HIGH RESOLUTION SIMULATION OF NAME INTENSIVE OBSERVING PERIODS USING THE WEATHER RESEARCH AND FORECASTING MODEL

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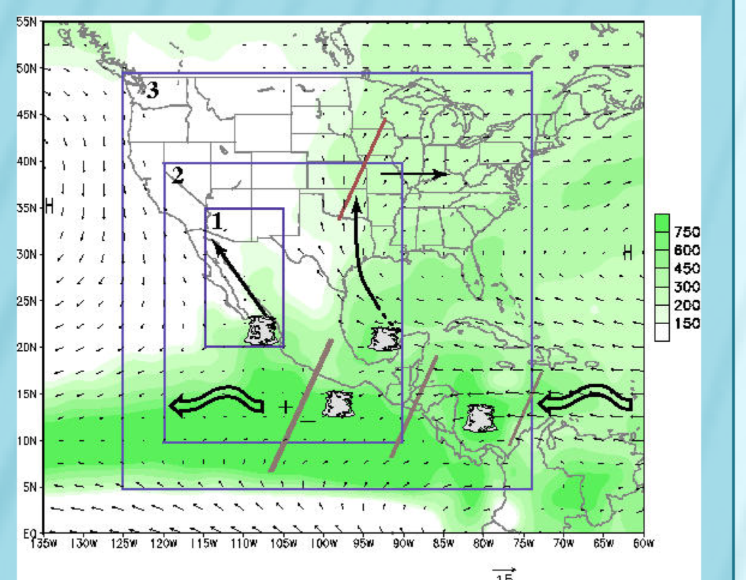
- Intensive and extensive observations collected in the southwest U.S., northwest Mexico during summer 2004
- Tiered observational approach
- Primary objective to improve weather and climate forecasts for the region

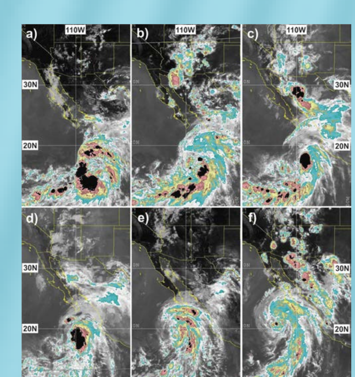


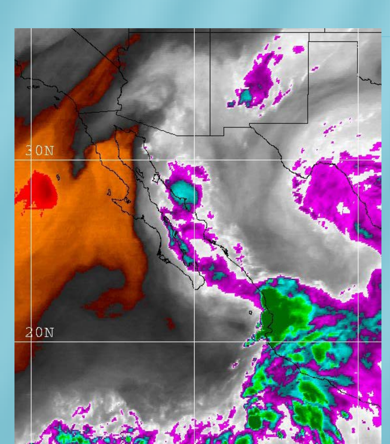
Intensive Observing Periods (IOPs)

- Individual missions - ten in total
- Called when a specific meteorological phenomenon (gulf surge, MCS development, etc) were predicted that would lead to burst periods in monsoon precipitation.
- Temporally intensive and high spatial resolution observations (satellite, surface, upper air, and radar)

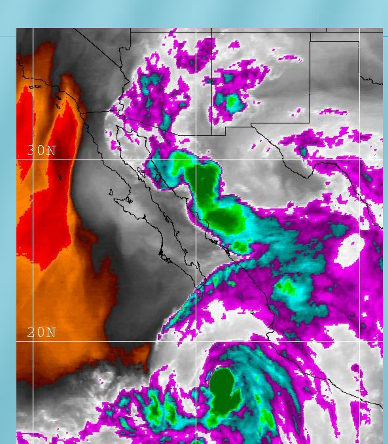
IOP 2

- 00Z July 12 – 00Z July 15
- Gulf surge induced by the passage of TS Blas at southern end of the Gulf of California
- Gulf surge and upper-level disturbance cause westward propagating MCSs off Sierra Madres and Mogollon Rim as shown in IR and water vapor satellite imagery.

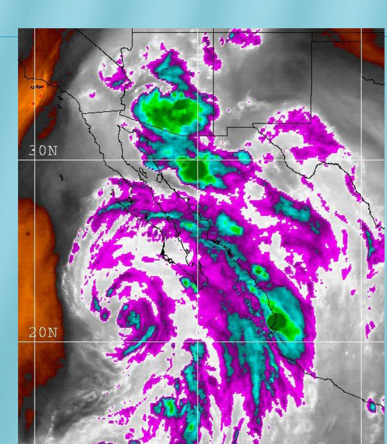




•Diurnal convection develops
•Propagated west by strong midlevel easterly flow



•Strong convection over Sonora
•Blas moving west – pressure rises in southern gulf



•Strong southerly winds at Yuma with increase in dewpoint
•Strong convection blow up in AZ

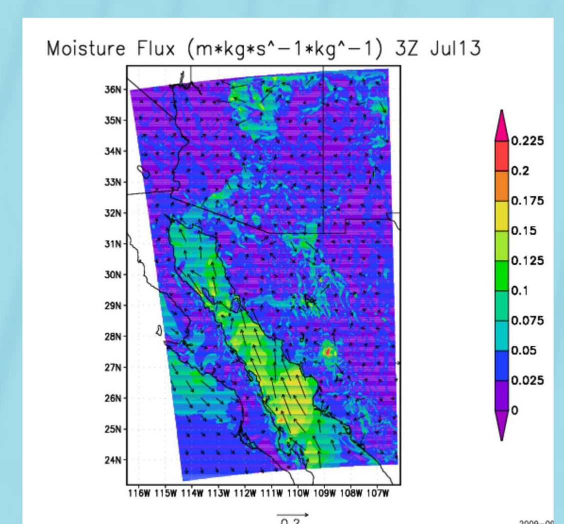
Why use a regional model?

- Gets near the scale of resolving individual thunderstorms and corresponding properties and effects, such as rainfall, MCS organization and structure, and outflow boundaries that may force new convection.
- Operational high resolution simulations can be used for utility real time flash flood advisories and severe weather watches and warnings (e.g. UA Atmospheric Sciences performs high resolution monsoon forecasts for runs in cooperation with the Salt River Project.)
- Allows for determination of data sensitivity—which is important because of a lack of data in Mexico. We use an adjoint model for this purpose.

WRF Simulation Metrics

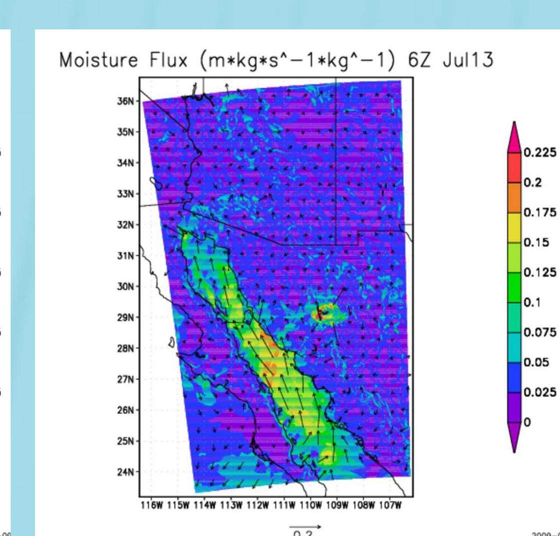
Surface moisture flux associated with gulf surge

Gulf Surge 8 PM July 12



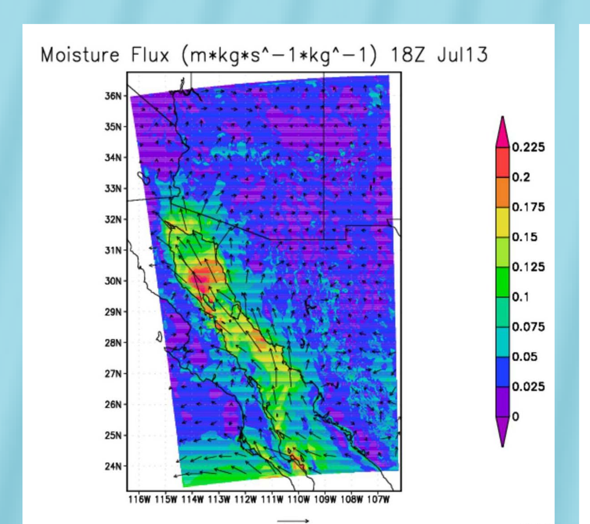
- Surge signature now present
  → Stronger flux
  → Vectors are parallel to the coast

Gulf Surge 11 PM July 12



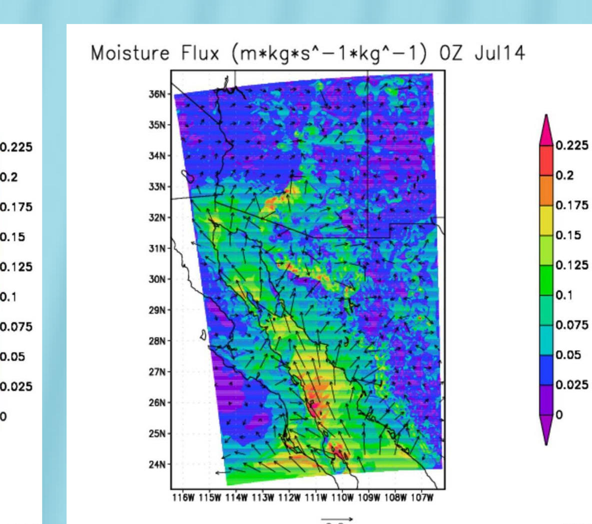
- Surge signature further north with stronger fluxes

Gulf Surge 11 AM July 13



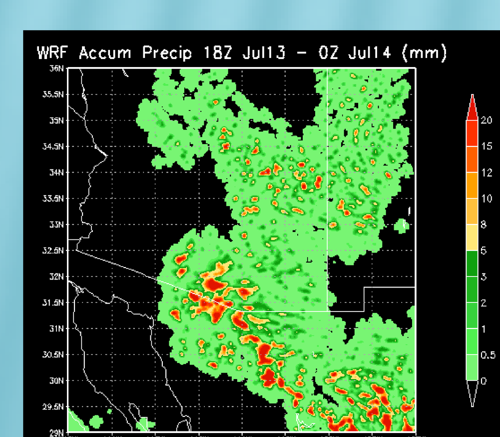
- Surge confined to northern gulf
- TS Blas starts to come into view

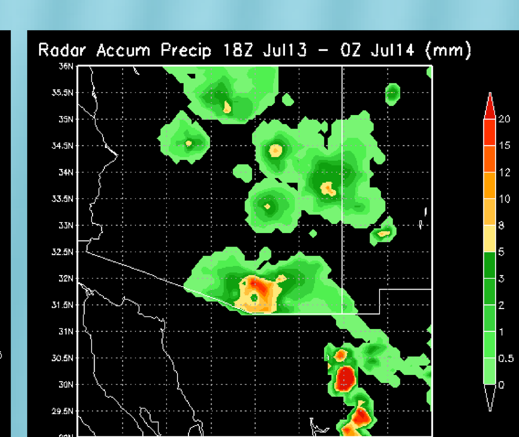
Gulf Surge 5 PM July 13



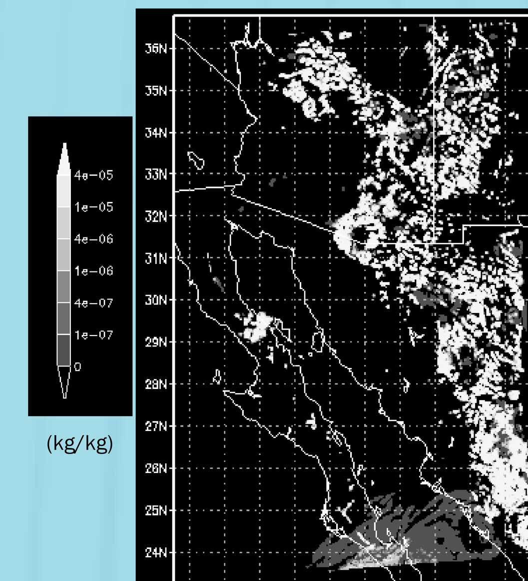
- Surge signature gone
- Moisture flux over south GoC result of Blas

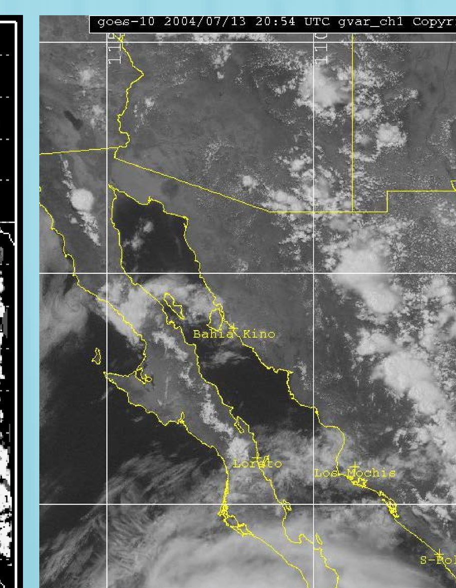
Precipitation development associated with MCS Model simulated vs. radar-derived rainfall.





MCS organization and propagation in late afternoon Model simulated cloud water vs. visible satellite imagery





Data Sensitivity Using WRF Adjoint

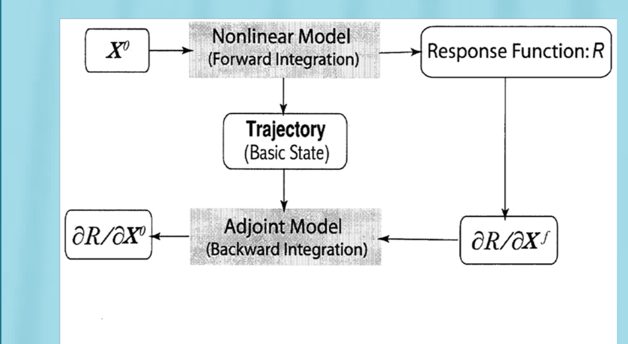


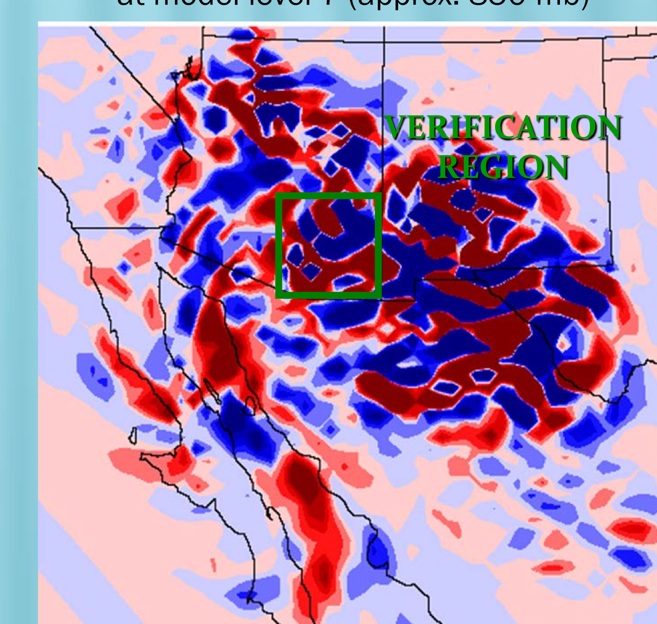
Figure 7: Schematic outlining the flow chart of adjoint sensitivity calculation.

WRF Adjoint is a linearized version of WRF integrated backward in time

1. Run WRF model forward in time
2. Declare response function (moisture flux convergence, dry static energy, etc.) and verification volume (seen as boxes in following images)
3. Extract basic "true" state (trajectory) from WRF forcing data (by running the model a timestep at verification time)
4. Adjoint model integrates backward in time to assess areas of greatest sensitivity to initial conditions (only sensitivity patterns shown)

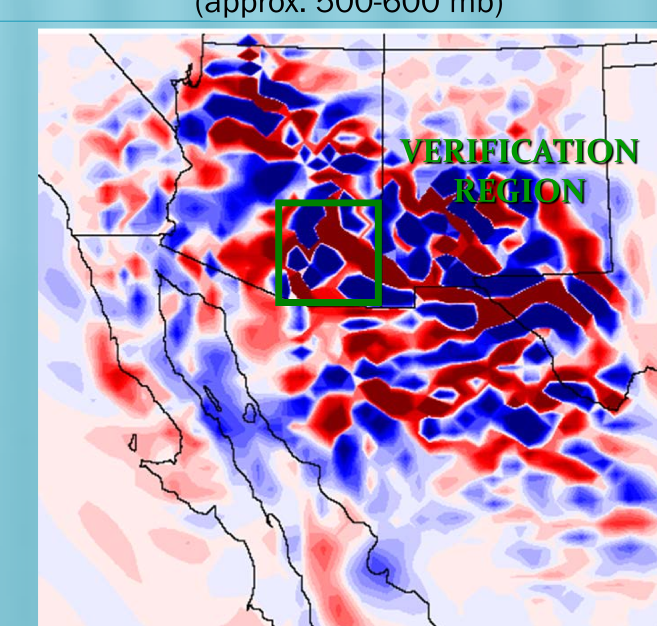
Low level sensitivity to water vapor at model level 7 (approx. 850 mb)

- Verification area: Southeast Arizona
- Verification height: levels 1-8 corresponding approximately from 1000 mb to 700 mb
- Response function: moisture flux convergence
- Shows that low level moisture flux convergence is sensitive to initial model specification of water vapor at about 850 mb in regions to south east south west, associated with the gulf surge



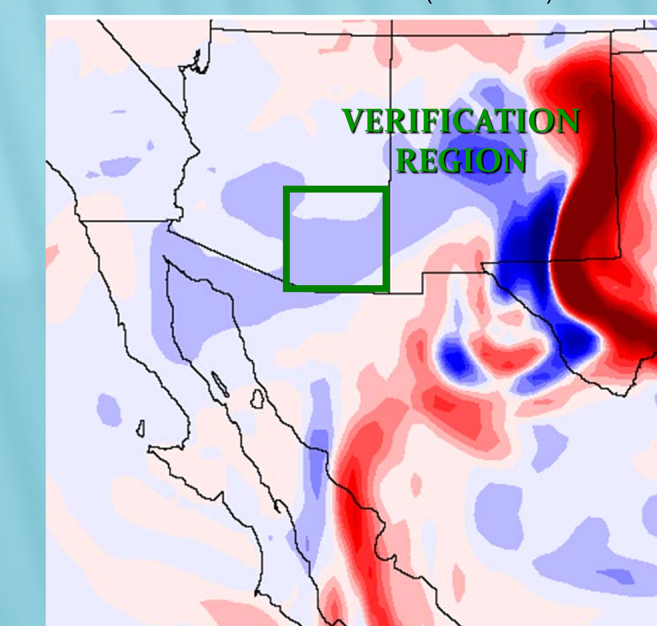
Mid level sensitivity to T at model level 7 (approx. 500-600 mb)

- Verification area: southern Arizona
- Verification height: levels 8-14 corresponding to 700 mb to 400 mb
- Response function: moisture flux convergence
- Shows that mid level moisture flux convergence is sensitive to temperature at 500-600 mb to south east in the region of the upper level disturbance



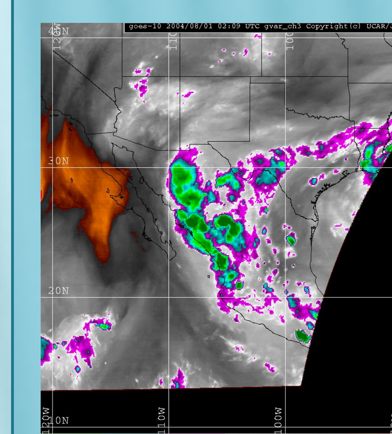
Upper level sensitivity to meridional wind at model level 17 (200 mb)

- Verification area: southeast Arizona
- Verification height: levels 14-20 corresponding to 400 mb to 100 mb
- Response function: dry static energy
- Shows that upper level dry static energy is sensitive to meridional wind at 200 mb in association with the upper level disturbance to the southeast.

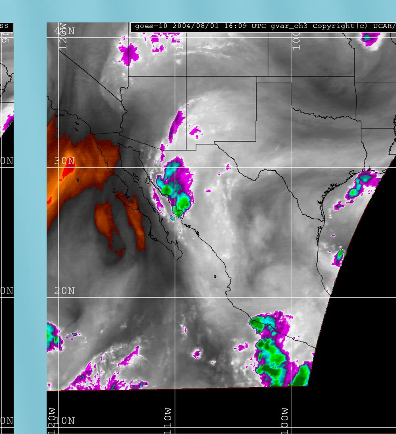


Future Work

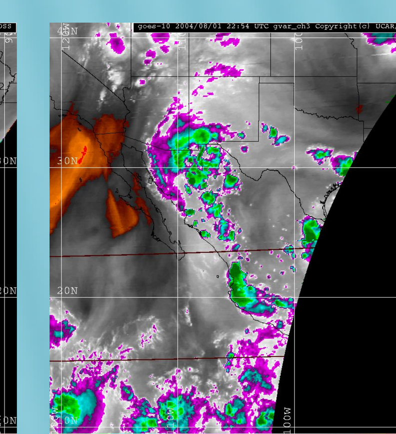
IOP 5



•MCS active in three corners region (Durango, Sinaloa, Chihuahua)

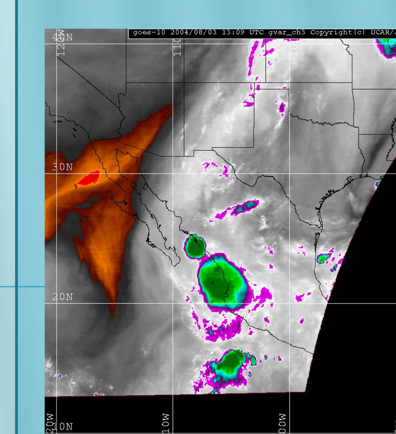


•MCS decayed
•MCV moved north

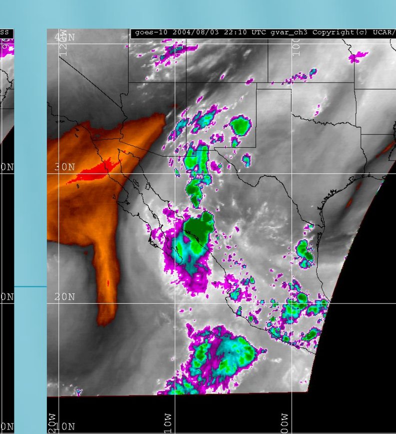


•MCS redevelop NE Sonora, NW Chihuahua

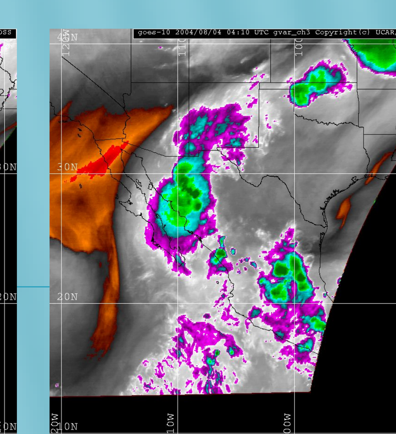
IOP 6



•Formation of MCS in southern gulf
•Westward moving



•Convection (MCC) begins to develop north of MCS



•MCS blow up

Acknowledgements

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