Wavelet Data Compression for Meteorological Data Sets

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Introduction

Wavelet transform-based data compression is one of the most effective data compression techniques that emerged and evolved in 1990s. This technique takes advantage of the wavelet basis functions that are localized in both time and frequency, and combines that with a well designed quantization scheme to achieve superior data compression.

The volume of meteorological data sets grows rapidly with ever-increasing observations and forecast model resolution. It becomes essential to compress this volume so that the data sets can be transmitted and stored promptly and efficiently. We applied the wavelet data compression technique to the typical meteorological imagery and grid data and achieved very promising results. With a small and acceptable amount of loss, 95% - 98% volume reduction for the test data sets was achieved.

Data Compression Scheme

The data compression scheme for imagery data consists of three steps: wavelet transform, quantization and entropy encoding. For grid data, few extra steps are carried out to ensure that appropriate precision of the data is maintained.

Applications

The wavelet data compression technique is being used in the FX-Net Workstation, an Internet-based meteorological workstation and a CIRA-NESDIS-OAR/HRD project to transmit real-time satellite data to NOAA WP-3 aircraft. A new file sharing system based on this compression technique is proposed to facilitate the efficient dissemination of model output data to a large number of remote users. Fig.1 illustrates one possible implementation for a file sharing system among data centers and hubs/field units.

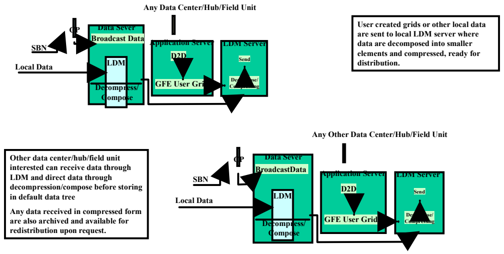

Figure 1. File sharing between Data Centers/Hubs/Field Units

Experimental Results

The wavelet compression package has been used in the FX-Net project since 1998. Beginning in 2003, it has also been used to compress satellite images that are transmitted in real time to NOAA WP-3 aircraft. Fig. 2 and 3 are the typical VIS images and its 20:1 compressed counterpart.

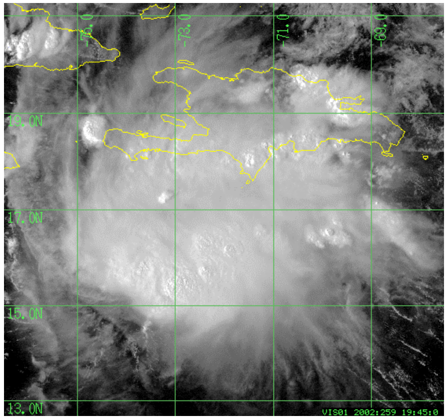

Figure 2. Original visible image

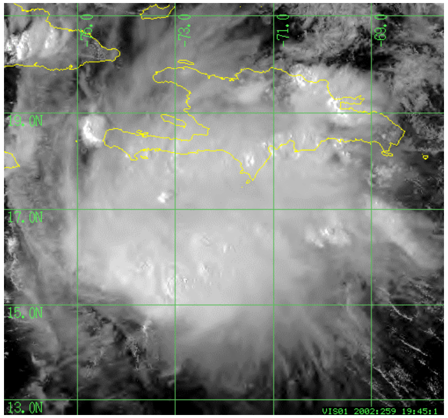

Figure 3. Same image with 20:1 compression

The compression has also been applied to the output grid of high resolution mesoscale models. Fig. 4 shows the compression factor achieved for the temperature fields from the Eta12 model, with precision control enabled. Fig. 5 and 6 are the original and 50:1 compressed temperature field that are displayed as pseudo-color images.

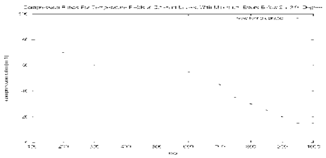

Figure 4. Compression ratios for Eta12 temperature fields at different heights

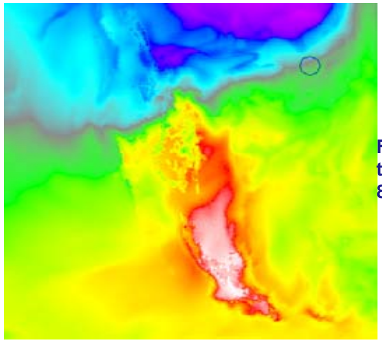

Figure 5 . Eta12 temperature field at 850 mb, original

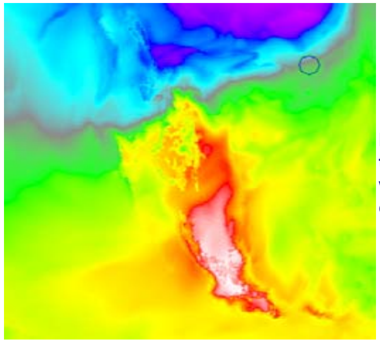

Figure 6. Same temperature field with 50:1 compression

Publications

Knaff, J., N. Wang, M. DeMaria and R. Zehr, 2003: Transmission and display of current GOES imagery aboard the NOAA WP-3 aircraft using wavelet compression techniques, *CIRA Fall 2003 Newsletter*.

Wang, N. and R. Brummer, 2002: Experiment of a wavelet-based data compression technique with precision control, *19th IIPS*, 83rd AMS Annual Meeting, Long Beach, CA.