The JPL GRIP Portal: A comprehensive depiction of the 2010 hurricane season with satellite, model and airborne imagery (NASA GRIP, NSF PREDICT, NOAA IFEX)

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. Montgomery, M. Boothe, C. Davis, C. Velden,
J. Hawkins, G. Stossmeister, J. Metin

R. Rogers, F. Marks, S. Gopalakrishnan, T. Quirino, T. Vukicevic

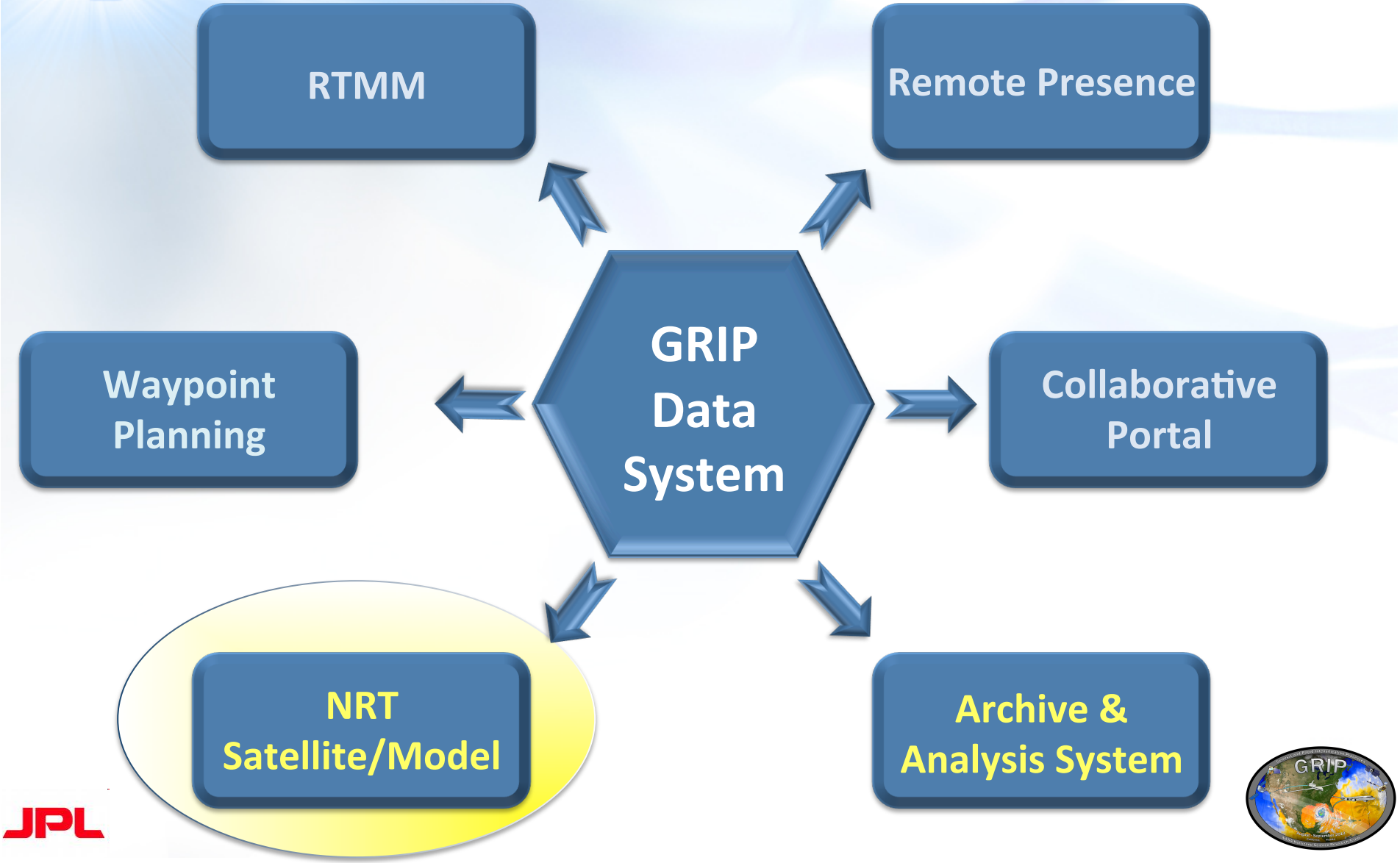
June 9, 2011

Collaborations

- **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

JPL

Joint NASA JPL and MSFC Project



GRIP Scientific Questions

Do **environmental stability and moisture** play key roles in determining whether disturbances develop or fail to develop into tropical cyclones? Or is the key factor related to **dynamic processes** and interaction with **environmental vertical wind shear**?

- What environmental (e.g., **vertical wind shear, upper-level outflow jets, low to mid-level moisture, upper-level troughs**), oceanic (e.g. **warm ocean eddies**) and inner core (e.g., **hot towers**) factors govern rapid intensification?
- Do **hot towers and convective bursts play a major role** or are they merely an indicator of energy conversion processes (e.g., associated with movement over a warm ocean eddy)?
- **What is the predictability of rapid intensification and what observations are most critical to its prediction**?
- What is the role of the Saharan Air Layer, in terms of the impact of its **mid-level dry air, mid-level easterly jet and suspended African dust** on intensification?
- What is the role of **internal structure changes, including rainbands, eyewall replacement cycles, and storm asymmetries on tropical cyclone intensity change**?
- Does the **formation of cyclonic vorticity at the surface** originate from midlevel cyclonic vorticity that builds downward, or does it originate at low levels and grow upward? **What is the role of deep convection** in this process?
- **How does the thermal structure within the vortex evolve** from cold to warm core? What physical processes are important for generating and maintaining the warm anomaly?

JPL

GRIP Scientific Questions – what data

- **Large-scale model and satellite 3D winds derived from cloud motion**
  - environmental vertical wind shear
  - upper-level troughs and outflow jets
- **Observations (AIRS, GPS-RO, MLS, AMSU) AND Large-scale model**
  - environmental stability and moisture
  - low to mid-level moisture
- **Ocean Heat Content and SST from Observations**
  - high-resolution SSTs and warm ocean eddies
- **Active and Passive Microwave and IR Observations: TRMM, CloudSAT, AMSR-E, SSM/I, AMSU, QuikSCAT, ASCAT, GOES**
  - inner core structure - hot towers and convective bursts
  - Role of internal structure changes, including rainbands, eyewall replacement cycles, and storm asymmetries on tropical cyclone intensity change?
  - Predictability of rapid intensification and what observations are most critical? Evolution of cyclonic vorticity – does midlevel cyclonic vorticity build downward, or does vorticity originate at low levels and grow upward? What is the role of deep convection ?
- **Observations of Aerosols, midlevel humidity; Flow from Large-scale model**
  - Saharan Air Layer - mid-level dry air, mid-level easterly jet and suspended African dust
    How does the thermal structure within the vortex evolve from cold to warm core?
    What physical processes are important for generating and maintaining the warm anomaly?

JPL

NRT Satellite/Model Data

http://grip.jpl.nasa.gov

- **GOAL**

  To provide a near-real time basin-scale view of the atmospheric and surface conditions, characterizing large-scale and storm scale processes, as depicted by satellites and models

- **Objective**

  To provide environmental context and temporal continuity for the field campaign observations to help:

  - mission planning and post-field campaign analysis

  - understanding of the physical processes

  - improving models through validation and data assimilation

JPL

NRT Satellite/Model Data – DATA TYPES

http://grip.jpl.nasa.gov

- Satellite DATA TYPES
  - SST and Ocean Heat Content
  - Surface Wind from scatterometry (ASCAT)
  - Total Precipitable Water (TPW) from AMSU
  - Temperature/Moisture Profiles and analysis
    - Relative Humidity at several pressure levels, LI, CAPE, Skew-T
  - GOES IR/VIS/Water Vapor;
  - CIMSS Overshooting Tops
  - 85 and 37 GHz Brightness Temperatures
  - Rain Indicator - Multi-frequency, multi-platform (passive MW)
  - 3D Radar reflectivity – TRMM-PR
  - CloudSAT Radar Reflectivity vertical profiles
  - CALIPSO
  - MODIS AOT and Fine-Particle Fraction
  - MLS – vertical profiles - temperature, water vapor, ice water content, Ozone
  - Satellite WINDS (CIMSS)
  - Best Tracks and Intensity; Pouch tracks (PREDICT)

JPL

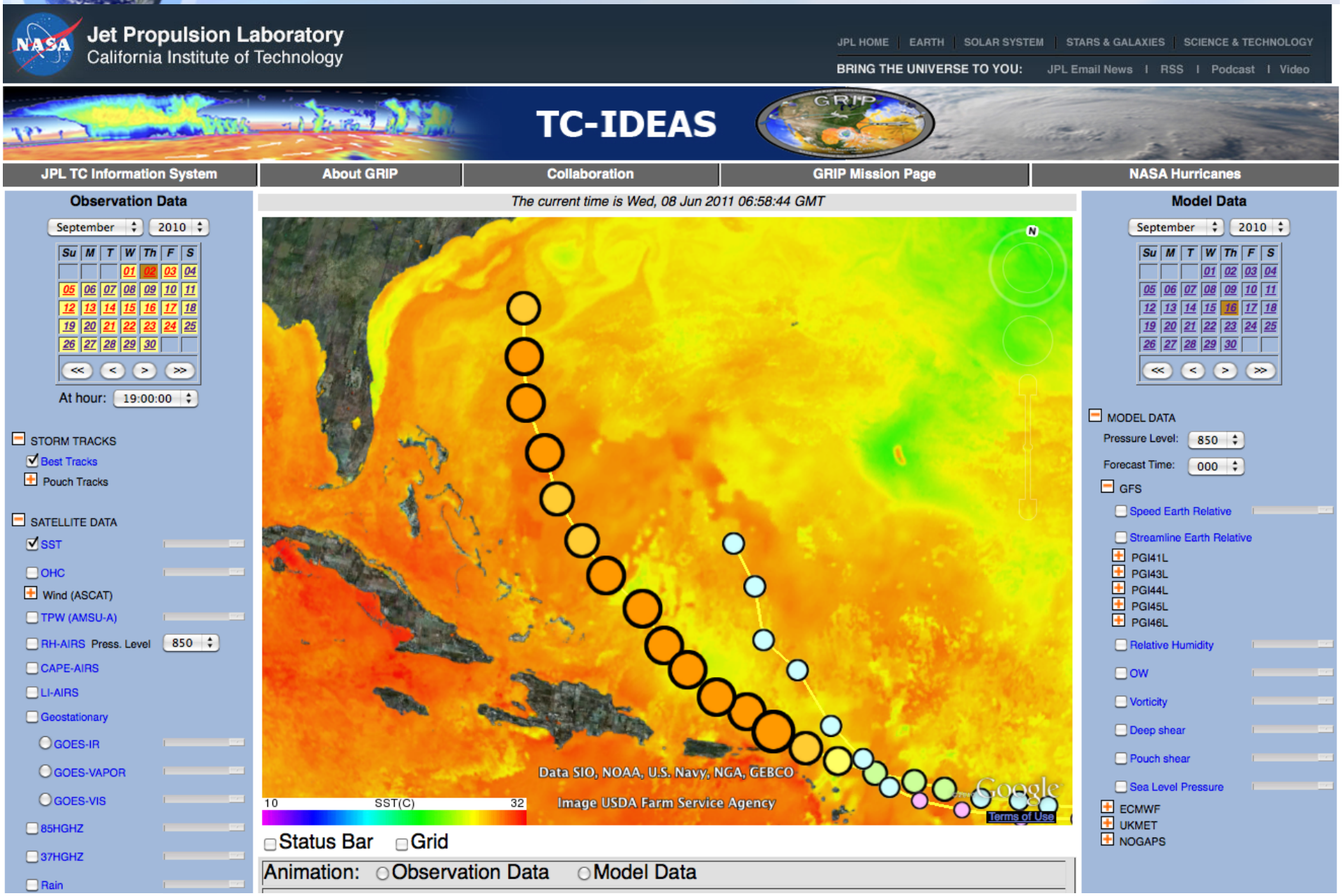
NRT Satellite/Model Data – DATA TYPES

http://grip.jpl.nasa.gov

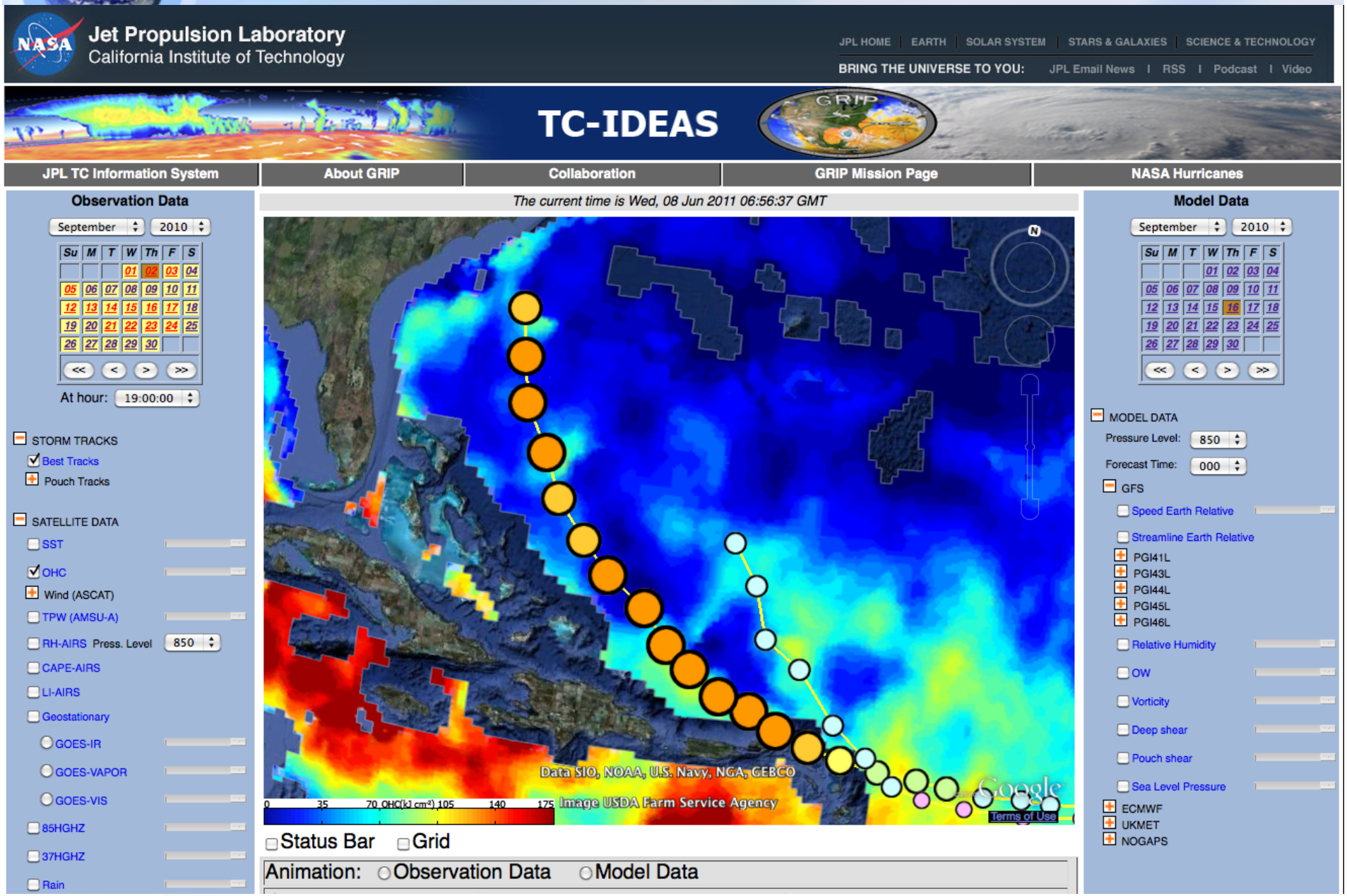
- **Model DATA TYPES**
  - Large-scale model (courtesy of PREDICT)
    - GFS, ECMWF, NOGAPS, UKMET
    - 850, 700, 500, 200mb
      - Earth-relative flow
      - Vorticity, OW
      - Relative humidity
    - Pouch analysis – location, storm-relative flow, forecast
    - Deep-layer shear (200/850mb)
    - Low-level shear
    - Surface pressure
  - Forecast Tracks and Intensity from ATCF – large number of models

JPL

Earl, September 2nd, 2010; SST and Best Track
http://grip.jpl.nasa.gov



Earl, September 2nd, 2010; SST and Best Track
http://grip.jpl.nasa.gov



TC-IDEAS

Observation Data

September 2010

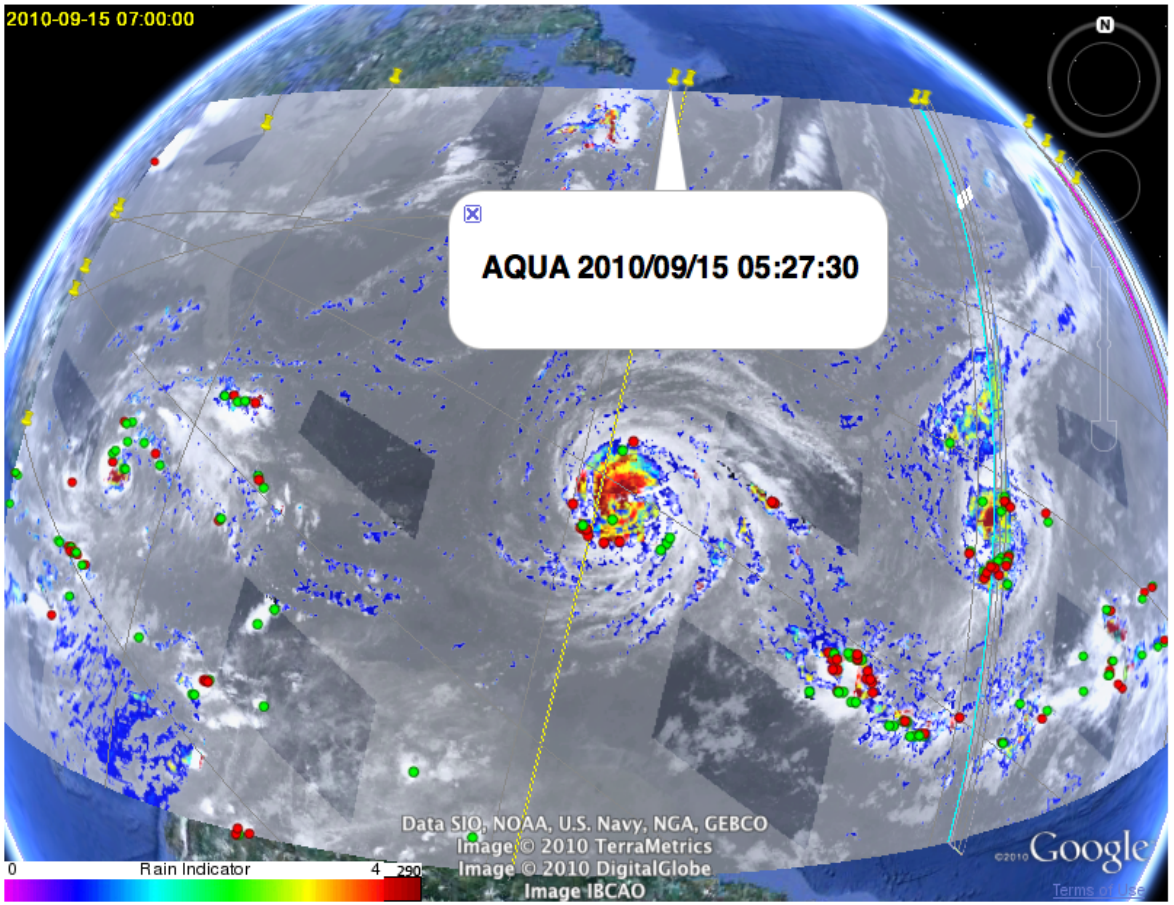
Su	M	T	W	Th	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

<< < > >>

At hour: 07:00:00

- [+] STORM TRACKS
- [-] SATELLITE DATA
  - [ ] SST
  - [ ] OHC
  - [+] Wind (ASCAT)
  - [ ] TPW (AMSU-A)
  - [ ] RH-AIRS Press. Level 850
  - [ ] CAPE-AIRS
  - [ ] LI-AIRS
  - [x] Geostationary
    - (•) GOES-IR
    - ( ) GOES-VAPOR
    - ( ) GOES-VIS
  - [x] 85HGHZ
  - [ ] 37HGHZ
  - [x] Rain
  - [x] TRMM PR Nadir
  - [x] CloudSat
  - [ ] CALIPSO
  - [-] MLS
    - [ ] Temperature

The current time is Thu, 11 Nov 2010 06:50:59 GMT



[ ] Status Bar [ ] Grid

Animation: (•) Observation Data ( ) Model Data

Select a time range to animate: *(from 2010-09-14 13:00:00 to 2010-09-15 13:00:00)*

Start 2010-09-14 13:00:00 ***End*** 2010-09-15 13:00:00 ***Animation Step*** 1 hour

Animate | Stop | Download

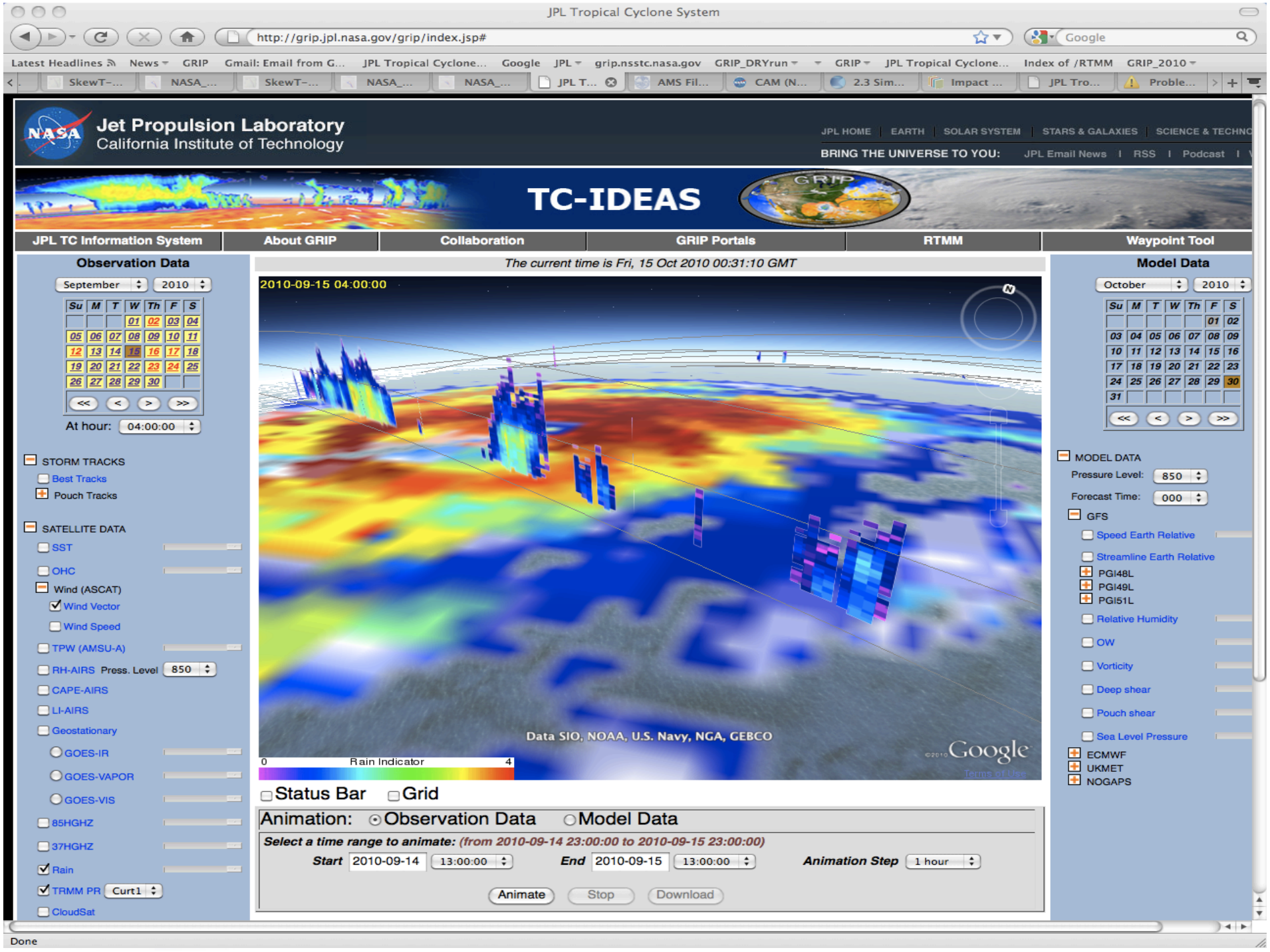
Model Data

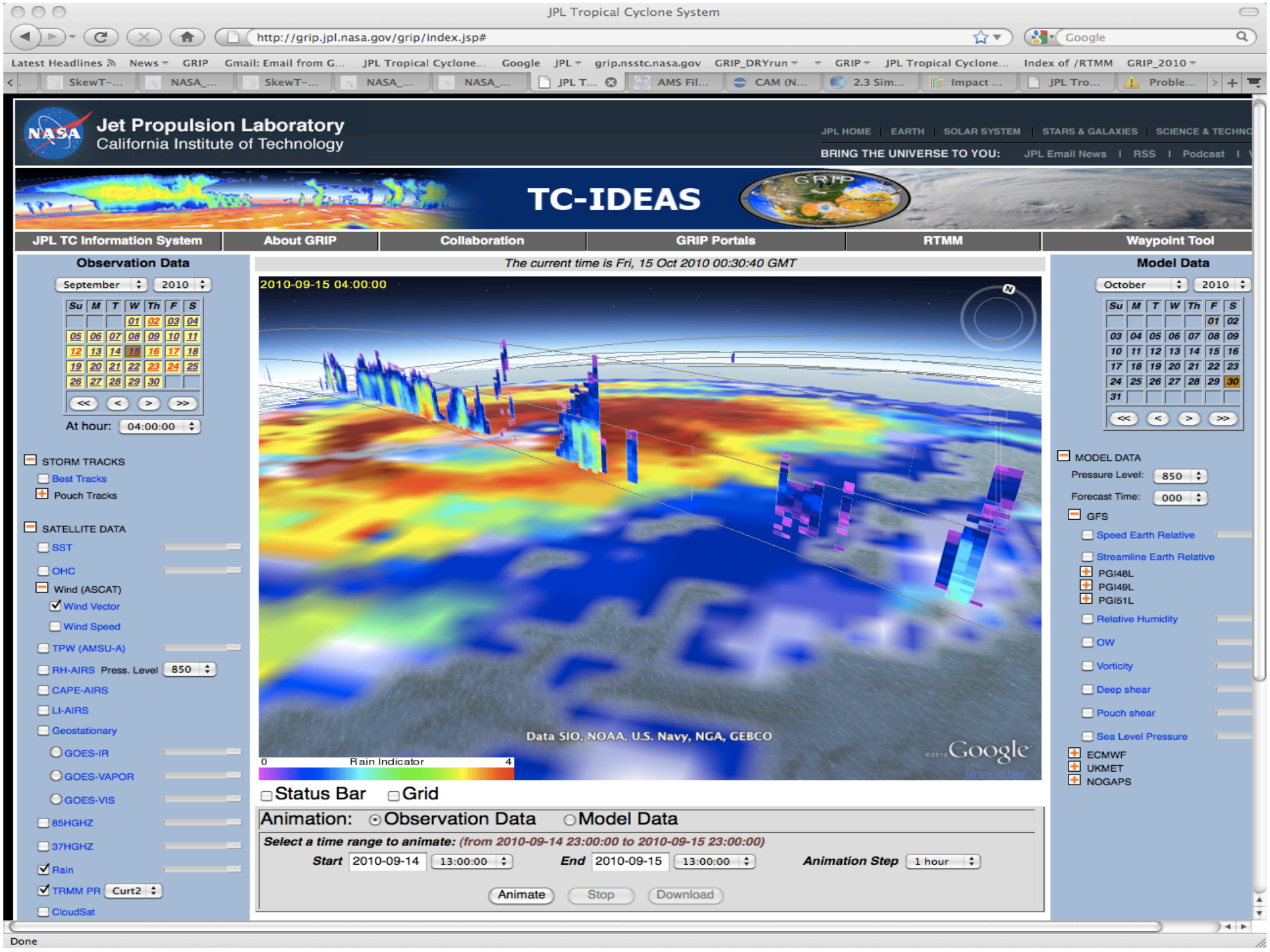
September 2010

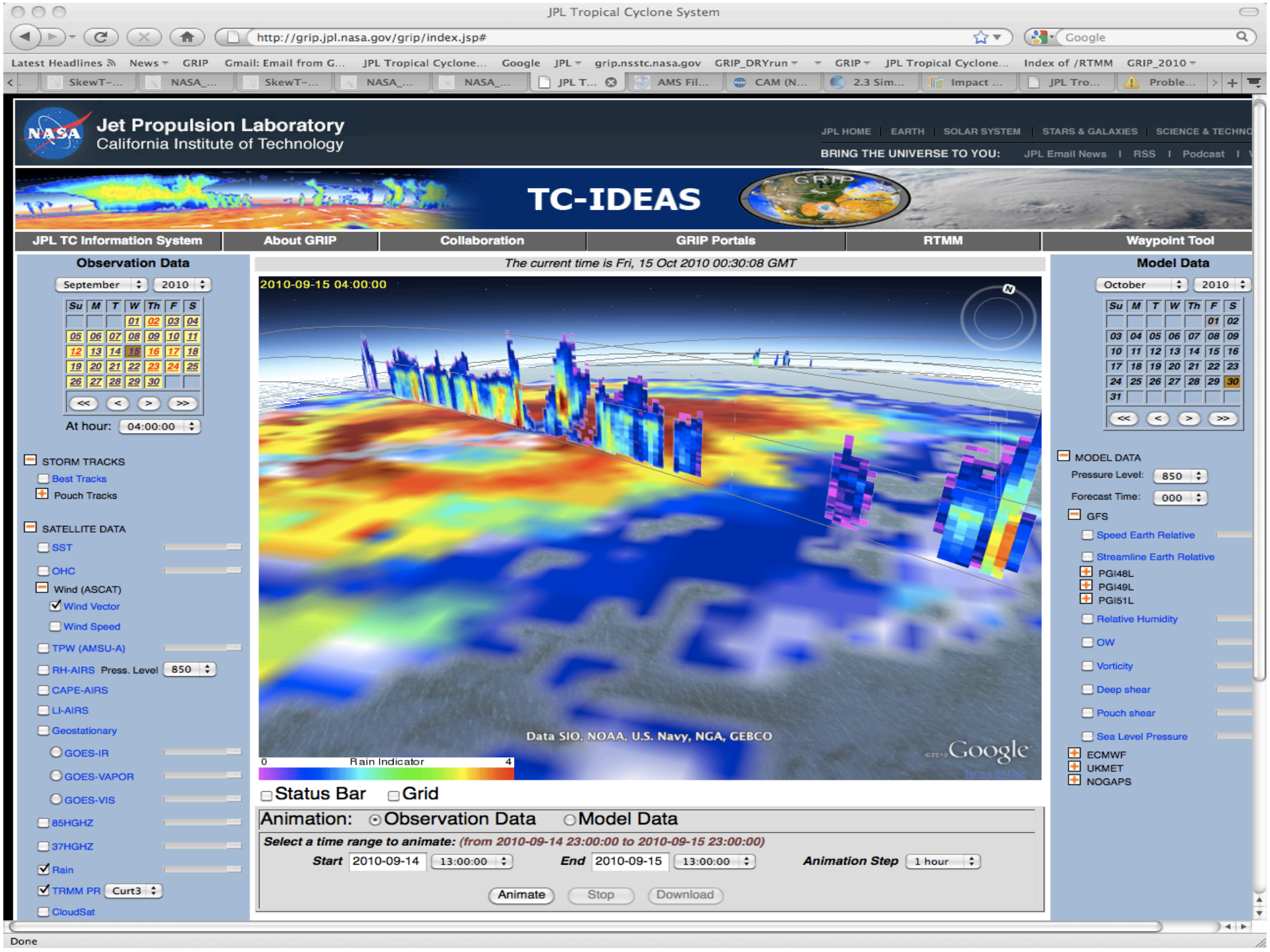
Su	M	T	W	Th	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

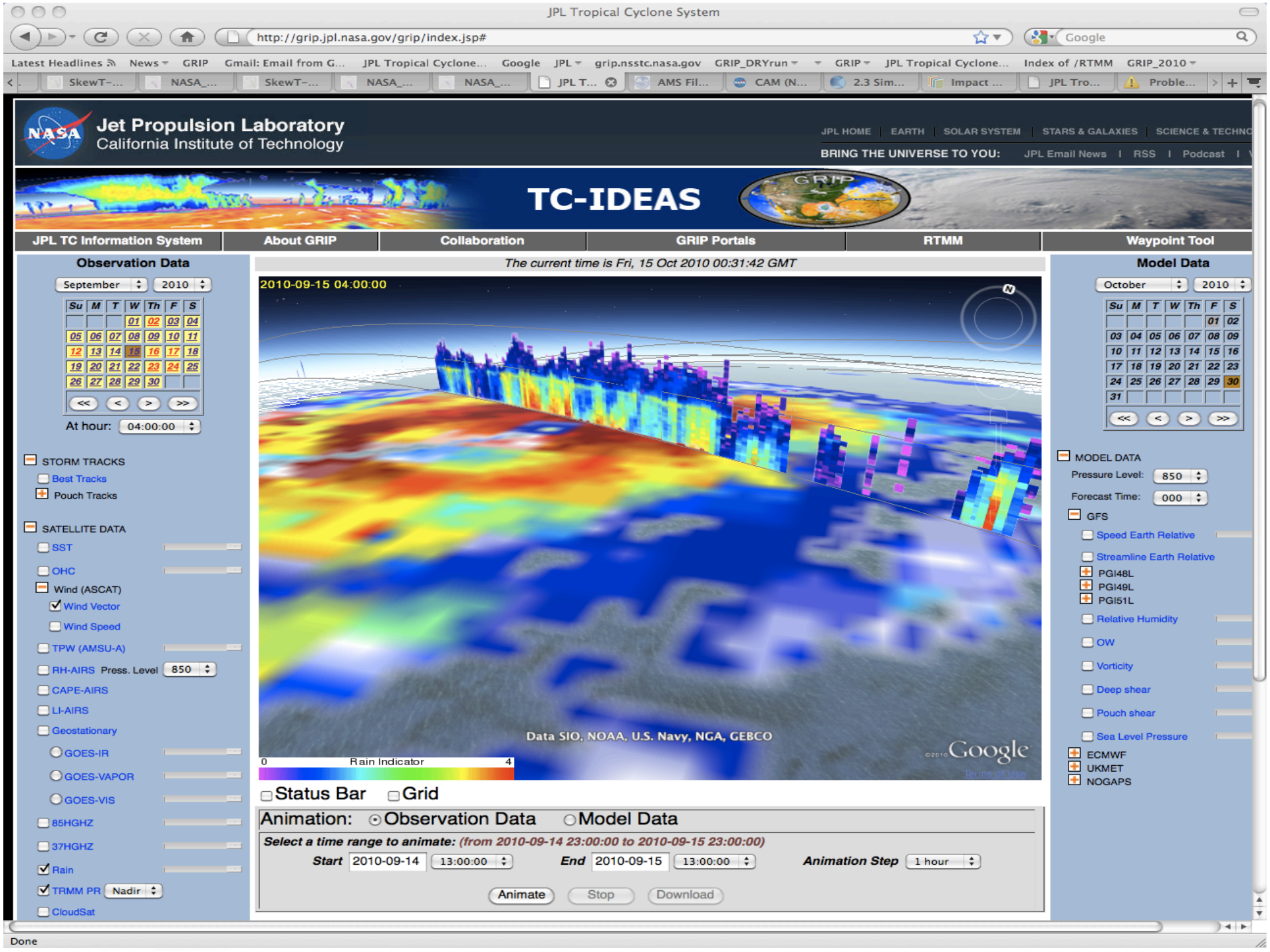
<< < > >>

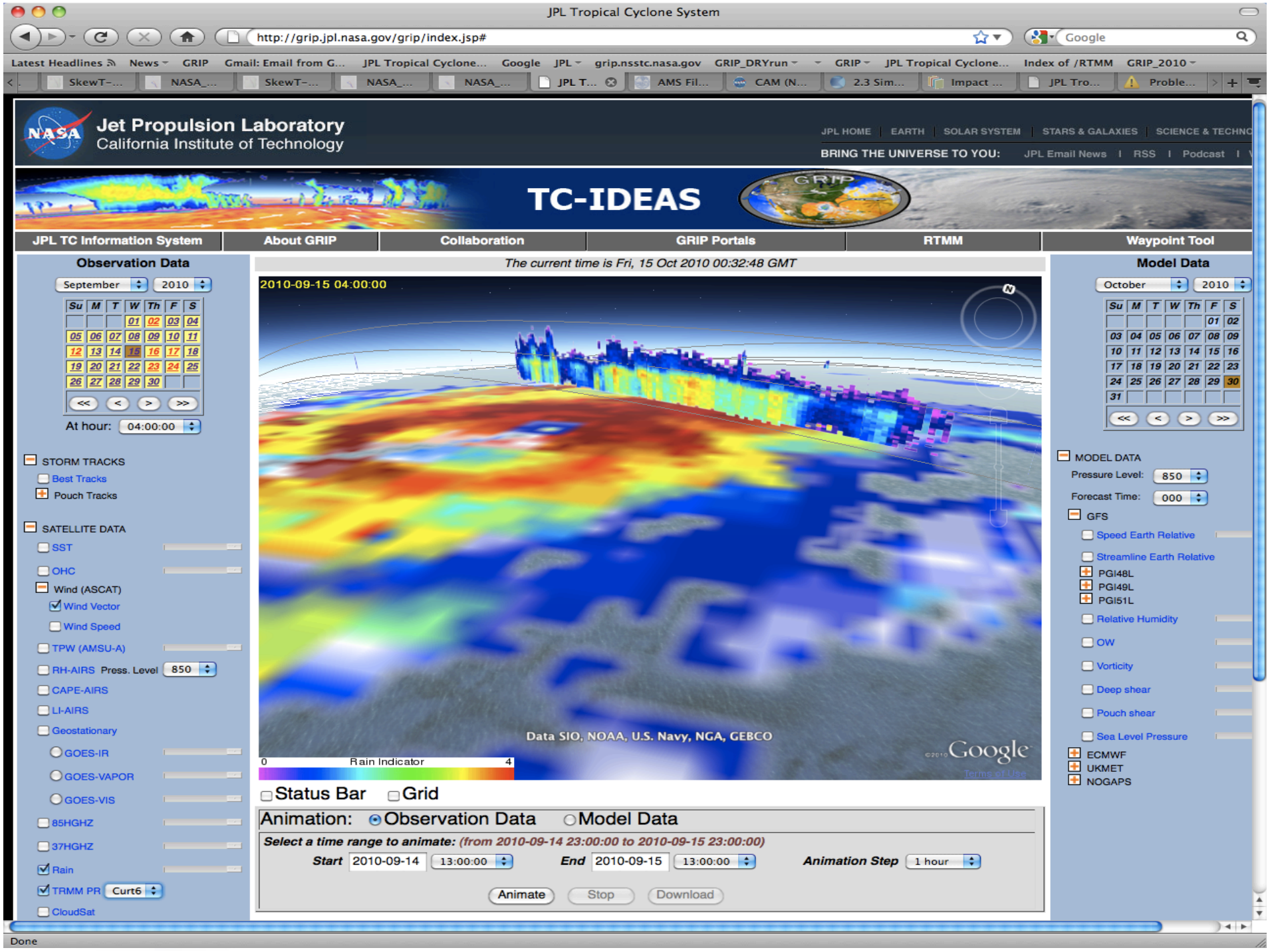
- [-] MODEL DATA
  - Pressure Level: 850
  - Forecast Time: 012
  - [-] GFS
    - [ ] Speed Earth Relative
    - [ ] Streamline Earth Relative
    - [+] PGI41L
    - [+] PGI43L
    - [+] PGI44L
    - [+] PGI45L
    - [ ] Relative Humidity
    - [ ] OW
    - [ ] Vorticity
    - [ ] Deep shear
    - [ ] Pouch shear
    - [ ] Sea Level Pressure
  - [+] ECMWF
  - [+] UKMET
  - [+] NOGAPS

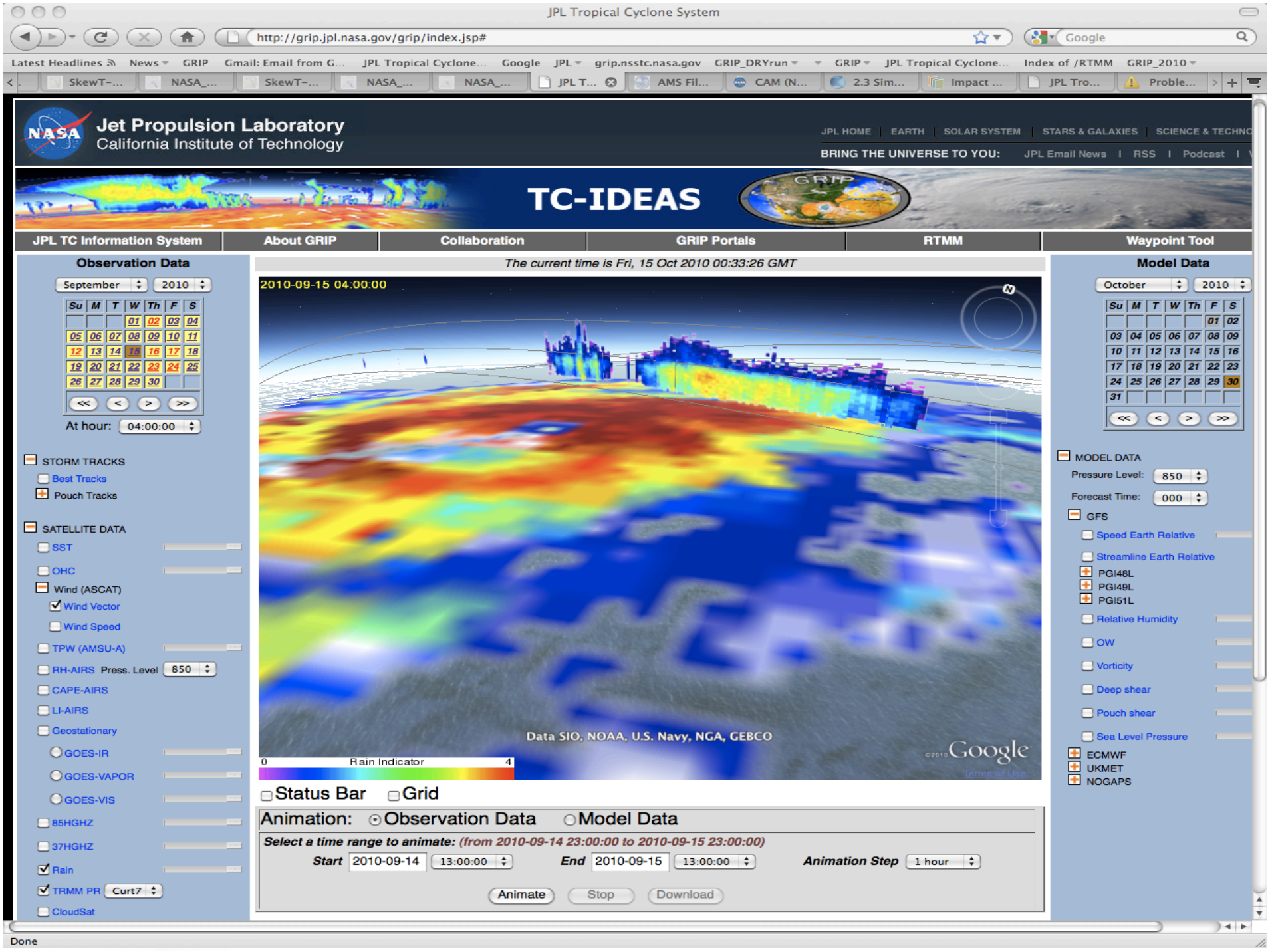

JPL Tropical Cyclone System
http://grip.jpl.nasa.gov/grip/index.jsp#
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNO
BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast
TC-IDEAS
JPL TC Information System
About GRIP
Collaboration
GRIP Portals
RTMM
Waypoint Tool
Observation Data
September
2010
At hour: 04:00:00
STORM TRACKS
Best Tracks
Pouch Tracks
SATELLITE DATA
SST
OHC
Wind (ASCAT)
Wind Vector
Wind Speed
TPW (AMSU-A)
RH-AIRS Press. Level 850
CAPE-AIRS
LI-AIRS
Geostationary
GOES-IR
GOES-VAPOR
GOES-VIS
85HGHZ
37HGHZ
Rain
TRMM PR Curt1
CloudSat
The current time is Fri, 15 Oct 2010 00:31:10 GMT
2010-09-15 04:00:00
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google
0 Rain Indicator 4
Status Bar
Grid
Animation: Observation Data Model Data
Select a time range to animate: (from 2010-09-14 23:00:00 to 2010-09-15 23:00:00)
Start 2010-09-14 13:00:00
End 2010-09-15 13:00:00
Animation Step 1 hour
Animate
Stop
Download
Model Data
October
2010
MODEL DATA
Pressure Level: 850
Forecast Time: 000
GFS
Speed Earth Relative
Streamline Earth Relative
PGI48L
PGI49L
PGI51L
Relative Humidity
OW
Vorticity
Deep shear
Pouch shear
Sea Level Pressure
ECMWF
UKMET
NOGAPS
Done


JPL Tropical Cyclone System
http://grip.jpl.nasa.gov/grip/index.jsp#
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNO
BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast
TC-IDEAS
JPL TC Information System
About GRIP
Collaboration
GRIP Portals
RTMM
Waypoint Tool
Observation Data
September
2010
At hour: 04:00:00
STORM TRACKS
Best Tracks
Pouch Tracks
SATELLITE DATA
SST
OHC
Wind (ASCAT)
Wind Vector
Wind Speed
TPW (AMSU-A)
RH-AIRS Press. Level 850
CAPE-AIRS
LI-AIRS
Geostationary
GOES-IR
GOES-VAPOR
GOES-VIS
85HGHZ
37HGHZ
Rain
TRMM PR Curt2
CloudSat
The current time is Fri, 15 Oct 2010 00:30:40 GMT
2010-09-15 04:00:00
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google
0 Rain Indicator 4
Status Bar
Grid
Animation: Observation Data Model Data
Select a time range to animate: (from 2010-09-14 23:00:00 to 2010-09-15 23:00:00)
Start 2010-09-14 13:00:00
End 2010-09-15 13:00:00
Animation Step 1 hour
Animate
Stop
Download
Model Data
October
2010
MODEL DATA
Pressure Level: 850
Forecast Time: 000
GFS
Speed Earth Relative
Streamline Earth Relative
PGI48L
PGI49L
PGI51L
Relative Humidity
OW
Vorticity
Deep shear
Pouch shear
Sea Level Pressure
ECMWF
UKMET
NOGAPS
Done


JPL Tropical Cyclone System
http://grip.jpl.nasa.gov/grip/index.jsp#
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNO
BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast
TC-IDEAS
JPL TC Information System
About GRIP
Collaboration
GRIP Portals
RTMM
Waypoint Tool
Observation Data
September
2010
At hour: 04:00:00
STORM TRACKS
Best Tracks
Pouch Tracks
SATELLITE DATA
SST
OHC
Wind (ASCAT)
Wind Vector
Wind Speed
TPW (AMSU-A)
RH-AIRS Press. Level 850
CAPE-AIRS
LI-AIRS
Geostationary
GOES-IR
GOES-VAPOR
GOES-VIS
85HGHZ
37HGHZ
Rain
TRMM PR Curt3
CloudSat
The current time is Fri, 15 Oct 2010 00:30:08 GMT
2010-09-15 04:00:00
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google
0
Rain Indicator
4
Status Bar
Grid
Animation: Observation Data Model Data
Select a time range to animate: (from 2010-09-14 23:00:00 to 2010-09-15 23:00:00)
Start 2010-09-14 13:00:00
End 2010-09-15 13:00:00
Animation Step 1 hour
Animate
Stop
Download
Model Data
October
2010
MODEL DATA
Pressure Level: 850
Forecast Time: 000
GFS
Speed Earth Relative
Streamline Earth Relative
PGI48L
PGI49L
PGI51L
Relative Humidity
OW
Vorticity
Deep shear
Pouch shear
Sea Level Pressure
ECMWF
UKMET
NOGAPS
Done


JPL Tropical Cyclone System
http://grip.jpl.nasa.gov/grip/index.jsp#
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNO
BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast
TC-IDEAS
JPL TC Information System
About GRIP
Collaboration
GRIP Portals
RTMM
Waypoint Tool
Observation Data
September
2010
At hour: 04:00:00
STORM TRACKS
Best Tracks
Pouch Tracks
SATELLITE DATA
SST
OHC
Wind (ASCAT)
Wind Vector
Wind Speed
TPW (AMSU-A)
RH-AIRS Press. Level 850
CAPE-AIRS
LI-AIRS
Geostationary
GOES-IR
GOES-VAPOR
GOES-VIS
85HGHZ
37HGHZ
Rain
TRMM PR Nadir
CloudSat
The current time is Fri, 15 Oct 2010 00:31:42 GMT
2010-09-15 04:00:00
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google
0 Rain Indicator 4
Status Bar
Grid
Animation: Observation Data Model Data
Select a time range to animate: (from 2010-09-14 23:00:00 to 2010-09-15 23:00:00)
Start 2010-09-14 13:00:00
End 2010-09-15 13:00:00
Animation Step 1 hour
Animate
Stop
Download
Model Data
October
2010
MODEL DATA
Pressure Level: 850
Forecast Time: 000
GFS
Speed Earth Relative
Streamline Earth Relative
PGI48L
PGI49L
PGI51L
Relative Humidity
OW
Vorticity
Deep shear
Pouch shear
Sea Level Pressure
ECMWF
UKMET
NOGAPS
Done


JPL Tropical Cyclone System
http://grip.jpl.nasa.gov/grip/index.jsp#
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNO
BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast
TC-IDEAS
JPL TC Information System
About GRIP
Collaboration
GRIP Portals
RTMM
Waypoint Tool
Observation Data
September
2010
At hour: 04:00:00
STORM TRACKS
Best Tracks
Pouch Tracks
SATELLITE DATA
SST
OHC
Wind (ASCAT)
Wind Vector
Wind Speed
TPW (AMSU-A)
RH-AIRS Press. Level 850
CAPE-AIRS
LI-AIRS
Geostationary
GOES-IR
GOES-VAPOR
GOES-VIS
85HGHZ
37HGHZ
Rain
TRMM PR Curt6
CloudSat
The current time is Fri, 15 Oct 2010 00:32:48 GMT
2010-09-15 04:00:00
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google
0 Rain Indicator 4
Status Bar
Grid
Animation: Observation Data Model Data
Select a time range to animate: (from 2010-09-14 23:00:00 to 2010-09-15 23:00:00)
Start 2010-09-14 13:00:00
End 2010-09-15 13:00:00
Animation Step 1 hour
Animate
Stop
Download
Model Data
October
2010
MODEL DATA
Pressure Level: 850
Forecast Time: 000
GFS
Speed Earth Relative
Streamline Earth Relative
PGI48L
PGI49L
PGI51L
Relative Humidity
OW
Vorticity
Deep shear
Pouch shear
Sea Level Pressure
ECMWF
UKMET
NOGAPS
Done


JPL Tropical Cyclone System
http://grip.jpl.nasa.gov/grip/index.jsp#
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNO
BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast
TC-IDEAS
JPL TC Information System
About GRIP
Collaboration
GRIP Portals
RTMM
Waypoint Tool
Observation Data
September
2010
At hour: 04:00:00
STORM TRACKS
Best Tracks
Pouch Tracks
SATELLITE DATA
SST
OHC
Wind (ASCAT)
Wind Vector
Wind Speed
TPW (AMSU-A)
RH-AIRS Press. Level 850
CAPE-AIRS
LI-AIRS
Geostationary
GOES-IR
GOES-VAPOR
GOES-VIS
85HGHZ
37HGHZ
Rain
TRMM PR Curt7
CloudSat
The current time is Fri, 15 Oct 2010 00:33:26 GMT
2010-09-15 04:00:00
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google
0
Rain Indicator
4
Status Bar
Grid
Animation: Observation Data Model Data
Select a time range to animate: (from 2010-09-14 23:00:00 to 2010-09-15 23:00:00)
Start 2010-09-14 13:00:00
End 2010-09-15 13:00:00
Animation Step 1 hour
Animate
Stop
Download
Model Data
October
2010
MODEL DATA
Pressure Level: 850
Forecast Time: 000
GFS
Speed Earth Relative
Streamline Earth Relative
PGI48L
PGI49L
PGI51L
Relative Humidity
OW
Vorticity
Deep shear
Pouch shear
Sea Level Pressure
ECMWF
UKMET
NOGAPS
Done

TC-IDEAS

The current time is Thu, 11 Nov 2010 06:54:14 GMT

Observation Data

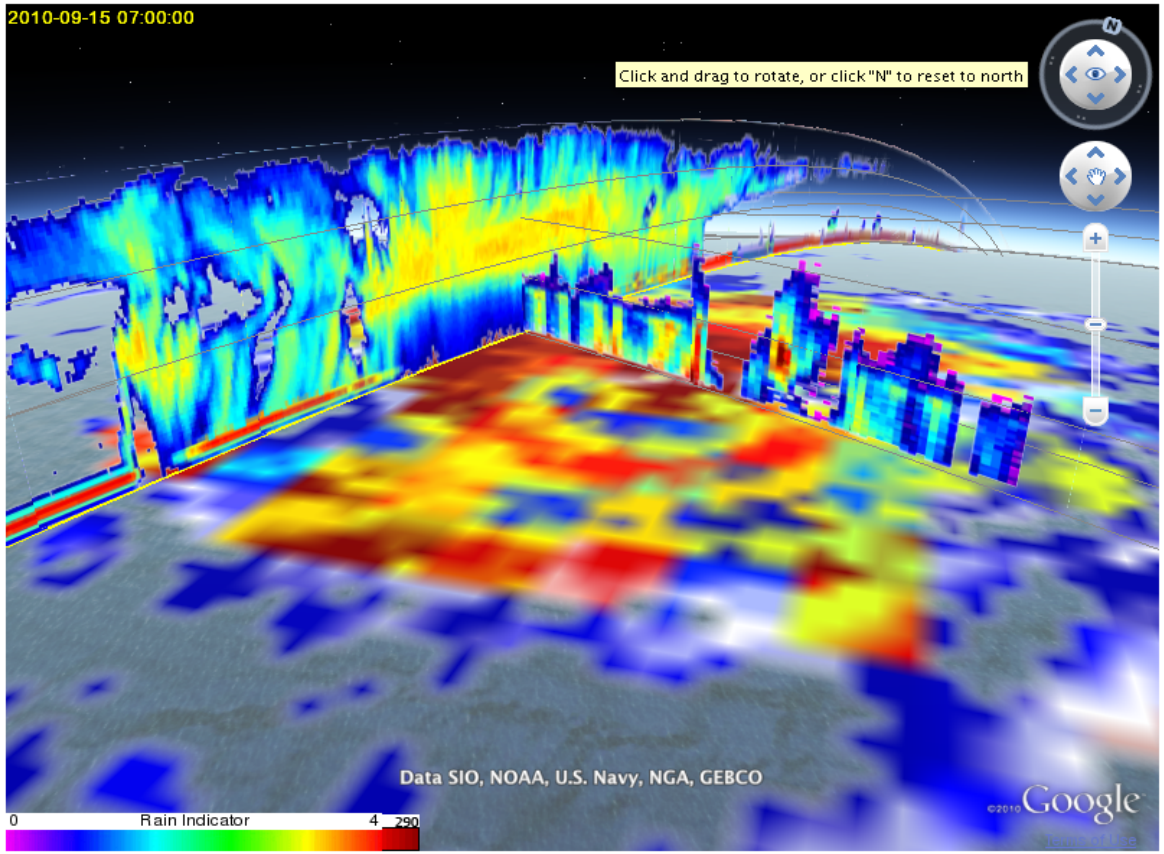
September 2010

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		

<< < > >>

At hour: 07:00:00

- [+] STORM TRACKS
- [−] SATELLITE DATA
  - [ ] SST
  - [ ] OHC
  - [+] Wind (ASCAT)
  - [ ] TPW (AMSU-A)
  - [ ] RH-AIRS Press. Level 850
  - [ ] CAPE-AIRS
  - [ ] LI-AIRS
  - [ ] Geostationary
    - ( ) GOES-IR
    - ( ) GOES-VAPOR
    - ( ) GOES-VIS
  - [x] 85HGHZ
  - [ ] 37HGHZ
  - [x] Rain
  - [x] TRMM PR Curt3
  - [x] CloudSat
  - [ ] CALIPSO
  - [−] MLS
    - [ ] Temperature
    - [ ] Water Vapor
    - [x] Ice Water Content
    - [ ] Ozone



[ ] Status Bar [ ] Grid

Animation: (•) Observation Data ( ) Model Data

Select a time range to animate: *(from 2010-09-14 13:00:00 to 2010-09-15 13:00:00)*

Start 2010-09-14 13:00:00 ***End*** 2010-09-15 13:00:00 ***Animation Step*** 1 hour

Animate | Stop | Download

Model Data

September 2010

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		

<< < > >>

- [−] MODEL DATA
  - Pressure Level: 850
  - Forecast Time: 012
  - [−] GFS
    - [ ] Speed Earth Relative
    - [ ] Streamline Earth Relative
    - [+] PGI41L
    - [+] PGI43L
    - [+] PGI44L
    - [+] PGI45L
    - [ ] Relative Humidity
    - [ ] OW
    - [ ] Vorticity
    - [ ] Deep shear
    - [ ] Pouch shear
    - [ ] Sea Level Pressure
  - [+] ECMWF
  - [+] UKMET
  - [+] NOGAPS

Jet Propulsion Laboratory
California Institute of Technology

JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNOLOGY

BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast | Video

TC-IDEAS

JPL TC Information System | About GRIP | Collaboration | GRIP Mission Page | NASA Hurricanes

Observation Data

September 2010

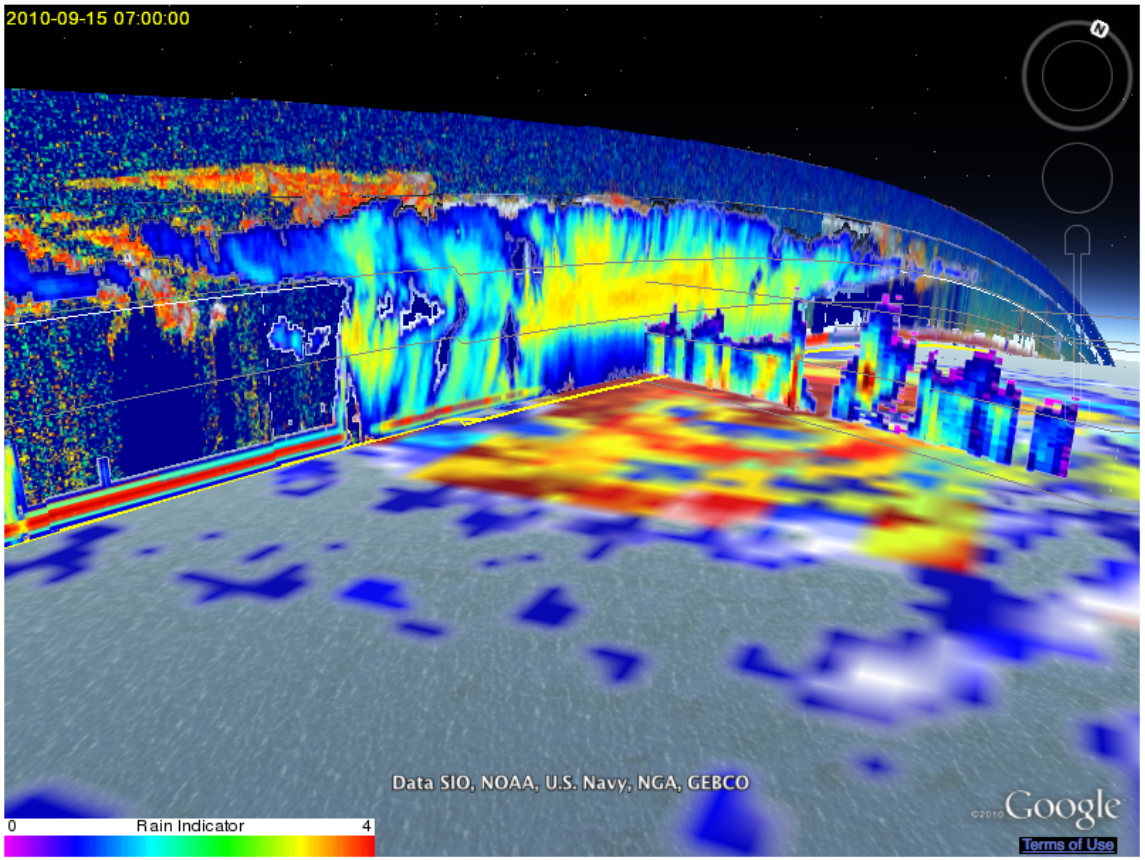
Su	M	T	W	Th	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

<< < > >>

At hour: 07:00:00

- STORM TRACKS
  - Best Tracks
  - Pouch Tracks
    - PGI41L
    - PGI43L
    - PGI44L
    - PGI45L
- SATELLITE DATA
  - SST
  - OHC
  - Wind (ASCAT)
  - TPW (AMSU-A)
  - RH-AIRS Press. Level 850
  - CAPE-AIRS
  - LI-AIRS
  - Geostationary
    - GOES-IR
    - GOES-VAPOR
    - GOES-VIS
  - 85HGHZ
  - 37HGHZ
  - Rain
  - TRMM PR Curt3

The current time is Tue, 07 Jun 2011 07:03:33 GMT



Status Bar | Grid

Animation: Observation Data | Model Data

Select a time range to animate: *(from 2010-09-14 17:00:00 to 2010-09-15 17:00:00)*

Start 2010-09-14 19:00:00 ***End*** 2010-09-15 19:00:00 ***Animation Step*** 1 hour

Animate | Stop | Download

Model Data

September 2010

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		

<< < > >>

- MODEL DATA
  - Pressure Level: 850
  - Forecast Time: 000
  - GFS
    - Speed Earth Relative
    - Streamline Earth Relative
    - PGI41L
    - PGI43L
    - PGI44L
    - PGI45L
    - PGI46L
    - Relative Humidity
    - OW
    - Vorticity
    - Deep shear
    - Pouch shear
    - Sea Level Pressure
  - ECMWF
  - UKMET
  - NOGAPS

Jet Propulsion Laboratory
California Institute of Technology

JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNOLOGY

BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast | Video

TC-IDEAS

JPL TC Information System | About GRIP | Collaboration | GRIP Portals | RTMM | Waypoint Tool

Observation Data

September 2010

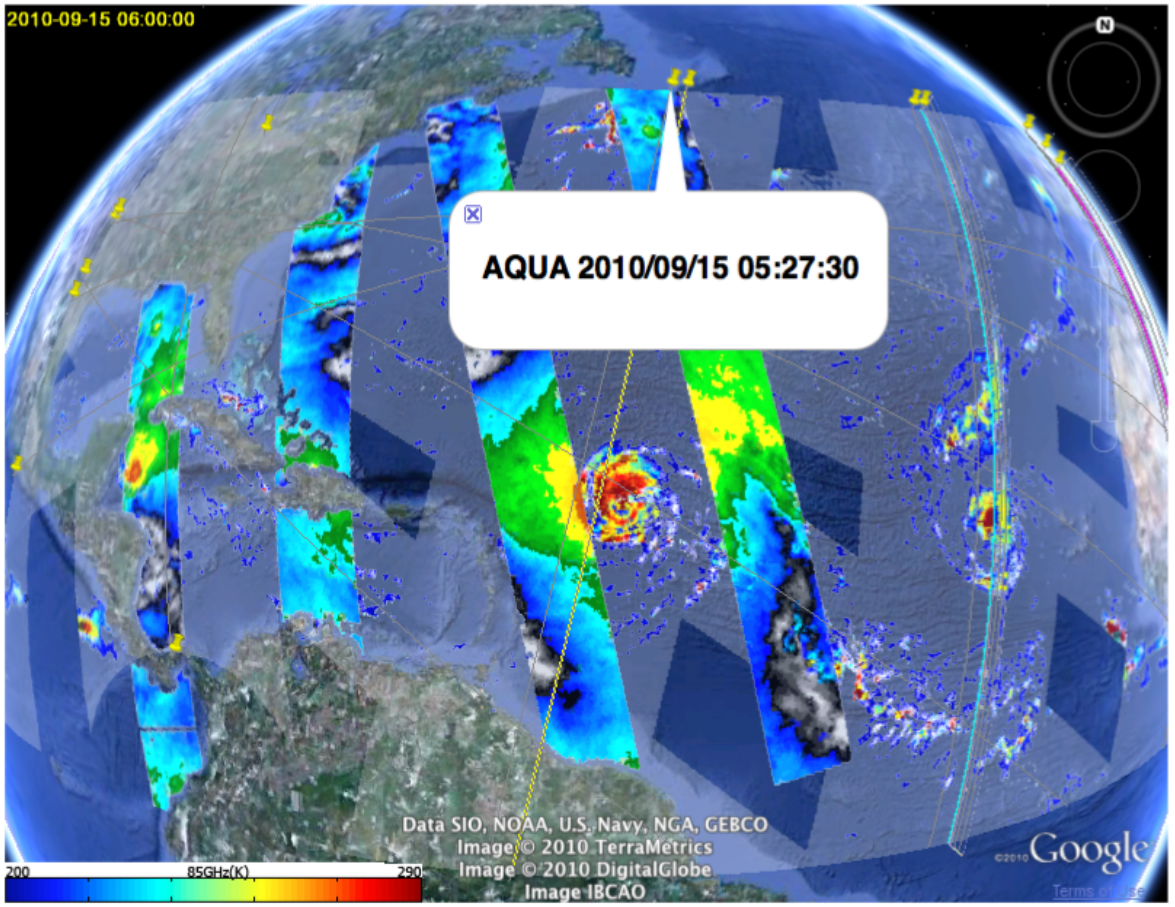
Su	M	T	W	Th	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

<< < > >>

At hour: 06:00:00

- [+] STORM TRACKS
- [-] SATELLITE DATA
  - [ ] SST
  - [ ] OHC
  - [-] Wind (ASCAT)
    - [ ] Wind Vector
    - [x] Wind Speed
  - [ ] TPW (AMSU-A)
  - [ ] RH-AIRS Press. Level 850
  - [ ] CAPE-AIRS
  - [ ] LI-AIRS
  - [x] Geostationary
    - (•) GOES-IR
    - ( ) GOES-VAPOR
    - ( ) GOES-VIS
  - [x] 85HGHZ
  - [ ] 37HGHZ
  - [x] Rain
  - [x] TRMM PR Nadir
  - [x] CloudSat
  - [ ] CALIPSO

The current time is Thu, 11 Nov 2010 06:49:26 GMT



[ ] Status Bar [ ] Grid

Animation: (•) Observation Data ( ) Model Data

Select a time range to animate: *(from 2010-09-14 13:00:00 to 2010-09-15 13:00:00)*

Start 2010-09-14 13:00:00 ***End*** 2010-09-15 13:00:00 ***Animation Step*** 1 hour

Animate | Stop | Download

Model Data

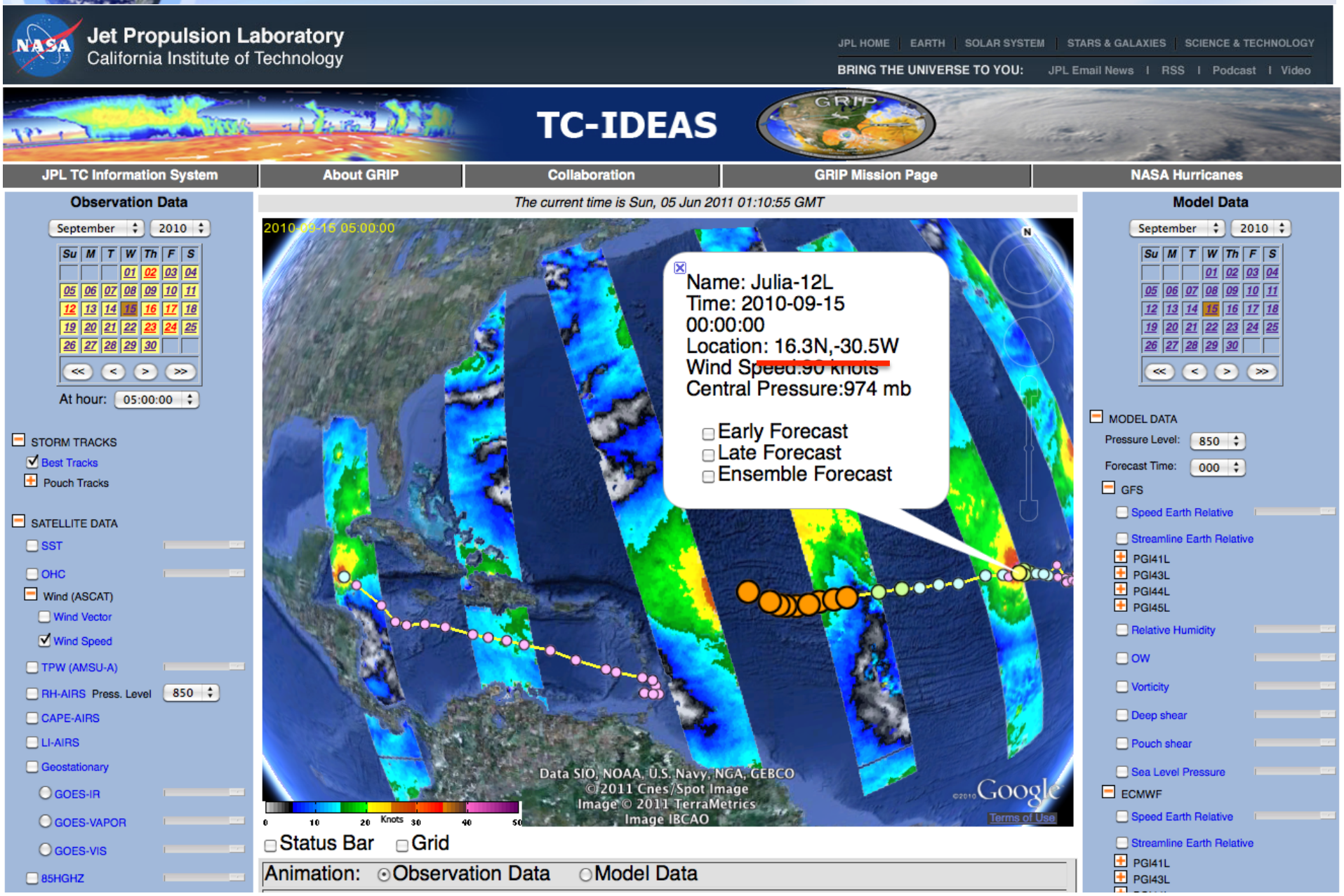
September 2010

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		

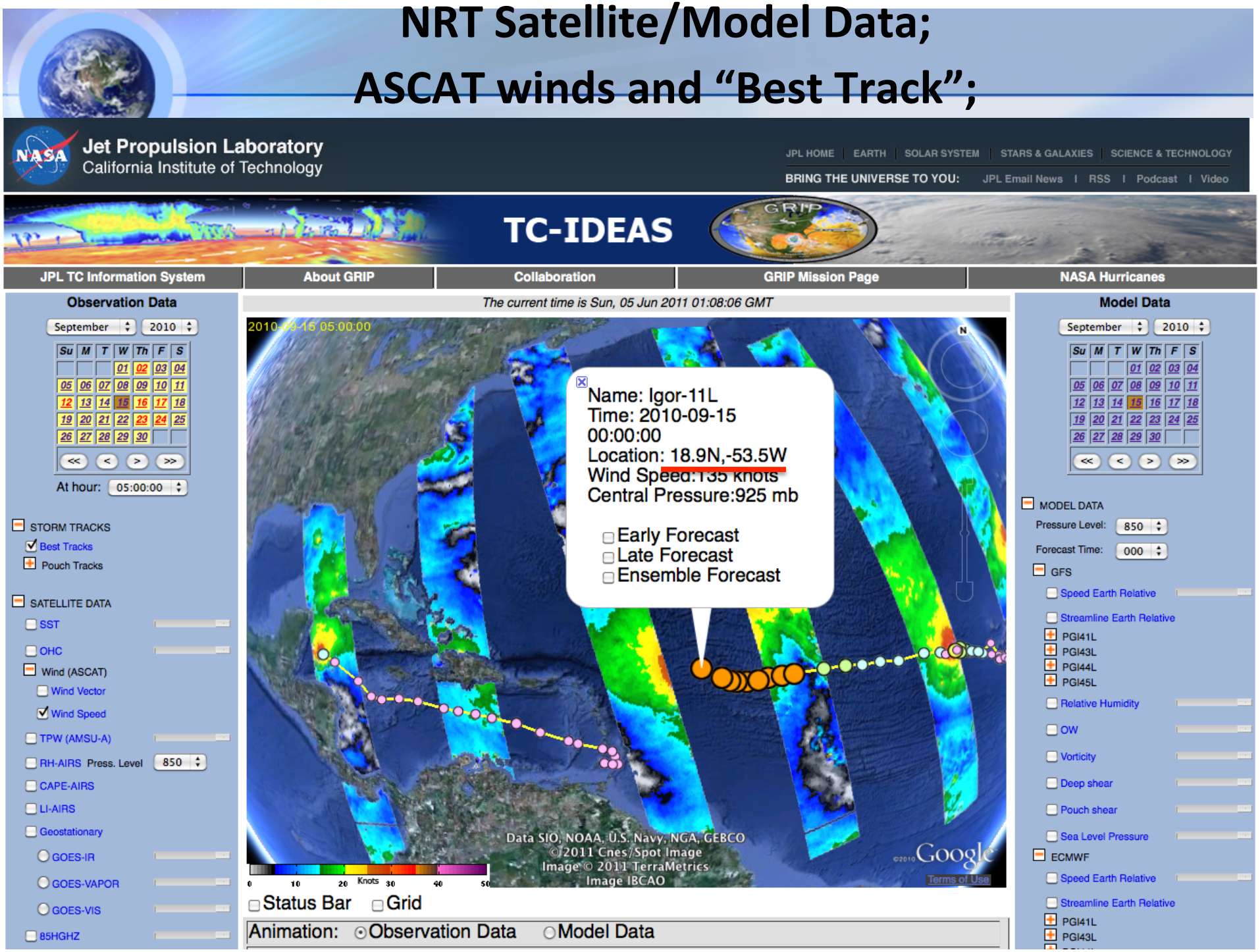
<< < > >>

- [-] MODEL DATA
  - Pressure Level: 850
  - Forecast Time: 012
  - [-] GFS
    - [ ] Speed Earth Relative
    - [ ] Streamline Earth Relative
    - [+] PGI41L
    - [+] PGI43L
    - [+] PGI44L
    - [+] PGI45L
    - [ ] Relative Humidity
    - [ ] OW
    - [ ] Vorticity
    - [ ] Deep shear
    - [ ] Pouch shear
    - [ ] Sea Level Pressure
  - [+] ECMWF
  - [+] UKMET
  - [+] NOGAPS

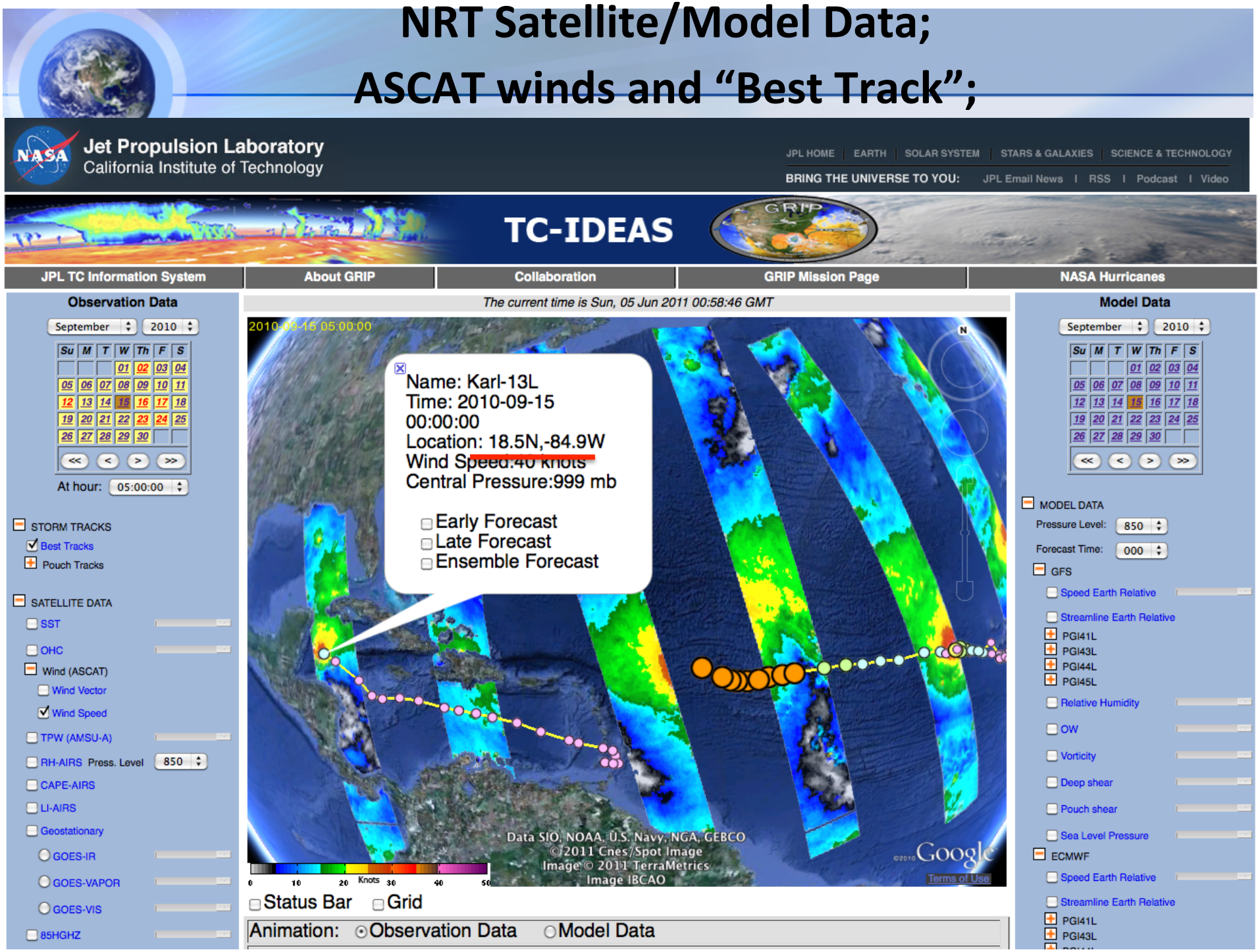
NRT Satellite/Model Data;
ASCAT winds and "Best Track";



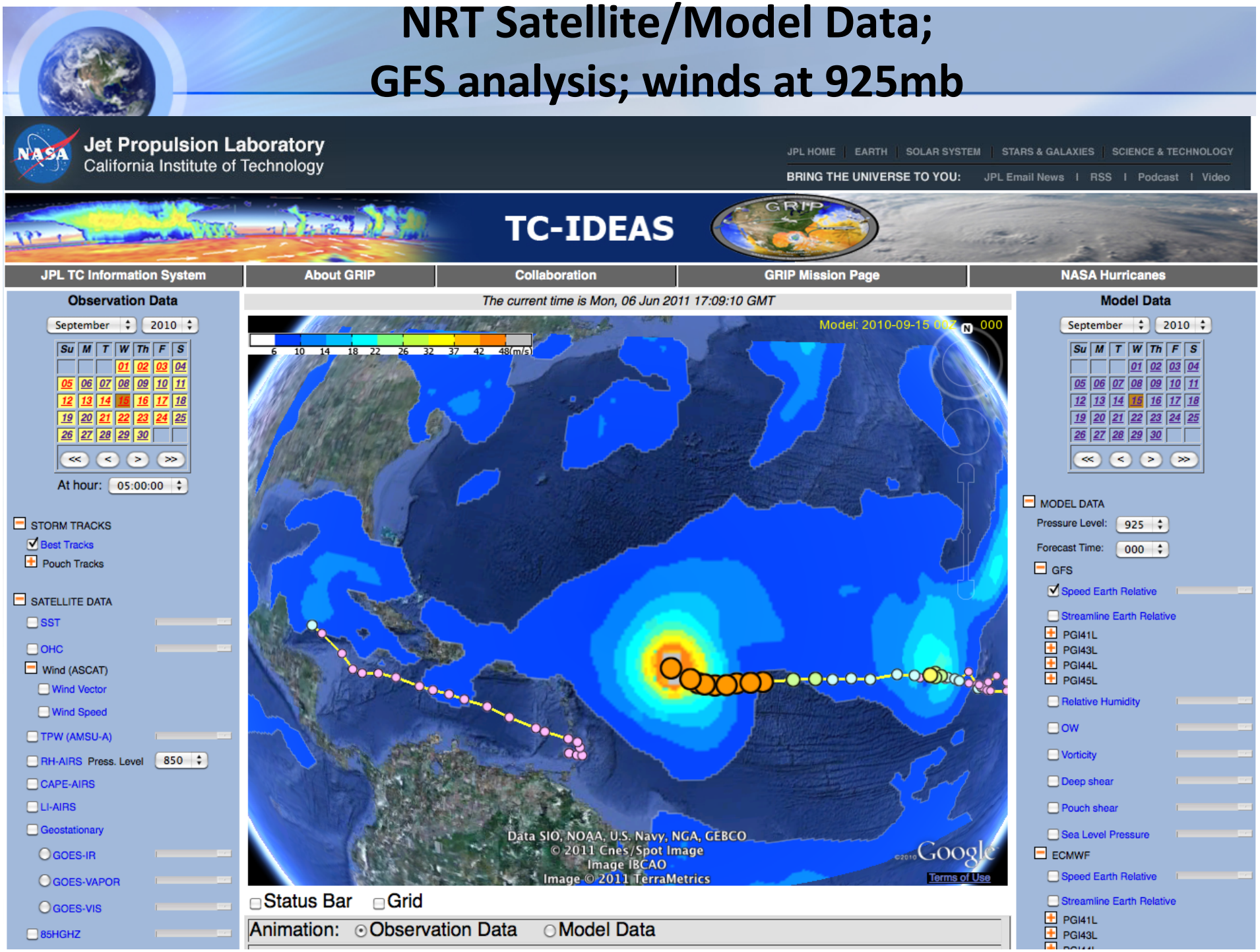
NRT Satellite/Model Data;
ASCAT winds and "Best Track";



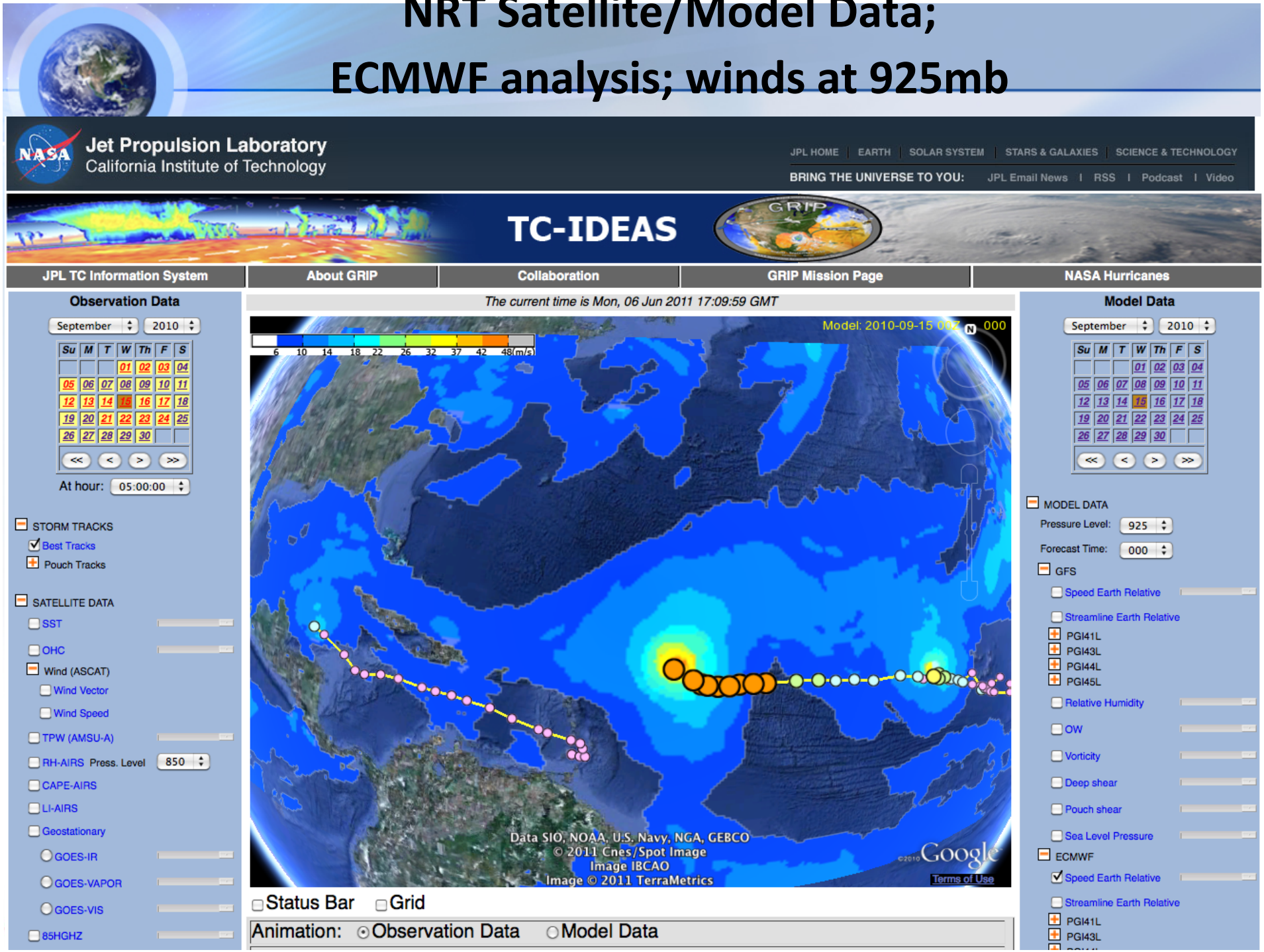
NRT Satellite/Model Data;
ASCAT winds and "Best Track";



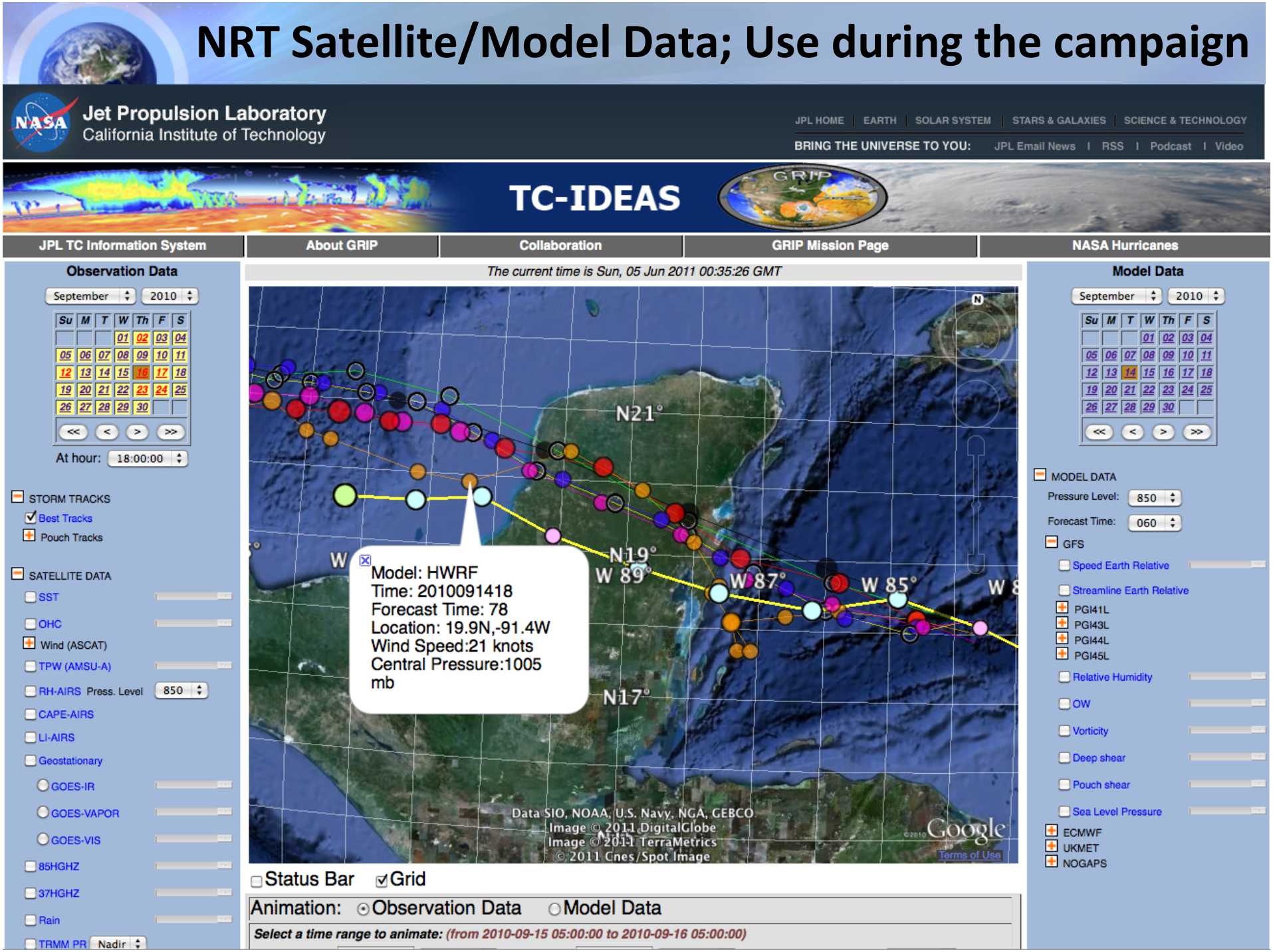
NRT Satellite/Model Data;
GFS analysis; winds at 925mb



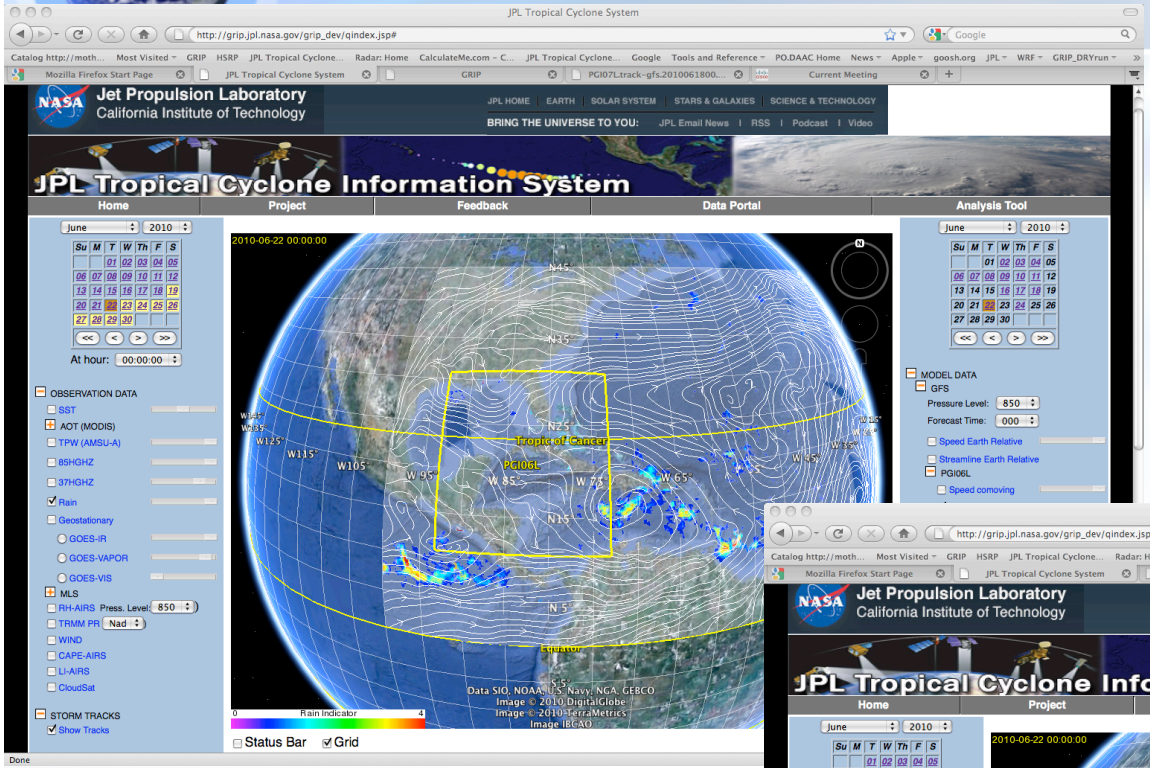
NRT Satellite/Model Data;
ECMWF analysis; winds at 925mb



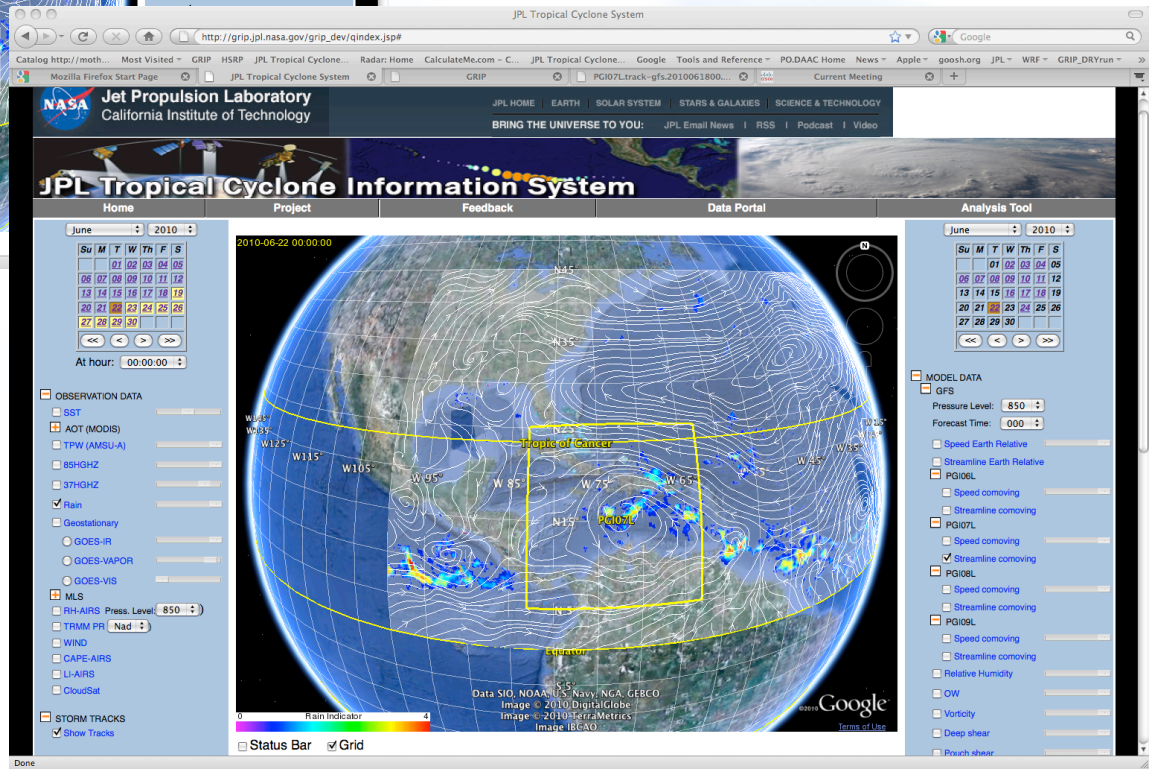
NRT Satellite/Model Data; Use during the campaign



Use during the campaign; Developer vs Non-developer

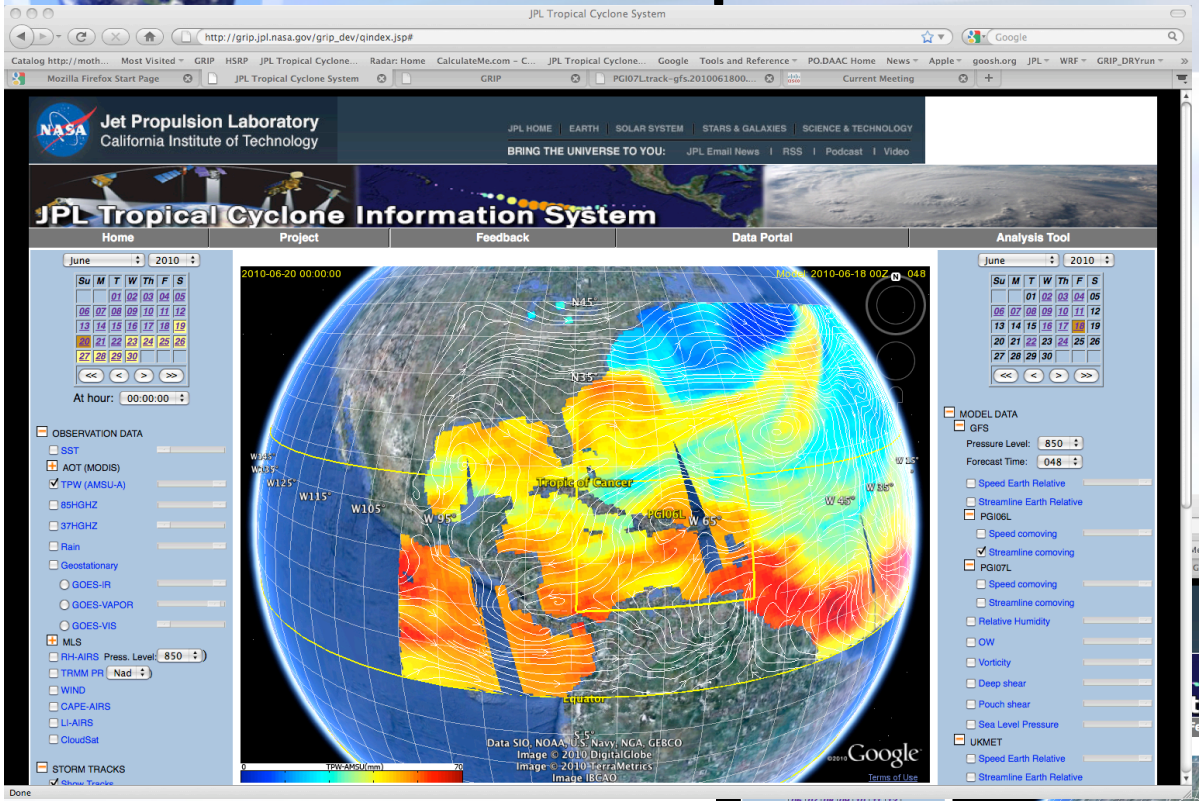


Convective activity, as depicted by the observed Rain Indicator, overlayed with GFS analysis of co-moving flow on June 22nd left-PGI06, right - PGI07

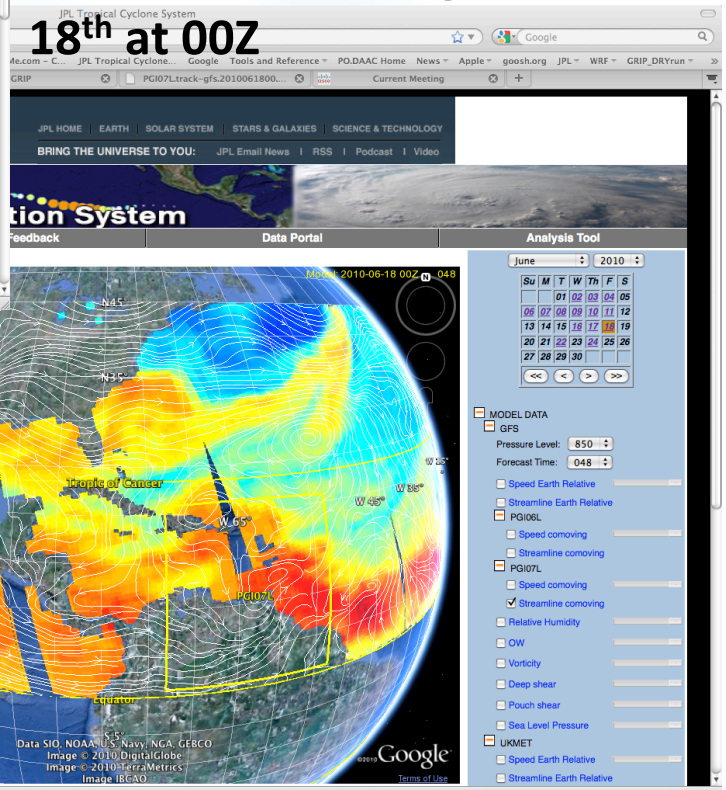


By the 22nd PGI06 shows no signs of development while PGI07 has convection near the center. PGI07 became hurricane ALEX.

Use during the campaign; Developer vs Non-developer



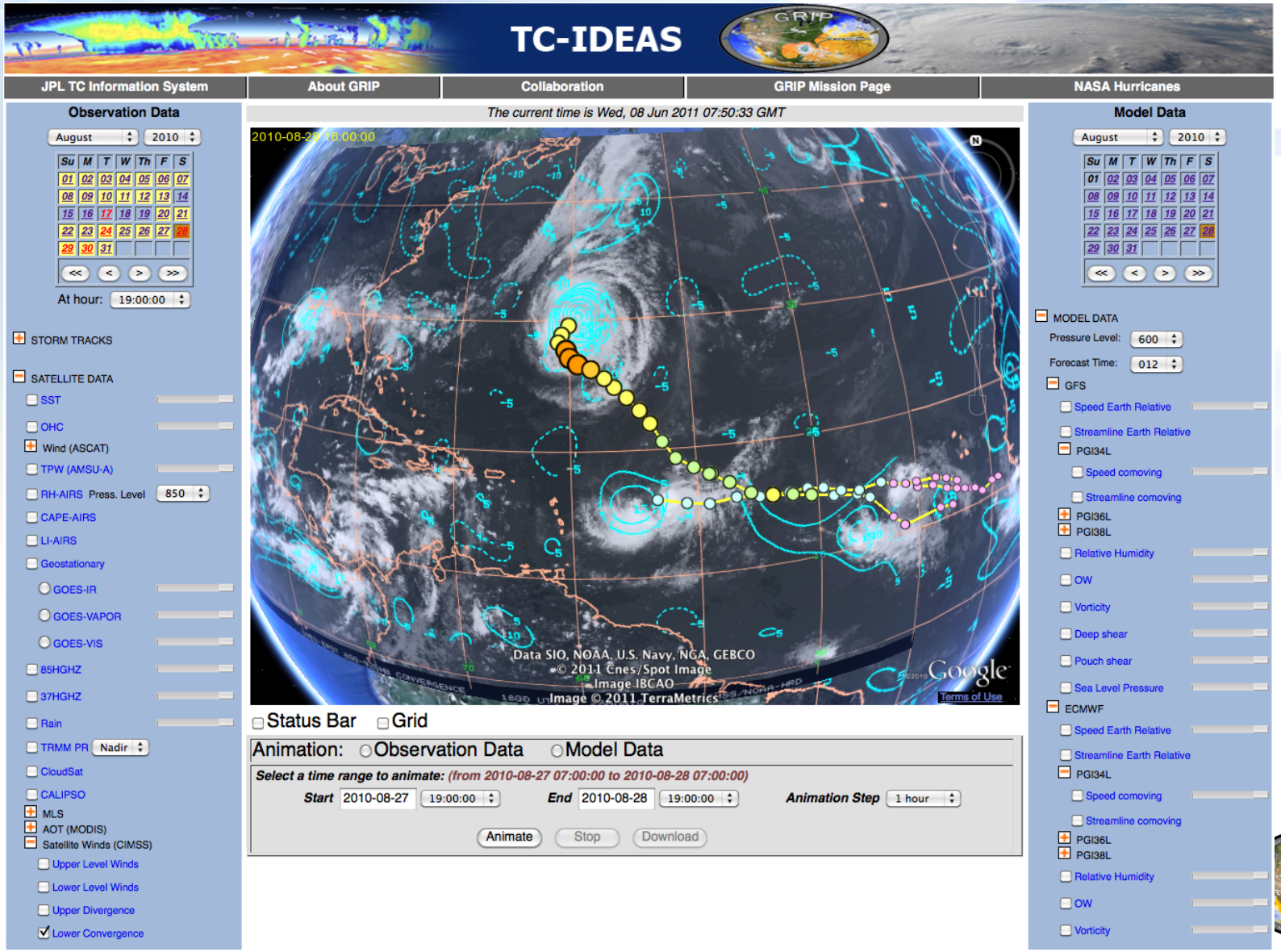
Moisture – observations of Total Precipitable Water (AMSU) on June 20th (00Z), overlayed with co-moving flow for each of the pouches from the GFS 48h forecast stating on June 18th at 00Z



PGI-06 has dry air north of the center while PGI07 is in moister environment.

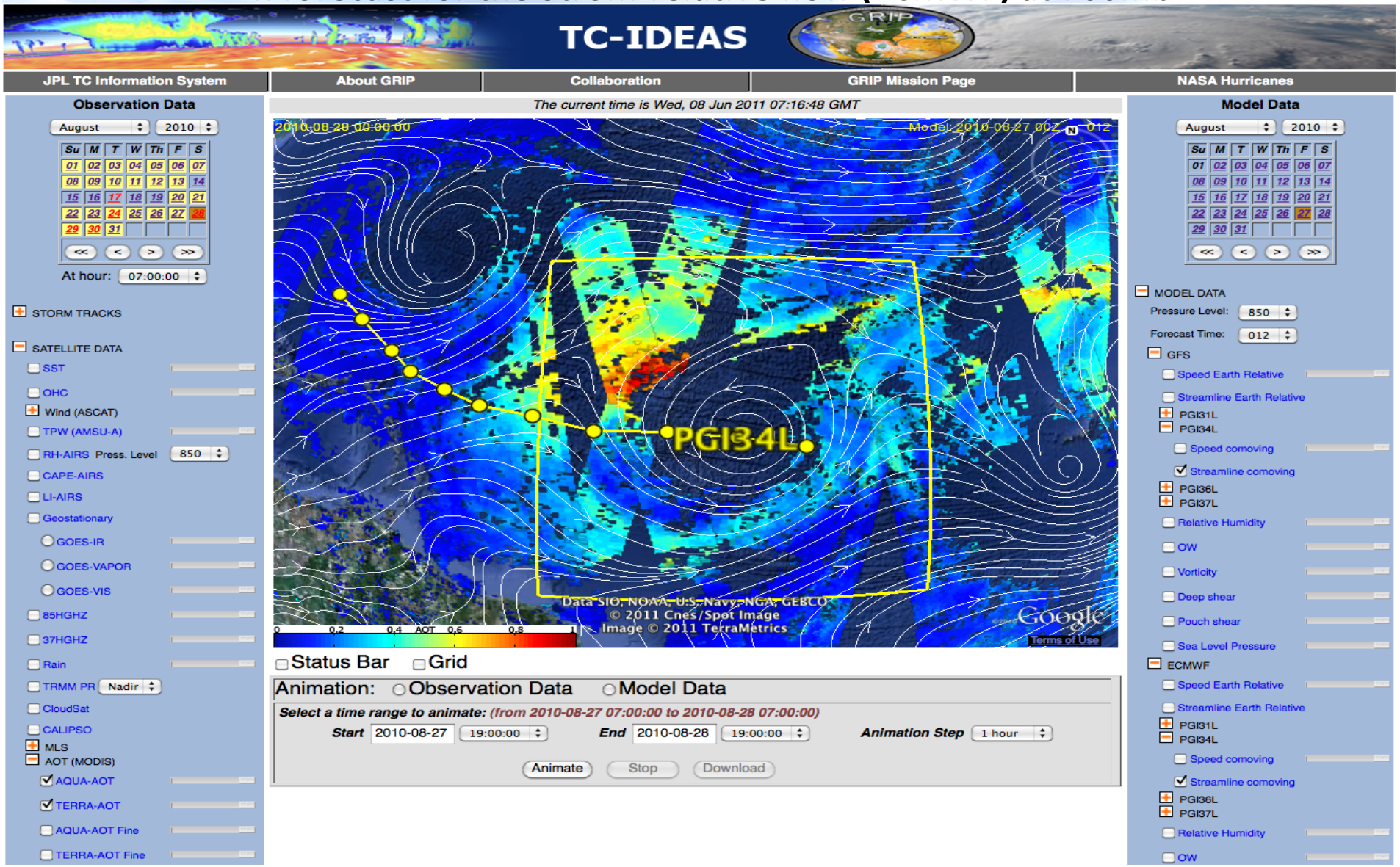
NRT Satellite Data – Use during the campaign

August 28th, 2010; Earl: CIMSS Low level Convergence and



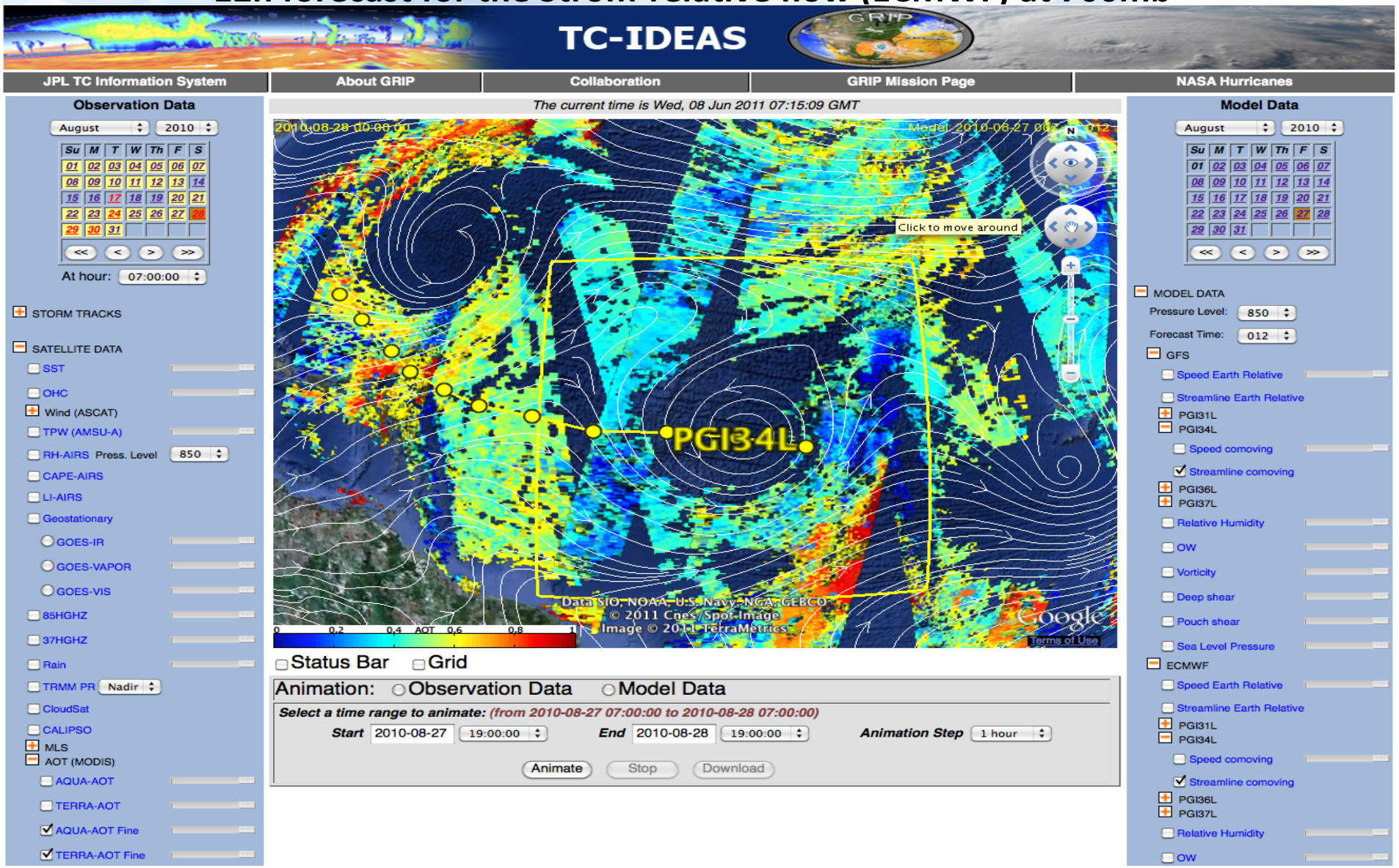
NRT Satellite Data – Use during the campaign

August 27th, 2010; Earl: AOT and 12h forecast for the Strom-relative flow (ECMWF) at 700mb



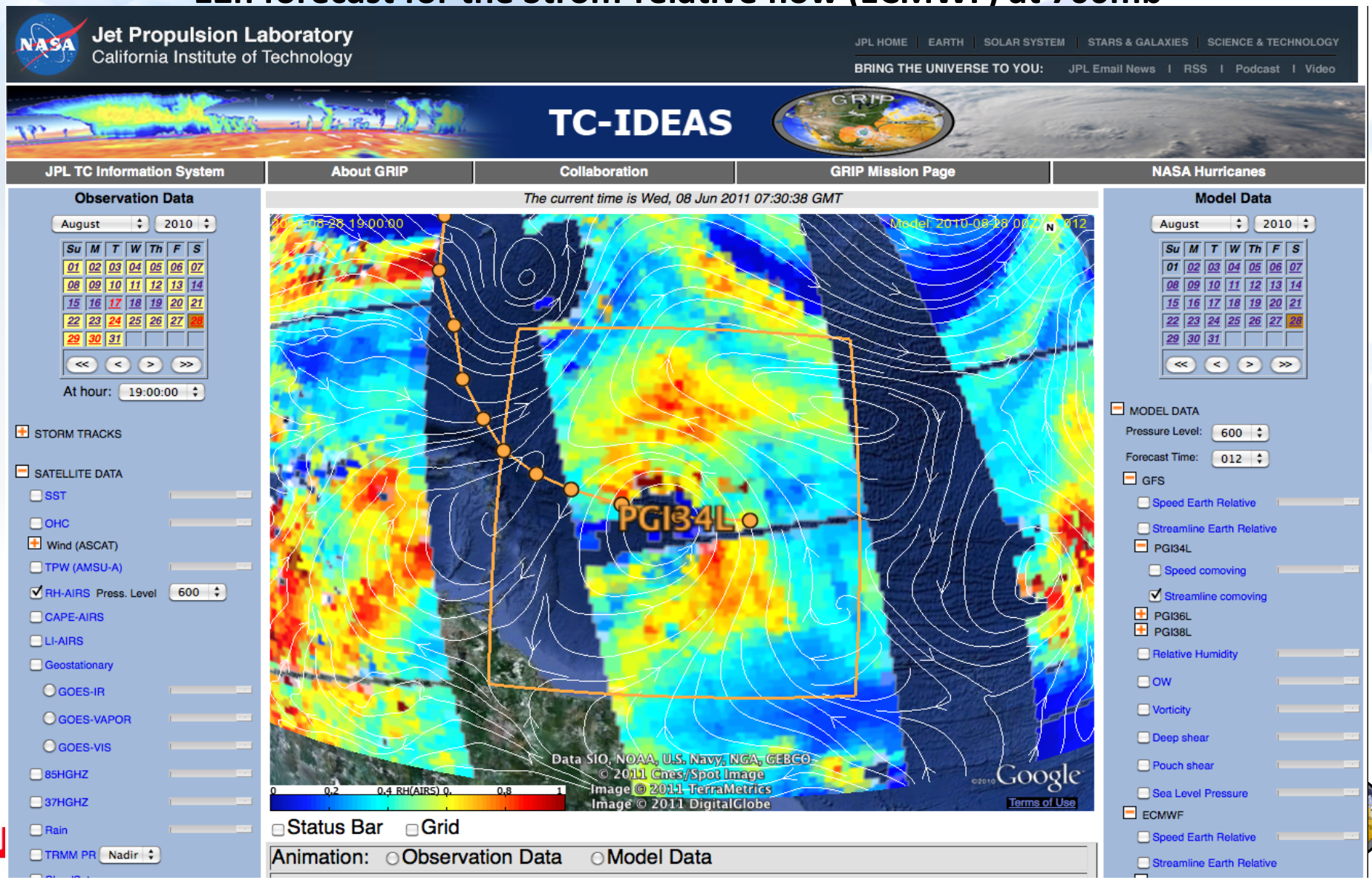
NRT Satellite Data – Use during the campaign

August 28th, 2010; Earl: AOT and 12h forecast for the Strom-relative flow (ECMWF) at 700mb



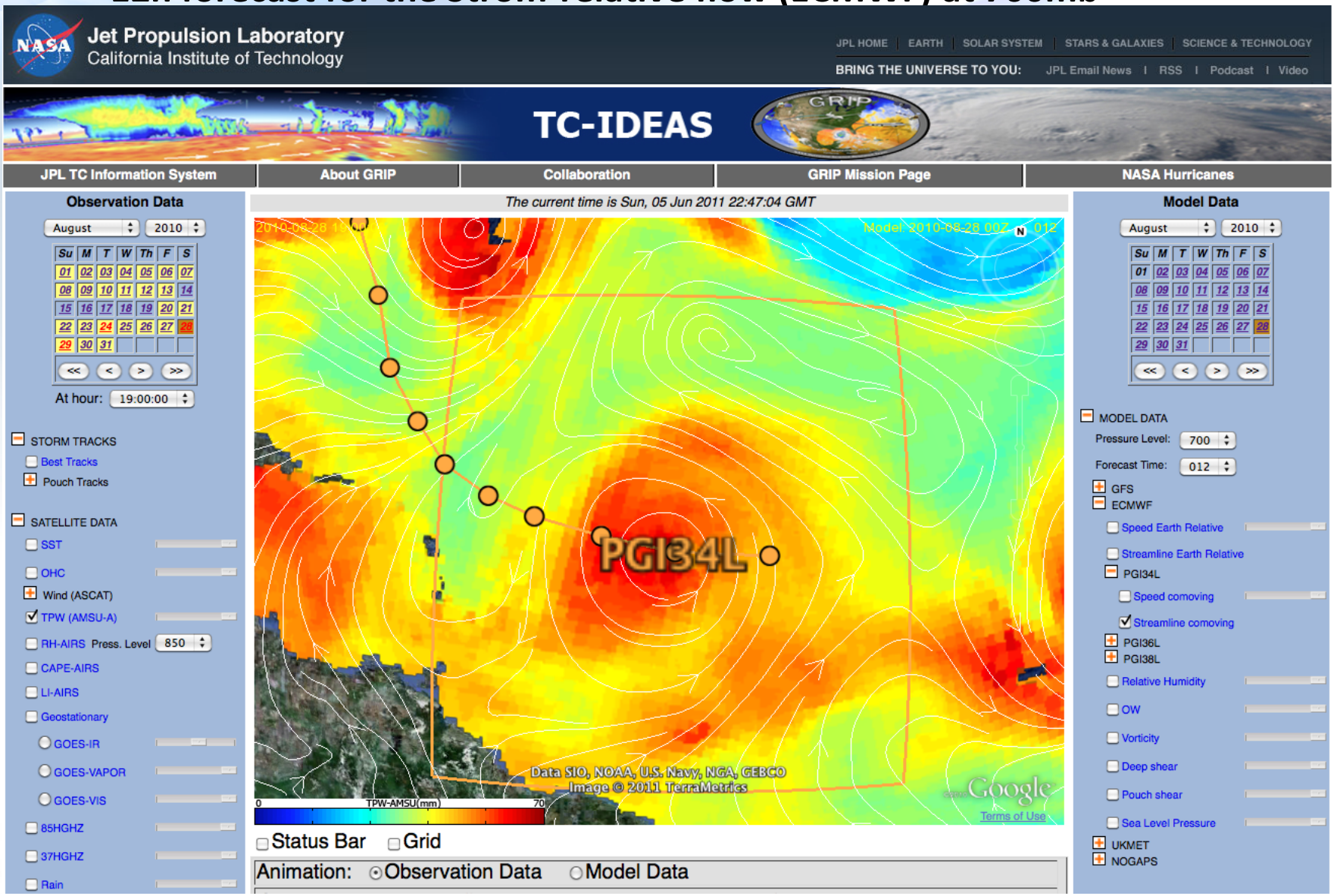
NRT Satellite Data – Use during the campaign

August 28th, 2010; Earl: AIRS RH at 600mb and 12h forecast for the Strom-relative flow (ECMWF) at 700mb



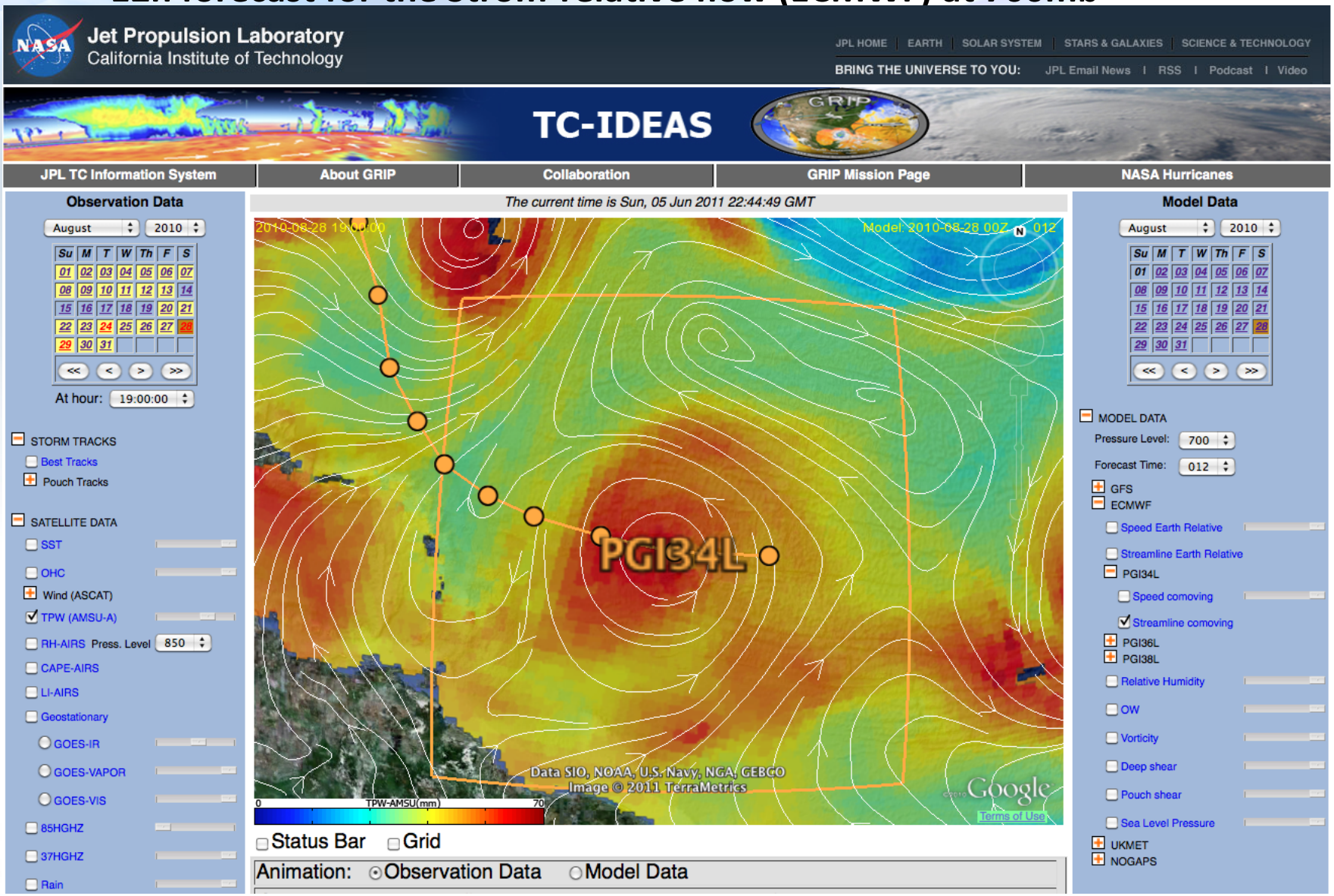
NRT Satellite Data – Use during the campaign

August 28th, 2010; Earl: Total Precipitable water (AMSU) and 12h forecast for the Strom-relative flow (ECMWF) at 700mb



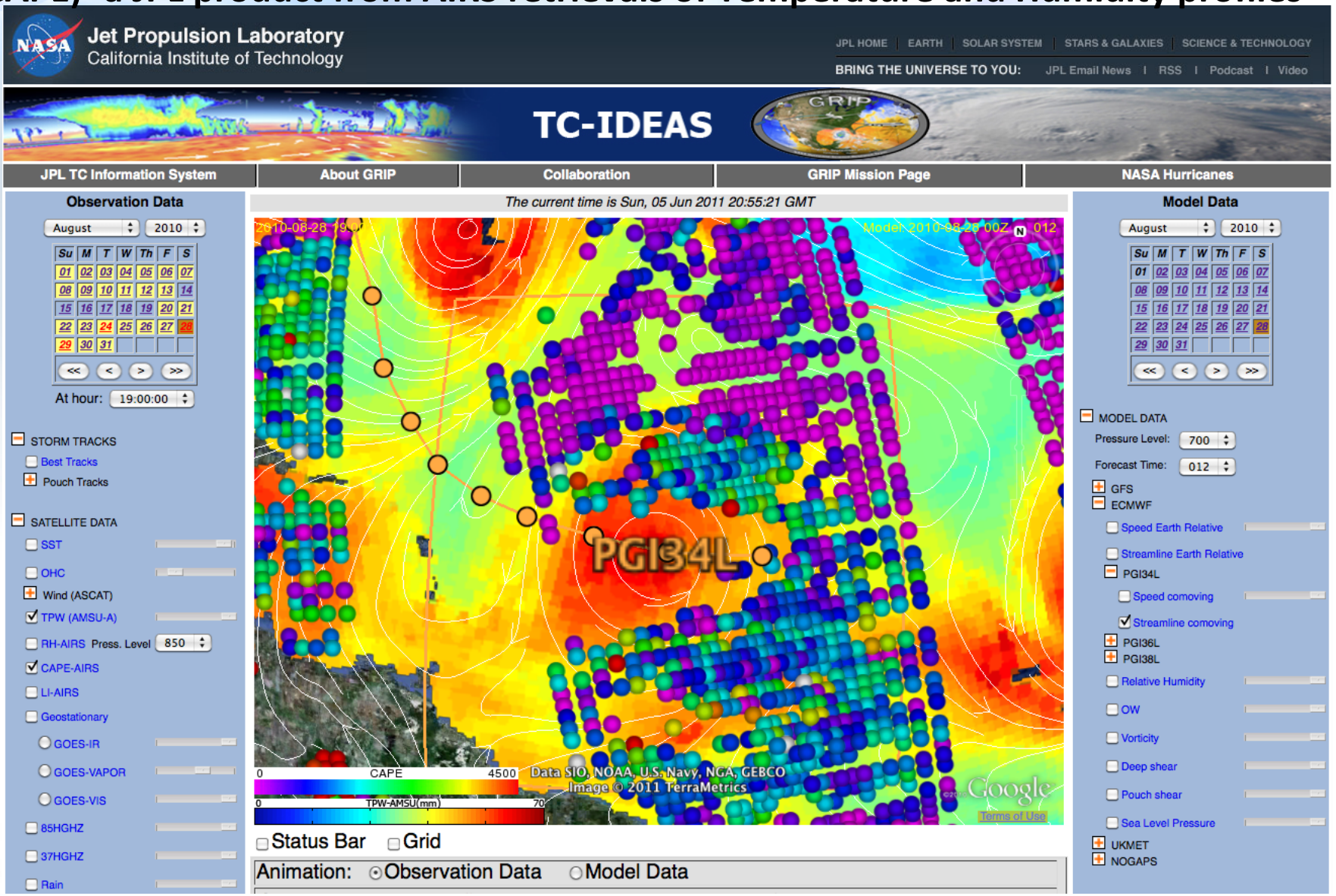
NRT Satellite Data – Use during the campaign

August 28th, 2010; Earl: Total Precipitable water (AMSU) and 12h forecast for the Strom-relative flow (ECMWF) at 700mb



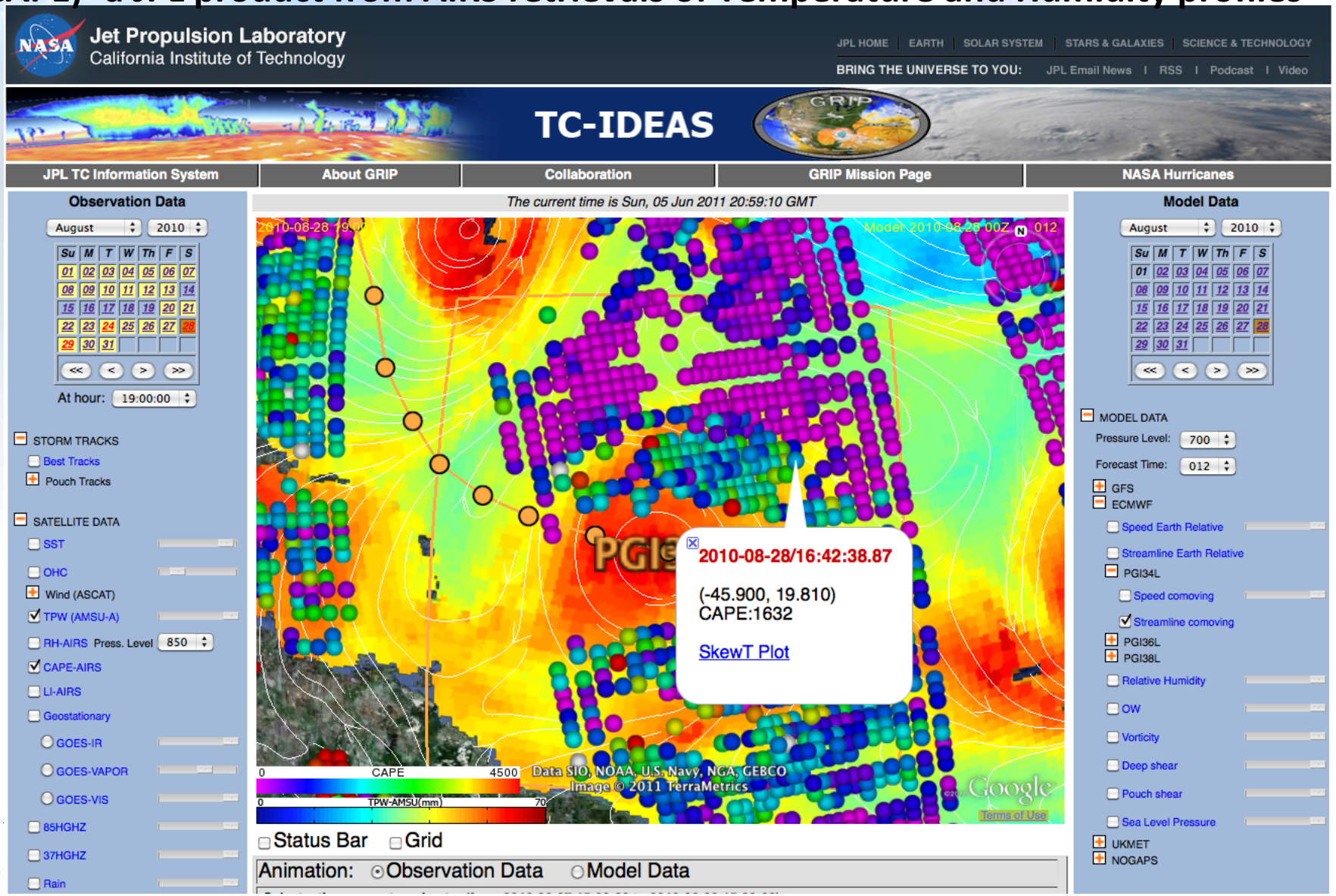
NRT Satellite Data – Use during the campaign

TPW (AMSU); 12h fcst for the Strom-relative flow (ECMWF) at 700mb and (CAPE)- a JPL product from AIRS retrievals of Temperature and Humidity profiles



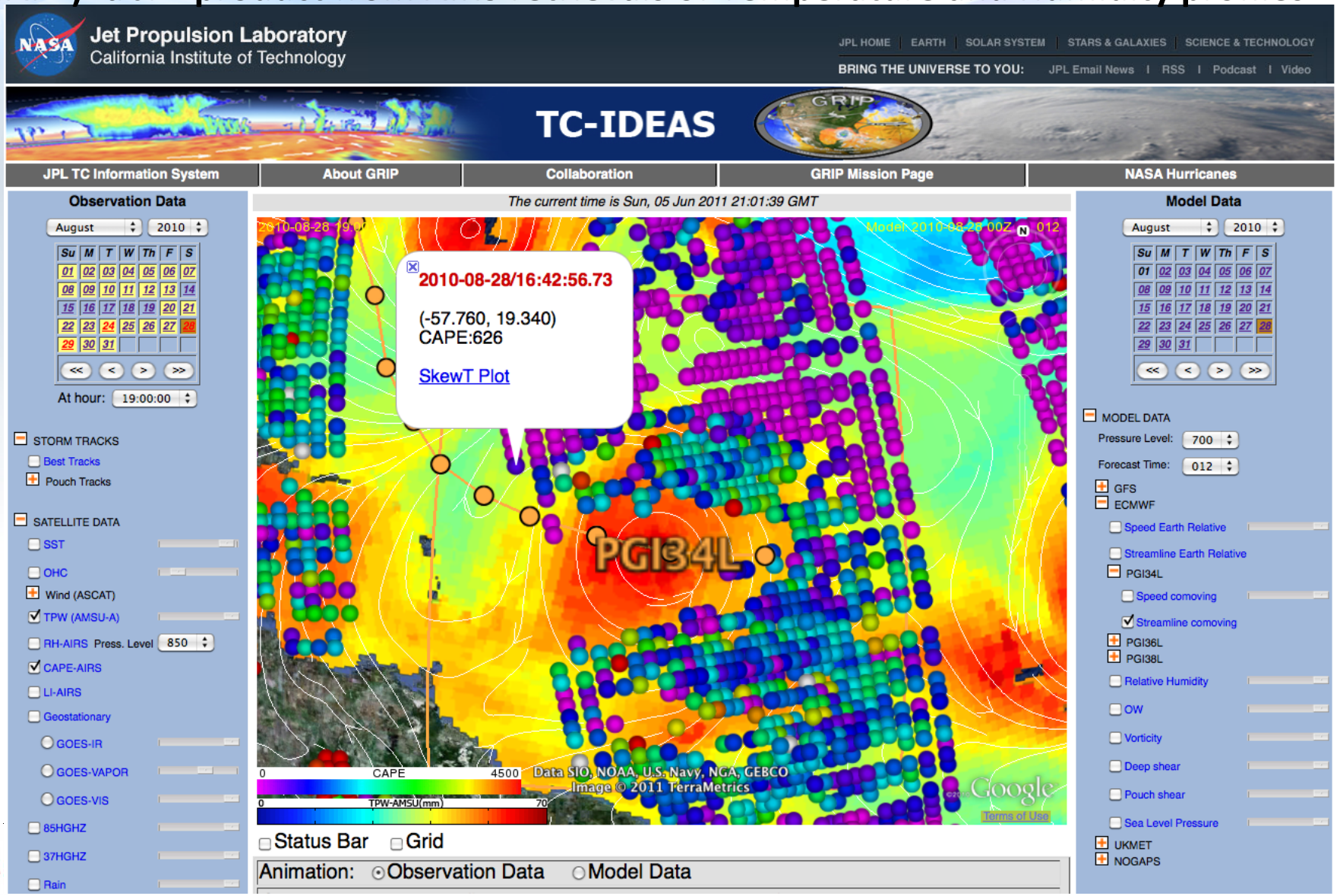
NRT Satellite Data – Use during the campaign

TPW (AMSU); 12h fcst for the Strom-relative flow (ECMWF) at 700mb and (CAPE)- a JPL product from AIRS retrievals of Temperature and Humidity profiles



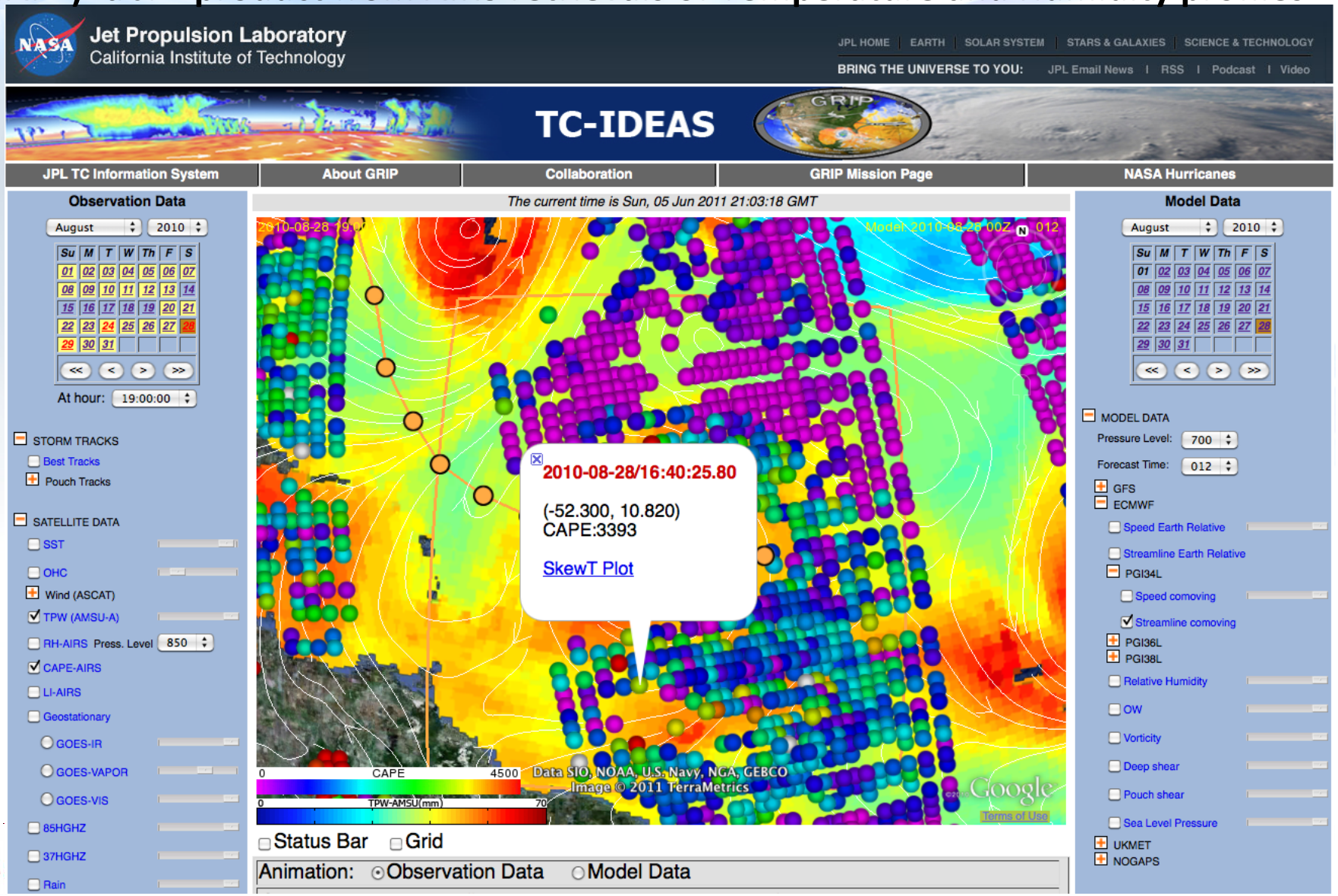
NRT Satellite Data – Use during the campaign

TPW (AMSU); 12h fcst for the Strom-relative flow (ECMWF) at 700mb and (CAPE)- a JPL product from AIRS retrievals of Temperature and Humidity profiles



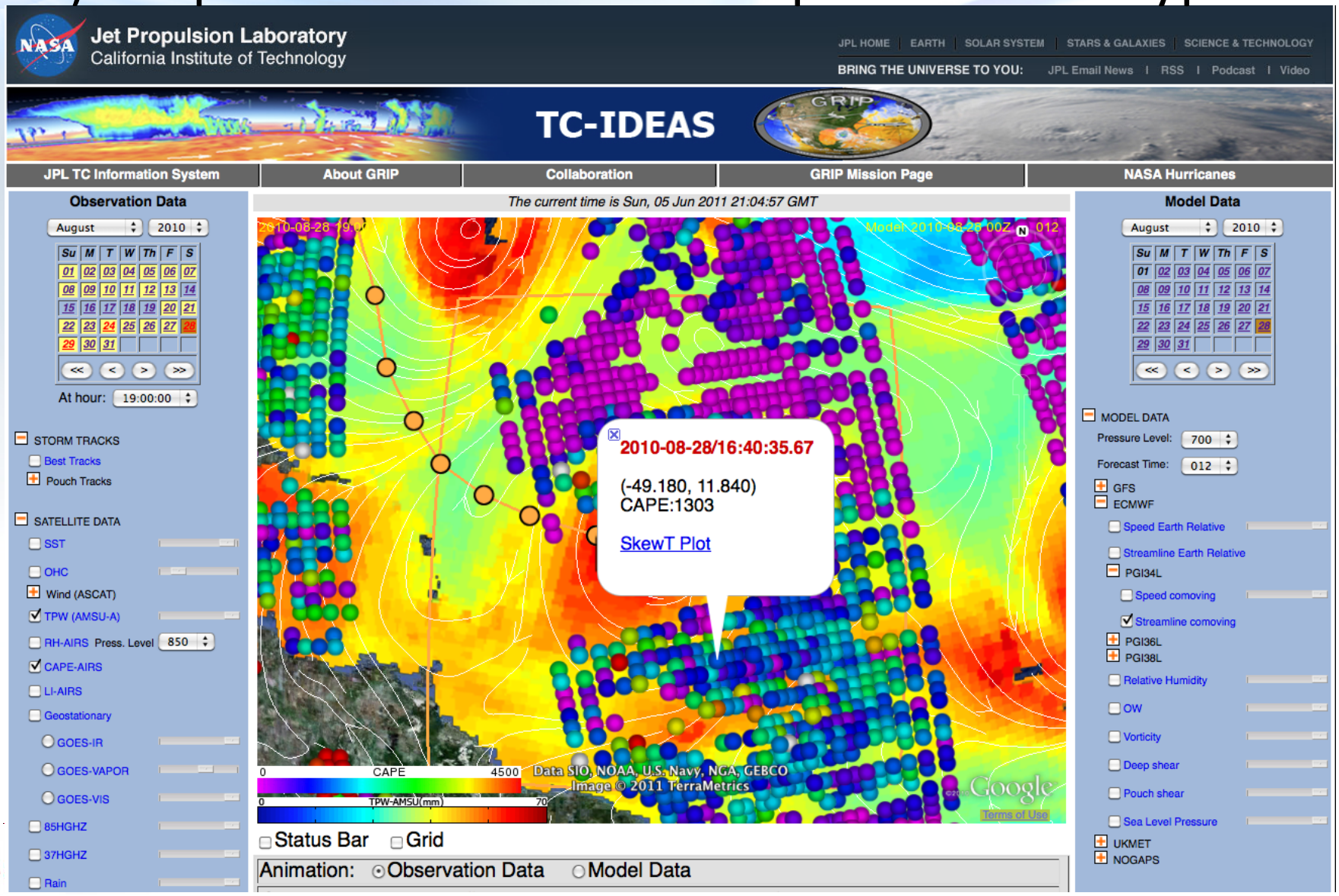
NRT Satellite Data – Use during the campaign

TPW (AMSU); 12h fcst for the Strom-relative flow (ECMWF) at 700mb and (CAPE)- a JPL product from AIRS retrievals of Temperature and Humidity profiles



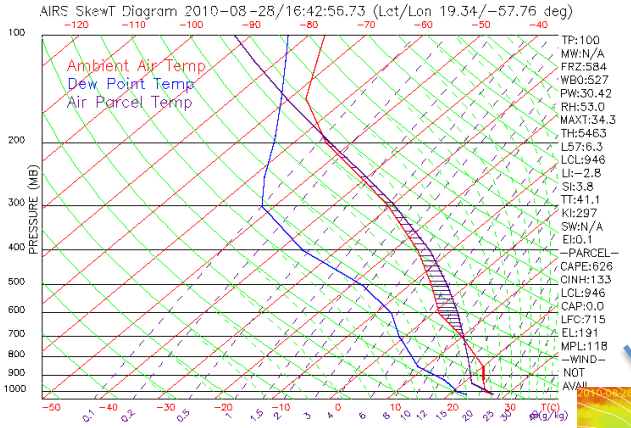
NRT Satellite Data – Use during the campaign

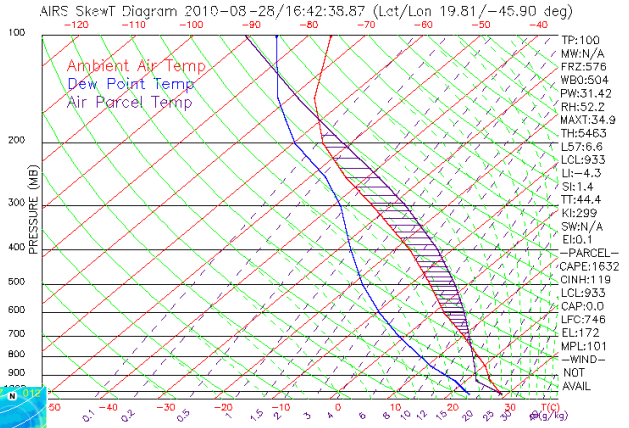
TPW (AMSU); 12h fcst for the Strom-relative flow (ECMWF) at 700mb and (CAPE)- a JPL product from AIRS retrievals of Temperature and Humidity profiles

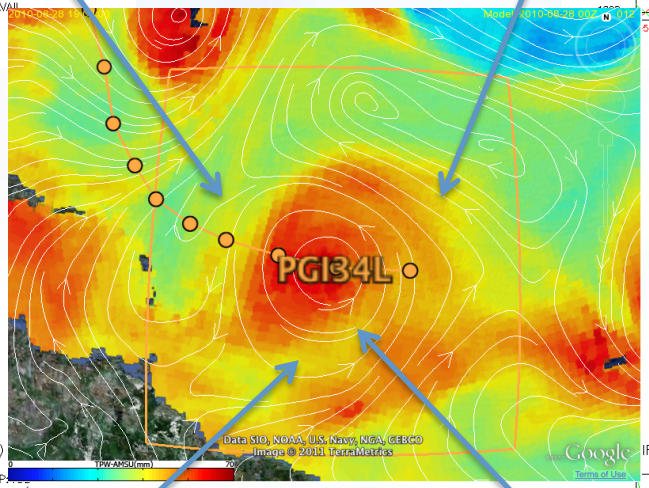


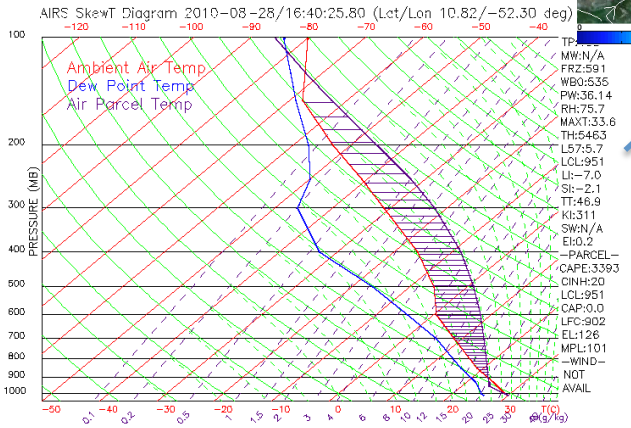
NRT Satellite Data – Use during the campaign

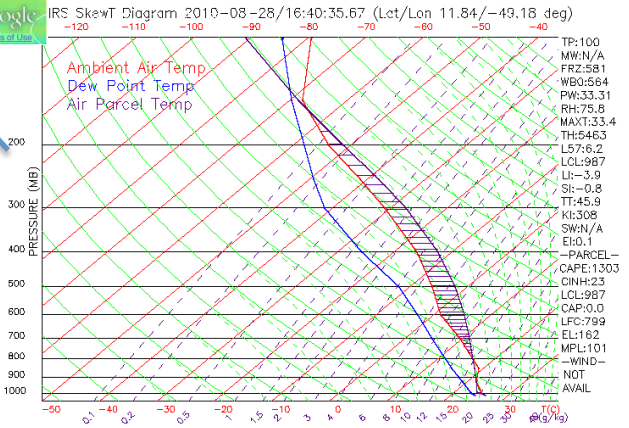
Hurricane Earl; Aug. 28, 2010 19Z





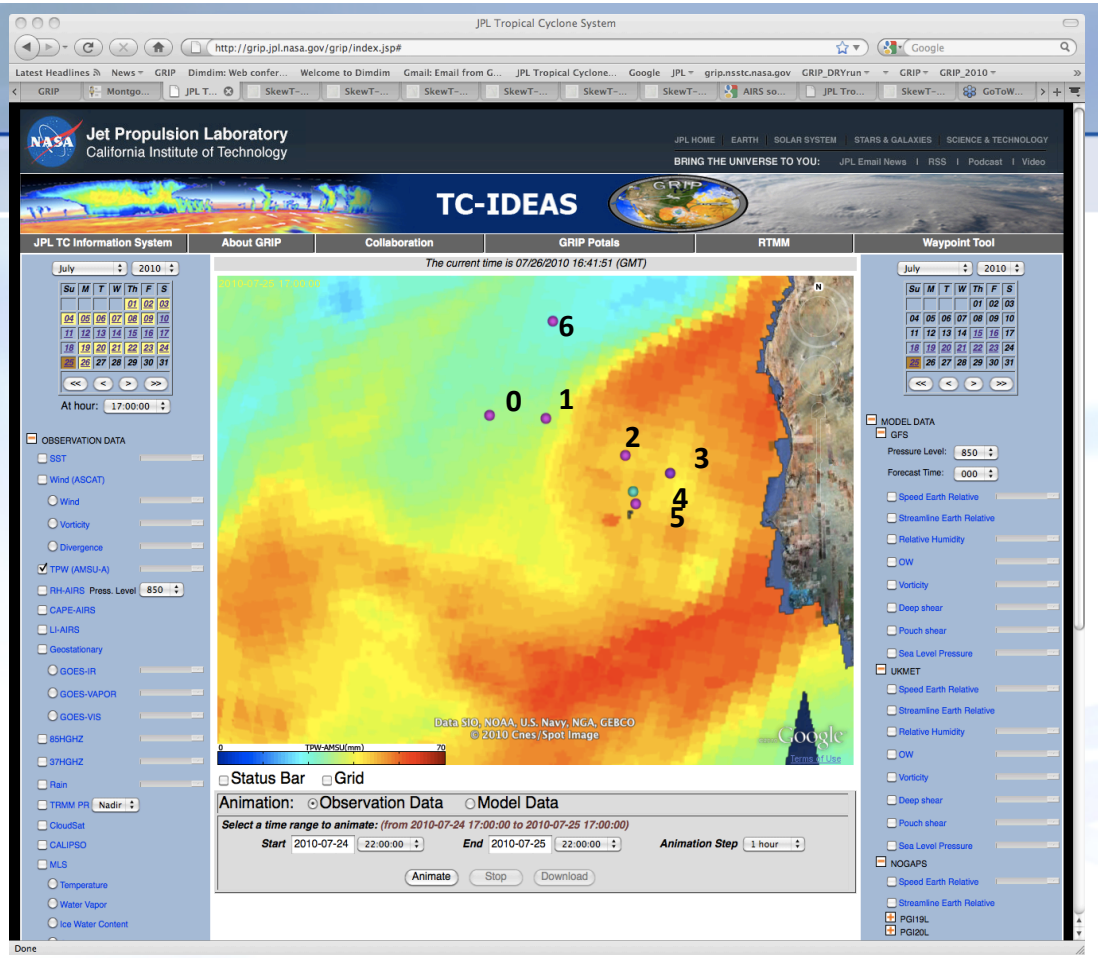




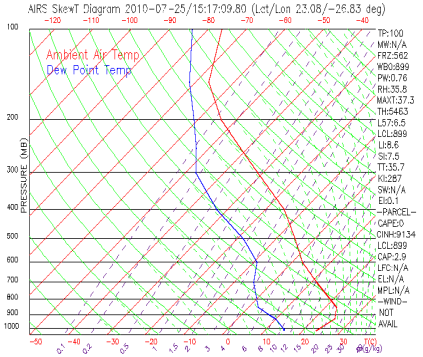


Use during the campaign

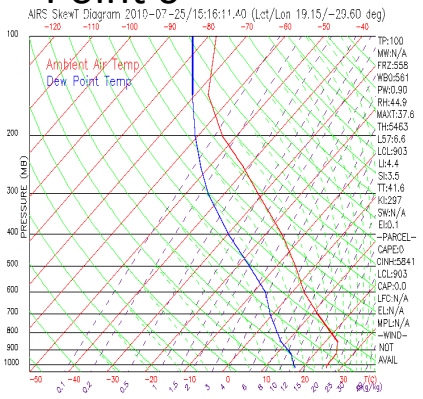
- AIRS estimates of the vertical structure of temperature and humidity help evaluate the origin of the environmental air and the potential for cyclogenesis



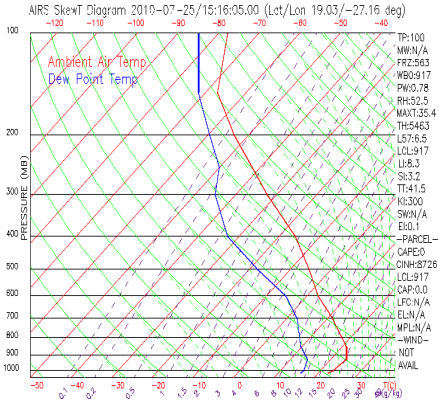
Point 6



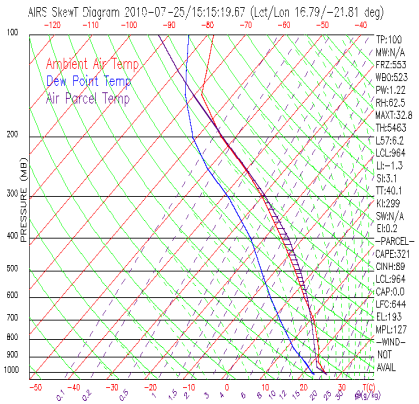
Point 0



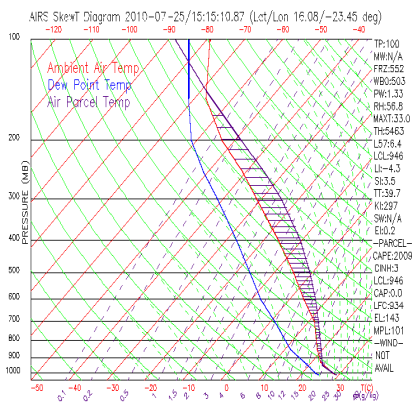
Point 1



Point 3



Point 4

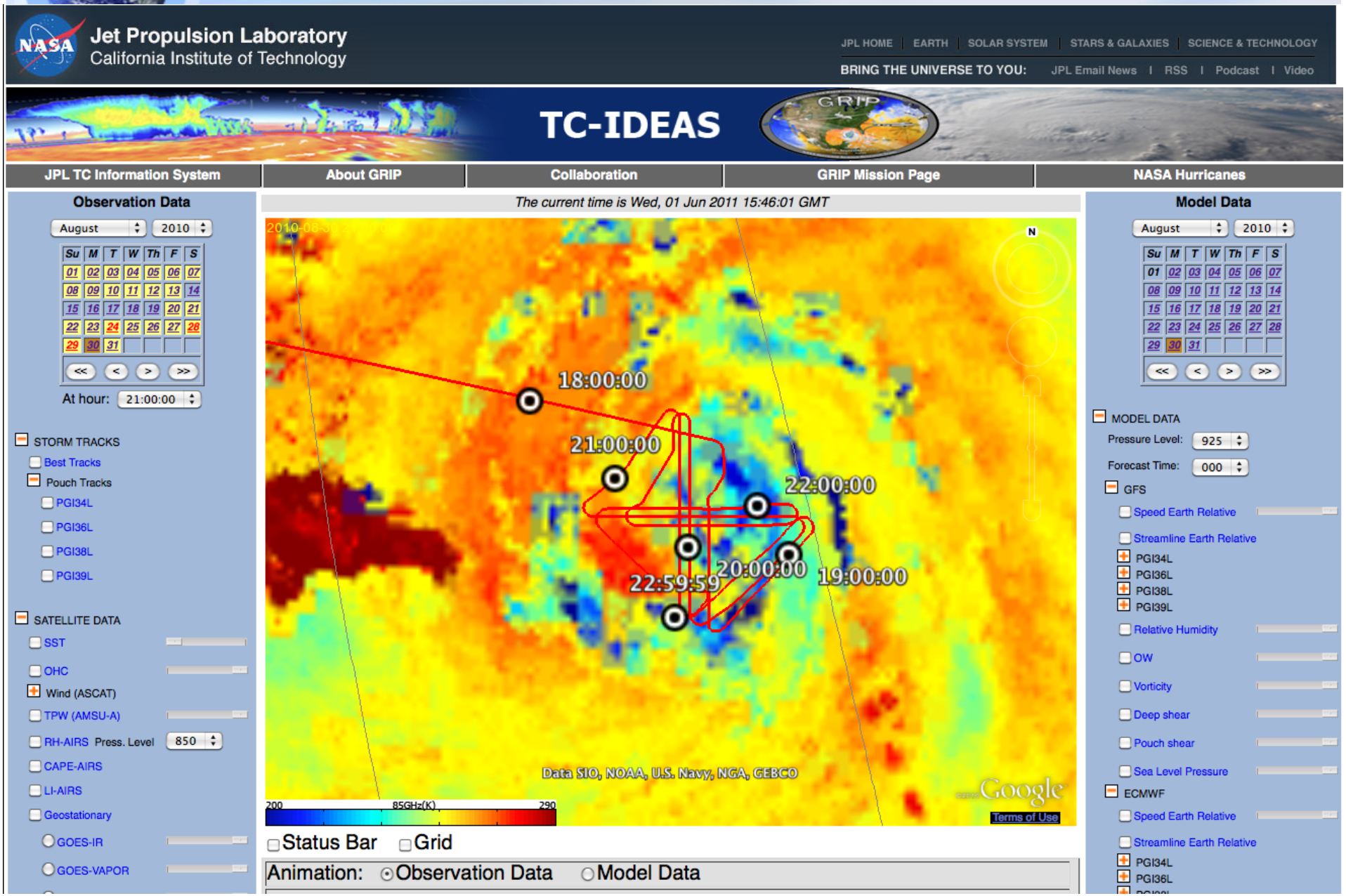


Incorporation of imagery from Airborne data after the campaign

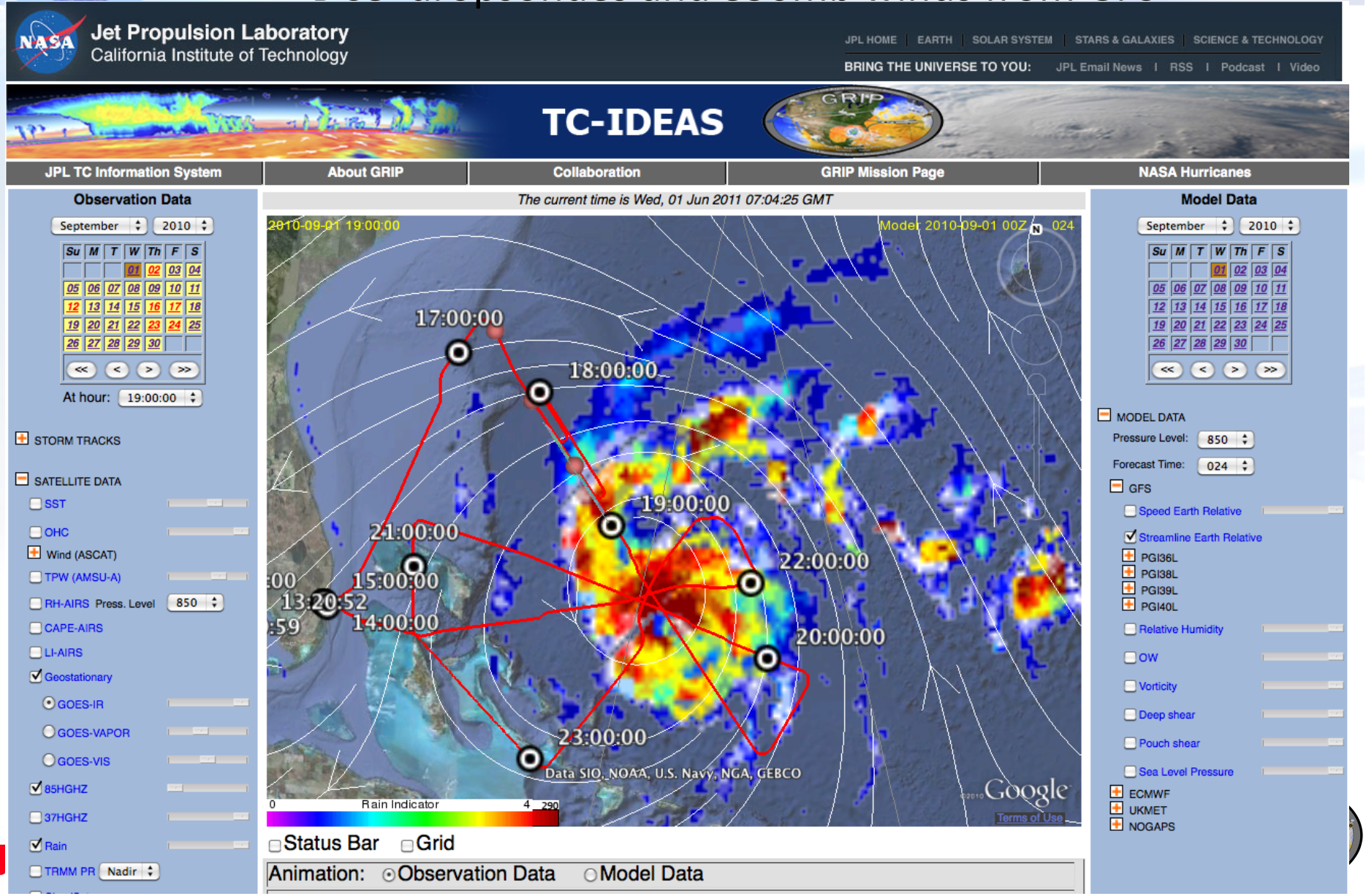
- Tracks
  - DC8, GH, NOAA flights
- HAMSR
  - Brightness Temperatures and retrieved reflectivity
- APR2
  - Radar reflectivity at Ku and Ka
- Dropsondes
  - DC8, GV, NOAA
- Coming up
  - Tracks from WB5, GV
  - HIRAD, LASE, DAWN, HIWRAP, LARGE …..????

JPL

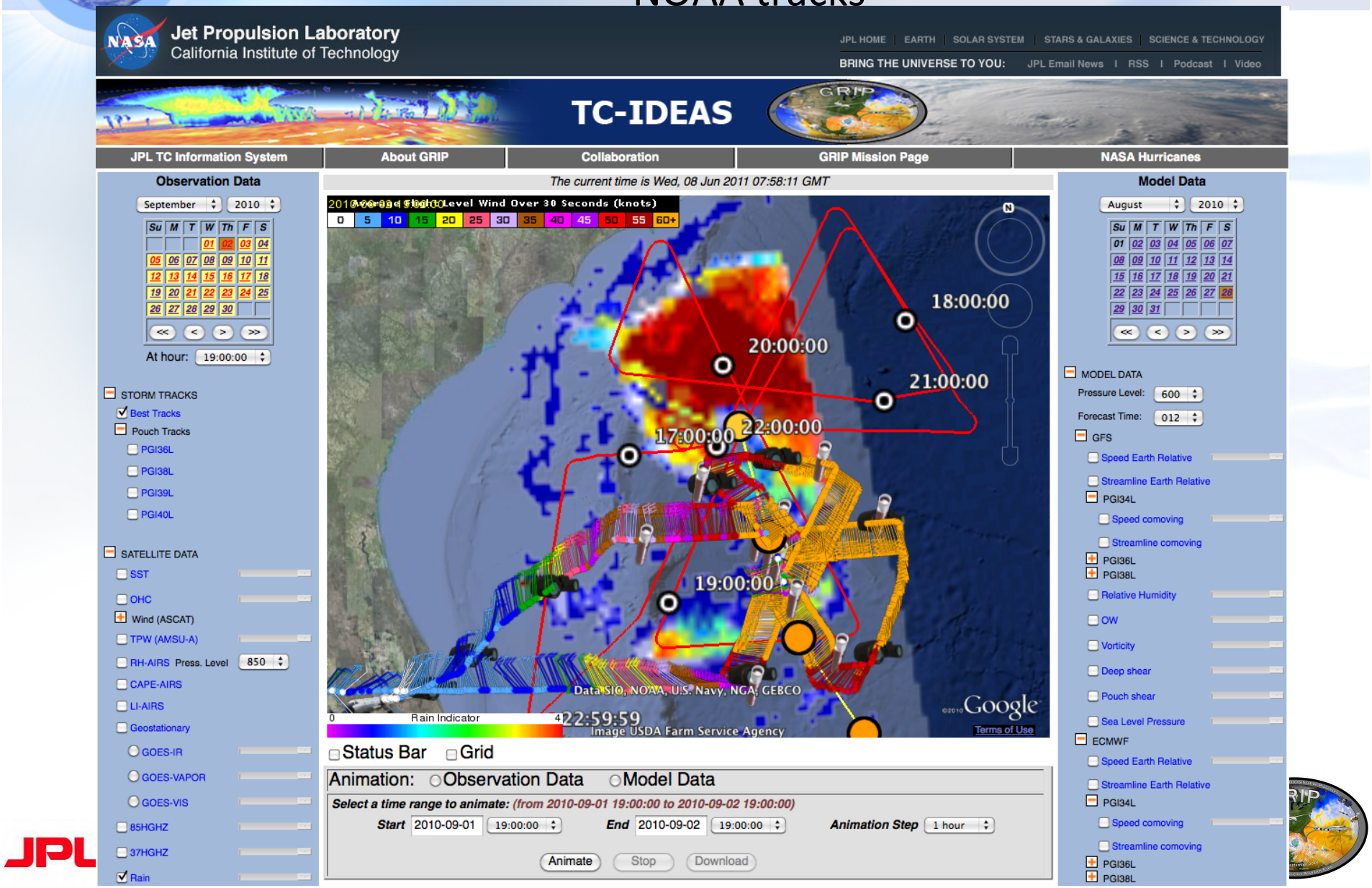
Hurricane Earl, August 30th, 21Z
85GHz brightness temperatures from satellites DC8 tracks



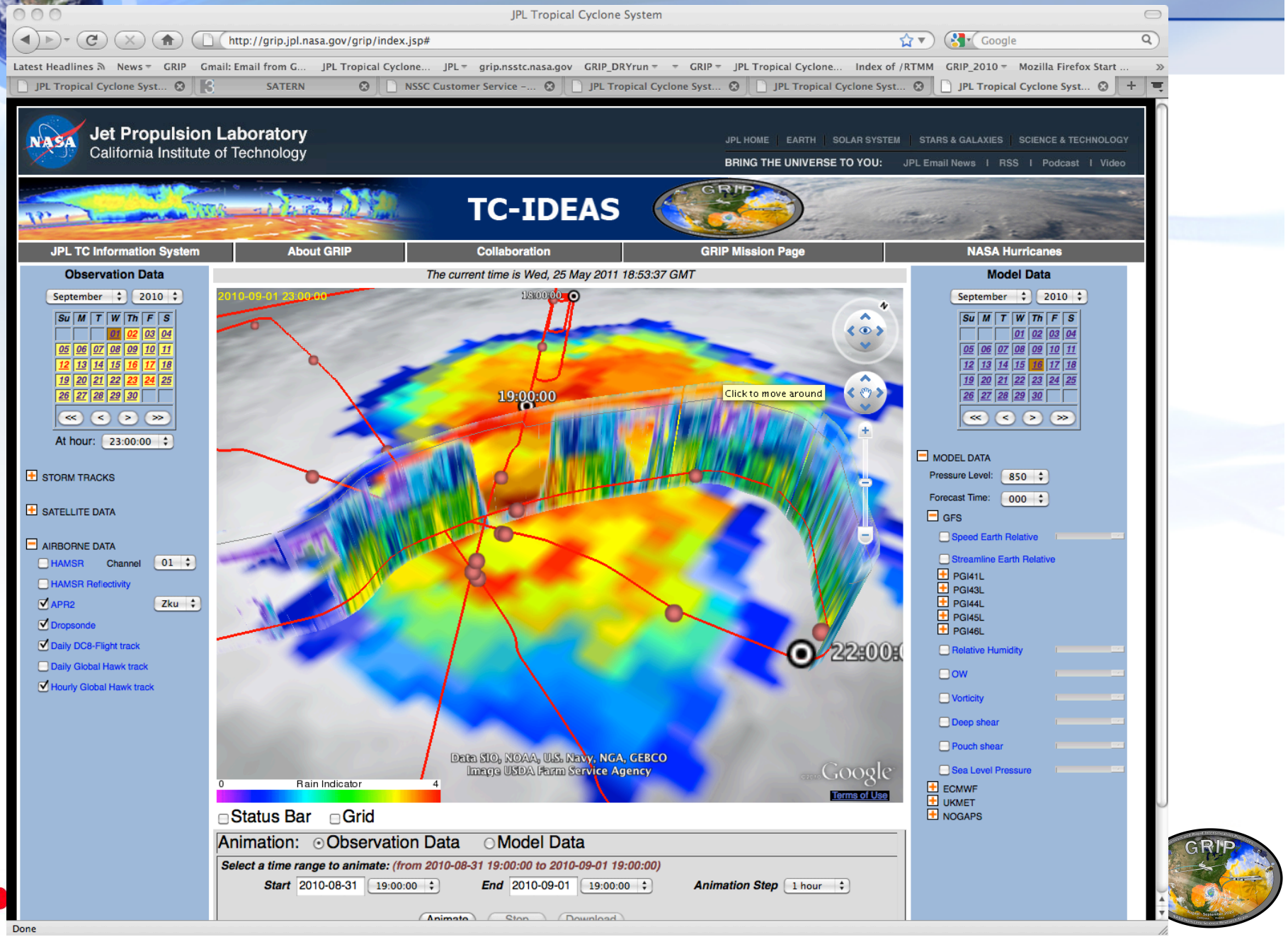
Hurricane Earl, September 1st, 19Z
Rain Index (from satellite Passive Microwave), DC8 tracks, DC8 dropsondes and 850mb winds from GFS



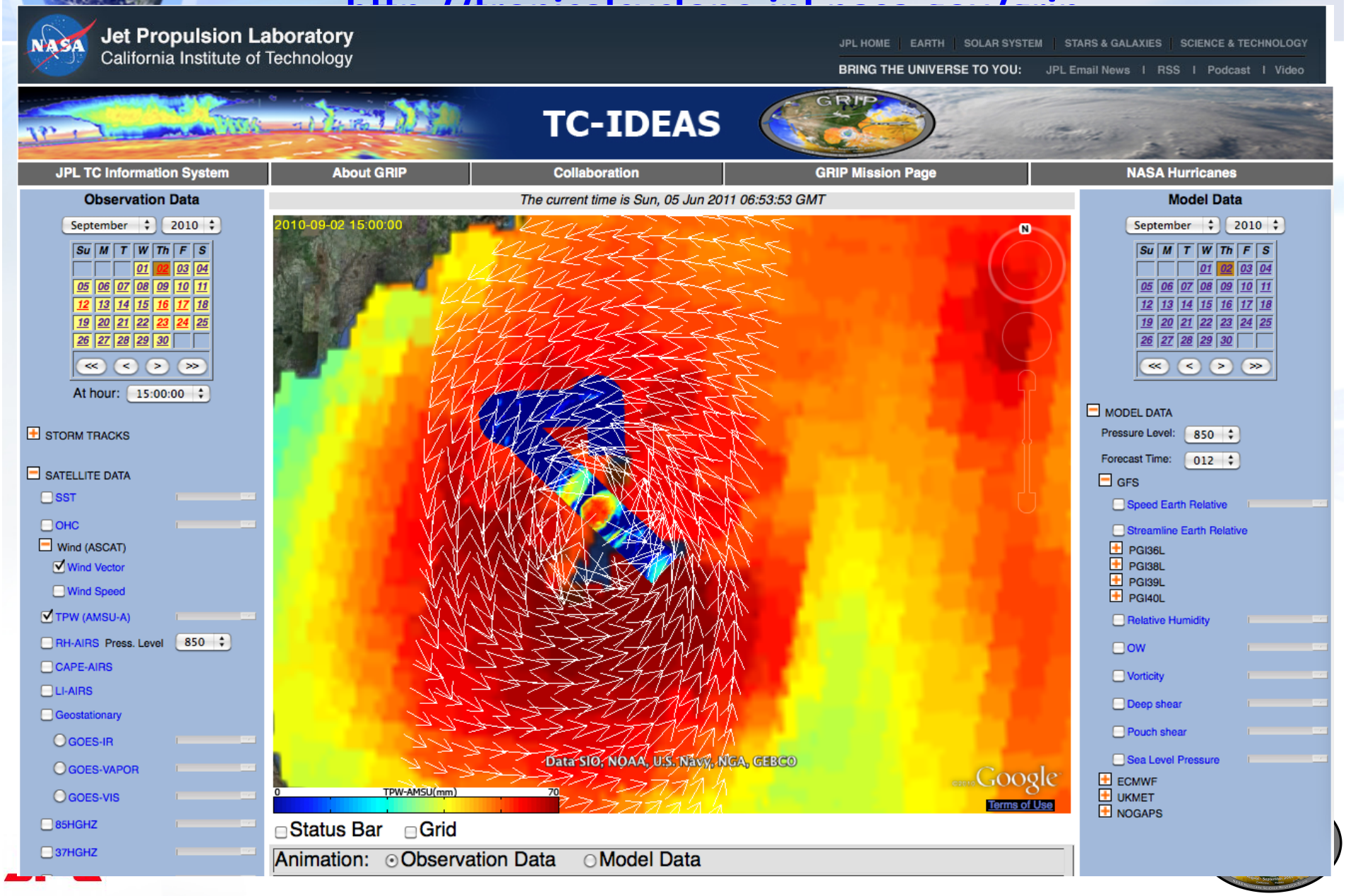
Hurricane Earl, September 2nd, 19Z
Rain Index (from satellite Passive Microwave), DC8 tracks, NOAA tracks



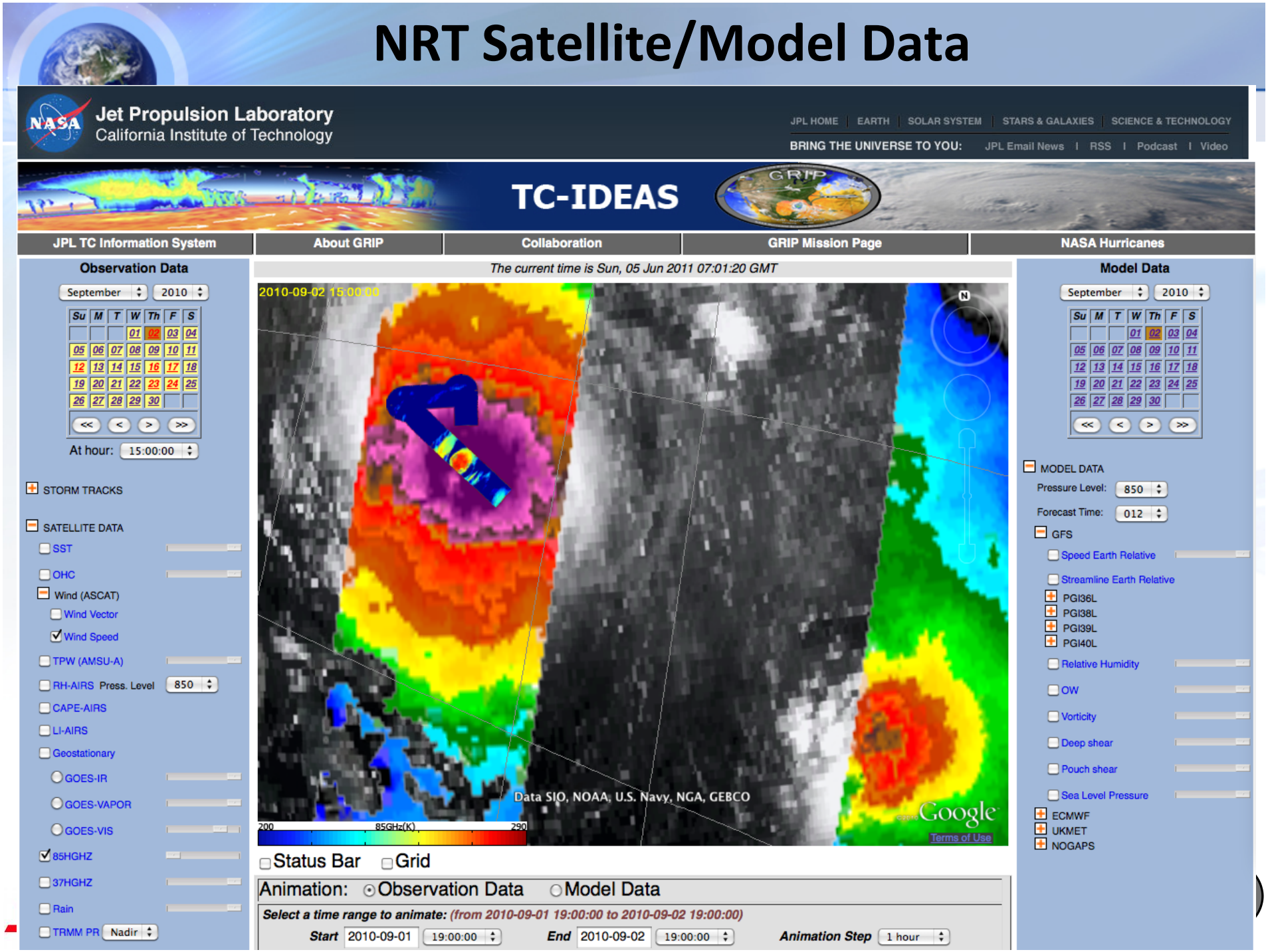
Hurricane Earl, September 1st, 23z



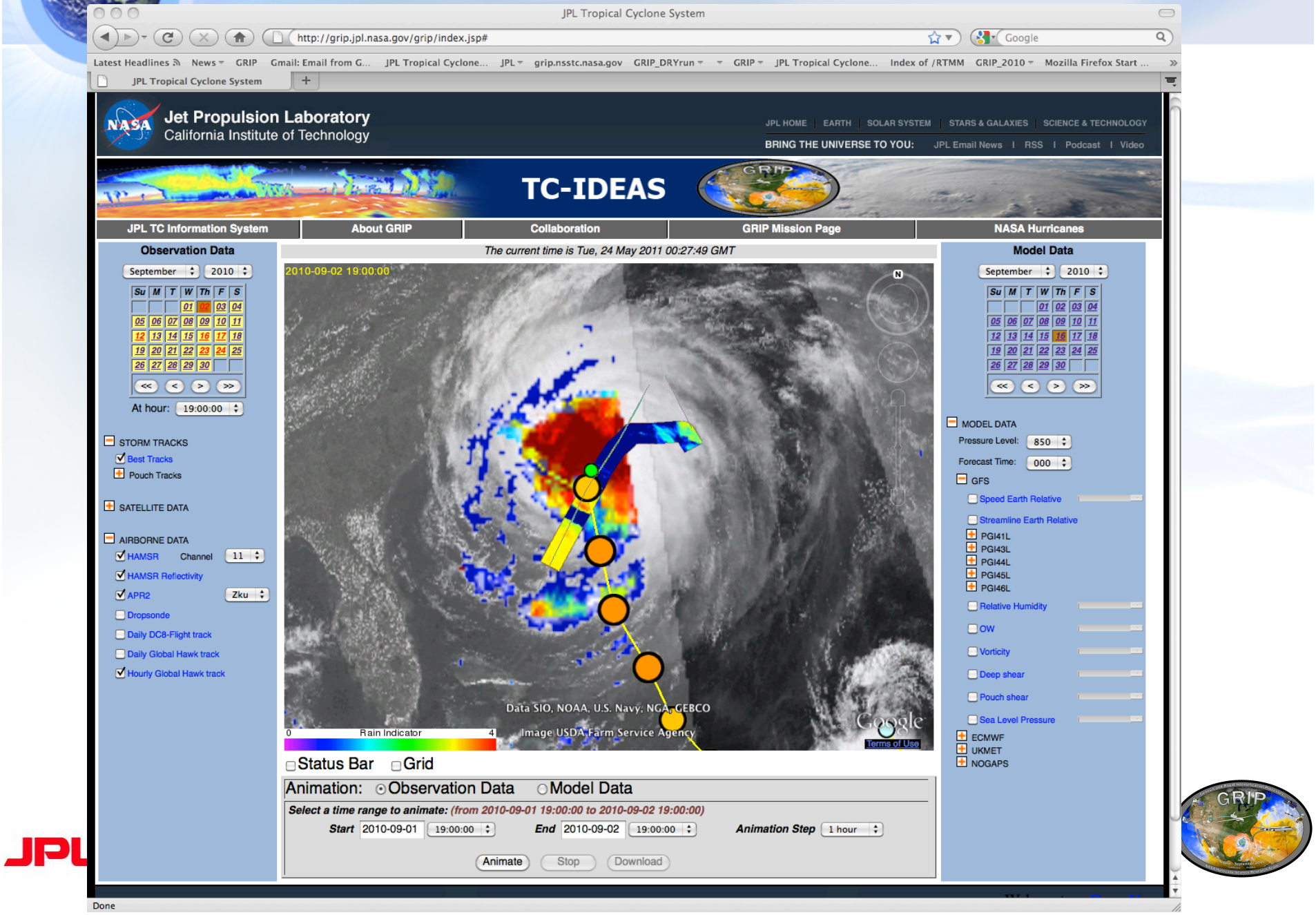
NRT Satellite/Model Data



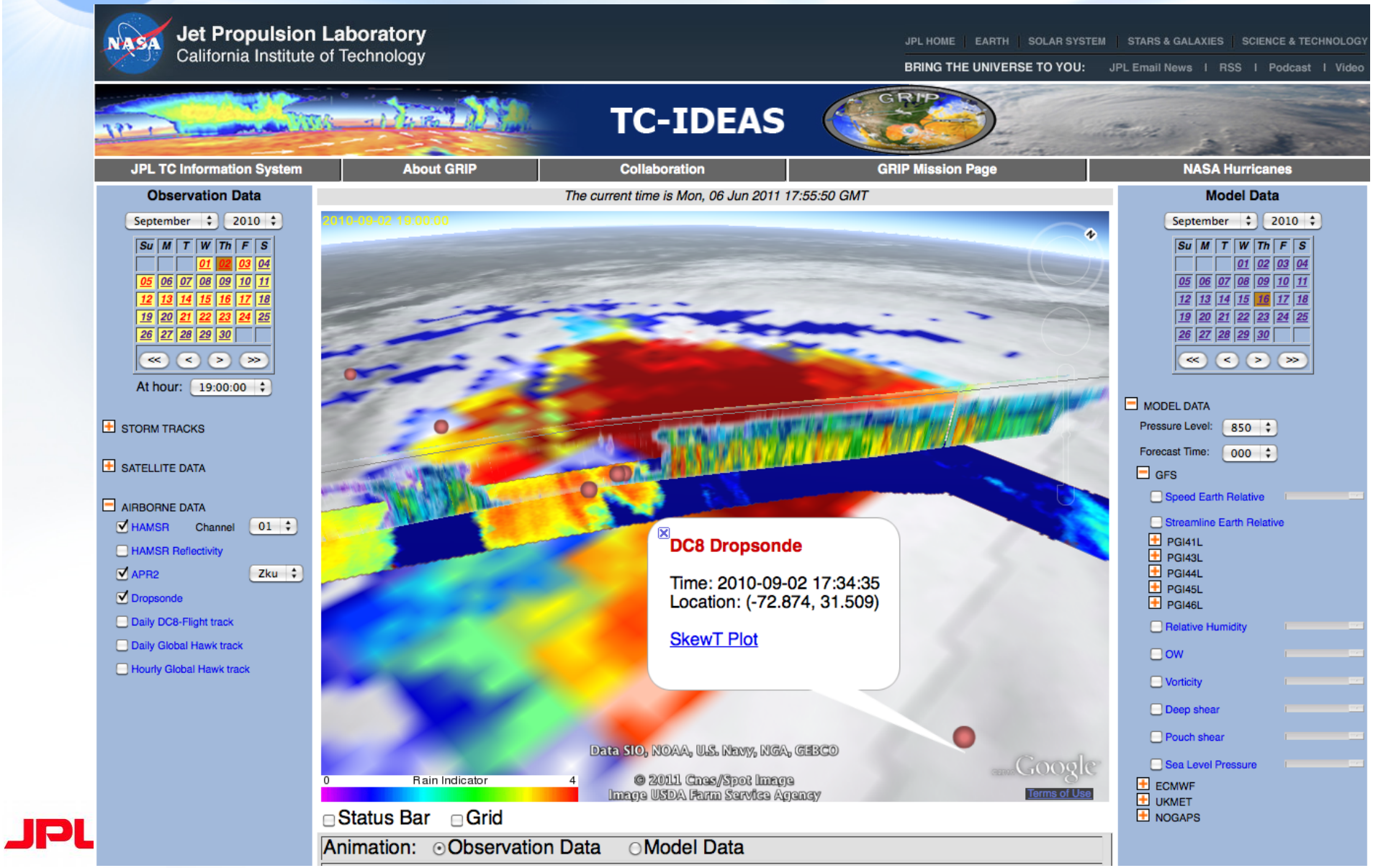
NRT Satellite/Model Data



Hurricane Earl, September 2nd, 19z
GOES IR, Rain Index (satellite PMW), HAMSR (ch. 11) and "Best Tracks"



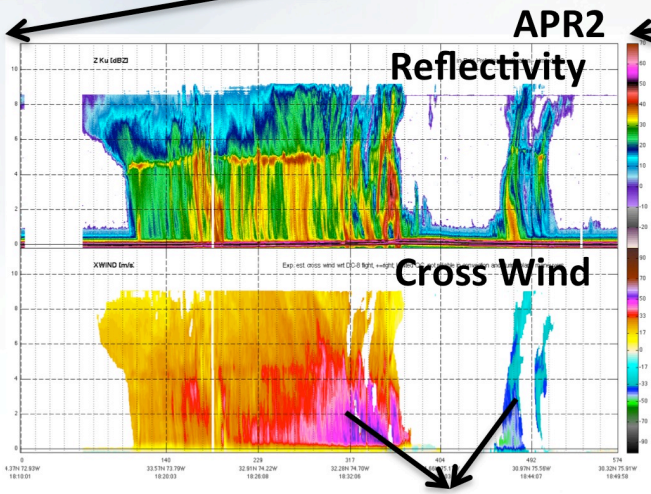
Hurricane Earl, September 2nd, 19z
GOES IR, Rain Index (satellite PMW),
HAMSR (ch. 11), APR2 and drops



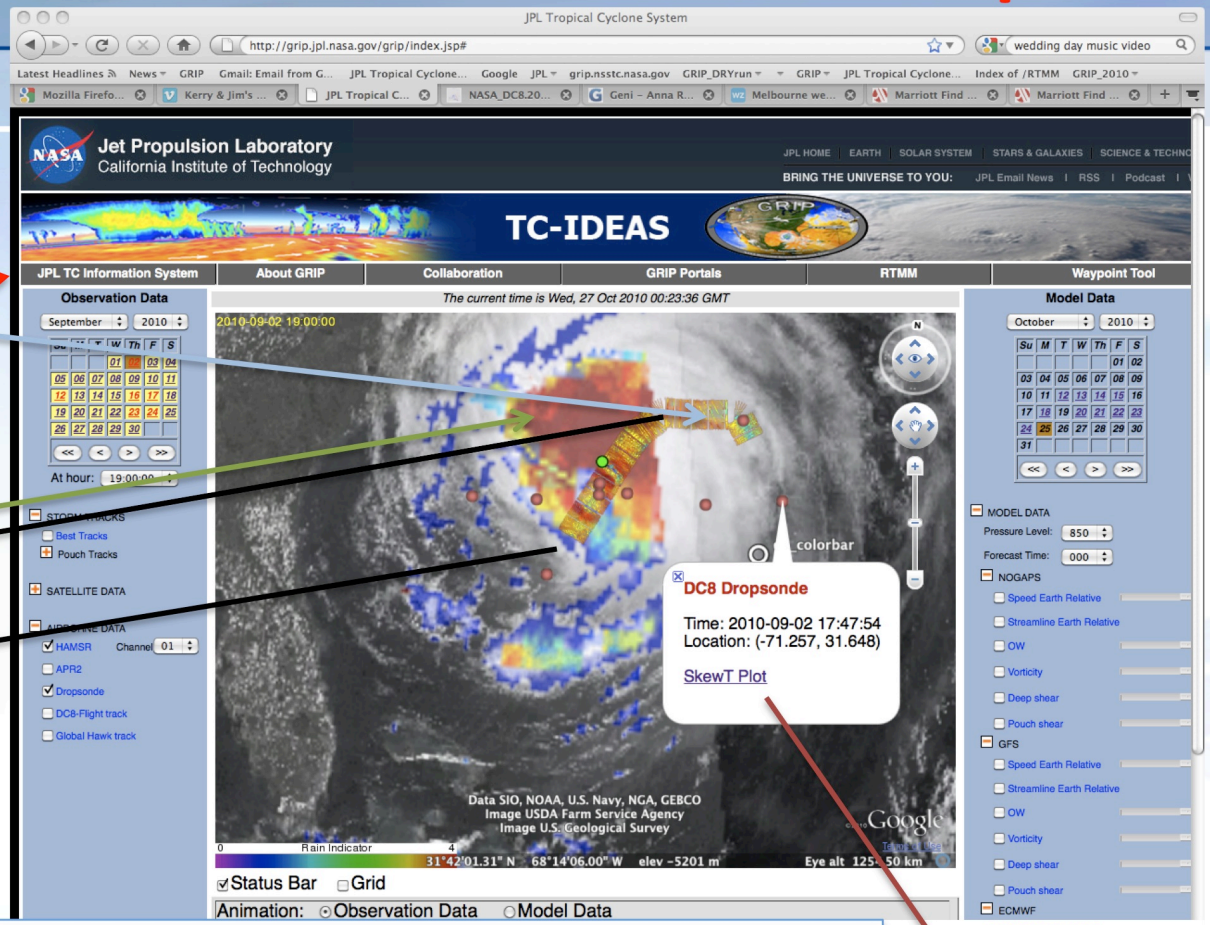
Hurricane Earl in the JPL GRIP portal

JPL participated with two instruments (HAMSR and **APR2**) and the **JPL GRIP portal** which blends satellite and airborne observations with model data.

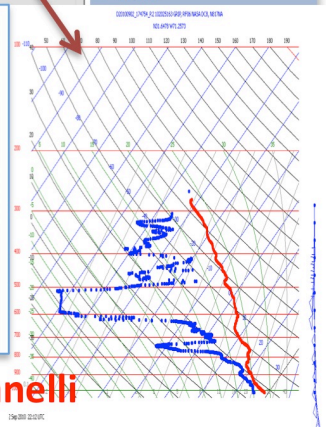
Rain from AMSR-E on AQUA



Note the change from positive to negative cross-wind flow as APR2 flies over the storm center, signifying the deep and intense cyclonic circulation



Multi-platform observations of Hurricane Earl include Visible Imagery from GOES, Passive Microwave observations from HAMSR (on the GH) and AMSR-E (on AQUA), Radar observations from APR2 (on DC8) In situ observations from dropsondes (on DC8)

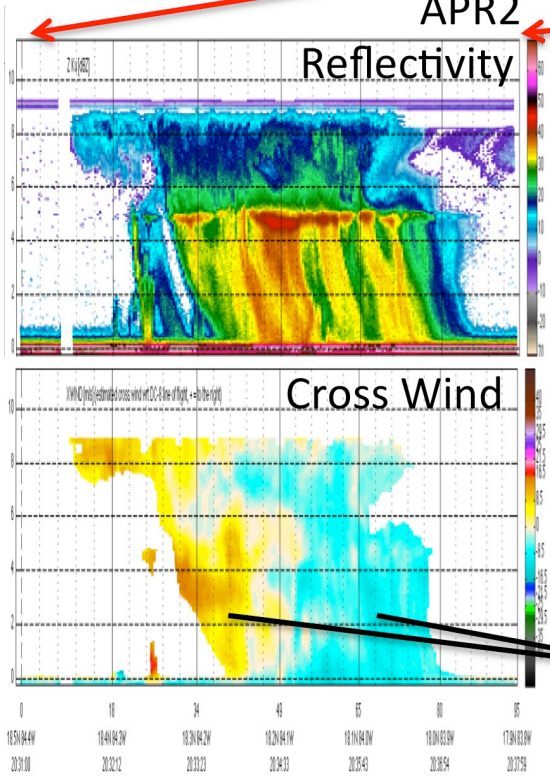


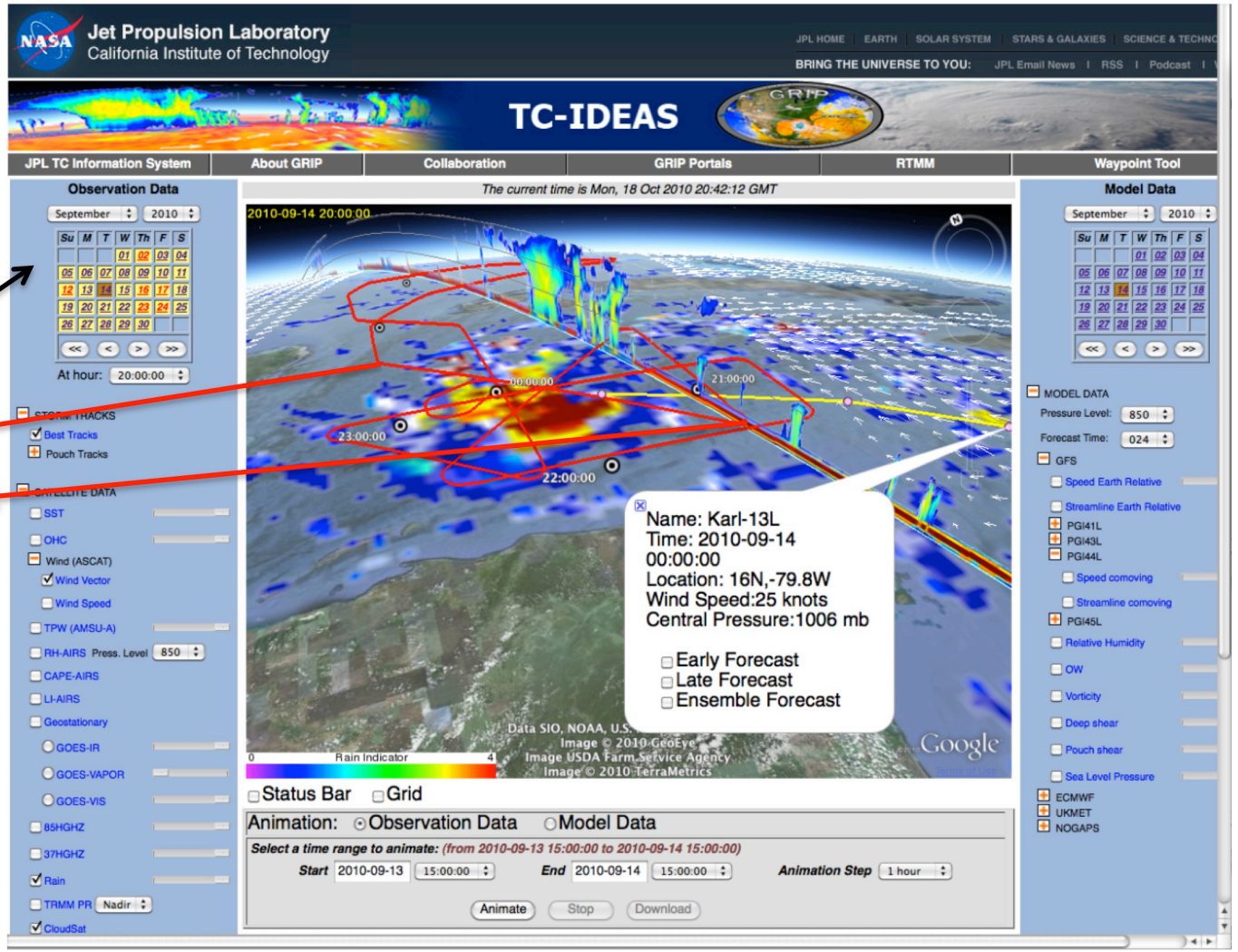
S. Durden, S. Hristova-Veleva, B. Lambrigtsen, S. Tanelli

Hurricane Karl, September 14 2010

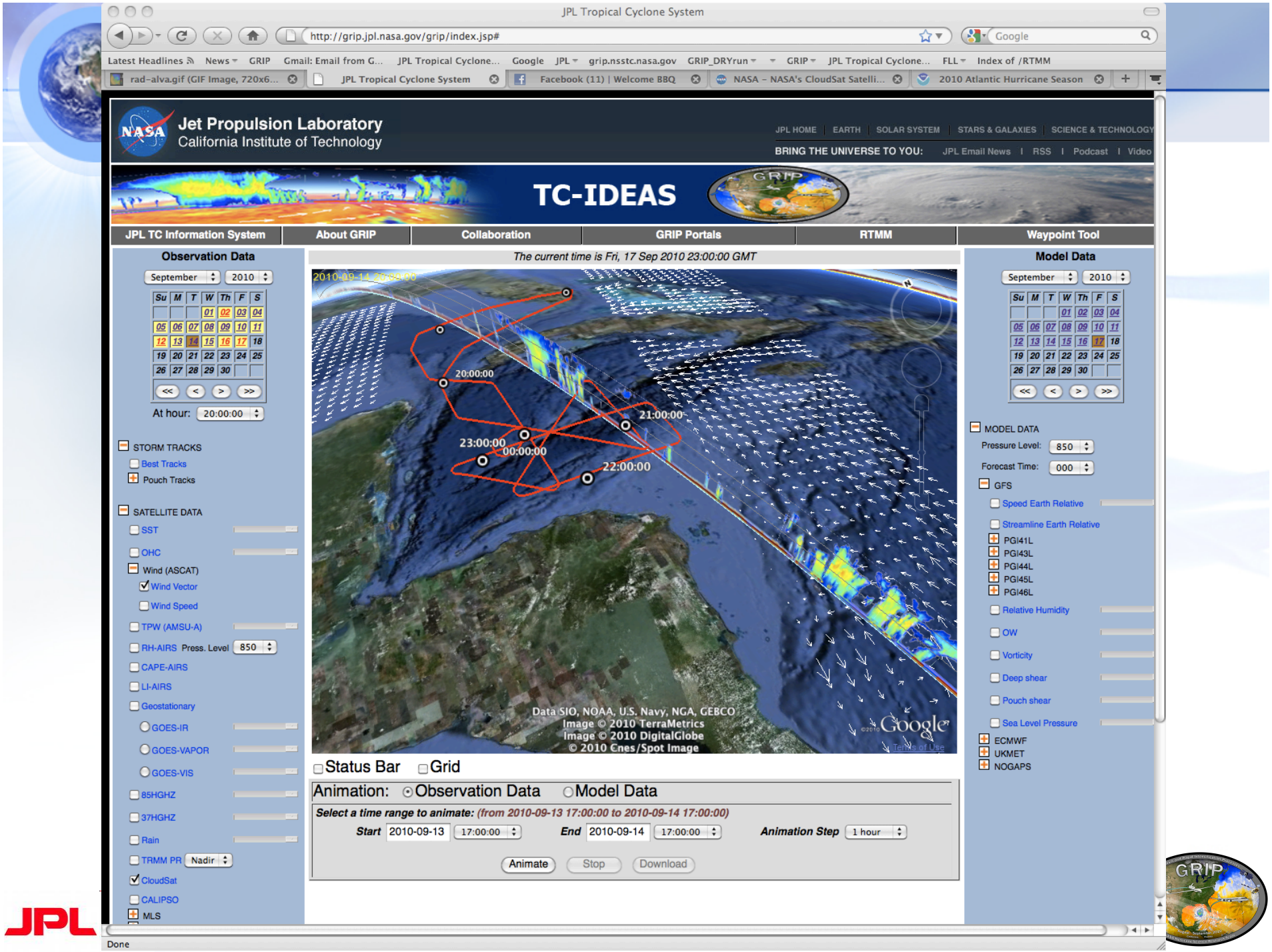
The 2010 NASA's GRIP Hurricane Field Experiment was aimed at better understanding hurricane cyclogenesis and rapid intensity changes.

JPL participated with two instruments (HAMSR and APR2) and the JPL GRIP portal which blends satellite and airborne observations with model data.



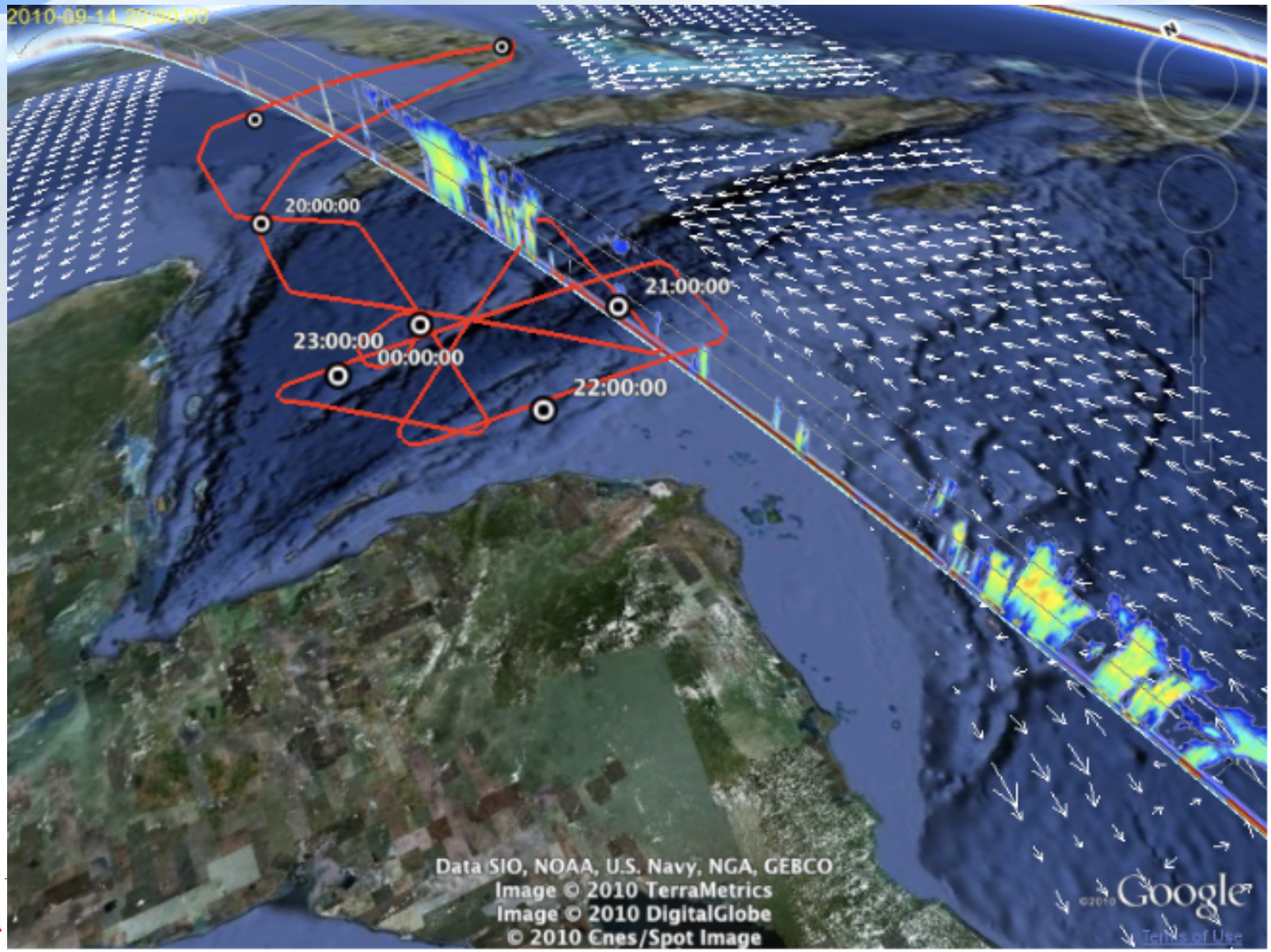


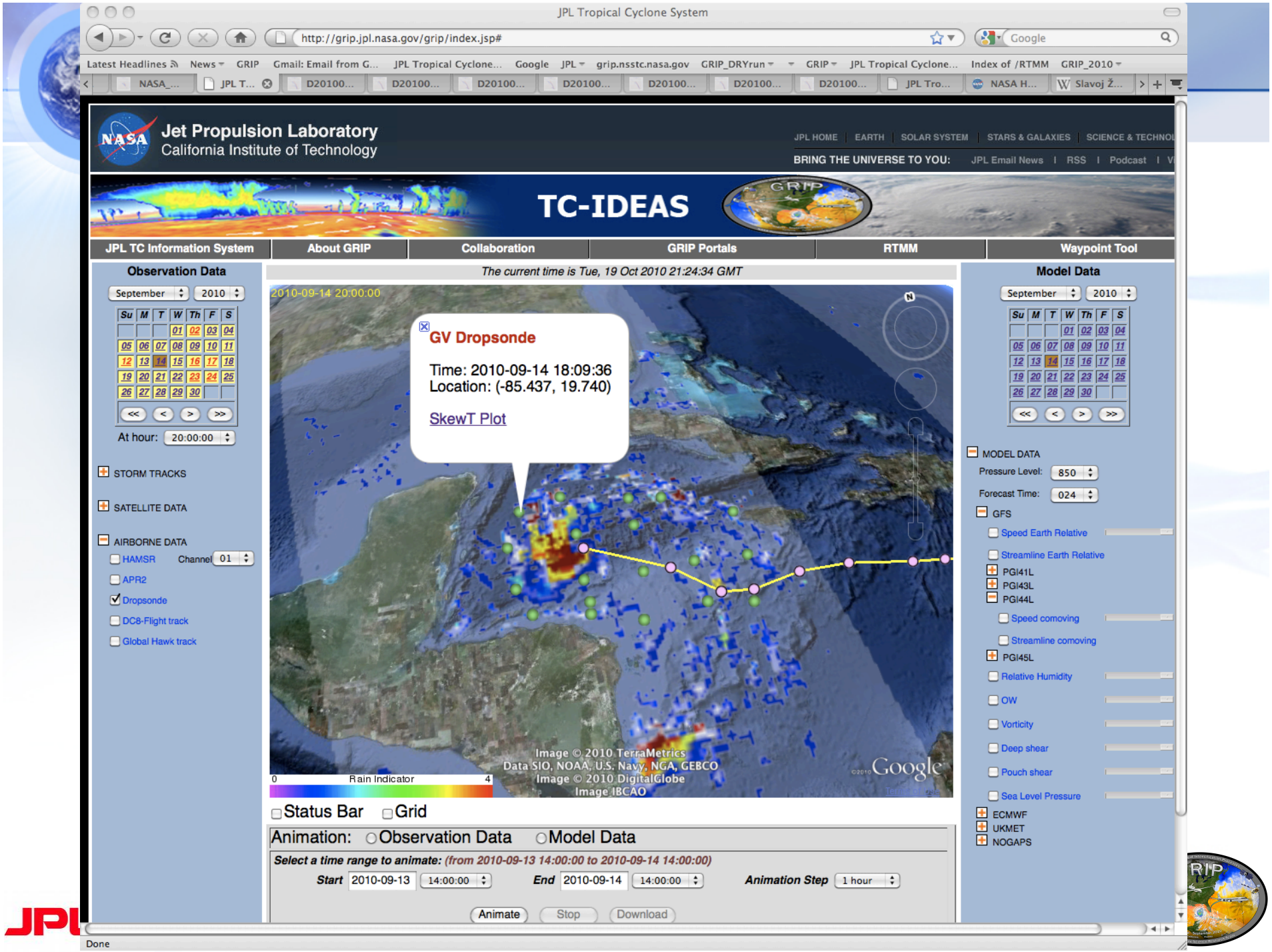
Note the change from positive to negative cross-wind flow as APR2 flies through the storm center, signifying the deep cyclonic circulation of the storm. APR2 observed the storm just a couple of hours after the long-awaited cyclogenesis.


JPL Tropical Cyclone System
http://grip.jpl.nasa.gov/grip/index.jsp#
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNOLOGY
BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast | Video
TC-IDEAS
JPL TC Information System
About GRIP
Collaboration
GRIP Portals
RTMM
Waypoint Tool
Observation Data
The current time is Fri, 17 Sep 2010 23:00:00 GMT
Model Data
STORM TRACKS
Best Tracks
Pouch Tracks
SATELLITE DATA
SST
OHC
Wind (ASCAT)
Wind Vector
Wind Speed
TPW (AMSU-A)
RH-AIRS Press. Level
CAPE-AIRS
LI-AIRS
Geostationary
GOES-IR
GOES-VAPOR
GOES-VIS
85HGHZ
37HGHZ
Rain
TRMM PR
CloudSat
CALIPSO
MLS
20:00:00
21:00:00
23:00:00
00:00:00
22:00:00
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2010 TerraMetrics
Image © 2010 DigitalGlobe
© 2010 Cnes/Spot Image
Google
MODEL DATA
Pressure Level:
Forecast Time:
GFS
Speed Earth Relative
Streamline Earth Relative
PGI41L
PGI43L
PGI44L
PGI45L
PGI46L
Relative Humidity
OW
Vorticity
Deep shear
Pouch shear
Sea Level Pressure
ECMWF
UKMET
NOGAPS
Status Bar
Grid
Animation: Observation Data Model Data
Select a time range to animate: (from 2010-09-13 17:00:00 to 2010-09-14 17:00:00)
Start 2010-09-13 17:00:00
End 2010-09-14 17:00:00
Animation Step 1 hour
Animate
Stop
Download
Done

NRT Satellite/Model Data – DATA TYPES

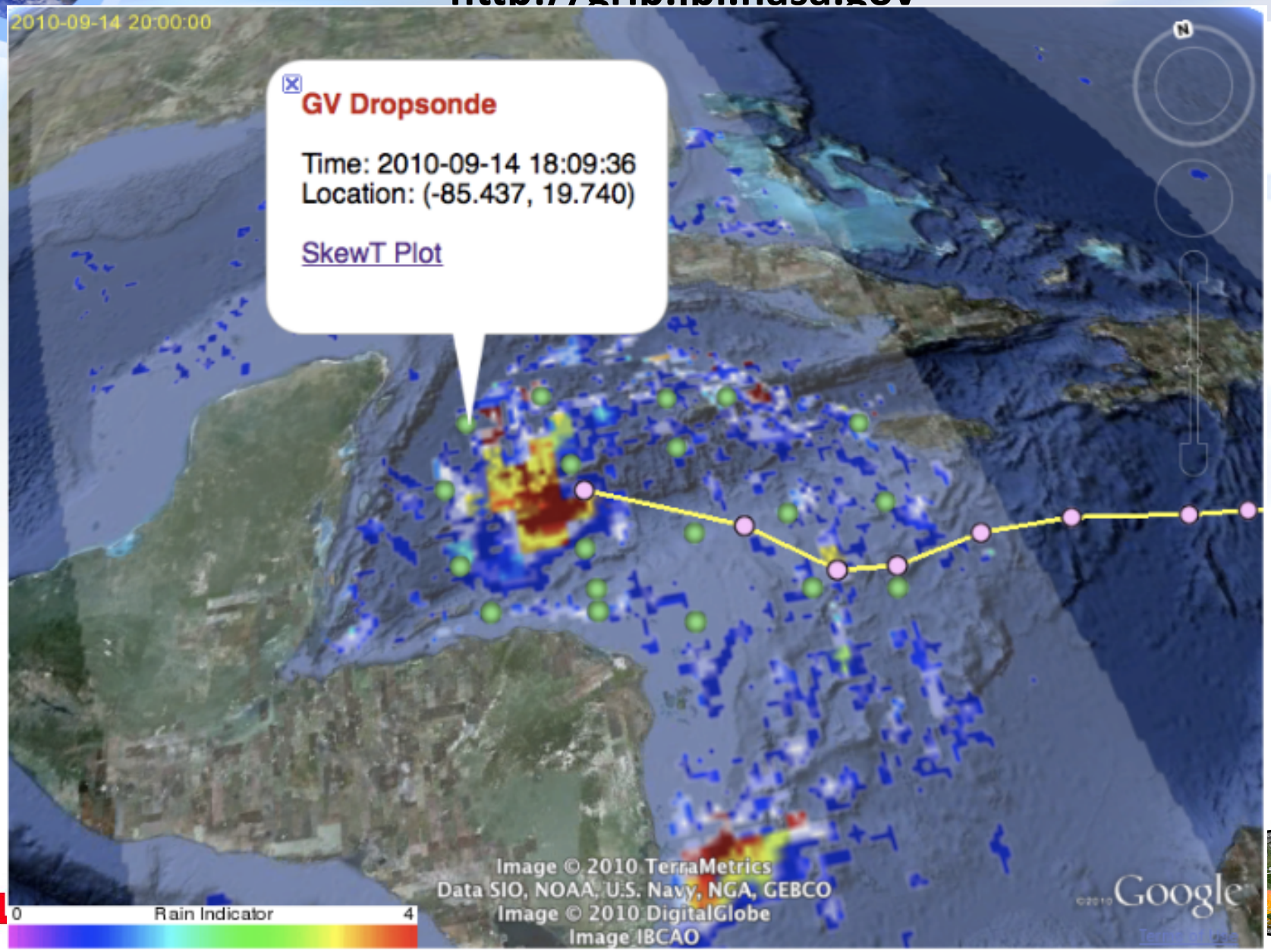
http://grip.jpl.nasa.gov

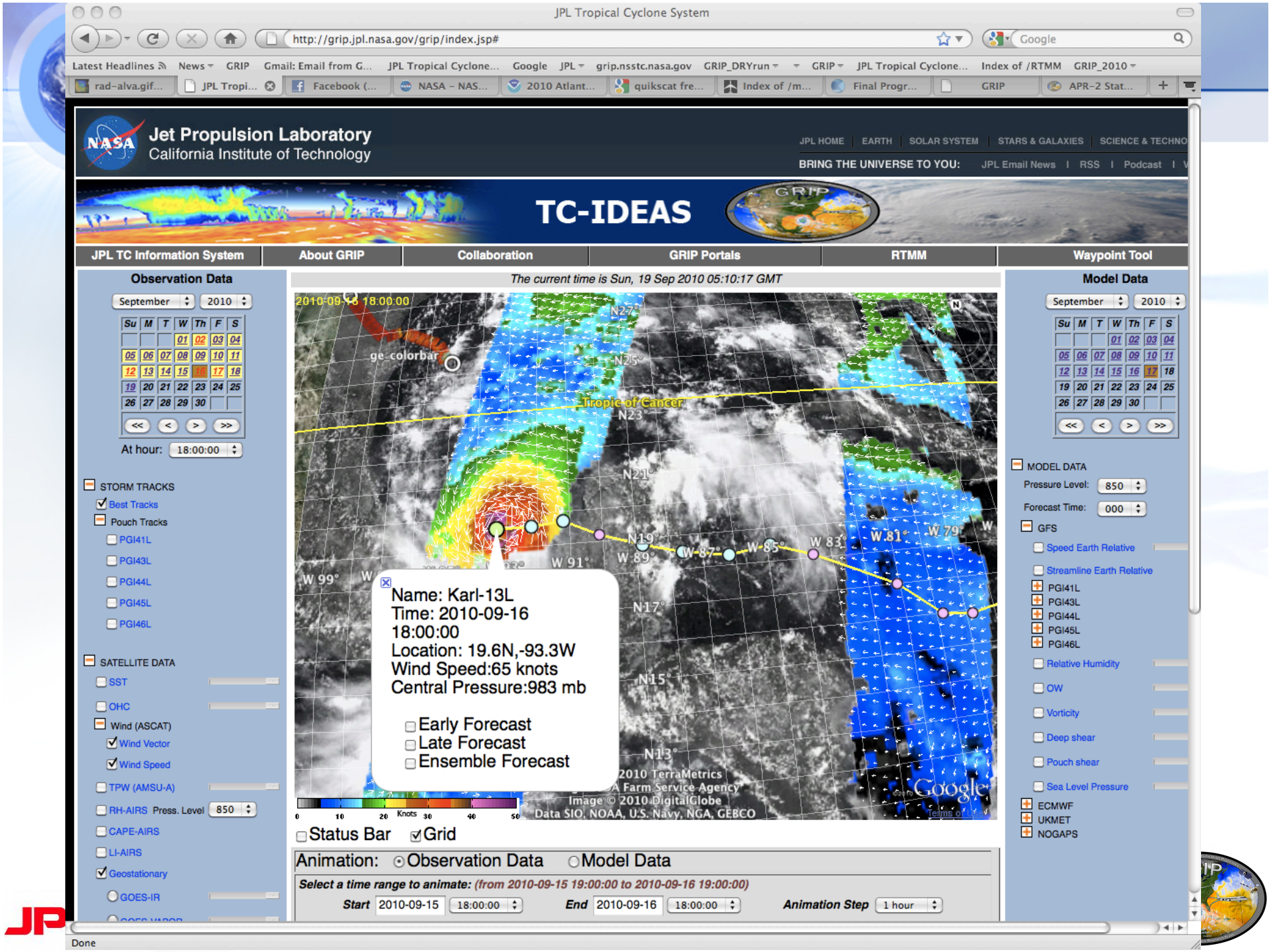



JPL Tropical Cyclone System
http://grip.jpl.nasa.gov/grip/index.jsp#
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNOL
BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast
TC-IDEAS
GRIP
JPL TC Information System
About GRIP
Collaboration
GRIP Portals
RTMM
Waypoint Tool
Observation Data
September
2010
At hour: 20:00:00
STORM TRACKS
SATELLITE DATA
AIRBORNE DATA
HAMSR
Channel 01
APR2
Dropsonde
DC8-Flight track
Global Hawk track
The current time is Tue, 19 Oct 2010 21:24:34 GMT
2010-09-14 20:00:00
GV Dropsonde
Time: 2010-09-14 18:09:36
Location: (-85.437, 19.740)
SkewT Plot
Image © 2010 TerraMetrics
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2010 DigitalGlobe
Image IBCAO
Google
0 Rain Indicator 4
Status Bar
Grid
Animation: Observation Data Model Data
Select a time range to animate: (from 2010-09-13 14:00:00 to 2010-09-14 14:00:00)
Start 2010-09-13 14:00:00
End 2010-09-14 14:00:00
Animation Step 1 hour
Animate
Stop
Download
Model Data
September
2010
MODEL DATA
Pressure Level: 850
Forecast Time: 024
GFS
Speed Earth Relative
Streamline Earth Relative
PGI41L
PGI43L
PGI44L
Speed comoving
Streamline comoving
PGI45L
Relative Humidity
OW
Vorticity
Deep shear
Pouch shear
Sea Level Pressure
ECMWF
UKMET
NOGAPS
Done

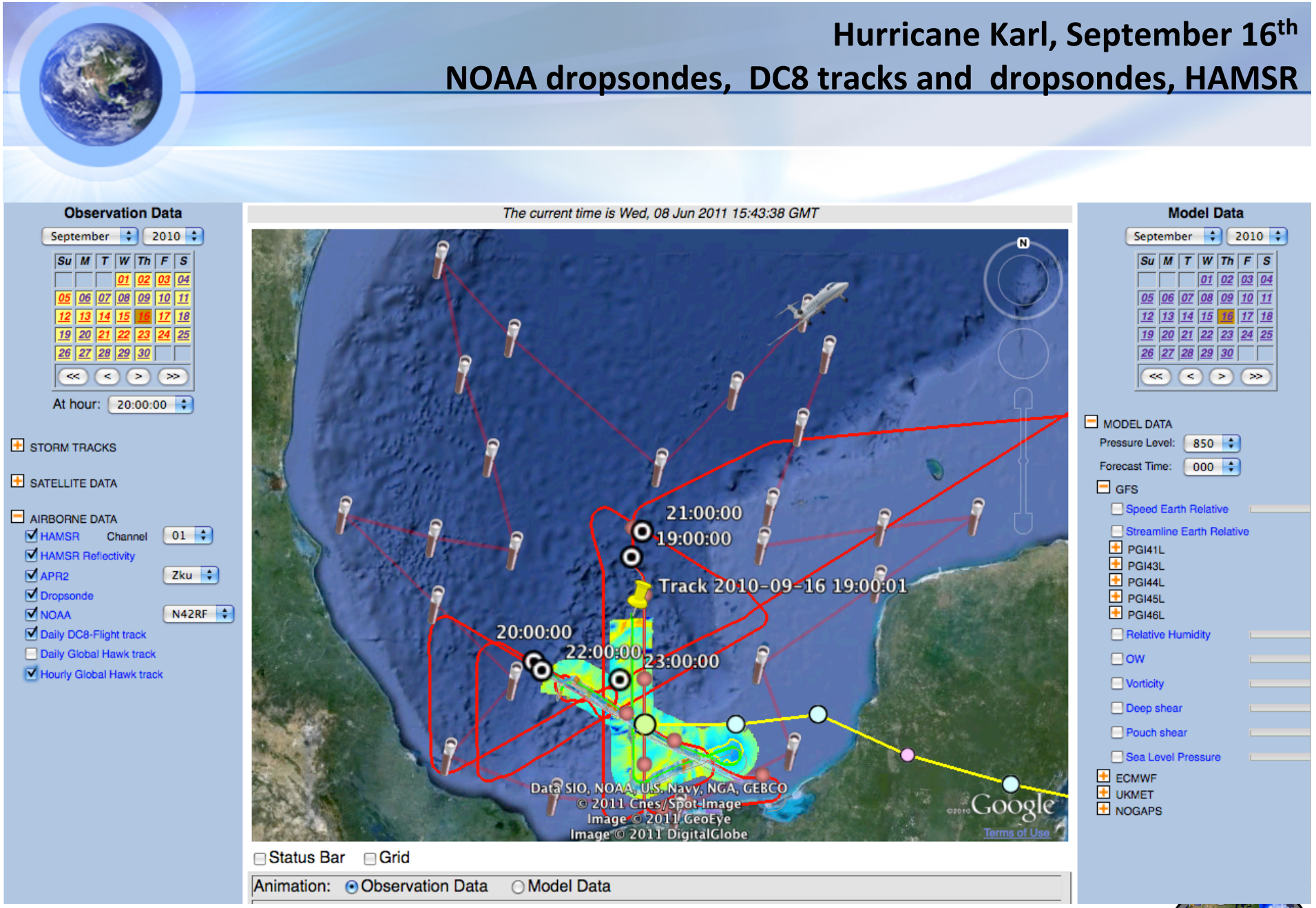
NRT Satellite/Model Data – DATA TYPES

http://grip.jpl.nasa.gov



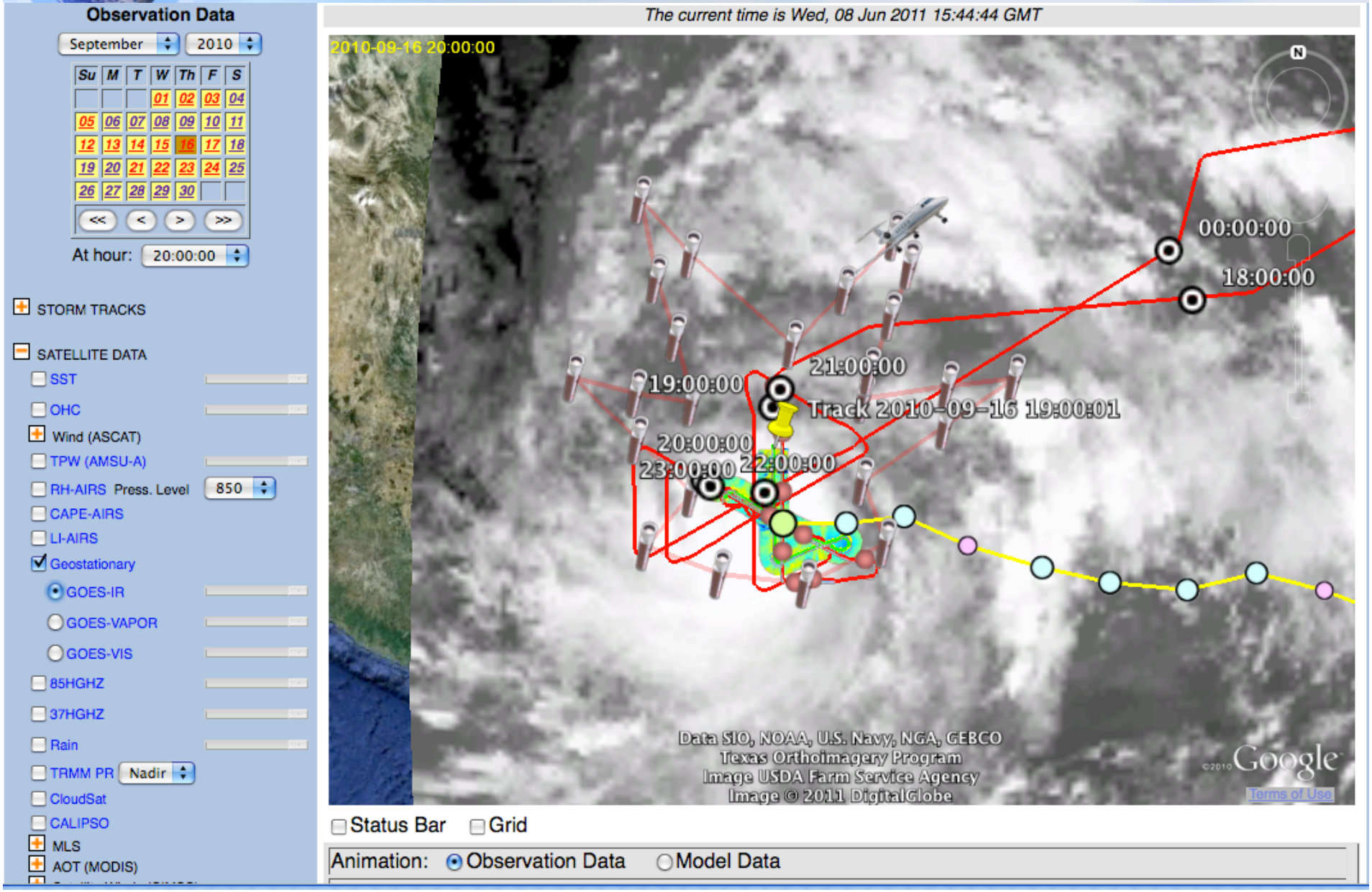

JPL Tropical Cyclone System
http://grip.jpl.nasa.gov/grip/index.jsp#
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNO
BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast
TC-IDEAS
JPL TC Information System
About GRIP
Collaboration
GRIP Portals
RTMM
Waypoint Tool
Observation Data
The current time is Sun, 19 Sep 2010 05:10:17 GMT
Model Data
STORM TRACKS
Best Tracks
Pouch Tracks
PGI41L
PGI43L
PGI44L
PGI45L
PGI46L
SATELLITE DATA
SST
OHC
Wind (ASCAT)
Wind Vector
Wind Speed
TPW (AMSU-A)
RH-AIRS Press. Level
CAPE-AIRS
LI-AIRS
Geostationary
GOES-IR
MODEL DATA
Pressure Level:
Forecast Time:
GFS
Speed Earth Relative
Streamline Earth Relative
Relative Humidity
OW
Vorticity
Deep shear
Pouch shear
Sea Level Pressure
ECMWF
UKMET
NOGAPS
Name: Karl-13L
Time: 2010-09-16 18:00:00
Location: 19.6N,-93.3W
Wind Speed:65 knots
Central Pressure:983 mb
Early Forecast
Late Forecast
Ensemble Forecast
Tropic of Cancer
Status Bar
Grid
Animation: Observation Data Model Data
Select a time range to animate: (from 2010-09-15 19:00:00 to 2010-09-16 19:00:00)
Start 2010-09-15 18:00:00
End 2010-09-16 18:00:00
Animation Step 1 hour
Done

Hurricane Karl, September 16th
NOAA dropsondes, DC8 tracks and dropsondes, HAMSR



JPL

Hurricane Karl, September 16th
NOAA dropsondes, DC8 tracks and dropsondes, HAMSR



Hurricane Karl, September 16th
Rain Index (satellite PMW), GFS 850mb winds, DC8 dropsondes, HAMSR

Jet Propulsion Laboratory
California Institute of Technology

JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNOLOGY
BRING THE UNIVERSE TO YOU: JPL Email News | RSS | Podcast | Video

TC-IDEAS

JPL TC Information System | About GRIP | Collaboration | GRIP Mission Page | NASA Hurricanes

Observation Data

September 2010

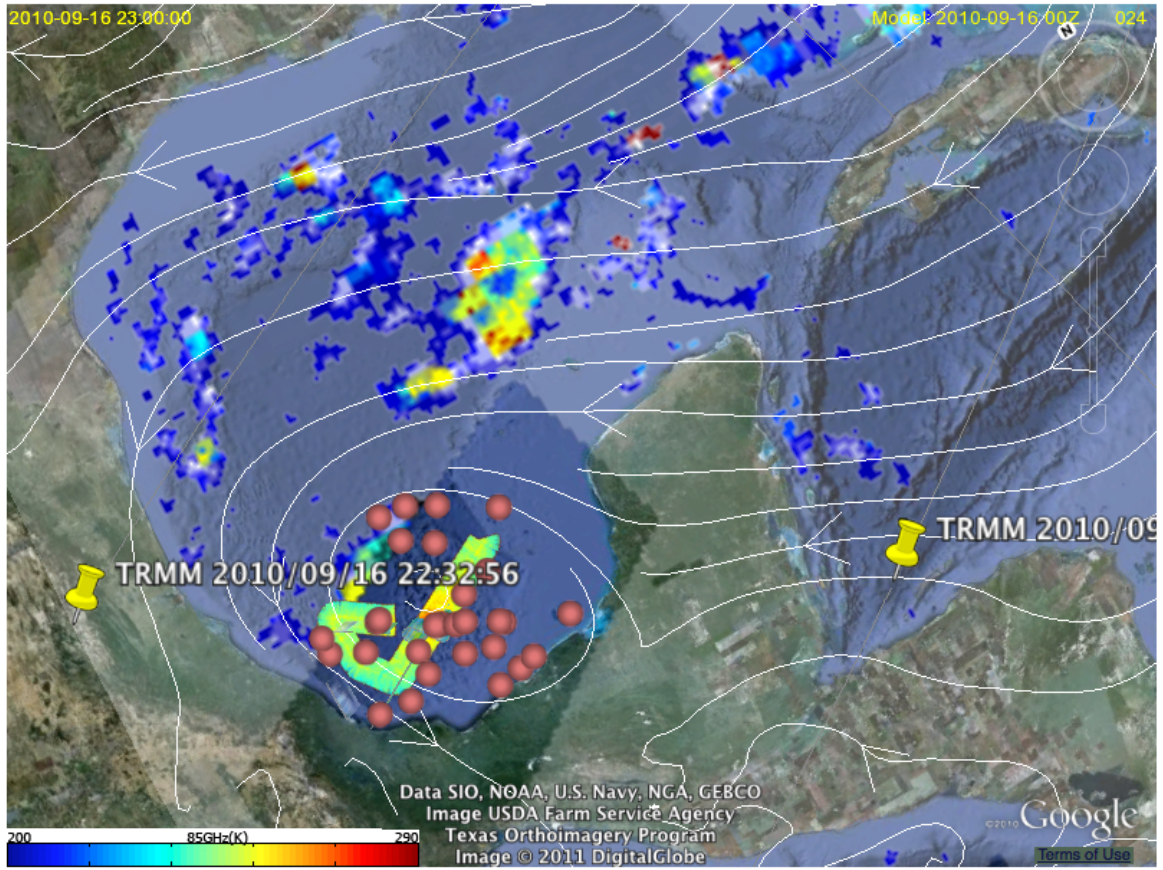
Su	M	T	W	Th	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

<< < > >>

At hour: 23:00:00

- [+] STORM TRACKS
- [-] SATELLITE DATA
  - [ ] SST
  - [ ] OHC
  - [+] Wind (ASCAT)
  - [ ] TPW (AMSU-A)
  - [ ] RH-AIRS Press. Level 850
  - [ ] CAPE-AIRS
  - [ ] LI-AIRS
  - [ ] Geostationary
    - ( ) GOES-IR
    - ( ) GOES-VAPOR
    - ( ) GOES-VIS
  - [x] 85HGHZ
  - [ ] 37HGHZ
  - [x] Rain
  - [ ] TRMM PR Nadir

The current time is Wed, 01 Jun 2011 01:25:32 GMT



[ ] Status Bar [ ] Grid

Animation: (•) Observation Data ( ) Model Data

Model Data

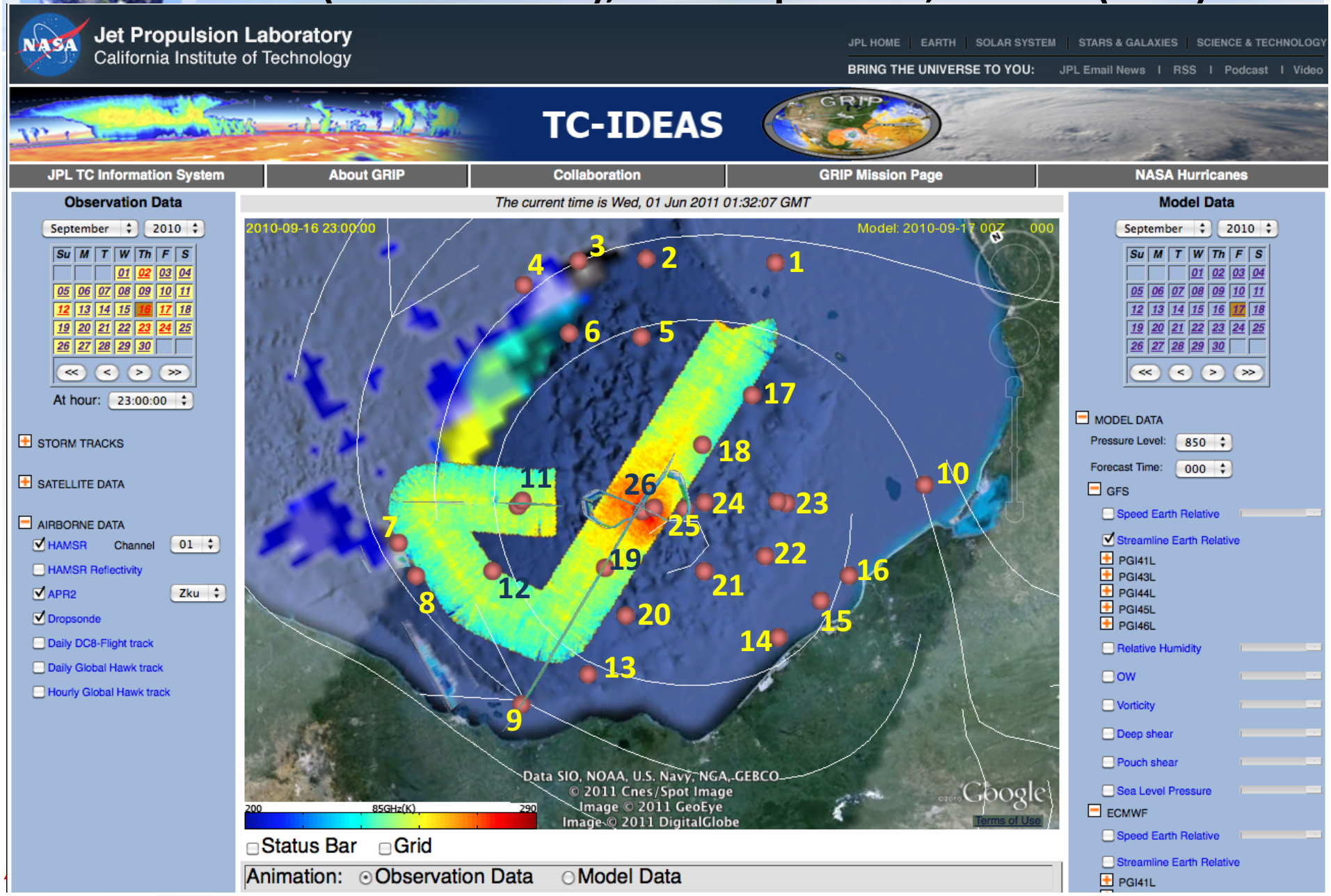
September 2010

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		

<< < > >>

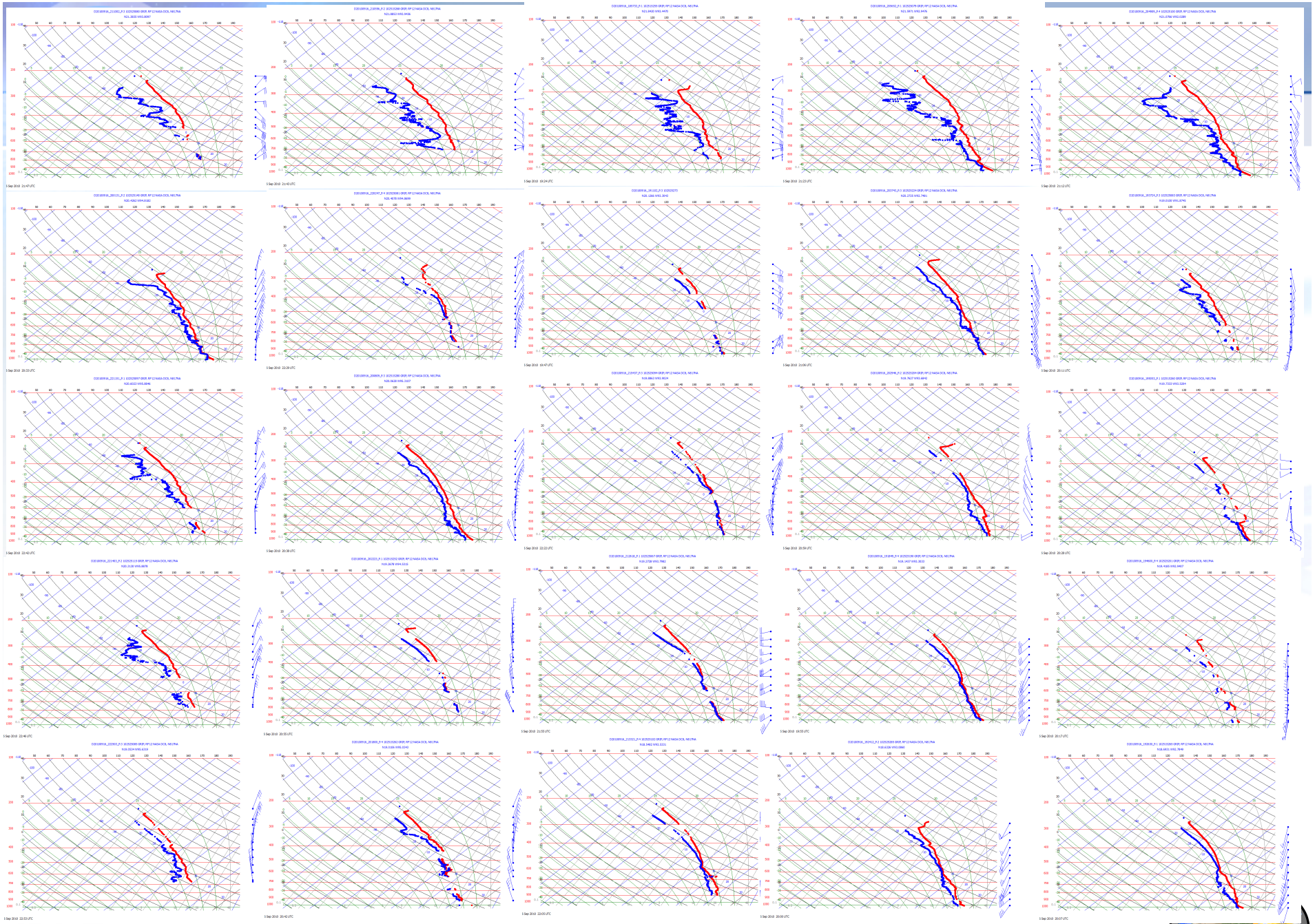
- [-] MODEL DATA
  - Pressure Level: 850
  - Forecast Time: 024
  - [+] GFS
  - [-] ECMWF
    - [ ] Speed Earth Relative
    - [x] Streamline Earth Relative
    - [+] PGI41L
    - [+] PGI43L
    - [+] PGI44L
    - [+] PGI45L
    - [+] PGI46L
    - [ ] Relative Humidity
    - [ ] OW
    - [ ] Vorticity
    - [ ] Deep shear
    - [ ] Pouch shear
    - [ ] Sea Level Pressure
  - [+] UKMET
  - [+] NOGAPS

Hurricane Karl, September 16th
Rain Index (satellite PMW), DC8 dropsondes, HAMSR (ch. 6)

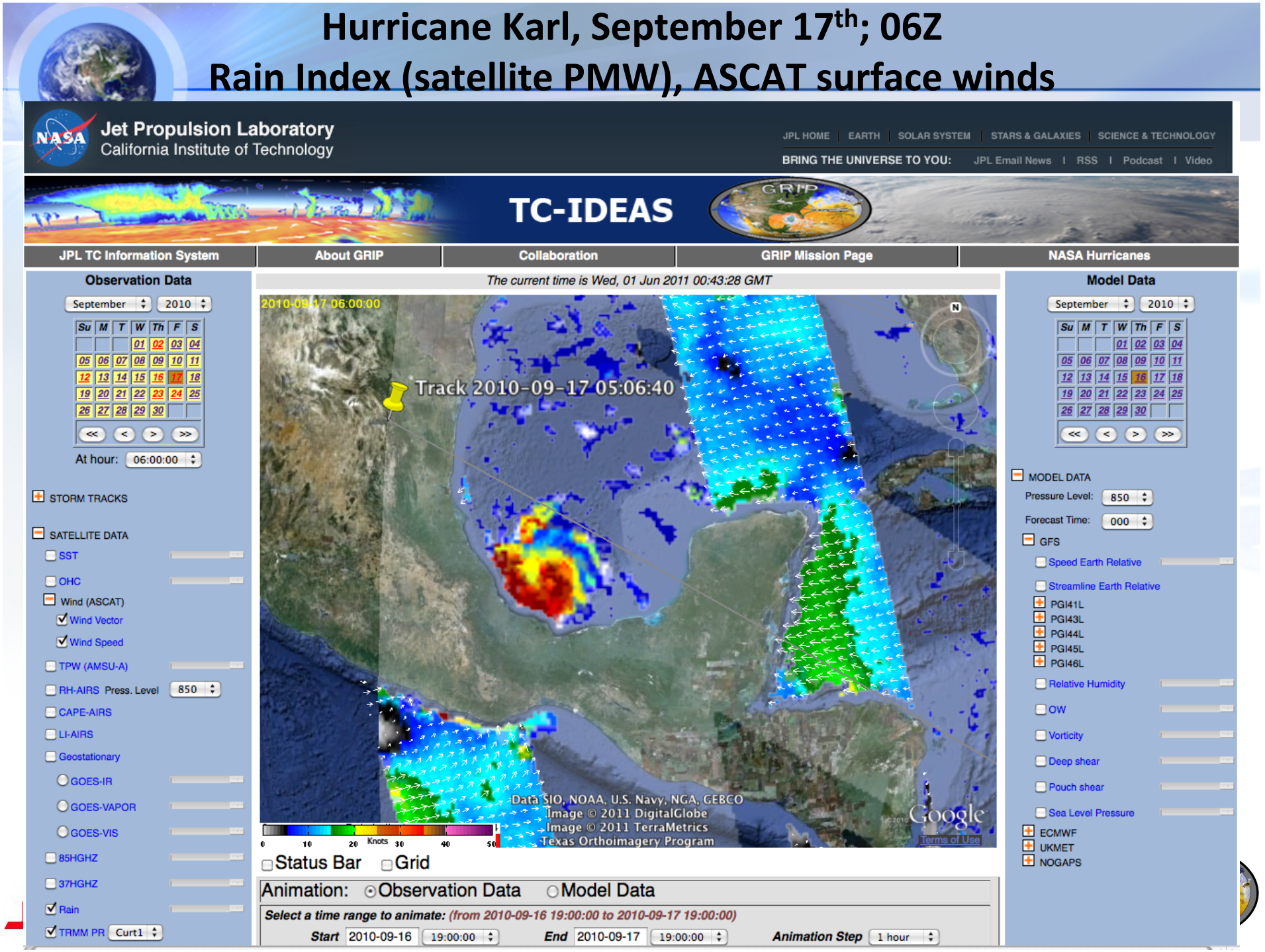


Layout of the soundings on the next slide, using the dropsonde numbers from the previous slide

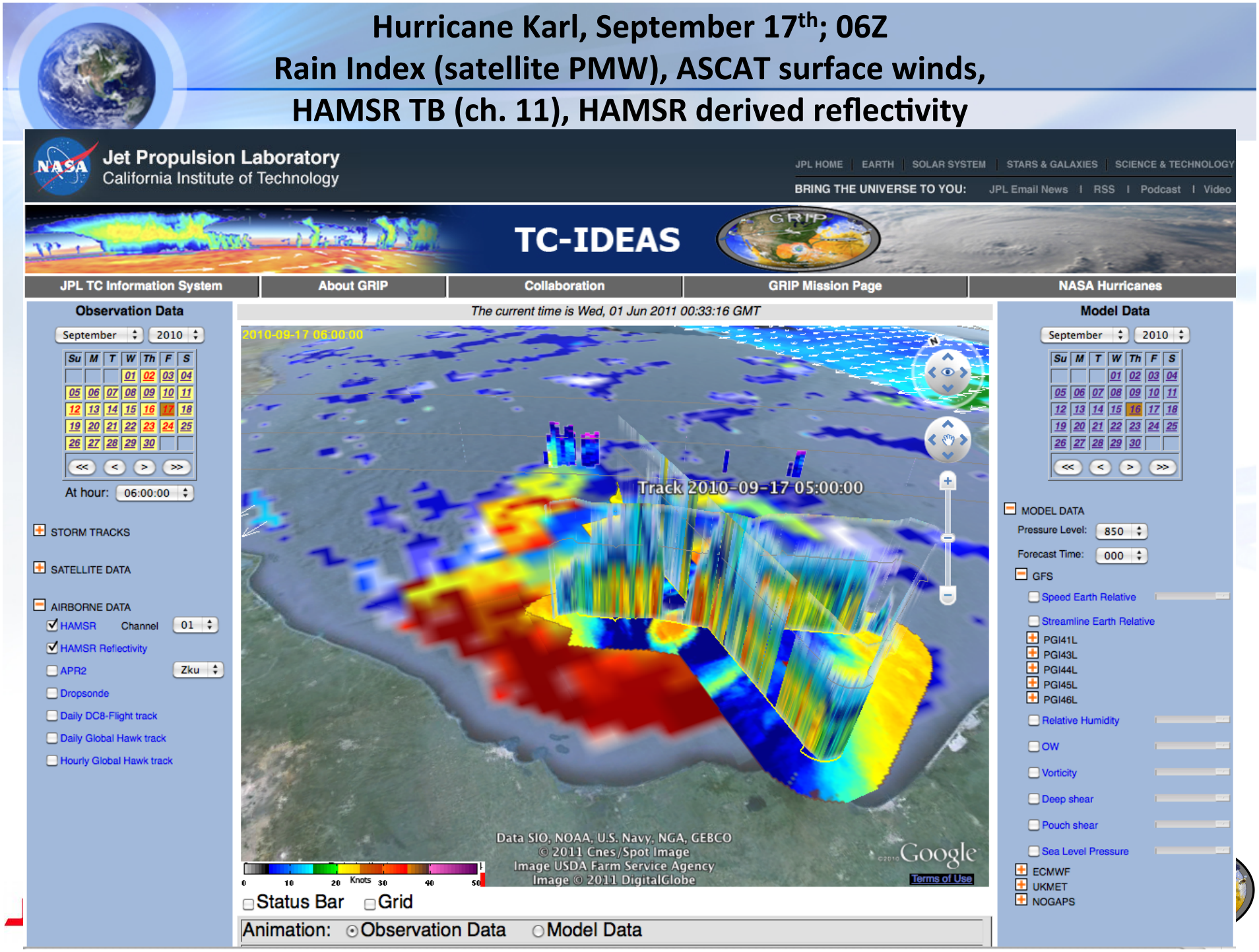
6	4	3	2	1
11a	11b	18	17	10
7	12	26	25	24
8	20	21	22	23a
9	13	14	15	16



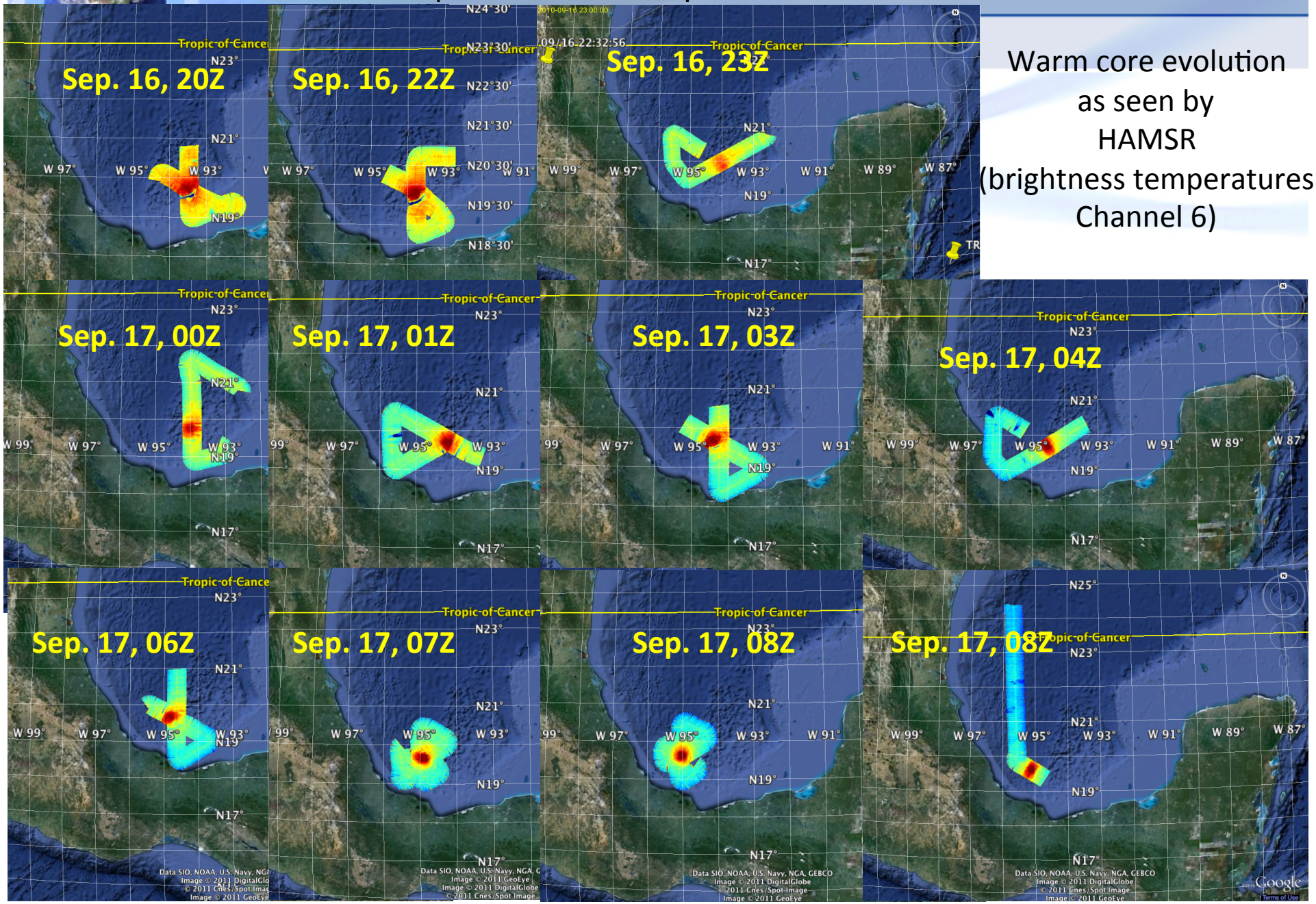
Hurricane Karl, September 17th; 06Z
Rain Index (satellite PMW), ASCAT surface winds



Hurricane Karl, September 17th; 06Z
Rain Index (satellite PMW), ASCAT surface winds, HAMSR TB (ch. 11), HAMSR derived reflectivity

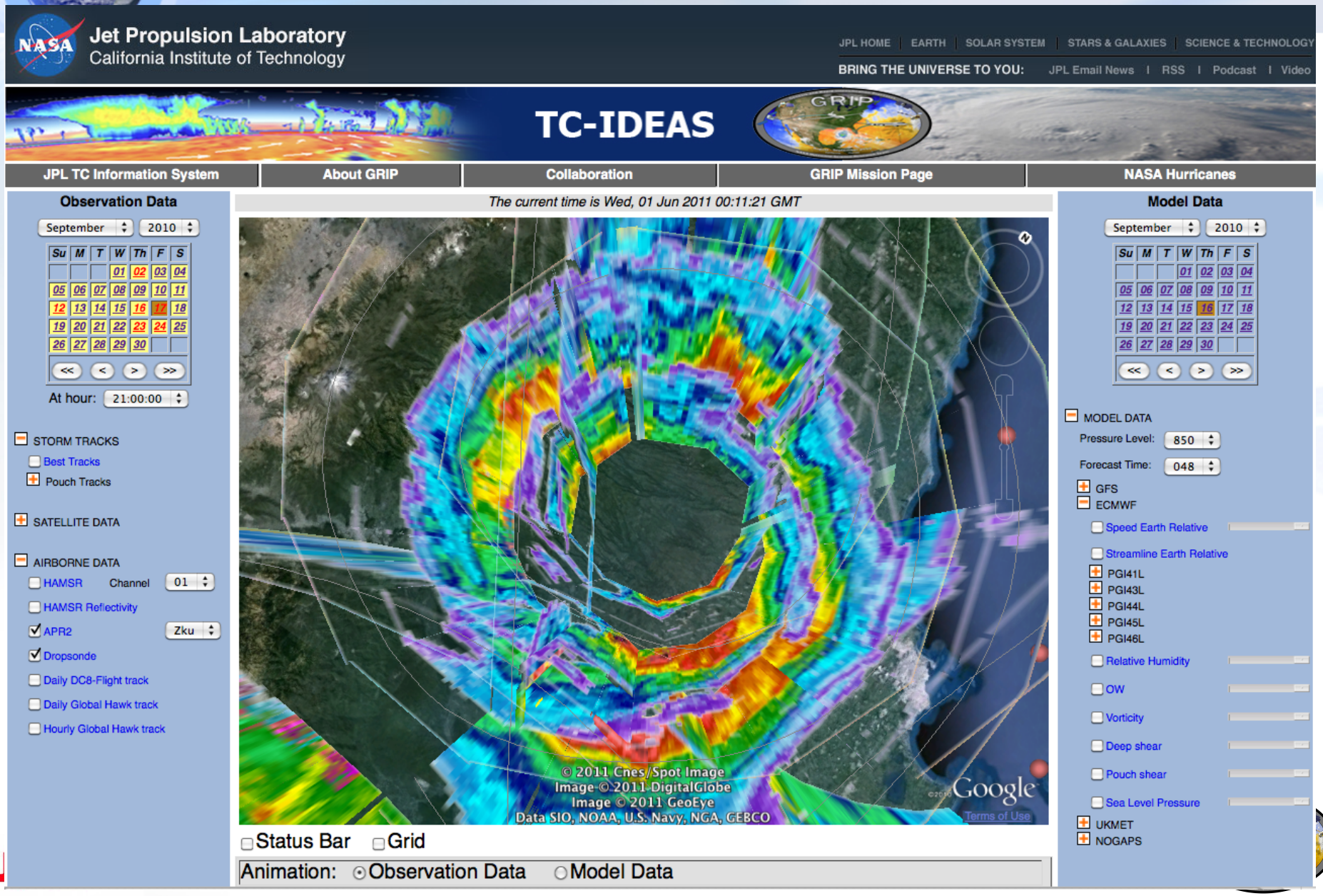


Hurricane Karl,
September 16th-September 17th



Warm core evolution as seen by HAMSR (brightness temperatures Channel 6)

Hurricane Karl at landfall, September 17th; 21Z; APR2 reflectivity (Ku), DC8 dropsondes



NRT Satellite/Model - ADVANTAGES

http://grip.jpl.nasa.gov

- **Can accommodate the displaying of new data**
  - Dropsondes
  - Airborne radar data
- **Responsive also to some of the requirements expressed during a recent PREDICT telecon**
  - Satellite data with overlays
  - Inclusion of Invests - Have all data, including all "INVEST" data
  - Planned inclusion of large-scale Model data (however, envisioned is the use of GFS instead of ECMWF)
  - Planned inclusion of hurricane model forecasted tracks.

JPL

NRT Satellite/Model - ADVANTAGES

http://grip.jpl.nasa.gov

svetla.veleva@jpl.nasa.gov

- Features
  - basin-scale view
  - large-scale and storm-scale data
  - includes 3D data (2D and curtain plots)
  - analysis (LI, CAPE, Skew-T ,RI , vorticity , divergence)
  - "Best Track" (possibly also forecast tracks)
  - overlays on demand, transparency
  - Animations, calendar, with hurricane days marked
  - uses Google Earth – ability to zoom and navigate

JPL

NRT Satellite/Model Data – DATA TYPES

http://grip.jpl.nasa.gov

Offers 10 (14) NRT satellite image products in the GRIP domain.

- **Except for the SST and the IR image, the products are generated hourly with 6 hour-composite observations**.
- The Rain Indicator is a JPL product computed from the brightness temperatures observed by TMI, AMSR-E and SSM/I.
- Stability indices (CAPE, LI) of the atmosphere. They, and the Skew-T plots, are produced at JPL from AIRS retrievals of vertical profiles of temperature and humidity.
- The GOES IR, VIS and Water Vapor channels are an hourly composite generated by the Naval Research Lab at Monterey.
- SST is a 1KM global daily product developed at JPL. It is blended using the GHRSST L2P products and in-situ observations.

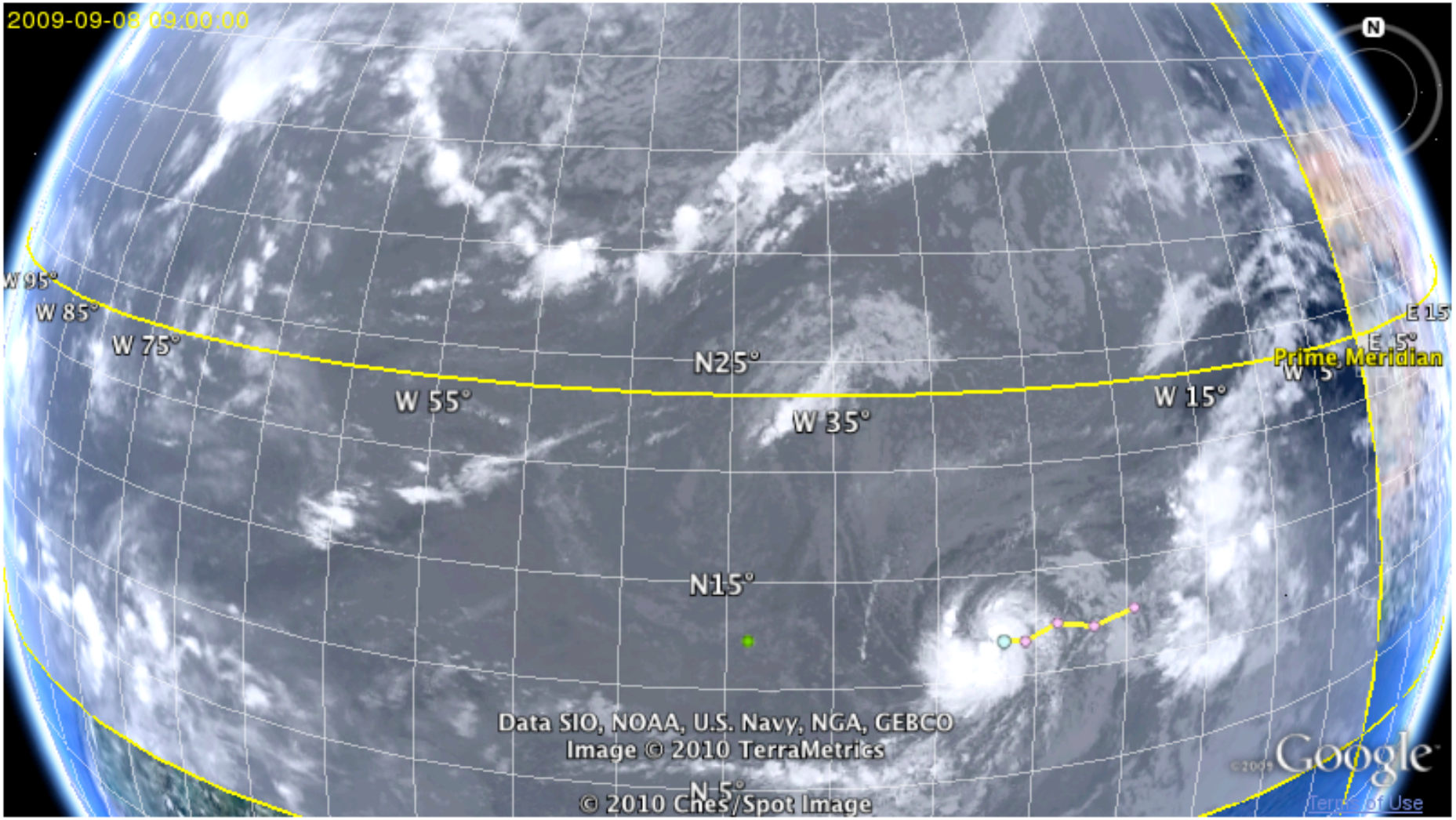
JPL

Products	Instruments	Satellites	Source	Latency
1KM Sea Surface Temperature (SST)	GHRSST L2P from PODAAC and in-situ	MODIS, AVHRR, GOES11+12, TMI, AMSR-E, SEVIRI	JPL derived product	12 hrs
Total Precipitable Water (TPW)	AMSU-A	NOAA-15/16/17/18/ 19 and MetOp-A	NOAA-NESDIS Realtime DDS data server	3 hrs
85 GHz Brightness temperature	SSMI, SSMIS, AMSR-E, TRMM TMI	DMSP F-15/16/17, AQUA, TRMM	NOAA-NESDIS, LANCE NASA GSFC PPS	3 hrs
Rain Indicator	SSMI, SSMIS, AMSR-E, TRMM TMI	DMSP F-15/16/17, AQUA, TRMM	JPL derived product	3 hrs
IR, VIS and WV hourly composite	GOES		Naval Research Lab – Monterey (NRL)	0.5 hrs
Surface Wind vector plots	QuikSCAT	QuikSCAT	JPL PoDAAC	Stopped operation since 11/23/2009
AIRS CAPE (Convective Available Potential Energy)	AIRS	Aqua	NASA GSFC/JPL AIRS Science Facility	
AIRS Lifting Index (LI) and SkewT diagrams	AIRS	Aqua	NASA GSFC/JPL AIRS Science Facility	
Radar Reflectivity converted from L1B Received Echo Poser	CloudSat	CloudSat	Colorado State CloudSat Data Processing Center	
Best Track			JPL	6 hr

NRT Satellite Data – DATA TYPES

http://grip.jpl.nasa.gov

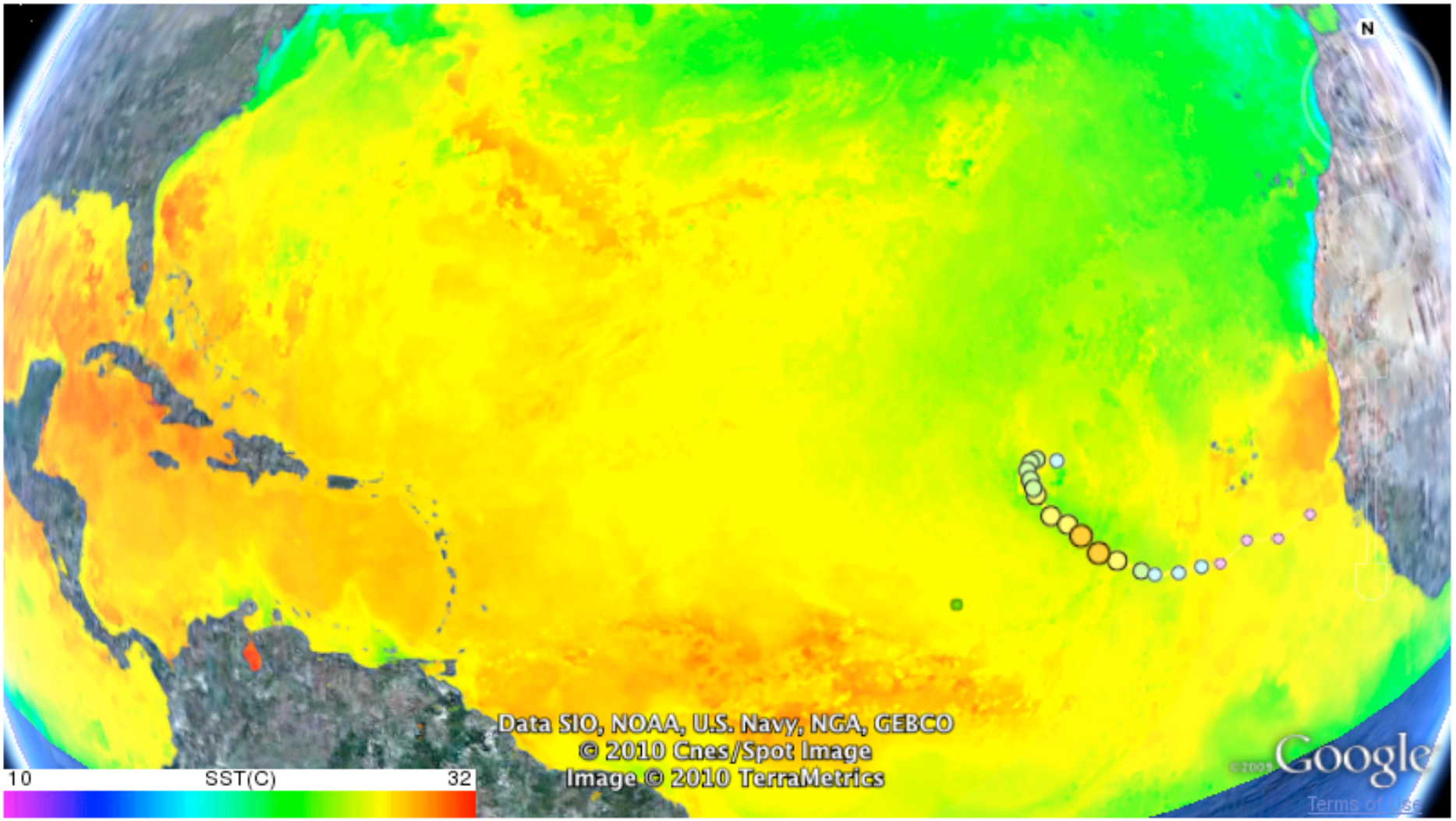
GOES and Meteosat IR – 4km resolution; NRL product



NRT Satellite Data – DATA TYPES

http://grip.jpl.nasa.gov

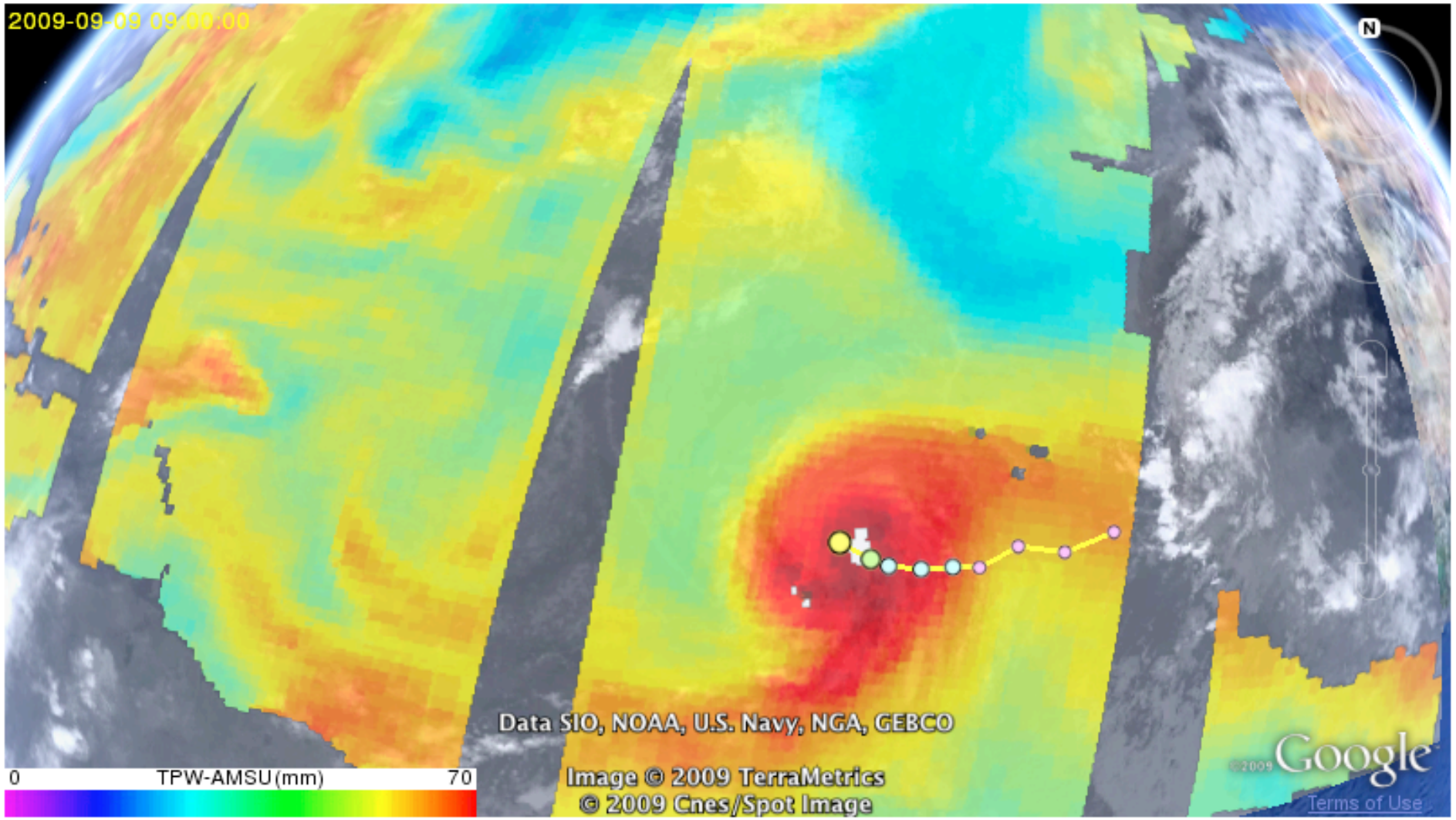
SST – 1km resolution; Observations-based; JPL daily product



NRT Satellite Data – DATA TYPES

http://grip.jpl.nasa.gov

Total Precipitable Water (TPW) from AMSU observations

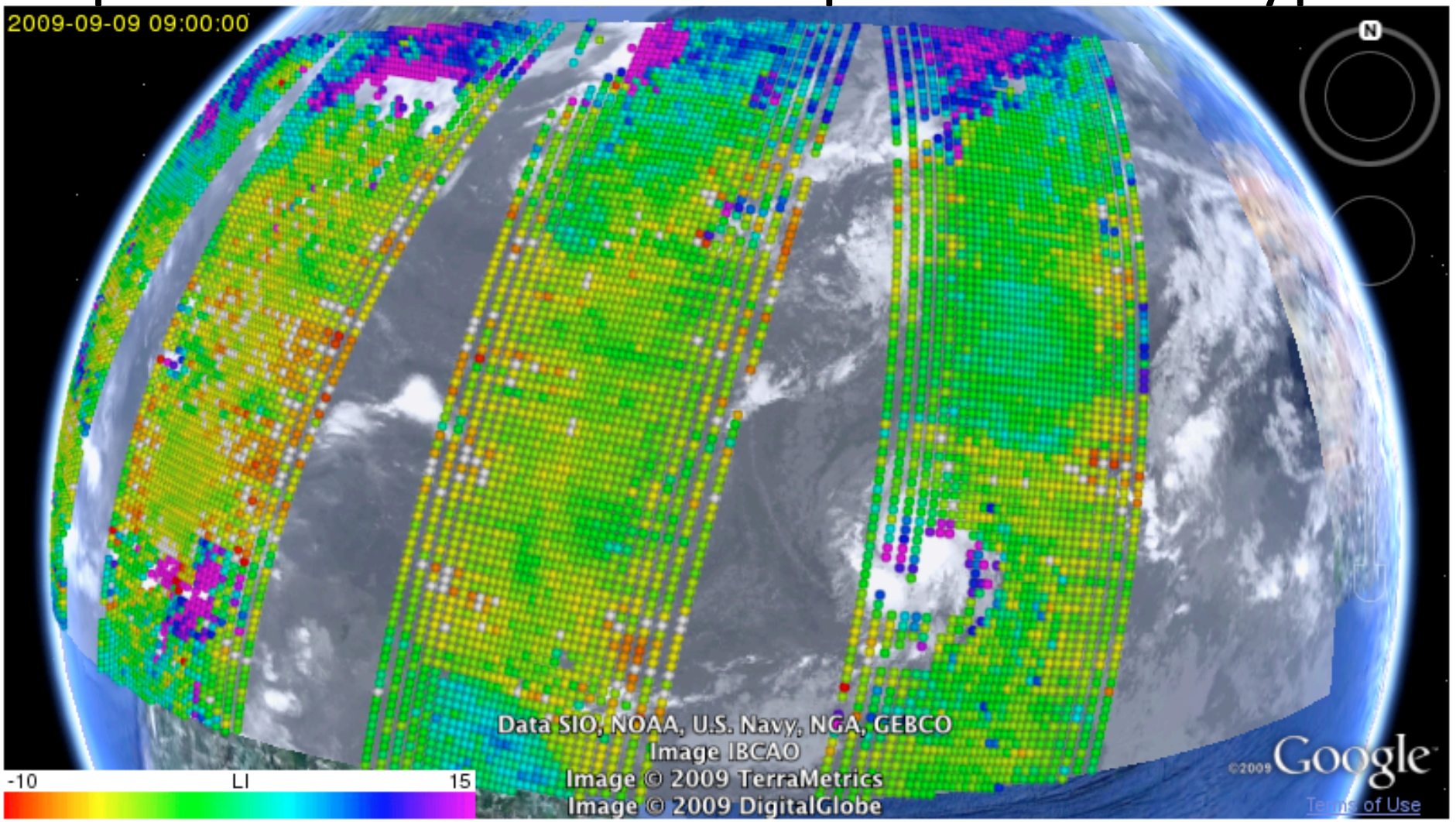


NRT Satellite/Model Data – DATA TYPES

http://grip.jpl.nasa.gov

Lifted Index (LI);

JPL product from AIRS retrievals of Temperature and humidity profiles

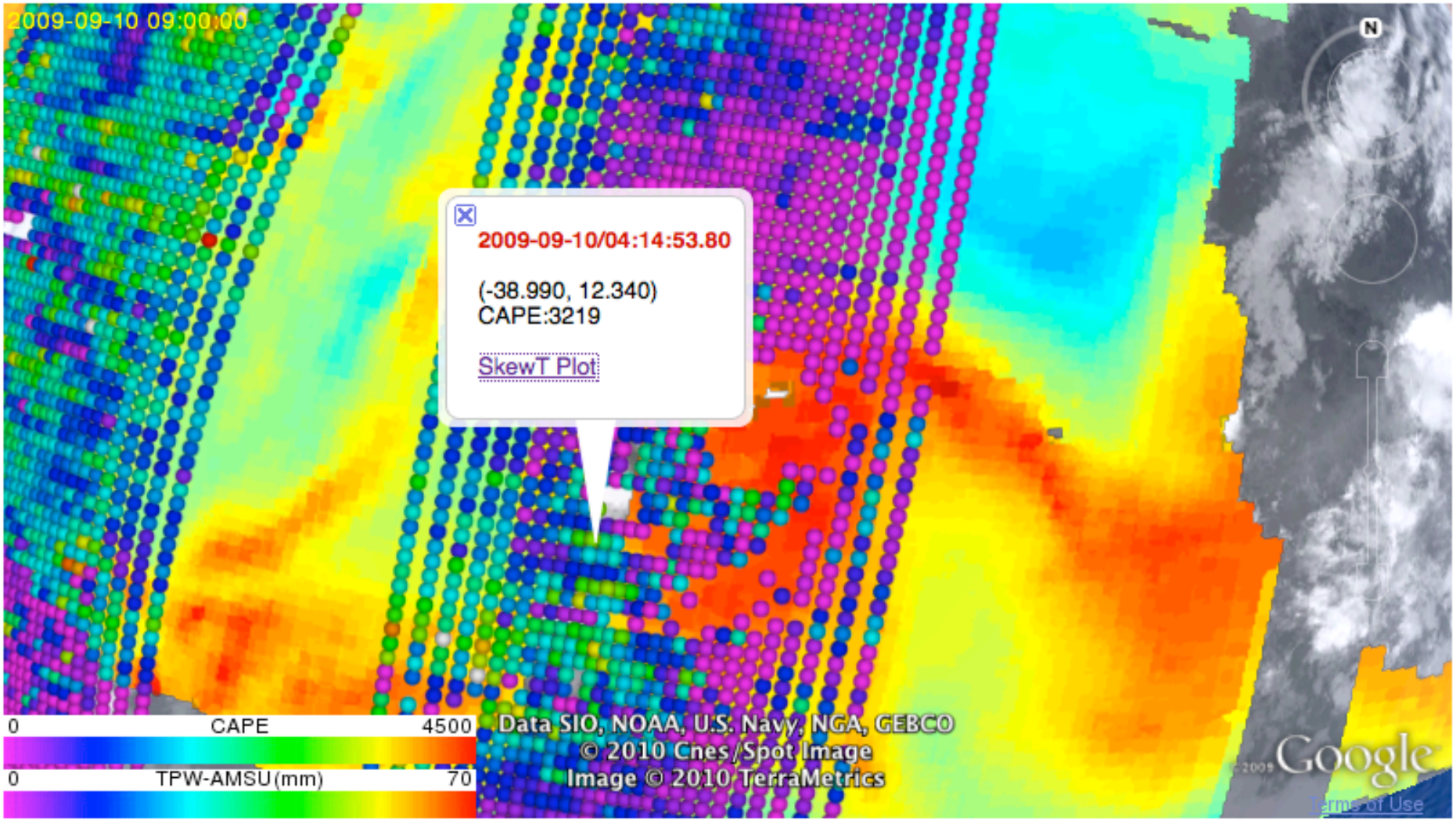


NRT Satellite Data – DATA TYPES

http://grip.jpl.nasa.gov

Convective Available Potential Energy (CAPE);

JPL product from AIRS retrievals of Temperature and humidity profiles

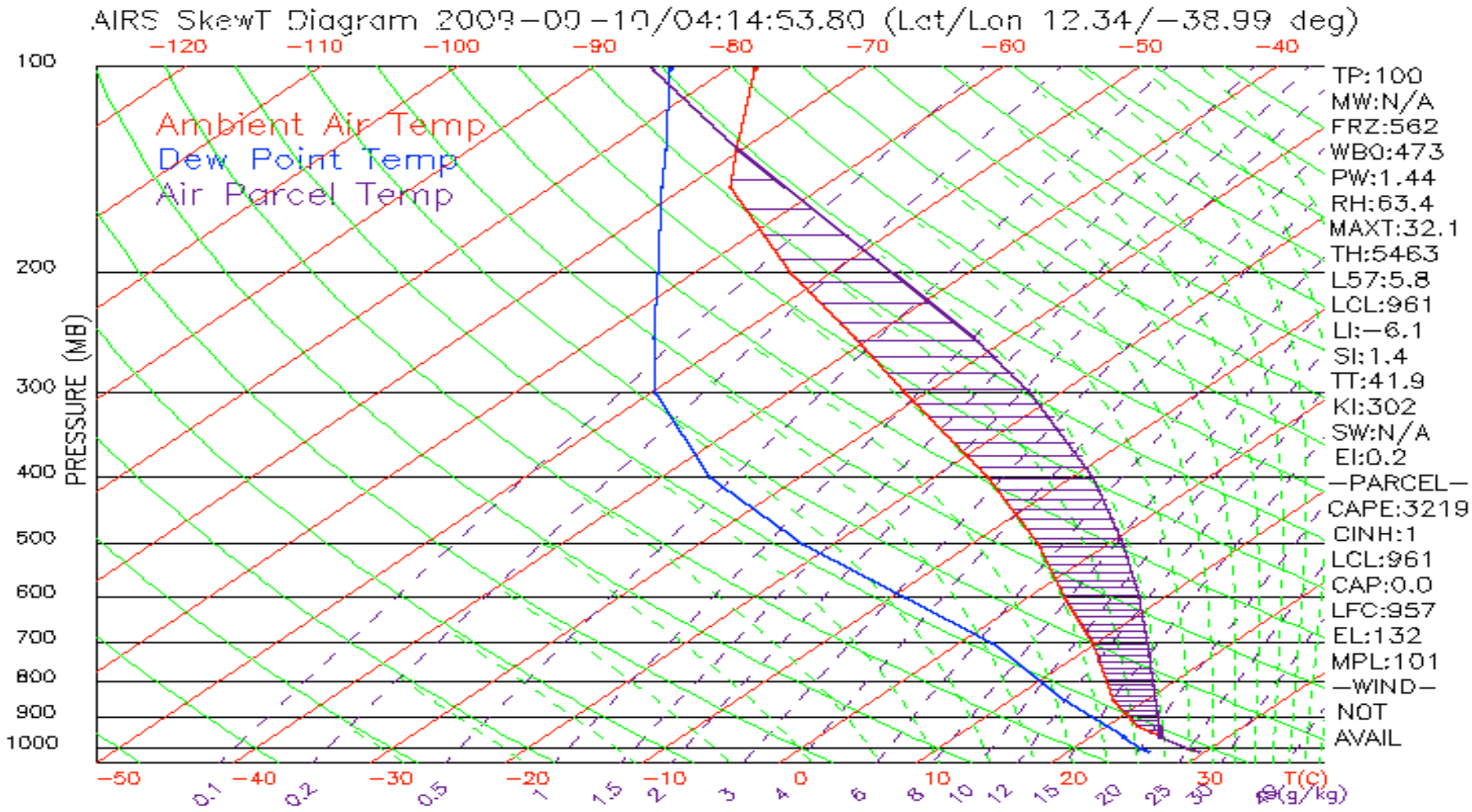


NRT Satellite Data – DATA TYPES

http://grip.jpl.nasa.gov

Skew-T;

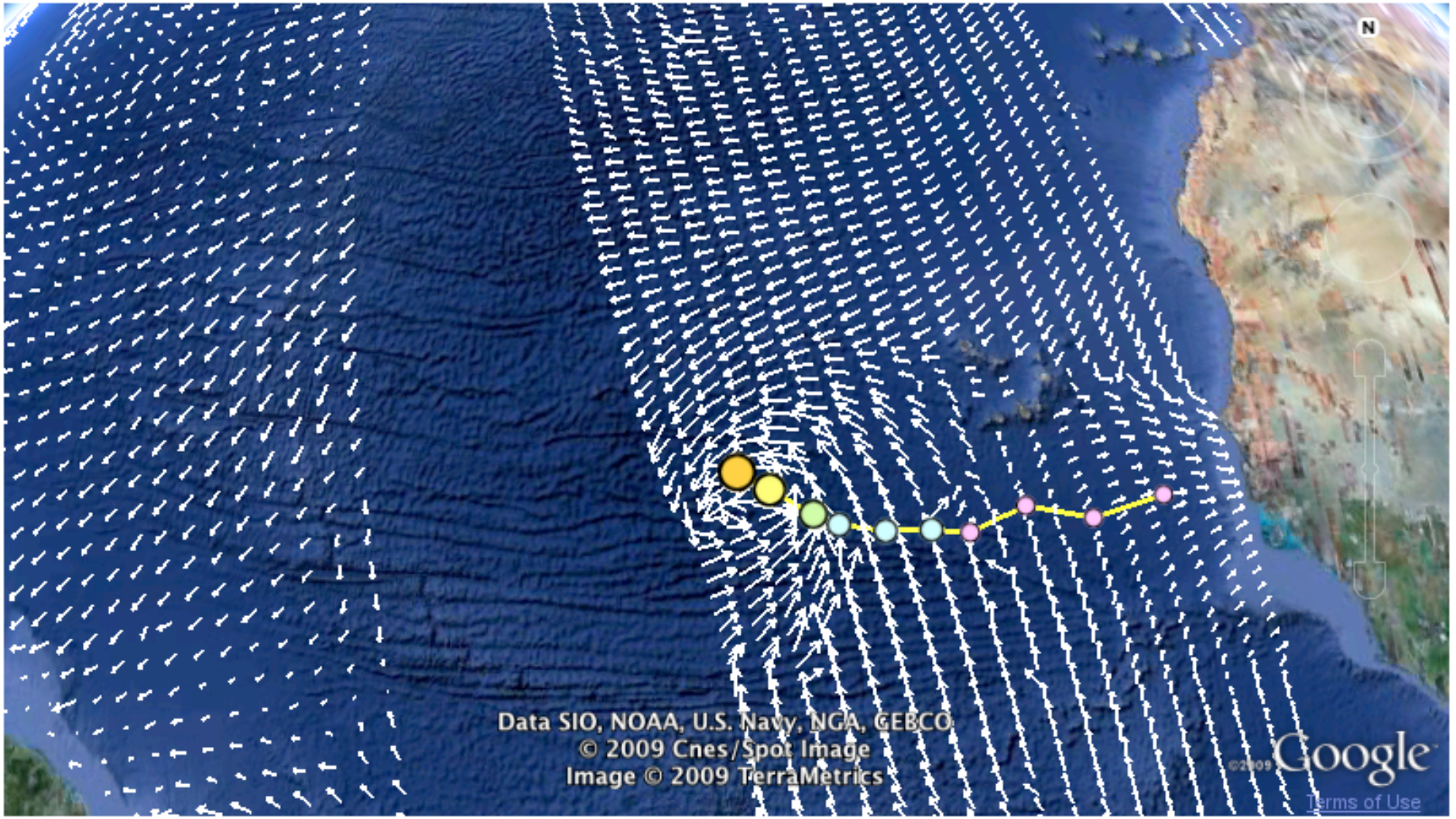
JPL product from AIRS retrievals of Temperature and humidity profiles



NRT Satellite Data – DATA TYPES

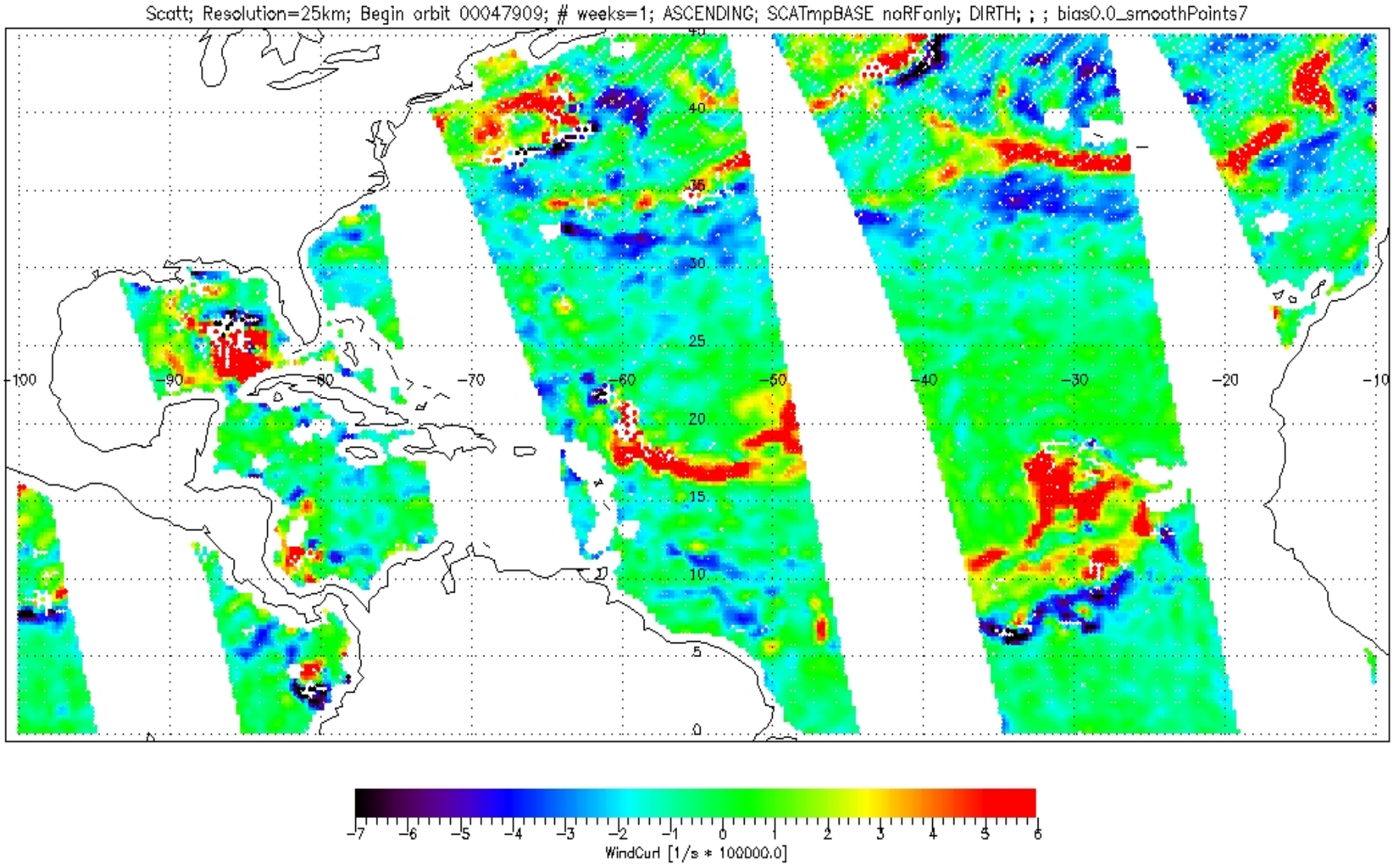
http://grip.jpl.nasa.gov

Near-surface wind retrieved from QuikSCAT observations



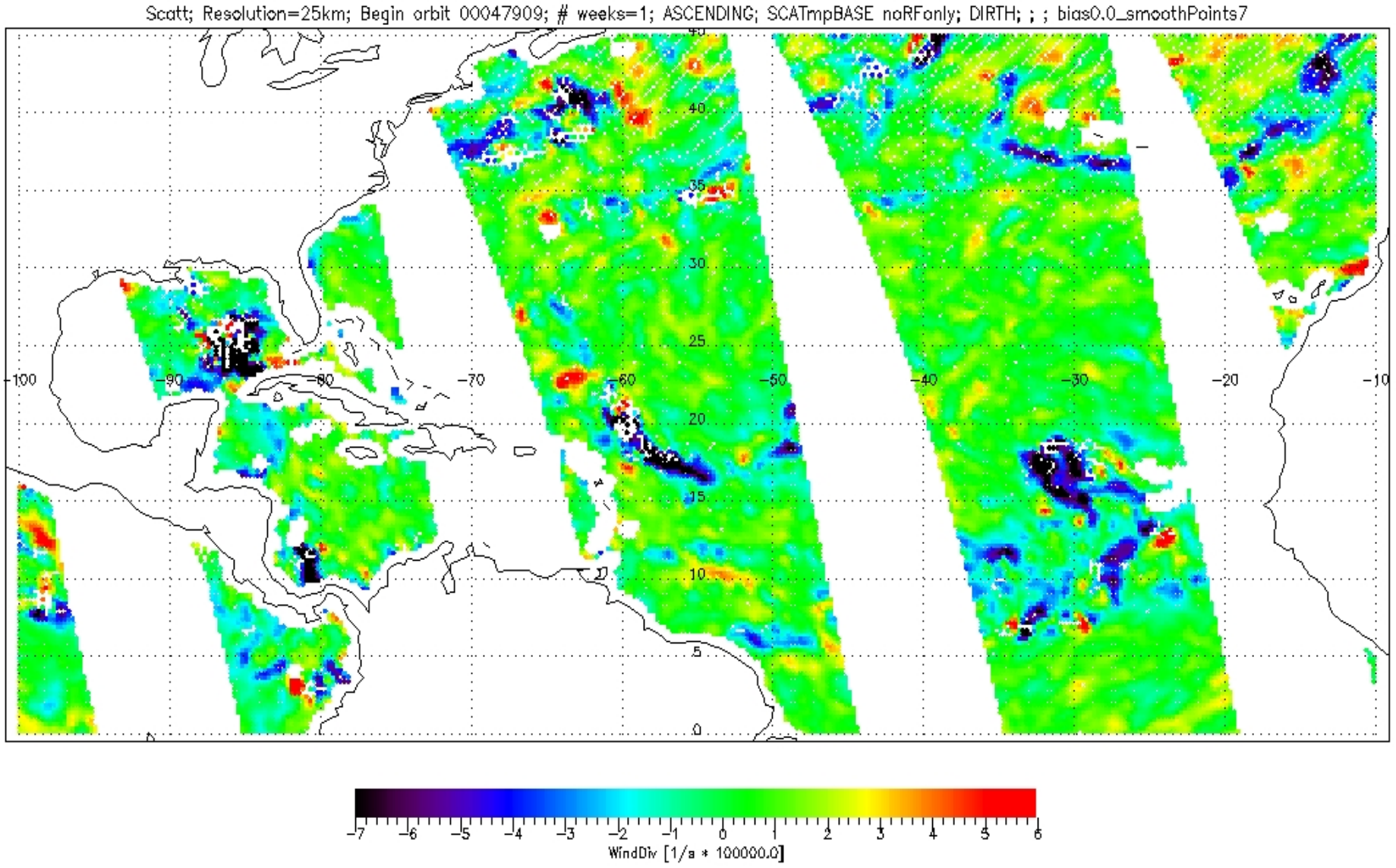
NRT Satellite/Model Data – DATA TYPES

Vorticity computed from QuikSCAT winds



NRT Satellite/Model Data – DATA TYPES

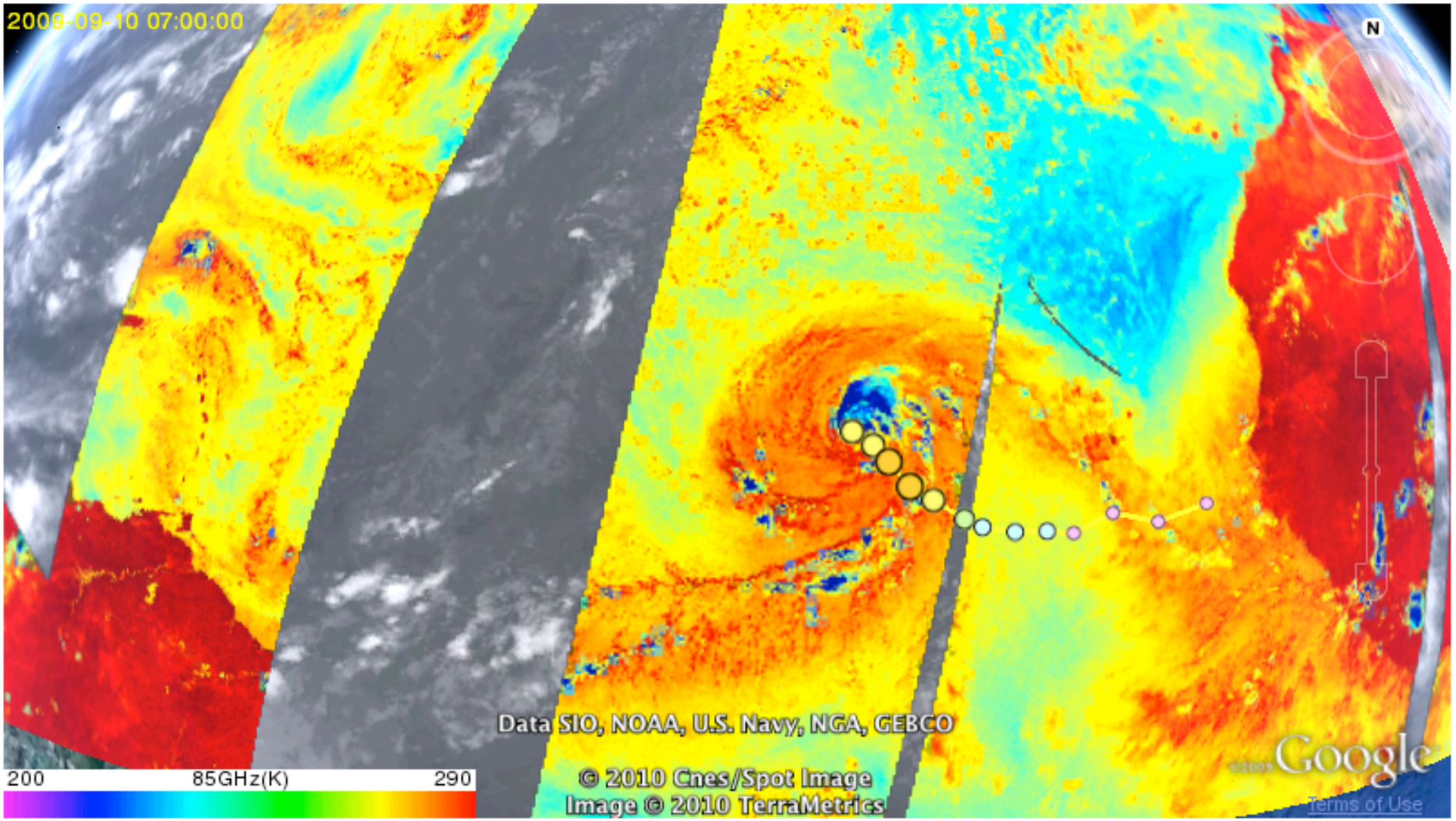
Divergence computed from QuikSCAT winds



NRT Satellite Data – DATA TYPES

http://grip.jpl.nasa.gov

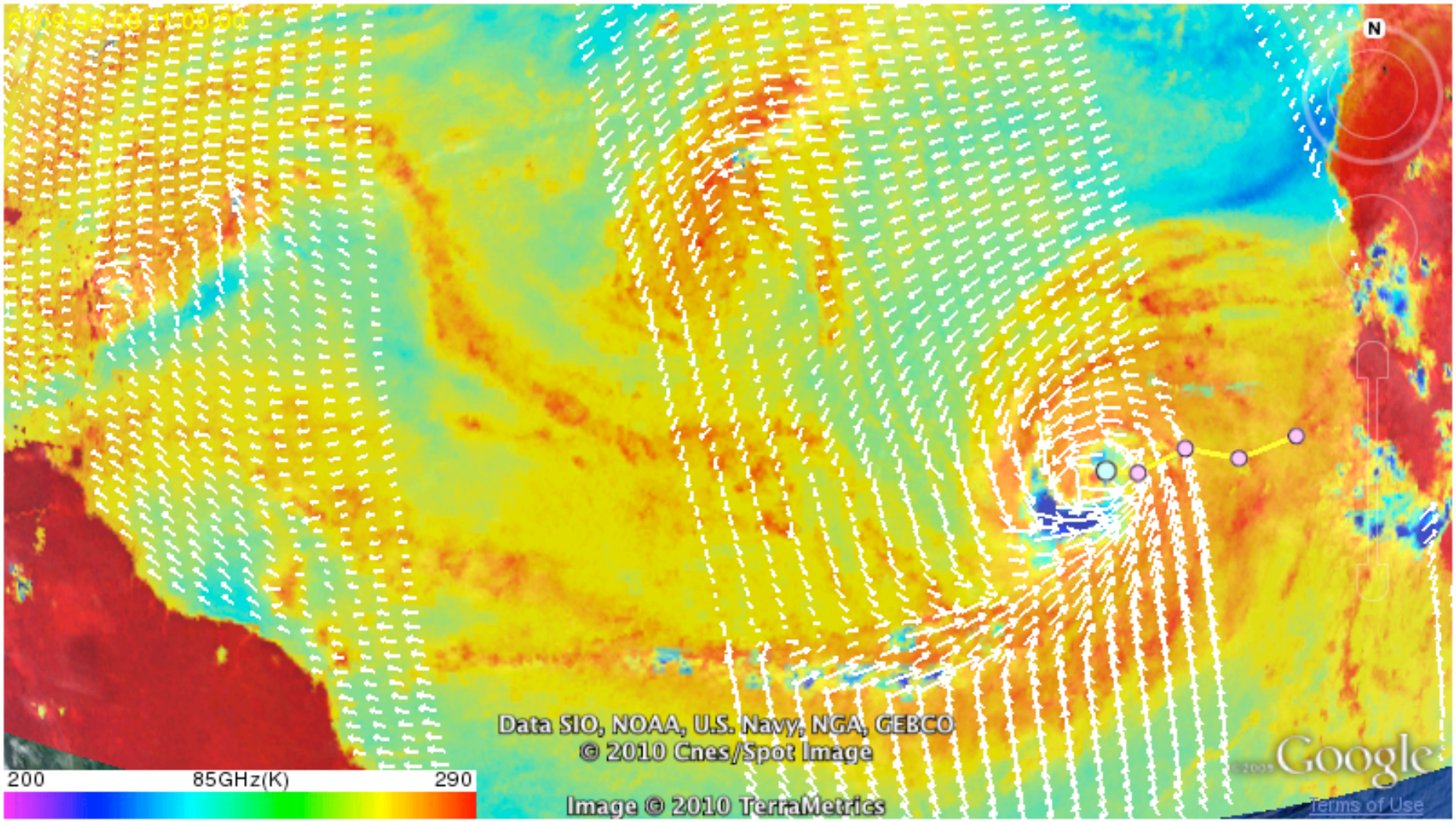
Overlay of IR and 85 GHz brightness temperatures



NRT Satellite/Model Data – DATA TYPES

http://grip.jpl.nasa.gov

Overlay of QuikSCAT winds and 85 GHz brightness temperatures

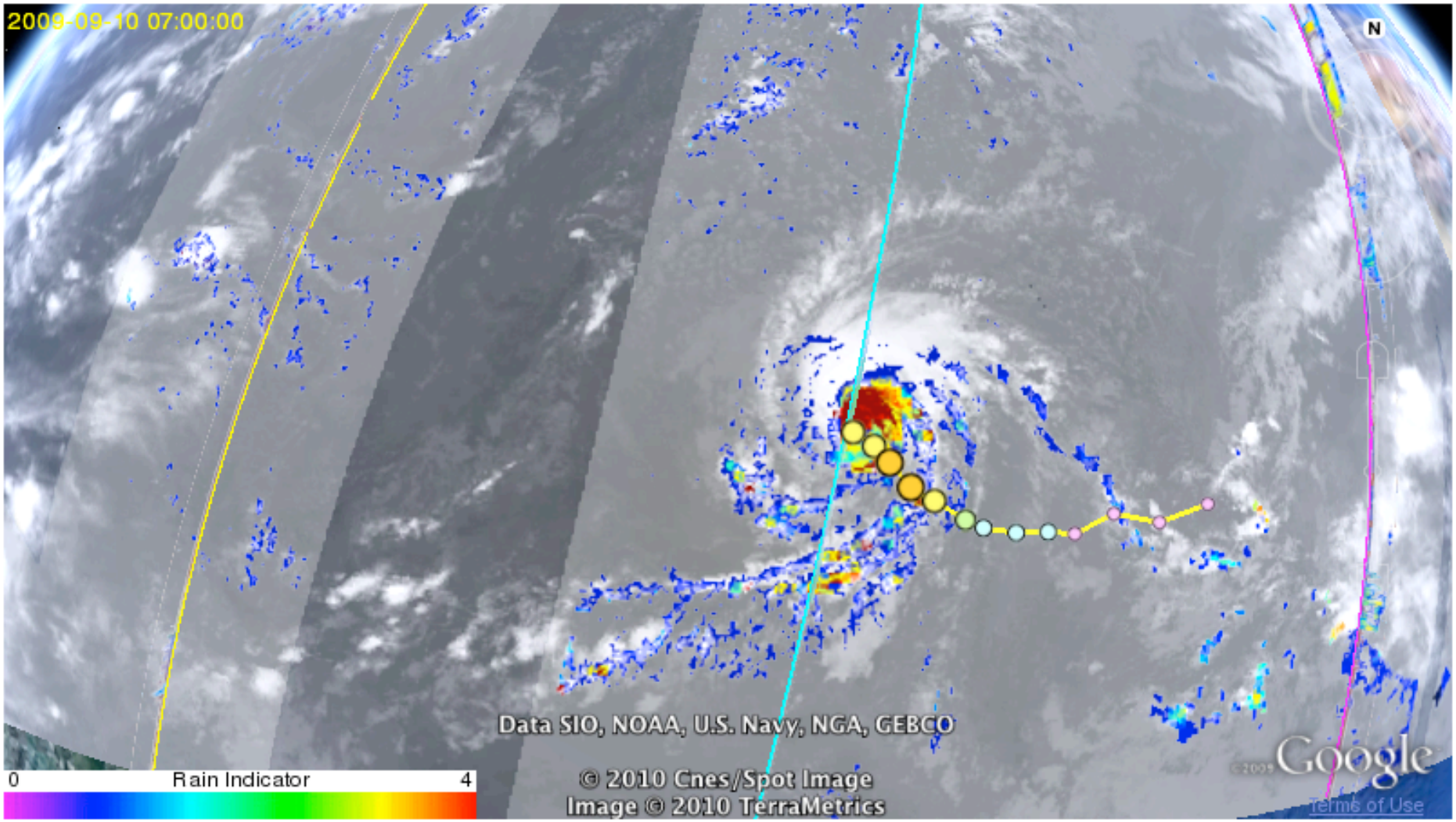


NRT Satellite Data – DATA TYPES

http://grip.jpl.nasa.gov

Overlay of IR,

Rain Indicator (JPL multi-frequency product) and CloudSAT tracks

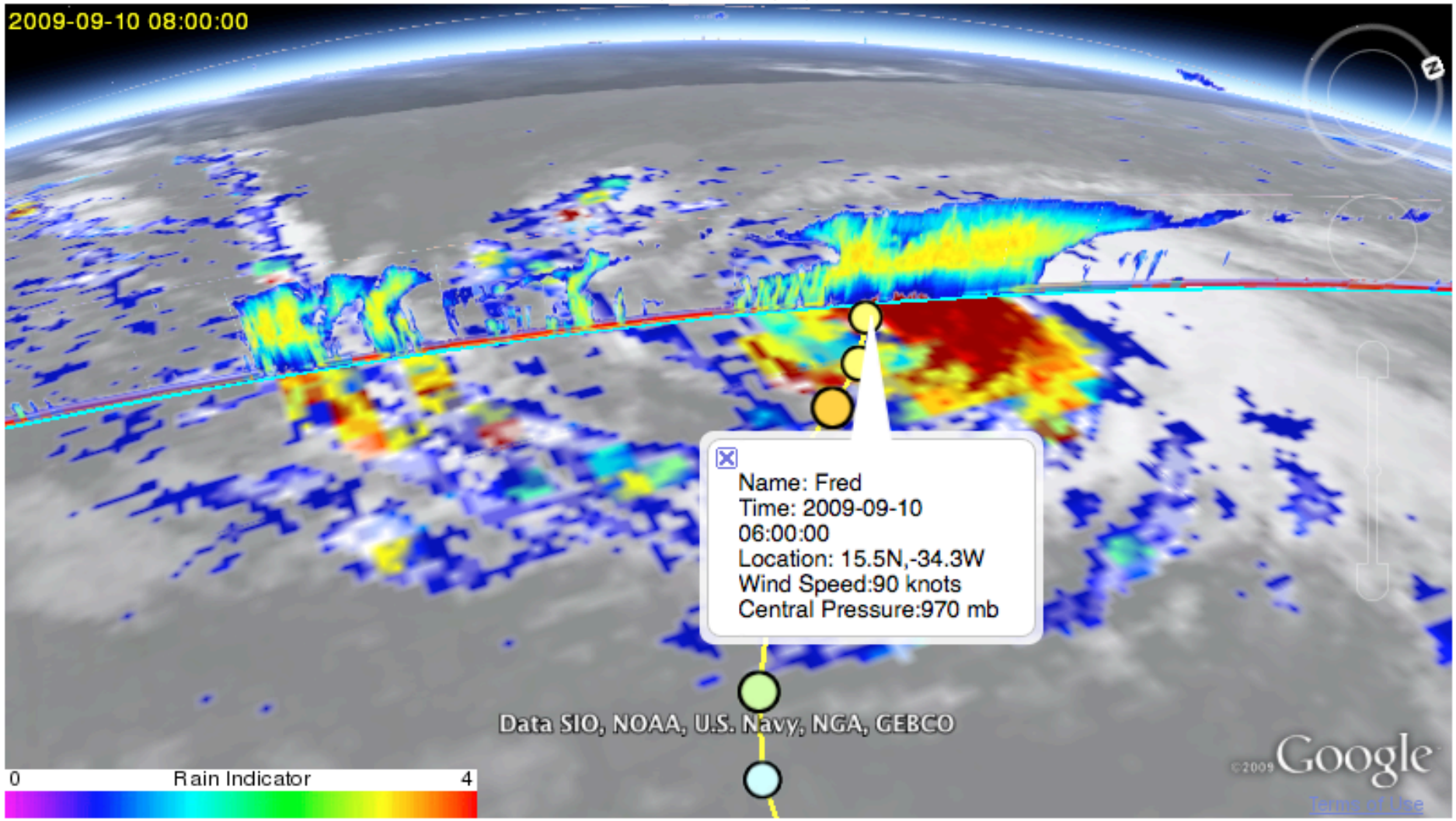


NRT Satellite – DATA TYPES

http://grip.jpl.nasa.gov

Overlay of IR,

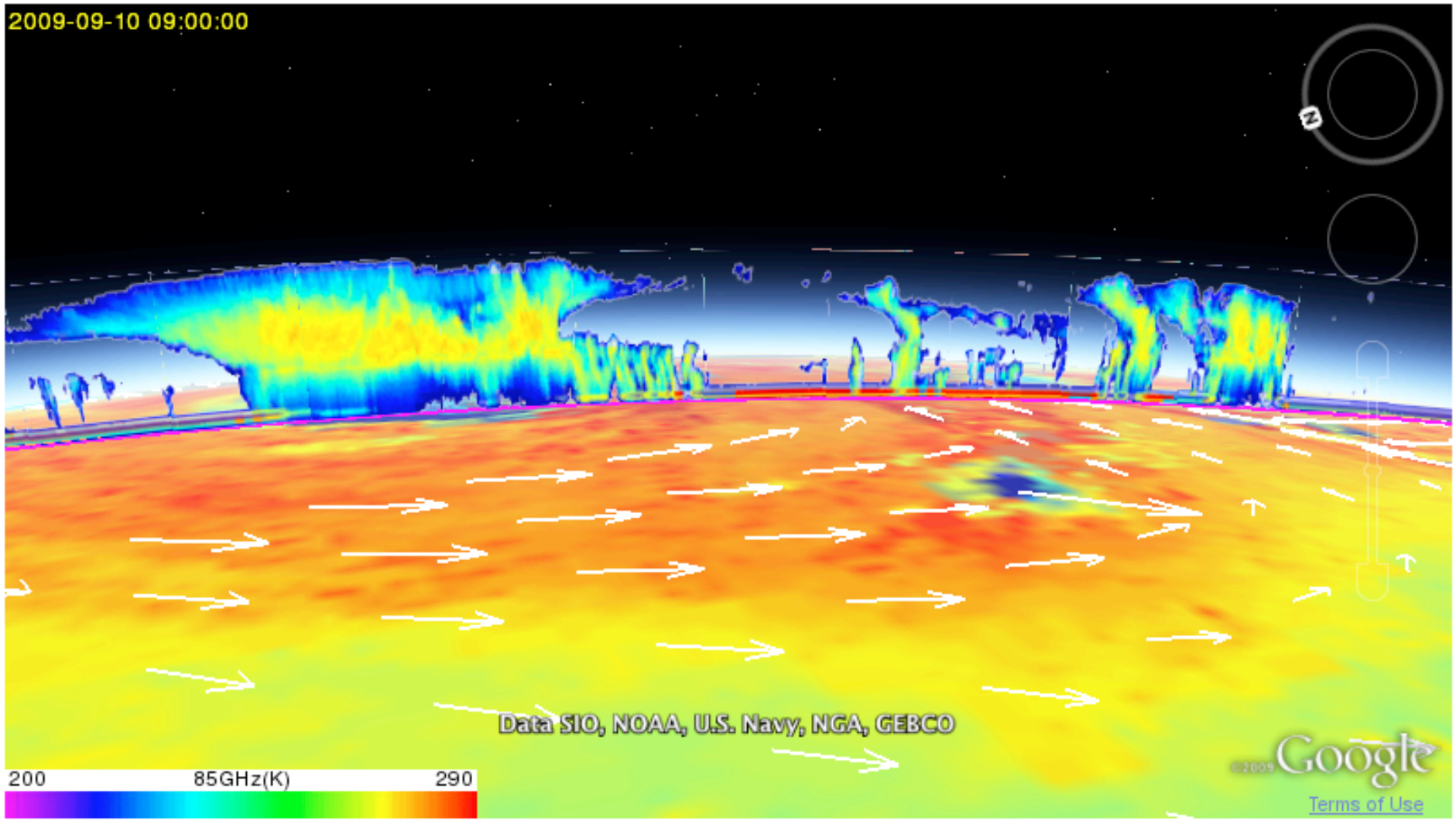
Rain Indicator (JPL multi-frequency product) and CloudSAT data



NRT Satellite Data – DATA TYPES

http://grip.jpl.nasa.gov

Overlay of Rain Indicator (JPL multi-frequency product)
CloudSAT reflectivity profile and QuikSCAT surface winds

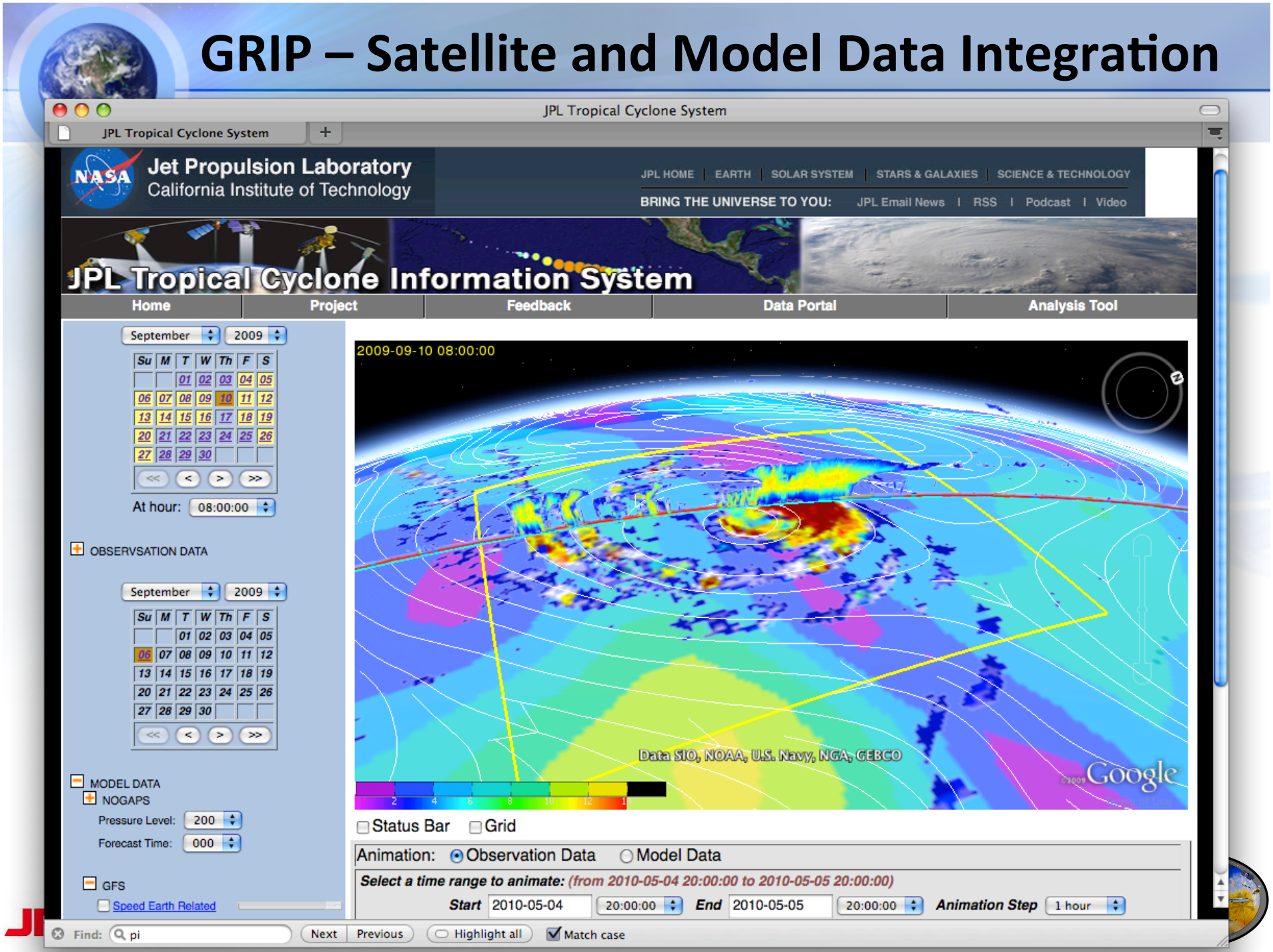


Satellite/Model Integration

- To help
  - understand the physical processes, validate and improve models
  - reveal the interplay between large-scale and storm scale hurricane processes.
- This satellite/model database is being developed as part of the NASA Hurricane Science Program.
- The large-scale model diagnostics during the field campaign will be provided by the PREDICT team.
- The high-resolution hurricane model forecasts and analysis during the field campaign will be provided by the IFEX and PREDICT teams.

JPL

GRIP – Satellite and Model Data Integration



NRT Satellite/Model Data – Data Types

http://grip.jpl.nasa.gov/

- **COMMING SOON**
  - **SATELLITE DATA**
    - TRMM-PR vertical profiles of reflectivity
    - 2D maps of Relative humidity at several levels
    - surface winds from ASCAT and ISRO's OceanSAT-2
    - MODIS AOT and Fine-Particle Fraction
    - MLS curtains of temperature, vapor, cloud ice
  - **MODEL DATA**
    - Storm Tracks from hurricane forecast models
    - HWRFx and ARW forecasts

JPL

Public vs Closed

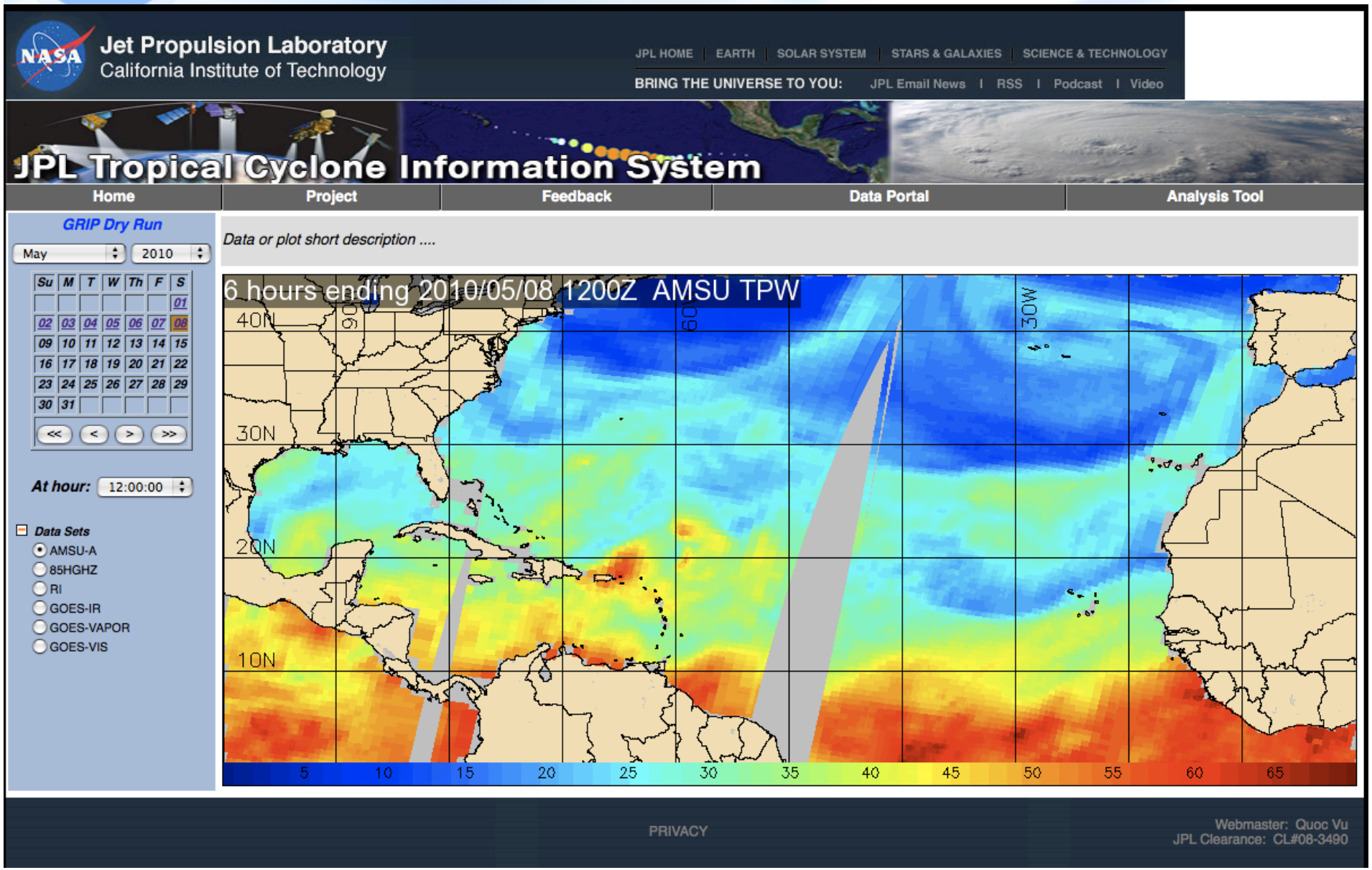
- **PUBLICLY available**
  - **ALL satellite data**
  - **Large-scale models - GFS, NOGAPS, UK Met**
  - **High resolution hurricane models (HWRFx, ARW)**
- **Password protected**
  - **ECMWF data will be provided through a separate, password protected, site which will have all other data as well.**

JPL

- Browsers
  - Google Earth
  - Browser with static images
  - Browser for mobile devices

GRIP – LIGHT

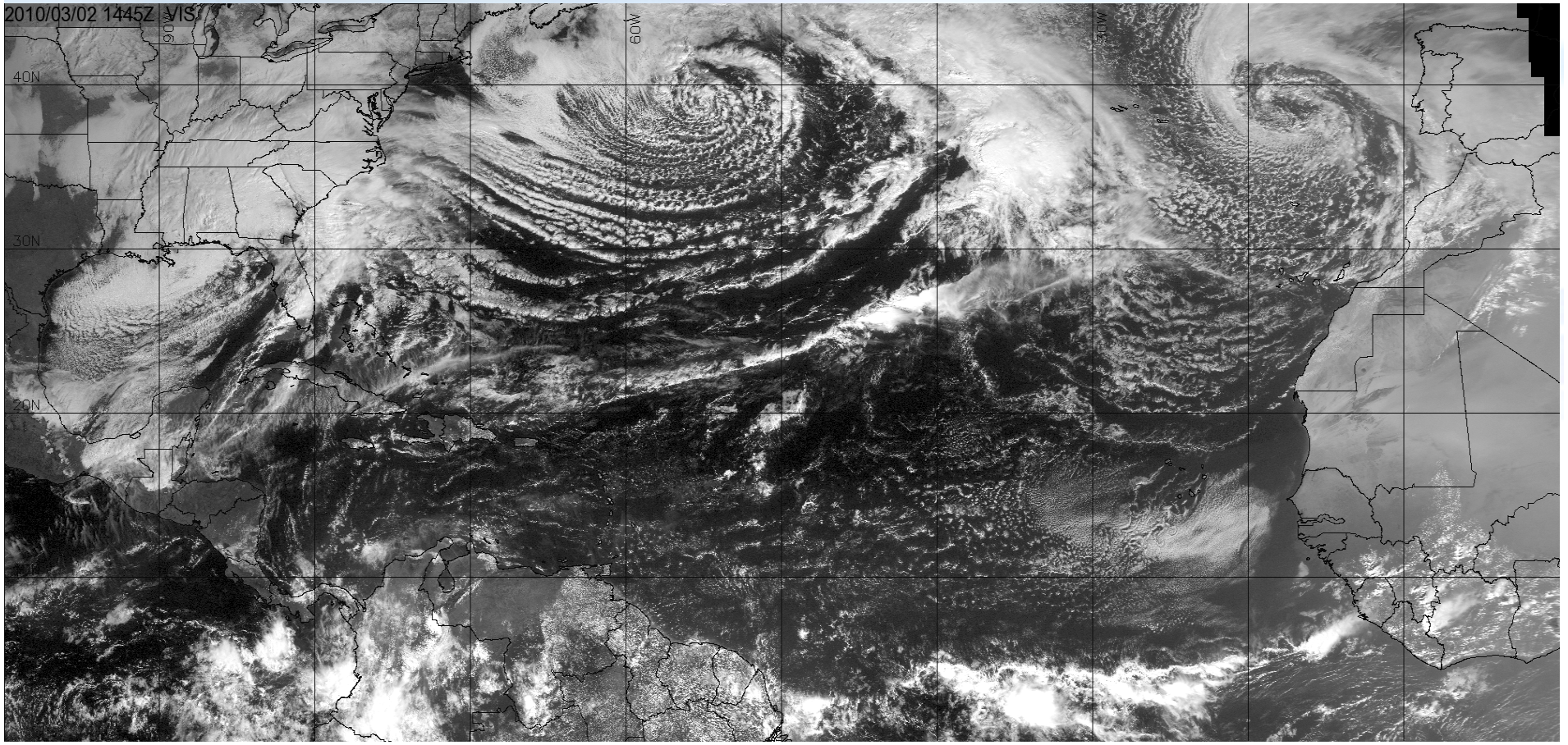
(web browser of pre-generated images)



- BACKUP

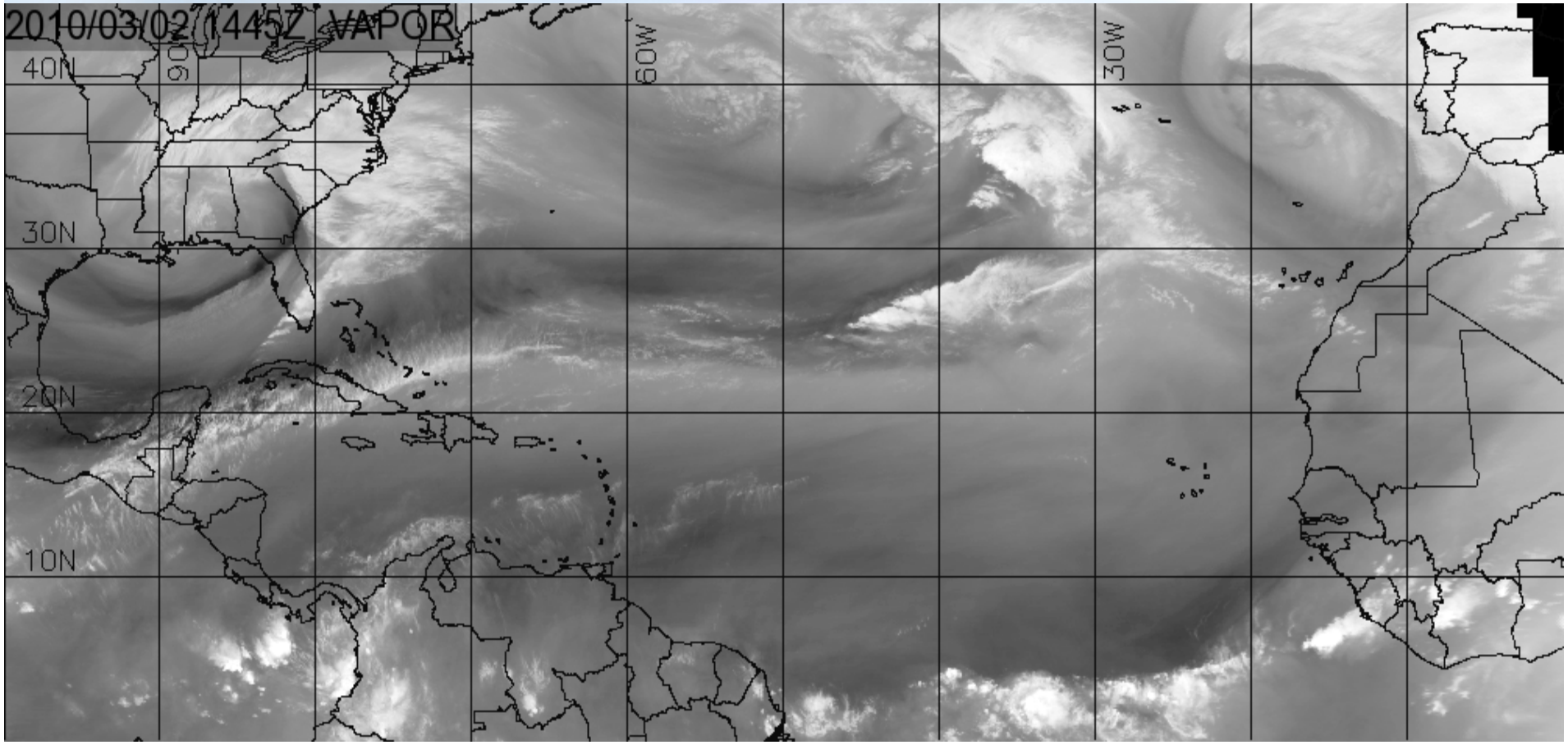
Coming soon – GOES Visible

http://grip.jpl.nasa.gov



Coming soon – GOES Water Vapor

http://grip.jpl.nasa.gov

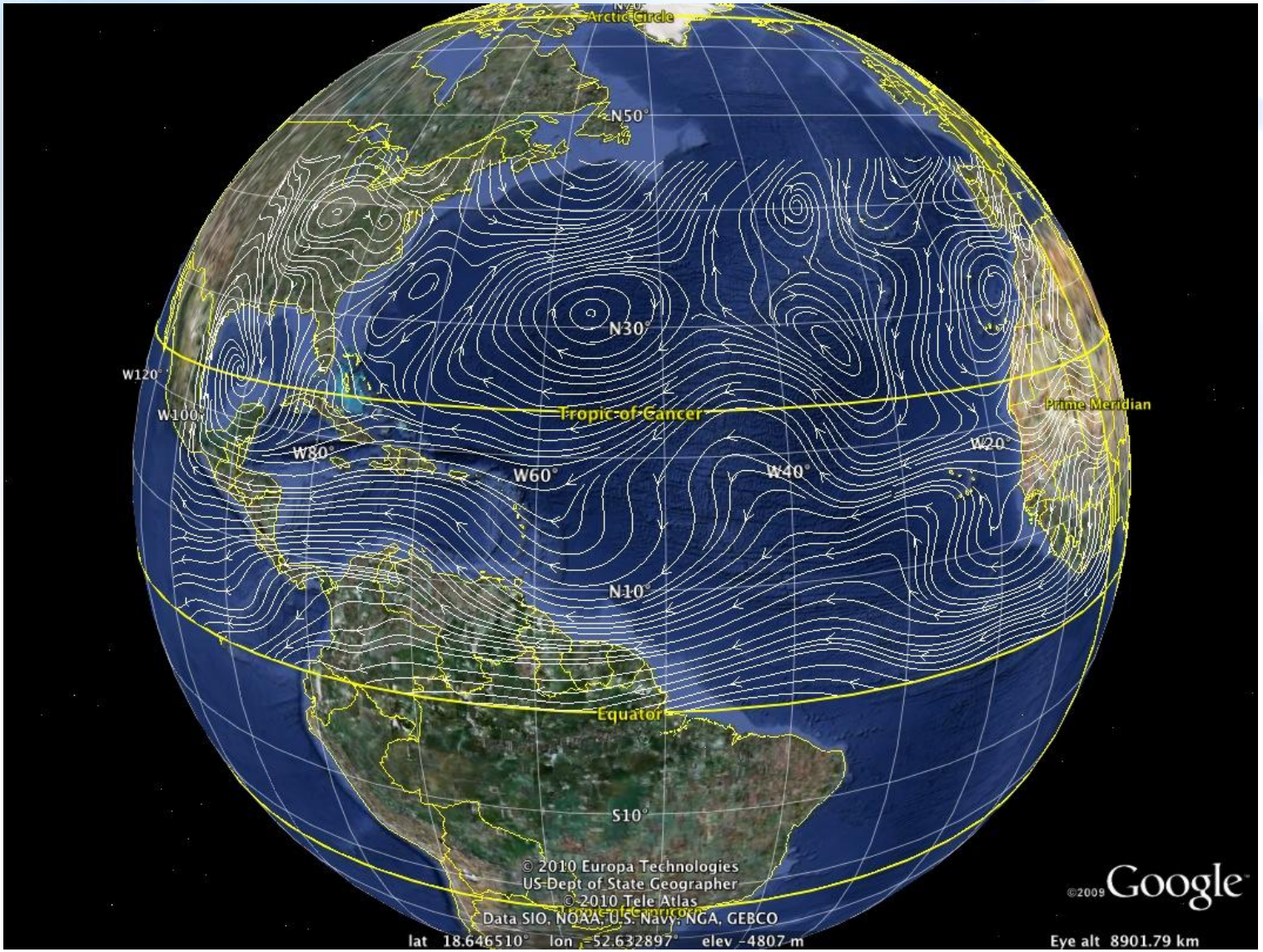


JPL

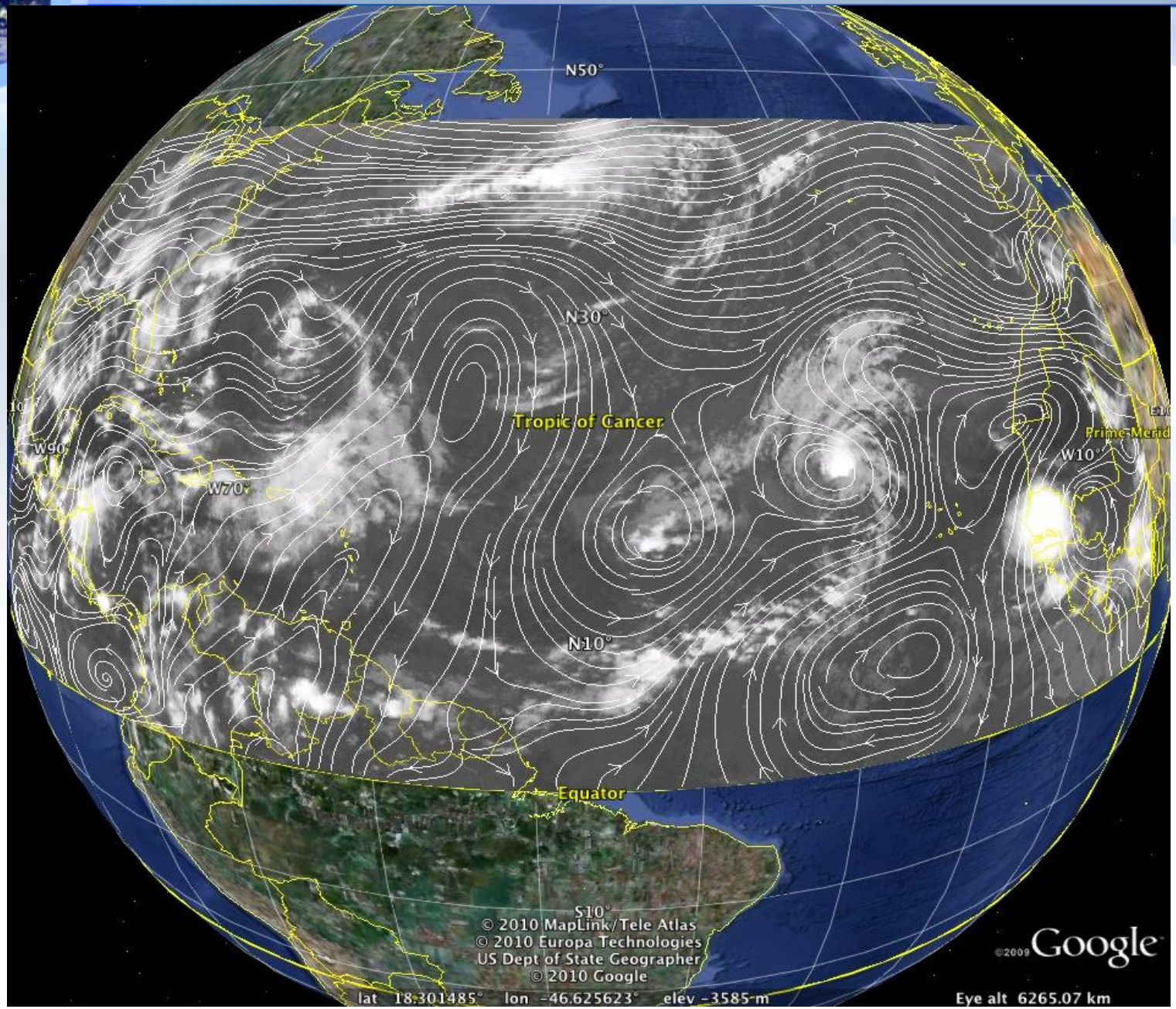
GRIP

Coming soon – MODEL DATA - 700mb Earth-relative

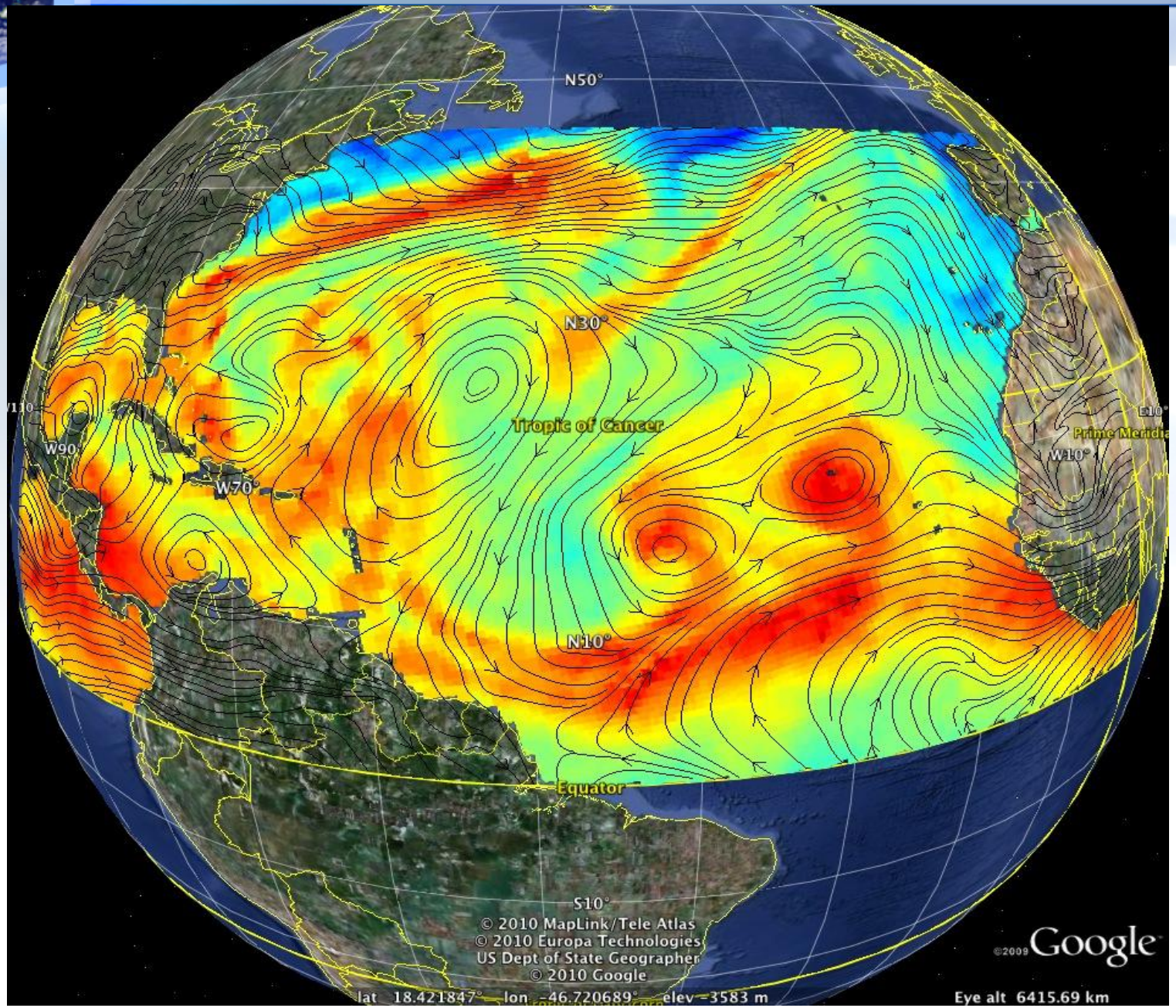
http://grip.jpl.nasa.gov

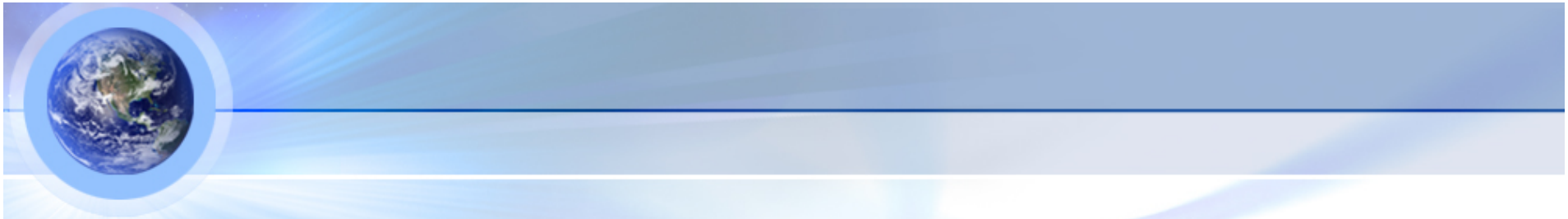


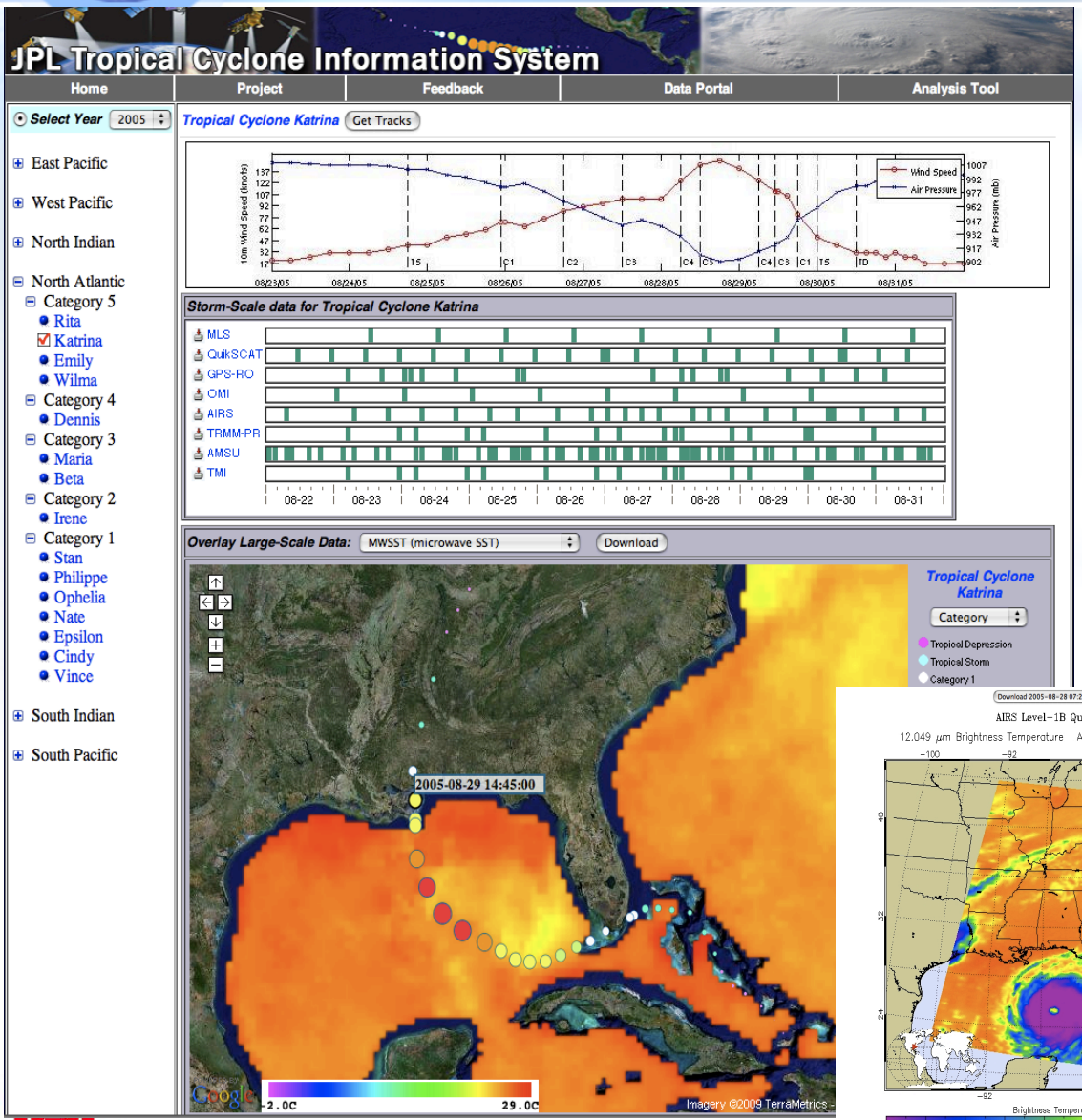
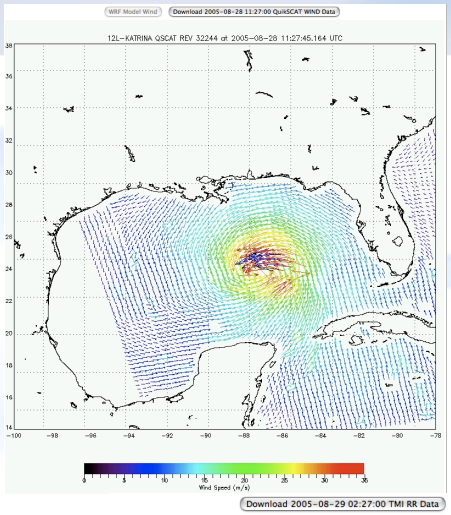
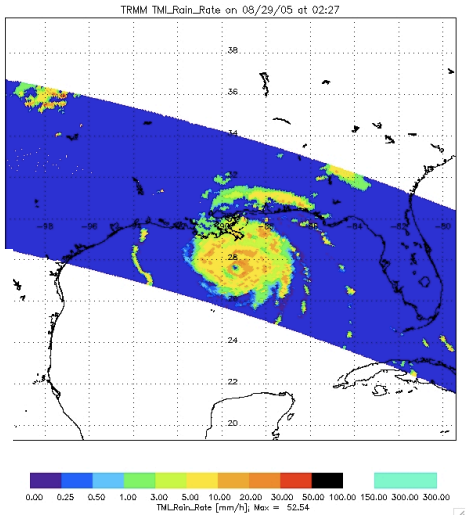
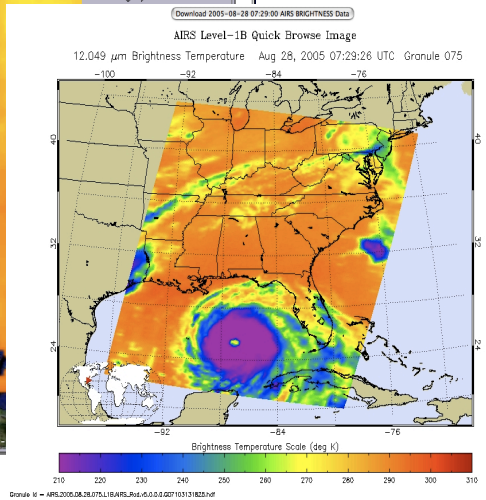
Coming soon – MODEL DATA - 700mb Co-moving



Coming soon – MODEL DATA - 925mb Co-moving





GRIP

Tropical Cyclone Data Portal – Current Status