

Convective mixing heights and plume penetration

questions about methods used in
Calmet and Calpuff

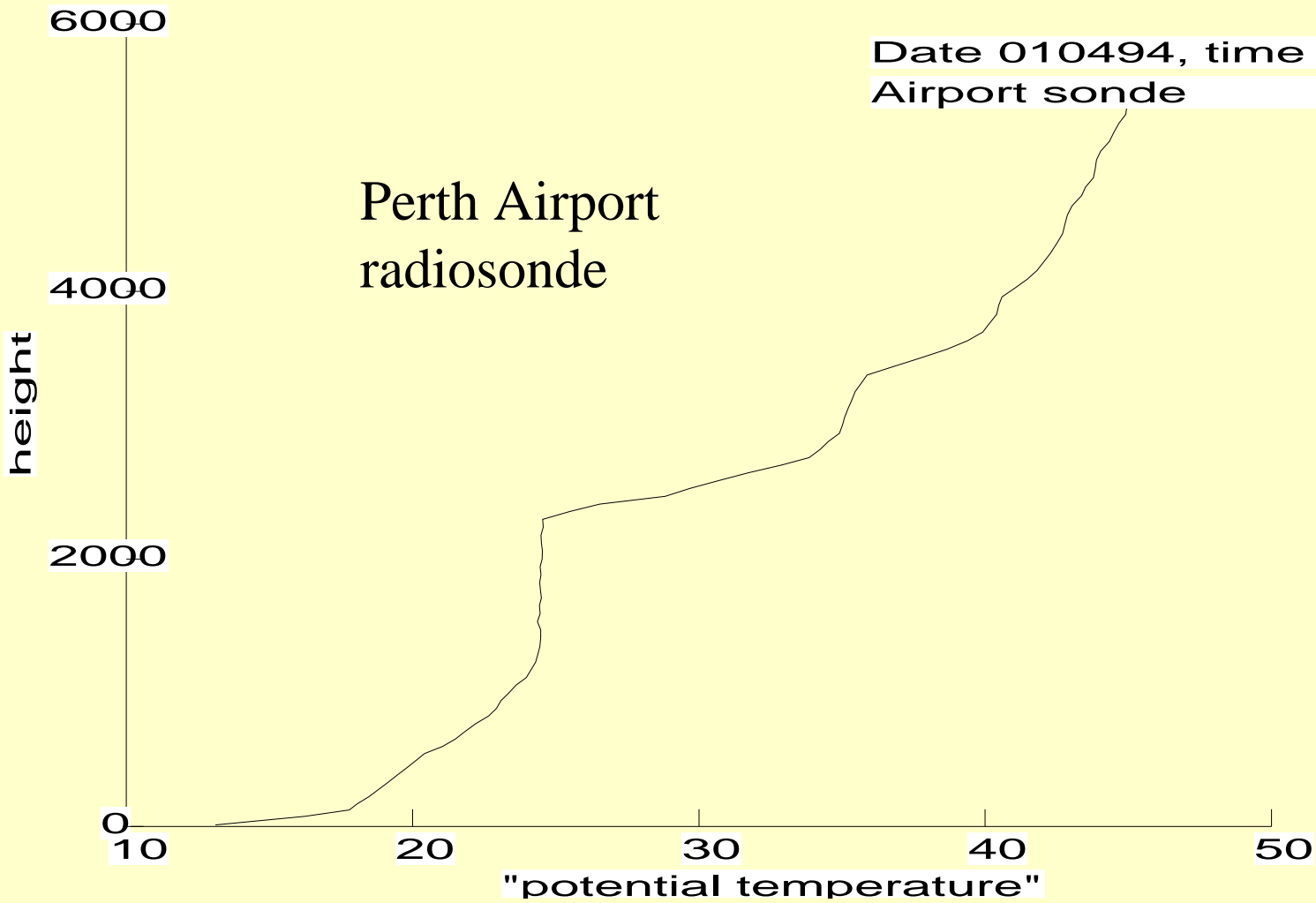
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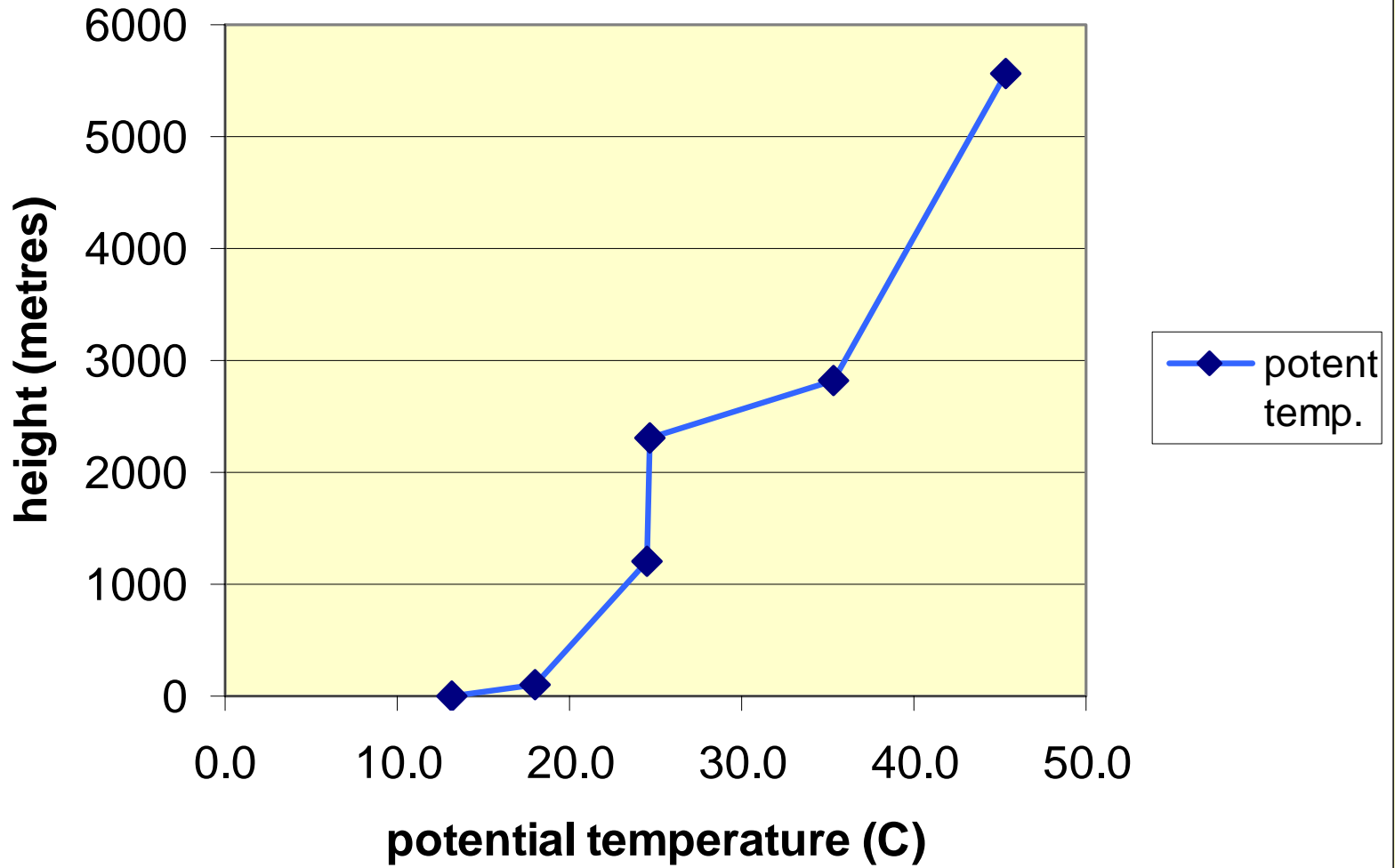
Compare Zic calculation schemes

- Aermet
- Calmet (Carson/Maul)
- WA DoE (Rayner and Watson, 1991)
- Trinity Consultants Aermet

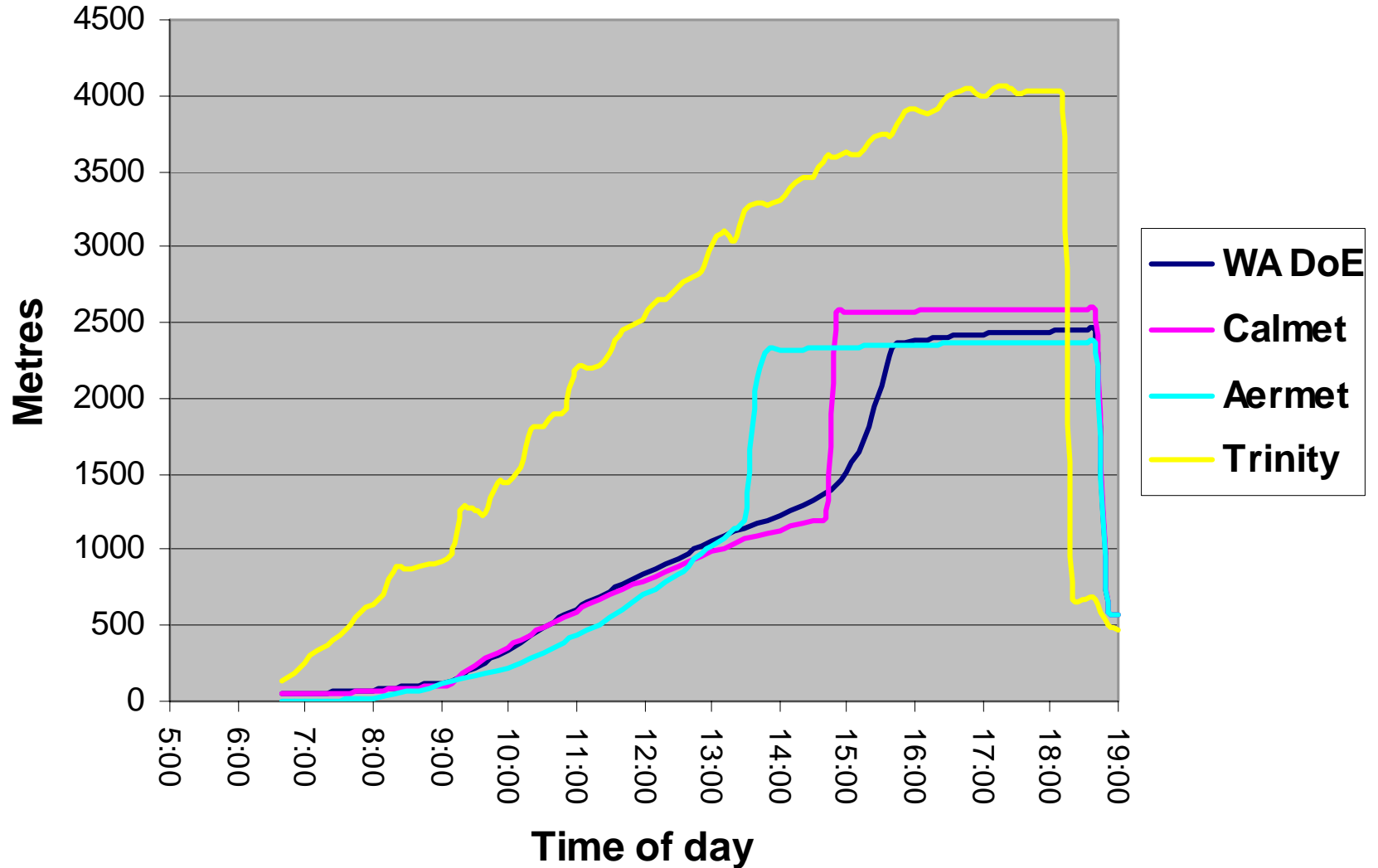
Meteorological data from Caversham, W.A.



potential temperature profile 1 Jan 1994



Comparison of mixing height schemes (10-minute steps)



Trinity Consultants Zi_c

$Zi_c = (Z_n^2 + 1400\Sigma H_s)^{1/2}$, where:

- $Z_n = u_*/(4f)$;
- f is the Coriolis parameter;
- ΣH_s is the “integrated sensible heat flux calculated by summing the values for each hour after sunrise”.
- results are poor

WA DoE (Rayner and Watson, 1991)

$$dh/dt = 0.18 q_*^3 / [gh\Delta\theta/T + 0.8 q_*^2] \quad (1)$$

$$d\theta_m/dt = [\Delta\theta dh/dt + H_s/\rho C_p] / h \quad (2)$$

$$\Delta\theta = \theta_{\text{sonde}}(h) - \theta_m \quad (3)$$

where $q_*^3 = w_*^3 + C_N^3 u_*^3$; $C_N \sim 1.33$.

$\Delta\theta(z)$ increases or decreases smoothly even when there is a sudden change in $\gamma(z)$ – see behaviour of $h(t)$ after 1400

Questions about Maul and new B&G schemes

- Maul formulae do not appear to have memory of ΔT ?
- B&G formula rigorous but the assumption of constant lapse rate may affect accuracy. An alternative is to solve 2 equations, one each for dh/dt and $d\Delta T/dt$.
- Why is the lapse rate determined over a fixed user-defined layer (default 200m)?

Plume penetration

- solution of Z_{ic} in Aermet can provide a measure of ΔT , which should be appropriate for use in determine plume penetration? But ΔT is not carried through to Calmet output – why?
- Instead, ΔT is determined in Calpuff from the temperature profile in a layer 30 m (why 30 m?) above the calculated Z_{ic} . This procedure may not correctly locate the actual height in the profile containing the largest lapse rate (i.e. the method is sensitive to inaccuracy in Z_{ic} estimation).