Model Evaluation and Validation: Data, Diagnostics and Tool Upgrades

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August 10th, 2012

Outline

- **New Data**
  - TCIS – 11 year data records
  - GRIP and HS3 NRT portals for data interrogation
- **Diagnostics**
  - Use of instrument simulators
  - Analysis of:
    - 2D fields
    - Vertical structures
    - Composites
    - Principal components
- **Tools – Upgrades and new development**
  - **the HWSS**
    - Slant path
    - Antenna convolution
  - **AIST project**

JPL

NASA

1. Observational Data for model validation

Funded by NASA's Hurricane Science Research Program

JPL

DATA:

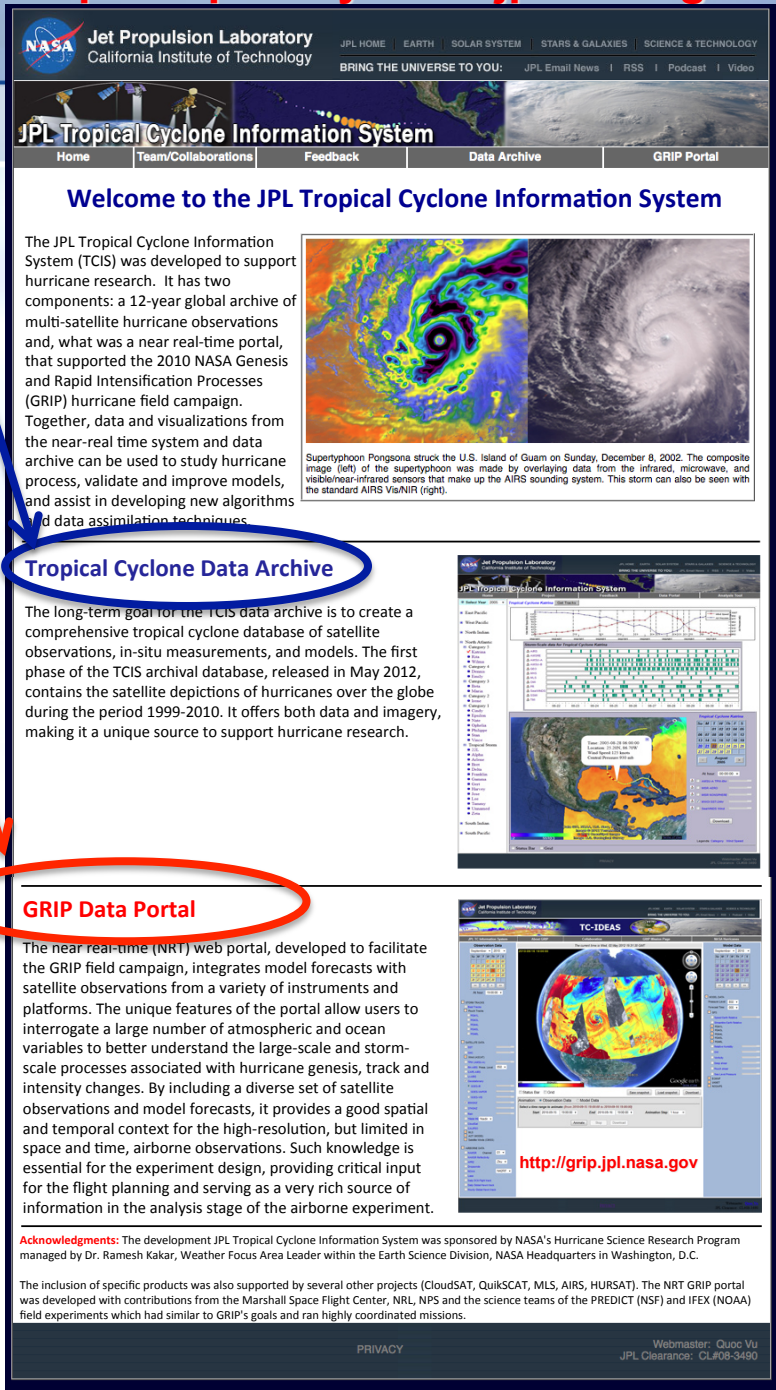
Tropical Cyclone Data Archive

- First phase released May 2012
- **Satellite depictions of hurricanes over the globe**
- **12-year record (1999-2010)**
- **offers both data and imagery**, making it a unique source to support hurricane research.

GRIP Portal – NRT in 2010, Atlantic

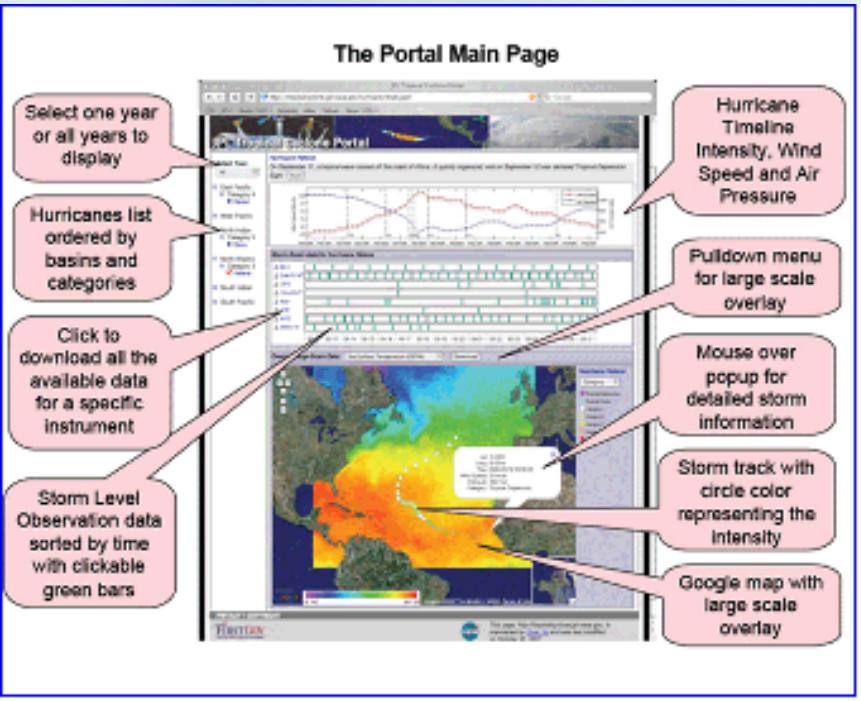
- **Integrates model forecasts with satellite and airborne observations from a variety of instruments and platforms**, providing good spatial and temporal context for the high-resolution, but limited in space and time, airborne observations.
- essential knowledge for the experiment design, flight planning, and a **very rich information source in the analysis stage of the experiment.**
- **Allows interrogation of a large number of atmospheric and ocean variables** to better understand the large-scale and storm-scale processes associated with hurricane genesis, track and intensity changes.

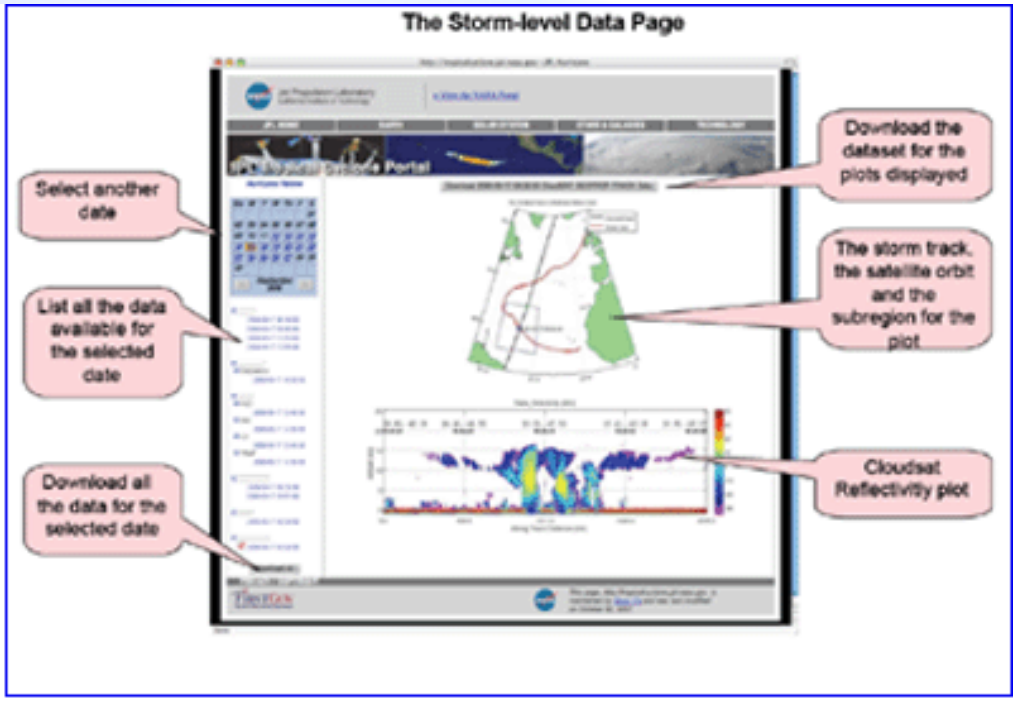
http://tropicalcyclone.jpl.nasa.gov



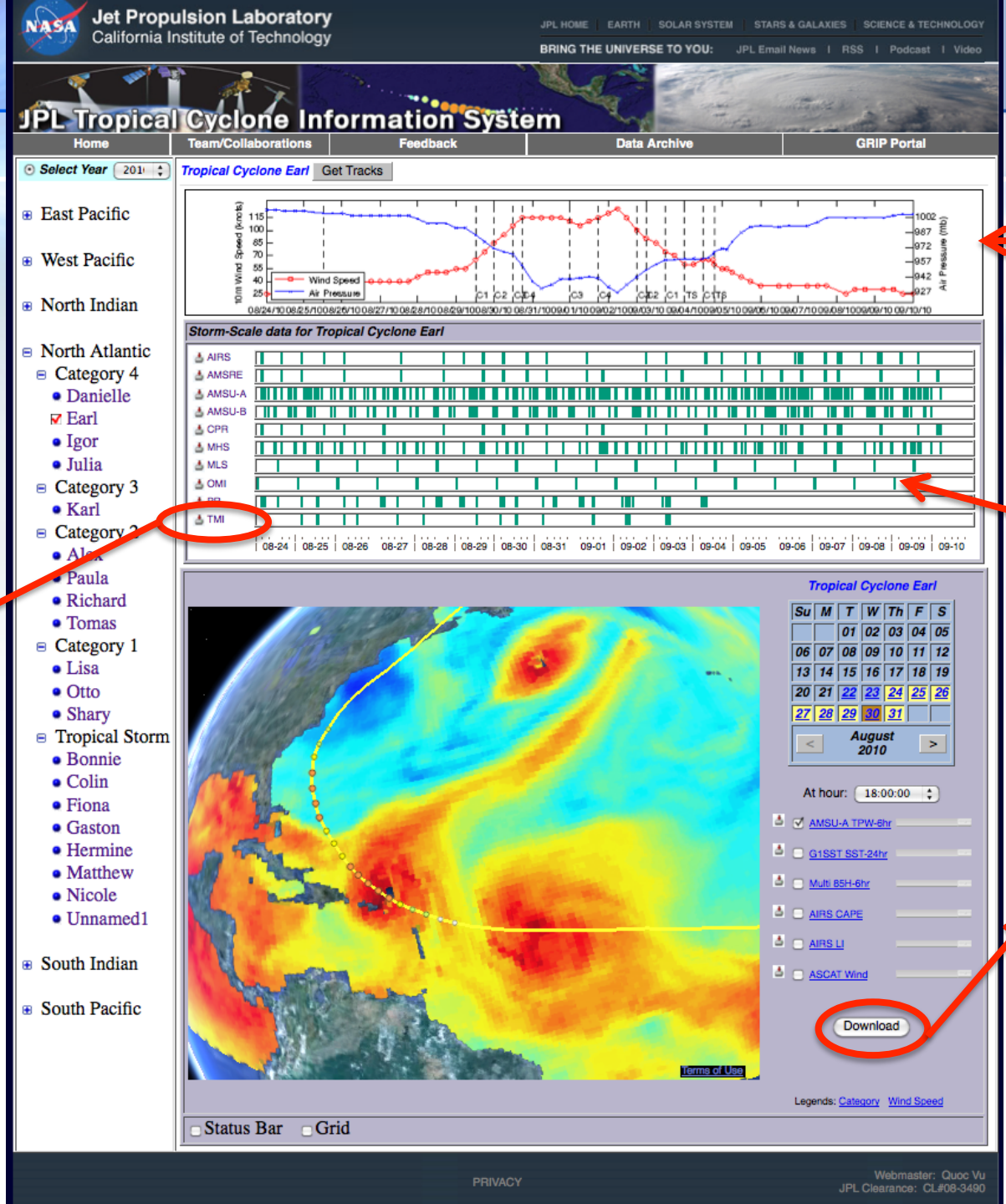
DATA: Tropical Cyclone Data Archive

Guidelines / Help





DATA



Earl, 2010

Timeline

View and download Storm-scale data

Download all data from this Instrument (TMI)

Download Selected large-scale data from this day

DATA

JPL Tropical Cyclone Information System

Home | Project | Feedback | Data Portal | Analysis Tool

Tropical Cyclone Rita

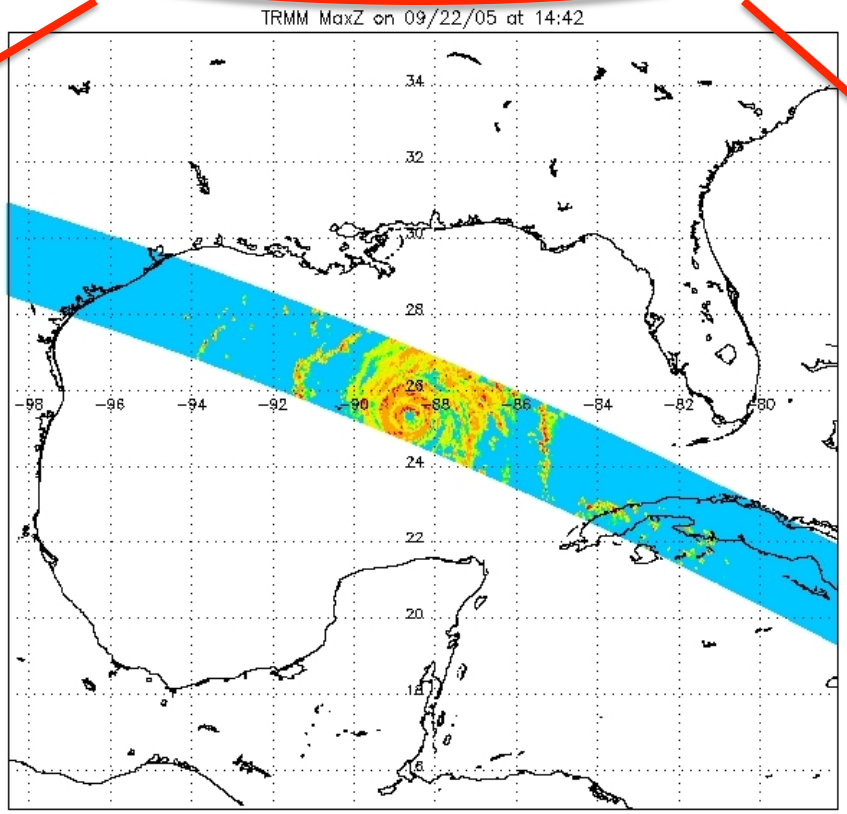
Su	M	T	W	Th	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

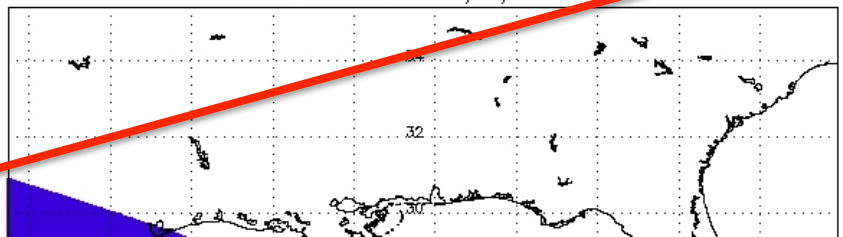
< September 2005 >

- MLS
- SeaWINDS
- GPS-RO
- OMI
- AIRS
- PR
  - TRMM
    - MaxZ-PIA-RR-RT
      - 2005-09-22 08:10:00
      - 2005-09-22 14:42:00
- TMI
- AMSRE
- AMSU-A
- SSMI
- GEO

Download All

Download 2005-09-22 14:42:00 PR MaxZ-PIA-RR-RT Data





Download NetCDF

At this time

All data on this day

JPL

NASA

DATA

JPL Tropical Cyclone Information System

Tropical Cyclone Rita

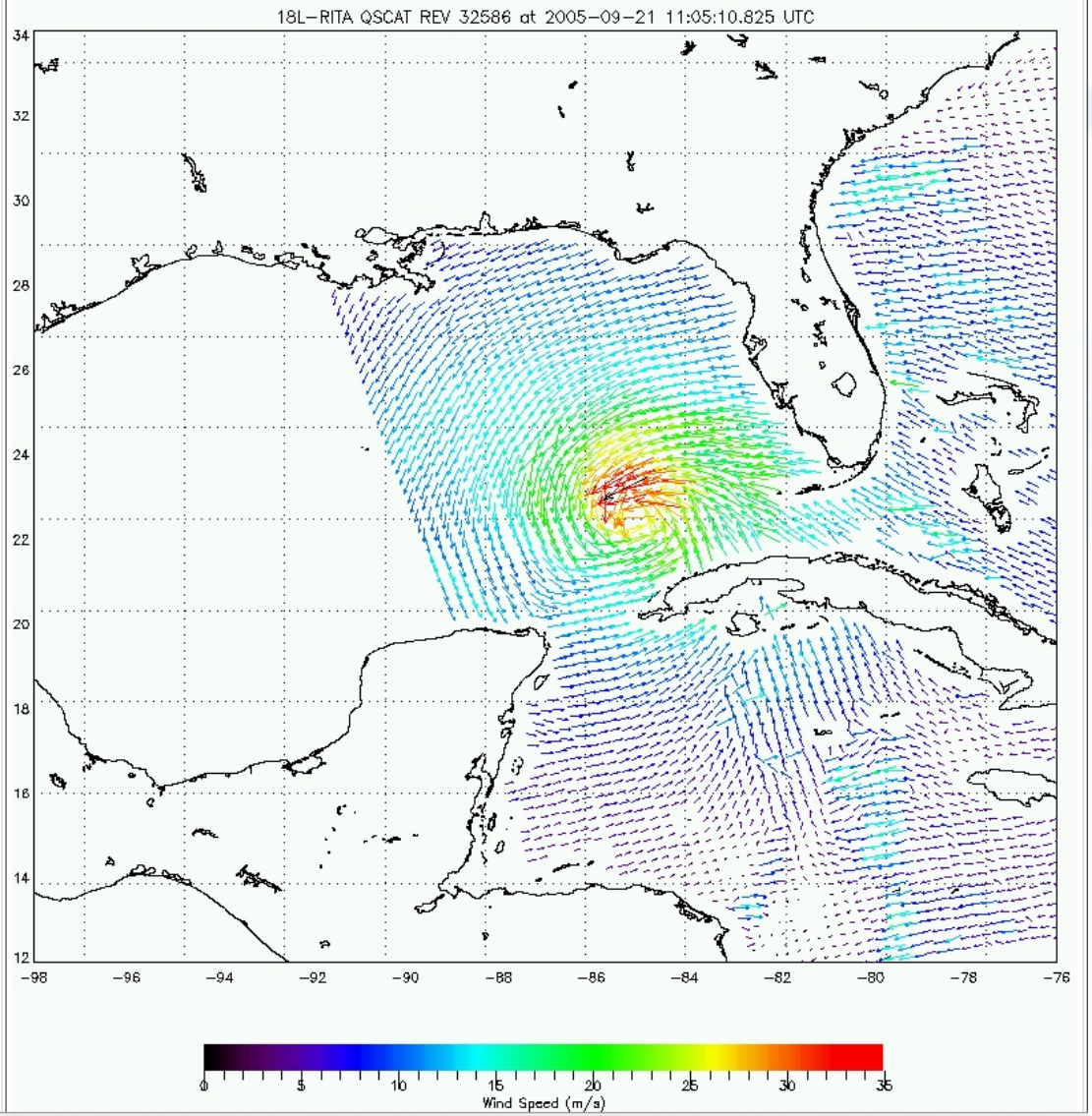
Su	M	T	W	Th	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

< September 2005 >

- MLS
- SeaWINDS
  - 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

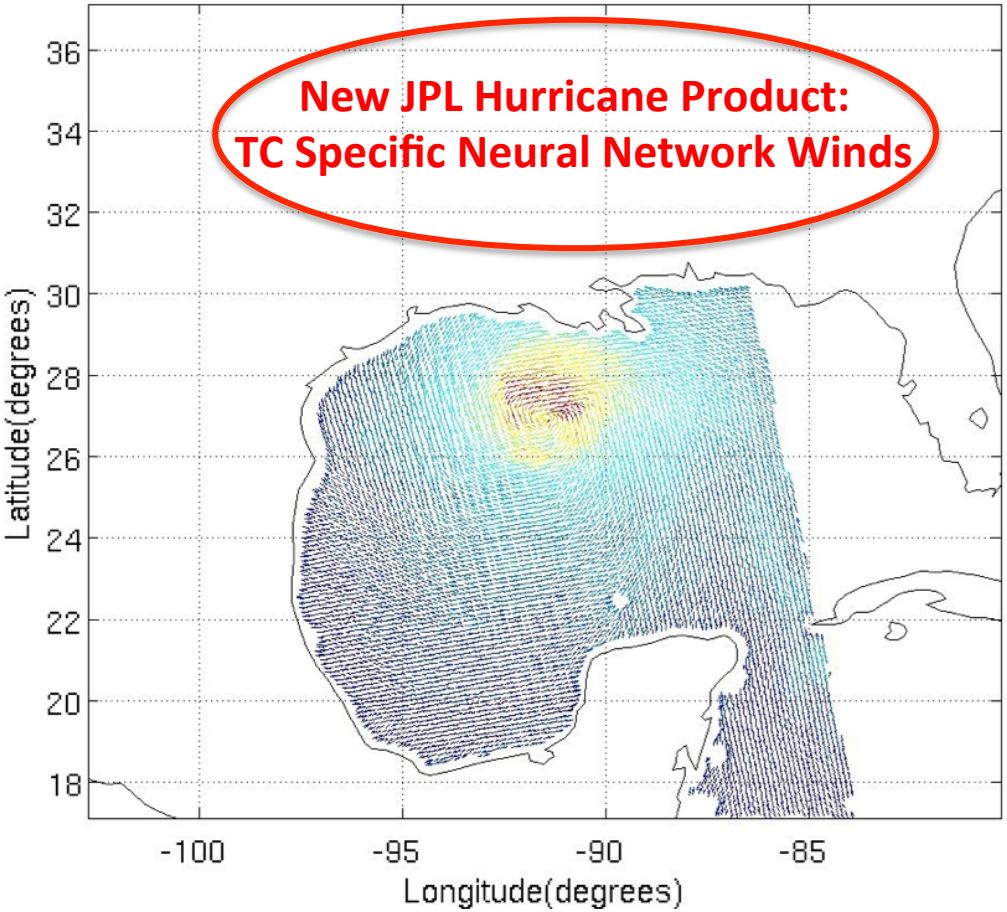
Download All

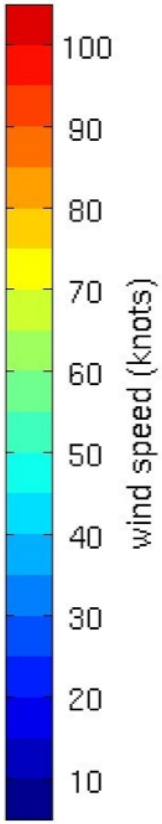
Download 2005-09-21 11:05:00 SeaWINDS WIND Data

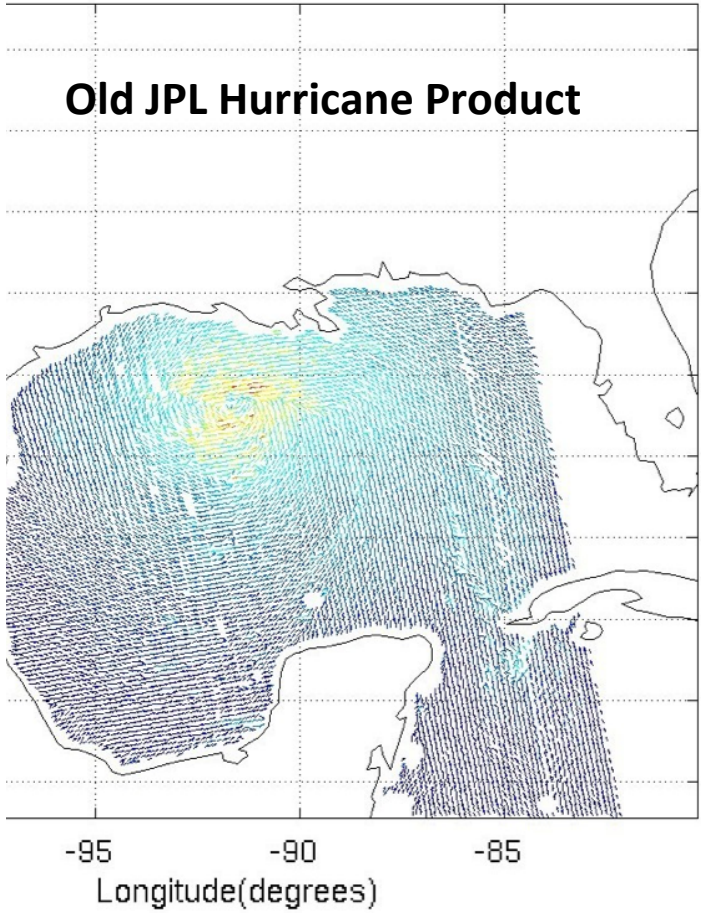


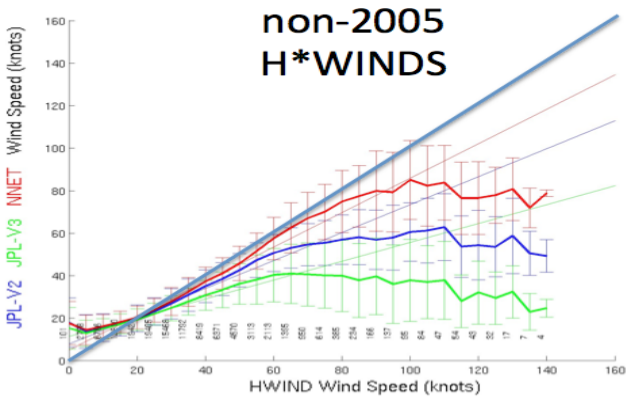
DATA

Scatterometer winds: Hurricane Rita, September 23, 2005









The Neural Net winds show only slight negative bias vs. H*WINDS up to 80 knots

The old JPL-V2 winds start to saturate at 40 knots.

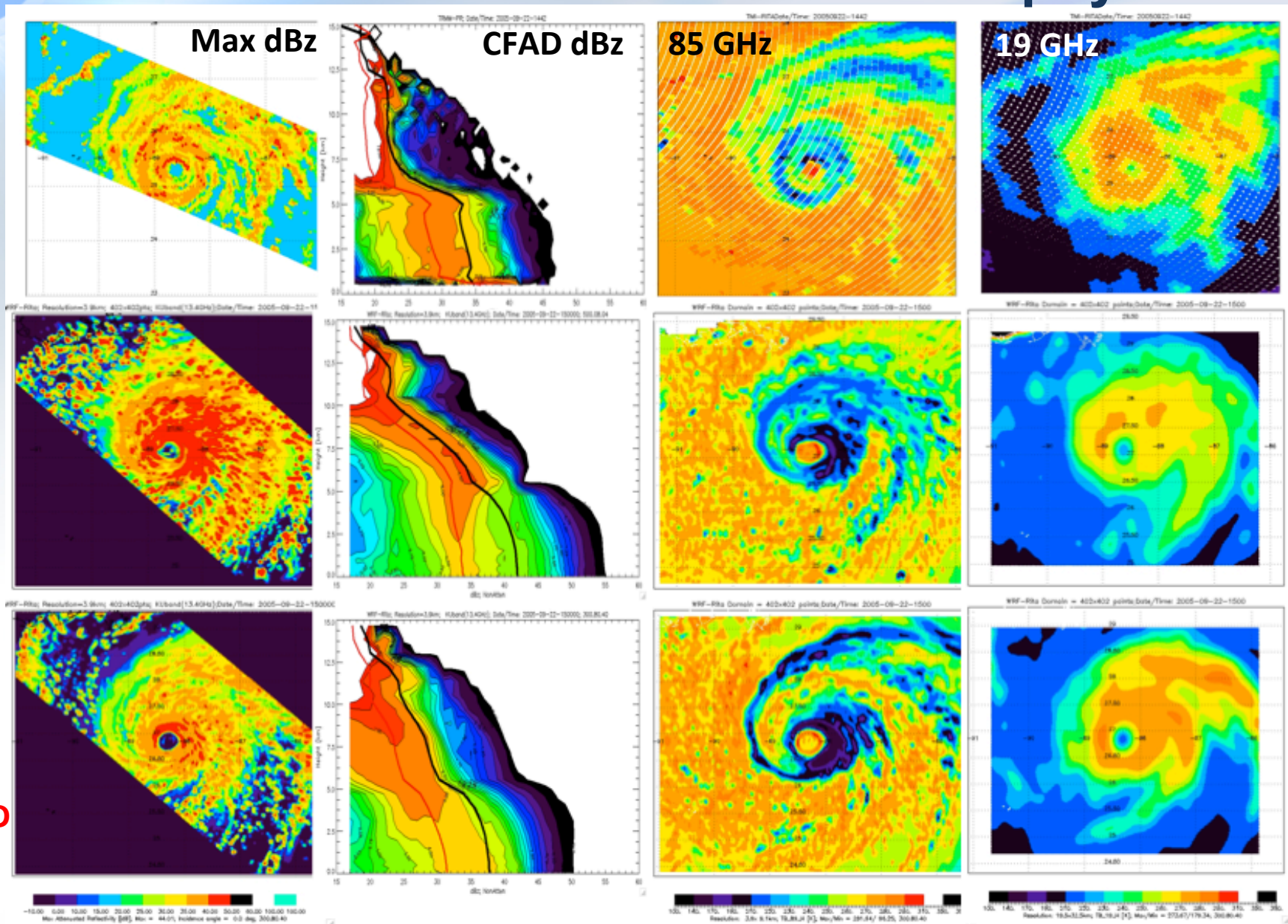
B. Stiles, R. Danielson, W. L. Poulsen, M. J. Brennan, and S. M. Hristova-Veleva, **2012:** "Multiple Scatterometer Hurricane Winds Ten years of optimized QuikSCAT cyclone winds validated against best track speeds, H*WIND and SFMR, and initial OceanSAT-2 cyclone winds", **2012 IOVWST, Utreht, ND**

The 12-year Global Data Archive

- **Advantages:**
  - **Offers imagery AND digital data**
  - **One of only three places where you can get easy access:**
    - **organized by storm (year and basin) – no need to search**
    - **no need to login (not password protected), order and wait**
  - **Contains more data than the websites at JAXA and HURSAT**
  - **It is organized and has an image to go with each set of data so you know what you are getting**
  - **All data are in netcdf**
  - **Offers subsets (2000x2000km) centered on the storm, reducing the volume of data!!!**

2. Model diagnostics and evaluation

JPL Research using the TCIS Data Archive: MODEL EVALUATION – the Microphysics



Evaluating the Impact of Using the Hurricane EnKF Data Assimilation System (HEDAS)

(Developed at NOAA's Hurricane Research Division)

HEDAS ANALYSIS

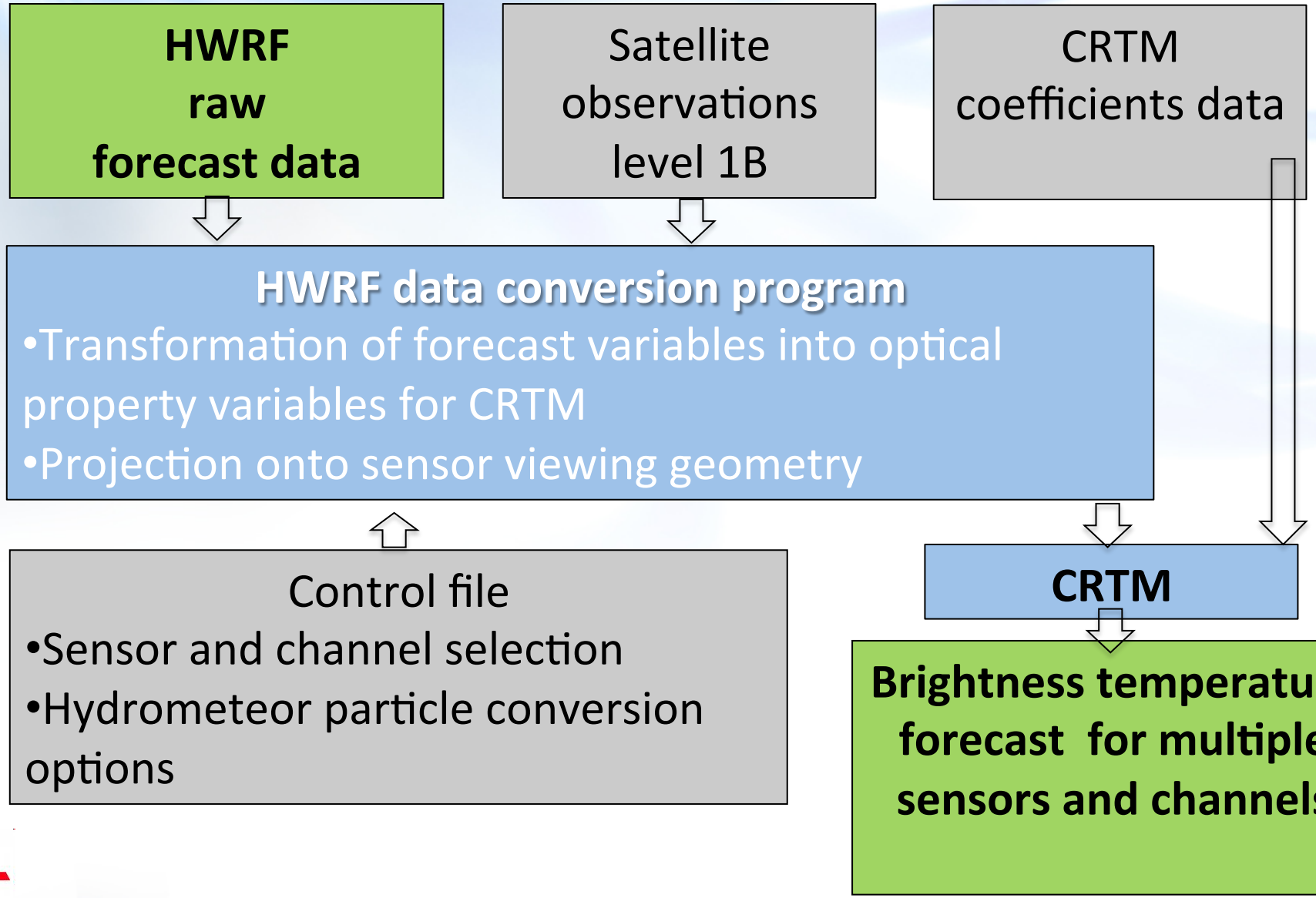
We compare three cases:

1. HWRF 2h forecast without data assimilation - noDA
2. HEDAS analysis after assimilating airborne data (no Doppler) - h3nd
3. As in 2 but also assimilating Doppler data - h3vk

Hurricane WRF Satellite Simulator (HWSS)

T. Greenwald (CIMSS/UW) and T. Vukicevic (HRD/NOAA)

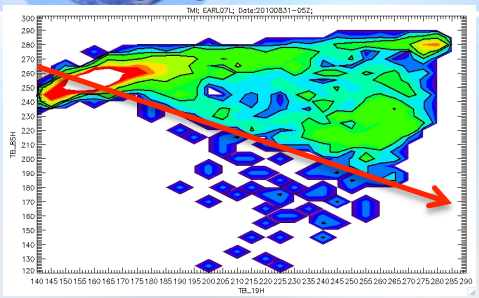
JHT supported project



Statistical Comparison – Joint PDFs

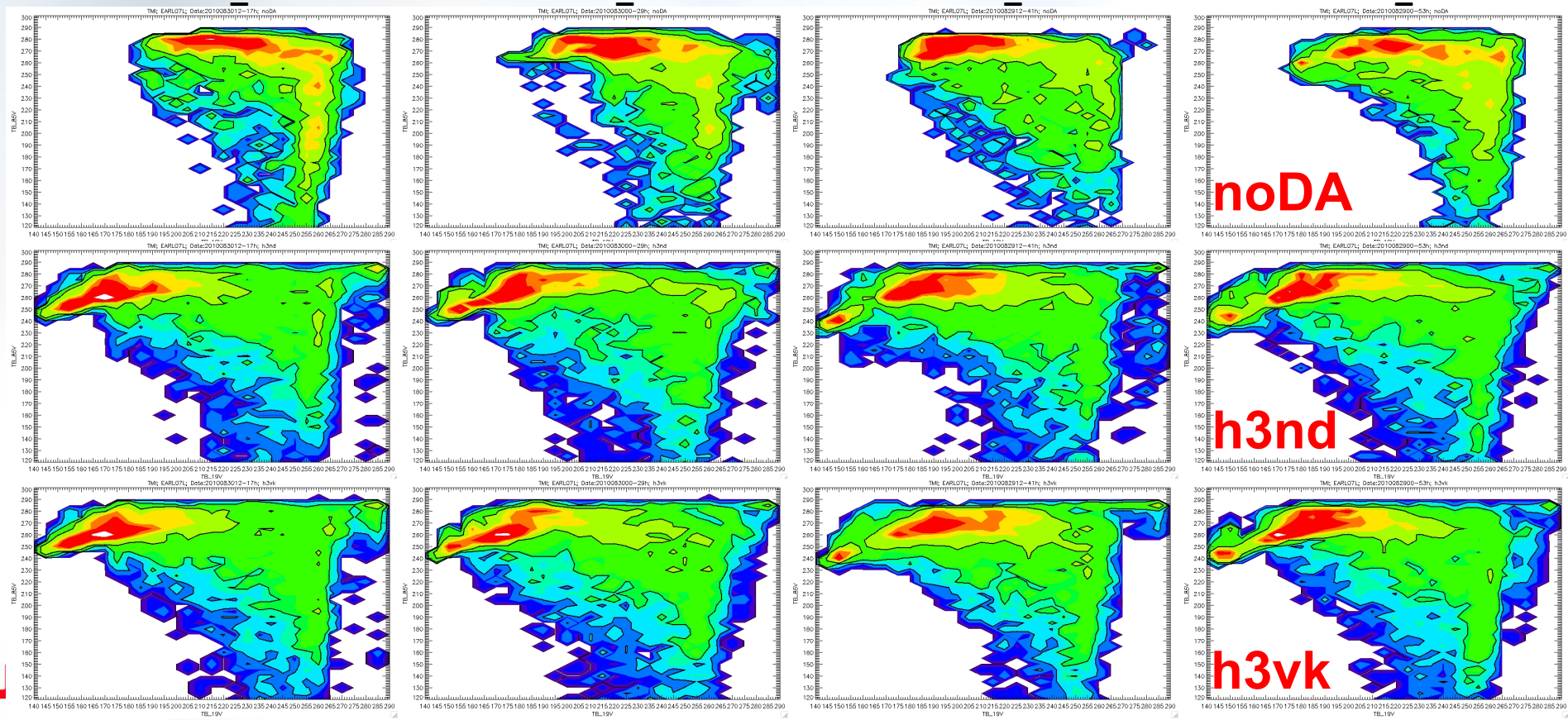
2010-08-31; At TMI resolution – 85H vs 19H

OBSERVED



- The statistical relationship between the 19 GHz TBs and the 85 GHT TB presents information on the vertical structure of the storm

2010-08-30_12Z 17h | **2010-08-30_00Z 29h** | **2010-08-29_12Z 41h** | **2010-08-29_00Z 53h**



Statistical Comparison – Joint PDFs

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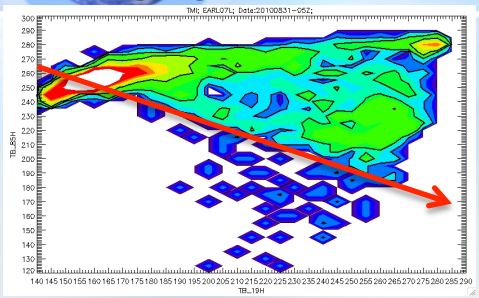
OBSERVED



- The statistical relationship between the 19 GHz TBs and the 85 GHT TB presents information on the vertical structure of the storm

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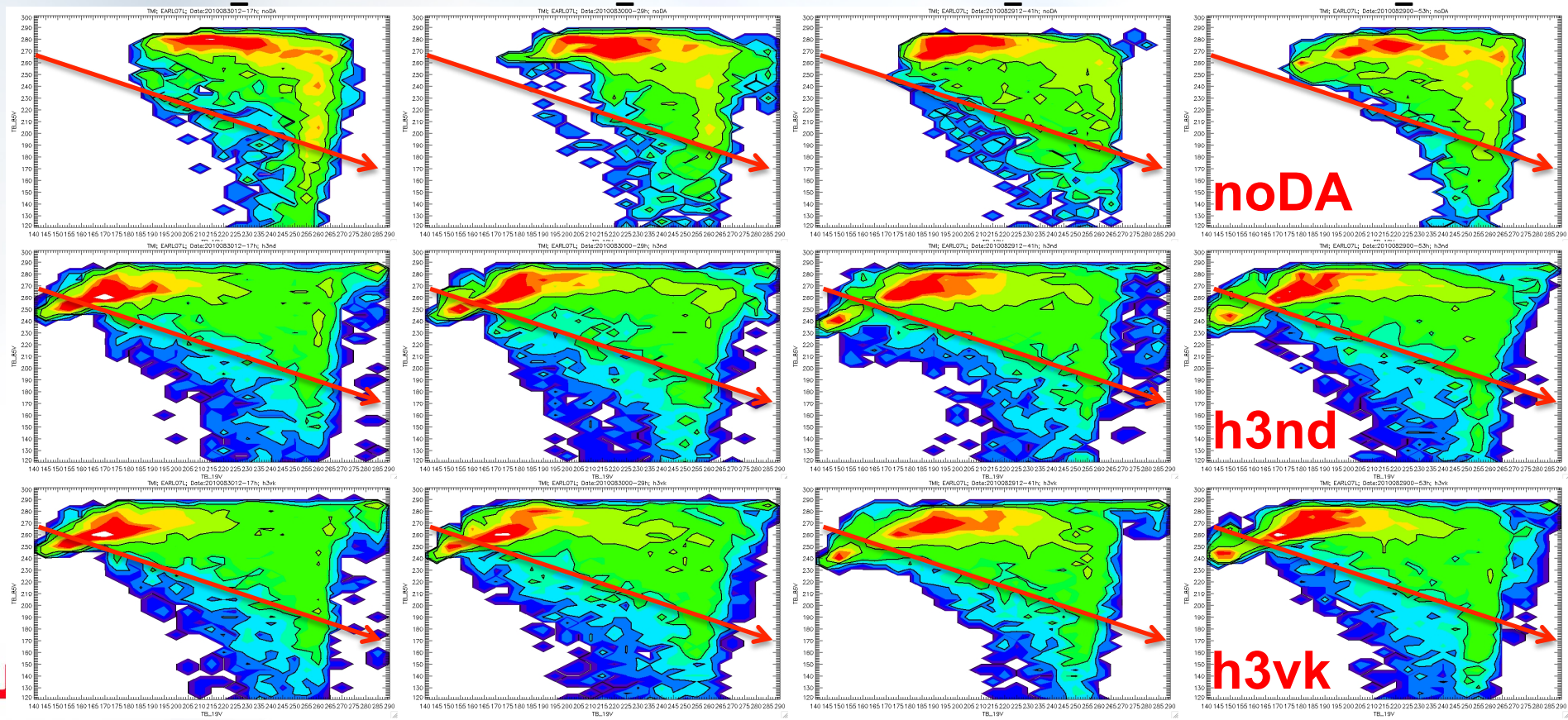

Statistical Comparison – Joint PDFs

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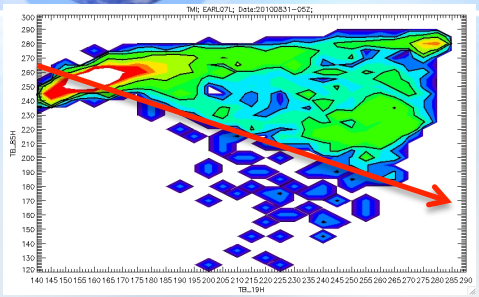
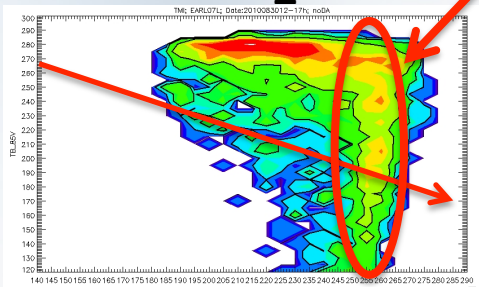
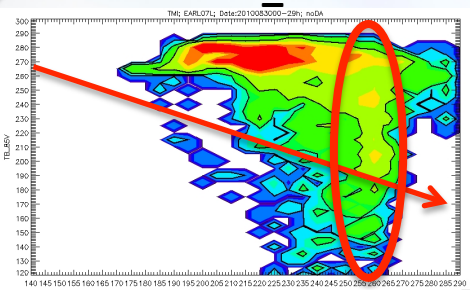
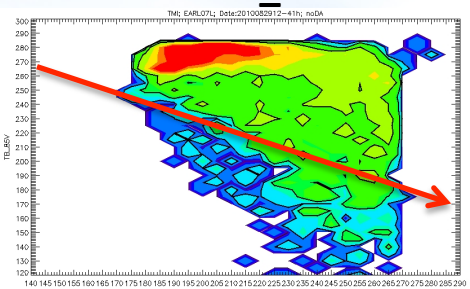
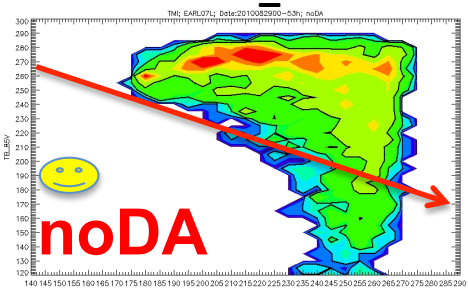
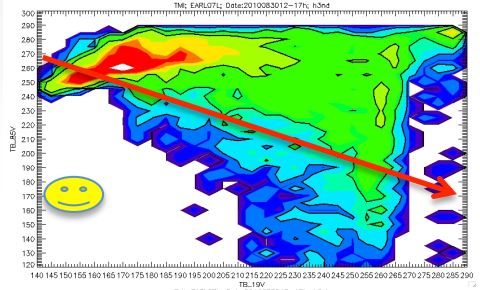
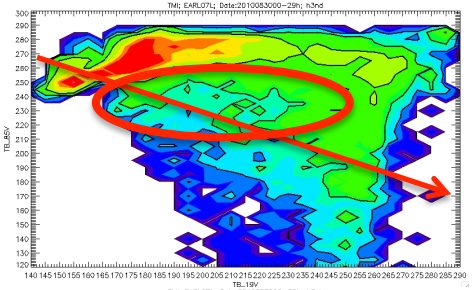
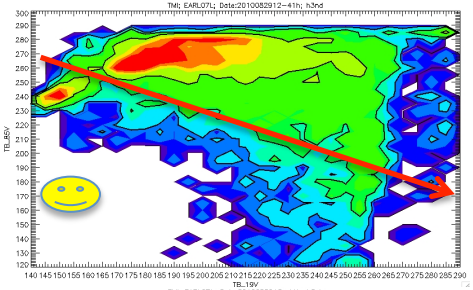
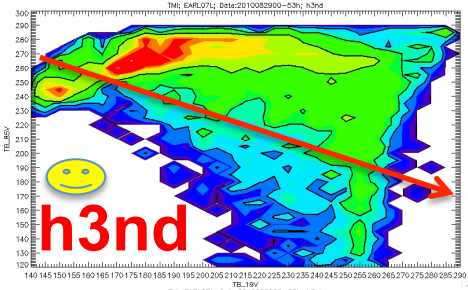
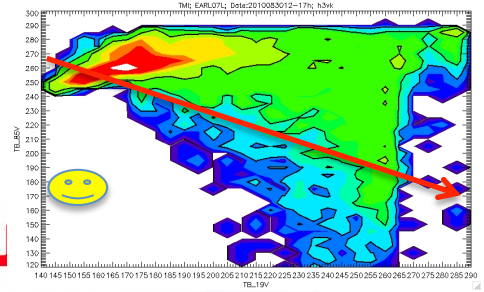
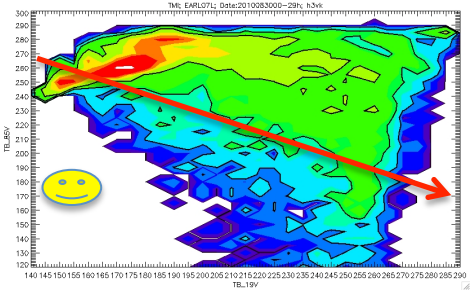
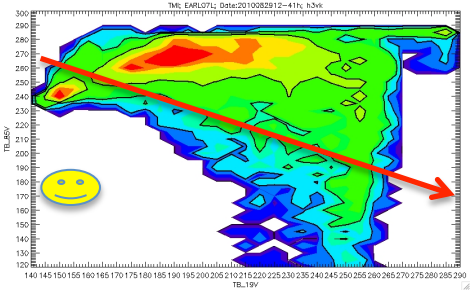
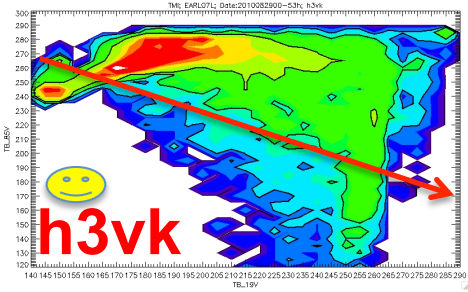
OBSERVED



- The statistical relationship between the 19 GHz TBs and the 85 GHT TB presents information on the vertical structure of the storm
- The vertical branch indicates too much scattering

2010-08-30_12Z 17h	2010-08-30_00Z 29h	2010-08-29_12Z 41h	2010-08-29_00Z 53h
			 noDA
			 h3nd
			 h3vk

Research using the TCIS Data Archive:

TCIS Data Archive: Climatology – Environmental Humidity and TC Intensity and Change

Using AIRS temperature and humidity

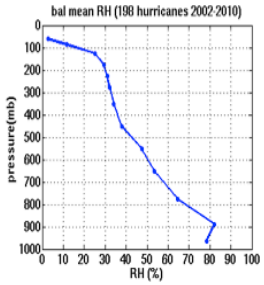
DATA

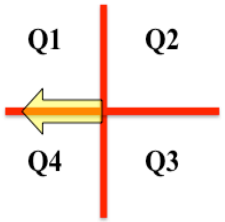
198 North Atlantic Ocean TCs from 09/2002 to 11/2010 based on NHC Best Track Data
- 74 Cat 1-5 hurricanes (37%)
- 36 Cat 3-5 hurricanes (18%)
- 10 Cat 5 hurricanes (5%)

AIRS Level 2 Relative Humidity (filtered by *pgood*)

Approach

To sort RH by the radial distance to the storm center, separated by four quadrants relative to storm movement, and composite RH as a function of storm intensity and intensification rate

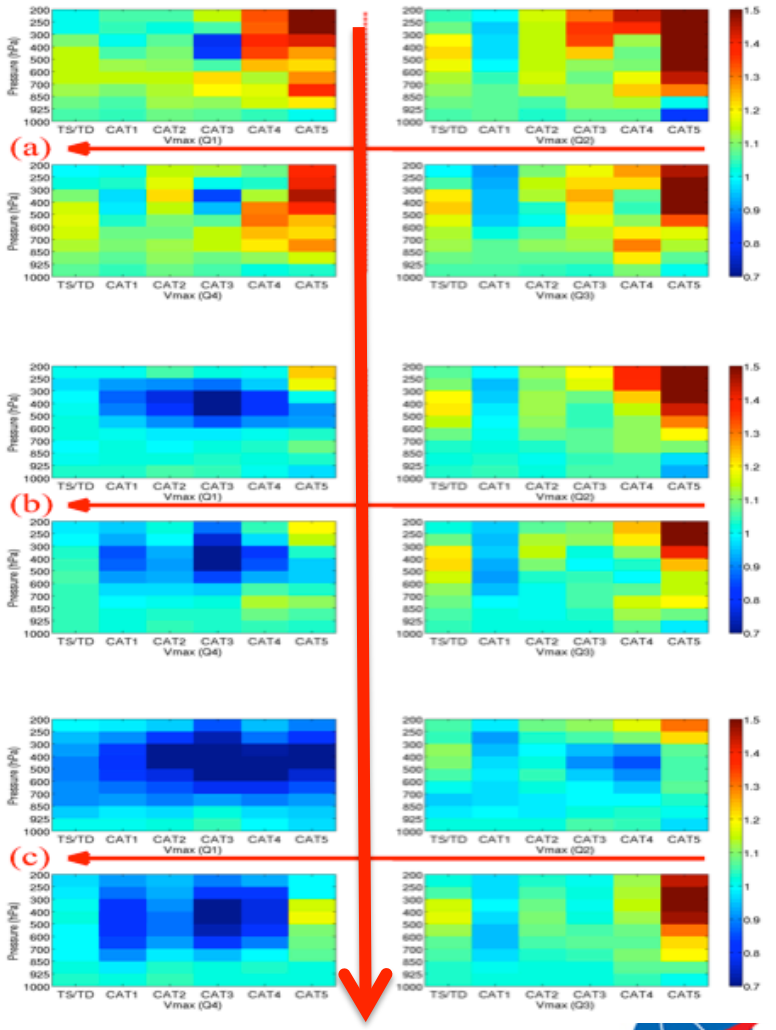




Range 200-400km

Range 400-600km

Range 600-800km



Longtao Wu[1,2], Hui Su[1], Robert G. Fovell[3], Bin Wang[4], Janice T. Shen[1], Brian H. Kahn[1], Svetla M. Hristova-Veleva[1], Bjorn H. Lambrigtsen[1], Eric J. Fetzer[1], Jonathan H. Jiang[1], 2012: "Relationship of Environmental Relative Humidity with Tropical Cyclone Intensity and Intensification Rate over North Atlantic", *to be submitted*

3. Tools – upgrades and new development

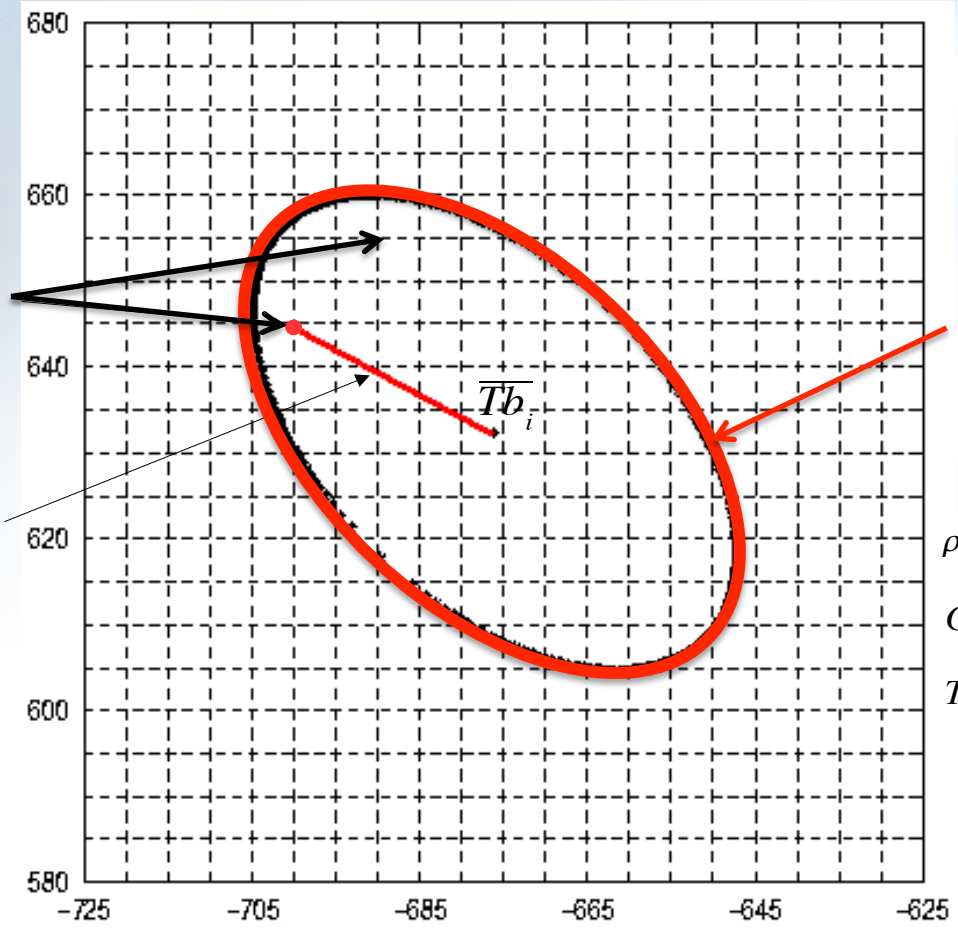
Simulating the Satellite Resolution

Resampling ...

Model resolution

$Tb(\rho)$

$G_i(\rho)$



Satellite resolution

$$\overline{Tb}_i = \int Tb(\rho)\, G_i(\rho)\, dA$$

where

ρ *indicates a particular location*

$G_i(\rho)$ *– antenna gain pattern*

$Tb(\rho)$ *– brightness temperature at location* ρ

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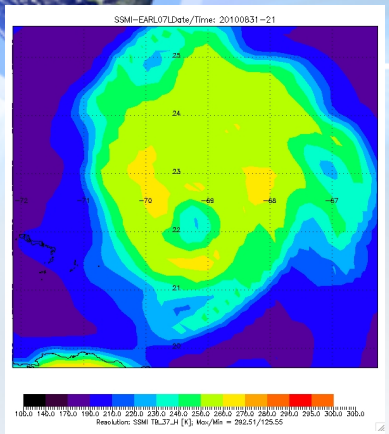
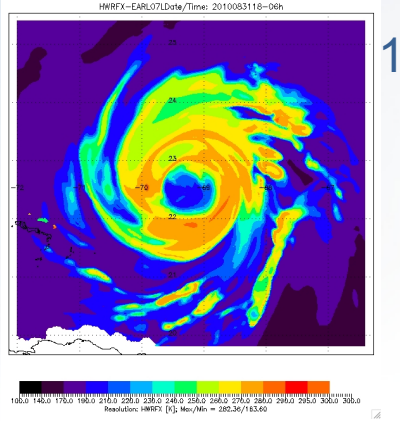
37 GHz H pol – September 01 2010 - Resolution

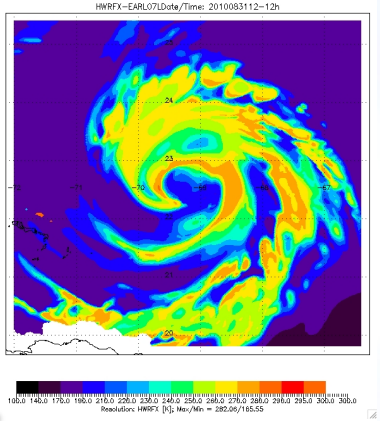
Observed

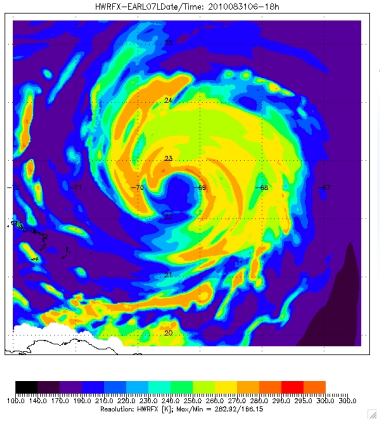


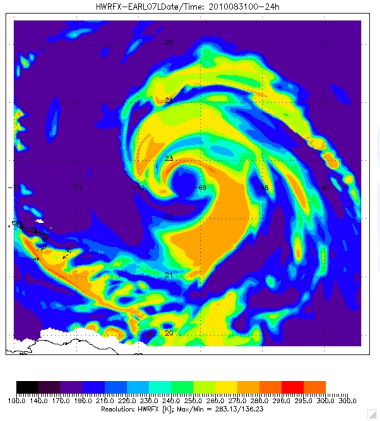
- **Observed**
- **HWRFX – at the model resolution**
- **HWRFX – antenna-convolved to simulate brightness temperatures at the satellite resolution (37GHz - 27.5 x45.0km)**

06h 12h 18h 24h

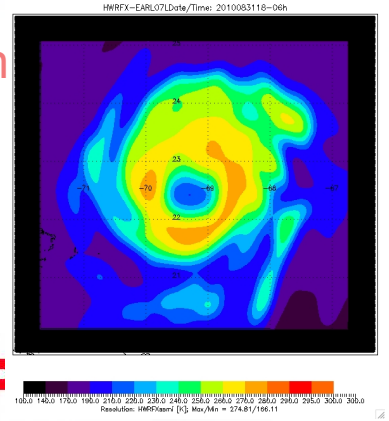


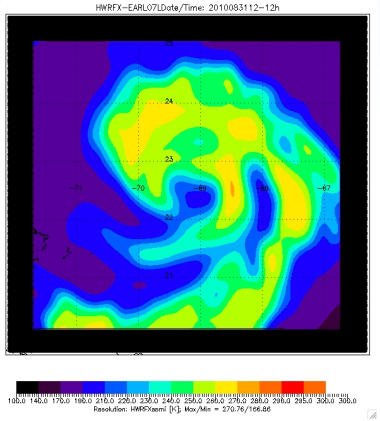


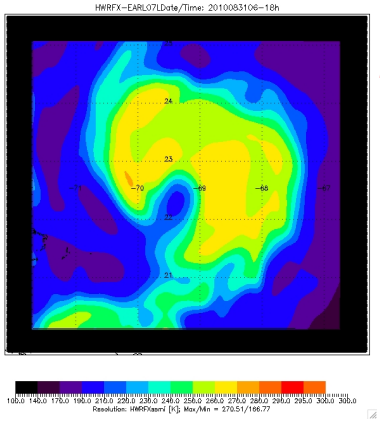


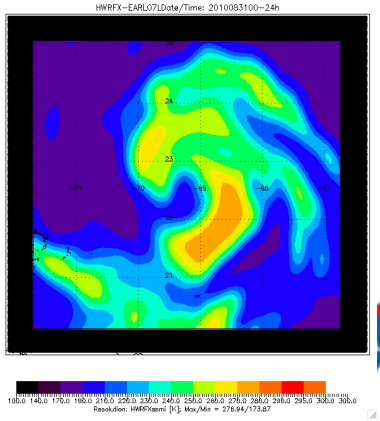


06h 12h 18h 24h





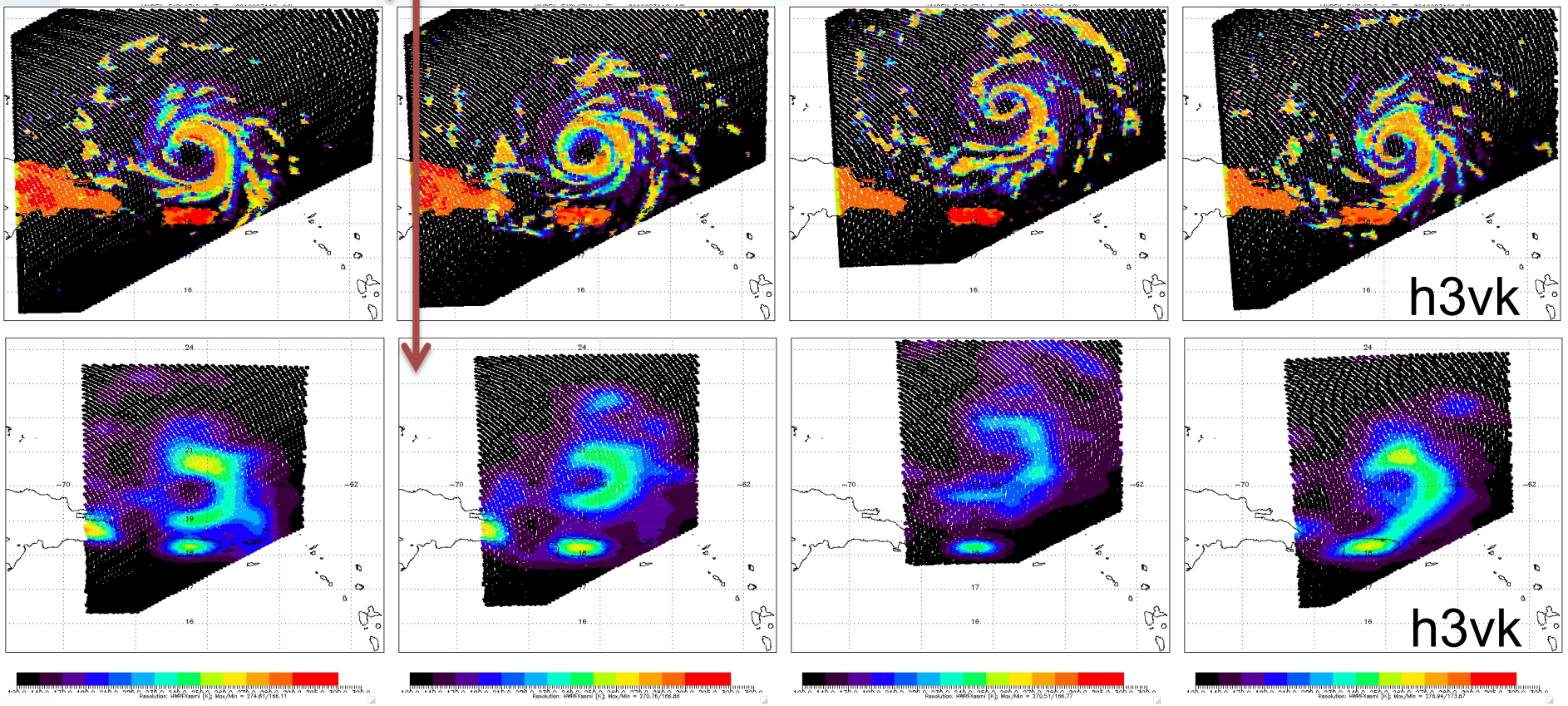




10 GHz H pol – August 31 2010 - Resolution

- HWRFX – at the model resolution
- HWRFX – antenna-convolved to simulate brightness temperatures at the satellite resolution (10GHz - 60 x45.0km)

2010-08-30_12Z 17h | 2010-08-30_00Z 29h | 2010-08-29_12Z 41h | 2010-08-29_00Z 53h



Fusion of hurricane models and observations: Developing the technology to improve the forecasts

PI: Svetla Hristova-Veleva / JPL

ESTO Earth Science Technology Office

Objective

To develop the technology to provide the fusion of observations and operational model simulations to help improve the understanding and forecasting of the hurricane processes.

Specifically,

- To develop processing techniques to enable multi-source data fusion across hurricane forecast models, satellite data, and *in-situ* sensors,
- To develop tools to manage the validation and assessment of model comparisons to more easily evaluate the performance of different numerical models,
- To develop interactive visualization techniques to enable analysis of highly complex systems.

In collaboration with:

R. Rogers, S. Gopalakrishnan,

F. Marks, T. Vukicevic - HRD/AOML

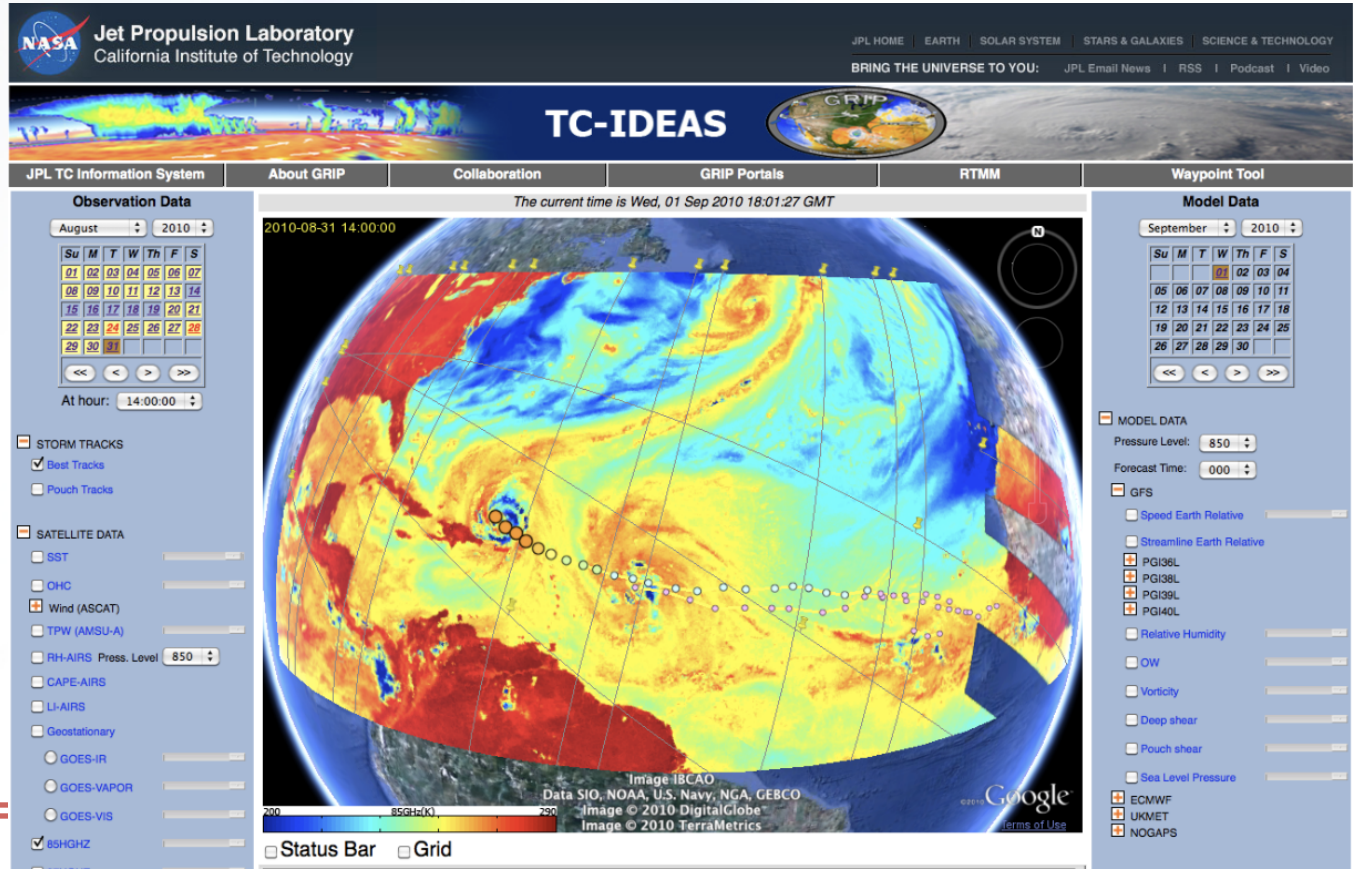
V. Tallapragada - NOAA/EMC

Approach:

Integration of the ISSARS instrument simulator with operational hurricane forecast models and incorporation of simulated satellite observables into the existing database of satellite and airborne observations.

Development of a set of advanced analysis tools

Development of data immersion to enable real-time interaction with the models, and visualization of highly complex systems



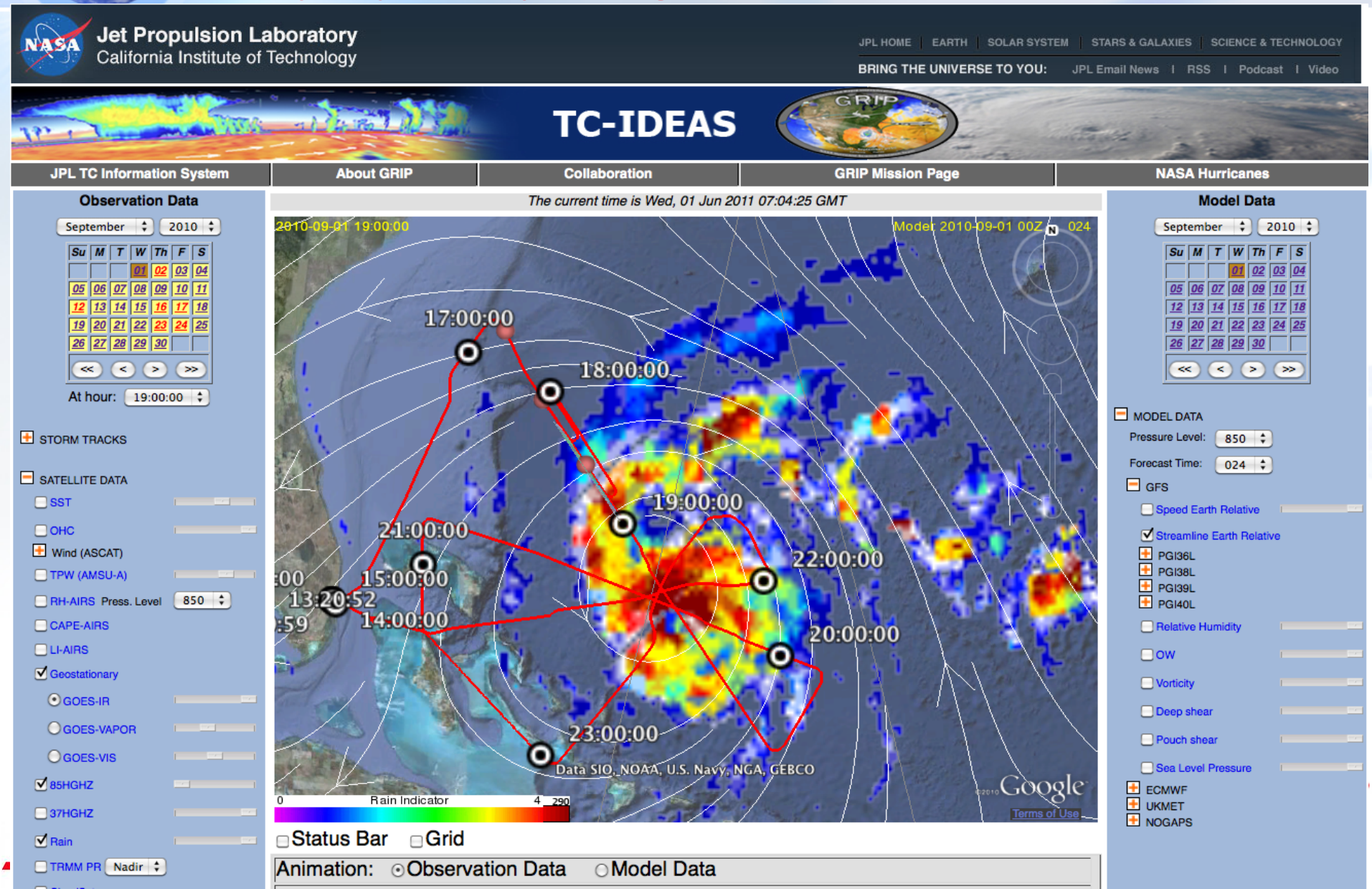
We will build on The GRIP/HS3 JPL PORTAL

- A near real-time (NRT) web portal
- Integrates large-scale model forecasts with satellite observations from a variety of instruments and platforms.
- The unique features of the portal allow users to interrogate a large number of atmospheric and ocean variables to better understand the large-scale and storm-scale processes associated with hurricane genesis, track and intensity changes.
- By including a diverse set of satellite observations and model forecasts, it provides a good spatial and temporal context for the high-resolution, but limited in space and time, airborne observations.
- Such knowledge is essential for the experiment design, providing critical input for the flight planning and serving as a very rich source of information in the analysis stage of the airborne experiment

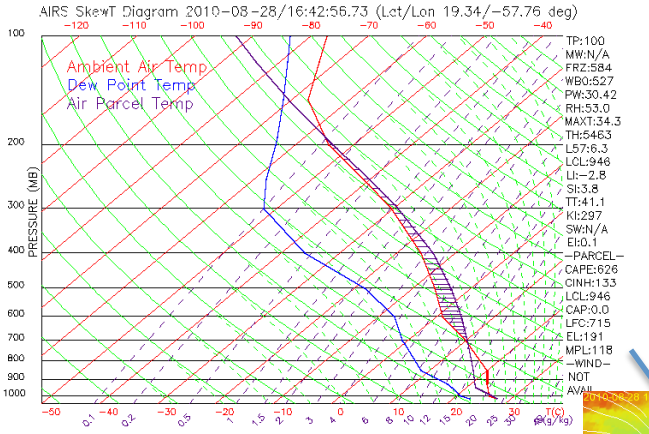
JPL

The JPL GRIP Portal – grip.jpl.nasa.gov

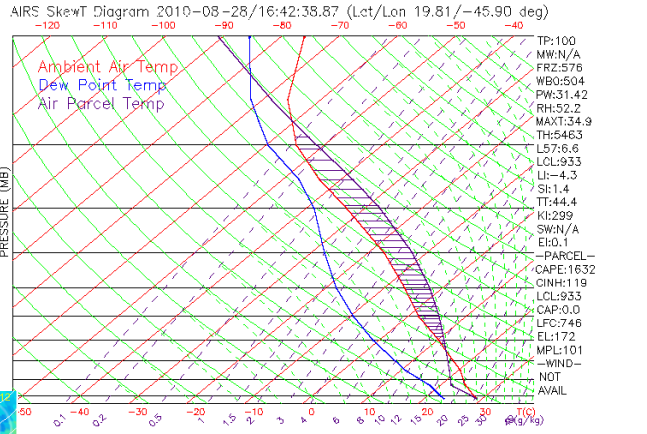
Hurricane Earl of 2010 – Bringing together model flow with satellite observations of precipitation, providing the context for the airborne observations

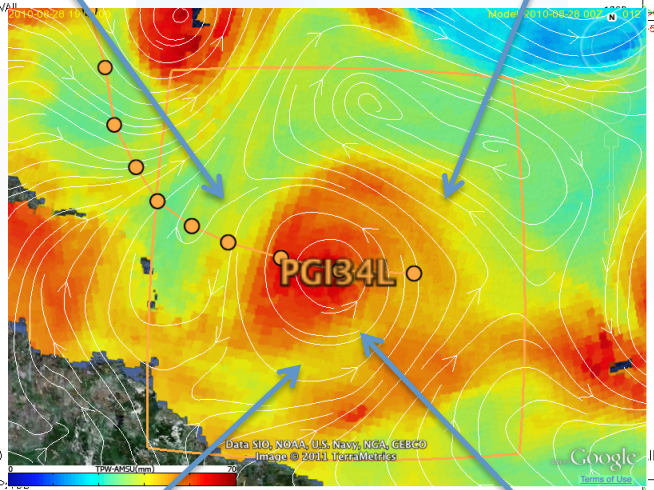


NRT Satellite Data – Use during the campaign

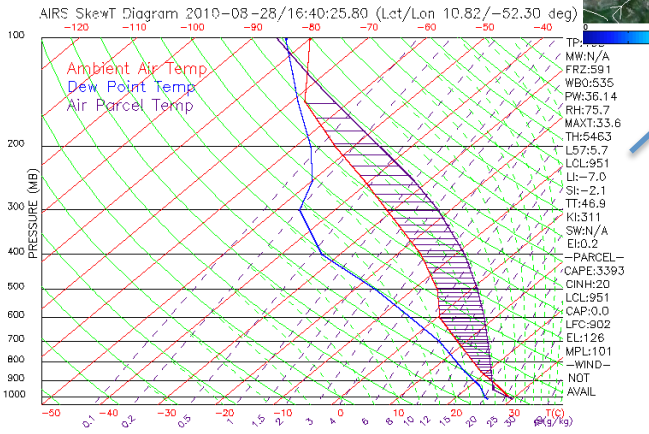


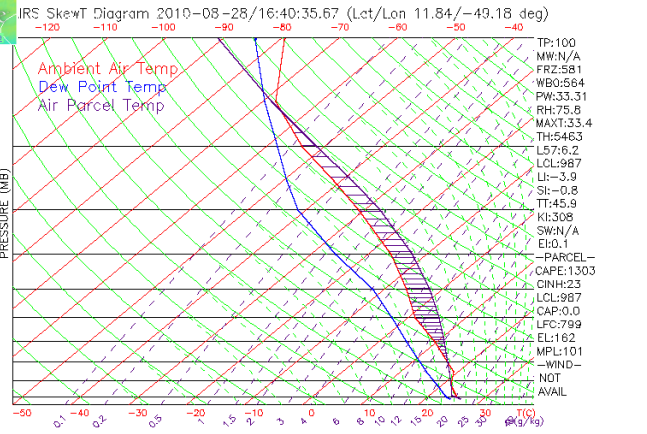
Hurricane Earl; Aug. 28, 2010 19Z





1. TPW from AMSU
2. Soundings from AIRS
3. Pouch-relative flow from ECMWF

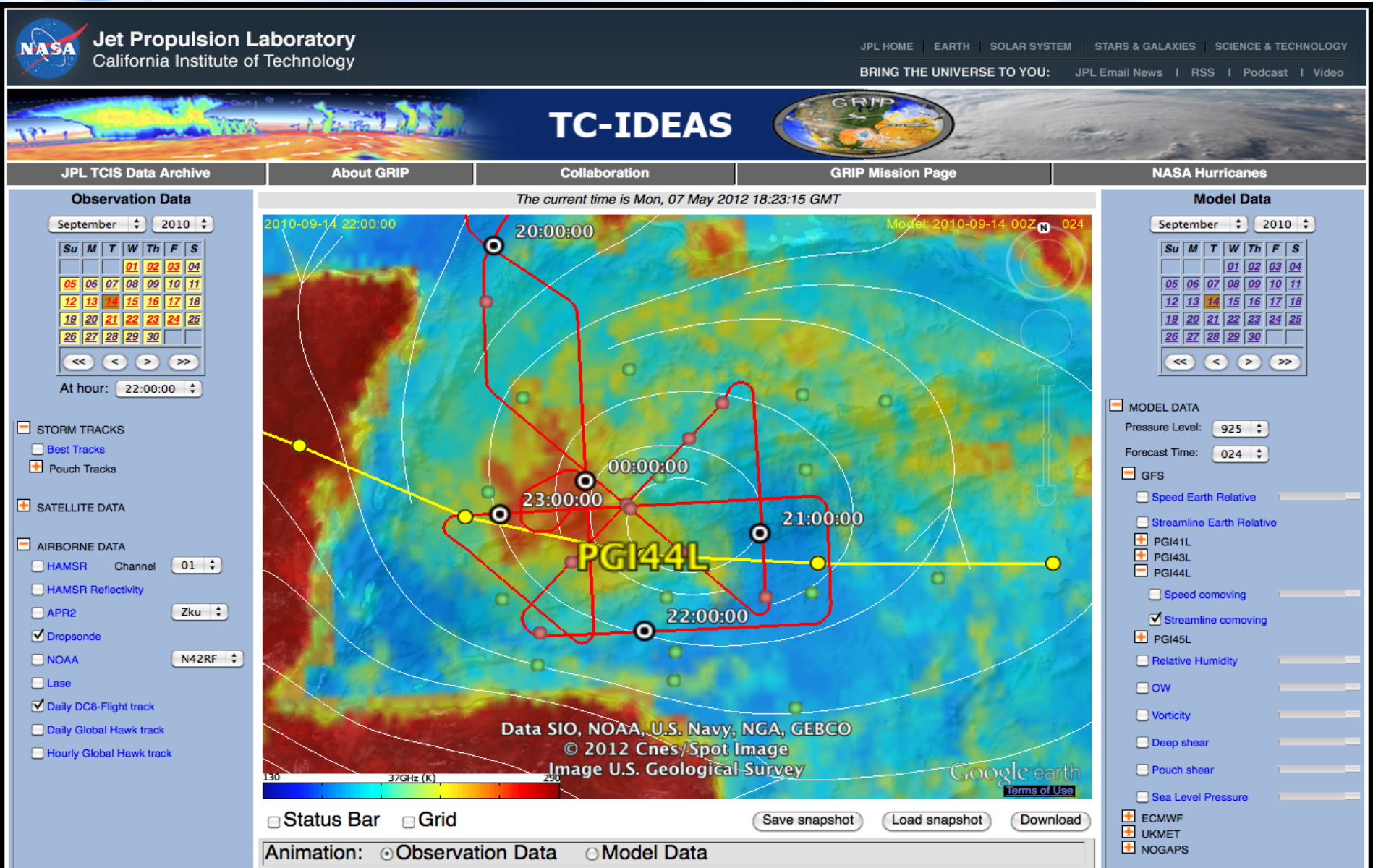




Multi-frequency active observations

TRMM-PR, CloudSAT and CALIPSO

Karl, just after genesis - 14th September 2010, 22Z
Bringing together model flow 37 GHz obs, airborne tracks and dropsonde data- providing the context for the airborne observations



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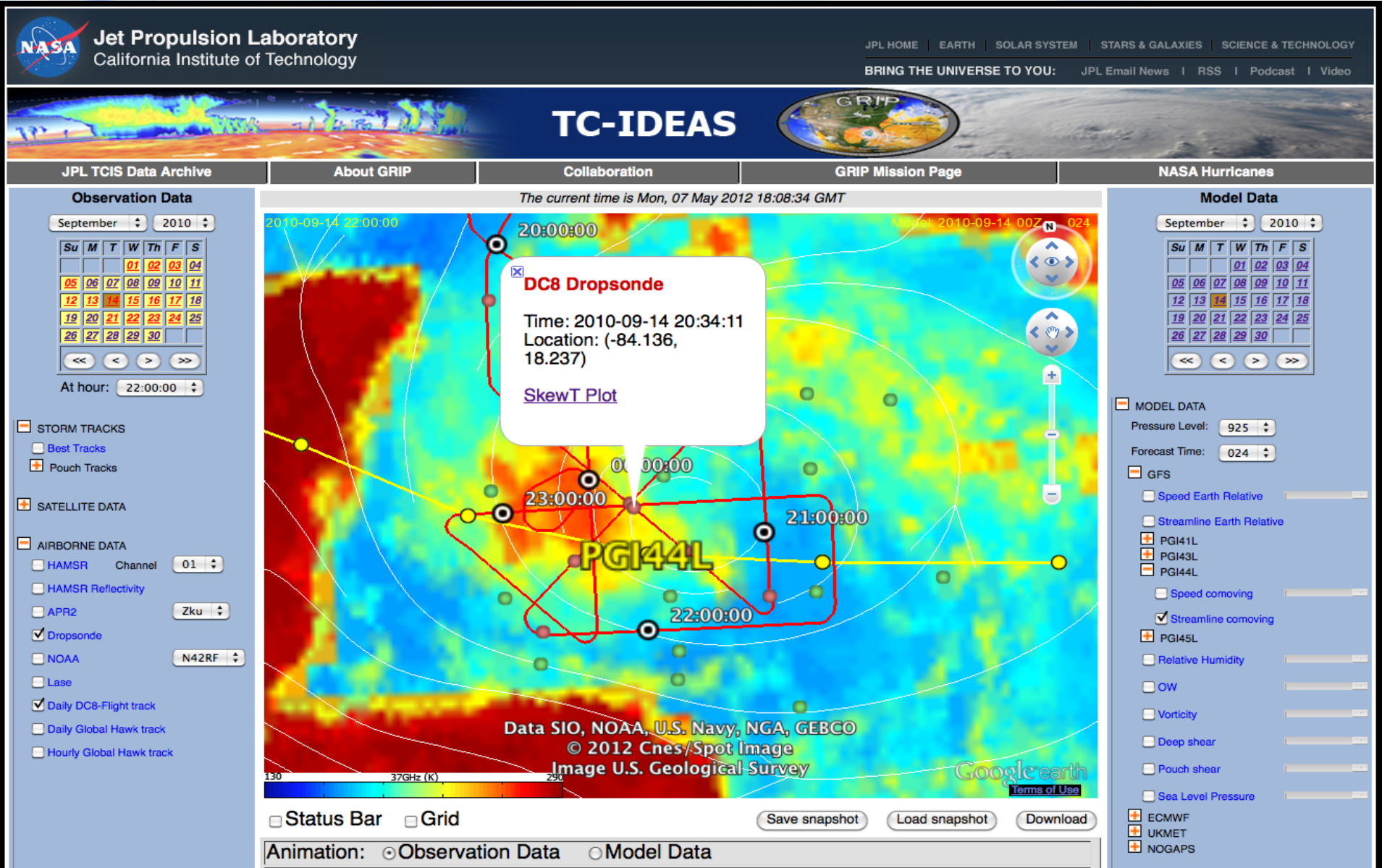

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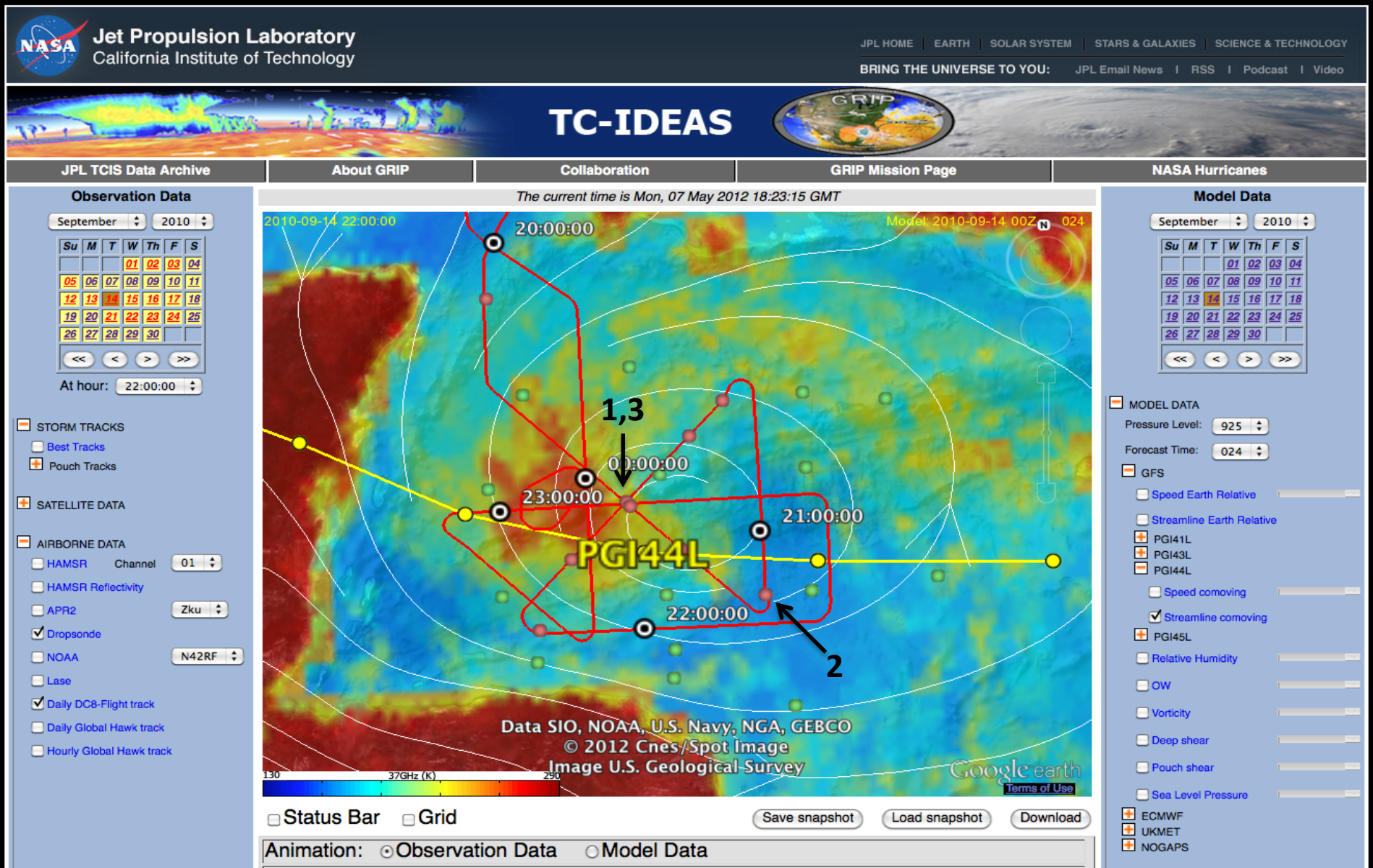
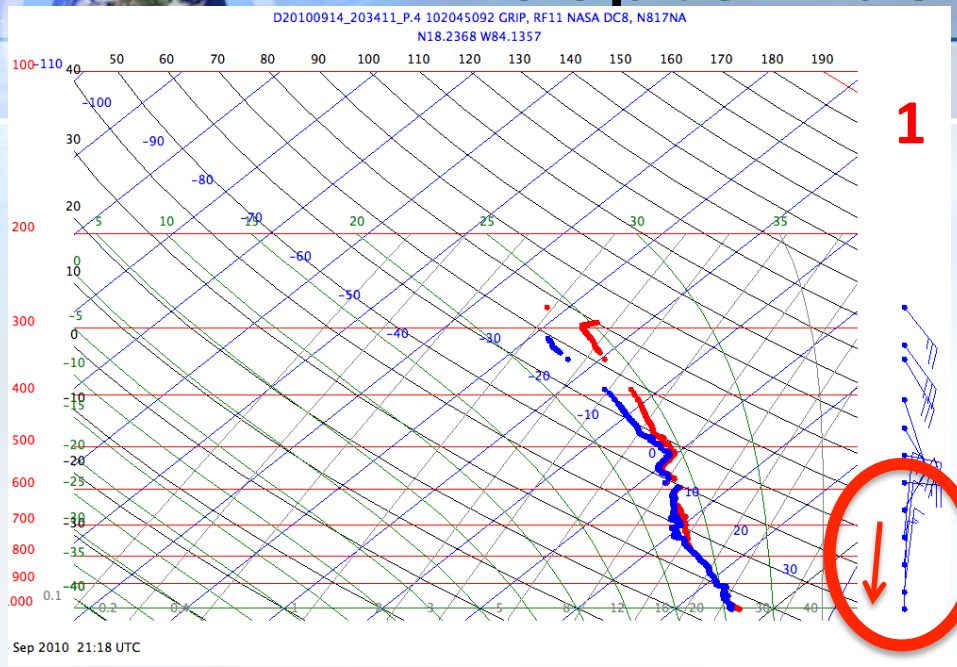


14th September 2010, 20-22 Z



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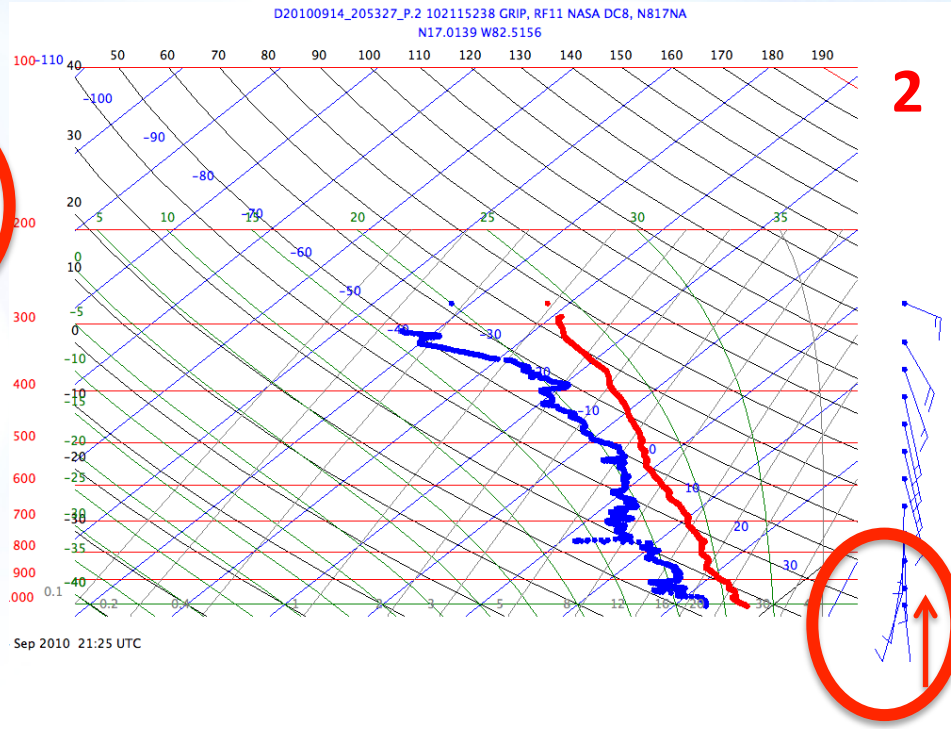

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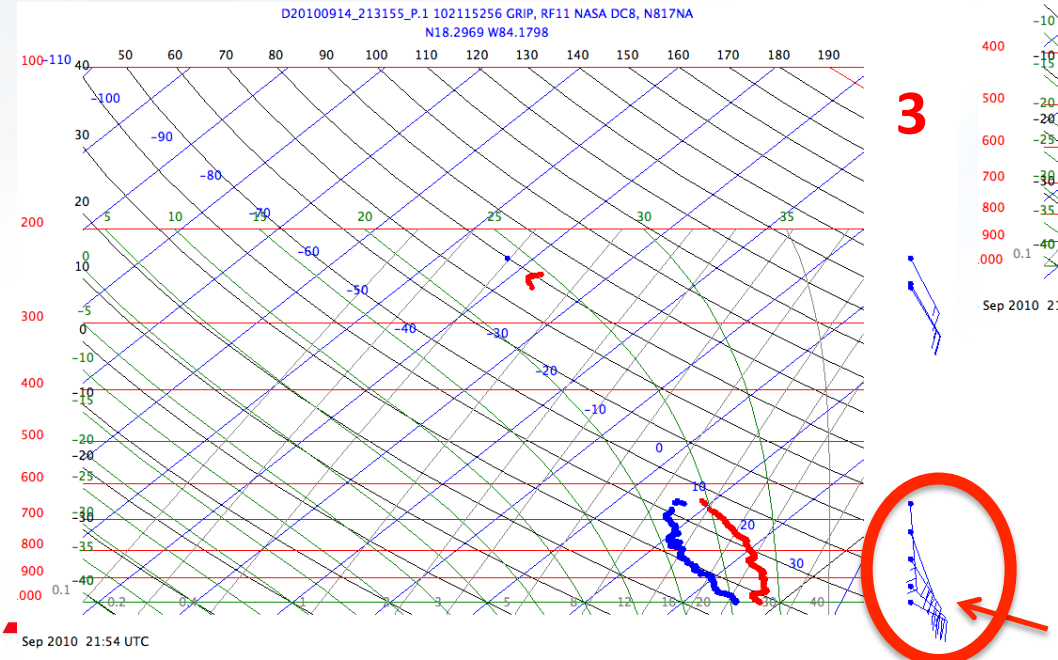
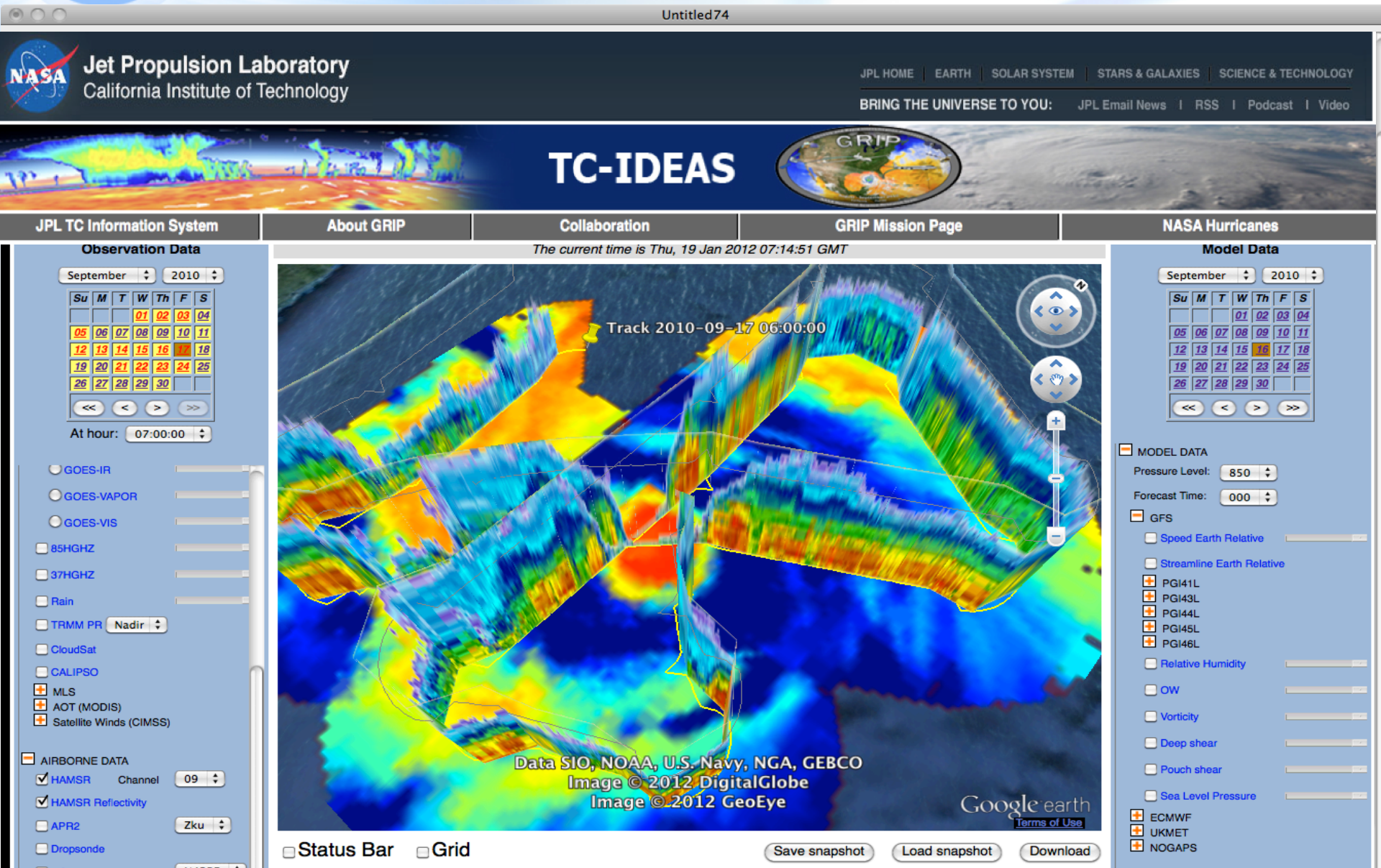


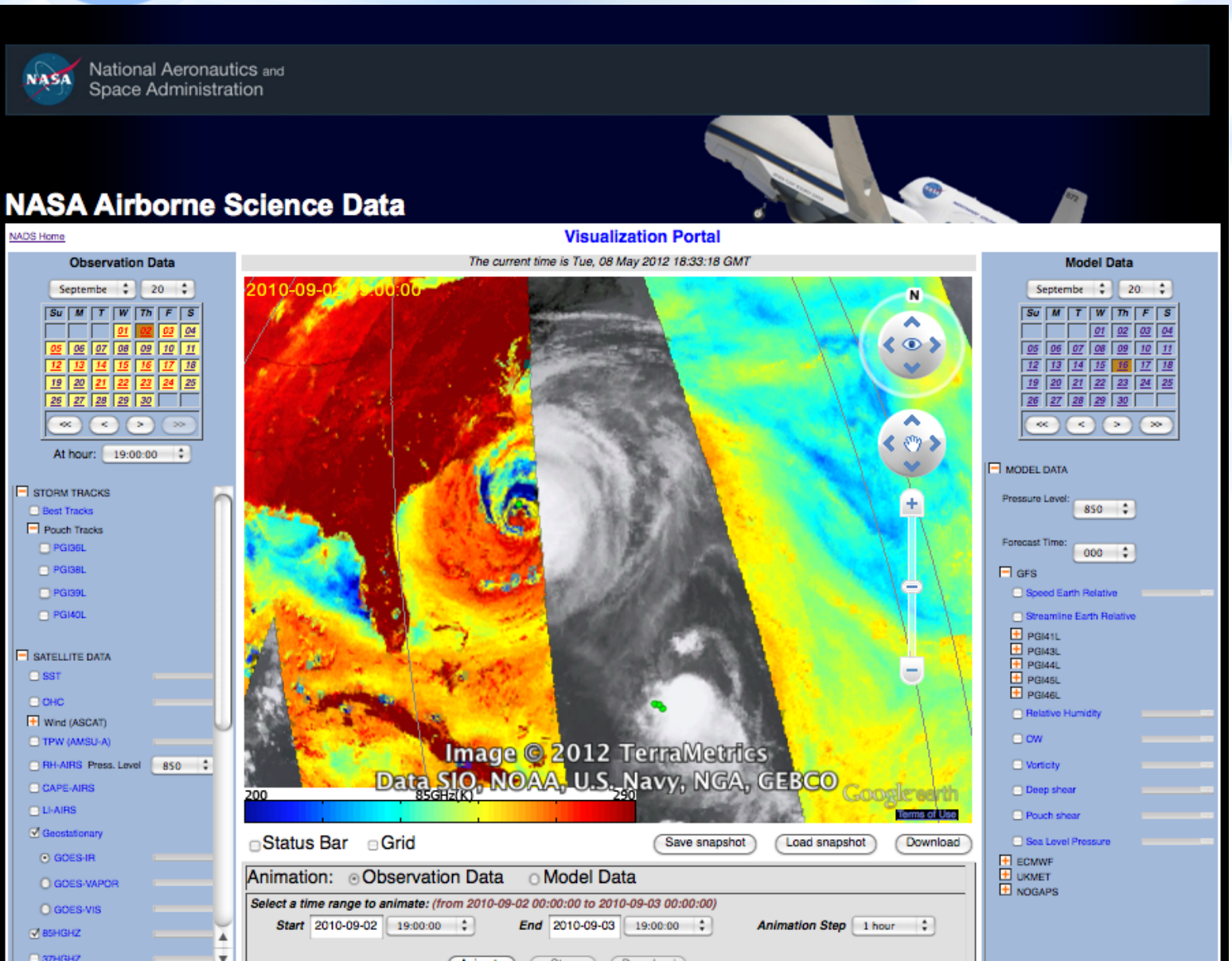
3

The 3D structure of the storm
17th September 2010, 07Z



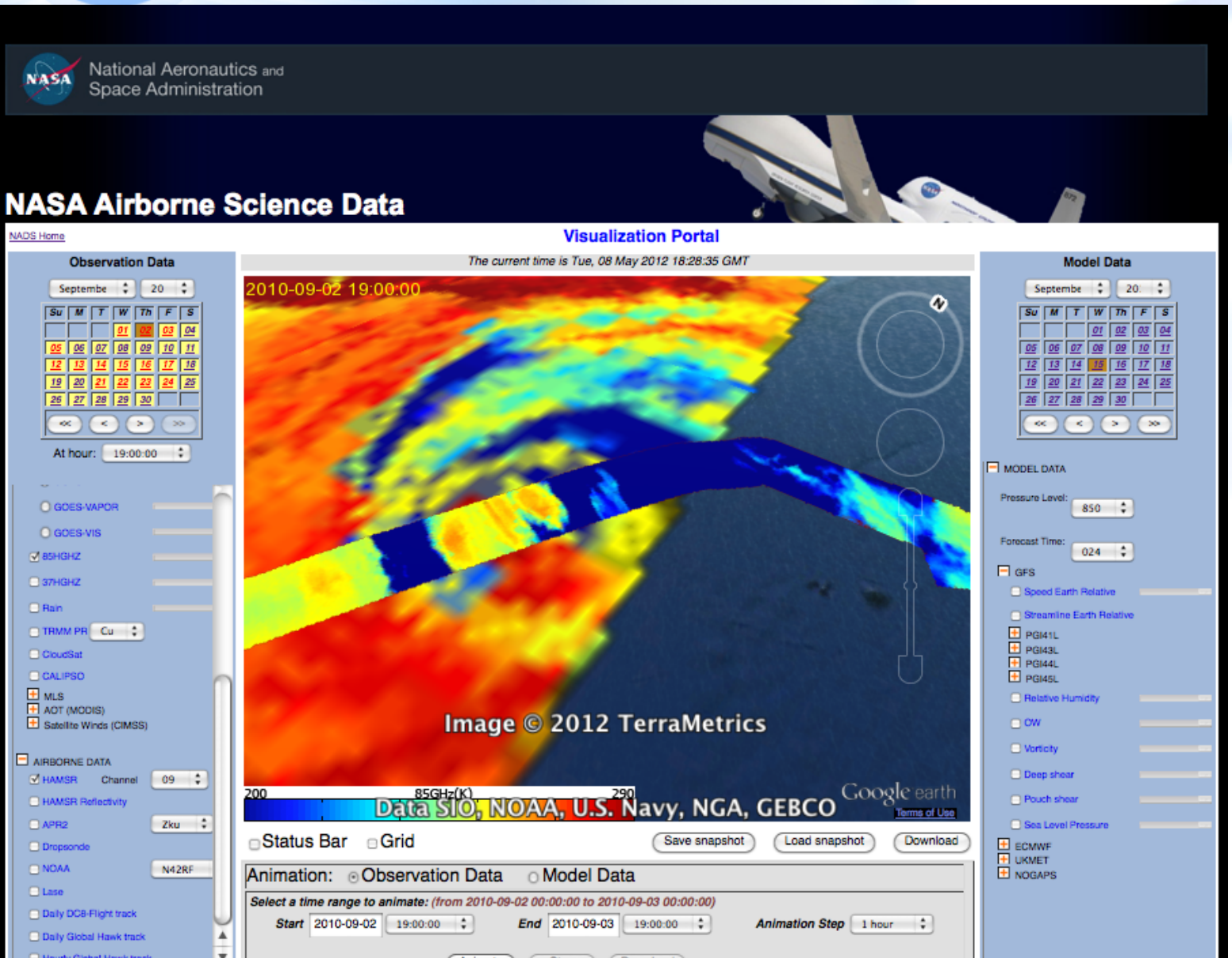
Investigate, share the scenes, get the data

02th September 2010, 19Z Earl



Investigate, share the scenes, get the data

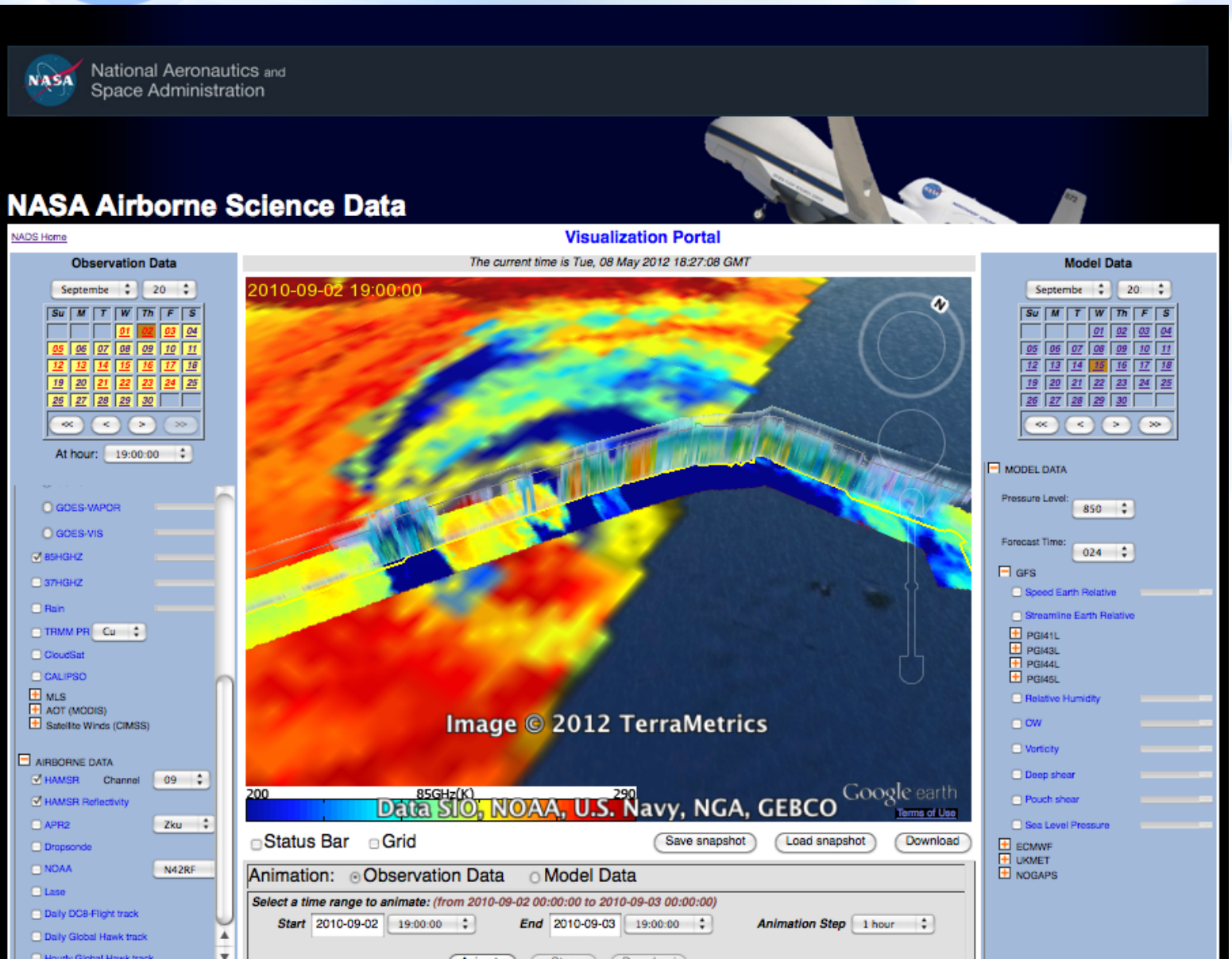
02th September 2010, 19Z Earl



85 GHz Tb
HAMSR – chan. 9

Investigate, share the scenes, get the data

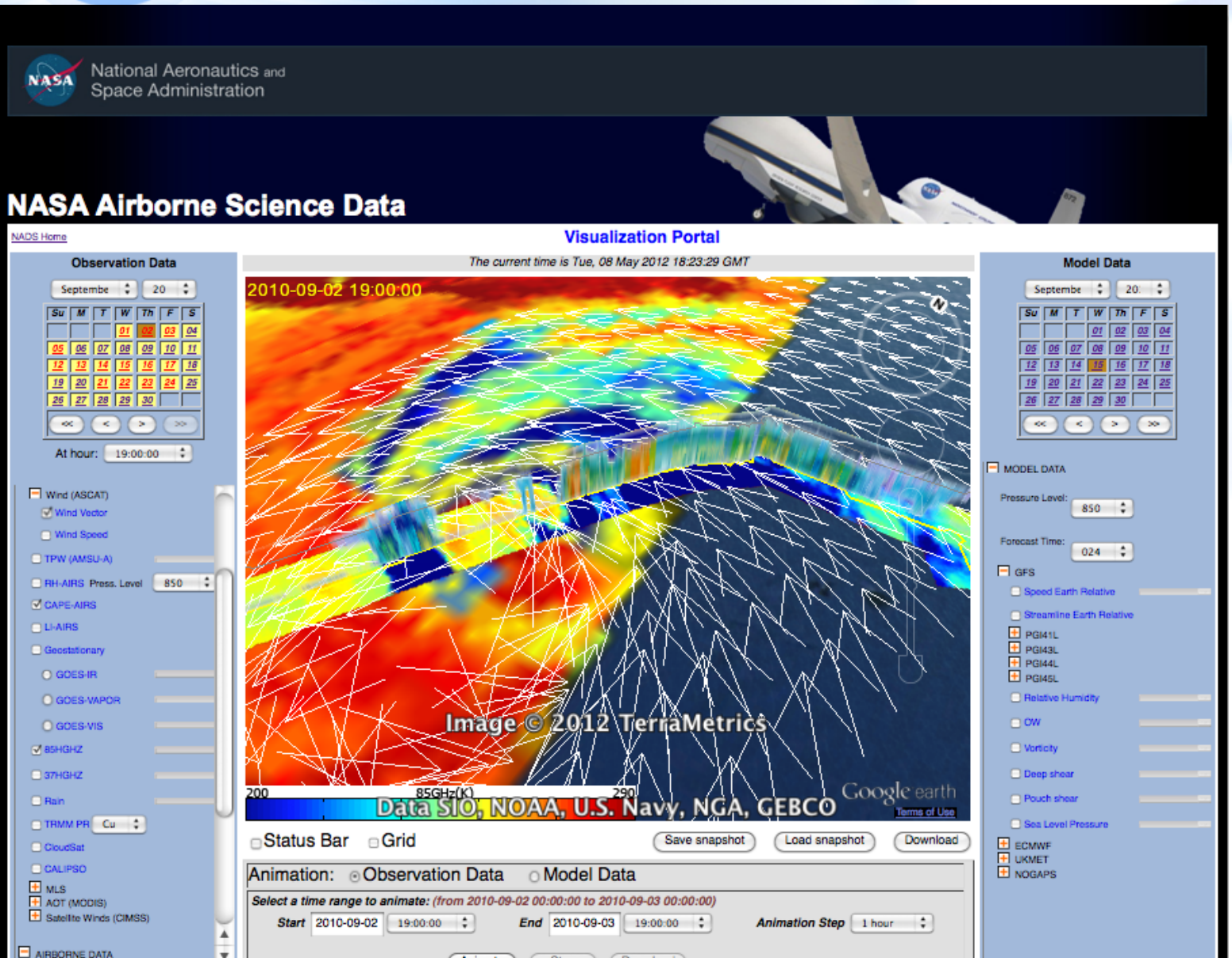
02th September 2010, 19Z Earl



85 GHz Tb
HAMSR – chan. 9
HAMSR – dBz

Investigate, share the scenes, get the data

02th September 2010, 19Z Earl



85 GHz Tb
HAMSR – chan. 9
HAMSR – dBz
ASCAT - winds

Cross Product Type Search

Browse By Type | Browse Across Types

Hide Filters

Filter: AccessGrantedTo = Add

Exclusive:

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Filename	=	ASCAT_MetOp-A_L2_Wind_20100903_0000.nc	Remove
Filename	=	HAMSR_GHAWK_L1B_20100902_1900.nc	Remove

To see these filters again, go to:
http://acce.jpl.nasa.gov/missions/NASD/browse/typesearch/1/Filename
/MULTI_COMPOSITE_L1_85H_20100903_0000.nc/Filename/ASCAT_MetOp-A_L2_Wind_20100903_0000.nc
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Page 1 of 1 (Products 1 to 3, out of 3)

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ASCAT_MetOp-A_L2_Wind_20100903_0000	ASCAT_Wind_L2	2010-09-03T00:00:00.000Z	2012-02-28T13:23:15.

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Product Metadata: HAMSR_GHAWK_L1B_20100902_1900

CAS.ProductId	94229ed5-6253-11e1-af2f-734eed206005
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PlatformId	GHAWK
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ProductType	HAMSR_L1B
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Download this Product:

HAMSR_GHAWK_L1B_20100902_1900.nc
42.4 MB
Mime Type: application/octet-stream
save

NEW FEATURES

- Option to save the scene
  - selected data
  - viewing geometry
- Data accesses
  - Displayed datasets can be downloaded in netcdf!!
- **Advantages**
  - Visualization facilitates exploration of multiparameter, multi-instrument observations
  - **"Snapshot" save** allows easy sharing and recollection
  - **"Download" button** gives you an immediate access to the digital data of interest
  - Digital data are stored in an unified format -netcdf

Summary

- **New Data**
  - TCIS – 11 year data records
  - GRIP and HS3 NRT portals for data interrogation
- **Diagnostics**
  - Use of instrument simulators
  - Analysis of:
    - 2D fields
    - Vertical structures
    - Composites
    - Principal components
- **Tools – Upgrades and new development**
  - **the HWSS**
    - Antenna convolution and Slant Path
  - **New AIST project – just staring up**
    - Integration of the ISSARS and HWSS instrument simulators with operational hurricane forecast models and incorporation of simulated satellite observables into the existing database of satellite and airborne observations.
    - Development of a set of advanced analysis tools

Summary

Advantages of the JPL TCIS:

- **The Tropical Cyclone Data Archive**
  - No need to query, find storms and discover – it is all there, organized and easy to obtain
  - It is global and covers 12 years of satellite observations
  - Imagery and digital data
  - Unified format - netcdf
- **GRIP/HS3 Portal**
  - Can go back in time!! Not just in NRT!
  - Google Earth Visualization allows overlay and interrogation of multi - parameter data
  - Offers model and multi-instrument data (satellite, airborne and in-situ)
  - New capability – save snapshots, download data

References:

- Hristova-Veleva, S. M., Y. Chao, A. Chau, Z. Haddad, B. Knosp, B. Lambrigtsen, P. Li, J. Martin, W. L. Poulsen, E. Rodriguez, B. Stiles, S. Tanelli, J. Turk, D. Vane, Q. Vu, 2010: "Impact of microphysical assumptions on the intensity and the structure of simulated hurricanes: Can satellite observations help determine the optimal set of microphysical assumptions?, AMS, 29th Conference on Hurricanes and Tropical Meteorology, May 2010, Tucson, AZ
- Hristova-Veleva, S. M., J. Steward, T. Vukicevic, Z, Haddad, S. Aberson, S. Gopalakrishnan, T. Quirino, F. J. Turk, P. P. Li, B. Knosp, B. Lambrigtsen, S. Durden, S. Tanelli, 2012: "The Experimental HWRF-HEDAS system: Using satellite observations to evaluate the model and to assess the impact of data assimilation", AMS, 30th Conference on Hurricanes and Tropical Meteorology, April 2012, Ponte Vedra Beach, FL
- Stiles, B., R. Danielson, W. L. Poulsen, M. J. Brennan, and S. M. Hristova-Veleva, 2012**:** Multiple Scatterometer Hurricane Winds Ten years of optimized QuikSCAT cyclone winds validated against best track speeds, H*WIND and SFMR, and initial OceanSAT-2 cyclone winds**,** 2012 IOVWST, Utreht, ND
- Wu, L., Hui Su, R. G. Fovell, B. Wang, J. T. Shen, B. H. Kahn,S. M. Hristova-Veleva, B. H. Lambrigtsen, E. J. Fetzer, J. H. Jiang, 2012: "Relationship of Environmental Relative Humidity with Tropical Cyclone Intensity and Intensification Rate over North Atlantic", *submitted*

Backup

The people on our team…

BRIAN KNOSP	- Database development and data repository retrievals
P PEGGY LI	- Google Earth display integration, Plot development
FRANCIS (Joe) TURK	- Data repository retrievals and plot development
WILLIAM (Lee) POULSEN	- Hurricane track display development, scatterometer winds
QUOC VU	- Website creation
STEPHEN LICATA	- Data plot development
TSAE-PYNG (Janice) SHEN	- Data plot development

Project development, concept, and design

SVETLA HRISTOVA-VELEVA, BJORN LAMBRIGTSEN,

YI CHAO, SIMONE TANELLI, HUI SU, ZIAD HADDAD, DEB VANE

svetla.veleva@jpl.nasa.gov

The JPL Tropical Cyclone Information System (TCIS)

Funded by the Hurricane Science Research Program

Collaborations

- **Satellite projects – CloudSAT, QuikSCAT, AIRS, MLS –** JPL/NASA
- **HURSAT** - NCDC/NOAA
- **NPS** - Naval Postgraduate School, Monterey, CA
- **CIMSS** - Cooperative Institute for Meteorological Satellite Studies at the University of Wisconsin-Madison
- **NRL** - U.S. Naval Research Laboratory, Washington, D.C.
- **RSMAS** - The Rosenstiel School of Marine and Atmospheric Science
- **HRD** - Hurricane Research Division/AOML/NOAA
- **NCAR** - National Center for Atmospheric Research, Boulder, CO
- **MSFC** - NASA's Marshall Space Flight Center, Huntsville, AL

The JPL Tropical Cyclone Information System (TCIS)

http://tropicalcyclone.jpl.nasa.gov

Objective of the TCIS

To provide a one-stop place that facilitates fusion of multi-parameter, multi-instrument observations (satellite, airborne and in-situ) and model output, relevant to both the large-scale and the storm-scale hurricane processes, in the atmosphere and in the ocean.

Goal:

- help understand the physical processes that determine hurricane genesis, intensity, track and impact on large-scale environment
- help improve hurricane forecast accuracy by facilitating validation and improvement of hurricane models through comparison with observations and development of new data assimilation techniques
- enable studies aimed at developing new algorithms, sensor systems and missions.

The 12-year Global Data Archive

- A wide variety of data types
- Organized by year, basin, storm
  - no need to search!!!
- DATA and imagery
- Large-scale and storm scale

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  - Large-scale (over the ocean basins; +2 days on either side)
    - SST
    - Scatterometer winds
    - TPW
    - Thermodynamic atmospheric structure from AIRS

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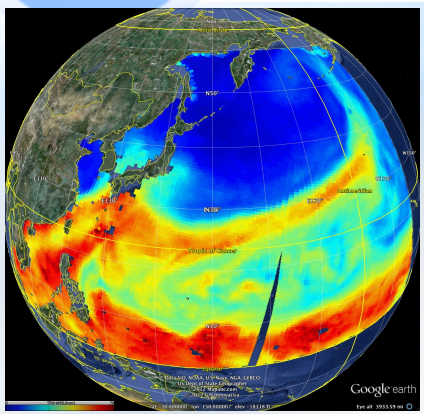
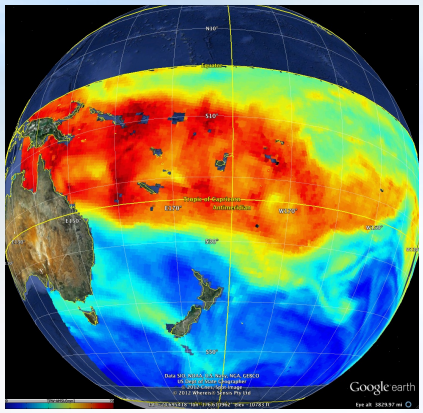
    - SST
    - Scatterometer winds
    - TPW
    - Thermodynamic atmospheric structure from AIRS
  - Storm scale
    - Geostationary IR: GOES, MTSAT, FY2, Meteosat, MSG (HURSAT Version 5)
    - Multi-frequency brightness temperatures from TRMM-TMI, AMSR-E, SSMI
    - full set of radar observations from TRMM-PR and CloudSAT
    - QuikSCAT surface winds
    - MLS, OMI

Basin Scale Domains
Example -TPW



West Pacific



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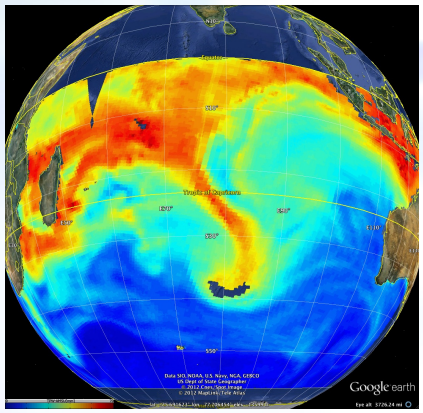
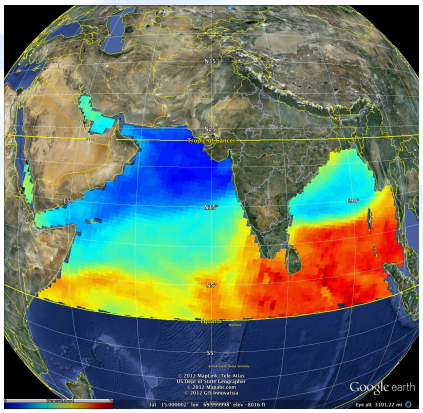


South Indian



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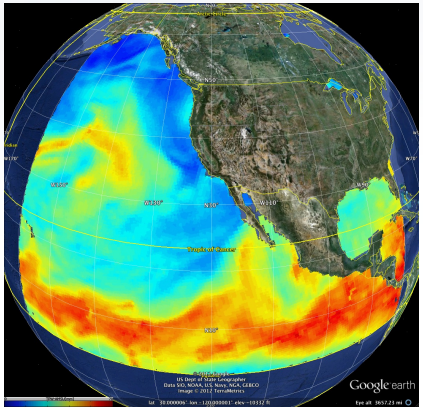
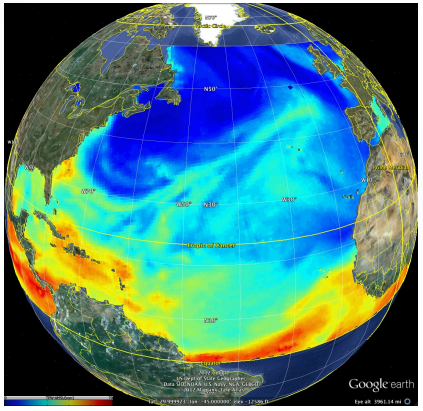
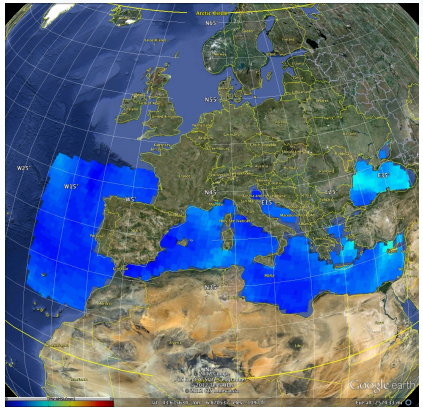


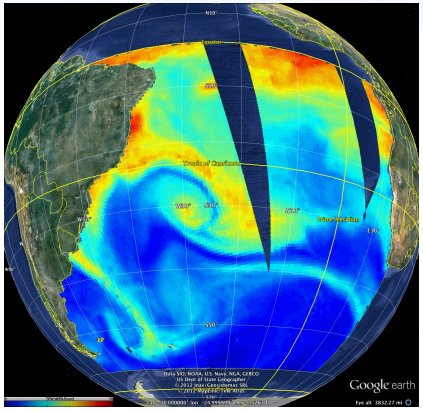
East Pacific



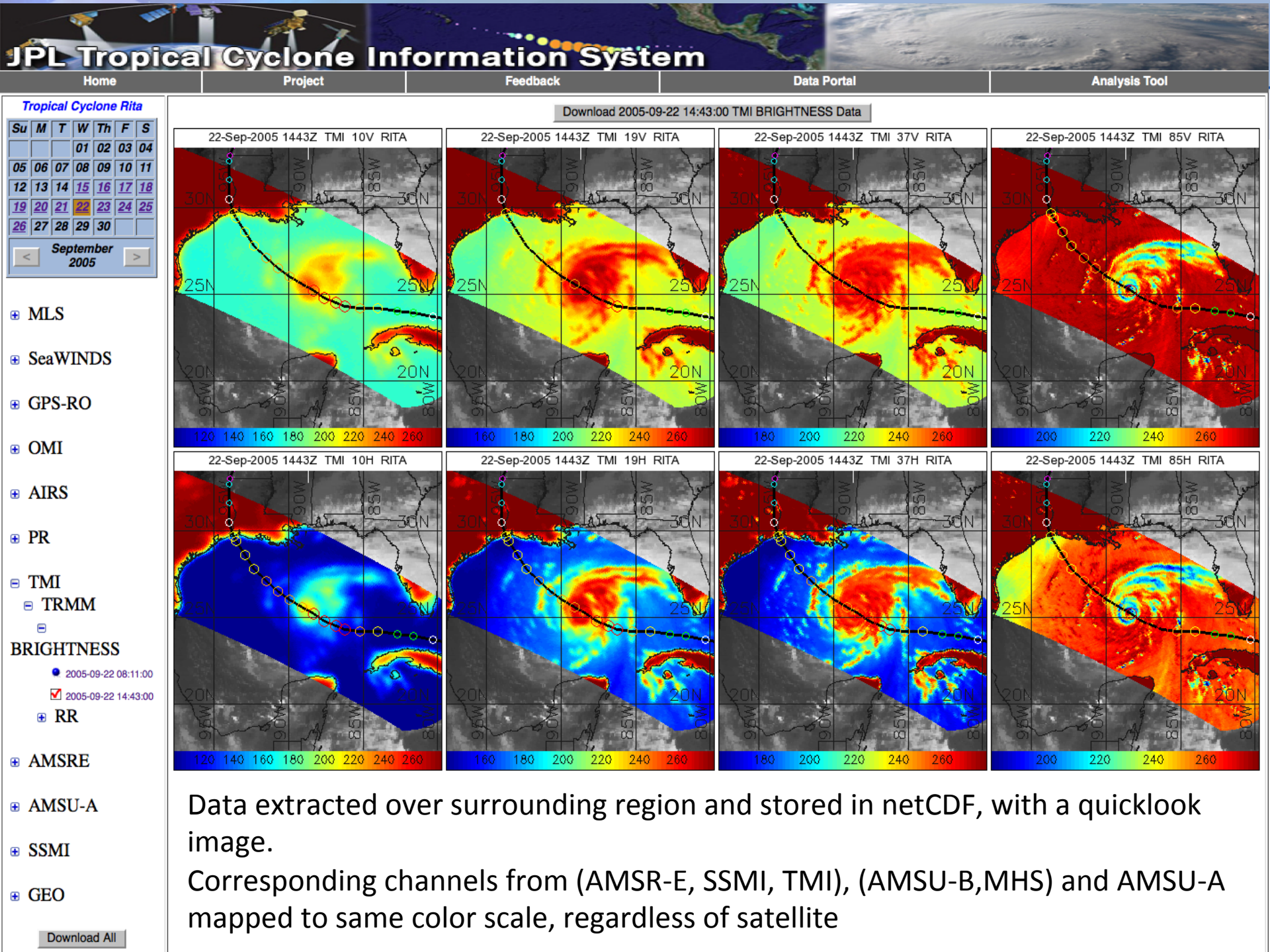
North Atlantic



Mediterranean Sea



South Atlantic



Data extracted over surrounding region and stored in netCDF, with a quicklook image.

Corresponding channels from (AMSR-E, SSMI, TMI), (AMSU-B,MHS) and AMSU-A mapped to same color scale, regardless of satellite

JPL Tropical Cyclone Information System

Tropical Cyclone Rita

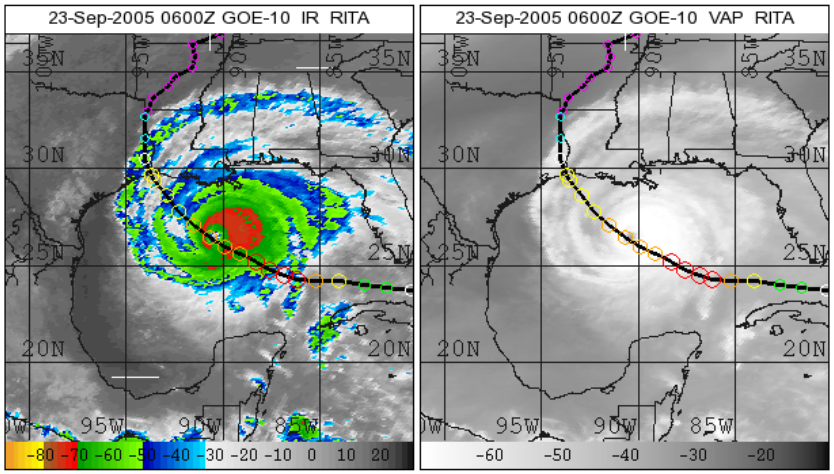
Su	M	T	W	Th	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

< September 2005 >

- MLS
- SeaWINDS
- GPS-RO
- OMI
- AIRS
- PR
- TMI
- 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



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