Motivation
- North Atlantic: favored region for extratropical transition (ET) of tropical cyclones (TCs) → cold and warm fronts
- Gulf Stream (GS) influences:
  - midlatitude winter cyclones
  - climatology of atmospheric fronts
- Mechanisms debated:
  - SST vs. SST
  - latent vs. sensible HF
  - Regional preconditioning vs. direct
  - Diabatic frontogenesis

Objectives
Does the Gulf Stream play a role in the extratropical transition of tropical cyclones in the region and how might this occur?

More Information
Publication in prep:

Atlantic hurricane season.

Cyclone phase space for Hurricane Teddy in ERA5 during the 2020 North Atlantic Tropical Cyclone phase space for Hurricane Teddy.

Gulf Stream SST and Baroclinicity

Vertical cross section of adiabatic frontogenesis (shaded), isentropes (green contours), boundary layer height (magenta), and 925hPa adiabatic frontogenesis associated with the ET of Hurricane Teddy (shaded), center of Teddy at each time (X marker) and cross section region (blue line). Inset: Vertical cross section of adiabatic frontogenesis (shaded), isentropes (green contours), boundary layer height (magenta), and 925hPa adiabatic frontogenesis associated with the ET of Hurricane Teddy (shaded), center of Teddy at each time (X marker) and cross section region (blue line).

Results shows enhanced surface baroclinicity when GS index is higher.

Mechanism: SHF V scales with diabatic frontogenesis by influencing near-surface temperatures (noisier signal).

Region more conducive for influence on ET.

Evidence for a relationship between ET fate & SST strength

Composites of anomalies from climatological daily mean SST gradient at a 7-day lead for times averaged by storm when TCs successfully transition (left) and do not successfully transition (right). Hatching indicates statistical significance for p < 0.1.

- Diminished SST V anomalies for unsuccessful ET and vice-versa.
- Persistent signal in days/weeks leading up to ET times contributes to baroclinicity for enhanced/diminished ET.
- Persistence implies predictability.

Is the ocean signature for ET completion an artifact of atmospheric conditions favoring ET?

Lift: Lead composites of 500hPa geopotential height anomalies differences between successful and not successful ET (top) and 95th–5th percentiles of the GS index. Right: Same but for 900hPa diabatic frontogenesis.

- Composite differences between extremes in GS Index show enhanced surface baroclinicity when GS index is higher.
- Mechanism: SHF V scales with diabatic frontogenesis by influencing near-surface temperatures (noisier signal).
- Region more conducive for influence on ET.

Bonus: Warm frontal structure in transitioned TCs appears to reflect WBC orientations – baroclinicity imprint?

Conclusions
1) Diminished SST gradient strength with unsuccessful ET (and vice-versa)
2) Enhanced baroclinicity associated with stronger GS SST V
3) GS strength appears to not be an artifact of atmospheric conditions conducive to ET
4) WBC orientation imprints on warm frontal structure at ET completion

References