University: University of Hawai‘i

Name of University Researcher Preparing Report: Yi-Leng Chen

NWS Office: National Weather Service Honolulu Forecast Office

Name of NWS Researcher Preparing Report: Robert Ballard

Partners or Cooperative Project: Partners Project

Project Title: High Resolution Experimental Forecasts over the Hawaiian Islands and Hindcast of Historical Tropical Cyclones

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Section 1: Summary of Project Objectives:

a) Upgrade our once per day high resolution (~ 1.5 km) experimental forecasts (using WRF-ARW) of island-scale weather for the Hawaiian Islands with data assimilation to twice per day, initialized by FV3GFS after March 20, 2019, to improve forecasts of trade wind weather, localized heavy rainfall and high wind events. b) Deliver the model data to the National Weather Service (NWS) Weather Forecast Honolulu Office (WFO-Honolulu) Interactive Forecast Preparation System/Graphic Forecast Editor (IFPS/GFE). c) Share the real-time the daily model run for the Commonwealth of the Northern Mariana Islands (CNMI)/Guam and American Samoa, funded by the Office of Insular Affairs/U.S. Department of the Interior (OIA), with the Pacific Region Headquarters (PRH) in order to bring the data to the NWS local offices. The WFO-Honolulu and PRH will provide feedback on model performance, past significant events or deviation from the environment. d) Test the performance of the new TC dynamical initialization scheme proposed by Nguyen and Chen (2011; 2014; MWR) (NC2014) with data assimilation in simulating the track, intensity, and structure of historical tropical cyclones up to five days for a few events impacting Hawai‘i [e.g., TC Lance (2018), TC Olivia (2018)] and compare our model performance with operational models, e.g., HWRF and COAMPS and rain gauge, surface, satellite and radar observations.

Section 2: Project Accomplishments and Findings:

a) Update of the high resolution WRF-ARW model over the Hawaiian Islands, (i) shifting the initial conditions from GFS to FV3GFS, (ii) upgrading the once daily high-resolution 72-h forecasts to twice daily; (iii) replacing the U.S. Geological Survey (USGS) land use data compiled by Zhang et al. (2005a,b) by the recently updated land cover from the Coastal Change Analysis Program (C-CAP, NOAA 2019) (Hsiao et al., 2020) due to the recent urbanization of the Ewa Plain and City of Kapolei,.

b) Bring twice daily high-resolution WRF-ARW and WRF-NMM experimental 72-h forecasts to the numerical model suite at NWS Honolulu. The WFO-Honolulu continues to evaluate the usefulness of experimental high resolution daily forecasts for graphical forecast products with a grid-size of 2.5 km, with feedback provided to the UH team.

c) We also produce one daily high resolution model run for the Commonwealth of the Northern Mariana Islands (CNMI)/Guam and American Samoa [funded by the Office of Insular Affairs/U.S. Department of the Interior (OIA)] and share our daily model output with the Pacific Region Headquarters (PRH). PRH continues to provide feedback on model performance and the challenges found in the forecast environment.

d) The NC2014 TC initialization scheme considers the interaction between TCs and the open ocean environment to improve TC initial intensity and structure. Similar to our previous studies, in addition to better resolution of winds, pressure, and size, the initial TC structure for both Lane and Olivia includes hydrometeors in the eyewall and spiral rainbands with asymmetric/symmetric structure, which are consistent with microwave images observed by polar orbiting satellites. Furthermore, the initial intensity is close to the best track data. This is in contrast to operational models from NCEP and the Central Weather Bureau (CWB), Taipei, Taiwan. The initial TC vortex from the operational Hurricane Weather Research and Forecasting (HWRF) model shows no radar reflectivity at the initial time. The Taiwan CWB developed and operated the Typhoon Weather Research and Forecasting (TWRF) method, which included blending and relocation. The TWRF analysis blends the vortex from cold start and two-cycle data assimilation with the large-scale environment from the Global Forecast System (GFS) model. The TWRF vortex is extracted only for wind, potential temperature, water vapor mixing ratio, and pressure, and is symmetric. In other words, the bogus TCs produced by TWRF and HWRF have no eyewalls or spiral rainbands at the model initial time. Our preliminary work during model integration shows promising results in improving TC track/intensity and rainfall forecasts using NC2014.

Section 3: Benefits and Lessons Learned: Operational Partner Perspective

The National Weather Service in Honolulu is creating post-processed output from the WRF-ARW model to produce high resolution hourly Probability of Precipitation and sensible weather grids to be used as guidance for NWS forecasters. This guidance is of a higher temporal and spatial resolution than other post-processed model guidance for those parameters and allows forecasters to better monitor and evaluate the potential evolution of significant events in the short term. In similar fashion, work is ongoing to create bias-corrected WRF-ARW temperature guidance for the forecasters. Finally, the high resolution model continues to provide the forecasters with enhanced wind guidance that can help them evaluate local wind effects, as well as assist them with the determination of the location of the volcanic haze plume.

Section 4: Benefits and Lessons Learned: University Partner Perspective

The main benefits to the university are the exposure of students to operational forecasting and better understanding of the forecast challenge in the operational environment. During the Fall 2019 semester, Dr. Chen was the Instructor for ATMO 405, Satellite Meteorology. He brought his class to attend the weather briefing every Friday morning. A forecaster (Norman Hui) and David Hitzl also taught a few classes on GOES-R ABI images when Dr. Chen was on travel attending conferences. Mr. Hitzl is an instructor with the NWS Pacific International Training Desk and a part-time PhD student under the supervision of Dr. Chen. Those interactions are valuable learning experiences for our students.

Section 5: Publications and Presentations

Hisao, F., Y.-L. Chen and D. E. Hitzl, 2020: Numerical simulations of local afternoon heavy rainfall events over Central Oahu under weak wind conditions during the warmseason, *Mon. Wea. Rev*. (Accepted)

Hitzl, D.E., Y.-L. Chen and F. Hsiao, 2020: Wintertime easterly and southeasterly airflow in the 'Alenuihaha Channel, Hawai‘i, *Mon. Wea. Rev*.,**148**,1337-1362.

Section 6: Summary of University/Operational Partner Interactions and Roles;

Part 2(b) and (c) are joint efforts between UH and NWS.