PACIFIC CLIMATE IMPACTS CONSORTIUM

PCIC SCIENCE BRIEF: ON THE CANADIAN PRECIPITATION ANALYSIS

Real-time precipitation data can be of use to areas ranging from forecasting to forest fire management. This Science Brief covers a recent paper that examines the past ten years of a near real-time Canadian precipitation product.

Writing in Atmosphere-Ocean, Fortin et al. (2018) examine the Canadian Precipitation Analysis (CaPA), a near real-time precipitation product covering all of North America that is produced by Environment and Climate Change Canada. They review papers that evaluate CaPA compared to precipitation observations as well as the applications of CaPA for various types of research, ranging from hydrology[1] and hydrometeorology[2] to biogeophysics[3]. They find that CaPA compares favourably against other precipitation data, and report that it has been used successfully in studies across a number of fields, including hydrometeorology, hydrology, land surface and atmospheric modelling.

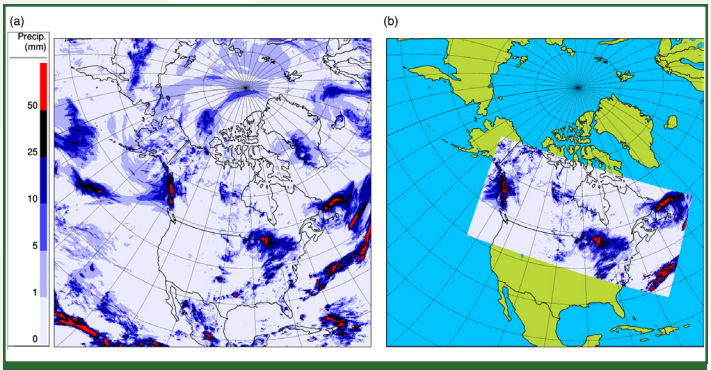

Figure 1: Comparisons of regional coverage for the CaPA data sets.
This figure shows the domains of the CaPA Regional Deterministic Precipitation Analysis, with a resolution of ten kilometres (a), and the CaPA High Resolution Deterministic Precipitation Analysis product, with a resolution of 2.5 kilometres (b). The data presented is the 24-hour precipitation total for August 18th, 2017 as of noon, coordinated universal time (UTC).

Precipitation largely governs the availability and quality of fresh water in Canada, and extreme precipitation can cause events such as flooding and landslides. Having access to real-time precipitation data can greatly aid areas ranging from weather and flood forecasting to forest fire management. Canada is, however, a large country with relatively sparse surface weather station coverage, which has meant that, until roughly eight years ago, such a product was not available.

In 2011, Environment Canada (now Environment and Climate Change Canada) began to offer a national real-time[4] precipitation product, the Canadian Precipitation Analysis[5](CaPA). CaPA is an amalgamation of rain gauge data, radar data and output from a numerical weather prediction model, fit to grids with resolutions of 2.5, 10 and 15 kilometres. The lower resolution products cover all of North America, while the 2.5 kilometre product covers most of Canada and part of the northern US (Figure 1). It includes both an estimate of precipitation and a confidence index, to indicate the estimated uncertainty at each point.

Over the time period in which CaPA has existed, it has been evaluated both by its developers and independently, and the product has been used in hydrometeorological, biogeophysical, land surface and atmospheric modelling and hydrologic modelling studies.

1. Hydrology is the scientific discipline that studies the movement and accumulation of water across and beneath the Earth's surface.
2. Hydrometeorology is the discipline that lies in the intersection between hydrology and meteorology and studies the cycle of water and energy between the land and the atmosphere.
3. Biogeophysics is the discipline that lies in the intersection of geology, physics and biology, and is focused on how living organisms (primarily microbes and plants) and the solid Earth interact, including the transfer of energy and materials.
4. Here "real time" is used to refer to analysis products that are produced continually, with new data becoming available shortly after the time for which they are valid. For CaPA, data is available four times daily. It is generated one hour after the accumulation period and then updated five hours later, after all of the observations come in.
5. The Canadian Precipitation Analysis dataset is available for download, here: http://dd.weather.gc.ca/analysis/precip/. Figures made from the dataset are available, here: http://www.weather.gc.ca/analysis/.

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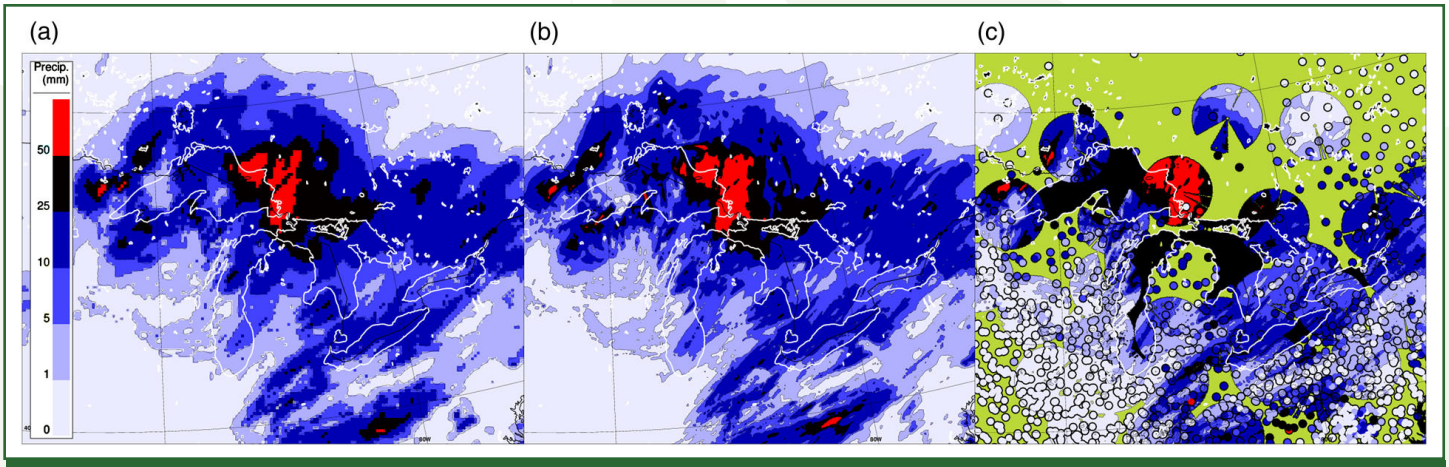

Figure 2: Comparison of the CaPA datasets and observational data.
This figure shows the 24-hour precipitation total for August 18th, 2017 (as of noon UTC) for three data sets: (a) the CaPA Regional Deterministic Precipitation Analysis, with a resolution of ten kilometres, (b) the CaPA High Resolution Deterministic Precipitation Analysis product, with a resolution of 2.5 kilometres and (c) observations from radar and rain gauges.

Fortin et al. (2018) review theses studies, examining CaPA's performance and suitability for use in scientific research. The first set of studies that the authors review are those that evaluate CaPA's ability to represent precipitation as compared to observations and other data sets. These studies find that CaPA is able to capture the properties of precipitation when tested against weather station data and that it is a competitive gridded precipitation product, although it suffers from its short data length. The authors note that uncertainty surrounding CaPA's precipitation values is dramatically higher at higher latitudes (north of roughly 56 degrees for most of Canada), owing to the sparsity of observational data.

The second set of studies that Fortin et al. review are those studies that use CaPA as one of their data sources. These studies, which cover a wide swath of disciplines as noted above, suggest that CaPA may be limited in its ability to represent precipitation in regions of complex topography and for snow in particular. The papers that the authors survey show that CaPA offers the advantage of being seamless at the US-Canadian border[6], which may be a factor in its selection for some studies. The authors note that interest in CaPA is growing, in particular for hydrometeorological applications.

The authors suggest that some of CaPA's current shortcomings are addressed, in part, by the higher resolution product. They also state that they can further address CaPA's shortcomings by accounting for the altitude at which observations are made. The authors and their colleagues at ECCC are currently implementing a method to take into account the altitudes of stations and the grid points of the weather forecast model that is used to develop the CaPA product[7]. They also indicate that improvements could be made to the way that CaPA handles observations, for example, by accounting for wind-induced undercatch using algorithms for real-time bias correction that have only recently been proposed. CaPA may also benefit from the deployment of new radars and corresponding new algorithms by ECCC that are better able to measure solid precipitation and measure precipitation at longer ranges. The authors state that efforts to include satellite precipitation data in CaPA should be made. Future work on CaPA also includes the development of a dataset going back to 1980 that would have a global coverage at a 50 kilometre resolution and coverage over North America at a 15 kilometre resolution.

Summary

Fortin et al. reviewed the literature surrounding CaPA, a near real-time precipitation product available in multiple resolutions that covers all of North America. Their results suggest that this dataset compares well against several other precipitation datasets and was used successfully across a variety of disciplines.

6. Because different datasets are used on each side of the border, which can be of differing resolutions and use differing methods in their development, "step changes" can occur in this region, with slightly differing values being found right next to each other on either side of the border.
7. The altitude of a given station is generally different from the altitude of the grid box in the weather forecast model that contains the station. The primary reason for this is that the elevation of a model's grid box is flattened to the average elevation of the area that it represents.

In addition to the uses already mentioned, such as forecasting and fire management, the availability of a high-resolution precipitation dataset such as CaPA could potentially be valuable for testing the output of regional climate models and statistical downscaling methods. It may also be quite valuable for hydrologic modelling in British Columbia, because precipitation is a first order, dominant term that has a large influence on the province's hydrology.

Fortin, V., et al., 2018: Ten Years of Science Based on the Canadian Precipitation Analysis: A CaPA System Overview and Literature Review. *Atmosphere-Ocean*, **56**, 3, 178-196, doi:10.1080/07055900.2018.1474728.