IC4.2 Part 1: Job Sheet

Interpreting Standardized Anomalies

Objectives:

1) become familiar with forecast anomaly resources on the Internet
2) Interpret the meaning of standardized anomalies anomalies and their relationship to severe winter weather hazards.

Data: Internet

Instructions: Review the following websites to become familiar with using online anomaly resources to identify significant anomalies. Recall from IC4 Lesson 2 that significant standardized anomalies normally range from 2-3 standard deviations from normal. Values of 4 to 5 standard deviations from normal are considerably rarer. Values over 6 standard deviations are extremely rare, and they are normally associated with deep tropical storms. Although the current weather being analyzed may not have anomalous winter weather, it is still useful to learn how and where to access anomaly information on the web. Bookmark the sites you find useful.

CONUS Sites: If you are investigating CONUS weather, go to the following website to view current anomaly forecasts for ensemble data or some individual model runs (site may take up to a minute to load):

http://eyewall.met.psu.edu/ensembles/index.html

1. Select “MREF” as the “Model” and “NOAM/500H” for the field. Move the scrollbar on the right side of the browser down to include the bottom image and the player buttons (“<” and “>”) at the top. Then step through the loop. Look for significant 500mb height anomalies (bottom) and ensemble spread (top). Low confidence in the strength of the anomaly occurs where ensemble spread (top) is correlated with the anomaly. High confidence in the strength of the anomaly occurs where ensemble spread (top) is not correlated with the anomaly.
2. Select “SREF” as the “Model” and “US/MSLP” as the field, and step through the loop. Look for significant anomalies in the pressure field, and gauge the confidence in the anomaly by looking at the correlation between the anomaly and the spread as in #1.
3. Select “SREF” as the “Model” and “US/850T” as the field, and step through the loop. Look for significant 850mb temperature anomalies, and gauge the confidence in the anomaly by looking at the correlation between the anomaly and the spread as in #1.
4. Select “SREF” as the “Model” and “US/850WIND” as the field, and step through the loop. Look for significant 850mb u anomalies (top image) and v anomalies (bottom image).

OCONUS Sites: If you are investigating OCONUS weather, go to the following website to view current anomaly forecasts for *individual model runs*:

http://www.hpc.ncep.noaa.gov/training/SDs/

1. Select the "500 hPa Heights" link or the "Previous Cycle 500 hPa" link under the "GFS Forecast" heading. Look for significant 500mb height anomalies in the GFS forecast.
2. Select the "850 hPa Temperatures" link or the "Previous Cycle 850 hPa" link under the "GFS Forecast" heading. Look for significant 850mb temperature anomalies in the GFS forecast.

Past Events Exercise: Now that you are done accessing forecast data, it is time to look up anomaly information on a few major events that we will name below. For both CONUS & OCONUS weather, use the following websites to view archived anomaly information from the reanalysis data:

The NCEP reanalysis data site is useful to view the evolution of systems and standardized anomalies:
http://www.hpc.ncep.noaa.gov/ncepreanal/

1. You can view a four panel display of standard pressure levels including 200 mb, 500 mb, 850 mb, and 1000 mb.

2. Standardized anomalies are provided to you for 500 mb heights, 850 mb temperature, and precipitable water.

3. You may pick a loop for any time period from 1948 to the end of 2007 at 12 hour increments. However, you shouldn't try to loop the entire time period.

4. Choose a beginning time in the box labeled 'Current Date', and an ending time in the box labeled 'End Date'.

Now go to the Penn State standardized anomaly reanalysis site to view the interactive Global re-analysis data for a memorable event at:
http://hart.met.psu.edu/meteo497/mapper.html

1. Data are available in 6-hour increments for many different variables.
2. The "Map Time Set" menu provides a loop of variables before and after the date entered. Pick "1 Day Before/After".
3. Pick the display "Region" (e.g. North America).

4. Select the variables for the 4 panel chart (e.g. “Heights” or “U-winds”).
5. You can select the plot size, but the default “Medium” should be fine.
6. You must use the Plot button to make the image. Be patient as the program uses raw data to create images. Feel free to peruse other variables/dates.

Review case 1:

1) Let’s review the evolution of the strong east coastal storm (aka storm of the century) from 1993 March 12- 14, 00 UTC. This coastal storm ranked #1 of all east coast snow storms in terms of the most number of people affected by the largest amount of snow. The severe winds added to the impact by creating blizzard conditions from Alabama to Maine. The west coast of Florida experienced one of the biggest storm surges in the state’s history.
2) From the Penn State reanalysis site, play a loop of data by entering in 12Z 13 March, 1993. Then select a ‘Map Time Set’ of 1 day before/after.
3) Click the “+” or “-“ 6hrs button to step back and forth from your selected date.
4) View the following variables:
   a) SLP/2m Temp/Prec Water/Precipitation
   b) Heights
   c) Thicknesses
   d) Temperatures
   e) Specific humidity
   f) U-winds, V-winds, Total wind magnitude
   g) 10m wind magnitude
5) Among the selection, what standardized anomalies stand out above the rest in this loop?
   a) SLP standardized anomalies dropped to -4 to -5 STDs as the low reached South Carolina on 18Z 13 March. Before then, the 2m temperatures reached the same negative values south of TX.
   b) The 850 mb height was first to reach -4 to -5 STDs west of Tampa on 06Z 13 March. The 500mb and 700 mb heights reached maximum negative STDs on 18Z 13 March over GA.
   c) The 500 mb temperatures standardized anomalies reached -4 to -5 STDs in NE on 18Z 12 March. 850 mb temperature standardized anomalies hit -4 to -5 STDs south of Lousiana on 00Z 14 March.
   d) The 850mb U-wind standardized anomalies hit +4 to +5 STDs over the southern Gulf of Mexico 06Z 13 March. Negative standardized anomalies almost reached -4 to -5 STDs on 18Z 13 March over southern PA. The 850 mb V-wind standardized anomalies reached +4 to +5 over the Bahamas on 12Z 13 March. The 850 and 700 mb total wind magnitude standardized anomalies reached +4 to +5 STDs over south FL on 12Z 13 March.
   e) The 850 mb U-wind standardized anomalies showed +4 to +5 STDs in the central Gulf on 00Z 13 March that expanded into FL.

6) How do you think the anomalies contributed to producing the scale of the snow, wind and storm surge? Were some anomalies a direct cause? Did some require to combine with other signals to create this disaster?
   a) Overall, the depth of the surface low and the heights aloft pointed to an unusually rare system, especially as it peaked in the Gulf up to NC. The unusually cold 500mb temperatures also support that this system was unusually strong. But alone, these values would not tell you that a record breaking snow event in the east coast and storm surge would occur.
   b) Looking further, we note nearly -4 STDs in the U-winds at 850 mb imply that Atlantic moisture flux was unusually high. The negative low-level temperature anomalies weren't notable in the zone of negative U wind anomalies but they don't have to be to indicate subfreezing air. So heavy snow rates could be inferred from what we've said so far. The anomalies don't inform us about the duration of the snow unless we look at the duration for which these anomalies remain over any one area. The size of this system allowed for long duration snow event over a wide area that contributed to the big snow band. In southern Alabama, significant, though not extreme negative 850 mb to surface temperature anomalies far to the south helped in areas ahead of the midlevel trough in context of being in saturated ascent is quite likely more rare than the values of the negative anomalies by themselves.
   c) The massive storm surge in western FL may have been most directly related to the +4 to +5 U wind anomalies from 2 m to 700mb impinging on the coast. The SLP anomalies were strong but not historic in the reanalysis data. However, we do know the central pressure of the system was much lower than 990mb depicted by the analysis. Perhaps here is another example where the U-wind anomalies and the central pressure anomalies combined together point toward a serious surge event.

Review Case 2

1) Let's review the evolution of one of the most severe ice storms in Oklahoma memory from 2007 December 9-11. This storm produced the worst power blackout seen in 20 years for Oklahoma because 2-3" of ice accumulated over the most densely populated areas from Oklahoma City to Tulsa. The worst of the icing ended by the morning of the 10th. A new wave of precipitation swept over the state late on the 10th but temperatures rose above freezing in most areas by then.
2) Using the Penn State reanalysis site, choose 00Z 10 December, 2007 as a starting time and set 'Map Time Set' to 1 day before/after.
3) Go through the same variables as with case 1.
4) Among the selection of variables, what standardized anomalies stand out above the rest in this loop?
   a) Precipitable water standardized anomalies reached +4 to +5 STDs over NM to the Oklahoma Panhandle by the morning of the 10th.
   b) Specific humidity standardized anomalies at 700mb approached +3 to +4 STDs over OK on the morning of the 9th, and continued through the end of the icing. The 500 mb and 850 mb STDs exceeded +4 and even approached +5 after the event in the Panhandles.
   c) The 250 – 700 mb height standardized anomalies reached -3 to -4 STDs over the Baja California area by midday on the 10th. However 500mb standardized anomalies were this strong as the system was moving south, west of the LA basin.
   d) The 500mb V-wind standardized anomalies show -4 to -5 STDs off the coast of Baja 06Z 10 Dec

and then an equal but positive vale after the system lifted in the afternoon of the 10th.

5) How do you think the anomalies contributed to producing the scale of the ice storm? For example, were there any anomalies that had a direct cause and effect to producing the disaster? Were there anomalies that indirectly caused the disaster? Were some anomalies requiring the presence of the right setup in order to be allowed to contribute to making this ice storm disaster?
   a) Here is an example where the atmosphere can produce an extraordinarily damaging event and yet not show a blaring signal in the standardized anomalies of most of the variables in the reanalysis data. The two anomalies that stand out are related to the depth of the closed low in midlevels well to the west, and the relatively high moisture reflected in the precipitable water and specific humidity over the low-level cold air. Perhaps what stands out most in this event is what is not highly anomalous. The U- and V-wind components in the low-level jet from the Gulf are not extraordinary. The low-level cold air is relatively common at just below freezing. There is no anomalously deep surface cyclone. And the thicknesses are relatively unnoteworthy. This ice storm fit the classic conceptual model of a Plains ice storm where a relatively deep trough lay well to the west, while a polar front undercuts a feed of rich Gulf moisture and so pattern matching is probably more informative than viewing the raw standardized anomalies alone. However, the queues for this ice storm disaster perhaps lay in the persistence of the highly anomalous elevated moisture over surface temperatures just slightly below freezing. Add in elevated instability and frontogenesis, and leave these signals to remain stationary to allow for high accumulations of ice.
   b) We're looking for the student to recognize that high values of standardized anomalies can directly influence the creation of a disaster, such as the example of the high U-wind anomalies directly impacting a coastline allowing for a storm surge to develop. Likewise, the student should also have seen an example where high standardized anomaly will signal a major societal impact if it's in the right context as we've seen with the strong negative U wind anomaly that happens to feed moisture into a region of strong ascent while column temperatures were modestly below normal as was the case north of the 'Storm of the Century'. Take that strong U-wind anomaly and deny it moisture, nothing much would happen. This was also the case when relatively high moisture standardized anomalies happen to persist over a frontal zone and slightly cooler than normal surface temperatures for an extended time period to yield a damaging ice storm.
   c) Overall, the student should be a critical thinker in trying to figure out how a large standardized anomaly signature can result in the eventual societal impact. The student should know that standardized anomalies allow one to make an assessment as to how rare a particular value of a parameter happens to be but to also know that the path between a large anomaly and the inevitable impact is not always so direct.