Costa Rican Warming: A Step Artifact?

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Now this is interesting.

San Jose, Juan Santamar and Puentarenas Costa Rica according to GISS sets the latitude for those stations at exactly 10N, and not a fraction of that. That means that it falls on the boundary between 2 grid boxes in their gridded datasets. Box One is centered on 9 N / 85 W and Box Two is centered on 11 N / 85 W. What makes that interesting is that the amount of infill for each box is determined by the radius from the center of the box not from any of the temperature stations in that box. So it will be interesting to see how close the trend for actual data from stations like San Jose match to the trend of the 250km infill GISS anomalies. I am going to try and make a visual layout of what the boxes look like and with Long/Lat's and where the temperature stations lie in relation to everything:

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88/14-----------86/14-----------84/14-----------82/14
  |     87/13     |     85/13     |     83/13     |
88/12-----------86/12-----------84/12-----------82/12
  |     87/11     |     85/11     |     83/11     |
88/10-----------86/10-------|||--84/10-----------82/10
  |     87/09     |     85/09     |     83/09     |
88/08-----------86/08-----------84/08-----------82/08
  |     87/07     |     85/07     |     83/07     |
88/06-----------86/06-----------84/04-----------82/06
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Ok there you go a bunch of grid boxes and the amazing thing according to GISS is that data from the box centered on 87W/09N can be used to determine what the "real temperature trend" in the box centered on 83W/09N is.

In the cases of San Jose, Juan Santamar and Puntarenas they all sit right on the line going between 86/10 and 84/10 (as shown by the three vertical lines). So by looking at the trends for the boxes they overlap and comparing them to the trends for those stations it will give us a good idea how much of those trends is infill from other boxes and how much is from the stations in the boxes. Remember for this comparison the data was turned back to 250km infill from the center point, normally it is 1200km infill.

First lets look in Figure 1 the trends for the two boxes based on the yearly anomalies from 1942-2009, Jan-Dec:

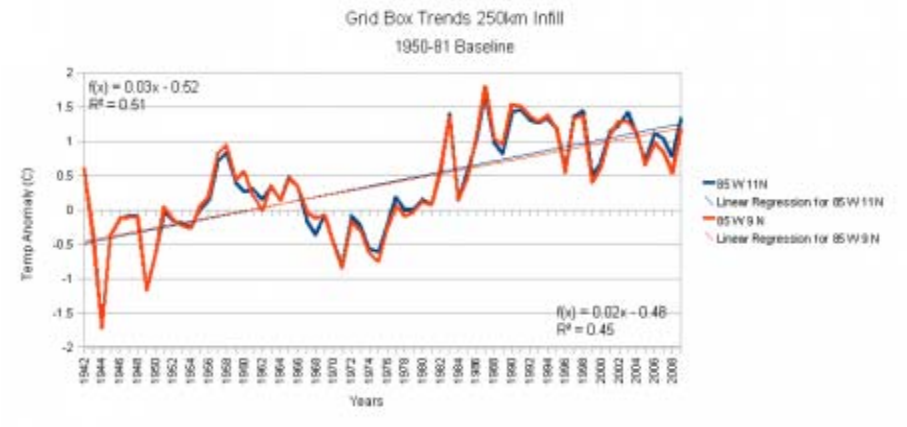

Figure 1

Now as you can see according to the anomalies from 1942 to 2009 the trend is warming of about 1.7° C. Now in Figure 2 we will see the graph of the absolute temperatures for these 3 stations:

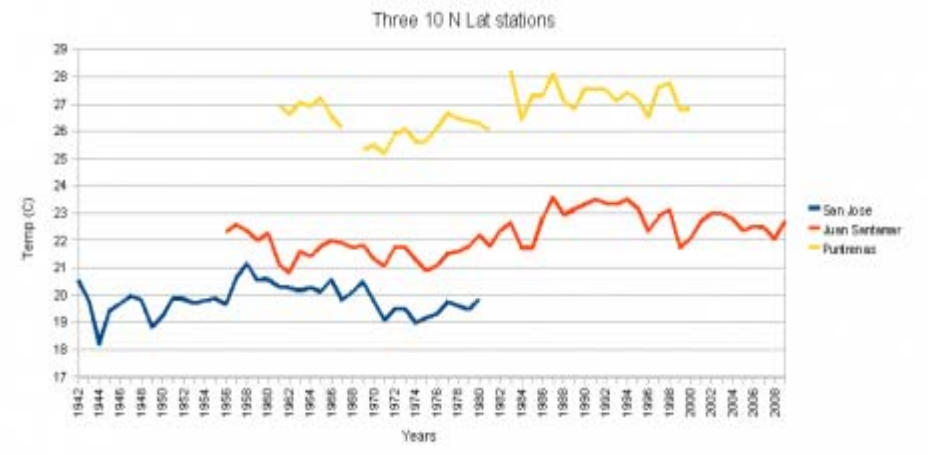

Figure 2

Notice that in the overlap period of the 3 stations that they are at different absolute temperatures. Matter of fact the trend for San Jose during its time of coverage is < -.1° C, for Juan Santamar we have a trend of 1.35° C and for Puntarenas 1.2° C.

So with 2 of the stations showing a warming trend but .35° C and .5° C less then the grid and with 1 station showing basically a flat trend does that mean most of the difference is due to infilling?

Not necessarily, first lets just do a simple average of the anomalies of those three stations and compare that to the grid trends. The Anomalies are based on taking each station's data and subtracting out the average for the baseline period of just that stations data, then averaging those anomalies and that gives us what is seen in Figure 3:

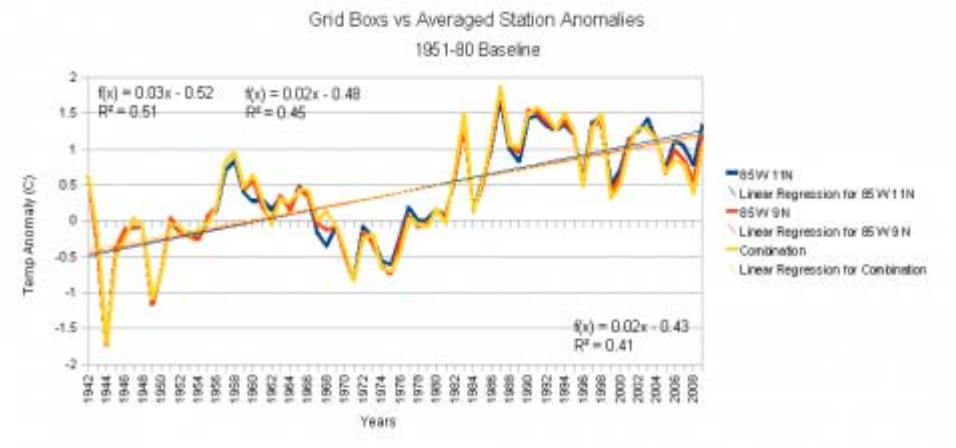

Figure 3

Now as you can see that gives a pretty good fit with a a combined station anomaly trend of 1.6° C over that time period. Now some might ask about geographical weighting of the data and when you look at the Lat/Long of each station you will see that there is very little difference. All three are set at 10° N Lat and they run at 84.1°, 84.2° and 84.8° W Long. So these stations are not that far apart in the horizontal sense but they are different in elevation. San Jose according to the GHCN station list (which seems to have gone MIA from the NCDC GHCN ftp server) is at 1141 meters, Juan Santamar is at 939 meters and Puntarenas is at 3 meters. So when you go back to the graph in Figure 2 you see that as you get lower in elevation the temperature starts rising, but it doesn't seem that GISS weights for elevation (at least they do not have any indication of such in their station list, there is no elevation listed).

Now what else is different between the three? Well according to GHCN San Jose and Juan Santamar are both classified as tropical and Puntarenas as water (that means it's down by the beach). According to GHCN San Jose is Urban and GISS has a pop of over 390,000, while the other two are classified by GHCN as S and GISS has pops of 33,000 and 26,000 for them today. So we started out with one thermometer up in the mountains in a city that grew over time, we added in another thermometer in 1956 at a little lower elevation with a smaller population and then added a third in 1961 much further down in elevation. We then lose the original thermometer in 1980, then lose the one down by the beach in 2000, leaving the one small town thermometer (which might be the international airport for San Jose the capital see: http://en.wikipedia.org/wiki/Juan_Santamar%C3%ADa_International_Airport). This lets us break down everything into separate time periods based on when we added and lost thermometers and see what the trends were for each one and compare it to the averaged trend line for those same periods.

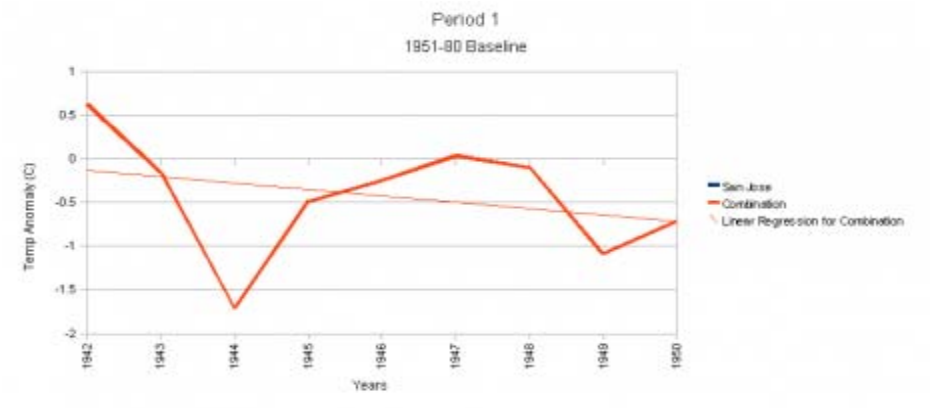

Figure 4

As can be seen in Figure 4, period 1 covers the years 1942 thru 1950 and there is only one thermometer for that period. Also shown is that there is a cooling trend of about -.6° C over that period. Also note the big drop in temperature right after the start of the graph. That big drop is going to play a big part in the 1.6° C warming trend we saw in Figure 3.

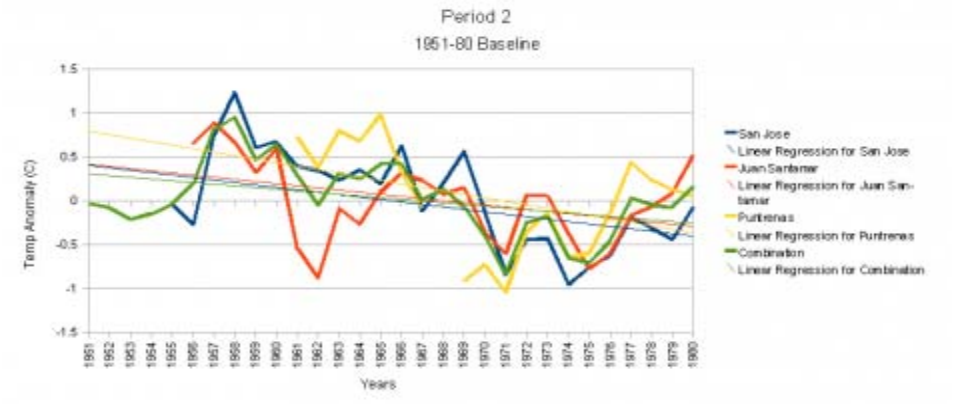

Figure 5

Now here in period 2, which covers the baseline years of 1951-80, we gained two new thermometers while still retaining the original one, however 1980 is the final year for our original thermometer. What that means is that it help shaped the combined/Grid box baseline and is what the other two thermometers are compared to in the future. Also note that all trends are cooling at that point including the combined at slightly over -.5° C.

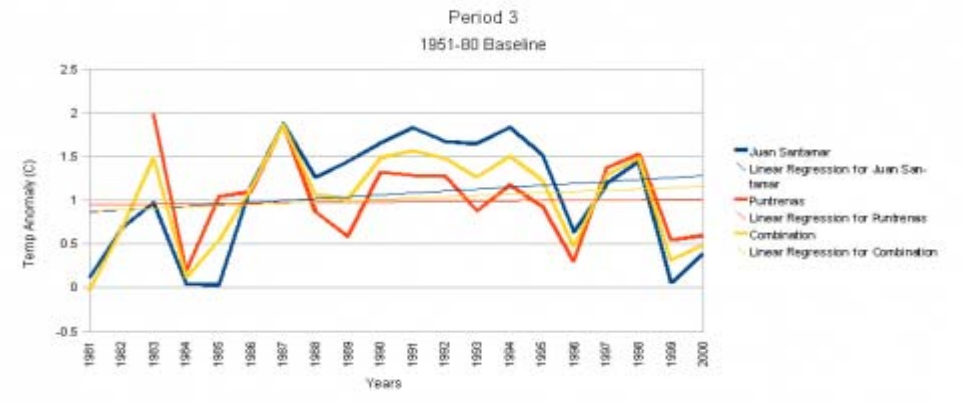

Figure 6

Now here in period 3 we just have two small towns that have thermometers, one at higher elevation and one down by the beach (http://en.wikipedia.org/wiki/Puntarenas). The one down by the water basically has a flat trend during this period with barely a small amount of warming. The higher elevation one is of much more interest, it has a warming trend of .4° C over that period. What makes it interesting is that the temperature at that station jumped up very quickly in 1985, then remained basically flat after 87 until 95 and then dropped back down. What this produced in the combined is a slight warming trend just under .2° C.

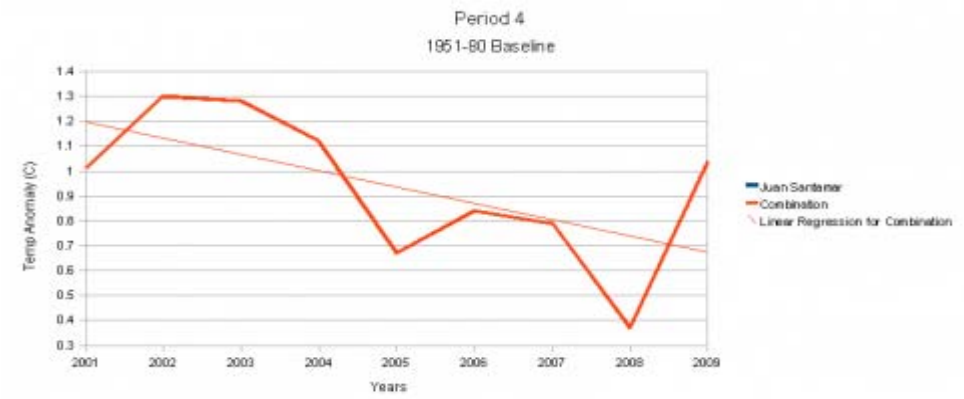

Figure 7

Now here in Period 4 we are back down to just one thermometer and it's in a small town at a higher elevation (which might be the 2 nd busiest airport in Central America) and we see a cooling trend of just over -.5° C for that period.

Now I broke that record up into 4 periods, 2 of which have just one station each, one is the baseline period where we introduced 2 into the record and ended our original and the last period is a long stable period of just two stations. Now of those 4 periods we had 3 with cooling trends and only 1 with a slight warming trend. What you see if you go back and look at Figure 2 is that from 1941-80 you had a big dip in temperatures followed by

some warming, then another dip of temperatures. From 1981-2009 you see a jump in temperatures followed by a flat trend since then, however the anomalies all stay above the baseline where before 1980 you had those dips below the baseline, that is what gives you the warming there, the comparison of those big dips prior to the baseline and the large jump after the baseline. You will be able to see this in the following three graphs:

Figure 8

Here we see a slight warming trend of just under .1° C for the period 1942-1980.

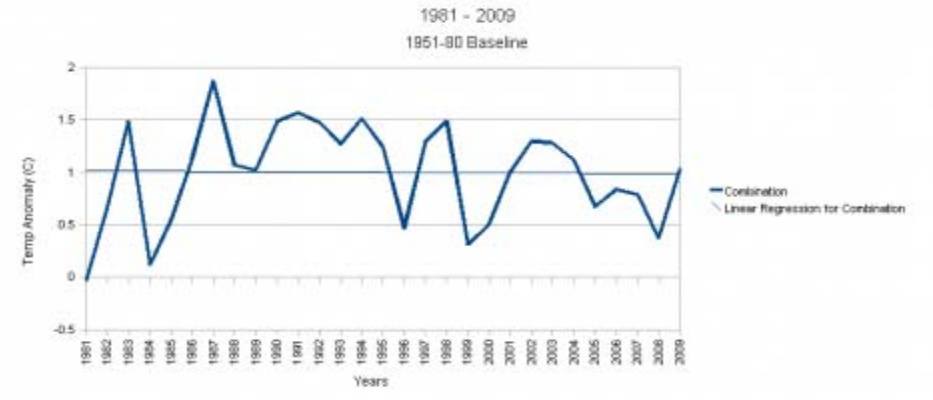

figure 9

Here you see a trend that is for almost all intents and purposes flat for 1981-2009, but is about 1.1° C higher then the trend in Figure 8.

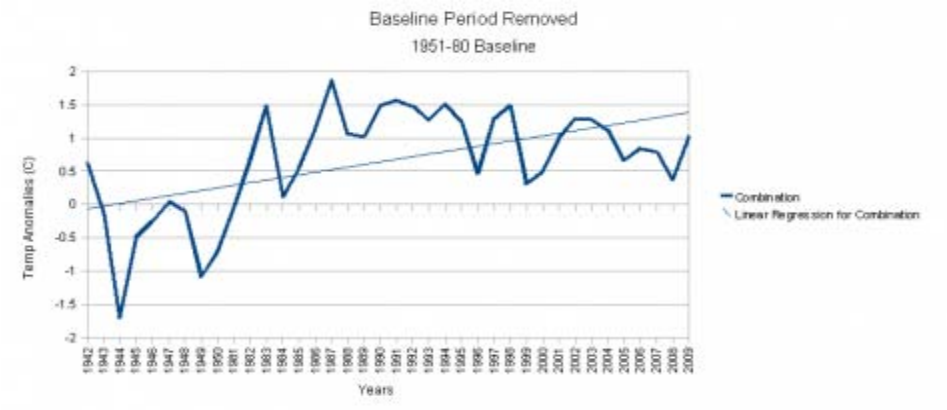

figure 10

Now in Figure 10 I took out the baseline years and just glued the period 1981-2009 to the end of 1950 and you can see you get a warming trend of about 1.5° C. That shows that you are basically comparing the anomalies of the two newer thermometers against the anomalies of the original thermometer, which is an apples to oranges comparison and giving you a nice big 1.5° C warming trend, where if you look at the one thermometer that runs from 1956 thru 2009 you only get a 1.35°.

Now lets see what GISS says the trend should be for our 2 selected boxes:

First 1200km infill

48 50 -85.00 9.00 1.2232

48 51 -85.00 11.00 1.1963

These numbers are what I get from the GISS trend map for 1942-2009, Jan to Dec years, in those two boxes. To make GISS trend and Anomaly maps go here: http://data.giss.nasa.gov/gistemp/maps/ . You can download the trend/anomaly for each grid box from the map page.

250km Infill

48 50 -85.00 9.00 1.6586

48 51 -85.00 11.00 1.7351

As we added in more thermometers the trend dropped by about .5° C but, as I think I have shown above, the “trend” for those grids is not based on a warming trend over that entire period but a step function right when you lost the original thermometer. The result causes an apples-to-oranges comparison of the 2 post Baseline thermometers to the original one pre Baseline. So to me the “warming” trend we see is more a case of change in instruments then what’s really going on there. When you had periods of instrument

stability you had mostly flat trends and when you didn’t it was just in the one station you had a big step jump that got the warming trend.