Enhancing high-quality climate data availability and accessibility for North African locations: the EURO4M and MEDARE joint approach

By Manola Brunet[1, 2], Phil Jones[2, 3], and Alba Gilabert[1]

[1] Centre for Climate Change, Geography Dep. University Rovira i Virgili, Tarragona, Spain

[2] Climatic Research Unit, School of Environmental Sciences, University of East Anglia, Norwich, UK

[3] Centre of Excellence for Climate Change Research, Department of Meteorology, King Abdulaziz University, Jeddah 21589, Saudi Arabia

1. Introduction

Here we show a joint effort to enhance land surface climate data availability over Northern Africa locations, which has been carried out in the framework of the EU-funded EUropean Reanalysis and Observations for Monitoring (EURO4M) project and linked to the World Meteorological Organization (WMO) MEditerranean DAta REscue (MEDARE) Initiative. Ancient temperature and precipitation (air pressure) observations recorded at the daily (hourly) scales at 63 (31) southern Mediterranean stations were rescued and some of the longest and more continuous maximum (Tx) and minimum (Tn) temperature records were merged with recent observations to extend back in time the instrumental series, after subjecting them to quality control and homogenisation procedures. Therefore, the whole array of procedures undertaken for locating, digitising and merging the past data with their recent observations, along with the results of the double Quality Control (QC) strategy to identify non-systematic biases in the time-series and the homogenisation procedures applied to 38 Tx and Tn digitised and merged climate time-series to account for systematic biases in these records are described.

2. Locating, accessing, digitising and coordination efforts

Before digitising historical records and posteriorly subject the digitised series to quality controls and homogenisation, first, there is the need to locate, organise and assess data sources, while ensuring coordination with other parent Data Rescue (DARE) activities to avoid duplication.

The MEDARE on-line metadata base (http://app.omm.urv.cat/urv/), containing information provided by most of the Mediterranean National Meteorological Services (NMS), along with on-line databanks (e.g. ECA&D: http://eca.knmi.nl/, the ISPD: http://rda.ucar.edu/datasets/ds132.0/) were examined to identify both currently available digitised and non-digitised climate records over North Africa locations.

Coordination with other DARE initiatives (e.g. ACRE: http://www.met-acre.org/; the EU ERA-CLIM: http://www.era-clim.eu/, CIRCE: http://www. circeproject.eu/, Millennium: http://137.44.8.2/ projects) and Med NMS (e.g. Algeria, Cyprus, France, Italy, Jordan, Libya, Spain) to avoid duplicating efforts followed next.

From both online repositories (e.g. the NOAA/NCDC/CDMP http://www.ncdc.noaa.gov/oa/climate/cdmp/cdmp.html, the BADC http://badc.nerc.ac.uk/browse/badc/corral/images/metobs) and physical archives at NHMS, scanned data were gathered. Table 1 (Table 2) gives details of collections of relevant climatic data books held at CDMP and BADC (holdings at Fontainebleau Archive), while Fig. 1 provides a location map of the sites from where data have been digitised.

Circa 2M station-values were digitised.

Table 1. Details on the data sources and holders from where ancient observations were digitised

Abbreviated name	Data source	Countries covered	Data centres	Year range
ABCM-France	Annales du Bureau Central Météorologique de France	Algeria, Egypt, Lebanon, Tunisia	NOAA, Météo-France, Ebro observatory	1884–1914
ASM-France	Annuaire de la Société Météorologique de France	Algeria	Météo-France	1852–1867
BM-Algérie	Bulletin Météorologique de l'Algérie	Algeria, Morocco, Tunisia	NOAA	1877–1938
BM-Cirenaica	Bolletino Meteorologico della Cirenaica	Libya	NOAA	1928-1931
BM-Maroc	Bulletin de Météorologique du Maroc	Algeria, Morocco, Spain	NOAA	1953–1978
BMA-Italiana	Bollettino Meteorologico dell'Africa Italiana	Libya	NOAA	1932-1936
BMD-España	Boletín Meteorológico Diario de España	Morocco, Spain	AEMet	1899–1948
Cairo-MR	Cairo. Meteorological Reports	Egypt	NOAA	1904–1941
CIRCE	CIRCE-project digital data files	Tunisia	Météo-France	1899–1961
Egypt-DWR	Egypt. Daily Weather Reports	Egypt	NOAA	1907–1957
Helwan-MR	Helwan Observatory Meteorological Reports	Egypt	NOAA	1942–1944
Libyan-NMC	Libyan National Meteorological Center Archives	Libya	LNMC	1916–2008
SM-Tunis	Service Météorologique de Tunis	Tunisia	NOAA	1907–1932
UK-DWR	UK Daily Weather Reports	Egypt	UK Met Office	1900–1904

Table 2. Description of the Meteo-France holdings kept in Fontainebleau (Brunet et al. 2013)

Collections of Météo-France Climate data hold in National Archives site Fontainebleau	Number of boxes	Period of records
Marine (logbooks)	725	1879-1985
France surface climate with voluntary observers reports	790	1739-1972
France synoptic stations (CRQ)	1304	1923-1970
France semaphore and lighthouses	252	1868-1970
German observations WWII (logbooks)	53	1940-1944
France military stations (CRQ, original logbooks)	75	1913-1953
Primary school (TCM)	55	1865-1908
Overseas territories, Southern and Antarctic Lands	140	1833-1988
African ex-colonies and foreign countries (CRQ, TCM, ...)	773	1833-1989
Others	100	
Total	4287	

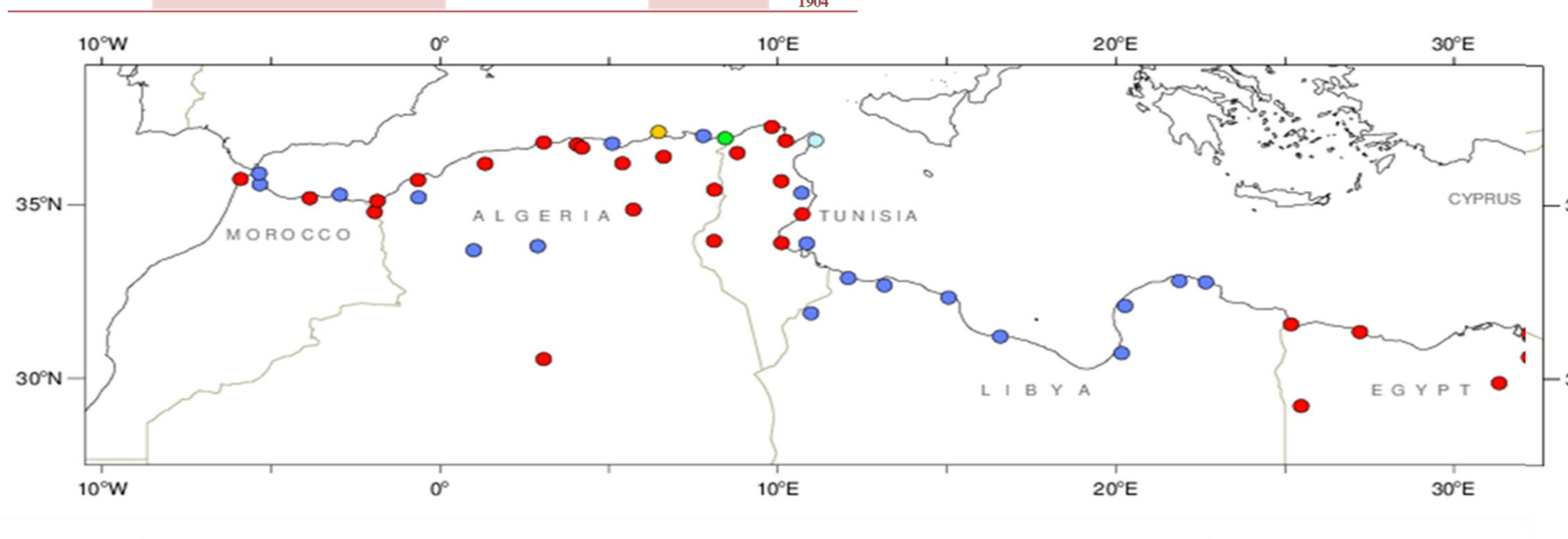

Figure 1. Location of sites with Tx/Tn , precipitation (RR) and air pressure (PP) series that have been recovered

3. Quality Control (QC) strategy and results

To QC the data, a double strategy was followed: visual cross-checking of sources/digitised data and automatic QCs using an expanded version of RClimDex (http://etccdi.pacificclimate.org/software.shtml): the C3 extraQC (http://www.c3.urv.cat/data.html). Visual cross-checking were aimed at examining calendar dates and times consistency, inter-station data comparisons, inter-variables coherency, daily and sub-daily values checks against monthly summaries, use of SLP maps and general weather setting. This step was essential to spot out data sources problems and improve digitisation. Special attention was paid to ensure data sources consistency (e.g. missing/duplicated images, low images quality), which provided a valuable feedback to the scanned data holders. The automated QC comprised gross error checks, tolerance, internal al temporal coherency checks and the results are shown in Table 3.

All the Qced observations are freely available at the ZENODO data base (https://zenodo.org/record/7531#.U57KOihjZVI) along with their accompanying documentation.

Table 3. Results summary of QCs applied to daily Tn, Tx and RR and hourly PP series

Parameters	Suspicious values				Corrected values				
	Total	Tolerance Test	Temporal coherency	Internal consistency	Total	Transcription errors	Data source errors (total)	(new values inserted)	(missing values inserted)
TN, TX, RR	5563	52%	10%	38%	3908	2244	1662	864	798
PP	7987	16%	84%		5772	5727	45	42	3
All data	13550				9680	7971	1707	906	**801**

4. Merging, extending back in time the temperature record over North African locations

To further extend back in time the temperature record and get as much as possible continuous Tx and Tn time-series, sites with the most ancient and complete digitised records were chosen for merging with present data and subjected to homogenisation. Fig. 2 provides an example of merged Tx and Tn series for Oran (Algeria) and sources used for reconstructing these long series (data gaps are evident, though).

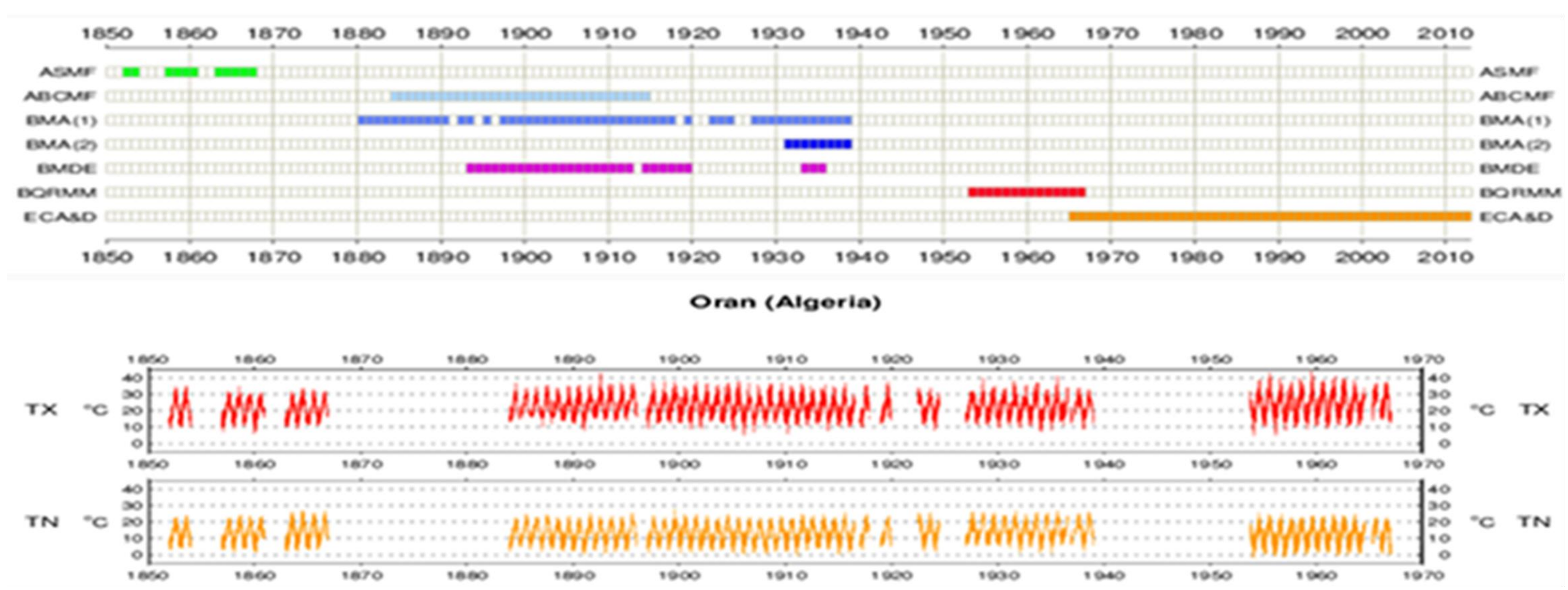

Figure 2. Example of merged Tx and Tn series for Oran (Algeria) by combining different data sources

5. Homogenisation approach and results

The daily Tx and Tn merged series were converted into monthly means and then subjected to two homogenisation methods:

(1) the ACMANT method (http://www.c3.urv.cat/data.html)

(2) the HomeR method (http://www.homogenisation.org/v_02_15/index.php?option=com_content&view=article&id=93:homer&catid=1:general&Itemid=1)

The methods identified a set of breakpoints that compromised the homogeneity of the merged records. Figure 3 (Figure 4) provides the number of breakpoints per year and per station for Tx and Tn detected by ACMANT (low-pass filtered temperature anomalies in Cdeg for area-averaged south-western Med stations and Libyan stations).

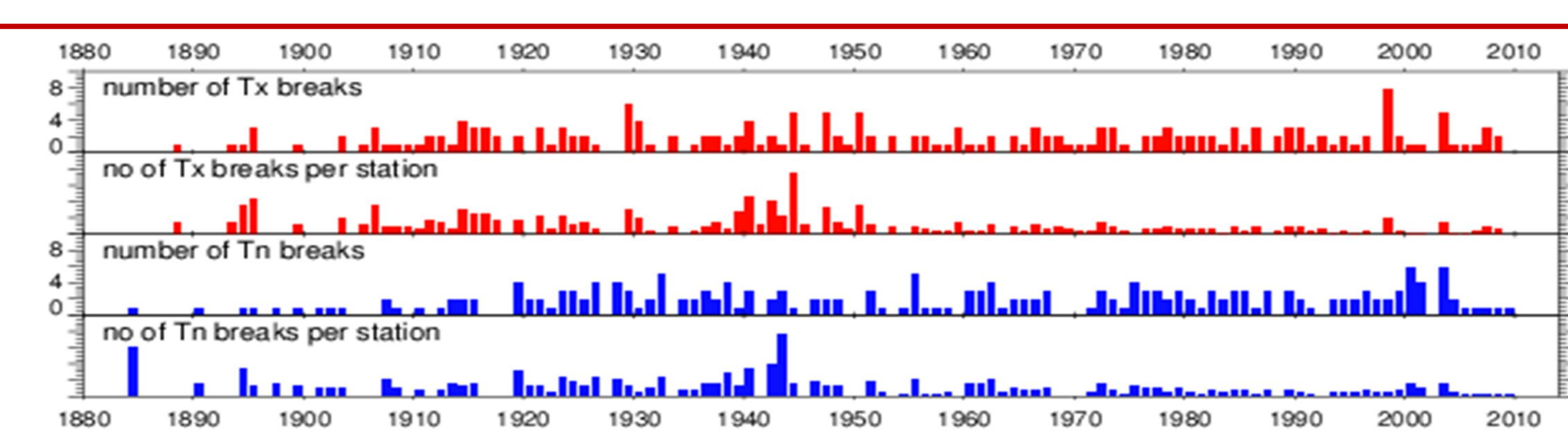

Figure 3. No. of breakpoints detected by ACMANT per variable and per station

The density of breaks detected by ACMANT is similar in both the modern and ancient periods (Fig. 3), but as the station network declines back in time the number of breaks per station is higher in the early period especially before the mid-20th century. The station metadata over the ancient period are poorly documented in the data sources employed for the DARE exercise, making difficult the attribution of breakpoints, although certain breaks coincide with station relocations or station-data merging points.

The two homogenisation methods derive comparable results, although some discrepancies can be observed during the data-sparse decades of the late-19th and early-20th centuries (Figure 4).

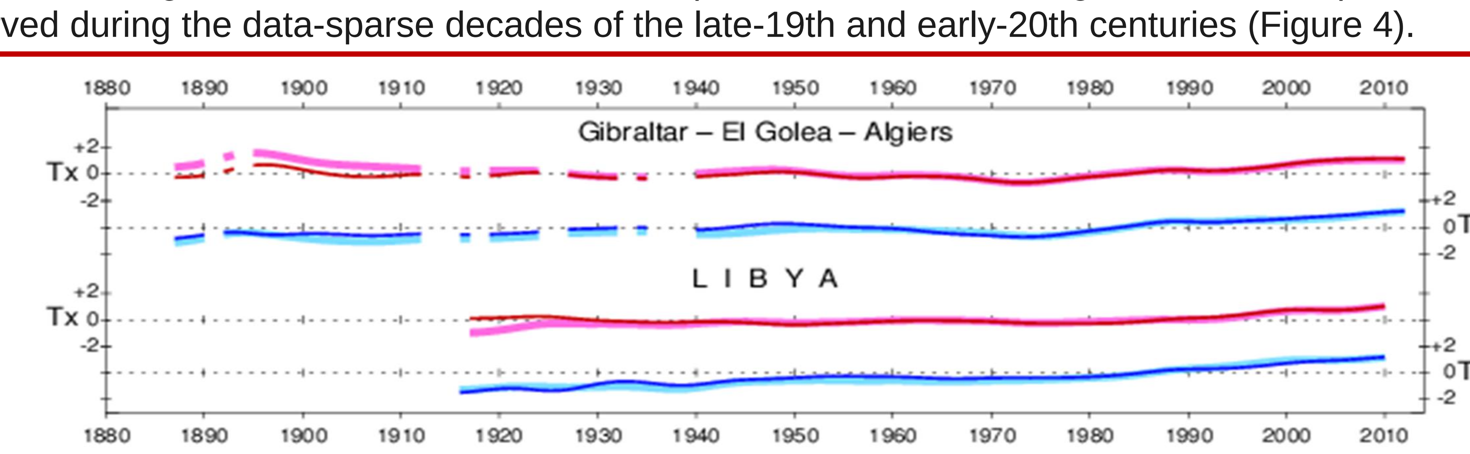

Figure 4. low-pass filtered temperature anomalies in Cdeg for area-averaged data in south-western Mediterranean and Libyan stations

6. Conclusions

The DARE exercise carried out under EURO4M in connexion with MEDARE will provide insights into climate variability over the North Africa data-sparse region and will shed more light on the impacts that anthropogenic climate change poses and will add to this vulnerable world region.

The application of the ACMANT and HOMER methods on the long-term merged-series leads to similar homogenised Tn and Tx products and increased reliability of the adjusted series.

All the 38 daily Tx/Tn homogenised records are freely available trough ECA&D data portal.

Acknowledgements: The research leading to these results has been funded by the European Union, Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 242093 (EURO4M project).