Strong Extratropical Cyclones leading to Cool-Season Extreme Weather Events over Central and Eastern North America

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42nd Northeastern Storm Conference

Saratoga Springs, NY

11 March 2017

Research support provided by NSF Grant AGS-1355960

Motivation

- Extratropical cyclones (ECs) play a major role in determining day-to-day weather conditions in the midlatitudes during the cool season

- Strong ECs can have considerable socioeconomic impacts on the regions they traverse due to their frequent association with damaging winds and heavy precipitation

- Strong ECs may lead to extreme weather events (EWEs)

EWEs are defined as high-impact weather events that are societally disruptive, geographically widespread, exceptionally prolonged, and climatologically infrequent

Motivation

- Opportunity to investigate ECs leading to EWEs over central and eastern North America motivates this study

- A climatology of ECs leading to EWEs over central and eastern North America will be constructed to investigate the location, frequency, and downstream impacts of this category of EC

Outline

- **Data and Methodology**
  - Candidate ECs leading to EWEs
  - Identification of ECs leading to EWEs

- **Climatological Results**
  - Track density
  - Genesis locations
  - Intraseasonal variability
  - Downstream impacts

- **Summary**

Candidate ECs leading to EWEs

- Cyclone tracks are identified during October–March 1979–2016 by applying the Hodges (1995) tracking algorithm to the MSLP field from the 0.5° NCEP CFSR (Saha et al. 2010)

- Time of formation (t_0) considered the first time a cyclone is identified using the Hodges (1995) tracking algorithm

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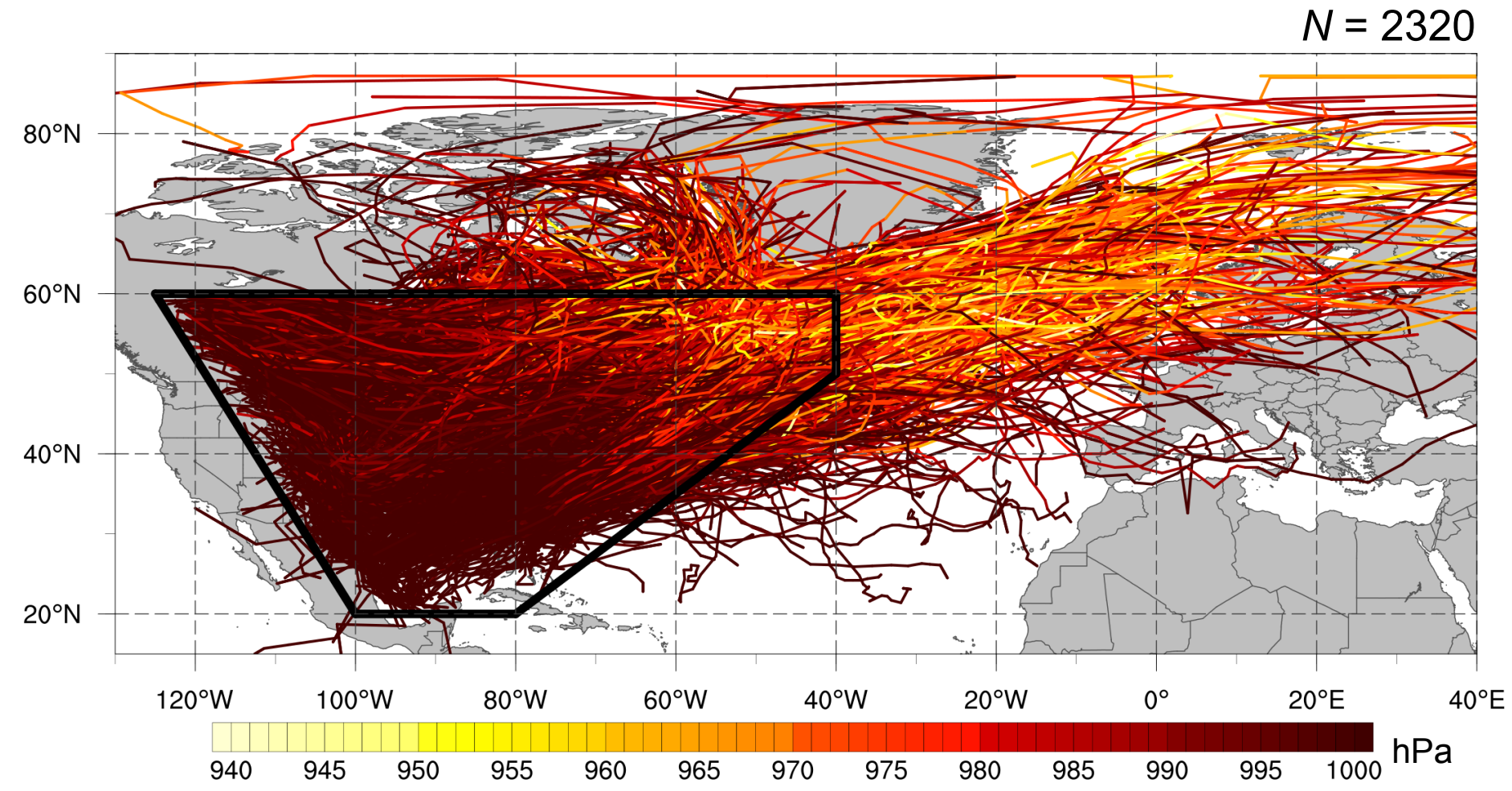
- Time of formation (t_0) considered the first time a cyclone is identified using the Hodges (1995) tracking algorithm

- Cyclones are required to form over and traverse the region surrounding central and eastern North America between t_0 and t_0 + 48 h

- Cyclone tracks corresponding to tropical cyclones in the IBTrACS dataset (Knapp et al. 2010) are removed (N = 12)

Candidate ECs leading to EWEs



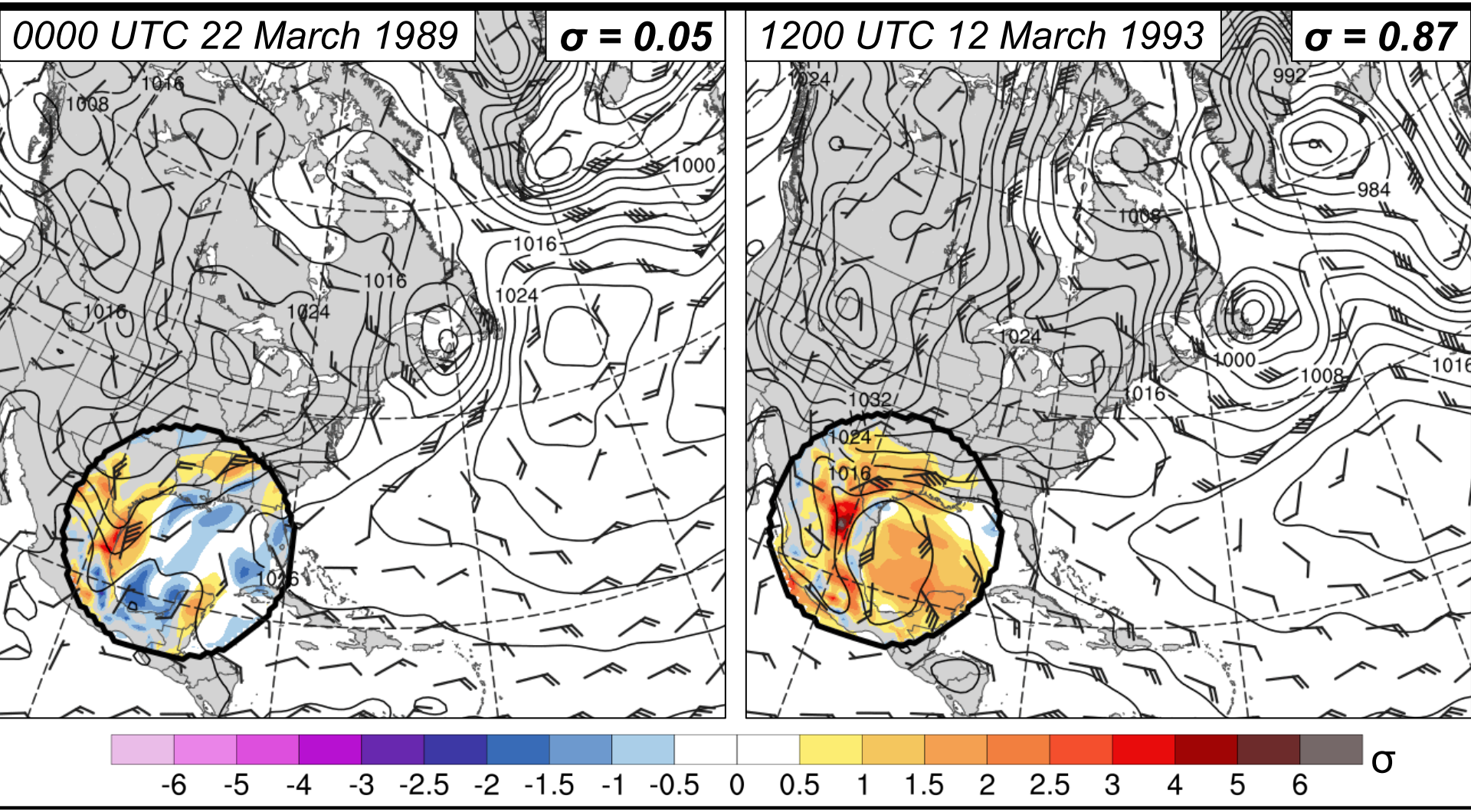
Tracks of ECs forming over and traversing the region surrounding central and eastern North America during October–March 1979–2016, shaded according to MSLP value (hPa)

Identification of ECs leading to EWEs

- ECs leading to EWEs are identified by examining 925-hPa standardized wind speed anomalies associated with each candidate EC leading to an EWE during its life cycle

  1) Calculate the area-averaged 925-hPa standardized wind speed anomaly within 1200 km of each candidate EC leading to an EWE during its life cycle

Identification of ECs leading to EWEs



MSLP (black contours, hPa), 925-hPa wind (barbs, kt), and 925-hPa standardized wind speed anomaly (shaded, σ)

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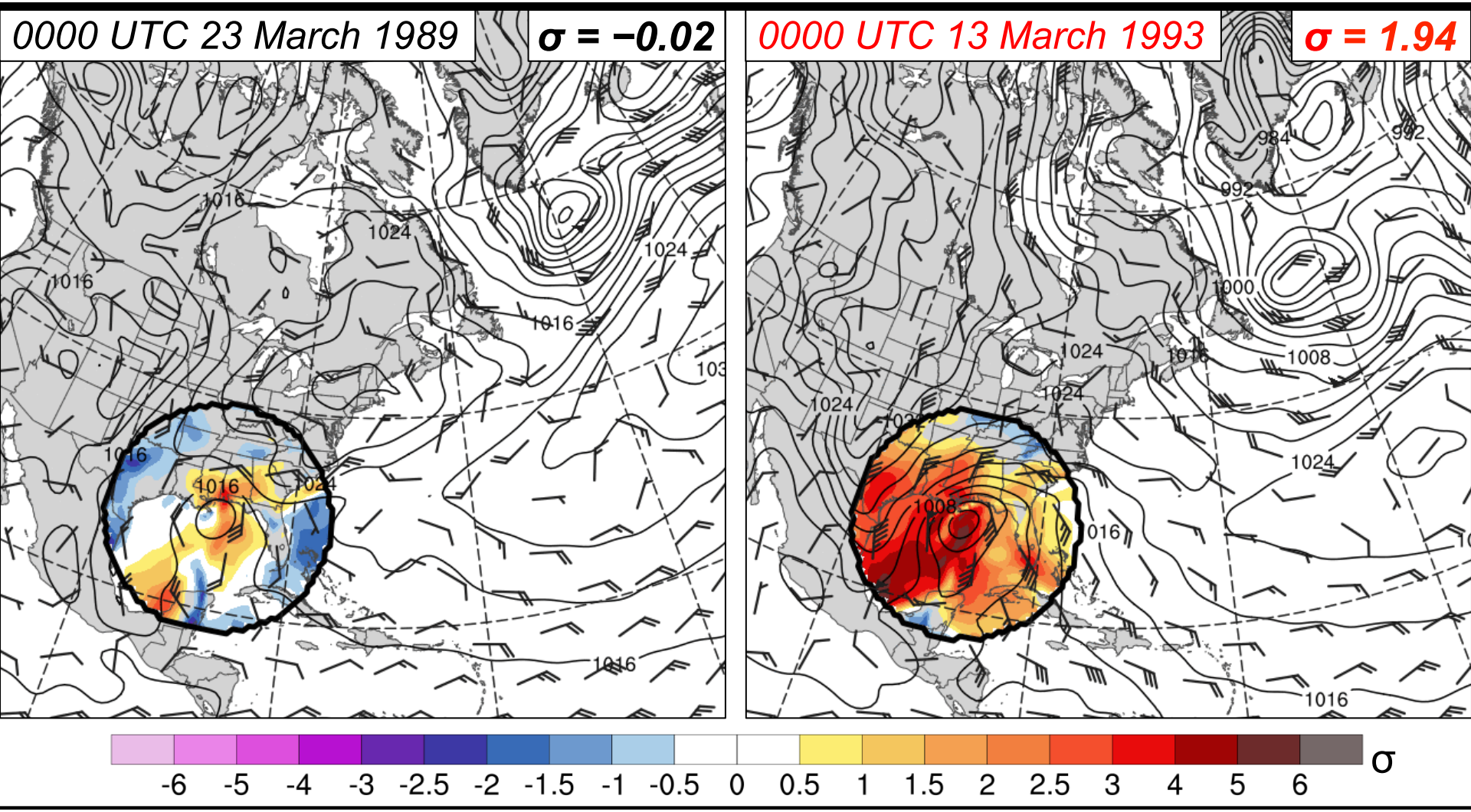

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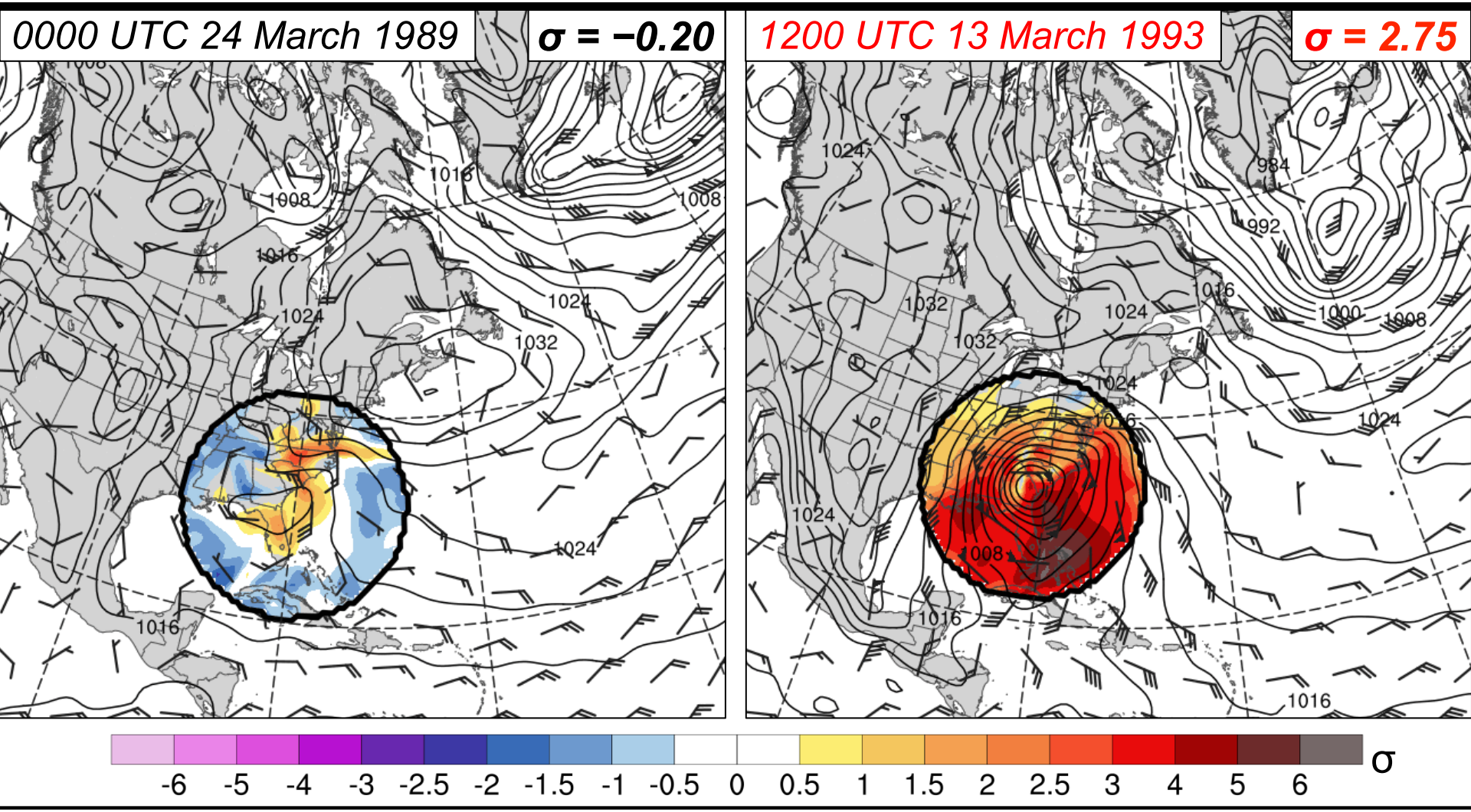

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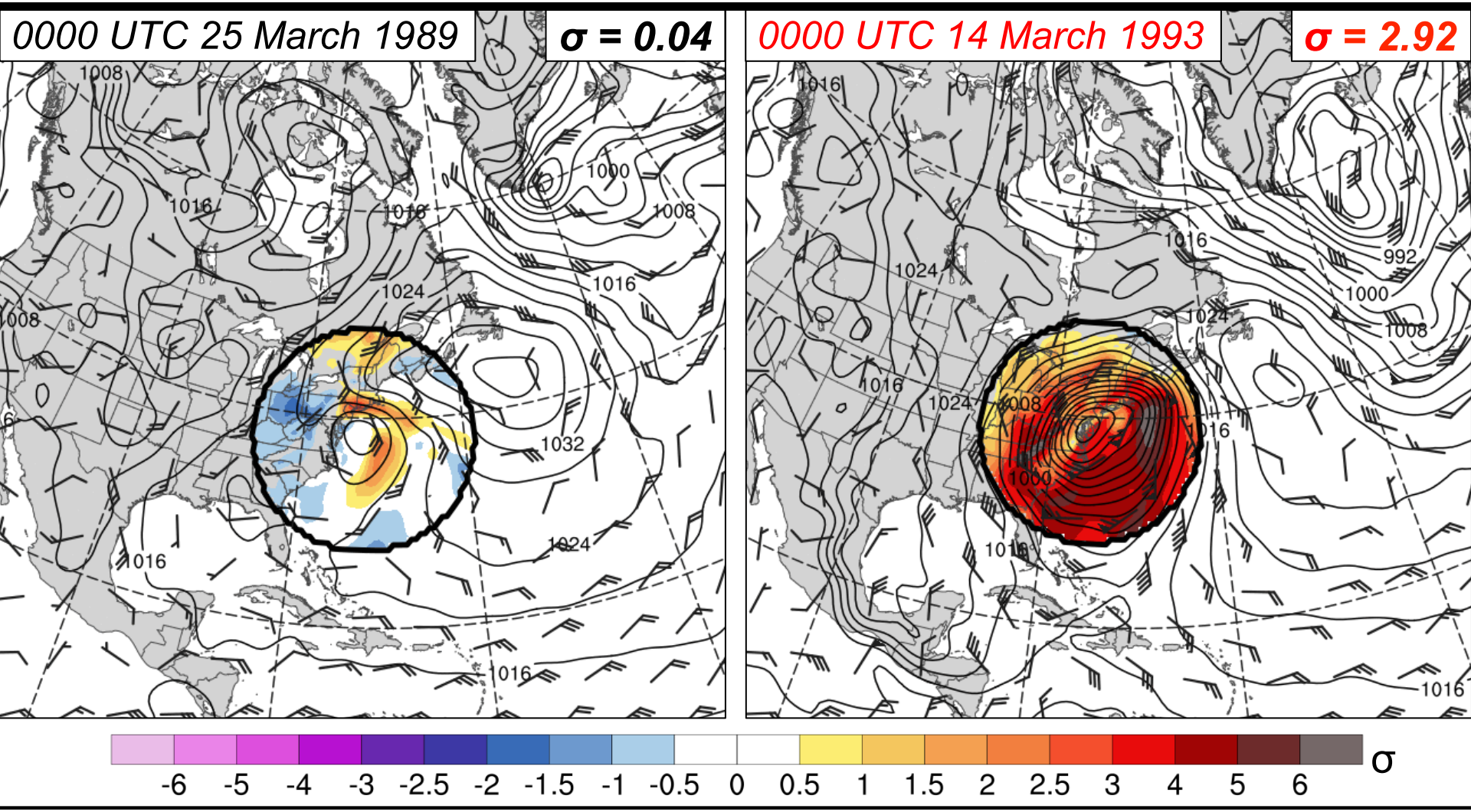

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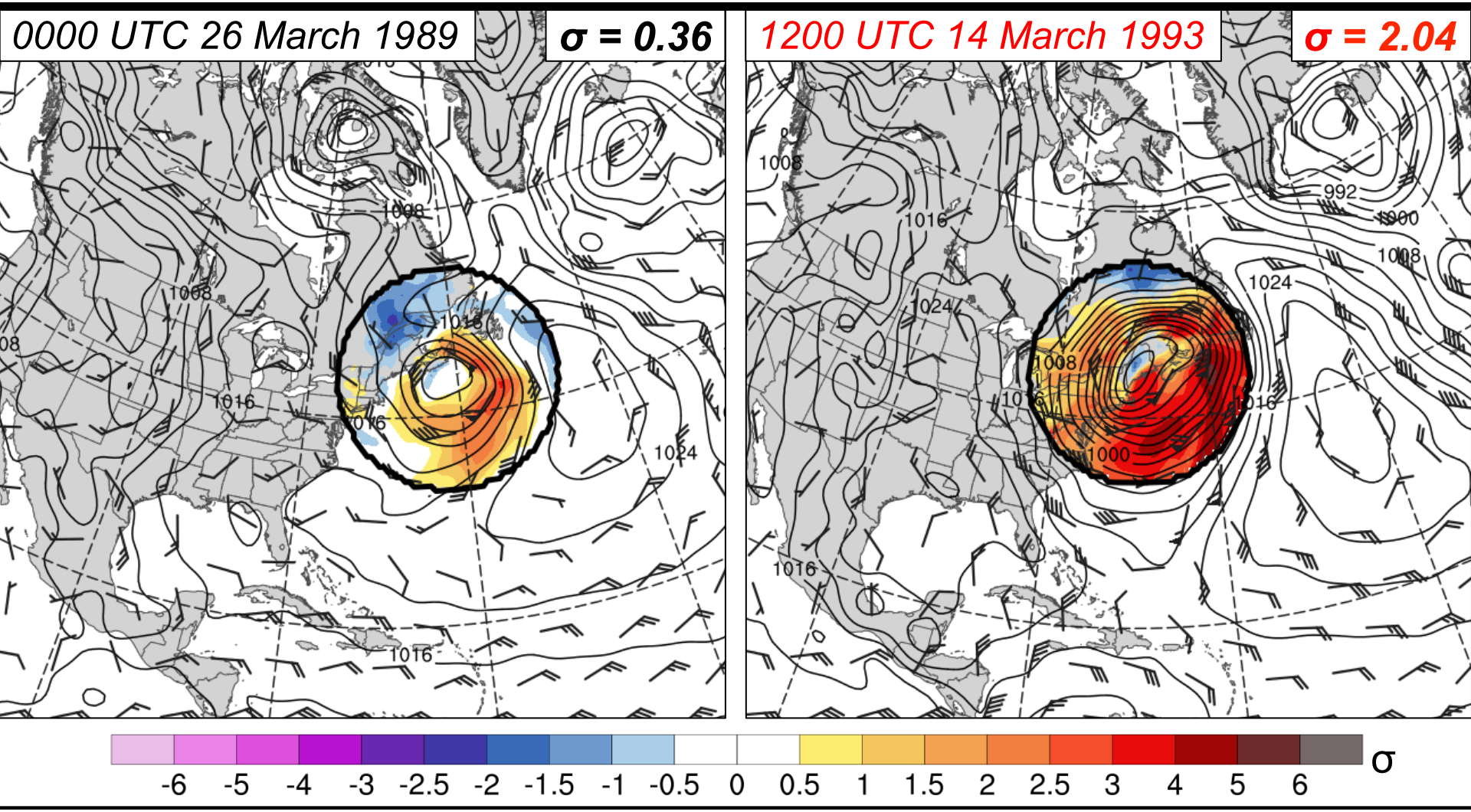

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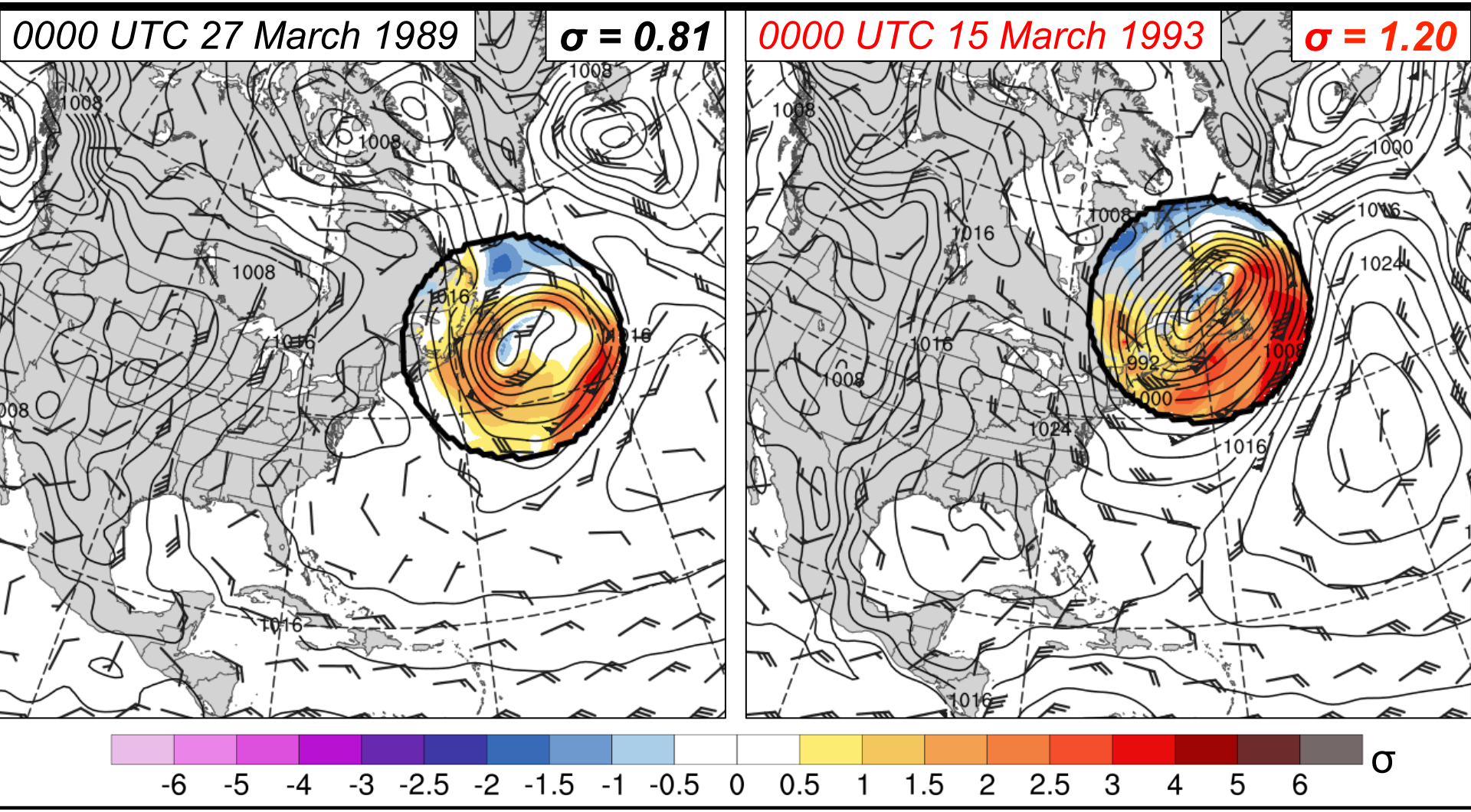

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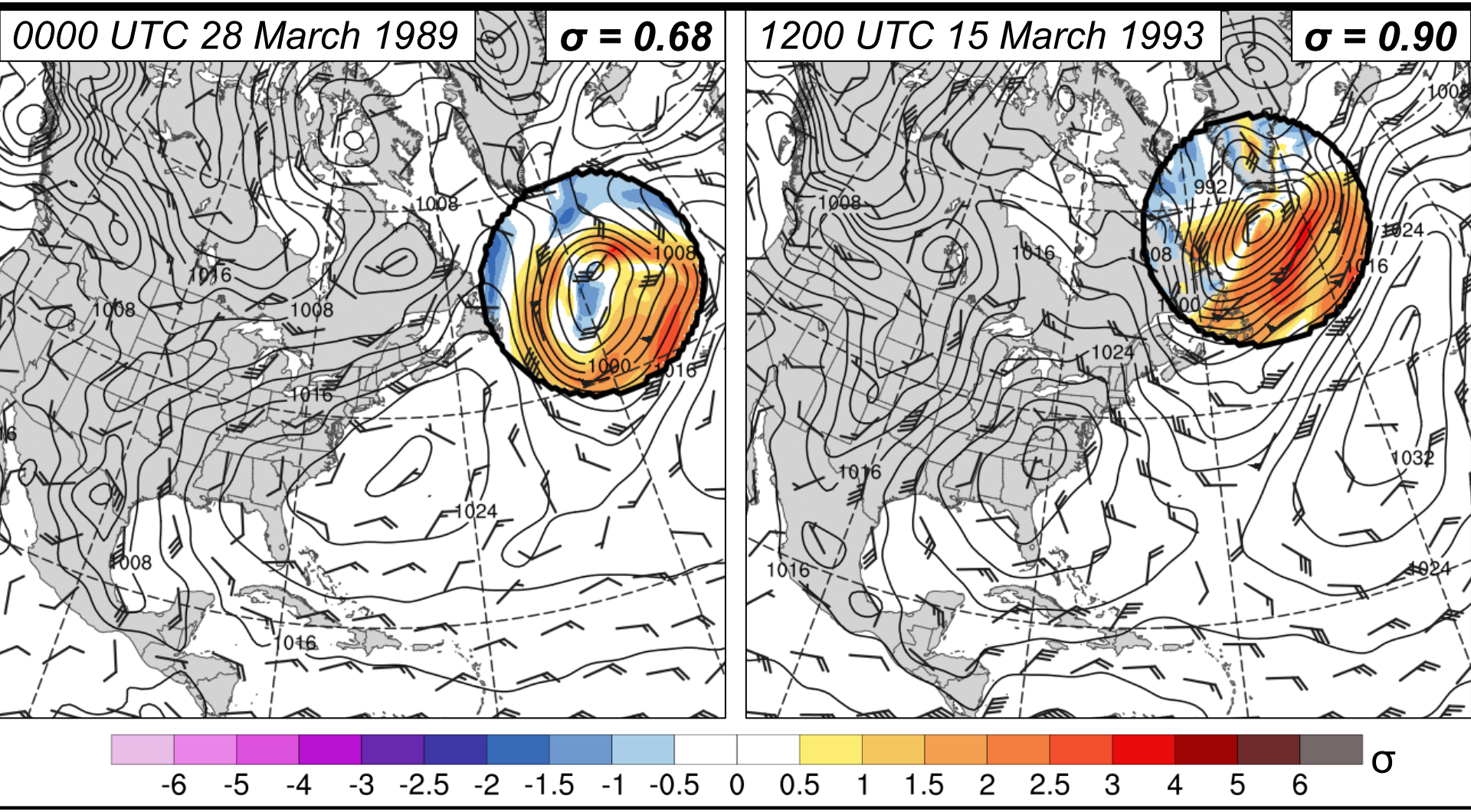

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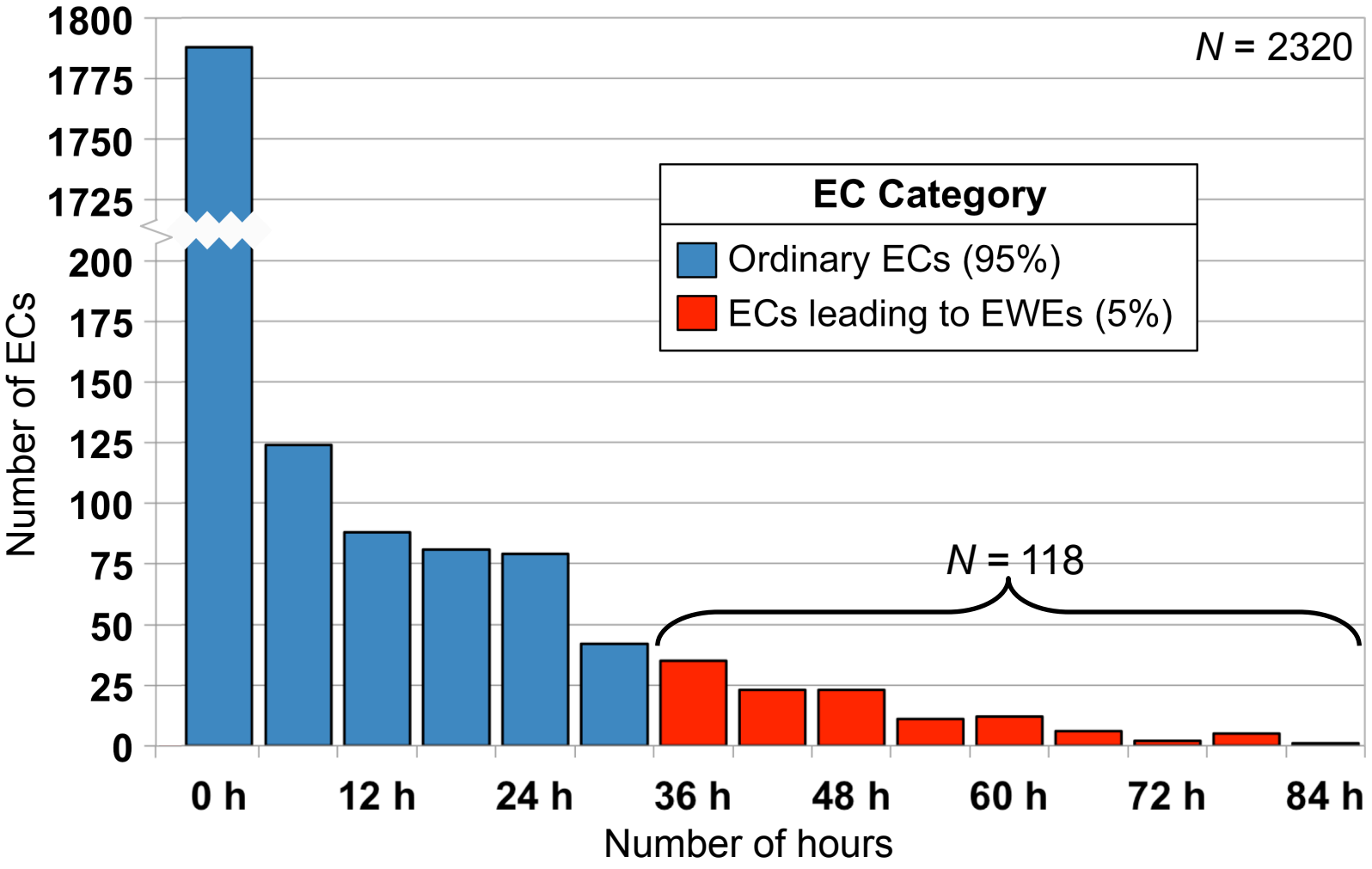
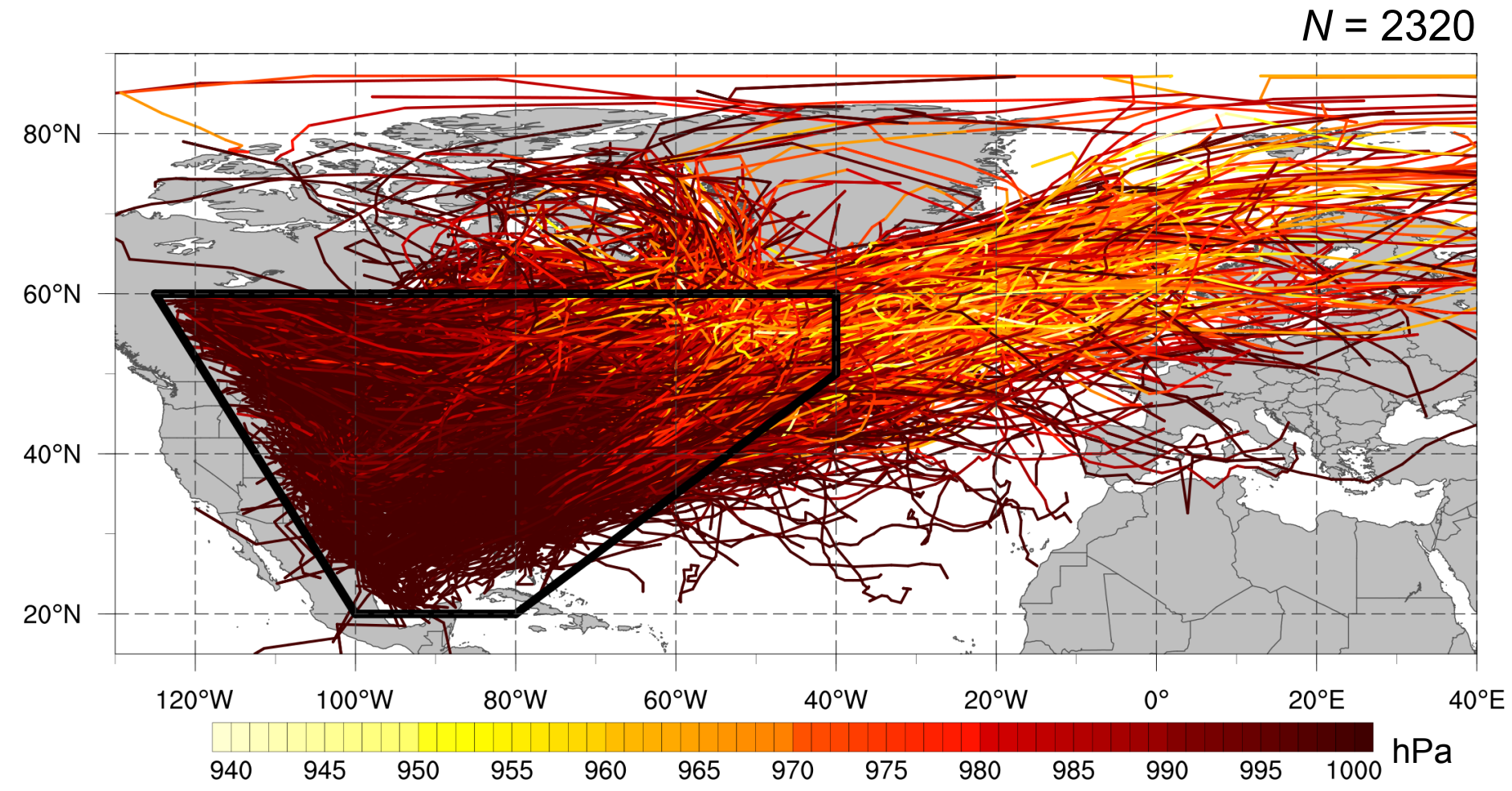
  2) Identify ECs leading to EWEs as those candidate ECs leading to EWEs that attain an area-averaged 925-hPa standardized wind speed anomaly ≥1σ for longer than 95% of candidate ECs leading to EWEs

Identification of ECs leading to EWEs



Distribution of hours that candidate ECs leading to EWEs attain an area-averaged 925-hPa standardized wind speed anomaly ≥1σ

Identification of ECs leading to EWEs



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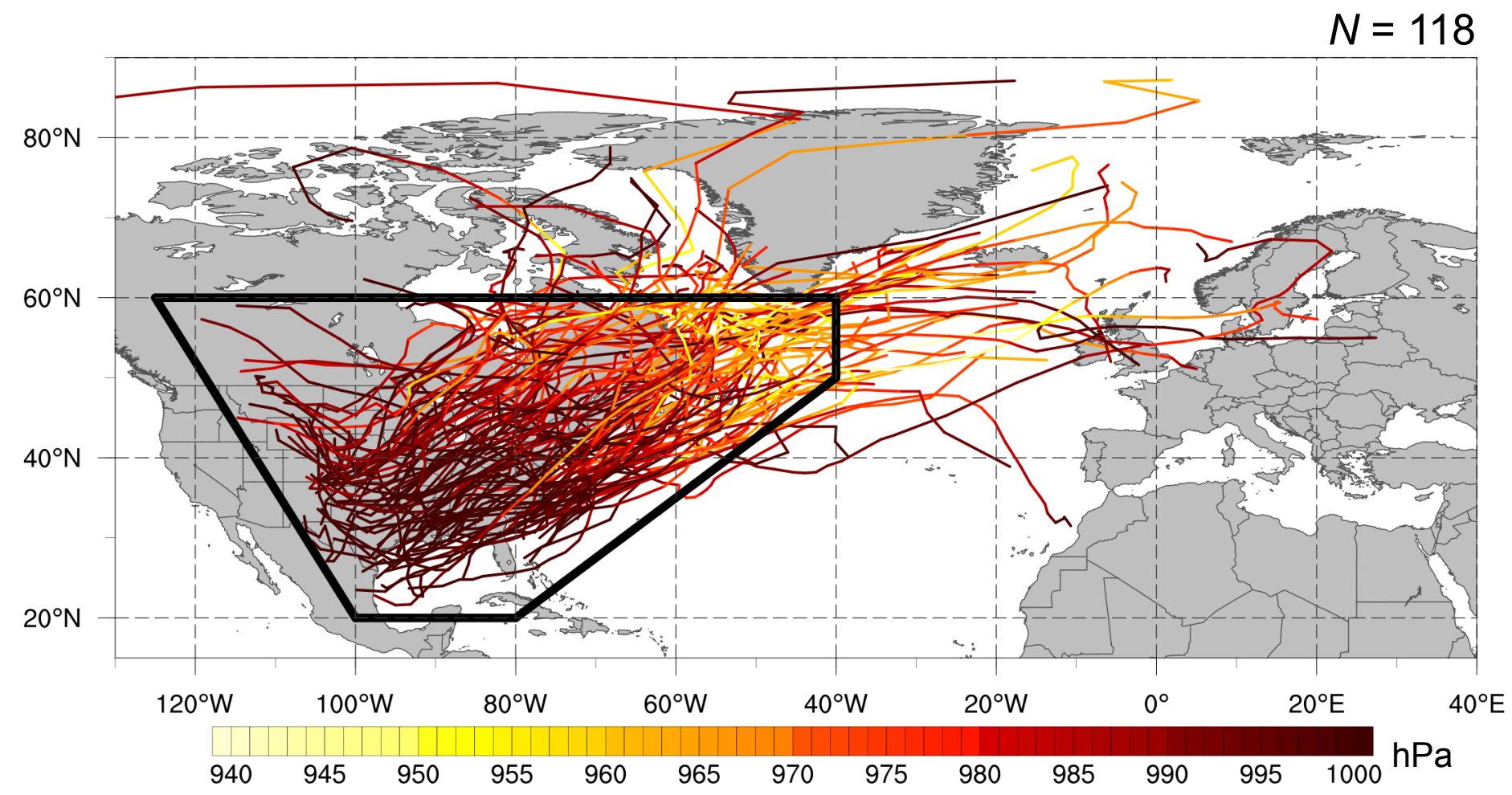
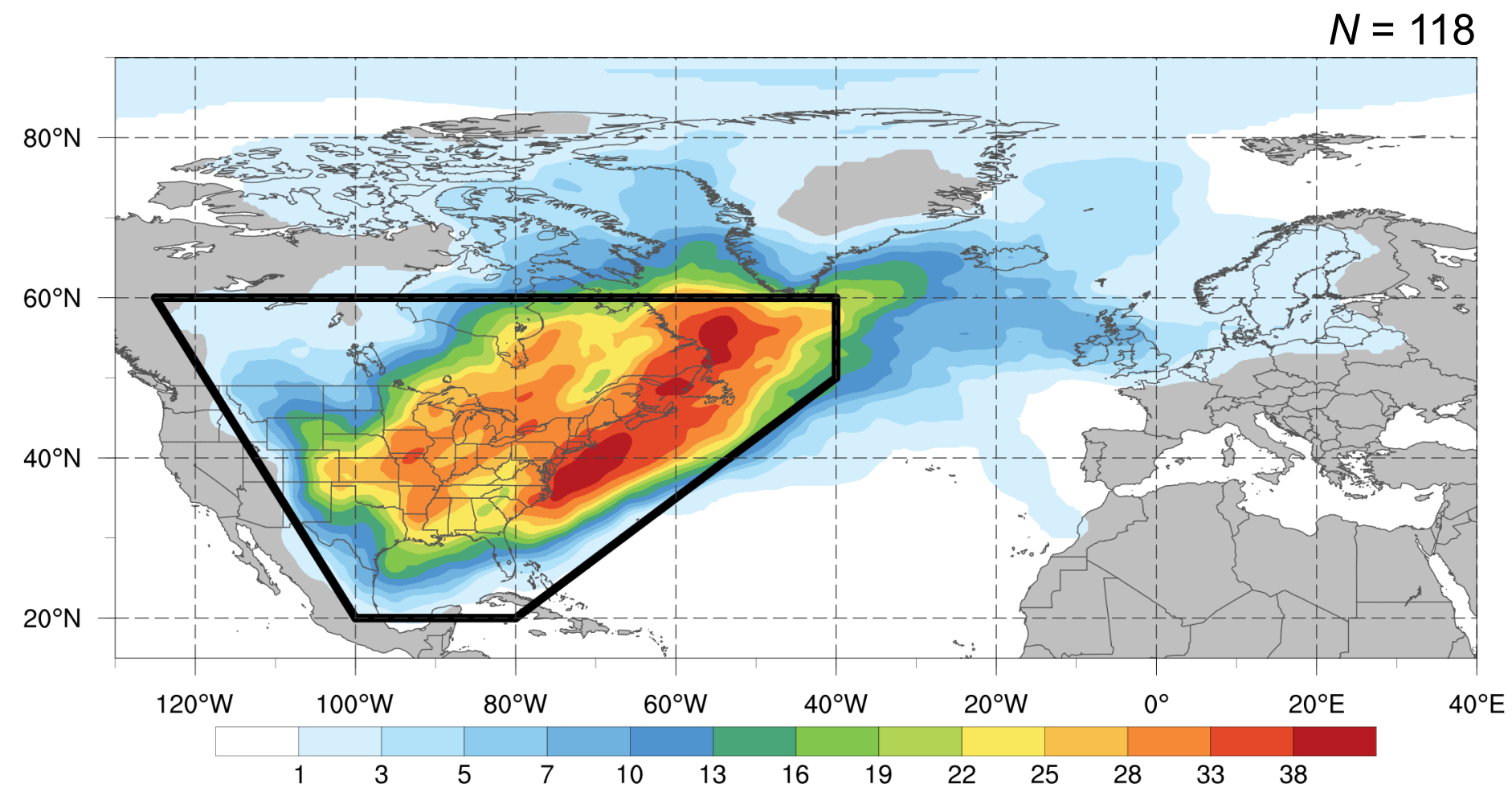


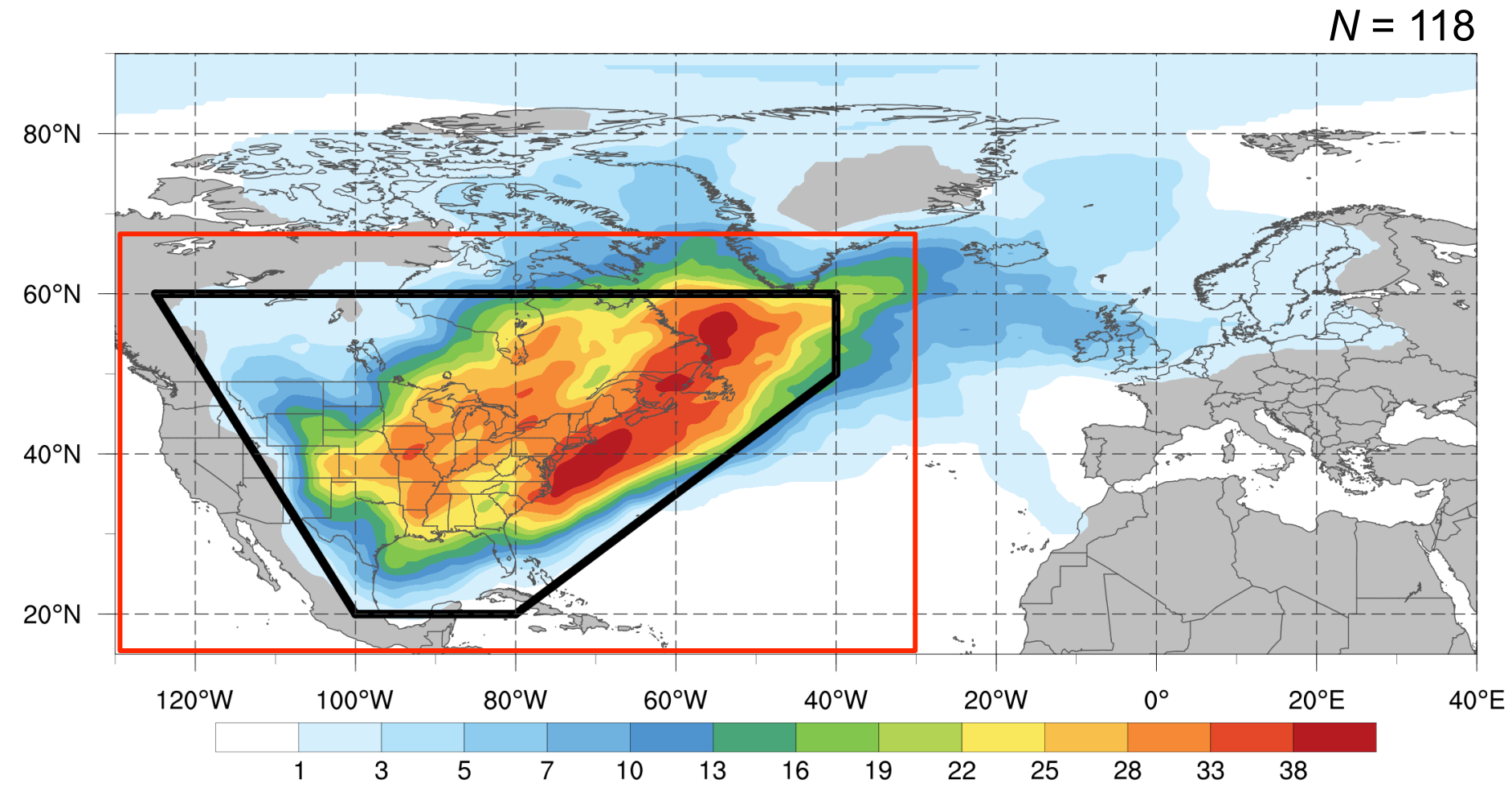
Tracks of ECs leading to EWEs during October–March 1979–2016, shaded according to MSLP value (hPa)

Track Density



Track density of ECs leading to EWEs during October–March 1979–2016, shaded according to the number of ECs passing within 350 km of a given grid point

Track Density



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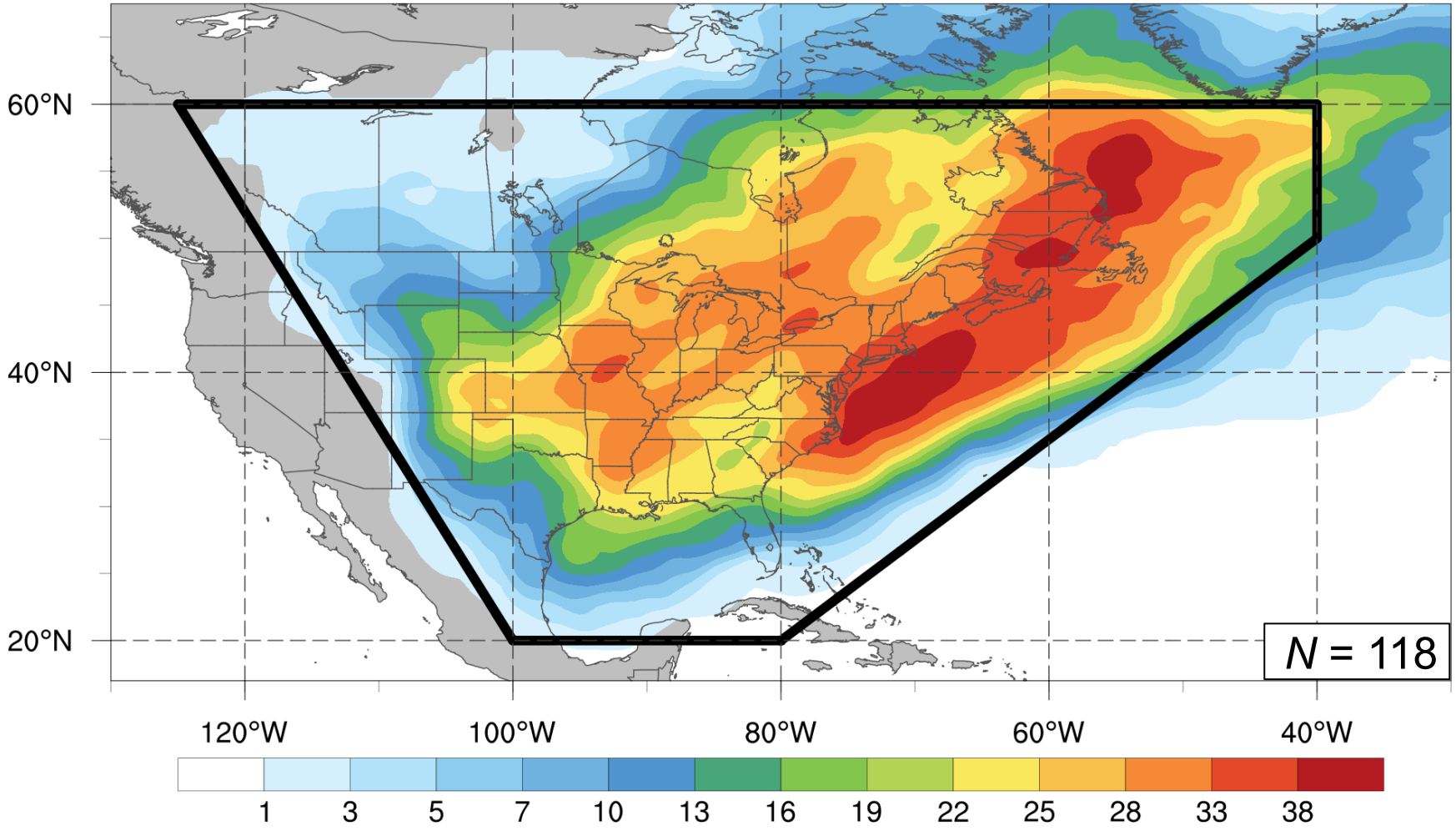

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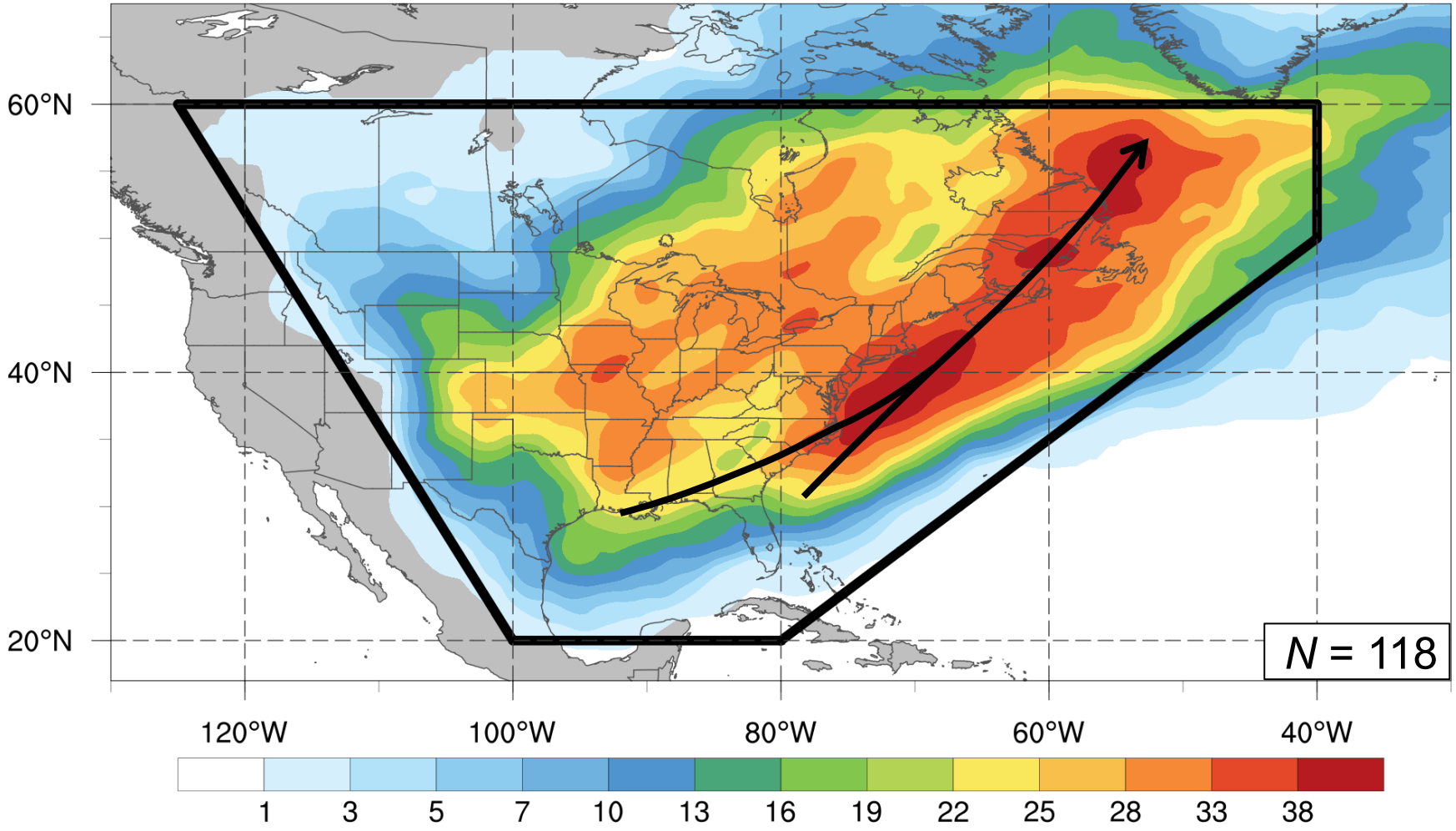

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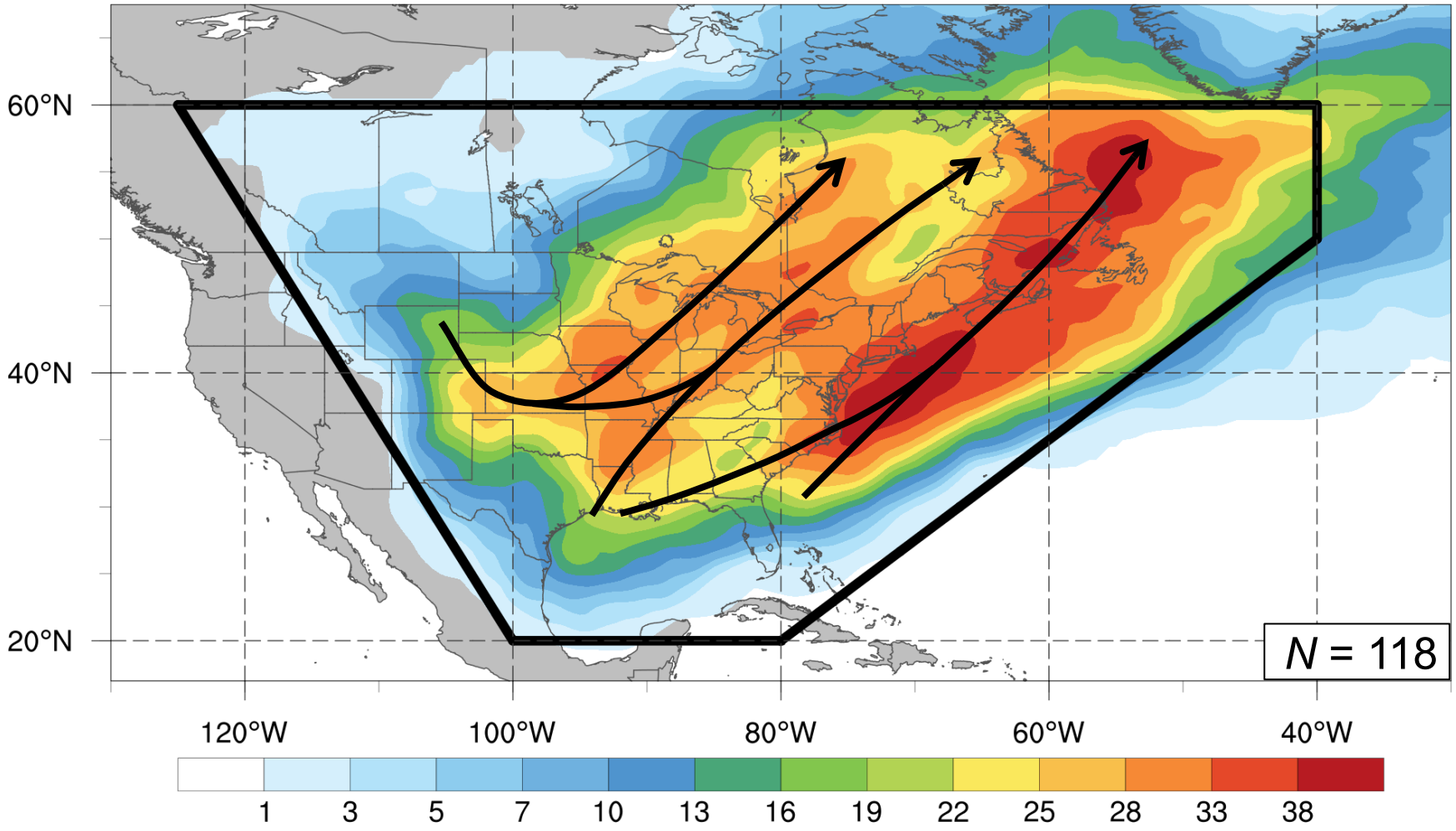

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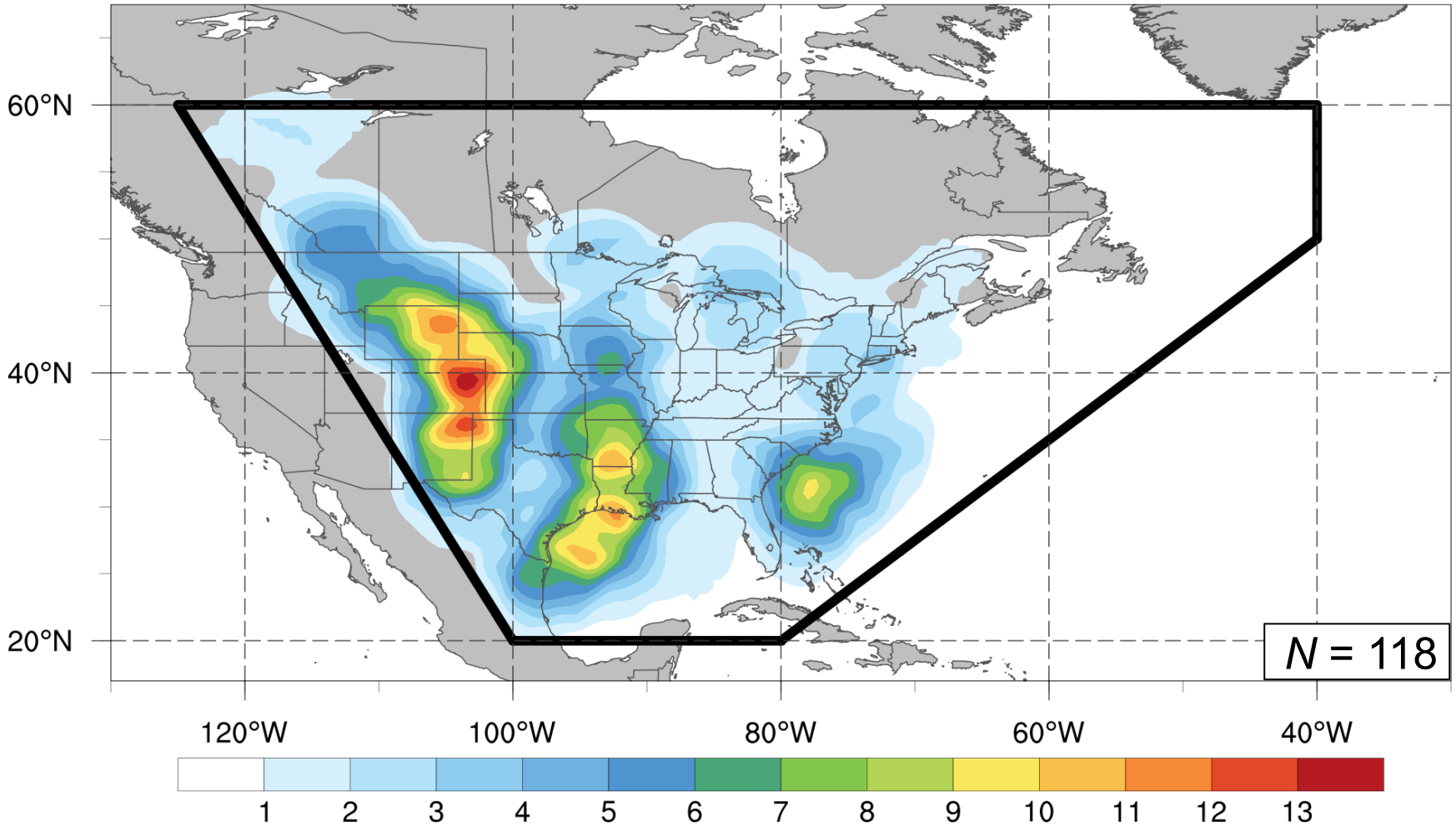
Genesis Locations



Genesis density of ECs leading to EWEs during October–March 1979–2016, shaded according to the number of ECs forming within 350 km of a given grid point

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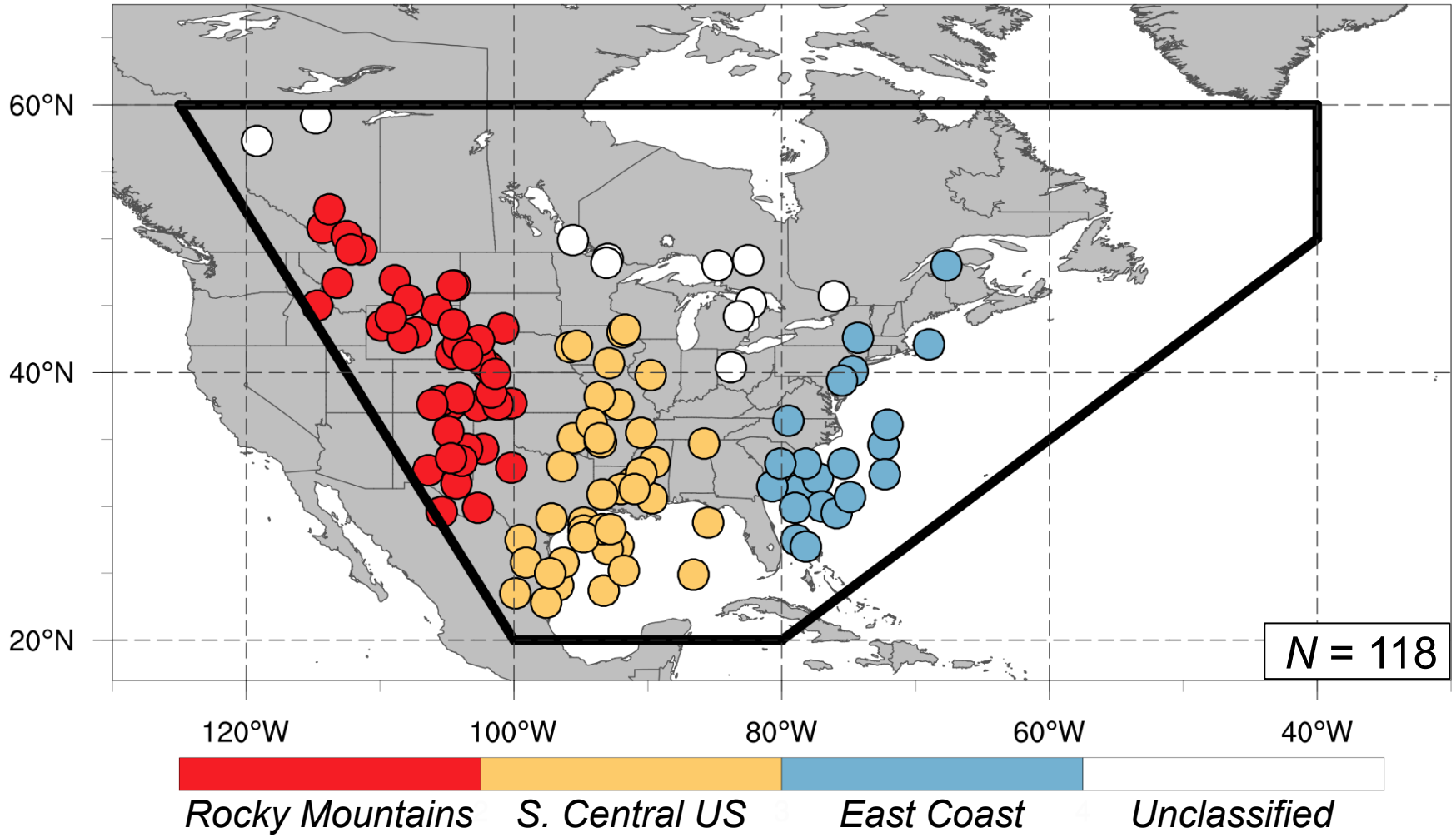
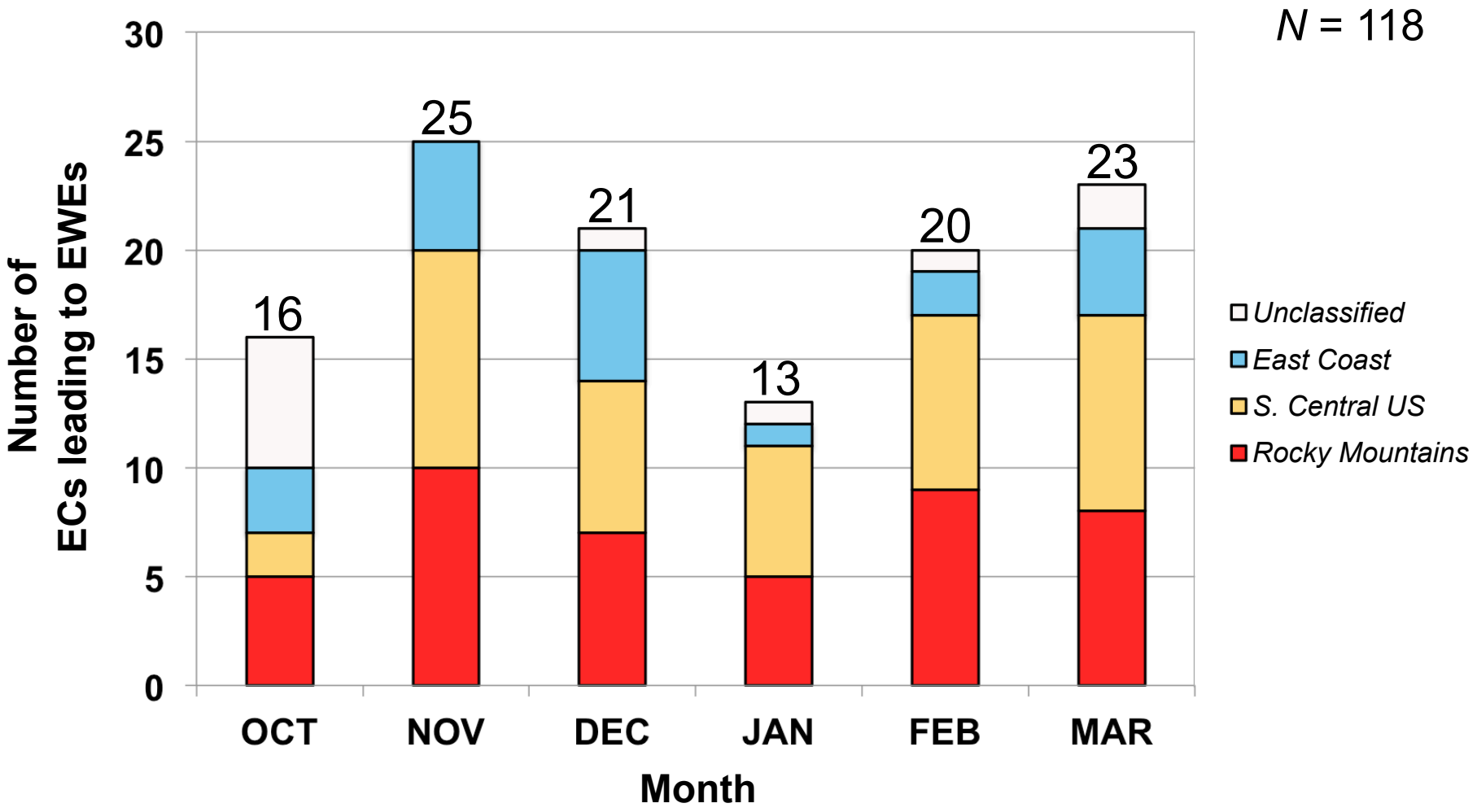


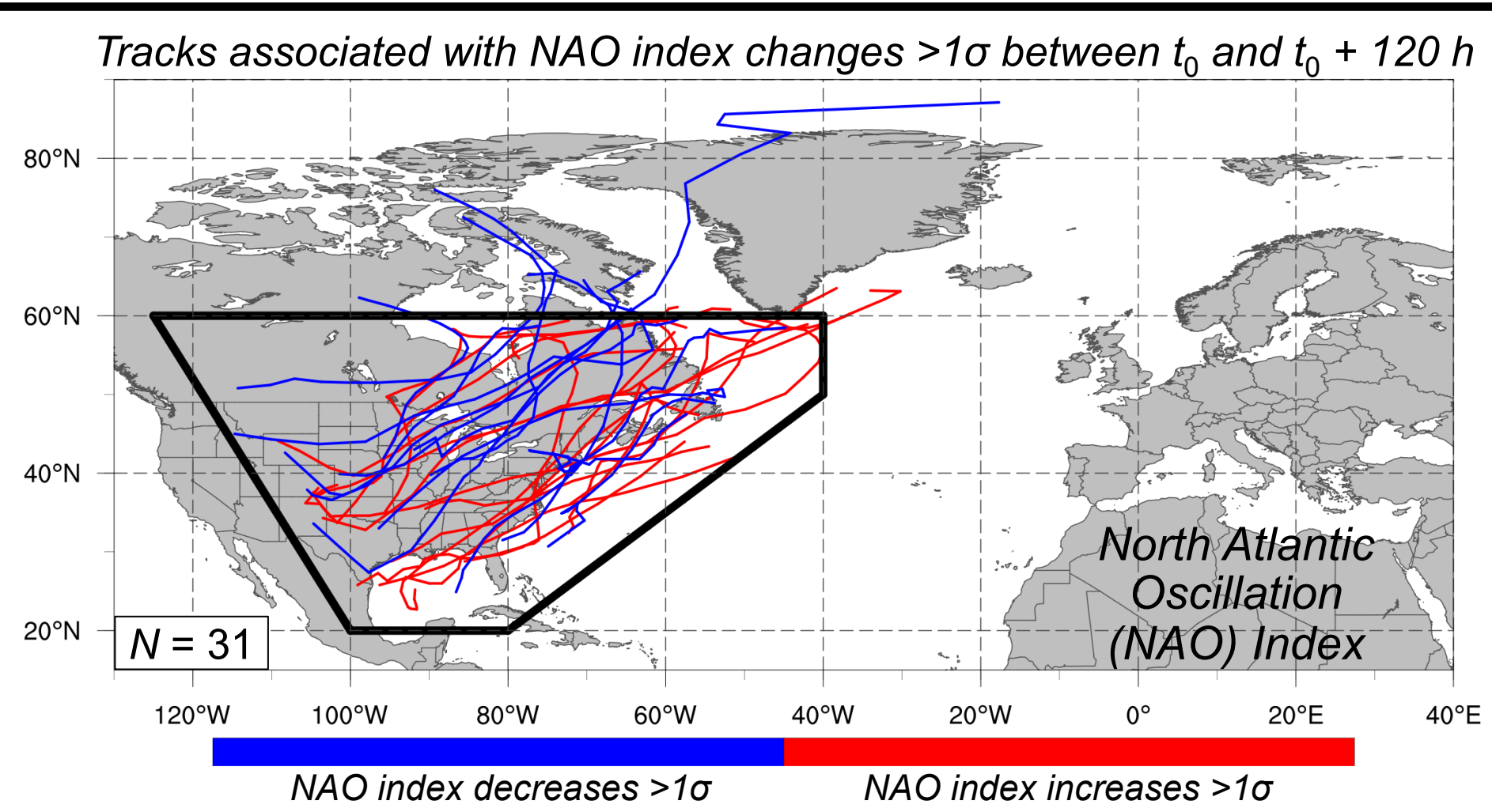
Genesis locations of ECs leading to EWEs during October–March 1979–2016, shaded according to their location of formation

Intraseasonal Variability



Intraseasonal variability associated with the formation of ECs leading to EWEs during October–March 1979–2016, shaded according to their location of formation

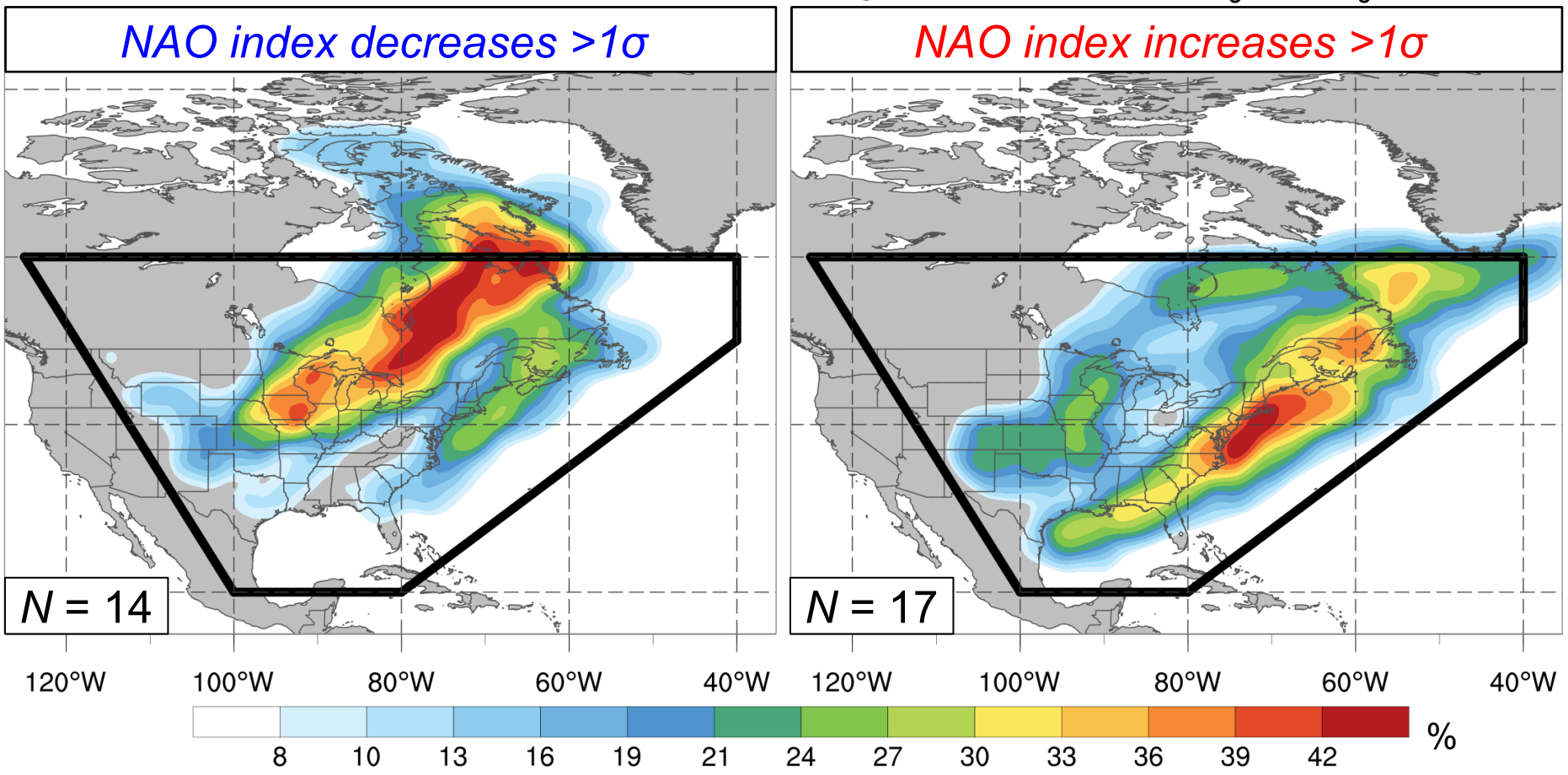
Downstream Impacts



Tracks of ECs leading to EWEs for which the NAO index decreases >1σ (blue) or increases >1σ (red) between t_0 and t_0 + 120 h

Downstream Impacts

Tracks associated with NAO index changes >1σ between t_0 and t_0 + 120 h



Track density of ECs leading to EWEs for which the NAO index decreases >1σ (left) or increases >1σ (right) between t_0 and t_0 + 120 h, shaded according to the percentage of ECs passing within 350 km of a given grid point

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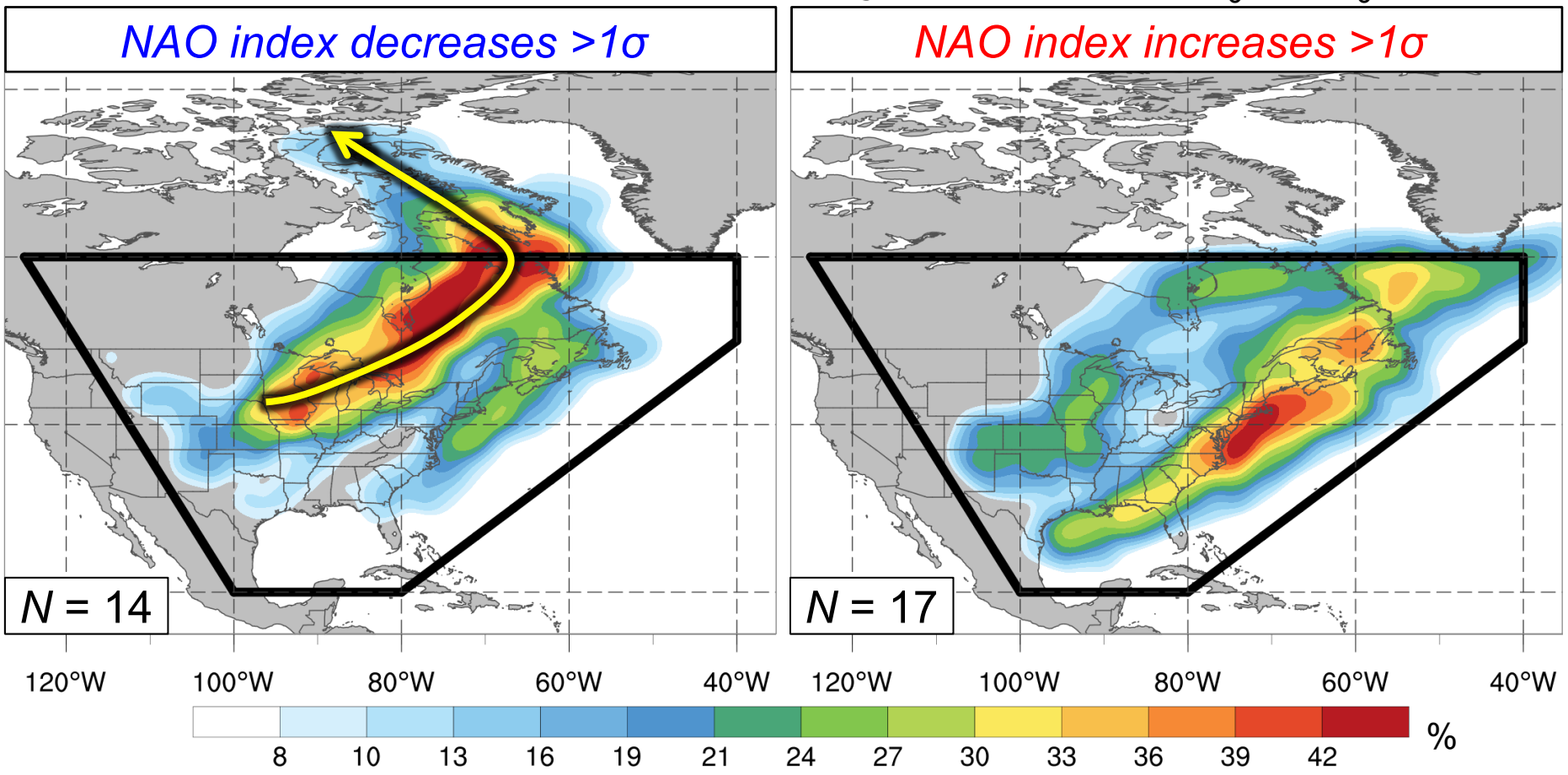

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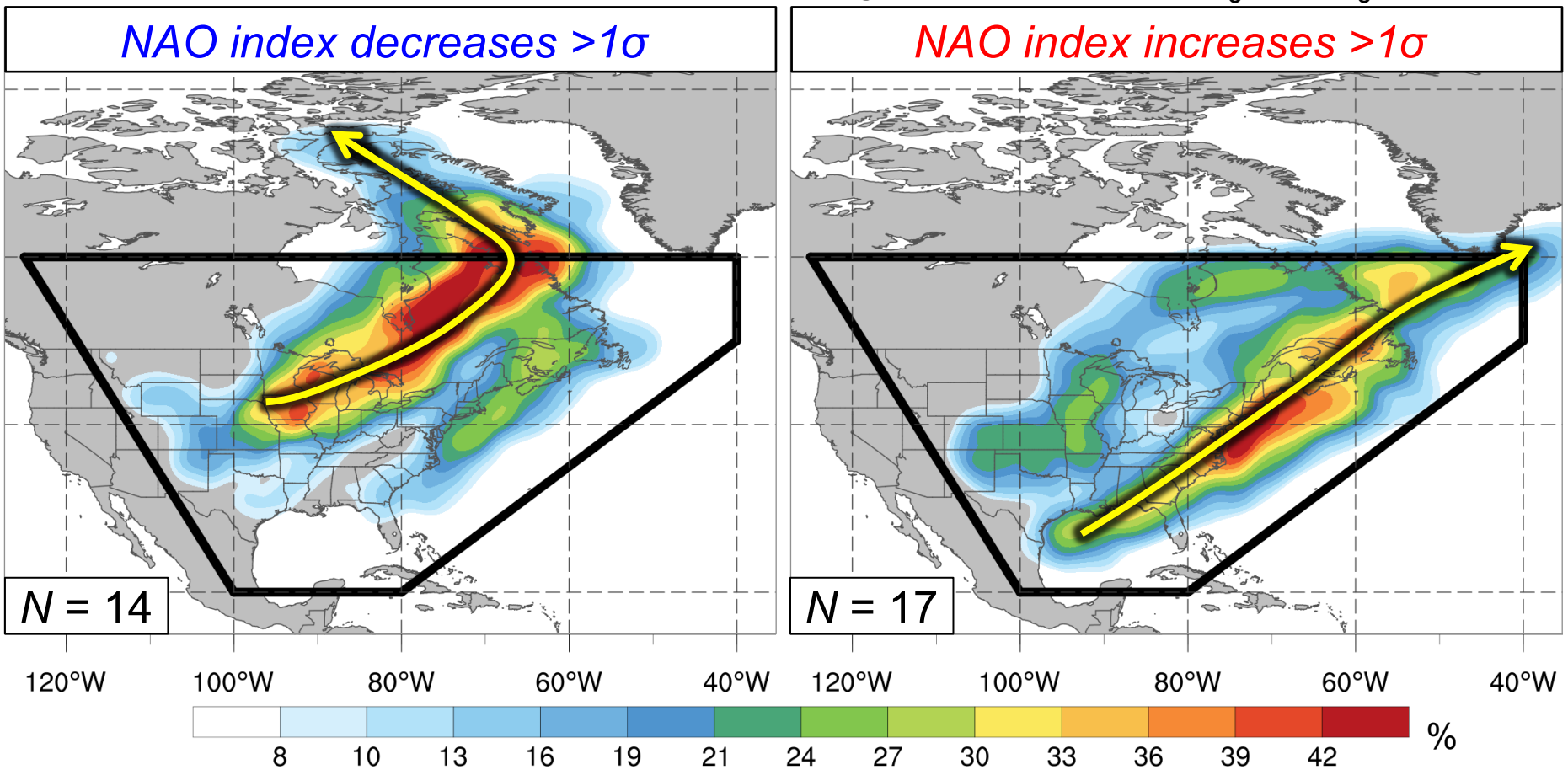

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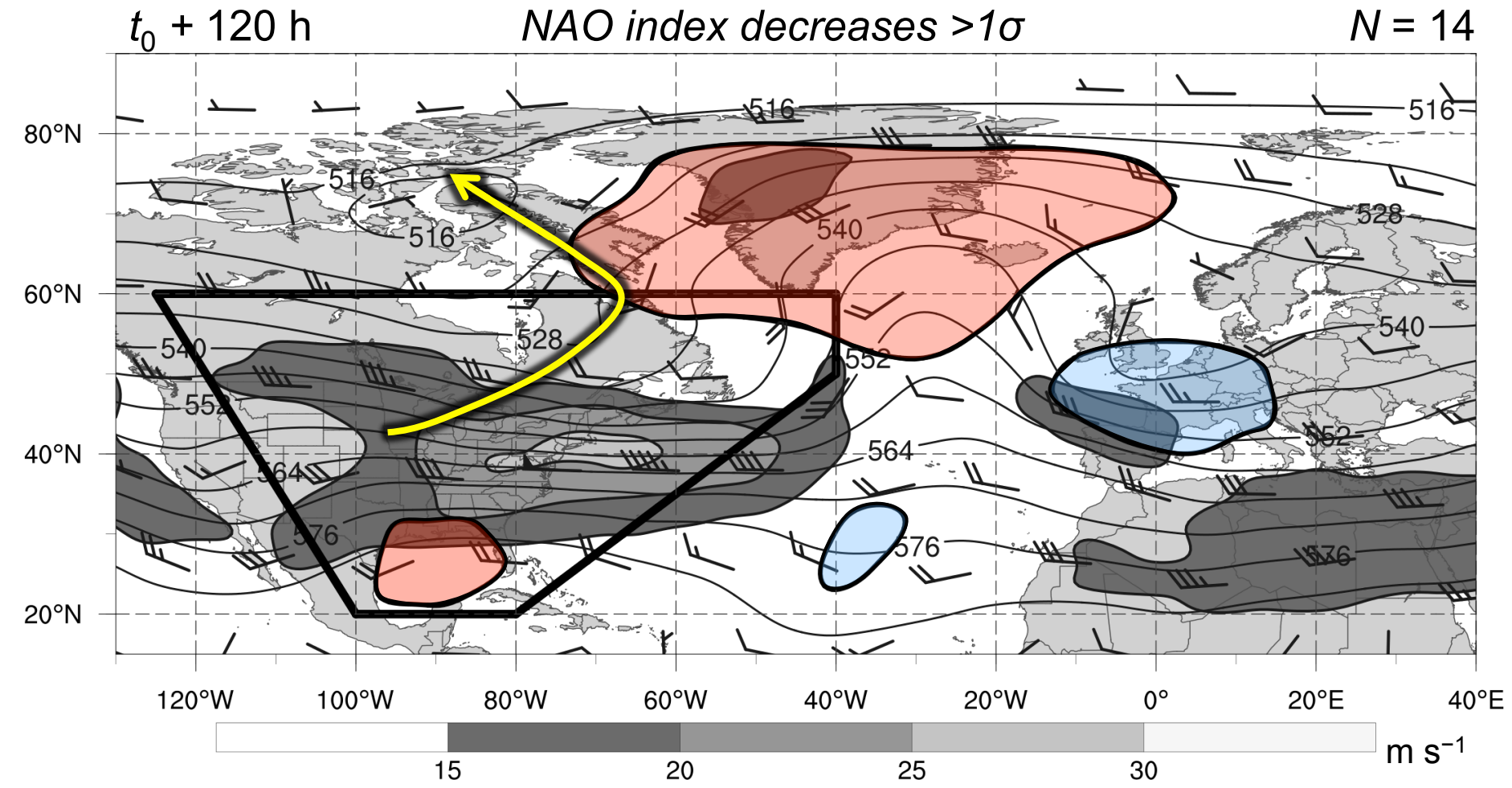

Earth-relative composite analyses of 500-hPa geopotential height (thin black contours, dam; enclosed by thick black contours and shaded where significant at 95% confidence level), wind (barbs, kt), and wind speed (shaded, m s^{-1})

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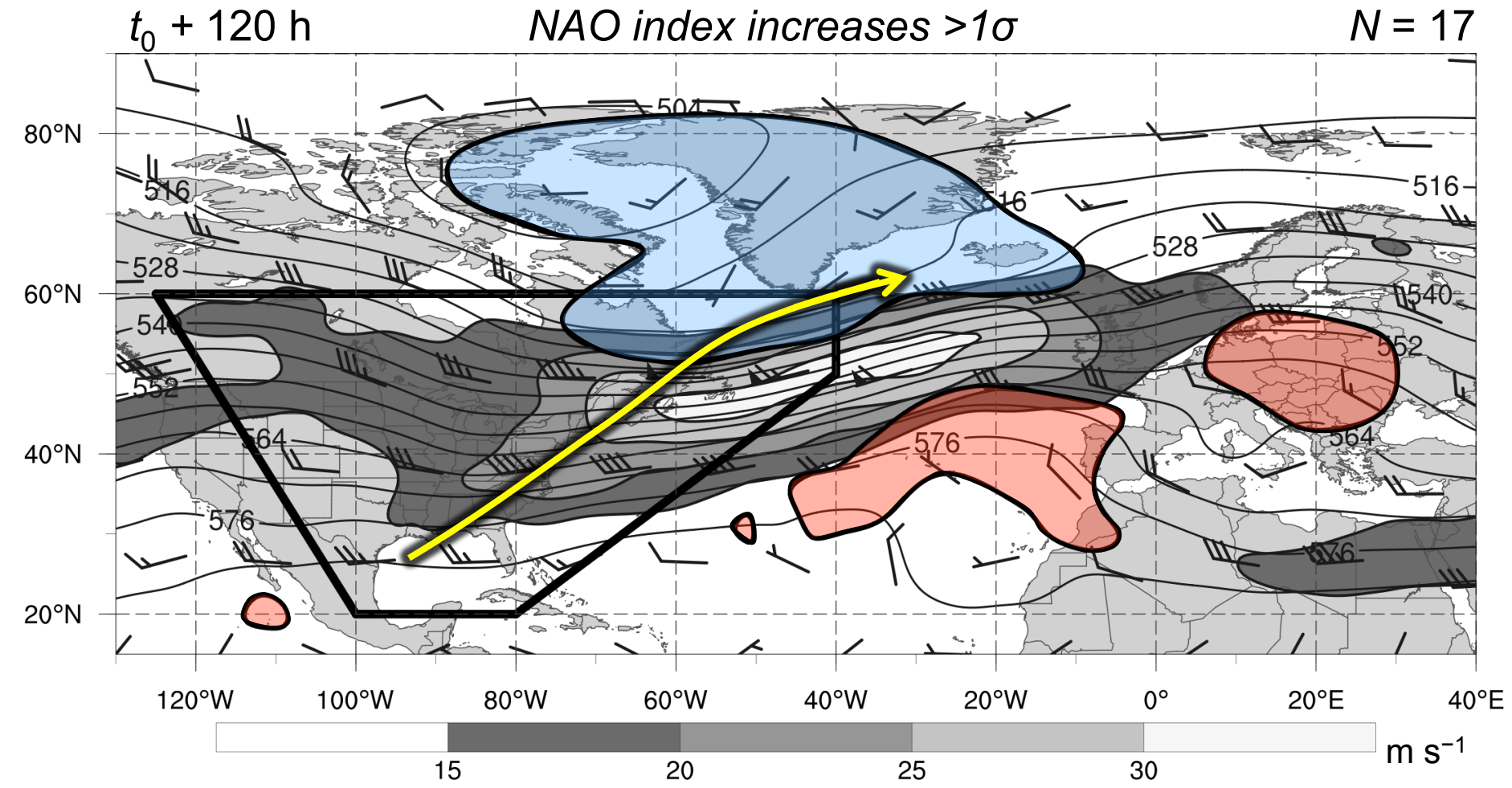

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Summary

- ECs leading to EWEs over central and eastern North America during October–March 1979–2016 are identified in terms of their 925-hPa standardized wind speed anomalies

- ECs leading to EWEs typically form in the lee of the Rockies, over the south central United States, and along the east coast of North America

- ECs leading to EWEs form most frequently during November and March, and least frequently during October and January

- ECs leading to EWEs associated with a decrease in the NAO index of >1σ between t_0 and t_0 + 120 h typically pass to the west of Greenland

- ECs leading to EWEs associated with an increase in the NAO index of >1σ between t_0 and t_0 + 120 h typically pass to the south of Greenland

Questions? AMBentley@albany.edu

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Special thanks: Brian Colle and Alicia Camacho