

# An Introduction UW-Madison SSEC/CIMSS Research and Facilities

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# WELCOME!!!



# CIMSS/SSEC/AOS/NOAA



Symbiotic relationship between CIMSS, SSEC, AOS, and NOAA/NESDIS

## Verner E. Suomi (1915-1995) "Father of Satellite Meteorology"



### **1959: 1st Meteorological Satellite Experiment**

Earth Radiation Balance Observations on Explorer VII

**1966: 1st Earth Imaging** from GEO

Spin-scan Camera on 1st Advanced Technology Satellite (ATS 1)









## Cooperative Institute for Meteorological Satellite Studies (CIMSS) Steve Ackerman Director

• Foster collaborative research among NOAA, NASA, and the University in those aspects of atmospheric and earth system science which exploit the use of satellite technology

• Serve as a center at which scientists and engineers working on problems of mutual interest may focus on satellite related research in atmospheric studies and earth system science.

• Stimulate the training of scientists and engineers in the disciplines involved in the atmospheric and earth sciences.

### The CIMSS Research Program









AERIPLUS Retrieved Cold Frontal Passag

12 Time (UTC) 20

16 18



# **CIMSS Staff**



# Graduation History of CIMSS Supported Graduate students



## **Products in NOAA NESDIS Operations** from CIMSS

Imager	Sounder
Derived Product Images	Derived Product Images
Water vapor	Water vapor
Lifted Index	Lifted Index
Skin Temperature	Skin Temperature
Winds from multiple satellites	Winds
High density infrared	7.0 micrometers
High density water vapor	7.5 micrometers
High density visible	
High density 3.9 um (operational in 2002)	
Derived wind fields (shear, divergence, etc)	
Hurricanes	
Objective Dvorak technique (SAB)	
Intensity estimates (from AMSUA)	
Sea Surface Temperature	Clouds
	Site-specific Cloud Product
Biomass Burning	Single FOV product DPI
Operational in 2002	
Rainfall	Retrievals
(auto-estimator via G. Vicente)	Temperature/moisture
	Layer PW
	Clear-sky Brightness Temperature
Clear-sky Brightness Temperature	
(in transition)	

## **GOES-R Warning Product Set**

The following list of GOES-R proxy products offers opportunity for nearreal time Warning Related utility.

Baseline Products: Volcanic Ash: detection & Height Cloud and Moisture Imagery Hurricane Intensity Lightning Detection: Events, Groups & Flashes Rainfall Rate / QPE Total Precipitable Water Fire/Hot Spot Characterization

Option 2 Products: Aircraft Icing Threat Convective Initiation Enhanced "V" / Overshooting Top Detection Low Cloud and Fog SO<sub>2</sub> Detection

### The Valley of Death is Being Crossed

From the NWS Milwaukee WFO Website 2012/11/26

VIIRS DNB data acquired by direct broadcast at SSEC, and processed by CSPP

C IIII ERB Mo	vies ERB Camera SatCam IDL Group MODIS Today SSEC DB MODIS Products EOS-FES data LAADS Search WiscCal	Ċ
TURR	National Weather Service Weather Forecast Office Milwaukee/Sullivan, WI	weath
	Home Site Map News Organization Search for: NWS All NOAA 👩	
cal forecast by r, St or Zip Code y, St Go RSS Feeds nt Hazards coks bes/Wamings coks mit Report mit Conditions ervations ar.	Check it Out! Satellite Instrument Measures Night-time Illumination The <u>Visible Infrared Imaging Radiometer (VIIRS)</u> instrument that was included in the payload on the Suomi Polar Orbiting satellite launched into orbit in October 2011 has the capability of measuring night-time illumination on the earth's surface. Depending on the phase of the moon and stray light, the following can be detected by VIIRS at night:	
illite w Cover wfall Analysis ip Analysis casts	Cities, Smoke, Dush, Ash, Low Clouds, Fog, Fires, Volcanoes (Lava), Auroras, Lightning, Boats	
icast Discussion vity Planner Weather ne Weather ere Weather ter Weather to Center blogy rs & Lakes vie	The below image was taken by VIIRS shortly after 2 am CST early Monday morning. The image clearly shows city illumination and reflectance of the metropolitan areas across the southeastern U.S. The moon phase at the time was waxing gibbous or increasing. The moons surface was 95.9% lit, so the moon was nearly full.	
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## **Training – VISIT and SHyMet**



The CIMSS VISIT team provided 32 live tele-training sessions to 49 NWS offices in FY2012. Recorded versions are also available.

# **Research to Operations: Successful Collaborations require good partnering!**



# **National Climate Data Center**

- Cloud Climate Data Records Andy Heidinger
- Snow and Ice Climate Data Records Jeff Key

#### **Other NOAA funded programs**

- CalNex Support Brad Pierce
- Weather Information for Mobile Devices Dave Santek, Russ Dengel
- Satellite Applications for Education Margaret Mooney

# **NOAA CIMSS S4 Compute Cluster**

- 1561.8 compute years of processing
- TC Produced an information Poster/booth on JCSDA supercomputing for the JCSDA 10th Workshop on Satellite Data Assimilation
- At workshop, S4 administration team met with users to discuss support and new possibilities and challenges

# JCSDA Supercomputing JIBB and S4: Resources for JCSDA Scientists and Researchers

#### S4 System Resources

3,072 processing cores at 2.2GHz 8.2 TB RAM 520 TB Storage QDR Infiniband Interconnect



#### **S**4

A collaboration between NESDIS and CIMSS, the Supercomputer for Satellite Simulations and data assimilation Studies (S4) is designed for the broader scientific community to foster the development of ideas that may be further from NWP operations.

# CIMSS/SSEC/AOS/NOAA



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## **SSEC** areas of technical expertise

- Observational Science (spacecraft system/mission design, instrumentation, field programs, spaceflight instrument fabrication,
- Computational & Visualization Science (hardware and software systems for information generation, data management, and communication)
- Analytical Science & Applications (satellite & conventional data analysis, technical development & analysis)

## **SSEC Major Space Flight Programs**

#### **High Speed Photometer**





Hubble 1990-93 Bob Bless, PI Astronomy **Diffuse X-ray Spectrometer** 







Bill Kraushaar, Physics Wilt Sanders, PIs

#### **Net Flux Radiometer**





Galileo Entry Probe 7 December 1995

Larry Sromovski, PI

#### SSEC Scanning-HIS Scanning High-resolution Interferometer Sounder



#### **Up- & Down-looking Spectra**





#### **Michelson Interferometer**





#### Research on Outer-Planet Atmospheres at SSEC

Science Team: Larry Sromovsky and Pat Fry

Planets: Jupiter, Neptune, Uranus



Research:Atmospheric circulationSeasonal responseDynamics of circulation featuresVertical cloud structure and composition

Techniques: Spectroscopy, Imaging, in situ observations, cloud tracking, radiation transfer modeling

SourcesHubble Space Telescope, Cassini, New HorizonsGround based telescopes (Keck and IRTF).Archived data from Voyager & Galileo missions.

ww.jpl.nasa.go

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# **DISC Drill**

Facts Requires 8 C-130 flights (62 tons and 8,500 cu ft) Requires 2 – 225 kW generators at peak operation ♦ 6 years to design/build/test Over 35,000 engineering hours and 800+ drawings Designed to accommodate bedrock coring and

bedrock coring and directional drilling



## **IDDO** Ice Drilling & Operations

Charlie Bentley, Don Lebar, and their large, impressively talented team

- WAIS Divide Ice Main Core Competed 12/31/11, Culmination of 10 yr effort
- Excellent quality core over 3,405 m depth, even in technically challenging warm ice
- 1<sup>st</sup> high-resolution southern hemisphere record of greenhouse gases and climate comparable to the Greenland records
- Will contribute significantly to improved understanding of climate variability over the last ~ 65,000 years



Drilling team



Spooling on the new 4,200 m cable



Ice core in DISC Drill

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#### **SSEC Data Center**



# National GOES Archive 1978-2003



# SSEC

Satellite / Meteorological Data Access Facilities



Now have >1 PB of raid storage for "online archive" of all GOES data, giving rapid access to ~ 30 years of satellite data!

## **SSEC Data Center - Activities**

- Assist Satellite Operations Control Center and other agencies in satellite checkout and troubleshooting of related problems
- Support to field experiments
  - Special archiving
  - Extended staffing, either on-call or on-site
- Provide large dataset backups for users
  - Read, write, and copy tapes
  - Provide specialized archives of user data
- Provide Help Desk support to users of the SSEC SDI, and assist in the generation of SDI user documentation
- Assist McIDAS User Services team with McIDAS testing for system upgrades
- Provide archive data to in-house and external users

# SSEC Data Center Incoming Data

170+ GB/day via Satellite (C-band, L-band, X-band)



GOES satellites	
~96 GB/day	
International Geo Satellites	~47 GB/da
NOAA Polar	
~27 GB/day	
Miscellaneous Polar and Non satellite ~85	GB/day
MODIS polar from NASA archive	~150 GB/
day	
NPP (VIIRS CrIS ATMS)	~700 GB/
day	

935+ GB/day via Internet (ftp, LDM, ADDE, http)

## Data Center Antennas

#### • C-Band

- 11 meter (87° West POES Wallops Relay, MSG)
- 7.3 meter (101° West POES Fairbanks Relay, MTSAT, Noaaport)
- 6.3 meter (Heated capable of receiving data from 87° West or 101° West)

#### • L-Band

- 7.3 meter (75° West -GOES-East Primary)
- 4.6 meter (135° West -GOES-West Primary)
- 4.5 meter (60° West -GOES-SA auto tracking)
- 4.5 meter (105° West -GOES-test/spare)
- 3.7 meter (offline spare)
- X-Band
  - 4.4 meter (Tracking EOS)
- L-X Band
  - 2.6 meter (Tracking NPP/JPSS)

### 11 simultaneous GEO satellites! <u>A first</u>: received, served ~real time & archived



COMS (S. Korea)



Meteosat-7 (Europe)



GOES-12



AFY2D (China)



Meteosat-9 (Europe)









Kalnan

AFY2E

(China)





MTSAT-1R (Japan)







GOES-14

GOES-15

### Community Satellite Processing Package SEC offers World-wide Access



- A software package for processing Suomi NPP, JPSS, POES, Metop, and FY-3 direct broadcast data.
- Have released multiple versions of the VIIRS, CrIS, and ATMS SDR software.
- CSPP is now used operationally by EUMETSAT, UK Met Office, MeteoFrance, and national agencies in Sweden, Norway, Mexico, South Africa, Australia, Japan, China, Russia...

SSEC DB Antenna

First Suomi NPP DB received data on 2012/02/23





#### International MODIS and AIRS Processing Package (IMAPP)

- > Supporting more than 900 registered users in 61 countries
- Supporting 11 Real-Time government and academic institutes
- Providing more than 50 NWS offices Real-Time MODIS images and products
- > Conducted 8 DB training workshops at 5 different continents so far
- Providing 1<sup>st</sup> Real-Time DB Data Assimilation System (DBCRAS) and Air Quality forecast system (IDEA-I) to users
- Received more than 10 years of funding from NASA





Allen Huang, PI; Kathy Strabala, PM Liam Gumley; Elisabeth Weisz, Brad Pierce; Bob Aune



- IMAPP provides L1 & L2 algorithms that can produce MODIS; AIRS; AMUS; & AMSR-E radiances and >18 MODIS; 3 AMSR-E; & 2 AIRS/AMSU products.
- IMAPP also provides tools & utilities such as MODIS in Google Earth & virtual appliance



Simulation of the 16 bands of ABI

## **McIDAS-V**



ABI simulation of overshooting tops, rotated to 3-D view from the side



ABI simulated image with transect showing 3-D difference field of AIRS retrieval minus ECMWF model forecast

- Powerful new data analysis and 3-D visualization tool from SSEC
- ► Fifth generation of Man-computer Interactive Data Access System
- Java-based, open-source, and freely available
- Incorporates functionality of VisAD, IDV, McIDAS-X, and HYDRA, for viewing data, developing algorithms, and validating results
- Includes tools for research and operational users of observational, model, and satellite data, including data from multi- and hyperspectral sensors on both current (GOES, POES, MSG, MTSAT, MODIS, METOP) and future (GOES-R, NPP/NPOESS) satellites
- Includes a "bridge" to McIDAS-X, allowing –X users to continue using legacy code in -X, while visualizing in McIDAS-V





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Analytical Science & Applications (satellite & conventional data analysis, technical development & analysis)

## Tracking Iceland's Eyjafjallajökull Volcanic Ash





The GOES-R volcanic ash products were provided to the UK Met Office in real-time to assist with decision making

### Multiple Geostationary Satellite Wind Data Automatically Produced





Katrina, 28 August 2005

# **Tropical Cyclones**



Wilma, 21 October 2005

#### **GOES WFABBA - Rapid Intensification of Wildfires**

#### Arizona



20 June 2002 16:15 UTC



18:15 UTC



21:15 UTC

#### Quebec



6 July 2002 11:45 UTC



17:45 UTC

# New Satellites: GOES-R+/JPSS Programs

**Algorithm Development Group (AWG)** 

- CIMSS and ASPB scientists are involved in 2/3 of the 64 operational algorithms under development
- > 15 funded tasks for AWG at CIMSS

#### **Risk Reduction**

10 funded tasks for Risk Reduction at CIMSS, investigating novel ideas and approaches

#### **Proving Ground**

Evaluating baseline products, testing advanced products, and training future users of the data

#### **High Impact Weather**

Investigating the impact of a high spatial and spectral resolution sounder in geo orbit

#### **Hurricane Sandy Environment from VIIRS Day/Night Band, 29 Oct**















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