**WHAT IS THE A-TRAIN?**

NASA and its international partners operate several Earth-observing satellites that closely follow one after another along the same orbital "track." This coordinated group of satellites, constituting a significant subset of NASA's current operating major satellite missions, is called the Afternoon Constellation, or the A-Train, for short. The satellites are in a polar orbit, crossing the equator at about 1:30 p.m. local time, within seconds to minutes of each other. This allows near-simultaneous observations of a wide variety of parameters to aid the scientific community in advancing our knowledge of Earth System Science and applying this knowledge for the benefit of society.

**Clouds and Weather**

An image of Hurricane Bill as seen from the MODIS instrument (flying on Aqua) with cloud heights from the CALIOP lidar (on CALIPSO) on August 19, 2009. Superimposed over the MODIS image is the polarized reflected sunlight observed by POLDER (on PARASOL).

**Net Radiation**

The above map shows net top-of-atmosphere radiation (difference between absorbed sunlight and emitted outgoing longwave radiation) from the Aqua/CERES instrument for July 2010. Positive values, indicating net warming, are found in the summertime (Northern Hemisphere). This is an example of synergy between A-Train instruments as CERES makes use of MODIS aerosol and cloud retrievals that are informed by CALIPSO and CloudSat observations.

**Sea Ice**

Images from Aqua of East Greenland, March 27, 2010. A MODIS image (upper left) shows glacial and snow cover on land, and sea ice (blue) in the coastal, low-salinity temperature (4°C), defined from MODIS (upper right), increases roughly with decreasing sea ice concentration, derived from AMSR-E (lower right), towards the ice-water boundary.

**Clouds and Weather**

Tropical Storm Debby crossed the Central Atlantic on August 24, 2006 and was observed by four different A-Train instruments: Aqua/MODIS (in gray) shows an overview of the storm; Aqua/AIRS water vapor mixing ratio data are superimposed; and CloudSat's radar (CPR) and CALIPSO's lidar (CALIOP) show different types of information on a vertical slice through the storm's center.

**Atmospheric Chemistry**

On May 5, 2010, Aura/OMI observed a sulfur dioxide (SO2) plume from the eruption of Iceland's Eyjafjallajökull volcano. Such a plume is an indicator of fresh volcanic ash clouds.

**Aerosols**

An aerosol-laden ash plume from the Eyjafjallajökull volcano in Iceland was observed from Aqua/MODIS (top image) and CALIPSO/CALIOP (bottom image) on May 16, 2010.
Taking the A-Train

A constellation like the A-Train is composed of a number of satellites following one another along a "track" in space. While they aren’t literally connected like railroad cars, precise engineering and planning—called constellation flying—allows for them to function as if they were "connected." Constellation flying allows the instruments on all of the A-Train satellites to function as if they were on a large platform together. This means that scientists can use instruments on several different satellites in the constellation to study a particular atmospheric phenomenon of interest—e.g., clouds, aerosols, going through a large storm front, detecting volcanic ash, etc.—and learn more than they could have with any one satellite by itself.

Combining data from these satellites enables scientists to gain a better understanding of a variety of Earth-system processes, including those relevant to climate. Data collected synchronously gives more-complete answers to important scientific questions that would be possible with satellite data collected at different times.

The Benefits of Constellation Flying

The A-Train is a series of satellites flying near each other, in order for multiple instruments to observe effects on the entire Earth system. By flying as a coordinated constellation, the satellites can work in concert to observe and study the planet below. This calls for ongoing coordinated maneuvering of the spacecrafts to keep them in a tight configuration. This means that scientists can use instruments on all of the satellites in the constellation to observe a single target. The overlapping footprints of constellation flying of multiple satellites enables us to observe the same location or event within a short time period.

With this configuration, the satellites can maintain their position relative to Aqua. It must also maneuver independently to preserve its position no more than 15 seconds ahead of CALIPSO. At the same time, other scientific missions, such as those by NASA, the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt), the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), the Japan Aerospace Exploration Agency (JAXA), and the Canadian Centre for Meteorological and Atmospheric Research (CCMAR), are using A-Train instruments to better understand Earth’s climate system.

The constellation configuration is a key feature of the A-Train. In order for the instruments on the A-Train satellites to be able to observe the same area of Earth simultaneously, all of the satellites must be within a certain distance of each other. This distance varies depending on the science goals of the mission and the specific instruments involved. For example, the Constellation A-Train Data Depot (ATDD) provides easy on-line data access and services for science, applications, and educational use, so that users can obtain Level-1 and higher-order products. Details are available at the mission and/or instrument web sites. In addition, cross-instrument A-Train data distribution involves coordination with other missions, such as the Global Carbon Observing System (GCOS), which shares data with the A-Train to enable coordinated observations of Earth's climate.

The Instruments on Board

The A-Train platforms and their instrumented spacecrafts described below work together to produce a comprehensive picture of the Earth’s system. They are sensitive to different wavelengths of light and are designed to observe different parts of the spectrum. These instruments provide a variety of different wavelengths and polarizations that allow them to explore different scientific questions and even more accurately measure the Earth’s climate system.

In contrast, CloudSat and CALIPSO’s radar and CAMS are active instruments that emit a short pulse of energy and reflect it back off a target. Each instrument detects radiation in one or more spectral bands of the spectrum. These bands are mutually exclusive for the sake of clarity and are selected for their scientific importance.

Satellite table:

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqua</td>
<td>MODerate-resolution Imaging Spectrometer (MODIS)</td>
</tr>
<tr>
<td>CALIPSO</td>
<td>Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIOP)</td>
</tr>
<tr>
<td>GCOM-W1</td>
<td>Global Change Observation Mission (GCOM-W1)</td>
</tr>
<tr>
<td>IASI</td>
<td>Infrared Atmospheric Sounding Interferometer (IASI)</td>
</tr>
<tr>
<td>IIR</td>
<td>Infrared Interferometer</td>
</tr>
</tbody>
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