Hi all,

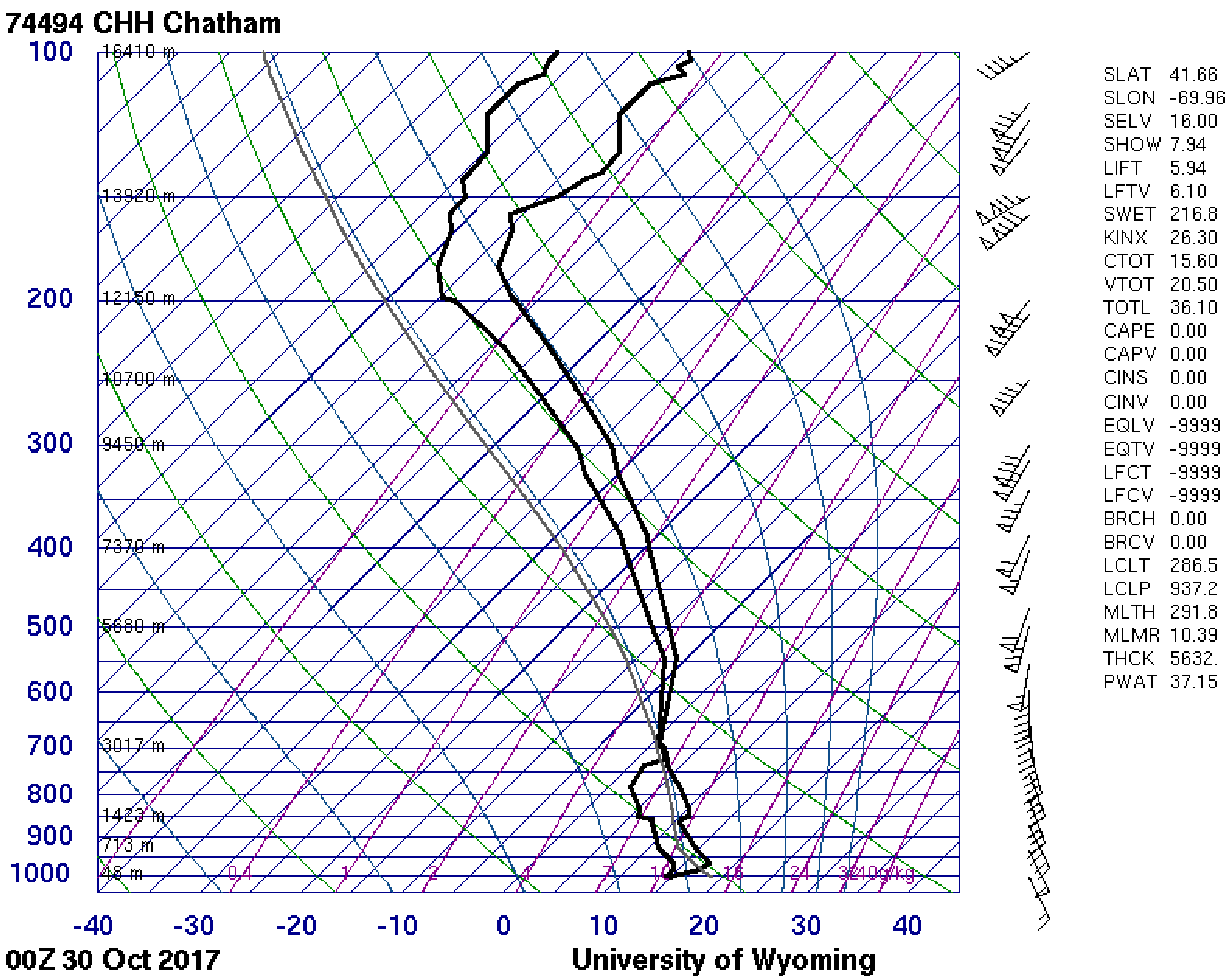
The focus on Friday map discussion for 17 Nov was on predictability issues associated with the East Coast storm of 30 October, the short-lived but record-setting Northeast cold snap of 10–11 Nov, and the continuing remarkably contorted upper-level flow across the North Pacific. Andrew Winters led a discussion of the applicability of his North Pacific Jet phase space diagram to predictability differences over the North Pacific for the current flow regime. Eric Bunker and Tomer Burg transitioned the discussion to the current forecast. Images used during map discussion can be found here: http://www.atmos.albany.edu/mapdisco/20171117/.

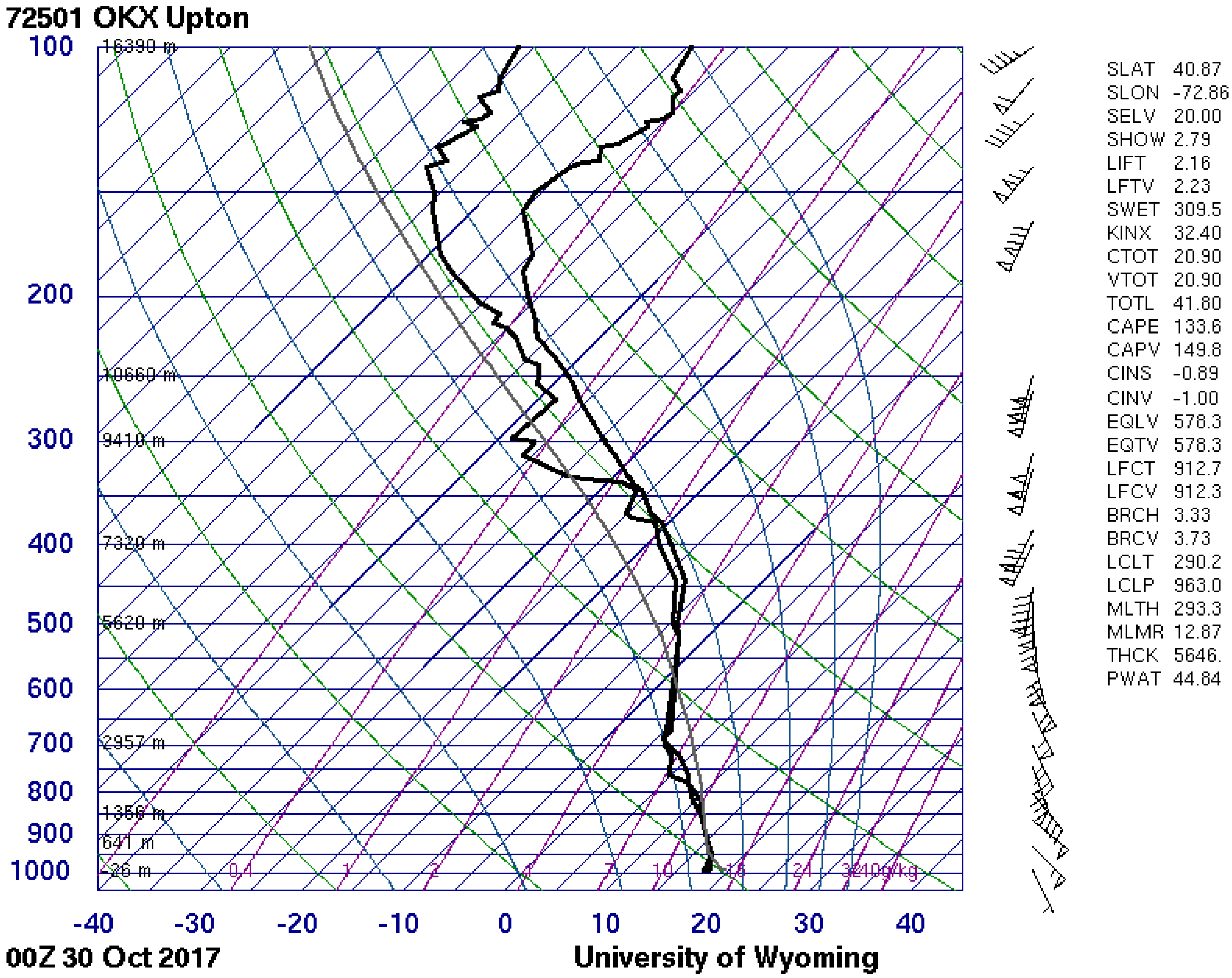
1. East Coast Storm of 30 October 2017:

This storm set a record for the lowest mean SLP (~975 hPa) ever observed in Albany for the month of October. Images of storm-related minimum SLP, total precipitation 28–30 Oct, and maximum wind gusts, respectively, from the NYS Mesonet, all courtesy of Nick Bassill, can be found here (http://operations.nysmesonet.org/~nbassill/archive/2017/10/31/recent/minp2.png) and here (http://operations.nysmesonet.org/~nbassill/archive/2017/10/31/recent/precip3.png) and here (http://operations.nysmesonet.org/~nbassill/archive/2017/10/31/recent/gust2.png). While this storm was windy and wet, the observed area-averaged rainfall totals were ~50–75% of the GFS/GEFS forecast rainfall amounts while the earlier dire model indications of widespread hurricane force wind gusts were “overblown” for the most part. We hypothesized that rainfall amounts may have been over forecast because of a faster storm forward speed while persistent but shallow surface-based stable layers accompanied by veering wind profiles, indicative of low-level warm-air advection, likely hindered the ability of 75+ kt winds 1–2 km above the surface to mix down to the ground.

Furthermore, although 0–6 km forecast shear values were > 40 kt from coastal New Jersey northeastward through southeastern New England, zero or near-zero SBCAPE values in the same region likely precluded the ability of widespread convective cores to organize sufficiently and mix higher wind speeds > 70–75 kt down to the surface If you browse the NCAR real-time ensemble sounding forecast from 0000 UTC 29 Oct and look at the forecast CHH and OKX soundings between 1800 UTC 29 Oct and 0600 UTC 30 Oct (with the observed soundings for CHH and OKX overlaid) you will see the shallow but persistent surface-based stable layer at CHH and OKX (https://ensemble.ucar.edu/sounding.php?d=2017102900). While the remnants of disorganized TD Philippe did get swept rapidly poleward toward southeastern New England as forecast to happen by many of the convection-permitting models, the associated deep convection was insufficiently intense, organized, and widespread enough to do anything more than be manifest as an area of enhanced rainfall along a surface trough within the warm-sector of the larger scale rapidly deepening surface cyclone. The observed CHH and OKX soundings for 0000 UTC 30 Oct (courtesy of the University of Wyoming) are appended below.

A interesting science opportunity exposed by this storm is to determine the dynamical and physical processes that can lead to the formation of convectively induced troughs in the warm sectors of extratropical cyclones that are able to tap moist tropical air streams. What happened with the rapidly deepening coastal cyclone of 30 October is that in effect warm frontogenesis occurred within the warm sector of this cyclone along the western edge of a poleward-directed corridor of very moist tropical air (atmospheric river or AR). One possibility is that low-level frontogenesis associated with differential diabatic heating across the poleward-directed AR can result in the generation of surface troughs in the warm sector of larger-scale cyclones under these circumstances. Investigating the origin, structure, and evolution of surface troughs that form in the warm sectors of extratropical cyclones could be a good thesis project for someone (e.g., a future CSTAR student).





2. Predictability Issue Associated with North Pacific Jet Evolution:

The intense East Coast cyclone of 30 Oct 2017 provider fodder as to its origins and its overall predictability. After a brief overview of interesting large- and synoptic-scale aspects of this cyclone, Andrew Winters provided his take on the cyclone based on his North Pacific Jet (NPJ) phase diagrams (http://www.atmos.albany.edu/facstaff/awinters/oct30cyclone/D5_DprogDt_NPJPD.php). The EOF principal component (PC) analysis displayed on the left side of this web site can be interpreted as follows "**Phase Diagram:** The ensemble spread phase diagrams all verify at 00Z on the day listed in the selected tab, with the **blue dot** showing the forecasted position of the GEFS ensemble mean verifying on the day listed in the selected tab, the **red x's** showing the individual ensemble members verifying on the day listed in the selected tab, and the **green dot** showing the 0-h forecast position in the phase diagram at the time when the forecast was initialized. All ensemble spread forecasts are hosted alongside GEFS ensemble mean forecasts of 250-hPa wind speed and geopotential height, 500-hPa relative vorticity and geopotential height, 850-hPa standardized temperature anomalies and mean sea-level pressure, and 24-h accumulated precipitation that all verify on the day listed in the selected tab."

For 9-day forecasts initialized at 0000 UTC 21 Oct within this PC1 and PC 2 phase space, the mostly poleward displacement of the green dot from the blue dot is > 1.0 PC unit. This PC space displacement difference represents the largest GEFS forecast error of the 2017–2018 cool season to date in the NPJ phase space. If you toggle back and forth between day -9 and day -0 using the d(prog)/dt option you will see that the observed NPJ is much more amplified and poleward-shifted at day -0 than it was at day -9. The 9-day GEFS NPJ forecast from 0000 UTC 21 Oct was poor. The downstream consequences of this poor GEFS NPJ forecast are readily apparent in the d(prog)/dt ensemble spread, 500-hPa height and vorticity evolution: no deep negatively tilted East Coast trough, no upstream short wave trough in NW flow over the northern Plains, and nary a clue about any big East Coast storm. From a predictability perspective, we can hypothesize that the GEFS failure to properly simulate eastern Asian cold surges associated with a much more amplified flow pattern in the 216 h (9 day) forecast verifying 0000 UTC 30 Oct contributed significantly to the overall observed forecast failure downstream over North America.

On a more regional scale, application of d(prog)/dt to the 0000 UTC 30 Oct 2017 NPJ phase diagram clearly shows that for the GEFS important details in the forecast as to the track and intensity of the forecast coastal cyclone were not mostly resolved until the day -2 forecast initialized at 0000 UTC 28 Oct. The day-3 forecast shows a 1008 hPa cyclone centered over eastern CT and eastern LI at 0000 UTC 30 Oct in conjunction with a moderately deep 500-hPa trough located over the mid atlantic region. The corresponding day -2 shows a significant change. A sub 988 surface cyclone (24 hPa deeper than in the previous 72 h forecast) is located farther south and westward near the coast of Delmarva in conjunction with a deeper and more negatively tilted 500-hPa trough centered over North Carolina and enhanced ridging over eastern Canada. This westward forecast shift in the track of a deeper cyclone is more threatening for heavier inland rains and an increased likelihood that the remnants of TD Philippe could reach coastal eastern New England. Subsequent changes in the storm track and cyclone intensity were minor and begs the question as to the origin of the forecast error at 72 h that mostly disappeared in the 48 h forecast. One possible candidate for forecast uncertainty was the trough located over North Dakota-northern Wisconsin region in the 72 h verifying 0000 UTC 27 Oct. At 500 hPa, the vorticity maximum located over North Dakota in the 72 h forecast shifts eastward to central Minnesota in the 48 h forecast. Simalarly, the 72 h forecast 500-hPa vorticity in the midAtlantic trough intensifies and shifts noticeably westward in the corresponding 48 h forecast, suggestive that the midAltantic trough may now be interacting with the upstream upper Midwest trough. Coincidence or enemy action? To be determined.

3. Northeast Cold Snap of 10–11 November 2017:

This cold snap produced simultaneous record-setting low temperature readings at DCA, NYC, and BOS. At DCA (Reagan National), the record low on Veteran's Day was the first November record low to be set there since 1976 (https://www.washingtonpost.com/news/capital-weather-gang/wp/2017/11/11/d-c-dips-to-a-record-low-first-in-november-in-four-decades-and-one-of-many-across-the-mid-atlantic-through-the-northeast/?utm_term=.2d3eac1d59f300. At NYC (Central Park), record lows were set on two consecutive days on either side of midnight (https://wattsupwiththat.com/2017/11/11/144-year-earliest-cold-record-for-new-york-city-to-be-broken/). At BOS (Logan Airport), record lows were also set on two days in a row (https://www.boston.com/weather/weather/2017/11/11/boston-is-experiencing-record-breaking-cold-temperatures). The DCA-NYC-BOS record minimum temperature "trifecta" strikes me as stunning in its rarity, given the observed well-established upward temperature trend due to a combination of ongoing global warming and increasing urbanization. The only way to set minimum temperature records in these major East Coast cities these days is on advection cold in the early stages of a cold-air outbreak. Setting minimum temperature records by radiative cooling in these cities under light wind conditions is virtually impossible in heavily urbanized areas.

The meteorology of the cold snap is fairly straight forward. Alicia Bentley's loops of SLP, 1000–500-hPa thickness, and 250-hPa wind speeds as well as SLP, SLP anomaly, and 10-m winds shows that the cold air reached DCA, NYC, and BOS by a direct shot from the NNW. This implied air trajectory enabled the arctic air to avoid being warmed by passage across the warmer waters of the eastern Great Lakes (http://www.atmos.albany.edu/student/abentley/realtime/northamer_mslp.php and http://www.atmos.albany.edu/student/abentley/realtime/northamer_mslp.php). A sub-504 dam 1000–500-hPa thickness into northern New York State and a -15 C 850-hPa temperature just north of NYC at 1200 UTC 10 Nov did the trick. Likewise, Alicia's loop of potential temperature and wind on the dynamic tropopause (DT), along with layer-mean 925–850-hPa relative vorticity, readily shows that an Arctic PV anomaly with a potential temperature between 276–282 K drove the surge of Arctic air into the Northeast (http://www.atmos.albany.edu/student/abentley/realtime/northamer_dt.php). Sounding observations (courtesy of the SPC) at 0000 and 1200 UTC 10 Nov 2017 from Maniwaki (WMW), Quebec, located just north of New York State, show the dramatic arrival of the arctic air mass as the DT lowers from ~300 hPa to ~600 hPa in 12 h (http://www.atmos.albany.edu/mapdisco/20171117/images/WMW_00Z10Nov17.gif and http://www.atmos.albany.edu/mapdisco/20171117/images/WMW_12Z10Nov17.gif). The strong low-level northerly winds made it possible for Arctic air to be advected equatorward relatively quickly. It is also likely that anomalous early season snow cover over parts of eastern Canada north of the St. Lawrence river reduced the rate of surface-based modification of southward-moving Arctic air into the Northeast. Snow cover anomalies were positive in much of southeastern Canada in October 2017 (https://climate.rutgers.edu/snowcover/chart_vis.php?ui_year=2017&ui_month=10&ui_set=2). These positive snow cover anomalies in eastern Canada north of the St. Lawrence river continued into November (https://www.ccin.ca/home/ccw/snow/current).

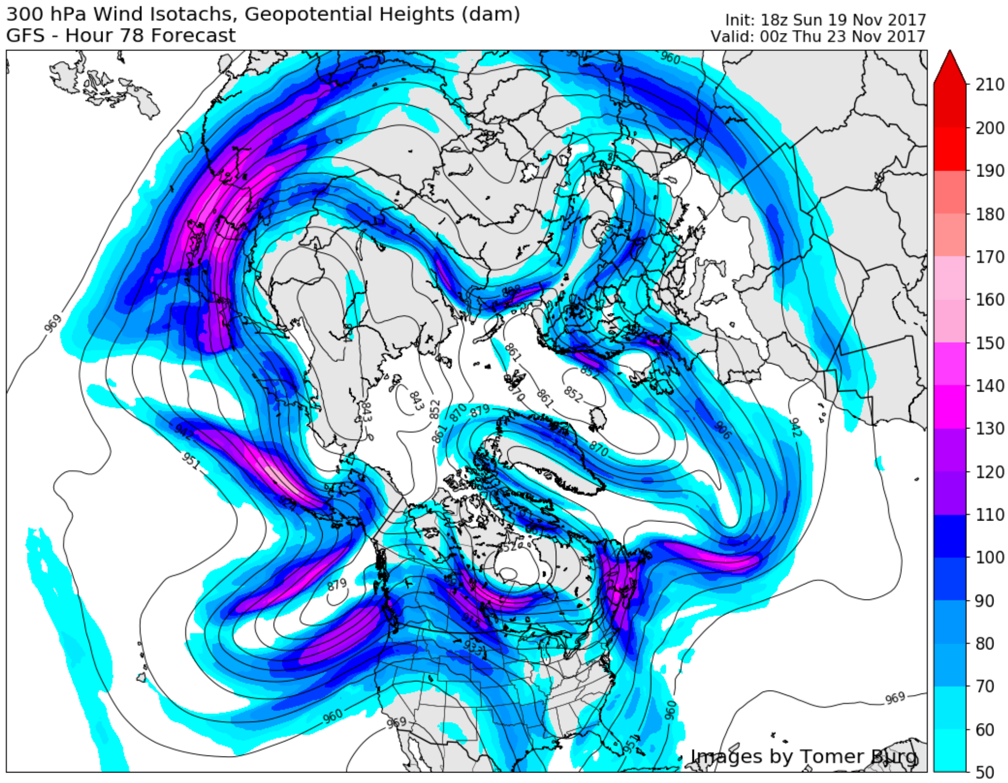
4. Current Forecast and East Asia Double Jet Structure (PFJ poleward of the STJ):

The current forecast focused on the considerable model run-to-run variability as to the placement of the large-scale troughs and ridges across the North Pacific and North America in both the GEFS and EPS as well as their respective deterministic runs. This uncertainly was particularly large from the Northern Plains to Atlantic Canada with regard to the southward extent of any future arctic air intrusions. We discussed how the continuing highly convoluted flow pattern in the North Pacific associated with a retracted and equatorward-shifted NPJ, as evidenced from an Andrew Winters NPJ phase diagram, is likely contributing to enhanced forecast uncertainty (http://www.atmos.albany.edu/facstaff/awinters/realtime/Scatter_NPJPD.php).

We also discussed a forecast zonally oriented double jet structure at 300-hPa on either side of the Tibetan Plateau that extended eastward from there in the GFS run initialized at 0600 UTC 17 Nov 2017. I don't recall seeing this double jet structure so well defined in this region of the world before (likely because I haven't looked closely enough at enough Eurasian jet-level maps). The map we initially looked during map discussion at was the 138 h forecast verifying at 0000 UTC 23 Nov (see below). An updated 78 h 300-hPa forecast verifying at 0000 UTC 23 Nov from the 1800 UTC 19 Nov GFS run, also attached for comparison purposes, shows a continuing forecast zonally oriented double jet structure, but it is not quite as well defined as it was in the attached earlier run. A comparison of the 300- and 200-hPa NH height/wind analyses established that the split jet was best defined at 300 hPa while at 200 hPa there was more of a single jet structure to the south. At 300 hPa, the entrance region of a northern stream polar front jet (PFJ) was located poleward and westward of the Tibetan Plateau in a confluent jet-entrance region. This confluent flow region was a result of the interaction of a northern stream flow that originated to the east of a high-latidue block over central far northern Russia with a more zonally oriented southern subtropical jet stream (STJ) that was emanating from the Middle East. At 200 hPa, the southern zonally oriented STJ was mostly dominant.

So, here is a cool jet-related WTF science opportunity. Use the Sawyer-Eliassen equation to compute the vertical circulation diagnostics associated with the two quasi-zonally oriented and parallel PFJ and STJs to determine: 1) how much of the vertical circulation in the jet-entrance and jet-exit regions is driven by the STJ vs the PFJ, 2) the magnitude, location, and extent of regions of constructive and destructive interference in the vertical circulations associated with the two jets, and 3) to what extent uncertainty associated with the aforementioned interacting PFJ and STJ vertical circulations may be contributing to the continuing greater uncertainty in the GEFS forecasts as illustrated in the NPJ phase diagram as discussed above.

Lance



300 hPa Wind Isotachs, Geopotential Heights (dam)
GFS - Hour 138 Forecast

Init: 06z Fri 17 Nov 2017
Valid: 00z Thu 23 Nov 2017