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Meteorological Support for TGF Data Characterization
Meaning of “Convection”
...and cloud electrification
... a nice photo from airplane

Source: http://eoimages.gsfc.nasa.gov
International Space Station Photograph Of A Thunderstorm With An Overshooting Top Over The Ivory Coast, 5 February 2008
VIS-IR Observations

When the sky is clear the satellite sees radiation from the earth’s surface.

When clouds are present in the column the satellite sees radiation from the tops of the highest level cloud.

Clouds absorb all of the emitted IR radiation beneath them.

Source: http://learningweather.psu.edu/
Vis-IR Refractive Index

Graph showing the imaginary refractive index and absorption for water and ice as a function of wavelength in micrometers.
MW Refractive Index
GEO- LEO

GEOSYNCHRONOUS EARTH ORBIT (GEO) SATELLITES

LOW EARTH ORBIT (LEO) SATELLITES
METEOSAT SECOND GENERATION (1)
METEOSAT SECOND GENERATION (2)

Spinning Enhanced Visible and Infrared Imager (SEVIRI).

<table>
<thead>
<tr>
<th>Channel</th>
<th>USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6 and 0.8 μm</td>
<td>Cloud detection, scene identification, cloud tracking, aerosol observation, vegetation monitoring. Heritage from AVHRR</td>
</tr>
<tr>
<td>1.6 μm</td>
<td>Discriminates between snow and cloud, ice and water clouds. Aerosol information. Heritage from ATS-R</td>
</tr>
<tr>
<td>3.9 μm</td>
<td>Low cloud and fog detection. Measurement of land and sea surface temperature at night. Spectral band broadened towards higher wavelength to improve signal-to-noise ratio. Heritage from AVHRR</td>
</tr>
<tr>
<td>6.2 and 7.3 μm</td>
<td>Upper- and mid-tropospheric water vapour. Cloud and water vapour tracking. Height allocation of semitransparent clouds</td>
</tr>
<tr>
<td>8.7 μm</td>
<td>Quantitative information of thin cirrus clouds. Discriminates between ice and water clouds. Heritage from HIRS</td>
</tr>
<tr>
<td>9.7 μm</td>
<td>Ozone radiance as input to NWP. Experimental channel used for tracking ozone patterns representative of wind motion in the lower stratosphere. Monitoring of evolution of total ozone field</td>
</tr>
<tr>
<td>10.8 and 12.0 μm</td>
<td>Measurement of earth surface and cloud top temperatures. Detection of cirrus and inference of total precipitable WV over sea.</td>
</tr>
<tr>
<td>13.4 μm</td>
<td>Split window channels from AVHRR. Improvement of height determination of transmissive cirrus clouds. Temperature information from lower troposphere (cloud free areas) for instability assessment. Known from GOES VAS instrument.</td>
</tr>
</tbody>
</table>

broadband HRV (High Resolution Visible)
Overshooting Tops

Overshooting top: a domelike protusion above a cumulonimbus anvil, representing the intrusion of an updraft through its equilibrium level (level of neutral buoyancy) (AMS Glossary definition)

- Two concepts of the upper part of the updraft:
  - Series of individual “bubbles” → short lived overshooting tops (5-15 minutes)
  - Quasi-steady continuous flow → elevated dome-like structure (large and persistent overshooting top) above the updraft area, with a lifetime of tens of minutes up to 60-100 minutes.

- General characteristics of satellite observed overshooting tops:
  - Horizontal size: 5-15 km
  - Vertical extent: 2-3 km
General appearance of overshooting tops in satellite imagery

- A - overshooting top
- B - gravity waves on the anvil top
- C - semitransparent part of the anvil
- D - cold-U shape

NOAA-15 2006-06-25 16:08 UTC
RGB composite of AVHRR bands 1, 2 and 4 (left) and color-enhanced AVHRR band 4 (right)
Observation of Convection Techniques 1: Color enhancement

Day and Night
High rate of False Alarms

Day Only
High rate of False Alarms

Large Ice particles

Day Only
Small Rate of False Alarms
Observation of Convection techniques 4: Severe Storm RGB

MSG – SEVIRI 2015/04/12 12:00

Day Only
Small Rate of False Alarms

Red = WV6.2 – WV7.3  
Green = IR3.9 – IR10.8  
Blue = NIR1.6 – VIS0.6

-35 to +5K  
-5 to +60K  
-75 to +25%

Strong Convective Cells
Observation of Convection techniques 5: Global Convection Diagnostic (GCD)

GCD is a binary index of deep, moist convection (Mosher 2002). It has been created to meet the needs of the aviation community for current information on thunderstorm over remote areas.

It operates on water vapor (6.25 μm) and thermal infrared (10.8 μm) image pairs from SEVIRI.

At a pixel:

IF: | $T_{ir} - T_{wv}$ | < 1°C, THEN
GCD declares the pixel “deep convective”
OTHERWISE, it remains “not deep convective.”

Day and Night
Small Rate of False Alarms

• Mosher, F. "Detection of deep convection around the globe." *Preprints, 10th Conference on Aviation, Range, and Aerospace Meteorology.* 2002.
The EUMETCAST Service

EUMETCast is EUMETSAT’s primary dissemination mechanism for the near real-time delivery of satellite data and products.

What is EUMETCast?

EUMETCast is a multi-service dissemination system based on standard Digital Video Broadcast (DVB) technology. It uses commercial telecommunication geostationary satellites to multi-cast files (data and products) to a wide user community. EUMETCast also delivers a range of third-party products.

EUMETCAST FEATURES

Secure delivery allows multicasts to be targeted to a specific user or group of users.

Use of DVB turnarounds allows the easy extension of geographical coverage.

Use of off-the-shelf, commercially available, DVB reception equipment.

Highly scalable system architecture.

Three EUMETCast services are available covering Europe, Africa and South America.

http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast/index.html
Data Processing Chain – step #1

Eumetsat → Eumetcast System (Near Real Time) → ISAC-CNR (Tor Vergata)

Dissemination of licenced products

Geostationary Satellites

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Detail</th>
<th>Timeliness</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSG Meteosat Second Generation</td>
<td>Meteosat 10 (MSG3) Longitude: 0°</td>
<td>15 min.</td>
</tr>
<tr>
<td>MTSAT Himawari (Multifunction Transport Satellite)</td>
<td>Himawari-7 Longitude: 145°E</td>
<td>30 Min.</td>
</tr>
<tr>
<td>FY FengYun Meteorological Satellites</td>
<td>FY-2D Longitude: 86.5°E, FY-2E Longitude: 105°E</td>
<td>30 Min.</td>
</tr>
</tbody>
</table>
Data Processing Chain – Step #2

- Receiving the data stream on multiple channels
- Products identification (PID) procedure
- Detection of transmission errors
- Decryption of correctly transmitted data (licenced products)

Processing Server

- Indexing of products for processing (based on data timeliness)
- Decompressing of selected data channels (for the GCD)
- Cropping data over the area of interest
- Data conversion (to simplify the storage procedure)
- Data upload on storage server

Storage Server

- Storage of Geostationary satellite data
- Storage of satellite data derived products
- Update of Web interface
Early results of real-time use of GCD in TGF analysis will be shown in next presentation
Global Lightning Network

- **GLN**
  - Started in 2009, partnership of TOA Systems of Melbourne FL and WSI Corporation of Andover MA
  - Provide overall global coverage with areas of concentration
    - Americas
    - Europe
    - Southeast Asia/Australia

![Map of global lightning network](map.png)

- US-Americas Sensors
- Global Sensors
Global Lightning Display

- **Google Earth Service**
  - End-user friendly for visualization and presentation

- Stroke cycle graph displays event age, counts

- Storm cells represent detected lightning when zoomed out

- Color-coded icons represent lightning strokes when zoomed in
Global Lightning Display

- **MIDS Software**
  - Detailed visualization, alerting and archival
Cloudsat Cloud Profiling Radar

CloudSat home page: http://cloudsat.atmos.colostate.edu/
CloudSat quick-look images and data browser: http://www.cloudsat.cira.colostate.edu/dpcstatusQL.php
GPM Core Instruments

Dual-Frequency (Ku-Ka band) Precipitation Radar (DPR):

- Increased sensitivity (~12 dBZ) for light rain and snow detection relative to TRMM
- Better measurement accuracy with differential attenuation correction
- Detailed microphysical information (DSD mean mass diameter & particle no. density) & identification of liquid, ice, and mixed-phase regions

Precipitation system around the Okinawa Island observed by the DPR at 2 (UTC) on June 14, 2014. Vertical cross section of three dimensional DPR rain rate along the white arrow