Western Region Technical Attachment
No. 93-16
June 1, 1993

A THUNDERSTORM GUST FRONT CAPTURED ON THE PHOENIX WSR-88D AND ON SATELLITE

Keith Meier and Dan Baumgardt
Western Region Scientific Services Division
Salt Lake City, UT

On the evening of 26 May 1993, strong thunderstorms occurred over eastern Arizona in the vicinity of Tucson. In conjunction with these thunderstorms, a gust front was generated, which propagated west-northwestward through the Phoenix area shortly after 0000 UTC 27 May. The gust front, and its associated high winds, caused a considerable dust storm within the Phoenix metropolitan area. This Technical Attachment documents the use of the WSR-88D radar and satellite imagery in tracking the outflow boundary.

WSR-88D

The availability of the WSR-88D radar data in Phoenix allowed the forecasters to issue timely special weather statements. The statements alluded to the detection of the gust front and associated dust storm prior to its arrival in the Phoenix metropolitan area. Figure 1a (base reflectivity) documents the gust front as it approached and moved passed the radar site located at Williams Air Force Base, just southeast of Phoenix. The velocity data (Fig. 1b) assisted forecasters in identifying the wind speeds behind the gust front. At 2357 UTC 26 May, the velocity data showed an area of velocities in excess of 36 knots (the embedded blue within the light green area). The leading edge of the gust front at 2357 UTC 26 May and 0021 UTC 27 May is best seen (southeast of Phoenix) at the interface between the outgoing (yellow) velocities and the incoming (green) velocities.

By 0102 UTC 27 May, the gust front had passed to the west and northwest of the radar site as shown by the line of outbound velocities (yellow) just southeast of the Phoenix metroplex. Over 30 minutes later at 0142 UTC 26 May, the leading edge of the gust front entered Phoenix, and can be identified by the interface between the outbound velocities (yellow/red) and the inbound velocities (green) to the northwest of the radar site.

The radar velocities for the 0.5° elevation angle corresponded well to ground truth observations. It was just prior to 0142 UTC that Mesa Falcon Field (≈ 13 nmi northwest of the radar site, near the "X" of PHX) reported a peak wind near 40 miles per hour (mph). Also, Stewart Mountain Dam (≈ 17 nmi north-northeast of the radar, indicated by the "*") reported 34 mph gusts behind the outflow boundary. As can be seen by the velocity panel at 0102 UTC, an incoming maximum of 36-50 knots (blue) was located behind the gust front. Since the wind direction was aligned nearly along the radar radial at that point, it is representative of wind speeds behind the gust front at approximately 1000 feet above the surface.

Satellite

The visible (with IR enhancement) satellite picture at 0031 UTC 27 May (Fig. 2) also identified the gust front, which moved westward from the area of thunderstorms towards the Phoenix area. The appearance of gust fronts on satellite imagery over the western United States is a rare occurrence, since the lower levels tend to be dry. These dry, low-level conditions typically do not support the formation of cumulus along the gust front (as is the case in most other areas of the United States). The gust front appeared on the satellite pictures as it moved through Phoenix (Fig. 3). Nearly an hour and a half later, the gust front was still apparent on the infrared satellite imagery (Fig. 4), still emanating westward from the complex of thunderstorms over eastern Arizona.

Concluding Discussion

This case exemplifies the tremendous advantages of using WSR-88D radar data in locating mesoscale boundaries. Also, it illustrates the usefulness in providing lead-time to the public for threatening weather conditions. These data were supplemented with a rare satellite depiction of a gust front over the western United States. Together, these two data sources will prove to be extremely useful tools in the location and prediction of threatening weather events in the future.

Figures

Figure 1a. Four-panel, 1.5° elevation angle, 0.54 nmi resolution base reflectivity product from the WSR-88D at Williams A.F.B., AZ. Product times are 1) 23:57 UTC 26 May 1993 2) 00:21 UTC 27 May 1993 3) 01:02 UTC 27 May 1993 4) 01:42 UTC 27 May 1993. Radar site indicated by the dark ring southeast of Phoenix. Stewart Mountain Dam is indicated by an "*".

Figure 1b. Same as Fig. 1a, except 0.5° elevation angle, base velocity product. Cool (warm) colors represent inbound (outbound) velocities.

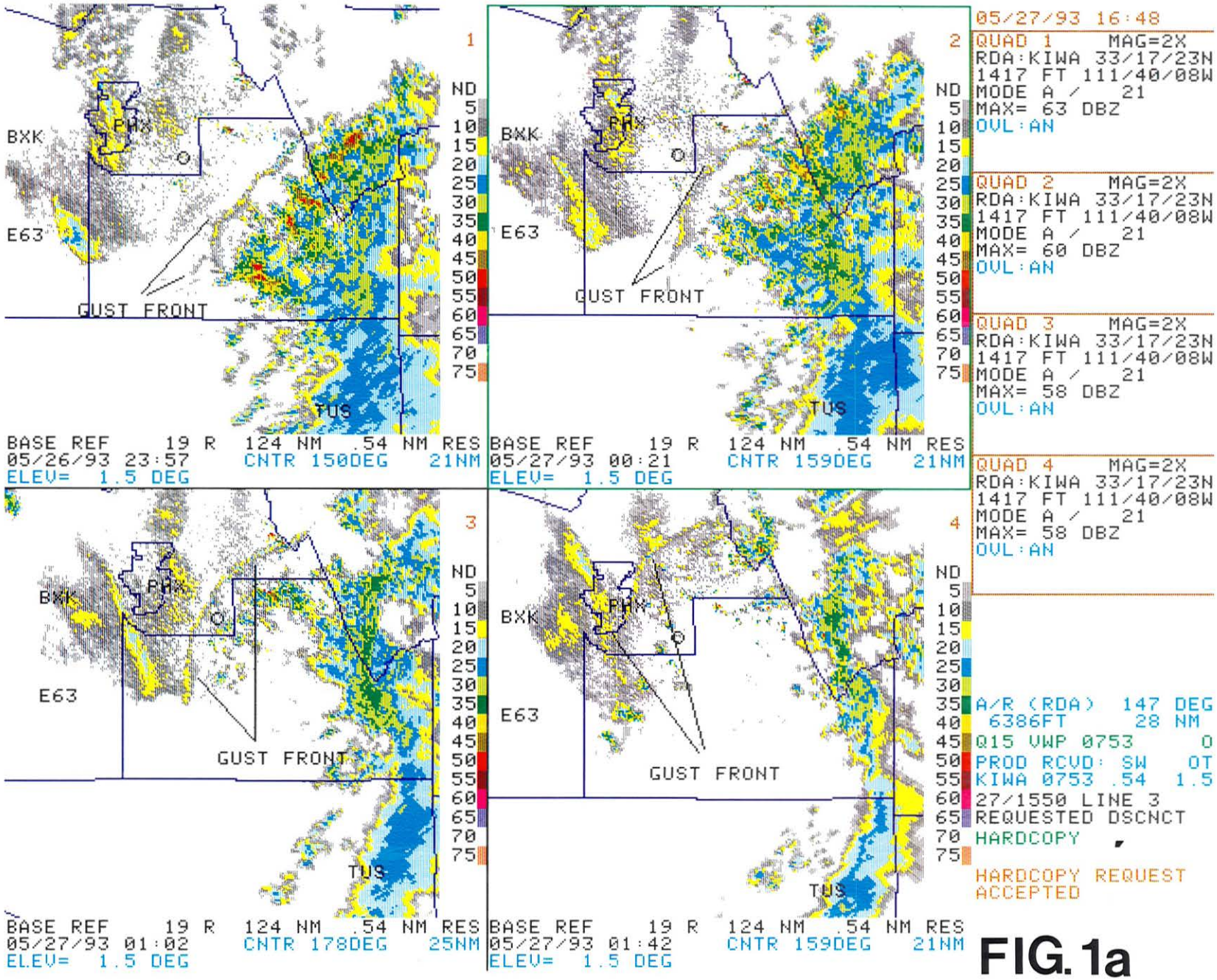
1
BXK
PHX
E63
GUST FRONT
TUS
ND
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
BASE REF 19 R 124 NM .54 NM RES
05/26/93 23:57 CNTR 150DEG 21NM
ELEV= 1.5 DEG
2
BXK
PHX
E63
GUST FRONT
TUS
BASE REF 19 R 124 NM .54 NM RES
05/27/93 00:21 CNTR 159DEG 21NM
ELEV= 1.5 DEG
3
BXK
PHX
E63
GUST FRONT
TUS
BASE REF 19 R 124 NM .54 NM RES
05/27/93 01:02 CNTR 178DEG 25NM
ELEV= 1.5 DEG
4
BXK
PHX
E63
GUST FRONT
TUS
BASE REF 19 R 124 NM .54 NM RES
05/27/93 01:42 CNTR 159DEG 21NM
ELEV= 1.5 DEG
05/27/93 16:48
QUAD 1 MAG=2X
RDA:KIWA 33/17/23N
1417 FT 111/40/08W
MODE A / 21
MAX= 63 DBZ
OVL:AN
QUAD 2 MAG=2X
RDA:KIWA 33/17/23N
1417 FT 111/40/08W
MODE A / 21
MAX= 60 DBZ
OVL:AN
QUAD 3 MAG=2X
RDA:KIWA 33/17/23N
1417 FT 111/40/08W
MODE A / 21
MAX= 58 DBZ
OVL:AN
QUAD 4 MAG=2X
RDA:KIWA 33/17/23N
1417 FT 111/40/08W
MODE A / 21
MAX= 58 DBZ
OVL:AN
A/R (RDA) 147 DEG
6386FT 28 NM
Q15 VWP 0753 0
PROD RCVD: SW OT
KIWA 0753 .54 1.5
27/1550 LINE 3
REQUESTED DSCNCT
HARDCOPY
HARDCOPY REQUEST
ACCEPTED

FIG. 1a

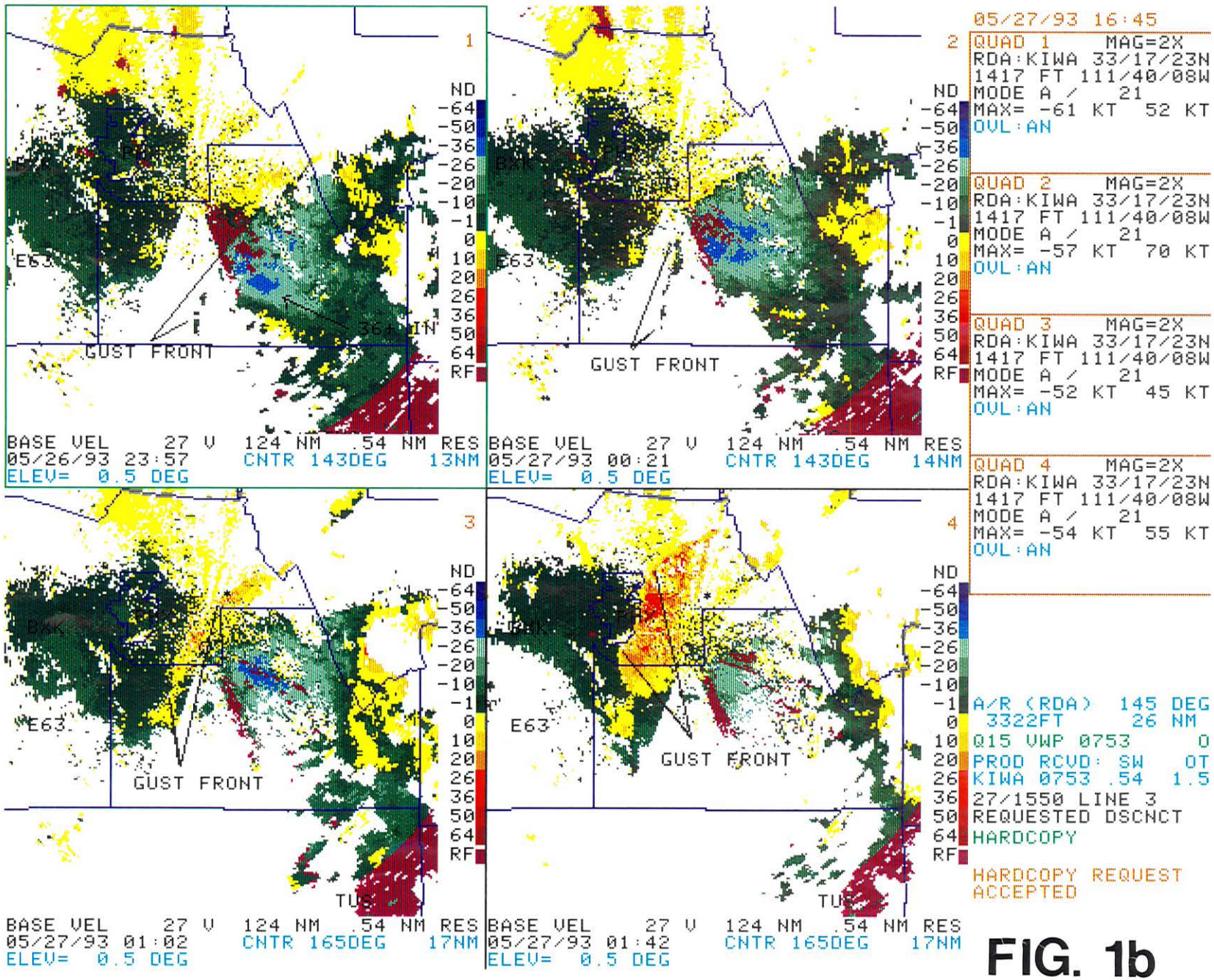
1
ND
-64
-50
-36
-26
-20
-10
-1
0
10
20
26
36
50
64
RF
E63
GUST FRONT
BASE VEL 27 V 124 NM .54 NM RES
05/26/93 23:57 CNTR 143DEG 13NM
ELEV= 0.5 DEG
2
GUST FRONT
BASE VEL 27 V 124 NM .54 NM RES
05/27/93 00:21 CNTR 143DEG 14NM
ELEV= 0.5 DEG
3
GUST FRONT
BASE VEL 27 V 124 NM .54 NM RES
05/27/93 01:02 CNTR 165DEG 17NM
ELEV= 0.5 DEG
4
GUST FRONT
BASE VEL 27 V 124 NM .54 NM RES
05/27/93 01:42 CNTR 165DEG 17NM
ELEV= 0.5 DEG
05/27/93 16:45
QUAD 1 MAG=2X
RDA:KIWA 33/17/23N
1417 FT 111/40/08W
MODE A / 21
MAX= -61 KT 52 KT
OVL:AN
QUAD 2 MAG=2X
RDA:KIWA 33/17/23N
1417 FT 111/40/08W
MODE A / 21
MAX= -57 KT 70 KT
OVL:AN
QUAD 3 MAG=2X
RDA:KIWA 33/17/23N
1417 FT 111/40/08W
MODE A / 21
MAX= -52 KT 45 KT
OVL:AN
QUAD 4 MAG=2X
RDA:KIWA 33/17/23N
1417 FT 111/40/08W
MODE A / 21
MAX= -54 KT 55 KT
OVL:AN
A/R (RDA) 145 DEG
3322FT 26 NM
Q15 VWP 0753 0
PROD RCVD: SW OT
KIWA 0753 .54 1.5
27/1550 LINE 3
REQUESTED DSCNCT
HARDCOPY
HARDCOPY REQUEST
ACCEPTED

FIG. 1b

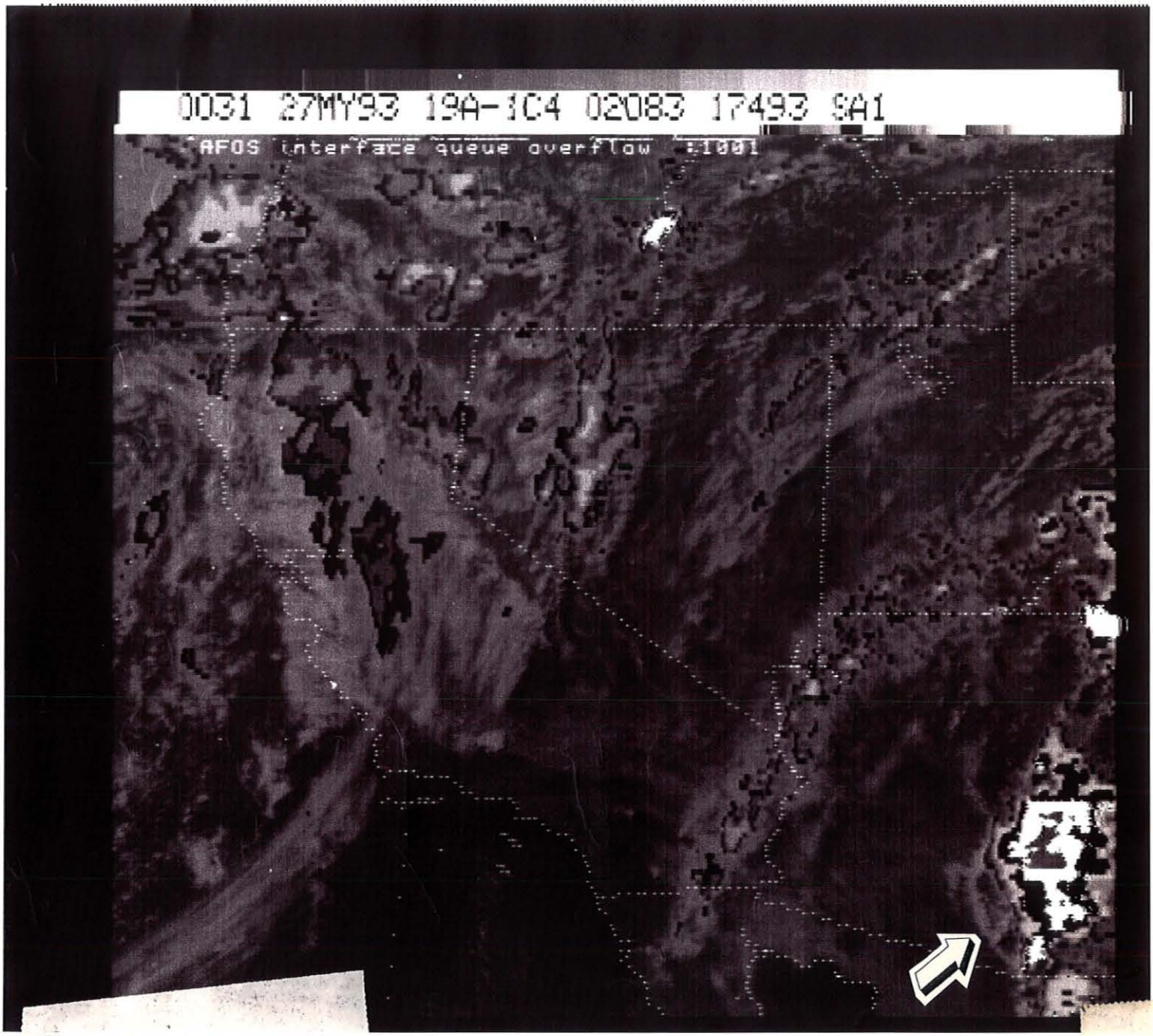

Figure 2. Visible-Infrared enhanced (cloud tops) satellite image from 0031 UTC 27 May 1993.

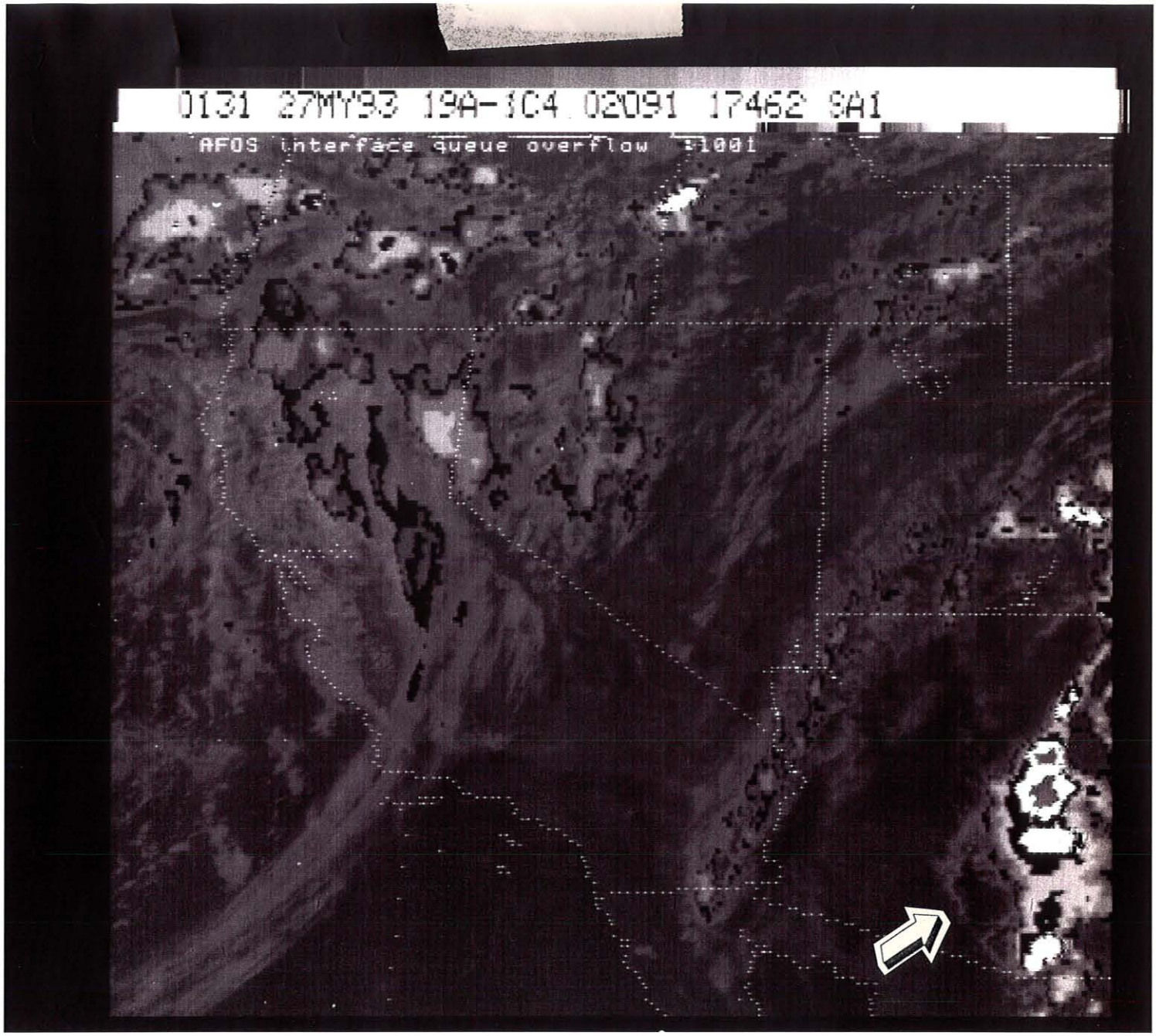

Figure 3. Same as Fig. 2, except at 0131 UTC 27 May 1993.