

RPI2.0

Risk Prediction Initiative

Annual Report 2013

20
years

Connecting science and reinsurance

rpi.bios.edu

Bermuda Institute of Ocean Sciences



History of the Risk Prediction Initiative

- 2013** Risk modelling workshop on European winter storm clustering
Focus on 'un-modelled' risks, such as global flood, and climate drivers of variability in extremes
RPI2.0 joins the Oasis Loss Modelling Framework
- 2012** Risk modelling workshop on Medium Term landfall rates
Seasonal Forecast Competition
- 2011** RPI2.0 established, refocussing the research on business-relevant applications and timescales
Research Update incorporates scientific contributions from tsunami experts
- 2008** *Climate Extremes and Society* published. Editors Henry Diaz & Rick Murnane
- 2007** Co-sponsorship of the 1st International Summit on Hurricanes and Climate Change
- 2006** First Cat. Modeling course: Tropical Cyclone and Earthquake Hazard, Vulnerability and Uncertainties
- 2004** *Hurricanes and Typhoons: Past, Present, and Future* published. Editors Rick Murnane & Kam-bui Liu
- 2003** First translation of Jesuit records on Northwest Pacific typhoons
Publication of RPI primer on *Weather Extremes and Atmospheric Oscillations*
- 2002** First proxy results for prehistoric hurricane landfall near New York City
Development of CLIPER risk model for total insured losses from US hurricane landfall
- 2001** Joint RPI-NOAA-WRMA workshop on climate data and forecast needs
First proxy records of prehistoric hurricane landfall in Mid-Atlantic region
Publication of RPI primer on tornadoes and hail
- 2000** First RPI seasonal forecast for US hurricane landfall
- 1999** First publication of RPI Science Review
- 1998** Creation of "extended best-track" data for North Atlantic
First workshop on the extra-tropical transition of tropical cyclones
- 1997** First workshop devoted to RPI-funded research
Initiated development of RPI wind speed probability model
Historical US hurricane losses normalized for changes in inflation, population and wealth
- 1996** Development of real-time Maximum Potential Intensity maps
Workshop on climate variability and tropical cyclone prediction
- 1995** First workshops on the influence of the El Niño-Southern Oscillation on tropical cyclone activity,
Climate Prediction and Insurance Risk
- 1994** The Risk Prediction Initiative founded at the Bermuda Institute of Ocean Sciences

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RPI2.0 – The Brokers Between Science and (Re)insurance



The Research Vessel Atlantic Explorer

RPI2.0 funds academic research relevant to the insurance and reinsurance industry and assists in translating this research into usable and actionable results for our member companies. Our experienced management team combines expert knowledge of climate-related natural disasters with a background in risk management. We help scientists focus their interests on needs and time-scales relevant to the (re)insurance industry in ad-

dition to stimulating and supporting high-level research on natural hazards such as tropical cyclones, floods and tornadoes.

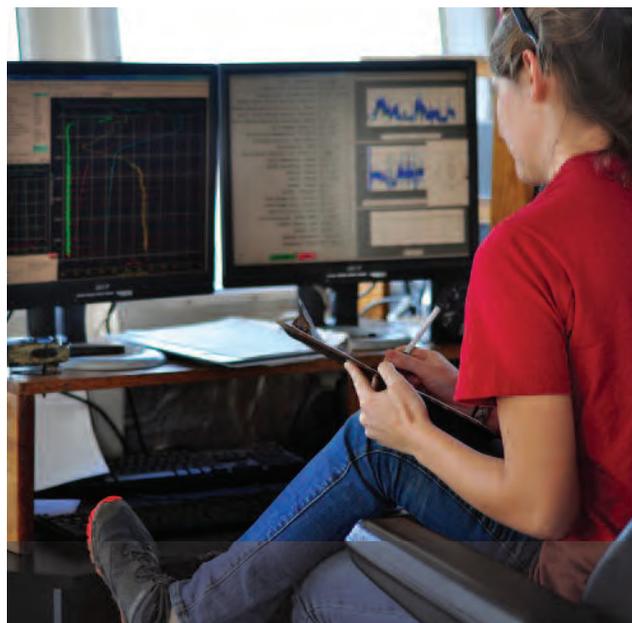
Among other available services, members of RPI2.0 receive reports and presentations focused on addressing business-relevant information on the science of extreme events; they have priority access to our hosted industry

events; and through our in-house company meetings, they have access to scientists and prestigious academic institutions, allowing the opportunity to influence future research.

Based in Bermuda, the risk capital of the world, RPI2.0 creates effective and efficient dialogue between scientists and (re)insurers involved in catastrophe risk. We offer our expert view of relevant emergent risks and continually promote the (re)insurance industry's interests within the scientific and engineering communities.

We are located within the Bermuda Institute of Ocean Sciences and as a result have long standing relationships with many leading scientists, allowing our members direct access to the scientific community. We offer our members unique access to academic experience aimed at answering the scientific questions which are relevant to their business.

We actively help scientists understand which questions the industry is asking and sponsor research targeted at answering those questions. Our support of

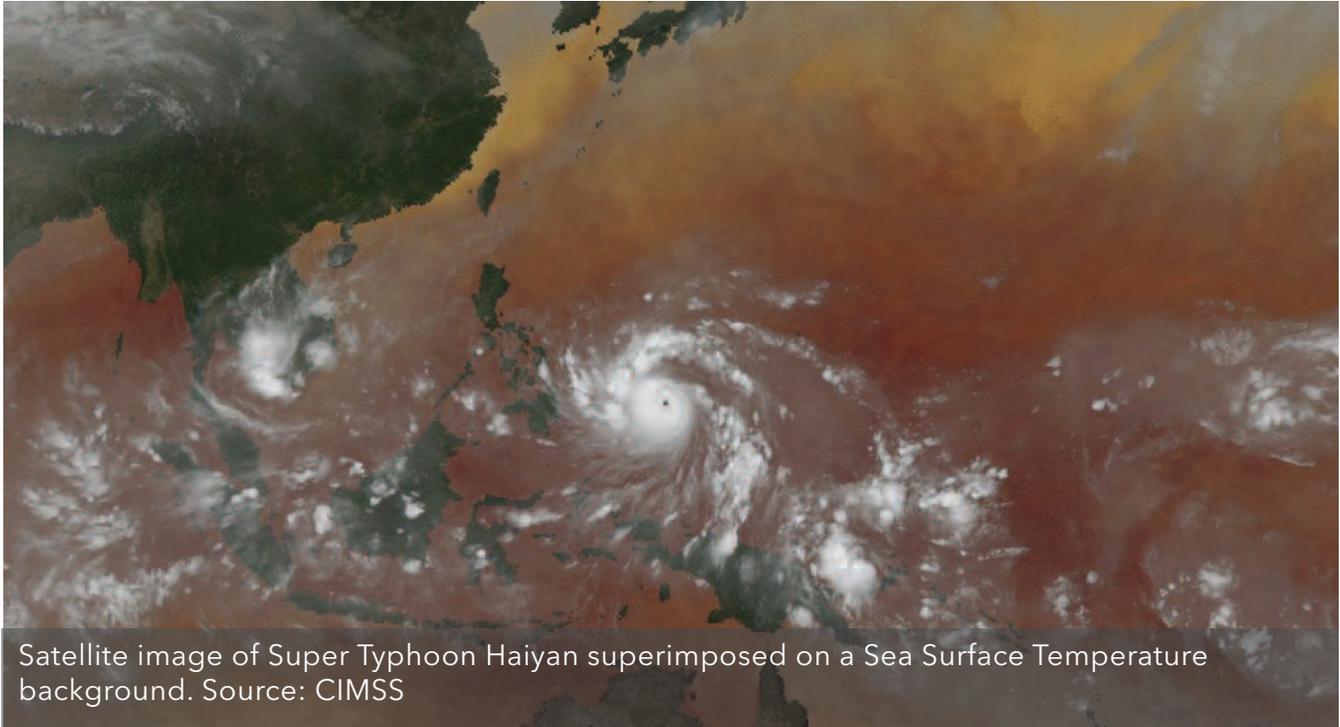


industry-defined research projects brings the scientific and business communities in closer alignment, enabling science to

"This year RPI strengthened its relationship with its member companies to provide a tighter link between funded academic research and relevant business deliverables. RPI also facilitated workshops on US hurricanes and European windstorms, where RPI-funded scientists and RPI members were able to openly discuss commercial catastrophe models. These two initiatives have improved the value of RPI for Aspen in 2013." Vivienne Lochhead, Aspen Re

educate (re)insurance underwriting and investment activities.

Research and Collaborative Initiatives



Satellite image of Super Typhoon Haiyan superimposed on a Sea Surface Temperature background. Source: CIMSS



Tropical Cyclones

The 2013 Atlantic hurricane season refuted all seasonal predictions by failing to produce a single major-loss inducing landfalling tropical cyclone, causing critics of seasonal forecasts to ask why the lack of activity was so consistently missed. Our project on “Evaluating Seasonal Forecasts of the Main Development Region and the Niño 3.4 Index” with Professor Leonard Smith of the London School of Economics and Political Science determined the average level of skill of ENSO forecasts using a high quality ensemble predictive system. Professor Smith found that there is still value in pursuing seasonal predictions of ENSO indices which are widely thought to correlate well with Atlantic hurricane season activity.

Despite the lack of general predictive skill for impacts in any given hurricane season, we successfully completed our Seasonal Landfall Forecast Competition following the end of the 2013 season, and announced the winners of each round; each winner demonstrated predictive skill over the climatology of landfalling US hurricanes. Having tested the concept satisfactorily, in 2014 we will hand the project over to an academic partner, who may then implement future competitions.

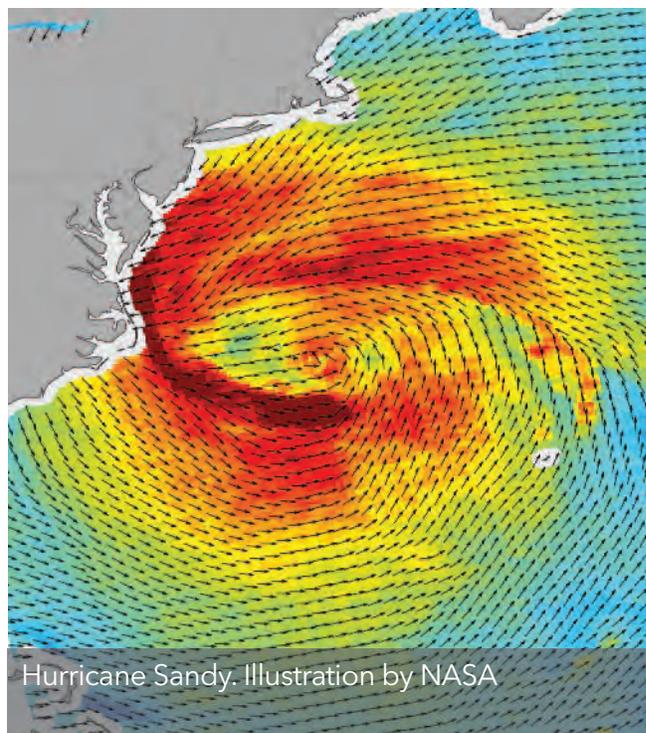
In the search for more skilful forecasts, our member companies voted to fund a research project by Dr. Louis-Phillipe Caron of Institut Català de Ciències del Clima (IC3), in Barcelona, Spain. The project is entitled, “Multi-annual Forecasts of Atlantic

Tropical Cyclones in a Climate Service Context,” and leverages an existing project on medium term (<10 years) TC variability, to focus on Atlantic tropical cyclone predictability over a more industry-relevant timeframe than generally less-skillful seasonal forecasts.

Professor Robert Hart of Florida State University continues his work on assessing the impact of cyclone interactions on US east coast hurricane risk. The completion of his project will hail a new understanding about how storms such as Sandy can be better represented within stochastic event sets, in addition to a means of implementation of such a parameterization.

Focus was placed on Sandy as an example of the impact that a large, weak storm can have, by way of the evolution of a large damaging storm tide. It is clear in this instance and others that the footprint size of a tropical cyclone can be at least as important as its intensity when it comes to the correlation with losses. With this in mind, the RPI2.0 member companies selected a proposal for funding entitled, “Development of an Improved Database of Tropical Cyclone Size” by Dr. Jonathan Vigh of the US National Corporation for Atmospheric Research (NCAR). This project will explore existing flight reconnaissance datasets to produce and provide a catalogue of size parameters, to augment the HURDAT dataset which is universally used for calibration of risk models.

Professor James Elsner and doctoral student, Sarah Strazzo, of Florida State University continue their statistical examination of the sensitivity and predictability of hurricanes to warming seas. This project was initiated as a consequence of interest in this field revealed at the 2012 RPI/RMS work-

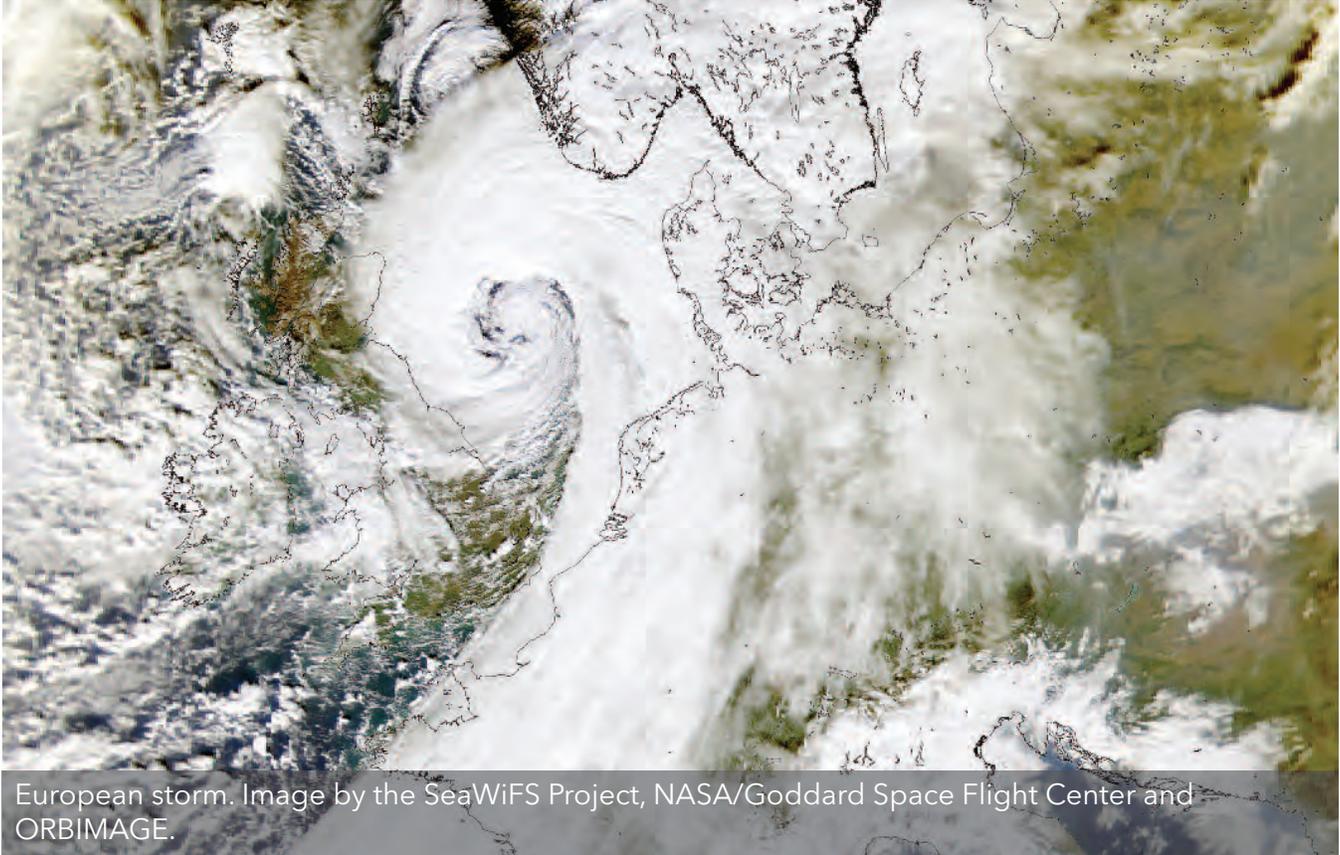


shop on medium term hurricane landfall rates. This project yields statistical relationships between hurricanes and climatic factors on a regional scale which have previously been unstudied.

In the Pacific, Super Typhoon Haiyan made an historic impact on the Philippines, causing \$14.5 billion in total losses; Indian Ocean Cyclone Phailin had a major impact on Indian crop losses and in some cases caused up to 100% loss ratios. Dr. Jonathan Woodruff’s RPI2.0 research project on “Reconstructing Past Typhoon Occurrences for the Southern Coast of Japan Using Coastal Sediments” established regional historical return periods spanning over 2 millennia into the past, from his analysis of sedimentary core samples in coastal Japanese lakes. Dr. Woodruff’s dataset has been delivered to our members for use in calibrating return periods of loss.



Extratropical Storms



European storm. Image by the SeaWiFS Project, NASA/Goddard Space Flight Center and ORBIMAGE.

In January 2013, blizzards, strong winds and extreme rainfall caused fatalities and property losses across much of the UK, France and the Iberian Peninsula. An October wind

power outages and transportation disruption in the UK and France.

This year, RPI2.0 joined the Oasis Loss Modelling Framework as an Associate Member, enabling our research datasets to be delivered via a loss simulation platform. RPI2.0 scientists Dr. Myles Allen & Neil Massey at the University of Oxford are developing stochastic event sets of European storms, for ingest into the Oasis LMF in 2014.

These are some events of many which are illustrative of the phenomenon known as 'clustering', where a hazard, such as extratropical storms, can affect one geographical sub-region over a short amount of time (in this case, over Western Europe) within the reinsurance contract time frame of one year. The

storm (often compared to '87J') with wind gusts reaching 99mph caused widespread

topic of clustering and frequency variability was discussed at this year's RPI/RMS joint workshop

on European winter storm modeling. RMS model developers and RPI scientists gave presentations on these topics and others, with interaction between member companies, model developers and independent scientists.

RPI member companies voted to fund a project in the next research cycle on “Seasonal Extra-tropical Storm Clustering” by Dr. Gregor C. Leckebusch and Professor Uwe Ulbrich, at the University of Birmingham and the Freie Universität Berlin, respectively. This project is expected to not only address the meteorological component of clustering, but also the effect and correlation with the clustering of insurance losses in Europe.

Professors Gary Lackmann and Walter Robinson of NC State University delivered a dataset on Atlantic and European winter storms under both current and climate change scenarios, via their project, “High-resolution Modeling Studies of the Changing Risks of Damage from Extratropical Cyclones.” This project also facilitated a successful Master’s thesis and defense by a student who has since moved from academia into the reinsurance industry to conduct risk modelling.

Professor Myles Allen and doctoral student Neil Massey at Oxford University’s Environmental Change Institute continue their development of a hazard catalogue of European winter storms under different



climate scenarios from their massive ensemble of climate model output datasets. The data derived from their project, “Using Large Ensemble Volunteer Computing to Develop a Weather Event Dataset for the Historical Period,” is being

Michelle Cipullo completed her Master’s research on an RPI2.0 project at NC State University this year. “I didn’t know anything about the (re)insurance industry before I started working on the RPI2.0 grant. I enjoyed the project and attending the conference, which provided insight into the industry. It’s because of this experience that I decided to pursue a career in modeling extreme events for the (re)insurance industry. I’m confident that my experience with RPI helped me be competitive when applying for jobs, and I am very thankful for that.” *Michelle currently works as a scientist at AIR-Worldwide.*

developed for direct use on a risk modelling platform, enabling a new independent view of risk.



Floods



Flooding in the Midwest

Flooding in Mexico, associated with Hurricanes Manuel and Raymond demonstrated that the rainfall flood hazard associated with tropical cyclones can augment the storm surge hazard, increasing the overall flood risk. Concern over federally regulated flood insurance programs continue in the US in 2013 as Colorado saw the largest flood event since 1976 cause economic property losses worth \$2 billion, and in many cases damaged property was uninsured. 2013 also saw one of the most debilitating floods in Central Europe since the 2002 flood (which was broadly hailed at the time as the '100 year flood'), killing 25 and causing an estimated €17 billion in economic losses. Additionally, a Mediterranean hybrid storm released nearly 400mm of rainfall within 24 hours over Sardinia in 2013.

In addition to precipitation-induced flooding, risk model vendors such as RMS have assessed that up to 40% of northeast hurricane losses in the US may be due to storm surge alone, as illustrated by Hurricane Sandy last year. It is clear that a change is on

the horizon in the industry's approach to assessing and managing storm surge risk. Given the importance of this phenomenon, RPI2.0 has engaged with scientists on this significant development and found that many researchers are already focusing their efforts on treating surge as a peril of equal importance as wind. We hope to deliver a project in the next funding cycle that brings focus to this particular hazard.

The need for a more comprehensive understanding of extreme precipitation and flood risk on different scales has been particularly highlighted in 2013. RPI2.0 member companies voted to fund a project by Dr. Philip Ward of the IVW, Institute for Environmental Studies, Amsterdam, Netherlands, entitled, "Mapping the Influence of Climate Variability on Global Scale Flood Risk." This research will deliver GIS datasets and maps of flood risk on global, regional and local scales, and will include variability influenced by climate indices such as the El Niño Southern Oscillation.



Severe Convective Storms

The 2013 tornado season in North America started slowly due to persistent cold air over the Continental US, but then three separate May outbreaks over the Southern Great Plains and Midwest led to the loss of 40 lives; the widest ever tornado recorded (2.6 miles on the ground); and economic losses of around \$5 billion, mainly due to the Moore Oklahoma EF5 tornado. Rare November tornadoes in the Midwest also led to tragic loss of life and approximately \$1 billion in insured losses.

The severe convective storms in 2013 follow large industry losses in the North America 2011 and 2012 tornado seasons, and there is concern within the industry that there is an increasing trend in the incidence of this loss-driving hazard. A recent report from Lloyd's indicates that whilst tornadoes account for more than half of the annual aggregated catastrophe losses since 1990, the link between climate change/variability and tornado instances is unclear. RPI2.0 research and collaborations are addressing this fundamental research question, through our ongoing project on "Torna-



Image by: University Corporation for Atmospheric Research

areas of study (such as paleotempestology, and the hurricane/climate change question) has allowed an evolution of the understanding of extremes, and this area of tornado and climate research is one of the next big themes for our attention. Further to this, we anticipate supporting Prof. James Elsner's initiative to host the First International Summit on Tornadoes and Climate Change in 2014.

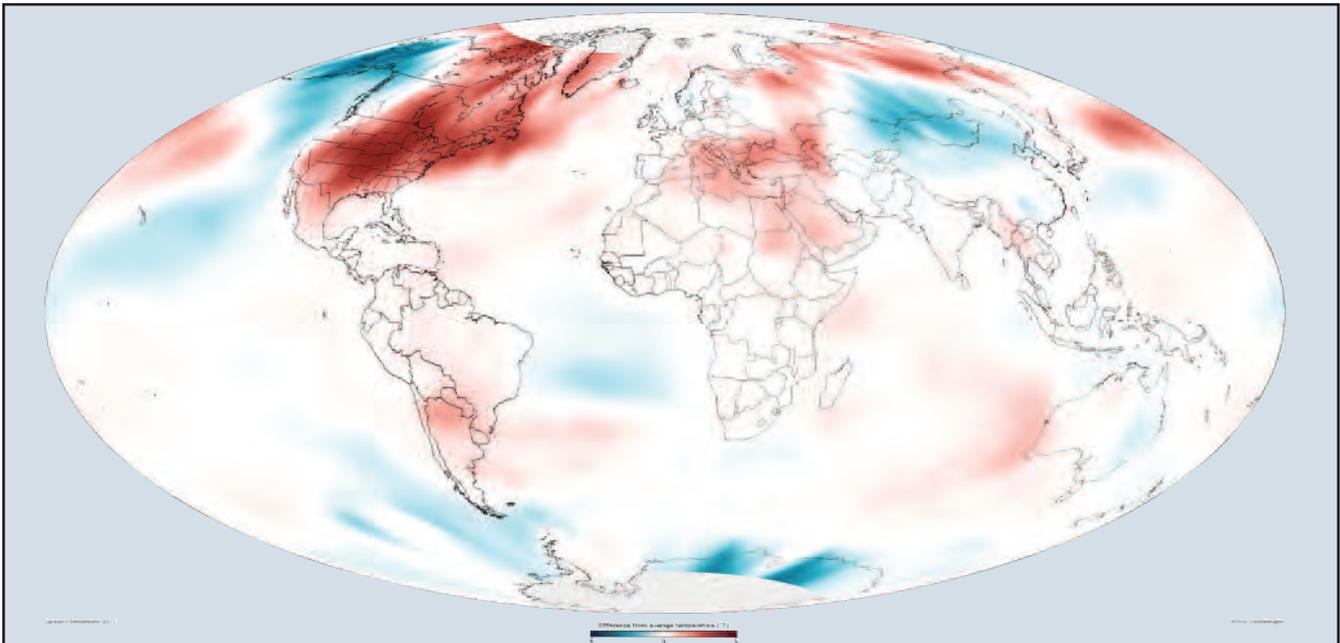
"The RPI funds seed projects to explore high-risk areas in hazard research; they have been on the forefront of innovative new directions in hurricane science, from paleotempestology to climate conditioning of the risk modeling storm catalogues. The next big trend is how climate affects tornadoes." *Professor James Elsner, Florida State University, RPI2.0 Researcher*

does, Hail Storms, and Climate," by Professor Kerry Emanuel and doctoral student Vince Agard of the Massachusetts Institute of Technology. Our previous work with researchers to bring focus to new

These events all highlight the growing need for research to be undertaken and for new scientific understanding to be translated into business relevance.



Climate and Extremes



Surface temperatures in 2012 compared to the 1981-2010 average. Source: NOAA

The recent release of the Working Group 1 Report for the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment highlights the significant uncertainties inherent in projecting and predicting the coming changes in extreme events. This uncertainty amplifies the challenges currently faced by the (re)insurance industry, including the need to disentangle

of high-loss extreme events are ambiguous rather than simply uncertain. Former RPI2.0 Program Manager, Falk Niehörster wrote a report in conjunction with his work with the Geneva Association, entitled, "Warming of the Oceans and Implications for the (Re)insurance Industry" to elucidate this concept for the benefit of the industry.

*"Our membership in RPI2.0 keeps TigerRisk on the leading edge of new developments in climate risk. While we and our clients use catastrophe risk models as a framework, RPI2.0 gives us valuable context and insight that goes beyond the models." **Bill Keogh, TigerRisk Partners***

the effects of climate change (if any) on predicted losses in the near term business decision time-frame.

As a consequence of ocean warming and global environmental change, the return periods for a number

Underwriters will often speak of writing more business to cover a given peril or region, 'because it doesn't correlate with the rest of the book.' However, it is often unclear whether there is an underlying climate mode of variability enhancing or suppressing perils in distant regions. In order to explore this notion,

Professor Tim LaRow of Florida State University was selected by the RPI2.0 member companies to conduct a project entitled, "Relating Large-Scale Climate Drivers to Regional/Continental/Global Scale Frequency of Extremes."



Snow covers the northeast US after storm. Source: NOAA.

RPI2.0 Hosted Workshops and Seminars

RPI2.0/RMS Workshop on European Winter Storm Modeling

When: October 2-3, 2013

The main discussion points of this workshop were scientific views on clustering and frequency variability of European winter storms. RMS model developers and RPI2.0 scientists presented on these topics and others, with time allotted for interaction between member companies, model developers and independent scientists. Following the scientific seminar, there was a closed-door session for RPI2.0 members/RMS clients to explore aspects of the RMS European wind model, in the context of the scientific discussions. RPI2.0 provided five independent scientists to participate in this workshop, from our network of researchers. Many thanks to RMS for jointly planning this event with RPI2.0, and to PartnerRe, who hosted the workshop in their Zürich office.

“RPI’s idea to host a workshop on European windstorms was very well received. As we develop and further understand risk such as European windstorms, it is important to engage closer with risk modelling and the academic communities. One of the big successes of RPI2.0 was its workshop on the RMS Medium Term Rates model. This workshop helped us, as clients of RMS to understand the reasoning and science behind the methodology used at that time. It enabled us to make an informed decision of how to use the MTR feature of the RMS models to make business decisions at the time.” *Paul Della-Marta, PartnerRe*

RPI2.0/BII Joint Catastrophe Risk Seminar

When: November 7-8, 2013

RPI2.0 joined forces with the Bermuda Insurance Institute (BII) to deliver a program of relevance and interest on the subjects of hurricane and severe convective risk on global, regional and local scales. Discussions and presentations were led by Professor Kerry Emanuel of the Massachusetts Institute of Technology, Professor James Elsner of Florida State University, and RPI’s Dr. Mark Guishard. Many thanks to the BII for administering this event which was held at the Bermuda Underwater Exploration Institute.

RPI2.0 Member Events

RPI2.0 Research Update 2013

When: October 11, 2013

RPI2.0 hosted its annual Research Update Workshop, at which world-renowned scientists presented their research on a variety of topics to RPI's members. This annual workshop offers our member companies the opportunity to keep up to date with the progress of currently funded research projects and also to liaise with scientists to ensure that their business needs remain a focal point of research.

Many thanks to XL Re, who hosted the workshop in their Bermuda offices, at O'Hara House, Hamilton.



In-House Meetings

One of the services each RPI2.0 company enjoys as part of their membership is the availability of our scientists for one-to-one discussions. We help to answer the most important questions about the science of extreme events posed by RPI2.0 members. After consulting our network of partners we present relevant scientific results in a distilled form. On request of the member, an appropriate and renowned scientist joins the RPI2.0 team for in-house events. As an example, topics presented during in-house meetings may include a seasonal outlook, updates and headlines of RPI2.0 funded research, dynamical model results and their current skill, as well as the latest insights into new developments in commercial risk modeling. Membership includes, as a minimum, one in-house event at the office of the sponsoring company with a focus on renewal dates in January, April or June. The wide reach of our network of researchers, aided by teleconferencing capabilities, has enabled us to provide in-house presentations in the offices of members, wherever they may be. In 2013, for example, we delivered in-house meetings in 5 different countries (in some instances simultaneously via videoconference).

Meetings and Conferences

RPI2.0 personnel attended the following meetings and conferences on behalf of member companies:

- Association of Bermuda Insurers and Reinsurers Meeting - Hamilton Bermuda, 4 March
- Briefing on Catastrophe Modelling in Transition Hamilton, Bermuda, 16 April
- European Geosciences Union General Assembly 2013, Vienna, Austria, 7-12 April
- 4th International Summit on Hurricanes and Climate Change, Kos, Greece, 13-18 June. As in the past, RPI2.0 partially supported this event
- Tokio Marine's 8th Summit on Global Warming and Climate Change, Atlanta Georgia, 28 June
- Oasis LMF working party meetings (periodically, via videoconference)

General Information

RPI2.0 Members

AQR Re, Aspen, Axis, Catlin,
PartnerRe, RMS, State Farm,
Tiger Risk, XL Group

RPI2.0 Staff for 2013

Mark Guishard Ph.D.,
RPI2.0 Program Manager
Falk Niehörster, Ph.D.,
RPI2.0 Program Manager
Bill Curry, Ph.D.,
BIOS President and Director
Charles King, M.Aq., Research
Specialist

RPI2.0 and BIOS Contact Information

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Membership Levels

- **RPI2.0 Bronze Membership - \$65K/year**

Our basic membership option includes information on current and past research projects, one in house presentation, short reports on research, access to our events, and web based information; these services are also included in Silver and Gold membership.

- **RPI2.0 Silver Membership - \$85K/year**

RPI2.0 will organize consulting services that target project(s) specified by you and tailored to your needs, plus two additional in-house events, at least one of which includes attendance by an independent scientist.

- **RPI2.0 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.

RPI2.0 Member Companies 2013

PartnerRe



AQR | Re Ltd.



CATLIN
Underwriting Ambition



RPI2.0 Publications in 2013

Cipullo, M. *High-resolution Modeling Studies of the Changing Risks of Damage from Extratropical Cyclones*, North Carolina State University, Master of Science Thesis, Marine, Earth & Atmos Sciences, 2013.

Elsner, James B., Sarah E. Strazzo, Thomas H. Jagger, Timothy LaRow, Ming Zhao, 2013: Sensitivity of Limiting Hurricane Intensity to SST in the Atlantic from Observations and GCMs. *J. Climate*, 26, 5949-5957.

Guishard, M.P., *Cyclone Classification - Background, Challenges and Implications for the Re/insurance Industry*, RPI2.0 Report, July 2013.

Guishard, M.P., Report on the 4th International Summit on Hurricanes and Climate Change, RPI2.0 Report, June 2013.

Niehörster, F. (editor), Aichinger, M., Murnane, R., Ranger, N. and Surminski, S., Warming of the Oceans and Implications for the (Re)Insurance Industry, *Geneva Association*, June 2013.

Strazzo, Sarah, James B. Elsner, Timothy LaRow, Daniel J. Halperin, Ming Zhao, 2013: Observed versus GCM-Generated Local Tropical Cyclone Frequency: Comparisons Using a Spatial Lattice. *J. Climate*, 26, 8257-8268.

Strazzo, Sarah, James B. Elsner, Jill C. Trepanier, Kerry A. Emanuel, Frequency, intensity, and sensitivity to sea surface temperature of North Atlantic tropical cyclones in best-track and simulated data, *Journal of Advances in Modeling Earth Systems*, Volume 5, Issue 3, pages 500-509, 3rd Quarter 2013.

Truchelut, Ryan E., Robert E. Hart, Briana Luthman, 2013: Global Identification of Previously Undetected Pre-Satellite-Era Tropical Cyclone Candidates in NOAA/CIRES Twentieth-Century Reanalysis Data. *J. Appl. Meteor. Climatol.*, 52, 2243-2259.

Woodruff, Jonathan D., Jennifer L. Irish, Suzana J. Camargo, Coastal flooding by tropical cyclones and sea-level rise, *Nature* 504, 44-52, December 2013.

Our Academic Network

Dalhousie University

ETH Zürich

Florida State University

Freie Universität Berlin

Institut Català de Ciències del Clima

London School of Economics and Political Science

Massachusetts Institute of Technology

National Center for Atmospheric Research

University of Oxford

Princeton University

University of Reading

University of Birmingham

University of Massachusetts Amherst

VU University Amsterdam

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