# The JPL Tropical Cyclone Information System: A 12-year global archive of multi-satellite hurricane observations and the 2010 GRIP portal of the Atlantic

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

May 10, 2012

# 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

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# 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.

JPL

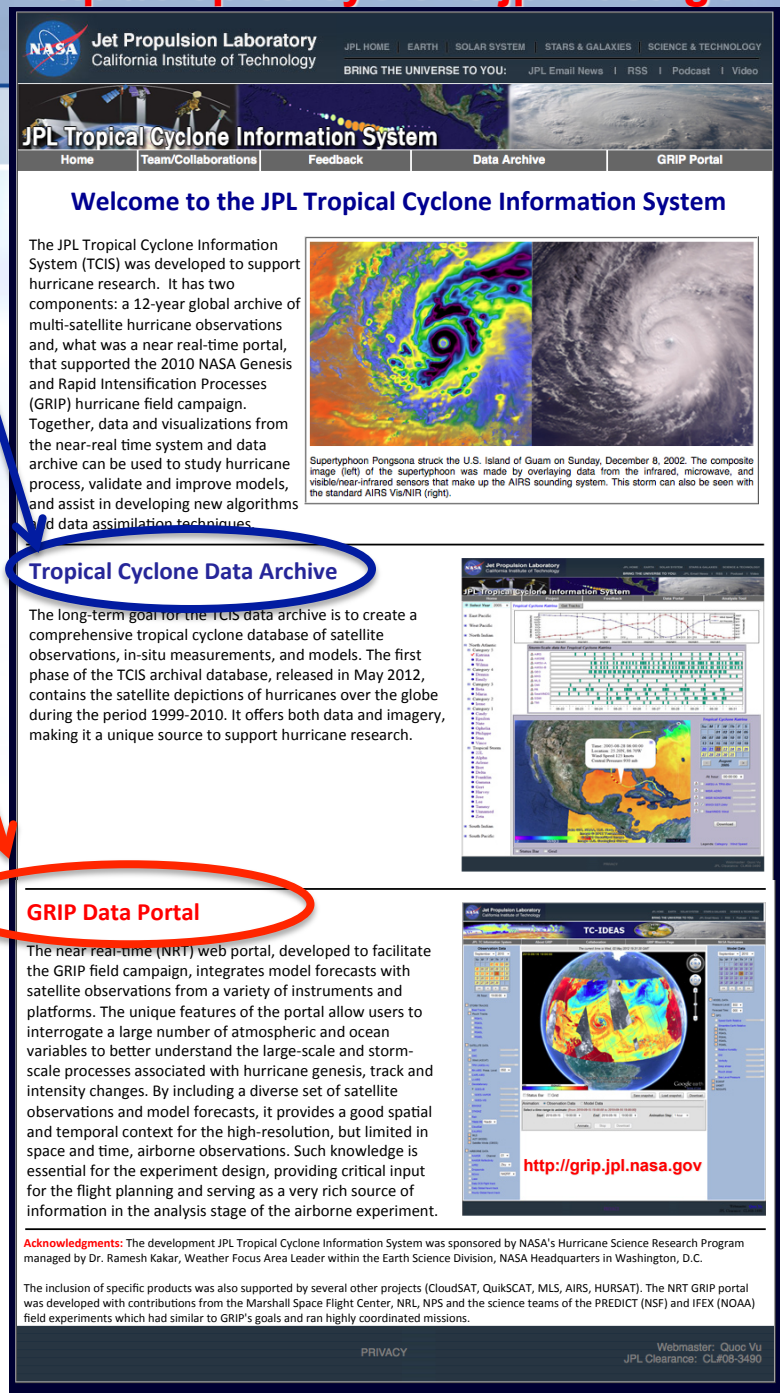
# Tropical Cyclone Data Archive

- 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

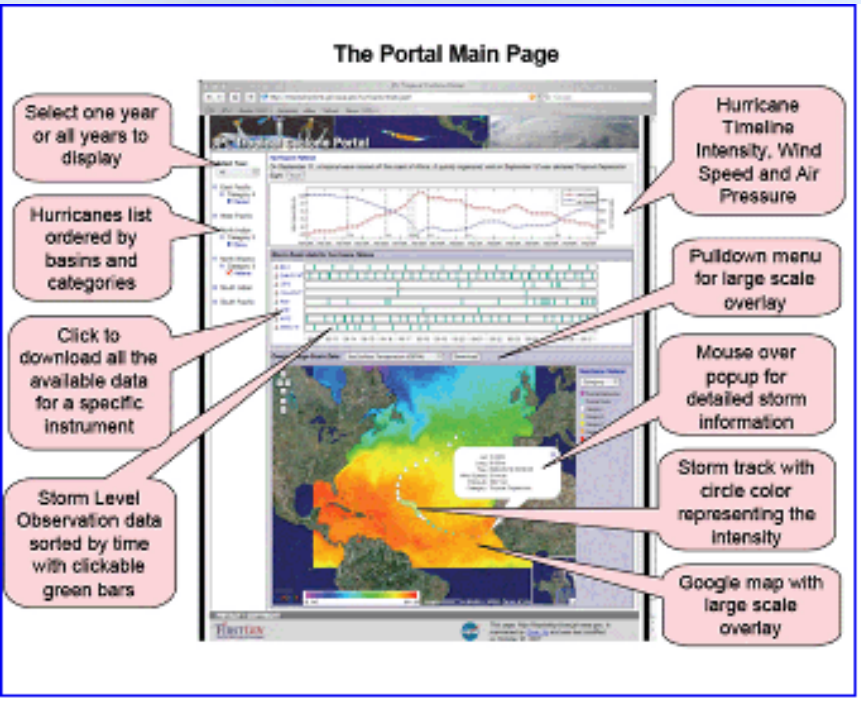


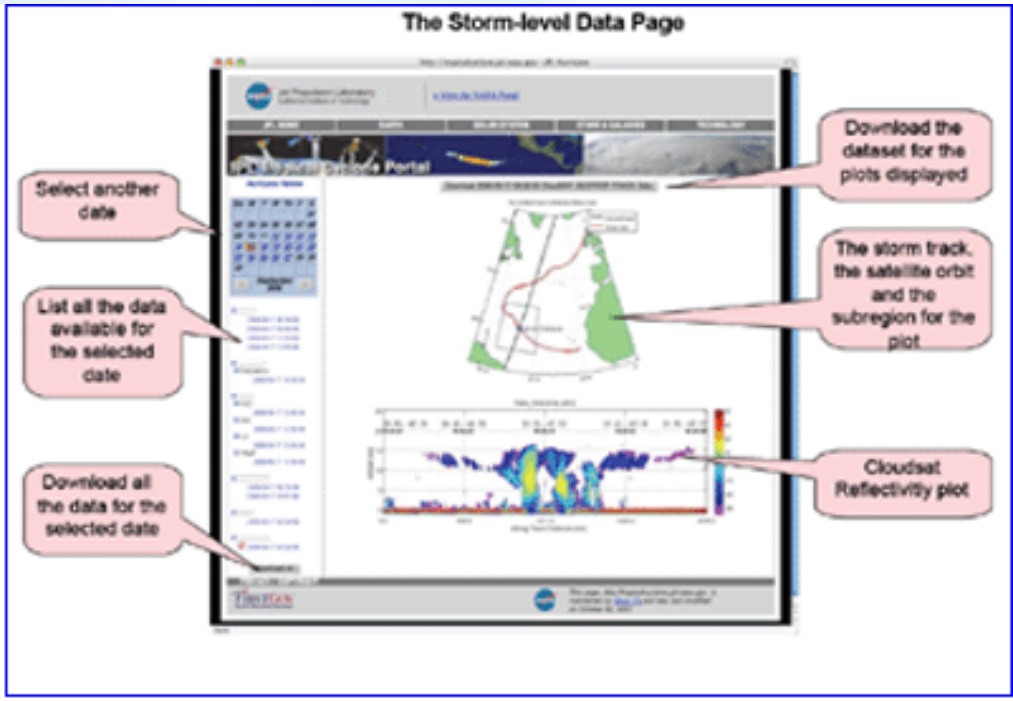
# The 12-year Global Data Archive

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

# Tropical Cyclone Data Archive

## Guidelines / Help



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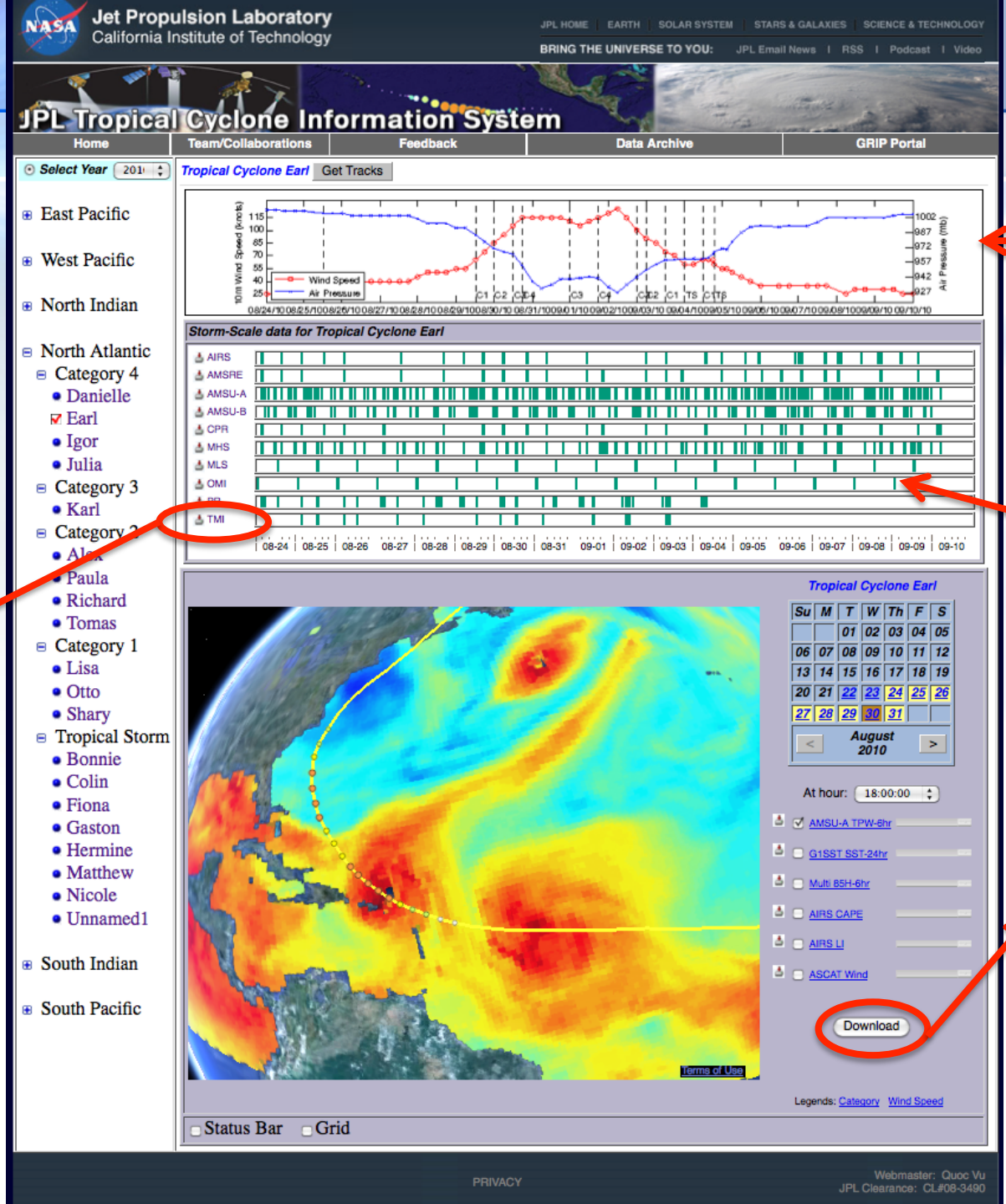
  - Large-scale (over the ocean basins; +2 days on either side)
    - SST
    - Scatterometer winds
    - TPW
    - Thermodynamic atmospheric structure from AIRS

Earl, 2010

Download all data from this Instrument (TMI)

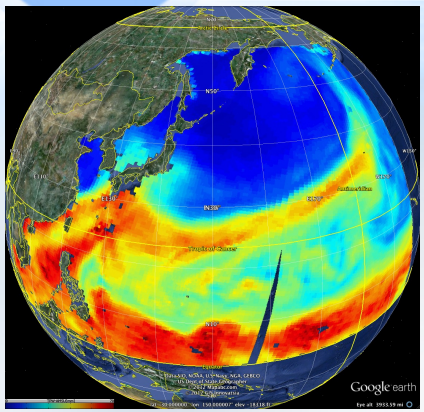



Timeline

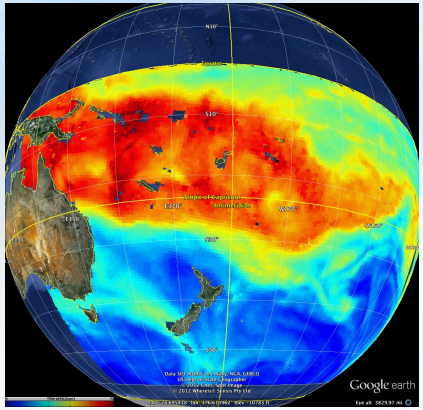
View and download Storm-scale data

Download Selected large-scale data from this day

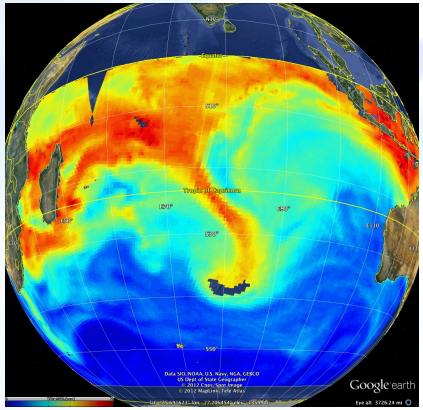
# Basin Scale Domains
# Example -TPW



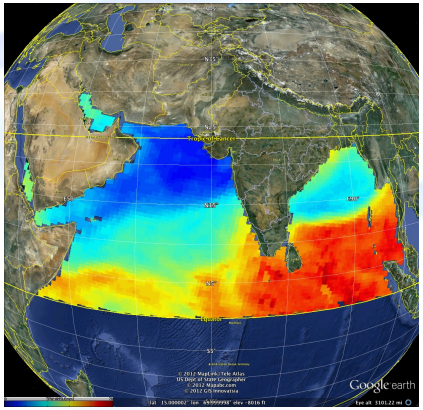

West Pacific



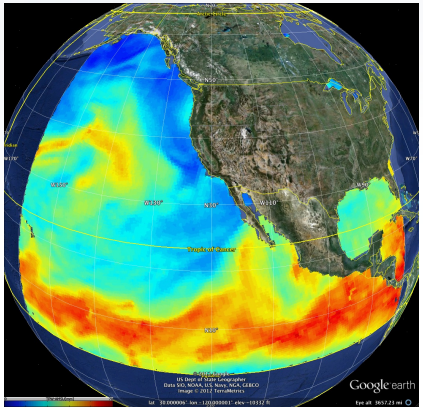

South Pacific



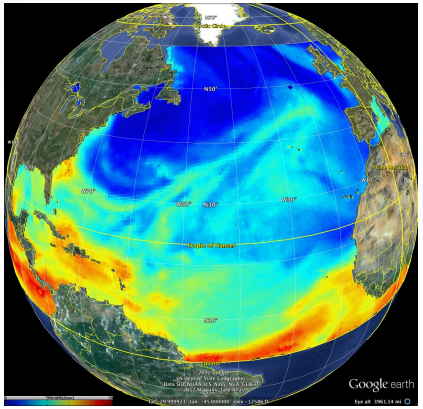

South Indian



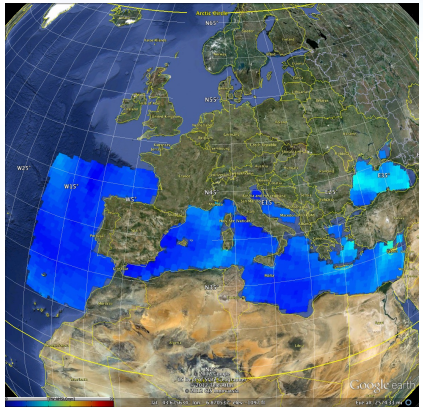

North Indian



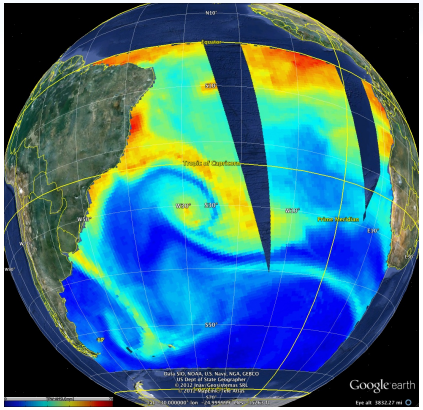

East Pacific




North Atlantic




Mediterranean Sea




South Atlantic

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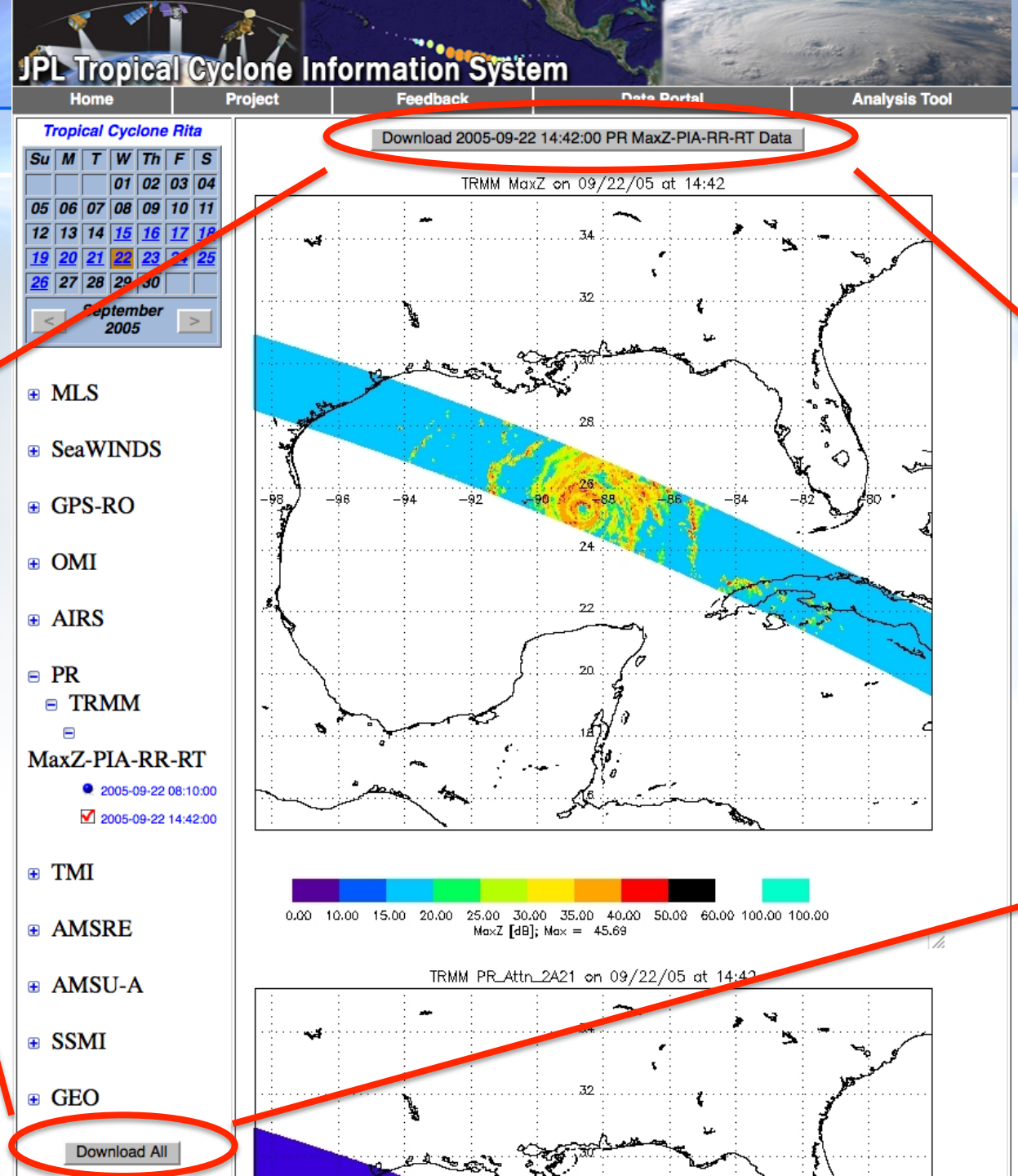
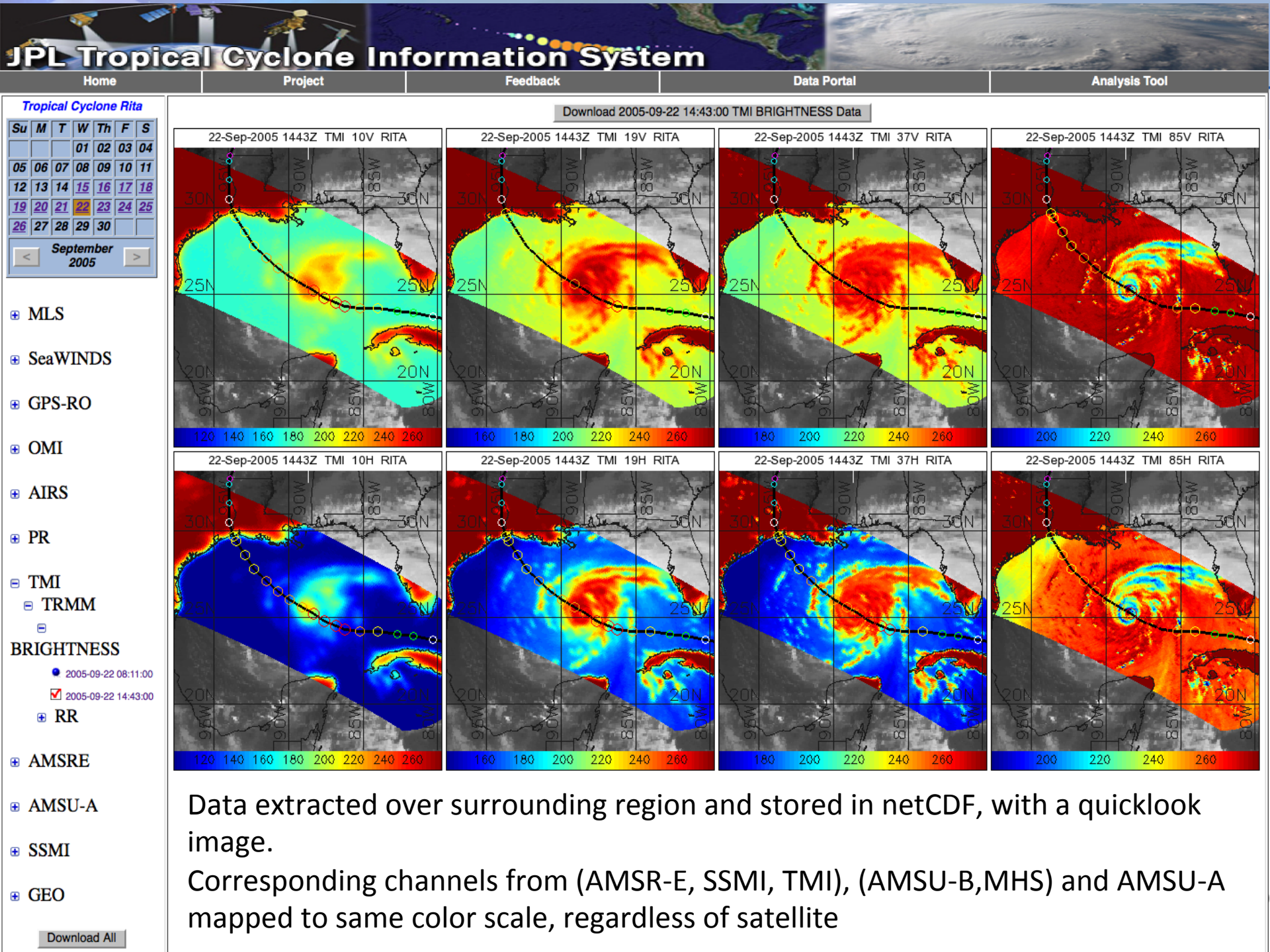
    - SST
    - Scatterometer winds
    - TPW
    - Thermodynamic atmospheric structure from AIRS
  - Storm scale
    - Geostationary IR: GOES, MTSAT, FY2, Meteosat, MSG (HURSAT Version 5)
    - Multi-frequency brightness temperatures from TRMM-TMI, AMSR-E, SSMI
    - full set of radar observations from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




Download NetCDF

At this time

All data on this day




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**

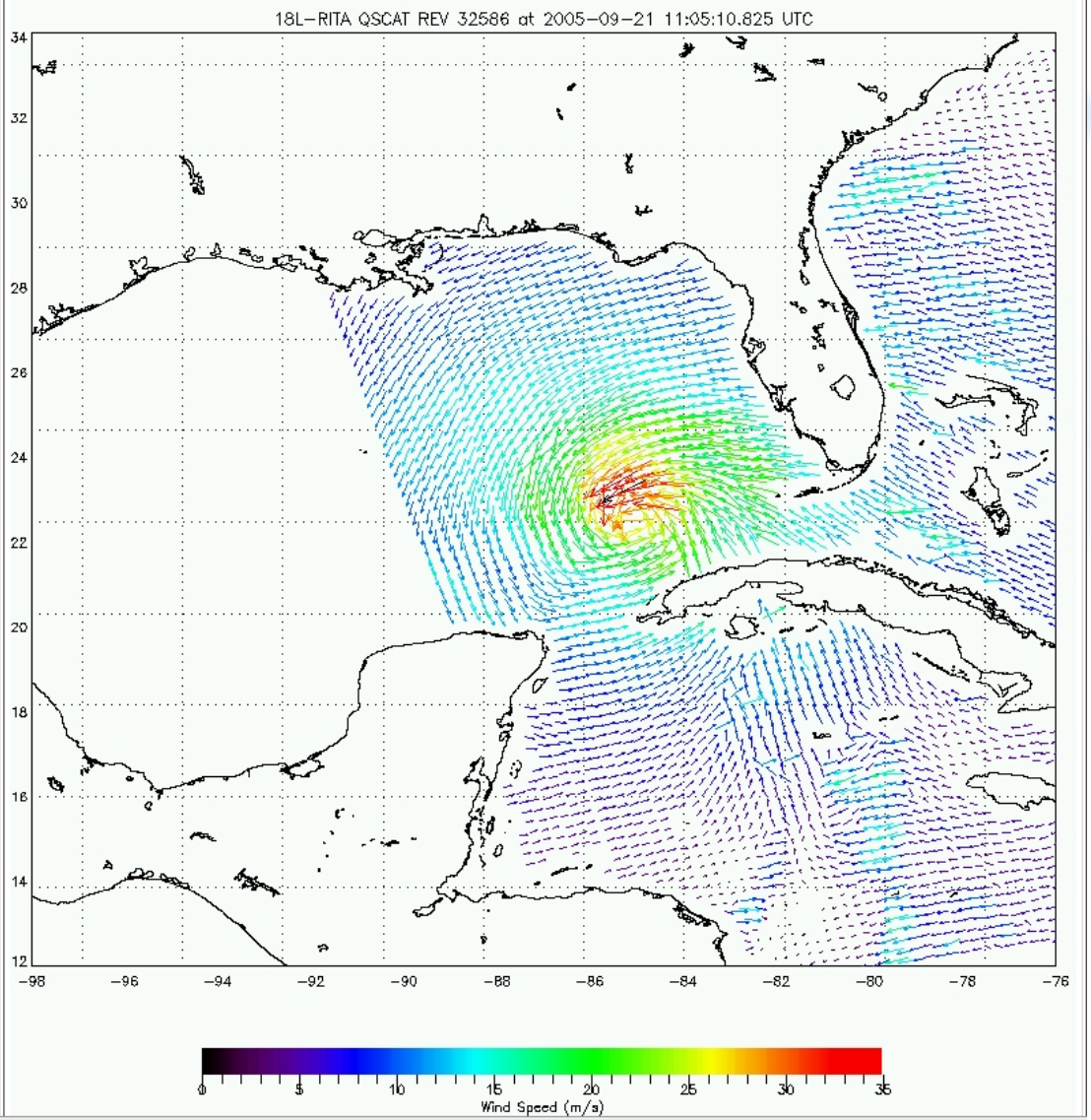
| Su | M | T | W | Th | F | S |
|---|---|---|---|---|---|---|
| | | | 01 | 02 | 03 | 04 |
| 05 | 06 | 07 | 08 | 09 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 | | |

< September 2005 >

- MLS
- SeaWINDS
  - 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



# 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 |
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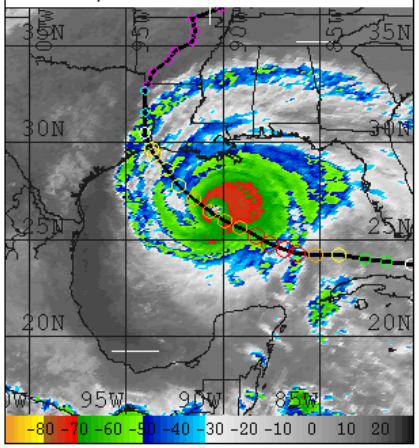
< September 2005 >

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

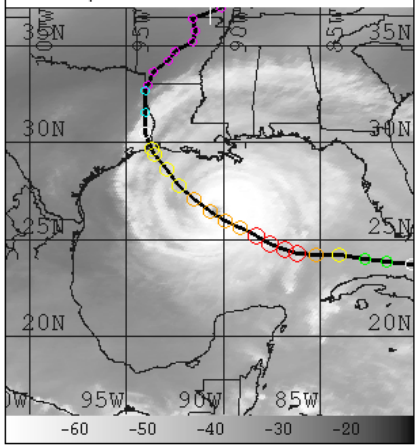
Download All

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

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



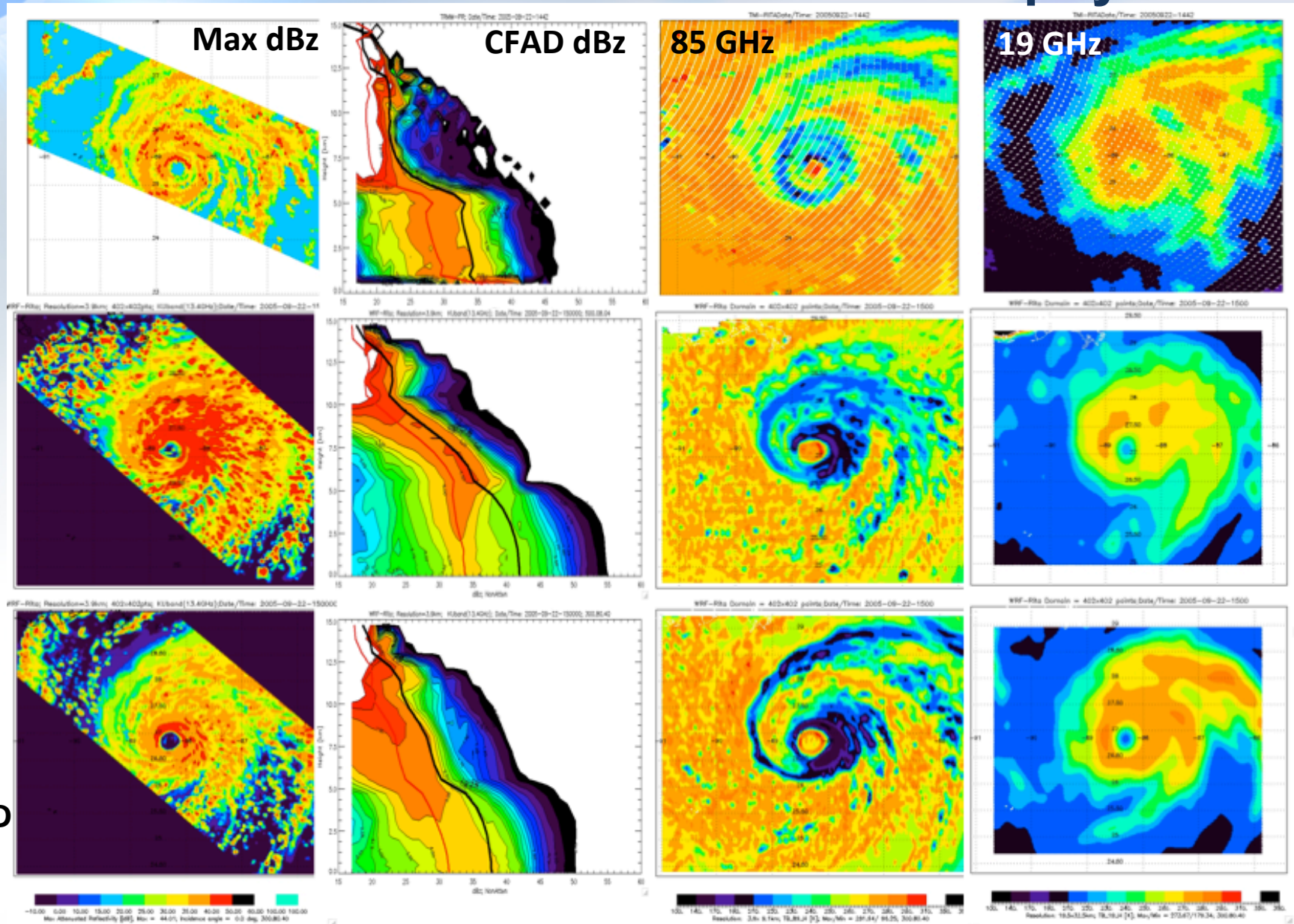

23-Sep-2005 0600Z GOE-10 VAP RITA



# 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!!!

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




JPL

# Research using the TCIS Data Archive:

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

### Using AIRS temperature and humidity

**DATA**

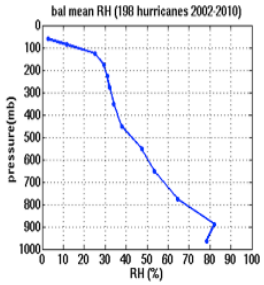
198 North Atlantic Ocean TCs from 09/2002 to 11/2010 based on NHC Best Track Data

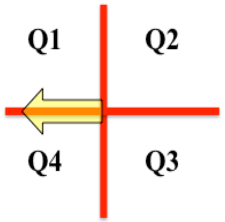
- 74 Cat 1-5 hurricanes (37%)
- 36 Cat 3-5 hurricanes (18%)
- 10 Cat 5 hurricanes (5%)

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

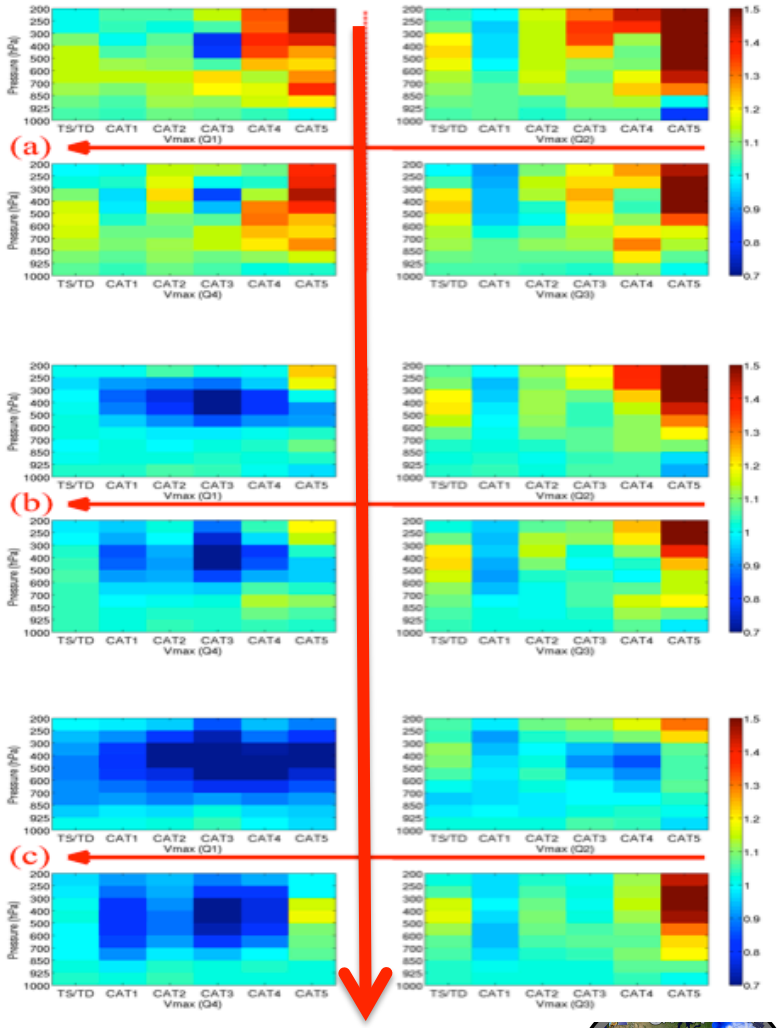



Range 200-400km

Range 400-600km

Range 600-800km



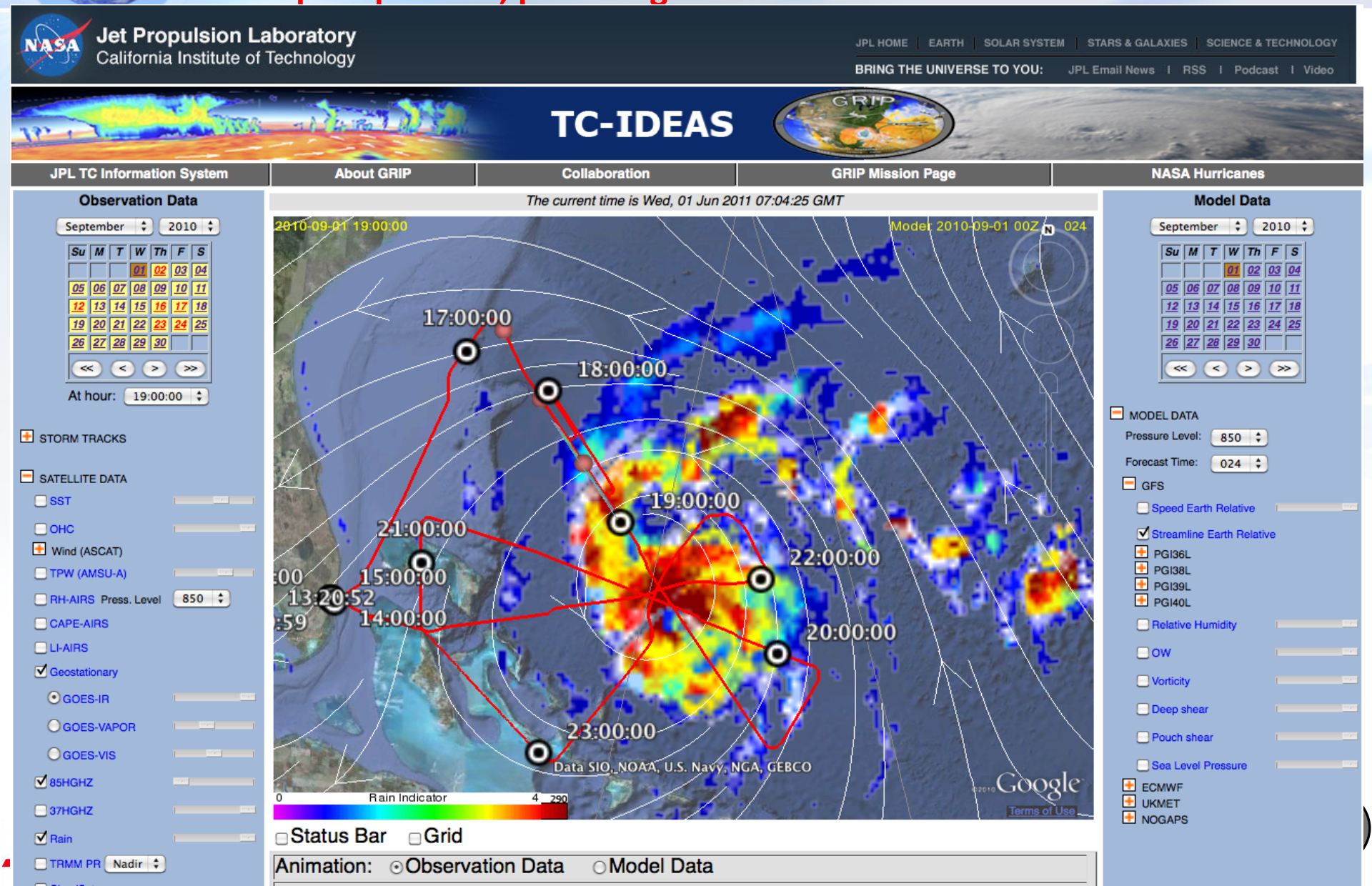

Longtao Wu[1,2], Hui Su[1], Robert G. Fovell[3], Bin Wang[4], Janice T. Shen[1], Brian H. Kahn[1], Svetla M. Hristova-Veleva[1], Bjorn H. Lambrigtsen[1], Eric J. Fetzer[1], Jonathan H. Jiang[1], 2012: "Relationship of Environmental Relative Humidity with Tropical Cyclone Intensity and Intensification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

# The GRIP PORTAL

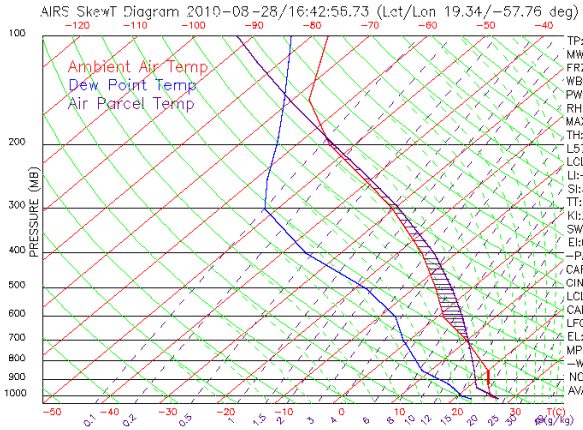
- A near real-time (NRT) web portal
- Developed to facilitate the GRIP field campaign
- Integrates model forecasts with satellite observations from a variety of instruments and platforms.
- The unique features of the portal allow users to interrogate a large number of atmospheric and ocean variables 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

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

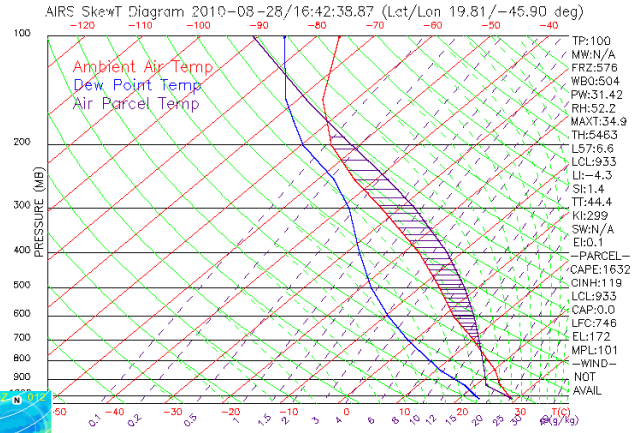
## Hurricane Earl of 2010 – Bringing together model flow with satellite observations of precipitation, providing the context for the airborne observations

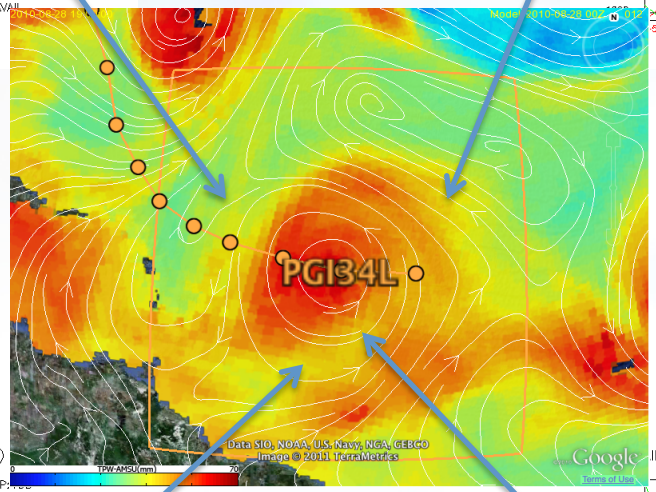


# NRT Satellite Data – Use during the campaign

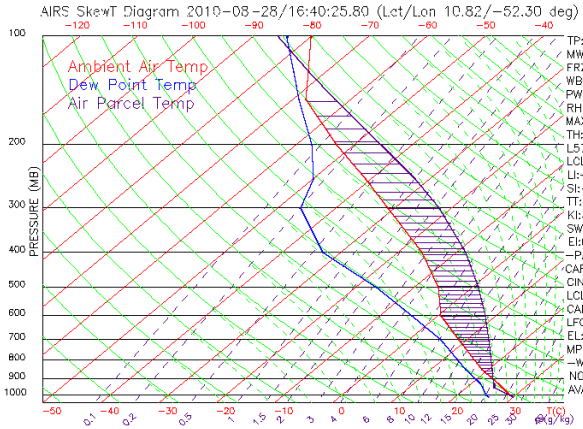


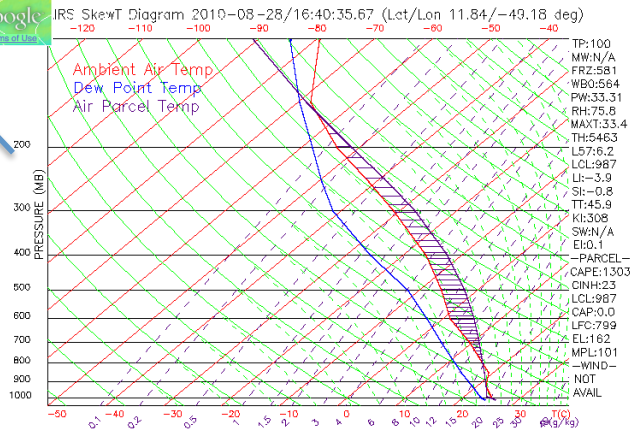

**Hurricane Earl; Aug. 28, 2010 19Z**



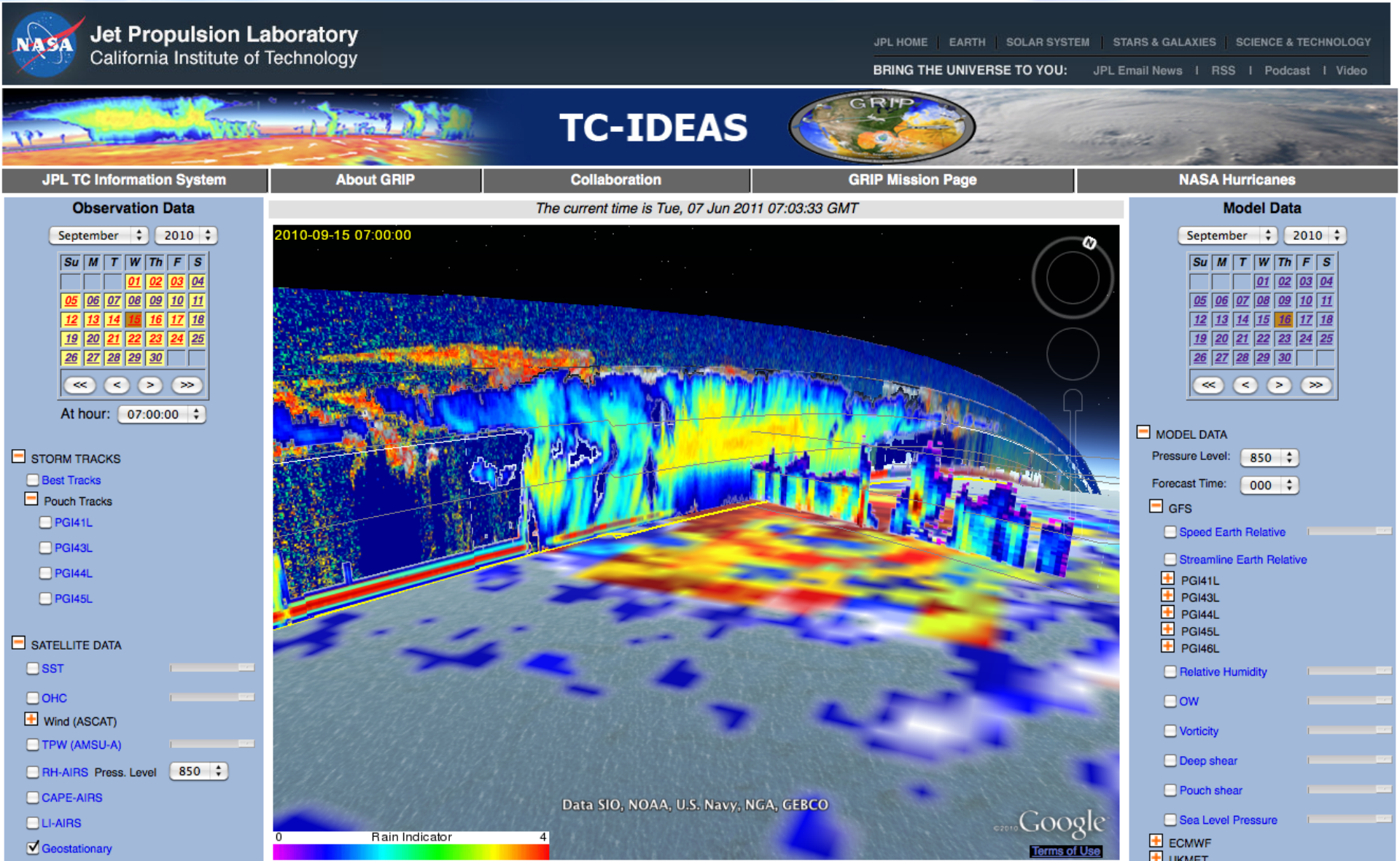

1. TPW from AMSU
2. Soundings from AIRS
3. Pouch-relative flow from ECMWF



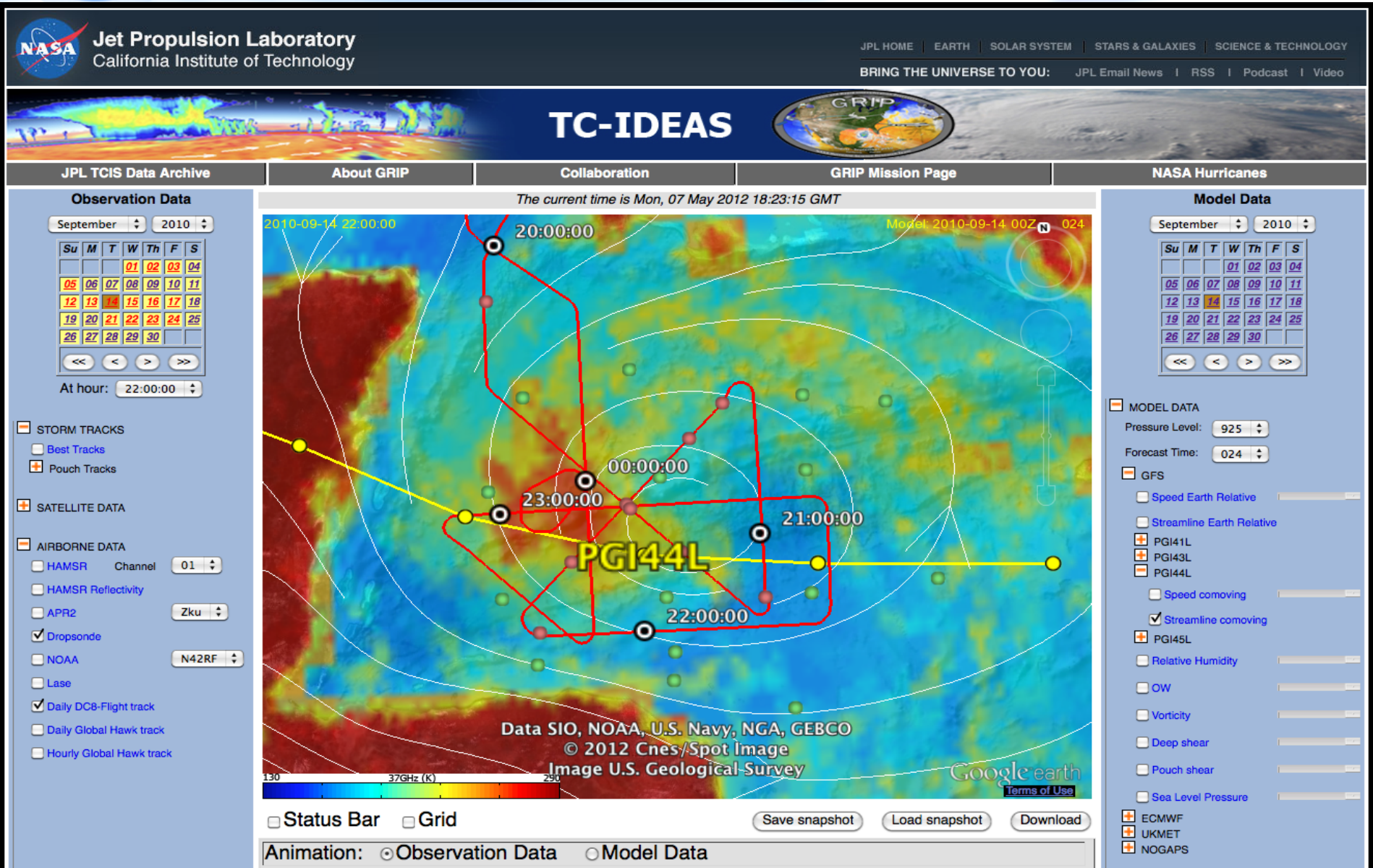



# Multi-frequency active observations

# 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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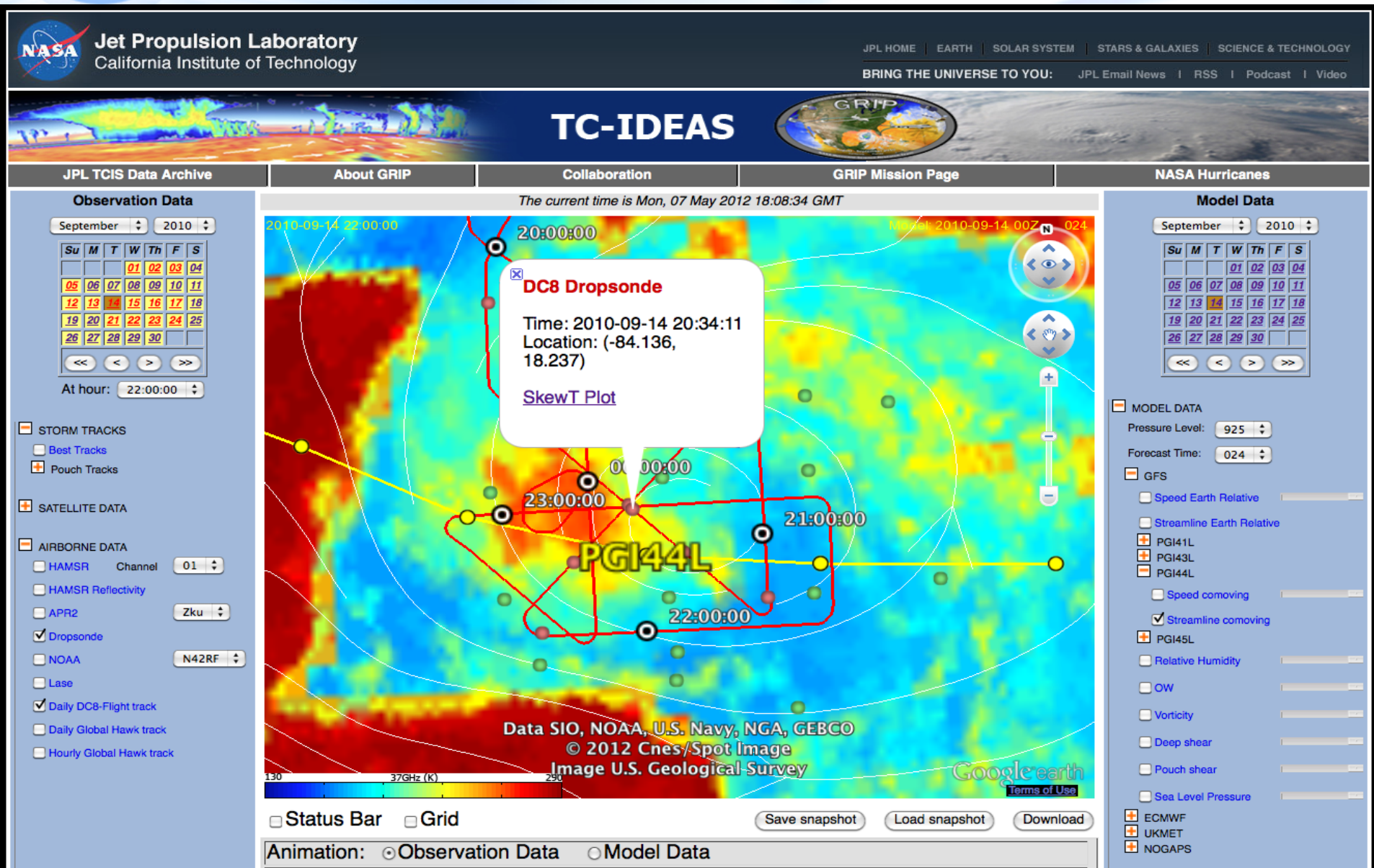

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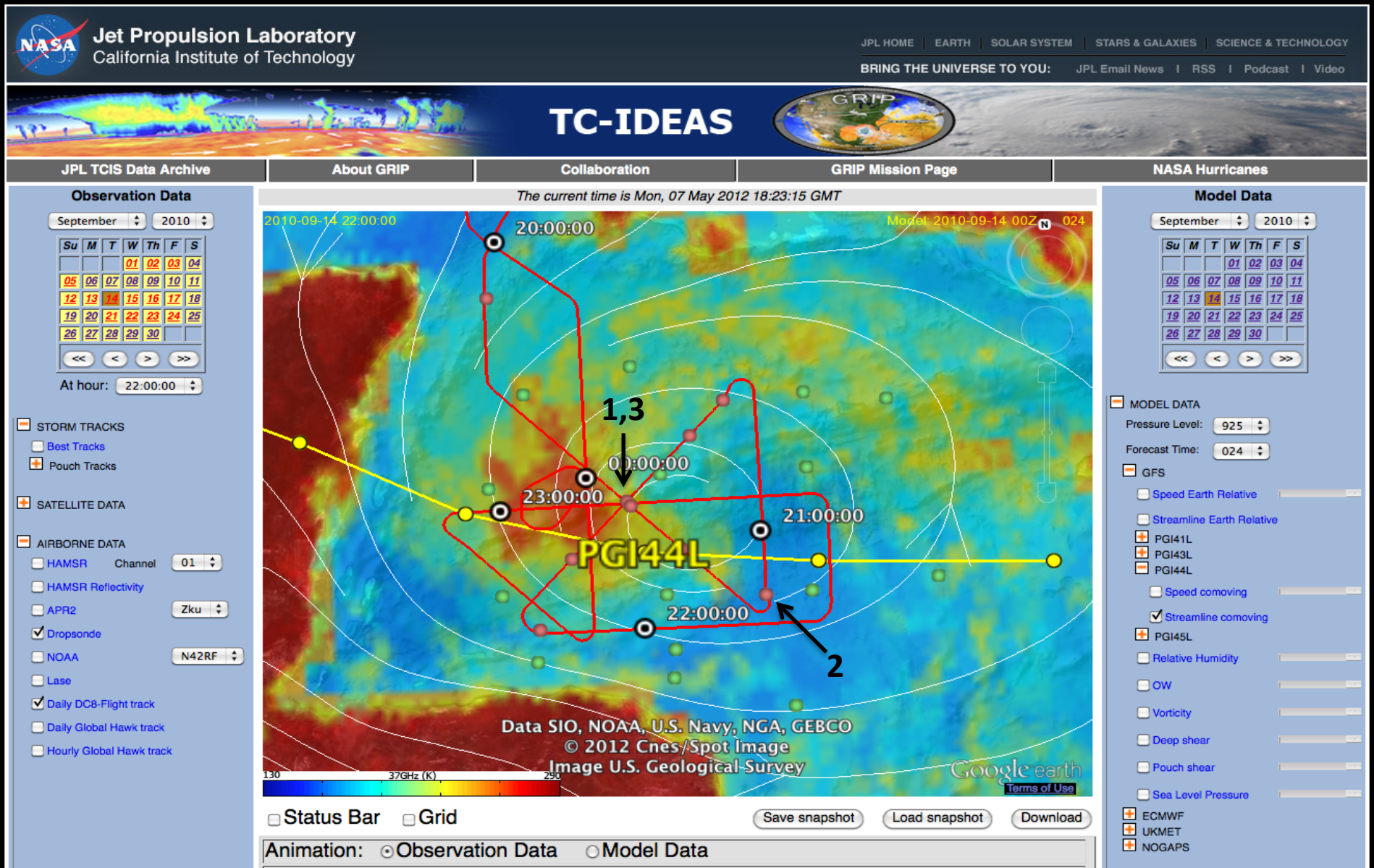
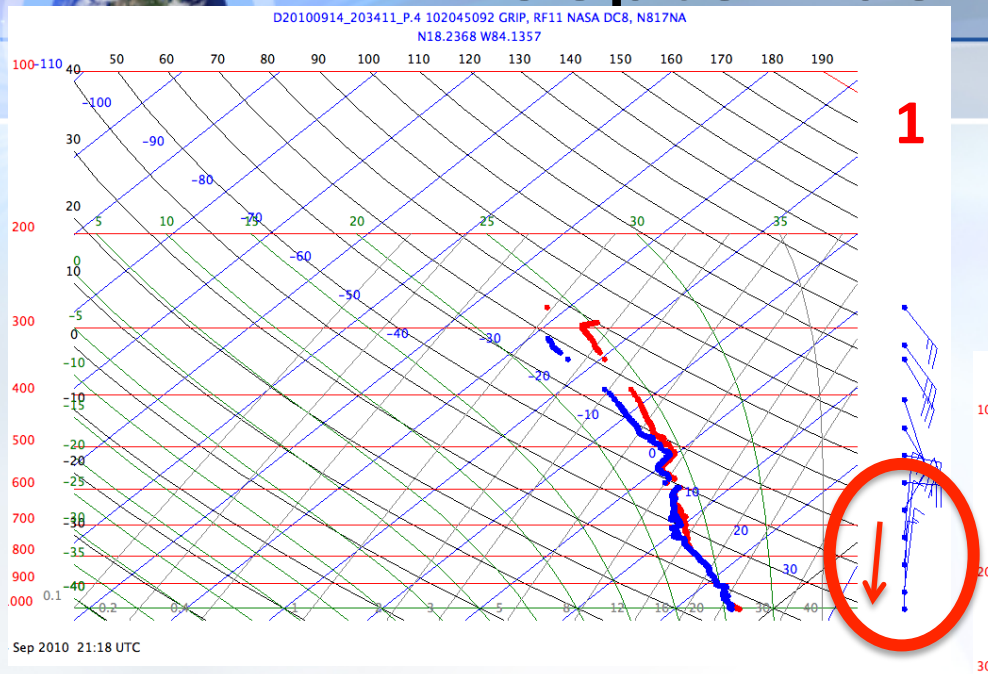
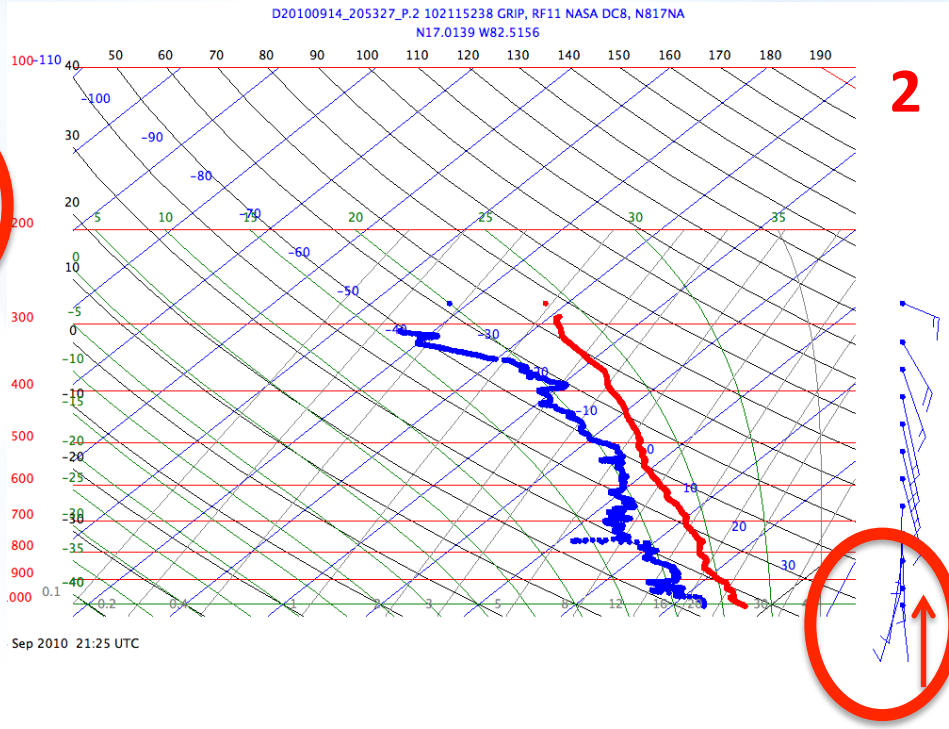
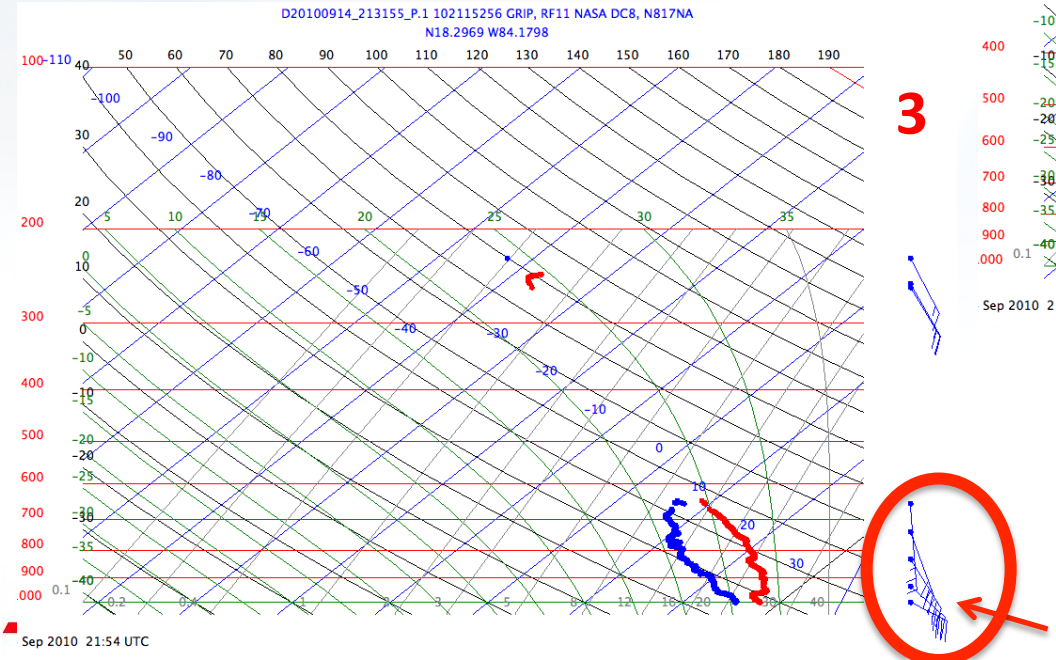


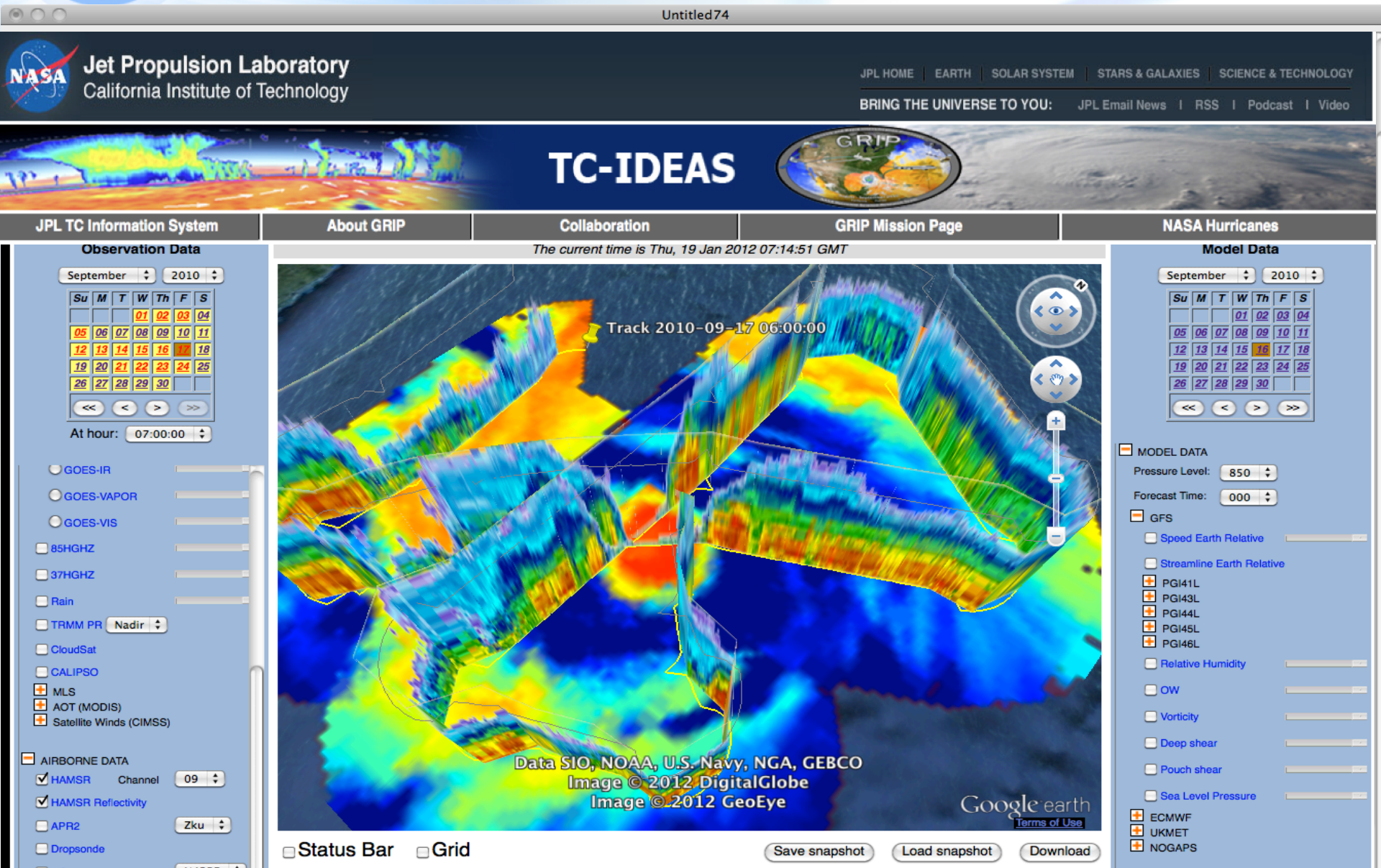
# 14th September 2010, 20-22 Z



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

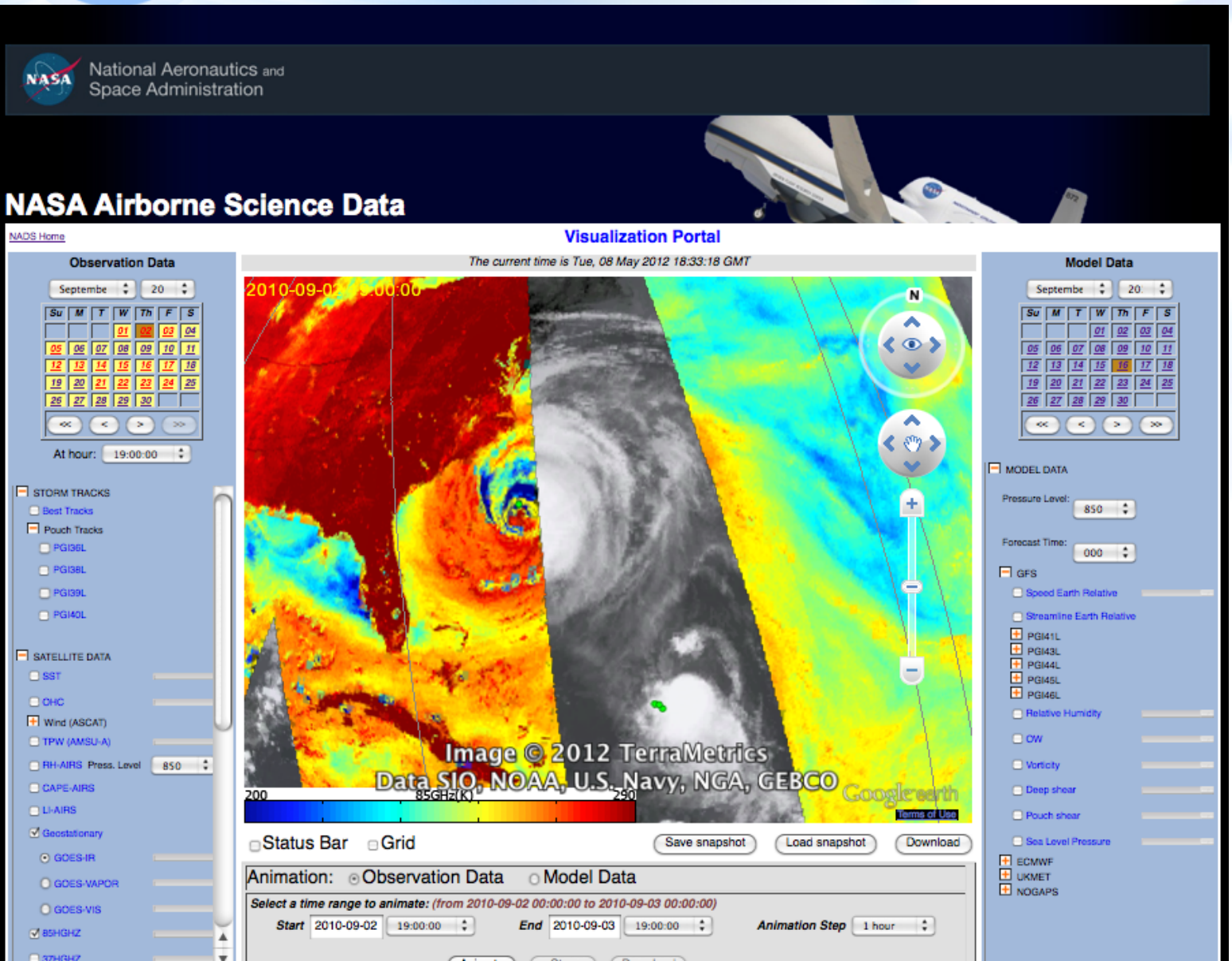


# NEW FEATURES

- 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

# Investigate, share the scenes, get the data

## 02th September 2010, 19Z Earl



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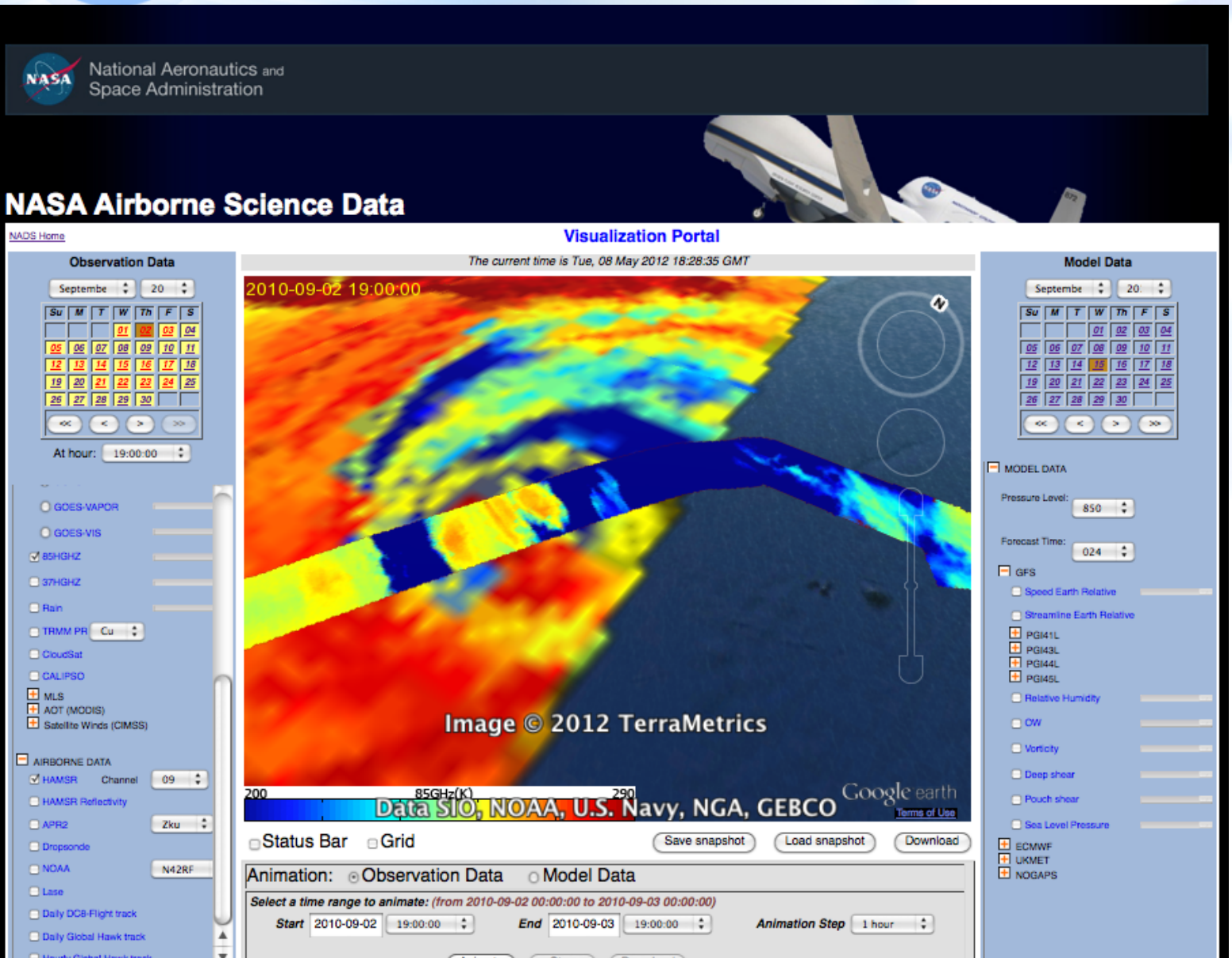


85 GHz Tb
HAMSR – chan. 9

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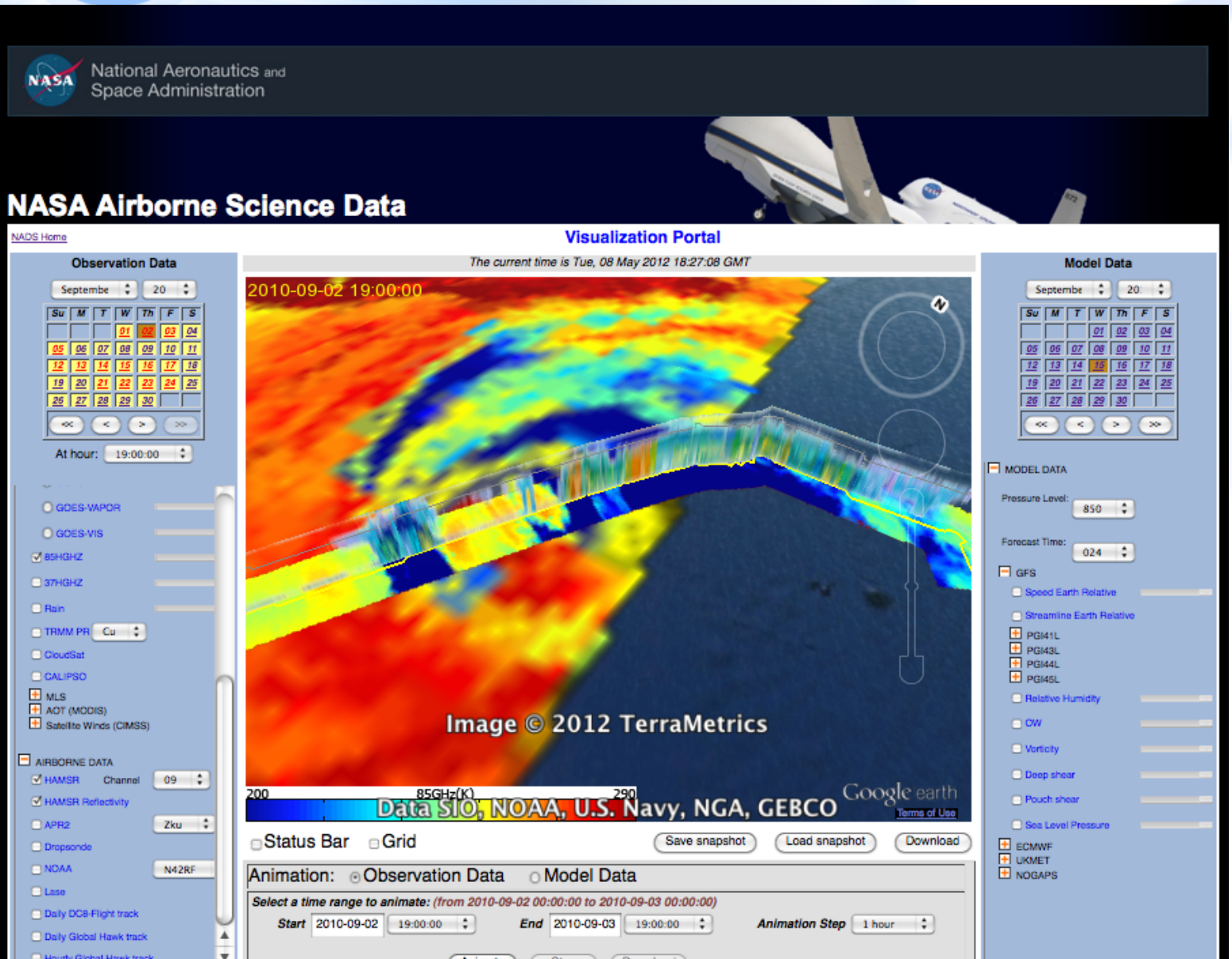
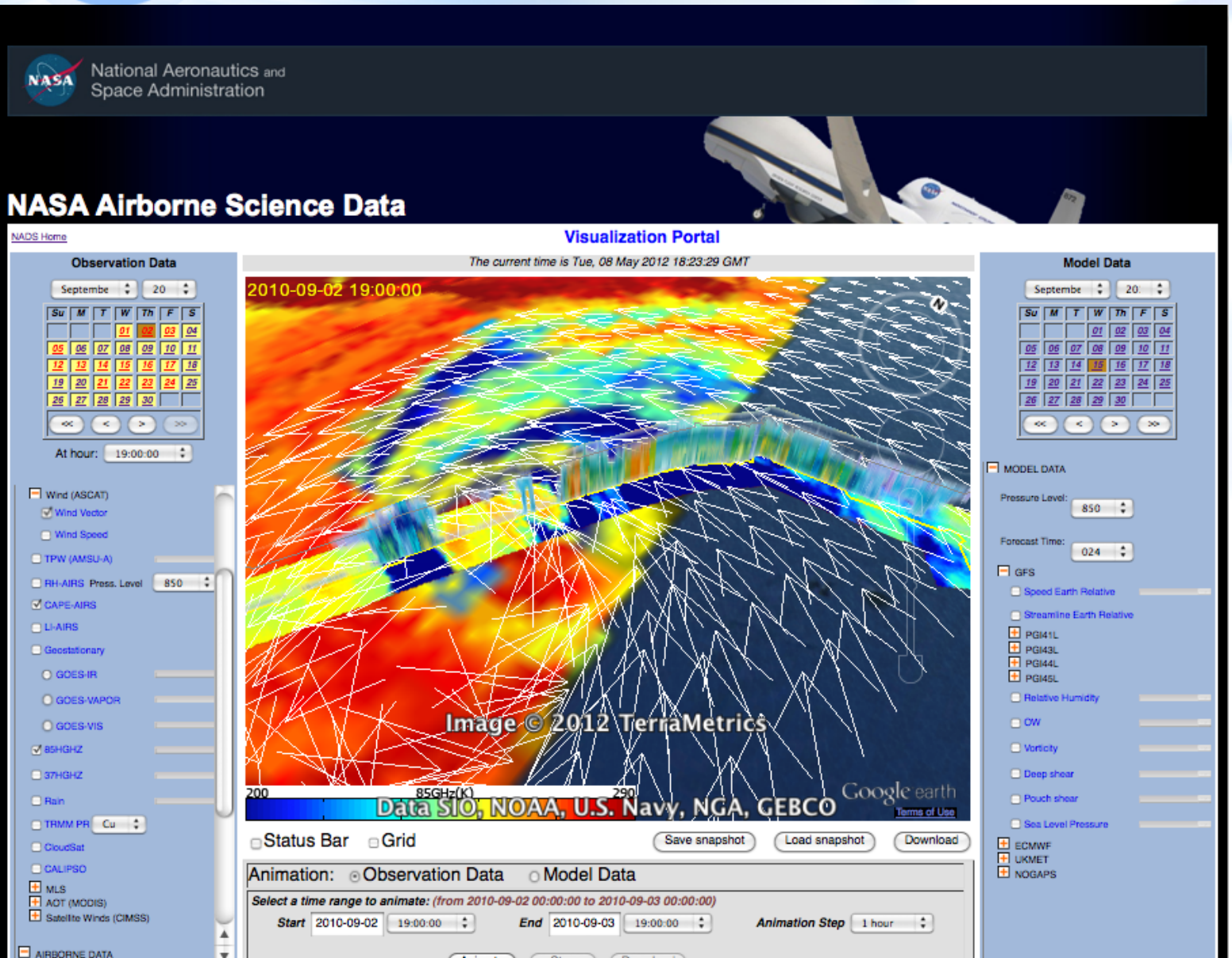
## 02th September 2010, 19Z Earl




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

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# NASA Airborne Science Data

Data Access Home → Browse Across Types

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## Cross Product Type Search

Browse By Type | Browse Across Types

Hide Filters

Filter: AccessGrantedTo = Add

Exclusive:

| | | | |
|---|---|---|---|
| Filename | = | MULTI_COMPOSITE_L1_85H_20100903_0000.nc | Remove |
| 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/Filename/HAMSR_GHAWK_L1B_20100902_1900.nc/

Page 1 of 1 (Products 1 to 3, out of 3)

| Product Name | ProductType | StartDateTime | CAS.ProductReceivedTi |
|---|---|---|---|
| MULTI_COMPOSITE_L1_85H_20100903_0000 | MULTI_85H_L1 | 2010-09-03T00:00:00.000Z | 2012-02-28T13:23:39. |
| HAMSR_GHAWK_L1B_20100902_1900 | HAMSR_L1B | 2010-09-02T19:00:00.000Z | 2012-02-28T13:31:30. |
| 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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Data Access Home → Browse By Type → HAMSR_L1B → Products → 94229ed5-6253-11e1-af2f-734eed20(

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## Product Metadata: HAMSR_GHAWK_L1B_20100902_1900

| | |
|---|---|
| CAS.ProductId | 94229ed5-6253-11e1-af2f-734eed206005 |
| CAS.ProductName | HAMSR_GHAWK_L1B_20100902_1900 |
| CAS.ProductReceivedTime | 2012-02-28T13:31:30.494-08:00 |
| FileLocation | /usr/local/acce/nasd/services/../archive/GRIP/HAMSR_L1B /HAMSR_GHAWK_L1B_20100902 _1900 |
| Filename | HAMSR_GHAWK_L1B_20100902_1900.nc |
| InstrumentId | HAMSR |
| MimeType | application/octet-stream<br>application<br>octet-stream |
| PlatformId | GHAWK |
| ProductStructure | Flat |
| ProductType | HAMSR_L1B |
| ProjectId | GRIP |
| StartDateTime | 2010-09-02T19:00:00.000Z |

Download this Product:

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

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Airborne Cloud Computing Environment
NASA Jet Propulsion Laboratory
Built On OODT
PRIVACY

SITE CONTACT: ANDREW F. HART
OR SHAKEH E. KHUDIKYAN

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# NEW FEATURES - summary

- 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

## 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 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