Supplemental Material for

Forty Five Years of Observed Soil Moisture in the Ukraine: No Summer Desiccation (Yet)

Alan Robock,[1] Mingquan Mu,[2] Konstantin Vinnikov,[3]
Iryna V. Trofimova,[4] and Tatyjana I. Adamenko[5]

[1]Department of Environmental Sciences, Rutgers University, New Brunswick, New Jersey

[2]Center for Clouds, Chemistry and Climate, Scripps Institution of Oceanography, La Jolla, California

[3]Department of Meteorology, University of Maryland, College Park

[4]Ukrainian Research Institute for Environment and Resources, Kiev, Ukraine

[5]Agrometeorology Department, Ukrainian Hydrometeorological Centre, Kiev, Ukraine

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Ukrainian Soil Moisture Stations

The individual soil moisture stations in the Ukraine are shown in Figure 1. The data are averaged into the 25 soil moisture districts listed in Table 1.

Soil Moisture Reanalyses

Li et al. [2004] explains the reanalysis soil moisture calculations in detail and they are summarized here. The European Centre for Medium Range Weather Forecasting (ECMWF) 40-year reanalysis [ERA40, *Simmons and Gibson*, 2000] and the National Centers for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) Reanalysis 1 [R-1, *Kalnay et al.*, 1996, *Kistler et al.*, 2001] calculated soil moisture in different ways. The calculated soil moisture depends on the land surface scheme used, the forcing (particularly precipitation and solar insolation), and the nudging employed. In terms of land surface, ERA40 uses a scheme called TESSEL [Tiled ECMWF Scheme for Surface Exchanges over Land, *Van Der Hurk et al.,* 2000]. The scheme has 4 prognostic layers for temperature and soil moisture with layer thicknesses of 7 cm, 21 cm, 72 cm and 189 cm going down from the top. There are some basic differences from the old scheme [VB95, *Viterbo and Beljaars*, 1995] employed in ERA15, especially the treatment of snow and vegetation, an added prognostic snow layer on top of the soil, and reduced infiltration over frozen soils. The uniform vegetation over land in VB95 was replaced by a 20-type vegetation map, with land surface parameters, such as root distribution and leaf area index, varying according to vegetation type.

R-1 and R-2 used the OSU LSM [*Pan and Mahrt*, 1987; *Pan*, 1990] with two layer thicknesses of 10 cm and 190 cm separately. Vegetation types were from Simple Biosphere model (SiB) climatology [*Dorman and Sellers*, 1989], while many parameters like soil properties (type, wilting point, critical point and porosity) and vegetation canopy cover were fixed globally.

Because model-generated precipitation and insolation are not perfect in reanalyses, soil moisture tends to drift to a too dry or too wet state. To prevent this, the soil moisture is nudged based on different criteria. For ERA40, soil moisture increments were provided by a linear combination of the screen level relative humidity and temperature increments each 6 hr [*Douville et al.*, 2000; *Mahfouf et al.*, 2000]. This nudging technique is more reliable than the old nudging scheme in ERA15, which only assimilated specific humidity [*Douville et al.*, 2000]. In R-1, soil moisture was nudged to the *Mintz and Serafini* [1992] climatology with a 60-day time scale. This nudging term is quite large [*Maurer et al.*, 2001] so interannual variations are suppressed [*Srinivasan et al*., 2000; *Kistler et al.*, 2001].

The temperature and precipitation simulated by ERA40 and R-1 are shown in Fig. 2 compared to observations.

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Table 1. The 25 districts with soil moisture observations. The data were averaged from 70 (for spring cereals – barley and maize) and 71 (for winter wheat) Ukraine stations. The total seeded areas are from 2002, typical of other years. All data come from the State Statistics Committee of the Ukraine.

Name of District	Lat. (°N)	Lon. (°E)	Total area (km^2)	Total seeded area for 2002 (km^2)	Winter wheat for 2002(km^2)	Spring cereals (barley and maize) for 2002 (km^2)	Forest (%)
Sumskaya	51.18	33.95	23,800	9,940	2,040	1,750	16
Poltavskaya	49.75	33.80	28,800	15,890	3,550	3,980	7
Kharkovskaya	49.65	36.55	31,400	16,640	4,200	3,310	10
Donetskaya	48.08	37.80	26,500	15,050	3,190	3,980	5
Luganskaya	49.03	38.87	26,700	10,020	2,470	1,720	9
Kirovogradskaya	48.42	31.82	24,600	14,640	3,500	3,490	4
Zaporozhskaya	47.08	35.98	27,200	15,460	3,830	3,560	1
Dnepropetrovskaya	48.17	34.67	31,900	18,020	3,980	4,900	3
Chernigovskaya	51.40	31.98	31,900	10,710	1,390	1,420	18
Kievskaya	50.30	30.52	28,100	12,120	2,610	1,850	20
Cherkasskaya	49.18	31.32	20,900	12,250	2,200	2,830	14
Zhitomirskaya	50.87	28.28	29,900	9,700	1,310	910	32
Vinnitskaya	49.07	28.60	26,500	15,650	3,260	3,330	11
Khmelnitskaya	49.42	27.00	20,600	10,810	2,270	1,820	12
Ternopolskaya	49.53	25.53	13,800	7,630	1,420	1,540	13
Chernovitskaya	48.47	26.68	8,100	3,120	520	690	29
Lvovskaya	49.88	24.05	21,800	6,590	1,240	530	25
Ivano-Frankovskaya	48.75	24.52	13,900	3,620	410	490	40
Volynskaya	51.20	24.90	20,200	5,540	1,180	360	29
Rovenskaya	50.75	26.17	20,100	5,730	920	600	36
Zakarpatskaya	48.50	22.93	12,800	1,910	290	330	49
Odesskaya	46.40	29.87	33,300	17,360	5,700	2,480	4
Nikolaevskaya	47.38	31.78	24,600	14,280	5,640	2,230	2
Khersonskaya	46.63	33.52	28,500	13,590	4,440	1,890	3
Krymskaya	45.22	34.15	26,100	9,100	3,210	830	10

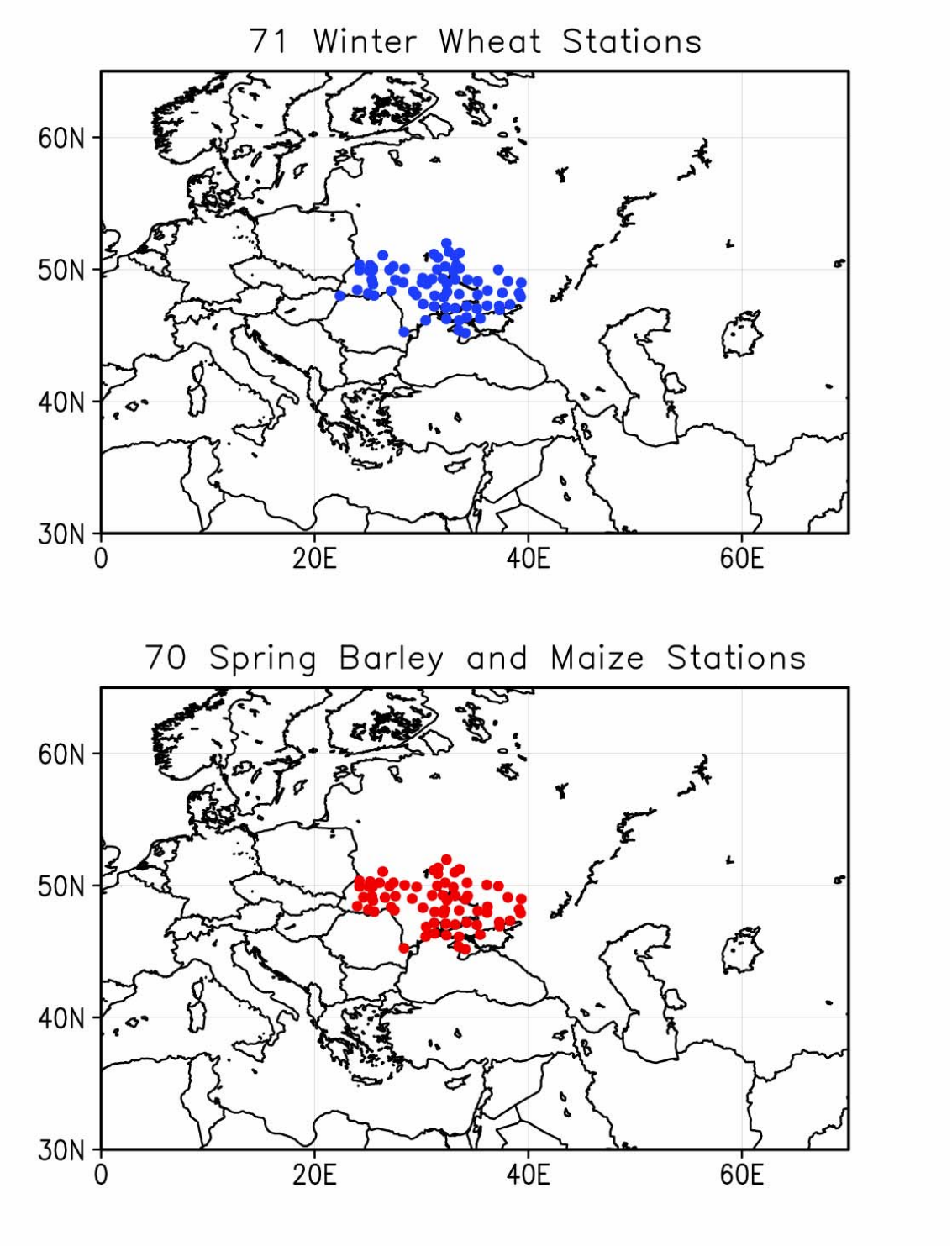

Figure 1. Location of soil moisture stations for winter and spring cereals with 45 yr of soil moisture observations, for the period 1958-2002.

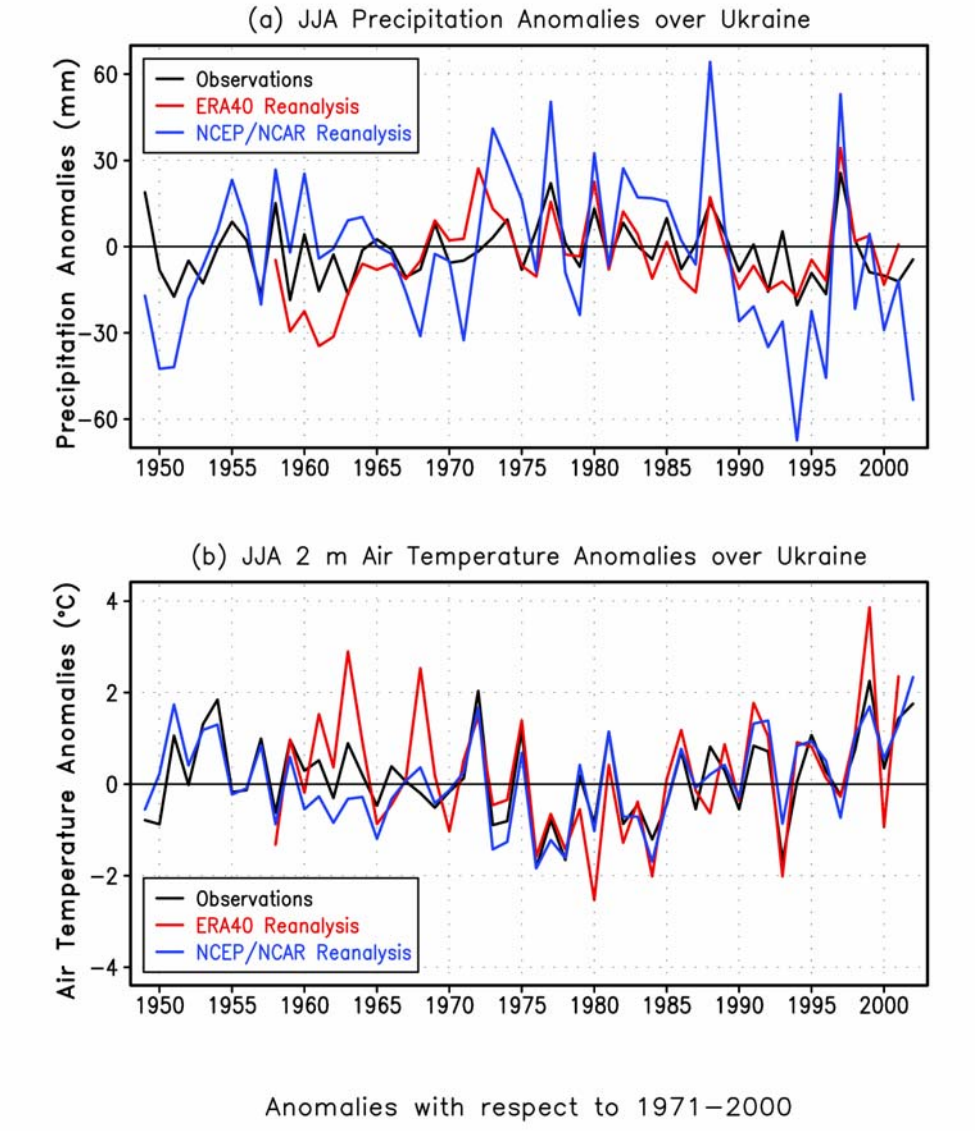

Figure 2. Precipitation and temperature anomalies over the Ukraine for ERA40 and R-1 (labeled NCEP/NCAR) reanalyses compared to observations.