John Kymissis & Elizabeth Olson, *Toward a Highly Spatially Resolved Cochlear Implant with Localized Sensing and Stimulation*

A cochlear implant restores hearing to a deaf individual by replacing the mechanosensing function of the ear. The device measures the sound signal with a behind-the-ear microphone and converts it into an electrical signal, which is then processed and delivered to the auditory nerve via a set of electrodes that are threaded into the cochlea. Theoretically, both the sound sensing and electrical stimulation could be done with a suitable piezoelectric material, implanted within the cochlea. Such a device would have great practical as well as cosmetic benefit. As a first step to the goal of a piezoelectric totally-implanted cochlear implant, we have used the piezoelectric polymer PVDF to make an intracochlear sound sensor. We tested this sensor first on the bench, then by rodent cochleae, and finally by human cochleae. These studies have shown the promise of the PVDF material for intracochlear sound sensing, and also the need for improvements, in particular for improved sensitivity. This improvement might be attainable through geometric or material enhancement and we continue to work on improving the PVDF intracochlear microphone, along with colleagues from Harvard Medical School.

Michael Tippett, Suzana Camargo & Adam Sobel, *Towards Long-Range Prediction of Tornado Activity*

Prediction of tornado activity more than a few days in advance has generally been considered difficult if not impossible. However, the record-breaking tornado activity of spring 2011 highlighted both the large impact of tornadoes on human life and property (an estimated 336 tornadoes during the April 2011 "Super Outbreak" killed 346 people and caused total damages estimated as high as $10 billion) and the difficulty of attributing the increased tornado activity to any particular climate phenomenon such as El Nino or climate change. Our 2012 RISE project proposed an approach that could lead to long-range tornado activity forecasts and explain how climate signals modulate tornado activity. In this method, tornado activity is associated with large-scale atmospheric parameters that describe the favorability of conditions for tornado activity. With RISE support, we were able to hire a post-doctoral scientist, organize a workshop, and publish results that provided credibility for our approach, allowed us to carry out the necessary work, and informed the scientific community. Subsequently, we have received federal (NOAA) and private (FM Global, Willis Re) funding. We issued an experimental forecast for seasonal tornado activity in spring 2015.