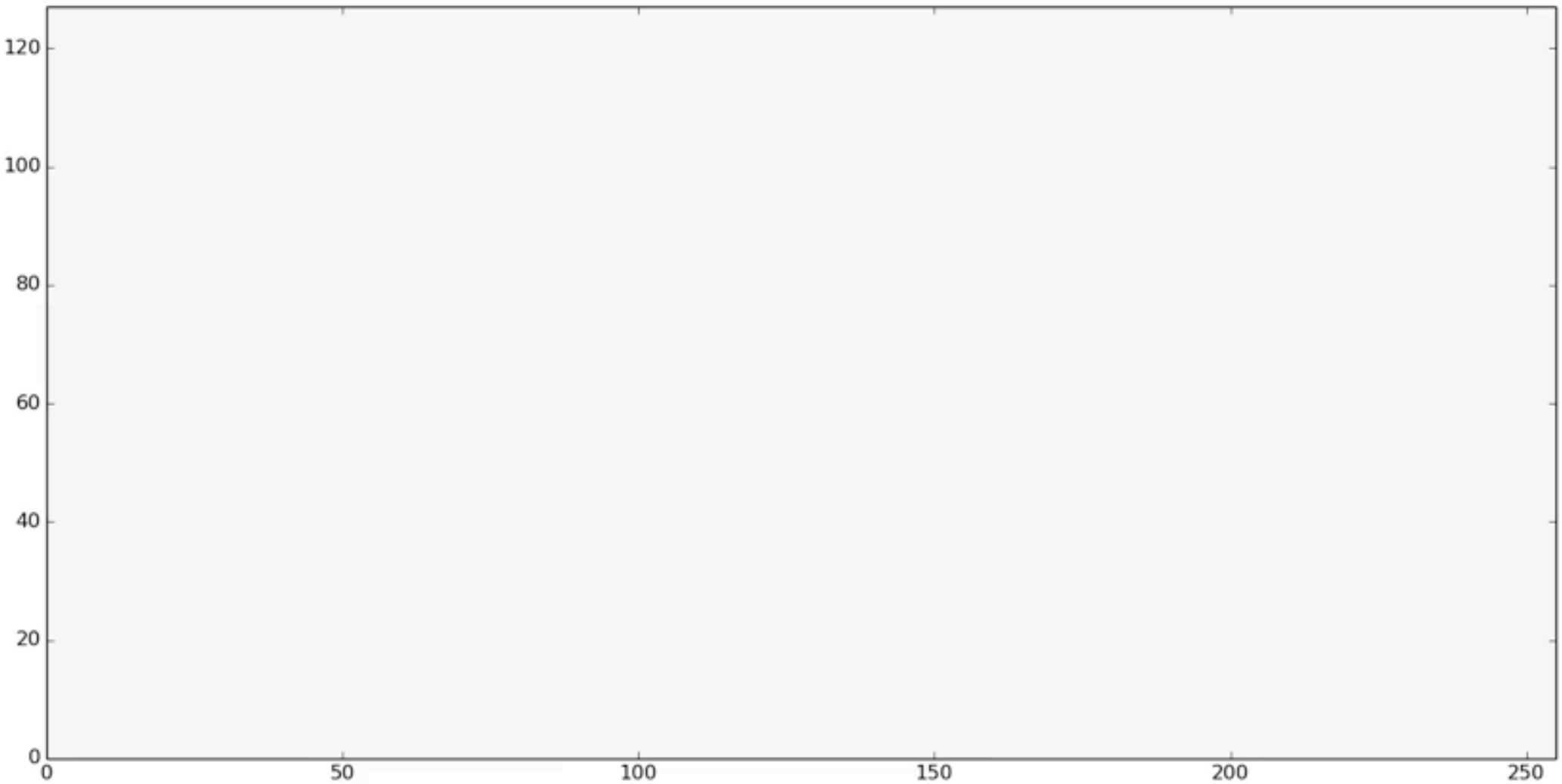
Convective Boundary Layer


120
100
80
60
40
20
0
0
50
100
150
200
250

Diurnal cycle

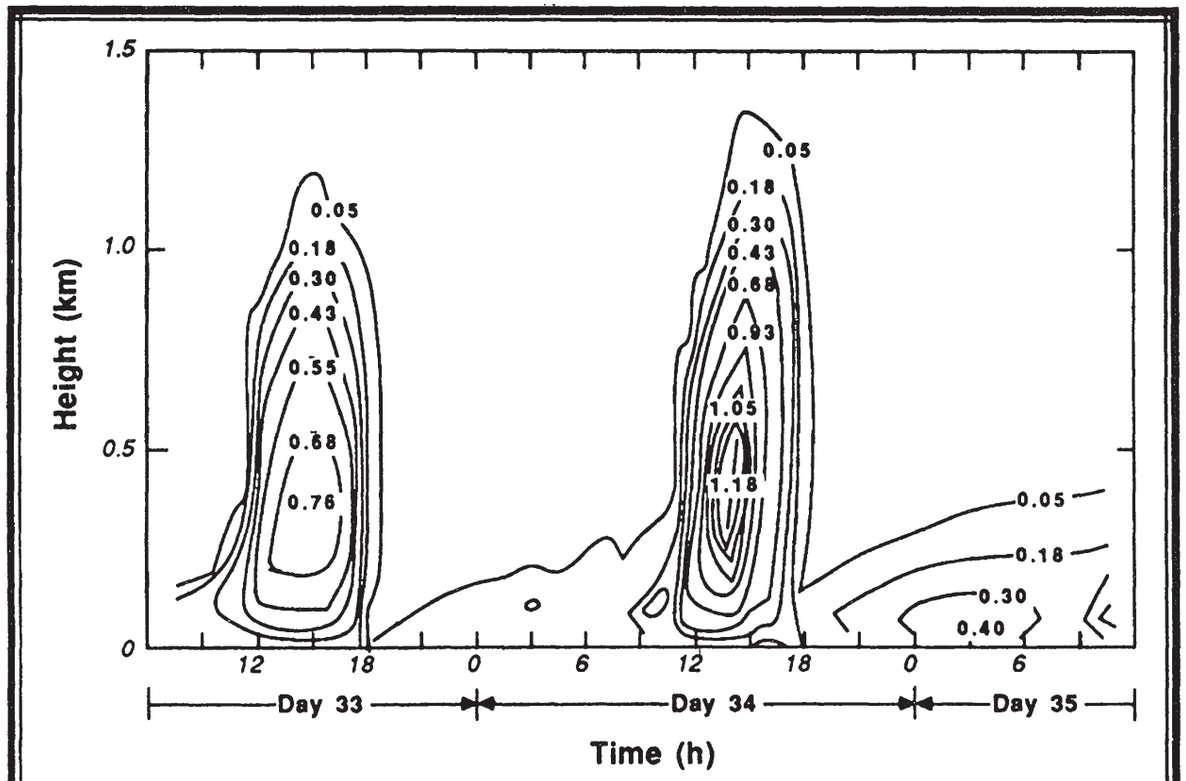
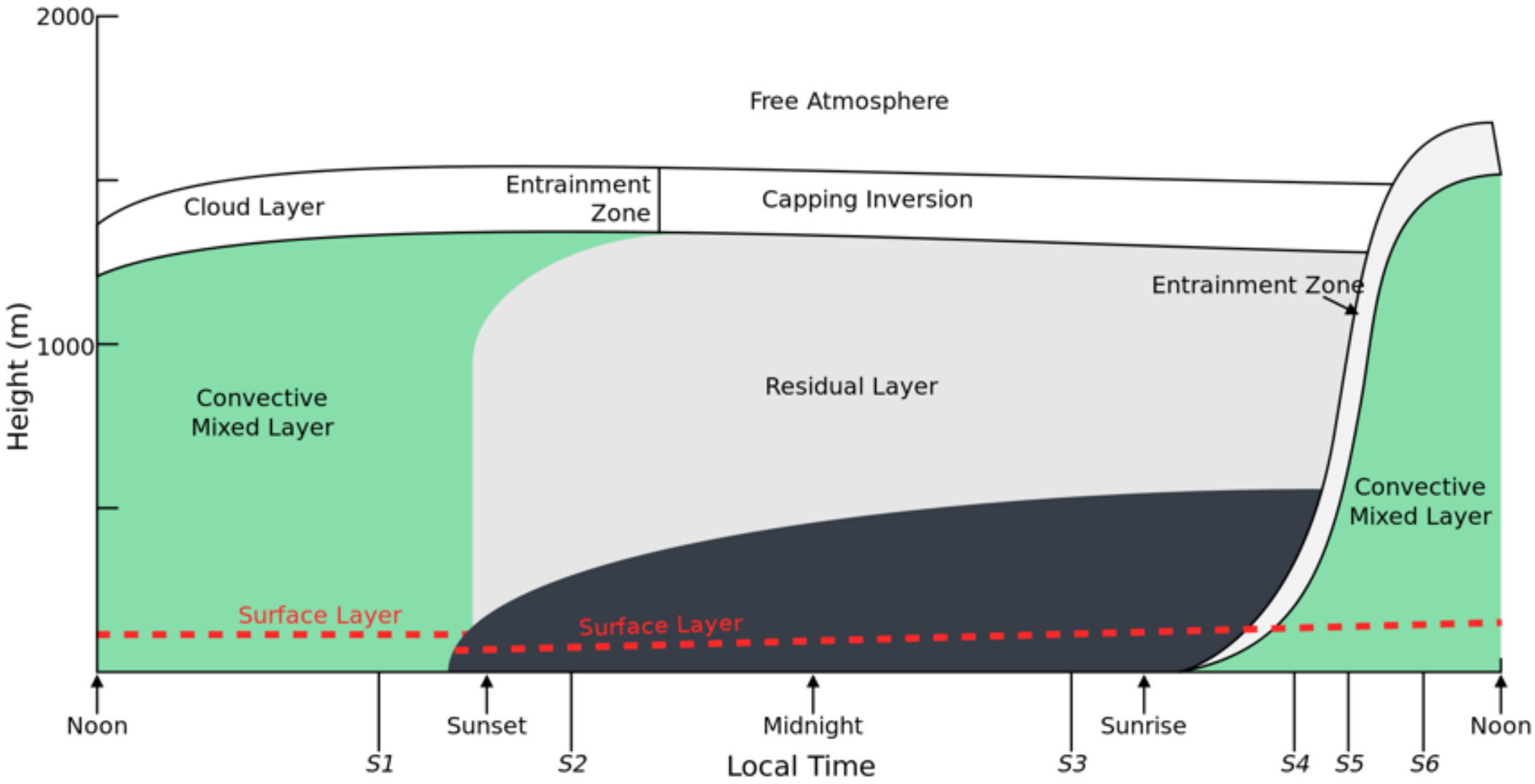


Fig. 5.1 Modeled time and space variation of $\bar{e}$ (turbulence kinetic energy, units $m^2 s^{-2}$), for Wangara. From Yamada and Mellor (1975).

Diurnal cycle schematic



Wikipedia

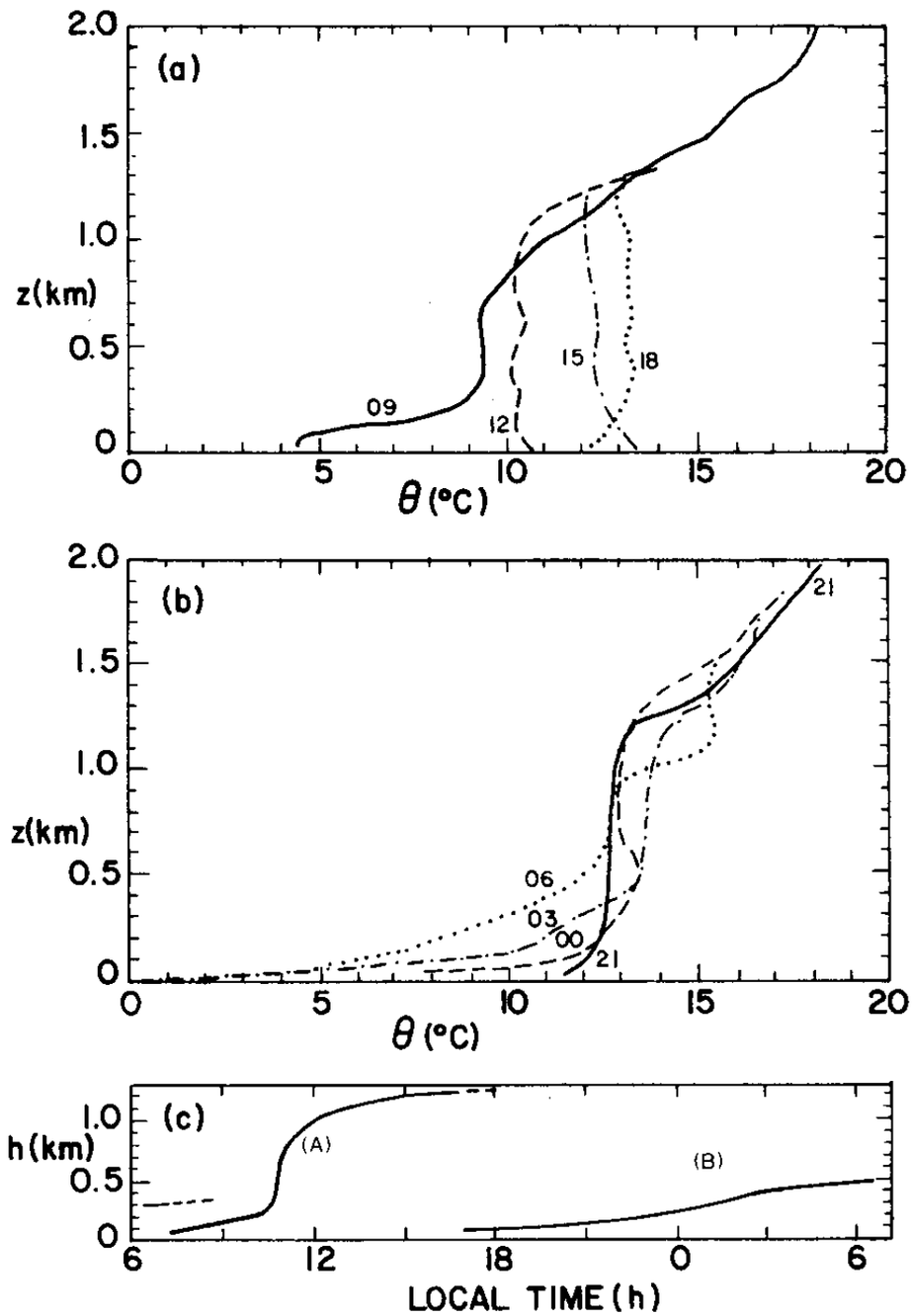
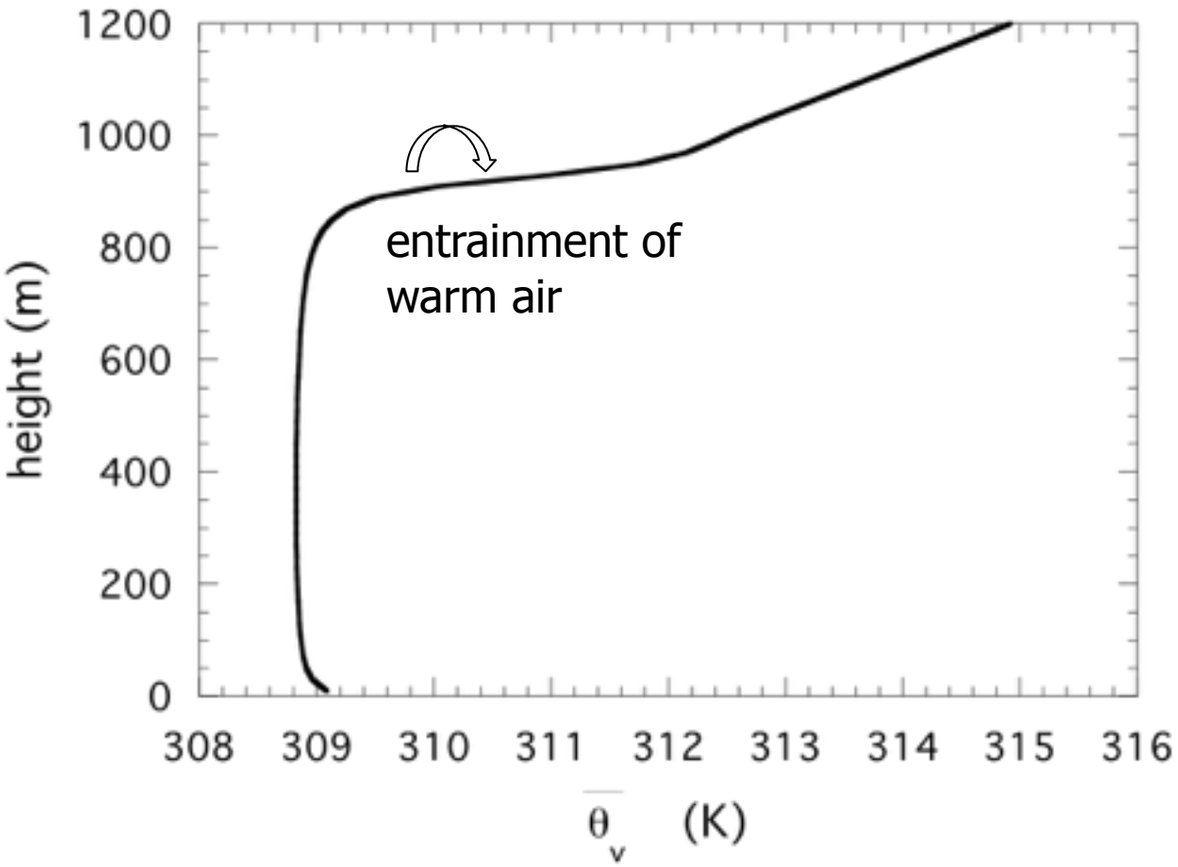
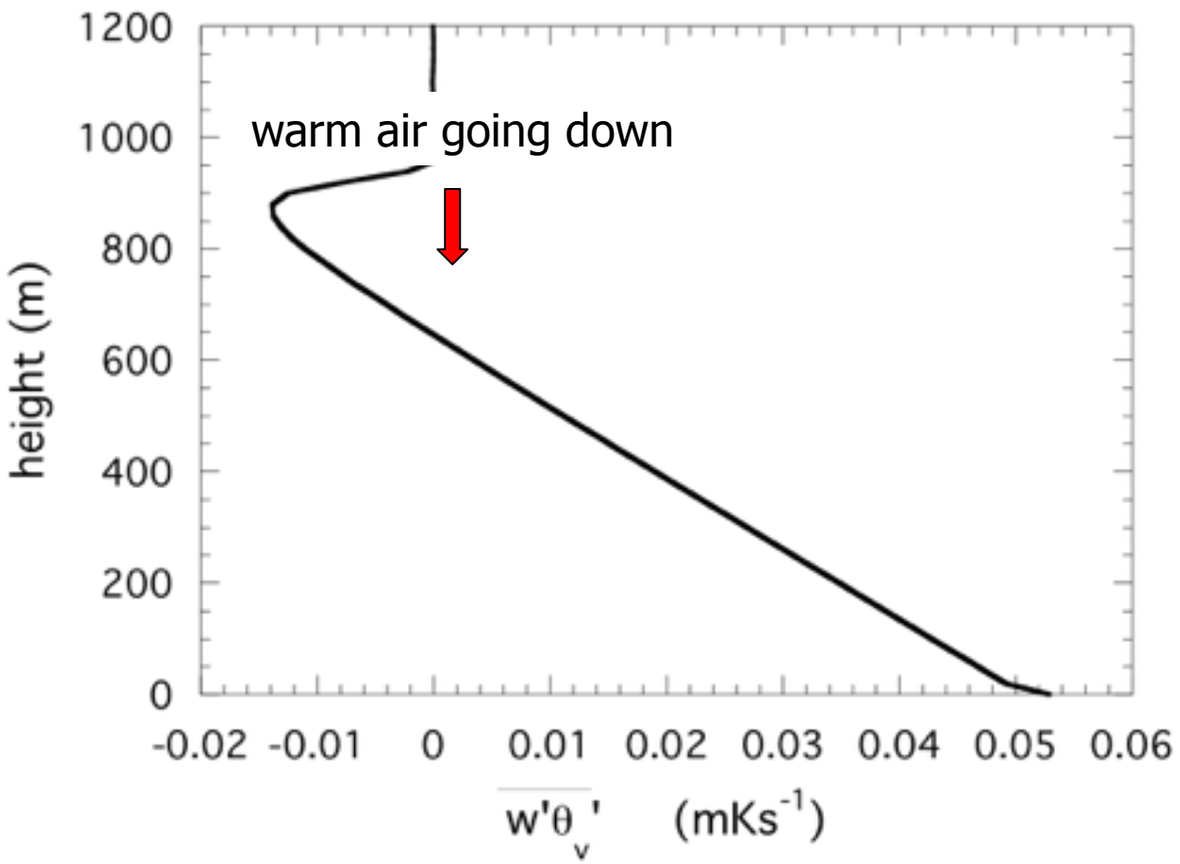


Fig. 5.2 Diurnal variation of potential temperature profiles and the PBL height during (a) day 33 and (b) days 33–34 of the Wangara Experiment. (c) Curve A, convective; Curve B, stable. [After Deardorff (1978).]

Linear flux profile in mixed layer





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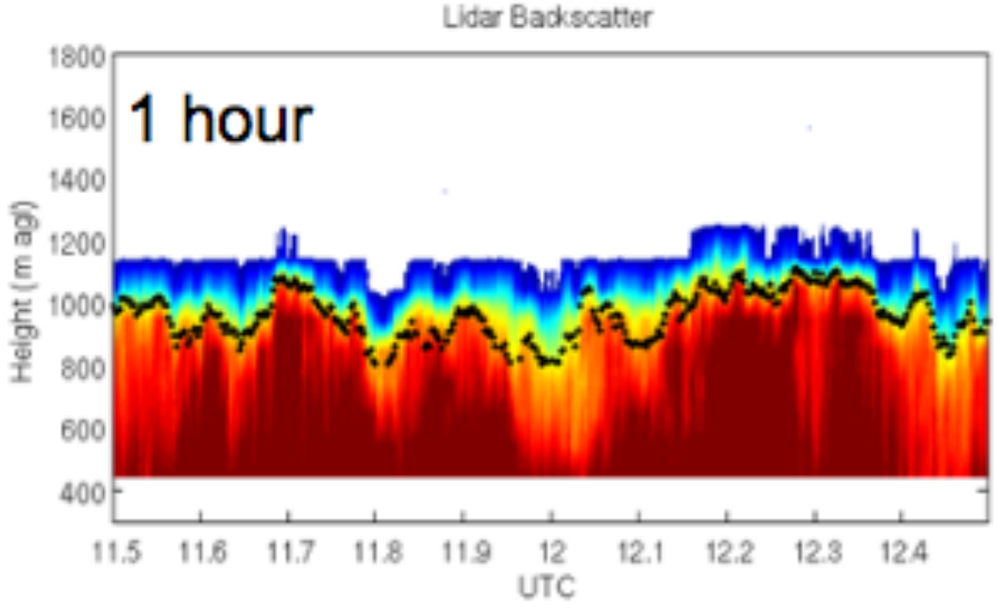
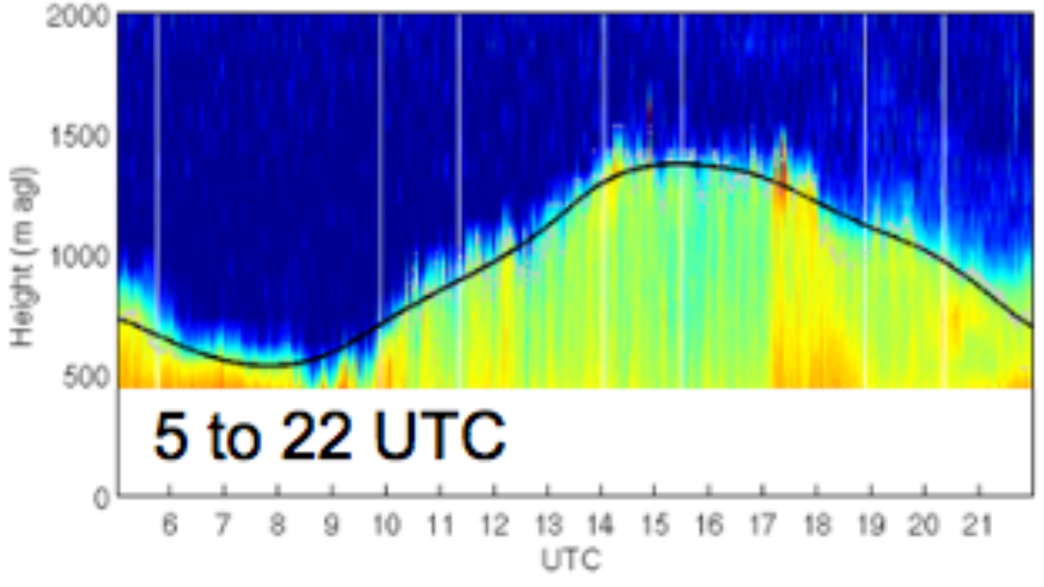
Small-scale fluctuations

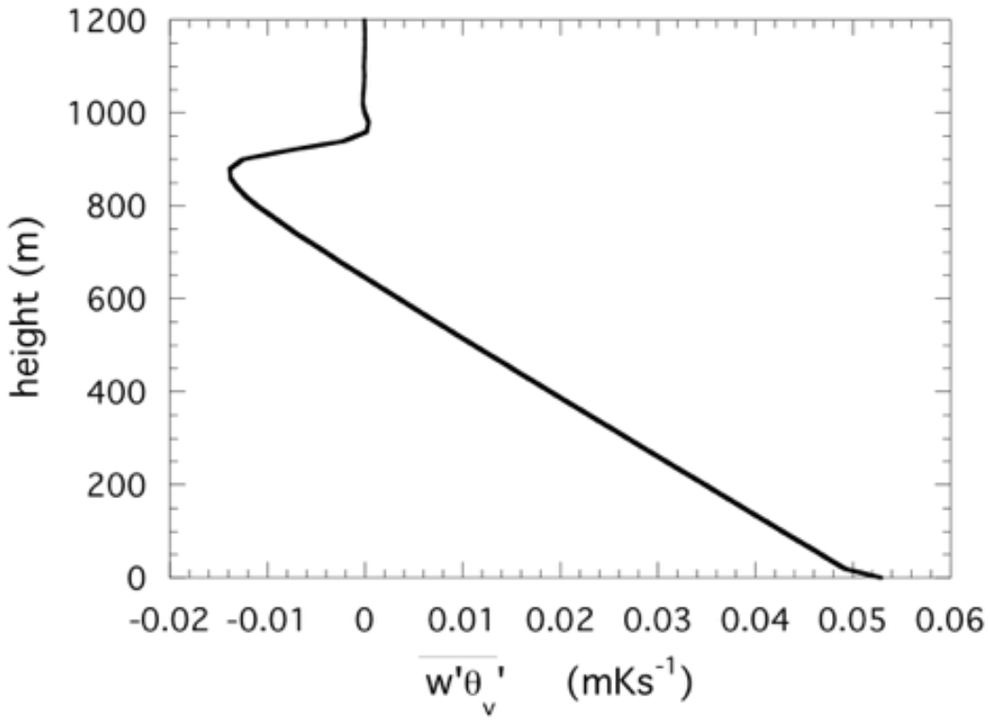


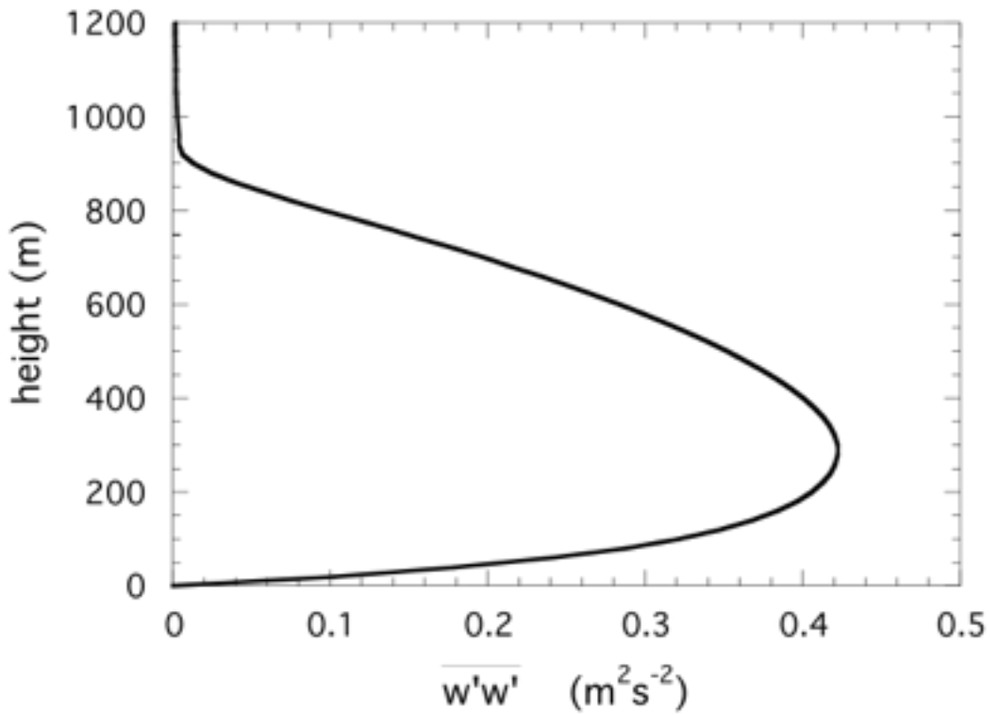
Diurnal increase CBL



Träumner et al. (2009)

Buoyancy production and TKE





$$\frac{\partial \overline{w'w'}}{\partial t} = 2\frac{g}{\overline{\theta_v}}\overline{w'\theta_v'} - \frac{\partial \overline{w'w'w'}}{\partial z} - \frac{2}{\overline{\rho}}\overline{w'\frac{\partial p'}{\partial z}} - 2\nu\overline{\left(\frac{\partial w'}{\partial x_j}\right)^2}$$

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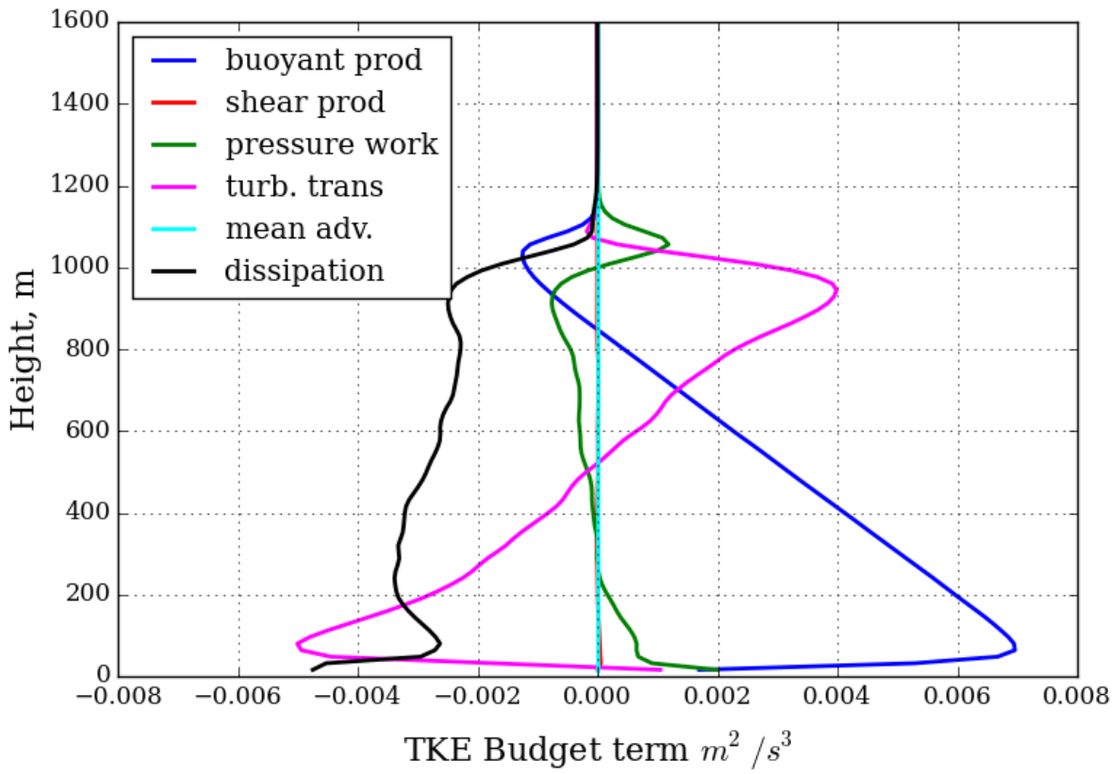
TKE budget



- **buoyant production** dominates (in this case zero mean wind)
  - negative in entrainment zone
- shear production:
  - near surface
  - directional shear: given if non-zero geostrophic wind in free troposphere
- **transport term:** vertical transport of TKE
  - important to compensate for loss of TKE by negative buoyancy term in entrainment zone
- **rate of change ~ - dissipation**
  —> dissipation strongly depends on numerical advection scheme (numerical diffusion)

$$\frac{\partial \overline{E}}{\partial t} = \frac{g}{\overline{\theta_v}} \overline{w' \theta_v'} - \overline{u' w'} \frac{\partial \overline{U}}{\partial z} - \overline{v' w'} \frac{\partial \overline{V}}{\partial z} - \frac{\partial \overline{w' w' w'}}{\partial z} - \frac{1}{\overline{\rho}} \frac{\overline{\partial w' p'}}{\partial z} - \varepsilon$$