I. Introduction

The work this past quarter focused mainly on continuing efforts that logically followed last quarter’s efforts. Specific direction from the GIMPAP TAC was received and is being implemented to the best of our abilities at this time. At the time of writing, funding is in the process of being transferred.

II. Near Term Objectives

- Finalize the NOAA Tech Memo documenting the gradient method
- Continue to explore real time GOES moist bias comparisons with GPS data as data availability allows.

III. Task Progress

New NOAA Tech Memo

A NOAA Tech Memo that documents the changes to the gradient algorithm and the testing that went into formulating the initial choice for coefficient weights has been drafted and has been published:


A copy can be obtained either from GSD by request via US mail or downloaded on-line. The download URL is:

Web-based real-time GOES and GPS comparisons

The web pages continue to be generated and are being examined. Currently we remain in the dry season and GOES-12 data have been similar in many regards to GOES-10 but still show worse agreement at times (note the RMS in Fig.1). However, we noticed that the statistics of the two were merging as the atmosphere dried in late 2005. We are speculating that both GOES products (10 and 12) perform better in drier conditions. This is also borne out in our IHOP and post-IHOP scatterplots (better agreement at the dry-end). However, it appears that the recent changes made in November to go to a single field of view product may not have produced drastic improvement, but this statement is speculative at this time and will not be feasibly tested until there is a higher moisture signal that we might now be beginning to see as we move into springtime.
Fig. 1. Plot of moisture difference and RMS in comparing co-located GPS water vapor data with product data from GOES-12 (black) and -10 (red). Note the best agreement in bias and RMS up until the end of February when at that time GOES-12 data appear to become more moist biased and RMS values near 4.5 mm are seen near March 13th and higher values earlier in the month.

On March 17th, we contacted Jamie Daniels at NESDIS and explored reasons for the above apparent breakdown in performance observed rather suddenly near the beginning of March. The excellent bias and RMS agreement we have been seeing up until about 1 March had been consistent. The sudden changes to higher discrepancies in moisture appear to have a sudden onset in GOES-12 and the GOES-12 comparisons are beginning to appear as they have in the past. One speculation is that the switch to the single field of view algorithm on about 1 November 2005 was during the drier climate conditions and algorithm performance could not really be assessed until the atmosphere returned to higher moist levels. If it is the atmospheric water increase causing the changes in Fig. 1, it may be that the new algorithm is not as good as we had anticipated. We will continue to study this over the coming months and are now collaborating with Tim Schmit to assist in possibly looking at particular cases to potentially discover problems that may be occurring. Thus, we might be able to improve both the retrieval algorithm and QC of the system.

As one might expect from the RMS values shown in Fig. 1, we would anticipate some single discrepancies to be higher. Given the results shown in Fig. 1 we dug into the issue further to identify some of the severe outliers by generating a ranked table of outliers.
Given a normal distribution, one would expect to see some differences on the order of 3-sigma (based on Fig. 1 this could be as high as 1.5 cm) and indeed we see one as high as 1.87 cm. Be careful on the tabulated data below since for the most part GOES data are more moist, that is not always the situation. Some of the large discrepancies have GOES being drier. The differences are given in **absolute value** so as to rank the outliers, the GPS is the second to last number and the GOES the last in each record. We also record the time and lat lon of the data. Decode the time by looking at the station ID (site) where the latter part of the character string includes yy (year), jjj (Julian day), and hh (hour), followed by lat and lon. We hope this will be enough information to identify the GOES retrieval in question. So taking the “worst” match below (1.87cm) we would decode that it happened on day 78 (Sunday, March 19th) at 02h UTC, at a latitude of 26.2085, a longitude of -98.1893, a GPS value of 3.31cm, and a GOES value of 5.19cm.

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<th>lon:</th>
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We then examined the large discrepancy highlighted in yellow a bit more closely and produced figures 2 and 3.
Fig. 2. An IR plot of the large discrepancy (denoted as the very blue site in extreme southern TX indicated by the light yellow arrow). We see that the site is on the edge of a cloud field near many broken clouds.

Furthermore, one can see that sites further up the coast were also moist-biased but not to the degree as the major outlier studied. It is also apparent that these other stations were in the same cloud-regime as the one in question. In addition, the many crosses (indicating GPS sites) in central TX, OK, and LA lack corresponding GOES retrievals, presumably since the cloudy conditions prevented their generation. Taking our tools one further step, we examined the time series at the site in question.
Fig. 3. A time series showing GOES-12 data (blue) and the associated GPS data (black) for the Texas station in question. The sudden excursion of the GOES moisture that occurred at 02ut on 19 March is clearly seen reporting well over 5 cm total water, and is indicated by the blue arrow.

The nature of the data in Fig. 3 suggests that the GOES moisture product was being generated sporadically as shown by the frequent breaks in the blue line connecting GOES observations. We assume this was associated with the cloudiness that we see in Fig. 2 that may have interfered with continuous retrieval processing for that location. Furthermore, (and this is only speculation) the 02h GOES retrieval perhaps should not have been generated and might have been thrown off by cloud contamination. We are working with Jaime Daniels and Tim Schmit to study outliers such as this one at a more in-depth level to improve the overall GOES product. Other cases (not shown here) have shown retrievals generated over low-level stratus also tend to have a high moist difference.
The tabulated data of outliers are now scheduled to be produced on a daily basis and made available to everyone involved via the web or email. Thus, it should enable NESDIS and CIMSS-UW/Madison to capture the data associated with a questionable sounding retrieval before it is purged (we are informed they have a 24-h data retention window).

Bias statistics are not perfect for assessment either. Figure 4 shows a case where there was a reported high bias, but when you look at the time series, it is evident there was a rapid change in moisture occurring simultaneous to the difference computation. As shown in the following plot, the GOES measurement was actually quite close in space and time to the GPS measure. Also look how closely GPS and GOES agree at the bottom of the time trace after things “stabilize.”

**Fig. 4.** Slows a trace from LSU GPS and GOES-12. There is an apparent large difference (denoted by arrow) between the two measures when taken at the same time, but as you can see, there was a rapidly changing moisture environment occurring at the measurement time. This is probably a reasonable GOES retrieval and shows how
important space/time correlation is. Also note how well the two data sources agree when PW levels are less than 1.0 cm.

GOES-R Relevance

We are working on acquiring AIRS product data and integrating that into the web page as well so we can begin to ascertain the kind of bias a GOES-R algorithm may produce, since many of the channels for GOES-R moisture are similar to the current AIRS and it is likely that many of the same algorithm tools will be used for cloud clearing etc. By this approach, we begin to assist in helping improve AIRS and ultimately GOES-R moisture products in much the same way as we are now doing with the current GOES.

IV. Anticipated Activities in the Next Quarter

- Continue to explore real-time GOES moist bias comparisons with GPS data. Work to identify problems and reduce the discrepancies we continue to detect in GOES-12/GPS. The ultimate goal is an improved product and a paper describing our assessment and road to improvement.

- Work to incorporate AIRS moisture product data into our assessment system.

V. Problems and Corrective Actions

The work in this project was leveraging off of funding from both GOES-R and JCSDA sources. JCSDA funding for us has been cut this FY due to their budget constraints. For this reason, we are in the process of reformulating our work goals to maximize the objectives for GIMPAP while staying within budget limits.

VI. Publications or Presentations


- The NOAA Tech Memo documenting the gradient technique is now available from GSD or on-line at: http://laps.fsl.noaa.gov/birk/papers/tech_memos/GSD_Tech_Memo_32.pdf.


- A corresponding link to the actual poster presented at the AMS satellite conference is available on-line at: http://laps.fsl.noaa.gov/birk/papers/AMS_2006/poster.pdf.