**Upper-tropospheric Precursors to the Formation of Subtropical Cyclones   
that Undergo Tropical Transition in the North Atlantic Basin**

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1. **Introduction** 
   * 1. See Galarneau et al. (2015) introductions
     2. See Zhang et al. (2016) introductions
     3. See McTaggart-Cowan et al. (2013) introductions
     4. See Bracken and Bosart (2000)
     5. Cite other STC papers that did composites and state how these differ from ours
2. **Data and methodology**
   1. *Categorization of NATL STCs that undergo TT*
      1. In order to examine the upper-tropospheric precursors to the formation of NATL STCs that undergo TT, all 62 NATL STCs that undergo TT identified during 1979–2010 from the McTaggart-Cowan et al. (2013) global climatology of baroclinically influenced tropical cyclogenesis by Bentley et al. (2016) are subjectively separated into categories according to the upper-tropospheric feature associated with their formation and composited.
      2. All NATL STCs that undergo TT are required to form in the presence of a cold-core upper-tropospheric disturbance and be classified as TCs in the International Best Track Archive for Climate Stewardship (IBTrACS) dataset (Knapp et al. 2010) during their life cycle.
      3. NATL STCs that undergo TT were identified during April–December by Bentley et al. (2016), with a peak in the frequency of formation during August–October. STC formation occurs more frequently over the western NATL than over the eastern NATL, with the higher frequency of formation attributed to the recurrent overlap of relatively high sea surface temperatures (SSTs) and lower-tropospheric baroclinicity in the western NATL basin (Guishard et al. 2009).
      4. Discuss subjective categorization methodology
      5. Figure 1 depicts representative examples of STCs included in each category.

1a) Otto – 0000 UTC 27 November 2004 (cutoff low)

1b) Olga – 0g00 UTC 25 November 2001 (meridional trough)

1c) Unnamed – 0000 UTC 24 July 1986 (zonal trough)

1d) Josephine – 0600 UTC 8 October 1984 (subtropical disturbance)

* + 1. Relate to PC1 vs. PC2 phase space to support subjective categories (Fig. 2)
       1. Look over word choice in Bosart et al. (2016) for calculating PC1 and PC2
  1. *Cyclone-relative compositing methodology* 
     1. Use same language as Archambault et al. (2015) composite analysis paper
     2. Define time of STC formation (i.e., t = t0)

1. **Composite results**
   1. *Cutoff low composites*
      1. (Fig. 3) Ten-panel of cyclone-relative cutoff low composites of:
         1. 250–150-hPa PV (blue contours, every 0.5 PVU), irrotational wind (vectors, >1 m s−1), and 200-hPa meridional wind anomaly (shaded according to color bar, m s−1; enclosed by black contours where significant at the 99% confidence interval)
         2. 250–150-hPa geopotential height (gray contours, every 5 dam) and wind speed (solid blue contours, every 5 m s−1 starting at 20 m s−1), 850–200-hPa vertical wind shear (vectors, m s−1), coupling index (red contours, °C), and PW anomaly (shaded according to color bar, mm; enclosed by black contours where significant at the 99% confidence interval). ([Link to figure testing](http://www.atmos.albany.edu/student/abentley/research_images/mthesis/paper/composites/midlat_comp.php))
   2. *Meridional trough composites*
      1. (Fig. 4) As in Fig. 3, but for meridional troughs
   3. *Zonal trough composites*
      1. (Fig. 5) As in Fig. 3, but for zonal troughs
   4. *Subtropical disturbance composites*
      1. (Fig. 6) As in Fig. 3, but for subtropical disturbances
2. **Climatological results** 
   * 1. (Fig. 7) Breakdown of Strong TT, Weak TT, and Trough Induced pathways in McTaggart-Cowan et al. (2013) by upper-tropospheric precursor
     2. Relate to image of Strong TT, Weak TT, and Trough Induced locations in Bentley et al. (2016) (their Fig. \_\_\_)
     3. (Fig. 8) Locations of STC formation in the North Atlantic basin
     4. (Fig. 9) Intraseasonal Variability of categories histogram
   1. (Fig. 10) Coupling Index histogram
3. **Summary and conclusions**
   * 1. The present study uses composite analysis to investigate the upper-tropospheric precursors to the formation of NATL STCs that undergo TT identified by Bentley et al. (2016).
     2. NATL STCs that undergo TT were subjectively separated into categories according to the upper-tropospheric feature associated with STC formation: 1) cutoff low, 2) meridional trough, 3) zonal trough, or 4) subtropical disturbance.
     3. Time-lagged cyclone-relative composite analysis, performed on STCs included in each category, illustrate the structure, motion, and evolution of the upper-tropospheric precursors to NATL STC formation.
     4. Composite analyses of NATL STCs forming in association with a cutoff low reveal that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
     5. Discuss location, and seasonality McTaggart-Cowan et al. (2013) development pathways
     6. (Fig. 11) Summary schematic of cutoff low composite
     7. Composite analyses of NATL STCs forming in association with a meridional trough reveal that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
     8. Discuss location, and seasonality McTaggart-Cowan et al. (2013) development pathways
     9. (Fig. 12) Summary schematic of meridional trough composite
     10. Composite analyses of NATL STCs forming in association with a zonal trough reveal that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
     11. Discuss location, and seasonality McTaggart-Cowan et al. (2013) development pathways
     12. (Fig. 13) Summary schematic of zonal trough composite
     13. Composite analyses of NATL STCs forming in association with a subtropical disturbance reveal that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
     14. Discuss location, and seasonality McTaggart-Cowan et al. (2013) development pathways
     15. (Fig. 14) Summary schematic of subtropical disturbance composite
     16. Additional conclusions that I haven’t thought of yet…
     17. Suggest possible differences in predictability associated with different categories