IC5.1: Optional Job Sheet Answer Key

Tropopause Pressure

Objective: Apply the knowledge gained from the winter weather AWOC IC 5 Lesson 1 training module to a case study.

Data: 15 March 2004 winter storm event in the Midwest. You will be using your WES machine in case review mode.

Instructions for questions 1-5:

- On your WES machine, load the 15 March 2004 case, DMX localization, and set the clock to 15 March 2004, 13:00 UTC. Focus on the 12 UTC 15 March NAM 40 and NAM 80 analysis for each question in this jobsheet, unless otherwise noted.
- On the CONUS map scale, load into a four panel, the following (watch the model type closely):

1. Into all four panels, the NAM 80 700mb frontogenesis loaded as an image.
2. Into the upper-left panel, the NAM 80 300-500 mb Qvector divergence, divergence, 300-500 mb Qvectors, and 500mb temperature .
3. Into the upper-right panel, the NAM 80 tropopause pressure and wind.
4. Into the lower left panel, the NAM 80 500mb height, wind and vorticity.
5. Into the lower right panel, NAM80 MSLP, the GOES-IR, lightning, surface obs.

Question 1. Identify all the short-wave troughs that you see in the tropopause pressure analysis (upper-right) that are impacting the CONUS. Where are they located?

The most prominent wave is located from eastern MT to central NE. Another major wave in western MX is impacting south TX. Finally, a major wave is departing Maine.

Question 2. Consider the Qvector convergence in northern NM, and SW CO, is there a short-wave trough in the tropopause pressure map?

No, the Q vector convergence bullseye is not associated with a short-wave trough. However, there is slight positive pressure advection implied by the angle of the winds with respect to the pressure field.

Question 3. Which wave is most likely to result in cyclogenesis, the one in the northern Plains, or the one in northern MX? Why?

The wave in the northern Plains is most likely to result in cyclogenesis. Its forcing will phase with a strong front in Iowa as implied by the stronger frontogenesis. You may try looking at thermal advection fields at 850mb to confirm this idea. In addition, the northern wave is negatively tilted and likely to deepen.

Question 4. Load the NAM 80 potential temperature difference from the ground to the tropopause pressure surface on one of the panels. Which wave is likely to yield the strongest vertical velocities at 700 mb (Northern Plains, Northern MX)?

This is a tough question. The northern wave has the advantage of potential phasing between vertical velocity associated with the front and that with the wave. However, the potential temperature difference is only 40 deg C ahead of the comma head. The southern wave is producing forcing over an area of > 45 deg C differences and positive CAPE too. The response is strong convection while stable lifting occurs to the north. For the most part, the wave to the north is sufficiently strong enough to overcome the stable air and produce more substantial lifting. However, subtle waves such as the subtle lifting offshore of TX can produce widespread convection in response to the low static stabilities.

Question 5. Which field shows the best clarity in terms of identifying areas of potential upper-level forcing?

Hopefully you will say the tropopause pressure charts. The upper-level waves are most obviously depicted in the tropopause pressure maps, while the Qvector divergence fields produce a noisier field of upward and downward forcing. The 500mb vorticity plot shows the southern wave more clearly than the north whereas the northern wave is producing much stronger vertical motion on the synoptic scale despite the weaker static stability. The tropopause pressure map reflects the northern wave as exhibiting very strong positive pressure forcing, and therefore, upper-level upper forcing.

Instructions for question 6:

- Keep the same time but swap the four-panel with a fresh one.
- On a regional scale, load the following:

1. Into the upper-left panel, the NAM 80 div Q for the 500-300mb layer.
2. Into the upper-right panel, the NAM 80 tropopause pressure and wind.
3. Into the lower-left panel, the NAM 40 div Q for the 500-300mb layer.
4. Into the lower-right panel, the NAM 40 tropopause pressure and wind

Question 6. Which forcing diagnostic appears to be more noisy as the model grid spacing goes from 80 to 40 km?

The div Q field begins to show a lot more noise, especially in the lee of the Rockies where mountain waves begin to be resolved in the 40 km NAM. Notice in northern andeastern CO and Wyoming that the 40 km div Q shows waves of convergence/divergence whereas the 80 km field shows convergence. The tropopause pressure and wind field show a little more structure in the 40 km model by essentially places with inferred positive pressure advection show up in the similar areas in both resolutions.

Question 7. Load the GOES WV imagery on all of the panels (load to all panels). Which forcing diagnostic appears to best match the shape of the ascent field as inferred by the clouds for the northern Plains shortwave?

Both the 500-300 mb div Q and the inferred pressure advection on the tropopause surface show ascent beginning in central NE and extending into western IA. Both diagnostics also show a cessation of ascent from central IA eastward even though there are high clouds present. The ascent is beginning over a midlevel dry slot and so it is not surprising that condensation hasn’t occurred until the air has ascended for some time. Likewise, the westerly winds aloft are advecting high cloud well east of the inferred upper-level forcing. However, notice that the div Q field shows a strong implied couplet of descent with downstream ascent starting in eastern Iowa to central Missouri where no such couplet is implied in the tropopause pressure field. One could say that perhaps there is a forcing couplet below the tropopause that is reflected by the div Q field. However, the GOES WV imagery cannot corroborate such in the upper level cloud field. Instead, the WV imagery implies that weak descent may be occurring east of the comma cloud feature, allowing for the slow drying of the cirrus clouds.