1) Motivation and Background

- Arctic cyclone 1 (AC1) formed along an old cold frontal boundary northeast of the Caspian Sea, moved poleward, performed a cyclonic loop with a subsequent Arctic cyclone (AC2) near the north coast of Russia, and eventually merged with AC2 over the Arctic Ocean.
- AC2 formed via lee cyclogenesis east of Greenland, and may have had some "DNA" from the remnants of Tropical Storm (TS) Alberto, which moved poleward across the central U.S. and northeast Canada.
- 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).
- Heavy precipitation, strong surface winds, and large waves due to Arctic cyclones may pose hazards to ships navigating through open passageways in the Arctic Ocean.
- Tropopause polar vortices (TPVs) are tropopause-based vortices of high-latitude origin (e.g., Cavallo and Holin 2010) that may act as precursors to the development of Arctic cyclones (e.g., Tao et al. 2017).
- The comparative rarity of two sequential intense Arctic cyclones that interacted with one another, one of which (AC2) may have had anticlockwise DNA from TS Alberto, motivates this presentation.

2) Data and Methods

- Data: ERA5 (Hersbach and Dee 2016) gridded to 0.25° horizontal resolution for all fields, with one of which (AC2) may have had antecedent DNA from TS Alberto, motivates this presentation.
- Manually tracked AC1, AC2, and a Canadian low (CL) by following the locations of minimum sea level pressure (SLP).
- Tracked TS Alberto using National Hurricane Center positions of TS Alberto during 1500 UTC 25 May–0600 UTC 29 May 2018 and remnants of TS Alberto using ERA5 afterward.

3) Track and Intensity

- Remnants of TS Alberto are absorbed into the cyclonic/frontal region of CL over southern Canada (Fig. 1a).
- CL moves northeastward, weakens over the Davis Strait, and redevelops as a lee cyclone (AC2) east of Greenland (Figs. 1a,b, 2).
- Successive deep troughs over Eurasia in early June that form in response to cyclonic wave breaking foster development of AC1 and AC2 (Figs. 3b,c,d).
- AC1 forms near the Caspian Sea along a trailing cold front, moves northeastward, deepens, and reaches the Kara Sea (Figs. 4a,c, 5c).
- AC2 intensifies as an ordinary baroclinic cyclone over northwestern Europe in conjunction with a strong jet stream (Fig. 4e,f).
- TPVs embedded within deep troughs likely contribute to rapid deepening of AC1 and AC2 in the left exit region of a jet streak (Figs. 4e-f and 4l).
- AC2 interacts and merges with AC1 and becomes the dominant cyclone, with a peak intensity of 962 hPa and a standardized SLP anomaly of ~−6σ (Fig. 5f).

4) Large-scale Flow Evolution

- ERA-Interim (Dee et al. 2011) 1979–2010 mean and standard deviation of selected fields for the Northern Hemisphere winter.
- Figure 2 illustrates the evolving standardized temperature and geopotential height anomalies for the period from 1 May to 1 June 2018.
- The evolution of the temperature and geopotential height anomalies shows a significant warming of the polar regions, particularly in the northeastern Canadian sector.
- The temperature anomalies are associated with the development of the Arctic cyclones, while the geopotential height anomalies indicate the presence of an anticyclonic anomaly over the central Arctic region.

5) Synoptic Evolution of Arctic Cyclones

- Figure 3 shows the evolution of the SLP and geopotential height anomalies for the period from 1 May to 1 June 2018.
- The SLP anomalies indicate the development of two intense Arctic cyclones, with one forming over the mid-latitude North Pacific (AC1) and the other forming over the northeastern Canadian sector (AC2).
- The geopotential height anomalies show a pronounced anticyclonic anomaly over the central Arctic region, associated with the development of the Arctic cyclones.

6) Interactions between Arctic Cyclones

- Figure 4 illustrates the evolution of the integrated vapor transport (IVT) and PW (mm) for the period from 1 May to 1 June 2018.
- The IVT and PW anomalies show a significant increase over the central Arctic region, associated with the development of the Arctic cyclones.
- The IVT and PW anomalies indicate the presence of moist air, contributing to reductions in Arctic sea-ice extent (e.g., Zhang et al. 2013).

7) Discussion

- The contributions of tropopause polar vortices and remnant tropical moisture from tropical storm Alberto to the development of two intense Arctic cyclones in June 2018.
- The implications of these findings for Arctic sea-ice extent and climate change.

References

- Tao et al. 2017)