Streakiness and Snow-Induced Cold Anomalies: Some Physics Challenges in WRF

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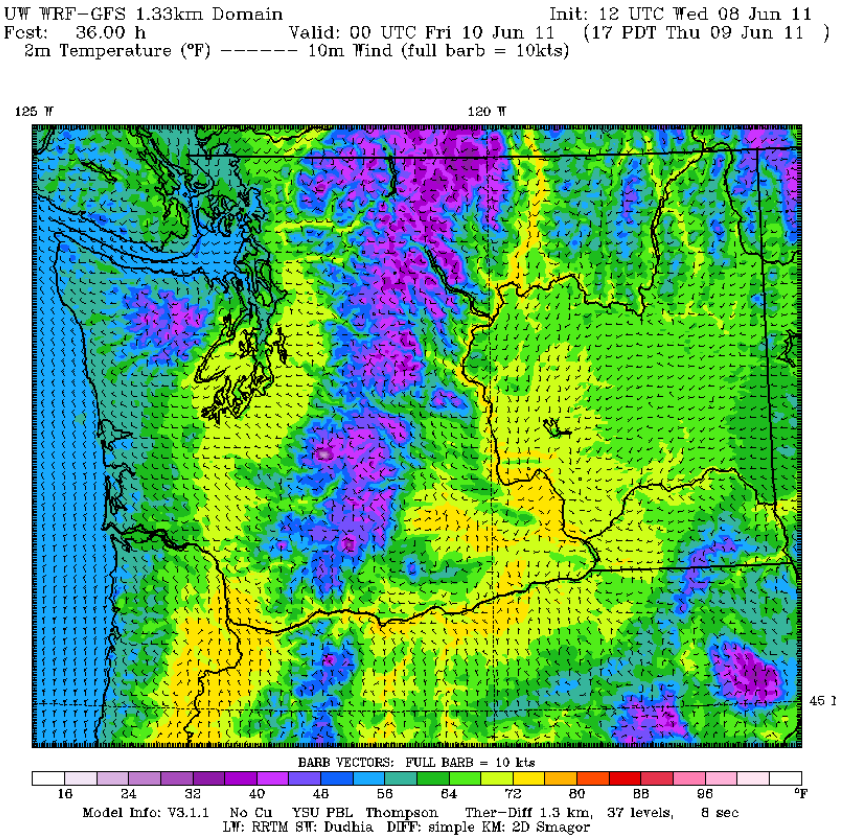
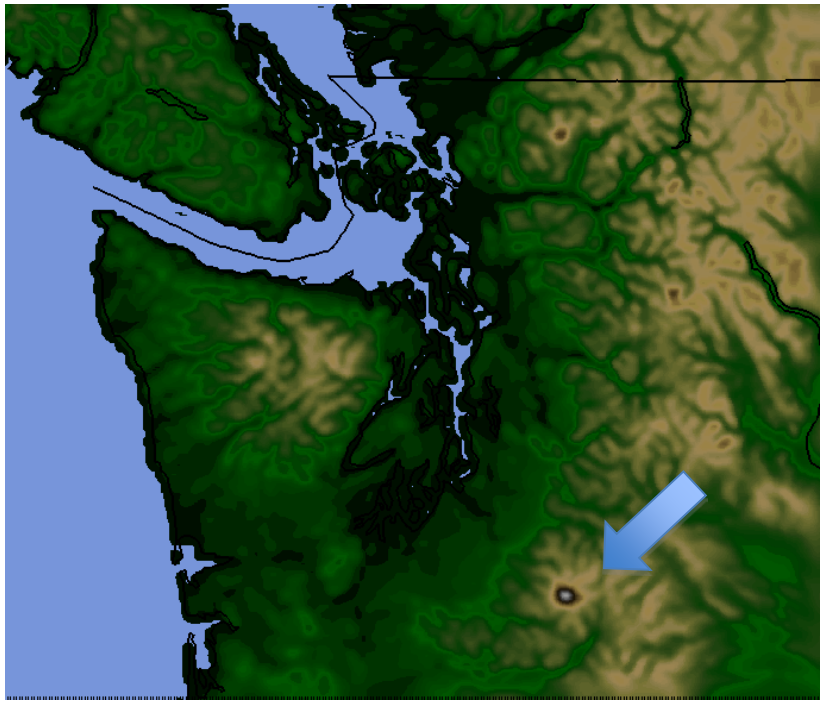
WRF Workshop: June 2011

Moving to Higher Resolution: Some Physics Issues Get Worse

- The UW real-time prediction system has been running domains at 36-12-4 km and now 1.3 km grid spacing.

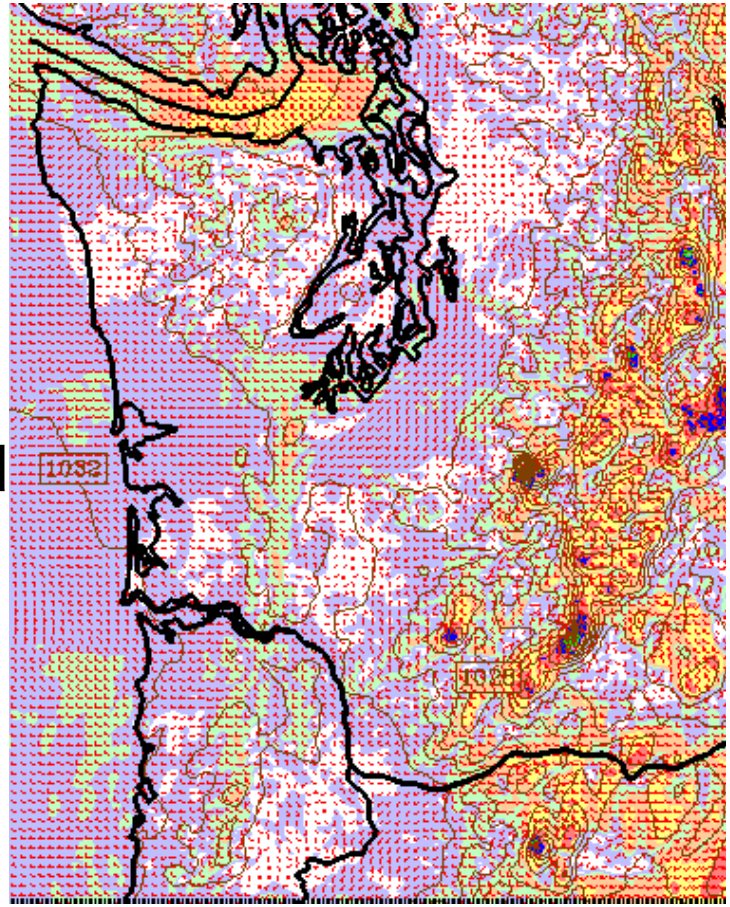


Moving to 4/3 km, one immediate issue was the loss of every 20 runs or so due to CFL errors on the higher volcanic peaks

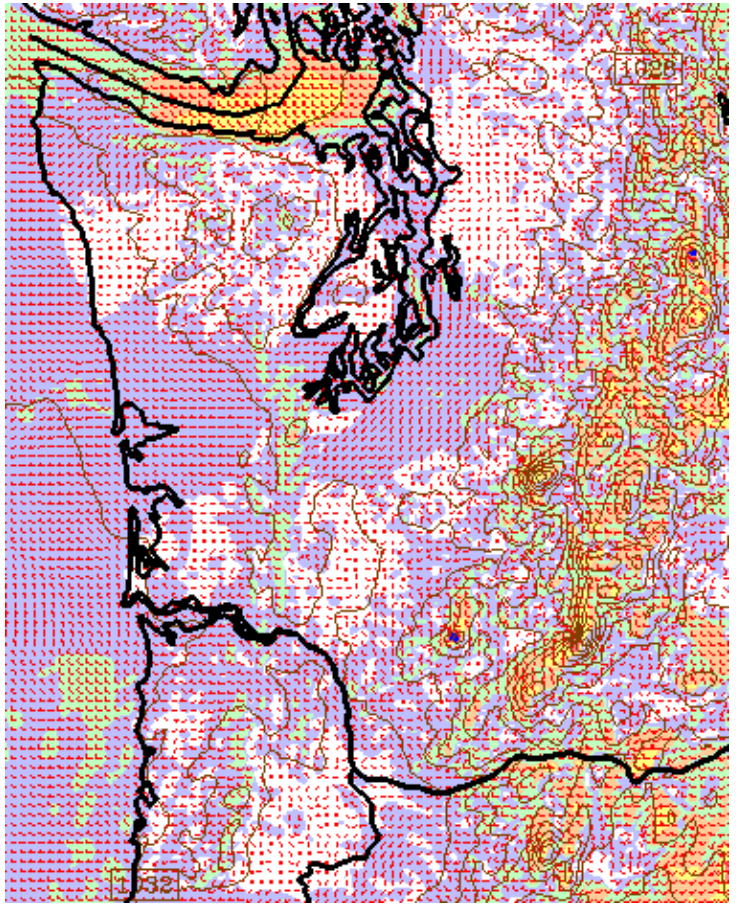


Jimy Dudhia Suggests Changing epssm to .2 (related to damping of vertically propagating sound waves)—it worked.

10m wind



.1

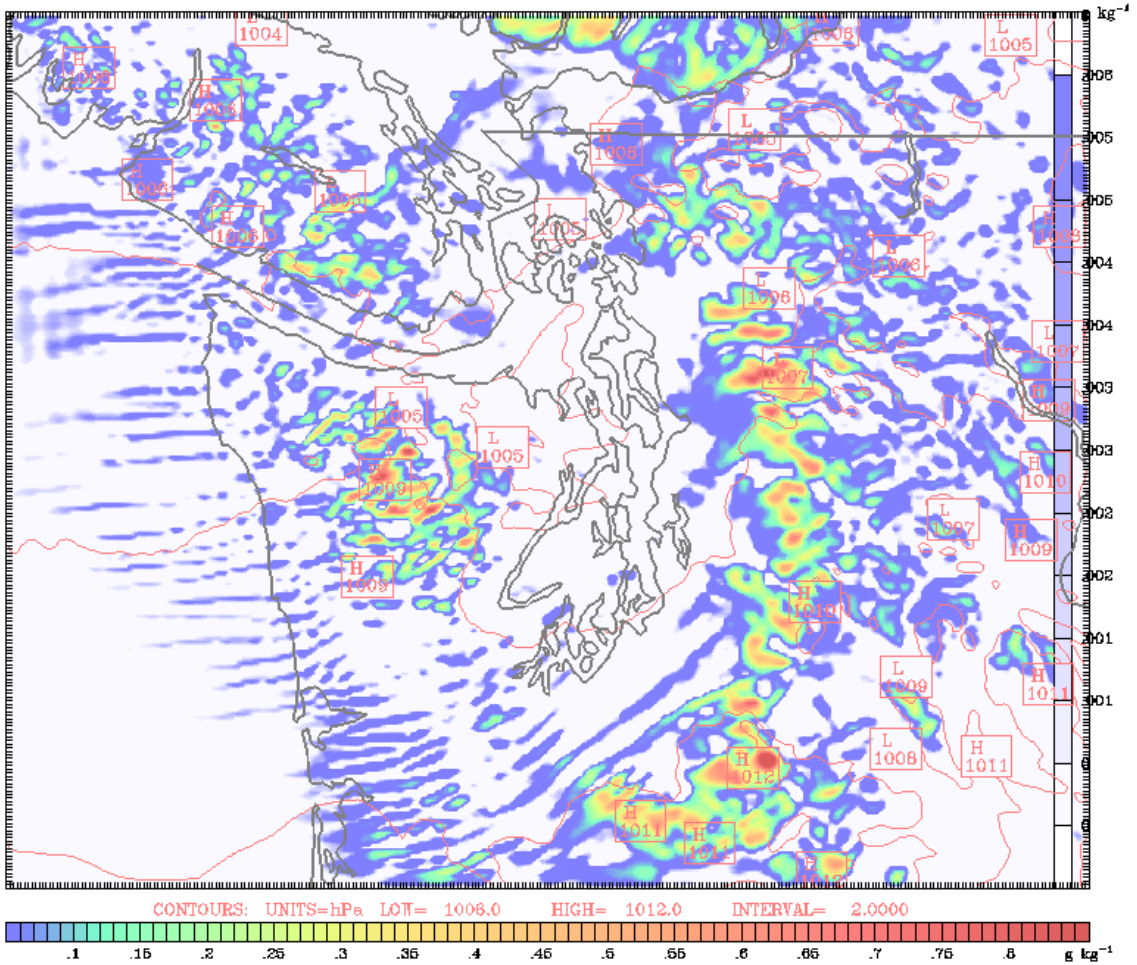


.2

Wavelike Streakiness Over the Oceans and Coastal Zone

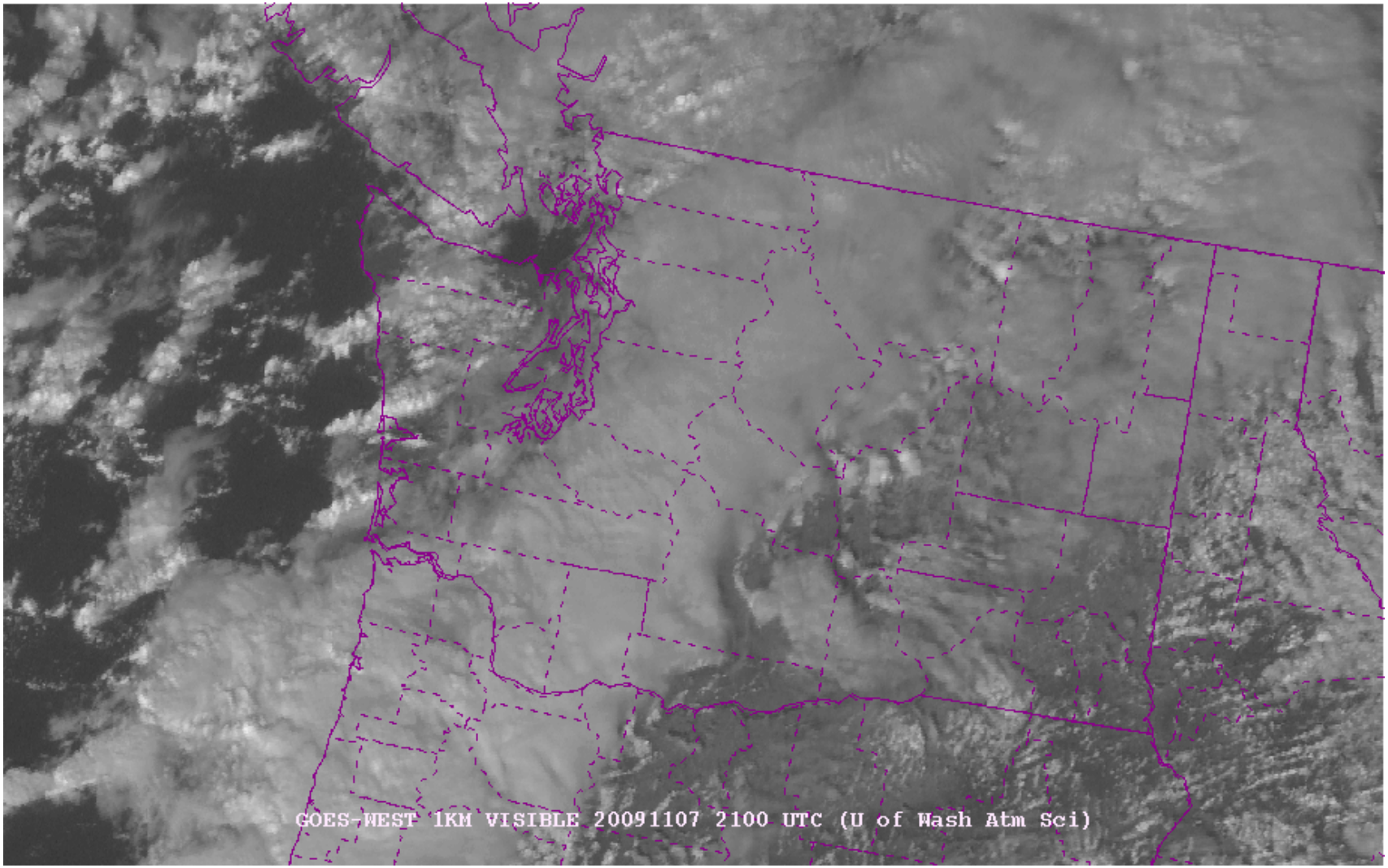
- It was subtle at 4km, but really apparent at 1.3 km
- Worse under less stable, post-frontal conditions.
- More apparent over the water.
- Less apparent over land, particularly in terrain.

std 1.33km Domain Init: 12 UTC Sat 07 Nov 09
Fcst: 9.00 h Valid: 21 UTC Sat 07 Nov 09 (13 PST Sat 07 Nov 09)
Average cloud mixing ratio 0-3K ft above surface
Sea Level Pressure (hPa)



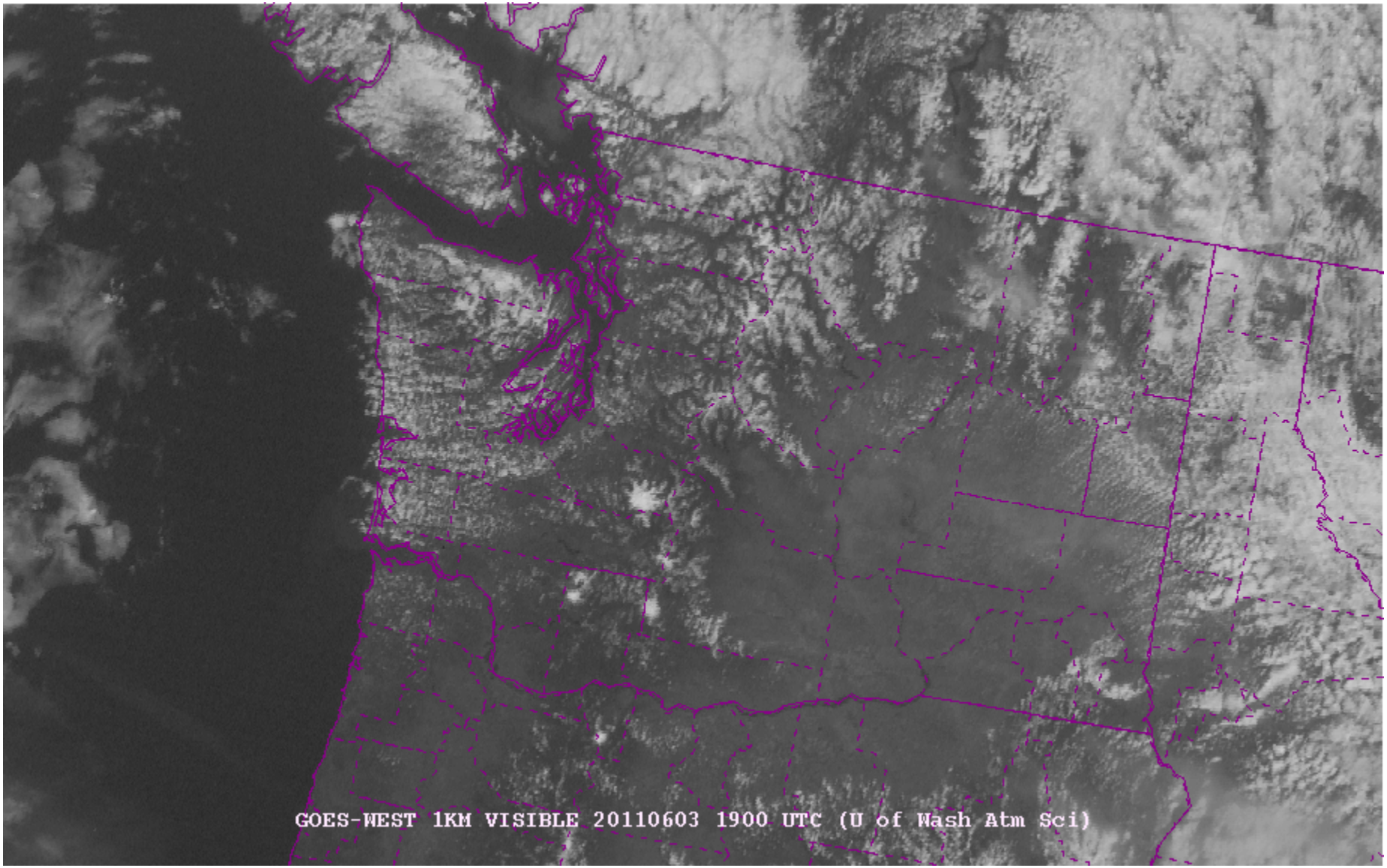
Streakiness

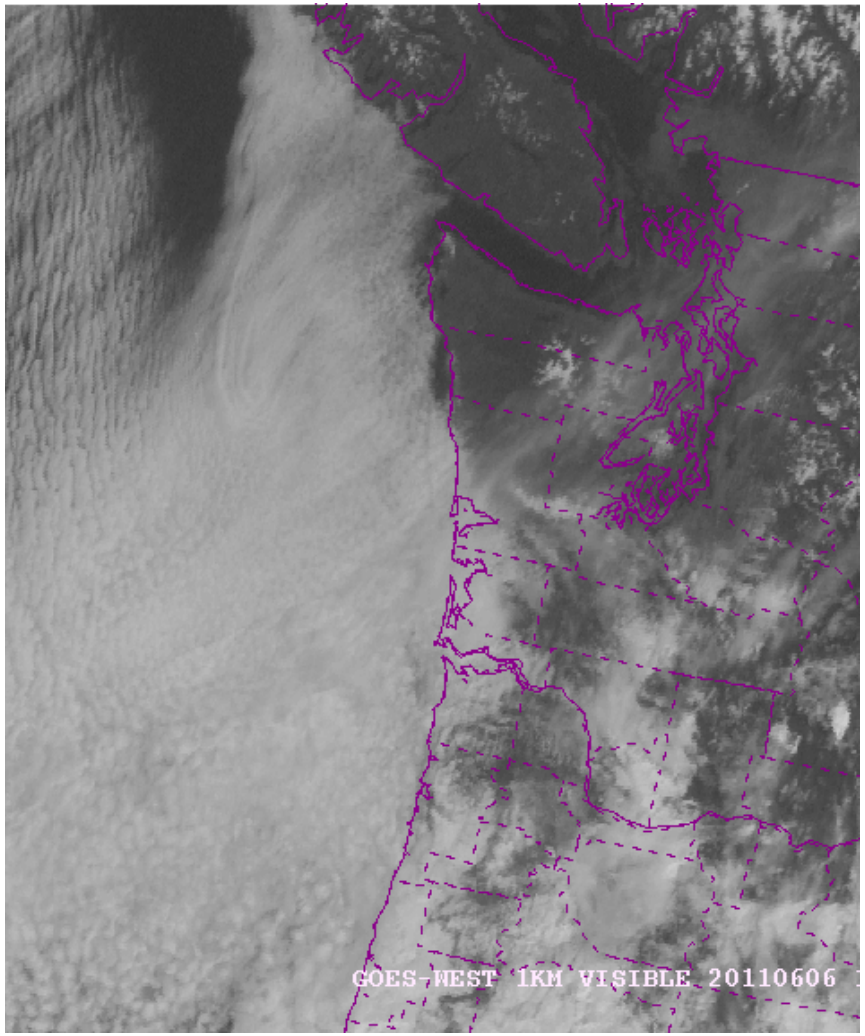
- How much is real, how much numerical artifact?
- Often occurs where nature is producing open cellular convection over the Pacific.

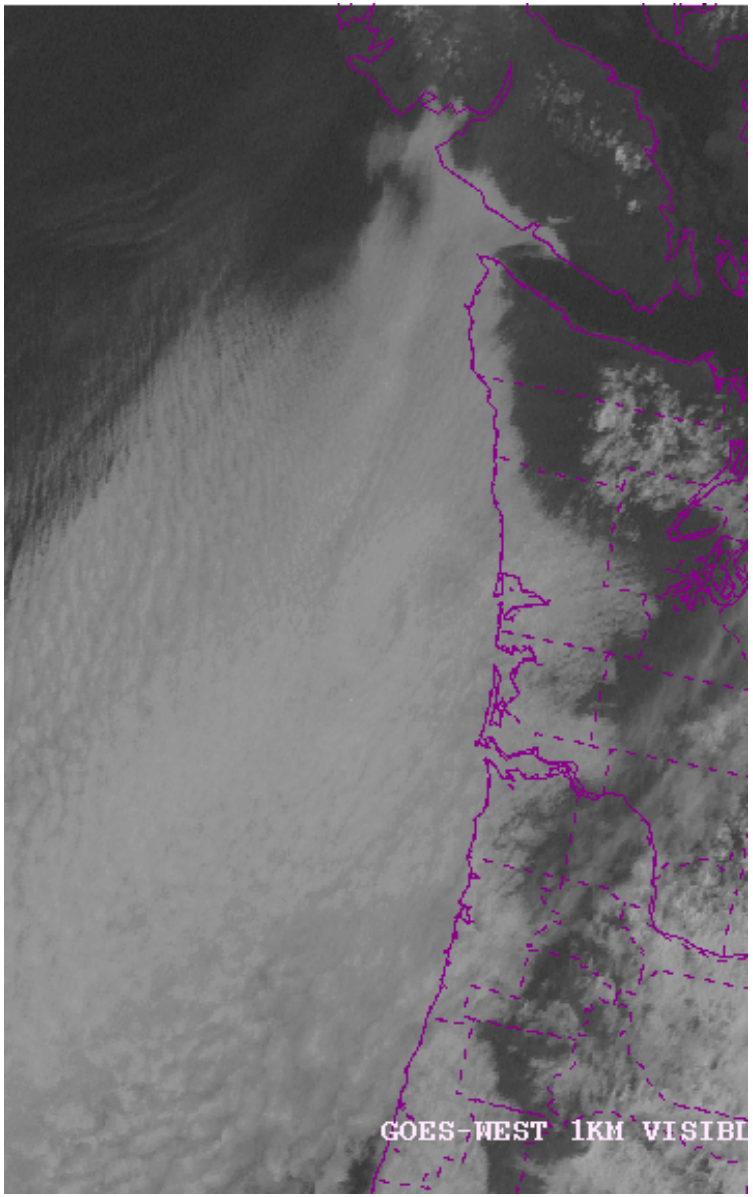

GOES-WEST 1KM VISIBLE 20091107 2100 UTC (U of Wash Atm Sci)

Have to be careful—some wavelike streaks are real!

Got to be careful…some streakiness is real




GOES-WEST 1KM VISIBLE 20110606


GOES-WEST 1KM VISIBL

The triggering of orographic rainbands by small-scale topography

Daniel J. Kirshbaum

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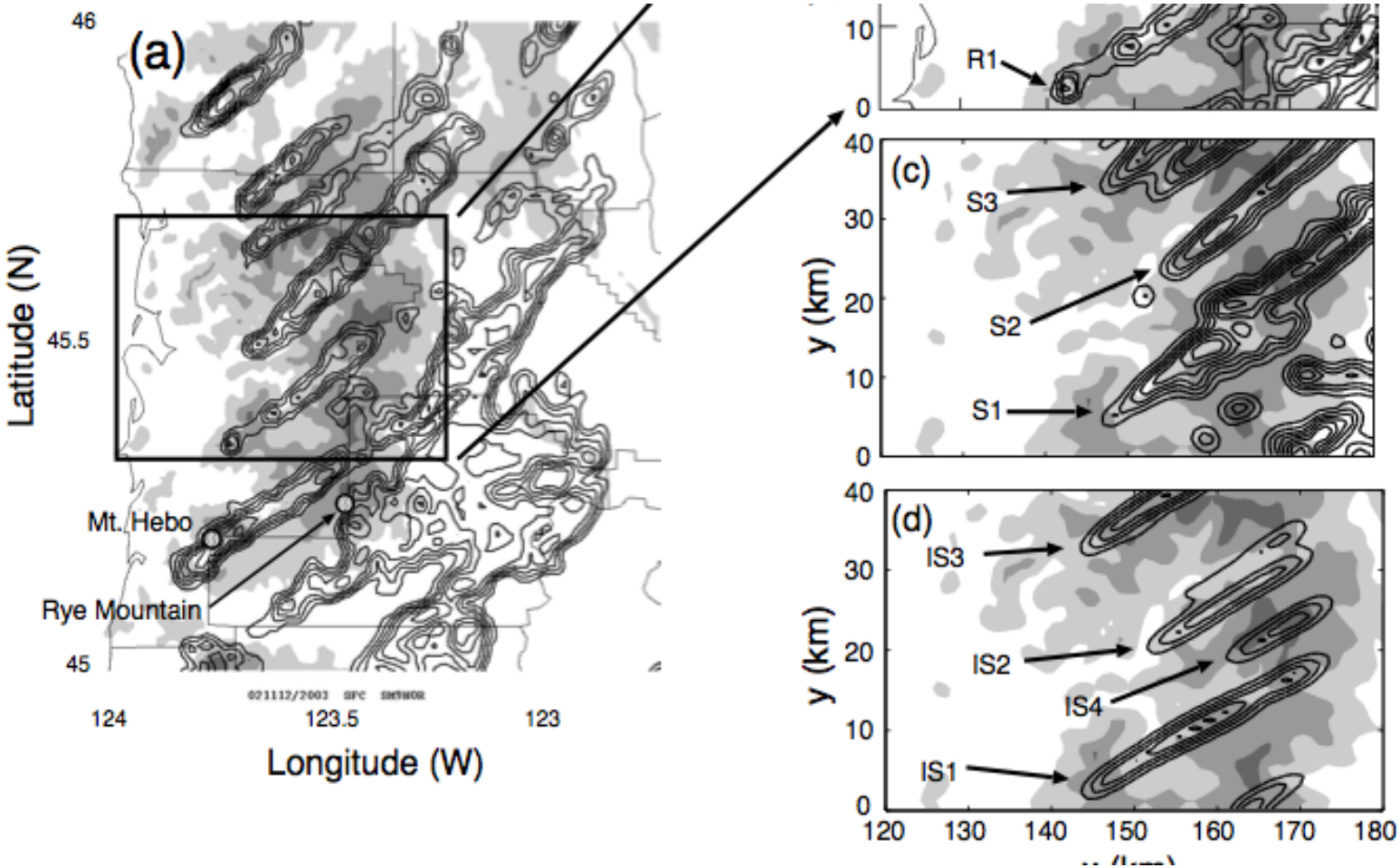
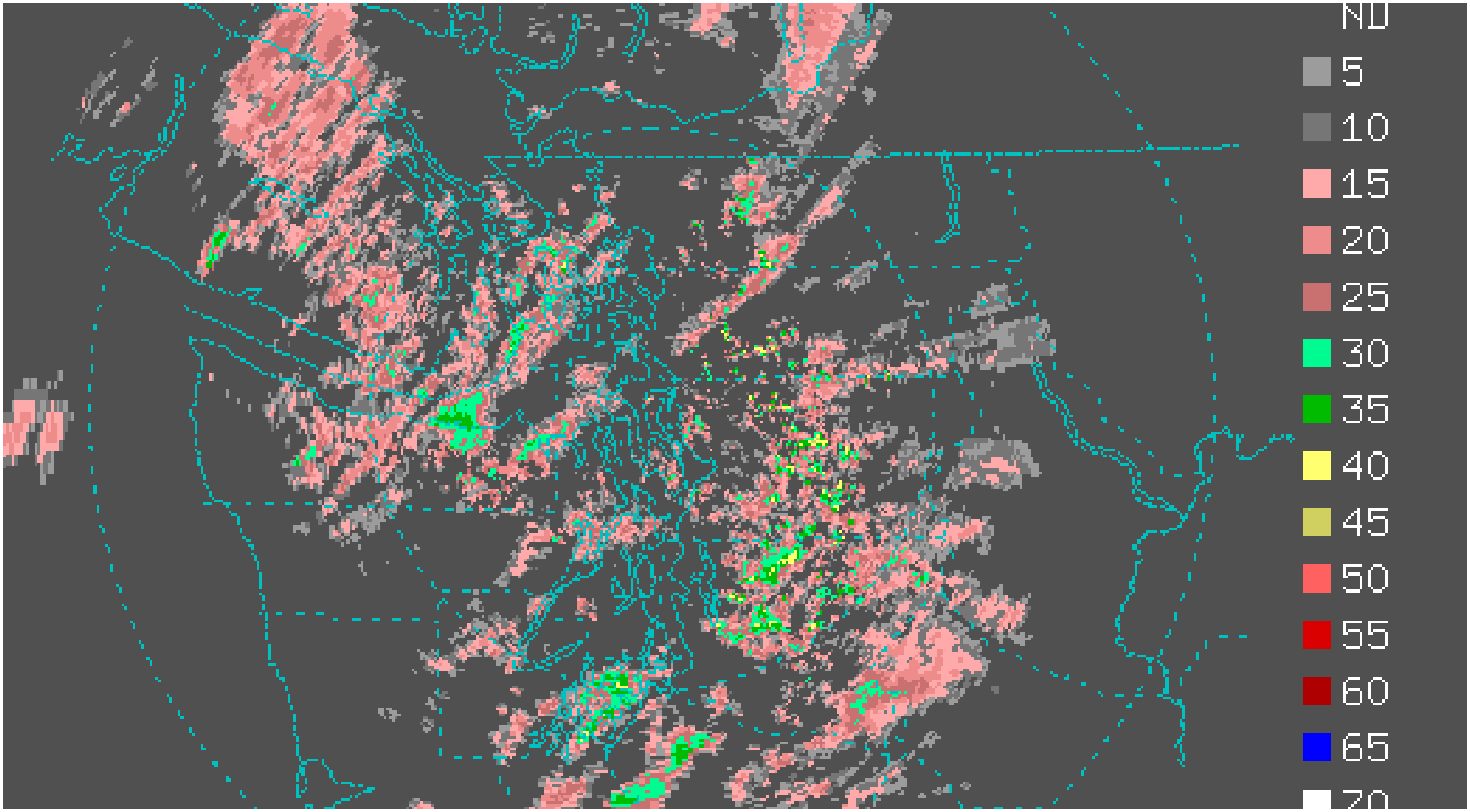

(a)
46
45.5
45
Latitude (N)
Mt. Hebo
Rye Mountain
124
123.5
123
Longitude (W)
R1
(c)
S3
S2
S1
y (km)
(d)
IS3
IS2
IS4
IS1
120
130
140
150
160
170
180


ND
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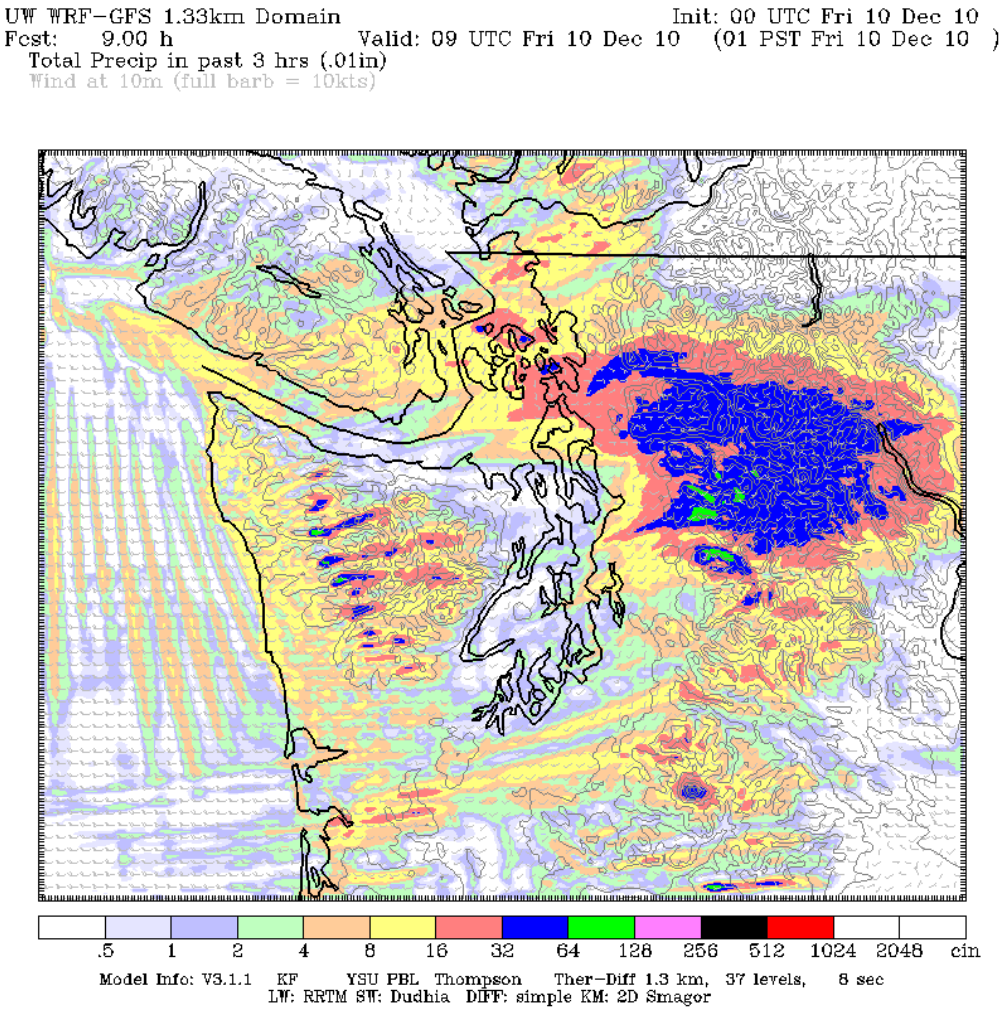
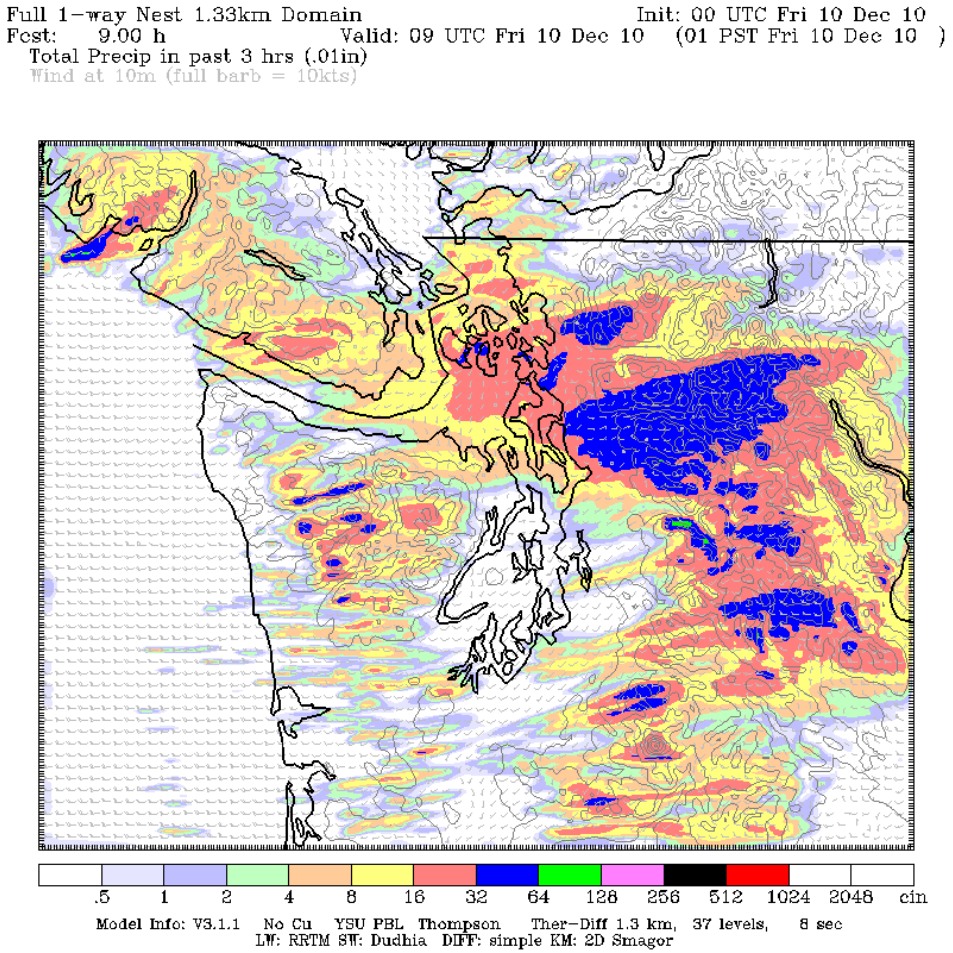
70

First issue—lots of streaks and unrealistic waves using nestdown for 1.3km

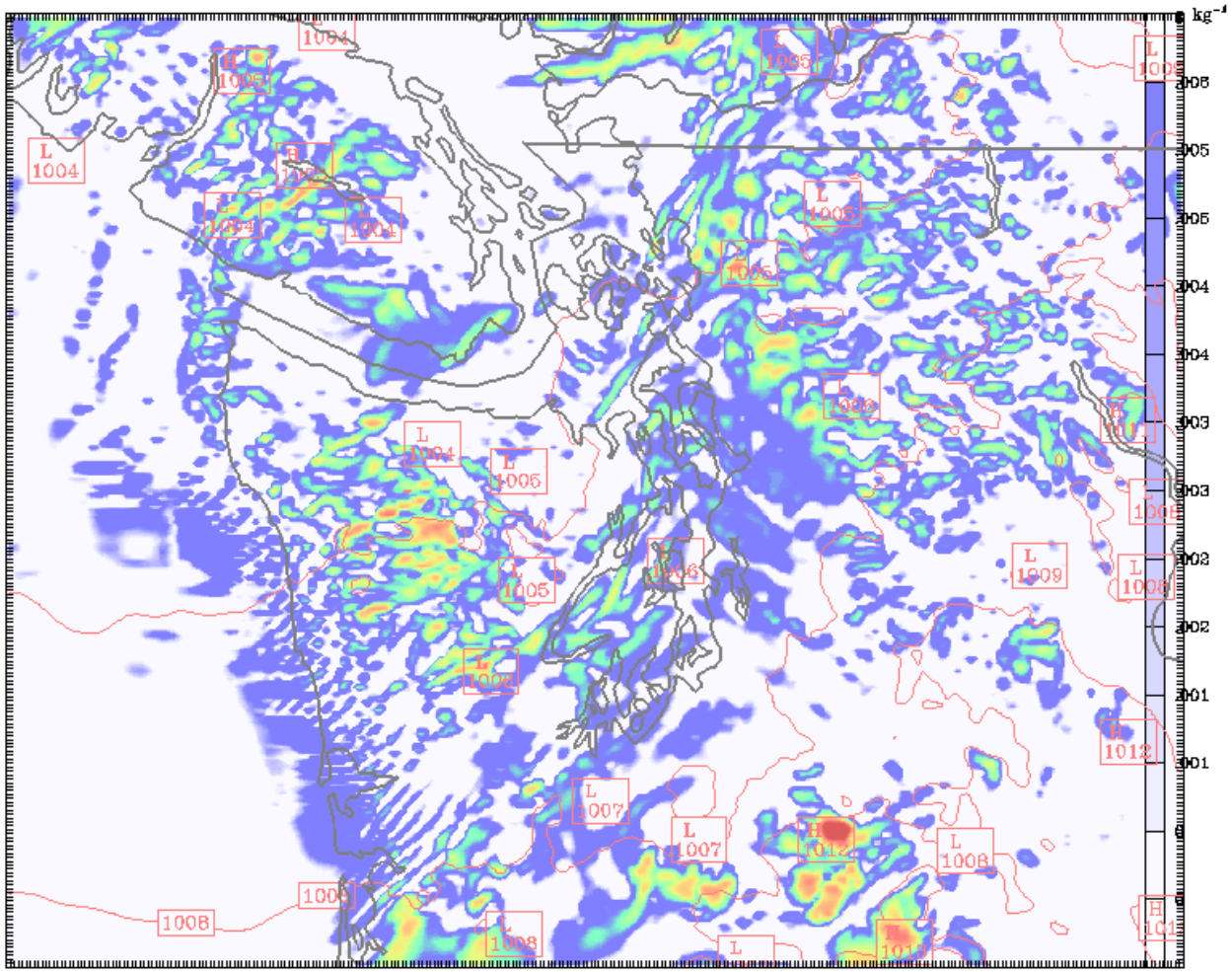


Switched to one way nesting—better, but still streaks



Two-way nesting no better.

fullynested.v33 1.33km Domain Init: 12 UTC Sat 07 Nov 09
Fcst: 7.00 h Valid: 19 UTC Sat 07 Nov 09 (11 PST Sat 07 Nov 09)
Average cloud mixing ratio 0-3K ft above surface
Sea Level Pressure (hPa)

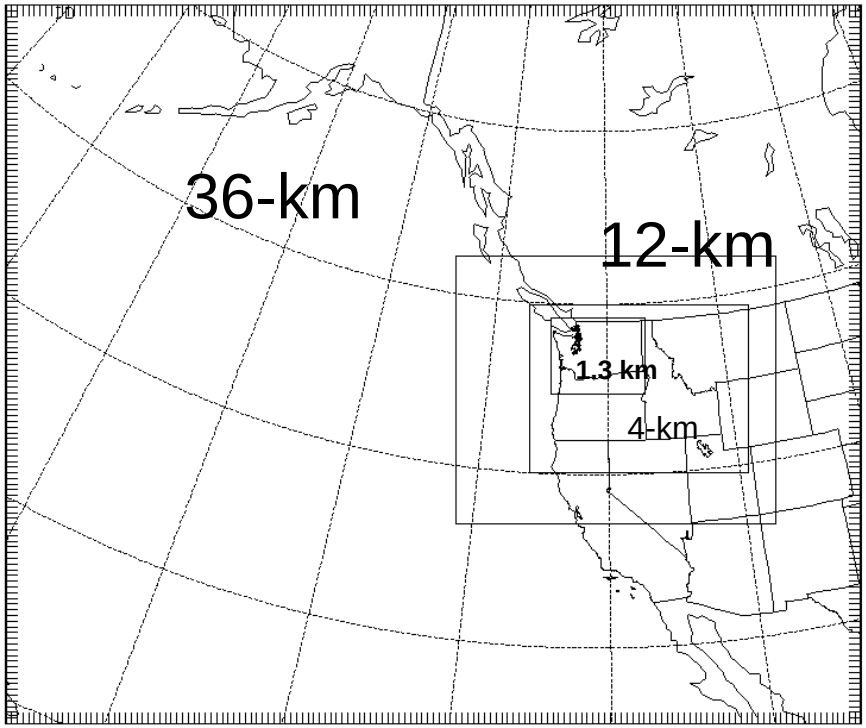


Model Info: V3.3 KF YSU PBL Thompson Ther-Diff 1.3 km, 37 levels, 8 sec
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

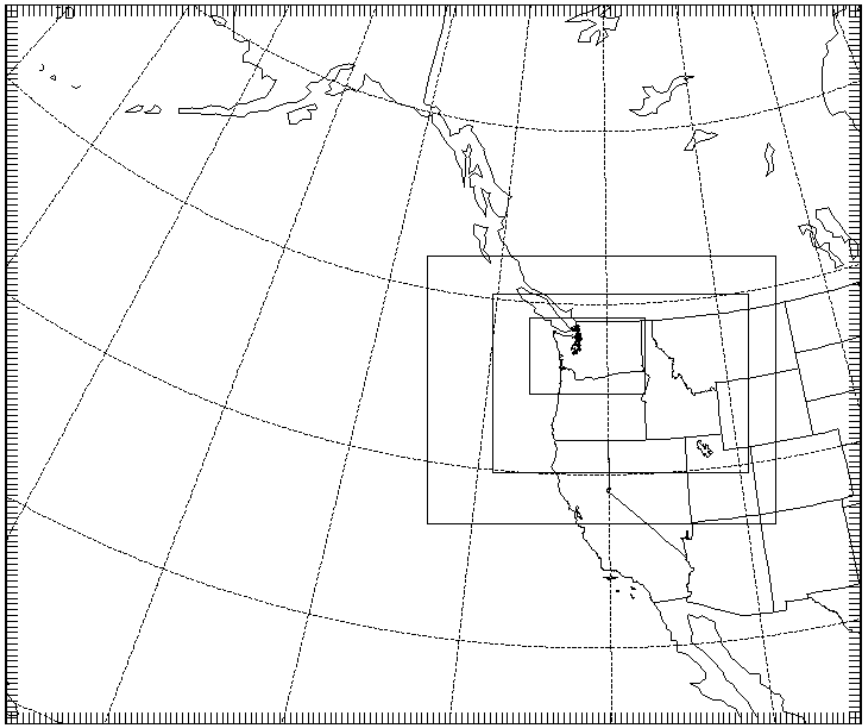
Other Approach

- Wei Wang suggested we play with the domain configuration…separating the 12 and 4-km domains more and pushing the 1.3 km away from the coast.
- This appeared to help substantially.

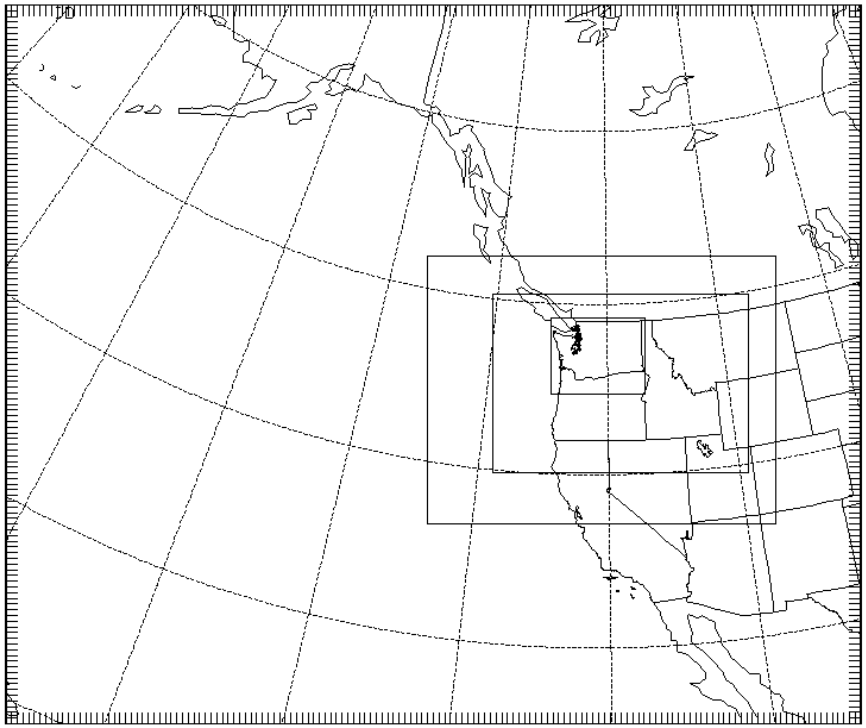
Original (problems)



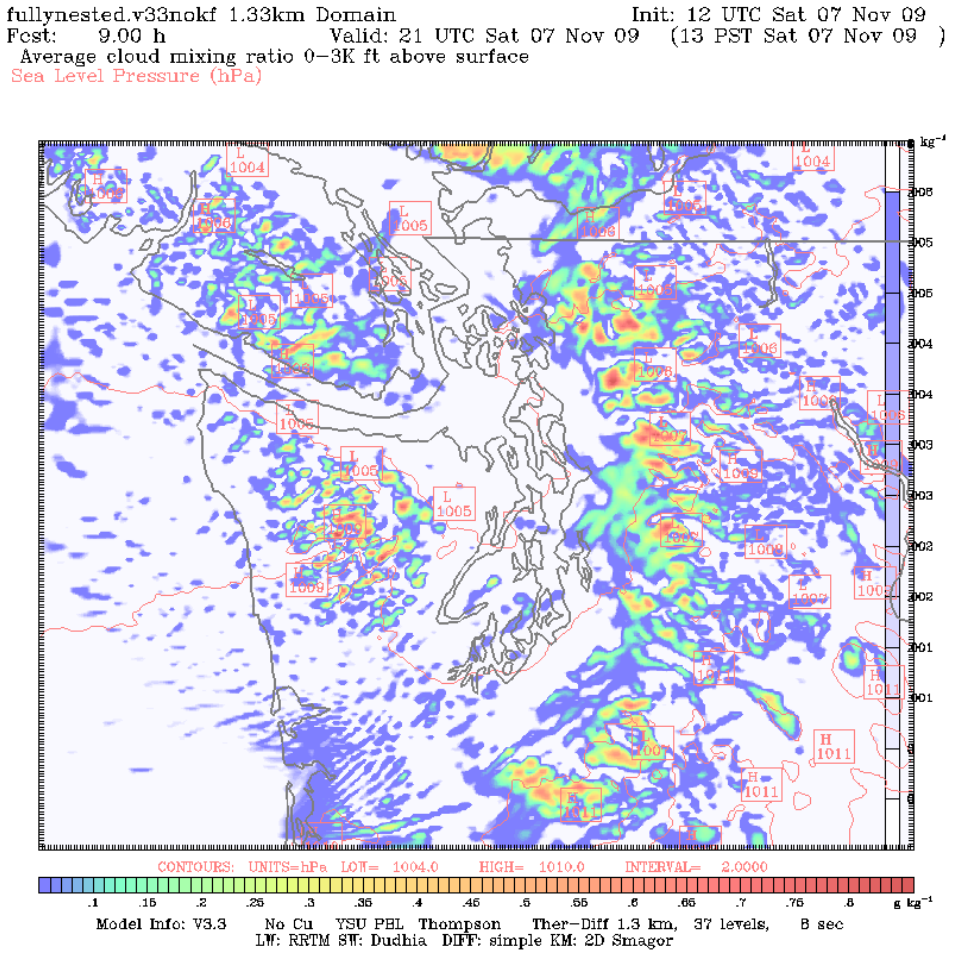
Pushed all domains out and increased separation, 4/3 km domain boundary pushed away from coast



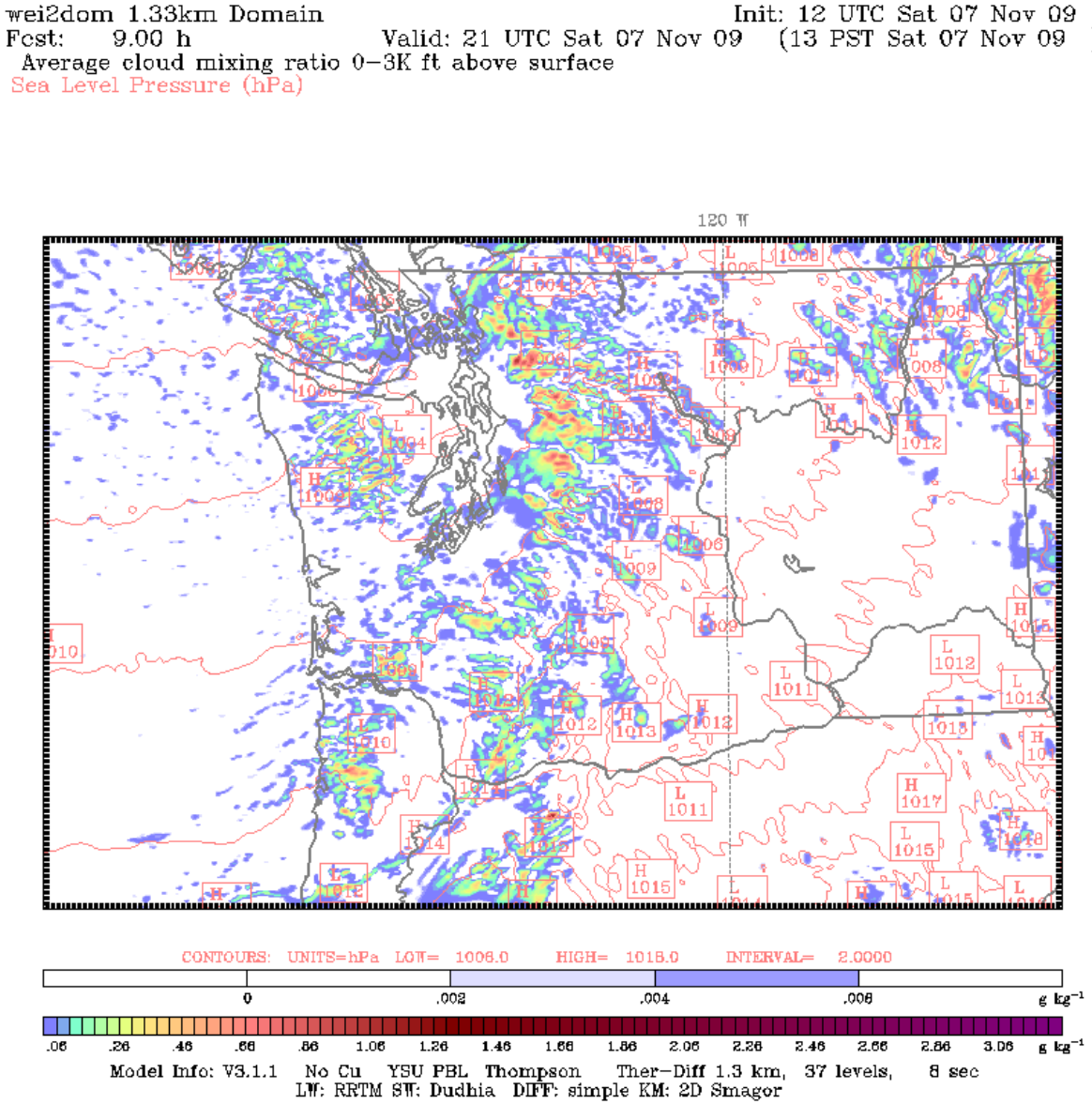
Alternative: kept 4/3 km in close to coast.



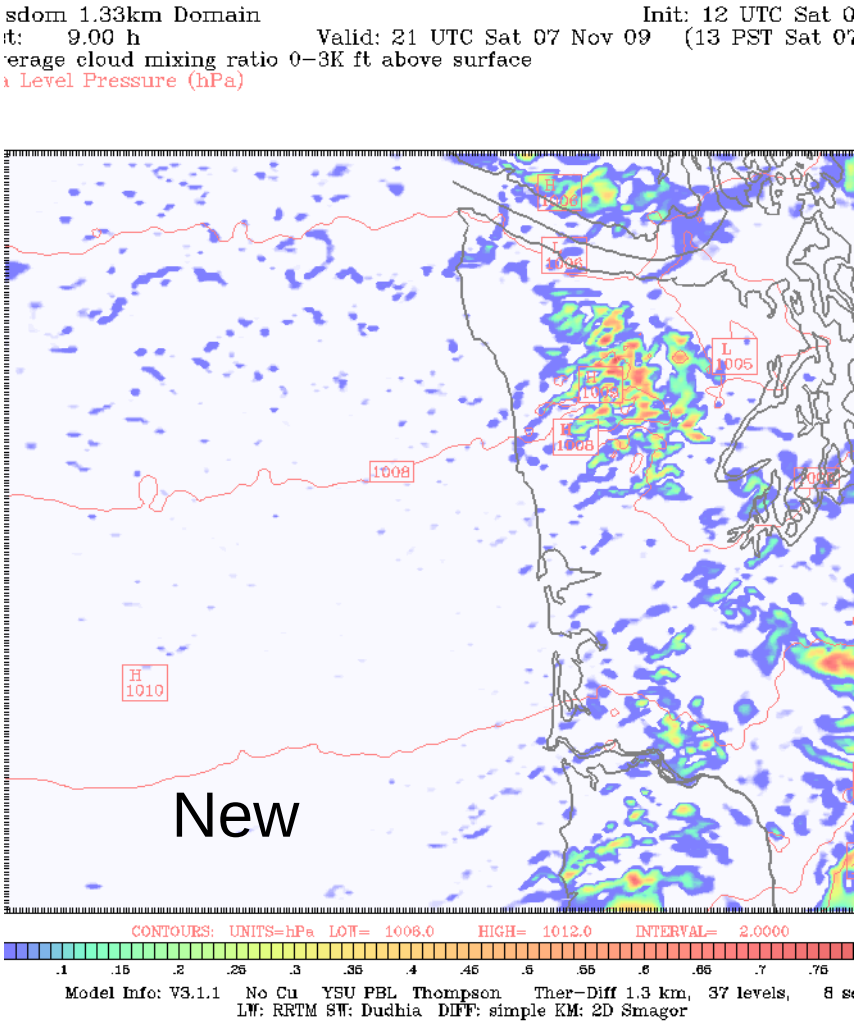
Original Approach

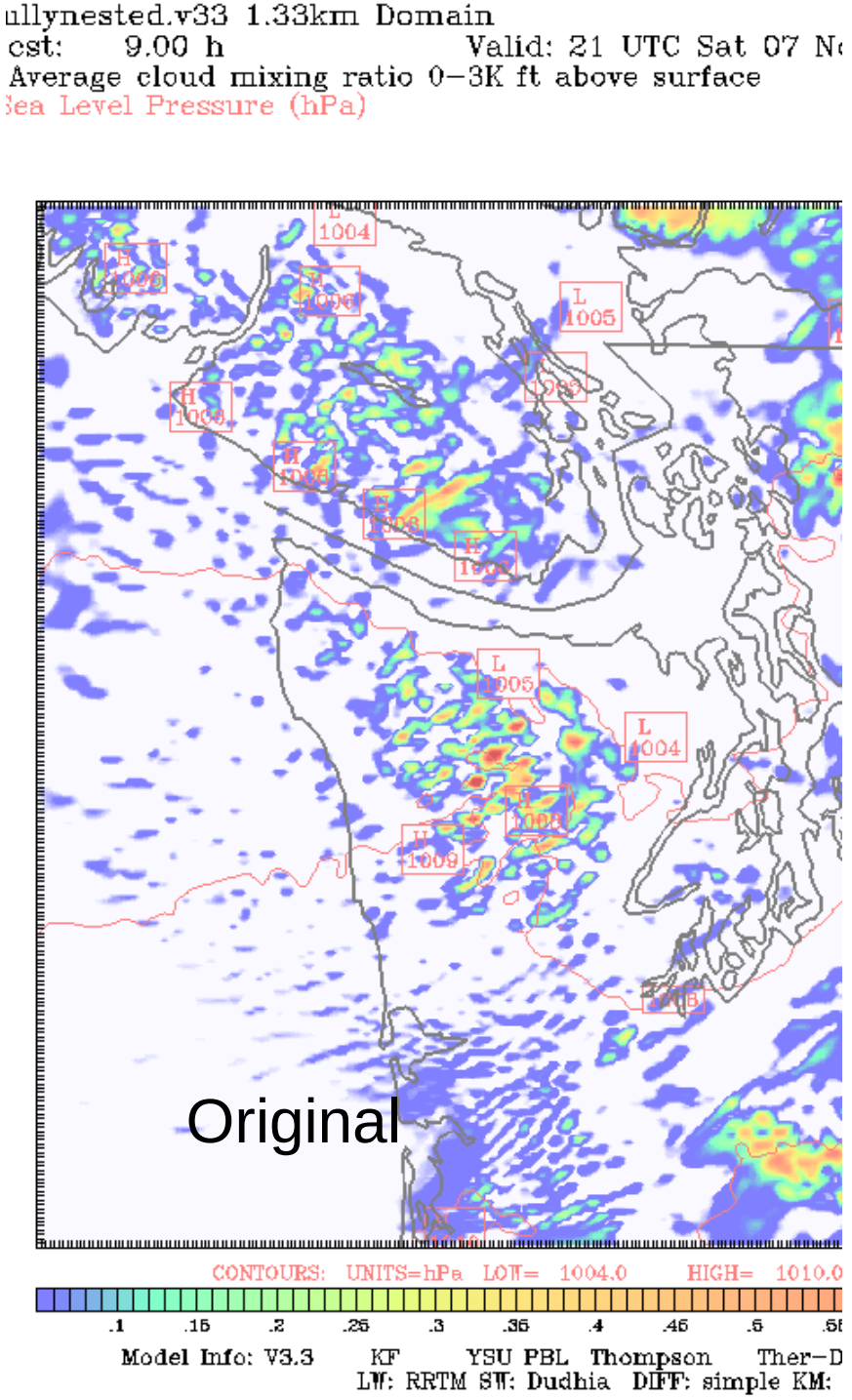


Pushed it all domains out



Just Expanded 12 and 4 km


sdom 1.33km Domain
Init: 12 UTC Sat 0
t: 9.00 h
Valid: 21 UTC Sat 07 Nov 09 (13 PST Sat 07
erage cloud mixing ratio 0-3K ft above surface
Level Pressure (hPa)
New
CONTOURS: UNITS=hPa LOW= 1006.0 HIGH= 1012.0 INTERVAL= 2.0000
.1 .15 .2 .25 .3 .35 .4 .45 .6 .55 .6 .65 .7 .75
Model Info: V3.1.1 No Cu YSU PBL Thompson Ther-Diff 1.3 km, 37 levels,
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor


ullynested.v33 1.33km Domain
cst: 9.00 h
Valid: 21 UTC Sat 07 N
Average cloud mixing ratio 0-3K ft above surface
ea Level Pressure (hPa)
Original
CONTOURS: UNITS=hPa LOW= 1004.0 HIGH= 1010.0
.1 .15 .2 .25 .3 .35 .4 .45 .5
Model Info: V3.3 KF YSU PBL Thompson Ther-D
LW: RRTM SW: Dudhia DIFF: simple KM:

Decision: Will Make This Change in our Real-time runs

WRF Problems Over Snow (YSU Scheme)

- As discussed at previous workshops, we had problems with the NOAH LSM, particularly over snow: much too cold at 2-m.
- Since then running the five-layer soil model and NAM snow field.
- Going to 1.3 km began using the NOAA high-resolution (1-km) snow product, available daily.

National Weather Service

National Operational Hydrologic Remote Sensing Center

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Snow Information
- National Analyses
- Interactive Maps
- 3D Visualization
- Airborne Surveys
- Satellite Obs
- Forecasts
- Data Archive
- SHEF Products

Observations near
City, ST Go

Science/Technology
- NOHRSC
- GIS Data Sets
- Special Purpose Imagery

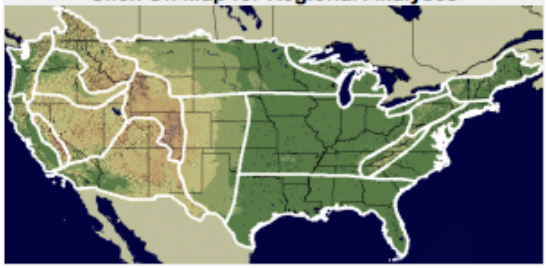
About The NOHRSC
- Staff

NOAA Links
- Snow Climatology
- Related Links

National Snow Analyses

Snow Reports | Model Assimilation Schedule | Snow Survey Schedule

Click On Map for Regional Analyses



Automated Model Discussion:
June 16, 2011

Area Covered By Snow:	2.3%
Area Covered Last Month:	5.3%
Snow Depth	
Average:	1.2 in
Minimum:	0.0 in
Maximum:	973.0 in
Std. Dev.:	9.6 in
Snow Water Equivalent	
Average:	0.5 in
Minimum:	0.0 in
Maximum:	509.0 in
Std. Dev.:	4.1 in

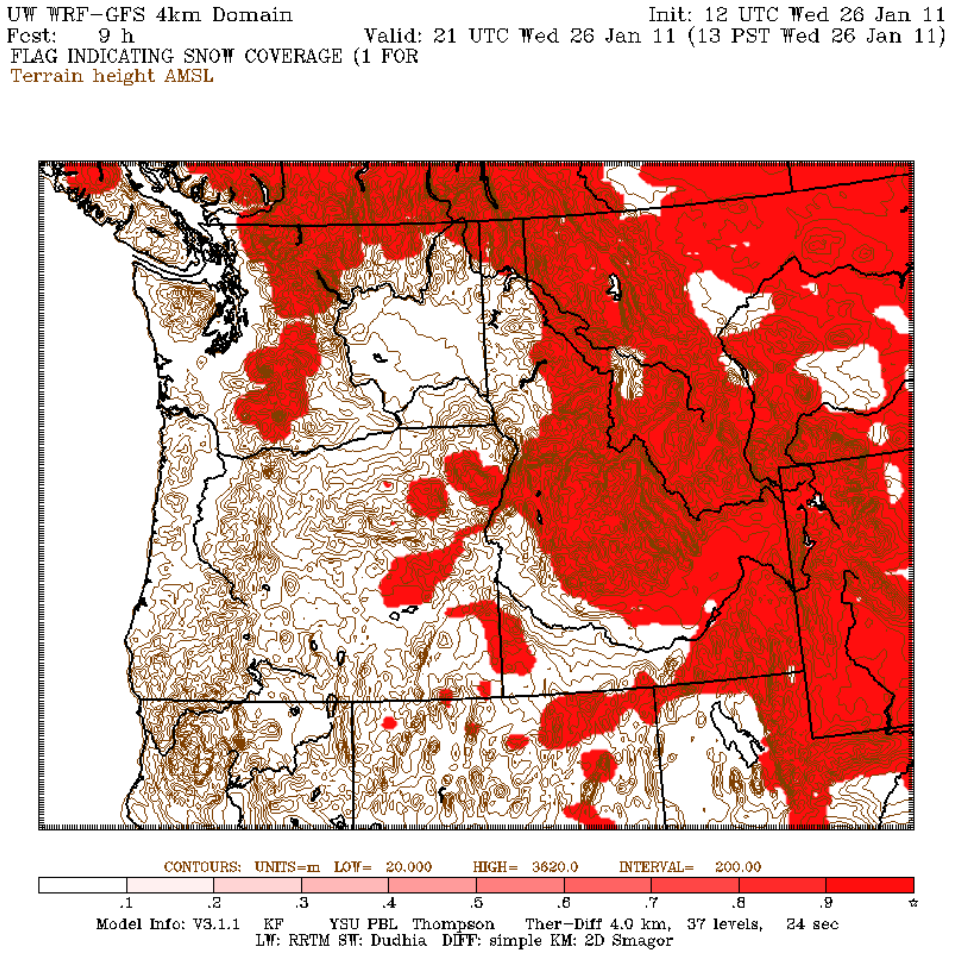
more... | Metric Units..

Select Region and Date

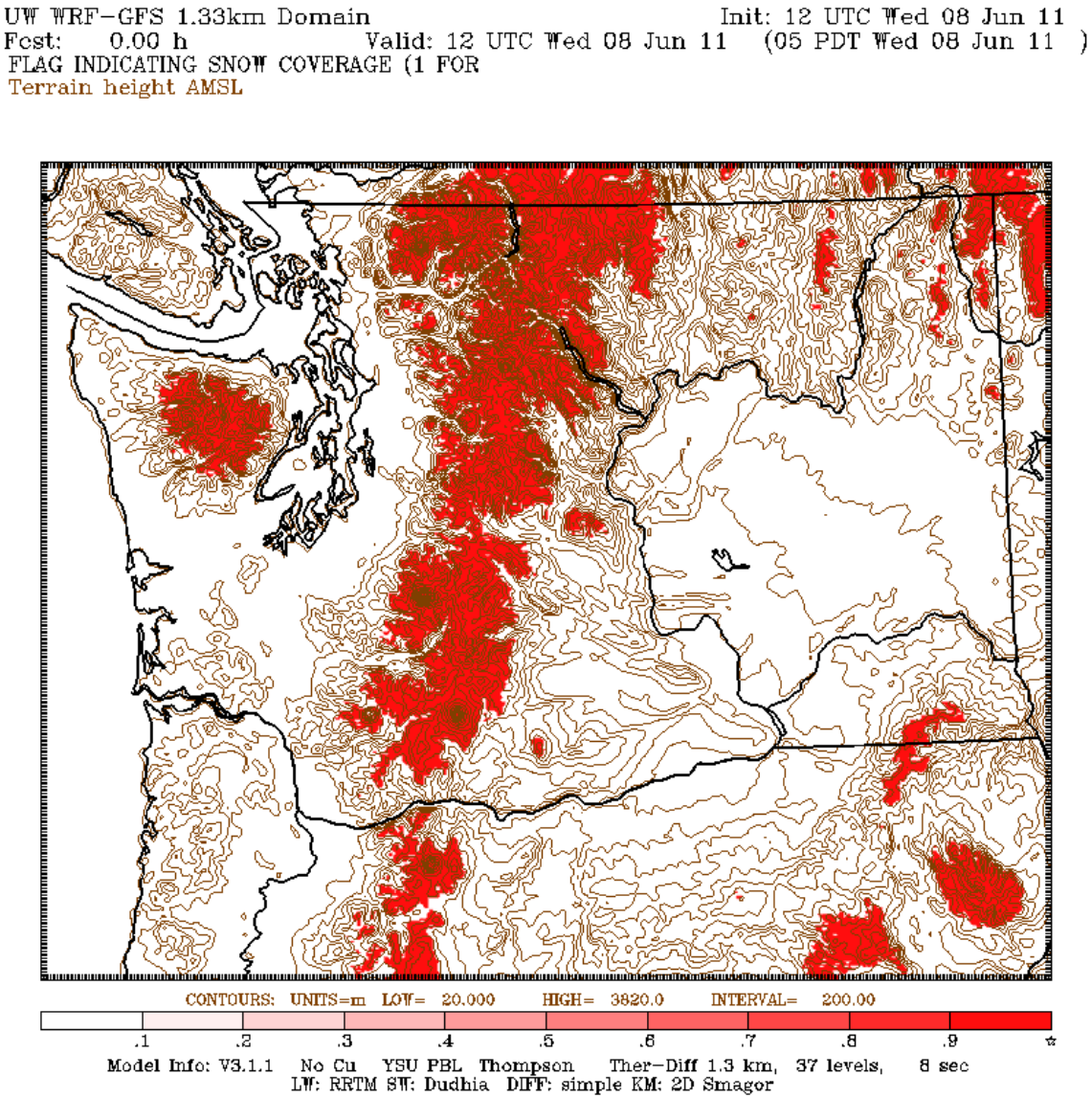
National | 2011 | June | 16 | - | + | Go

Snow Water Equivalent	Snow Depth	Average Snowpack Temp
		

NAM Snow Cover



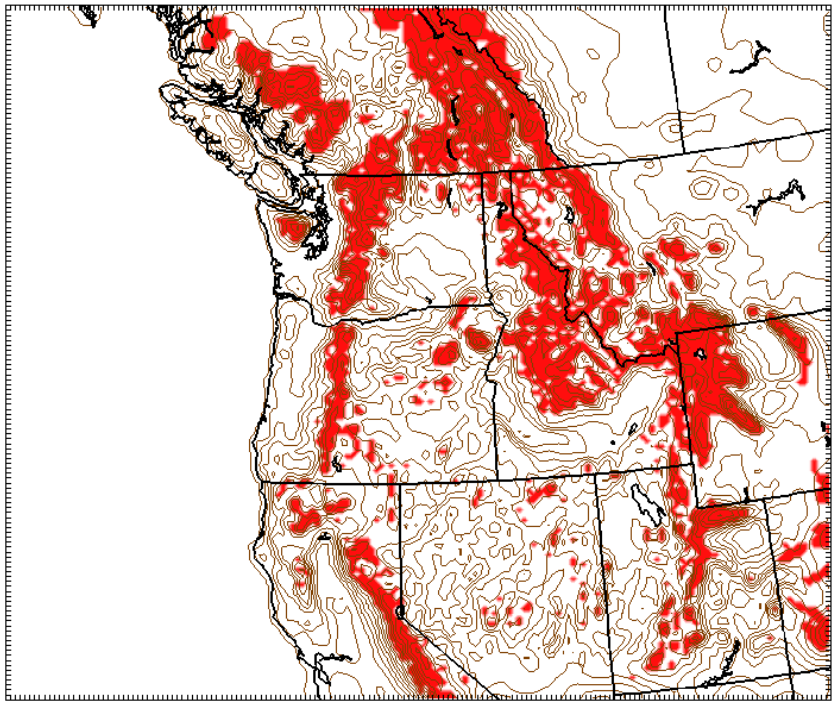
High-Resolution Snow Update Every Day



But With More Snowcover and Spring Coming on We Noticed a BIG Problem:

2-m temps—taken from YSU model—always near freezing over snow

UW WRF-GFS 12km Domain Init: 00 UTC Fri 13 May 11
Fcst: 24 h Valid: 00 UTC Sat 14 May 11 (17 PDT Fri 13 May 11)
FLAG INDICATING SNOW COVERAGE (1 FOR
Terrain height AMSL

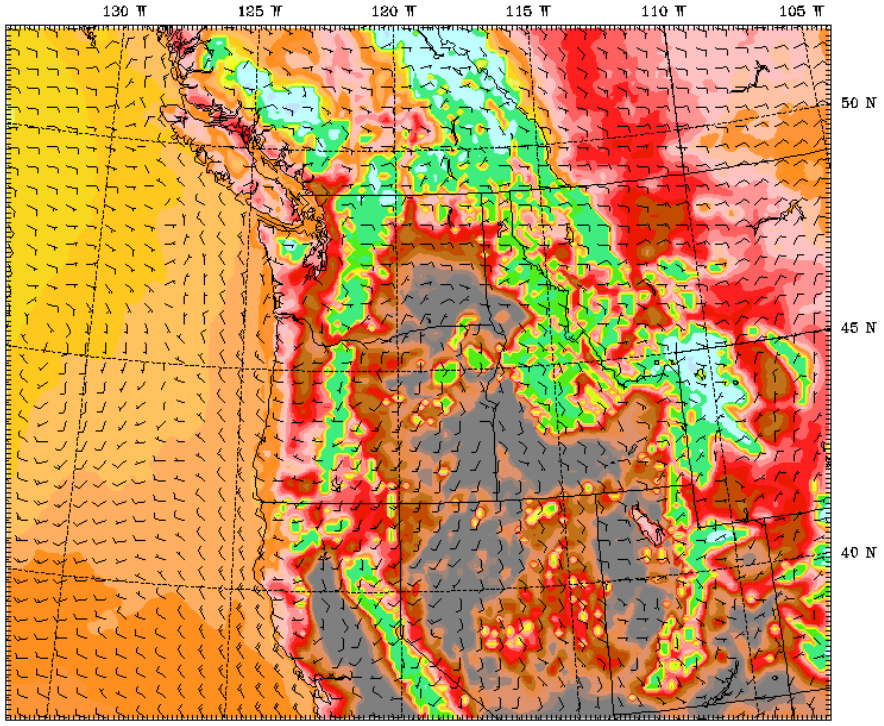


CONTOURS: UNITS=m LOW= 20.000 HIGH= 3420.0 INTERVAL= 200.00

.1 .2 .3 .4 .5 .6 .7 .8 .9

Model Info: V3.1.1 KF YSU PBL Thompson Ther-Diff 12 km, 37 levels, 72 sec
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

UW WRF-GFS 12km Domain
Fcst: 24 h
Init: 00 UTC Fri 13 May 11
Valid: 00 UTC Sat 14 May 11 (17 PDT Fri 13 May 11)
2m Temperature (°C) ------- 10m Wind (full barb = 10kts)



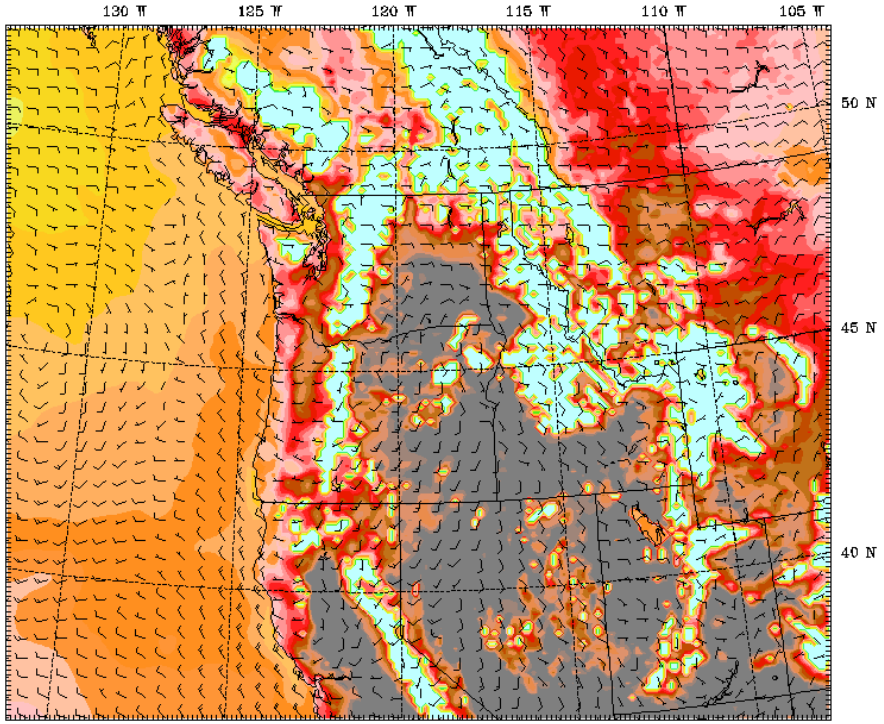
BARB VECTORS: FULL BARB = 10 kts

-21 -18 -15 -12 -9 -6 -3 0 3 6 9 12 15 18 21 24 27 30 33 °C

Model Info: V3.1.1 KF YSU PBL Thompson Ther-Diff 12 km, 37 levels, 72 sec
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

UW WRF-GFS 12km Domain
Fcst: 24 h
Ground/sea-surface temperature

Init: 00 UTC Fri 13 May 11
Valid: 00 UTC Sat 14 May 11 (17 PDT Fri 13 May 11)

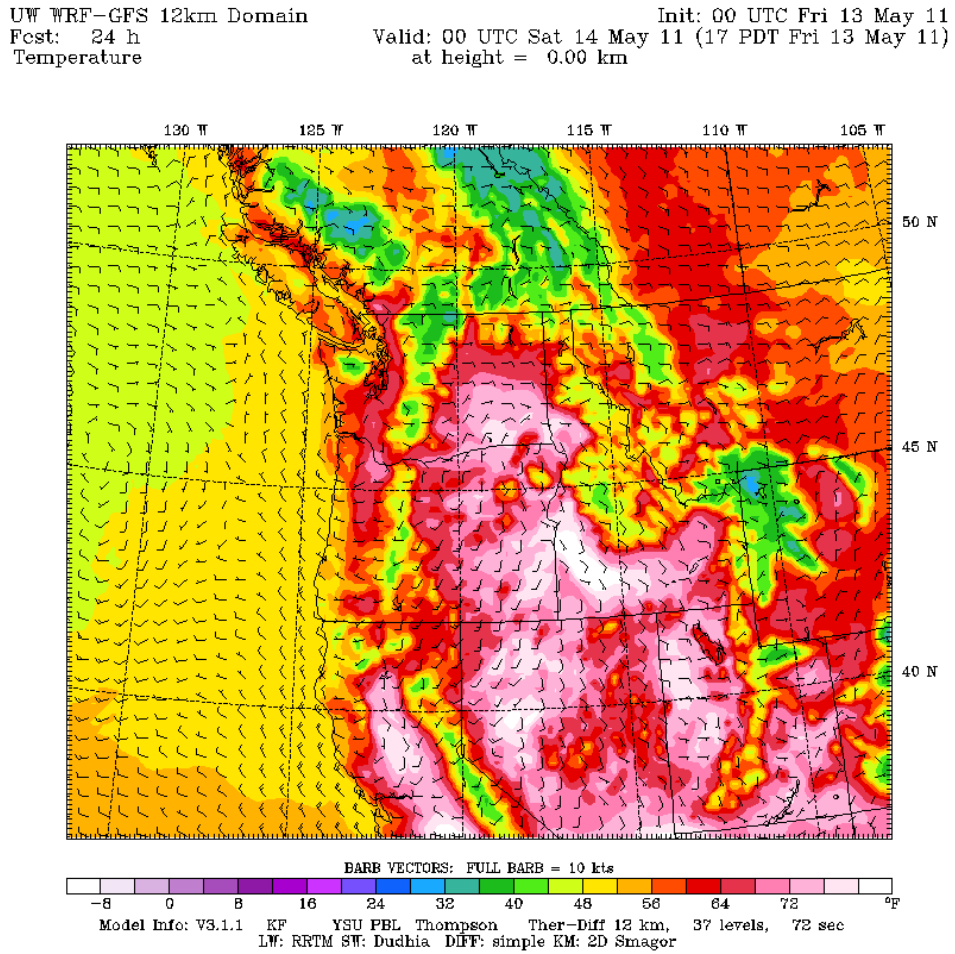


BARB VECTORS: FULL BARB = 10 kts

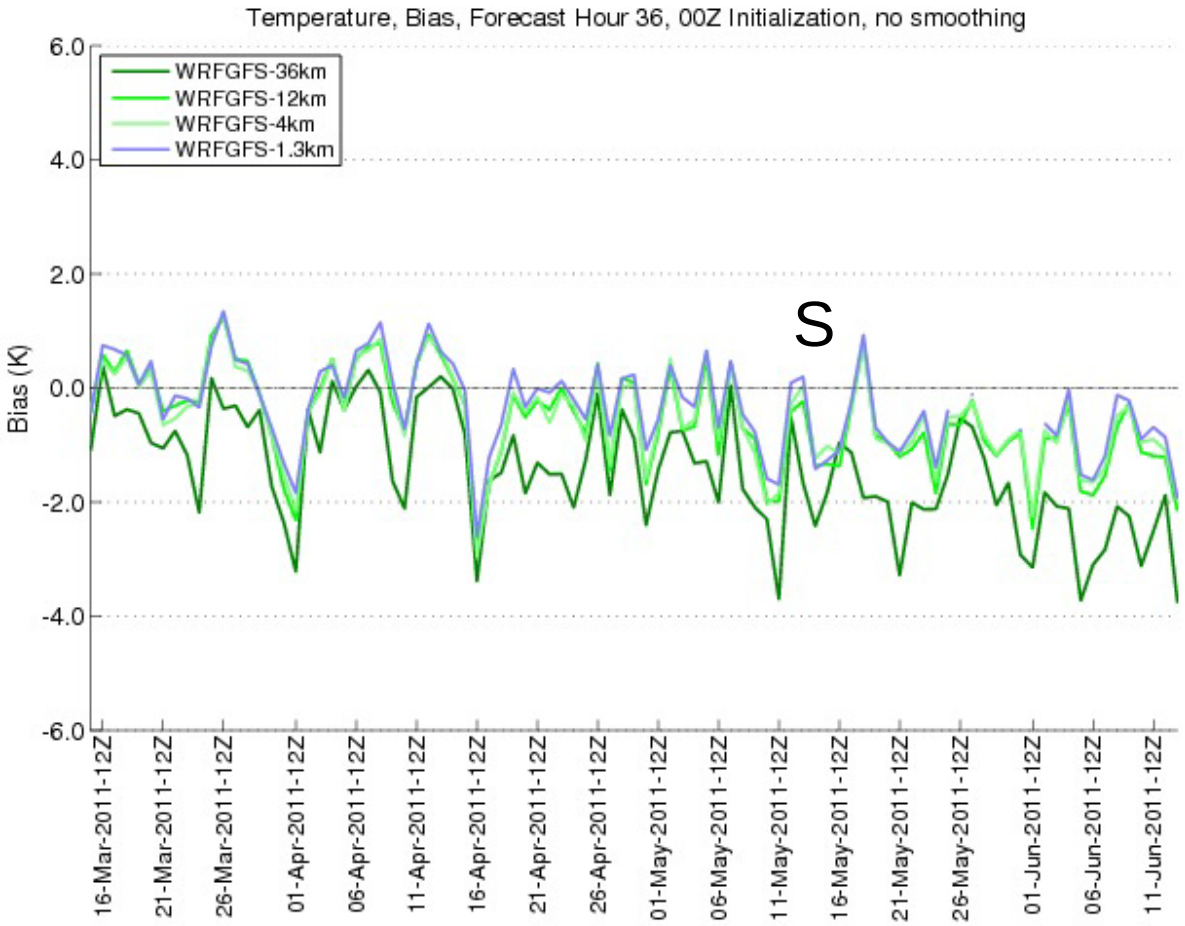
−21 −18 −15 −12 −9 −6 −3 0 3 6 9 12 15 18 21 24 27 30 33 °C

Model Info: V3.1.1 KF YSU PBL Thompson Ther-Diff 12 km, 37 levels, 72 sec
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

After talking to WRF folks—like Jimy-- who confirmed there is a problem with 2-m temp output, switched to lowest model level—roughly 19 m



Small Impact on Verification Scores



Conclusions

- UW 1.3 km is now stable and looking very good.
- Verifications look promising
- Still the issue of cold temperatures with NOAH LSM over snow

The End