Linkages Between the Great Arctic Cyclone of August 2012 and Tropopause Polar Vortices

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1) Introduction

- Tropopause polar vortices (TPVs) are defined as tropopause-based vortices of high-latitude origin and are major features (Pyle et al. 2004; Cavallo and Hakim 2010).
- TPVs may interact with and strengthen jet streams, and act as precursors to the development of intense Arctic cyclones, including the Great Arctic Cyclone of August 2012 (hereafter AC12; e.g., Simmonds and Rudeva 2012; Yamazaki et al. 2015).
- Arctic cyclones may be associated with strong surface winds and poleward advection of warm, moist air, contributing to reductions in Arctic sea-ice extent (e.g., Zhang et al. 2013).
- AC12 was considered the “most extreme” Arctic cyclone in a 1979–2012 CFSR climatology of Arctic cyclones when considering a combination of factors, including minimum SLP intensity, size, depth, and longevity (Simmonds and Rudeva 2012).
- AC12 led to reductions in Arctic sea-ice extent during a time in which Arctic sea ice was thin, with sea-ice volume decreasing twice as fast as normal during AC12 due to melting of bottom and perimeter ice floes (Zhang et al. 2013).
- Strong surface winds associated with AC12 helped to break up the thin Arctic sea ice as well (e.g., Parkinson and Comiso 2013).
- This study will examine the linkages between the development of AC12 and TPVs.

2) Data and Methods

- Data: ERA-Interim (Dee et al. 2011)
- Utilized TPV tracking algorithm developed by Nicholas Szapiro and Steven Cavallo to identify and track TPVs of interest for AC12 (https://github.com/nickszapo/tpvTrack)
- Manually tracked a predecessor surface cyclone (L1) and AC12 by following the locations of minimum SLP.

3) Track and Intensity of TPVs and Cyclones

4) Synoptic Evolution of TPVs and Cyclones

5) Three-dimensional Structure of TPVs and Cyclones

6) Impacts of Cyclones on Arctic Sea Ice

7) Conclusions

- TPV-1 approaches and interacts with AC12 in region of strong baroclinicity, likely supporting the development of AC12.
- TPV-1 is within AC12: the dual-jet configuration and jet coupling over AC12.
- The presence of warm, moist air and relatively strong lower-tropospheric ascent in the region of jet coupling and the subsequent interaction between TPV-1 and AC12 likely facilitate the intense origin of AC12.
- Widespread strong surface winds associated with AC12 contributes to reduction in Arctic sea-ice extent.

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