EnVis/Hum: High-resolution Ocean Model Visualization and Display

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Abstract: High-resolution computational ocean models now in production provide excellent resolution of important physical features, but the sheer size of the model output makes effective visualization challenging. We present a combination of two systems: EnVis, a suite of batch-mode visualization tools, and Hum, a parallel pipelined motion picture program.

Since computational models typically run on compute platforms that do not provide any hardware acceleration for graphics, EnVis employs software rendering techniques. It creates high-resolution RGB images from an input dataset, and uses a variety of surface shading techniques that make small-scale features much more apparent to researchers than do conventional flat-shaded methods. In addition to surface shading, EnVis also uses arbitrary-resolution lookup tables for coloring scalar fields, providing visual discrimination even in regions containing small variations in the field. EnVis also enables compositing of other image data such as terrain over masked portions of a model output image.

In order to provide interactive frame rates for researchers exploring large global datasets, Hum employs a multithreaded architecture implementing pipelines composed of image loading, decoding, caching and display functionality. Other threads manage user interaction on multiple displays, where interactive pan and zoom features are provided. These allow a researcher to efficiently examine both large- and small-scale features. Hum's implementation of speculative prefetching keeps its imaging pipelines full, caching recently displayed image data for later redisplay, and automating prediction of which frames are likely to be required in the future. Where available, Hum can display stereo pairs of images, and can also overlay vector glyphs at a user-selectable display density.

To place the use of EnVis and Hum in the context of a specific ocean modeling workflow, we present visualization examples using output from the Navy Layered Ocean Model at the Naval Research Laboratory. Visualization of ocean model results is an important tool which helps us to assess the realism of the ocean model, identify and diagnose problems, and learn more about the ocean and how it behaves. At the time of Hum's initial development in early 1999, NRL was running a 1/16 degree global model with a resolution of 4096 x 2304, which is significantly finer than a standard computer monitor. Hum was used to display and animate the 1/16° global images generated by EnVis. Existing applications were very limited in

viewing these large images, and it became apparent that a new animation tool was needed to work with these large images and image sequences, which easily exceed local workstation memory. Global model resolutions have now increased to 1/32 degree with a resolution of 8192 x 4608 on each layer, reconfirming the need for these tools. Performance characteristics of EnVis rendering and Hum animations are supplied for typical model and hardware configurations.