Some thoughts on thresholding the 2005 Southern Nevada Complex (SNC).

Issues to expect for burned areas covering desert vegetation:

> Per-pixel contribution from green vegetation may be less than from non-productive vegetation, and soil or rock that did not burn.

> Post-fire, per-pixel contribution from char and ash may also be less than from unburned soil and rock.

> Thus, detectors of fire-caused change (dNBR) may show less range, and have less contrast within the burn than in more-vegetated regions.

> Consequently, expect less pronounced patchiness in dNBR with more visual uniformity to the burned areas.

> Patchiness and linear drainage-related features should be evident from the contrast with unburned-to-low severity, however.

> Such moisture-limited regions tend to show high inter- and intra-annual variation in plant growth, which is also transitory. So, scene to scene differences that are not fire-related are likely to appear in unburned areas.

> If this is prominent, burn-to-unburned distinctions may get ugly and spatially variable outside burns. Be less concerned about this in unburned, and focus more on the burned; knowing that fire-related information is diminished somewhat.

> The burned-unburned threshold is important here, however. Burning has significant ecological implications though severity may not vary much across pixels (except for the sub-pixel contribution of unburned patches).

> Since the SNC predominantly covered large areas of desert, an initial assessment (IA) was used.

> The IA here can show more variation and range than an extended assessment, and timing can offer IA scenes of good radiometric quality. These IA characteristics are not necessarily true in other regions.

> Vegetation here is adapted to drought with many annual species; so even in IA, some rapid regrowth may occur due to rains right after burning.

> Unlike EA in grasslands, where complete or enhanced vegetation regrowth quickly follows burning and may obscure the burn scar, the EA of SNC exhibited very little change not because of highly-detectable regrowth, but seemingly due to other factors like erosion of char and ash from mostly bare surfaces, and dryness or lack of greenness in both pre- and post-fire scenes.

> With the IA we hope to achieve good distinction between burned and unburned, define the spatial complexity of the burn, and partition the detected degree of change into low, moderate and high categories.

> Use of the IA and conditions of SNC vegetation require dNBR severity-class thresholds to be shifted downward, to reflect a higher degree of ecological impact than generally indicated by the amount of remotely-sensed change.

Many of the approaches and interpretations illustrated in slides also apply to other case studies and generically to selecting thresholds.

Suggested preferences to set up for thresholding:

The dNBR or RdNBR should have appropriate grayscales to display the continuous data. Since less range and contrast is expected in dNBR, breakpoints of -600 to 1000 seem to work okay, as opposed to the more typical -800 to 1100. RdNBR breakpoints may be a little more difficult to set, due to greater range of the data, but those around -1500 to 2300 appeared to look comparable to the dNBR. (You can experiment using the LUT values in “inquire cursor” to compare gray tones with the dNBR in a linked viewer. If gray LUT values in RdNBR are similar for average unburned pixels, and for the high dNBR pixels, the grayscales are closely matched. Don’t compare the higher RdNBR values because these are highly weighted by low pre-fire NBR.)

Have the dNBR or RdNBR open in one viewer as a continuous grayscale image, and the same opened in a second exactly overlapping viewer as a pseudo color image. It is useful to have viewers linked and sized as large as possible in order to toggle between them for reference from the Windows task bar.

Pre- and post-fire Landsat false-color composites are useful to have in a third linked viewer. The fire perimeter can be kept underneath images until needed as well.

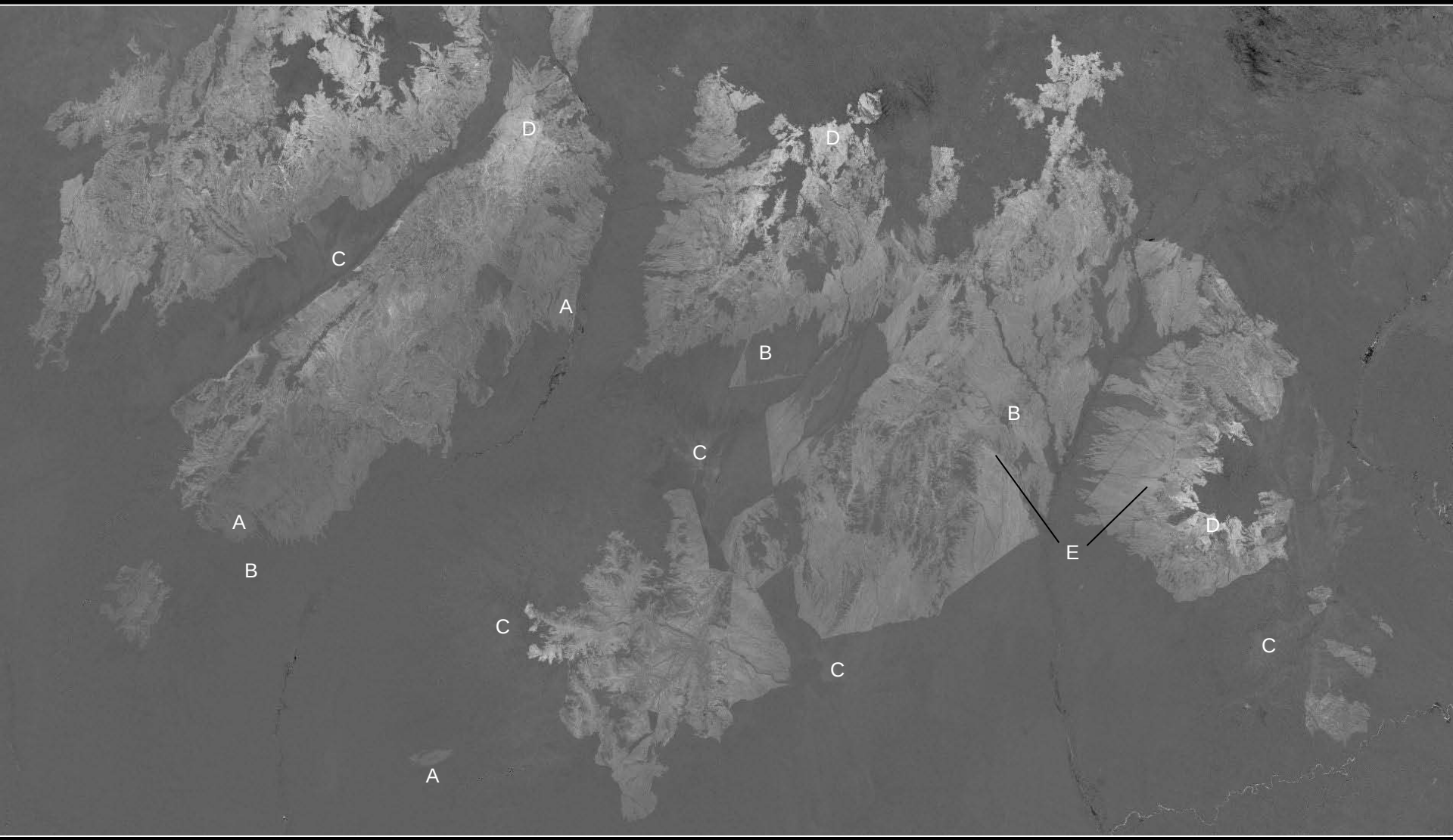
It facilitates interpretation and comparison to initially color the pseudo color image with the same gray tones as the grayscale image. The various techniques of selecting and coloring ranges of data in either grayscale or pseudo color displays were covered in an earlier session. I won’t describe them here, but if you have questions drop me a line.

All one needs to see are the value and color columns of the attribute editor. Shrink column width to minimum size needed, and arrange the editor so the value and color columns are next to the left edge (using Column Properties). Shrink the width of the editor to minimally obstruct one’s monitor. Elongate the editor top to bottom of monitor (to quickly select 50 or more values at once) and position off to the side.

It is good to see as much area as possible, but not so much that the data resolution is significantly degraded by the screen resolution. The Imagine reset button sets the zoom to the default scale, which is one data pixel for one screen pixel. For large burns like SNC, one can zoom out one click below the default for starters and then reset as needed for detail. I would not recommend working below that scale; rather, one can pan around images to see different areas.

The following slides contain tiff images rather than jpegs, so they can be enlarged to 150% to see more detail.

Use the grayscale dNBR/RdNBR as a reference to the distribution and pattern of the burn.

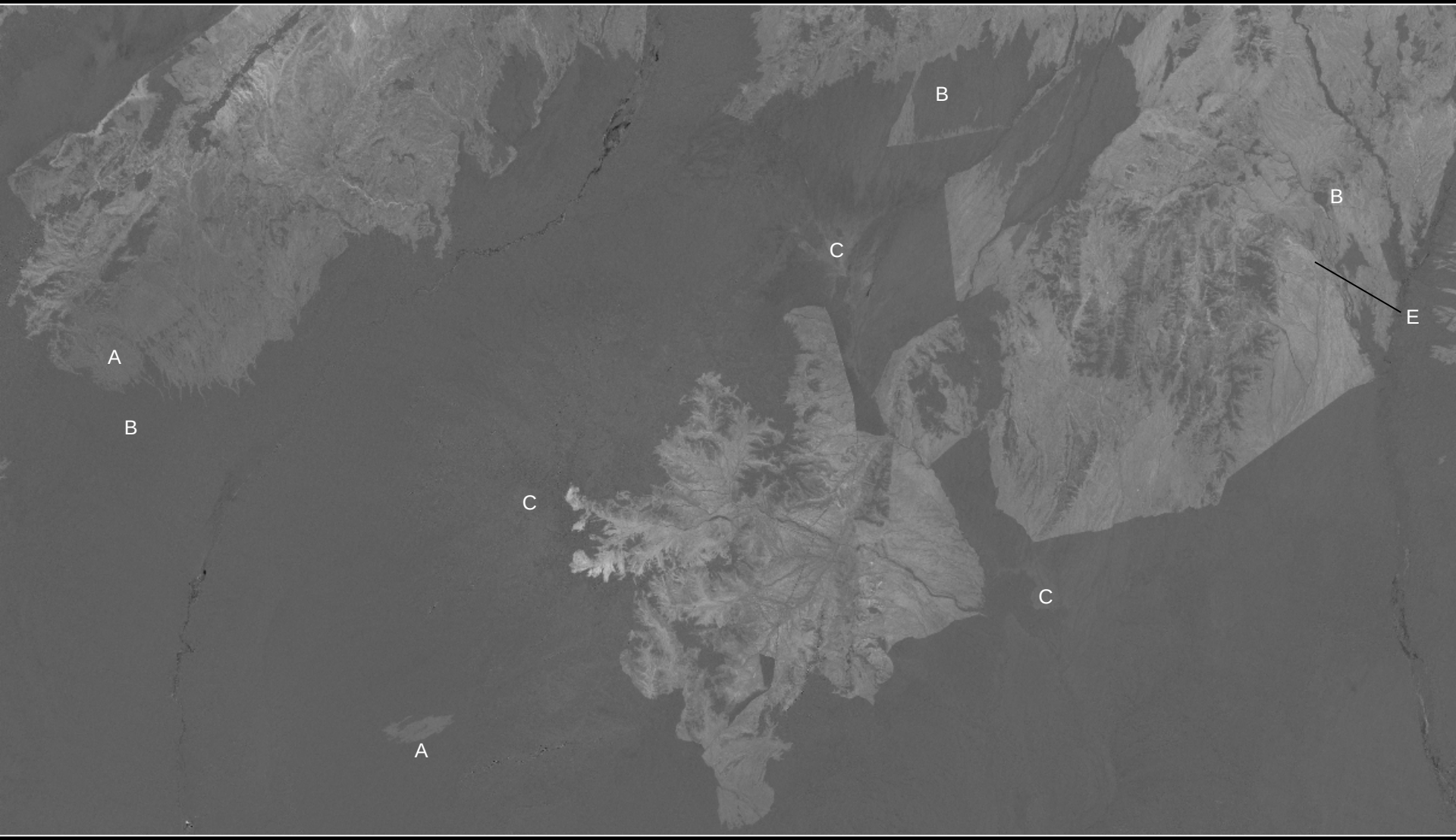


Look for the faintest areas of burn (A) that are distinct from nearby unburned. Find typical areas or islands of uniform unburned (B). The low threshold should include most of A, while B remains mostly unclassified (unburned). Low pixels are expected to show up in B, since value-ranges within categories overlap along the dNBR gradient. Find a happy medium between low pixels in B, and unburned pixels in A. The low threshold probably should be lowered if there are no low pixels in B. Minimize low in unburned (B), but also minimize unburned in low (A). Small unburned patches in the burn (B) should remain reasonably well defined after setting a low threshold. The MTBS "unburned to low" category is defined to include some burned area.

C – Note areas outside the burn that are lighter than other more typical unburned areas, where detected changes are not likely due to fire. Do not be too concerned about "burn pixels" showing up here in quantity or patches. Also, avoid these areas when sampling for the unchanged mean value (i.e. unburned bias). This dNBR is good; it has little variation in unburned.

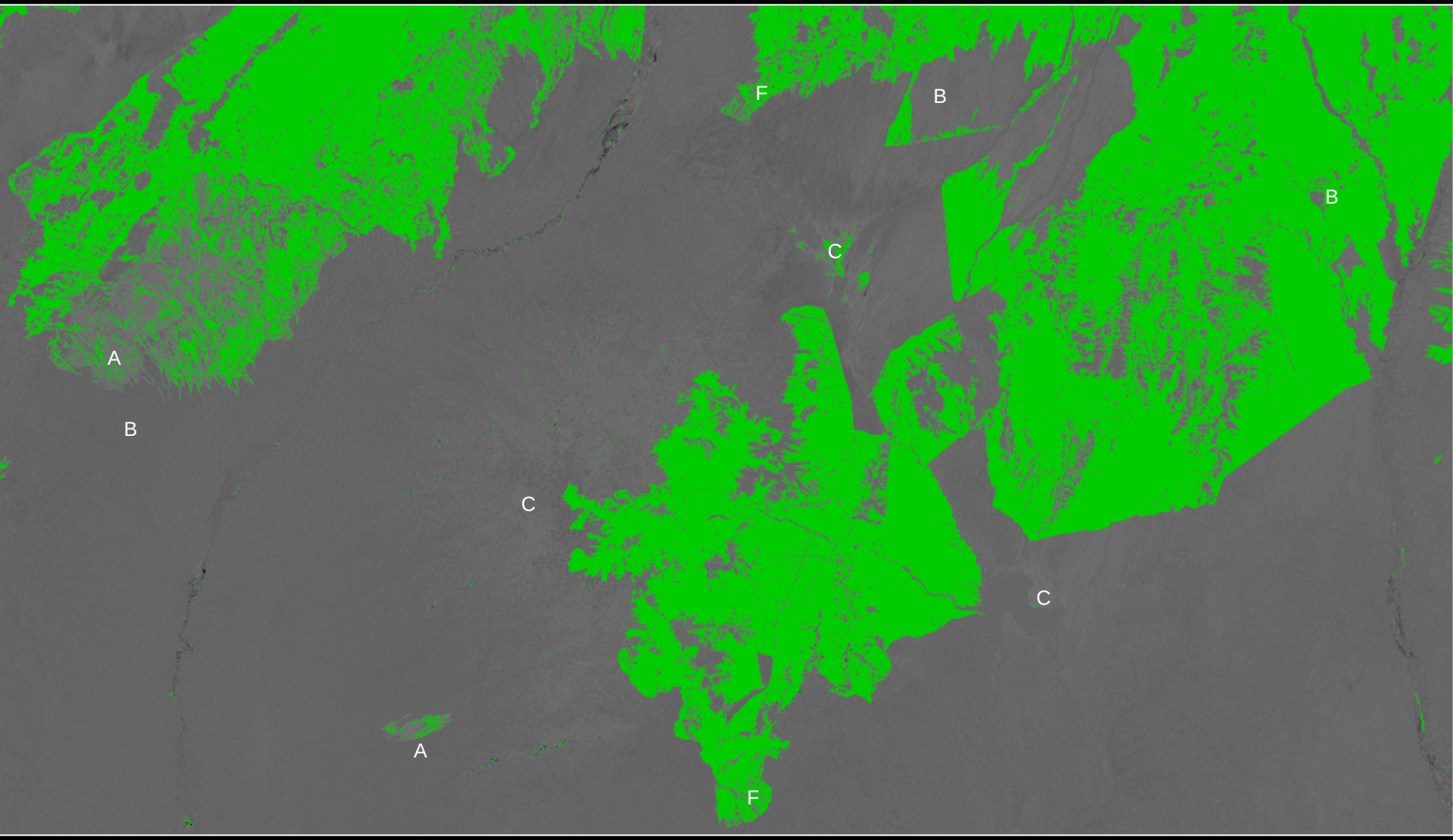
D – Note brighter areas in the burn are not well delimited and rather nebulous, spread over the highest ridges from which there is only gradual decrease into lower-change values. Thus, one should not expect very clear demarcation between moderate and high classes. One can try to find some smaller candidate training areas like (E) where slight distinctions appear.

Unburned and Low Threshold. dNBR grayscale breakpoints -600 to 1000



dNBR showing enlarged area of interest to refer back to for reference.

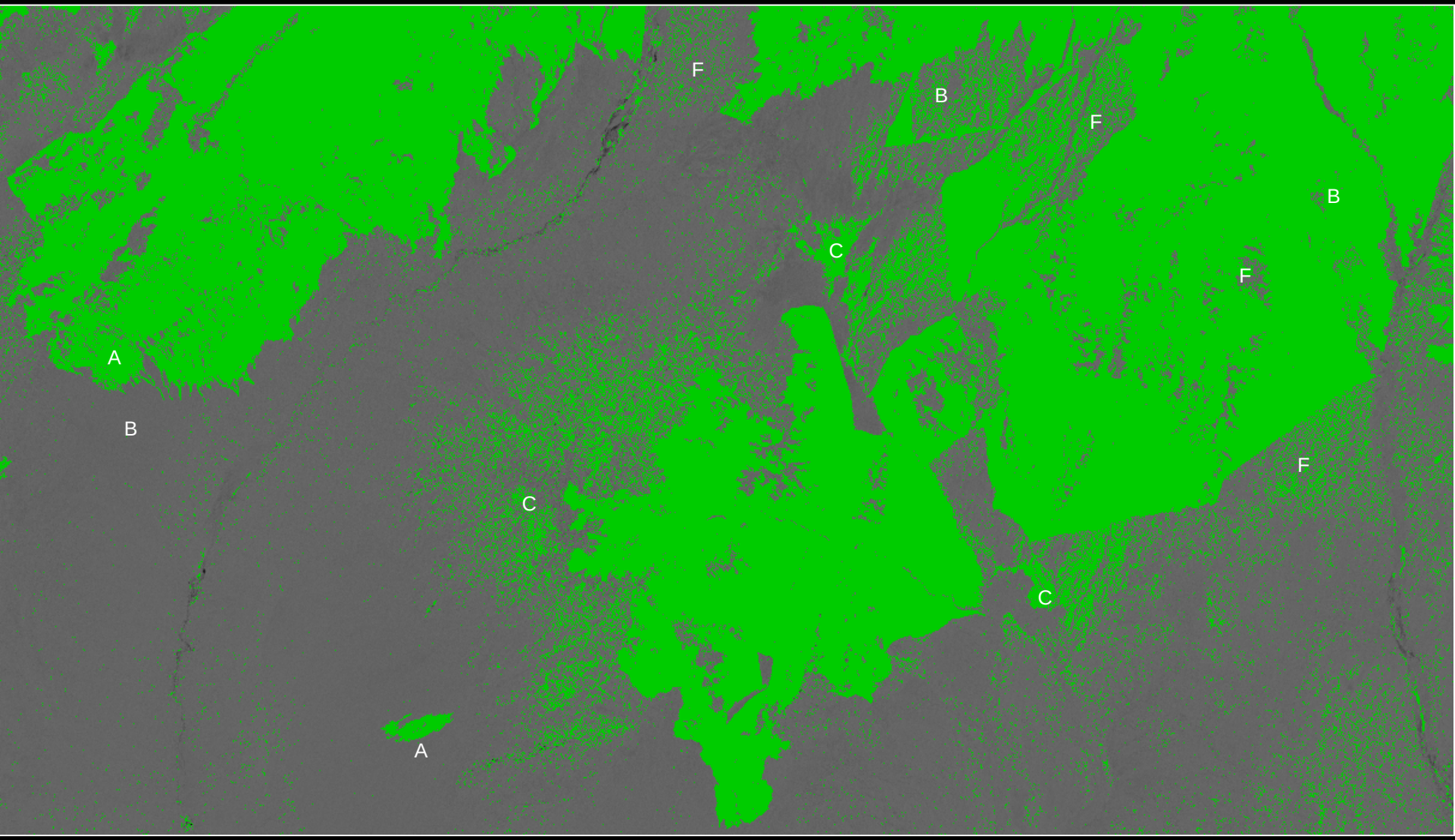
Unburned and Low Threshold. dNBR >= 100 set to 0.80 Green



It is useful to start with a threshold that you suspect to be too high (like >=150), and color decreasing values of dNBR to fill out the burn. At >=100 most of the burn is colored. We have a conservative estimate of burned area approaching a low threshold. Flicker with grayscale dNBR (previous slide) to gauge progress.

The low threshold should be lowered, however, because not enough green shows up around A, and essentially no green shows up around B. Look for other areas as well to support this interpretation (F) and pan other areas outside this view. Green pixels around C are expected and can be ignored; they are due to change in the unburned not related to fire.

Unburned and Low Threshold. dNBR >= 40 set to 0.80 Green

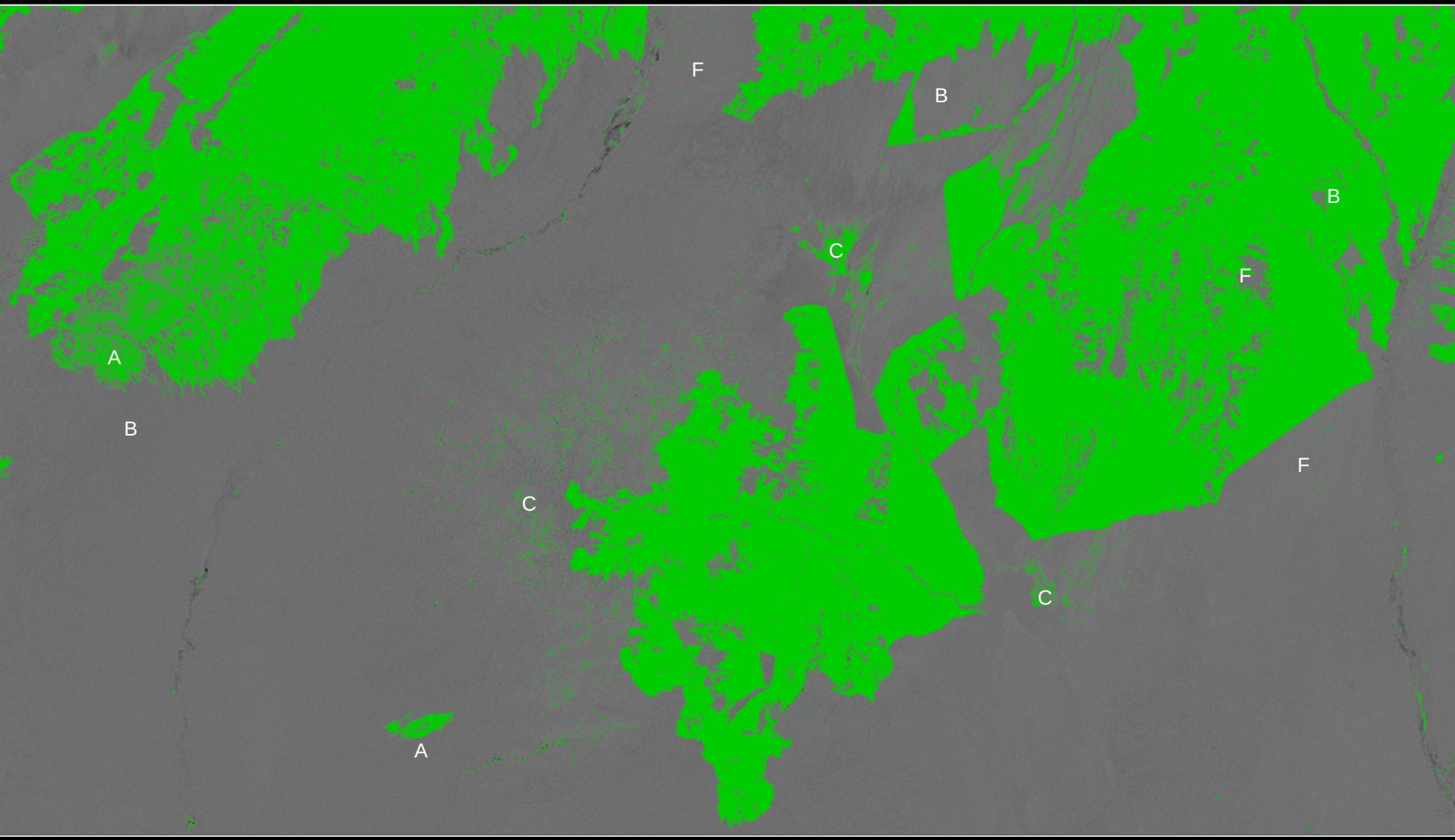


From that point, 100 in this case, take a sizeable jump down (50 to 60 points) to establish a side-bar value that certainly appears too low.

Now the low threshold should be raised. Green at A looks generally okay, but too much green now shows up around B and F. Pan other areas outside this view. Most green pixels around C are expected and can be ignored; they are due to change in the unburned not related to fire.

Where features like C are distinct patches, it may be questionable whether they burned. If other evidence is lacking, consider the shape, color and context, flickering between false-color Landsat images. Are characteristics at C consistent with nearby burned areas? In this case, I considered each C to be phenological or moisture difference. Other cases may be more dramatic, as with erosion or logging, but generally shape, color and context compared to the burn give pretty high confidence to decide if they burned or represent other causes of change.

Unburned and Low Threshold. dNBR >= 70 set to 0.80 Green

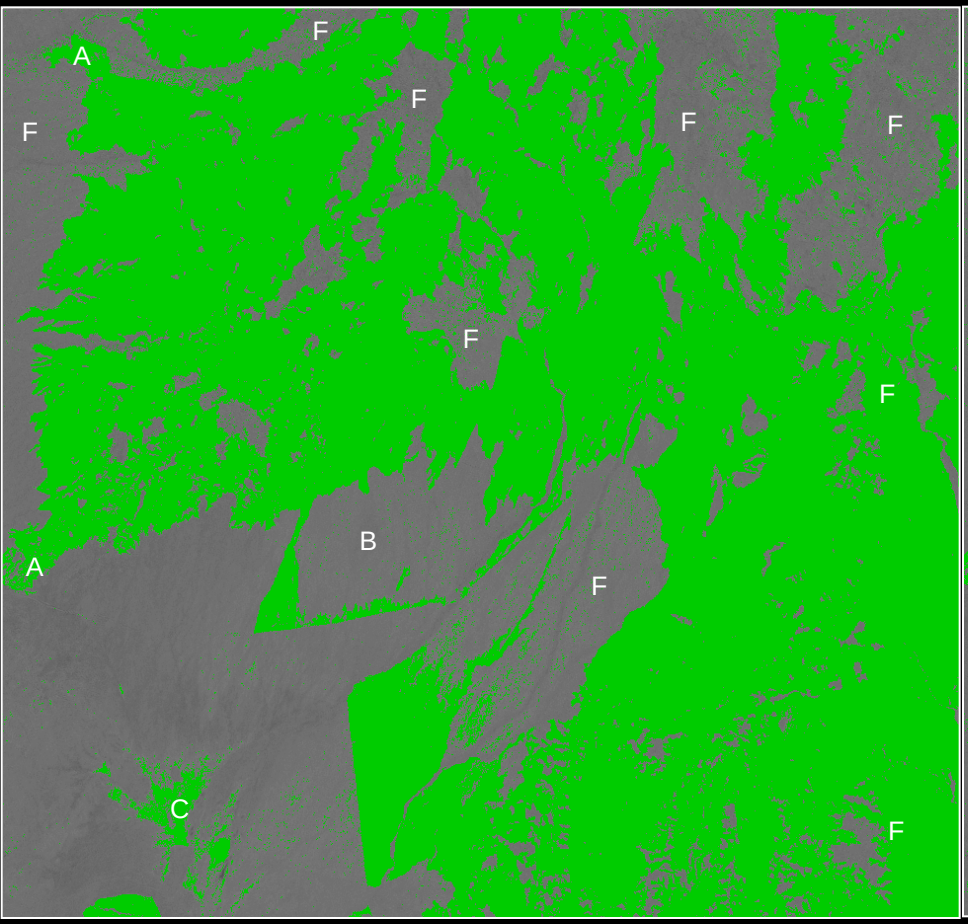


At this point, we have established that 40 is too low and 100 is too high, so we try the midpoint 70, which looks about right. Toggling back and forth with the grayscale dNBR, the vast majority of what we perceive as burned has been colored green, and most small unburned patches and linear features within the perimeter remain defined as not green. Still, very little green shows up around B and F, so we could try going a little lower. We surmise that an optimal threshold now would be between 40 and 70, but probably much closer to 70, since the image at 40 had excessive green in unburned areas.

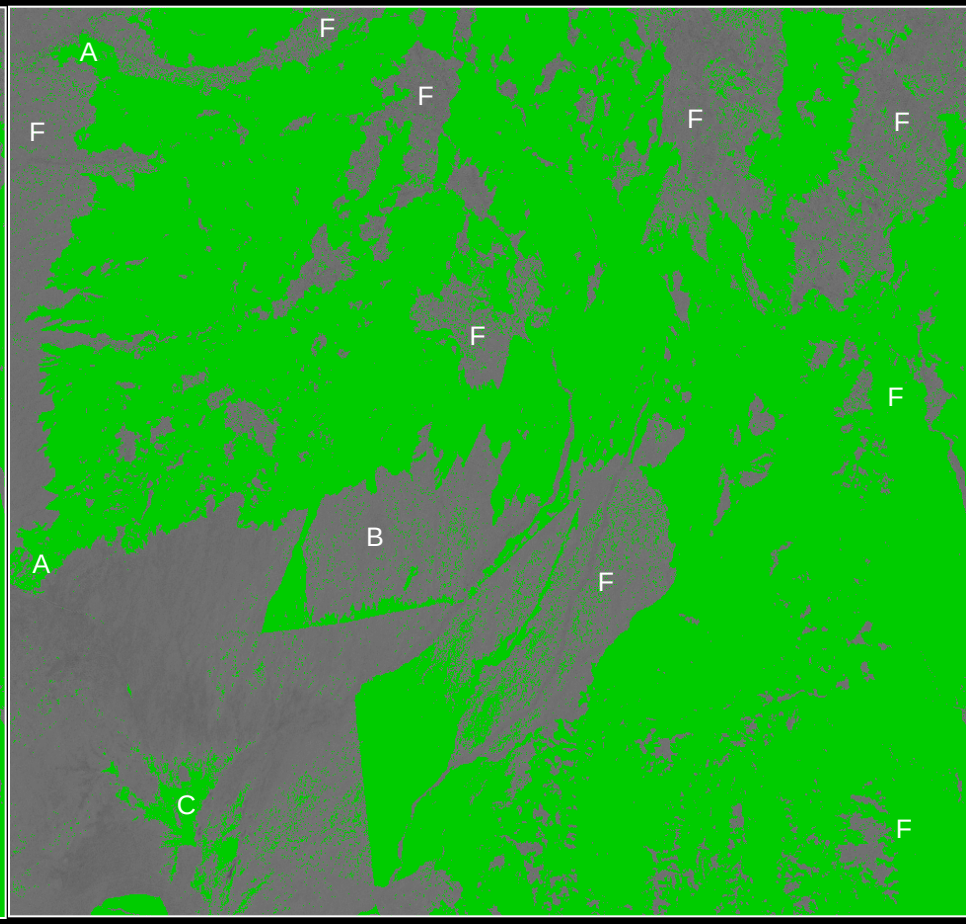
Unburned gray tones (values) in this dNBR are relatively uniform, so expect a small increment of decrease in dNBR to make a large change in the amount of green in the unburned, once the low threshold is crossed. By the same token, do not expect much overlap to occur with unburned in low. A sharper distinction is possible without markedly “contaminating” the unburned. This is generally not the case with less-well matched NBR’s. In those cases, expect to lower the low threshold to values where more green shows in the unburned area than in this example, due to more temporal variability in reflectance there.

This may be a good time to enlarge the slide to 150% to see more detail.

Unburned and Low Threshold. dNBR >= 70 set to 0.80 Green



Unburned and Low Threshold. dNBR >= 60 set to 0.80 Green

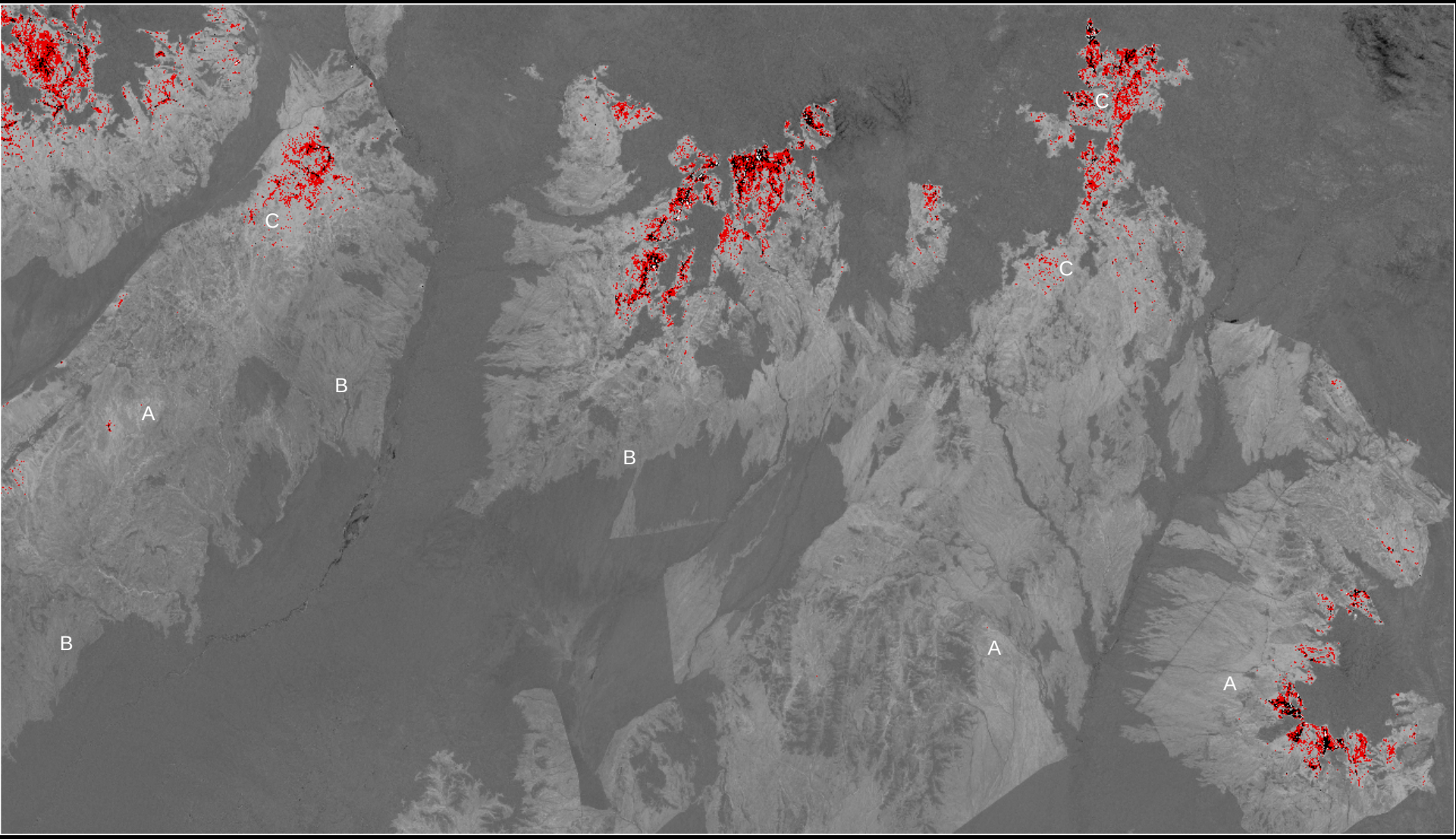


For final determination, view image at default scale, come down in dNBR just slightly (e.g. 10 points), and go back an forth to compare, in this case between 70 and 60. This view also includes some new area above previous views.

For reasons previously discussed, a drop of only 10 points starts to color up many more pixels in the unburned (B, F). In addition to the amount of green in unburned, it is the slight increment causing the difference that is indicative. One can be reasonably certain, from 60 on down mostly only pixels in unburned areas will be colored up, so there is no point going any lower. In fact, that is essentially what we see going down from 70. (One can color the range 60-70 with a unique color, like black, to confirm this.)

At 60, are too many unburned pixels classified as low? Consider only areas apparently unchanged by other causes (not C) by toggling with the grayscale dNBR. Similarly, are we starting to wrongly-classify too much of the within-perimeter unburned? Note at 60, how many new randomly scattered pixels occur within unburned patches. The random scattering of pixels is also indicative. It shows indistinct spatial variation within a narrow range of dNBR, as might be expected over unburned areas. It may also suggests being within the more-frequent dNBR range of a class rather than near the tails of a class's frequency distribution. Based on these considerations, I would choose 70 over 60 as the low threshold. You could always split the difference again, but it usually is not necessary.

High Threshold. dNBR >= 500 set to 0.90 Red, dNBR >= 600 Black , dNBR >= 700 White

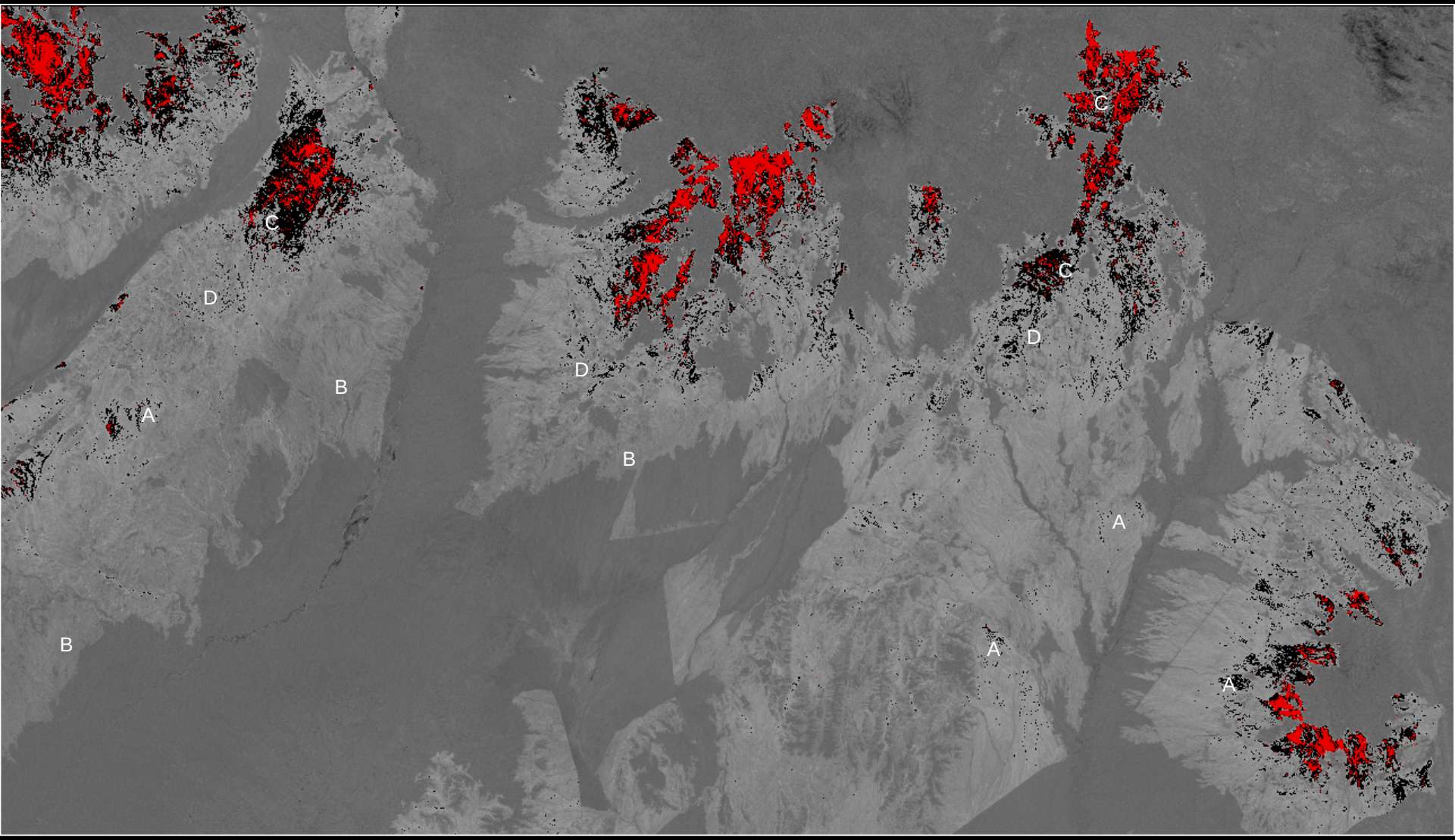


Referring back to slides 1, 3 and 4, we know it is going to be difficult to set a high threshold. We see very little patchiness or pattern, mostly just subtle gradations of lighter grays, beyond the burn-unburned distinction. High values occur in limited areas on ridge tops, but not in well-defined patches, and brightest values are comparatively low dNBR (black and white >= 600).

I reset the color table of the pseudo color image in order to see detail, which would be totally obscured if working with the previous green class. Starting high, dNBR >= 700 showed a handful of pixels; dropping down 100 points picked up only a few more; dropping another 100 began to fill out some epicenters of high red. We will try to grow those out, but where should we stop; where do we go from here? There are some relatively lighter zones remaining, e.g. around A. There are no distinct edges, but hopefully we can include some such brighter targets representing desert vegetation, while not amorphously scattering red pixels all over. Areas around B provide the lowest end of the spectrum for contrast.

dNBR 500 could be a plausible high threshold, but the relative amount of scattered pixels (e.g. near C) would suggest going lower even in other ecosystems.

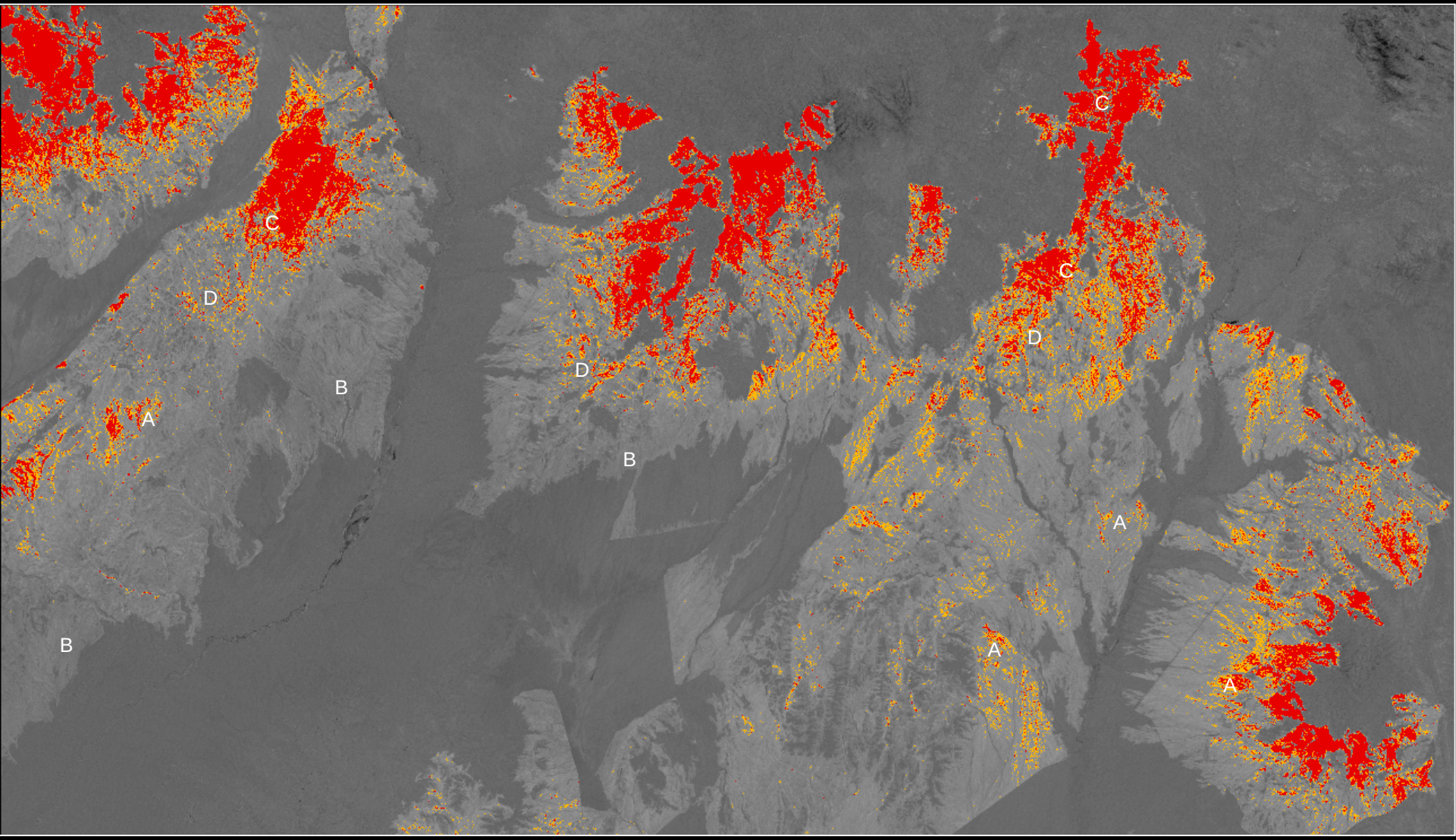
High Threshold. dNBR >= 350 Black , dNBR >= 500 set to 0.90 Red



Dropping from 500 to 400 (not shown) revealed that nearly all new pixels were tightly associated with the previous red patches, expanding outward a little and filling interior spots. However, 400-500 dNBR pixels were not large in number and some red patches remained small or fragmented. Dropping another 50 to 350 (black) more fully filled in the previous red areas, and also began to identify a fair number of pixels in new areas, e.g. near A and D. If selecting a more conventional high threshold, it probably would be around 400, because relatively few of those pixels were scattered around and disassociated from larger patches, i.e. the epicenters established by values >= 500. (This may be an optional class for trans-ecotype burns to distinguish high within the non-desert types present.)

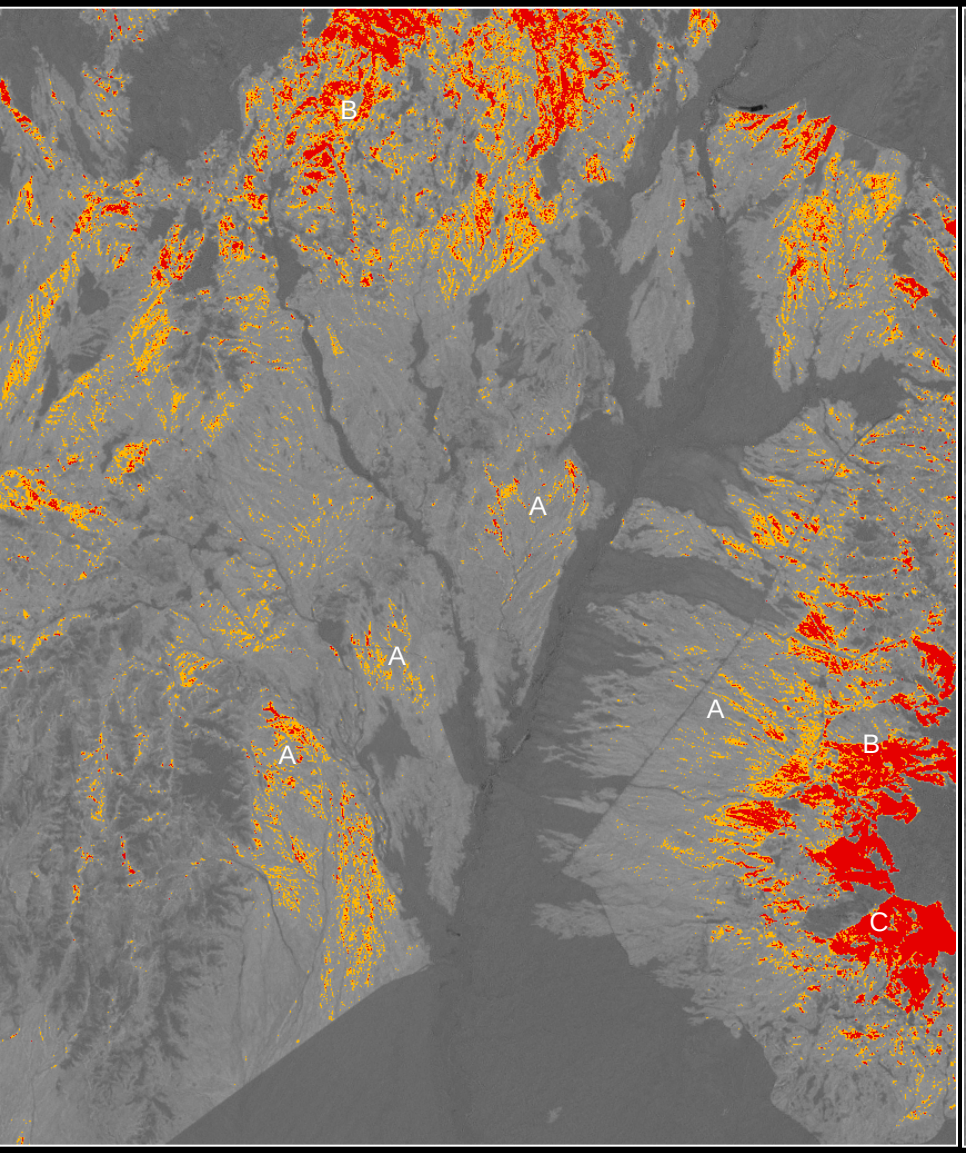
However for the SNC, we intentionally drive the high class downward in dNBR to ramp up the severity of ecological effects on desert vegetation. In essence we attempt to bring some of the high severity designation into the lower elevation desert region, down from the ridge tops of more dense vegetation. At 350 some new epicenters have formed along with scattered isolated pixels away from the ridge tops , e.g. near A and D.

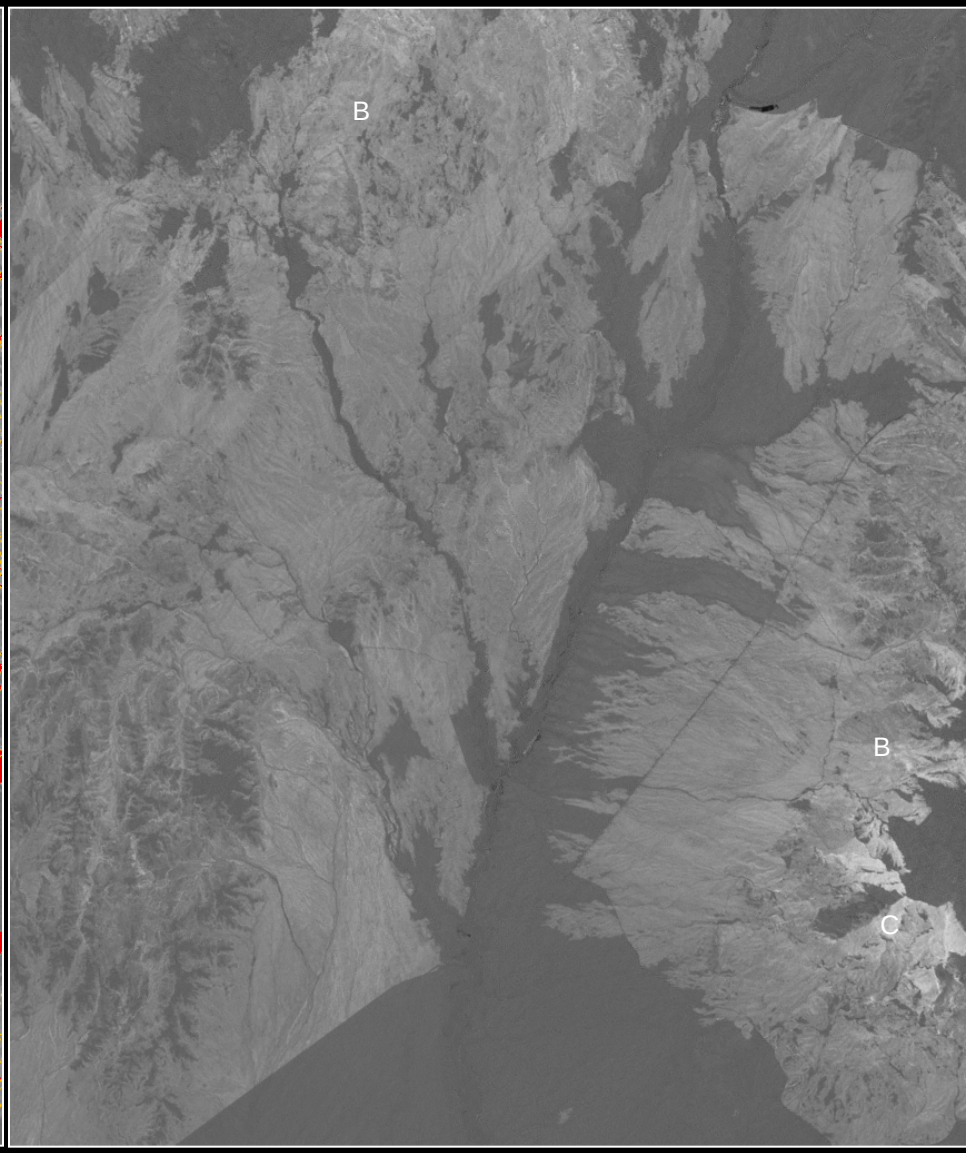
High Threshold. dNBR >= 300 Orange, dNBR >= 350 set to 0.90 Red



One more drop of 50 points to 300 filled out many small patches around formerly isolated pixels or few-pixel clusters, e.g. near A and D.

High Threshold. dNBR >= 300 Orange, dNBR >= 350 set to 0.90 Red

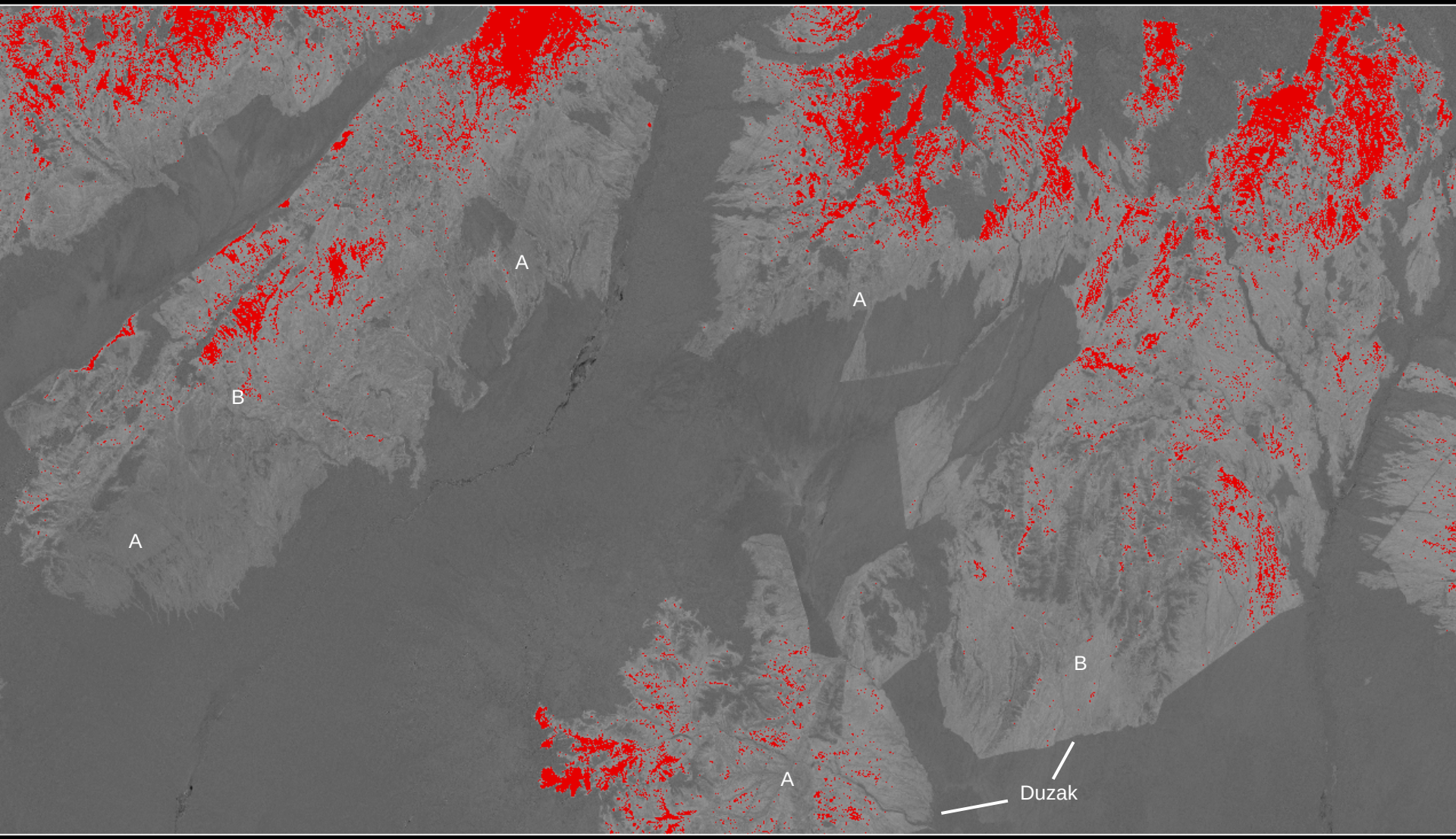




For final determination, view image at default scale and compare with the dNBR (flicker between viewers). At 300, orange and red areas do appear to be related to subtle patterns of lighter dNBR (A), and more or less delineate the pattern around pixels that were isolated at >= 350. In addition, some interior “holes” in red patches have been filled (B). By bringing the threshold down to 300, however, we loose distinction of the fairly bright dNBR areas (C), which have quite higher dNBR than the lower end of the orange (e.g. around A), and would be better defined by a threshold around 400. Thus, >= 300 is a compromise that arises from using a 5-level classification, and the burn encompassing proportionately little area represented by C.

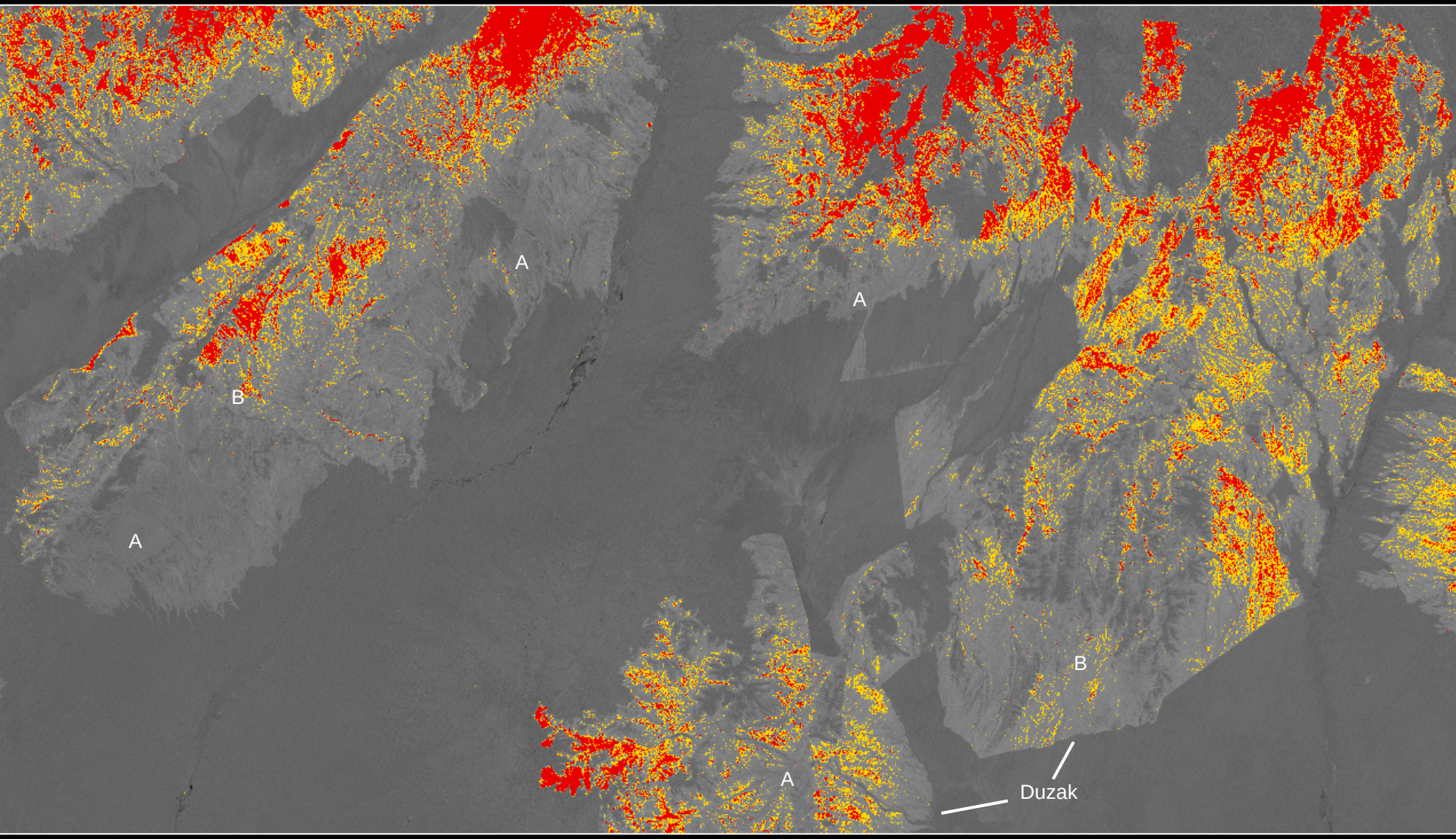
Try thresholds within a range of 300 + or - 20. It wasn’t real clear cut, but going lower than 300 lead increasingly to scattered pixels showing up in new areas, diminishing the pattern features, and leading to a tendency to go even lower in order to achieve some kind of pattern that was not visually evident in dNBR. At >= 300, some area of the desert is segregated out as a higher degree of change (this was one objective), larger patches are essentially filled, and there does not appear much distinguishable pattern or range of values below that level.

High Threshold. dNBR >= 300 set to 0.90 Red



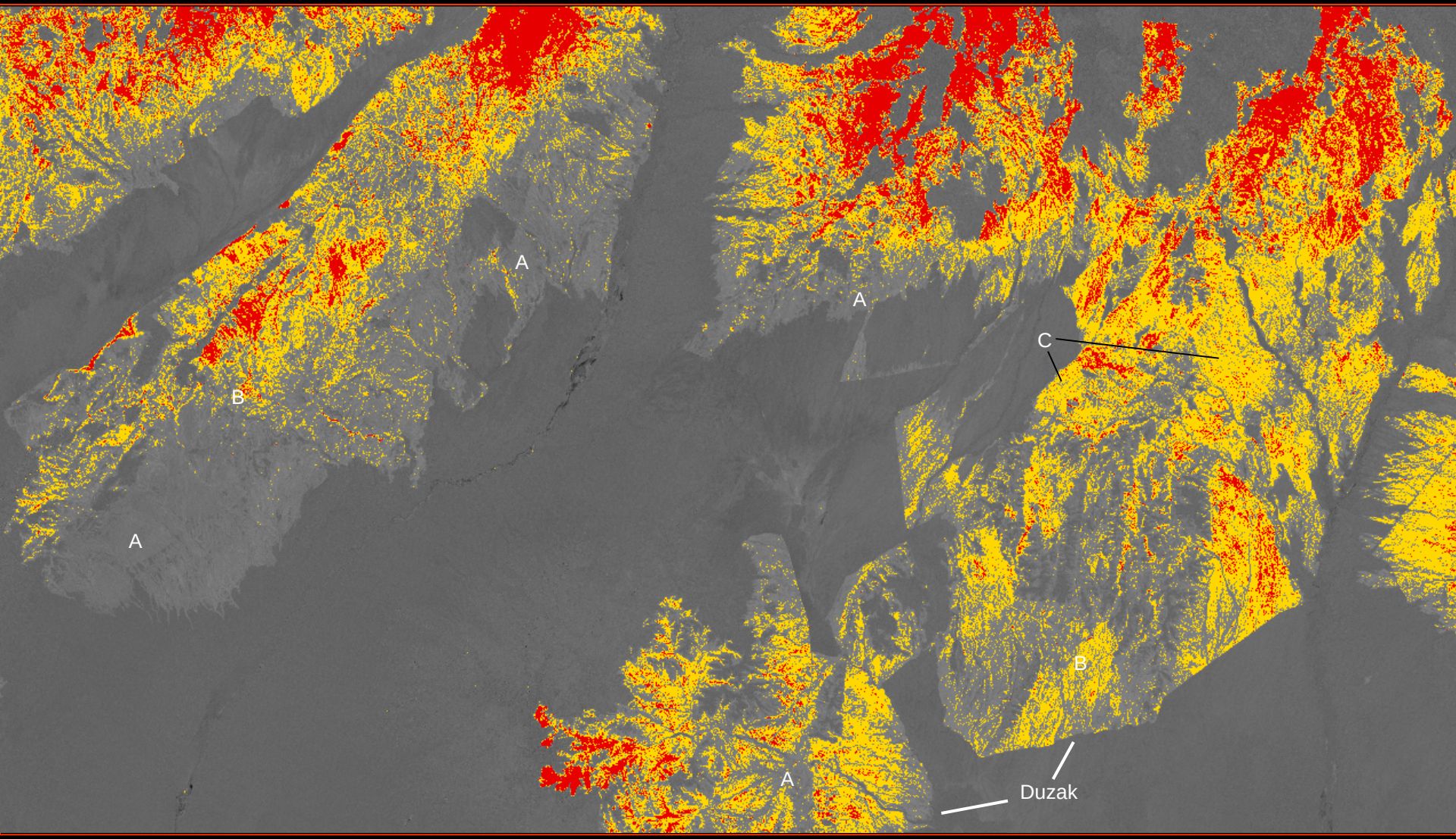
The moderate threshold defines the pattern of the low class just as much as any pattern that might exist within the moderate range of values. With the high class colored, we see some distinction in remaining gray tones of dNBR (albeit subtle ones). Areas around A seem characteristically darker than the lighter tones (B), which separate A from the high class. So, we want to preserve this distinction in the low and moderate classes. We see less of this as large contiguous areas on the Duzak, but consider the finer generally linear patterns. For many ecological and fire-behavior reasons, pattern in the low class may be relatively discrete and occur in patches much like the high class. It is also natural to have the low class surrounding unburned patches, like a buffer between unburned and moderate.

Moderate Threshold. dNBR >= 250 Gold, dNBR >= 300 set to 0.90 Red



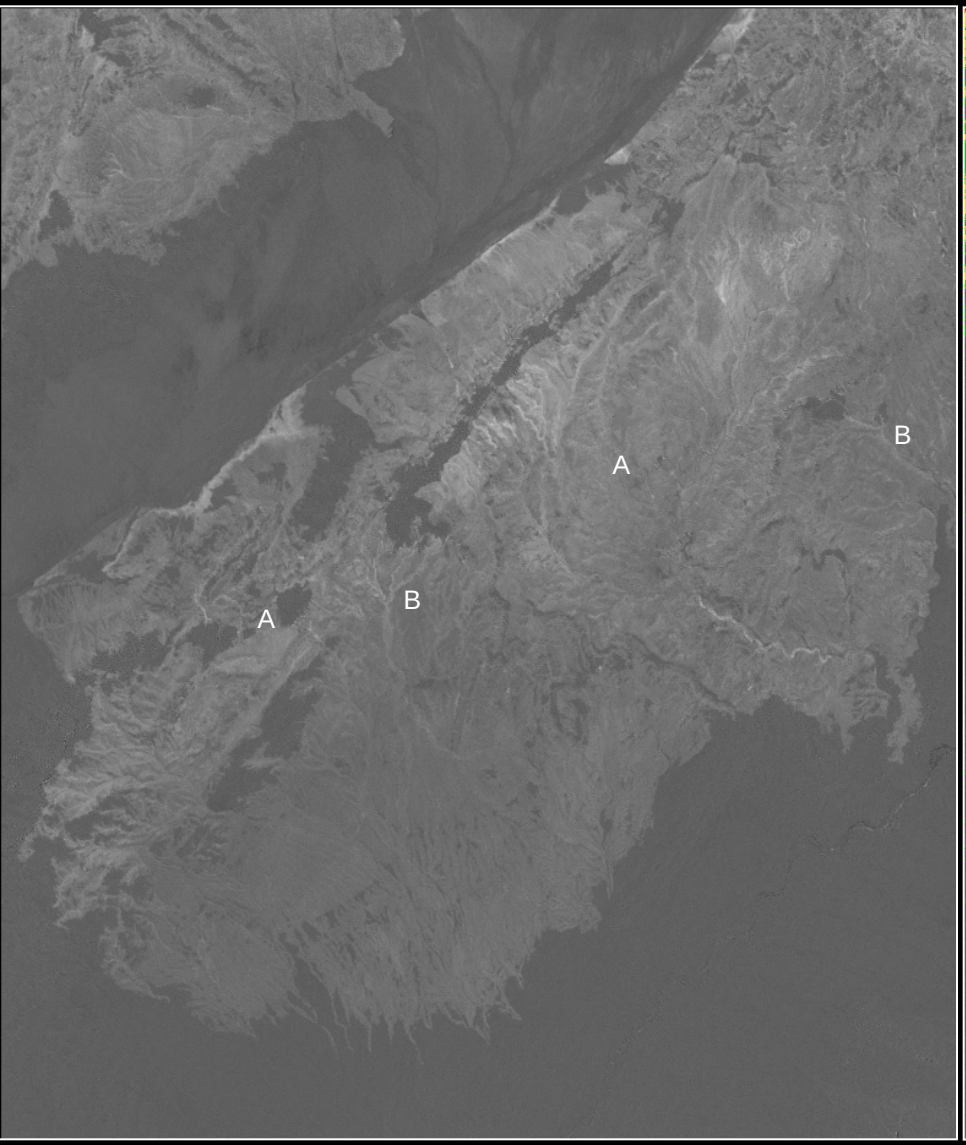
Dropping 50 points to 250, we still see lighter gray patterns (B) surrounding the darker grays (A). Most new gold pixels are tightly bound around the high patches. Further differentiation is warranted, and more area of moderate seems needed by lowering the threshold further.

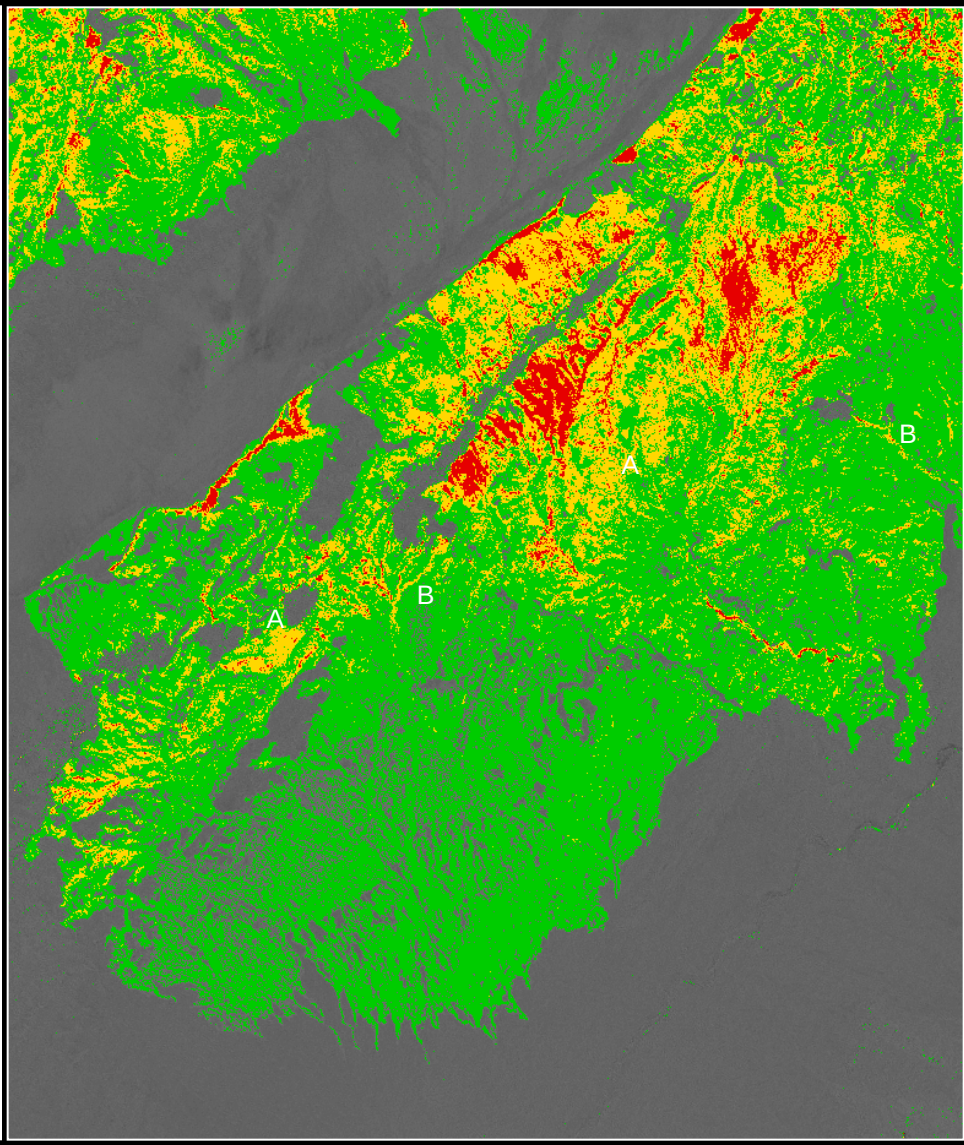
Moderate Threshold. dNBR >= 200 Gold, dNBR >= 300 set to 0.90 Red



Dropping another 50 points to 200, larger contiguous areas of gold appear, and the class is more widely distributed away from red patches, which is good. However, some new areas are rather speckled with gold pixels, other yellow patches are fairly speckled with gray pixels (C), and the darker gray area (A) looks as though it could be better delineated. Go back and forth between slides to see the affect.

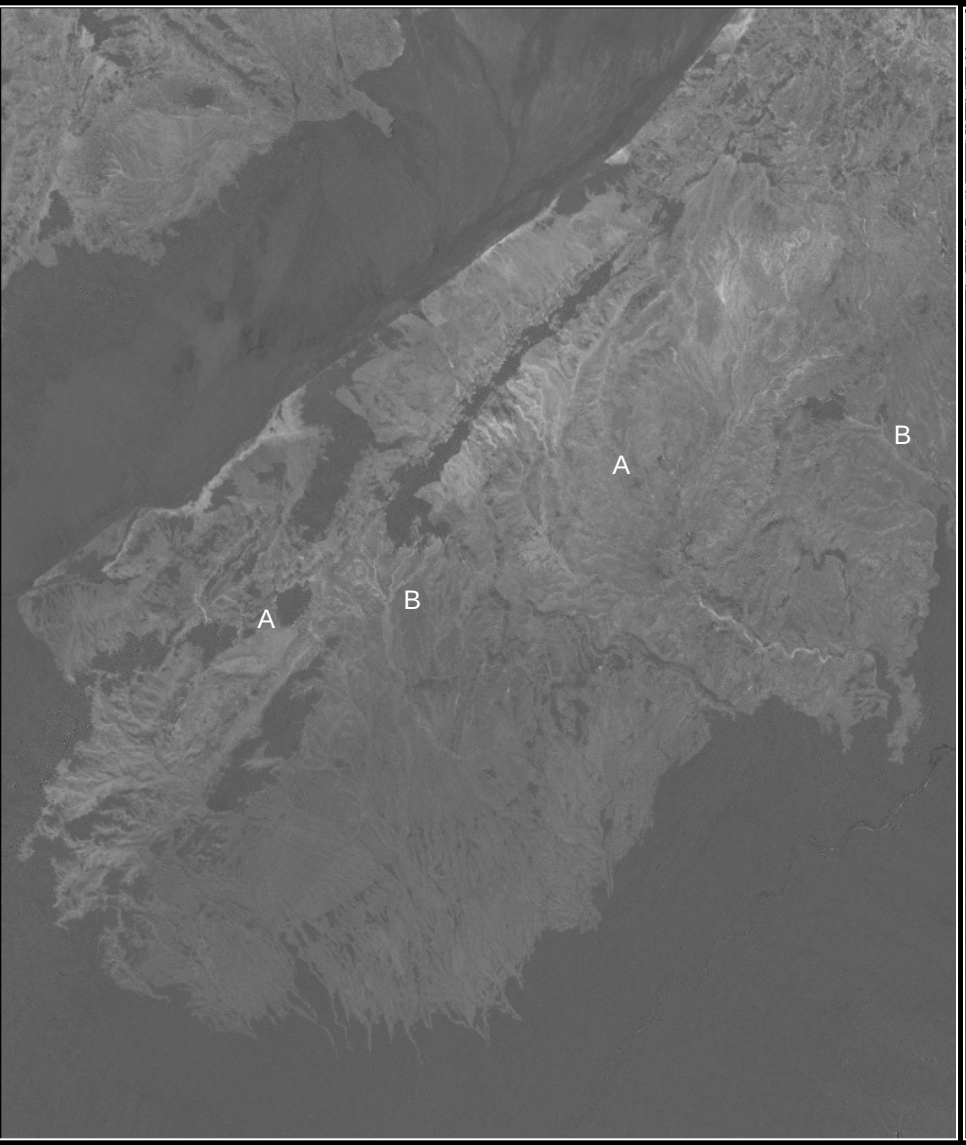
Moderate Threshold. dNBR >= 70 set to 0.80 Green, dNBR >= 200 Gold, dNBR >= 300 set to 0.90 Red

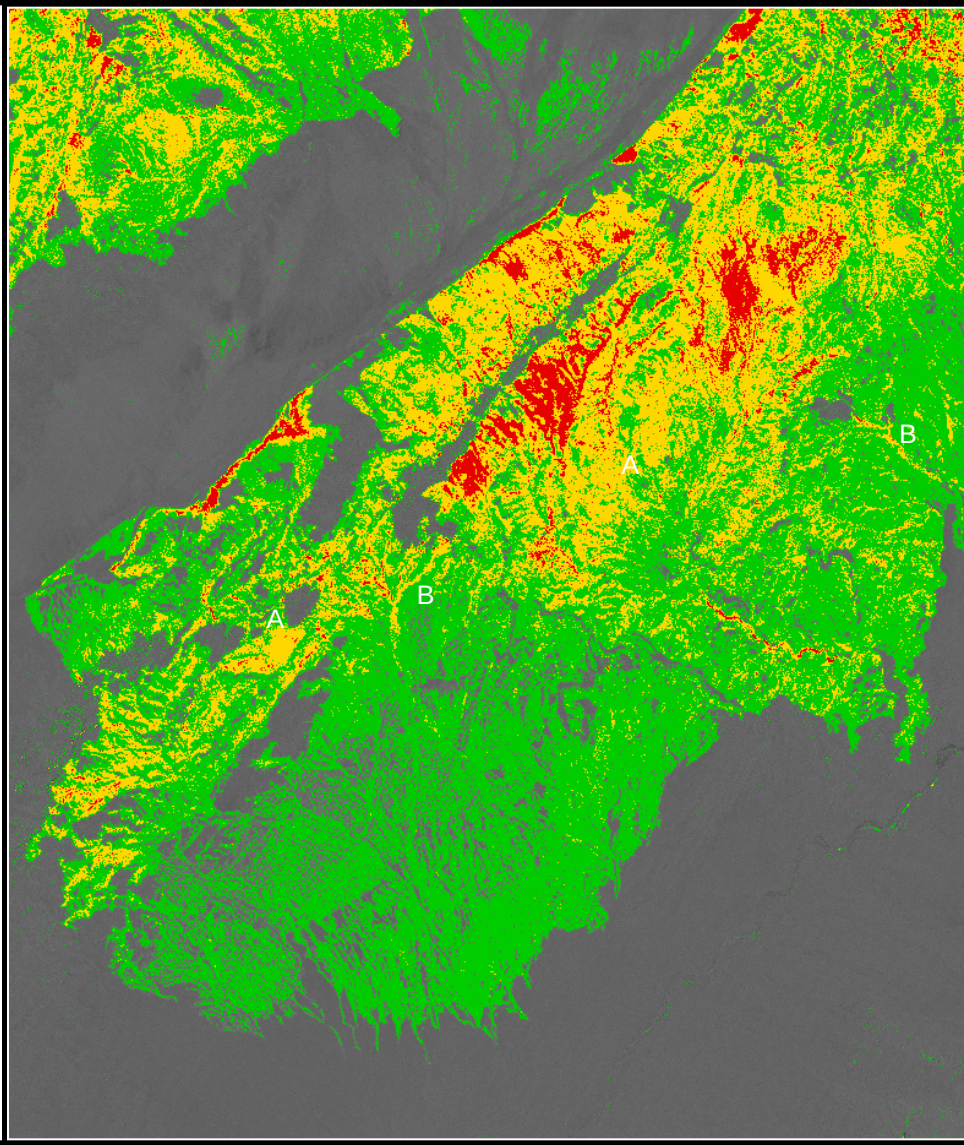




Getting near the moderate threshold it can be helpful to classify (color) the remaining low class. Enlarged to default zoom, the 200 threshold looks pretty good, but seems to miss some of the lighter gray pattern, like around B. In addition there is noteworthy speckling in some of the yellow patches (A). The terrain is complex in that area, however, so some small spots of low within moderate are expected. Overall however, it seems the moderate threshold can be lowered somewhat without excessively coloring new areas gold. One should look at other areas of the burn to confirm. Go back and forth between slides to see the affect.

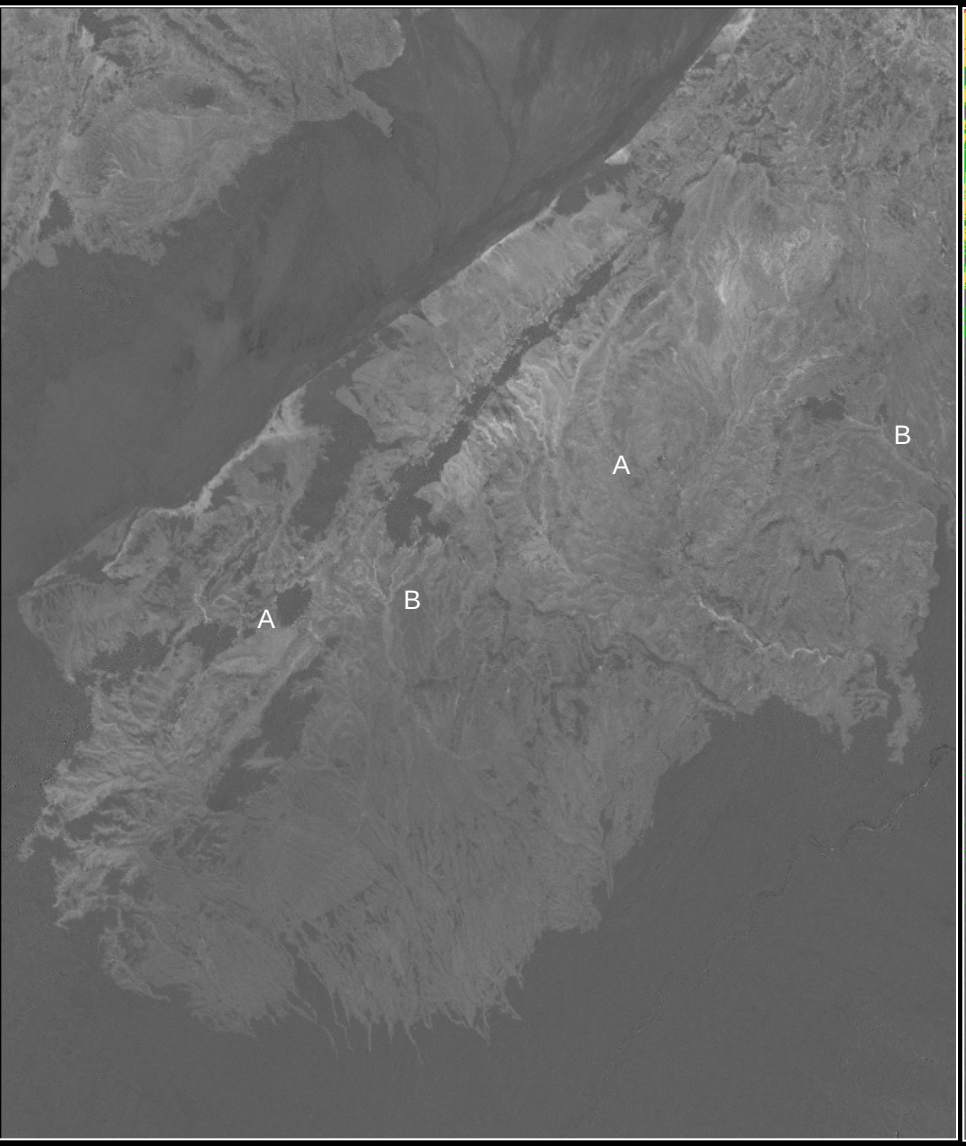
Moderate Threshold. dNBR >= 70 set to 0.80 Green, dNBR >= 180 Gold, dNBR >= 300 set to 0.90 Red

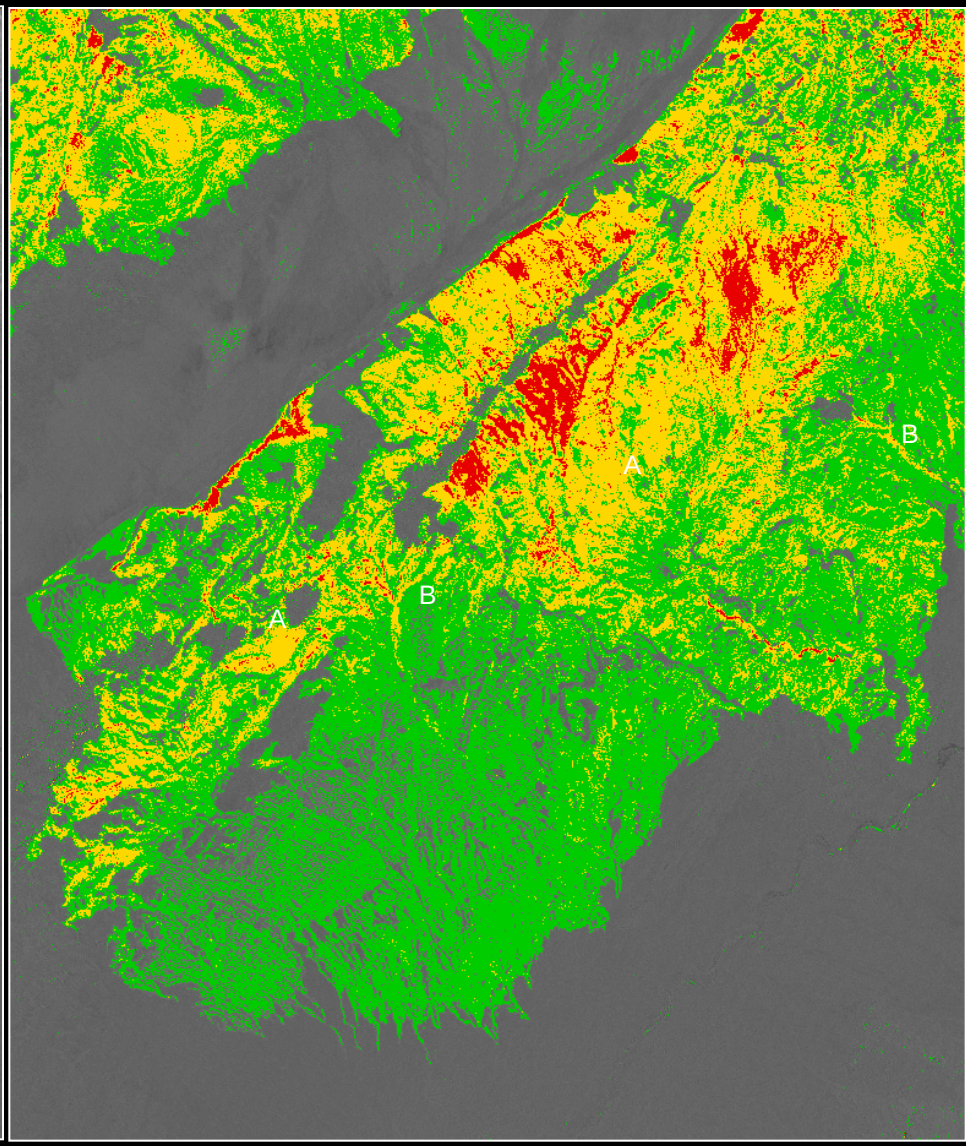




At a 180 threshold, there is a little better definition in the lighter gray pattern, like around B, and patches like around A become more uniform yellow.

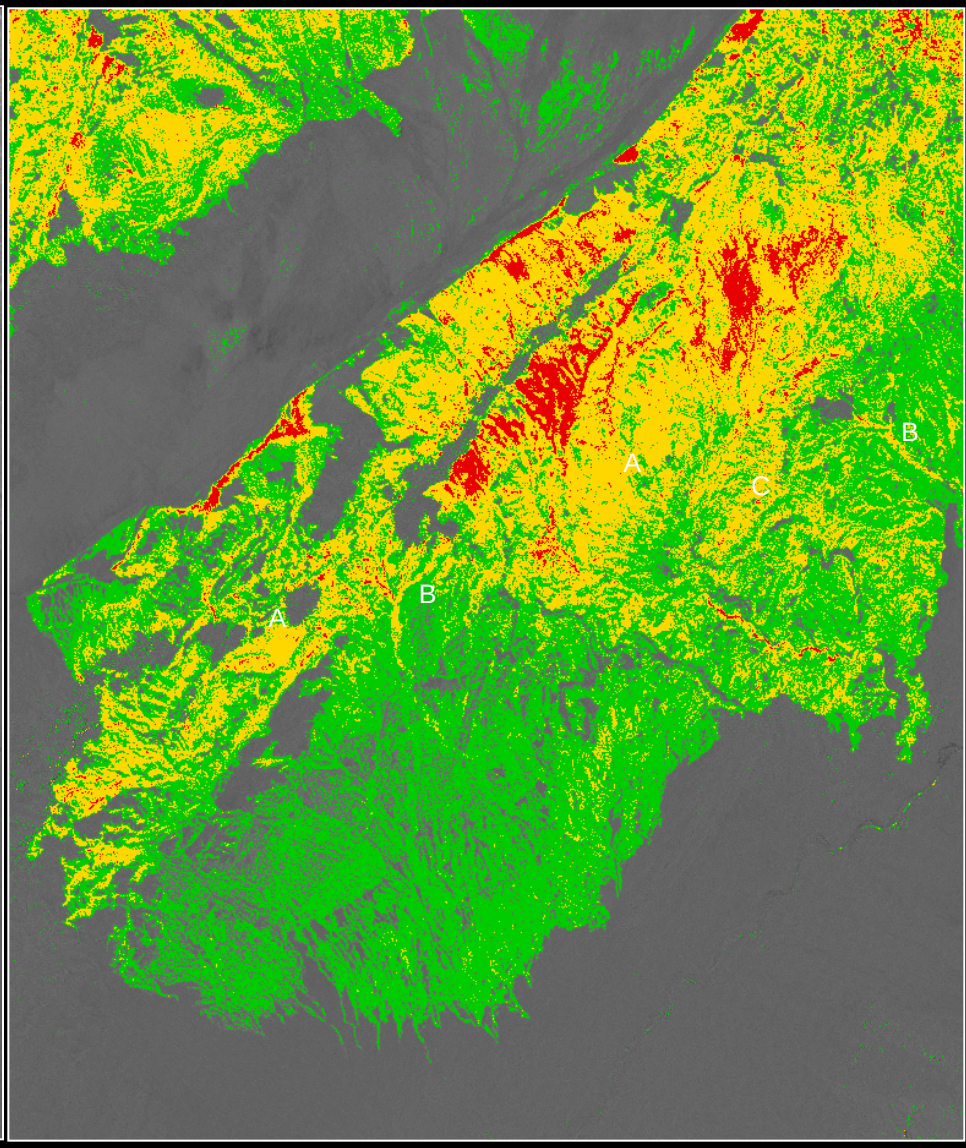
Moderate Threshold. dNBR >= 70 set to 0.80 Green, dNBR >= 170 Gold, dNBR >= 300 set to 0.90 Red





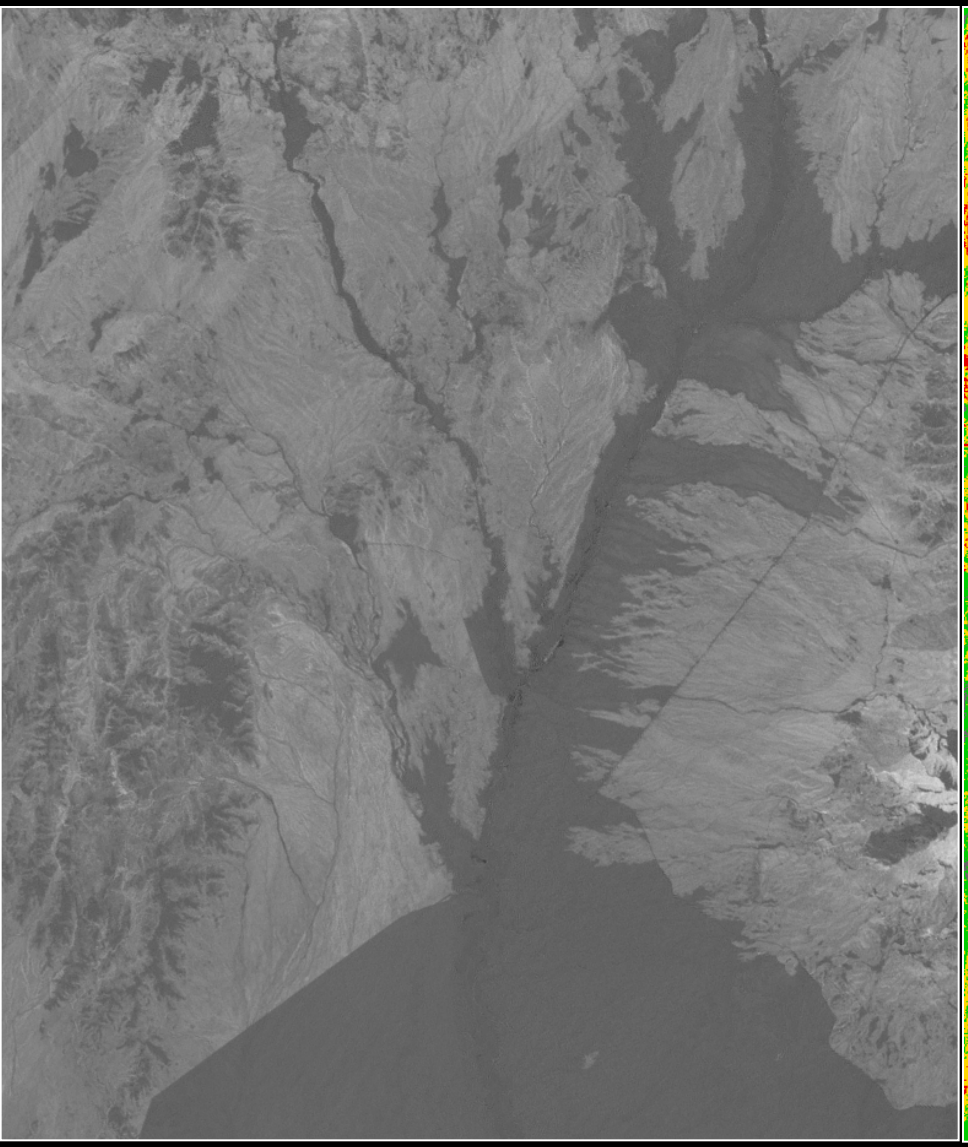
At a 170 threshold, some of the lighter dNBR pattern seems to fill out, e.g. B, and a little more uniformity within yellow patches like A.

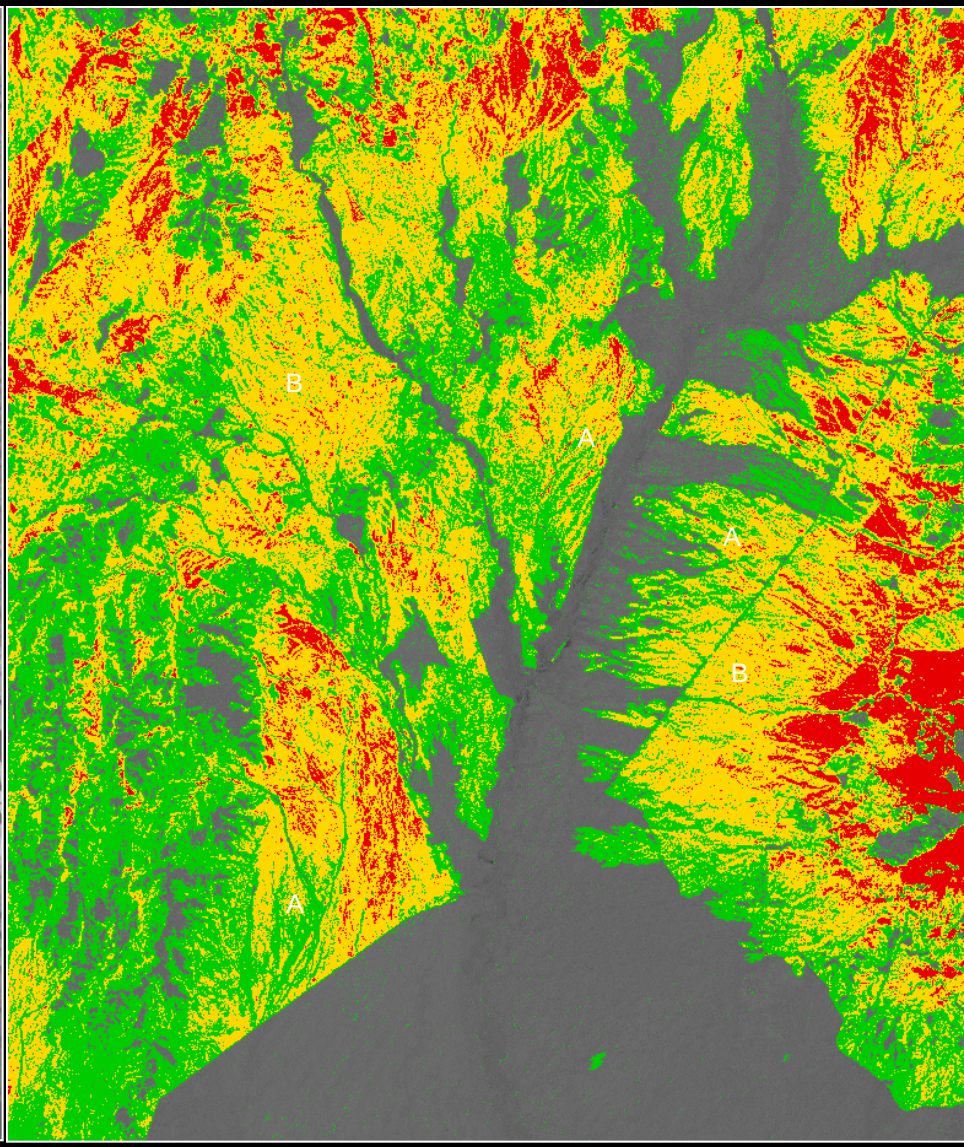
Moderate Threshold. dNBR >= 70 set to 0.80 Green, dNBR >= 160 Gold, dNBR >= 300 set to 0.90 Red



At 160 threshold, the previous trends continue, but now there begins to be a breakdown in the green pattern, e.g. some areas around A and C (smaller more fragmented spots). There is no clear breakpoint between 200 and 160, however, as changes in the classification occur gradually by similar increments of pixels. If you move this slide up below slide 16 (200 threshold) and flicker between the two, my impression is that 200 is too high and 160 is probably getting too low for a moderate threshold. Both 170 and 180 seem reasonable. One needs examine other areas in default zoom to confirm. Go back and forth between slides to see the affect.

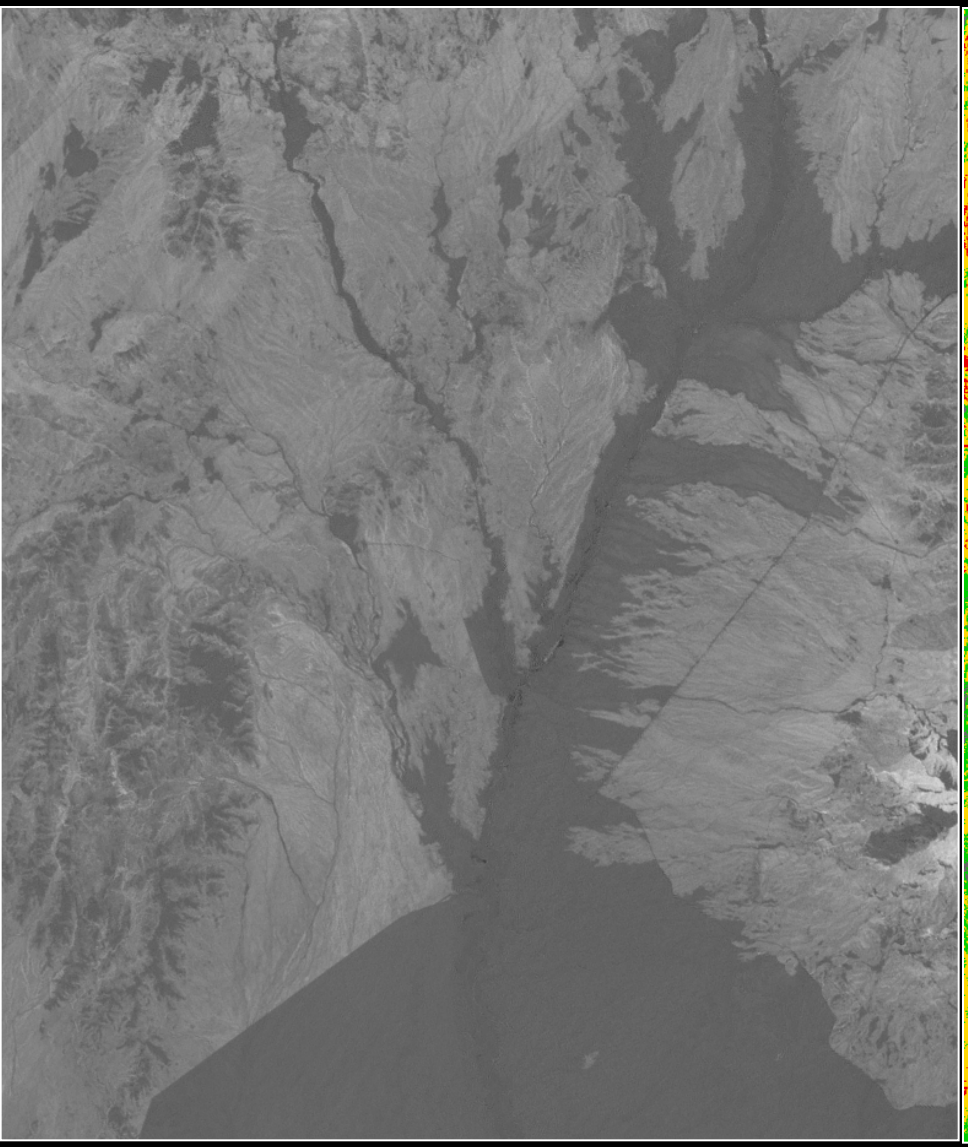
Moderate Threshold. dNBR >= 70 set to 0.80 Green, dNBR >= 200 Gold, dNBR >= 300 set to 0.90 Red

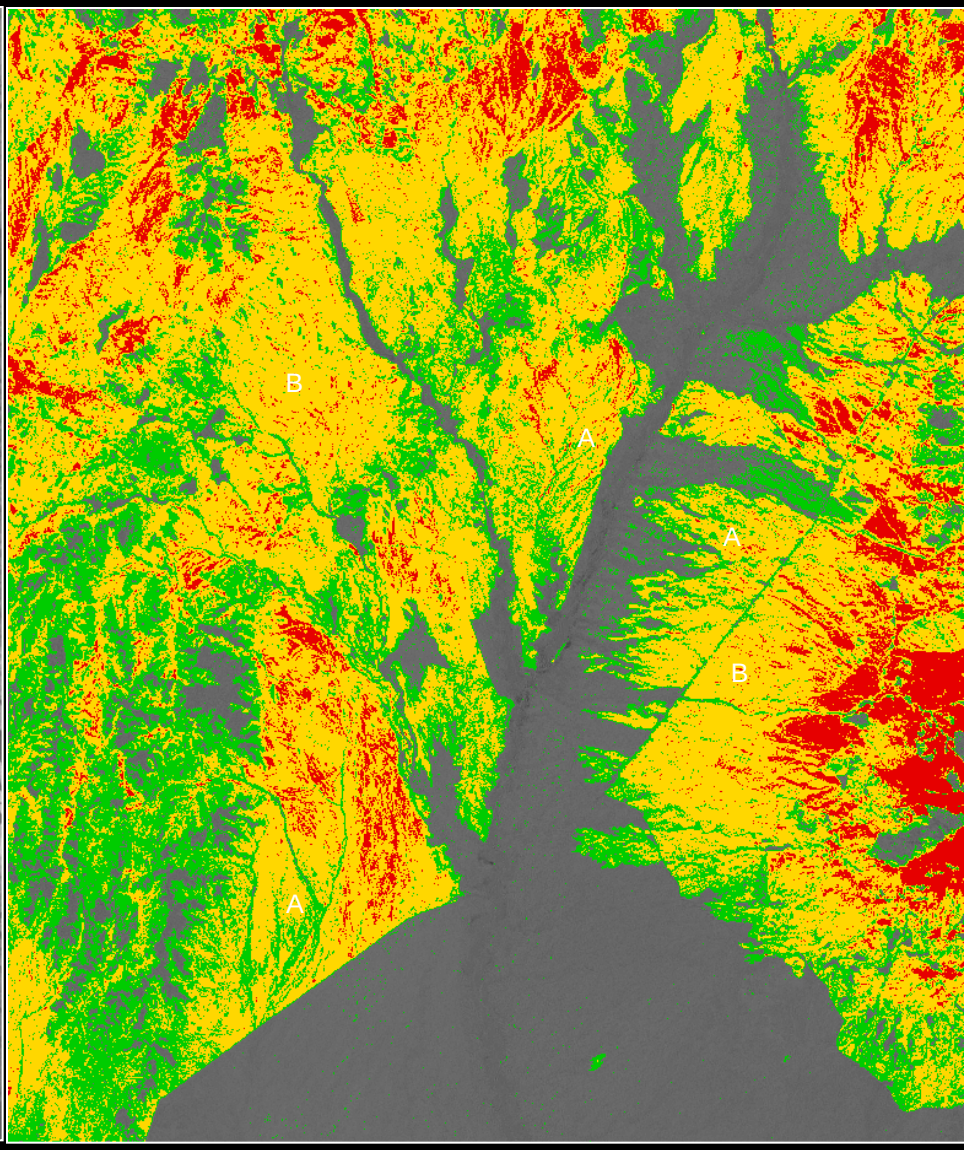




Another area enlarged to default zoom, the 200 threshold. Consider a balance between the uniformity of patches (B), and maintaining the definition of pattern or features (A) in the dNBR. Go back and forth between slides to see the affect.

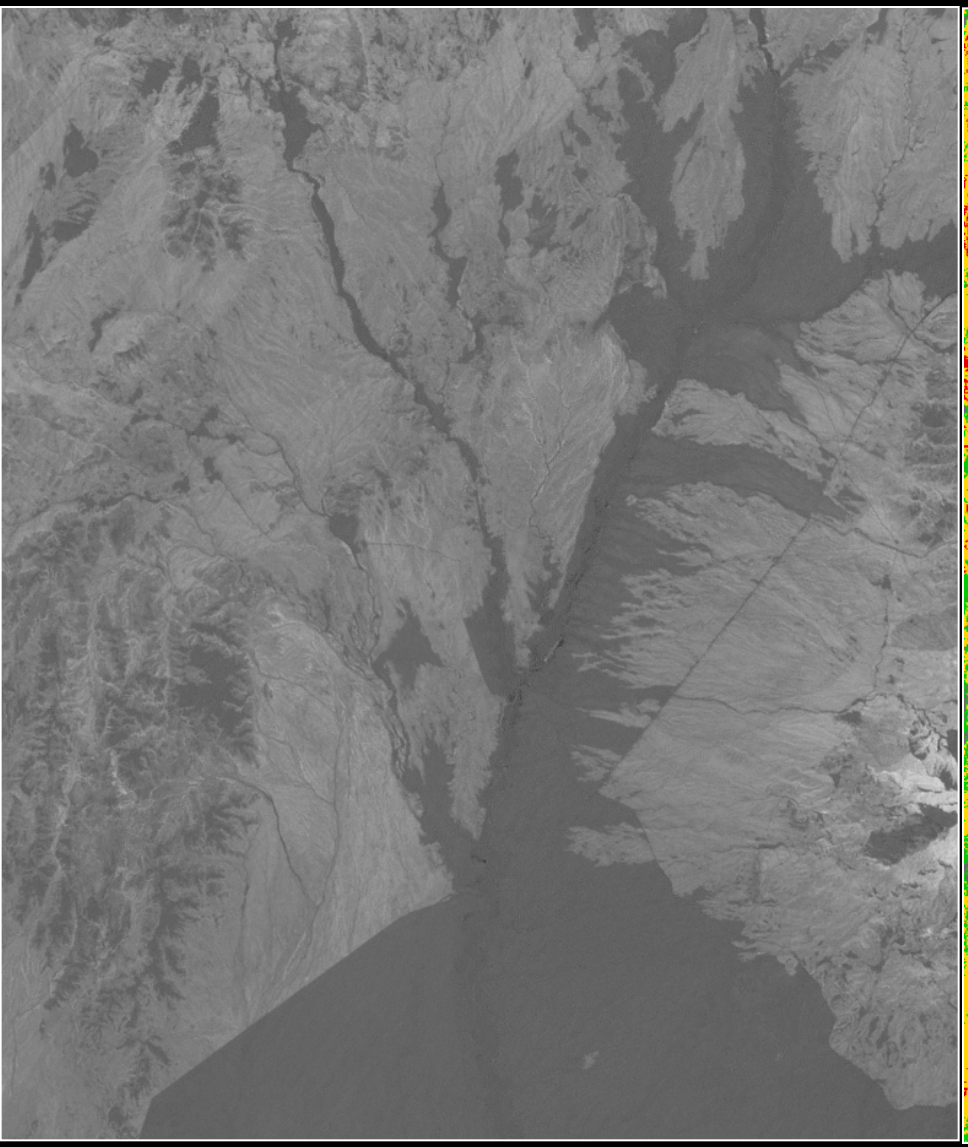
Moderate Threshold. dNBR >= 70 set to 0.80 Green, dNBR >= 180 Gold, dNBR >= 300 set to 0.90 Red

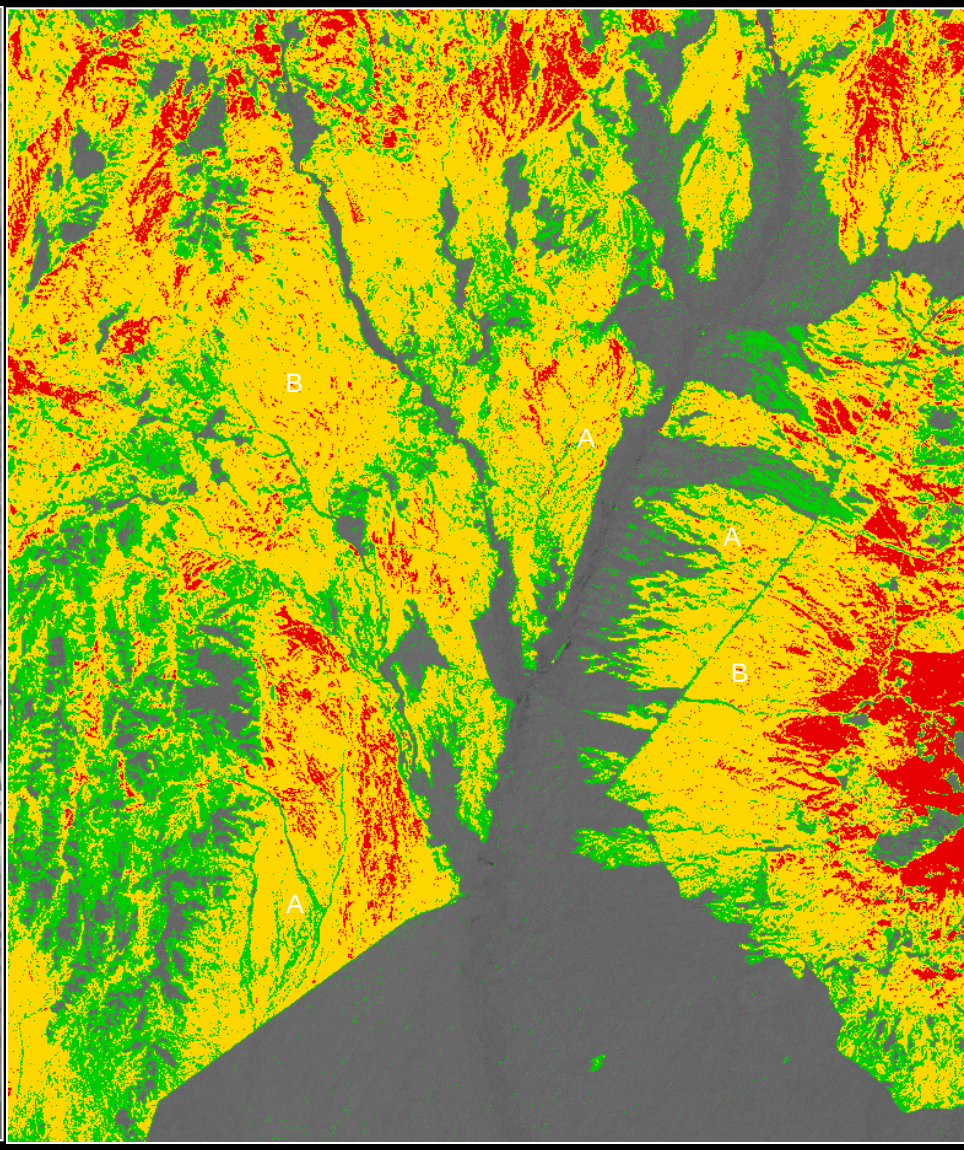




The 180 threshold.

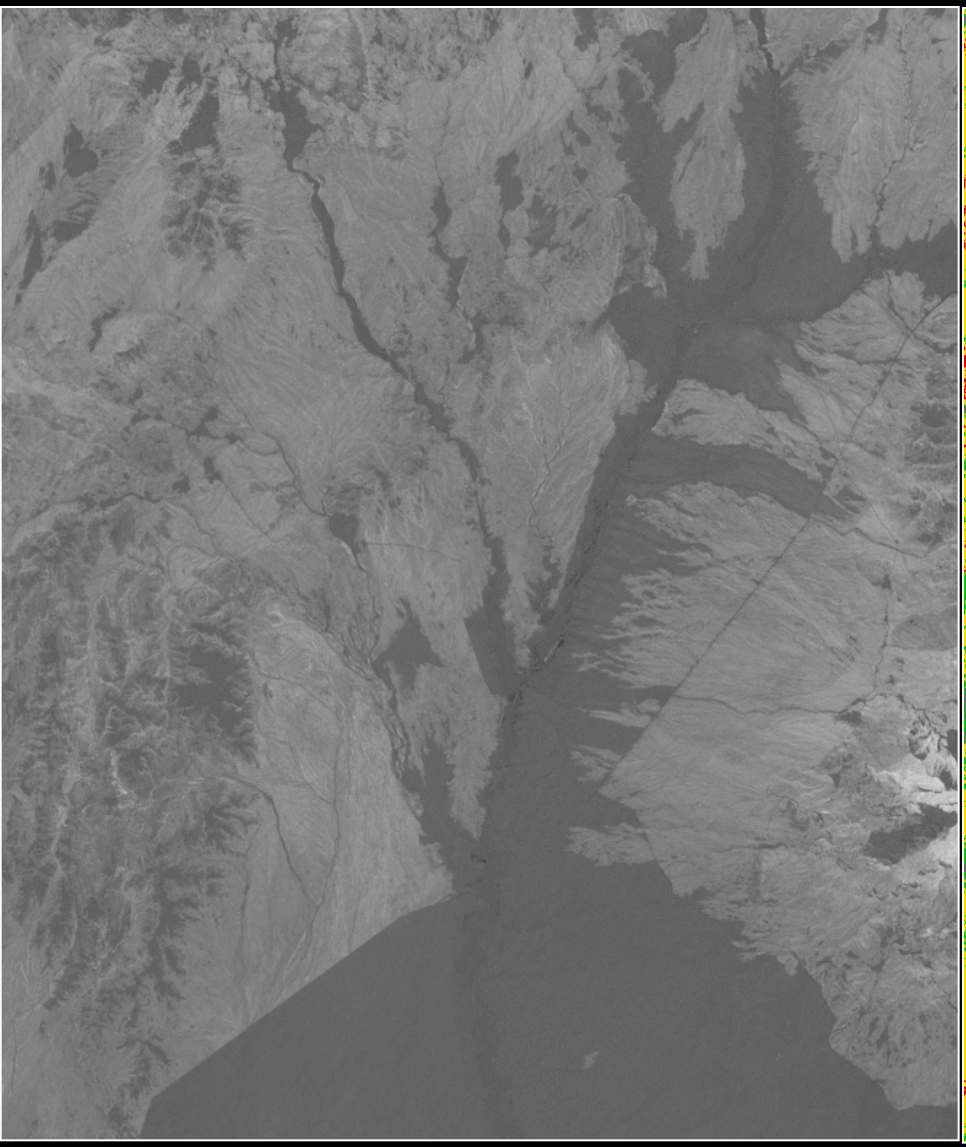
Moderate Threshold. dNBR >= 70 set to 0.80 Green, dNBR >= 170 Gold, dNBR >= 300 set to 0.90 Red

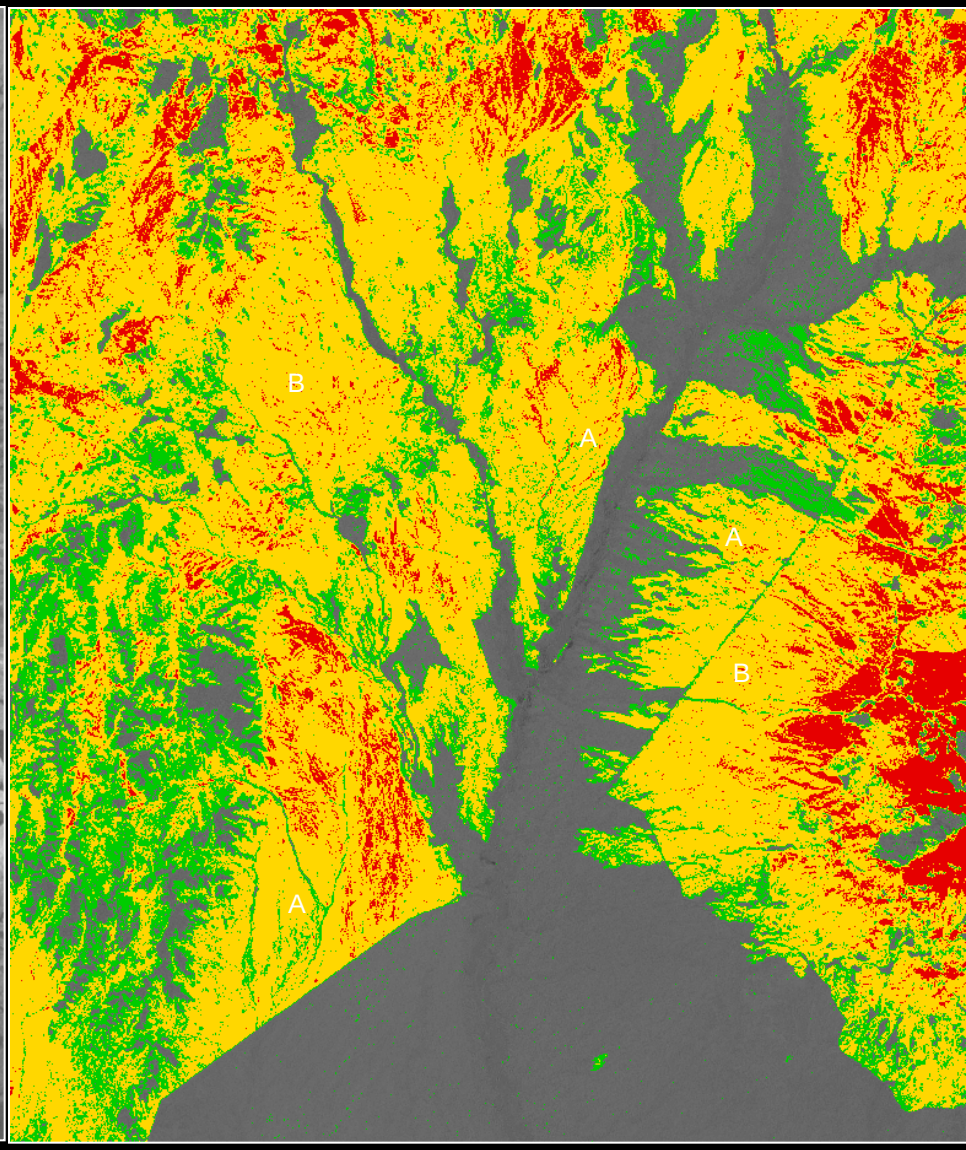




The 170 threshold.

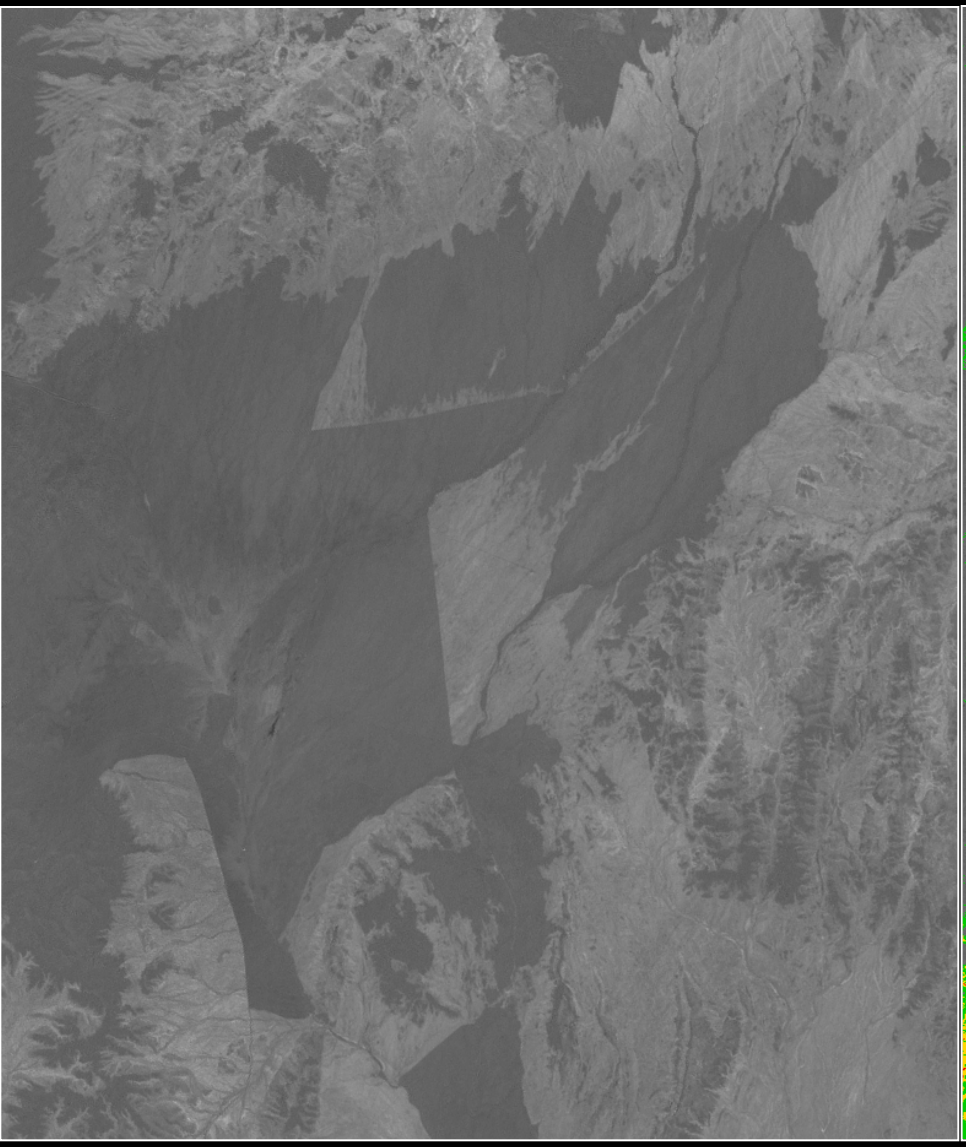
Moderate Threshold. dNBR >= 70 set to 0.80 Green, dNBR >= 160 Gold, dNBR >= 300 set to 0.90 Red

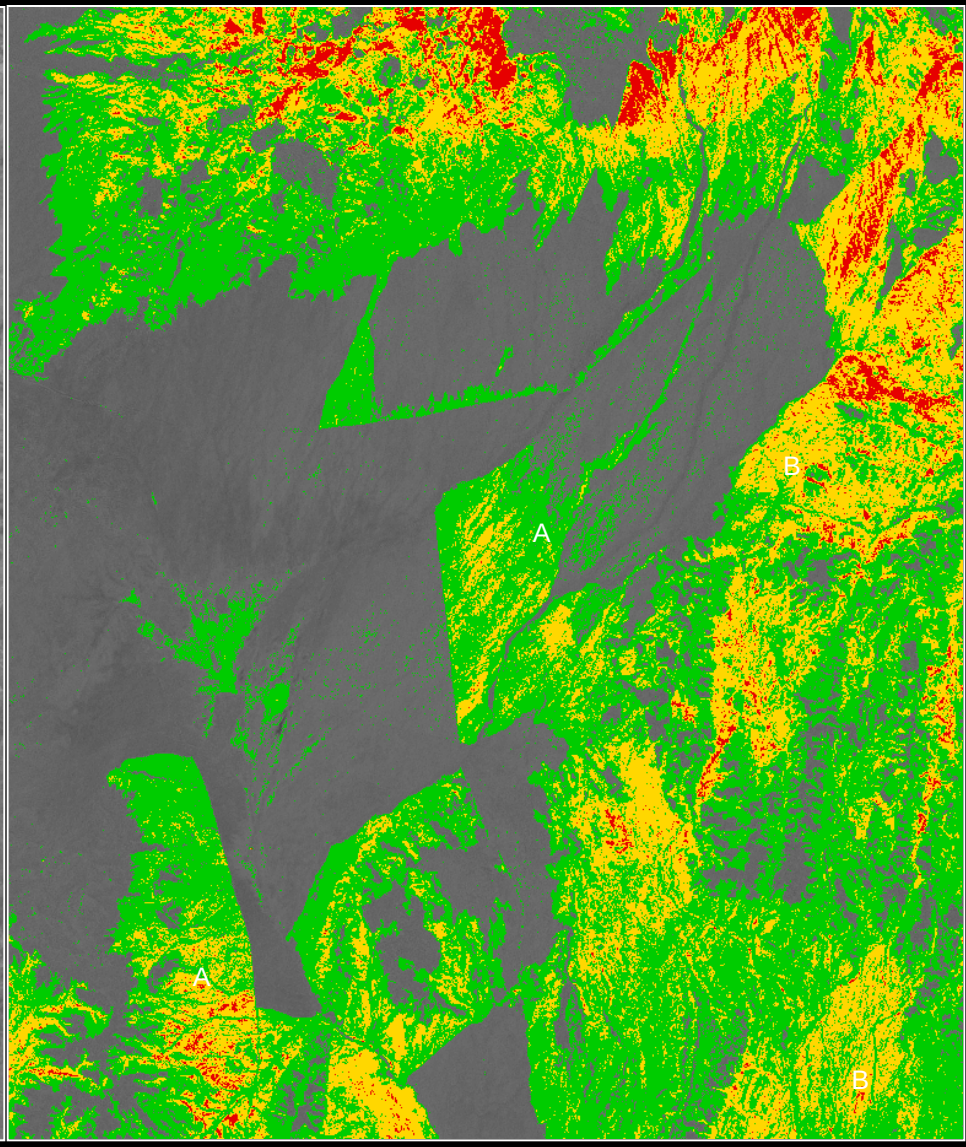




The 160 threshold. Again the 170 or 180 thresholds seemed well balanced without over-saturating either low or moderate. Go back and forth between slides to see the affect.

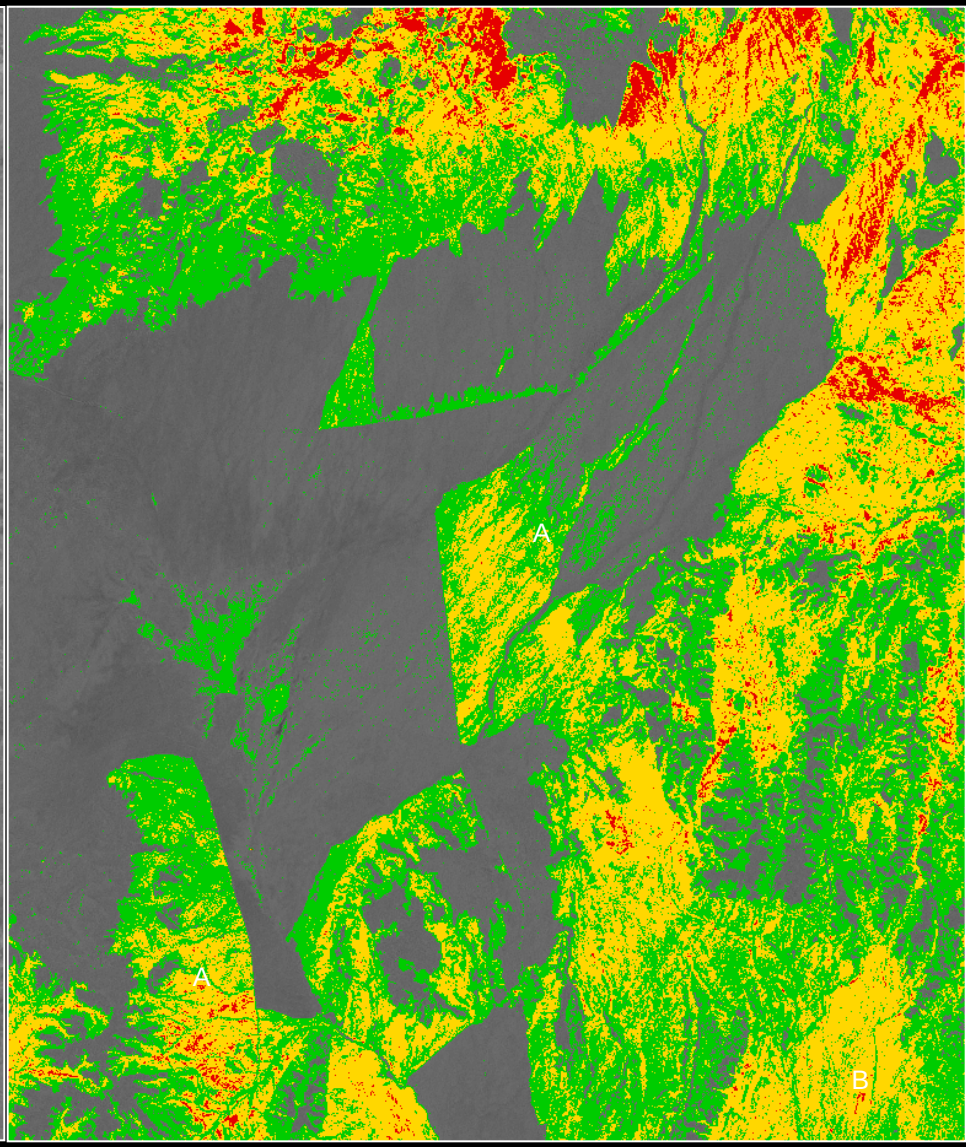
Moderate Threshold. dNBR >= 70 set to 0.80 Green, dNBR >= 200 Gold, dNBR >= 300 set to 0.90 Red





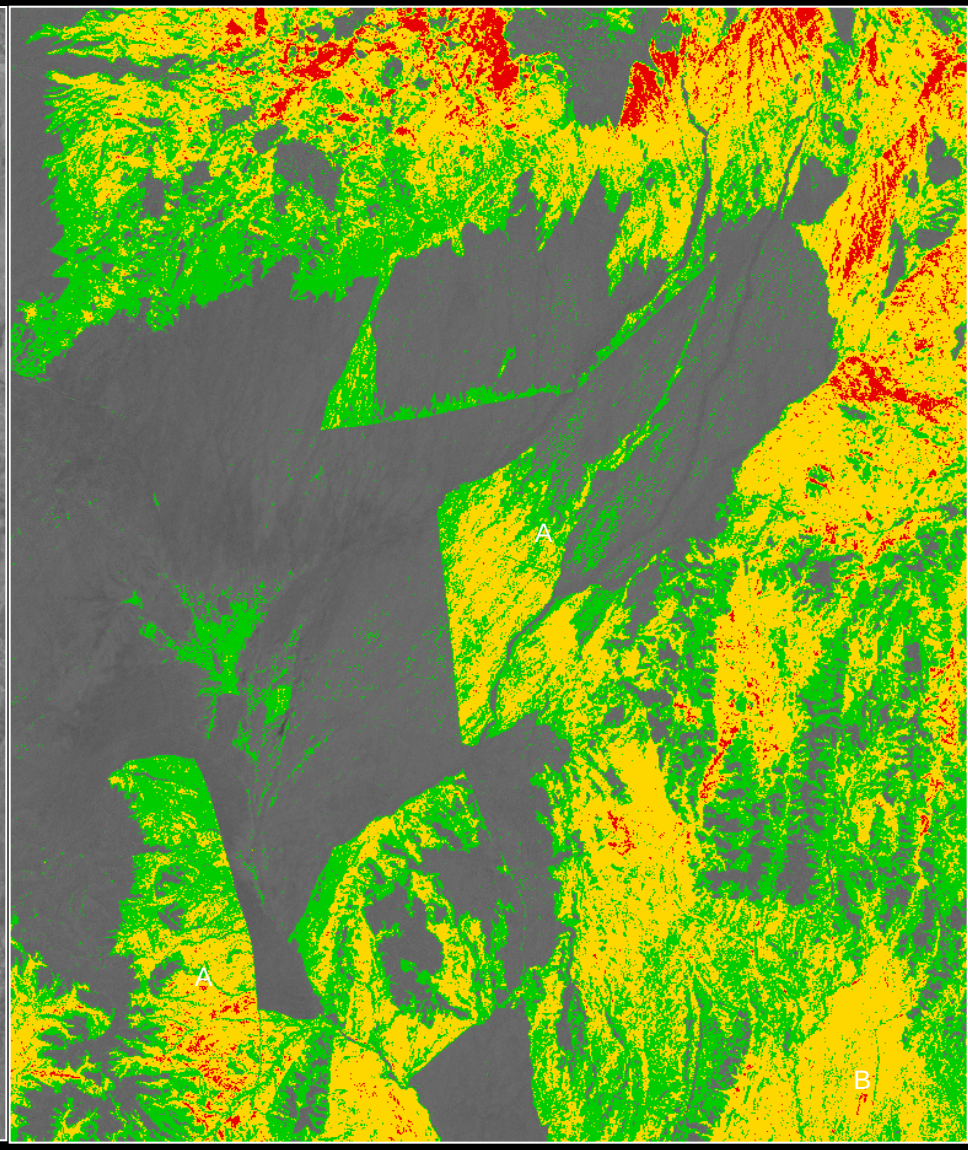
Another area enlarged to default zoom, the 200 threshold

Moderate Threshold. dNBR >= 70 set to 0.80 Green, dNBR >= 180 Gold, dNBR >= 300 set to 0.90 Red



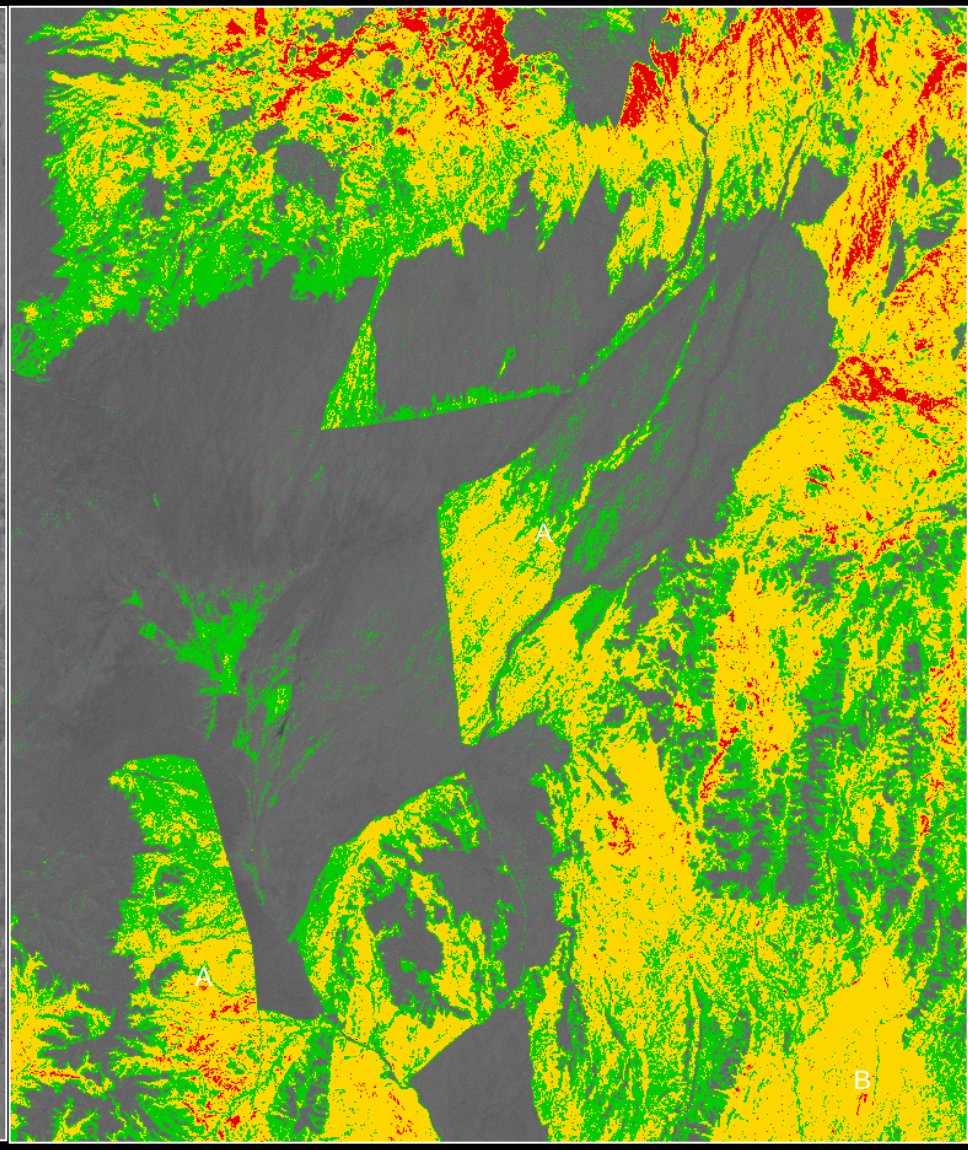
The 180 threshold

Moderate Threshold. dNBR >= 70 set to 0.80 Green, dNBR >= 170 Gold, dNBR >= 300 set to 0.90 Red



The 170 threshold

Final Thresholds. dNBR >= 70 set to 0.80 Green, dNBR >= 160 Gold, dNBR >= 300 set to 0.90 Red



The 160 threshold. Go back and forth between slides to see the affect.

After looking at three areas, 170 and 180 seem most representative of pattern in dNBR. Originally I chose 180, but reviewing it again in more detail, I think I would have changed that to 170.

Again, the final threshold numbers (70, 180, 300) seem low, but in this desert initial assessment, we knew that lower-change values represented higher severity due to environmental conditions and desert vegetation responses. So, thresholds were shifted downward. The unburned to burned value, however, was defined in the conventional way.