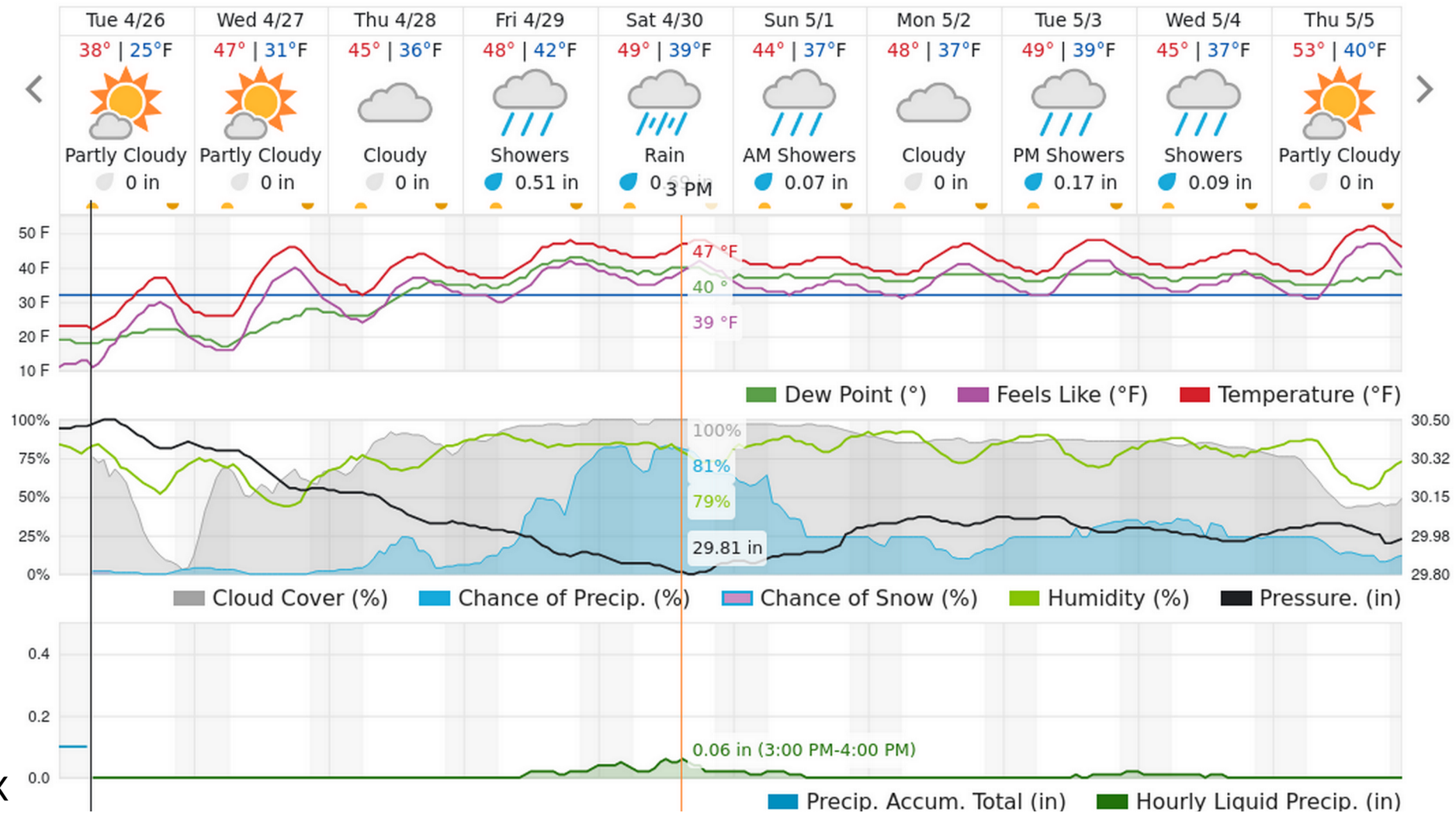
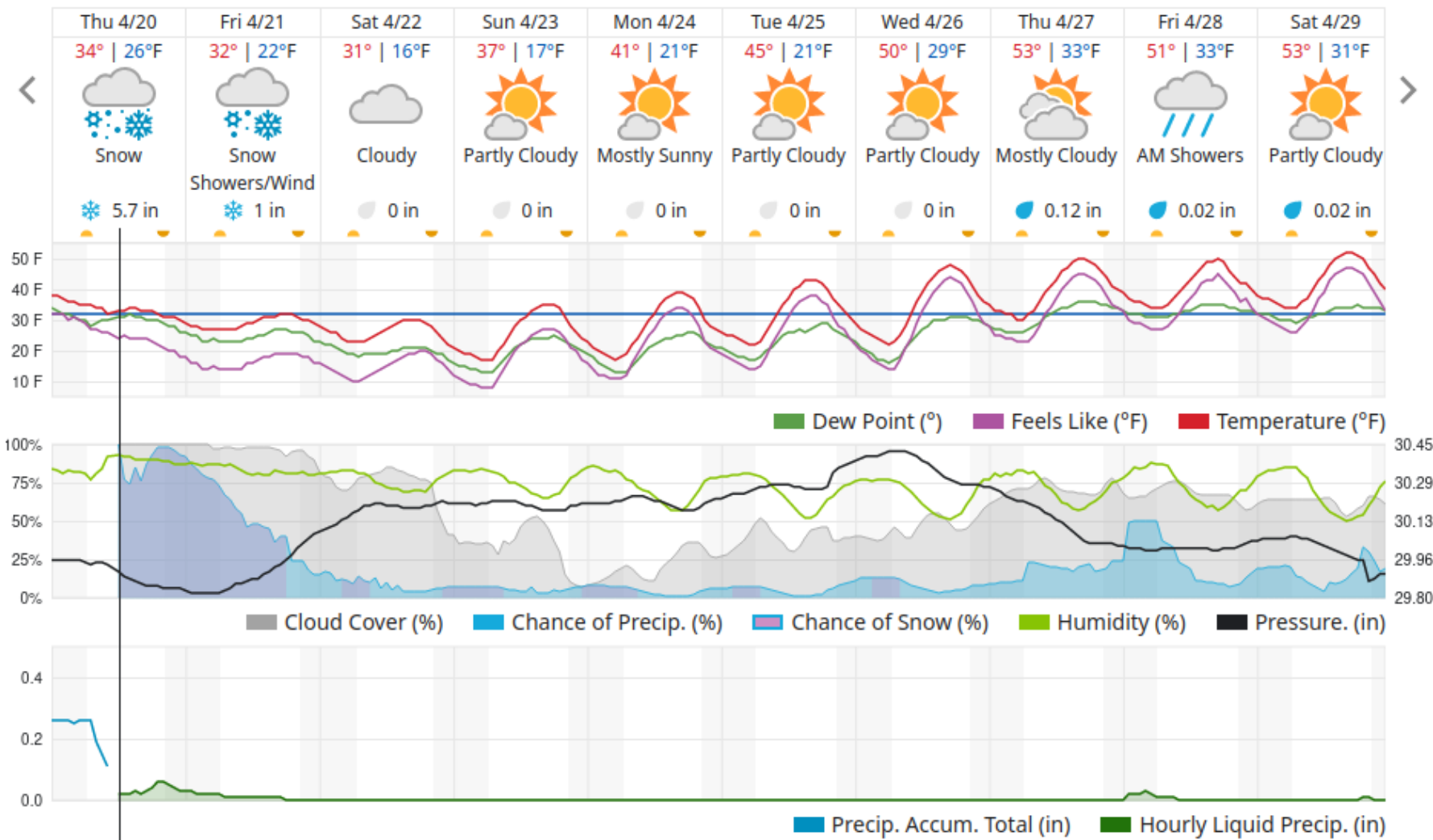


Weather Modification Operations Forecasting

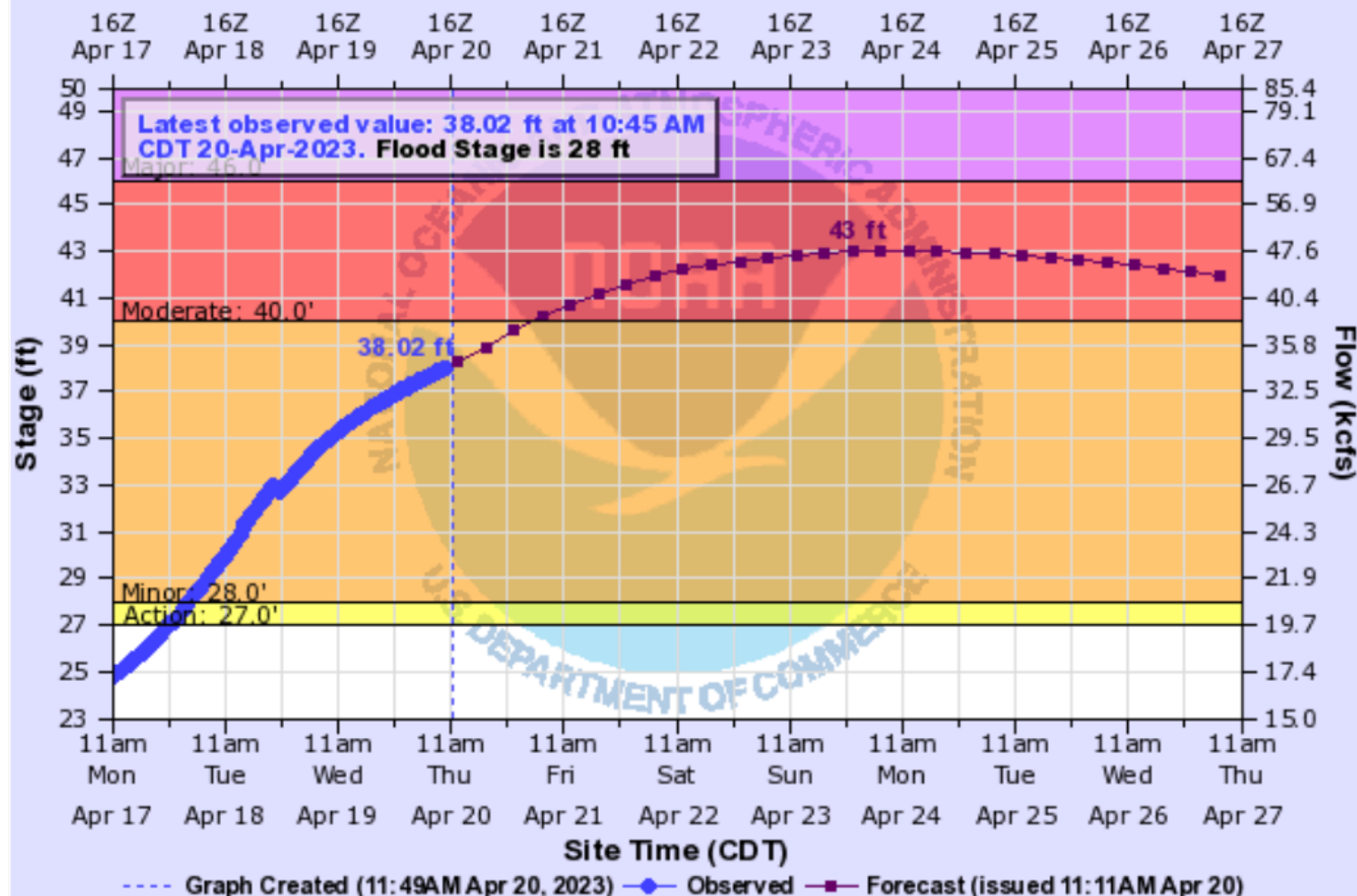


Weather Modification Operations Forecasting



RED RIVER OF THE NORTH AT GRAND FORKS

Universal Time (UTC)



Why use Weather Forecast?

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



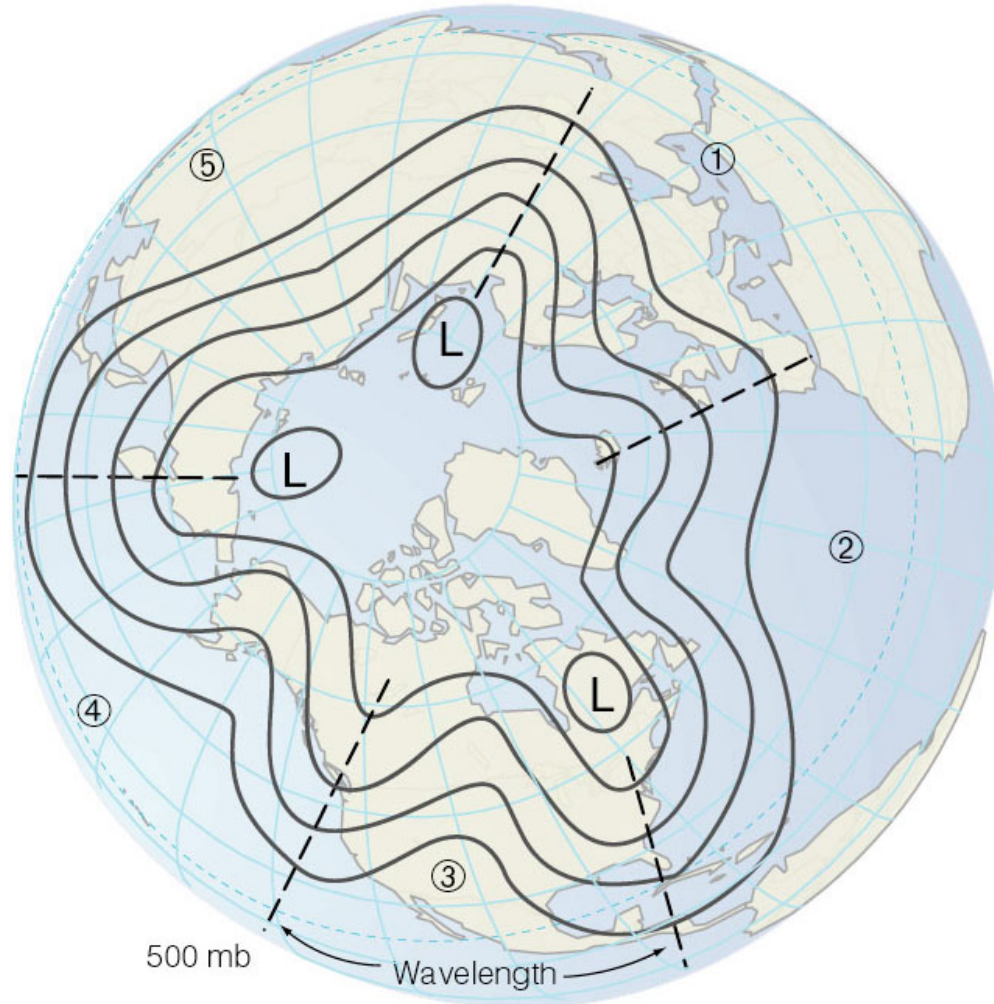
Weather Spacial and Time Scales

- 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)



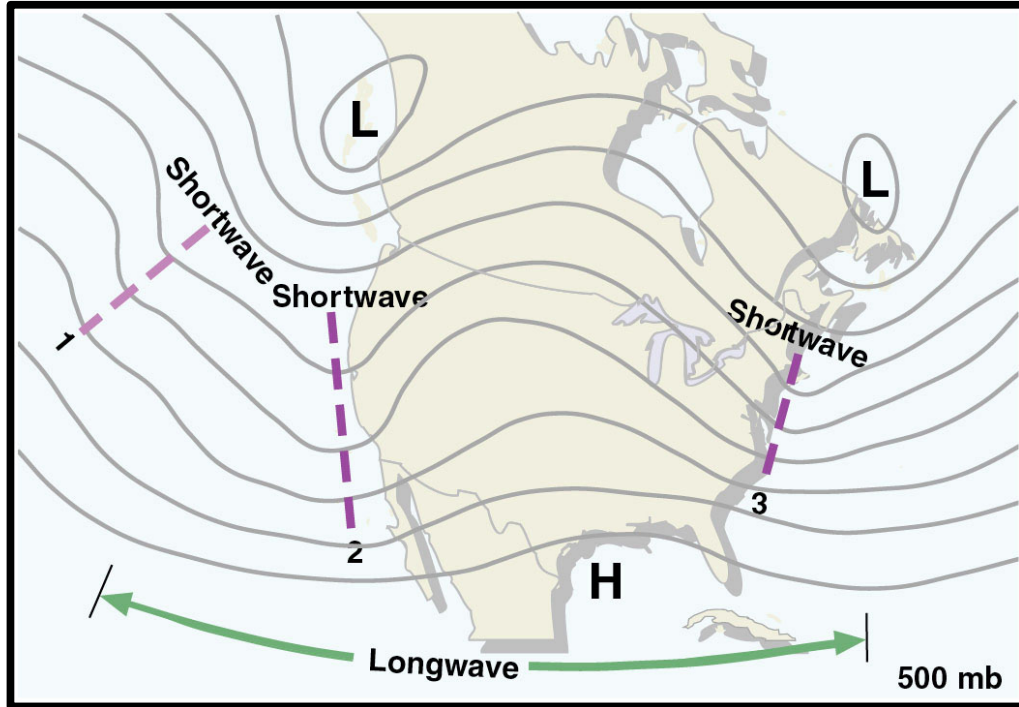
Atmospheric Waves: Long Waves

**500 mb
Pressure
Level**

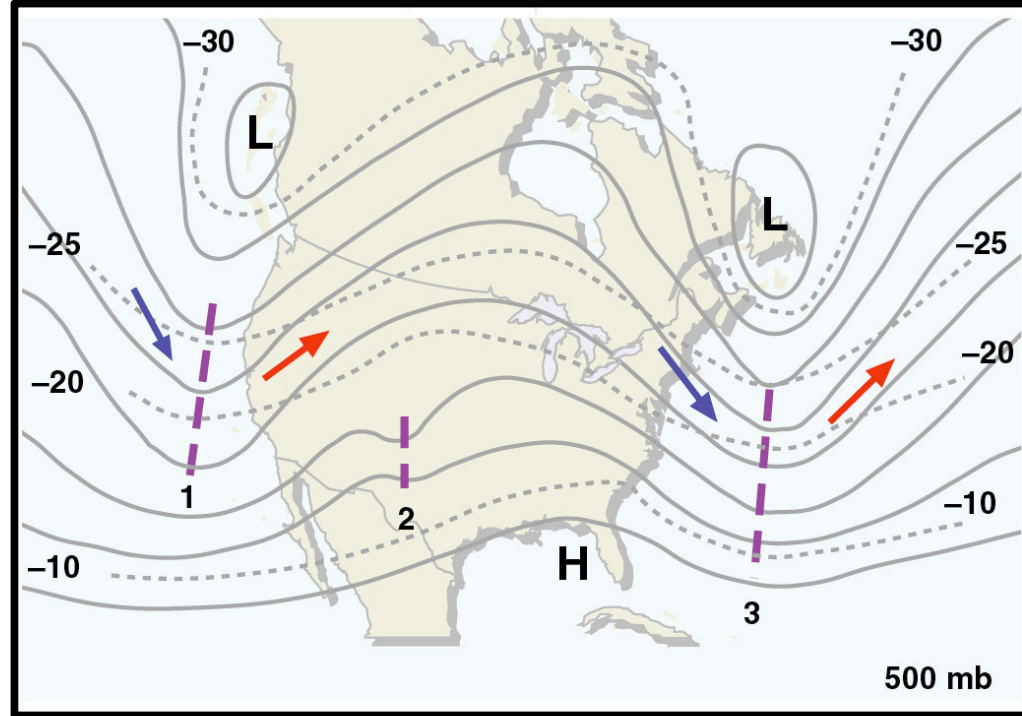


Atmospheric Waves: Short Waves

Day 1



Day 2 (24 Hours Later)



500 mb Pressure Level

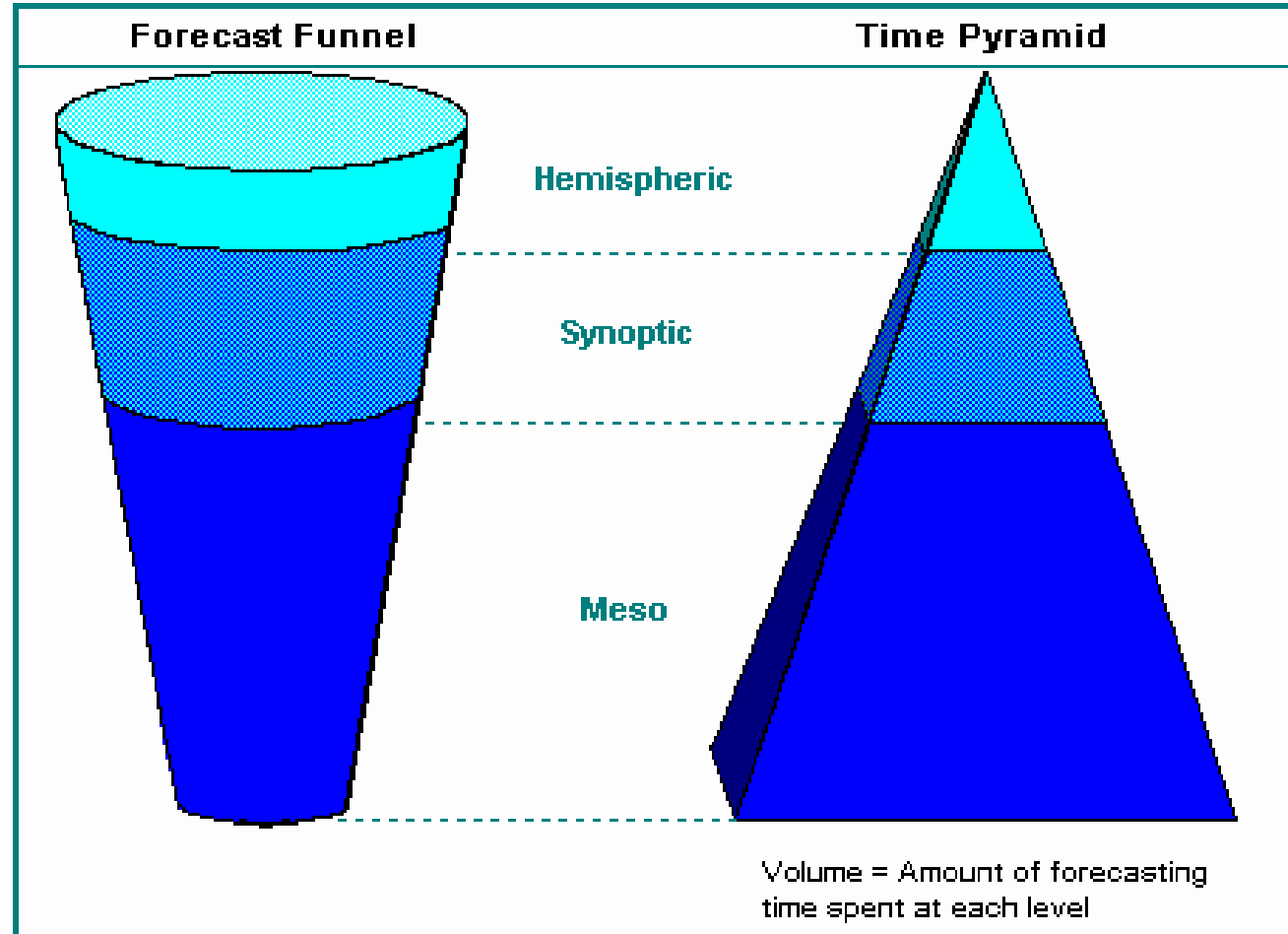
Weather Variability

- Long Waves
- Move slowly.
- Dominate pattern on weekly basis.
- Short Waves
- Move quickly through the flow.
- Produce day-to-day variations.



Weather Forecast Funnel

- Start with the Big Picture
- Move Downscale



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



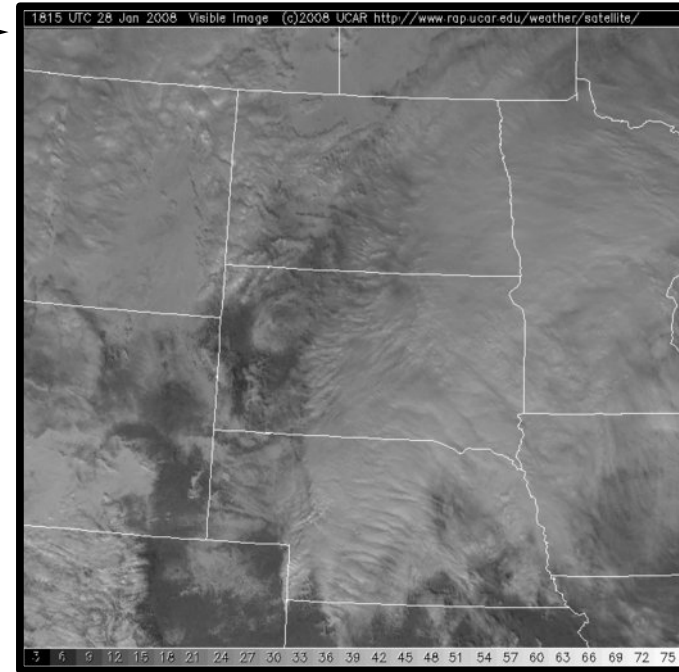
Weather Information

- Satellite
- Radar
- Upper Air
- Surface
Observations
- Model Output
- Someone Else's Forecast



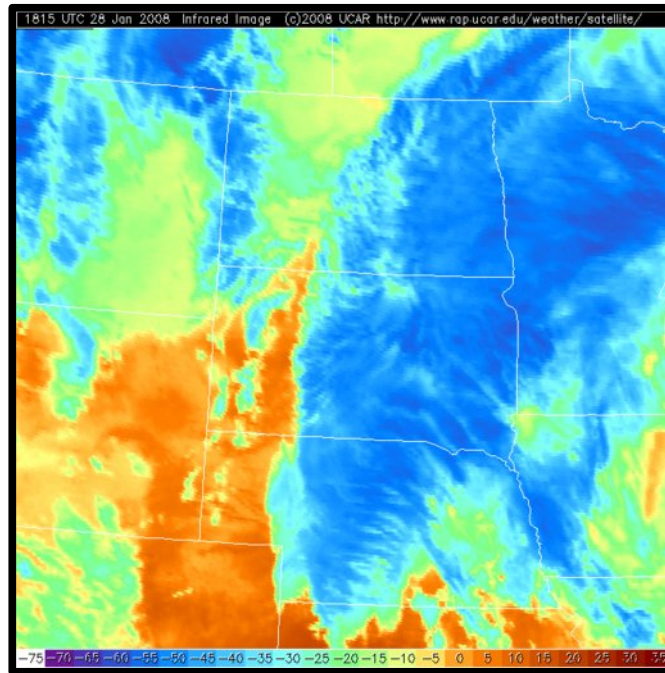
Satellite Observations

- Clouds and Water Vapor



- Large Scale View

- Cloud Top Temperature



- Boundaries

- Initiating Convection

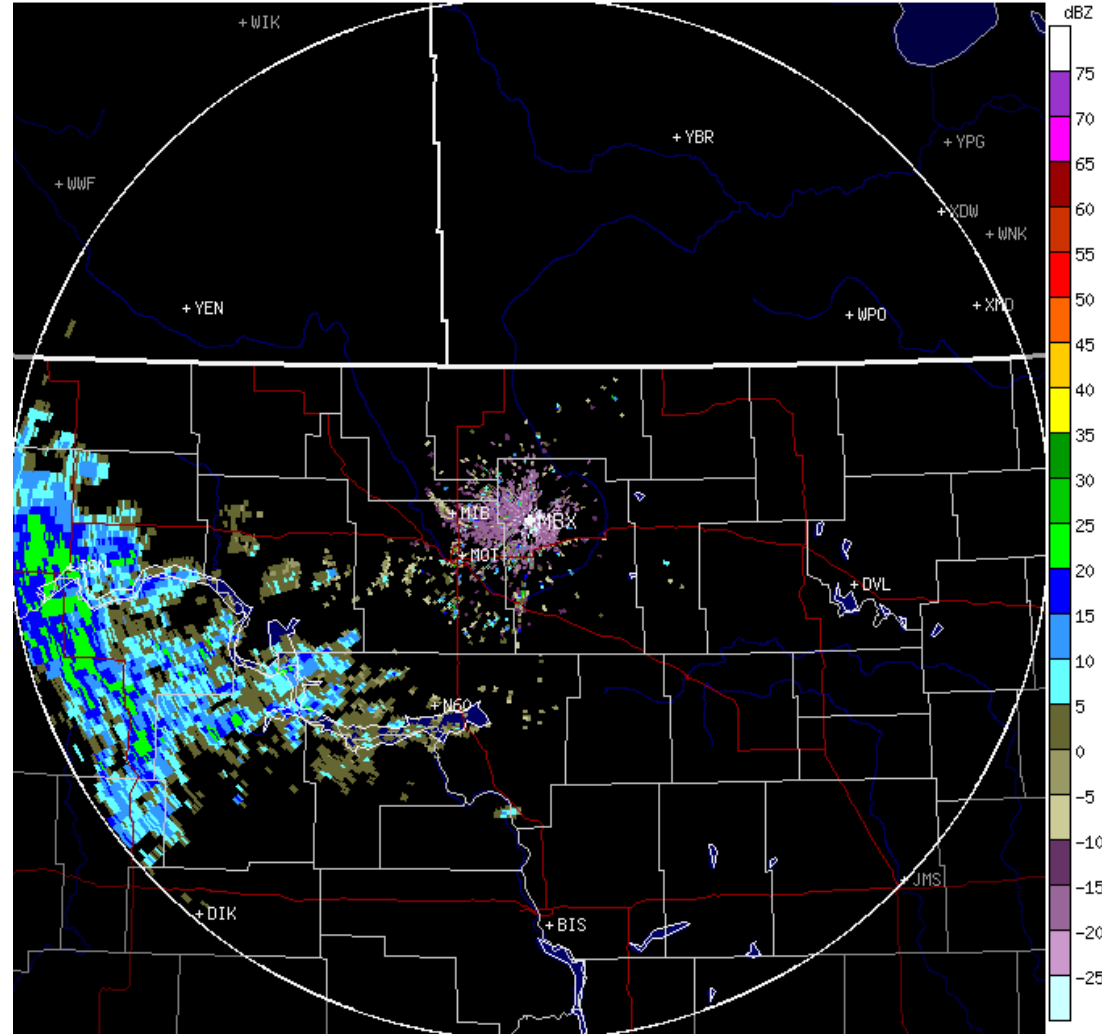
Radar Observations

- 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

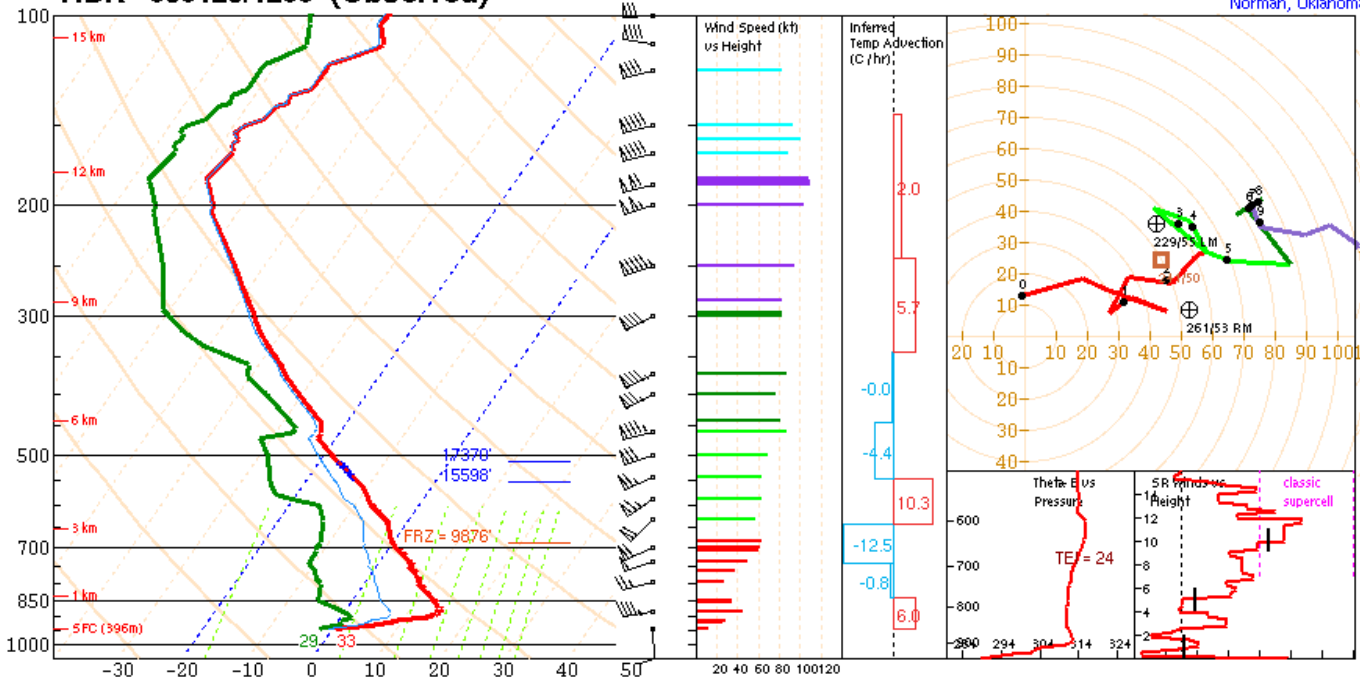
(c) UCAR <http://www.rap.ucar.edu/weather/radar/>



Atmospheric Soundings

ABR 080128/1200 (Observed)

NOAA/NWS Storm Prediction Center
Norman, Oklahoma

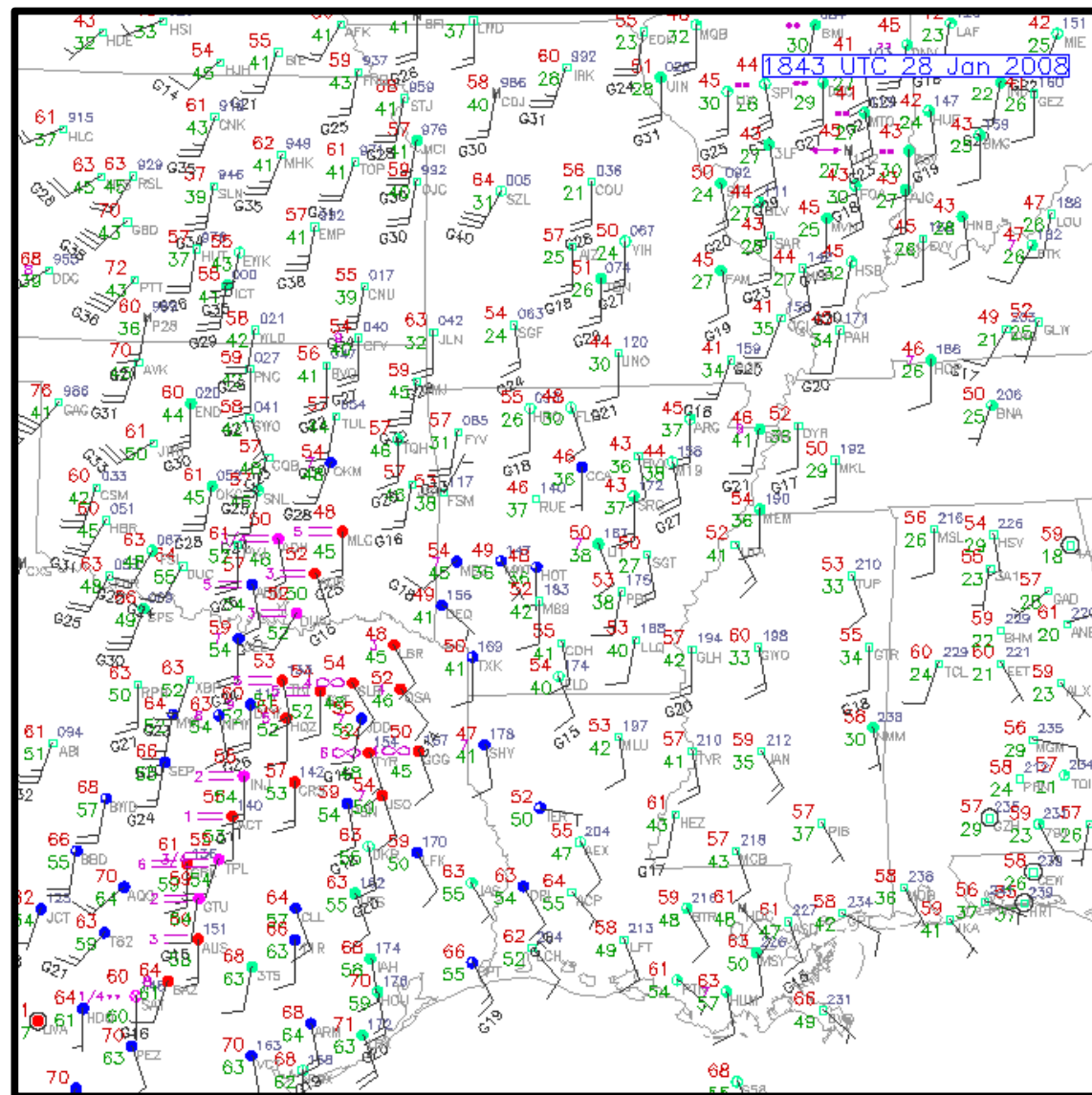


Any Ideas?

[illegible]

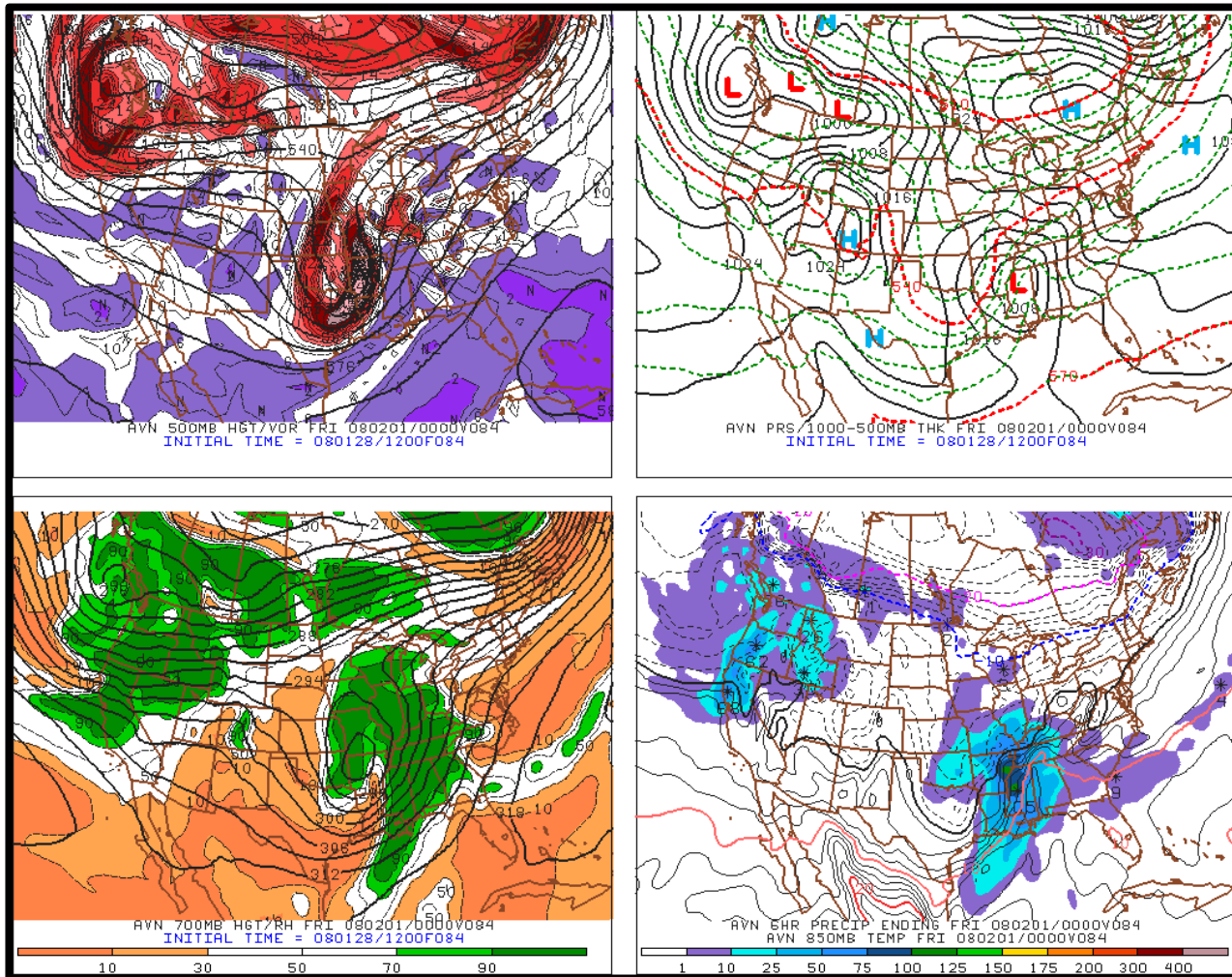
Surface Observations

- Low-level Moisture
- Temperatures
- Winds
- Advection



Weather Model Output

- Nowcasting to Long Range
- Forcing Features
- Moisture Fields
- Vertical Motions
- Waves

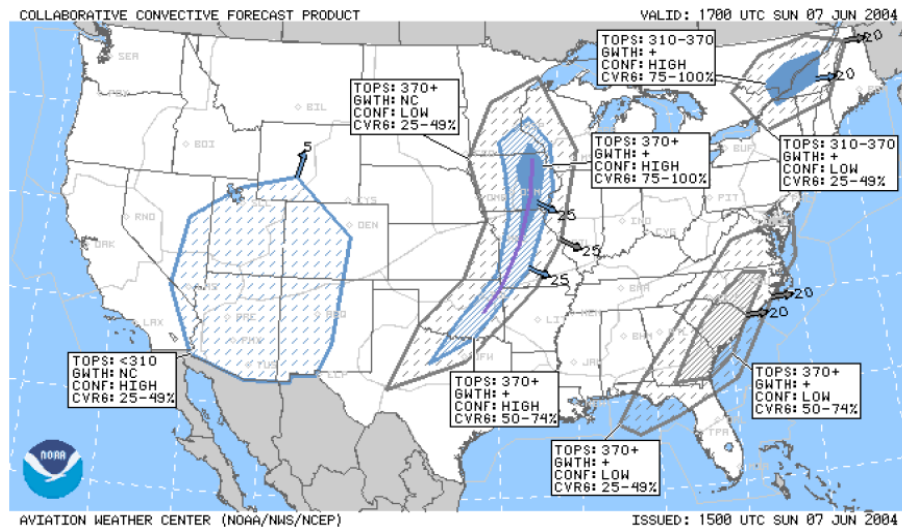
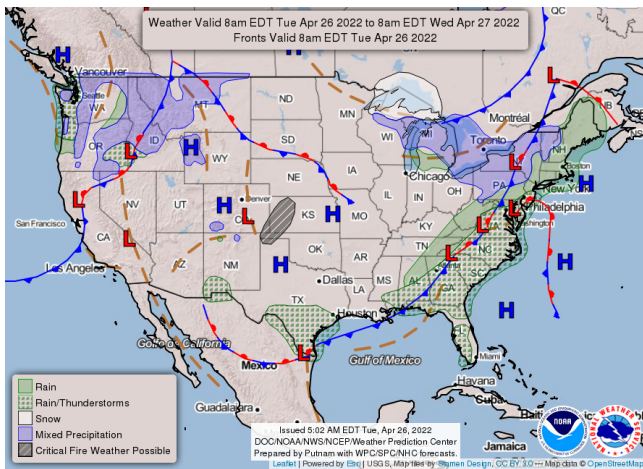


- SPC
- NWS
- WPC
- XYZ

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 Synopsis 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.