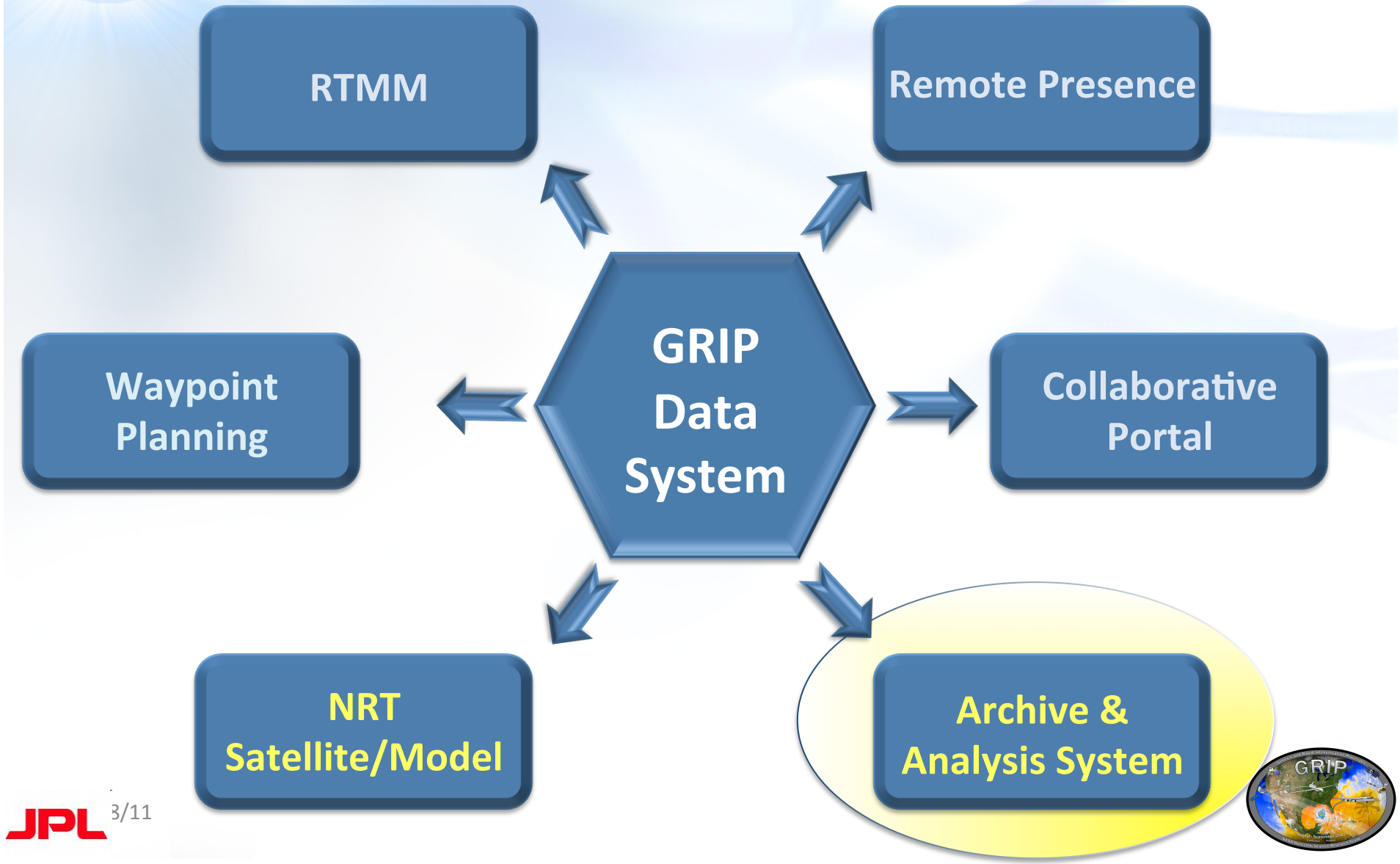
The JPL Tropical Cyclone Information System - a satellite database and analysis tools to study hurricanes

S. Hristova-Veleva, P. P. Li , F. J. Turk, B. Knosp , Q. Vu
B. Lambrigtsen, Y. Chao, Z. Haddad, D. Vane,
H. Su, S. Tanelli

M. Goodman, H. Conover (and team)

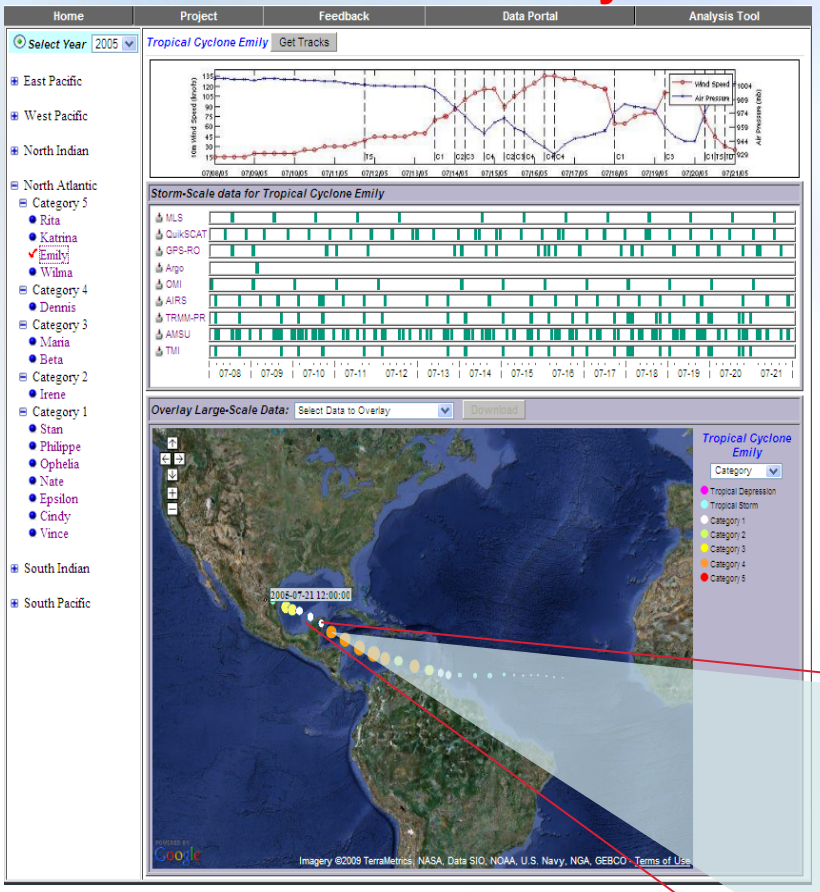
June 9, 2011

Joint NASA JPL and MSFC Project



Tropical Cyclone – Integrated Data Exchange and Analysis System (TC-IDEAS)

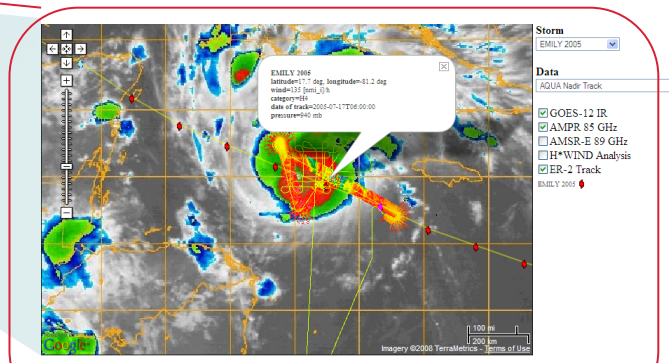
Joint NASA Jet Propulsion Lab and Marshall Space Flight Center Project
Funded by the Hurricane Science Research Program



Select by basin, name, or category with corresponding data availability timelines

Objective: To facilitate fusion of multi-parameter hurricane observations (satellite, airborne and *in-situ*) and model simulations with the purpose of:

- **supporting both research and field campaigns (incorporating RTMM)**
- **understanding the physical processes**
- **improving hurricane forecast by facilitating model validation and data assimilation**
- **enabling the development of new algorithms, sensors and missions.**



ER-2 /AMPR data over GOES IR

RTMM

TC-IDEAS –

Historical database and analysis

http://tropicalcyclone.jpl.nasa.gov

- **Data Portal**
  - **Data organized by year, basin, storm**
  - **DATA and imagery**
  - **A wider variety of data types (MLS, OMI, ARGO floats, Ocean Heat Potential, Multi-frequency brightness temperatures, full set of radar observations, retrieved precipitation parameters, Aerosol Optical Depth)**
- **Analysis System**
  - Will communicate with satellite and airborne data
  - Space and time sub-sectioning and aggregation
  - Stability, Skew-T, EOFs, WRF simulations, instrument simulators

2 main components
In the current
JPL TCIS

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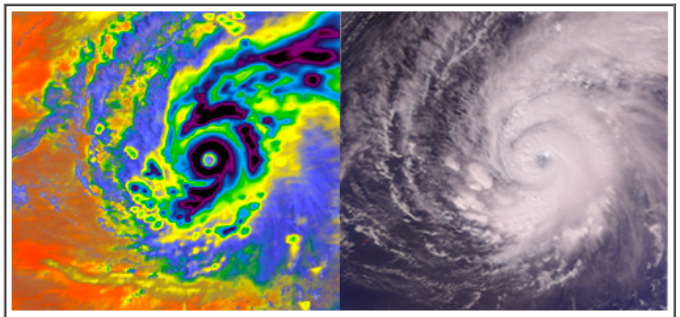
Welcome to the JPL Tropical Cyclone Information System

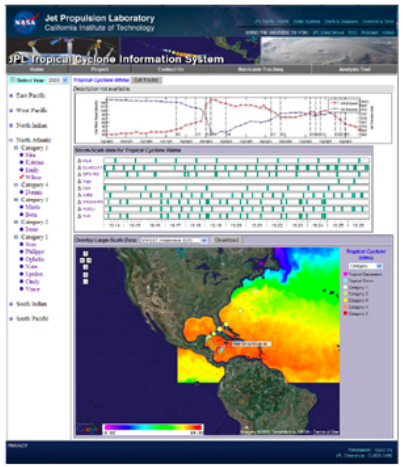
The JPL Tropical Cyclone Information System (TCIS) brings together satellite and in situ data sets from various sources to help you find information for a particular tropical cyclone over the world ocean. Currently, we have populated the entire 2005 and we will add data from other years in the future. We hope that you will find our analysis tools useful for your studies to improve hurricane models and plan future satellite missions with a particular focus on tropical cyclones.



Supertyphoon Pongsona struck the U.S. Island of Guam on Sunday, December 8, 2002. The composite image (left) of the supertyphoon was made by overlaying data from the infrared, microwave, and visible/near-infrared sensors that make up the AIRS sounding system. This storm can also be seen with the standard AIRS Vis/NIR (right).

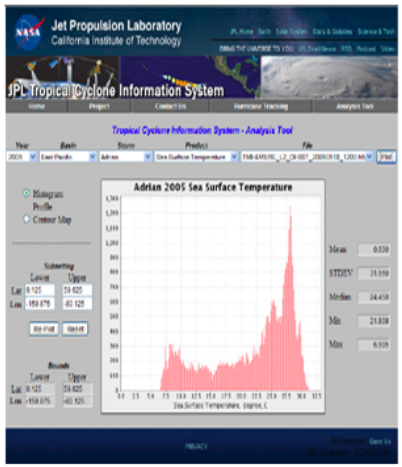
Tropical Cyclone Data Portal

Here you can search for specific storms in 2005 and directly access data and plots associated with that storm.



Data Analysis Tool

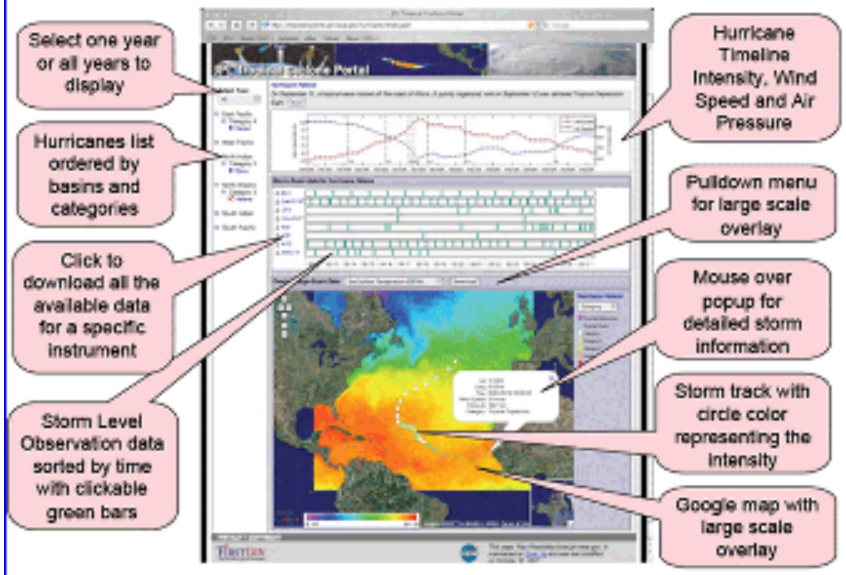
This tool will let you analyze data associated with a storm. You can plot histograms, maps, and profiles for many different data sets and products.



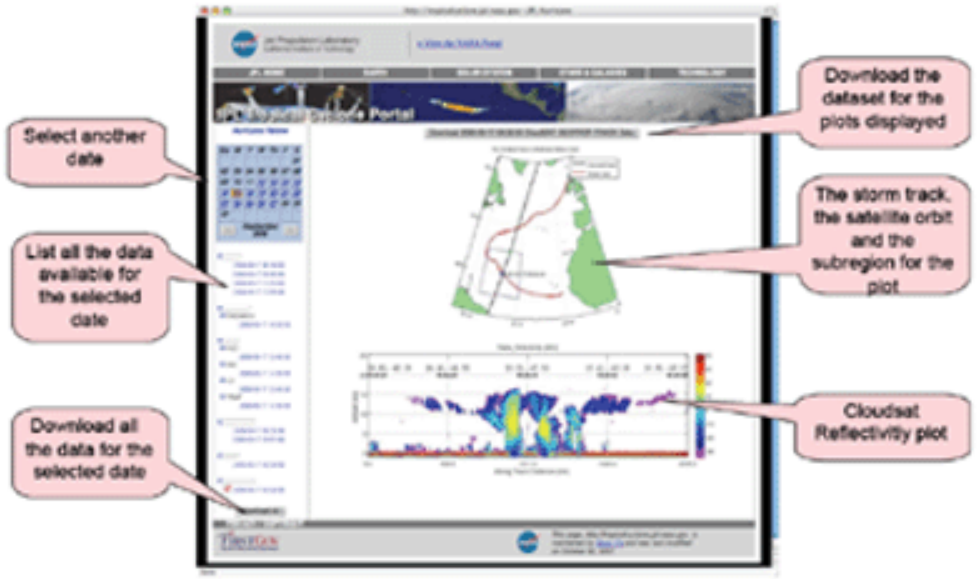
PRIVACY

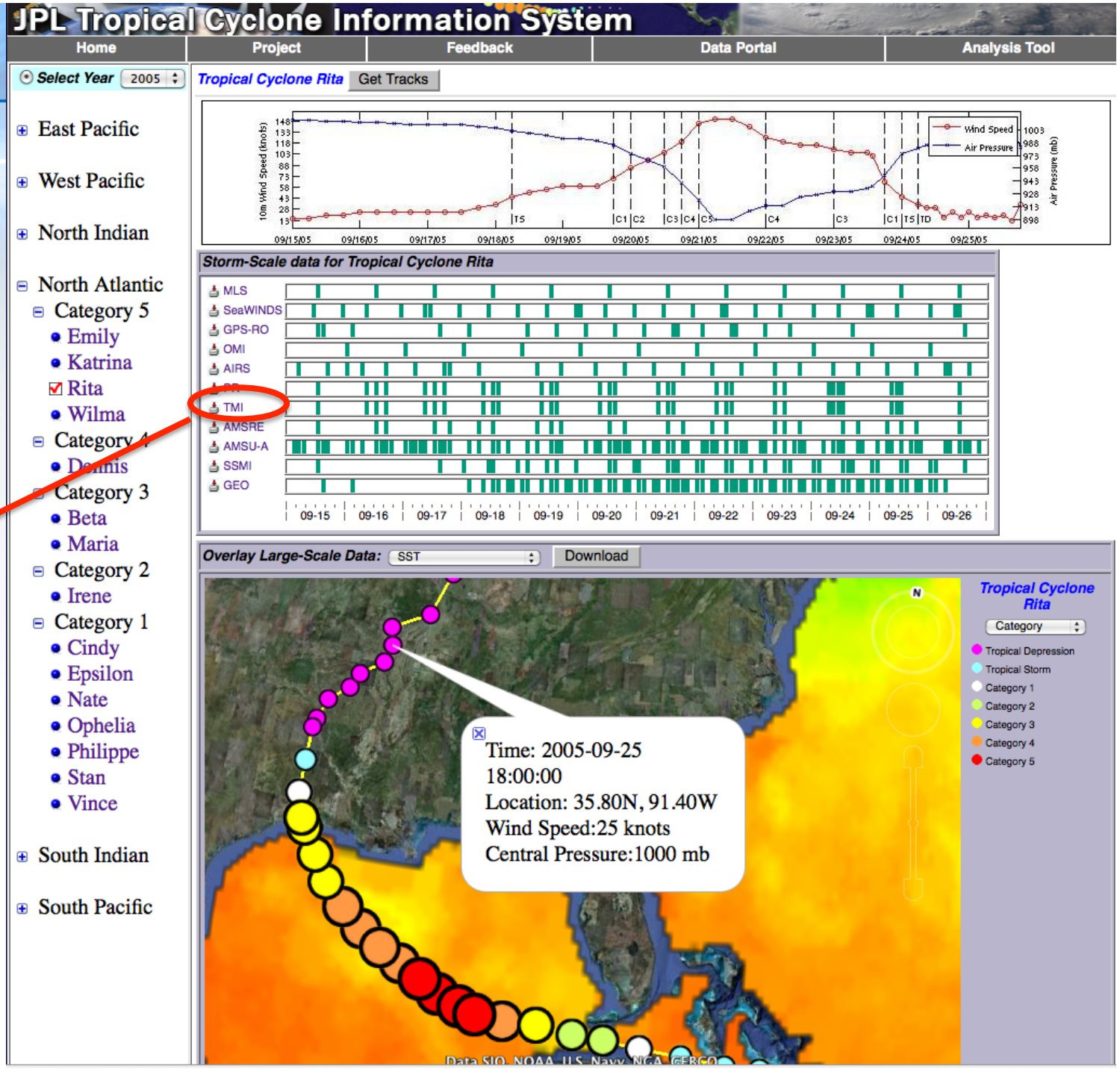
Webmaster: Quoc Vu
JPL Clearance: CL#08-3490

The Portal Main Page

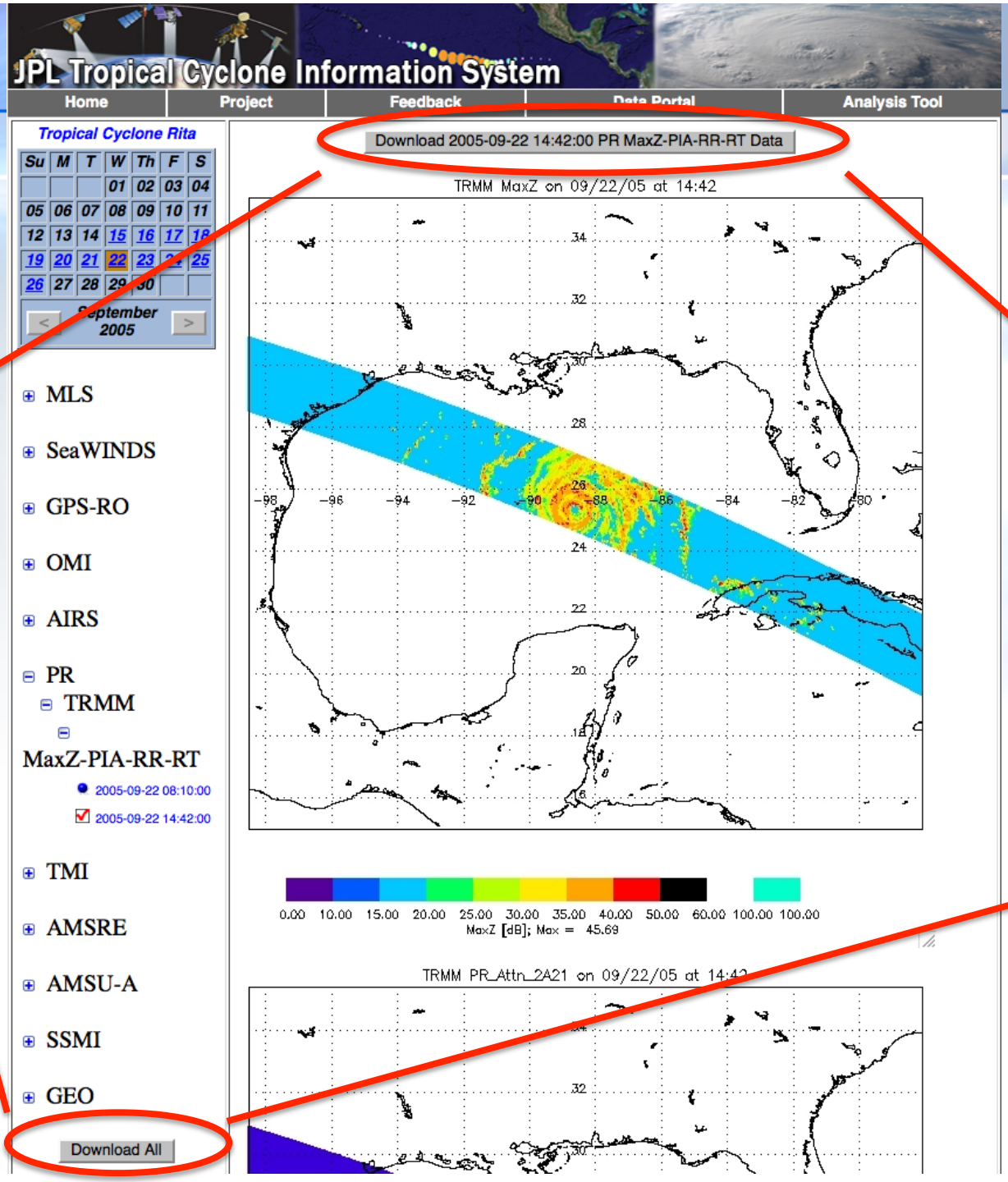


The Storm-level Data Page





Download all data from this instrument



Download NetCDF

At this time

All data on this day

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Tropical Cyclone Rita

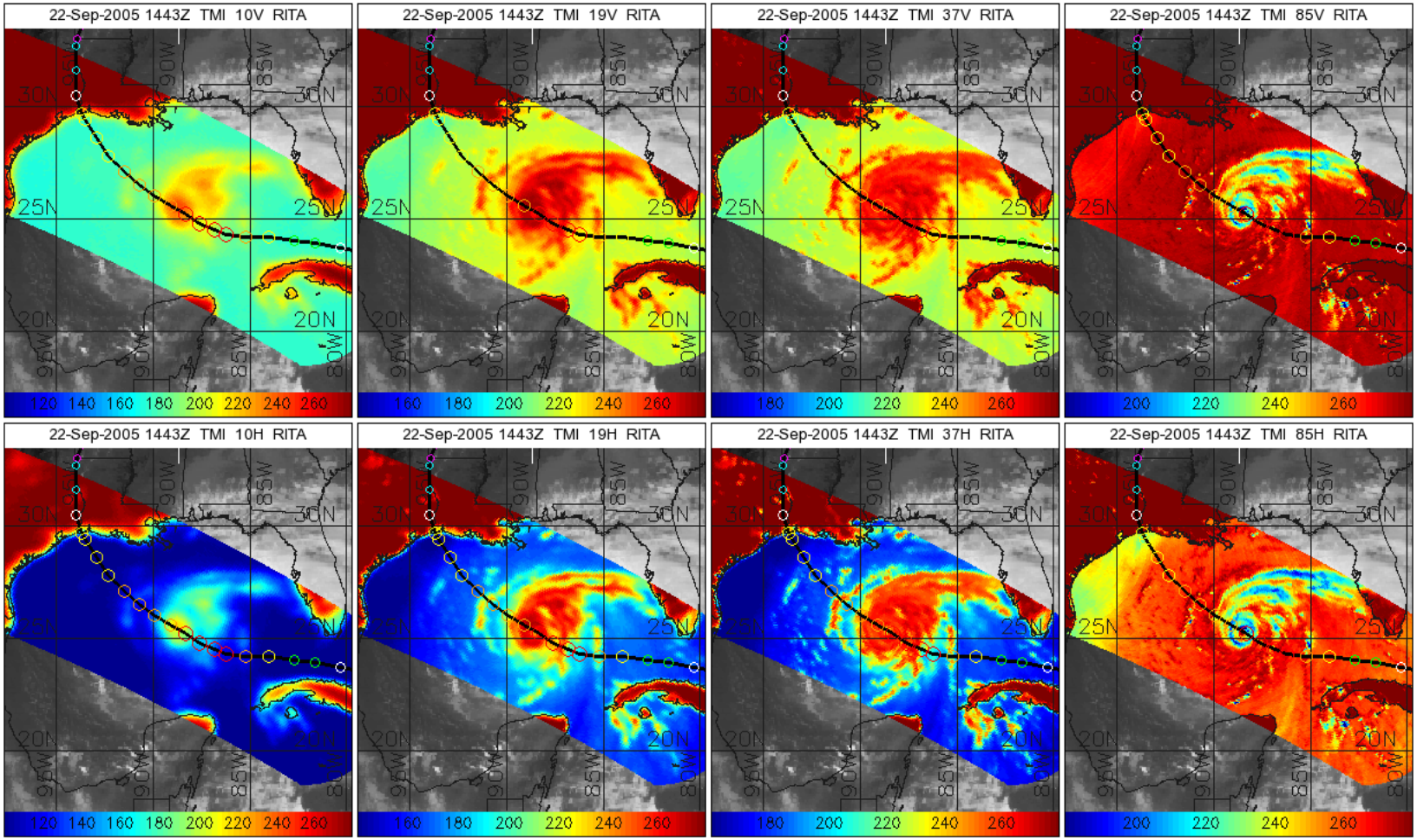
Su	M	T	W	Th	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

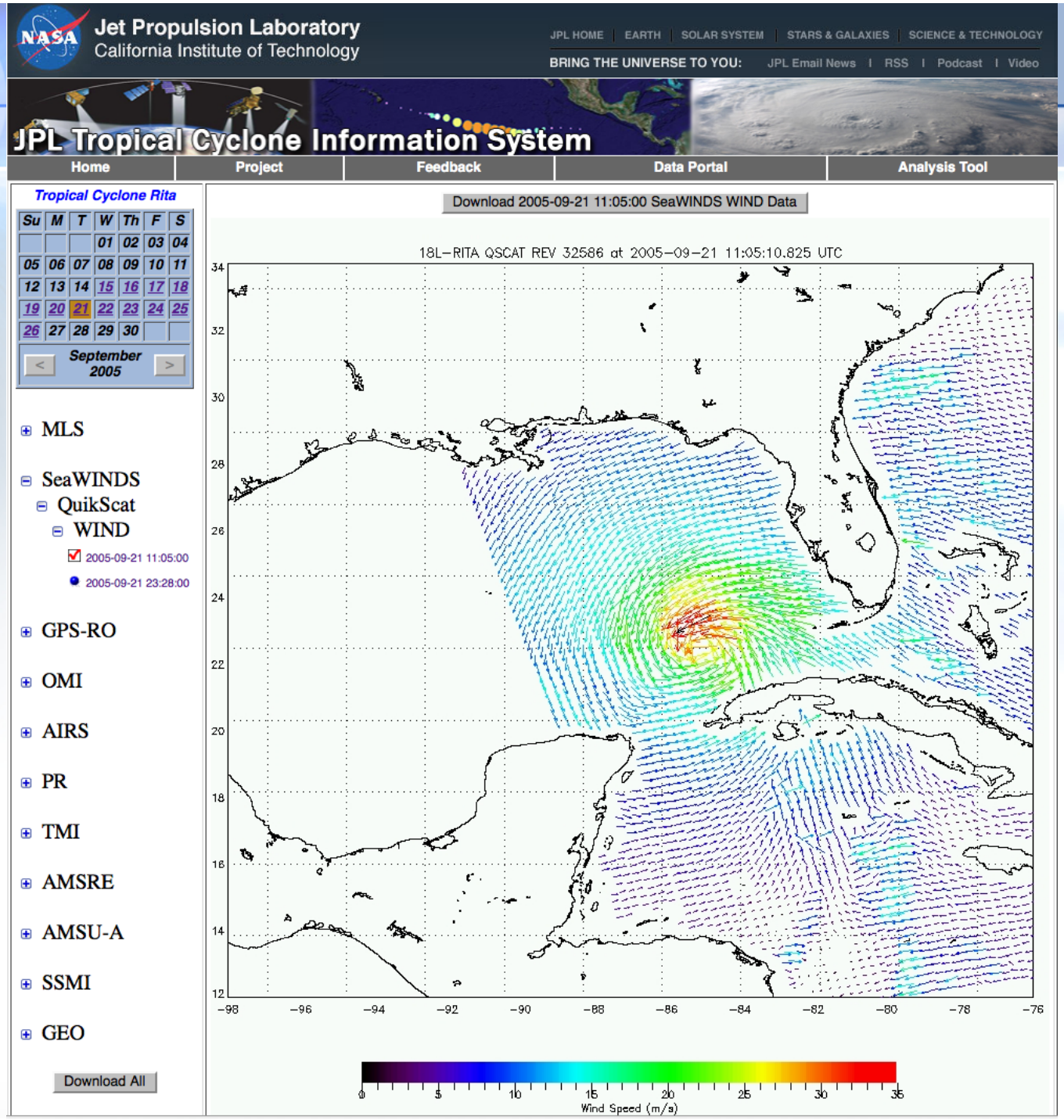
< September 2005 >

- MLS
- SeaWINDS
- GPS-RO
- OMI
- AIRS
- PR
- TMI
  - TRMM
    - BRIGHTNESS
      - 2005-09-22 08:11:00
      - 2005-09-22 14:43:00
    - RR
- AMSRE
- AMSU-A
- SSMI
- GEO

Download All

Download 2005-09-22 14:43:00 TMI BRIGHTNESS Data

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Tropical Cyclone Rita
Su M T W Th F S
September 2005
MLS
SeaWINDS
QuikScat
WIND
2005-09-21 11:05:00
2005-09-21 23:28:00
GPS-RO
OMI
AIRS
PR
TMI
AMSRE
AMSU-A
SSMI
GEO
Download All
Download 2005-09-21 11:05:00 SeaWINDS WIND Data
18L-RITA QSCAT REV 32586 at 2005-09-21 11:05:10.825 UTC
Wind Speed (m/s)

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Tropical Cyclone Rita

Su	M	T	W	Th	F	S
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12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

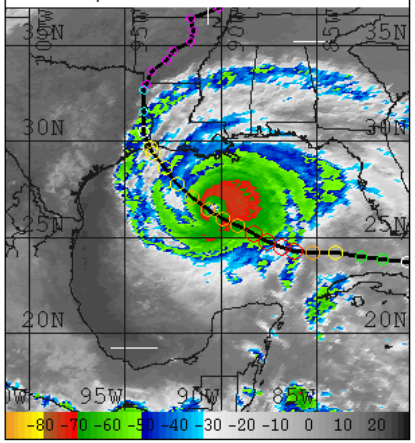
< September 2005 >

- MLS
- SeaWINDS
- GPS-RO
- OMI
- AIRS
- PR
- TMI
- AMSRE
- AMSU-A
- SSMI
- GEO
  - GOE12
  - GOE10
    - BRIGHTNESS
      - 2005-09-23 06:00:00

Download All

Download 2005-09-23 06:00:00 GEO BRIGHTNESS Data

23-Sep-2005 0600Z GOE-10 IR RITA



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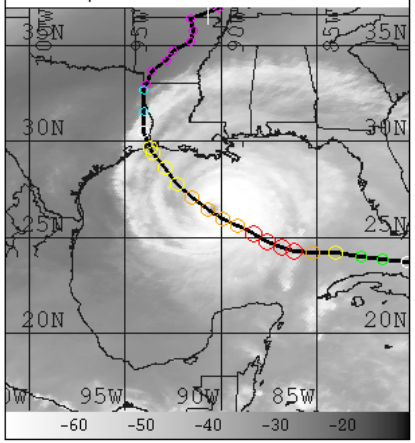
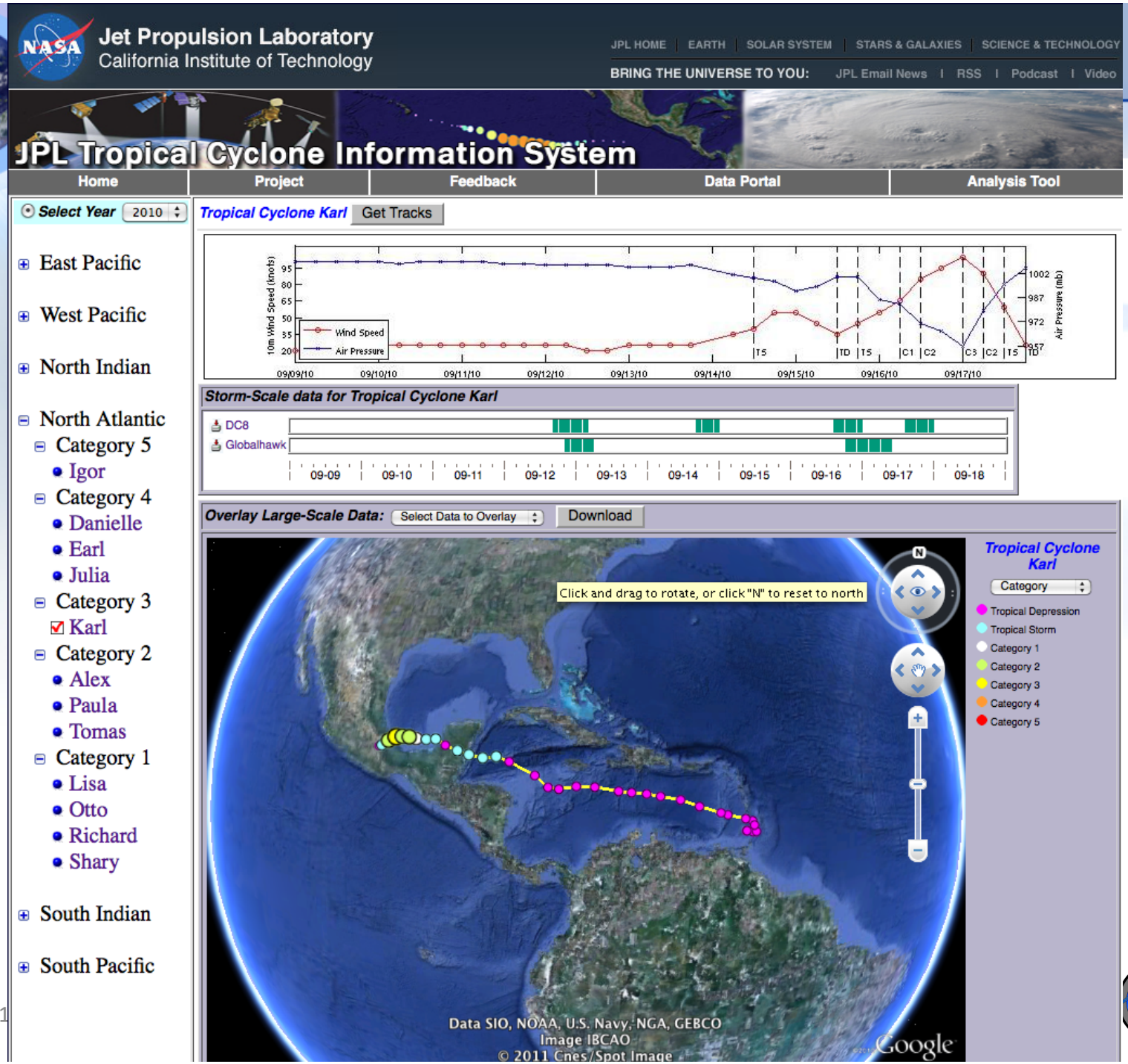


New Features

- The large scale – GE
  - Available
    - SST; TPW; 85 GHz; AIRS (Skew-T)
  - Coming
    - 37 GHz, Rain Indicator, AOT, IR, OHC
    - Model: ECMWF; GFS
- Format - netcdf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West Pacific
North Indian
North Atlantic
Category 5
Igor
Category 4
Danielle
Earl
Julia
Category 3
Karl
Category 2
Alex
Paula
Tomas
Category 1
Lisa
Otto
Richard
Shary
South Indian
South Pacific
Tropical Cyclone Karl
Get Tracks
10m Wind Speed (knots)
Air Pressure (mb)
Wind Speed
Air Pressure
09/09/10
09/10/10
09/11/10
09/12/10
09/13/10
09/14/10
09/15/10
09/16/10
09/17/10
Storm-Scale data for Tropical Cyclone Karl
DC8
Globalhawk
09-09
09-10
09-11
09-12
09-13
09-14
09-15
09-16
09-17
09-18
Overlay Large-Scale Data:
Select Data to Overlay
Download
Click and drag to rotate, or click "N" to reset to north
Tropical Cyclone Karl
Category
Tropical Depression
Tropical Storm
Category 1
Category 2
Category 3
Category 4
Category 5
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image IBCAO
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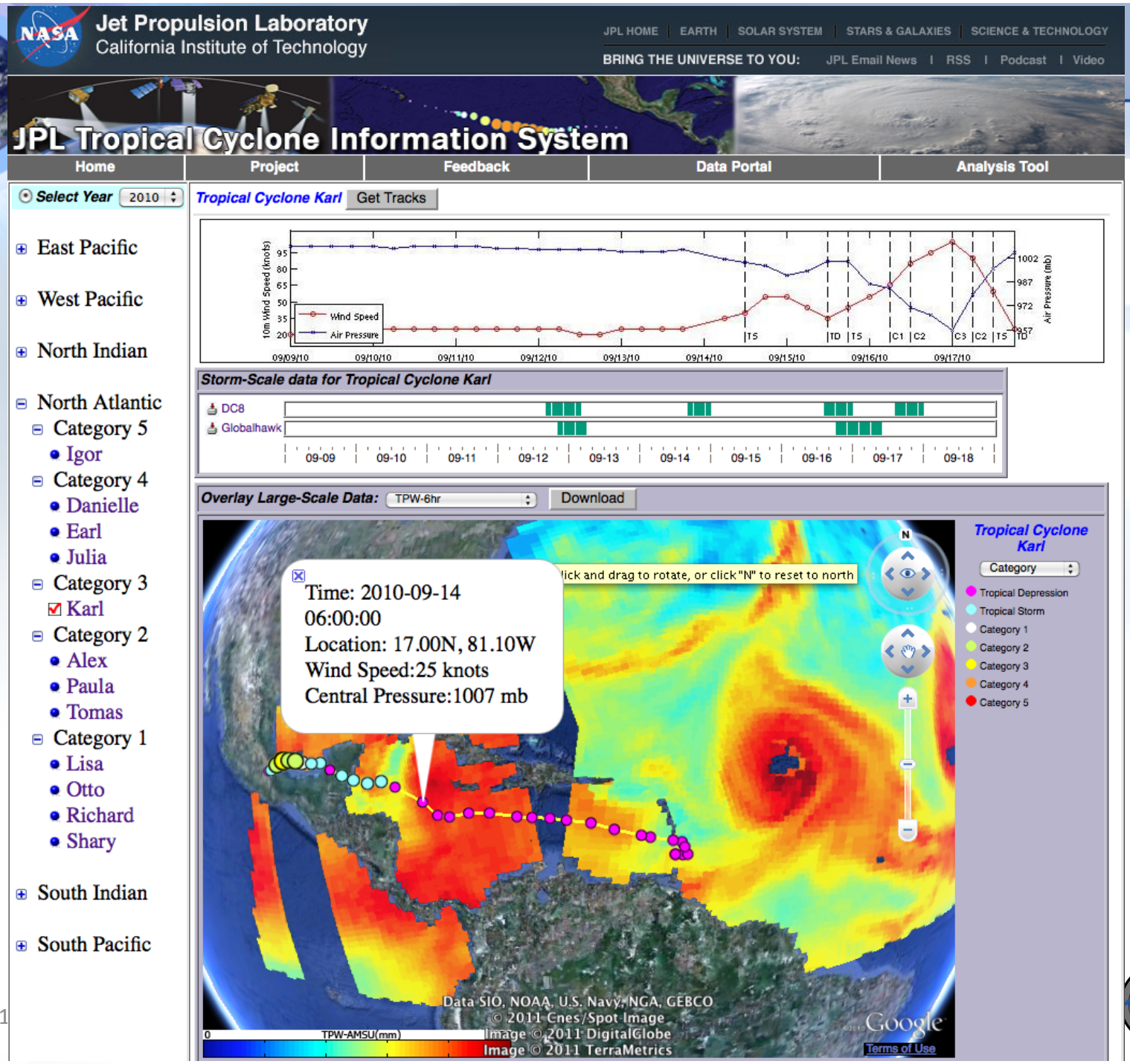
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DC8
Globalhawk
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09-16
09-17
09-18
Overlay Large-Scale Data:
TPW-6hr
Download
Time: 2010-09-14
06:00:00
Location: 17.00N, 81.10W
Wind Speed:25 knots
Central Pressure:1007 mb
Tropical Cyclone Karl
Category
Tropical Depression
Tropical Storm
Category 1
Category 2
Category 3
Category 4
Category 5
TPW-AMSU(mm)
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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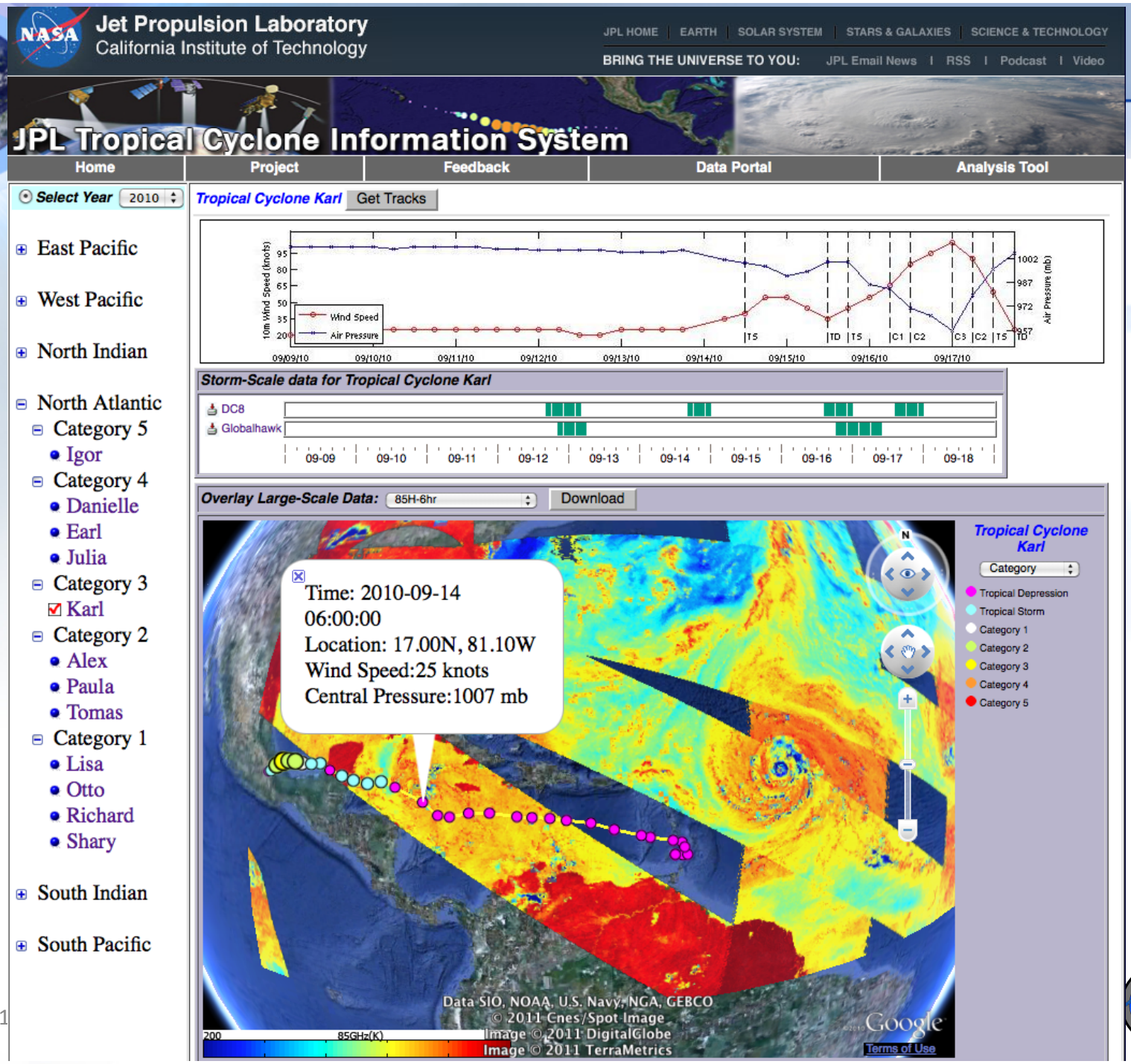
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09/10/10
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Storm-Scale data for Tropical Cyclone Karl
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Overlay Large-Scale Data:
85H-6hr
Download
Time: 2010-09-14
06:00:00
Location: 17.00N, 81.10W
Wind Speed:25 knots
Central Pressure:1007 mb
Tropical Cyclone Karl
Category
Tropical Depression
Tropical Storm
Category 1
Category 2
Category 3
Category 4
Category 5
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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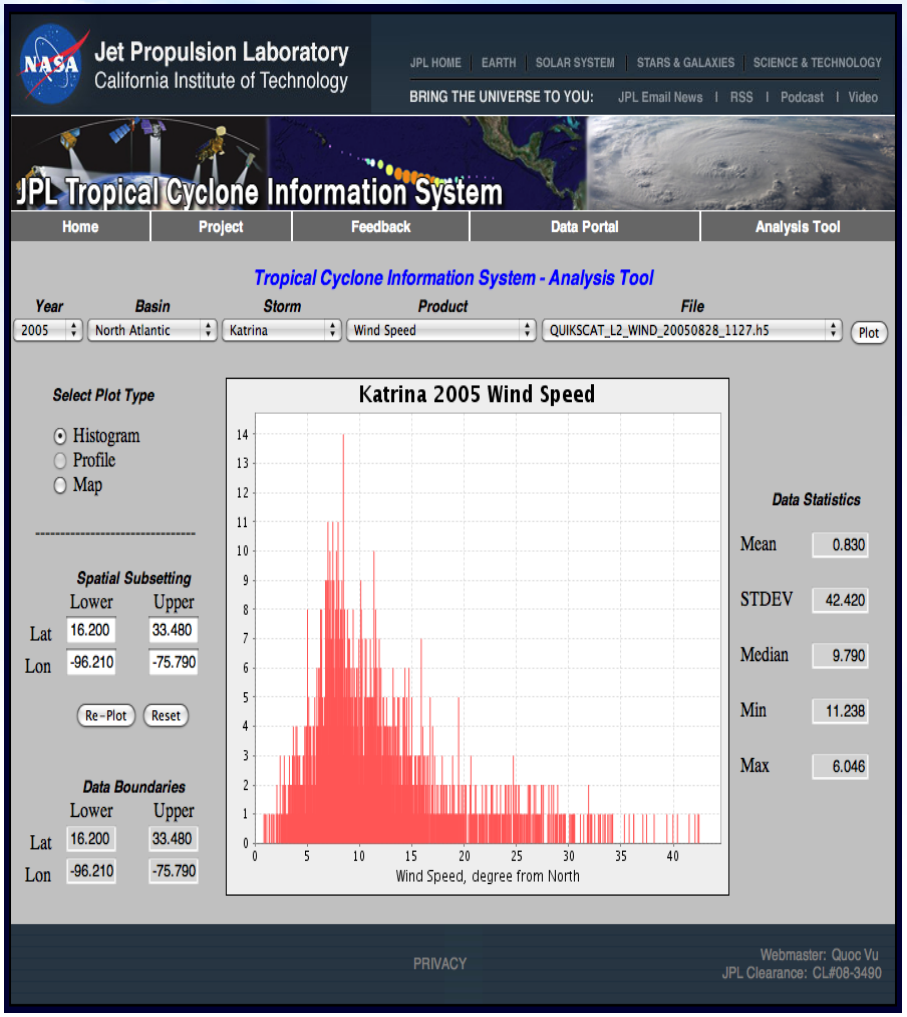
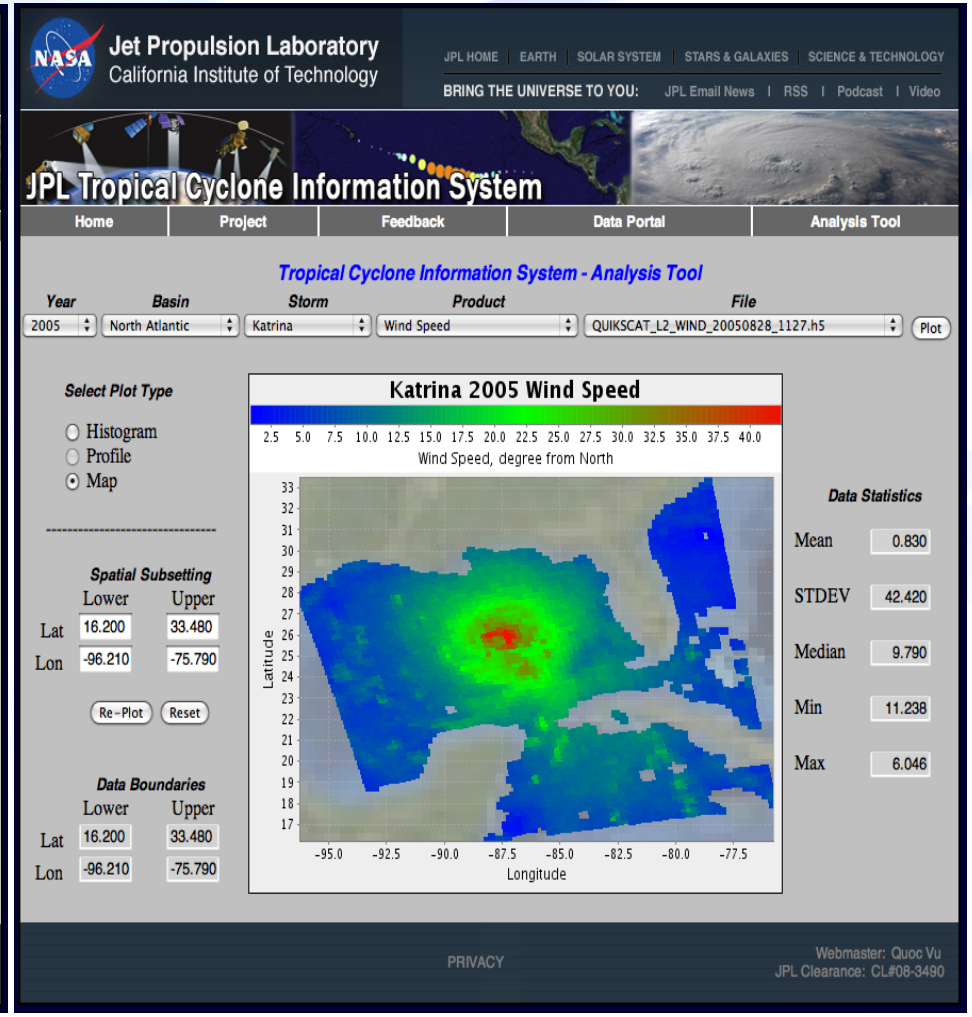
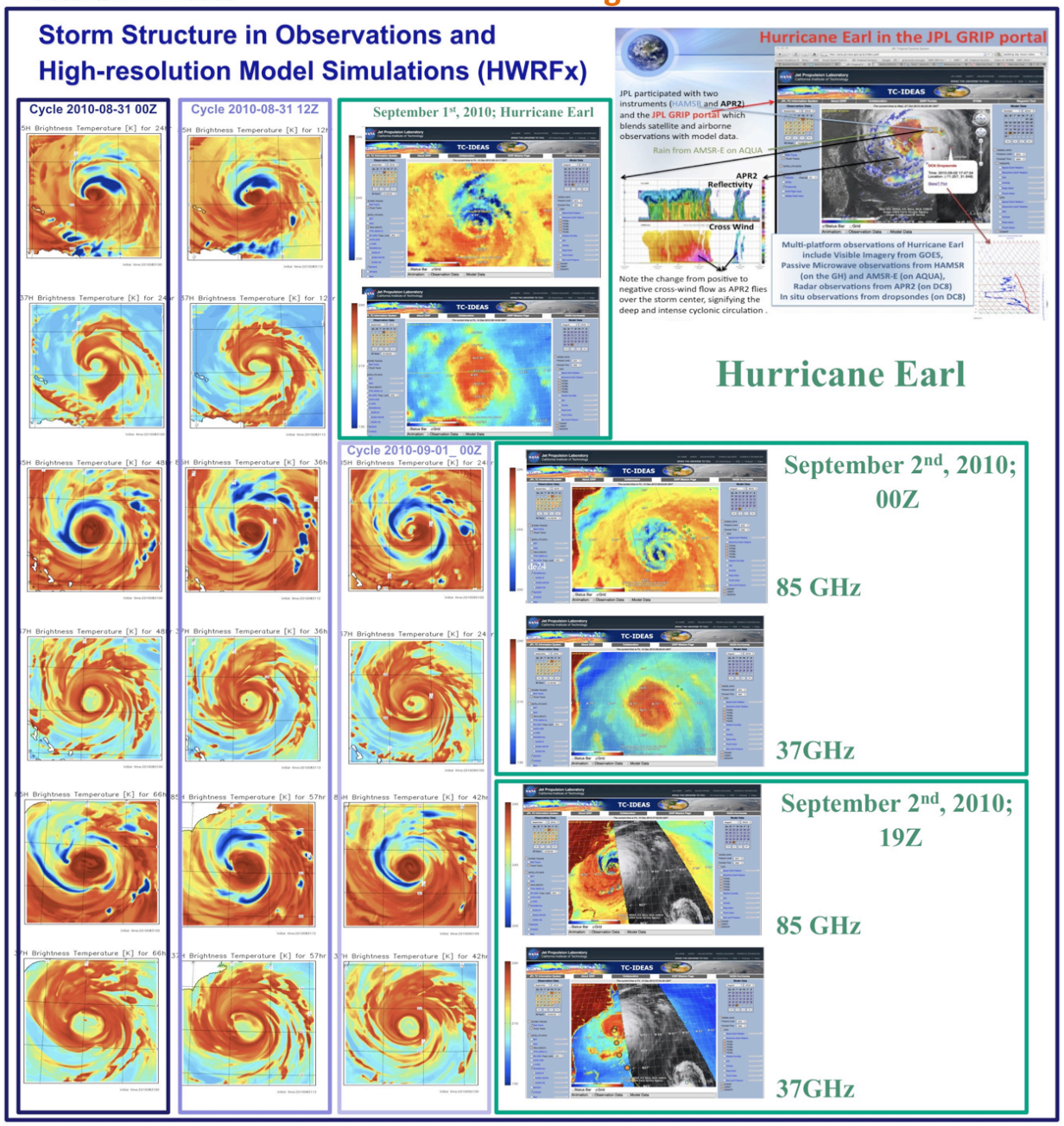
200
85GHz(K)

Analysis Tools – Current Status
Single Parameter Statistics





Poster # A41B-0086 - 2010 Fall AGU meeting – Hristova-Veleva et al.



RESEARCH

MODEL VALIDATION

- **Collaboration with NOAA's Hurricane Research Division**
- Used the JPL GRIP portal to identified a number of cases to use for the evaluation of different hurricane forecasts.
- Focus on evaluating the HRD's forecast of hurricane Earl.
- Used the model forecast of the thermodynamic and hydrometeor fields to forward simulate satellite observables (HRD).
- Compared the structure of the observed and forecasted storms (the brightness temperatures at 37 and 89 GHz).
- Found some deficiencies, even though the model was capable in depicting the precipitation structure and its evolution

- However, the previous study was

Beyond the image comparison …

- In this study we again used the **HWRFX model forecast** of the thermodynamic and hydrometeor fields to forward simulate satellite observables **(brightness temperatures computed at HRD)**

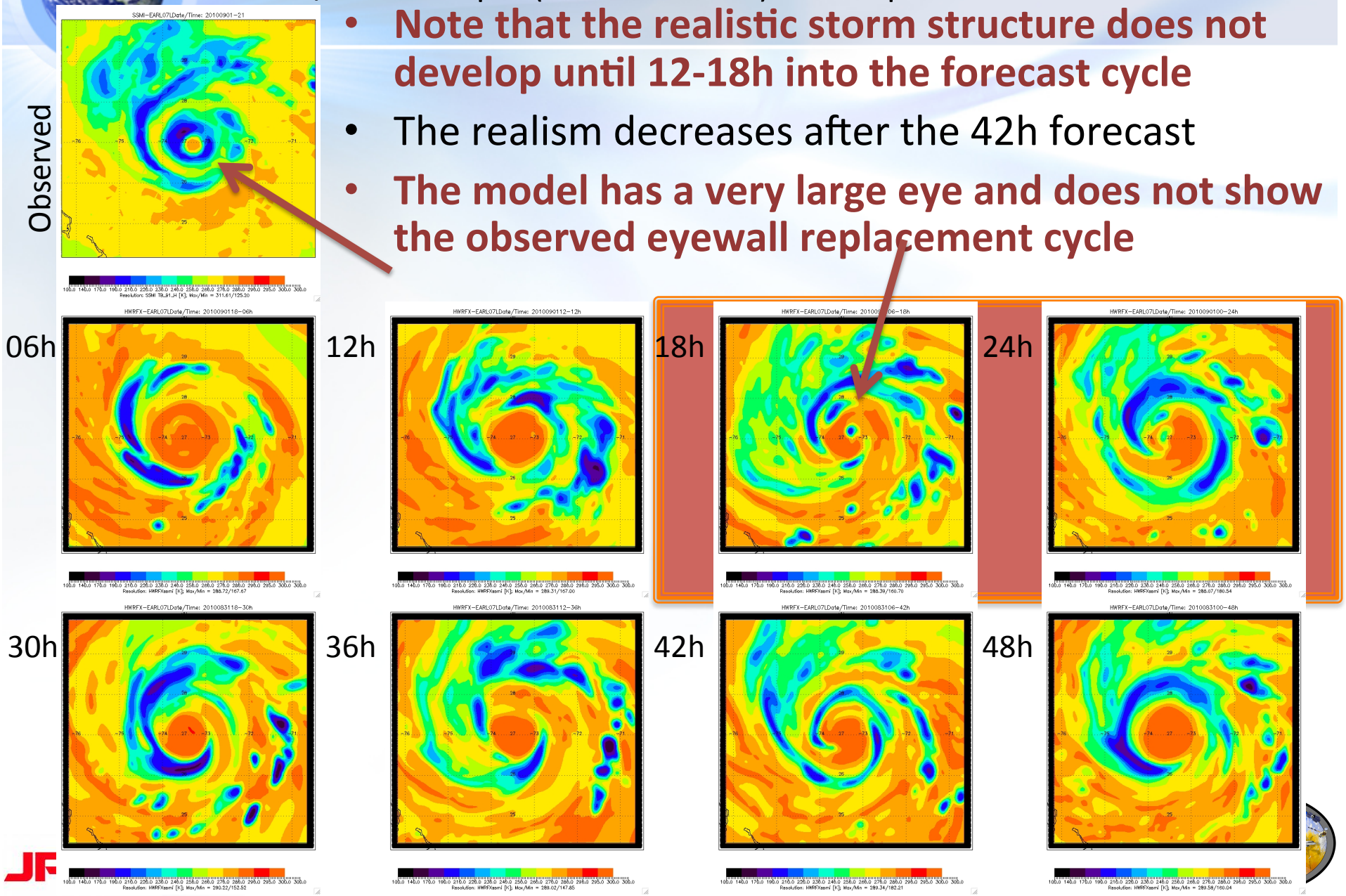
- We use the digital data to evaluate the model forecast. We consider the impact of:

  - **Satellite sampling**
  - **Resolution of the satellite data**
  - **Physics-induced biases**

STRUCTURE

85/91 GHz H pol (sat. resolution) – 02 Sept. 2010

- **Note that the realistic storm structure does not develop until 12-18h into the forecast cycle**
- The realism decreases after the 42h forecast
- **The model has a very large eye and does not show the observed eyewall replacement cycle**



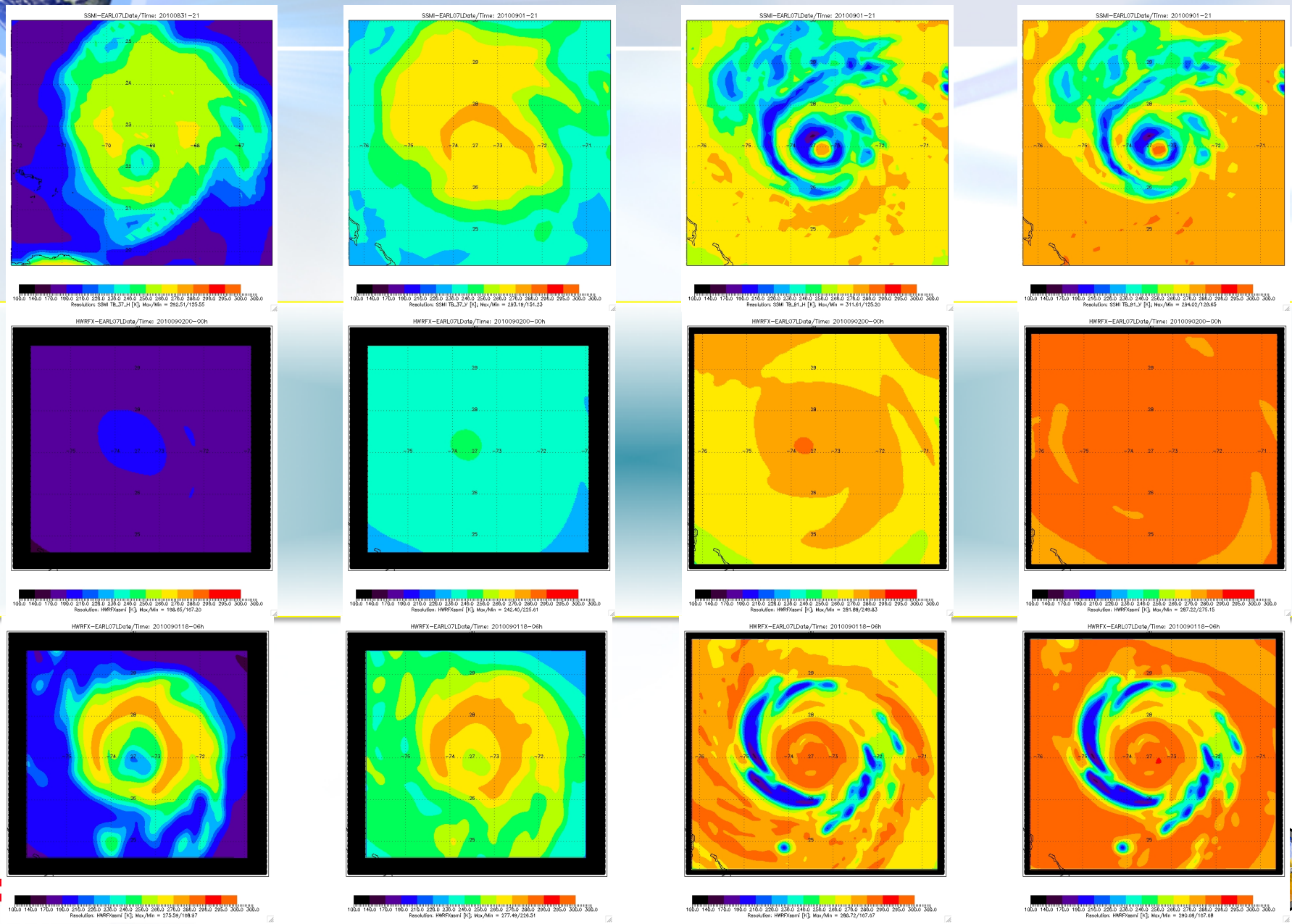
Evaluating the initial conditions

37H 37V 85H 85V

OBSERVED

ANALYSIS

06h Forecast



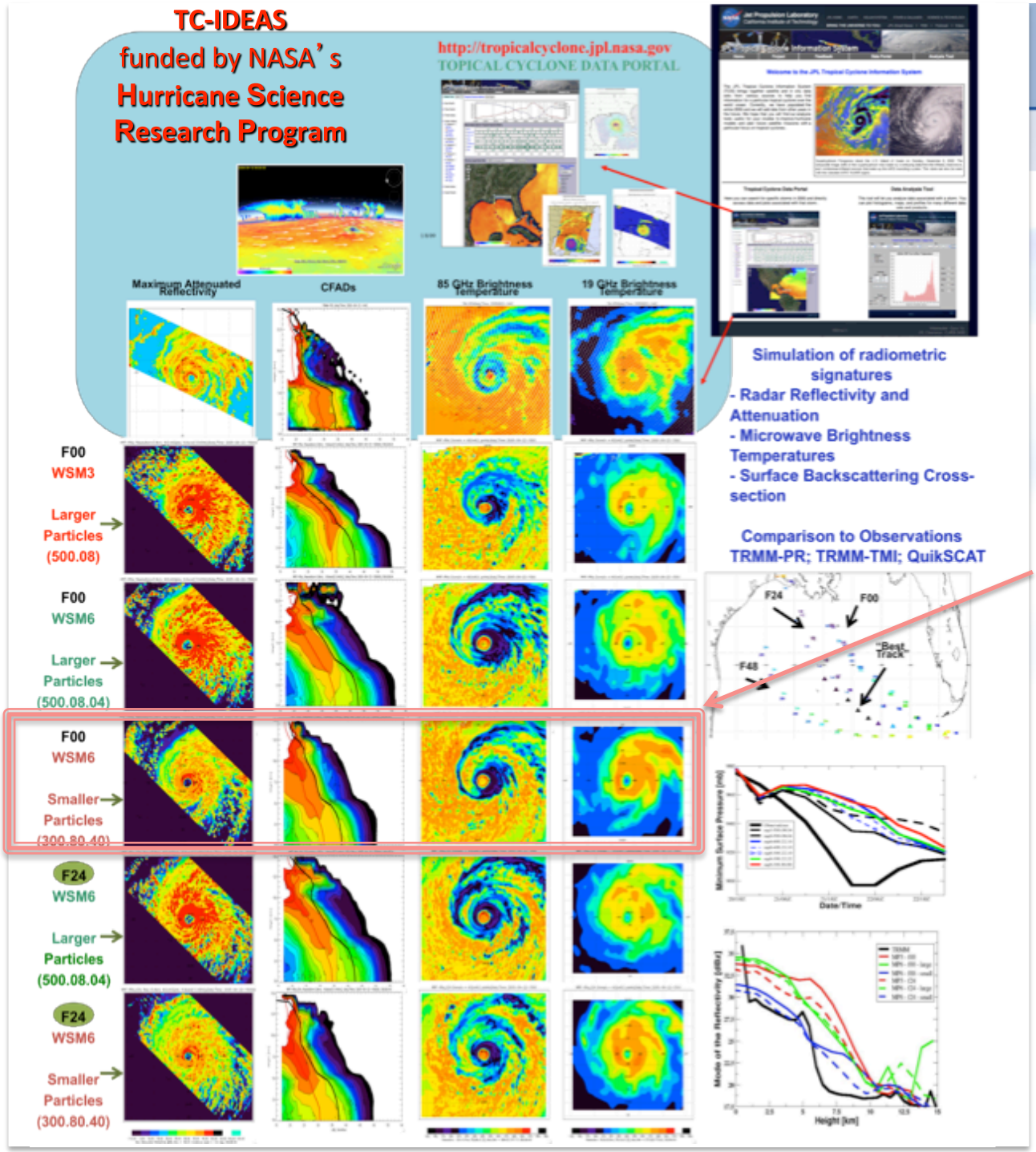
Summary

1. The long spin-up time might be the result of sub-optimal initial conditions which do not contain the observed precipitation structures.

2. During the model initialization we should make every effort to assimilate the microwave satellite information inside the precipitating hurricane core in order to incorporate:

   – **the precipitation-related thermodynamics**

   – **the important vortex asymmetries**



RESEARCH

MODEL IMPROVEMENTS

- Using instrument simulators and multiparameter satellite observations we can discriminate between model forecasts using different microphysical assumptions.
- Assuming hydrometeor distributions with smaller particles results in model forecasts with radiometric signatures that are closer to observations.
- Will have impact in two ways:
  – providing guidance on the optimal set of physical parameterizations
  – improving the data assimilation outcome by designing model fore-casts whose radiometric signatures are close to the observed ones, increasing the relative importance of the observa-tions during the assimilation.
- Improved understanding of the PSD characteristics will lead to decrease in the uncertainty of satellite retrievals of precipitation which often use model-derived retrieval databases.

•that reflect the microphysical

Use during the campaign; Developer vs Non-developer