Storm Chasing in the North Pacific

Breaking Wave Dissipation in Mixed Seas

Jeff Simmen: The Laboratory is renowned for its seagoing research programs. The feature you are about to watch gives us a look at an expedition in the North Pacific led by oceanographer Jim Thomson.

He and his team set out to search for intense winds and large waves, and to measure the cascade of energy from wind, to waves, to turbulence in the ocean generated by wave breaking.

Narrator: Scientists from the Applied Physics Laboratory at the University of Washington set out for the North Pacific in search of rough weather – intense wind and large waves – to study the balance of wind and wave energy. The goal: to improve notoriously unreliable wave forecasts.

Jim Thomson: This project has been to study wave breaking in mixed seas. And that's a sea that has both swell – has waves that are old and big and long – and then has waves that are small, short wind waves that are made locally. There are very few measurements of waves in the open ocean. We don't really know how well the forecast models do. There's still a lot of room for improvement.

Narrator: Jim Thomson chronicled the expedition for the ***New York Times*** "Scientist at Work" blog.

Thomson (reading): *Today, we arrived at Station P (Papa), one of the oldest measurement sites in the world. Since 2010, we have had a mooring at Station Papa – our Waverider. That's the mooring we came to recover and to replace.*

Thomson: During the experiment the largest waves we saw were four and a half meters, almost five meters, which is still very large waves that contain a lot of energy. And it's really representative of most of what's happening in the ocean a lot of the time. The maximum winds we observed were thirty knots. Again, that's really representative of a rough day on the ocean. Until our mooring was deployed two years ago, there were no measurements of the waves at Station Papa.

Over this two-year time series, we were able to see what is the long-term result of this breaking process. And the long-term result is to keep the waves in balance with the winds. So when the winds become strong…. that's a lot of energy being put into the ocean. But a very large fraction of that is actually going directly into breaking. We call that equilibrium.

Michael Schwendeman: On a day when we were taking a lot of data and there was good breaking going on, we would throw out two SWIFTs and one of the small Waverider buoys.

Thomson: SWIFT. It's a buoy that drifts and moves with the waves. And the idea is to make all of our measurements in a reference frame that follows the waves. So you move with the wave and then you measure the breaking in that reference frame rather than staying put in one place and watching the wave go by.

Schwendeman: That's where the coupling of the SWIFT measurements and the video measurements is really key. The key thing is that the SWIFTS can say what's going on in the water. This is what the turbulence is doing. And the video that we take can say: this is what waves are breaking that have created all this turbulence.

The cool part about it was coming back from the cruise with all this data… for the next four years of my thesis. And that's been a really cool experience. And that's a really great thing about fieldwork.

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Thomson: This experiment follows on to what we've been doing the last five years, mostly funded by the National Science Foundation. A different series of projects that have started from very small pure wind waves on Lake Washington, to the Strait of Juan de Fuca, which has some influence from the open ocean.

And the energy is really the key thing that we're looking for . So as the wave is formed, it gains energy from the wind. When it breaks, it loses energy. Then the combination of those two things – the net of those two things is what gives you a wave field a day later. And so if we want to improve the wave forecast for the Navy or the merchant marine or for anyone, we need to understand how much energy is going into the waves and how much energy is coming out of the waves. And we need to be able to do that across all different wave sizes and shapes.

Simmen: Like many APL-UW research programs, Thomson's research spans fundamental physics, instrument and sensor development, and the application of findings to real-world problems – in this case, to improve wave forecasts on the open ocean used by the Navy and the merchant marine.

This is APL — The Applied Physics Laboratory at the University of Washington in Seattle.