

# Julie Pullen

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## Research

### *Overview*

I investigate and predict complex coastal circulations and patterns surrounding cities and mountains. I utilize high-resolution ( $< 5\text{km}$ ) two-way coupled ocean/atmosphere models and observations from targeted field campaigns around the globe. Currently my research is focused on New York City and the volcanic islands of the Philippines and Madeira. My work has direct societal impact in the realms of contaminant transport, heat wave projections, and coastal and river flood prediction. My research also contributes to the understanding and development of resilience and sustainability in coastal environments, and the enhancement of Earth System Models on weather, subseasonal-to-seasonal, and climate timescales.

I work with large teams of international multi-disciplinary scientists to advance fundamental knowledge of circulation regimes in the coastal ocean and atmosphere. I have served on the management/steering team for field studies in urban air dispersion (DHS/DTRA NYC Urban Dispersion Program) and archipelago oceanography (ONR Philippines Straits Dynamics Experiment, PhilEx and PISTON). These positions allowed me to shape research strategy and implementation. I have developed a broad array of collaborations across the earth sciences: marine geology, meteorology, oceanography, transport & dispersion, hydrology and climatology. These collaborations have resulted in publications in oceanography, meteorology, hydrology and earth systems journals. My spheres of engagement span academia, national labs, non-profits, foundations, domestic government, and international institutions. Recent projects have been supported by ONR, NRL, DTRA, DHS, the Coast Guard, Brookhaven National Laboratory and the Carnegie Corporation.

From the earliest moments of my professional education I have been drawn to research questions that require multi-disciplinary tools and perspectives. For example, my doctoral research included collaborations with marine geologists to map and model sediment and ocean current distributions during extreme flood events. During this collaboration, I found that a limiting factor in my modeling work was the mismatch in scales between the downscaled regional ocean I had implemented and the global atmosphere model I was using as forcing. I

addressed this knowledge gap as a postdoctoral fellow at the Naval Research Laboratory Marine Meteorology group. While there, I pioneered the linkage of the air and sea portions of the Navy's mesoscale modeling system (COAMPS) and applied it to the downslope Bora winds, Po River, and Adriatic Sea dynamics. The work revealed that air/sea fluxes were improved in the 2-way coupled model and led to more realistic forecasts in both realms. My success also garnered research publication awards and led to additional discoveries in coastal air/sea response.

### *Coastal Processes*

Coastal mountains modulate winds in ways that can have a substantial impact on ocean circulation. In the volcanic archipelago of the Philippines, I used both modeling and satellite observations to discover that monsoon wind surges induce the generation, intensification, and off-shore propagation of a pair of counter-rotating oceanic eddies (Pullen et al., 2008). On a subsequent research cruise we were able to predict, verify and sample *in situ* an eddy formed as a direct response to one of these atmospheric cold surge (Pullen et al., 2011) – thus confirming that the ocean circulation pattern was a robust and generic feature. Working with a Woods Hole postdoc and international collaborators the double gyre eddies were characterized as Lagrangian Coherent Structures (Rypina et al., 2010) with distinct biological features (May et al., 2011).

My current research is focused on rain and rivers in the Maritime Continent (Philippines, Indonesia, Singapore, Malaysia). I have shown how atmospheric signals (ENSO/MJOs/cold surges) layer to produce extreme rainfall in the mountains (Pullen et al., 2015). The demonstrated ability of a coupled air-sea model to represent complex precipitation events heralds the potential to warn populations in mountainous areas most at risk for flooding, and mitigate associated flood risks.

### *Urban Atmosphere*

The heterogeneous nature of several recent NYC extreme heat events was documented in my Ph.D. student's studies using a ~1km resolution mesoscale meteorological model with an urban canopy parameterization (Meir et al. 2013). The health impacts of expected NYC increased heat event frequency, magnitude, and duration is addressed in our NYC Panel on Climate Change contribution (Kinney et al., 2015).

Building on prior studies showing that more corrugated building heights (e.g., NYC vs. Washington D.C) led to more spread in contaminant plume distributions (Pullen et al., 2005), my student linked the weather model to a transport and dispersion tool (DTRA's HPAC) as a collaboration with NCAR scientists. She found high sensitivity of plume characteristics to proximity and transport over rivers and coasts (Meir et al., 2016). Suggested improvements to the heat flux algorithms for transport over water were an additional outcome.

### *Other Current Efforts*

Engaging students in research and sustaining their interest through downstream applications and societal relevance are themes that have driven my approach to science. Coastal ocean, atmosphere and river modeling, forecasting and monitoring systems are particularly well-suited for student involvement. I contribute to the Davidson Laboratory integrated modeling system in the areas of coupled meteorological and hydrological prediction, in addition to my core area of coastal ocean prediction. We are planning to add an urbanized weather model to the NYHOPS system to form a coupled air-sea/river-hydrologic forecast system for the NY/NJ region.

I am organizing modeling approaches and am engaged in studies for the multi-national field and modeling campaign of the Years of the Maritime Continent (YMC, 2017-2019). YMC is focused on measuring and predicting Madden Julian Oscillation (MJO) propagation across the Maritime Continent, and its associated wet and dry phase interaction with island terrain. The initiative involves scientists and agencies from Indonesia, Philippines, Malaysia, Singapore, Taiwan, Australia, U.K., and Japan. I have contributed to the U.S. Science Plan and International Implementation Plan for the field and modeling components.

A key aspect of improving MJO prediction in the Maritime Continent is to understand and simulate oceanic feedbacks to atmospheric propagating signals. My current research, funded by ONR (2016-2019), will integrate meteorological, hydrological, and oceanographic modeling and observations to examine river discharge effects on upper ocean structure and evolution.