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SCRIBE marine

J. Marcoux*, J. Mclean, M. Schäffer and R.Verret

Development Branch
Canadian Meteorological Centre
Meteorological Service of Canada

1 Introduction

SCRIBE is a rules based expert system for generating weather forecasts from a digital weather element database (Verret et al., 1995). This system has been generating public forecasts for several years in an operational environment.

During the past year, the SCRIBE package has been expanded to handle all marine forecasts under the responsibility of the Meteorological Service of Canada (MSC). The SCRIBE marine product generator has been made compliant to the marine Standard Operating Procedures of the MSC as of 2003 June 14^{th}. SCRIBE marine is based on the same framework as the public counterpart with a set of rules specific to the marine milieu, putting emphasis on wind and wave forecasting.

2 Guidance

The content of the SCRIBE matrices have been revised to incorporate guidance more suitable to the marine environment especially with regards to wind and waves. An algorithm has been developed to produce first guess sea state for regions outside the wave model domain and some studies have been done to improve wind guidance.

2.1 Winds

Up to now the wind guidance used for point forecasts in the SCRIBE system was direct model output at level $\eta = 1.0$ of the Canadian GEM model. Verifications of model winds at $\eta = 1.0$ against buoy observations, as can be seen in table 1, show that direct model winds at $\eta = 1.0$ overforecasts the *Light* wind speed category (more than 2:1) and underforecasts the *Storm* category (less than 1:2).

		Forecast					
		Light	Moderate	Strong	Gale	Storm	Total
O	Light	3523	197	28	5	0	3753
b	Moderate	2991	1375	177	3	0	4546
s	Strong	1653	1062	1498	68	0	4281
	Gale	195	22	181	149	0	547
	Storm	6	0	0	3	0	9
	Total	8368	2656	1884	228	0	13136

Table 1: Verification of wind forecast at $\eta = 1.0$ from 2002 Oct 10^{th} to 2003 Jan 07^{th} for 55 buoys (Atlantic and Pacific)

Stricly speaking the wind speed at the surface is zero and increase logarithmically with altitude to reach some maximum value at higher level. In the GEM model, physical parameterizations, taking into account the characteristics of the surface and the low-level stability of the atmosphere, are incorporated in the treatments of the surface level.

The 10 m wind is interpolated using zero at the surface, $\eta = 1.0$, and the value computed for the first level that is modeled directly by the numerical treatments. This is η level 0.995, roughly 40 metres, for the regional GEM model.

	Light		Moderate		Strong		Gale		Storm	
Bias	2.0	*2.23*	0.58	*0.58*	0.57	*0.44*	1.02	*0.42*	2.89	*0.00*
POD	88.57	*93.87*	34.49	*30.25*	42.07	*34.99*	43.33	*27.24*	0.00	*0.00*
FAR	55.72	*57.90*	40.13	*48.23*	25.79	*20.49*	57.45	*34.65*	100.00	N/A
Threat	41.89	*40.97*	28.02	*23.60*	36.70	*32.10*	27.34	*23.80*	N/A	N/A

Table 2: Comparaison of verifications score by category for wind forecast at $\eta = .995$ in `fixed fonts` and $\eta = 1.0$ in *italics*

Table 2 shows different scores by wind speed category for both $\eta = .995$ and $\eta = 1.0$ levels. The winds forecast at $.995\eta$ level appears to be more skillful for

* *Corresponding author address*: Jacques Marcoux, 2121 Trans-Canada Highway, Montreal (Quebec) Canada H9P 1J3. E-mail: Jacques.Marcoux@ec.gc.ca

stonger winds event therefore it has been decided to use these winds in the SCRIBE marine matrices.

2.2 Wave heights

Wave height guidance is extracted at representative sample points from the WAM model (Komen et al., 1994) run at CMC twice a day for the Atlantic and Pacific oceans. Elsewhere wave heights are computed using the Bretschneider (Bretschneider, 1963) algorithm with fetch and depth taken into account. A new method for combining waves is introduced for the wave heights; a clustering algorithm is applied during concept generation. The concepts generated are a mix of single values and ranges depending on the outcome of the clustering. If there is little variation in the wave height over the clustering time period then a single value is used otherwise a range is given.

2.3 Clustering

The clustering algorithm that is applied during the data reduction process on the weather element matrices i.e. the *concept generation* stage, attempts to find natural groups of components (or data) based on some similarity. The clustering algorithm also finds the centroid of a group of data sets.

To determine cluster membership, most algorithms evaluate the distance between a point and the cluster centroids. The output from a clustering algorithm is basically a statistical description of the cluster centroids with the number of components in each cluster[1].

Figure 1 shows a sample of data reduction using the previous SCRIBE technique (dotted line histogram) and the clustering algorithm (solid line histogram). Model output in three hour time steps is plotted with diamond symbol. The windbarbs at the top are from the previous SCRIBE technique with, just underneath, the one from the clustering algorithm. Windbarbs from model output plotted are at the bottom.

The winds are combined until the vector difference between the winds are greater than 8 knots, OR the winds have been reduced to 5 concepts. The winds are then rounded to 45 degree/5 knot increments.

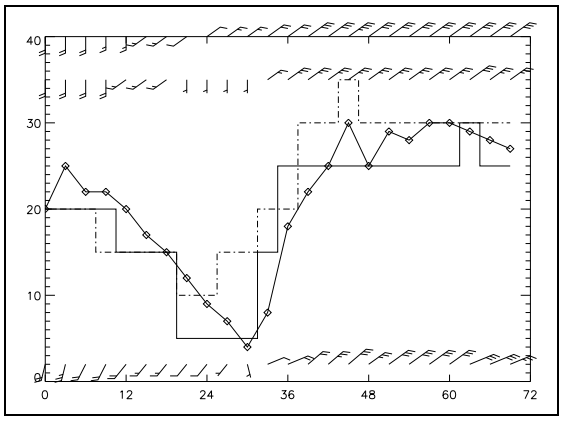

Figure 1: Sample is for the Coats region of the Arctic Waters for 2002 Apr 23^{rd}, 12Z model run.

In this particuliar case the clustering algorithm captures the sequence of wind changes more efficiently than the previous technique. Notice the lull in the wind just before the hour = 30 that just showed as a wind shift using the old technique.

3 Architecture

SCRIBE marine is based on an open architecture framework where external models, such as a wave model, can be launched from SCRIBE data and the output can be ingested back into SCRIBE. Québec Region exploited this characteristic by coupling a wave model with SCRIBE.

A wave model (WAM Cycle-4), including bathymetry currents and ice, is run in Québec Region for the lower St-Lawrence River and the Gulf (Jacob et al., 2002).

- Wave model is run using the winds forecast by the Canadian GEM model in GRIB format. Wave height forecast is then converted from GRIB data to SCRIBE METEOCODE format
- In the meantime the forecaster make any needed adjustments to the weather elements except for the wave heights.

[1] For further information on the clustering algorithm, check out http://cne.gmu.edu/. This site presents the alogorithm simply and elegantly

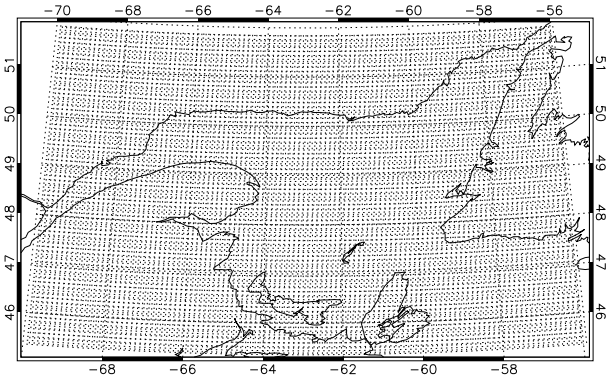

Figure 2: WAM domain for the lower St-Lawrence River and the Gulf

- A check is then done to verify if there is significant difference between the adjusted winds forecast and the original model winds forecast used by the wave model.
- If the differences are significant[2] the wave model is restarted with the winds of the regional model *corrected* according to the winds in the METEOCODE. One does not take the winds directly from the METEOCODE, but rather the winds of the model *corrected*, in order to maintain the pattern of the winds and to eliminate potential discontinuities.
- The new wave model output is then fed back into SCRIBE to produce the final wave height forecast.

A similar setup is being developed for Hudson Bay and for the Great Lakes.

4 Concept editor

The interface has been modified to include the relevant parameters related to marine forecasts. In addition, new functionality has been added to allow forecasters to manipulate the weather elements either with the regular SCRIBE graphical user interface or with a code editor based on Atlantic Region's Comar program.

[2] 10 kts for the speed and/or 30° for the direction

4.1 Comar code editor

The original Comar (Coded marine) program was developed and implemented in the Atlantic Region in the early eighties. The program allows the forecaster to input a series of codes into a text editor in a format similar to Aviation terminal forecasts. The SCRIBE version has maintained most of the original coding format of the weather elements.

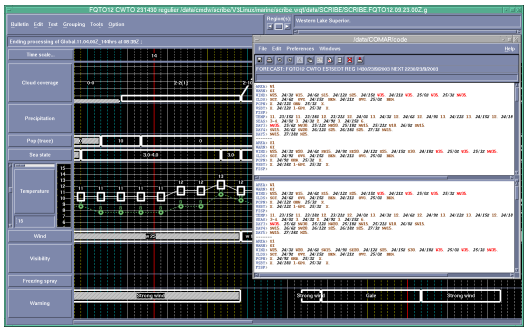

Figure 3: GUI and Comar concept editor

The SCRIBE version of Comar has many new features that were not available on the original interface, such as:

- syntax highlighting to enhance the readability of the code. It also gives the forecaster a first line of defence for error checking. Comar codes that are incorrect will be immediately obvious
- splitable window into two separate panes with the top window containing the editable working copy of Comar Codes and the bottom window containing the model derived METEOCODE in the Comar format
- toolbar containing the major functions of the editor

5 Products

SCRIBE can generate all the marine product in both languages as defined in the marine Standard Operating Procedures of the MSC as of 2003 June 14^{th}.

The marine forecast services basically consists of:

5.1 Marine weather forecast

Overs day 1 and day 2. It provides marine users with information and advice on the present and future states of the atmosphere and the effects such conditions will have on sea state for a maximum of 36 hours in advance. Marine weather forecasts are amended as needed when forthcoming conditions are expected to be significantly different from forecast conditions such that safety may be at risk or marine community may experience intensive inconvenience. Warning tag are updated automatically by SCRIBE.

5.2 Extended marine forecast

Time coverage is day 3, day 4 and day 5. The extended forecast if for planning purpose. At this time the option issuing the forecast automatically from SCRIBE is considered. It would be modified by regional forecasters only on the significant cases at the discretion of regions.

5.3 Sea state forecasts

It provides information on significant wave height for day 1 and day 2. It can be partly automated as described in section 3 page 2.

5.4 NAVTEX bulletins

NAVTEX, a component of the GMDSS, is one of the recognised ways of providing MSI (Marine Safety Information) to about 250 nautical miles offshore. It contains basically the same information as the plain language marine weather forecasts but in a more compact coded form.

5.5 MAFOR bulletins

MAFOR is the coded forecast for shipping operation agreed upon internationally through WMO. It is a coded version of the regular marine forecast. SCRIBE make it easier to keep MAFOR consistent with the marine forecast even when an updated is necessary.

6 Conclusions

SCRIBE is a versatile system for generating weather forecasts in different format freeing the forecaster from having to code the same forecast in different format. Also it provides the forecast in both official languages eliminating the need to translate the routine forecast.

The guidance have been improved especially with regards to winds and waves. The work done in Québec Region with the WAM model will be adapted to inland waters in other regions to improve on the algorithm that is used now. UMOS technique will likely be used in the near future for marine wind forecasts.

References

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