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?

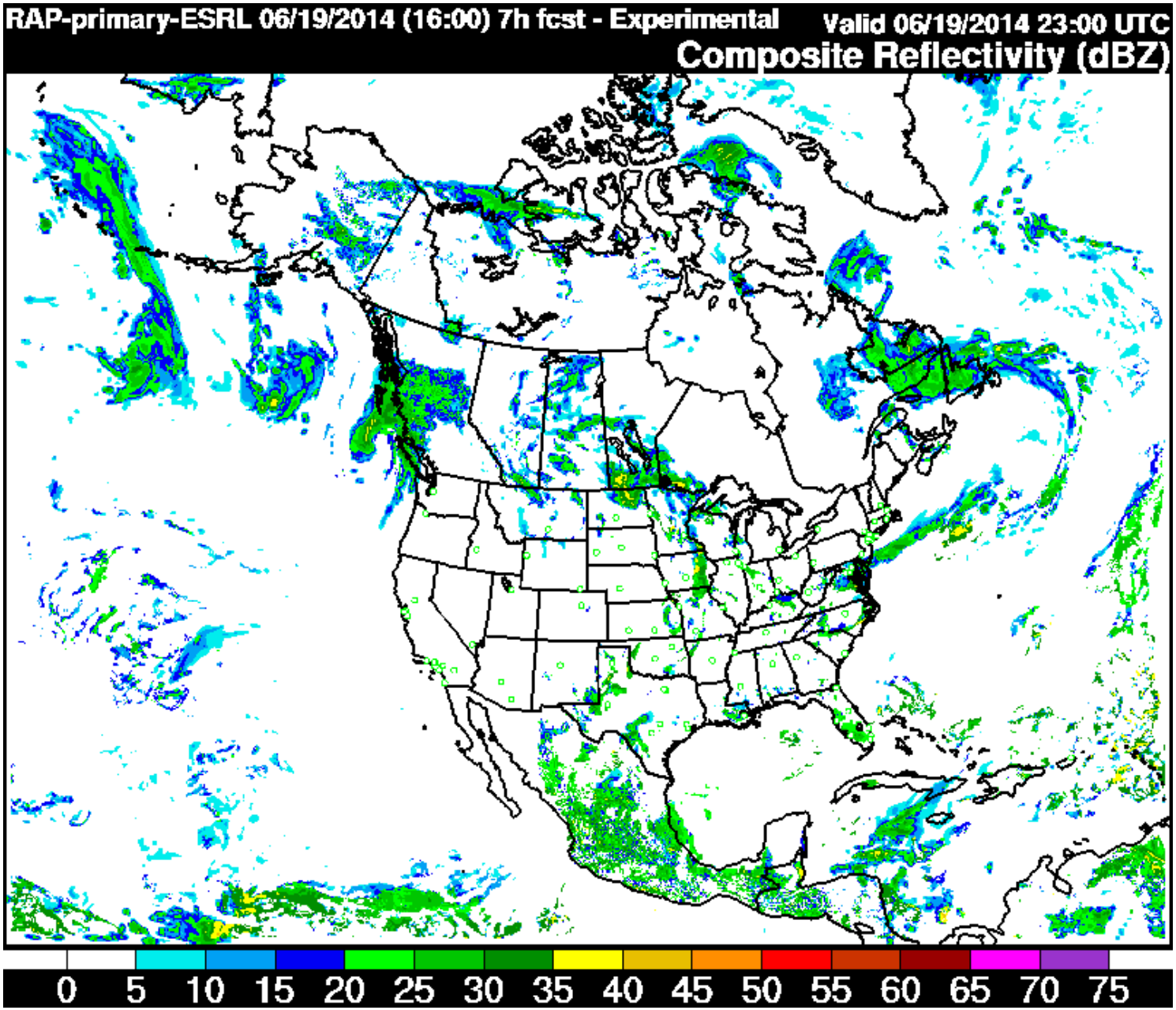
- For many WRF applications, users take either of two routes:
  - Cold start using GFS, ECMWF, or other operational model grids
  - High-resolution data assimilation with local data assets using WRFDA, DART EnKF, or something else.
- Today, there is another possibility over much of North America: **high-resolution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

Mesoscale Data Assimilation:

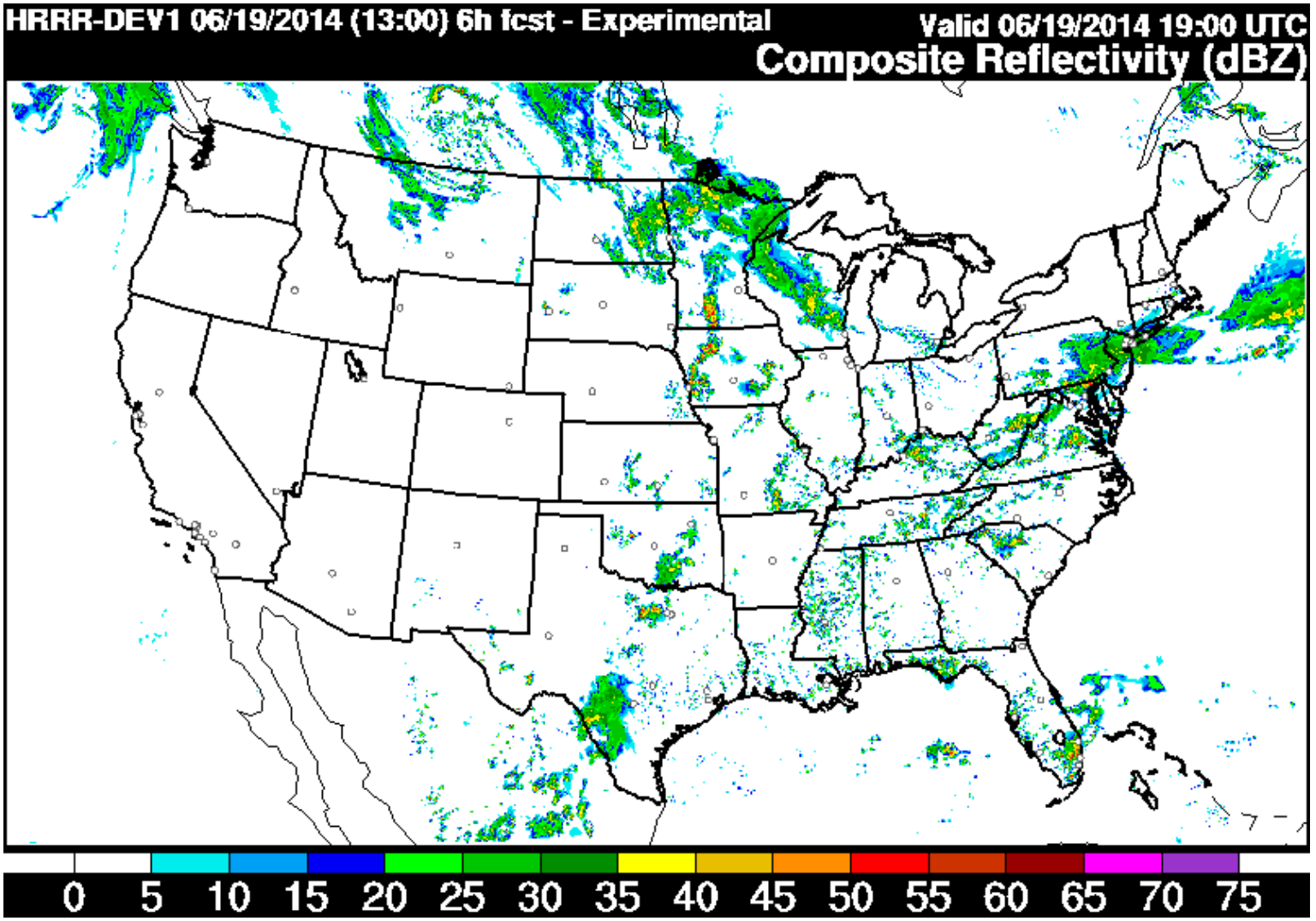
Why not let someone else do the hard work?

- 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.

Rapid Refresh



HRRR

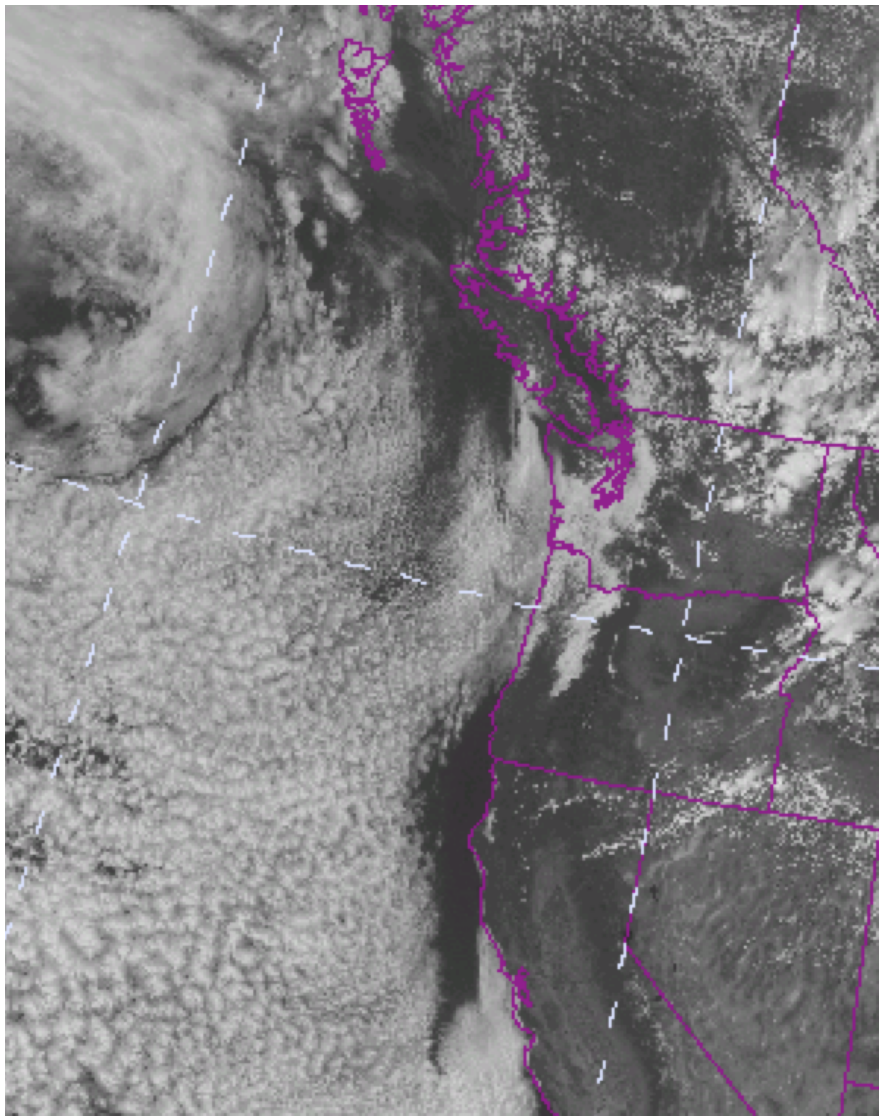

HRRR-DEV1 06/19/2014 (13:00) 6h fcst - Experimental
Valid 06/19/2014 19:00 UTC
Composite Reflectivity (dBZ)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

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?

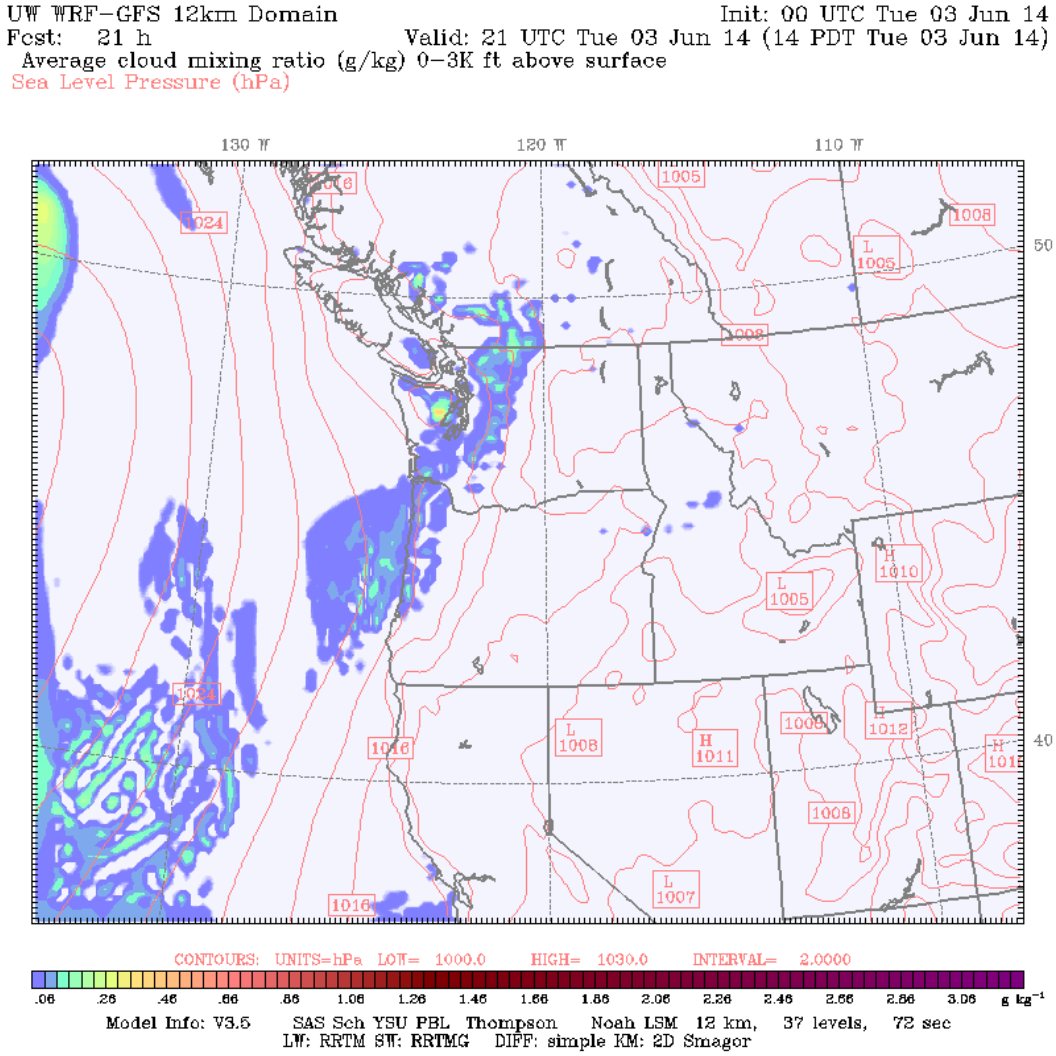
June 3, 2014
21 UTC



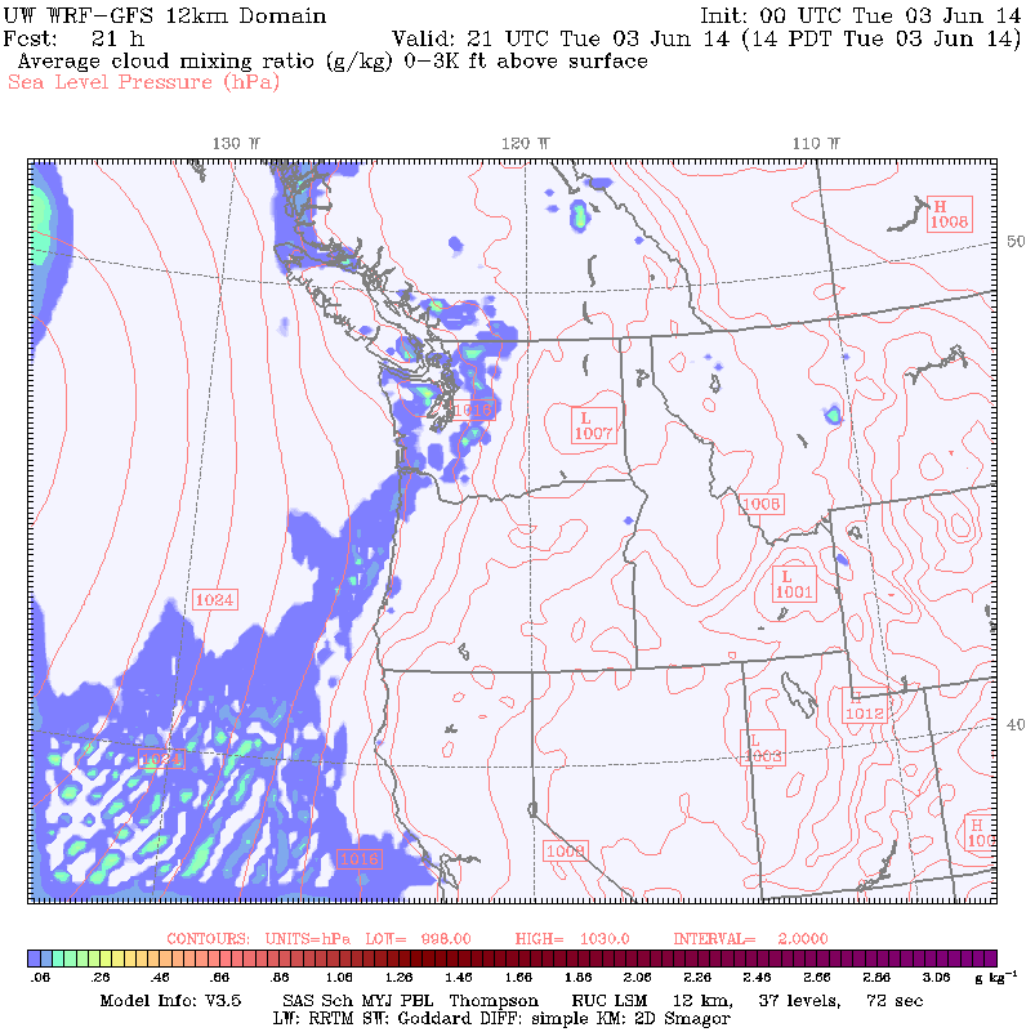
Four Runs

- 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.

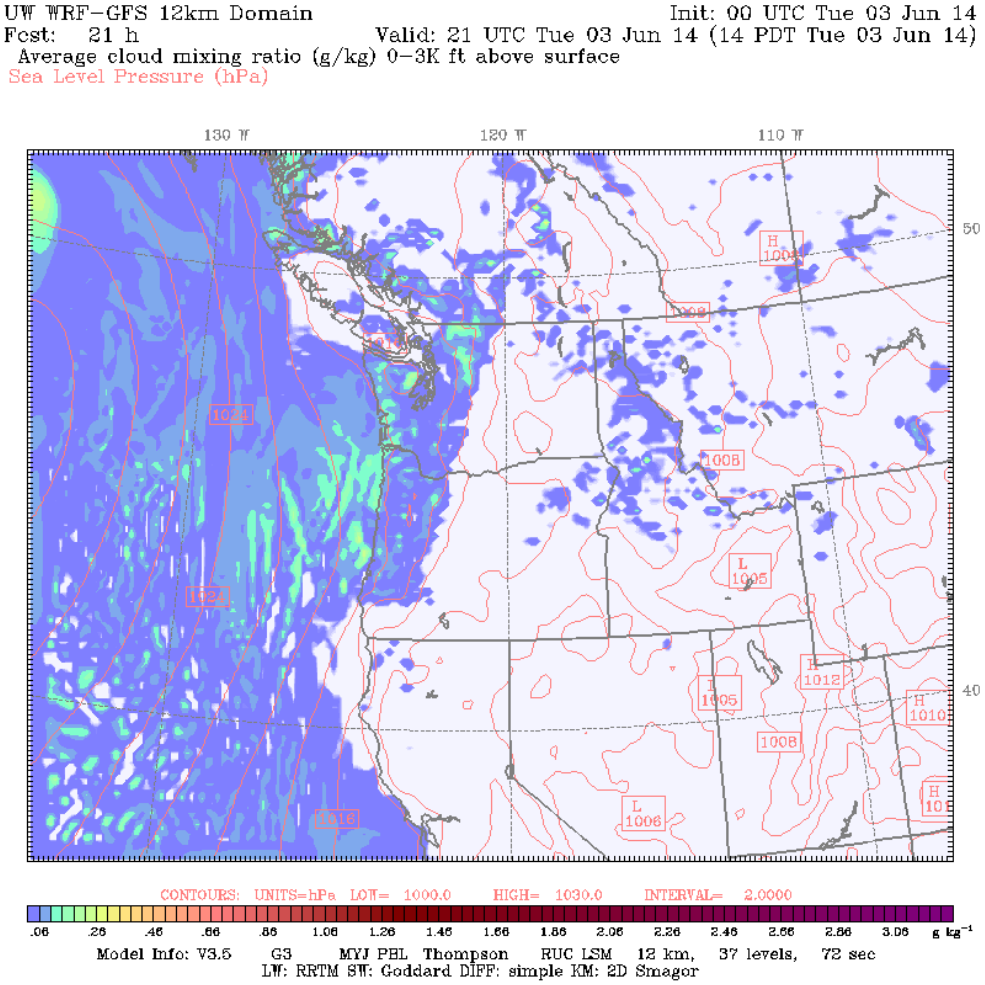
GFS Initialization, 21h forecast



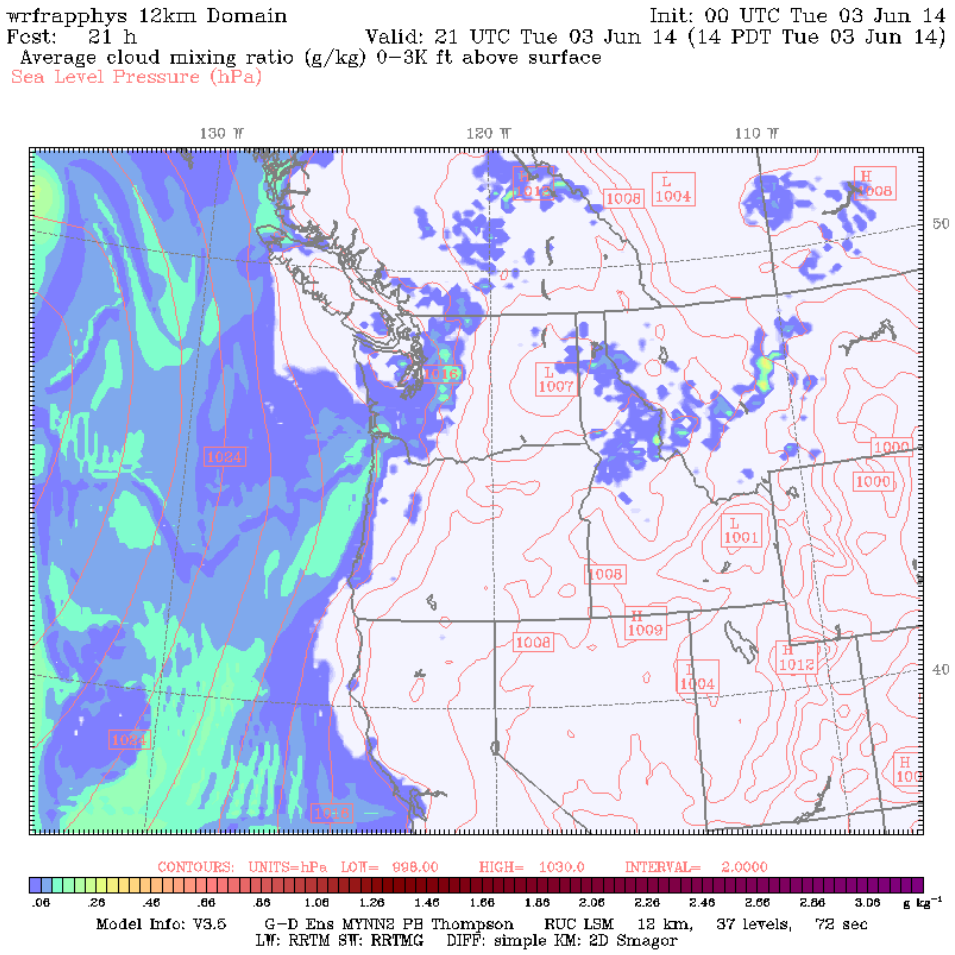
Using Rapid Refresh Initialization, Same Physics



Using Rapid Refresh Initialization and Old Rapid Refresh Physics

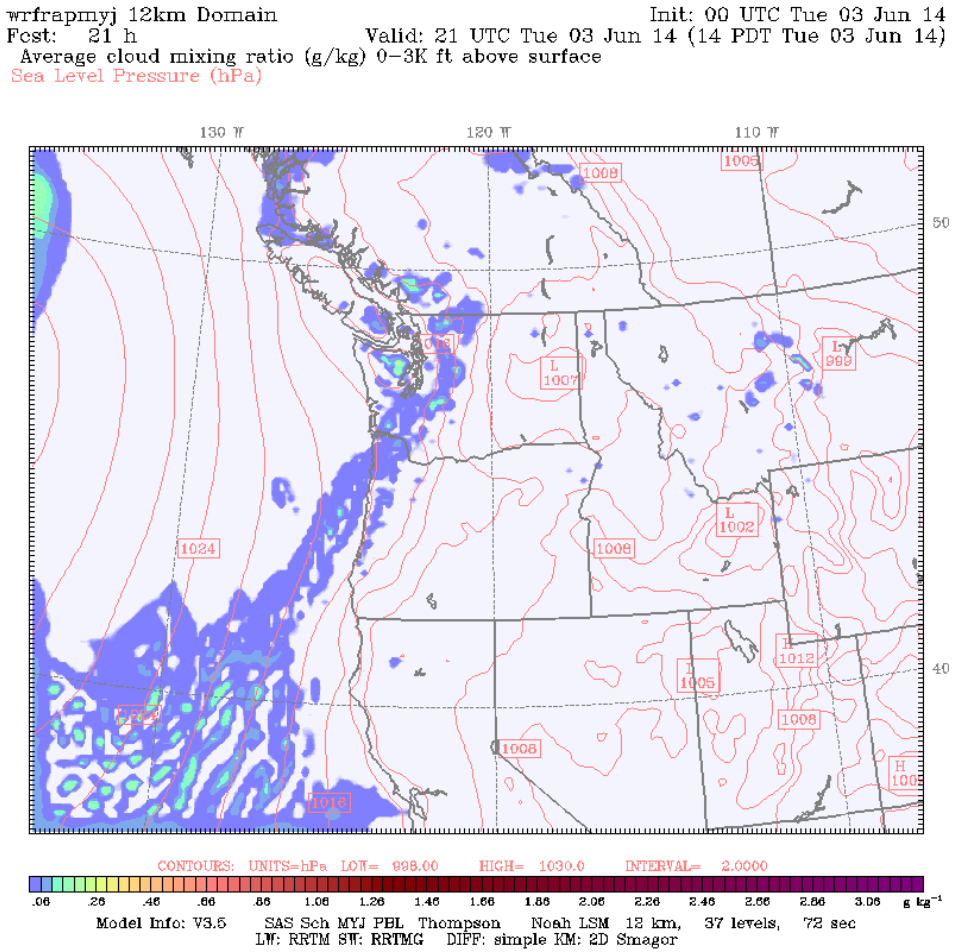


With New (V2) RR Physics

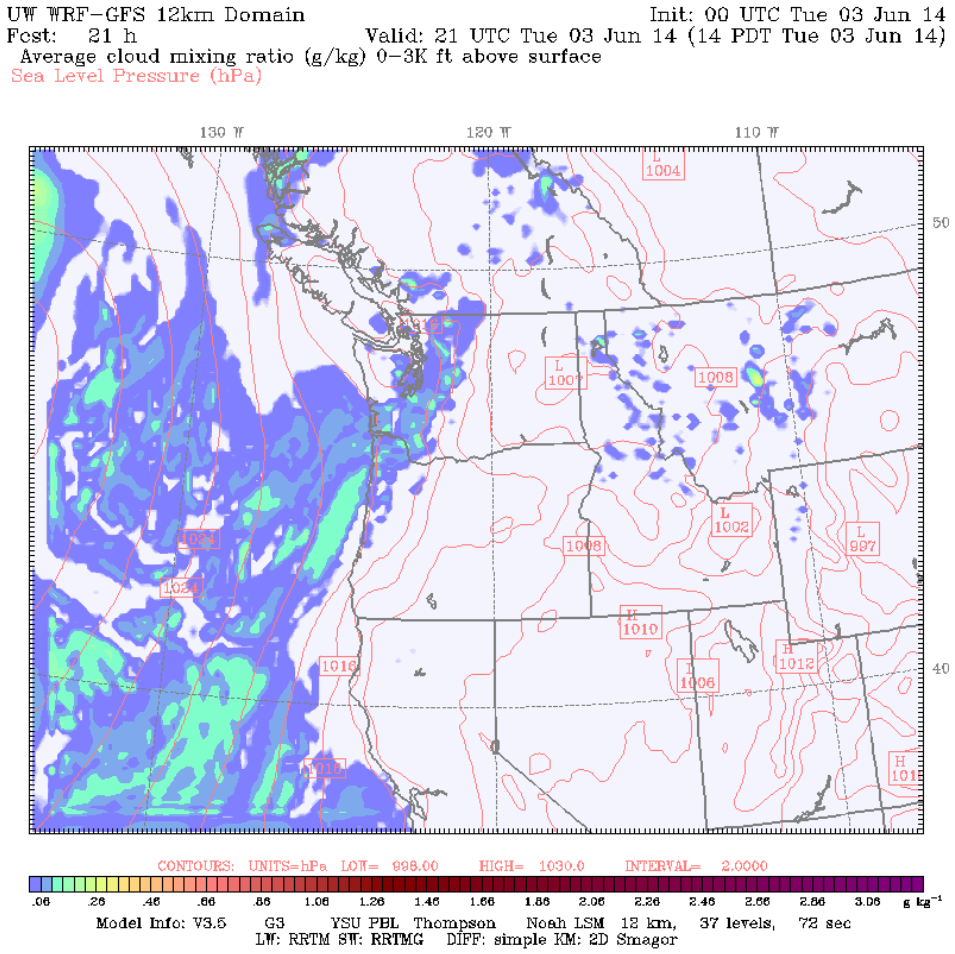


What are the physics changes that really counted?

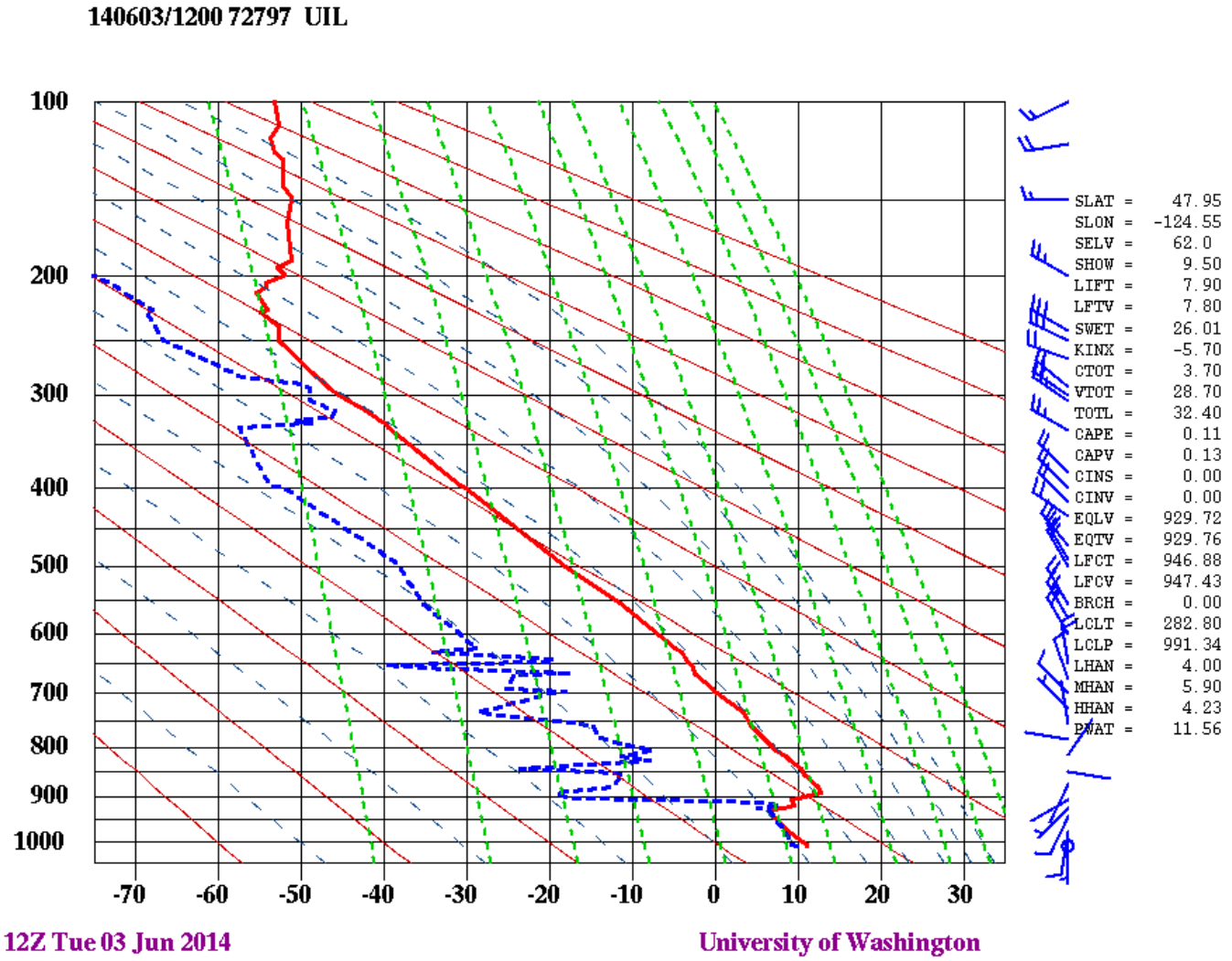
YSU to MYJ PBL (RR initialization)



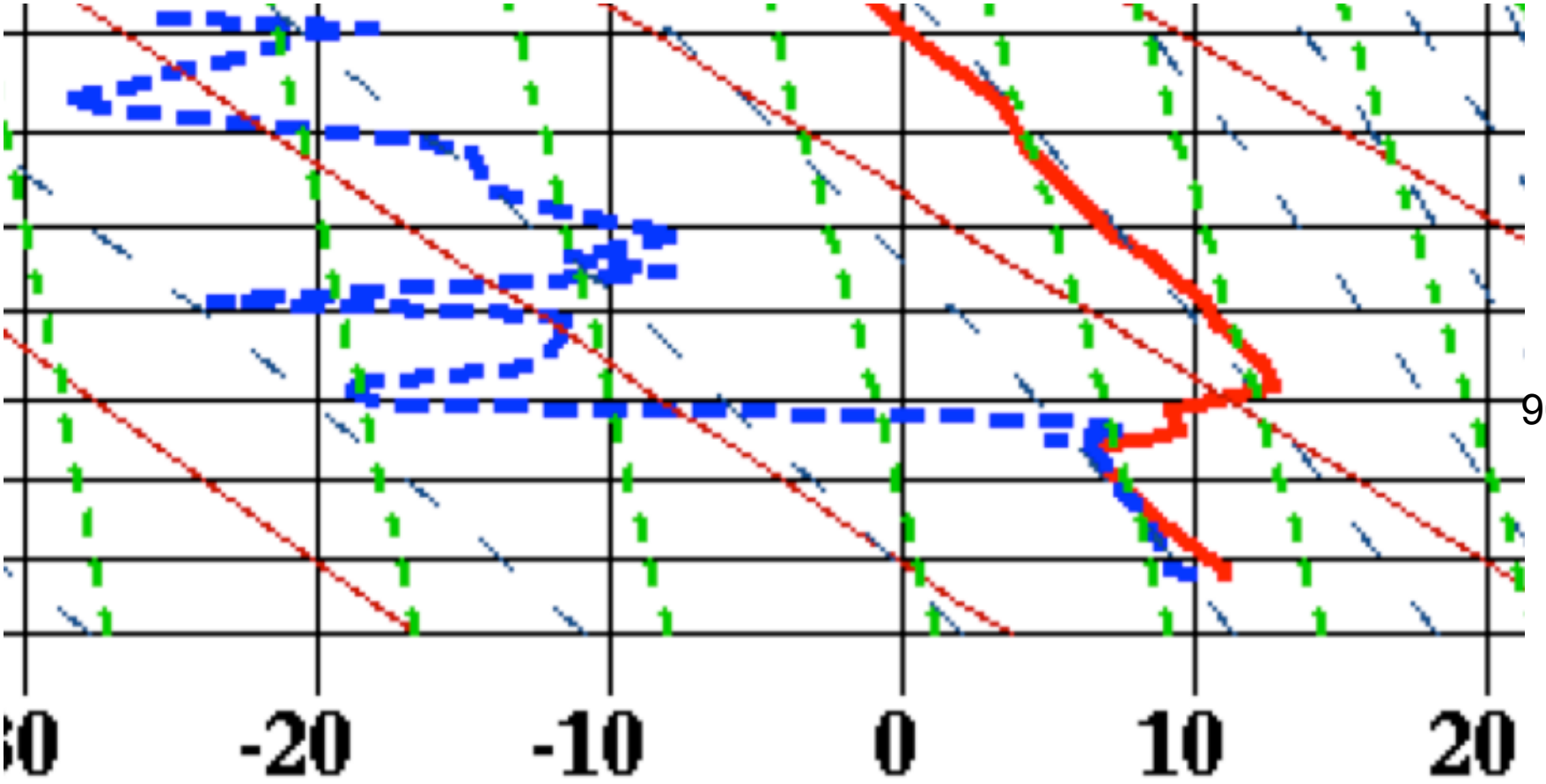
SAS CU to Grell (G3)



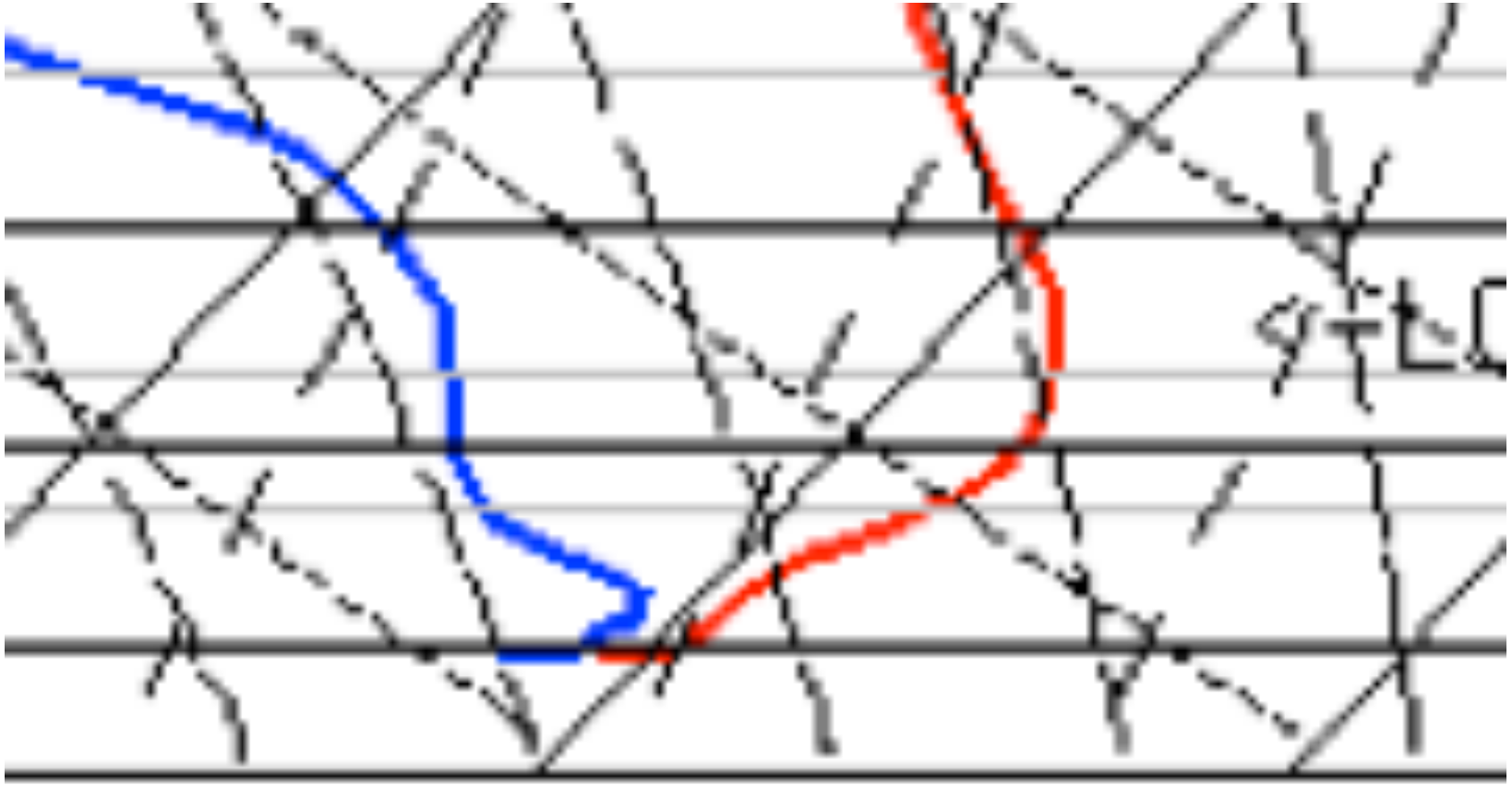
Observed Sounding at Quillayute on the Washington Coast: 6/4/13 at 12UTC



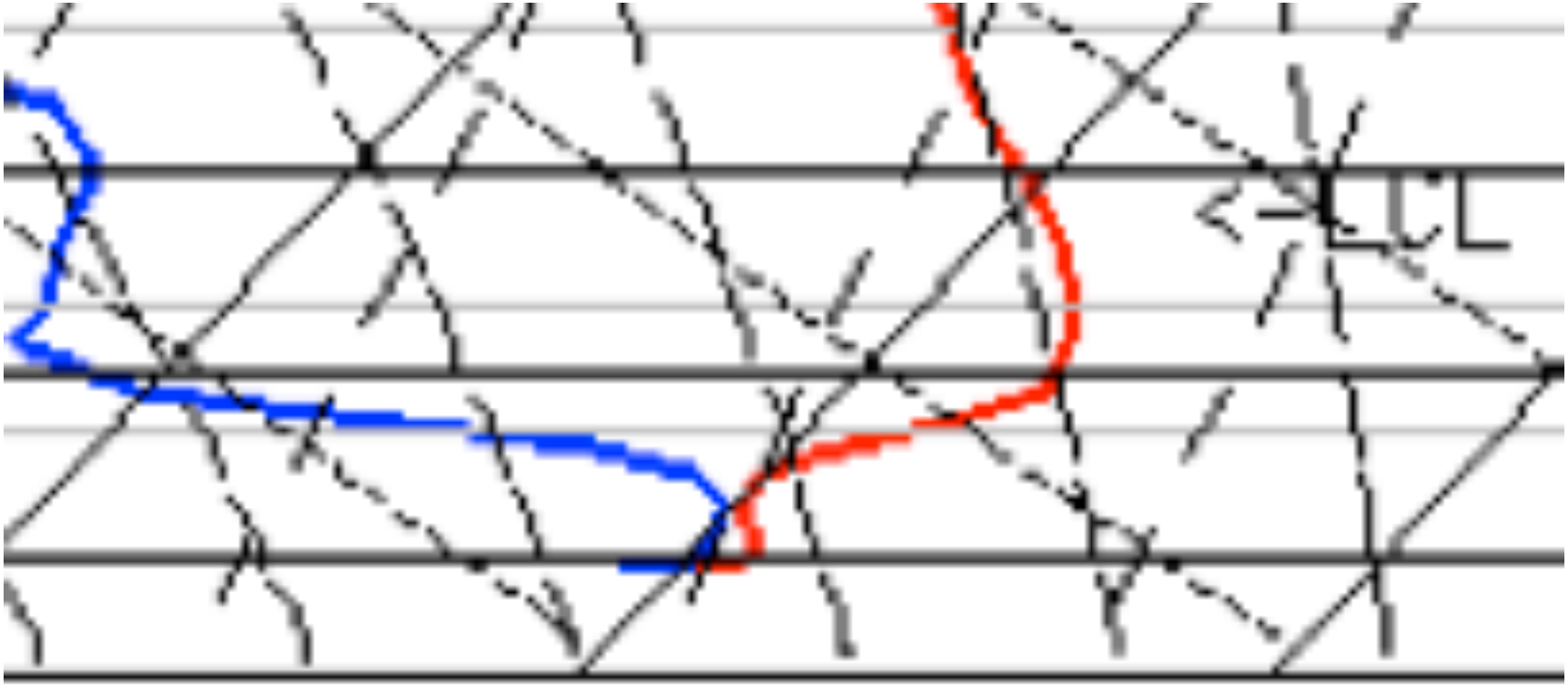
Observed Sounding



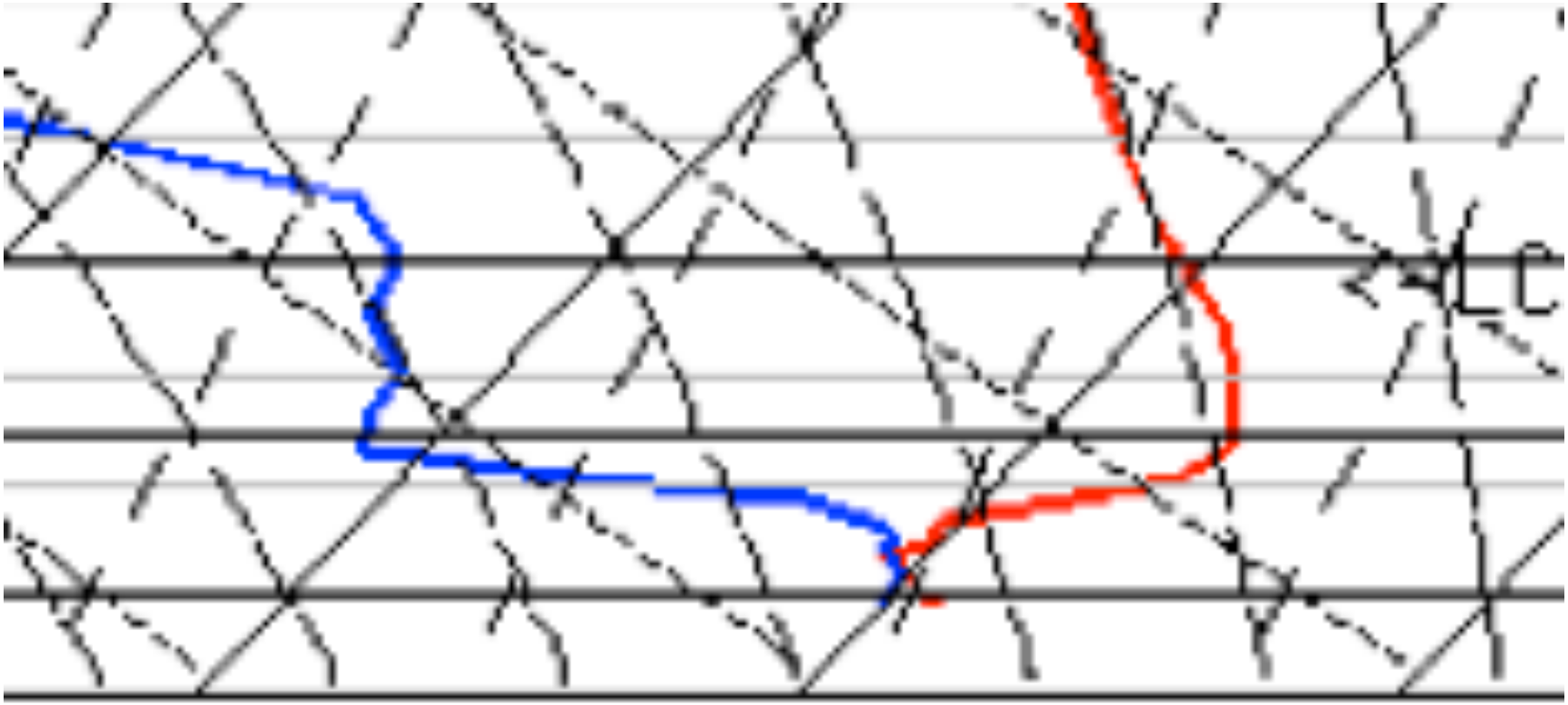
GFS Initialization, Standard Physics



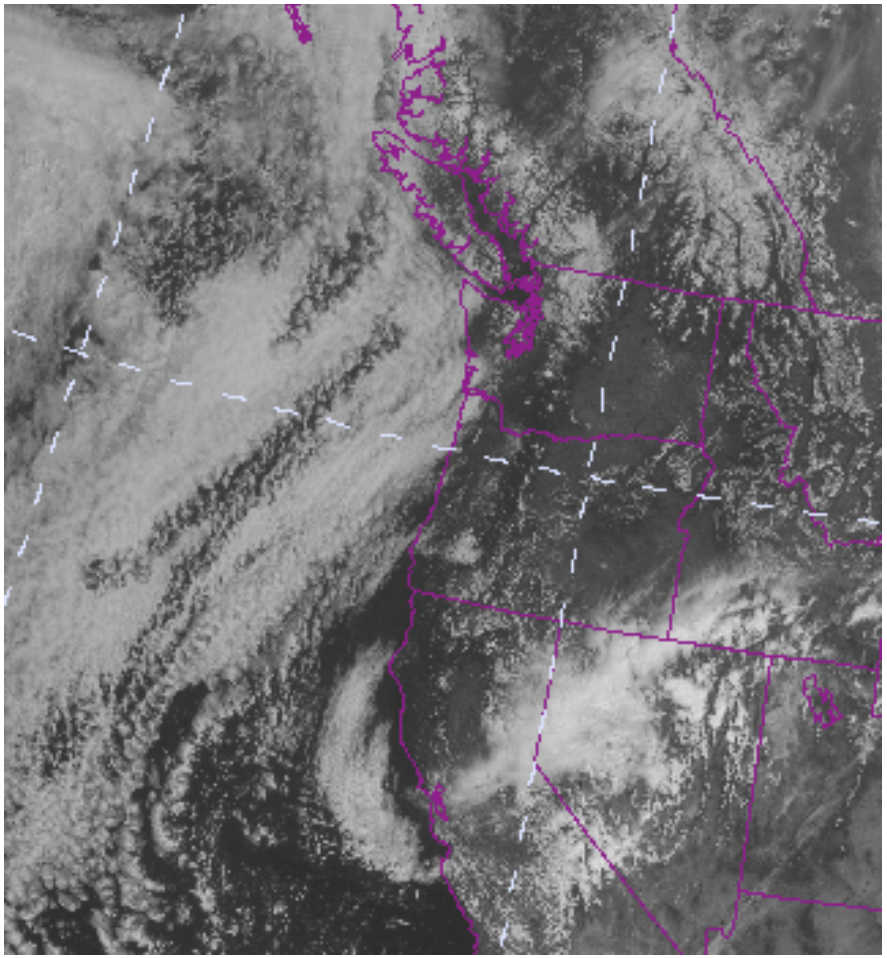
Using RAP initialization



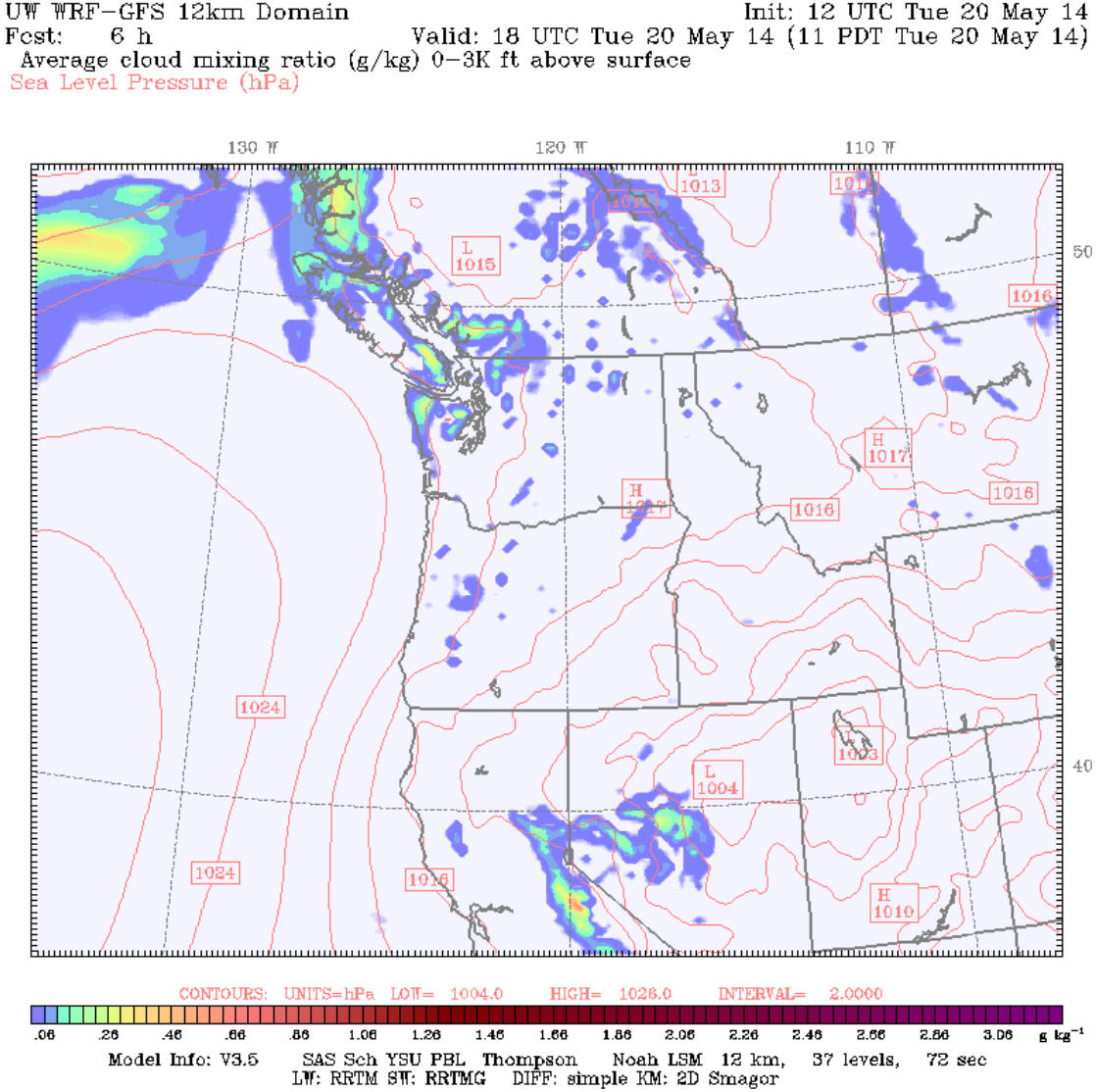
RAP Initialization, RR Physics



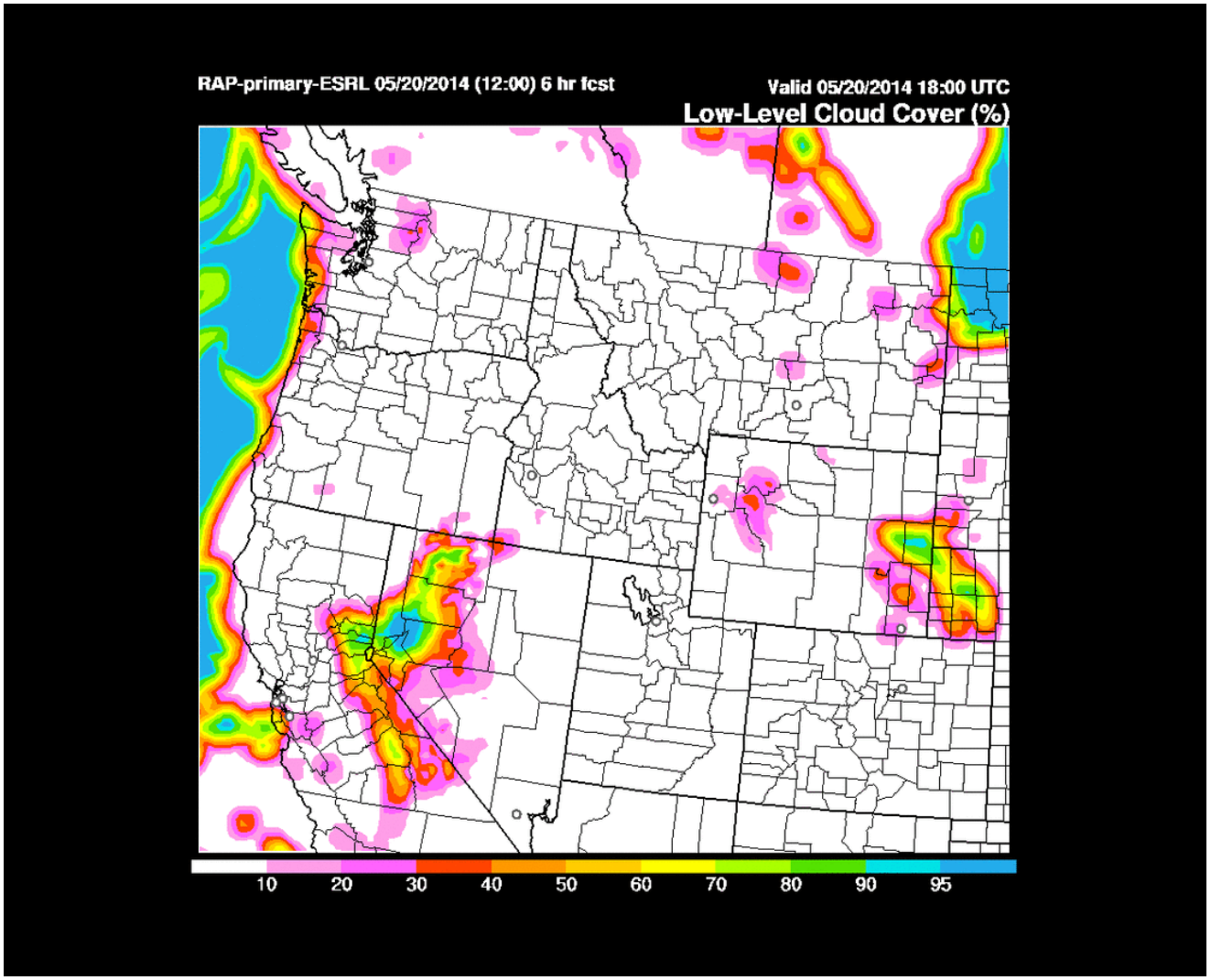
May 20th, 18 UTC



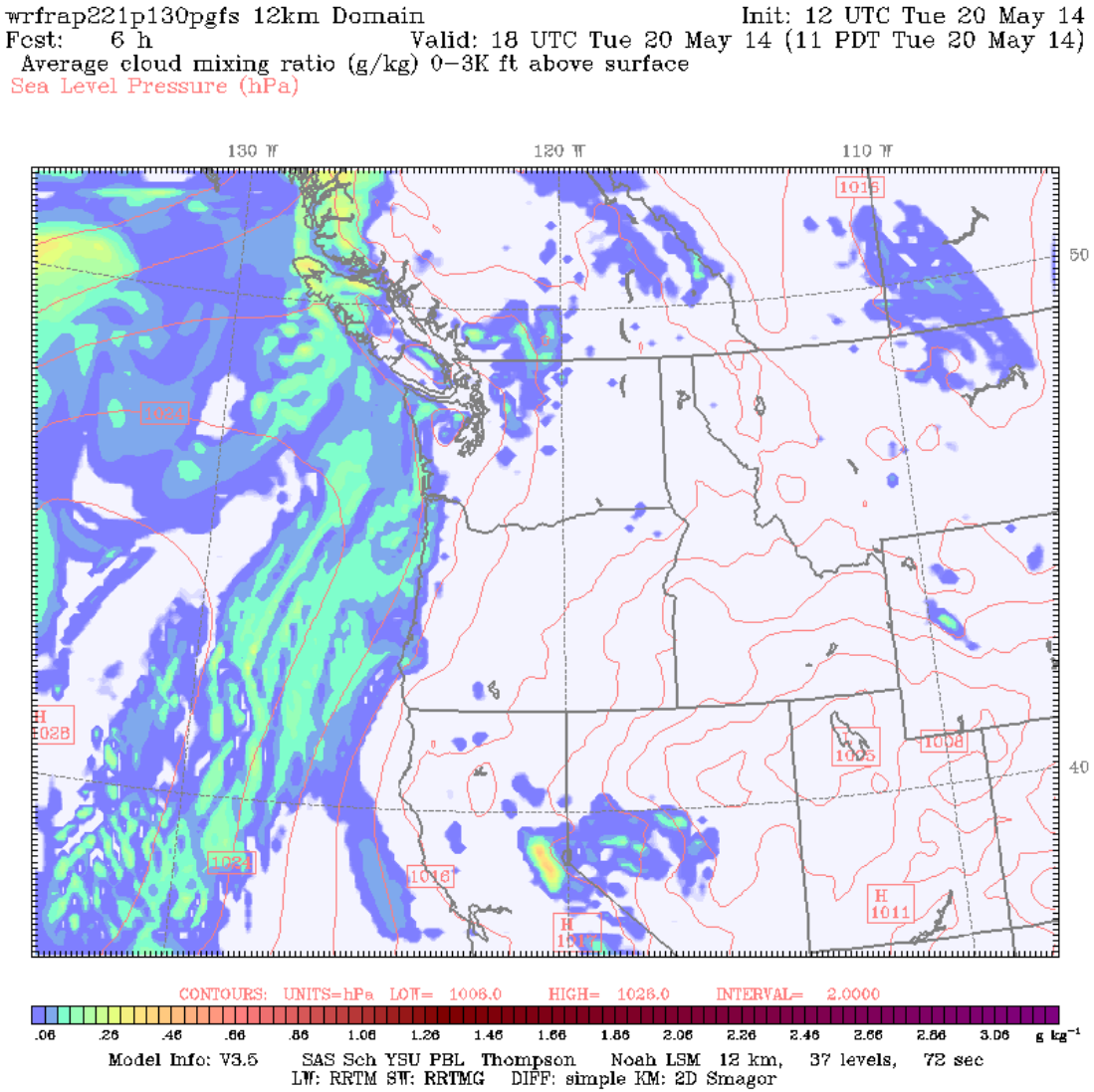
GFS Init, Standard, 6h



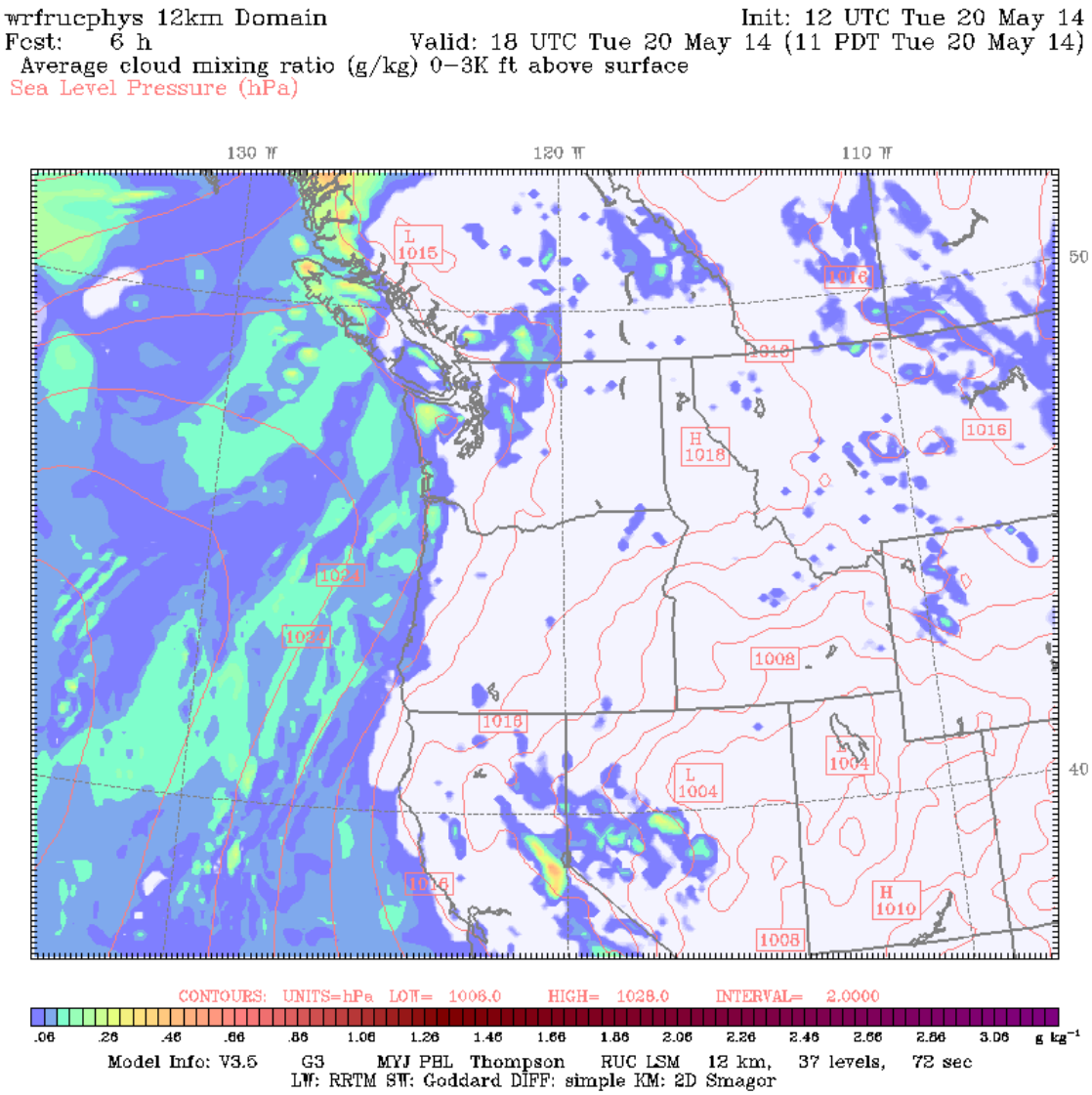
RR at Same Time: Clouds!



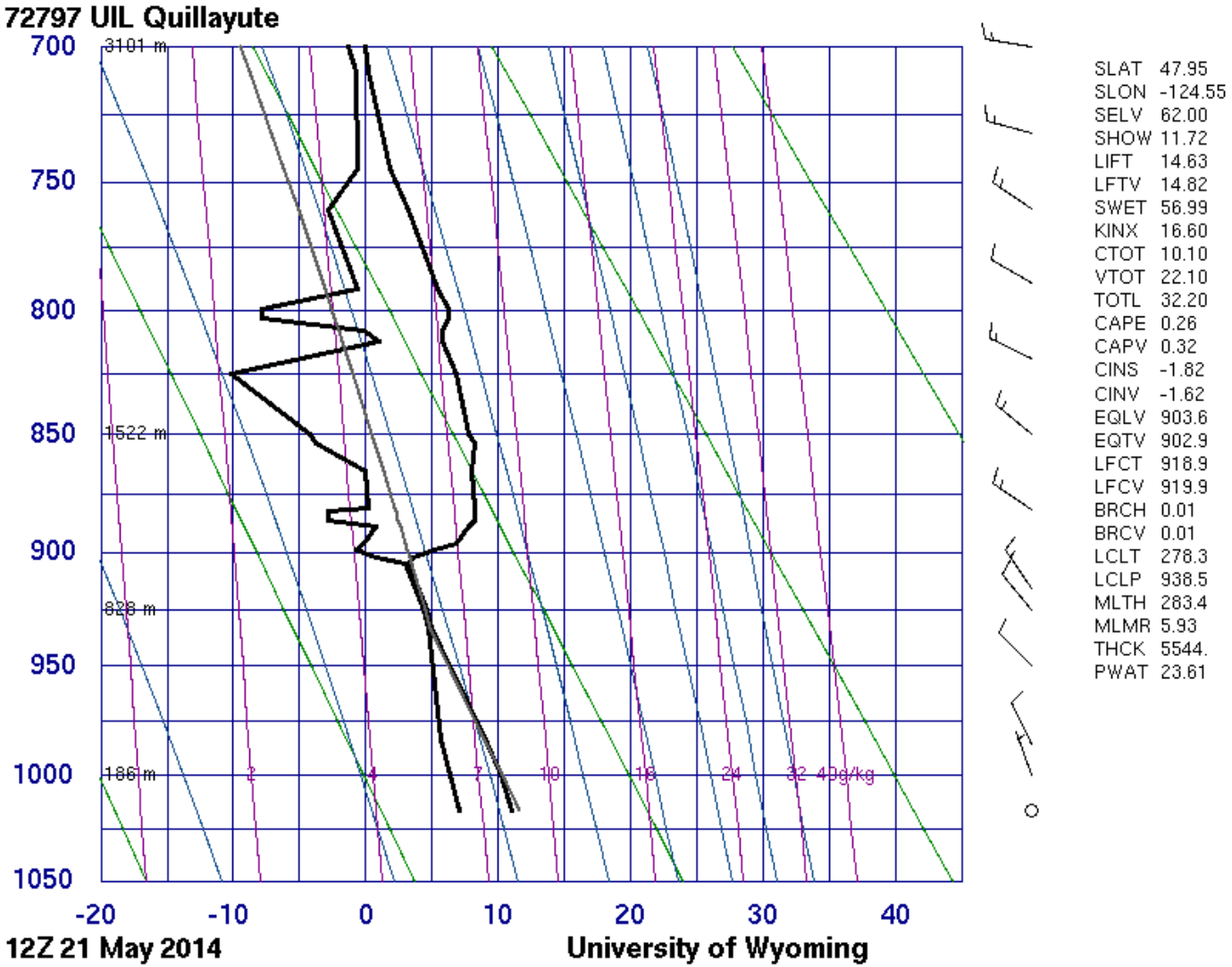
RR Initialization, Standard Physics



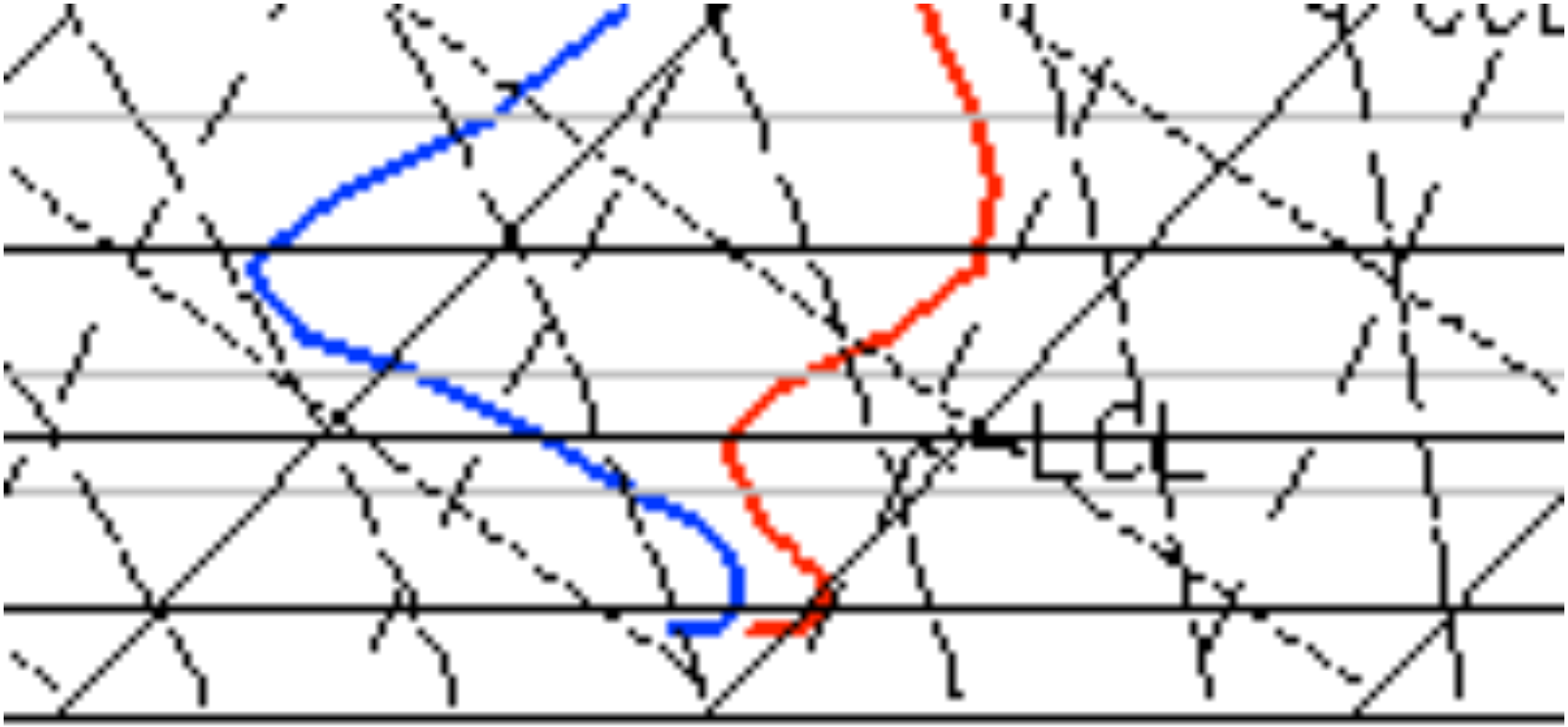
RR Init, Old RR Physics



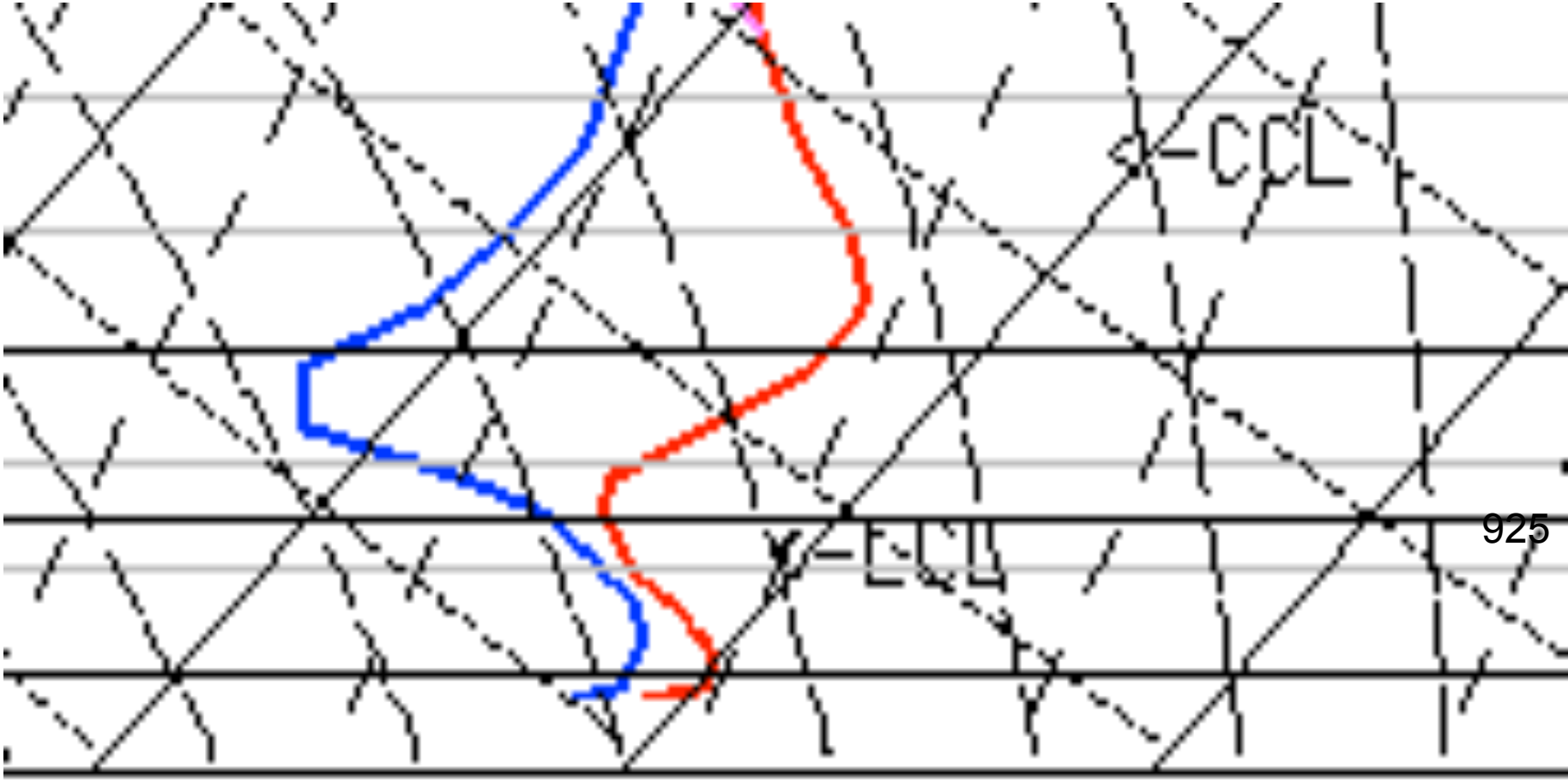
What about the next morning? 12 UTC 21 May 2014



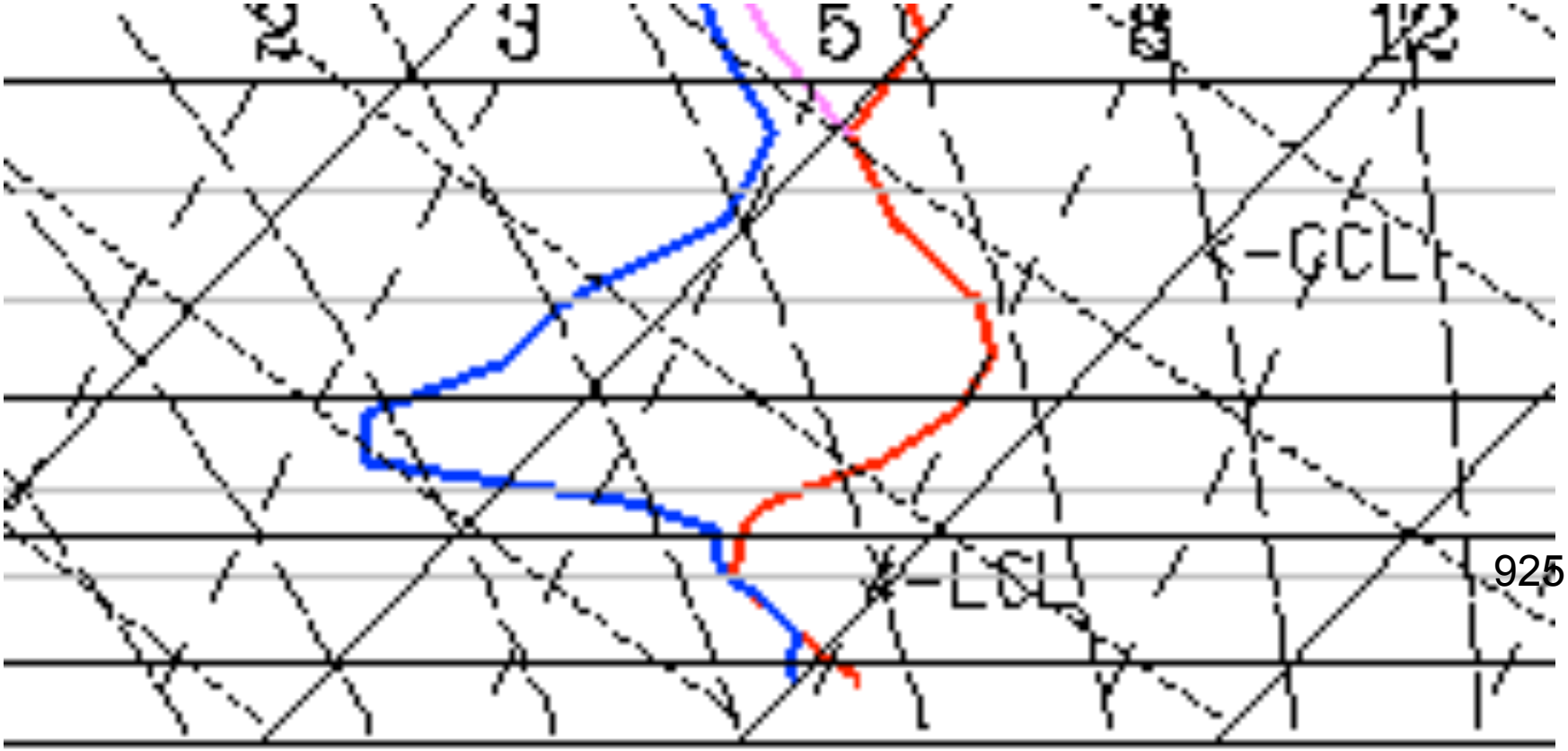
Real-Time GFS-forced



Forced by RR, Standard Physics

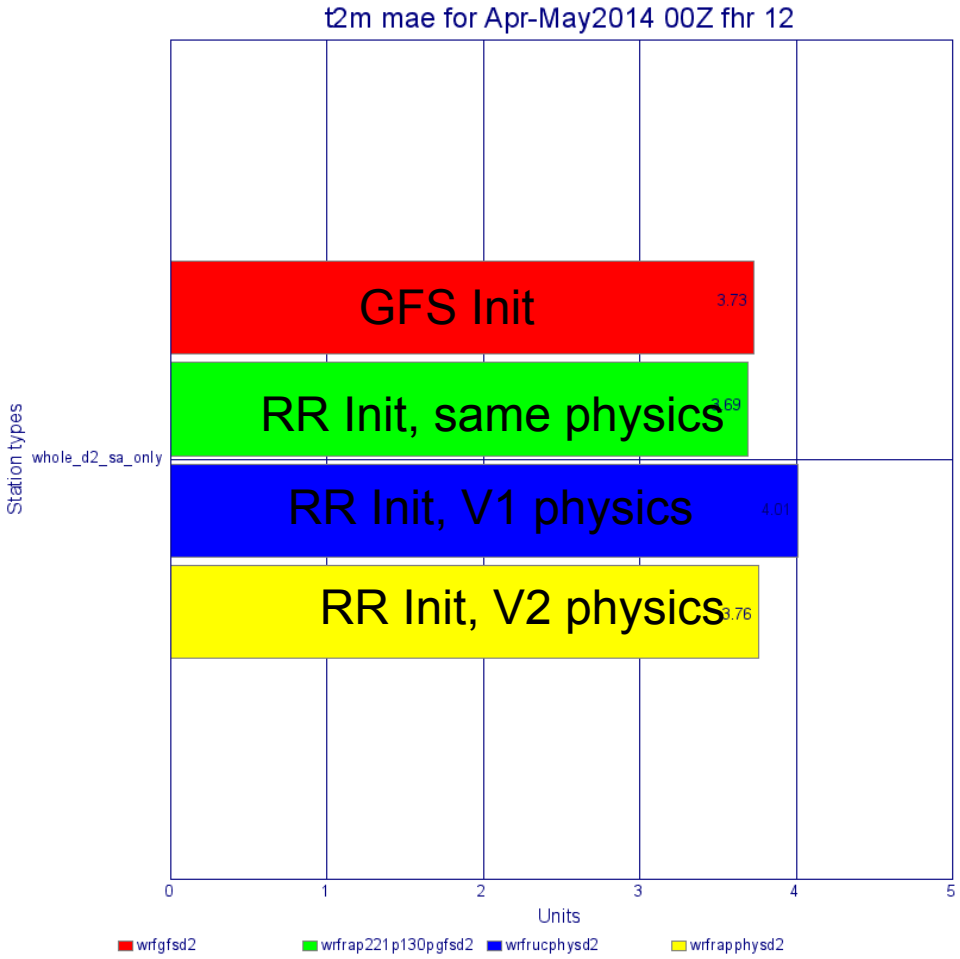


RR Init and RR Physics

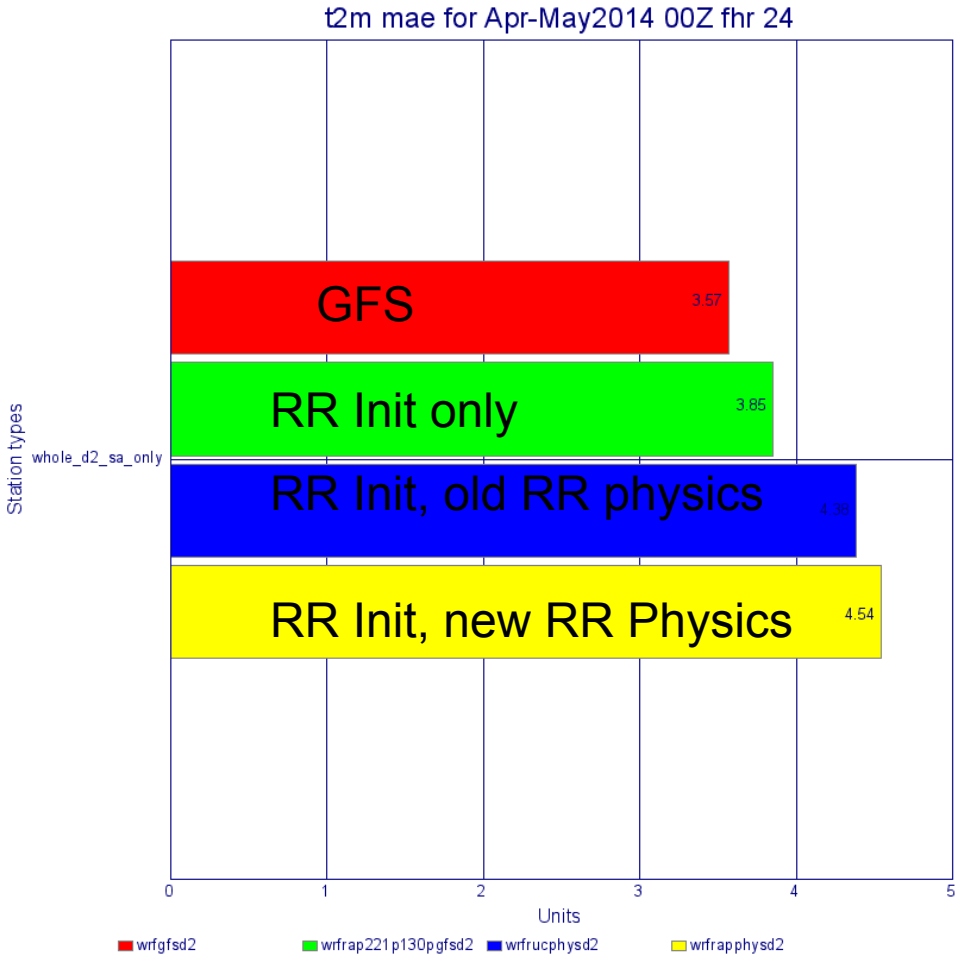


Long-Term Tests
April-May

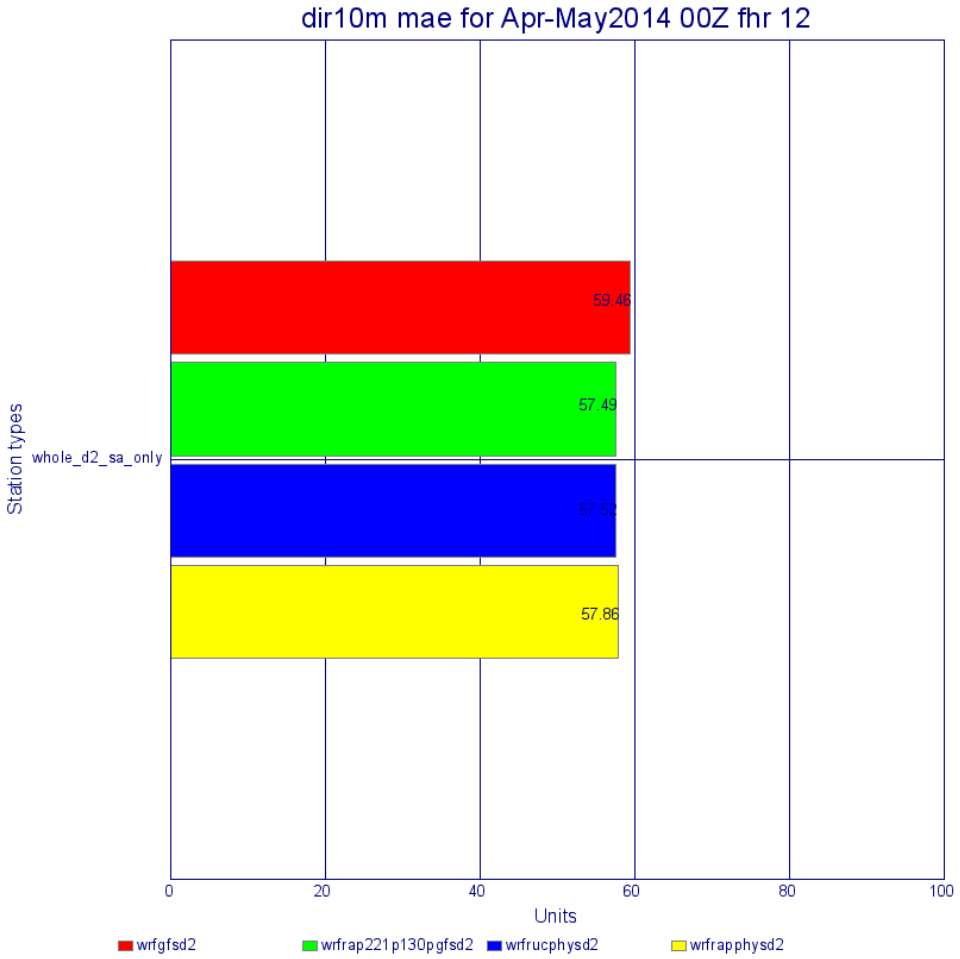
T 2m, MAE, 12h forecast



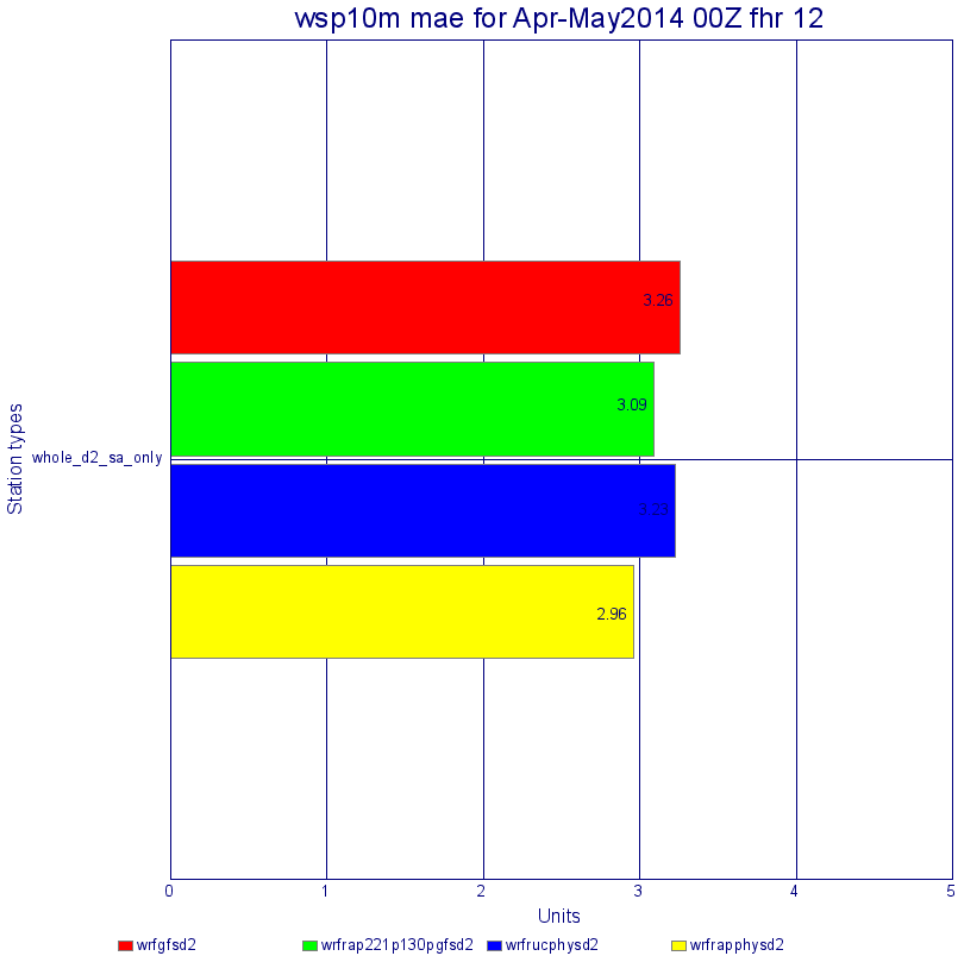
T2, 24h, MAE


t2m mae for Apr-May2014 00Z fhr 24
Station types
whole_d2_sa_only
GFS
3.57
RR Init only
3.85
RR Init, old RR physics
4.38
RR Init, new RR Physics
4.54
0
1
2
3
4
5
Units
wrfgfsd2
wrfrap221p130pgfsd2
wrfrucphysd2
wrfrapphysd2

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