NWS Alaska Region Research Notes RN-05-0003
ARH December 2005

Typhoons in Alaska?
Extratropical Transition and its Implications for Northern Alaska

Justin Arnott

WFO Fairbanks

Typhoons in Alaska?
Extratropical Transition and its Implications for Northern Alaska
By Justin Arnott

Typhoons that recurve in the Western North Pacific can pose a significant threat to Alaska. As these typhoons move poleward, they encounter ever-decreasing sea surface temperatures, SSTs. As the SSTs decrease to below 26°C (80°F), the core convection responsible for the most intense winds in the typhoon cannot sustain itself and will slowly decay with time. However, when an upstream trough approaches the poleward moving tropical cyclone, significant dynamical forcing can cause the ex-typhoon to transition into a powerful extratropical cyclone. Essentially, the typhoon provides an excellent "seed" for explosive extratropical cyclogenesis. This process is called extratropical transition, ET, and it occurs in approximately 50% of typhoons.

The newly-born extratropical cyclones have several distinguishing characteristics. While the peak sustained winds are usually weaker than found in the original typhoon, the area of gale or storm force winds is typically greater. As the ET cyclone increases its forward speed, significant right/left asymmetries typically develop in the wind and precipitation fields. Typically, the strongest winds occur right of track, while heavy precipitation usually falls left of track. Remnants of the original typhoon's warm core signature usually remain and can be traced using boundary layer θ_e. Finally, since these ET cyclones frequently drive "trapped-fetch" ocean wave growth, they may result in extremely large waves.

Not all interactions between an upstream trough and a typhoon result in ET. In some cases, the trough is too strong and will completely destroy the typhoon. In other cases, the outflow anticyclone above a strong typhoon can deform and even destroy an approaching midlatitude trough. A very important fact to note is that operational numerical models typically perform very poorly with cases of interactions between the tropics and extratropics, such as ET. Therefore, when ET is anticipated or occurring, the details of the ET cyclone and the larger scale pattern are often poorly forecast. Recognizing the impacts typical of ET cyclones can lead to more accurate forecasts.

Recall the very warm and moist air mass typically found on the eastern side of an ET cyclone. As this air encounters the approaching cooler air mass associated with the midlatitude trough, significant isentropic lift can result in extremely heavy precipitation. Because ET in the Western Pacific basin occurs most frequently in August and September, the first cooling months in northern Alaska, the precipitation from an ET cyclone may be snow in the interior of Alaska and heavy rain in Southeast Alaska, profoundly impacting the weather long after the cyclone dissipates.

An ET cyclone affected Fairbanks in September 1992. Between September 12th and 14th, 16.7 inches of snow fell in Fairbanks. This incredible early season snowfall preconditioned the atmosphere for another snowfall, contributing to the development of a dome of surface-based arctic air. Then, the moisture flowed in with an ET cyclone and overran the dome of artic air, allowing for cooling. The precipitation from the ET cyclone created an additional 6.6 inches of snow between September 17th and 19th. This amazing week of weather led to more than three weeks of below normal temperatures and eight daily record lows, reminding northern Alaskans that former typhoons can bring snow to the northern interior and heavy rain elsewhere.

Model Performance during ET

Numerical models are notorious for poorly forecasting interactions between the tropics and extratropics. Unfortunately, one cannot yet say with much authority which model performs best during ET. The author is currently working with a PSU statistics professor and a PSU meteorology professor on a paper addressing forecasts of ET using data from the NOGAPS and GFS models. The difference in model performance is dependent primarily on model initialization. In the pre-2000 GFS and the NOGAPS models, the initial analysis is augmented by the insertion of a "synthetic vortex" to better resolve the tropical cyclone at early lead times. After 2000, this procedure was removed from the GFS. It was believed that the vortex analyzed by the model is probably the vortex best suited for the model.

The study found that at short 12 or 24 hour lead times, the models using a "synthetic vortex" perform better than the post-2000 GFS. However, at 36 hour lead times, the post-2000 GFS, without a synthetic vortex, performs better. What the paper suggests is that a synthetic vortex, although helpful at improving tropical cyclone structure modeling in the near term, can bias the forecast towards a more tropical structure in the long term. In other words, by imposing a "synthetic tropical cyclone" one can artificially delay the transition to an extratropical cyclone structure. Although one cannot yet point to one model that handles ET best, some insights as to why models perform poorly at different lead times have been gained. Keeping these factors in mind may prove beneficial when anticipating the result of future instances of ET.

References:

Bowyer and MacAfee, 2005: The Theory of Trapped-Fetch Waves with Tropical Cyclones – An Operational Perspective, *Weather and Forecasting,* **20,** 229-24.

Jones, and Coauthors, 2003: The Extratropical Transition of Tropical Cyclones: Forecast Challenges, Current Understanding, and Future Directions, *Weather and Forecasting*, **18,** 1052-1092.

MacAfee and Bowyer, 2005: The Modeling of Trapped-Fetch Waves with Tropical

Cyclones – A Desktop Operational Model, *Weather and Forecasting,* **20,** 245-263.