WRF Model Simulation of June 2013 Alberta Flooding Event

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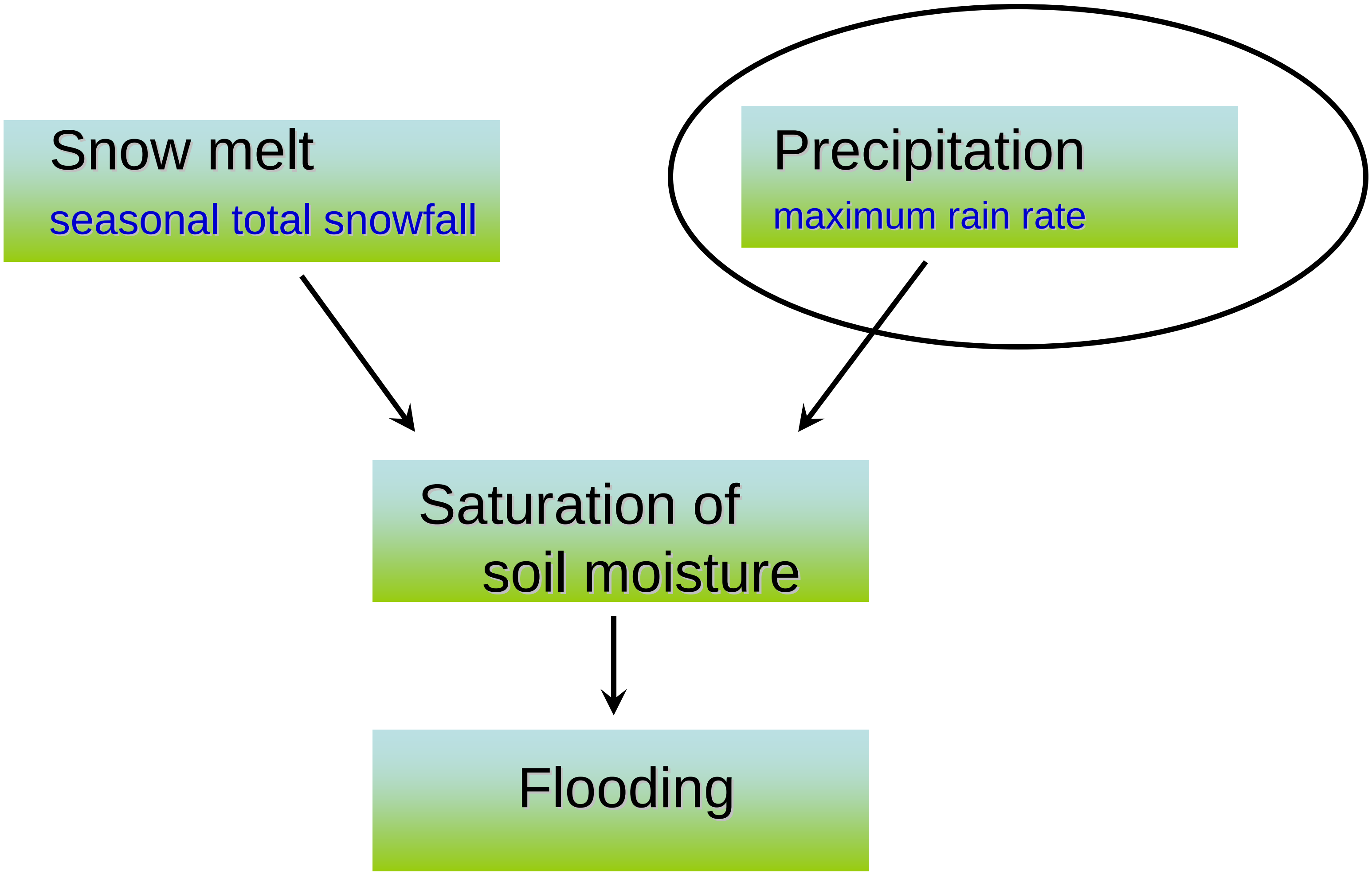
June 2013 Alberta Flooding



Outline

WRF (Weather Research and Forecast) numerical experiments to examine –

storm evolution and rainfall distribution during June 2013 Alberta Flooding

-> Synoptic precondition

-> Water vapor sources

-> the role of terrain

THE WEATHER RESEARCH & FORECASTING MODEL

Weather Research & Forecasting model WRF the state-of-art model for regional climate modeling

WRF has many different model configuration options:

- Adjustable model grids both horizontally and vertically
- Two dynamical cores (NMM & ARW)
- A wide selection of model physics parameterizations:

  7 cumulus parameterizations

  14 explicit moisture schemes

  6 radiation schemes

  10 planetary boundary layer schemes

  5 land surface schemes

This site (wrf-model.org) provides general information on the WRF model and its organization and offers links to WRF users' pages, real-time applications, and WRF announcements. For full, updated information on use of the modeling system, users are encouraged to visit the WRF-ARW and WRF-NMM home pages (see above).

WRF setup

Data Uncertainties

- Initial and Boundary Condition

  NCEP reanalysis with 1 degree resolution every 6 hours.

Model Uncertainties:

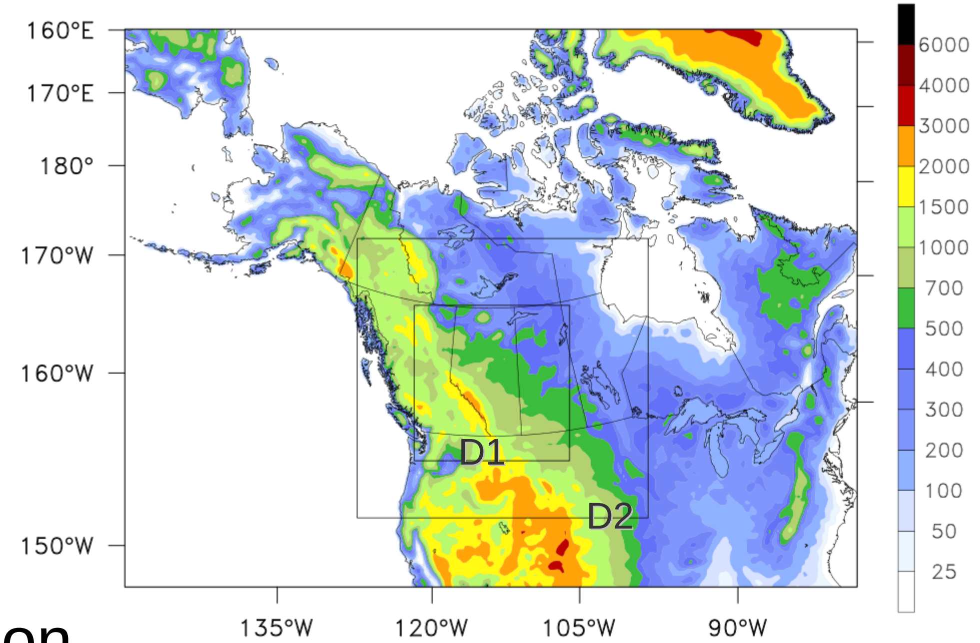
- Regional domain

  Domain-1, Domain-2

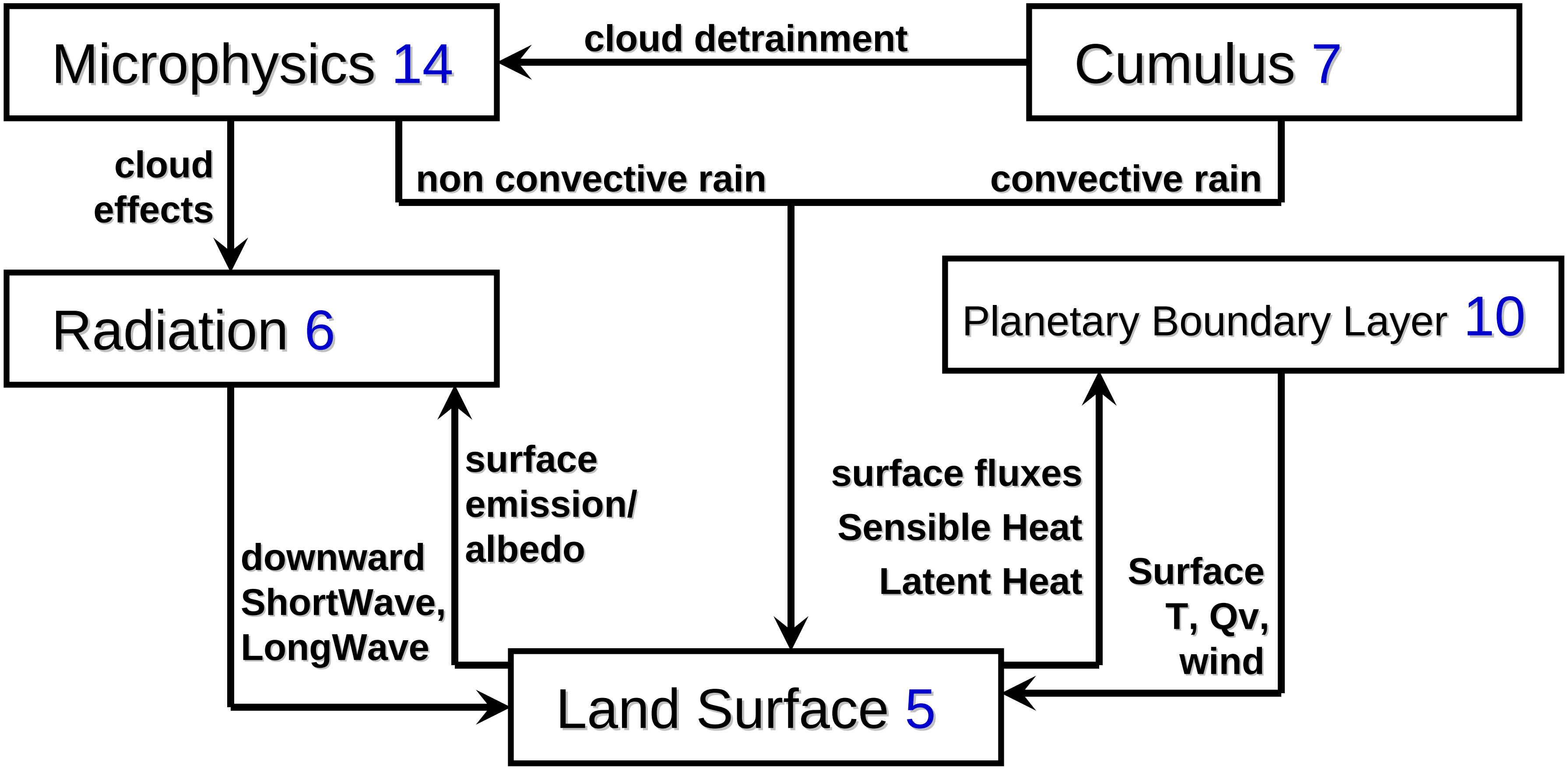
- Resolution

  D1: 3km, D2: 27km

- Dynamics
- Physical parameterization

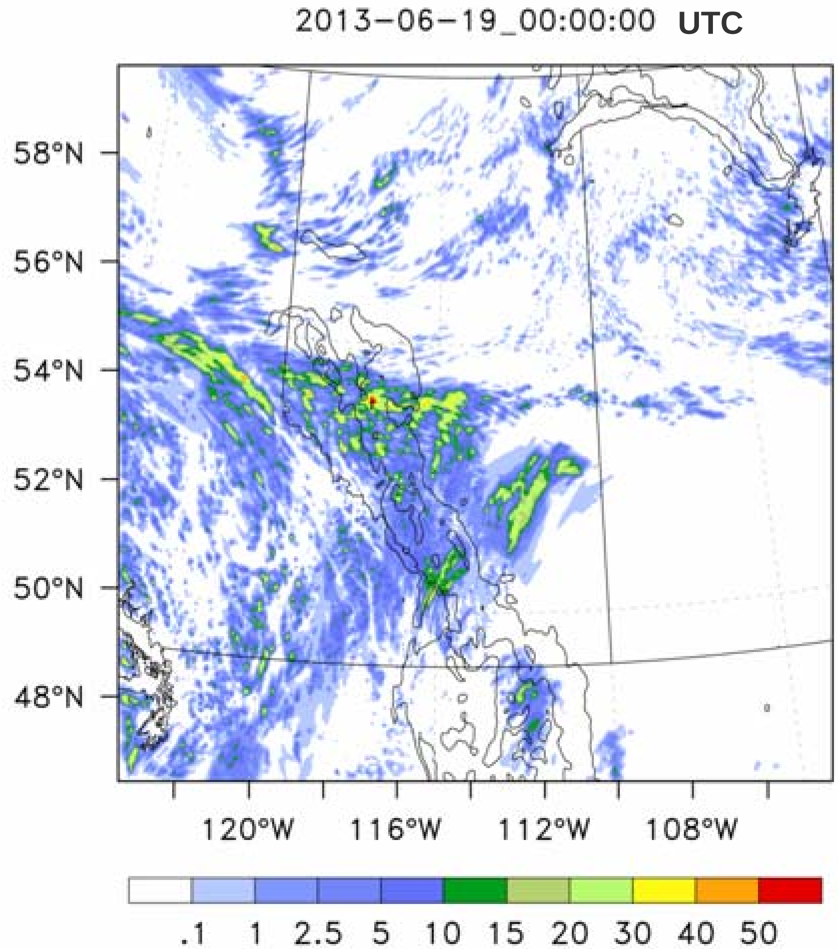


WRF Model Physics Parameterizations



WRF simulation vs CMORPH

WRF



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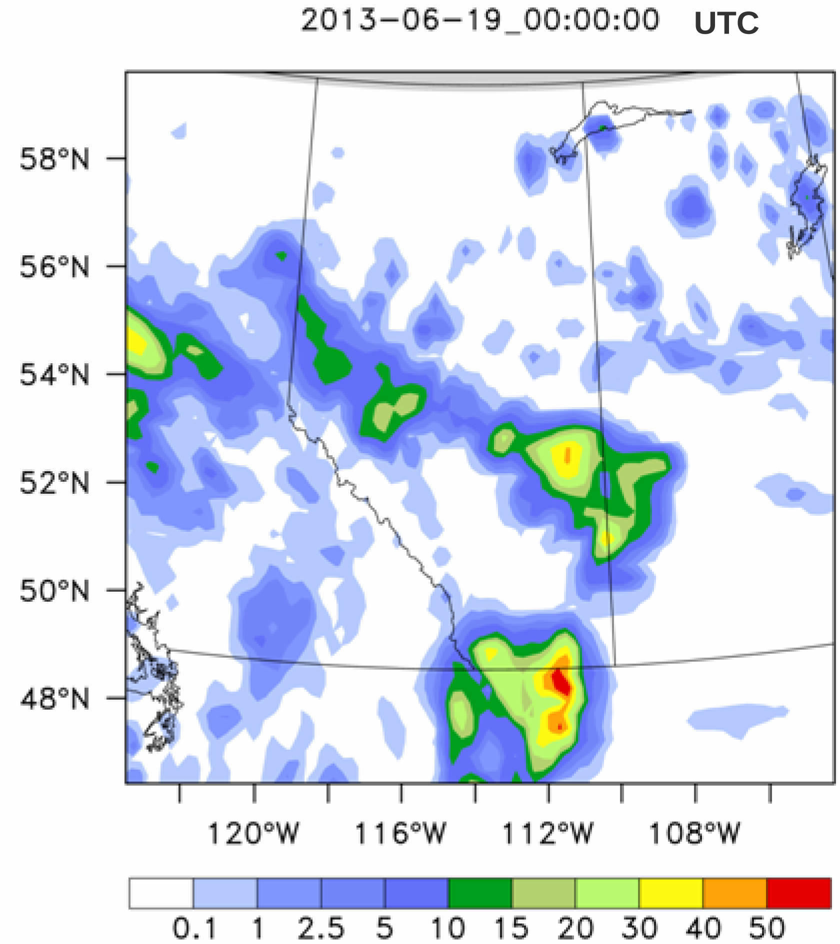
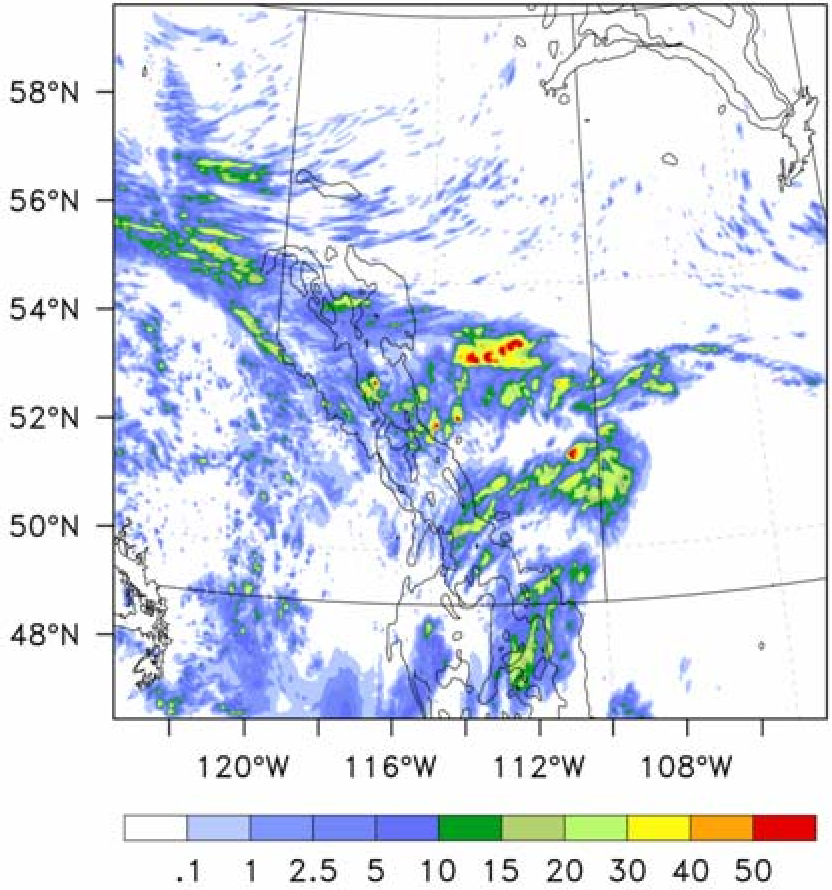


WRF simulation vs CMORPH

WRF

2013-06-19_06:00:00 UTC



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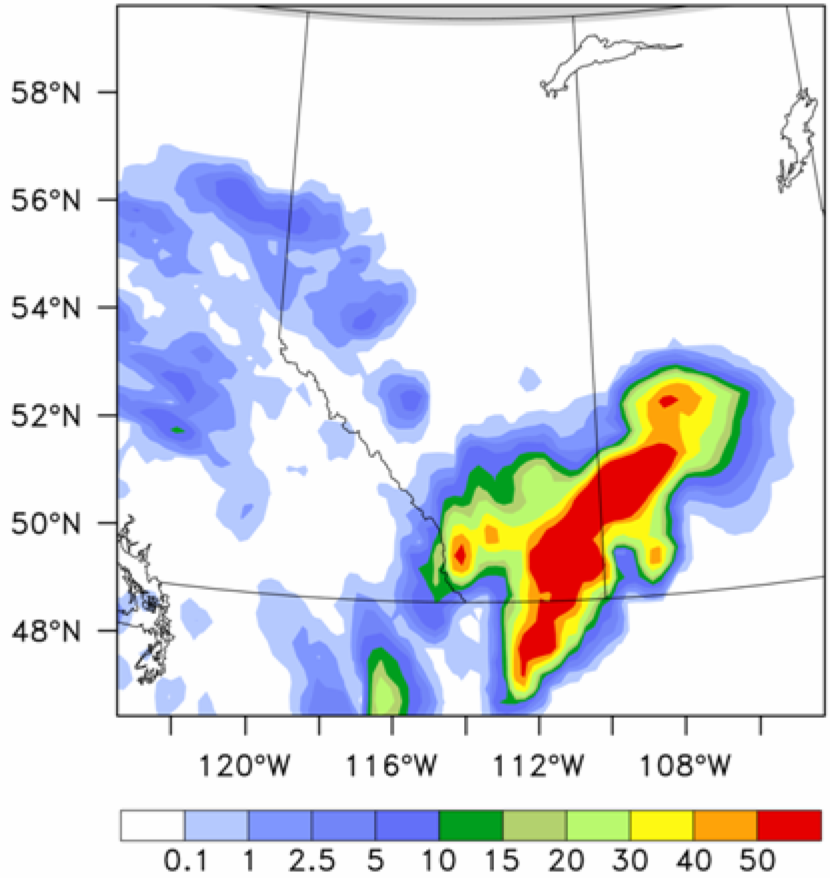

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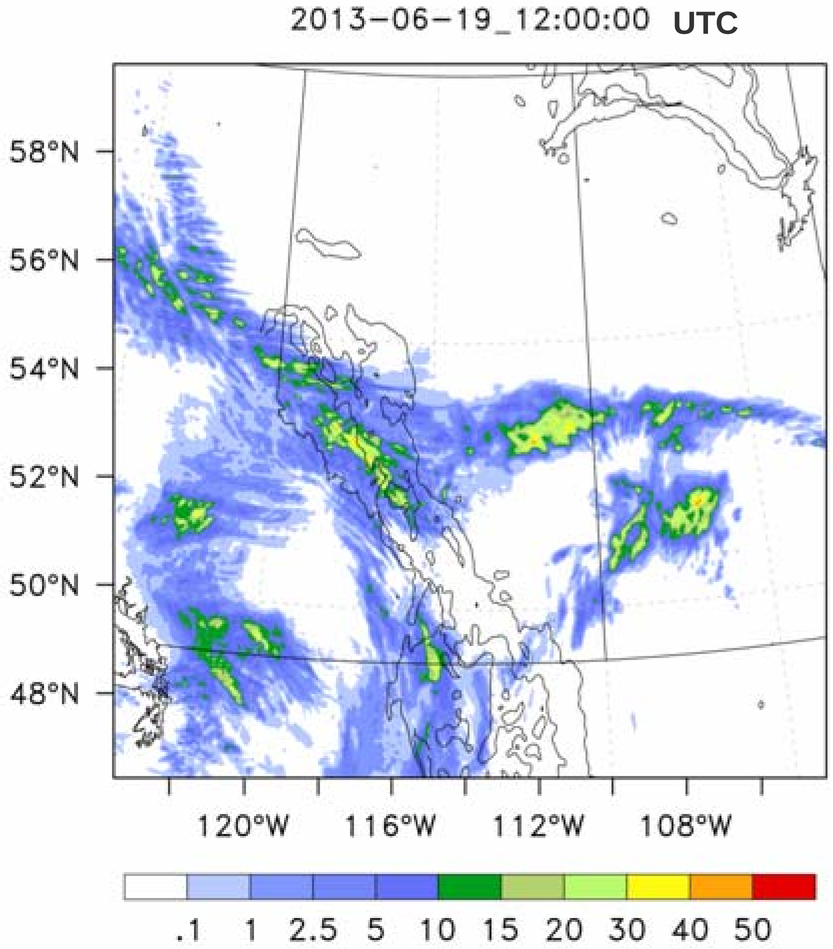

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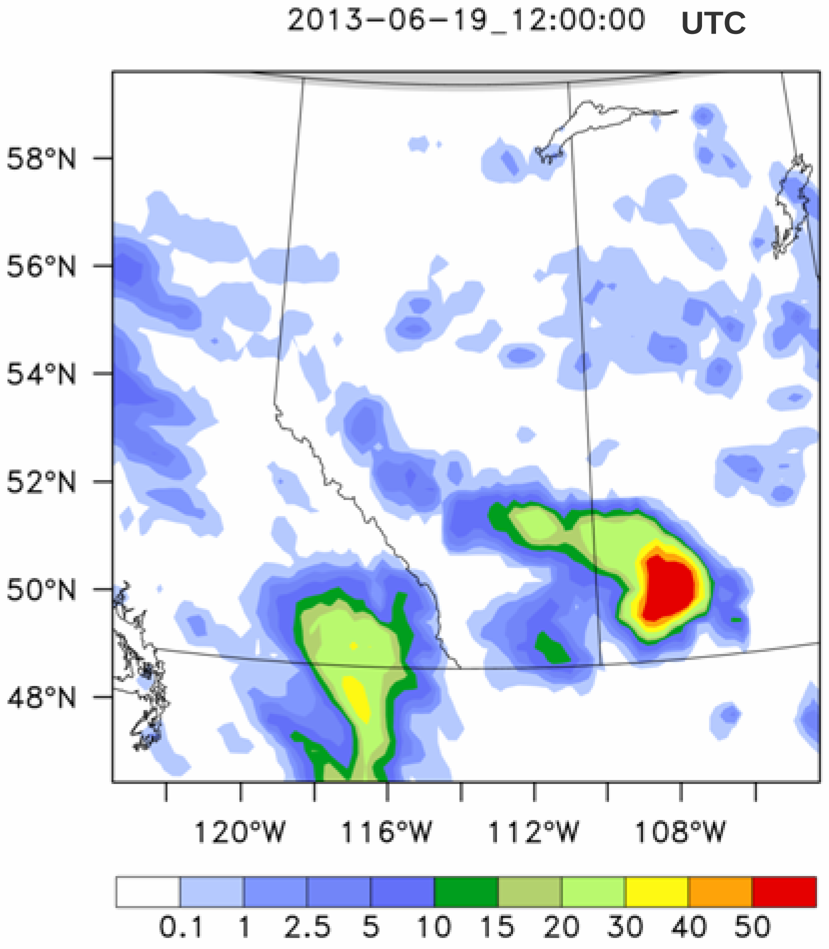

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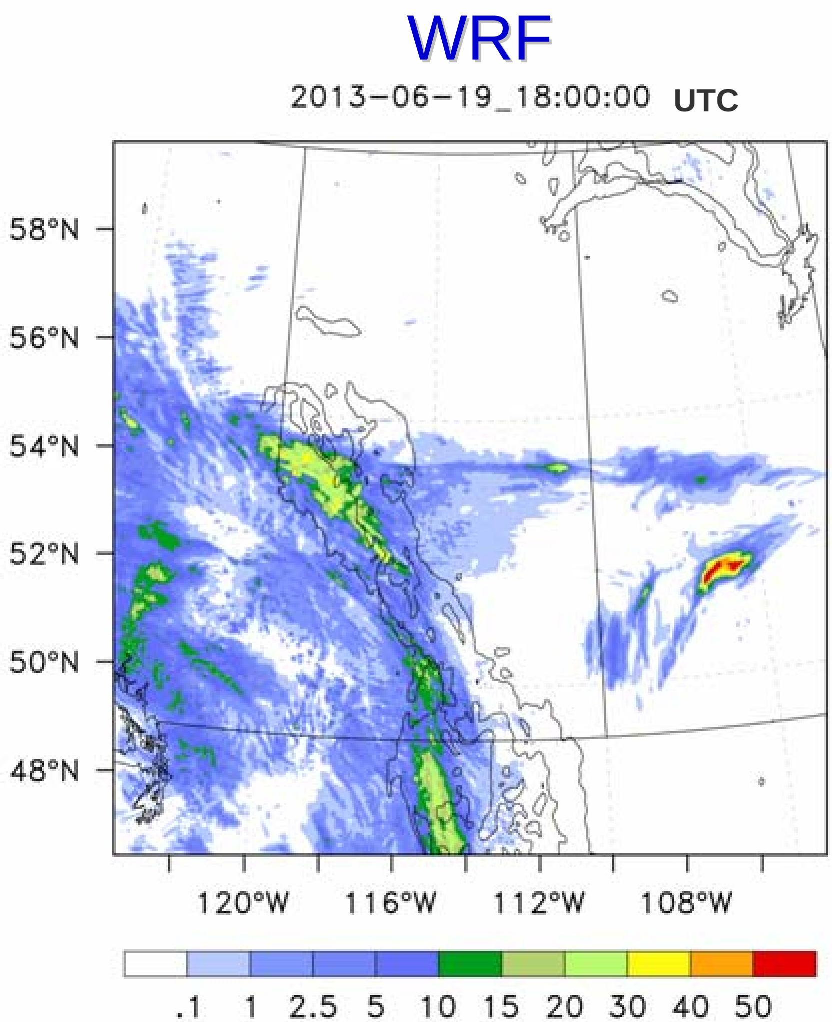

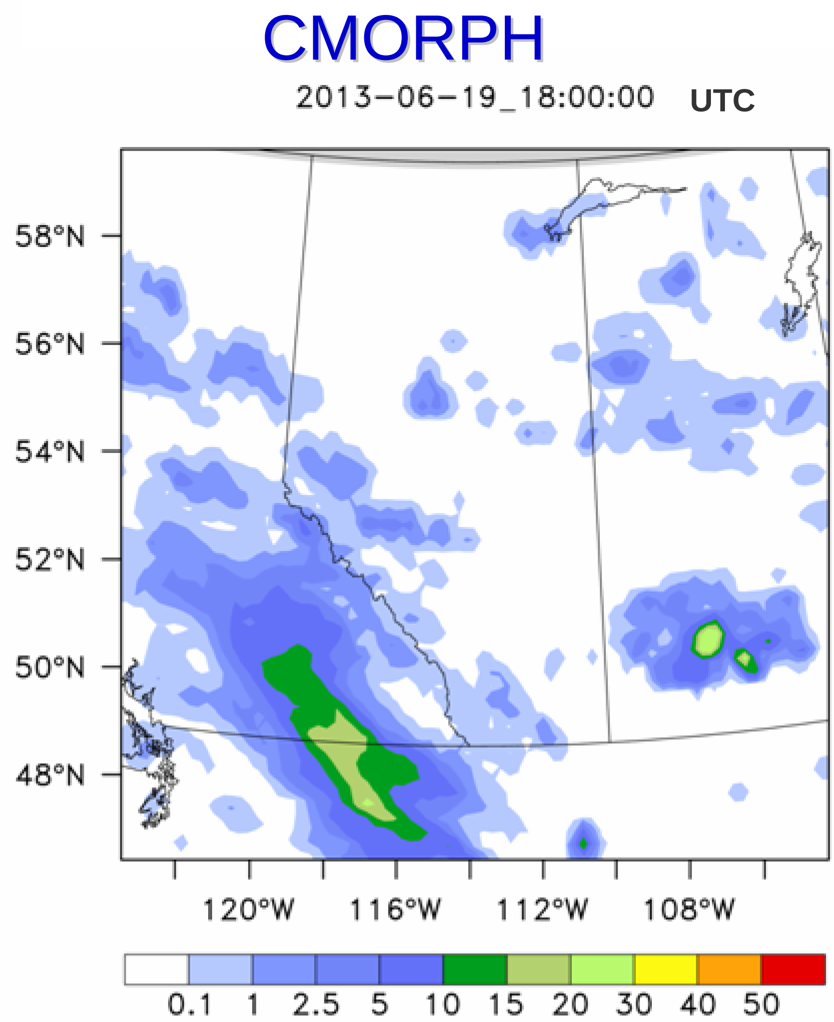

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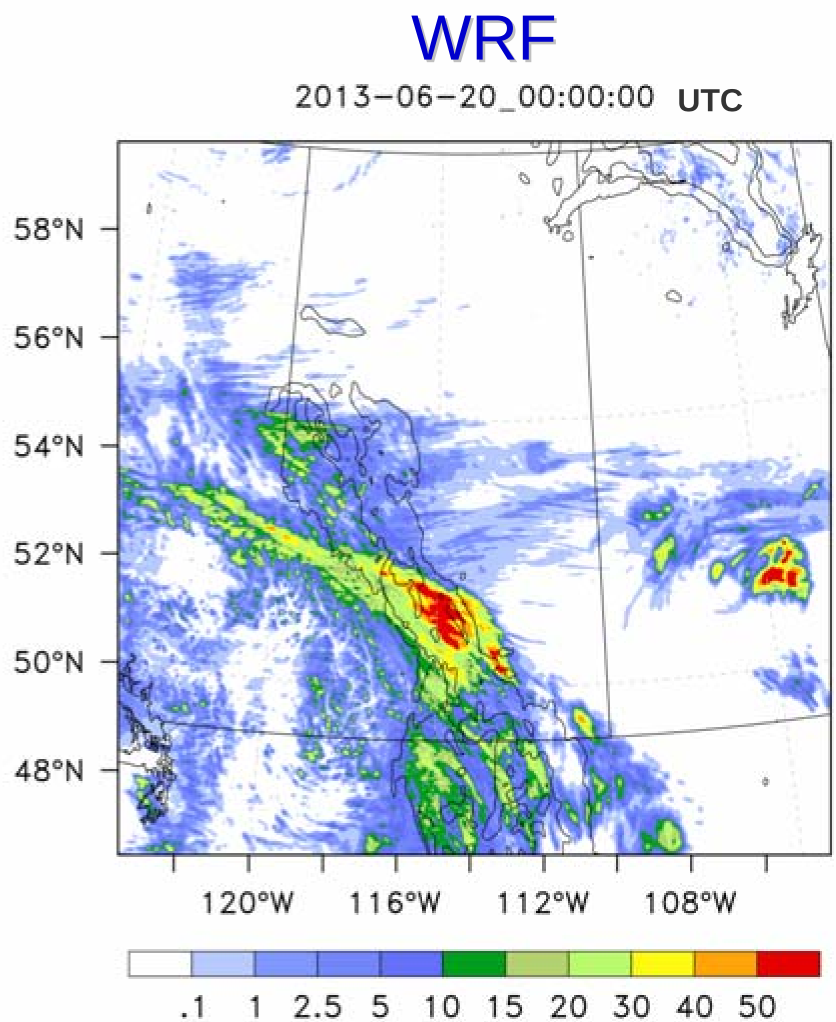

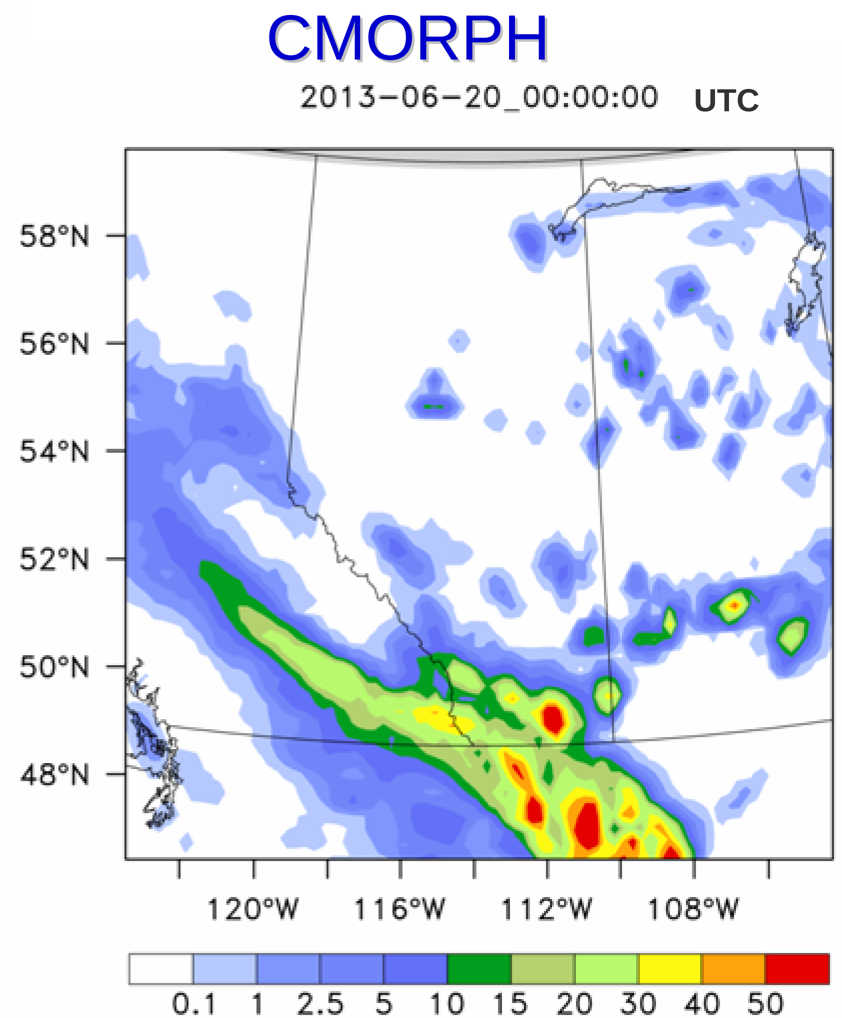

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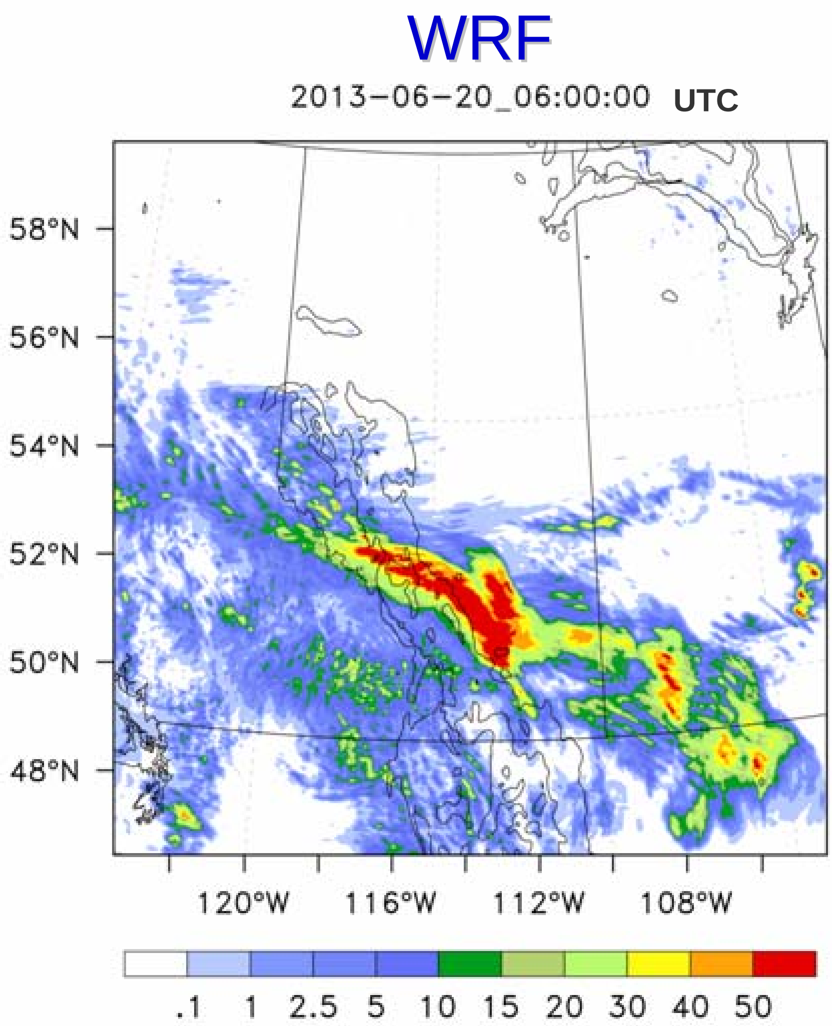

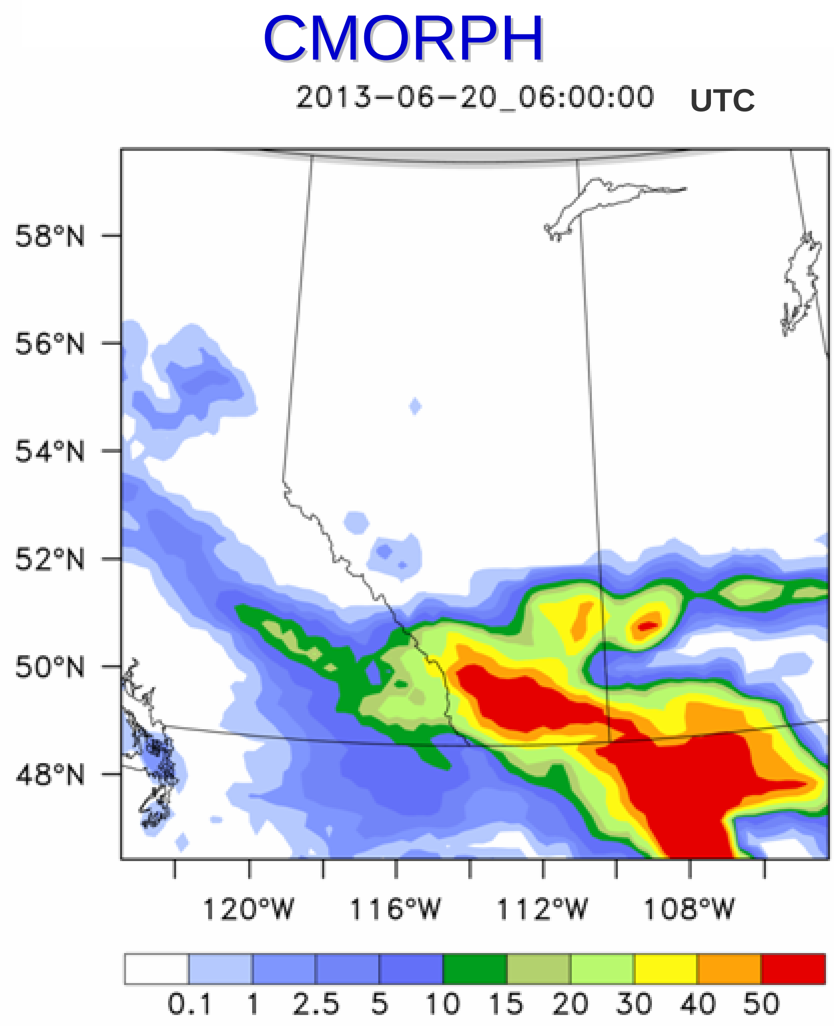

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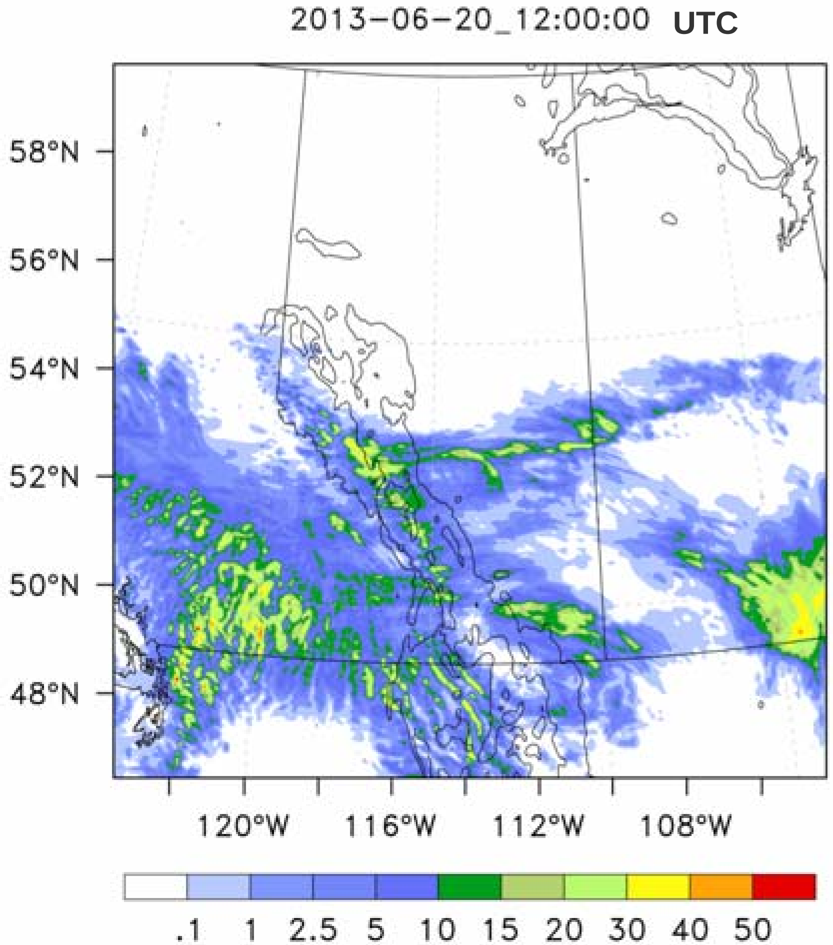

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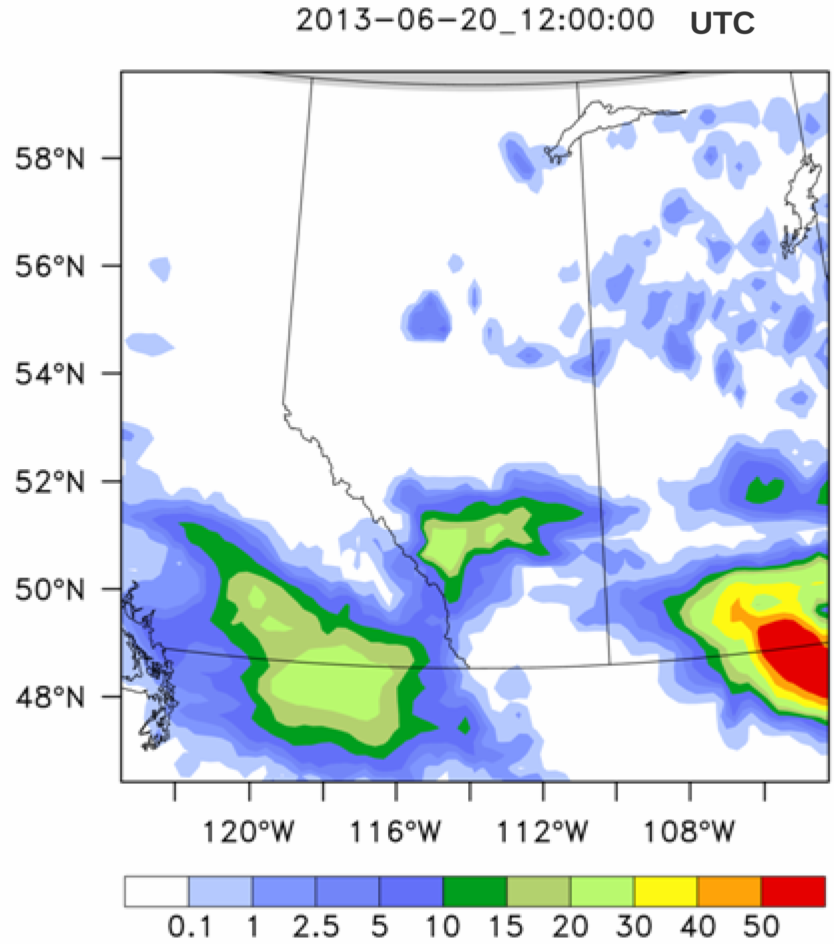

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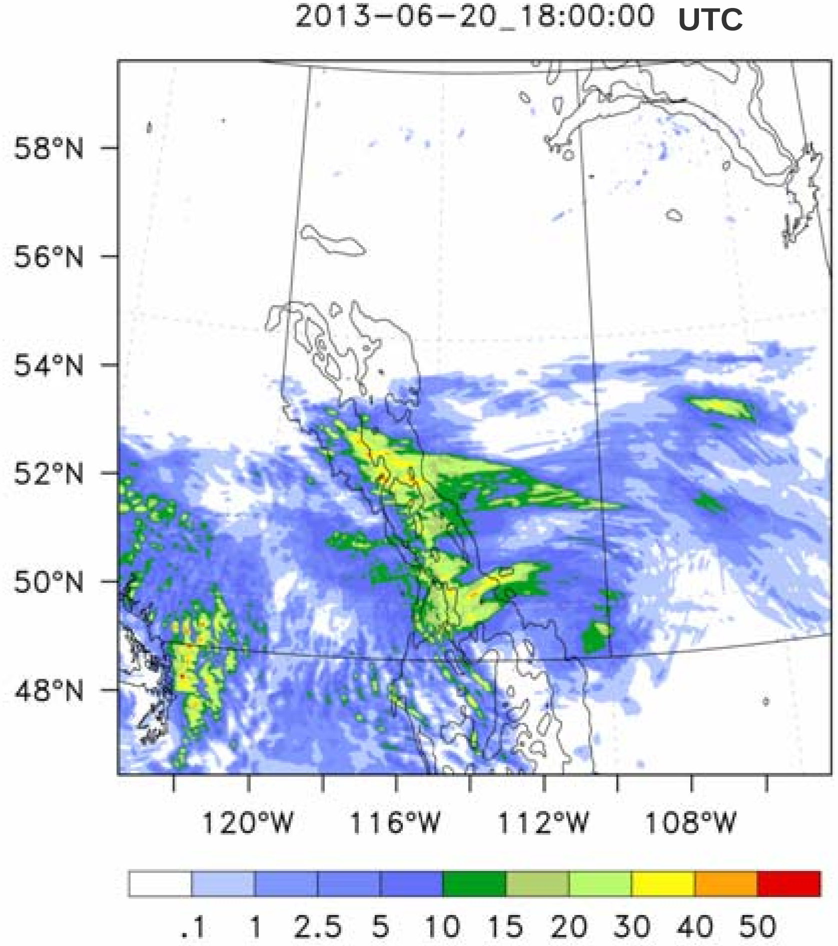

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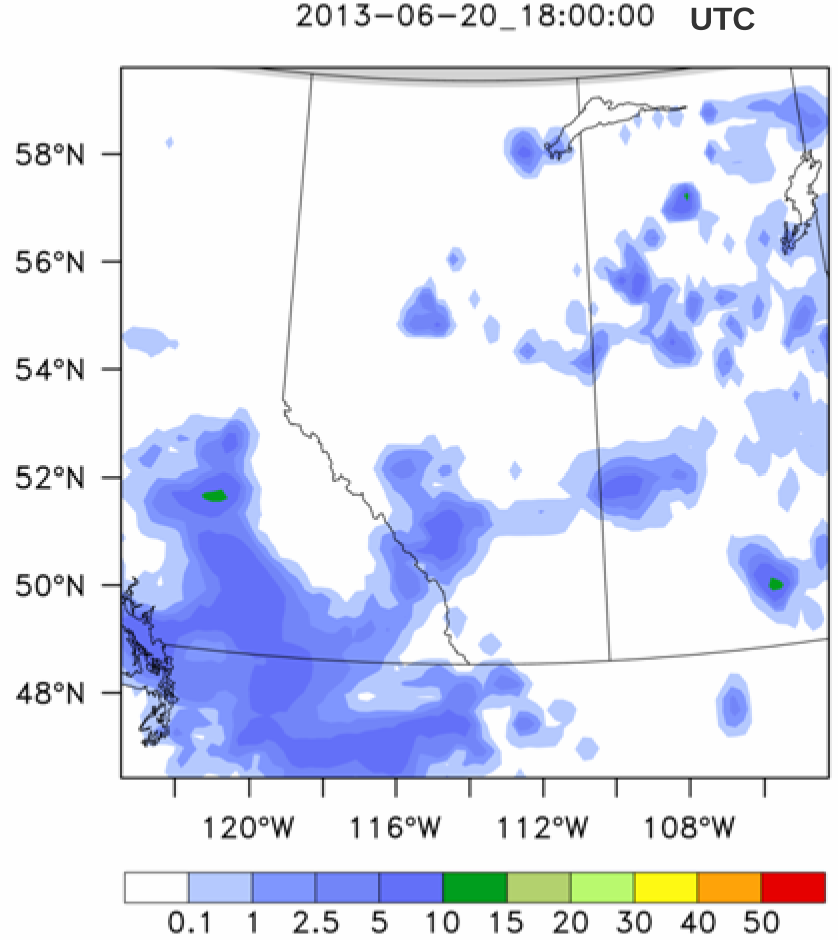

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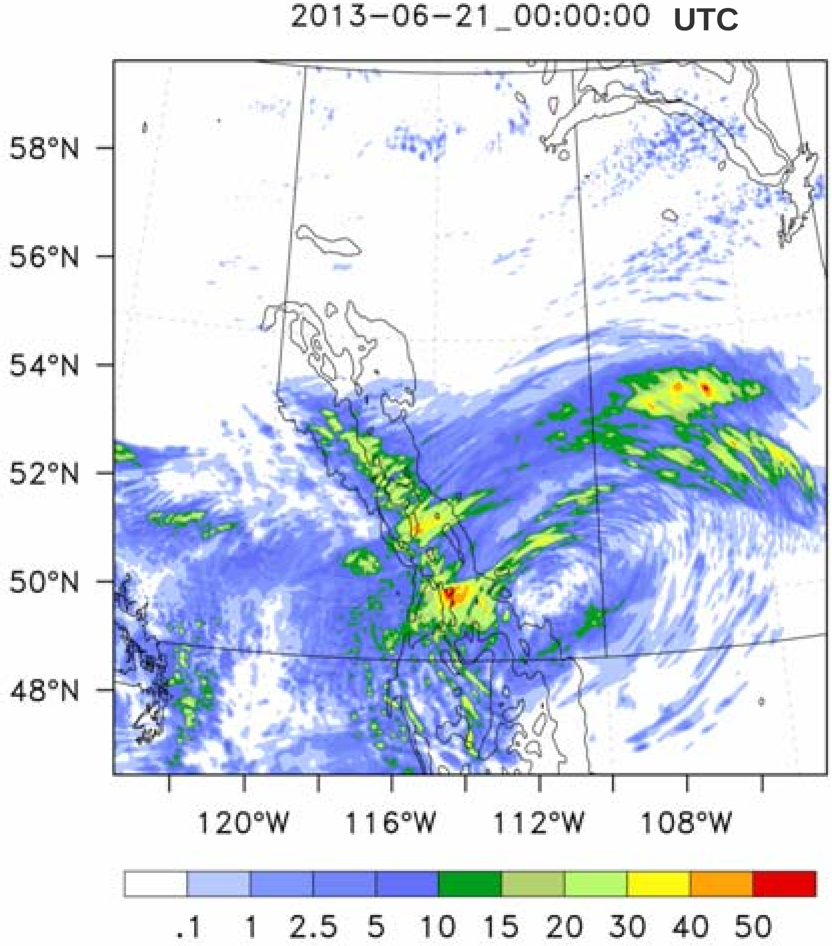

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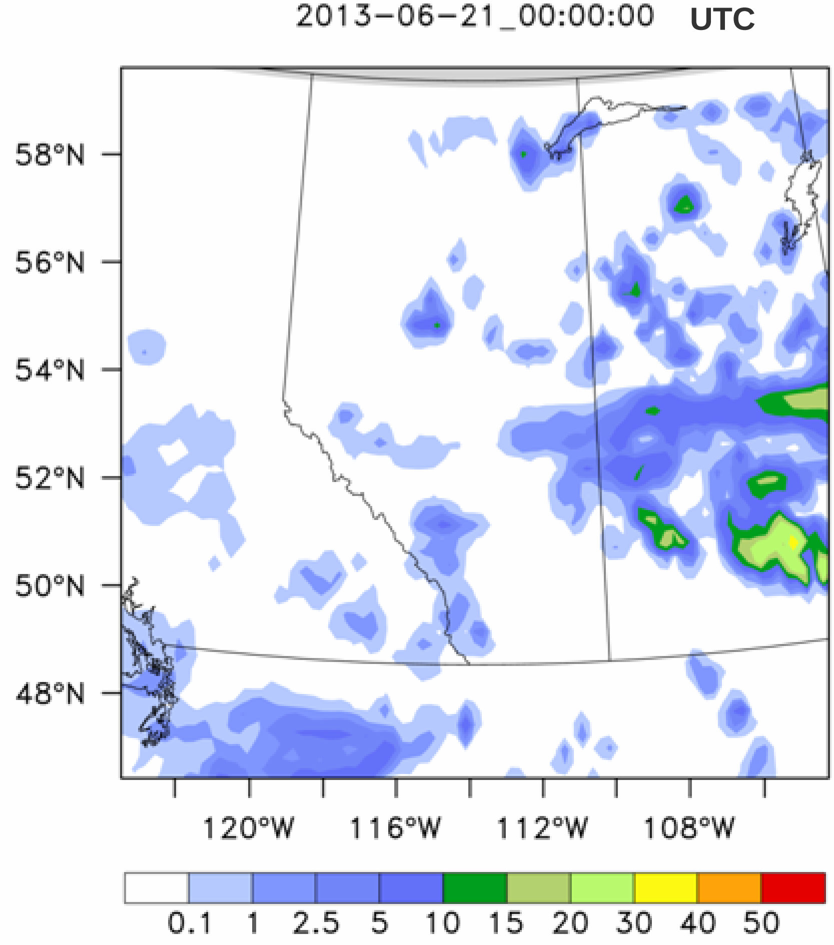

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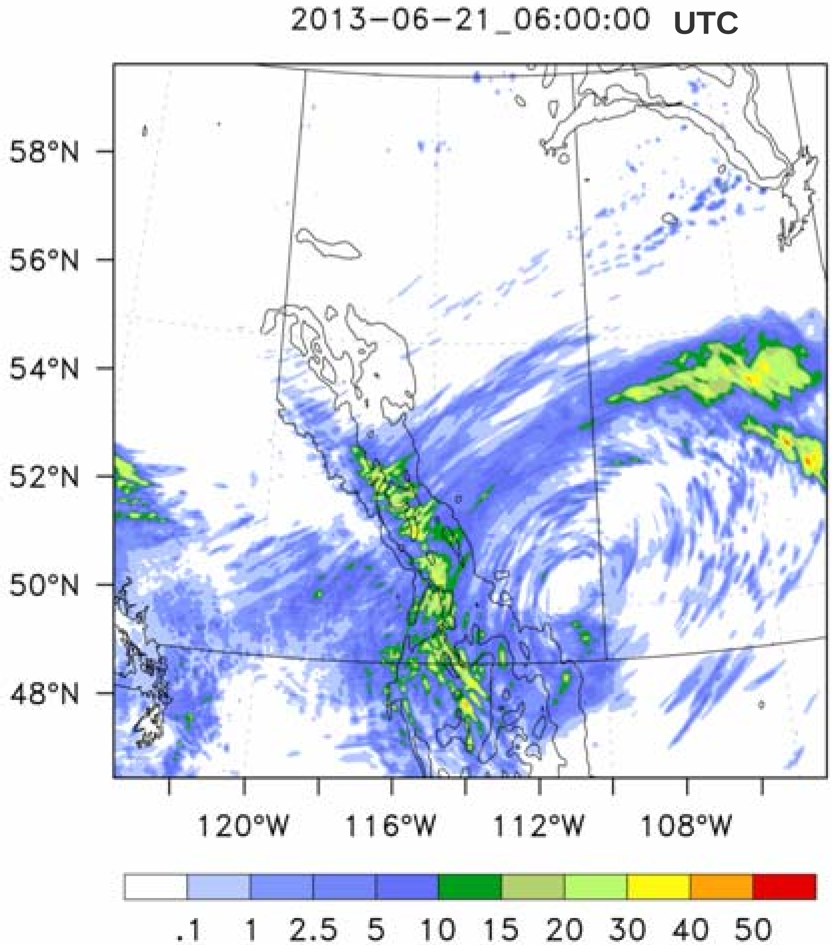

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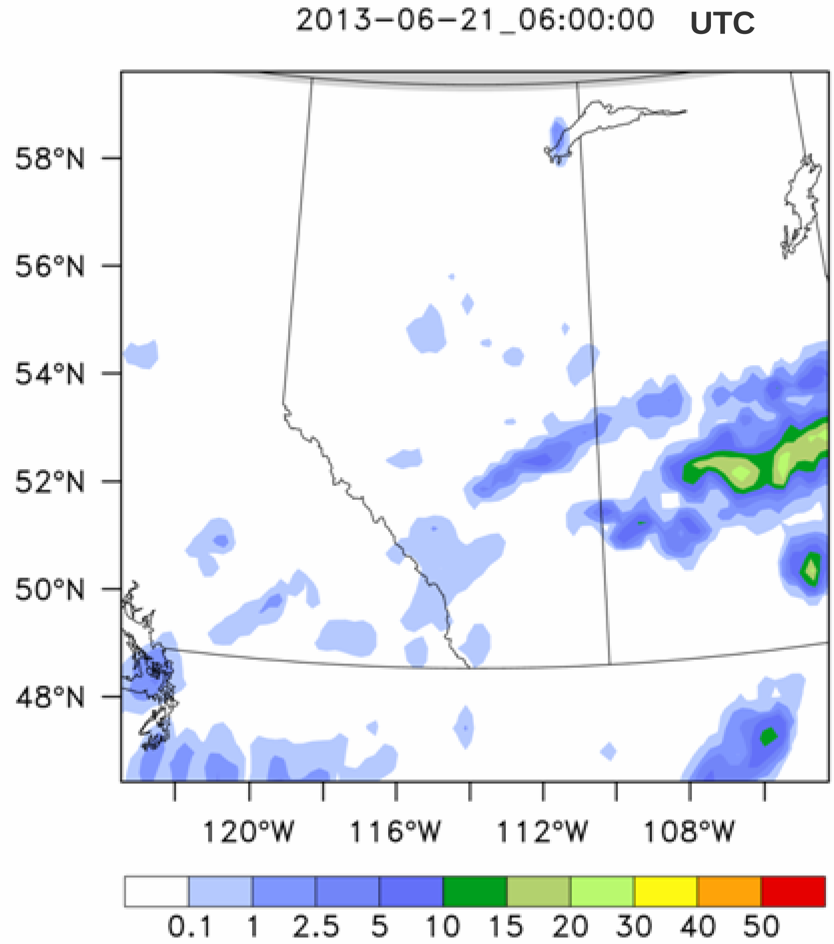

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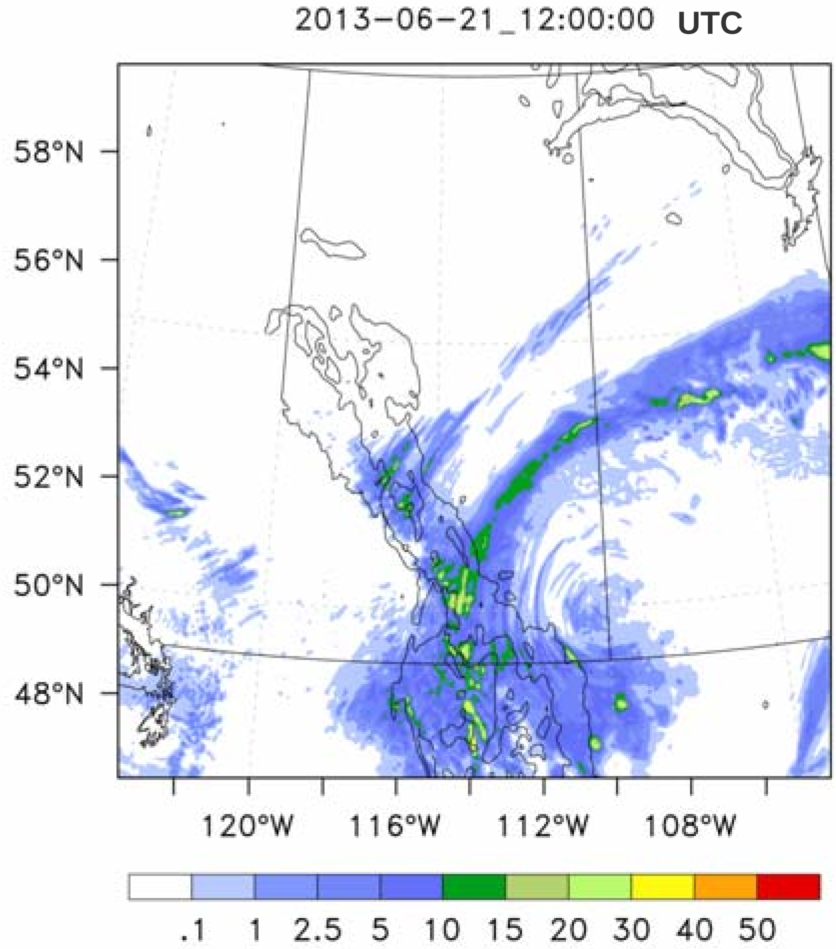

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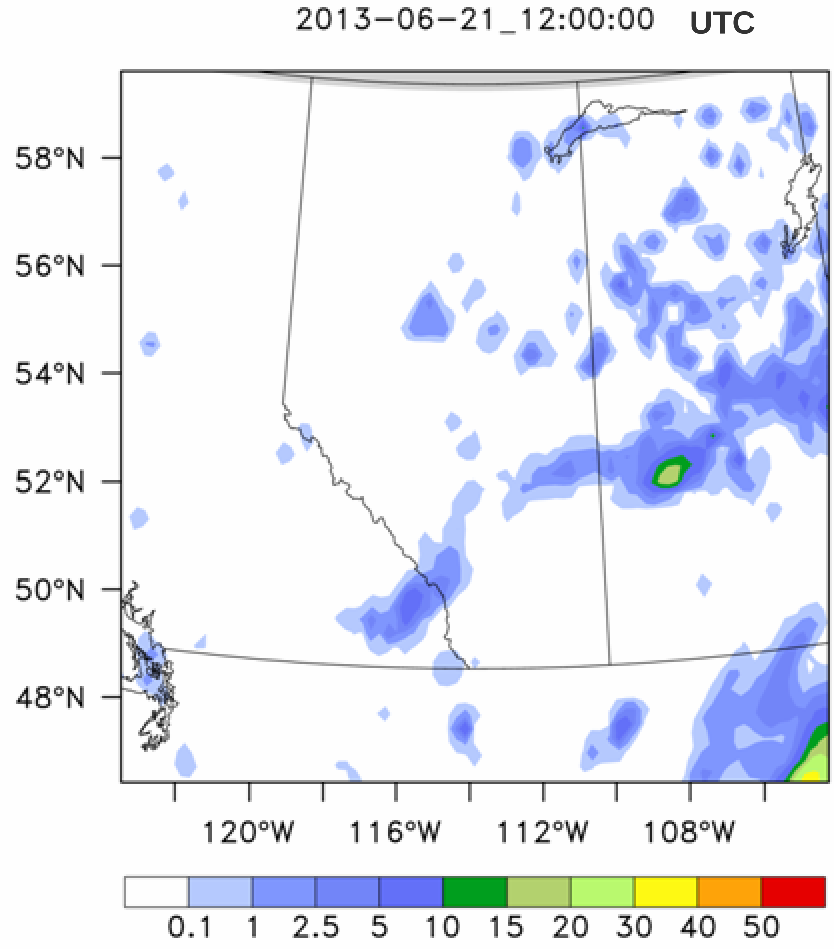
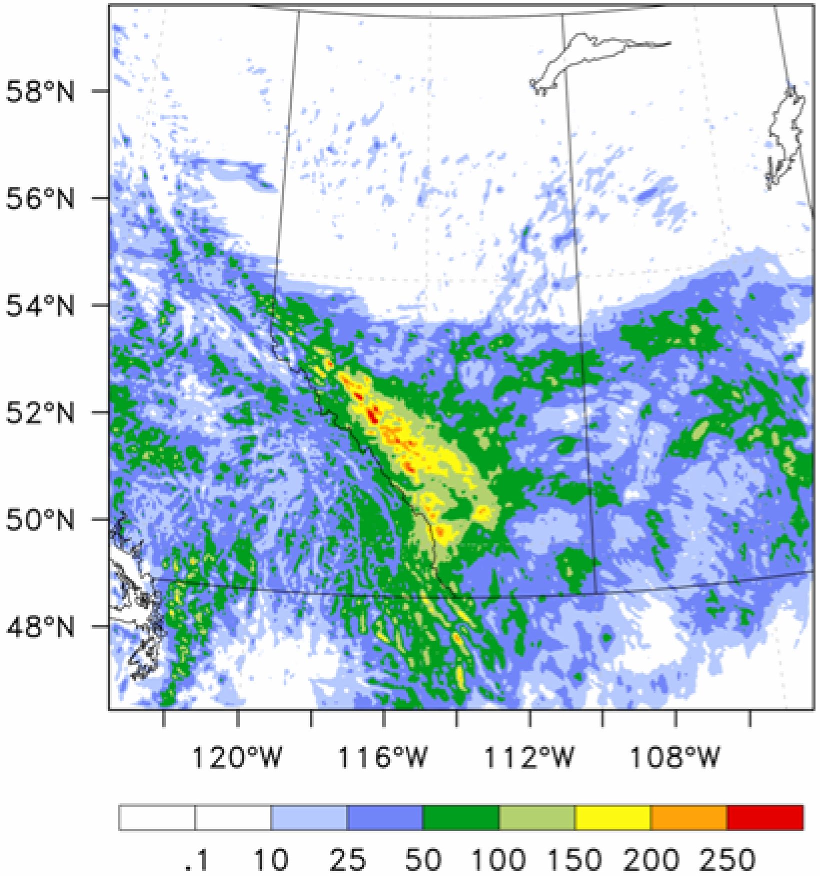


WRF simulated total rain

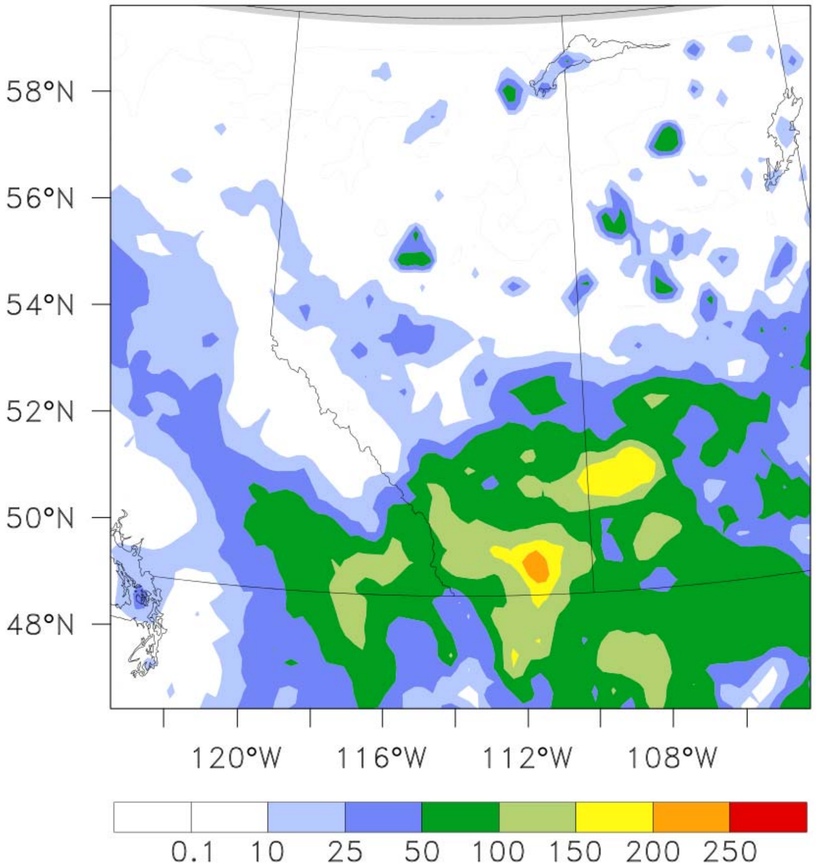
WRF

06/19 – 06/22

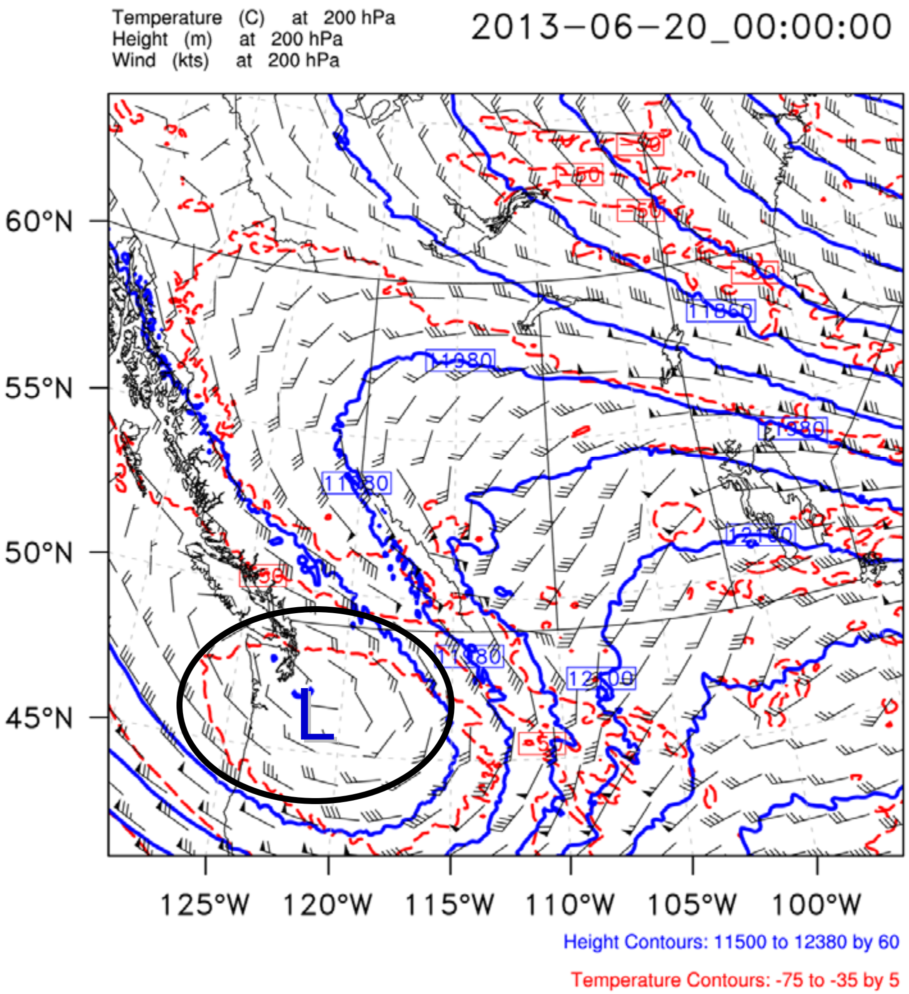


CMORPH

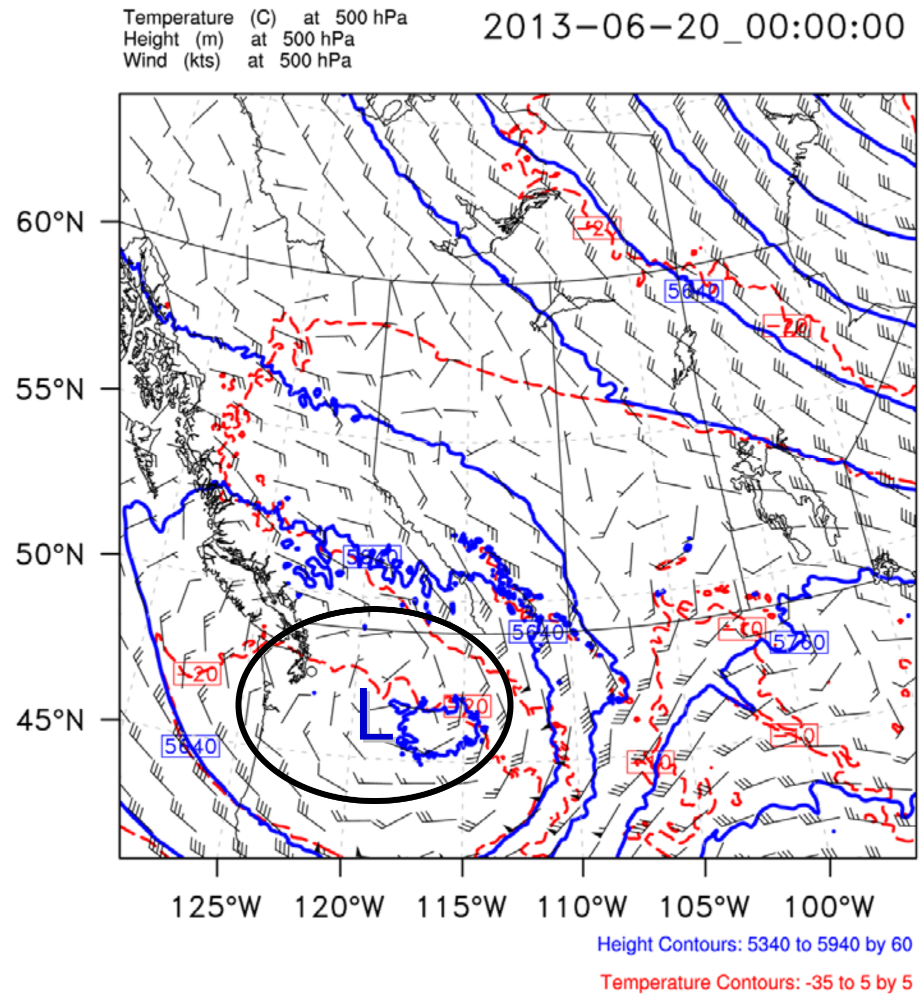
06/19 – 06/22



Synoptic Conditions for the Flooding

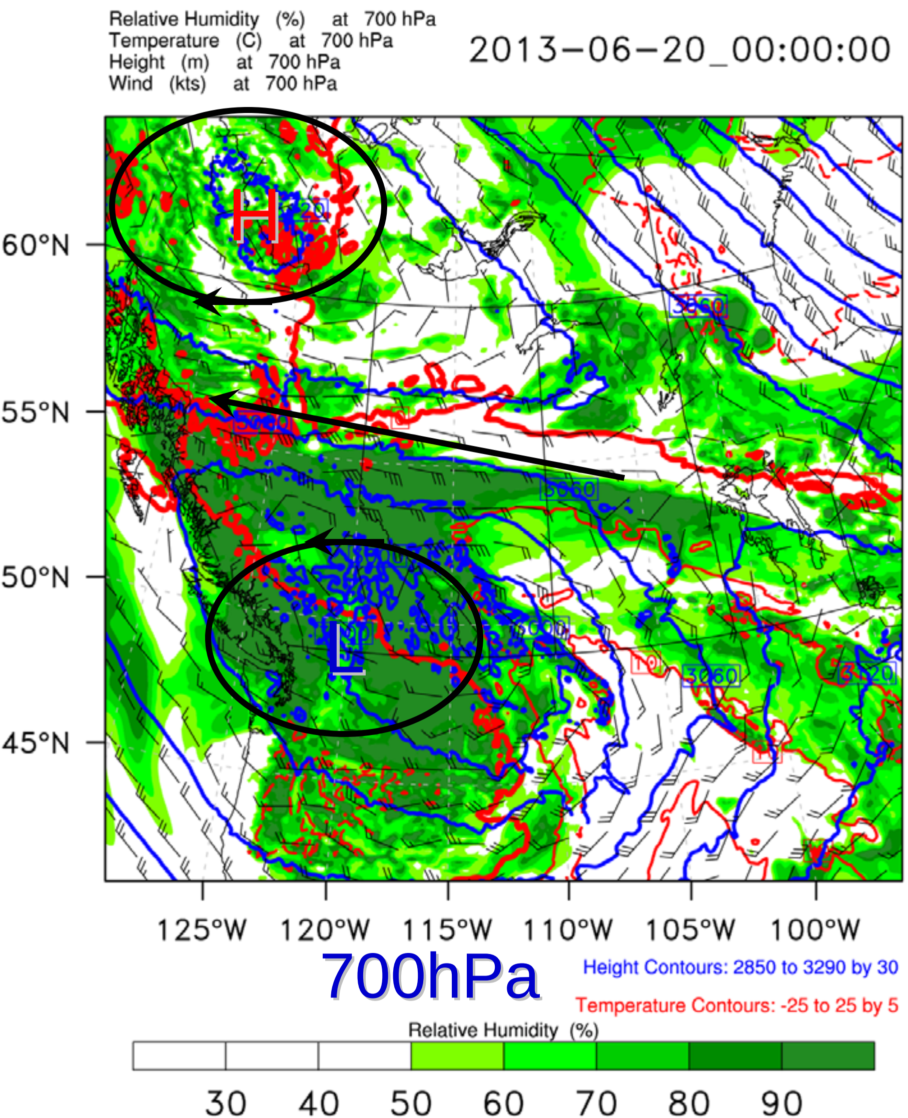


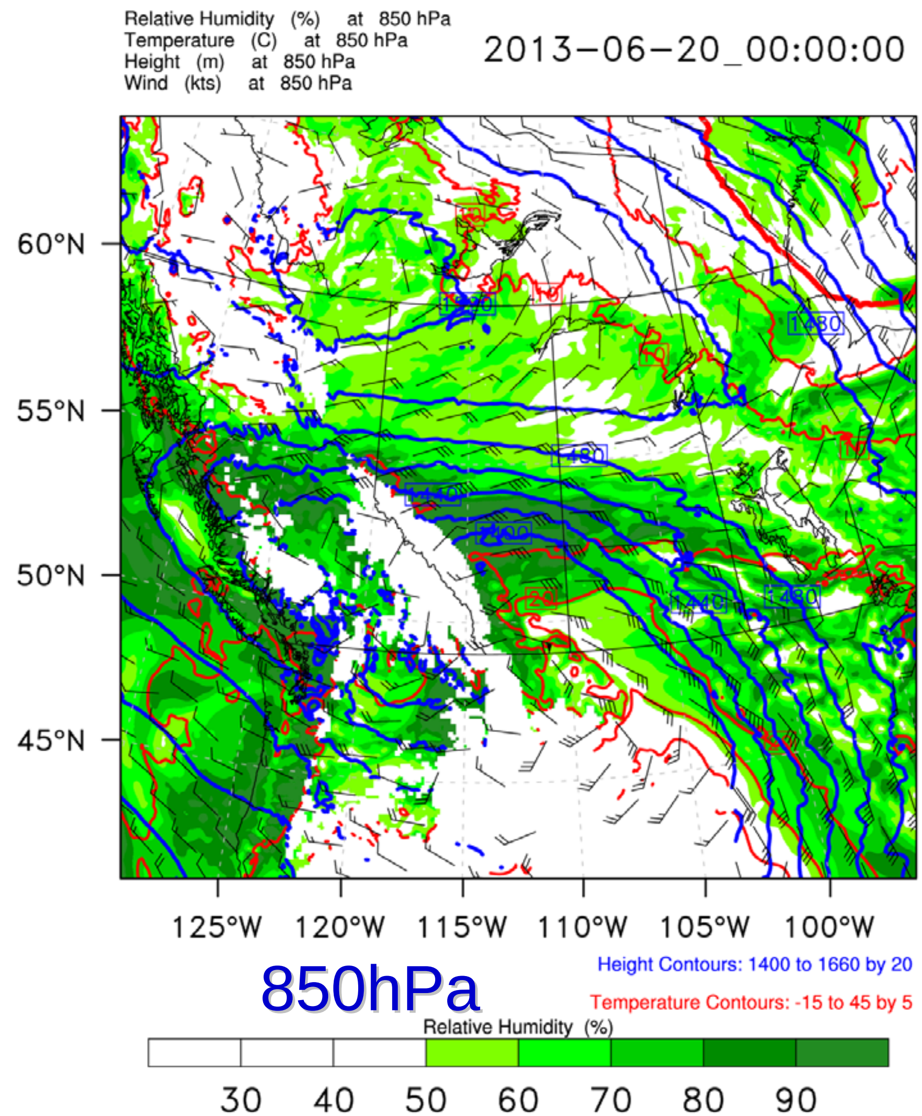
200hPa



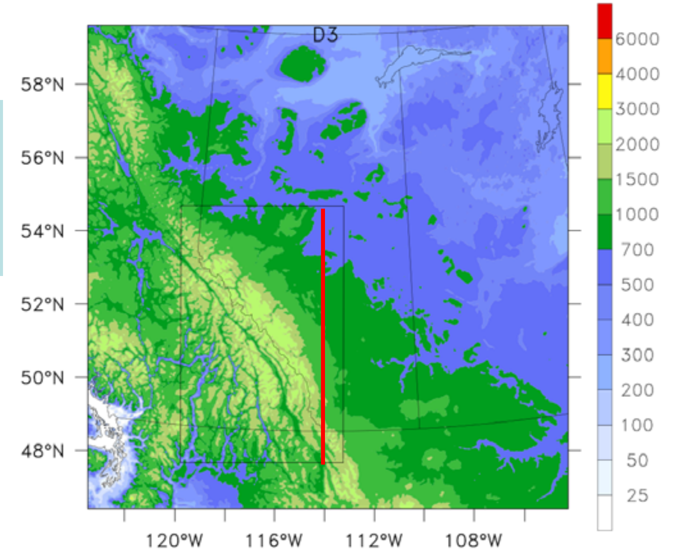
500hPa

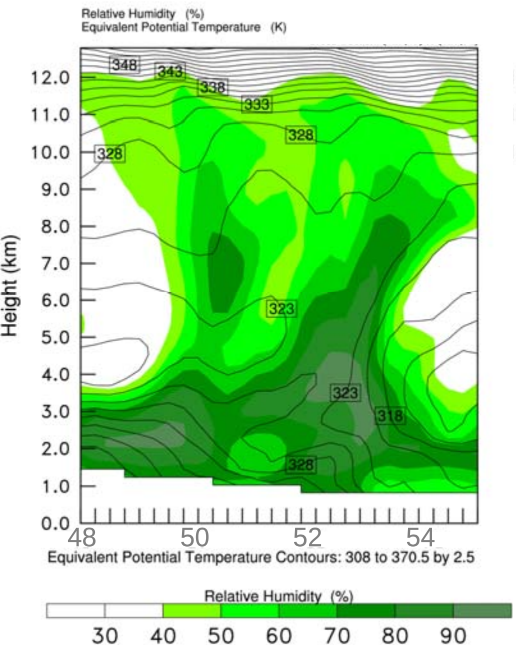
Synoptic Conditions for the Flooding





Water Vapor Sources





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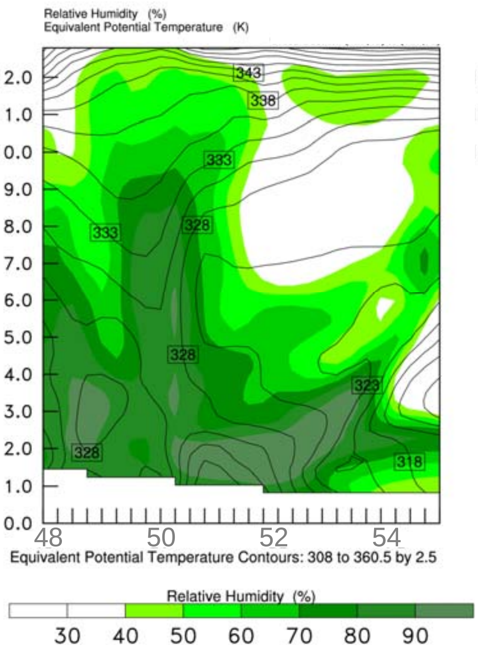

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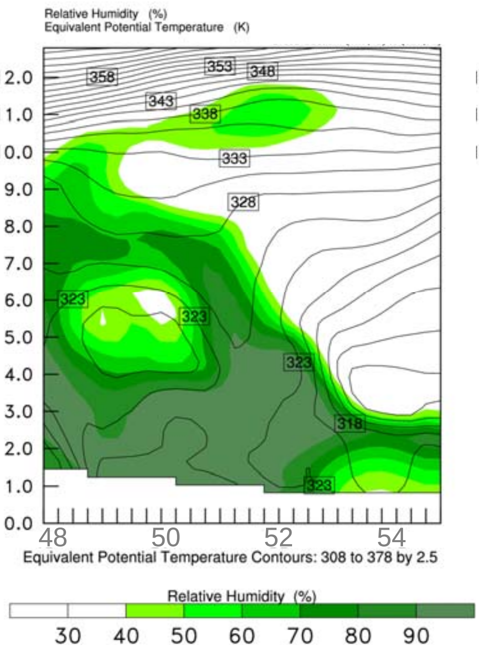

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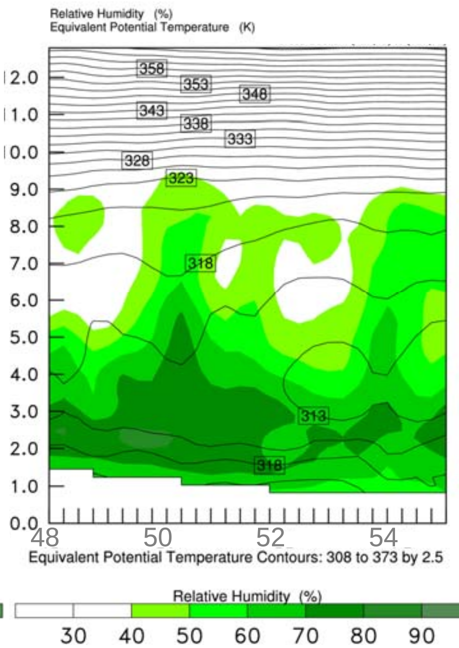

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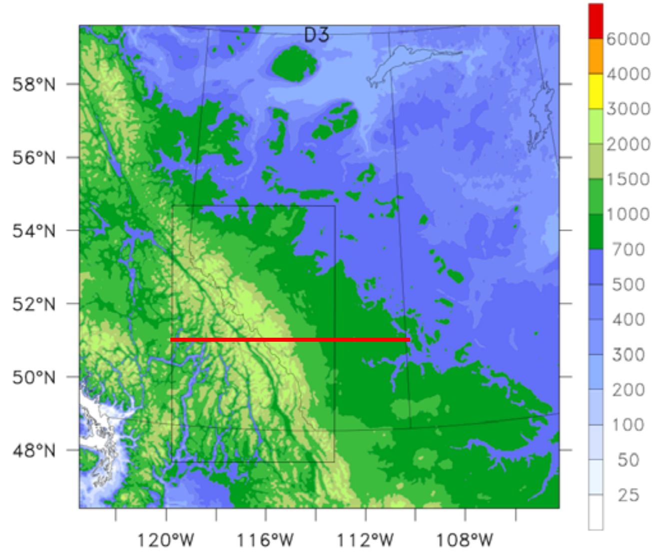
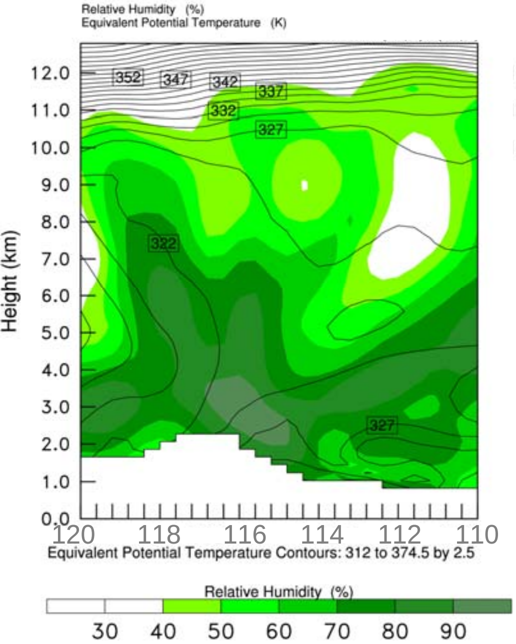
Water Vapor Sources





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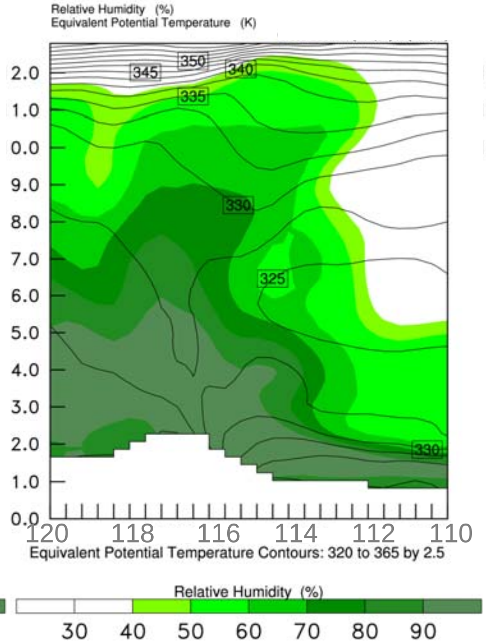

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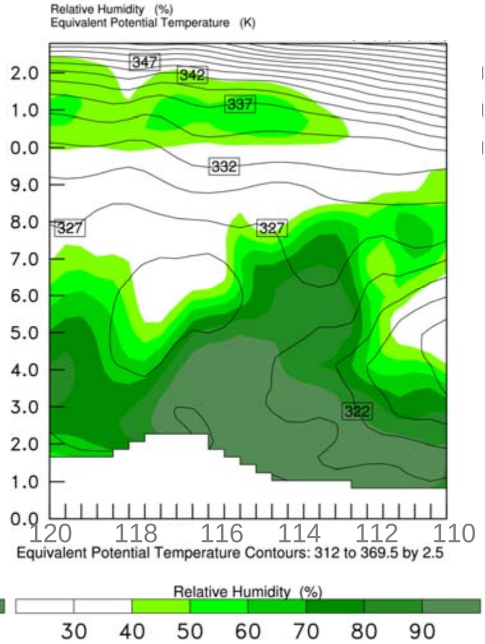

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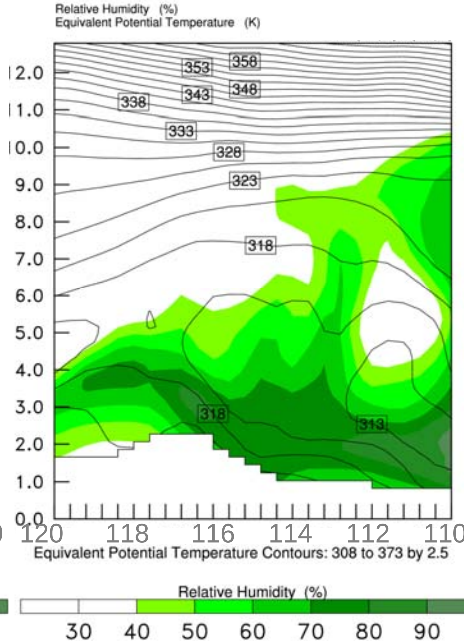
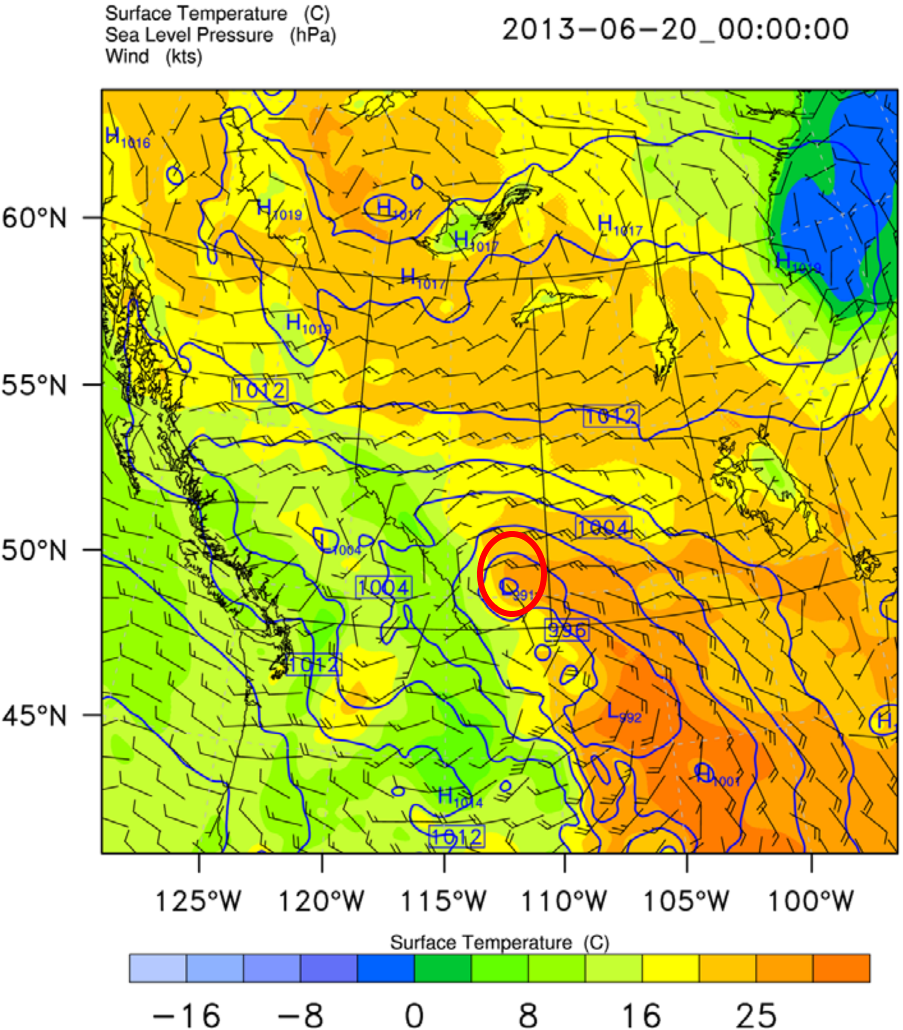


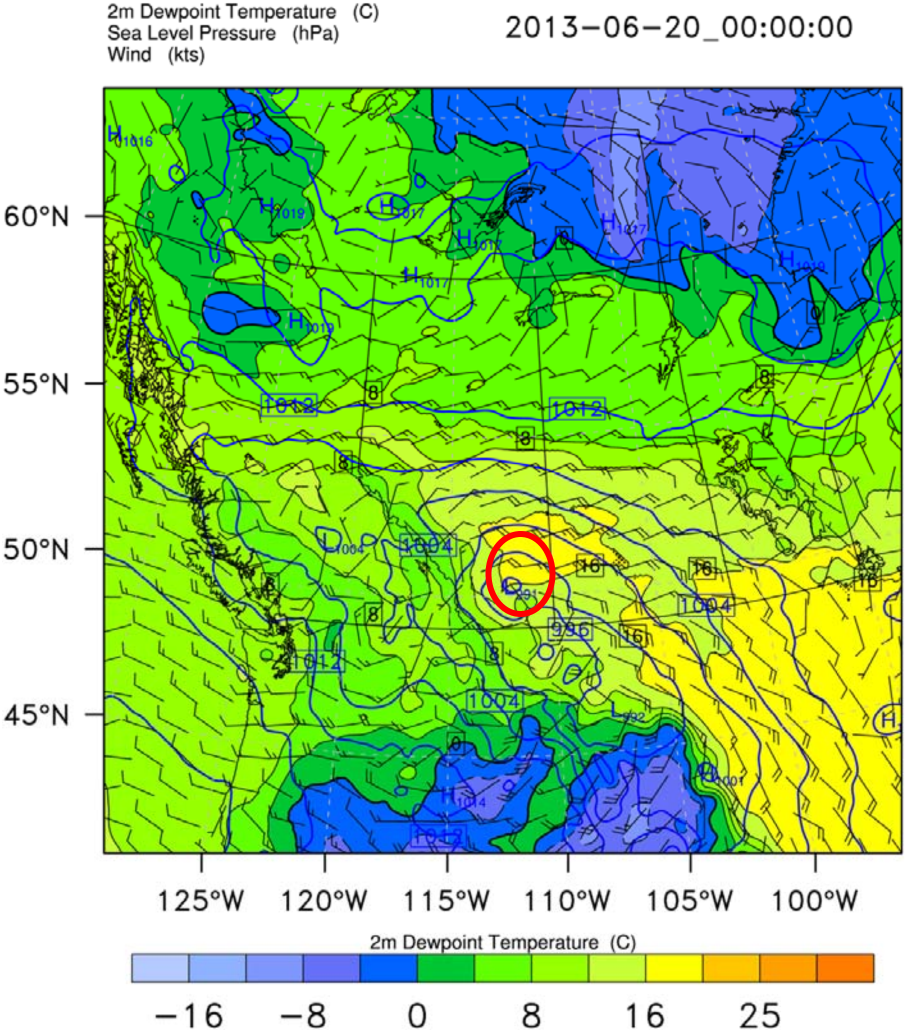
2013-06-22

Water Vapor Sources

Surface Temperature

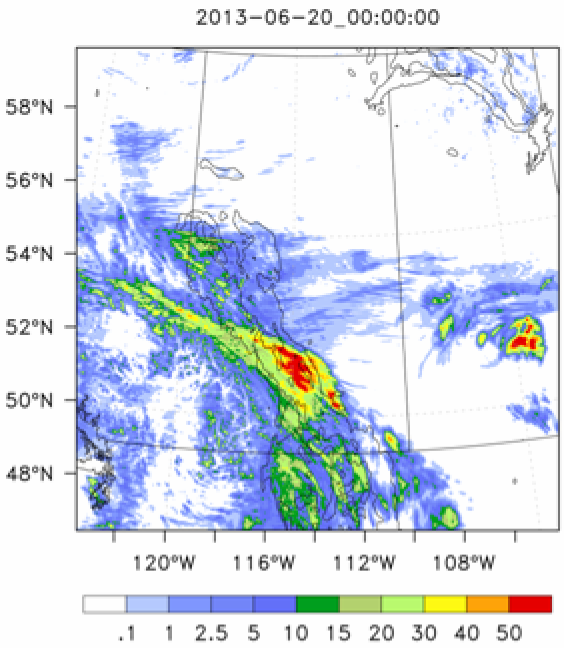


2m Dewpoint temperature

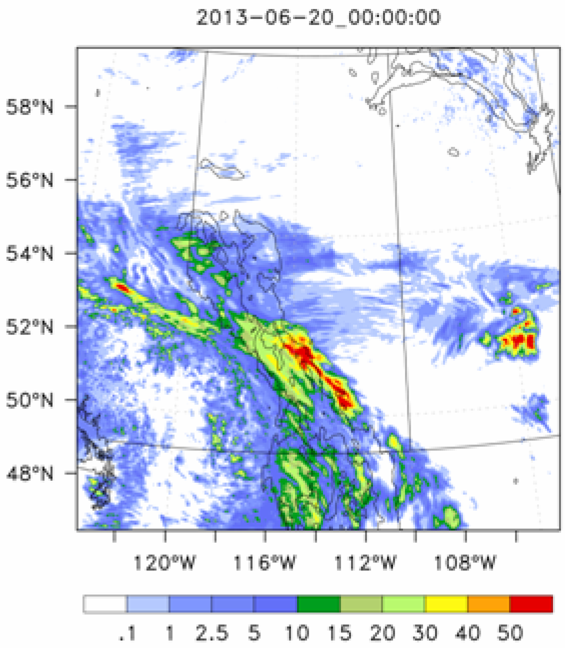


Effects of Orography

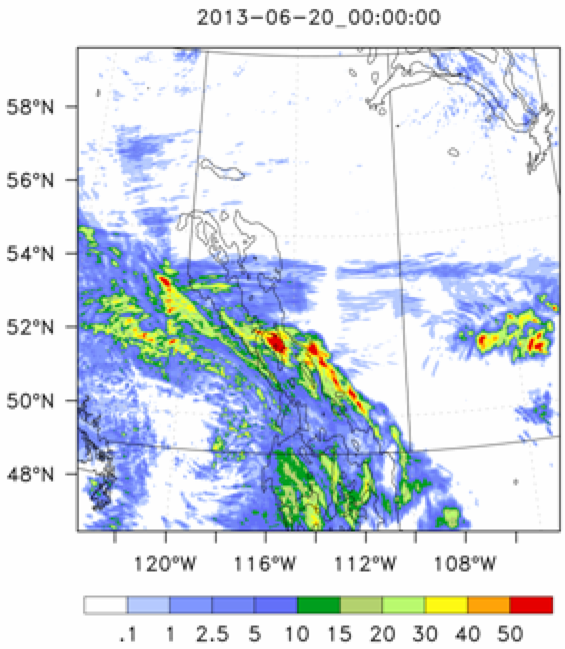
Original terrain



Smooth terrain

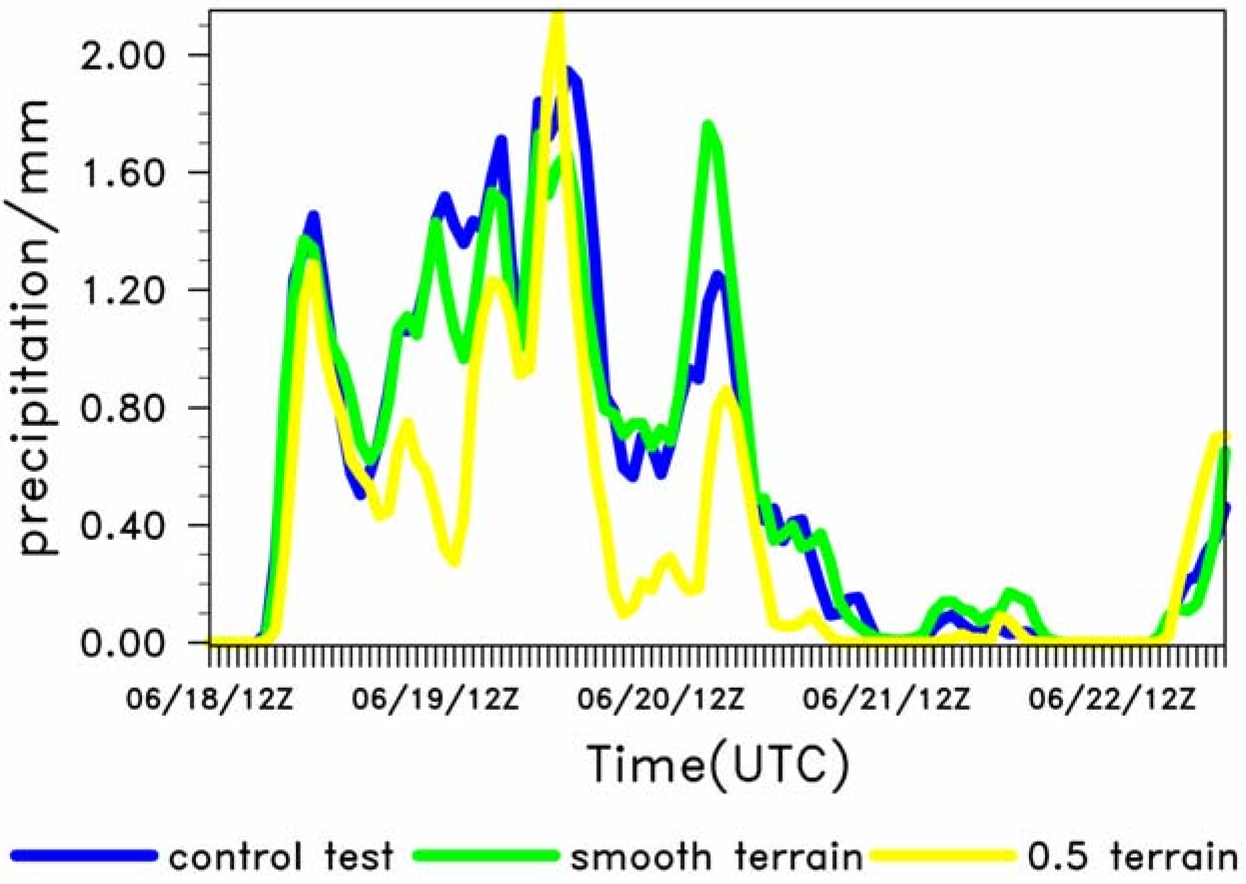


0.5 terrain



Effects of Orography

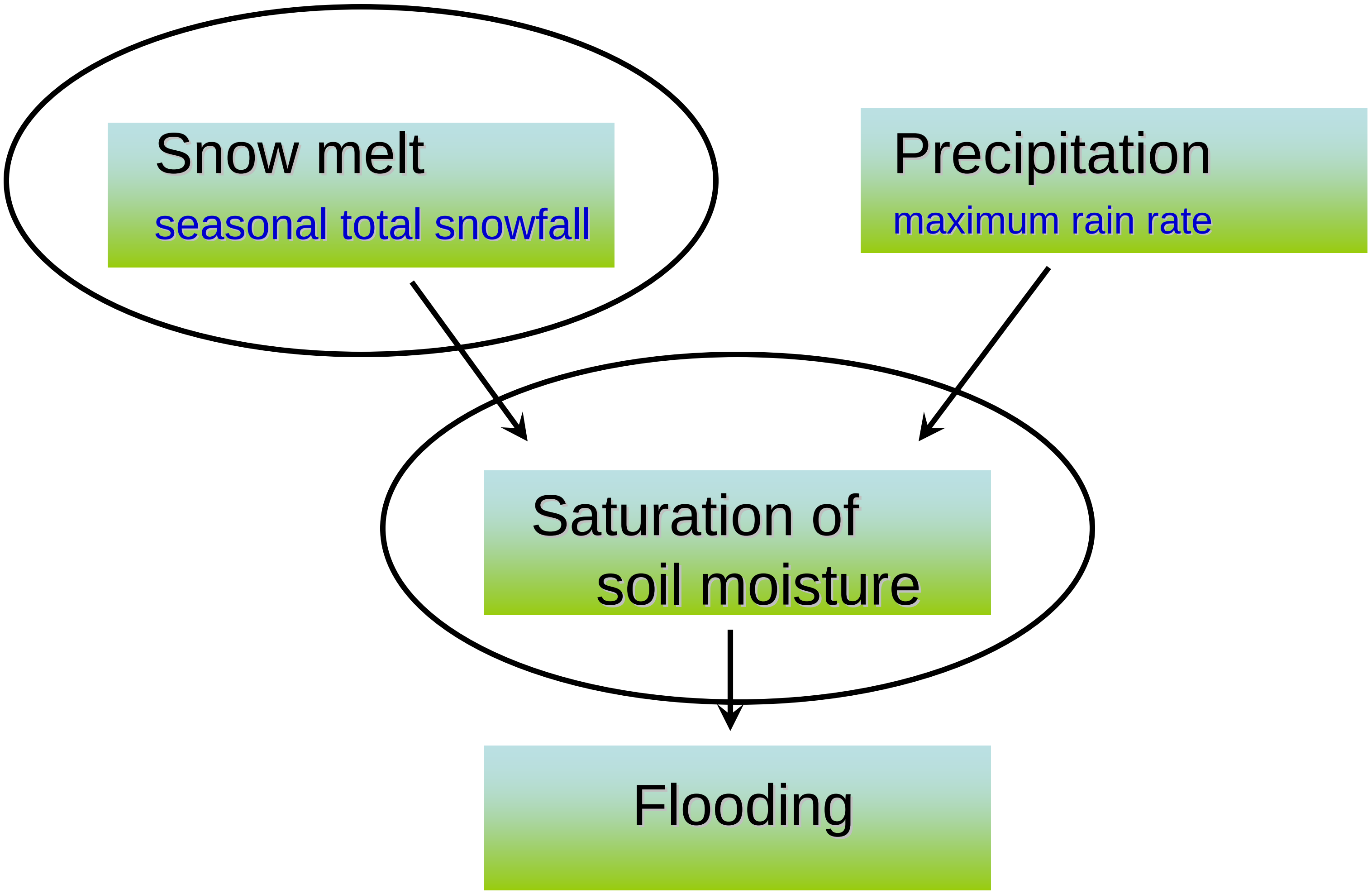
WRF simulated total rain (06/19-06/21)



Summary

- Rainfall structure and evolution play a critical role: large-scale dynamics, especially in settings with strong moisture convergence, can result in land surface processes playing a secondary role in determining flood properties.
- Local terrain can alter ‘‘details’’ of the heavy rainfall distribution, but not the occurrence of heavy rainfall and flooding over the region.
- A reduction in mountain elevation decreases maximum precipitation significantly over the mountains and foothills, indicating that heavy precipitation was mainly contributed by the orographic lifting of the mountains.

June 2013 Alberta Flooding



Next step

- Whether a combination of heavy rain and melting snow caused this serious flood event.
- Examine the antecedent soil moisture conditions: how much previous rainstorms had moistened the soil during the entire season and especially over the few days leading up to the June 2013 Alberta flood so that the normally arid mountainsides were likely not able to rapidly absorb the additional rainfall of the sudden.
- Whether land surface processes playing a secondary role in flooding. What is the major role of surface evaporation, changing the buoyancy or providing additional moisture to the already plentiful moisture influx from the Prairies. Local evaporation may have enhanced the precipitation and helped perpetuate and prolong the conditions.

Future work:
Regional Climate Change Studies Using WRF

Modeling studies of regional climate of Canadian Prairies using WRF model, paired with long-term trend analyses of variables linked to the hydrologic cycle to study:

1) human impacts (due to land-use and land-cover change) on regional climate;

2) the climatology of extreme rainfall and flooding: to use regional climate analyses based on WRF simulations as a vehicle for enhancing global model capabilities for regional climate analyses, with a special focus on the climatology of heavy rainfall and flooding.