

The Impact of GOES Rapid-Scan Atmospheric Motion Vectors (AMVs) on Global Numerical Weather Prediction Model Forecasts

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What are RS-AMVs?

- Vectors derived by tracking cloud targets in successive rapid-scan satellite imagery (usually 1 to 7.5 minutes apart)
- Tracked cloud targets are more coherent between shorter time interval images
- More targets at higher resolution pass automated quality control
- Better able to capture mesoscale features (see poster by Bedka et al.)
- Statistically, better quality than routine AMVs (if solid satellite image registration is available)
- Crucial parameters: accurate image-to-image registration, vector height assignment, and quality control
- Further Details: Velden *et al.*, BAMS 2005



RS-AMVs have not been thoroughly tested

- ***Challenge:***

- ***How to optimize the assimilation of this high-density data (often regional) into a global prediction System***

- ***How do deal with higher correlated errors?***



TROPEX

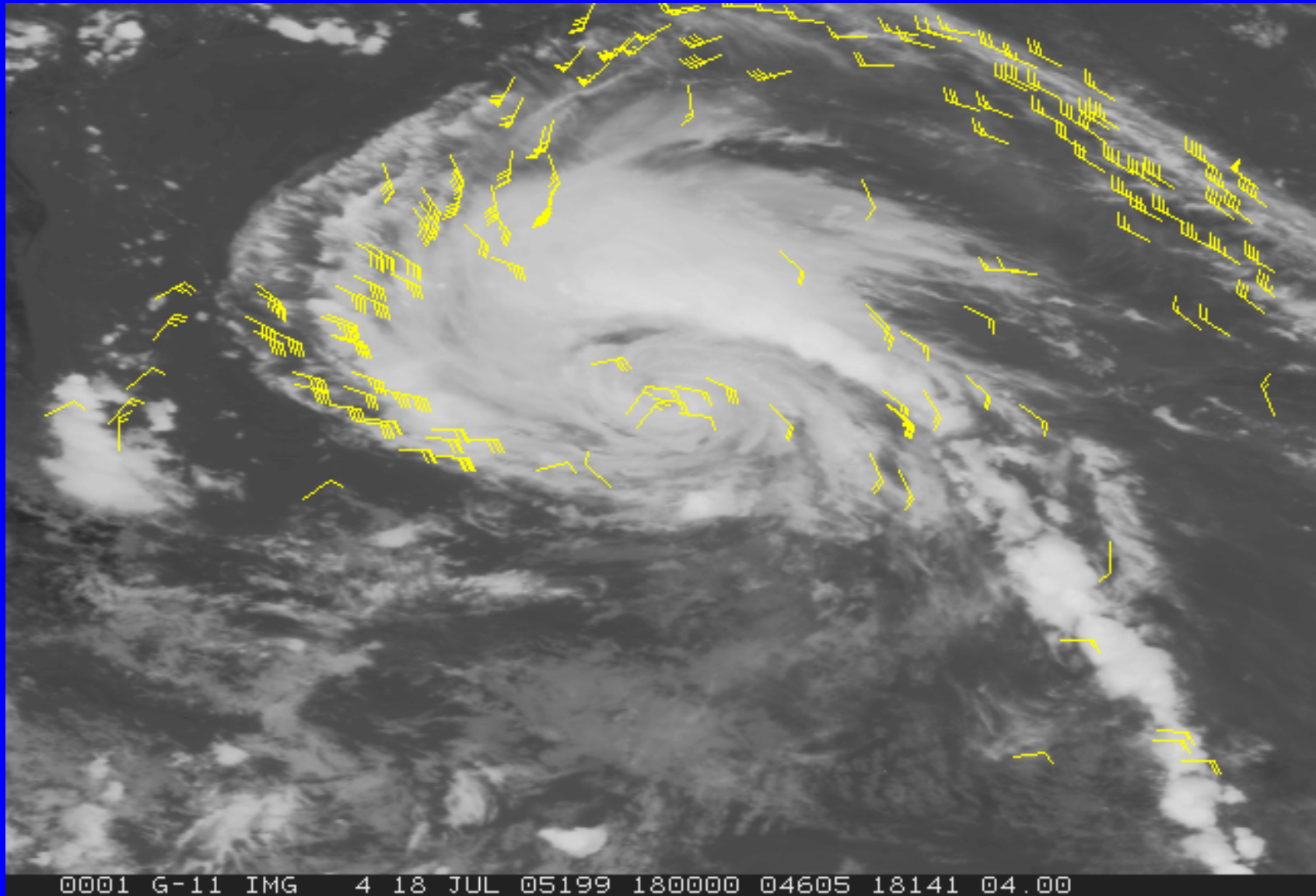
(TROpical cyclone Predictability EXperiments)

<http://cimss.ssec.wisc.edu/tropic/tropex/>

- Collaboration between UW-CIMSS (data providers) and the Naval Research Laboratory - MRY (data assimilators)
- Objective: Employ RS-AMV datasets with the NOGAPS (global model) in data impact and targeting experiments to assess impacts on Tropical Cyclone track and intensity forecasts
- Data: Special GOES RS-AMV datasets collected during the Atlantic hurricane season in 2005 and 2006

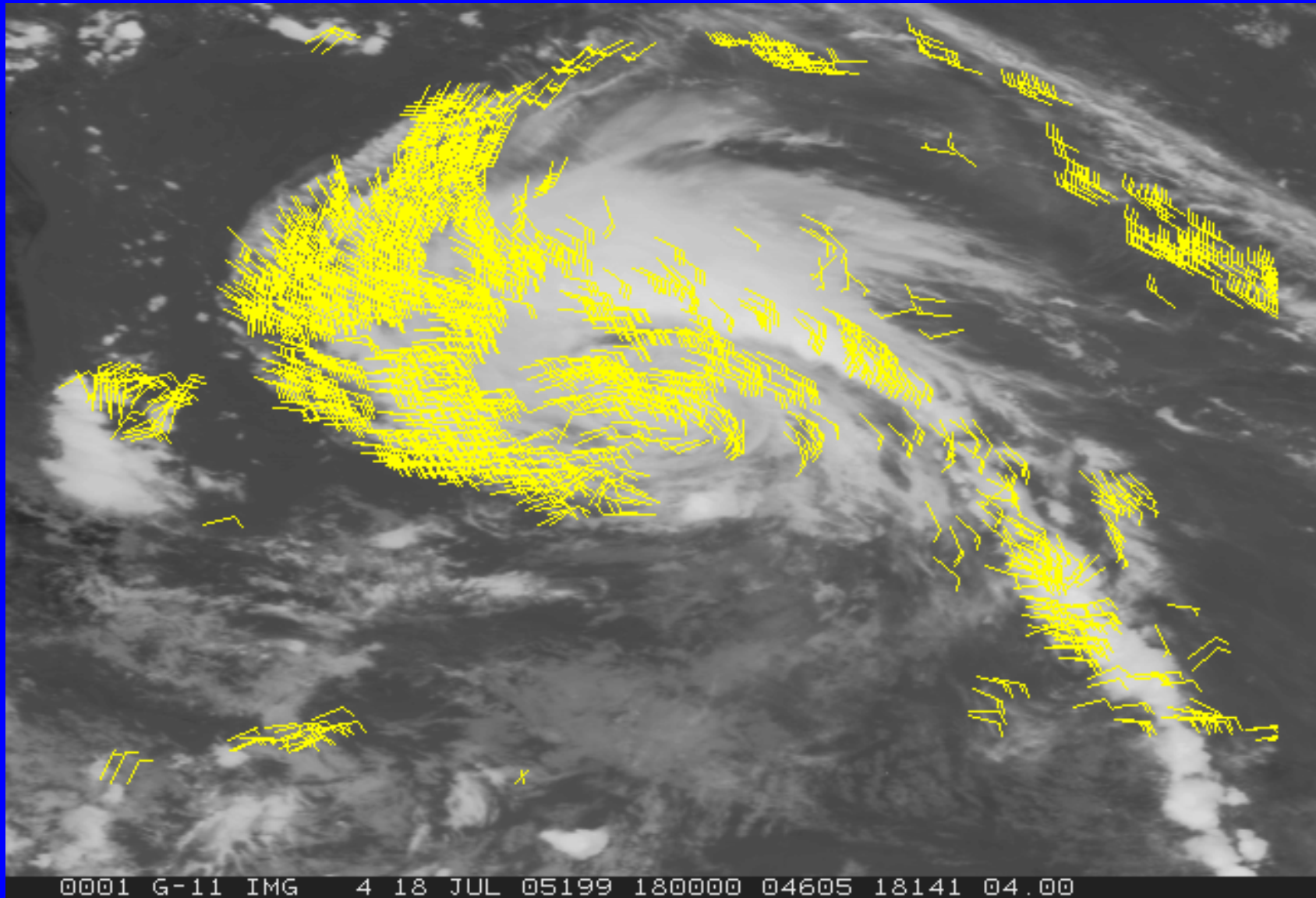


GOES-11 IR Imagery and derived 150 - 200 hPa AMVs. Valid 18UTC July 18th, 2005



GOES-11 IR Imagery and derived 150 - 200 hPa AMVs.

Valid 18UTC July 18th, 2005



NWP Trial – NOGAPS Data Assimilation Experiment

First Results

Collaborator: Rolf Langland (NRL-MRY)

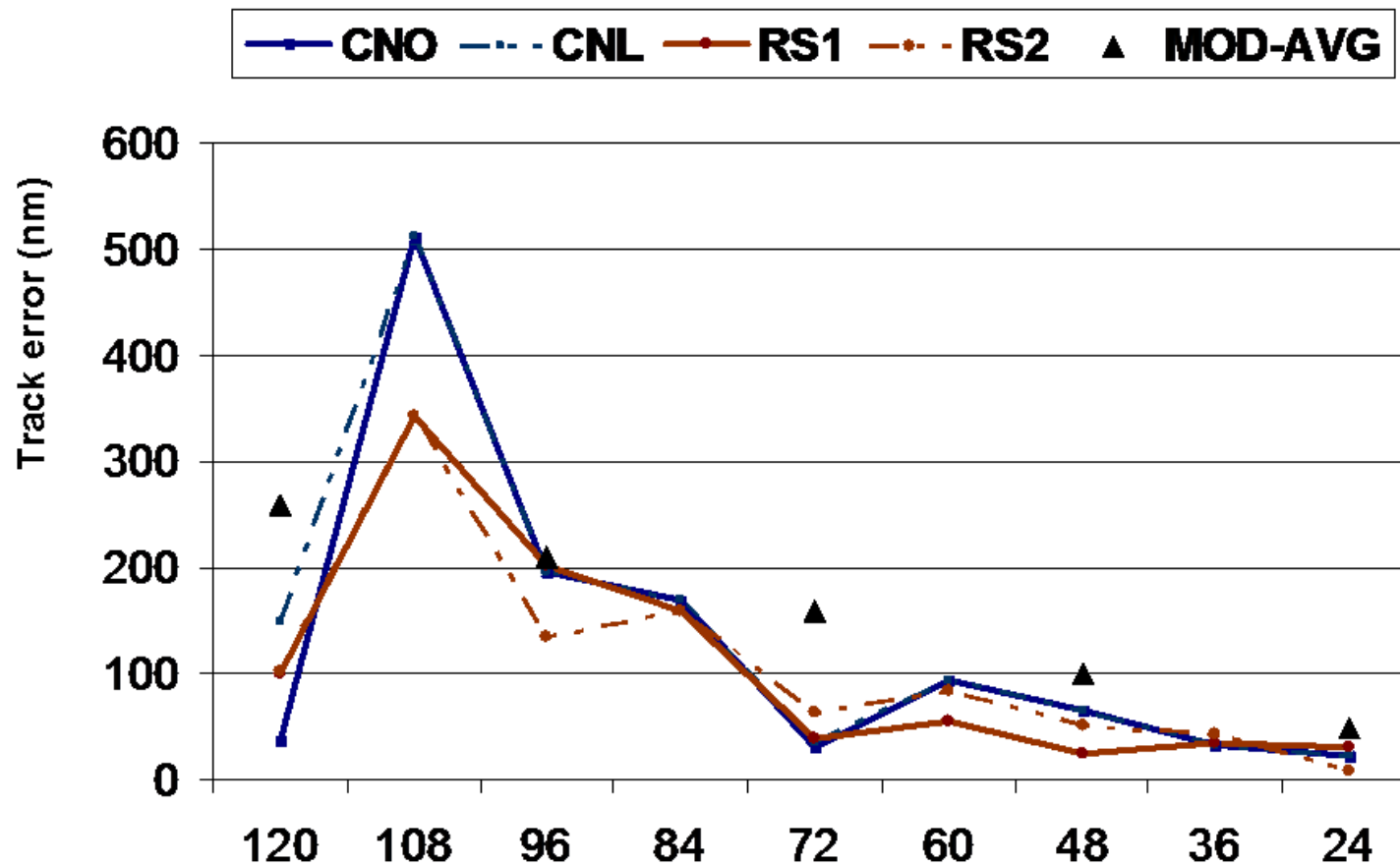


Experiment Summary

- NRL 3D-VAR data assimilation scheme
- 'Super-obs' of the AMVs are created
- CNO: Operational AMVs over ocean only (control)
- CNL: Operational AMVs over land and ocean
- RS1: CNO + GOES limited-area RS-AMVs valid just at model initialization time
- RS2: CNO + RS-AMVs valid between +/- 3 hours of analysis time



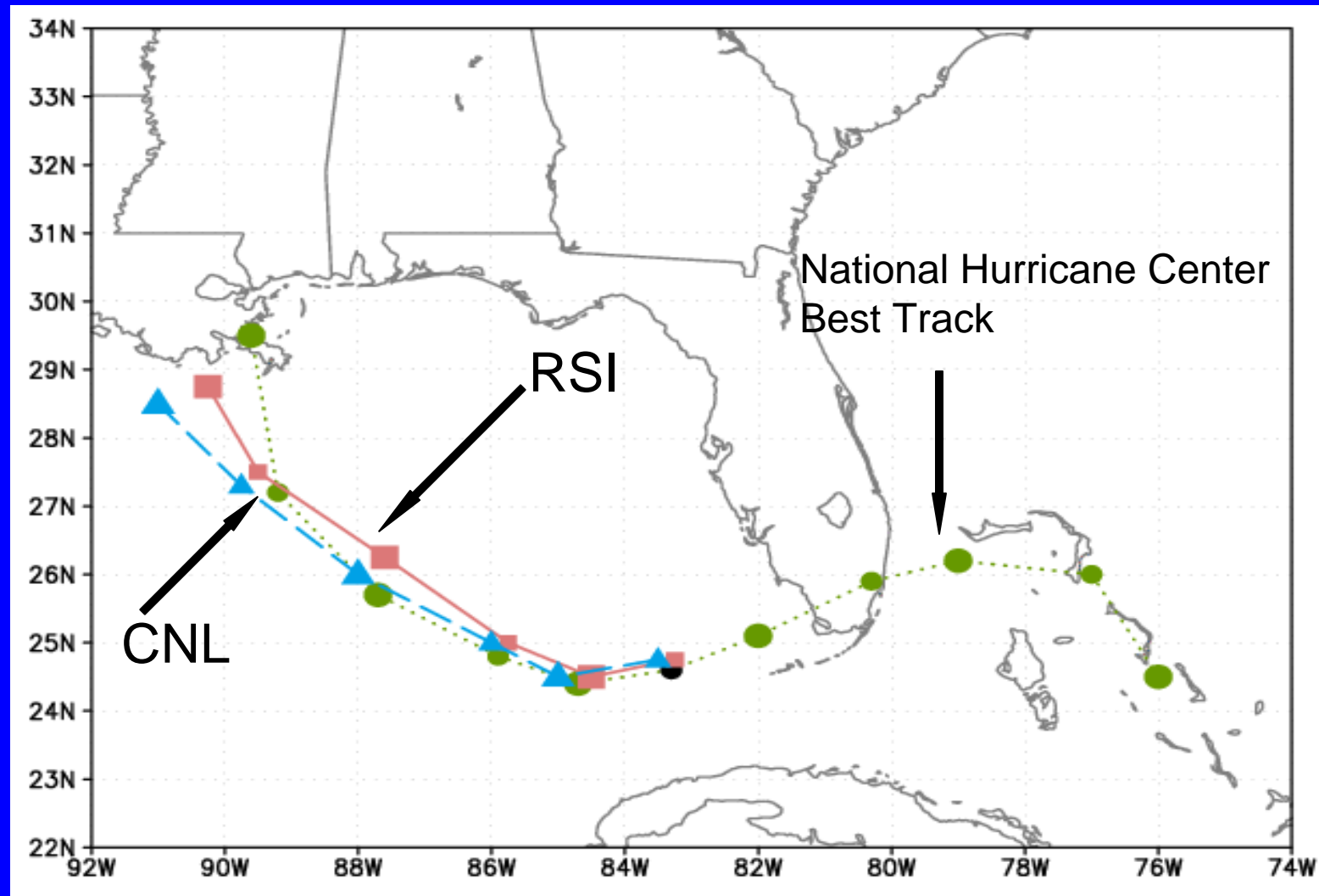
Distance error (nm) in NOGAPS prediction of the 120-hr Hurricane Katrina (2005) landfall forecast



(MOD-AVG) is the NOGAPS model average tropical cyclone track error for the North Atlantic for all 2005 cases.



48-hr NOGAPS forecasts of Hurricane Katrina landfall



NWP Trial – NCEP GFS Data Assimilation Experiment

Preliminary Results

- T126 28-Levels
- GFS and assimilation (SSI) run for three months (July 28th - October 28th, 2005)
- ‘CNTRL’: All operational observations assimilated
- ‘NO-AMV’ experiment: All operational GOES AMVs removed
- ‘Rapid-Scan’: TROPEX GOES RS-AMVs assimilated;
Operational GOES AMVs removed from coincident region



Atlantic Tropical Cyclone Track Impact: forecast errors (km)

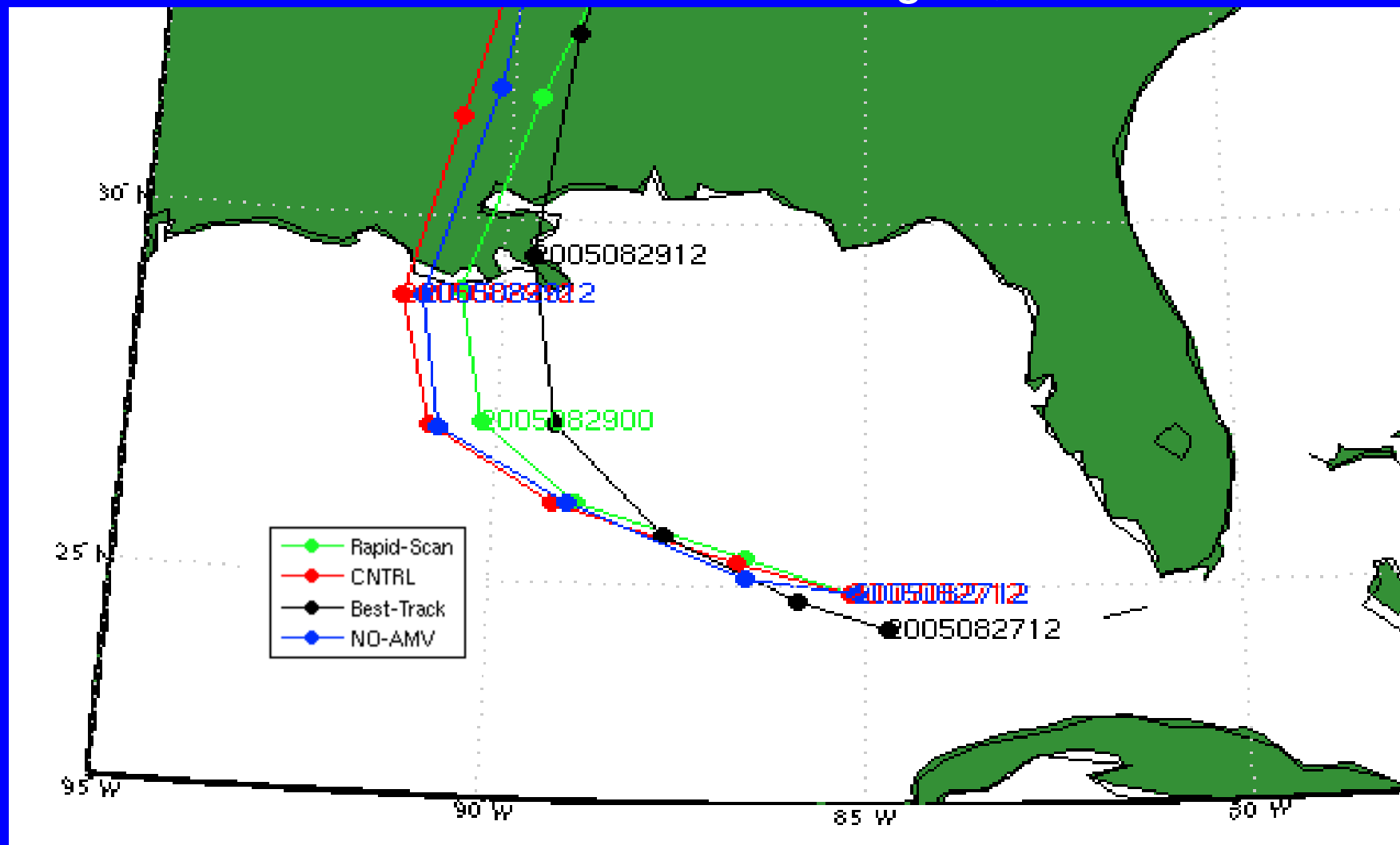
Forecast Time (hrs)	12	24	36	48	60	72	84	96	108	120
NO-AMV (km)	81.5	128.5	168.5	197.2	234.7	299.3	347.9	388.3	463.1	562.1
CNTRL (km)	76.5	121.5	160.3	192.0	230.8	273.4	311.0	342.5	383.5	430.0
Rapid-Scan (km)	79.4	126.3	166.8	193.9	239.7	296.2	329.3	356.7	413.9	433.2
Number of Cases	75	72	66	61	55	51	47	43	37	30

Numbers in red statistically different from control at 95%



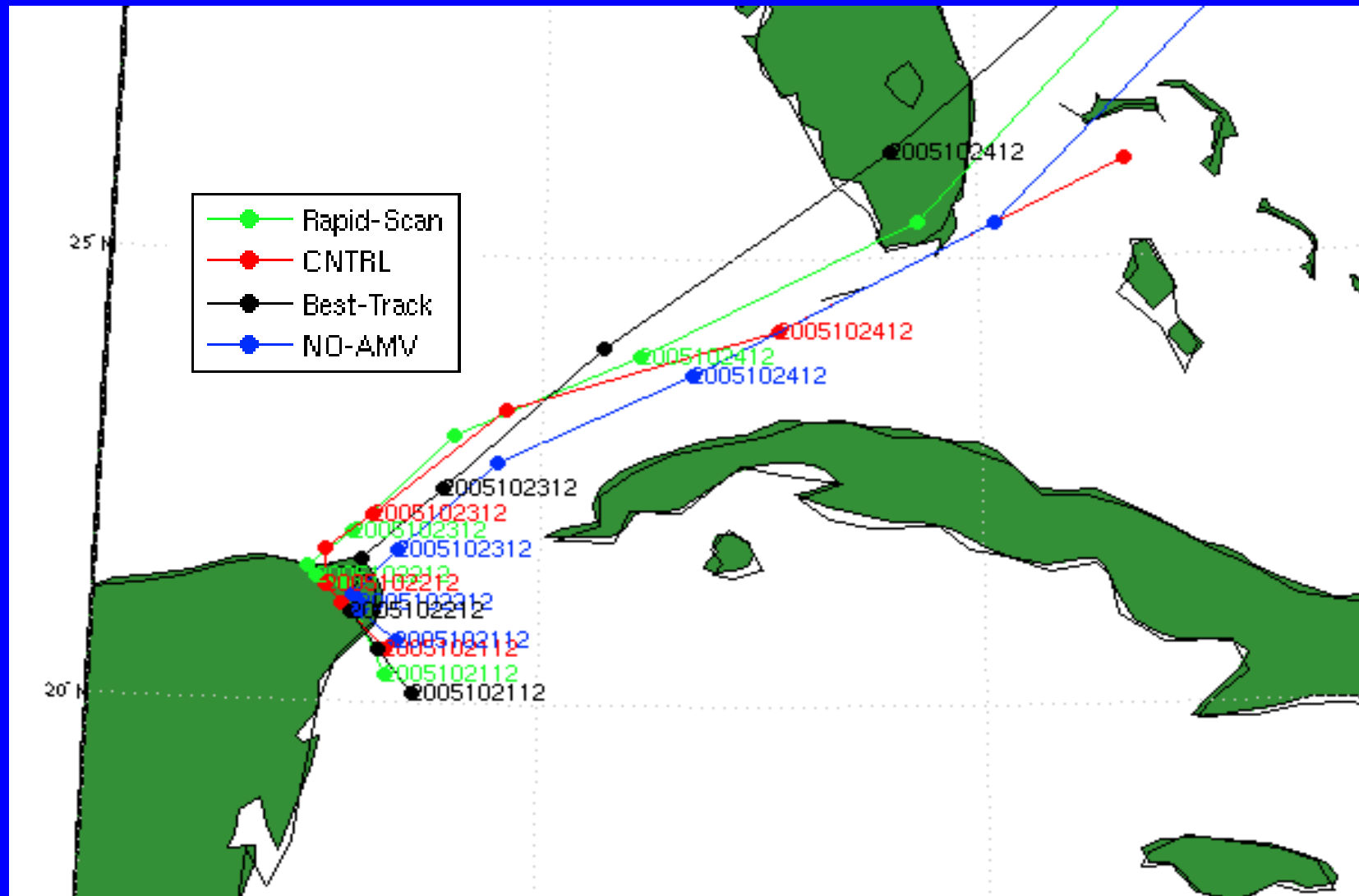
Hurricane Katrina GFS Forecasts

Initialized: 00 UTC 27 August, 2005

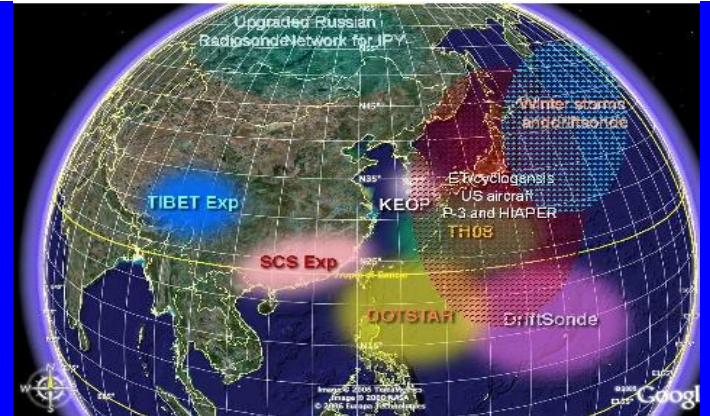


Hurricane Wilma GFS Forecasts

Initialized: 00 UTC 21 October, 2005



Future Experiment:



THORPEX Pacific Asian Regional Campaign (T-PARC 2008)

As part of the T-PARC field campaign in Aug/Sept of 2008 over the western North Pacific, CIMSS will collaborate with NRL and the University of Miami to provide RS-AMVs from the Japanese MTSAT, and design targeted data impact experiments to improve the prediction of tropical cyclone formation, intensity change and extratropical transition in the western North Pacific.



Preliminary Findings

- Rapid-Scan AMVs provide high temporal and spatial resolution data.
- This data significantly improved the landfall forecast of Hurricane Katrina in the US Navy's NOGAPS model.
- While operational AMVs significantly improve tropical cyclone track forecasts in NCEP's GFS model, the RS-AMVS had neutral impact.
- Future experiments such as T-PARC will allow additional opportunities for continued understanding of the optimal assimilation of these data in order to maximize positive impact on numerical weather prediction, e.g:

Will 4DVAR-type schemes take fuller advantage of the RS-AMV data?

Can improved AMV quality indicators provide superior data selection?

Impact of model resolution on results?

Can we better specify and account for the correlated errors?



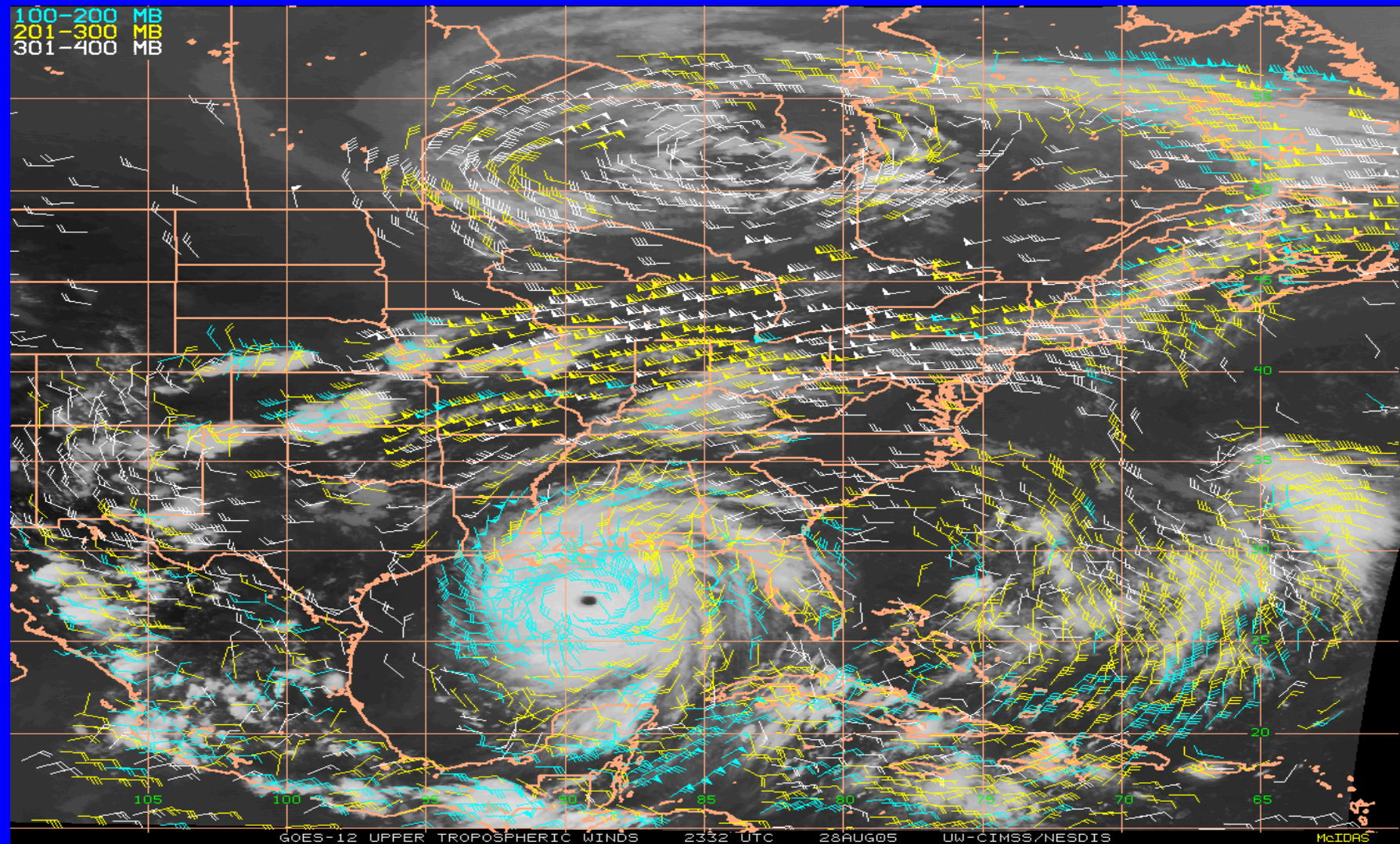
Thank You!



Example TROPEX RS-AMV Coverage:

Upper-Level GOES RS-AMVs

Hurricane Emily: valid 00Z August 29th, 2005



Outline

- Background: Rapid-Scan Atmospheric Motion Vectors (RS-AMVs)
- NWP Trials:
 - 1) U.S. Naval Research Lab NOGAPS Data Impact Experiment
 - 2) NCEP GFS Data Impact Experiment
- Conclusions/Future Directions

