Catastrophe modeling and climate change

London, UK - Lloyds of London released a Catastrophe Modeling and Climate Change Report on May 15th, 2014. The document provides an overview and examples of the development of catastrophe modeling technology utilized by insurers, reinsurers, governments and other financial entities. This technology is aimed at gauging changes in climate and weather patterns and estimating how risk analysis related to extreme weather events can affect the insurance industry.

Catastrophe models in time

Commercially available catastrophe models (often referred to as ‘cat models’) have only been in existence for the last 25 years. Despite the commercial availability of the first probabilistic catastrophe models in the late 1980s, their use was not widespread.

In 1989, the magnitude of loss caused by both Hurricane Hugo and the Loma Prieta earthquake sparked interest in the use of catastrophe models amongst insurers and reinsurers. However, it was the unprecedented loss from Hurricane Andrew in 1992 which really highlighted the deficiencies in quantifying catastrophe risk losses.

Catastrophe models are now an integral part of any organization that deals with natural catastrophe risk. State-of-the-art weather models like the Global Climate Model (GCM) have become an integral tool in meteorological research and help scientists simulate future climate and emission scenarios.

GCM findings on future climate scenarios

Despite the differences in various GCM research methodologies, all models agree, for example with regard to windstorms specifically, that changes in near-surface temperature, baroclinicity and sea-ice will greatly affect the strength and location of cyclone activity at mid-latitudes.

EQECAT (a catastrophe risk modeling firm) carried out research on windstorm activity in the European mid-latitudes which highlighted the following observations in future climate scenarios:

1. Fewer smaller storms but an increase in the frequency of very large storms;
2. A shift in the latitude of European windstorms towards central Europe;
3. A four-fold increase in the frequency of years with several severe storms.
Climate change in facts and figures (ref. Lloyds’ Catastrophe Modeling and Climate Change report)

The Summary for Policymakers of the Intergovernmental Panel on Climate Change’s (IPCC) Fifth Assessment Report (2013) reports an unequivocal warming of the climate system. Global average air temperatures during the last three decades have been the warmest since 1850 and, in the northern hemisphere, the past 30 years were likely the warmest period for at least 1,400 years. These long term changes are generating widespread impacts, notably:

• Increasing accumulation of energy in the world’s oceans: it is virtually certain that the top 700m of the oceans warmed over the last four decades.

• From 1901-2010 global mean sea levels rose by approximately 19cm. The rate of sea level change since the middle of the 19th century is larger than the average rate of change over the past two millennia.

• The ice sheets in Greenland and Antarctica are increasingly shrinking, the size of glaciers all over the world is decreasing and the level of Arctic sea ice in the Northern Hemisphere is falling.

• Atmospheric levels of the greenhouse gases carbon dioxide (CO2), methane and nitrous oxide are higher than at any time during the last 800,000 years. The main causes for this are the combustion of fossil fuels and changes in land use. Since pre-industrial times atmospheric CO2 concentrations have increased by 40% and the world’s oceans have absorbed about 30% of the emitted carbon. This increased uptake by the oceans results in their increased acidification levels.

• The winter of 1989/1990 had the highest windstorm frequency with 37 events recorded. It proved a notable year as several of the windstorms were significant from an insurance loss perspective, such as windstorms Daria (25th January), Vivan (26th February) and Wiebke (28th February). Such seasonal intensity is not in isolation, as it also took place during the 1999 storm season as Anatol, Lothar and Martin caused a total loss of $13.9 billion. Lothar and Martin occurred within 36hrs of each other, both impacting similar areas of central Europe.

• Studying the insured losses from single historic windstorms, the most significant events were recorded from Daria (1990) and Lothar (1999) with insured losses totaling $8.2 billion and $8 billion respectively. However, the most recent large scale loss from a windstorm was in 2007 when Kyrill (18th January) impacted much of central Europe causing an insured loss of $6.7 billion.

• By the 2080s, UK projections show that there could be around three times as many days in winter with heavy rainfall (defined as more than 25mm in a day) as in the recent past. It is plausible that the amount
of rain in extreme rain storms (defined as storms with a 1 in 5 annual probability, or rarer) could increase locally by 40%.

- In the UK, central estimates of sea level rise for a medium emissions scenario (a world in which there are reduced emissions, but there is still an increasing reliance on fossil fuels) are in the range of 24-36 cm by the 2080s, relative to 1990 levels. However, under a high emissions scenario (in which reliance on fossil fuels continues to increase rapidly) there is a chance that the sea level could rise by approximately 70 cm. There are credible (though unlikely) extreme scenarios that suggest an even greater increase in sea level of up to 1.9m.

- In 2011, there was record-breaking damage from severe thunderstorms in the US. After local national Weather Service meteorologists, insurance assessors and government officials were able to view the dozens of affected states, it was determined that total economic losses were approximately USD2 billion. Various insurers reported that more than 225,000 claims were filed by policyholders, with total insured losses in excess of USD1.4 billion (ref. [http://www.aon.com/attachments/reinsurance/201106_us_april_may_severe_weather_outbreaks_recap.pdf](http://www.aon.com/attachments/reinsurance/201106_us_april_may_severe_weather_outbreaks_recap.pdf)).

- The small low-level islands in the South Pacific are directly experiencing the effects of sea level rise. A telling example is the case of the low-lying Pacific nation of Kiribati, which is currently negotiating to buy land in Fiji so it can relocate its islanders under threat from rising sea levels. Meanwhile, the Japanese company Shimizu Corporation has proposed building a ‘floating nation’ for Kiribati, with the help of a set of circular, vast "lily-pads" on the surface of the ocean.