

# 3D Online Visualization and Synergy of NASA A-Train Data using Google Earth

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NASA/GES DISC ATDD Portal

<http://disc.gsfc.nasa.gov/atdd>

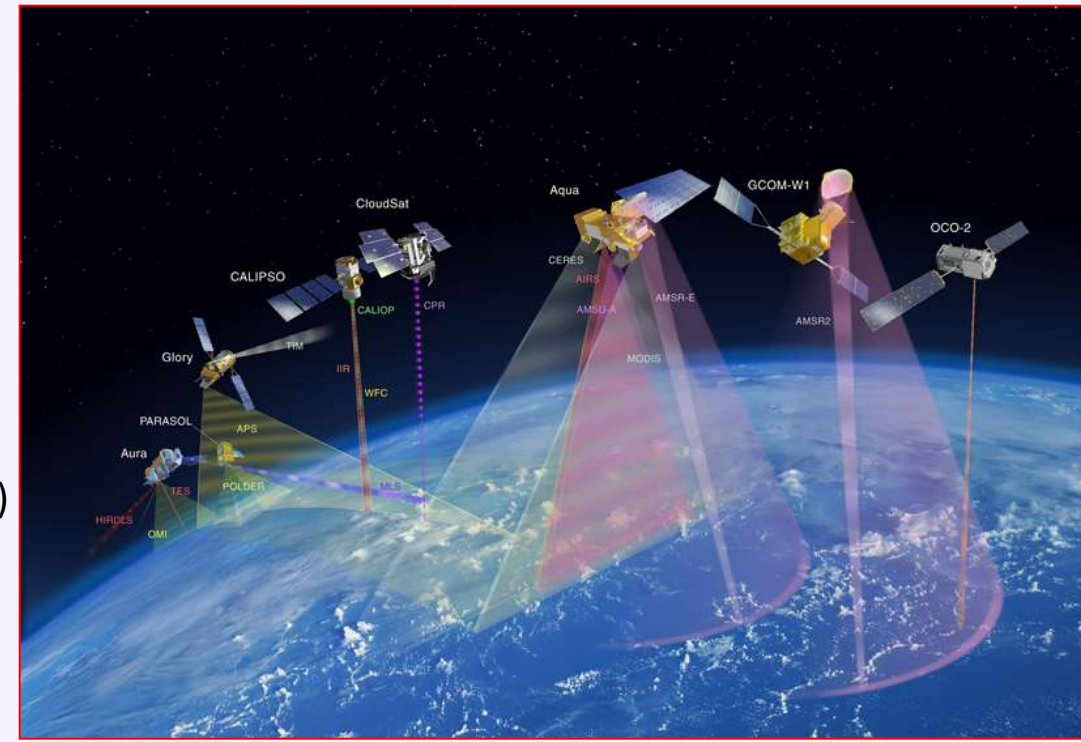
NASA/GES DISC Google Earth Portal

<http://disc.gsfc.nasa.gov/googlearth/>

## NASA A-Train Constellation Formation

The NASA Afternoon A-Train Satellite Constellation is a succession of seven US & international sun-synchronous orbit satellites, consisting of:

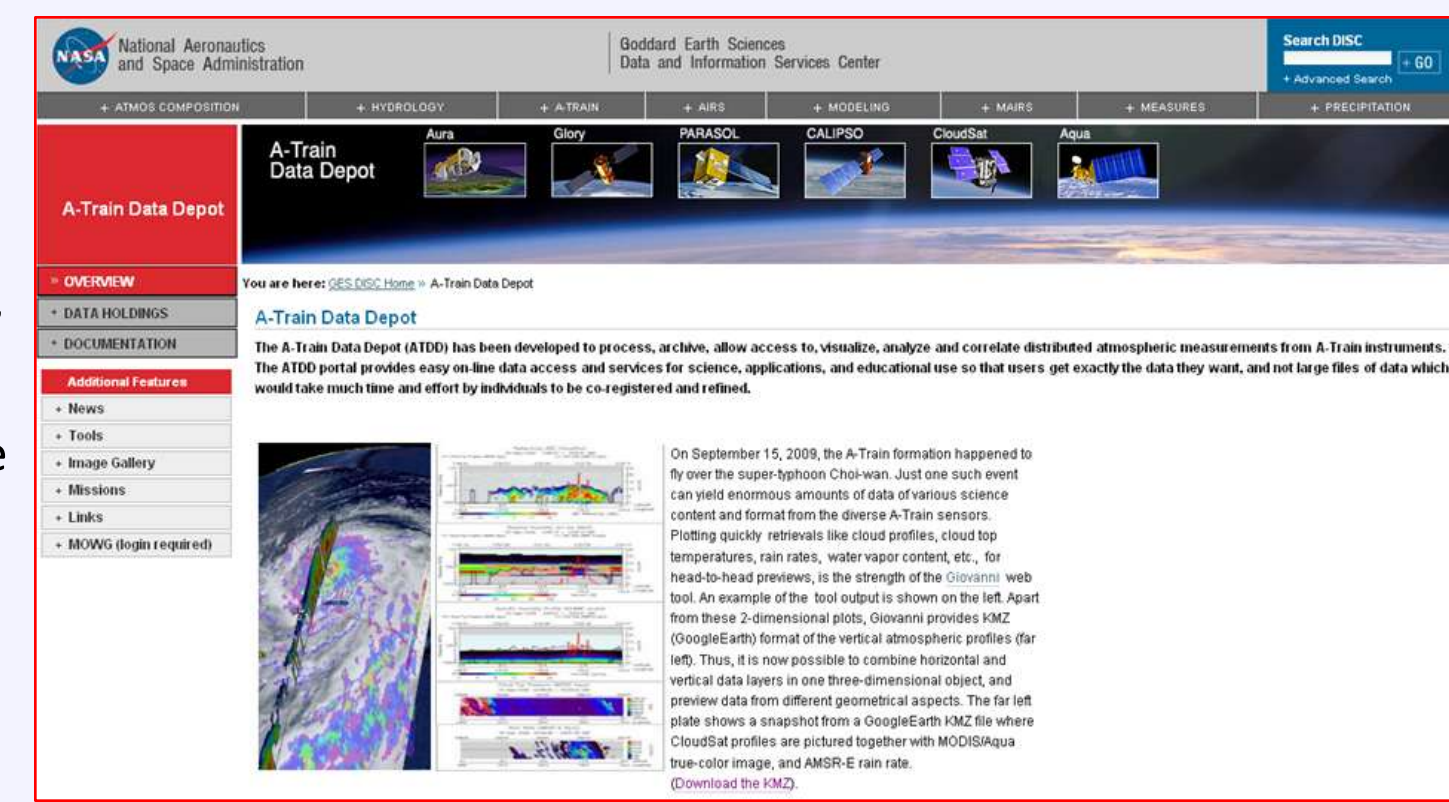
- COO-2 (Orbiting Carbon Observatory) (will launch in Feb. 2013);
- GCOM-W1 (Global Change Observation Mission);
- Aqua;
- CloudSat;
- CALIPSO (Cloud-Aerosol Lidar & Infrared Pathfinder Satellite Observations)
- Glory (launched on Nov. 22, 2010 2:30am PST);
- Aura.



The A-Train makes possible synergy of information from multiple resources, so more information about earth condition is obtained from the combined observations than would be possible from the sum of the observations taken independently.

## NASA Goddard A-Train Data Depot (ATDD)

The A-Train Data Depot (ATDD) -- <http://disc.gsfc.nasa.gov/atdd> processes, archives, allows access to, and visualizes distributed atmospheric measurements from various A-Train sensors, for analysis and correlation.



The ATDD Portal (right) provides easy on-line data access and services for science, applications, and educational use so that users easily get exactly the data they want, with no need to download large volumes of whole data sets.

**A-Train Data Depot**  
A-Train Constellation Community  
Science Investigators

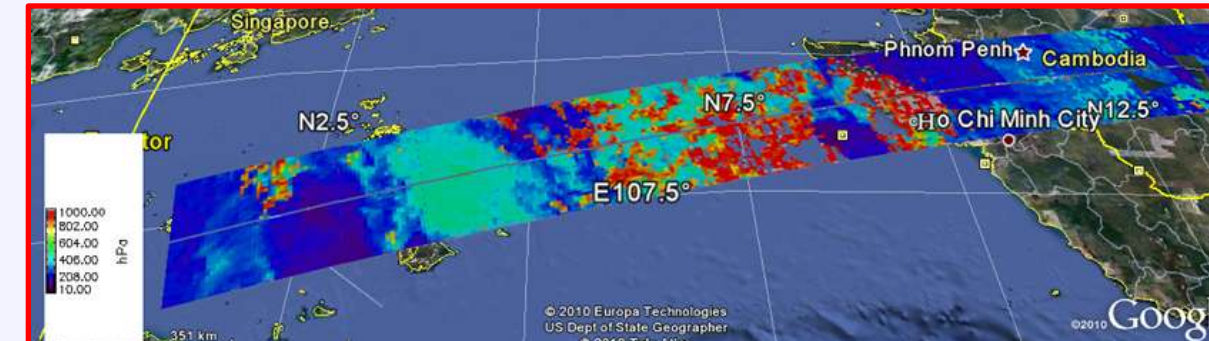
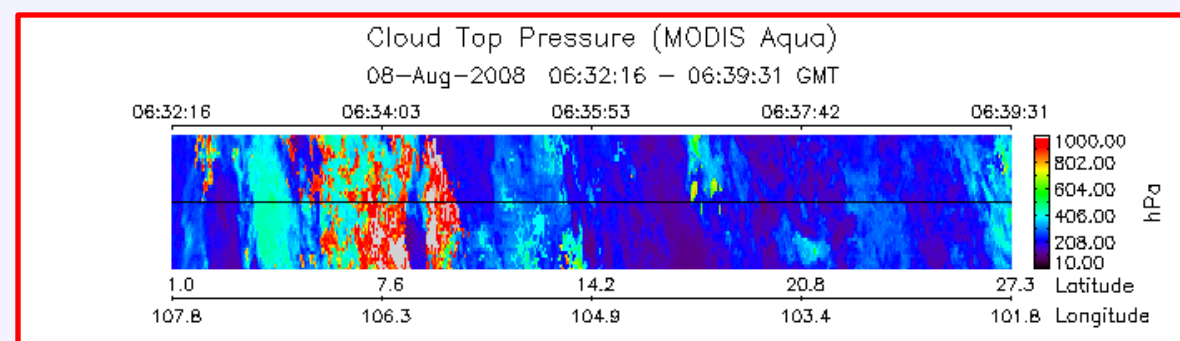
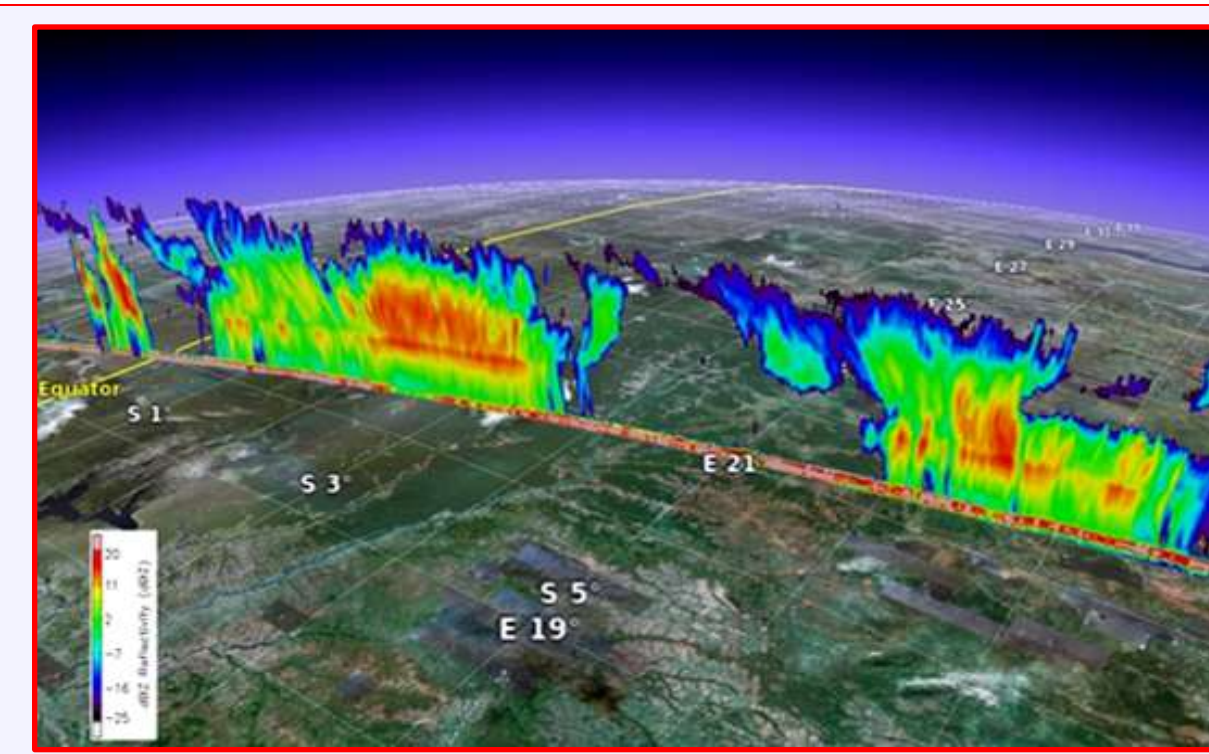
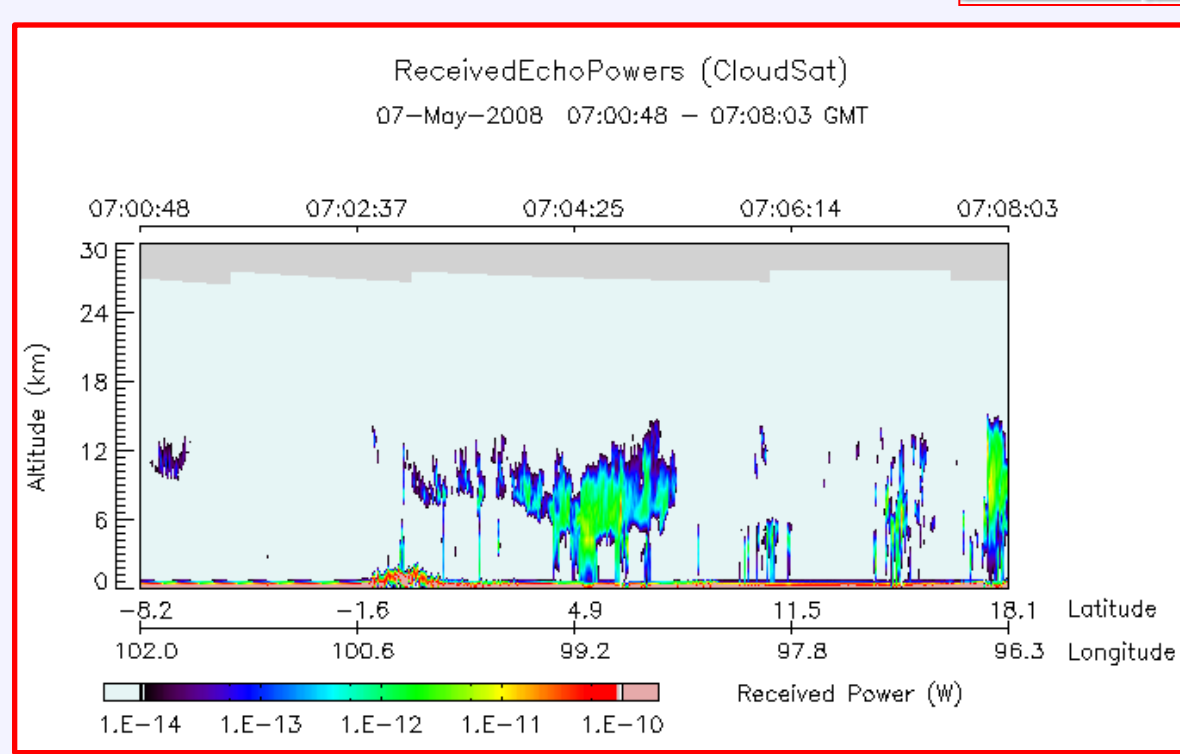
- Links to all A-Train datasets from one portal: full and subsetted datasets archived locally, downloaded via ftp.
- Subsets, archives and makes accessible parameters in HDF.
- HDF read programs work for ATDD generated parameter subsets.
- Users can dynamically specify and acquire subsetted data swaths.
- Allows users to co-register dataset parameters that have different formats, resolutions, and scales.
- Using Giovanni, provides quick dynamic visualization and exploration of data from different instruments to determine the desirability of the data prior to their downloading.
- Provides online multiple data products comparison and analysis in multiple Google Earth windows.
- Provides easy downloading of co-registered data and multiple downloadable files.

MODIS & OMI co-location w/ CloudSat & CALIPSO  
S4PM  
Archive S4PA  
Mirador Search  
CloudSat and CALIPSO Science Teams

## A-Train Data online analysis and visualization system

Right: A-Train data online analysis and visualization system web interface:

Giovanni Version 3 (G3) adopts service- and workflow-oriented asynchronous architecture and uses standard protocols, such as FTP, OPENDAP, GrADS Data Server to transparently access local and remote data. Service-Oriented Architecture guarantees that data processing and rendering modules are implemented through standard web services.



Above: 3D Vertical profiles of cloud from CloudSat satellite and 2D swath data of Cloud Top Pressure from MODIS/Aqua were rendered by G3 A-Train instance.

Above: 3D Vertical profiles of cloud from CloudSat satellite and 2D swath data of Cloud Top Pressure from MODIS/Aqua are visualized in Google Earth after processing and rendering by G3 A-Train instance.

## Integrating Google Earth Plug-in into Giovanni A-Train Instance

Web Interface Design for integrating A-Train Data Depot with Google Earth Plug-in

The interface is based on AJAX technology, and mainly consists of: (see left figure)

Design principles followed:

- o Web-based, no need to open new third vendors' application /windows
- o Seamlessly integrated into A-Train instance
- o Making interfaces between Giovanni infrastructure and Google Earth "new stuff" as simple as possible
- o Uniform interface as A-Train instance

Functions added and processes for user request  
a. Add new tab "View in Google Earth" in A-Train instance interface for user viewing and comparing multiple parameters in multiple Google Earth windows in one browser.

```
<dataset scope="Curians">
  <datatype>
    <sensorName>MODIS Aqua</sensorName>
    <datasetName>MAC07S0.002</datasetName>
    <shortName>MAC07S0</shortName>
    <version>2</version>
  </dataset>
  <url>
    http://gcmd.gsfc.nasa.gov/getd4f.htm?GES_DISC_MAC07S0_v2
  </url>
  <parameterSet></parameterSet>
  <dataset>
    <datatype>
      <sensorName>AIRS Aqua</sensorName>
      <datasetName>AIRXRET.005</datasetName>
      <shortName>AIRXRET</shortName>
      <version>5</version>
    </dataset>
    <url>
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    </url>
    <parameterSet></parameterSet>
    <dataset>
      <datatype>
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        <datasetName>VFM.002</datasetName>
      </datatype>
    </dataset>
  </dataset>
```

SciFlow XML from A-Train

### Integrating Mediator

- Parse SciFlow XML file
- Invoke KMZ generator
- Create & update JSON file based on available KMZ files

```
{
  "items": [
    {
      "source": "section/Vertical Profiles",
      "name": "A-Train Vertical & Strips Profiles",
      "children": [
        {
          "source": "MODIS Aqua",
          "name": "MODIS Aqua",
          "children": [
            {
              "source": "http://gdal1-tsl.sci.gsfc.nasa.gov/daac-bin/G3/kmz_wrapper.cgi?filePathName=/ftp/soomring/G3/TSI/w/129164191316130/kmz_11_0/20101106_06_Retrieved_Temperature_Profile-MODIS_Aqua",
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              "children": [
                {
                  "source": "http://gdal1-tsl.sci.gsfc.nasa.gov/daac-bin/G3/kmz_wrapper.cgi?filePathName=/ftp/soomring/G3/TSI/w/129164191316130/kmz_11_0/20101106_06_Retrieved_Temperature_Profile-MODIS_Aqua",
                  "name": "Cloud Optical Thickness-MODIS Aqua",
                  "children": [
                    {
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                      "name": "Cloud Top Pressure-AIRS Aqua",
                      "children": [
                        {
                          "source": "http://disc.gsfc.nasa.gov/daac-bin/G3/kmz_wrapper.cgi?filePathName=/ftp/soomring/G3/TSI/w/129164191316130/kmz_11_0/20101106_06_Retrieved_Temperature_Profile-MODIS_Aqua",
                          "name": "CloudSat",
                          "children": [
                            {
                              "source": "http://disc.gsfc.nasa.gov/daac-bin/G3/kmz_wrapper.cgi?filePathName=/ftp/soomring/G3/TSI/w/129164191316130/kmz_11_0/20101106_06_Retrieved_Temperature_Profile-MODIS_Aqua",
                              "name": "CloudSat",
                              "children": [
                                {
                                  "source": "http://disc.gsfc.nasa.gov/daac-bin/G3/kmz_wrapper.cgi?filePathName=/ftp/soomring/G3/TSI/w/129164191316130/kmz_11_0/20101106_06_Retrieved_Temperature_Profile-MODIS_Aqua",
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                                        {
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                                                            {
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                                                                      "children": [
                                                                        {
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                                                                            {
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  ]
}
```

- b. New function for automatically analyzing workflow XML file from A-Train to obtain details of the data that user selected, e.g. sensorName, datasetName, etc.
- c. KMZ generator is invoked to produce KMZ files for each data user selected
- d. Create and dynamically update JSON file based on produced KMZ files.
- e. Utilize AJAX to automatically update the control panel based on updated JSON file for user-selected data of interest.
- f. Track user operations to display data in multiple Google Earth window.

### A-Train Data Collocated Along the CloudSat Track

CloudSat, MLS, CALIPSO lidar, and coregistered MODIS/Aqua, AIRS, AMSR-E, OMI, POLDER/PARASOL, ECMWF, and MERRA data.

Display Control Panel

- MODIS Aqua
  - Atmospheric T
  - Cloud Optical T
  - Cloud Top Pres
- AIRS Aqua
  - Atmospheric Te
  - Cloud Top Pres
- CloudSat
  - ReceivedEchoP
  - Profile-AIRS Aqua
  - Cloud Top Pressure-AIRS Aqua
  - Reflectivity dBZ
  - Rain Rate-AMS

## URL for A-Train system with new functions and simple example

[http://gdata1-ts1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance\\_id=atrain](http://gdata1-ts1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=atrain)

Visualize and compare A-Train data:

Vertical profile for Cloud/Aerosol Classification (Vertical Feature Mask) from Clipo-Lidar and horizontal strip for Cloud Top Pressure from MODIS/Aqua

A-Train Along CloudSat Track Instance

## Online visualize and compare multiple data in multiple GE

A-Train Data Depot Tab menu including the tab of "View in Google Earth"

A-Train Data Depot Caption

3D visualization of A-Train data for science -- 1

Vertical profile for RO (Radar Only) Ice Water Content from CloudSat is compared with horizontal strip for Total Cloud Liquid Water from AIRS/Aqua to reflect the relationship between these two kinds of data

Visualize and compare A-Train data in multiple Google Earth windows in one browser:

Any vertical profiles and horizontal strips from A-Train Data Depot can be visualized in four Google Earth windows allowing comparison of related data parameters at the same time

Above: Comparison of versatile 2D and 3D data from A-Train sensors in multi-GE windows of one browser window

Above: Comparison of Atmospheric Temperature Profiles from ECMWF model, MLS, MODIS/Aqua and AIRS/Aqua in multi-GE windows.

## Synergy and visually comparison of ATDD data with other data in GE

Right: March 9, 2009 Atmospheric Temperature Profile (3D) from MODIS/Aqua & Cloud Top Pressure 2D surface strips from MODIS/Aqua

Left: Typhoon Prapiroon GMT 5:48:00am -- 5:55:00am 2006-08-02 Vertical orbit curtain describing cloud vertical structure (Radar Reflectivity, dBZ) derived from CloudSat satellite, and daily rainfall (3B42) from TRMM satellite, and wind field from QuikSCAT satellite

## Future work: Combining other data with A-Train data in GE

Future work holds out the possibility of intercomparing A-Train and non-A-Train data using multiple window Google Earth interface. Ultimately the interface could also be used for downloading the visualized data to the user's computer.

MODIS fire pixel counts of Oct 2004: The forest fire broke out on Oct. 14 2004 afternoon in Heihe, Heilongjiang, China, lasted for about 6 days. Comparison of averaged UV aerosol index, N2O from OMI, and CO from AIRS for Oct 13-16 2004 in Google Earth (right).

2D surface swath data and 3D vertical profiles from A-Train sensors are comparing with global rain rate from TRMM sensor.

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