# The AIR Multiple Peril Crop Insurance (MPCI) Model for Canada

In the summers of 2001 and 2002, drought impacted Canada nearly coast to coast and caused a drop in agricultural production by an estimated CAD 3.6 billion. Recent years, however, have seen more losses from excess moisture than from drought. The AIR MPCI Model for Canada provides (re)insurers with a probabilistic risk management tool that accounts for both generalized large-scale and local risks to help better understand crop risk and make more informed decisions.

AIR

Multiple Peril Crop Insurance (MPCI) exists in an ever-changing environment: Yields have improved due to technological progress; farmer participation has changed; premium rates have been continually adjusted; and crop markets and cropland have shifted due to climatic conditions and financial pressures. Simply relying on historical losses to estimate future risk is insufficient. A probabilistic approach can describe the full breadth of possible crop year loss scenarios that could occur to crops planted with the technology and insured with the policy conditions in use today. Insurers and reinsurers will be most effective by taking the probabilistic approach to assessing and managing this complex and mutable risk.

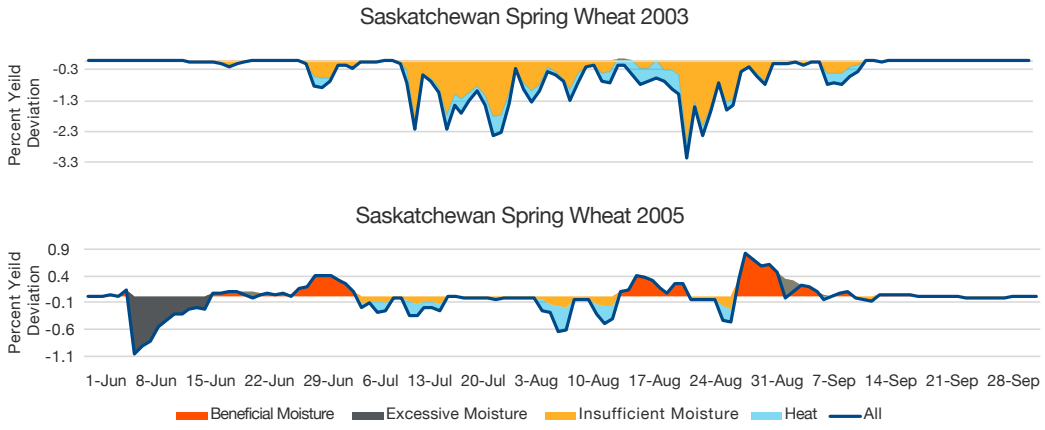
## The Industry's First Probabilistic Approach to Modeling Multiple Peril Crop Losses in Canada

AIR released the industry's first probabilistic Multiple Peril Crop Insurance Model in 2007—which has since become the standard for crop insurance in the United States. In the following decade, AIR's suite of crop models expanded to include the MPCI Model for China, the Crop Hail Model for the United States, and the Crop Hail Model for Canada. Building on our extensive crop modeling experience, AIR then developed the Multiple Peril Crop Insurance (MPCI) Model for Canada to better meet the needs of this growing (re)insurance market.

## Weather Impact on Yield Outcome

Most losses in the Canadian MPCI program occur when yield falls below the value guaranteed by the provincial crop insurance program for the coverage level selected by the policyholder. The primary determinant of a yield outcome for non-irrigated crops is weather.

Adverse weather effects can be highly localized and can affect different crops in different ways. Crops can experience stress from drought (including drought-related effects from grasshopper damage), flood/excess moisture, heat, frost/freeze, hail, and winterkill—primary insured perils and major causes of loss. Depending on the stage of the growing season and the duration or timing of such adverse weather conditions, the impact on crops can be significant. For example, one long period of intense heat can cause more damage than several periods of shorter duration; flooding that occurs during freezing temperatures has a greater impact than either peril separately; and prolonged drought during a warmer-than-average winter can allow the grasshopper population to increase and wreak havoc on crops in the coming season.




A combination of adverse weather perils impact crop yield.

To determine the intensity of these modeled perils, the AIR MPCI Model for Canada accounts for compounding weather conditions and event duration. The vulnerability of specific crops to weather events is determined based upon developmental stage, which varies by geographic location and time of year.

## Accounting for the Impact of Technological Improvements on Yield

Estimating yields based on prior history is made more complex by technological improvements, which lead to increased production and improved crop tolerance of natural perils. As these improvements are introduced gradually over time, they result in a trend in average yields that may obscure the true impact of weather on yields. To accurately isolate and quantify the effects of weather on today's crop yield potential, it is necessary to remove the long-term impact of technological improvements. Therefore, AIR detrends historical yield time series with an approach that explicitly accounts for the impact of weather events on yields that may otherwise be attributed to a technological trend. More accurate quantification of weather impacts on yields means more accurate loss estimation under current technology and policy conditions.

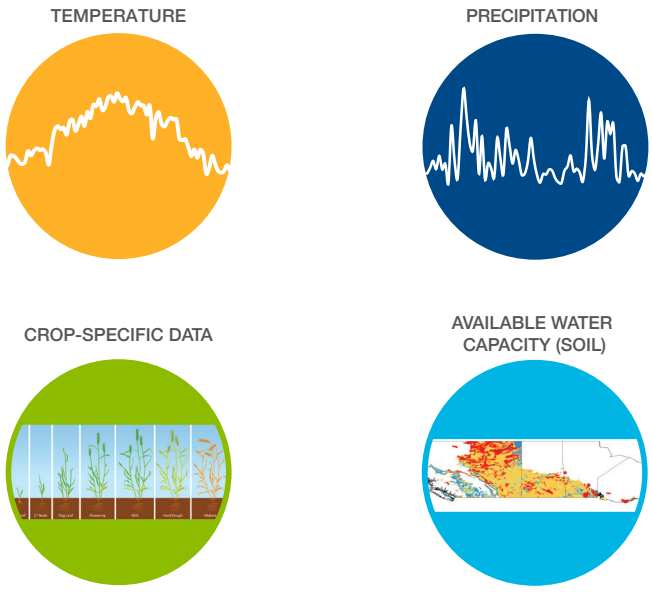
## The AIR MPCI Model for Canada Is Kept Current

Regular model updates ensure that analyses reflect the latest available weather, yield, price, and exposure information. AIR incorporates new agricultural land and crop inventory in Canada from Agriculture and Agri-Food Canada (AAFC) when updating the model. Changes to the crop insurance program are also incorporated, following provincial publication of these changes.

## Leveraging High-Resolution Location, Weather, and Crop Data

AIR's location-specific and crop-specific approach leverages high-resolution temperature, precipitation, soil, and elevation data as well as crop-specific phenological data. For temperature and precipitation, AIR uses high-resolution data of daily observations dating back to 1979, which contributes to more accurate spatial yield simulation.

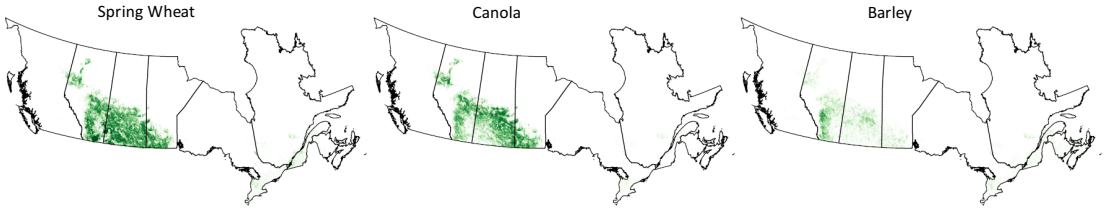
The result of the analysis is an estimate of yields by crop year for each major crop insured in Canada that realistically reflects the effects of weather, thus providing improved risk estimates for policies insuring yield in each province.




Key components of AIR's location-specific and crop-specific approach include high-resolution temperature, precipitation, soil, and elevation data, along with crop-specific phenological data.

## Assessing Risk of Yield Loss Through Modeling at High Resolution

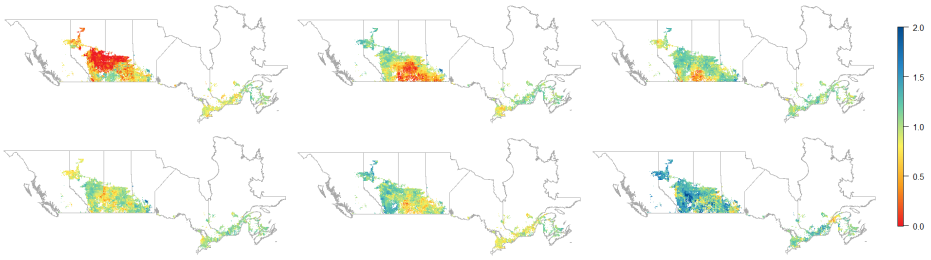
Farmers adjust their crops and planting areas based on climate conditions and experience to maximize their profits. To accurately model cropland and exposure at high resolution (8-km grid) for 11 major crops—barley, blueberry, canola, corn, flaxseed, lentil, oats, pea, potato, soybean, and wheat (winter and spring)—the AIR MPCI model employs high-resolution satellite data of agricultural land and crop inventory in Canada from Agriculture and Agri-Food Canada (AAFC) and census data, which contributes to the accuracy of location-specific yield simulation for the most precise estimate of losses available to the market.




High-resolution satellite data of agricultural land and crop inventory from the AAFC and census data provide an accurate view of cropland and exposure in Canada.

## Capturing Spatial Yield Correlations in the Stochastic Catalog for Better Risk Protection

AIR has developed a set of 10,000 potential yield outcomes that can occur in each province. The AIR catalog generation process carefully maintains correlations—correlations between neighboring counties and provinces, correlations between crops within a location (from province down to a single 8-km grid cell), and price correlations across crops. These correlations are critical from a risk management perspective because they are the basis of any risk protection available from a well-diversified crop insurance portfolio.




The stochastic catalog captures spatial yield correlations among neighboring provinces.

## AIR's Canada MPCI Model Accounts for Province-Specific Policy Conditions and Losses

Each province in Canada operates its own crop insurance program and can set province-specific program options, rates, and policy conditions. The AIR MPCI Model for Canada accounts for these program, rate, and policy variations to provide more accurate views of crop risk based on policy conditions in each province.

Each province's policy conditions are used to calculate yield deficit through a comparison of the actual yield to the yield guarantee. Some provinces set yield guarantees by area averages, whereas others only consider individual production histories. Methods to calculate yield guarantees can also vary widely; some provinces cushion or trend the yields used in their calculations, increasing yield guarantees. Modifications to yield guarantees can significantly impact pricing and, therefore, losses.

Where price risk is covered, AIR combines the AWI-based yield probability distributions with a price model. Because coverage level options and preferences can differ among provinces, the MPCI price model assesses the historical relationship between the planting price and harvest price and the difference between expected and actual yield on a provincial basis.

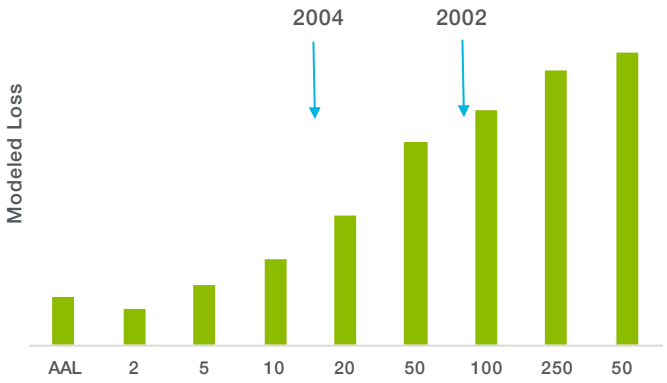
## Capturing Unseeded, Reseeded, and Hail Spot Losses

At the beginning of the crop season, flood/excess moisture or frost/freeze conditions can prevent planting entirely or kill the crops that have been planted. These losses are often covered under unseeded and reseeded benefits and can account for a significant portion of crop insurance losses. The unseeded and reseeded acreage is estimated by monitoring the weather conditions daily around planting dates and before seeding deadlines.

Hail is a significant peril in the Prairie Provinces of Alberta, Saskatchewan, and Manitoba during the growing season; while crop hail insurance is offered by several companies as a separate policy, hail damage can also be covered within the MPCI program as spot losses (e.g., in Alberta) or as an impact on end-of-season yield. The Canada MPCI model uses AIR's 10,000-year stochastic catalog of simulated hailstorms over a domain that includes Canadian cropland south of 59°N and east of 129°W and the contiguous United States.

## Modeled Losses Are Validated Against Historical Losses

To ensure the most reliable modeled loss estimates available, losses from the AIR MPCI Model for Canada are carefully validated against actual loss experience. Losses are calculated for all explicitly modeled crops on an 8-km grid and then combined and aggregated to the province level. Losses from the remainder of the Canadian crop insurance program (including crops and insurance products that are not explicitly modeled) are added statistically on the province level. The loss cost is compared with industry loss experience (see figures).





**Saskatchewan**

Severe drought struck Saskatchewan in 2002, and outbreaks of grasshoppers in northwestern Saskatchewan increased crop losses. In 2004, crops experienced damage from flood/excess moisture and frost, and corn was affected by a lack of heat.

**Manitoba**

Prolonged and intense rainfall during the 2005 growing season led to the most widespread flooding on record in Manitoba and caused severe crop damage from flood/excess moisture. In 2011, heavy rain and snow from the previous fall and winter primed conditions along the Assiniboine River for flood/excess moisture, resulting in the largest fraction of cropland left unseeded in the last 38 years.

## Model at a Glance

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| **Model Domain** | British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island |
| **Modeled Perils** | Drought (including drought-related effects from grasshopper damage), flood/excess moisture, heat, frost/freeze, hail, winterkill |
| **Covered Crops** | Barley, blueberry, canola, corn, flaxseed, lentil, oats, pea, potato, soybean, wheat (winter and spring), other (including crops and insurance products that are not explicitly modeled) |
| **Supported Geographic Resolution** | Modeled on an underlying 8-km grid and aggregated to the province level to reflect the exposure data available to Touchstone Re™ users |
| **Supported Policy Conditions** | The AIR Canada MPCI model reflects the unique policy terms in each province—estimating losses due to yield deficits, price changes, unseeded and reseeded acreage, hail spot damage, and winterkill (where appropriate) using current liability and coverage level information. |

## Model Highlights

- Provides a probabilistic yield catalog that takes into account the spatial and temporal correlations of crop losses—a prerequisite for building a well-diversified crop insurance portfolio
- Uses high-resolution cropland and exposure, generated with satellite data, which contributes to the accuracy of location-specific yield and loss estimates
- Accurately isolate the impacts of weather on crop yields from long-term technology trends, allowing accurate yield estimations from a wide variety of weather scenarios that consider variation in vulnerability by crop location, type, and developmental stage
- Extensively tested against data provided by crop insurers, provincial governments, 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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