

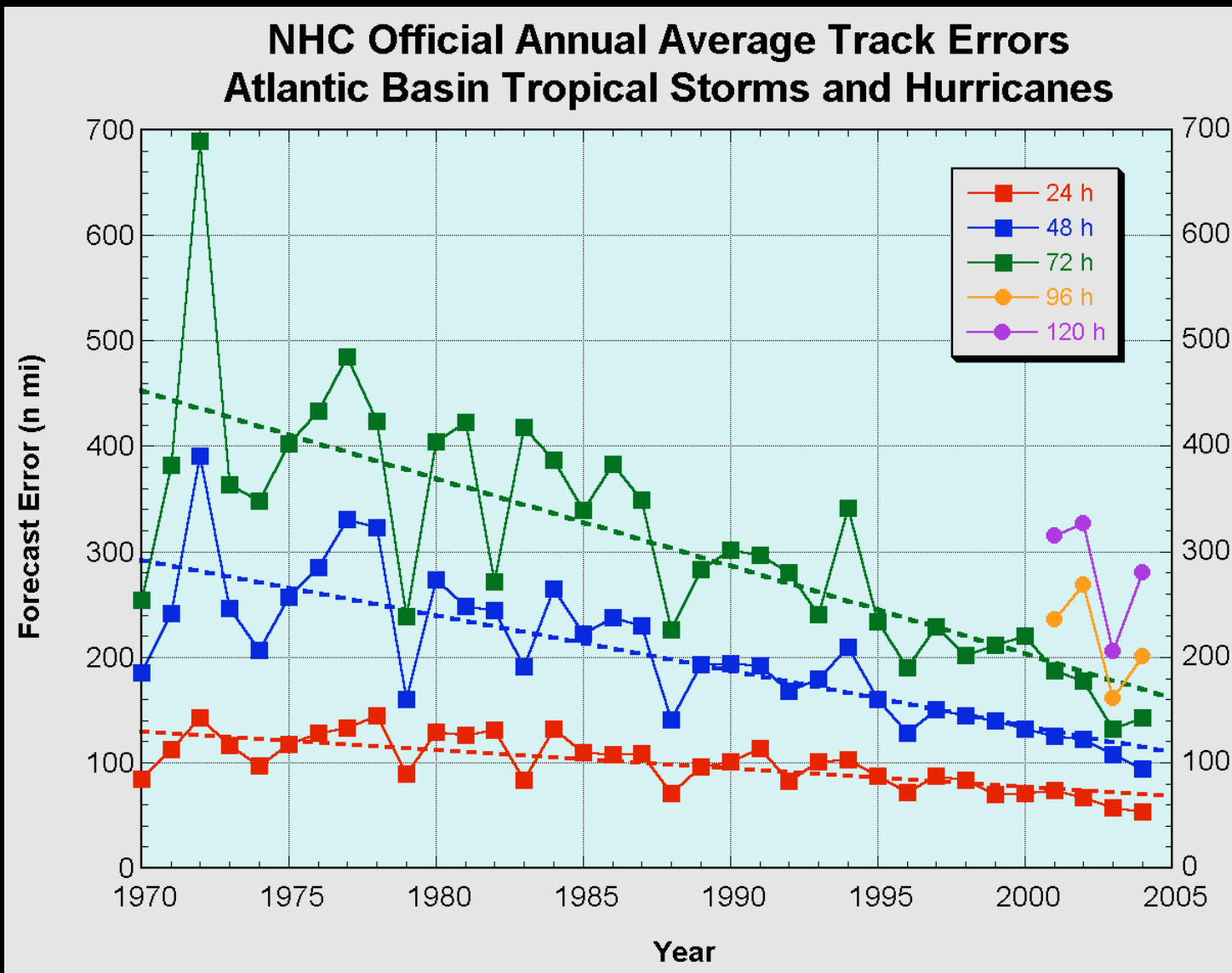
Impact of microphysics on hurricane track forecasts

Robert Fovell

University of California, Los Angeles

rfovell@ucla.edu

Trend in track errors



NHC forecast 36h prior to landfall

Hurricane Rita

September 22, 2005

4 PM CDT Thursday

NWS TPC/National Hurricane Center
Advisory 21

Current Center Location 25.8 N 89.5 W

Max Sustained Wind 145 mph

Current Movement WNW at 9 mph

● Current Center Location

● Forecast Center Positions

H Sustained wind > 73 mph

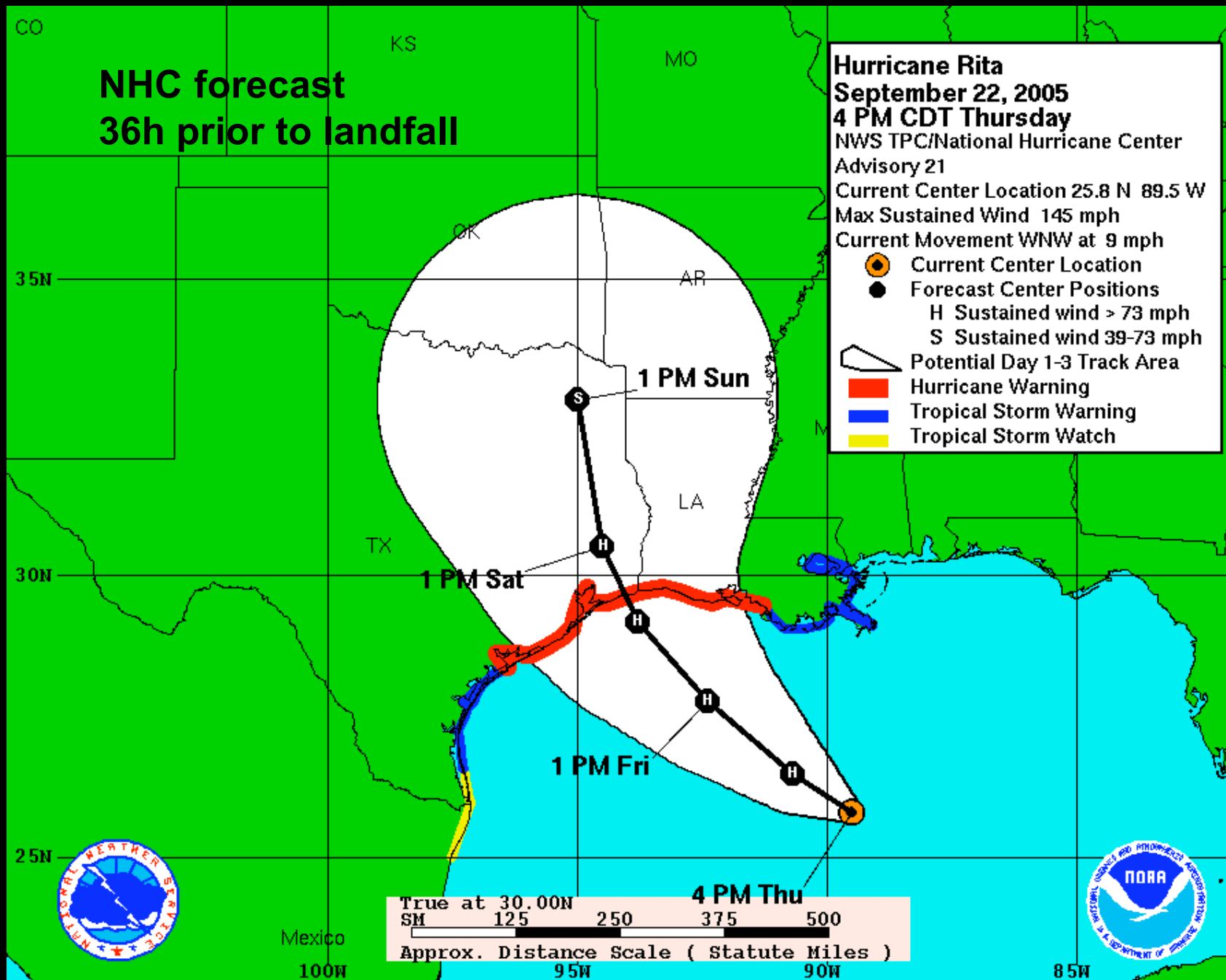
S Sustained wind 39-73 mph

△ Potential Day 1-3 Track Area

Red Hurricane Warning

Blue Tropical Storm Warning

Yellow Tropical Storm Watch

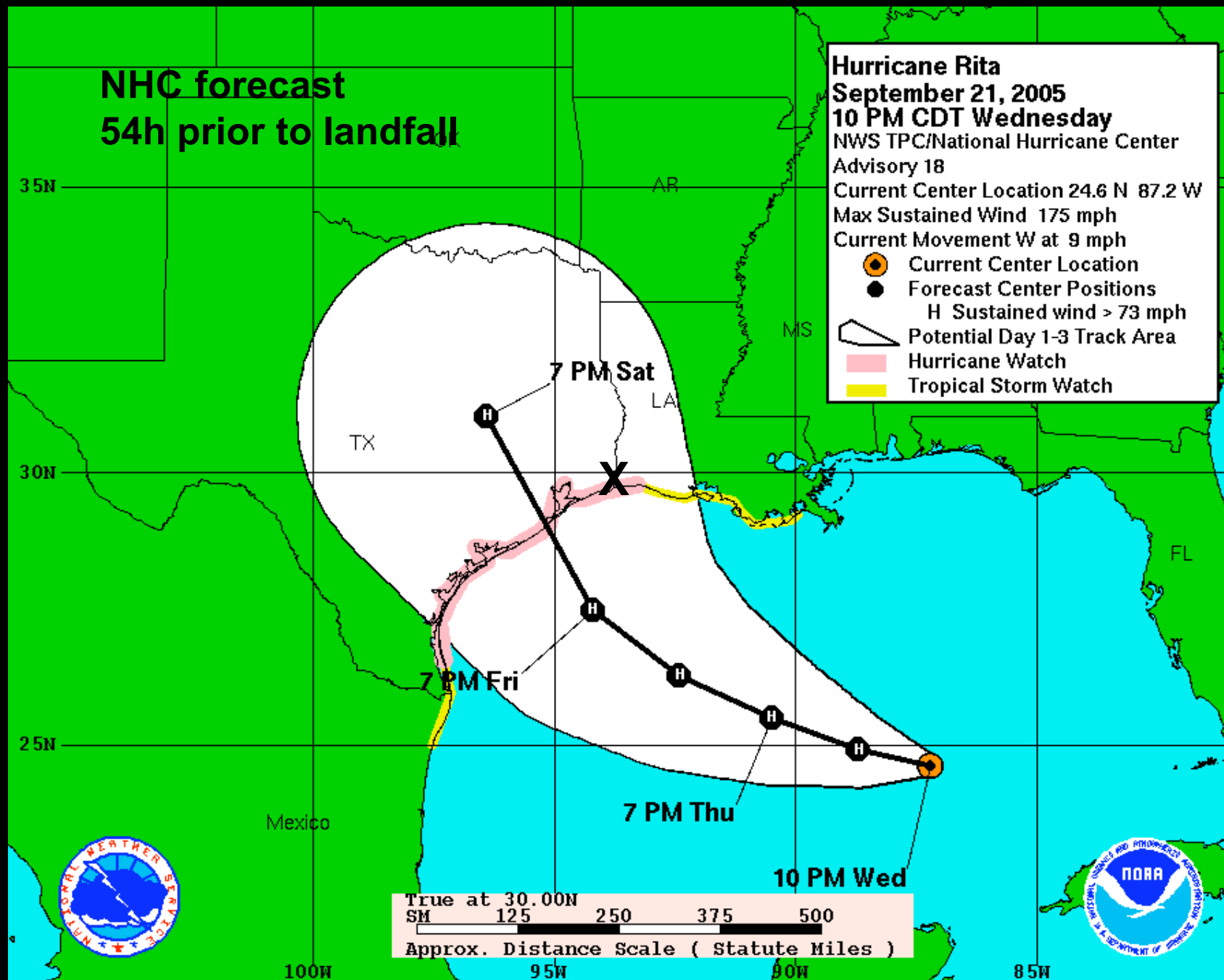


Source: NHC

NHC forecast 54h prior to landfall

Hurricane Rita
September 21, 2005
10 PM CDT Wednesday
NWS TPC/National Hurricane Center
Advisory 18
Current Center Location 24.6 N 87.2 W
Max Sustained Wind 175 mph
Current Movement W at 9 mph

- Current Center Location
- Forecast Center Positions
- H Sustained wind > 73 mph
- Potential Day 1-3 Track Area
- H Hurricane Watch
- T Tropical Storm Watch

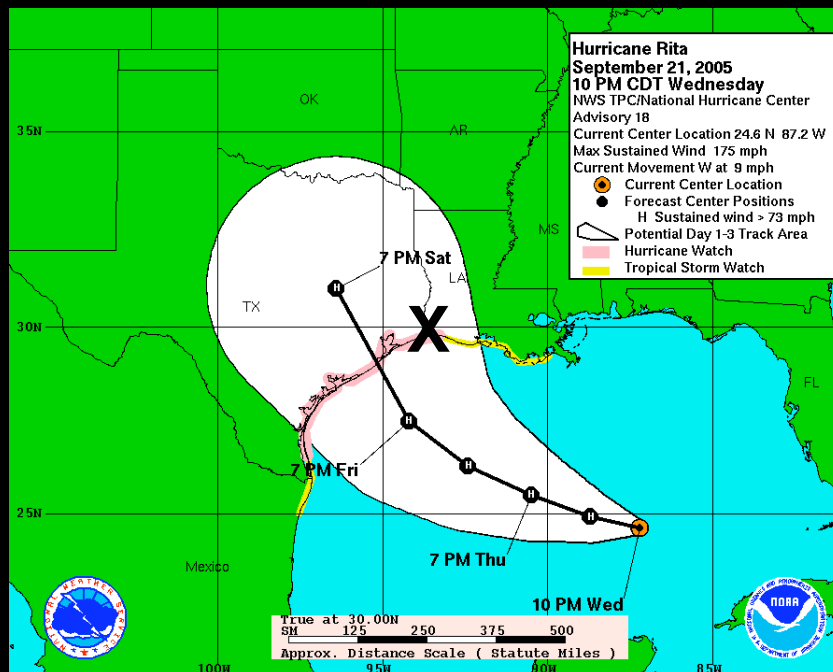


Source: NHC

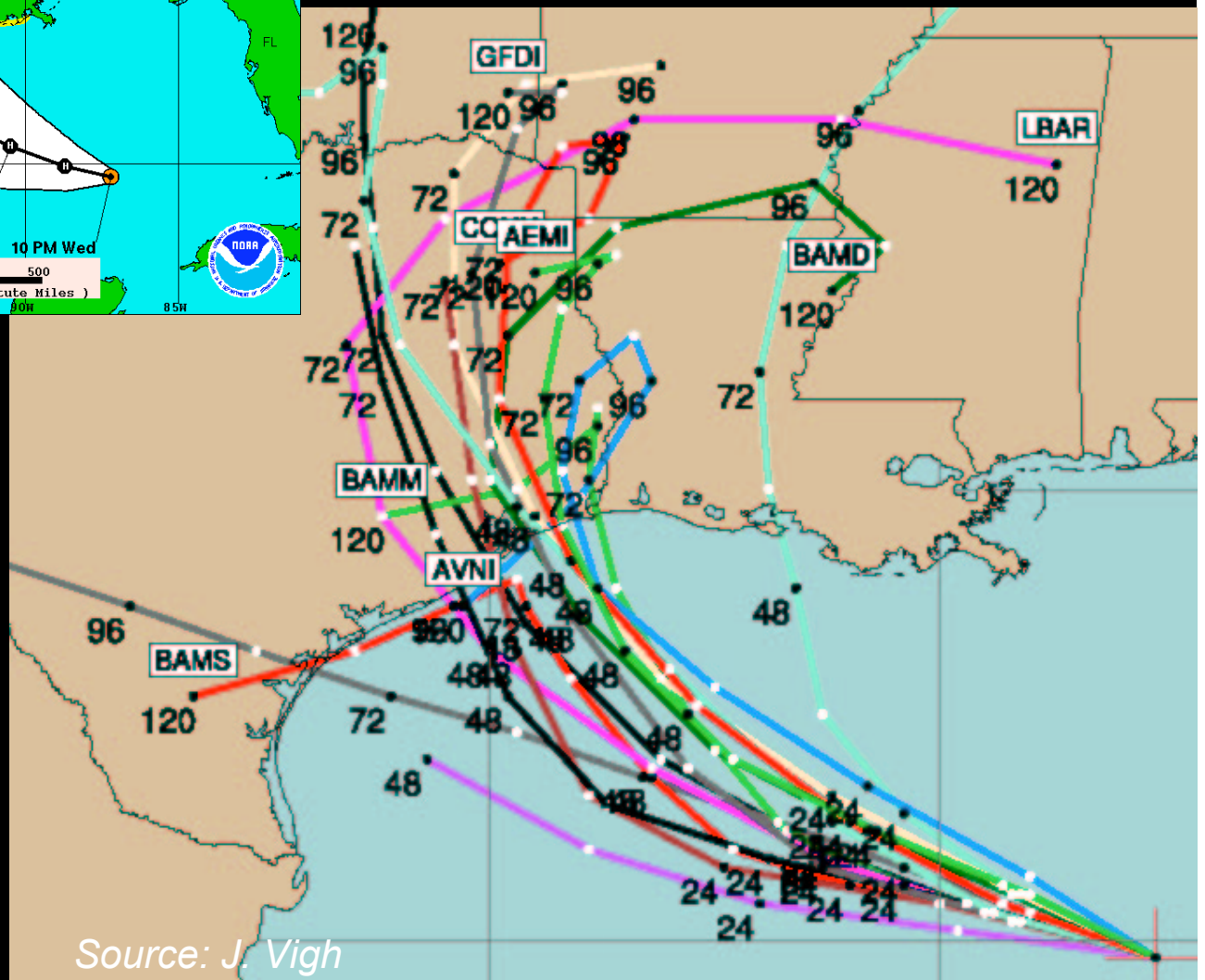
Houston before Rita



Source: Houston Chronicle



NHC
 Multi-model
 Ensemble
 06 UTC 22 Sept



WRF ensemble

- WRF 2.1.2 and 2.0.3
- 30 km ensemble
 - Vary microphysics and cumulus schemes
- 12 km ensemble
 - No parameterized convection
 - Vary microphysics schemes
- Subgrid diffusion generally deactivated though also investigated

30 km ensemble results

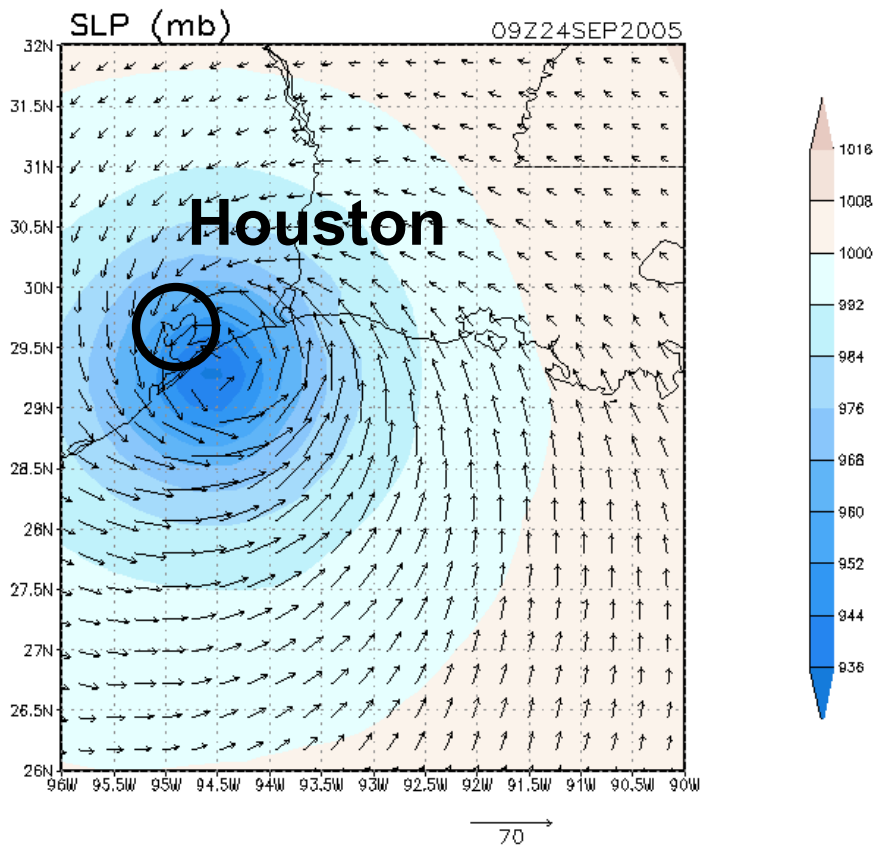
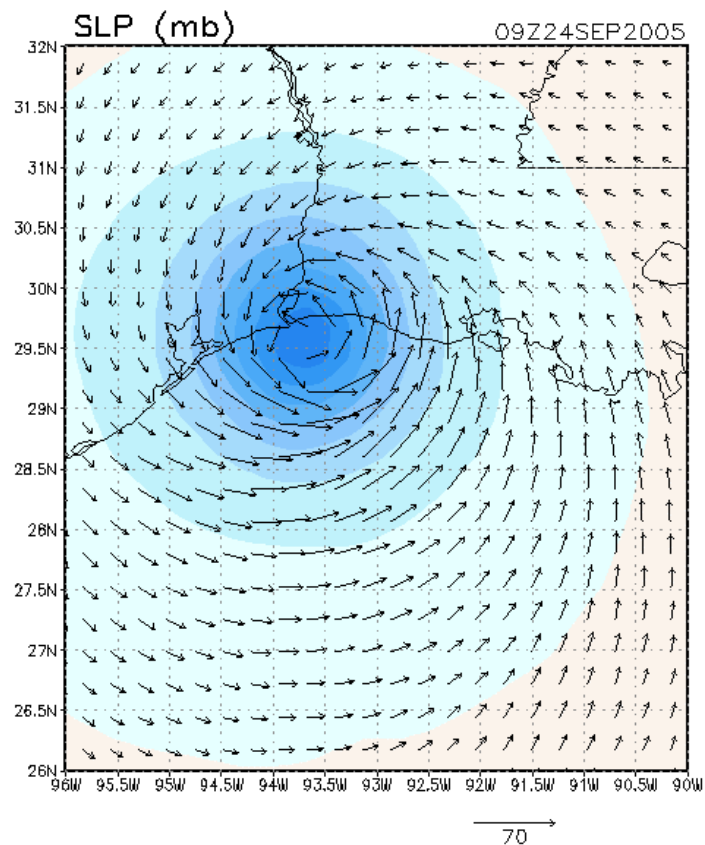
Ensemble matrix

	NONE	KF2	BMJ	Grell
NONE				
Kessler				
LFO		Control		
WSM3				
WSM6				

Control run (KF2/LFO) landfall forecasts (10 m winds & SLP)

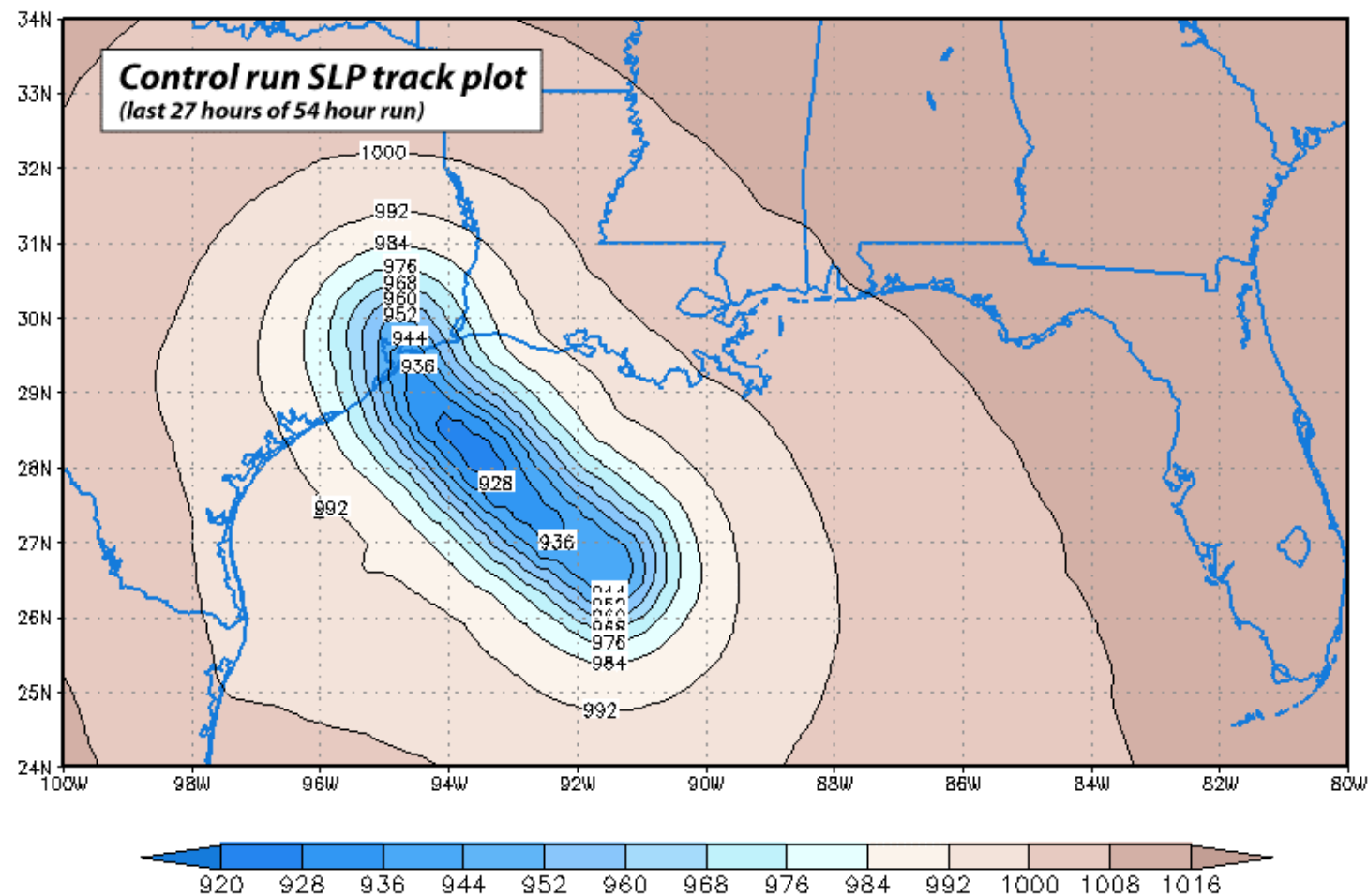
39h from
18 UTC 22 Sept

51h from
06 UTC 22 Sept

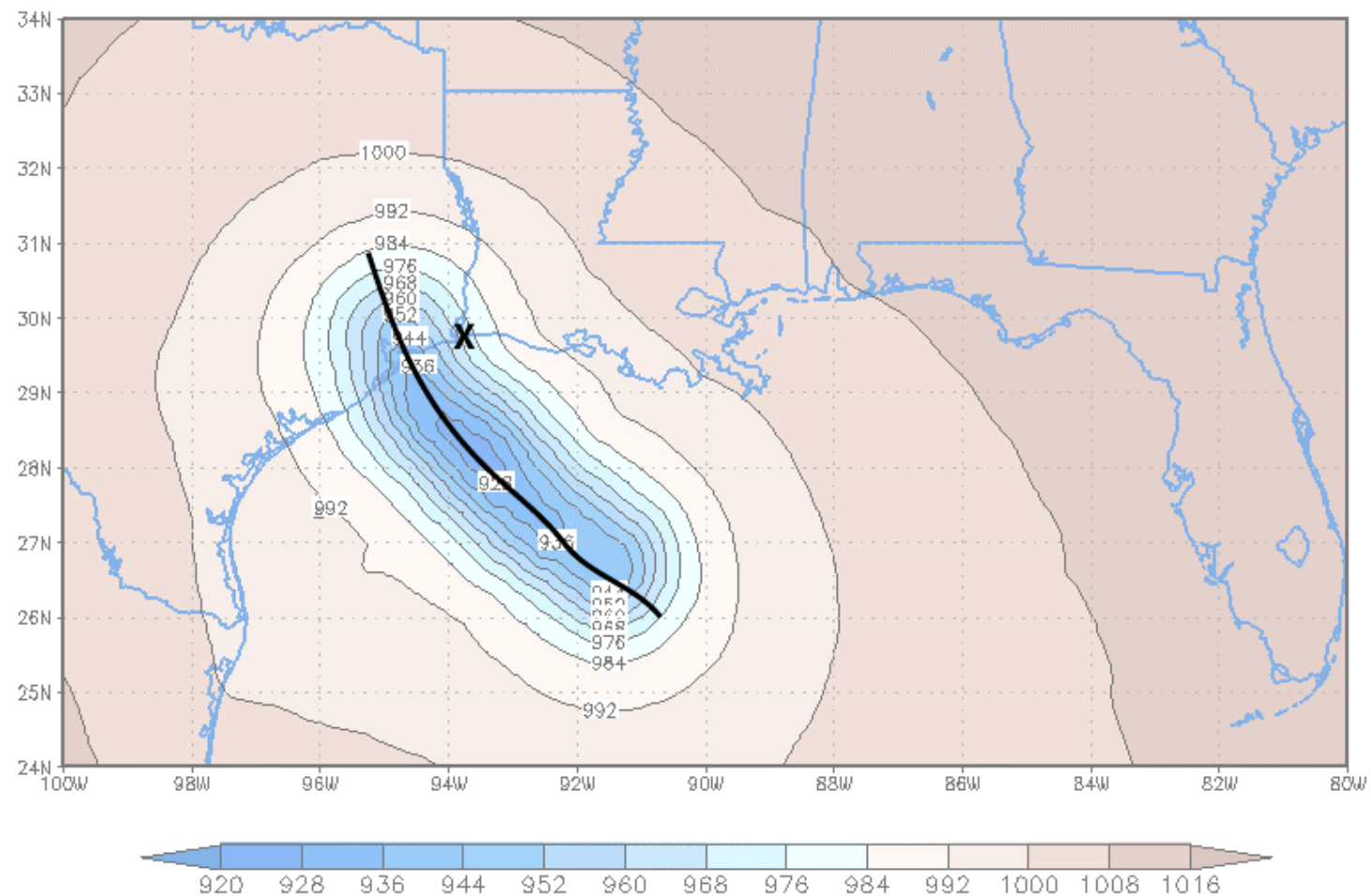


Control run (KF2/LFO)

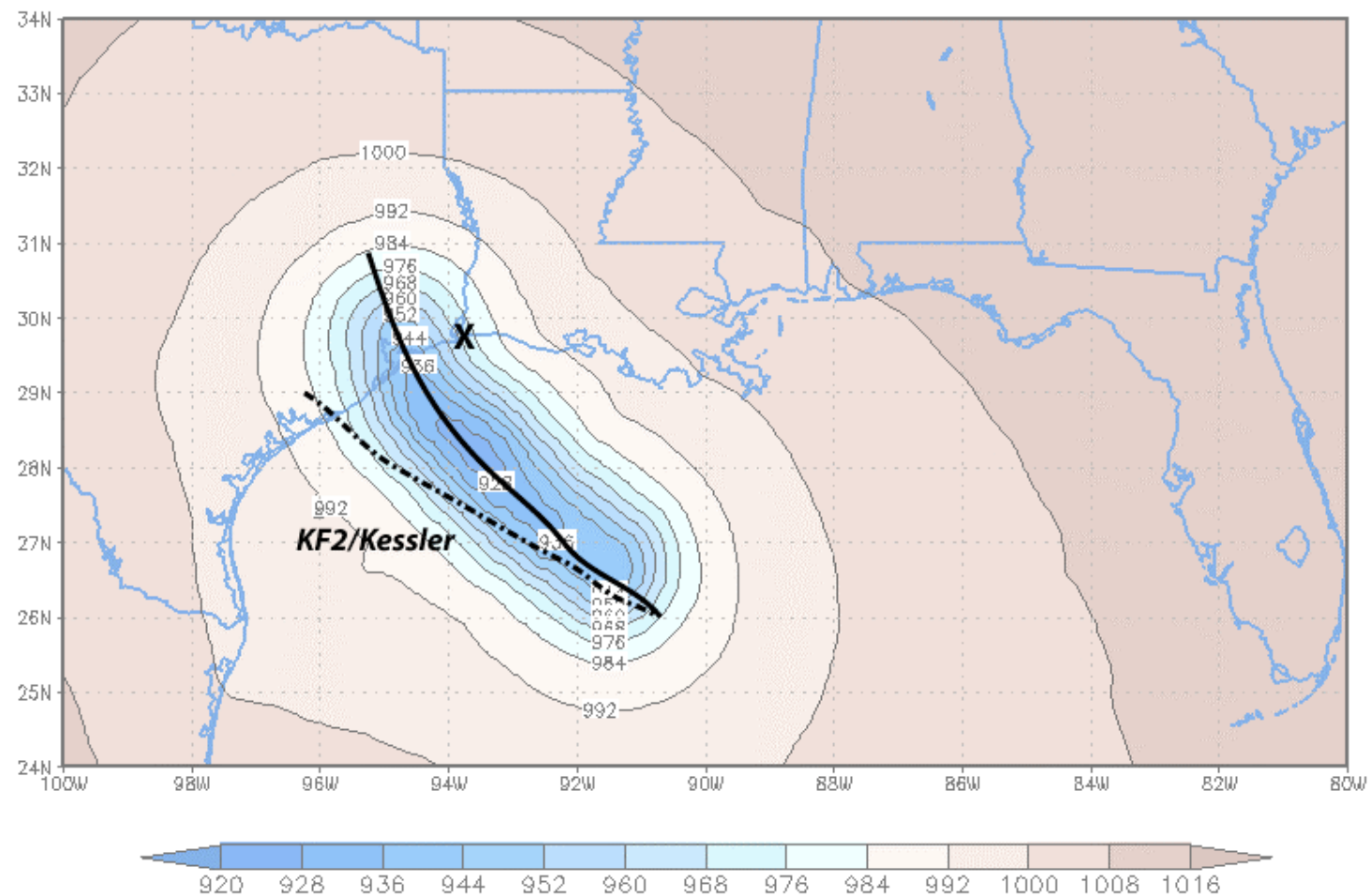
simulation started 06 UTC 22 Sept.



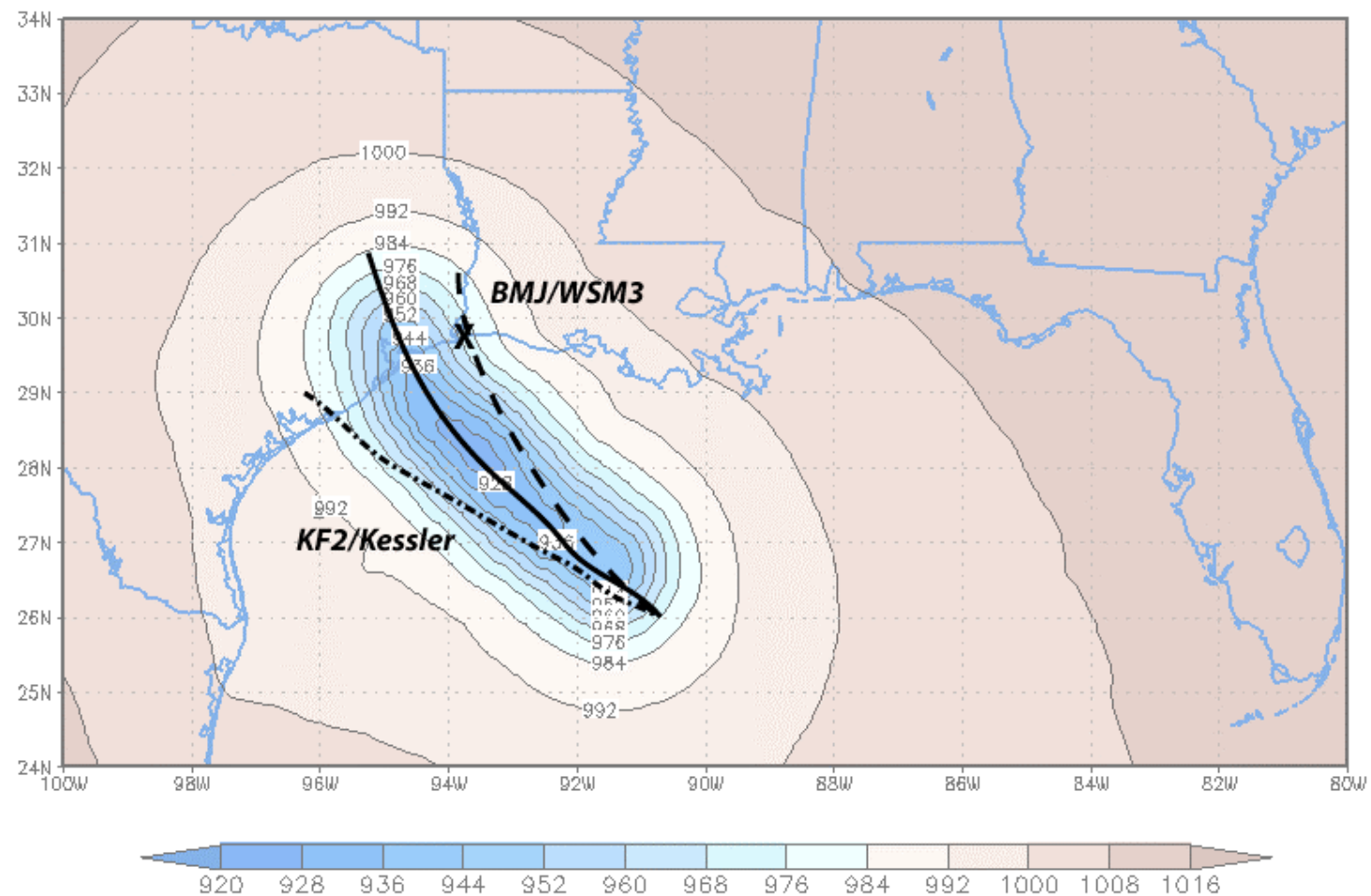
Control run (KF2/LFO)



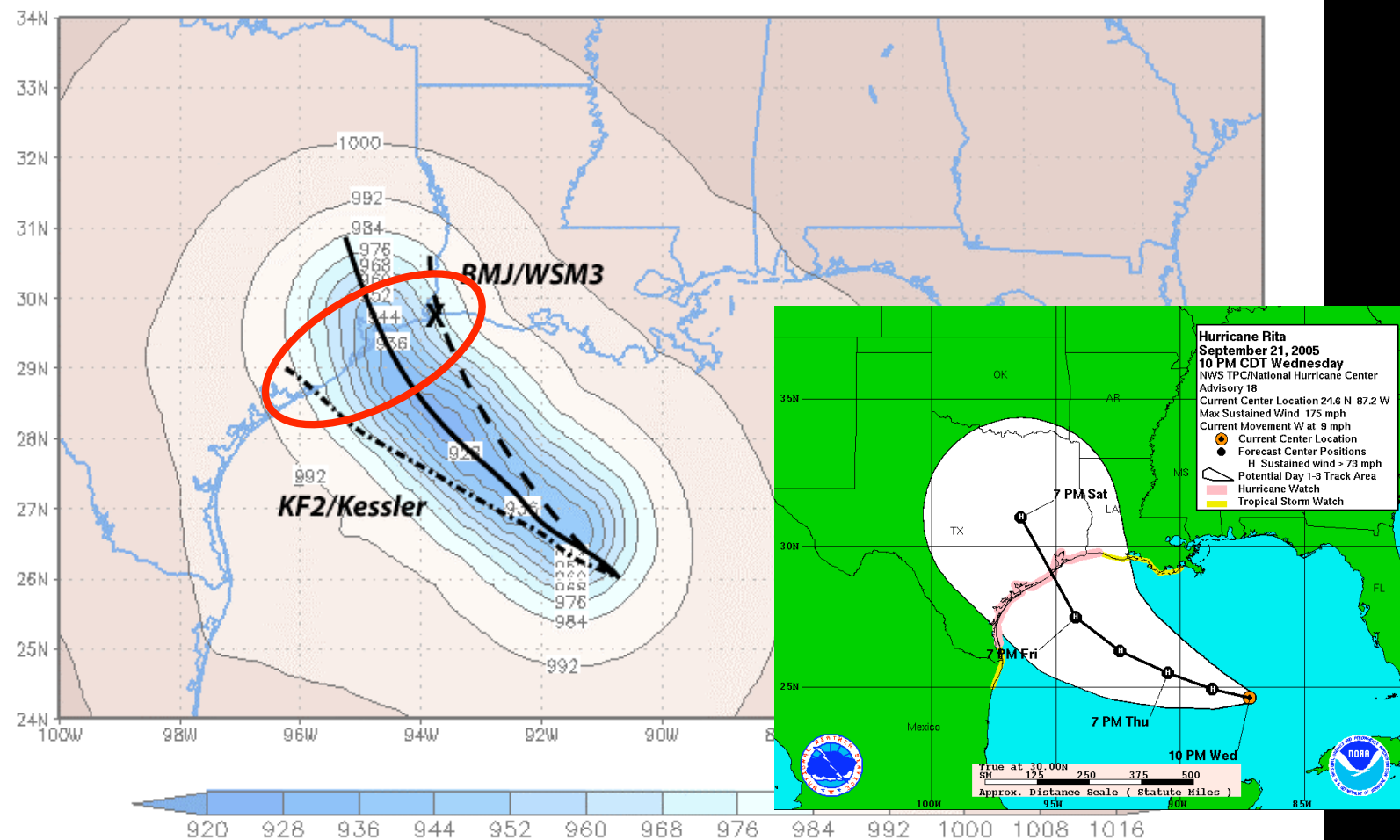
KF2/Kessler run added



BMJ/WSM3 run added



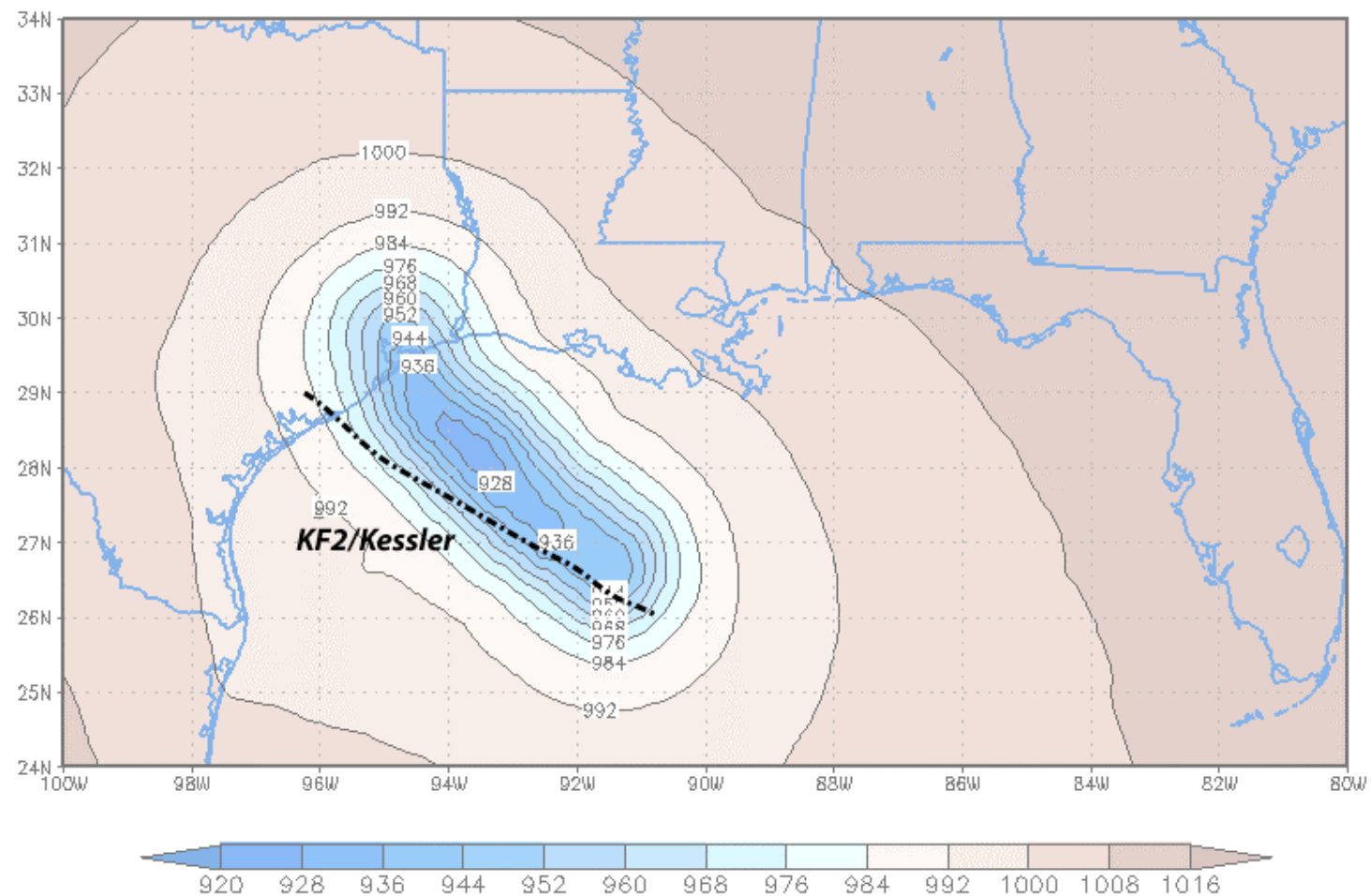
30 km ensemble spread



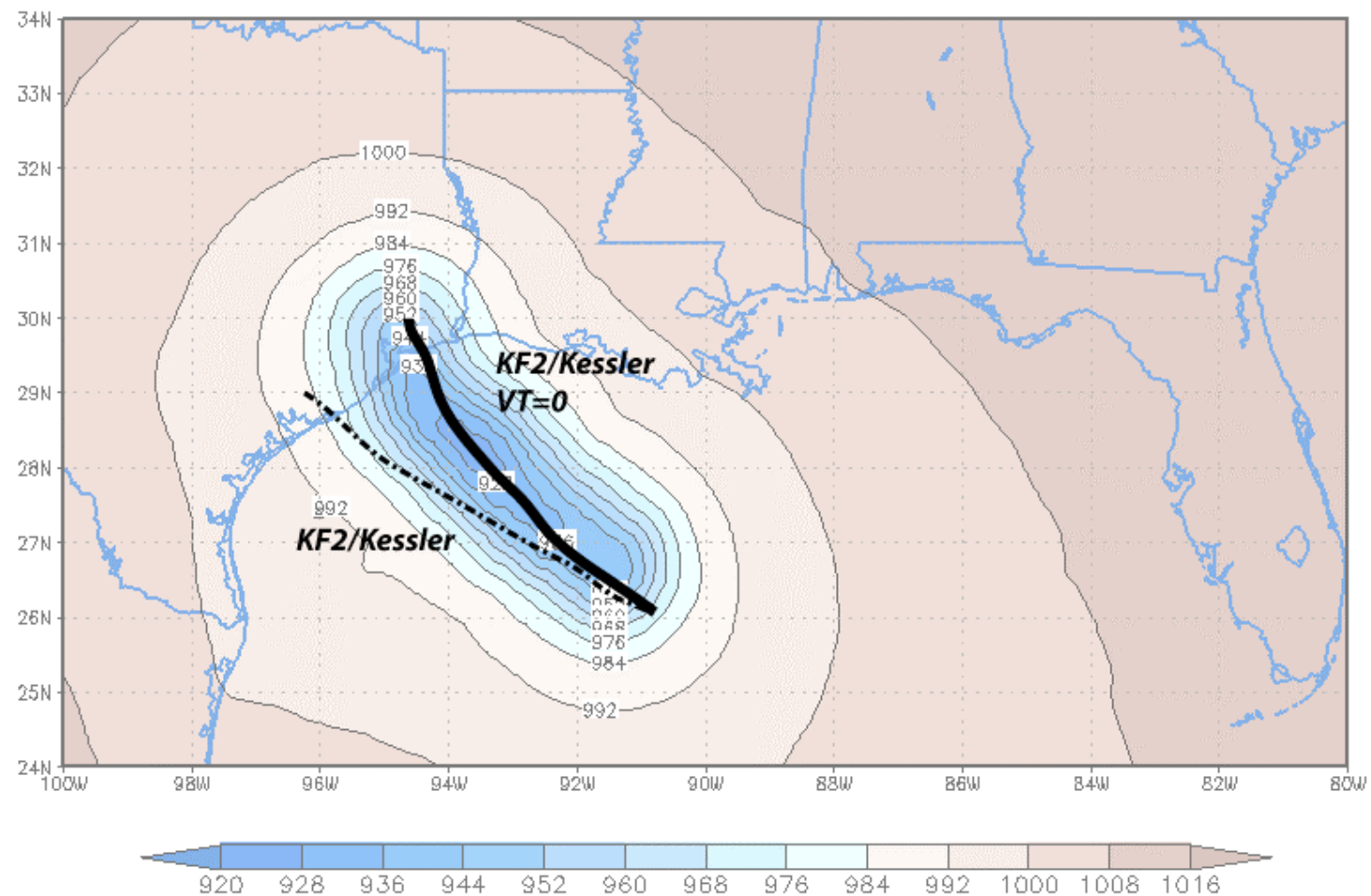
30 km fallspeed experiment

(V_T = terminal velocity)

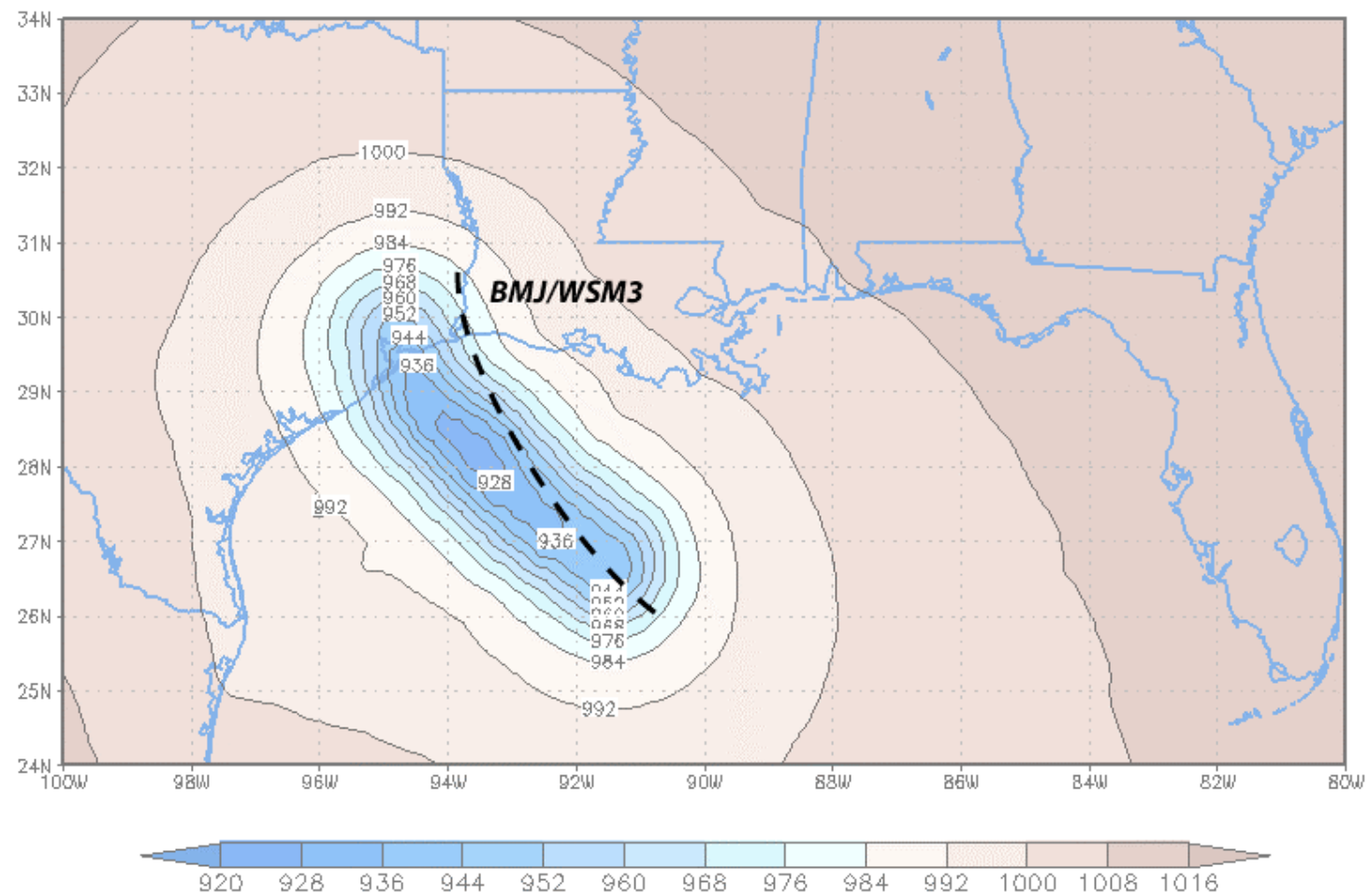
Original Kessler



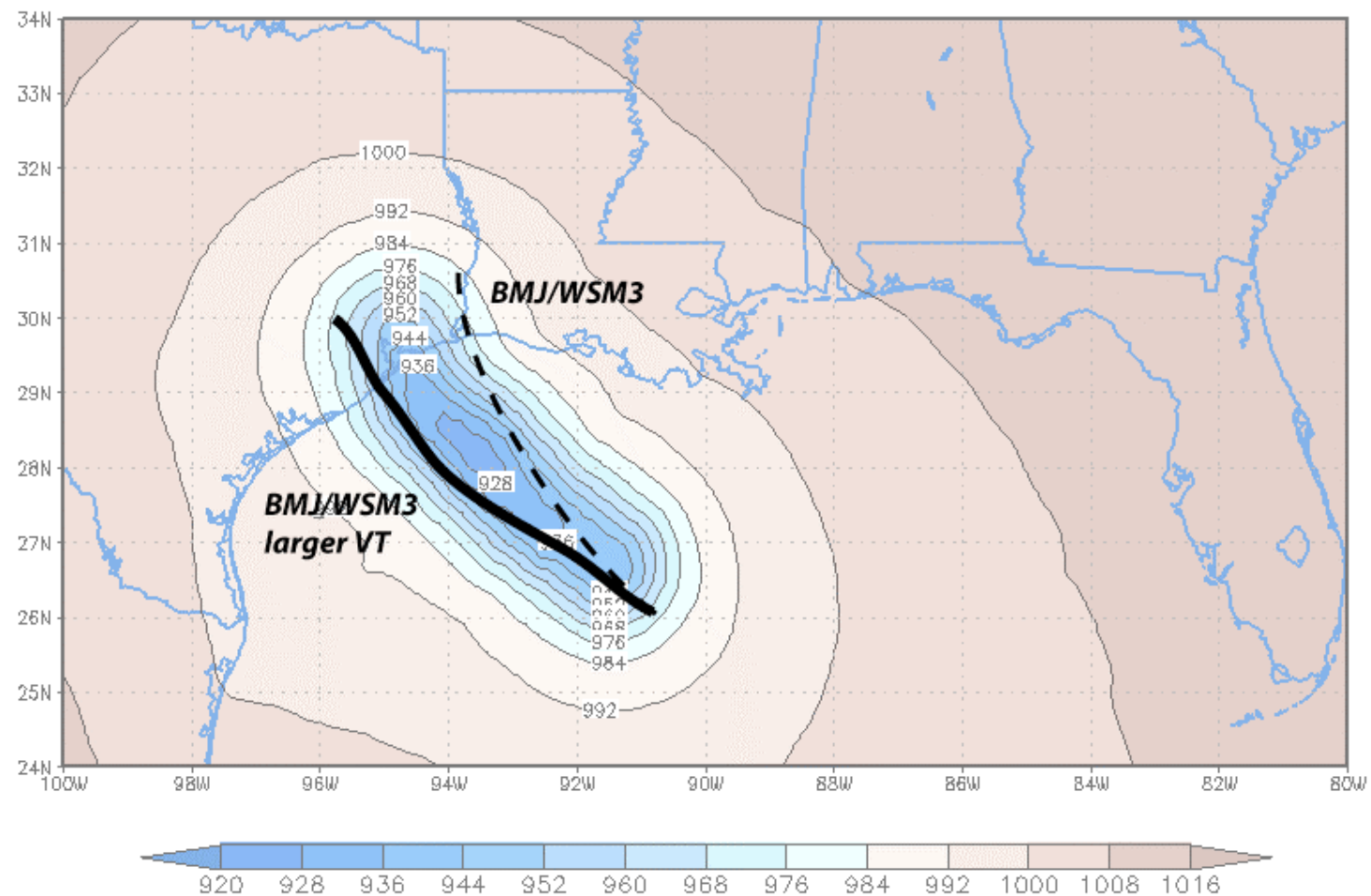
Kessler with no fallspeed



Original WSM3



WSM3 with increased ice VT

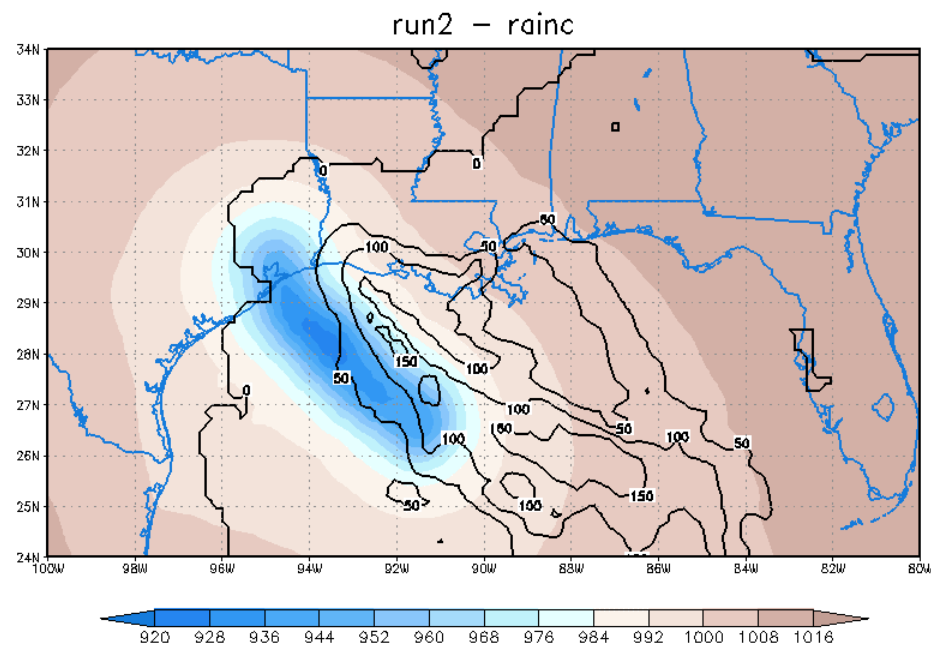
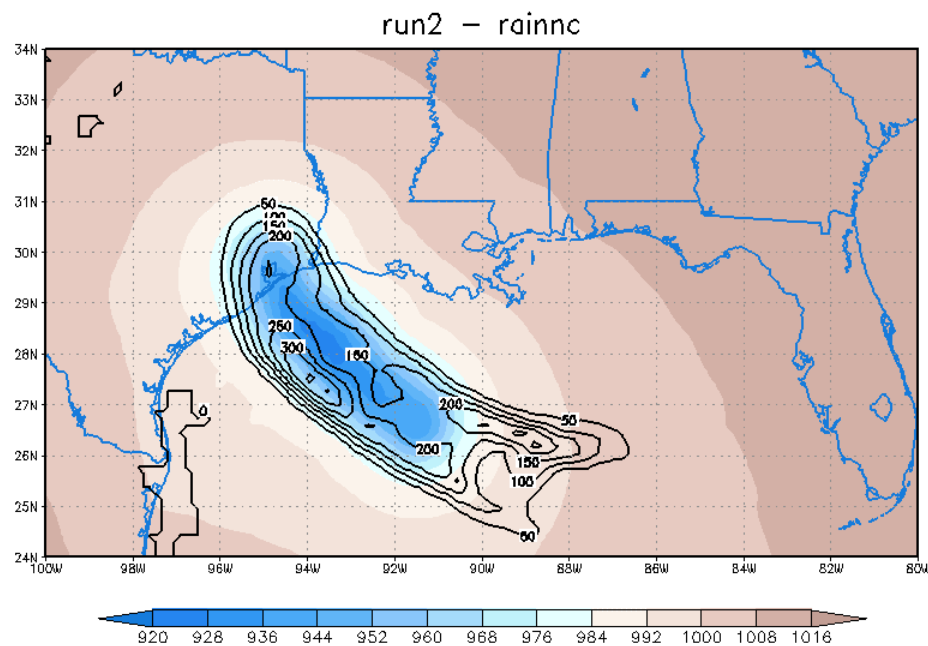


“It takes two to tang[le]”

Parameterized vs. explicit
convection

Control run (KF2/LFO)

explicit and parameterized rainfall

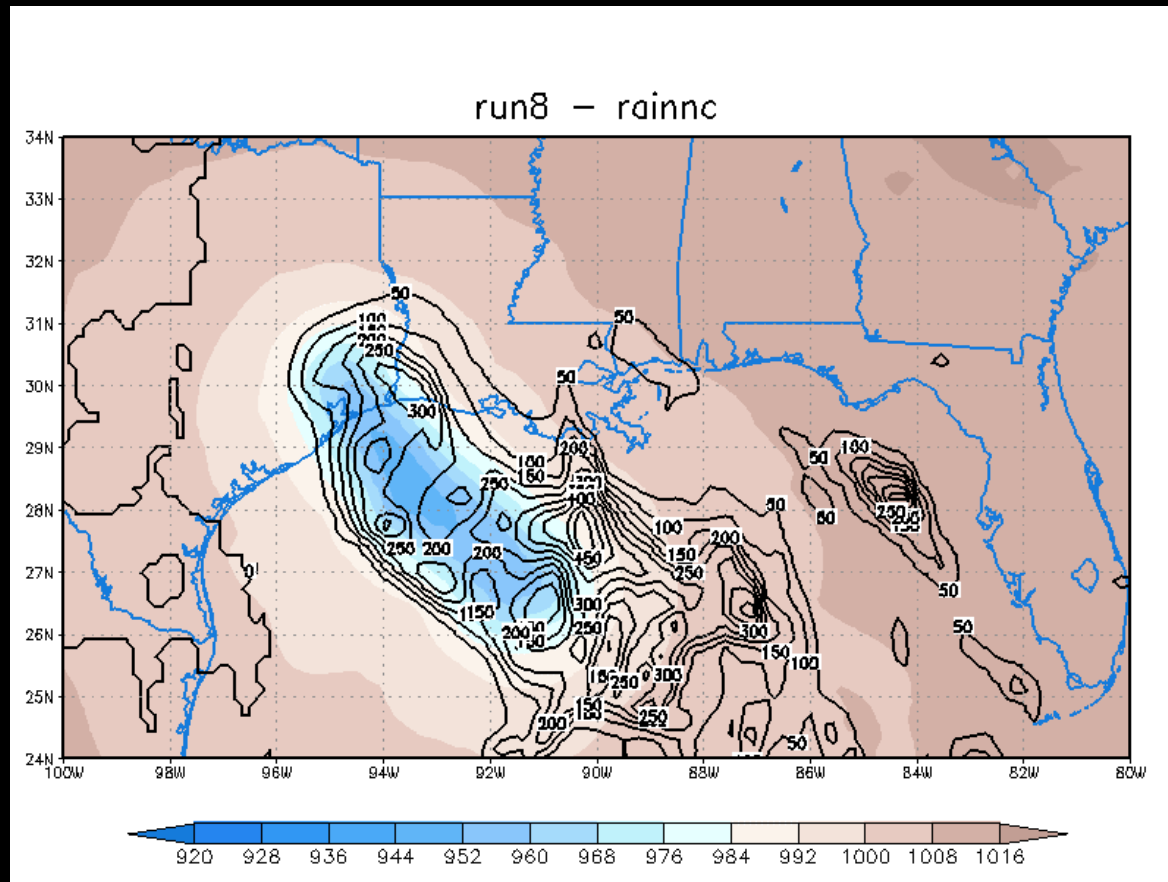


explicit scheme

cumulus scheme

Combined precip largest west of track

NONE/LFO run (no convective parameterization)

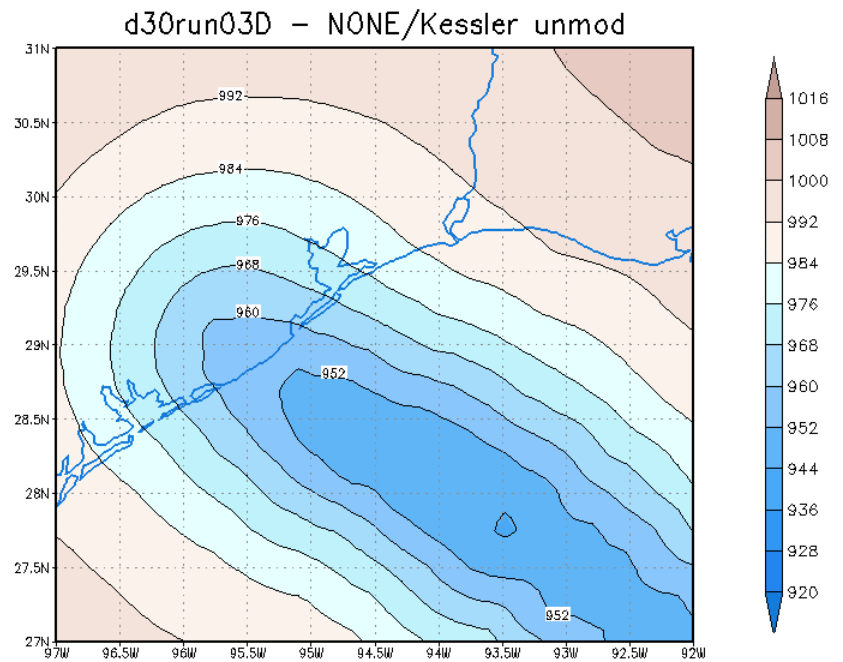
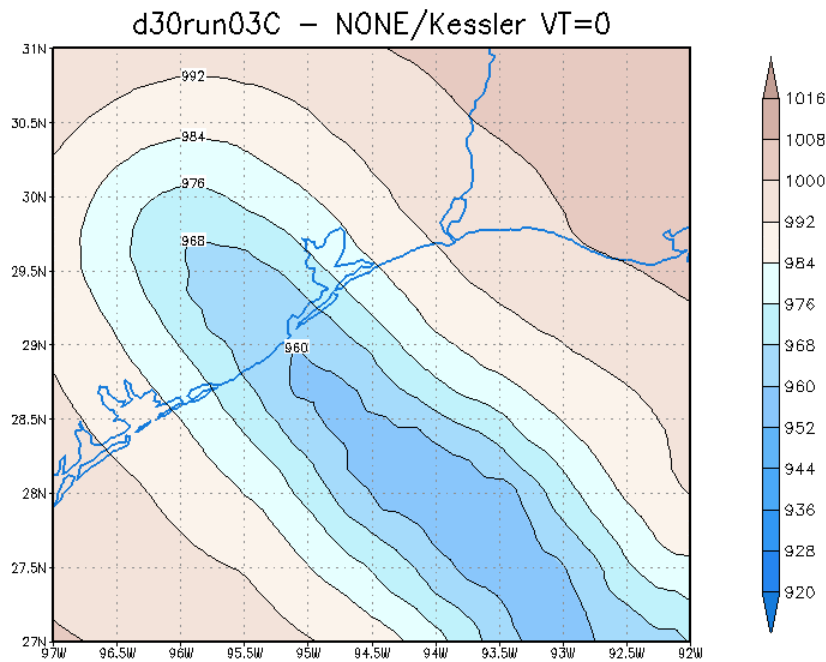


Combined precip largest *east* of track

Less fallspeed sensitivity without cumulus parameterization

Kessler VT=0

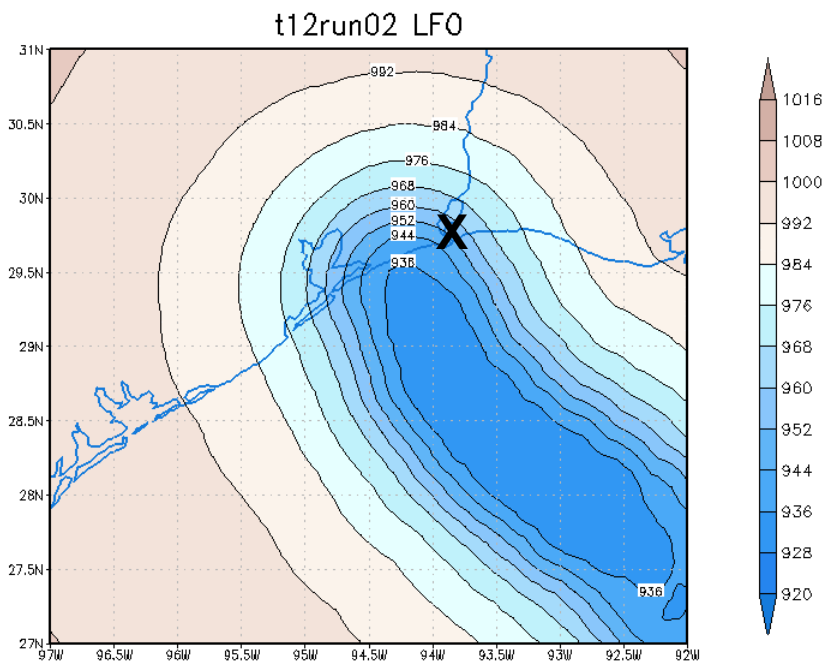
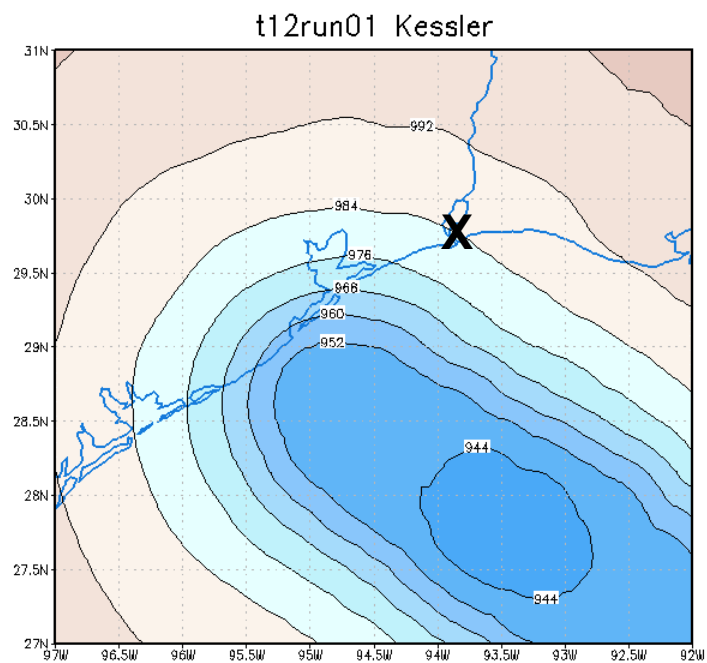
Kessler unmodified



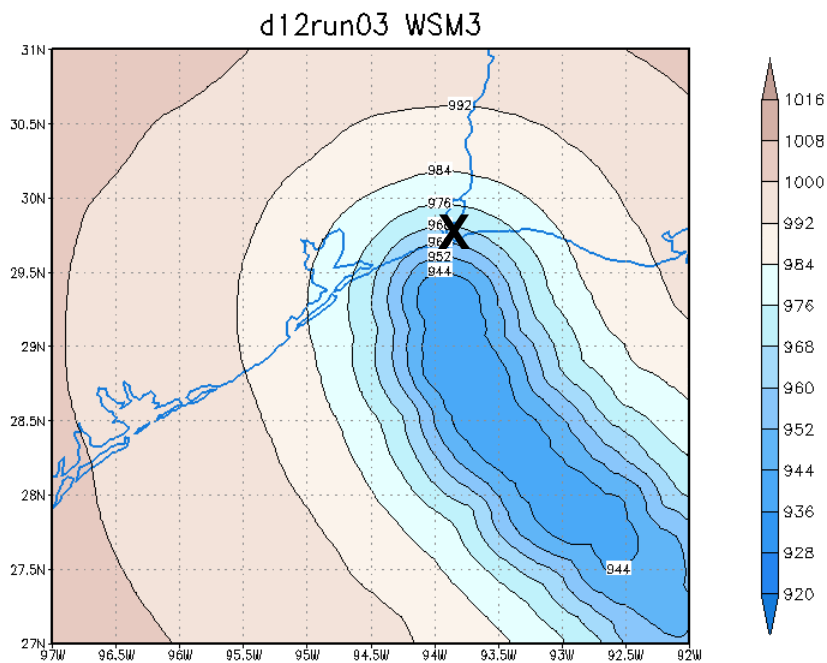
Changing VT altered explicit-cumulus interaction

12 km ensemble

(No convective scheme)



Kessler
(underdeveloped)



LFO
(overdeveloped)

WSM3
(closest to obs)

Vortex-following composites

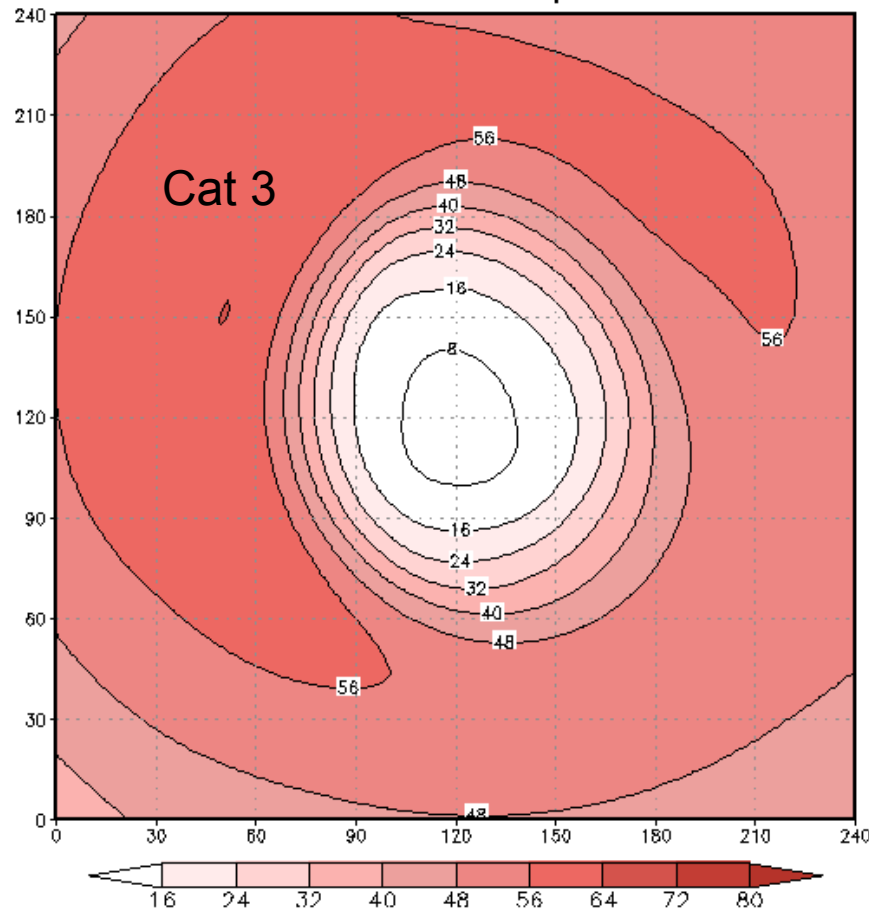
- Based on SLP field
- Identified point maximizing north-south and east-west symmetry
- Construct composite fields, isolate asymmetric components

850 mb wind speed

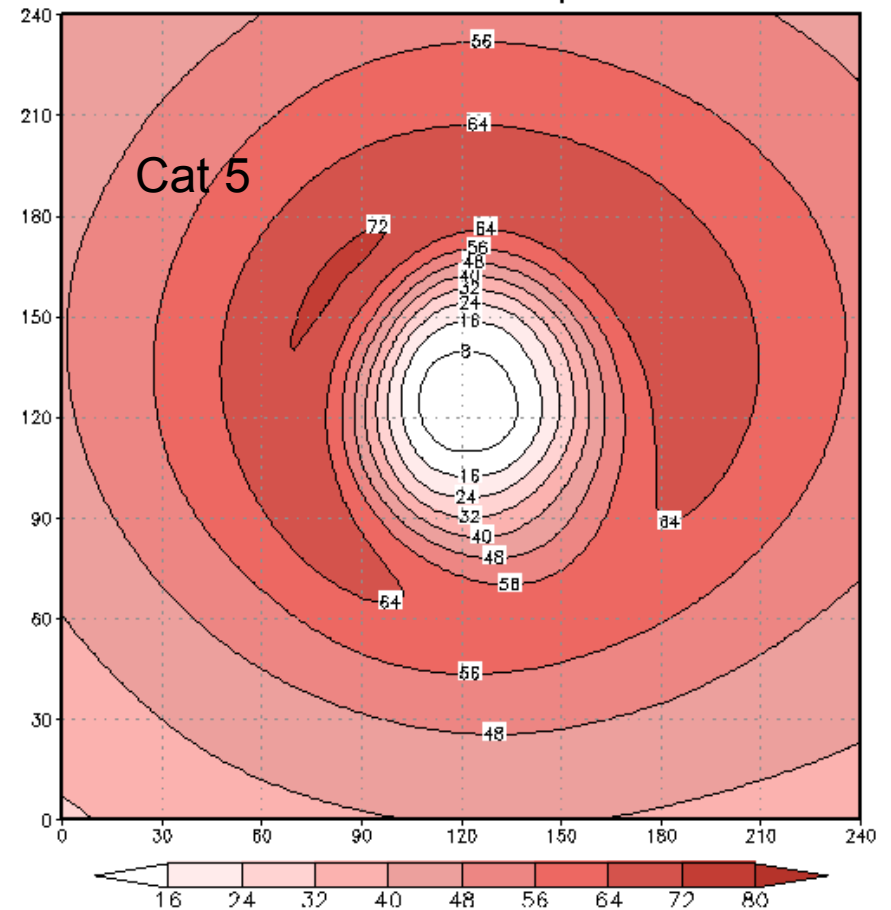
Kessler

LFO

t12run01 - 850 mb wspd - 48-54h



t12run02 - 850 mb wspd - 48-54h

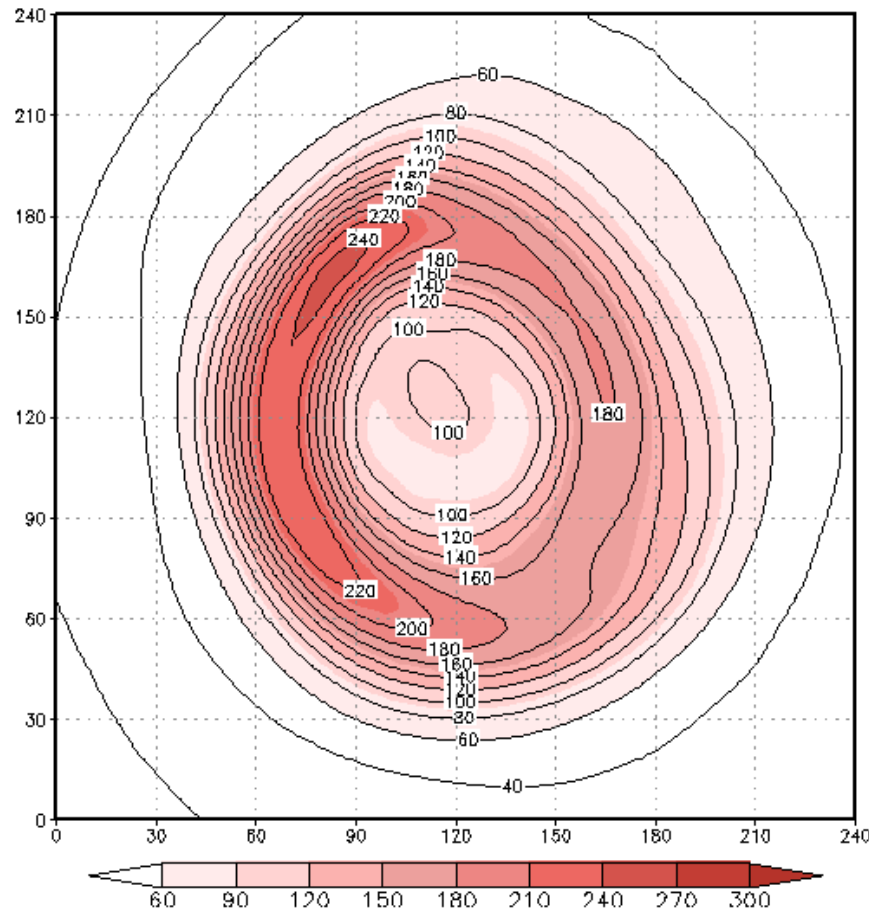


Absolute vorticity at 850 mb

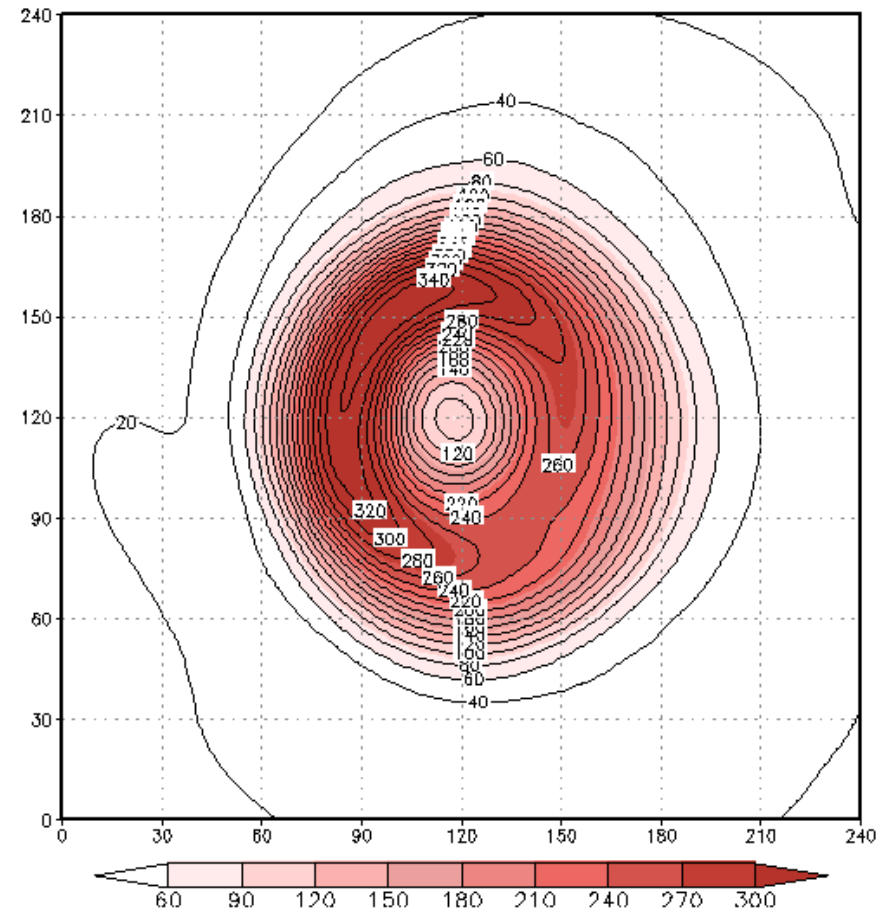
Kessler

LFO

t12run01 - avor@850mb - 48-54h



t12run02 - avor@850mb - 48-54h

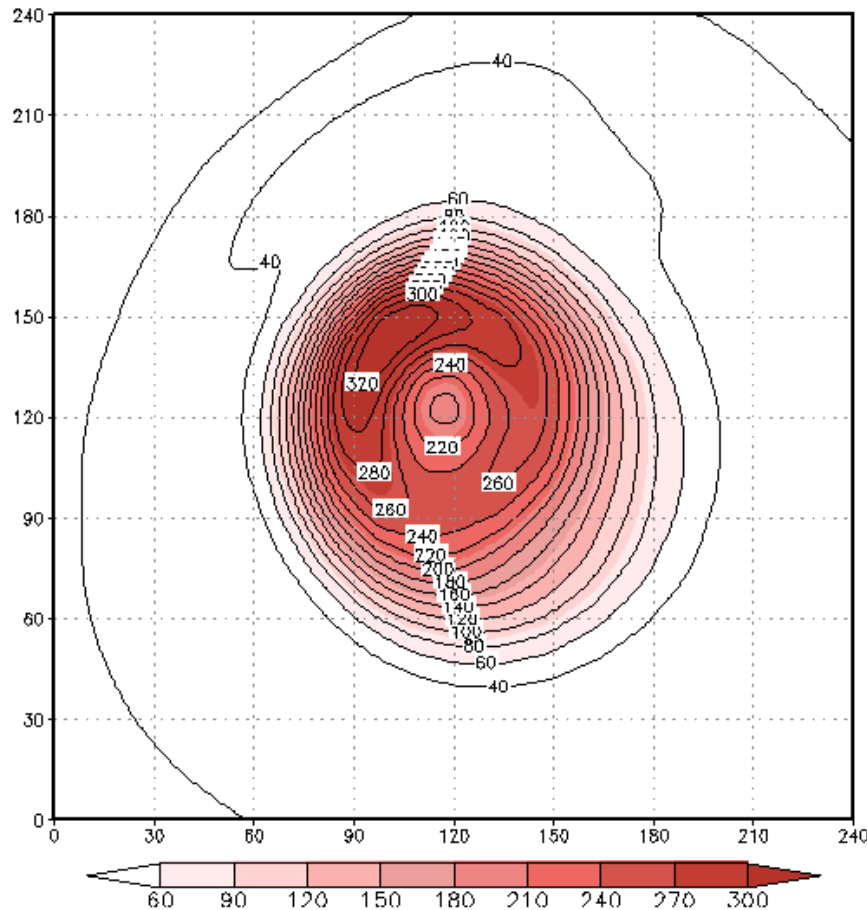


Absolute vorticity at 850 mb

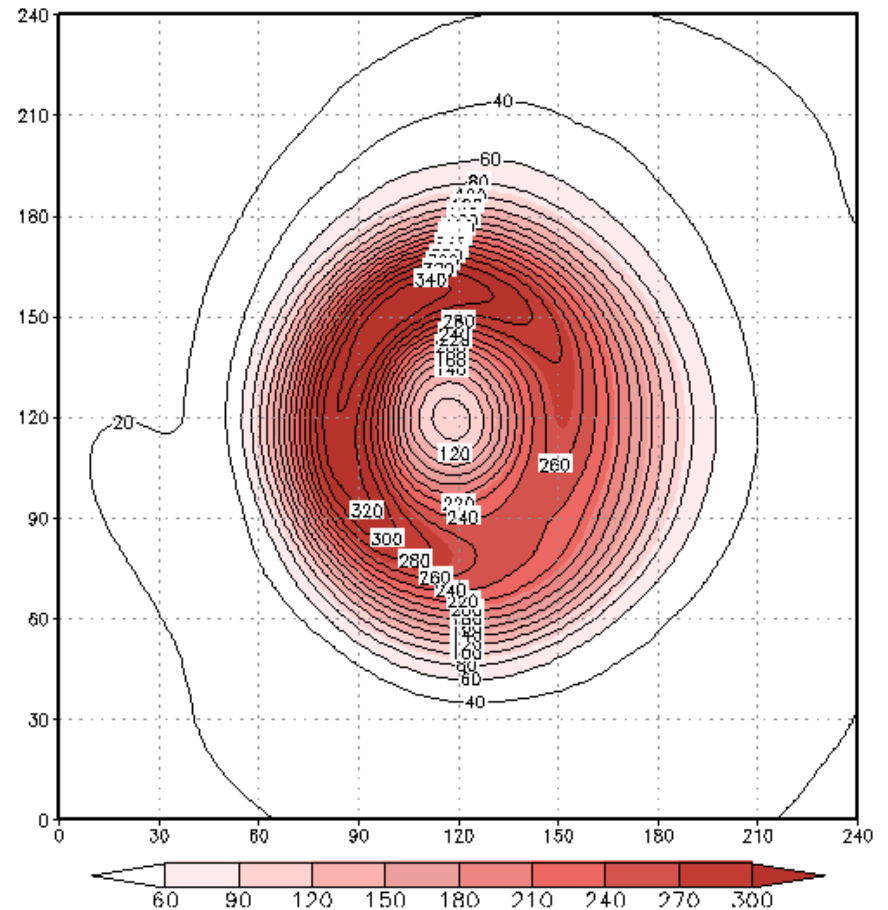
WSM3

LFO

d12run03 - avor@850mb - 48-54h

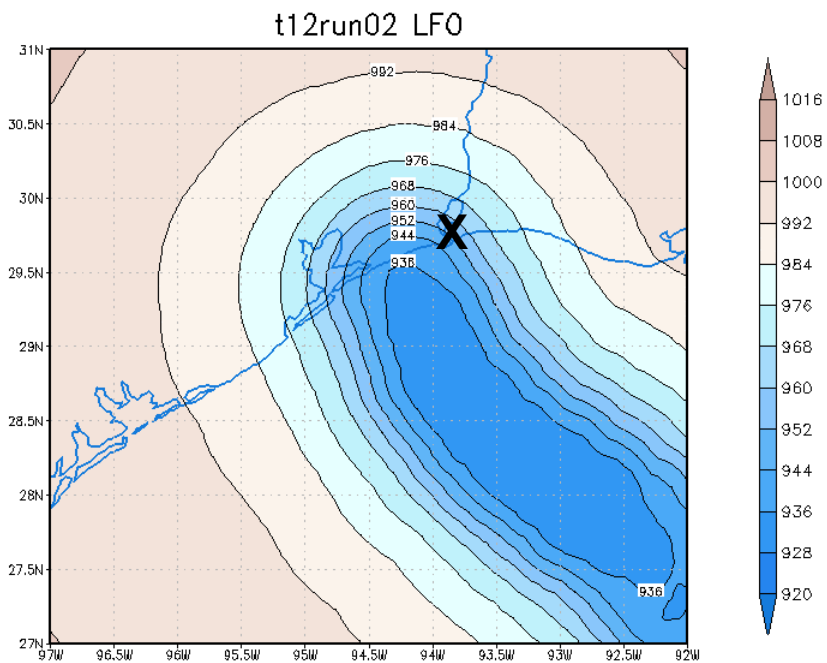
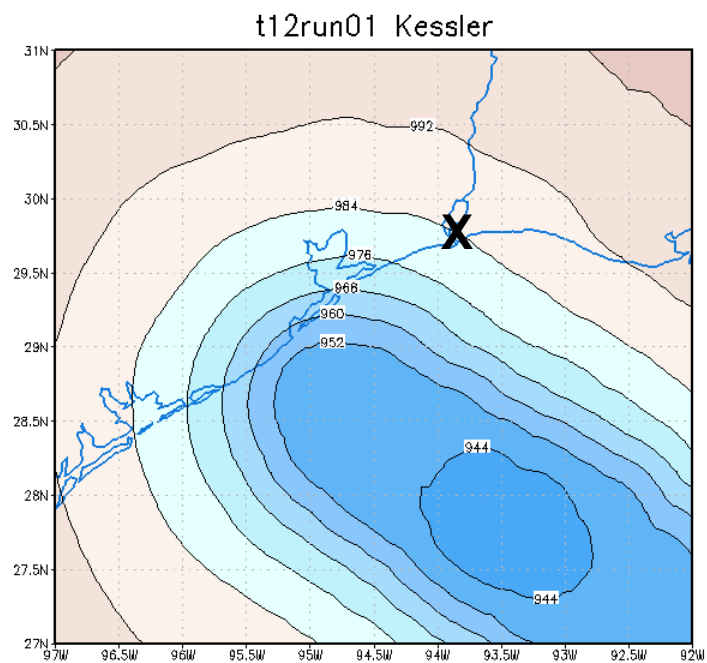


t12run02 - avor@850mb - 48-54h

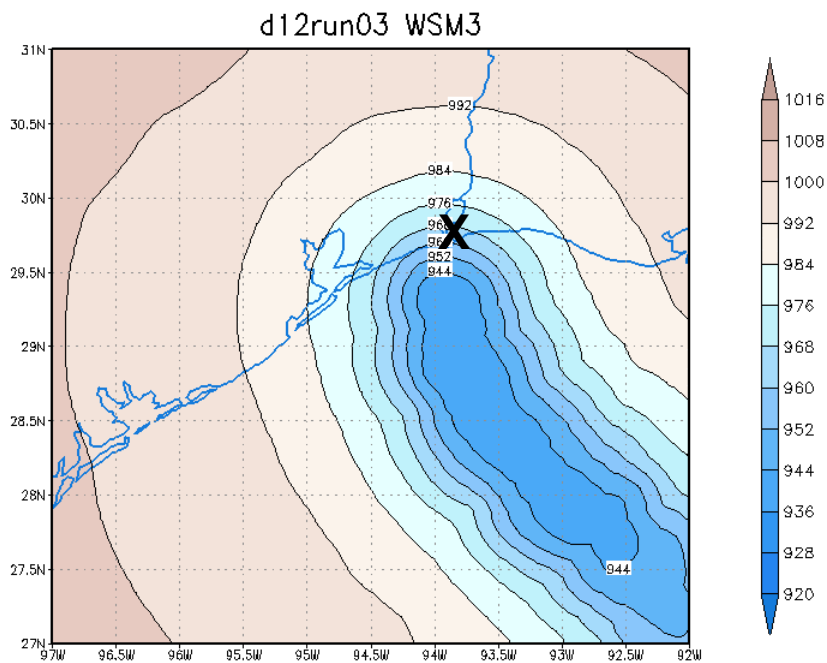


Vortex propagation

- Steering flow
- Vortex asymmetries
 - Beta effect
 - Other sources (convection, friction, etc.)
- Vortex tilt



Kessler
(underdeveloped)



LFO
(overdeveloped)

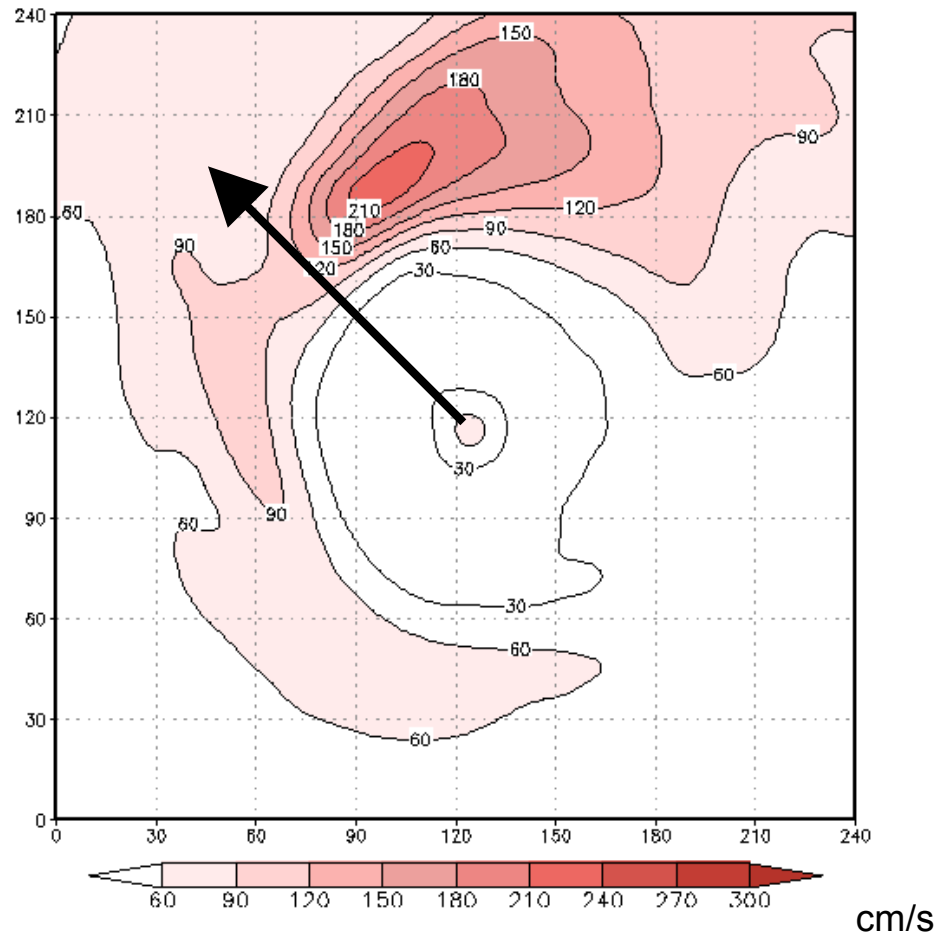
WSM3
(closest to obs)

Maximum vertical velocity

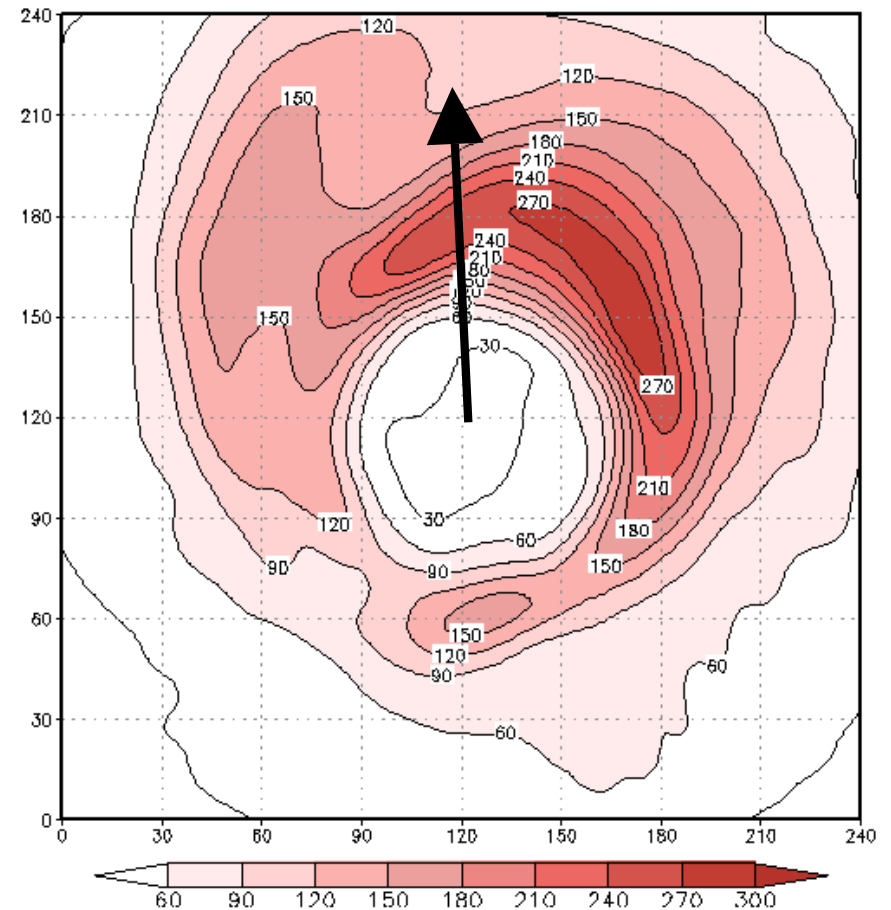
Kessler

LFO

t12run01 - wmax - 48-54h



t12run02 - wmax - 48-54h

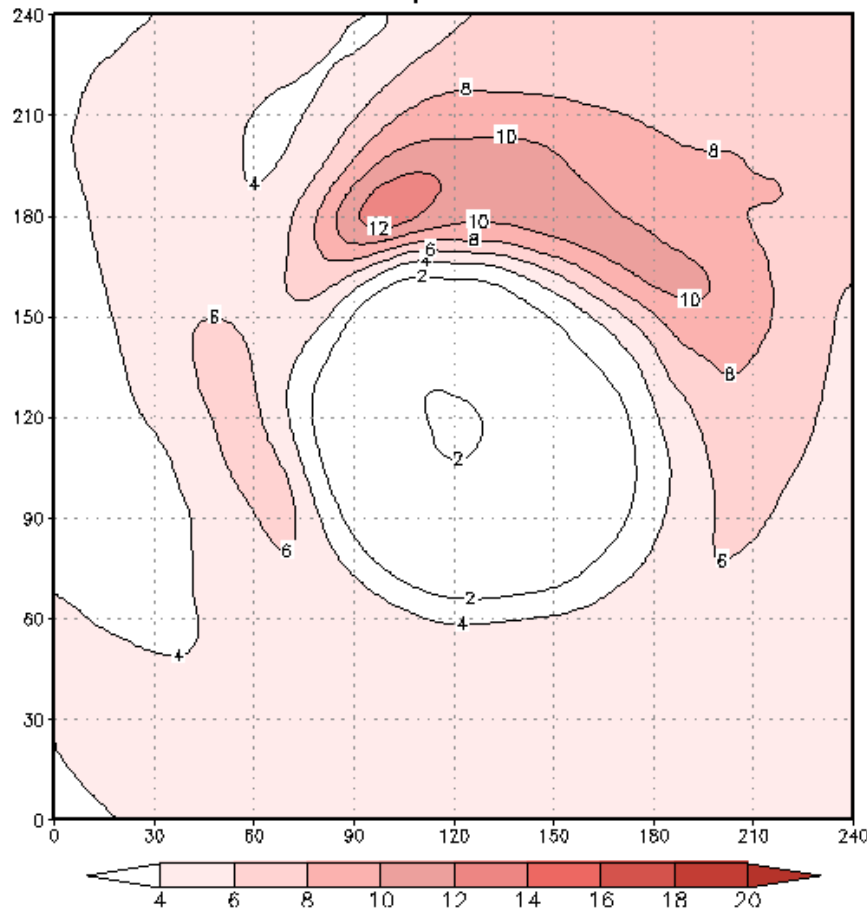


Non-precipitating condensate

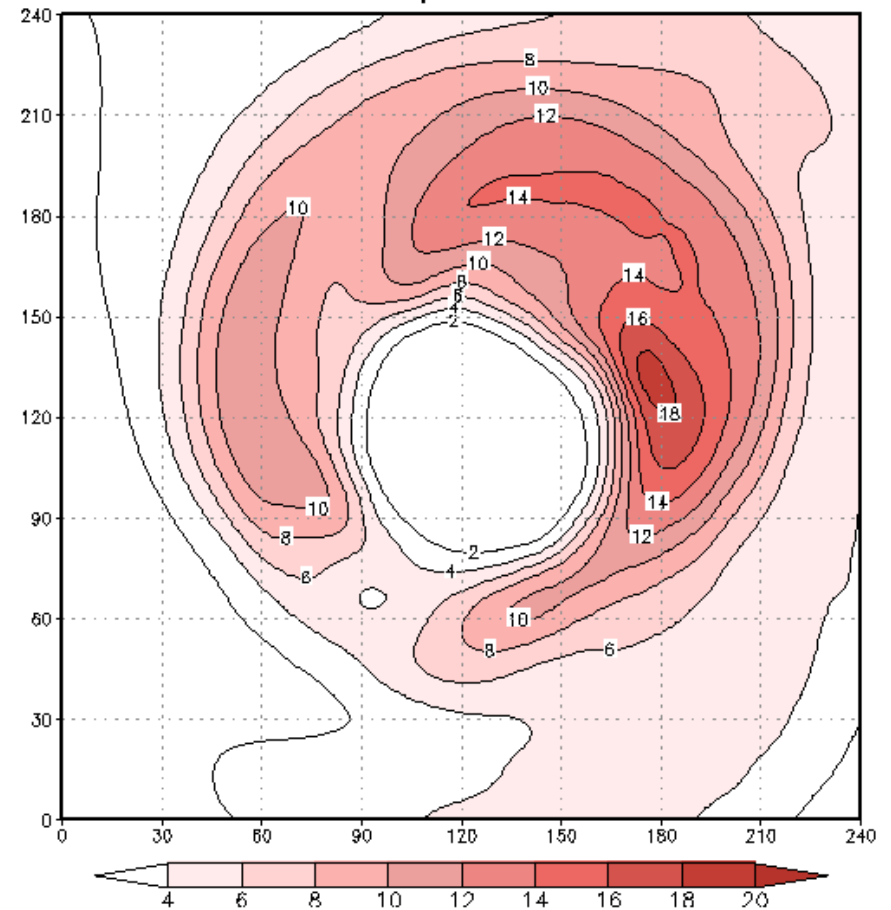
Kessler

LFO

t12run01 - qclsum - 48-54h



t12run02 - qclsum - 48-54h

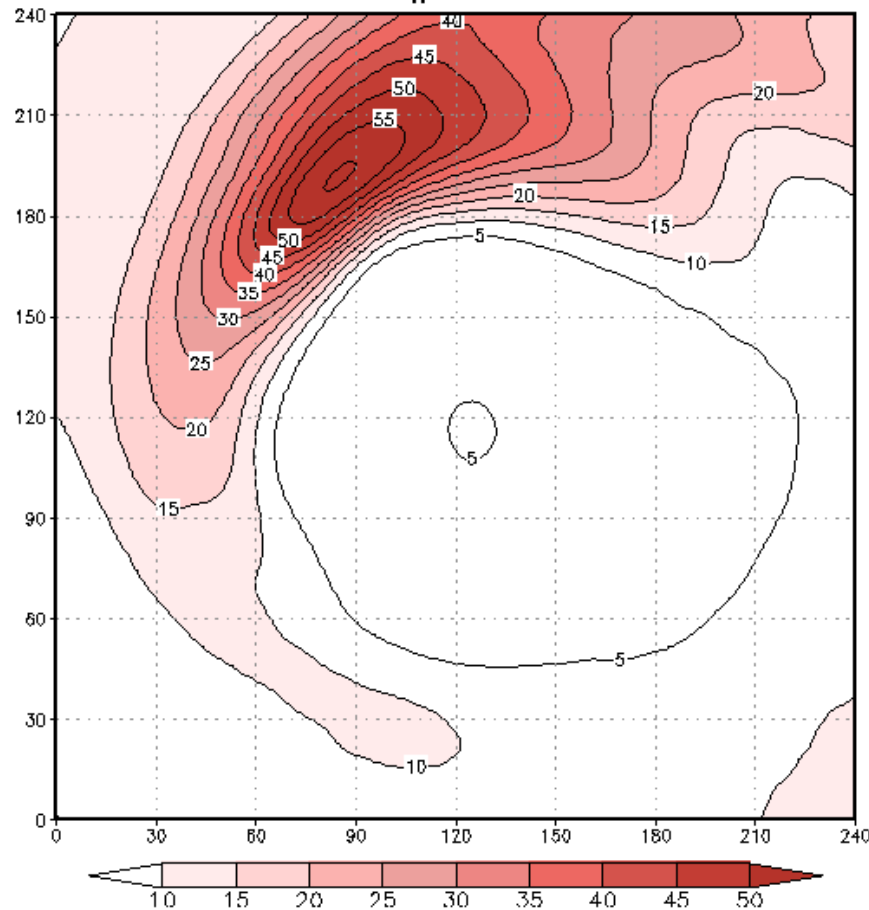


Precipitating condensate

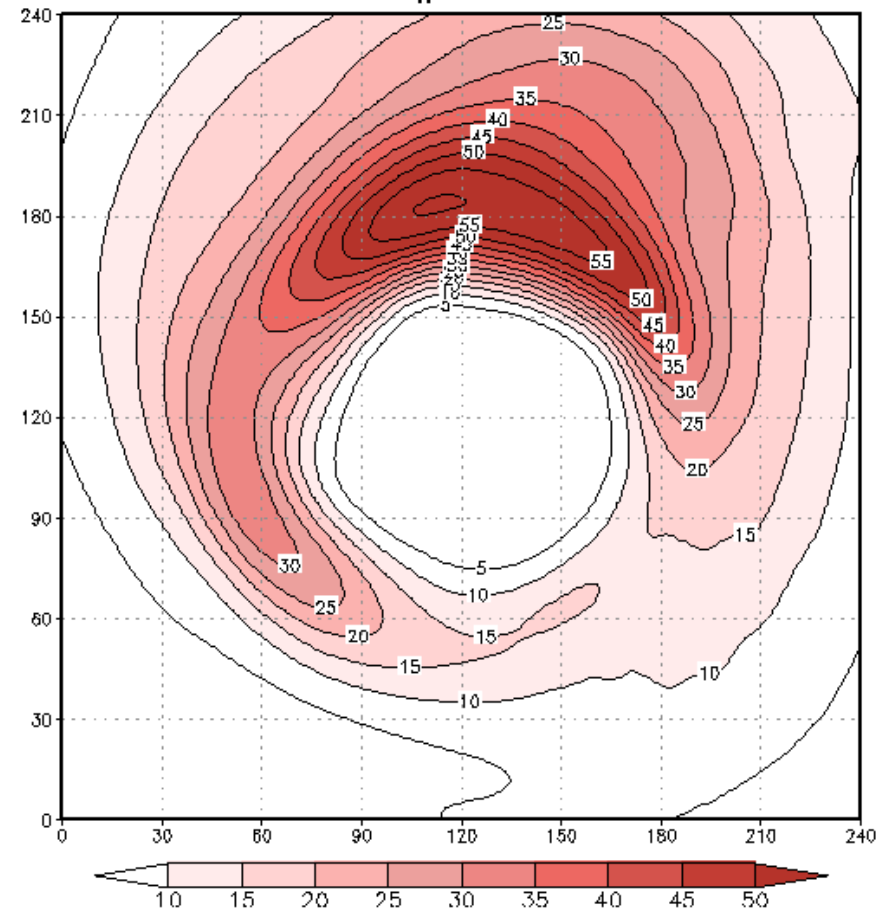
Kessler

LFO

t12run01 - qprsum - 48-54h



t12run02 - qprsum - 48-54h

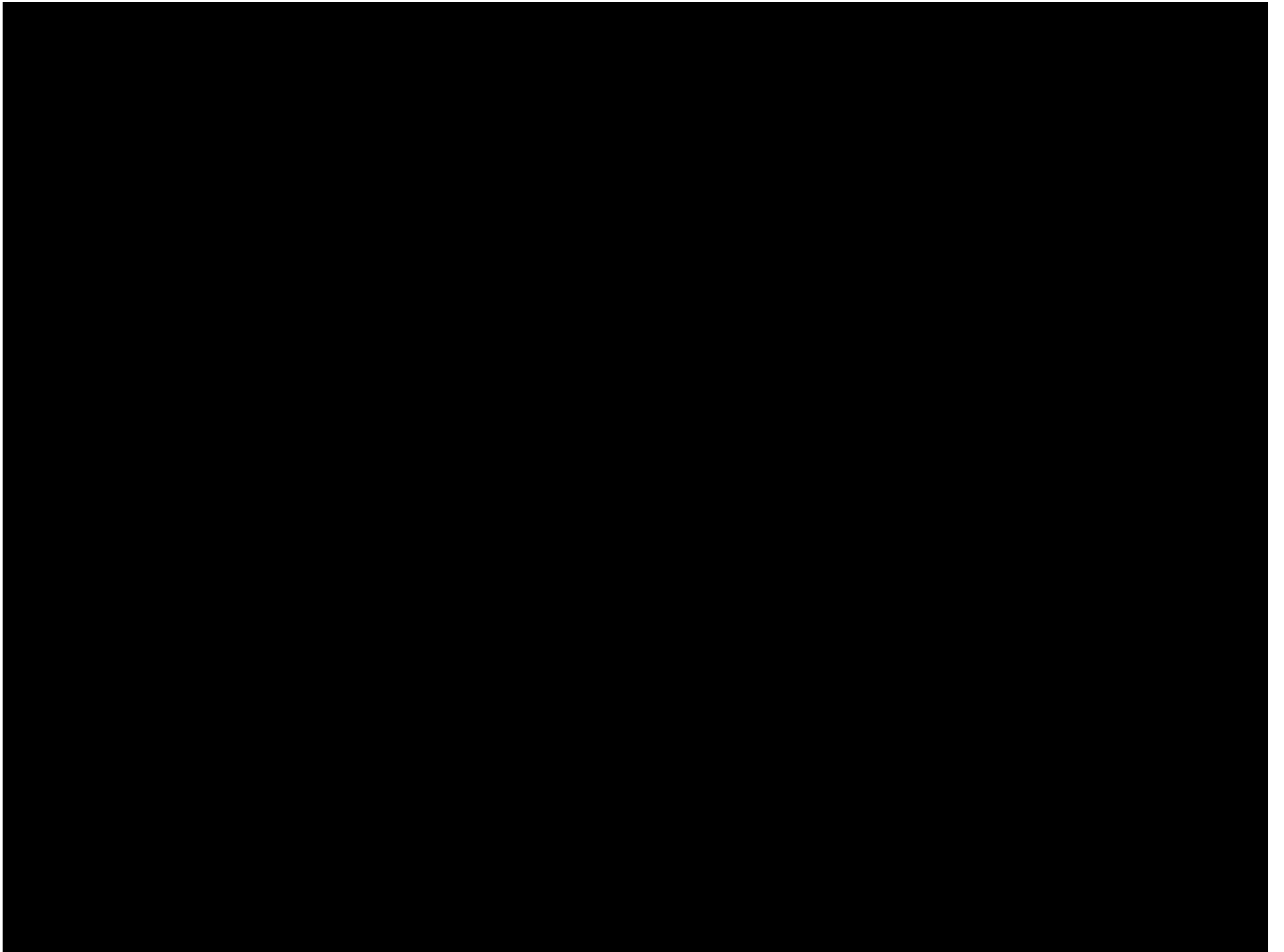


Discussion

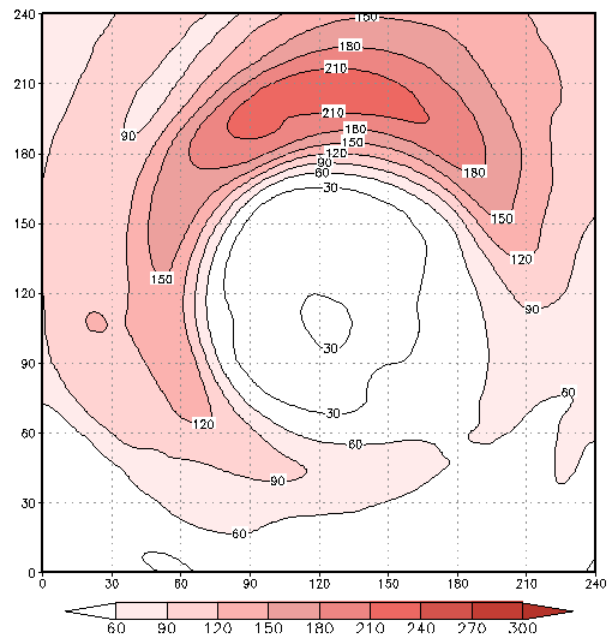
- Kessler scheme yields larger, weaker vortex
 - Greater westward displacement possibly due to enhanced beta effect
 - Vortex also shallower ~ different steering
 - Vortex slightly tilted to north
- LFO/WSM3 runs possessed...
 - Stronger updrafts
 - Concentrated in NE quadrant
 - Local vorticity increase from stretching
 - Self-propagation could favor more eastward path
- Source of difference?

Further discussion

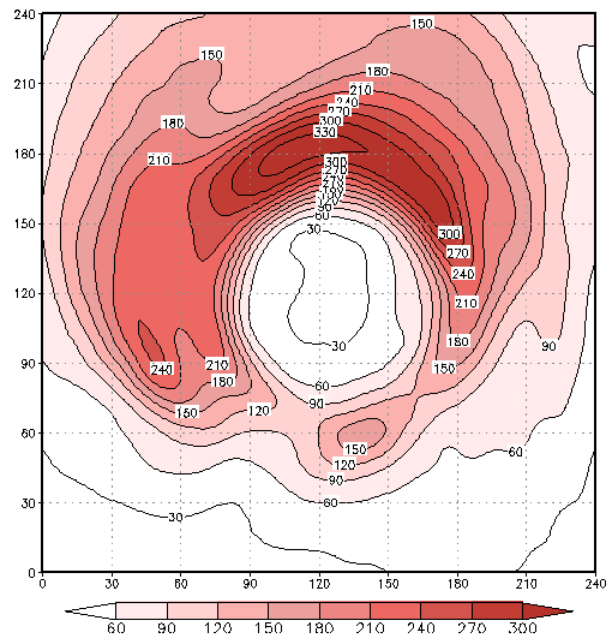
- Track sensitive to microphysics in 30 & 12 km runs
 - Extend to other lead times, cases
- Suspect no “best” microphysical scheme
 - Possible compensation for other deficiencies (in input data, model physics, resolution, etc.)
- Possible microphysics provide efficient path to excite latent sensitivity



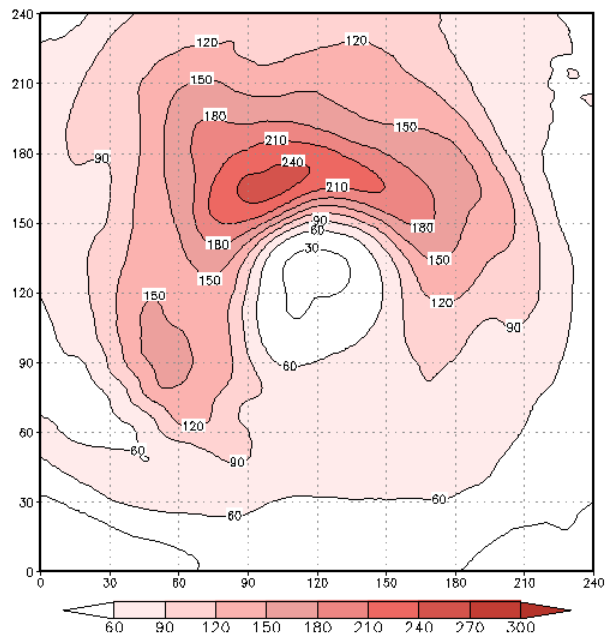
t12run01 - wmax - 42-48h



t12run02 - wmax - 42-48h



d12run03 - wmax - 42-48h

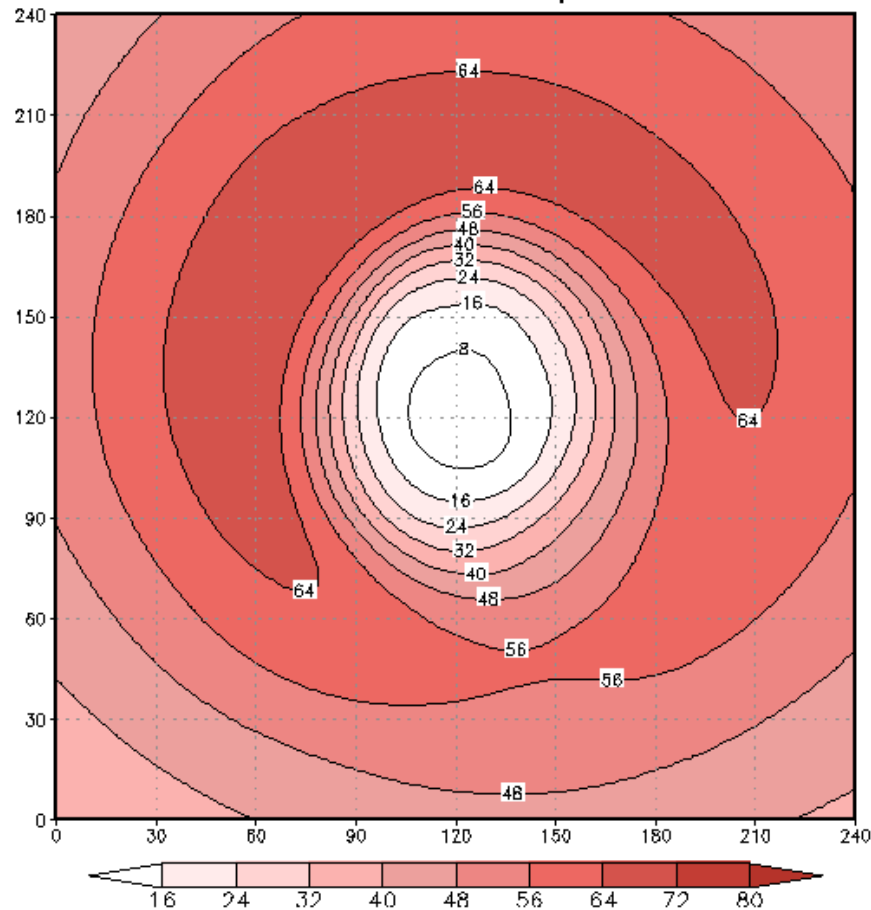


850 mb wind speed

WSM3

LFO

d12run03 - 850 mb wspd - 48-54h



t12run02 - 850 mb wspd - 48-54h

