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Subject: **Synopsis of Friday map discussion for 1 March 2013**
Date: 3 March 2013 8:02:24 PM EST
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Hi Everyone,

Friday map discussion for 1 March 2013 focused on: 1) a brief review of winter (DJF) 2012-2013, 2) characteristics of the DJF subtropical jet (STJ) form the western North Pacific eastward to the western North Atlantic, 3) an impressive Central American cold surge, 4) anticyclonic wave breaking (AWB) and trough phasing/merger, and 5) and large forecast uncertainty with a potential midweek storm along the Middle Atlantic coast.

Sublinks used during map discussion can be found within the master web link: http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/. Alicia Bentley, Chip Helms, Philippe Papin and Jaymes Kenyon provided ample assistance in generating products and interpreting results.

I. Map Discussion Overview:

a) Winter 2012-2013 (1 Dec to 27 Feb) Northern Hemisphere (NH) flow patterns:

During DJF 2012-2013, the Arctic Oscillation (AO) was weakly or moderately negative (with brief positive periods in early Jan and mid-Feb). The mostly negative AO values during DJF were consistent with observed positive height anomalies above 200 hPa within the stratospheric polar vortex (http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/hgt.shtml). The corresponding DJF NH 200 hPa temperature anomaly pattern over the Arctic Ocean was also positive with a core +6 C anomaly centered near the North Pole (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/DJF/NH_200T'_DJF_12-13.gif). Observed positive high-latitude 850 hPa temperature, height and mean SLP anomalies were also consistent with the persistent negative phase of the AO (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/DJF/NH

_850T'_DJF_12-13.gif;
http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/DJF/NH_850Z'_DJF_12-13.gif;
http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/DJF/NH_SLP'_DJF_12-13.gif).

b) Characteristics of the winter 2012-2013 subtropical jet (STJ):

The DJF NH mean and anomaly 200 hPa geopotential height patterns (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/DJF/NH_200Z_DJF_12-13.gif; http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/DJF/NH_200Z'_DJF_12-13.gif) imply that the North Pacific subtropical jet (STJ) was anomalously strong over the western North Pacific. A second anomalously strong STJ region was located over the eastern North Pacific northeastward across northwestern Mexico to the southwestern U.S. This second STJ corridor occurred in conjunction with weakly positive (< 1 C) tropical SST anomalies from east of 150 W to Central America (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/DJF/Tropics_SST'_DJF_12-13.gif), a strip of negative OLR anomalies from just east of the Dateline east-northeastward to near the tip of Baja, CA (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/DJF/Tropics_OLR'_DJF_12-13.gif), and a band of positive (3-6 mm) precipitable water (PW) anomalies that extended eastward and then east-northeastward from the tropical eastern North Pacific to the southeastern U.S (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/DJF/NH_PW'_DJF_12-13.gif). These overlapping regions of positive SST and PW anomalies, and negative OLR anomalies, coincided with an active lower latitude storm track (http://www.cpc.ncep.noaa.gov/products/precip/CWlink/stormtracks/mstrack.shtml) that was accompanied by frequent precipitation episodes that partially alleviated the long-term drought in portions of the Southern Plains and Southeast..

The strength of the mid-winter STJ over much of the Caribbean, southern U.S. and western North Atlantic was considerably weaker than the climatologically expected long-term climatological STJ (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/DJF/NH_200Z'_DJF_12-13.gif). As a result, the STJ didn't become well established across the southern U.S. until early to mid Feb (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/200vort.

html). The observed strengthening of the STJ across the southern U.S. occurred in conjunction with a series of upper-level disturbances that moved southeastward over western/central North America to the east of a persistent ridge over the eastern North Pacific. These upper-level disturbances were associated with lower and middle tropospheric warm-air advection. Light to moderate precipitation amounts accompanying the passage of these upper-level disturbances collectively increased the snow cover over the Plains and enabled cold air in their wake to reach the Gulf coast and the Gulf of Mexico. The resulting increase in lower midlatitude and subtropical baroclinicity in the wake of the aforementioned disturbances at the longitudes of central and eastern North America contributed to the observed strengthening of the STJ across the southern U.S..

c) Central American cold surge:

An impressive ongoing cold surge across extreme eastern Mexico, the Gulf of Mexico and parts of Central America (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/850temp_stdanom_namer_loop.html; original source provided by Kyle Griffin) that is forecast to reach Panama by 4 March likely reflects the passages of the aforementioned upper-level disturbances and the increased snow cover over parts of the southern Plains and parts of the Midwest. An 18 h ECMWF forecast of surface winds over the Gulf of Mexico and Caribbean verifying 0600 UTC 3 March (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/10m_wind.png) shows that cold surge-induced gap flow is well underway in the Gulf of Tehuantepec (35-45 m/s) and is beginning in other areas of El Salvador and Nicaragua. The standardized 850 hPa temperature anomaly pattern across the CONUS prior to and during the cold surge indicates the presence of modest negative values (between -1 and -2 sigma) over much of the western CONUS as the cold surge was getting organized. As the cold air moved south over partially snow-covered ground, the negative standardized temperature anomalies increased to between -2 and -3 sigma over the Gulf of Mexico by 1 March and to less than -4 sigma (with small areas < -5 sigma) along the north coast of Central America all the way to Panama by 4 March. This 850 hPa temperature standardized anomaly pattern is consistent with the relatively abrupt southward displacement of normally cold air over the CONUS as opposed to very cold air from Canada being able to reach the southwestern Caribbean. Although this cold surge wasn't in the same league as the 13-14 March 1993 Superstorm cold surge (e.g., Schultz et al. 1997), it is/was still an impressive event. Our cursory discussion suggested that dynamical and thermodynamical processes contributed to the intensity of the event. Other relevant recent gap flow references include Stteenburgh et al. (1999), Chelton et al.

(2000), and Karnauskas et al. (2008).

d) Anticyclonic wave breaking (AWB) and trough phasing/merger over eastern North America and the western North Atlantic:

Since late Jan, frequent AWB over the central and eastern North Pacific, as evidenced by loops of dynamic tropopause (DT) potential temperature and winds, and layer-mean 925-850 hPa relative vorticity) (http://www.met.nps.edu/~hmarcham/2013.html; choose the DT option for the North Pacific, North America and North Atlantic; source: Heather Archambault), has served to reinforce the strong ridge over the eastern North Pacific and extreme western North America that was discussed above. East and south of the AWB regions positively tilted PV streamers (tails) have proliferated. Where these PV streamers have fractured at their southwestern ends to produce individual vortices they have acted as a source for surface disturbance formation ahead of these fractured upper-level vortices in the STJ-related southern stream westerlies over interior North America. Where these PV streamers have extended well southwestward into lower latitudes without fracturing their southwestern ends have acted as an entrance region for the STJ in conjunction. Additionally, it appears that Coriolis torques acting on diabatically driven upper-level (200 hPa) outflow arising from areas of anomalous convection in the tropical eastern North Pacific have enabled negative PV advection by the irrotational wind (http://www.atmos.albany.edu/student/heathera/dt/troppac/15_to_28_feb13.html) to strengthen the meridional PV gradient in the STJ entrance region as typified by the maps for 1200 UTC 24 Feb (http://www.atmos.albany.edu/student/heathera/dt/troppac/15_to_28_feb13.html).

The creation of an active STJ-driven southern stream westerly flow with embedded upper-level disturbances across the southern U.S. along with a separate northern stream with embedded disturbances has created ample opportunities for the phasing of these northern and southern stream disturbances (trough mergers) from eastern North America eastward across the western North Atlantic since late Jan. Frequent strong cyclogenesis events along the western North Atlantic "bombing range" over the last month or so (http://www.cpc.ncep.noaa.gov/products/precip/CWlink/stormtracks/mstrack.shtml) are testimony to these repeated trough phasing events (and were a subject of previous Fri map discussions). The repeated cyclogenetic activity over the western North Atlantic and induced downstream AWB has created a very favorable environment for high-latitude blocking over the northern and northeastern North Atlantic (http://www.atmos.albany.edu/student/heathera/dt/atl/15_to_28_feb13.html).

Forecast uncertainty associated with a possible midweek coastal storm

Map discussion concluded with a discussion of a potential midweek storm near the Middle Atlantic coast. The GEFS ensemble 500 hPa geopotential height mean/spread and spaghetti forecasts (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/spread.html; http://www.atmos.albany.edu/student/ppapin/mapdisco/20130301/images/spegetti.html) were extremely helpful in showing the outlier nature of the deterministic GFS solution initialized from 1200 UTC 1 March. Although this deterministic GFS solution showed a significant precipitation event spreading northward across southwestern New York and southern and central New England by mid-week (which yet again prompted Lucy, Charlie Brown and the Football comparisons), it was an outlier among the GEFS members. Of the 20 GEFS ensemble members from the 1200 UTC 1 March run, only two ensemble members supported the operational deterministic GFS run (a 10% probability at face value). As of the GEFS run from 1200 UTC 1 Mar, the ensemble members indicated that the storm threat region was likely to be much farther south in the VA/MD region with additional uncertainty related to precipitation type. [Brief update: Although the GEFS ensembles from 1200 and 1800 UTC 3 Mar continue to suggest the VA/MD will feel the worst effects of the Wed storm, 20-35% of the ensemble members are indicating that the storm may have an impact in parts of southern New England and eastern Long Island.}

II. Science Issues:

The two most-discussed science opportunities involved the origins of the STJ and the dynamics and thermodynamics of clustered oceanic cyclogenesis events. The first science opportunity prompted consideration of the role of AWB and subsequent PV streamer formation to the south and east of the AWB region in generating a longitudinally confined region of enhanced meridional potential temperature and PV gradient in the middle and upper troposphere. Regions where the southwestern ends of these PV streamers interact with active tropical convection seem to be preferred longitudes for the possible formation of STJ entrance regions. Convectively generated and daiabatically driven upper-level outflow by the irrotational wind and the associated negative PV advection by the poleward-directed irrotational wind in the upper troposphere appears to be one mechanism that can help to strengthen the meridional potential temperature and

PV gradients. Physically, these advection patterns strengthen the STJ by the action of the Coriolis torques acting on the poleward-directed irrotational wind. Addionally, cooling in the middle and upper troposphere beneath the PV streamer would be one operative mechanism for destabilizing the troposphere along the equatorward flank of the PV streamer. This destabilization of the troposphere would be manifest as an increase of CAPE and deep moisture in elongated bands along the anticyclonic flank of the STJ. An investigation of the dynamical and physical linkages between STJ formation and the location of AWB and lower-latitude PV streamers would likely prove to be enlightening.

The second science opportunity originates from watching a parade of western Atlantic cyclones during February and early March in which there appear to be linkages between the preceding cyclones and the trailing cyclones. Sanders and Gyakum (1980) remarked on the tendency for some North Atlantic explosive cyclones to occur in clusters and prompted them to wonder to what extent a leading cyclone could precondition the atmosphere for a trailing cyclone to intensify. The active western North Atlantic "bombing range" of the last few weeks prompted a revisit to this question. Ship observations and satellite imagery in the wake of strong oceanic cyclones in which cold-air is frequently transported well equatorward of the storm track often reveal numerous reports of cumuloform clouds (TCU, Cb) in the ship observations and open cellular convection in the satellite imagery. These ship and satellite observations are indicative of dynamic-driven atmospheric destabilization through cooling aloft associated with trough passage and sensible- and latent heating-driven destabilization and moistening through oceanic heat and moisture fluxes into the overlying cold air mass. A trailing poleward-moving cyclone that is able to ingest air parcels into its updraft region that have previously experienced dynamically driven cooling aloft and oceanic sensible- and latent heat-driven warming and moistening below in the wake of a predecessor storm would also be subject to vigorous ascent in a near moist-neutral environment. Given a relatively low DT near 500 hPa (strong, cold trough aloft) characteristic of the cool season, a relatively low maximum vertical motion height would be expected (assuming for simplicity a parabolic vertical motion shape). Under these conditions, dw/dp would be relatively large in the lower half of the troposphere and the generation of low-level cyclonic vorticity by low-level divergence beneath the low-level ascent maximum would be very efficient. Evidence for these hypothesized effects should be sought in studies of cool season clustered oceanic storms. The use of archived oceanic weather ship observations to better establish the thermodynamic/shear environment of oceanic storms might also prove insightful.

III. References:

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Friday map discussion next week will be superseded by the 38th Annual Northeastern Storm Conference (NESC) which will take place next weekend (8-10 March) in Rutland, VT. Those interested can find the NESC agenda here: (https://sites.google.com/site/lyndonstateamsnwa/north-eastern-storm-conference). Friday map discussion will resume on 15 March.

Lance
