

Talking Points for VISITview Lesson

The Satellite Rainfall Hydro-Estimator

1. This presentation will focus on the HYDRO-ESTIMATOR, which estimates rainfall amounts based on satellite imagery. This slide shows an H-E graphic, an accompanying SPENES, and IR imagery (with an MB enhancement).

2. Outline

3. Objectives

4. Part 1 Intro

5. Why do we need/use satellite rainfall estimates?

6. History of satellite precipitation estimates

7. September 2002

8. Hydroestimator rainfall rates are based, in part, on cloud top temperatures. The accompanying rain rate curve shows the general rain rate/cloud top temperature relationship..of higher rain rates with colder cloud tops. Adjustments can be made to the rain rate curve..to account for parameters such as Precipitable Water, Relative Humidity values, and equilibrium level.

9. The Hydroestimator uses a screening technique that separates raining and non-raining pixels according to the difference between the pixel 10.7 micron brightness temperature and the mean value of the surrounding pixels. This difference is used to adjust the relationship between brightness temperature and rainfall rate in the raining pixels. This screening technique was not yet developed for use in the original Autoestimator... therefore, radar was used (in a qualitative sense) to distinguish rain vs. no rain areas.

The Hydroestimator uses separate adjustments for PW and RH that improve estimates in arid and very humid environments. For very humid (high PW) environments, the rain rate curve is adjusted upward. For arid environments (low RH)..the rain rate is reduced. This different treatment of PW/RH also may produce better estimates for precipitation with winter storms.

10. Products

11. Hourly Rainfall Estimates sent to AWIPS. The capability to produce multi-hour totals on AWIPS workstations is not available with Build 5.2.2...but will hopefully be available on a future build later this year.

12. This is an example of a 1 Hour Hydro-Estimator graphic. This graphic is called the 1 hr

Auto SPE on AWIPS. It can be accessed by clicking “NCEP/Hydro” on the menu bar, followed by clicking 1 hr Auto SPE on the pull-down menu. You can zoom in on an area by clicking on the graphic. Looping a series of 1 hr Auto SPE graphics will show trends with regard to intensity and movement. To access Manual IFFA estimates, when available...click on “Manual SPE”.

13. To access 1 hour Auto Satellite Precipitation Estimate (produced by the Hydroestimator), click on “NCEP/Hydro” on Menu Bar, then click “1 hr SPE” on Pull Down Menu. Access Manual IFFFA estimates by clicking on “Manual SPE” on the Pull Down Menu. Auto estimates are produced every hour, and available about 15 minutes after image time. IFFA estimates are not produced on a regular basis. They are produced only when the Satellite Analysis Branch Precip Meteorologist feels that they are significantly better than Auto estimates (for a given situation).

14. Part 2 Intro

15. SAB Products

16. Satellite Precipitation Estimate messages (SPENES) contain sections regarding: Location (state names); Event (a headline describing the precip event); Satellite Analysis and Trends; a listing of satellite estimates, when applicable. Note...satellite estimates from the Hydro-estimator version of the Autoestimator will generally be used for rainfall events. However..if the Hydro-estimator is not handling an event well, then either an alternative “in-house” version of the Autoestimator will be used or Manual IFFA estimates will be used.

17. Hydroestimator v/s Manual IFFA

18. Internet graphic of IFFA product over Texas

19. Sample of internet auto-estimate graphic

20. Precipitation program of SAB

21. The SAB Web Site: <http://www.ssd.noaa.gov> provides links to satellite imagery and various operational satellite products. <http://www.ssd.noaa.gov/PS/PCPN> provides NESDIS Satellite Precipitation estimate messages and graphics as well as links to NESIDS Office of Research and Applications.

The ORA Flash Flood Home Page Web Site on the slide provides Hydro-Estimator graphics over the U.S., the Pacific Ocean, and other locations. Note...Home Pages contain additional Satellite Precipitation Estimates that are not on AWIPS.

22. Part 3 Intro

23. Hydroestimator works best for:

24. Hydroestimator limitations:

25. GOES IR MB enhancement

26. Hydroestimator examples handled well

27. Texas - November 15-16, 2001

28. This is an example of an event with heavy cold-top convection that has a long duration and extensive coverage area. The Meso-Convective Complex (MCC) type event is comprised of several clusters/areas of cold top convection which develop and merge over parts of central to south Texas.

29. The images above show a comparison between Hydro-Estimates and Stage 3 (radar and rain gage) data from the River Forecast Center for the 24 hour period ending 12Z on November 16, 2001. Pattern-wise, they are similar for the central to south Texas area. As for max amounts, the Hydro-estimator is indicating up to 6-10" (orange color), with localized max up to 11". The WGRFC Stage 3 has max amounts of 10-12". Meanwhile..the Flash Flood Watch statement issues at 1024Z from San Antonio mentions that "rainfall amounts of 2-5 inches have already occurred with isolated amounts up to 8-10."

30. Tennessee - March 17, 2002

31. This IR loop is from 0015Z-1215Z, with missing images between 0345Z-0645Z due to the satellite eclipse period. The loop starts out with small clusters of warm and cold top thunderstorms for the first 3 hours of the loop, followed by an extensive increase in coverage and intensity of convection across most of Tennessee. Cell training occurs as well.

32. A comparison of Auto Estimates and Stage 3 data from the LMRFC for 24 hours ending March 17 at 12Z show a similar pattern. Maximum amounts for the Autoestimator are 4". Stage III indicated max amounts in the 4-5" range over middle Tennessee. The duration, coverage, and coldness of the convective cloud tops were factors that the Hydro-estimator handled well..

33. Arkansas - May 10, 2002

34. This GOES 8 IR 3 hour loop, with an MB enhancement, shows the most persistent cold top thunderstorms located over sw Arkansas..where cell training and mergers occur.

35. This slide shows a comparison between Autoestimates and Stage 3 data from LMRFC. The estimate graphic is for the 6 hour period ending 10Z on May 10. The max estimate is 5.8". The 24 hour LMRFC Stage 3 graphic indicates 6+" over sw Arkansas. Both of these graphics match up fairly well for intensity and location.

36. Hydroestimator examples not handled well

37. Pennsylvania - June 26, 2002

38. Where is the flash flood? This satellite loop shows a sequence of GOES-8 IR images from 1645Z to 2015Z. It begins with warm top thunderstorms over ne PA. Subsequent imagery shows that cloud tops cool, with thunderstorms increasing in coverage and intensity. While the cold tops move/shear northeastward, warmer cells linger/redevelop..resulting in persistent heavy rainfall.

39. Color-enhanced IR loop for the same times as before

40. Visible loop

41. The upper left graphic shows Hydro-Estimates for the ne PA area. Max estimates range from 0.5"-1.2" for the 3 hours ending 1830Z. Below the Hydro-Est graphic is a Flash Flood Warning from Mt Holly, NJ issued at 1806Z. It states that rain gage reports as of 18Z indicate that up to 3" of rain has fallen over..with FFW's for ne Carbon and n Monroe counties. Obviously, the Hydro-Est underestimated the amounts...it did not take into account cell mergers and had difficulty estimating for the warm top cells that remained/redeveloped after the cold top convection moved ne. On the right hand side of the slide is the corresponding manual IFFA estimate graphic and the Stage III graphic. Max IFFA estimates ranged from 1.5-3.5". Since IFFA estimates are a mix of human-machine. the meteorologist takes into account the factors that the Hydro-Est doesn't, such as cell mergers. Also, the meteorologist can better handle warm tops than the Hydro-Est does. Stage 3 data (radar and rain gage) from 12Z-18Z indicated amounts up to 3-4".

42. Florida - June 22-23, 2002

43. What grabs your attention in this loop? Where is the flash flood?

44. This G8 color-enhanced IR loop (RSO) is for the period from June 22 1845Z thru June 23 0115Z. The loop shows thunderstorms over much of central and northern Florida. But look n of Tampa.. over the counties of citrus and Hernando (outlined in red in the previous gray-shade IR loop). Notice how warm and cold top cells keep forming offshore, and then repeatedly train and merge over w Hernando county (red outline in previous IR loop) and sw Citrus county.

45. Visible loop - ends at 1955 UTC

46. The upper left image shows Hydro-Estimates for the period from June 22 19Z to June 23 10Z. While the Hydro-Est indicates up to 3.3" over inland counties, it shows only 1-2" over the Citrus and Hernando counties along the coast. By comparison, manual IFFA estimates for w Hernando were up to 9" for the 6 hr period from 1845Z-0045Z. The meteorologist was able to take into account cell mergers and other factors. The low amounts for the Hydro were a result of: no merger factor; a relatively small area of convection (compared to the larger inland convection which did have higher estimates); and estimating too light for warm top cells.As for a comparison to radar and Stage III: The Flood Warning statement indicates radar estimates of nearly 13" for the 6 hours ending 00Z, which was likely too high. The stage III data (gage and radar) indicates amounts of 6-8" over western Hernando.

47. Texas - October 22-23, 2002

48. These GOES 8 IR images show warm top thunderstorms (cloud top temps in the -40s C) initially located to the nw of Lubbock, Texas. The convection affects Hockley and Lubbock counties.

49. Recognizing the very warm top nature of the event, the SAB Satellite Precipitation meteorologist issued a Satellite Precipitation Estimate Message (SPENES), along with Interactive Flash Flood Analyzer Estimates (IFFA). The Hydro-Estimator, as we will see on a subsequent slide, was significantly underestimating the event.

50. This GOES 8 IR satellite loop shows 6 hour animation of the warm top convection that affected Hockley and Lubbock counties, with some cell training and mergers occurring.

51. This upper portion of this slide shows 2 GOES 8 IR images..for 0545Z and 0615Z. Warm top convection is now over Lubbock county. The lower right portion of the slide shows observations for Lubbock (LBB) for 0553Z thru 0653Z. For the hour ending 0653Z, 2.16" of rain was observed..with $\frac{3}{4}$ " of an inch falling in 8 minutes..between 0553Z and 0601Z. Another 1.02" fell in 24 minutes between 0601Z and 0625Z. Notice, however, that the Hydro-Estimator estimated only 0.3" for the period between 0530Z-0630Z. So, in this case with very warm top clouds of -40s C...the Hydro-Est has significantly underestimated. Obviously, the Hydro-Est was not correcting enough for the very warm tops. Also, it did not pick up on cell mergers..as per satellite loop. And....the convection covered a very small area.

52. This slide shows a comparison between 6 HR Hydro-Estimates (upper left), 6 HR manual IFFA estimates (upper right), 6 HR and Stage III data (lower left) from the Western Gulf River Forecast Center. The max amounts are 1" for Hydro-Estimates, 4" for IFFA estimates, and 3-4" for Stage III.

53. Quiz 1

54. We are looking at a South Texas heavy rainfall event from November 2, 2002. First..look at the IR loop...What do you notice? Now..look at the VIS loop...what do you notice? Now..take your time and carefully compare them to each other. On the lower left portion of the slide..are Satellite Derived winds for mostly high and mid levels. On the lower right portion of the slide..are Surface observations.Now looking at the loops and data, and keeping in mind what we discussed earlier about characteristics of the Hydro-estimator..how do you think the Hydro-Estimator did with this event. Why?

55. When we look at the Hydro-Est for the 3 hour period ending 15Z overlayed with actual observations, we see that the H-E had the heaviest estimates offshore..2.8". Estimated amounts overland and along the coast were much lighter than what was actually observed. The question is..Why? One might have expected the H-E to do well since there are cold tops and the duration has been several hours. However.....the cold cloud tops are sheared offshore, while the cloud bases still protrude overland. The previous loops, and the images shown at the bottom

of this slide show that. Thus, heavy rain persists overland..but the H-E sees the cold cloud tops moving away and focuses in on the tops. Thus, it underestimates the rainfall amounts.

56. Quiz 1 answer

57. Quiz 2

58. This G8 IR loop, with the MB enhancement, runs from 0345Z-1745Z. It shows an MCS over S TX..which develops and is strengthened by clusters of cells which merge into the area main complex. Would you expect the Hydro-Estimator to do well in this case? Why..or why not?

59. While the coverage area of heavy rainfall may vary somewhat between the Hydro-Est and the Stage III data, overall the location and values of the heaviest amounts are fairly close.

60. Quiz 3

61. What features do you see in this loop? What are the cloud top trends? Which location(s) do you think received the heaviest rain? Did the Hydro-estimator handle this case well? Why..or why not?

62. Rainfall estimates

63. Quiz 3 answer

64. Part 5 intro

65. Future hydroestimator improvements

66. Summary

67. SAB Precipitation support

68. Hydroestimator on AWIPS

69. Hydroestimator works best for:

70. Hydroestimator limitations:

71. Contacts

72. Acknowledgements

73. Questions? Email charles.kadin@noaa.gov