Exercises using sea level height data

Mean sea level height can be measured by satellite altimeters. The single track altimeter data is often merged and gridded and presented in the form that can be analyzed and visualized with WIM/WAM. Sea level height shows ocean dynamics, such as eddies, upwelling, El Nino, etc. Altimetry data is available through clouds that make it especially valuable in cloudy regions where the usefulness of visible and infrared imagery is limited. The task of this exercise is to download a series of global altimetry files, select your area of interest and remap to your area of interest. Finally, we will make image loops that show the dynamics of eddies. An example of what you need to accomplish is included in a PowerPoint presentation file *7_sea_level_anomaly.ppt* in the *Course* folder of the WIM CD and is also available on the web at http://spg.ucsd.edu/Satellite_Projects/Sea_Level_Anomalies_in_Eastern_Central_Pacific/ Sea_level_anomalies_in_eastern_central_pacific.htm. This particular example shows sea level anomalies in the Eastern Central Pacific that is a very dynamic region and well suited for this kind of analysis.

Here is what you need to do:

- Download some sea level height data from the French AVISO ftp site at

  ftp://ftp.cls.fr/pub/oceano/AVISO/SSH/duacs/global/dt/upd/msla/merged/h/

- These are weekly maps of Sea Level Anomaly (SLA) merged from TOPEX/POSEIDON, Jason and ERS-1/2 created by SSALTO/DUACS and distributed by AVISO. The data series starts in 1992 and with 52 datasets per year there are currently over 1400 weekly datasets. You don't need to download all as it may take several hours - just get a series of files from your period of interest.

- After downloading the data files, uncompress them, e.g. with *gzip –d *.gz.*

- The files are net-CDF files but you can view them with WIM as regular HDF files.

- Select your area of interest and create your target projection map. For example, open any 9-km standard global equal angle image (e.g. of SeaWiFS or MODIS) and cut out your area of interest (select a rectangle with the mouse left button down and then do *Cut* (the ✂ icon on toolbar). Now create coastlines for this cut image with *Geo-Get Map Overlay – coast_inter.b – Background Value* = 0, *Foreground Value* = 1. Stretch the colors End value down, so that you can see the coastlines. Now fill the land with pixel value 255 (to make it white) with *Edit – Draw – Fill Paint* with *Outline* = 255 and *Fill* = 255. As "paint" can easily spill outside of the broken coastlines, you may have to experiment with this and may-be use the *Undo* icon ↶ on the Toolbar to return to the previous step. Save your target map as HDF. An example is shown below. Note that land is white (pixel value 255), coastlines

have pixel value 1 and ocean is black (pixel value 0). You can overlay other features, such as grids, grid labels, stations, color scales, etc. You also need to consider where the date label will be written. The best place would be over land. Write down the X and Y coordinates where you want the date label to start.


- Now you are ready to remap the global images to your projection and overlay at the same time the land with coastlines file that you just made. The overlay is just needed to make the images look better. You can do all that with *wam_series*. Open *wam_series* and fill the text boxes. An example screenshot of *wam_series* is given below. You will probably need to replace the "From dir:" with the location of your files, "File pattern:" with a pattern matching your files, "To dir:" with the directory where you want the output, the "Overlay" and "Remap to" with your overlay file name. Everything else can be like in this example. Try to understand the meaning of the many options. *WAM.pdf* has detailed information on *wam_series*.

- I will explain some of the operations done with wam_series very shortly. We save PNG as we are going to use them in creating an animated GIF but as a test you can also save HDF. We apply *Median* filter to make the images look smoother. The "*Overlay*" and the "*Remap to*" text boxes refer to the same HDF image (shown above) that serves both as the target projection and as the overlay image. Annotate location is default in the upper right corner (that's why there are -1 and -1). You can replace them with the X and Y coordinates where you want the label to start. Please note that the Float32 pixels are converted to a Byte with Linear scaling with *Slope* = 1 and *Intercept* = -100. Byte images save space and are better to visualize. The negative intercept is needed as sea level anomalies are both positive and negative. As with this scaling pixel value 100 means anomaly of 0, therefore I set the color Stretch from 36 to 164 as they are symmetric relative to 100 (both are 64 pixels away

from 100). As a result, negative anomalies are shown as blue and positive as yellow or red (using my default palette *chl1_white_end.lut*. If you want to use another palette, select the "Load Palette" check box and specify the palette file next to it.
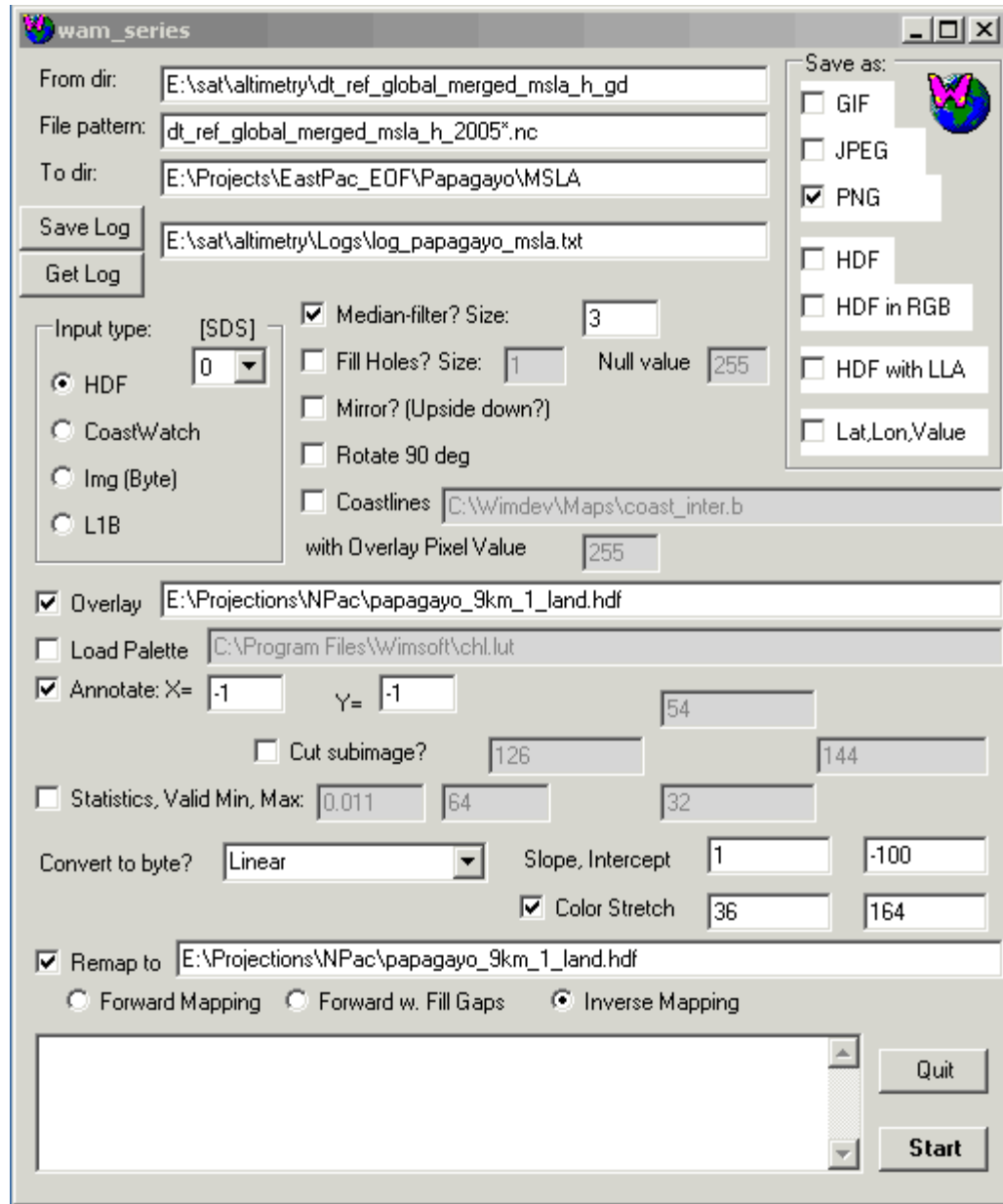
- A sample PNG image is shown below.
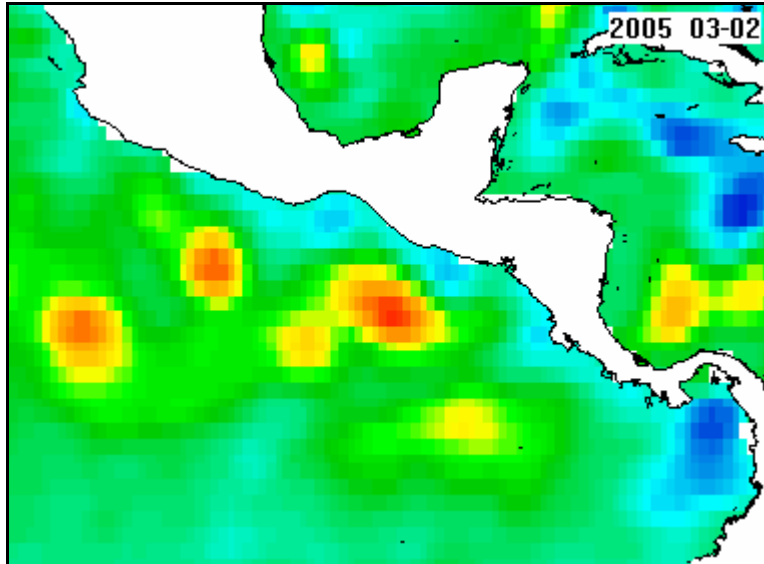
- Assuming that you downloaded a series of these images you can now make an animated GIF using, for example, *Babarosa Gif Animator* (you can get it in the *Tools* folder of the WIM/WAM CD). My results are shown in http://spg.ucsds.edu/Satellite_Projects/Sea_Level_Anomalies_in_Eastern_Central _Pacific/Sea_level_anomalies_in_eastern_central_pacific.htm.