The AIR Crop Hail Model for Canada

In 2016, the Canadian Prairie Provinces experienced one of the most active—and longest—hail seasons in at least 25 years. The number of hailstorms more than doubled the 30-year average and both the number of claims and total losses paid by the private hail insurance industry resulted in an industrywide loss to premium ratio of 85%. Manitoba was hardest hit with a loss to premium ratio of 143%.

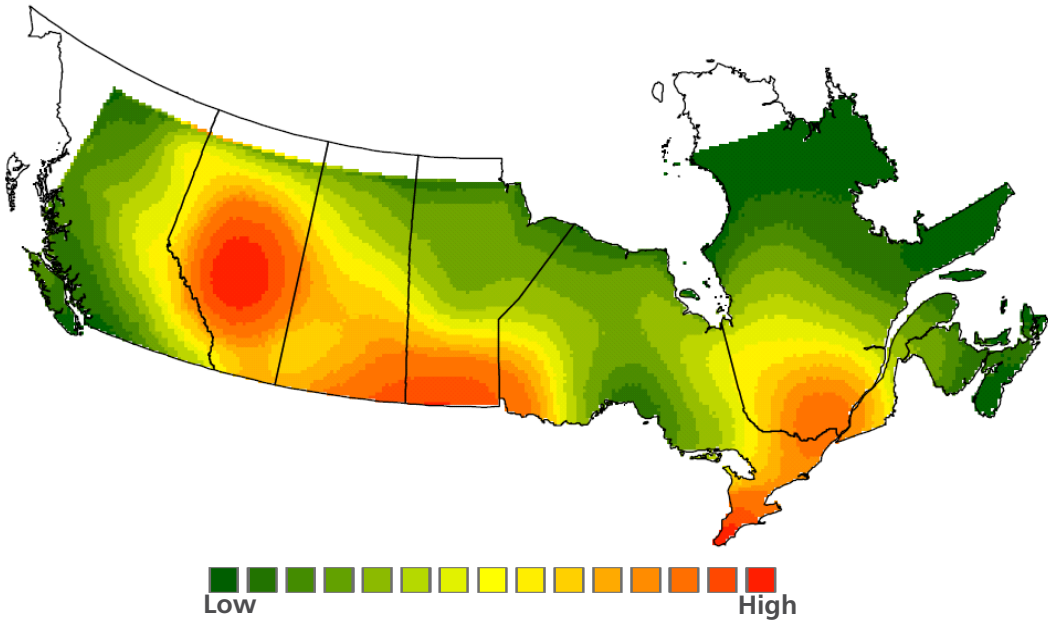
AIR

Crops in Canada are damaged by hail every year, resulting in an average CAD 200 million in losses per year. The localized nature of the peril and the relatively short historical record both of hail activity and its damage to crops create challenges for crop insurers and reinsurers assessing their risk. The new AIR Crop Hail Model for Canada is the industry's first probabilistic model that captures the effects of hail on Canadian crops, providing companies with a comprehensive view of their risk.

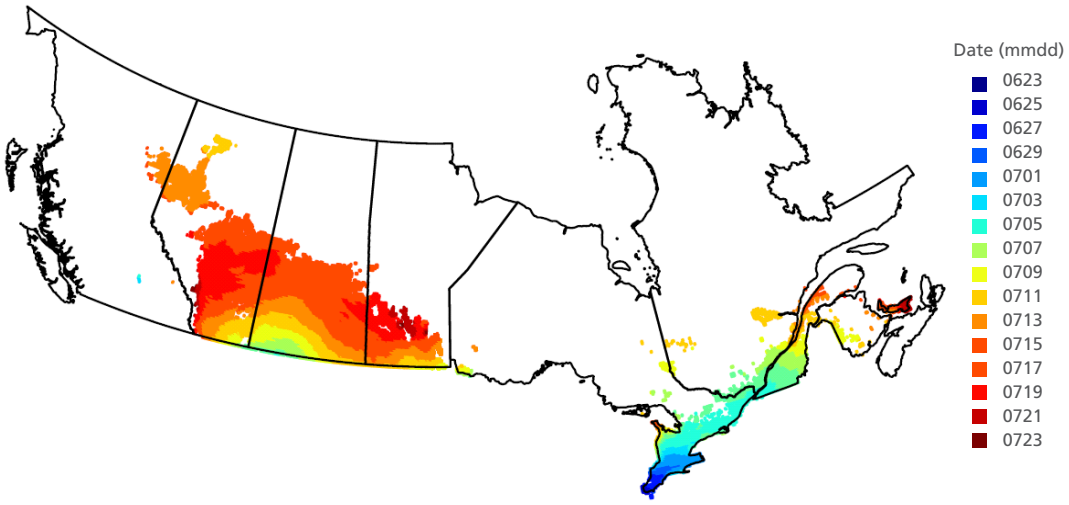
Integrates Statistical Modeling with the Latest Meteorological Research for a Robust View of Crop Hail Risk

The AIR Crop Hail Model for Canada leverages AIR's 10,000-year stochastic catalog of simulated hailstorms over a domain that includes Canadian provinces south of 59° N and east of 129° W and the contiguous United States. This is the same catalog that is used by AIR's industry-leading severe thunderstorm models for Canada and the U.S., in which hailstorms are a modeled peril.

Despite Alberta's "Hailstorm Alley" being one of North America's most volatile hail zones, detailed data on outbreaks are incomplete. The model's stochastic catalog is therefore based on historical meteorological data in addition to the limited data on reported hail outbreaks. Specifically, to provide a comprehensive view of hail risk in Canada, AIR "smart-smoothed" the limited observational data leveraging the high-resolution meteorological parameter called Significant Hail Parameter (SHiP) to determine when and where conditions were favorable for hailstorm formation. This allows the model to account for crop hail risk in areas that may not show major activity in the brief historical record.



Spatial distribution of average annual hailstorm frequency in the AIR Crop Hail Model for Canada.



The average onset of spring wheat flowering, a critical crop developmental stage, occurs later as one moves northward. Crop damage varies based on the developmental stage at the time of the hailstorm and, as shown here, the developmental stages vary by geographic location. Developmental stages within the model are based on typical planting and harvest dates and Growing Degree Days.

CONTINUOUS VIEW OF CROP HAIL RISK BETWEEN CANADA AND U.S.

AIR's new Crop Hail Model for Canada leverages the same 10,000-year hail catalog used by AIR's existing Crop Hail Model for the U.S. Hail outbreaks are simulated across the entire domain of the nine southernmost provinces of Canada and the contiguous U.S., with no artificial break in activity at the border. Users of AIR's software can easily assess the risk of crop losses for both Canadian and U.S. reinsurance submissions for a complete view of crop hail risk across an entire North American portfolio.

Captures the Highly Localized Effects of Hailstorms

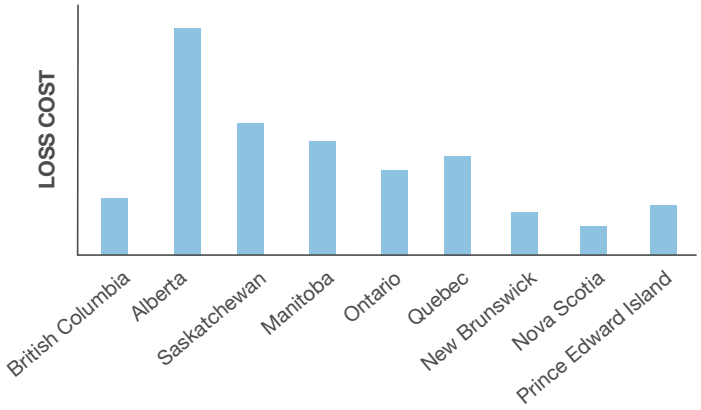
Hailstorms can be highly localized and last just minutes. AIR scientists use both radar and satellite data to define historical hail swaths, the dimensions of which form the basis for developing high resolution footprints of simulated events that are realistic in size and shape. AIR's event footprints, whose dimensions are based on historical observations rather than an artificially imposed grid size, are the key to the model's ability to generate robust tails of the exceedance probability curve.

Provides a Realistic Representation of Hailstorm Frequency

The extreme variability observed in hailstorm occurrence from year to year makes risk management challenging. The AIR model provides realistic scenarios of daily hailstorm activity based on historical location-level and seasonal occurrence rates and weather patterns, explicitly capturing the spatial and temporal variability displayed in the record of observed hailstorm losses. The daily simulation enables the model to capture both large outbreaks, with the potential to produce large insured losses, as well as smaller events that may produce lower losses that could still impact a company's portfolio on an aggregate basis.

Crop-Specific Damage Functions Provide the Most Accurate Loss Estimates

Because hail affects different crops differently, the AIR Crop Hail Model for Canada features crop-specific damage functions—for barley, canola, corn, flax, lentil, oats, pea, potato, soybean, and wheat—that account for the unique damage mechanisms at various stages of



Modeled loss cost of the insurable exposure of the 10 main Canadian crops (barley, canola, corn, flax, lentil, oats, pea, potato, soybean, and wheat). As can be expected, modeled loss cost is largest in the three Prairie Provinces of Alberta, Saskatchewan, and Manitoba.

each crop's development. In the model, hail damage is a function of hail impact energy, which takes into account storm duration, the density of individual hailstones and their size, the number of hailstones by diameter per cubic meter, and the accompanying wind speed.

The extent of crop damage depends on what developmental stage the crop is in, which varies by geographic location and time of year. For example, wheat plants may recover from early season hail damage if the plant has not been completely destroyed, but the ability of the crop to recover declines rapidly as damage occurs in later developmental stages. Damage functions that vary by developmental stage, for explicitly modeled crops, are critical factors in the estimation of crop losses.

Extensive Loss Validation

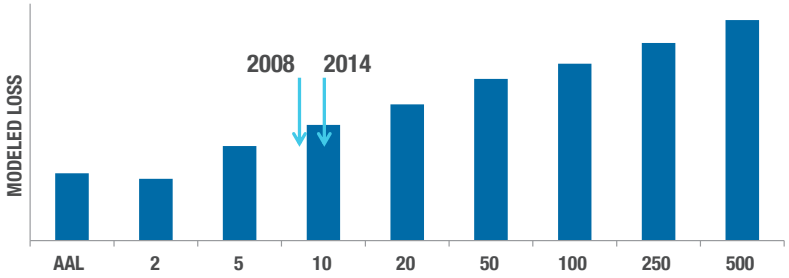
Modeled losses are extensively tested by calculating loss costs for the individual modeled crops and comparing those against both the hail frequency pattern in the 10,000-year hail catalog and historical experience reported by the major crop insurance providers in the Prairie Provinces. While crop-specific damaged area and associated losses are calculated for individual storm events, the total losses for all explicitly modeled crops are then combined and aggregated to the province level (see loss cost graph). Losses from the remainder of Canadian crops are added statistically on the province level, and total loss cost for all crops is calculated for comparison with industry loss experience (see return period plots).

CONVENIENT DAMAGE ESTIMATION TO BOTH CROPS AND PROPERTY WITH TOUCHSTONE RE

Since hail is usually produced by severe thunderstorms, hail-induced crop damage can be associated with a thunderstorm outbreak causing extensive property damage at the same time. Because hailstorms are localized events, however, it may also be that they inflict damage on crops while leaving nearby property unaffected—and vice versa. In addition, some hailstorms have no effect on crops because they occur outside of the crop growing season. Because the AIR Crop Hail Model for Canada and the AIR Severe Thunderstorm Model for Canada use the same hail catalog, users of AIR's Touchstone Re™ software can easily compare (and aggregate, if desired) property and crop losses on an annual basis by province.

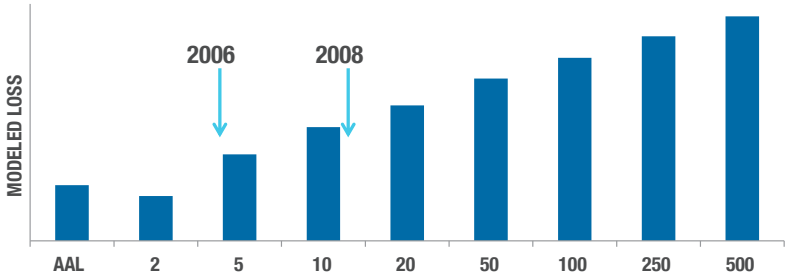
Alberta

Alberta crops suffered from several notable hailstorms during July 2008, including storms that shredded entire fields of corn in Taber, the “Corn Capital of Canada.” Late July and early August storms in 2014 resulted in large losses, with severe storms August 6-8 causing significant damage.



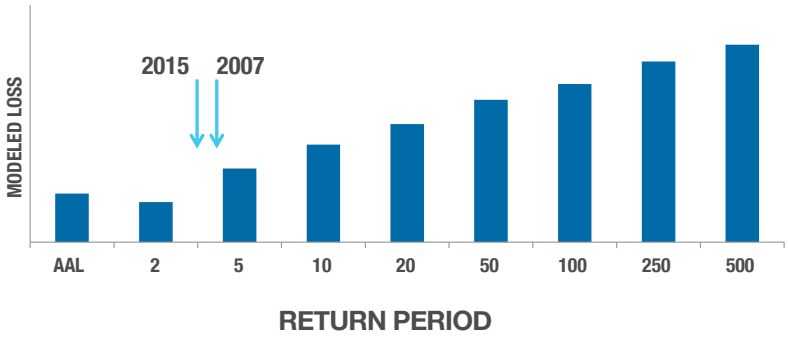
Saskatchewan

Saskatchewan producers incurred their highest hail losses in more than a decade in 2006 as a result of late season hail in August, while 2008 saw storms nearly every day in July, including two catastrophic storms on July 9 and 10.



Manitoba

Excessive heat and humidity in Manitoba spawned hailstorms throughout the 2007 growing season, damaging spring wheat and canola. Manitoba was the hardest hita of the Prairies in 2015 with several widespread storms, including severe events in late June and late July.



Model at a Glance

Modeled Peril	Hail
Model Domain	Nova Scotia, New Brunswick, and Prince Edward Island; areas of Quebec, Ontario, Manitoba, Saskatchewan, and Alberta south of 59° N; areas of British Columbia south of 59° N and east of 129° W.
Supported Geographic Resolution	Province
Vulnerability Module	Vulnerability varies by hail impact energy (hailstone size, density, and wind speed), crop type, and crop developmental stage at time of hailstorm
Covered Crops	Barley, canola, corn, flax, lentil, oats, pea, potato, soybean, and wheat are all explicitly modeled. All other crops are modeled implicitly.

Model Highlights

- Utilizes a 10,000-year stochastic hail catalog, which is also used by the AIR's severe thunderstorm models for Canada and the U.S., in which hailstorms are a modeled peril
- Employs sophisticated statistical techniques—data smoothing and augmentation—to compensate for the limited historical record of hailstorm reporting
- Crop-specific damage functions account for the unique damage mechanisms imposed by hail at various plant developmental stages
- Extensively tested against data provided by crop insurers and published research

ABOUT AIR WORLDWIDE

AIR Worldwide (AIR) provides risk modeling solutions that make individuals, businesses, and society more resilient to extreme events. In 1987, AIR Worldwide founded the catastrophe modeling industry and today models the risk from natural catastrophes, supply chain disruptions, terrorism, pandemics, casualty catastrophes, and cyber incidents. Insurance, reinsurance, financial, corporate, and government clients rely on AIR's advanced science, software, and consulting services for catastrophe risk management, insurance-linked securities, longevity modeling, site-specific engineering analyses, and agricultural risk management. AIR Worldwide, a Verisk (Nasdaq:VRSK) business, is headquartered in Boston, with additional offices in North America, Europe, and Asia. For more information, please visit www.air-worldwide.com. For more information about Verisk, a leading data analytics provider serving customers in insurance, energy and specialized markets, and financial services, please visit www.verisk.com.

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