Evaluating PBL Schemes in WRF3.2

Wanli Wu

Y. Liu, F. Vandenberghe, A. Bourgeois, J. Grim,

T. Warner, J. Knievel, J. Dudhia, C. Bruyere

National Center for Atmospheric Research

D. Stauffer

Penn. State University

M. Padovani, G. Luft and K. Fling

U.S. Army Test and Evaluation Command Center

NCAR

Outline

- **Motivation**

- **Description of the Weather Case**

- **Experiment Design & Model Configuration**

- **Preliminary Results**

- **Summary**

Motivation

A East Coast winter storm (February 10-13 2008), which evolves unstable, neutral and strong stable PBL regimes, was chosen for evaluating the PBL parameterizations in WRF-ARW (public release3.2).
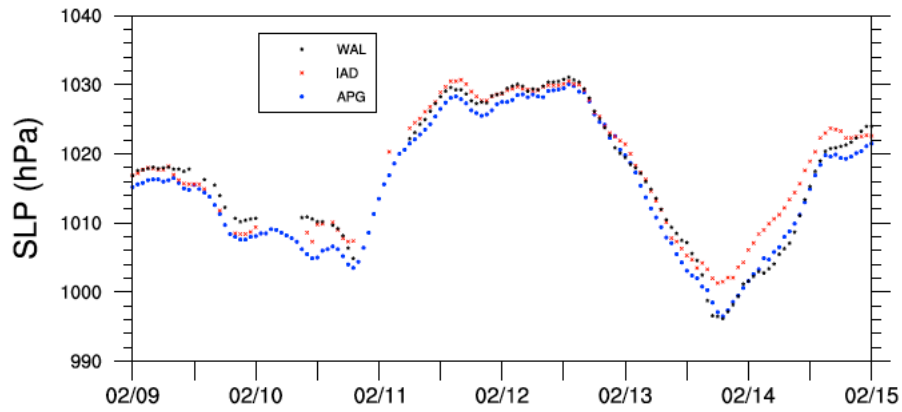
850 hPa circulations (NAM analysis)
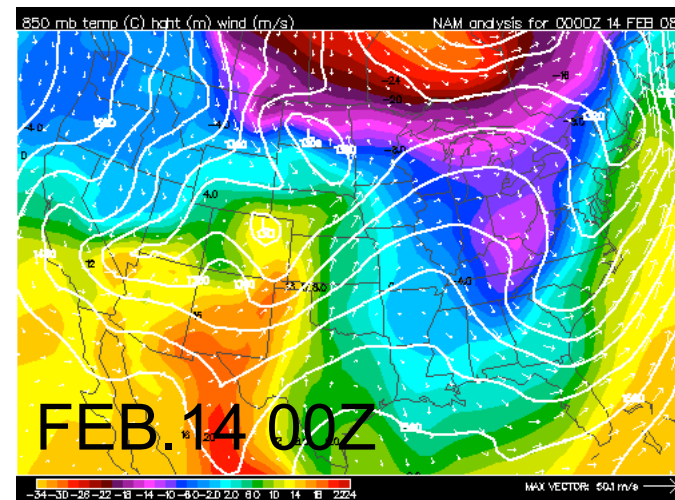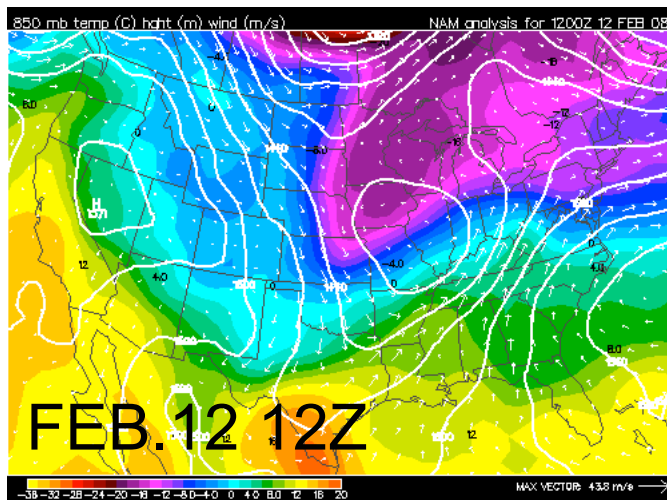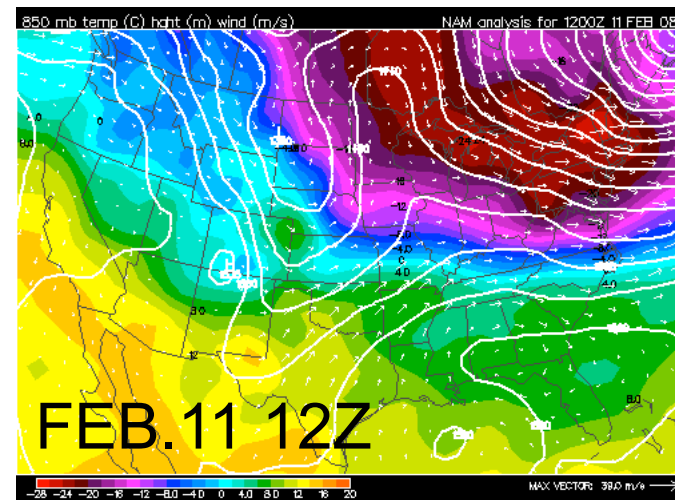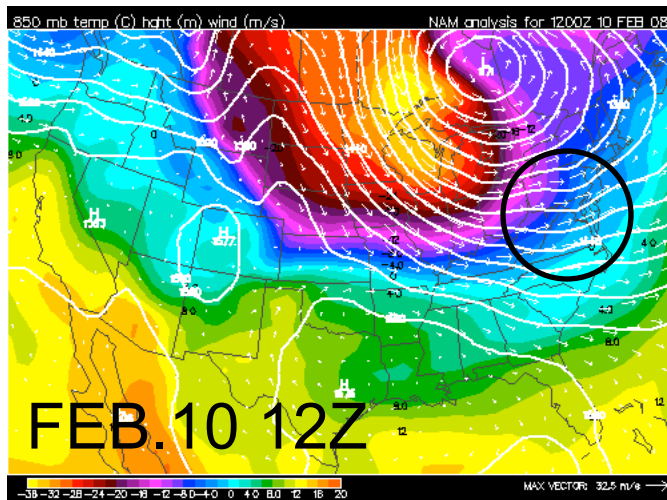
Current analysis focuses on Chesapeake Bay area, particularly on three stations:
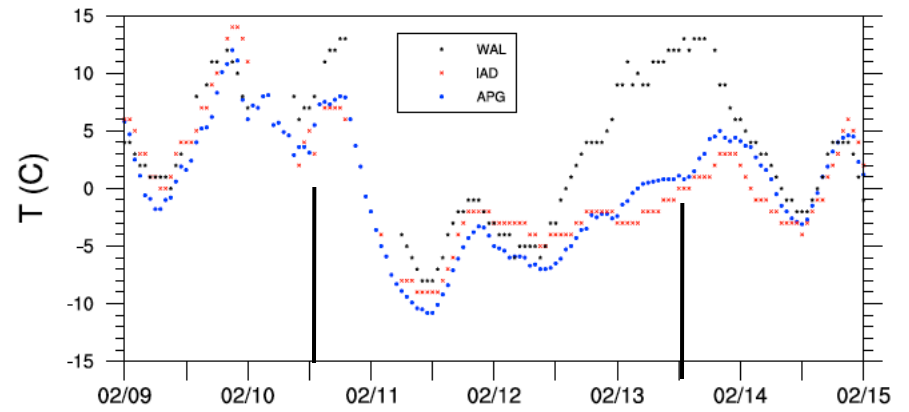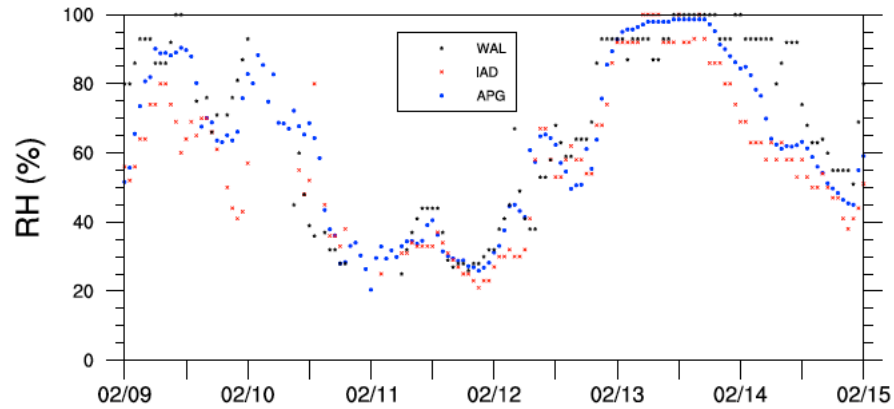## APG: Aberdeen; IAD: Sterling; WAL: Wallops Island
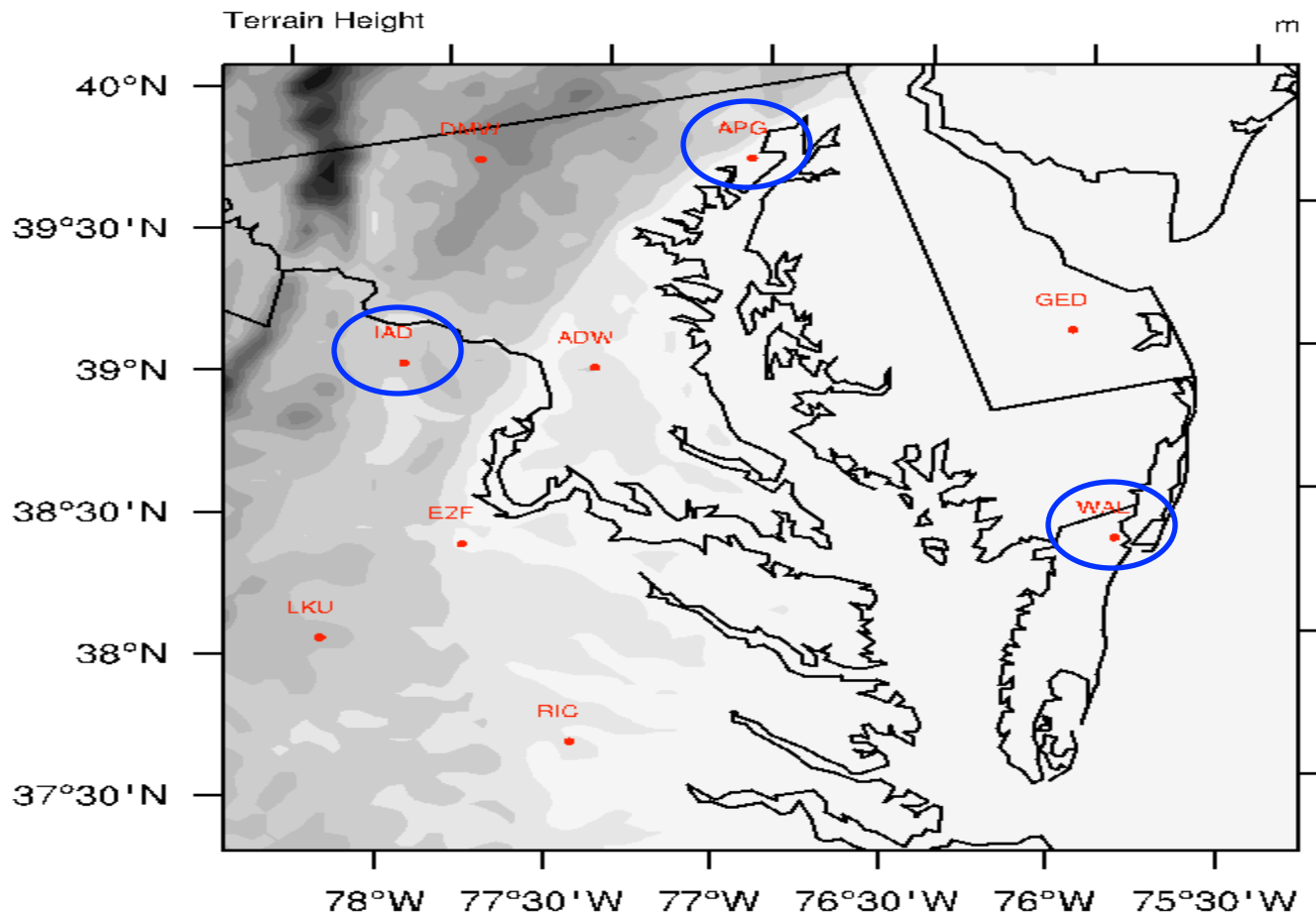
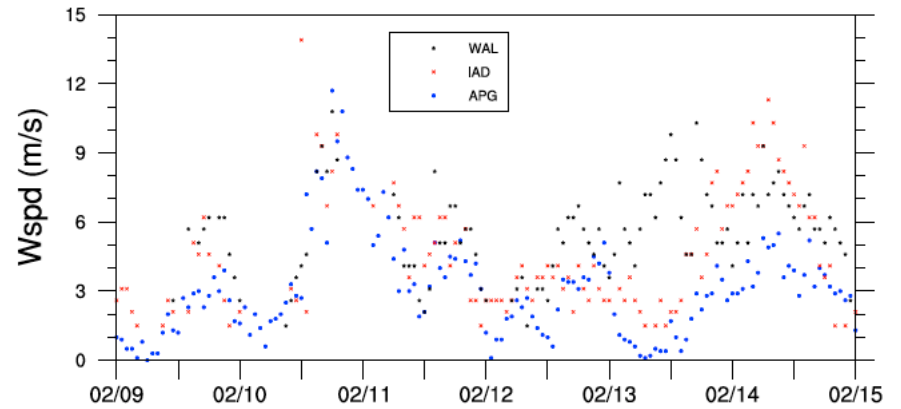# Hourly observations at **APG**, **IAD**, and **WAL**
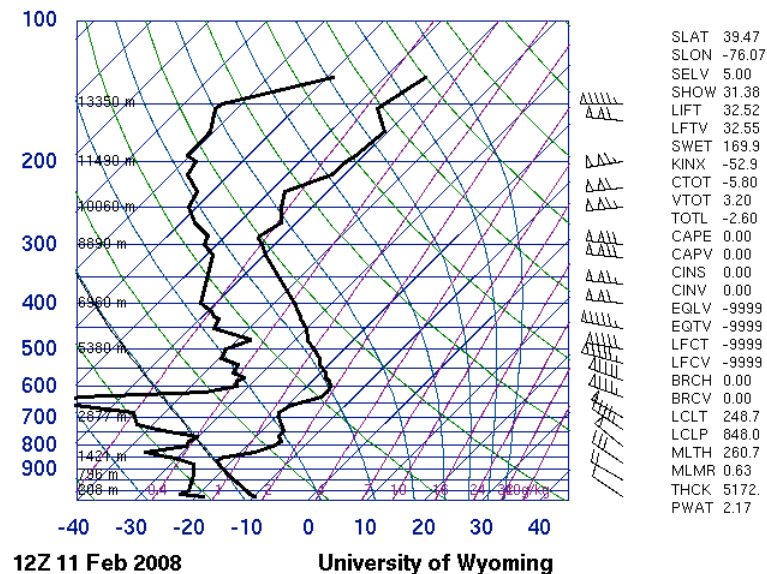

Sea Level Pressure

2-meter Temperature

2-meter Relative Humidity

10-meter wind speed
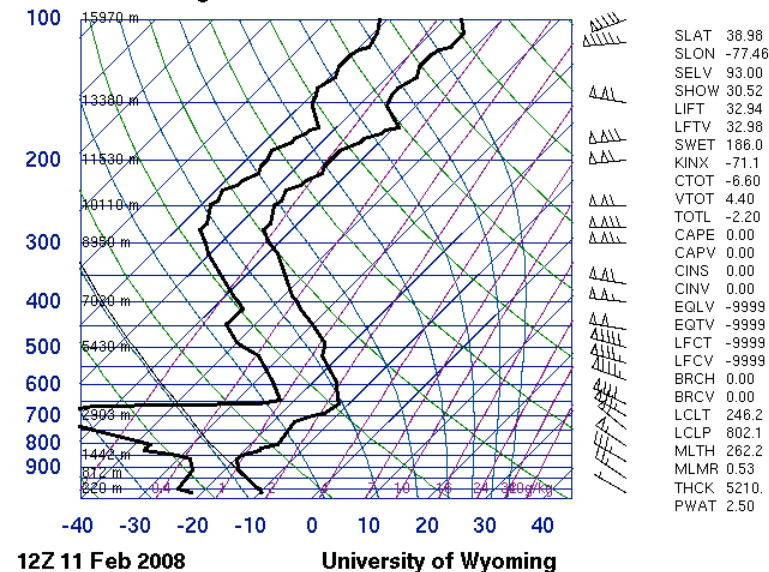
Radiosonde Observations at APG, IAD and WAL

Feb. 11 12Z
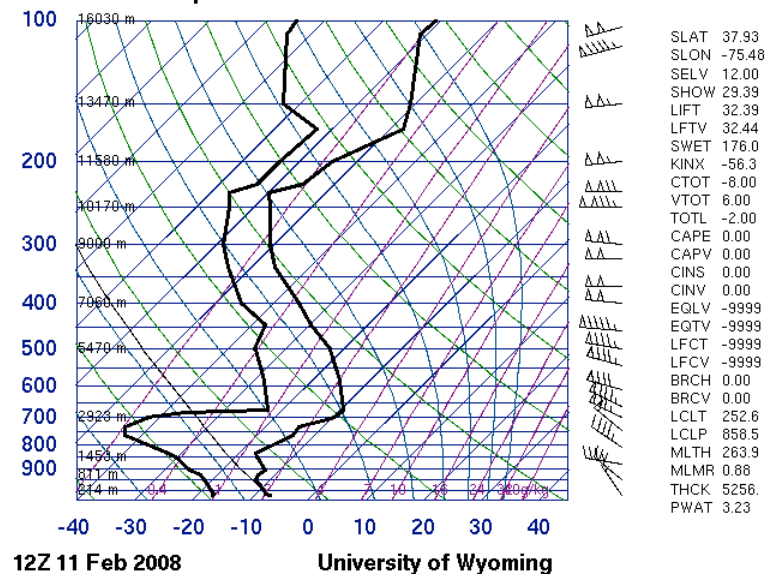
Radiosonde Observations at APG, IAD and WAL

Feb. 13 12Z

WRF (V3.2) Model Domain & Configuration
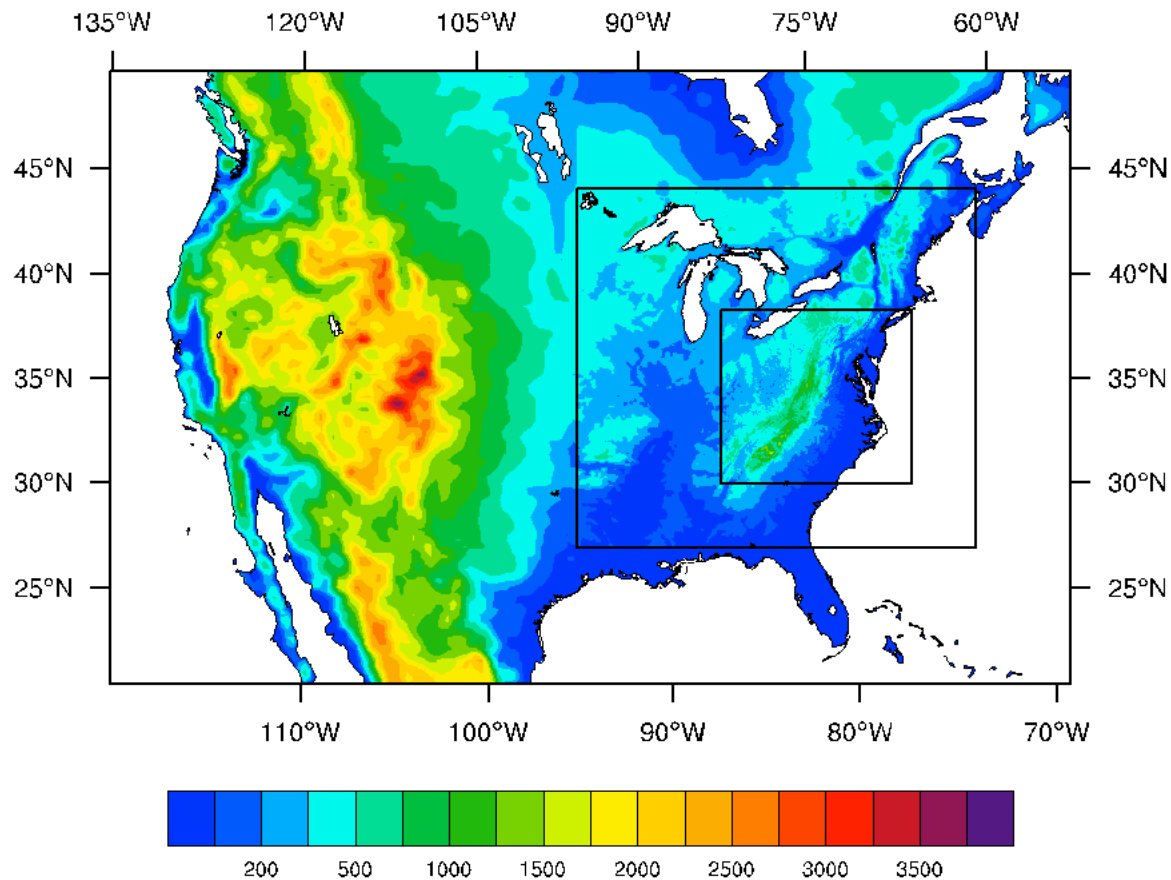
- WRF-ARW 3.2
- 3 nested domain at 32.4, 10.8, and 3.6 km; 37 vertical levels
- IC and LBC by NCEP GFS
- Lin microphysics
- Kain-Fritsch cumulus physics
- Noha land surface model
- RRTMG shortwave and longwave radiations
- RTG SST daily update
- 90m SRTM terrain
- All experiments run from 9th Feb. 2008 00UTC for 6 days to 15th Feb. 2008 00UTC without FDDA varying PBL schemes

List of Experiments

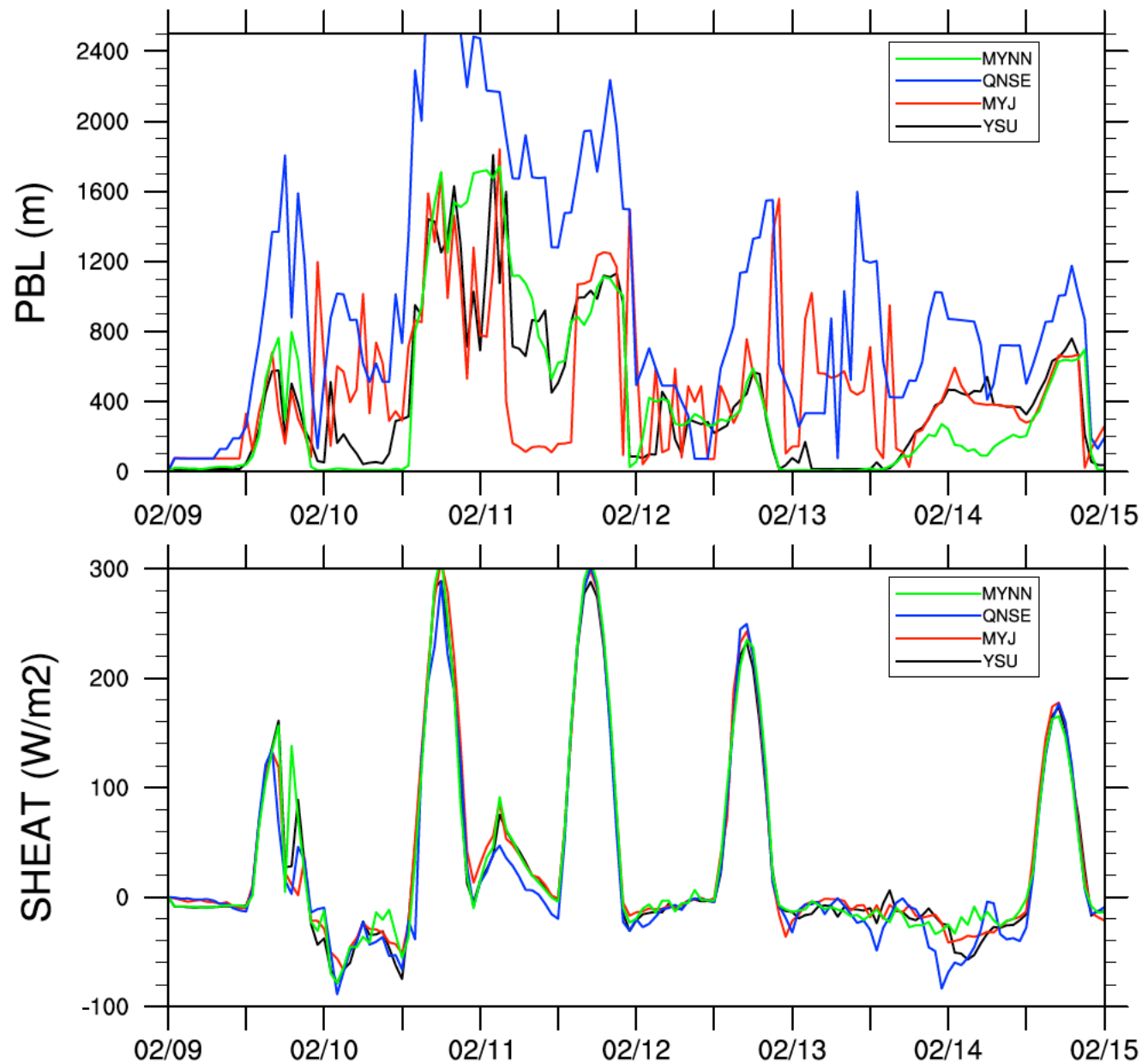| EXPERIMENT	SURFACE LAYER	BOUNDARY LAYER	REFERENCE
1	MM5 similarity	YSU	Hong et al (2006)
2	ETA similarity	MYJ	Mellor and Yamada (1982) Janjic (2002)
3	QNSE	QNSE	Galoerin et al (2007)
4	MYNN	MYNN2.5	Nakanishi and Niino (2204)

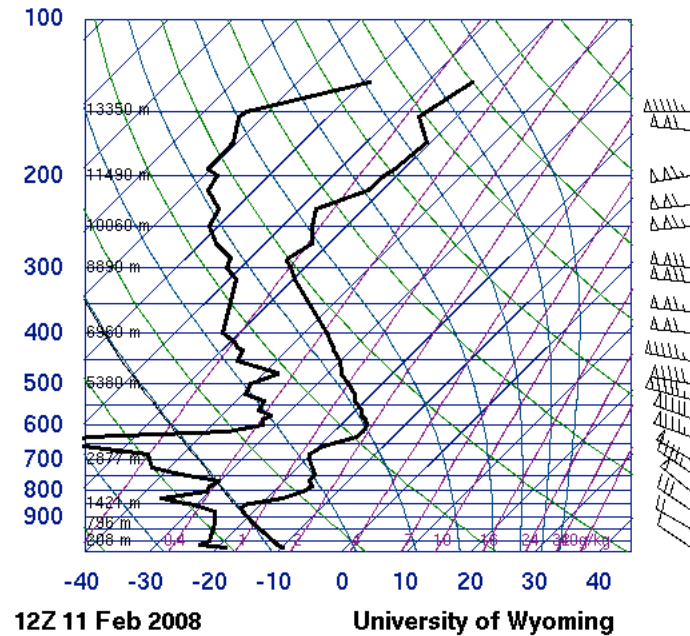# Aberdeen Proving Ground (APG)

WRF **PBL Height** and **Sensible Heat** at APG
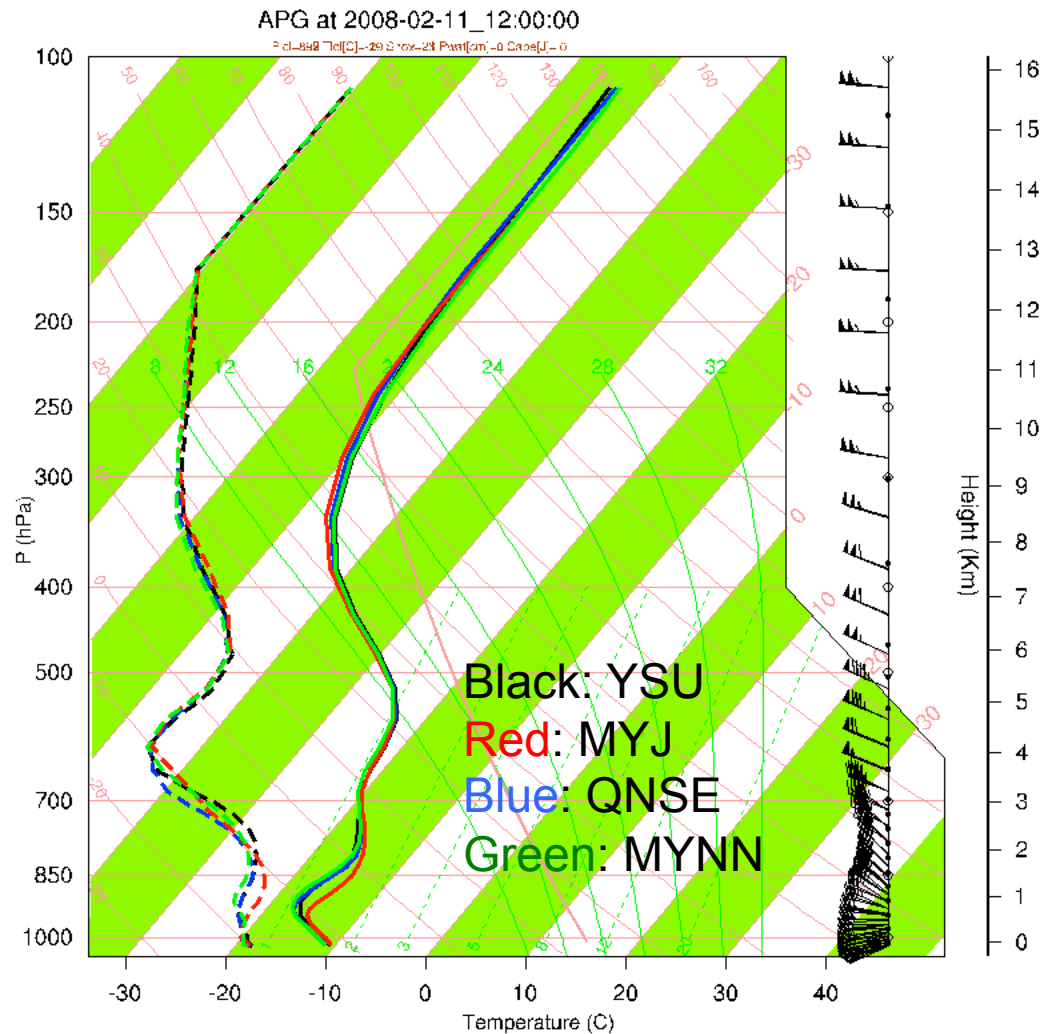
Black: YSU
Red: MYJ
Blue: QNSE
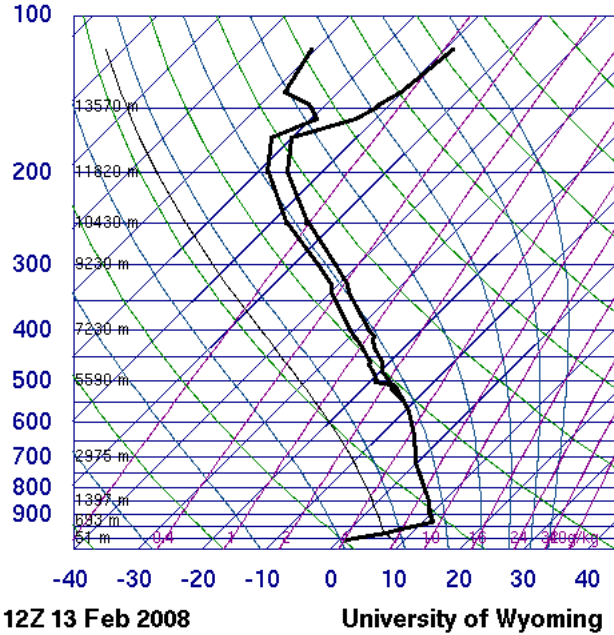Green: MYNN

Skew-T APG (Feb. 11 12Z)

74002 APG Aberdeen Prv Grnd &

SLAT	39.47
SLON	-76.07
SELV	5.00
SHOW	31.38
LIFT	32.52
LFTV	32.55
SWET	169.9
KINX	-52.9
CTOT	-5.80
VTOT	3.20
TOTL	-2.60
CAPE	0.00
CAPV	0.00
CINS	0.00
CINV	0.00
EQLV	-9999
EQTV	-9999
LFCT	-9999
LFCV	-9999
BRCH	0.00
BRCV	0.00
LCLT	248.7
LCLP	848.0
MLTH	260.7
MLMR	0.63
THCK	5172.
PWAT	2.17

12Z 11 Feb 2008   University of Wyoming

APG at 2008-02-11_12:00:00

Black: YSU
Red: MYJ
Blue: QNSE
Green: MYNN

Skew-T APG (Feb. 13 12 Z)

Black: YSU
Red: MYJ
Blue: QNSE
Green: MYNN

WRF Forecasts and Observations at APG
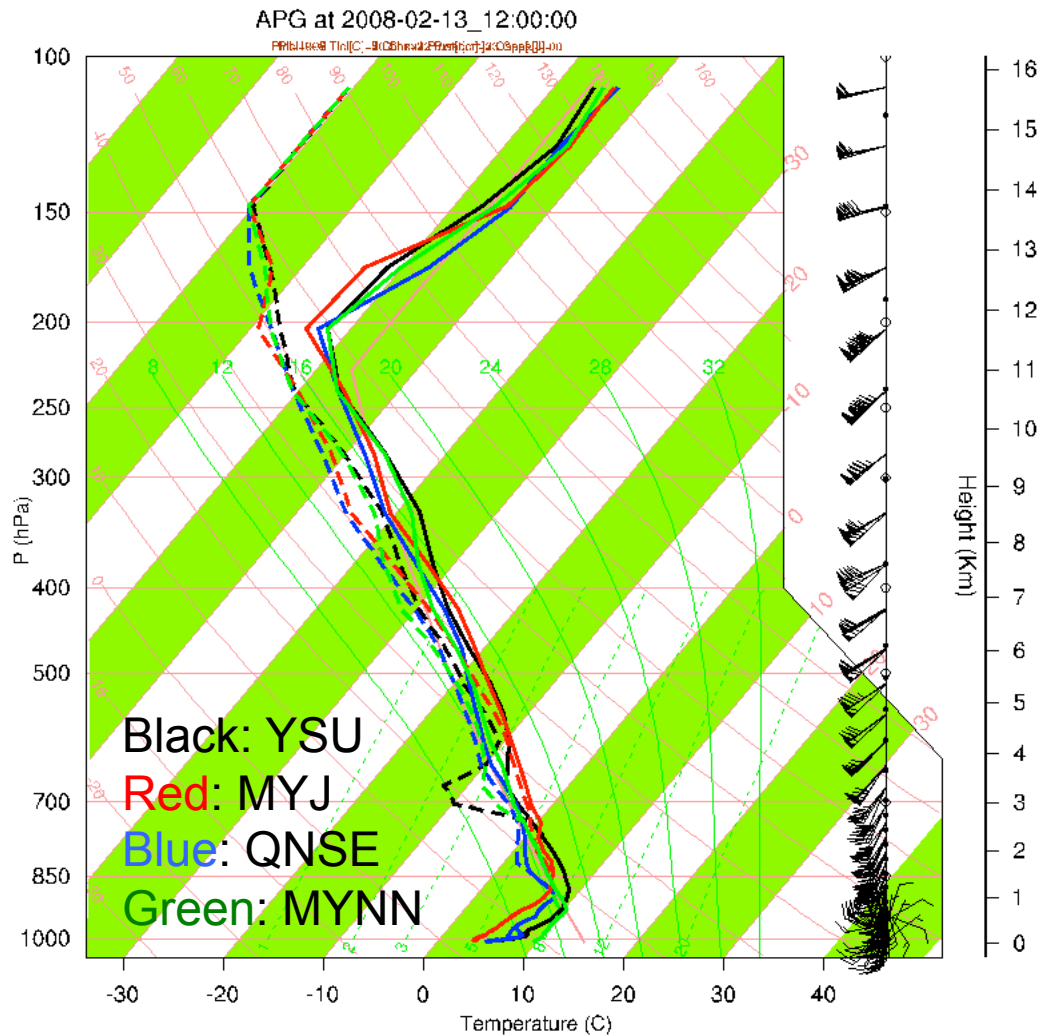
Dot: OBS
Black: YSU
Red: MYJ
Blue: QNSE
Green: MYNN
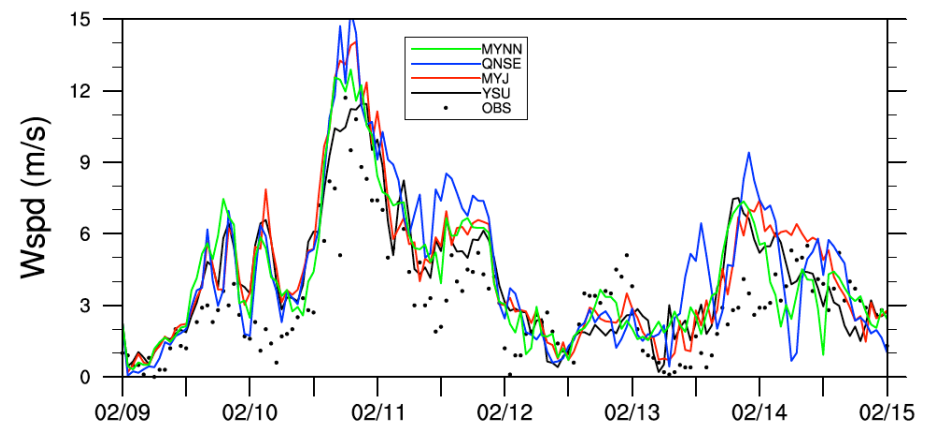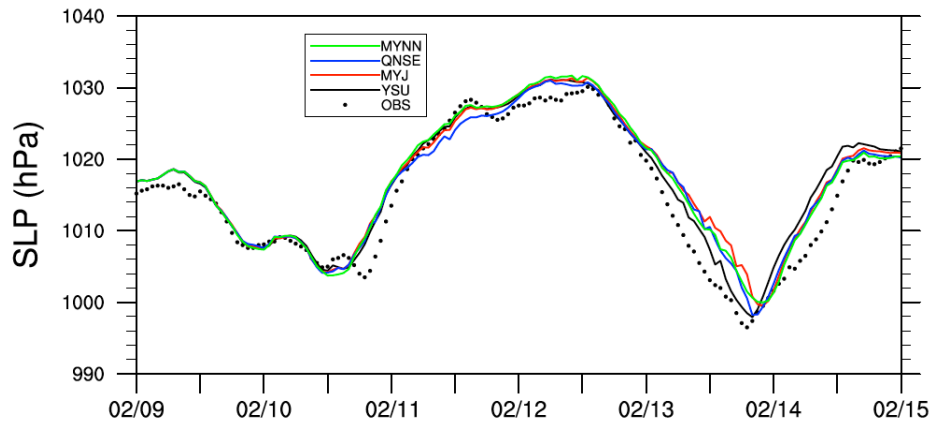
Precipitation at APG
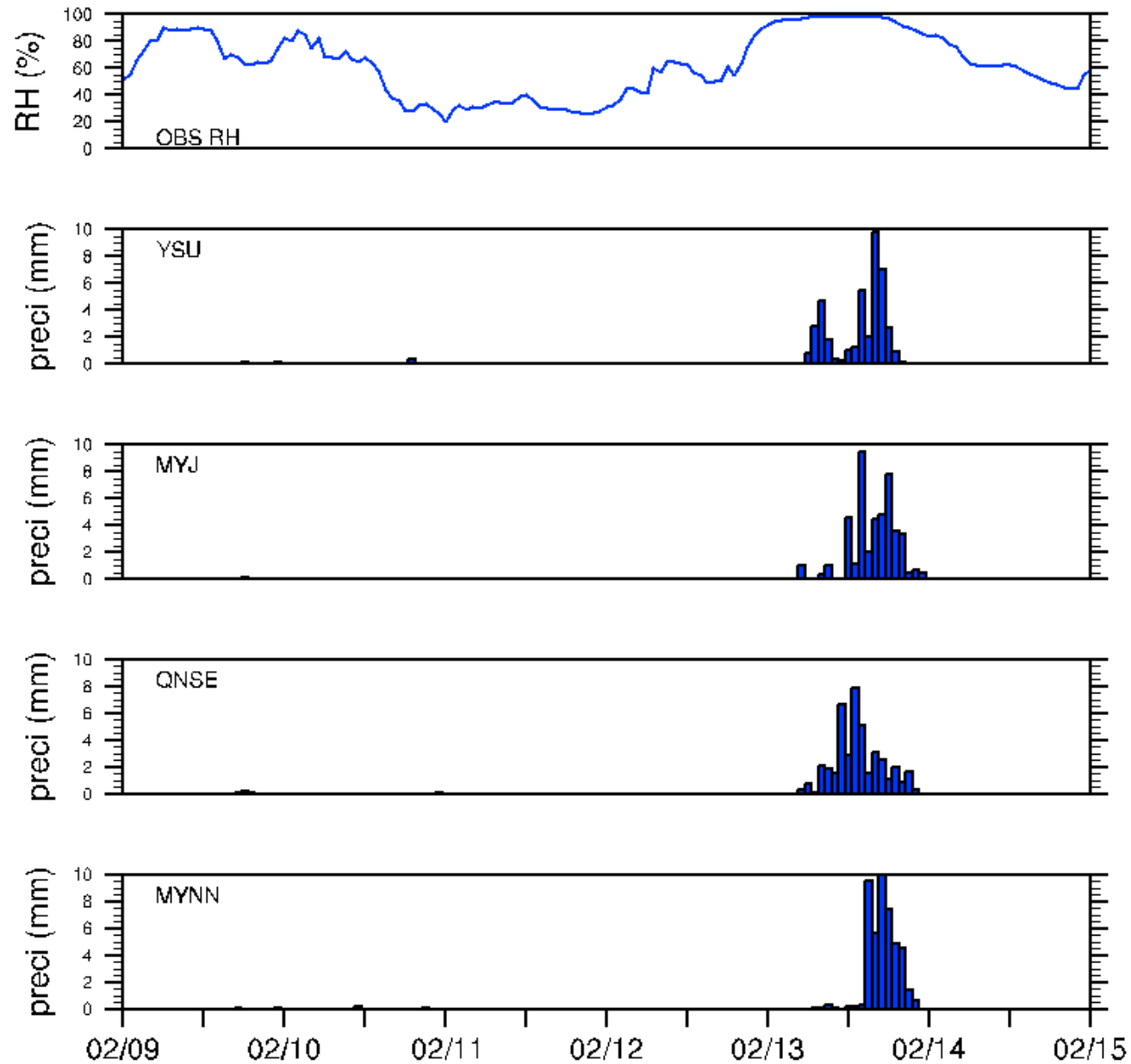
Sterling (IAD)

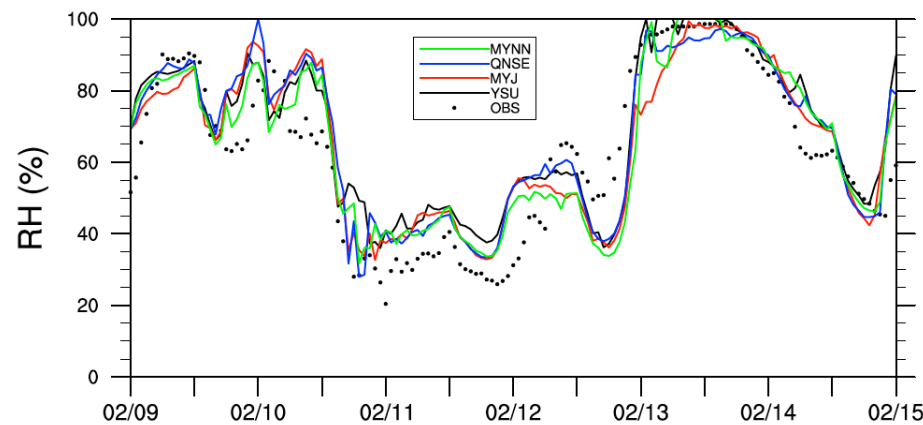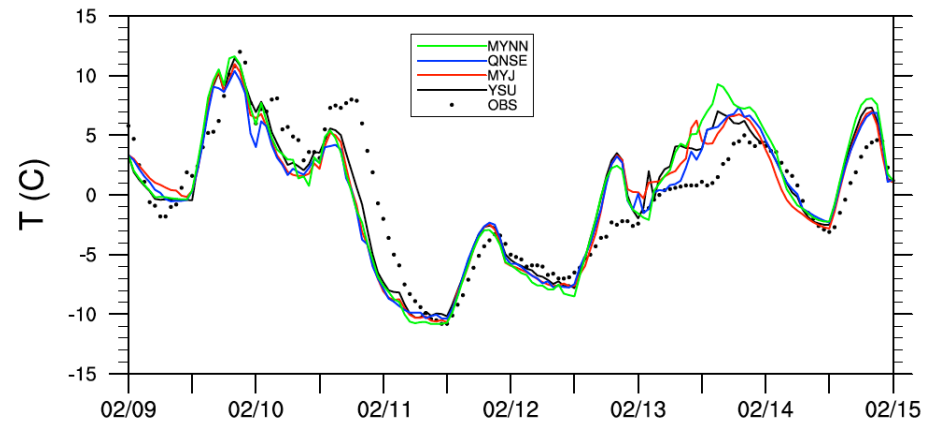WRF PBL Height and Sensible heat at IAD

Skew-T IAD

IAD at 2008-02-11_12:00:00

IAD at 2008-02-13_12:00:00
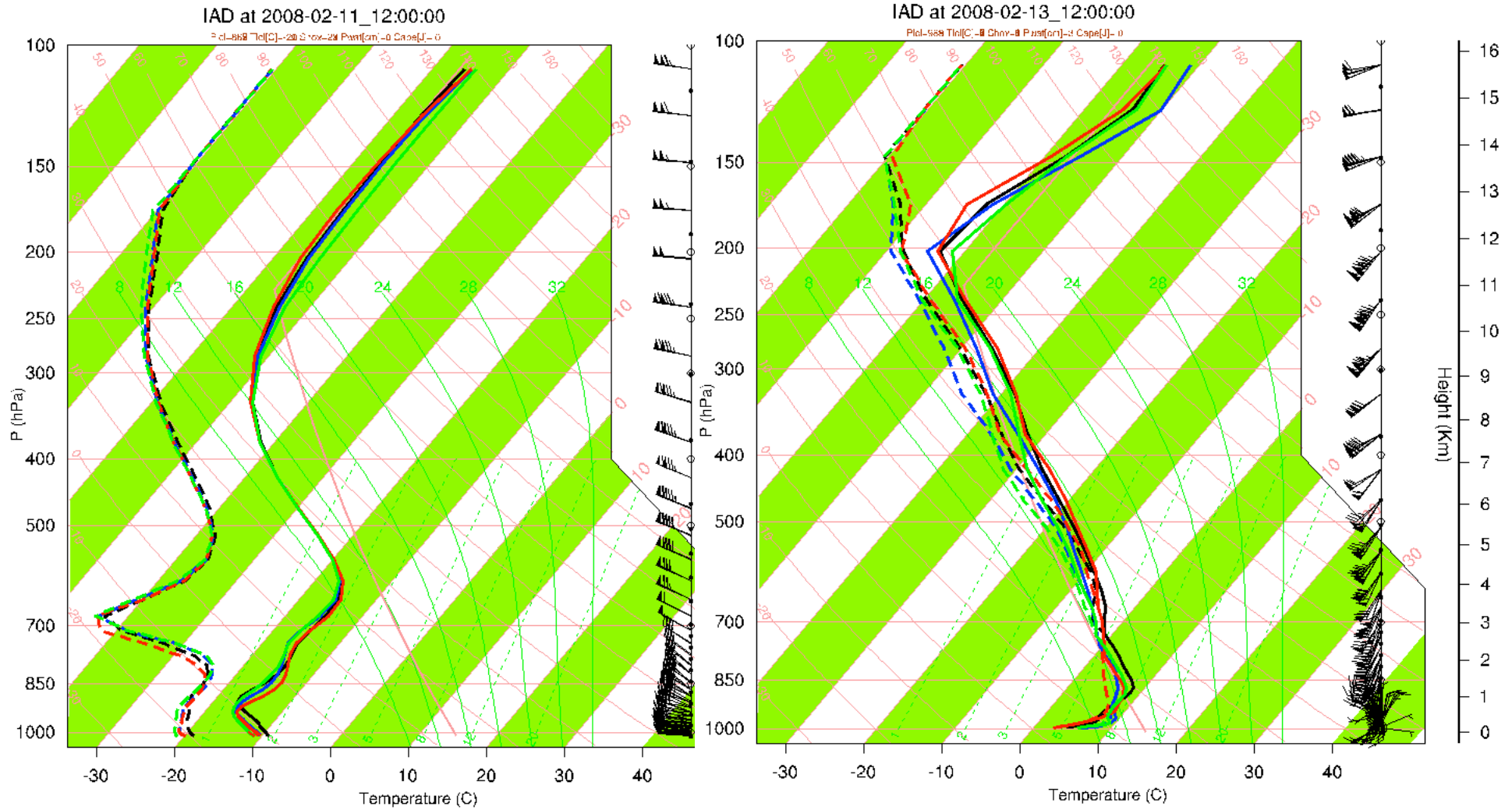
WRF Forecasts and Observations at IAD
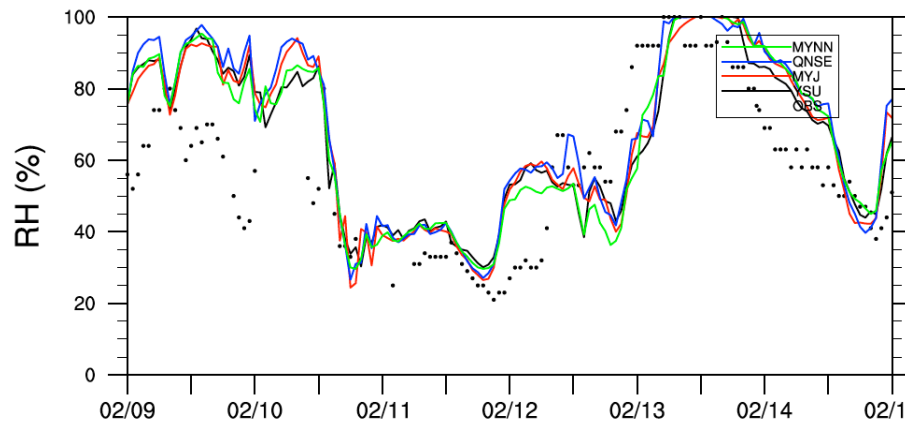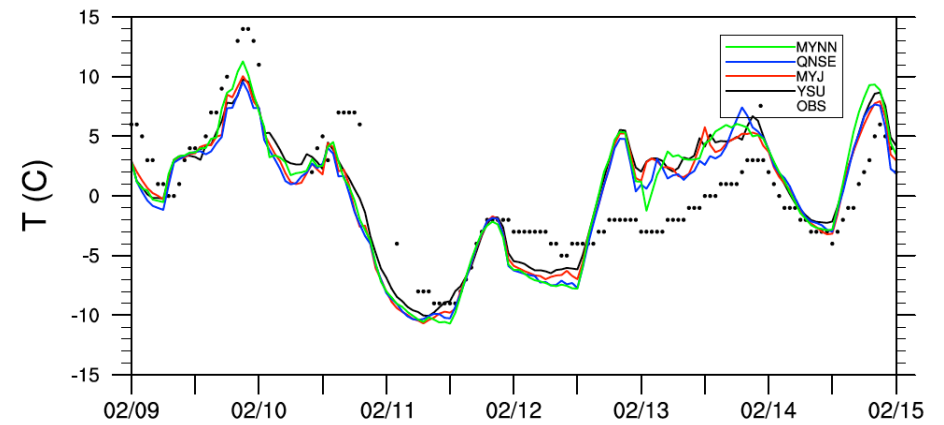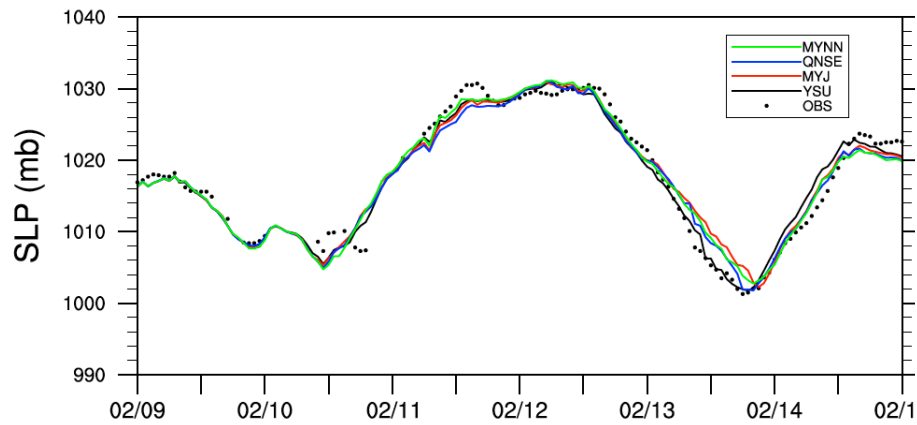
Precipitation at IAD
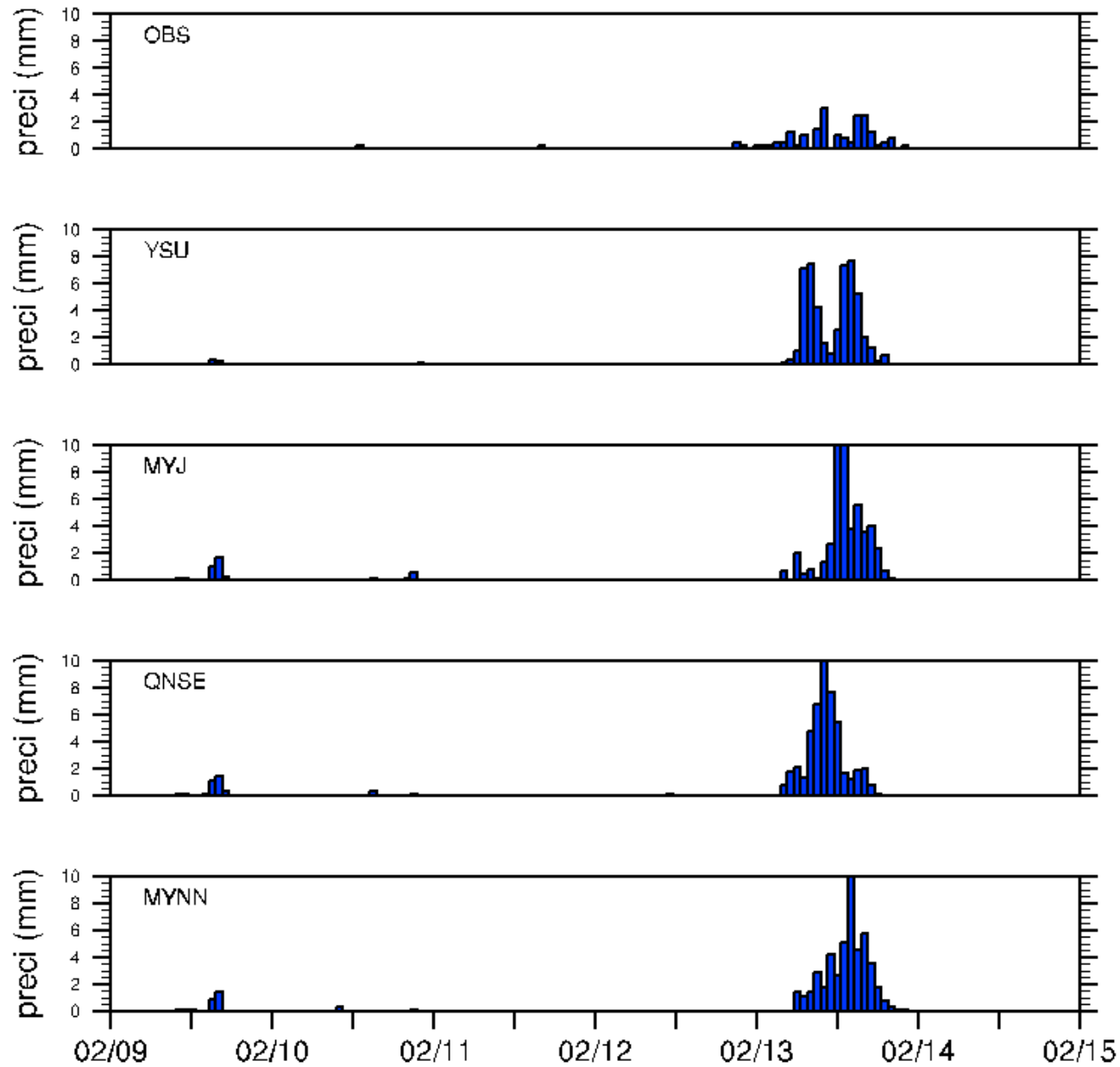
Wallops Island (WAL)

WRF PBL Height and Sensible Heat at WAL
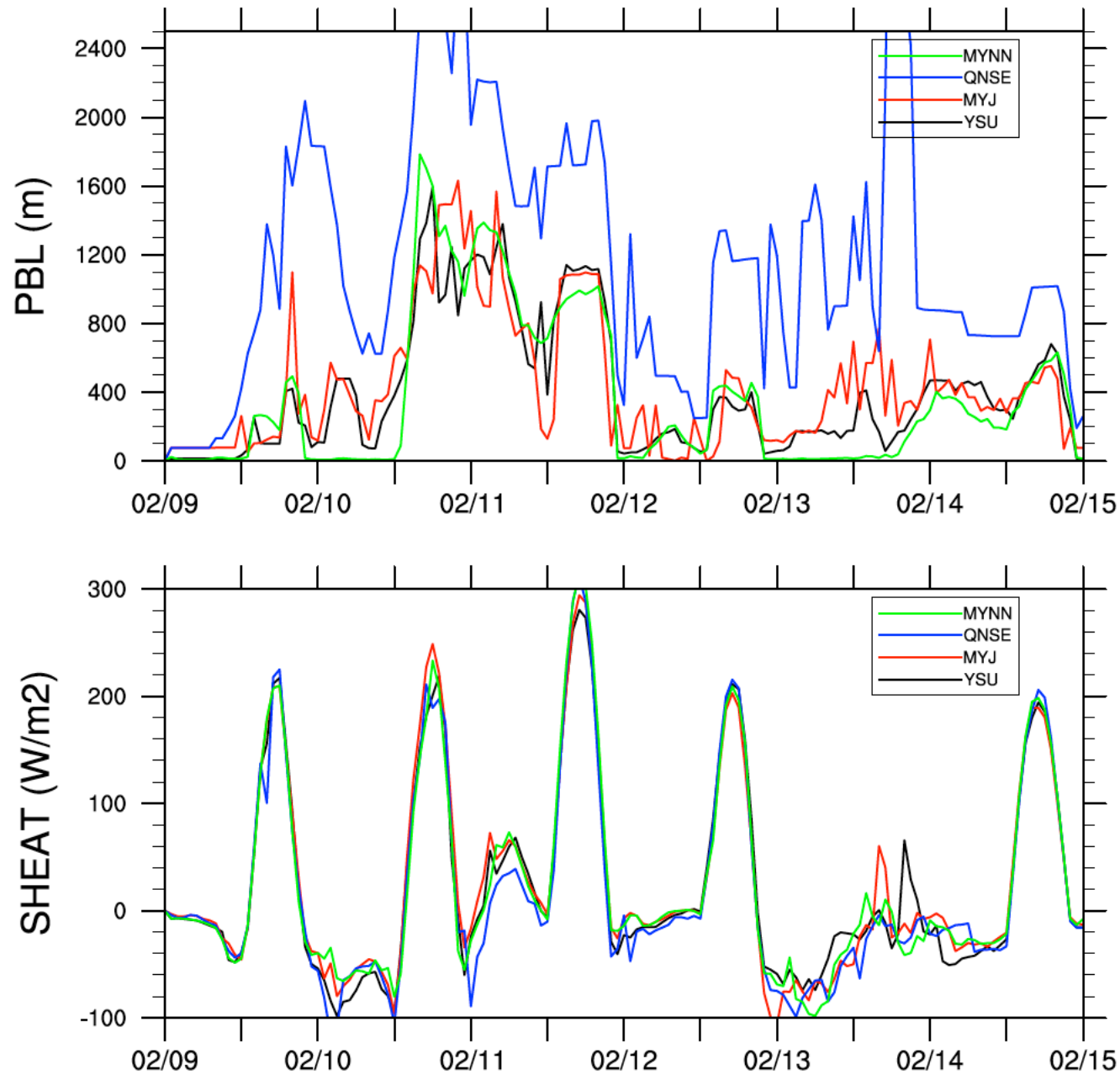
Skew-T WAL (Feb 11 12 Z)

72402 WAL Wallops Island

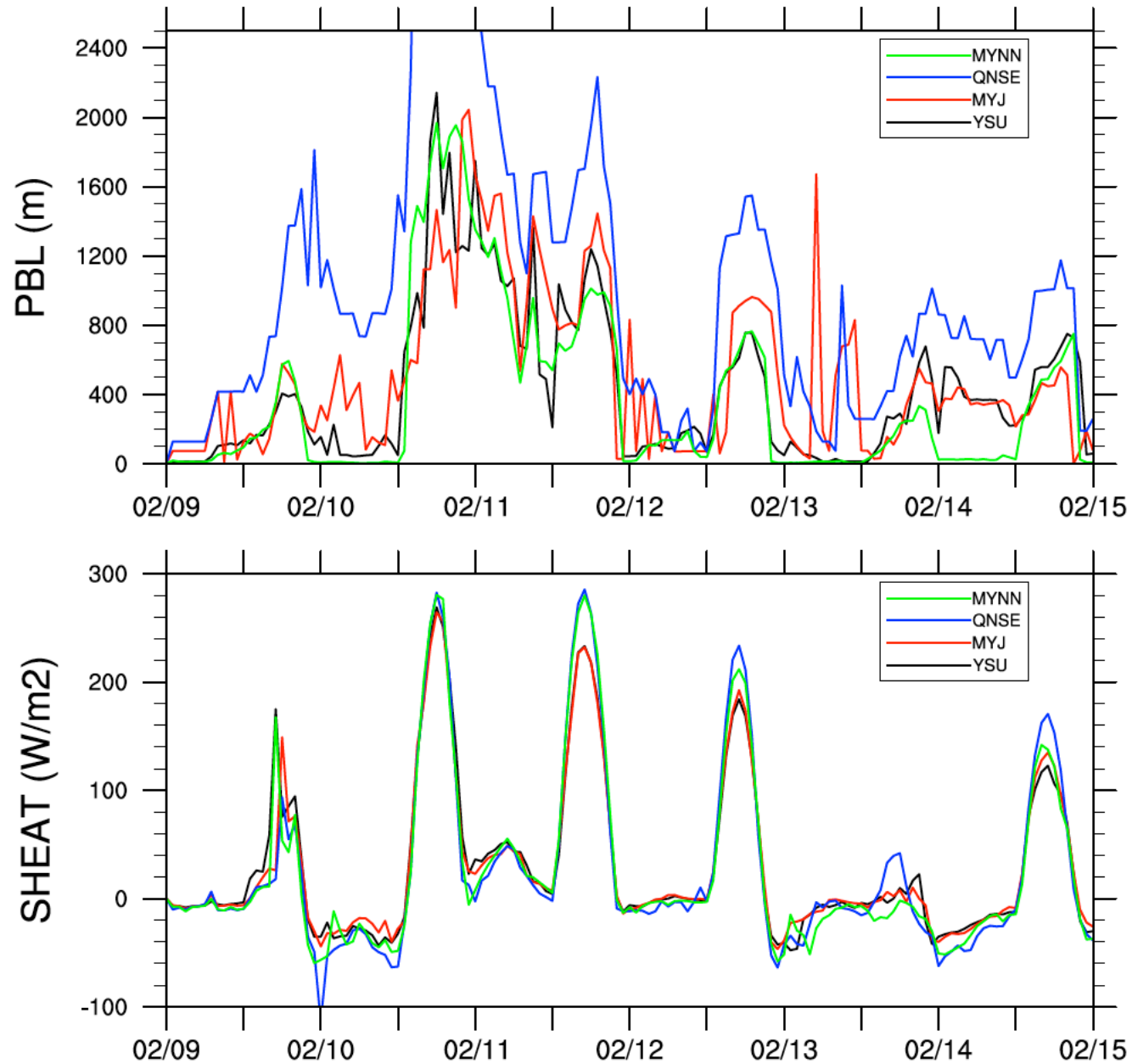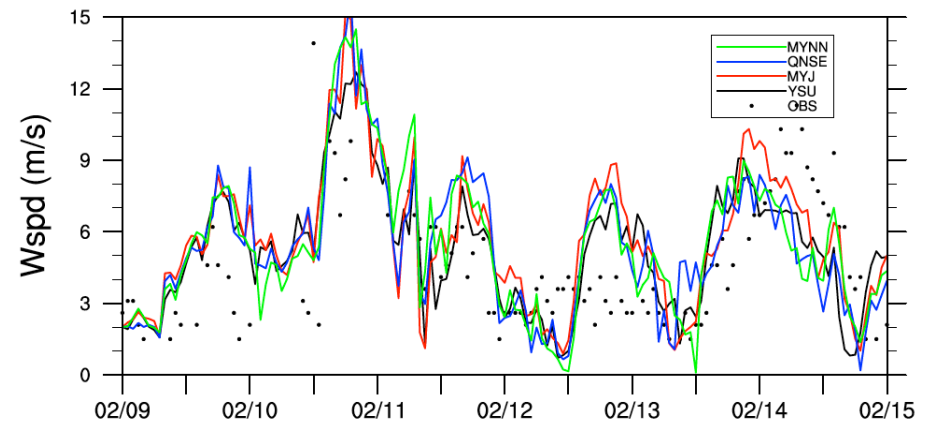12Z 11 Feb 2008   University of Wyoming
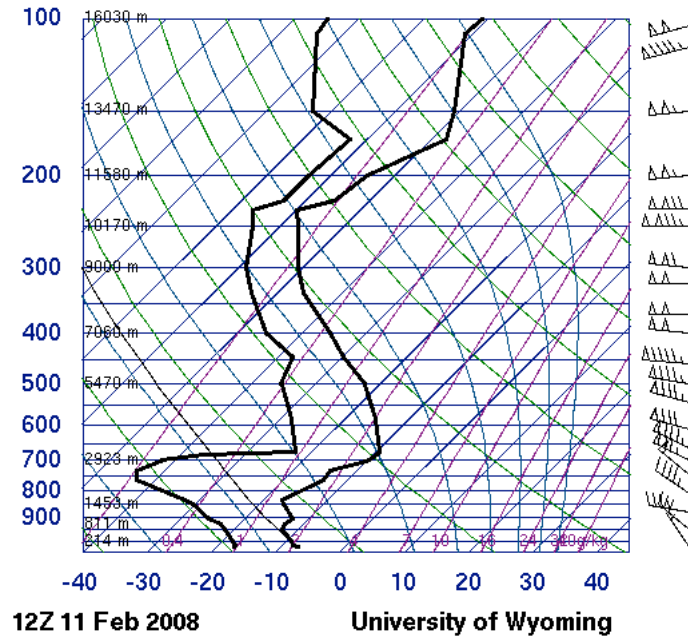
SLAT   37.93
SLON   -75.48
SELV   12.00
SHOW   29.39
LIFT   32.39
LFTV   32.44
SWET   176.0
KINX   -56.3
CTOT   -8.00
VTOT   6.00
TOTL   -2.00
CAPE   0.00
CAPV   0.00
CINS   0.00
CINV   0.00
EQLV   -9999
EQTV   -9999
LFCT   -9999
LFCV   -9999
BRCH   0.00
BRCV   0.00
LCLT   252.6
LCLP   858.5
MLTH   263.9
MLMR   0.88
THCK   5256.
PWAT   3.23

WAL at 2008-02-11_12:00:00

Black: YSU
Red: MYJ
Blue: QNSE
Green: MYNN
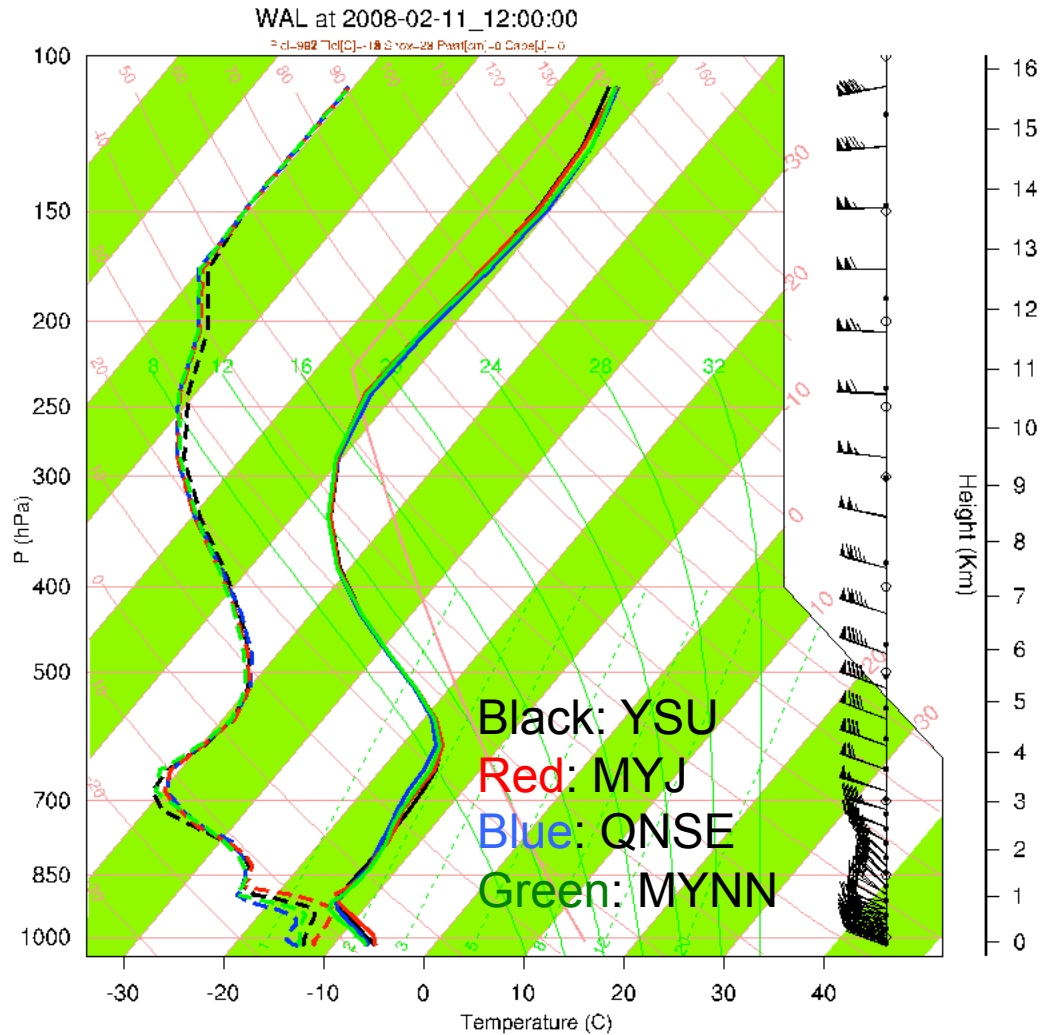
Skew-T WAL (Feb 13 12 Z)

72402 WAL Wallops Island

12Z 13 Feb 2008   University of Wyoming
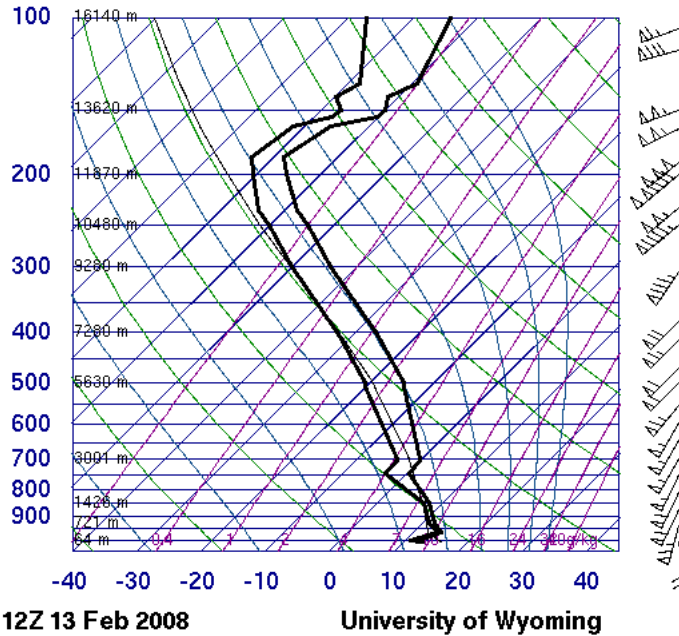
SLAT	37.93
SLON	-75.48
SELV	12.00
SHOW	3.64
LIFT	4.73
LFTV	4.70
SWET	333.3
KINX	26.60
CTOT	22.00
VTOT	22.70
TOTL	44.70
CAPE	7.72
CAPV	12.79
CINS	-52.4
CINV	-52.7
EQLV	730.2
EQTV	726.5
LFCT	786.2
LFCV	794.5
BRCH	0.13
BRCV	0.21
LCLT	285.3
LCLP	963.2
MLTH	288.4
MLMR	9.39
THCK	5566.
PWAT	29.10

WAL at 2008-02-13_12:00:00

Black: YSU
Red: MYJ
Blue: QNSE
Green: MYNN
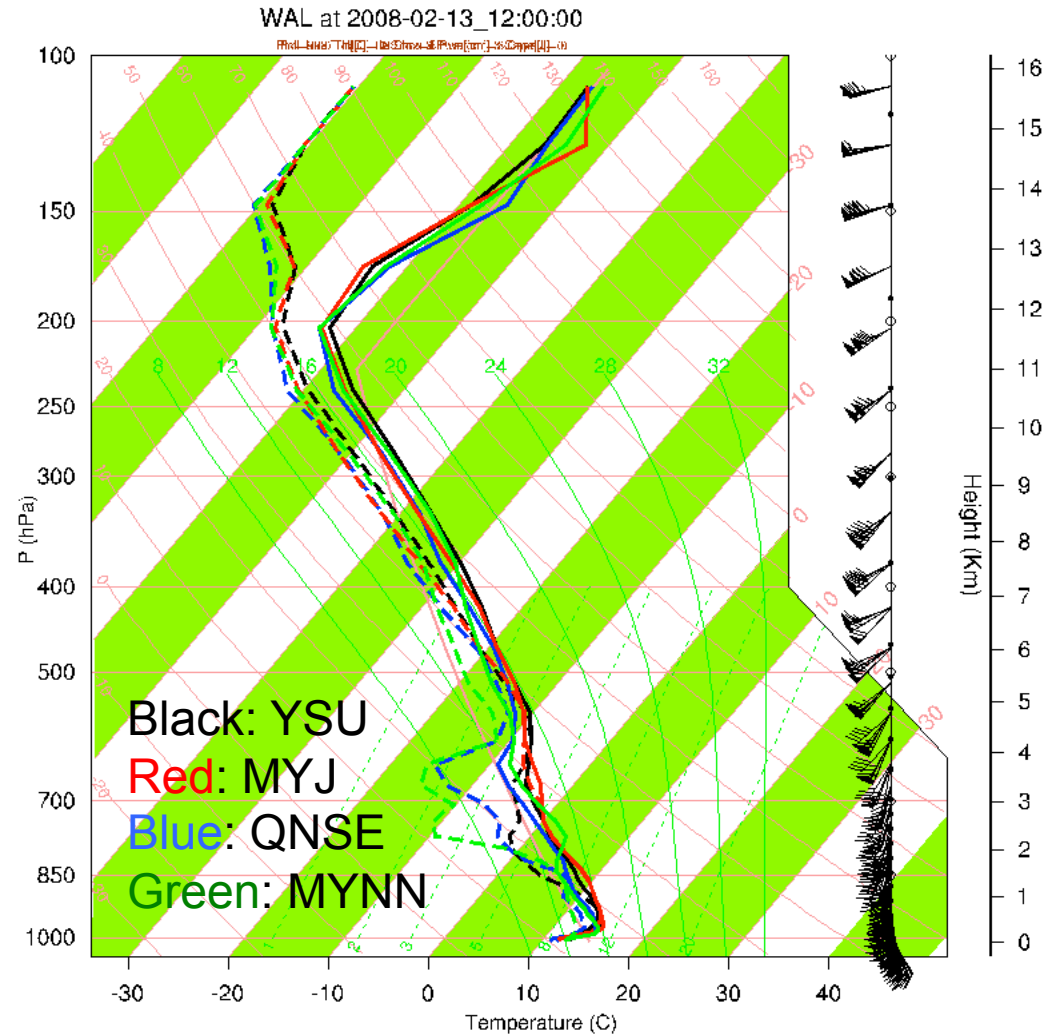
WRF Forecasts and Observations at WAL
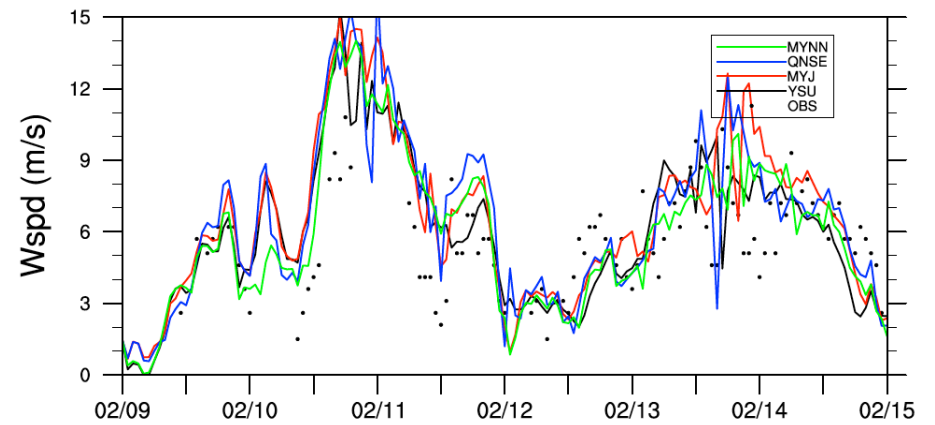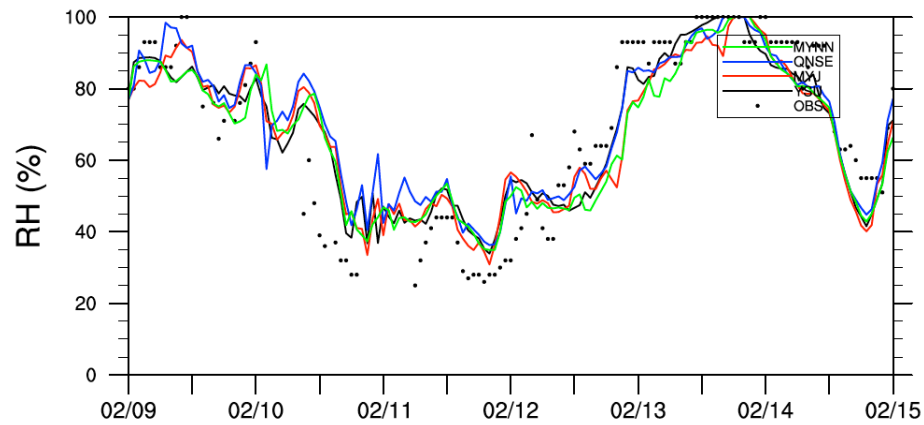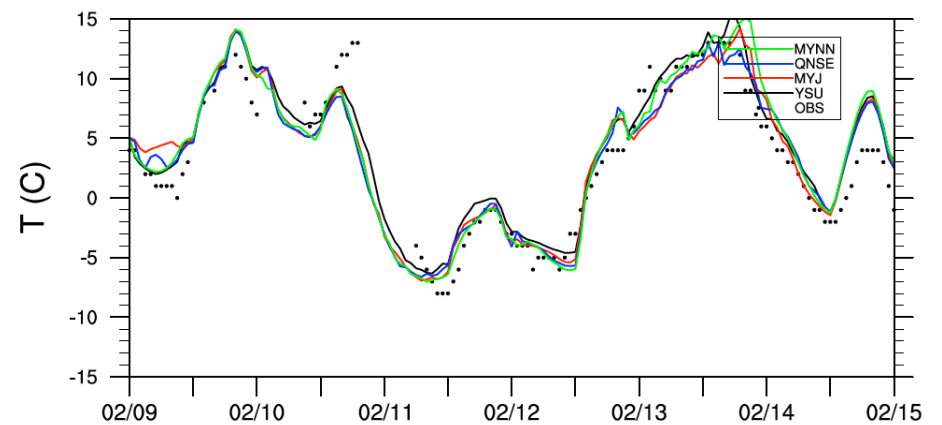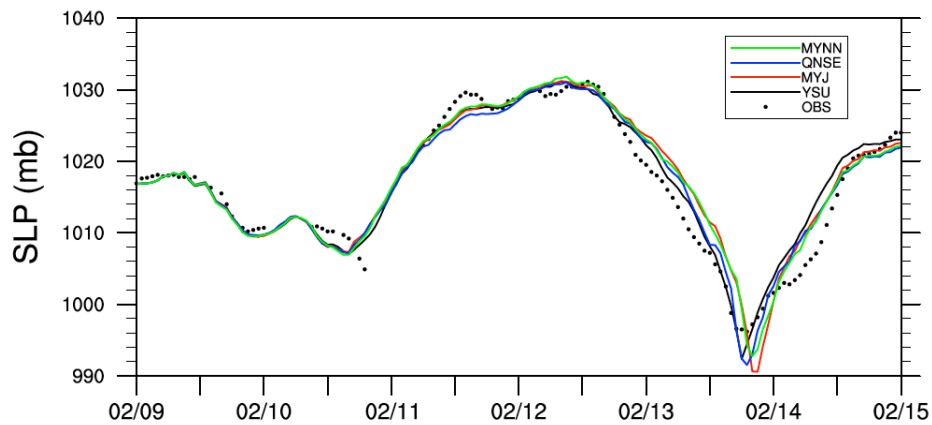
Precipitation at WAL
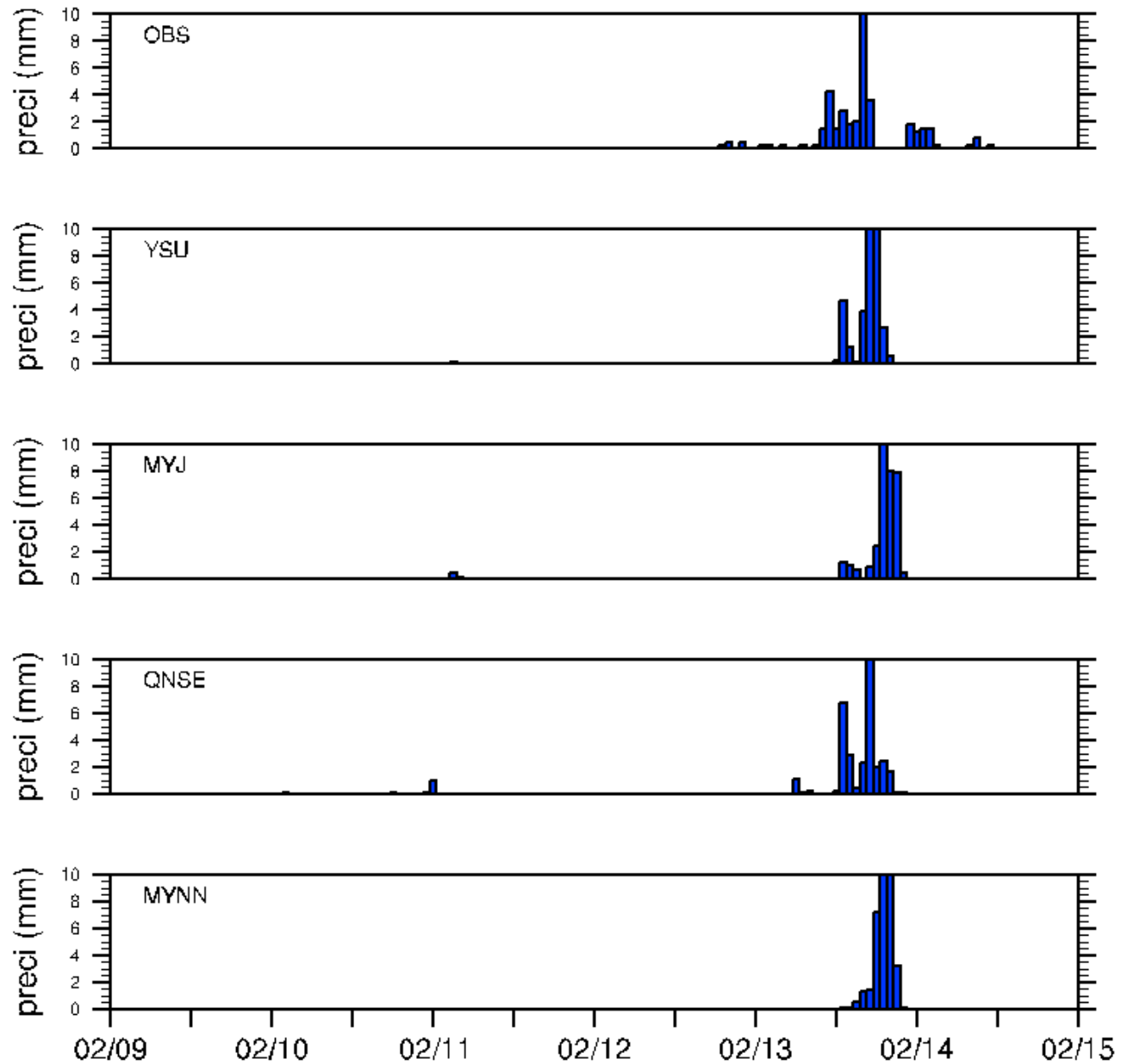
Summary

- Six-day forecasts for an eastern state winter storm were performed with WRF3.2 and varying PBL schemes.

- All four PBL schemes show quite similar behaviors: do general well in unstable and weak stable boundary layers, but poor in stable boundary layer. Overall YSU does slight better than other three.

- QNSE predicts much higher PBL height than other three (YSU, MYJ and MYNN). YSU and MYNN have the relative lower PBL heights.

- The model shows systematic warm and wet biases and stronger wind

- Precipitation displays its sensitivity to the PBL schemes. All four schemes over-predict observed precipitation. Both YSU and QNSE well reproduce the time and duration of the precipitation while MJY and MYNN show few hours of delay. The precipitation deficiency may be due to microphysics, radiation schemes used.

- The model displays good skills in medium-range forecast.

- Detailed analysis on PBL vertical profile & TKE is ongoing to understand the PBL schemes and particularly the deficiency in stable boundary condition.

- The WRF-ARW systematic biases can be alleviated through FDDA. Test runs with the NCAR-ATEC RTFDDA is planned.