HYDROLOGIC FORECASTING AT MANITOBA HYDROLOGIC FORECAST CENTRE (HFC)

Manitoba Hydrologic Forecast Center

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Manitoba Infrastructure

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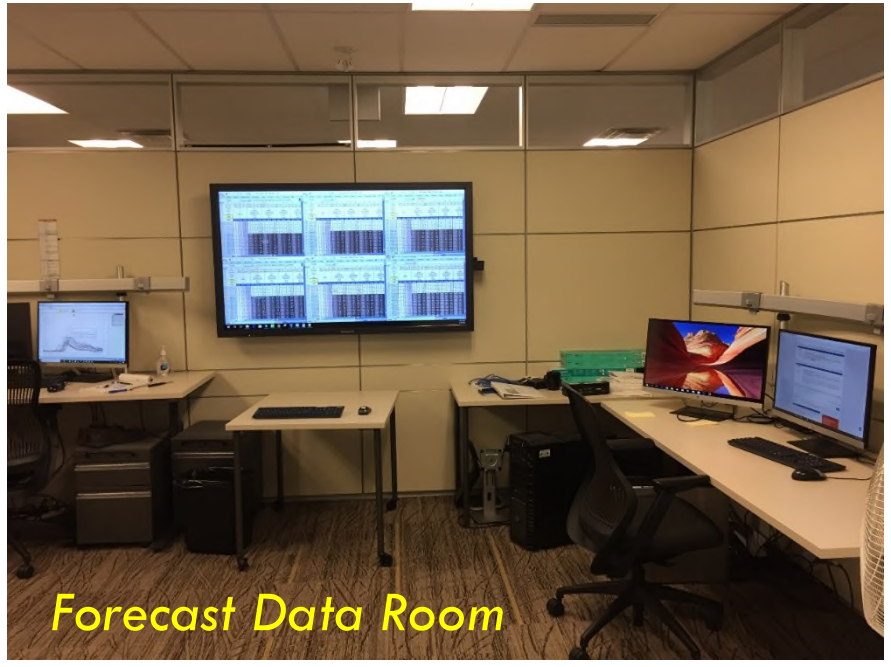
OUTLINE: HYDROLOGIC FORECASTING IN MB

- **Background**
- **Procedures**
- **Tools**
- **Data Source**
- **Platform**
- **Challenges**
- **Vulnerabilities**
- **Ongoing Works**

HYDROLOGIC FORECASTING IN MANITOBA

- Started in early 1950's following the widespread flooding of the Red River
- Operational forecasting is issued over 100 locations across the province
- Significant upgrades have been made in the past few years in regards to forecasting tools and methodologies and information dissemination

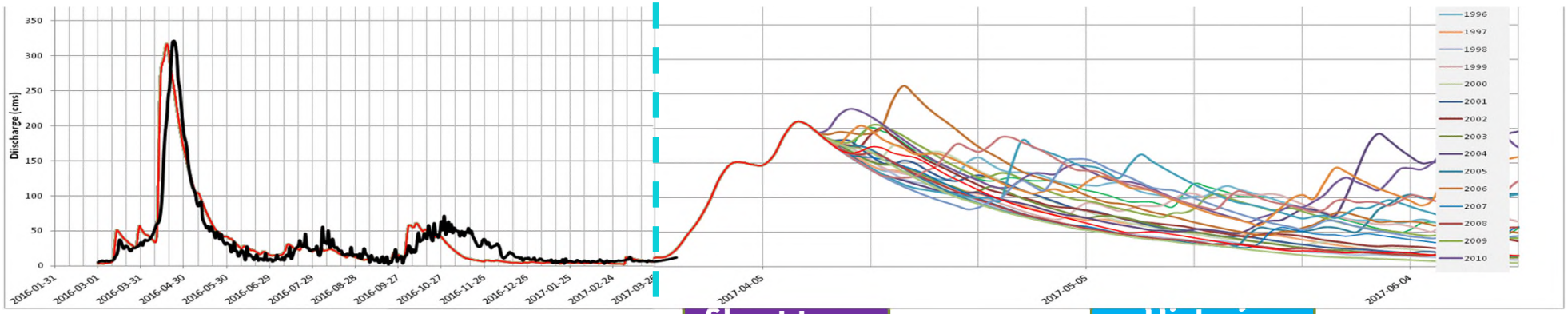

Flood Operation Centre


Forecast Data Room

FORECASTING PROCEDURE

- Multi-model, Ensemble Stream Flow Forecasting is used
- Multiple hydrologic models are used to generate future runoff probabilities
- Ensemble Stream Flow Forecast is used for each model simulation
  - Day -2 yr to Day 0: Model spin up using observed data
  - Day 0 to Day 2: GEM-REG forecast
  - Day 3 to Day 10: GEM-GLB forecast
  - Day 11 to Day 30: Multiple “historical simulation” runs:

FLOOD FORECASTING CYCLE



Short term Weather Forecast Input

Historic Recorded Weather Data Input

Hydrologic Model Spin-up

INITIAL STATE

Hydrologic Forecast Simulation

Model Calibration, Real-time meteorological data forcing for model spin-up

Soil Moisture Precipitation Snowpack at time zero

Hydrologic Models WATFLOOD, HEC-HMS, HBV, HSPF

Ensemble forecasts Results LD, UD, MD

2 - 4 years back

0 - 10 Days

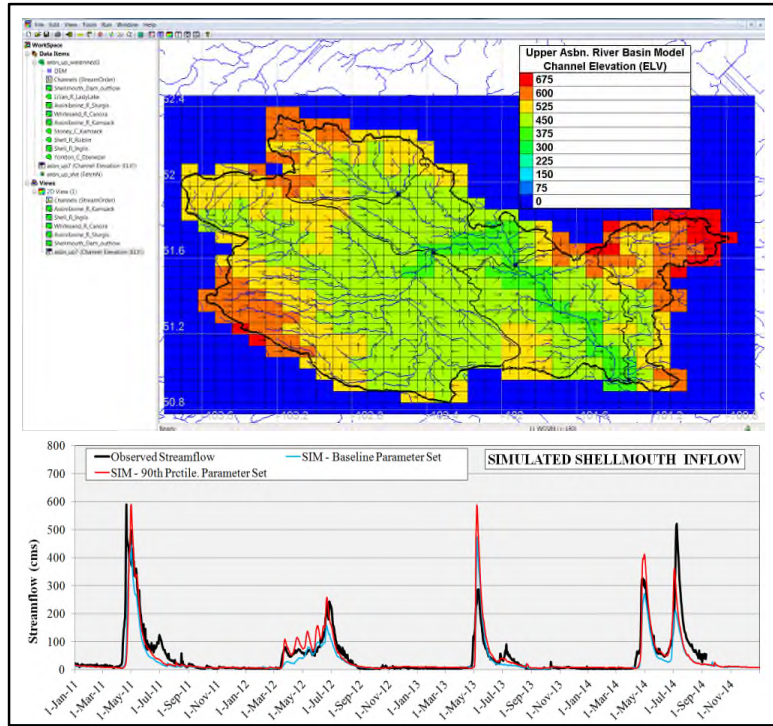
1 – 3 Month s

Start day (Day 0)

OPERATIONAL FORECASTING MODELS

- **WATFLOOD:** a physically based, distributed model
- **HBV-EC:** a partially distributed, physically based
- **HEC-HMS:** a conceptual lumped model
- **HSPF:** a partially distributed, conceptual model
- **HBV-96 (IHMS):** a partially distributed, physically based
- **SWAT:** a physically based, distributed model
- **Statistical Tools** – IAO, etc





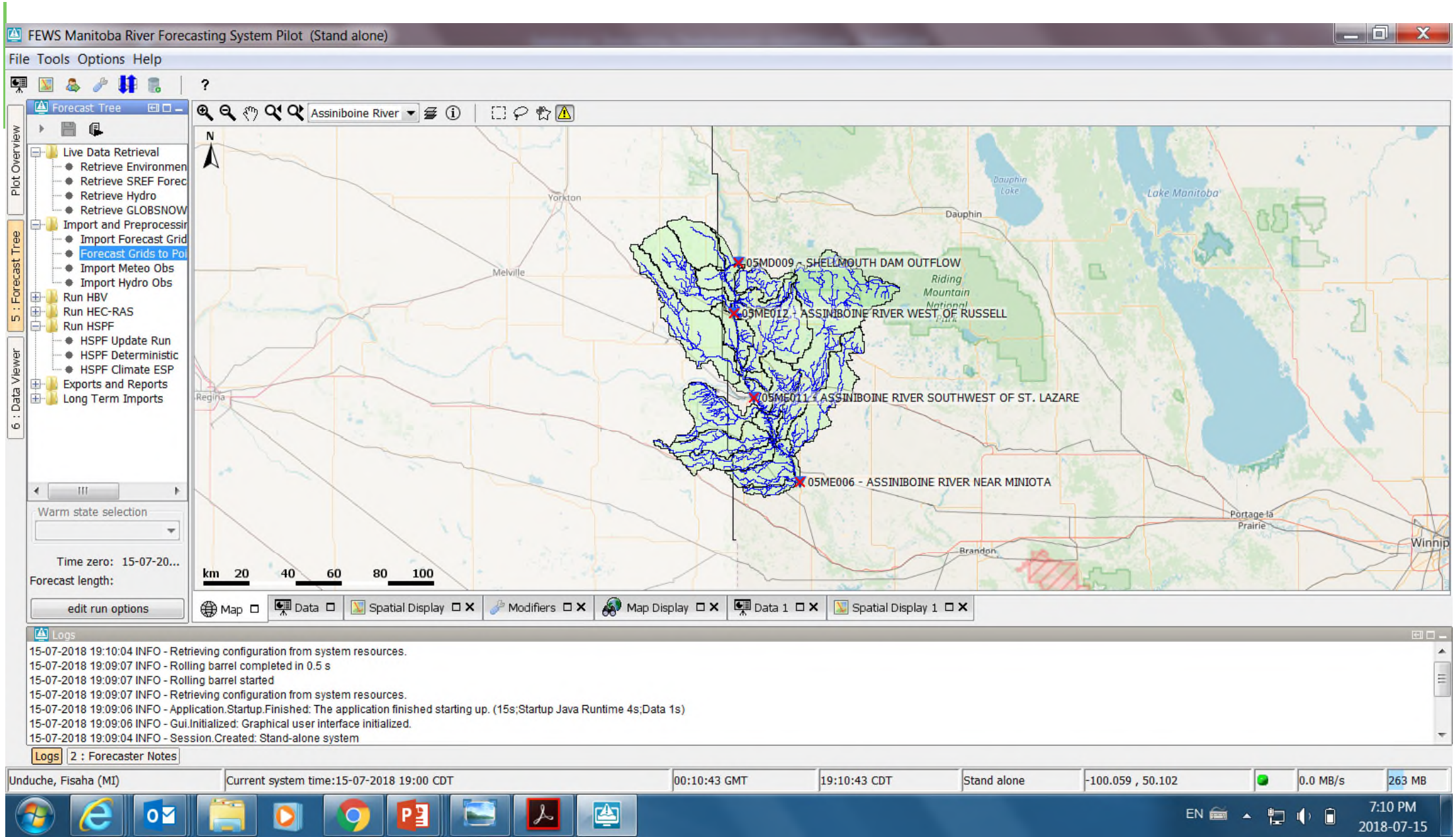
OPERATIONAL FORECASTING MODELS

- Models being considered for operational use:
  - **Sacramento / SNOW 17**
  - **HYPE**
  - **RAVEN**
  - **MESH**

Lack of GUI or Pre and Post Processing Tools

- Hydraulic routing models:
  - **HEC-RAS**
  - **MIKE11**

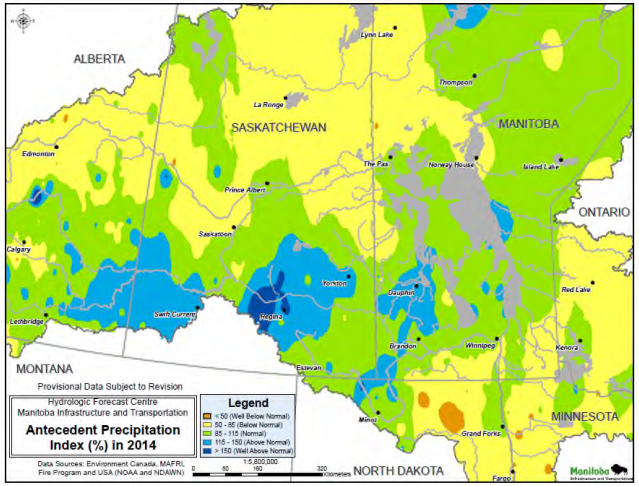
FEWS: MANITOBA FLOOD EARLY WARNING SYSTEM



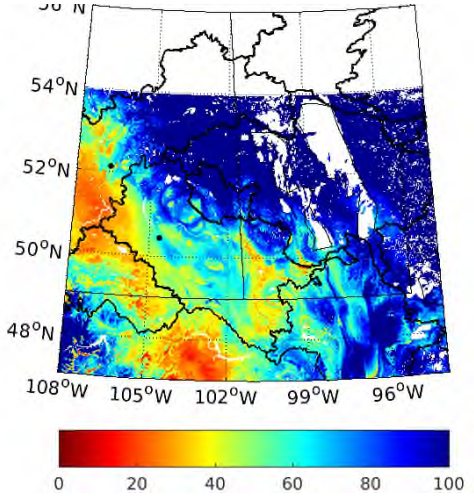
DATA ACQUISITION: OBSERVED DATA

- **Gauge data:** Quality controlled Precipitation data from over 1200 weather stations
- **CaPA data:** Canadian Adaptive Precipitation Analysis
- **Measured SWE data:** by staff at Manitoba Infrastructure every February and March
- **Calculated SWE data:** from Snow Data Assimilation System (SNODAS)
- **Calculated SWE data:** from Gamma Survey, an airborne radiation technology
- **Measured soil moisture data:** by staff at Manitoba Infrastructure

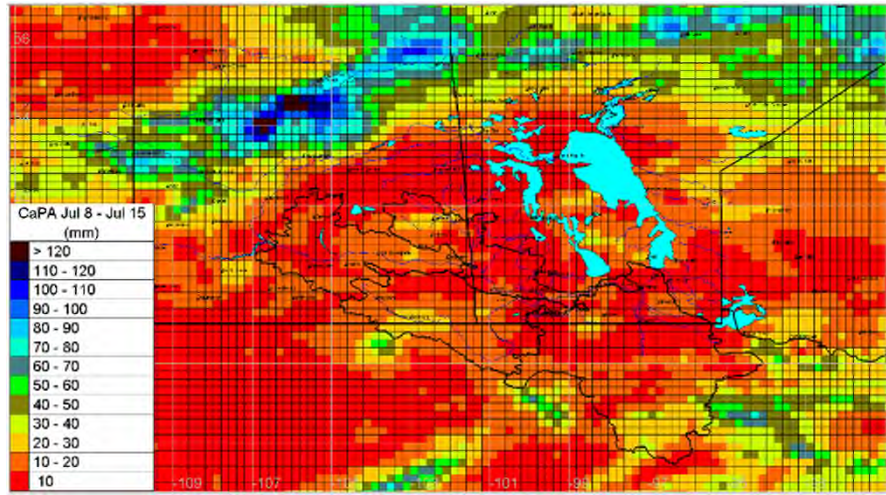
A map from gauge data



A map from SNODAS data

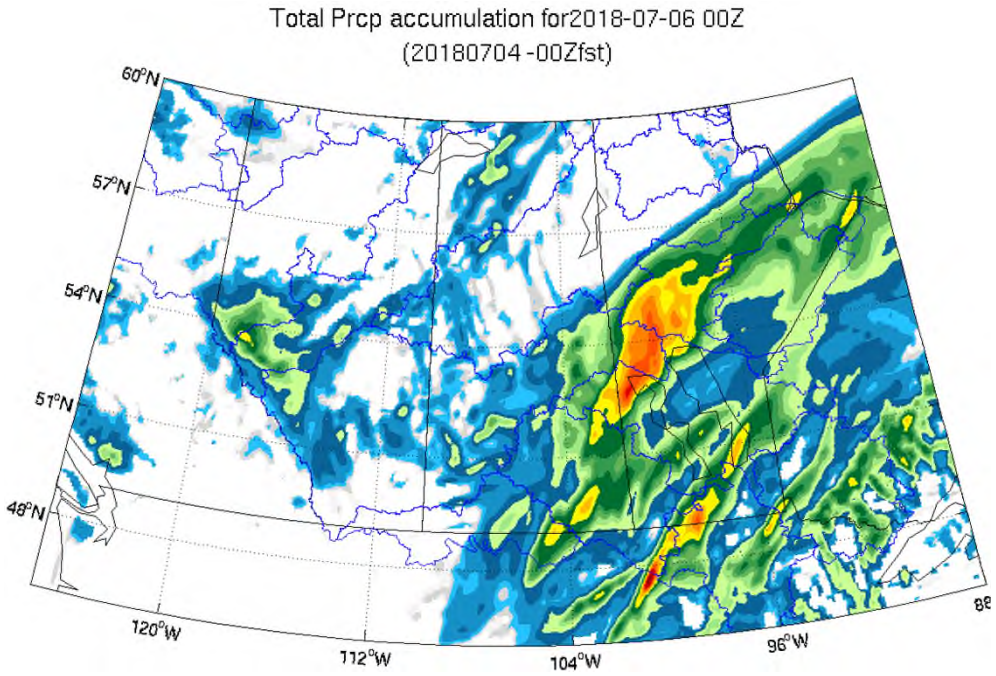


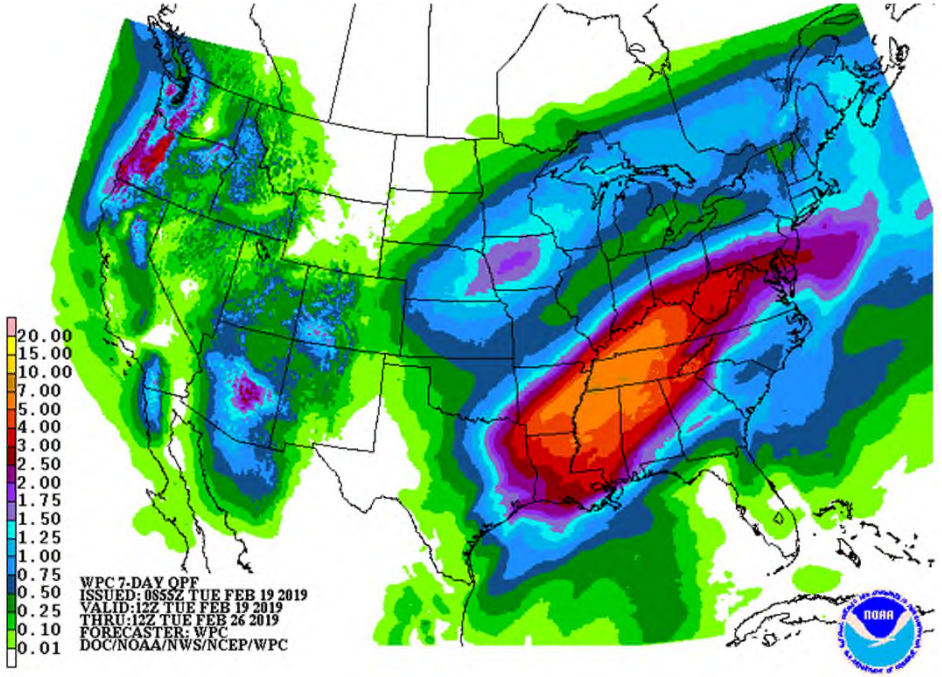
A map from CaPA data



DATA ACQUISITION: FORECASTED PRECIPITATION

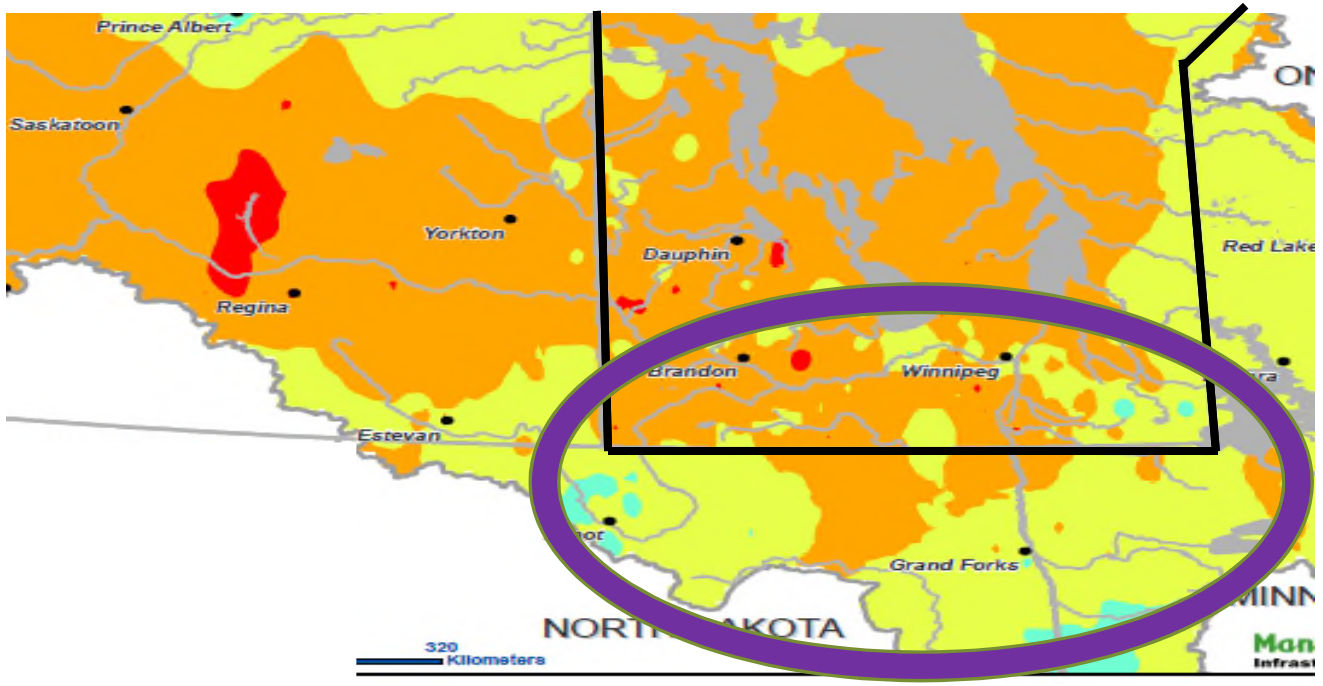
- Precipitation Forecast
  - Environment and Climate Change Canada's GEM-REG Deterministic Forecast
  - NWS QPF deterministic Forecast
  - Automatic downloading and processing tools

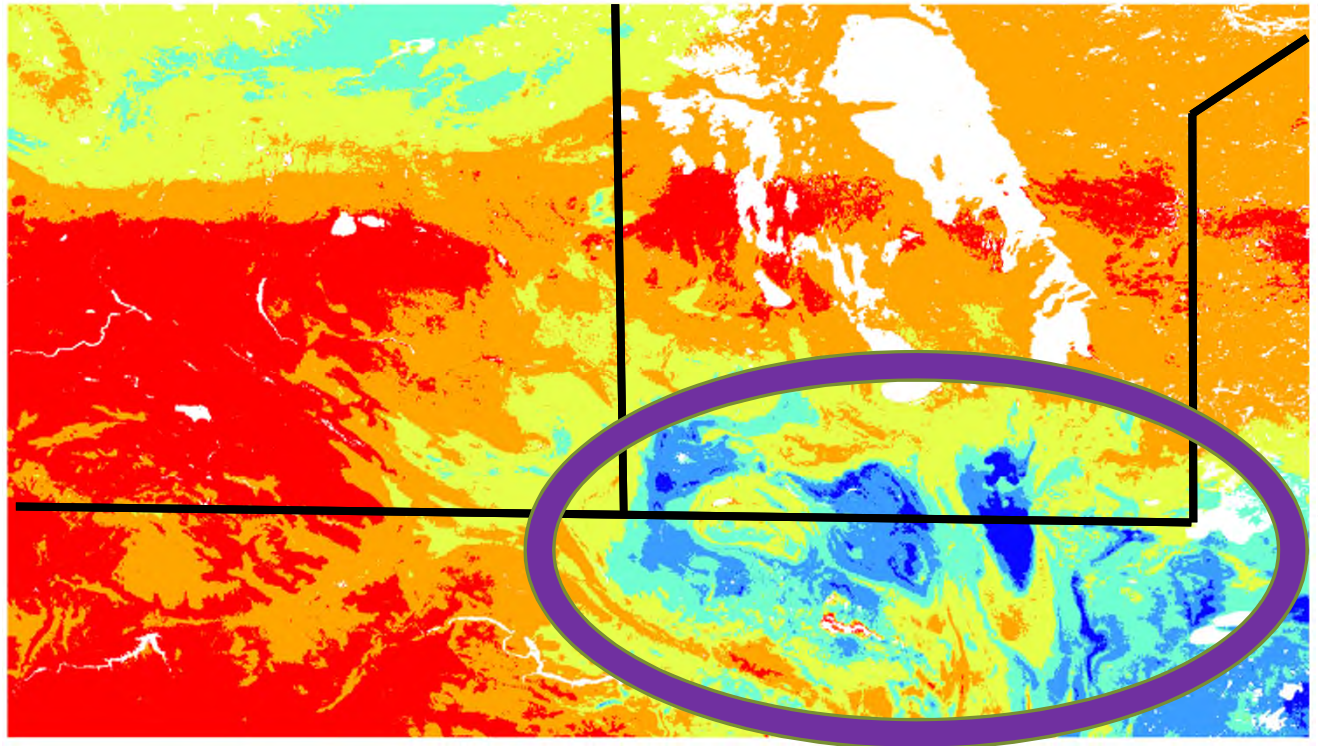




CHALLENGES

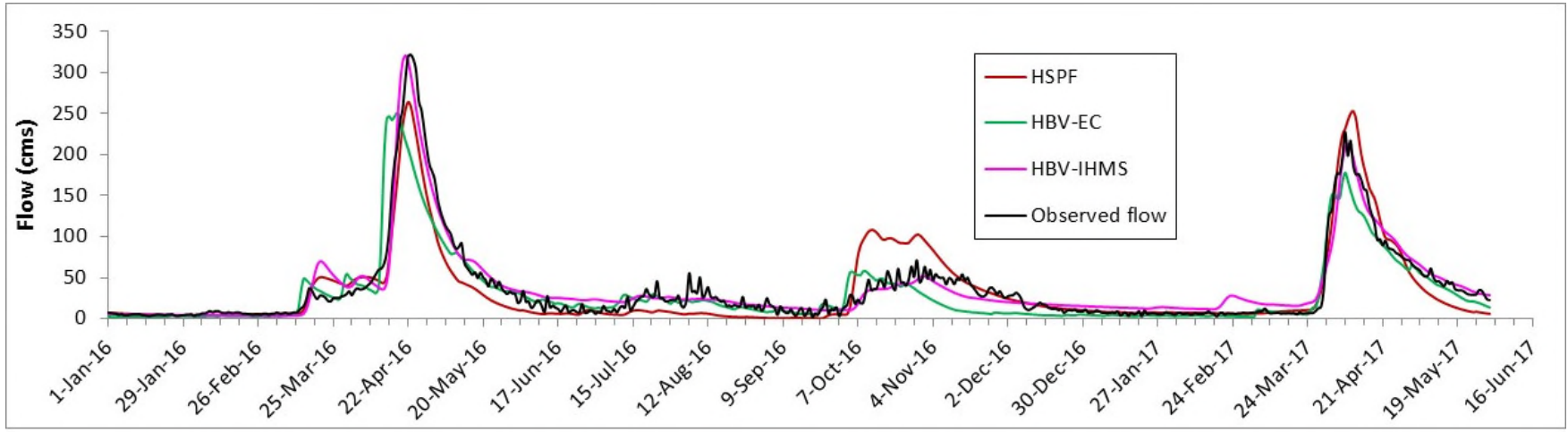
- Data Accuracy
  - Observed data from various sources may not always agree

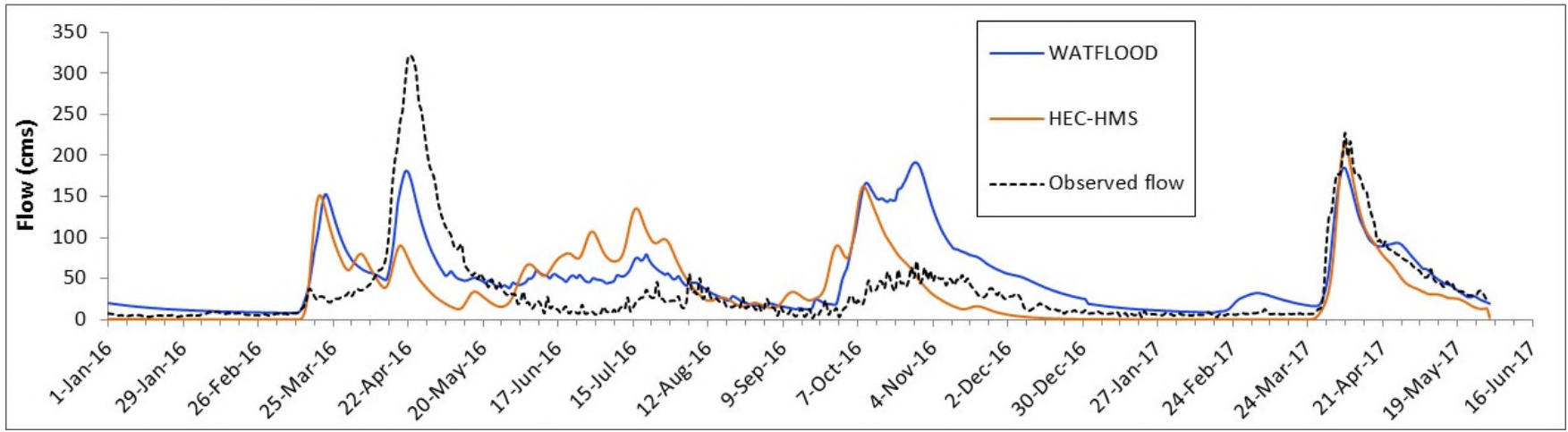




CHALLENGES: MODEL UNCERTAINTIES

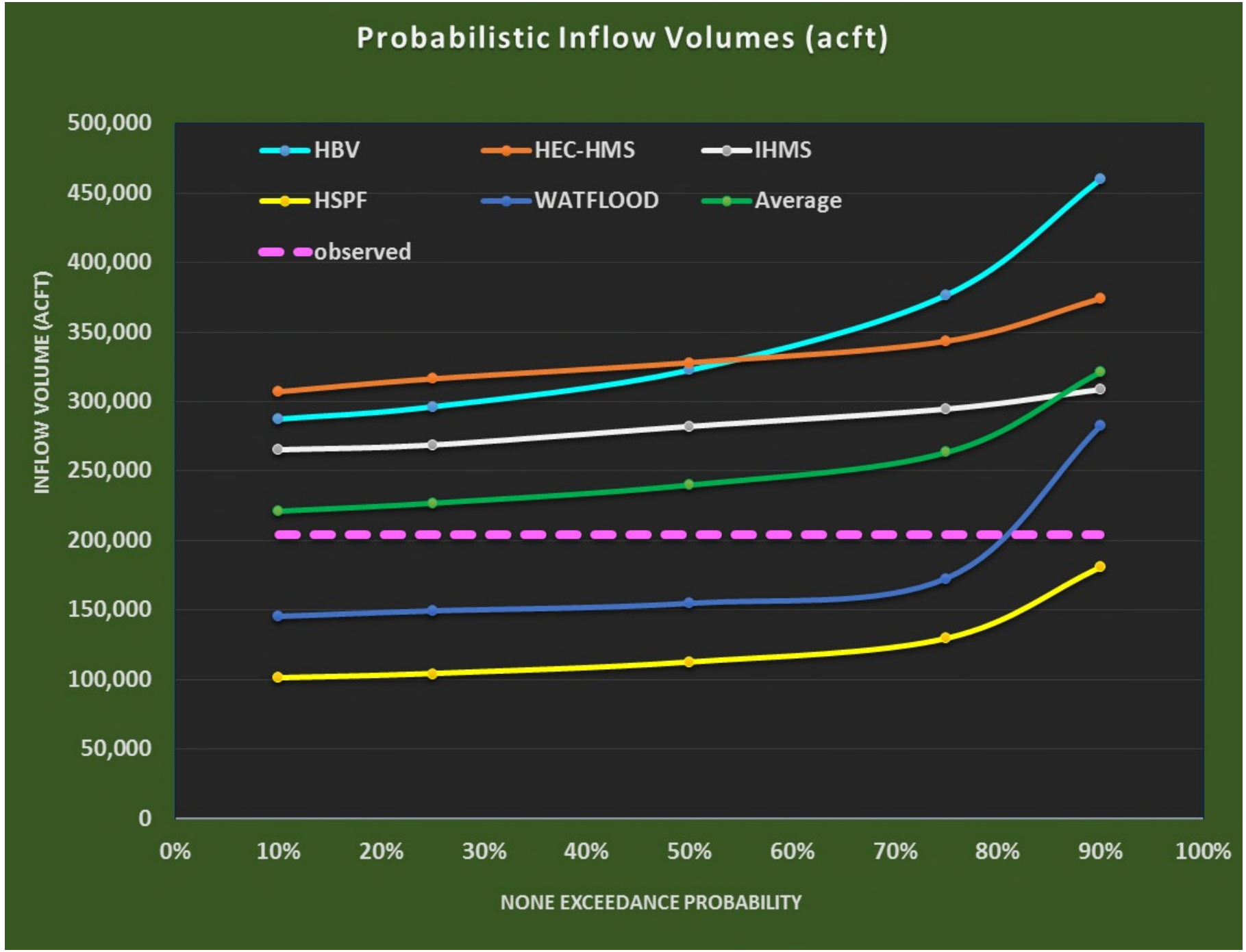
- E.g. Operational forecasting in 2016 to 2017
  - All models were very good in 2017, unlike 2016

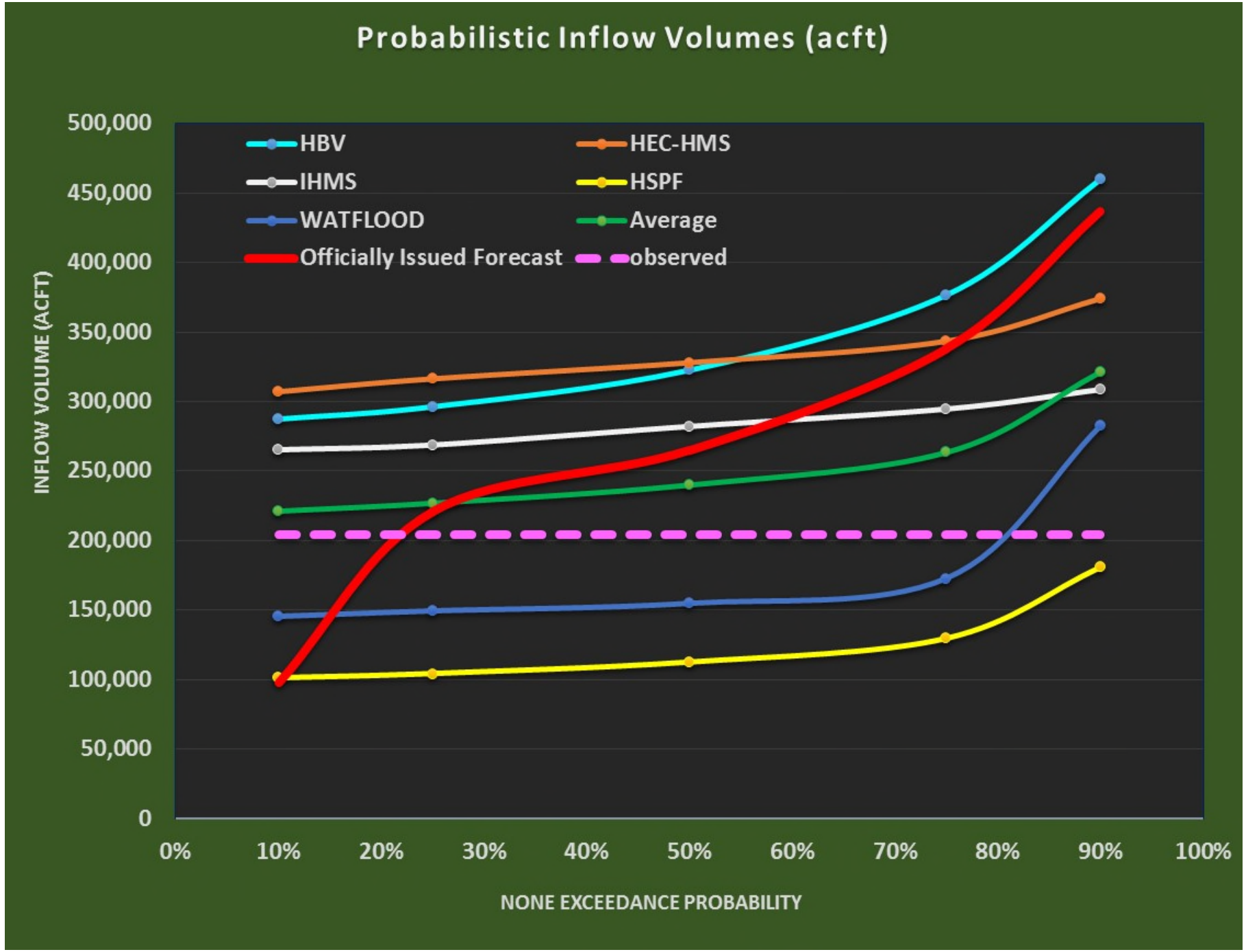




CHALLENGES: MODEL UNCERTAINTIES

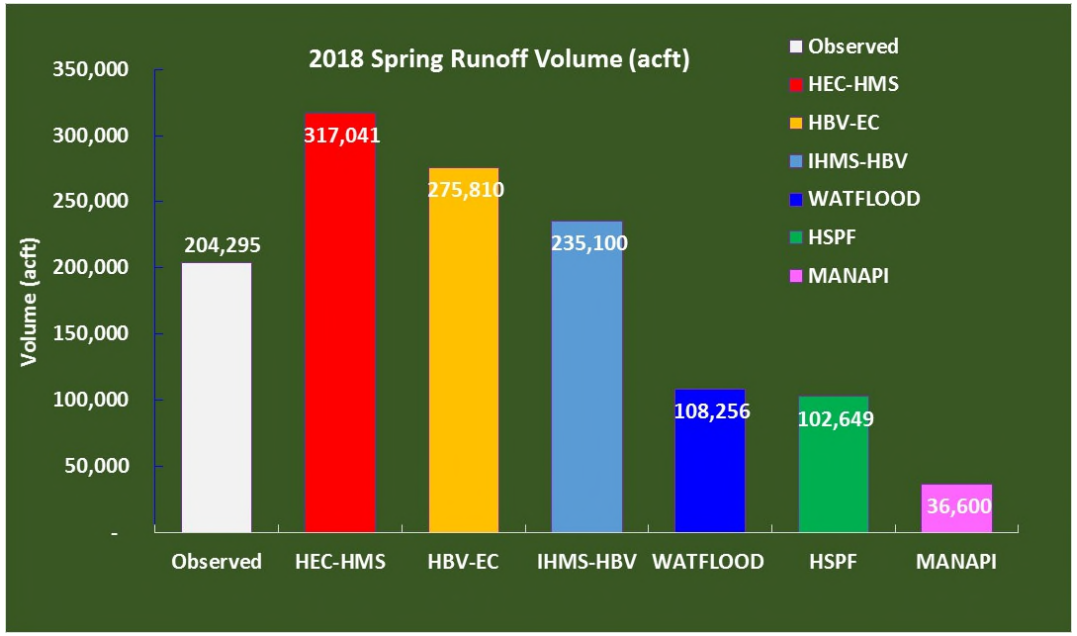
- Operational forecasting in 2018:
  - The Second Latest Melt in 105 years of Data

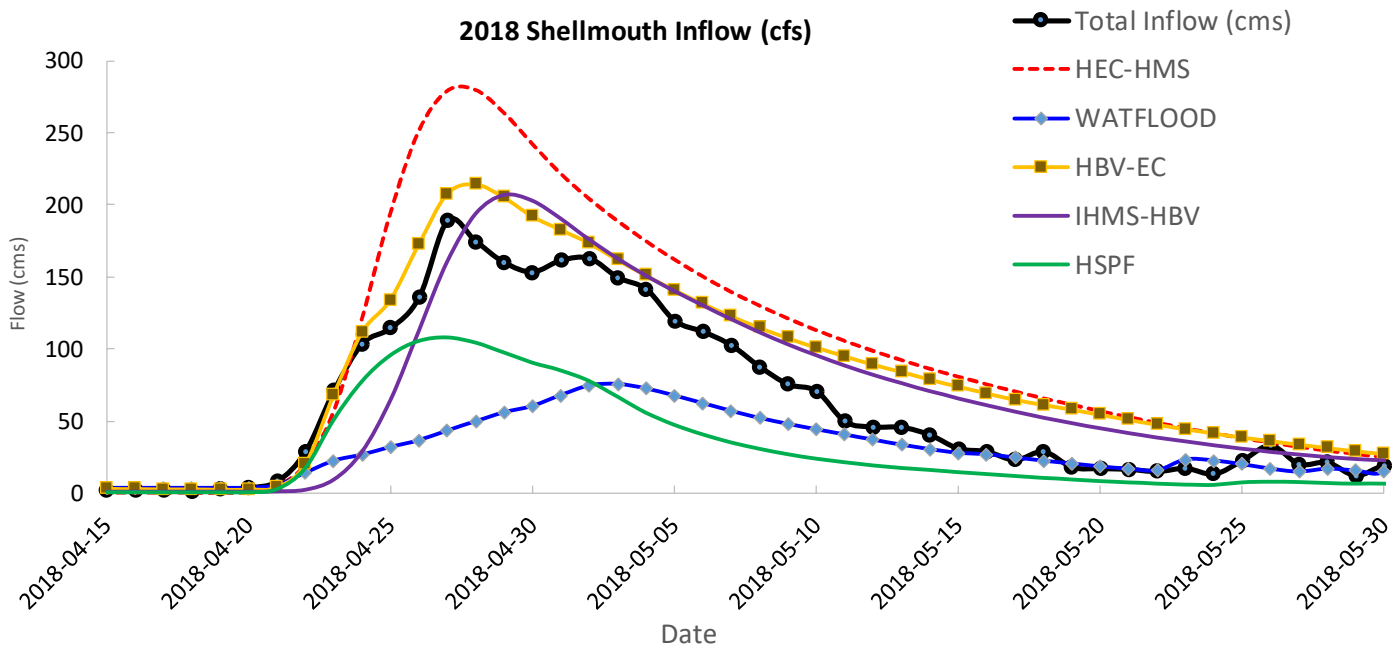

Probabilistic Inflow Volumes (acft)
HBV
HEC-HMS
IHMS
HSPF
WATFLOOD
Average
observed
INFLOW VOLUME (ACFT)
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
NONE EXCEEDANCE PROBABILITY


Probabilistic Inflow Volumes (acft)
HBV
HEC-HMS
IHMS
HSPF
WATFLOOD
Average
Officially Issued Forecast
observed
INFLOW VOLUME (ACFT)
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
NONE EXCEEDANCE PROBABILITY

CHALLENGES: MODEL UNCERTAINTIES

- Volume
- Timing





VULNERABILITIES

- Extreme event calibrations
- Ice jam related flooding
- Frozen ground effects
- Soil moisture model enforcing
- Forecasting staff / resource capacity in extreme events

ONGOING WORKS

- Multi-variate model calibration and verification
- Data assimilation in runoff forecasting
- Forecasting ice jam related levels – empirical equations
- Develop FEWS for most major rivers
- Streamline the data process, quality control, etc

Thank You!