UNIVERSITY of HAWAI'I MĀNOA

Department of Atmospheric Sciences
M.S. Defense Announcement

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SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY

M.S. Defense Title:

Investigating Atmospheric Rivers using GPS TPW from Ocean Transits

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Abstract:

An Atmospheric River (AR) can be described as a feature within a warm conveyor belt with anomalous total column precipitable water (TPW). Close monitoring of ARs is heavily reliant on satellites and models that have poor spatial and temporal resolution for monitoring TPW. Satellite retrieval of TPW is also very difficult for most sensors in extremely cloudy or heavy precipitating events, which describes the conditions during AR events. Ship-based Global Positioning System (GPS) receivers have been successful in obtaining millimeter TPW accuracy within 100 km from the nearest ground-based reference receiver and is not limited to cloud cover or precipitation. We extend this capability with a field experiment using a GPS meteorology system installed on board a cargo ship to monitor TPW within ARs over the Eastern Pacific Ocean. In a 14-day cruise the GPS captured TPW spikes >50 mm during the early development of two ARs, which caused flooding conditions for the west coast of California and moderate to heavy rainfall events for Hawaii between the periods of February 3-16, 2014. Comparison between TPW solutions processed using different GPS reference sites provide an internal validation for the GPS TPW estimates in the deep ocean and indicate the errors here are typically less than 5 mm. Land, satellite and model –based observations provide an external validation of 1.65 mm, 6.11 mm and 13.38 mm RMSE, respectively.

The zones most heavily trafficked by cargo containers are near the coasts, yet these areas are a challenge for satellite retrievals. Commercial ship-based GPS receivers offer an extremely cost-effective approach for acquiring meteorological observations over the oceans, and can provide important calibration/validation data for satellite retrieval algorithms. Ship-based systems could be particularly useful for augmenting our meteorological observing networks to improve weather prediction and nowcasting, which in turn provide critical support of hazard response and mitigation efforts in coastal regions.