CIMSS

1980-2000

Cooperative Institute for Meteorological Satellite Studies

Outline

- Overview of GIFTS NMP Requirements
- Overview of CIMSS/SSEC and high-spectral resolution observations
- Overview of GIFTPAP Algorithms
- GIFTPAP Milestones for FY03

GIFTS NMP Requirements

Baseline Validation

The purpose of the EO-3 project is to accomplish the in-space validation of a measurement concept that will resolve both spatially and by altitude, temperature water vapor, and water-vapor and cloud-tracer winds in the atmosphere.

Measurement Concept

1. Accurately measure vertical profiles of water vapor to infer tropospheric winds
2. Track water vapor features at discrete pressure levels using a time sequence of high spatial resolution moisture analyses obtained from geosynchronous soundings.
3. Generate high-quality water vapor-derived winds from moisture field measurements from the GIFTS instrument.
4. FTS will providing vertical resolution, LFPA will provide horizontal coverage and geosynchronous satellite observation platform (high temporal resolution) making possible revolutionary wind profiles and moisture transport measurements.

<u>THE VALIDATION OF THIS CAPABILITY IS EO-3'S PURPOSE.</u>

NOAA will execute an extensive validation plan as documented in the GIFTS Product Assessment Plan (PAP), utilizing data products produced by the GIFTS Instrument.

GIFTS NMP Requirements

Measurement Concept Validation Requirements

• Temperature Profiles	< 1.0 K for 1-km layers
• Surface Temperature	< 0.5 K
• Water Vapor	< 20% for 2-km layers
• Wind Velocity	< 4 m/s for 2-km layers
• Relationship between measurements of atmospheric properties and the point on the earth's surface above which the measurements were taken.	<10 km

Notes:

1. Temperature and water vapor accuracies are stated in terms of RMS errors (1s) averaged over a single layer.

2. Accuracy of wind velocity measurements is the magnitude of the difference vector between measured and true wind.

NOAA GIFTS Demonstration Plan stated goals are to

* conduct real time study of

    forecasting impact of radiances / winds

    nowcasting impact of derived product images

* gather case study data sets to enable

    validating GIFTS products

    testing of NWP assimilation approaches

* archive golden year of level 1-b radiances

    Pacific winter storms

    severe storms in tornado alley

    hurricanes in the Atlantic

* establish utilization approaches for HES day one

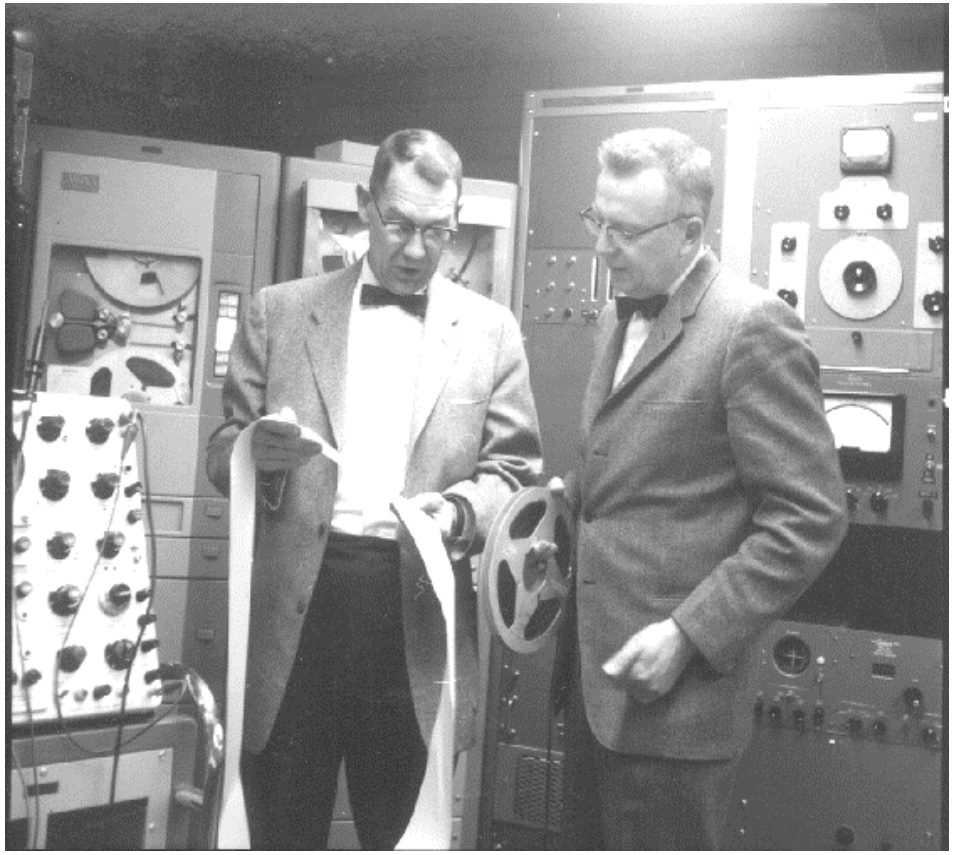
Algorithm development will address GOES products

soundings
winds
cloud properties
land surface products
ocean products
earth radiation budget
ozone / trace gases / volcanic ash

Derived product images will include

3 layers of moisture and total column
atmospheric stability
cloud temperature and phase
land surface temperature diurnal excursions

Verner E. Suomi (1915-1995)
with Robert J. Parent (left), SSEC Co-founder



1959: 1st Meteorological Satellite Experiment

Earth Radiation Balance Observations on Explorer VII

1966: 1st Earth Imaging from GEO

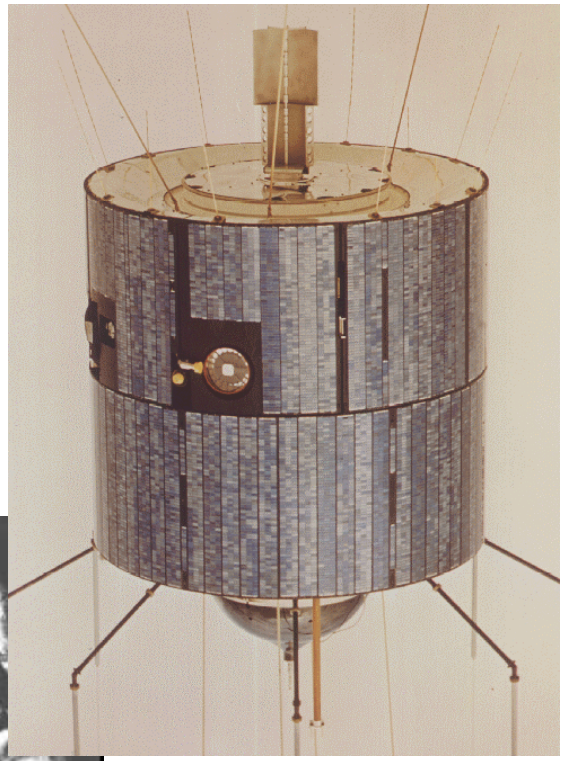
Spin-scan Camera on 1st Advanced Technology Satellite (ATS 1)

"Father of Satellite Meteorology"

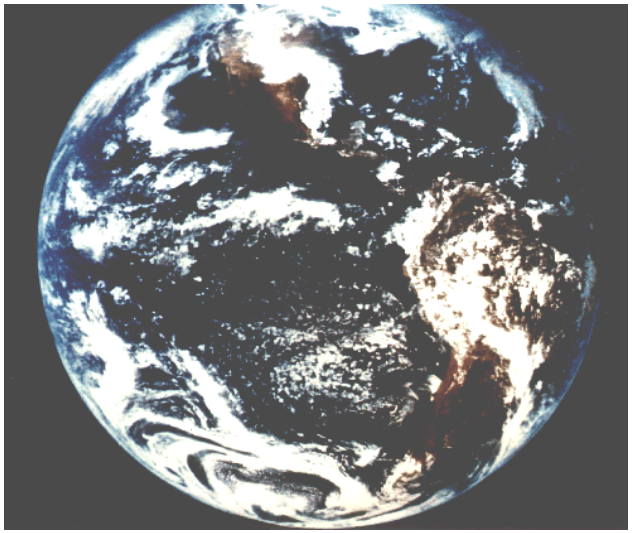
UW - NOAA - NASA

working together to use GEO for many years

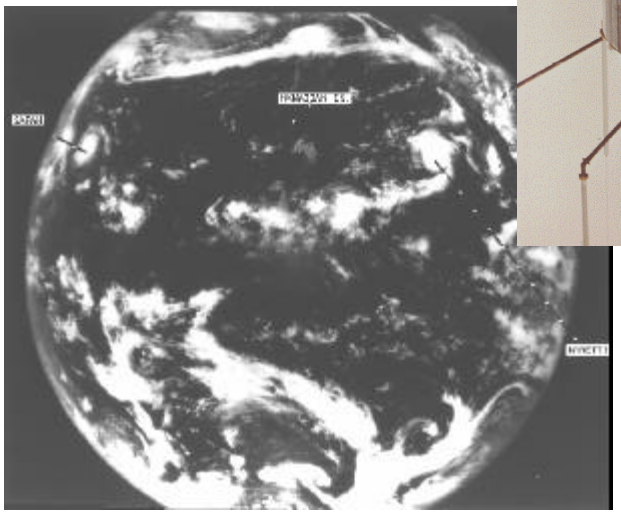
- **1966/67: 1st Earth Imaging from Geostationary Orbit**
  - **Suomi and Parent's Spin-Scan Cloud Camera on ATS**



ATS-3



ATS-3 (color)



ATS-1 (B/W)

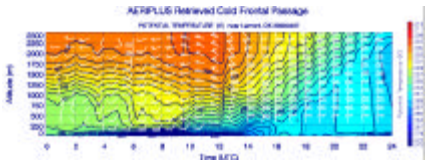
UW - NOAA - NASA

working together to use GEO for many years

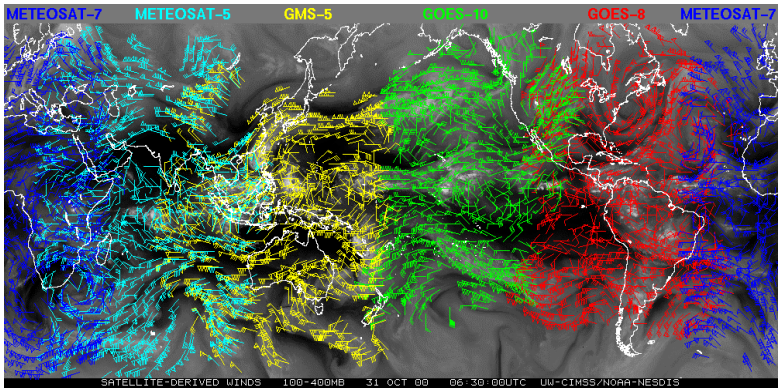
- **1974 - : 1st integrated processing system to display, navigate, loop images, and measure winds**
  - **Suomi's "Man Computer Interactive Data Access System" (McIDAS)**
- **1978 - : National Archive of GOES data at UW SSEC**
- **1980: 1st Geostationary Sounder**
  - **Temperature and Water Vapor Profiles from VAS infrared observations on GOES-4 (Geostationary Operational Environmental Satellite)**

CIMSS Mission

- To 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.
- To serve as a center at which scientists and engineers working on problems of mutual interest can focus on satellite related research in atmospheric studies and earth system science.
- To stimulate the training of scientists and engineers in the disciplines involved in the atmospheric and earth sciences.



algorithms



theory
modeling

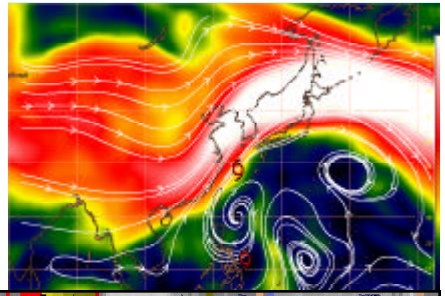
INFORMATION

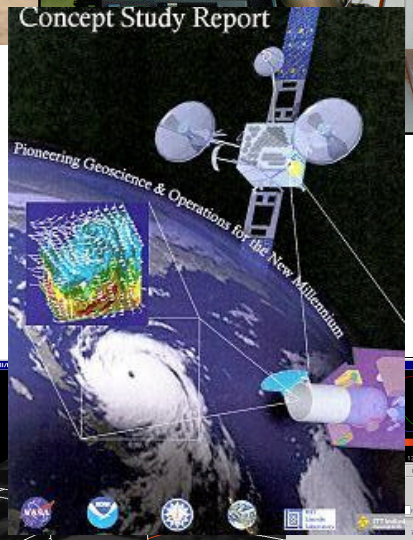
DATA EDUCATION KNOWLEDGE

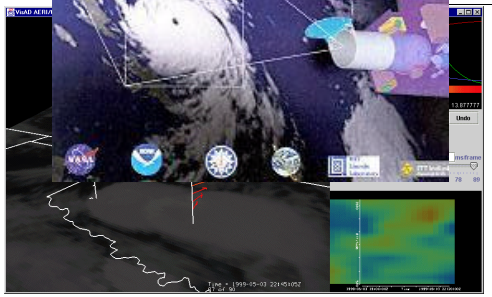
ACTION

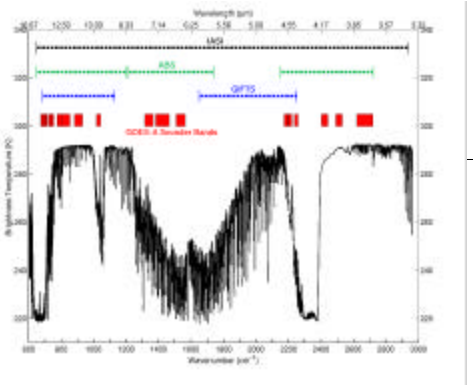
new instruments

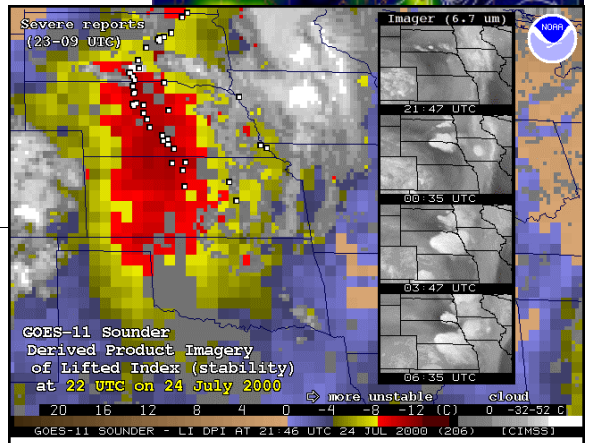
applications











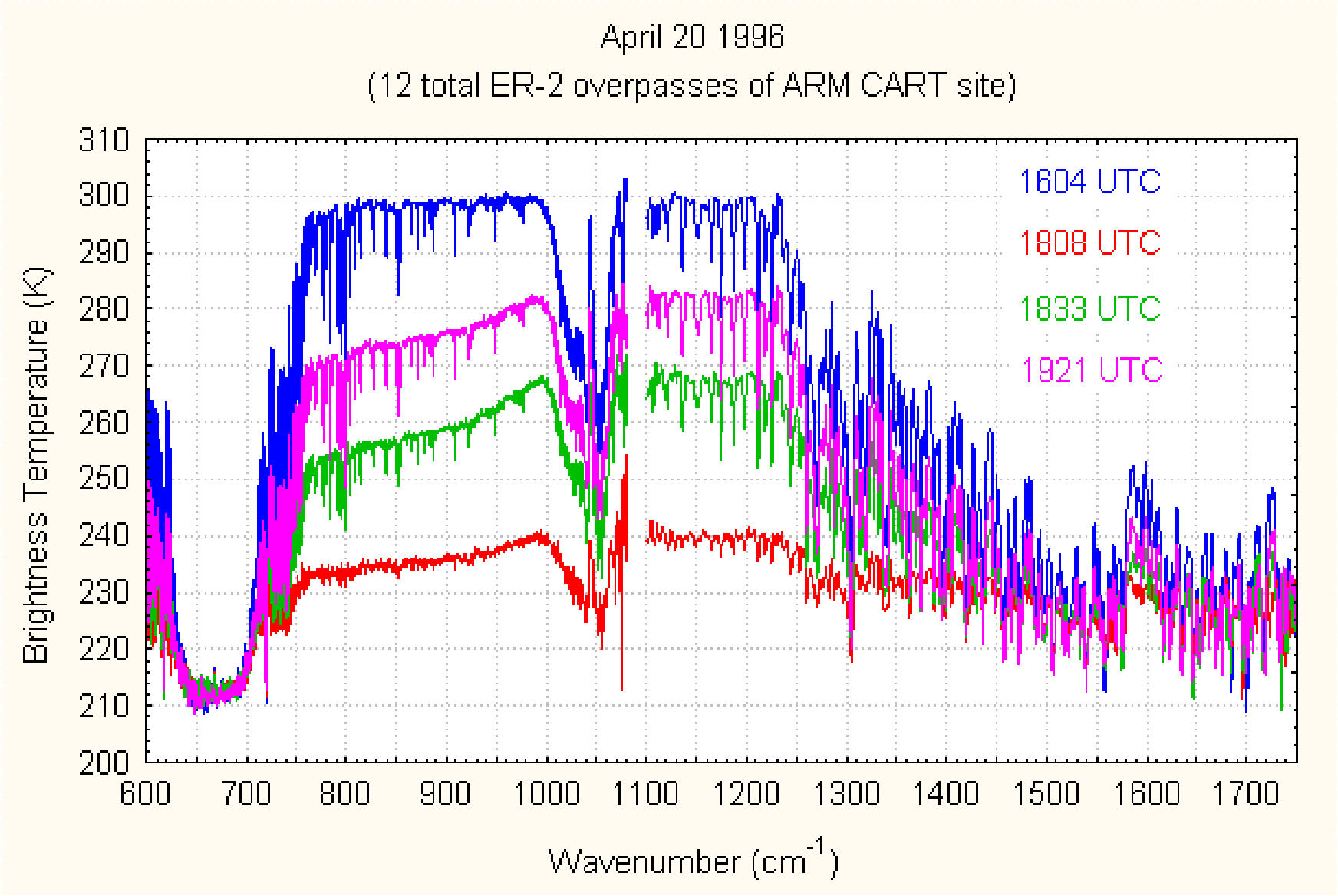
The GOES-11 Sounder depicted an axis of large atmospheric instability (red region) prior to a long-lived super cell. The development is shown by a time sequence of the GOES-11 Imager water vapor imagery. Subsequent severe weather reports illustrate the storm track.

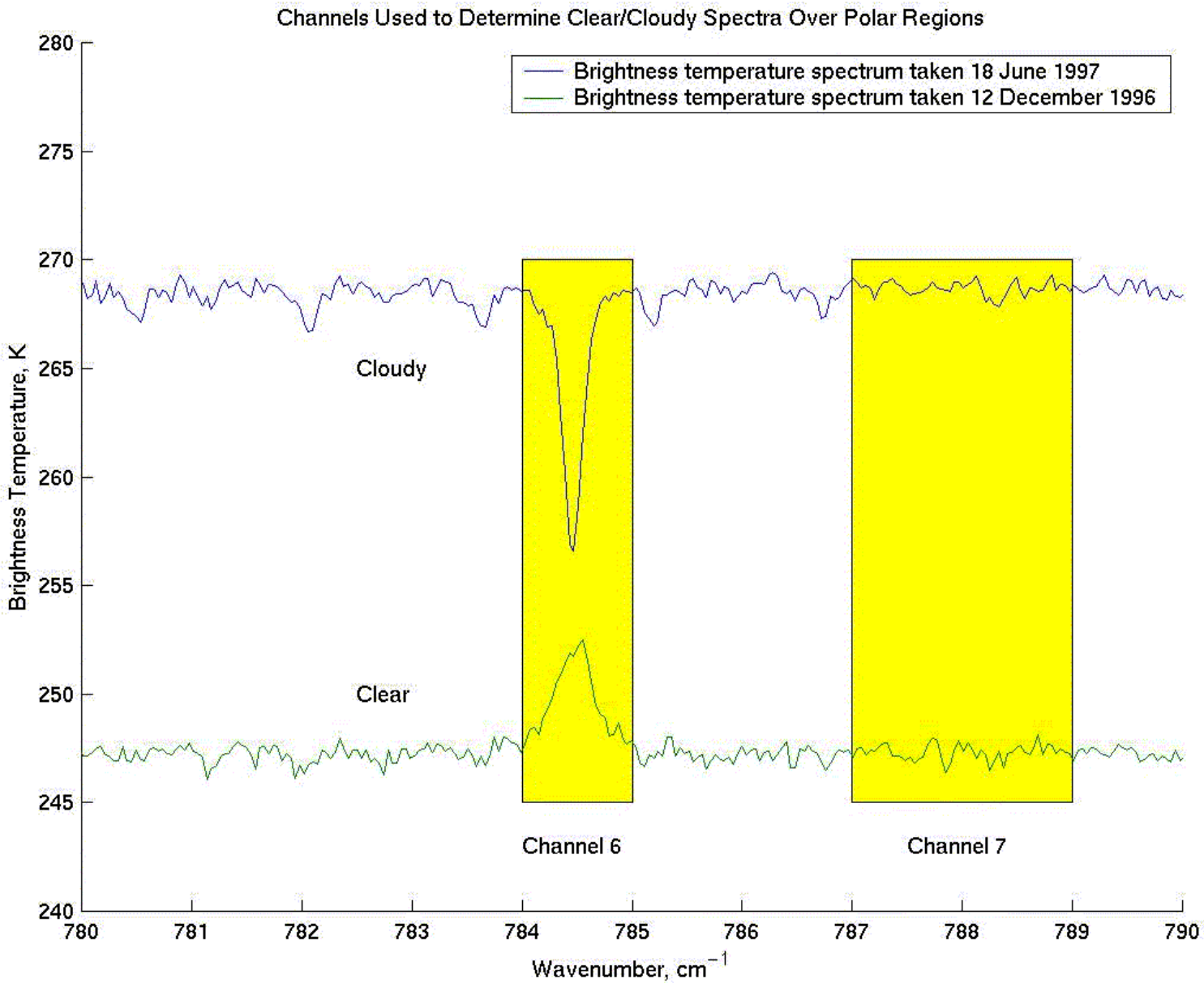
CIMSS understands transition from Research to Operations

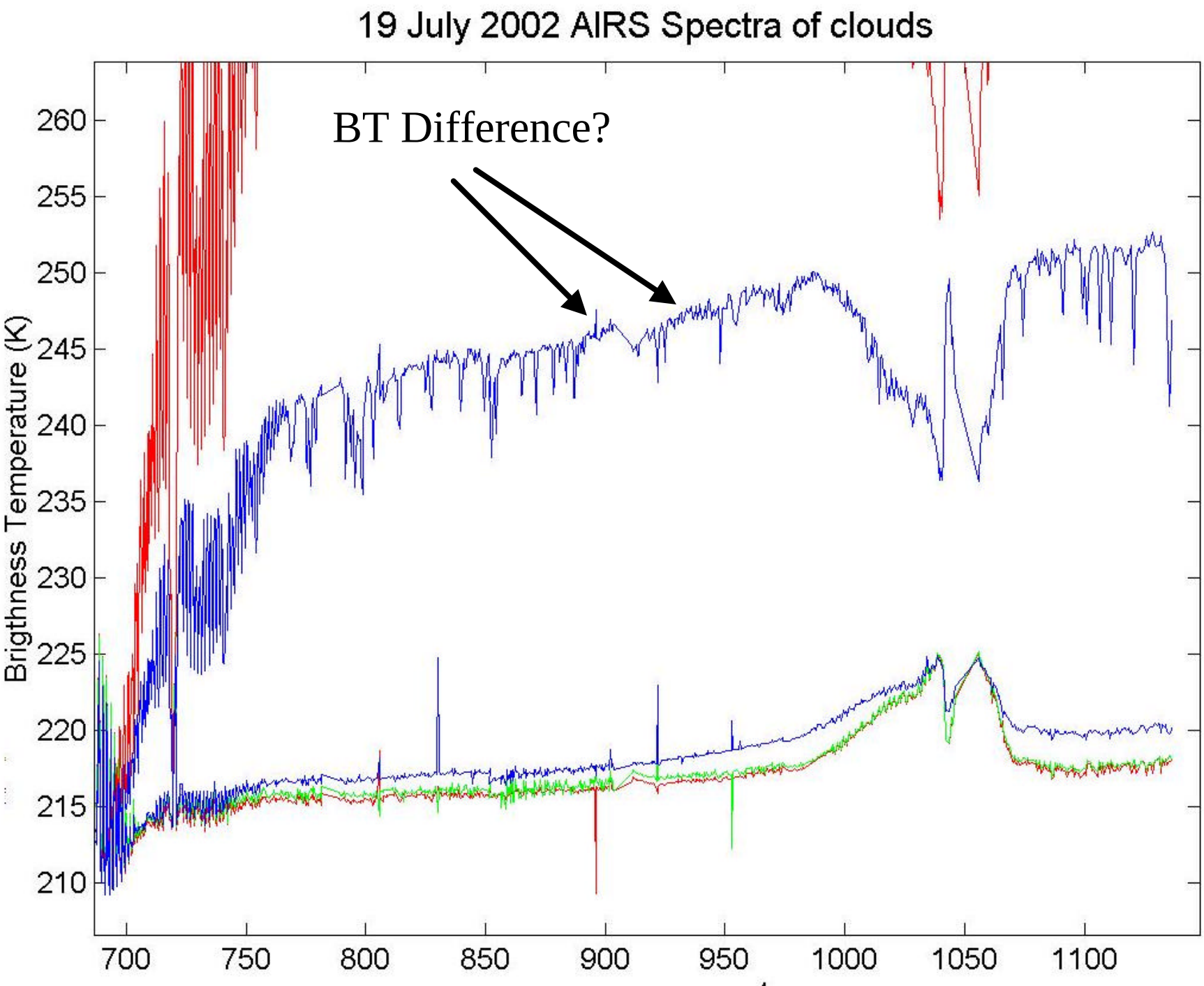
UW has a long history with high-spectral resolution measurement systems

Table 1. UW High-resolution Interferometer Sounder (HIS) Program

	Satellite Instrument Design	Instrument Developments	Field Programs
'79	HIS for GOES Soundings		
1980			
'81			
'82			
'83		HIS-Aircraft Instrument	
'84			
1985			
'86			Kitt Peak; COHMEX, SE US; FIRE 1, Wisconsin - HIS
'87	GHIS, GOES Mod – replace filter wheel with FTS	AIRS Competition	
'88			GAPEX, Denver – Uplooking HIS
'89	GAP, Geo for EOS Trace Gas Sounding		
1990	ITS, Itfr Thermal Sounder – EUMETSAT (CrIS Precursor)	AERI Groundbased system for DOE ARM Program [1990-96] Marine AERI [1995-97] Scanning HIS smaller aircraft instrument for UAV, ER-2, DC8 [1996-98] NAST-I Scanner for NPOESS Program [1997-98] PIFTS Planetary Imaging FTS [1998-02]	
'91			CaPE/SERON, SE US; FIRE 2 Kansas - HIS, SPECTRE, Kansas - AERI
'92			STORMFEST, SGP - HIS, AERI
'93			CAMEX 1, Atlantic Coast - HIS, AERI
'94	Small FTS NASA New Millennium Program (NMP)		ASHOE, New Zealand - HIS
1995			Gulf of Mexico - HIS, AERI; CAMEX 2 - HIS
'96			SUCCESS, SGP – HIS; CSP, TWP – AERI
'97	GIFTS Geo Imaging FTS Sounder (NASA NMP, Navy, NOAA) (HES/ABS Precursor)		WINCE, Wisconsin – HIS, AERI; FIRE 3, Alaska – HIS; SHEBA - AERI
'98			Wallops '98 – NAST, HIS; CAMEX 3, Atlantic/Gulf – NAST (ER2) SHIS (DC8); NOAA K, Dryden – SHIS (ER2); AERI
'99			WINTEX, Wisc (ER2) – NAST, SHIS, AERI; KWAJEX, Kwajalein - SHIS (DC8); Wallops '99 – NAST, Intessa
2000			SAFARI, S Africa – SHIS (ER2); AFWEX, SGP – NAST (Proteus); SHIS (DC8); WISC-T2000, Wisconsin – SHIS (ER2)
'01			Texas 2001 – SHIS (ER2); Trace-P, Pacific Rim – NAST (Proteus) CLAMS, Wallops – SHIS (ER2), NAST (Proteus)
'02			IHOP – SHIS (ER2); NAST (Proteus); CRYSTAL, NAST (Proteus)


April 20 1996
(12 total ER-2 overpasses of ARM CART site)
1604 UTC
1808 UTC
1833 UTC
1921 UTC
Brightness Temperature (K)
310
300
290
280
270
260
250
240
230
220
210
200
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
Wavenumber (cm-1)


Channels Used to Determine Clear/Cloudy Spectra Over Polar Regions
Brightness temperature spectrum taken 18 June 1997
Brightness temperature spectrum taken 12 December 1996
Cloudy
Clear
Channel 6
Channel 7
Brightness Temperature, K
Wavenumber, cm^{-1}
280
275
270
265
260
255
250
245
240
780
781
782
783
784
785
786
787
788
789
790


19 July 2002 AIRS Spectra of clouds
BT Difference?
Brigthness Temperature (K)
260
255
250
245
240
235
230
225
220
215
210
700
750
800
850
900
950
1000
1050
1100

Products in 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 (in transition)	
Derived wind fields (shear, divergence, etc)	
Hurricanes	
Objective Dvorak technique (SAB)	
Intensity estimates (from *AMSU-A*)	
Sea Surface Temperature	Clouds
	Site-specific Cloud Product
Biomass Burning	Single FOV product DPI
(produced 24x7)	
Rainfall	Retrievals
(auto-estimator via G. Vicente)	Temperature/moisture
	Layer PW
	Clear-sky Brightness Temperature
Clear-sky Brightness Temperature	

GOES in NWP, routine and experimental:

Model	GOES Data
NCEP Global	Sounder Radiance, Imager Winds, Imager Radiances
Eta Model	Sounder Radiance, Sounder PW, Imager Winds, Sounder Clouds
FSL's RUC	Sounder TPW, Sounder Clouds
CIMSS CRAS	Sounder PW, Sounder Clouds
Australia (LAPS)	Imager Winds
ECMWF	Imager Winds, Imager Radiances
GFDL (experimental)	Imager Winds, GWINDEX rapid-scan winds
NOGAPS	Imager Winds, Sounder Winds
NAAPS	Biomass Fire Product
CSU RAMS (University of Sao Paulo/NASA-Ames)	Biomass Fire Product
UW ALEXI	Sounder Skin Temperature time-change

Data Assimilation -- CIMSS has a role in every listed GOES product

The road to the next generation Geostationary Sounders

(# of channels)

(~1600) ***HES*** (operational)

(~1600) ***GIFTS*** (experimental)

CrIS (operational)

IASI (operational)

(~2400) **AIRS** (operational)

(18) ***GOES Sounder*** (operational)

Aircraft data (experimental), **IMG**

(12) ***VAS*** (experimental)

Ground-based (exp)

HIRS (operational)

IRIS (experimental)

Pioneering work (theory)

time

To be ready for the HES system, we must learn from preceding instruments.

GIFTS PAP
Algorithm Development

- Radiances
- Atmospheric Soundings
- Winds
- Clouds
- Surface
- Composition
- Radiation Budget
- Data and Product Access and Visualization

Definitions of Algorithm Types for GIFTS

- Validation – Features: satisfy NASA/Navy validation needs, case study application, become next generation operational algorithms

- Demonstration – Features: satisfy NOAA demonstration needs, Real-time application,

FY03 Writing Activities

⇒ Outline of NOAA Product Algorithm Description
⇒ Draft of NOAA Product Algorithm Description
⇒ Version 1 of key NOAA Product Algorithm Description
⇒ Conference papers on key GIFTS algorithms
⇒ Support NOAA Reviews
⇒ Support CDR Materials
⇒ Submit one or more papers on NOAA Product Algorithms
⇒ Grant Annual Report/Continuation Proposal

UW's Experience and Expertise will establish and execute "day one" algorithms for GIFTS (and approaches for HES)