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SWIS AND ENHANCING THE EL

[Editor's Note: The attached was first published as an Eastern Region Technical
Attachment and has application in the Western Region as well.]

SWIS AND ENHANCING THE EL

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The Satellite Weather Interpretation System (SWIS) should add to the forecaster's tool box better methods for examining weather features in satellite imagery. Being able to animate pictures will add another dimension to our analysis of satellite data. Similarly, the ability to enhance specific grey shades in the imagery will allow us to high- light features of importance that previously might have escaped our attention with standard enhancement schemes.

Speaking further on the latter capability, SWIS will allow users to assign various shades of six basic colors (in addition to black, white, and grey shades) to specific grey shades inherent to the re- ceived picture. Here, however, it is important to understand that this does not mean assigning colors to specific temperatures or temp- erature ranges in infrared imagery. But rather, colors can be as- signed to grey shades that are meant to represent those temperatures.

This is important because we are dealing with an analog (rather than digital) transmission signal. At times, there may be fluctuations in signal strength that cause variations (lightening or darkening) in the output of grey shades.

This should not present much of a problem if we are simply assigning colors to step contours of a standard enhancement curve (i.e. changing the black segment at -60 to -65 degrees C in the MB-curve to red). Where we can run into problems is in trying to specify (color enhance) an exact temperature range within a linearly enhanced segment of or in an unenhanced infrared image. Fluctuations in signal strength here could lead to false indications of warming or cooling of cloud top temperatures.

This limitation of the SWIS unit is not expected to be a major hin- drance by any means. But a caution flag should arise whenever we attempt to provide fine detail to the infrared image using SWIS.

Enhancement limitations not withstanding, there's much to be gained by using the SWIS enhancement capability providing the user understands the most important features to be highlighted. The following two cases illustrate a relationship between the enhancement of specific temperature intervals and significant weather events. The relation- ship may not always hold, but it can serve as a starting point in the forecaster's search for meaningful data, instead of "nice-looking" pictures.

In forecasting convective weather, Doswell et al. (1982) and McCann (1982) have shown that in the analysis of radiosonde data, the Equili- brium Level (EL) is an important parameter for recognizing strong thunderstorms. Recall that in parcel theory, the EL is simply the level, at which a rising parcel of saturated air becomes colder than the environmental temperature and begins to decelerate (Figure 1).

Stone (1984) has provided a means using AFOS for the forecaster to quickly determine the EL. By knowing the approximate temperature of

the EL and setting the enhancement of infrared imagery at or around
this temperature, strong convection can be monitored, perhaps leading
to the anticipation of severe weather.

CASE ONE:

On 17 August 1985, remnants of Hurricane Danny crossed the Carolinas.
The 1530Z visible GOES picture (Figure 2) shows the cloud shield
encompassing North Carolina and the surrounding area. It is difficult
to distinguish vertical cloud development during midday with straight
visible imagery. Furthermore, with visible imagery, changing sun
angle makes it virtually impossible for the forecaster to quantify
changes in thunderstorm cloud tops over time.

That morning, using Stone's stability analysis program, a representa-
tive EL temperature of minus 56 degrees Celsius had been determined
for the area. On the basis of this EL temperature, an enhancement
scheme was selected from the list of available enhancement techniques
that would highlight temperatures near or above the level of the EL.
The C3 composite visible/infrared enhancement fit this criteria be-
cause its threshold between visible and infrared coincided with the EL
temperature.

It is worthwhile to note here that the current design of SWIS will not
permit the forecaster to manipulate the threshold temperature on
composite VIS/IR imagery. We will still be limited to the existing
enhancement curves for this type of imagery coming from the Satellite
Services Division of NESDIS in Washington. Where the forecaster can
make adjustments to highlight clouds reaching the EL is on straight
infrared imagery, linearly enhanced or completely unenhanced by the
NESDIS computer.

At 1630Z (Figure 3), C3 enhanced imagery began showing cloud top
temperatures at or above the EL over western South Carolina. Twenty
minutes later, at 1650Z, a tornado first appeared northwest of
Spartanburg, SC (see arrow) injuring 39 people, destroying 9 houses
and 38 mobile homes.

With the old Unifax system for receiving satellite pictures, the 1630Z
image would not have arrived to the forecaster until 15 minutes after
the damage had occurred. With SWIS, the forecaster may have gotten a
glimpse of the incoming picture at the same time the damage was occur-
ring. With a direct satellite reception device, such as the Univer-
sity of Wisconsin-based McIDAS, and possibly with future upgraded SWIS
equipment, the image would have been seen by the forecaster some 10 to
15 minutes prior to the event and might have played a role in the
warning process.

By 1930Z (Figure 4), the imagery showed the same thunderstorm cluster
with cloud top temperatures now reduced to minus 75 degrees. Even
with delayed reception of satellite imagery, knowledge of thunder-
storms that continue to overshoot the EL implying a strong persistent
updraft, can play a role in the process of recognizing and warning for
hazardous weather. Between 1630 and 1930Z, severe wind or tornado
damage occurred in several locations across northwest South Carolina.

CASE TWO:

On 24 June 1986, the stability analysis program with 1200Z radiosonde
data from Greensboro showed the EL with a corresponding temperature of
about minus 57 degrees Celsius. All of the standard stability indices
indicated ample thermodynamic support for convection that day across
North Carolina.

The C6 composite visible/infrared enhancement, routinely available
that summer on the DA3 sector, had an infrared threshold (minus 54 C)
approximating the EL with an additional black contour (minus 60 C) to
indicate cloud tops in excess of the EL.

Prior to 1800Z, no infrared segments had been observed implying cloud
tops had been warmer than minus 54, thus lower than the EL. At 1800Z
(Figure 5), a convective cell just to the east of Raleigh-Durham (RDU)
showed infrared enhancement. At 1825Z, three-inch diameter hail fell
from the thunderstorm.

By 1900Z (Figure 6), a line of thunderstorms had developed over north-
east North Carolina. Several cells had cloud top temperatures colder
than the indicated EL temperature. Arrows in the picture show reports
of severe weather that occurred within 15 minutes of the image time.

By 2000Z (Figure 7), the line of thunderstorms over eastern North
Carolina had grown larger with indicated cloud tops well in excess of
the EL. Arrows pinpoint numerous reports of severe weather having
occurred during the ensuing hour. A thunderstorm in western North
Carolina also began showing a cloud top colder than the EL. At the
time of the image, baseball-sized hail had been occurring from that
cell.

In subsequent hours, the thunderstorms continued to produce severe
weather and imagery continued to show cloud tops well in excess of the
EL.

FINAL THOUGHTS AND CONCLUSIONS:

With the capability to enhance specific temperature intervals and the
prospects of earlier GOES imagery reception at the forecast office in
the future, we should recognize the greater role satellite imagery
could have in the warning process for severe or hazardous weather.

Also, though not explicitly discussed in this paper, animation of the
imagery should provide the forecaster with a more accurate means of
extrapolating the movement of weather features in the near term, thus
leading to a better anticipation of significant weather events.

By highlighting the convective cloud tops that reach or exceed the
equilibrium level, the forecaster will be helping to define those
thunderstorms capable of producing severe or hazardous weather.

But in all of our analyses of satellite imagery, we must understand
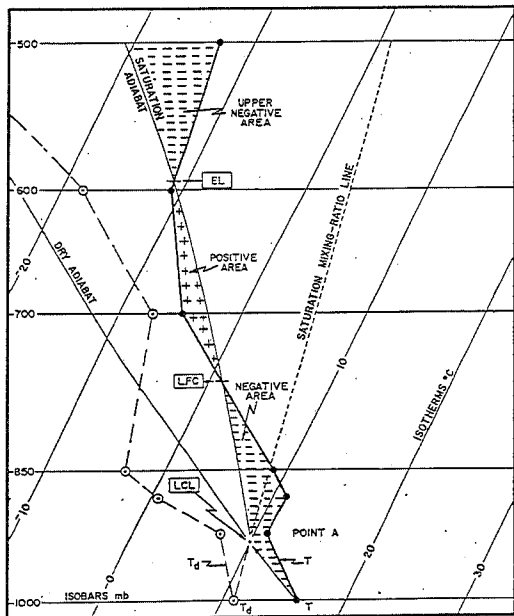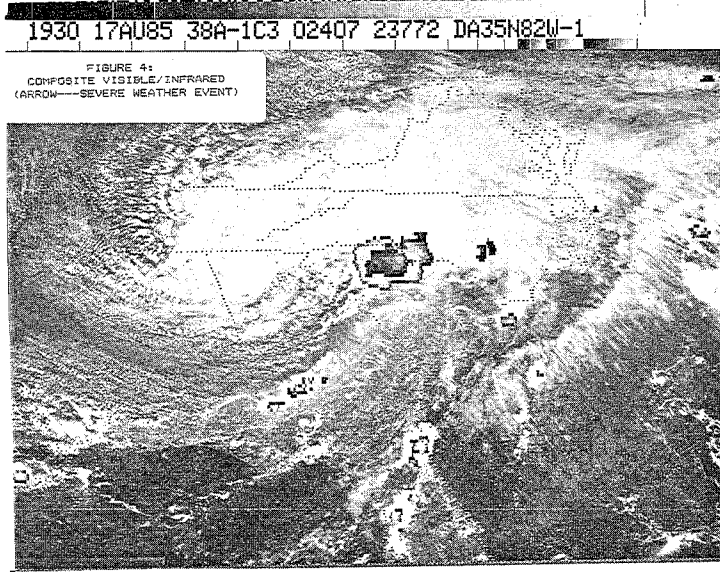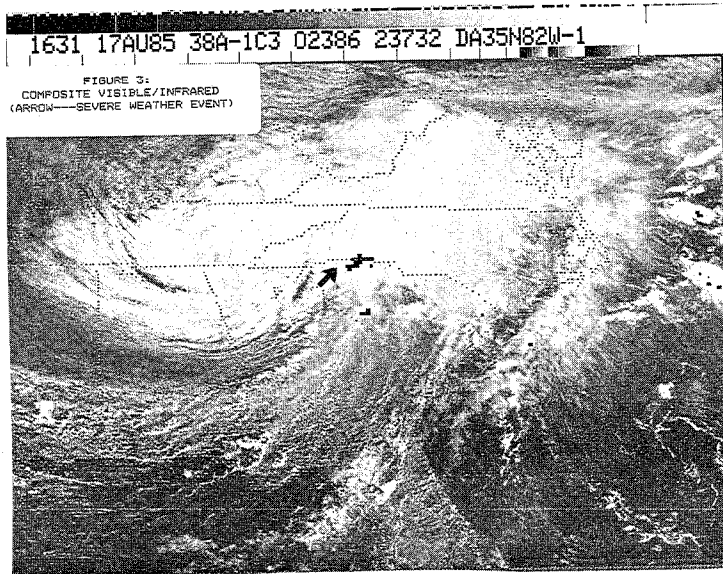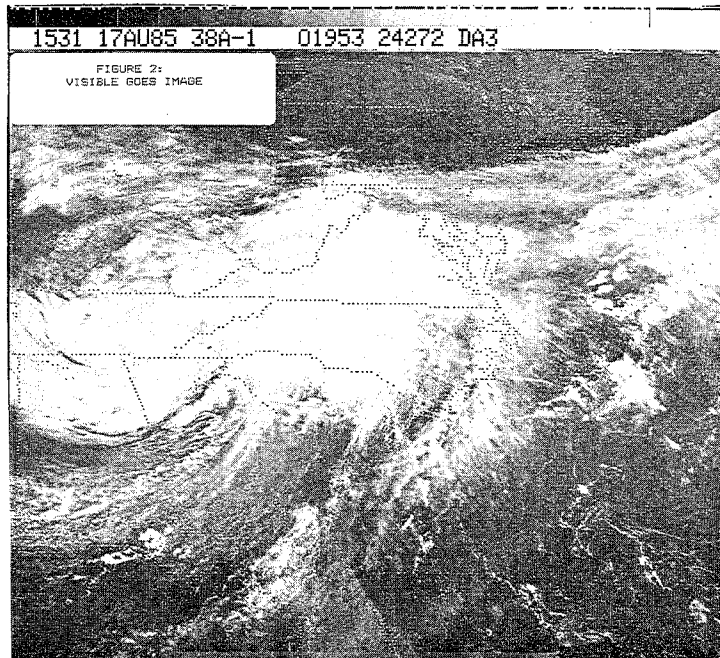the limitations of the equipment and systems we are using. SWIS, at

FIGURE 1:

FINDING THE EQUILIBRIUM LEVEL

1531 17AU85 38A-1   01953 24272 DA3

FIGURE 2:
VISIBLE GOES IMAGE

1631 17AU85 38A-1C3 02386 23732 DA35N82W-1

FIGURE 3:
COMPOSITE VISIBLE/INFRARED
(ARROW---SEVERE WEATHER EVENT)

1930 17AU85 38A-1C3 02407 23772 DA35N82W-1

FIGURE 4:
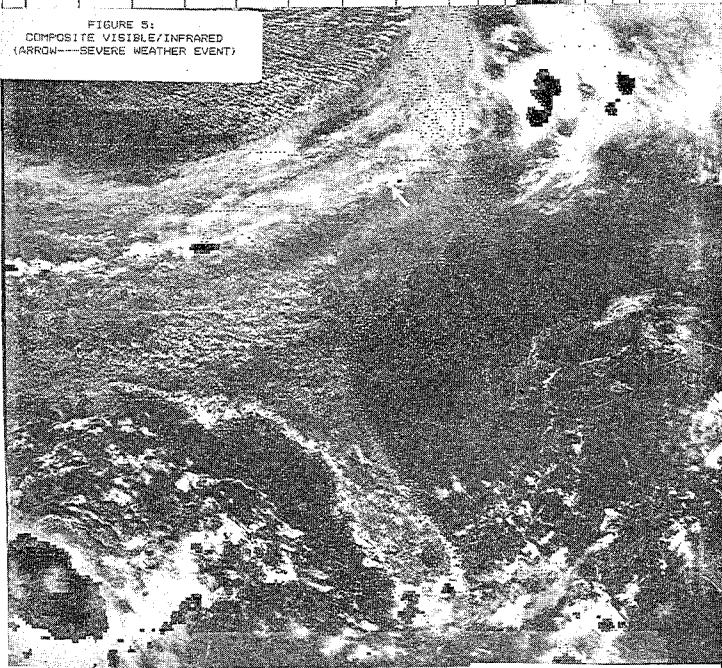COMPOSITE VISIBLE/INFRARED
(ARROW---SEVERE WEATHER EVENT)

times, may give us false indications of warming or cooling of cloud
top temperatures. Besides SWIS, there are limitations inherent in the
GOES imagery (temperature averaging, sensor time response lag, dis-
placement errors, etc) not discussed in this paper that the user
should understand before attempting to use the data in realtime fash-
ion for short-fused events. Additional references are listed below
for this purpose.

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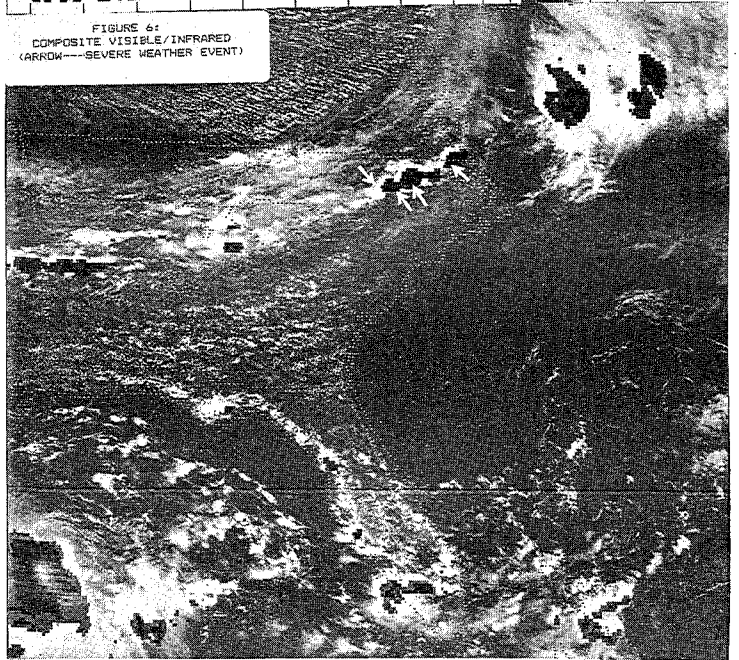   National Weather Service, Washington D.C., 1-E.

1801 24JN86 38A-1C6 02008 26524 DA3

FIGURE 5:
COMPOSITE VISIBLE/INFRARED
(ARROW---SEVERE WEATHER EVENT)

1901 24JN86 38A-1C6 01996 26504 DA3

FIGURE 6:
COMPOSITE VISIBLE/INFRARED
(ARROW---SEVERE WEATHER EVENT)

2000 24JN86 38A-1C6 01997 26484 DA3

FIGURE 7:
COMPOSITE VISIBLE/INFRARED
(ARROW---SEVERE WEATHER EVENT)