1   **Supplementary Information**

2   **1.   Appendix S1 - Exposure Metadata**

3   **1.1. Creation of an Historic Exposures Database**
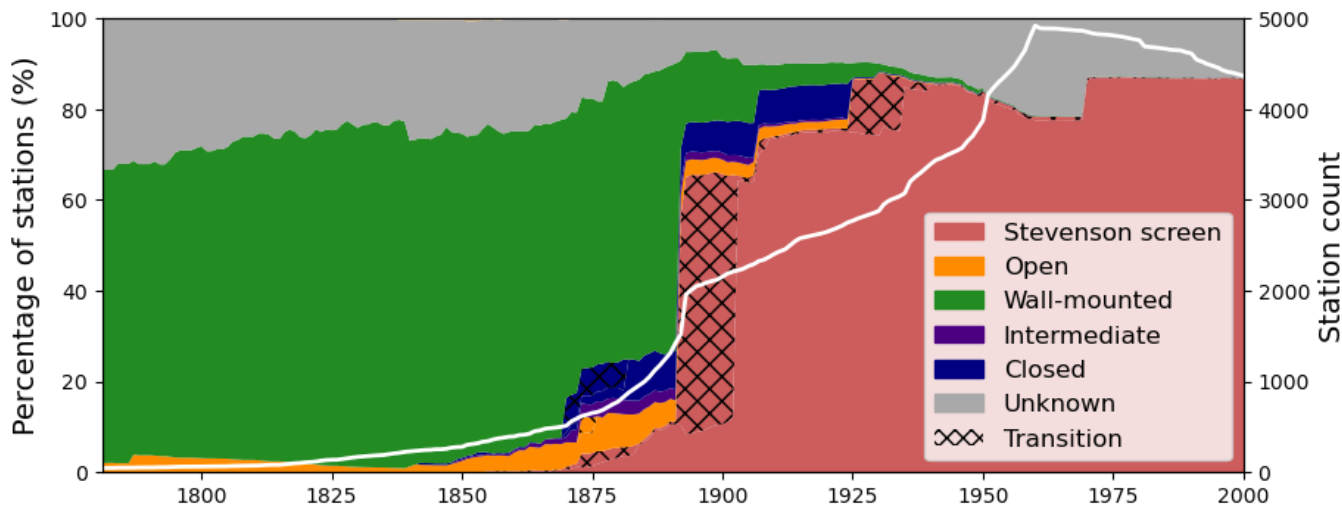
4   The creation of a database of historic exposures was a substantial undertaking that had not

5   previously been completed for most series within the CRUTEM5 station database. As this study

6   is concerned specifically with the transition to Stevenson-type screens at mid-latitude stations,

7   metadata collation was prioritised for stations or countries between 30° and 60° latitude,

8   metadata were only collated for stations which have data before 1961 (by which time the

9   majority of stations would have had Stevenson screens), and only metadata detailing

10   exposures in use prior to the transition to Stevenson screens were recorded. Unless the

11   metadata suggested otherwise, it was assumed that stations did not revert back to historic

12   exposures once the transition to a Stevenson screen had been made.

13   The [HathiTrust Digital Library](), [Internet Archive](), [Met Office Digital Library and Archive]() and

14   [NOAA Foreign Data Climate Repository]() all proved to be particularly useful sources of exposure

15   metadata. Each contains freely available scans of yearbooks and other meteorological sources.

16   These sources were carefully examined for any information related to thermometer

17   exposures: either descriptions of the thermometer exposure in use at a station during a given

18   time period, mentions of when exposure changes were implemented, or more general

19   information regarding the type(s) of exposures found in particular regions. Any gathered

20   metadata was mapped to the stations in the CRUTEM5_ext database using information about

21   the station name, station location and/or station ID number.

22   The exposure metadata were compiled for station records at an annual resolution and given a

23   source code to indicate the level of confidence attached to the information. A source code of

24   '1' was applied when a given exposure was known to be in use at the station in the specific

25   year; a source code of '2' was applied when the exposure was estimated using station-specific

26   metadata; a source code of '3' was applied when the exposure was estimated and applied to

27   all stations within a country or region based on country or Meteorological Service-specific

28   metadata and a source code of '4' was applied where no exposure information was found.

29   Where the transition between two screen types (including the introduction of the Stevenson-

30   type screen) was known to occur in a particular period, but could not be pinpointed to a year,

31   a transition zone was noted in the database and the details of both screen types entered.

32 The exposure metadata database provides the basis for applying the exposure bias

33 adjustments reported in this study. However, it will also be a valuable resource for future

34 studies of thermometer exposures and, as such, it is likely that future studies might extend it

35 (e.g. to include other exposure transitions such as the changes from Stevenson screens to the

36 different screen typically used for automatic weather stations) or enhance it (e.g. if additional

37 sources, or more station-specific sources, are obtained by data rescue projects).

38 **1.2. Results**

39 **Figure S1.** Temporal evolution of the thermometer exposures in use at mid-latitude weather

40 stations in CRUTEM5_ext. The coloured shading represents the percentage of stations with

41 each exposure over time (left-hand axis) and the white line shows the CRUTEM5_ext station

42 count (right-hand axis). Note, only stations between 30° to 60° latitude, with data before 1961,

43 are included.

44 The database contains at least one entry of exposure metadata for 88% of stations in the mid-

45 latitudes and illustrates how methods of exposing thermometers have evolved over time. As

46 can be seen in Figure S1, wall-mounted exposures were almost exclusively used in the early

47 part of the CRUTEM5_ext record, until the introduction of early varieties of freestanding

48 exposures (first open, then intermediate and closed) from the mid-1840s onwards. All four

49 categories of historic exposure were in use in the decades which followed with none

50 universally adopted. This began to change with the invention of the Stevenson screen in the

51 1860s. Its use grew gradually at first, but by the early 1900s it was the most commonly used

52 exposure and by the 1930s it had been almost universally adopted.

53   The use of, and transition between, exposures was not spatially or temporally homogenous

54   (Video S1). Different countries and Meteorological Services favoured different exposures and

55   introduced the Stevenson screen at different times. In the UK for example, wall-mounted, then

56   open exposures were commonly used before the Stevenson screen was adopted in the early

57   1870s. In contrast, in India and Southeast Australia, intermediate exposures were the favoured

58   historic exposure, and the Stevenson screen was not introduced until later – in the 1920s and

59   1890s respectively. This spatiotemporal heterogeneity reinforces the need to consider the

60   exposure history of individual countries or regions when accounting for the exposure bias.

2. Appendix S2 - Uncertainty associated with the exposure bias estimates.

As noted in the main paper, each of the exposure bias models, and thus estimates (Section 4), contains uncertainties which can vary dependent on
the station and month of the year. The uncertainties associated with individual monthly bias estimates produced for CRUTEM5_ ext are included in
the data released with this paper (see Data Availability) and Table S2 provides an indication of the uncertainty associated with each of the applied
bias-estimation models.

Table S2. Uncertainties associated with the applied bias estimation models.

	Coefficient(s)		Constant	Coefficient Standard Error		Constant Standard Error	Covariance			Residual standard deviation
	1	2		1	2		Coefficient 1 & Constant	Coefficients 1 & 2	Coefficient 2 & Constant	
Open ($min\Delta T_m$)	-0.062		0.390	0.016		0.243	-0.004			0.153
Open ($max\Delta T_m$)	-0.058		0.881	0.019		0.292	-0.005			0.325
Wall-mounted	0.005	-8.38×10^{-6}	-0.469	7.49×10^{-4}	1.35×10^{-6}	0.084	-5.9×10^{-5}	-9.93×10^{-10}	9.79×10^{-8}	0.223
Closed	-0.002		-0.043	3.87×10^{-4}		0.055	-1.8×10^{-5}			0.191