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Methods supporting ANUClimate 2.0 grids of daily and monthly climate across Australia

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Abstract:

ANUClimate 2.0 consists of high resolution grids of 18 sets of daily and monthly climate variables across the terrestrial landmass of Australia. Rainfall grids have been generated from 1900, temperature, vapour pressure and solar radiation grids from 1960 and pan evaporation from 1970. All grids have been generated to the near present, currently 2021. The underpinning spatial models incorporate enhanced approaches to the interpolation of Australia's national point climate data. Most climate values have been modelled by expressing each value as a normalised anomaly with respect to gridded 1976-2005 monthly means. These means and the anomalies were all interpolated by trivariate thin plate smoothing spline functions of longitude, latitude and vertically exaggerated elevation using ANUSPLIN Version 4.6, with additional dependences on proximity to the coast for the temperature and vapour pressure variables. ANUClimate 2.0 incorporates systematic upgrades to the methods and data quality assurance employed in ANUClimate 1.0.

It is well known that anomaly-based interpolation can separately account for the strong dependence of temperature on topography via "background field" parameters and on the broad atmospheric processes that give rise to the anomalies with respect to the background field. The accuracy and robustness of this approach has been enhanced by incorporating key physical process aspects of the climate variables and using 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 enhanced the coverage of the supporting spatial networks. In the case of monthly mean minimum and maximum temperature background fields, accuracy has been further enhanced by incorporating process-based coastal effects that have reduced predictive error in the coastal margins by around 25%. The ANUSPLIN package has also been extended to facilitate the systematic use of background fields in anomaly-based interpolation. This has enabled robust automation of the analyses for many thousands of days for each climate variable.

Daily rainfall has been modelled by separately interpolating daily rainfall occurrence and positive daily rainfall. This recognises the differing spatial coherence of the two rainfall fields and permits robust analysis that is resistant to common rainfall observation errors, particularly rainfall values recorded on the wrong day. Both the occurrence analyses and the positive rainfall analyses were obtained by fitting tri-variate thin plate smoothing spline functions of longitude, latitude and vertically exaggerated elevation. The daily occurrence surfaces are applied using a smooth adaptive occurrence threshold that minimises the bias of the interpolated rainfall and maximises occurrence accuracy.

All the spline analyses apply suitably large thresholds to extreme studentised residuals to provide automated quality assessment of the input point data values. This has removed around 1% of the daily rainfall values from the analyses and around 0.2% of daily maximum temperature values. Extensive close inspection of all data sets has verified the reliability of these assessments in detecting common observation errors. The thresholds are set quite conservatively and make little difference to overall summary predictive error statistics. The error statistics reflect improvements in Bureau of Meteorology data quality after the late 1990s.

Reference:

Hutchinson M.F., Xu T., Kesteven J.L., Marang I.J., Evans B.J. 2021. ANUClimate v2.0, NCI Australia. (dataset) https://dx.doi.org/10.25914/60a10aa56dd1b.