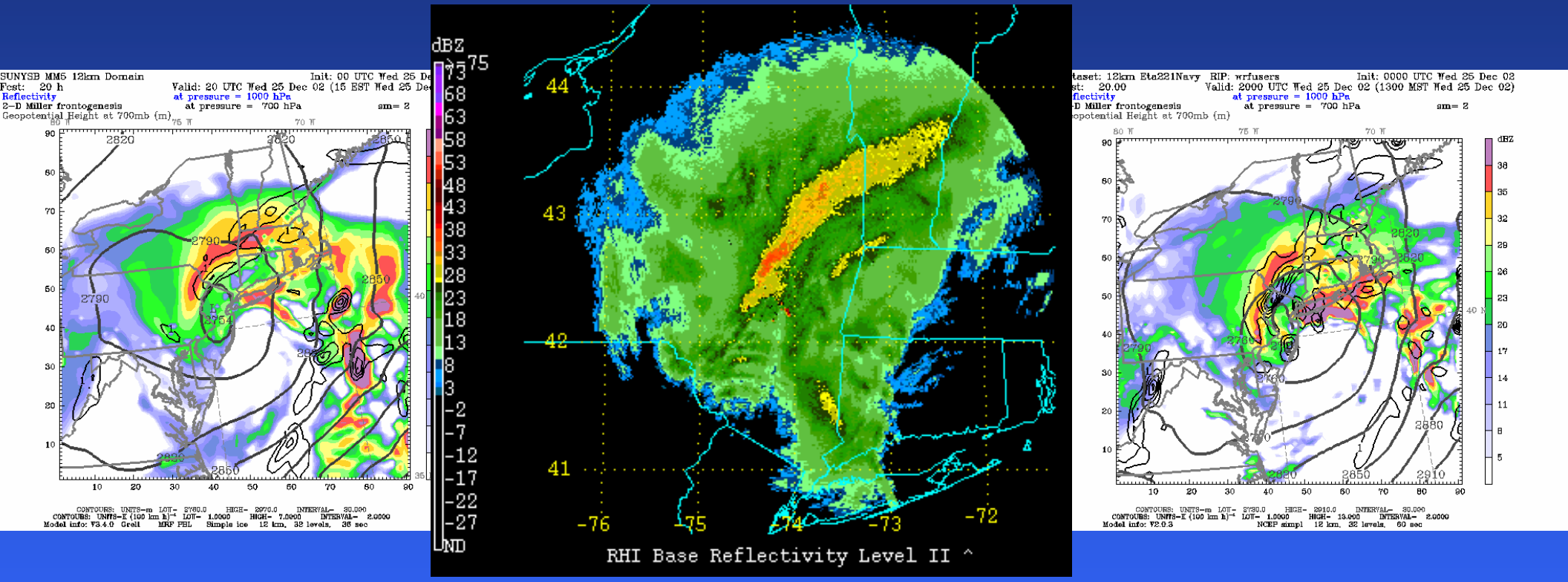
# Comparison of MM5 and WRF Forecasts of the 25 December 2002 Banded Snowstorm

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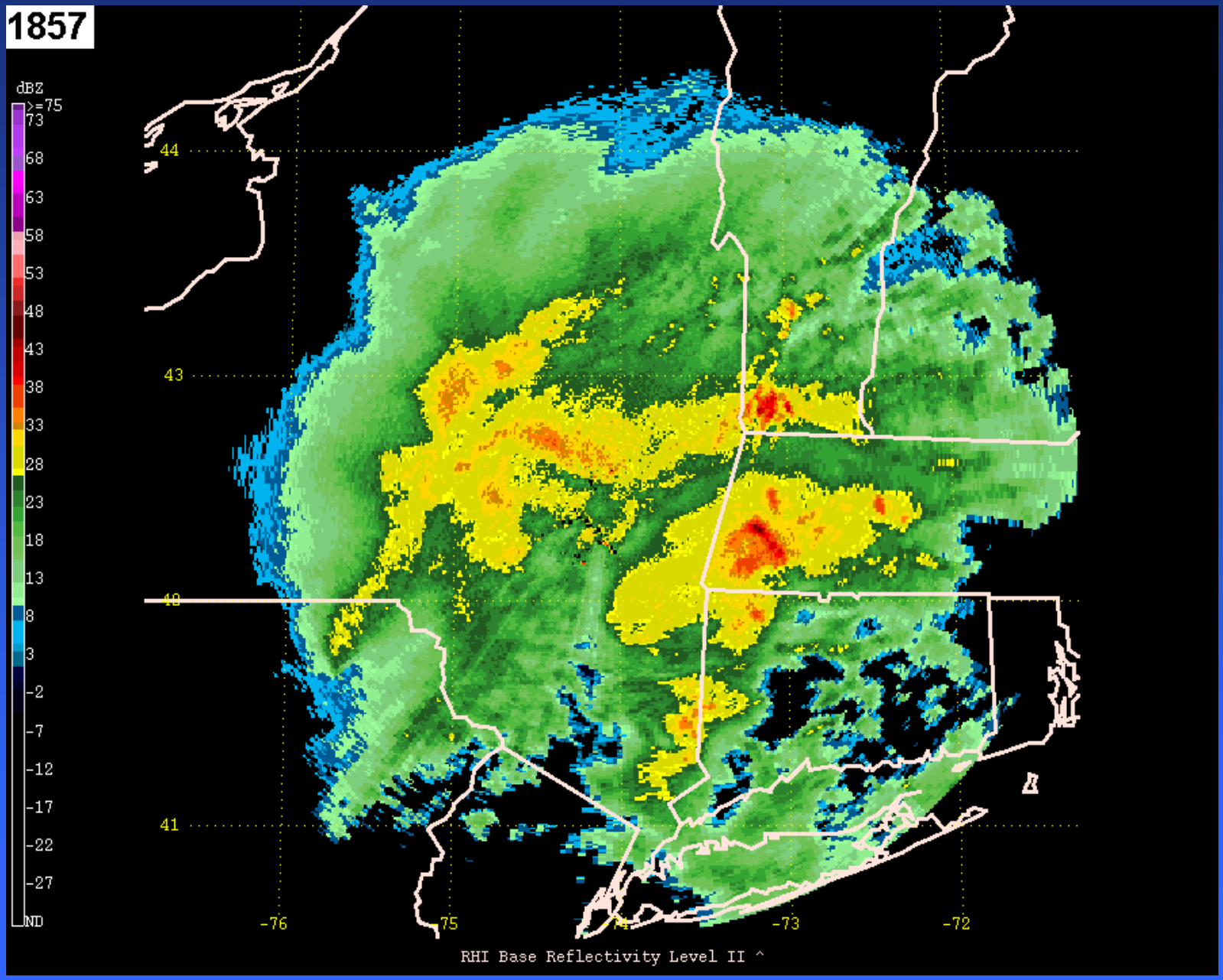
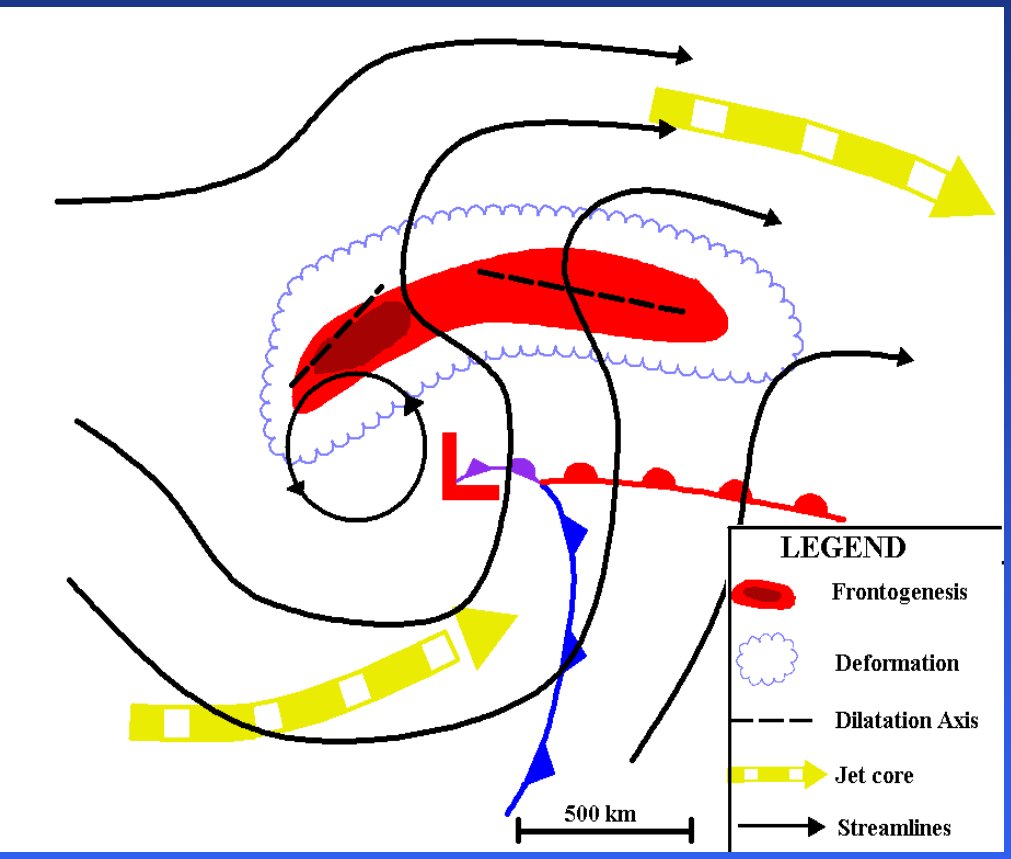
Stony Brook University, State University of New York, Stony Brook, New York

# 25 December 2002 Snowstorm



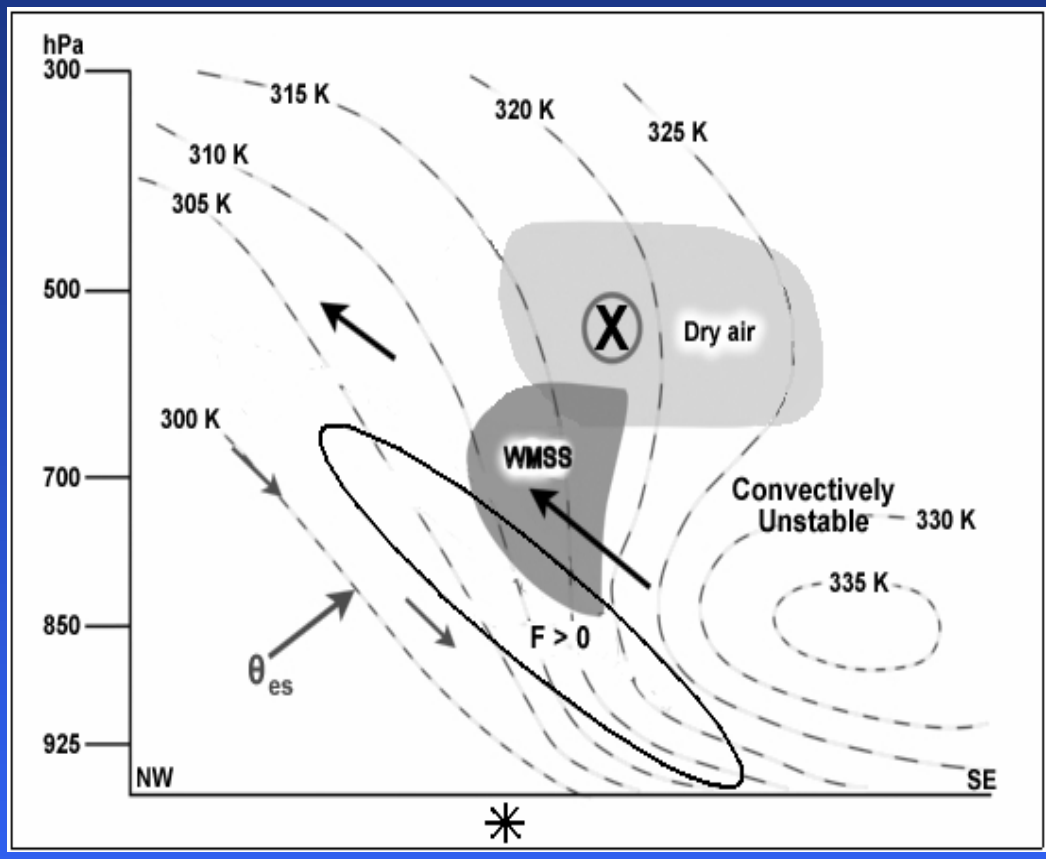
# Conceptual Models

## Plan-view




Novak et al. 2004

## Cross Section

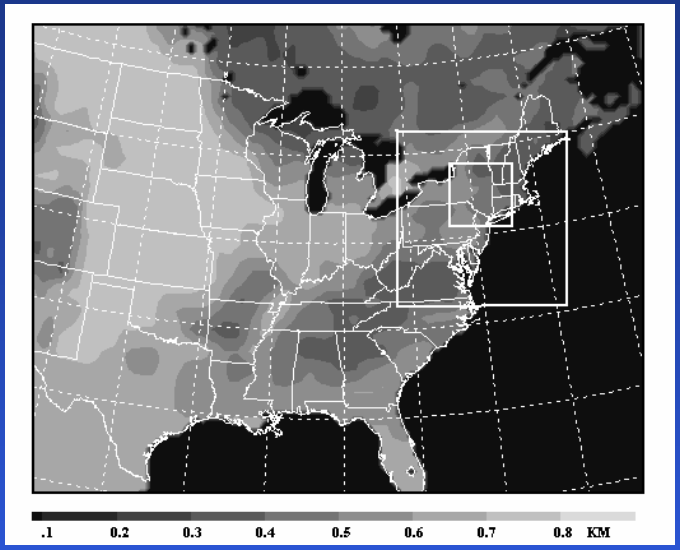



Novak et al. 2005
(adapted from Moore et al. 2004)

***Frontogenesis in the presence of weak moist symmetric stability and sufficient moisture***

# Case Study Design

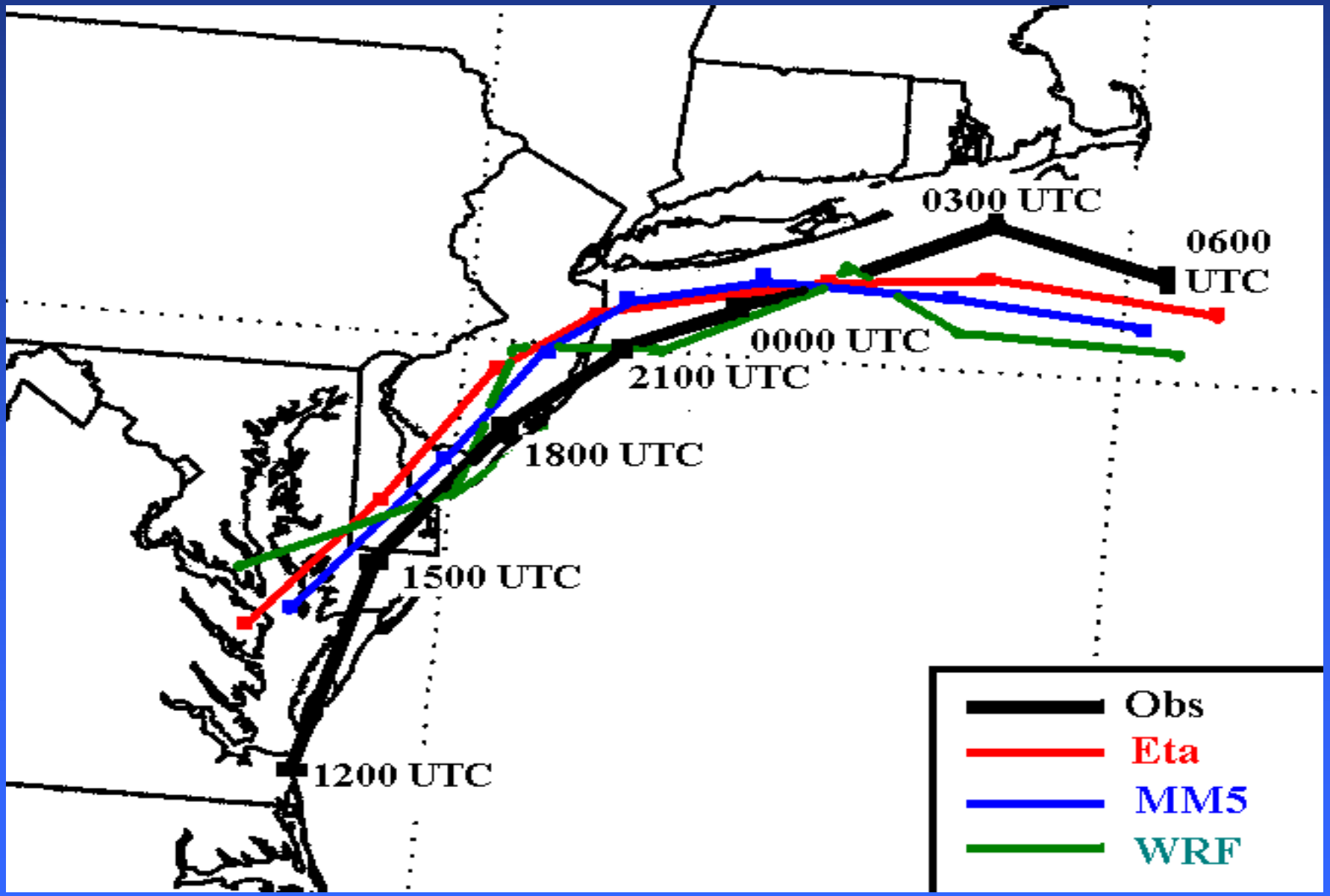
- Compare Eta, MM5, and WRF forecasts to observations
- Models initialized at 0000 UTC 25 Dec 2002
- MM5/WRF one way nest



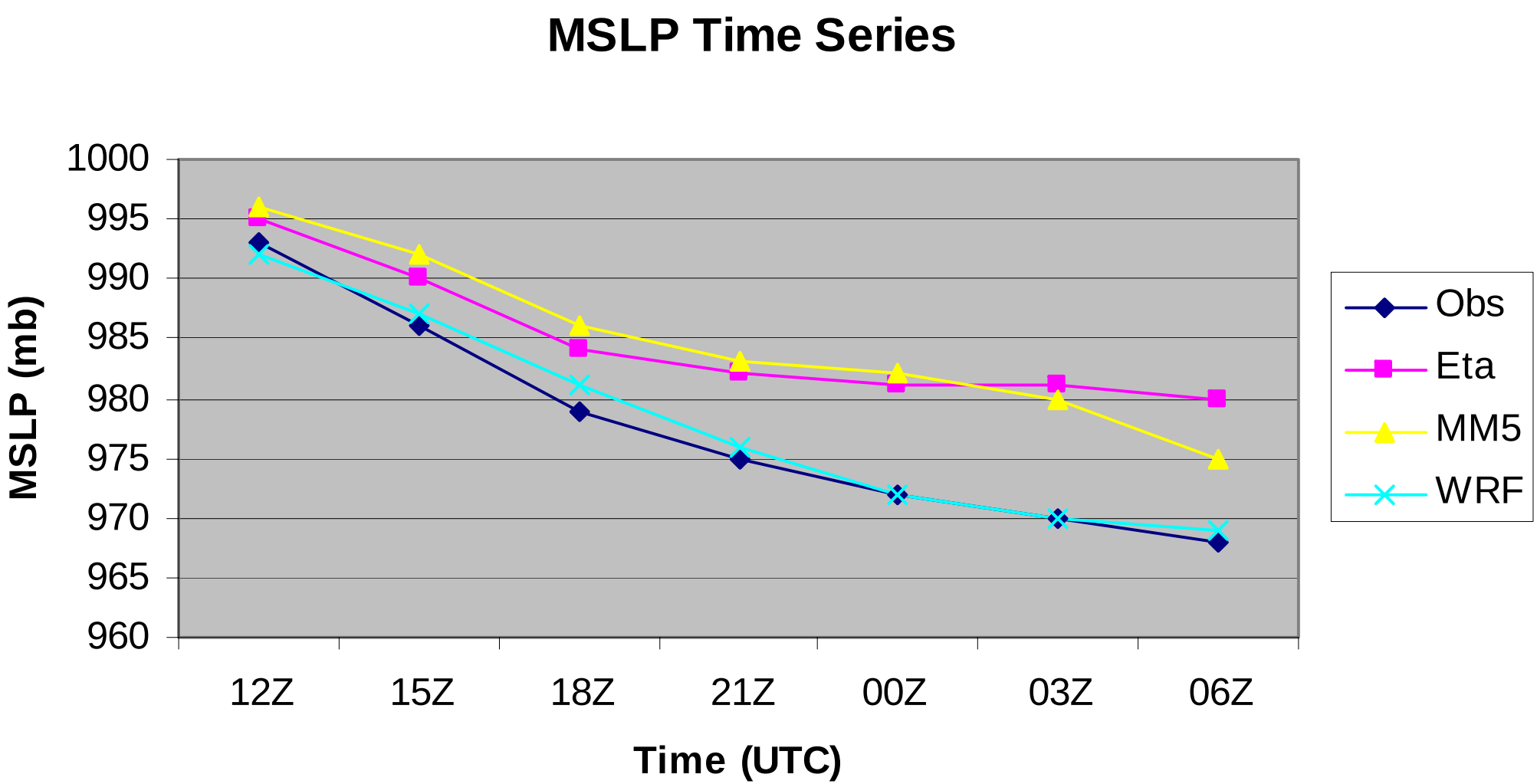

| Model | SST | Convection | BL | Micro-physics |
|---|---|---|---|---|
| **Eta** | Eta | BMJ | MYJ | Ferrier |
| **MM5 v3.4.0** | Navy | Grell | MRF | Simple Ice (3 class) |
| **WRF v2.0.3** | Navy | Grell–Devenyi | MRF | WSM-3 |

# 25 December 2002 Snowstorm

## Low Track Comparison



# 25 December 2002 Snowstorm

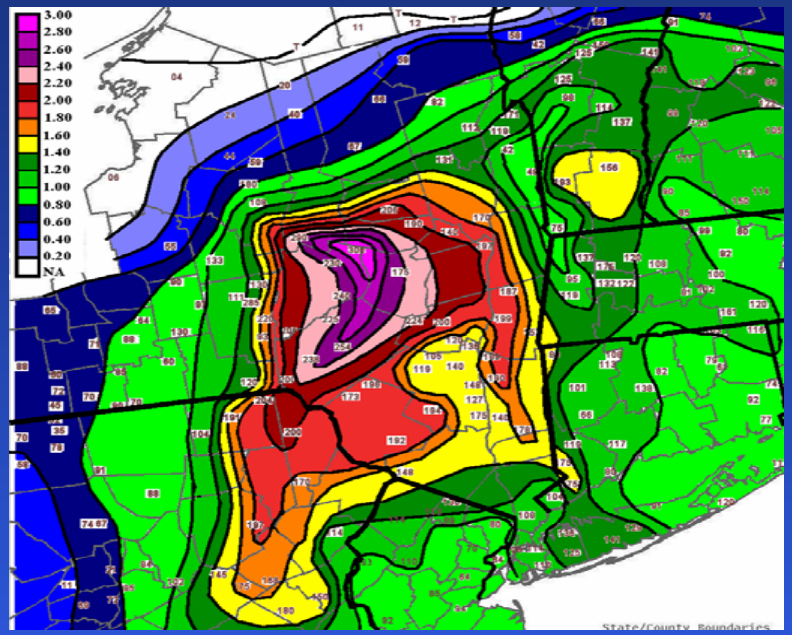


# QPF Performance

## 12 UTC 25 Dec – 12 UTC 26 Dec QPF

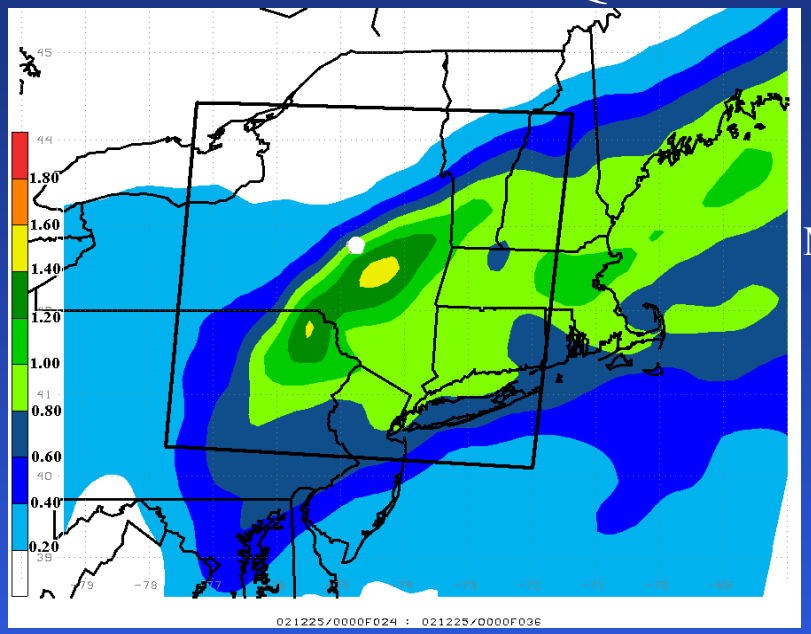
### Obs

Max =3.00 in (76.2 mm)



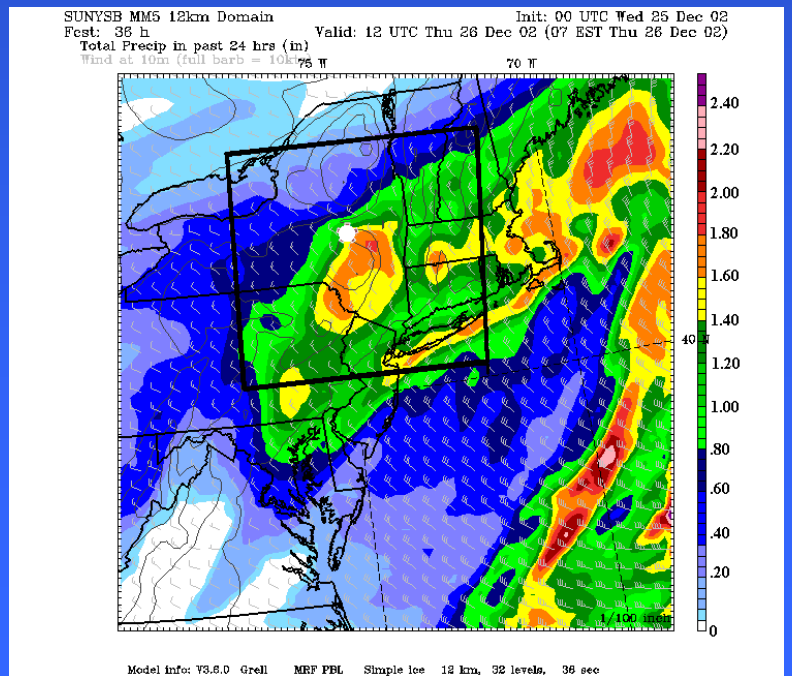

### Eta

Max =1.50 in (38.1 mm)



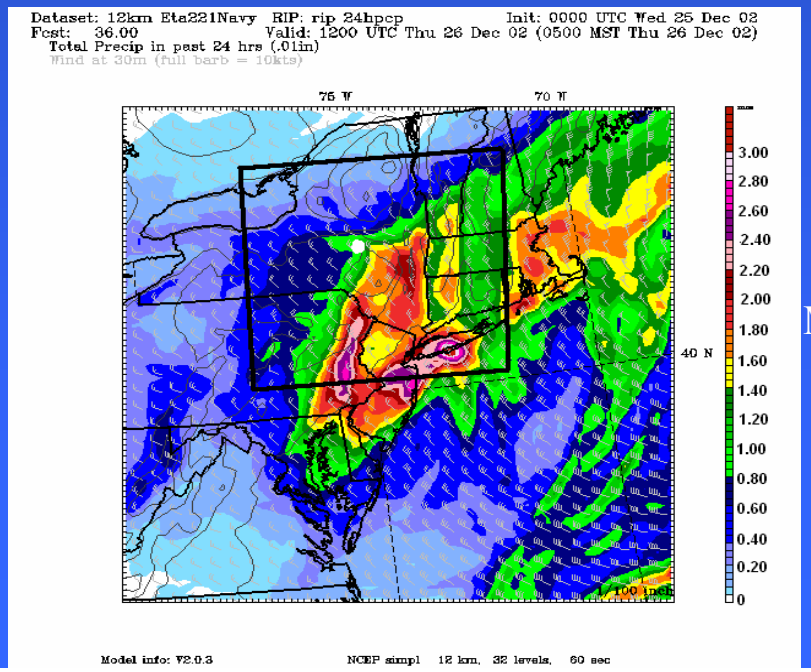

### MM5

Max =1.85 in (47 mm)



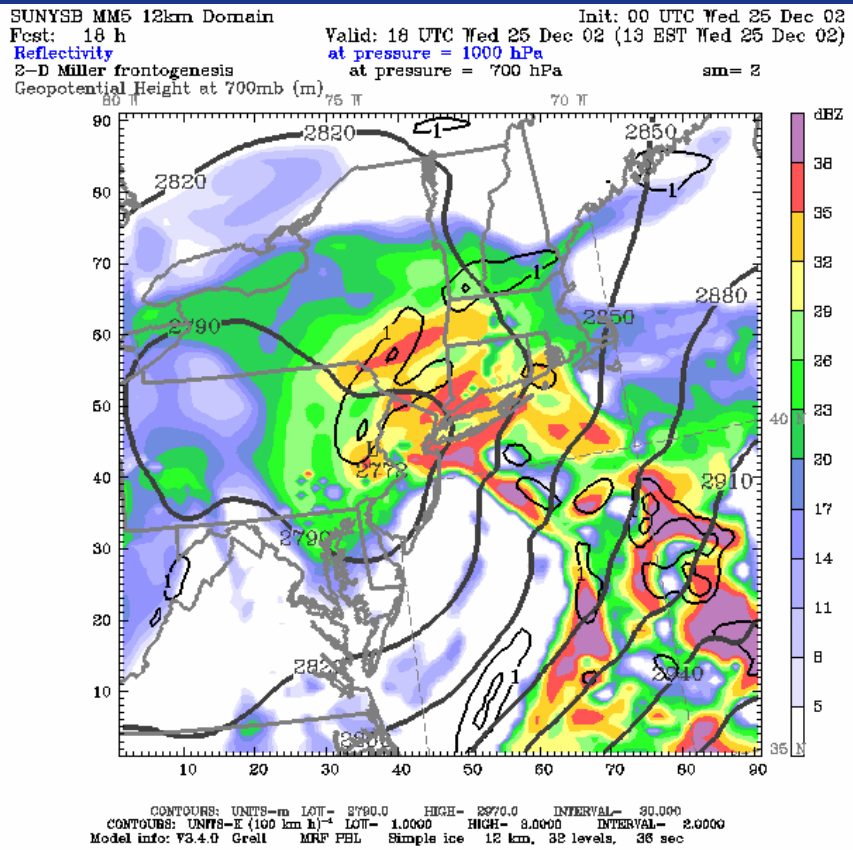

### WRF

Max =2.70 in (68.6 mm)

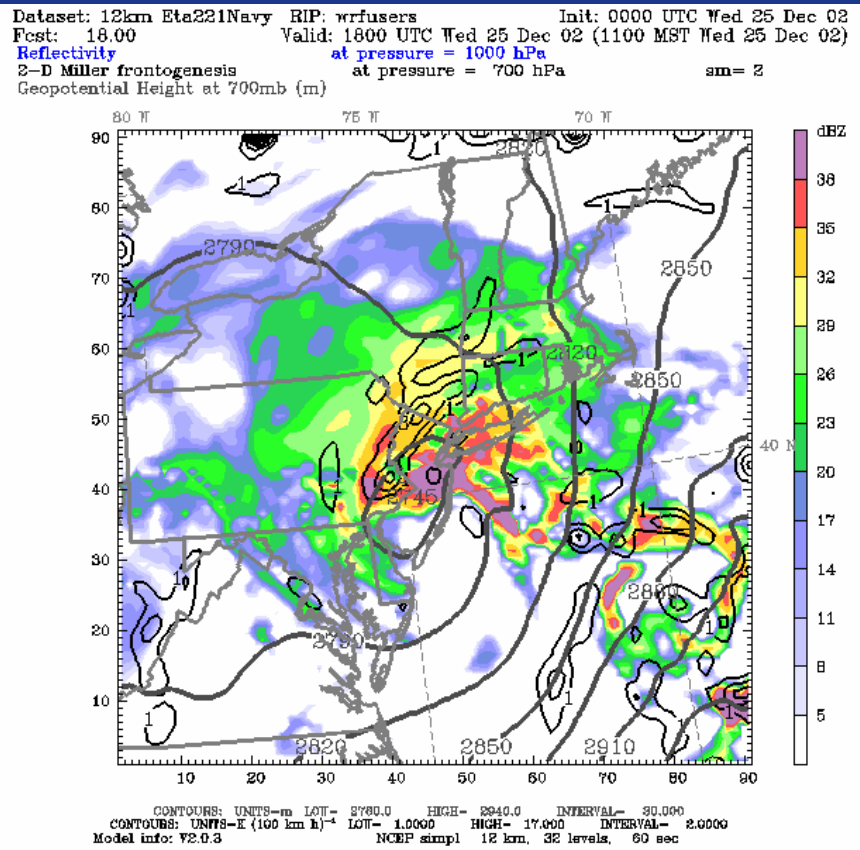


# 1800 UTC

## 12 km MM5



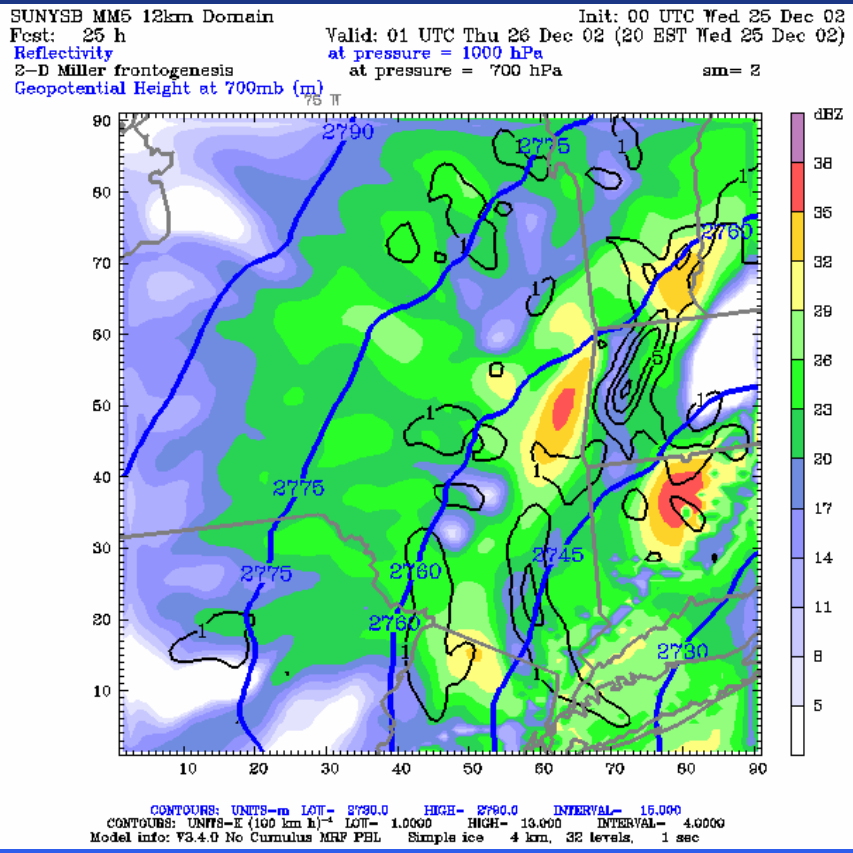

## 12 km WRF



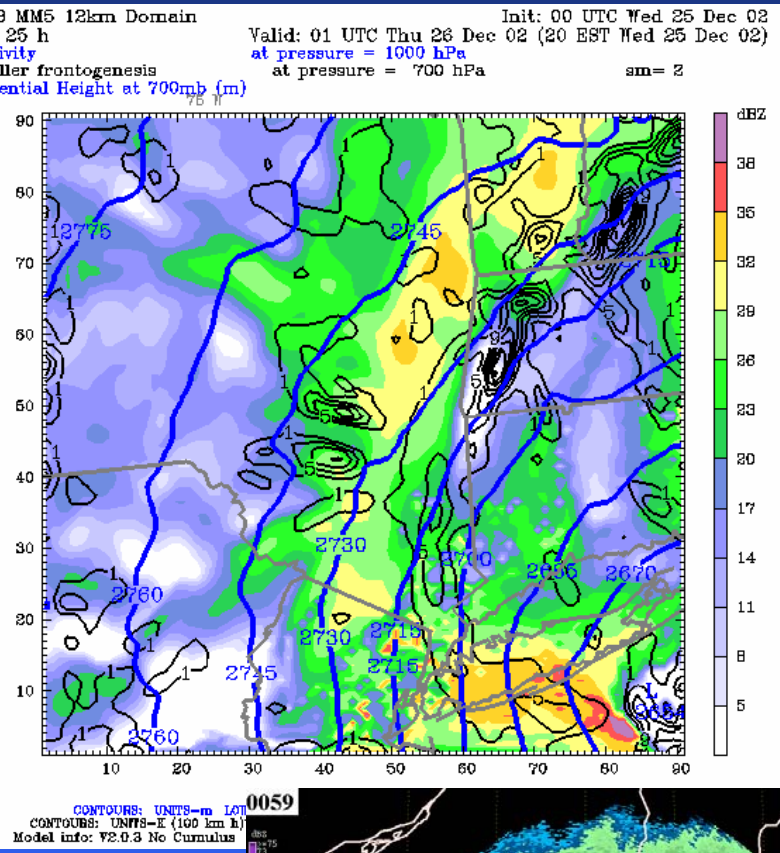

- Simulated Radar Reflectivity (shaded, dBZ)
- 700-hPa height (thick solid, m)
- 700-hPa 2D Miller Frontogenesis (thin solid, °C 100 $km^{-1}$ $h^{-1}$)

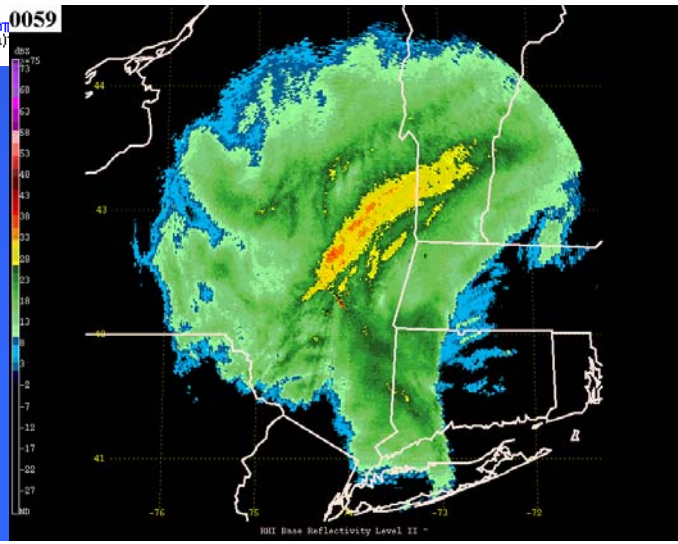
# 0000 UTC

## 4 km MM5




## 4 km WRF

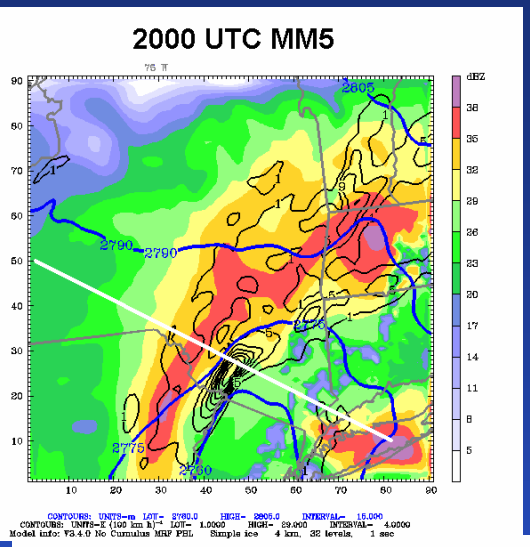



- Simulated Radar Reflectivity (shaded, dBZ)
- 700-hPa height (thick solid, m)
- 700-hPa 2D Miller Frontogenesis (thin solid, °C 100 $km^{-1}$ $h^{-1}$)

# 4 km MM5

# 4 km WRF

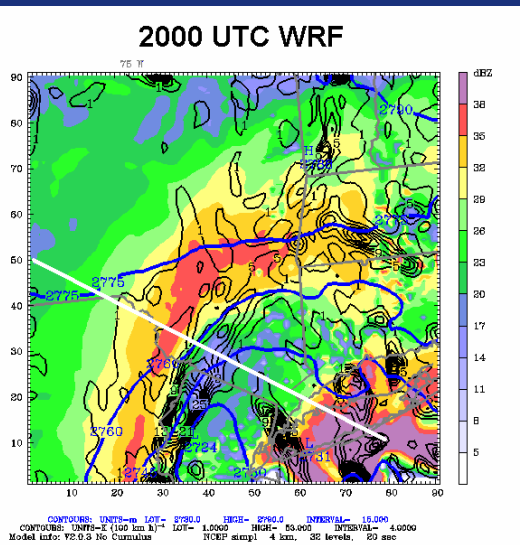


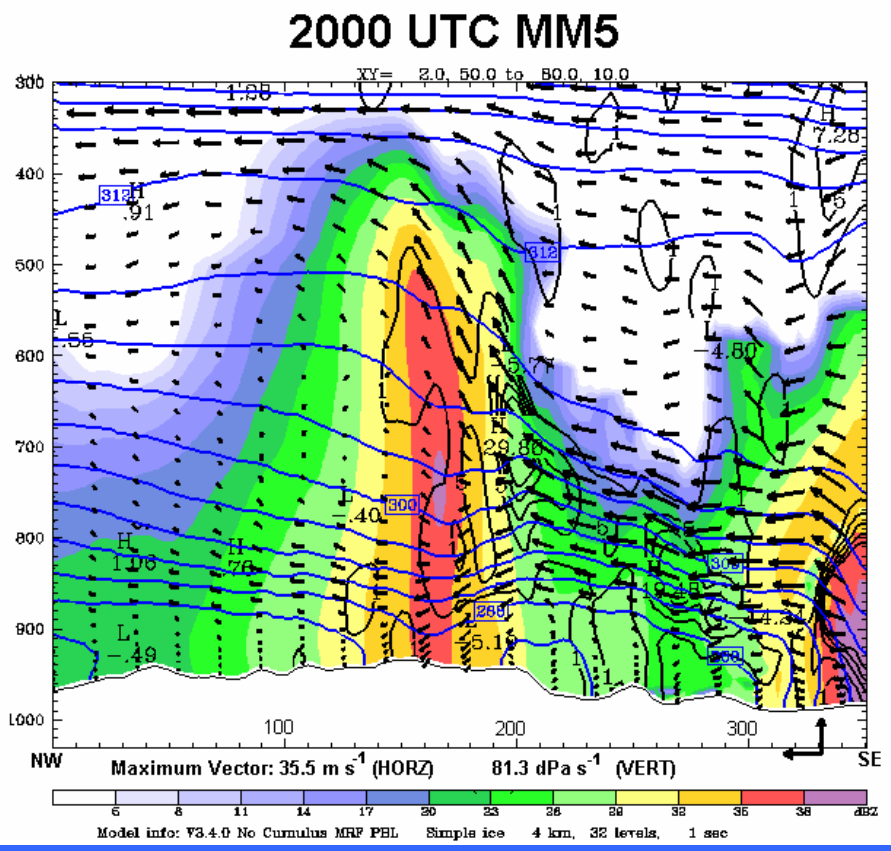

Reflectivity (shaded)

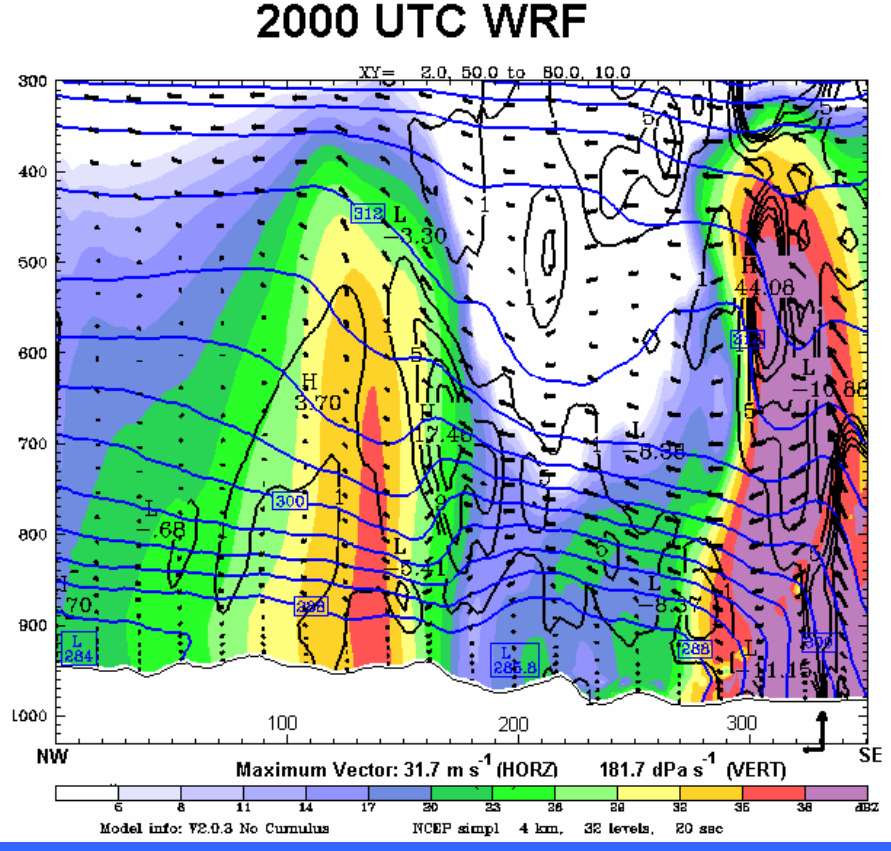
2D Frontogenesis

$\Theta_{es}$ (blue)

Circulation

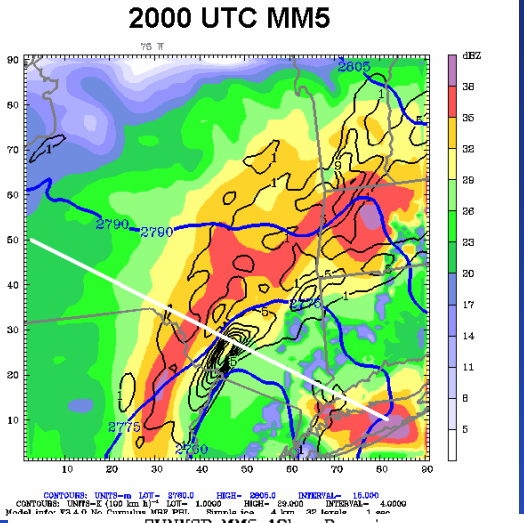


# 4 km MM5

# 4 km WRF

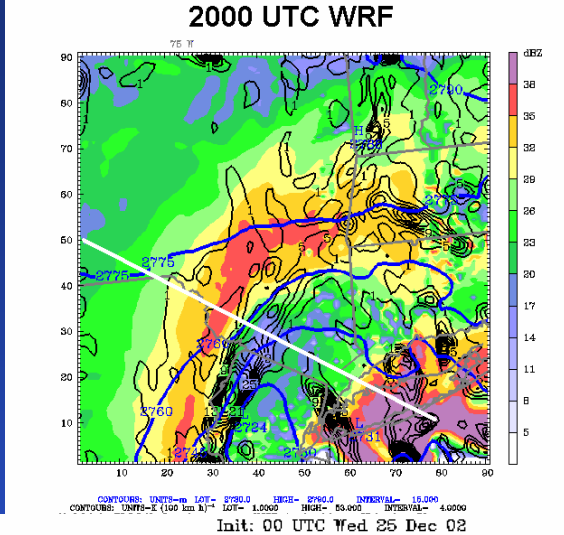


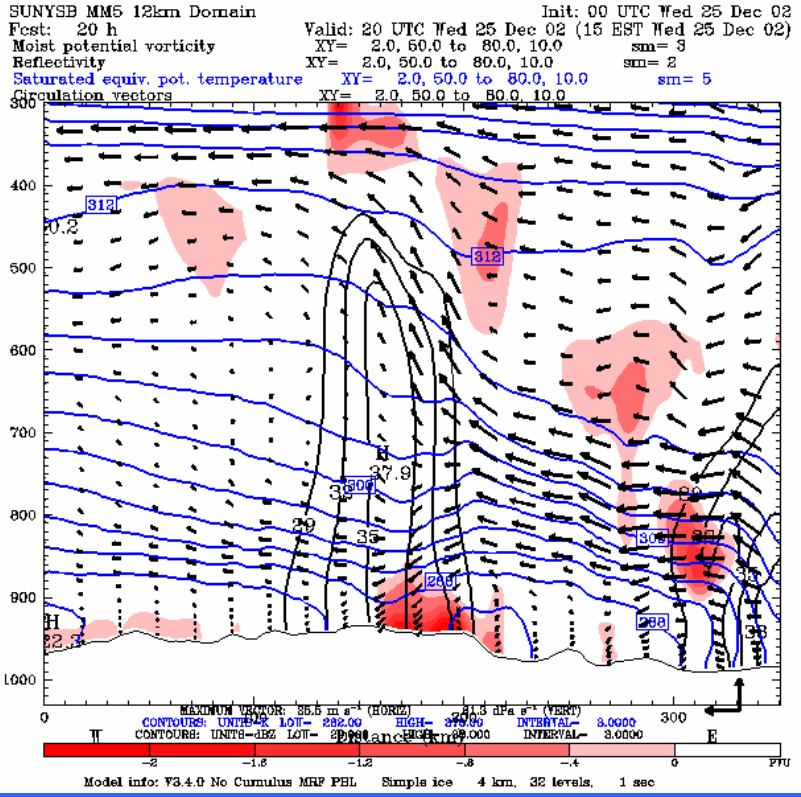

Reflectivity

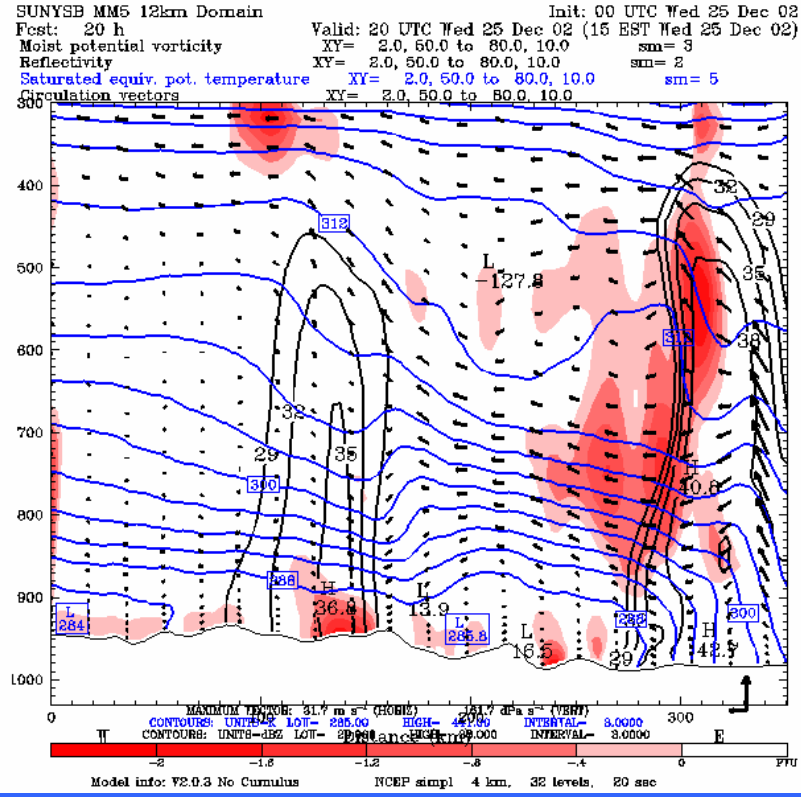
$MPV_f < 0$ (shaded)

$\Theta_{es}$ (blue)

Circulation

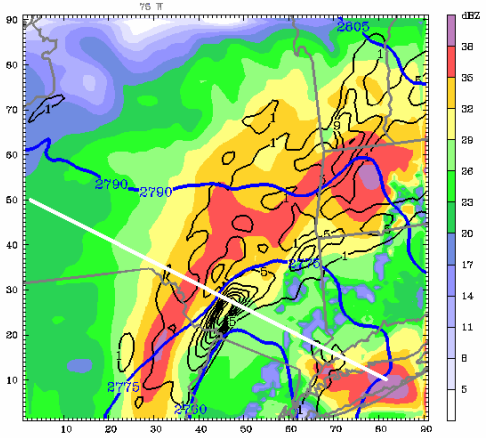


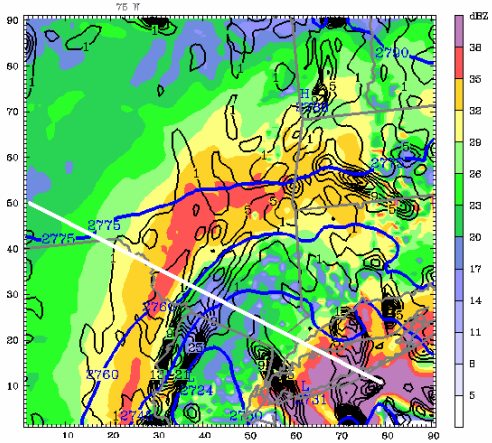



# Relationship between the Band, Frontogenesis, WSS, Moisture and Ascent

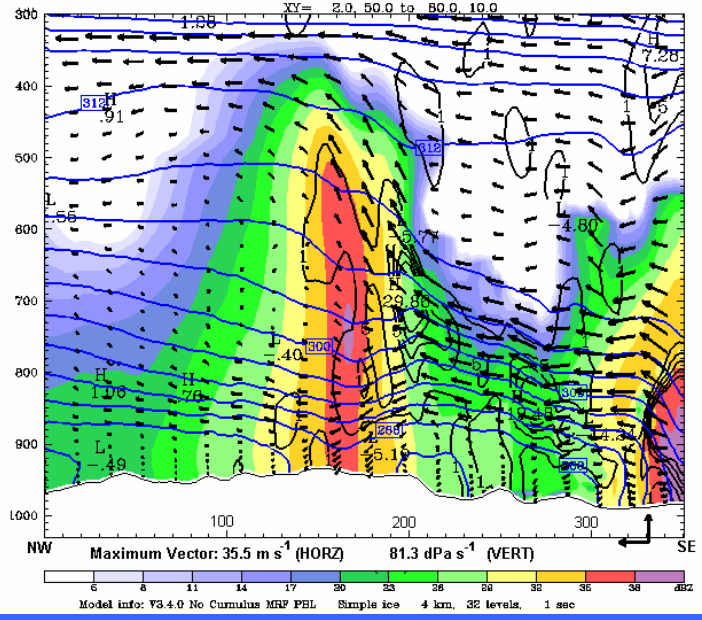
2000 UTC MM5



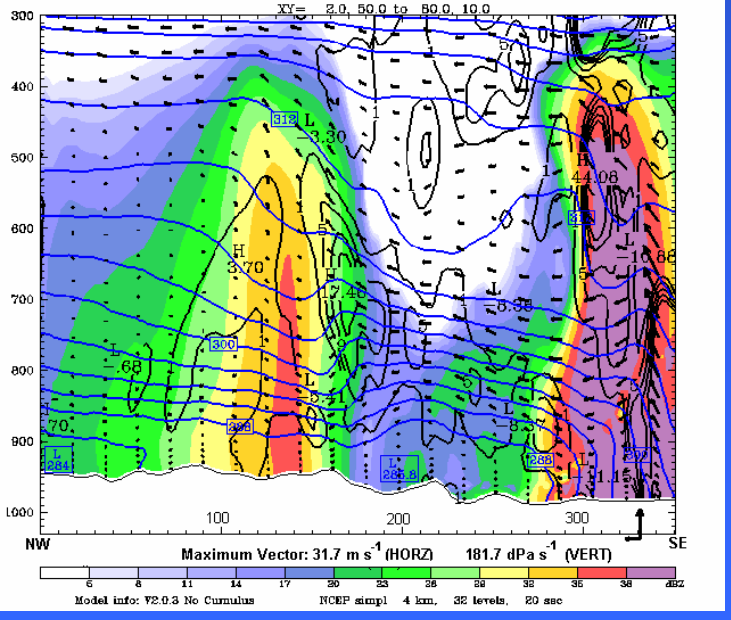
2000 UTC WRF



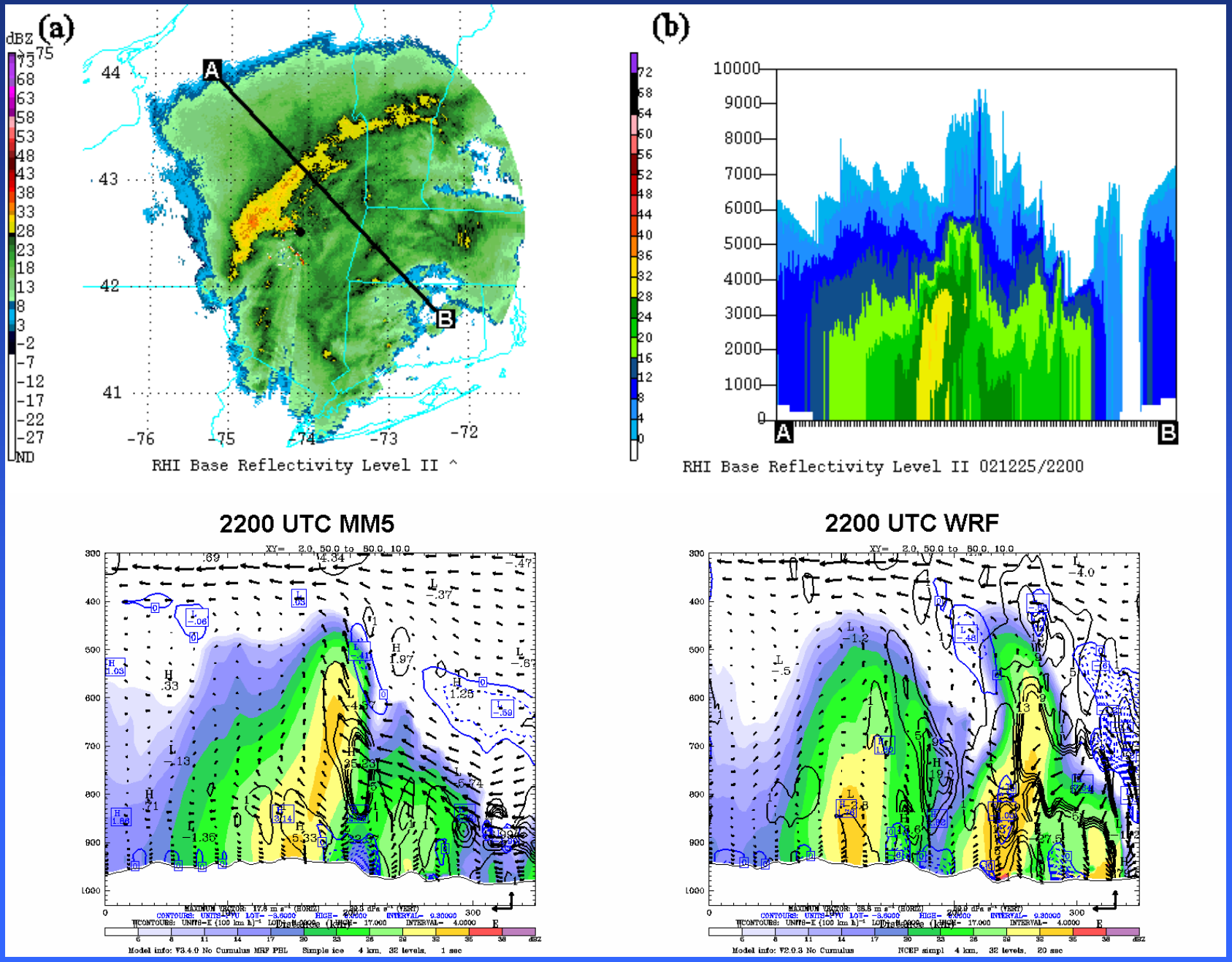
2000 UTC MM5



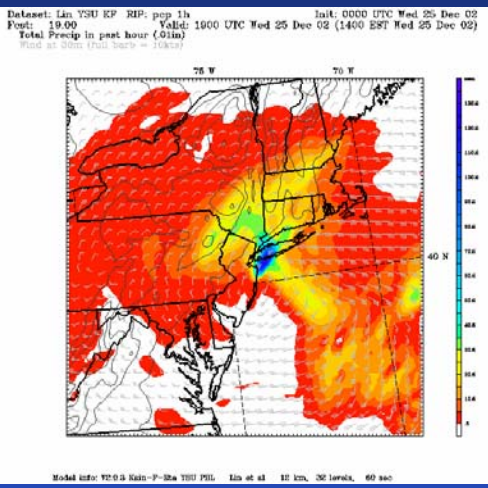

2000 UTC WRF



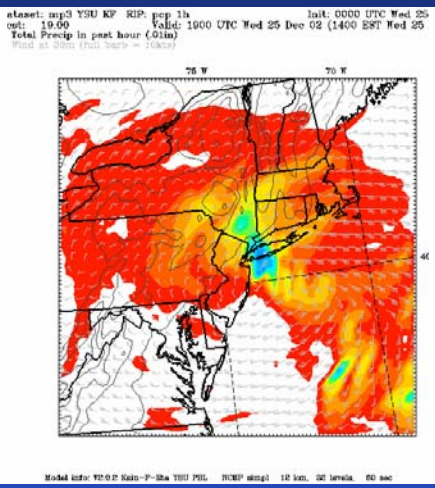
# Precipitation Drift?



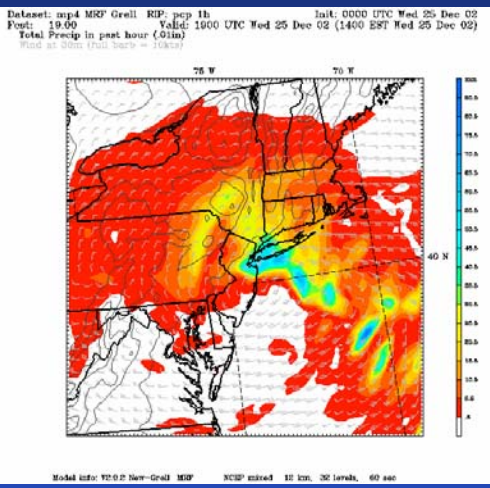
# Ensemble Members (1 h precip ending 19 UTC)



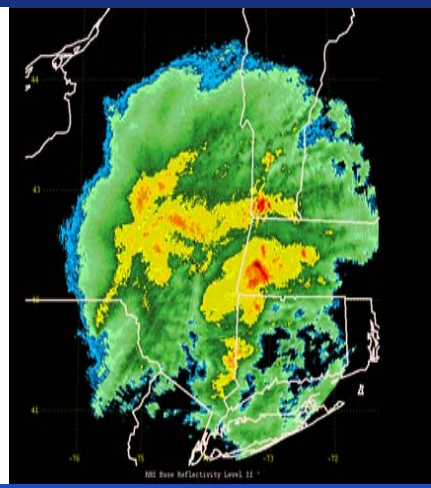
WRF Eta init
KF / YSU
Lin



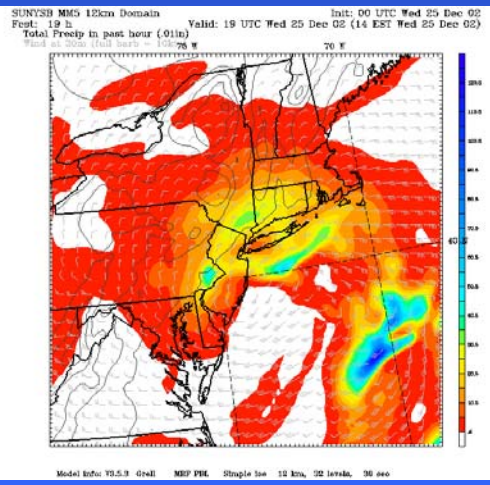
WRF Eta Init
KF/ YSU
WSM-3



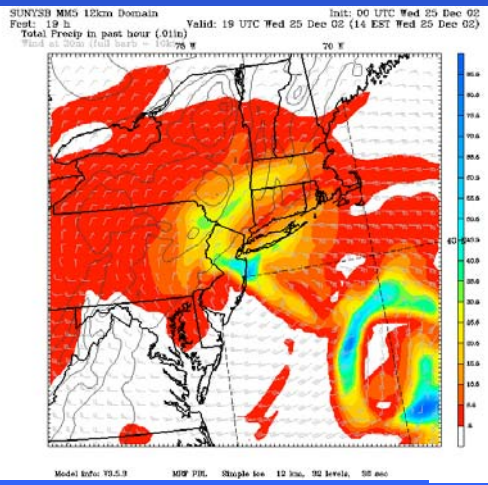
WRF Eta Init Grell–
Devenyi / MRF
WSM-5



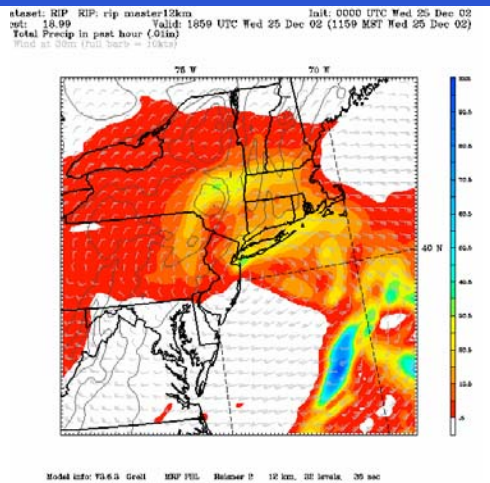
19 UTC
Radar



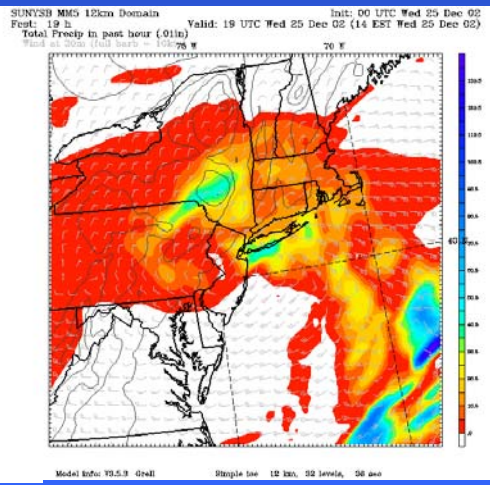
MM5 GFS init
Grell /MRF
Simple Ice



MM5 Eta init
KF / MRF
Simple Ice

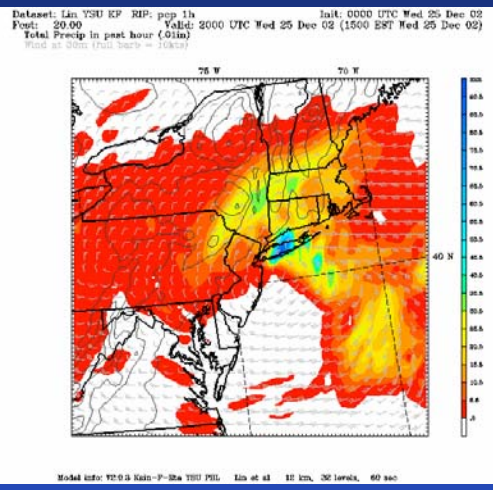


MM5 Eta init
Grell / MRF
Reisner 2

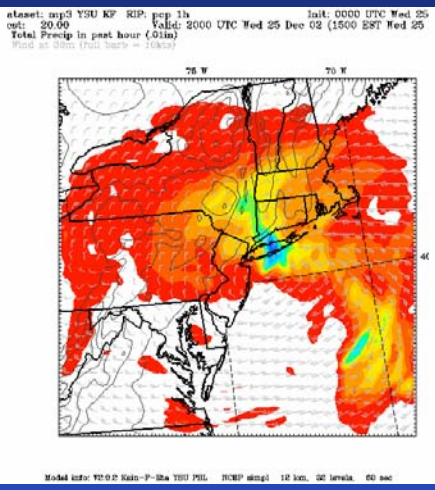


MM5 Eta init
Grell / GS
Simple Ice

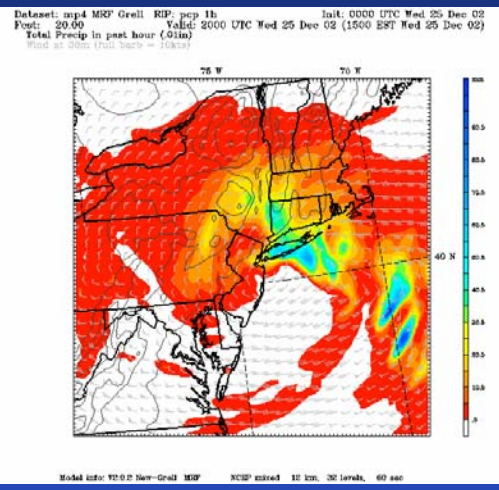
# Ensemble Members (1 h precip ending 20 UTC)



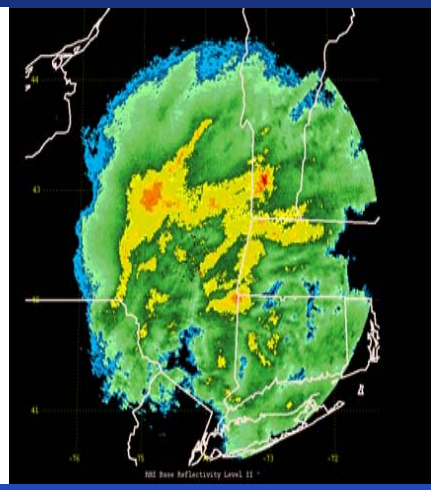
WRF Eta init
KF / YSU
Lin



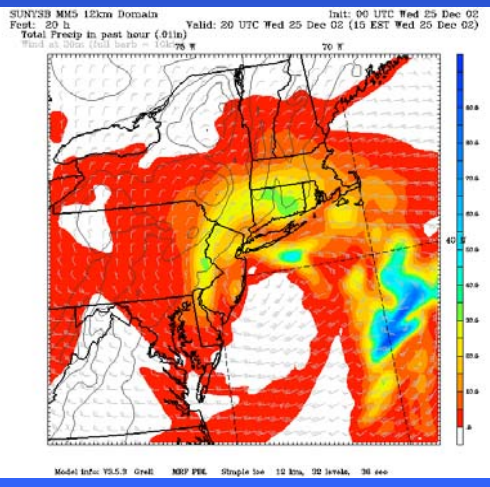
WRF Eta Init
KF/ YSU
WSM-3



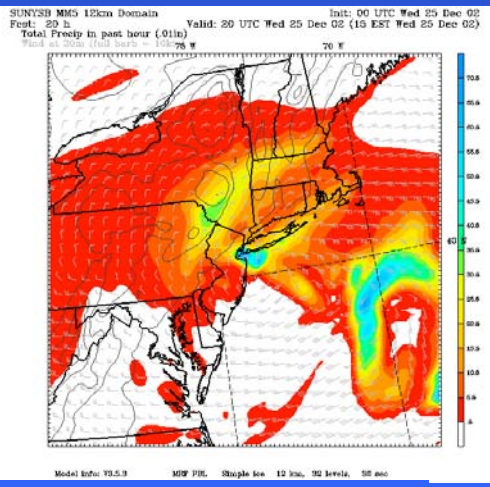
WRF Eta Init Grell–
Devenyi / MRF
WSM-5



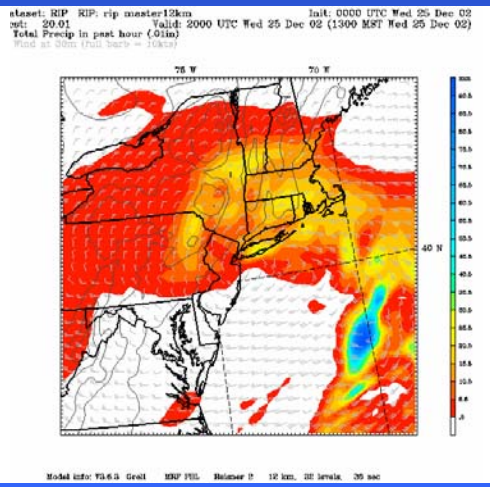
20 UTC
Radar



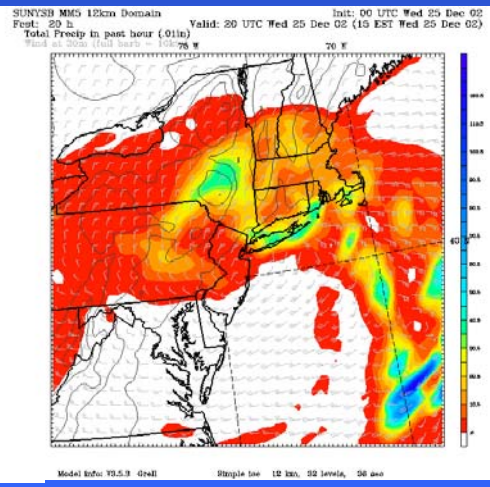
MM5 GFS init
Grell /MRF
Simple Ice



MM5 Eta init
KF / MRF
Simple Ice

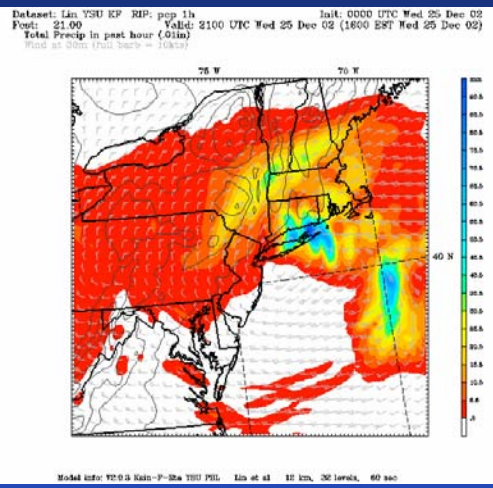


MM5 Eta init
Grell / MRF
Reisner 2

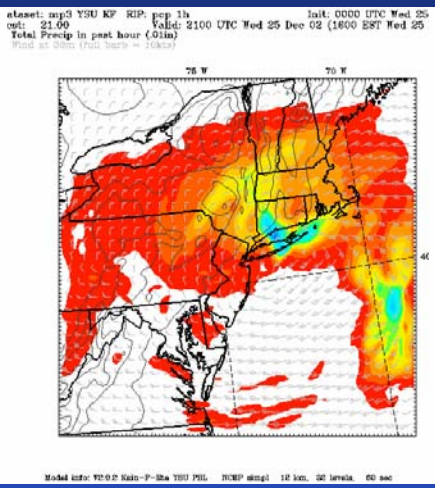


MM5 Eta init
Grell / GS
Simple Ice

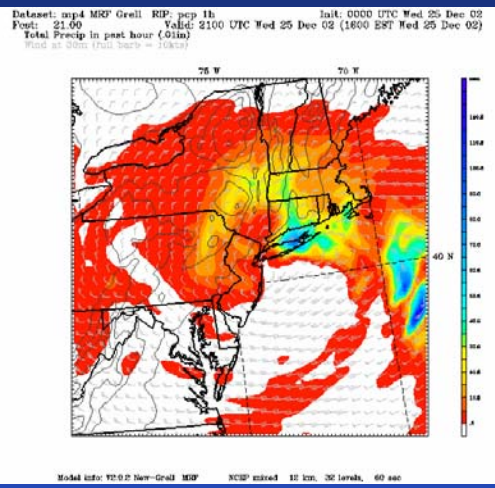
# Ensemble Members (1 h precip ending 21 UTC)



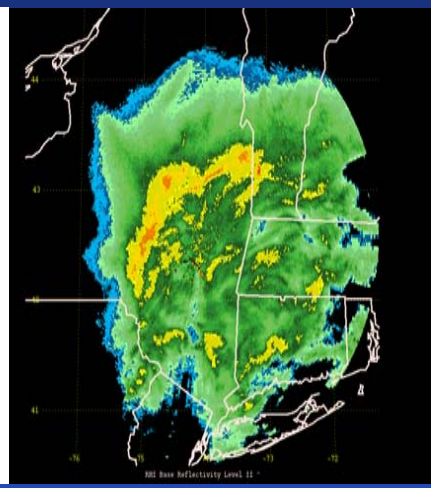
WRF Eta init
KF / YSU
Lin



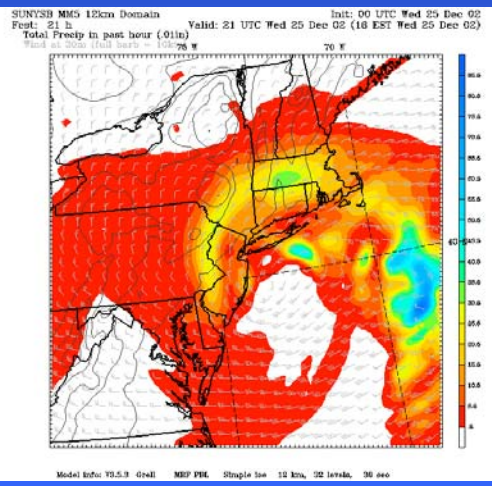
WRF Eta Init
KF/ YSU
WSM-3



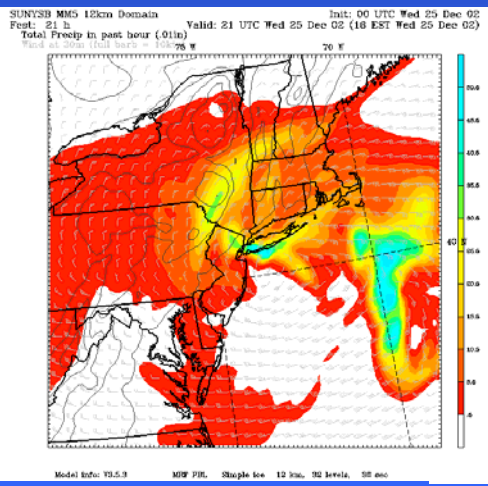
WRF Eta Init Grell–
Devenyi / MRF
WSM-5



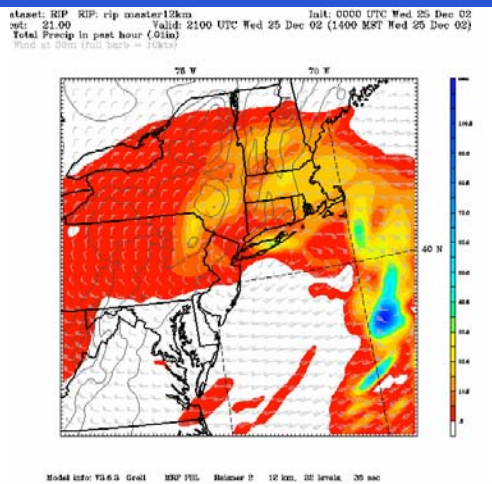
21 UTC
Radar



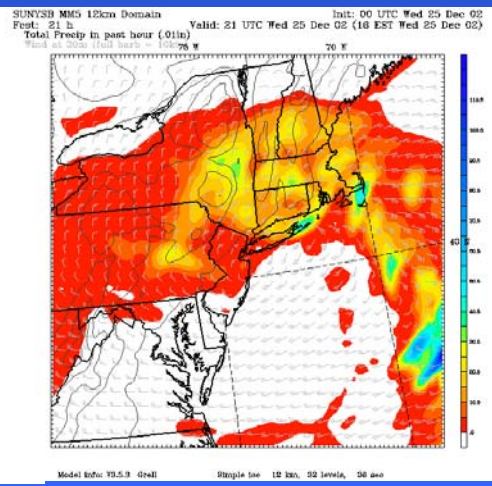
MM5 GFS init
Grell /MRF
Simple Ice



MM5 Eta init
KF / MRF
Simple Ice

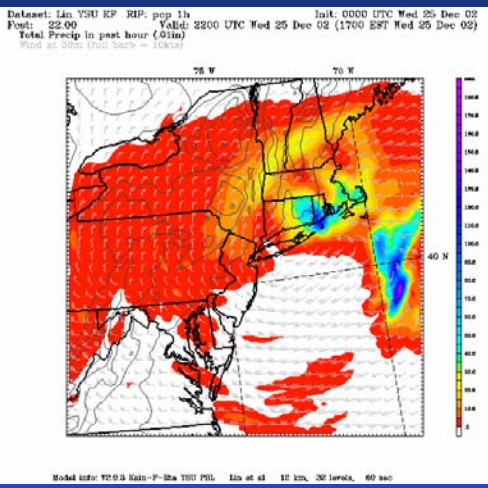


MM5 Eta init
Grell / MRF
Reisner 2

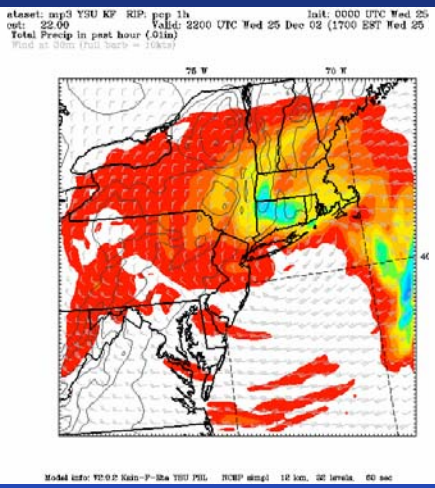


MM5 Eta init
Grell / GS
Simple Ice

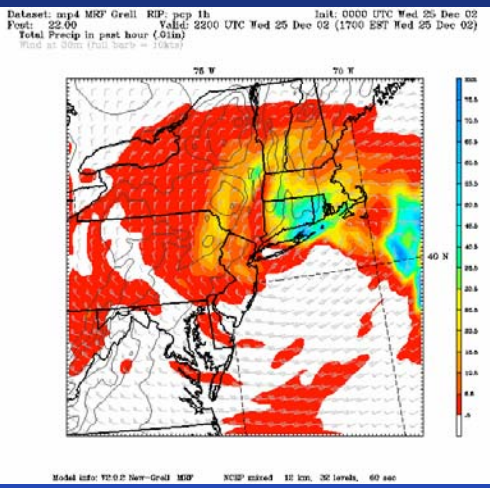
# Ensemble Members (1 h precip ending 22 UTC)



WRF Eta init
KF / YSU
Lin

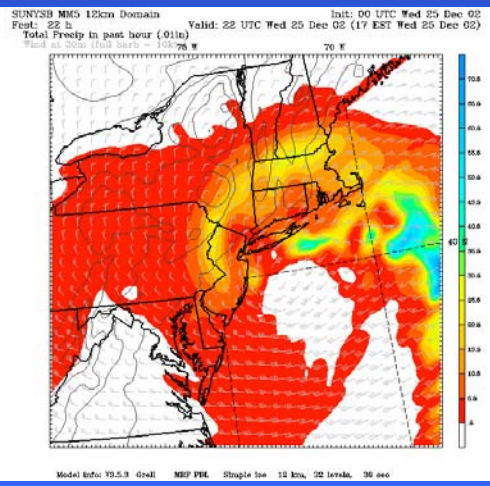


WRF Eta Init
KF/ YSU
WSM-3

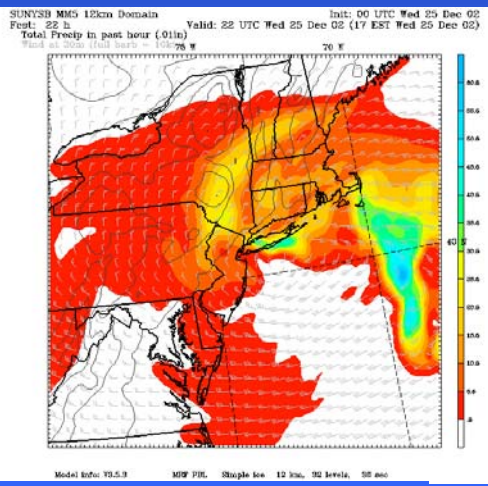


WRF Eta Init Grell–
Devenyi / MRF
WSM-5

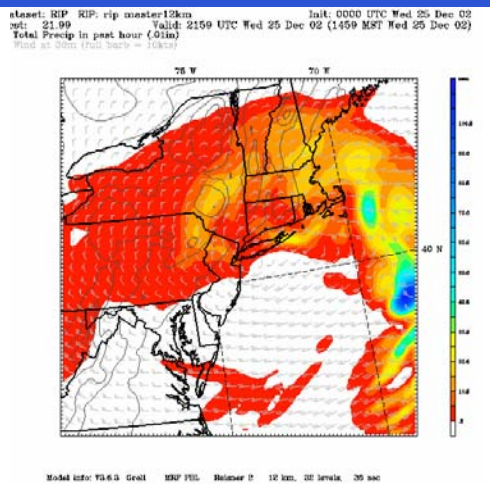
22 UTC
Radar



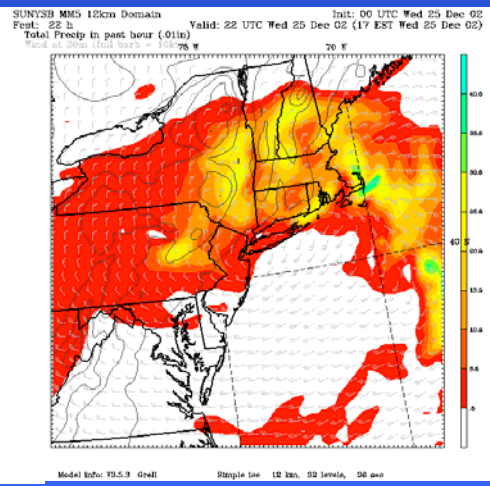
MM5 GFS init
Grell /MRF
Simple Ice



MM5 Eta init
KF / MRF
Simple Ice

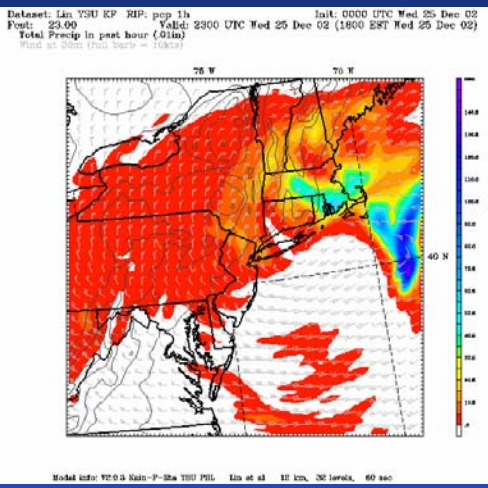


MM5 Eta init
Grell / MRF
Reisner 2

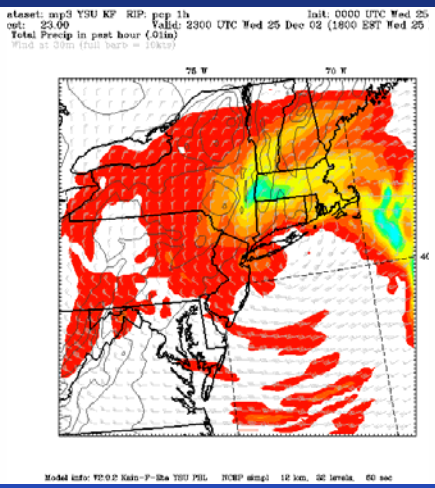


MM5 Eta init
Grell / GS
Simple Ice

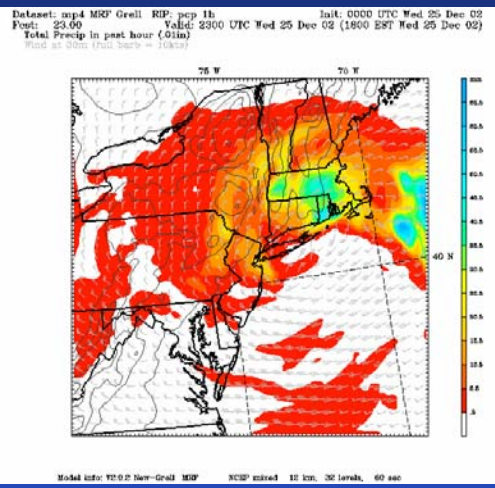
# Ensemble Members (1 h precip ending 23 UTC)



WRF Eta init
KF / YSU
Lin

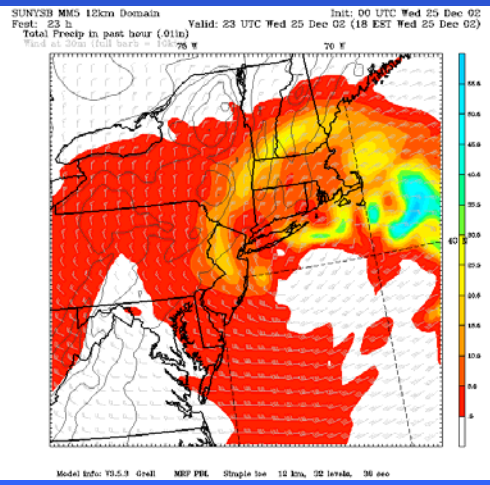


WRF Eta Init
KF/ YSU
WSM-3

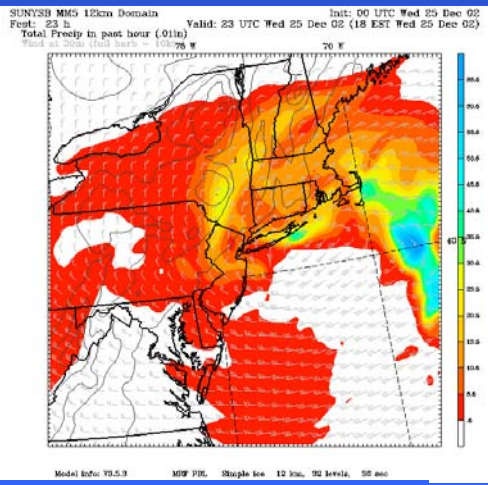


WRF Eta Init Grell–
Devenyi / MRF
WSM-5

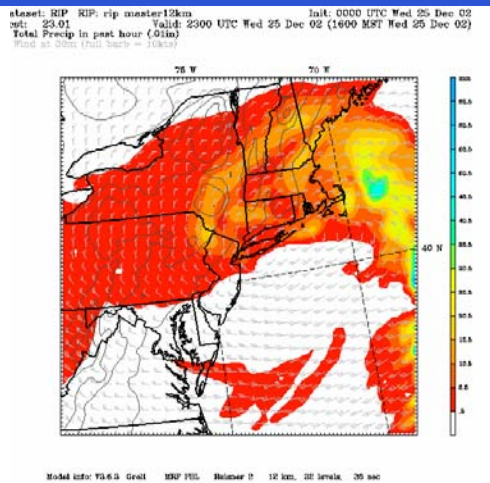
23 UTC
Radar



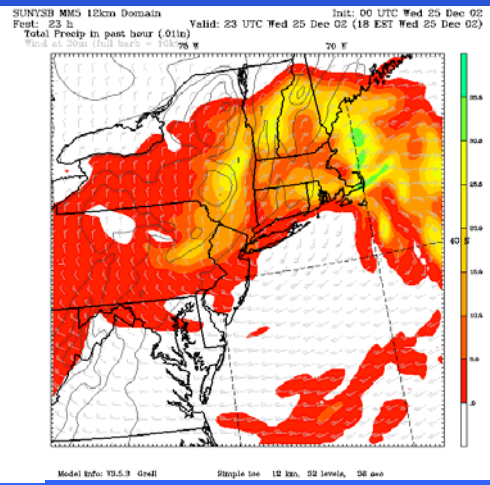
MM5 GFS init
Grell /MRF
Simple Ice



MM5 Eta init
KF / MRF
Simple Ice

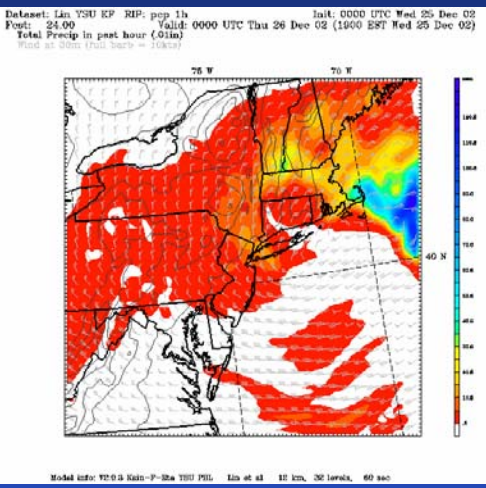


MM5 Eta init
Grell / MRF
Reisner 2

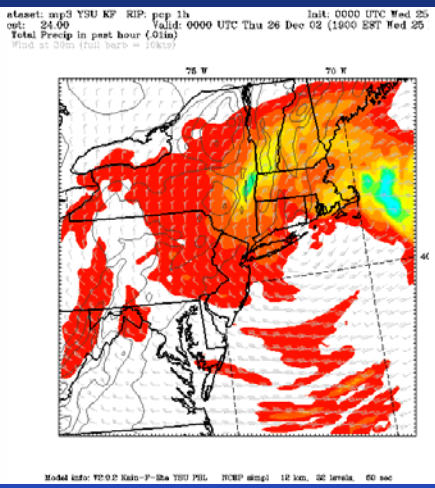


MM5 Eta init
Grell / GS
Simple Ice

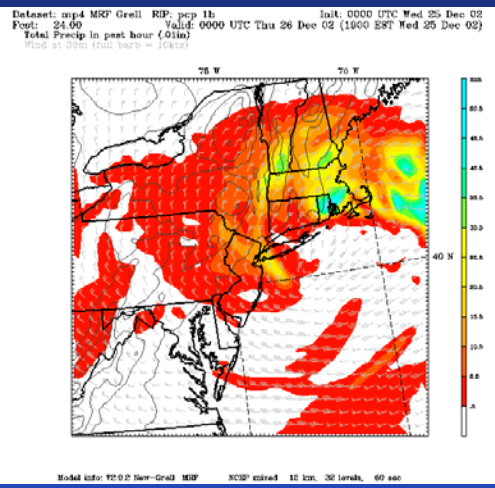
# Ensemble Members (1 h precip ending 00 UTC)



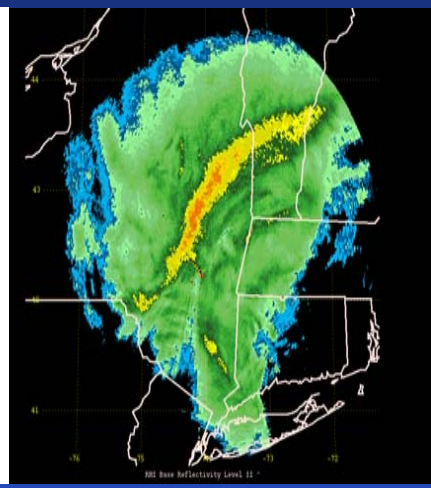
WRF Eta init
KF / YSU
Lin



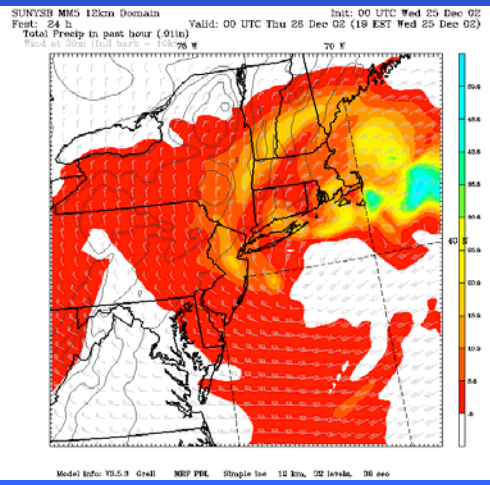
WRF Eta Init
KF/ YSU
WSM-3



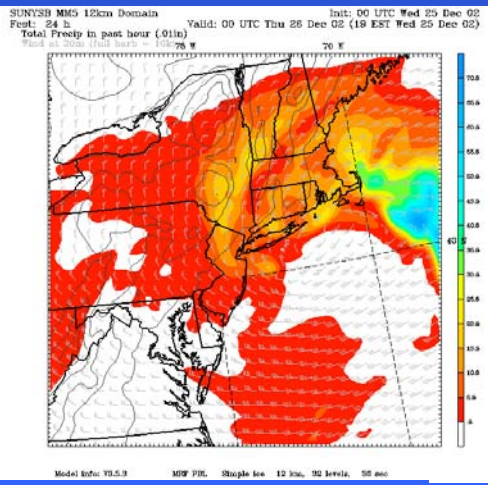
WRF Eta Init Grell–
Devenyi / MRF
WSM-5



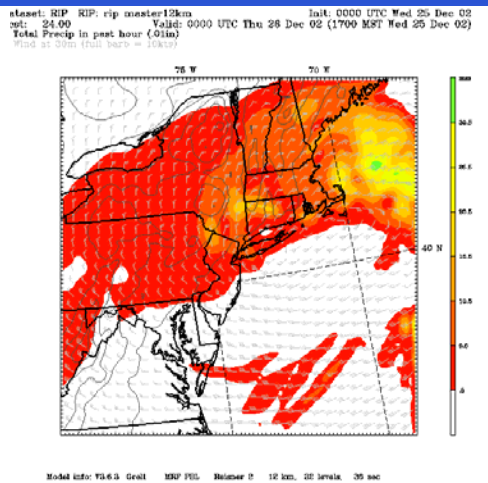
00 UTC
Radar



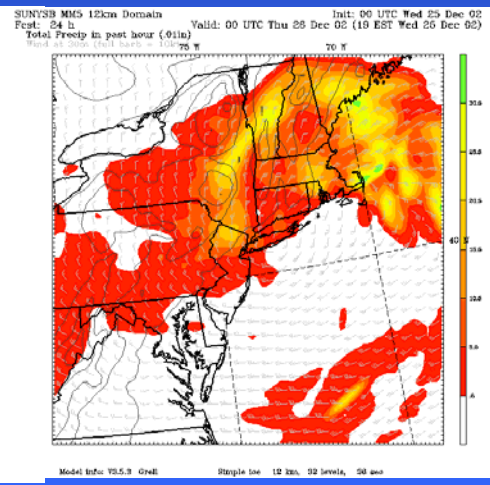
MM5 GFS init
Grell /MRF
Simple Ice



MM5 Eta init
KF / MRF
Simple Ice

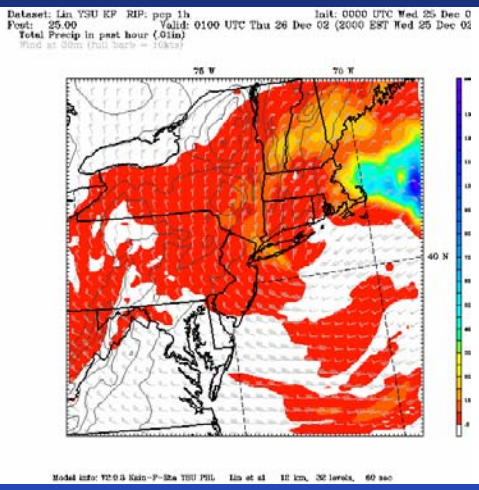


MM5 Eta init
Grell / MRF
Reisner 2

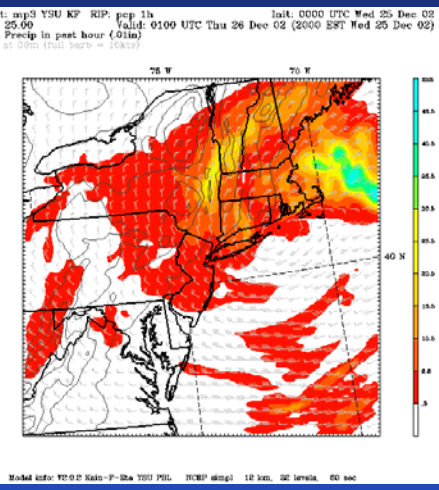


MM5 Eta init
Grell / GS
Simple Ice

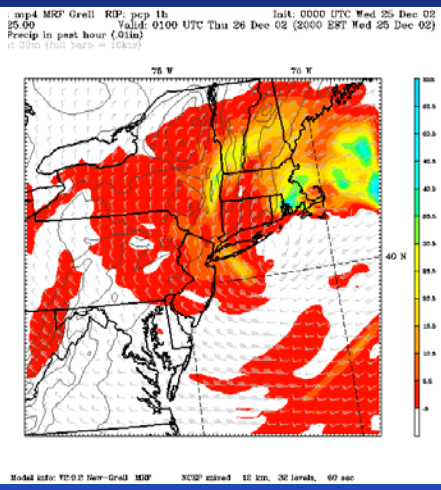
# Ensemble Members (1 h precip ending 01 UTC)



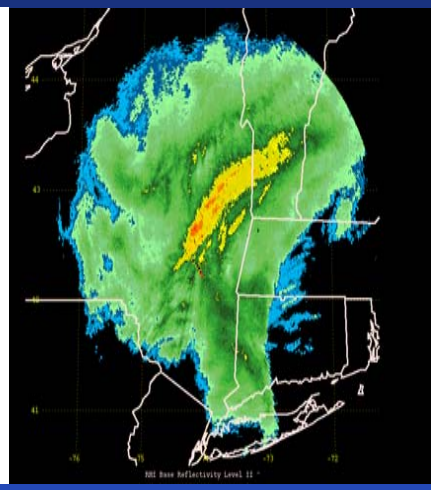
WRF Eta init
KF / YSU
Lin



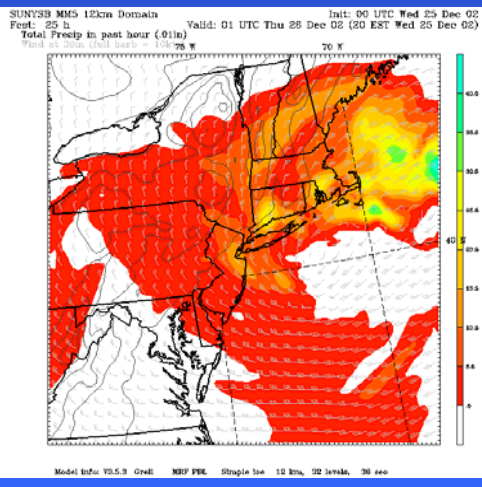
WRF Eta Init
KF/ YSU
WSM-3



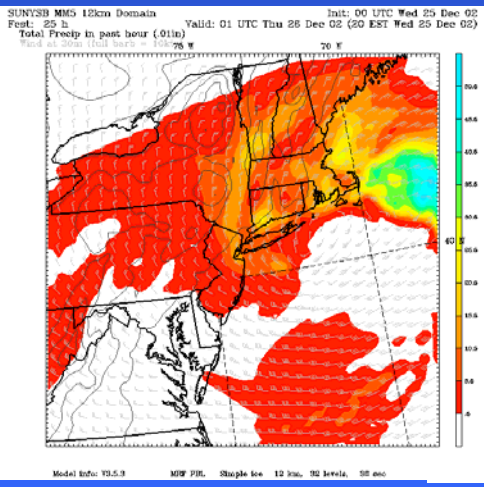
WRF Eta Init Grell–
Devenyi / MRF
WSM-5



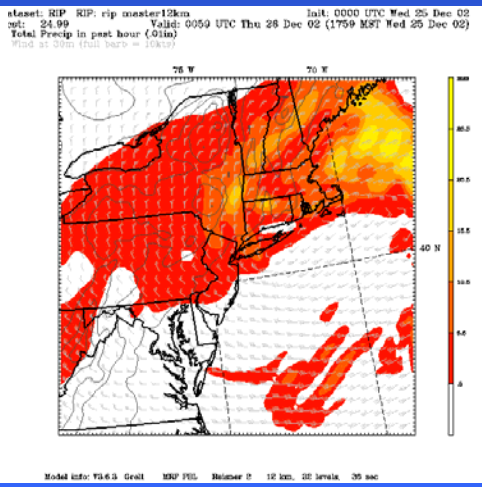
01 UTC
Radar



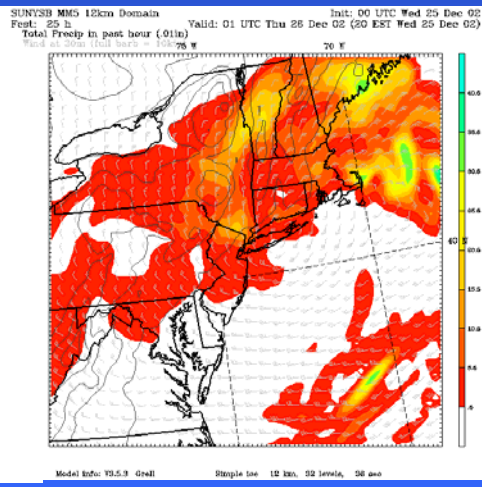
MM5 GFS init
Grell /MRF
Simple Ice



MM5 Eta init
KF / MRF
Simple Ice

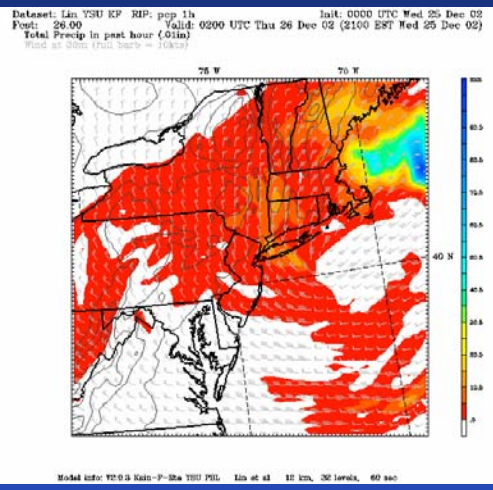


MM5 Eta init
Grell / MRF
Reisner 2

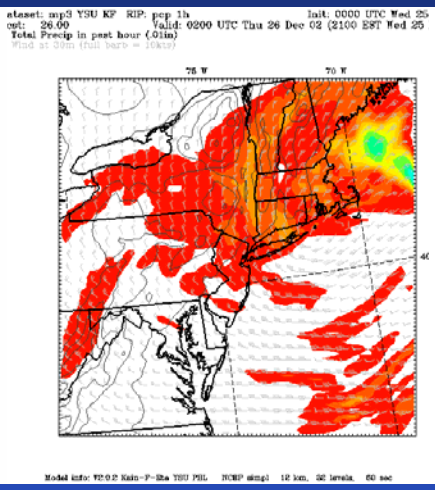


MM5 Eta init
Grell / GS
Simple Ice

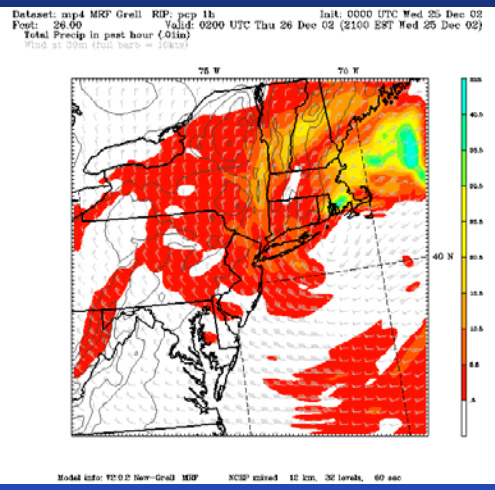
# Ensemble Members (1 h precip ending 02 UTC)



WRF Eta init
KF / YSU
Lin

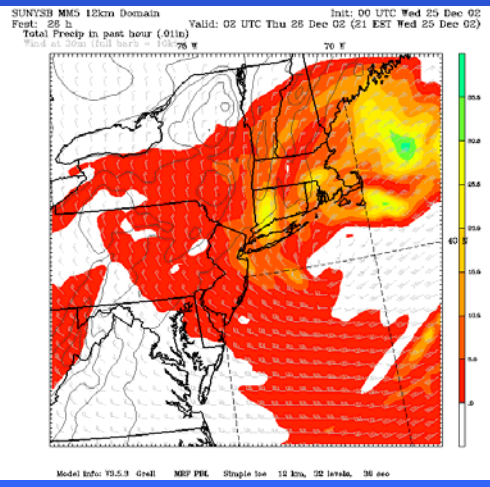


WRF Eta Init
KF/ YSU
WSM-3

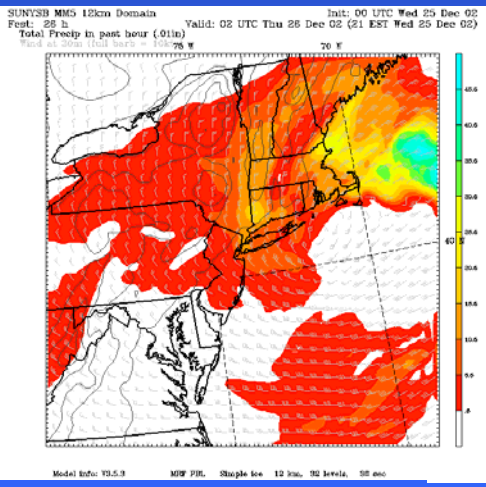


WRF Eta Init Grell–
Devenyi / MRF
WSM-5

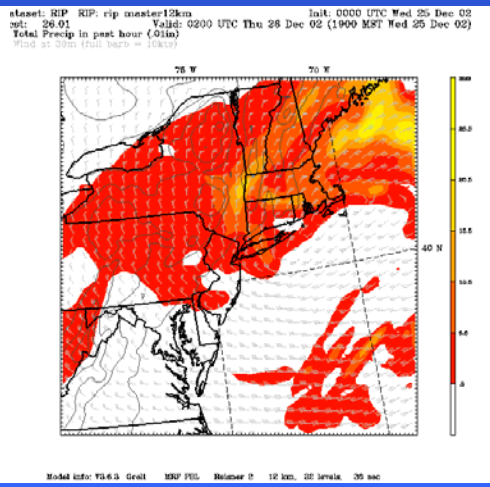
02 UTC
Radar



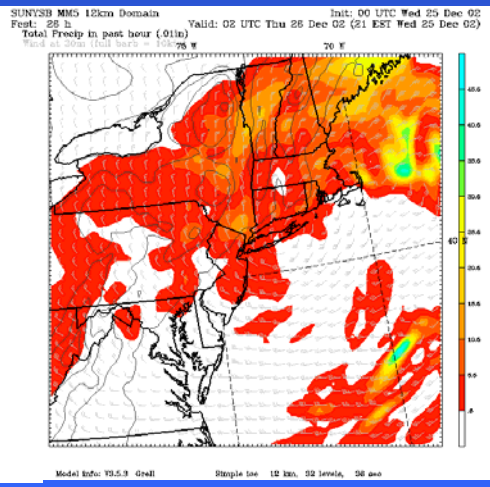
MM5 GFS init
Grell /MRF
Simple Ice



MM5 Eta init
KF / MRF
Simple Ice



MM5 Eta init
Grell / MRF
Reisner 2



MM5 Eta init
Grell / GS
Simple Ice

# Findings

- WRF and MM5 capable of simulating mesoscale band formation and dissipation

- WRF more accurate in cyclone strength and precipitation amount than MM5

- MM5 more accurate in initial band formation timing and location

- Both model forecasts showed a narrow sloping ascent maxima associated with strong midlevel frontogenesis and weak moist symmetric stability

- Small ensemble suggests some predictability in this case

# Future Work

- Diagnose 3D hydrometeor trajectories across the band
- Explore role of diabatic heating on MPV destruction
- Use more diverse ensemble system to explore model sensitivities in this case