GeoMetWatch-STORM: The Next-Generation Global Space-based Disaster Information Observatories

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“Best Practices for Risk Reduction and Rapid Response Mapping”

United Nations International Conference on Space-based Technologies for Disaster Risk Management
Beijing, China
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STORM/GMW
Global Natural Catastrophe Update

Natural loss events January – June 2011

World map

Number of events: 355

- Natural catastrophes
- Geophysical events (earthquake, tsunami, volcanic activity)
- Hydrological events (flood, mass movement)
- Climatological events (extreme temperature, drought, wildfire)

Selection of significant loss events (see table)

- Severe storms, tornadoes
  - USA, 20–25 May
- Floods
  - USA, April–June
  - Severe storms, tornadoes
  - USA, 22–28 April
- Wildfires
  - USA, May–June
- Landslides, flash floods
  - Brazil, 12/16 Jan
- Earthquake, tsunami
  - Japan, 11 March
- Cyclone Yasi
  - Australia, 2 Feb
- Floods, flash floods
  - Australia, Dec 2010-Jan 2011
- Earthquake
  - New Zealand, 22 Feb
  - New Zealand, 13 June
Extreme Year 2011 for Disasters

In United States:

- Unprecedented triple-digit heat and devastating drought.
- Deadly tornadoes leveling towns
- Massive rivers over flowing
- A billion-dollar blizzard
- Total weather losses top 35 billion and that’s not counting Hurricane Irene
- More than 700 US disaster & weather deaths so far (September)
- 1st 6 months of 2011 – 98 disasters in US (double the average of the 1990s)
- Almost 1,000 all-time records set
Warming World & Wild Weather:

- North America – Hotter Days & nights
- Southern North America – Draught
- South America – Draught
- USA Caribbean – Hurricanes
- Europe – Urban Heat Waves & Draught
- Mediterranean Region – Draught
- West Africa – Draught
- East Africa – Floods
- Pacific Islands – Sea Level Rise
- Australia – Hotter Days & Nights
- Global – Heavy Rain; Flooding; Extreme heat; Warm temperature extremes
Startup GeoMetWatch Awarded U.S. License To Sell Hyperspectral Satellite Data

TURNER BRINTON, WASHINGTON

Start-up firm GeoMetWatch on Sept. 15 was awarded a U.S. Commerce Department license to sell space-based hyperspectral sounding data, which it hopes to sell to government weather organizations around the world, according to the company’s top official.

Las Vegas, Nev.-based GeoMetWatch has tapped Utah State University’s Space Dynamics Laboratory to design a hyperspectral instrument that could be hosted on a commercial geostationary communications satellite, David Crain, the company’s chief executive officer, said in an interview.

A hyperspectral sounding instrument on its low Earth orbiting MetOp-A satellite that was launched in 2006, and the capability is planned to fly on the Meteosat Third Generation geostationary satellites that are first slated for launch in 2016.

The U.S. National Oceanic and Atmospheric Administration (NOAA) and NASA plan to deploy hyperspectral instruments on the low Earth orbiting Joint Polar Satellite System spacecraft scheduled to begin launching in 2015, as well as an operational precursor satellite set to launch next year. The agencies planned to field instruments in purchasing the data through various business models, Crain said. The optimal arrangement for the company would be to have one anchor tenant with an unlimited license to redistribute the data. Other options that would not provide unlimited access to redistribute the data also are possible, Crain said. GeoMetWatch will consider several options for financing the project, including venture capital arrangements and debt financing, Crain said.

GeoMetWatch has contracted with the Space Dynamics Laboratory for initial design work for the hyperspectral sounder and hopes to launch 12 small satellites into low Earth orbit to gather atmospheric density, pressure, moisture and temperature data through a relatively new method known as GPS radio occultation.

GeoOptics and its satellite and instrument manufacturer, Broad Reach Engineering of Golden, Colo., the week of Oct. 11 unveiled its nearly completed first prototype satellite in a public ceremony in Boulder, Colo., GeoOptics President Tom Yunch said Oct. 21. The two companies expect to move to the satellite production phase in the coming months, Yunch said.

GeoOptics plans to contract by
Featuring GeoMetWatch’s World Most Advanced Remote Sensing Science & Technology

Sounding and Tracking Observatory for Regional Meteorology (STORM)

Talking Points:

- Sensor Technology
- Science and Algorithms
- Processing Technology
- Products and Services
- Societal Benefits
- Partnership
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# Top-Level GIFTS / STORM Comparison

<table>
<thead>
<tr>
<th>Parameter</th>
<th>GIFTS</th>
<th>STORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral Bands</td>
<td>LW: ≤685 cm(^{-1}) to ≥1130 cm(^{-1})</td>
<td>same</td>
</tr>
<tr>
<td></td>
<td>SMW: ≤1650 cm(^{-1}) to ≥2250 cm(^{-1})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VIS: ≥0.725 µm to ≤0.875 µm</td>
<td></td>
</tr>
<tr>
<td>Spectral Resolution</td>
<td>7 resolutions in range 0.6 - 36.7 cm(^{-1})</td>
<td>0.6, 1.2, and 9.6 cm(^{-1})</td>
</tr>
<tr>
<td>FPA Field-of-view (FOV)</td>
<td>14.3 mrad (0.82°)</td>
<td>same</td>
</tr>
<tr>
<td>Field-of-regard (FOR)</td>
<td>≥0.306 rad (17.53°)</td>
<td>same</td>
</tr>
<tr>
<td></td>
<td>(pointing mirror design: 0.450 rad)</td>
<td></td>
</tr>
<tr>
<td>IR FPA format</td>
<td>128 X 128 pixels, 60 µm pixel pitch</td>
<td>same</td>
</tr>
<tr>
<td>Noise equivalent spectral radiance (NESR) goal</td>
<td>LW: ≤0.4 mW/(m(^{2})-sr-cm(^{-1}))</td>
<td>same</td>
</tr>
<tr>
<td></td>
<td>SMW: ≤0.06 mW/(m(^{2})-sr-cm(^{-1}))</td>
<td></td>
</tr>
<tr>
<td>Calibration accuracy goal</td>
<td>≤ 1K (3(\sigma))</td>
<td>same</td>
</tr>
<tr>
<td>Data Rate</td>
<td>Max: 70 – 80 Mb/sec</td>
<td>same</td>
</tr>
<tr>
<td></td>
<td>Nom: 58 – 73 Mb/sec</td>
<td></td>
</tr>
<tr>
<td>Mass*</td>
<td>200 kg</td>
<td>300 kg</td>
</tr>
<tr>
<td>Volume</td>
<td>1.8 X 1.0 X 1.4 m(^{3})</td>
<td>same</td>
</tr>
<tr>
<td>Power*</td>
<td>535 W</td>
<td>550 W</td>
</tr>
<tr>
<td>Thermal Rejection *</td>
<td>Design assumed yaw-flip</td>
<td>≥350 W @ 0 °C</td>
</tr>
</tbody>
</table>

* Mass, power, and thermal rejection change due to expected no-yaw-flip operations
STORM Leverages GIFTS-Based Sensor Module Technologies

~$400 million Investment made so far
GIFTS Characteristics

- Two 128x 128 infrared focal plane detector arrays with 4 km footprint size
- A 512 x 512 visible focal plane detector array with 1 km footprint size
- Array field of view footprint is 512 km x 512 km at satellite sub-point
- 10.9 second full spectral resolution integration time per field of view
- ~ 80,000 Atmospheric Soundings every minute

Performance Objectives:
- Spectral Coverage: (1) 680 - 1150 cm\(^{-1}\)
  (2) 1650-2250 cm\(^{-1}\)
- Spectral Resolution: 0.6 cm\(^{-1}\), unapodized
- Spectral Stability: 1 part per 10\(^6\) (3 \(\sigma\))
- Absolute Radiometric Accuracy: 1.0 K (3 \(\sigma\))
- Radiometric Noise: LW Band: 0.4 mW/m\(^2\)-sr-cm\(^{-1}\)
  SW Band: 0.06 mW/m\(^2\)-sr-cm\(^{-1}\)
GIFTS Spatial & Temporal Coverage Illustration

Global Disk Sounding: 300 Steps
Spectral Resolution: 1.2 cm\(^{-1}\)
< 1 Hr

Sounding Regional: 144 Steps
Spectral Resolution: 0.6 cm\(^{-1}\)
< 1/2 Hr
(imagery < 5 min)

Global Disk Imaging: 422 Steps
Spectral Resolution: 36 cm\(^{-1}\)
< 10 Min

Mesoscale Sounding: 36 Steps
Spectral Resolution: 0.6 cm\(^{-1}\)
< 7 min
(imagery < 1 min)
Sounding and Tracking Observatory for Regional Meteorology (STORM)

Talking Points:

- Sensor Technology
- **Science and Algorithms**
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State-of-the-Art Simulation & Science/Algorithm Capability

- Large Domain NWP
- Ultra-spectral resolution Radiative Transfer Model
- Sensor Modeling
- Design trade Study

ABI band 14 (11.2 µm) BT (K) 2005-08-28

STORM/GMW
Regional Simulation (ABI 16 Panel)
30 Minutes Interval Image Loop

ABI band data for 2005 June 04 15:00 UTC
OSSE of GEO advanced IR sounder for storm nowcasting

Red = extreme instability

“STORM” sensor system provides needed instability and warning information hours earlier than current GOES Sounder (+4-5 hrs) and Radar (+8 hrs)
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GeoMetWatch/STORM Products

• Imagery
  – High resolution “true” color and RGB composite animation
  – High resolution spectral image animation
  – High quality digital visible and infrared image
  – Local, regional and full disk single spectral or multi-channel composite image and animation

• Radiance
  – Routinely calibrated digital spectral radiances traceable to national standard
  – Routine digital radiance signal, noise, and quality status for scientific and quantitative applications
  – Any customized digital radiance subsets at various coverage and frequency

• Real-time Product
  – 4D fields of primary products of temperature, water vapor, clouds, and wind.
  – 3D fields of aerosol, pollutions, and trace gases.
  – 3D fields of volcanic ash and gases.
  – 3D fields of land and ocean surface temperature.
  – 3D fields of surface emissivity and albedo.
  – 3D fields of land surface type, coverage and vegetation index.
  – 3D fields of hot spot.
  – 3D fields of weather instability.
  – 3D fields of ice/snow, cover, depth and motion.
  – 3D fields of visibility, turbulence, icing threat, low cloud and fog.
  – 3D fields of flood and standing water.
  – 3D fields of Hurricane intensity and track.
  – 3D fields of longwave and shortwave radiation.
  – Customized products such as high spatial and temporal resolution temperature, humidity, wind, cloud transient, surface temperature, surface type and other products critical for fire management, aviation safety, severe storm watch, air pollution monitoring, renewable energy production, and hazardous events warning and so on.
Applications:

- Hazard Events Monitoring/Prediction
- Air Pollution Monitoring/Forecasting
- Aviation Safety Warning/Prediction
- Renewable Energy Production Prediction
- Fire Management
- Regional High Resolution Numerical Weather Forecasting
**GeoMetWatch/STORM Services**

**Services:**

To provide an end-to-end real-time and/or routine support system for the

- **Decision Making**
  For the management of the above weather and environmental events for public safety, security, recreational, sport, business, government function and many other social and special activities

- **Resources Management**
  For the operational management of the land use, agriculture production, transportation, aviation safety, renewable energy and other resources

- **Risks Mitigation**
  For social, economical, environmental informational/impact analysis, and investment, business, and policy strategic planning
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Aviation Safety

RGB(12–11 μm, 11–8.5 μm, 11 μm)

Ash Cloud

STORM/GMW
Typhoon Track Forecast

ABD band 14 (11.2 μm) BT (K) 2005-08-28

GIFTS Water Vapor Tracer Winds for Hurricane Bonnie (August 26, 1998)
Air Quality Monitoring/Forecast

MODIS 2010/05/25 AOD & AOD Trajectories on 2010/05/25 01Z

STORM/GMW
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GeoMetWatch

Space Dynamics Laboratory
Utah State University

Space Science & Engineering Center
University of Wisconsin

STORM SENSOR

DATA PROCESSING

$$

Unprecedented Severe Weather Forecast Capability

$$

SSP
GeoMetWatch

Space Dynamics Laboratory
Utah State University

STORM SENSOR

Space Science & Engineering Center
University of Wisconsin

DATA PROCESSING

SSP

DATA Centers

Applications:
Weather
Environmental
Aviation
Resources
Renewable Energy
Carbon

Data Buy Users

Other Users

Users: P & S

: Partnership Opportunity