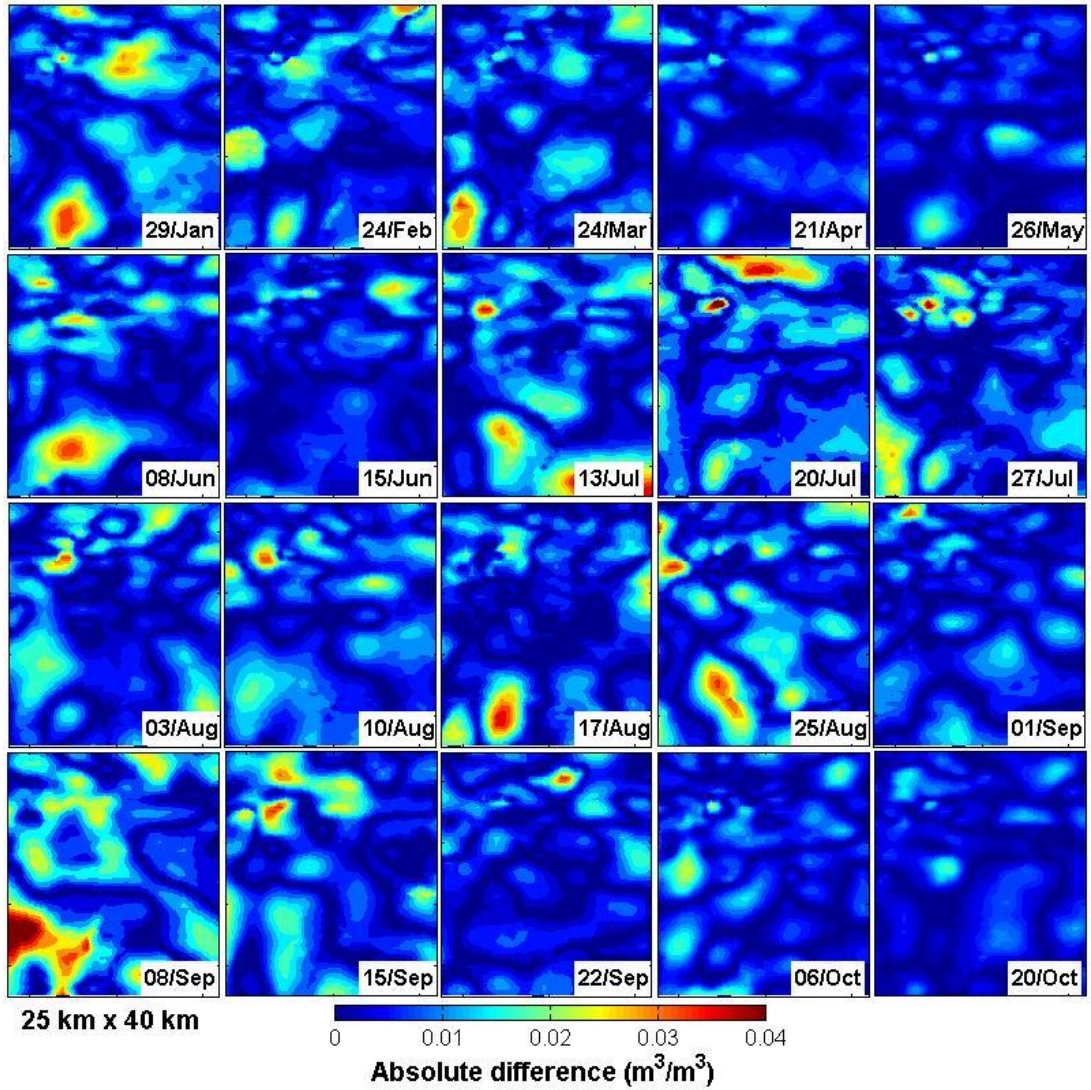


Figure S2. Absolute difference maps from the cosmic-ray rover surveys (Fig. 3) and the modelled results (Fig. 6). The areas of greatest difference are the University of Arizona, Sentinel Hill and the Pecan farms.

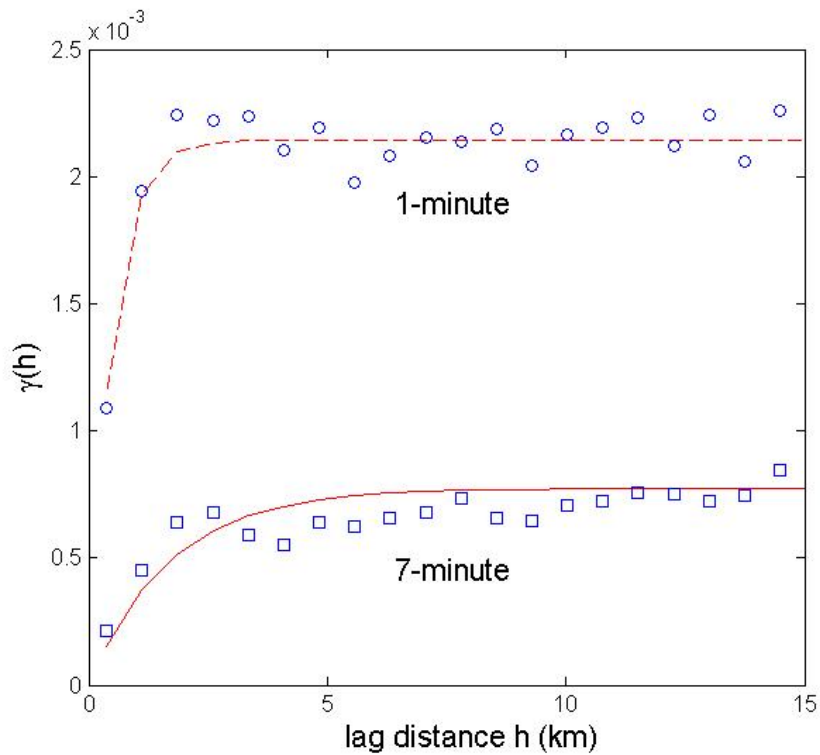


Figure S3. An example variogram (blue points) and exponential variogram model (red lines) for the one-minute and the seven-minute cosmic-ray rover data. Due to statistical noise of one-minute data, the correlation length of some surveys is close to zero which does not produce accurate maps. The seven-minute averaging increases the correlation length and decreases the overall variance, and produces more realistic maps. The difference between 1-minute and 7-minute data sets is also seen in the soil moisture data (Fig. 1) and in the standard deviation plot (Fig. 4).

Date	Cosmic-ray rover				COSMOS: Santa Rita		SMOS
	θ mean	θ min	θ max	σ	θ	θ	nearest meas. +/- days
	$(\text{m}^3 \text{m}^{-3})$						
29-Jan-12	0.10	0.06	0.14	0.02	0.07	0.06	0
24-Feb-12	0.09	0.03	0.15	0.02	0.06	0.06	1
24-Mar-12	0.10	0.06	0.14	0.02	0.06	0.04	1
21-Apr-12	0.07	0.04	0.14	0.02	0.05	0.02	1
26-May-12	0.07	0.03	0.13	0.02	0.02	0.03	0
8-Jun-12	0.09	0.04	0.13	0.02	0.02	0.02	0
15-Jun-12	0.08	0.04	0.13	0.02	0.02	0.02	2
13-Jul-12	0.12	0.07	0.18	0.02	0.05	0.27	0
20-Jul-12	0.14	0.09	0.25	0.02	0.08	0.04	1
27-Jul-12	0.14	0.10	0.20	0.02	0.08	0.08	1
3-Aug-12	0.14	0.08	0.20	0.02	0.06	0.06	0
10-Aug-12	0.14	0.08	0.20	0.02	0.06	0.05	1
17-Aug-12	0.13	0.08	0.19	0.02	0.08	0.15	1
25-Aug-12	0.14	0.07	0.19	0.02	0.06	0.17	1
1-Sep-12	0.12	0.06	0.16	0.02	0.05	0.06	1
8-Sep-12	0.12	0.07	0.20	0.02	0.06	0.14	0
15-Sep-12	0.11	0.06	0.17	0.02	0.07	0.06	1
22-Sep-12	0.09	0.05	0.13	0.02	0.04	0.06	1
6-Oct-12	0.08	0.04	0.12	0.02	0.03	0.04	0
20-Oct-12	0.08	0.04	0.12	0.02	0.03	0.05	1
17-Nov-12	0.09	0.04	0.13	0.02	0.03	0.05	1
15-Dec-12	0.12	0.09	0.18	0.02	0.05	N/A	N/A

Table S1. Cosmic-ray rover's mean soil moisture (θ mean), minimum soil moisture (θ min), maximum soil moisture (θ max) and standard deviation (σ) from the 22 map surveys. The minimum and maximum values are extracted from the interpolated maps to give a realistic range. The COSMOS Santa Rita soil moisture values have been averaged for the survey duration. The SMOS values are listed as the nearest measurement with a time offset of up to 2 days.