NWS-CR-TA-91-04

CRH SSD
FEBRUARY 1991

CENTRAL REGION TECHNICAL ATTACHMENT 91-04

A FORECAST TECHNIQUES HANDBOOK

Daniel M. Bloom and Anton F. Kapela
National Weather Service Forecast Office
Sioux Falls, South Dakota

1. Introduction

Many tools for forecasting are available at a Weather Service Forecast Office (WSFO). However, at the WSFO Sioux Falls, these tools and techniques were scattered throughout various locations in the office. The notebook described in this paper resulted from a long term effort to gather this information into one place and to make it easier for the forecaster to use on a real time basis.

2. Sources of Information

Several sources for information were considered. Information on some of the AFOS applications in operational use were included such as hodographs, convect program, and MESOS. Summer and winter storm checklists were collected into sections, such as Arctic outbreak, derechoes, and severe weather checklists. Local studies, such as cumulus development, terrain effects, and maximum temperatures were included. Another forecaster in the office contributed information on microbursts. Information on more commonly known tools, such as MOS, PIVA, jetstream, trajectory, and wind chill, have been collected. Some rules of thumb from the National Meteorological Center (NMC) were used. A few sections from hydrology fit the context of the handbook.

In addition to collecting the material, each technique or tool was placed in a separate section of the notebook. The material gathered into some sections was still too cumbersome for forecasters to access on a real time basis. Further work on these sections was necessary. Important points in some sections were highlighted with a yellow highlighter. In some cases, only parts of the articles were included. For other articles, it was found more useful to take notes of the important points and type them on a separate sheet of paper.

3. Parts of the Forecast Techniques Handbook

Due to the number of sections, the handbook was broke up into three parts: one for summer, one for winter, and a general one that can be used any season. A complete index is found in Appendix 1. The remainder of this section will briefly describe the sections in each of these three parts.

A. General Part

Buss Cu - A local cumulus cloud development study was done at the WSFO Sioux Falls in the early 70's. No paper was found on it. The information was passed down from forecaster to forecaster. A brief summary of the technique was written by one of the forecasters and included in the text.

Dam Break - Classic rules of thumb for dam breaks were included in this text for quick reference.

Flash Flood - A variety of information went into the flash flood section. Some information from the June 9, 1972 Rapid City flash flood was included. Information for this section was also taken from Maddox et al. (1978), Maddox (1979), and Hughes and Longsdorf (1978).

Hage Lows - The section on Hage lows comes from Central Region Technical Attachment 71-14.

Isallobaric Wind - Information on isallobaric wind came from Western Region Technical Attachment 68-10 and notes from a seminar given by the second author based on Saucier (1955).

Isentropic Analysis - Information on isentropic analysis came from Truett (1987), Moore (1988), and notes from a seminar given by the second author.

Jet Stream - The section on jet streams included jet streaks as well as jet streams. The text included information from Reihl (1952), Namis and Clapp (1949), Uccellini (1979), and notes from a seminar given by the second author.

MOS - The section on MOS contained quick references for decoding the FPC and FRH products in AFOS.

PIVA/NIVA - The PIVA section included information on PIVA, NIVA and vertical motion covered in notes from a seminar by the second author based on Sangster (1980).

QG Diagnostic - The QG Diagnostic section has information on the use of the UA or AUA programs by Barnes (1985 and 1987). Notes from Anderson (1988a) were also included.

QPF NMC - Notes from a seminar given by Sokich (National Meteorological Center) in 1988 comprise the section QPF NMC.

SANGSTER - Central Region Technical Attachment 74-11 was the basis for the section on geostrophic wind.

Satellite - The section on satellites includes information from GOES Technical Attachment 75-g8.

Symmetric Instability - Part of a paper by Lussky, 1989, comprised the section on symmetric instability or slantwise convection.

Terrain Effects - The section, terrain effects, contains notes from the second author on how the terrain in various parts of South Dakota affect the state's weather.

Thermal Wind - The information on thermal wind came from notes from a seminar by the second author based on Sutcliffe and Forsdyke (1950).

Trajectory - Part of Reap (1978) comprise the section on trajectory.

Upslope Effects - A paper by Spagnol (1982) comprises the section on how orographically enhanced (upslope effect) precipitation is generated.

ZRVL - Rosendal's 1979 work on zero relative vorticity line comprised the ZRVL technique section.

B. Summer Part

Derechoes - The work by Johns and Hirt (1987) and checklist comprised the section on derechoes.

Hodographs - The section on hodographs includes notes on hodographs and Richardson number from a seminar given by Anderson (1987) as well as parts from Anderson (1988b), Rasmussen and Wilhelmson (1983), Scofield (1987), and Stone (1988).

Max Temp - Max temperature forecasting included a local study done at this WSFO. No paper was found.

MCC - The section on MCC includes checklists for different types and notes from Anderson (1989).

MESOS - The section on MESOS includes the ADAP decision tree and notes on the ADAP or MESOS products available. Information from the following works were included: Bothwell (1986), Bunting (1987), Doswell (1982), Hudson (1971), Iribarne and Godson (1973), Johns et al. (1986), McGinley (1984), McNulty (1978), Moller (1980), Siebers and Schaefer (1983), Snow et al. (1980), and Stone (1987).

Microburst - The section on microbursts includes checklists and notes on wet, intermediate, and dry microbursts. The notes were written by Anderson and based on Caracena et al. (1989).

QPF - The QPF rules of thumb in this part comes from QPF general guidelines/rules of thumb - convection/warm season rules.

Rainfall from Satellites - Rainfall from satellites comes from the work of Scofield and Oliver (1977).

Severe Thunderstorm Detection - The section, severe thunderstorm detection, contains information on radar echoes and techniques to interpret the echoes. Information in this section came from radar courses at the National Weather Service Training Center.

Severe Thunderstorm Forecasting - Notes from Johns (1986) comprise the section on severe thunderstorm forecasting. Seminar notes on nocturnal thunderstorm forecasting by Anderson (1988a) were included.

Severe Weather Checklists - The section, severe weather checklists, includes checklists from Miller (1972), and NWS Central Region Applied Research Paper 88-3.

Stability Index - The stability index section consisted of notes from Sadowski and Rieck (1977) on stability indexes used by the National Weather Service.

Tstm Prob Nomogram - The thunderstorm probability nomogram contains a nomogram on thunderstorm probability from Foster and Reap (1977) and a brief instruction how to use it.

Wrist - Wrist includes Lowden's 1984 work on the wrist technique.

C. Winter Part

Arctic Outbreak - The Arctic outbreak section comes from a paper by Van Ess and Kapela (1989).

Cook's 200 mb - The section called Cook's 200 mb consists of parts of a paper by Cook (1980). Notes were taken from this paper for further simplification.

Frzg Pcpn - A variety of information on freezing precipitation was collected for this section on freezing precipitation. Central Region Technical Attachment 87-30 was tapped for information. Notes

from a paper Western Region Technical Attachment 79-2 have been included. A paper on winter precipitation type by McNulty (1988) was also included.

Frost/Freeze - The section on frost/freeze included standard climatological information on the earliest fall and latest spring dates for frost or freezing temperatures.

Hvy Snw - The section on heavy snow has a variety of forecast suggestions. Papers by Goetsch (1987b) and Koontz (1986) are a major part of this section. Information on heavy snow overlays from Goree and Younkin (1966). Other QPF rules of thumb have been included.

Magic Chart - The Magic chart section consists of a paper by Sangster and Jagler (1985) and Chaston (1989).

Major Midwest Snowstorms - Summary pages and tables from Weber (1979) have been placed in the section called major Midwest snowstorms.

Max Temp - This section on maximum temperatures in this part of the handbook consists of a local study on maximum temperatures at Sioux Falls by Theophilus (1973).

Models - The section on models contains notes on how the LFM and NGM compare on handling various types of winter weather. Notes from papers by Rammer (1977) and Junker (1985) were included.

MOS - The section on MOS in this part only considers how to use parts of MOS which are applicable only to winter. This is the probability of freezing rain and the probability of snow and snow amounts.

QPF Rules - The QPF rules of thumb section in this part consist of rules of thumb by the National Meteorological Center which apply to snow and cold weather.

Winter Forecast Rules - The winter forecast rules section consists of miscellaneous rules of thumb which did not fit into other sections of this part of the handbook. Notes from papers by Weismueller (1984), Lejenas and Okland (1985), and National Weather Service Western Region Technical Attachment 84-09, from the winter weather workshop in Boulder, Colorado (1985).

Wind Chill - The last section in this part has wind chill charts for quick easy reference.

4. Summary

The intention of the handbook has been to present meteorological tools, techniques and ideas in a brief and concise form as could be used in a real-time forecast situation. To accomplish this, only pertinent parts of some texts, tables, etc., were included. Notes were taken on some articles and were presented as a summary of the article as it would apply to forecast at this WSFO.

As long as there is research on new forecast techniques and tools, this handbook will never be complete. The authors intend to expand the contents as new forecast tools become available that are applicable for operational use.

5. References

Anderson, L. C., 1987: Unpublished Seminar Notes, available from National Weather Service NEXRAD Operational Test Facility, Norman, OK.

_____, 1988a: Unpublished Seminar Notes, available from National Weather Service NEXRAD Operational Test Facility, Norman, OK.

_____, 1988b: A Collection of Severe Weather Parameters Used for a Checklist. Central Region Applied Research Paper 88-3, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

_____, 1989: Unpublished Seminar Notes, available from National Weather Service NEXRAD Operational Test Facility, Norman, OK.

Barnes, S. L., 1985: Omega Diagnostics as a Supplement to LFM/MOS Guidance in Weakly Forced Convective Situations. Mon. Wea. Rev., 113, 2122-2141.

_____, 1987: Analysis of Quasi-Geostrophic Forcing During the AIMCS Project. NOAA Technical Memorandum ERL ESG-27, available from NOAA Environmental Research Laboratories, Boulder, CO.

Bothwell, P., 1986: Mesos Data Analysis Notes No. 1-7. Southern Region Technical Attachments, available from National Weather Service Southern Region, Scientific Services Division, Fort Worth, TX.

Bunting, W. F., 1987: A Study of Mesos Analyses During the 10 September 1986 Severe Weather and Flood Event in Michigan. Central Region Technical Attachment 87-10, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

Caracena, F., Holle, R. L., and C. A. Doswell III, 1989: Microbursts, A Handbook for Visual Identification. NOAA/ERL/NSSL Mesoscale Research Division.

Chaston P. R., 1989: The Magic Chart For Forecasting Snow Amounts. Nat. Wea. Dig., 14, 20-22.

Cook, B. J., 1980: A Snow Index Using 200 MB Warm Advection. Nat. Wea. Dig., 5, 29-40.

Doswell, C. A. III, 1982: The Operational Meteorology of Convective Weather, Volume I: Operational Mesoanalysis. NOAA Technical Memorandum NSSFC-5, available from National Severe Storms Forecast Center, Kansas City, MO.

Foster, D. S., and R. M. Reap, 1977: Thunderstorm Probability Nomogram. TDL Office Note 77-6, available from National Weather Service Techniques Development Laboratory, Silver Spring, MD.

Goetsch, E. H., 1987a: Summary of Significant Satellite Signatures Involving Thunderstorms. Central Region Technical Attachment 87-9, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

_____, 1987b: Checklist of Significant Winter Weather Forecasting Techniques - A Summary of Some Long-Established Methods. Central Region Technical Attachment 87-30, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

Goree, P. A., and R. J. Younkin, 1966: Synoptic Climatology of Heavy Snowfall over the Central and Eastern United States. Mon. Wea. Rev., 94, 663-669.

Hudson, H. R., 1971: On the Relationship Between Horizontal Moisture Convergence and Convective Cloud Formation. J. Appl. Meteor., 10, 755-762.

Hughes, L. A., and L. L. Longsdorf, 1978: Guidelines for Flash Flood and Small Tributary Flood Prediction. NOAA Technical Memorandum NWS CR-58, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

Iribarne, J. V., and W. L. Godson, 1973: Atmospheric Thermodynamics. B. M. McCormac, Ed., Reidal Publishing Co., 128-131.

Johns, R. H., 1986: Notes on Severe Thunderstorm Forecasting, unpublished reported available from National Severe Storms Forecast Center, Kansas City, MO.

_____, and W. D. Hirt, 1987: Derechos: Widespread Convectively Induced Windstorms. Wea. and Forecasting, 2, 32-49.

Junker, N. W., 1985: Recognizing Characteristic Model Errors and Incorporating Them into Precipitation Forecasts. Preprints, 6th Conf. on Hydrometeorology (Indianapolis, IN), Amer. Meteor. Soc., Boston, MA, 270-276.

Koontz, G., 1986: Heavy Snow Forecasting Aids. Central Region Technical Attachment 86-26, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

Lejenas and Okland, 1985: Characteristics of Northern Hemisphere Blocking as Determined from a Long Time Series of Observational Data. Unpublished paper from the Winter Weather Workshop, Boulder, CO.

Lowden, J. D., 1984: The Wrist Technique. Central Region Technical Attachment 84-14, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

Lussky, G. R., 1989: Heavy Rains and Flooding in Montana: A Case for Operational Use of Symmetric Instability Diagnosis. Wea. and Forecasting, 4, 186-201.

Maddox, R. A., 1979: A Methodology for Forecasting Heavy Convective Preparation and Flash Flooding. Nat. Wea. Dig., 4, 30-42.

_____, C. F. Chappell, and L. R. Hoxit, 1978: Meteorological Conditions Associated with Significant Flash Floods. Preprints, Conf. on Weather Forecasting and Analysis and Aviation Meteorology (Silver Spring, MD), Amer. Meteor. Soc., Boston, MA, 44-51.

_____, L. R. Hoxit, C. F. Chappell, and F. Caracena, 1978: Comparison of Meteorological Aspects of the Big Thompson and Rapid City Flash Floods. Mon. Wea. Rev., 106, 375-389.

_____, C. F. Chappell, and L. R. Hoxit, 1979: Synoptic and Meso-Scale Aspects of Flash Flood Events. Bull. Amer. Meteor. Soc., 60, 115-123.

McGinley, J., 1986: Mesoscale Meteorology and Forecasting, Chapter 28: Nowcasting Mesoscale Phenomena. P. S. Ray, Ed., Amer. Meteor. Soc., Boston, MA, 793 pp.

McNulty, R. P., 1978: On the Potential Use of LFM-II Boundary Layer Moisture and Moisture Convergence in Convective Forecasting. Conf. on Weather Forecasting and Analysis and Aviation Meteorology (Silver Springs, MD), Amer. Meteor. Soc., Boston, MA, 88-93.

_____, 1988: Winter Precipitation Type. Central Region Technical Attachment 88-4, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

Miller, R. C., 1972: Notes on Analysis and Severe-Storm Forecasting. Procedures of the Air Force Global Weather Central, Air Weather Service Technical Report 200.

Moller, A. R., 1980: Mesoscale Surface Analysis of the 10 April, 1979 Tornadoes in Texas and Oklahoma. Preprints, 8th Conf. on Weather Forecasting and Analysis (Denver, CO), Amer. Meteor. Soc., Boston, MA, 36-43.

Moore, J. T., 1988: Isentropic Analysis and Interpretation: Operational Applications to Synoptic and Mesoscale Forecast Problems. Available from National Weather Service Training Center, Kansas City, MO.

Namis, J., and P. F. Clapp, 1949: Confluence Theory of the High Tropospheric Jet Stream. J. of Meteor., 6, 330-336.

National Weather Service Central Region, 1971: Hage Lows. Central Region Technical Attachment 71-4, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

_____, 1974: Checksheet for Use of the Surface Geostrophic Wind (Sangster) Chart. Central Region Technical Attachment 74-11, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

National Weather Service Western Region, 1968: The Isallobaric Wind. Western Region Technical Attachment 68-10, available from National Weather Service Western Region, Scientific Services Division, Salt Lake City, UT.

_____, 1979: A Study of Freezing Precipitation Parameters. Western Region Technical Attachment 79-2, available from National Weather Service Western Region, Scientific Services Division, Salt Lake City, UT.

_____, 1984: Closed Plateau Lows. Western Region Technical Attachment 84-09, available from National Weather Service Western Region, Scientific Services Division, Salt Lake City, UT.

Rammer, B., 1977: Surface Cyclogenetic Problem of the LFM in Lee of the Rockies. Western Region Technical Attachment 77-39 (revised), available from National Weather Service Western Region, Scientific Services Division, Salt Lake City, UT.

Rasmussen, E. N., and R. B. Wilhelmson, 1983: Relationships Between Storm Characteristics and 1200 GMT Hodographs, Low-Level Shear, and Stability. Preprints, 13th Conf. on Severe Local Storms (Tulsa, OK), Amer. Meteor. Soc., Boston, MA, J5-J8.

Reap, R. M., 1978: Techniques Development Laboratory Three-Dimensional Trajectory Model. Technical Procedures Bulletin No. 225, available from National Weather Service, Techniques Development Laboratory, Silver Spring, MD.

Reihl, H., J. Badner, J. E. Hovde, N. E. LaSeur, L. L. Means, W. C. Palmer, M. J. Schroeder, and L. W. Snellman, 1952: Forecasting in the Middle Latitudes. Meteorological Monograph No. 5, Amer. Meteor. Soc., 80 pp.

Rosendal, H. E., 1979: Applications of the Zero Relative Vorticity Line in Synoptic Forecasting. NOAA Technical Memorandum NWS PR-20, available from National Weather Service Pacific Region, Honolulu, HI.

Sangster, W. E., 1980: A New Concept in Diagnosing Large Scale Vertical Motion. Central Region Technical Attachment 80-20, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

_____, and E. C. Jagler, 1985: The (7WG, 8WT) "Magic" Chart. Central Region Technical Attachment 85-1, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

Saucier, W. J., 1955: Principles of Meteorological Analysis, Univ. of Chicago Press, Chicago, IL, 240-249.

Scofield, R. A., 1987: Ingredients For a Short Range Forecasting Heavy Precipitation Index, Preprints, 7th Conf. on Hydrometeorology (Edmonton, Alberta, Canada), Amer. Meteor. Soc., Boston, MA.

_____, and V. J. Oliver, 1977a: A Scheme for Estimating Convective Rainfall from Satellite Imagery. NOAA/NESS Technical Memorandum 86, available from NOAA, National Environmental Data and Information Service, Camp Springs, MD, 47 pp.

_____, and _____, 1977b: Using Satellite Imagery to Estimate Rainfall from Two Types of Convective Systems. Proceedings, 10th Conf. on Hurricanes and Tropical Meteorology (Miami Beach, FL), Amer. Meteor. Soc., Boston, MA, 204-211.

Siebers, A. L. and J. T. Schaefer, 1983: The Temporal Shear of the Surface Wind Field - A Potential Severe Thunderstorm Forecast Tool. Preprints, 13th Conf. on Severe Local Storms (Tulsa, OK), Amer. Meteor. Soc., Boston, MA, 257-260.

Spagnol, J. 1982: The Upslope Effect. Preprints, 9th Conf. on Weather Forecasting and Analysis, Pacific Weather Center/AES, Vancouver, B. C., Canada.

Snow, J. T., D. R. Smith, F. W. Leslie, and R. H. Brady, 1988: Mesoanalysis of Surface Variables Associated with the Severe Weather of 9-10 July, 1980. Nat. Wea. Dig., 8, 28-39.

Stone, H. M., 1987: Mesoscale Forecasting Topics. NOAA Technical Memorandum NWS ER-72, available from National Weather Service Eastern Region, Scientific Services Division, Bohemia, NY.

_____, 1988a: Convection Parameters and Hodograph Program - ConvectA and ConvectB. NOAA Eastern Region Computer Programs and Problems ERCP-37 (Revised), available from National Weather Service Eastern Region, Scientific Services Division, Bohemia, NY.

_____, 1988b: Wind Shear as a Predictor of Severe Weather for the Eastern U.S. NOAA Technical Memorandum NWS ER-75, available from National Weather Service Eastern Region, Scientific Services Division, Bohemia, NY.

Sutcliffe, R. C., and A. G. Forsdyke, 1950: The Theory and Use of Upper Air Thickness Patterns in Forecasting. Quart. J. Roy. Meteor. Soc., 76, 189-217.

Theophilus, D. C., 1973: Max Temperature with Snow. Central Region Technical Attachment 73-5, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

Truett, S. C., 1987: Isentropic Analysis. Central Region Technical Attachment 87-4, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

Uccellini, L. W., and D. R. Johnson, 1979: The Coupling of Upper and Lower Tropospheric Jet Streaks and Implications for the Development of Severe Convective Storms. Mon. Wea. Rev., 107, 682-703.

Van Ess R., and A. F. Kapela, 1989: Arctic Outbreaks. Central Region Technical Attachment 89-20, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

Wasinger L. F., 1984: Some Relationships of DVIP Level 5 on the RHI Scope to the PPi Scope. Central Region Technical Attachment 84-13, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

Weber, E. M., 1979: Major Midwest Snow Storms. USAF 3WW Technical Note 79-2, Offutt AFB, NE, 95 pp.

Weismueller, J. L., 1984: November 26-27, 1983: A Plunging Type 500 MB Low. Central Region Technical Attachment 84-4, available from National Weather Service Central Region, Scientific Services Division, Kansas City, MO.

APPENDIX 1

FORECAST TECHNIQUES HANDBOOK INDEX

...WINTER SEASON...
ARCTIC OUTBREAK
COOK'S 200 MB
FRZG PCPN
FROST/FREEZE
HVY SNW
MAGIC CHART
MAJOR MIDWEST SNOWSTORMS
MAX TEMP
MODELS
MOS
QPF RULES OF THUMB
WINTER FCST RULES
WIND CHILL