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

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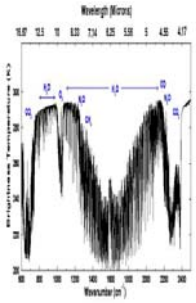
1. INTRODUCTION



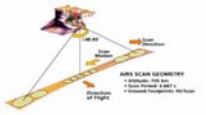
➢Contemporary and future ultraspectral sounders (e.g. AIRS, IASI, GIFTS) and hyperspectral imagers (e.g. AVIRIS) provide high spectral and spatial resolutions for improved weather forecast and geographic information.

➢ 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 NOAA's future GOES data processing studies, we develop various 2D/ 3D lossless compression methods tested AIRS, GIFTS and AVIRIS data.

2. AIRS ULTRASPECTRAL GRATING DATA COMPRESSION

Atmospheric Infrared Sounder (AIRS)

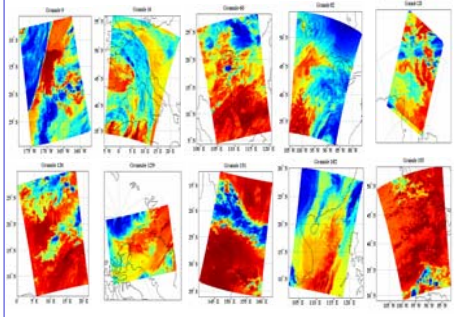


• Each AIRS granule consists of 2378 channels with 135 scan lines containing 90 cross-track footprints per scan line.

•Infrared Spectral Coverage
3.74 - 4.61 μm
6.20 - 8.22 μm
8.80 - 15.4 μm

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

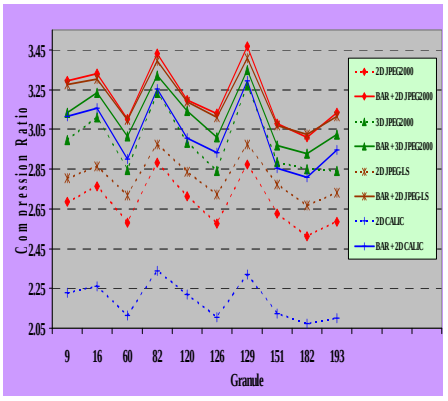
Granule 9	00:53:31 UTC	-12 H	(Pacific Ocean, Daytime)
Granule 16	01:35:31 UTC	+2 H	(Europe, Nighttime)
Granule 60	05:59:31 UTC	+7 H	(Asia, Daytime)
Granule 82	08:11:31 UTC	-5 H	(North America, Nighttime)
Granule 120	11:59:31 UTC	-10 H	(Antarctica, Nighttime)
Granule 126	12:35:31 UTC	-0 H	(Africa, Daytime)
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)



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

• CIMSS's DATA PREPROCESSING SCHEME

CIMSS's **Bias-Adjusted Reordering (BAR) data preprocessing scheme** (***Huang et al. 2004***) improves the performance of state-of-the-art compression methods.

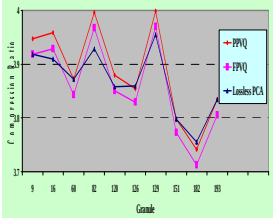


• CIMSS's NEW LOSSLESS COMPRESSION METHODS

• **Lossless PCA** (***Huang et al. 2004***)

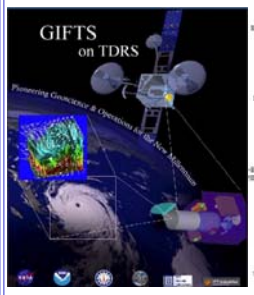
• **Predictive Partitioned Vector Quantization (PPVQ)** (***Huang et al. 2004***)

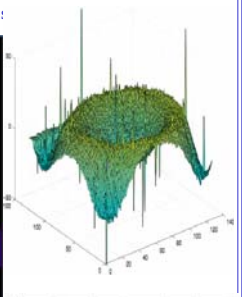
• **Fast Precomputed Vector Quantization (FPVQ) with optimal bit allocation** (***Huang et al. 2005***)

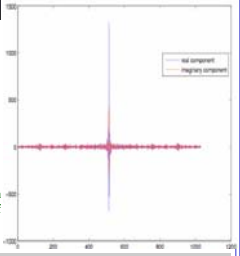


3. GIFTS ULTRASPECTRAL INTERFEROMETER DATA COMPRESSION

Geostationary Imaging Fourier Transform S





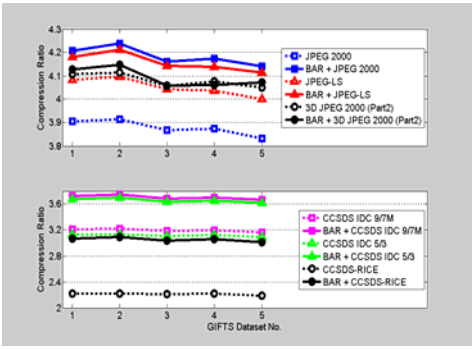


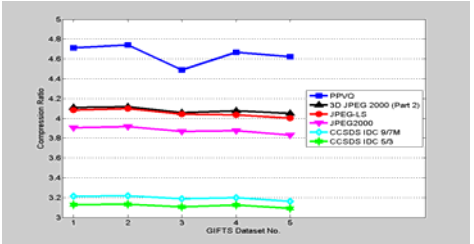
Each GIFTS datas consists of

• longwave real and imaginary parts, each with 1031 channels; 128 x 128 spatial samples

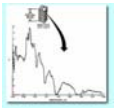
• midwave/shortwave real and imaginary parts, each with 2062 channels; 128 x 128 spatial samples

Five GIFTS uplooking interferometer data collected on 13 Sept. 2006 by SDL, Univ. of Utah for compression studies



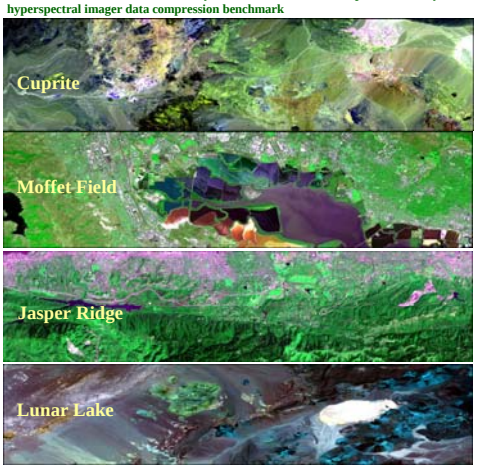


4. AVIRIS HYPERSPECTRAL IMAGER DATA COMPRESSION



• **NASA JPL AVIRIS hyperspectral imager has 224 bands with wavelengths from 400 to 2500 nanometers (nm)**

• **AVIRIS test dataset has been widely used in IEEE & SPIE compression society for hyperspectral imager data compression benchmark**

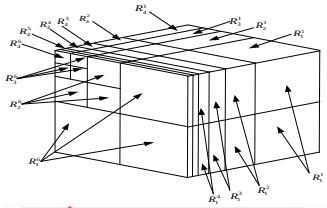


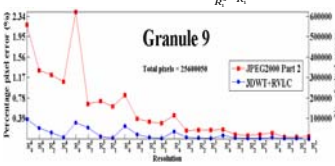
CIMSS's **LAIS-LUT method** (***Huang et al. 2006***) *pushes lossless compression of the AVIRIS hyperspectral imagery data to a new high with an average compression ratio of 3.47.*

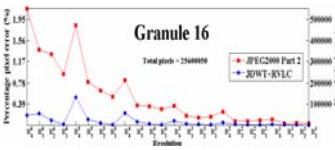
Method	Cuprite	Jasper Ridge	Lunar Lake	Moffat Field	Average
2D-CALIC	2.24	2.04	2.42	2.39	2.26
LCL-3D	2.91	2.81	2.94	2.77	2.86
DC JPEG-LS	2.91	2.81	2.93	2.84	2.87
ASAP	2.97	2.87	3.10	3.08	3.00
ACAP	2.97	2.88	3.11	3.10	3.01
3D-CALIC	2.97	2.98	3.01	3.17	3.04
SLSQ	3.15	3.15	3.15	3.14	3.15
M-CALIC	3.14	3.06	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**

5. TOWARDS ERROR RESILIENCE IN SATELLITE NOISY TRANSMISSION

CIMSS's 3DWT-RVLC method (***Huang et al. 2005***) yields significantly better error resilience than 3D JPEG2000 (Part 2).



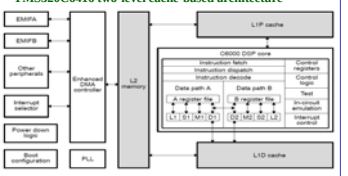




6. TOWARDS HARDWARE IMPLEMENTATION FOR REAL-TIME SATELLITE REBROADCAST

TMS320C6416 DSP board

TMS320C6416 two-level cache-based architecture



Compression ratio comparison between 3DWT-RVLC and the DSP version of 3DWT-RVLC

Granule	9	16	60	82	120	126	129	151	182	193	Average
3DWT-RVLC	2.53	2.80	2.40	2.67	2.52	2.40	2.70	2.46	2.41	2.28	2.51
DSP 3DWT-RVLC	2.37	2.44	2.28	2.53	2.37	2.28	2.52	2.32	2.27	2.27	2.36

7. SUMMARY

This poster 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.

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.