Uncertainty in Stream Flow Simulation: Hydrological Analysis of the Upper Assiniboine River Basin

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FloodNet 3.1 aims to evaluate flood forecasting techniques currently in practice across Canada. One of the common challenges faced by the forecast centres in SK and MB is to better model Prairie Potholes.

Source: USGS

Research objectives

- Impact of model structure on the accuracy of hydrological modeling of a Canadian prairie watershed
- Impact of land use and climate change on downstream hydrograph of the Upper Assiniboine River Basin
- Multi-model comparison using a common optimization technique

Objective-1

What is the goal?

To evaluate multiple methods of pothole wetland representation within a singular watershed-scale hydrologic model

How?

Utilized the Soil Water Assessment Tool SWAT) with three different structural arrangement

- Lumped
- Distributed
- Distributed with modification to the potholes representation

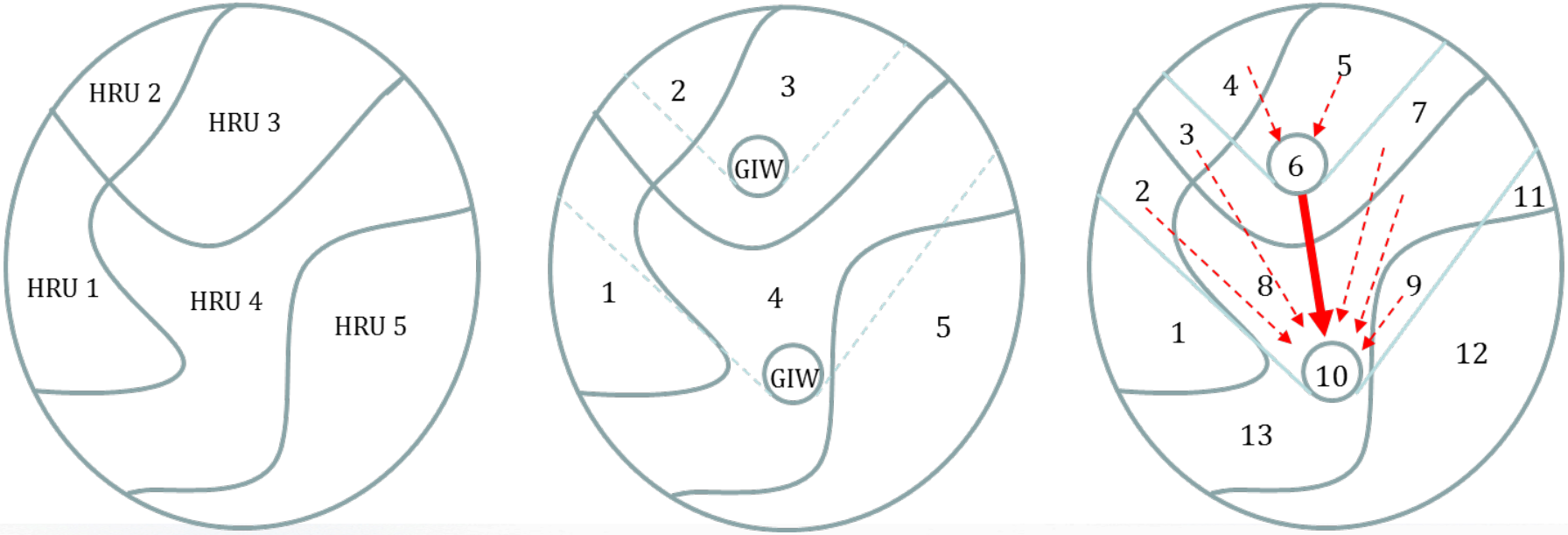
Objective-1

Why SWAT?

- SWAT has routine for ponds, wetlands, and potholes
- Freely available with open source code
- Experimental base interest of Hydrologic Forecast Centre, Manitoba
- Successfully applied for water quantity/quality analysis in the Prairie Pothole Region

Modified concept of pothole representation

SWAT works based on Hydrologic Response Unit (HRU) which is a combination of soil type, land use and Digital Elevation Model. Modified concept added another attribute, shape file of Geographically Isolated Wetlands (GIWs), while generating HRUs.



Study area

Why the Upper Assiniboine River Basin?

- Importance to SK and MB
- The lake of prairie

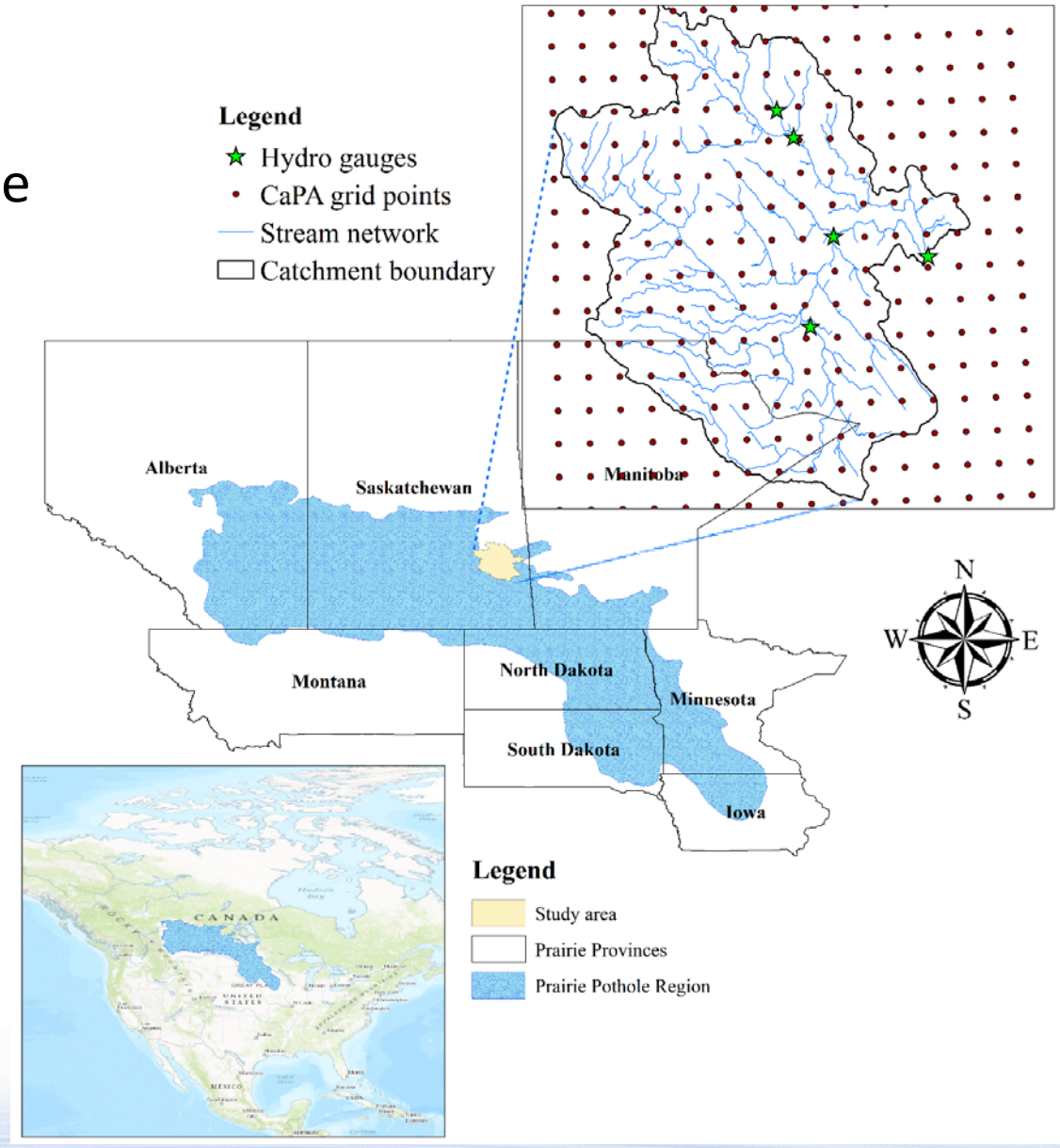
Area = 13,000 km²

Agriculture = 72%

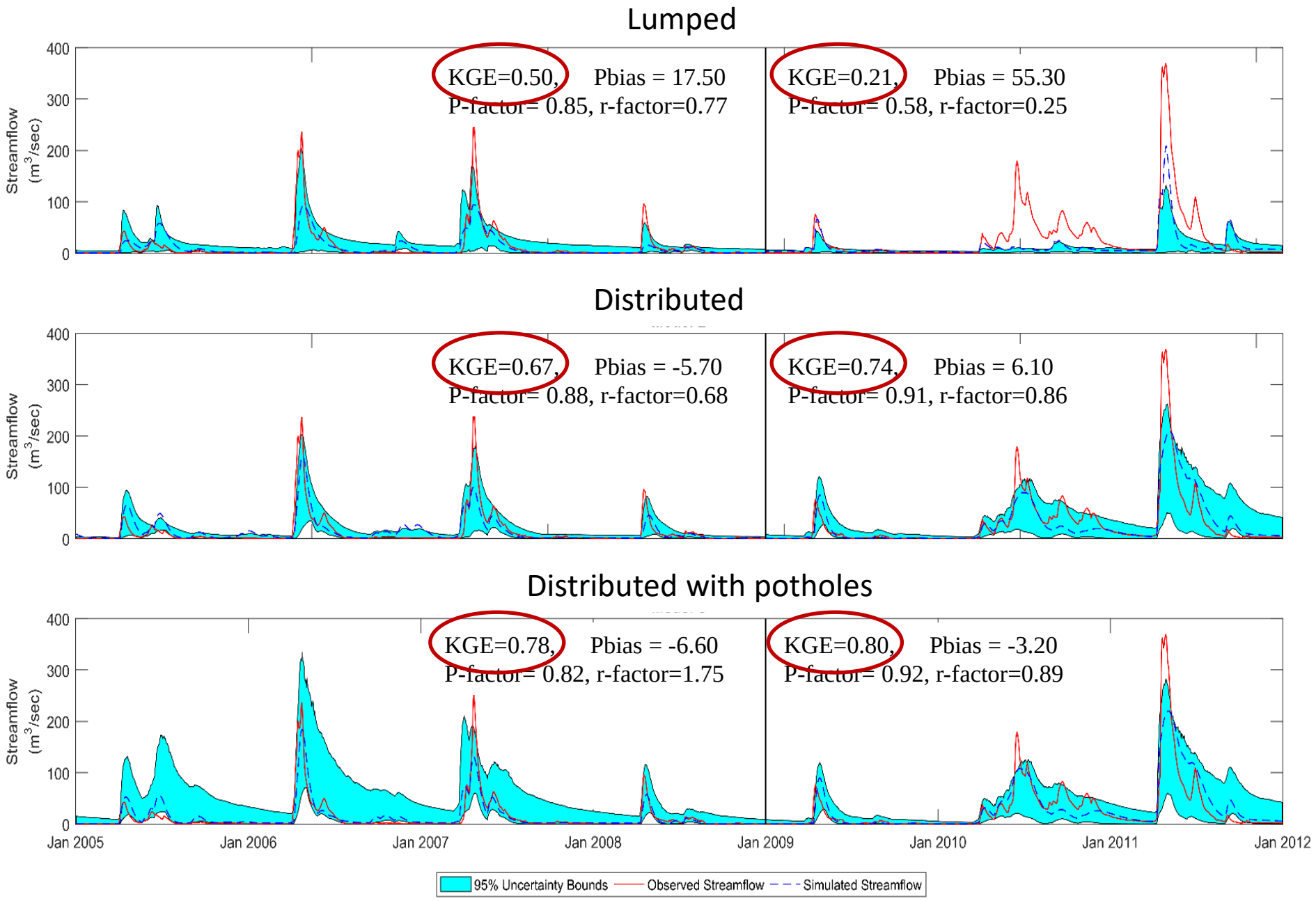
Forest = 12%

GIWs (Potholes) = 140 km²

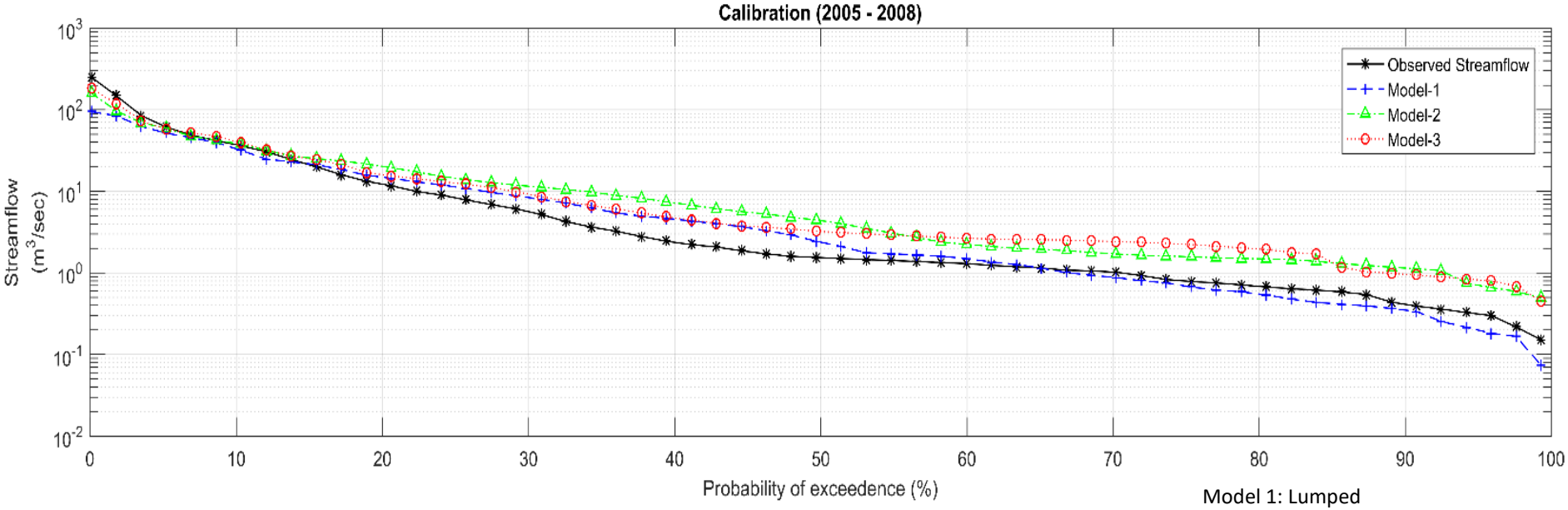
Density of GIWs = 3.5/km²



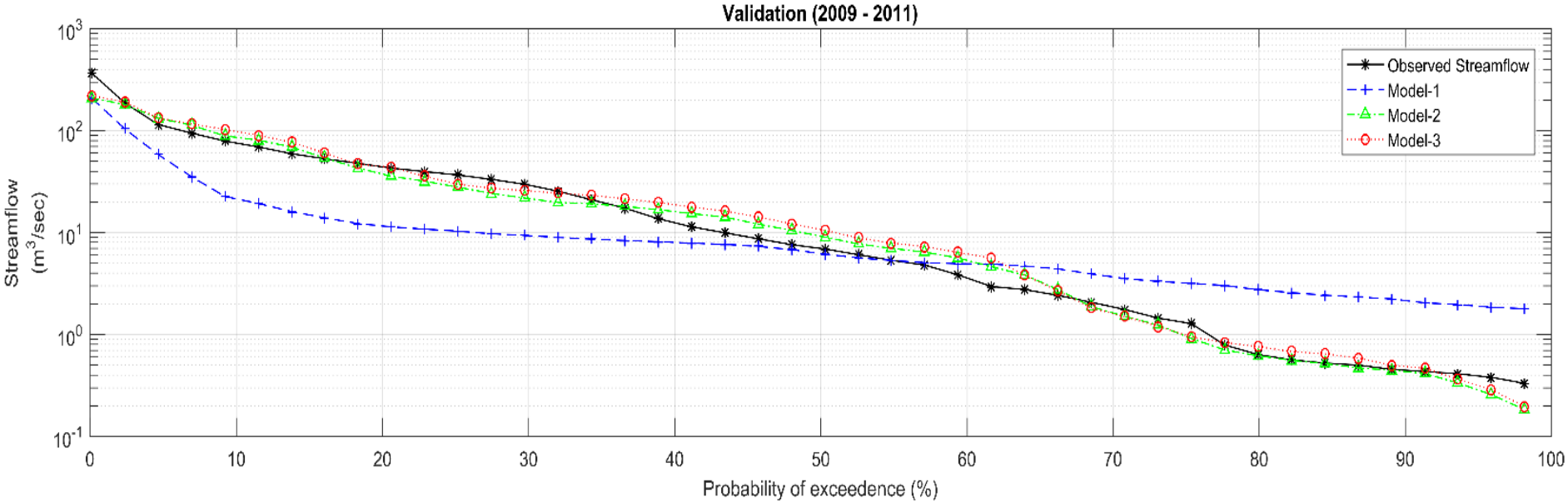
Results


Lumped
KGE=0.50, Pbias = 17.50
P-factor= 0.85, r-factor=0.77
KGE=0.21, Pbias = 55.30
P-factor= 0.58, r-factor=0.25
Distributed
KGE=0.67, Pbias = -5.70
P-factor= 0.88, r-factor=0.68
KGE=0.74, Pbias = 6.10
P-factor= 0.91, r-factor=0.86
Distributed with potholes
KGE=0.78, Pbias = -6.60
P-factor= 0.82, r-factor=1.75
KGE=0.80, Pbias = -3.20
P-factor= 0.92, r-factor=0.89
Streamflow (m3/sec)
0
100
200
300
400
Jan 2005
Jan 2006
Jan 2007
Jan 2008
Jan 2009
Jan 2010
Jan 2011
Jan 2012
95% Uncertainty Bounds
Observed Streamflow
Simulated Streamflow

Results contd…



Model 1: Lumped
Model 2: Distributed
Model 3: Distributed with potholes



Conclusion

- Modification to SWAT seems promising, capture the spill-spill processes and enhances potholes represnetation
- Distributed models can be used for forecasting stream flow in prairie region
- The efficiency of the modified model will further be evaluated using different climate and land use change scenarios
- Performance comparison of the model developed to those in practice at the HFC in MB will highlight the significance of this research

Acknowledgment

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Thank you

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