Near 0°C Precipitation

Cross-Cut GHP Project

Reporting Period: August 2017 – October 2018

Starting date: December 2014

End date: 2019

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Annual Progress Report to the GEWEX GHP Panel Meeting

(Santiago, Chile, Oct. 24-26, 2018)

Background and Objectives

The overarching issue being addressed is improving our understanding of future changes in hazardous cold/shoulder season freezing precipitation

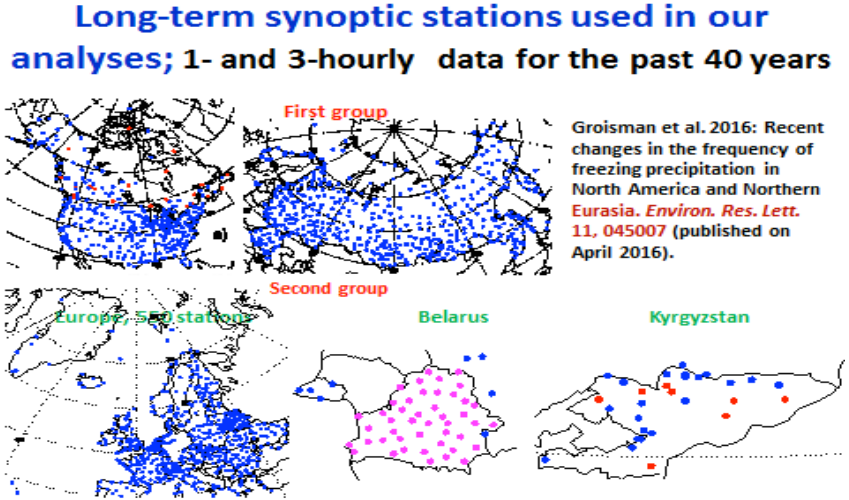
Achieving this requires:

- understanding past and present changes as well as considering future conditions.

Addressing these issues requires an examination of several sub-issues including:

- data requirements and availability
- climatology of key variables and phenomena
- simulation and understanding of key driving processes
- assessment of projections and their shortcomings

Data, Climatology, and the Latest Changes



For these stations, long-term mean values of annual occurrence of the days with freezing events, their trends and changes in the past decade were estimated (compared to the previous 30 years).

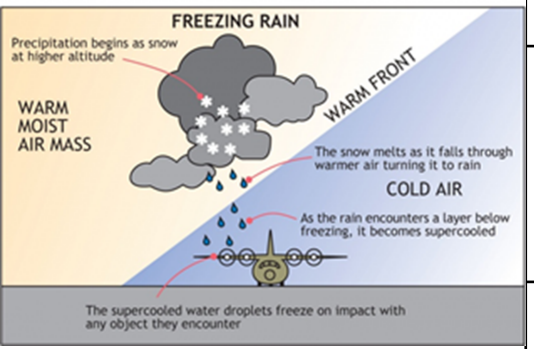
Data: (a)1,500 stations with 40 years of synoptic data, **(b)** the co-located upper air soundings, and **(c)** the NCEP Climate Forecast System Reanalysis V2, CFSRv2 information.

Using combination of in situ, co-located upper air, and reanalyses data, **"weather conditions conducive to freezing rain, WCCFR"** were defined, when with a high probability precipitation occurs in the form of freezing rain.

Next three slides show the WCCFR climatology for North America and Northern Eurasia at elevations below 1200 m and the latest WCCFR changes after 2005.

Generalized definition of weather conditions conducive to freezing rain (WCCFR) during precipitation

Main mechanism

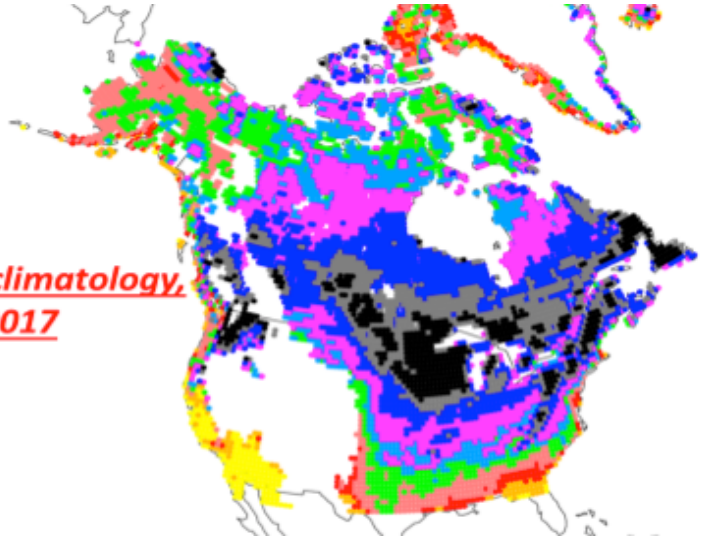


Meteorological variable	Boundary (ies)
Near-surface air temperature, $T_{surface}$	$T_{surface} \in [-5.0°C, 0.2°C]$
Air temperature at 850 hPa	$T_{850hPa} > -0.4°C$
Air temperature at 700 hPa	$T_{700hPa} > -6°C$

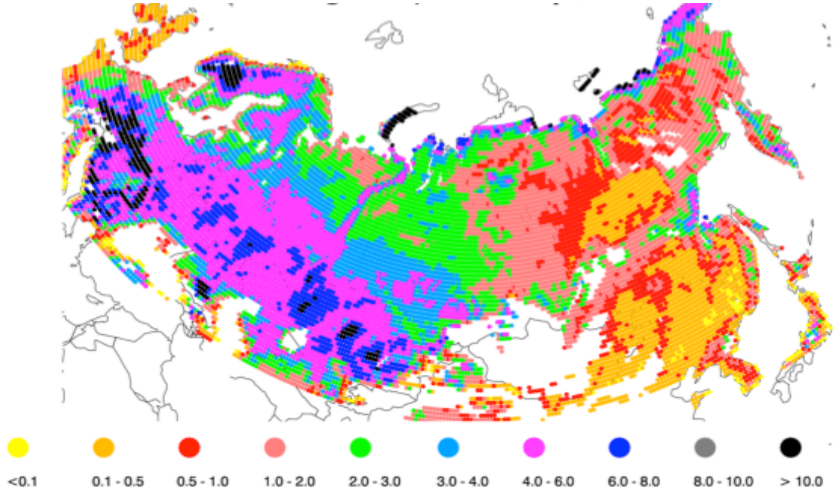
Relationship was derived from synoptic and aerologic observations in the U.S., Canada, Russia, and Northern Europe and is valid at elevations below 1200 m

Freezing Rain ‘Weather’ Climatology

Annual number of days with weather conditions conducive to freezing rain



Freezing Rain climatology, 1979-2017

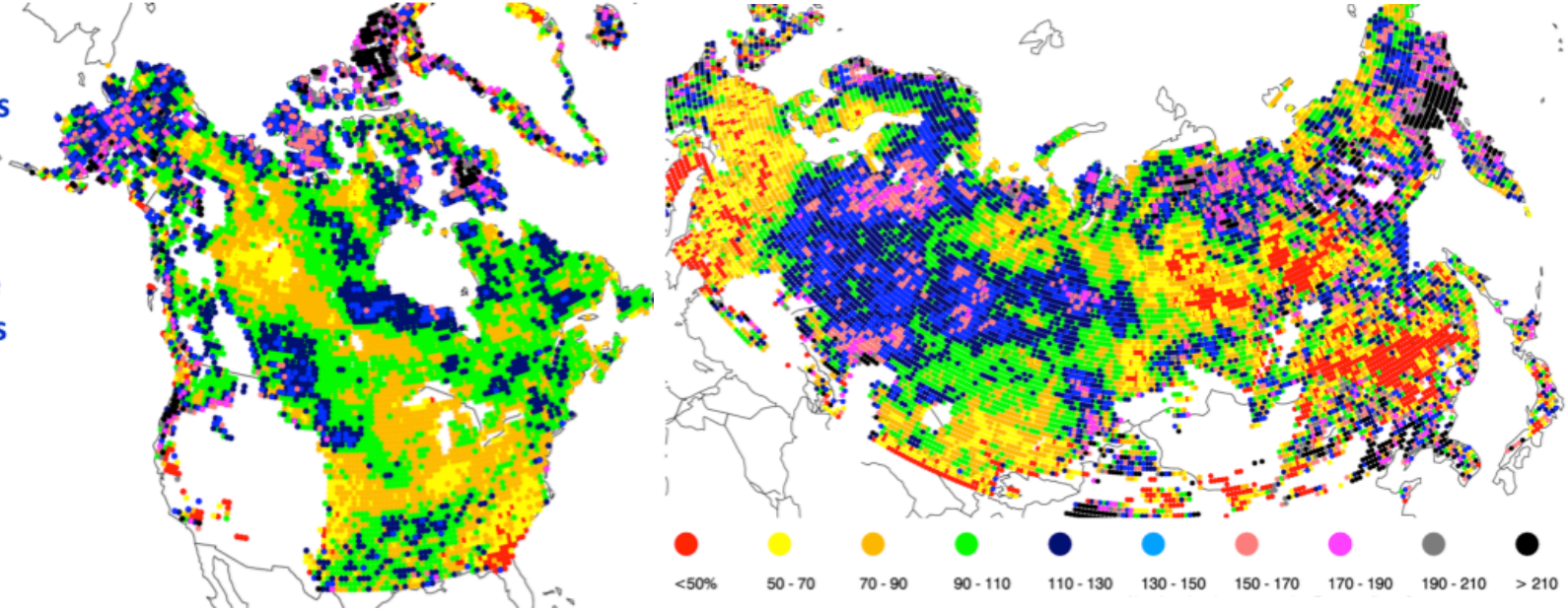


64% of WCCFR are classified as Freezing Precipitation” by CFSRv2

Only grid cells with mean elevation below 1200 m ASL are shown

Changes in the number of days conducive to freezing rain (%)

Freezing rain days change in the past 13 years (2005-2017) compared to the previous 26 years (1979-2004), %



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Simulation, Understanding and Projections

Simulation and understanding

- CRCM5 Canadian Regional Climate Model was found to provide a somewhat realistic ability to simulate freezing rain over parts of eastern Canada (Bresson et al., 2017; Matte et al., 2018).
- Parameterization using a new microphysics scheme has been developed to simulate freezing rain. It considers gradual melting and freezing of precipitation without adding significant computing time (Barszcz et al., 2018)

Projections

- Examination of many CMIP5 models over Canada has illustrated that the near 0°C region will (of course!) move northward but there is large variation between models in the actual displacement. These models also exhibit wide variations in the likelihood of any precipitation occurring within these near 0°C regions.

Ongoing Activities and Latest Publications

- **Fifteen presentations** during the past 12 months at the international Conferences and Workshops including dedicated Session at The GEWEX Open Science Conference in May 2018.
- **Latest publications**

- Barszcz, A., J. A. Milbrandt, J. M. Thériault, 2018: Improving the explicit prediction of freezing rain in a km-scale numerical weather prediction model. *Weather and Forecasting,* *https://doi.org/10.1175/WAF-D-17-0136.1*
- Bresson, E, R. Laprise, D. Paquin, J.M. Thériault and R de Elia, 2017: Evaluating CRCM5 ability to simulate mixed precipitation, *Atmos.-Ocean*, **55**, 79-93.
- Matte, D., J. M. Thériault and R. Laprise, 2018: Climate change study of mixed precipitation over southern Quebec using a Regional Climate Model, *Climate Dyn.* *https://doi.org/10.1007/s00382-018-4231-2*

Planned Activities

- Expand our estimates of weather conditions conducive to freezing rain to high-elevation regions

- Prepare a review article “Precipitation near 0°C in a changing climate: tendencies and related natural hazards”. Authors: Multi-authored from several countries. Expected completion: 2019

Concluding Remarks

- This Cross-Cut Project is directly related to the **CLIMATE EXTREMES WCRP Grand Challenge**. For example, freezing precipitation leads to numerous socio-economic impacts and there continues to be major issues associated with its detection, change, understanding, and prediction and projection.
- This cross-cut is overcoming challenges to collectively address this issue
- Significant progress has been made in:
  - Bringing together appropriate datasets
  - Producing new climatologies and measures of change
  - Improving model simulation capabilities and
  - Examining projections
- A key outcome will be a **collective article** addressing the freezing precipitation issue.