Assignment 1 Solutions

METR 130

Spring Semester 2011

Problem 1
(Calculation of Neutral ABL depth, h_n)

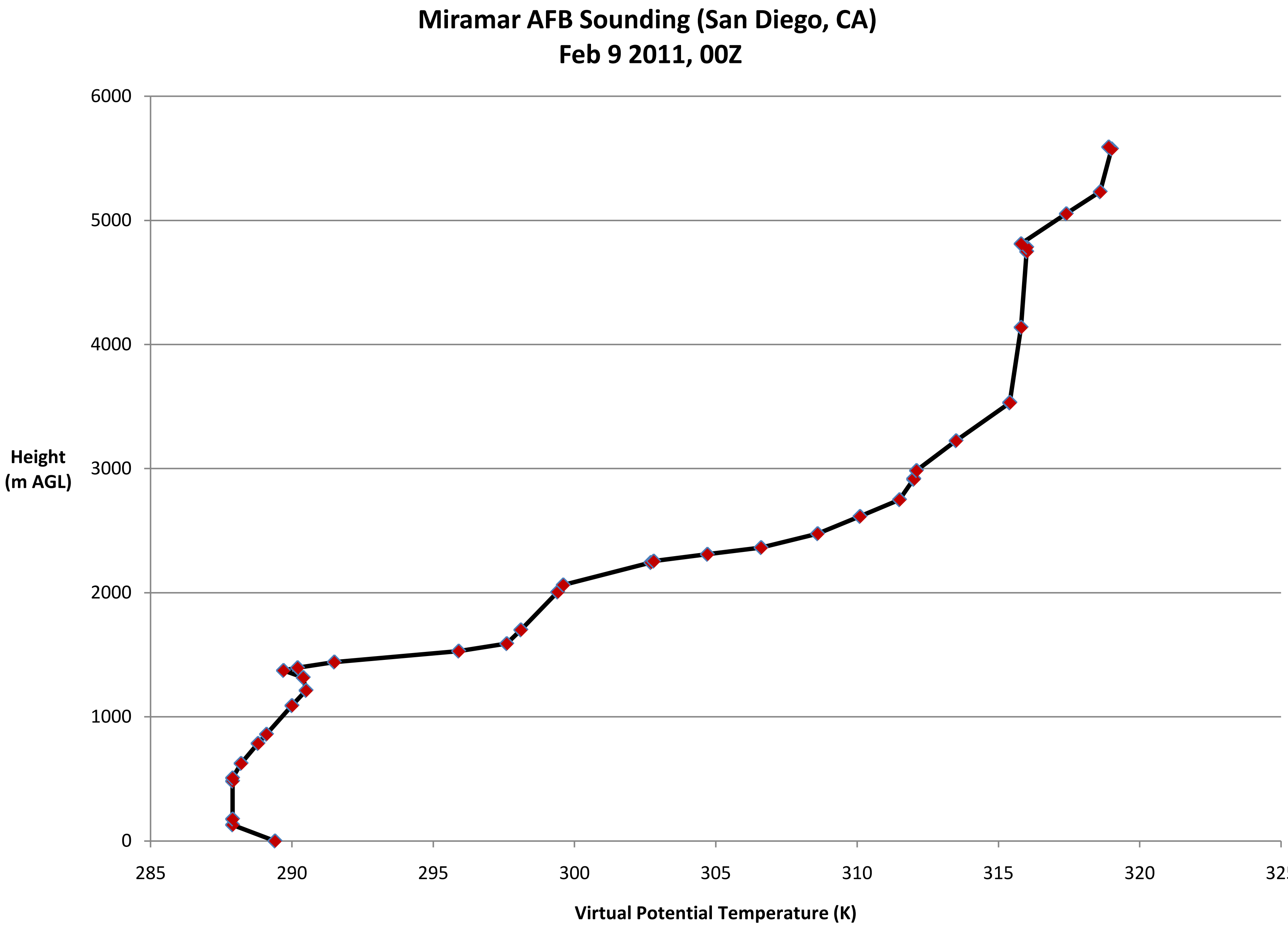
- Given relationship $h_n = cu_*/f$
- $c = 0.6$, u_* is friction velocity and f is Coriolis parameter
- u_* determined from $C_g = u_*^2/G^2 = f(Ro)$
- Surface Rossby Number, $Ro = G/fz_0$
- G is geostrophic wind speed, z_0 is surface roughness length.
- Set typical values
  - $G = 10$ m/s (typical for 850 mb)
  - $f = 10^{-4}$ s^{-1} (value for 45 degrees latitude)
  - $z_0 = 0.1$ meters (short vegetation on open land, general value for land areas)
  - Using these leads to $Ro = 10^6$
  - C_g (from class handout) ≈ 0.0016
  - With $G = 10$ m/s this leads from above to $u_* = 0.4$ m/s
- Using this u_* with $f = 10^{-4}$ and $c = 0.6$ gives …

$$\mathbf{h_n = (0.6)(0.4\ m/s)/(10^{-4}\ s^{-1}) = 2400\ m}$$

Problem 2

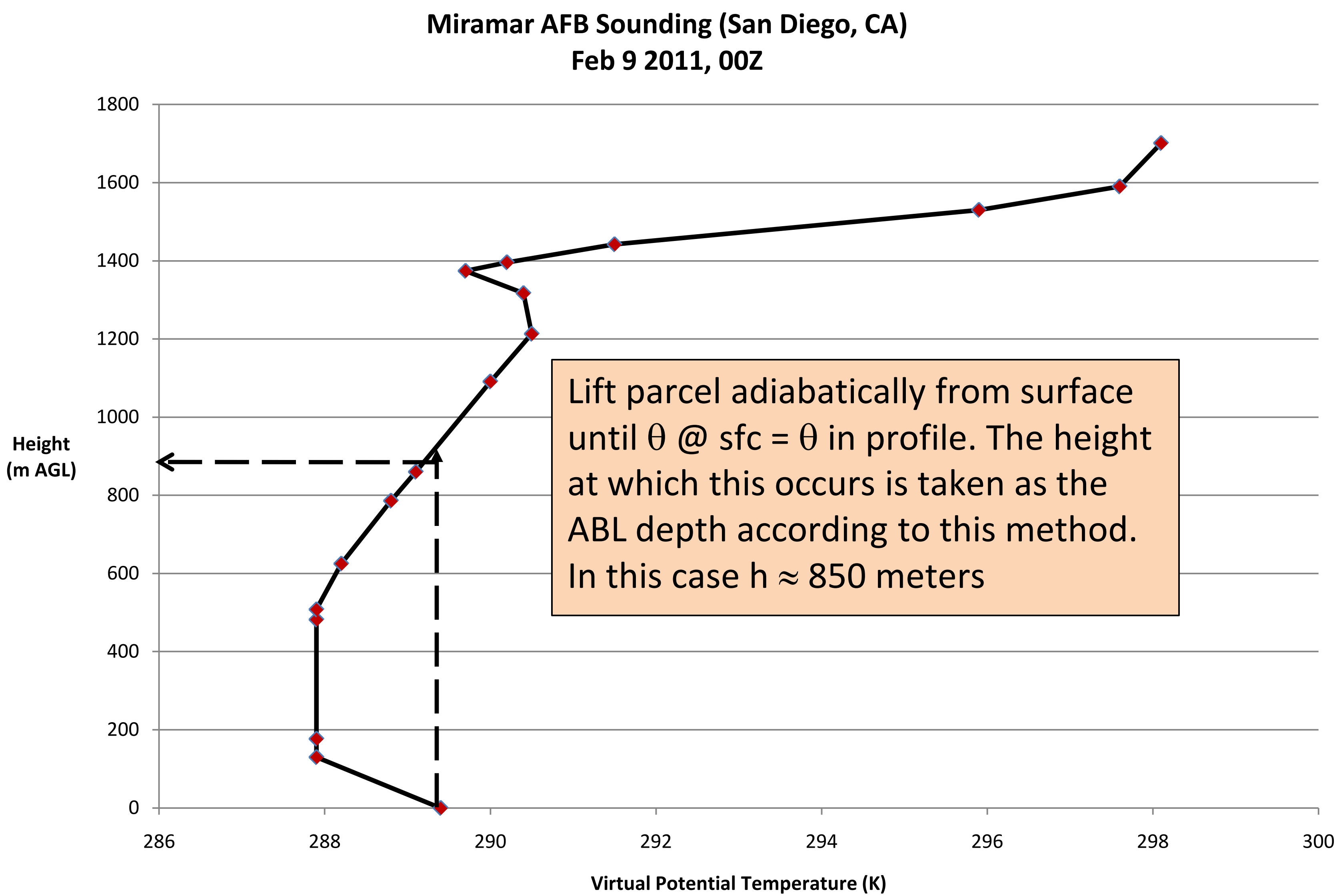
(Determining ABL depths from routine sounding data using methods in Seidel et al. 2010)

Show for typical, “well behaved” sounding: Miramar AFB (San Diego) on Feb. 9, 2011.


Miramar AFB Sounding (San Diego, CA)
Feb 9 2011, 00Z
Height
(m AGL)
6000
5000
4000
3000
2000
1000
0
285
290
295
300
305
310
315
320
325
Virtual Potential Temperature (K)

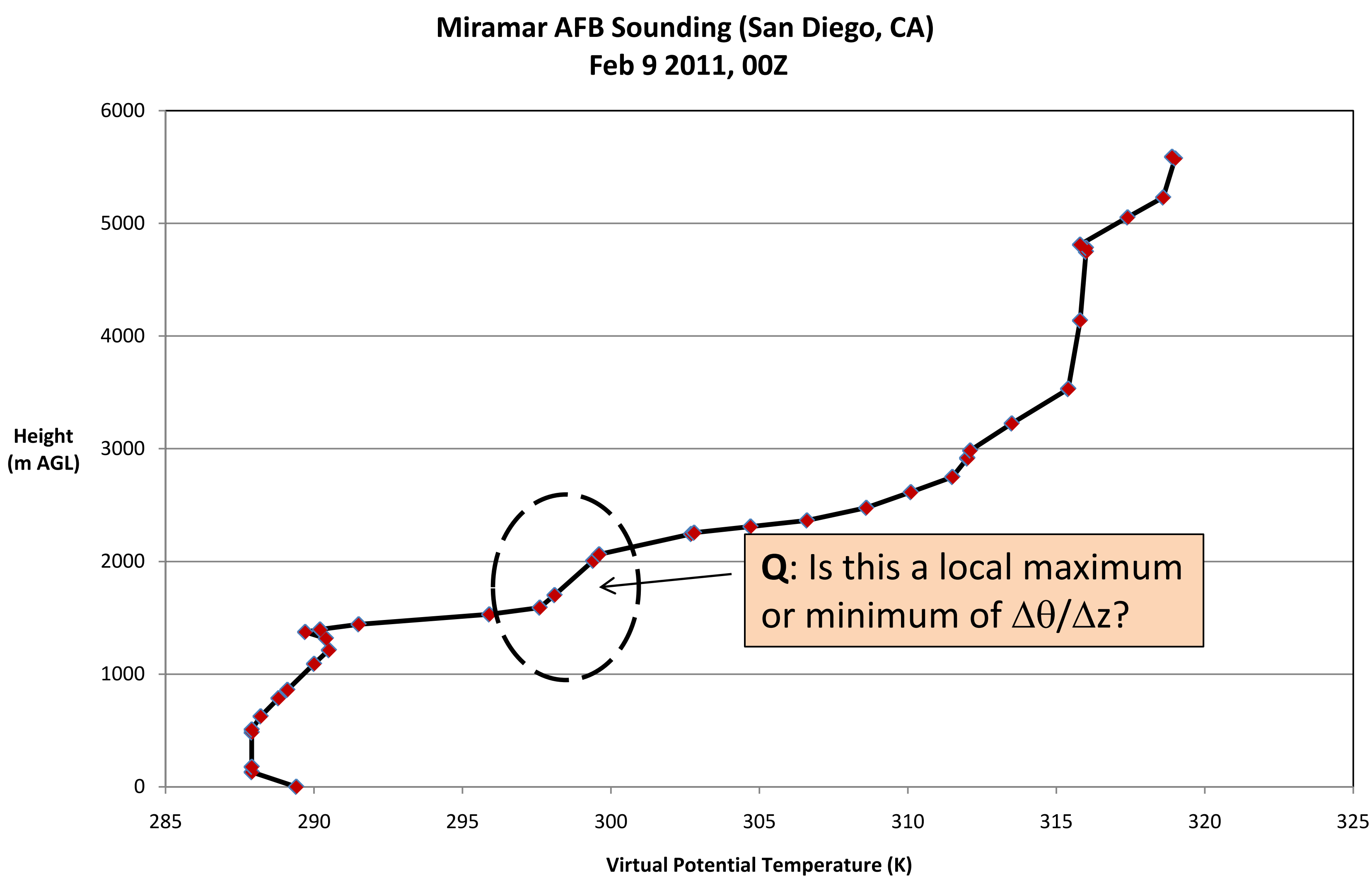
METHOD 1: PARCEL METHOD

Used for determining daytime ABL depth (CML /CBL) since it requires unstable air @ sfc



METHOD 2: MAXIMUM VERTICAL GRADIENT OF POTENTIAL TEMPERATURE

Used primarily for determining depth of ABL capped by an elevated stable layer (either CML/CBL or a near-neutral ABL).



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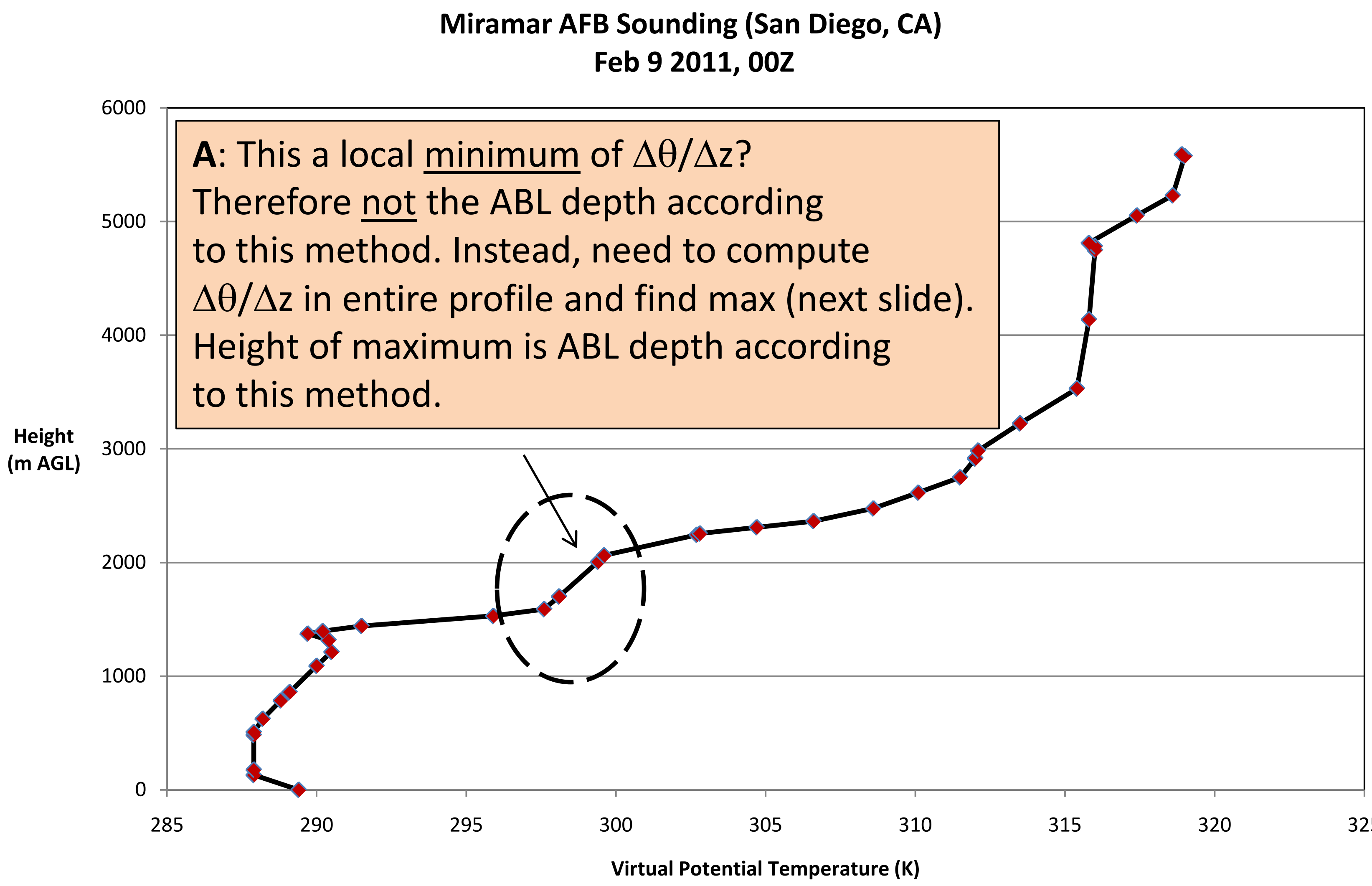

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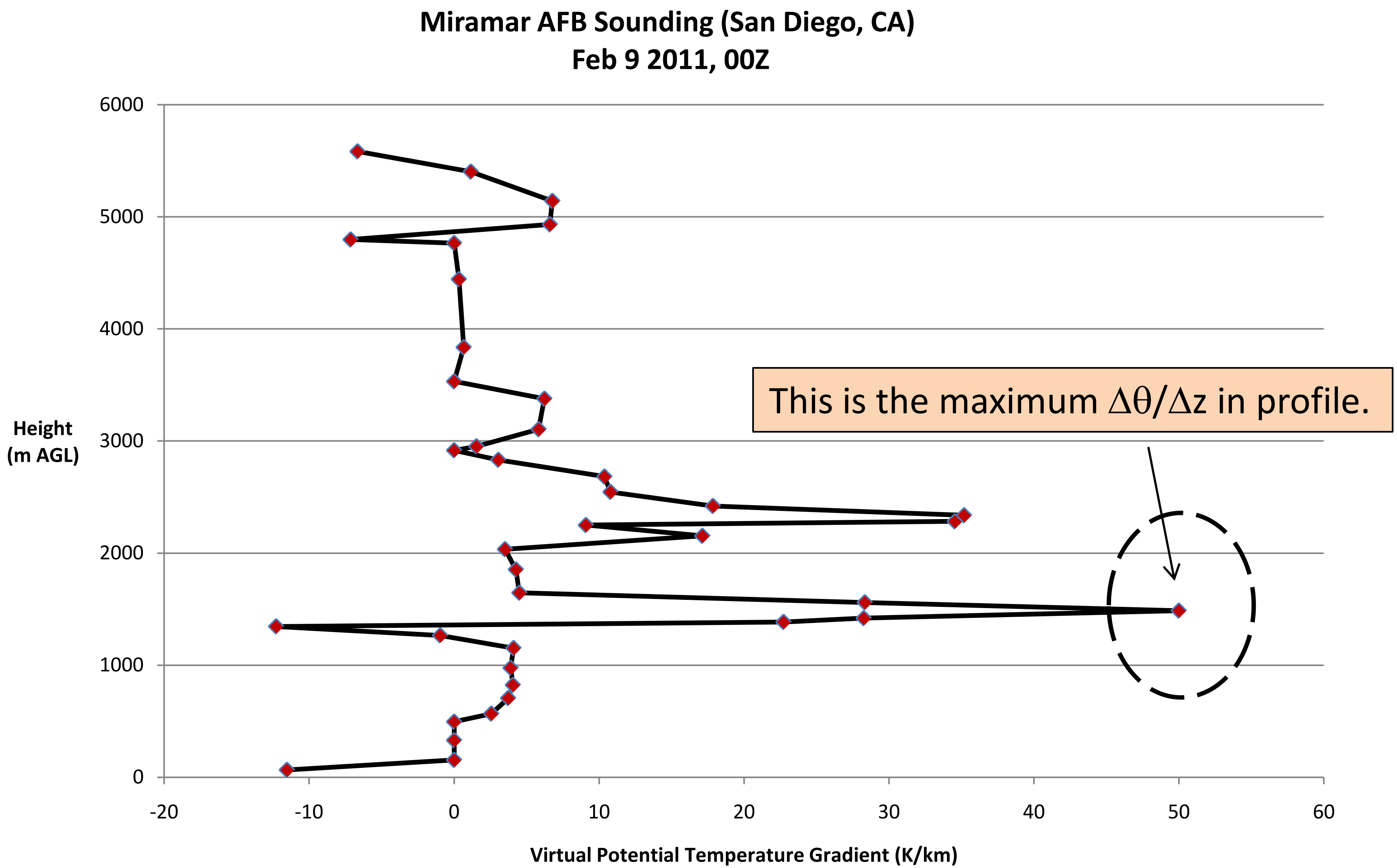

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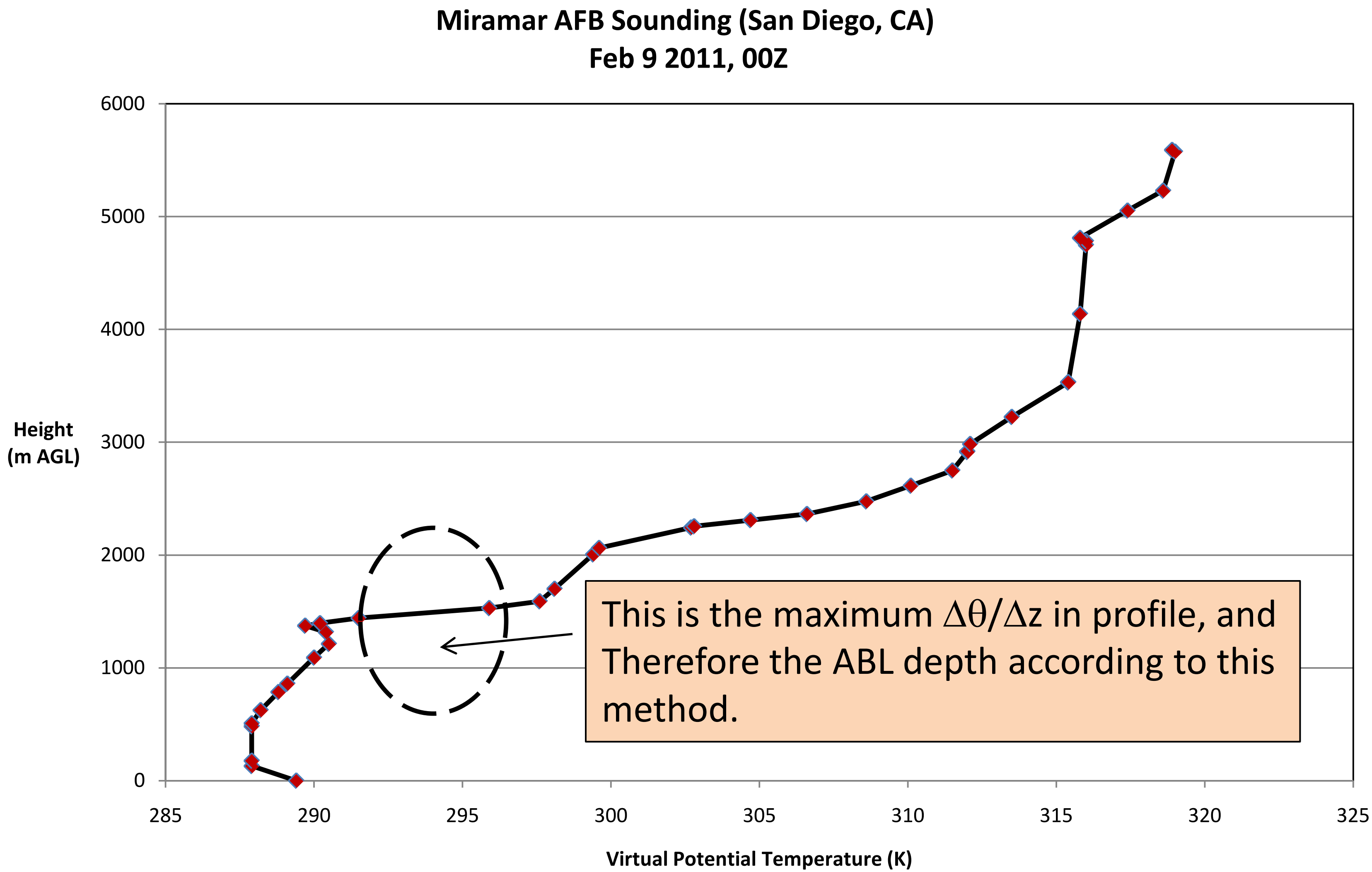
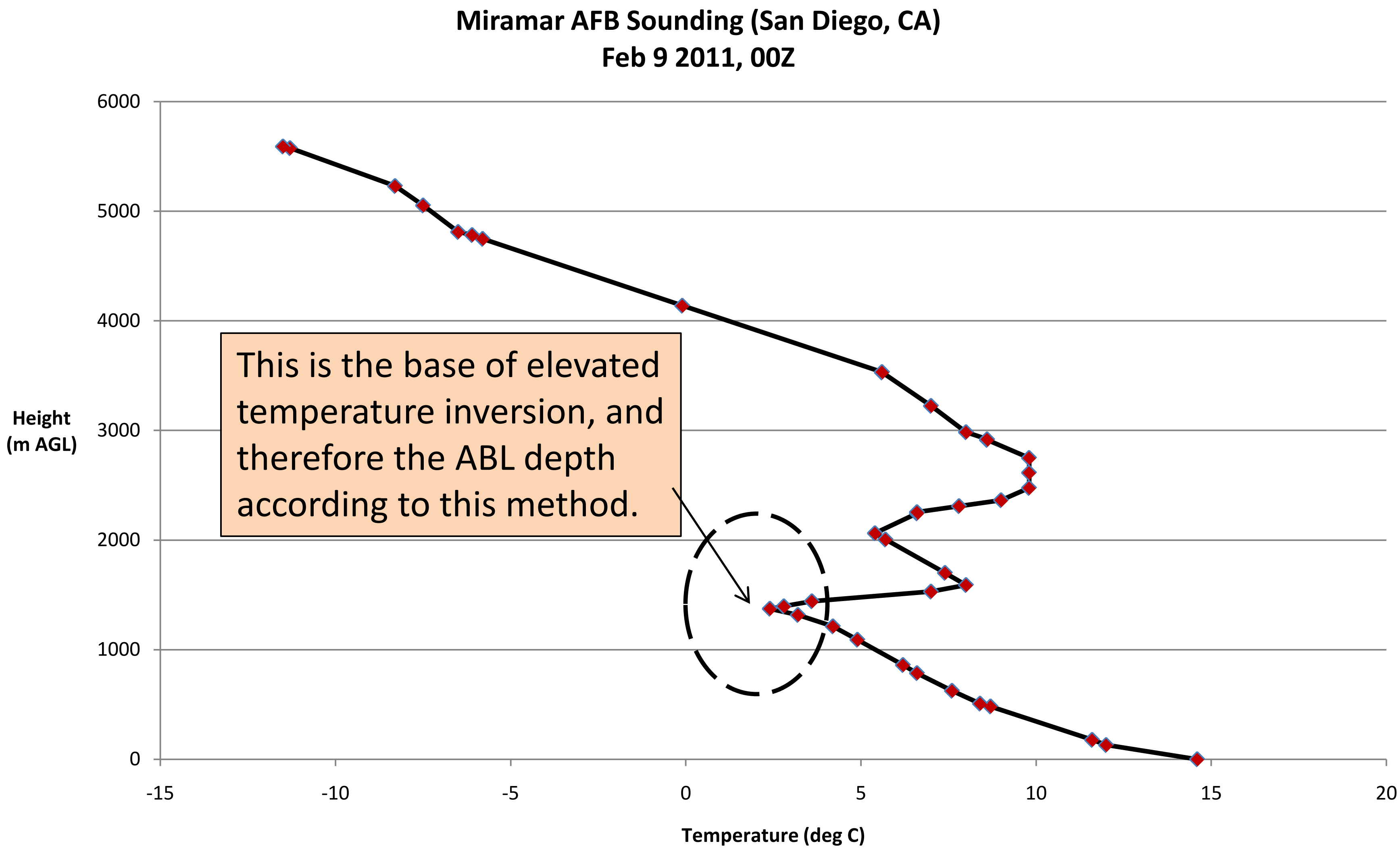


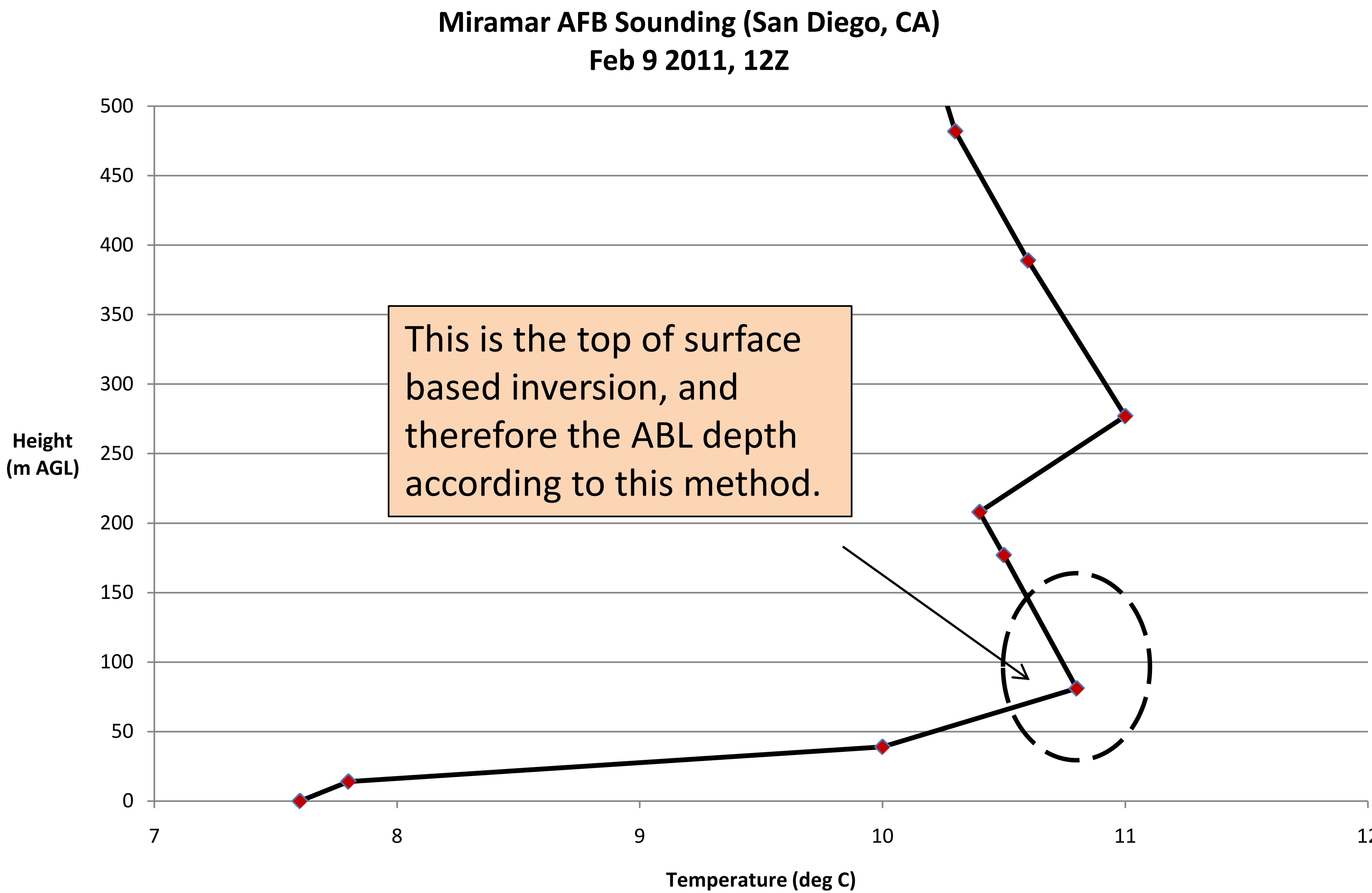
METHOD 3: BASE OF ELEVATED TEMPERATURE INVERSION

Used for determining depth of ABL capped by an elevated stable layer (either CML/CBL or a near-neutral ABL).



METHOD 4: TOP OF SURFACE BASED TEMPERATURE INVERSION

Used for determining depth of nighttime ABL depth (stable ABL, aka "SBL")



Summary Table

Sounding	Method 1 (Parcel Method)	Method 2 (Max Theta Gradient)	Method 3 (Base of Elevated T-inv)	Method 4 (Top of Surface-based T-inv)
00Z	~ 900 m	1486 m	1374 m	-
12Z	-	-	-	81 m

Take average of Methods 1, 2 and 3 for daytime ABL depth = 1250 m

25th Percentile (Seidel) = 750 m

75th Percentile (Seidel) = 2500 m

Midpoint (Seidel) = 1625 m

Problem 3 (with appropriate discussion)

Average of San Diego & Seidel = AVERAGE(1250, 1625) = 1440 m

Problem 4: Value for c that better describes ABL capped by an elevated stable layer …

Let h = 1440 m and plug into neutral ABL eq. w/ u_* and f from Problem 1 …

$c = hf/u_* = (1440\ \mathrm{m})(10^{-4}\ \mathrm{s}^{-1})/(0.4\ \mathrm{m/s}) = 0.36$