GEOL 308L: Natural Hazards

Lab 10: Sea-Level Rise: 50 years

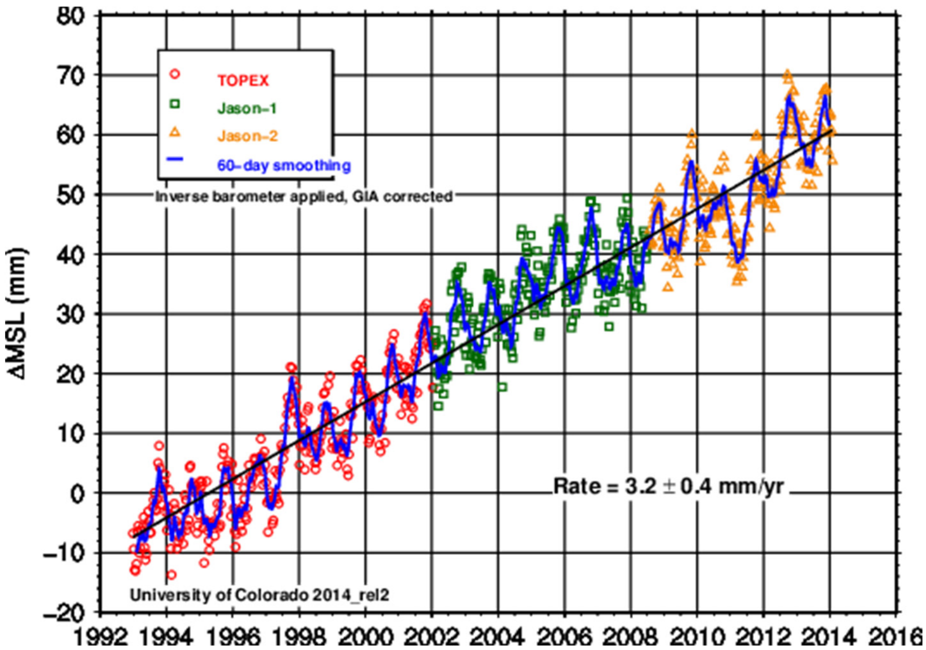

Figure 1. Global mean sea level variations from three different altimeter missions. (Nerem et al., 2010)

Accelerated rates of sea-level rise (SLR) due to the anthropogenic contribution to climate change are increasingly recognized as a hazard to people in coastal zones globally. The 20th century rate of SLR was 1.7 ± 0.3 mm/yr Church and White (2006). Nerem at al. (2010) use satellite altimetry measurements of water surface elevations to estimate a global SLR rate of 3.2 ± 0.4 mm/yr.

The impact of SLR on coastal regions can be significant, particularly for low relief regions (Nicholls and Cazenave, 2011). In addition, SLR rates vary globally for different reasons (Nerem et al., 2010).

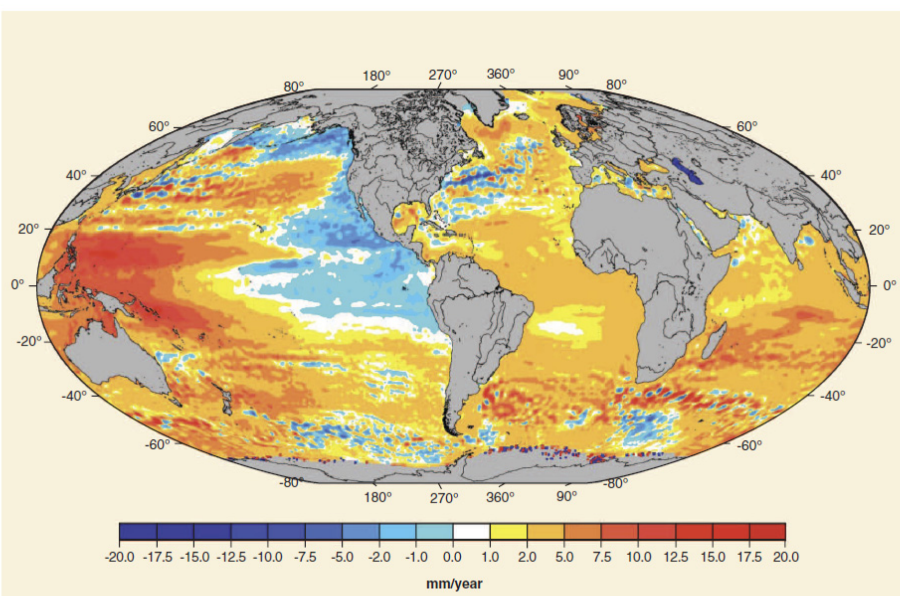

Figure 2. Regional sea-level trends from satellite altimetry (Topex/Poseidon, Jason-1&2, GFO, ERS-1&2, and Envisat missions) for the period October 1992 to July 2009 (Nicholls and Cazenave, 2011)

In some places, regional tectonic deformation is causing vertical land motion (VLM) that is on the same order of magnitude as SLR (Wang et al., 2003; Williams et al., 2012). Estimating local SLR in these tectonically active regions must include estimates of VLM rates in order to be valid.

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Objectives:

- Learn about the differences between global and local sea-level rise.
- Learn about how global sea-level rise will affect a coastal region.
- Learn about how tectonic deformation can affect local sea-level.

Products:

- Map and text document discussing the effect of a 50-year forecast of global sea-level rise given a modern rate.
- Map and text document discussing the variation in vertical land motion due to tectonics in northern California.

You have been accepted into the new Coastal Resilience Institute, recently formed at Humboldt State University. This opportunity includes a monthly stipend that will support your research about the impacts of SLR. One of the main goals you will meet is to develop a suite of strategies to accommodate future SLR. Your first assignment is to establish the base level of secular local SLR in the Humboldt Bay region. You are tasked to combine modern rates of SLR with modern rates of VLM to forecast the local sea level of Humboldt Bay in 2067, 50 years from now.

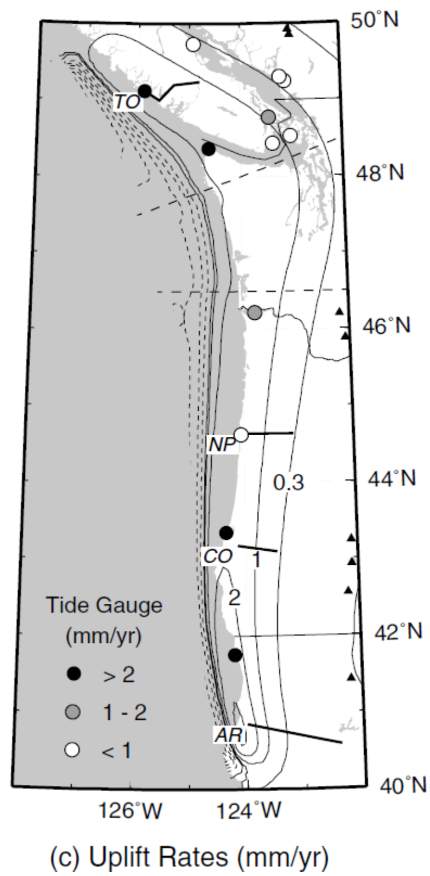

Figure 3. Model uplift rates (contour lines) and uplift rates derived from tide gage records (Wang et al., 2003)

You find a series of data sets on the server, while you are poking around. There is a point shapefile that is attributed for VLM rates in mm/yr (called “vertical_rate.shp”). You find a 5-meter resolution bathymetry/topography raster (DEM). Your first project will be to take the global SLR rate of 3.2 mm/yr, combine it with the VLM rates, and apply those rates to the raster.

Step 1: Use some way to create a raster that represents the SLR rate. If you take the DEM and divide it by itself, you have a unity raster that you can multiply by the SLR rate to get a SLR rate raster. You may want to get it into the same elevation units as your DEM. Hint: use the raster calculator. Hint #2: for all your raster calculator functions, copy and paste your formulas into a text file for later use (your report).

Step 2: Extrapolate VLM rates from the point data and create a VLM raster with a 5 m resolution. The VLM rates will also want to be in the same vertical elevation units.

Step 3. Use Map Algebra to combine your VLM and SLR rate rasters with the DEM raster to create a new DEM raster with elevations relative to the new sea level in 2067. Hint #1: use the raster calculator. Hint #2: Try sketching out your methods on scratch paper first.

Step 4: Create a residual raster by subtracting the 2017 DEM from your forecast 2067 DEM. Make this residual raster with vertical units of cm.

Step 5: Compose two maps: (1) a 2067 DEM raster map and (2) a 2067 residual raster map. Write a few paragraphs describing what you did.

(1) Use the 2067 forecast DEM as a basis for your map. Try using the hillshade to help visualize your data. Write at least one paragraph describing what these data represent and how you created this data set.
(2) Compose a final map with this residual raster so that people can see where there are regions of greater SLR and regions of lesser SLR. Write at least one paragraph that describes what this residual raster represents and how you created this data set.

Derived Data:

- Step 1. (1) unity raster, (2) global SLR raster
- Step 2: (1) VLM raster
- Step 3: (1) 2067 DEM forecast raster
- Step 4: (1) residual raster
- Step 5: (1) map using the results from step 3, (2) map using the results from step 4, (3) several paragraphs describing the methods and the results.

References

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