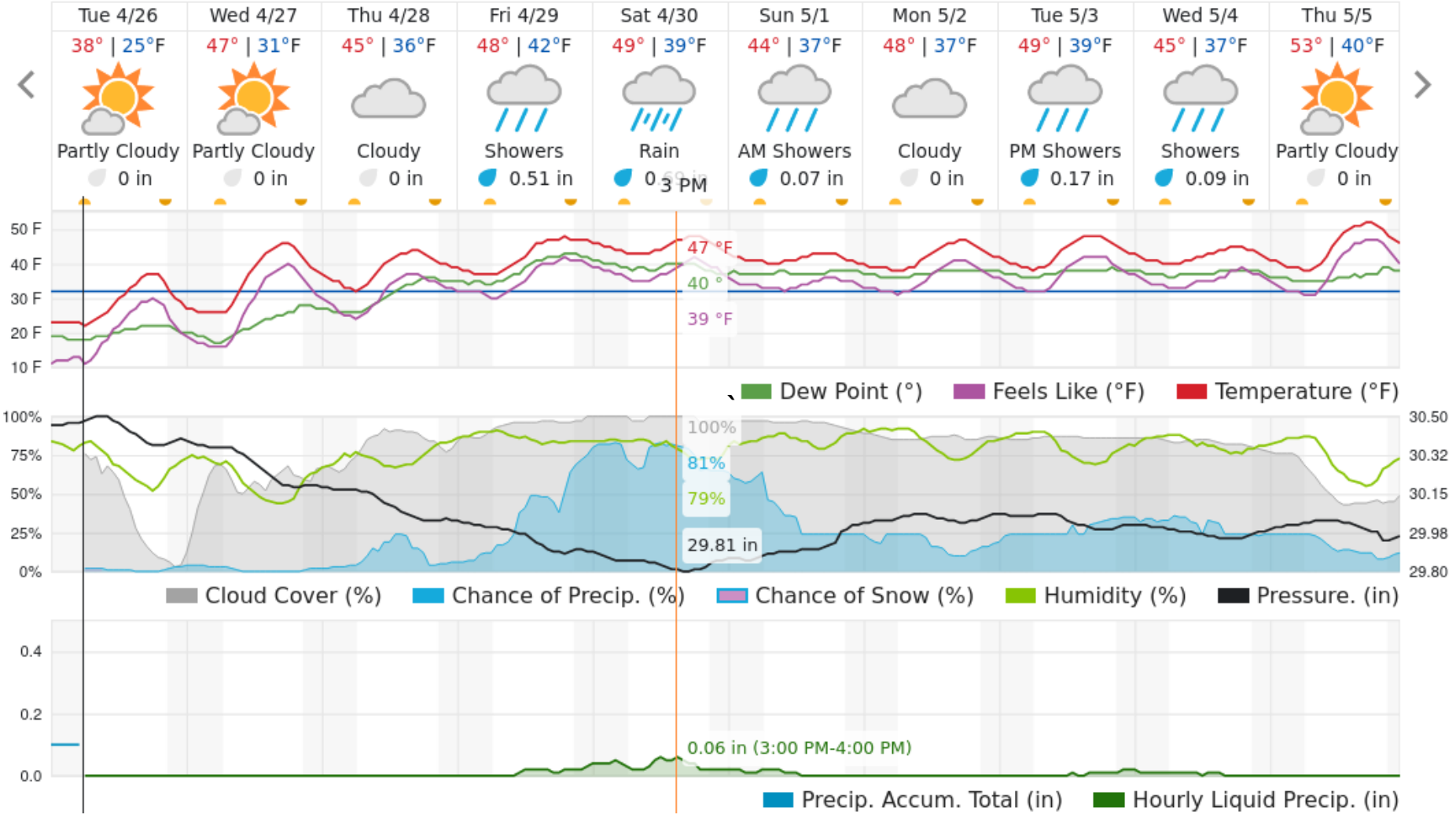
Weather Modification Operations Forecasting



Why use Weather Forecast?

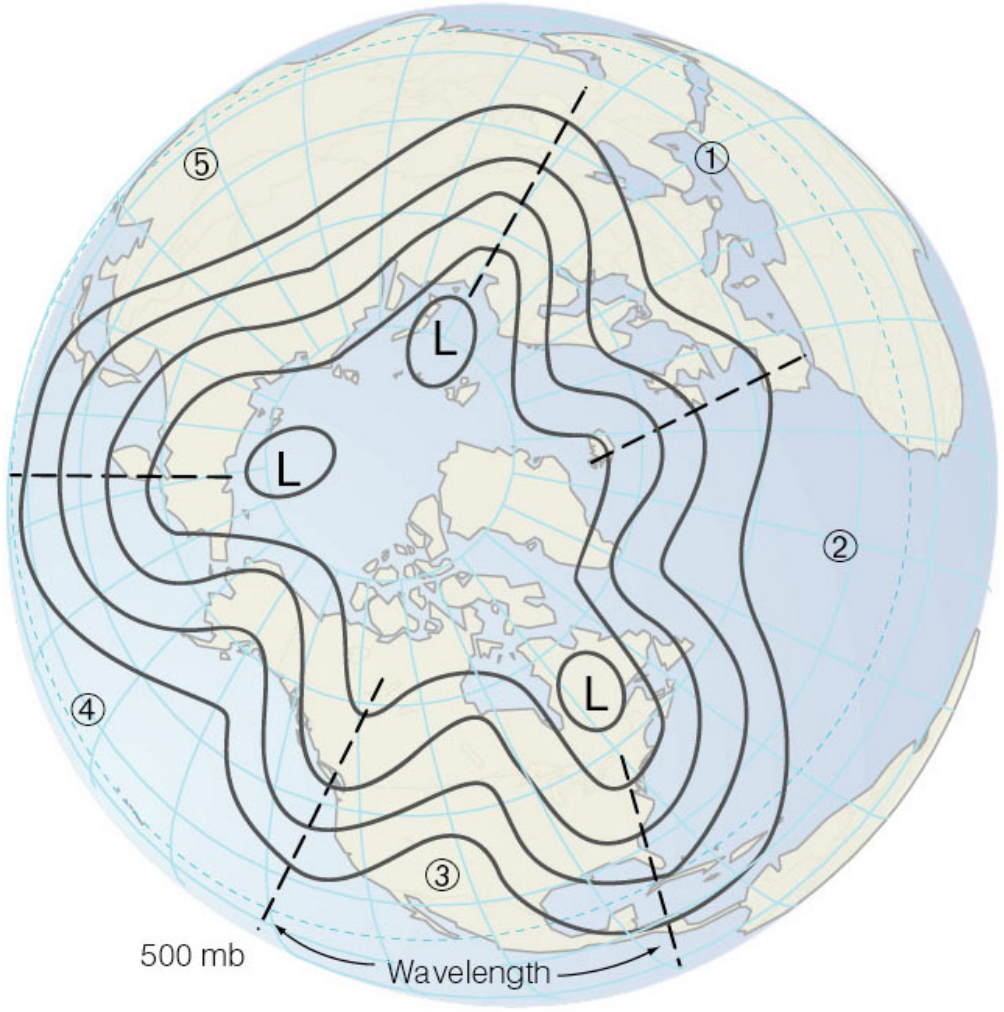
- Strategy for Cloud Seeding Operations
  - Timing of Aircraft Launches
  - Positioning of Resources
- Project Personnel Scheduling
- Maintenance Scheduling of Equipment

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)

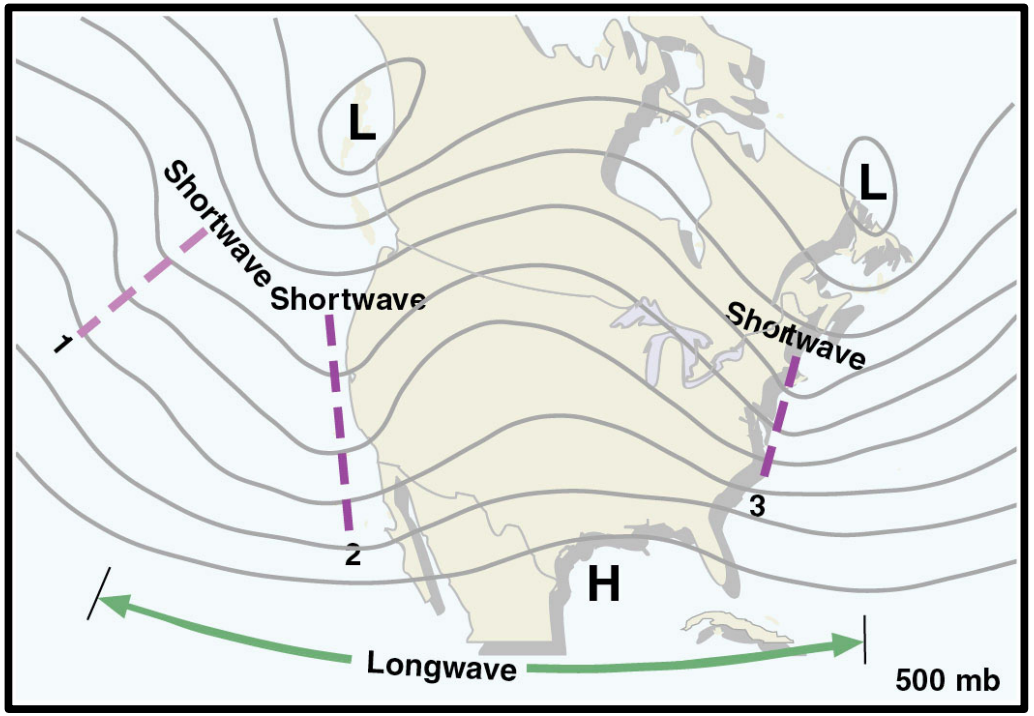
Atmospheric Waves: Long Waves

500 mb Pressure Level

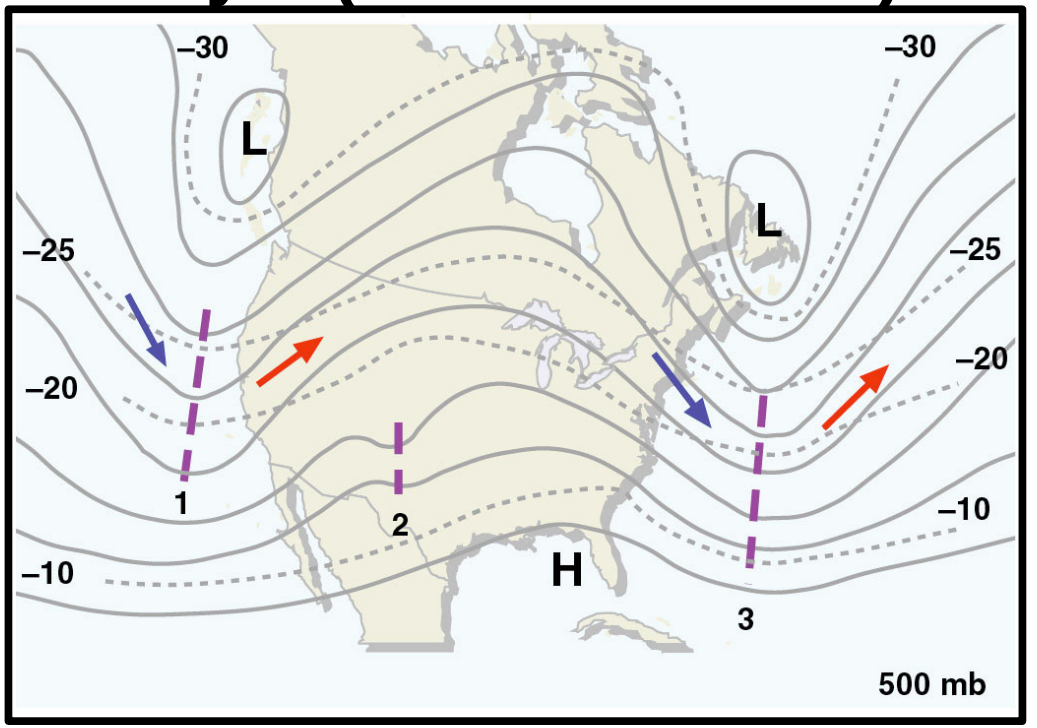


Atmospheric Waves: Short Waves

Day 1



Day 2 (24 Hours Later)



500 mb Pressure Level

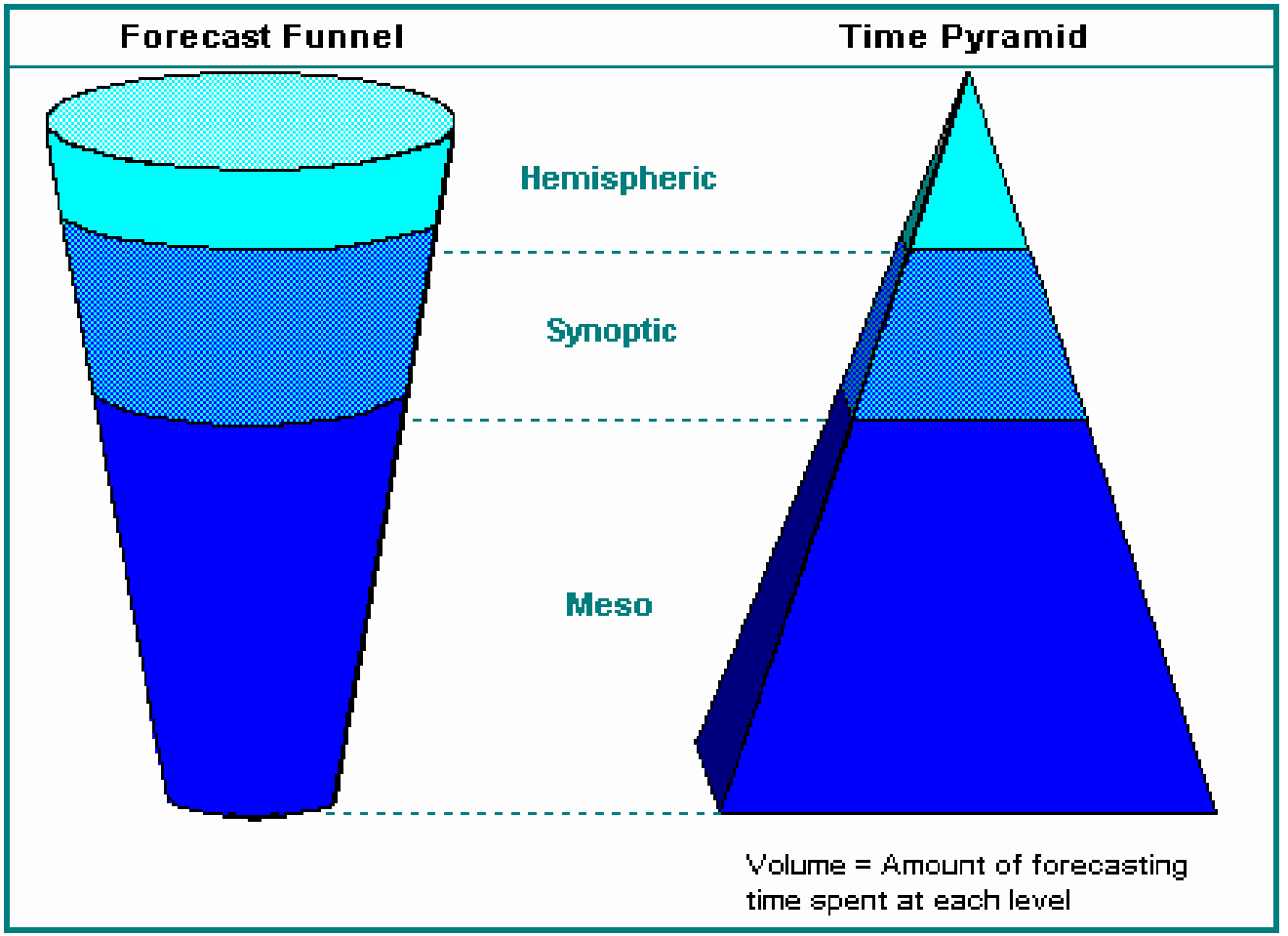
Weather Variability

- **<u>Long Waves</u>**
- Move slowly.
- Dominate pattern on weekly basis.

- **<u>Short Waves</u>**
- 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

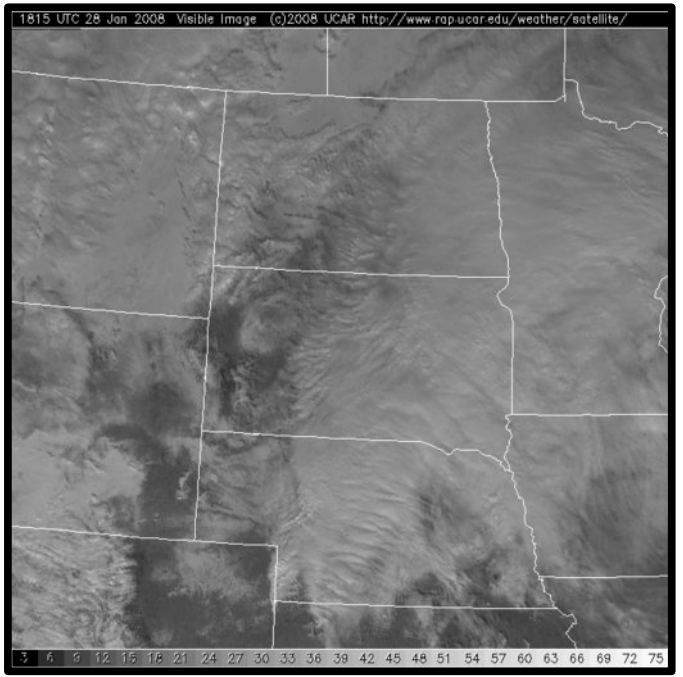
Solution → Information

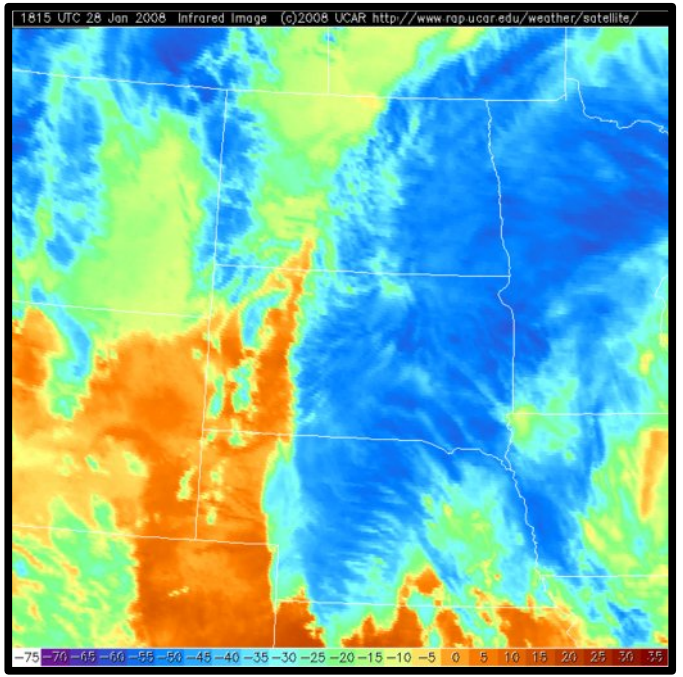
Weather Information

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

Satellite Observations

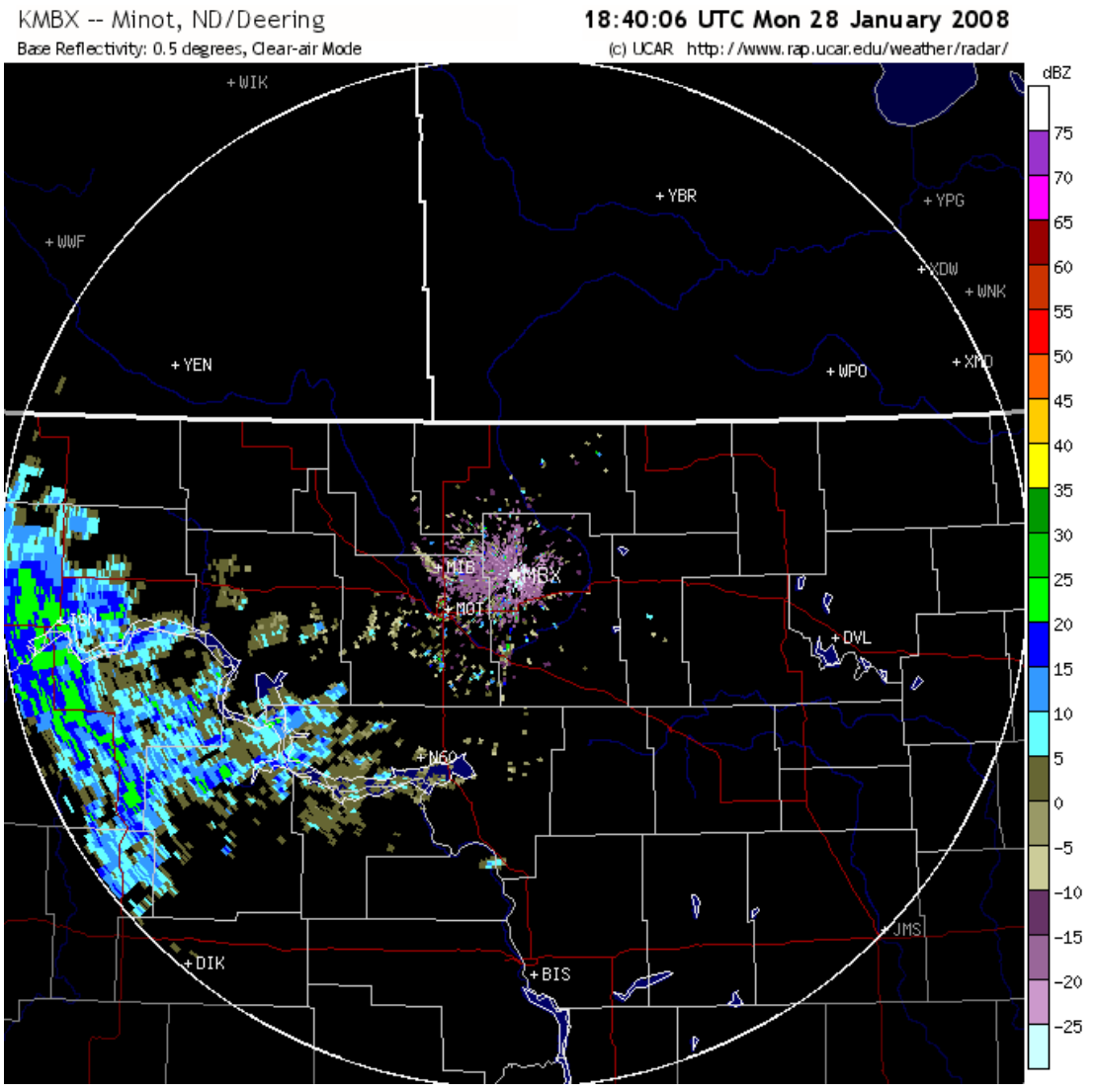
- Clouds and Water Vapor
- Large Scale View
- Cloud Top Temperature
- Boundaries
- Initiating Convection



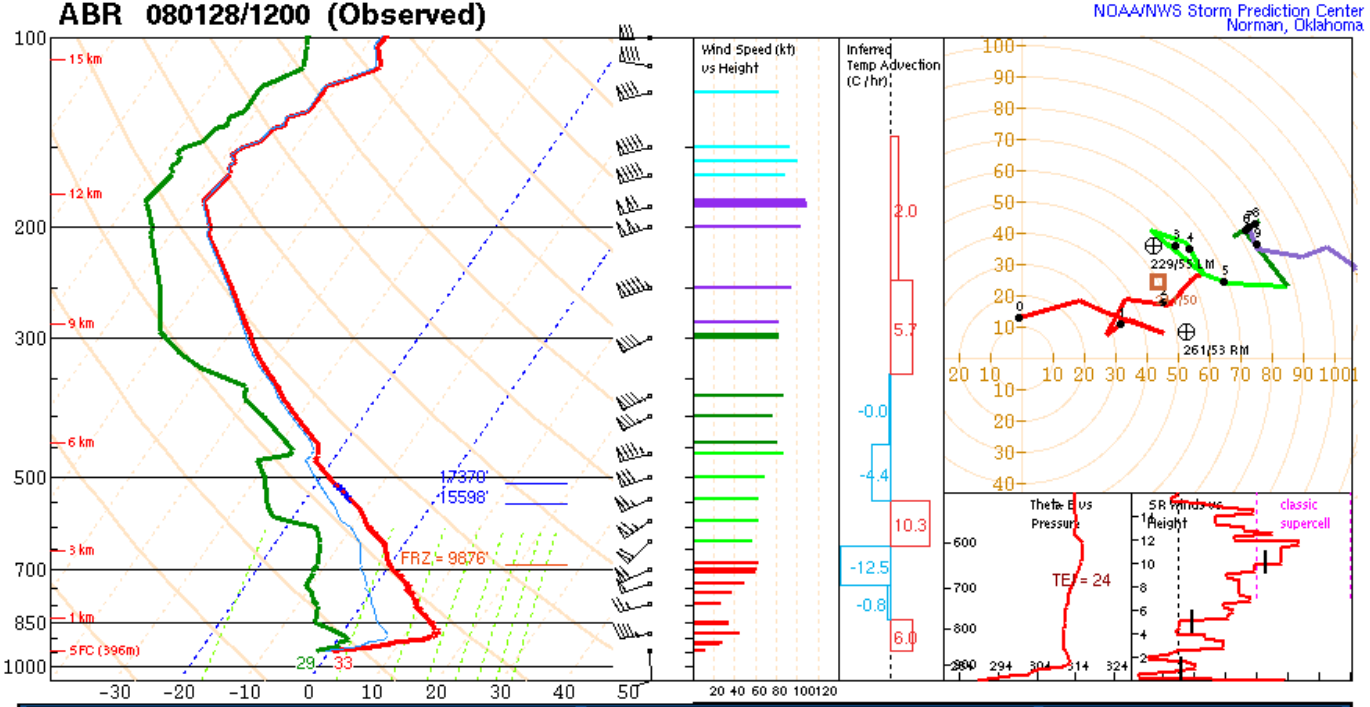


Radar Observations

- Current Convection
- Outflow Boundaries
- Echo Tops
- Coverage
- Movement
- Intensity
- Trend



Atmospheric Soundings



PARCEL	CAPE	CINH	LCL	LI	LFC	EL
SURFACE	0	0	336m	19	M	1102'
MIXED LAYER	0	0	1822m	7	M	5976'
FCST SURFACE	0	0	2916m	1	M	9562'
MU (600 mb)	0	0	4672m	1	M	15324'

PW = 0.48 .in	3CAPE = 67 J/kg	WBZ = 0'	WNDG = 0.0
K = 15	DCAPE = 376 J/kg	FZL = 8577'	ESP = 0.0
MidRH = 38%	DownT = 49 F	ConvT = M	MMP = 0.99
LowRH = 44%	MeanW = 4.0 g/kg	MaxT = 75F	NCAPE = 0.00
SigSevere = 0 m3/s3			

Sfc-3km AgI Lapse Rate =	1.0 C/km
3-6km AgI Lapse Rate =	7.5 C/km
850-500mb Lapse Rate =	7.6 C/km
700-500mb Lapse Rate =	7.7 C/km

Supercell = 0.0
Left Supercell = 0.0
Sig Tor (CIN) = 0.0
Sig Tor (fixed) = 0.0
Sig Hail = 0.0

	SRH(m2/s2)	Shear(kt)	MnWind	SRW
SFC - 1 km	51	29	250/34	98/21
SFC - 3 km	96	51	244/40	118/19
SFC - 6 km		77	245/48	145/15

BRN Shear = 25 m²/s²
4-6km SR Wind = 224/24 kt

.....Storm Motion Vectors.....
Bunkers Right = 261/53 kt
Bunkers Left = 229/55 kt

Corfidi Downshear = 241/98 kt
Corfidi Upshear = 236/33 kt

1km & 6km AGL Wind Barbs

*** BEST GUESS PRECIP TYPE ***
Snow.
Based on sfc temperature of 33.4 F.

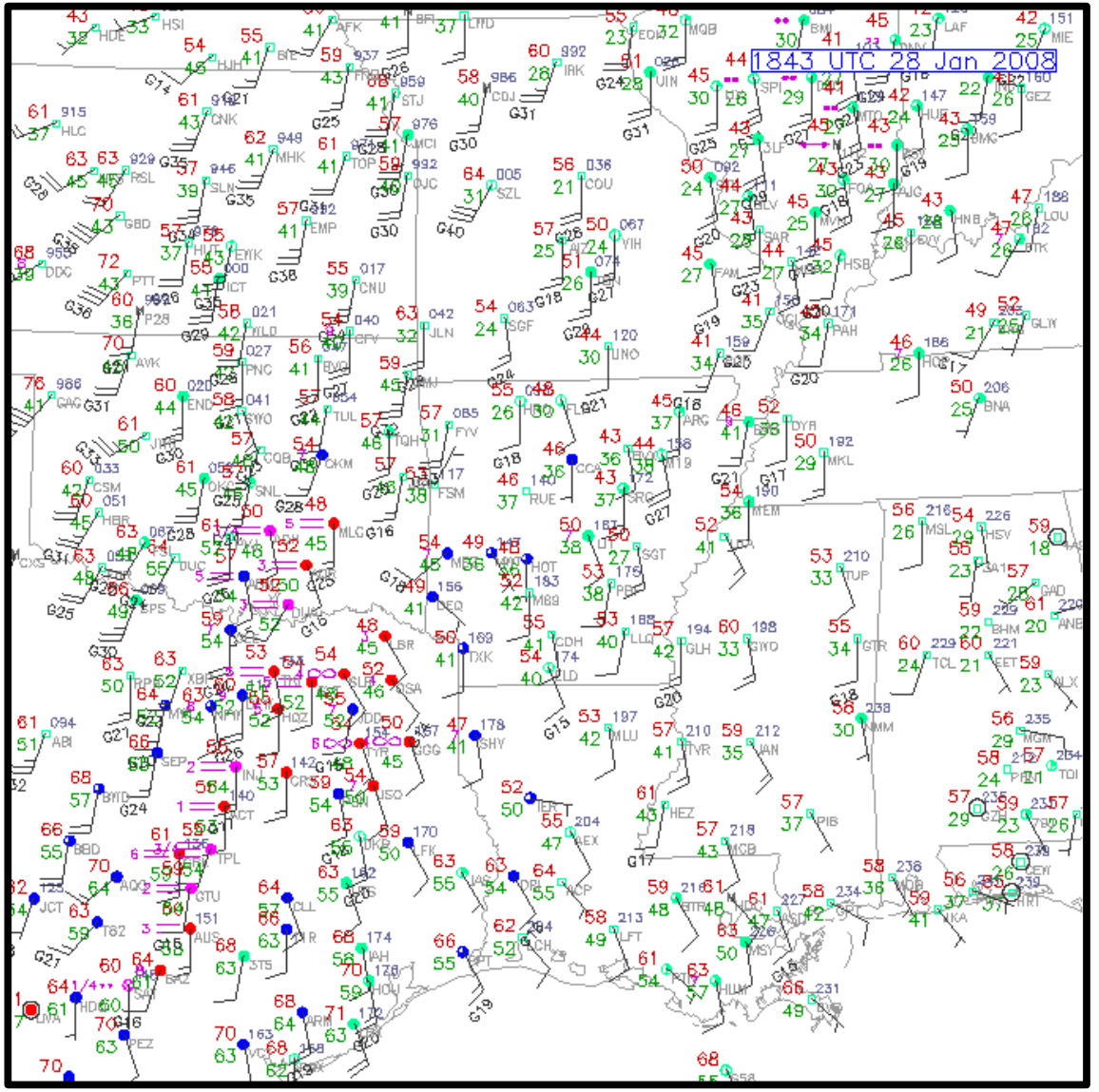
SARS - Sounding Analogs

SUPERCELL	SGFNT HAIL
No Quality Matches	No Quality Matches

Any Ideas?

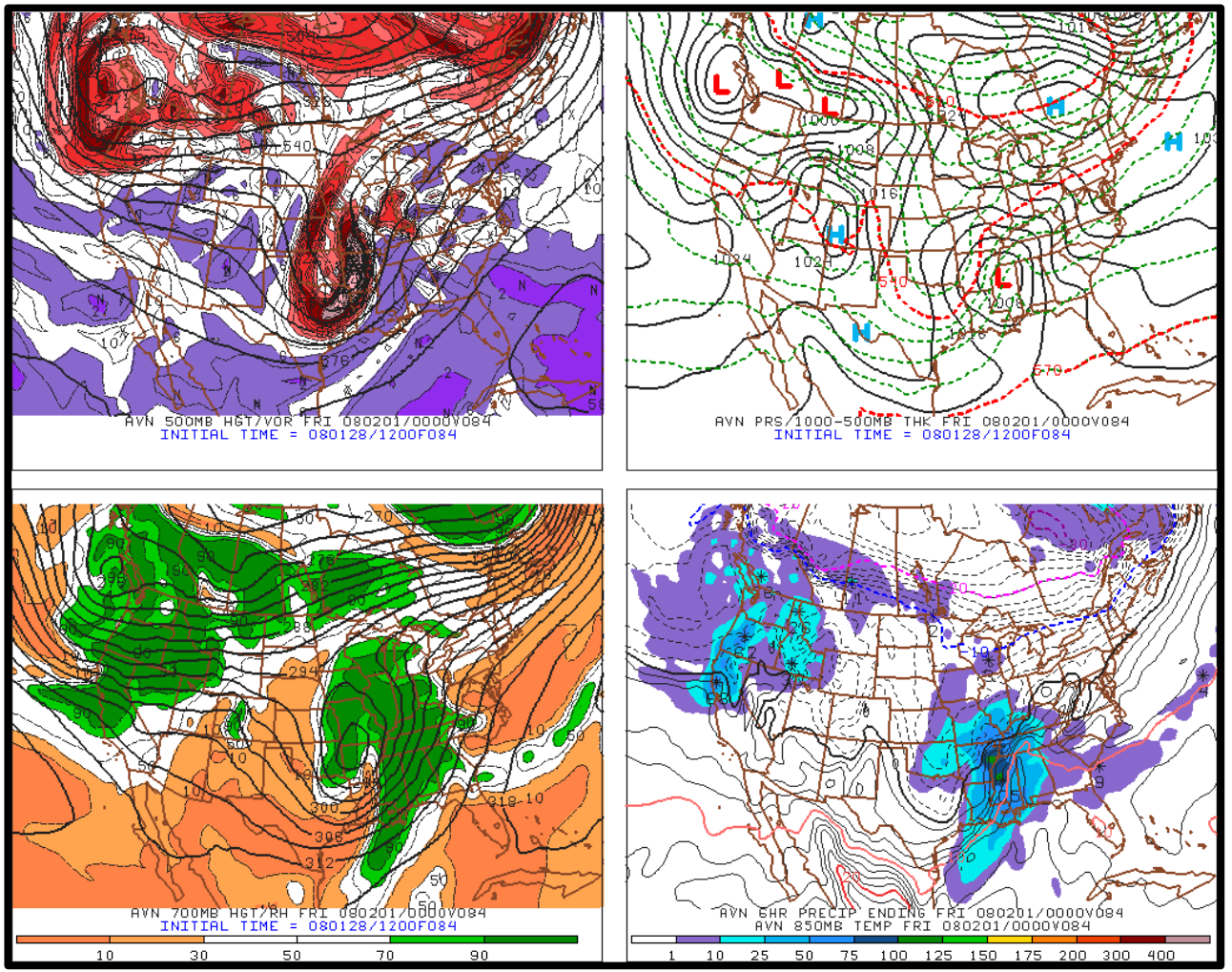
Surface Observations

- 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

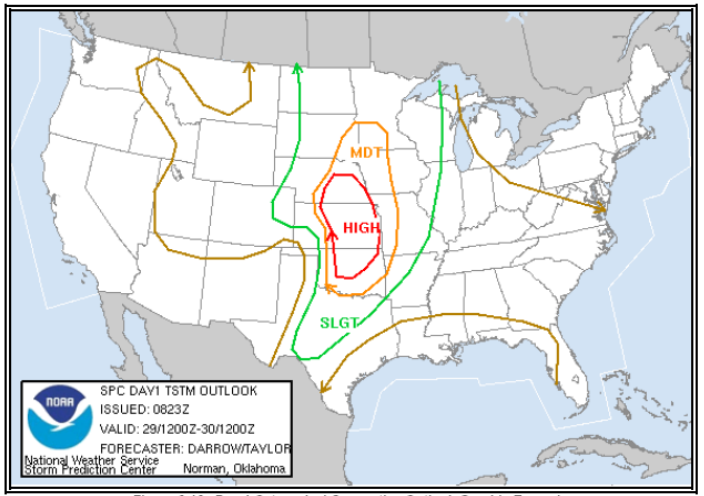
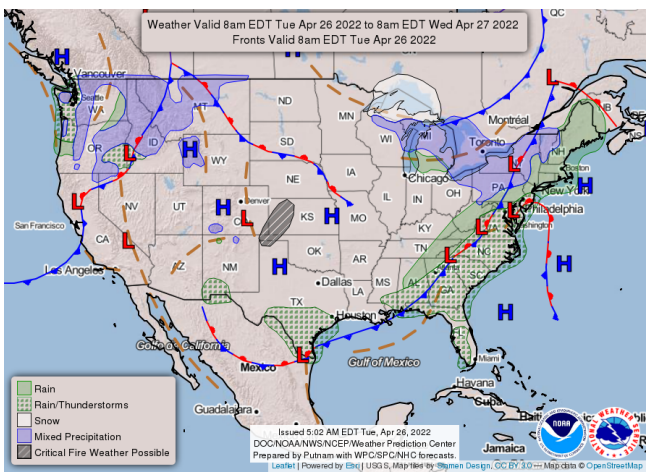


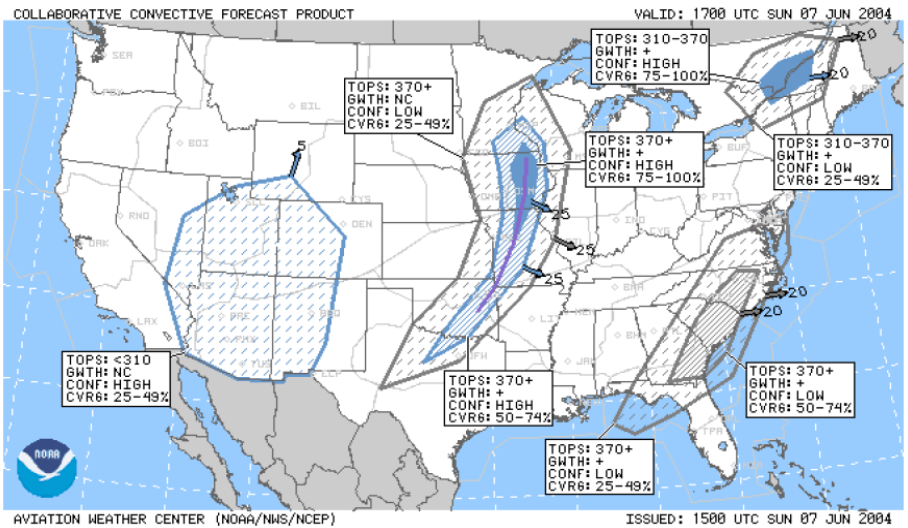
Figure 6-16. Day 1 Categorical Convective Outlook Graphic Example

SPC: Storm Prediction Center
Excessive Rainfall Forecast

NWS: National Weather Service
Bismarck, North Dakota

WPC: Weather Prediction Center





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.

NDCMP Forecasts Indices

	Lifted Index (<1)	K index (>30)	Total Totals (>48)	Sweat (>200)	Cape (>125)	Cap (<3)	Bulk Richarson Number (>3)	Helicity (>125)
D 1	-1.17	31.9	51.6	292	152	4.54	4.78	107
D 2	0.85	24.1	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

NDCMP Hailcast Model Output

(centimeters)	BPP	ISN	MOT
MAX	0	0	0
MIN	0	0	0
Control	0	0	0
AVG	0	0	0

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.