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Subject: **Synopsis of Friday map discussion for 25 January 2013**
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Hi Everyone,

Friday map discussion resumed this week. Topics discussed included: 1) the Australian heat wave in the first part of Jan 2013, 2) the western Pacific explosive extratropical cyclogenesis event of 13-15 January 2013, 3) a sudden stratospheric warming event from late Dec 2012 and early Jan 2013, 4) the recent and ongoing spate of explosive oceanic cyclogenesis events over the North Atlantic, and 5) the upcoming forecast continental explosive cyclone event over eastern Canada.

Imagery used in support of this week's Friday map discussion can be found here:
http://www.atmos.albany.edu/student/ppapin/mapdisco/20130125/

1. Australian heat wave:

As was reported on the tropical listserv and elsewhere, Australia was plagued by an extended heat wave that began in the southwestern part of the country in late Dec 2012 and slowly spread eastward across the rest of the country before abating in mid Jan 2013 http://www.atmos.albany.edu/student/ppapin/mapdisco/20130125/images/850temp/spac.html). Reports from Australia indicate that numerous maximum and high minimum temperature records were set as temperatures pushed close to 50 C in some places. The extended heat wave was associated with a moderately amplified poleward-shifted upper-level flow with a strong subtropical continental anticyclone situated over interior Australia (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130125/images/jet/spac.html; http://www.atmos.albany.edu/student/ppapin/mapdisco/20130125/images/500vort/spac.html).

TC Narelle, which moved southward and neared the northwest coast of Australia on 11 Jan, proved to be a vehicle for helping to extend the heat wave eastward. TC Narelle followed the western coast of Australia poleward while remaining offshore from 11-15 Jan, turned southeastward near the southwestern tip of Australia on 15 Jan, and then accelerated southeastward as it underwent extratropical transition (ET) and explosive reintensification as an extratropical cyclone (EC) in conjunction with a reamplifying large-scale flow from 15-18 Jan. The ET and EC of TC Narelle were robust with the storm deepening to under 940 hPa well south of Tasmania by 0000 UTC 18 Jan. Very hot air, characterized by1000-500 hPa thickness values that reached 588 dam over interior Australia, was dragged eastward and southeastward across southeastern Australia and Tasmania to the east of the explosively intensifying EC that was TC Narelle.

Science issues and opportunities discussed included: 1) comparing and contrasting the dynamical and thermodynamical processes that govern Australia heat waves with heat waves in other subtropical locations, and 2) investigating the relationship between heat waves and convective mode in different subtropical and midlatitude continental locations around the world. The second science opportunity was suggested by the comparative absence of derechos over Australia as compared to the U.S. when entrenched continental subtropical anticyclones are present. Factors hypothesized to be important for understanding the differences in convective mode between Australia and the U.S. included elevated mixed layers (mostly absent over Australia, given the lack of substantial higher terrain to the west), 2) surface to 6 km shear (weaker over Australia with the upper-level jet more apt to be situated over the Southern Ocean to the south of Australia), and available deep tropical moisture (a huge semi-arid subtropical continental and no "handy" Gulf of Mexico or irrigated corn fields) to help "juice up" the atmosphere ahead of eastward-moving upper-level disturbances.

2. Western North Pacific explosive oceanic cyclogenesis:

A weak tropical disturbance originated from deep convection associated with an active MJO near 130 E on 10 Jan. Although this area of disturbed weather was never categorized as a tropical depression, it moved steadily poleward and by 13 Jan and EC that had formed in this area of disturbed weather was located near 30 N and 130 E. Subsequently, this EC explosively intensified as it moved northeastward, interacted with the western North Pacific subtropical jet (STJ), and deepened to under 935 hPa near 39 N and 155 E by 0000 UTC 15 Jan (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130125/images/500vort/npac.html). A broad region of diabatically driven outflow in the 300-200 hPa layer was observed poleward of the region of active MJO convection. This region of diabatically driven upper-level outflow was concentrated in the equatorward entrance region of the aforementioned STJ (http://www.atmos.albany.edu/student/ppapin/mapdisco/20130125/images/jet/npac.html; http://www.atmos.albany.edu/student/ppapin/mapdisco/20130125/images/850temp/npac.html).

Coriolis torques acting on this diabatically driven outflow likely contribute to the strengthening of the STJ and the intensity of the subsequent explosive EC event. This explosive EC, and subsequent strong ECs, contributed to the formation of downstream Rossby wave trains (RWTs). A sharp PV trough formed near 160 W and a massive ridge developed over the eastern Pacific and far western North America between 15-20 Jan. Diabatically driven upper-level outflow on the forward side of trough near 160 E helped to thin the PV trough (negative PV advection by the irrotational wind acted to advect lower values of PV westward which eventually resulted in the formation of a cutoff cyclone north of Hawaii and a Kona low surface development).

Science issues and opportunities discussed included: 1) determine whether the timing, frequency and intensity of extratropical cyclogenesis in the western North Pacific can be linked to the phase and amplitude of the MJO, and 2) investigate to what extent feedback processes associated with an active EC storm track in the western North Pacific can lock in cold air over eastern Asia in winter and lead to extended periods of below normal temperatures in this region, and 3) compare and contrast the impact of EC-STJ vs. TC-STJ interactions on downstream development and the formation of RWTs.

3. Sudden Stratospheric Warming (SSW) of late Dec 2012 and early Jan 2013:

Although there were periods in late Oct and early Dec 2012 when the Arctic Oscillation (AO) was negative, indicative of a weakened tropospheric polar vortex, the stratospheric polar vortex remained anomalously strong (http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/hgt.shtml). It wasn't until late Dec and early Jan 2013 that the stratospheric polar vortex weakened significantly. By ~20 Jan, the tropospheric and stratospheric polar vortices were in phase and were anomalously weak in conjunction with a major SSW event. We briefly reviewed the structure and evolution of the SSW using the real-time and archived stratospheric imagery archive available at Andreas Dornbrack's Arctic ECMWF web site (http://www.pa.op.dlr.de/arctic/ecmwf.php). This most recent SSW event featured a wave number two breakdown of the polar vortex. These two povortices were displaced southward across northeastern Asia and northern Canada, respectively. Both vortices were associated with the bulk of the Arctic air in the Northern Hemisphere.

Science issues and opportunities discussed included: 1) investigate possible linkages between the occurrence and structure of SSW events and the amplitude and phase of the MJO, western North Pacific EC events, downstream development and the formation of RWTs, and high-latitude anticyclonic wave breaking (AWB) and blocking events, 2) determine what dynamical and thermodynamical processes govern whether a SSW event will feature a wave number one or a wave number two breakdown of the polar vortex, and 3) establish whether there are preferred longitudes along which the wave number two polar vortices will tend to traverse in the aftermath of a SSW event and, if so, why there should be preferred longitudes (e.g., reflection of topographic forcing?).

4. North Atlantic Multiple Explosive Cyclogenesis Events:

The North Atlantic "bombing range" has been very active the last few weeks (see also a separate earlier post to the map listserv on this subject). Repeated incursions of arctic air over eastern North America and the western North Atlantic have established a very strong baroclinic zone beneath a 150-200 kt jet stream over the western North Atlantic (http://www.atmos.albany.edu/student/abentley/mapdisco/20130125/atlantic_mslp.html). Moisture-starved dynamic tropopause (DT) disturbances associated with Alberta Clippers and other weak low-level continental disturbances have triggered explosive cyclogenesis once they moved offshore away from a low-level cold-air advection environment onshore and encountered a low-level warm-advection environment in the presence of reduced atmospheric stability offshore (http://www.atmos.albany.edu/student/abentley/mapdisco/20130125/atlantic_dt_2pvu.html; http://www.atmos.albany.edu/student/ppapin/mapdisco/20130125/images/dt/natl.html). In this reduced static stability and high baroclinic environment, explosive cyclogenesis occurred when an area of strong 500 hPa cyclonic vorticity advection ahead of a strong DT disturbance overspread a developing low-level disturbance as seen nicely over the western North Atlantic at 1800 UTC 24 Jan and 0000 UTC 25 Jan near 37 N and 65 W (http://www.atmos.albany.edu/student/abentley/mapdisco/20130125/atlantic_vort.html; http://www.atmos.albany.edu/student/ppapin/mapdisco/20130125/images/500vort/natl.html). The surface cyclone subsequently deepened explosively to ~930 hPa as it moved northeastward in the next 36 h (this cyclone was discussed in separate posts).

Science issues and opportunities discussed included: 1) investigate the dynamical and thermodynamical processes that govern clusters of explosively deepening cyclones (aka "cluster bombs"), the mutual interactions between these storms and the atmosphere and ocean, and the bulk upscale effects of these storms on the downstream large-scale flow, 2) determine the extent to which the lead storm in a "cluster bomb" group can condition the large-scale environment for a subsequent storm, and 3) assess "cluster bomb" predictability issues (e.g., how critical is it to forecast the first storm in a series correctly in order to forecast the subsequent storms properly)).

5. Forecast Continental Bomb of 29-30 January 2013:

Since late last week, the GFS has been forecasting a major land bomb to occur over eastern North America later this week. The storm is forecast to form along a strengthening cold front in the Midwest late Tuesday and early Wed (29-30 Jan) and strengthen rapidly over the subsequent 48-60 h, achieving a central pressure < 950 hPa over northeastern Canada and < 940 hPa shortly thereafter over the northern Davis Strait. Kyle Griffin's forecast standardized anomaly maps from the GFS forecast run initialized at 1800 UTC 27 Jan shows a pegged -5 sigma 1000 hPa height anomaly developing over northeastern Canada in the 84 h forecast verifying 0600 UTC 31 Jan that expands in area and is present through the 126 h forecast verifying 0000 UTC 2 Feb (http://www.atmos.albany.edu/student/kgriffin/maps/1000hght_stdanom/1000hght_stdanom_namer_loop.html). This is one impressive continental bomb, comparable to the intense cyclone of 9-10 Jan 1978 that formed along a strong cold front over the eastern U.S. and then tracked through northeastern Canada while intensifying rapidly.

The 9-10 Jan 1978 continental bomb helped to trigger the retrogression of the time-mean 500 hPa long wave trough from the western North Atlantic to eastern North America. Noteworthy cyclones followed the retrogression of this 500 hPa trough over eastern North America and the establishment of a southern stream in the westerlies (20-21 Jan, 25-26 Jan, and 6-7 Feb). Although the GFS and ECMWF models are not forecasting a comparable 500 hPa trough retrogression beyond week one in forecasts initialized at 1200 UTC 27 Jan, it would probably be prudent to keep our guard up and watch for science-related predictability issues while we are waiting. A related science issue and opportunity would be to investigate the dynamical processes that control whether an active southern stream (strong STJ) will present across the southern U.S., northern Mexico, and the Gulf of Mexico.

When the southern stream is absent as it was during much of the 2011-2012 winter and so far a good part of the 2012-2013 winter, upper-level disturbances in the active northern stream (porridge too cold) reaching the northern U.S. are typically moisture-starved and are unable to trigger cyclogenesis until the upper-level disturbance reaches the North Atlantic. This situation results in a colossal waste of cold air for storm lovers. In the opposite situation when the southern stream is dominant and the northern stream is inactive (porridge too warm), storminess can be common across the southern half of the U.S. because the absence of significant cold air masses means that much of the precipitation will fall as rain, freezing rain and sleet instead of widespread snowstorms. When both northern and southern streams are present (porridge just right) the possibility exists that these streams can phase with resulting explosive cyclogenesis.

This Goldilocks theory of cyclogenesis could be put to the text by a careful stratification of the available gridded datasets into three categories based on whether the northern, southern, or both streams are dominant. This stream stratification could serve as the basis for a careful climatological, composite, and case study analysis of the dynamical and thermodynamical processes that govern the three streams (it would also make for some compelling "streaming" video…..hopefully).

Lance
