SLOSH MOMs/MEOWs for South Florida:
Final Project Report for FEMA's National Hurricane Program

Project Background:

For the National Hurricane Program (NHP), storm surge planning and operational products in the state of Florida are spread across 11 SLOSH basins. This often leads to confusion about which SLOSH grid to use for a particular area. In addition, areas of basin overlap between the 11 SLOSH basins results in discontinuities at the grid boundaries. To alleviate these problems and potentially simultaneously update study areas previously covered by six SLOSH basins, a single large basin "Superbasin" was developed (see Figure 1) covering all of South Florida. The grid is 424X1500 for a total of 636,000 grid cells, making it the basin with the most grid cells to date. Implementation of the South Florida Superbasin incorporated additional benefits following new research and improvements to the SLOSH modeling system.

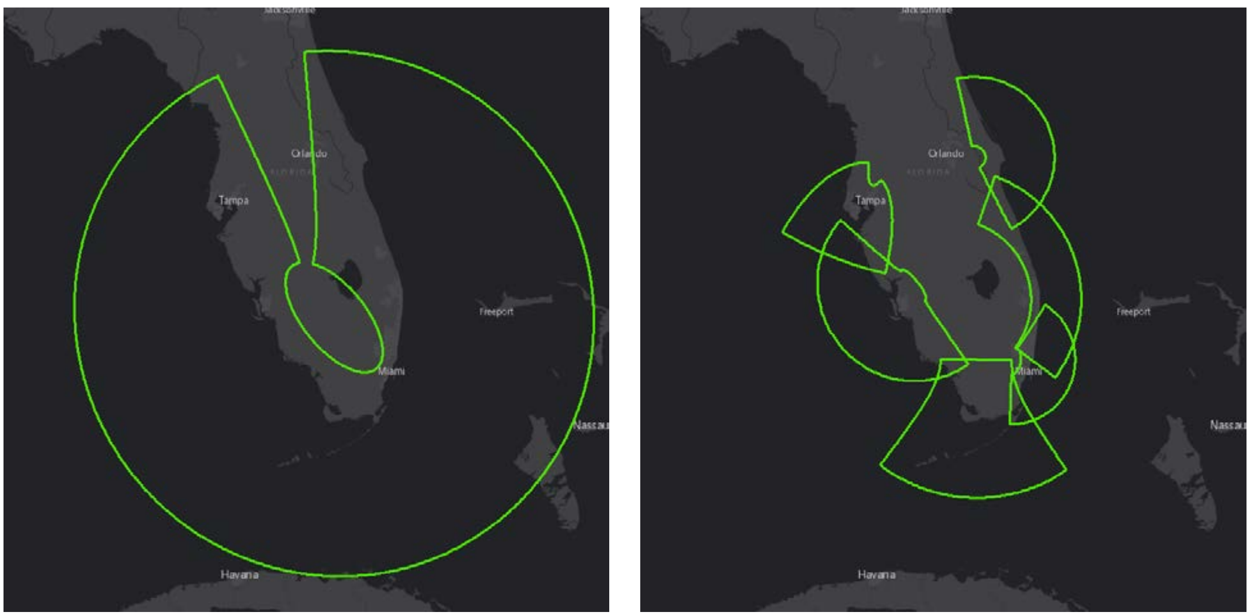

Figure 1: South Florida SLOSH (hSF1) basin (left) and SLOSH grids that can potentially be replaced (right)

Grid and Model Improvements:

The west coast of Florida can experience an abnormal rise in water by a storm traveling northward off the coast from a phenomenon known as a coastal Kelvin wave. This occurred during Hurricane Dennis in 2005. Water levels from South Florida through the Panhandle were elevated an additional 3-4 feet above the predicted water levels along the coastline due to a coastal Kelvin wave. The current SLOSH basin configurations and modeling techniques do not allow the full effects of coastal Kelvin waves to be captured along the coastline – water level information is not passed from one SLOSH basin to the next. The new South Florida SLOSH basin eliminates this problem by having one basin that spans from the west coast of South Florida and into North

Florida. Ultimately, this new basin allows the increased water levels associated with a coastal Kelvin wave to be captured in the MOMs/MEOWs along the west coast of Florida.

Central and South Florida are estimated to have 469,000 acres of mangrove forests. Recent research has shown that mangroves are effective at reducing the magnitude and inland extent of storm surge inundation (Zhang et al., 2012). One must properly account for the frictional effects of mangroves when modeling storm surge in Florida. The National Hurricane Center (NHC) has developed a new friction parameterization to take into account the attenuation effects of mangroves for the South Florida SLOSH basin. This modification provides a more accurate simulation of the storm surge in this region, which is critical to the NHP.

Publication: Zhang, K., H. Liu, Y. Li, X. Hongzhou, S. Jian, J. Rhome, T.J. Smith III: 2012. The role of mangroves in attenuating storm surges. Estuarine, Coastal and Shelf Science 102, 11-23.

Specifically, the SLOSH slip coefficient was modified to allow for increased friction in shallow water and over land. A slip coefficient of 0.009 was used in shallow water depths from 1 ft to 30 ft (water depth + storm surge). A slip coefficient of 0.25 was used for over land cells up to 56 ft that become inundated by storm surge. The bottom stress coefficients were calculated using the new shallow water- and over land-dependent values for the slip coefficient.

The following briefly outlines the changes made to various subroutines in the SLOSH source code 'runslhg.f'. The subroutines modified are: 'BTMSTR(ZLATO)', 'FLW1DM', 'FRCPNT', 'MOMNTM', and 'MNTMBD'. The bottom stress coefficients were calculated using the new shallow water- and over land-dependent values for the slip coefficient. This was handled by using 2-dimensional arrays for the variables in the 'SCND' common block. Array dimension 1, index 1 in the common block arrays is for the shallow water modification and dimension 1, index 2 is for the over land modification. The calculation of the new bottom stress coefficients is in subroutine 'BTMSTR(ZLATO)'. In the other subroutines, a check for land cells is conducted to invoke the proper index for the bottom stress coefficient arrays. Extremely minimal, if any, slow-down of the SLOSH code was observed due to this modification.

Verification:

The new friction parametrization and grid configuration was validated against high water marks and inundation extents as well as other numerical modeling results (Zhang et al., 2013) for Hurricane Wilma (2005) and Hurricane Andrew (1992).

Publication: Zhang, K., Y. Li, and H. Lui, J. Rhome, and C. Forbes. 2013: Transition of the Coastal and Estuarine Storm Tide Model to an operational forecast model: A case study of Florida. Weather and Forecasting 28, 1019-1037.