

A REVIEW OF THE TURKEY FEBRUARY HEAT WAVE OF 2016

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Abstract:

Climate change, in other word global warming, is one of the most serious environmental, economic, and social threats that this world faces. A change in the Earth's surface temperature also leads to increase in extreme events as well as extreme temperatures. Increasing in magnitude, severity and duration of extreme temperature events are harmful to both as the ecosystem and on human health. Human influence has also led to significant regional temperature increases at the continental and subcontinental levels. Humans cannot realise heatwaves impact which occurs in spring and autumn as much as ecosystems and habitats. Warming continued in 2016, setting a new temperature record of approximately 1.1 °C above the pre-industrial period. Heat wave is a period of abnormally hot weather. Heat wave is daily maximum temperature on more than five consecutive days exceeding the average maximum temperature by 5°C. Heat waves effected most of the Turkey in February 2016 and they were very intense between 15 and 19 February in 2016. In this study we investigate these extreme events and used mean maximum, maximum and mean temperature values of Turkish State Meteorological Service's 130 stations. During the period, extreme maximum temperatures were exceed their long term February's extreme maximum temperature records in 65 stations. Heat waves were seen in 123 stations and repeated in 36 of these stations again and continued until mid of March in some stations.

Keywords: *Extreme events, heat wave, climate change, climate impact*

INTRODUCTION

Climate change, in other word global warming, is one of the most serious environmental, economic, and social threats that this world faces. There are many assessments to monitor climate and to estimate climate variability over many regions and also globally by national and international institutions. A change in the Earth's surface temperature also leads to increase in extreme events as well as extreme temperatures. Increasing in magnitude, severity and duration of extreme temperature events are harmful to both as the ecosystem and on human health.

Human influence has also led to significant regional temperature increases at the continental and subcontinental levels. Warming continued in 2016, setting a new temperature record of approximately 1.1 °C above the pre-industrial period (WMO, 2016)

According to WMO's Meteorology vocabulary, a heat wave is an extreme weather event with marked warming of the air, or the invasion of very warm air, over a large area; it usually lasts from a few days to a few weeks (TT-DEWCE, 2015). Heat wave (also referred to as extreme heat event) is a period of abnormally hot weather. Heat waves and warm spells have various and in some cases overlapping definitions (IPCC, 2012). Changes in many extreme weather and climate events have been observed since about 1950. It is very likely that the number of cold days and nights has decreased and the number of warm days and nights has increased on the global scale. It is likely that the frequency of heat waves has increased in large parts of Europe, Asia and Australia (IPCC, 2013).

Heat or hot weather that lasts for several days, often referred to as a "heatwave", is a pervasive natural hazard that can exact a heavy toll on human systems, affecting health, livelihoods and infrastructure. Natural systems can also be severely affected by the impacts sustained beyond the duration of a heatwave. Although there is no universally acceptable definition of heatwaves (Perkins and Alexander, 2013; Robinson, 2001), they are understood to be periods of unusually hot and dry or hot and humid weather that have a subtle onset and cessation, a duration of at least two to three days and a discernible impact on human activities (WMO-No:1142, 2015).

TT-DEWCE recommended 4 metrics for standard characterization of a heat wave to quantitatively reflect a heat wave event. The definition of heat wave should be complemented by characterization with magnitude, duration, severity and extend (TT-DEWCE, 2015). Magnitude should be computed based on an index or a set of indices of thermal condition(s) exceeding certain threshold(s). Duration will lead to the computation of the persistence of a heat wave and should be based on recording the starting time and the ending time of the event. Severity is a measure which integrates two aspects of the event, its magnitude, and its persistence. Extent is computed to inform on the geographical area affected and the widespread aspect of the heat wave.

Heat wave is daily maximum temperature on more than five consecutive days exceeding the average maximum temperature by 5°C. Cold wave is daily minimum temperature on more than five consecutive days below the average minimum temperature by 5°C (Frich et al., 2002; Coskun et al., 2017).

200 stations had heat waves in 2016. Total number of heat wave is 561 (some of the stations had more than once) (based on 1971-2000 normals). There was no cold wave in 2016. Highest number of heat wave occurred in 2010 which was the warmest year in Turkey. Highest number of cold wave occurred in 1992 which was the coldest year in Turkey after Pinatubo Volcano eruption (Coskun et al., 2017) (Fig. 1).

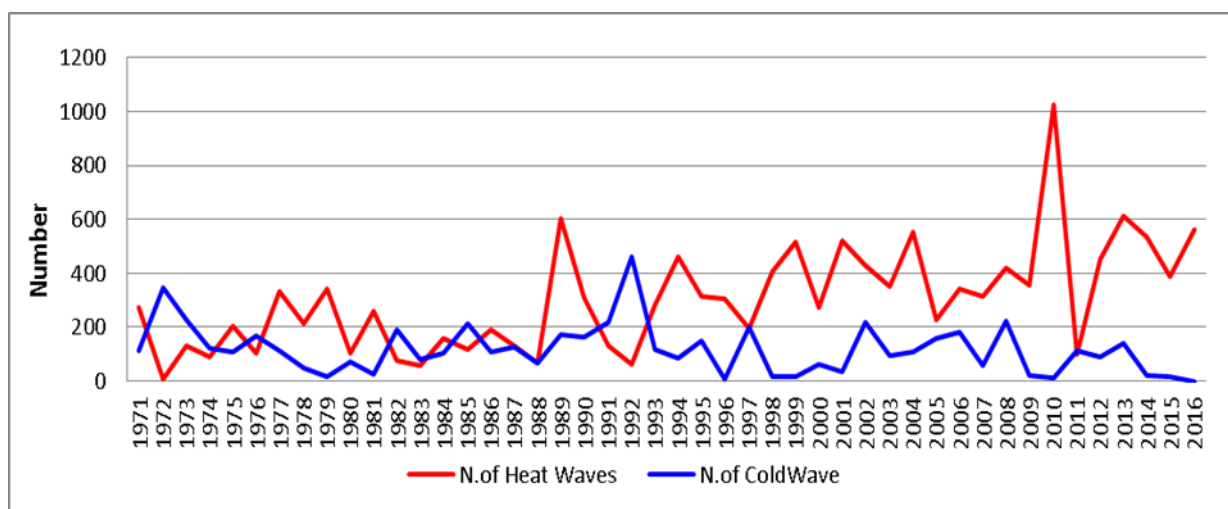


Figure 1. Annual Number of Heat & Cold Waves in Turkey (Coskun et al., 2017).

Unal et al. (2013) had a results confirm that the number of excessive hot days, heat waves, and their durations have increased through the 2000s, especially on the southern part of the western Turkey.

DATA AND METHODS

Heat waves effected most of the Turkey in February 2016 and they were very intense between 15 and 19 February in 2016. In this study we investigate these extreme events and use mean maximum, maximum and mean temperature values of Turkish State Meteorological Service's 130 stations.

In line with the definition of Frich et al., (2002); we used daily maximum temperature which were exceeding their average maximum temperature by 5°C and continue at least 5 days to calculate heat wave events for every stations.

Mean temperatures were higher than normal (1981-2010) between the January and the May in 2016. The average temperature of Turkey in February 2016 was 8.2 ° C and it was 4.7°C above 1981-2010 normal (3.5° C). With this figure, it was the hottest February since 1971 (Figure 1). In February 2016, extreme maximum temperatures were exceed their long term February's extreme maximum temperature records in 65 stations (Figure 2). Heat waves were seen in 123 stations and repeated in 36 of these stations again and continued until mid of March in some stations.

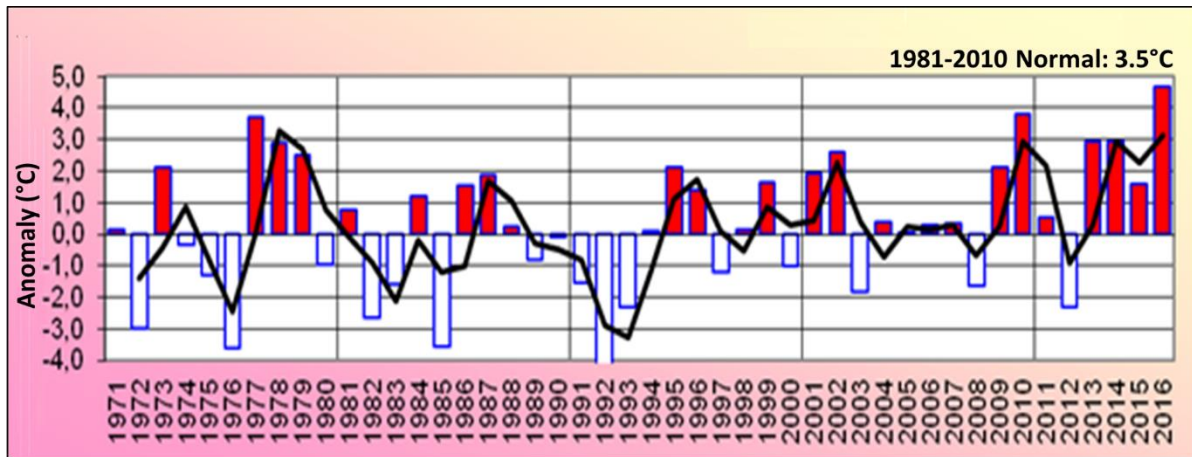


Figure 1. February mean temperature anomalies (TSMS, 2016-a)

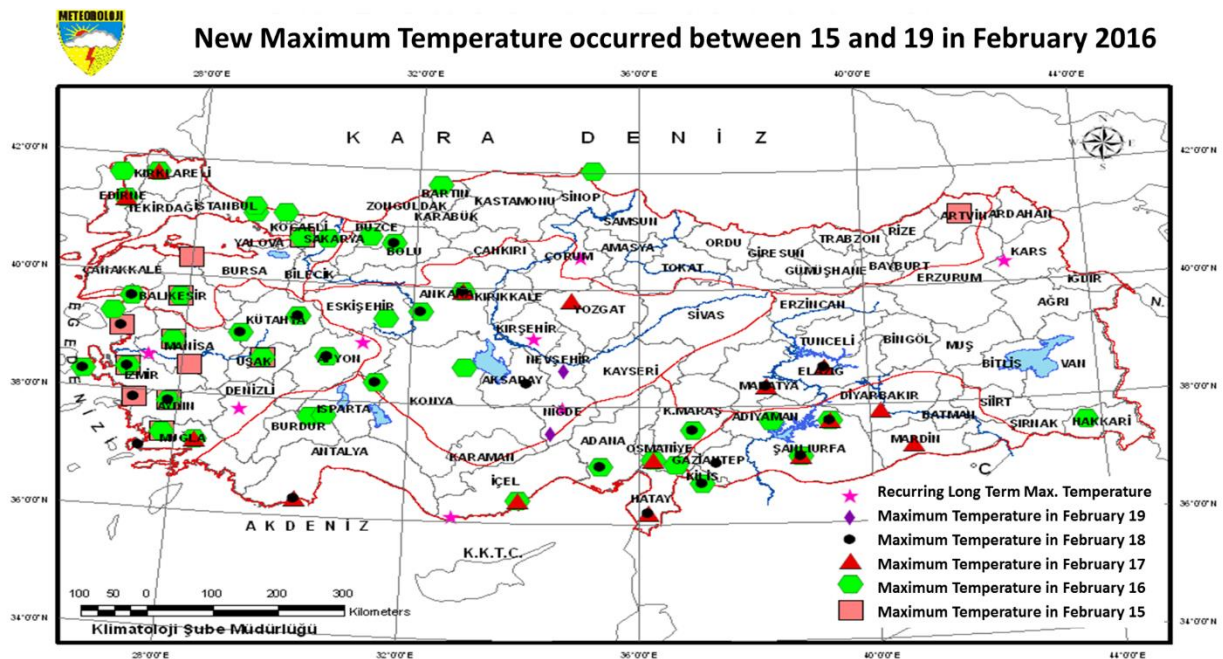


Figure 2. New maximum temperature occurred between 15 and 19 February in 2016 (TSMS, 2016-b)

In the Marmara Region: Maximum temperatures set a new record at 10 meteorological stations, including Balıkesir, Bandırma, Edirne, Sarıyer, Kırklareli, Kocaeli, Kumköy, Şile and Uzunköprü in February (Fig. 3; 4).

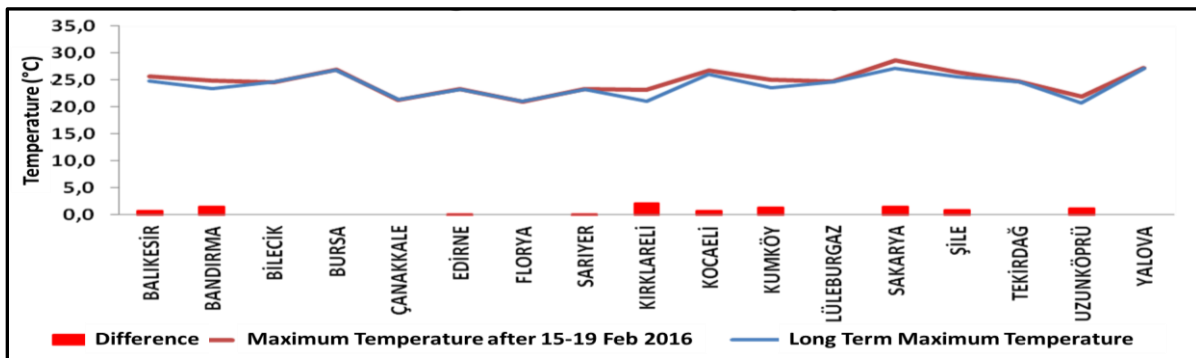


Figure 3. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their differences in the Marmara Region (TSMS, 2016-b).

		February Long Term Maximum Temperature	15 Feb. 2016 Maximum Temperature	16 Feb 2016 Maximum Temperature	17 Feb 2016 Maximum Temperature	18 Feb 2016 Maximum Temperature	19 Feb 2016 Maximum Temperature	February Maximum Temperature after 15-19 Feb 2016
MARMARA REGION	BALIKESİR	24,8	25,0	25,6				25,6
	BANDIRMA	23,4	24,9					24,9
	BİLECİK	24,6						24,6
	BURSA	26,9						26,9
	ÇANAKKALE	21,3						21,3
	EDİRNE	23,2		23,3				23,3
	FLORYA	21,0						21,0
	SARIYER	23,2		23,3				23,3
	KIRKLARELİ	21,0		22,0	23,1			23,1
	KOCAELİ	26,0	26,1	26,7				26,7
	KUMKÖY	23,6	23,6	25,0				25,0
	LÜLEBURGAZ	24,7						24,7
	SAKARYA	27,1		28,7				28,7
	ŞİLE	25,6		26,5				26,5
TEKİRDAĞ	24,7						24,7	
UZUNKÖPRÜ	20,8		21,5	22,0			22,0	
YALOVA	27,2						27,2	

Figure 4. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their values by stations in the Marmara Region (TSMS, 2016-b).

In the Aegean Region: Maximum temperatures set a new record at 16 meteorological stations, including Afyonkarahisar, Akhisar, Aydın, Ayvalık, Bodrum, Çeşme, Dikili, Edremit, İzmir, Kuşadası, Kütahya, Milas, Muğla, Salihli, Simav and Uşak in February. Denizli, Emirdag and Manisa stations repeated their long term values. (Fig. 5; 6).

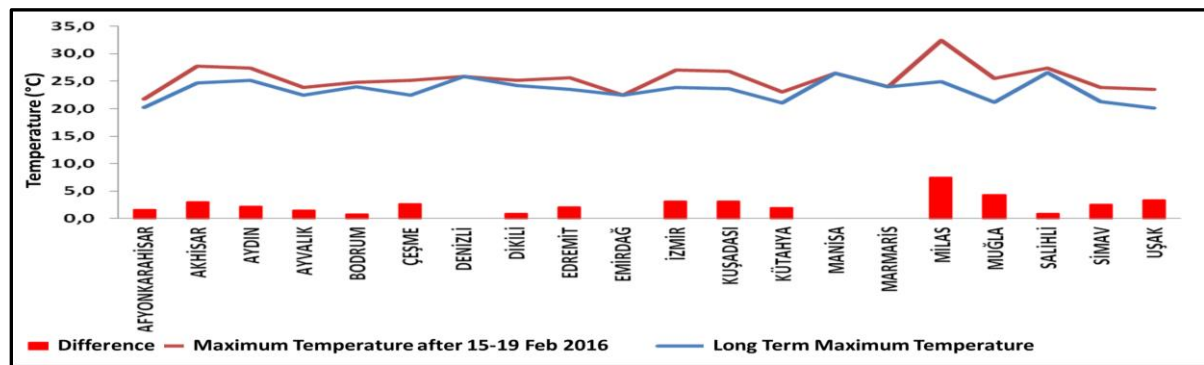


Figure 5. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their differences in the Aegean Region (TSMS, 2016-b).

		February Long Term Maximum Temperature	15 Feb. 2016 Maximum Temperature	16 Feb 2016 Maximum Temperature	17 Feb 2016 Maximum Temperature	18 Feb 2016 Maximum Temperature	19 Feb 2016 Maximum Temperature	February Maximum Temperature after 15-19 Feb 2016
AEGEAN REGION	AFYONKARAHISAR	20,2		21,6		21,8		21,8
	AKHISAR	24,7	26,6	27,7				27,7
	AYDIN	25,2	25,9	26,9		27,4		27,4
	AYVALIK	22,4		23,9				23,9
	BODRUM	24,0				24,8		24,8
	ÇEŞME	22,4		24,9		25,1		25,1
	DENİZLİ	25,9				25,9		25,9
	DİKİLİ	24,2	24,6			25,1		25,1
	EDREMIT	23,5		25,2		25,6		25,6
	EMİRDAĞ	22,5		22,5				22,5
	İZMİR	23,9	24,7	26,9		27,0		27,0
	KUŞADASI	23,6	25,9	25,9		26,8		26,8
	KÜTAHYA	21,0		22,0		23,0		23,0
	MANİSA	26,4	26,4					26,4
	MARMARİS	24,0						24,0
	MİLAS	24,9	26,0	32,4				32,4
MUĞLA	21,2		25,0	25,5			25,5	
SALİHLİ	26,5	27,4					27,4	
SİMAV	21,3		22,8		23,9		23,9	
UŞAK	20,1	20,4	23,5				23,5	

Figure 6. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their values by stations in the Aegean Region (TSMS, 2016-b).

In the Mediterranean Region: Maximum temperatures set a new record at 9 meteorological stations, including Adana, Antakya, Burdur, Finike, Isparta, Islahiye, Kahramanmaraş, Osmaniye and Silifke in February. Anamur station repeated their long term value (Fig. 7; 8).

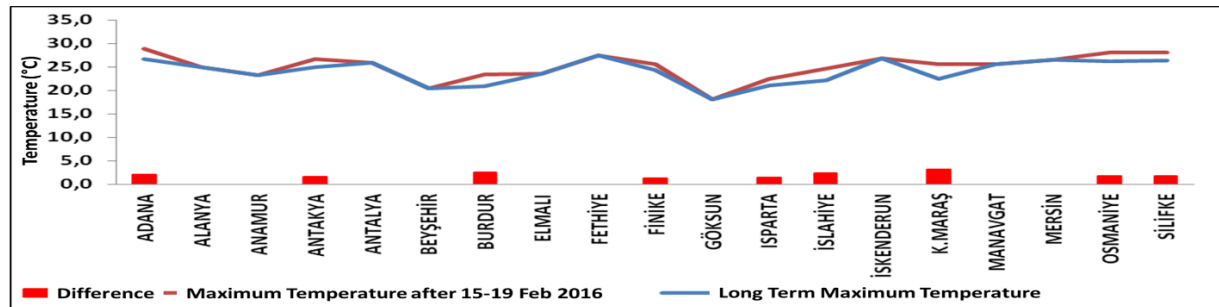


Figure 7. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their differences in the Mediterranean Region (TSMS, 2016-b).

		February Long Term Maximum Temperature	15 Feb. 2016 Maximum Temperature	16 Feb 2016 Maximum Temperature	17 Feb 2016 Maximum Temperature	18 Feb 2016 Maximum Temperature	19 Feb 2016 Maximum Temperature	February Maximum Temperature after 15-19 Feb 2016
MEDITERRANEAN REGION	ADANA	26,7		28,2		28,8		28,8
	ALANYA	25,0						25,0
	ANAMUR	23,2			23,2			23,2
	ANTAKYA	25,0			25,9	26,6		26,6
	ANTALYA	25,9						25,9
	BEYŞEHİR	20,4						20,4
	BURDUR	20,9		23,4				23,4
	ELMALI	23,5						23,5
	FETHİYE	27,4						27,4
	FİNİKE	24,3			24,9	25,5		25,5
	GÖKSUN	18,1						18,1
	İSPARTA	21,0		22,5				22,5
	İSLAHIYE	22,2		24,6		24,6		24,6
	İSKENDERUN	26,8						26,8
	K.MARAŞ	22,4		24,6			25,5	25,5
MANAVGAT	25,6						25,6	
MERSİN	26,5						26,5	
OSMANIYE	26,2		26,5	28,0			28,0	
SİLİFKE	26,3		27,8	28,1			28,1	

Figure 8. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their values by stations in the Mediterranean Region (TSMS, 2016-b).

In the Central Anatolian Region: Maximum temperatures set a new record at 9 meteorological stations, including Aksaray, Akşehir, Ankara, Cihanbeyli Nevşehir, Polatlı, Sivrihisar, Ulukışla and Yozgat in February. Kırşehir and Niğde stations repeated their long term values. (Fig. 9; 10).

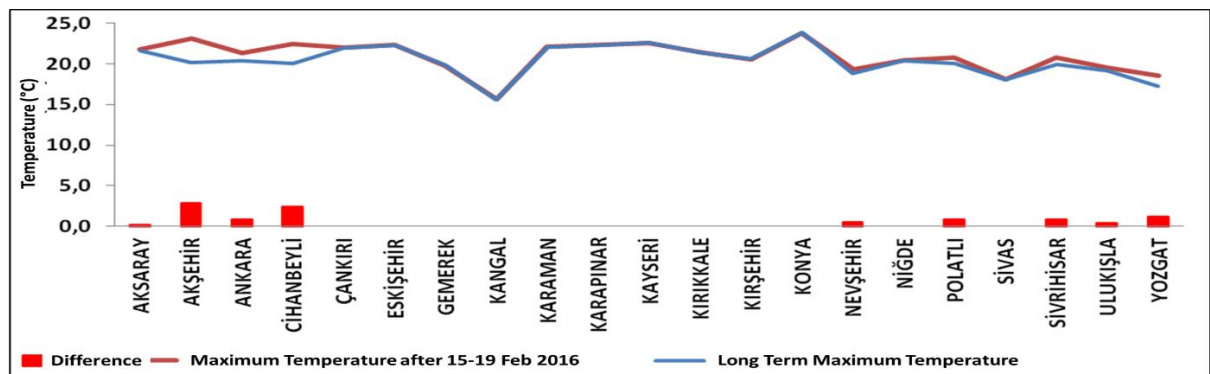


Figure 9. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their differences in the Central Anatolian Region (TSMS, 2016-b).

		February Long Term Maximum Temperature	15 Feb. 2016 Maximum Temperature	16 Feb 2016 Maximum Temperature	17 Feb 2016 Maximum Temperature	18 Feb 2016 Maximum Temperature	19 Feb 2016 Maximum Temperature	February Maximum Temperature after 15-19 Feb 2016
CENTRAL ANATOLIAN REGION	AKSARAY	21,6				21,8		21,8
	AKŞEHİR	20,2		22,3		23,1		23,1
	ANKARA	20,4		20,5	20,6	21,3		21,3
	ÇİHANBEYLİ	20,0	20,0	22,4				22,4
	ÇANKIRI	22,0						22,0
	ESKİŞEHİR	22,3						22,3
	GEMEREK	19,8						19,8
	KANGAL	15,6						15,6
	KARAMAN	22,1						22,1
	KARAPINAR	22,3						22,3
	KAYSERİ	22,6						22,6
	KIRIKKALE	21,4						21,4
	KIRŞEHİR	20,6			20,6			20,6
	KONYA	23,8						23,8
	NEVŞEHİR	18,8					19,3	19,3
	NIĞDE	20,4		20,4				20,4
POLATLI	20,0		20,2			20,8	20,8	
SİVAS	18,1						18,1	
SIVRIHISAR	19,9		20,8				20,8	
ULUKIŞLA	19,2					19,6	19,6	
YOZGAT	17,3		17,3	18,5			18,5	

Figure 10. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their values by stations in the Central Anatolian Region (TSMS, 2016-b).

In the Blacksea Region: Maximum temperatures set a new record at 5 meteorological stations, including Amasra, Artvin, Bolu, Duzce and Sinop in February. Corum station repeated their long term value. (Fig. 11; 12).

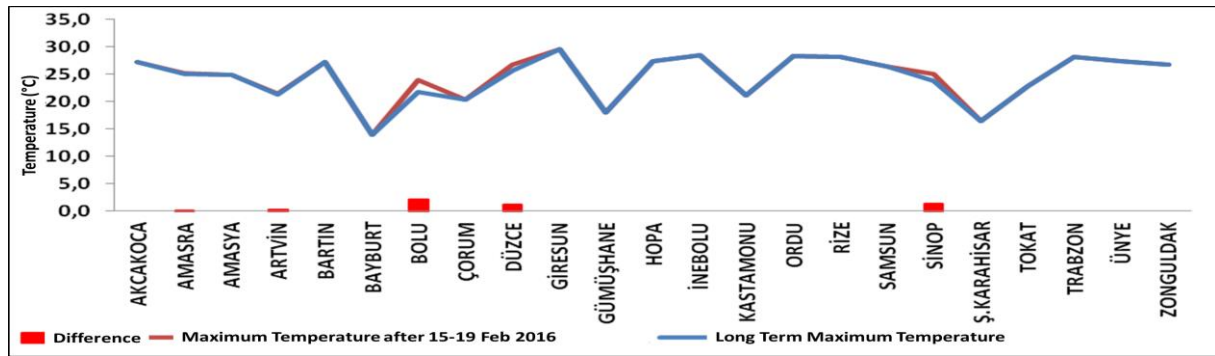


Figure 11. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their differences in the Blacksea Region (TSMS, 2016-b).

		February Long Term Maximum Temperature	15 Feb. 2016 Maximum Temperature	16 Feb 2016 Maximum Temperature	17 Feb 2016 Maximum Temperature	18 Feb 2016 Maximum Temperature	19 Feb 2016 Maximum Temperature	February Maximum Temperature after 15-19 Feb 2016
BLACKSEA REGION	AKCAKOCA	27,2						27,2
	AMASRA	25,0		25,1				25,1
	AMASYA	24,8						24,8
	ARTVIN	21,2	21,5					21,5
	BARTIN	27,2						27,2
	BAYBURT	13,9						13,9
	BOLU	21,8		23,9		24,0		24,0
	ÇORUM	20,4				20,4		20,4
	DÜZCE	25,6		26,8				26,8
	GİRESUN	29,5						29,5
	GÜMÜŞHANE	18,0						18,0
	HOPA	27,3						27,3
	İNEBOLU	28,4						28,4
	KASTAMONU	21,1						21,1
	ORDU	28,3						28,3
	RİZE	28,1						28,1
	SAMSUN	26,5						26,5
	SİNOP	23,7		25,0				25,0
	Ş.KARAHİSAR	16,4						16,4
TOKAT	22,8						22,8	
TRABZON	28,2						28,2	
ÜNYE	27,3						27,3	
ZONGULDAK	26,7						26,7	

Figure 12. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their values by stations in the Blacksea Region (TSMS, 2016-b).

In the Eastern Anatolia Region: Maximum temperatures set a new record at 3 meteorological stations, including Elazig, Hakkari and Malatya in February. Sarikamis station repeated their long term value (Fig. 13; 14).

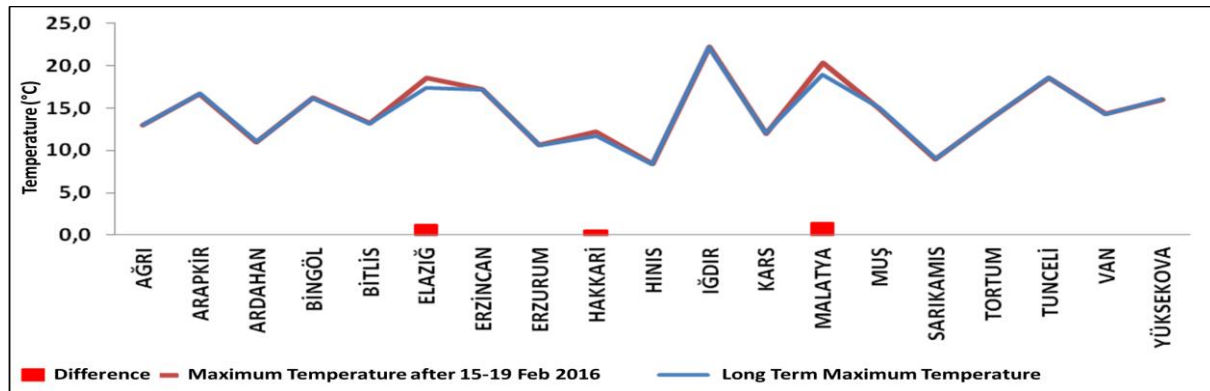


Figure 13. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their differences in the Eastern Anatolia Region (TSMS, 2016-b).

		February Long Term Maximum Temperature	15 Feb. 2016 Maximum Temperature	16 Feb 2016 Maximum Temperature	17 Feb 2016 Maximum Temperature	18 Feb 2016 Maximum Temperature	19 Feb 2016 Maximum Temperature	February Maximum Temperature after 15-19 Feb 2016
EASTERN ANATOLIAN REGION	AĞRI	13,0						13,0
	ARAPKIR	16,7						16,7
	ARDAHAN	11,0						11,0
	BİNGÖL	16,2						16,2
	BİTLİS	13,2						13,2
	ELAZIĞ	17,4			18,2	18,6		18,6
	ERZİNCAN	17,2						17,2
	ERZURUM	10,6						10,6
	HAKKARİ	11,7		12,2				12,2
	HİNİS	8,4						8,4
	İĞDIR	22,2						22,2
	KARS	12,0						12,0
	MALATYA	18,9			19,0	20,3		20,3
	MUŞ	15,0						15,0
	SARIKAMIS	9,0			9,0			9,0
	TORTUM	13,9						13,9
TUNCELİ	18,6						18,6	
VAN	14,3						14,3	
YÜKSEKOVA	16,0						16,0	

Figure 14. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their values by stations in the Eastern Anatolia Region (TSMS, 2016-b).

In the Southeast Anatolia Region: Maximum temperatures set a new record at 7 meteorological stations, including Adiyaman, Diyarbakir, Gaziantep, Kilis, Mardin, Siverek and Sanliurfa in February (Fig. 15; 16).

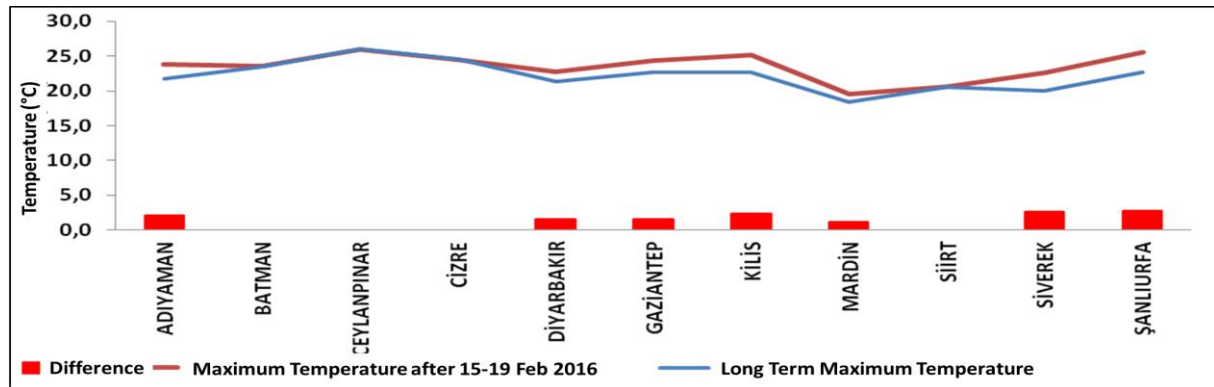


Figure 15. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their differences in the Southeast Anatolia Region (TSMS, 2016-b).

		February Long Term Maximum Temperature	15 Feb. 2016 Maximum Temperature	16 Feb 2016 Maximum Temperature	17 Feb 2016 Maximum Temperature	18 Feb 2016 Maximum Temperature	19 Feb 2016 Maximum Temperature	February Maximum Temperature after 15-19 Feb 2016
SOUTHEAST ANATOLIAN REGION	ADIYAMAN	21,7		23,8		23,8		23,8
	BATMAN	23,5						23,5
	CEYLANPINAR	26,0						26,0
	CIZRE	24,5						24,5
	DIYARBAKIR	21,3			22,8			22,8
	GAZIANTEP	22,7				24,3		24,3
	KILIS	22,7		25,0		25,1		25,1
	MARDIN	18,4			19,5			19,5
	SIIRT	20,6						20,6
	SIVEREK	20,0		20,2	21,2	22,6		22,6
	ŞANLIURFA	22,7		23,3	24	25,5		25,5

Figure 16. Long term maximum temperature, new maximum temperature occurred between 15 and 19 February in 2016 and their values by stations in the Southeast Anatolia Region (TSMS, 2016-b).

CONCLUSIONS AND RECOMMENDATIONS

In a line with climate change, global mean temperature continue to rise. Almost every year and every month has signed a new record especially for two decades. A change in the Earth’s surface temperature also leads to increase in extreme events as well as extreme temperatures. Increasing in magnitude, severity and duration of extreme temperature events are harmful to both as the ecosystem and on human health. Human influence has also led to significant regional temperature increases at the continental and subcontinental levels. Humans cannot realise heatwaves impact which occurs in winter, spring and autumn as much as ecosystems and habitats. Due to heatwaves are occurred and continued end of winter or early spring; the nature waking up earlier, trees are blooming earlier then their blooming time and so on. Then short term cold weather or winter are appearing and harmful to trees. Other issue is snow layers on mountain are starting to melt earlier with heatwaves.

Turkoglu et al. (2016) conclude that in Turkey, positive temperature anomalies have been observed since 1994 until present days. Negative relationships were found between phenological periods of apple, cherry and wheat and the average temperatures of February-May period when the plants grow faster. This situation shows that the plants shift their phenological periods to the earlier times in response to the increasing temperatures.

Demircan et al. (2017) concluded that probability of occurring maximum temperature in certain time interval in a month may show a pattern in month and also the pattern is inclined to change with increasing temperature trend due to climate change. Daily maximum temperatures were increasing about 12 to 17 days in February since 1981. They offered third week of February is possible heatwave occurring time according to the long terms patterns and heatwave occurred in February 2016 was appropriated with this pattern.

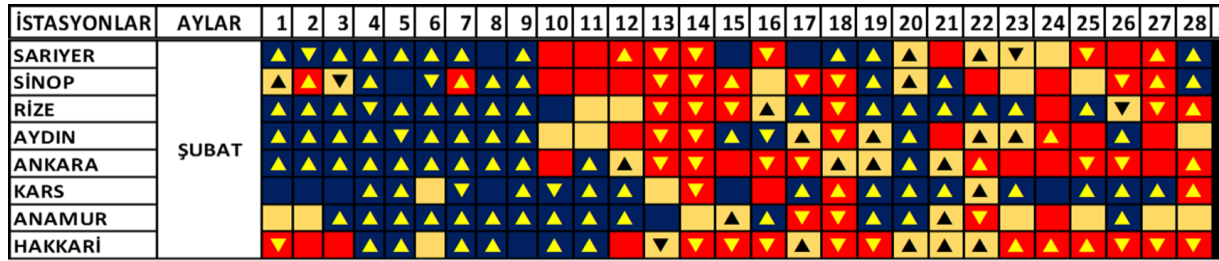


Figure 3. Monthly pattern of daily extreme maximum temperatures. (According to 1971-2000 term; Red= Warm, Blue= Cold, Yellow= normal; according to 1981-2015 term; increasing=▲, decreasing=▼) (Demircan et al., 2017)

REFERENCES

- WMO-No. 1189, WMO Statement on the State of the Global Climate in 2016, World Meteorological Organization, 2017
- TT-DEWCE WMO, Guidelines on the Definition and Monitoring of Extreme Weather and Climate Events, draft version – first review by TT-DEWCE, December 2015
- IPCC, Glossary of terms. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 555-564, 2012.
- Intergovernmental Panel on Climate Change (IPCC): Summary for policymakers. In: Climate change 2013: The physical science basis. Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change. Cambridge and New York: Cambridge University Press, 2013.
- Perkins, S.E., L.V. Alexander and J.R. Nairn, Increasing frequency, intensity and duration of observed heatwaves and warm spells. *Geophys. Res. Lett.*, 39, L20714. doi: 10.1029/2012GL053361, 2012.
- WMO-No. 1142, Heatwaves and Health: Guidance on Warning-System Development, World Meteorological Organization and World Health Organization, 2015
- Frich, A.; L.V. Alexander, P. Della-Marta, B. Gleason, M. Haylock, A.M.G. Klein Tank, and T. Peterson (January 2002). "Observed coherent changes in climatic extremes during the second half of the twentieth century" (PDF). *Climate Research* 19: 193–212. doi:10.3354/cr019193
- Coşkun, M., Sümer, U.M., Ulupınar, Y., Şensoy, S., Demircan, M., Bölük, E., Arabacı, H., Eskiöğlü, O., Kervankıran, S., State of the Climate in Turkey in 2016, Turkish State Meteorological Service, 2017
- Unal, Y.S., E. Tan, and S.S. Menten, Summer heat waves over western Turkey between 1965 and 2006, *Theor. Appl. Climatol.* 112, 1-2, 339-350, DOI: 10.1007/s00704-012-0704-0, 2013.
- Turkish State Meteorological Service, Temperature Analysis of February 2016, <https://www.mgm.gov.tr/FILES/Haberler/2016/subat2016.pdf>, 2016 (a)
- Turkish State Meteorological Service, Extreme Temperature between 15 and 19 February in 2016, <https://www.mgm.gov.tr/FILES/iklim/subat-rekor.pdf>, 2016 (b)
- Türkoğlu, N., Şensoy, S. and Aydın, O.; Effects of climate changes on phenological periods of apple, cherry and wheat in Turkey, *Journal of Human Sciences*, Vol 13, No 1, DOI: <https://doi.org/10.14687/ijhs.v13i1.3464>, 2016
- Demircan, M., Arabacı, H., Coskun, M., Turkoglu, N., Cicek, I., Climate Change and Public Calendar: Maximum Temperature Patterns and It's Change, Turkey Climate Change Congress - TCLCC'2017 5-7 July 2017, Istanbul, Turkey

