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Supplement of

The "dirty weather" diaries of Reverend Richard Davis: insights about early colonial-era meteorology and climate variability for northern New Zealand, 1839–1851

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S1. Scanning and Transcription of the Davis Diary

After permissions were granted to digitally image the Davis meteorological diary, an additional visit was undertaken to determine whether flatbed scanning or photography was the best method for capturing the source material. ACL graciously removed a small magnetic security strip that had been sown into the binder of the diary that enabled imaging to be undertaken with a portable flatbed scanner. Each diary page was scanned (see Figure 2 for an example) as a high-resolution tagged image format file (TIFF) and subsequently all the images were placed in archive on the NIWA server. In most cases more than one scan was needed to capture a single year's worth of data in the diary. Each TIFF file served as a master file that was locked to prevent alteration, and these master files were subsequently copied and divided into individual months. Scans for each month were parsed using cropping techniques in Adobe Photoshop. Subsequently, paper copies of the parsed monthly images were then printed in A3 format, which were then handled for data entry. Access to the original TIFF scans were also allowed for reference in case of clarity issues during data keying.

Diary entries were transcribed from the original handwritten version to MS-Excel spreadsheet format to facilitate data analysis. As Davis' cursive handwritten script was sometimes difficult to decipher, significant care was taken when entering the data into the spreadsheet and optical character recognition was not possible. In cases where the handwriting was unclear, multiple team members were consulted and the data was only recorded once a consensus was reached. For numerical data (for example, temperature or pressure), monthly totals were calculated to check for data entry accuracy. When outliers were found during subsequent data analysis, the original handwritten diary and transcribed data was consulted to check for transcription errors.

S2. Additional notes about Davis' arrival in New Zealand

Richard Davis sailed to New Zealand in 1823-24 via Parramatta, Sydney and Hobart, Australia (along with crew, other clergymen and convicts) and arrived in the Bay of Islands on 15 August 1824 on the brig *Governor Macquarie* (Figure 1). He was largely self-educated, but received additional tuition through his clerical training. Davis could read Hebrew, and had wide-ranging interests in geology, mechanics, geometry and spherical trigonometry. He also had learned surveying and navigational skills, including uses of a theodolite and sextant.

S3. Details about the NIWA Virtual Climate Station Network

NIWA's Virtual Climate Station Network estimates daily climate variables on a 0.05° latitude/longitude grid covering all of New Zealand (approximately 5 km grid resolution, 11491 grid points). Daily data are available for 1960 to present for rainfall and 1972 to present for 10 other variables, including maximum and minimum temperature, mean sea level pressure, solar radiation, and wind speed. The data is

calculated by a spatial interpolation methodology that uses surface observation data at approximately 200 climate stations throughout New Zealand. The model used to interpolate the data is a thin plate smoothing spline model, ANUSPLIN (Hutchinson, 2005). This model has been shown to perform well in New Zealand conditions (Sansom and Thompson, 2003; Tait and Turner, 2005; Zheng and Basher, 1995).

Tait et al. (2006) explains the method used to generate the VCSN data. The thin plate smoothing spline works by fitting a surface to the data with some error allowed at each data point, so the surface can be smoother than if the data were fitted exactly. Each station is omitted in turn from the estimation of the fitted surface and the mean error is found. This is repeated for a range of values of a smoothing parameter, then the value that minimises the mean error is taken to give the optimum smoothing. This process is called minimising the generalised cross validation (GCV). It can be automated once the order of the derivative, which controls the surface roughness, has been chosen.

As most meteorological variables are affected by topography, the interpolation was carried out using a spline model with two position variables (latitude and longitude) and a topographical variable (elevation). For the rainfall variable, instead of elevation, a covariate of the 1951-80 mean annual rainfall was used (a digitised contour map of mean annual rainfall).

Because the interpolation method depends on surface observation data, the location and density of stations has an effect on the quality of the VCSN data. In lowland areas (where most of the population resides), there are many climate stations, but in mountainous or isolated areas the network is sparse. Therefore, the accuracy of VCSN data is more reliable in lowland areas.

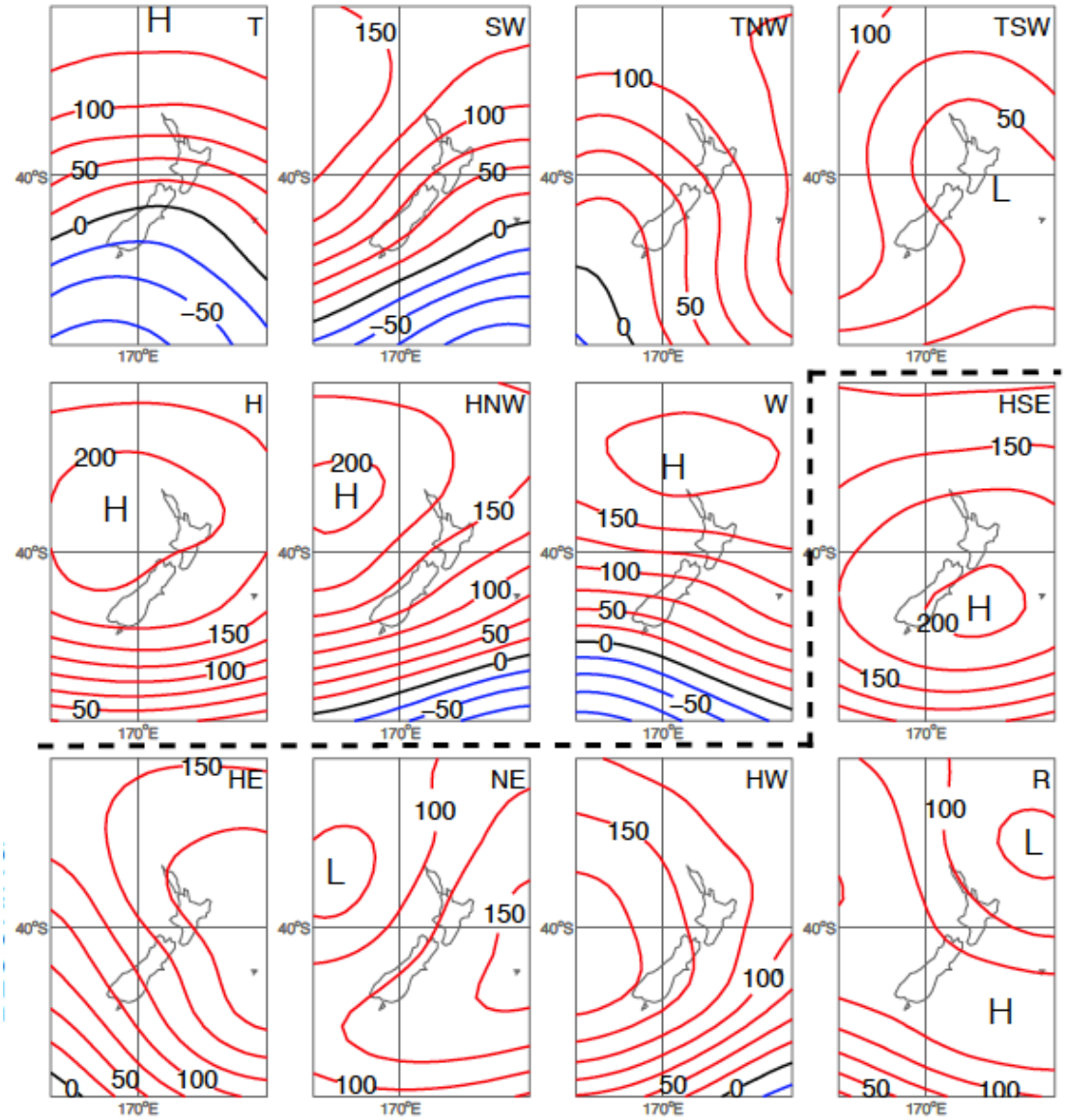
S4. Kidson's (2000) Synoptic weather types

The synoptic weather types for New Zealand follows a preexisting classification undertaken by Kidson (2000). The archetype patterns for each of the 12 types are shown in Figure S1 and follows a recent reproduction from Ackerley et al. (2011).

S5. Regression equations for converting Davis 9AM to Tmin and 12 noon to Tmax

See attached regression plots.

Figure S1. Kidson's synoptic weather types for New Zealand (reproduced from Ackerley et al., 2011). Paraphrasing Ackerley et al. (2011), the names for the types are indicated in top right of each panel, where T stands for Trough, SW for Southwesterly, TNW for Trough-Northwesterly, TSW for Trough-Southwesterly, H for High, HNW for High to the Northwest, W for Westerly, HSE for High to the Southeast, HE for High to the East, NE for Northeasterly, HW for High to the West, and R for Ridge.



S6. Supplementary References

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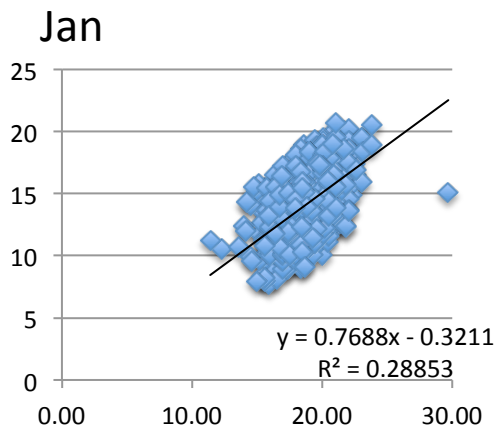
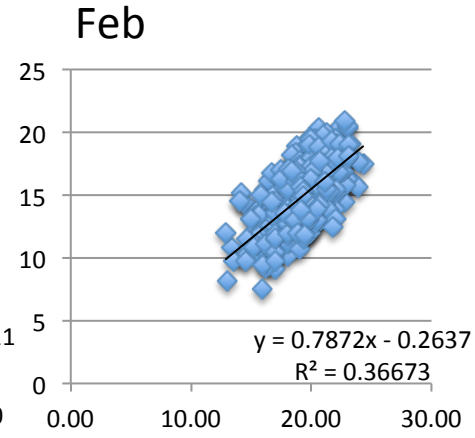
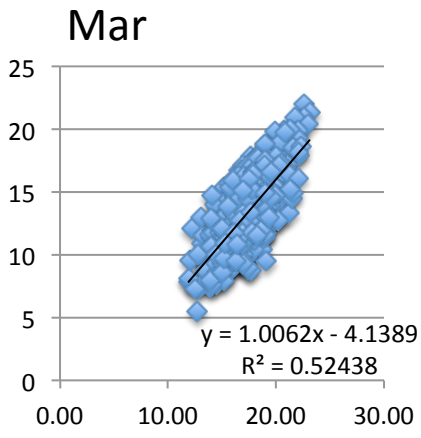
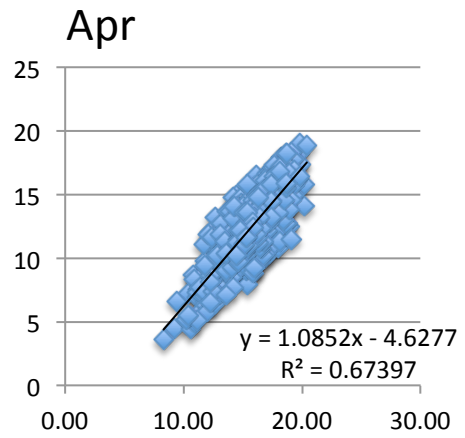
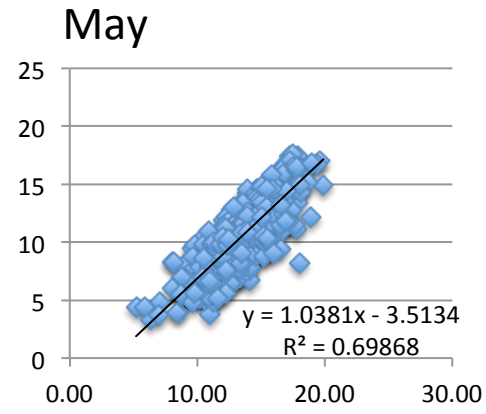
Regression equations used to convert 9am temperature to Tmin

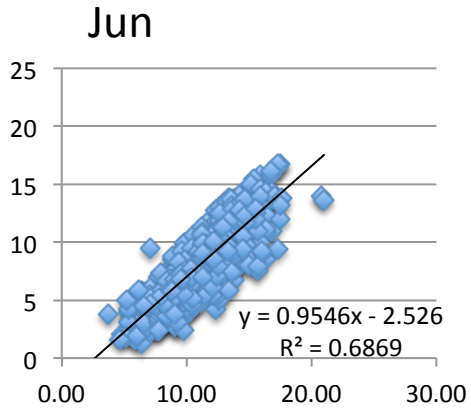


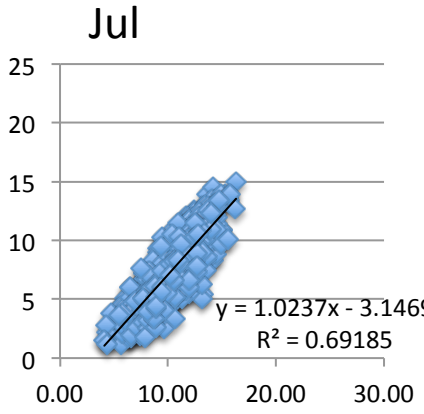


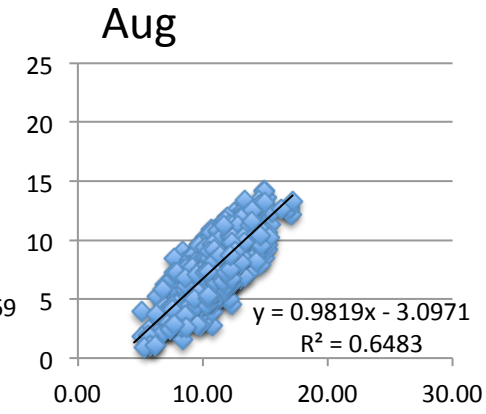


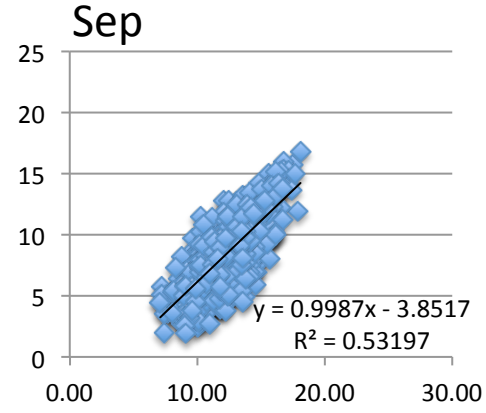


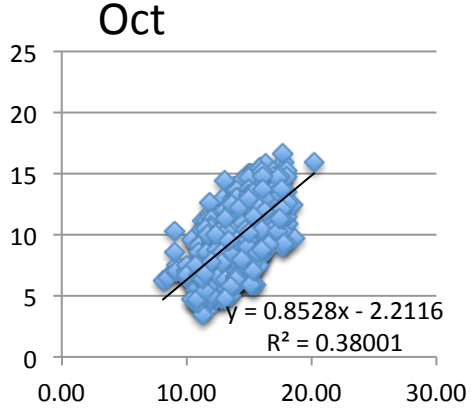


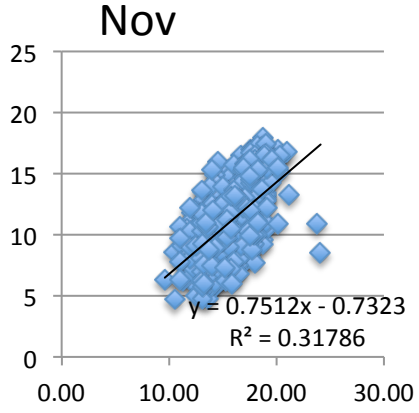


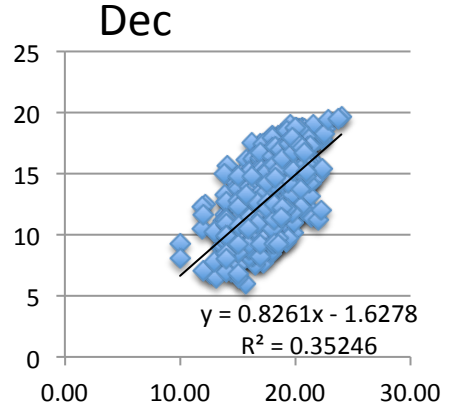












Regression equations used to convert 12 noon temperature to Tmax

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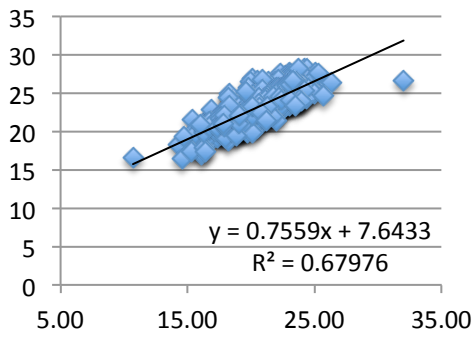

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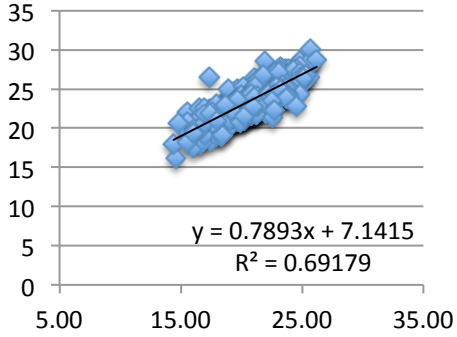

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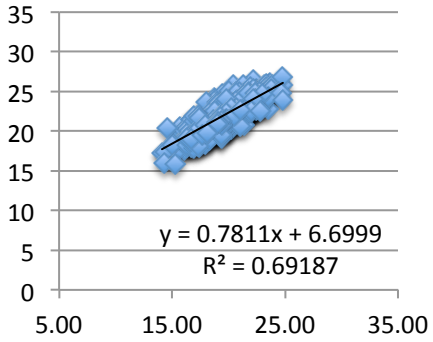

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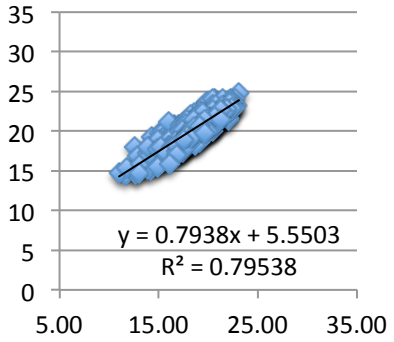

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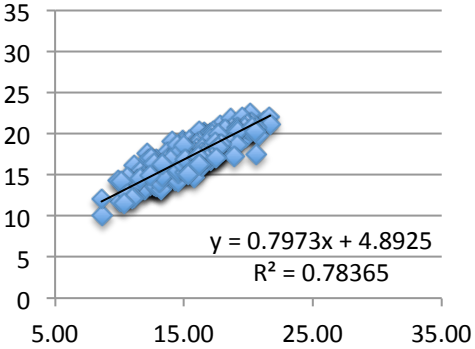

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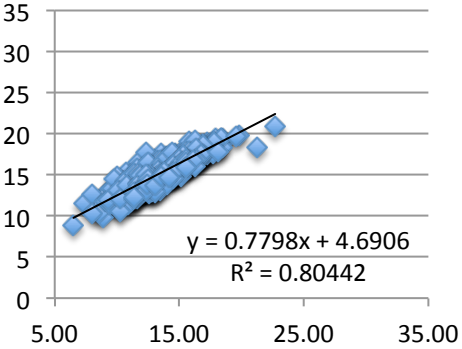

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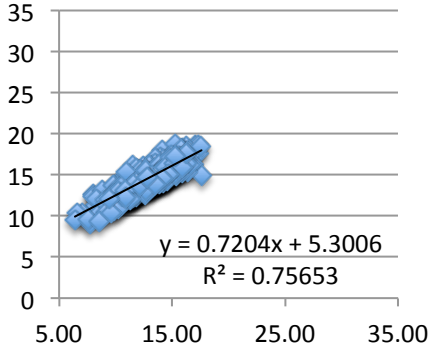

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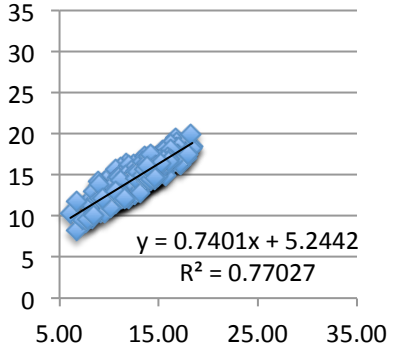

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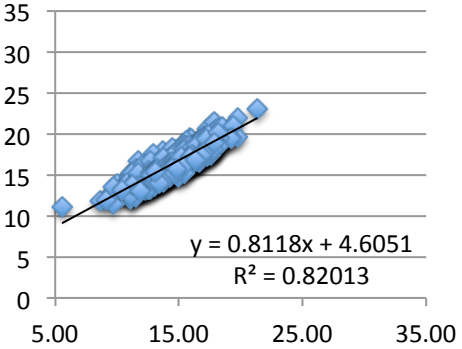

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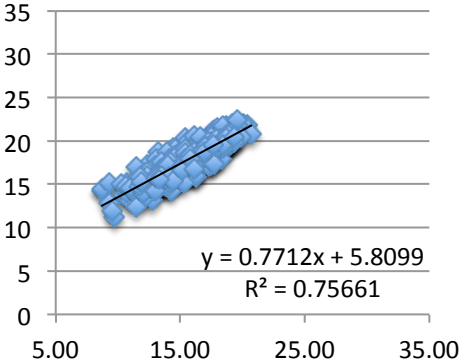

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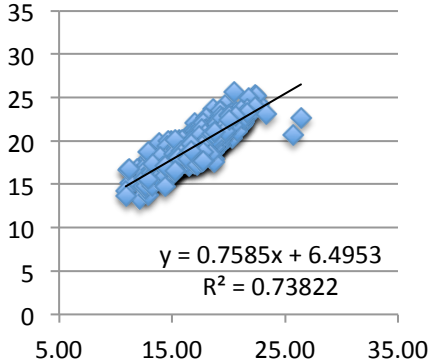

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