GeoMetWatch-STORM: Global Constellation of Next-Generation Ultra-spectral Geostationary Observatories

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Space Dynamics Laboratory
Utah State University

Space Science & Engineering Center
University of Wisconsin

STORM SENSOR

DATA PROCESSING

$$

Satellite System Provider

Unprecedented Weather Forecast; Environmental Monitoring; & Disaster Mitigation Capability

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

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 hyper-

ested 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

mospheric profiling, but they are not adequate for tracking fast-moving storms, Crain said.

"They can make one observation of [the continental United States] every 45 minutes to an hour, and they take about eight hours to profile [their full field of view]," he said. "That time is really too slow to be of much benefit for severe weather tracking or forecasting.

"The benefit of the hyperspectral sensor we will fly is it will have much higher spectral resolution, which gives you much higher vertical resolution in the atmospheric profiles. We can profile [the continental United States] in five to 15

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 Yunck said Oct. 21. The two companies expect to move into the satellite production phase in the coming months, Yunck said.

GeoOptics plans to contract by

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Sounding and Tracking Observatory for Regional Meteorology (STORM)

Talking Points:

- Sensor Technology
- Science and Algorithms
- Processing Technology
- Products
- 1st Asia STORM Data Buyer Partnership

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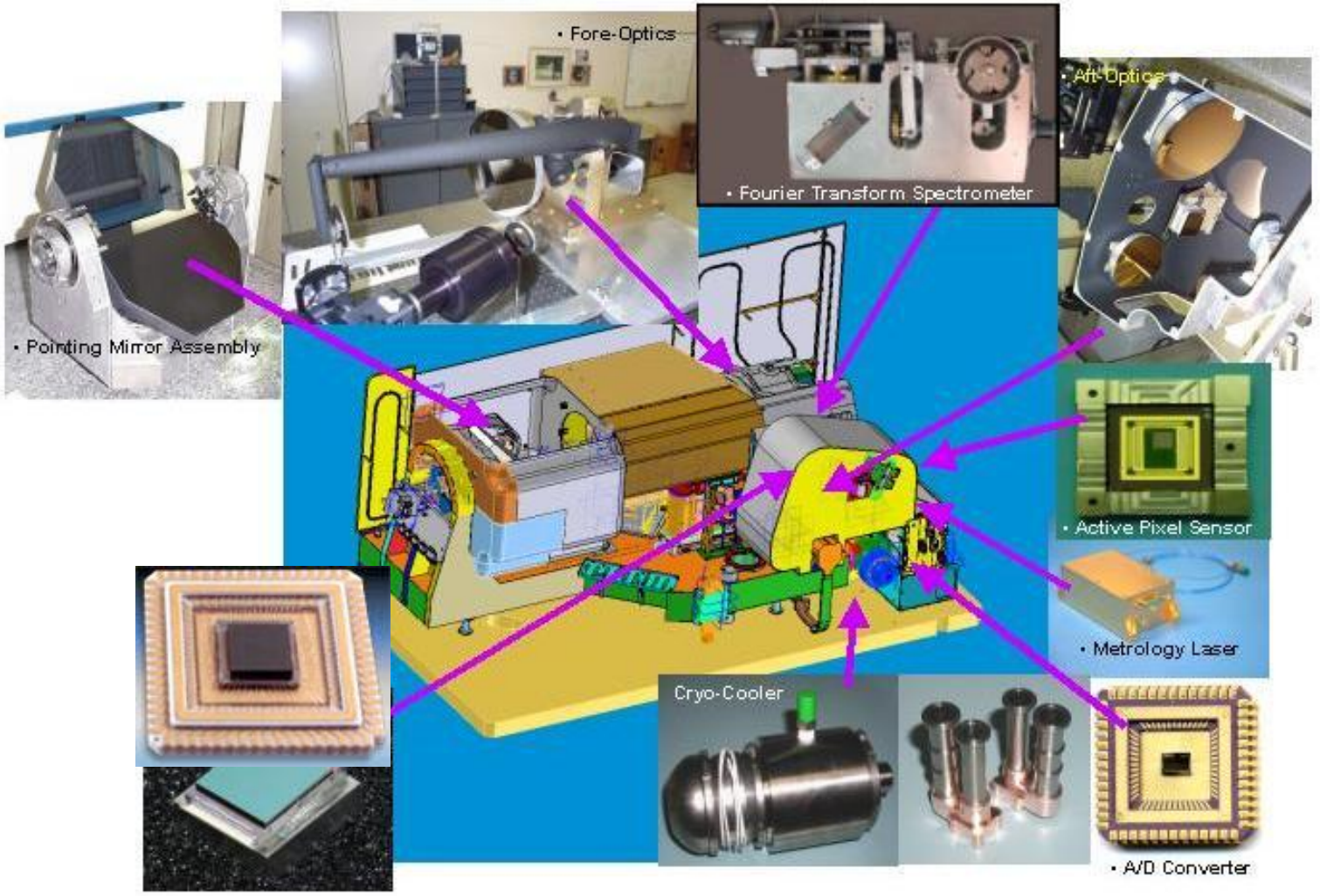
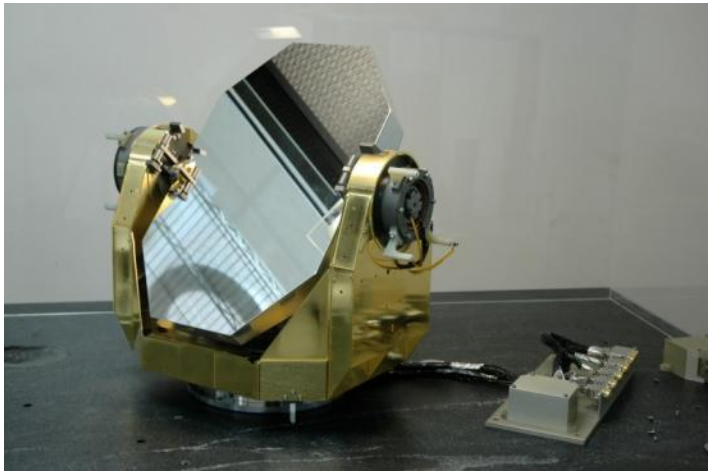
STORM Leverages GIFTS-Based Sensor Module Technologies

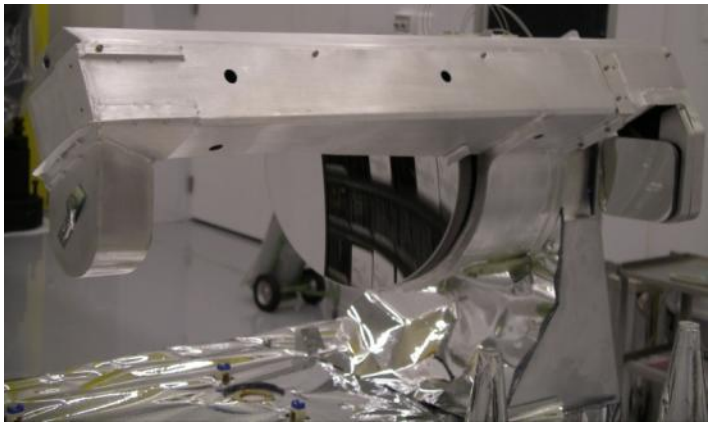
Hundreds of million Investment made so far



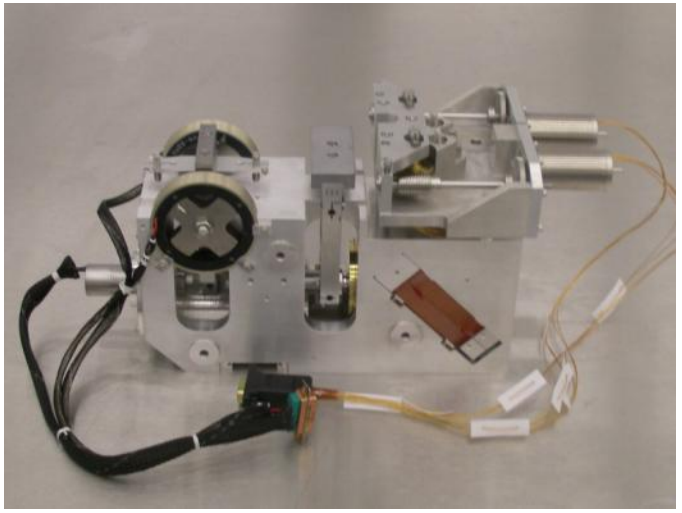
GIFTS Pointing Mirror and Afocal Telescope

- Pointing Mirror
  - 2-axis pointing mirror
  - 17.6 x 11.0 inches
  - SiC mirror
- Afocal Telescope
  - SiC mirrors and metering structure
  - Entrance Pupil: 240 mm
  - Afocal Magnification: 6.86

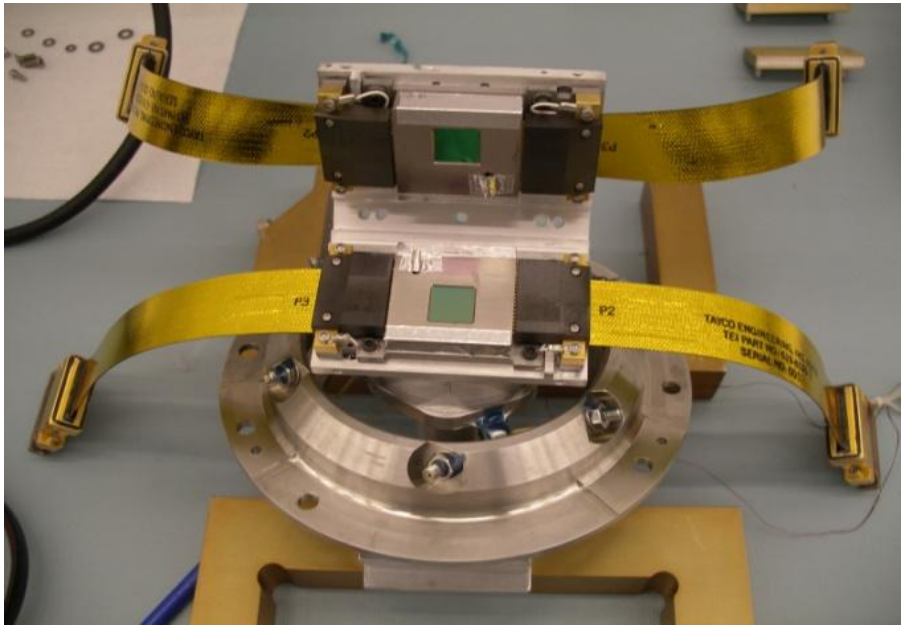




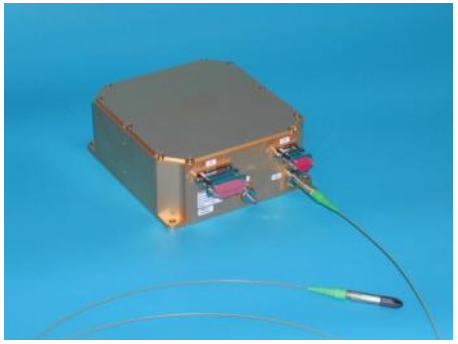
GIFTS Optics



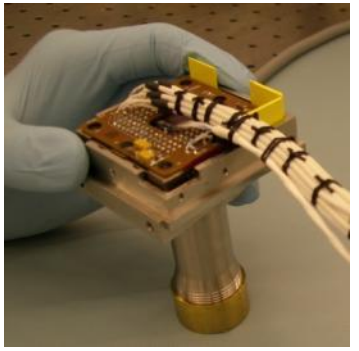
Interferometer



Focal planes and fiber support structure



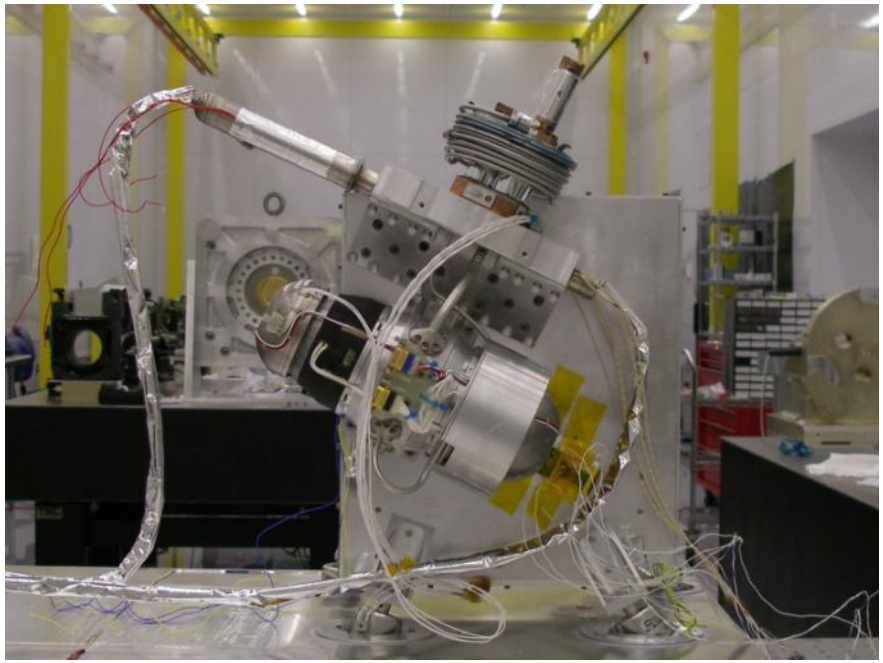
Laser

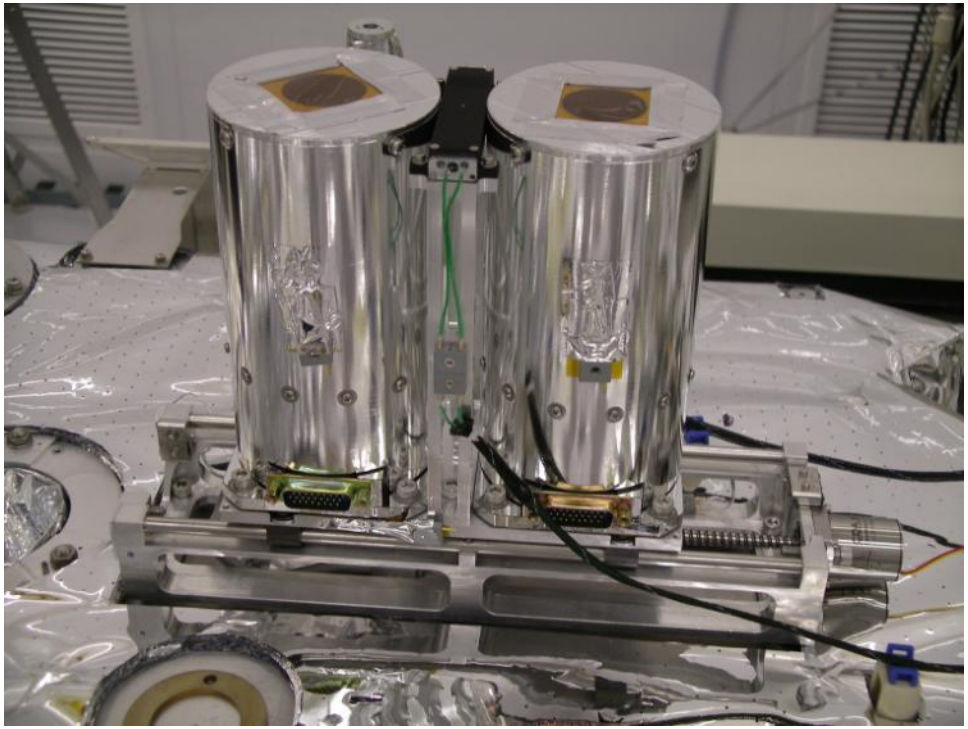


Visible Sensor

GIFTS Hardware

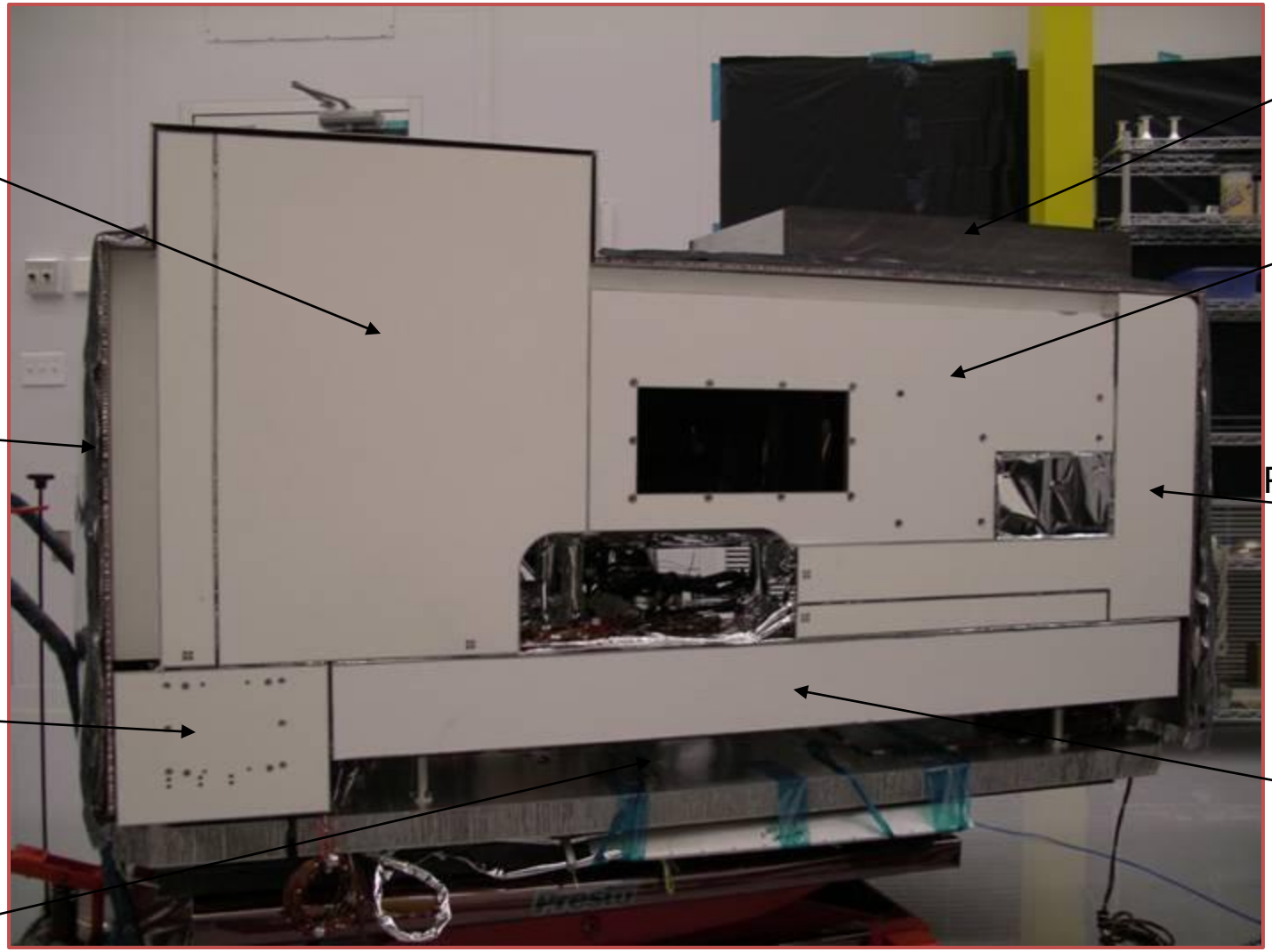
Cryocooler



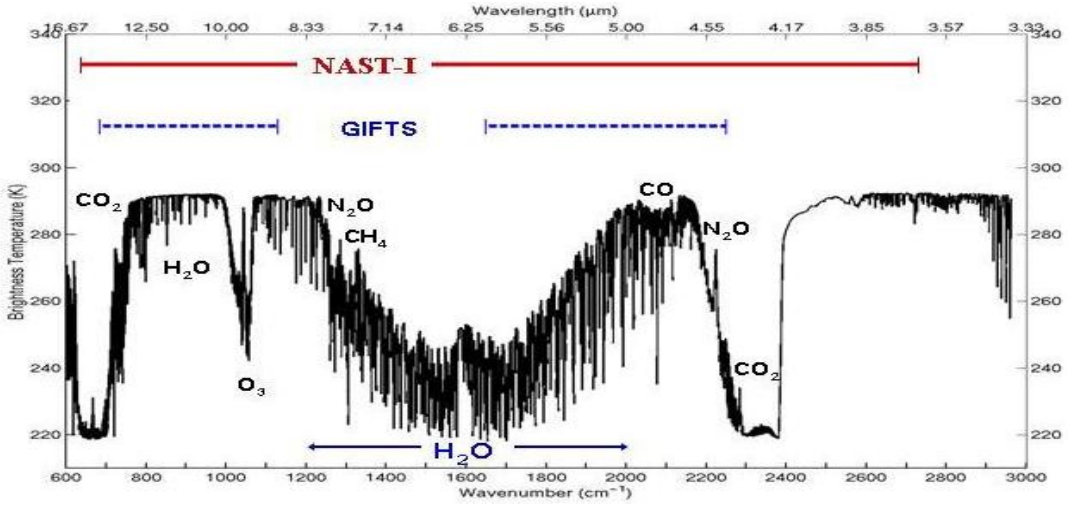


Calibration Blackbodies on translation stage

GIFTS System Configuration



GIFTS Characteristics



(8.8 to 14.6 microns) (4.4 to 6.1 microns)

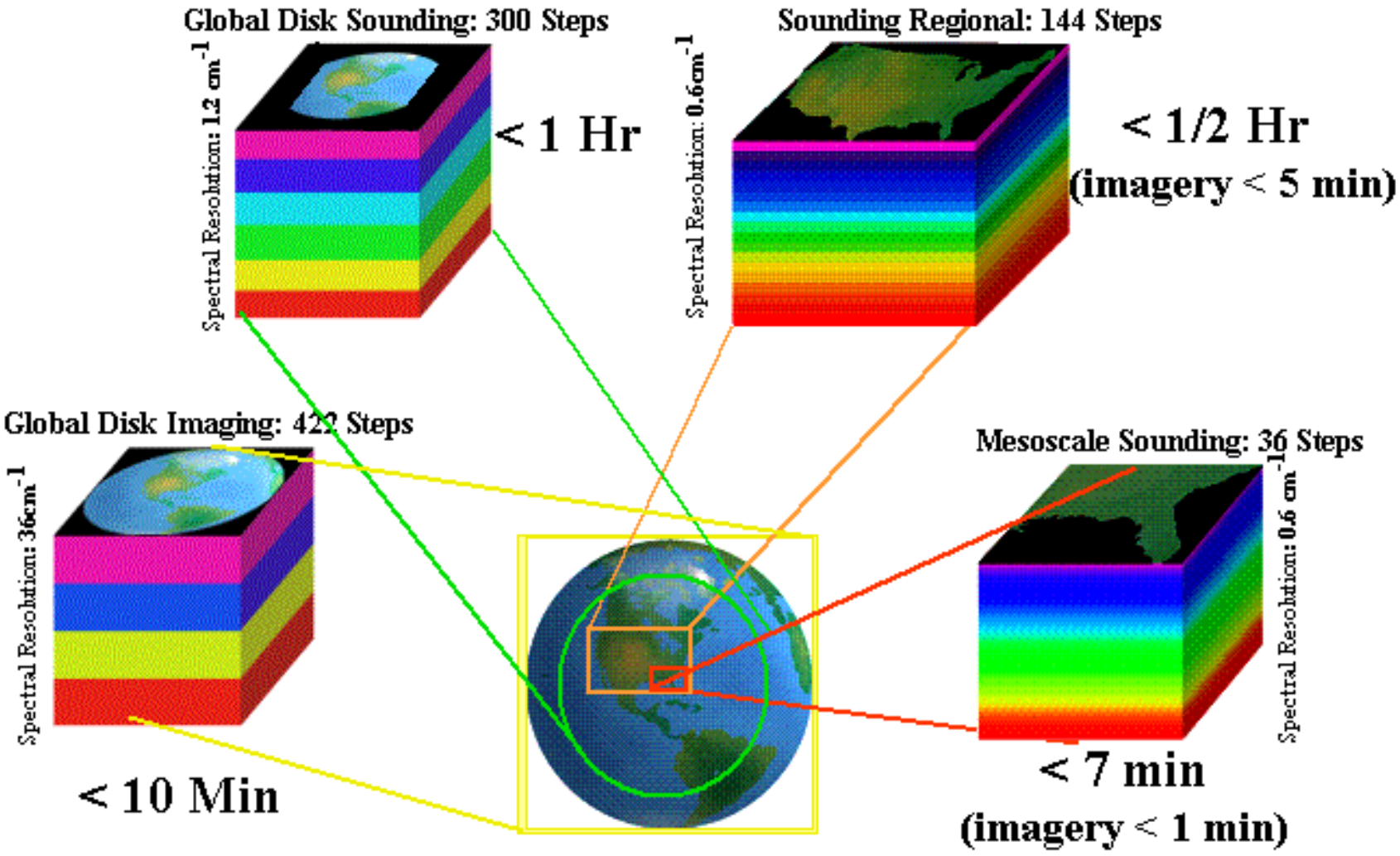
Performance Objectives:

- **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 σ)
- **Absolute Radiometric Accuracy:** 1.0 K (3 σ)
- **Radiometric Noise:** LW Band: 0.4 mW/m^2-sr-cm^{-1}
  SW Band: 0.06 mW/m^2-sr-cm^{-1}

- 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

GIFTS Spatial & Temporal Coverage Illustration



STORM Sensor System Characteristic

Each STORM sensor package is designed with a goal to make measurements in:

- Pan Imaging band at 300m ground sample distance (GSD).
- Visible/Near IR bands (0.5 - 3.5 micron) at 500m GSD.
- Ultra-spectral IR Data (4.3-15.2 micron) with 0.6-2.5 cm^{-1} spectral resolution at 2km GSD, depending upon customer requirements

Top-Level GIFTS / 1st STORM Comparison

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

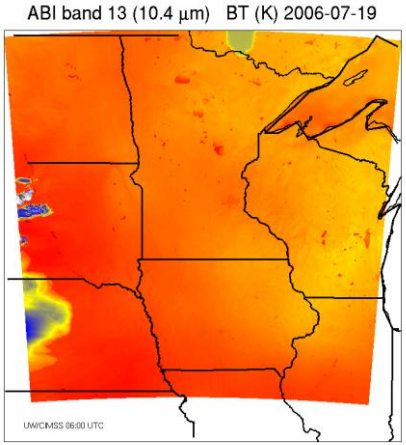
* Mass, power, and thermal rejection change due to expected no-yaw-flip operations

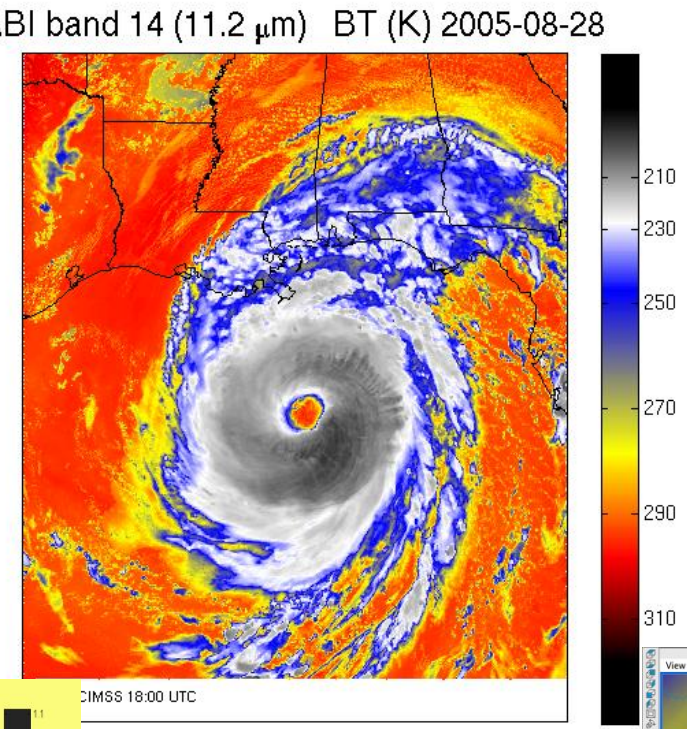
Sounding and Tracking Observatory for Regional Meteorology (STORM)

Talking Points:

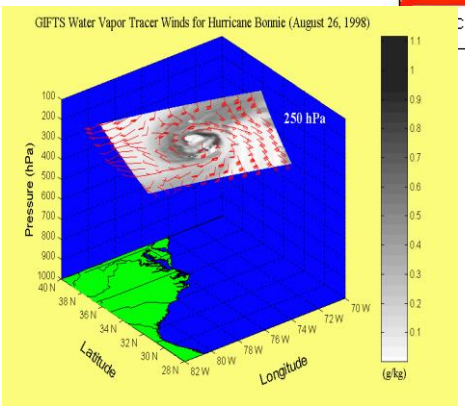
- Sensor Technology
- **Science and Algorithms**
- Processing Technology
- Products and Services
- Societal Benefits
- 1st Asia STORM Data Buyer Partnership

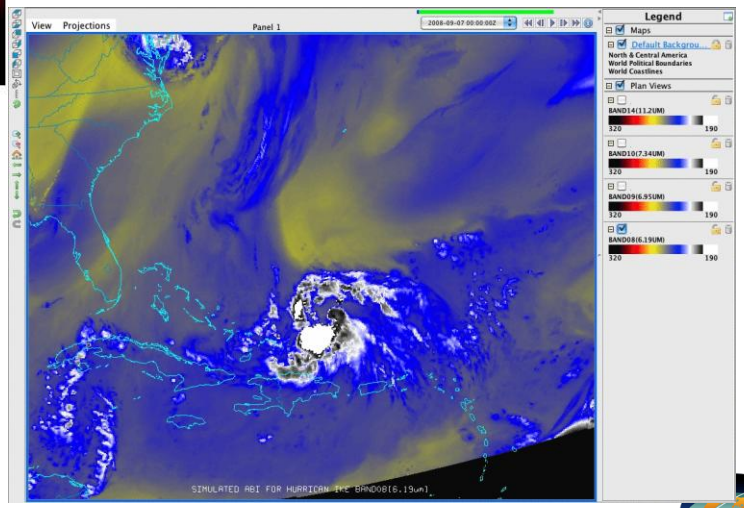
State-of-the-Art Simulation & Science/Algorithm Capability





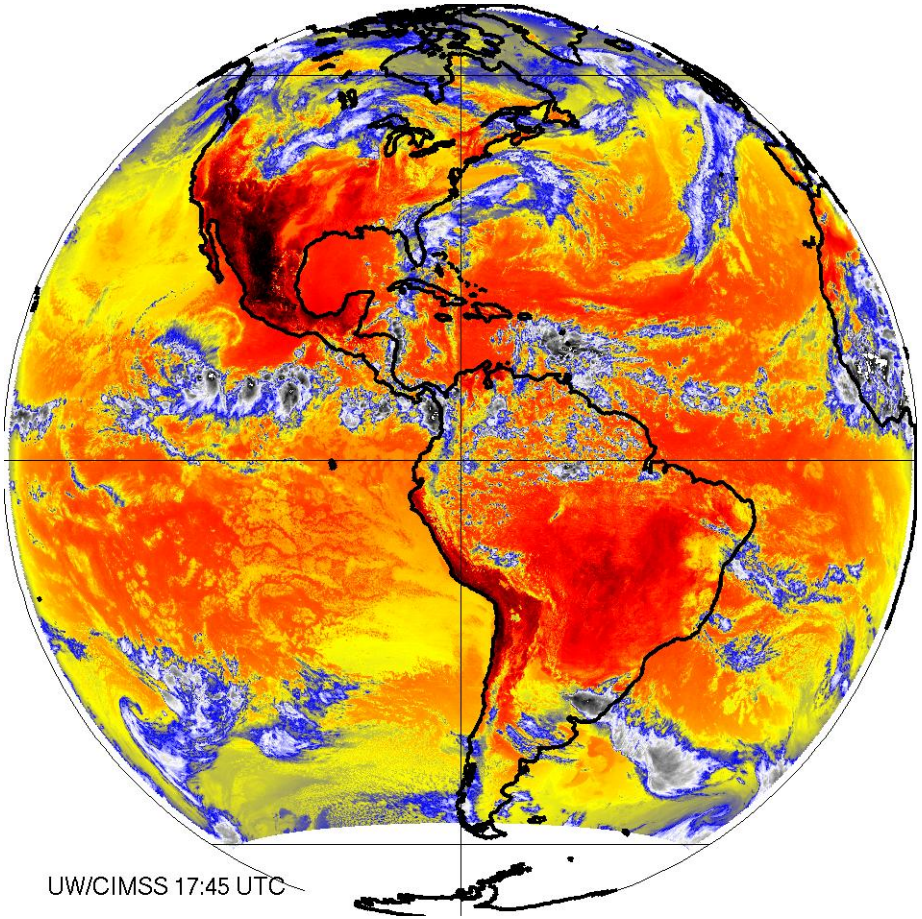
- Large Domain NWP
- Ultra-spectral resolution Radiative Transfer Model
- Sensor Modeling
- Design trade Study



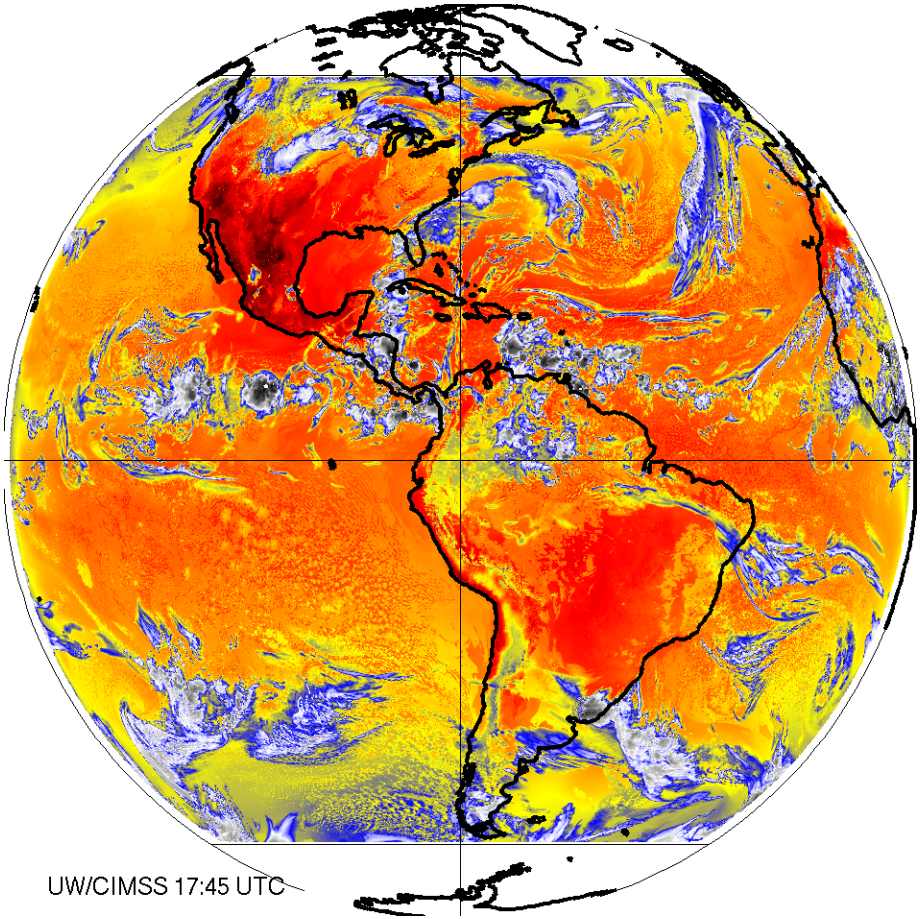


Large Domain Simulation

GOES-12 Band 4 (10.8 μm)



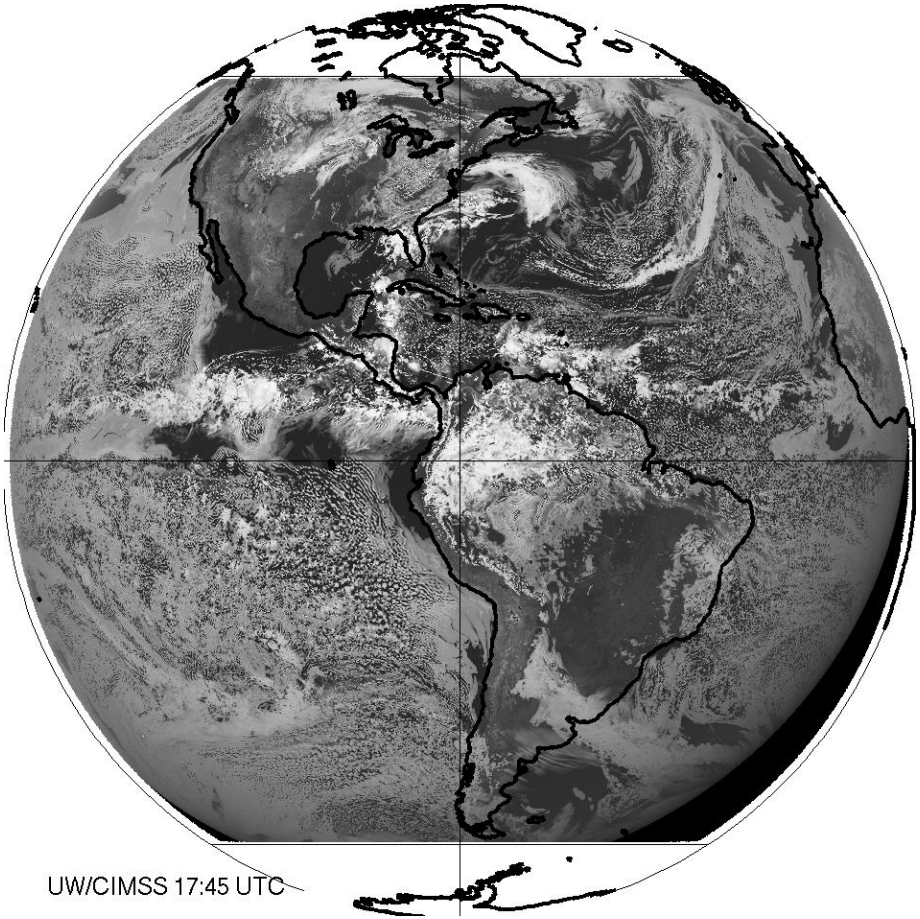
Proxy ABI Band 14 (11.2 μm)



Comparison of observed and simulated IR brightness temperatures for the 6-km "full disk" domain from the NCSA-FCM simulation

Large Domain Simulation

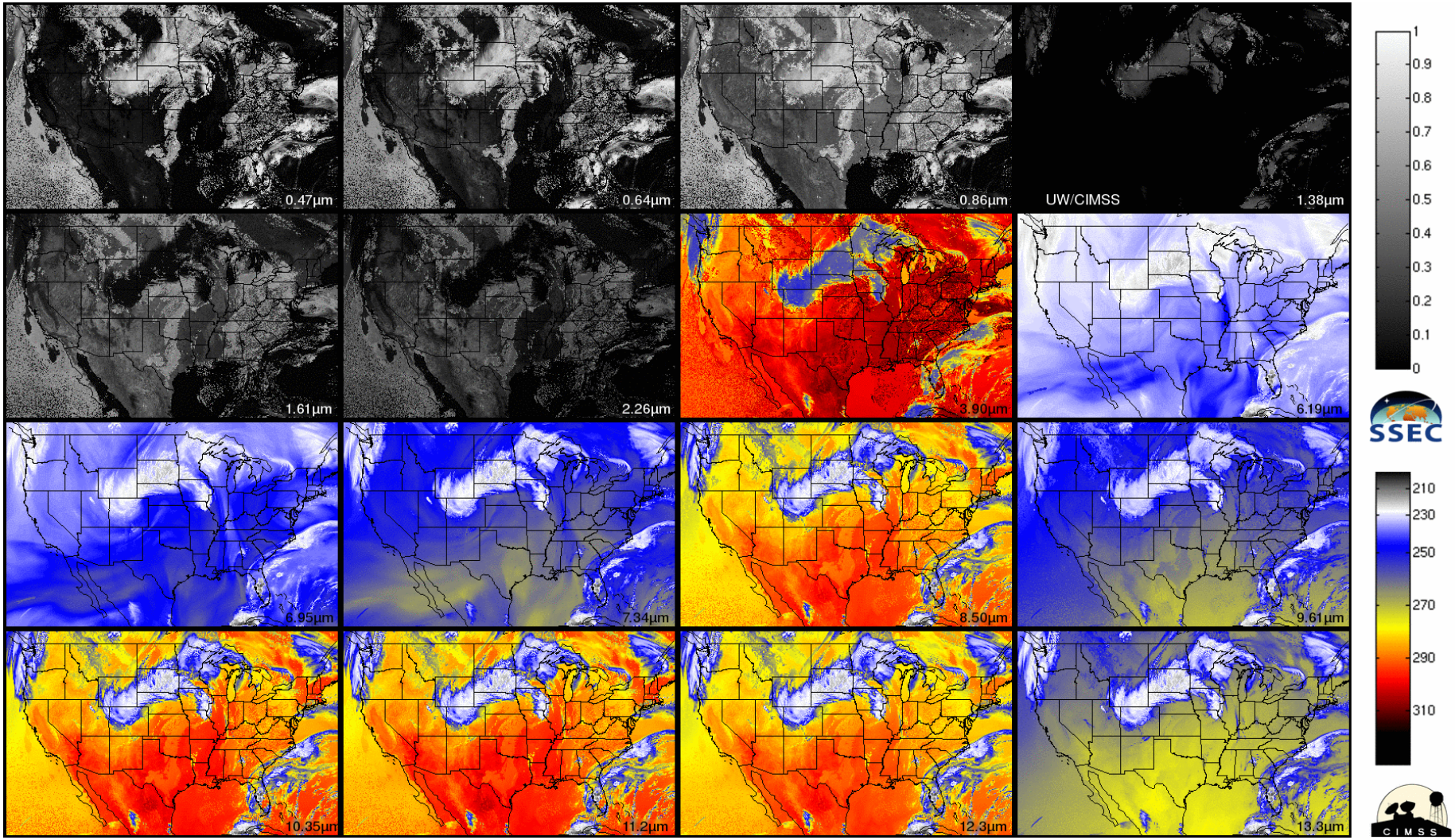
ABI Band 2 (0.64 μm)



ABI Band 4 (1.38 μm)

Representative examples of simulated ABI visible imagery for the 6-km “full disk” domain

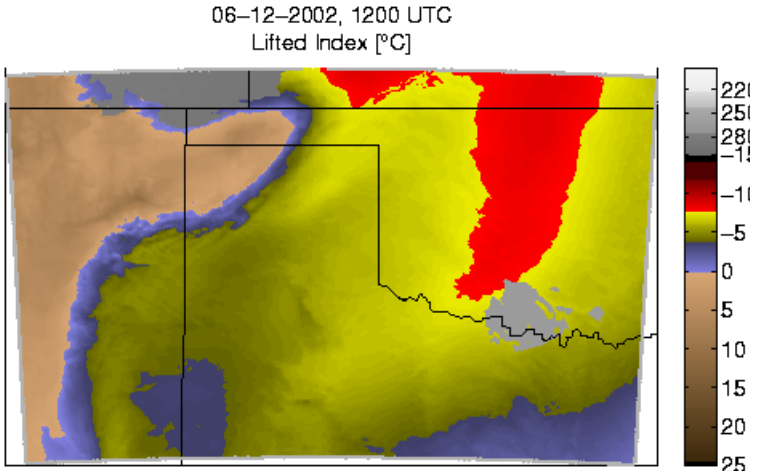
Regional Simulation (ABI 16 Panel)
30 Minutes Interval Image Loop



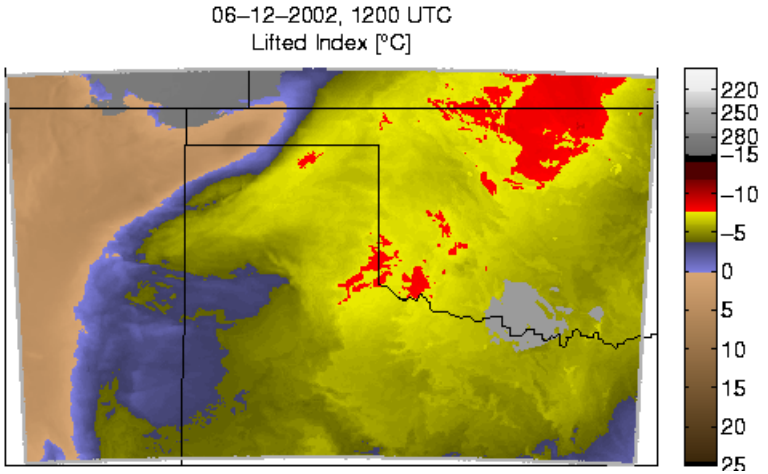
ABI band data for 2005 June 04 15:00 UTC

OSSE of GEO advanced IR sounder for storm nowcasting

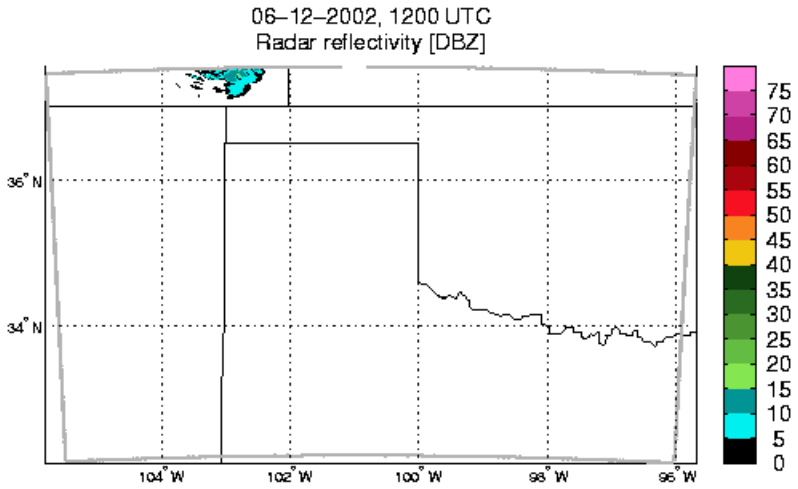
True



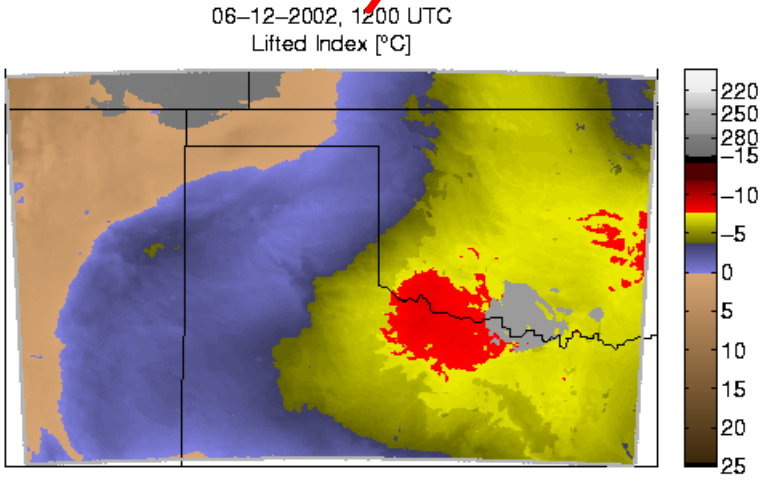
GIFTS/HES/IRS/STORM



Red = extreme instability



Simulated Radar



ABI/GOES Sounder like

***"STORM" sensor system* provides needed instability and warning information hours earlier than current GOES Sounder (+4-5 hrs) and Radar (+8 hrs)**

Sounding and Tracking Observatory for Regional Meteorology (STORM)

Talking Points:

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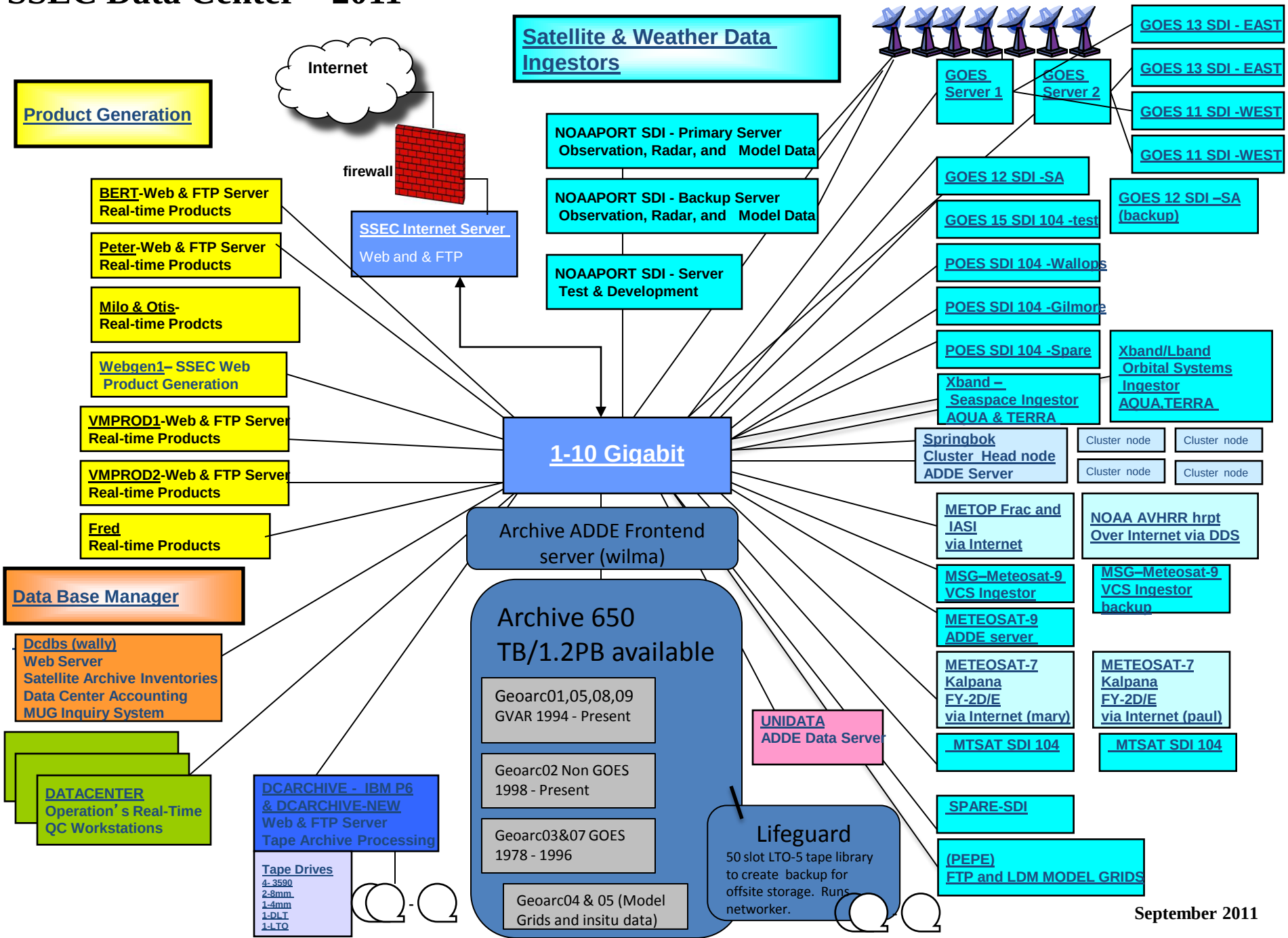
- Science and Algorithms
- **Processing Technology**
- Products and Services
- Societal Benefits
- 1st Asia STORM Data Buyer Partnership

SSEC Data Center – 2011



September 2011

Sounding and Tracking Observatory for Regional Meteorology (STORM)

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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, sever storm watch, air pollution monitoring, renewable energy production, and hazardous events warning and so on.

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GeoMetWatch-STORM: Global Constellation Goal & Milestone

- GMW first launch is slated for 2015 in East Asia (100-140 East), with the full complement GMW global constellation, comprised of the Six-Satellite-STORM-System (S4), at ~60 degree interval, to be fully deployed by 2019-2020.
- Each GMW STORM sensor makes
  - full-disk observations in all bands every 20 minutes to 1 hour.
  - Regional observation (~1000km x ~1000km) modes allow faster observation of severe weather events, such as hurricanes/typhoons, every 1-2 minutes.
  - Larger regions, or customer-specified observation areas of special interest, are possible with various high temporal resolutions ranging from 5 to 15 minutes.

International Users & GeoMetWatch

Partnership & ways forward

- As a premier data-buyer
  - Serves as an expert user and domestic distributor
- As a partner/investor to develop Receiving, Processing and Application to provide services
- As the GMW-STORM Asia Data Center
  - Be a 1st Asia Data-Buyer to become eligible
  - The site for an advanced satellite remote sensing science & technology power house with high global standing to serve Asia users