Drought risk in the North Eurasian regions: assessment of El-Nino effects

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We analyzed the probability of drought conditions in the North Eurasian regions and assessed El-Nino/Southern Oscillation (ENSO) effects [1]. Based on observations [2] for the period 1891-2013, we analyzed the spring-summer (May-July) anomalies of surface air temperature (SAT) δT and precipitation δP, as well as of drought index D in the mid-latitudes of the European (ER) and Asian (AR) parts of Russia .

To estimate the El-Nino/La-Nina effects, we used their indices based on sea surface temperature (SST) in the Niño-3 (150°–90°W, 4°N–4°S), Nino-3,4 (170°–120°W, 4°N–4°S) and Nino-4 (160°E–150°W, 4°N–4°S) regions in the equatorial latitudes of the Pacific Ocean (ftp://www.coaps.fsu.edu/ pub/JMA_SST_Index/). The El-Nino (*E*) and La-Nina (*L*) phases were distinguished using 5-month moving averages of the SST anomaly in the Nino-3 region (JMA index). El-Nino (warm) and La-Nina (cold) phases were defined by the index values of at least 0.5°C and at most –0.5°C, respectively, over six consecutive months (including October–December). All other cases were considered as neutral phases (*N*).

The beginning of 2015 in the El-Nino phase was characterized by the highest positive anomalies in the Nino-4 region and we present here the results with Nino-4 as the El-Nino index. According to ensemble model forecasts, the probability that El-Nino phase will persist till the end of this year is about 60% (more than 70% for May-July and June-August). The corresponding probability for neutral and La-Nina phases is estimated at about 30% and 10%, correspondingly (http://iri.columbia.edu).

Table 1 shows the probabilities of positive spring–summer temperature anomalies δT in the ER and AR for different El-Nino phase transitions estimated with the use of the Nino-4 index. The transitions characterized by the highest probability of temperature anomalies, including extreme ones ($\delta T > 1$°C), for the ER and AR are shown in bold. It should be noted that the *E*→*E* transition expected in 2015 is characterized by the highest probability (0.71) of extremely high temperature in May-July over the AR with a low risk of high temperatures for the ER.

Table 1. Probability of different surface temperature anomalies (δT) in the ER (and AR) in May-July for different ENSO phases (characterized by the Nino-4 index) based on observations for 1891–2013

δT	*N*→ $n = 67$			*E*→ $n = 28$			*L*→ $n = 28$		
	N→*E* n=17	*N*→*L* n=9	*N*→*N* n=41	*E*→*E* n=7	*E*→*L* n=8	*E*→*N* n=13	*L*→*E* n=4	*L*→*L* n=10	*L*→*N* n=14
>0	0.41 (0.47)	0.56 (0.44)	0.63 (0.61)	0.29 (**0.71**)	**0.88** (0.62)	0.54 (0.38)	0.50 (0.50)	0.40 (0.50)	0.43 (0.57)
	0.53 (0.51)			**0.57** (**0.57**)			0.44 (0.52)		
>1 K	0.12 (0.24)	0.22 (0.11)	0.22 (0.22)	0.14 (**0.71**)	**0.50** (0.12)	0.31 (0.15)	0.25 (0.25)	0.20 (0.20)	0.21 (0.29)
	0.19 (0.19)			**0.32** (**0.33**)			0.22 (0.25)		

Table 2 presents the probability of negative precipitation anomalies in the ER and AR (δP) in May–July for different ENSO phase transitions estimated with the use of Nino-4 index.

Table 2. Probability of negative precipitation anomalies (δP) in the ER (and AR) in May-July for different ENSO phases (characterized by the Nino-4 index) from observations for 1891–2013

δP	$N\to$ $n = 67$			$E\to$ $n = 28$			$L\to$ $n = 28$		
	$N\to E$ $n=17$	$N\to L$ $n=9$	$N\to N$ $n=41$	$E\to E$ $n=7$	$E\to L$ $n=8$	$E\to N$ $n=13$	$L\to E$ $n=4$	$L\to L$ $n=10$	$L\to N$ $n=14$
< 0	0.47 (0.35)	0.56 (0.33)	0.51 (0.34)	0.29 (0.57)	0.38 (0.50)	0.54 (0.62)	0.50 (**0.75**)	**0.60** (0.50)	0.43 (0.36)
	0.51 (0.34)			0.40 (**0.56**)			**0.51** (0.54)		

Table 3 shows probability of different drought conditions (index D) in the ER (and AR) in May-July for different ENSO phase transitions with the use of the Nino-4 index.

Table 3. Probability of different drought conditions (index D) in the ER (and AR) in May-July for different ENSO phases (characterized by the Nino-4 index) from observations for 1891–2013

D	$N\to$ $n = 67$			$E\to$ $n = 28$			$L\to$ $n = 28$		
	$N\to E$ $n=17$	$N\to L$ $n=9$	$N\to N$ $n=41$	$E\to E$ $n=7$	$E\to L$ $n=8$	$E\to N$ $n=13$	$L\to E$ $n=4$	$L\to L$ $n=10$	$L\to N$ $n=14$
≥20%	0.24 (0.35)	**0.56** (0.33)	0.51 (0.29)	0.43 (**0.71**)	0.50 (0.38)	0.46 (0.38)	0.25 (0.50)	0.30 (0.30)	0.29 (0.36)
	0.44 (0.32)			**0.46** (**0.49**)			0.28 (0.39)		
≥30%	0.12 (0.06)	0.22 (0)	0.27 (0.20)	0 (**0.43**)	**0.38** (0.12)	0.31 (0.23)	0.25 (0.25)	0.30 (0.20)	0.21 (0.21)
	0.20 (0.09)			0.23 (**0.26**)			**0.25** (0.22)		

According to Table 3 the $E\to E$ transition expected in 2015 is characterized by the high risk of drought conditions in May-July in AR. Severe drought conditions ($D \geq 30\%$) in AR were realized three times in seven $E\to E$ transitions since 1891.

References

1. Mokhov I.I. and A.V. Timazhev (2013) Climatic anomalies in Eurasia from El-Nino/La-Nina effects. *Doklady Earth Sci.,* **453**(1), 1141-1144.
2. Meshcherskaya A.V., V.M. Mirvis, and M.P. Golod (2011) The drought in 2010 against the background of multiannual changes in aridity in the major grain-producing regions of the European part of Russia. *Tr. MGO,* **563**, 94–121 (in Russian)