# Predictability of Atmospheric Conditions over Complex Terrain with Ensemble Kalman Filter Data Assimilation: Evaluation During MATERHORN Field Program

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Objective
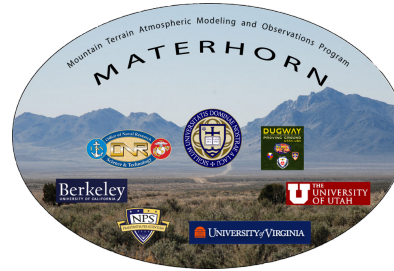
MATERHORN-M

> To evaluate model performance in predicting synoptic and local flows over mountainous terrain and thus **[model evaluation]**

> To improve predictability **[data assimilation]**

> **Two field experiments were conducted over Dugway Proving Ground (DPG), Utah during the fall 2012 (Sep. 21 – Oct. 20, 2012) and spring 2013 (May of 2013)**

Emphasis of this study

> Impact of data assimilation on predicting atmospheric conditions over complex terrain

# EnKF analysis and forecast cycles for MATERHORN fall 2012 experiment
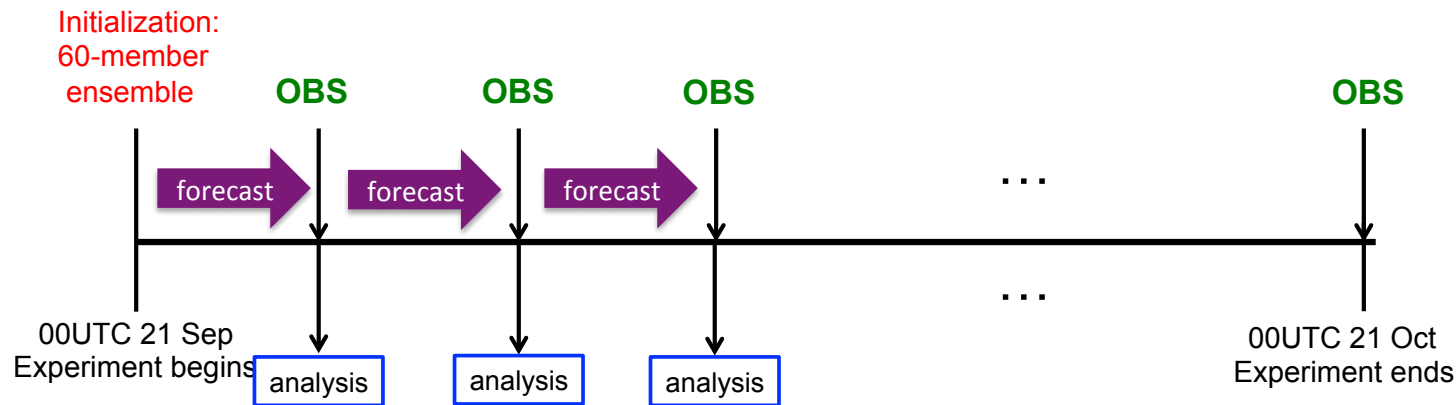
- WRF DART EnKF system (Anderson et al. 2009)
- Observations include SAMS surface data in DPG, MATERHORN sounding observations and NCEP bufr data.
- 3-hour continuous cycled for on month period
- One-way nested domains with
- 30/10/3.33/1.11km horizontal resolution
- Boundary conditions are from NCEP NAM forecasts
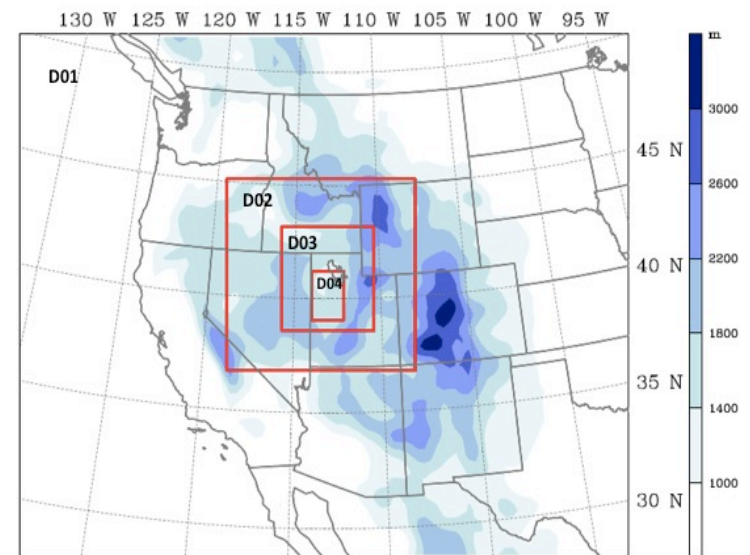
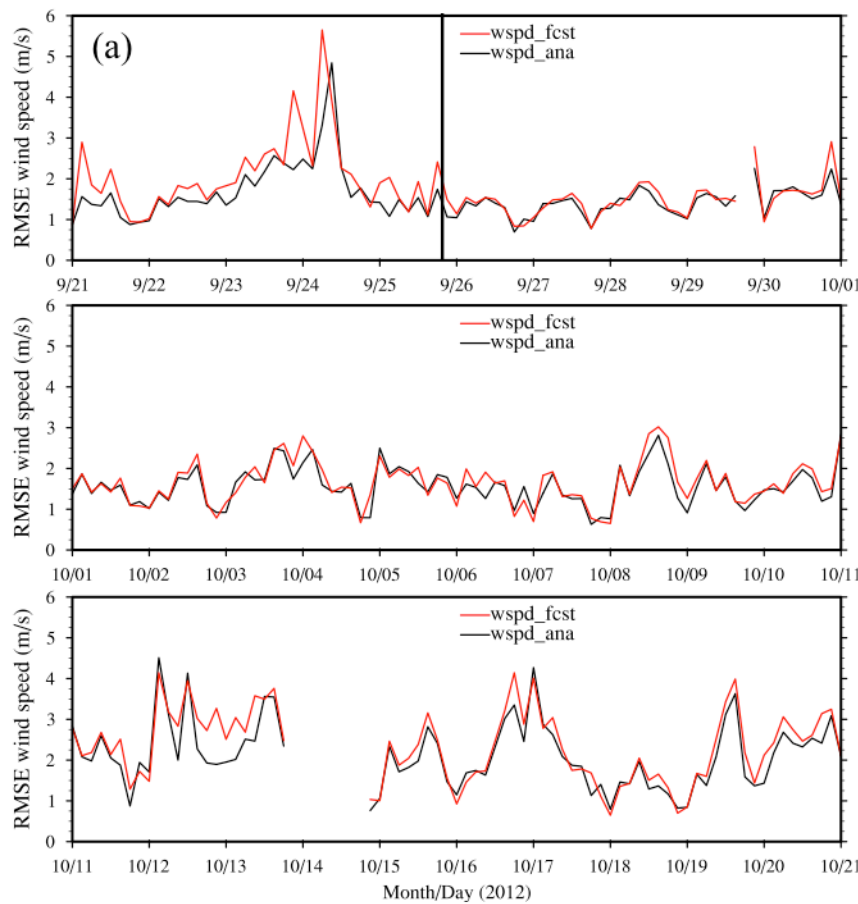# EnKF analysis and forecast cycles for MATERHORN fall 2012 experiment
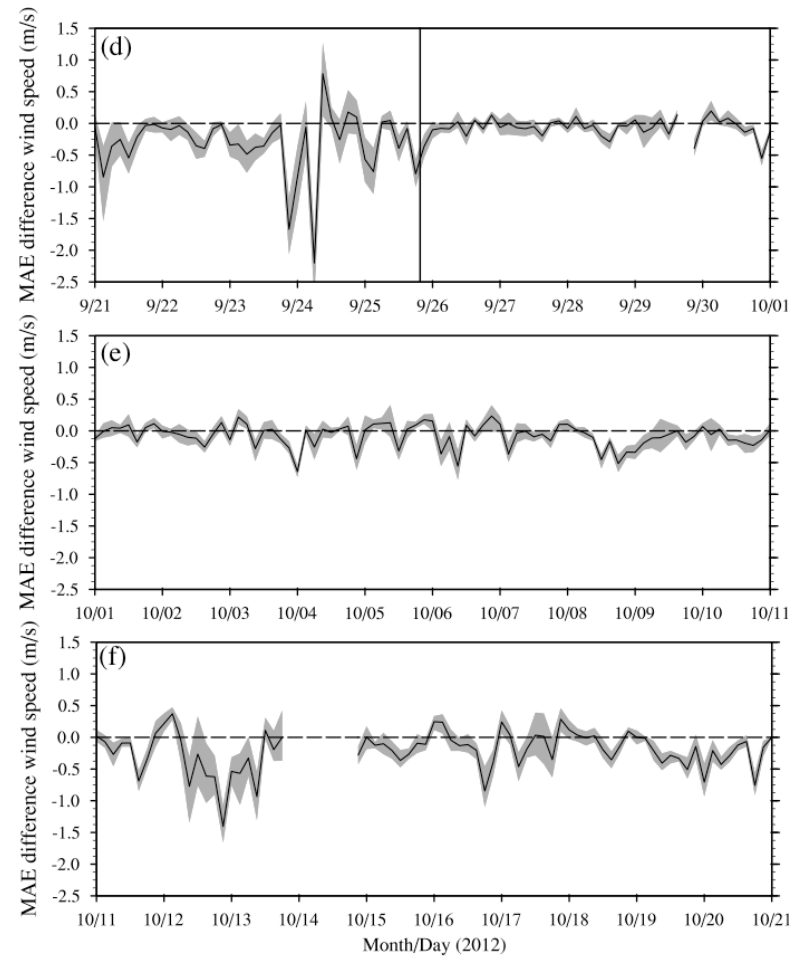

D04 - Dugway Proving Ground

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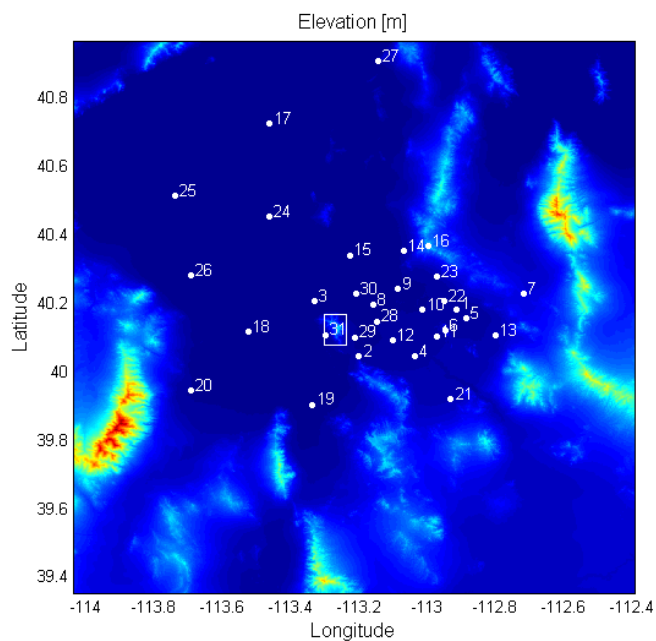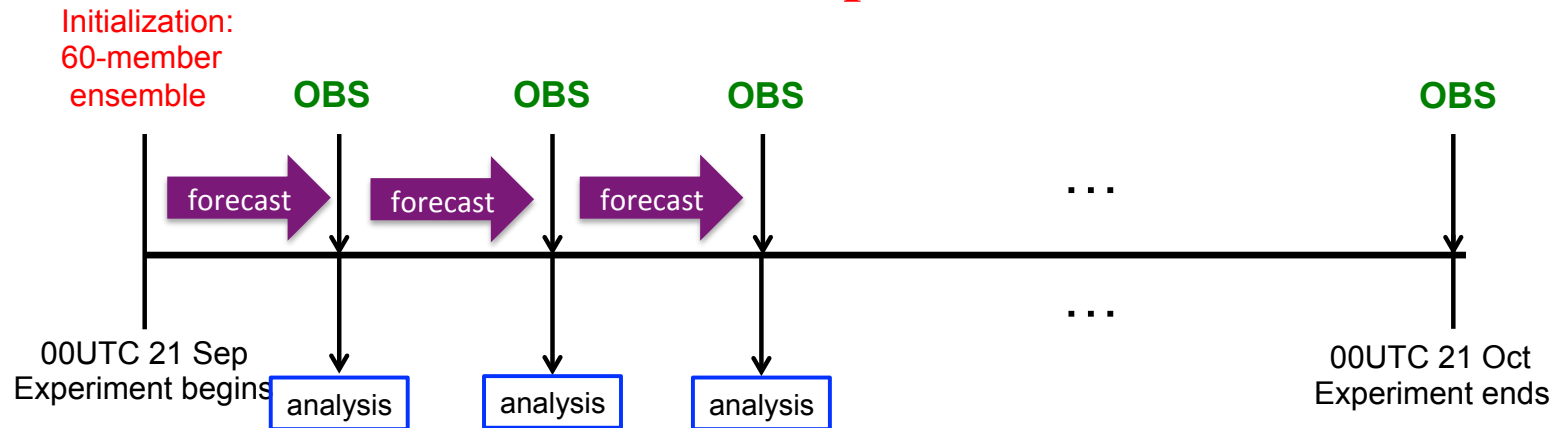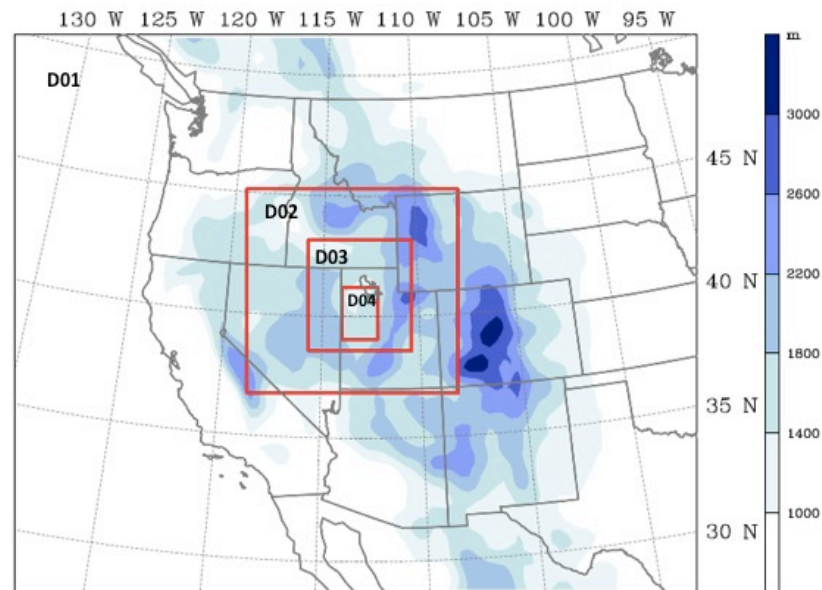
EnKF analysis vs. forecast

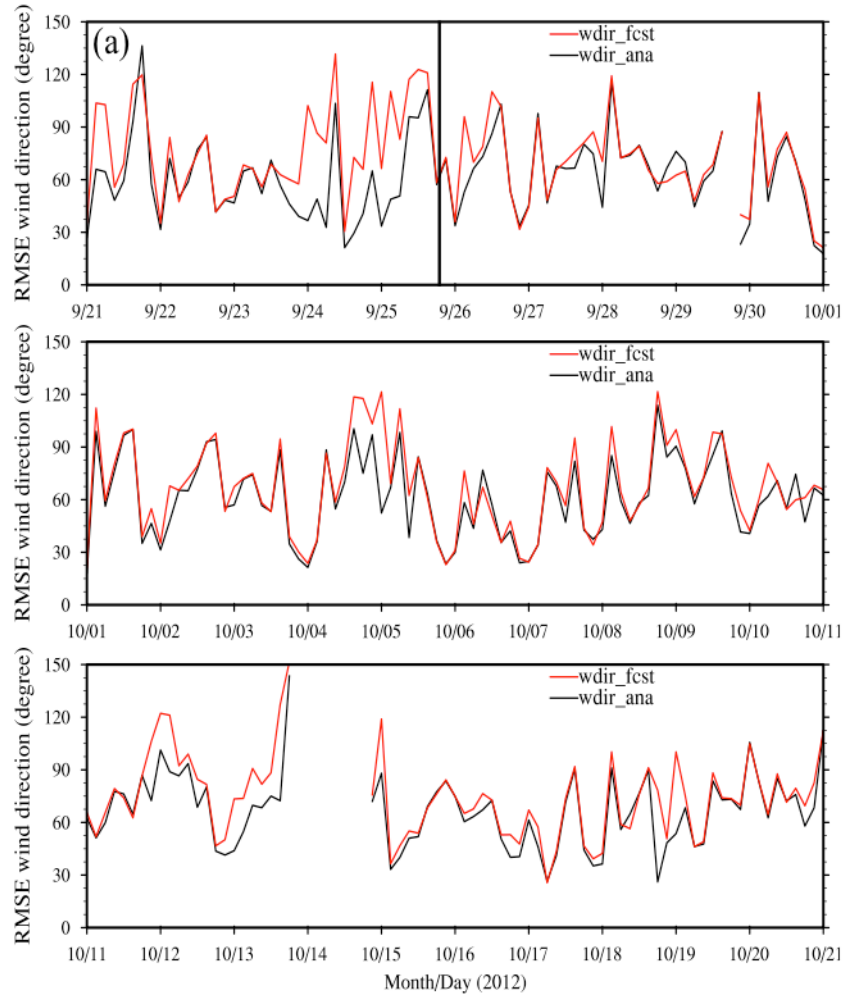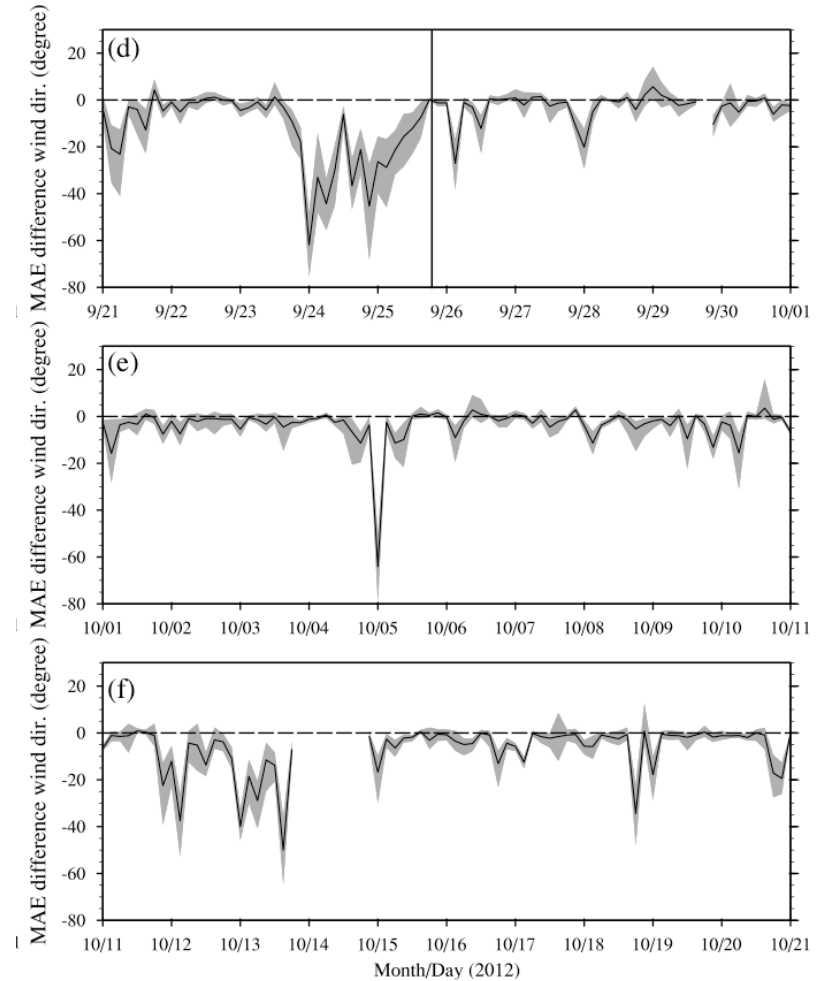## Surface wind speed errors

RMSE

MAE differences (A – F)
with confident interval

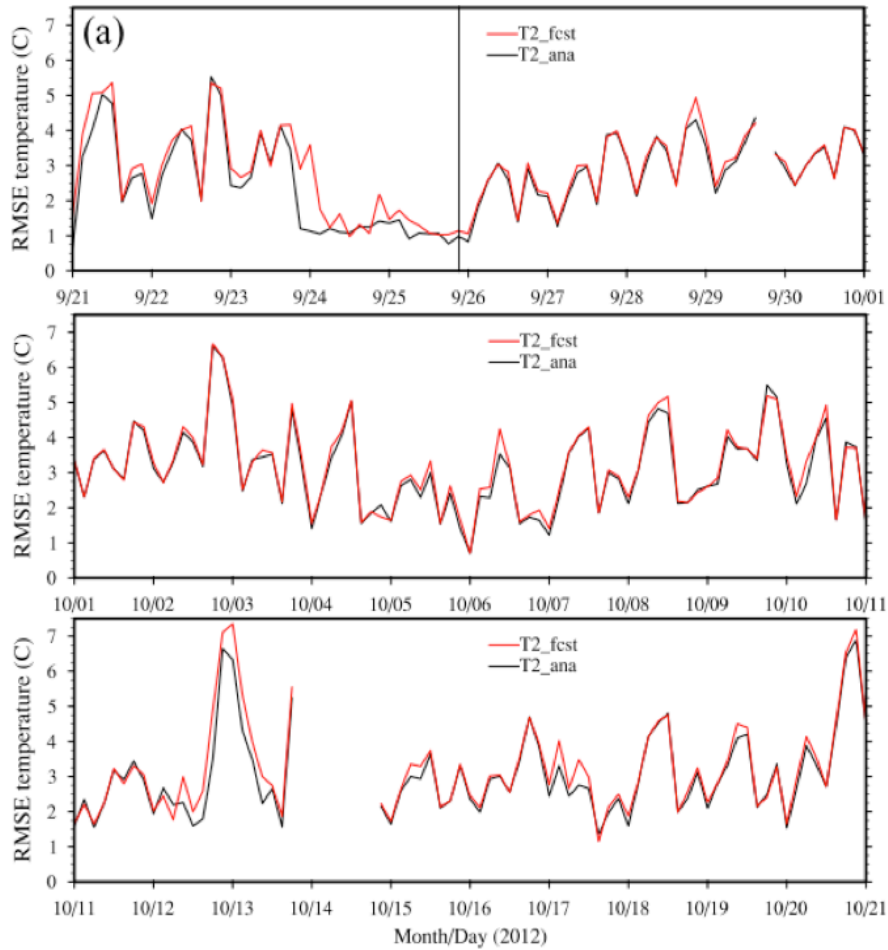# EnKF analysis vs. forecast

Surface wind direction errors

RMSE

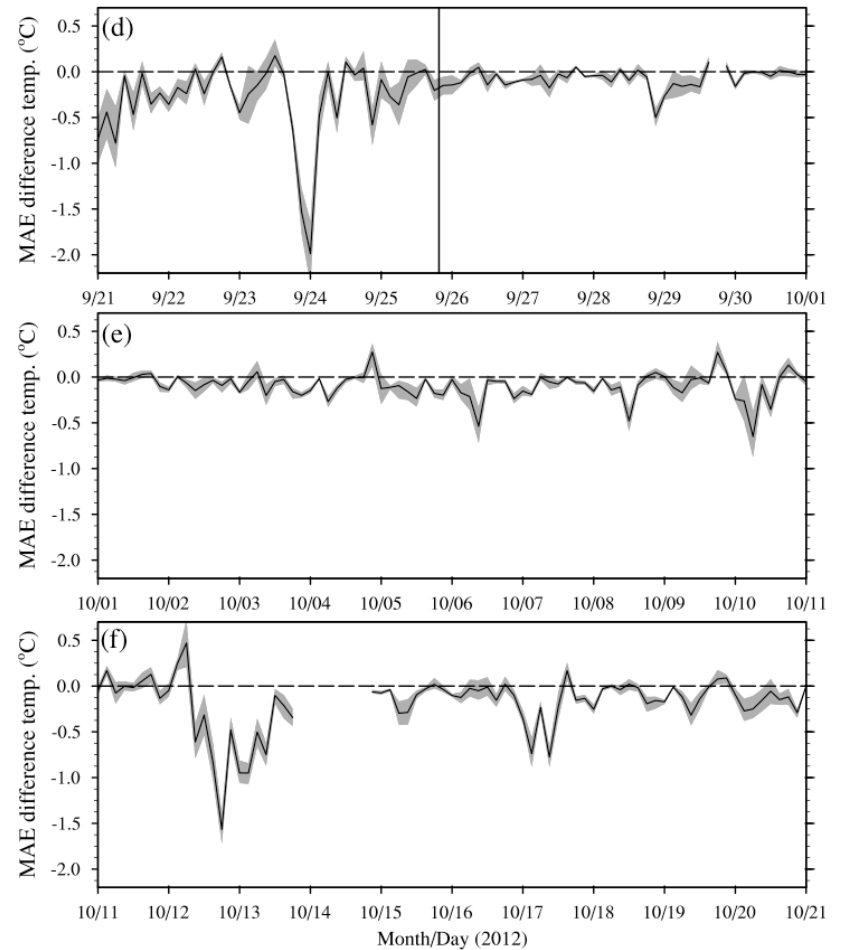**MAE differences (A – F)
with confident interval**

EnKF analysis vs. forecast
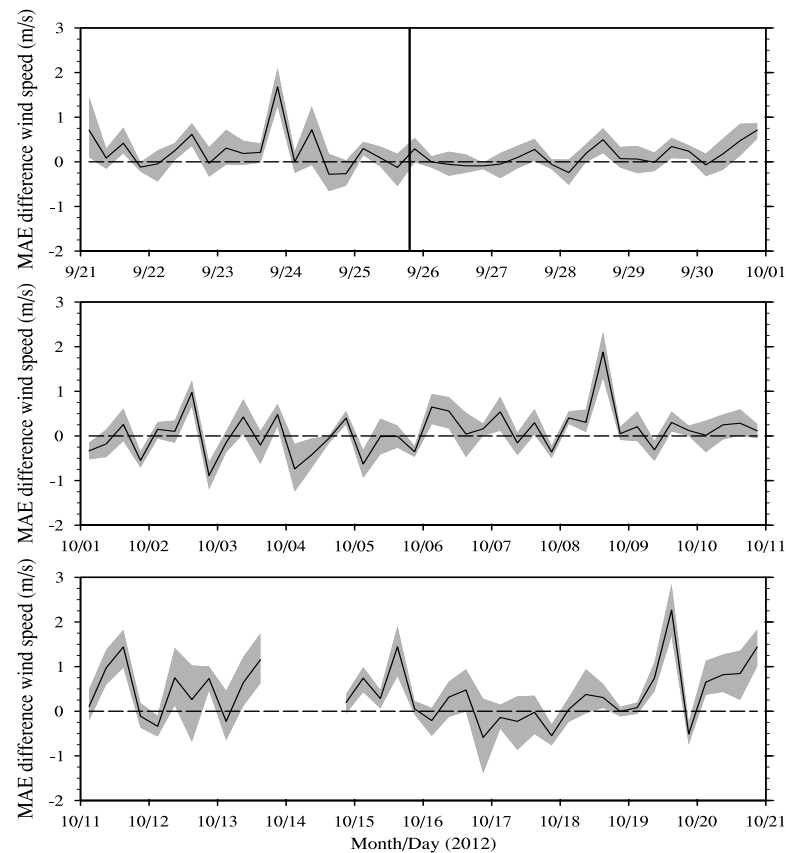
Surface temperature errors

RMSE

MAE differences (A – F) with confident interval

# 3-h forecast from EnKF analysis vs. NCEP NAM 3-h forecast

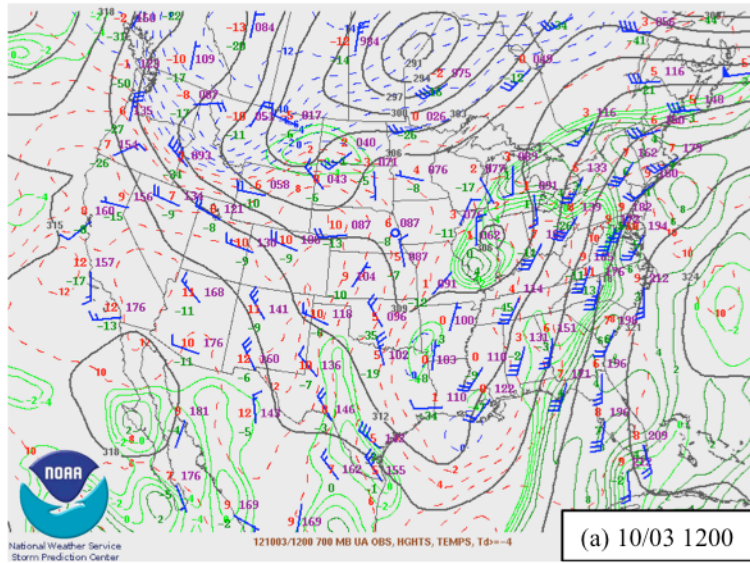## RMSEs differences of 10-m wind speed against surface observations

- Comparable!
- The EnKF/WRF does not beat NAM forecast, but it can provide more detailed small-scale flow features due to the use of the high-resolution grids.

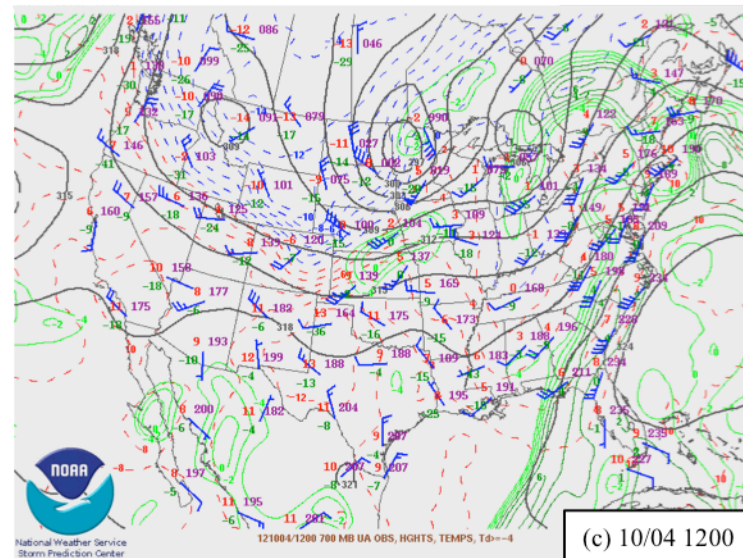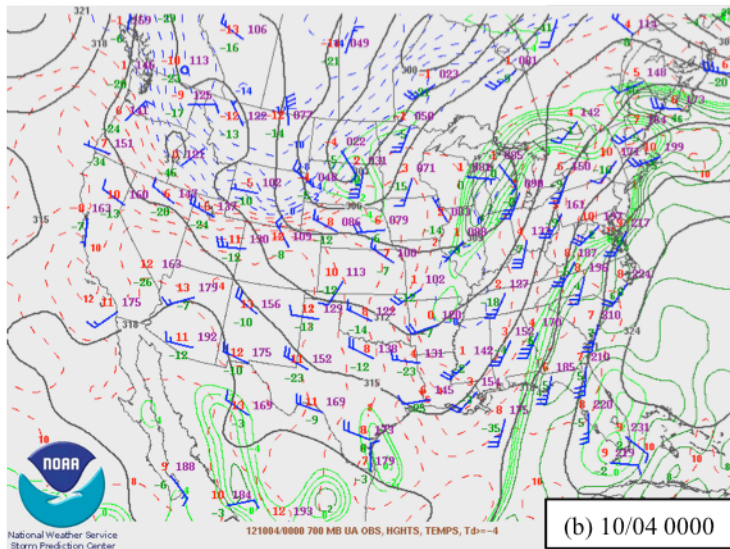# A case study: IOP3 2000 UTC 3 to 2000UTC 4 October 2012

Surface weather maps (about every 6h) during IOP3

(a) 10/03 1230

(b) 10/03 1730

(c) 10/03 2330

(d) 10/04 0530
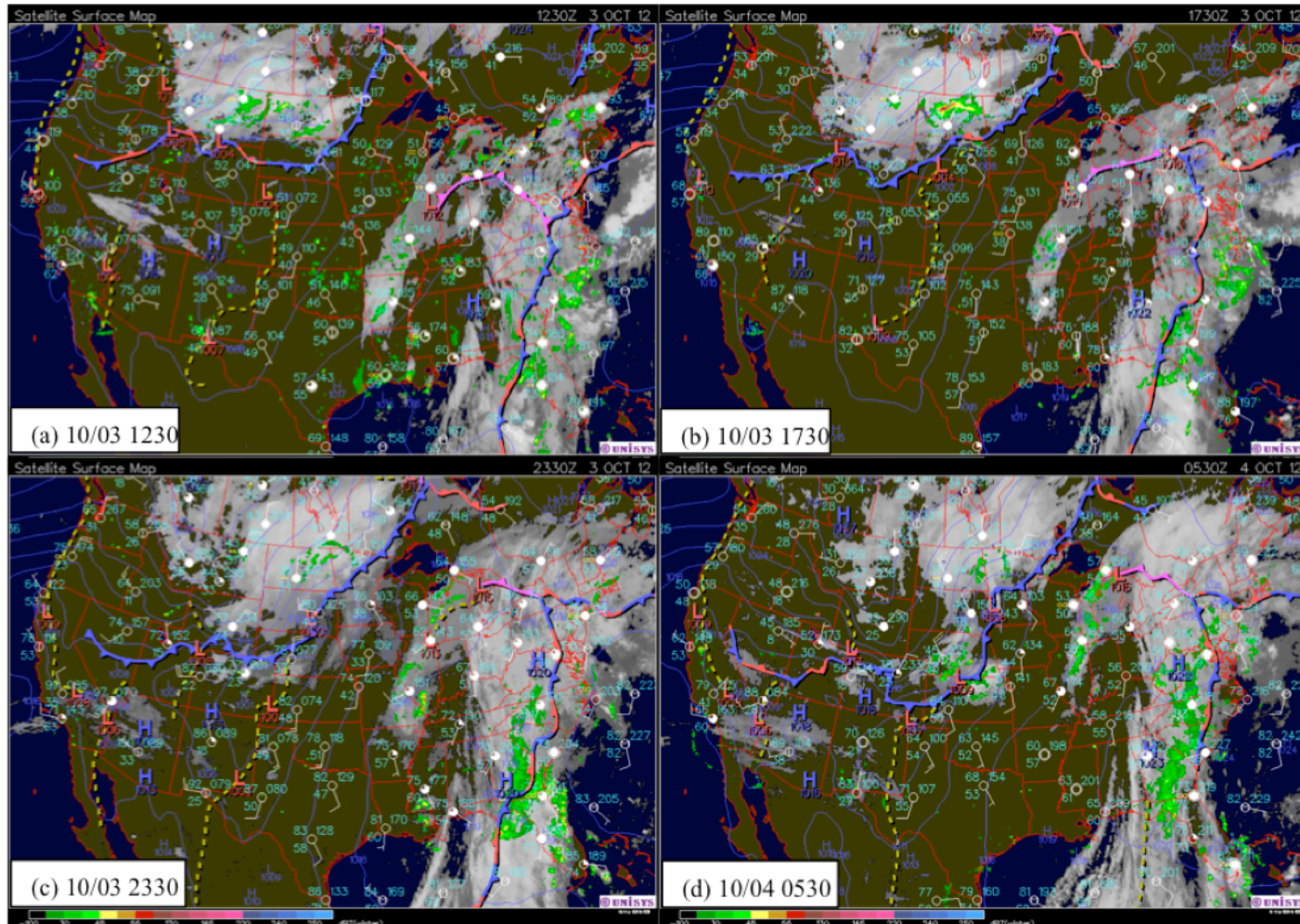
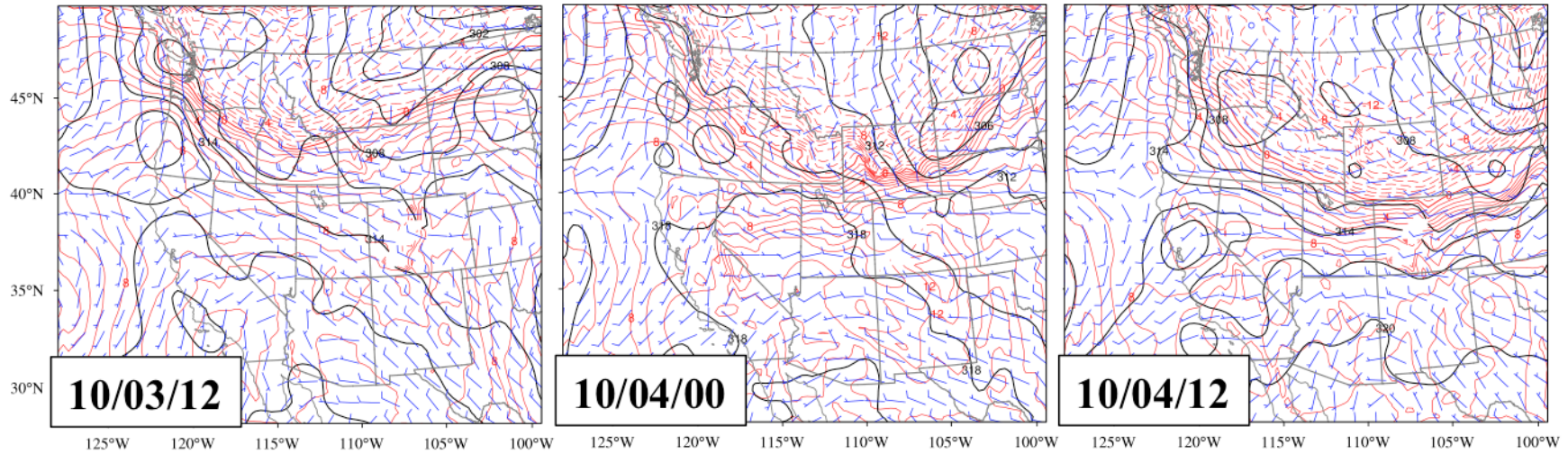# A case study: IOP3 2000 UTC 3 to 2000UTC 4 October 2012

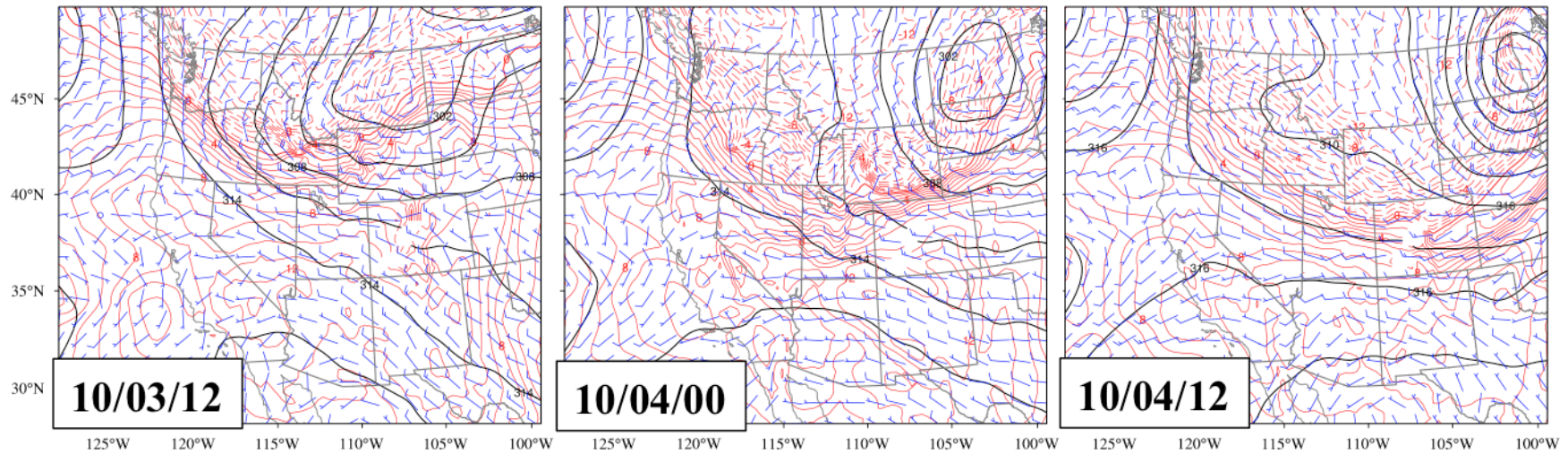700 hPa synoptic analysis during IOP3

A case study: IOP3 2000 UTC 3 to 2000UTC 4 October 2012
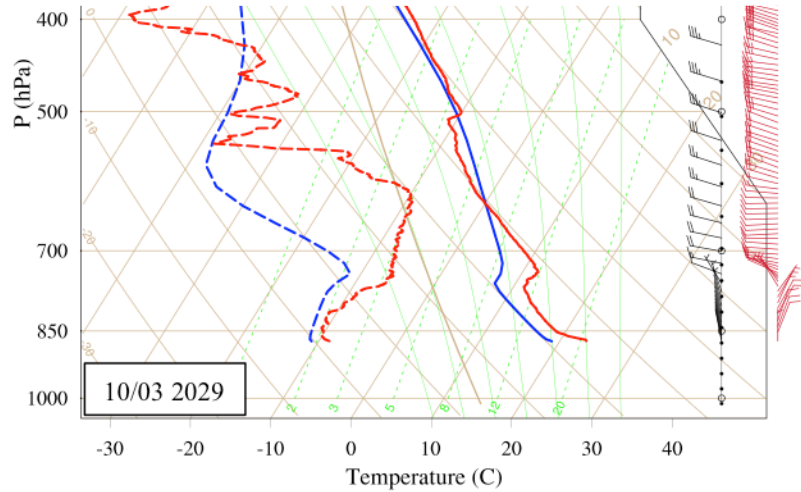
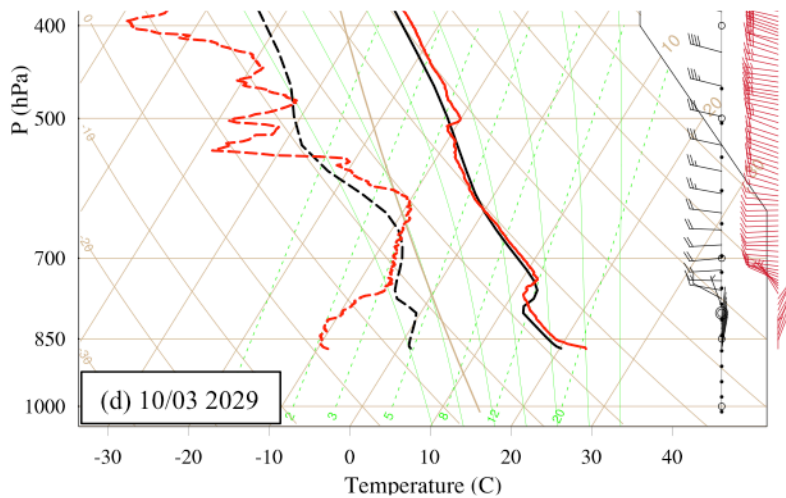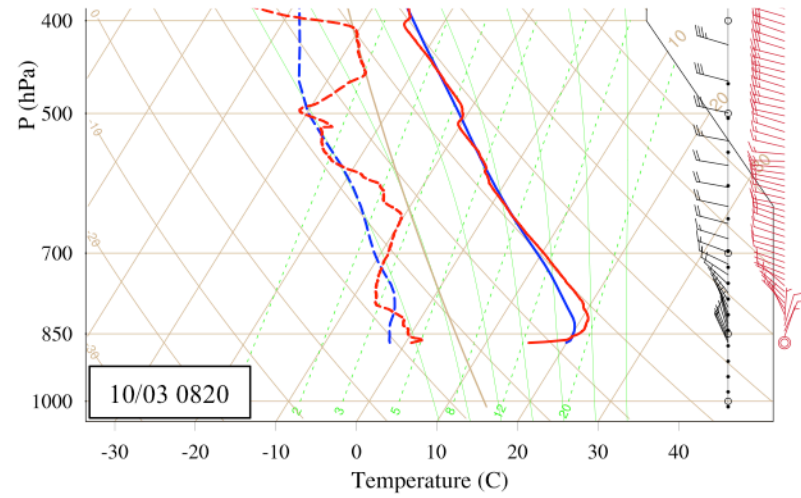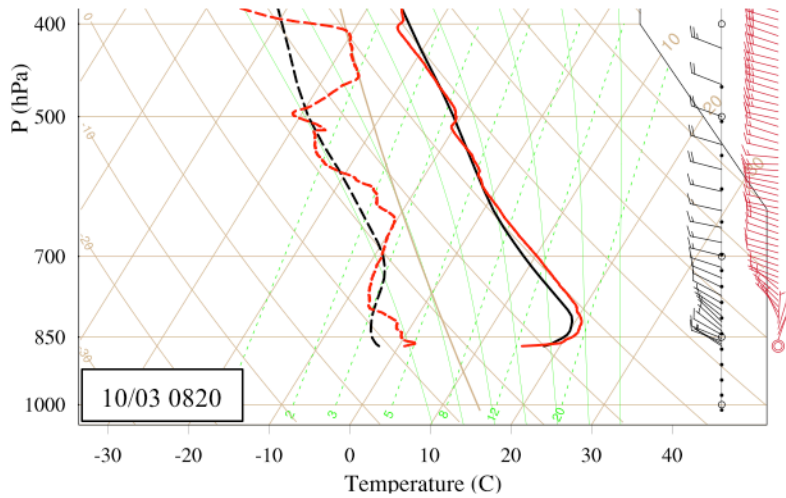## 700mb forecast

EnKF ensemble Mean

Deterministic WRF forecast

A case study: IOP3 2000 UTC 3 to 2000UTC 4 October 2012

Skew-T diagrams
radiosonde observations, EnKF forecasts and deterministic forecasts

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North-south cross-section of wind fields

IOP-4

(a) 10/07 0000 UTC

(b) 10/07 0600 UTC

(c) 10/07 1200 UTC

(d) 10/07 18000 UTC

IOP-8 (Quiescent case)

10/19 0600 UTC

10/19 1200 UTC
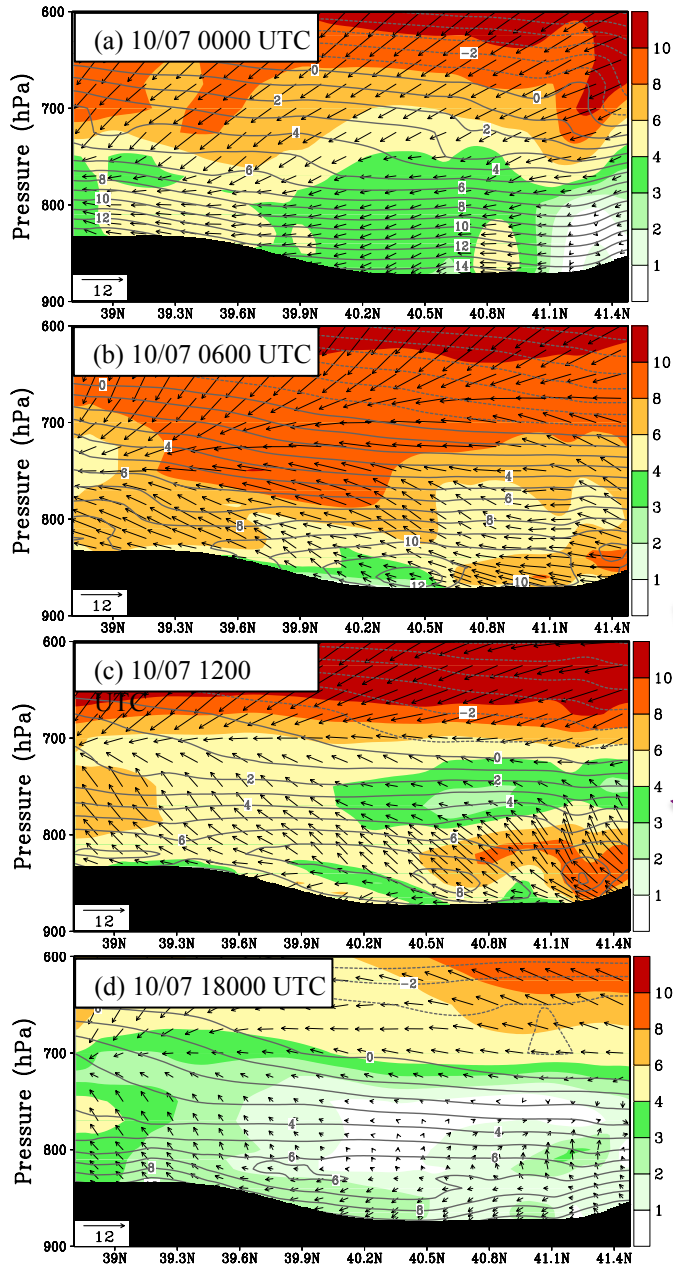
Katabatic flow at nighttime
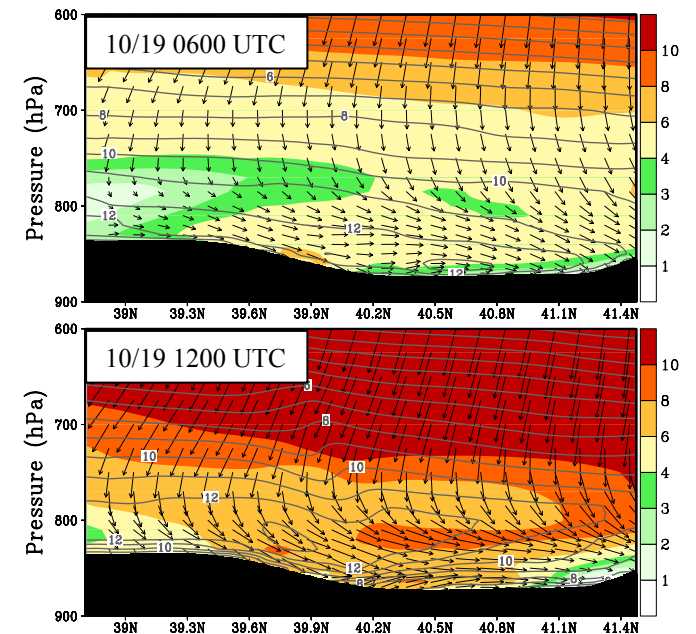
Northerly flow under the influence of the ridge at nighttime

Summary

➢ As part of MATERHORN-M research, A month-long, 3-hourly, continuous EnKF data assimilation and forecast cycle is conducted for evaluating the predictability of near-surface atmospheric conditions over DPG.

➢ Results illustrated that the quality of EnKF analysis is generally good.

➢ The EnKF analyses and forecasts captured major weather systems during the MATERHORN IOPs, showing the potential of data assimilation to improve prediction over complex terrain.