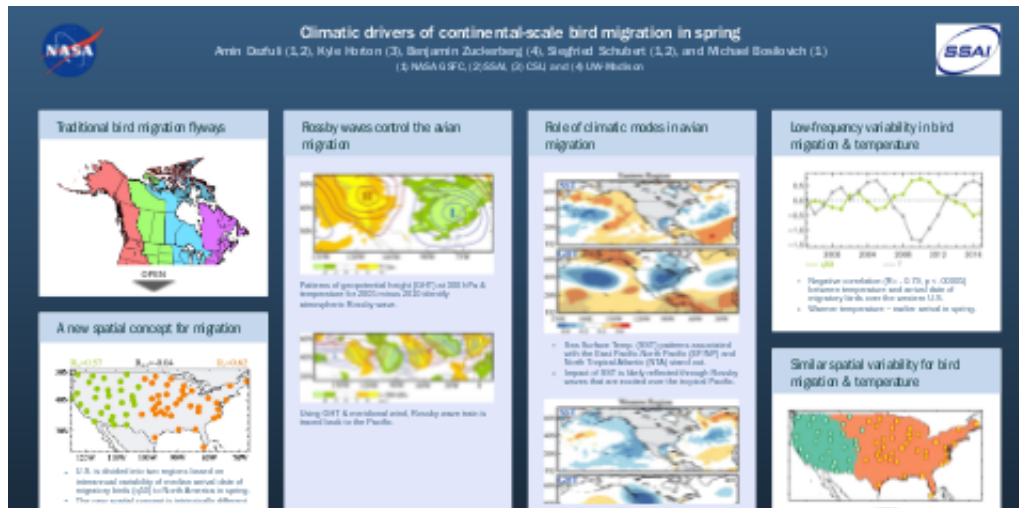


# Climatic drivers of continental-scale bird migration in spring



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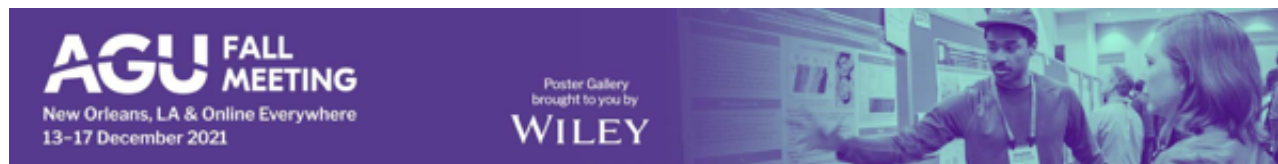
Accept

Amin Dezfuli (1,2), Kyle Horton (3), Benjamin Zuckerberg (4), Siegfried Schubert (1,2), and Michael Bosilovich (1)

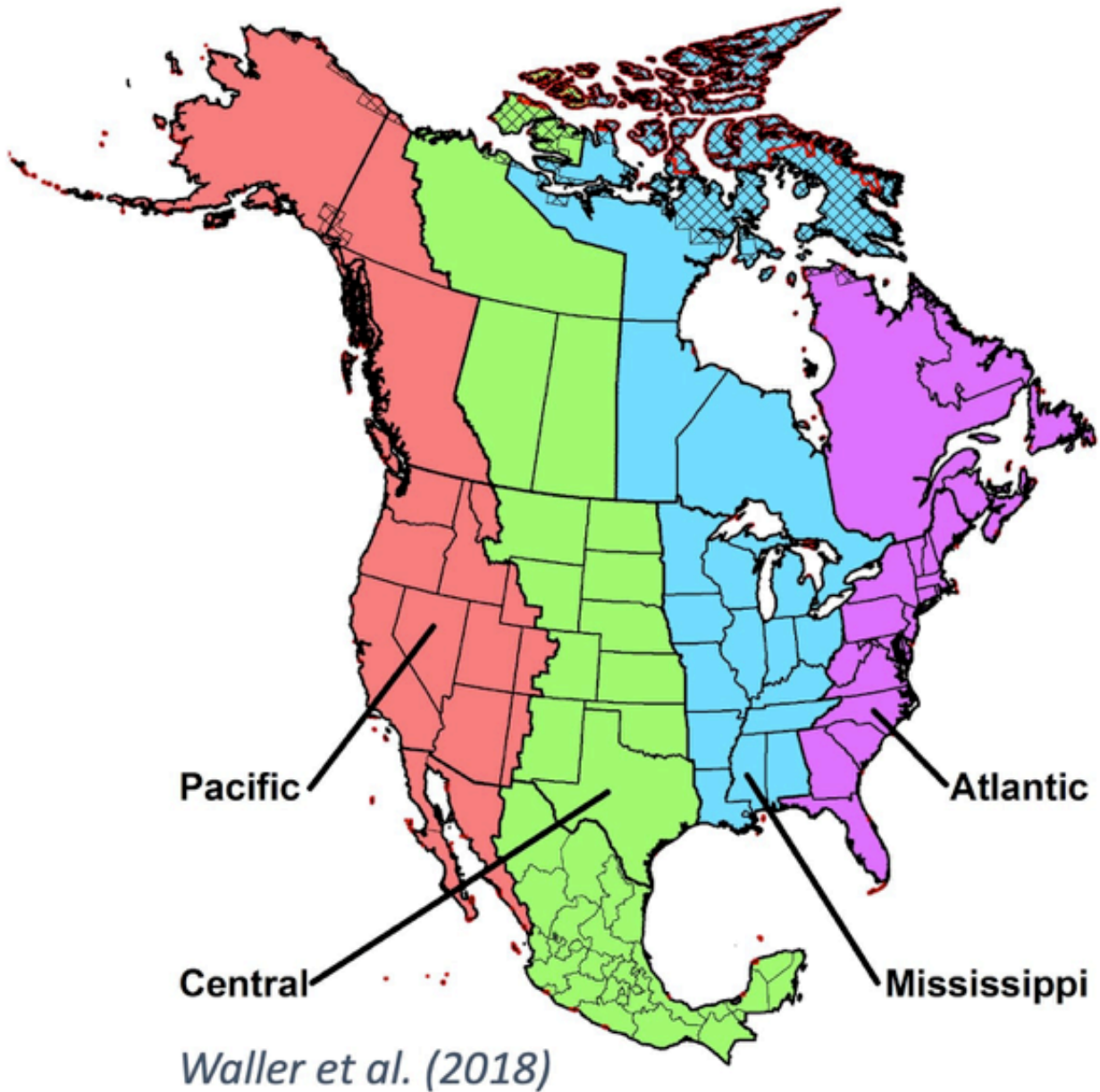
(1) NASA GSFC, (2) SSAI, (3) CSU, and (4) UW-Madison



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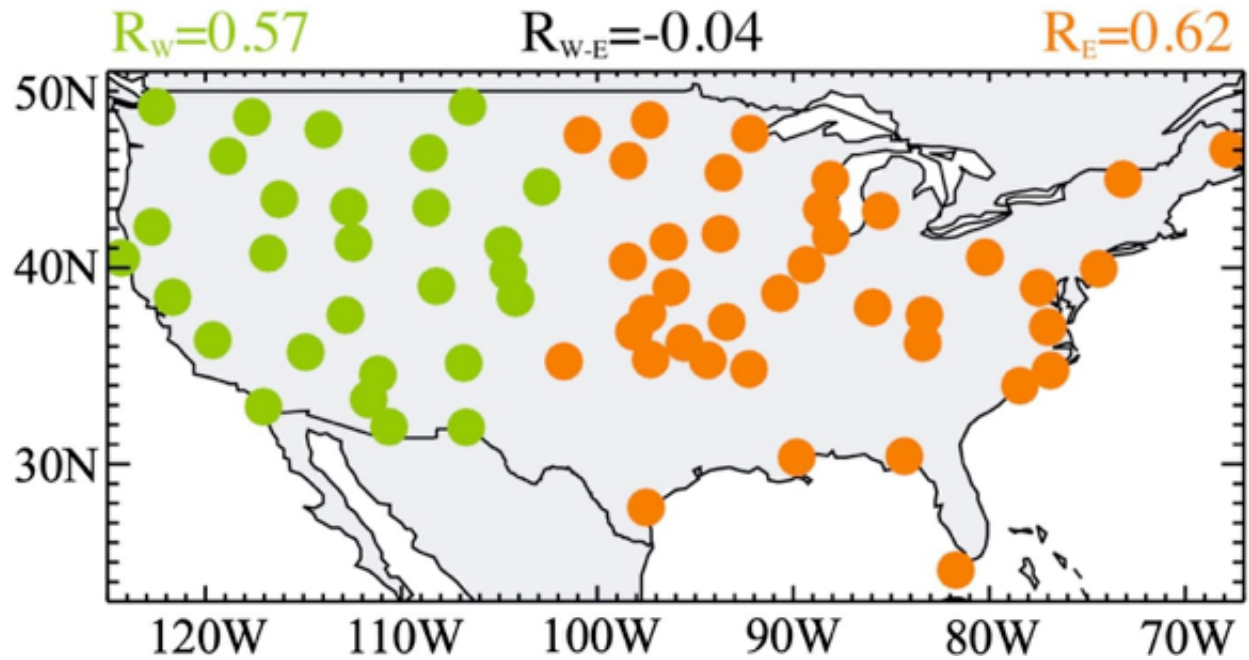


## TRADITIONAL BIRD MIGRATION FLYWAYS

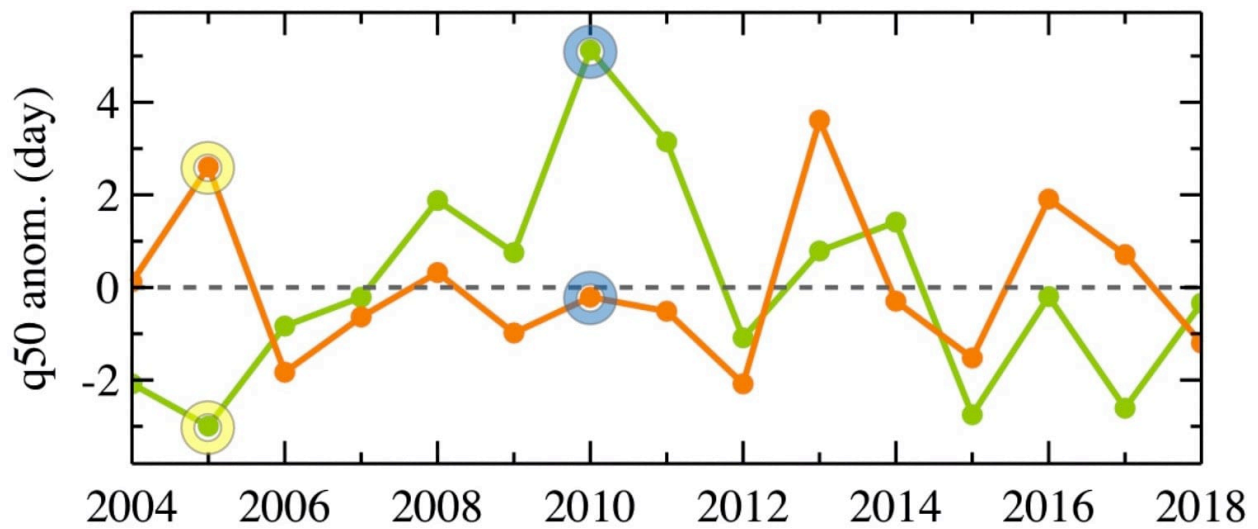


- For ~100 years, for management purposes, the continental patterns of avian migration in North America have been described in the context of three or four primary flyways.
- This spatial approach fails to reflect a critical characterization of migration — phenology.
- Phenology: seasonal timing of key life cycle events.

# A NEW SPATIAL CONCEPT FOR MIGRATION

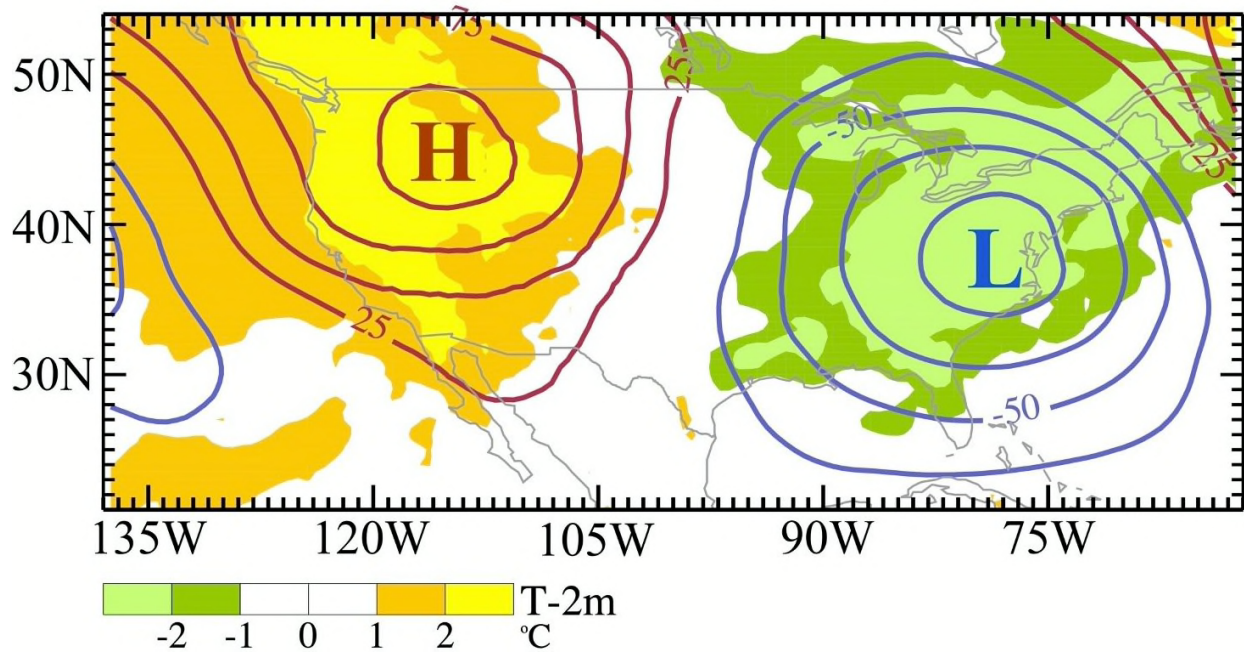


- U.S. is divided into two regions based on interannual variability of median arrival date of migratory birds (q50) to North America in spring.
- The new spatial concept is intrinsically different from flyway strategy.

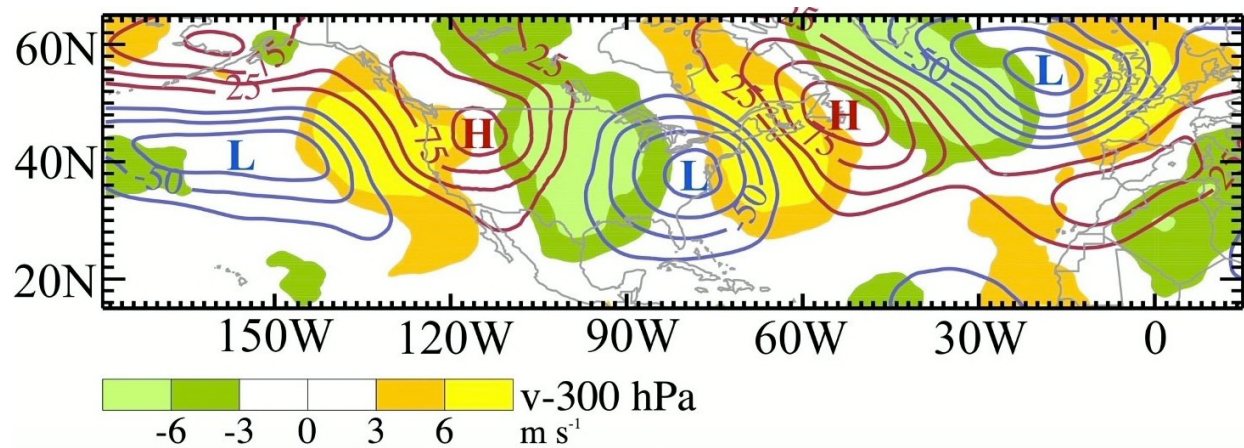


- Opposite q50 anomalies for the two regions in some years (e.g., 2010 and 2005).

# ROSSBY WAVES CONTROL THE AVIAN MIGRATION



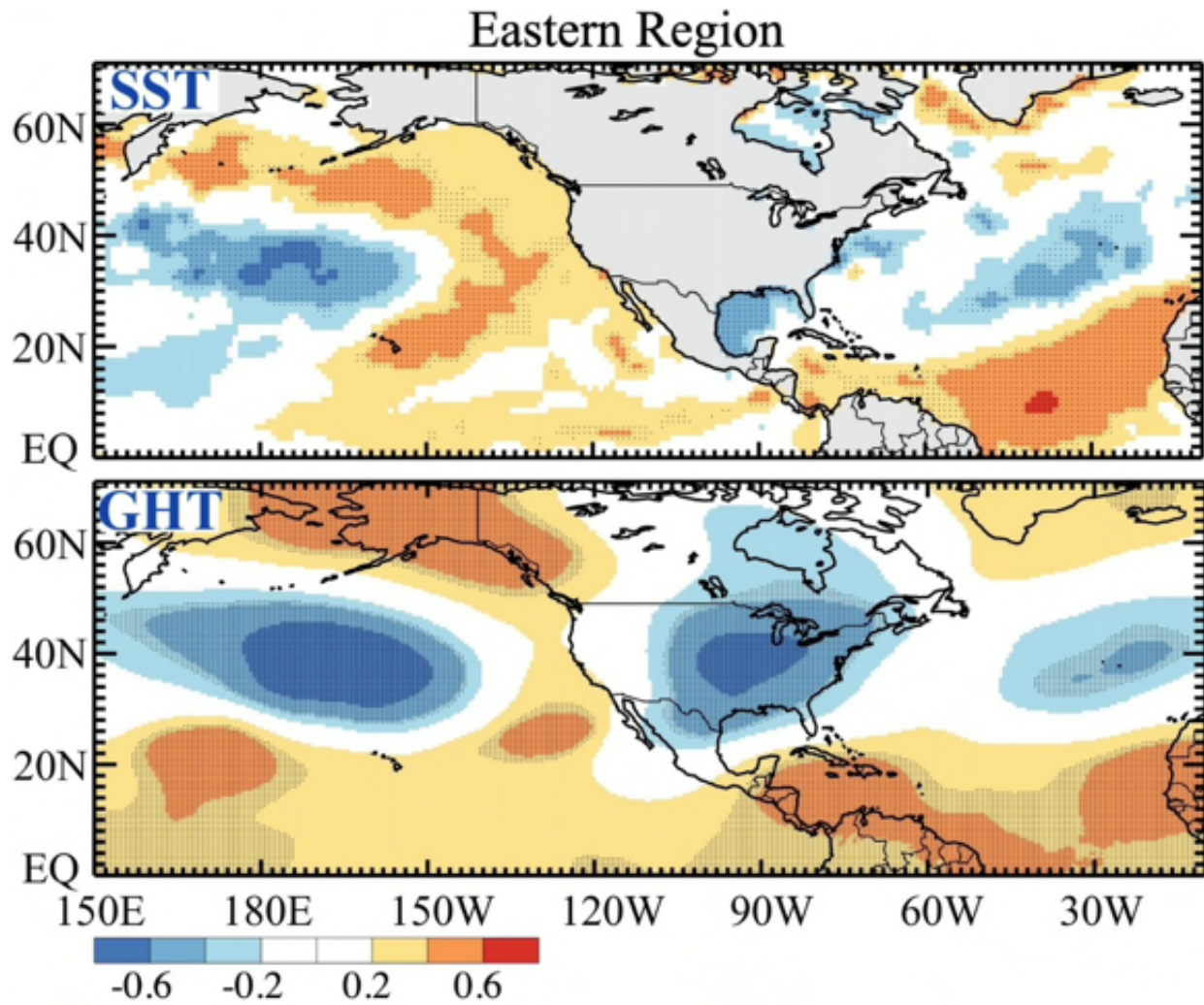
Patterns of geopotential height (GHT) at 300 hPa & temperature for 2005 minus 2010 identify atmospheric Rossby wave.



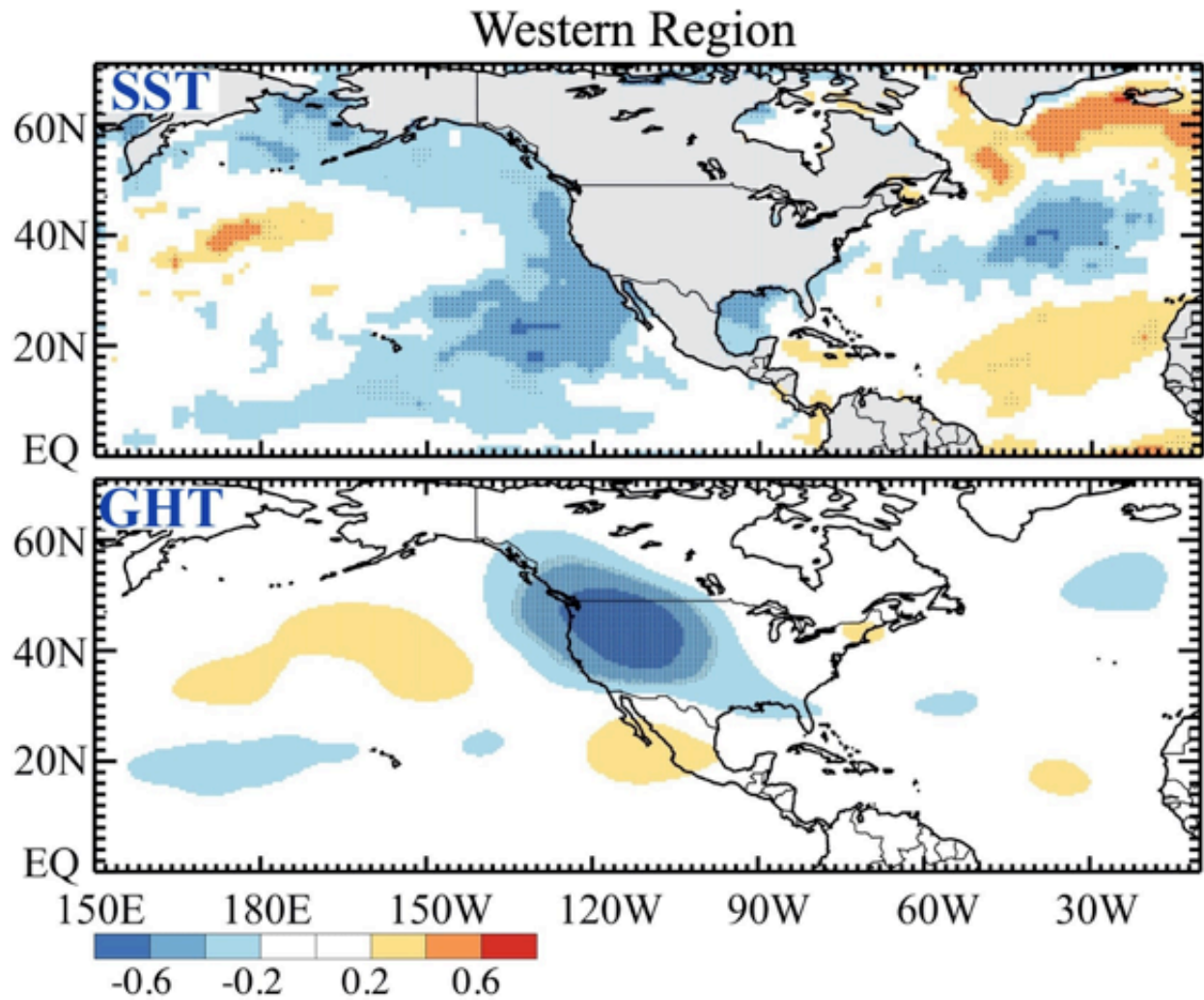
Using GHT & meridional wind, Rossby wave train is traced back to the Pacific.



## ROLE OF CLIMATIC MODES IN AVIAN MIGRATION

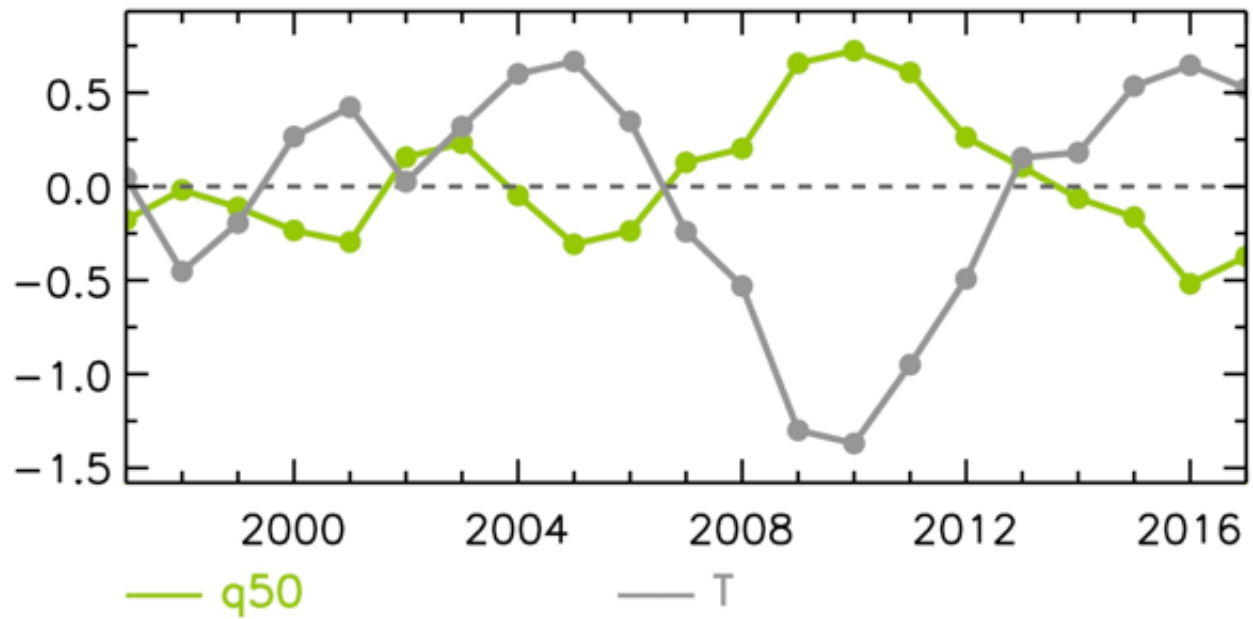


- Sea Surface Temp. (SST) patterns associated with the East Pacific-North Pacific (EP/NP) and North Tropical Atlantic (NTA) stand out.
- Impact of SST is likely reflected through Rossby waves that are excited over the tropical Pacific.



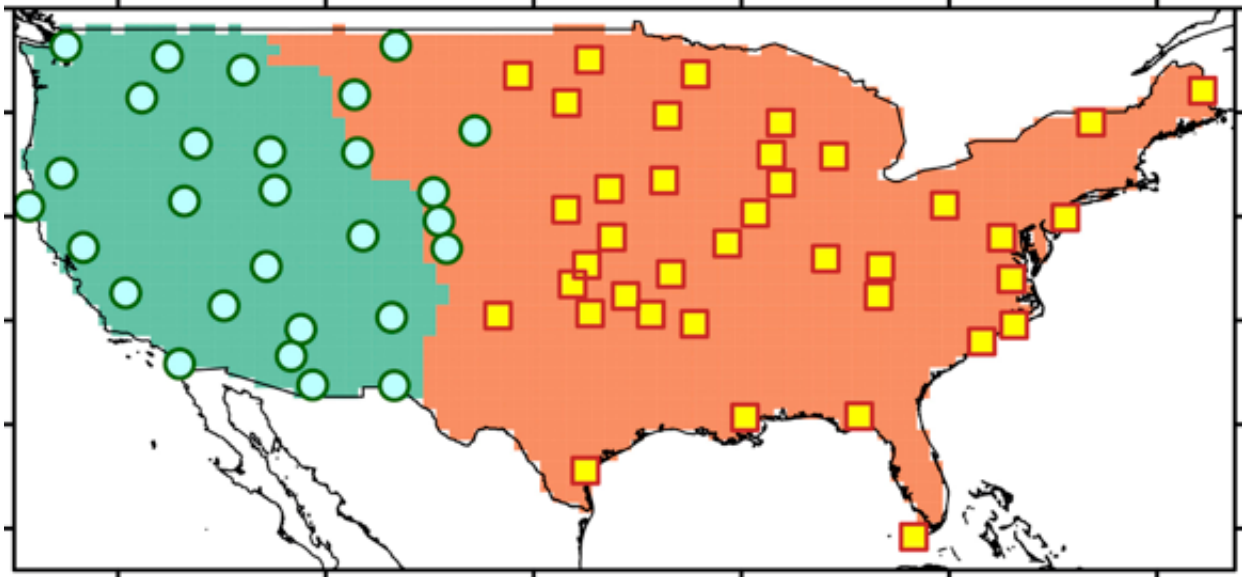
- Generally weaker and more spatially limited (than eastern region) link to large-scale climatic feature like Rossby waves.
- High correlations with adjacent waters, which likely affect the region through temperature advection.

## LOW-FREQUENCY VARIABILITY IN BIRD MIGRATION & TEMPERATURE



- Negative correlation ( $R = -0.79$ ,  $p < .00005$ ) between temperature and arrival date of migratory birds over the western U.S.
- Warmer temperature  $\sim$  earlier arrival in spring.

## SIMILAR SPATIAL VARIABILITY FOR BIRD MIGRATION & TEMPERATURE



- Climate regions obtained objectively based on similarity in interannual variability of Mar-Apr-May temperature (shading).
- Consistent with two-region pattern from bird migration variability.

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Dezfuli, A., Horton, K.G., Zuckerberg, B., Bosilovich, M.G. and Schubert, S.D., 2021. Continental patterns of bird migration linked to climate variability. *Bull. Amer. Meteor. Soc.*, (accepted), <https://doi.org/10.1175/BAMS-D-21-0220.1>  
(<https://doi.org/10.1175/BAMS-D-21-0220.1>)



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## ABSTRACT

Avian migration studies conventionally divide North America into three or four primary flyways. This strategy has been adopted for convenience or determined by the time-averaged movement patterns, so it may not adequately reflect the real temporal variability of bird migration phenology. Using a unique radar-based data set (NEXRAD) covering the contiguous U.S. (CONUS), and an objective regionalization approach, we have identified two regions with distinct interannual variability of spring migration. This two-region approach helped us to distinguish the climatic drivers of year-to-year variability specific to the western and eastern CONUS. For example, we identified an east-west dipole pattern in migratory behavior linked to atmospheric Rossby waves that appeared to be triggered by oceanic forcing in the tropical Pacific. Our results offer a new geographic framework that would facilitate exploring the climatic cues affecting the interannual variability of migration phenology at the continental scale.

## REFERENCES

Dezfuli, A., Horton, K.G., Zuckerberg, B., Bosilovich, M.G. and Schubert, S.D., 2021. Continental patterns of bird migration linked to climate variability. *Bull. Amer. Meteor. Soc.*, (accepted), <https://doi.org/10.1175/BAMS-D-21-0220.1>  
(<https://doi.org/10.1175/BAMS-D-21-0220.1>)



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