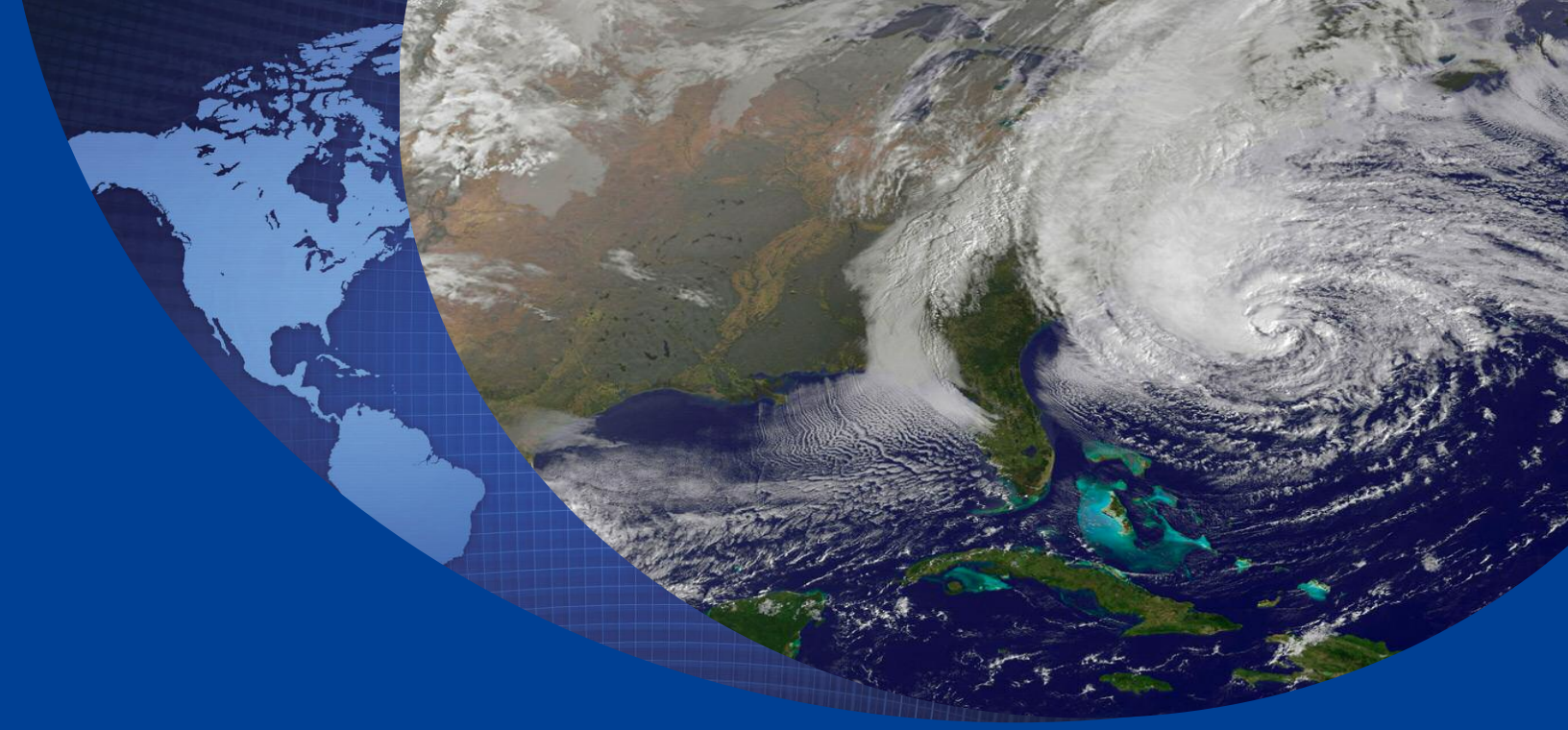


RPI2.0

Annual Report 2012

Bermuda Institute of Ocean Sciences

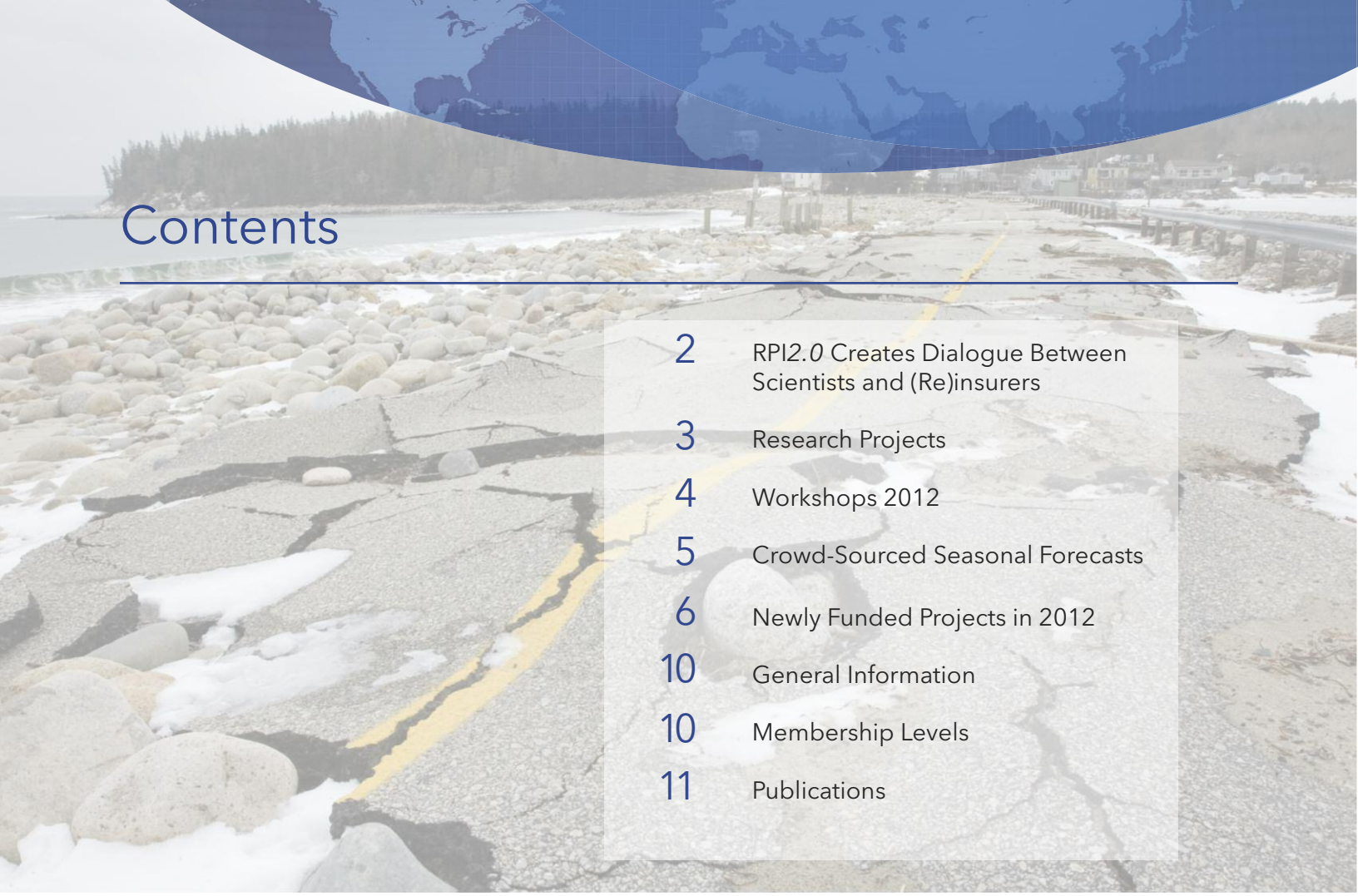
BIOS

RPI*2.0* Creates Dialogue Between Scientists and (Re)insurers

The frequent occurrence of extreme and record temperatures and precipitation events could be one of the most noteworthy meteorological features of 2012. Not only was 2012 the warmest year on record for the U.S. and produced one of the most severe drought events in U.S. history, there were also numerous intense precipitation events in the UK. However, most insurers would view Hurricane Sandy as the striking event for 2012; it certainly was for residents in the Mid-Atlantic region who experienced the storm surge, flooding and power outages associated with the storm's landfall. In addition, Sandy set a variety of hurricane records including ones for size, central pressure and storm surge. Despite the quality of National Hurricane Center (NHC) forecasts, public awareness efforts, and the overall emergency response, Hurricane Sandy ranks as the second costliest hurricane in U.S. history and raised numerous communication issues for the forecasting and emergency management communities.

"Funds from RPI have been vital in allowing me to develop key sedimentary reconstructions of tropical cyclone and tsunami occurrences from southern Japan. These records not only provide key data sets for improved risk assessments, but also equip me with the preliminary data now required to leverage funding from larger funding agencies." **Jon Woodruff, UMass Amherst**

Another significant event of 2012 was the Risk Prediction Initiative's (RPI*2.0*) first full year of operations since progressing from RPI. Based in Bermuda, the risk capital of the world, RPI*2.0* is the catalyst for creating a better and more productive dialogue between scientists and (re)insurers involved in catastrophe risk. RPI2.0's team of experienced scientists combines expert knowledge of climate-related natural disasters with a background in risk management. RPI*2.0* helps scientists focus on the needs and time-scales relevant to the (re)insurance industry and supports research on natural hazards such as hurricanes, typhoons, and tornados. Our 2012 products and services included in-house and co-sponsored workshops, the launch of an effort at crowd-sourced seasonal hurricane forecasts and, most important, the support for a number of new and exciting research projects. This report provides an overview of our activities throughout this successful year.



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RPI*2.0* Research Projects

Research supported by RPI*2.0* focuses on hazards and time-scales relevant to our members. Not surprisingly, the hazards of interest are those that produce significant insured loss such as landfalling hurricanes and European wind storms. Relevant time scales for the insurance business range from seasonal to decadal and focus on understanding natural variability and the significance of anthropogenic forcing.

Five new research projects were initiated in 2012 with a total commitment by RPI*2.0* of nearly $350,000. The research projects focus on a number of hazards relevant to members including tropical cyclones, tornadoes, and European wind storms. Two hurricane-related projects address issues identified as a result of the joint RPI-RMS workshop on the RMS v11.0 hurricane model. In coming years RPI*2.0* will look to support additional research on relevant hazards such as earthquakes and floods.

RPI*2.0* Workshops 2012

In addition to a number of in-house events hosted by member companies, the Risk Prediction Initiative led or participated in three major workshops during 2012. To increase added value for our members, RPI*2.0* leads guided discussion sessions for all workshop presentations and follow-up publications from our events.

"Research supported [by an NSF grant] requires similar modeling strategies, and the RPI support allows us to leverage this work to study windstorms; without this support, we would not be examining this aspect. In addition, graduate student Michelle Cipullo has benefited professionally from work on her RPI-supported project; in fact, this project has inspired her to seek employment in the risk management field upon graduation." **Gary Lackmann, NCSU**

Perhaps the most innovative workshop in 2012 involved RPI*2.0* and RMS scientists and focused on the medium-term rates for hurricane landfall used in v11.0 of the RMS U.S. hurricane model. The discussion was summarized in an RPI*2.0* publication available exclusively to RPI members and resulted in the decision to support new research projects which aim to provide alternative views on medium-term rates of U.S. hurricane landfalls.

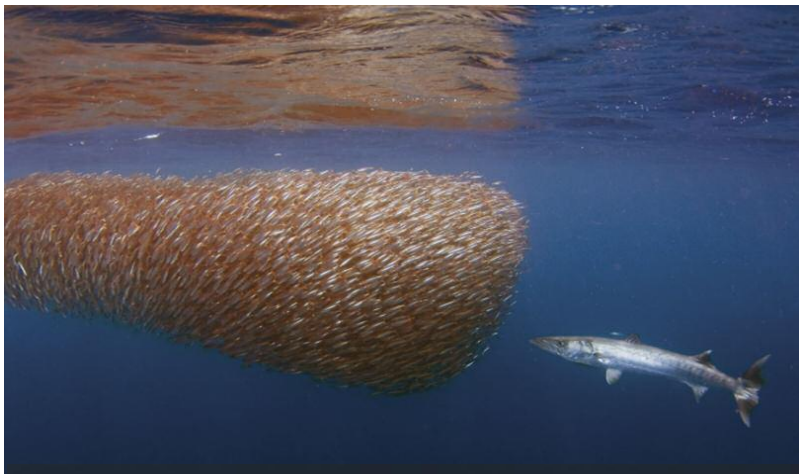
RPI*2.0* sponsored the workshop, "The Attribution of Extreme Events," with other sponsors including the UK Government Foreign and Commonwealth Office, the U.S. National Ocean and Atmosphere Administration, and the UK Department of Energy and Climate Change. The workshop was hosted by the Smith School of Enterprise and the Environment, the Environmental Change Institute and the Oxford Martin School at the University of Oxford. By bringing together a group of prominent international scientists, the workshop resulted in a number of relevant discussions about the relationship between the ability to detect and attribute climate change and the liability for climate change impacts.

The annual RPI*2.0* Research Update workshop had a new feature this year, with newly-funded scientists presenting their proposed research. This gave scientists and members the opportunity to review projects in their early stages and focus the research on aspects of most relevance to RPI*2.0* members. A talk by Prof. Robert Hart on the interaction of tropical cyclones with frontal systems proved particularly prophetic given Hurricane Sandy's dynamics a few weeks after the workshop.

Crowd-Sourced Seasonal Forecasts

A number of research groups and private meteorologists issue seasonal hurricane forecasts. However, measuring and comparing the skill of these forecasts is complicated, if not impossible, because the predictands and forecast lead times vary and the methodologies can change through time. In addition, some forecast parameters, such as basin-wide "Accumulated Cyclone Energy" (ACE), are irrelevant to RPI*2.0* members.

These factors motivated RPI*2.0* to explore the utility of a crowd-sourced seasonal hurricane forecast competition for business decisions of our members. The combination of a wide range of independent forecasts can be superior than any individual forecast – a phenomenon which is often referred to as crowd or swarm-intelligence. Submitted forecasts will be collected at four times throughout the year, and each forecast will predict the probability for a specific number of hurricanes or storms making landfall for different regions along the U.S. Gulf and east coasts. The crowd forecast will be derived from all submitted forecasts and, at the end of the hurricane season, the "ignorance skill score" will be used to determine the winning forecast. This methodology will be maintained over a number of years to determine if any single forecaster, method or the crowd forecast has skill beyond climatology. In the future, the crowd-sourcing experiment may be expanded to different basins, such as the western pacific for typhoons, to compare predictability of storms in different regions of the globe.



Utilizing swarm-intelligence to reduce individual risk.

"With RPI funding I am able to support Sarah Strazzo working on her Ph.D. in Geography at Florida State University. Her support through RPI will allow her to concentrate on the research without having to worry about teaching classes."
James Elsner, FSU

December's crowd forecast for the 2013 Atlantic hurricane season was very similar to climatology, which shouldn't be surprising given the long lead time for the forecast. Future forecasts could differ more from climatology if it becomes clear that important climatic influences, such as the El Niño-Southern Oscillation (ENSO), are likely to produce anomalous conditions during the hurricane season.

Newly Funded Projects in 2012

2012 tornado outbreak in Arkansas.

Todd Kimberlain, National Hurricane Center: *A Re-analysis of Eastern Pacific Tropical Cyclones*

Over the past decade, support from RPI and other institutions has produced significant improvements to the best-track hurricane data for the North Atlantic. A similar effort is needed in other regions subject to tropical cyclone landfalls. RPI*2.0* provided seed funding to kick-start a reanalysis effort in the eastern North Pacific. This initial effort focused on 21 storms in 1986 and 1987.

Best-track data form the foundation for the hazard component of all tropical cyclone catastrophe risk models. Before this grant only the North Atlantic basin had the benefit of reanalyzed best track data. However, as the insurance market grows in other regions with tropical cyclones, the importance of reanalysis efforts throughout the world will grow. RPI*2.0*'s rationale for supporting this project is that more realistic data for historical events and improved best-track data will enhance the quality of catastrophe risk model hazard catalogs for other regions.

Kerry Emanuel, MIT: *Tornadoes, Hail Storms, and Climate*

There have been significant advances in understanding the meteorological conditions conducive to severe thunderstorms. However, there is still uncertainty regarding climatic conditions conducive to severe weather including tornadic activity. This project examines environmental factors that might contribute to inter-annual variability and attempts to quantify this variability using a range of models.

Insured losses from tornadoes have grown significantly in recent years but it is unclear whether the increased losses are simply within the range of natural variability, an artifact of more exposure and denser populations, or part of a worrisome trend somehow related to anthropogenic forcing. RPI*2.0* hopes this research will provide insights that will help clarify the important processes that contribute to inter-annual variability and trends in tornado activity.

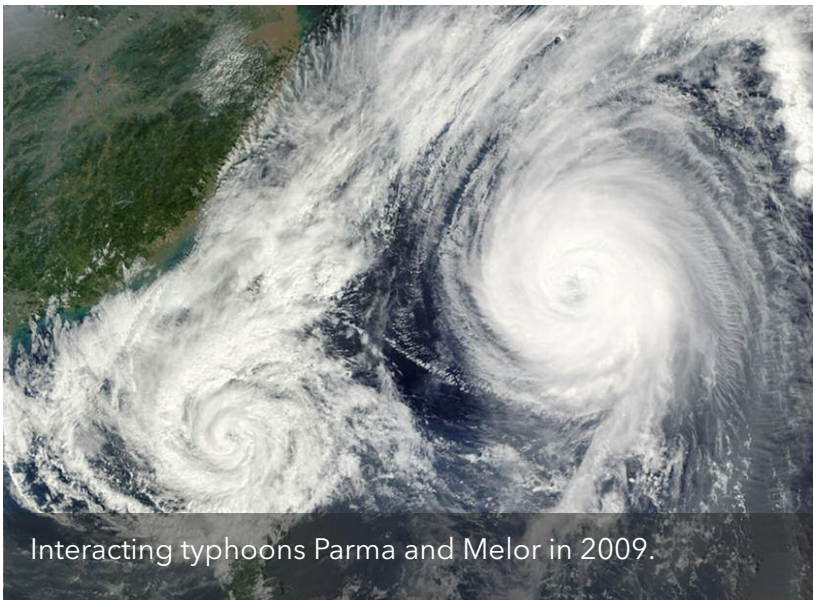
James Elsner, FSU: *Sensitivity and Predictability of Hurricanes to Warming Seas*

This project develops statistical and spatial models to predict the number and location of hurricanes on seasonal and longer time scales, and explores the local sensitivity of hurricane activity to warming oceans. The ultimate aim is to improve understanding of how hurricane activity might change in the future.

Member interest in this research is two-fold. First, there is a natural interest in understanding the cause of the observed intensification of the strongest storms in the Atlantic. Second, these types of statistical models are used to determine medium-term rates used in hurricane catastrophe risk models. This research followed on from the RPI*2.0* workshop on the medium-term rates of RMS RiskLink v11.0 and should lead to alternative views on medium-term rates and-ultimately improve estimates of hurricane risk in the Atlantic.

Robert Hart, FSU: *The Impact of Cyclone Interaction in Quantifying United States East Coast Tropical Cyclone Risk*

Storm tracks and intensities in existing hurricane hazard catalogs make the assumption that a tropical cyclone does not interact with other tropical or extra-tropical cyclones. While this assumption is valid in most cases, it is known that such interactions are not unusual and can alter hurricane tracks. This



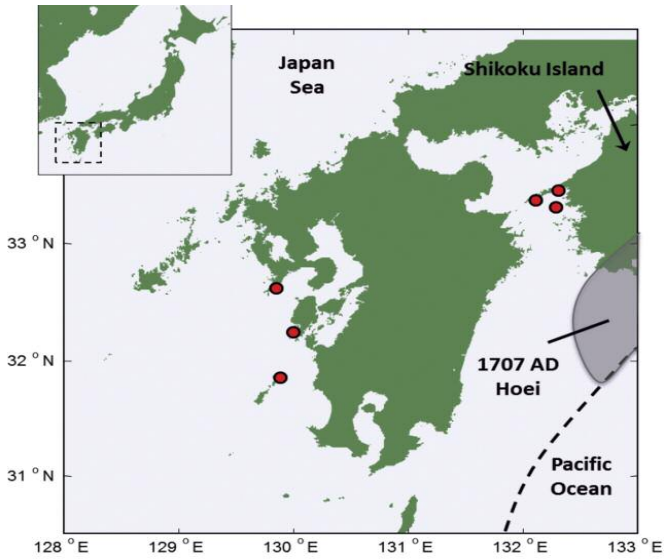
Interacting typhoons Parma and Melor in 2009.

project helps quantify the risk of these interactions and their role in US hurricane risk.

The relevance of this research was made clear by Hurricane Sandy. The track and intensity of Sandy was strongly influenced by its interaction with an extra-tropical low pressure system. Quantifying the frequency of such interactions in the historical record is important for the improvement of hurricane hazard catalogs, which currently do not account for these interactions.

Gary Lackmann and Walter Robinson, NCSU: *High-resolution Modeling Studies of the Changing Risks of Damage from Extratropical Cyclones*

This research examines how European wind storm risk might change in the future. The study uses a high-resolution regional model embedded in global climate model to



Location of coastal lake sediment cores for reconstructing typhoon lanfdfalls.

examine changes in extreme cyclone events in two types of experimental setups. First, a surrogate climate change environment of historical high-impact cyclone events demonstrates the impact of changes in the atmosphere on particular categories of storms. Second, ensembles of seasonal simulations aim to provide a climatological picture of expected changes in storm seasons.

This project is a good example of how RPI*2.0* leverages its resources to achieve goals that would otherwise be unfeasible. In this case we supplement a much larger NSF grant by supporting a graduate student to expand the research effort to include the analysis of model output (storm footprints of wind at 10 meters) that is relevant for vulnerability functions used in catastrophe risk models and would not have been considered without RPI*2.0* funding.

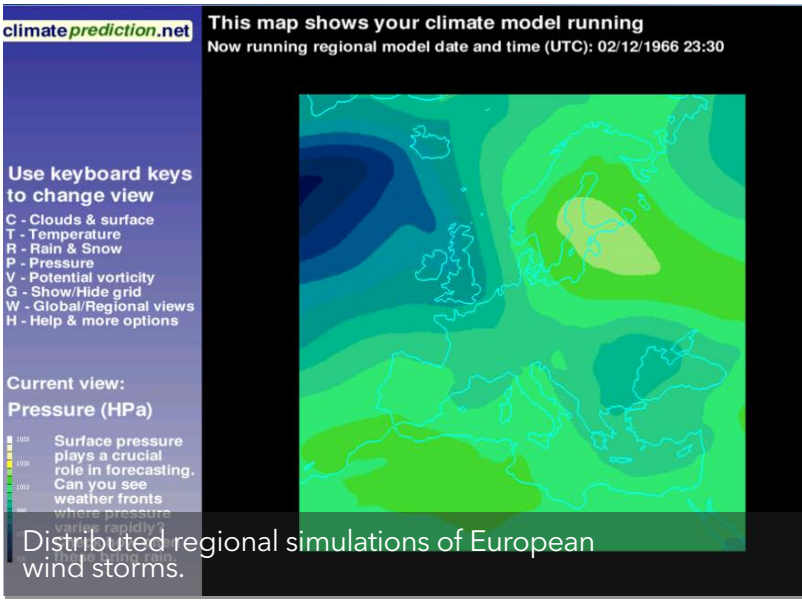
Jonathan Woodruff, UMass, Amherst:
Reconstructing Past Typhoon Occurrences for the Southern Coast of Japan Using Coastal Sediments

Tsunamis are much more frequent in the Pacific than the Atlantic and, thus, it is important to distinguish sedimentary differences between typhoon and tsunami deposits. This project uses techniques analogous to those pioneered by RPI scientists who developed the field of paleotempestology and extends the record of typhoon landfall in Japan through the collection and analysis of cores from coastal lakes. This project provides new data sets that extend records of these extreme events beyond the instrumental record. In addition to developing a chronology of landfalling typhoons, the project examines deposits produced by the recent tsunami generated by the Tohoku earthquake.

One of RPI*2.0*'s goals is to provide support for projects that are relevant to its members but unlikely to receive funds from more traditional sources. This project is a good example, as it extends paleotempestological studies to a new region and provides a means for the researcher to gather preliminary data that can be used to garner more significant support from other agencies. After the Tohoku tsunami it is clear that the Pacific paleotempestological studies should be extended to an analysis of tsunami deposits.

Myles Allen, Oxford University: *Using Large Ensemble Volunteer Computing to Develop a Weather Event Dataset for the Historical Period*

A variety of efforts now exploit unused computational resources for scientific problems. This project uses such resources to develop a catalog of European wind storms. This potentially huge set of synthetic storm events will be for a climate consistent with the 1950-2011 period and is generated from a regional climate model running in a distributed computing environment with volunteers all over the world.



Distributed regional simulations of European wind storms.

This project takes a novel approach to developing an event set of European wind storms and is of interest to RPI*2.0* members because of the relatively large differences among European wind storm catastrophe risk models. The event set of over 50,000 storms could potentially form the basis for an independent European wind storm hazard catalog.

Leonard Smith, London School of Economics: *Evaluating Seasonal Forecasts of the Main Development Region and the Niño 3.4 Index*

This project is focused on testing the skill of seasonal forecasts for the tropical North Atlantic and the equatorial Pacific. The skill of the forecasts will be quantified through a comparison to a set of reference forecasts, and their likely value to the insurance industry will be assessed.

As climate change evolves, the industry faces a paradigm shift away from historic towards predictive risk estimation. Seasonal forecasts for the equatorial Pacific are important for predicting future El Niño-Southern Oscillation (ENSO) conditions. RPI*2.0* members are interested in ENSO as it is correlated with tropical cyclone activity and probability of extreme weather throughout the world.

General Information

List of RPI*2.0* Members

Amlin, Aspen, Axis, Guy Carpenter, Partner Re, RMS, State Farm, Tiger Risk, XL Group

RPI*2.0* Staff for 2012

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Richard Murnane, Ph.D., RPI Program Manager
Bill Curry, Ph.D, BIOS President and Director
Charles King, **M.Aq.**, Research Specialist

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Membership Levels

- **RPI*2.0* Bronze Membership - $65K/year**
  Our basic membership option includes information on current and past research projects, one in house presentation, results of forecasting competitions, and web based information; these services are also included in Silver and Gold membership.

- **RPI*2.0* Silver Membership - $85K/year**
  RPI*2.0* will organize consulting services that target project(s) specified by you and tailored to your needs (additional charges may apply), plus two additional in-house events, one of which includes attendance by an independent scientist.

- **RPI*2.0* Gold Membership – $125K/year**
  Includes sponsorship for a graduate student at one of our world renowned partner universities and a fellowship named after your company. In addition, quarterly visits to your company will be made, two of which include attendance by an independent scientist.

Publications
(RPI*2.0* Reports and Peer-reviewed Journals)

F. Niehörster and R. Murnane (2012), "Medium-term rates of hurricane landfalls in RMS RiskLink v11 – a scientific assessment", Members Report No1/2012, Risk Prediction Initiative

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M. Elbot and F. Niehörster, (RPI student project 2012) "The Global Marketplace and Extreme Weather", submitted to Weather, Climate and Society (in review)

A. Rumyantseva and F. Niehörster (RPI student project 2012), "Evaluation of potential improvement of hurricane intensity forecasts by including upper ocean layer analysis", submitted to Climate Dynamics (in review)

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