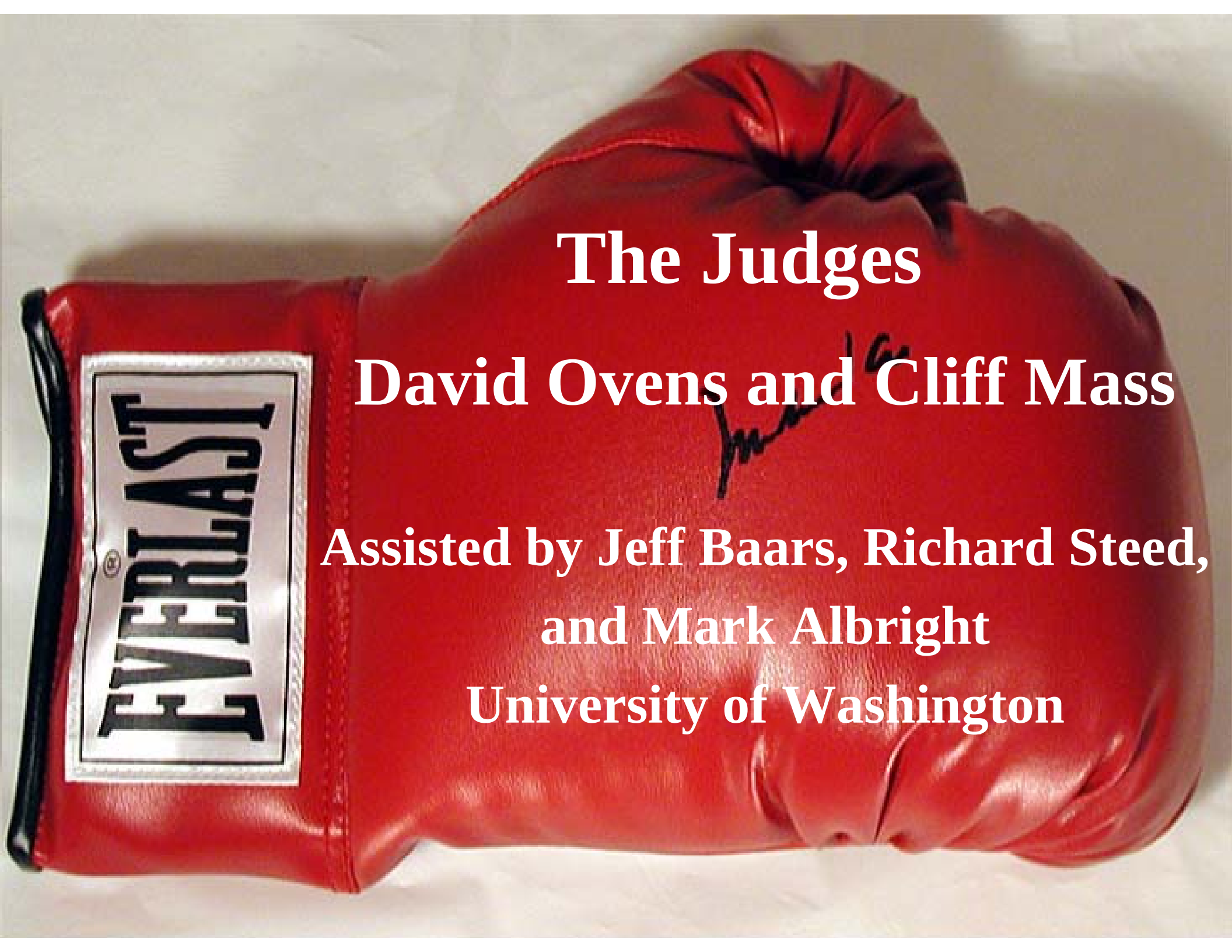
WRF versus MM5: The Battle for the Pacific Northwest

WRF

MM5



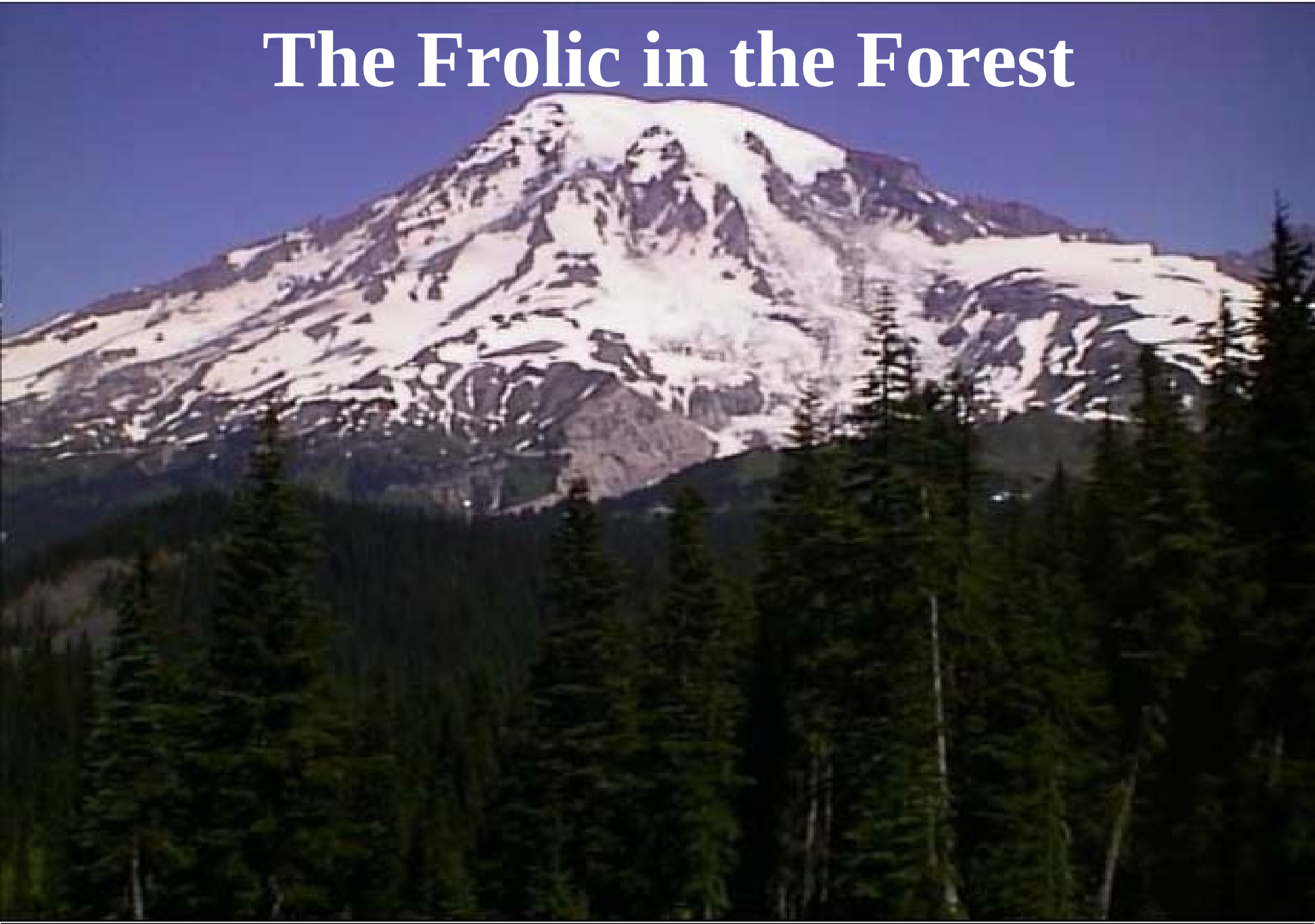
The Judges

David Ovens and Cliff Mass

Assisted by Jeff Baars, Richard Steed, and Mark Albright

University of Washington

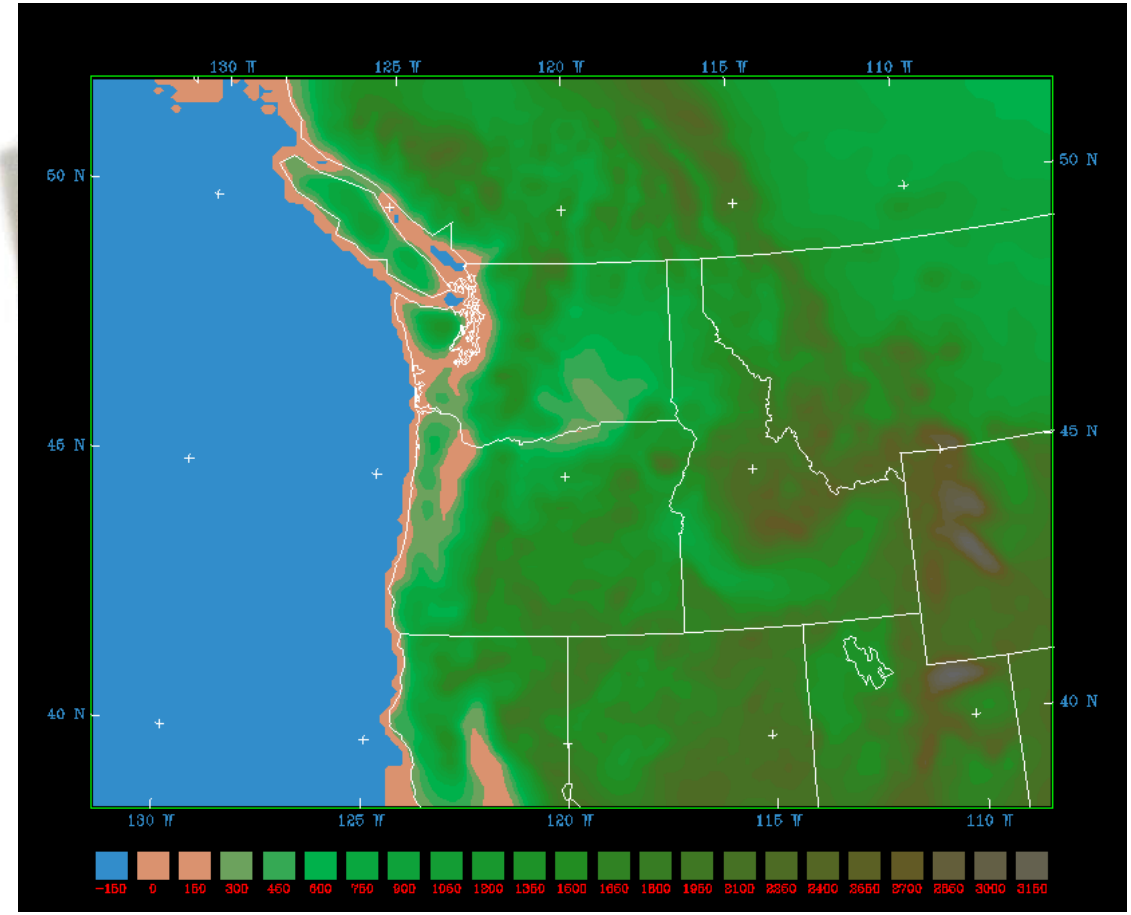
The Frolic in the Forest



MM5 versus WRF

The Domains

36 and 12 km grid spacing

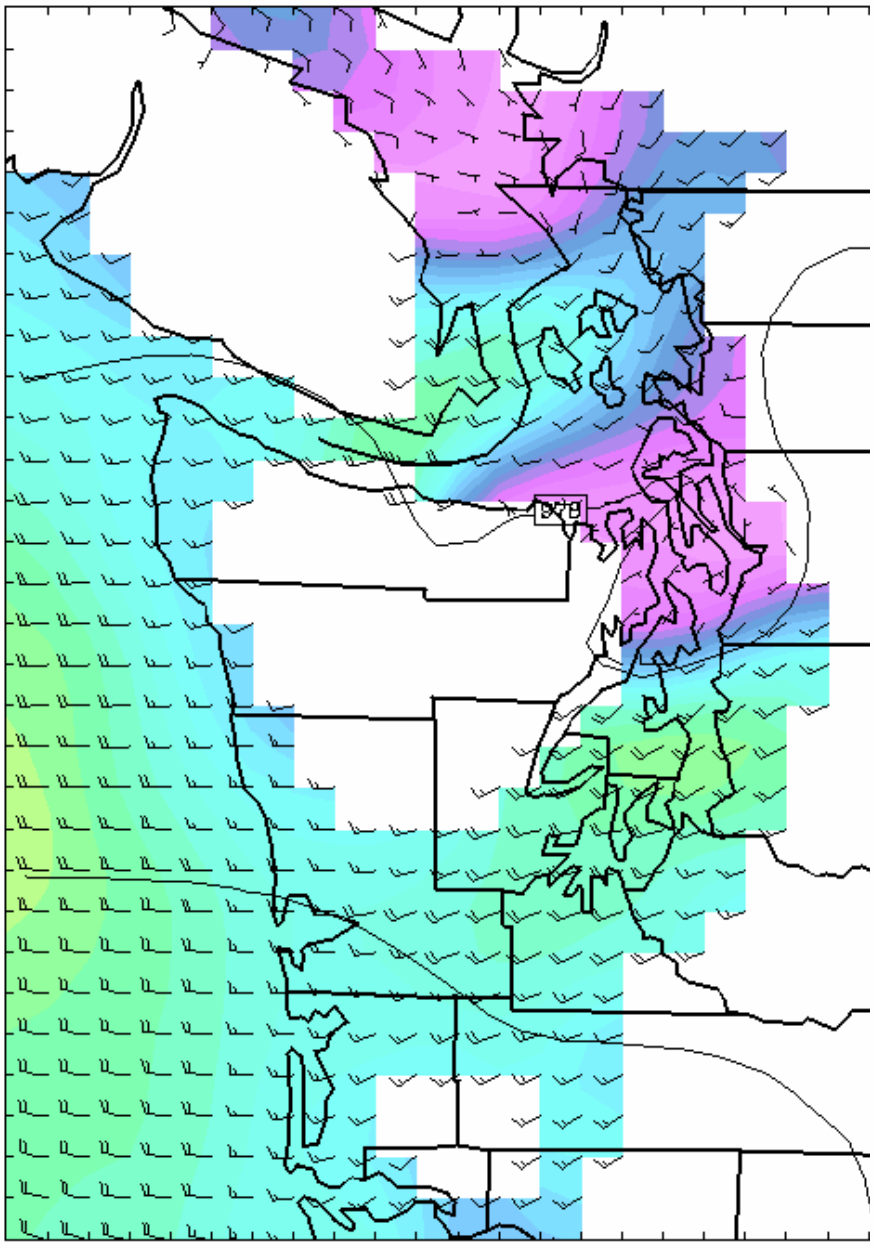


The Match

- MM5 and WRF (ARW core) have been run in parallel since February 4, 2005
- 48-h forecast, twice a day
- Both are initialized and receive boundary conditions from NCEP's GFS model.
- WRF terrain adjusted to be virtually identical to MM5
- These runs have some differences:
  - MM5 36-km domain was nudged to GFS run, no nudging for WRF (not available!!!)
  - MM5 used Reisner II microphysics, WRF used WSM 3-class simple ice.
  - MM5 uses MRF PBL, WRF uses Yonsei
  - MM5 used CCM2 radiation, WRF-simple Dudhi

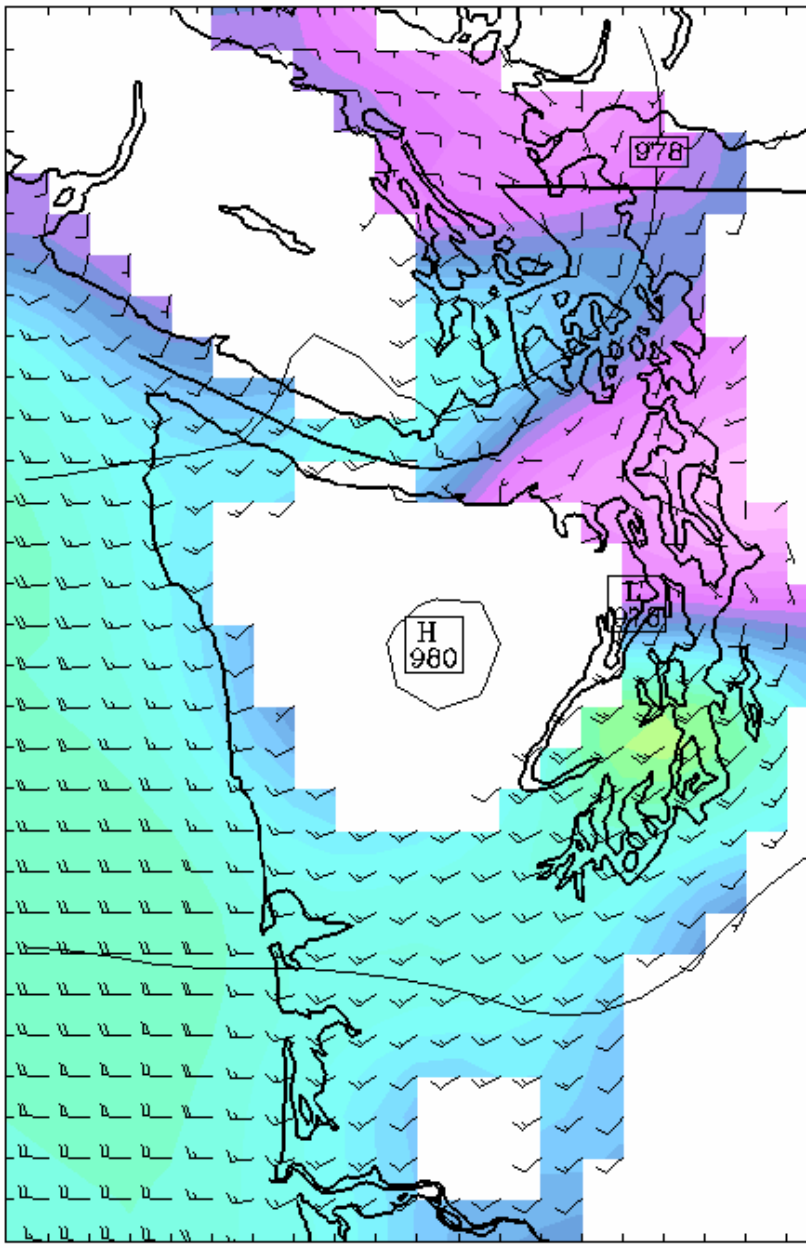
Subjective Evaluation

UW WRF-GFS 12km Domain
Fcst: 12 h Valid: 00 UTC Wed 01 Jun
Pressure (hPa) AND Winds (full barb = 10kts) at 1000ft



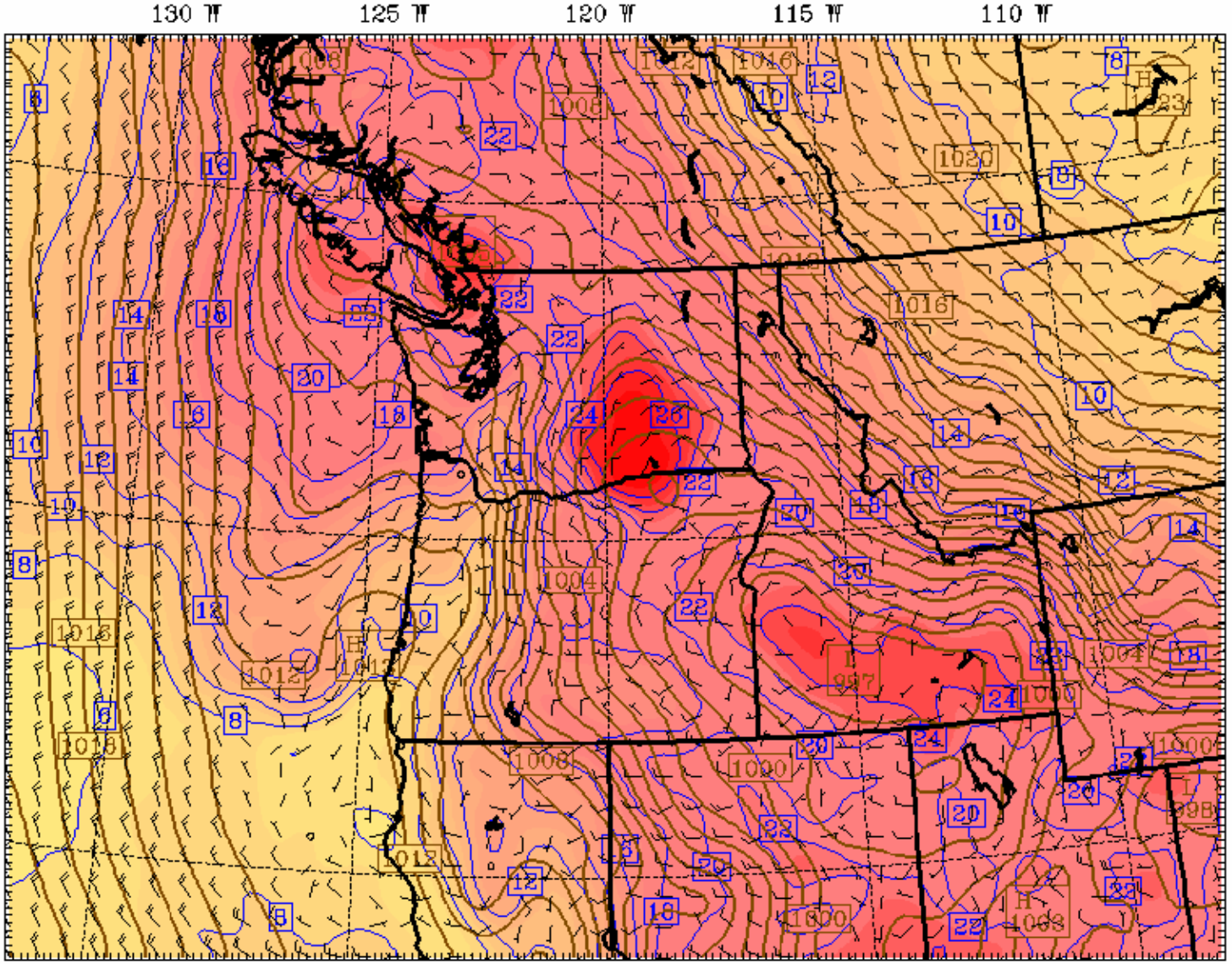
CONTOURS: UNITS=hPa LOW= 976.00 HIGH= 980.00 I
Model Info: V2.0.3.1 KF YSU PBL WSM 3class Ther-Diff 12 k
LW: RRTM SW: Dudhia DIFF: none

MM5-GFS 12km Domain
12 h Valid: 00 UTC Wed 01
sure (hPa) AND Winds (full barb = 10kts) at 1000ft



CONTOURS: UNITS=hPa LOW= 978.00 HIGH= 982.00
Model info: V3.6.3 Kain-Frsch MRF PBL Reisner 2 12 k

UW MM5-GFS 12km Domain
Fcst: 42 h
Init: 12 UTC Fri 27 May 05
Valid: 06 UTC Sun 29 May 05 (23 PDT Sat 28 May 05)
Temperature at 925 mb (°C)
Sea Level Pressure (hPa)
Wind at 10m (full barb = 10kts)

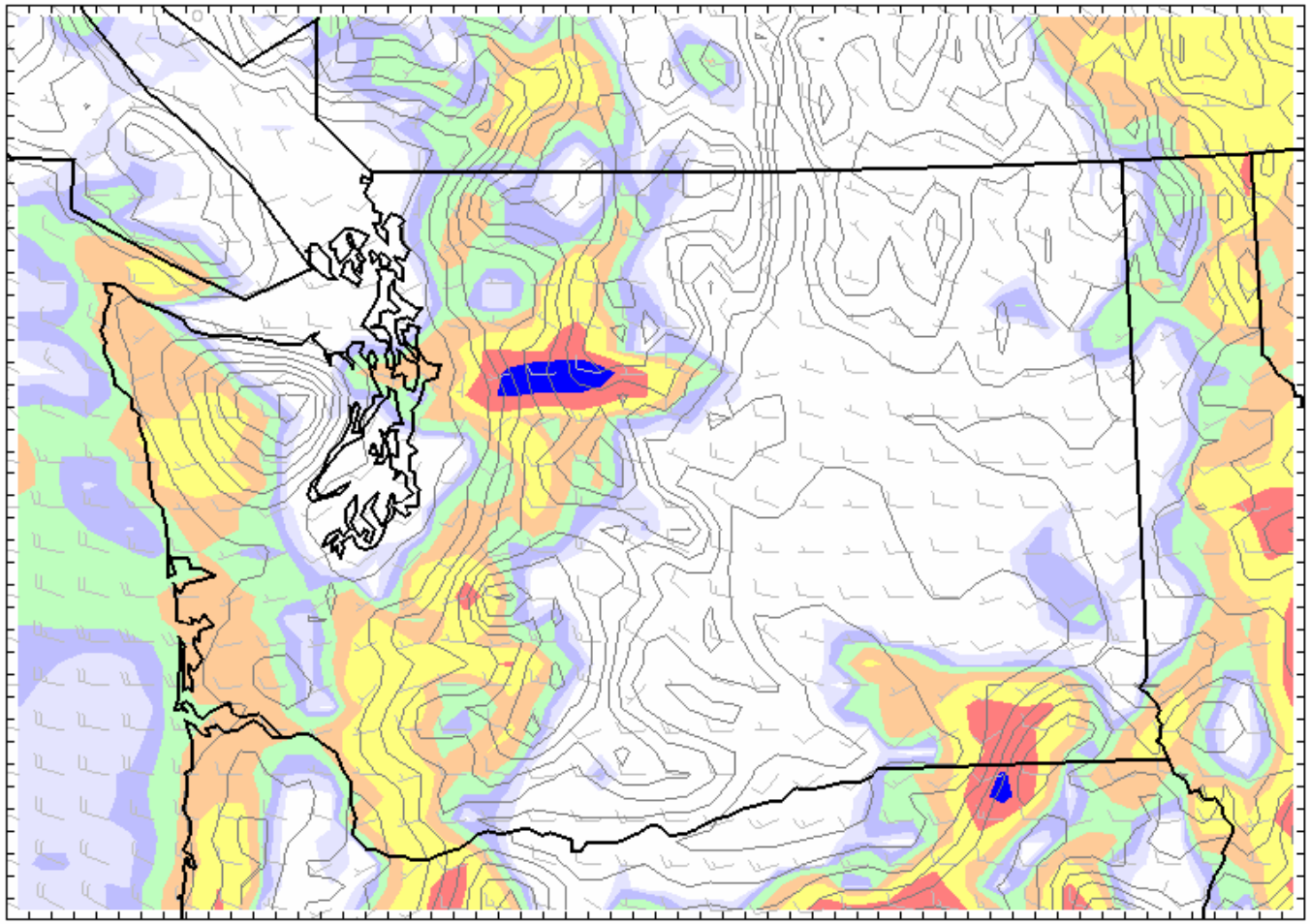


CONTOURS: UNITS=hPa LOW= 997.00 HIGH= 1023.0 INTERVAL= 1.0000
CONTOURS: UNITS=°C LOW= 6.0000 HIGH= 26.000 INTERVAL= 2.0000

−18 −15 −12 −9 −6 −3 0 3 6 9 12 15 18 21 24 27 30 °C

Model info: V3.6.3 Kain-Frsch MRF PBL Reisner 2 12 km, 37 levels, 36 sec

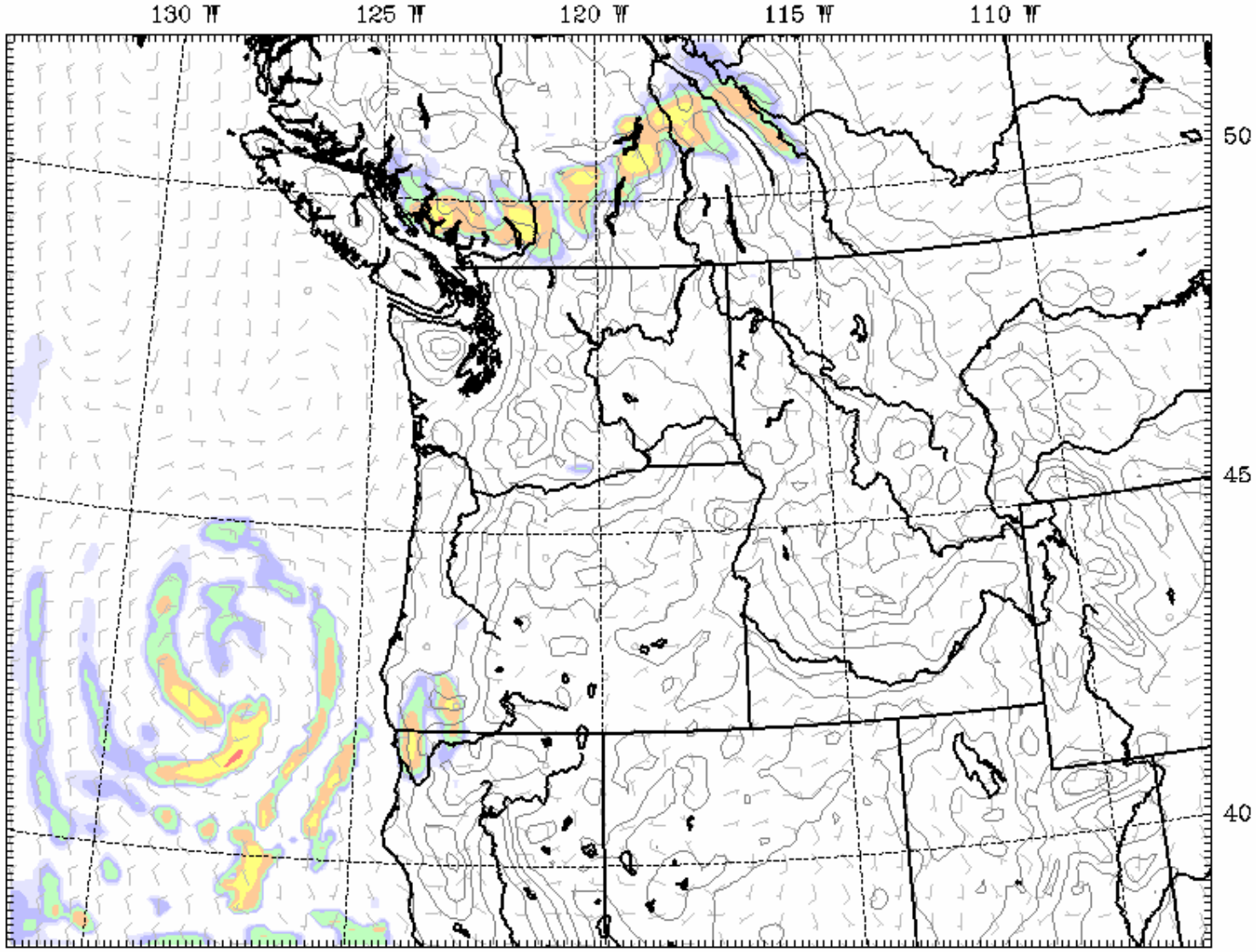
UW WRF-WRF 12km Domain
Init: 12 UTC Tue 31 May 05
Fcst: 21 h
Valid: 09 UTC Wed 01 Jun 05 (02 PDT Wed 01 Jun 05)
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)



.5 1 2 4 8 16 32 64 128 256 512 1024 2048 mm

Model Info: V2.0.3.1 KF YSU PBL WSM 3class Ther-Diff 12 km, 37 levels, 60 sec
LW: RRTM SW: Dudhia DIFF: none

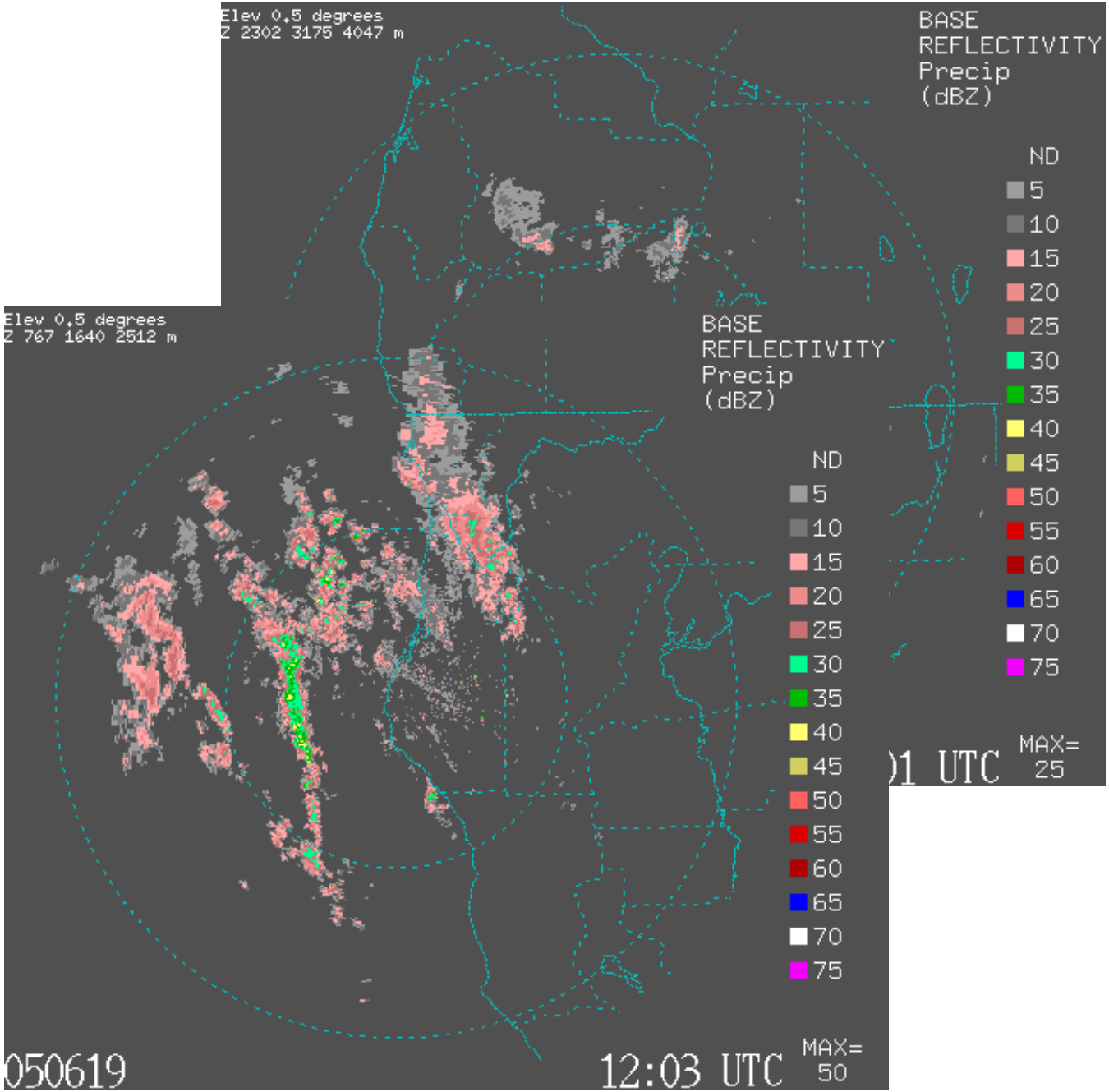
UW MM5-GFS 12km Domain
Init: 12 UTC Sat 18 Jun 05
Fcst: 24 h
Valid: 12 UTC Sun 19 Jun 05 (05 PDT Sun 19 Jun 05)
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)

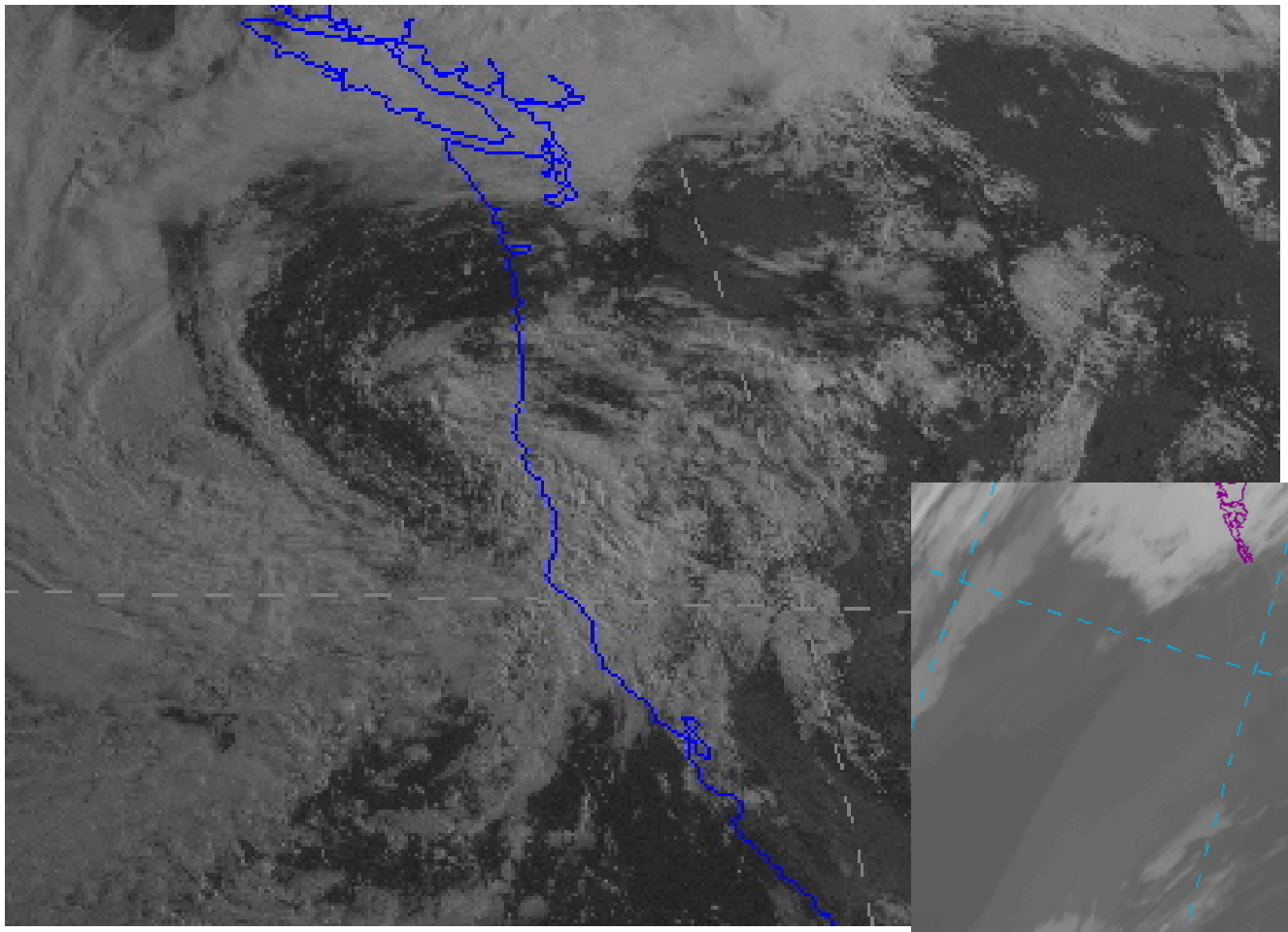


1/100 inch

.5 1 2 4 8 16 32 64 128 256 512 1024 2048

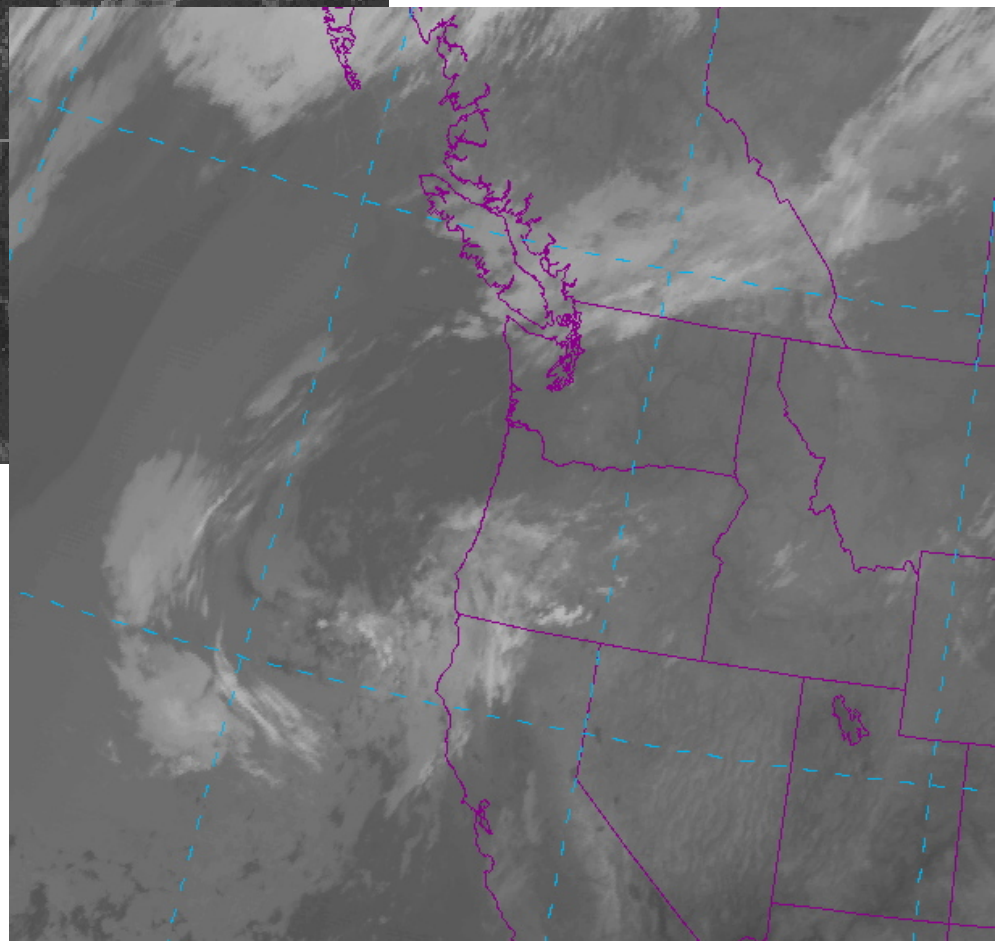
Model info: V3.6.3 Kain-Frsch MRF PBL Reisner 2 12 km, 37 levels, 36 sec


Elev 0.5 degrees
Z 2302 3175 4047 m
BASE
REFLECTIVITY
Precip
(dBZ)
ND
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
)1 UTC
MAX=
25
Elev 0.5 degrees
Z 767 1640 2512 m
BASE
REFLECTIVITY
Precip
(dBZ)
ND
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
050619
12:03 UTC
MAX=
50



15 UTC 19 June

12 UTC 19 June



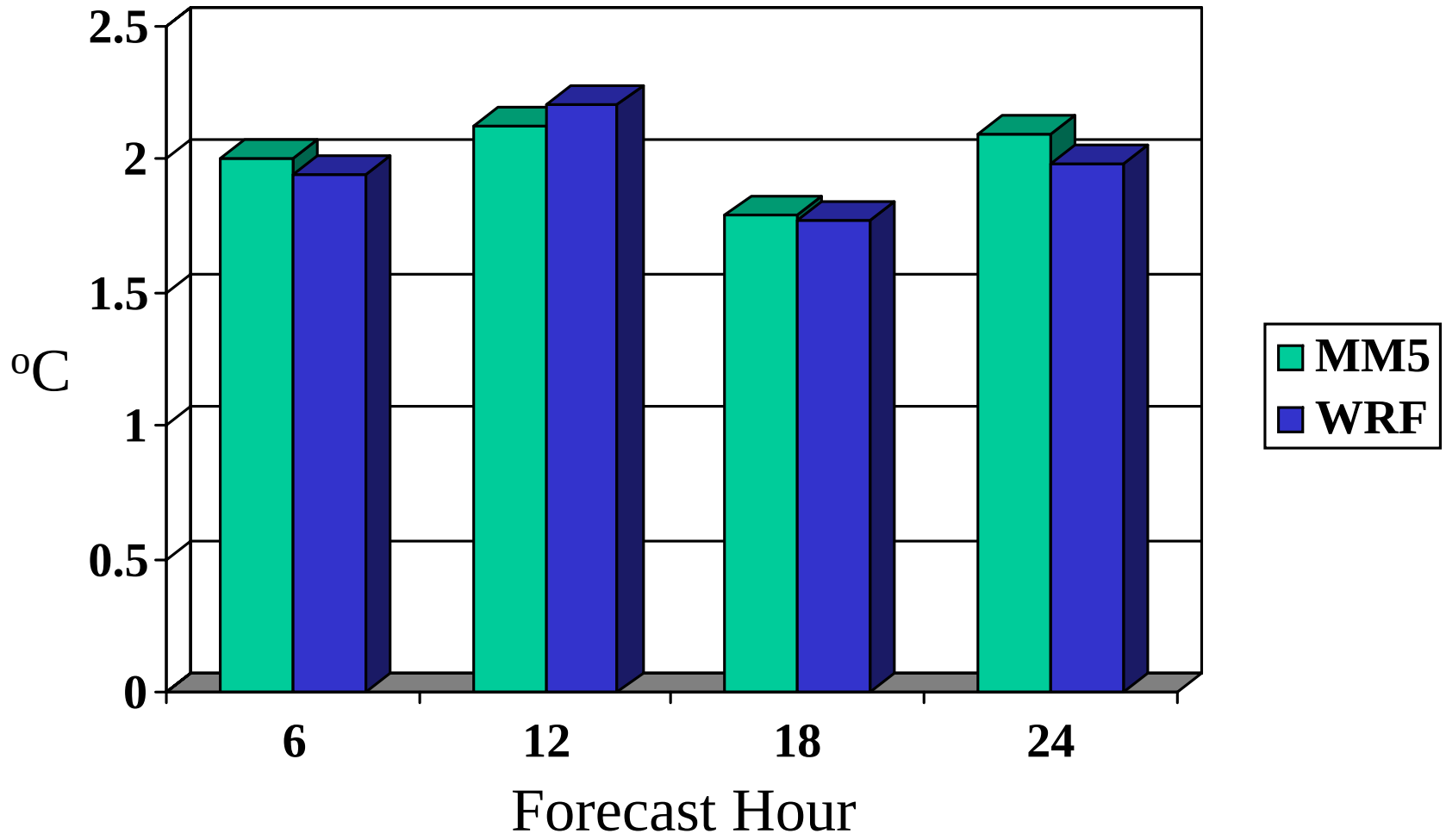
Round One Subjective Impressions

- **Surface and near surface wind and temperature fields are similar**
- **WRF has more intense, detailed, and more extensive precipitation structures.**

Round Two
Objective Verifications

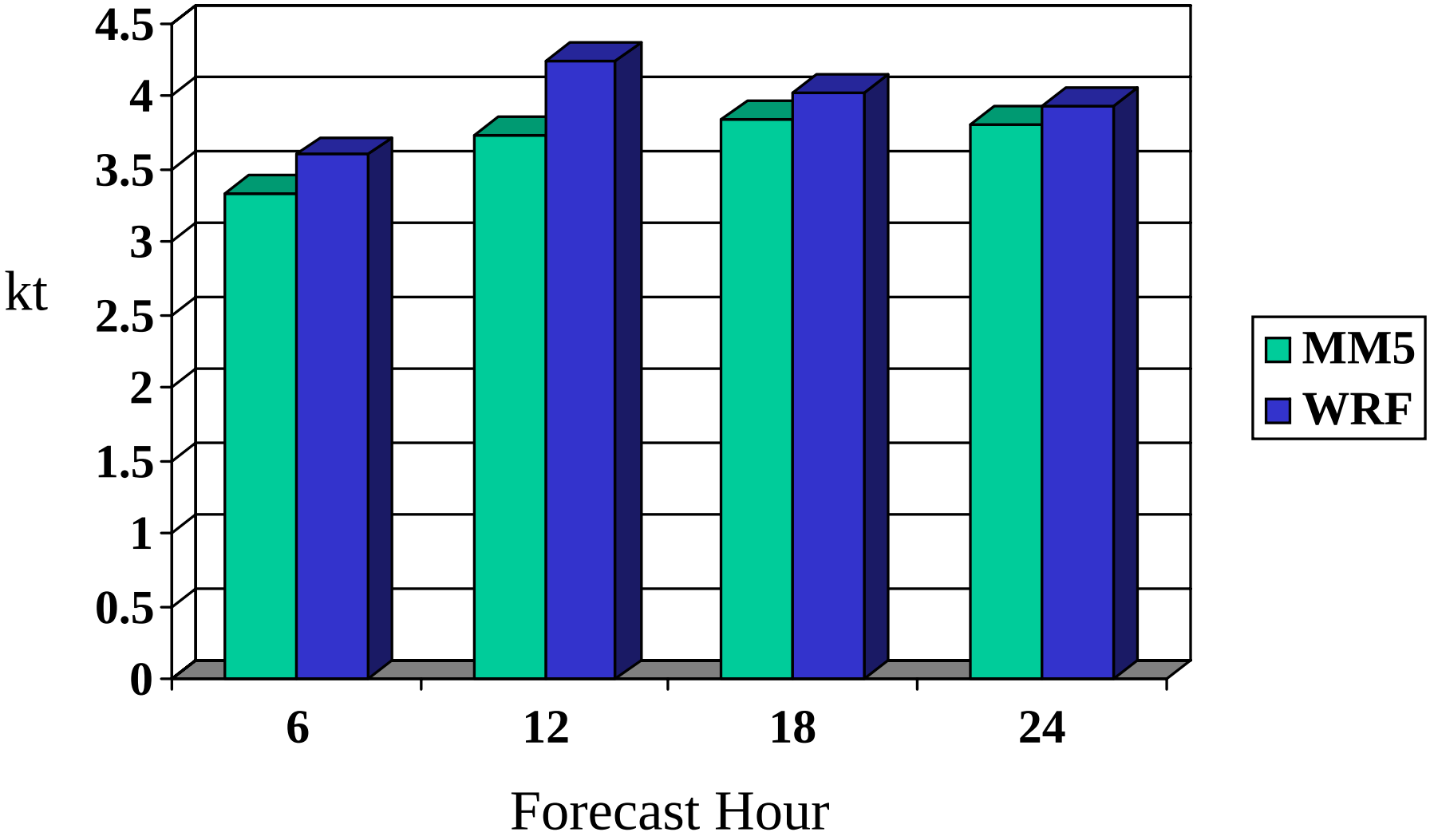
- Both WRF and MM5 were verified against large array of surface observations over the Pacific Northwest.
- Model output was linearly interpolated to observation sites within the 12-km domain encompassing the Pacific Northwest.
- Will show statistics from 12 UTC March 29 to 12 UTC June 6, 2005

2- m Temperature
Mean Absolute Error

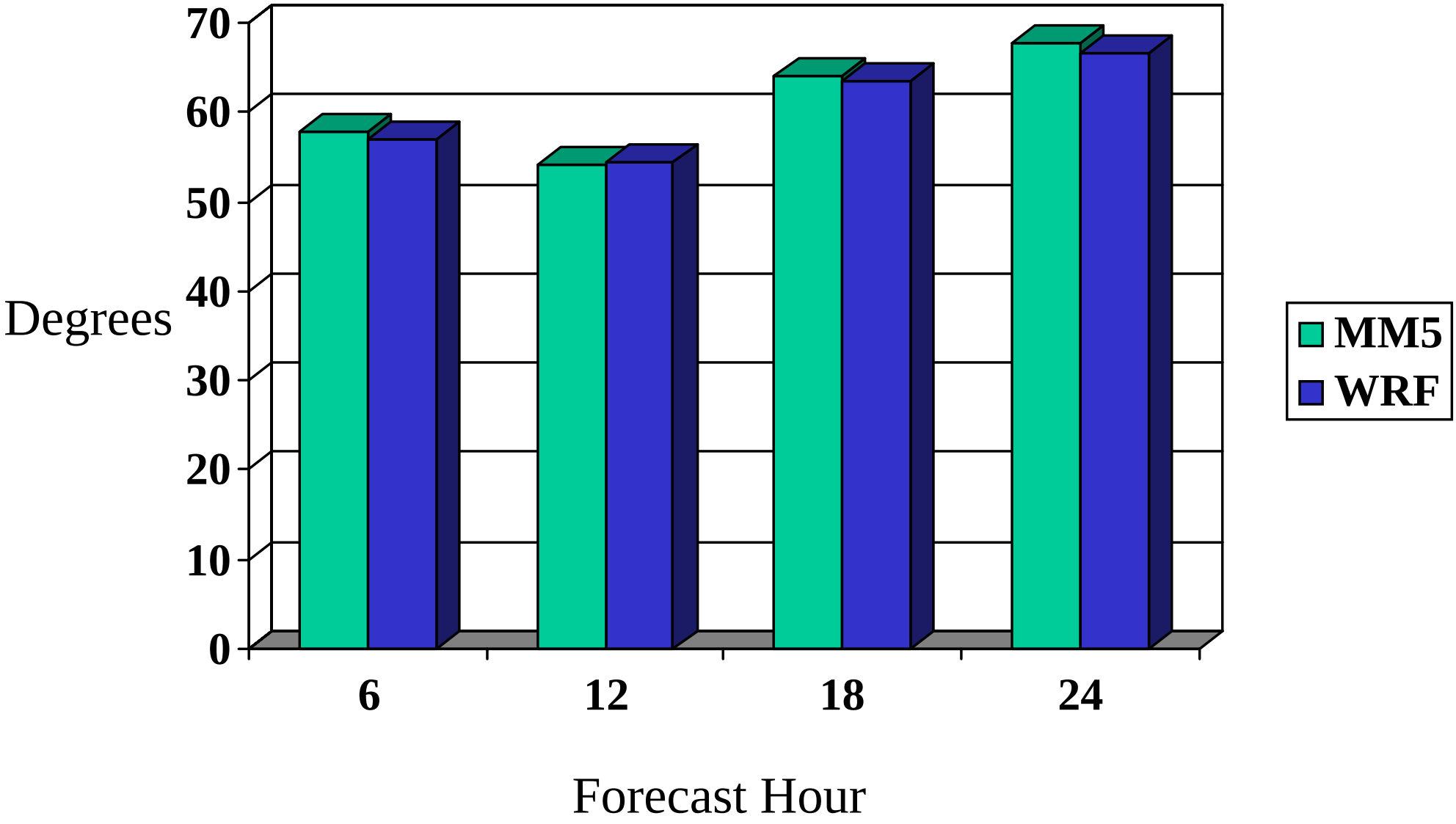


12-km domain, 12 UTC initialization, roughly 60,000 observations in each

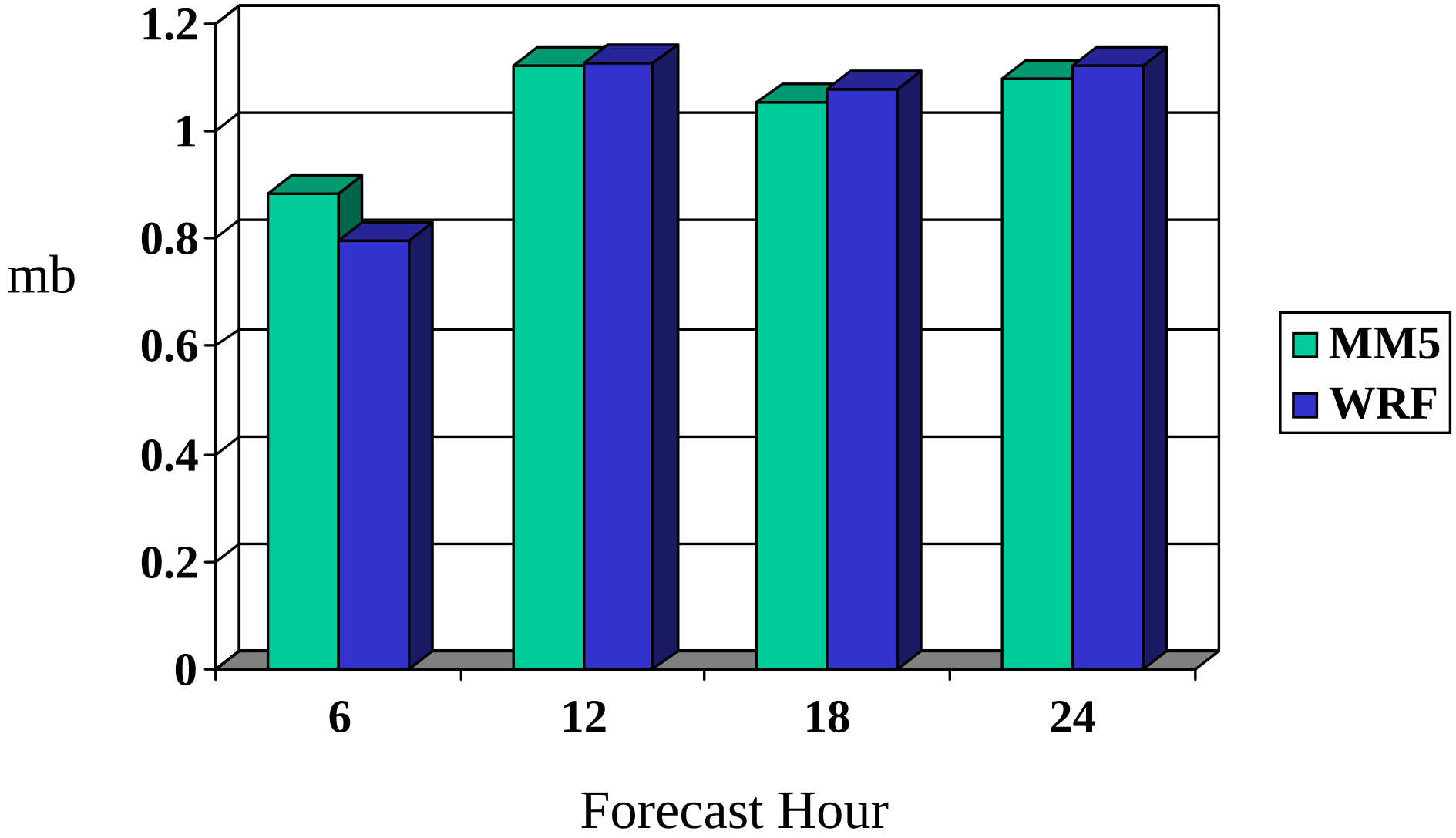
10-m Wind Speed
Mean Absolute Error



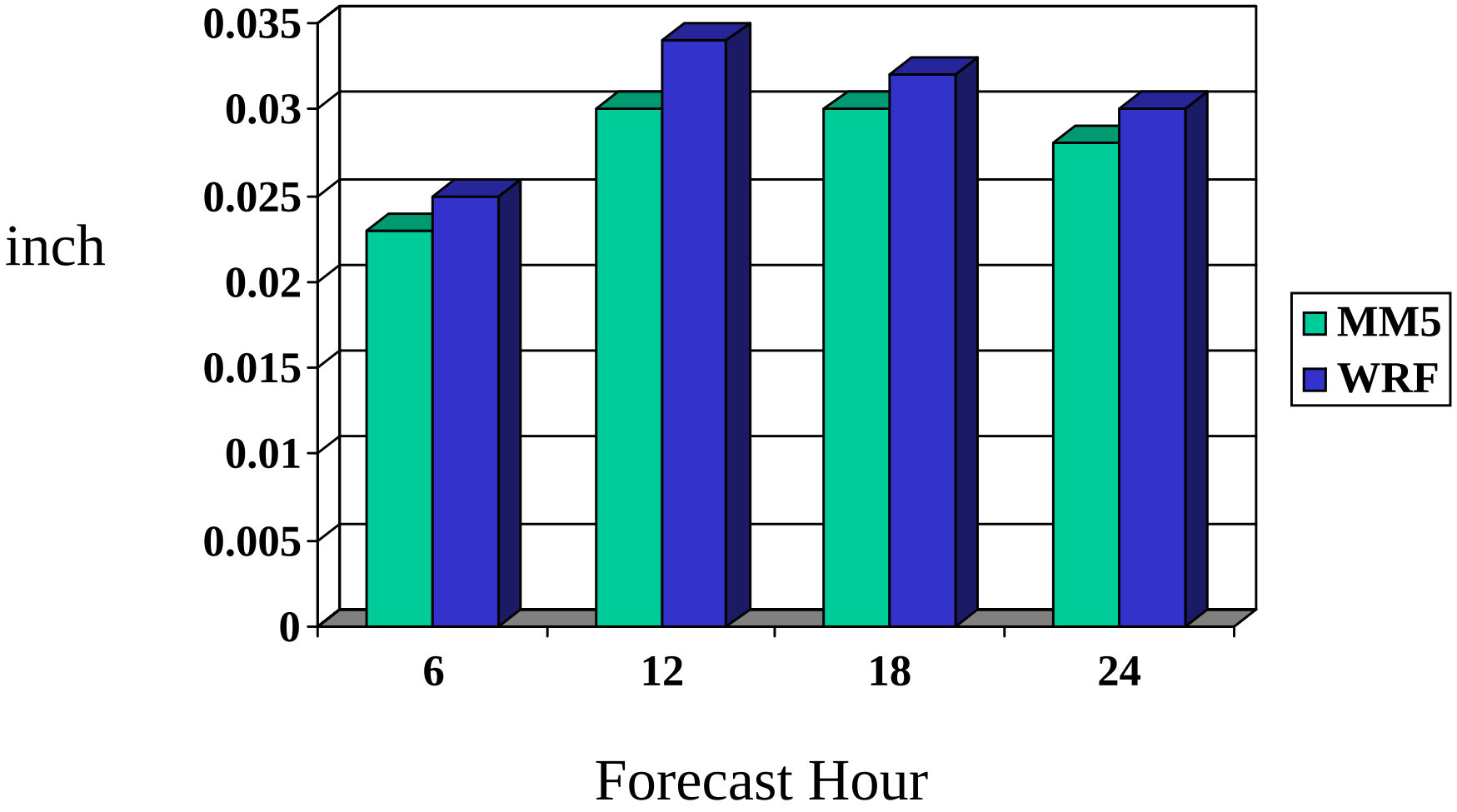
Wind Direction
Mean Absolute Error



Surface Pressure
Mean Absolute Error

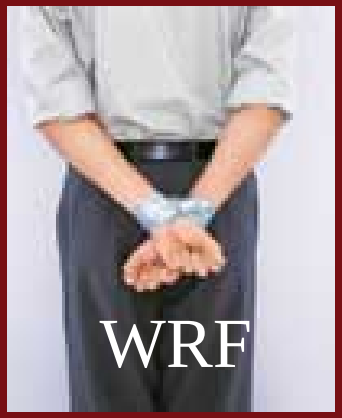


6-h Precipitation Mean Absolute Error

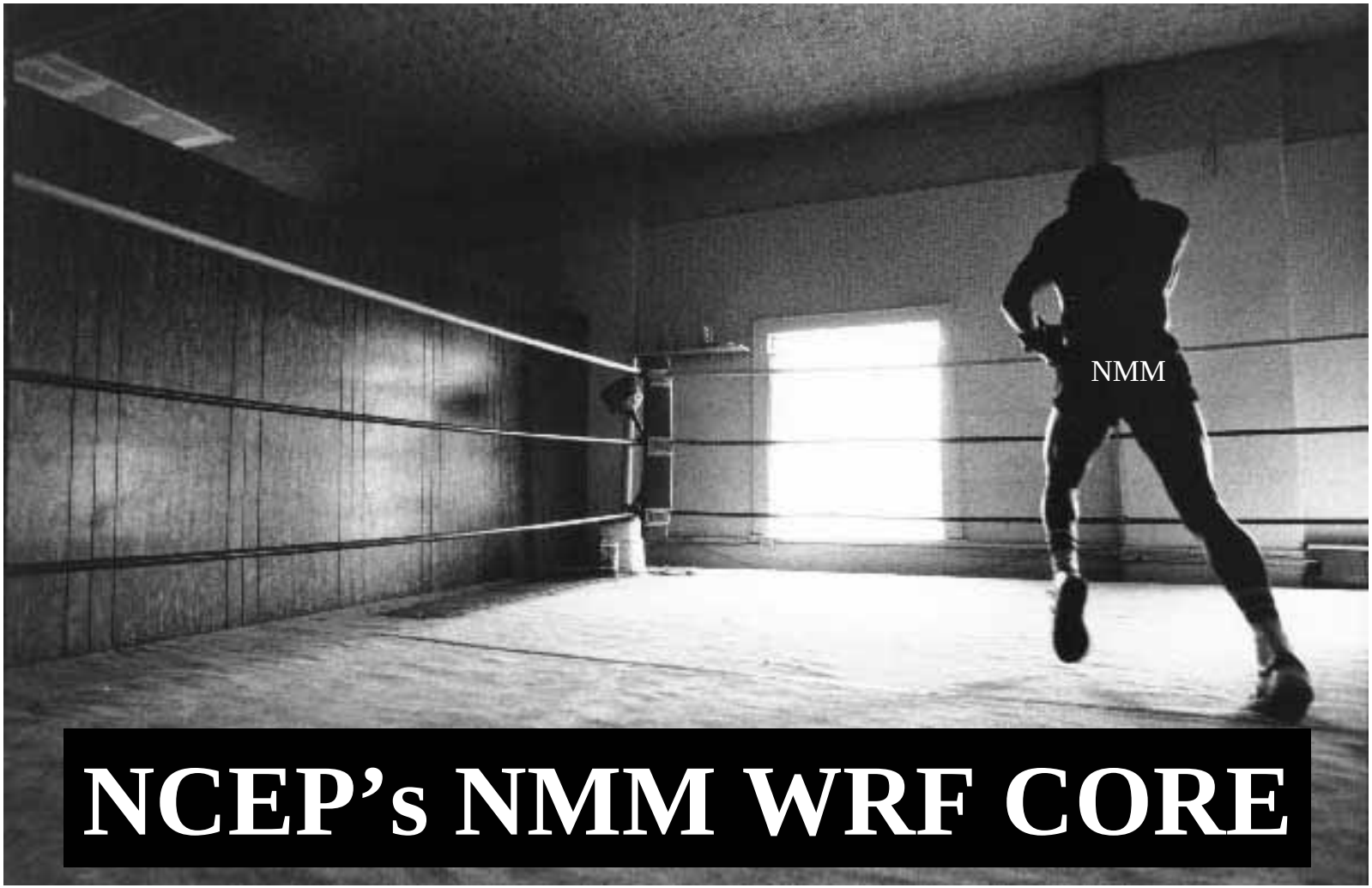


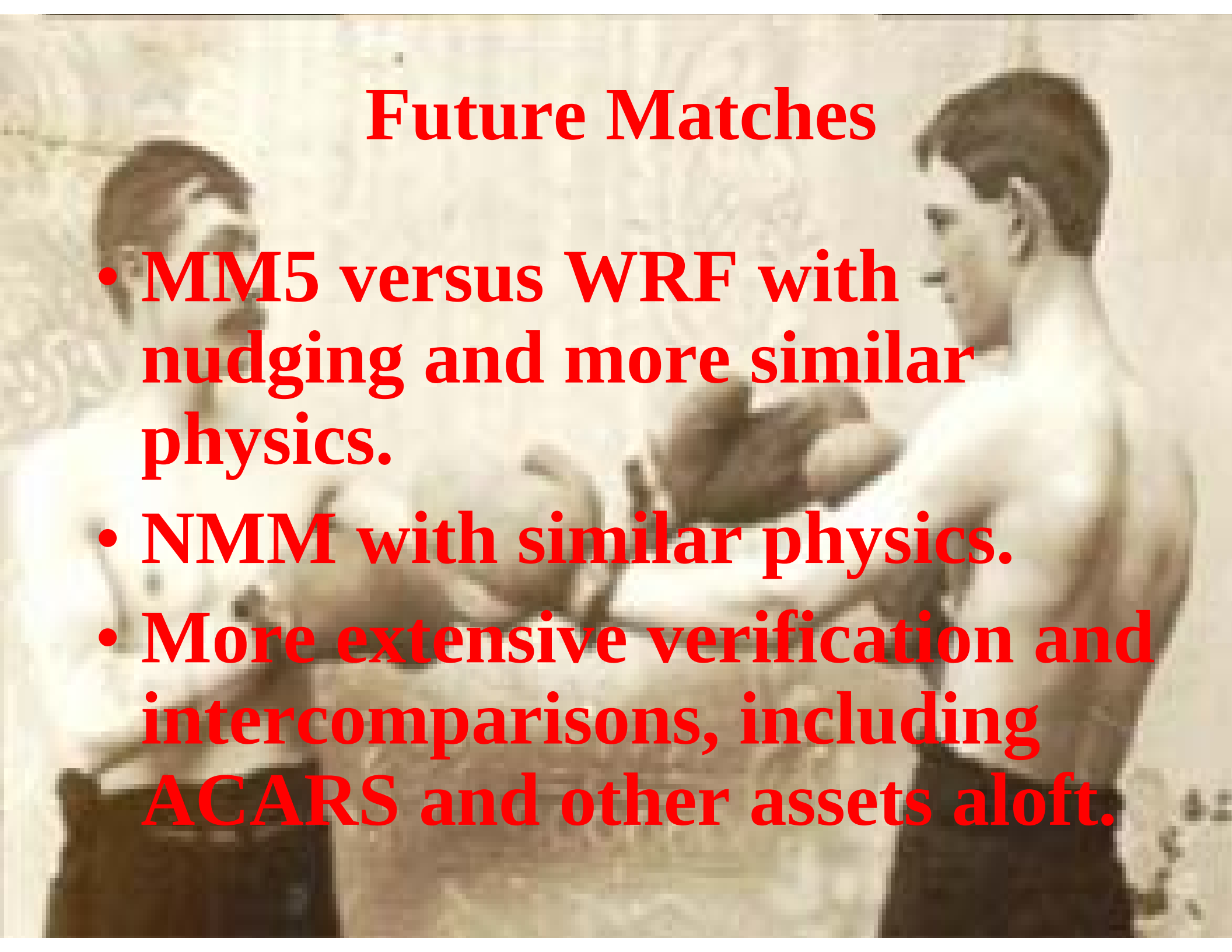
Initial Results

- **No knockout … MM5 and WRF have similar overall performance, with MM5 possessing a small superiority-- particularly for precipitation and wind speed.**
- **However, this was not a completely even match, with MM5 using superior radiation scheme, better microphysics scheme, and nudging on outer domain.**



And another challenger in the wings needs to be tested…





Future Matches

- MM5 versus WRF with nudging and more similar physics.
- NMM with similar physics.
- More extensive verification and intercomparisons, including ACARS and other assets aloft.

Important Questions

- **Do we really need two WRF cores?**
- **Is one better than the other?**
- **If not, does a second add any useful diversity for use in ensembles?**
- **Should the Pacific Northwest real-time runs switch to WRF? (Can't do so until WRF verifies at least as well as MM5.)**


EVERLAST
END OF MATCH
COVERAGE