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DATA ARTICLE

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Digitizing Ottoman daily weather observations of Halkali Agricultural School in Istanbul, Turkiye (1896–1917)

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Abstract

Daily weather observations measured by students and staff at Halkali Agricultural School (a school opened in 1892 on agriculture and animal husbandry during the Ottoman period) from 1896 to 1917 in Istanbul, Turkiye have been transcribed from the original publications into digital form and translated from Ottoman Turkish (the Perso-Arabic script) to English (Latin alphabet). Over 55,000 observations of daily maximum, minimum and average temperature; rainfall, soil and under soil (0.25 m) temperature; humidity, pressure and wind speed were recovered. In addition, weather observations taken in Kandilli Observatory and Earthquake Research Institute from 1911 to 1936 and taken in Florya Meteorological Station from 1937 to 2022 could inform long-term temperature changes in Istanbul. The publication of a new historical data set that includes, for the first time, digitized and quality-controlled daily meteorological observations in Istanbul will enhance the understanding of weather changes in Turkiye back to the late 19th century. These observations will be used to fill gaps in existing temperature and pressure records and to the improvement of the accuracy of reanalysis products prior to the 1950s. It will be the first data set publication of other parameters such as soil temperature, wind speed and humidity for that period in that region. Data are available on the CEDA Archive in csv file format.

KEYWORDS

data rescue, digitizing, Halkali, Istanbul, Turkiye, weather records

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1 | INTRODUCTION

Many communities and civilizations have been damaged or even destroyed by meteorological disasters, whereas others have grown and thrived. Meteorology is therefore considered to be as old as humanity itself, and it is a constantly evolving scientific discipline (Atabay, 2017). Geographical studies and travel books, such as 'Melhame' and 'acaibu'l-mahlukat', describe meteorological phenomena in the Ottoman Empire through the 13th/19th century (Kocabaş, 2023). While Melhame includes weather forecasts, meteorological observations, astronomy and the impacts of meteorological events, acaibu'l-mahlukat includes the scientific explanation of these phenomena (Demir, 1999; Kocabaş, 2020; Koksal, 2013; TDV, 2022).

Thanks to the invention of the thermometer, barometer and other measuring instruments, it was possible to measure certain meteorological parameters, such as temperature, pressure, humidity, sunshine duration and wind direction, from the 17th century; consequently, numerous data were collected from various stations and altitudes. Although meteorological observations obtained from individual stations provide limited weather forecasting ability over larger areas, the information exchange among the stations enabled by the invention of the telegraph (BOUN, 2022), helped data to be mapped and made better forecasts possible.

During the Seljuk and Ottoman empires, observatories were mostly used for astronomical observations rather than for meteorological research, which was then intensified during the Tanzimat, a period of reform in the Ottoman Empire from 1839 to 1876. In numerous locations, such as Istanbul, Izmir, Jerusalem, Trabzon, Tekirdag and Merzifon, many meteorological observations were made by foreigners for private and governmental purposes.

1.1 | Governmental efforts

The institutionalization of meteorology in the Ottoman Empire started with the establishment of the Kandilli Observatory in 1867 and was completed during the Republic of Turkiye. With the recommendations of the French Government, Kandilli Observatory was established in Istanbul under the name of 'Rasathane-i Amire'. In 1873, Turkiye was represented at the First International Meteorology Congress held in Vienna, and it was decided to establish meteorology stations in different places such as Istanbul, Izmir, Sinop, Bursa, Trabzon, Thessaloniki, Vlore and Beirut. Due to a destructive fire, Kandilli Observatory had to end its meteorological studies in 1911 when the observatory was re-established in Icadiye (8 km from Pera where the observatory was first established) to continue its works (till 1936) on meteorology with the assistance of the French National Meteorology Director, Prof. Angot, who provided the necessary meteorological instruments. In addition, the weather forecasts for Istanbul were made available and reported to the Administration of Postal Telephone and Telegraph and the Railways Administration (Batur, 2005; BOUN, 2022; Dizer, 1994; Ozcep, 2020; TSMS, 2022).

The development of aircraft and the use of planes in wars have shown the importance of knowing cloudiness, fog and precipitation conditions of the regions where the aircraft will reconnaissance or attack and knowing wind and temperature conditions for cannon shots, which accelerated the establishment of a meteorology organization in the Ottoman Empire, especially during the First World War. It was decided that meteorology stations operated by the ministries for different purposes such as agriculture, education and army should gather under one roof in the meteorology congress that was held in Istanbul between 22 and 25 April 1918. However, the decisions taken in this congress could not be implemented. Meteorological observations for climate studies of Turkiye's Western, Southern, Thrace and Central Anatolian Regions started to be obtained regularly in 1926. The Turkish State Meteorological Service, the only legal organization which provides all meteorological information in Turkiye, was officially founded in 1937. On May 31, 1949, The Turkish State Meteorological Service became a member of the World Meteorological Organization which was established to increase international cooperation (TSMS, 2022). Many written historical documents and meteorological instruments and devices, recorded and used throughout the history of meteorology in the Ottoman Empire have been exhibited at the Meteorology Museum.

1.1.1 | Halkali Agricultural School: Historical background

The Tanzimat reform movement elevated the importance of agriculture in the Ottoman Empire. In 1884, it was decided to establish agricultural schools, and eight students were sent to France to study agriculture in preparation for adopting contemporary agricultural technology (Cesme, 2014; Demirel & Doganay, 2012). Halkalı Agricultural School (Figure 1) in Istanbul was subsequently opened and started to train students in 1892. The school was constructed in the rural area of Istanbul at that time targeting agricultural activities. It was located in Halkali (Lat: 41.03, Lon: 28.78), far from the city centre, and close to the Küçükçekmece Lake (Figure 2). It is noted that there were not many settlements near Halkali

FIGURE 1 Halkali Agricultural School.

FIGURE 2 Istanbul topography and settlements on a 1:200.000 scale map in 1866. The map also shows the Simendifer (chemin de fer in French, Railway in English) line (red line) between Istanbul and Edirne.

station, whereas a large population resided near the Bosporus, where the main royal residence of the Ottoman sultans was situated.

The students took a 14-h meteorology course, which was divided into three sections, in addition to the agricultural and husbandry courses. The course began with a discussion of the causes of wind formation, followed by discussions of winds, wind speed, and wind direction. In addition, the causes of cloud formation, clouds, rain, fog, hurricanes, tornadoes and snow were examined and investigated in more depth. Finally, the course included topics such as atmospheric electricity, lightning and thunder. In addition, students received training and information on weather forecasting, climate, temperature in water resources and the impacts of humidity and altitude on the regional climate, among other topics. Because of rising costs and inadequate management, the Halkal Agricultural School was considered for closure in 1922, as reported by the New Agriculture Newspaper (*Yeni Ziraat Gazatesi*). Despite this, the school continued its operation for several more years and having provided agriculture and husbandry education in Istanbul for more than 40 years, the Halkali Agricultural School was closed in 1928 and relocated to Ankara. The meteorological measurements that were started at Halkali Agricultural School were carried on in Ankara as well. However, there are no published meteorological observation records after 1917, the last year of observations in the rescued books at Halkali School.

1.2 | Personal efforts

The first known-recorded temperature measurements in Istanbul were made by Father Dalmas at Saint Benoît Monastery from 1839 to 1847. Meteorological observations were made by W. Noe, who was the director of the Mekteb-i Fünun-i Şahane (school), in his house (Kalyoncukulluk) until the 1848 Beyoğlu fire, and by Ritter, one of the French engineers brought in by the government for water affairs, in Kuruçeşme (1856–1860). From 1865 to 1886, Mr W.H. Lyne made observations at Haydarpaşa British Cemetery. Meteorological observations from different parts of the empire were regularly published in the Journal of 'Observations Métérologique du Réseau Oriental'. These observations were also processed daily on synoptic maps. In the second half of the 19th century, observations were made in Istanbul, Soulina, Constanta, Varna, Burgas, Trabzon, Rhodes, Kavala, Thessaloniki, Monastery, Valona, Çanakkale, Elbassan, Durazzo, Beirut and Fao, and it is noticed that these places were the regions where trade and ports were located (BOUN, 2022; Dizer, 1994; Ozcep, 2020; TSMS, 2022). Although there is a quite good meteorological history of the Ottoman period, it was not possible to access these observations.

In this paper, we describe the rescue process and digitization of weather observations (from the Meteorology Museum) made in Istanbul from 1896 to 1917 and make available the rescued data for further use. Many approaches including employing students, using volunteer citizen scientists, using speech recognition, optical character recognition and key entry are used to digitize and rescue observations over the years. (Ashcroft et al., 2018; Brönnimann et al., 2006; Hawkins et al., 2019; Ryan et al., 2018). Many global digitized and rescued data projects are listed in the International Data Rescue (I-DARE) Portal and C3S Data Rescue Service; however, there is no data rescue project specific to Turkiye to date apart from the digitized weather observations data in the NOAA-CDMP from 1962 to 1971 in Turkiye (Ashcroft et al., 2018). There were some individual attempts to rescue data sets, but these attempts were not successful.

An outline of the study's structure is as follows: the second section provides information on the station itself, including rescued observations, data representation and digitization processes. The third section explores the rescued observations and their comparison with data from the 20thRCV3 and Kandilli, with a view to understanding the correlations during overlap. The fourth section discusses the study's future directions, potential data uses, and some uncertainty affecting the data. Finally, the results and analysis of the study are summarized in Section 5.

2 | DATA SOURCE AND METHOD

2.1 | Observatory

Meteorological observations were made in the observatory (Figure 3) in Halkali Agricultural School, which was stated to be on the west side of the school in the first edition of *Halkali Ziraat Mektebi Alisi Mecmuasi* (Cesme, 2014). As described in the previous section, the observatory was located in the rural area at an elevation of 119 m. It is noted that the observatory building and meteorological instruments were protected in a fenced area.

2.2 | Daily weather reports

Halkalı Agricultural School paid more attention to meteorological observations and weather forecasts that were important factors for agriculture. Students and staff at Halkali measured many parameters including daily maximum, minimum and average temperature, rainfall, soil and under soil (0.25 m) temperature, humidity, pressure, wind speed, wind direction and weather status from late-1896 to 1917. The main purpose of these observations was to carry out appropriate agricultural activities under the prevailing weather conditions. Over 55,000 observations were recovered, and the total count of observations broken down by years is given in Table 1.

These observations were published in the school's own journal, *Halkali Ziraat Mektebi Alisi Mecmuasi*, aiming to publish the observation charts. Some weather observations recorded were published in issues 2, 3, 4, 5 and

FIGURE 3 Observatory in Halkali Agricultural School.

7 of the journal (Ozcep, 2020). These observations were also recorded in the daily weather reports (Figure 4), and over 20 years of observations were compiled in three different observation books (1-month observation per page). These books are still held in the Meteorology Museum of the Turkish State Meteorological Service. Figure 5 shows three observation books studied here, and eight notebooks of varying sizes in which foreign scientists recorded meteorological observations made at various locations around Anatolia between 1875 and 1898.

2.3 | Observing times and date conversion

Thanks to the page format of observation books, observing times (UTC/GMT +3) were noted in the second column of each page. Observing times were left blank during the years of 1906–1910. In 1896, 1897 and 1912, observations were made twice a day; however, there was no evidence or explanation of why these additional observations were recorded. The observing times in the morning varied from 7 to 11 a.m., mostly at around 8 a.m. Hours of evening observations were at 4.30–8 p.m., mostly at around 7 p.m. (Figure 6). About 7–8 a.m. and 5 p.m. are also common observing times for manual temperature readings (Janis, 2002; Rumbaugh, 1934).

After the reform movement (Tanzimat), the Rumi calendar based on the Julian calendar was officially adopted by the Ottoman Empire until 1926. Therefore, all dates on the observation books were from the Rumi calendar. The web-based program 'Date Conversion Guide' developed by The Turkish Historical Society (TTK) was used to convert dates from Rumi to Gregorian calendars (TTK, 2022). The developer, the Turkish Historical Society, also known as the Turkish Historical Association or the Turkish History Foundation is a research society studying the history of Turkiye and the Turkish people, founded in 1931 by Mustafa Kemal Atatürk. For the conversion process to be carried out effectively, the type of calendar (Rumi) was chosen first, and then all dates (day, month and year) were manually entered into the programme. The results from the programme were carefully noted next to the original date column.

2.4 | Digitizing and quality control

Guidelines on Best Practices for Climate Data Rescue published by the World Meteorological Organization (WMO) were followed for rescuing the weather observations (WMO, 2016). The guideline covers all necessary steps to be taken on how to organize and rescue data sets from imaging to storing.

Written permission to get access to all original observation books was granted from the Turkish State Meteorological Service, and the photos of each page were taken under the surveillance of responsible staff at the museum. Observation books were not transferred physically to avoid further damages (the books shown in Figure 5 are very old and fragile). During the imaging process, the readability of photos was regularly considered. All of them taken meticulously were transferred to the

TABLE 1 Number of observations each year.

Years	Minimum temperature	Maximum temperature	Average temperature	Temperature difference (max–min)	Soil temperature	Under soil (0.25 m) temperature	Humidity	Pressure	Wind speed
1896	17	17	17	17	0	0	14	17	13
1897	273	272	273	273	0	0	278	278	228
1898	347	349	350	350	0	0	349	347	216
1899	365	365	365	365	0	0	365	365	356
1900	365	365	365	365	0	0	297	365	365
1901	363	363	363	363	0	0	363	363	354
1902	363	363	363	363	0	0	365	365	355
1903	364	364	364	364	321	321	365	365	353
1904	364	366	366	366	366	364	366	366	361
1905	362	364	364	364	361	362	344	360	350
1906	365	365	365	365	363	361	359	365	358
1907	358	365	365	365	364	31	364	365	362
1908	364	366	366	366	366	0	366	366	342
1909	359	354	359	359	358	0	365	365	334
1910	286	286	286	286	286	0	286	286	254
1911	76	76	76	77	0	0	76	77	40
1912	144	144	144	144	0	0	144	147	144
1913	239	239	239	239	0	0	240	242	240
1914	293	293	293	293	0	0	290	293	291
1915	365	365	365	365	0	0	365	365	363
1916	364	366	366	366	0	0	366	366	366
1917	337	337	337	337	0	0	337	337	337

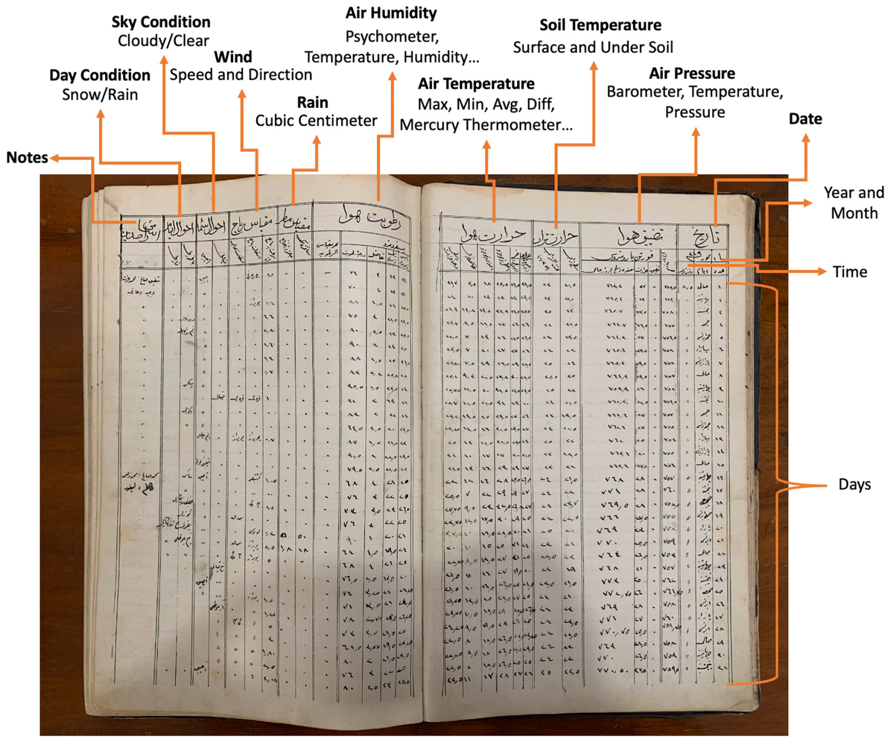

FIGURE 4 Ottoman empire weather records with translation from 1897 to 1917 in Istanbul.

FIGURE 5 Observation books held in Meteorology Museum.

computer (into an image inventory), and then named according to the page order of each book.

In order to understand what kind of parameters were observed in the books, headings (Figure 4) were translated from Ottoman Turkish (the Perso-Arabic script) to English (Latin alphabet) followed by assigning photos to the date of observation (Rumi) to avoid complications as Rumi dates were different from Gregorian dates (a month in Rumi calendar equals the parts of previous and following months in Gregorian calendar).

To reduce keying errors and know exactly where to find the data on a page, two different templates were created, one for each page, and the other for completed data sets (1896–1917) including Gregorian dates. All pages were translated and digitized, then imported to the template for combining observations, and creating data sets. All digitized values were double-checked by two different people who entered the data independently and checked one another's work, were transcribed as they were written and were entered on a given page template for quality control purposes.

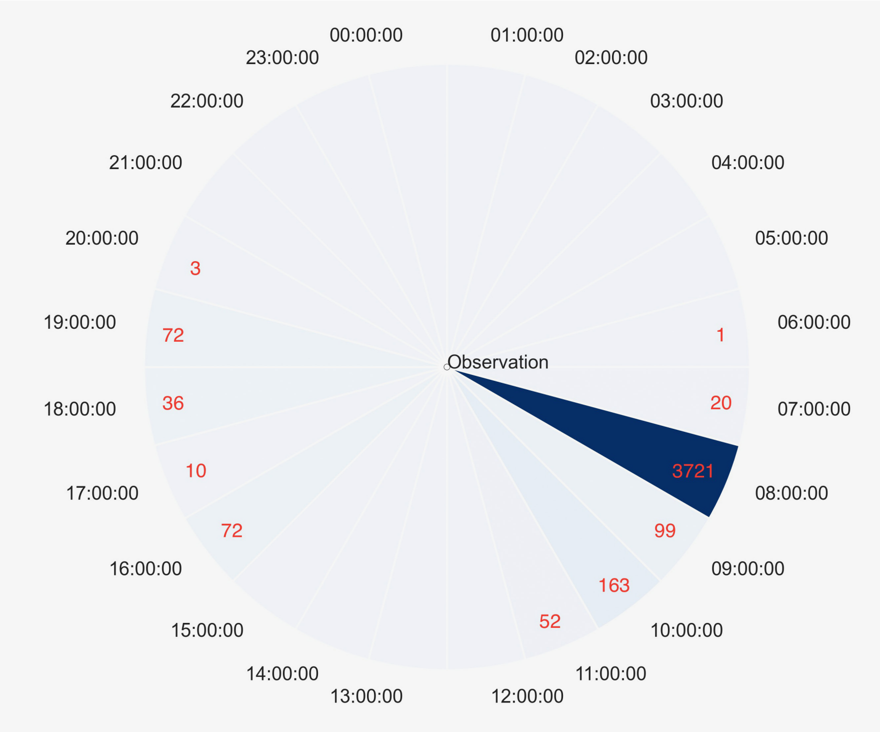

FIGURE 6 Observing Times (UTC +3) and the number of observations in that time (red numbers).

2.5 | Data comparison and representation

To compare data sets with other stations, the earliest and available weather observations taken at the Kandilli Observatory and Earthquake Research Institute from 1911 to 1936 were used and showed consistent results for temperature and pressure.

Florya Meteorological Station (the closest station to Halkali) from Turkish Metoffice, and NOAA-CIRES-DOE 20th Century Reanalysis V3 data were also used. Location-specific (Lat: 41.03, Lon: 28.78) time-series data were retrieved from NOAA PSL. As the reanalysis spatial coverage is 1.0° latitude × 1.0° longitude global grid and due to the lack of stations used in reanalysis work in those times and locations, and not yet validated homogeneity on the local scale (Slivinski et al., 2021), parameters in reanalysis data were subject to representation effects.

Even if data for a specific location (same lat–lon with Halkali Agricultural School) were retrieved, parameters were affected by urban, rural and sea areas as the reanalysis data resolution is coarser (run at a resolution of T254, approximately 75 km at the equator) and covers the wider area of Istanbul. In addition, there is a lack of stations in the International Surface Pressure Databank (ISPD; Compo et al., 2019) at those times and locations, which affects the accuracy of meteorological parameter estimations. As a part of further works, this recovered data set will be used in optimal interpolation and to see how including this novel dataset could improve (i.e. reduce the uncertainty of) the temperature/pressure records in the Mediterranean region more widely.

3 | RESULTS AND CLIMATOLOGICAL ANALYSES

Students and staff at Halkali Agricultural School recorded the weather observations with some notes in unpublished books from 1896 to 1917 in Istanbul. Due to the school's primary objective of assisting agricultural activities, climate and meteorological activities were examined and studied. Summary statistics are given across all available data (excluding rainfall, see the section 'Rainfall Records') although there are some gaps in a few years (most likely the result of conflicts in the decline and dissolution of the Ottoman Empire).

There is no information accessible in the weather reports describing the types and positions of instruments; however, metadata can be inferred from data and observatories (Figure 3). The translation of the weather reports implies that a maximum–minimum thermometer was used to measure temperature, a Fortin barometer was used to measure station pressure, and a psychrometer was used to measure relative humidity. Further examination of the observatory photograph reveals that the wind direction was measured by a vane at the top of the wooden building in the centre of the image (probably wind speed as well). Meteorological instruments like barometers were likely housed in the wooden building, a meteorological shelter (also known as a military-style shelter) and max–min thermometer was likely sheltered in the Montsouris (French) stand (Brunet et al., 2008) on the right edge of the photo. In the observatory, one instrument is spotted: in the centre of the photo, at the fence corner, which could be a rain gauge for measuring rainfall.

3.1 | Temperature records

Over 20,000 temperature observations including maximum, average and minimum were recovered in this study. With the observations taken in Kandilli Observatory and Earthquake Research Institute from 1911 to 1936 and taken in Florya Meteorological Station from 1937 to 2022, long-term temperature changes are given in Figure 7. It is observed that the average temperature in the Ottoman period (about 14.55°C) is colder than in the early 21st century (around 16°C). However, it is noted that there might be differences between Halkali and Florya independently of climate change (as it is also shown for Kandilli) and due to measurement or data biases (e.g. observing times), and data adjustment.

As noted in the above figure, temperature records from Halkali and Kandilli overlapped from late-1911 to 1917. To understand the correlation between the two series during the overlap, a scatterplot of average temperature is shown in Figure 8. The average temperature was 15.2°C in Halkali and 13.5°C in Kandilli from 1912 to 1917.

In terms of extreme values in the Ottoman data, while the highest temperature ever recorded was 40°C on August 9–10, 1899, the lowest temperature (−16°C) was recorded on January 23, 1907. It is also noted that September (24.8°C) and October (23.8°C) temperature values were exceptionally higher than the averages [the average (1896–1917) of September and October is 20.4°C and 16.4°C, respectively] in 1910.

While maximum temperature at Halkali reaches 40°C especially in summer months, reanalysis data only reach 34.97°C. The second highest temperature (39.5°C) recorded on 07/07/1916 at Halkali shows consistency with reanalysis data (34.6°C) on 06/07/1916. In addition, August 1908 temperature records reached their maximum in both rescued and reanalysis. Minimum temperature records on 22 and 23 January 1907 reached their lowest observations in both rescued (−16°C) and reanalysis (−7.2°C) data.

Seasonal averages for maximum, minimum and average temperature values are given in Table 2. The average temperature varies between 20°C and 25°C in the summer months and between 3°C and 8°C in the winter months.

3.2 | Rainfall records

During the digitizing process of observation records, it is noted that there were two different problems in transferring rainfall records. The first one was to determine if it was raining or not. As some columns were left blank, '..' or '.' and a dot represents zero in written Ottoman, it was not possible to identify rainfall in the station. The last one was to comprehend the rainfall unit, for which two distinct columns were translated (one for height and one for cubic centimetre). In most cases, cubic centimetre values were 10 times greater than height, but this relationship could not be observed in all records. Therefore, rainfall records

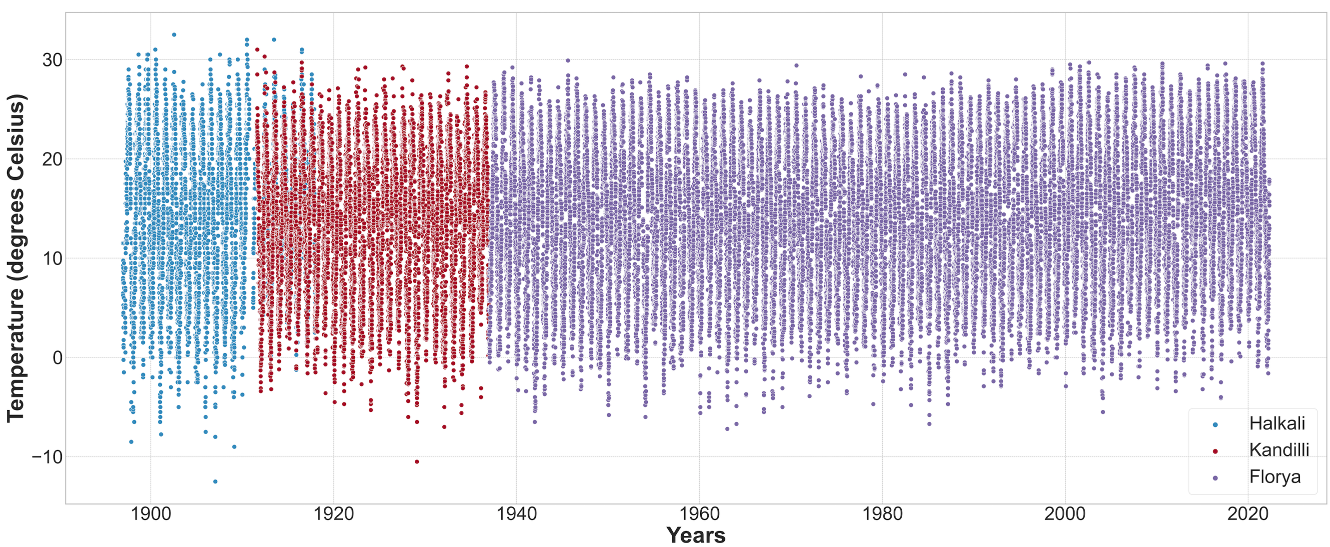

FIGURE 7 Temperature (°C) evolution in Halkali (blue), Kandilli (red) and Florya (purple) from 1896 to 2022 (the last record was on 30 April).

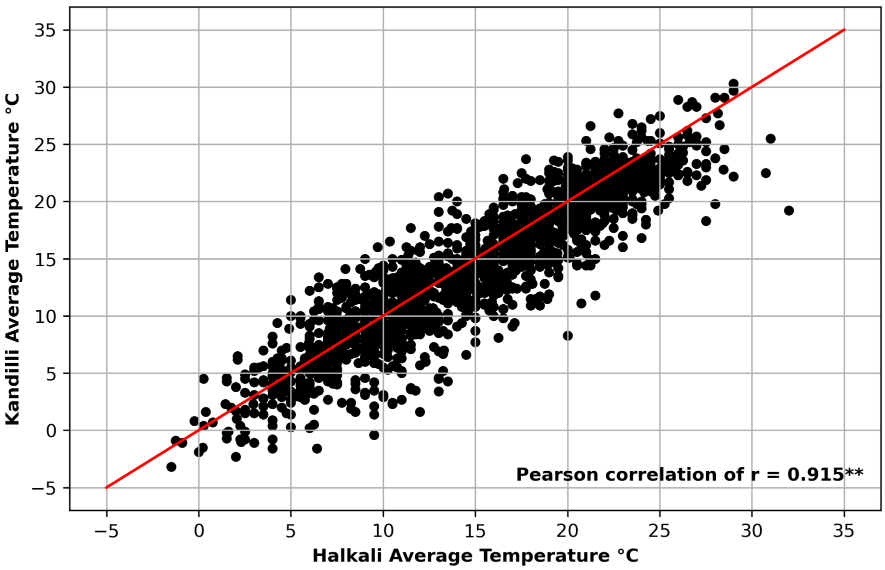

FIGURE 8 A scatter plot of average temperature (°C) in Halkali and Kandilli. (**Correlation is significant at the 0.01 level).

were not included in data sets and will be analysed in further studies with a greater emphasis on the notes section of the observation pages to identify any explanation of rainfall, or maybe by looking at the manifestation of the 'drizzle' problem.

3.3 | Soil temperature, air humidity, pressure and wind speed observations

As the main purpose of Halkali Agriculture School was to carry out agricultural activities, the surface soil temperature was measured from mid-February 1903 to mid-October 1910, but the observations of under soil (0.25 m) temperature ceased after mid-February 1907. It is noted that both surface soil and subsurface soil temperature data were consistent with the average air temperature, and surface soil (14.9°C) was about 1.5°C warmer than subsurface soil (13.5°C) on average. From August through November, the average of subsurface and surface temperatures remained almost the same as the subsurface temperature began to fall later than the surface (Islam et al., 2015; Singh & Sharma, 2017).

Relative humidity values have been seen to fall in the summer months and increase in the winter months. The highest levels of humidity (85%) were recorded in February, while the lowest levels (69%) were recorded in August. From 1896 to 1917, the yearly average humidity is 78.4%, summer humidity is 71.6%, and winter humidity is 85.2%. Monthly temperature and relative humidity averages are given in Figure 9.

Over 6.000 pressure observations were recovered from Ottoman daily weather books, and the average pressure value is about 1,007.7 hPa.

In the observation books, wind speed (in metres per second) and wind direction were recorded. Due to the inability to digitize sophisticated handwriting for directions, it was not possible to build a wind rose diagram to determine the nature of the winds over Istanbul in the late 19th century. The average wind speed (1896–1917) in Istanbul during the winter months (December, January, and February) is about 2.77 m/second, according to measurements of wind speed.

3.4 | Ottoman vs. 20thCRv3 data

As this is the first retrieved observation record in Istanbul in the early 20th century, it is worth having a look at the comparison with NOAA-CIRES-DOE 20th Century Reanalysis V3 data (Compo et al., 2011) especially for temperature and pressure records.

3.4.1 | Temperature

Considering the explanation of representation effects and data adjustment, temperature changes in Halkali, Reanalysis and Kandilli from 1896 to 1917 are given in Figure 10. It is noted that the average temperature in Halkali (14.55°C) shows consistency with reanalysis data (14.68°C). Monthly changes (1896–1917) of average temperature in both rescued and reanalysis data are given in Figure 11. While there is little variation observed from April to November, there is a significant variation (up to 1.3°C in February) in other months. To understand the correlation between Halkali and Reanalysis data, a scatterplot of average temperature is shown in Figure 12.

TABLE 2 Seasonal Maximum, Minimum and Average Temperature (°C) Values.

	Maximum temperature (°C)				Minimum temperature (°C)				Average temperature (°C)			
Years	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn
1896	12.0				3.5				7.87			
1897	14.0	25.0	34.0	31.0	−5.0	−1.0	16.0	−8.5	5.36	12.23	23.89	14.25
1898	22.0	32.0	34.5	36.0	−9.0	−8.0	10.0	0.0	5.86	12.08	21.70	18.54
1899	19.0	34.5	40.0	36.0	−4.0	−3.0	10.0	1.0	7.41	13.85	22.24	17.65
1900	17.0	28.0	38.0	31.0	−2.0	−6.0	10.5	3.0	6.80	11.40	23.63	16.40
1901	17.5	27.0	37.0	32.5	−11.0	−4.0	11.5	1.5	4.72	11.46	21.67	15.98
1902	19.0	30.5	39.0	32.0	−5.5	−4.0	8.5	−4.0	5.88	11.55	23.10	12.62
1903	17.0	36.0	34.3	31.5	−7.5	0.0	12.0	−3.0	5.82	13.24	21.93	15.18
1904	17.0	30.0	35.0	31.0	−5.0	−2.0	6.0	−3.0	6.23	10.79	21.42	13.65
1905	15.0	30.5	36.0	36.0	−8.0	−4.0	8.5	3.0	3.66	10.19	21.62	16.70
1906	19.0	29.0	37.0	33.0	−8.5	−1.0	10.0	3.0	6.05	13.64	23.43	14.64
1907	16.5	34.0	32.0	29.0	−16.0	−3.5	9.5	2.0	4.57	10.83	22.49	15.55
1908	17.0	36.0	39.0	33.0	−5.0	−1.0	11.0	0.0	5.50	13.12	22.81	14.77
1909	19.0	30.0	38.0	31.0	−9.0	−1.0	12.0	−2.0	5.55	12.80	24.38	17.33
1910	18.0	31.0	37.0	31.0	−6.5	−2.0	12.0	17.0	7.99	12.58	24.45	24.52
1911		27.0				2.0				14.13		
1912		27.5	35.0	27.5		0.5	5.0	2.5		12.03	20.31	13.56
1913	12.0	28.0	38.0	27.5	−2.0	−4.0	10.0	12.0	3.78	12.44	22.28	20.55
1914	15.0	30.0	33.5	27.8	2.0	3.5	11.5	3.0	7.70	13.63	22.40	16.58
1915	15.0	23.0	31.0	31.0	−5.8	3.0	9.0	−5.0	8.10	10.81	20.48	14.32
1916	18.0	26.0	39.5	35.0	−2.0	1.0	10.0	7.0	7.21	12.60	23.06	16.69
1917	18.0	27.0	34.0	33.0	−2.0	1.4	10.0	6.0	7.80	13.15	22.55	17.99

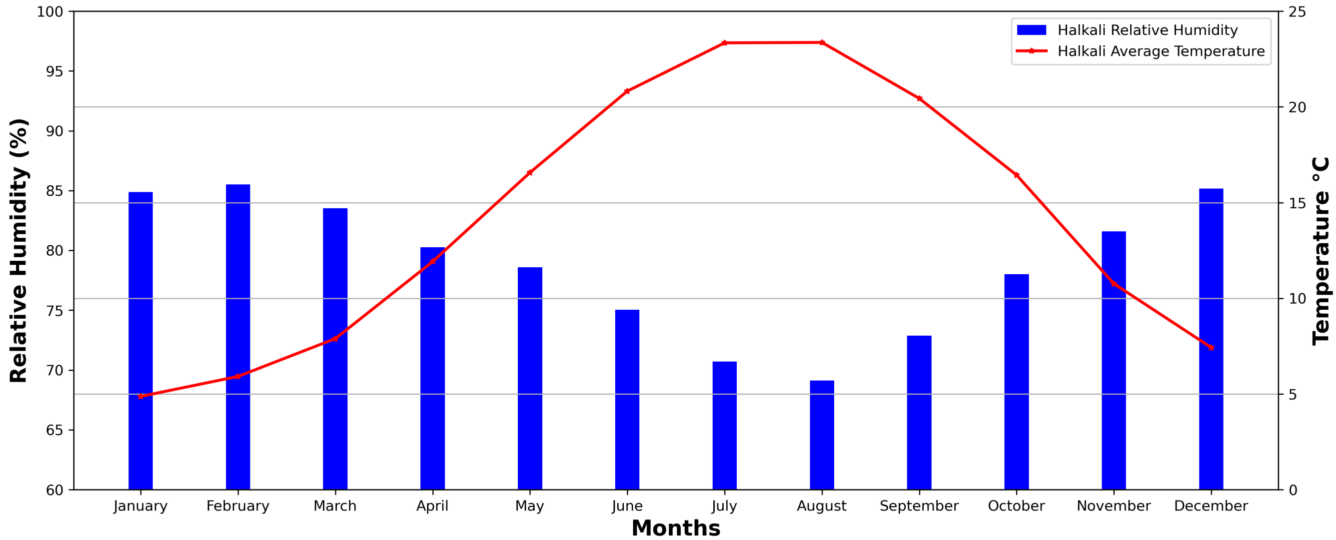

FIGURE 9 Monthly Temperature (°C) and Relative Humidity (%) Mean Values in Halkali (Istanbul).

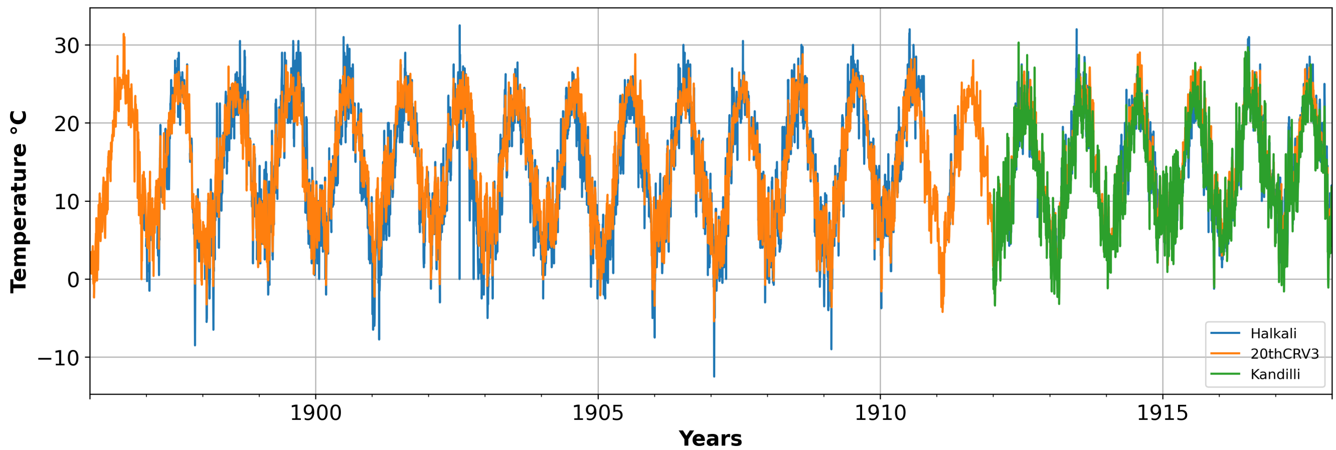

FIGURE 10 Average Temperature (°C) Evolution in Halkali (blue), Reanalysis (orange) and Kandilli (green) from 1896 to 1917.

3.4.2 | Pressure

Pressure changes in Halkali, Reanalysis and Kandilli from 1896 to 1917 are given in Figure 13. While the average pressure of reanalysis is 999.8 hPa, the average of rescued data is 1,015.3 hPa. As noted in the figure, the early Ottoman period data (1896–1901) and the later period data may have been measured with different instruments or kinds of instruments, which will cause uncertainty. Monthly changes (1896–1917) of pressure in both rescued and reanalysis data are given in Figure 11. Although the difference between rescued and reanalysis pressure is about 10 hPa in all months, pressure changes throughout the year show consistency. To understand the correlation between Halkali and Reanalysis data, a scatterplot of pressure (hPa) is shown in Figure 14.

4 | POTENTIAL DATA USE AND REUSE

The International Surface Pressure Databank (ISPD) is the world's largest collection (1722–2015) of pressure observations (Compo et al., 2019). It was established to extract meteorological observations from international archives and merge them with observations. As pressure observations are more important than ever, and mostly used by reanalyses (Hawkins et al., 2022), pressure observations from this study will be used to fill the gap years in the ISPD run of data from 1896 to 1917 (PSL NOAA, 2023). Only the years 1896, 1897, 1906, 1907, 1908 and 1909 are in the ISPD list of stations; however, these years are not fully completed (in some stations, there are only a few days of observations). The comparison of surface pressure

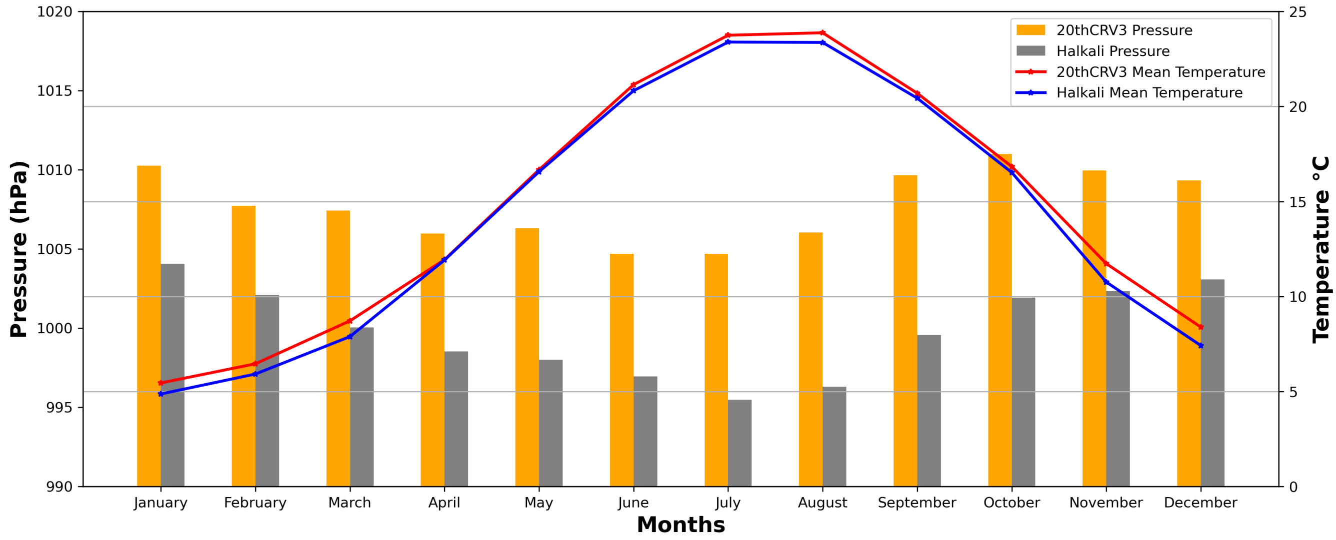

FIGURE 11 Monthly changes of 1896–1917 in temperature and pressure (observation and reanalysis data)—note that observations in some years are incomplete.

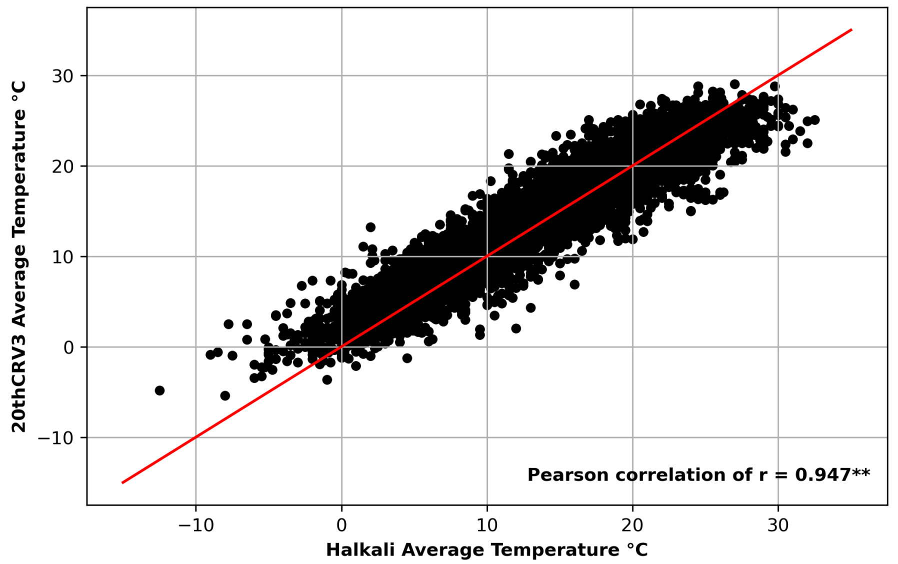

FIGURE 12 A scatter plot of average temperature (°C) in Halkali and Reanalysis (20th CRV3). (**Correlation is significant at the 0.01 level).

observations rescued in this study (orange) and held in the ISPD data bank (blue) is given in Figure 15.

In addition, this data set can provide some more quantitative analysis in the context of reanalysis and in long-term climate trends, on optimal interpolation to see how including this novel data set could improve (i.e. reduce the uncertainty of) temperature and pressure records in the Mediterranean region more widely as the possibility of using different instruments, the different observing times which are expected to bias minimum (and mean) temperature compared with calendar day especially in winter times (Janis, 2002), the lack of information on evening measurements, less information on how measurements were taken and the instrument position can have some uncertainty impacts.

Other variables, such as air temperature, soil temperature, humidity, wind speed and rainfall, can be used to determine any extremes, long-term trends (few were given here) or urban heat island effects (as Istanbul was not developed as much as now). In addition, the data set can be collaborated and reused in further data rescue projects in Turkiye, as well as in Greece, Bulgaria and Romania, as there are not many stations over the eastern Mediterranean areas that go back to the 19th century.

5 | CONCLUSIONS

In this study, numerous observations, including temperature, humidity, pressure, soil temperature and wind speed, were digitized and analysed for the first time. This data recovery effort will fill a geographic gap and extend the temporal range in observations for Turkiye and the wider region. It should also help link observational and

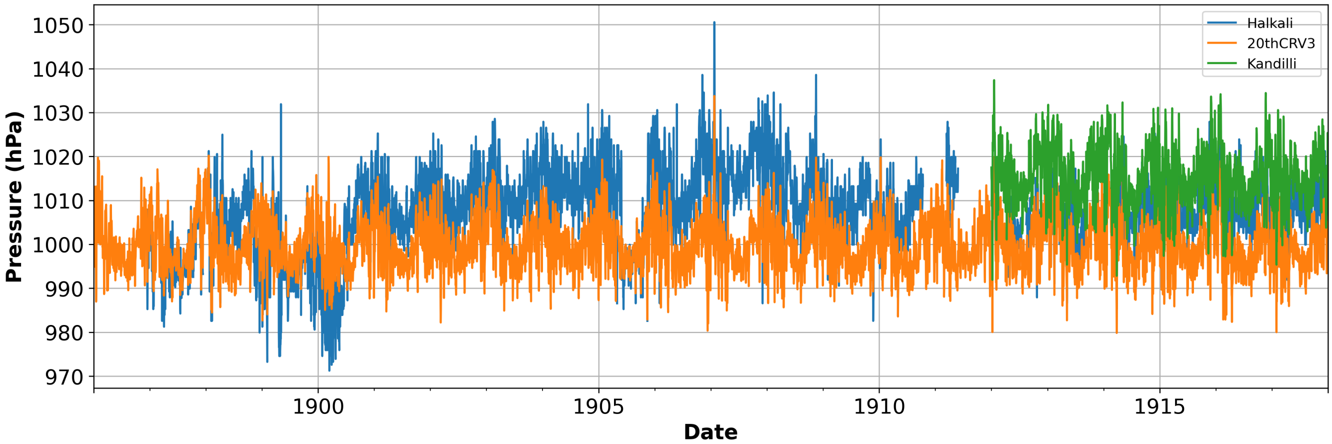

FIGURE 13 Surface Pressure (hPa) Evolution in Halkali (blue), Reanalysis (orange) and Kandilli (green) from 1896 to 1917.

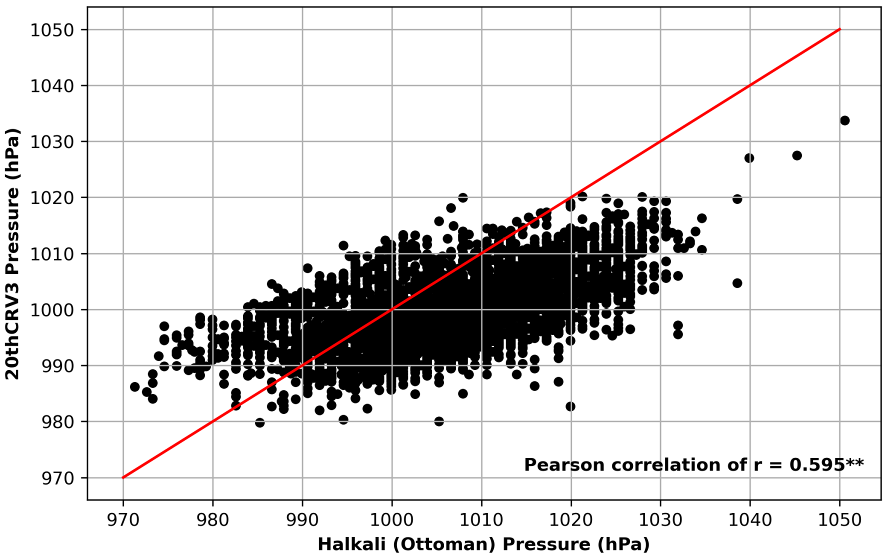

FIGURE 14 A Scatter Plot of Pressure (hPa) in Halkali and Reanalysis (20th CRV3). (**Correlation is significant at the 0.01 level).

paleoclimate studies. To gain maximum benefit from this data resource, additional research into the detailed analysis and translation of these observation books is required with a special effort made to transcribe the Ottoman records in the complex script that relate to rainfall and wind speed.

With over 20,000 temperature observations, the average temperature varies between 20°C and 25°C in the summer months and between 3°C and 8°C in the winter months. It is found that Reanalysis, Kandilli and Halkali data are strongly correlated. Both surface soil and subsurface soil temperature data were consistent with the average air temperature, and surface soil was warmer than subsurface soil on average. From August to November, the average subsurface and surface temperatures remained almost the same as the subsurface temperature began to fall later than the surface. Relative humidity values have been seen to fall in the summer months and increase in the winter months. The average pressure value was 1007.7 hPa, and stronger winds were observed in the winter months in Istanbul. Monthly changes (1896–1917) of average temperature and pressure in both rescued and reanalysis data show consistency through the year with variability on a monthly scale by considering the representation effects.

We have made the data set, as far as developed, available in csv (comma-separated values) format with an accompanying description file and photographs of the original observation book pages. We hope these observations and additional work, such as digitizing more weather observations and identifying new historical data sets, will support research and improve understanding of climate change in Turkiye and more widely across the Eastern Mediterranean and the Mediterranean Basin as a whole. For further improvements, a new environmental data service in Turkiye should be established and accessed by individuals and governmental and non-governmental organizations under the surveillance of the Turkish State

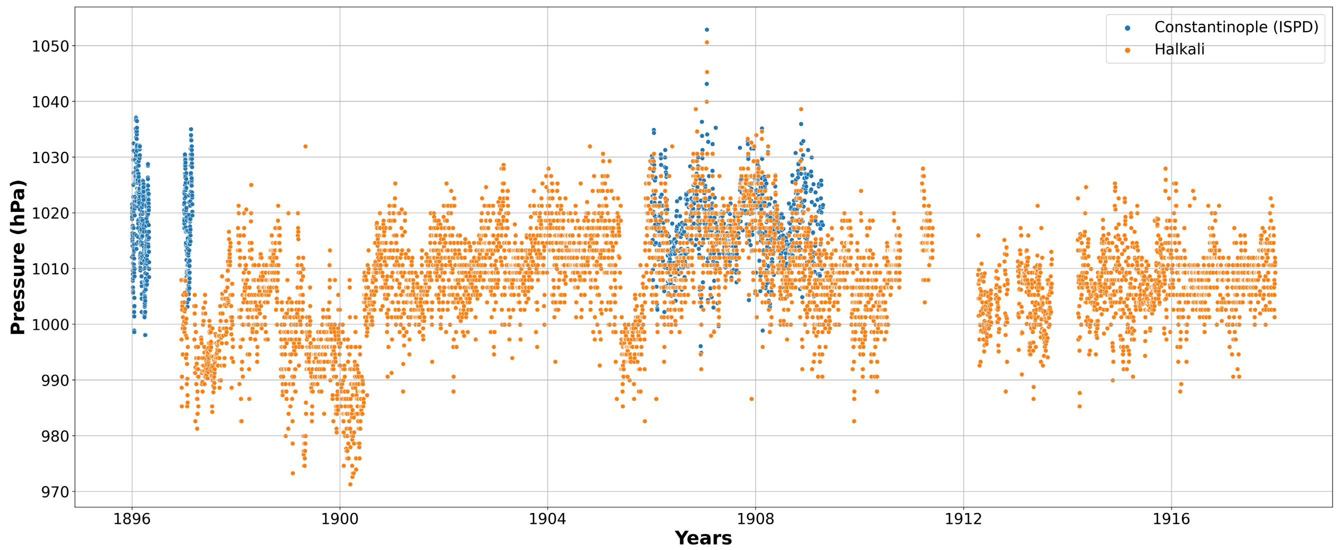

FIGURE 15 Surface Pressure (hPa) Evolution in ISPD (blue) and Halkali (orange) from 1896 to 1917.

Meteorological Service in collaboration with international partners.

The dataset is held in the CEDA Archive with free access to the dataset through a request made at the dataset webpage.

AUTHOR CONTRIBUTIONS

Ferhat Yilmaz: Conceptualization (lead); formal analysis (lead); methodology (lead); visualization (lead); writing – original draft (lead); writing – review and editing (lead). **Michel Tsamados:** Conceptualization (supporting); formal analysis (supporting); methodology (supporting); supervision (equal); visualization (supporting); writing – review and editing (supporting). **Dan Osborn:** Conceptualization (supporting); formal analysis (supporting); methodology (supporting); supervision (equal); visualization (supporting); writing – review and editing (supporting).

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest in connection to this article.

OPEN RESEARCH BADGES

This article has been awarded Open Data Badge for making publicly available the digitally-shareable data necessary to reproduce the reported results. Data is available at Open Science Framework.

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