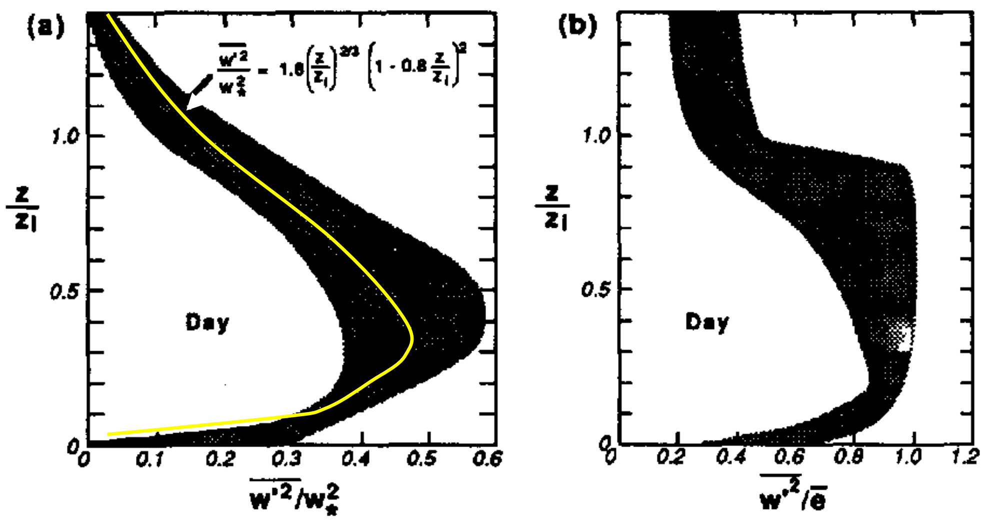


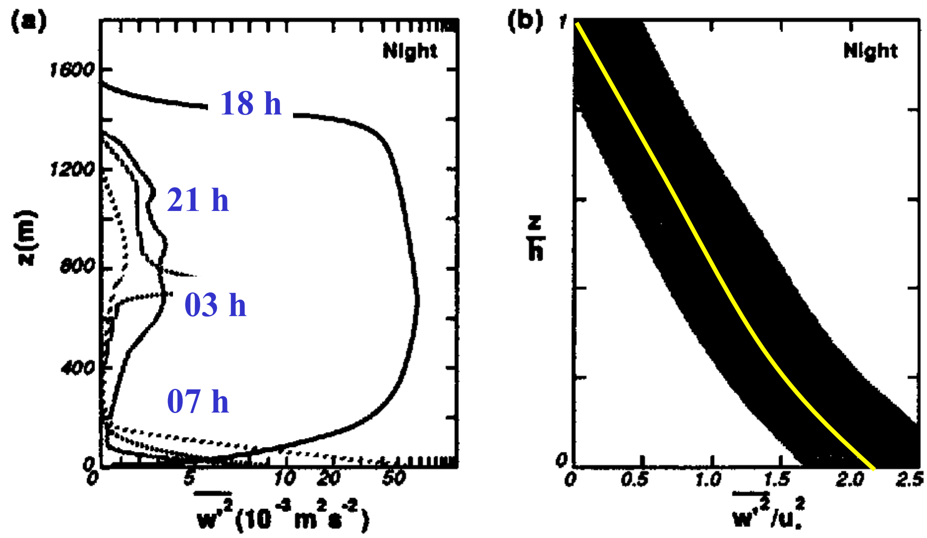
(a) Variation of vertical velocity variance with height, z during daytime. Range of measured and modelled values are shaded. (b) Range of the ratio of the vertical velocity variance to the eddy kinetic energy.

N

•The vertical velocity variance during the daytime is small near the surface, increases to a maximum about a third of the distance from the ground to the top of the mixed layer, and then decreases with height.

•This is related to the vertical acceleration experienced by thermals during their initial rise, which is reduced by dilution with environmental air, by drag, and by warming and stabilizing of the environment near the top of the mixed layer.

•In cloud-free conditions with light winds, glider pilots and birds would expect to find the maximum lift at $z/z_i = 0.3$.

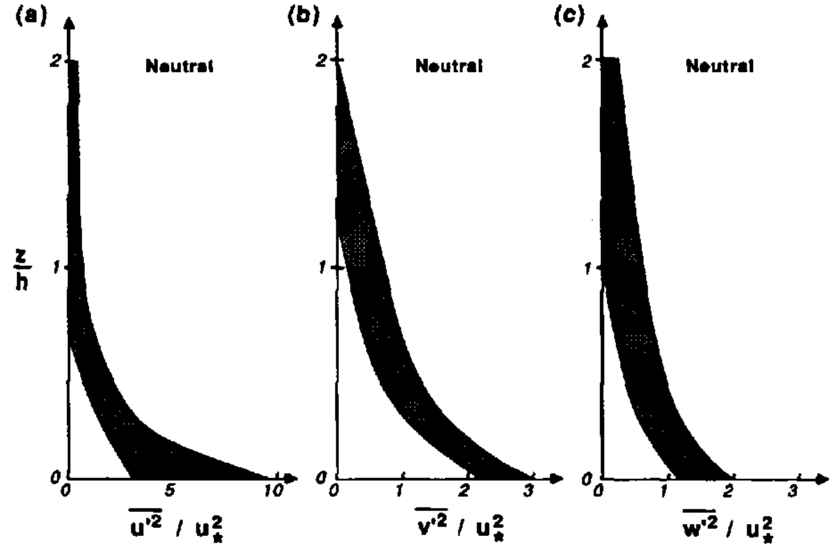


(a) Modelled profiles of vertical velocity variance during Night 33-34 of Wangara. Abscissa changes from the linear to logarithmic at 10. (b) Range of vertical velocity variance, normalized by a measure of stable boundary layer depth, h.

N

•At night, turbulence rapidly decreases over the residual layer, leaving a much thinner layer of turbulent air near the ground.

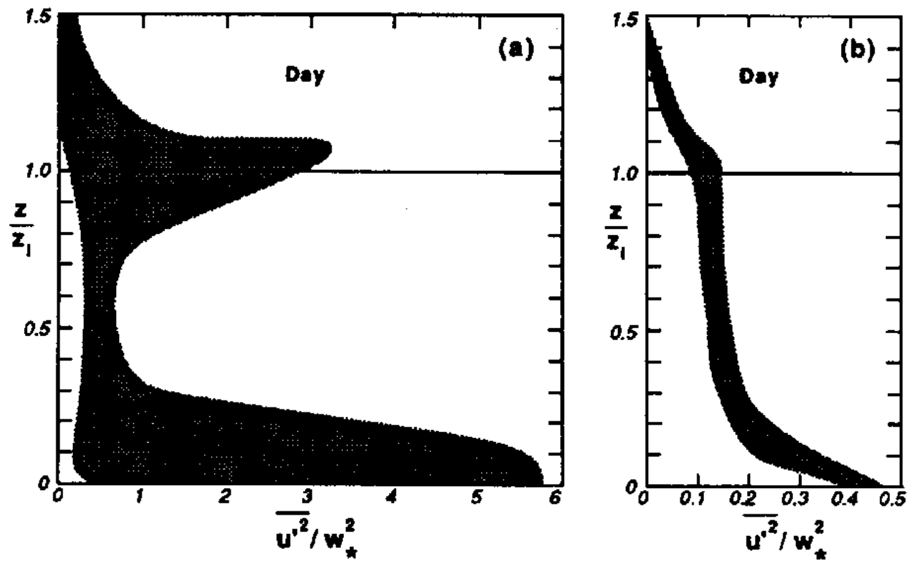
•The depth of this turbulent stable BL is often relatively small (h ≈ 200 m).



Normalized velocity variance verses height in statically neutral conditions, where h (≈ 2 km) is the height where $\bar{v}$ is zero. Based on a large-eddy simulation by Mason and Thomson (1987) using u_g = 10 m s^{-1}, v_g = 0, and u_* = 0.4 m s^{-1}.

N

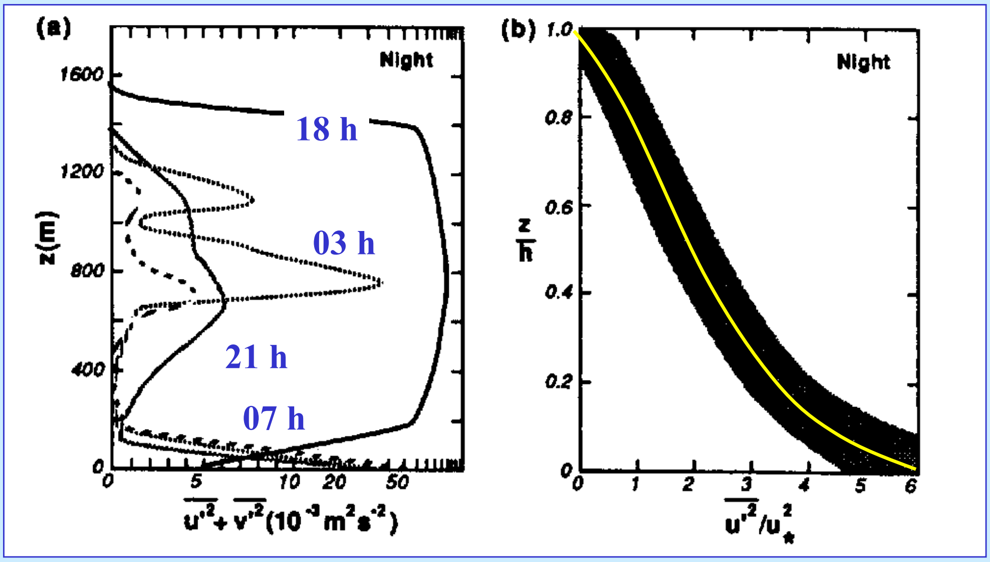
•In statically neutral conditions the variances also decrease with height from large values at the surface: however the depth scale is much larger (h ≈ 2 km).



(a) Range of horizontal velocity variance, normalized by the convective velocity scale w_*^2, versus dimensionless height z/z_i, for typical conditions with combined convection and wind shear.
(b) Idealized range for free convection with no mean shear.

N

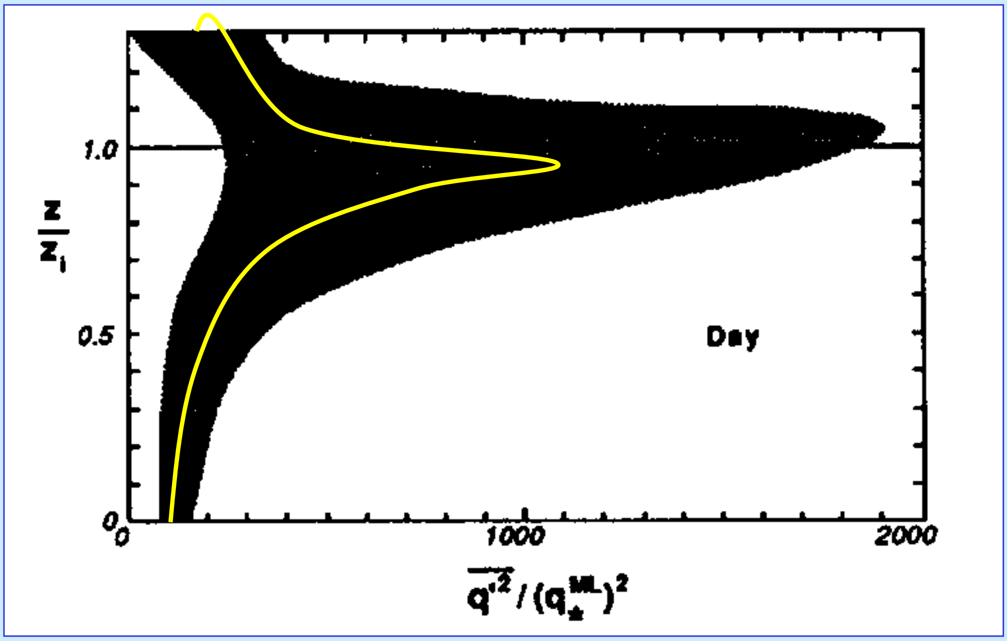
- The horizontal components are often largest near the ground during the day, associated with the strong wind shears in the surface layer.
- The horizontal variance is roughly constant throughout the mixed layer, but decreases with height above the mixed layer top.



(a) Modelled profiles of horizontal eddy kinetic energy during Night 33-34 of Wangara. Abscissa changes from the linear to logarithmic at 10. (b) Range of vertical velocity variance, normalized by a measure of stable boundary layer depth, h.

N

- At night, the horizontal variance decreases rapidly with height to near the top of the stable boundary layer.
- This shape is similar to that of the vertical velocity variance.



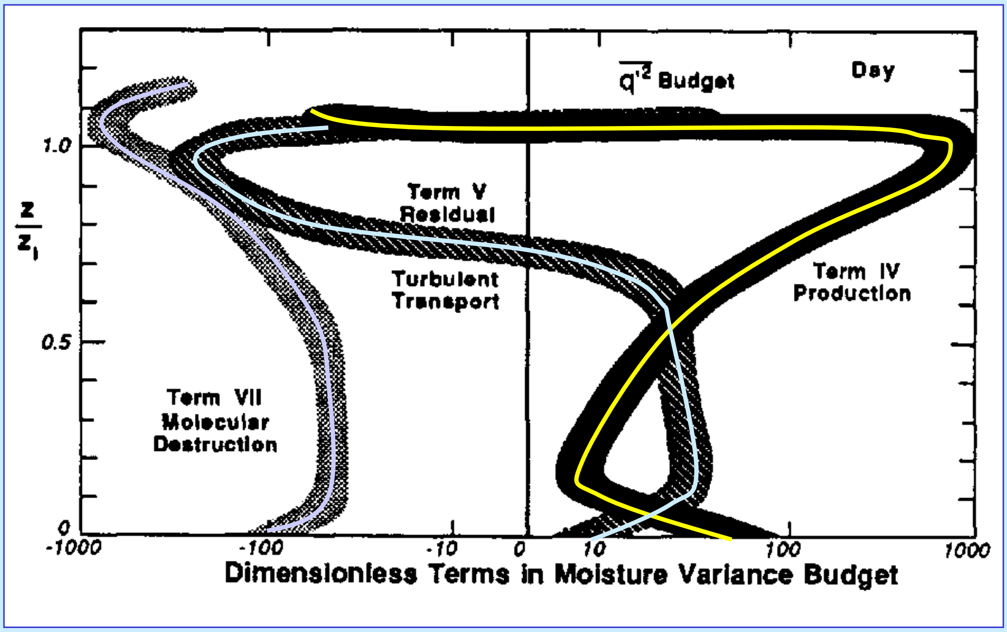
Modelled vertical profiles of dimensionless specific humidity variance for Wangara Day 33.

N

•Humidity variance is small near the ground, because thermals have nearly the same humidity as their environment.

•At the top of the mixed layer, the drier air from aloft is being entrained down between the moist thermals, creating large humidity variances.

•Part of this variance might be associated with the excitation of gravity waves by the penetrative convection.



Modelled vertical profiles of terms in the specific humidity variance equation for Wangara Day 33 at hour 14.1.

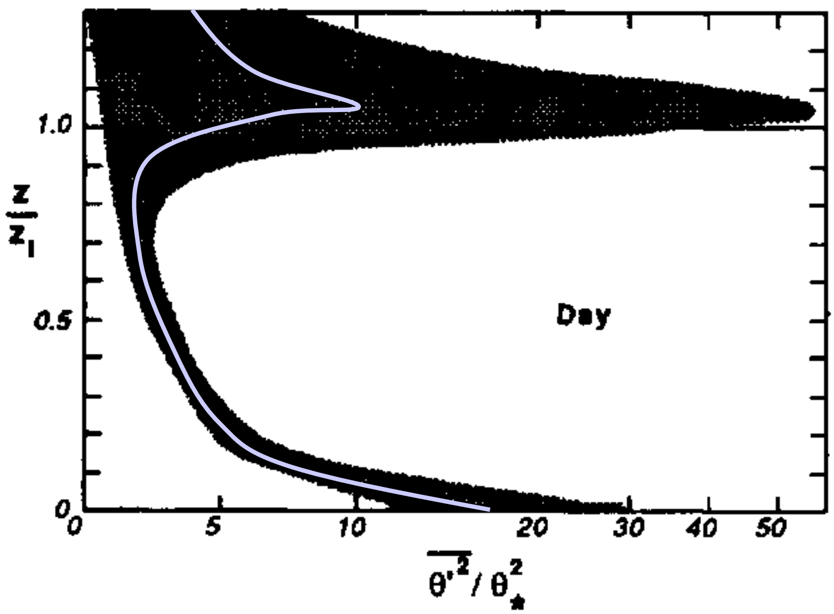
N

•Profiles made dimensionless by dividing by $w_*(q_{*ML})^2/z_i$. Abscissa changes from linear to logarithmic at ± 10.

•w_* = 2.04 m/s, q_* = 1.3 × 10^{-5} g/g, and z_I = 1305 m. The thickness of the curves is meant to suggest some uncertainty in the precise values.

•The figure shows production terms balancing loss terms in the budget, assuming a steady state situation where storage and mean advection terms are neglected.

•Notice that the transport terms (found as a residual) are +ve in the bottom half of the mixed layer, but are –ve in the top half. The integrated effect of these terms is zero. Such is the case for most transport terms – they merely move moisture variance from one part of the mixed layer (where there is excess production) to another part (where there is excess dissipation), leaving zero net effect when averaged over the whole mixed layer.



Modelled vertical profiles of dimensionless virtual potential temperature variance for Wangara Day 33.

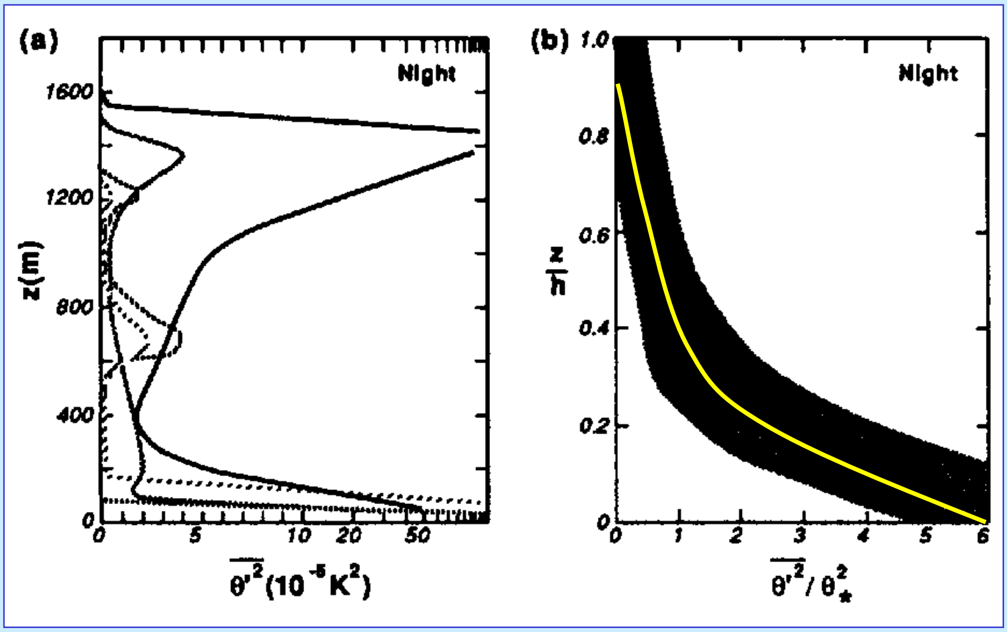
N

•Abscissa changes from linear to logarithmic at ± 10.

•The temperature variance at the top of the mixed layer is similar to the humidity variance, because the contrast between warmer air and the cooler overshooting thermals.

•Gravity waves may contribute to the variance also.

•There is a greater difference near the bottom of the mixed layer, because warm thermals in a cooler environment enhance the magnitude of the variance there.

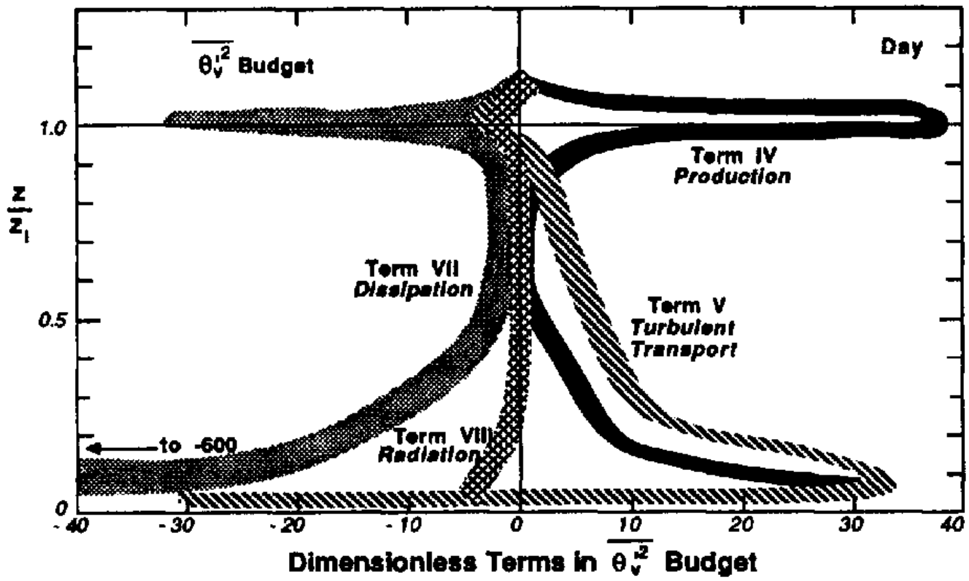


Modelled profiles of virtual potential temperature variance during the night 33-34 of Wangara.

N

•At night the largest temperature fluctuations are near the ground in the nocturnal boundary layer, with weaker, sporadic turbulence in the residual layer aloft.

•The right panel shows the range of temperature variance normalized by the surface layer temperature scale, plotted as a function of height normalized by boundary layer depth.



Modelled vertical profiles in the virtual potential temperature variance budget equation.

N

- Profiles made dimensionless by dividing by $w_*(q_{*ML})^2/z_i$. For Wangara Day 33, hour 14.1.
- The thickness of the curves is meant to suggest some uncertainty in the precise values.
- Figure shows the contribution to the heat budget during the daytime, again neglecting storage and advection.
- The radiation term is small, but definitely nonzero.
- The dissipation is largest near the ground, as is the turbulent transport of temperature variance.