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OBSERVATIONS AND NOWCASTING IN SCRIBE

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1. Introduction

Automated weather forecasts for all regions of Canada have been available for quite some time based on SCRIBE (Verret et al, 1993), a system developed at the Canadian Meteorological Centre (CMC). This system has until now been restricted to using guidance from numerical weather prediction (NWP) models and their derived statistical outputs, namely Perfect Prog (PP) (Klein et, 1959) or updateable Model Output statistics (UMOS) (Wilson and Vallée, 2002). In practice, this means that the generated forecasts are solely based on model data, without any explicit observation data. Therefore, the SCRIBE product generator is totally unaware of recent weather events, and this limitation is particularly acute for weather products that are generated long after the model run. This “blind” effect would generally result in forecasts that are not as up-to-date in their first 18 to 24 hours, were it not for the adjustments made by the operational forecasters. The key impetus for the work presented in this paper is to create a sub-system that minimize these necessary manual adjustments.

It has been demonstrated in several experiments that most of the modification work that forecasters perform on the SCRIBE guidance is to merge model forecasts with current observations. Thus, the main functionally of this sub-system is to merge the SCRIBE weather elements with the latest local observations and nowcasting model data. This will eliminates most of the errors in the initial period of the forecasts and is expected to reduce by 50% the time spent by forecasters to quality control the initial parts of the SCRIBE forecasts. The added value to the SCRIBE forecast in the initial period is expected to be of the order of 5-10%. The sub-system is capable of ingesting surface, radar and lightning observations and projecting these observations in the short future using short range forecast model. Satellite data will be used at later stage.

2. The SCRIBE System

SCRIBE is an Expert System capable of generating automatically or interactively any type of weather products for a region or a specific locality (see Verret et al, 1997 for more details). The data that feed the system come from a set of matrices which are generated after the 00:00Z and 12:00Z model runs. These matrices contain different types of weather elements such as NWP output, statistical guidance form PP model and UMOS model and other analyses model and climatology data. The time resolution is 3 hours. Once ready these regular matrices are sent to each regional SCRIBE system. Upon arrival, the data are processed by the Concept Generator and are synthesized and downsized to a set of well defined weather elements *concepts*. These concepts, which can be displayed on a graphical interface, are then updated by the forecaster to reflect the latest observations and understanding of the weather situation. Verification as shown that value is added

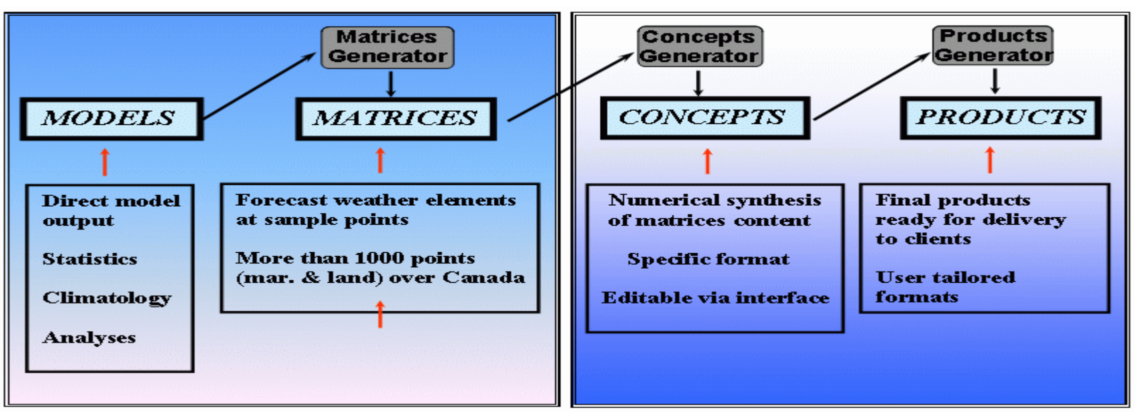

Fig. 1. Basic Scribe System information flow with the different data format.

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by the forecaster to the initial SCRIBE set of weather concepts but only for the first 24 hours. Beyond this period (day 2-3) little or no value is added to the forecast. From these concepts, the Product Generator can produce either automatically or manually any type of weather products, which can then be sent to the client. Figure 1 shows the main steps in the Scribe data processing

.3. Architecture of the New System

The aim of the present project is to enable the SCRIBE system to update its weather elements with observed and nowcasting data on a continuous basis. At any time, the pure model data can be replaced interactively with the latest observations and short range forecast weather elements for the next 9 hours. The time resolution of the observed and nowcasting data is increased to 1 hour. To fulfill this task, three dynamic databases are prepared. The first one contains the observed weather elements, the second contains the short-term forecast weather elements, statistical model and NWP model data, and the third one synthesize and merge the observed and forecast data into a consistent set of continuous weather elements.

Observations Database

Observed data (Fig. 2) are extracted on an hourly basis and are used in different ways such as bias correction, tendency recognition, and short term persistence. This provides a direct and positive impact on the beginning of forecast time period. The database contains data form different sources: METAR, SPECI, Synoptic observations, radar data and lightning data. Up to 450 stations are used to feed the database. A Quality Control Module is used to remove or replace erroneous data that could deteriorate the forecast. Automatic stations are processed with specific rules to take into account their related type of data. Another module will remove redundant SPECI that do not add information to the knowledge of the weather situation.

Radar data are extracted from the dynamic CMC North-American Mosaic Radar Database inside an 18 km radius around the station where radar coverage is available. A similar strategy is applied to the observed lightning strikes available from the Canadian Lighting Detection Network.

Forecasted Weather Elements Database

A database of forecast weather elements is prepared every hour. It contains the short-term weather element forecasts that provide a link between pure SCRIBE model weather elements and the observations. These data come from different sources. First we use a very short-range statistical model based on Multiple Discriminate Analysis (MDA) that provides probabilities of occurrence of weather elements such as cloud cover, visibility, and precipitation (occurrence, types, convective/deep convection/stratiform). Second, we used forecast radar reflectivities based on the latest radar observations. The projection in the short term is based on extrapolation techniques developed by McGill University. A Similar technique is used to forecast the lighting clusters in the short term. Finally, the CMC Operational Regional Model (Regional GEM) and the UMOS Statistical Model provide hourly forecasted data .

Synthesized Weather Element Database

The observed and forecasted weather elements available in the databases are processed into the Data Merger (Fig 2) where they are analyzed and synthesized into a consistent sequence of hourly weather events starting from 6 hours (t_{-6}) before the system cutoff time to 12 hours after (t_{+12}). This is done by an ensemble of rules. The forecasting strategies (or rules) depend on the type and the availability of the data. The rules evaluate and priorise the different set of data, they apply bias correction (from 1 to 9 hours) on variables such as temperature, dew point, wind, cloud and precipitation amounts, they use persistency (1-3hours), observed convective cloud (TCU-CB) and, when necessary, they will use statistical model (UMOS) and NWP model data.

The format output is a file containing a set of continuous weather elements at one-hour time resolution. This Observed and Short Range Forecast (OSRF) data file will be sent to regional offices were the SCRIBE system will use it to update the regular SCRIBE concepts. Figure 2 shows the data flow leading to the generation of the OSRF data file and Figure 3 shows an example of the output.

Concepts generator and Coupling module

As for the regular Scribe matrices, the OSRF data file will be converted into the Scribe *Concepts* format. An adapted concept generator, specially designed to manipulate the hourly weather element data, transforms the OSRF files into concepts. The forecaster is than able to update the SCRIBE concepts interactively by merging the OSRF concepts with the regular concepts, display the result on the SCRIBE interface and generate the product text. The lower section of Figure 2 illustrates this process.

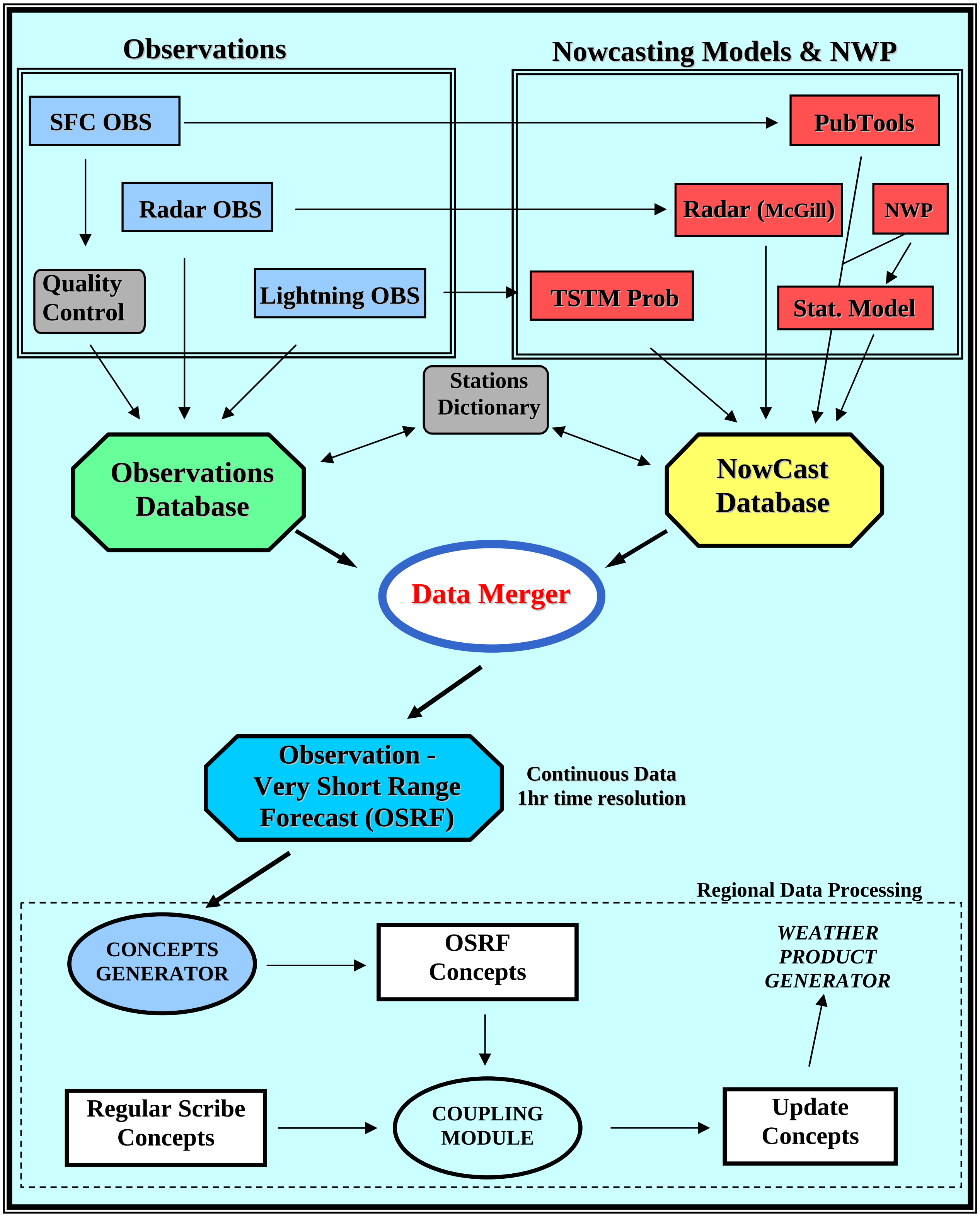

Fig. 2. *Architecture of the Nowcasting Scribe Sub-system*. Observations and Nowcasting data are processed, synthesized and merged into a continuous set of weather elements which are send to each regional offices. Data are than locally transformed into weather elements concepts and used in real time to update the SCRIBE weather elements.

STN: CYWK	SKY	CIG	PRECIPITATION						POP	ACC		TEMP		WIND			VIS	
DATE HR	/10		PCPN1	POP	PCPN2	POP	PCPN3	POP		Qp	Tp	T	Td	DD	VV	GST	(SM)	TP
20031030 0300	10	4	+S	100		0		0	100	2.0	SN	-2.0	-3.0	62	25	42	0.34	PP
20031030 0400	10	10	-IP	50	-S	50		0	100	2.0	SN	-2.0	-2.0	55	28	46	0.55	PP
20031030 0500	10	18	-IP	33	-S	33	-ZR	33	100	1.0	SN	-2.0	-2.0	30	31	57	0.75	PP
20031030 0600	10	17	-IP	50	-S	50		0	100	11.0	SN	-2.0	-2.0	47	27	52	0.75	PP
20031030 0700	10	17		0		0		0	0	0.0		-1.0	-1.6	47	27		0.00	PP
20031030 0800	10	5	IP	50	-S	50		0	100	2.0	SN	-2.0	-2.0	40	22	46	0.50	PP
20031030 0900	**10**	**7**	**-S**	**33**	**-IP**	**33**	**-ZR**	**33**	**100**	**1.0**	**SN**	**-1.0**	**-1.0**	**40**	**22**	**42**	**0.63**	**PP**
20031030 1000	10	999	-S	33	-IP	33	-ZR	33	100	0.9	SN	-0.3	-0.3	42	20	30	0.50	FG
20031030 1100	10	999	-S	60	-R	40		0	100	0.6	SN	0.6	0.6	50	22	32	0.50	FG
20031030 1200	10		-S	60	-R	40		0	100	0.8	SN	1.7	1.7	58	23	33	0.50	FG
20031030 1300	10		-R	100		0		0	100	1.6	RA	3.0	3.0	72	19	29	0.50	FG
20031030 1400	10		-R	100		0		0	100	1.5	RA	4.3	4.3	91	16		0.50	FG
20031030 1500	10	999	-R	100		0		0	100	1.9	RA	5.7	5.5	118	14		3.00	BF
20031030 1600	10	999	-R	100		0		0	100	0.7	RA	5.0	4.8	167	14		0.50	FG
20031030 1700	9	999	-RW	100		0		0	60	0.1	RA	4.0	3.6	204	19	30	0.50	FG
20031030 1800	9	999	-RW	100		0		0	50	0.0		3.0	2.2	221	29	39	3.00	BF
20031030 1900	9	999	-RW	100		0		0	60	0.1	RA	2.0	1.5	224	30	40	0.50	FG
20031030 2000	9	999	-RW	100		0		0	60	0.1	RA	1.0	-0.1	227	32	42	3.00	BF
20031030 2100	9	999	-RW	80	-SW	20		0	80	0.2	RA	0.0	-1.5	229	33	43	3.00	BF

Fig. 3. Example of Observations & Short Range Forecast (OSRF) data file for Wabush Lake CYWK. Data file starts with 7 hours of synthesized observations, including the current observation, followed by 12 hours of forecasted data.

4. Conclusion

The system is now completed, functional and can process more than 450 sites which can update almost all Canadian Public Forecast Regions. A prototype version is available since December 2003 in all Canadian Weather Office for testing and evaluation. Objective verification results will be performed and presented soon.

5. Reference

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