Does dynamical downscaling affect model biases and projections of explosive extratropical cyclones?

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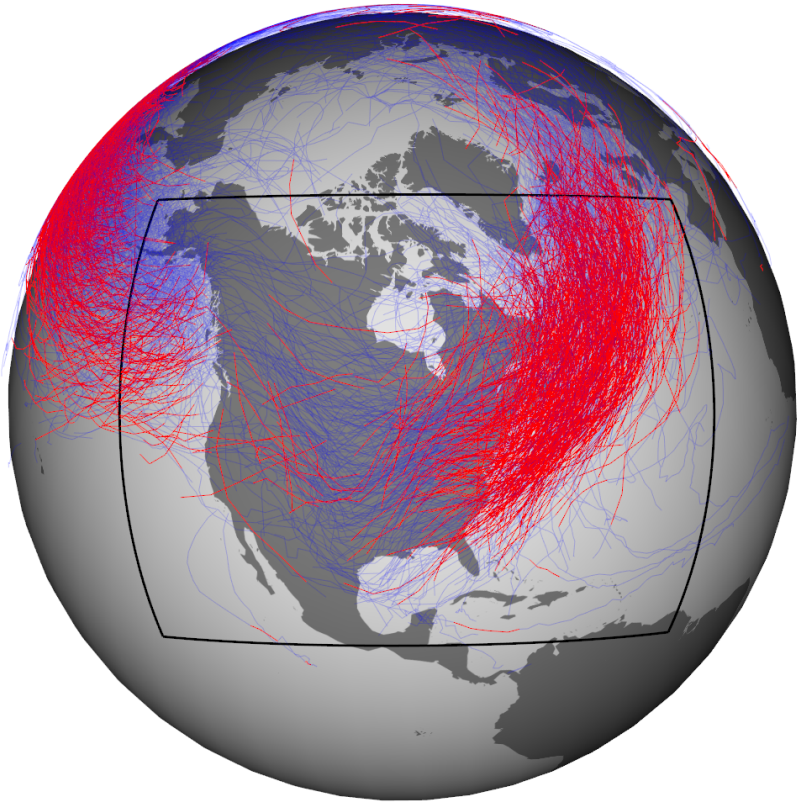
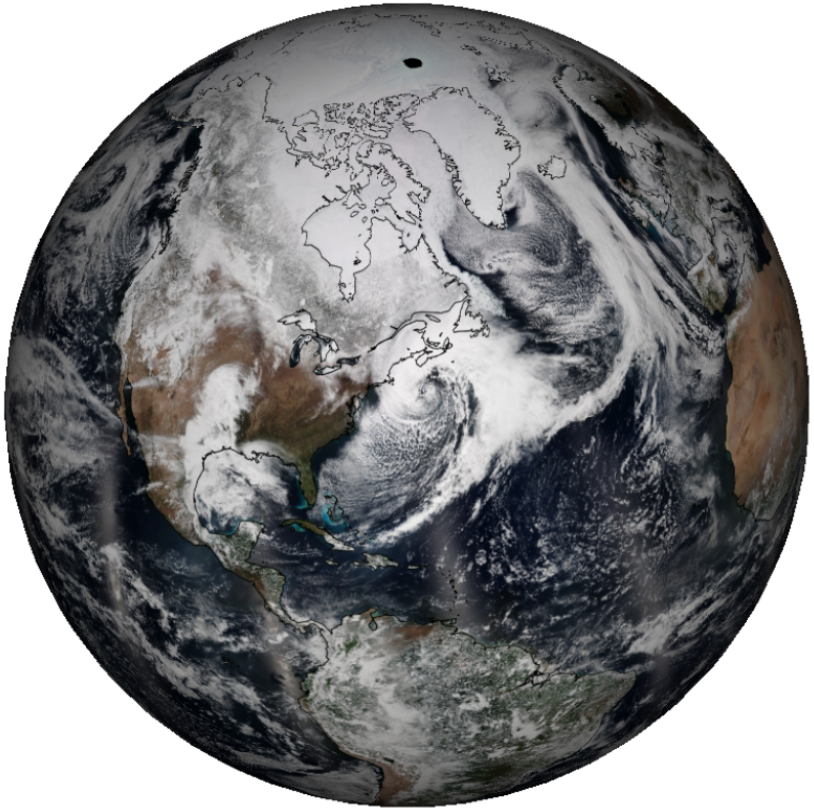


Explosive extratropical cyclones (ETCs)

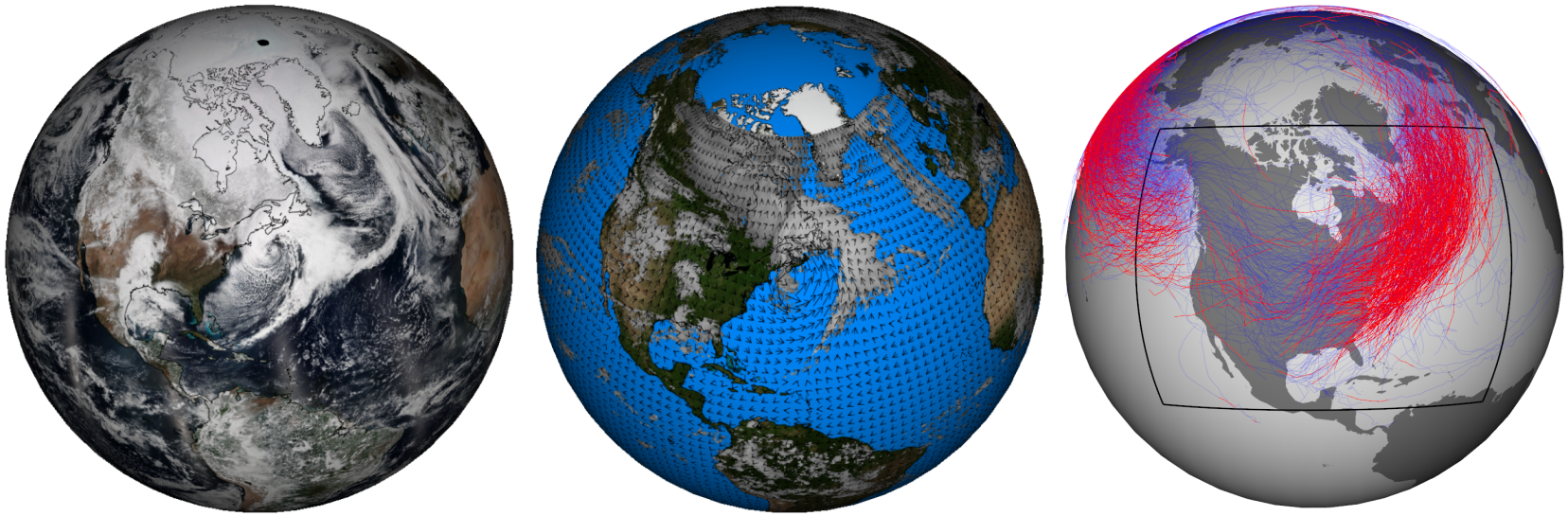


$$b = \frac{24hPa}{24h} \frac{sin(\theta)}{sin(60°)}$$

Motivation

- Seiler and Zwiers (2015) *Climate Dynamics*
  - CMIP5 models tend to simulate too few and too weak explosive ETCs
- Willison et al. (2013) *Journal of the atmospheric sciences*
  - As diabatic effects strengthen ETCs, additional precipitation forms and more latent heat is released
  - This positive feedback mechanism is enhanced when increasing the horizontal resolution
- Long et al. (2009) *Journal of Geophysical Research: Atmospheres*
  - Dynamical downscaling increases the frequency ETCs with MSLP $<$ 995 hPa along North America's Atlantic coast

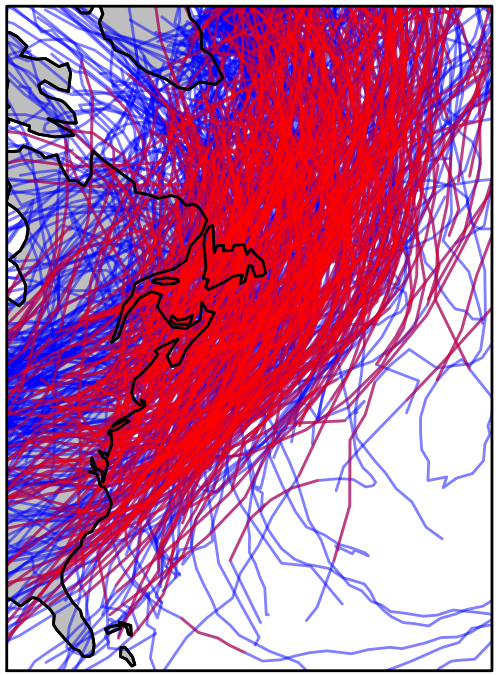
Methods



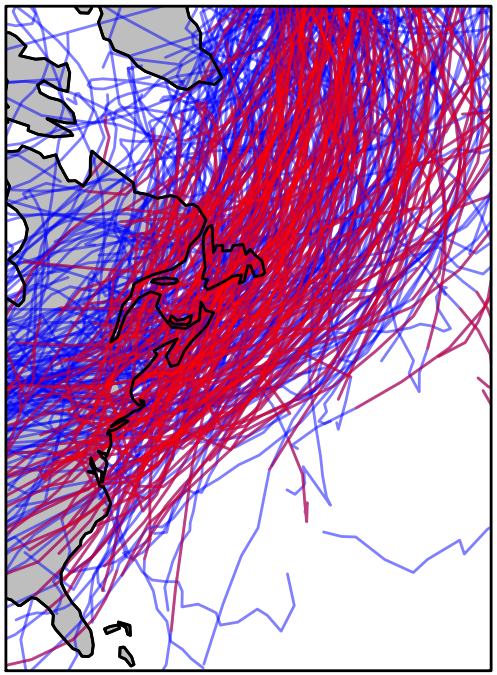
- Objective feature tracking algorithm TRACK
- 6h wind fields at 850 hPa & MSLP
- Reanalysis: ERA-Interim, GCM: CanESM2, RCM: CanRCM4

Impacts of dynamical downscaling

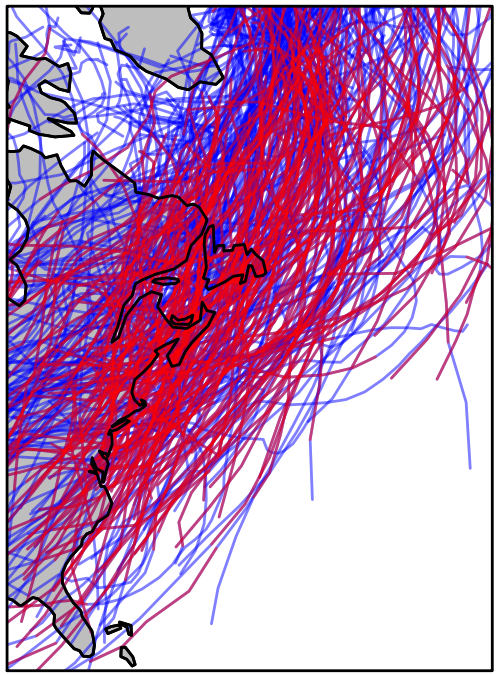
(a) ERA−MSLP−T42−H



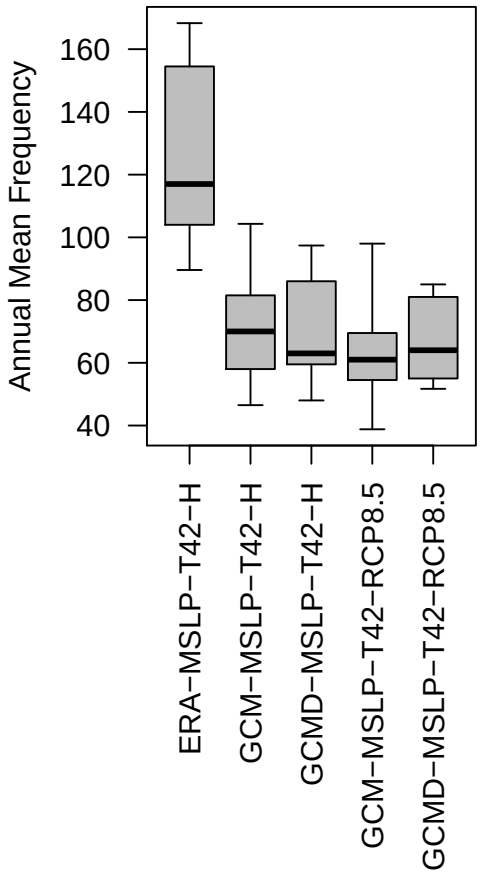
(b) GCM−MSLP−T42−H

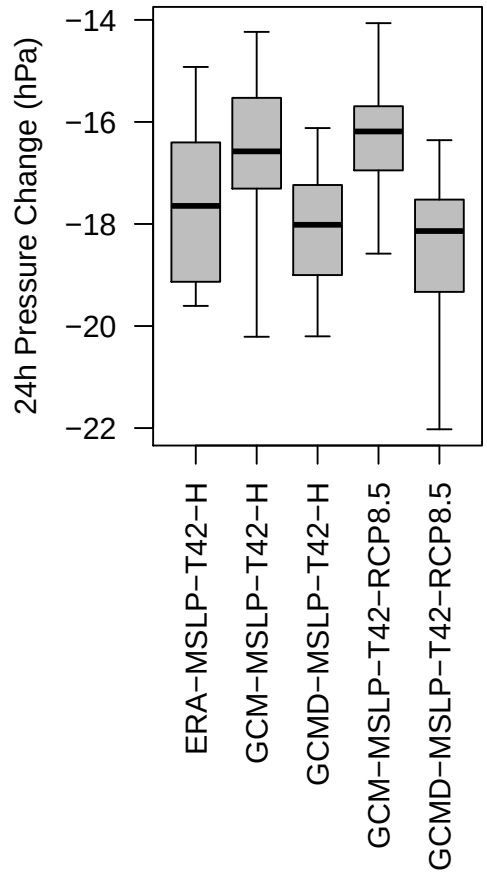


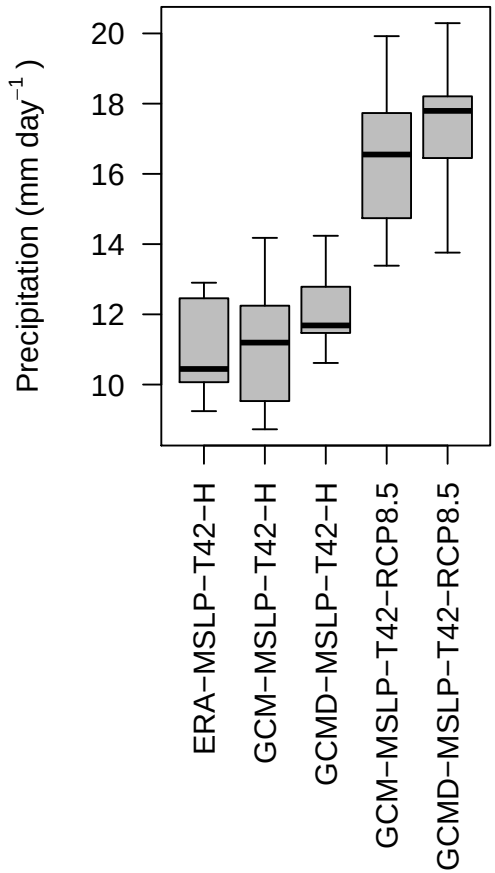
(c) GCMD−MSLP−T42−H



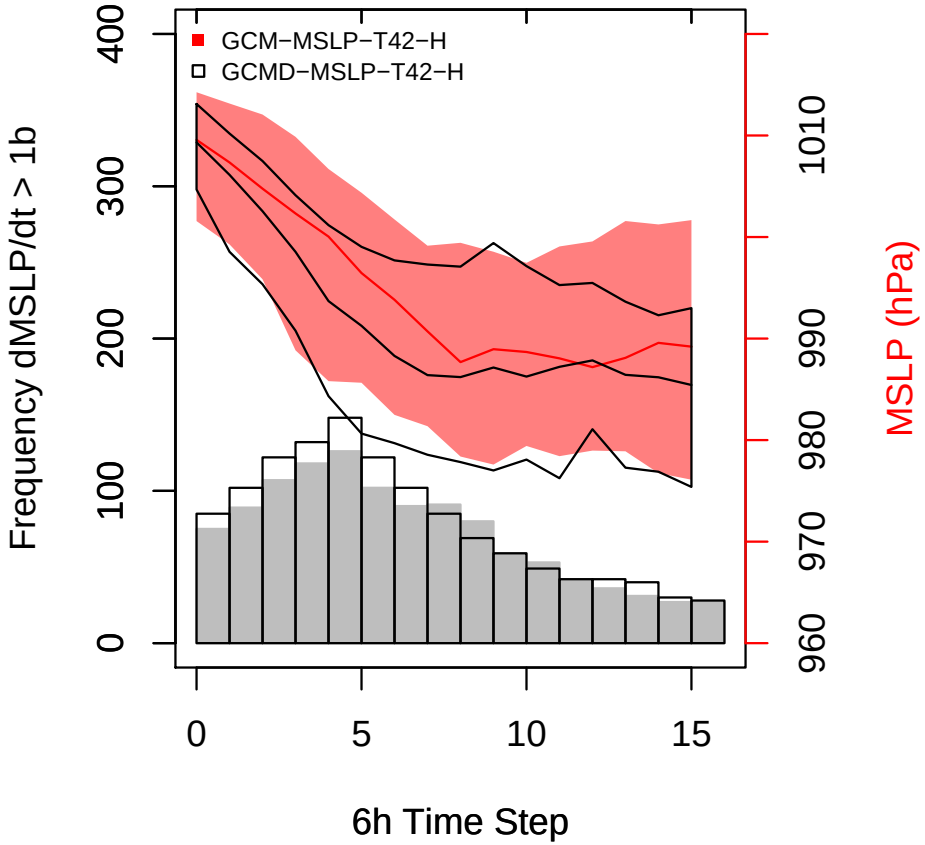
Impacts of dynamical downscaling



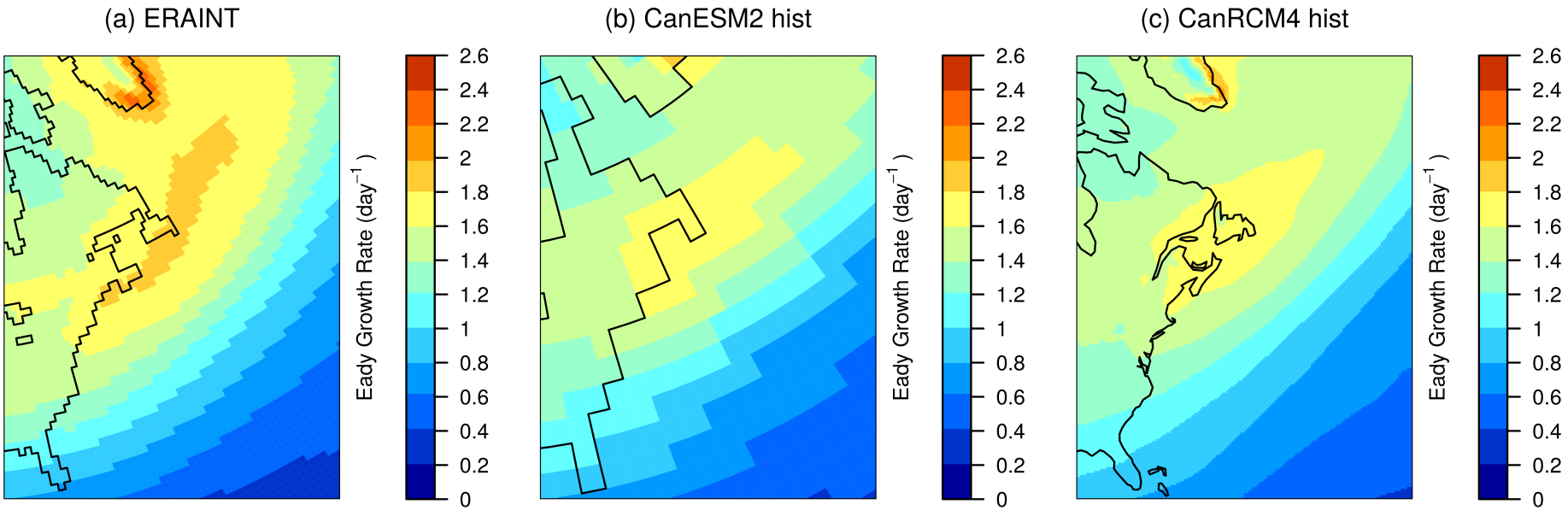




Impacts of dynamical downscaling

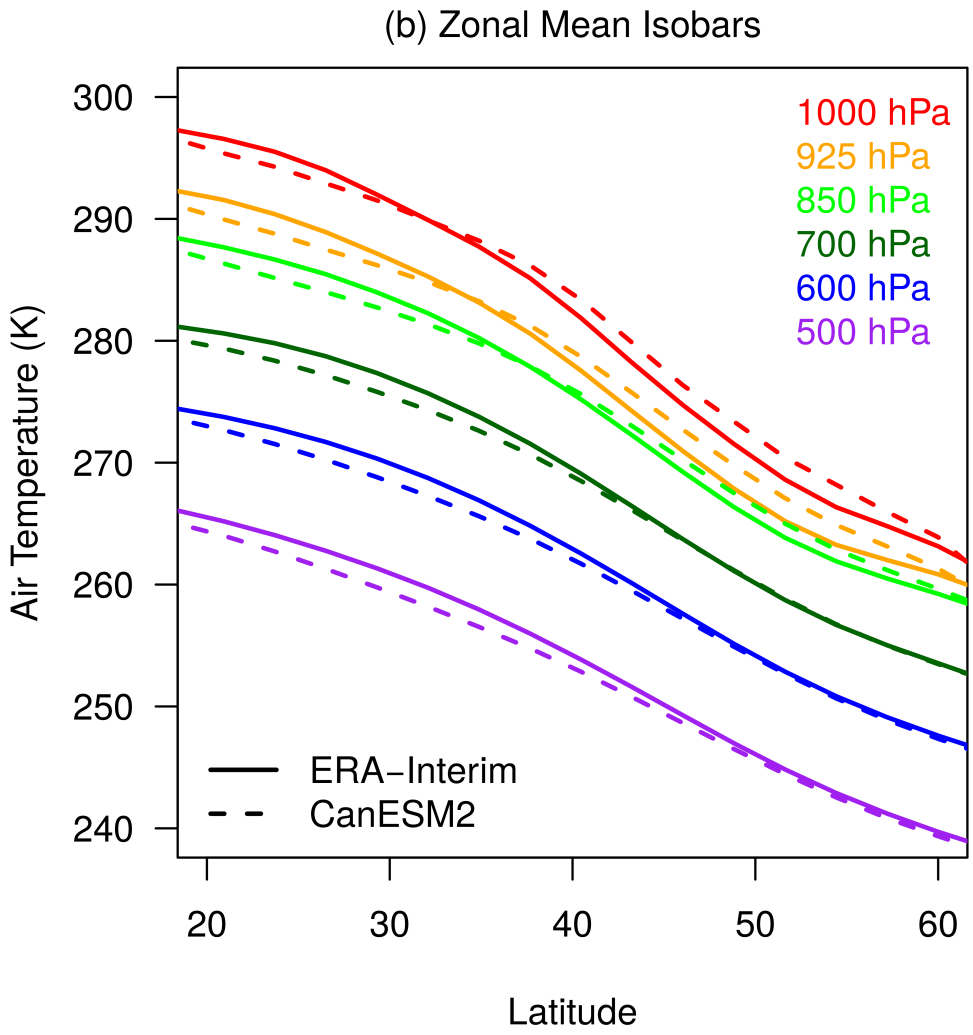


Eady Growth Rate



$$\sigma = 0.31 f \left| \frac{\partial \mathbf{v}}{\partial z} \right| N^{-1}$$

Air temperature bias

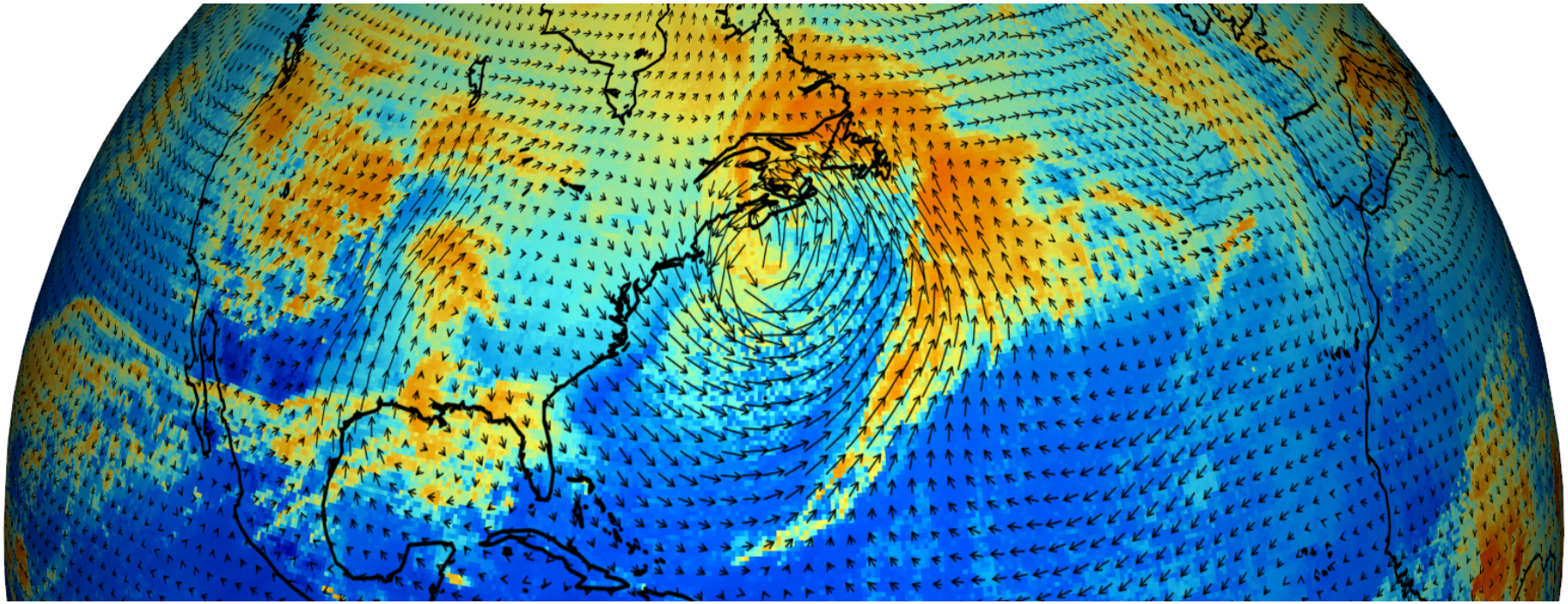


Conclusions

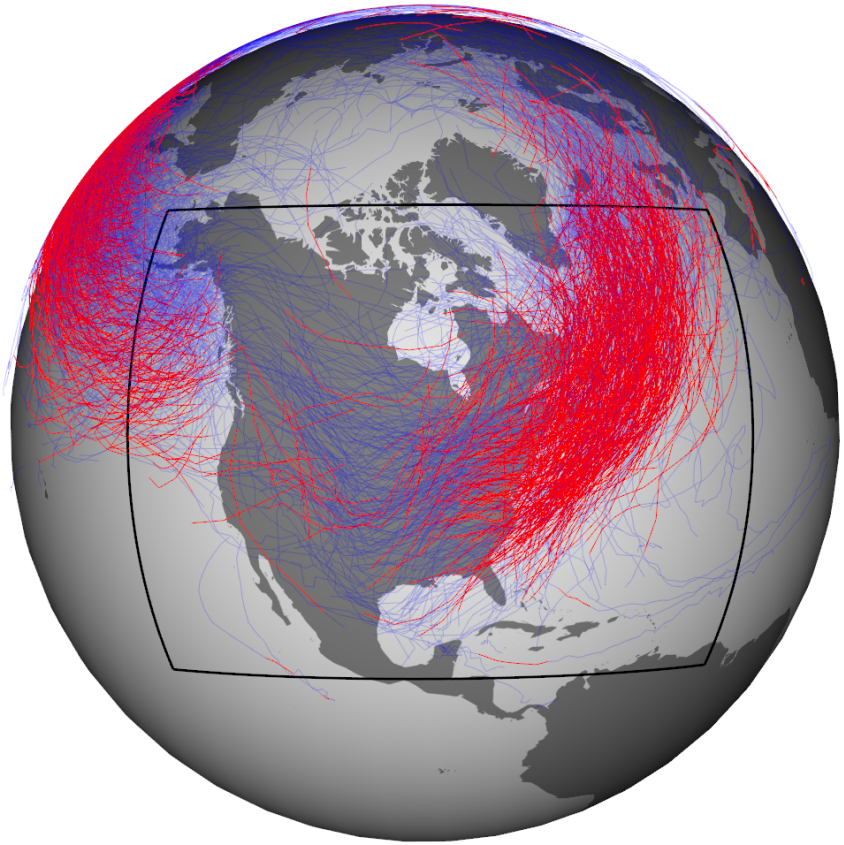
- Impact of downscaling is very limited
  - Significant enhancement of deepening rate
    - historical: 1.5 hPa per 24 hrs
    - RCP8.5: 2.3 hPa per 24 hrs
- Potential main bias source is a weak meridional temperature gradient
- Explosive ETC precipitation is projected to increase
  - 49% GCM, 43% RCM
  - Consistent with increase in specific humidity

Outlook

- Track storms from global data which is regridded onto the RCM grid
- Identify MSLP minima in vicinity of vorticity maxima
- Compute storm composites to analyze explosive ETC structure



Thank you!



Environment Canada

MEOPAR
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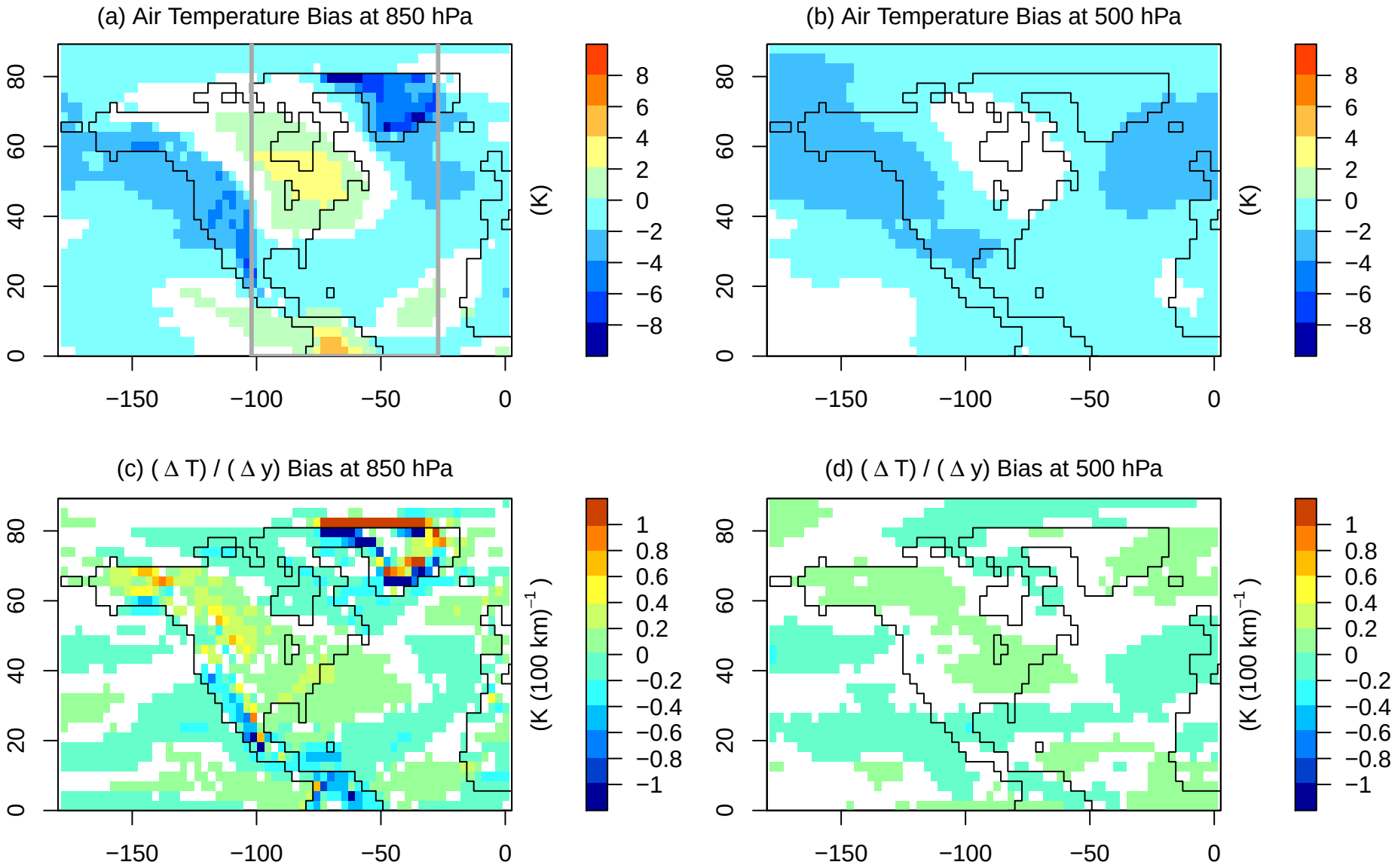
Air temperature bias



Zonal mean air temperature