Wind maps of Australia

Over a short time span the wind seems very fickle. However, the average character of the wind at a given spot over months and years is much more regular.

This characteristic has allowed scientists at the CSIRO Division of Land Use Research to compile maps showing the wind's strength over the whole of the Australian continent for each month.

The maps are of two sorts: one type shows average wind speed at fixed times — 9 a.m. and 3 p.m. — while the other shows the speed integrated over a day — the daily 'wind-run'.

The second group of maps was derived from the first — at first thought an impossible task — with the help of another map that shows a measure of the distribution of wind speeds throughout the day at 73 sites across the country. These wind-speed distributions were ascertained for the major weather stations where Bureau of Meteorology observers record wind speed at 3-hour intervals.

The resultant wind maps are the first of their kind to be compiled for Australia. Previously, researchers had to make do with a map of the country upon which a couple of dozen wind 'roses', giving some information on wind direction and intensity, were scattered. Although the new maps have sacrificed the wind direction information, they have more than made up for this loss in the detail of wind strength presented.

This information is important for scientists and engineers undertaking wind-energy research. It is also very useful in a wide range of other fields, such as wind-erosion control, evaporation, and pollution dispersal.

The wind-speed maps are based on data from about 500 stations throughout Australia, where Bureau of Meteorology observers note the wind strength on the Beaufort scale at 9 a.m. and 3 p.m. This subjective rating (see the box) is obviously liable to error. But the researchers averaged and smoothed the readings using a special computer program, and they estimate that the final mapped figures should be accurate to within 1 metre per second (3·6 km per hour).

The 3-hourly wind-speed data obtained from anemometers at the 73 major stations allowed a good estimate of daily wind-run (the average wind speed expressed in terms of kilometres per day) to be calculated for each of these stations.

The researchers made use of these calculations in deriving wind-run data for all the other stations. First they averaged the 9 a.m. and 3 p.m. wind-speed readings. Then they plotted on a map the ratio of the calculated wind-run figure for each major station to the average of the 9 a.m. and 3 p.m. speeds for that station. Again, computer smoothing of the data was used.

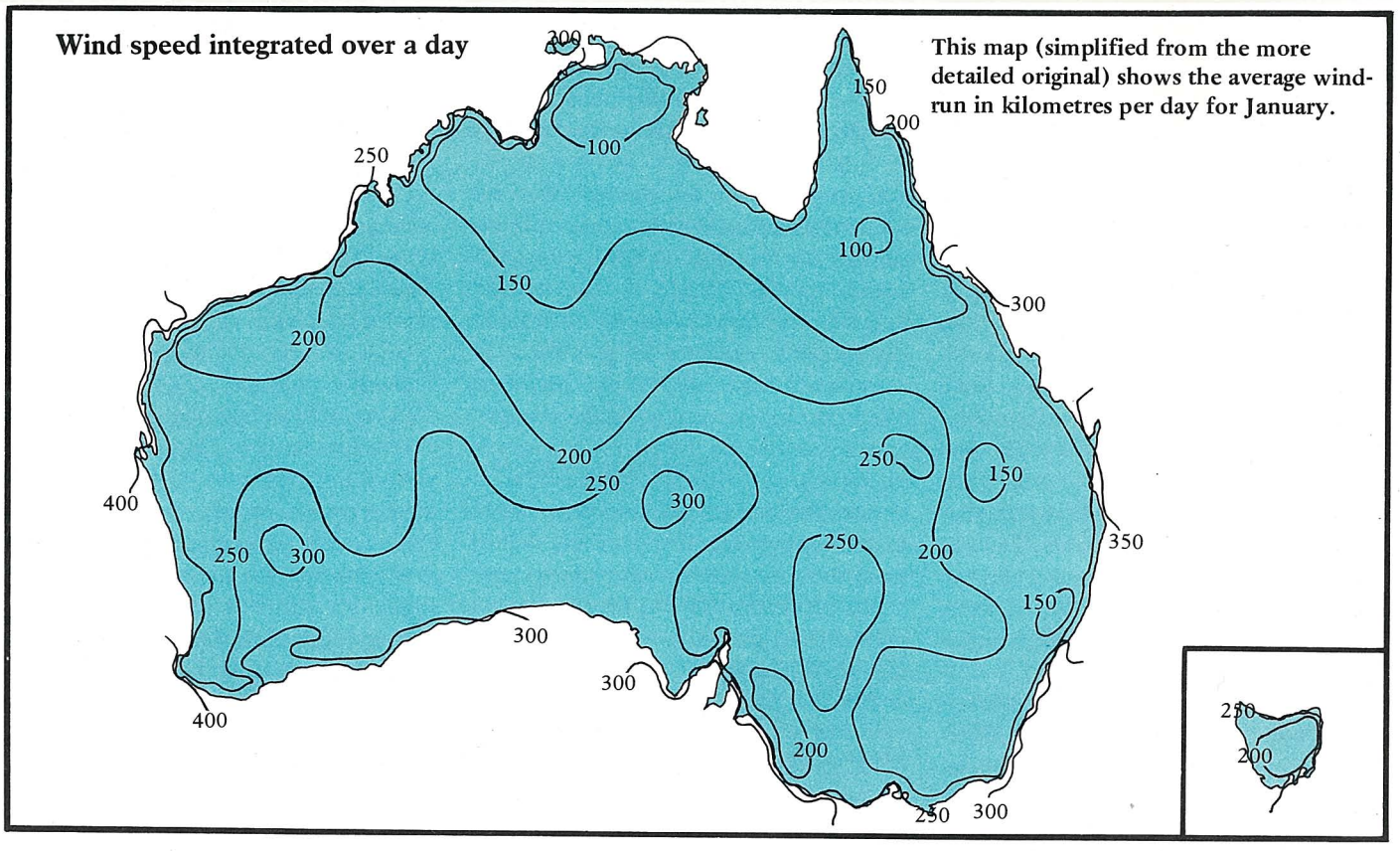
As this ratio was found to vary evenly across the continent, they were able to determine for each minor station the ratio needed to obtain a reasonably accurate wind-run figure from the average of the 9 a.m. and 3 p.m. wind-speed values. And so wind-run information for the whole continent is now available in monthly maps.

Highest speeds

Interestingly, maximum monthly average speeds at 3 p.m. are always 1–2 m per second greater than those at 9 a.m. The highest speeds, 7–8 m per second, are recorded in November, with April being the month with the lowest average speeds.

The bulk of the Australian continent has mean wind speeds that don't exceed 5 m per second in any month, a gloomy outlook for wind-power generation.

Wind speed integrated over a day



This map (simplified from the more detailed original) shows the average wind-run in kilometres per day for January.

The Beaufort scale and wind roses

In 1805, Admiral Sir Francis Beaufort developed a scale for judging wind strength at sea by its effects on surrounding objects. This was later adapted for use on land and is still used today where instruments are not available.

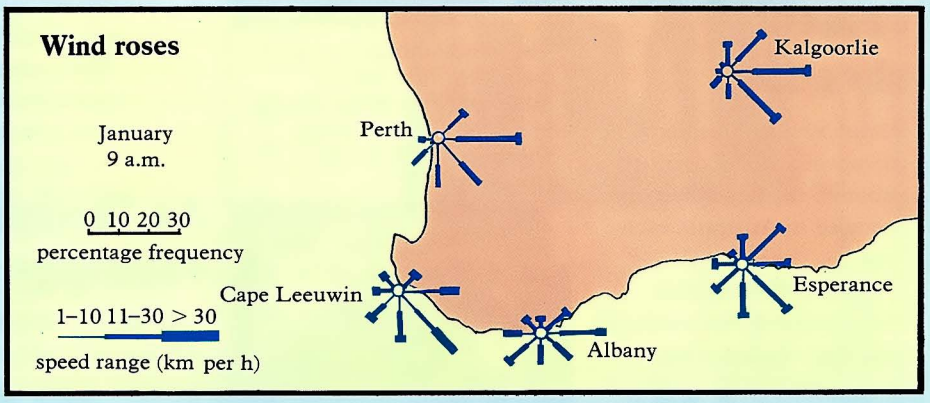
Some 500 of the Bureau of Meteorology stations that provided data for the CSIRO wind maps use this subjective scale, which is set out in the table.

Before these maps were compiled, the most detailed wind maps available were those issued by the Bureau of Meteorology. These have several dozen 'wind roses' scattered on a map of Australia. A wind rose shows, for a given location, how long (as a percentage of the total observations) the wind blew along each of the eight major points of the compass. The longer it blew, the greater is the length of the appropriate radiating line. The varying widths of the lines indicate how long the wind stayed in different strength ranges.

Wind roses for a small section of the south-western corner of the country (for January 3 p.m.) are shown here.

The Beaufort scale

Beaufort number	speed (m per sec)	description
0	< 0·3	calm — smoke rises vertically
1	0·3–1·5	light air — smoke drifts
2	1·6–2·9	light breeze — wind felt on face, leaves rustle
3	3·0–5·6	gentle breeze — leaves and twigs in constant motion
4	5·7–8·4	moderate breeze — dust and loose paper raised
5	8·5–11·2	fresh breeze — small trees sway, crests on waves
6	11·3–14·0	strong breeze — whistling in wires, umbrellas hard to use
7–12	> 14·1	near gale, gale, strong gale, storm, violent storm, hurricane



One of the windiest spots in Australia — Maatsuyker Island in southern Tasmania.

However, all is not lost. A relatively narrow coastal strip receives strong winds, particularly in the south, where average speeds in excess of 7 m per second are found. Noteworthy are the exposed sites at Shark Bay, North-West Cape, and Cape Leeuwin in Western Australia.

Monthly 3 p.m. averages of more than 6 m per second are found on Kangaroo Island, and the Eyre, Yorke, and Fleurieu Peninsulas, S.A.; in Torres Strait and between Cooktown and Cairns, Qld; at Roeburne and between Geraldton and Carnarvon, W.A.; and in southern Tasmania. In New South Wales, such winds are restricted to Cape Howe and Cape Hawke.

Coastal regions therefore offer good sites for wind generators. They form a transition zone between the very windy sea and the much calmer inland (caused by the much greater drag of uneven terrain).

The wind-run maps closely parallel the wind-speed maps, with high values appearing on the south-west of the continent, the south (including Tasmania), and the far north-east of Queensland. Again, wind-run values are generally high along the coast and decrease rapidly between 100 and 200 km inland.

Wind power

Although wind-run is a good indicator of the potential power output of a wind-power generator, the data on the maps are not sufficient for any detailed calculation of the wind-energy potential of particular sites. However, the maps will aid in identifying those generally windy regions where prospecting for windy sites should be focused.

Furthermore, in the future the researchers hope to produce monthly maps showing how wind-power potential varies throughout the country. They will use the same set of data as used for the present maps (it is on a computer file), but subject it to much more detailed analysis.

Since power in the wind varies as the cube of the wind speed, simple averages are not enough: distributions of wind speed in time are necessary. (The cube of the average is not the same as the average of the cubes.) However, they hope the same general technique as before can be used.

That is, they plan to use correlations between the wind-power potential and wind-speed data obtained at data-rich sites to obtain estimates of wind-power potential at locations where only two daily wind-speed readings are taken.

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More about the topic

'Seasonal Estimates of Wind Speed and Wind-run for Australia.' M. F. Hutchinson, J. D. Kalma, and M. E. Johnson. (CSIRO Division of Land Use Research: Canberra 1982.)

'AUSTWIND: a Data File of Monthly Wind Data for Australia.' M. E. Johnson and J. D. Kalma. (CSIRO Division of Land Use Research: Canberra 1979.)

Spatial patterns of wind speed and wind-run in Australia: implications for network design. J. D. Kalma and M. F. Hutchinson. *Proceedings, Workshop on Solar and Wind Data Networks for Australia, Canberra, November 1981.*