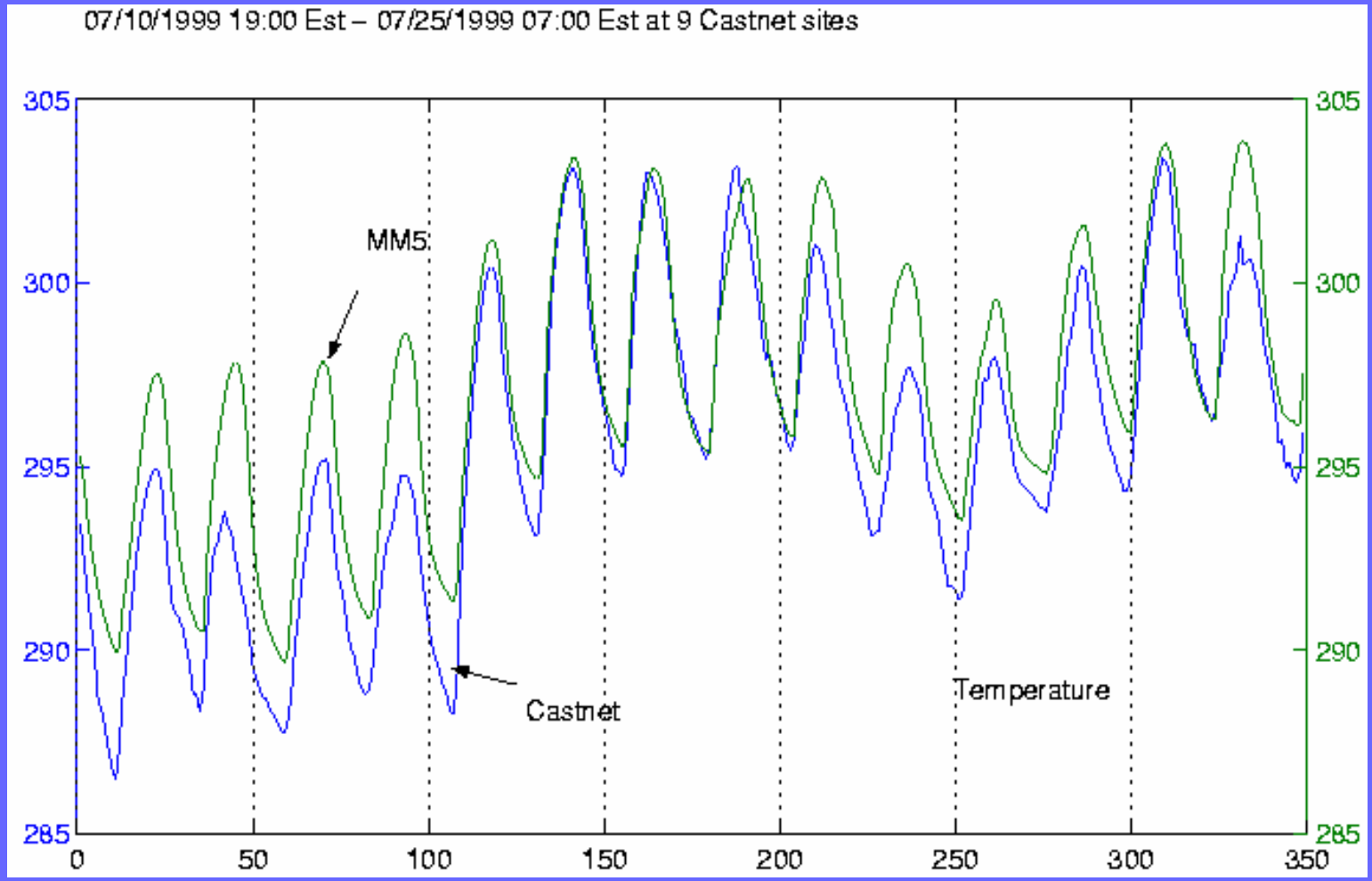
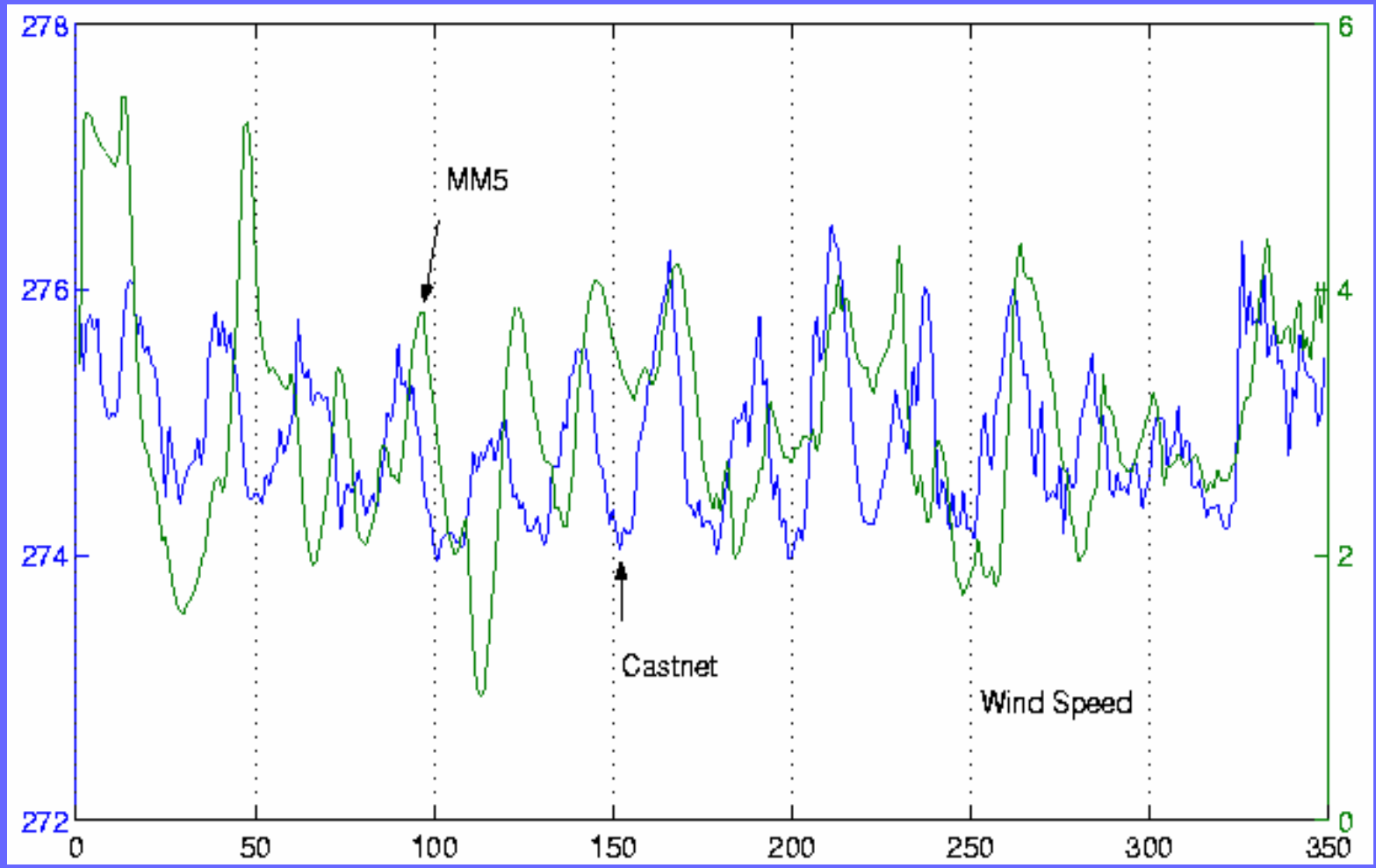
Diurnal Variations in Surface Temperatures and Winds Generated by Various Boundary-Layer Schemes

Da-Lin Zhang and Weizhong Zheng
Department of Meteorology, University of Maryland

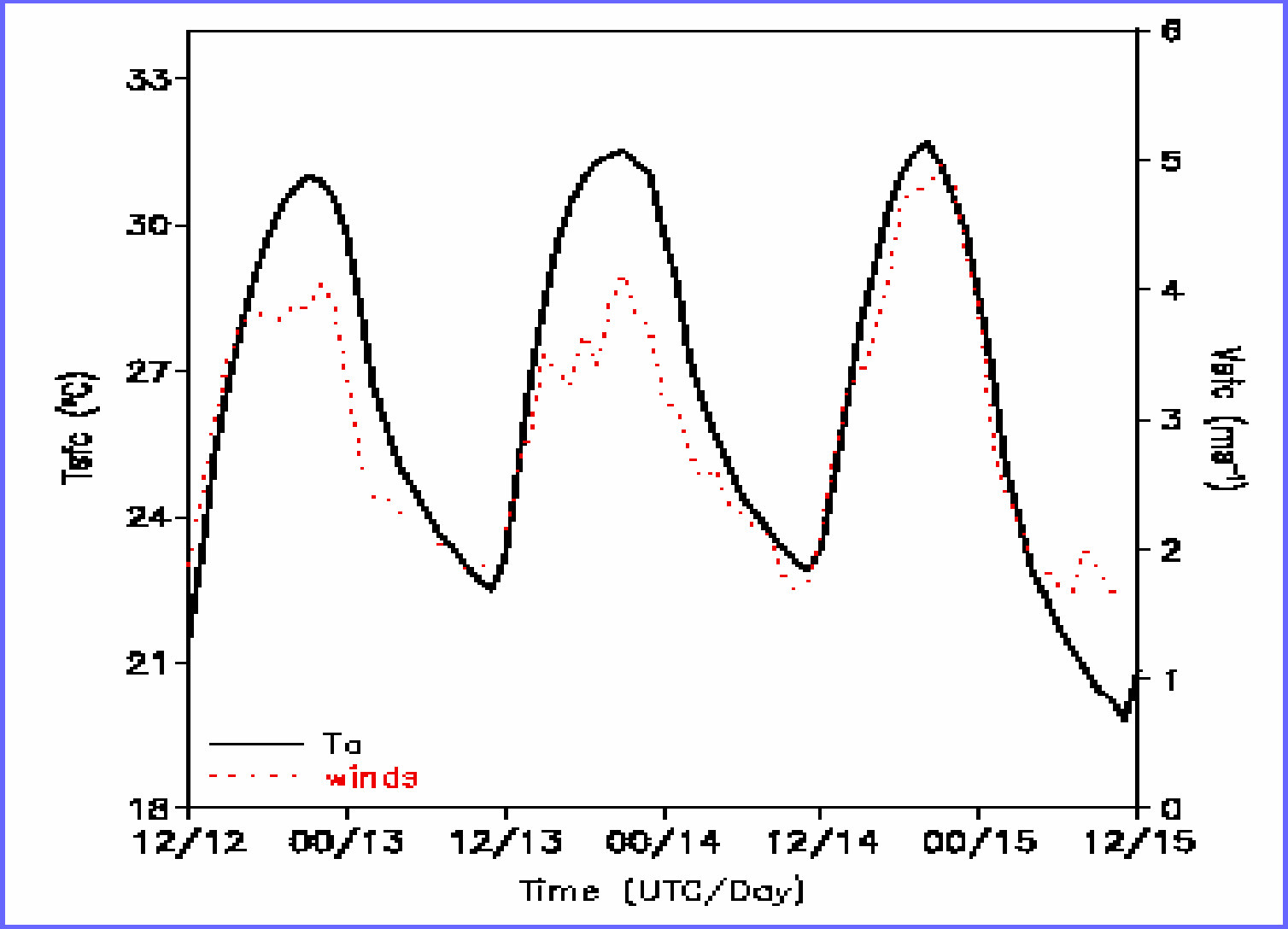
Verification of the MM5-simulated Tsfc against 9 Castnet sites observations by Ku and Gopal at NDEC with the Gayno-Seaman scheme



Verification of the MM5-simulated Vsfc against 9 Castnet sites observations by Ku and Gopal at NDEC with the Gayno-Seaman scheme



Observed diurnal cycles of Tsfc and Vsfc over 105 surface stations during 12 – 15 July 1997



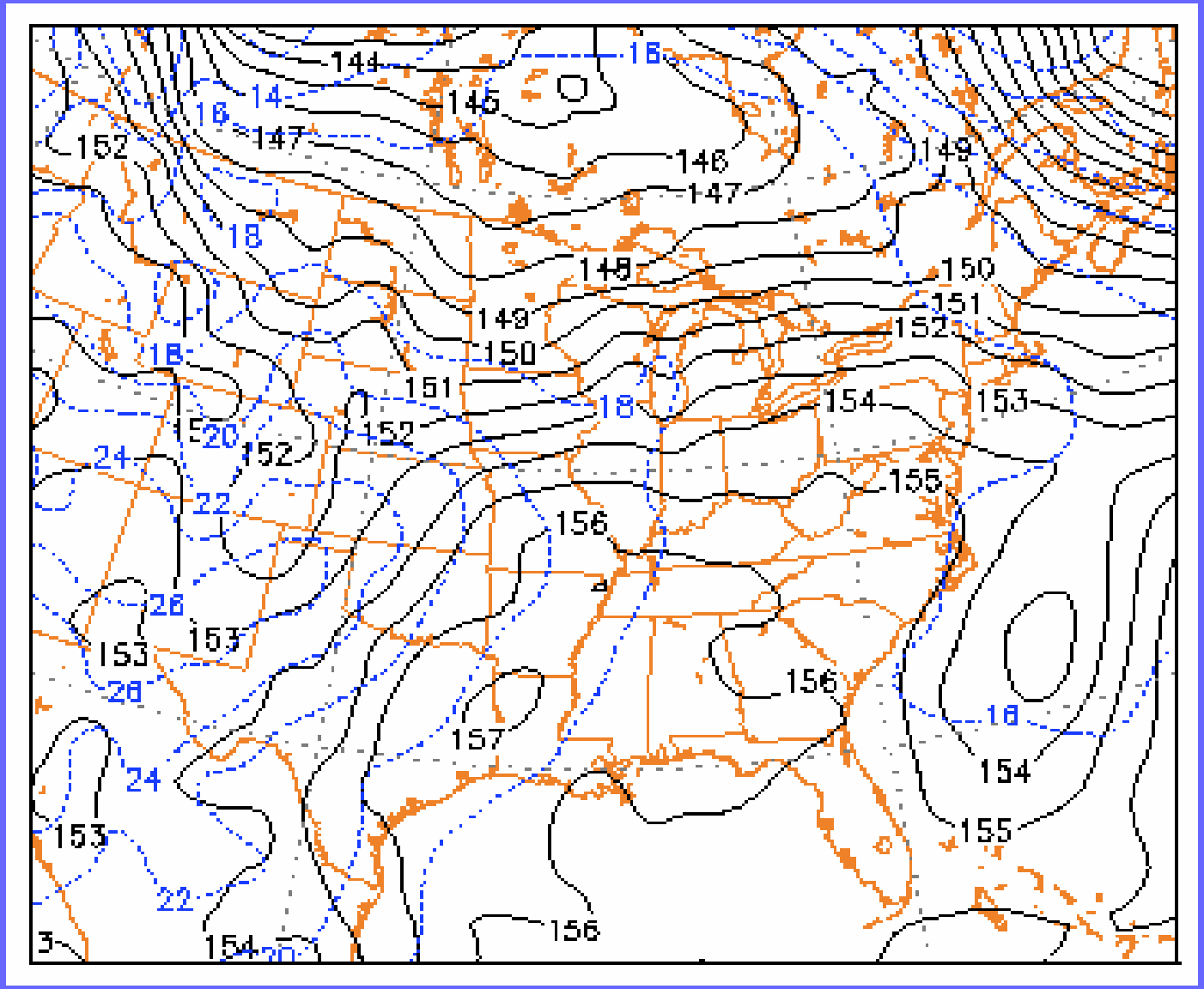
Model description – MM5

- Two-way nested, Δx = 36/12 km;
- Kain-Fritsch cumulus parameterization
- Simple cloud/ice parameterization
- PBL schemes being tested:

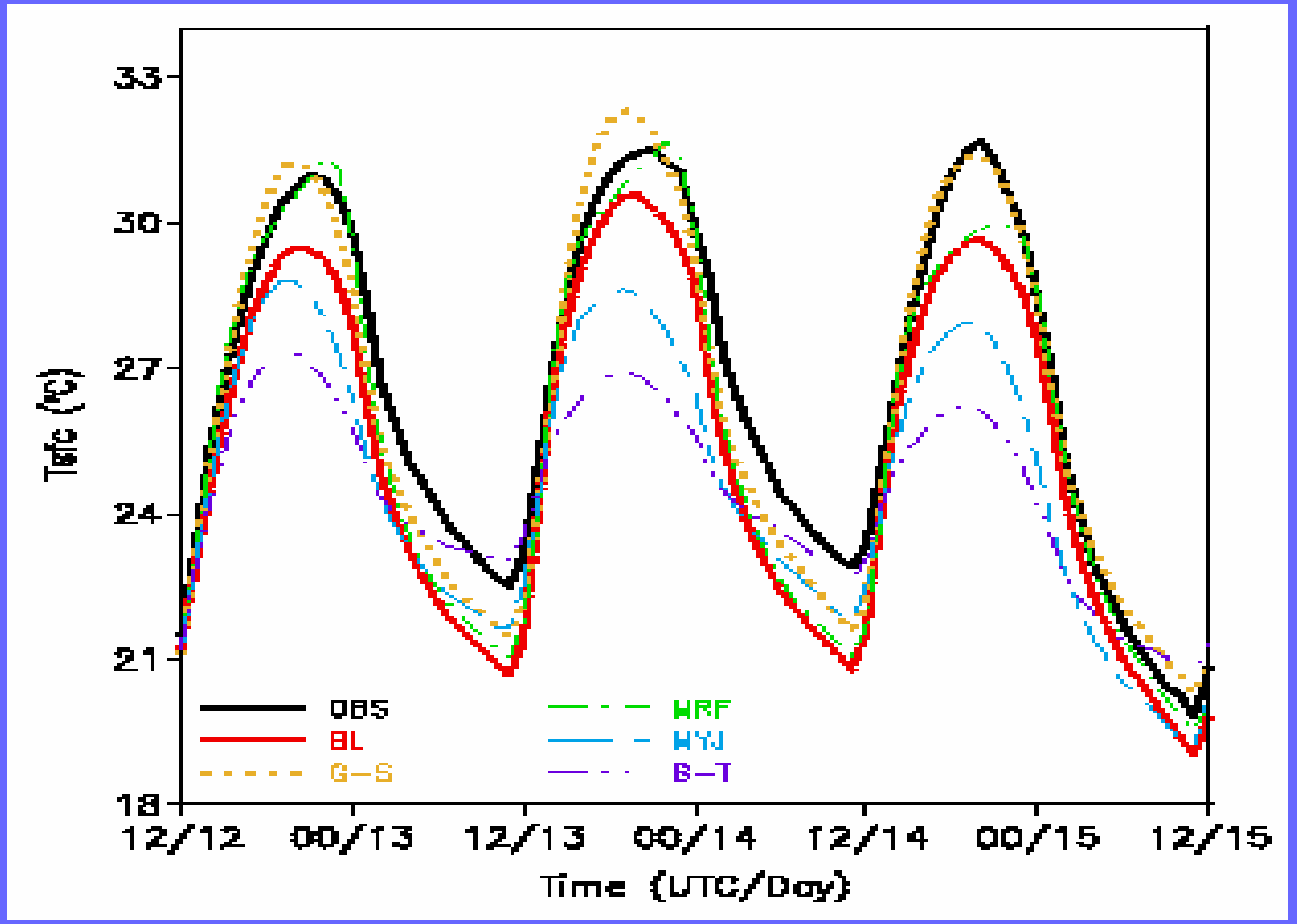
  a) Blackadar; b) Gayno-Seaman; c) MRF;

  d) Miller-Yamada-Jajic; e) Burke-Thompson.
- Surface layer (half-σ) at 10 m
- Integration: 1200 UTC 12 - 15 June 1997

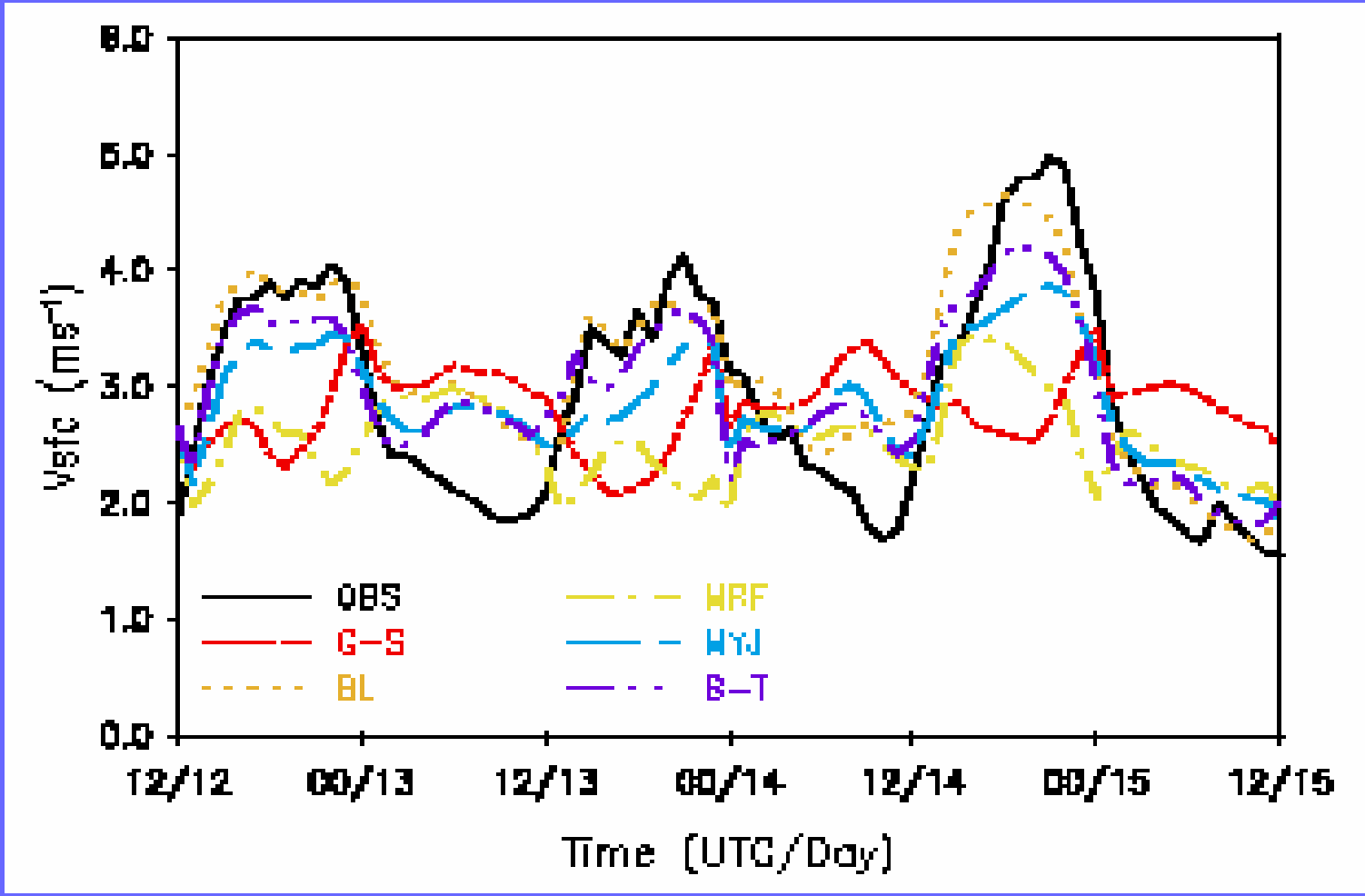
Averaged 850-hPa height and temperature fields during 12 – 15 July 1997



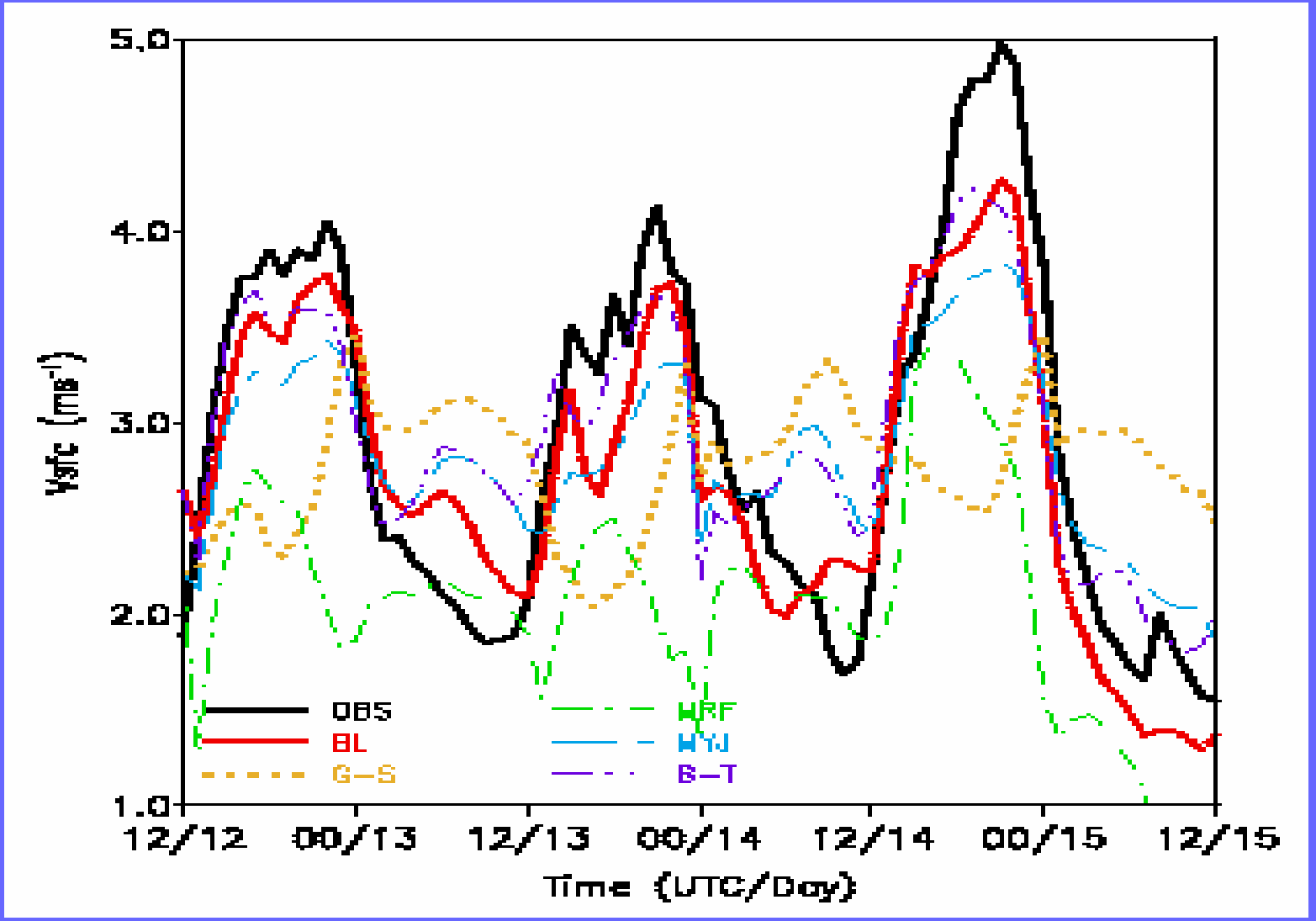
Comparison of diurnal cycles of Tsfc between the observed and the simulated with the Blackadar, Gayno-Seaman, MRF, Miller-Yamada-Jajic and Burke-Thompson schemes



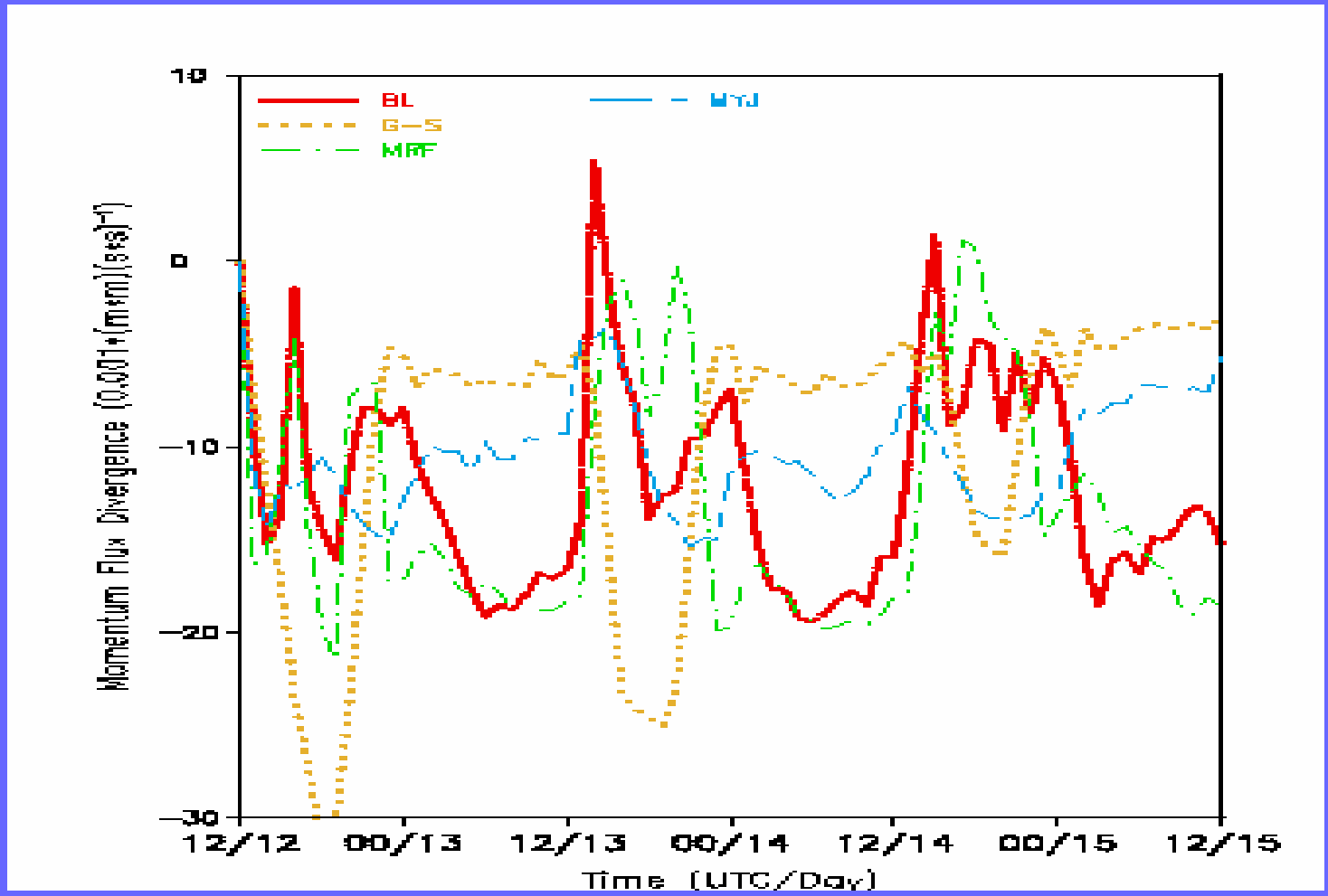
Comparison of diurnal cycles of Vsfc between the observed and the simulated with the (old) Blackadar, Gayno-Seaman, MRF, Miller-Yamada-Jajic and Burke-Thompson schemes



Comparison of diurnal cycles of Vsfc between the observed and the simulated with the (new) Blackadar, Gayno-Seaman, MRF, Miller-Yamada-Jajic and Burke-Thompson schemes



Simulated surface layer momentum flux divergence by the (new) Blackadar, Gayno-Seaman, MRF, Miller-Yamada-Jajic and Burke-Thompson schemes



Stability parameters in the nocturnal SFC layer used in the Blackadar scheme:

$R_b > 0.2$, Stable

$0.2 > R_b > 0$, Damped mechanic turbulence

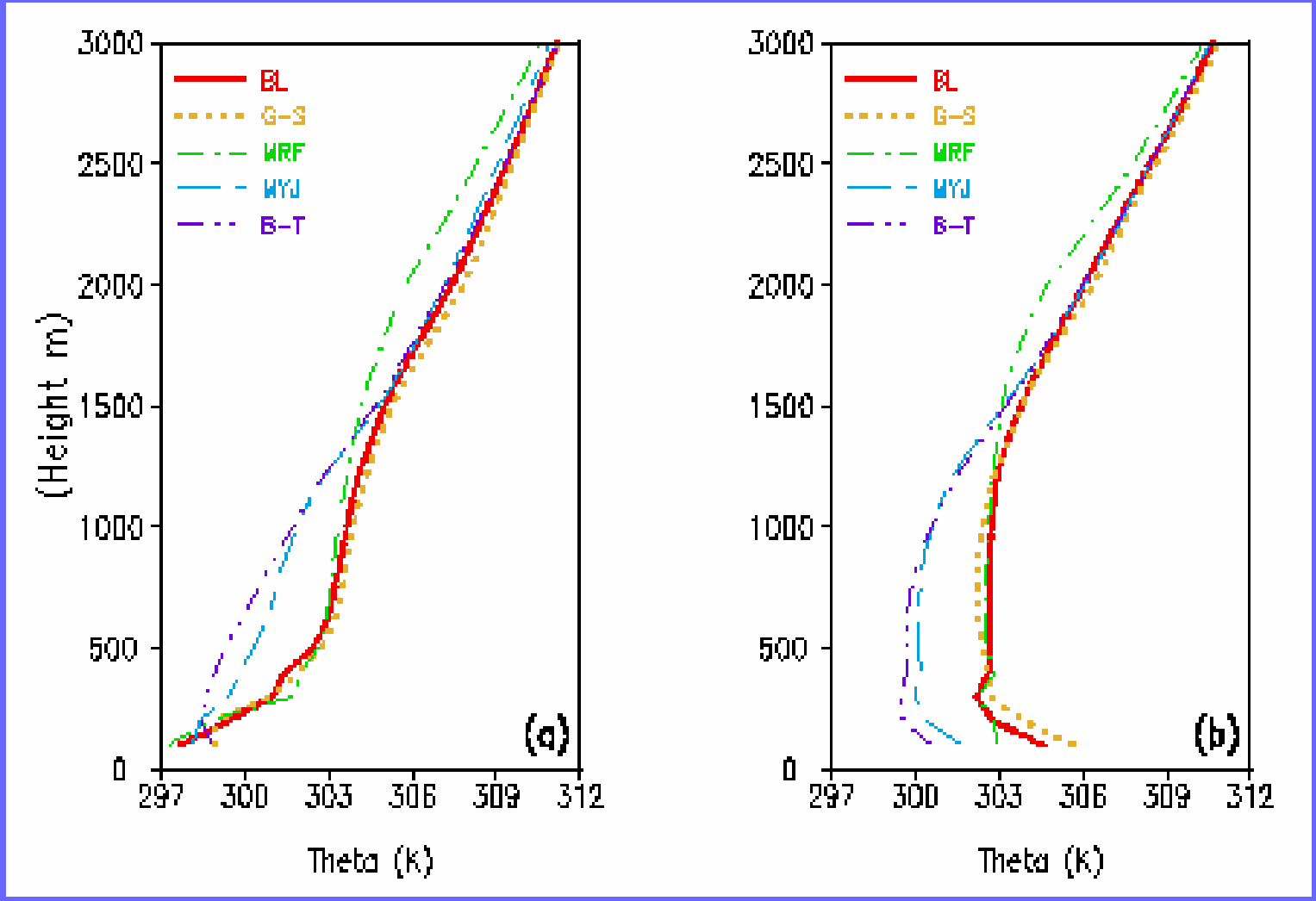
$R_b < 0$, Forced convection

where $R_b = \frac{g\, z_a}{\theta_a} \frac{\theta_a - \theta_g}{V_a^2}$

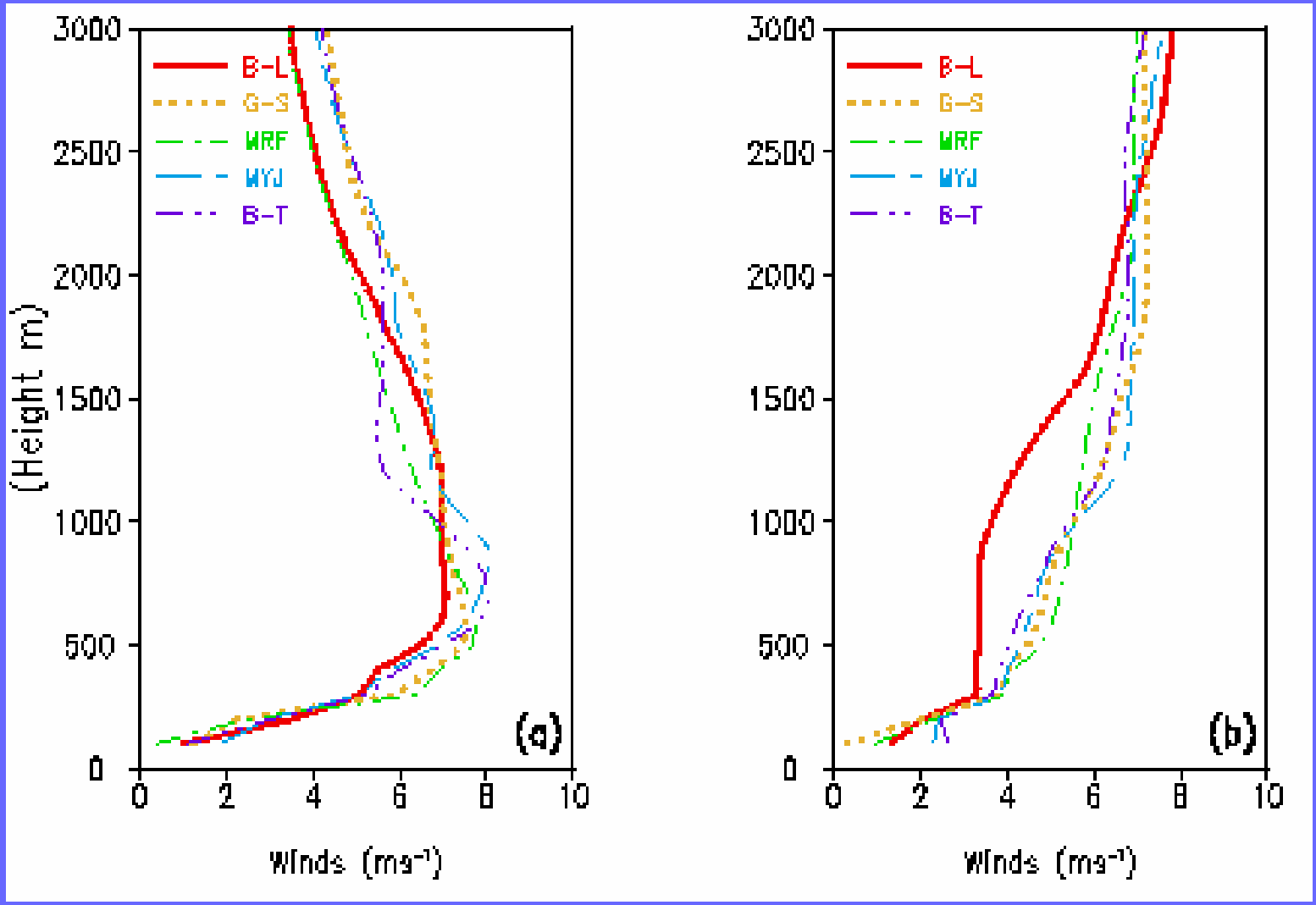
However, in the original code:

$$R_b = \frac{g\, z_a}{\theta_{va}} \frac{\theta_{va} - \theta_{vg}[q_s(T_a)]}{V_a^2}$$

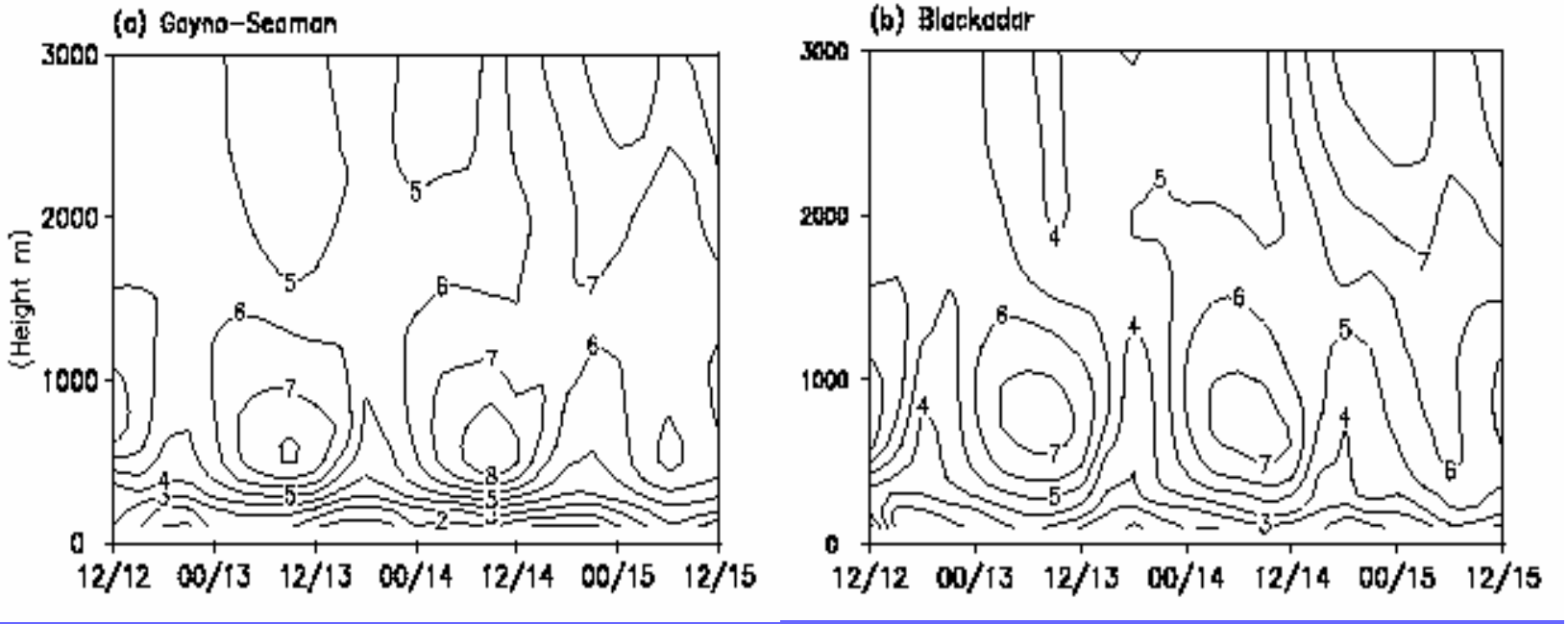
Vertical profiles of the simulated (area-averaged) θ(z) with different PBL schemes for a) 0200 LST and b) 1400 LST



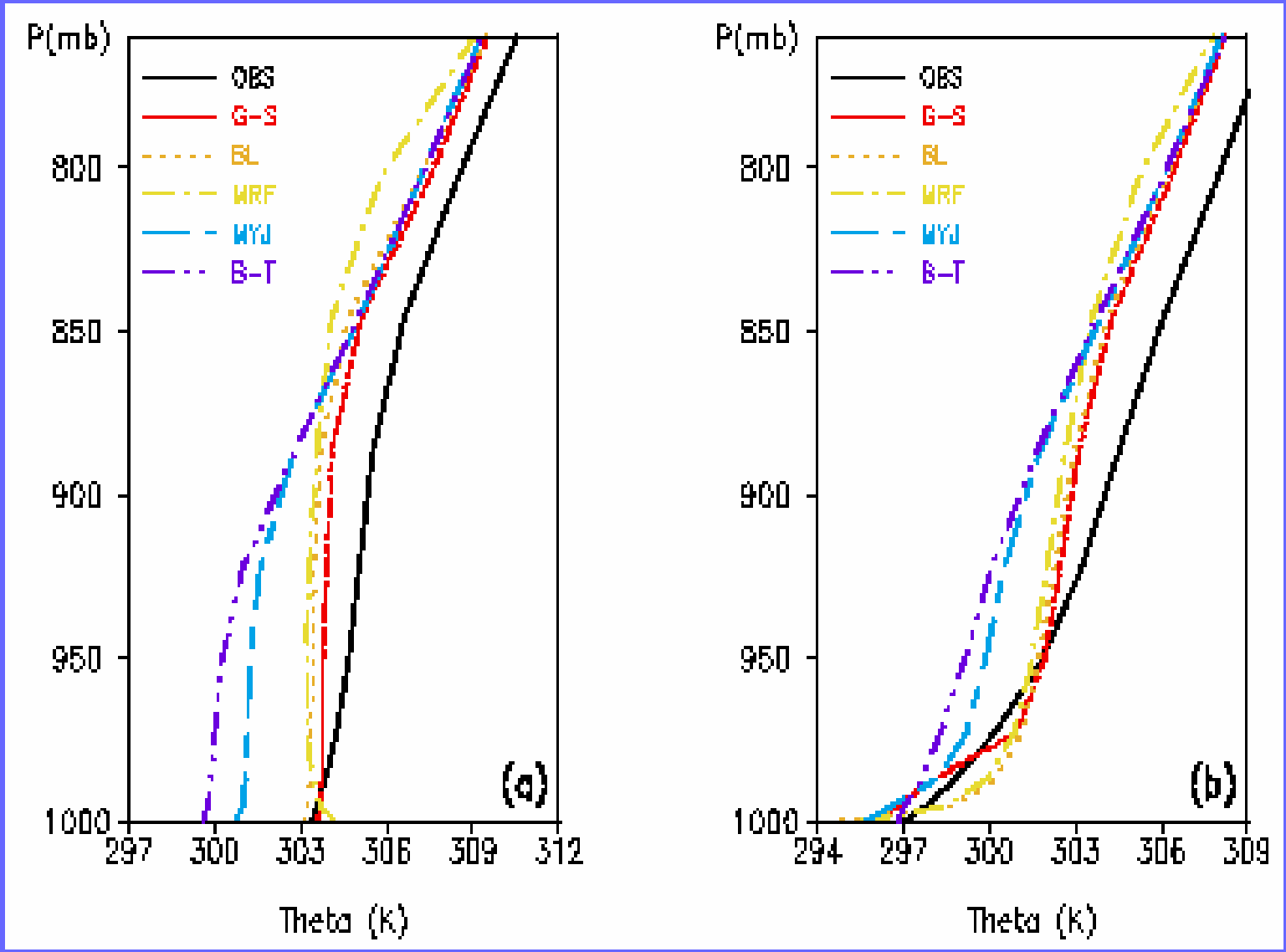
Vertical profiles of the simulated (area-averaged) V(z) with different PBL schemes for a) 0200 LST and b) 1400 LST



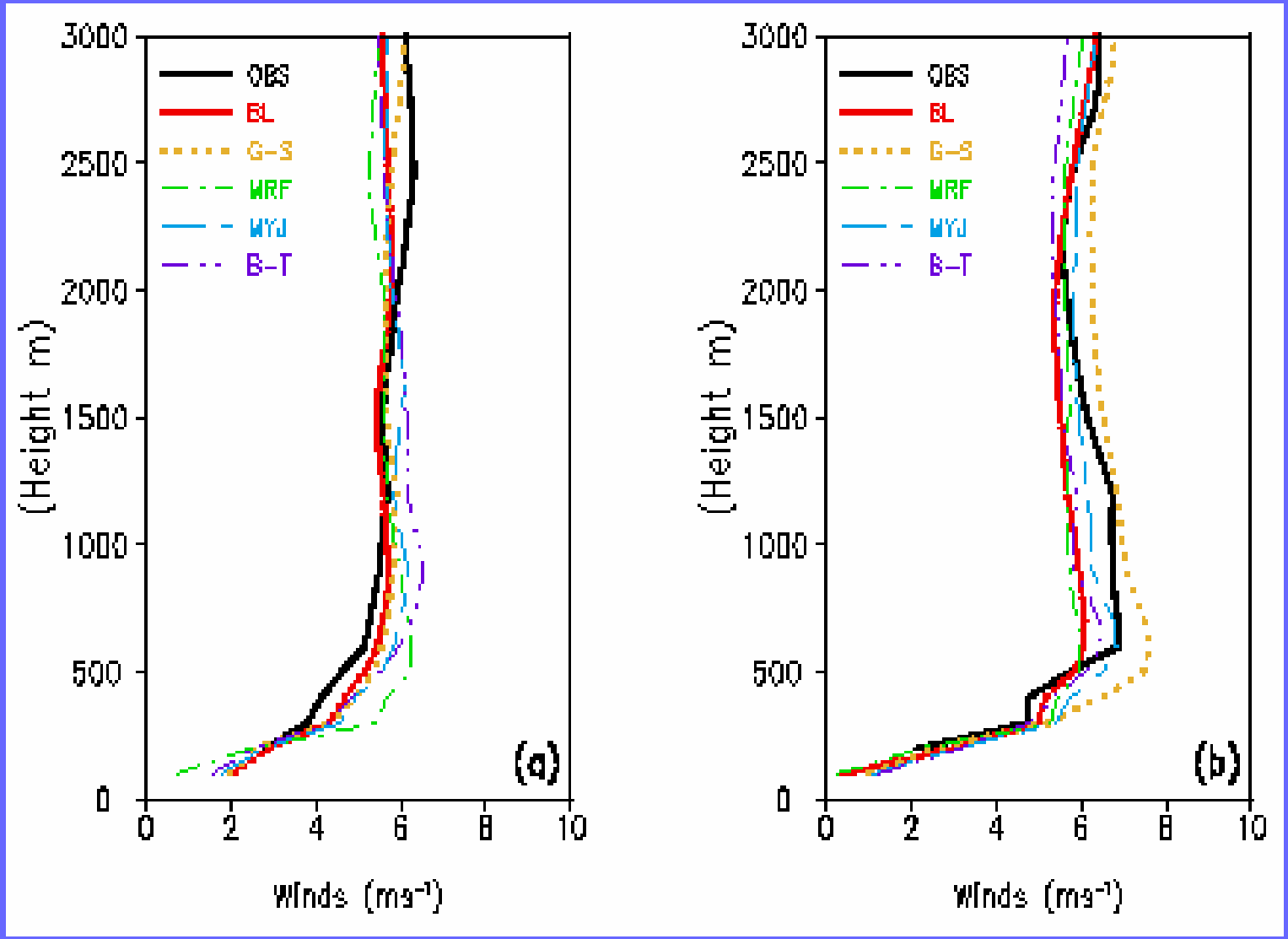
Height-time cross sections of V(z, t) generated by the Gayno-Seaman and (b) Blackadar schemes



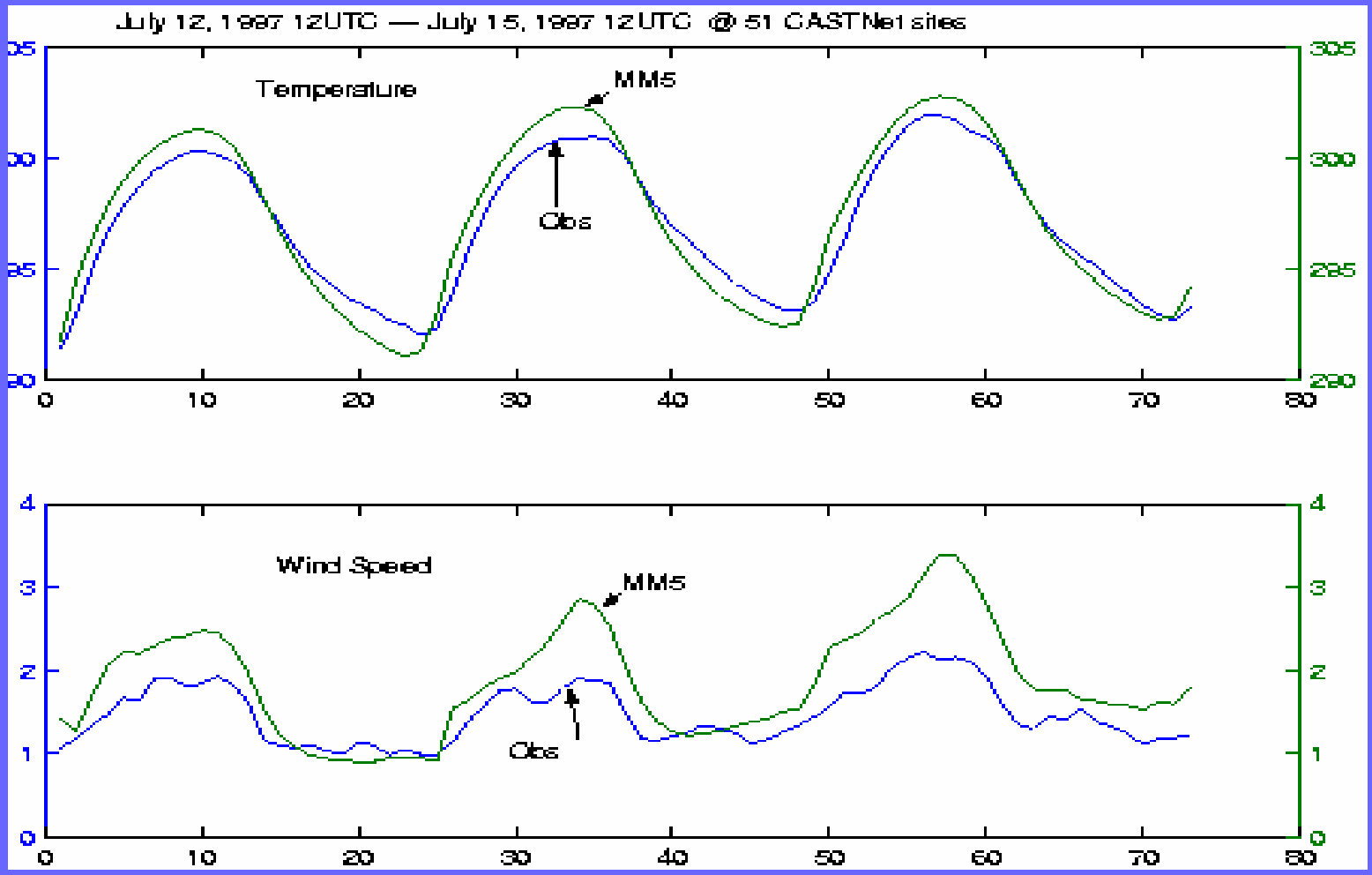
Vertical profiles of the observed and the simulated θ(z) with different PBL schemes for a) 0000 UTC; and b) 1200 UTC



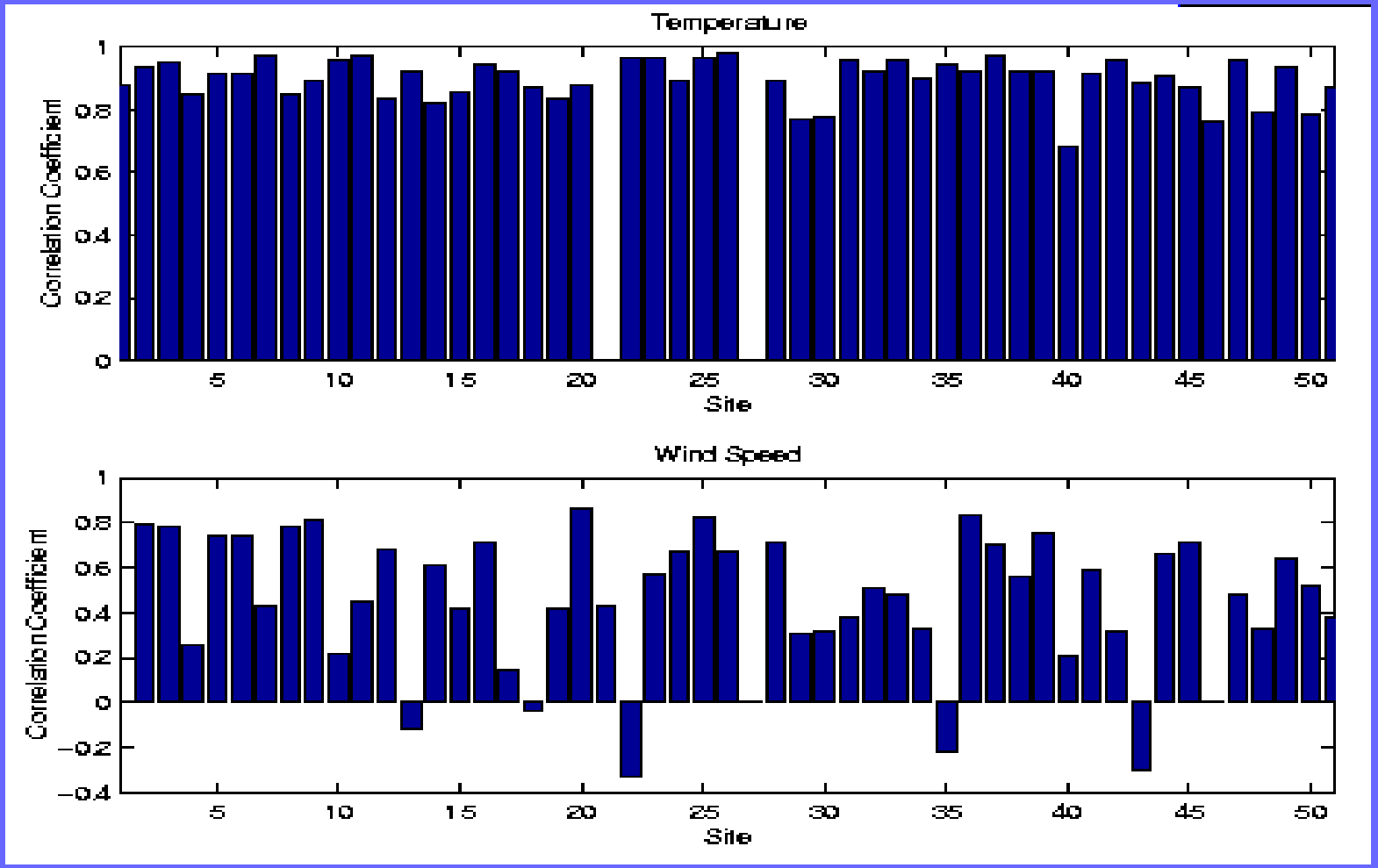
Vertical profiles of the observed and the simulated V(z) with different PBL schemes for a) 0000 UTC; and b) 1200 UTC



Verification of the MM5-simulated Tsfc and Vsfc against 9 Castnet sites observations by Ku and Gopal at NDEC with the modified Blackadar scheme



Correlation coefficients of the MM5-simulated Tsfc and Vsfc with 9 Castnet sites observations by Ku-Gopal at NDEC with the modified Blackadar scheme



Summary and conclusions

- The modified Blackadar PBL scheme is able to reproduce the diurnal cycles of surface winds;
- Non-local closure schemes tend to better reproduce the daytime surface wind maximum; K-theory does not seem to be a good option.
- The nocturnal surface wind minimum could be reproduced if the effects of low-level jets could be accounted for in the PBL schemes.