CURRENT STATUS OF LOSSLESS COMPRESSION OF ULTRASPECTRAL SOUNDER AND HYPERSPECTRAL IMAGER DATA

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SSEC/CIMSS Satellite Data Compression Web site:
http://math.ssec.wisc.edu/compression/

1St IASI International Conference, Anglet, France, 13-16 November 2007

C I M S S

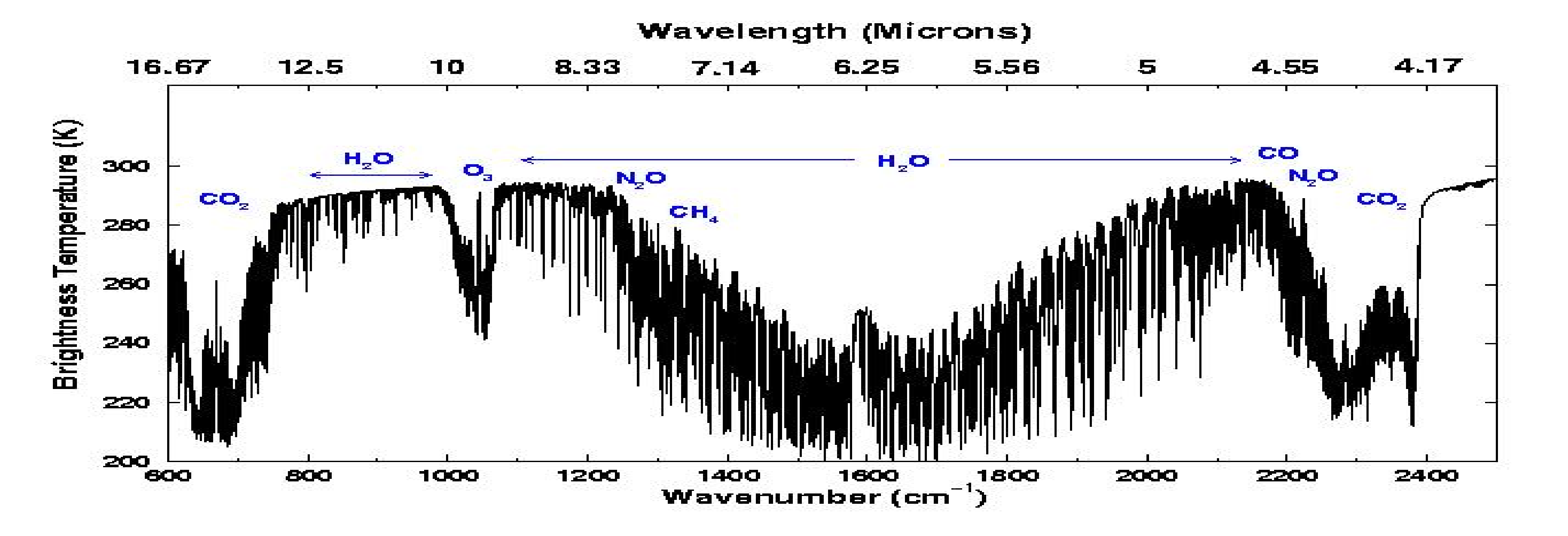
SSEC

INTRODUCTION

➢Contemporary and future ultraspectral sounders (e.g. AIRS, IASI, GIFTS) and hyperspectral imagers (e.g. AVIRIS) provide high spectral and spatial resolutions for improved weather/climate forecast and geographic information.

➢ Given the unprecedented volumes of three-dimensional data generated by these advanced sensors, the use of robust data compression techniques will be beneficial for data transmission and archiving.

➢In support of the NOAA next-generation GOES data processing, UW SSEC/CIMSS developed various 2D/ 3D lossless compression methods and data preprocessing schemes applied to the AVIRIS, AIRS, IASI, and GIFTS data.



INTRODUCTION – Continues with a short story …..

Application of Principal Component Analysis to High-Resolution Infrared Measurement Compression and Retrieval

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ABSTRACT

A simulation study is used to demonstrate the application of principal component analysis to both the compression of, and meteorological parameter retrieval from, high-resolution infrared spectra. The study discusses the fundamental aspects of spectral correlation, distributions, and noise; the correlation between principal components (PCs) and atmospheric-level temperature and water vapor; and how an optimal subset of PCs is selected so a good compression ratio and high retrieval accuracy are obtained.

Principal component analysis, principal component compression, and principal component regression under certain conditions are shown to provide 1) nearly full spectral information with little degradation, 2) noise reduction, 3) data compression with a compression ratio of approximately 15, and 4) tolerable loss of accuracy in temperature and water vapor retrieval. The techniques will therefore be valuable tools for data compression and the accurate retrieval of meteorological parameters from new-generation satellite instruments.

INTRODUCTION – Continues with a short story …..

NASA's Science Mission Directorate Awards 64 Grants for the NASA Research Announcement (NRA) Modeling, Analysis and Prediction Climate Variability and Change

………………

Haine, Thomas Johns Hopkins University
Space-Based Estimates of Arctic/Sub-Arctic Exchange Using Data Assimilation and Ocean Models

Hansen, James Goddard Institute for Space Studies
Global Climate Model Development

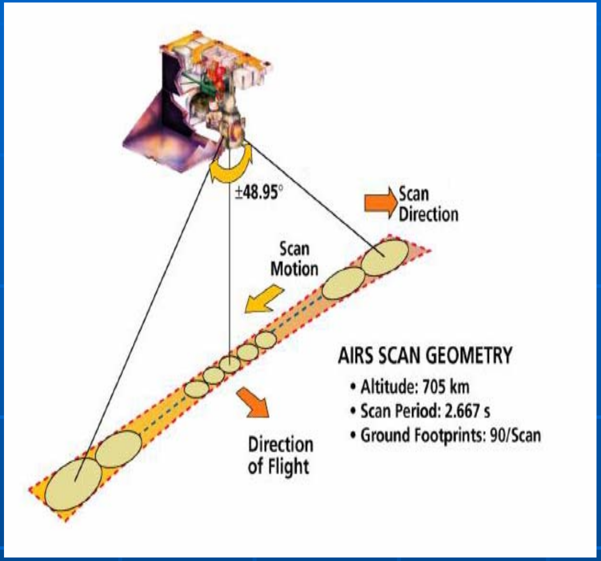
Huang, Hung Lung University of Wisconsin-Madison
FPGA Re-Configurable Computation Demonstration: AIRS/MODIS Co-Registration and Cloud Characterization for Data Assimilation

Jacob, Daniel Harvard University
Investigation of the Effects of Land Cover Change on Chemistry-Climate Interactions
……………… 2005-2006

AIRS ULTRASPECTRAL GRATING DATA COMPRESSION

10 selected NASA AIRS digital counts granules on March 2, 2004

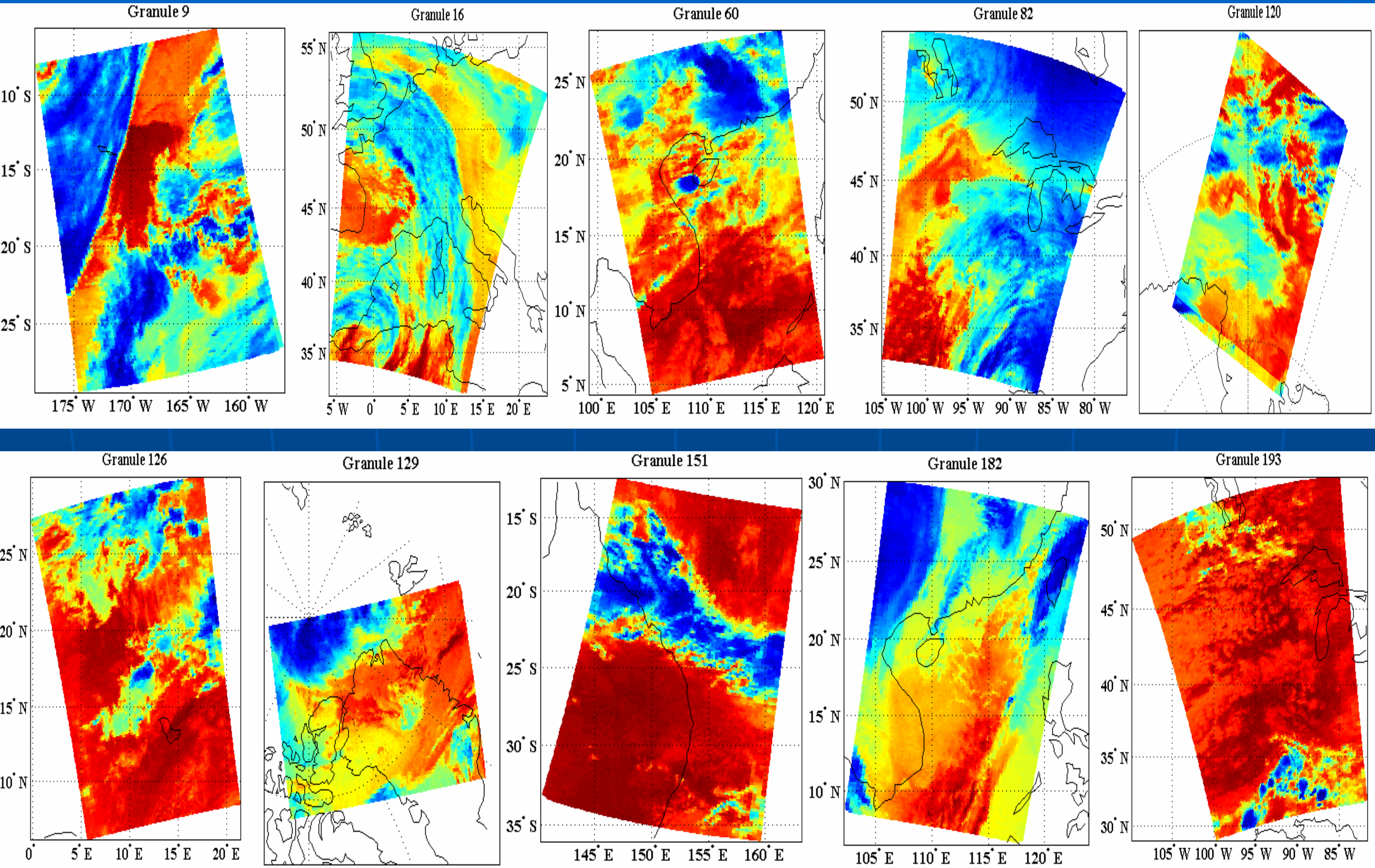
Granule 9	00:53:31 UTC	-12 H	(Pacific Ocean, Daytime)
Granule 16	01:35:31 UTC	+2 H	(Europe, Nighttime)
Granule 60	05:59:31 UTC	+7 H	(Asia, Daytime)
Granule 82	08:11:31 UTC	-5 H	(North America, Nighttime)
Granule 120	11:59:31 UTC	-10 H	(Antarctica, Nighttime)
Granule 126	12:35:31 UTC	-0 H	(Africa, Daytime)
Granule 129	12:53:31 UTC	-2 H	(Arctic, Daytime)
Granule 151	15:05:31 UTC	+11 H	(Australia, Nighttime)
Granule 182	18:11:31 UTC	+8 H	(Asia, Nighttime)
Granule 193	19:17:31 UTC	-7 H	(North America, Daytime)



- Each granule consists of 2378 channels with 135 scan lines containing 90 cross-track footprints per scan line.
- Test data publicly available via anonymous ftp

(ftp://ftp.ssec.wisc.edu/pub/bormin/Count)

AIRS digital counts at 800.01cm^{-1} for the 10 selected granules



Bias-Adjusted Reordering (BAR) Preprocessing Scheme

- Ultraspectral sounder data features strong correlations in disjoint spectral affected by the same type of absorbing gases at various altitudes

- The Bias-Adjusted Reordering (BAR) preprocessing scheme is used for exploring the correlation among remote disjoint channels

- This preprocessing technique aims to improve the compression ratio of any existing scheme

The BAR Scheme (patent application pending)

Given the *i-th* reordered vector $\tilde{V}^i$, we are seeking V^* and b^*, the minimum norm solution of

$$\min_{\substack{V \in S \\ b \in \square}} f^i(V, b),$$

where the cost function is $f^i(V,b) = \left\| \tilde{V}^i - V - b \right\|^2 = \sum_{k=1}^{n_s} (\tilde{v}_k^i - v_k - b)^2$

Then the $(i+1)$-*th* reordered vector is simply $\tilde{V}^{i+1} = V^* + b^*$

b^*

The optimal value of b* is obtained by $\left. \frac{\partial f^i(V,b)}{\partial b} \right|_{b=b^*} = 0,$ which yields

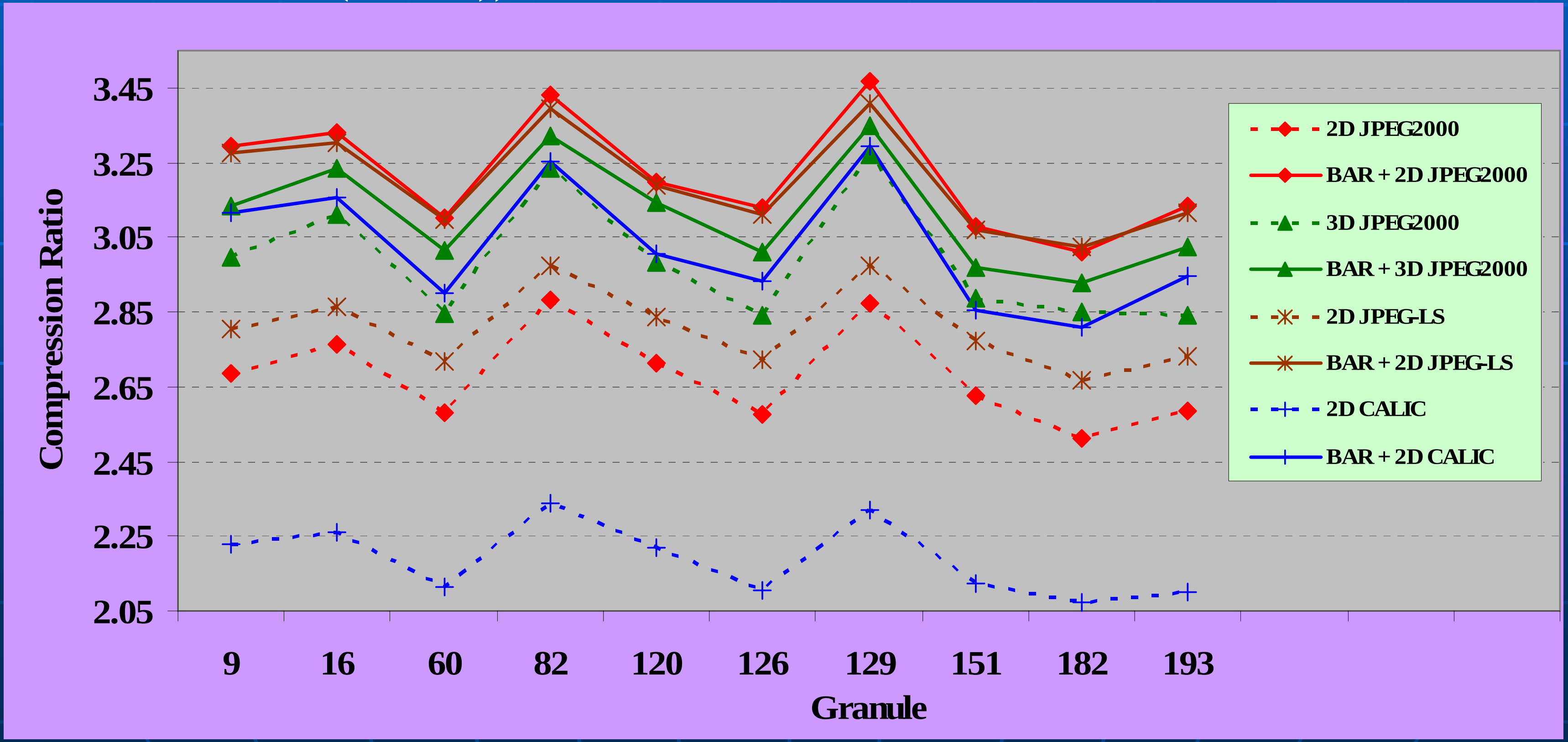
$$b^* = \frac{1}{n_s} \sum_{k=1}^{n_s} (\tilde{v}_k^i - v_k) = \langle \tilde{V}^i \rangle - \langle V \rangle$$

For lossless compression, is rounded to the nearest integer [b*] and the $(i+1)$-*th* reordered vector becomes

$$\tilde{V}^{i+1} = V^* + [b^*]$$

CIMSS-DEVELOPED DATA PREPROCESSING SCHEME

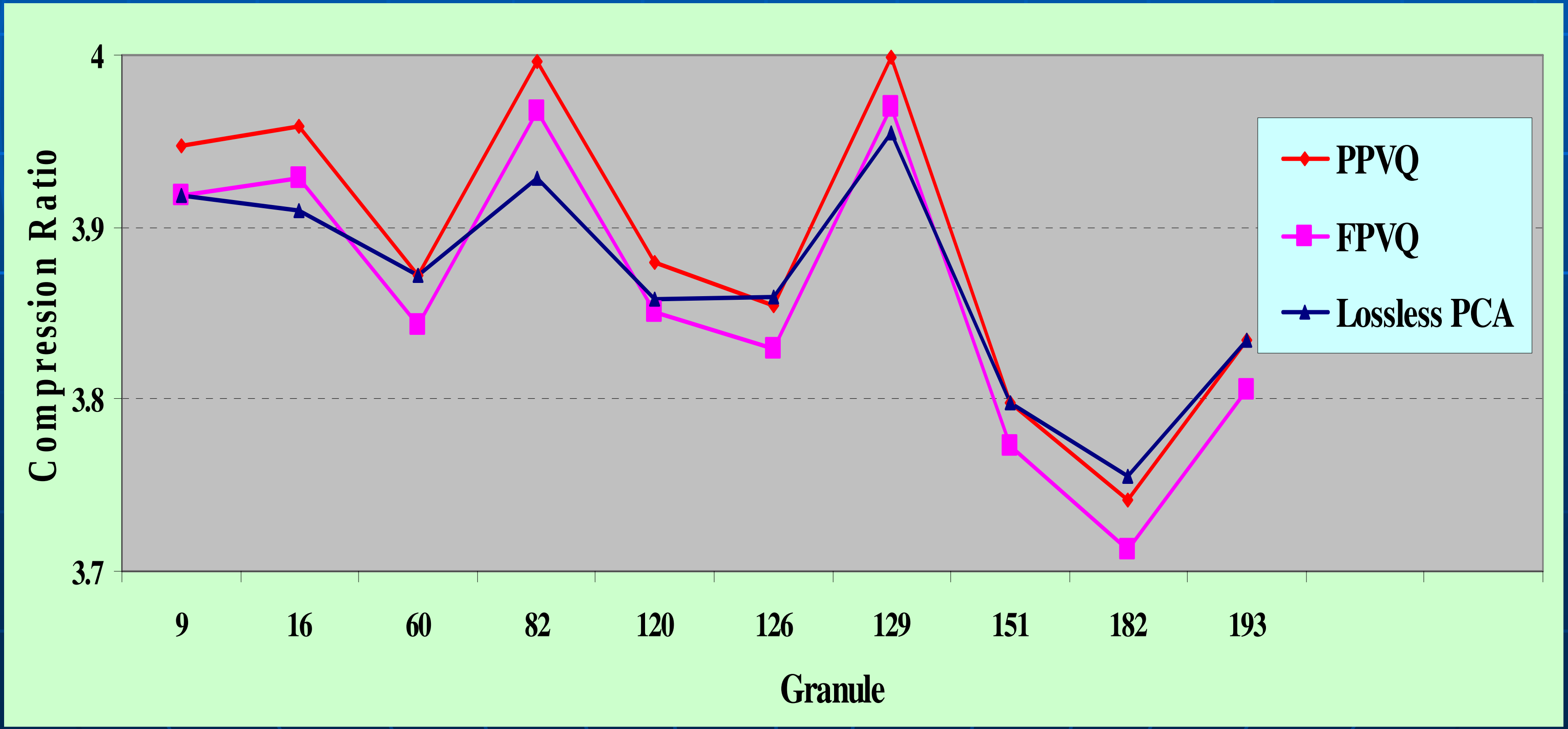
CIMSS's Bias-Adjusted Reordering (BAR) data preprocessing scheme (*Huang et al. 2004*) improves the performance of existing state-of-the-art compression methods (2D CALIC, 2D JPEG-LS, 2D JPEG2000 (Part 1), 3D JPEG2000 (Part 2))



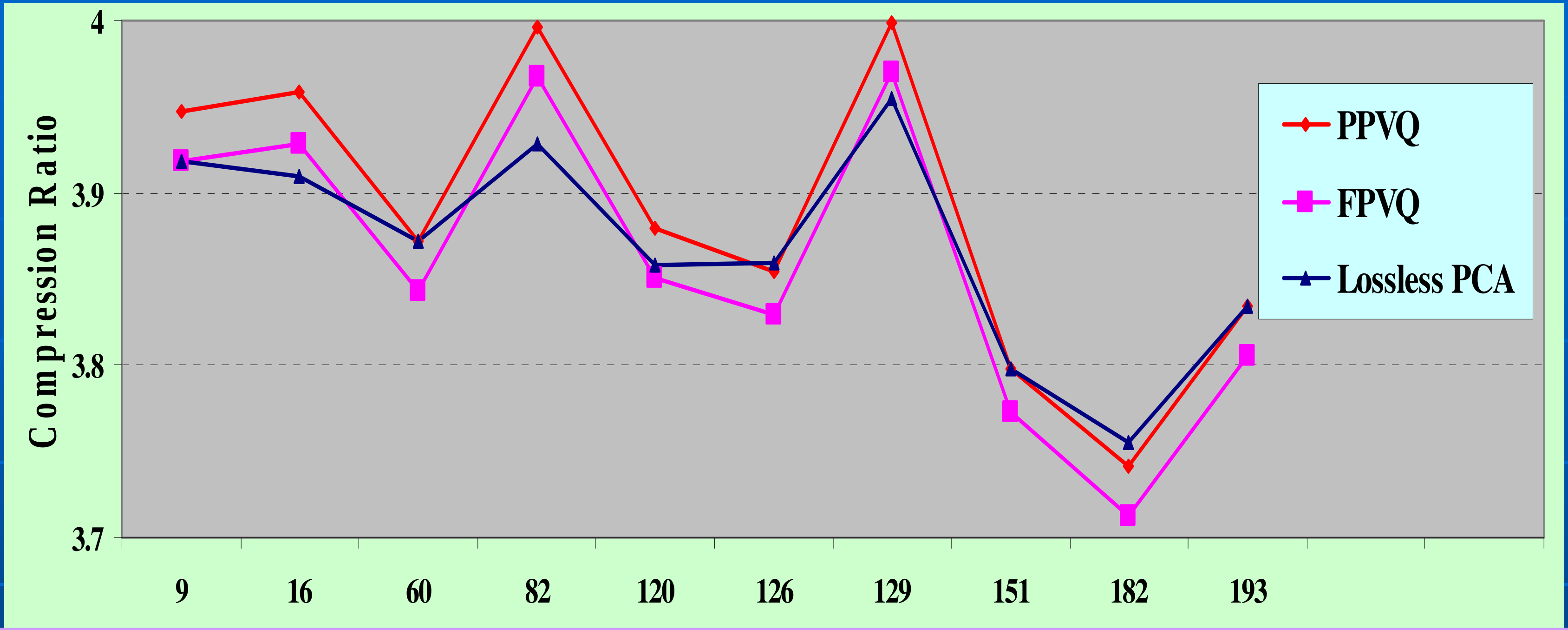
JPEG-LS: Former ISO lossless standard
JPEG-2000: Current ISO lossless standard

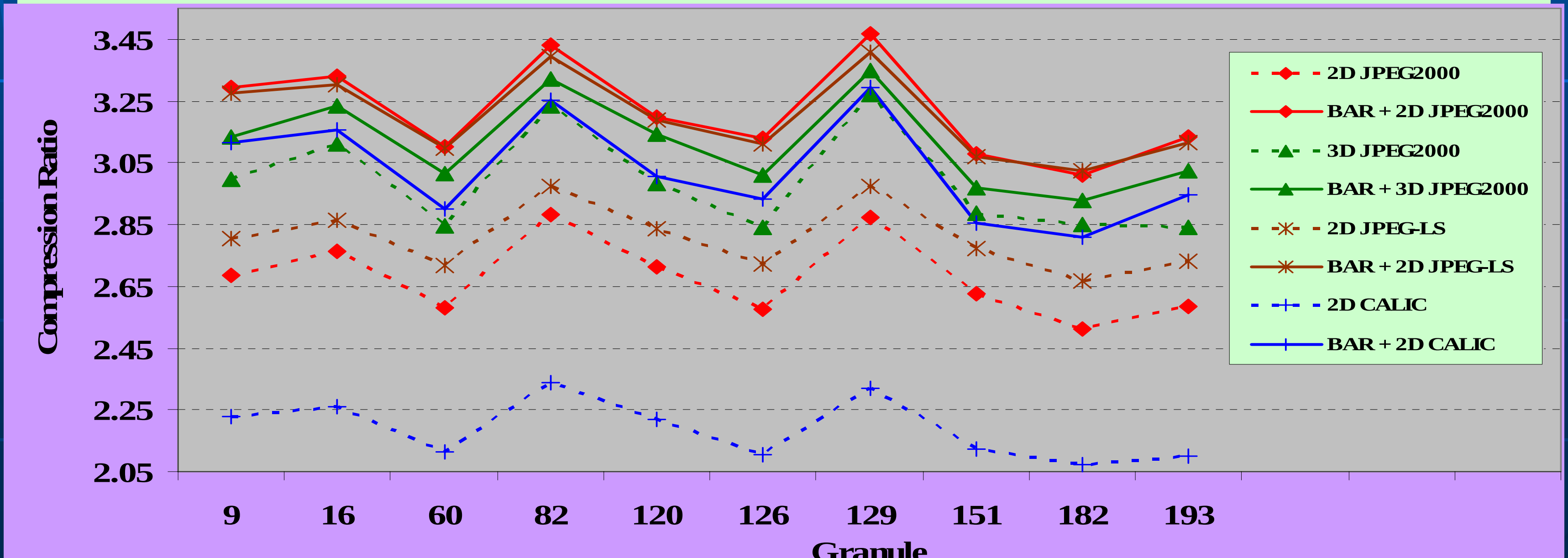
CIMSS-DEVELOPED NEW LOSSLESS COMPRESSION METHODS

- Lossless PCA (*Huang et al. 2004*)
- Predictive Partitioned Vector Quantization (PPVQ) (Huang et al. 2004)
- Fast Precomputed Vector Quantization (FPVQ) with optimal bit allocation (Huang et al. 2005)



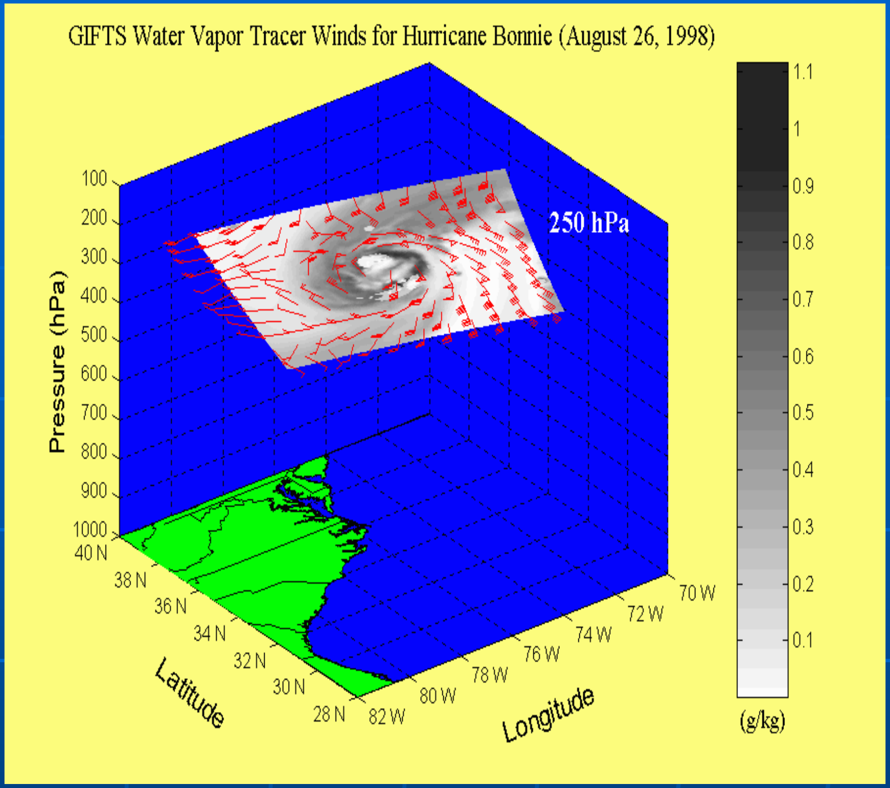
Comparison of CIMSS-DEVELOPED NEW LOSSLESS Performance with the EX*ISTING* methods (AIRS Data)





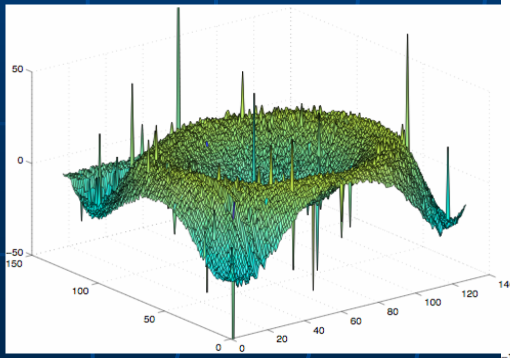
GIFTS ULTRASPECTRAL INTERFEROMETER DATA COMPRESSION

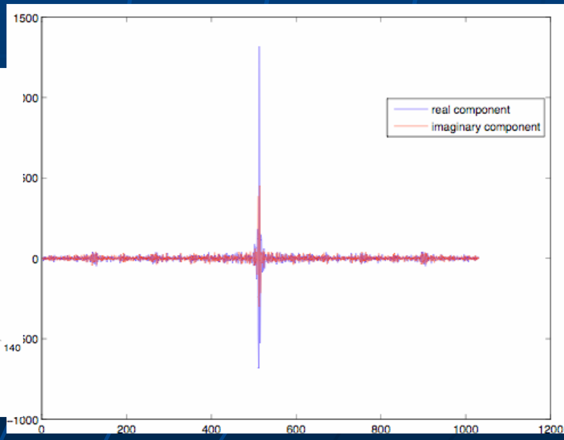
Geostationary Imaging Fourier Transform Spectrometer (GIFTS)



5 GIFTS uplooking interferometer dataset collected on
13 Sept. 2006 by SDL, Utah State Univ. for compression study

- **Each GIFTS dataset consists of**
- **longwave complex interferograms, each with 1031 points;**
- **128 x 128 spatial samples (33.8 MB), and**
- **midwave/shortwave complex interferograms, each with 2062 points; 128 x 128 spatial samples (67.6MB)**





Lossless Compression of GIFTS Data

- Predictive Partitioned Vector Quantization (PPVQ) scheme consists of 4 steps
  - Linear Prediction
  - Channel Partitioning
  - Faster Vector Quantization
  - Entropy Coding

Predictive Partitioned Vector Quantization (PPVQ)

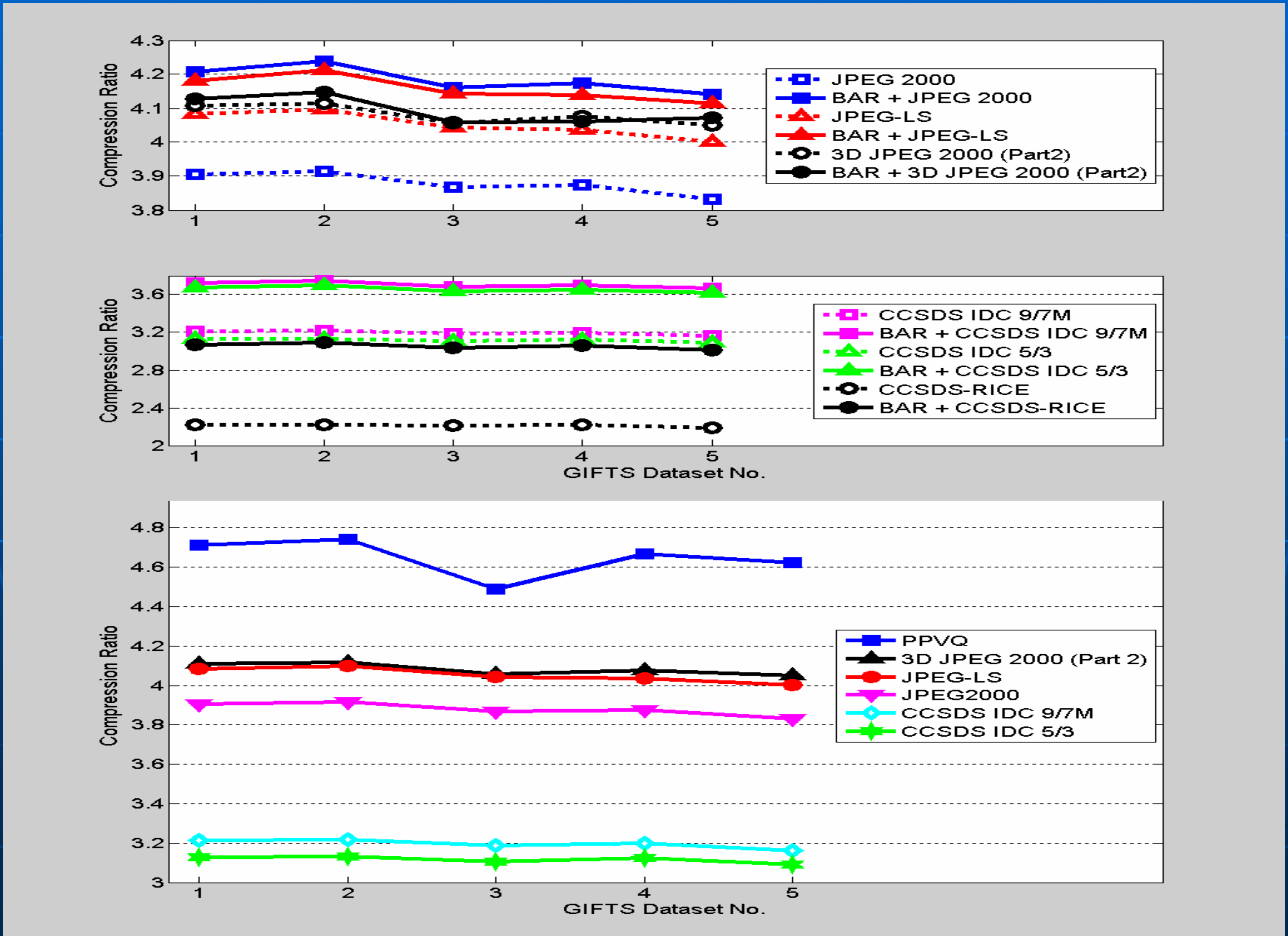
- Linear Prediction
  - Reduce dynamic range by knowledge of previous channels
- Channel Partitioning
  - Group channels with same bit depths together
- Faster Vector Quantization
  - Unlike Linde-Buzo-Gray (LBG) algorithm, the codebook design is not done by the splitting method.
- Entropy Coding
  - Compress VQ indices, codebook, and VQ residual close to their optimal entropy bound

Compression Ratio Result (GIFTS DATA)

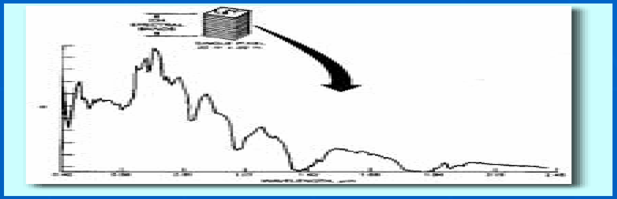
GIFTS Data No.	JPEG2000	JPEG-LS	3D JPEG 2000 (Part 2)	CCSDS-IDC 9/7 M	CCSDS-IDC 5/3	PPVQ
1	3.90	4.08	4.11	3.21	3.13	**4.71**
2	3.92	4.10	4.12	3.22	3.13	**4.74**
3	3.87	4.04	4.06	3.19	3.11	**4.49**
4	3.87	4.04	4.08	3.20	3.12	**4.67**
5	3.83	4.00	4.05	3.16	3.09	**4.62**
Avg CR	3.88	4.05	4.08	3.20	3.12	**4.65**

- PPVQ takes about several minutes to compress one huge GIFTS dataset on an AMD Opteron PC for ground data processing purposes (i.e. rebroadcast or archiving).
- The current code is written in Matlab and C/C^{++} mixed.

Comparison of CIMSS-DEVELOPED NEW LOSSLESS Performance with the EXISTING methods (GIFTS Data)

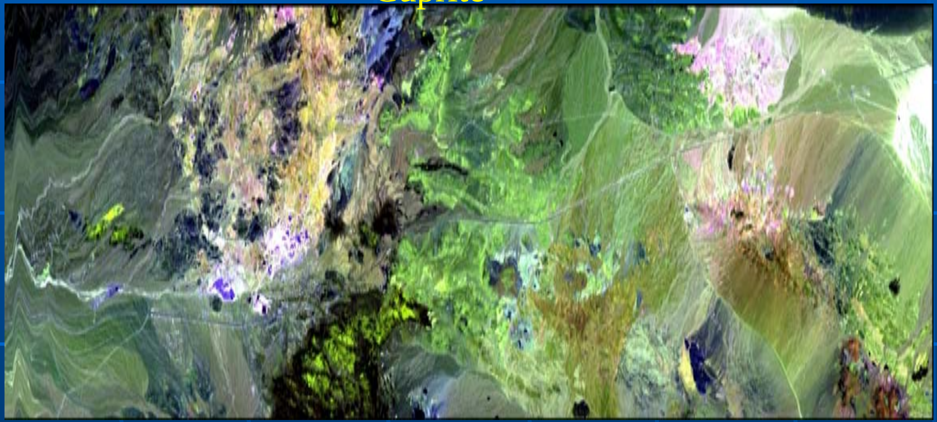


AVIRIS HYPERSPECTRAL IMAGER DATA COMPRESSION

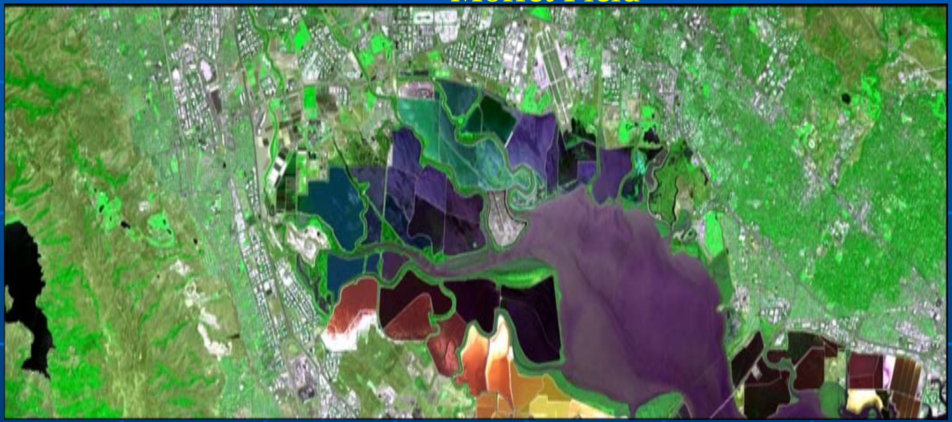


- NASA JPL AVIRIS hyperspectral imager has 224 bands with wavelengths from 400 to 2500 nanometers (nm)
- The following AVIRIS test dataset has been widely used in the IEEE/SPIE compression society for decades

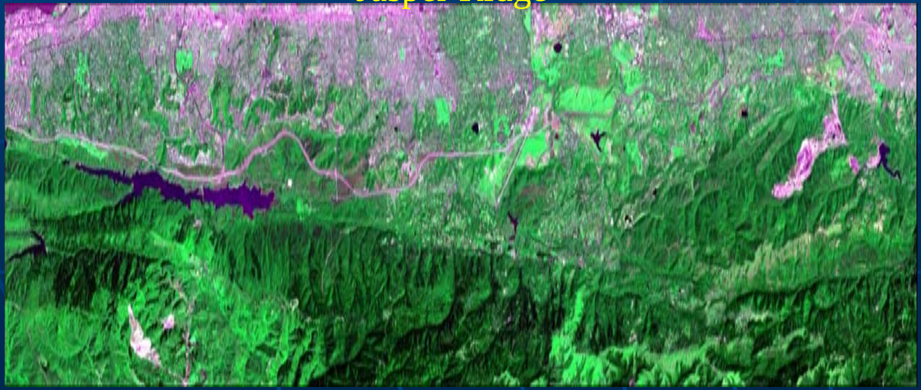
Cuprite



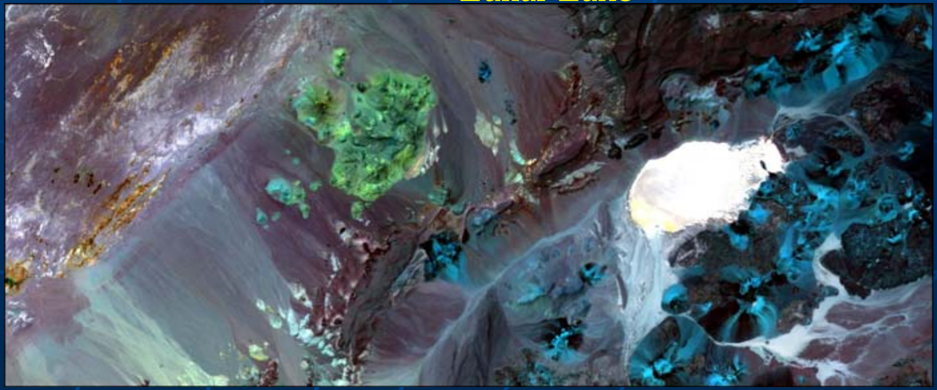
Moffet Field



Jasper Ridge



Lunar Lake

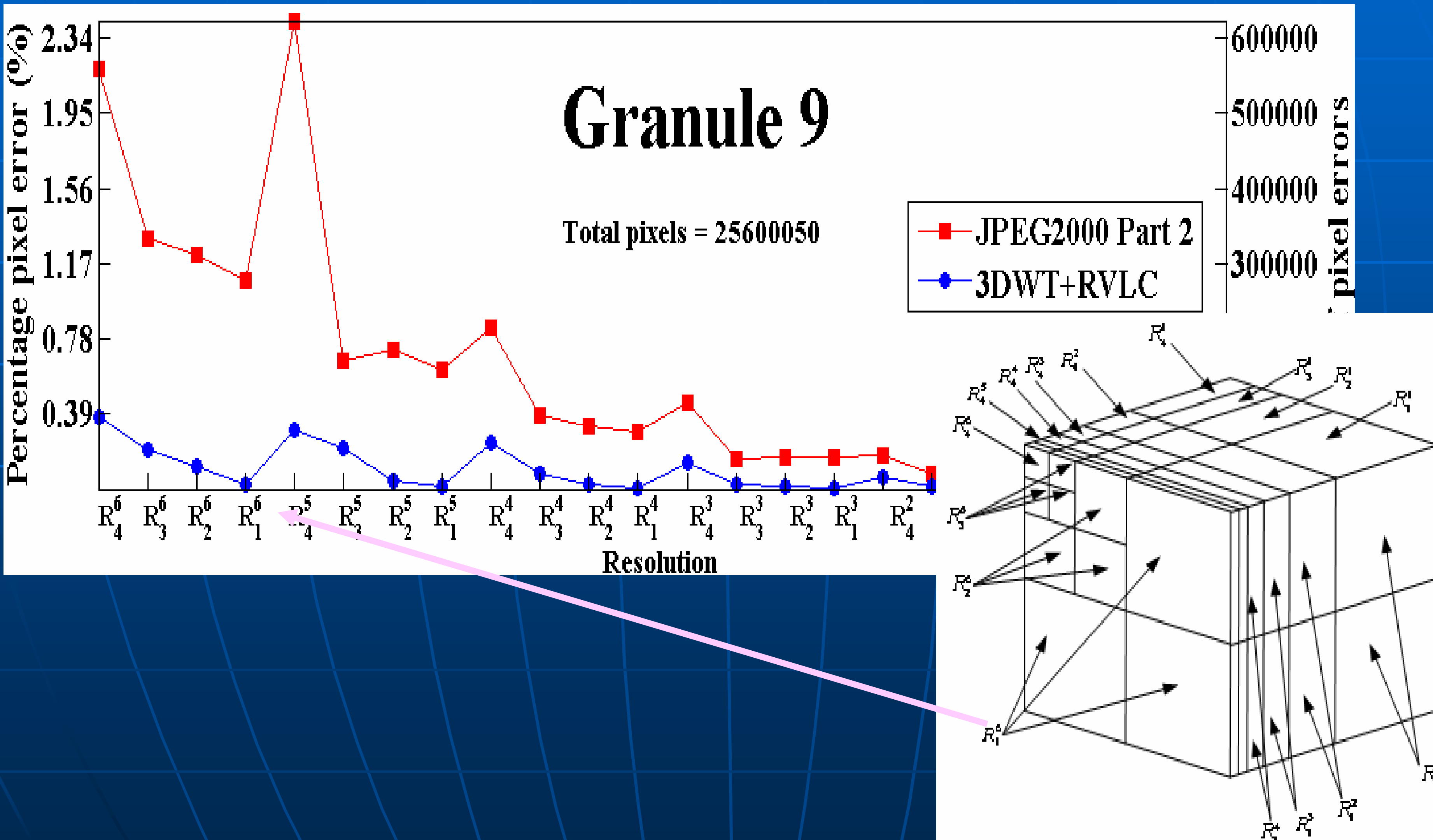


CIMSS's LAIS-LUT method (*Huang et al. 2006*) *pushes lossless compression of the AVIRIS hyperspectral imagery data to a new high with an average compression ratio of 3.47*

Method	Cuprite	Jasper Ridge	Lunar Lake	Moffat Field	Average
2D-CALIC	2.24	2.04	2.42	2.39	2.26
LCL-3D	2.91	2.81	2.94	2.77	2.86
Dif. JPEG-LS	2.91	2.81	2.93	2.84	2.87
ASAP	2.97	2.87	3.10	3.08	3.00
ACAP	2.97	2.88	3.11	3.10	3.01
3D-CALIC	2.97	2.98	3.01	3.17	3.04
SLSQ	3.15	3.15	3.15	3.14	3.15
M-CALIC	3.14	3.06	3.19	3.27	3.16
SLSQ-HEU	3.23	3.22	3.22	3.20	3.22
LUT	3.44	3.23	3.40	3.17	3.31
LAIS-LUT	**3.58**	**3.42**	**3.53**	**3.36**	**3.47**

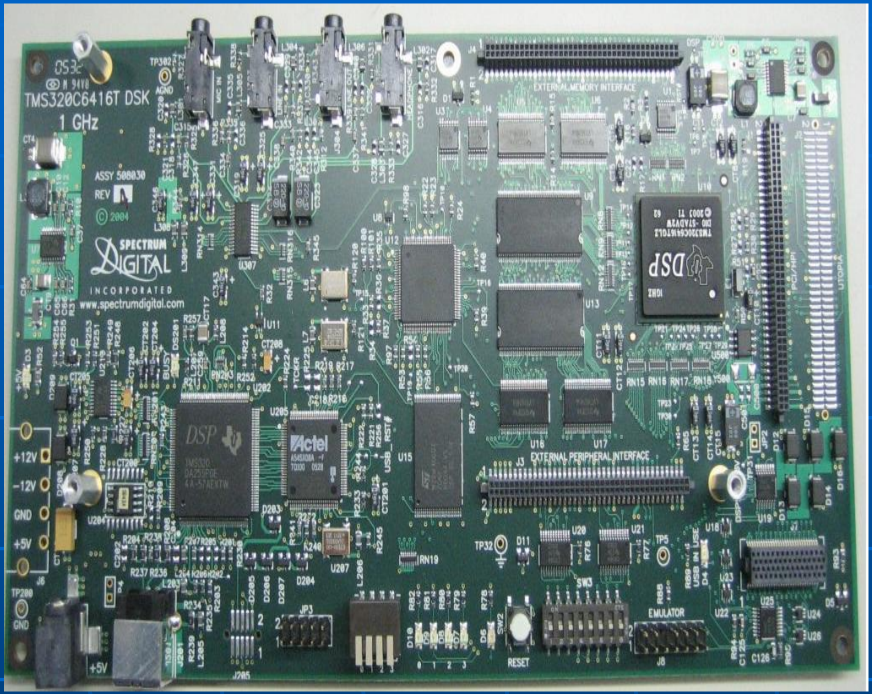
TOWARDS ERROR RESILIENCE IN SATELLITE "NOISY" TRANSMISSION

CIMSS's 3D Wavelet – Reversible Variable Length Coding (3DWT-RVLC) method (*Huang et al. 2005*) yields significantly better error resilience than 3D JPEG2000.

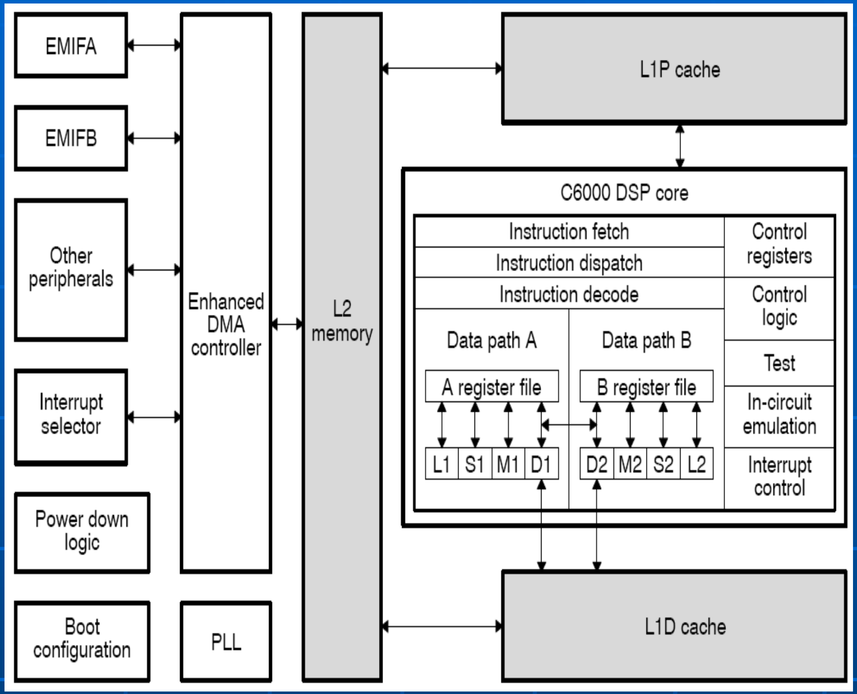


DSP IMPLEMENTATION FOR REAL-TIME SATELLITE REBROADCAST

TMS320C6416 DSP board



TMS320C6416 two-level cache-based architecture



Compression ratios of 3DWT-RVLC vs. the DSP version of 3DWT-RVLC

Granule	9	16	60	82	120	126	129	151	182	193	Average
3DWT-RVLC	2.53	2.60	2.40	2.67	2.52	2.40	2.70	2.46	2.41	2.39	2.51
DSP 3DWT-RVLC	2.37	2.44	2.28	2.52	2.37	2.28	2.52	2.32	2.27	2.27	2.36

TOWARD REAL-TIME SATELLITE ONBOARD COMPRESSION

- **CIMSS's fast linear-time minimum-redundancy prefix coding (Huang et al. 2007) yields a theoretically superior compression gain and faster execution time than the CCSDS's Rice coding.**

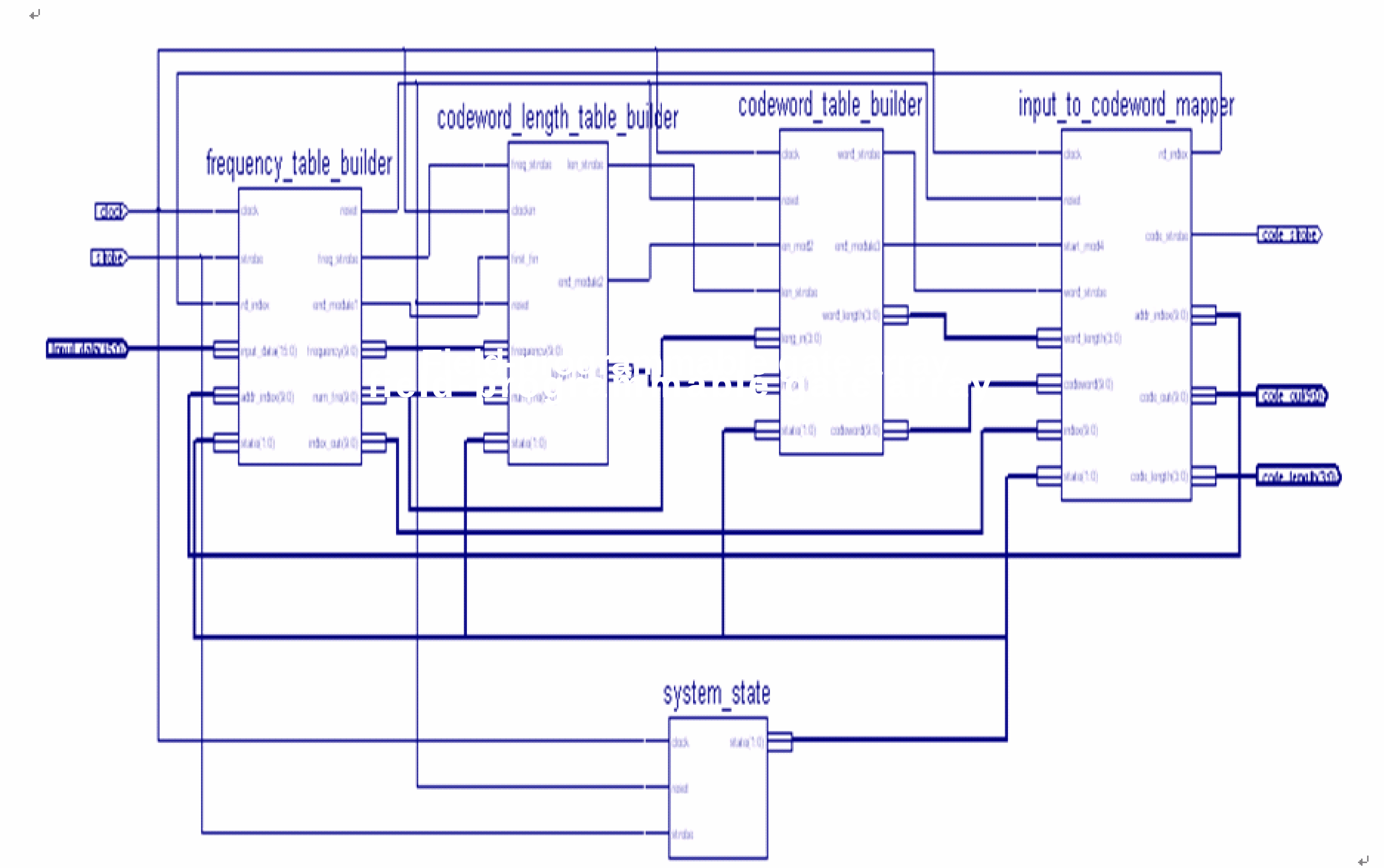
- ***The Rice coding is optimal only when the input data is of geometric distribution, whereas the prefix coding is optimal for any data distribution.***

AIRS Garnule No.	CCSDS Rice Coding CPU time (second)	Prefix Coding CPU time (second)
9	0.72	0.56
16	0.69	0.57
60	0.70	0.55
82	0.74	0.55
120	0.63	0.56
126	0.65	0.56
129	0.67	0.56
151	0.72	0.56
182	0.64	0.56
193	0.65	0.56

```
Case 1
   Number    Fixed    Frequency      Variable   Length
   5         101          2            '0000'      4
   4         100          3            '0001'      4
   3         011          3            '0010'      4
   2         010          4            '0011'      4
   1         001         13            '01'        2
   0         000         14            '1'         1
---------------------------------------------------
Total                    39

Total length

Fixed:   3*39=117
Prefix:  8+12+12+16+26+14=88    *

Rice k0:   14+26+12+12+15+12=91
Rice k1:   39+1*27+2*7+3*5=95
Rice k2:   39+39+34+10=122
Rice k3:   39*3=117

*****************************************************
Case 2

   Number    Fixed    Frequency      Variable   Length
   5         101          4            '000'       3
   4         100          4            '001'       3
   3         011          4            '010'       3
   2         010          4            '011'       3
   1         001          4            '10'        2
   0         000          4            '11'        2
---------------------------------------------------
Total                    24

Total length

Fixed:   3*24=72
Prefix:  4*(2+2+3+3+3+3)=64    *

Rice k0:   4*(1+2+3+4+5+6)=84
Rice k1:   24+4*(1+1+2+2+3+3)=72
Rice k2:   24+24+4*(1+1+1+1+2+2)=80
Rice k3:   3*24=72
```

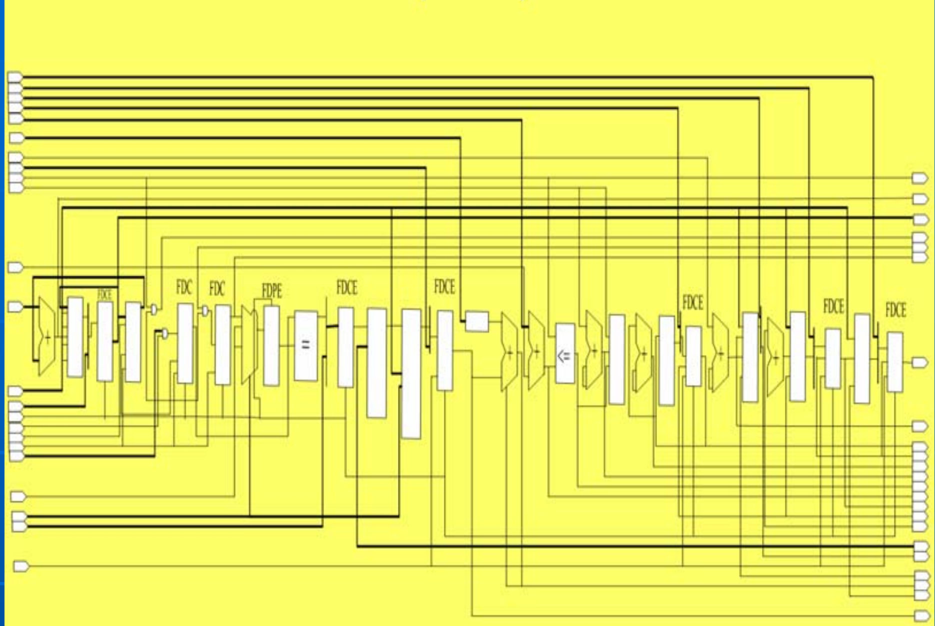
Prefix

TOWARD FPGA IMPLEMENTATION OF THE LINEAR-TIME MIMIMUM-REDUNDANCE PREFIX CODING

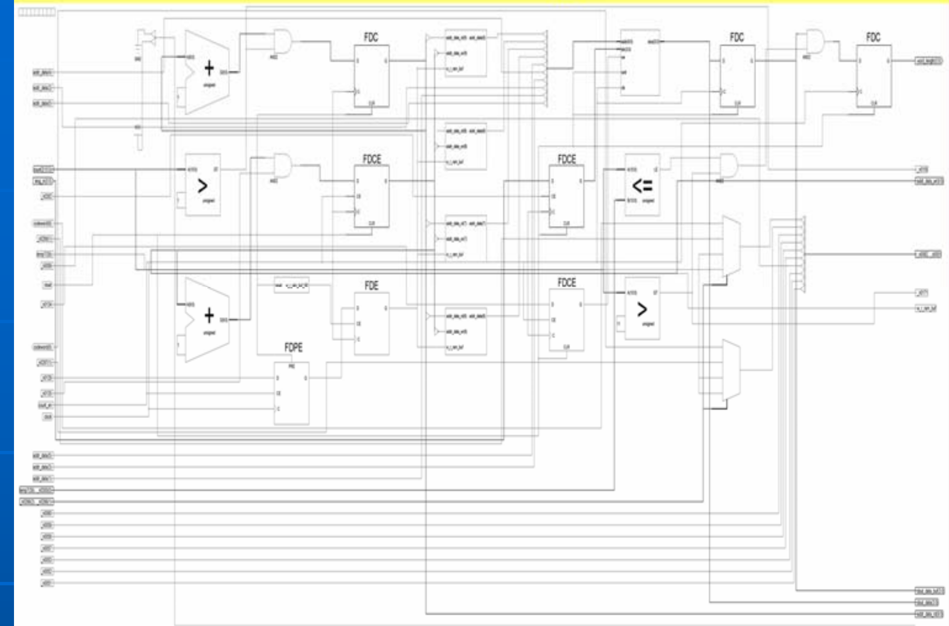


FPGA: Field-Programmable Gate Array

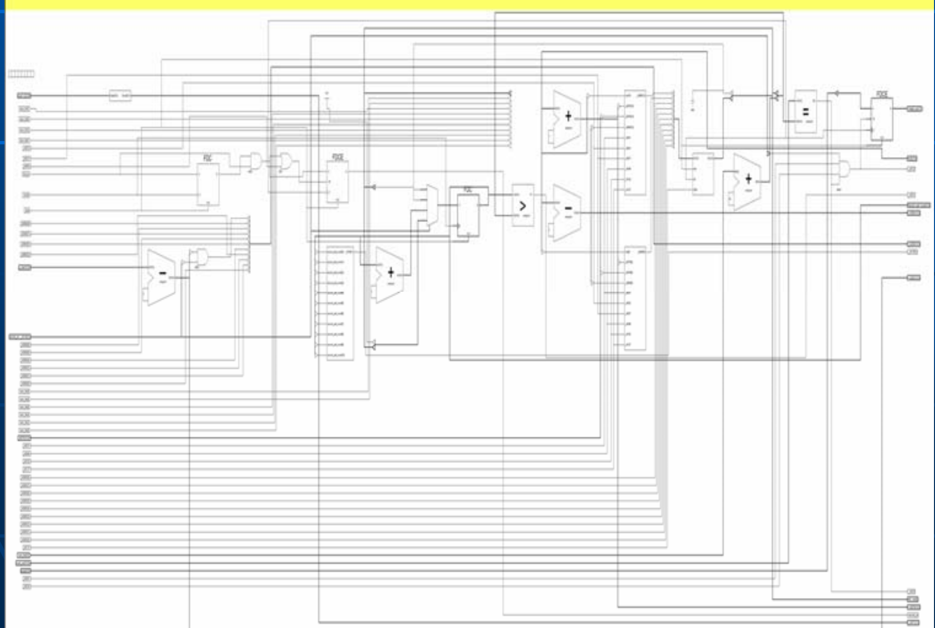
Module 1: Frequency Table Builder



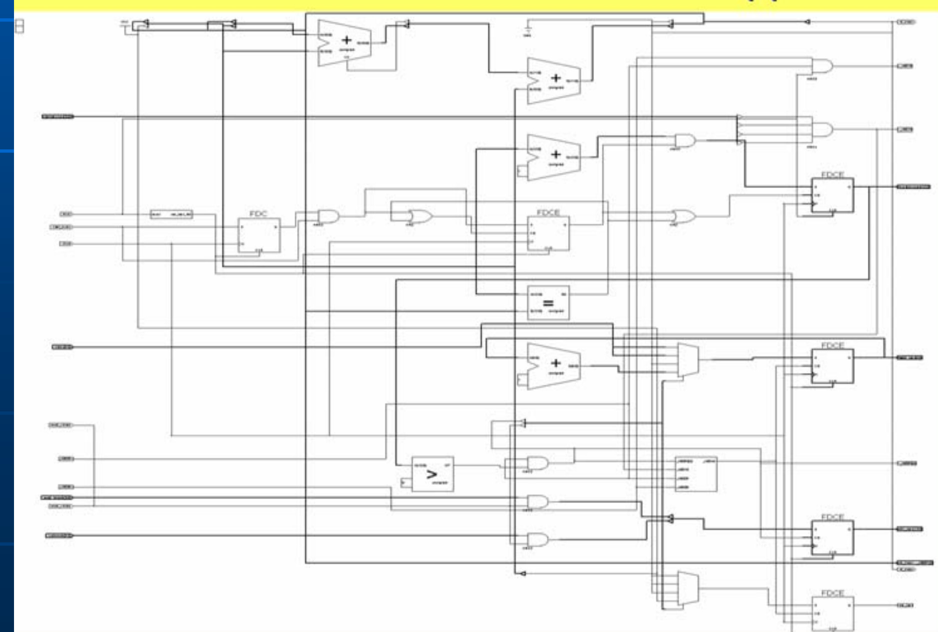
Module 2: Codeword Length Table Builder



Module 3: Codeword Table Builder



Module 4: Data-to-Codeword Mapper



Toward the VLSI design of the Fast Radiative Transfer Model: Implementation of the Exponential Function in VHDL

Bormin Huang, Jianlong Zhang, and Allen Huang
Space Science and Engineering Center
University of Wisconson-Madison

1. In the era of hyperspectral sounders, the efficient computation of the radiative transfer model is desired.

2. The fast radiative transfer model is very suitable for the FPGA implementation to take advantage of the hardware's efficiency and parallelism, where radiances of many channels can be calculated in parallel in FPGA.

3. The success of the VLSI implementation of the fast radiative transfer model relies on the VLSI design of the exponential function for use in the transmittance calculation:

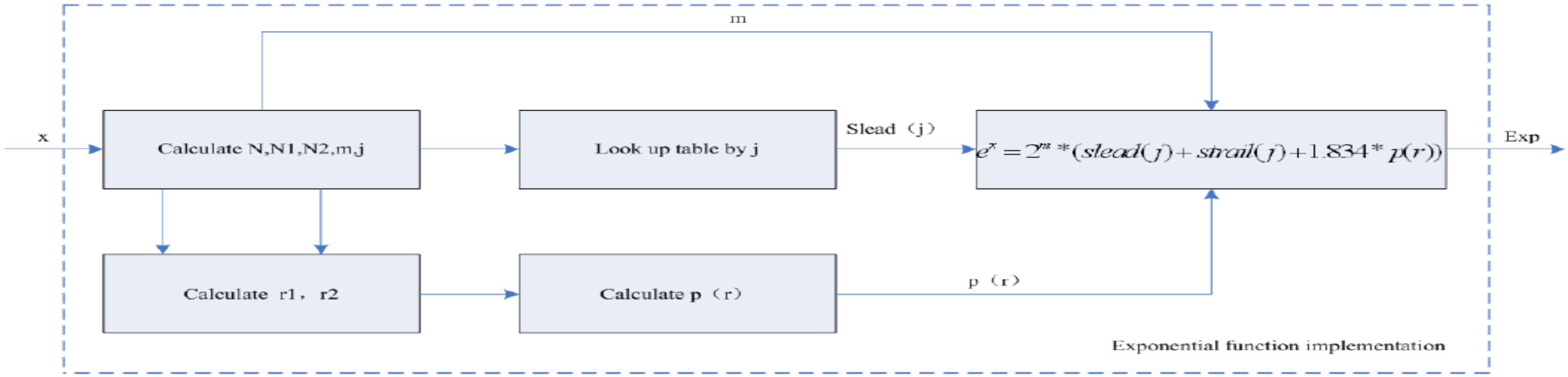
$$R_\nu = \varepsilon_{\nu s} B_\nu(T_s)\tau_\nu(p_s) - \int_0^{p_s} B_\nu[T(p)] \frac{d\tau_\nu(p)}{dp} dp + r_{\nu s}\tau_\nu(p_s) \int_0^{p_s} B_\nu[T(p)] \frac{d\tau_\nu{}^*(p)}{dp} dp + R_\nu{}^{\text{sun}} \tau_\nu{}^{1+\sec\Theta}(p_s) r_{\nu s}{}^{\text{sun}},$$

with the fast transmittance model:

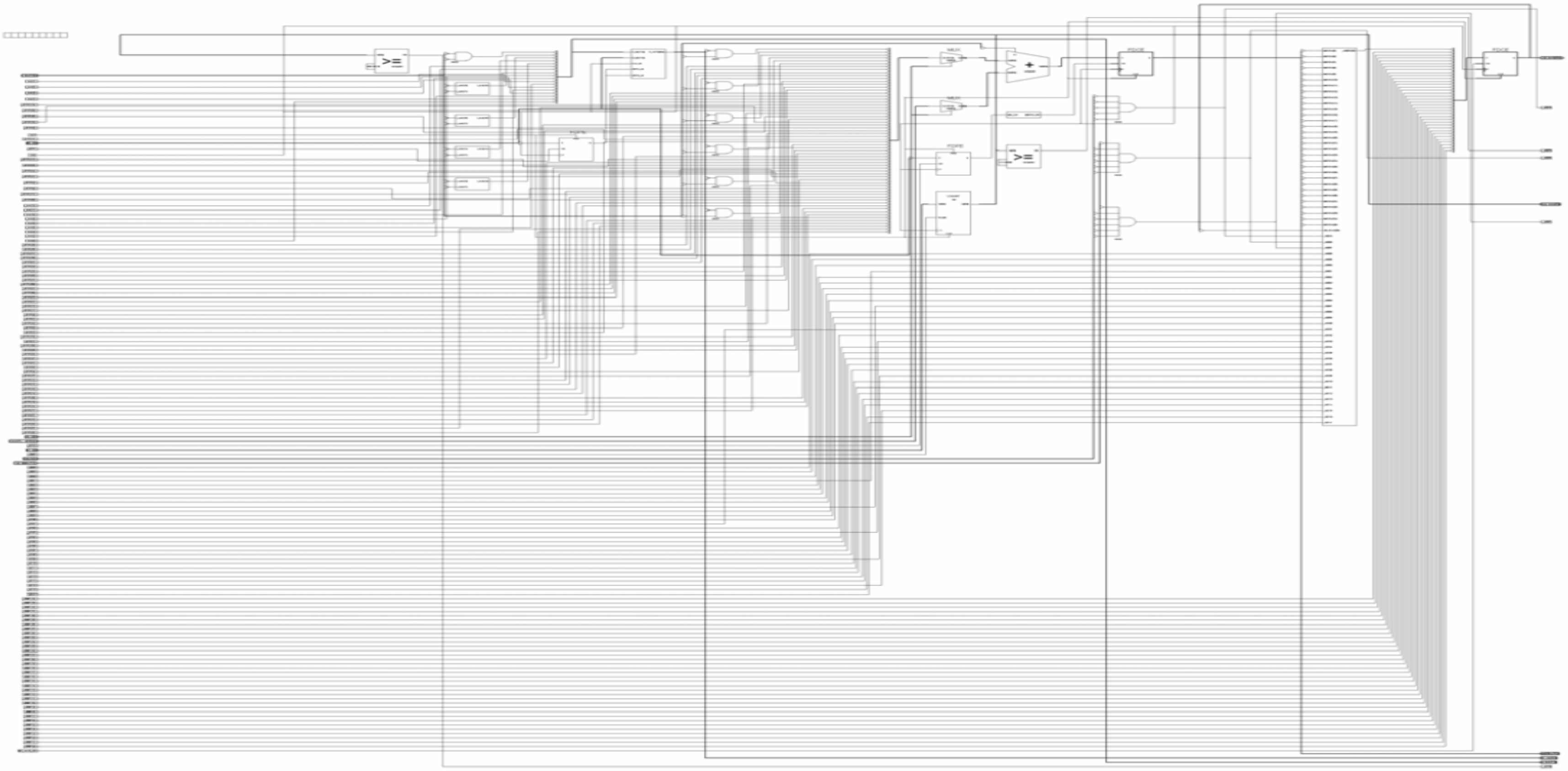
$$\tau_\nu(p_j) = \exp\left\{ \sum_{k=1}^{j} \left[\sum_{l_f=1}^{m_f} a_{\nu l_f k}{}^{\text{fixed}} X_{l_f k}{}^{\text{fixed}} + \sum_{l_w=1}^{m_w} b_{\nu l_w k}{}^{\text{water}} X_{l_w k}{}^{\text{water}} + \sum_{l_o=1}^{m_o} b_{\nu l_o k}{}^{\text{ozone}} X_{l_o k}{}^{\text{ozone}} \right] \right\}.$$

Very High Speed Integrated Circuit Hardware Description Language (VHDL)

4. An efficient approximate exponential function for VHDL implementation is developed by adopting Tang's algorithm with some simplifications:



5. **Our VHDL implementation of the exponential function:**



6. Numerical evaluation of the VHDL implementation of the exponential function:

(Higher accuracy is achievable, if needed, by reducing the simplifications in the exponential function.)

Input data X	Matlab's exp(X)	Matlab simulation	Matlab simulation, %	VHDL simulation	VHDL simulation %
1.5	4.4817	4.4973	0.3481%	4.4976	0.3548%
1	2.7183	2.7217	0.1251%	2.7218	0.1288%
4	54.598	54.545	0.0971%	54.552	0.0843%
3	20.086	20.186	0.4979%	20.188	0.5078%
2	7.389	7.389	0%	7.389	0%
0.5	1.649	1.649	0%	1.649	0%
0.25	1.284	1.278	0.4673%	1.278	0.4673%
0.95	2.586	2.581	0.1933%	2.581	0.1933%
0.66	1.935	1.934	0.0517%	1.934	0.0517%
0.33	1.391	1.393	0.1438%	1.393	0.1438%
0.12	1.127	1.120	0.6211%	1.120	0.6211%
-0.12	0.8869	0.8871	0.0226%	0.8871	0.0226%
-0.25	0.7788	0.7801	0.1669%	0.7801	0.1669%
-0.33	0.7189	0.7178	0.1530%	0.7177	0.1669%
-0.66	0.5169	0.5128	0.7932%	0.5128	0.7932%
-0.95	0.3867	0.3869	0.0517%	0.3869	0.0517%
-2	0.1353	0.1346	0.5174%	0.1346	0.5174%
-3	0.0498	0.0497	0.2008%	0.0497	0.2008%
-4	0.0183	0.0184	0.5464%	0.0184	0.5464%
-5	0.0067	0.0067	0%	0.0067	0%

7. Execution time

For one single exponential calculation, Matlab's built-in C code takes $3.5*10^{-4}$ seconds at the high-end AMD Opteron 2.4 GHz CPU, whereas the estimated Xilinx Virtex FPGA (model: x4vlx100) takes $3*10^{-5}$ seconds. The FPGA is ~10x faster!

For implementation of 10 exponential calculations in parallel in one Xilinx Virtex FPGA (model x4vlx100), it is ~100x faster!!

For parallel implementation of four such FPGAs, it is ~400x faster!!

The bottom line: hardware parallelism is much more efficient than software parallelism.

7. Used resource for Xilinx Virtex FPGA x4vlx100:

Number of Slices:	1245	out of	49152	2%
Number of Slice Flip Flops:	596	out of	98304	0.61%
Number of 4-input LUTs:	2247	out of	98304	2%
Number of DSP48s:	3	out of	96	3%

SUMMARY

- This talk presents the current status of lossless compression of ultraspectral sounder and hyperspectral imager data that have been conducted since 2004 at the Cooperative Institute of Meteorological Satellite Studies (CIMSS), the University of Wisconsin-Madison.
- Besides the new algorithm development CIMSS is actively working toward the DSP/FPGA/VHDL implementation.
- So far a book chapter & more than 50 papers are published
- Several compression schemes/methods are under consideration for patent applications
- CIMSS is looking forward to conducting IASI compression and is in need of IASI raw data counts.
- CIMSS is also actively looking for national/international institution/industry partnership for H/W implementation and applications

SUMMARY - continue

- New IASI initiative also includes
  - Development of a novel retrieval capability for advanced sounder
    - To develop innovative retrieval algorithms for the enhanced use of clear and cloudy IASI radiances
    - To demonstrate the ultimate IASI sounding capability that is not limited by the traditional inverse approaches.

Acknowledgement

This work is prepared in support of National Oceanic & Atmospheric Administration (NOAA) GOES-R data compression research under grant NA07EC0676.

NOAA co-leads are Roger Heymann of NOAA NESDIS OSD and Tim Schmit of NOAA NESDIS STAR.

Congratulations to Roger Heymann and Tim Schmit for receiving the 2006 NOAA Bronze medal.
Their medal citation is "For reducing costs and increasing satellite earth science global data distribution and archiving through world-leading R&D in data compression."

Useful Links

For references, datasets, publications, & software

CIMSS Satellite Data Compression Web site:
http://math.ssec.wisc.edu/compression/

CCSDS Web site:

Per CCSDS's request, CIMSS sent in 20+ published papers for their posting at the CCSDS web site: http://www.ccsds.org/

Reference

File Edit View Go Bookmarks Tools Help

http://math.ssec.wisc.edu/compression/publications.html

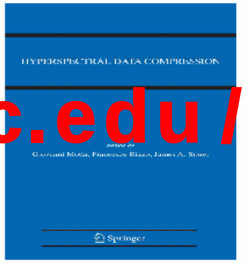
Satellite Data Compression Team

Cooperative Institute for Meteorological Satellite Studies
Space Science and Engineering Center
University of Wisconsin-Madison

- Home
- Projects
- Conferences
- Software
- Data
- Selected Publications
- Related Links

Book Chapter

B. Huang, A. Ahuja, H.-L. Huang, "Lossless Compression of Ultraspectral Sounder Data," *Hyperspectral Data Compression*, pp. 75-106, G. Motta, F. Rizzo, and J. Storer, Ed., Springer, 2006.



http://math.ssec.wisc.edu/compression/

Selected Publications (since 2004)

56. B. Huang, and Y. Sriraja, “Lossless Compression of Ultraspectral Sounder Data Using Integer Multiwavelet Transform,” *IEEE Geoscience and Remote Sensing Letters (accepted with minor revision)* .

55. B. Huang, “Fast Minimum-redundancy Prefix Coding for Real-Time Space Data Compression,” *2007 SPIE Conference on Satellite Data Compression, Communication, and Archiving III (submitted)*.

54. B. Huang, H.-L. Huang, R. Knuteson, M. Smuga-Otto, W. L. Smith, “Lossless Data Compression Studies for the Geostationary Imaging Fourier Transform Spectrometer (GIFTS) with the Bias-adjusted Reordering Preprocessing,” *2007 SPIE Conference on Satellite Data Compression, Communication, and Archiving III (submitted)*.

53. B. Huang, H.-L. Huang, and W. L. Smith, “Lossless Compression Studies for the Geostationary Imaging Fourier Transform Spectrometer (GIFTS) Data via adaptive vector quantization with linear prediction,” *2007 SPIE Conference on Satellite Data Compression, Communication, and Archiving III (submitted)*.

52. S. C. Wei and B. Huang, “Use of Independent Component Analysis for Lossless Compression of Ultraspectral Sounder Data,” *2007 SPIE Conference on Satellite Data Compression, Communication, and Archiving III (submitted)*.

51. S. C. Wei and B. Huang, “Ultraspectral sounder data compression using the Tungstall coding,” *2007 SPIE Conference on Satellite Data Compression, Communication, and Archiving III (submitted)*.

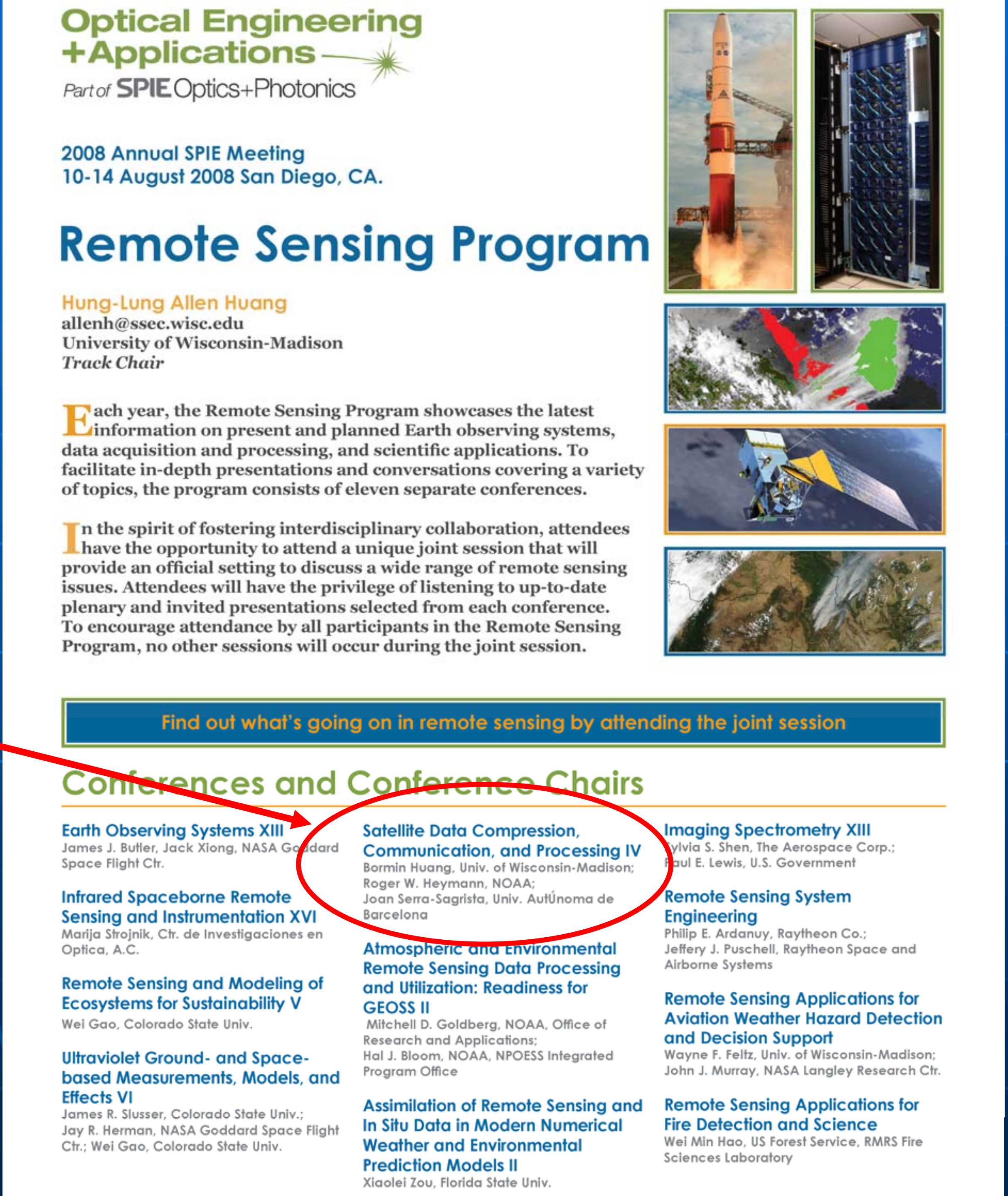
50. B. Huang, and H.-L. Huang, “Current Status of Lossless Compression of Ultraspectral Sounder and Hyperspectral Image Data,” *Joint 2007 EUMETSAT Meteorological Satellite Conference and the 15th Satellite Meteorology & Oceanography Conference of the American Meteorological Society (submitted)* .

49. B. Huang, A. Ahuja, Y. Sriraja, and H.-L. Huang, “ Lossless Compression Studies for NOAA’s Future GOES Advanced Sounders,” in *23rd Conf. Interactive Information Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, AMS Annual Meeting, 2007.*

48. B. Huang, and Y. Sriraja, “Predictor-guided lookup tables for lossless compression of hyperspectral imagery,” *IEEE Signal Processing Letters (accepted)* .

47. B. Huang, A. Ahuja, and H.-L. Huang, “Optimal compression of high spectral resolution satellite data via adaptive vector quantization with linear prediction,” *Journal of Atmospheric and Oceanic Technology (accepted with minor revisions)* .

Satellite Data Compression, Communication, and Processing Conference



Optical Engineering + Applications

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Remote Sensing Program

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Track Chair

Each year, the Remote Sensing Program showcases the latest information on present and planned Earth observing systems, data acquisition and processing, and scientific applications. To facilitate in-depth presentations and conversations covering a variety of topics, the program consists of eleven separate conferences.

In the spirit of fostering interdisciplinary collaboration, attendees have the opportunity to attend a unique joint session that will provide an official setting to discuss a wide range of remote sensing issues. Attendees will have the privilege of listening to up-to-date plenary and invited presentations selected from each conference. To encourage attendance by all participants in the Remote Sensing Program, no other sessions will occur during the joint session.

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Conferences and Conference Chairs

Earth Observing Systems XIII
James J. Butler, Jack Xiong, NASA Goddard Space Flight Ctr.

Infrared Spaceborne Remote Sensing and Instrumentation XVI
Marija Strojnik, Ctr. de Investigaciones en Optica, A.C.

Remote Sensing and Modeling of Ecosystems for Sustainability V
Wei Gao, Colorado State Univ.

Ultraviolet Ground- and Space-based Measurements, Models, and Effects VI
James R. Slusser, Colorado State Univ.; Jay R. Herman, NASA Goddard Space Flight Ctr.; Wei Gao, Colorado State Univ.

Satellite Data Compression, Communication, and Processing IV
Bormin Huang, Univ. of Wisconsin-Madison; Roger W. Heymann, NOAA; Joan Serra-Sagrista, Univ. AutÚnoma de Barcelona

Atmospheric and Environmental Remote Sensing Data Processing and Utilization: Readiness for GEOSS II
Mitchell D. Goldberg, NOAA, Office of Research and Applications; Hal J. Bloom, NOAA, NPOESS Integrated Program Office

Assimilation of Remote Sensing and In Situ Data in Modern Numerical Weather and Environmental Prediction Models II
Xiaolei Zou, Florida State Univ.

Imaging Spectrometry XIII
Sylvia S. Shen, The Aerospace Corp.; Paul E. Lewis, U.S. Government

Remote Sensing System Engineering
Philip E. Ardanuy, Raytheon Co.; Jeffery J. Puschell, Raytheon Space and Airborne Systems

Remote Sensing Applications for Aviation Weather Hazard Detection and Decision Support
Wayne F. Feltz, Univ. of Wisconsin-Madison; John J. Murray, NASA Langley Research Ctr.

Remote Sensing Applications for Fire Detection and Science
Wei Min Hao, US Forest Service, RMRS Fire Sciences Laboratory

Call for Papers and Announcement

Satellite Data Compression, Communication, and Processing IV (OP404)

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With the advances in contemporary and future active and passive sensor technology with high spectral and/or spatial resolutions, more powerful airborne and space-borne instruments are being developed for remote sensing of the atmosphere, oceans, lands of Earth and other planets. Their finer resolution and faster scanning result in significant data volume increases. These increases present challenges to data transmission and archiving; particularly for satellites with limited access to a growing congested radio frequency (RF) spectrum. Data compression techniques provide reduced data volume for effective data transfer within the limited satellite RF spectrum, while reducing the cost of data transfer and storage. Satellite data communications techniques facilitate data transmission in the wireless error-prone channels.

This conference provides an interdisciplinary forum for exchanging the latest research results and views on the current work in the areas of satellite data compression and communication. The advances in satellite data compression have been influenced by the progress and knowledge in generic 2D and 3D image and video coding techniques. Research in these areas is also welcome in hope to inspire the scientists in satellite data compression. This conference also extends its interests to data processing techniques to reduce, improve or extract the noisy data via onboard pre-processing or onsite post-processing. Topics of interest include but are not limited to:

Data Compression

Ultraspectral, hyperspectral and multispectral data compression, generic 2D image and 3D video coding, lossless, near-lossless, and lossy compression, computationally efficient lossless compression , error-resilient compression, applications of compression to geophysical product retrieval, compression-based anomaly quantization, wavelet compression, multiwavelet compression, fractal compression, entropy coding, multiple description coding, error control, bit-rate allocation, compression of geographic information systems (GIS), active sensor data compression, interferogram data compression, grating data compression, radar and lidar data compression, space data compression, other topics related to data compression.

Data Communication

Channel coding, source coding, advanced modulations, error-correction coding, restricted radio frequency (RF) spectrum, telemetry systems, telecommand systems, space link protocol, link analysis, transmission techniques, multiple access, satellite networks, multibeam satellites, communication payload, wireless communication, applications of Europe's DVB satellite standard, application of CCSDS modulation and coding, application of the CCSDS 4D-8PSK-TCM modulation by space agencies, controlling out-of-band emissions. All of these issues relate to how much data can be transmitted.

Data Processing

Filter design, digital filters, data reduction, sampling and quantization, data archiving, data indexing, image registration, image restoration , image interpolation, data recovery, image restoration, destriping, bowtie correction, data calibration, data correction, data enhancement, noise filtering, analog and digital signal processing, statistical signal processing, adaptive signal processing, geometric transformation, image stabilization, color correction, brightness and contrast adjustment, data representation and transforms, super-resolution, multi-resolution processing and wavelets, motion analysis & tracking, feature extraction, morphological image processing, neural networks, fuzzy processing, data format, content-