WESTERN REGION TECHNICAL ATTACHMENT
NO. 87-27
August 4, 1987

IMPACT OF WEATHER ON AVIATION #1

Density Altitude

Dennis Sturm, WSFO Phoenix

[Editor's note: Earlier this year, all Western Region WSFOs conducted studies on weather phenomena which had an adverse impact on airports in their forecast areas. The following was provided by Dennis Sturm, WSFO Phoenix.]

Both field elevation and temperature will affect the performance of an airplane, especially light, non-turbocharged engine aircraft. Density at high elevation stations is low by virtue of the altitude. Likewise, an increase in temperature makes the air less dense, which increases the density altitude. (The density altitude is pressure altitude modified by temperature.)

As density altitude increases, aircraft performance decreases. Engine performance and aircraft airframe efficiency are adversely affected, which alter takeoff and landing distances and rate of climb.

The warmer a high elevation airport is, the less efficient the aircraft engine (due to lack of oxygen) and the less efficient the aircraft wings (requiring the true airspeed to be higher). These result in longer takeoff and landing distances and shallower climbouts on takeoff.

For example, look at the Cessna 172P takeoff distance chart on the next page. For a maximum weight of 2,400 pounds, with a temperature of 86F (30C), the ground roll at Phoenix (approximately 1,000 feet MSL) is 1,090 feet, but at Flagstaff (approximately 7,000 feet MSL) the ground roll is 2,000 feet. The Cessna will need almost twice as much runway to depart Flagstaff as was needed to depart Phoenix. Also, over twice as much distance would be needed to clear a 50-foot obstacle--2,000 feet at Phoenix versus 4,220 feet at Flagstaff--due to the shallower climbout at Flagstaff.

Note that the distances on the chart are for calm winds. A headwind will shorten distances. In the Cessna 172P case, distances will decrease ten percent for each 9 knots of headwind. The chart also shows that weight affects the takeoff distance. The same plane at Flagstaff in 86 degree F weather could decrease the amount of runway needed for takeoff by more than 700 feet if the aircraft weighed 2,000 rather than 2,400 pounds (all other factors being equal.)

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE
Silver Spring, Md. 20910

July 23, 1987 W/OSD21:GMC

MEMORANDUM FOR: Addressees Listed Below

FROM: Gary M. Carter
Chief, Synoptic-Scale Techniques Branch, TDL

SUBJECT: Comparative Verification of NGM-based Perfect Prog Forecasts

As you know, the new, NGM-based perfect prog system to forecast probability of precipitation (PoP), maximum/minimum temperature, surface wind, and cloud amount is now fully operational. (In deference to AFOS loading considerations, this statistical guidance for 204 locations throughout the contiguous United States was implemented in two phases on May 11 and June 17.) By making use of recent AFOS-era verification data, we've compared the accuracy and skill of the perfect prog forecasts to the LFM-based MOS guidance produced during May and June. These results are shown in Attachments 1-13.

The PoP and temperature forecast scores are provided for each NWS region separately in addition to the overall results for all 93 stations combined. Except for surface wind, the corresponding scores for the locals are plotted for general reference. Of course, the local forecasters did not have access to the perfect prog guidance throughout the entire 2-month period.

As shown in Attachment 1, the national results for PoP indicate that there is little difference in the skill of the MOS and perfect prog guidance; however, some regional variations are evident in Attachments 2-5. The mean absolute errors for the maximum/minimum temperature forecasts (Attachments 6-10) reveal the superiority of MOS over perfect prog. As indicated by the mean algebraic errors which are given in parentheses, the NGM-based temperature guidance suffers from a dramatic cold bias. The skill levels of the MOS and perfect prog best category cloud forecasts are quite similar (see Attachment 11). Finally, the results in Attachments 12 and 13 indicate the perfect prog surface wind forecasts are usually more skillful than MOS for both direction and speed. However, the mean absolute error statistics given in parentheses reveal that MOS is superior to perfect prog in forecasting wind direction.

In addition to calculating average scores for the guidance during the past 2 months, we used archived data to produce perfect prog maximum temperature forecasts for an East Coast cold air damming event that occurred on January 18, 1987 (see Attachment 14). As indicated by comparison of the errors presented in Attachment 15, it is apparent that the NGM-based perfect prog system could have provided guidance for the Central and Southern Appalachians that was much better than that produced by the operational MOS temperature system.

I hope you'll find this preliminary analysis of the new perfect prog guidance to be of some use to forecasters in your region.

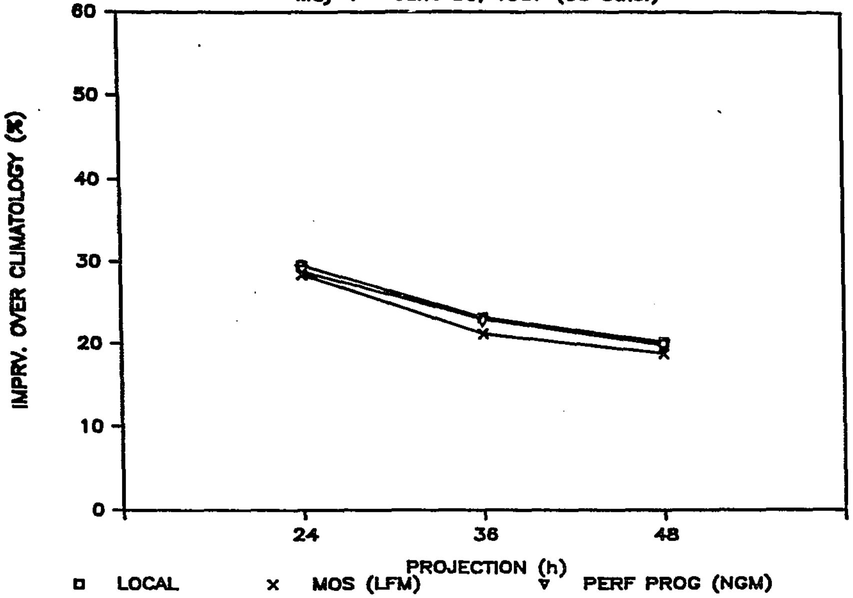
Attachments (15)

Addressees:
W/ER3 - Fred L. Zuckerberg
W/SR3 - Daniel L. Smith
W/CR3 - Joseph T. Schaefer
W/WR3 - Glenn E. Rasch

Attachment 1

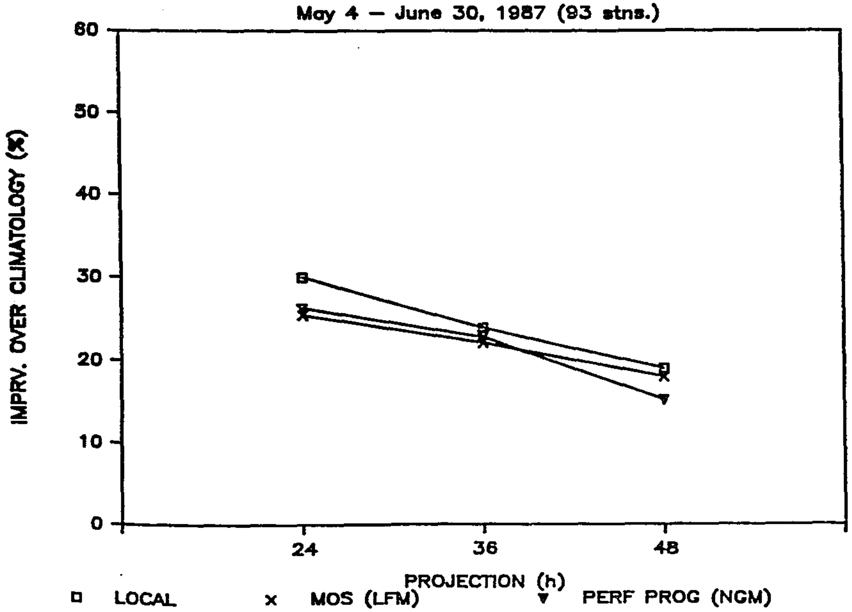
POP FORECASTS, 0000 GMT

May 4 — June 30, 1987 (93 stns.)



POP FORECASTS, 1200 GMT

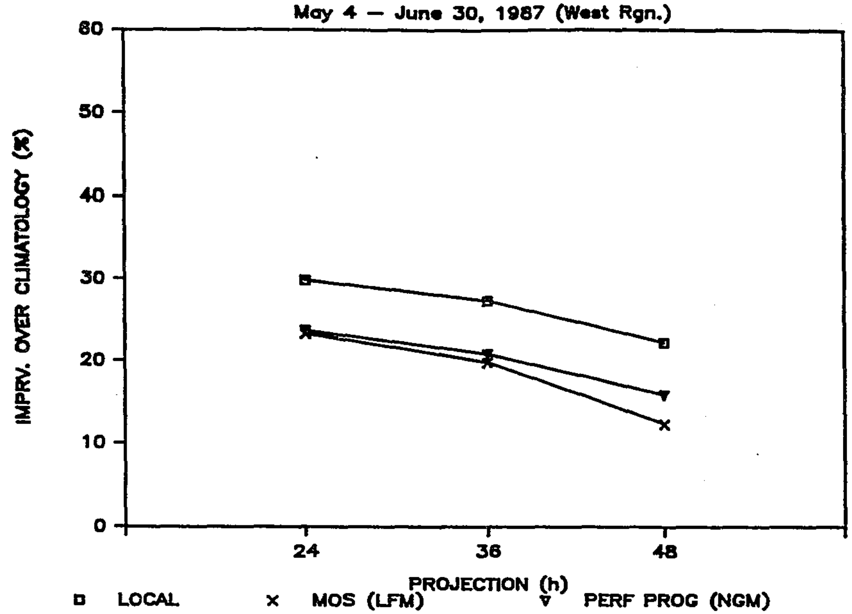
May 4 — June 30, 1987 (93 stns.)



Attachment 5

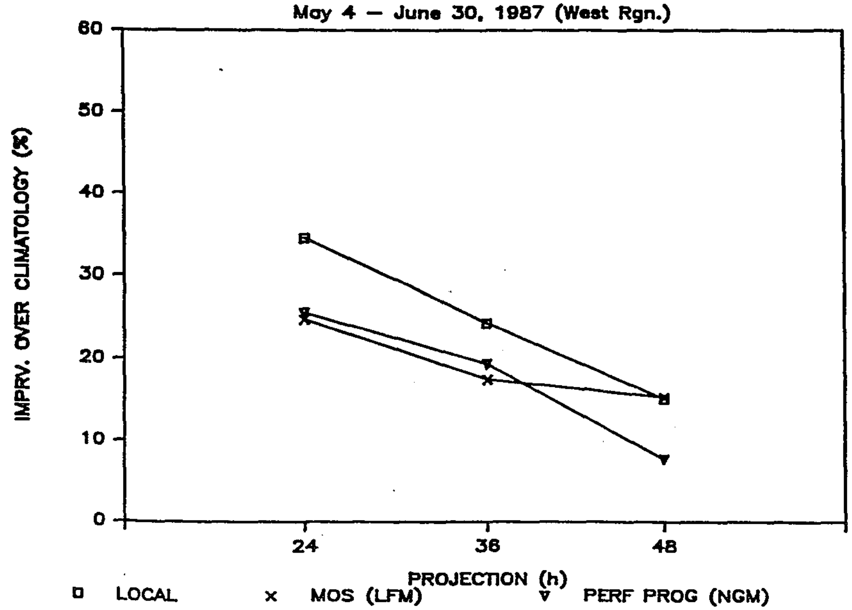
POP FORECASTS, 0000 GMT

May 4 — June 30, 1987 (West Rgn.)

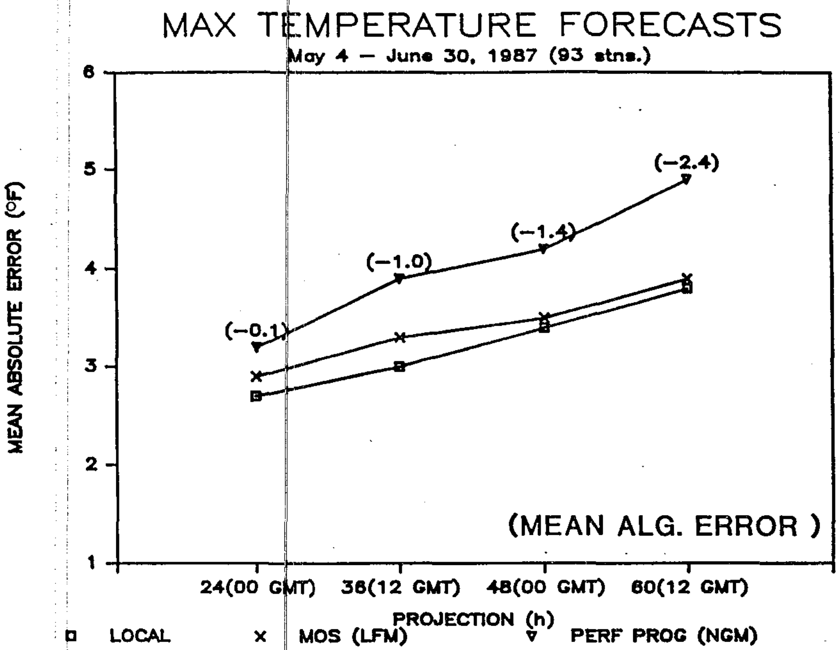


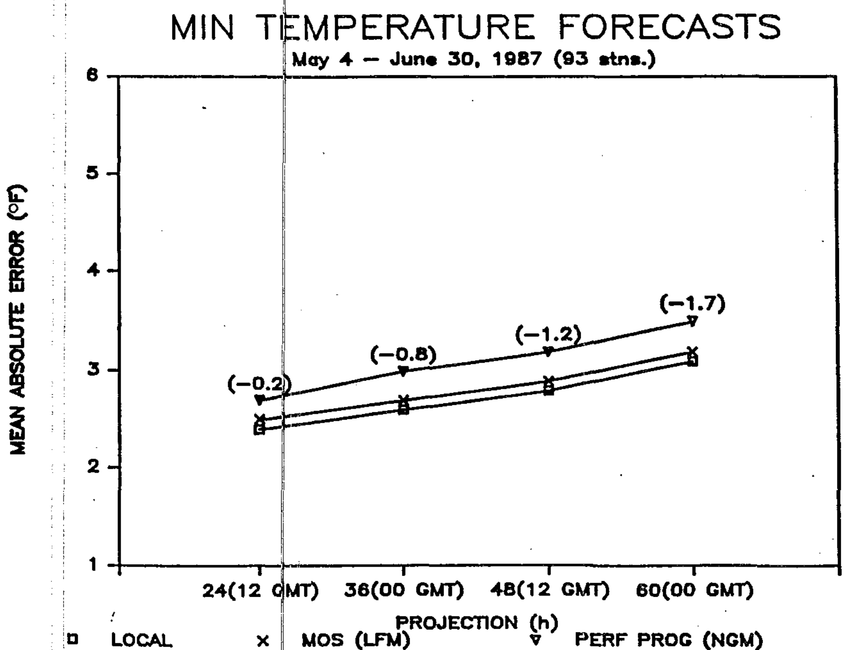
POP FORECASTS, 1200 GMT

May 4 — June 30, 1987 (West Rgn.)

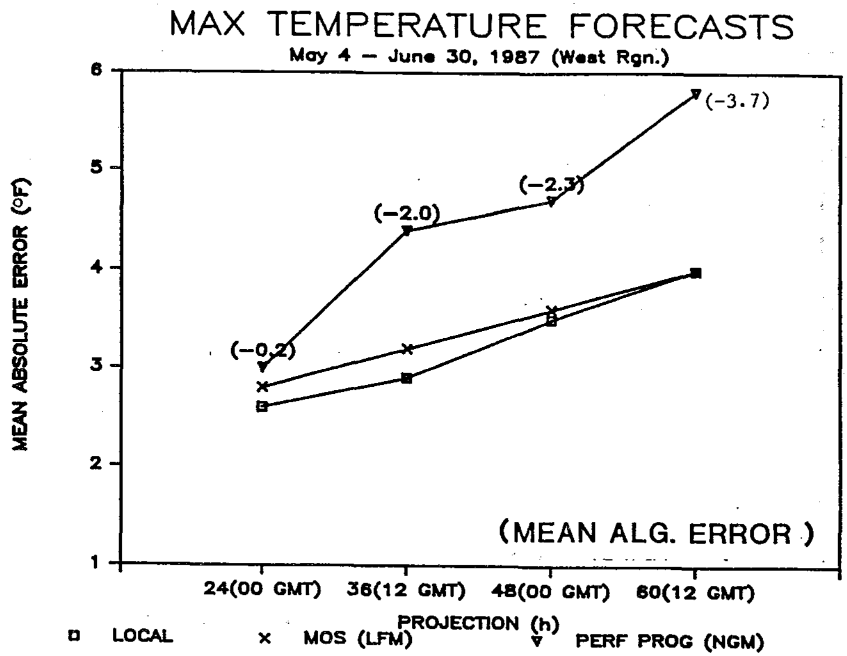


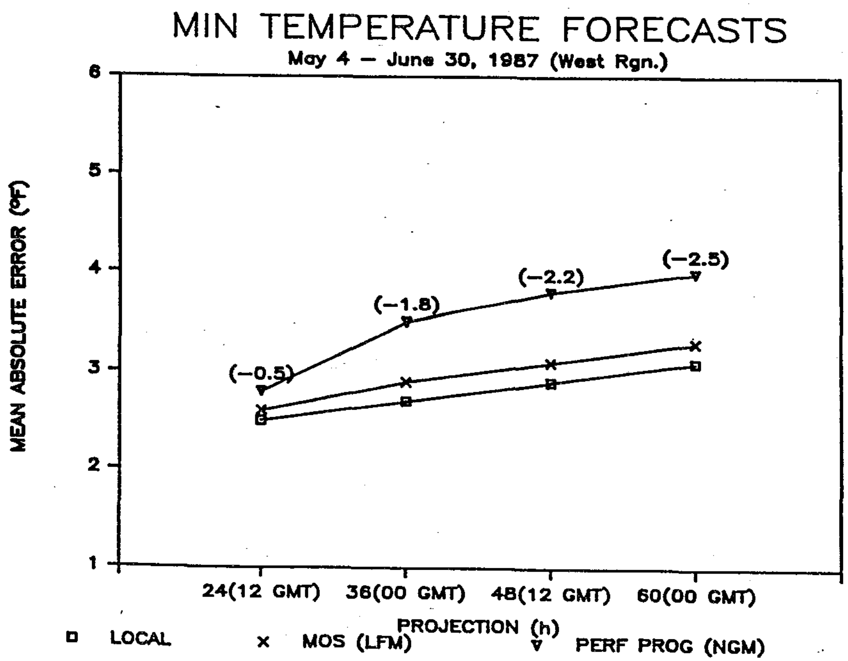
Attachment 6



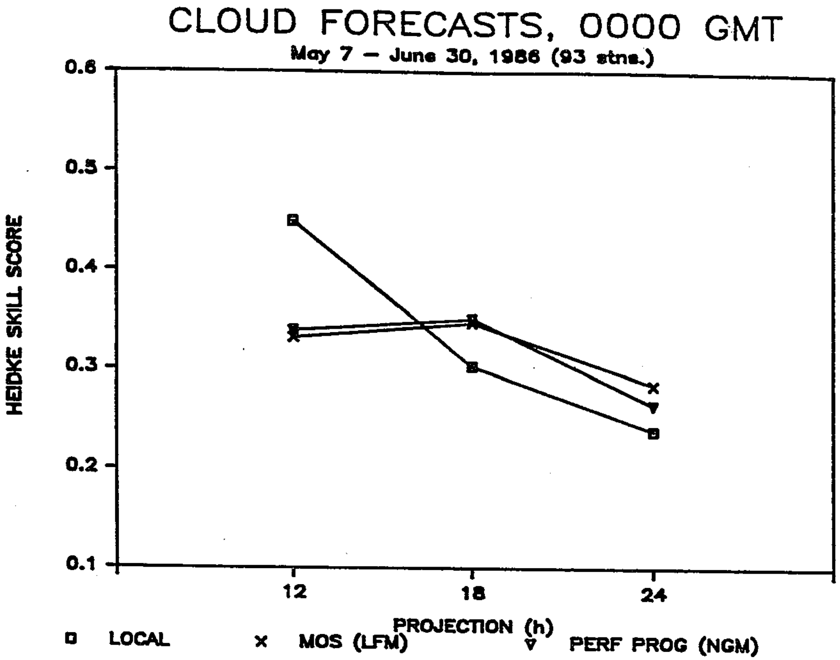


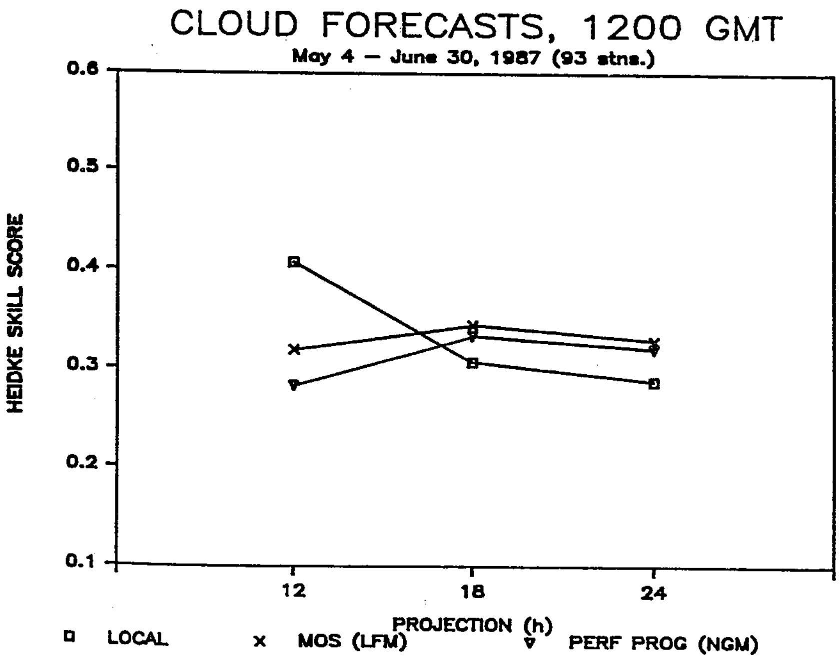
Attachment 10



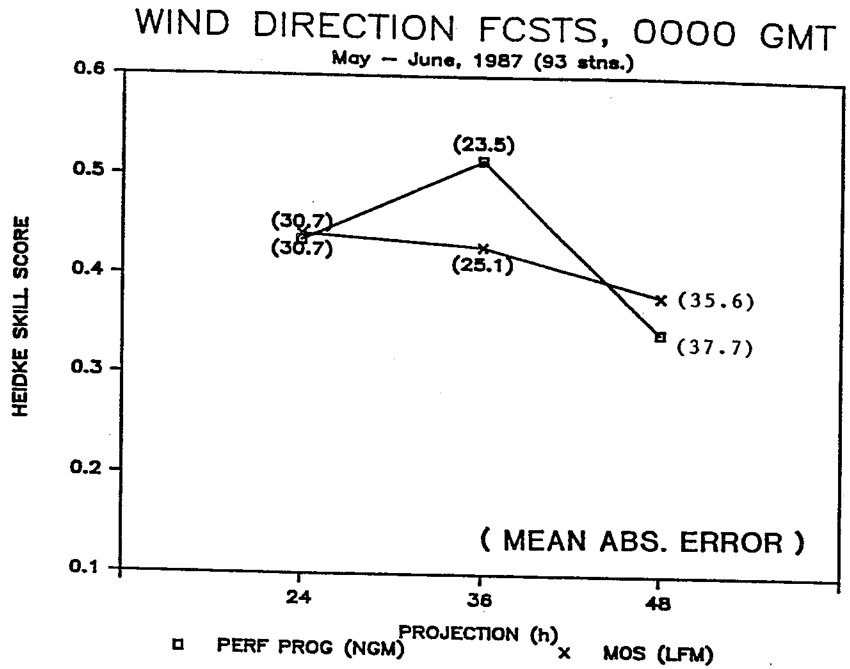


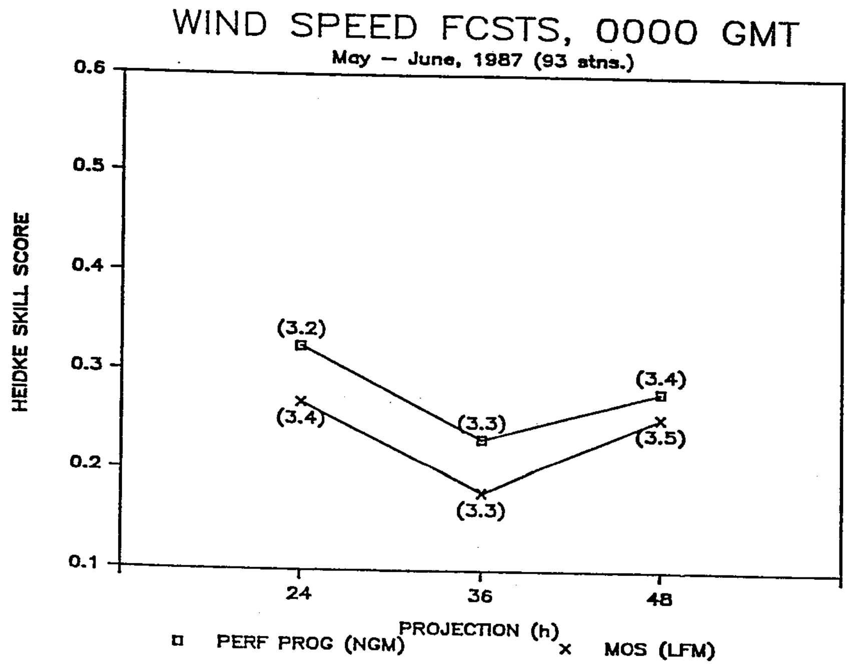
Attachment 11



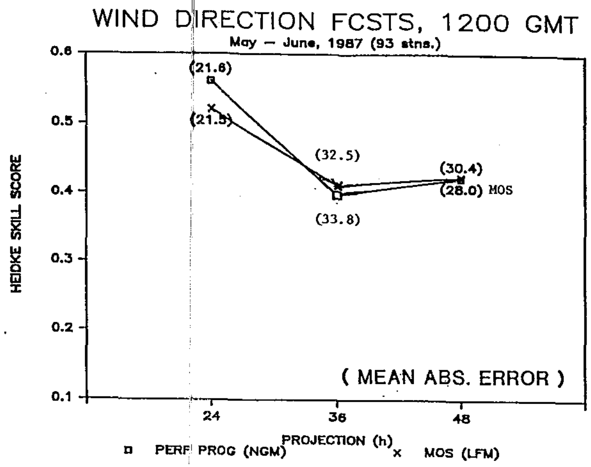


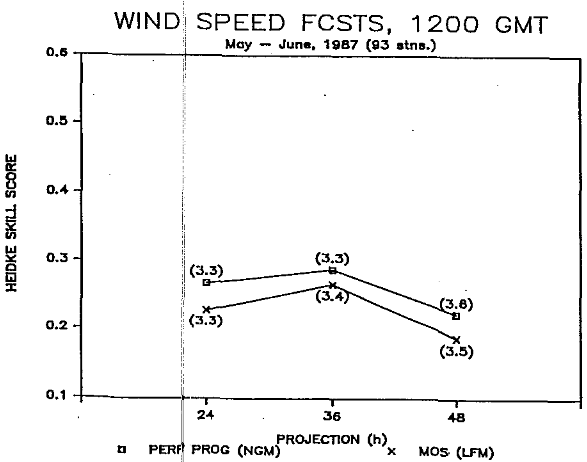
Attachment 12



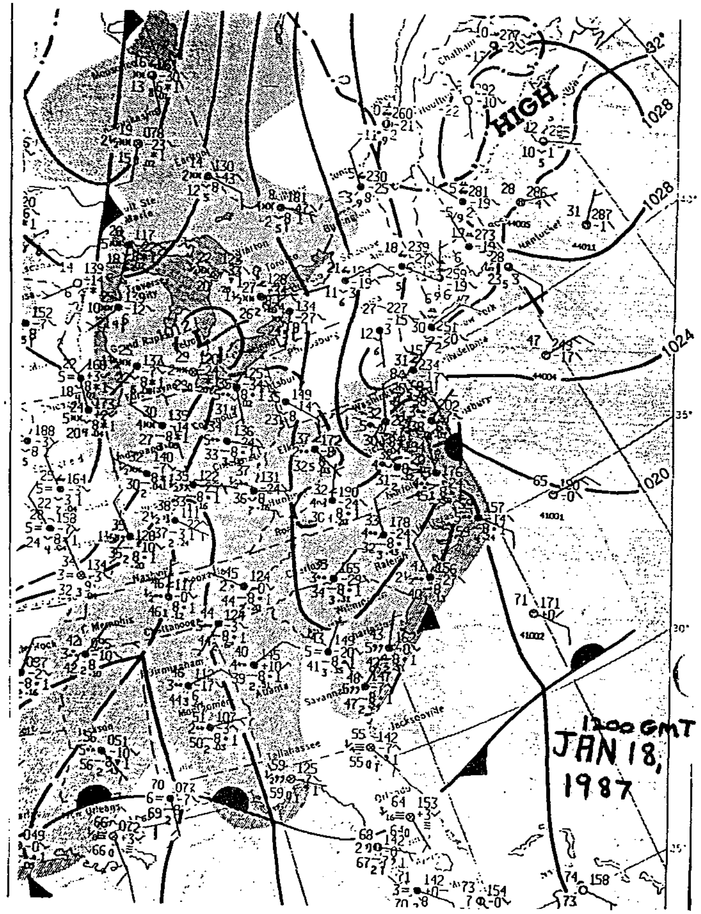


Attachment 13





Attachment 14



Attachment 15

MAX TEMP
FORECAST ERRORS
0000 GMT, 24 Hour Forecasts
January 18, 1987

STATIONS	OBS MAX	LFM MOS	NGM PP	IMPV OVER MOS
BWI	37	+ 4	0	+ 4
DCA	38	+ 4	− 1	+ 3
IAD	34	+ 7	+ 2	+ 5
RIC	36	+11	+ 1	+10
ROA	37	+ 4	0	+ 4
RDU	38	+16	+ 4	+12
AVL	41	+ 8	+ 4	+ 4
GSO	38	+ 8	+ 2	+ 6
CLT	40	+10	+ 3	+ 7
GSP	40	+10	+ 5	+ 5
CAE	43	+17	+ 5	+12
AGS	45	+19	+ 1	+18
ATL	43	+13	0	+13
AHN	41	+16	+ 1	+15
M A E	----	10.5	2.1	----
ACY	44	+ 1	− 5	− 4
ORF	44	+13	− 4	+ 9
HAT	64	− 2	− 8	− 6
ILM	48	+16	+ 5	+11
CHS	51	+12	− 1	+11
M A E	----	8.8	4.6	----
TOTAL MAE		10.1	2.7	