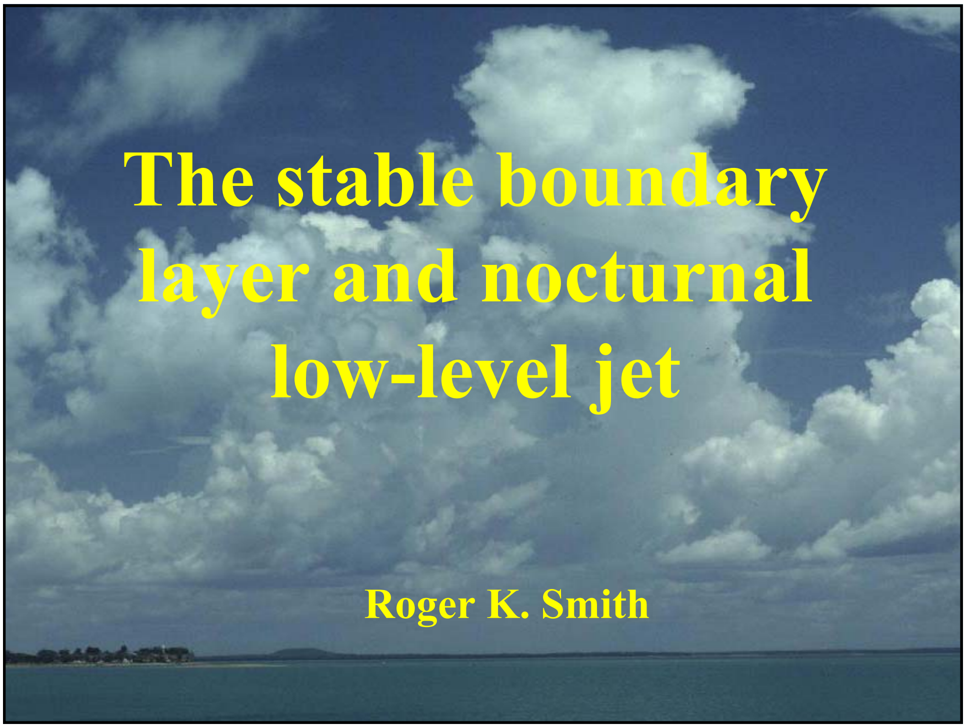
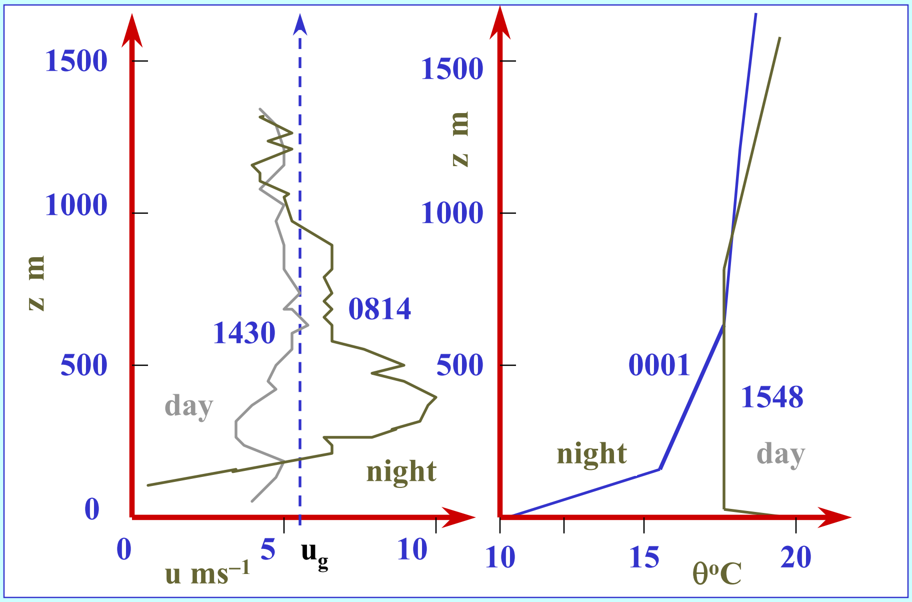
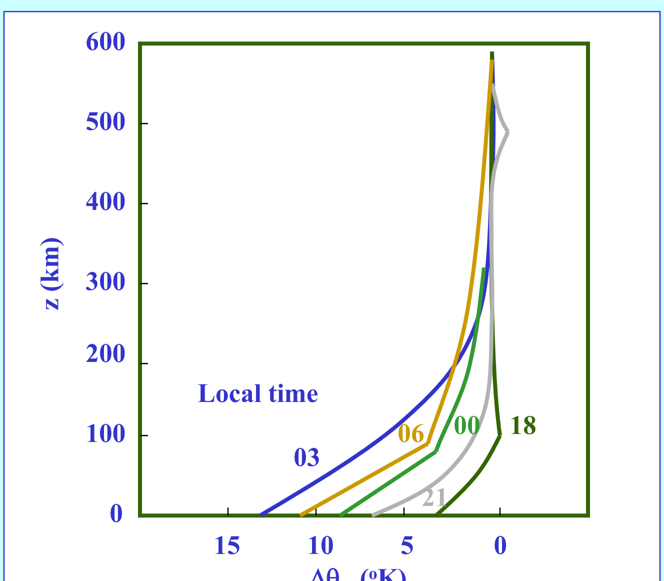


Nocturnal low-level jet

- The low-level jet (LLJ) is a thin stream of fast moving air, with maximum wind speeds of 10 to 20 ms^{-1} usually located 100 to 300 m above the ground.
- Peak speeds up to 30 ms^{-1} have been reported and altitudes of the peak were occasionally as high as 300 m above ground.
- The LLJ can have a width of hundreds of kilometres and a length of thousands of kilometres, making it more like a sheet than a narrow ribbon, in some cases.
- In many cases the LLJ reaches its peak during the night and reaches its peak during the predawn hours.
- LLJs occur on 10% of winter nights in parts of Australia, with peak speeds between 00 and 05 local time (Brook, 1985).

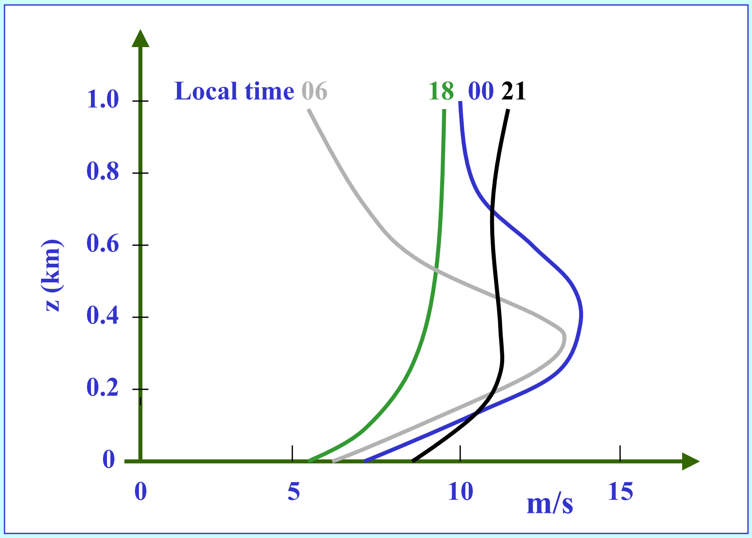


The profile of wind component in the direction of the geostrophic wind (u_g) showing a **nocturnal jet**, compared with the profile the previous afternoon.



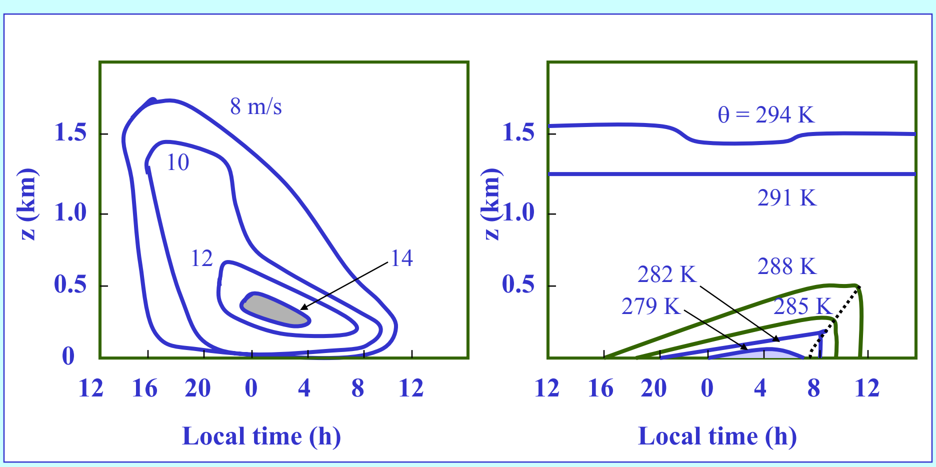
Nocturnal stable layer evolution during during Wangara Night 6-7

Stull, 1983



Nocturnal jet evolution during during Wangara Night 13-14

Malcher and Kraus, 1983

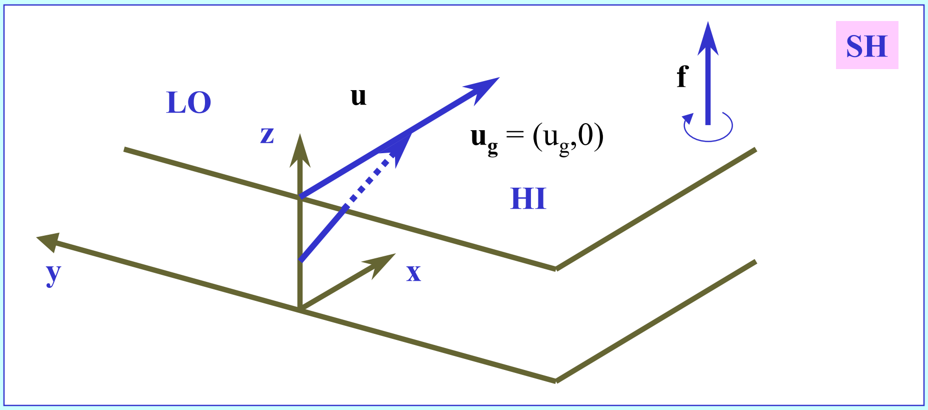


Boundary-layer evolution during Wangara Night 13-14

Malcher and Kraus, 1983

A simple theory for the nocturnal LLJ

- Consider a homogeneous layer of inviscid fluid on an f-plane confined between rigid horizontal boundaries.



Mathematical formulation

Momentum equations assuming a linear drag law

$$\frac{\partial u}{\partial t} - fv = -\mu u$$

$$\frac{\partial v}{\partial t} + fu = fu_g - \mu v$$

$$\frac{\partial u}{\partial t} - fv = -\mu u, \qquad \frac{\partial v}{\partial t} + fu = fu_g - \mu v$$

Daytime

Steady $\left(\frac{\partial u}{\partial t}, \frac{\partial v}{\partial t}\right) = 0$

$$-fv = -\mu u$$
$$fu = fu_g - \mu v \qquad \varepsilon = \frac{\mu}{f}$$

$$u = \frac{u_g}{1+\varepsilon^2}, \quad v = \frac{\varepsilon u_g}{1+\varepsilon^2}, \quad |u| = \frac{u_g}{1+\varepsilon^2}$$

Nighttime

No friction $\mu = 0$

$$\frac{\partial u}{\partial t} - fv = 0$$
$$\frac{\partial v}{\partial t} + fu = -fu_g$$

$$\left(\frac{\partial^2}{\partial t^2} + f^2\right)(u, v) = f^2(u_g, 0)$$

Daytime

$$v = \varepsilon u$$
$$u = u_g - \varepsilon v \qquad \varepsilon = \frac{\mu}{f}$$

$$u = \frac{u_g}{1+\varepsilon^2}, \quad v = \frac{\varepsilon u_g}{1+\varepsilon^2}, \quad |u| = \frac{u_g}{1+\varepsilon^2}$$

Nighttime $\left(\frac{\partial^2}{\partial t^2} + f^2\right)(u, v) = f^2(u_g, 0)$

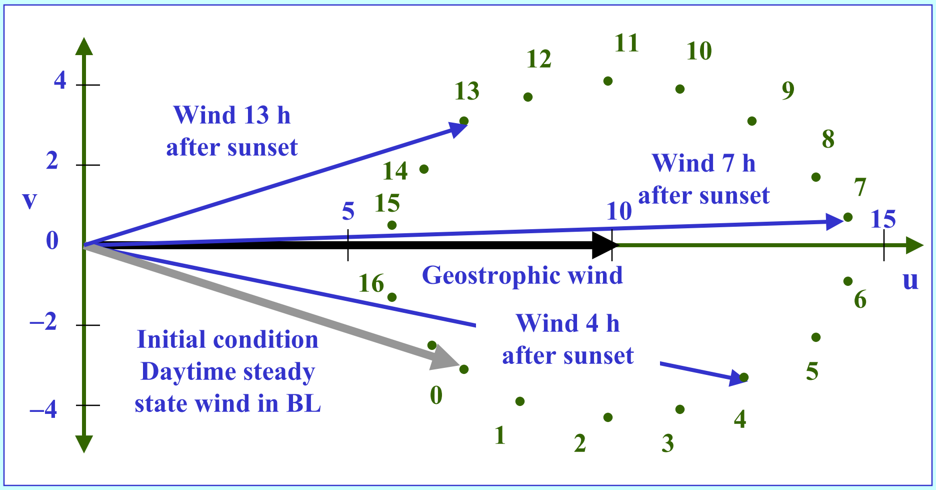
$$u = u_g + A\cos ft + B\sin ft$$
$$u = \quad C\cos ft + D\sin ft$$

$$\frac{\partial u}{\partial t} - fv = 0 \;\Rightarrow\; B = C, \quad D = -A$$

t = 0

$$u = \frac{u_g}{1+\varepsilon^2}, \quad v = \frac{\varepsilon u_g}{1+\varepsilon^2} \;\Rightarrow\; \begin{cases} u = u_g + \frac{\varepsilon u_g}{1+\varepsilon^2}(-\varepsilon\cos ft + \sin ft) \\ v = -\frac{\varepsilon u_g}{1+\varepsilon^2}(\cos ft + \varepsilon\sin ft) \end{cases}$$

Inertial turning of the LLJ



Southern Hemisphere

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The Australian nocturnal jet and diurnal variations of boundary-layer winds over Mt. Isa in north-eastern Australia

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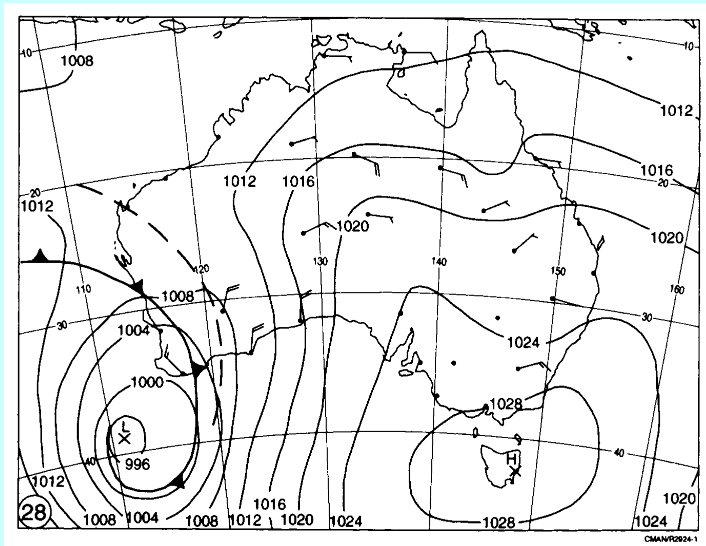
SUMMARY

An analysis of radiosonde data shows the nocturnal boundary-layer jet over Australia to be continental in scale. The detailed temporal development of the jet is described using two years of boundary-layer wind-profiler data from Mt. Isa in north-eastern Australia. A distinct isallobaric wind is found, which has a spectral peak near the inertial period. This is associated with the diurnal pressure-oscillation and developments in the heat low over central and western Australia. However, it is not important for the development of the nocturnal jet. The nocturnal jet begins as a shallow disturbance and grows through the night. Most of the year the wind maximum is at about 500 m above the ground and has a well-defined jet-profile. In the summer-monsoon season the vertical extent of the wind maximum increases, but has weaker vertical shear. The jet results from an inertial response, but is affected by other processes. The amplitude of the jet is less than would be expected from a straightforward response to the daytime ageostrophic flow and there is super-inertial rotation and damping of the wind vector late in the night.



Vector difference of the maximum wind below 1500 m above ground level at 0300 EST from that at 2100 EST, across Australia for the night of 27/28 May 1991. Isobars are of Mslp at 1000 EST on 28 May.

The End