Convective Precipitation Initiation over the Lee Side of the Canadian Rockies

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GWF
GLOBAL WATER FUTURES
SOLUTIONS TO WATER THREATS
IN AN ERA OF GLOBAL CHANGE

High river, Alberta Canada. June 20th 2013

Canadian press, Jordar Verlage

Regional climate modeling in a convection permitting configuration to complement field experiments.

Research gap

Limited understanding of processes modulating the initiation of convective precipitation over complex topography.

Objective

Describe the mesoscale atmospheric features that control the initiation of convection in mountainous regions.

Field experiments

To better understand convective precipitation features

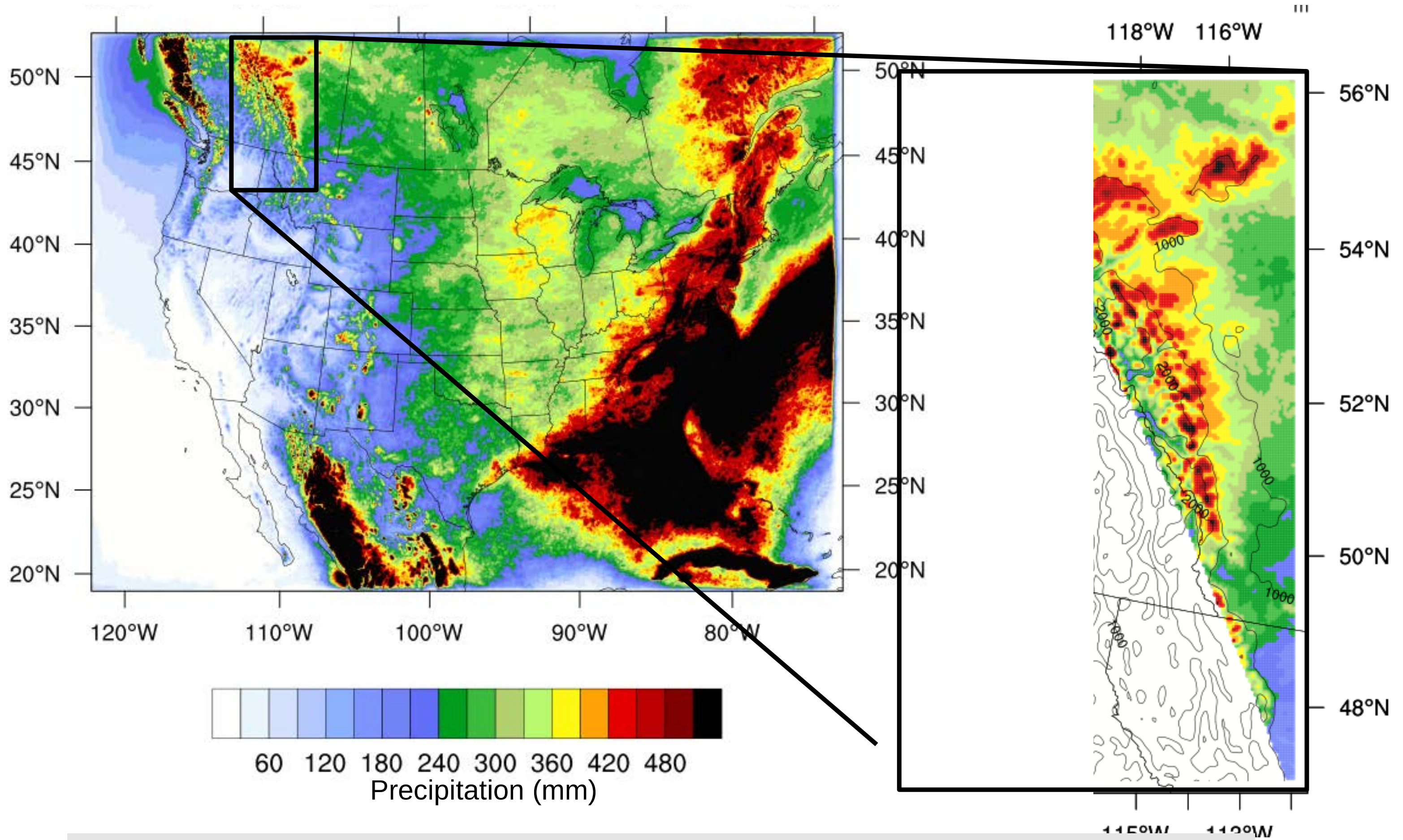
Data and Domain

Weather Research and Forecasting Model (WRF) version 3.4.1.

- Boundary conditions: ERA-Interim
- Run period: 2001-2013
- 4 km horizontal grid spacing
- Convection permitting configuration
- Spectral nudging above the boundary layer

Microphysics	New Thompson et al. scheme
Land-surface	Noah MP (Noah Multi Physics)
Planetary boundary layer	YSU (Yonsei University)
Cloud or cumulus parameterization	No Cumulus parameterization used
Long-wave and Short-wave scheme	RRTMG (Radiative Transfer Model)

Precipitation amount in MJJA shows a regional maximum



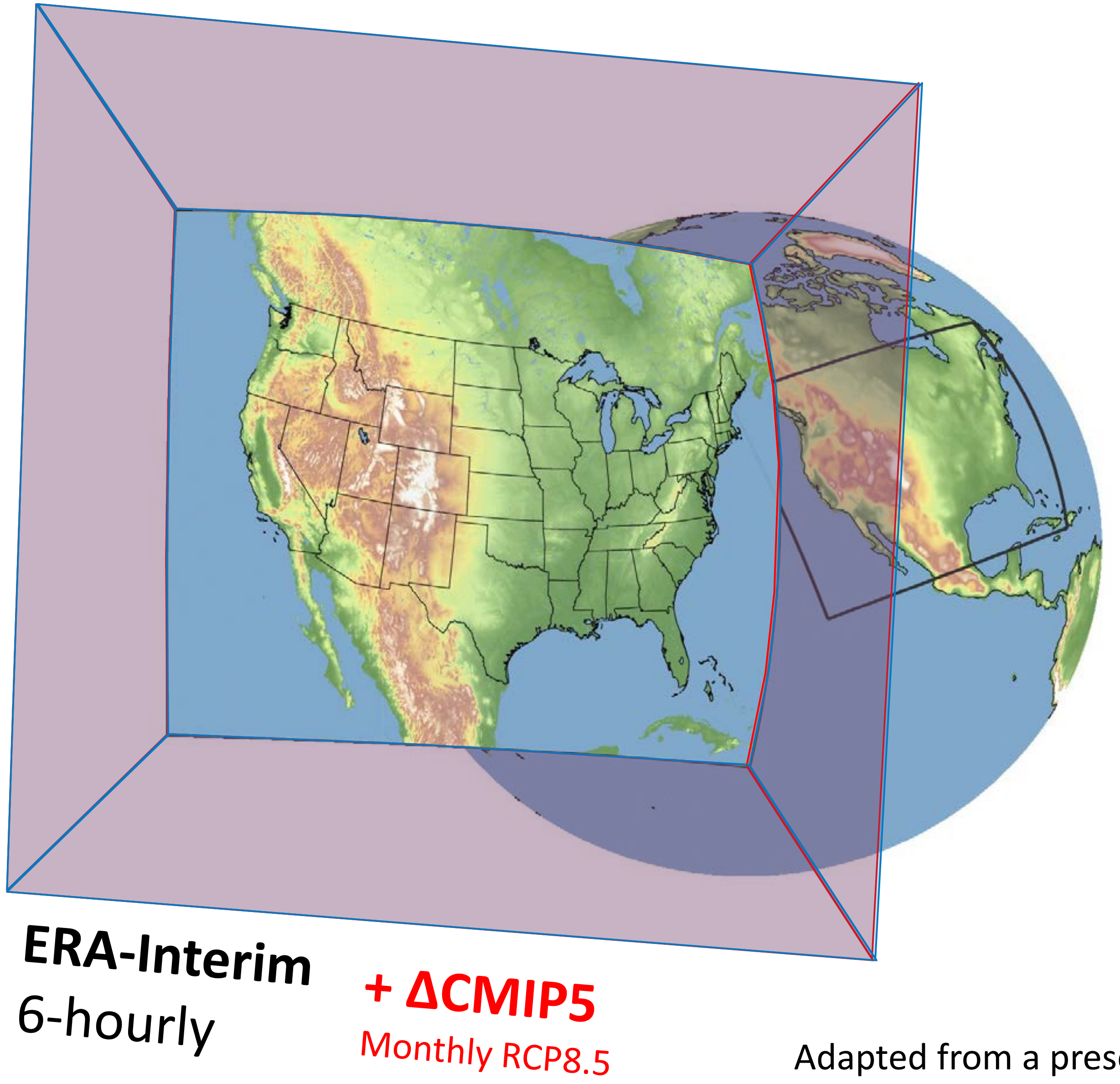
Liu C, Ikeda K, Rasmussen R, et al. **2017. Continental-scale convection-permitting modeling of the current and future climate of North America**. *Climate Dynamics*.

WRF Future Climate Simulation

Pseudo Global Warming (PGW)
[Schär et al. 1996]

- Monthly averaged climate change perturbations from **19 CMIP5 GCMs** (RCP8.5)
- **ΔCMIP5** =2071 to 2100 – 1976 to 2005

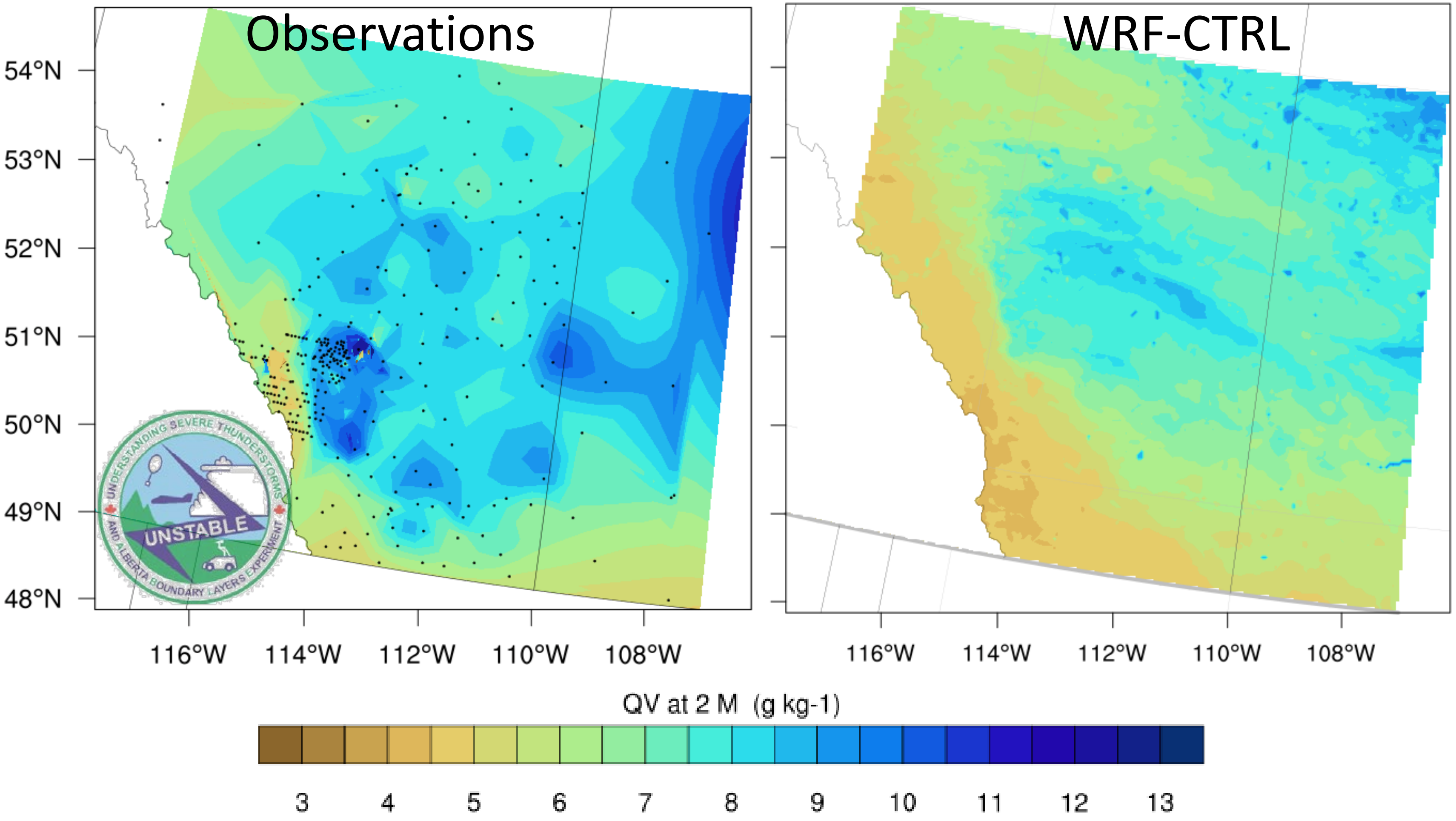
- Thermodynamic response of climate change
- No changes in weather patterns / moisture convergence
- No issues with internal variability



Adapted from a presentation made by Andreas Prein

Verification of specific humidity during a dryline event

From July 13th 12:00 pm until July 14th 06:00 am (19 hours average)



- The model captured a zonal gradient at the lee side.
- The simulation is drier than observations.

Specific Humidity climatology in July

Average of each hour in each month of low level specific humidity

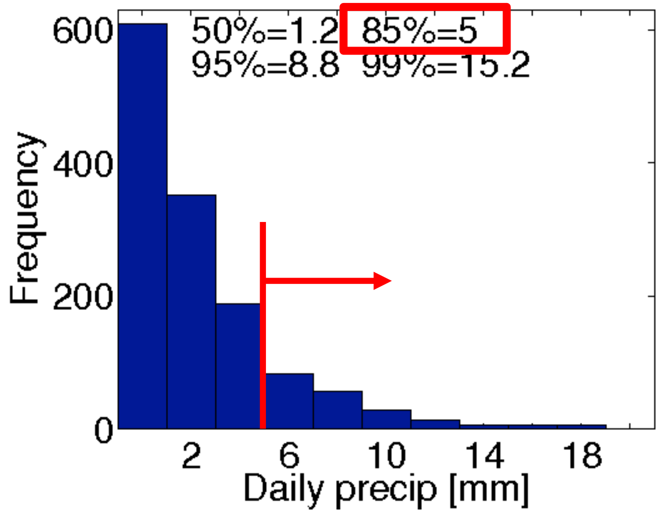
- Clear diurnal cycle of the low level moisture.
- More humidity in the warmer climate and a stronger zonal gradient.

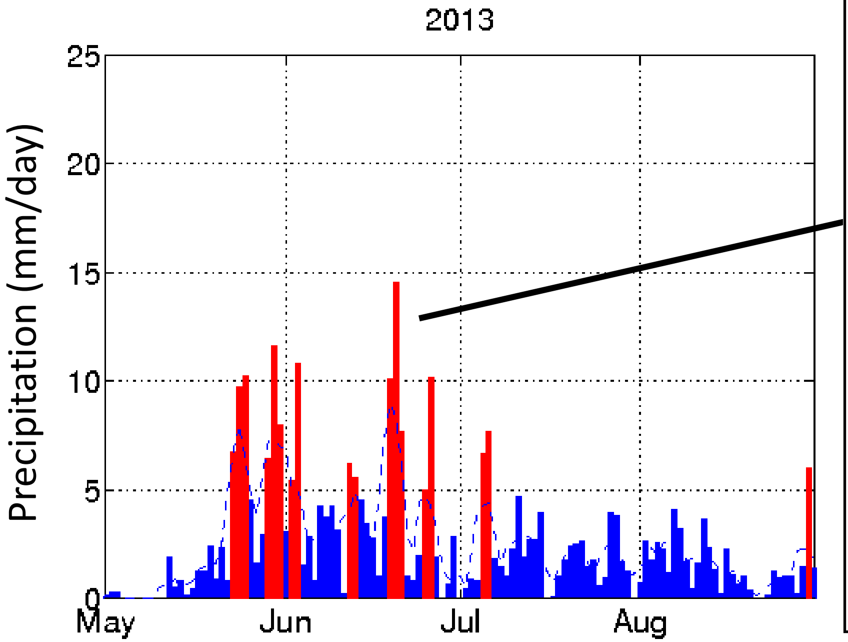
Specific humidity (g/kg)

Specific humidity (g/kg)

Storms selection

- 240 days above 5 mm in 13 years
- Contributes to 50.8% of the total precipitation
- 100 storms are associated with the 85% quantile





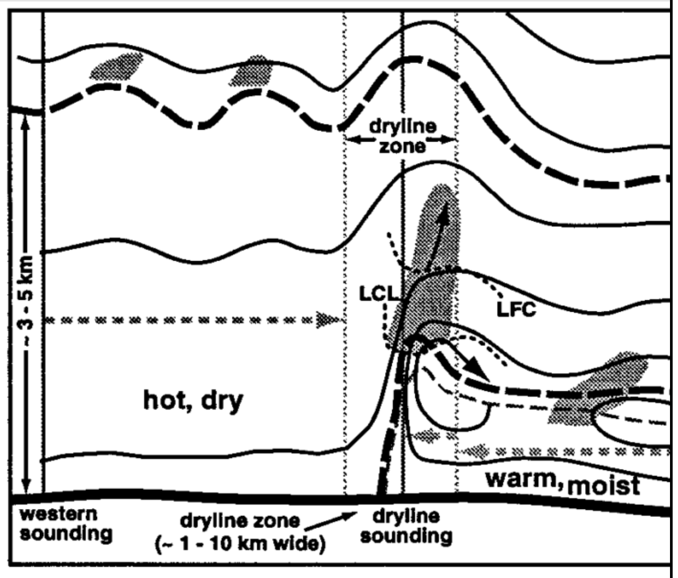
A mesoscale feature initiating storms

Precipitation contours (mm): .1 to 5 by .5

The Dryline

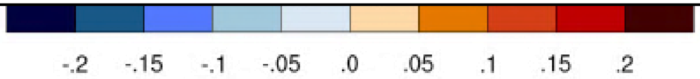
Detected on strong zonal gradient specific humidity at low levels.

- ∇Qv>0.03 g /(kg km)
- Induce a solenoidal circulation
- The uplift parcels are on the dry zone.



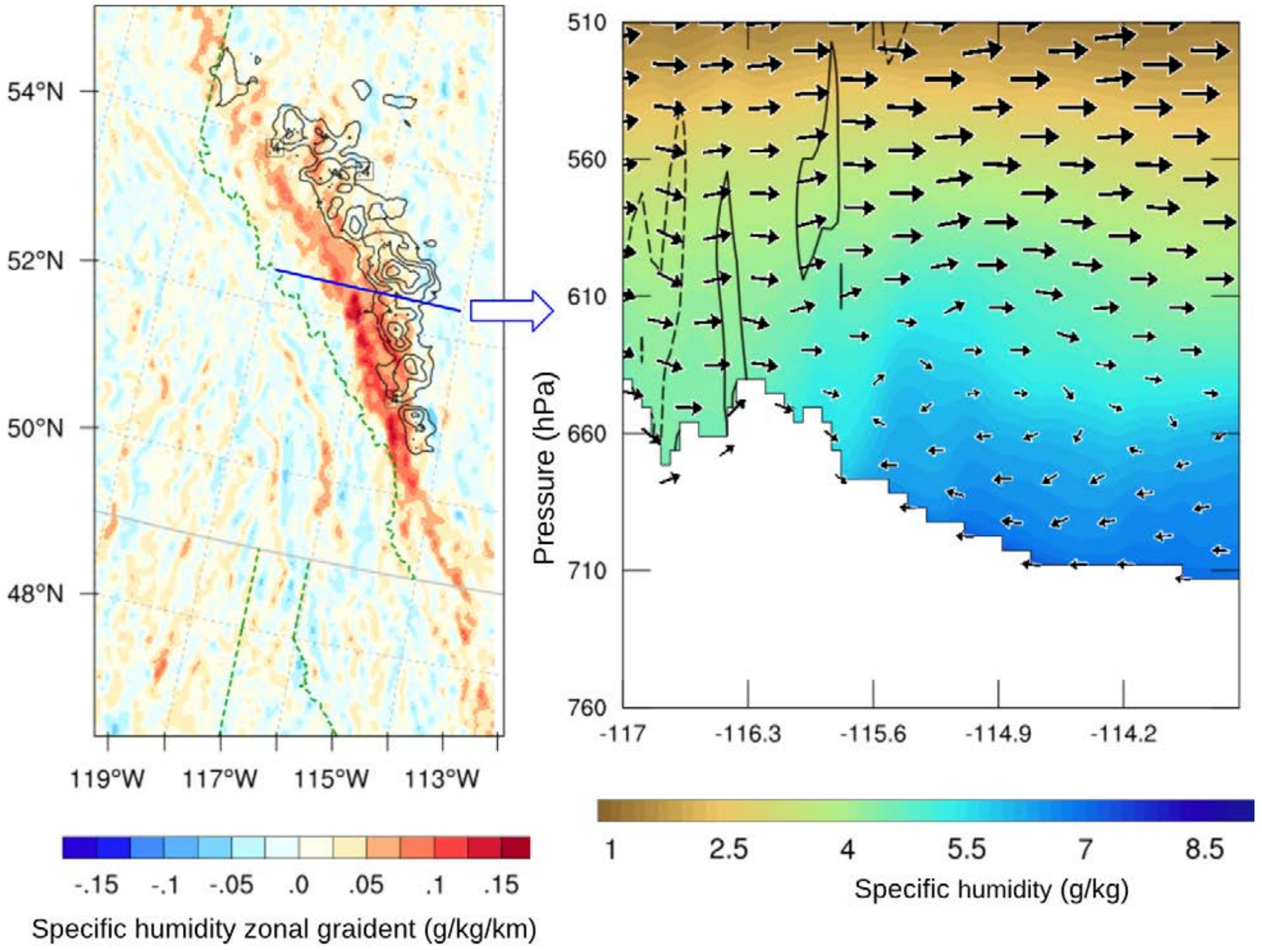
Ziegler and Rasmussen

Vertical wind speed contours (m/s): -1 to 1 by .2

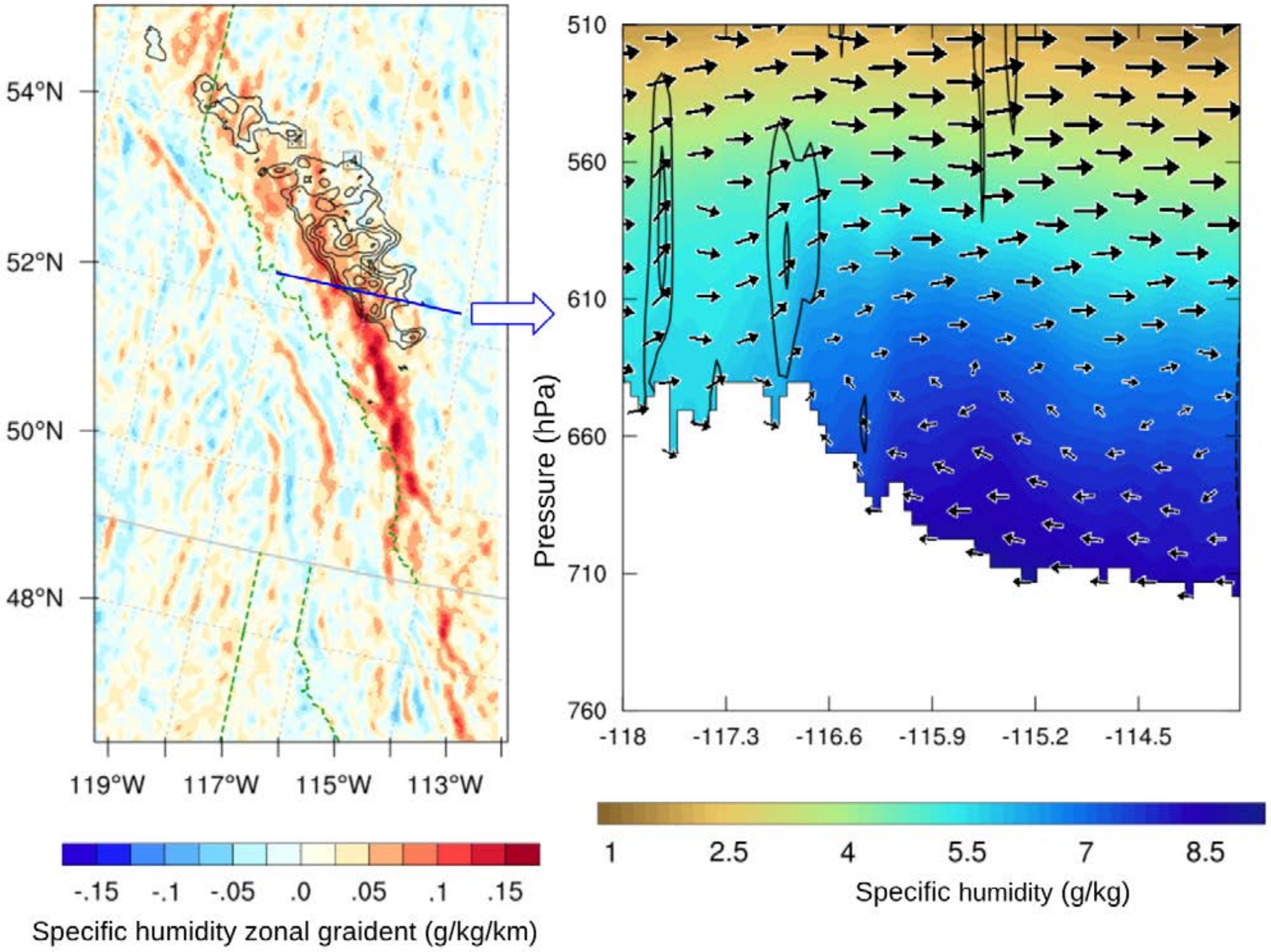


Dryline composites

CTRL (37 storms)

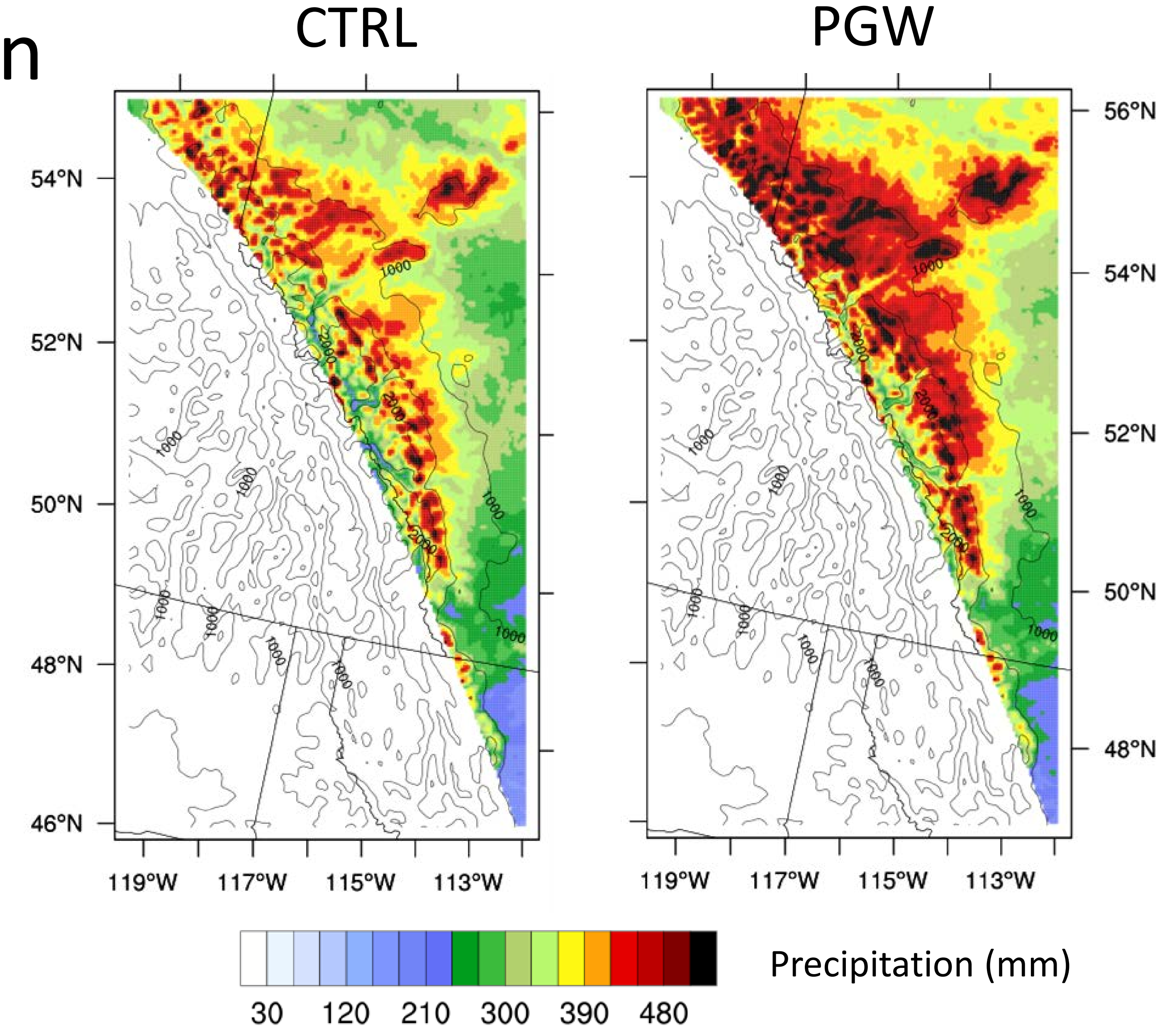


PGW (34 storms)



13 years-average of total precipitation in MJJA

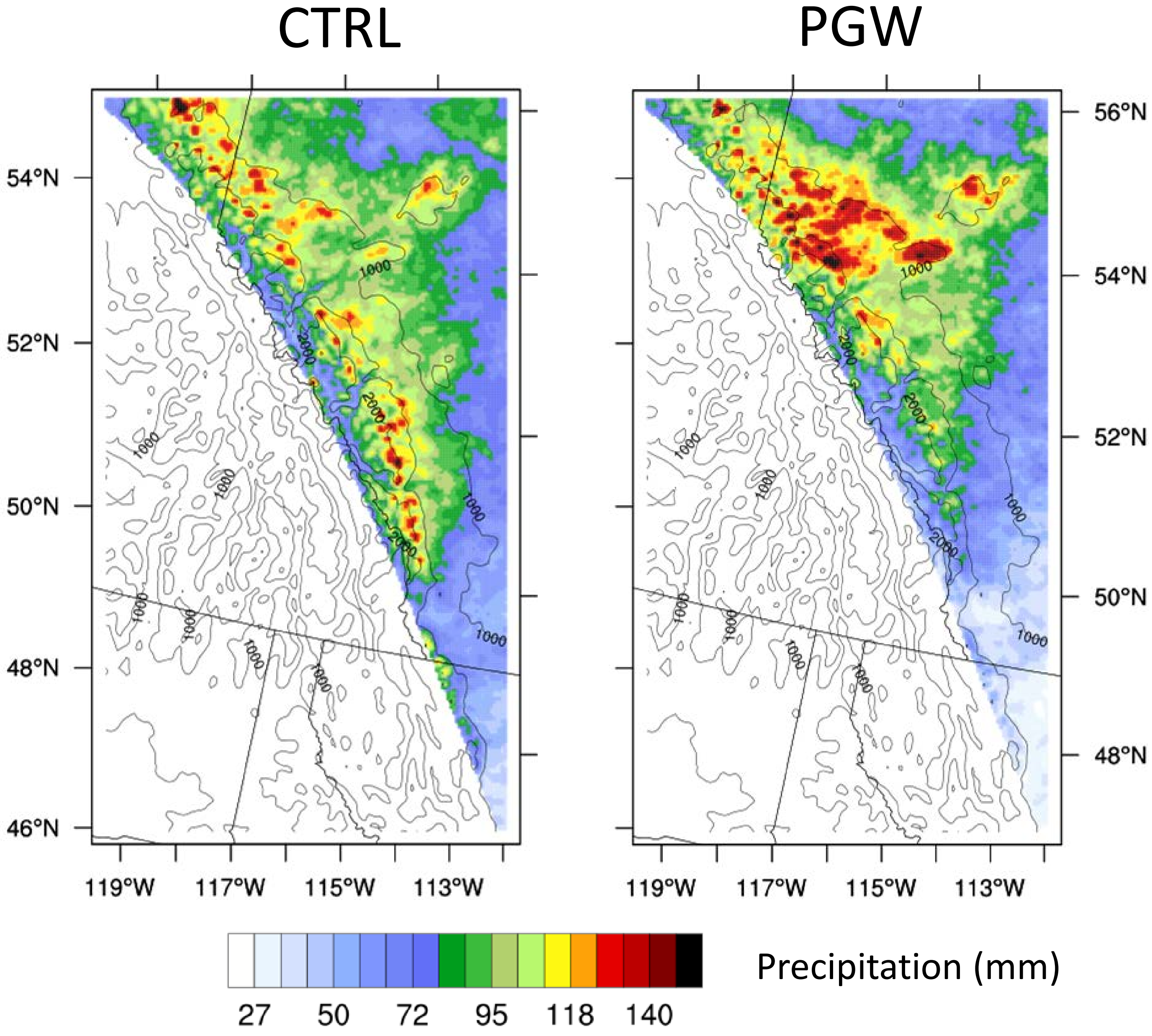
Precipitation increases 12% in average



Dryline-initiated precipitation in MJJA

Shifting to the north

Precipitation increases 22% in average



Conclusions

- The warmer climate shows a more humid conditions, and a stronger specific humidity gradient. This may produce more severe storms at the lee side of the Canadian Rockies, specially in the north, with a more concentrated location of the dryline-initiated convective precipitation.

- This study provides a reference point to evaluate the forecast of convective precipitation triggered by the dryline, improving our current predictions skills (timing and location).