1. Title: Regional Satellite Cloud Composites from GOES

Good day! My name is Bernie Connell and I'll be presenting Regional Satellite Cloud Composites from GOES. This presentation reflects how one can create and use cloud composites on a regional scale to assist with everyday forecasting tasks. Cloud composites refer to a shorter time span than cloud climatology. Many people think about climate in terms of decades and many of our examples here deal with less than 10 years of imagery. Our primary distinction between climatology and composite is time. Here, we're highlighting a regional application to visualize weather patterns from a different perspective - the diurnal geostationary satellite. Listed are the people who helped put this presentation together. There are many people who contributed to the research and compositing efforts. Those contributors are listed on another slide.

2. Objectives

The objectives we will address in this module include: 1) To learn what a regional satellite cloud composite is 2) To find out what types of cloud composites can be created and 3) To find out how cloud composites fit into the forecast process. The key word throughout this session is Regional. We're going to show simple techniques used, resultant composites, and applications.

3. What are they?

What are satellite composites? They are the result of a long-term investigation of a feature of interest using satellite imagery. They are a tool for global and regional applications. Satellite based composites are relatively new. The first composites were developed in the 60s. We're focusing on cloud composites here. The last point recognizes that there are many types of composites to consider. I like to think of regional climate applications of cloud composites as a form of pattern typing and visualizing.

4. Motivation on the Regional Scale

Why do we want to use these composites on a regional scale? Satellite data provide a greater spatial representation of cloud cover and cloud frequency than surface based measurements. One can obtain a diurnal perspective from the geostationary satellite.

5. Motivation on the Regional Scale (2)

The composited information can be used to train new forecasters. The process of making composites lends well to learning about a phenomena for a particular area that is not well understood. We'll talk more about this throughout the presentation. The composited information can be utilized directly in the forecast process - as a first guess for the cloud cover or it can be made into conditional probabilities.

6. Developing a local satellite cloud composite …

is a process. We can give you some standard composites, but experience tells us that it will be more meaningful for your office if the climatology is tailored to address a topic of interest to YOU. This is a very general list of the steps in the process. First, you identify a topic of interest. You do a preliminary assessment, then we make modifications, evaluate, make more modifications, and evaluate. Finally we implement the results. As we go through examples in this presentation, you will get a better picture of how this process works. We'll take a brief look at simple techniques for cloud identification and compositing. Think of these steps as we go through this information and see if this is something that will benefit your office.

7. Type of Cloud Composites - Qualitative

We can look at numerous types of cloud composites. They can be simple channels like visible, water vapor or infrared. Or they can be a combination of channels like the fog product. We first may want to look at qualitative composites to get a feel for what is possible. We then take this information to develop a quantitative product which is more useful in models or everyday applications. To demonstrate qualitative we'll look at image average, maximum and minimum composites, we'll start with looking at example from the Tallahassee WFO.

8. Tallahassee sample area

This slide shows the sample area for the Tallahasse summer sea breeze project. In Tallahassee, they knew that various background synoptic wind regimes affected convective development associated with the sea breeze. They wanted to see if the satellite based cloud frequency would add information to the timing and extent of their sea breeze convective development They initiated a study that covered the summer months of June, July, and August. What I'm going to show here are results from the years 1996-2000.

9. Visible average composite July 1999 hrs 14-21

This slide demonstrates the visible average composite. Here we're looking at the month of July 1999 for the hours of 14 through 21 UTC. We're looking at hourly 1 km visible imagery. Even though this is averaging dark background with lighter cloud cover, we still get the impression of less cloud cover at the beginning of the day, particularly when we can see surface features on the Florida peninsula. We get the impression of more cloud cover in many areas with a brighter overall image at the end of the day. We can even discern cloud movement.

10. Visible composite of maximum brightness count for July 1999 hrs 14-21

This slide demonstrates the visible composite of maximum brightness count for July of 1999, the same month as in the previous slide. What this means is that for each hour of the month and for each day included, we went pixel by pixel and pulled out the largest brightness count value. This type of composite will give a unique perspective. Early in the day, we get the impression of a large convective storm offshore, smaller storms here and there, and where we don't see cirrus, we see the ground, small cumulus, or stratus. As we go through the diurnal sequence, we can see the movement of individual storms, clearing in some areas with further redevelopment. Besides telling us where clouds are, it's also telling us where they are not and giving us some impression of the size of storms. Visible imagery gives us cloud information during the day, and as we'll see in the next slide, the IR 10.7 µm will give us cloud information 24 hours.

11. 10.7 um composite of coldest pixels for July 1999: 24 hours

This is a composite of the maximum brightness count for the infrared which translates to a composite of coldest pixels. We're looking at July 1999 for a 24 hour period. We can follow individual storms from one hour to the next. Over land, we see maximum deep convective coverage in the afternoon around 22 UTC which is 6 PM local time, and minimum deep convective coverage in the morning between 11 and 12 UTC which correspinds to 7-8 AM local time. Over the ocean, we see a pattern that is opposite: more cloud cover earlier in the morning and less cloud cover later in the day.

12. Visible composite of minimum brightness count for July 1999 hrs 14-21

This is an example of the visible composite of minimum brightness count for July 1999 for the hours 14-21 UTC. This sequence for this month shows that there were some nice cloudless days. You can see hints that it is picking up on some cirrus cloud particularly over the gulf region. At the end of the day, dark cloud shadows are being detected. Two points we know about visible albedo before we start: surface albedo will vary throughout the day due to change in sun angle and the surface albedo will also vary due to changes in vegetative characteristics over time and even changes in surface moisture. An albedo correction based on solar angle was applied to the images to help alleviate these problems, but you can see that the resulting images are not smooth throughout the day: we can still see an effect of the change in the sun angle throughout the day and the change in surface characteristics throughout the month (wet/dry soil; different stages of vegetative growth; haze)

13. Quantitative cloud composites

We'll move along to take a quick look at some simple QUANTITATIVE threshold techniques to get cloud frequencies.

14. Concept of visible and IR threshold techniques

This page demonstrates the concept of visible and IR threshold techniques. Frame 1. For a visible threshold, we start with a background image similar to a composite of minimum brightness count, and use that as a reference. This reference image is compared pixel by pixel with a regular image.

Frame 2. If the pixel in the regular image is 20 or more brightness counts brighter than the background image, it is left as the current cloud value. If not designated as a cloud, the pixel is designated with a zero. The zero is expressed as black in this cloud/no-cloud image<

Frame 3. If we compare this cloud no-cloud imgage with the original image, most would agree it looks pretty good. This method does not distinguish between types of cloud.

Let’s stop and think about how we might use a simple threshold technique to detect clouds in the IR imagery. We’re looking at summer months (June, July, and August) and we’ve got warm background land and water surfaces. What would we get if we designated as cloud any pixel colder than 283K or 10C?

Frame 4. The result is the image in frame 4. One of the first things you'll notice is that small clouds inland are not detected and we see that the cloud offshore, represented by the dark blue color is dectected. First remember that the 10.7 µm imagery is sampled at 4 km at nadir and the visible imagery is sampled at 1 km at nadir, so we have a coarser resolution in the IR than in the visible. If you are viewing small clouds on the order of 1km, you can see it in the visible imagery, but in a 4 km pixel for the IR, the thermal signal gets averaged in with the background. The result is that it is difficult to detect small clouds in the IR. Let’s let this sit for awhile and we’ll come back to it in a few slides.

15. Quantitative cloud composites on various time scales

Let’s now look at some of the results by using these simple methods and first we’ll focus on the traditional ways of looking at these: monthly. Since we have hourly images, we can look at the diurnal monthly variation as well.

16. Visible diurnal / monthly cloud frequency

And now a quantitative look at results. To summarize briefly what has been done up to this point with the visible imagery: It's been navigated, albedo corrected, we derived a monthly background, applied the background to regular images to obtain cloud/no cloud composites and then summed up the composites by each hour over the entire month. We've applied a color table which goes from 0 to 100% cloud frequency. Here we are not seeing pink values in the 0 to 10% range, we do see the blues representing 10 to 30% frequency, greens representing the 30 to 50 % range, yellows represent the 50 to 70% range, orange and red representing 70 to 80% frequency. In the afternoon, we can even detect some 90% and close to 100% values at black and white respectively. Stop the loop. Early in the day, we can see the highest cloud cover offshore and inland (Alabama and Georgia); lesser cloud cover along the Gulf coast in the panhandle area and noticeably less cloud frequency in the peninsula area. As we move through the day with the images, we can see the rapid development of clouds along the coast and burnoff of clouds further inland. We can also see the influence of the sea breeze front moving inland as there is decreasing cloud cover behind it. We can see small scale influences of rivers - where there is subsident, divergent flows over the cooler water which suppresses convection. We see it over some of the larger rivers as well as some of the inland water ways in the peninsula. At the end of the loop, there is a cloud frequency composite for the month, which for this visible set includes 8 hours. The sample size is 244. It paints a familiar pattern, and gives yet another perspective on cloud development during daylight hours.

17. Infrared (10.7 um) diurnal / monthly cloud frequency

This page demonstrates a 24 hour loop of cloud frequencies derived from IR imagery using a threshold of 283K or 10 C. The first 8 hours of this loop correspond to the same time as the previous visible loop. There are many similarities as well as differences between this infrared imagery and the visible composites. Early in the day we see higher cloud cover over the Gulf and inland over Georgia, with less cloud cover in the Panhandle and in the peninsula area. We don't see the rapid early morning cloud development along the coast because this infrared method does not detect small clouds. At this time at 17:15 UTC in the visible composties, there was already 50 % cloud cover in many areas along the coast and here it is much lower. In the visible imagery, we noted overall maximum cloud extent and frequency at 21 UTC (5 PM local time) - the end of the range of visible data. In these IR composites, maximum cloud extent and frequency occurs a few hours later at 01 UTC (9 PM local time). Because this imagery is at a coarser resolution, we don't see the effects of small scale features as readily such as lower cloud frequency over rivers as we saw in the visible imagery. But, because we do have 24 hour coverage, the IR imagery does provide continuity of coverage throughout day and night.

18. Visible & IR 10.7 um monthly cloud freq. June-Aug 1996-2000

The overall monthly composites are good for looking at broad patterns. Here we are looking at visible composites for hours 14 through 21 UTC during June, July, and August for the years 1996 through 2000. The eye-catching features are high cloud frequencies predominantly over land for June of 1997 and 1999 and minimum cloud frequency for June of 1998. In many of these months we see the direct influence of the water/land boundary with higher cloud frequency in a strip along the coast indicating the influence of the sea breeze. There is variability from month to month and year to year. Frame 2 here shows the IR threshold cloud frequency for the same 8-hour time period as in the visible. Overall they show similar patterns to the visible composites, but with less cloud frequency. Frame 3 shows the IR threshold cloud frequency for the entire 24 hour period. The additional hours overall add cloud frequency inland.

19. IR 10.7 seasonal cloud freq. Jun-Aug. 1996-2000

This composite shows individual months over 5 years as well as the seasonal component. As we sample more hours over more years, the view looks smoother. It strongly shows the influence of a large landmass next to a large body of water.

20. Composites stratified by Regime

(Returning to our Quantitative Cloud Composites page) Another way we can look at these cloud frequency composites is stratification by regime.

21. Mesoscale Summer Sea-breeze example

As we have alluded to in previous slides, the mesoscale summer sea-breeze composites were developed in collaboration with the WFO in Tallahassee and Ken Gould was and still is our main contact. Regimes were selected based on a mean boundary layer flow which incorporated direction of flow and flow strength. This type of categorization reminds me of wind rose concept.

22. Benefits of Regime Composites

There are many benefits to creating regime composites with this list highlighting them. The Composites show preferred areas of development as well as preferred areas of suppressed convection. They show the effect of synoptic flow changes and when we use high resolution imagery, they show the effects of small scale features. As a forecaster who looks at the imagery day in and day out, you likely have insight to the timing and amount of cloud development throughout the day. The composites give a quantitative measure. It is one additional piece of information and can be integrated with other complimentary data sets.

23. Tallahassee Regime Description

A total of 11 regimes were defined by the Tallahassee office. This lists 9 of them. The 2 that are not listed are: Regime 10 completely suppressed, and Regime 11 completely disturbed. We're going to take a closer look at only 4 regimes to show contrasting aspects: (1) Light and variable or light SE flow, (2) Light to moderate E to NE flow, (4) Light to moderate W to SW flow, and (8) Light to moderate N to NW flow.

24. Influence of coastline shape

Before we look at loops of the 4 regimes, we'll review the concept of shape of coastline and how that can affect convective development. Under calm conditions, and with onshore flow, a convex coastline will enhance convergence while a concave coastline will enhance divergence.

25. Visible cloud freq. Regime 1

This is a loop of visible cloud frequencies for regime 1: Light and Variable or light SE flow with a sample size of 29 days. Notice the influence of the convex coastline where Apalachicola is at the tip. Later in the day we see a convective hot spot. On the peninsula,we also see the sea-breeze front starting along both coasts and moving inland. Because this is light and variable flow, we generally see the sea breeze moving inland on all coastlines throughout the day.

26. Visible cloud freq. Regime 2

This loop shows the visible cloud frequencies for regime 2: Boundary layer winds are out of the NE at less than 10 kts (n=50). We see more cloud cover in the gulf early in the morning. We see clearing from the coast outwards in the gulf as the day progresses. Late in the day, the blowoff from convection appears to be moving towards the southwest. Also later in the day, there is reduced cloud cover inland in Georgia and Alabama. There are higher cloud frequencies in the convex region of Apalachicola, not as frequent as in the previous regime, and also located more to the south and west.

27. Visible cloud freq. Regime 4

This loop demonstrates the visible cloud frequency for regime 4: boundary layer winds out of the SW at less than 10 kts (n=54). Of the 4 we are examining here, this Regime has the most widespread cloud frequency. This one more closely matches the sea-breeze convection zone for Regime 1. We're still seeing higher cloud frequencies in the Apalachicola convex region but notice that the pattern of higher frequencies has shifted to the east. West/SW facing coastal areas show less cloud cover and east facing coastal areas show more.

28. Visible cloud freq. Regime 8

This loop shows the visible cloud frequencies for regime 8: boundary layer winds are out of the NW at less than 10 kts. (n(max)=43). This case is similar to the NE case in that we see cloud cover over the Gulf early in the day with very little cloud cover inland . The sea-breeze convection zone does not extend as far inland as for Regimes 1 and 4. We still observe higher cloud frequencies than surrounding areas in the Apalachicola region, with the convection focused towards the southeast.

29. VIS and IR Comparison Regimes 1/ 2/ 4/ 8 1715UTC

This is a zoomed in view for 1715 UTC (1:15 PM local time) for the visible composites and it highlights features of contrasting Regimes. Onshore flow has more cloud cover inland, offshore flow has less cloud cover inland. Focusing on the coastline near line x for regimes 1 and 8 we see that where there is SE flow, the line of cloud frequency representing the sea-breeze front has progressed inland whereas for NW flow, the higher cloud frequencies hug the coast. Focusing on regimes 2 and 4 and the coast line near line y, we see higher cloud frequencies hug the coast for NE flow as opposed to a shift in higher frequencies inland for SW flow. These are patterns we expect and it is reassuring to see in the data. At the circle designated by letter Z, we see less cloud frequency over the river area. It is hard to see here, but we observe shifts in the cloud line similar to what we see along the coast for the different background flows. Looking at these features reminds me of the issues of quality control of the data. As I mentioned earlier, before we can actually do the compositing, the imagery has to be checked and properly navigated, and this is particularly important for 1 km data. Starting with GOES 13 and later satellites with improved navigation, this should not be an issue. The first time I loaded the imagery and put on maps to compare the various regimes I saw the patterns shift to the right or the left and my first thought was oh no, what happened to the navigation. It only took moments to realize it wasn't the navigation and the pattern was distinct enough to show in the imagery. These are results for 1 km visible imagery. If we use 4 km IR imagery and a simple threshold technique, we get the results shown on frame 2. Frame 2. The first obvious difference is less detection of cloud cover. At this time of day, there are still a significant proportion of small cumulus. The 4 km resolution of the IR pixel sees not only the small cumulus but also background warm ground. The result is that the pixel is warmer than 283K and does not get detected as having cloud. From this, we cannot readily discern differences in the progression of the sea breeze front at 4 km and we cannot readily discern areas near rivers with less cloud cover. We can see regime differences and the effect of having a coastline.

30. VIS and IR Comparison Regimes 1/ 2/ 4/ 8 2115UTC

Frame 1. Here we're looking at the study area 4 hours later at 21 UTC (5 PM local time) for the 4 regimes. When we compare this with the IR derived composites. Frame 2. we are seeing very similar cloud frequencies. At this time of day, many clouds are larger in extent and are being detected by the IR threshold method which detects a cloud if BT is less than or= 283K). Frame 3. We can do another level of threshold for BT less than or =235K and see areas associated with deep convection for each regime.

31. Applications of Sat Clim at TAE WFO

This is a list of areas where the office has benefited from having regime climatologies and where the satellite information has contributed to the process. I remember having conversations with Ken and he would say that they would fine tune their forecasts- increase or decrease cloud cover based on information from the cloud composites and they would increase or decrease precipitation estimations based on what they were seeing with their radar derived precipitation.

32. Sea-breeze PoP Procedure

Frame 1. The sea breeze has a strong influence on the forecasting at Tallahassee and the regime concept has been applied to observations other than satellite as well. In particular Brian Mroczka has developed a procedure which utilizes their Regime information. As you can see here, they have a regime PoP based on Radar derived precipitation and have set it up so that it can be blended with model guidance. Frame 2. Different inputs can be weighted and Frame 3. other thermodynamic inputs can be used to adjust the probabilities up or down. The next step is getting the cloud frequencies into the process.

33. Regime Climatology PoP 2003-2008

This is an example of regime climatology PoP. It is for a different 5-year period from 2003-2008. To orient on the color table, the brown colors represent probabilities up to 25%, the greens go from 25 to 65%, the aqua represents 65-75%. In all cases, we see higher probabilities of precipitation in a broad strip of land near the coast. Notice similarities to patterns observed in the cloud frequencies. For example for regime 1 with SE flow, the higher probabilities are shifted inland and regimae 8 with NW flow puts higher probabilities along the coast. For regime 2 with NE flow, high probabilities hug the SW coast while for regime 4 with SW flow, high probabilities are pushed inland. On the last slide of this loop, I noticed that Brian had included the suppressed and disturbed regimes. We often think that these two cases do not have the influence of the coast or shape of the coast. I find it interesting to see high PoP near the convex region and high PoP in a strip along the coast.

34. Composites Stratified by Event

Going back to our types of cloud composites, we'll look at quantitative examples stratified by event and for this we'll review an example from the mid-west part of the country.

35. High Wind Events Cheyenne WFO

One of the more challenging forecasts for the WFO in Cheyenne is high wind events. How can satellite climatologies be utilized? Cindy Combs here at CIRA has worked with the Cheyenne office and the first question they tackled was: how to stratify the imagery. Cheyene is at 6100 ft MSL and they have plains and mountainous areas in their region of responsibility. In general, they are concerned with high wind events of 40- 50 mph and greater. Normally, Cheyenne experiences between 15 and 25 events annually with a majority of them occurring between December and January. Many of the wind events start in the late evening or early morning hours. Because of this, visible imagery was not very helpful. IR 10.7 imagery was used. Thresholding for the IR cloud composite was done differently for Cheyenne than for Tallahassee. Ten-day warmest pixel running image were created to use as backgrounds. For the current image, a pixel was denoted as cloud if its value was 12 deg colder than the background. The results that will be shown here focus on December, January, and February over 5 seasons from 1998-2002. There were 44 events during this time period; events lasted from a few hours up to multiple days.

36. High wind events - first evaluation

The first look at the data was for during the event, 12 hours preceding an event, and 12 hour after the event. A regime like approach was used in that days were classified and information composited on an hour by hour basis. In some cases parts of days were used and they weren’t evaluated in a relative sense. When they looked at the results, they determined it was better to evaluate in an event relative sense and initially focus on precursor signals.

37. Pre-high wind event cloud climatologies

This is a loop of 3 time periods preceding high wind events. Again for the December through Feb time period for 1998-2002. Stop the loop to see: 9-12 hours preceeding , 5-8 hours preceeding, and 1-4 hours preceeding. Note the jet streak cloudiness over the Montana Rockies and the growth of the streak over time. Cheyenne has had a large turnover in personnel since this project began. The new crew is interested in continuing with the project. The next step is to get composites into AWIPS so they can be evaluated.

38. Eureka Marine Stratus Project

Another project underway is with the Eureka WFO in California. They are investigating a better way to estimate stratus burn-off during the day by relating it to the marine layer depth just before sunrise. In this region where there are coastal mountains, one can readily compare where the cloud butts up against terrain in imagery with terrain maps in GIS to get a good idea of the depth of the marine cloud layer. The Eureka office is doing this. The marine stratus depth (in this study) is an average between Cape Mendocino (the little point of land just south of Eureka) and the Oregon border.

39. General Eureka cloud composite July 1999-2005

n=210 This loop of composites is the first check of the data for consistency. It is the month of July for a 7-year period from 1999 through 2005. It consists of every other hour except 14 UTC which is near sunrise. The marine stratus layer is a dominant feature. At 16 UTC (9AM local time) the stratus deck is already beginning it's retreat; the cloud cover inland is minimal, ocean cloud cover is high. As we progress through the day we see the marine stratus further retreat reaching a minimum at 02 UTC The maximum cloud cover inland over the mountains is at approximately 22 UTC. The stratus starts to build back inland at 04 UTC (9 PM local time) Overnight it continues to move further inland.

40. Eureka: 1000 ft Marine depth at 12 UTC

Background before we move on: The Eureka project uses the visible, 3.9 and 10.7 um imagery. Data were divided into 4 monthly periods: mid May through mid June, mid June through mid July, mid July through mid August, and mid August through mid September. We'll be showing the mid July through mid August period for 1999 - 2007. Only included in these composites were days with minimal disruption of the marine stratus layer: no synoptic or strong mesoscale disturbances affected the region. Cloud detection was determined by using the BT difference between the 10.7 and 3.9 um imagery along with additional thresholding both day and night. During the day, the visible imagery was used as well. This follows a technique use by Jedlovec and Laws in 2003. Regime 3 captures days in which the marine stratus depth was 1000 ft. at 12 UTC (5 AM local time) as determined by comparing cloud location overlaid on elevation data in a GIS (at Eureka). Eighty-nine days went into this set of composites. Stop the loop and go back one frame to 12 UTC which has the maximum inland extent. The study area is in northern California near the coast from Cape Mendicino to the Oregon border. Complete dissipation of the stratus layer occurs between 00 and 02 UTC.

41. Eureka: 1500 ft Marine depth at 12 UTC

This is an example of regime 4 which represents a 1500 ft marine depth at 12 UTC (5 AM local time) as measured near Eureka. This is for mid July through mid August for 1999-2007; 31 case days fit this 1500 ft criteria. Stop, go back one slide to the 12 UTC image and compare the inland extent of the 1000 ft layer with the inland extent of this 1500 ft layer. Note 3 predominant river valleys: starting with the Klamath and Trinity River valleys towards the north, there is greater than 20% cloud cover further inland than for the 1000 ft layer on the previous slide at this time. For the Mad River valley in the middle, the cloud extent has not progressed much further inland. We do see that the clouds have filled the valley with greater frequency and extent. For the southern Eel River valley, now there is a broader, further inland, and more frequent cloud cover. When does the marine cloud layer dissipate? Moving forward in time, by 00 UTC there still is 60% cloud cover remaining in places near the coast. By 02 UTC (7 PM local time) most of the cloud cover has dissipated. By 04 UTC (9PM local time), the marine stratus has started building back in again.

42. Eureka: 2000 ft Marine depth at 12 UTC

This animation is for regime 5 which represents a 2000 ft. marine depth at 12 UTC. Thirteen cases fit this criteria. You might notice that the composites look a little blocky with fewer cases. Stop the loop and compare the 1000ft depth cloud extent for the 3 prominent river regions. All 3 regions show broader, further inland and more frequent cloud extent which we might expect with a deeper marine boundary layer. Mel Nordquist, the SOO at Eureka, and Cindy Combs here at CIRA continue to work on this project and getting imagery into AWIPS. They had a conference paper at the AMS Satellite Conference in Annapolis, MD in September 2010. They plan on putting out a technical paper soon when they firm up comparison of these results with ground based observations. You can contact either of them for more specifics of the study.

43. CIRA Satellite Climatology Web page for other examples

Do browse the CIRA RAMM branch web page for Satellite Climatology Applications You can get there by the link listed at the top or you can google 'CIRA satellite climatology' You see examples that have been presented here from Cheyenne and Tallahassee as well as other sites in the US and a few International applications as well. Remember these are regional applications of satellite cloud climatologies.

44. Conditional climatologies

Given a set of cloud frequencies based on a traditional month, a diurnal regime, or an event, one can calculate the probability of it being cloudy at a later time if it is clear earlier, and vice versa for burnoff situations. We can also do something with persistence. What is the probability of it being cloudy 3 hours later if it was cloudy to begin with or what is the probability of it being clear 3 hours later if it was clear to begin with.

45. GOES Satellite Image Database at CIRA

The database was started in the late 90s. It consists of images from both GOES east and west. The data have been collected at 4 km resolution every hour for visible imagery and every other hour for the other channels. The data have undergone quality control measures.

46. Developing a local satellite cloud climatology

As I mentioned at the beginning of this presentation, developing a local satellite cloud climatology is a process. We can give you some standard composites, but experience tells us that it will be more meaningful for your office if the climatology is tailored to address a topic of interest to YOU. If you think this is something you want to do, ..next slide

47. Can our office get involved?

Contact one of us with your ideas and your questions.

48. Contributors

We would like to acknowledge the many people who contributed to the various projects mentioned here from the Tallahassee, Cheyenne, and Eureka offices.

49. Contributors (2)

We would also like to recognize the many students who have worked on archiving imagery and quality control of the data over the years.

50. References and Links

Here is a list of the CIRA climatology web page and a couple conference and journal papers describing the various climatologies. In the near future, look for a Technical document from the Eureka WFO. These will also be listed on the Student Guide page for this lesson. RAMMB Satellite Climatology Applications
http://rammb.cira.colostate.edu/research/satellite_climatologies/

Thank you for joining in!