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Measuring the Flood from BC to Manitoba – Challenges and Opportunities

CCRN Extremes workshop –Canmore Feb 11,12, 2014

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Outline

- Basic Governance for Water in Canada
 - Federal and Provincial Roles
 - International and inter-provincial waters
- Hydrometric Monitoring in Canada
 - Hydro-meteorological and hydraulic modelling systems
 - Great Lakes Example of Water Resources Assessment
- Software Tools for National Assessment
- Conclusions



Environment Act

- (1) The powers, duties and functions of the Minister extend to and include all matters over which Parliament has jurisdiction, not by law assigned to any other department, board or agency of the Government of Canada, relating to
 - (a) the preservation and enhancement of the quality of the natural environment, including water, air and soil quality;
 - (b) renewable resources, including migratory birds and other non-domestic flora and fauna;
 - (c) [water](#);
 - (d) [meteorology](#);
 - (e) notwithstanding paragraph 4(2)(g) of the Department of Health Act, the enforcement of [any rules or regulations made by the International Joint Commission](#), promulgated pursuant to the treaty between the United States of America and His Majesty, King Edward VII, relating to boundary waters and questions arising between the United States and Canada, in so far as they relate to the preservation and enhancement of the quality of the natural environment; and
 - (f) the coordination of the policies and programs of the Government of Canada respecting the [preservation and enhancement of the quality of the natural environment](#).
 - (g) and (h) [Repealed, 1995, c. 11, s. 18]
- (2) The powers, duties and functions of the Minister also extend to and include such other matters, relating to the environment and over which Parliament has jurisdiction, as are by law assigned to the Minister.



Water is a shared jurisdiction

Provincial

- Provinces have the lead on water management and protection within their boundaries
- Provincial legislative powers include:
 - flow regulation
 - authorization of water use development
 - water supply
 - pollution control
 - thermal and hydroelectric power development



Municipal

- Provision of water and wastewater services, including drinking water
- Land use planning policies

Federal

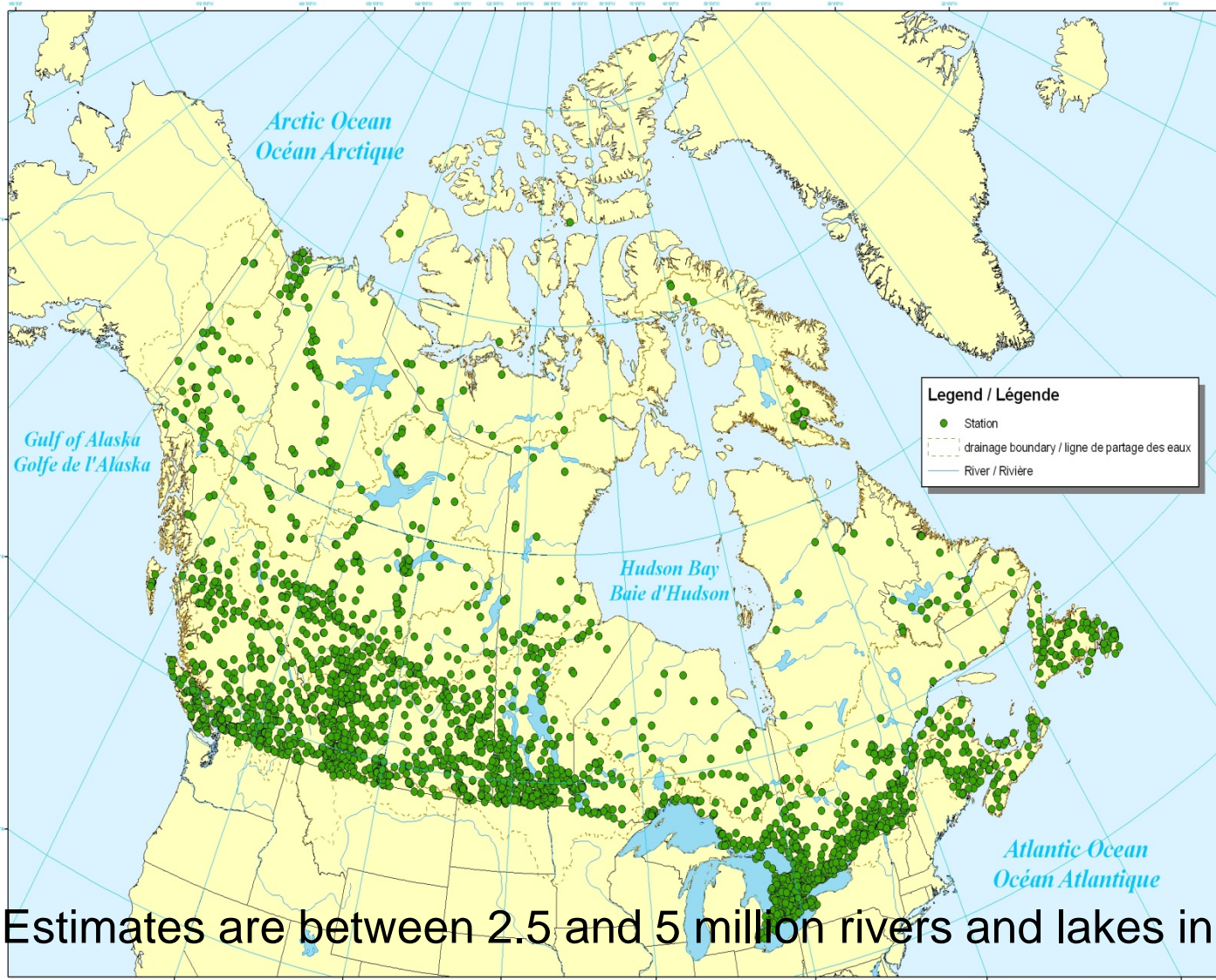
- EXCLUSIVE ROLES: fisheries, navigation, relations with foreign governments, public property (including government buildings, National Parks, migratory bird sanctuaries, Canadian Forces bases, National Historic Sites, national wildlife sanctuaries, etc.) and lands reserved for Indians

Shared

- Drinking water, pollution prevention, water quantity/supply monitoring, aquatic ecosystems, domestic interjurisdictional waters, infrastructure, environmental assessment, science/research, Heritage Rivers, etc.



National Hydrometric Program Programme national de relevés hydrométriques



PROVINCE or TERRITORY PROVINCE ou TERRITOIRE	Number of Active Stations ** Nombre de stations en activité **
Alberta	463
British Columbia / Colombie-Britannique	450
Manitoba	290
New Brunswick / Nouveau Brunswick	55
Newfoundland and Labrador / Terre-Neuve-et-Labrador	99
Nova Scotia / Nouvelle-Ecosse	29
Nunavut	36
Northwest Territories / Territoires du Nord-Ouest	88
Ontario	571
Prince Edward Island / Île-du-Prince-Édouard	10
Quebec / Québec	215
Saskatchewan	281
Yukon Territory / Territoire du Yukon	50
TOTAL	2637

** HYDEX, June 2009 / HYDEX, Juin 2009

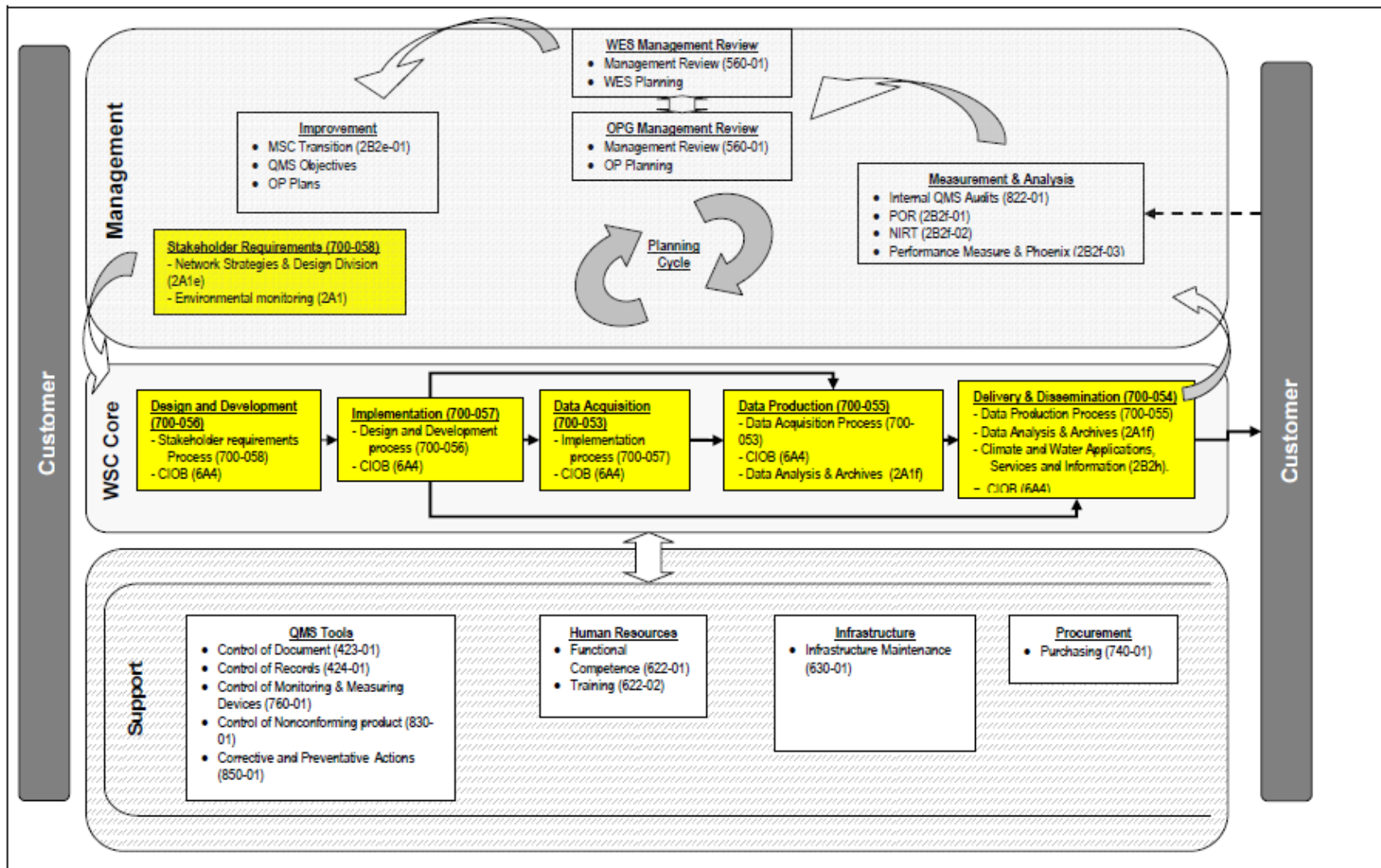
Estimates are between 2.5 and 5 million rivers and lakes in Canada

Why a national cost-shared program ?

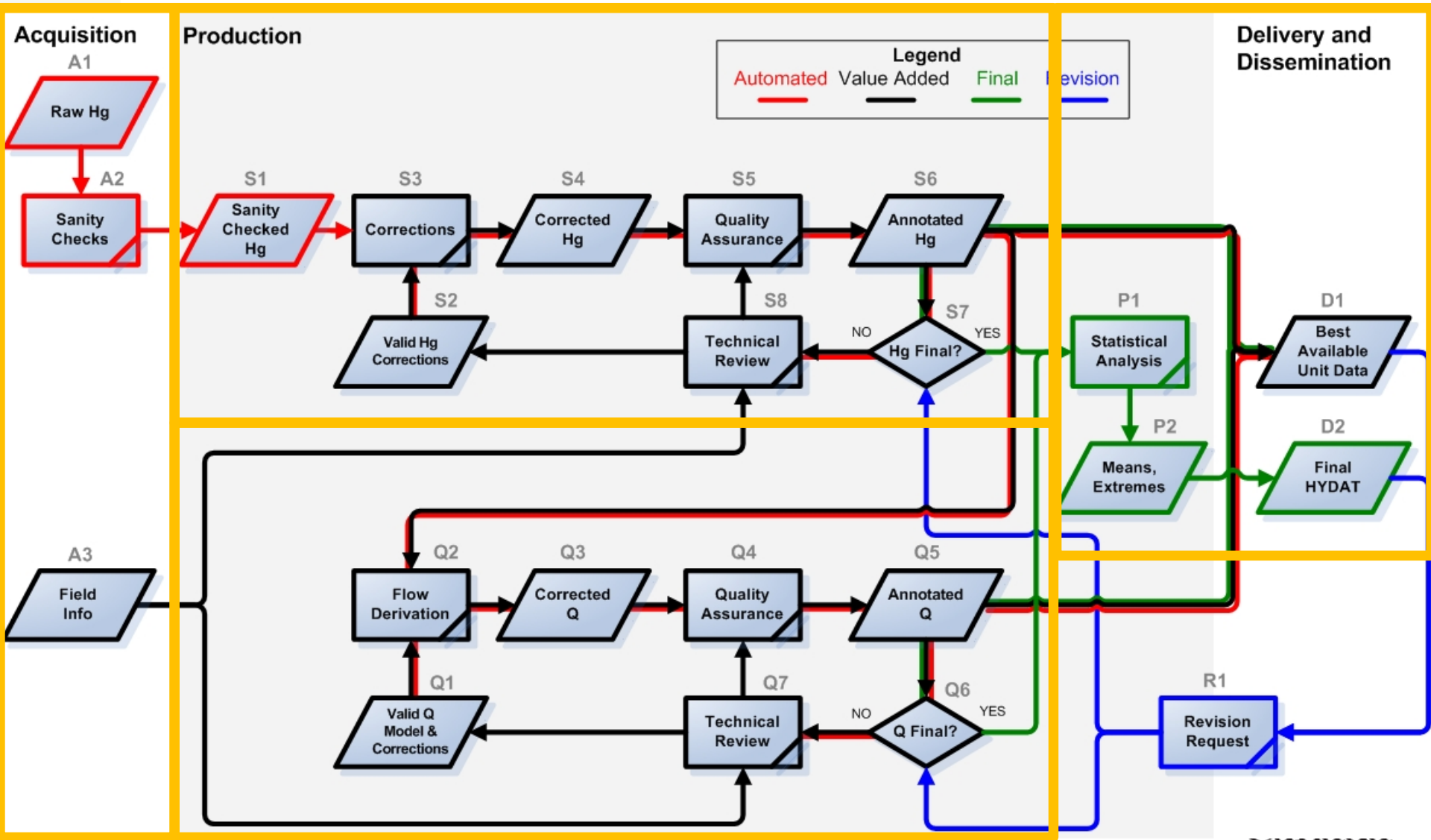
- Flow is an estimated value – cannot be measured directly
 - Estimations is precise but not necessarily always accurate
- Consistency in Approach
- Product stability
- Scientific reliability
- Well defined data
- Uniformity in production



Data Quality and QMS



WSC Data Workflow



How do we ensure data quality?

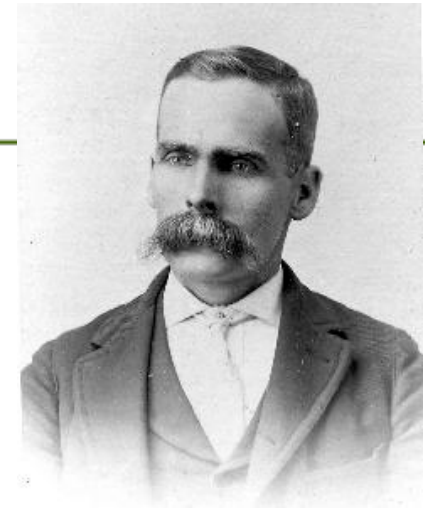
- Specifications
 - Instrumentation
 - Office systems
- Standard Operating Procedures –field and office
- Training
 - APTP – progression for technologists
 - Common competencies for technologies
- Clear roles and responsibilities
 - Technologist, supervisor , data control
- Quality Assurance Program (QAP)
 - Established feedback mechanism



100 years of service

100 years ago. Minister of the Interior at the time was Frank Oliver – MP from Edmonton

- Sir Wilfred Laurier was PM.
- Deputy Minister was W.W.Cory
- First published Data :“Report of Progress of Streamflow for Calendar Year, 1909” by P.M. Sauder, Chief Hydrographer.
- **“The first appropriation made by Parliament for hydrographic work was in 1908” as this vote was not available until the season was too far advanced, only a part of it was used in purchasing equipment in 1909”**
- **“In Organizing the Hydrographic Surveys, it was realized with the funds available, it would be impossible to make complete investigations of the whole water supply “**
- **Spent two years in Montana with USGS**
-



Preparing for the Event

- On the morning of the 17th of June one of the supervisors in the Water Survey of Canada (WSC) Alberta office sent out an email to WSC AB based on a discussion with the local Warning Preparedness Meteorologist (WPM) that read
- I'M DRAFTING AN E-MAIL WITH MORE DETAIL HOWEVER YOU NEED TO KNOW THAT A SYSTEM IS MOVING INTO ALBERTA LATER IN THE WEEK THAT WILL SEE SUBSTANTIAL RAINFALL AMOUNTS IN THE FOOTHILLS FROM WATERTON TO JASPER WITH THE BULL'S-EYE CURRENTLY OVER SUNDRE \ ROCKY. MORE TO COME
- This turned out to be rather understated but marked the start of WSC preparations for an event that is the largest high water event (so far) in the careers for most of the current Alberta staff. Staff field teams were alerted and preliminary schedules of availability for flood response were quickly sketched out.



The flow event

- On Thursday June 20 the City of Calgary declared a state of emergency and reports were coming in from southwestern Alberta of widespread flooding and damage.
 - The Harry Hays building was closed on June 21 and consequently WSC moved operations to the warehouse located just south of the evacuated portions of Calgary.
 - Staff at WSC prepared for flood response which includes repair of damaged stations, measurements where possible to develop correlations between extraordinary water levels (stage) and actual flow (discharge) in the rivers, and to attempt collection of data where telemetry failed.



Flood response

- WSC Alberta continued in full flood response until June 28,
 - repairing stations where possible,
 - taking additional measurements where sufficiently safe to do so and passing information to partners.
 - A team from HQ traveled to Alberta to conduct measurement
 - a team drove in from Saskatchewan to help out.
- By the 28th when the water was clearly subsiding, over 30 stations had been damaged or destroyed but WSC had maintained sufficient stations and taken 129 key measurements at 69 sites to guide the provincial forecasters and emergency response organizations.



Flood response (SK)

- WSC SK continued and carried on downstream taking cortical measurements for flood routing by the province.
- Adjusting real-time flow estimations and phoning in measurements to the province of Saskatchewan
- Inflow into Lake Diefenbaker were of concerns as were outflows
- Critical Point were
 - South Sask Alberta/Sask near border
 - South Sask Medicine hat
 - Red Deer at Blindloss
 - North Sask near Border
 - South sask at Saskatoon



2013 Alberta Flood

WSC Gauge at Sheep River at Okotoks was washed away as crews onsite were preparing to remove it with heavy equipment.



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Waiparous Creek Near the Mouth



All that remained was stilling well and mangled cableway. Shelter washed



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Staking High Water Marks Along Debris Line



Highwood River at Diebel's Ranch

Before – Looking Across to Gauge/Cableway



After – Cableway/Shelter Destroyed. Stilling well remains intact.



Remains of Cableway



Remains of Shelter



Collecting Data for
Peak Estimation



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Highwood River at Diebel's Ranch

This is the only WSC gauge on the Highwood River above the town of High River. This temporary gauge was constructed on the original stilling well.

After pumping sediment from the well it was operational



Highwood River Near the Mouth



Gauge shortly before it is washed away



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Station foundation all that remains



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Marmot Creek Near Main Stem

Before



After – debris jam in weir
Flow is shifted to other side



Red Deer River Below Burnt Timber Creek



All that remains from
cableway is displaced
deadman.



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Elbow River Below Glenmore Dam

Station operational post flood, but in talks with the City of Calgary (cost share partner) to reestablish gauge



Replacing Damaged Equipment



Post Flood Challenges

Dealing with erosion issues and shifts in channel dynamics.
Complete change to many stage/discharge relationships.



Flow Estimation



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Post-Flood - Alberta

- The post flood response started on July 2
 - station repairs,
 - evaluation of sites that required post event evaluation and indirect measurements
 - changes to network operation for future events.
 - Flood levels at WSC stations were up to a metre higher than previously noted high water marks.
- As of December 2013 flood repairs continue with most stations back in operation, although several remain as temporary installations.

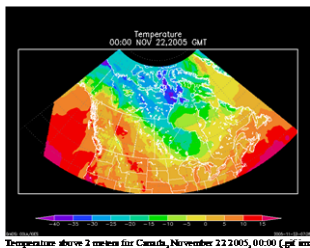
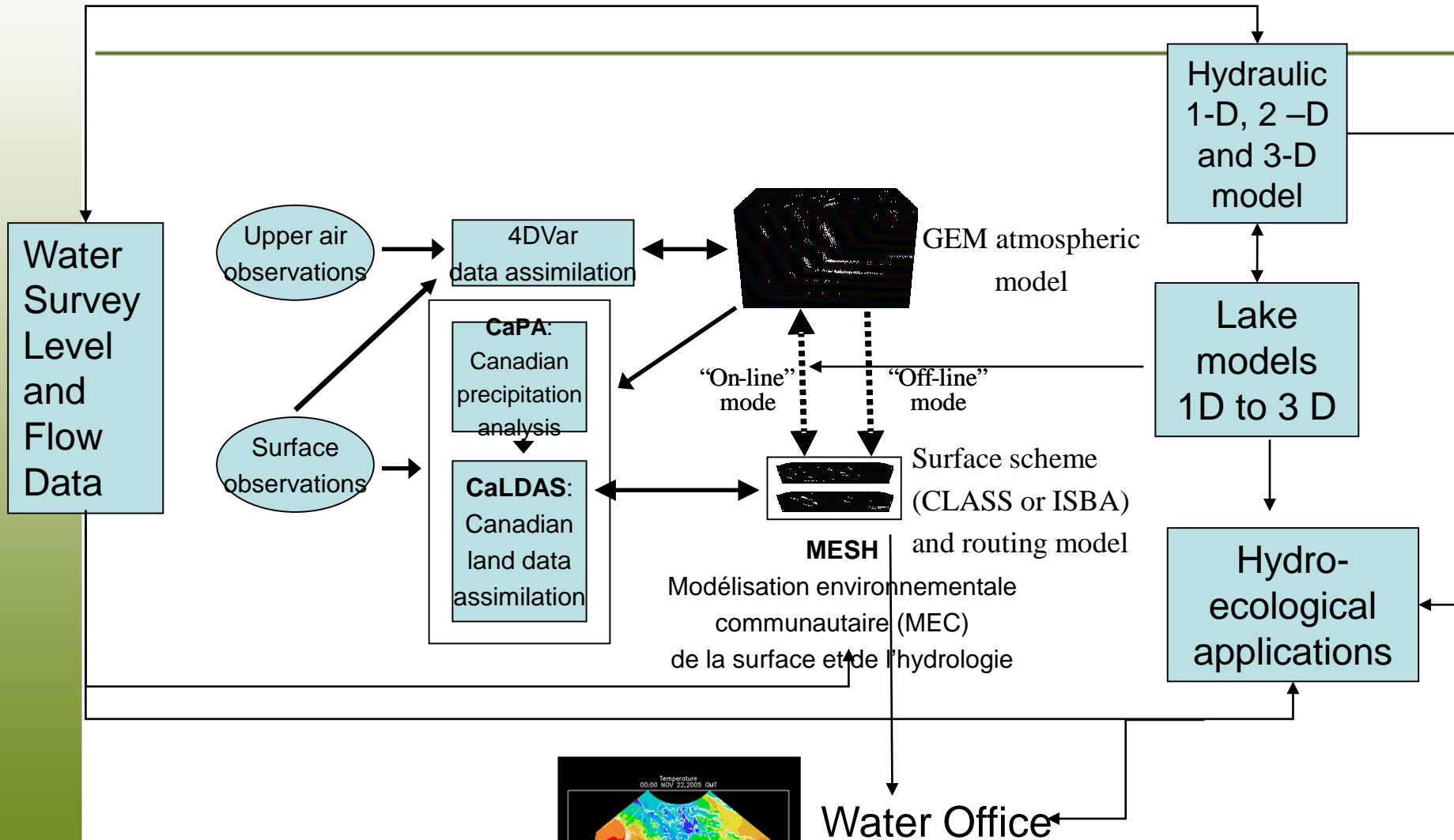


Post-Flood - Alberta

- Extensive bank and site remediation remains, and work for post-event flood analysis is ongoing for indirect measurements, and modeling is planned to start by spring.
- The demands of the flood and post event work have delayed the overall operation of WSC AB by about 18 weeks.



EC Prediction Framework for Water



Canadian Precipitation Analysis (CaPA)

- Combines different sources of information on precipitation into a single, near real-time analysis using optimal interpolation
- Analysis is then used to improve environmental predictions and provide forcing for Canadian land-data assimilation system (CaLDAS)

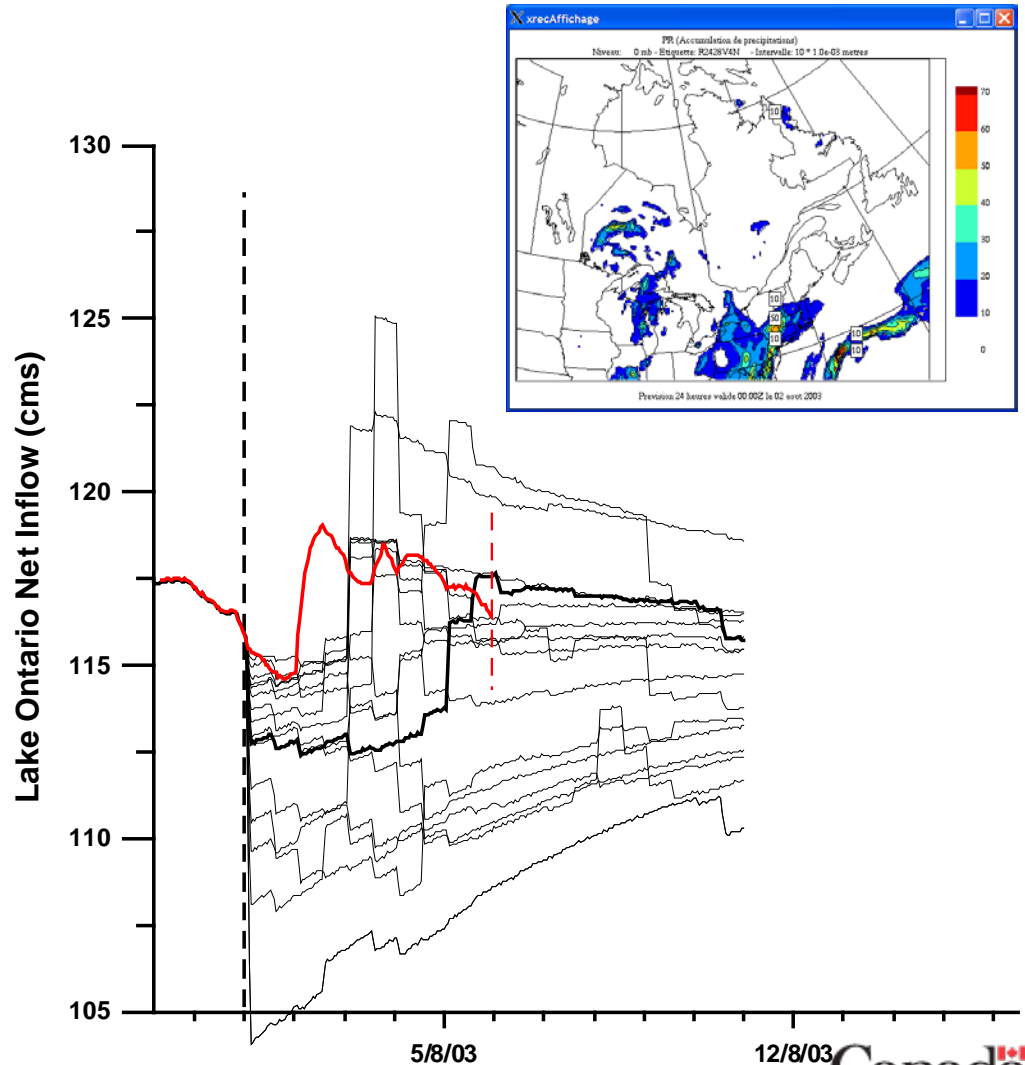
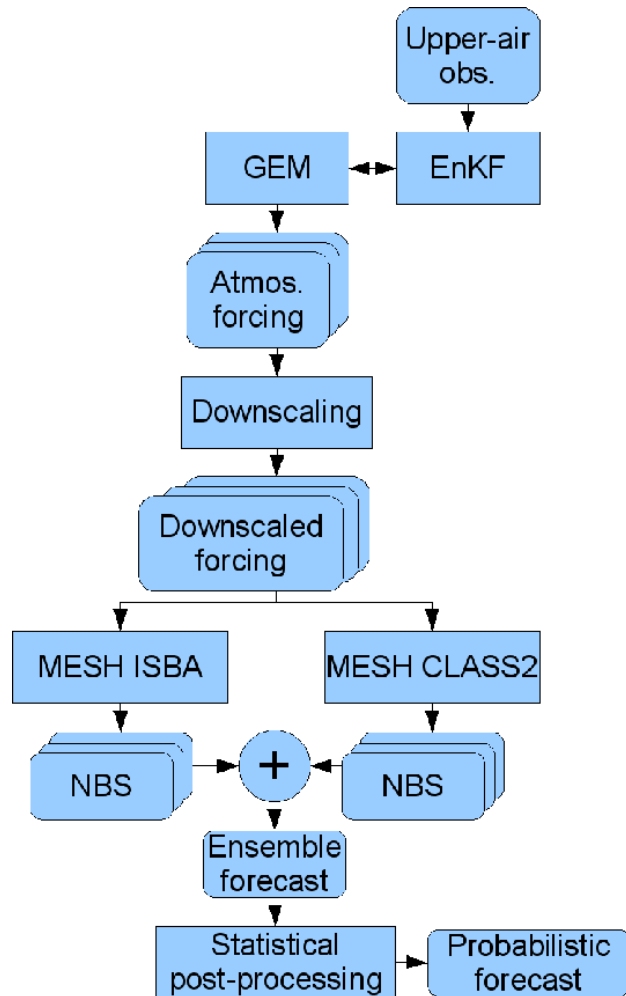


Canadian Land Data Assimilation System (CaLDAS)

- CaLDAS provides initial conditions (soil moisture, soil temperature) for both the atmospheric model (GEM) and the hydrological model (MESH)
- Using:
 - Forcings from GEM + CaPA precipitation analysis
- It finds:
 - Values of surface soil moisture and temperature which minimize the error in the diagnostics of 2m temperature and relative humidity made by the land surface model
- Work is in progress to include satellite observations of soil moisture

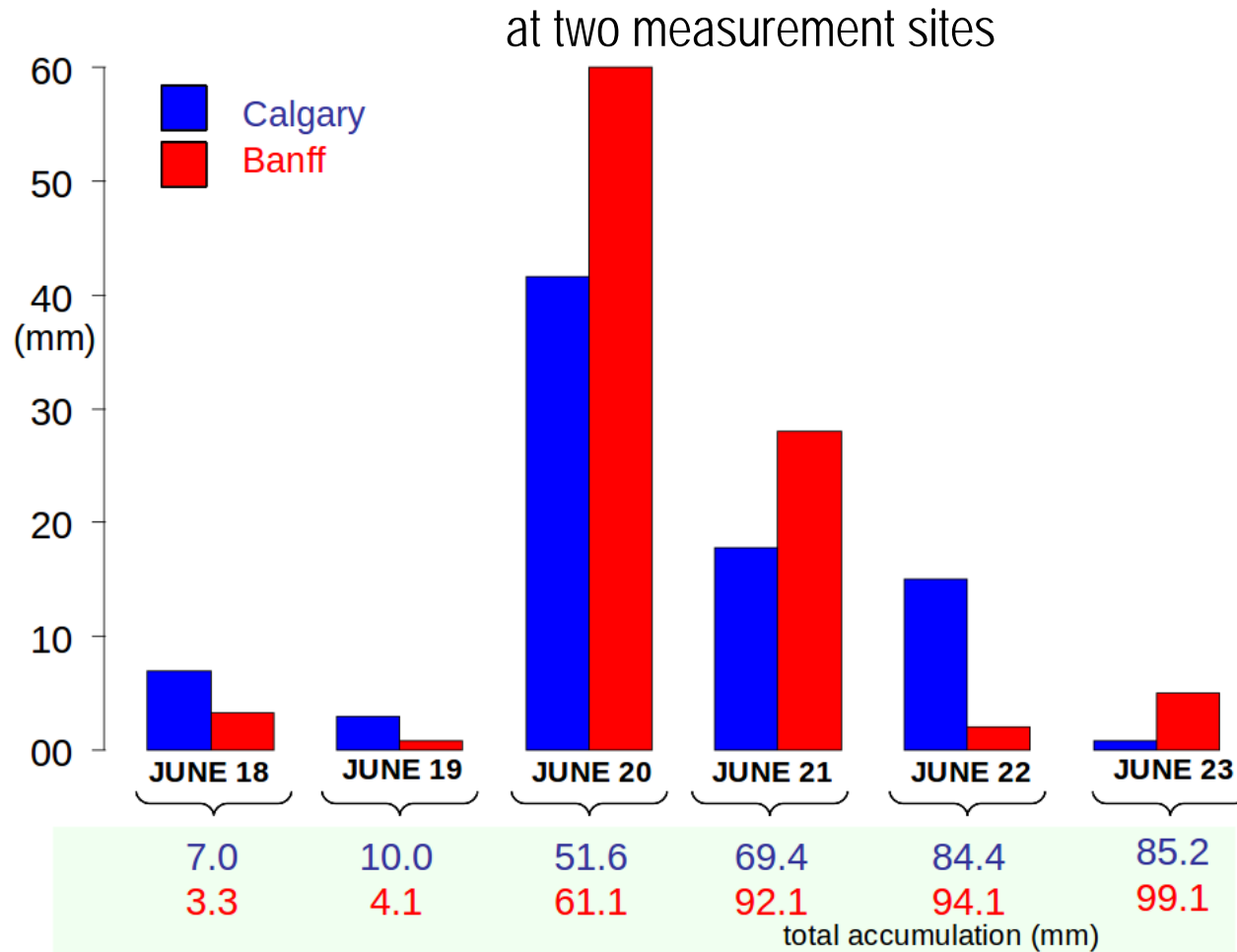


Ensemble Predictions (15 day) Fortin



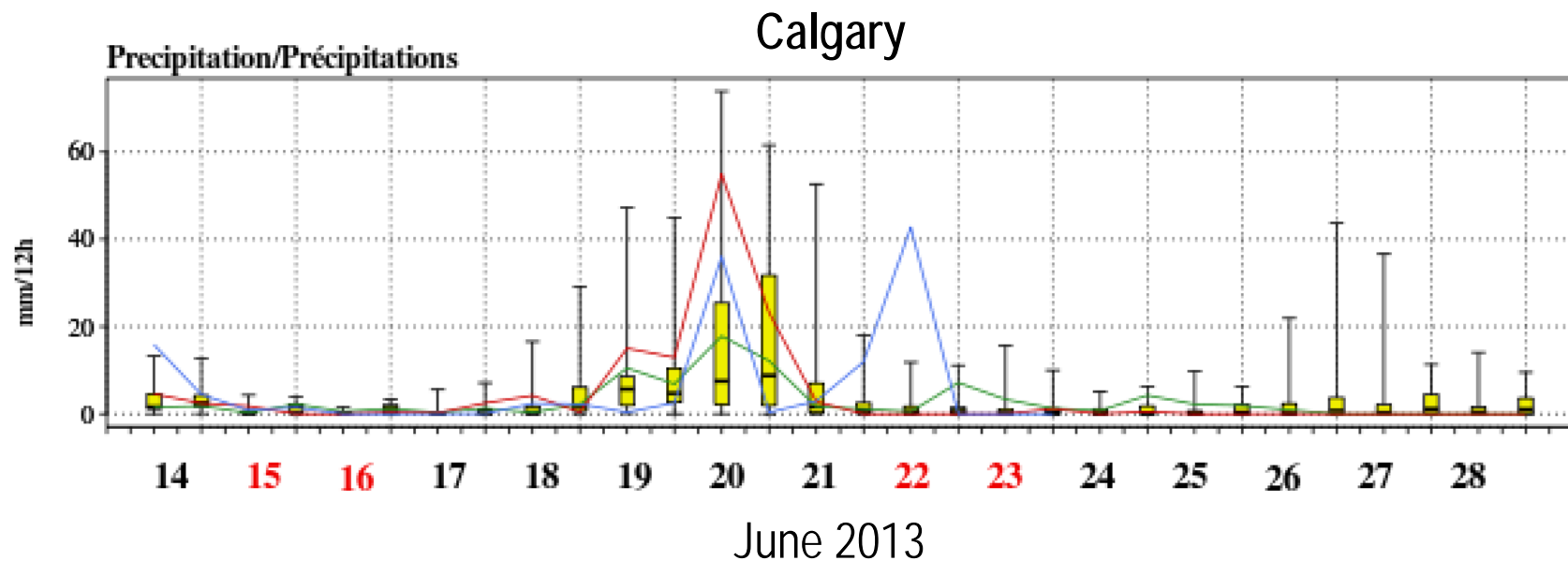
Observations at Calgary and Banff during the 2013 Southern Alberta Floods

Daily precipitation amounts (from noon the previous day to noon the current day)



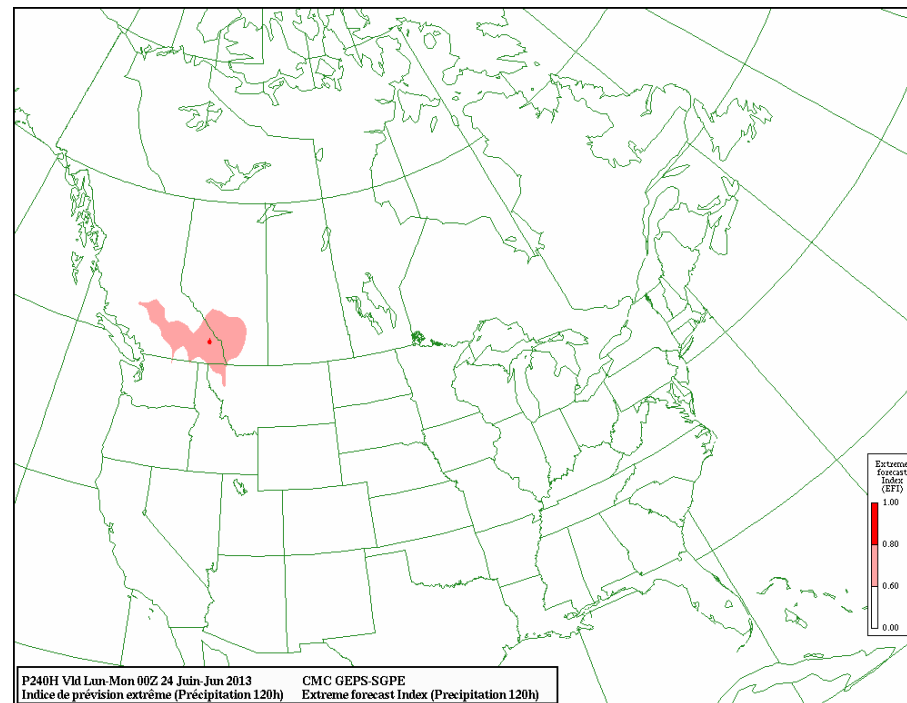
Performance of Forecasting Systems during the 2013 Southern Alberta Floods

- At the medium-range (7-day lead time)
 - The North American Ensemble Forecasting System (NAEFS) unambiguously forecasted strong precipitation over the area of interest



Performance of Forecasting Systems during the 2013 Southern Alberta Floods

- At the medium-range (5- to 10-day lead time)
 - The experimental Extreme Forecast Index (EFI) calculated from the Global Ensemble Prediction System clearly indicated the possibility of extreme precipitation



Performance of Forecasting Systems during the 2013 Southern Alberta Floods

- At the short-range (3-day lead time)
 - The Regional Ensemble Prediction System (REPS) indicated the probability of heavy precipitation (regions with 90% chances of at least 40 mm in 24 hours)

