Weather Modification Operations Forecasting
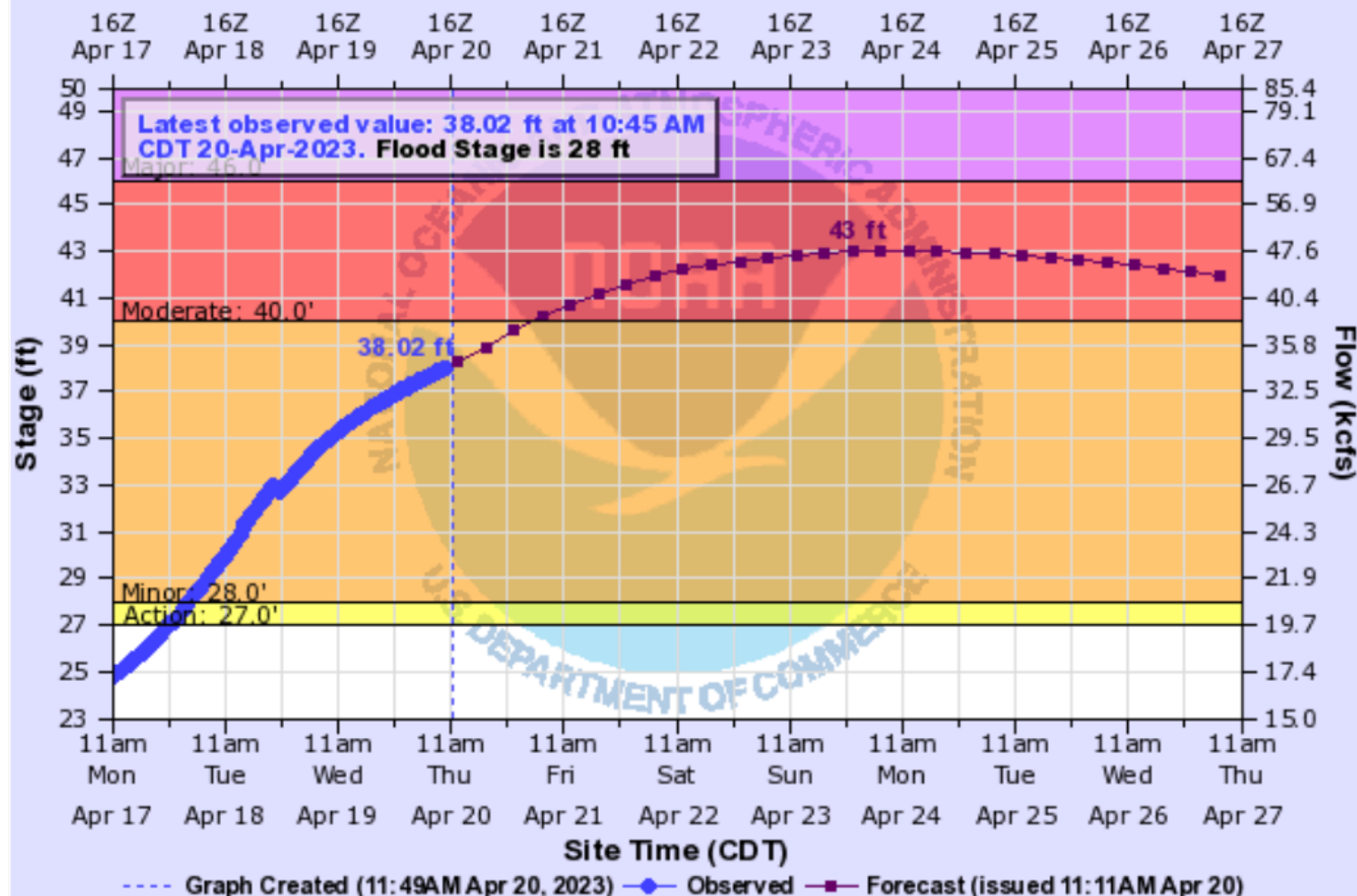

GFK

2022

Weather Modification Operations Forecasting

GFK

2023

RED RIVER OF THE NORTH AT GRAND FORKS

Latest observed value: 38.02 ft at 10:45 AM CDT 20-Apr-2023. Flood Stage is 28 ft

43 ft

38.02 ft

Major: 46.0'

Moderate: 40.0'

Minor: 28.0'

Action: 27.0'

Stage (ft)

Flow (kcfs)

Universal Time (UTC)

Site Time (CDT)

- - - Graph Created (11:49AM Apr 20, 2023) — Observed — Forecast (issued 11:11AM Apr 20)

EGFM5(plotting HGIRG) "Gage 0" Datum: 780'

Observations courtesy of US Geological Survey

2023

Why use Weather Forecast?

- Strategy for Cloud Seeding Operations
  - Timing of Aircraft Launches
  - Positioning of Resources
- Project Personnel Scheduling
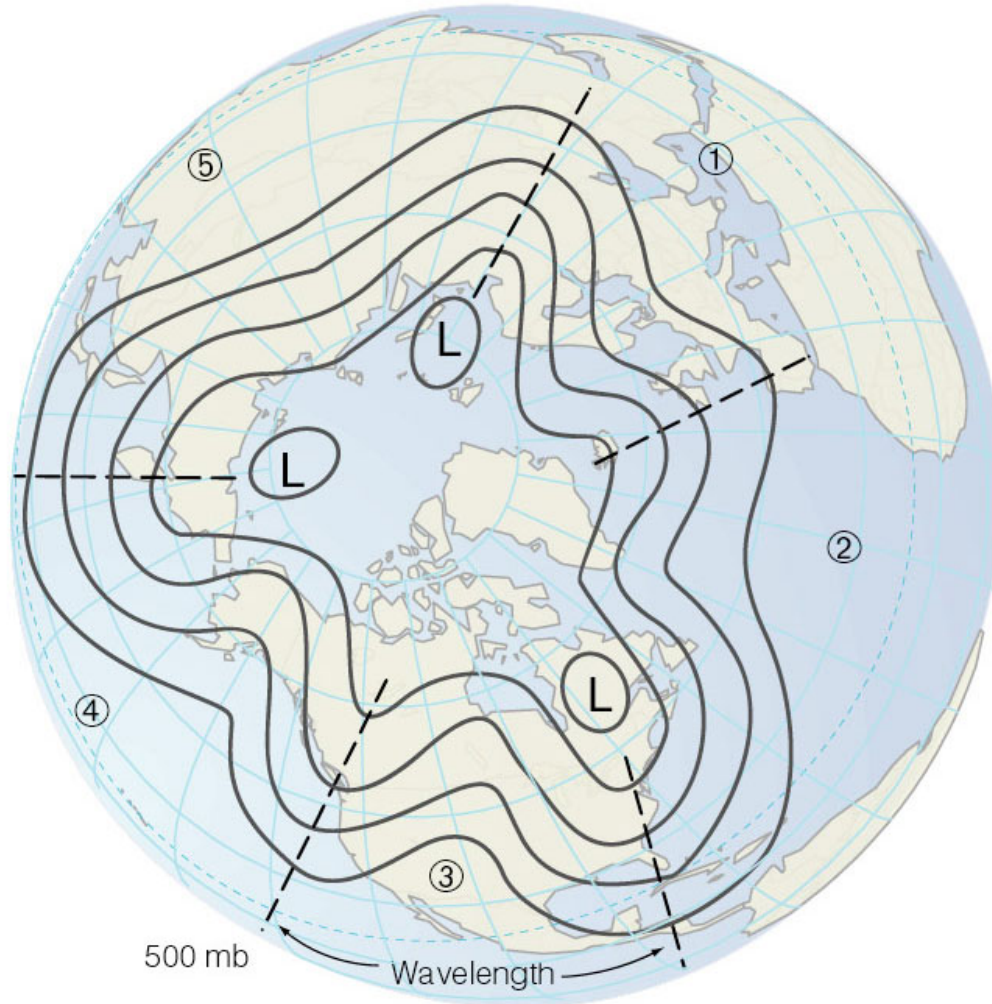- Maintenance Scheduling of Equipment

Bowman 2021

Weather Spacial and Time Scales

- Spacial Scales
  - Synoptic (>2000 km)
  - Meso-α (200-2000 km)
  - Meso-β (20-200 km)
  - Micro (< 20 km)
- Time Scales
  - Long-range (>24 hours)
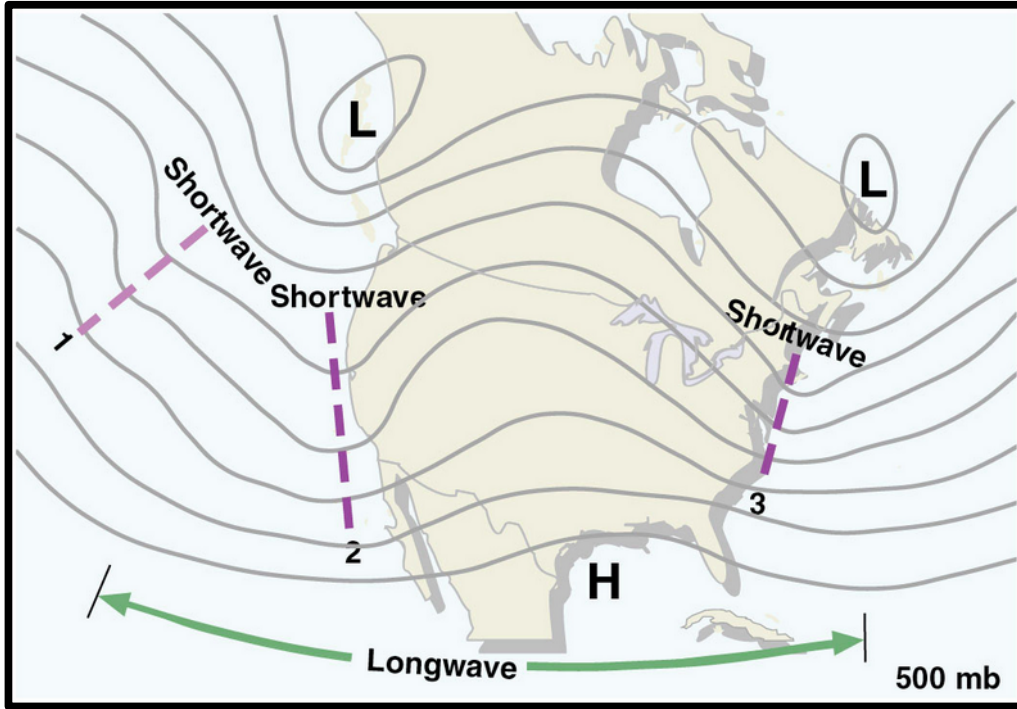 - Short-range (6-24 hours)
  - Nowcasting (< 6 hours)
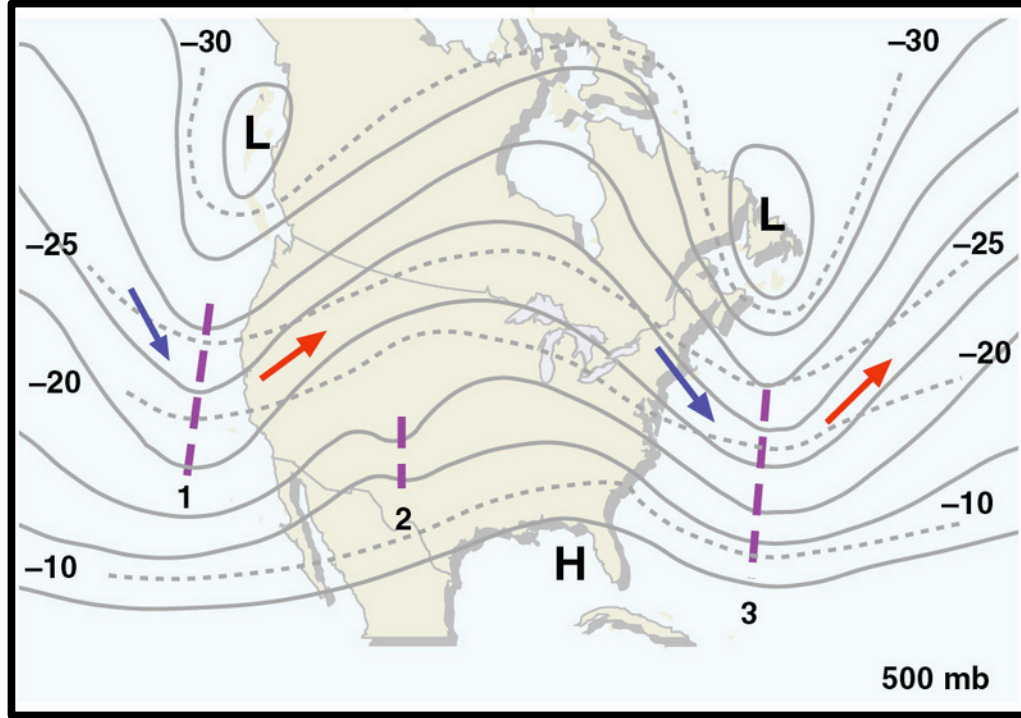
Atmospheric Waves: Long Waves

500 mb Pressure Level

Atmospheric Waves: Short Waves
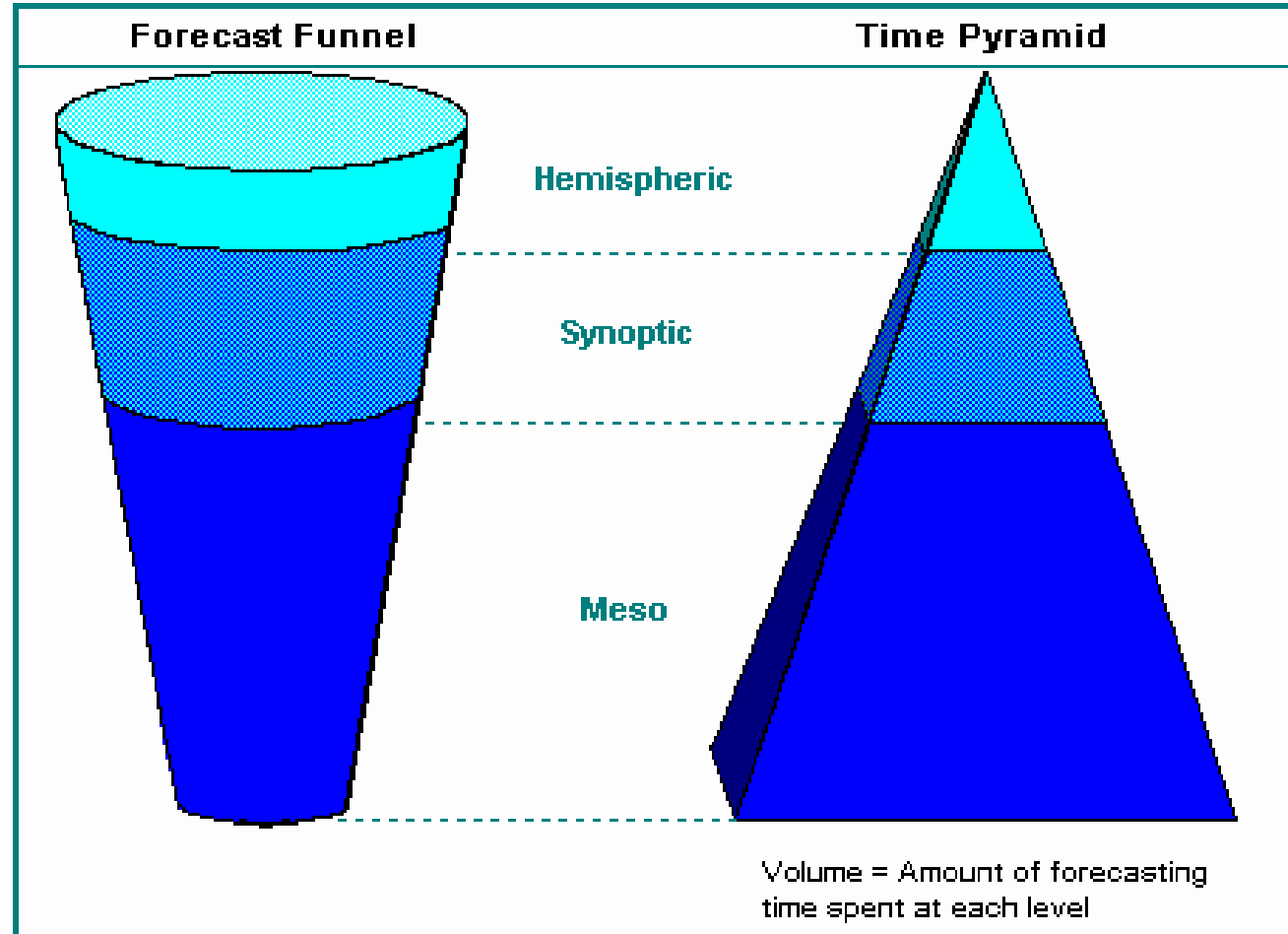

500 mb Pressure Level

Weather Variability

- **Long Waves**
- Move slowly.
- Dominate pattern on weekly basis.

- **Short Waves**
- Move quickly through the flow.
- Produce day-to-day variations.

Bowman 2021

Weather Forecast Funnel

- Start with the Big Picture

- Move Downscale

Forecast Funnel — Time Pyramid

Hemispheric

Synoptic

Meso

Volume = Amount of forecasting time spent at each level

Convective Weather Forecast

- Terrible problem!
  - Thunderstorm Initiation/coverage/severity
  - Multiple Factors
  - Small Scale Variability
- More excuses for the meteorologist!
  - Lack of Data
  - Lack of Understanding
  - Inadequate Models

Uncertainty for Weather Forecast

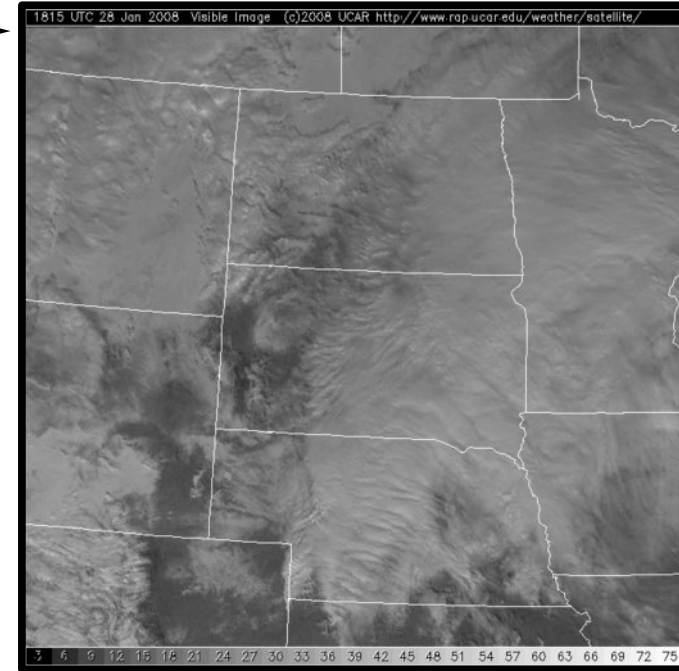# Solution → Information

Weather Information

- Satellite

- Radar

- Upper Air

- Surface
  Observations
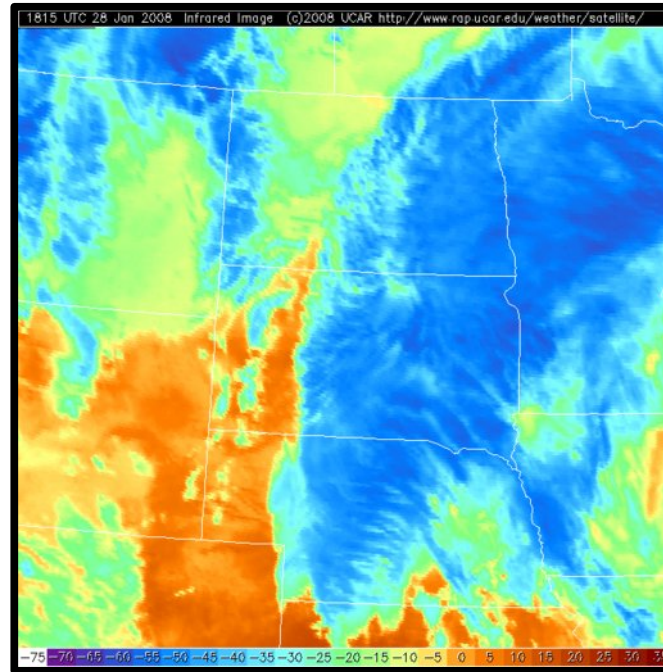
- Model Output

- Someone Else's Forecast

Satellite Observations

- Clouds and Water Vapor

- Large Scale View

- Cloud Top Temperature

- Boundaries

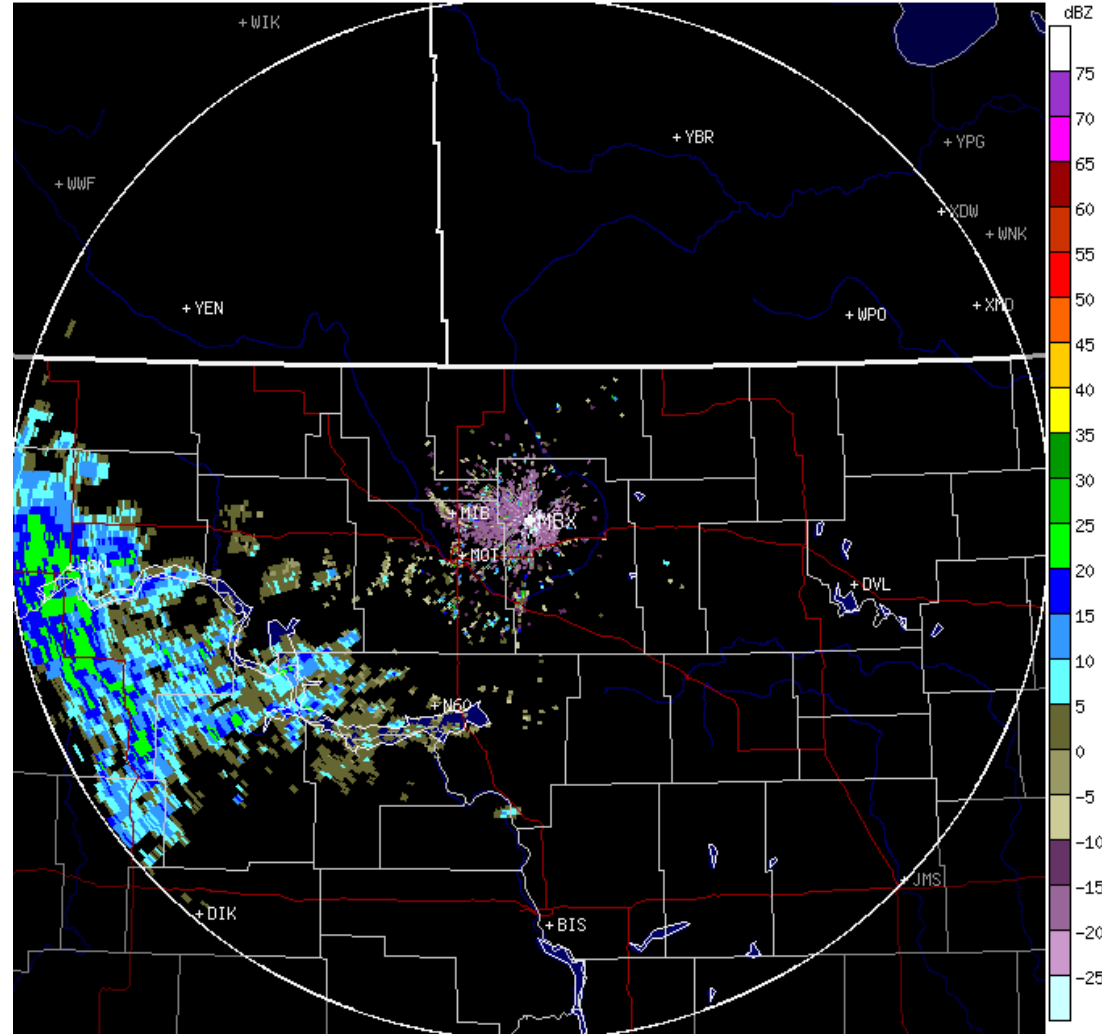- Initiating Convection

Radar Observations

- Current Convection

- Outflow Boundaries

- Echo Tops

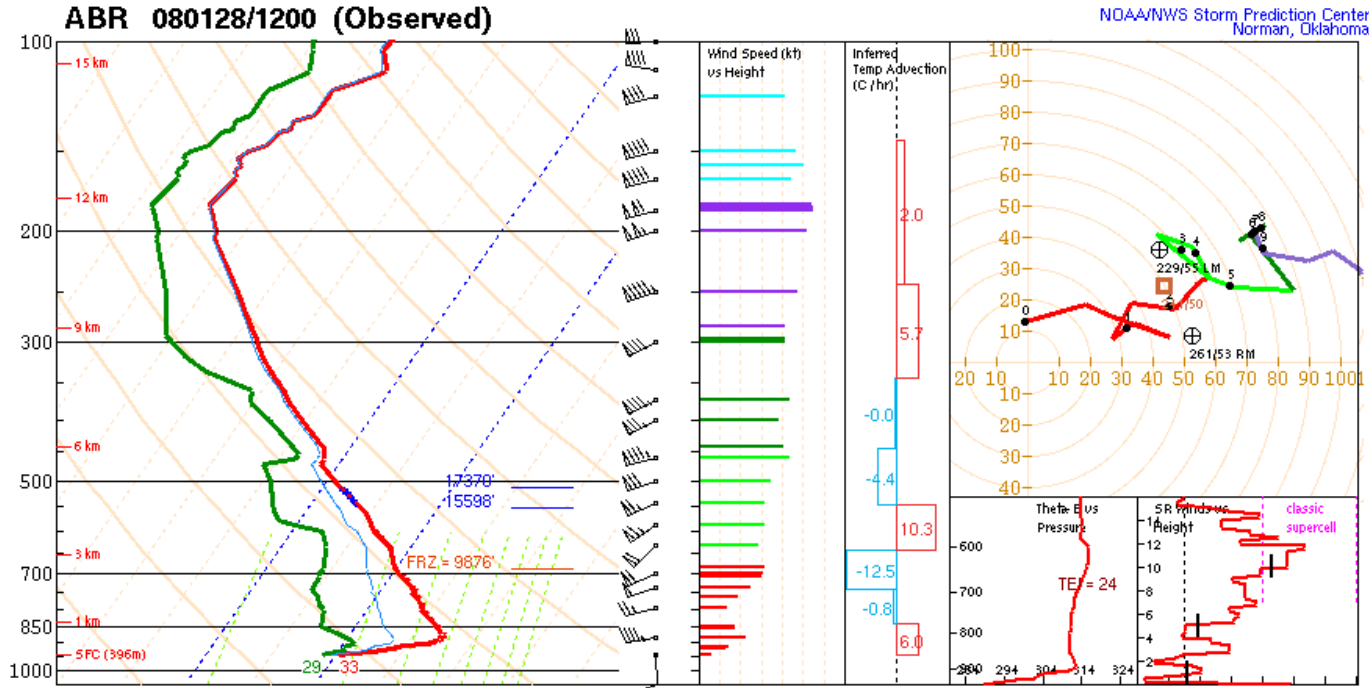- Coverage

- Movement

- Intensity

- Trend

KMBX -- Minot, ND/Deering
Base Reflectivity: 0.5 degrees, Clear-air Mode
18:40:06 UTC Mon 28 January 2008
(c) UCAR http://www.rap.ucar.edu/weather/radar/

Atmospheric Soundings

Any Ideas?

Surface Observations

- Low-level Moisture

- Temperatures

- Winds

- Advection
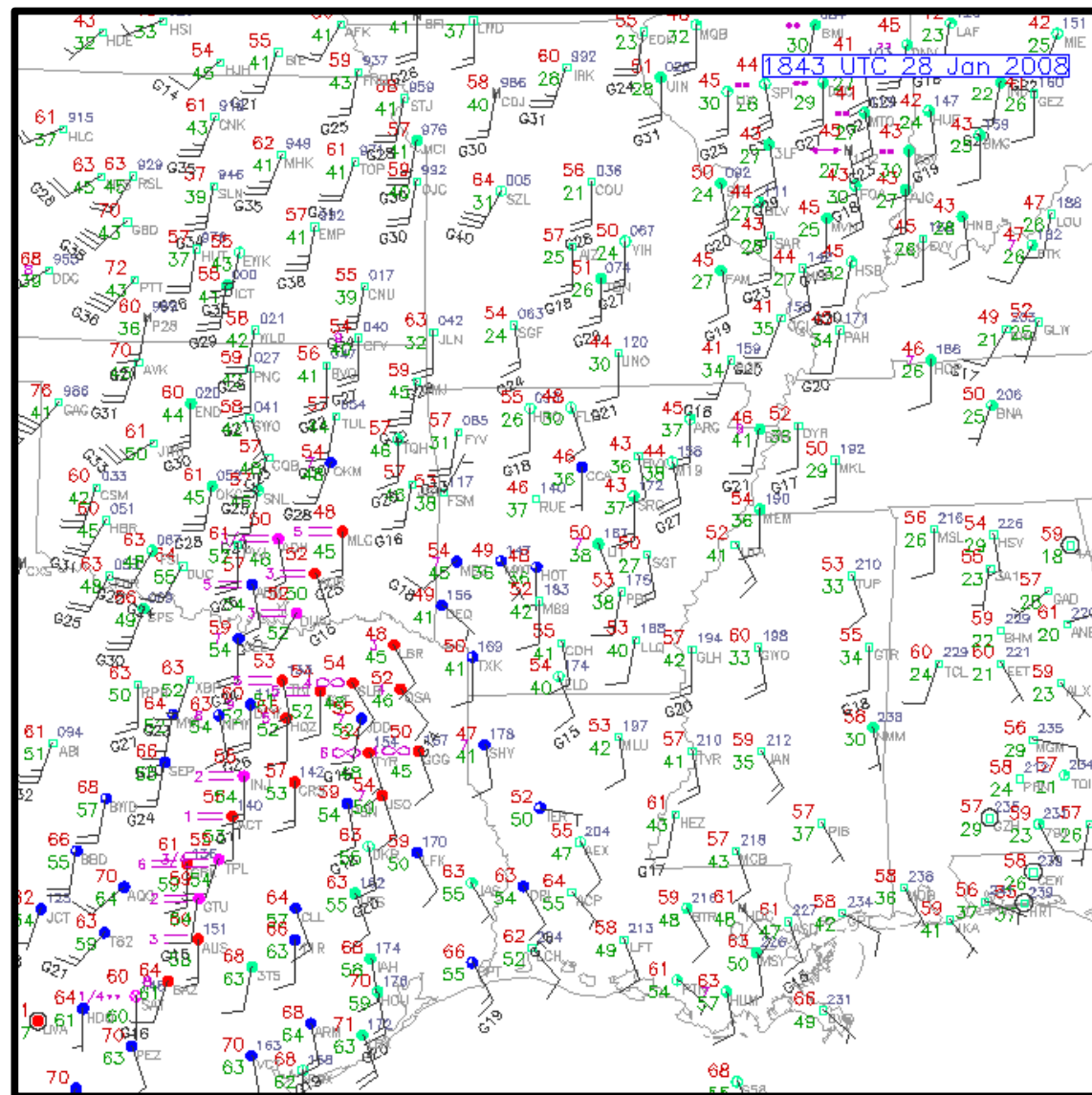
Weather Model Output

- Nowcasting to Long Range

- Forcing Features

- Moisture Fields

- Vertical Motions

- Waves
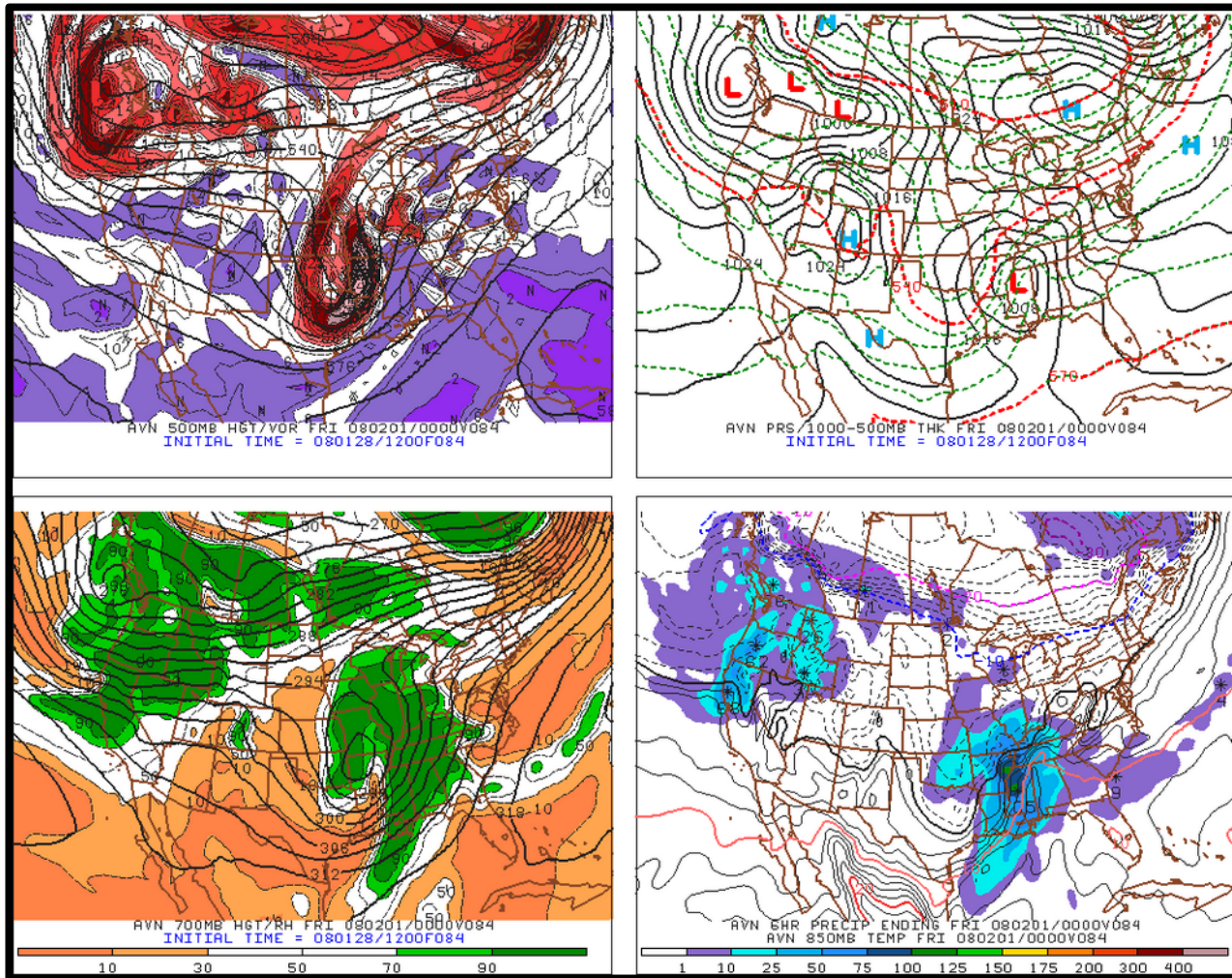
Other Weather Forecasts

- SPC
- NWS
- WPC
- XYZ

Figure 6-16. Day 1 Categorical Convective Outlook Graphic Example

SPC: Storm Prediction Center
Excessive Rainfall Forecast

NWS: National Weather Service
Bismarck, North Dakota

WPC: Weather Prediction Center
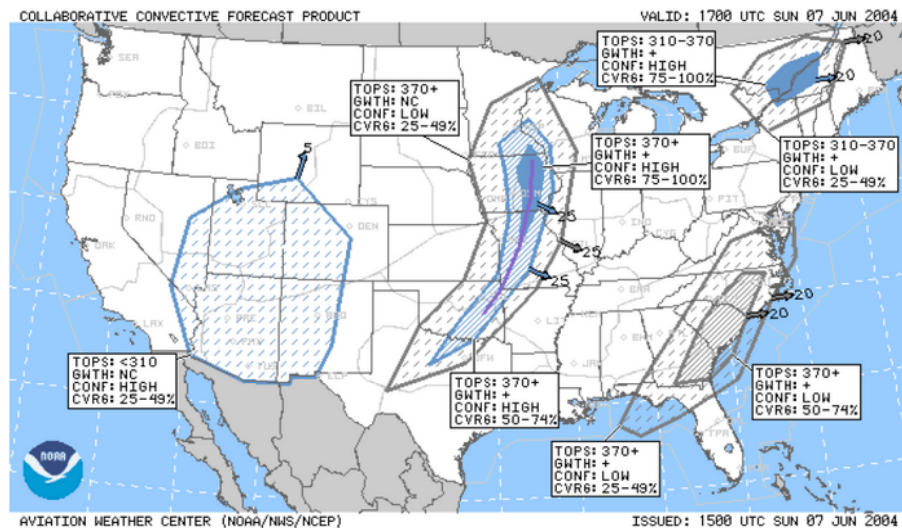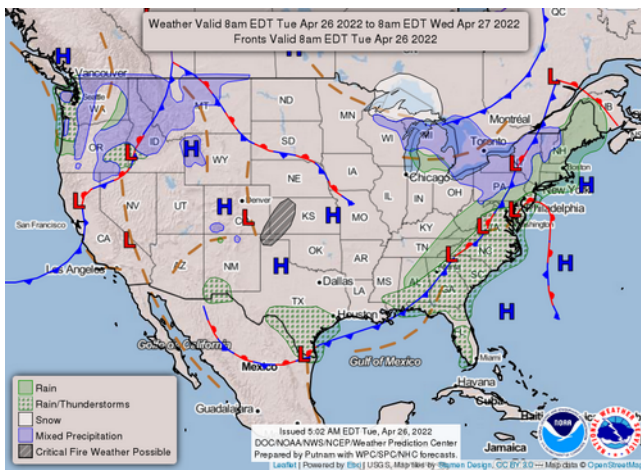
North Dakota Cloud Modification Project (NDCMP) Weather Forecasts

	District 1		District 2	
Transition (UTC)	23		23	
Day	**First**	**Second**	**First**	**Second**
Forecasted Weather	NO SIG HAIL		NO SIG HAIL	
Confidence Factor	9	8	9	9

NDCMP Synopisis Forecasts

Dew points and instability should increase in E MT and along the ND border this afternoon, setting the stage for thunderstorms this evening. Low pressure is expected to develop in E MT and with a shortwave moving through this afternoon, storms should fire. As the system moves E storms should spread over both districts, producing several hail threats. Storms will spread out ahead of the low as the shortwave moves through the state, and a LLJ develops ahead of the low tonight, providing the necessary forcing to keep storms strong overnight. Eventually the storms will move off to the east, but with the low pressure and associated cold front trailing, some chances will exist through the morning. The extended period continues to look active, with the front hanging back on Wednesday and several impulses possible through the weekend.

North Dakota Cloud Modification Project (NDCMP) Forecasts Indices

	Lifted Index (<1)	K Index (>30)	Total Totals (>48)	Sweat (>200)	CAPE (>125)	Cap (>3)	Bulk Richarson Number (>3)	Helicity (>125)
D1	-1.17	31.9	51.6	292	152	4.54	4.78	107
D2	24.1	46.8	46.8	198	50	5.54	0.48	116

Bulk Richardson Number (BRN)

- Bulk Richardson Number (BRN) is an indicator of thunderstorm type.

- BRN assesses the relative importance of CAPE and shear.

  - < 10   → Thunderstorms Unlikely

  - 11-49 → Moderate Chance - Supercell in Nature

  - 50+   → Strong Chance - Multicell Type

North Dakota Cloud Modification Project (NDCMP) Hailcast Model Output

(centimeters)	BPP	ISN	MOT
Max	0	0	0
Min	0	0	0
Control	0	0	0
AVG	0	0	0

North Dakota Cloud Modification Project (NDCMP) Weather Forecast Process

- Forecast timing determined by weather climatology and data availability.

- Forecast information is shared with all project personnel.

- Forecasts are updated as needed.