A regional weather, wind wave, and storm surge forecast system

Zavala-Hidalgo, Jorge[1], Gómez-Ramos, Octavio[1], Zavala-Romero, Olmo[1], Romero-Centeno, Rosario[1], Pedraza-Díaz, Angélica[1], López-Espinoza, Erika Danaé[1], Arellano-Guerrero, Fernando [1], Robles-Muñoz, Daniel[1], Osorio-Tia, Ma. Elena[2], Díaz-García, Ovel[1], Ruiz-Angulo, Ángel[1], Pierard-Manzano, Claudio Marcelo[1], Hernández-Vargas, Gisell[1], Calva-Chávez, Miriam Alin[1], Herrera-Moro, Dulce[1], Oropeza-Alfaro, Pavel Ernesto[1], Cruz-Santiago, Pedro Damian[1], Zazueta-García, Ixchel Stephanie[1], Gutiérrez-Valdez, Vladimir Mijail Aaron[1], Medina-Peña, Rául [1], Pantoja-Ortiz, Samantha[1]

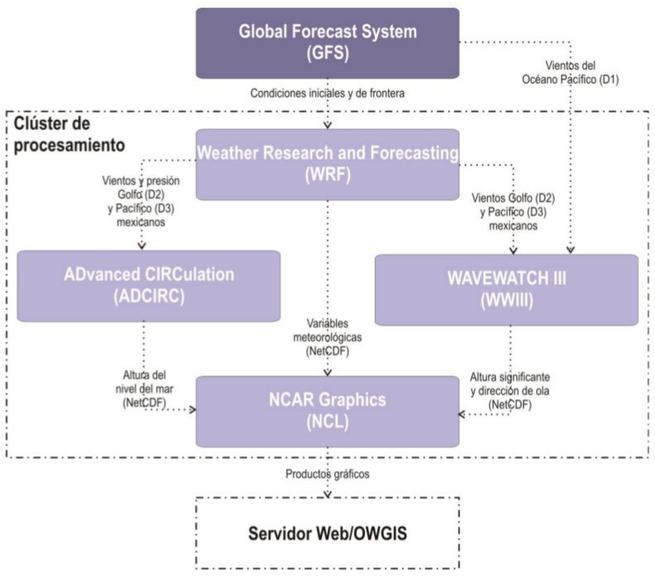
[1]Centro de Ciencias de la Atmósfera, Universidad Nacional Autónoma de México
[2]Facultad de Ingeniería, Universidad Nacional Autónoma de México
jzavala@atmosfera.unam.mx

ABSTRACT

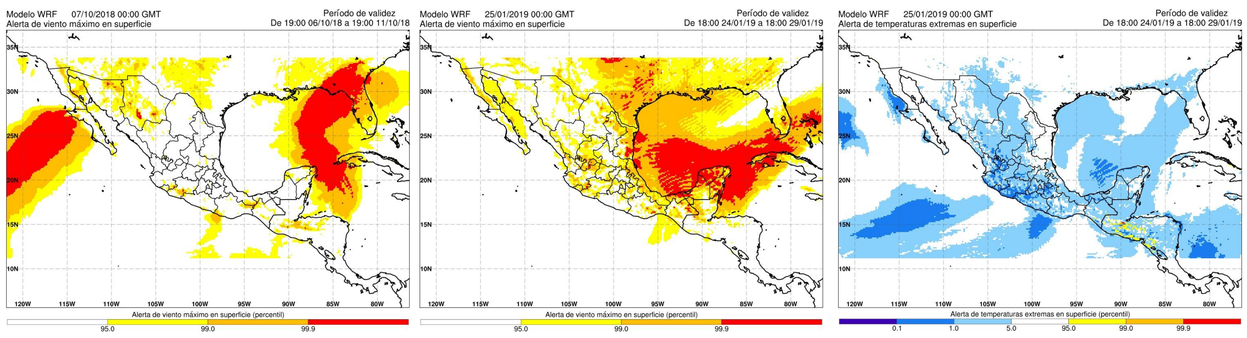
A regional forecast system including meteorology, wind waves, and storm surge was developed for the Mexican seas and coasts. It includes information of uncertainties and displays alerts of extreme values for some variables. This system was developed in order to improve the quality of the forecast. Different post-processed products are presented in a user-friendly viewing website. The system is based on the Weather, Research, and Forecasting model (WRF), the Wave Watch III model (WWIII), and the ADvanced CIRCulation model (ADCIRC) for meteorology, waves, and storm surge respectively. It is completely automated, running every day through scripts developed at home, and the information is represented in maps and time series.

BRIEF DESCRIPTION OF THE SYSTEM

The system performs a 120-hourly forecast every day, following the diagram in figure 1. First, it runs the WRF model with boundary and initial conditions from the Global Forecast System (GFS). Winds and surface pressure are then used as forcings for the ADCIRC and WWIII models. The output of each model, in NetCDF format, are used for post-processing computing warnings, graphs and time series. In addition, the outputs are visualized with the OWGIS system. The system runs completely automated based on bash scripts and NCAR Graphics (NCL).



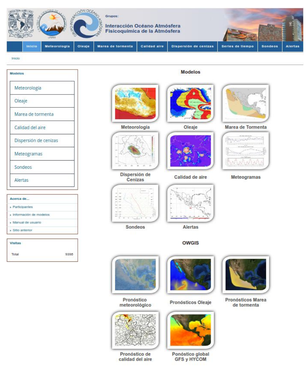
WARNINGS

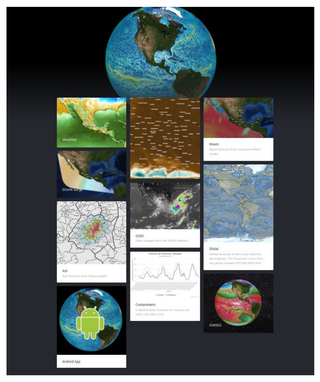


Warning system for winds, precipitation, and temperature are included. Hourly and for the 5-days period maps display the warning maps. Warnings are based in a 30-year hindcast climatological local percentiles.

THE WEB SITE

pronosticos.unam.mx





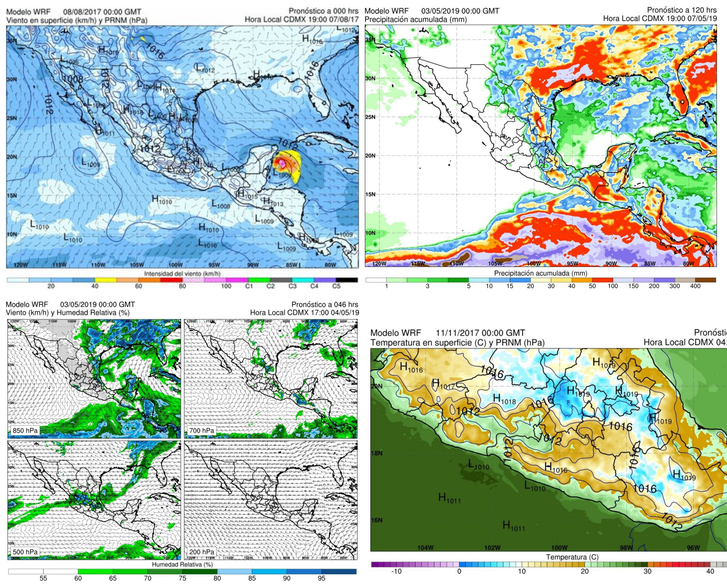
SUPERCOMPUTER RESOURCES

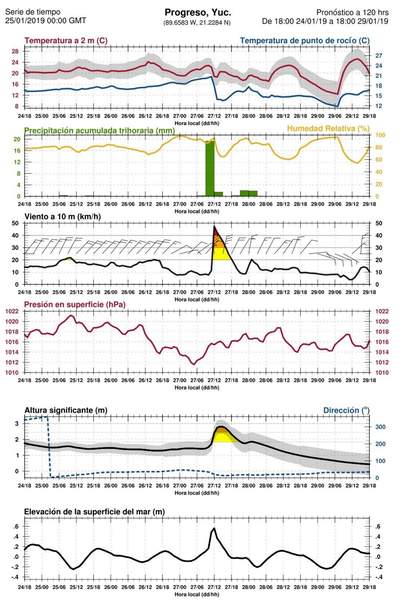
The development of the forecast, its validation and its run were run in both the UNAM supercomputer *Miztli* and the Centro de Ciencias de la Atmósfera supercomputer *Ometeotl.* The later has 1360 cores with a capacity of 42 Tflops. For the forecast 120 cores are dedicated every day.

THE DEVELOP GROUP

THE WEATHER FORECAST

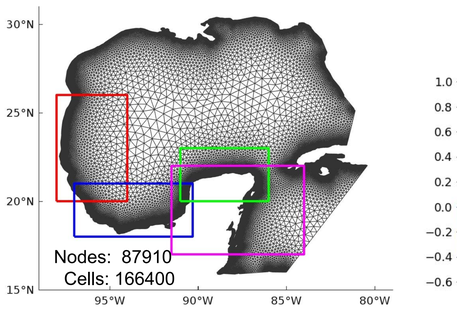
The meteorological forecast was performed using the WRF model with to domains: one of 15 km of horizontal resolution and the other of 5 km, 50 vertical levels, and output every hour. It generates different products including precipitation, winds, temperature, wind shear, vertical velocity (omega), cloudiness, precipitable water, stability Index, meteograms, virtual rawsoundigs, warning maps, etc., for a total of 4451 figures every day.



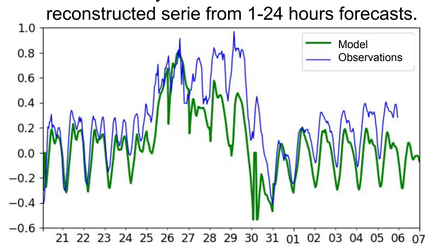


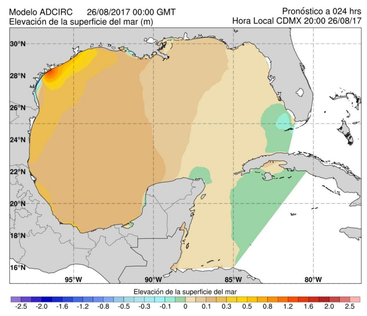
THE SEA LEVEL (STORM SURGE) FORECAST

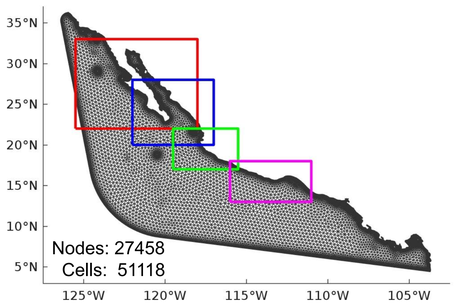
The storm surge forecast was performed using the ADCIRC model with two domains, one for the Gulf of Mexico and other for the Mexican Pacific coast. Both meshes have a 500 m resolution along the coastline, and the outputs are plotted for the full domain and four extra zoomed areas.

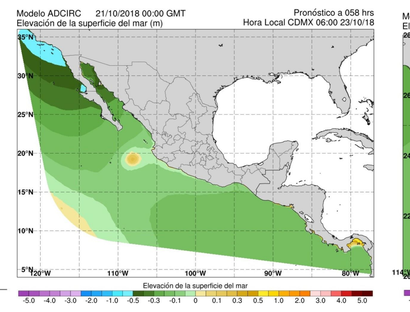


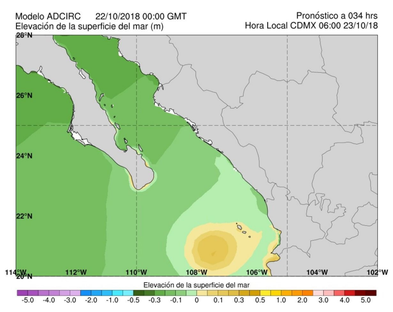
Hurricane Harvey (Sept. 2017). Sea level at Galveston Bay Entrance station vs. reconstructed serie from 1-24 hours forecasts.





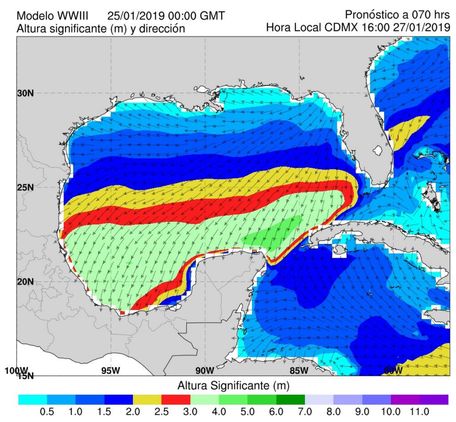


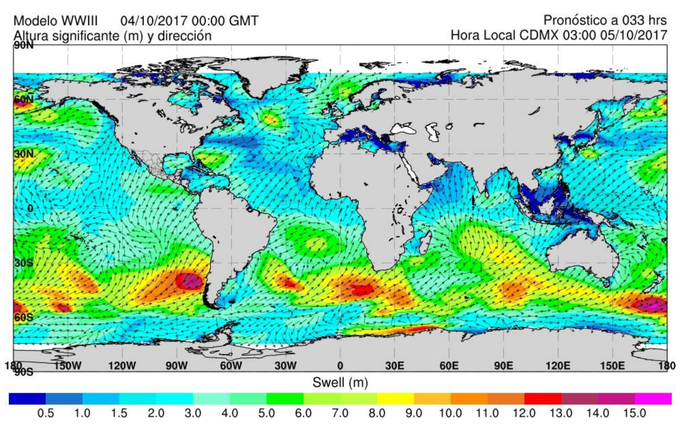




THE WAVE FORECAT

The wave forecast was performed with the WWIII in 3 domains: global, Mexican Pacific, and Gulf of Mexico and North Western Caribbean. The global model is forced with the GFS winds while the regional domains with the hourly winds from the WRF forecast. The spatial resolution of the global model is one degree and the regional forecast with 22 km.





Significant wave height for the regional Gulf of Mexico domain and for the Global Domain.

ACKNOWLEDGMENT

- Research funded by the National Council of Science and Technology of Mexico - Mexican Ministry of Energy - Hydrocarbon Trust, project 201441. This is a contribution of the Gulf of Mexico Research Consortium (CIGoM).
- Resources from UNAM supercomputer are due to grant LANCAD-UNAM-DGTIC-110, *Miztli*; *Ometeotl* supercomputer is also used for the daily forecast.