Dancers from "Dora Stratou" welcome us to Greece

Ionian Sea Rainfall Experiment

Southwest of Pylos, Messinia the Ionian Sea is over 3 km deep within 20 km of shore

One of the biggest impacts of climate change on human societies will be a potential change in global rainfall patterns. Knowledge of the global distribution of rainfall is one of the biggest challenges facing climatologists today. This is because rainfall patterns change over very small space and time scales, making measurements from any single type of instrument difficult to extrapolate to global scales. This challenge is even greater over the oceans where few people live and standard rain gauges are unavailable. Eventually satellite instruments will provide global coverage of rainfall patterns, but currently these instruments average the rainfall over large spatial scales with poor temporal resolution. Major research efforts are underway to understand the satellite measurements with land-based weather radars, and in turn, the measurements from the land-based weather radars are evaluated using dense rain gauge networks. But these validation systems are unavailable over the oceans. A new method for measuring rainfall at sea is to simply listen to the sound of the rain splashing at the ocean surface. This sound is surprisingly loud and has unique characteristics that allow it to be identified as rainfall generated and then to be quantified. The Ionian Sea Rainfall Experiment will attempt to link radar, rain gauge and underwater ambient sound measurements of rain to show that such measurements will improve our ability to understand satellite measurements of rainfall over the oceans.

A unique combination of geography and scientific resources exist in the Ionian Sea southwest of Greece that allow this experiment to take place. Here the ocean is very deep, over 3 km deep, very close to shore, less than 20 km southwest from Pylos, Messinia. This means that deep ocean ambient sound measurements can be made within the coverage area of a land-based radar. And in turn, a dense rain gauge network can be placed on land at the same range from the radar as the acoustic measurements. The Nestor Institute for Deep Sea Research, located in Pylos, has experience deploying ocean moorings in this part of the Ionian Sea and will assist scientists from the University of Washington deploying a mooring with Acoustic Rain Gauges (ARGs) 10 km southwest of Pylos. The National Observatory of Athens (NOA) has a polarimetric X-band weather radar that will be located in the town of Methoni and be operated in collaboration with researchers from the University of Connecticut. And finally, residents of the town of Finikounda have agreed to allow rain gauges to be set up in their yards under the guidance of scientists from NOA and George Mason University.

Collaborators Jeff Nystuen, University of Washington, Stratos Anassontzis, University of Athens, Eyal Amitai, George Mason University and Manos Anagnostou, University of Connecticut discussing the Ionian Sea Rainfall Experiment over dinner in Pylos, Messinia.

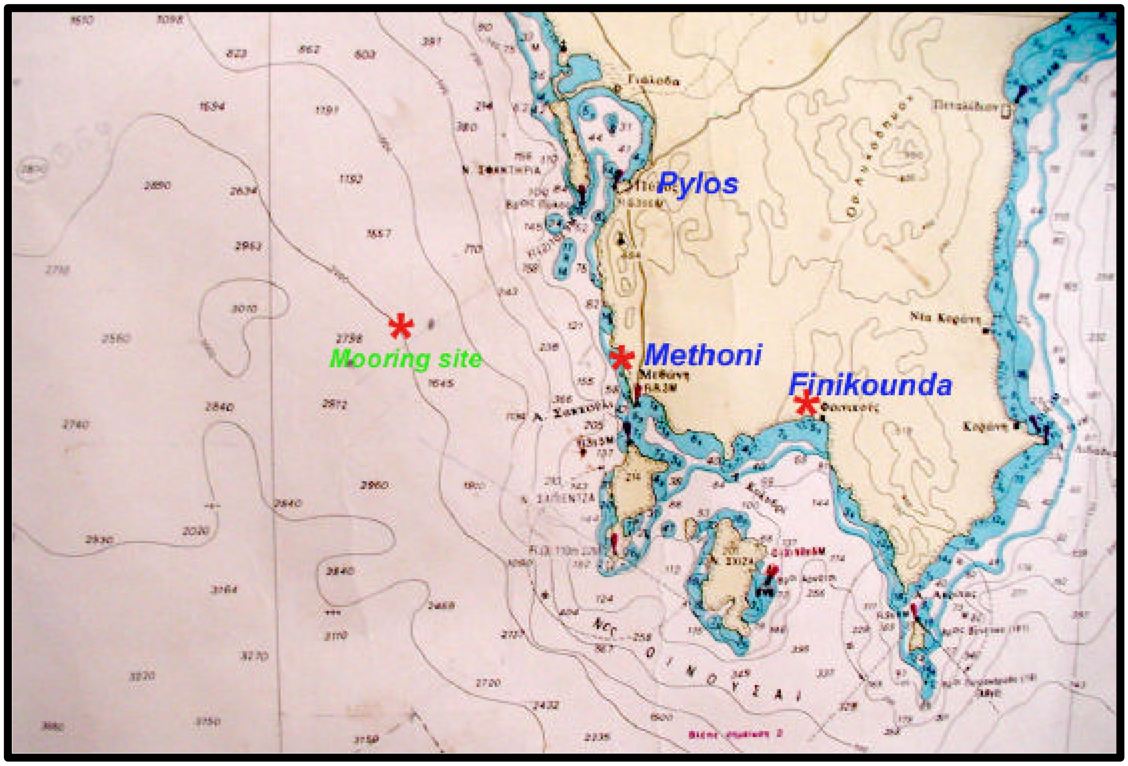

Chart showing the location for the Ionian Sea Rainfall Experiment. The ARG mooring will be 10 km southwest of Pylos at the 2 km isobath. The Polarimetric X-Band Radar will be at Methoni. The Dense Rain Gauge Network will be at Finikounda. The distance between Pylos and Methoni is roughly 10 km.

Finikounda will be the site of the Dense Rain Gauge network.

Rainfall is one of the most challenging geophysical quantities to measure because of its variability in both time and space. The assumption that rainfall is uniform within a measurement cell of a weather radar, or especially, a satellite-based instrument, is often dubious, and can lead to incorrect measurements. This problem, often referred to as “beam filling”, has traditionally been explored by scientists using Dense Rain Gauge (DRG) networks within single measurement cells of a weather radar (Amitai ref.). The acoustic measurement of rainfall has the unique feature that the measurement cell, or listening area, of the rain gauge is a function of the depth of deployment. This area is roughly $p(3d)^2$, where d is the hydrophone depth. Thus, a new way to explore the beam filling problem will be to use Acoustic Rain Gauges placed at different depths in the ocean. This is one of the scientific goals of the Ionian Sea Rainfall Experiment. ARGs will be placed at 50 m, 200 m, 1000 m and 2000 m depths on an ocean mooring roughly 10 km from the NOA Polarimetric X-Band Radar located in Methoni. The NOA radar has a high spatial resolution, roughly 110 m by 140 m measurement cells at 10 km range. Thus, the listening areas for the different ARGs average over 4, 70, 1700 and 7000 radar cells, respectively. The DRG network in Finikounda will also be at roughly 10 km range from the NOA radar, and so the radar rainfall statistics over the ARG mooring and the DRG network should be similar.

Another component of rainfall variability that can be studied in the Ionian Sea Rainfall Experiment is rainfall classification based on the drop size distribution (DSD) in the rain. In fact, different types of rainfall, e.g. widespread “stratiform” drizzle, heavy convective rainfall, or frontal rainfall, have different DSDs. By measuring the DSD within a rain, classification of the rainfall is possible (Atlas et al. 1998). This is important because different types of rainfall inject latent heat into different layers of the atmosphere and generate different levels of mixing at the ocean surface. Different sized raindrops produce different sounds underwater because the character of the raindrop splash depends on the size of the raindrop (Nystuen, 2001). This allows the DSD to be measured acoustically. Similarly, because the NOA radar is polarimetric, vertical and horizontal components of backscatter are measured, it can also measure components of the DSD. Furthermore, the radar measures the spatial distribution of the rain, another component of rainfall classification. And while collection-type rain gauges are unable to identify rainfall type, one of the rain gauges in the Finikounda DRG network is actually a Video Disdrometer. This is a new type of instrument that measures the shape of individual raindrops optically and will also be used to measure the DSD. The experiment is scheduled for the rainy season in the winter of 2003/2004. Convective rainfall, widespread drizzle and rain associated by wintertime cold weather fronts (frontal rain) are all expected.