Hi all,

Friday map discussion for 24 Feb began with a short presentation on the interesting upper-level cutoff cyclone that crossed central Florida on 23 Feb. This cutoff cyclone originated from the southern end of the trough that brought the most recent round of heavy rains to California on 18–19 Feb. The bulk of Friday map discussion was centered around a presentation on stratospheric-tropospheric interactions that was led by Prof. Andrea Lang and her Ph.D. student Hannah Attard. Materials used in both discussions can be found here: http://www.atmos.albany.edu/mapdisco/20170224/. Map discussion concluded with a current forecast presentation by Kyle Pallozzi and Tomer Burg.

Lance

1. Florida Cutoff cyclone of 23 Feb 2017:

Alicia Bentley's loop of 500-hPa geopotential heights, temperatures, winds, and relative vorticity (http://www.atmos.albany.edu/student/abentley/realtime/northamer_rel.php) shows that the deep trough that brought the most recent round of heavy rains to California on 17–18 Feb became highly elongated north-south by 1200 UTC 20 Feb. By 1200 UTC 21 Feb, the southern end of this trough had fractured into a separate cutoff cyclone centered near the Texas-Louisiana border. Over the next 48 h this cutoff cyclone moved east-southeastward across the Gulf of Mexico and was situated over southeastern Florida by 1200 UTC 23 Feb. Passage of this cyclone brought moderate amounts of rain to southern and central peninsula Florida with a strip of 75-100 mm totals along the east-central coast (http://www.atmos.albany.edu/mapdisco/20170224/images/FL_Precip.pdf).

A loop of surface map station plots centered on Florida (source: NCAR-RAL; http://www.atmos.albany.edu/mapdisco/20170224/images/metars.pdf) shows that a weak cyclonic circulation gradually crossed north-central peninsular Florida between 0000–1200 UTC 23 Feb. This weak cyclonic circulation can best be seen between DAB and MLB at 0600 UTC 23 Feb. Although surface baroclinicity was weak across Florida, the upper-level cyclone was distinctly cold core as evidenced by the 1200 UTC 23 Feb Miami sounding (MFL) which shows a depressed dynamic tropopause (DT) to just above 500 hPa (you are not going to see this sounding very often at MFL!) with a relatively steep lapse rate and moist air below the DT and a warm and dry stable atmosphere above the DT (http://www.atmos.albany.edu/mapdisco/20170224/images/soundings.pdf).

At Cape Canaveral (XMR) to the north of the cutoff cyclone the DT is higher (~ 300 hPa) and backing winds between the surface and 500 hPa are indicative of cold-air advection. At Tampa (TBW) to the west, the DT is also located near 300 hPa. The TBW sounding shows that backing winds below 700 hPa (veering winds above 700 hPa) are indicative of cold-air advection (warm-air advection) wrapping around the backside of the cutoff cyclone. The impact of the locally depressed DT is also evident in the 500–200 hPa thermal vorticity minimum that moves across Florida between 0600 and 1200 UTC 23 Feb (http://www.atmos.albany.edu/student/abentley/realtime/northamer_subtrop.php). This 500–200 hPa thermal vorticity minimum is indicative of the presence of relatively warm

stratospheric air above the Das opposed to a warm-core cyclone. Note how the coupling index becomes negative (values from -5 to -10) by 0600 UTC 24 Feb as the remnant Florida cutoff cyclone moves across the warmer Gulf Stream waters. I was hoping that there would be a small chance for some "tropical mischief" when the aforementioned cold-core cutoff cyclone reached the Gulf Stream,

2. Stratospheric-Tropospheric Interactions (Andrea Lang and Hannah Attard):

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Motivation:

Why should we care about what is going on in the stratosphere? Short answer, the provides the top boundary conditions for weather in the troposphere and when the stratosphere is in an extreme state, such information nudges the troposphere toward preferred outcomes. The subseasonal impacts from sudden stratospheric warming [SSW] (e.g., weak vortex) events on the troposphere can be viewed by browsing the NOAA/ESRL's SSWC: Sudden Stratospheric Warming Compendium data set (https://www.esrl.noaa.gov/csd/groups/csd8/sswcompendium/). For example, the surface temperature anomalies in the 60 day period following a SSW are show in this link: https://www.esrl.noaa.gov/csd/groups/csd8/sswcompendium/plots/composite/static/JRA55/SSWC_tsfcAnom60_JRA55_compOnly.png. SSWs are also known to produce negative AO conditions.

The 2016/2017 update to date:

This winter has been extreme in the stratosphere. In the following links you can see the 10-hPa zonal mean U at 60˚N, via the CFSR (http://www.atmos.albany.edu/student/hattard/plots/mapdisco/feb24_2017/u_60N_10hpa_24feb17.png), the MERRA (https://acd-ext.gsfc.nasa.gov/Data_services/met/metdata/annual/merra2/u60n_10_2016_merra2.pdf), and the ECMWF (http://users.met.fu-berlin.de/~Aktuell/strat-www/wdiag/ts.php?plot=fluxes&alert=1&lng=eng). Using the zonal mean zonal winds at 10 hPa as a proxy for the strength of the stratospheric polar vortex, the vortex was weak in late October/early November, was strong in December and is currently weak and expected to stay weak. These perturbations to the vortex were associated with wave forcing from the troposphere, which is typically manifested as blocking in the N. Atlantic/W.Europe region or sometimes in the N. Pacific/Alaska region. Hannah Attard's loop from 1 Oct 2016 through 24 Feb 2017 of the tropopause potential temperature (fills) and geopotential height at 500 hPa (black) and 10 hPa (white) shows that roughly 5-10 days prior to variability in the stratospheric vortex, we see signatures of blocking/high amplitude flow near the tropopause (http://www.atmos.albany.edu/student/hattard/plots/mapdisco/feb24_2017/dt_nh.html). These vortex perturbations were associated with anomalous poleward heat flux from the upper troposphere into the stratosphere (http://www.atmos.albany.edu/student/hattard/plots/mapdisco/feb24_2017/heatflux_2016_2017season.png), where the poleward heat flux is proportional to the upward component of wave activity flux (Plumb 1985).

The anomalous upward wave activity flux has lead to persistent positive geopotential height anomalies in the stratosphere over the pole this season, seen via polar-cap height anomalies here: http://www.atmos.albany.edu/student/hattard/plots/mapdisco/feb24_2017/polarcap_height_20162017season.png.

The current forecast is for an SSW event to occur near the end of the month. The reversal of the zonal mean winds to easterly have implications on how Rossby waves propagate (or are absorbed) in the stratosphere. The forecast from the GFS, ECMWF and NASA/GEOS-5 are all pointing to a major warming. When the models resolve the warming in the forecast, theoretically we should see improvement in the 2+ week forecast skill as per the motivation discussion. See Hannah's real-time page: http://www.atmos.albany.edu/student/hattard/realtime.php

A current area of research is how is the anomalous sea-ice influencing the anomalous upward wave activity flux (or visa versa) this year?
What are the processes and physics that models need to resolve to skillfully forecast an SSW?