



CIMSS Story & Highlights (1975 – 1997)

In dedication to our founding father, Verner E. Suomi (1915 - 1995)

1975



UW (V. Suomi) and NESS (W. Smith) agree that UW-SSEC and NESS Radiation Branch should combine forces for building the ground data processing system for the GOES-D VAS

(Vern Suomi gets support from Dave Johnson, Director of NESS, and Bill Smith gets agreement from key NESS sounding team members to move to Madison.)

- The UW had the data reception capability and McIDAS
- NESS had the sounding data processing algorithms and software
- McIDAS was felt to be a key element in order to obtain reliable mesoscale value of VAS

Nimbus-6 is launched with HIRS and ERB

UW-SSEC, NASA GSFC, and NESS sounding group work VAS design and oversee VAS instrument development by Santa Barbara Research Center, CA

1976



Australia Connection

Bill Smith's 10 month visit to Melbourne Australia, to work with Kelly, LeMarshall, et. al., (BoM), Platt, Dilly, et. al (CSIRO) and trip across the Nullabor to meet Merv Lynch at WAIT, develops the everlasting Australian connection.

- Australia possessed regional model
- US possessed satellite data

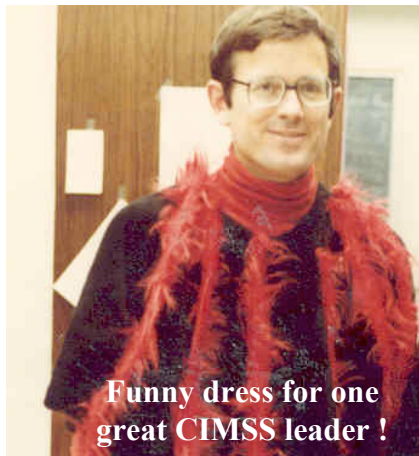
(Remainder of NESS group continues processing of Nimbus 6 HIRS/MSU/SSU and ERB data.

Data communications link between Canberra Australia and NASA GSFC established to communicate real-time Nimbus satellite radiances and products to Australia.)

- Strong positive impact of N-6 soundings on Australian region forecast shown
- CSIRO LIDAR data used to validate CO₂ slicing cloud height concept using Nimbus-5 ITPR data (important for future VAS cloud wind height assignment)

Seeds planted for future CIMSS/Australia cooperation, and personnel exchange, for research on the applications of satellite sounding and wind data to the numerical analysis/prediction

1977



NESS scientists arrive in Madison May, 1977

(Bill Smith, Kit Hayden, Ben Howell, Fred Nagle, and Hal Woolf. Dave Small proceeded them to set up logistics for move. Others (e.g., Geary Callan, Leroy Herman, John Lewis, Bob Aune, Cecil Parish, et. al.,) follow later. The Mesoscale Sounding Branch of NESDIS is formed at UW-Madison.

Work begins on VAS data processing system.

- NESS group teams with Prof. Suomi's team (Revercomb, Sromovsky, Menzel, Krauss, Dedecker, Benson, Daly, Hibbard, Davis, Eric Suomi, Norton, and others)
- Students, beginning with those of Prof. Suomi and Horn, get involved and many of them eventually become key members of the soon to be formed CIMSS (e.g., Wade, Schreiner, Diak, Velden, A. Huang, Prins, Frey, Strabala, Schmit, Lee, Moeller, Van Delst, Wu, Nelson, Feltz, Gumley, Olander, Deslover, B. Huang, and others).
- VAS thought to be limited for mesoscale sounding applications because of poor spectral/vertical resolution.
 - MSB developed partial interferometer approach as VAS replacement on GOES
 - SSEC (Revercomb and Sromovsky) developed instrument techniques to accomplish the desired interferometer measurements.

This is the very beginning of Hyperspectral Sounding

1978



*Group also prepares for the launch of
TIROS-N Operational Vertical Sounder
as a prelude to GOES-VAS.*

*(The TOVS contained the HIRS instrument, which was
like VAS, and a microwave sounding unit, MSU)*

- A local VHF antenna and direct readout system was put in place at UW-Madison, along with communications to S-Band receivers located at Wallops Is. VA, Redwood City CA, and Gilmore Creek AL were established
- **A McIDAS-based direct readout TOVS sounding data processing system was developed by the joint NESDIS/SSEC group. This system will evolve into the International TOVS Processing Package!**

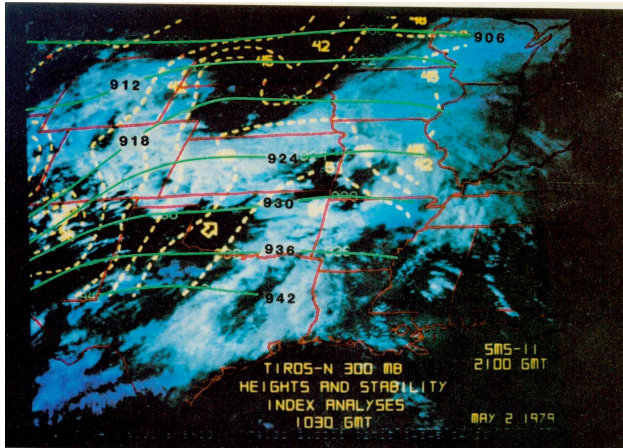


TIROS-N is launched on October 13, 1978

- Direct readout TOVS data received at UW-SSEC
- **Mesoscale soundings produced using McIDAS-based TOVS sounding software developed by the soon to be called CIMSS team**

1979

Mesoscale Applications of TIROS-N/NOAA-6 (27 June 1979) conducted to prepare for VAS



– Total-totals stability index from early morning (7 AM) NOAA-6 data to forecast where convective storms would develop (daily forecasts which received NSSFC attention).

The 7 AM NOAA-6 and 3 PM TIROS-N data provided a rough glimpse of what VAS would provide in terms of diurnal change weather forcing atmospheric variables.

– McIDAS proves crucial for subjectively separating mesoscale features from sounding retrieval cloud induced noise.

- McIDAS used for “Special Effort” to improve satellite sounding data and winds for FGGE.
- Daily real-time processing of T-N / N-6 direct readout TOVS data produces exciting glimpse of mesoscale sounding forecast capabilities of geostationary satellite sounding system to come.
- Thermal winds from soundings combined with cloud motions to provide “wind profiles”
- ***Value of McIDAS for editing and enhancing sounding data proven***
- Interferometric sounding technique matures with realistic simulations. Aircraft demonstration proposed. ***High resolution Interferometer Sounder (HIS) Program Begins***

***(Smith goes to China as part of US scientific delegation -
Beginning of strong Chinese Connection to CIMSS)***

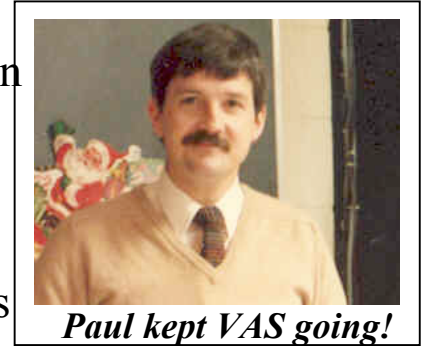
1980



VAS Launched on Sept. 9, 1980 !

- First results were outstanding in terms of spatial and time consistency

- Good agreement with NOAA TOVS retrievals and radiosondes



- SST from combined polar and geostationary data
- Surface energy budget from satellite data

-CIMSS was Formalized

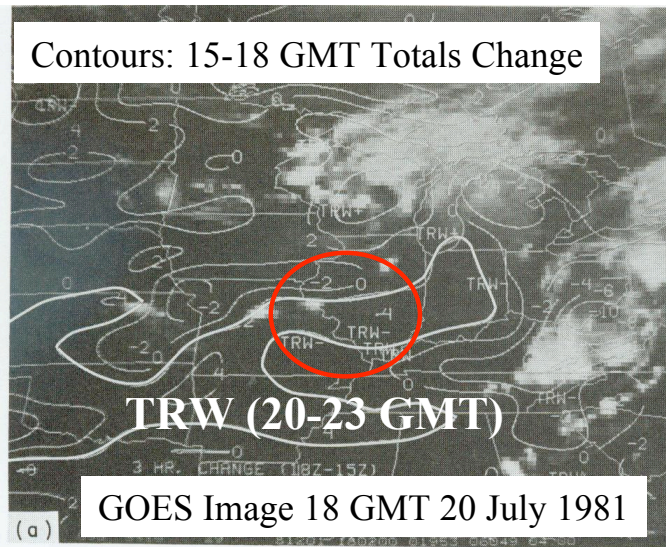
- Suomi wanted to insure security for the NOAA staff who moved their families to Madison

- V. E. Suomi was the first CIMSS Director

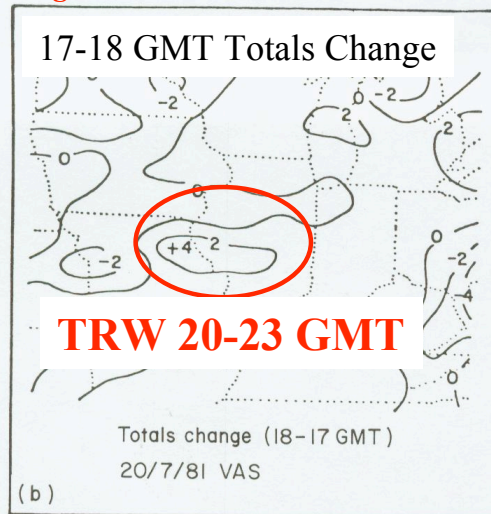
- Consisted of NOAA and UW employees and students

- CIRA @ Colorado State University formed as partner institute within new "Development Laboratory" of NESS (W. Smith, Director)

1981



1-Hr Change Occurred 3 hr Prior to Thunderstorms



Severe Weather Forecasting Potential of VAS Demonstrated

- Led to installation of McIDAS at the National Severe Storms Forecast Center
- Time variation of Total-Totals stability index used to predict location of afternoon thunderstorms

TOVS Export Package Produced

- Intended for direct readout users of TIROS-N/NOAA satellite data
- Initiated plans for the International TOVS Working Group of the IRC/IAMAS
- TOVS Sounding impacts limited area model forecasts
- Sea surface temperature derived from VAS data



Zhou Feng Xian (Chinese IAP)

Feng Xian brought the Chinese scientific talent to CIMSS which contributed greatly to the success of CIMSS science programs beginning with the VAS

1982



Mr. McIDAS

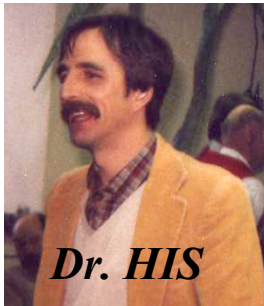
McIDAS/VAS inspired Centralized Storm Information System

- McIDAS installed at National Severe Storms Laboratory (NSSL) in Kansas City
- McIDAS installed at National Hurricane Center (NHC) in Miami
- Australian based CIMSS NWP Model produces Mesoscale forecasts with VAS data

High resolution Interferometer Sounder

funded by NASA and NOAA

- SSEC teamed with Santa Barbara Research Center (optical/detector assembly) and BOMEM (FTS)
- Full interferogram interferometer chosen as risk free approach (i.e., few accepted partial interferogram concept)



Dr. HIS

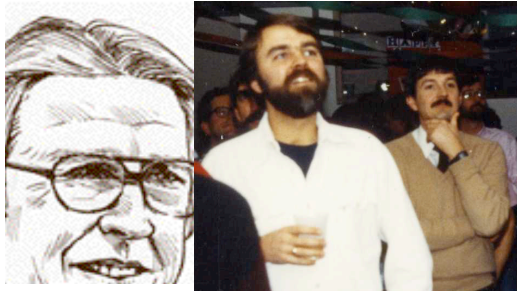
Satellite Hurricane Research Transitions into Operations

- Intensity (eye surface pressure) from microwave sounder upper level warm core
- Close interaction with NHC
 - o Use of VAS water vapor tracer and thermal winds to forecast landfall position
 - o Improved cloud motion winds through VAS CO₂ slicing altitude assignment
 - o Real-time VAS data interpretation support by CIMSS



TCs are fun!!

1983



A Rare Moment Relaxing
(ITOVs Supporters)

International TOVS Working Group Formed

- Beginning of large scale international cooperative effort on retrieval and use of satellite sounding data
- 14 meetings held since 1983
- recommendations guide the World Meteorological organization
- TOVS export package (original ITPP) distributed International community begins using TIROS-N/NOAA satellite data

NHC and NSSL Applications Support

- Real-time VAS and NOAA satellite PW and Stability Products
- TS trajectory forecasts using VAS cloud/water vapor winds

1984



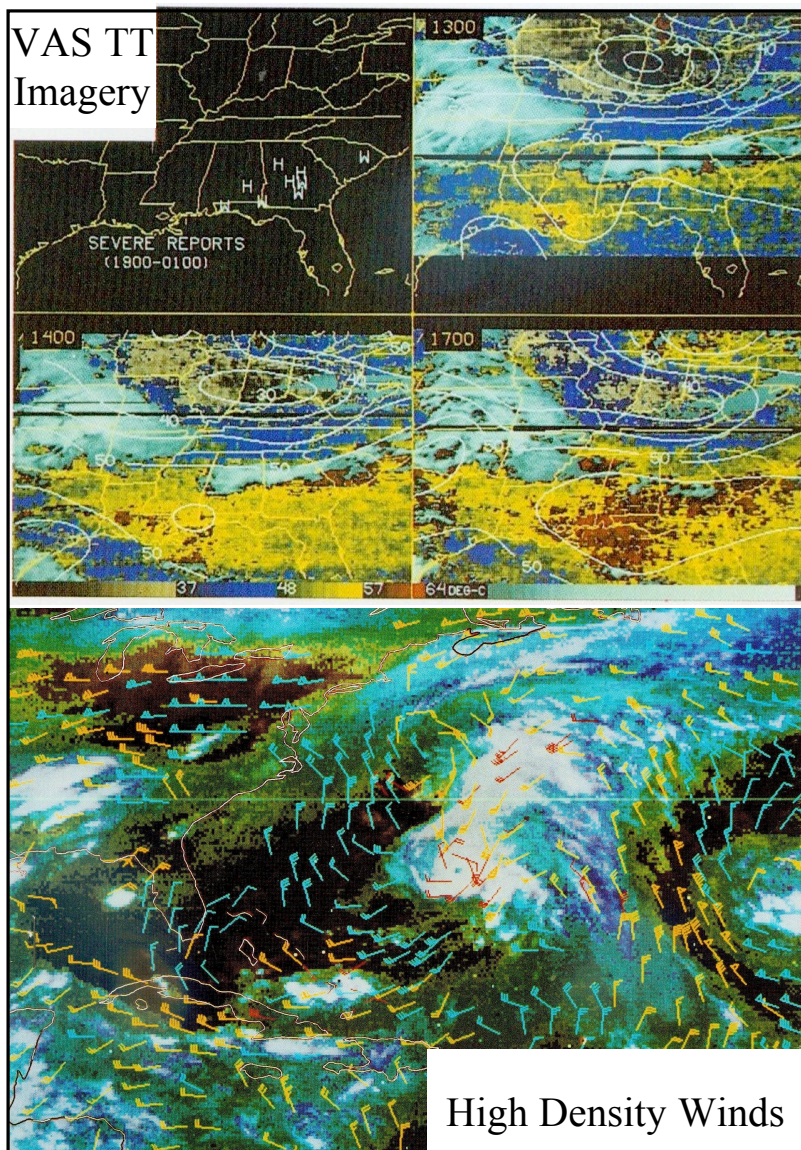
Dress-code Difference ?? *Ben puts CIMSS in the AIR!*

*Smith Transitions from NOAA to UW
to become Professor & Director of CIMSS*

Hurricane Research and Operations

- CIMSS works closely with NHC
- NWP model prediction of hurricane track using VAS soundings and winds (e.g., Hurricane Debby)

1985



Combined Satellite Sounding and Imagery

- Helps forecasters by being able to see VAS sounding information relative to cloud cover
- Used at weather service forecast offices

First ER-2 Flights of HIS during Oklahoma-Kansas PRE-STORM Experiment

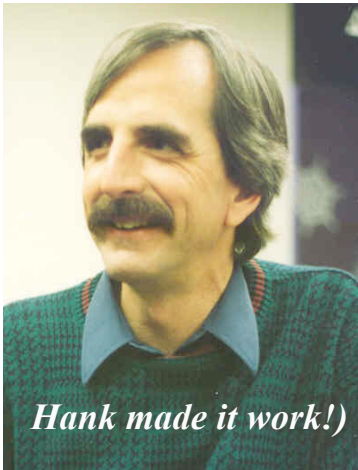
- First data noisy due to sample position errors caused by mirror vibration during its movement
- After slowing down Michelson mirror (a twist of a mirror speed dial), the spectra were great!
- Additional flights over Colorado in the fall reveal much improved performance
- VAS used to estimate PBL height

VAS Used by Forecast Centers

- NSSFC uses VAS stability indices in production of convective storm outlook
- Trajectory models show positive impact of VAS thermal and cloud/water vapor winds
- High density, manually produced, water vapor winds

HIS Has Very Successful ER-2 Flights During COHMEX and FIRE

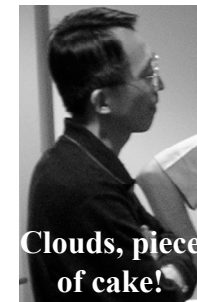
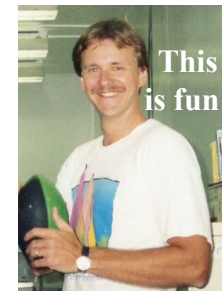
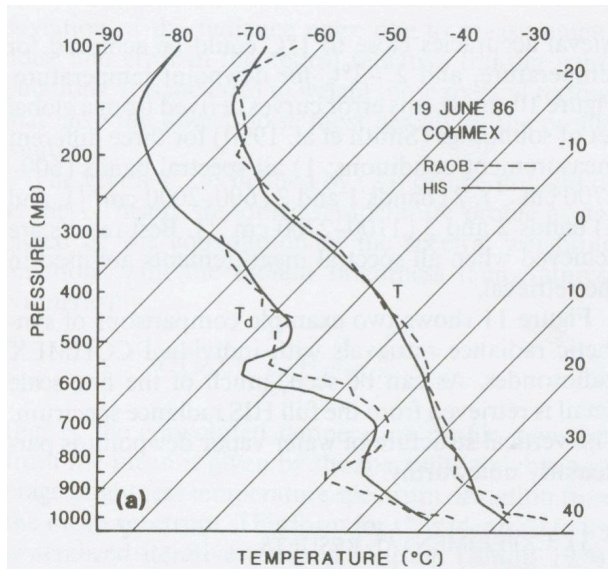
1986



- Accurate radiometric calibration methodology developed
- *First validated high vertical resolution mesoscale soundings produced during COHMEX (Alabama)*
- COHMEX soundings lead NASA and NOAA to consider HIS for advanced sounders
- Interferometer sounder considered for 3-axis GOES-Next (GOES-8 series)
- FIRE-I, held in Madison, shows HIS potential for observing Cirrus cloud microphysics

Sounding Applications & Improvements

- Ocean energy flux obtained from VAS data
- Cloudy satellite sounding profiling improved
- Atmospheric transmittance using Kitt Peak Telescope
- Improved cloud heights using HIS hyperspectral CO₂ slicing



1987



Isentropic Coordinates Only !

EOS Polar Platform AIRS Interferometer Proposed

- Although unsuccessful for EOS, HIS based proposal adopted for METOP

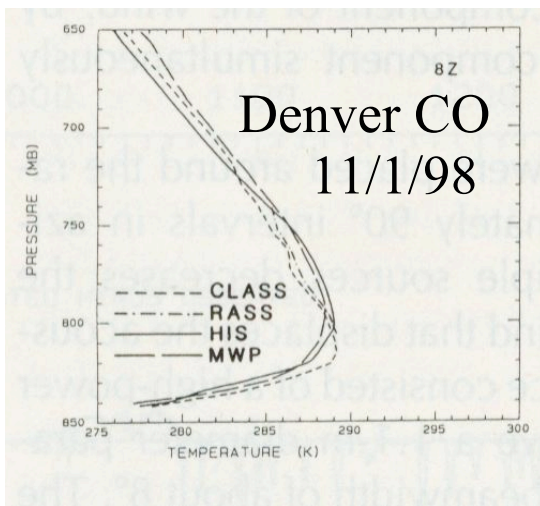
Moisture Emphasized

- Water vapor continuum validated with HIS
- Moisture structure retrieved from high resolution MAMS data
- Water vapor transport observed over the Amazon region

GAPEX (Ground Atmospheric Profiling Experiment)

- Initiates AERI development
- HIS at DEN looking up from the ground rather than down from an aircraft
- *High vertical resolution PBL profiles observed (i.e., surface inversion characteristics)*
- Led to development of Atmospheric Emitted Radiance Interferometer (AERI) for DoE ARM program

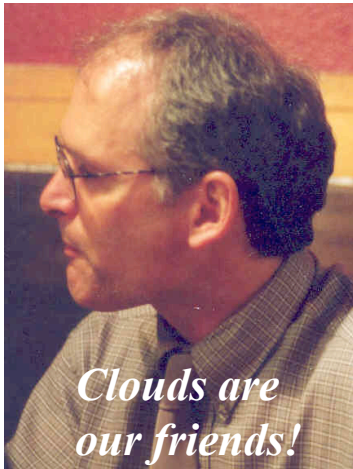
1988



VAS Applications Improved

- Cloudy Soundings Improved with use of Visible Data
- VAS Imagery & Soundings integrated into NWP

1989



*Clouds are
our friends!*

1990



Mr. AERI

***HIS Data Analysis leads to
Hyperspectral Sounding Emphasis***

- Spectral Radiative Properties of CIRRUS diagnosed with HIS
- Vertical sounding resolution advantage of HIS analyzed
- Land surface energetics and PBL development
- Ozone measurements
- Biomass burning detection

DoE ARM Program is Initiated

Atmospheric Emitted Radiance Instrument Development

- AERI based on capabilities demonstrated GB-HIS experiment
- Simplified ruggedized autonomously operated upward looking FTS
- Research on operational retrieval software intensified

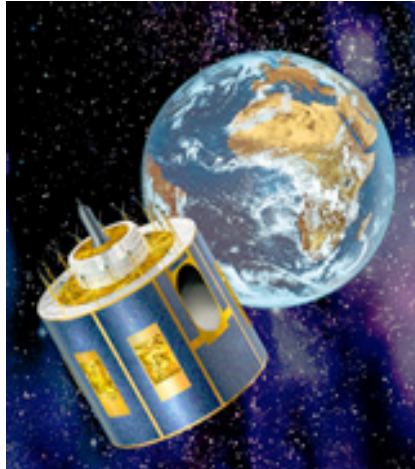
GOES High resolution Interferometer Sounder (GHIS)

- Replace GOES Filter Wheel with an interferometer for GOES-L,M,N,O,P
- ITT and MIT-LL successful demonstrate concept

Applications Demonstrated with HIS & VAS

- Simultaneous parameter retrieval demonstrated
- Ocean currents from time-sequenced VAS
- Assimilation of ERBE data to improve cloud diagnosis within NWP model
- Surface emissivity spectral characteristics

1991



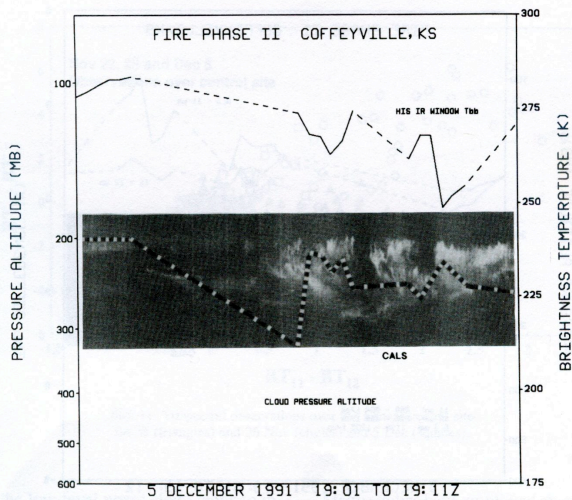
EUMETSAT Ties Strengthened

- *SEVERI* instrument spectral specification (Smith spends 6 months at EUMETSAT)
- Interferometer Thermal Sounder (ITS) study performed by UW/SSEC with SBRC sponsored by EUMETSAT
- ITS design intended for NOAA HIRS replacement

The 2nd First International Satellite Cloud Climatology Experiment (FIRE-Phase II) Kansas

- Cloud properties
 - Microphysical properties
 - Type and height

1992/1993



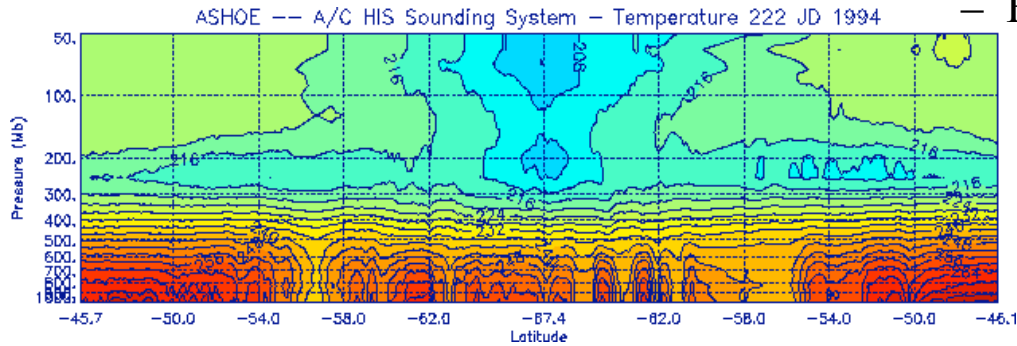
CRAS
*Satellite Data
Assimilation
Studies
Continue*

Hyperspectral Radiance Studies

- Trace gas concentration from HIS local variance
- Optimal spectral channels for Cirrus detection
- Water vapor radiance cloud height estimation
- Water vapor information content of solar absorption spectra
- HIS used to validate HIRS measurements and calculations
- Retrieval of ozone profile

1994

Airborne Southern Hemisphere Ozone Experiment



– Eigenvector Regression Technique

- demonstrated robustness in application to Southern Hemisphere remote oceanic data
- provide SH oceanic validation for five different NWP model

3-axis Stabilized GOES-8 Launched !!

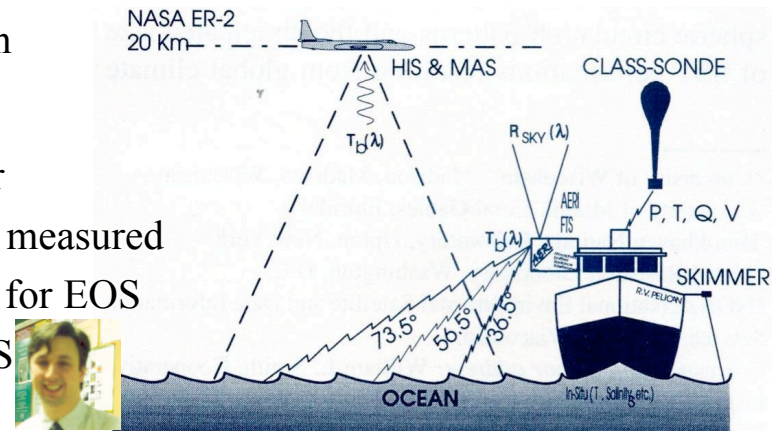
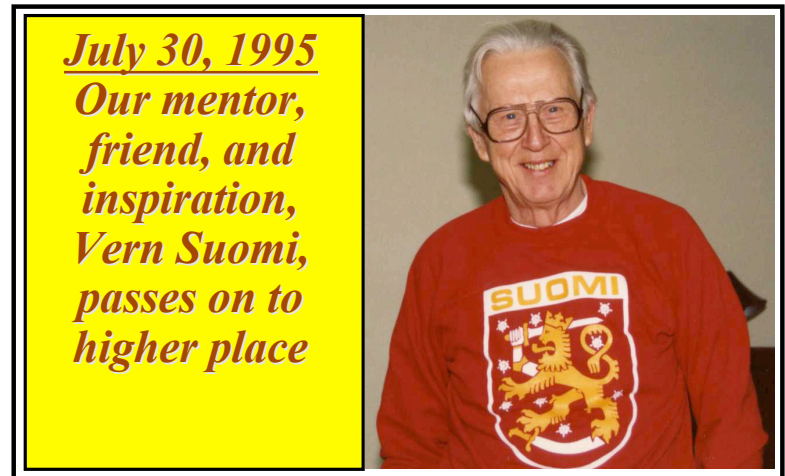
- CIMSS provides sounding software
- CRAS produces GOES IR imagery forecast

1995

- ITS design adopted for NPOESS CrIS instrument
- CAMEX-I HIS data assimilation demonstrates potential of GHIS (land/sea breeze moisture circulation observed)

AERI GOES TO SEA

- Sea surface temperature observed with $< 0.2^{\circ}\text{C}$ error
- Ocean emissivity angular and sea state dependence measured
- Led to development of the Marine AERI (MEARI) for EOS
- High accuracy SST retrieval demonstrated with HIS



1996/1997

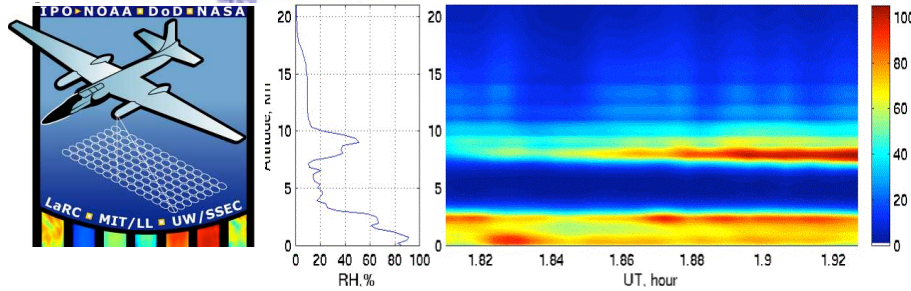
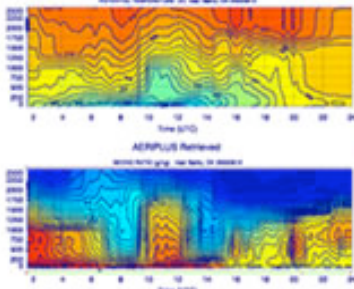


SUCCESS Field Campaign Conducted

- Cloud properties
 - Altitude using minimum spectral emissivity variance
 - Detection of strong spectral dependence of IR absorption by “invisible” cirrus

AERI/MAERI Remote Sensing Accomplishments

- Robust recursive retrieval algorithm developed and tested
- Routine PBL retrievals for at DoE ARM CART-site
- Ocean surface emissivity model improved

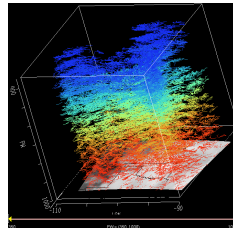
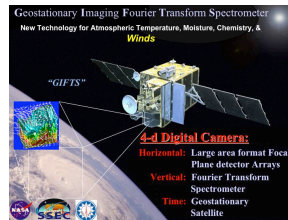


Scanning HIS and NAST Development Begins

GIFTS Imaging Spectrometer Concept Developed

(Water Vapor Flux & Wind Profiles)

Smith departs for NASA



To Be Continued by Paul Menzel, Don Johnson, and Steve Ackerman



A Special Thanks

- Professor Verner Suomi, the inspiration for CIMSS
- The SSEC Support Staff (Tom Haig, Bob Fox, John Roberts, and all their excellent administrative staff)
- NOAA, for establishing and maintaining CIMSS
- NASA, NOAA, NSF, Navy, Air Force, EUMETSAT, IPO, and others for its support of CIMSS research and development programs
- The international highly talented, and success oriented, CIMSS staff
- The visiting scientists, from over 18 nations around the world, who devoted their talents and energy towards the success of CIMSS programs
- The 80+ graduate students working on CIMSS projects, most of which have become today's scientific leaders across the globe
- God, for blessing CIMSS with people that have made it the "World Class" R & D organization that it is