6B.3 **TOWARDS A COORDINATED NORTH AMERICAN DAILY PRECIPITATION ANALYSIS**

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1. INTRODUCTION

Accurate and timely information on past precipitation is crucial for various environmental prediction applications, including hydrological forecasting, drought monitoring and forest fire prevention. Precipitation observations are also critical for the verification of numerical weather predictions, and are generally the most important forcing in land data assimilation systems. Hence, a reliable gridded precipitation dataset available in near real-time is of great value for many environmental prediction systems, some of which are shared between North American countries. For example, hydrological models provide guidance for managing watersheds shared between Canada and the U.S., as well as between the U.S. and Mexico. The three countries also jointly develop and use the North American Ensemble Forecasting System. In both cases, all parties involved need to come to an understanding as to which precipitation dataset to use. For this reason, as part of the North American Climate Services Partnership (NACSP) initiative, the US Climate Prediction Centre (CPC), the Canadian Meteorological Centre (CMC) and the Mexican National Water Commission (CONAGUA) are working towards the development of a coordinated daily precipitation analysis for North America, which should be completed by the end of 2016.

2. PROJECT PHASES

The first phase of this project consists in identifying national networks which could participate in a coordinated daily precipitation analysis, in addition to observations already shared over the Global Telecommunication System (GTS). From this database, a subset of stations has been identified which do not take part in the precipitation analysis, but are rather kept for verification purposes. During the second phase of the project, skill and bias of existing analysis systems are to be compared using this verification dataset, in order to identify their strengths and weaknesses. The challenge will then be to agree upon a methodology for obtaining a coordinated North American precipitation analysis, which will be made available to other users, and in particular to other NACSP projects.

3. CAPA SYSTEM

As a contribution to this project, an evaluation of CMC's Canadian Precipitation Analysis (CaPA) system is presented for July and August 2012, in which CaPA assimilates daily precipitation obtained by merging all available national observational networks which could potentially contribute to a future coordinated analysis, including Standard Hydrological Exchange Format (SHEF) reports, as well as national and provincial climatological networks.

CaPA combines different sources of information on precipitation with a short term forecast provided by the Regional Deterministic Prediction System (RDPS) in order to provide a gridded analysis covering all of North America (Mahfouf et al., 2007, Fortin and Roy, 2011; Fortin et al., 2012). The use of a background field from a model makes it possible to assess precipitation amounts even in regions where the observational network is very sparse (example of CaPA analysis at Figure 1).

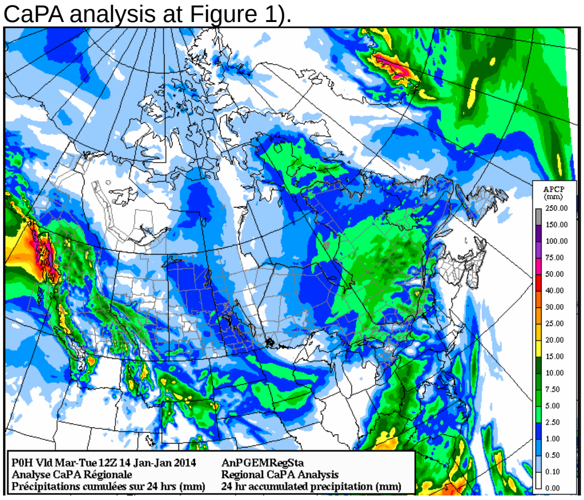

Figure 1. Example of operational 24h accumulation of precipitation for January 14th, 2014

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The Canadian Precipitation Analysis system (CaPA) can be run in different configurations, one of which is the Regional Deterministic Precipitation Analysis, or RDPA. In this mode, CaPA provides quantitative precipitation estimates (QPE) over North America, on a grid having a resolution of approximately 10 km. Six-hour accumulations, valid at synoptic times (00, 06, 12 and 18 UTC), are computed one hour after valid time, and revised six hour later in order to include more observations. A twenty-four hour QPE, valid at 12 UTC, is also computed in order to include stations which only provide daily reports. In fall 2014 CaPA will include assimilation of Radar composite data (Fortin et al., 2014).

4. CAPA EVALUATION ON TWO SUMMER MONTHS OF 2012 FOR NORTH AMERICAN REGION

In CaPA version used for this project, each day, an average of 12 200 stations are assimilated by CaPA, and about 170 stations evenly distributed across North America are used for verification purposes (Figure 2). In order for the verification to be done on the independent observations, the stations used for verification of the analysis are removed from the observational database and all stations in a radius of 5 km around previously selected stations were removed before running CaPA for verification purposes. Those stations are in majority manned synoptic stations which are known as the most reliable observations.

Figure 2. Verification stations used for independent verification of 24 h analysis

The following scores and statistics are used to evaluate CaPA analysis: frequency bias index (FBI) which measures bias, equitable Threat Score (ETS) which measures skill across different climates, departures from the partial mean (DPM) of the observations, computed for selected thresholds and departures from the partial standard deviation (DPS) of the observations, computed for selected thresholds (for details see Fortin, V. and G. Roy, 2011 and Fortin et al., 2014).

Figure 3 presents FBI-1 and ETS as function of precipitation thresholds for analysis in red and forecast in blue verified against independent set of observations presented in Figure 2. Assimilated observations improve FBI-1 score for almost all precipitation thresholds as seen in upper left panel and improve ETS for all precipitation as seen in upper right panel. However, statistically significant improvements, as shown by 80% confidence intervals above zero on lower panels are especially for ETS while for FBI -1 statistically significant improvements are for precipitation between 2 mm to 10 mm.

Figure 4 presents DPM and DPS for the same evaluation of analysis in red against forecast in blue and observations are added in black. Analyses is closer to the observations for precipitation up to 25 mm and slightly less than forecast for precipitation less than 50 mm. It is somewhat expected because analysis is always smoother than forecast, so high precipitation quantities are less well presented by analysis.

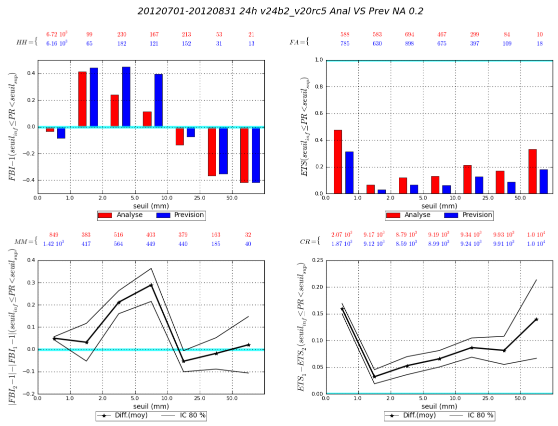

Figure 3. Frequency Bias Indicator and Equitable Treat Score for precipitation between thresholds for analysis (red) and forecast (blue), as well as their difference and 80 % confidence interval on the bottom panel

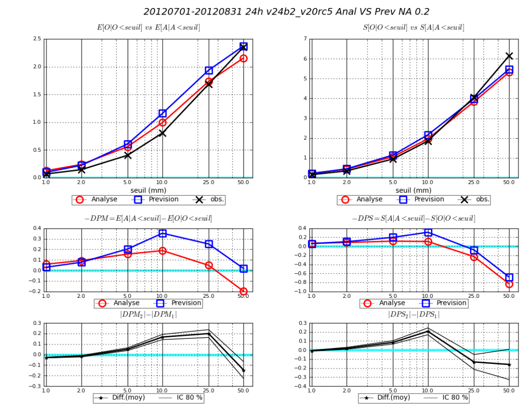

Figure 4. Departure from Partial Mean and Departure from the Partial Standard Deviation computed for selected thresholds for analysis (red), forecast (blue) and observation (black), as well as differences from observation and 80 % confidence interval on the bottom panel

5. INFLUENCE OF BACKGROUND FIELD

In Canada, especially northern part of the country, the network is very sparse, so the use of background field is recommended in order to fill that gap. The influence of background field on precipitation analysis is evaluated in Figure 5 for FBI -1 and ETS and in Figure 6 for DPM and DPS. FBI-1 is better for analysis using background field for almost all precipitation categories (except precipitation less than 1 mm and between 5 and 10 mm). Improvements are significant for precipitations larger than 10 mm as presented by differences between two analysis and confidence intervals of 80 % above zero on the bottom panel. ETS is equal or better for analysis with background field and significantly better for precipitations between 10 and 25 mm and greater than 50 mm. It is evident from Figure 6 that DPM and DPS are much closer to observations in analysis using background field (red) than without background field (blue), especially for larger precipitation thresholds (greater than 25 mm and 50 mm).

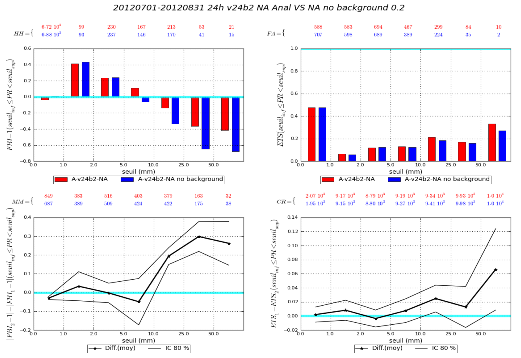

Figure 5. Frequency Bias Indicator and Equitable Treat Score for precipitation between threshold for analysis (red) and analysis without background (blue), as well as their difference and 80 % confidence interval on the bottom panel

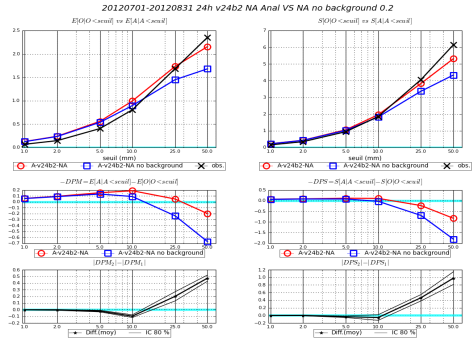

Figure 6. Departure from Partial Mean and Departure from the Partial Standard Deviation computed for selected thresholds for analysis (red), analysis without background (blue) and observation (black), as well as differences from observation and 80 % confidence interval on the bottom panel

6. FUTURE PLANS

Results clearly demonstrate that the additional observations significantly improve the bias and skill of CaPA, and that the use of a model background is still justified to fill the gaps between the observations.

The following steps are planned in the future:

1) Canadian Meteorological Centre and Climate Prediction Centre will run their precipitation analysis on 2005 data shared between parties including Mexican data. This step should be completed in 2014.

2) Information exchange and documentation share on the NCEP CPC analysis and CMC CAPA analysis systems will continue.

3) Evaluate both systems on exactly the same input data on North American domain by 2015.

4) Ensure that the unified precipitation analysis is available to other North American Climate Services Partnership projects and to the general public by the end of 2016.

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