

#### #4 – Active Particulate Sensors

Kim Wood, ATMO 656b

*Agency information, etc.*

TRMM, CALIPSO, and CloudSat are NASA missions; TRMM is joint with JAXA, CALIPSO is joint with CNES, and CloudSat is joint with the Canadian Space Agency. Note that TRMM was “boosted” from 350km to 403km in 2001; instrument resolution changed as a result.

Additionally, much of the TRMM instruments' data is used in conjunction with each other to address particular questions or issues. See second page for definition of most of the acronyms used in these tables.

#### *Mission orbital parameters*

| Mission  | Purpose                                 | Precession rate | Orbit radius | ascending node time | Inclination           | Repeat time      |
|----------|---|-----------------|--------------|---------------------|-----------------------|------------------|
| TRMM     | measure tropical & subtropical rainfall | ~46 days        | 403km        | changes every orbit | 35 degrees to equator | 16 orbits/day    |
| CALIPSO  | actively measure aerosols & clouds      | sun-synchronous | 705km        | equator at 13:30    | 98.2 degrees          | 14.55 orbits/day |
| CloudSat | measure altitude & properties of clouds | sun-synchronous | 705km        | equator at 13:30    | 98.2 degrees          | 14.55 orbits/day |

#### *TRMM instruments*

| Inst. Name | Purpose  | Wavelength range               | # of Channels | Channel center line                                 | Spectral resolution | Horizontal swath | Horizontal resolution | Vertical resolution | Launch & end dates             |
|------------|--|--------------------------------|---------------|---|---------------------|------------------|-----------------------|---------------------|--------------------------------|
| PR         | scans 3D storm structure maps  | N/A                            | 1             | 13.8 GHz  | N/A                 | 247km            | 5km                   | 250m                | Nov 27 1997<br>3 year lifetime |
| TMI        | Rainfall rates over oceans; associated latent heating                            | N/A                            | 9             | 10.7, 19.4, 22.2, 37, 85.5 GHz*                     | N/A                 | 760km            | 5-45km                | 4km                 |                                |
| VIRS       | Measure terrestrial radiation (from clouds or surface)<br>Estimate precipitation | N/A                            | 5             | Vis: 0.63µm<br>SWIR: 1.6, 3.75µm<br>TIR: 10.8, 12µm | N/A                 | 833km            | 2.4km                 | N/A                 |                                |
| CERES      | Radiative energy budget<br>Role of clouds on earth's energy balance              | 0.3-5µm<br>8-12µm<br>0.3-200µm | 3             | ?<br>10µm?<br>?                                     | N/A                 | full earth       | 25km                  | N/A                 |                                |
| LIS        | detect distribution & variability of total lightning occurrences                 | 1nm                            | 1             | 777.4nm   | N/A                 | 600km            | 5km                   | N/A                 |                                |

\* all channels but 22.2GHz have dual polarization for a total of 9 channels on the TMI instrument

#### *CloudSat instrument*

| Instr. Name | purpose   | Wavelength range | # of Channels | Channel center line | Spectral resolution | Horizontal swath | Horizontal resolution | Vertical resolution | Launch & end dates               |
|-------------|---|------------------|---------------|---------------------|---------------------|------------------|-----------------------|---------------------|----------------------------------|
| CPR         | cloud profile info, liquid/ice water content profiles, precip | N/A              | 1             | 94GHz               | N/A                 | 1.1km            | 1.4-1.7km             | 500m                | Apr 28 2006<br>2-3 year lifetime |

### *CALIPSO instruments*

| Instr. Name | purpose  | Wavelength range | # of Channels | Channel center line | Spectral resolution | Horizontal swath | Horizontal resolution | Vertical resolution | Launch & end dates             |
|-------------|--|------------------|---------------|---------------------|---------------------|------------------|-----------------------|---------------------|--------------------------------|
| CALIOP      | Lidar instrument giving cloud profile info, cirrus optical depth, aerosol profiles | N/A              | 3             | 532 (2)*, 1064 nm   | N/A                 | 130 mrad (90m)   | 333m                  | 30-60m              | Apr 28 2006<br>3 year lifetime |
| IIR         | cirrus cloud optical properties  | N/A              | 3             | 8.65, 10.6, 12.0µm  | 0.9, 0.6, 1.0 µm    | 64km             | 1km                   | N/A                 |                                |
| WFC         | measure radiance/reflectance   | 620-670 nm       | 1             | 645 nm              | 50nm                | 61km             | 125m-1km              | N/A                 |                                |

\* there are two 532nm channels on CALIOP to measure two orthogonal polarization components at that wavelength

### *Acronyms*

TRMM: *Tropical Rainfall Measuring Mission*  
 PR – Precipitation Radar  
 TMI – TRMM Microwave Imager  
 VIRS – Visible and InfraRed Scanner  
 CERES – Cloud and Earth Radiant Energy Sensor  
 LIS – Lightning Imaging Sensor

CALIPSO: *Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation*  
 CALIOP – Cloud-Aerosol Lidar with Orthogonal Polarization  
 IIR – Imaging Infrared Radiometer  
 WFC – Wide Field Camera

CloudSat: CPR – Cloud Profiling Radar

### *Useful web sites*

TRMM: <http://disc.sci.gsfc.nasa.gov/TRMM/index.shtml>  
<http://trmm.gsfc.nasa.gov/>  
[http://www.eorc.jaxa.jp/TRMM/about/mechanism/main\\_e.htm](http://www.eorc.jaxa.jp/TRMM/about/mechanism/main_e.htm)  
<http://lba.cptec.inpe.br/lba/eng/trmm/doctrmmi.html>

CALIPSO: [http://www.nasa.gov/mission\\_pages/calipso/spacecraft/index.html](http://www.nasa.gov/mission_pages/calipso/spacecraft/index.html)  
<http://www-calipso.larc.nasa.gov/about/>  
[http://smc.cnes.fr/CALIPSO/GP\\_satellite.htm](http://smc.cnes.fr/CALIPSO/GP_satellite.htm)

CloudSat: <http://cloudsat.atmos.colostate.edu/overview>  
[http://www.nasa.gov/mission\\_pages/cloudsat/spacecraft/index.html](http://www.nasa.gov/mission_pages/cloudsat/spacecraft/index.html)

### *Disclaimer*

Many of the available mission web sites (even across NASA web pages), especially those for TRMM, have conflicting numbers for horizontal resolution, channel center values, etc. Thus some of the listed parameters may be different than what a particular web page lists for an instrument. For TRMM, at least, this is likely due in part to the “TRMM boost”; measurement parameters such as horizontal resolution would inevitably change between the 350km and 403km orbits.