YSU邊界層參數法之強化混和作用測試

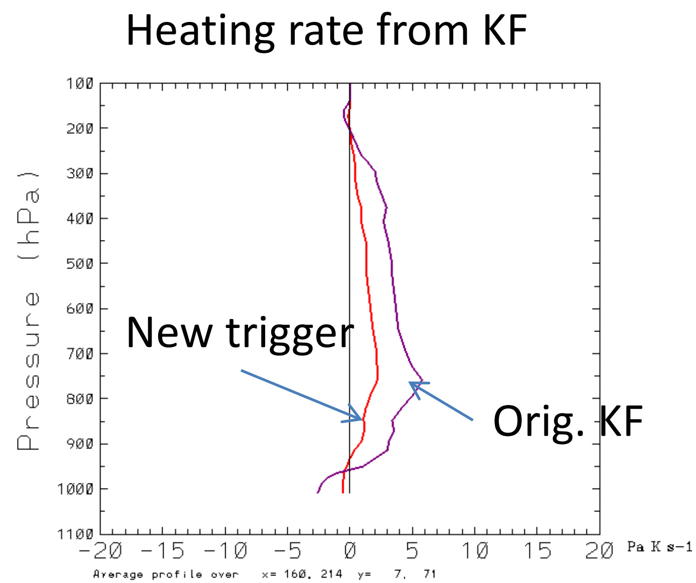
報告: 資訊中心 戴俐卉

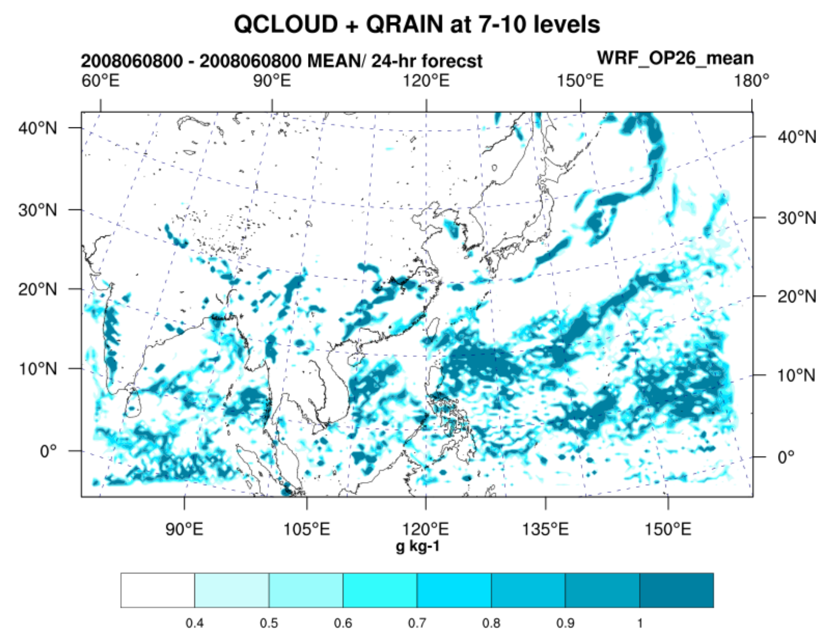
大　綱

- YSU top_down mixing使用動機及原理
- 模式設定與個案測試
- 綜觀校驗
- 結論

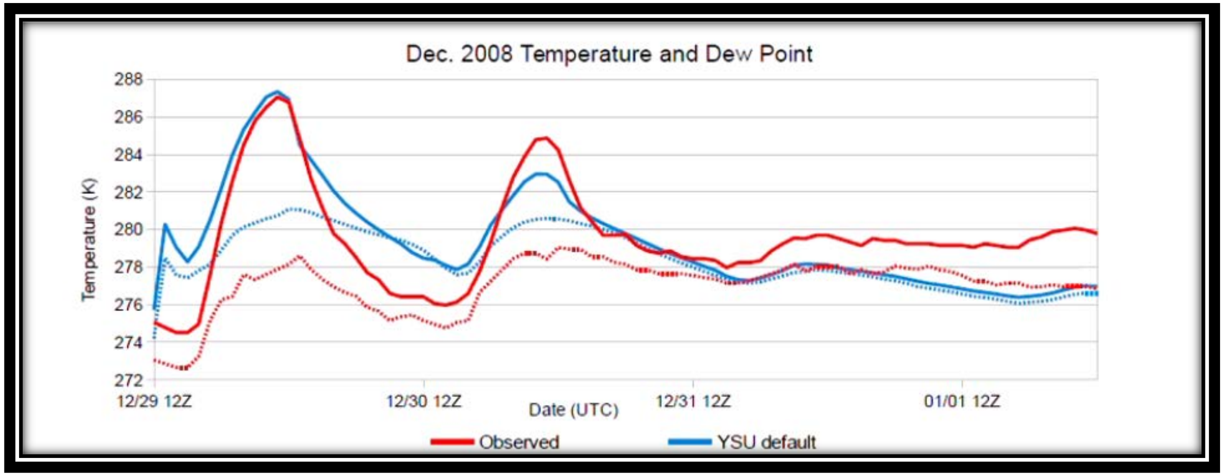
動 機

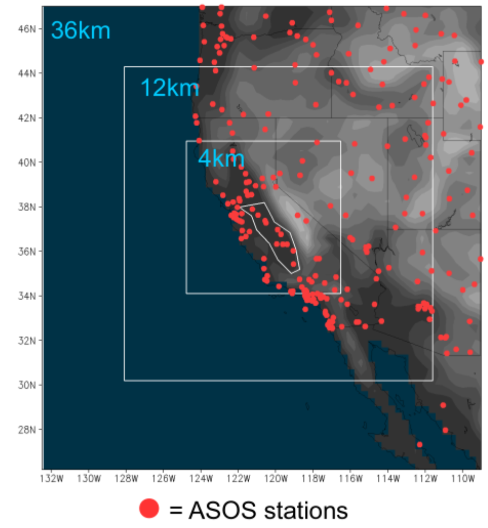
◆K-F scheme with new trigger
➔積雲對流不易觸發
➔產生海洋邊界層層雲（Qc）過多的現象

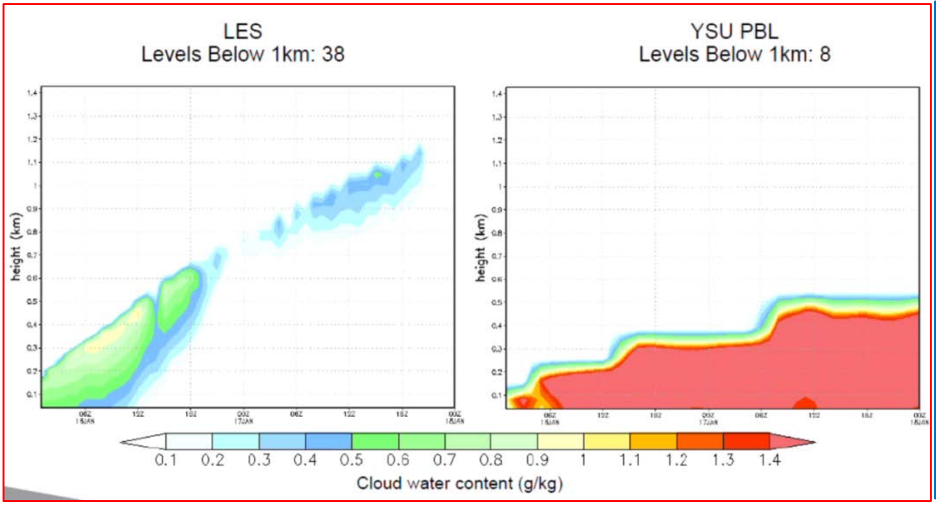


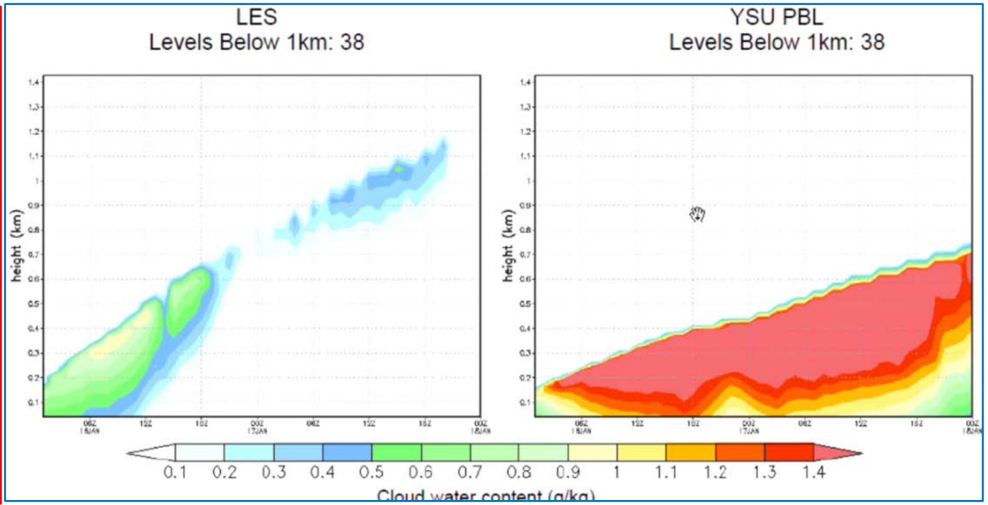


Wilson-Fovell 2014









YSU top-down mixing

- 原理: $\frac{\partial C}{\partial t}=\frac{\partial}{\partial z}\left[K_c\left(\frac{\partial C}{\partial z}-\gamma_c\right)-\overline{(w'c')_h}\left(\frac{z}{h}\right)^3\right]$

Wilson and Fovell (2014)

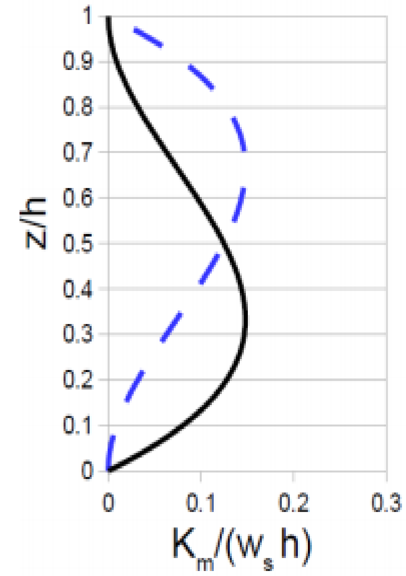
Non-local K profile: added in a reversed diffusivity profile

$$\mathrm{K}_m = kw_s z\left(1-\frac{z}{h}\right)^p + kw_{pbl}(h-z)\left(1-\frac{h-z}{h}\right)^p,$$

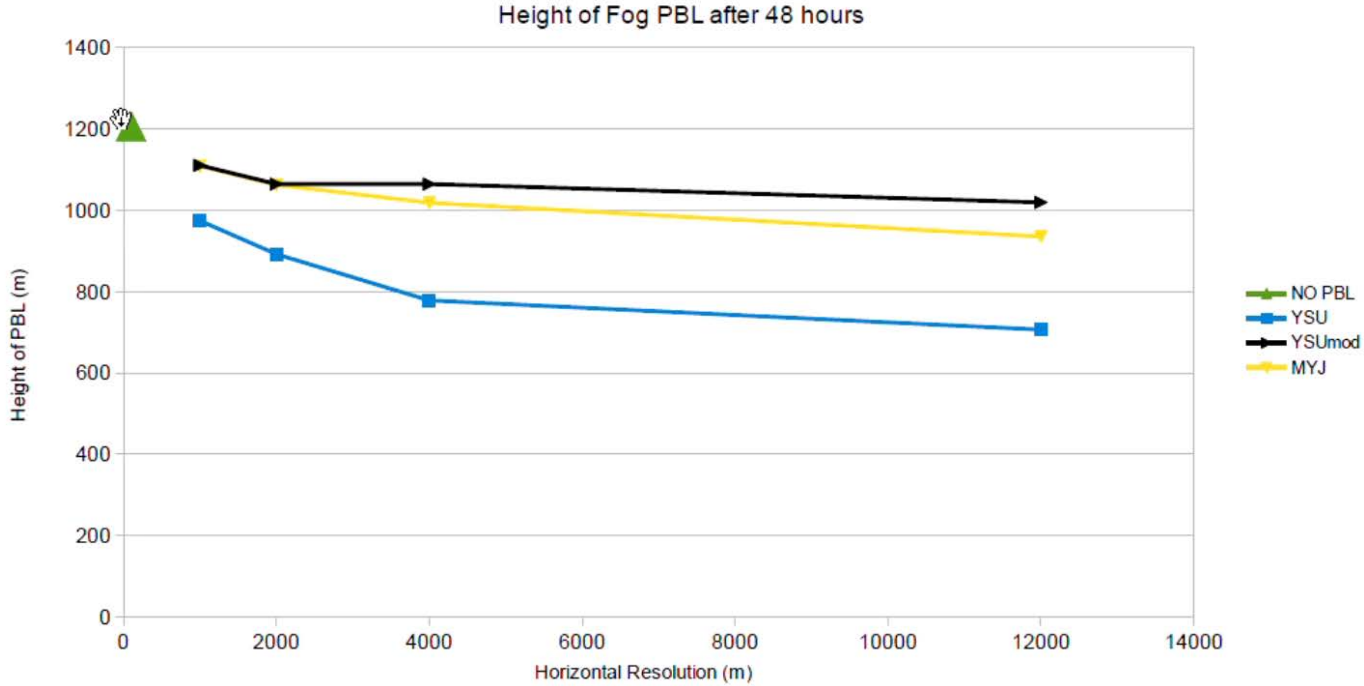
w_{pbl} ~ function of cloud top radiative cooling

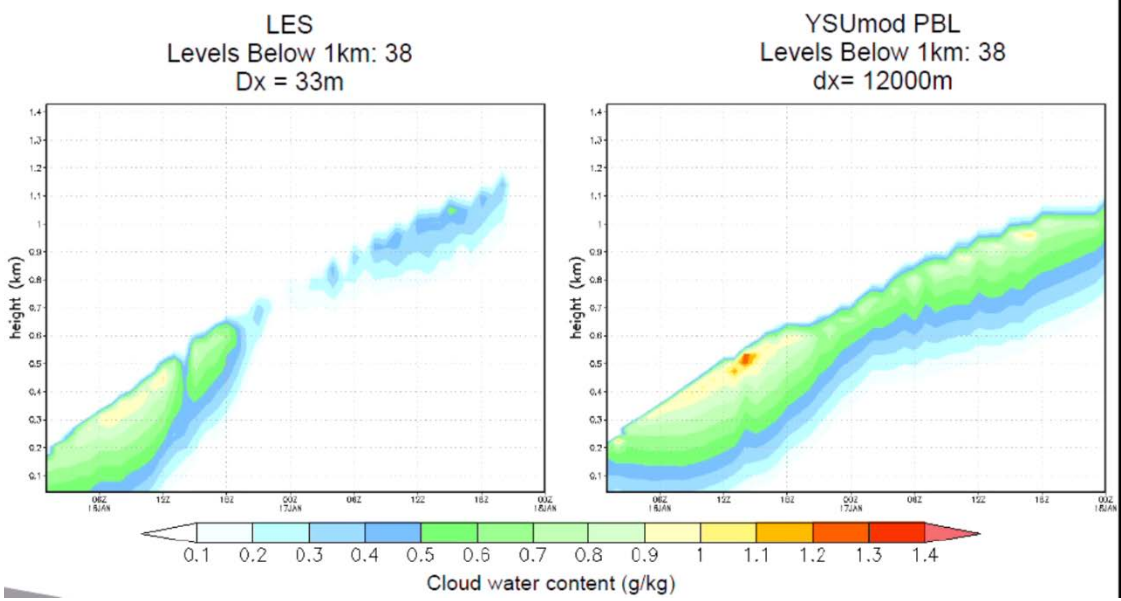
Entrainment: a function of surface flux and PBLtop flux

$$\overline{(w'\theta')_h} = -0.15\left(\frac{\theta_v}{g}\right)\frac{w_m^3}{h} - ENT_{eff}\left(\frac{\theta_v}{g}\right)\frac{w_l^3}{h}$$



W_s: mixed layer velocity scale base on surface flux (W_s=Ws(sfc. Heat flux))
W_l: mixed layer velocity scale base on PBL top (W_l=W_l(PBL top flux))
k: von Karman constant (=0.4)
z: the height above the ground surface
h: PBL height
W_m: velocity scale base on surface flux

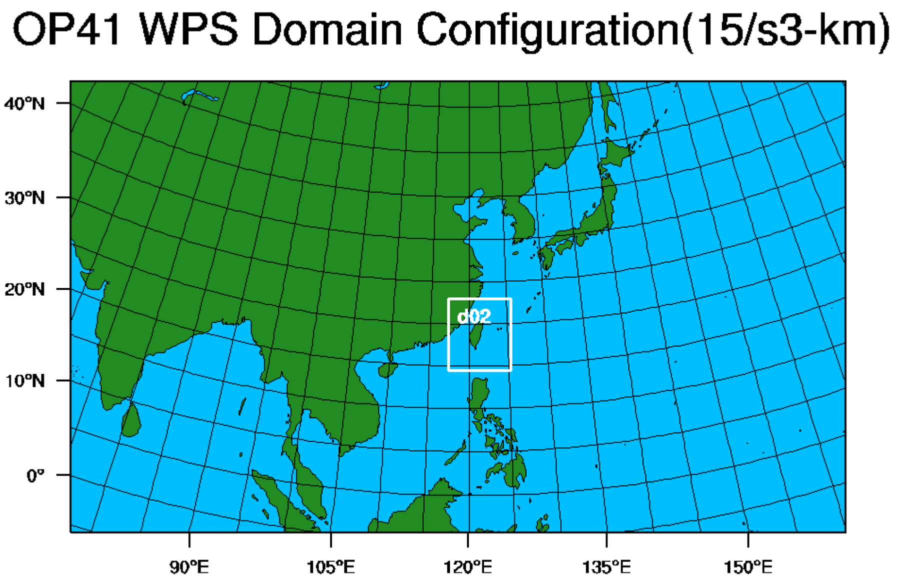

Height of Fog PBL after 48 hours
Height of PBL (m)
Horizontal Resolution (m)
NO PBL
YSU
YSUmod
MYJ
0
200
400
600
800
1000
1200
1400
0
2000
4000
6000
8000
10000
12000
14000


LES
Levels Below 1km: 38
Dx = 33m
YSUmod PBL
Levels Below 1km: 38
dx= 12000m
height (km)
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
Cloud water content (g/kg)

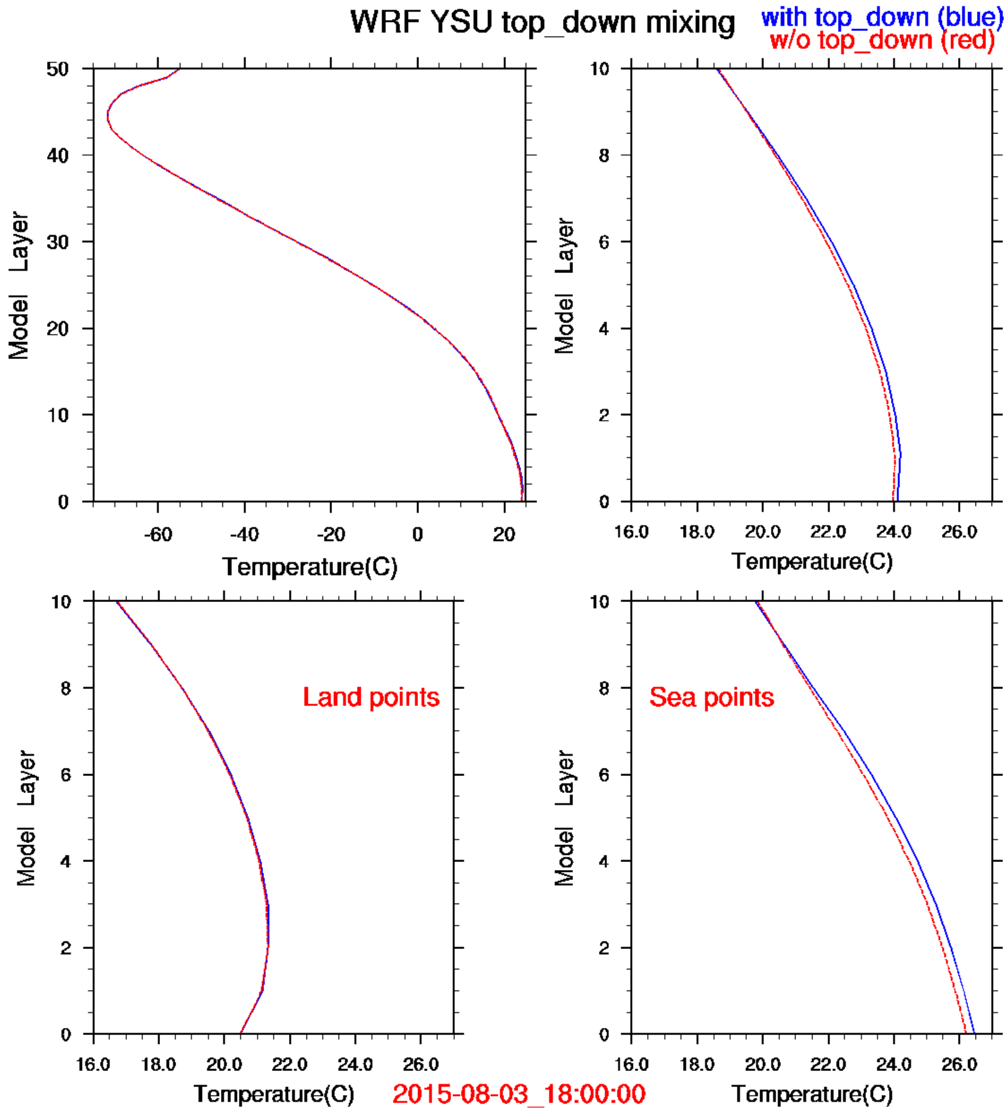
模式設定

WRFV3.8

- 2 domains 15/3km
- RRTMG/RRGMG
- CU: KF with new trigger
- MP: GODDARD
- YSU
- Old MM5 surface layer scheme
- Unified Noah land-surface model

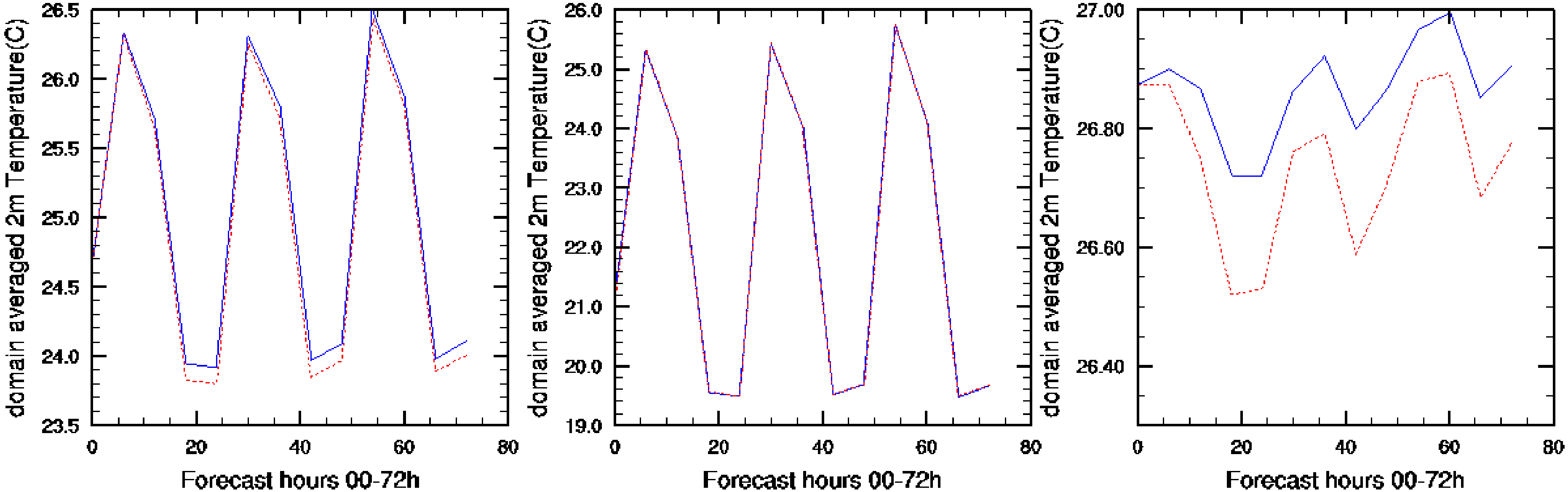


2015/08/03/00 Case Study (w/wo top_down mixing)_vertical_T



2015/08/03/00 Case Study (w/wo top_down mixing)_2mT

2mT: with(blue solid) vs. without(red dotted)



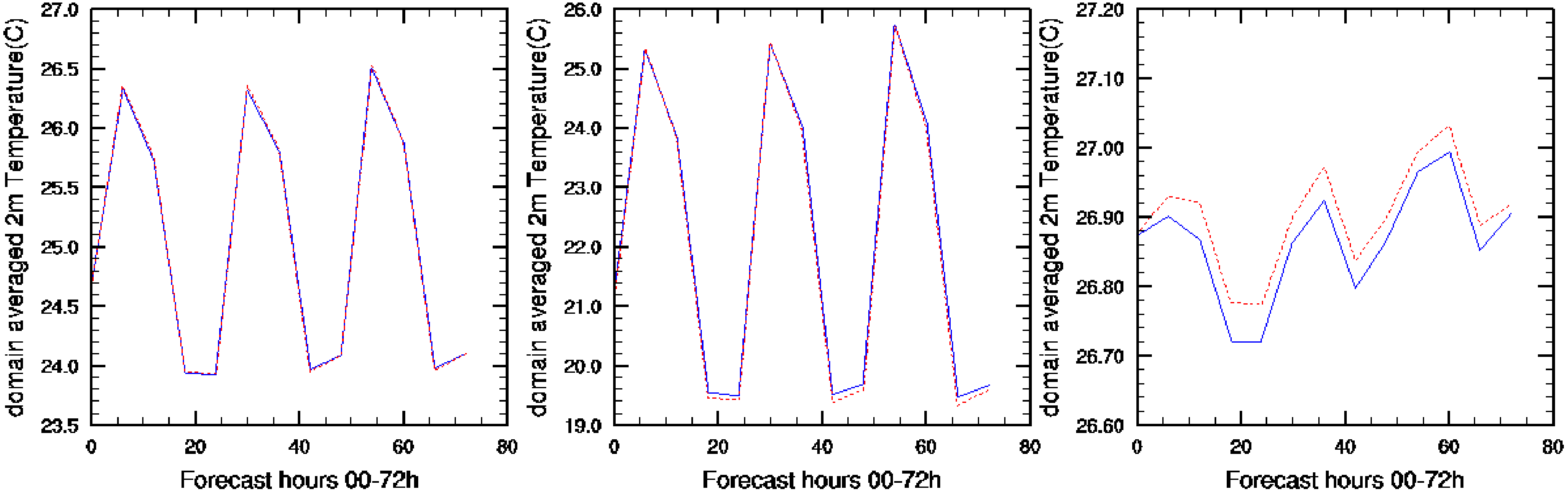
land points

sea points

INI 2015/08/03/00

2015/08/03/00 Case Study (w/wo top_down mixing)_2mT_62

2mT: 52lev(blue solid) vs. 62lev(red dotted)



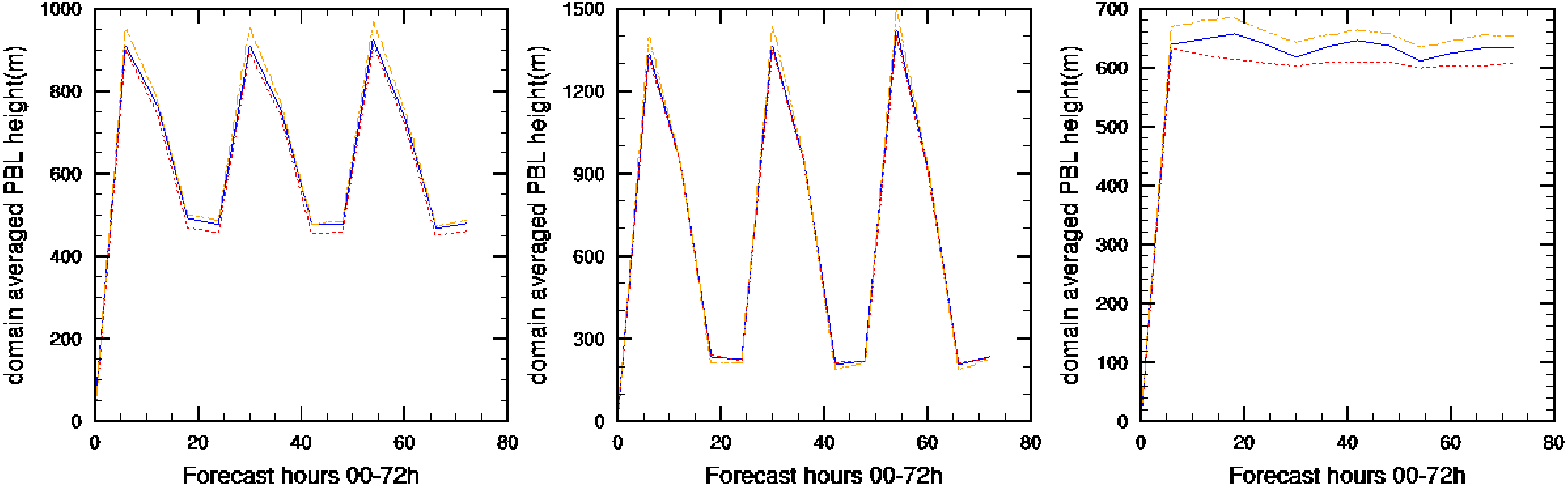
land points

sea points

INI 2015/08/03/00

2015/08/03/00 Case Study (w/wo top_down mixing)_PBLH

PBL Height: w(blue),wo(red) vs. 62lev(orange)



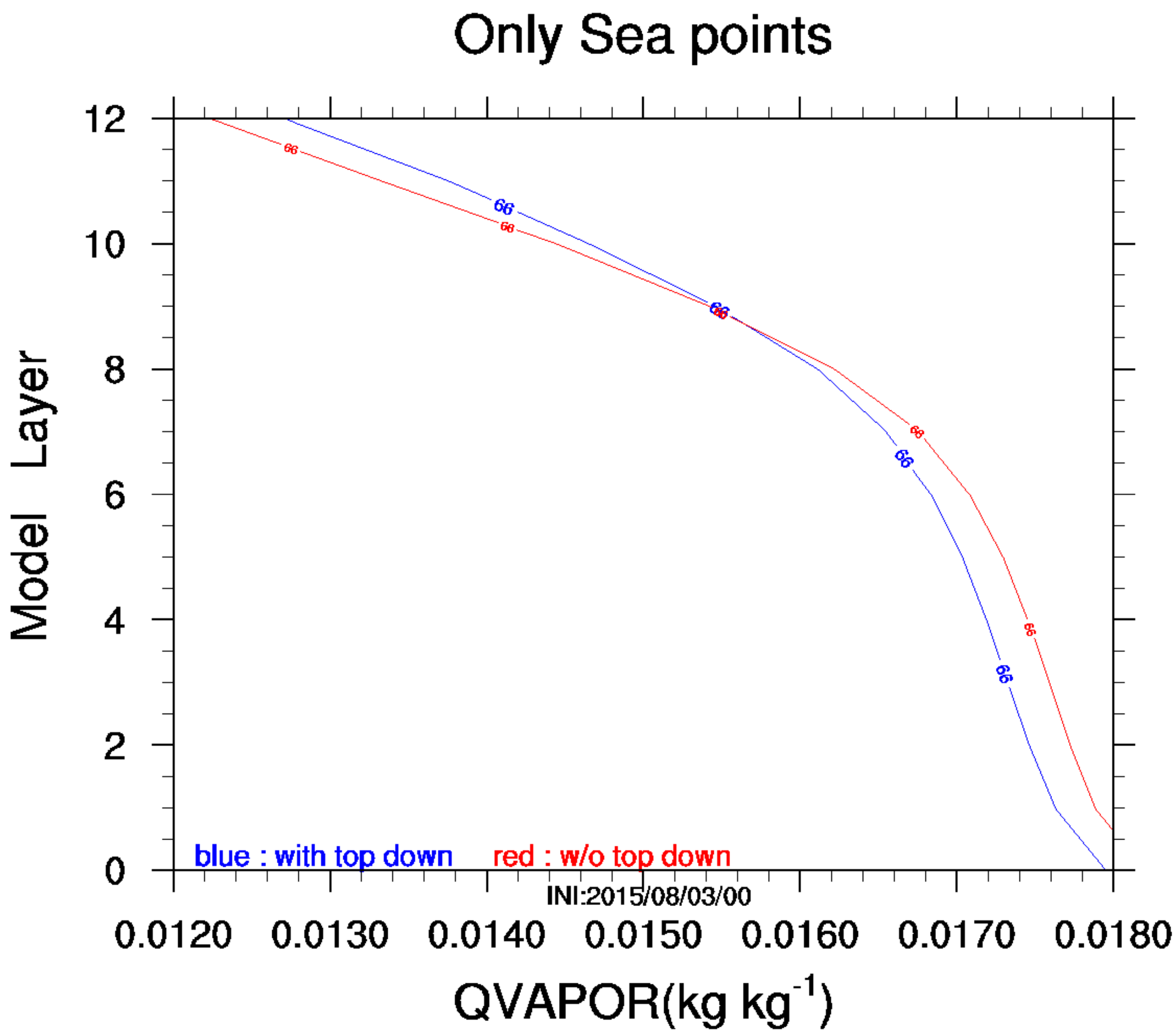
land points

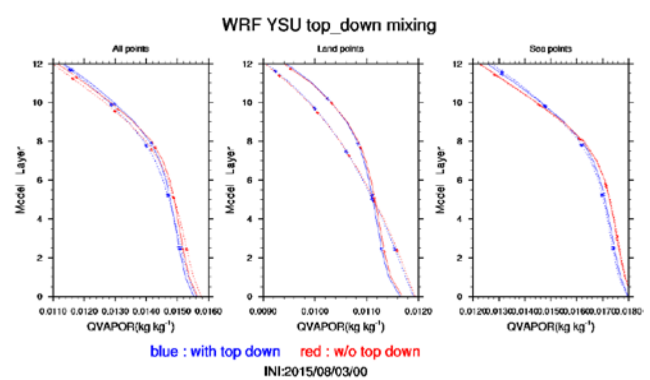
sea points

INI 2015/08/03/00

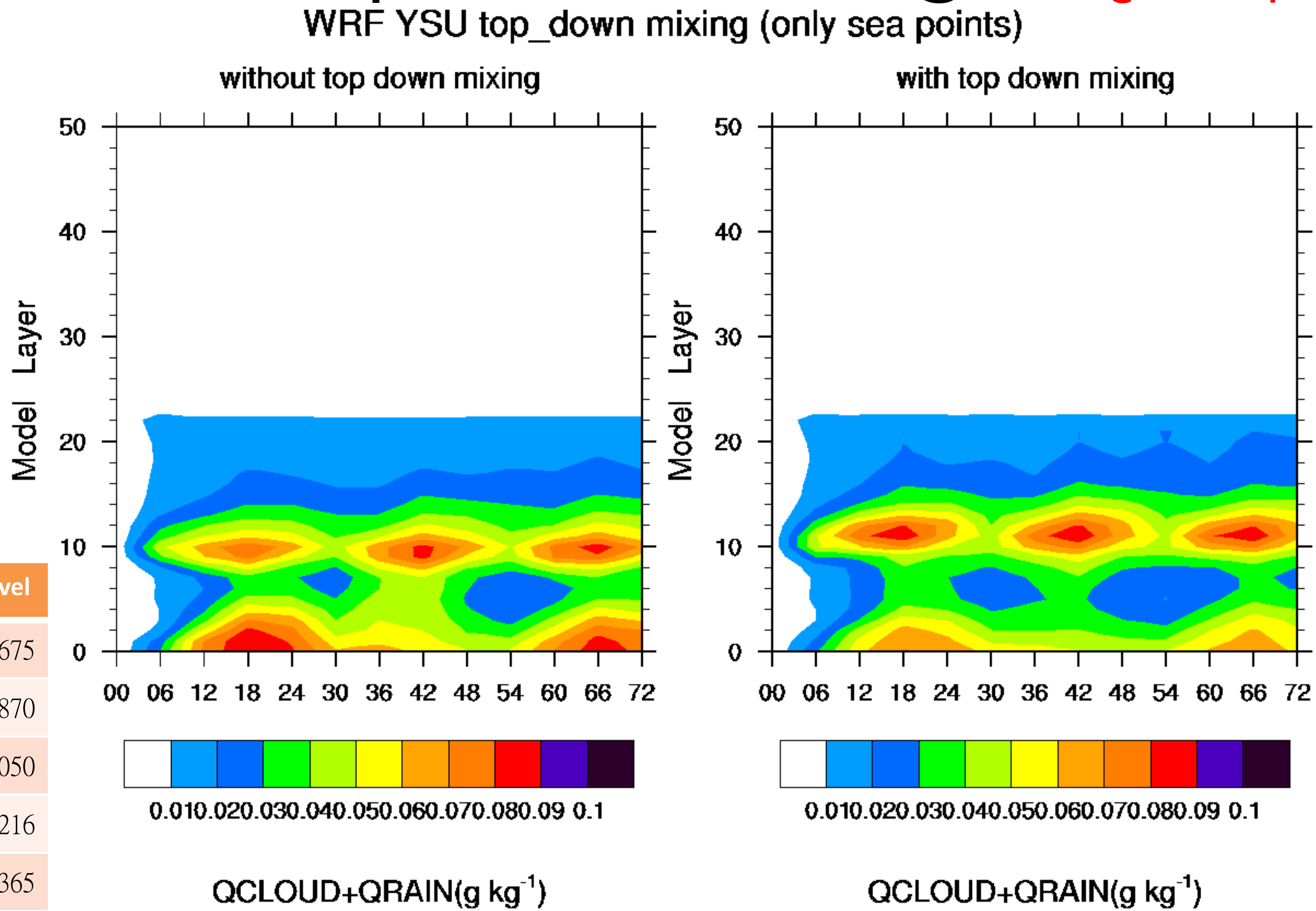
(lev62) 3517s → 4179s (18.8% cpu time)

2015/08/03/00 Case Study (w/wo top_down mixing)_Q_v



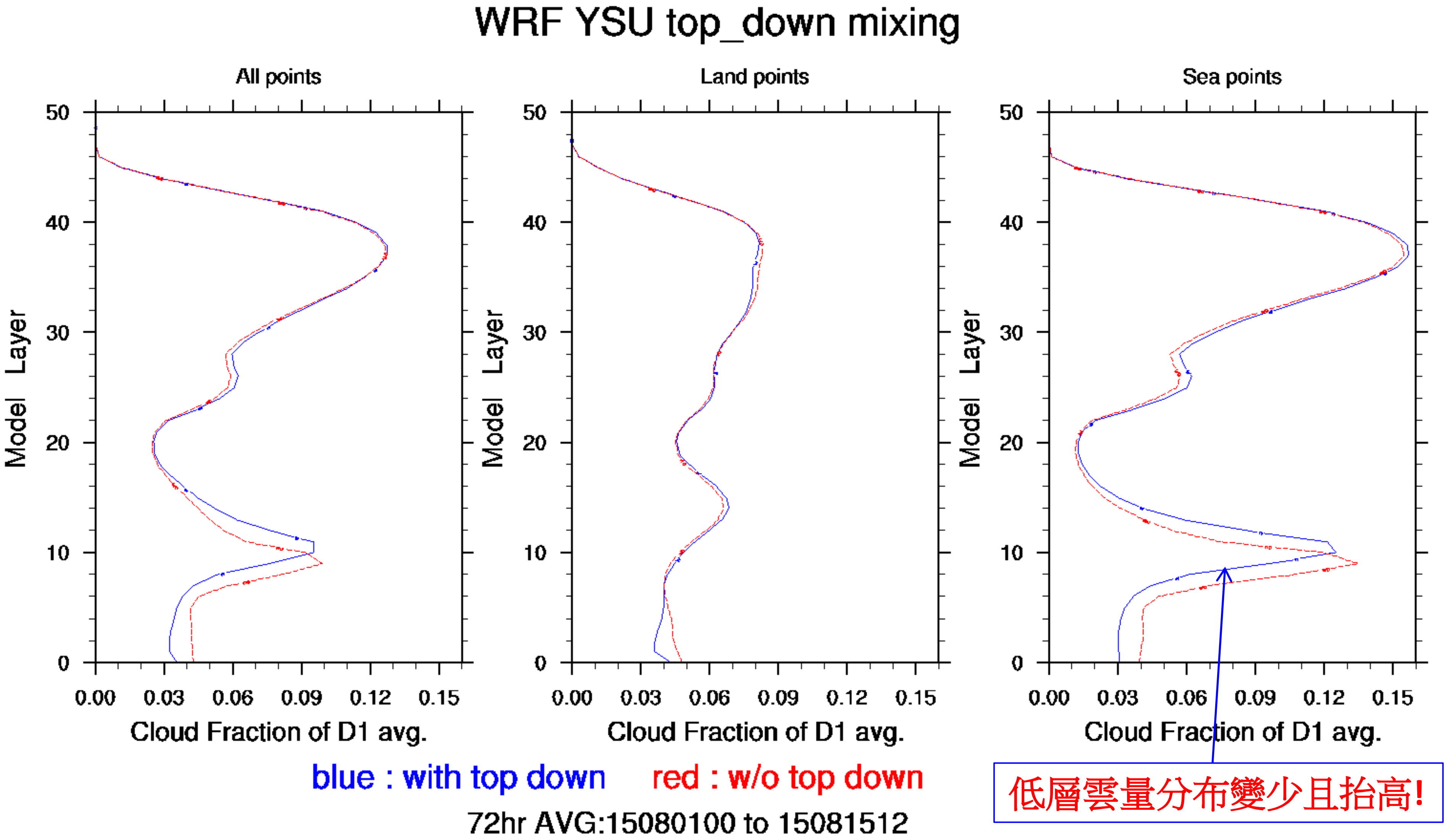


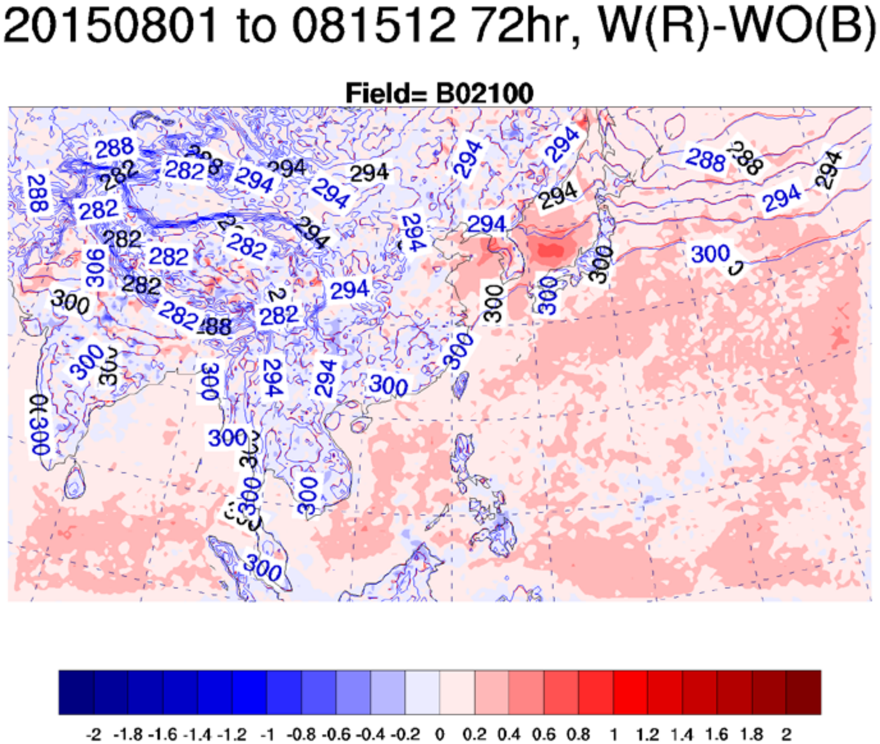
2015/08/03/00 Case Study (w/wo top_down mixing)_Q_c+Q_r

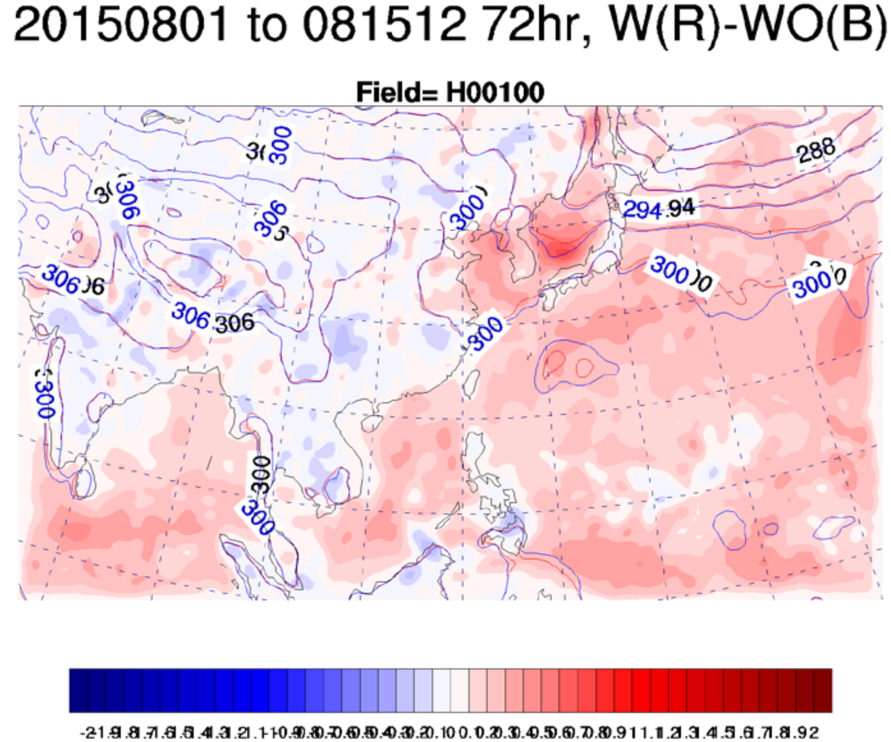


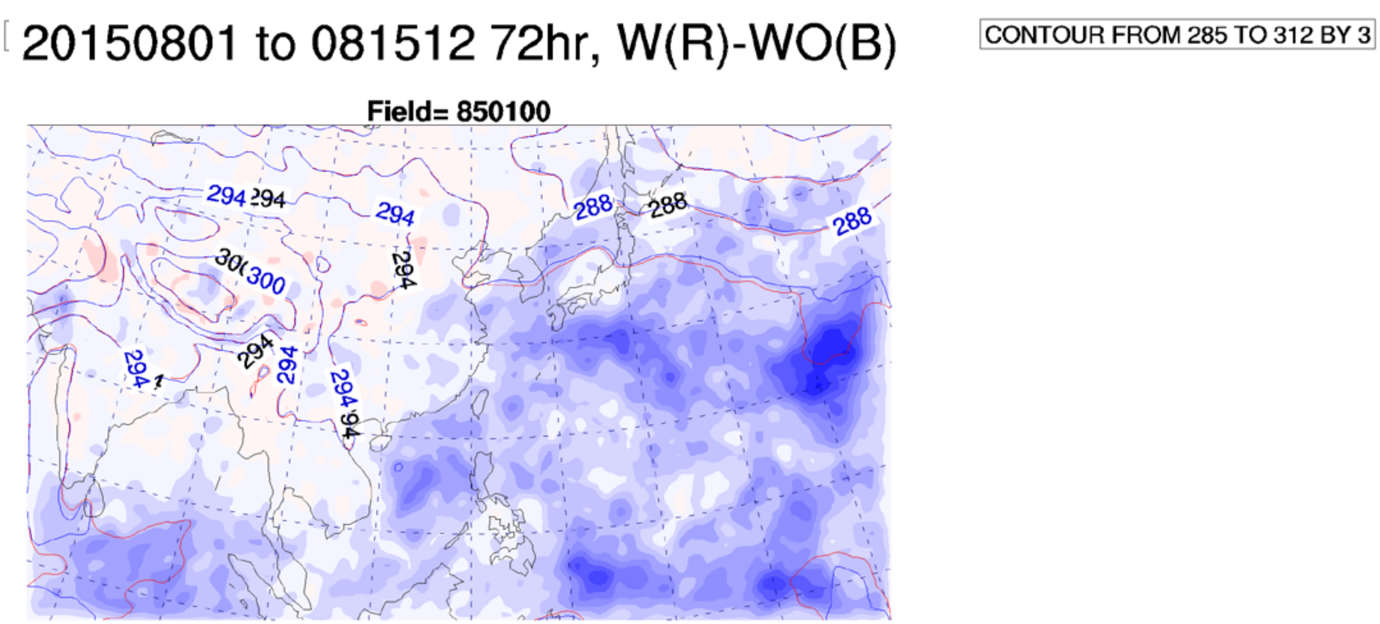
OP41 Eta level	
13	0.8675
12	0.8870
11	0.9050
10	0.9216
9	0.9365

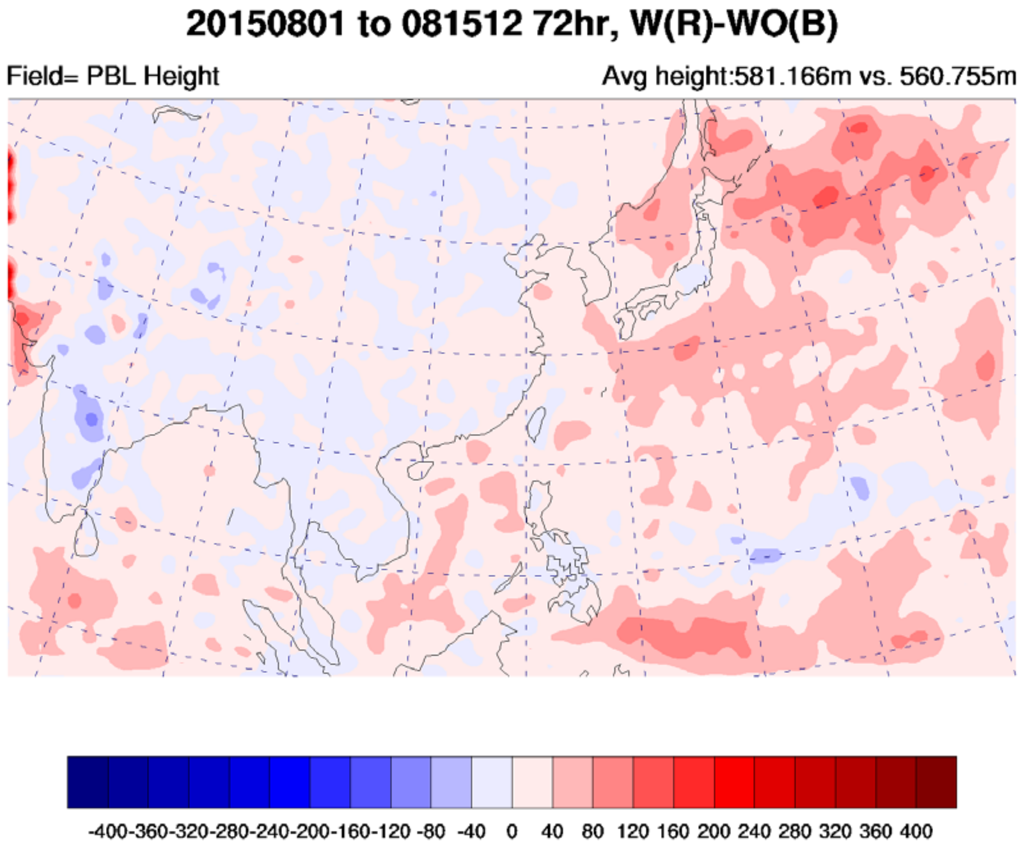
2015年8月15天平均雲量垂直分布

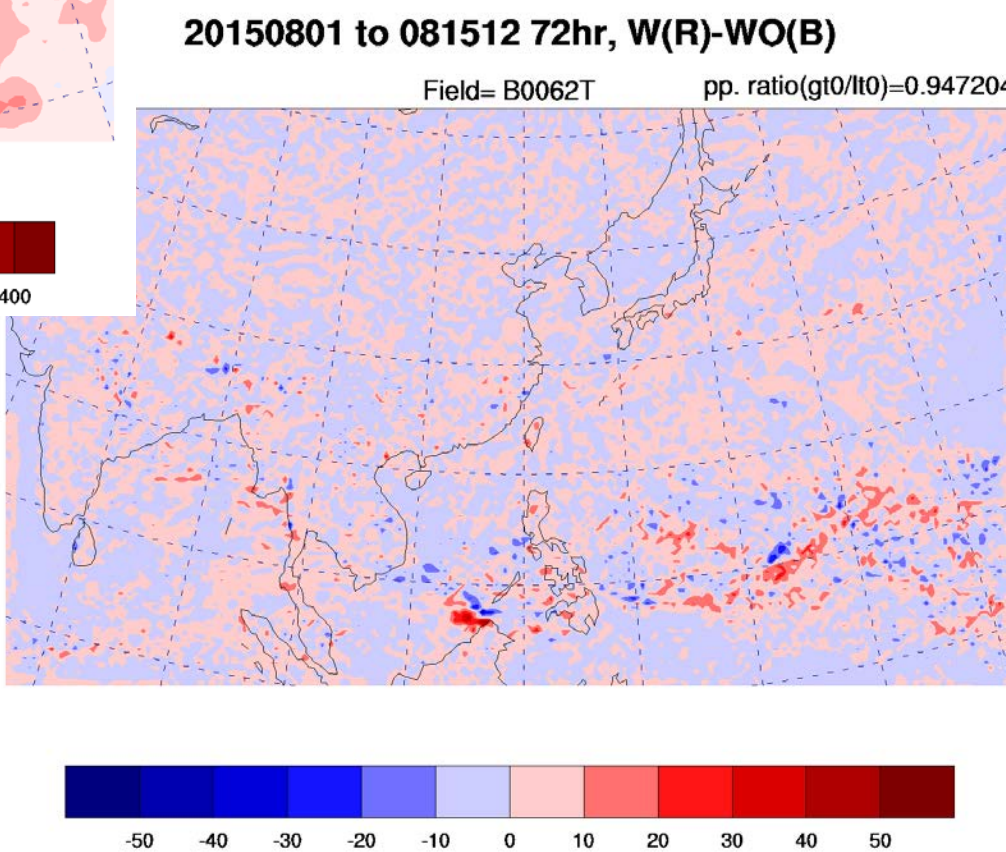



20150801 to 081512 72hr, W(R)-WO(B)
Field= B02100
-2 -1.8 -1.6 -1.4 -1.2 -1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2

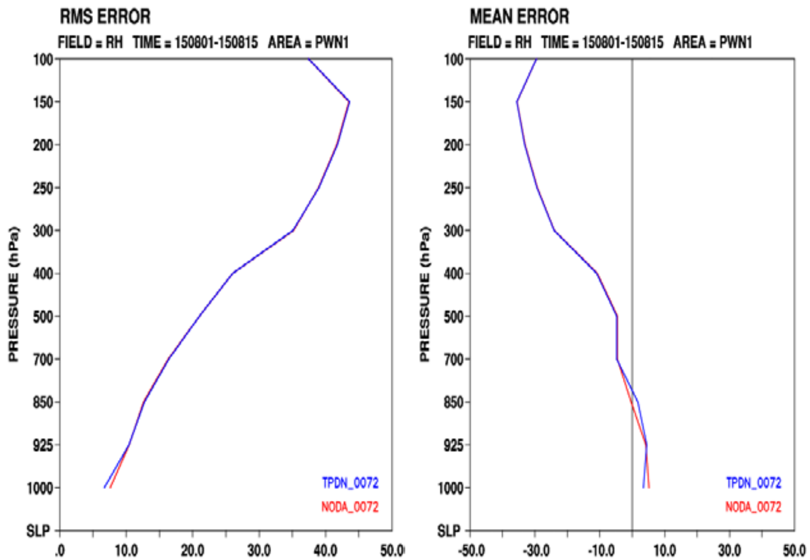

20150801 to 081512 72hr, W(R)-WO(B)
Field= H00100

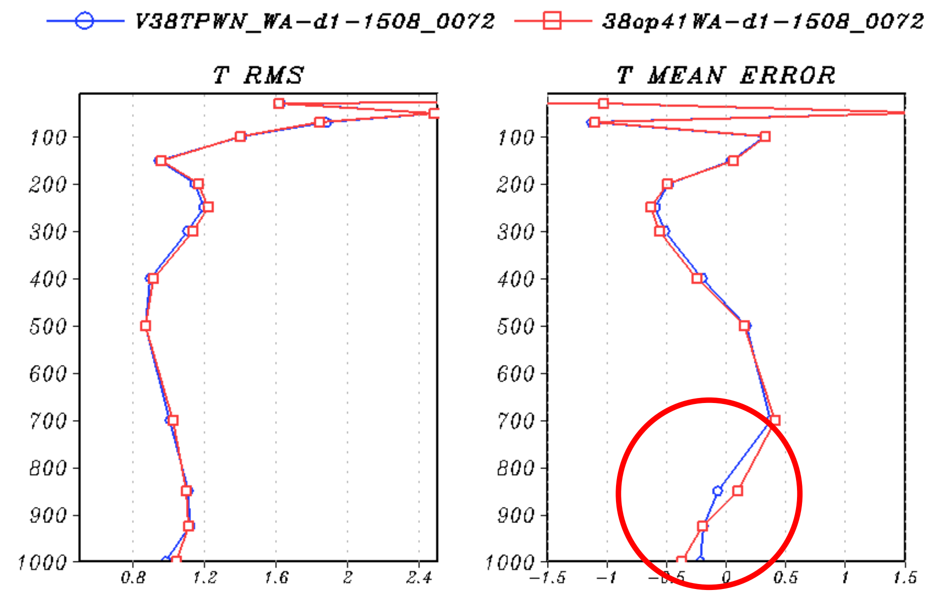

20150801 to 081512 72hr, W(R)-WO(B)
CONTOUR FROM 285 TO 312 BY 3
Field= 850100

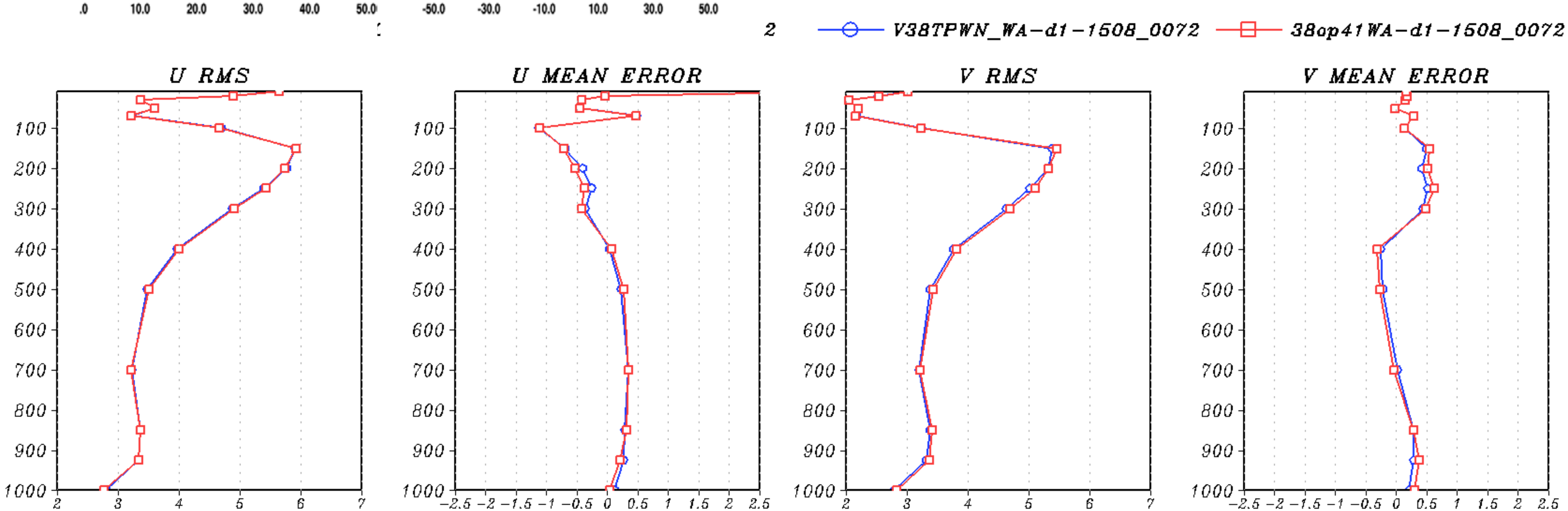

20150801 to 081512 72hr, W(R)-WO(B)
Field= PBL Height
Avg height:581.166m vs. 560.755m
-400 -360 -320 -280 -240 -200 -160 -120 -80 -40 0 40 80 120 160 200 240 280 320 360 400


20150801 to 081512 72hr, W(R)-WO(B)
Field= B0062T
pp. ratio(gt0/lt0)=0.947204
-50 -40 -30 -20 -10 0 10 20 30 40 50

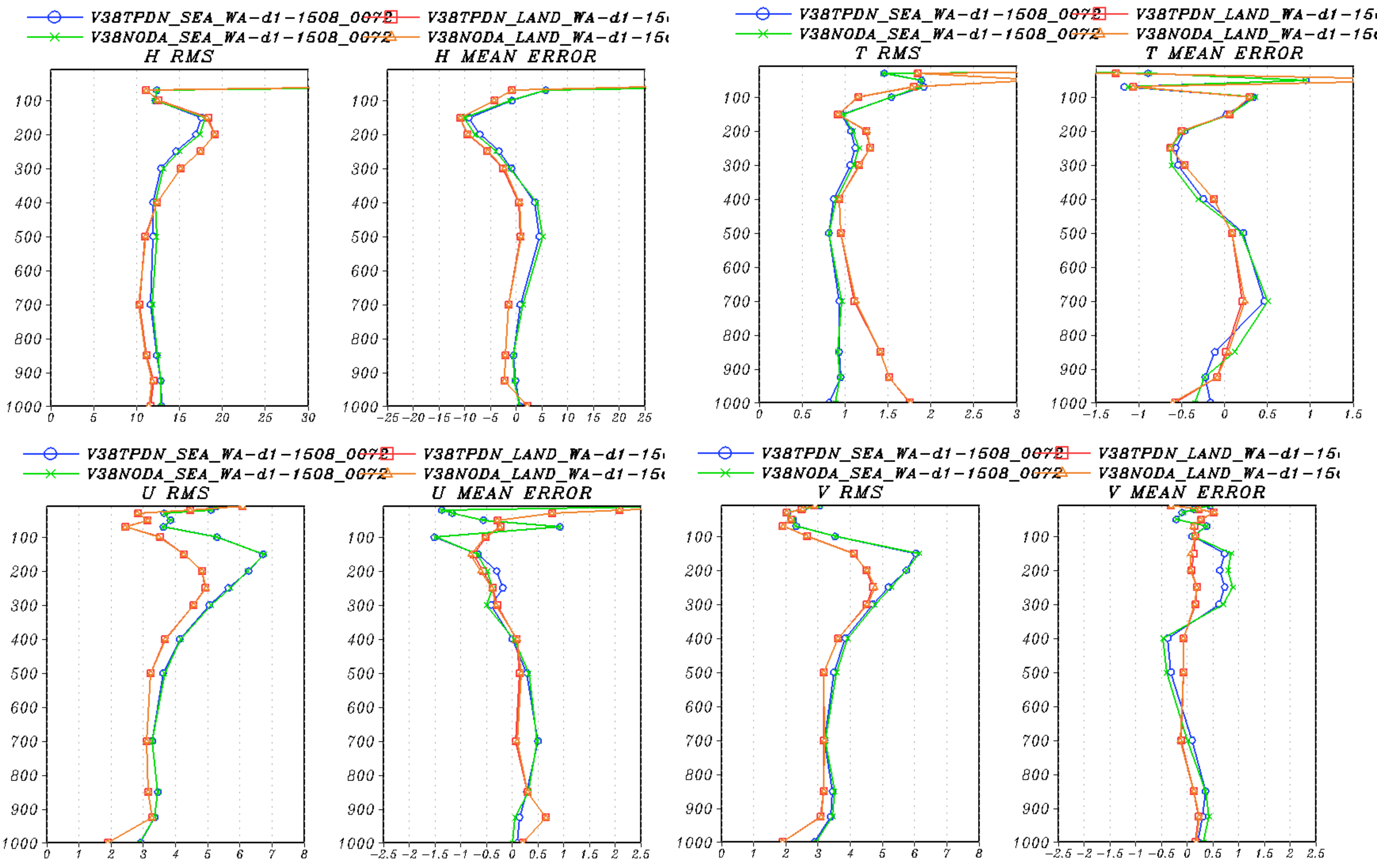
Top_Down mixing 綜觀校驗
(2015年8月份15天 72hr的預報)







綜觀校驗(海陸點分開計算)



結　論

- YSU邊界層參數法在加入雲頂輻射冷卻效應加強了邊界層雲頂的冷卻沉降及混和作用，使得上層較暖、乾的空氣被帶入下層，冷、濕空氣進入上層，因此整體而言可以看到低層變暖、乾，邊界層頂變冷濕的現象。
- 綜觀而言，該現象在海洋上最為明顯，因為我們預報區域會呈現大範圍低雲的海陸差異現象。
- 一般而言，在YSU邊界層參數法中開啟top_down mixing作用，改變了邊界層的溫度、水氣以及動量分布，進而影響自由大氣。此一改變，可以改善我們模式預報區域中溫度的冷偏差，以及動量、水氣垂直分布誤差，並且提高邊界層高度。且對於降雨並不會造成系統性的影響。
- 對於原先因為使用K-F new trigger產生之過多淺雲而言，開啟此一作用僅能略為減少海上的雲量，不過它亦提高了雲的分布高度，此一結果更為接近ECWMF Interim cloud fraction data。