

The MAP06 Project and support to NAMMA

Forecasting African Easterly Waves with GEOS5

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The 2006 NASA Modeling and Analysis Project (MAP06)

Objective:

Application of NASA's advanced satellite remote sensing technologies and earth system modeling capabilities to improve understanding and prediction of tropical cyclones

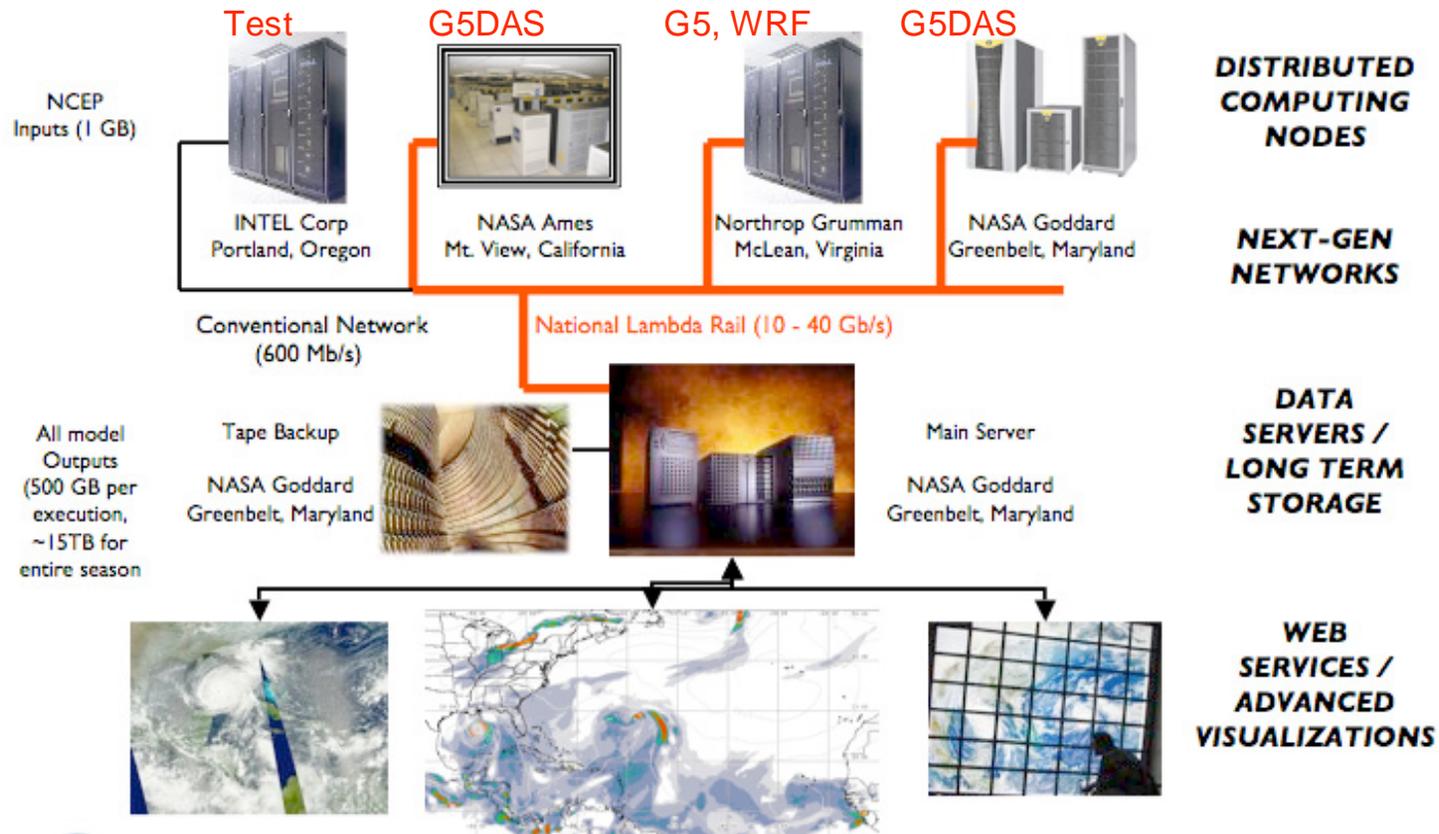
Science Questions:

- **Can satellite data assimilation improve prediction (out to 5 days) of easterly waves, tropical cyclogenesis and hurricanes?**
- **What impact is gained with increased model resolution?**
- **What role do aerosols play in tropical cyclogenesis in the Atlantic basin?**
- **What roles do land – ocean – atmosphere interactions play in the structure and evolution of easterly waves as they propagate off the western African coast?**

The Approach...

MAP'06

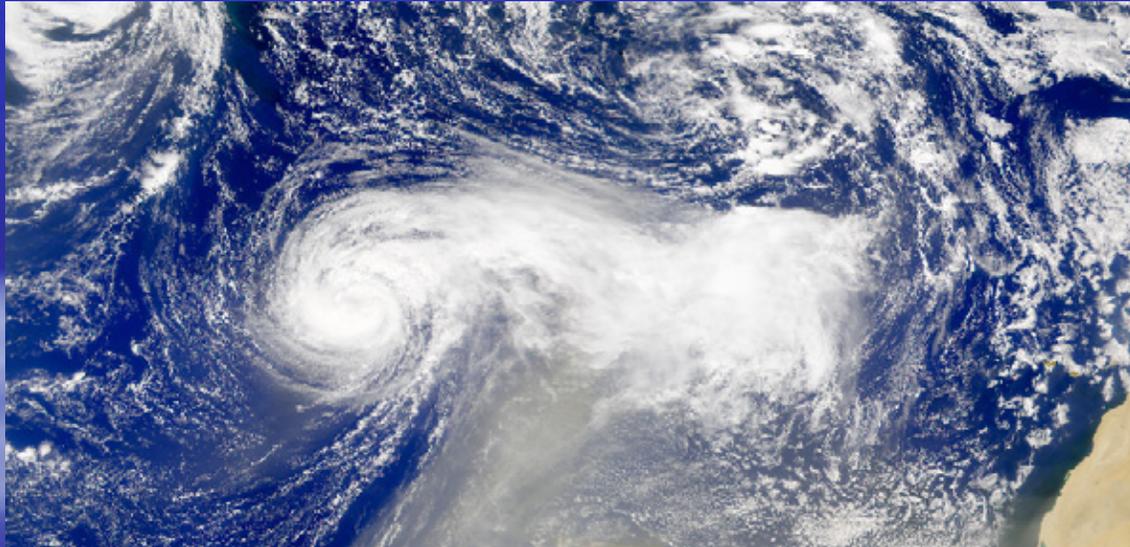
2006 Hurricane Season - Global Modeling



NASA Goddard Space Flight Center
Software Integration & Visualization Office

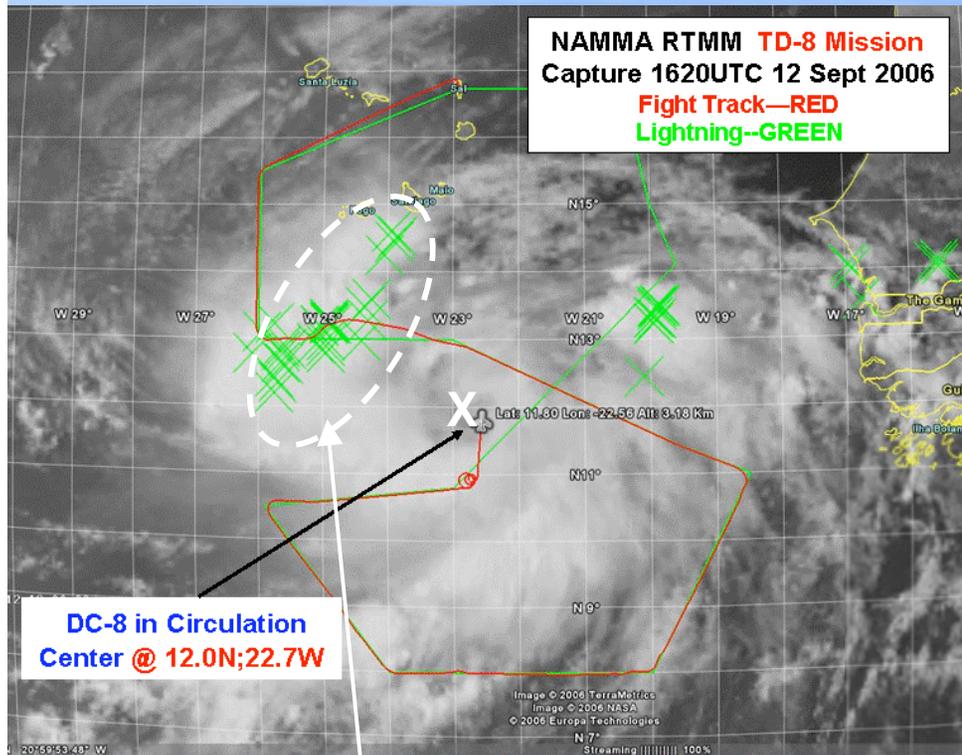
NASA ESD Hurricane Field Campaign: N-AMMA-06

- Out of Africa: African Easterly Waves are the progenitors of many late-season, strong category hurricanes that strike the U.S.
- Leverages off AMMA SOP-3 and will be based in Cape Verde
- Multidisciplinary approach involving Weather, Water & Energy, Composition foci
- Platforms to include DC-8, Aerosonde, TOGA & NPOL radars, micropulse lidars
- Partnering with European consortium, NOAA HRD
- NAMMA-06 science in line with CCSP objectives

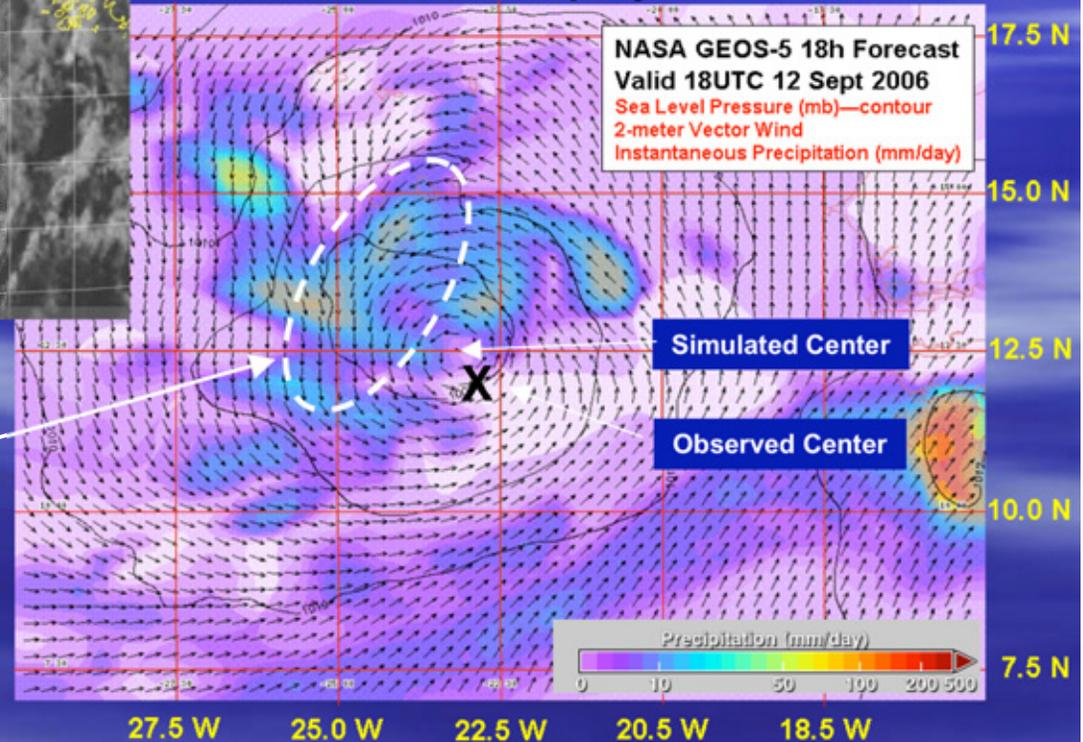


African SAL: Impact on tropical cyclogenesis - hypothesize to be a hurricane suppressant, in an ocean marginally suitable for hurricane generation; examine SAL impact on microphysics, thermodynamic instability, shear, airmass dessication

NASA Earth System Modeling in Support of NAMMA



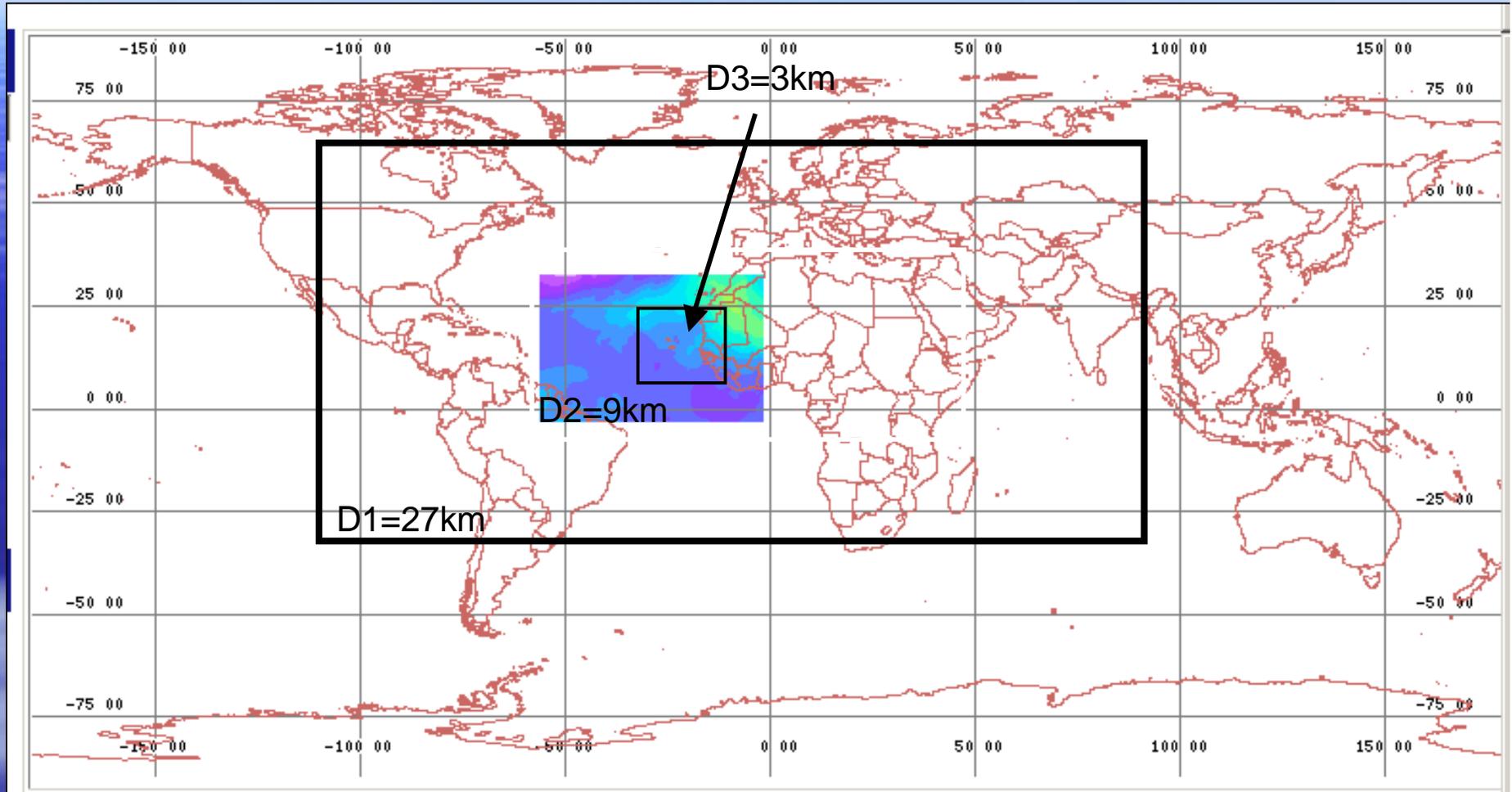
- NASA GEOS-5 at 1/4 degree resolution demonstrates skill in simulating AEW's and tropical depressions during NAMMA
- Provided value-added product to NAMMA Forecast Team
- Joint GSFC-MSFC project



**Heaviest Precipitation
NW of Circulation Center**

NASA Earth System Modeling in Support of NAMMA

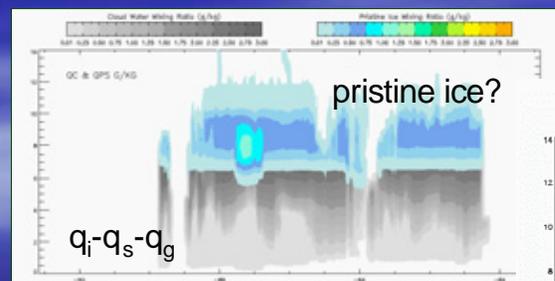
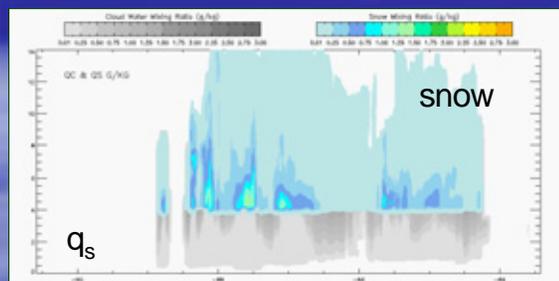
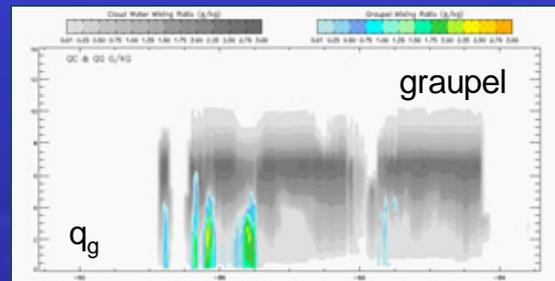
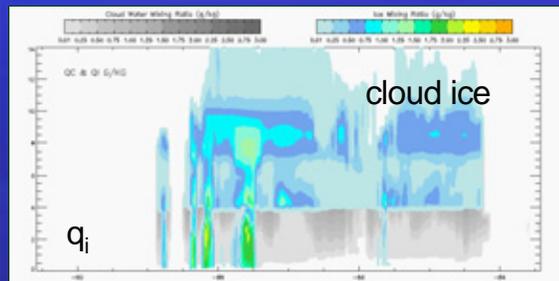
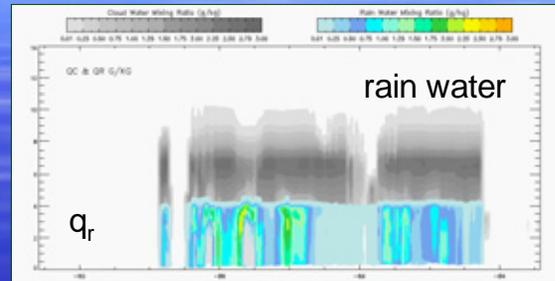
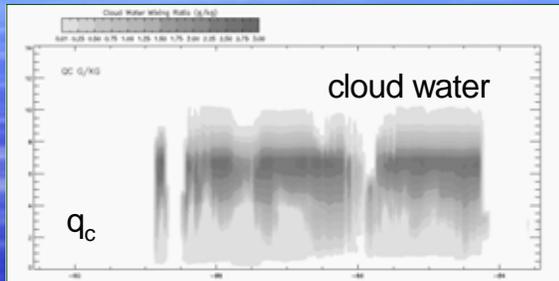
Driving WRF with GEOS-5 Analyses and LBC



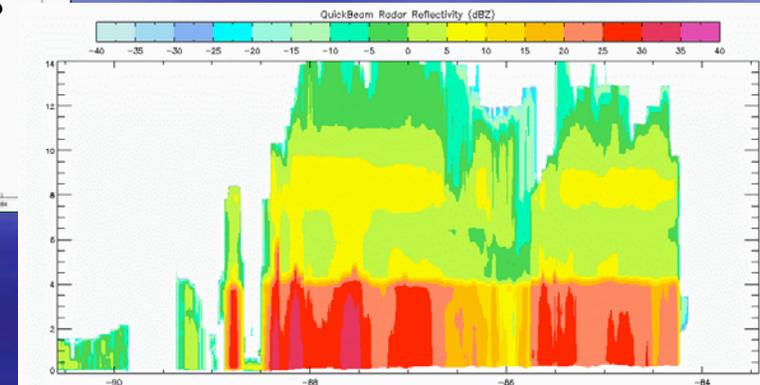
Use of QuickBeam CloudSat Radar Simulator and WRF

A tool available to the NASA MAP Community

WRF Microphysics Cross Section



Preliminary Results

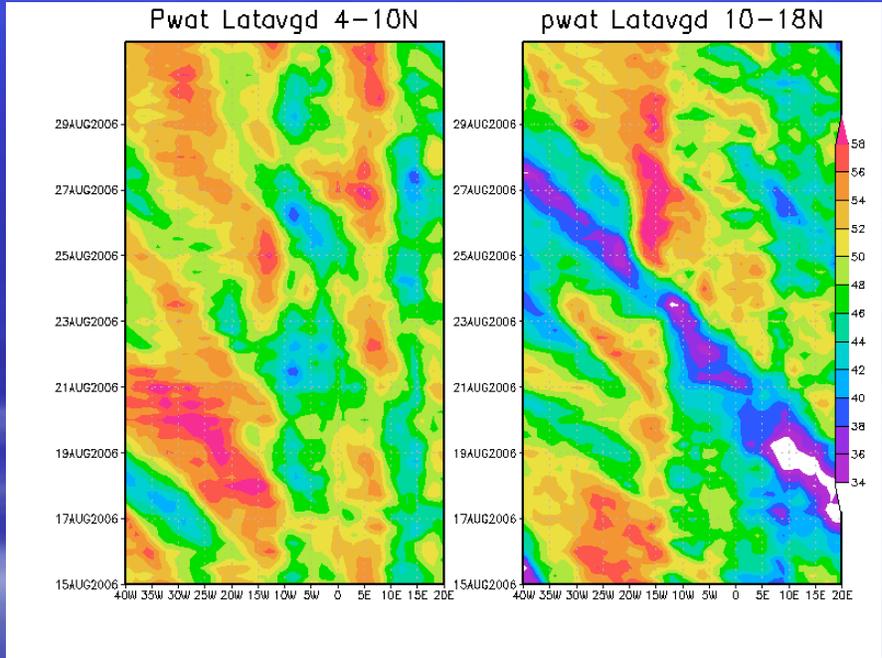
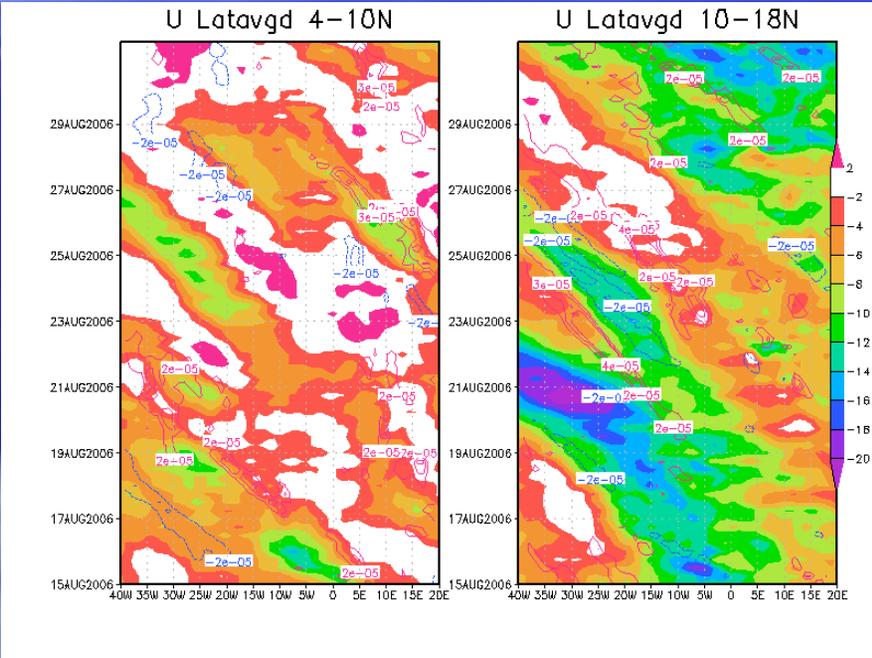


GEOS-5 0.25 Degree Forecasts during NAMMA

Developing versus non-developing waves

- One of the challenges in the African Monsoon region and nearby Tropical Atlantic is to discriminate between developing and non-developing systems
- The African Easterly Jet dynamics and instabilities are among the most challenging issues of weather forecasting
- The GEOS-5 was put to a demanding test
- 7 waves transitioned during the campaign
- 36-48 hour forecast of wave development stage was very satisfactory
- Subjective GEOS-5 based decision of discriminating developing versus non-developing was generally correct
- Propagation speed was occasionally inaccurate, often slower than observed on land, faster on ocean
- Intensity: organization and intensification process very well-captured in the early stages, but explosive deepening was always missing and mature tropical systems ended being generally under-represented

AEWs in the NCEP Analyses during the SOP-3 phase of the NAMMA: August

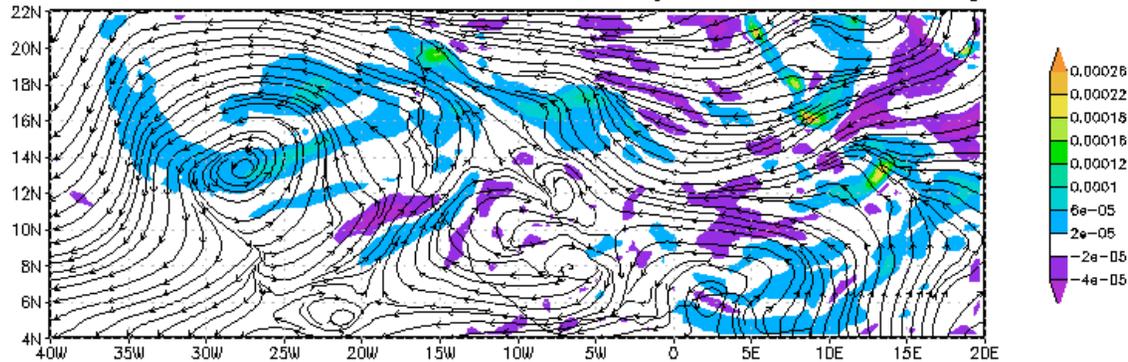


700hPa u (shaded), vorticity (contours)
Time upward

Precip. Water

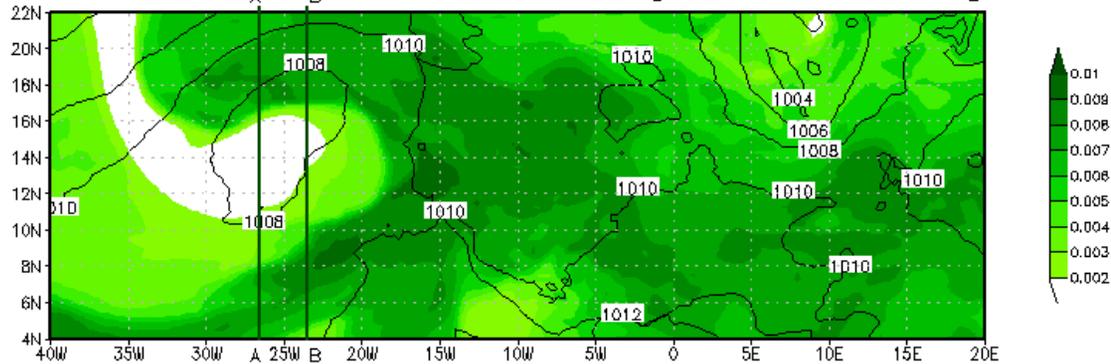
Example of GEOS-5 forecasting a non-developing wave, possibly because of Saharan Air intrusion

G5NCEP 42H FCST; INIT 00z25Aug; VERIF 18z26Aug



Wind at 650hPa
850 hPa Vort

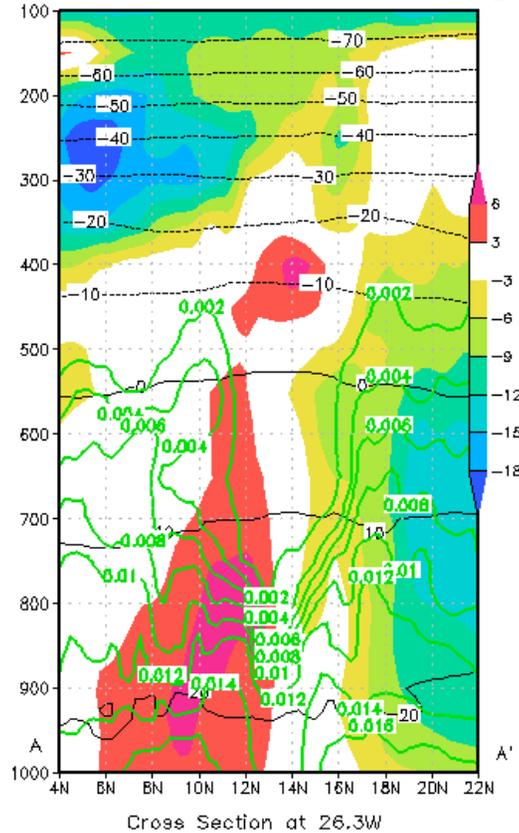
G5NCEP 42H FCST; INIT 00z25Aug; VERIF 18z26Aug



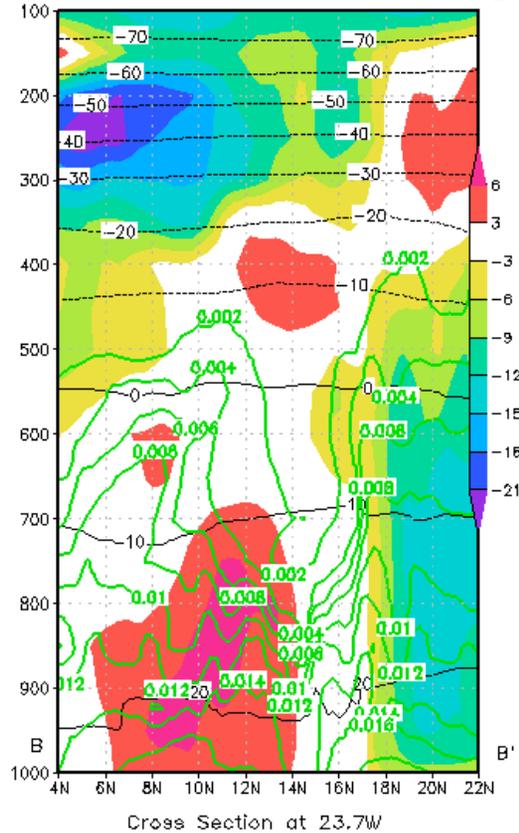
650 sp. hum (shaded)
and slp (solid)

GEOS-5 forecast of dry air intrusion at 500-700 hPa suggestive of non-development

INIT 00z25; VER 18z26Aug



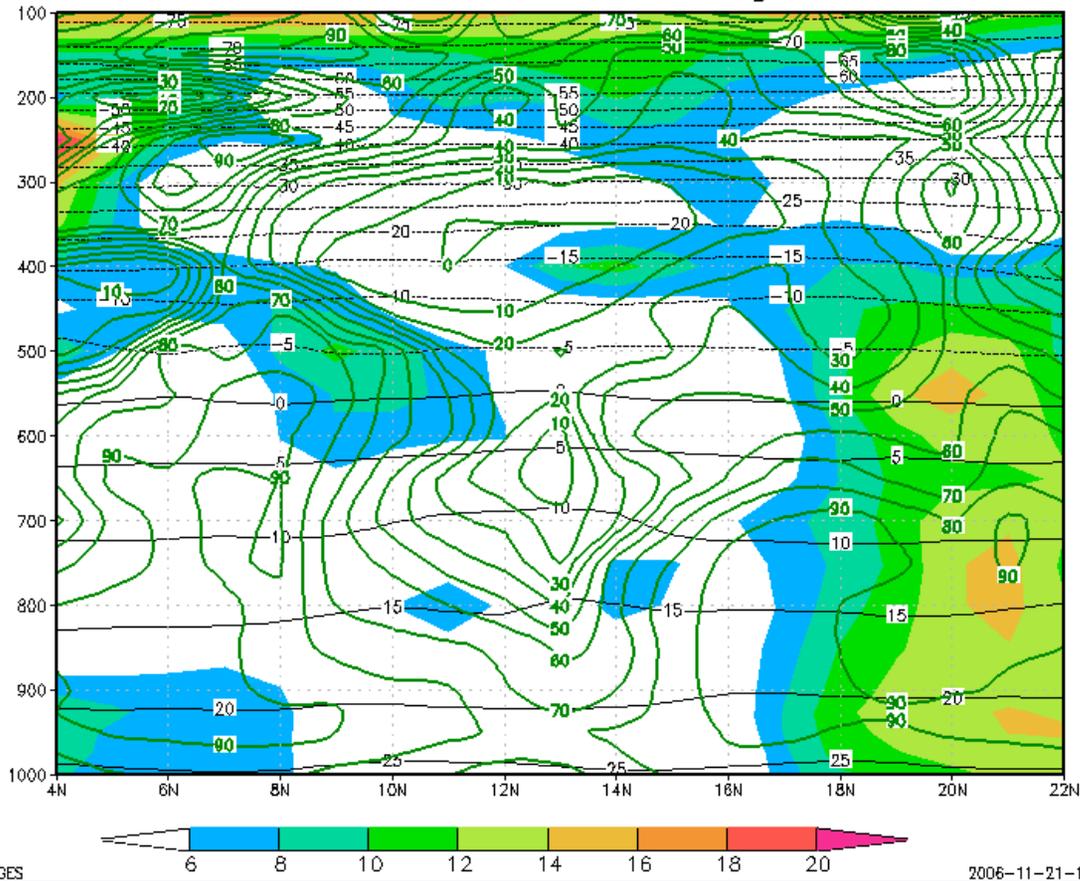
INIT 00z25; VER 18z26Aug



Zonal Wind (shaded)
Temp (black solid)
Spec hum (green thick)

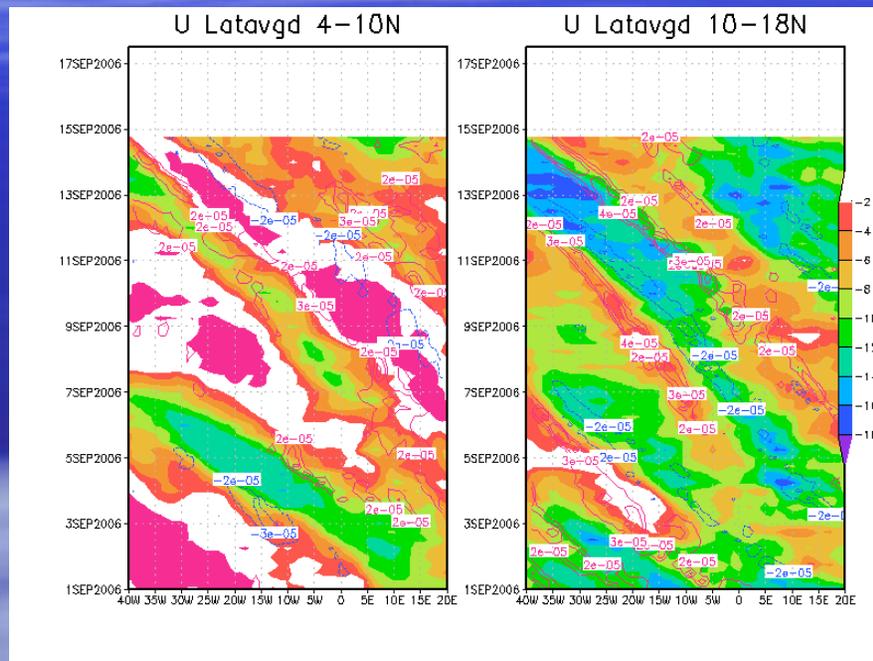
NCEP analysis: Saharan Air intrusion at about 600-700 hPa suppresses development in a scenario which would otherwise be dynamically very favorable

NCEP AN CS 32W 12z27Aug2006

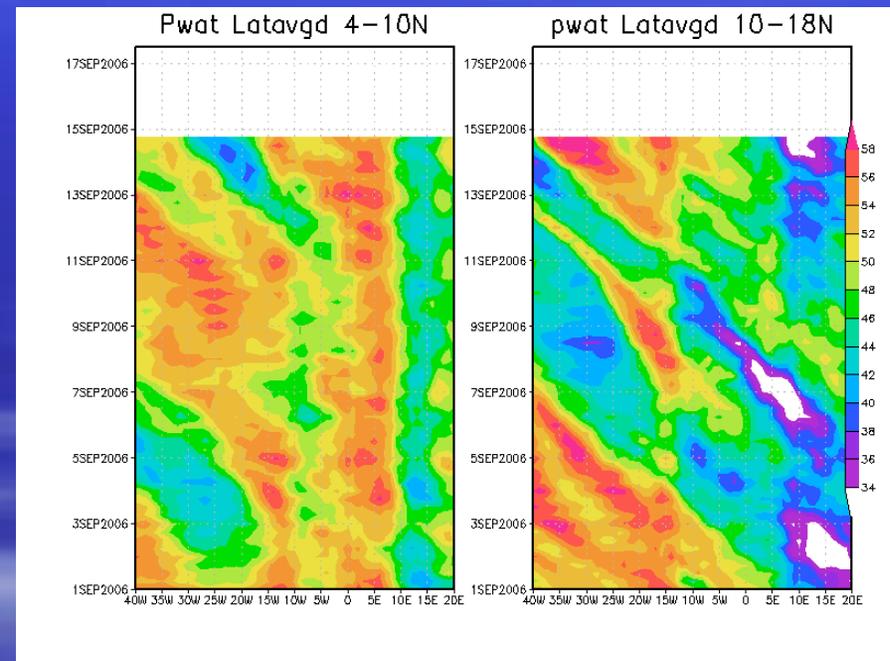


Wind speed (shaded)
Temp (black solid)
Rel. hum. (green thick)

AEWs in the NCEP Analyses during the SOP-3 phase of the NAMMA: September



700hPa u (shaded), vorticity (contours)
Time upward



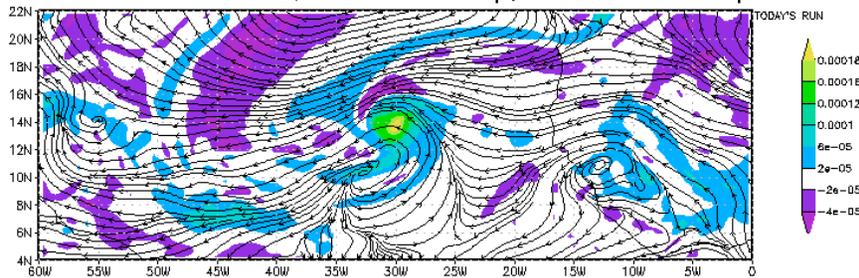
Precip. Water

GEOS5 prediction of Hurricane Helene precursor

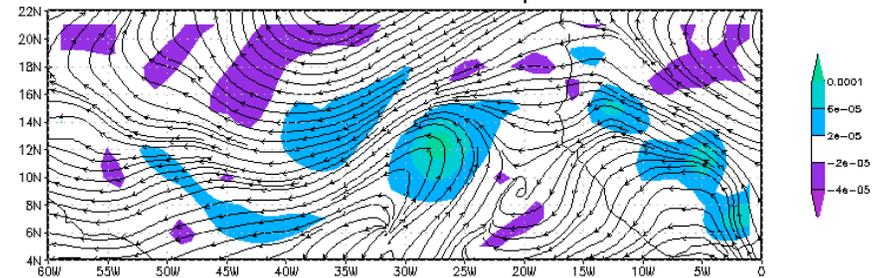
Hurricane Helene's (2006) precursor was an example of an AEW which was very well predicted by the GEOS5. The forecast was one of the components that perhaps helped NAMMA mission scientists to make the appropriate decisions.

650 hPa wind (streams) and 850 hPa vorticity (shaded)

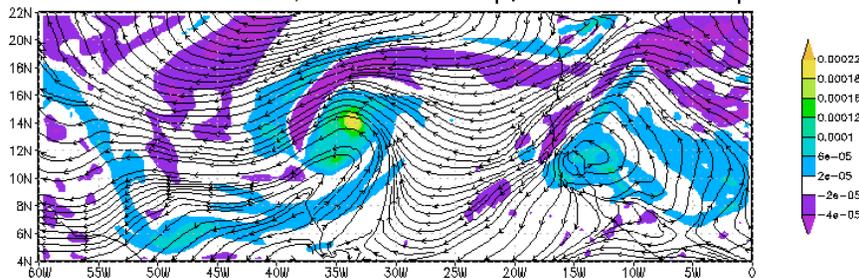
G5NCEP 36H FCST; INIT 00z12Sep; VERIF 12z13Sep



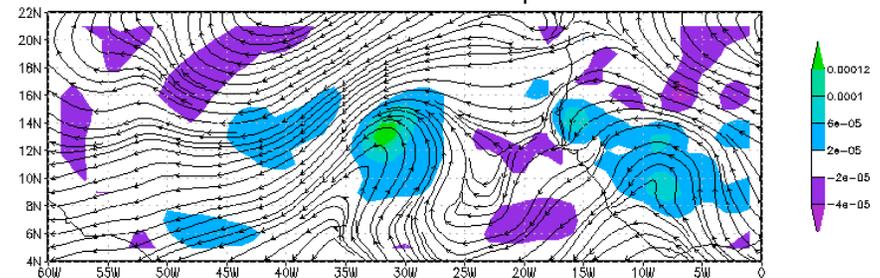
NCEP AN 12z13Sep



G5NCEP 48H FCST; INIT 00z12Sep; VERIF 00z14Sep

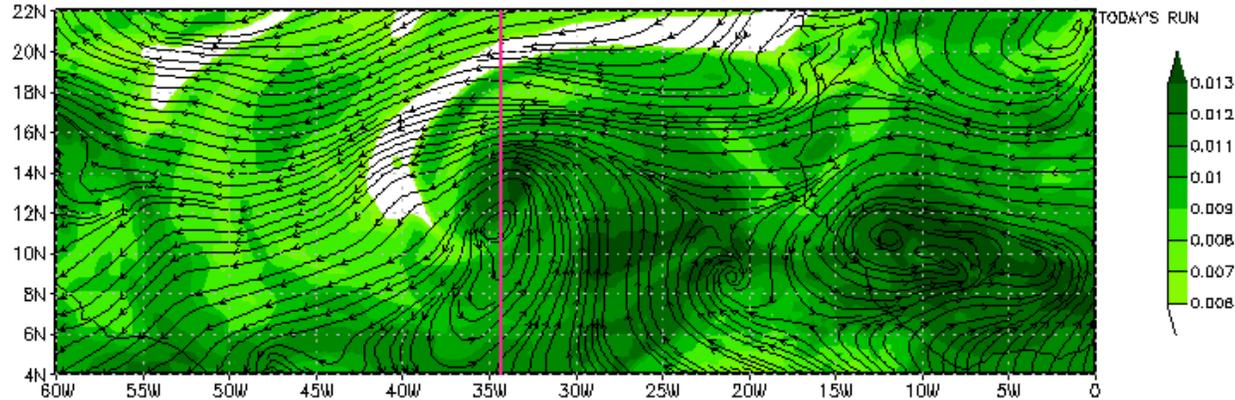


NCEP AN 00z14Sep

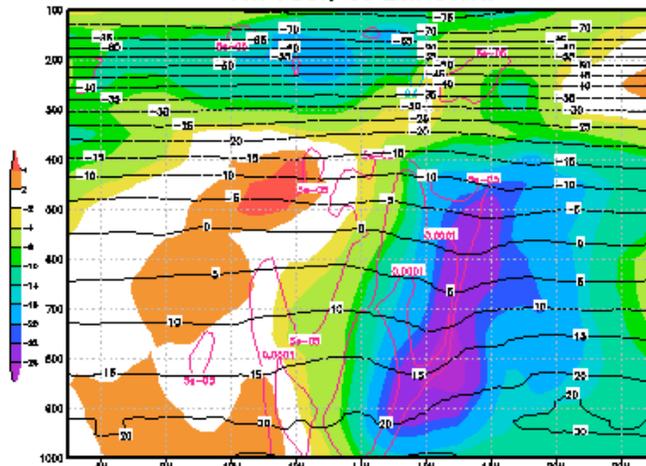


GEOS5 representation of Helene's precursor

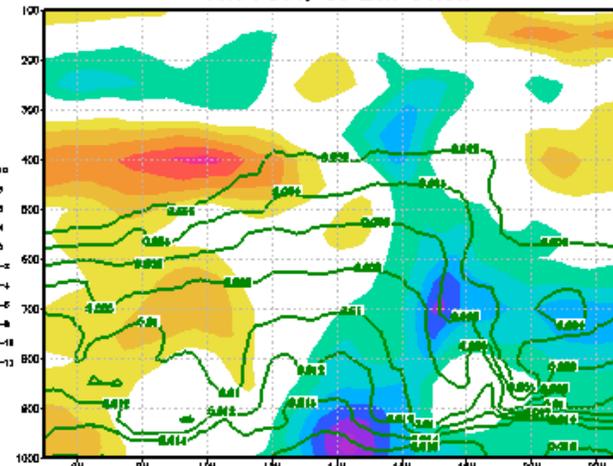
G5NCEP 48H FCST; INIT 00z12Sep; VERIF 00z14Sep



48H FCST; CS Lon 34.3W

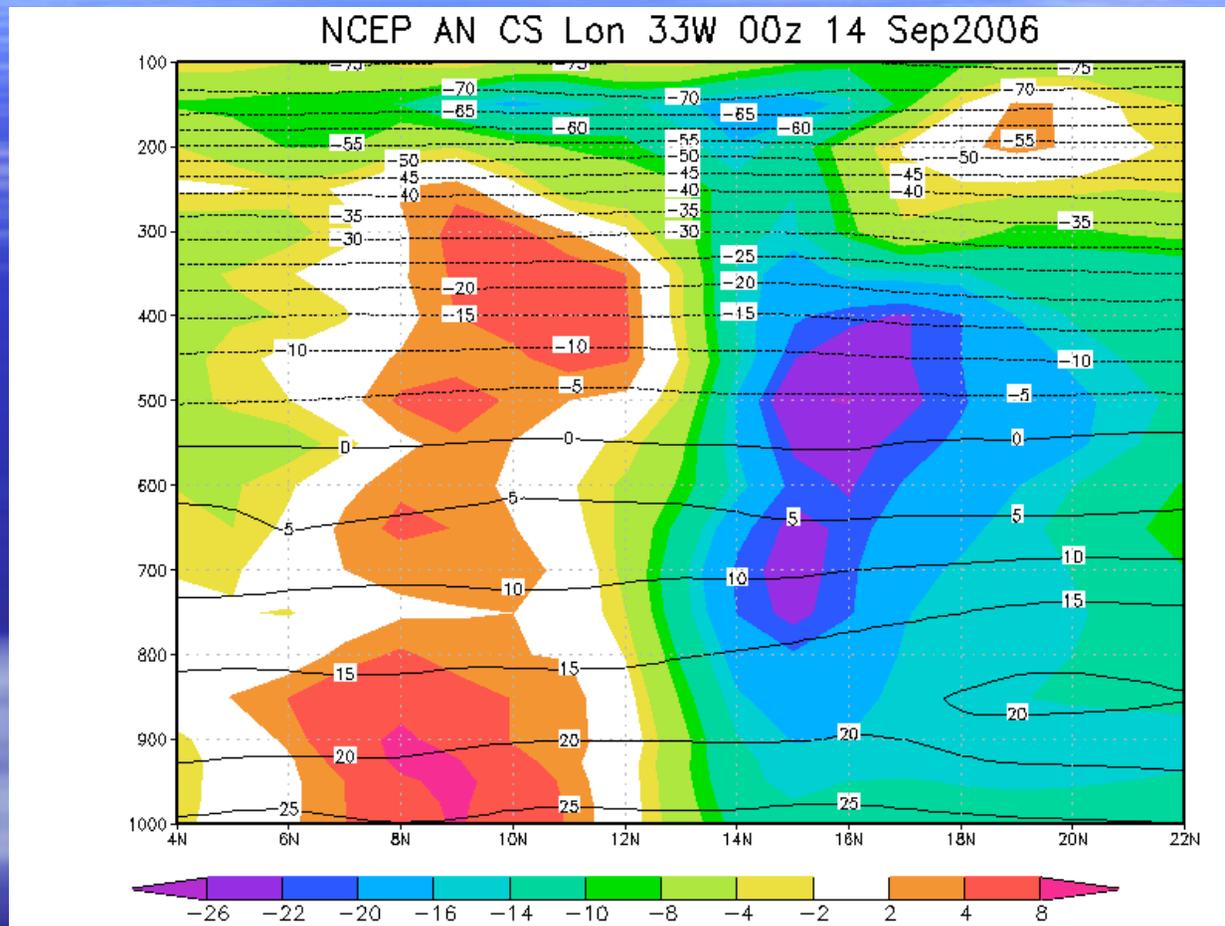


48H FCST; CS Lon 34.3W



A vertically aligned column, with increasing low-level cyclonic vorticity, rapidly grows in the model output in response to the strong horizontal shear. Low-level convergence increases moisture levels where the vortex is forming. The GEOS5 is suggesting that the wave may become a TS by 00z 14Sep 2006

Helene's representation in the NCEP Analyses

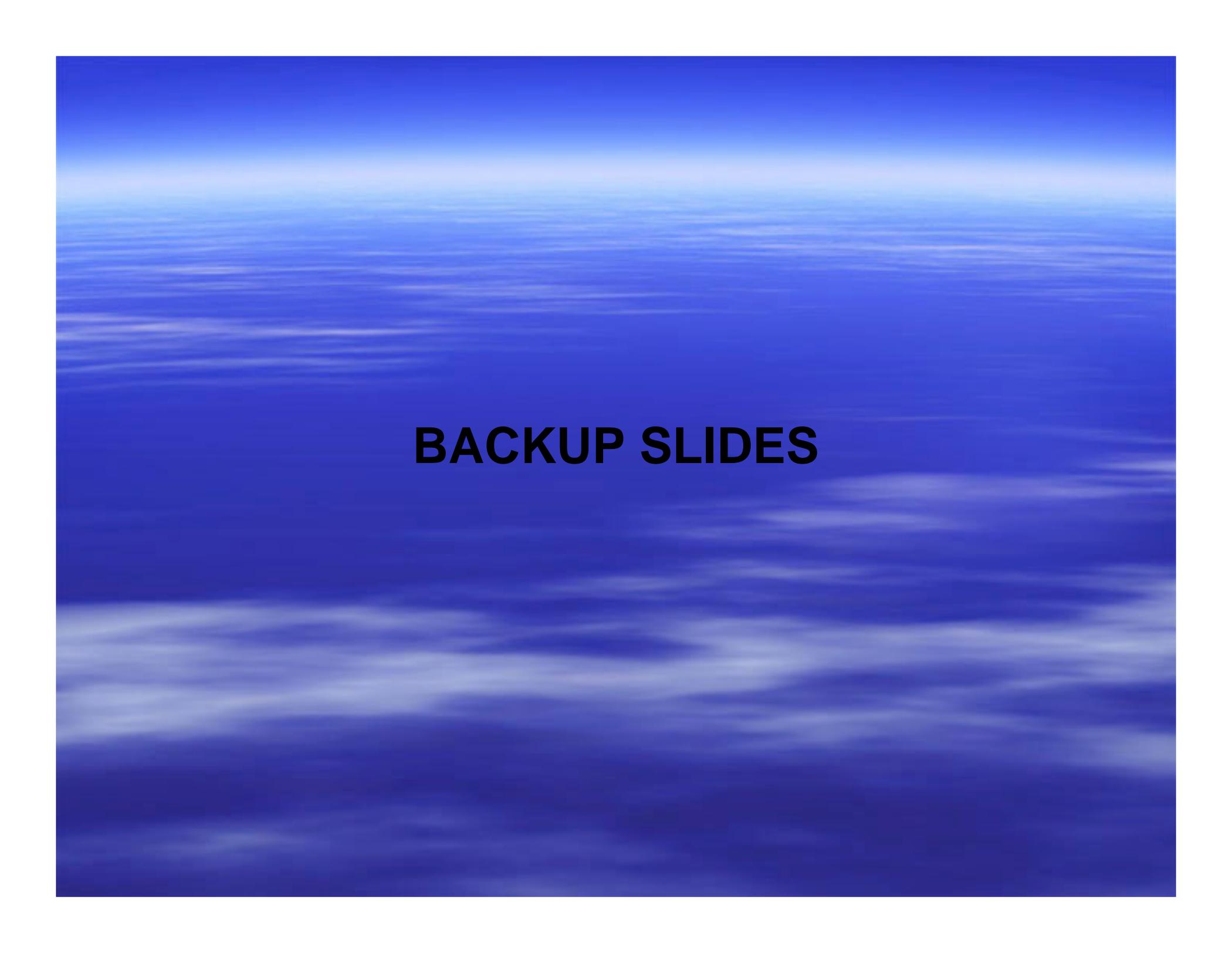


Zonal wind (shaded)
Temperature (solid line)

The NCEP Analyses confirm a tropical feature, still quite asymmetric but well-defined, that the NHC names TS Helene at 00z 14 September.

Conclusions

- The GEOS-5 has revealed very good potential to represent the dynamics of the African Monsoon region and the tropical Atlantic
- Particularly well-captured were the early phases of organizations of waves into smaller vortices
- Intensity of well-developed systems was still under-represented
- GEOS-5 may prove an excellent tool to perform research on NAMMA and to help understanding of tropical cyclogenesis

The background is a solid blue gradient with a subtle, horizontal wave-like pattern. The color transitions from a lighter blue at the top to a darker blue at the bottom. The text is centered in the middle of the image.

BACKUP SLIDES

The Approach....

- **Employ global (GEOS-5) and regional (WRF) modeling systems**
- **Conduct data assimilation using GSI (the next generation NCEP operational system) with GEOS-5**
- **Satellite DA and model assessment/evaluation using multiple satellite missions (AIRS, MODIS, AMSU, TRMM, CloudSat/CALIPSO)**
- **Conduct global assimilation and simulations on a daily basis during the 2006 hurricane season --- statistically significant assessment of performance**
- **Run regional WRF on demand with GEOS-5 initial and lateral boundary data**
- **Enabled by NASA High End Computing**