

Beyond Cold Starts

Improving WRF Forecasts of Pacific Stratus with Rapid Refresh Initializations

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Is there an easy way to get beyond cold starts?

- For many WRF applications, users take either of two routes:
 - Cold start using GFS, ECMWF, or other operational model grids
 - High-resolution data assimilation with local data assets using WRFDA, DART EnKF, or something else.
- Today, there is another possibility over much of North America: **high-resolution initialization using NOAA Rapid Refresh grids.**

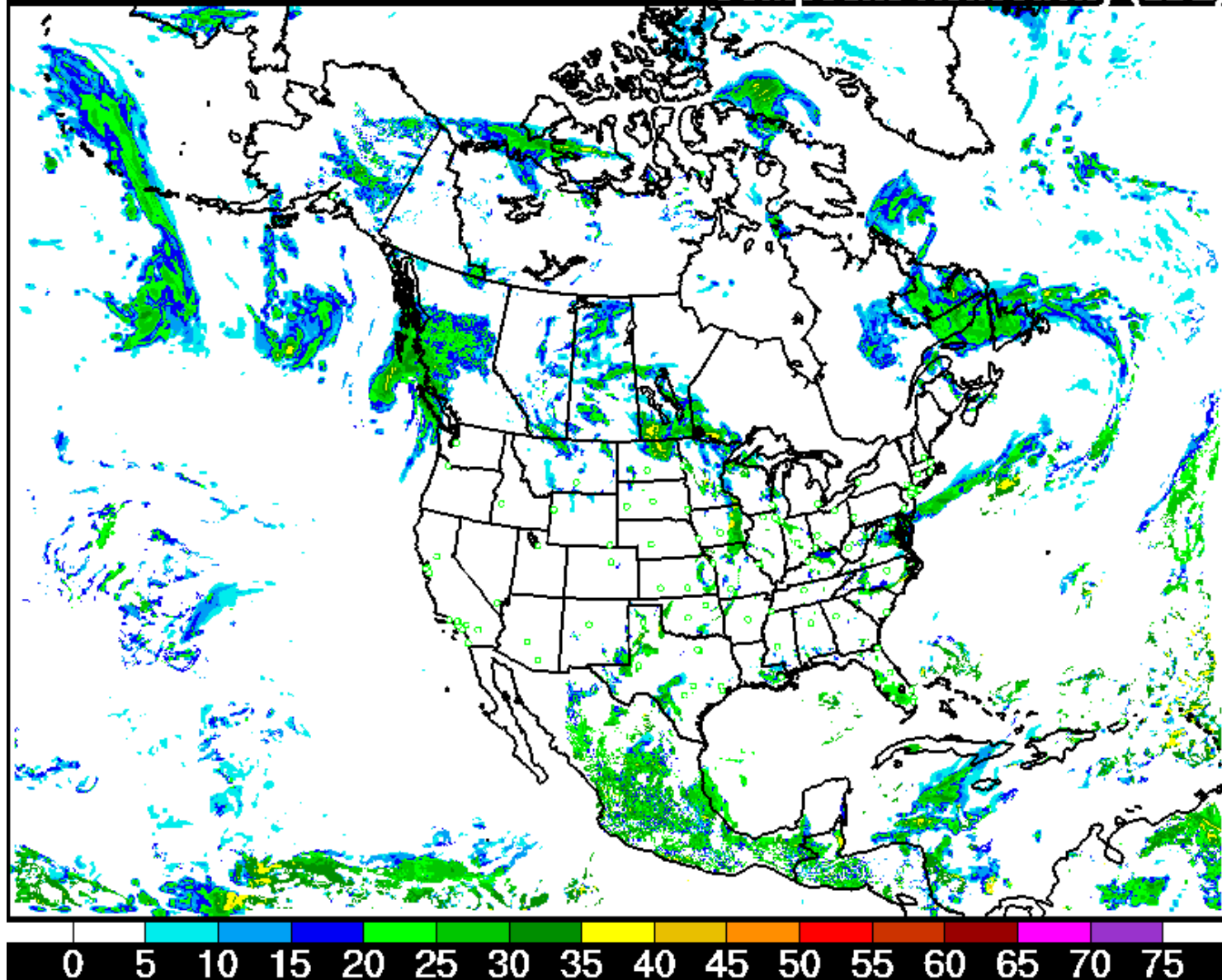
Mesoscale Data Assimilation:

Why not let someone else do the hard work?

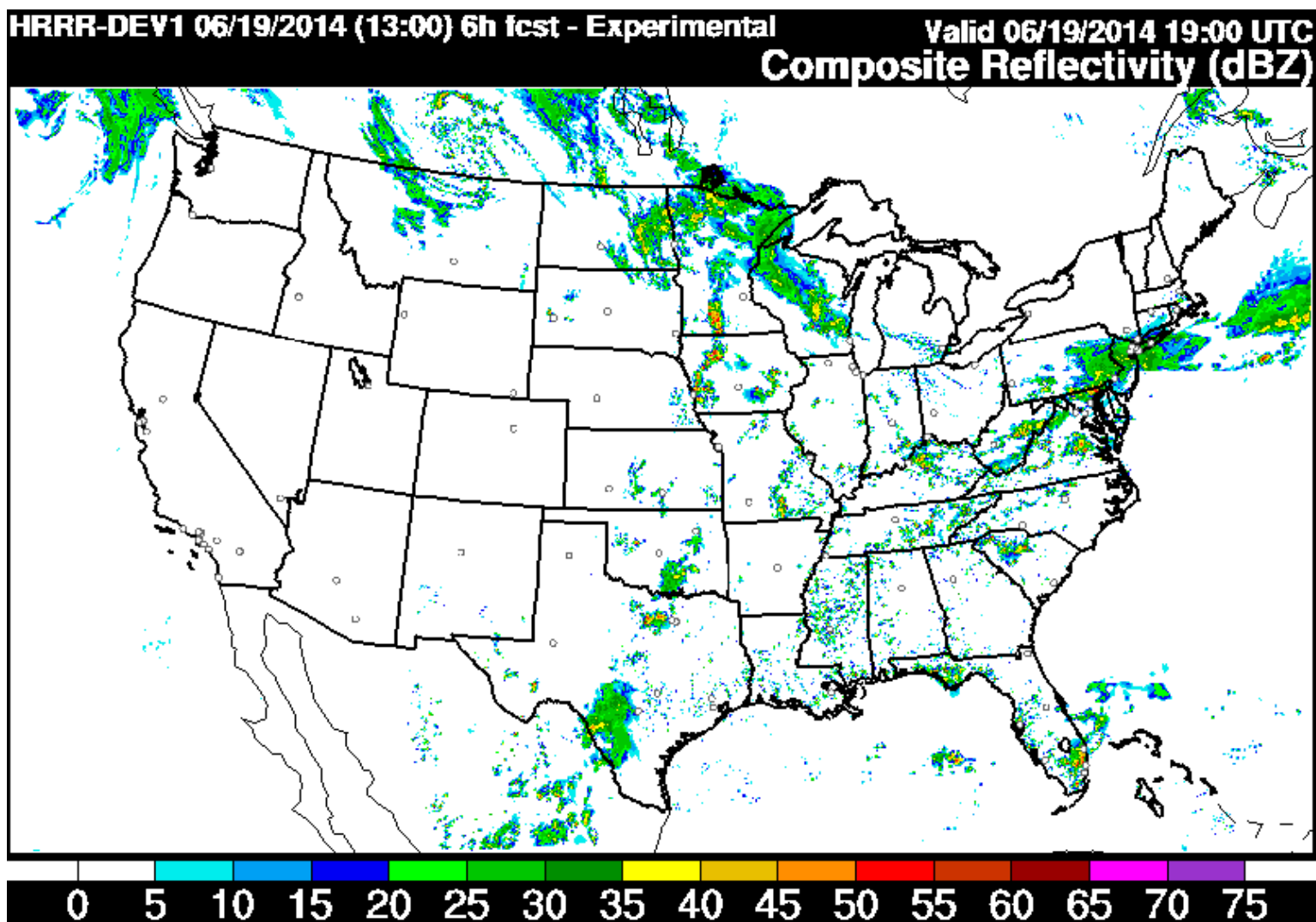
- The NOAA/NWS runs the Rapid Refresh (RR) and High Resolution Rapid Refresh (HRRR) systems hourly, completing analyses and short-term forecasts.
 - RR: 13 km grid spacing, 18 hr forecast
 - HRRR, 3-km grid spacing, 15 hr forecast
- Both make use a wide variety of mesoscale data sources, including radar, satellite, mesonets, soundings, aircraft data, and more.

RAP-primary-ESRL 06/19/2014 (16:00) 7h fcst - Experimental Valid 06/19/2014 23:00 UTC
Composite Reflectivity (dBZ)

Rapid
Refresh



HRRR

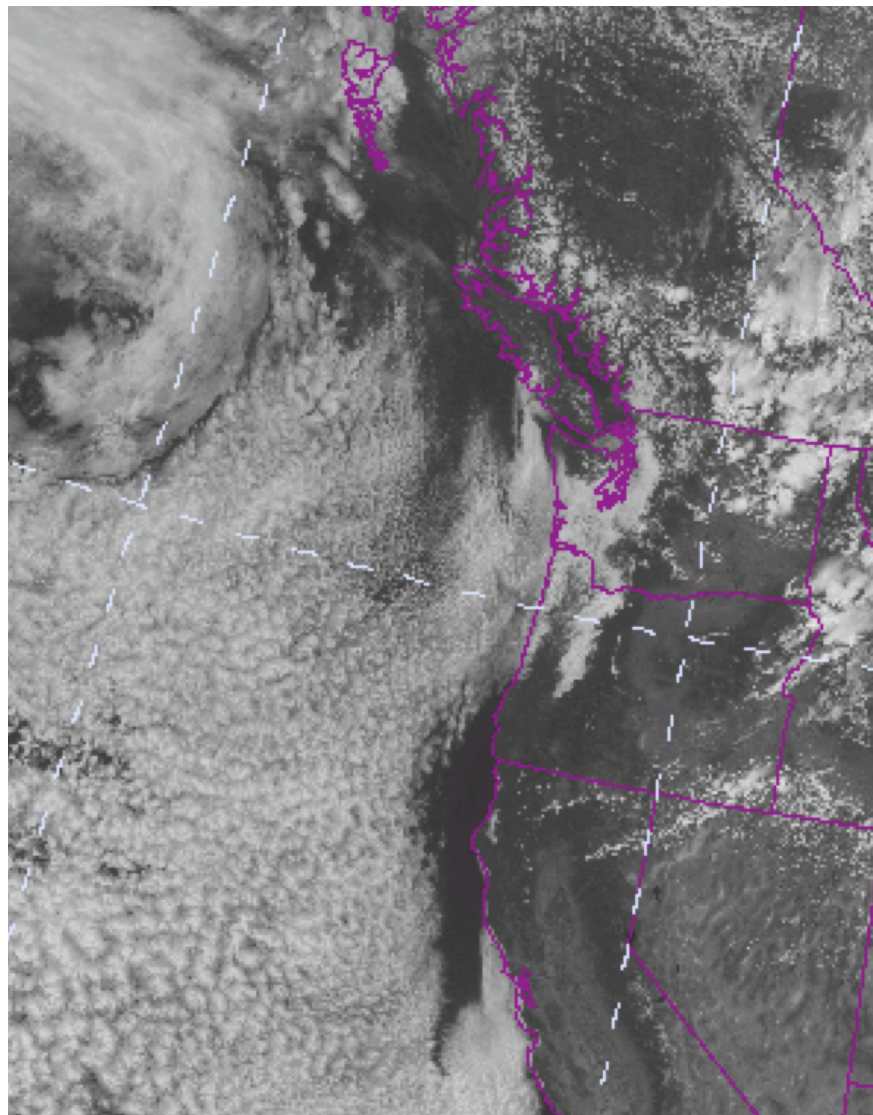


Rapid Refresh for WRF Initialization

- Rapid Refresh has become substantially more realistic and skillful during the last few years.
- But hard to prove this from stats on their web site!
- Rapid Refresh 3-D grids are available.
- RR is based on WRF, so fewer incompatibilities.
- So why not try using RR grids for initialization of WRF?

**A test: Can mesoscale
initialization from RR help with
coastal stratus, a major problem
for the Northwest real-time WRF?**

**June 3, 2014
21 UTC**

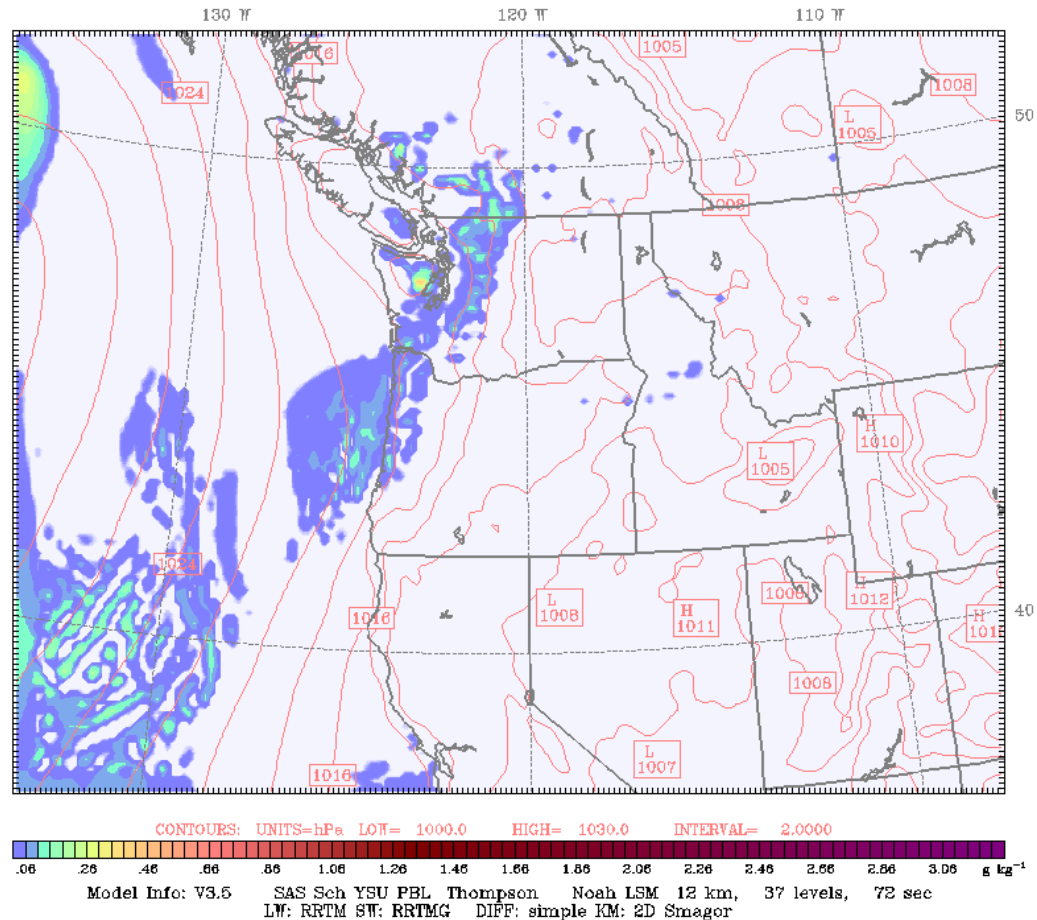


Four Runs

- UW Real-time WRF initialized with GFS using YSU PBL, Thompson microphysics, NOAA LSM, SAS Cumulus Param. , RRTM radiation
- UW Real-Time WRF with same physics, but initialized with Rapid Refresh grids
- WRF with old RR physics (RUC LSM, MYJ PBL, G3 CU, Thompson Micro) and new (MYNN, GF CU), both with Rapid Refresh initialization
- All 12km, 37 levels, 10 levels below 900 hPa.

GFS Initialization, 21h forecast

UW WRF-GFS 12km Domain
Fest: 21 h
Valid: 21 UTC Tue 03 Jun 14 (14 PDT Tue 03 Jun 14)
Init: 00 UTC Tue 03 Jun 14
Average cloud mixing ratio (g/kg) 0-3K ft above surface
Sea Level Pressure (hPa)



Using Rapid Refresh Initialization, Same Physics

UW WRF-GFS 12km Domain

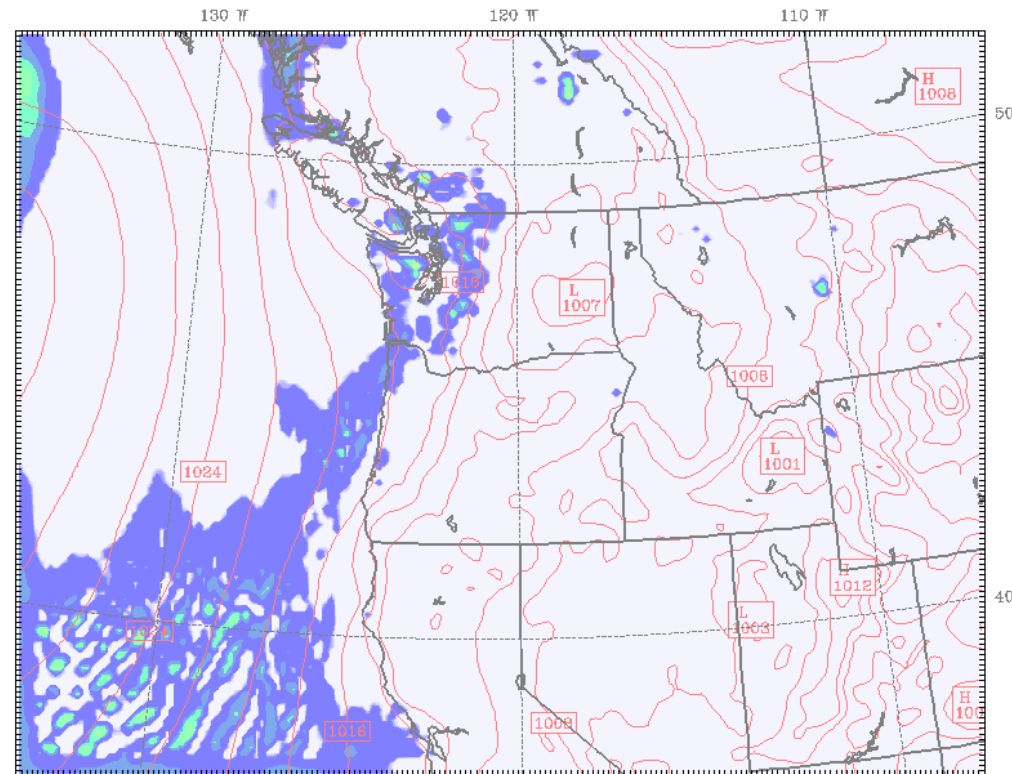
Init: 00 UTC Tue 03 Jun 14

Fcst: 21 h

Valid: 21 UTC Tue 03 Jun 14 (14 PDT Tue 03 Jun 14)

Average cloud mixing ratio (g/kg) 0-3K ft above surface

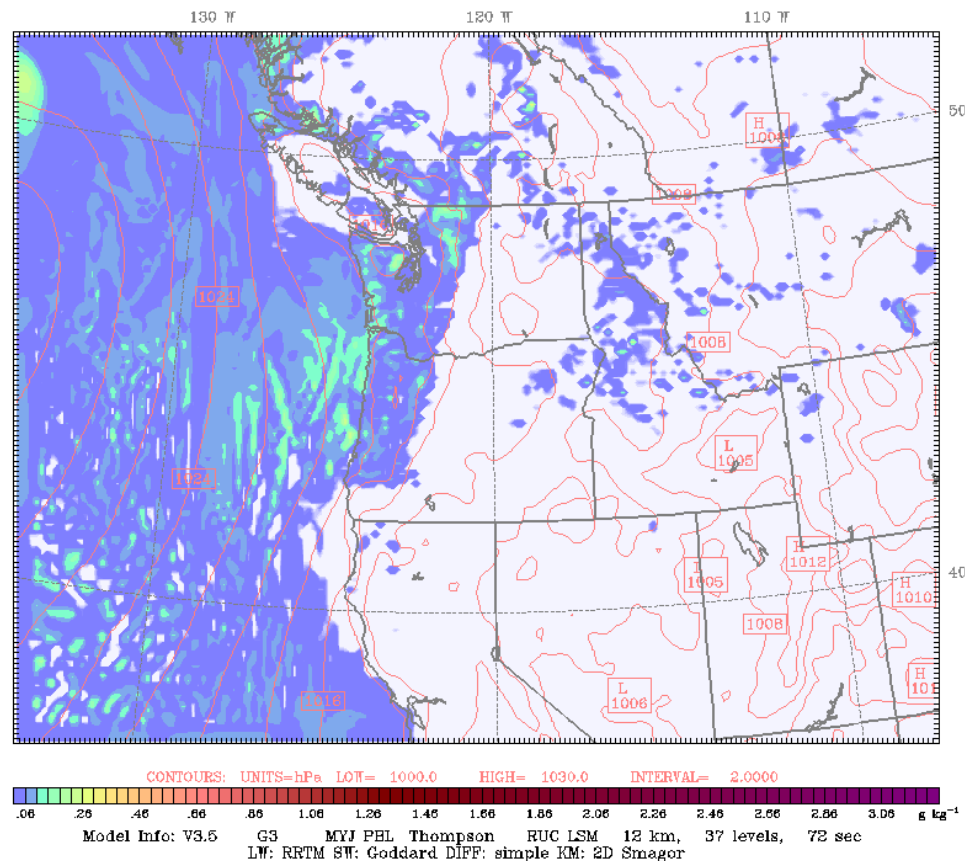
Sea Level Pressure (hPa)



Model Info: V3.5 SAS Sch MYJ PBL Thompson RUC LSM 12 km, 37 levels, 72 sec
LW: RRTM SW: Goddard DIFF: simple KM: 2D Smagor

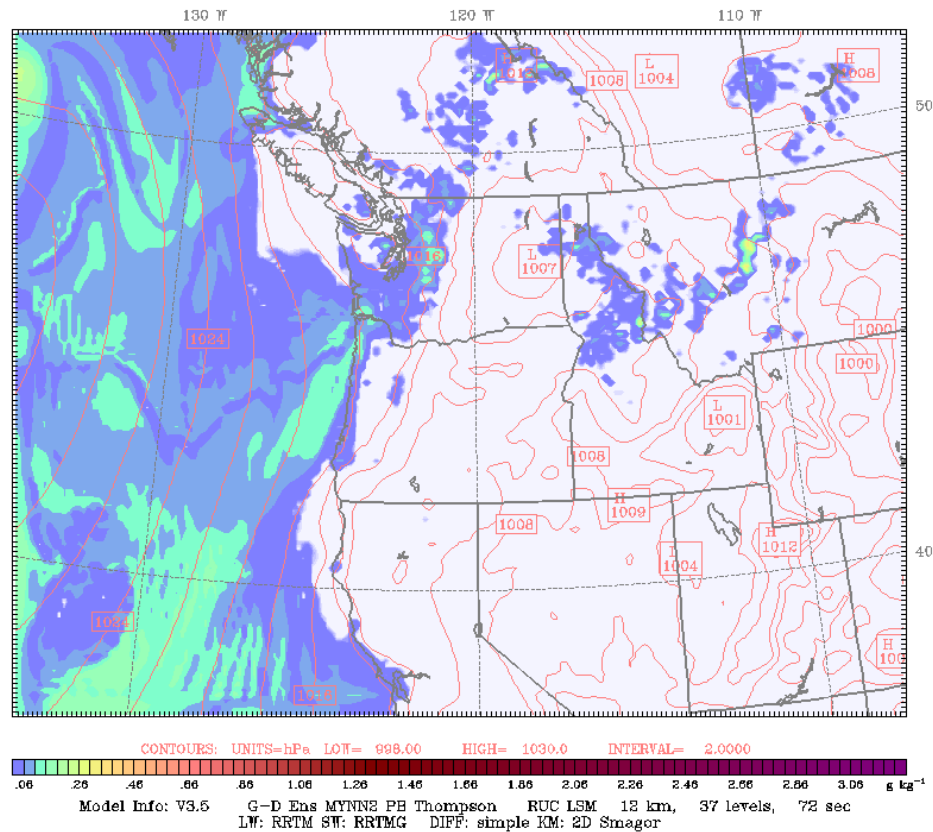
Using Rapid Refresh Initialization and Old Rapid Refresh Physics

UW WRF-GFS 12km Domain Init: 00 UTC Tue 03 Jun 14
Fcst: 21 h Valid: 21 UTC Tue 03 Jun 14 (14 PDT Tue 03 Jun 14)
Average cloud mixing ratio (g/kg) 0-3K ft above surface
Sea Level Pressure (hPa)



With New (V2) RR Physics

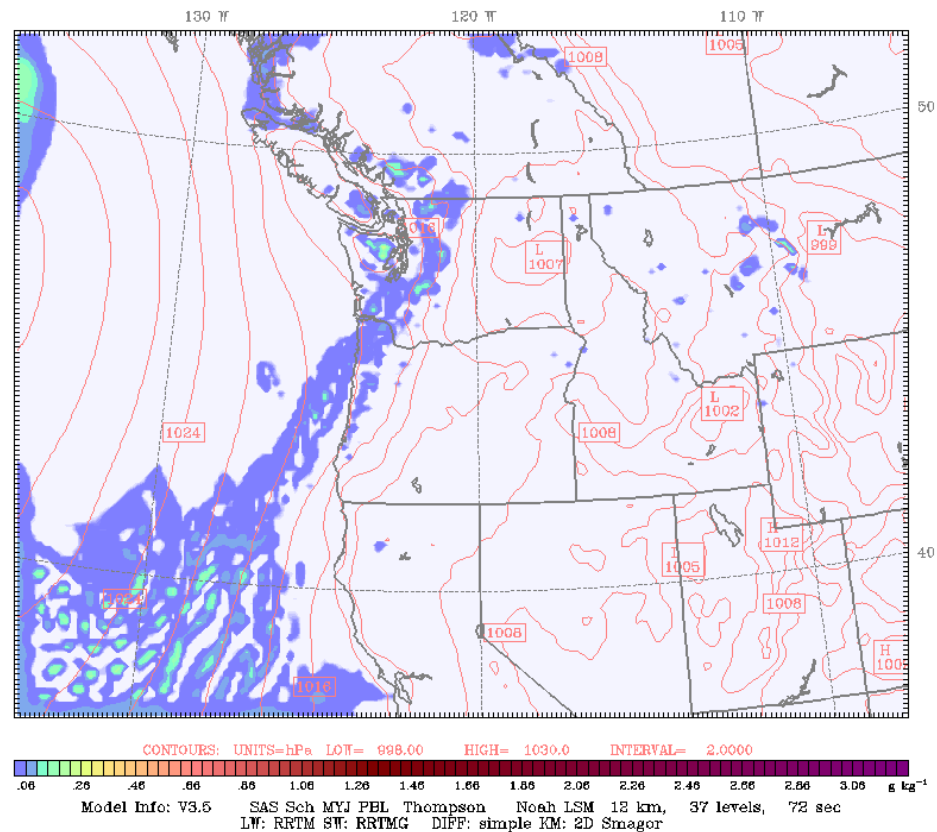
wrfrapphys 12km Domain
Fcst: 21 h
Valid: 21 UTC Tue 03 Jun 14 (14 PDT Tue 03 Jun 14)
Init: 00 UTC Tue 03 Jun 14
Average cloud mixing ratio (g/kg) 0-3K ft above surface
Sea Level Pressure (hPa)



**What are the physics changes that
really counted?**

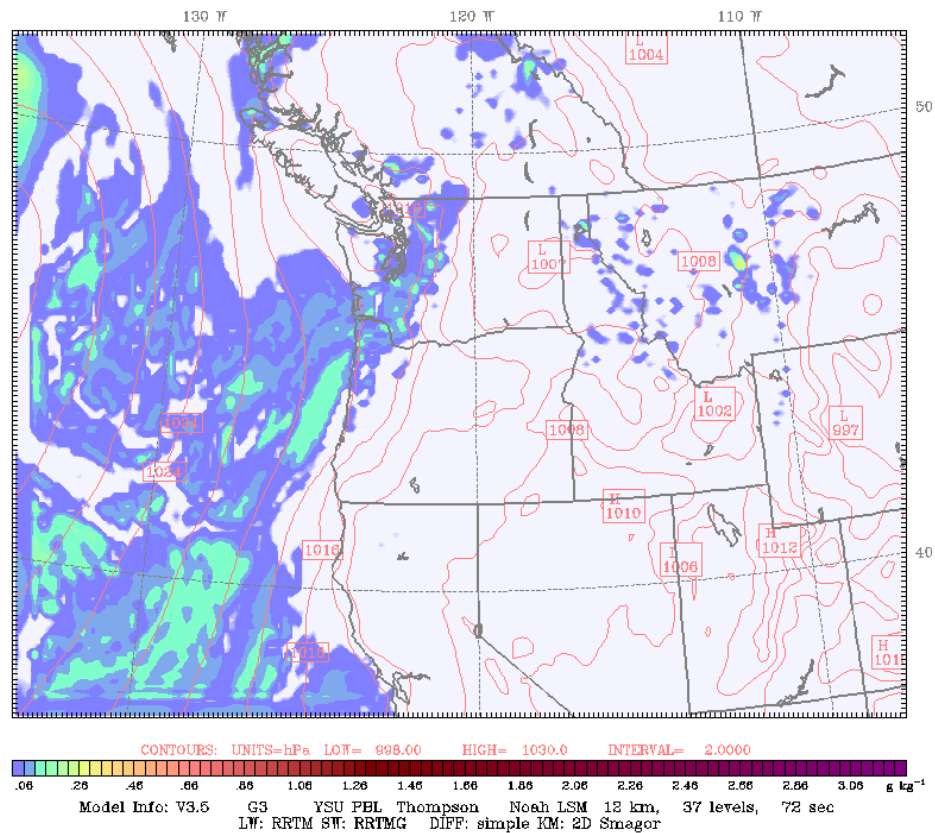
YSU to MYJ PBL (RR initialization)

wrfrapmyj 12km Domain
Fcst: 21 h
Valid: 21 UTC Tue 03 Jun 14 (14 PDT Tue 03 Jun 14)
Init: 00 UTC Tue 03 Jun 14
Average cloud mixing ratio (g/kg) 0–3K ft above surface
Sea Level Pressure (hPa)



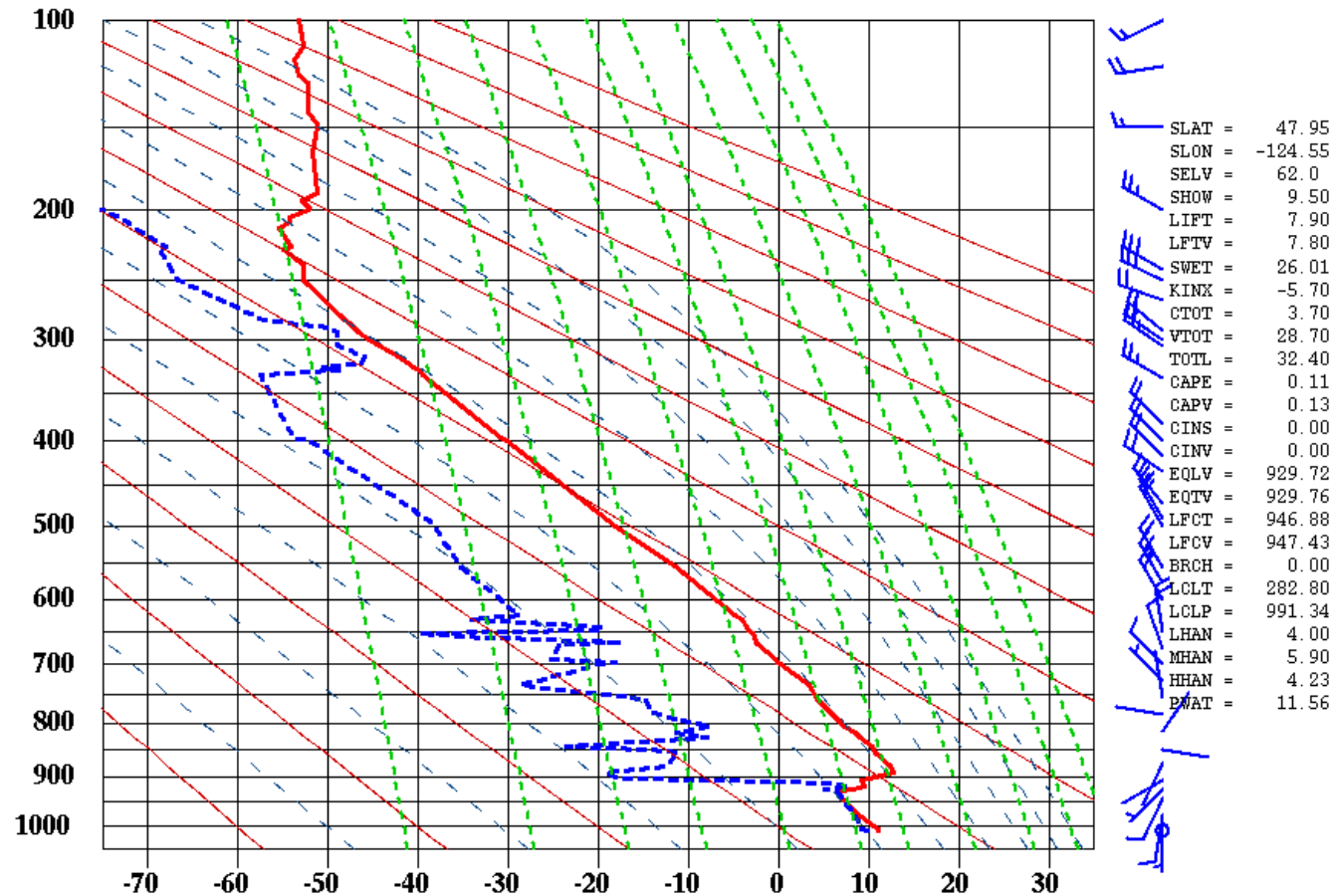
SAS CU to Grell (G3)

UW WRF-GFS 12km Domain Init: 00 UTC Tue 03 Jun 14
Fest: 21 h Valid: 21 UTC Tue 03 Jun 14 (14 PDT Tue 03 Jun 14)
Average cloud mixing ratio (g/kg) 0–3K ft above surface
Sea Level Pressure (hPa)



Observed Sounding at Quillayute on the Washington Coast: 6/4/13 at 12UTC

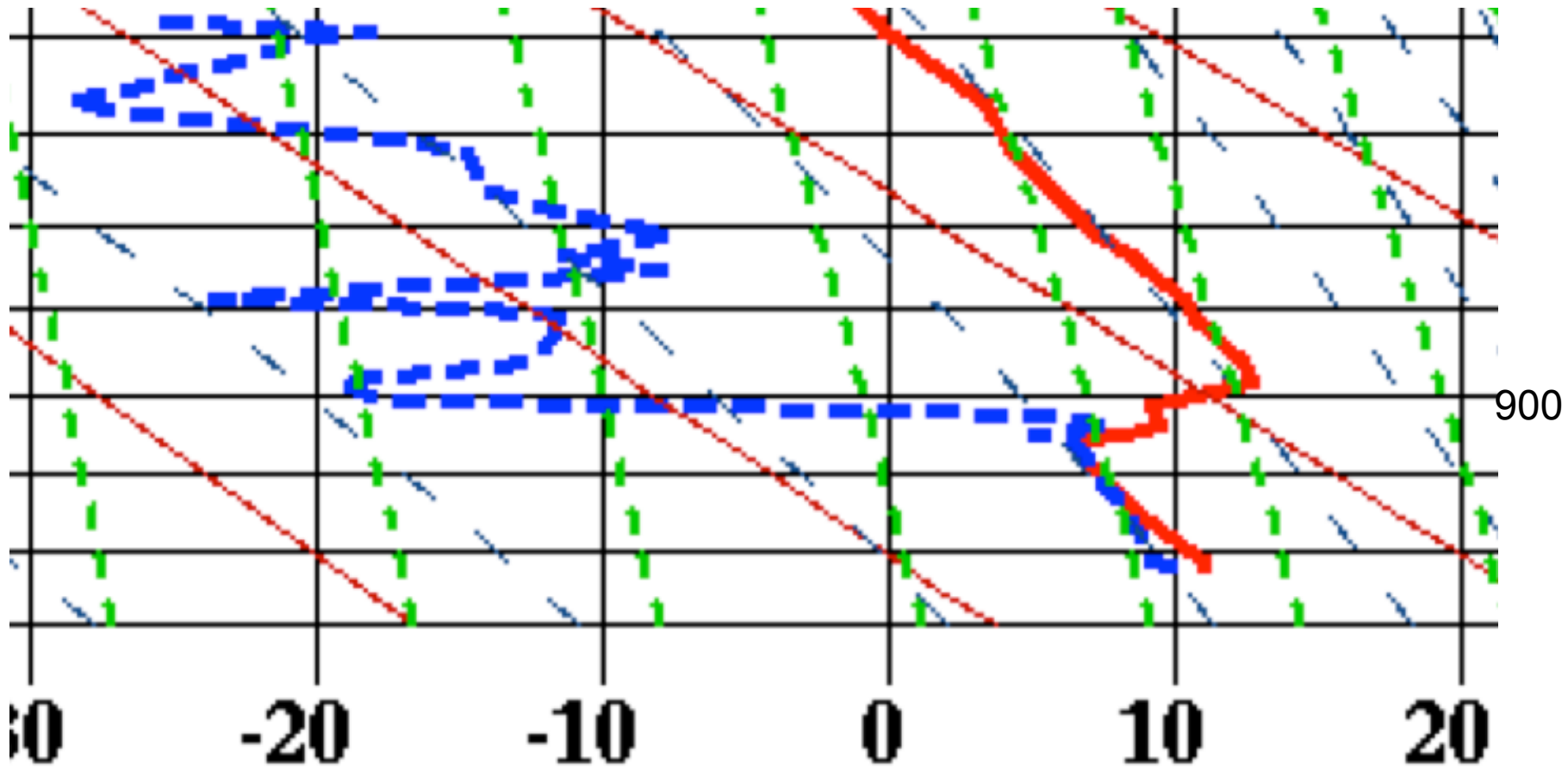
140603/1200 72797 UIL



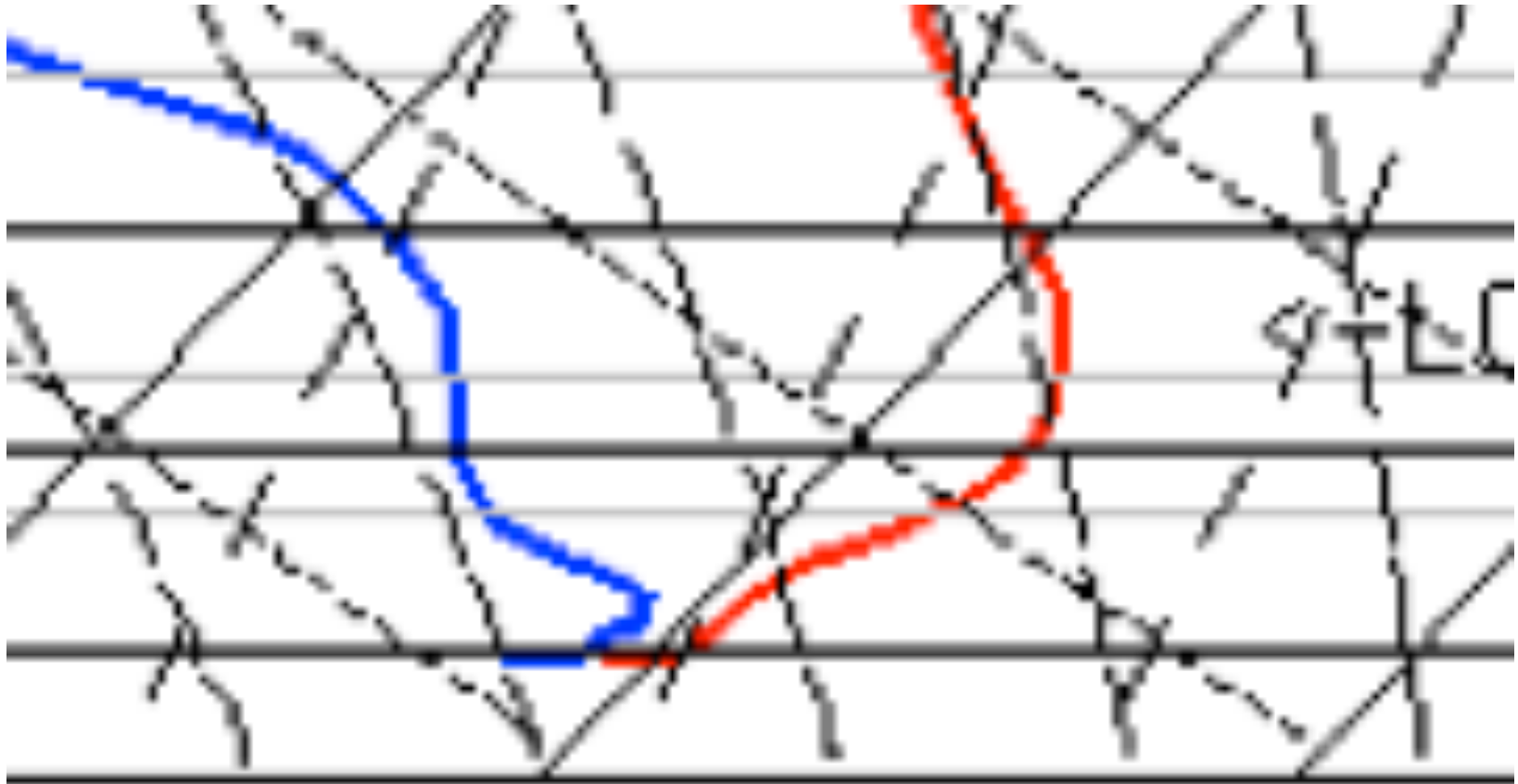
12Z Tue 03 Jun 2014

University of Washington

Observed Sounding

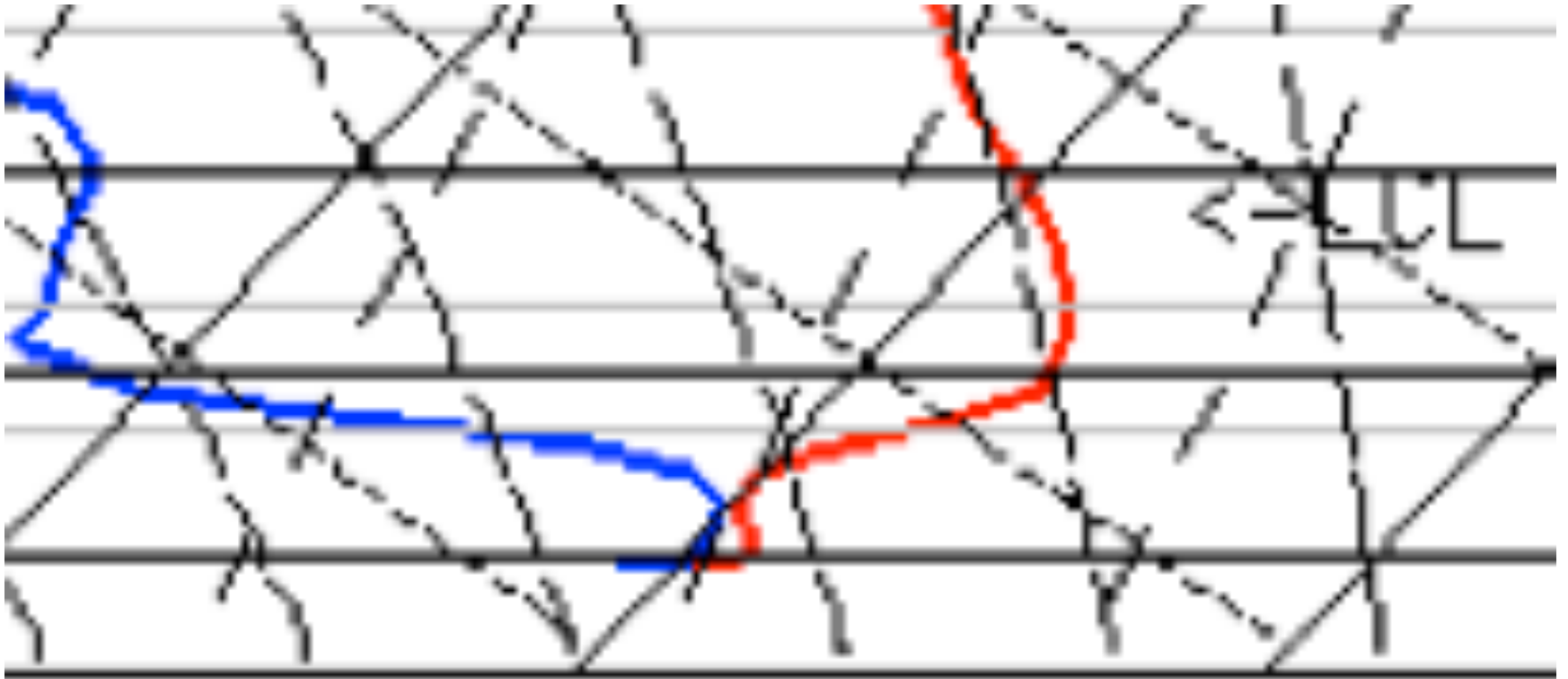


GFS Initialization, Standard Physics

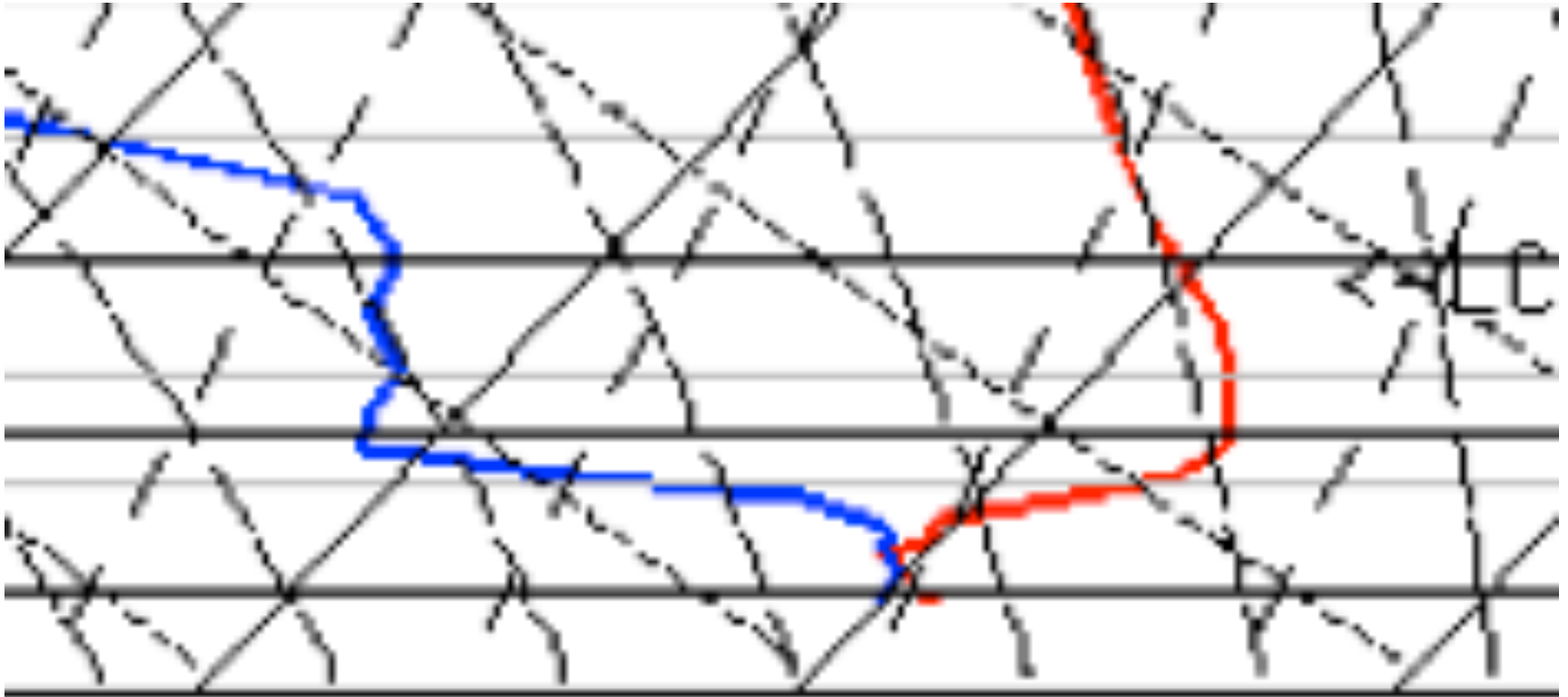


925

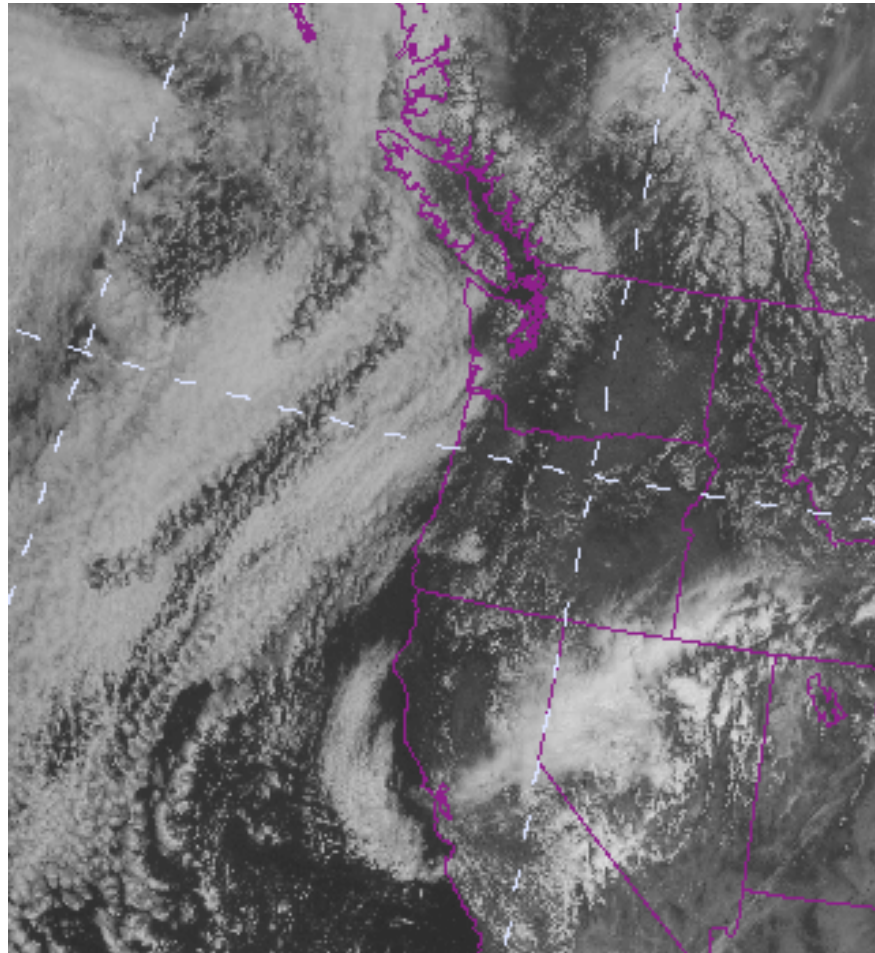
Using RAP initialization



RAP Initialization, RR Physics



May 20th, 18 UTC



GFS Init, Standard, 6h

UW WRF-GFS 12km Domain

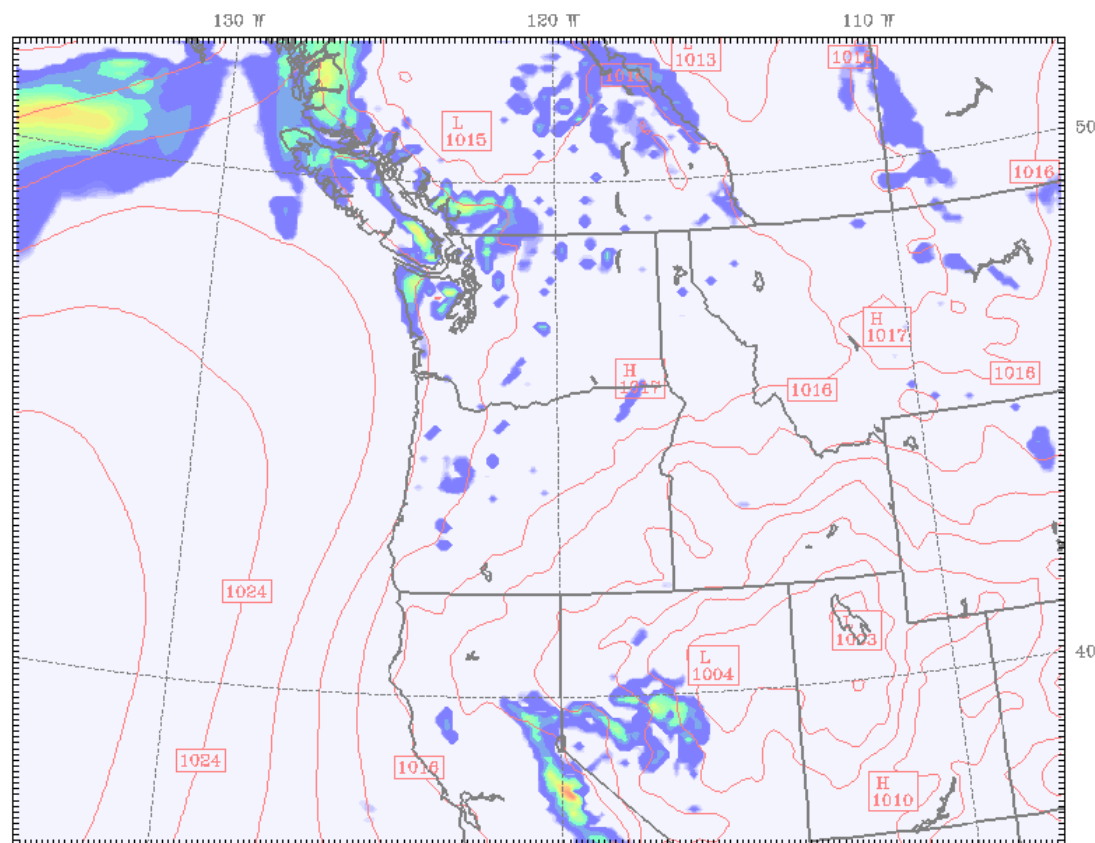
Init: 12 UTC Tue 20 May 14

Fcst: 6 h

Valid: 18 UTC Tue 20 May 14 (11 PDT Tue 20 May 14)

Average cloud mixing ratio (g/kg) 0-3K ft above surface

Sea Level Pressure (hPa)



CONTOURS: UNITS=hPa LOW= 1004.0 HIGH= 1028.0 INTERVAL= 2.0000

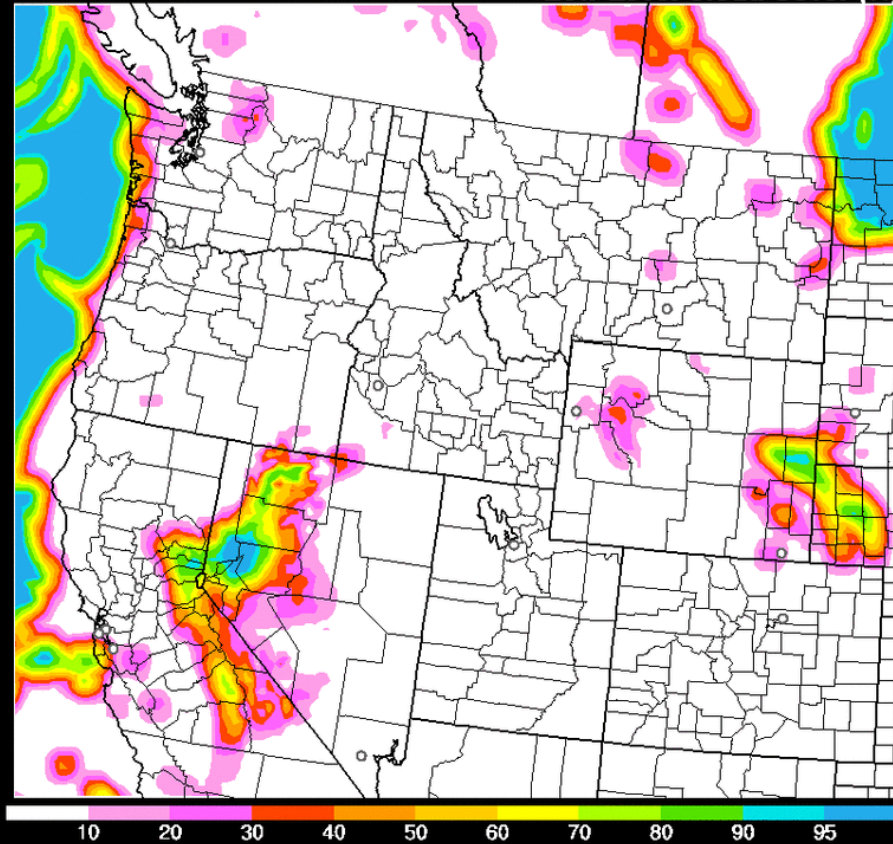
Model Info: V3.5 SAS Sch YSU PBL Thompson Noah LSM 12 km, 37 levels, 72 sec
LW: RRTM SW: RRTMG DIFF: simple KM: 2D Smagor

RR at Same Time: Clouds!

RAP-primary-ESRL 05/20/2014 (12:00) 6 hr fcst

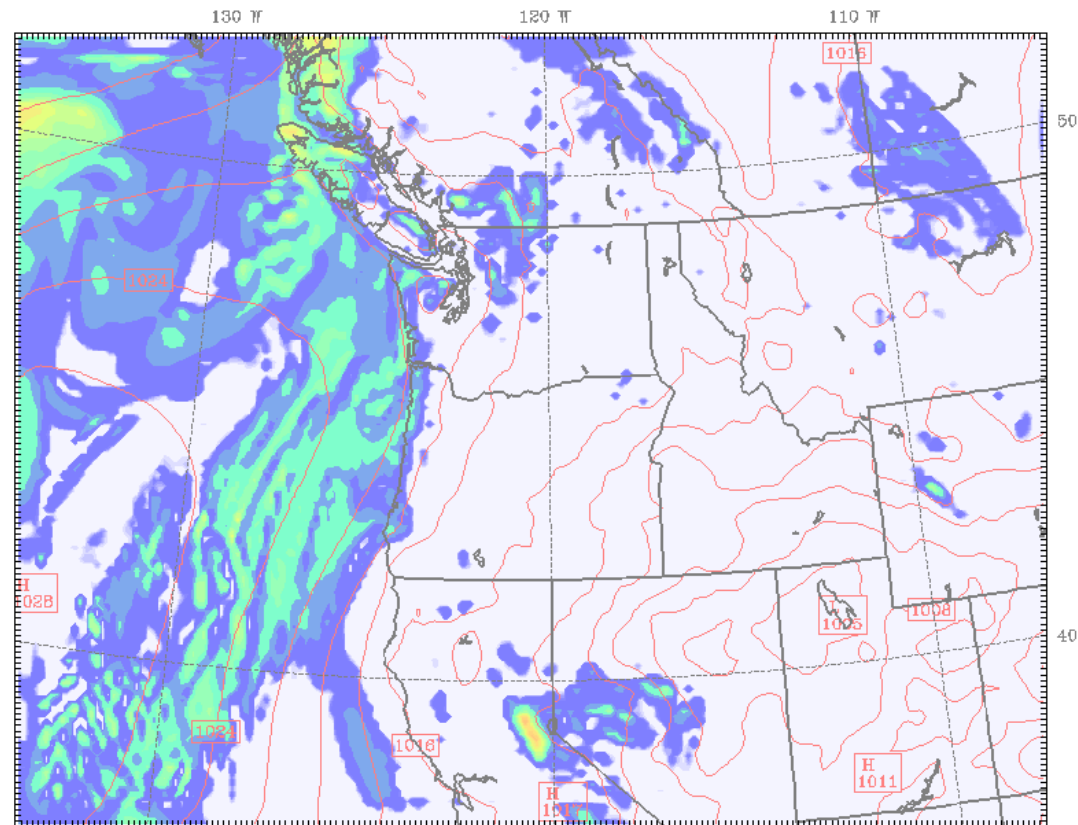
Valid 05/20/2014 18:00 UTC

Low-Level Cloud Cover (%)



RR Initialization, Standard Physics

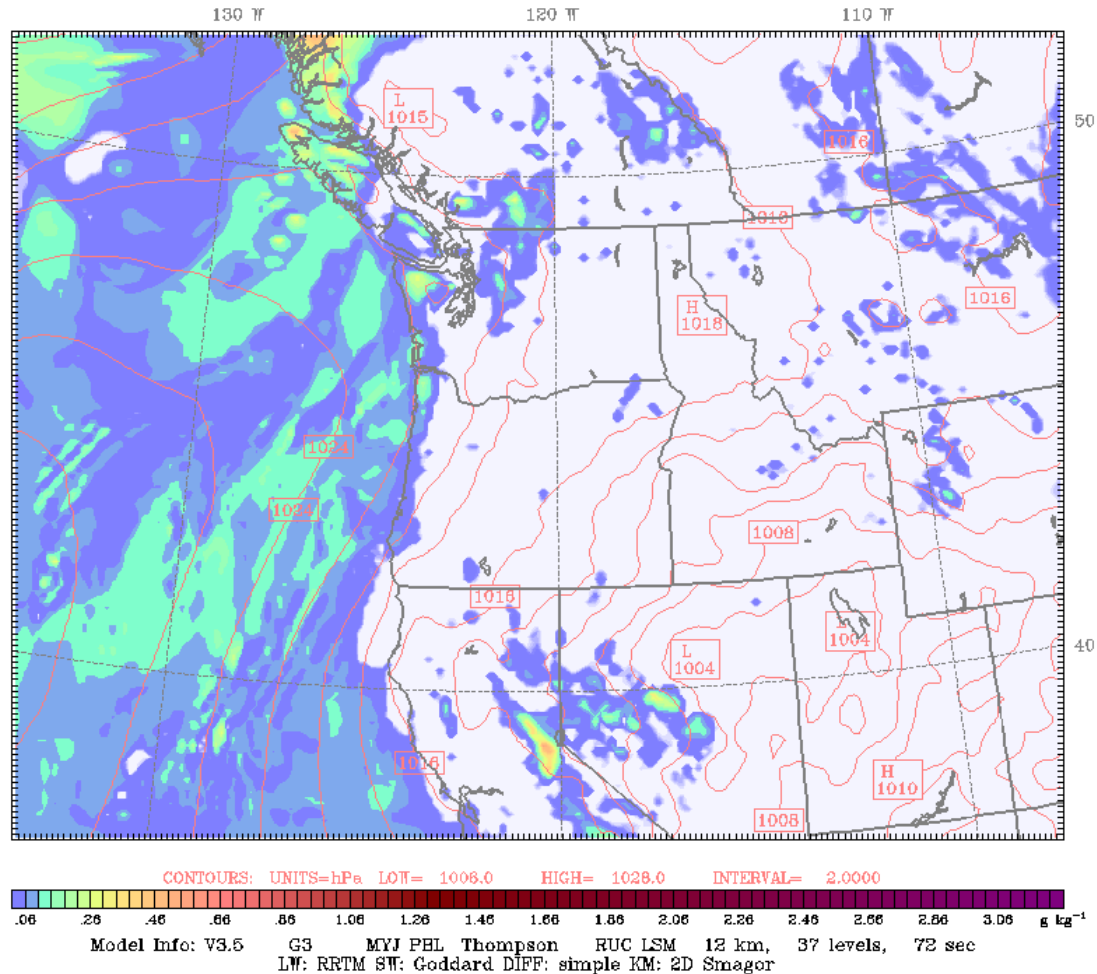
wrfrap221p130pgfs 12km Domain
Fest: 6 h Init: 12 UTC Tue 20 May 14
Valid: 18 UTC Tue 20 May 14 (11 PDT Tue 20 May 14)
Average cloud mixing ratio (g/kg) 0-3K ft above surface
Sea Level Pressure (hPa)



CONTOURS: UNITS=hPa LOW= 1008.0 HIGH= 1028.0 INTERVAL= 2.0000
Model Info: V3.5 SAS Sch YSU PBL Thompson Noah LSM 12 km, 37 levels, 72 sec
LW: RRTM SW: RRTMG DIFF: simple KM: 2D Smagor g kg^{-1}

RR Init, Old RR Physics

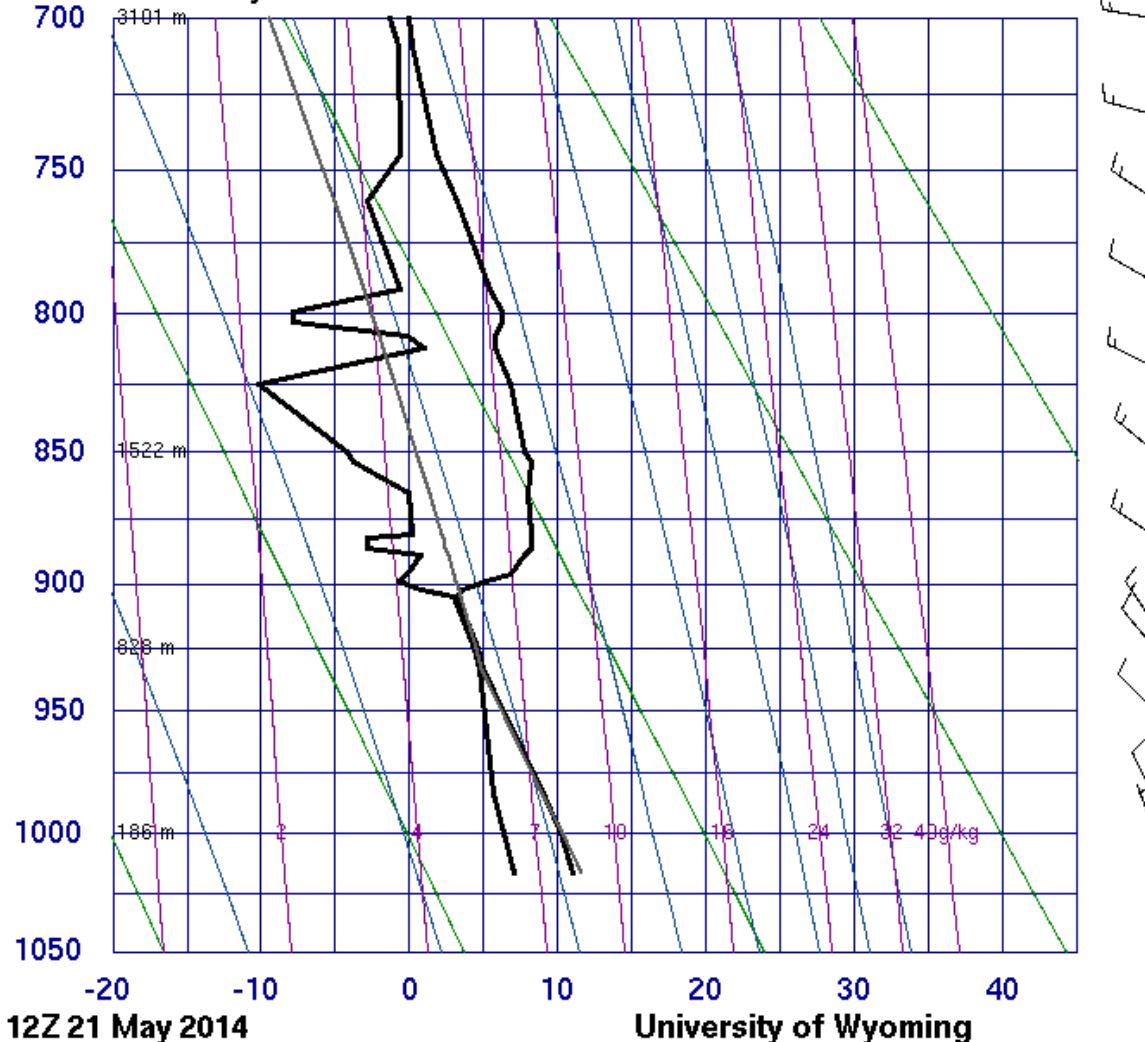
wrfrucphys 12km Domain
Fest: 6 h
Valid: 18 UTC Tue 20 May 14 (11 PDT Tue 20 May 14)
Init: 12 UTC Tue 20 May 14
Average cloud mixing ratio (g/kg) 0-3K ft above surface
Sea Level Pressure (hPa)



What about the next morning? 12

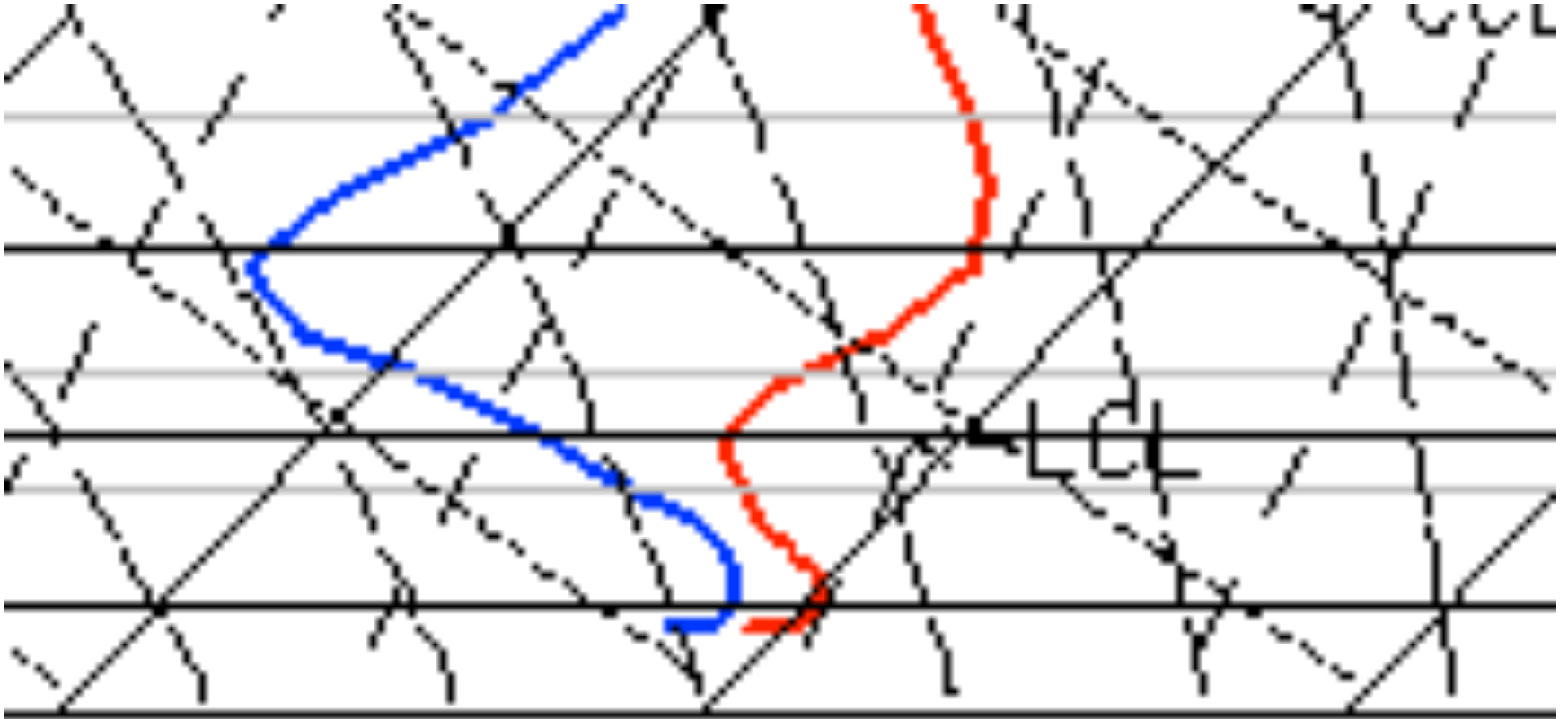
UTC 21 May 2014

72797 UIL Quillayute

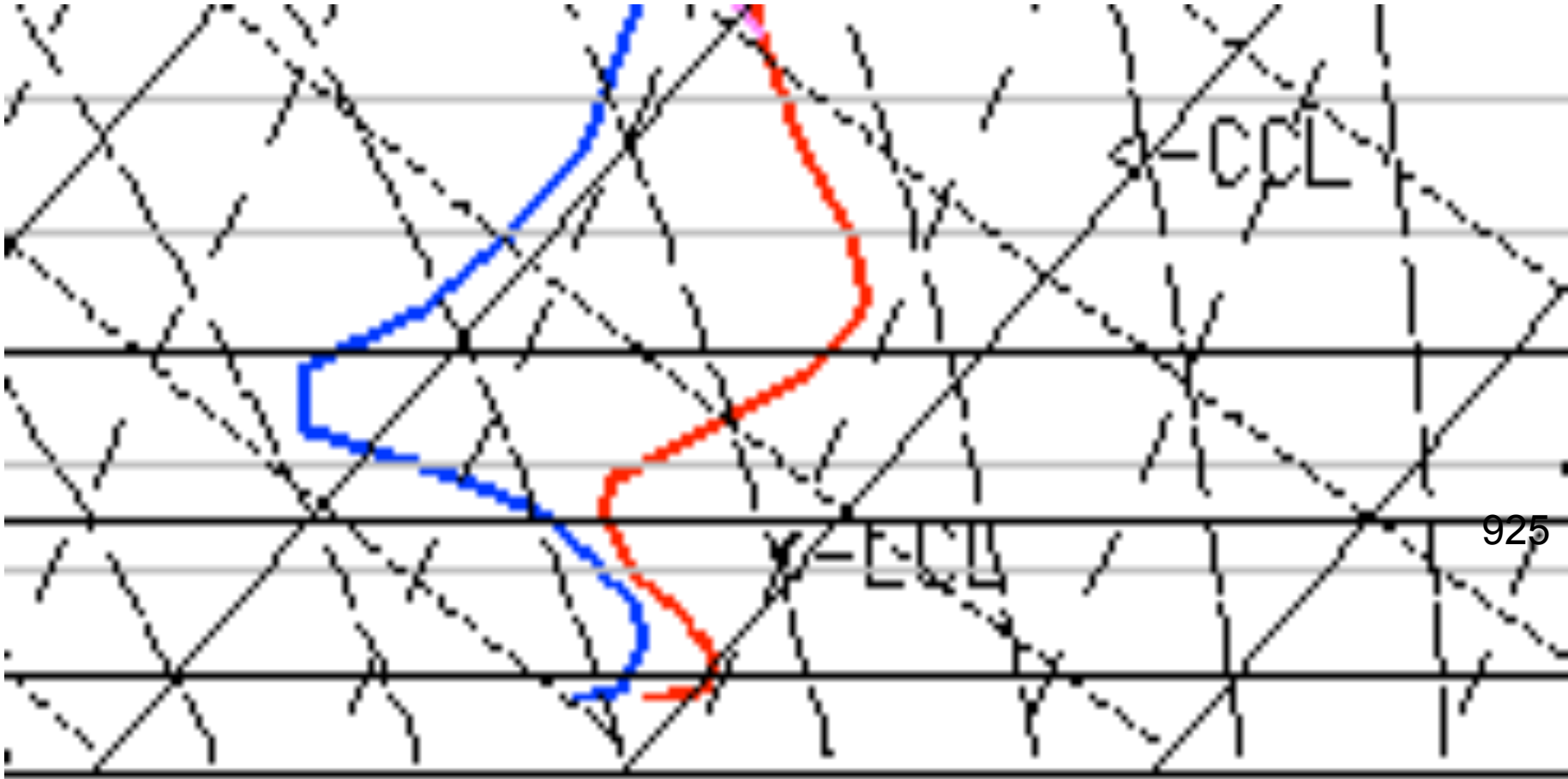


SLAT 47.95
 SLON -124.55
 SELV 62.00
 SHOW 11.72
 LIFT 14.63
 LFTV 14.82
 SWET 56.99
 KINX 16.60
 CTOT 10.10
 VTOT 22.10
 TOTL 32.20
 CAPE 0.26
 CAPV 0.32
 CINS -1.82
 CINV -1.62
 EQLV 903.6
 EQTV 902.9
 LFCT 918.9
 LFCV 919.9
 BRCH 0.01
 BRCV 0.01
 LCLT 278.3
 LCLP 938.5
 MLTH 283.4
 MLMR 5.93
 THCK 5544.
 PWAT 23.61

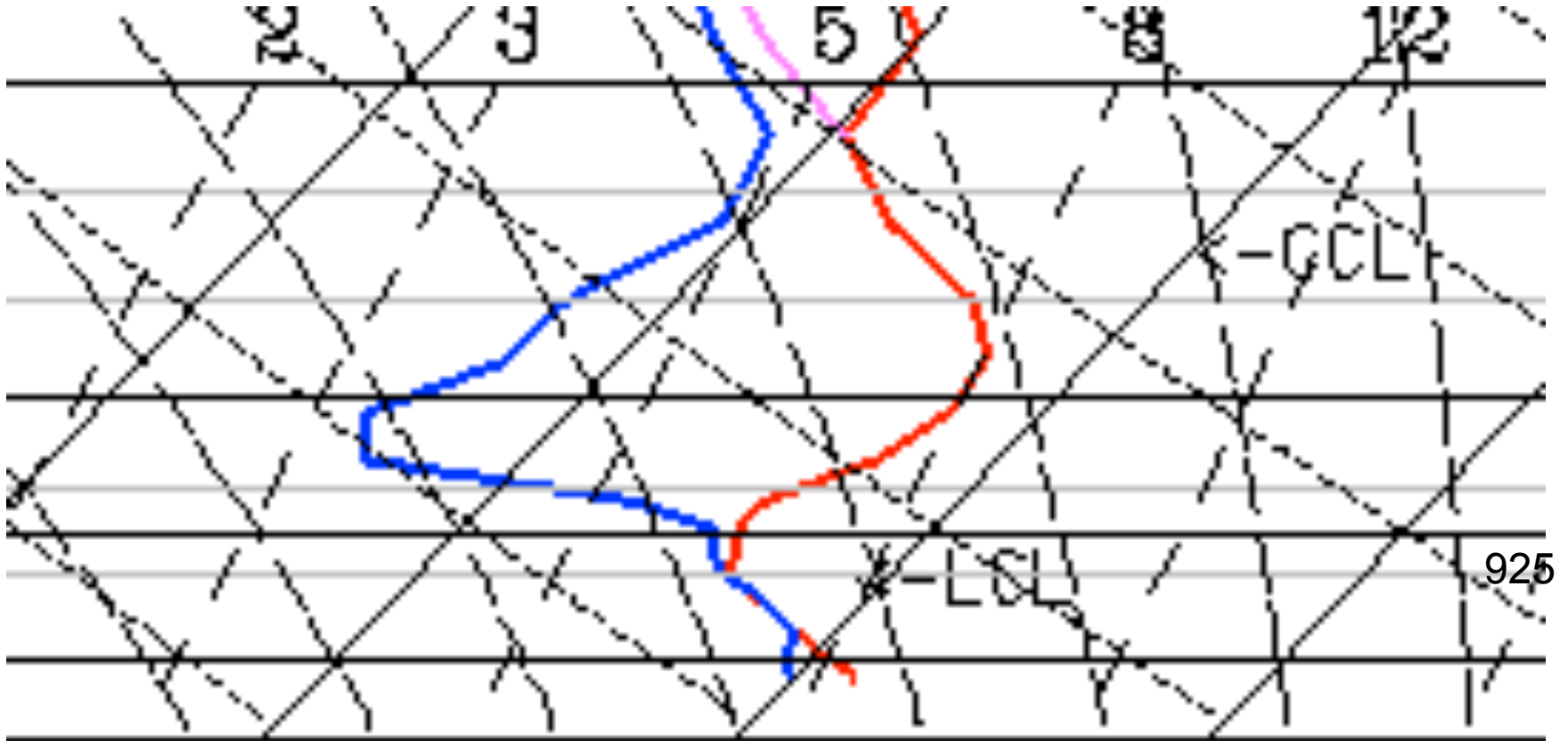
Real-Time GFS-forced



Forced by RR, Standard Physics



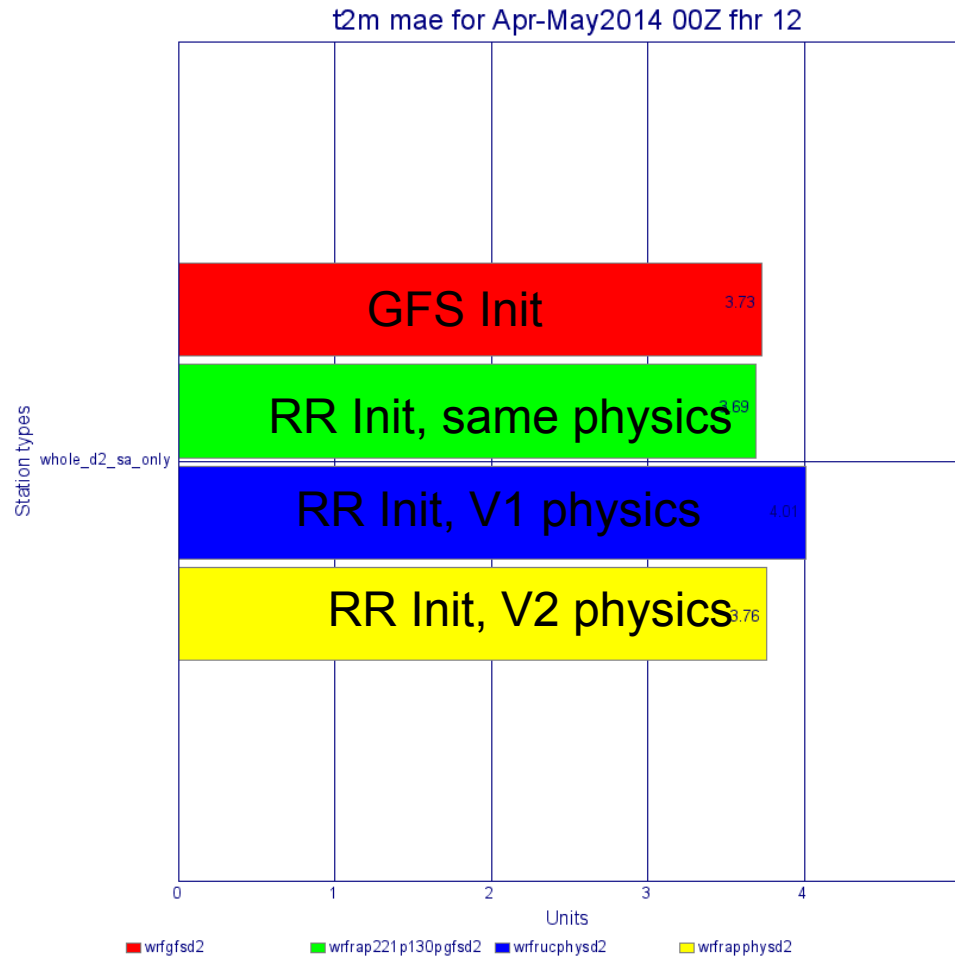
RR Init and RR Physics



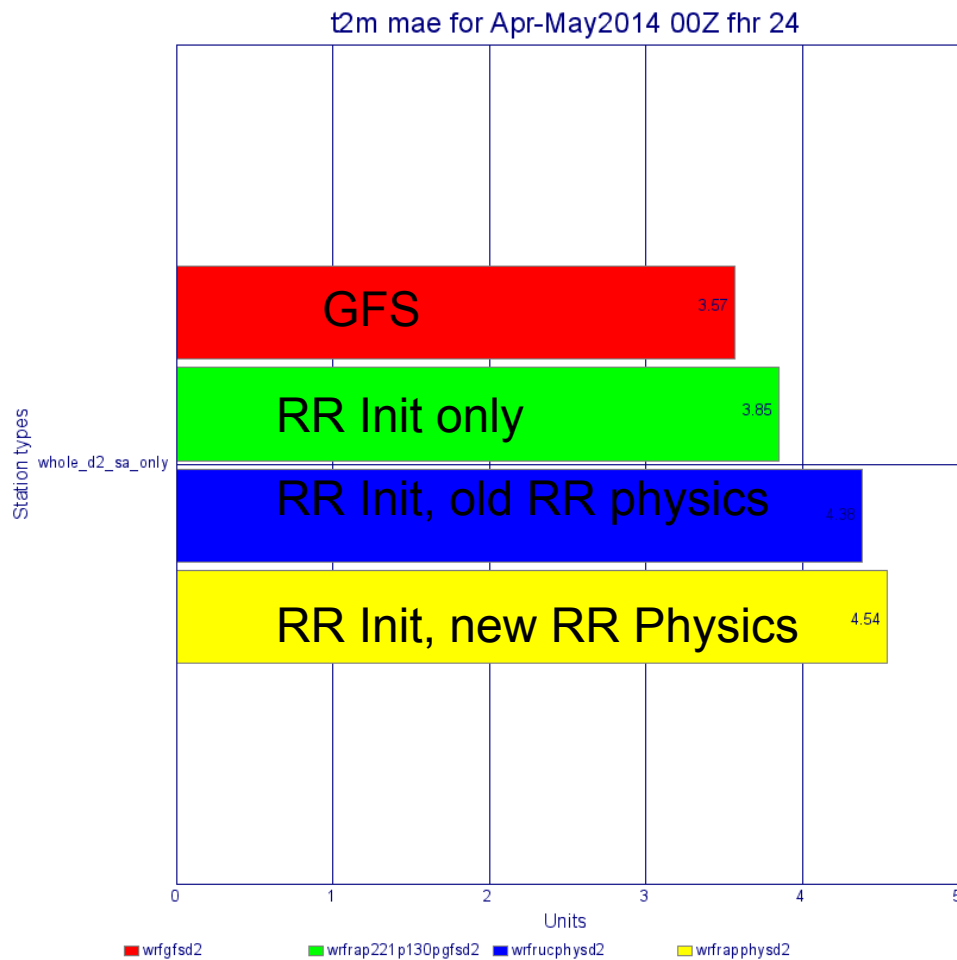
Long-Term Tests

April-May

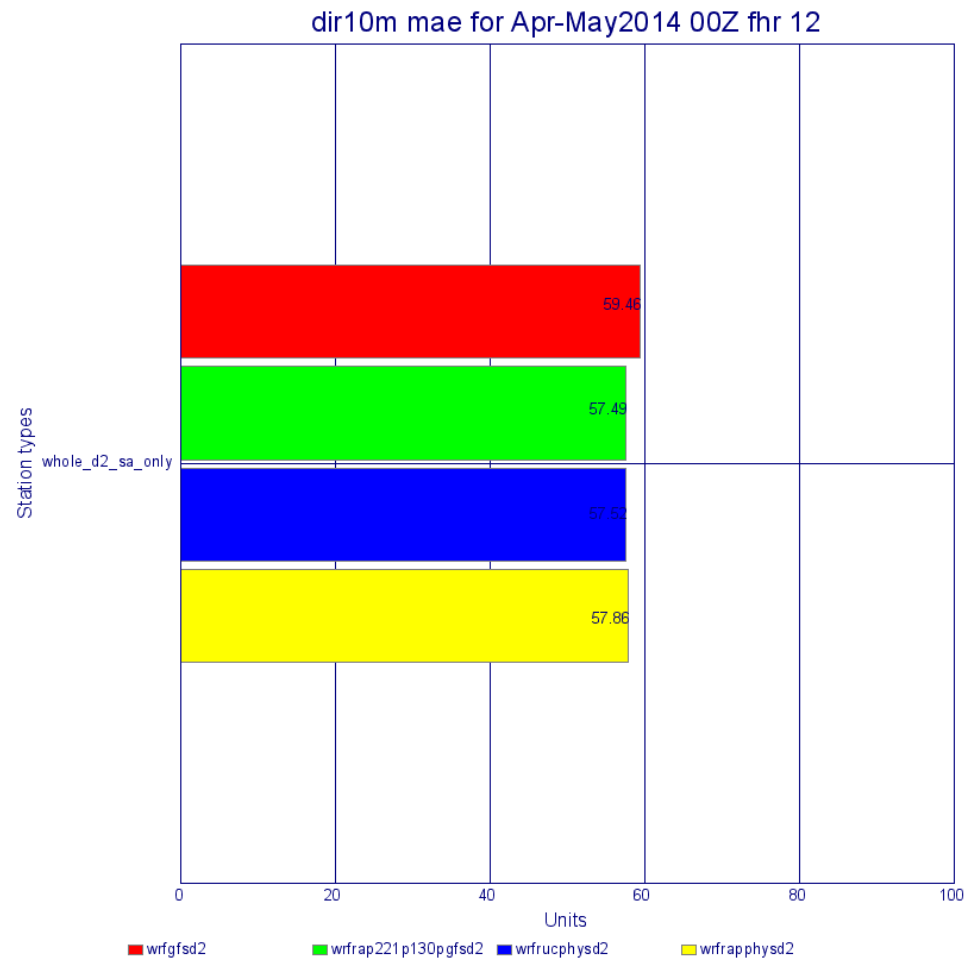
T 2m, MAE, 12h forecast



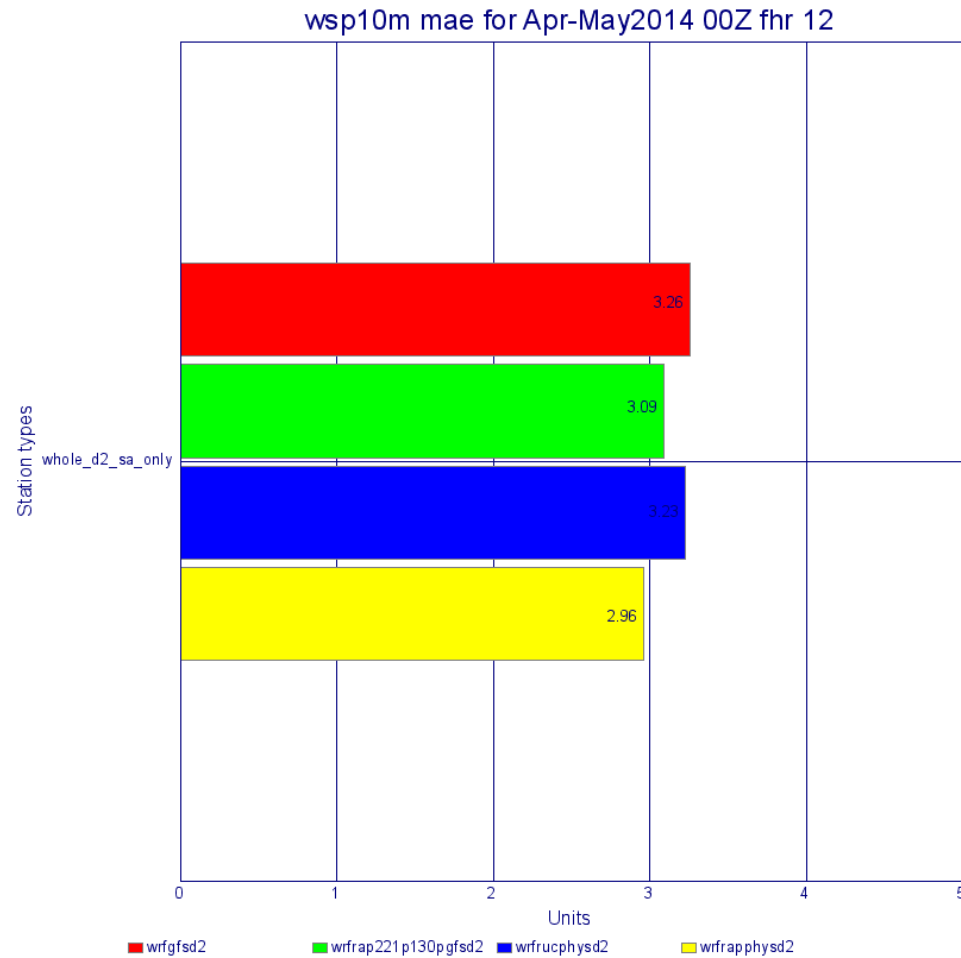
T2, 24h, MAE



Wind Direction, 10 m, 12 h



Wind speed, 10 m, 12 h



Conclusions

- Initialization with NOAA Rapid Refresh grids does help in initializing shallow low clouds and maintaining them early in the forecasts.
- Rapid Refresh physics package contributes to establishment and maintenance of shallow, stable features.
- Overall verification for the entire domain (NW U.S. and adjacent waters) for an extended does not suggest much overall improvement with RR Physics.

Conclusions

- The effects of RAP initialization fades over the first day of the forecast, but physics effects remain substantial.
- Will verify impacts on other seasons before deciding to go with RR initialization and physics changes in the operational system.

The End