

2022 Hurricane Season Flood Alert System

Government of Newfoundland and Labrador

To: Mohammad Khayer

Date: April 28, 2022

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wood.



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Reviewer: Michael Abbott

Date: April 28, 2022



1 Scope of Work

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited, is pleased to provide the following proposal for the 2022 Hurricane Season Flood Alert System for the Water Resources Management Division (WRMD) Department of Environment and Climate Change of the Government of Newfoundland and Labrador.

Wood is the current provider of this service to the WRMD and has customized these products specifically to meet the residents of Newfoundland and Labrador's critical and unique needs. In 2014, the Minister Responsible for Fire and Emergency Services-NL summarized the system's impact:

"The Hurricane Flood Alert Service will enhance public safety for communities and residents of Newfoundland and Labrador living in flood-prone areas."

Rural Newfoundland and Labrador have a unique transportation reliance that does not exist in Mainland Canada. Initially, the primary access to most NL communities was by sea. Hence areas were settled due to their ease of boat access. Road access was created for these remote outposts as primary transportation shifted from vessels to cars. In most cases, a single road provides the only access to communities and serves as the only link between the residents and their essential services, such as hospitals. When flooding destroys these roads, entire peninsulas full of communities are completely cut off from services and supplies. With no alternate routes in emergencies, communities are forced to rely on costly air-based assistance. In 2010, when Hurricane Igor ravaged the Province, roughly 150 communities were isolated. During Hurricane Igor, a 100 ft section of the Trans-Canada Highway completely washed away, and there were over 100 additional breaks in main roads and secondary roads. Losses from the hurricane were estimated to be \$200 million, distinguishing Igor as the costliest cyclone in Newfoundland history.

Few of these communities have a public atmospheric forecast from Environment and Climate Change Canada (ECCC), which is why the customized Wood services play such a critical role in preventing flood-related tragedies. The Wood Hurricane Season Flood Alert System utilizes proprietary modelling and over 20 years of Newfoundland-based experience to provide precision accuracy for communities not covered under the Environment and Climate Change Canada services. Working directly with WRMD staff and Fire & Emergency Services – NL, Wood has become an indispensable member of the flood alert team in Newfoundland and the meteorological service is highly integrated into existing operations.

The Wood forecasting team has extensive knowledge and experience with the complexity of Newfoundland and Labrador weather and continually strives to provide the most accurate forecasts to our clients. Our weather forecasting operations are headquartered in St. John's, with additional staff in Halifax and Ottawa. Many of our meteorologists located outside the Province have lived in Newfoundland and Labrador, allowing them to gain considerable knowledge and confidence in identifying localized weather effects. This local knowledge allows Wood to continually deliver the most accurate forecasts to our clients in Newfoundland and Labrador.

Wood has been providing road weather forecasting services to the Government of Newfoundland and Labrador in several capacities since 2002. Wood has one of the largest private weather offices in Canada. Our footprint is firmly planted in Eastern Canada, with many of our clients returning because of our unparalleled experience and accuracy in producing the most valuable forecasts for their operations.



2 Hurricane Season Flood Alert System

2.1 Background

Significant precipitation events, particularly rainfall, can result in abnormally high-water levels. While heavy rainfall over a longer period, i.e., weeks, months, etc., can cause localized flooding, the most troublesome situation involves an area receiving a substantial amount of rainfall over a short timeframe, which overwhelms the water table, leading to flash flooding. This Hurricane Season Flood Alert System is designed to forecast such an event.

2.2 Modelling

Precipitation is the most vital weather parameter forecasted over land regions because of its significant impact on the operations of nearly every industry. Wood utilizes many publicly available weather models from organizations around the world to produce the most accurate precipitation forecasts for its clients. A listing of the available weather models is provided in the below table.

Table 1 Models Utilized by the Wood Weather Office

Model	Resolution	Number of Model Runs per Day	Lead time (hours)
RDPS	10 km	4	84
GFS	25 km	4	384
NAM	12 km & 32 km	4	84
RAP	13 km	24	21
HRDPS	2.5 km	4	48
ECMWF	11 km	4	240
SREF	17 km	4	87
GDPS	15 km	2	240
HMON	2.5 km nested grid	4 (Only while tropical system active)	Up to 126
HWRF	2 km nested grid	4 (Only while tropical system active)	Up to 126

While weather models output a future projection of precipitation, there are often significant differences in the placement of the precipitation, especially when dealing with small-scale features, such as thunderstorms and ocean-effect snow. For large scale systems, which are the typical storms received in Newfoundland and Labrador, the weather model's most significant challenge is dealing with the lack of precipitation measurements, which are incorporated into the initialization of each model run. Therefore, for the flood



forecasting product to provide the most significant benefit to the Department’s needs, Wood utilizes forecast models whose precipitation forecasting accuracy is considered to be strong and then combines this with direct meteorologist intervention based on scientific knowledge, training, and localized terrain effects. A final precipitation amount is generated based on a weighted average of all applicable outputs and direct meteorological analysis.

The figure below displays how significantly different four weather models can be at predicting precipitation over an area. One can note a large amount of rain predicted from the NAM model (bottom right of the image) for an area just west of St. Albans, while the other models have significantly less. Our goal is to weed out the outliers, focus on the models recognized for their accuracy and develop a system that will consider precipitation over a general area rather than just for a single point.

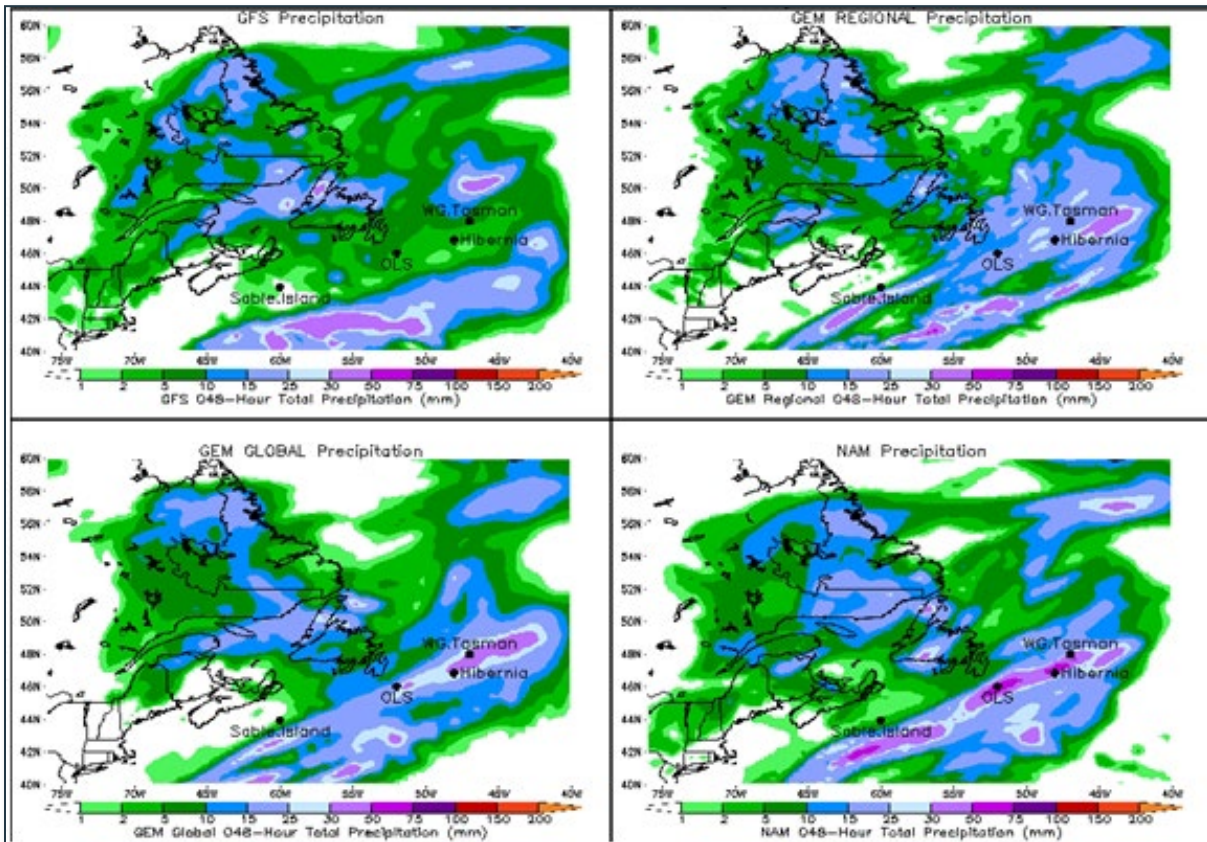


Figure 1 Sample Model Output Showing Total Precipitation over 48 Hours

During the Atlantic hurricane season (June-November), there are models run exclusively for projecting the expected path of tropical systems. Two key models are called the HMON (used since 2017) and the HWRF (used since 2007). Wood downloads, processes and plots data from these models whenever a tropical system can affect Atlantic Canada.



In September 2020, remnants of post-tropical storm Sally were forecasted to track across eastern Newfoundland. Most North American models projected rainfall totals of 50 - 100 mm (GFS, NAM etc.) and Canadian models (RDPS, GDPS etc.). The HMON and HWRF hurricane models provided added value by estimating slightly higher amounts between 75 - 125 mm for portions of Eastern Newfoundland, which verified well against observations, with the exception of Placentia and Goobies recorded rainfall totals (Figure 2). This storm caused infrastructure damage to roadways along route 92 in North Harbour, where several road washouts occurred.

<p>Weather summary for Newfoundland issued by Environment Canada at 7:30 p.m. NDT Saturday 19 September 2020.</p> <p>Discussion.</p> <p>A trough of low pressure formed off the east coast of the United States on Friday that tapped into tropical moisture associated with the remnants of Hurricane Sally. Rain associated with the system developed over eastern Newfoundland Friday and intensified Friday night before tapering off Saturday morning.</p> <p>The following is a summary of weather event information received by Environment and Climate Change Canada as of 7:30 P.M. NDT.</p> <p>1. Summary of rainfall in millimetres (since 12:30 A.M. NDT Friday):</p> <p>Placentia: 205.9 Goobies: 153.8 Bay Roberts: 125.8 North Harbour: 123.2 Spaniard's Bay: 122.9 Random Island: 122.4 Whitbourne: 117.0 New Harbour Barrens: 113.6 Town of Burin: 109.5 Carbonear: 108.7 Port de Grave: 108.2 St. Lawrence: 104.2 Hodgewater Line: 103.6 Green's Harbour: 101.9</p>	<p>Avondale: 101.1 Point May: 99.6 Bishop's Cove: 92.4 Clarke's Beach: 91.6 Harcourt: 86.5 Lethbridge: 86.0 St-Pierre: 83.6 Winterland: 83.5 Marystown: 83.3 Terra Nova: 76.5 Mount Carmel: 73.4 Salmonier Nature Park: 71.2 St. Joesph's: 71.2 Grand Bank: 64.8 Portland: 64.2 Berry Hill Pond (Bay d'Espoir Hwy): 61.2 Bonavista: 60.4 St. John's West: 60.3 Green Island (Trinity Bay): 59.4 New-wes-valley: 58.9 Mount Pearl: 56.4 St. John's Int'l Airport: 55.2 St. Alban's: 55.0 Gander Int'l Airport: 50.2 Rodger's Cove: 48.3 Gander West: 47.0</p> <p>Please note that this summary may contain preliminary or unofficial information and does not constitute a complete or final report.</p> <p>End/NLWO</p>
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Figure 2 Environment Canada and Climate Change storm rainfall totals from post-tropical storm Sally

Wood utilizes these hurricane models during these events when a tropical system can affect Newfoundland and Labrador. For example, a plot of expected precipitation during remnants of the post-tropical storm



Sally is shown in the figure below.

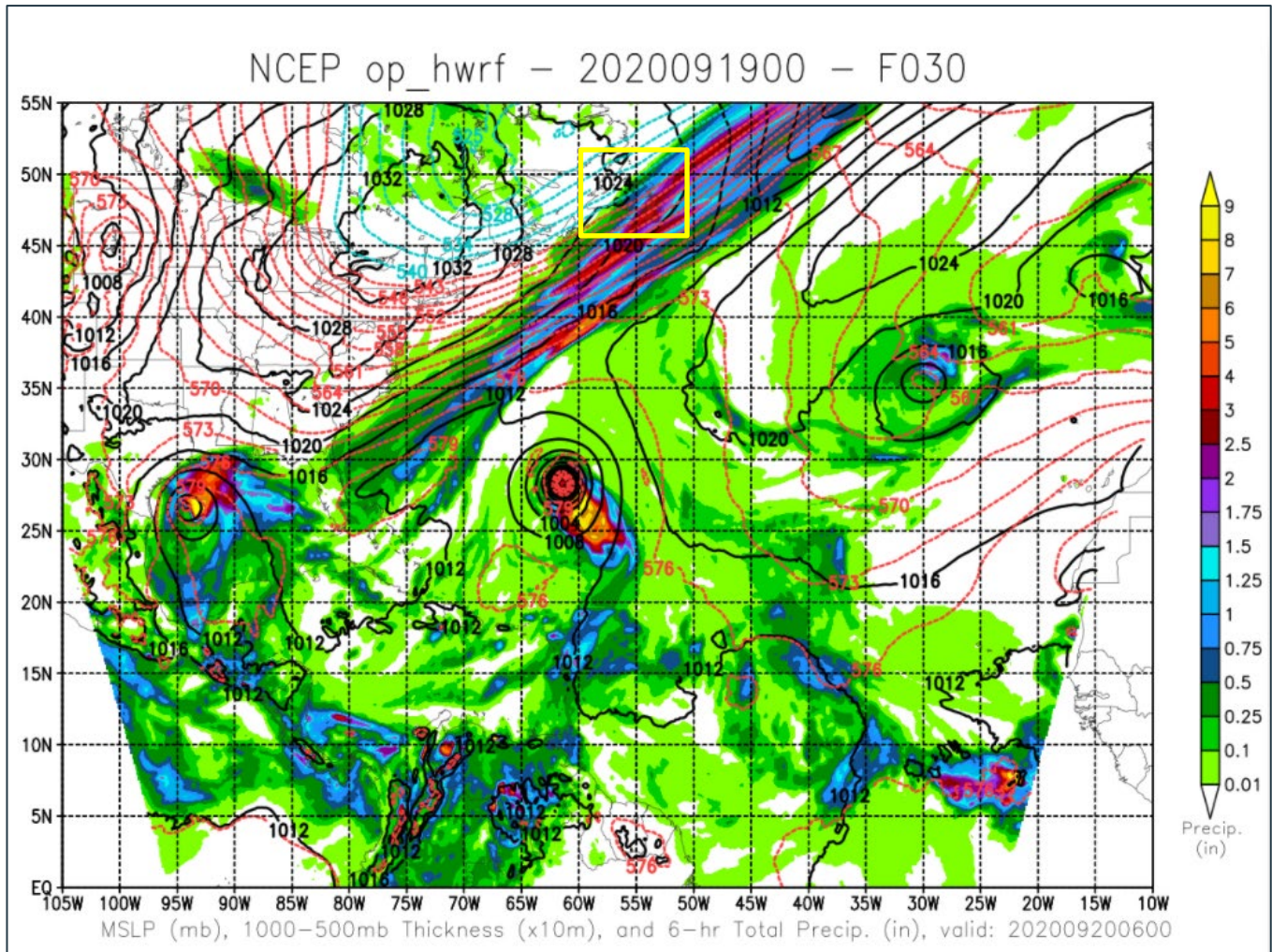


Figure 3 Precipitation Output from HWRf Hurricane Model for Remnants of Sally; Newfoundland located in the yellow box

2.3 Data Visualization

As indicated above, Wood discounts models that are considered outliers, but sometimes there is a benefit to seeing what the outliers are predicting. The outlier might be a low probability but a high impact event. Similarly, while Wood creates the forecast for the locations specified, there is benefit in understanding what precipitation is forecasted nearby. To help with this, Wood has created a product called DecisionVue. DecisionVue is designed to give the users the ability to look at several models and the range of values forecasted by the models. DecisionVue also lets the users create custom alarms which are triggered by the models. Wood will include access to DecisionVue as part of this year's service.

Figure 4 below provides an example of visualizing the model data using DecisionVue. Visualizing the model benefits the user by raising awareness of what is happening in the area from what is happening at a given location.

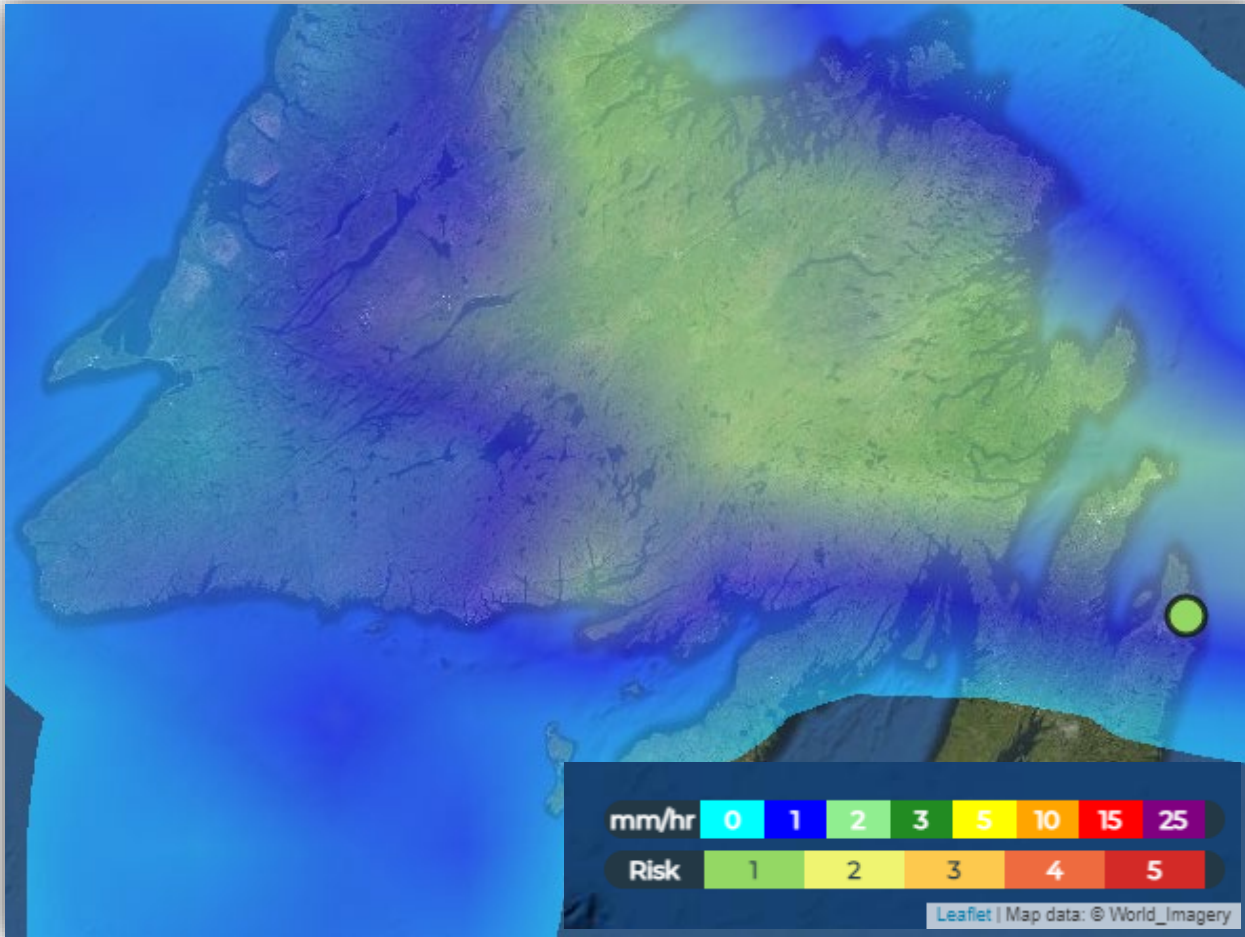


Figure 4 DecisionVue Model Data Visualization

Figure 5 allows the user to examine the forecast parameters in question over time. In the case of the WRMD Flood Alert System, Heavy Rain Strong Winds will be included as the only parameters. If the model value exceeds the user-defined threshold, the table will change from green to yellow and then the red. In the below example, one or more of the models is forecasted to exceed the user's threshold for heavy snow on Thursday, April 28th and April 29th.

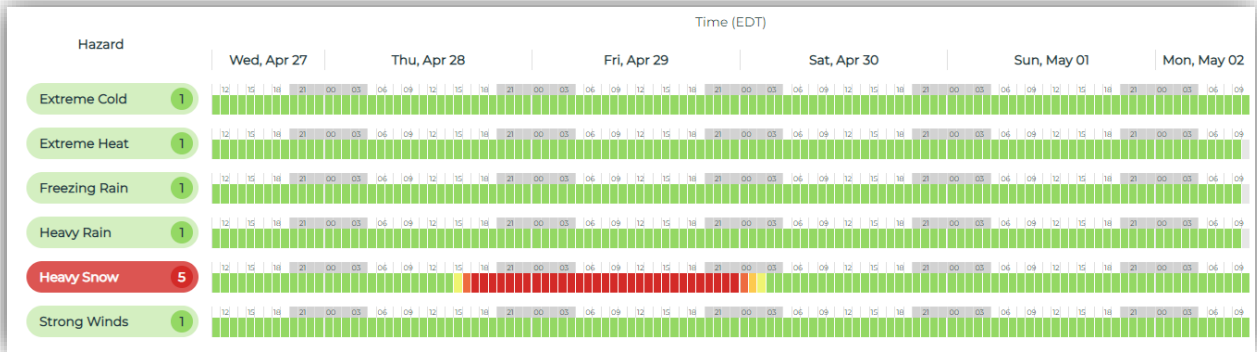


Figure 5 DecisionVue Risk Level Visualization

Figure 6 shows the spread of values within the different models for snow accumulation. Having knowledge of the spread in the forecasted values will help the client better understand the alignment between the different models, which in some cases will translate into forecast confidence.

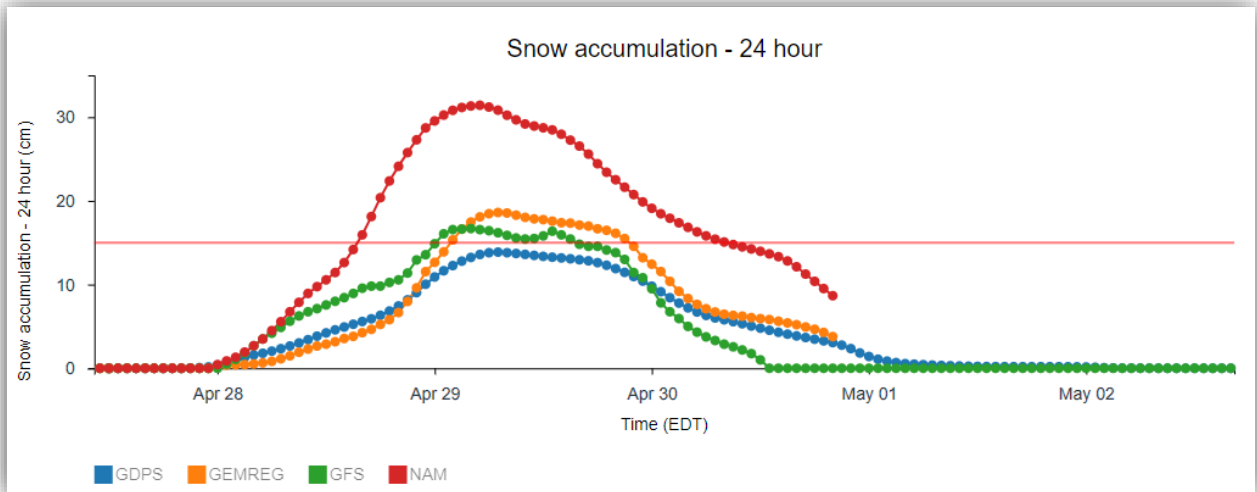


Figure 6 DecisionVue Model Correlation

2.4 GIS Products

The forecast data is also provided to WRMD in an Esri Shapefile format. The Esri Shapefile is a set of files that allow for the storage of geometry as well as attribution. Wood creates a new Shapefile daily, available for download from the Wood FTP site. The Shapefile can be used within a GIS desktop package or via the Internet through a web service.

2.5 Web Portal and Web Services

To help expand the user base for the data, Wood will make the data available through our custom Weather



Web Portal and web services following two common data standards. These products were designed to allow users outside of WRMD to view and consume the data produced by the service simply and efficiently. Each of the services displays the same information. Details on the Wood Weather Web Portal and the data standard used are as follows:

Table 2 Data Service Descriptions

Model	Resolution
Weather Web Portal	The Weather Web Portal is a GIS-enabled website that displays the HSFAS data, current radar data along with Environment and Climate Change Canada public weather station recent observations
Google KMZ Service	The Google KMZ file was designed by Google to allow for the storage of geometry as well as attribution, all within a single file. Wood designed the service in such a manner to permit the user to download the Google KMZ file once and always have access to the most recent data. This was accomplished by adding a pointer in the KMZ file that the client downloads to a second KMZ file that resides on the Wood server. The second KMZ file is updated daily with the most recent alerts.



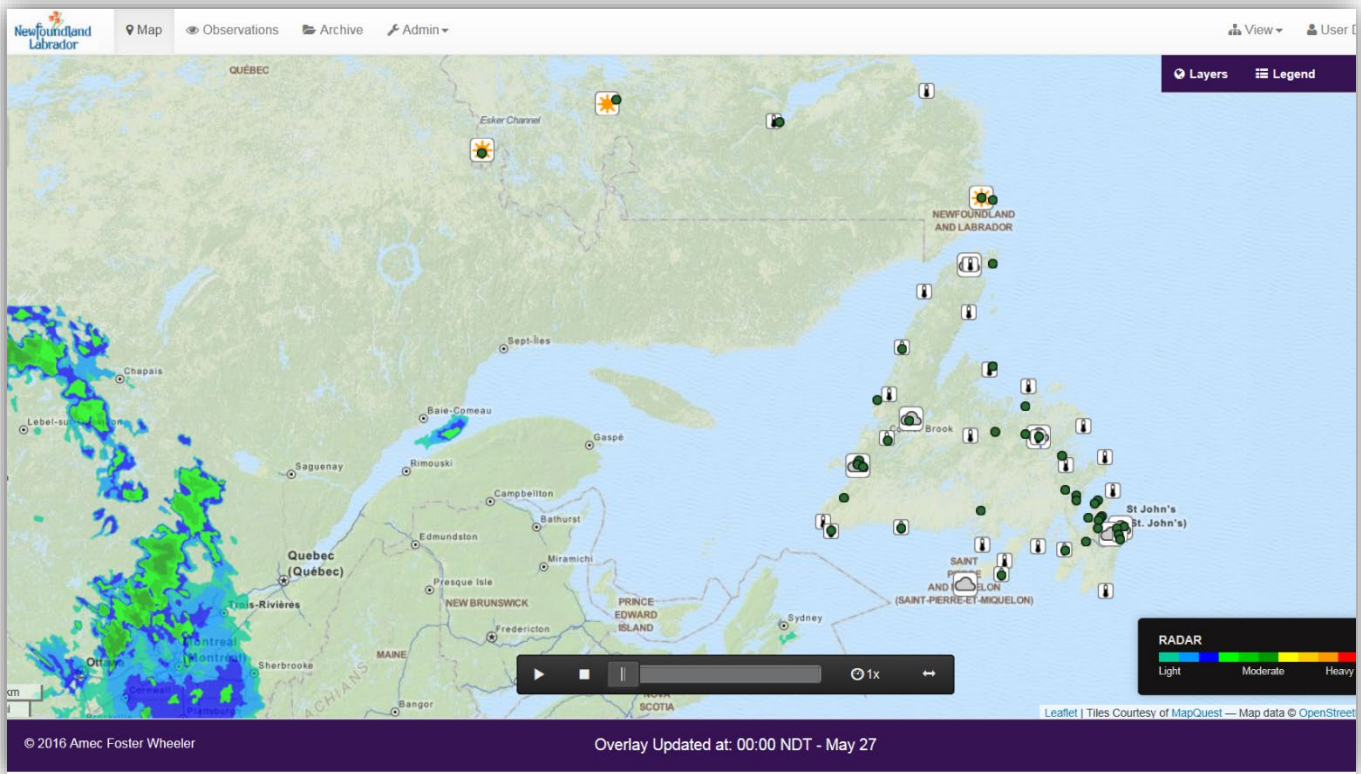


Figure 4 Weather Portal Showing Community Hurricane Flood Alert Status and Radar.

3 Deliverables

The following represent the deliverables for the Hurricane Season Flood Alert System.

3.1 Season

- ◆ The Hurricane Season Flood Alert System service will be active from June 1 through December 31.
- ◆ Outside the June 1 to December 31st season, up to 5 daily forecasts to support possible emergency situations can be requested.

3.2 Forecast

- ◆ The morning forecast will be issued at approximately 9:00 NST/NDT.
- ◆ The afternoon forecast will be issued at approximately 4:00 PM NST/NDT only in cases where the morning forecast has indicated an alert.
- ◆ The forecast will be emailed in PDF format. The forecast content will match that of the previous season.

- ◆ A forecast ESRI point Shapefile; containing points whose attributes record the alerts will be placed on the Wood FTP site.
- ◆ A forecast XML file will be placed on the Wood FTP site.
- ◆ Access to the Weather portal showing the communities included in the forecast along with the forecasted precipitation and alerts.
- ◆ Access to the model data and custom alerting through DecisionVue

3.3 Reports

- ◆ At the beginning of the Hurricane Season, a general hurricane outlook for Newfoundland will be produced.
- ◆ A short end-of-season report will be produced at the end of the hurricane season.
- ◆ At the end of the Hurricane Season, all the issued flood alerts will be provided in an Excel worksheet.

4 Pricing

The following table details the breakdown of costs for the forecasting services and provides transparency of the Wood effort for each task.

Table 3 Hurricane Season Flood Alert System Cost Breakdown (June 1, 2022 – December 31, 2022)

Task	Hours	Rate	Amount	Total Units	Subtotal
Project Management	2	\$190	\$380	7	\$2,660
Daily Forecasting	42	\$90	\$3,780	7	\$26,460
DecisionVue Setup	8	\$124	\$992	7	\$6,944
Pre Season Hurricane Outlook Report	20	\$124	\$2,480	1	\$2,480
End of Season Hurricane Summary Report	24	\$124	\$2,976	1	\$2,976
End of Season Hurricane Excel Report	16	\$124	\$1,984	1	\$1,985

Season Total	\$43,520
Months	7
Monthly	\$6,217.14

5 Contact Information

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