Making the most of the ground based meteorological network using anomaly-based interpolation

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Abstract: High resolution spatially extended values of climate variables play a central role in the assessment of climate trends and extremes, in downscaling of projected future climates and in ecosystem modelling. The ground based meteorological network remains a key resource for deriving these spatially extended climate variables, particularly for the pre-remote sensing era. With the advent of remotely sensed data sources, and the modest decline in ground observing networks, it is attractive to combine both data sources to maximize spatial coverage and accuracy. We report here on the production, and potential applications, of new anomaly-based fine scale spatial interpolations of the key climate variables for ecosystem modelling, at daily and monthly time scale, across the Australian continent. The methods incorporate several innovations that have significantly improved spatial predictive accuracy, as well as providing a platform for the incorporation of additional remotely sensed data.

It is well known that anomaly-based interpolation methods can separately account for the strong dependence on topography of "background field" parameters and the broad atmospheric processes that give rise to the anomalies with respect to the background field. We have enhanced the accuracy, and robustness to source data error, of both. This is done in part by incorporating key physical process aspects of the different climate variables. A key background field parameter is the monthly mean for a specified standard period, which was set as the 30 year period 1976-2005. We have developed new regression procedures to estimate 1976-2005 monthly means for all stations with minimal records over the last century, whether or not they have records in the 1967-2005 period. This has substantially increased the supporting spatial networks. Separate robust correlations for each season take advantage of the strong spatial correlations in monthly temperature and precipitation data. In the case of monthly mean temperature background fields, accuracy has been further enhanced by incorporating process-based coastal effects that have reduced predictive error by around 10%.

A new anomaly structure has been devised for monthly and daily precipitation to take account of the skewness in precipitation data and the large proportion of zero values that present significant challenges to standard interpolation methods. The new structure has been found in particular to accommodate the large spatial gradients in precipitation in the eastern highlands. The anomalies with respect to the various background field parameters for each background field are interpolated by a new extension of the ANUSPLIN package that automates much of the extensive housekeeping required for anomaly-based interpolation. This also includes a new robust method for automatically detecting and removing data errors. Close inspection of the analyses confirms that the data errors are often associated with missing data on preceding days, and in the case of precipitation, non-recognised multi-day accumulations, as well as values systematically recorded for the preceding day.

The methods provide a major advance on the methods reported by Hutchinson *et al*. (2009). Predictive errors of the interpolated monthly temperature fields, in particular, are around 25% less than the errors reported by Jones *et al*. (2009). There are smaller reductions in precipitation errors, reflecting the lower spatial coherence of precipitation fields and the presence of uncorrected errors in test data. The new methods have the potential to improve the automated correction or deletion of such errors. The full set of interpolated grids, called ANUClimate, form a key component of the TERN eMAST facility at http://www.emast.org.au/ and provide key inputs to the National Carbon Accounting System (NCAS) for the Department of Environment.

References:

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