Forecasting Texas Snow Storms

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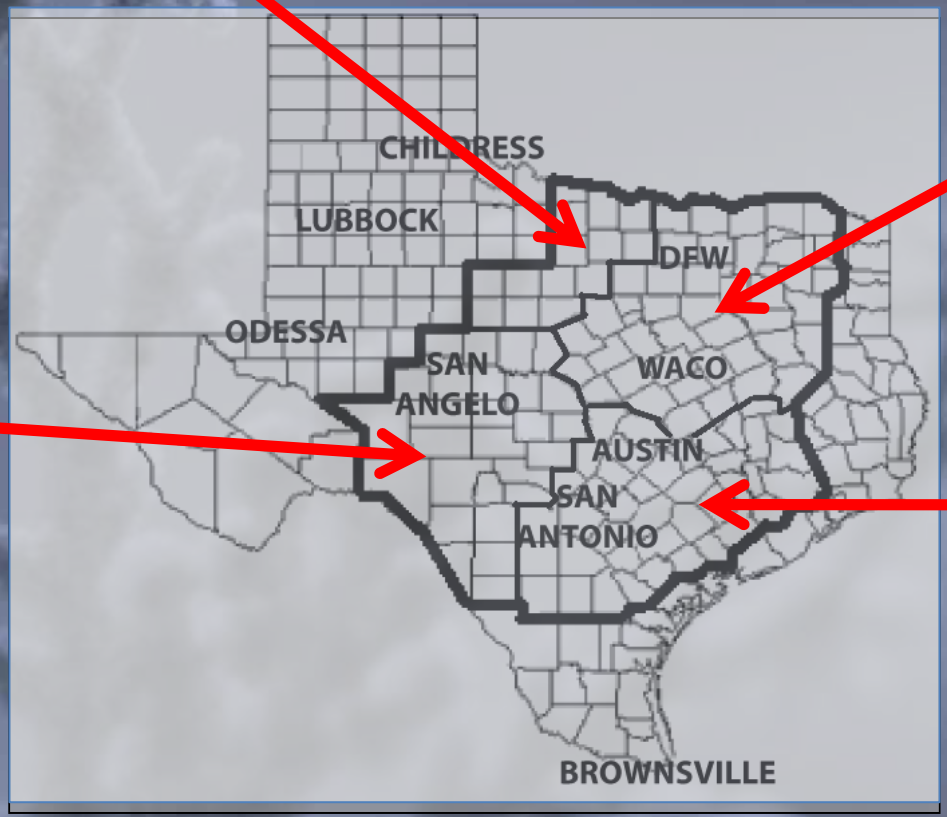
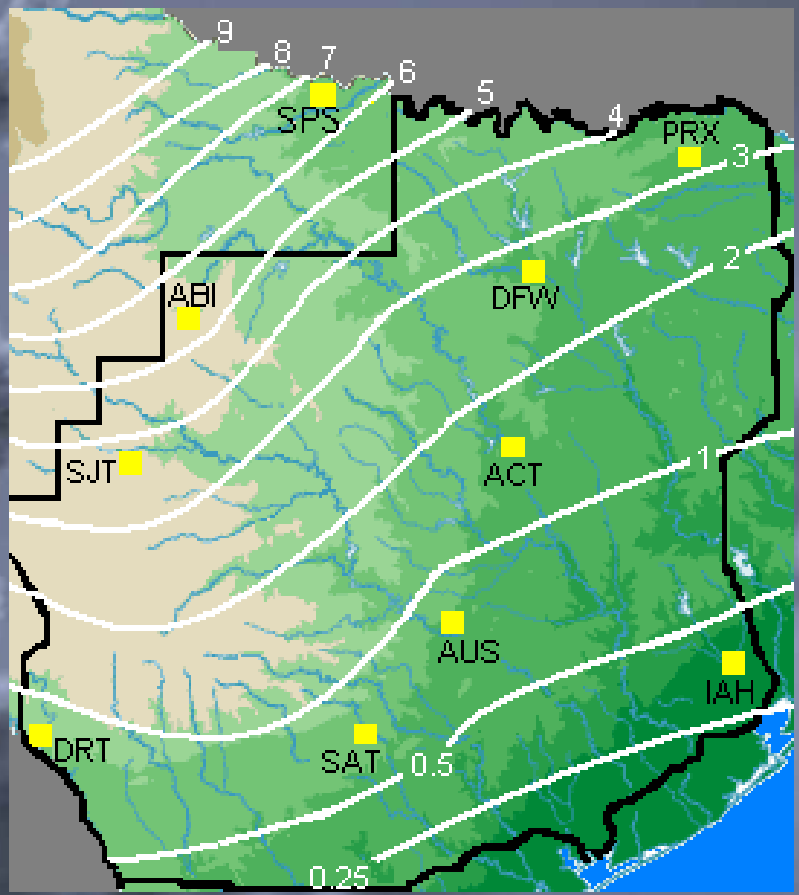
Winter Weather Workshop 2007

Study Area


Northwest
North
West Central
South Central
CHILDRESS
LUBBOCK
DFW
ODESSA
SAN ANGELO
WACO
AUSTIN
SAN ANTONIO
BROWNSVILLE

Mean Seasonal Snowfall



Based on LCD data between 1965 and 1995

- Sleet is officially recorded in the snow total
  - Freezing rain (ice) is not
- Cases contained a max accumulation of at least 4 inches
  - 4 inches is Winter Storm Warning Criteria
- 50 cases found between 1948 and 2005

Methodology for each case…

- 500 mb heights analyzed and classified
  - 6 synoptic categories emerged
- Moisture (specific humidity)
  - 500 mb and 700 mb over snowfall region
- Temperature
  - 500 mb in the core of the upper low or shortwave
  - 700 mb and 850 mb over the snowfall region
- Standardized anomalies examined for height, moisture, and temperature parameters

What is a standardized anomaly?

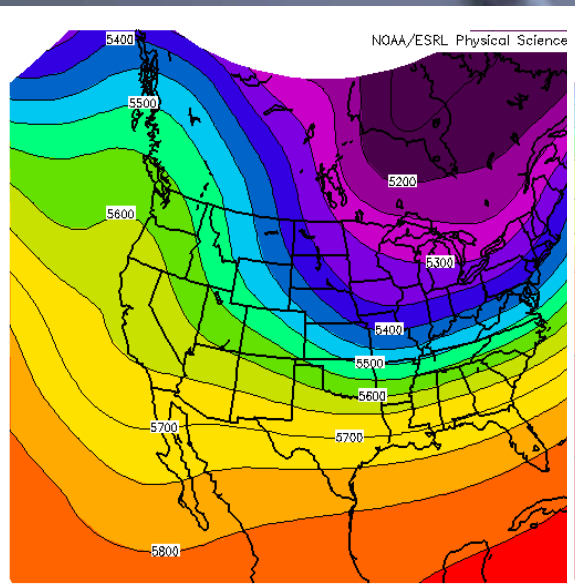
- Essentially a number which shows the departure from normal (standard deviation)
- Takes into account season/latitude
- 0 is normal
- ±1 Standard Deviation ~ 68th percentile
- ±2 Standard Deviations ~ 95th percentile
- ±3 Standard Deviations ~ 99.7th percentile

Synoptic Types

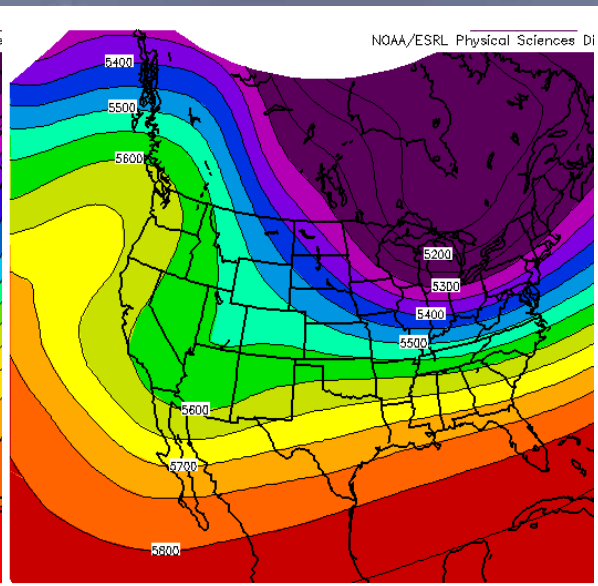
- Southwestern Cutoff Low (4 cases)
- Rex Block/Backwards S (7 cases)
- Pacific Ridge (18 cases)
- Pronounced Split Flow (9 cases)
- Omega Block (4 cases)
- Full Latitude Trough (8 cases)

Southwestern Cutoff Low

- All snow events lasted 48 or more hours
- 2 cases had around a foot of snow



500mb Geopotential Heights (m) Composite Mean
1/29/77 0z 1/12/85 0z 1/5/97 0z 2/24/03 0z
NCEP/NCAR Reanalysis



500mb Geopotential Heights (m) Composite Mean
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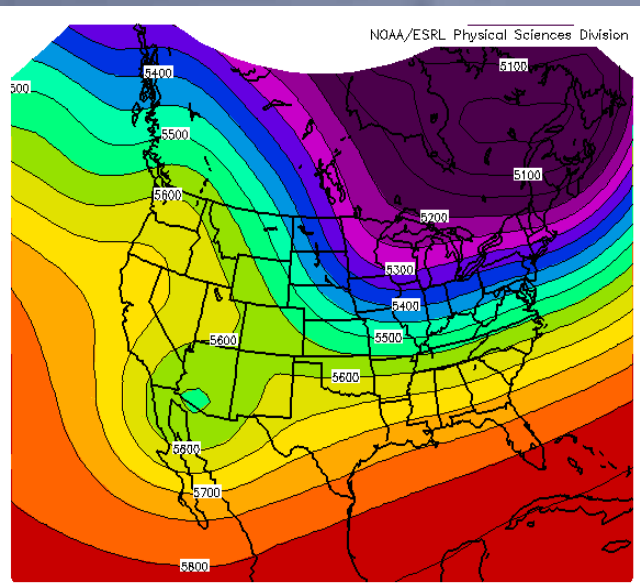
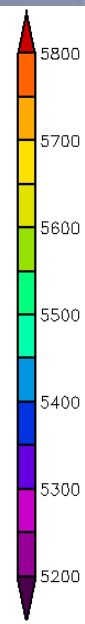
NCEP/NCAR Reanalysis



500mb Geopotential Heights (m) Composite Mean
1/31/77 0z 1/14/85 0z 1/7/97 0z 2/26/03 0z
NCEP/NCAR Reanalysis

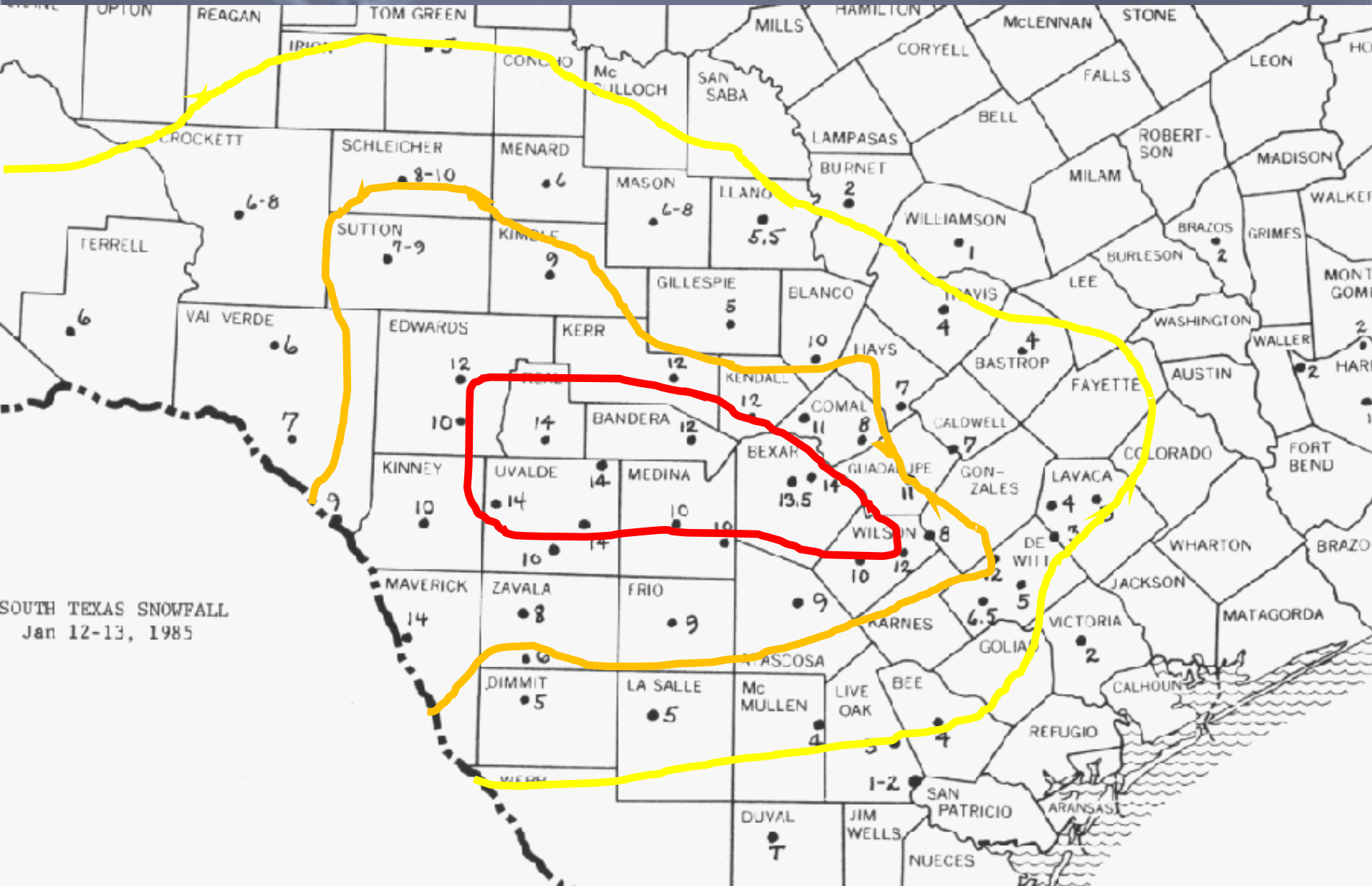


T-48 hrs **T-24 hrs** **Time of event**

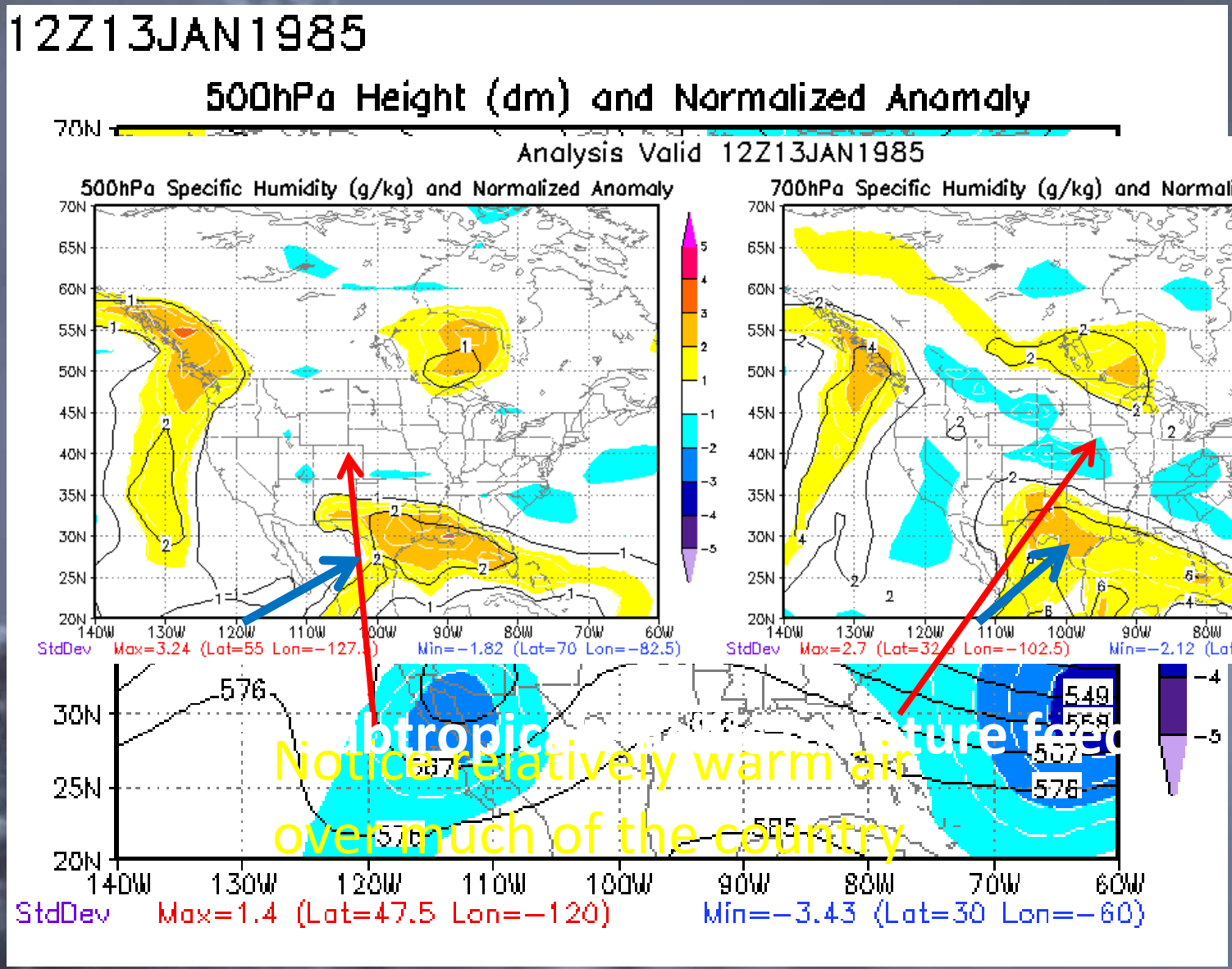
Southwestern Cutoff Low

- Meteorological Characteristics
  - Warm temperatures - warmest at 700 mb
  - High Moisture Content
    - Highest 500-mb and 700-mb mixing ratios
    - Highest average max snowfall of 6 types (9 in)
- Likely responsible for more ice storms than snow storms

Jan 12-13 1985 Snow Event



Jan '85 Upper Level Setup

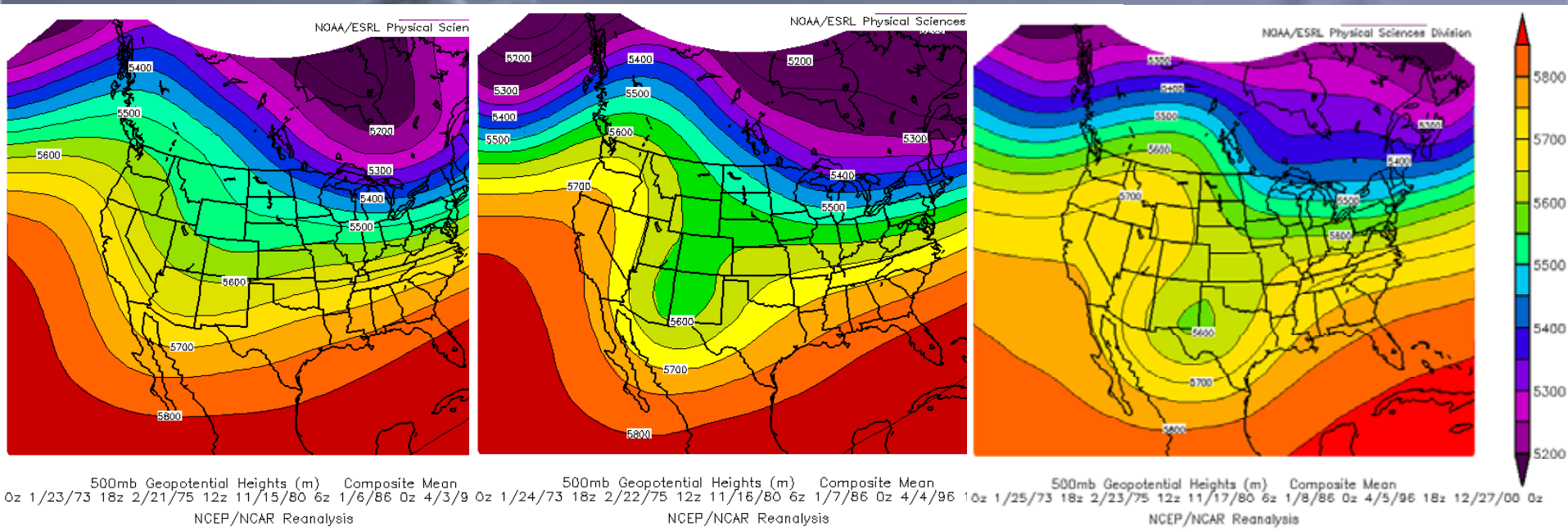


Southwestern Cutoff Low Summary

- All events occurred during coldest part of season (3 in Jan, 1 in Feb)
- Main forecast challenge is whether it's cold enough at all levels for snow
- Moisture is plentiful
- Potential for prolonged events with lots of snow over large area

Rex Block/Backward S

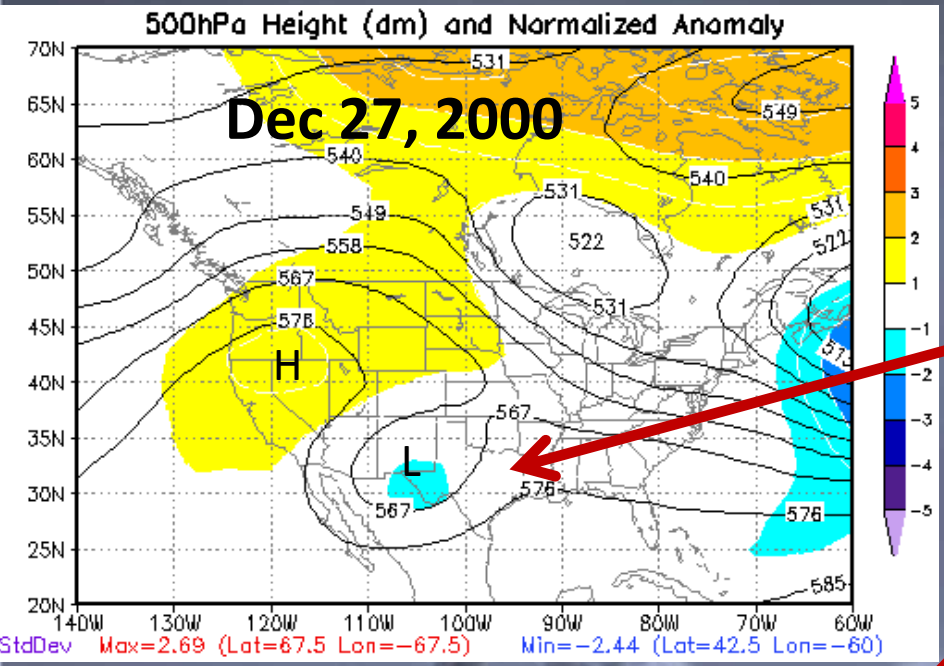
- Best combo of high moisture and cold temps
- Produced localized high amounts of snow near or beneath upper level low



T-48 hrs **T-24 hrs** **Time of event**

Rex Block/Backward S

- No seasonal correlation (occurred Nov-Apr)
- Position of Rex block important
  - Too far west lack of cold air
  - Too far east lack of moisture
- Tendency for cases to produce snow only in Northwest or West Central regions
- Lowest average areal 4” coverage of snow

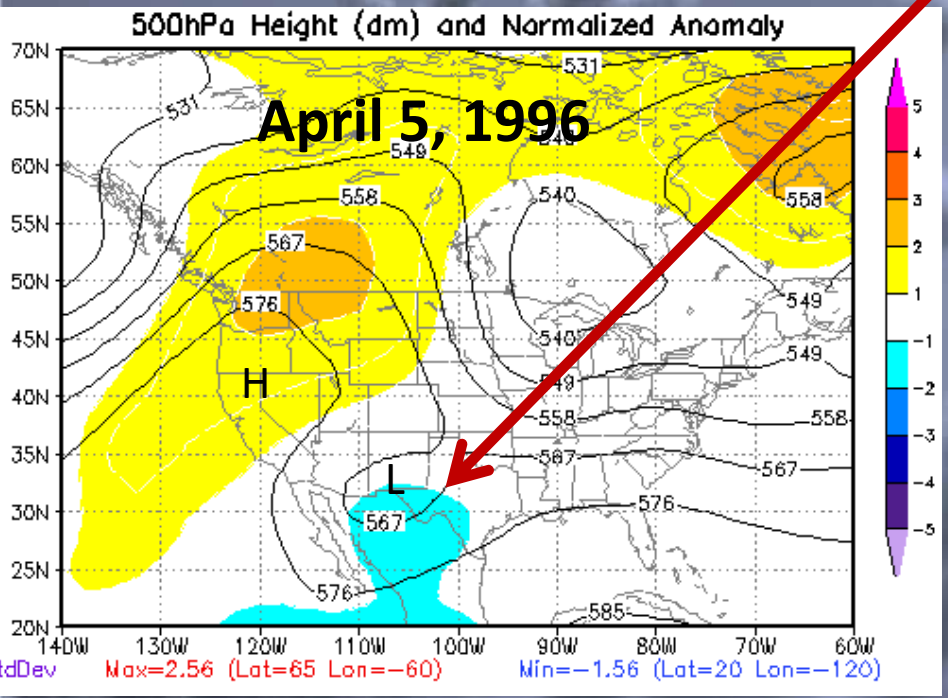


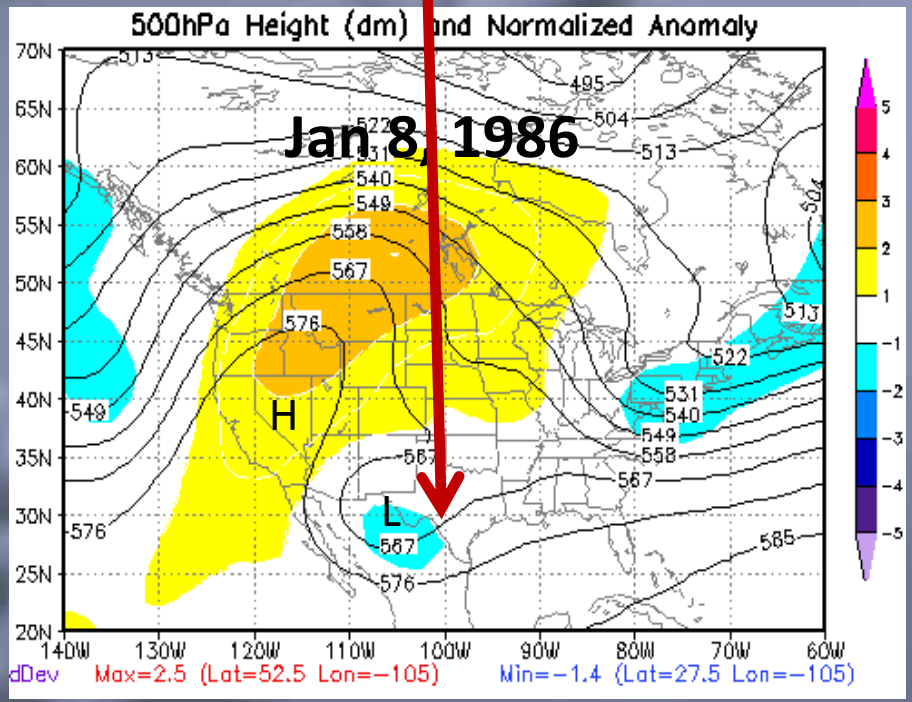
Isolated pockets of 8” to 12” of sleet and snow in North Texas

Abilene 9.3” (Midland 18”) 5 dead

No snow in North Texas

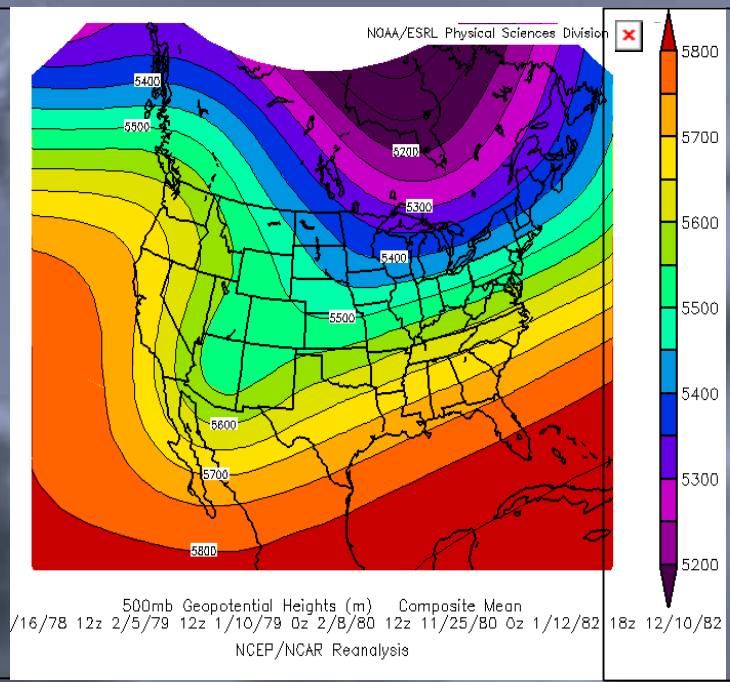
8.2” pocket of snow at Del Rio





Pacific Ridge

- Similar but more progressive than Rex Block/Backward S pattern
- Most common snow producing pattern

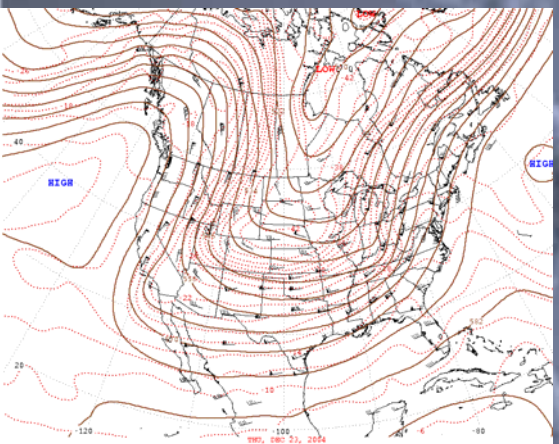


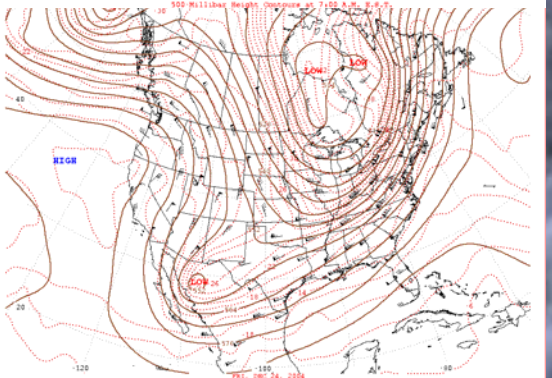
T-48 hrs **T-24 hrs** **Time of event**

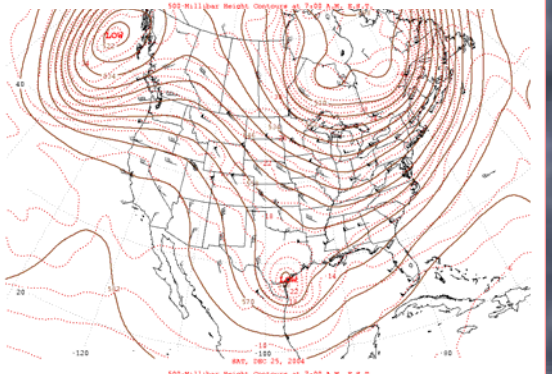
Pacific Ridge

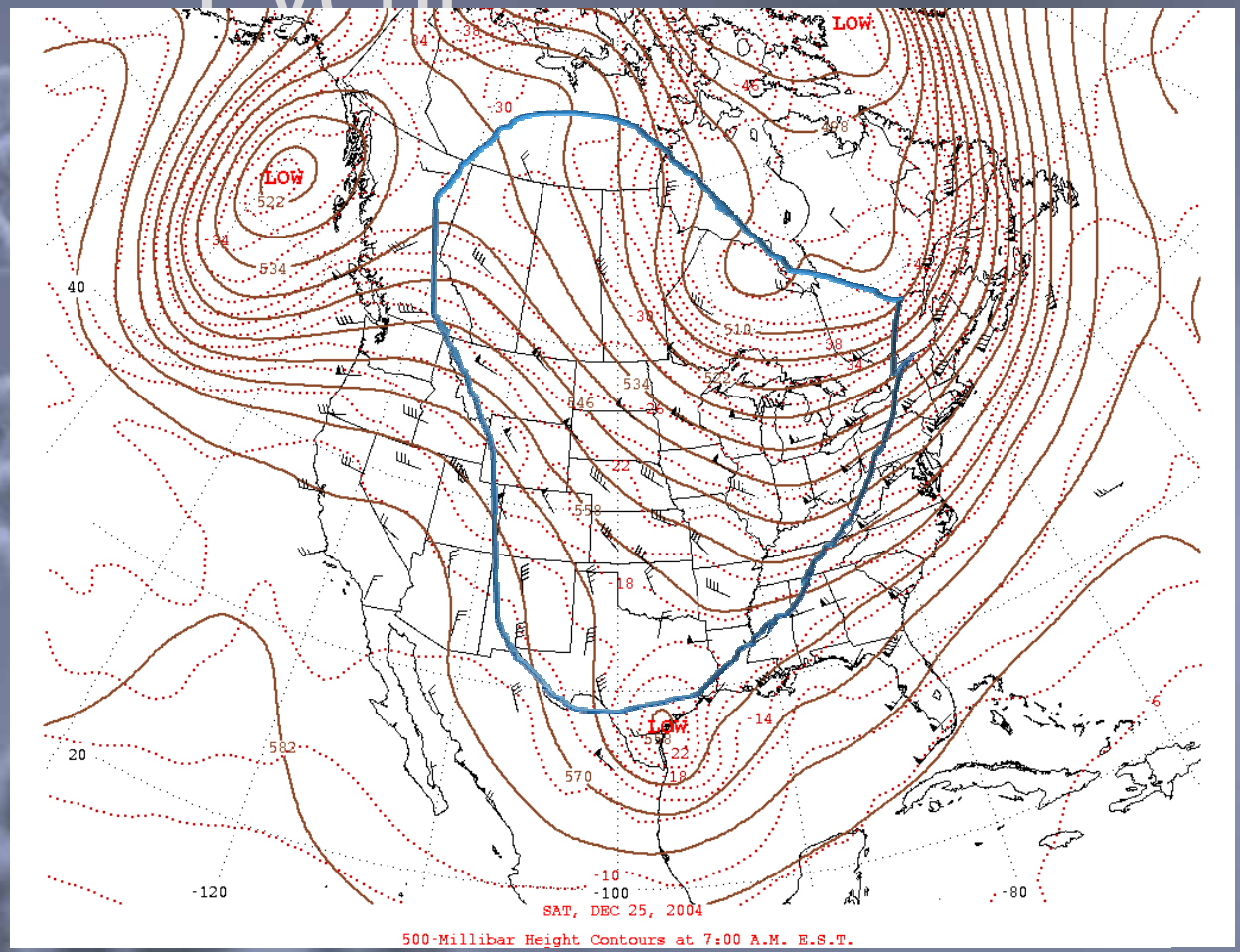
- 500-mb height/temperature anomalies were noteworthy and averaged 2 SD below normal
- However, 700 mb and 850 mb anomalies were often insignificant
- Cold air plunges south as the northern longwave trough moves east
- Shortwave moves into Pacific NW ~48 hrs before event and amplifies/deepens
- Often becomes a “bowling ball” upper low

Christmas Eve 2004 South Texas Event



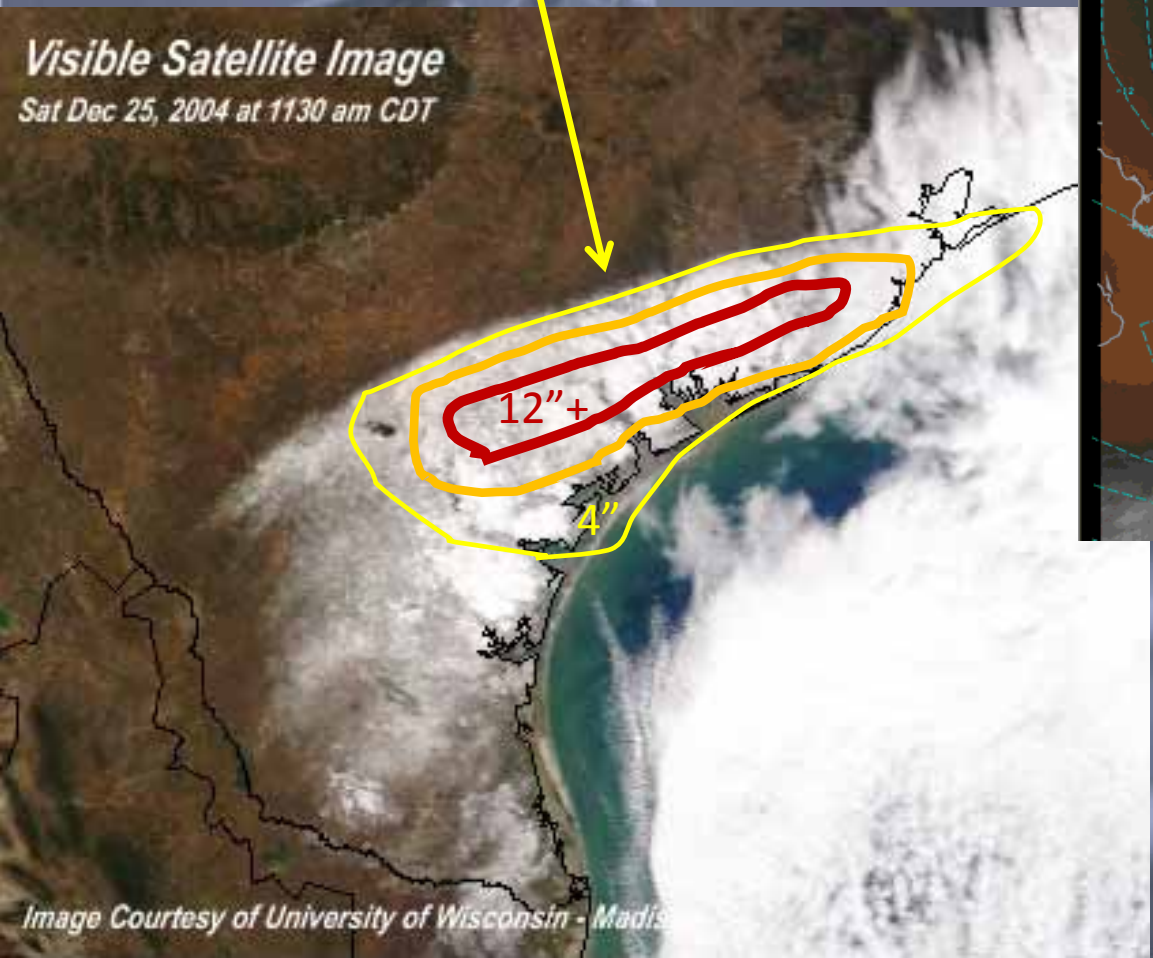


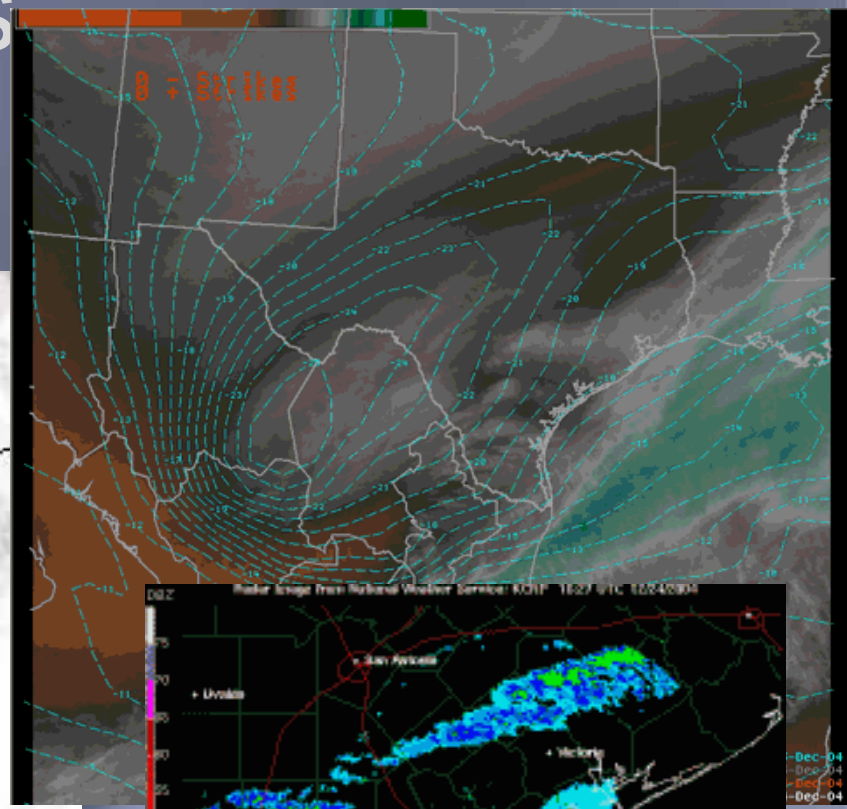


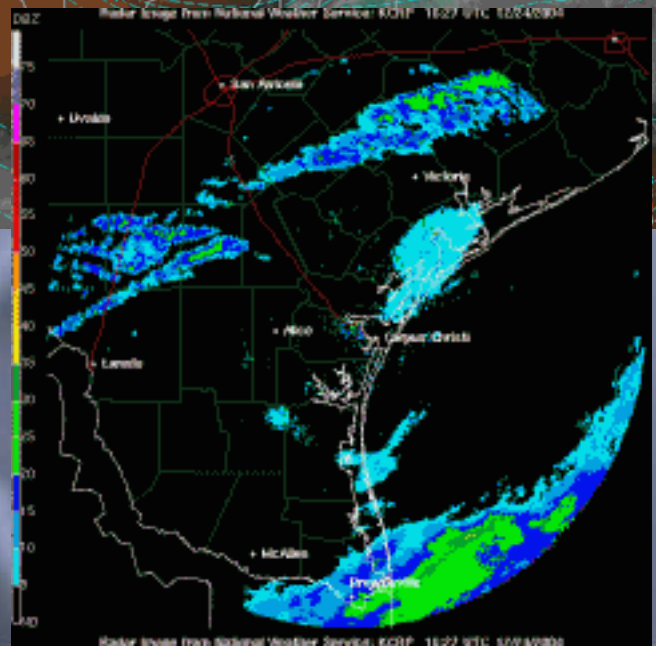


Christmas Eve 2004 South Texas

Narrow band of very heavy snow





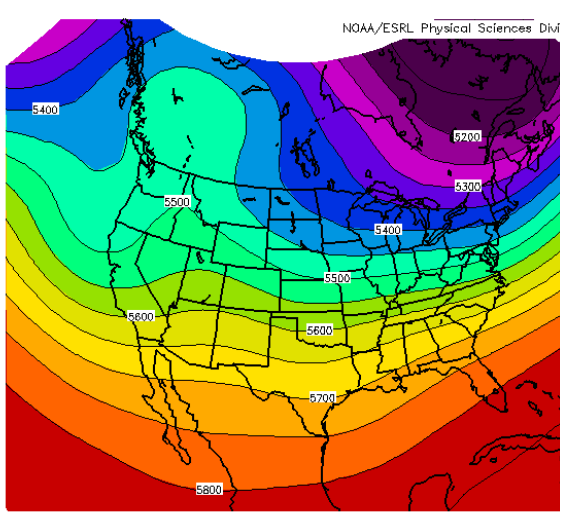


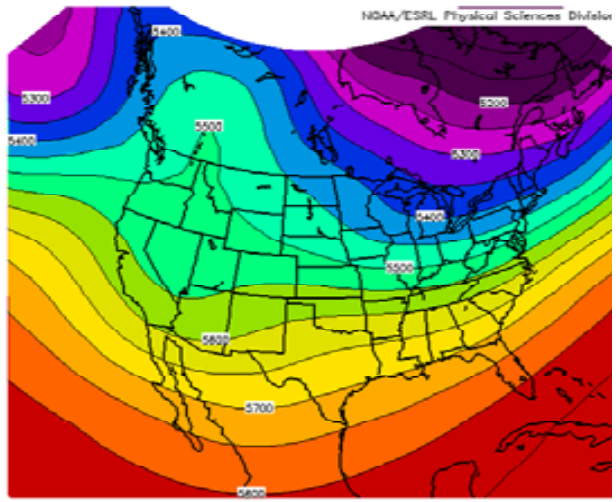
Pacific Ridge Summary

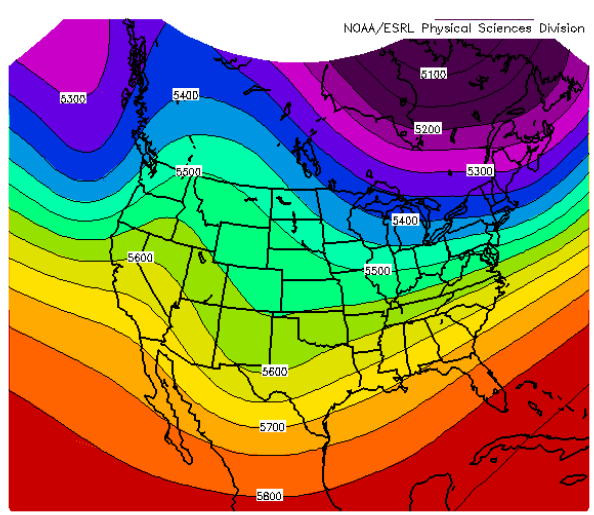
- Usually a narrow swath of heavy snow from WSW to ENE
- Climatologically favored pattern with good lead time of a snow event in the region
- Still very hard to forecast amounts and N-S placement of snow band until event begins

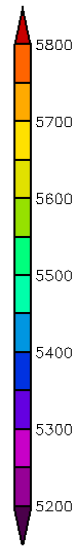
Pronounced Split Flow

- Overall zonal flow with fast moving southern stream shortwaves
- No cases since 1983 (most were in the 70s)





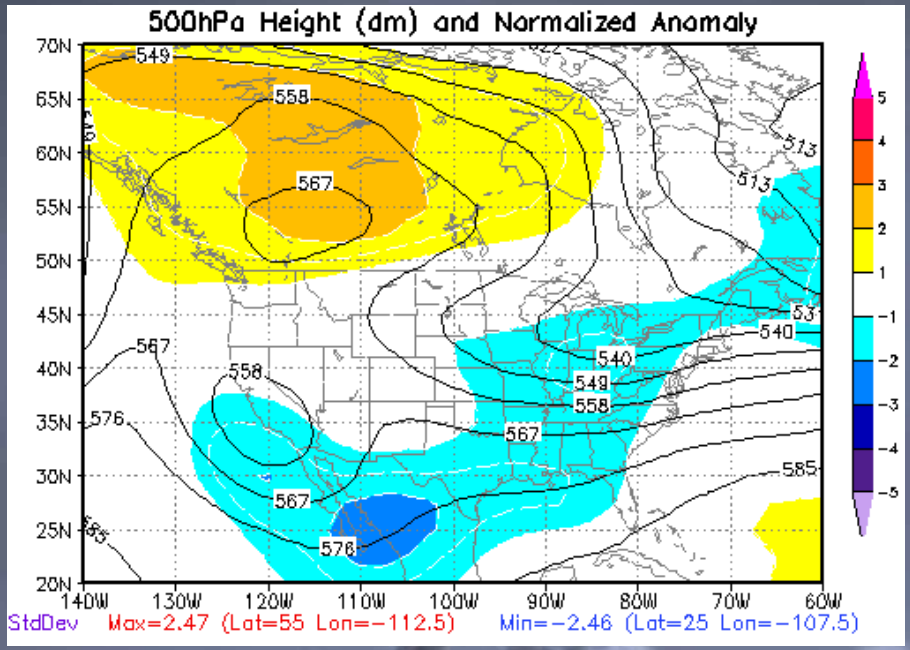




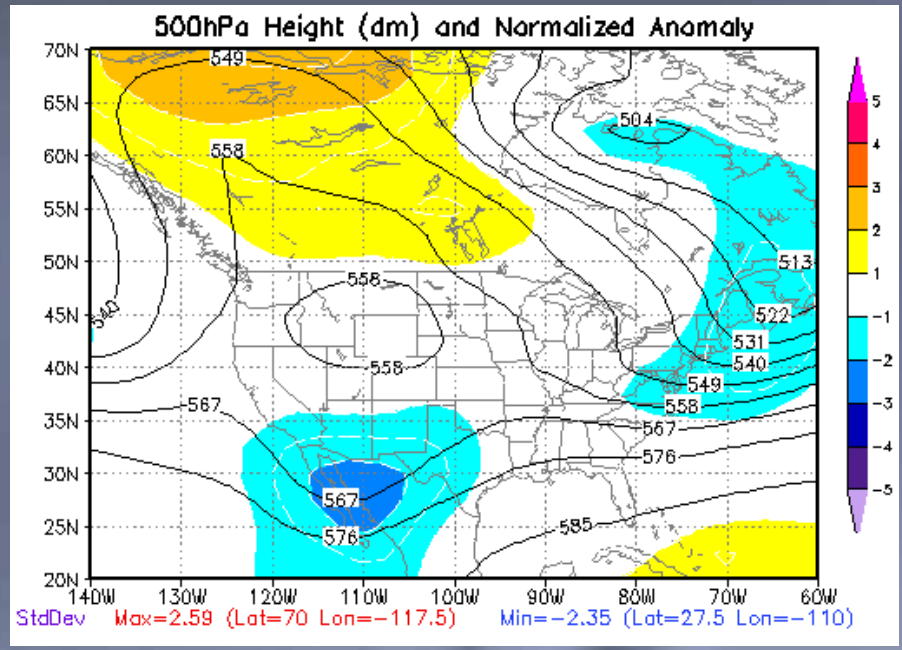
T-48 hrs **T-24 hrs** **Time of event**

Pronounced Split Flow

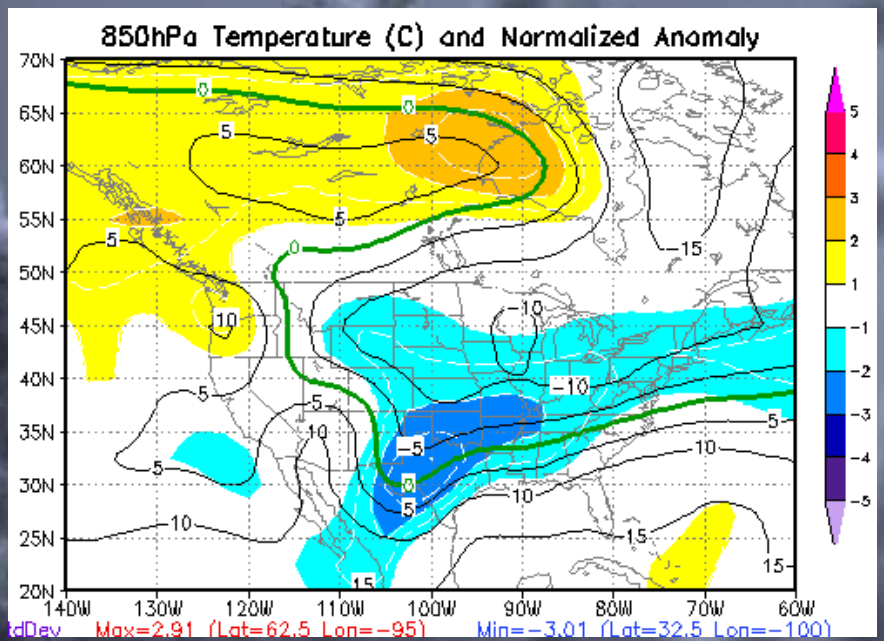
- High 500-mb moisture anomalies due to Pacific moisture injection
- Typically results in heavy snows across the North and/or North Central regions
- Second highest average snow amount of all 6 types

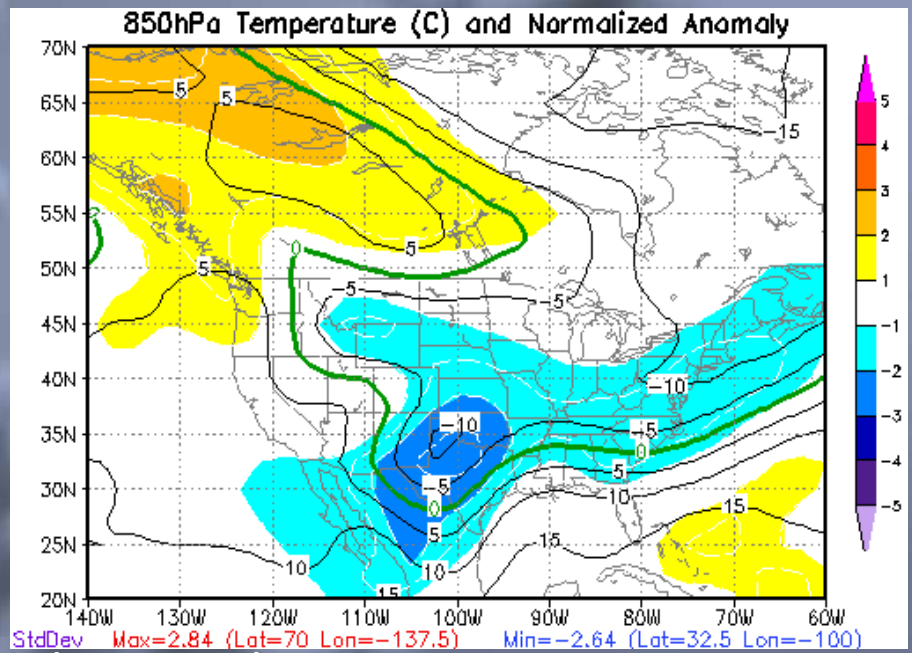


12 Nov 1976



13 Nov 1976





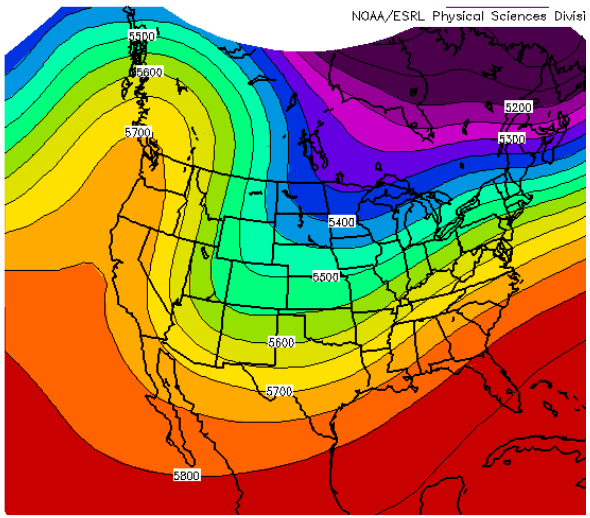
Resulted in 13” in Eastland and Comanche Counties

Pronounced Split Flow Summary

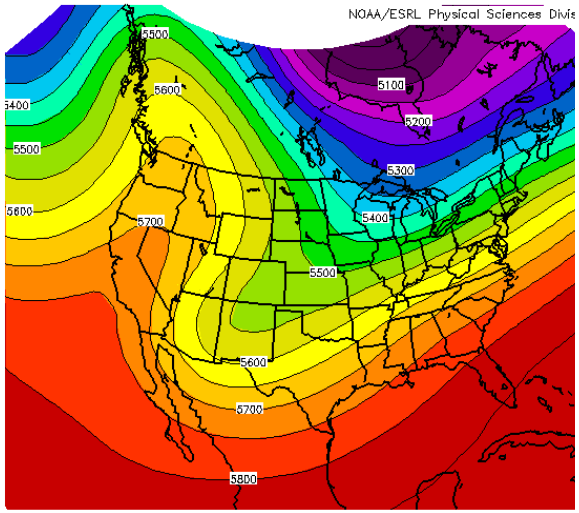
- Some of the warmest upper level temperatures
- Cold air needs to already be in place to produce snow
- Typically occurs during coldest months and in the northern part of the study region
- Shortwaves in southern stream are subtle
- Very difficult to forecast beyond a day

Omega Block

- Similar to Rex Block/Backward S pattern
- Colder temperatures, but less moisture



500mb Geopotential Heights (m) Composite Mean
2/22/66 0z 1/1/85 6z 12/9/86 18z 2/12/04 6z
NCEP/NCAR Reanalysis



500mb Geopotential Heights (m) Composite Mean
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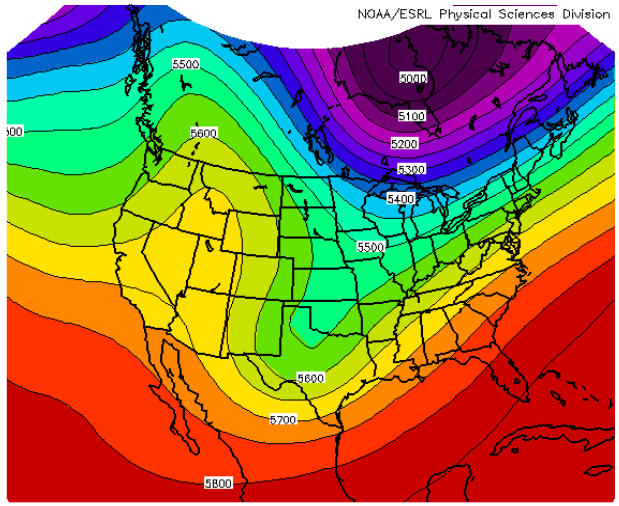
NCEP/NCAR Reanalysis



500mb Geopotential Heights (m) Composite Mean
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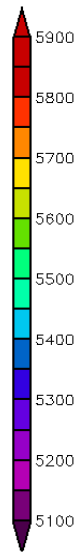
NCEP/NCAR Reanalysis

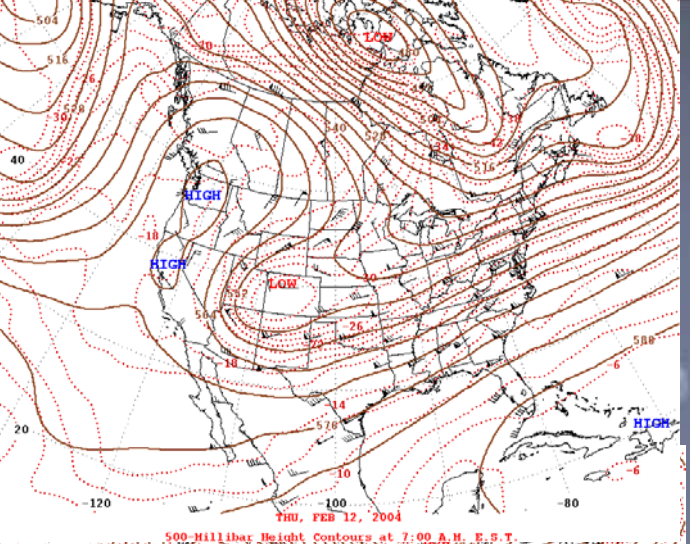


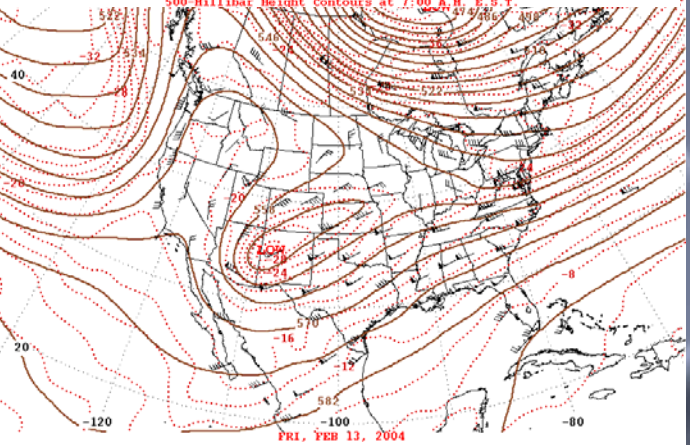
T-48 hrs **T-24 hrs** **Time of event**

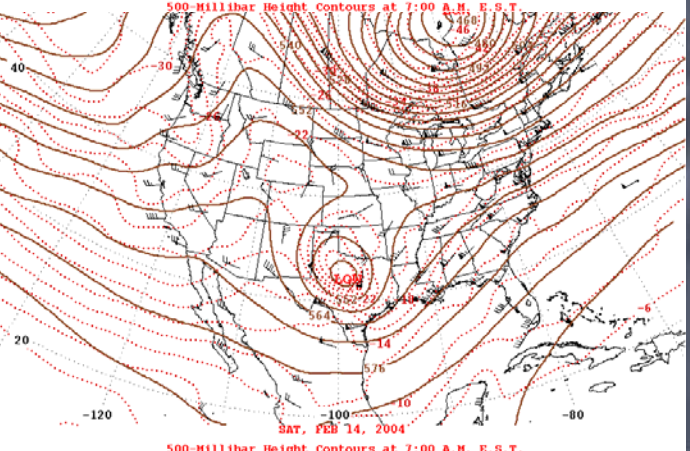
Omega Block

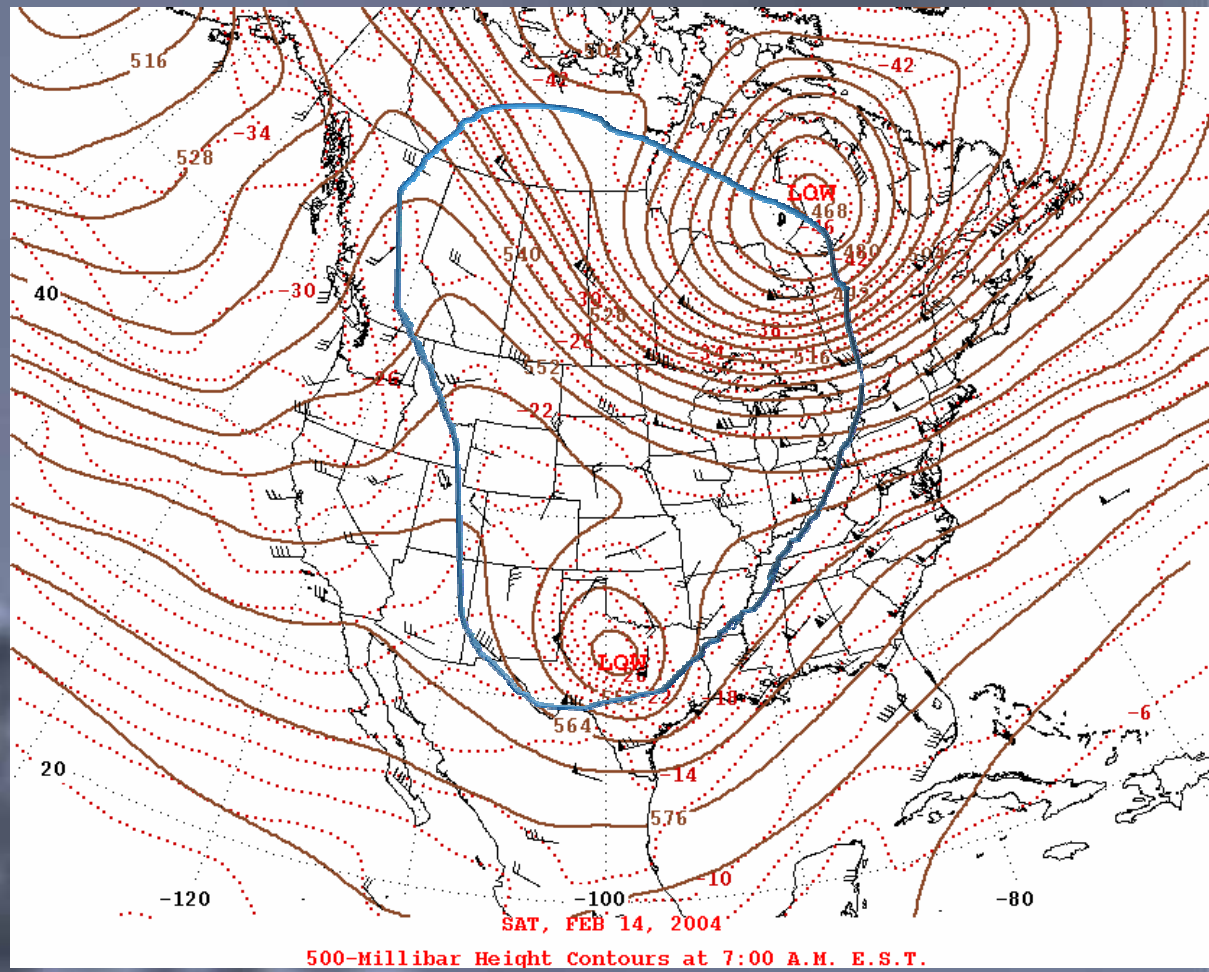
- Strong positive temperature anomalies over western Canada
- 500 mb temps coldest of all synoptic types
- Lowest moisture content of all types - moisture appears to be limiting factor
- Upper level placement of features critical; too far north means lack of upper level support, too far east means lack of moisture

Valentines Day 2004

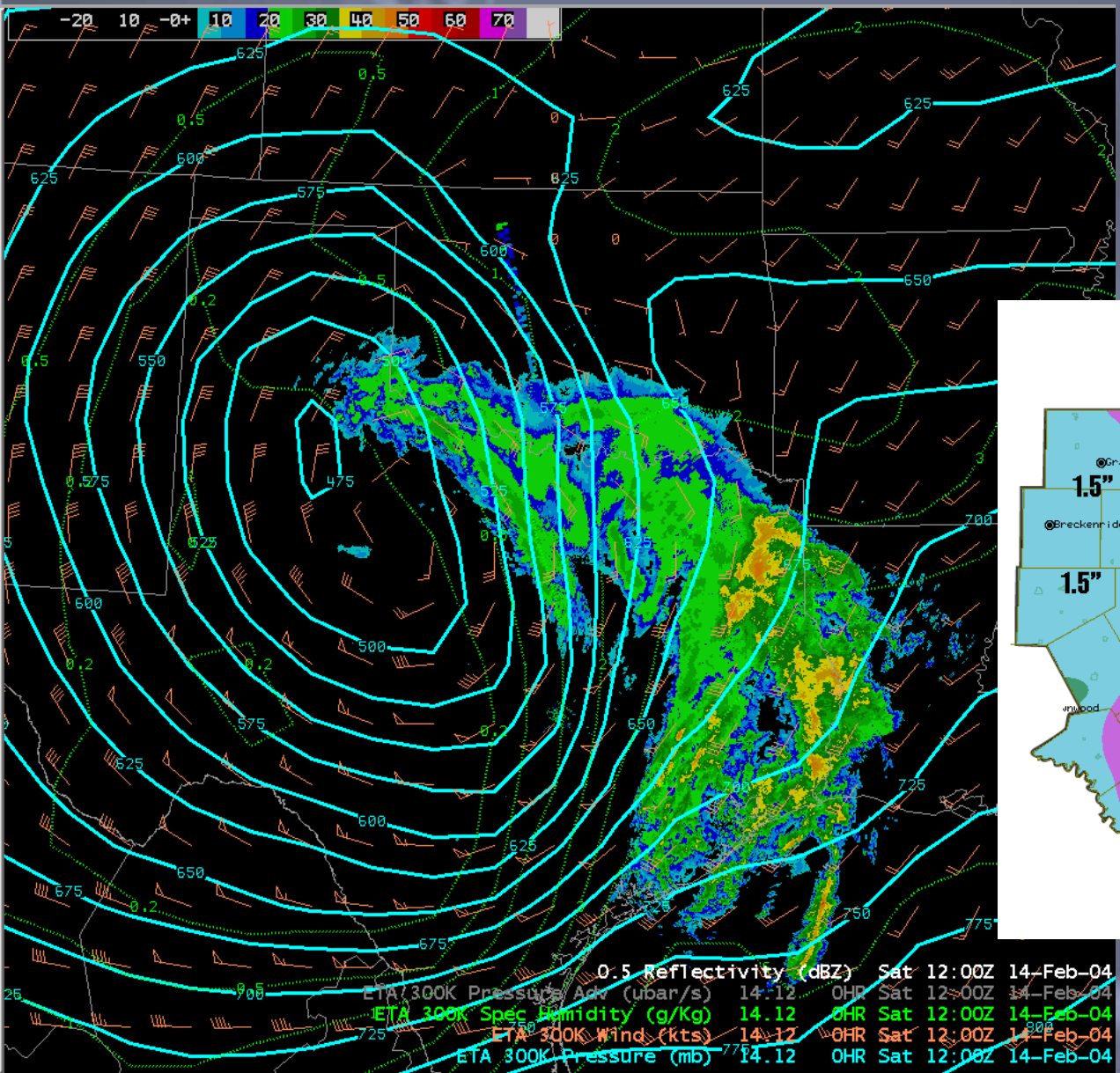


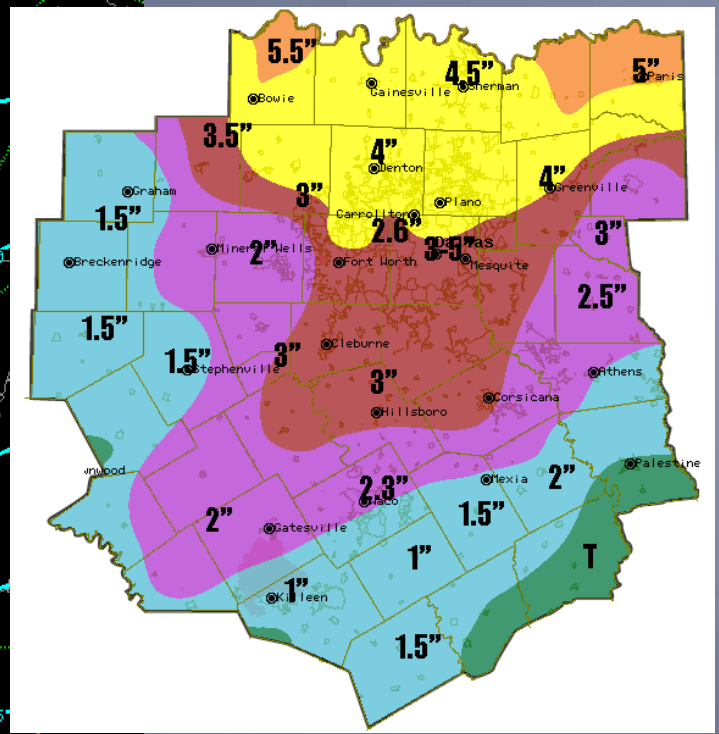






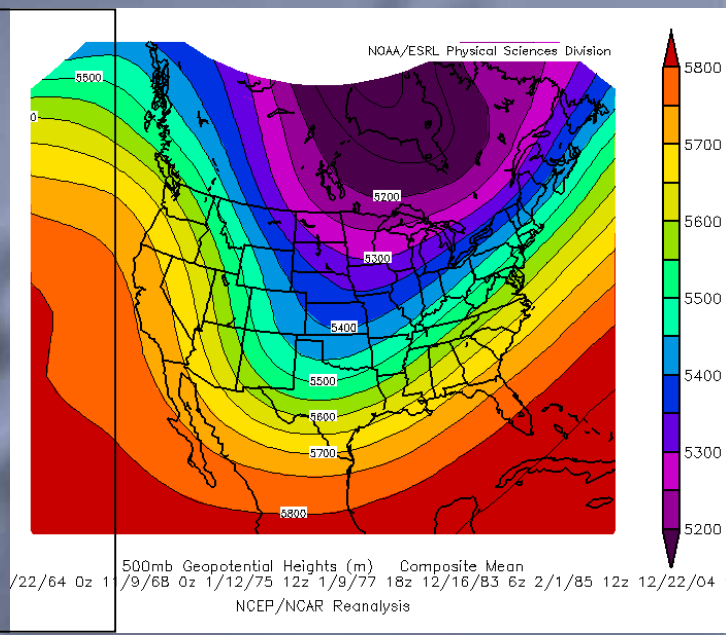
Valentines Day 2004 Event





Full Latitude Trough

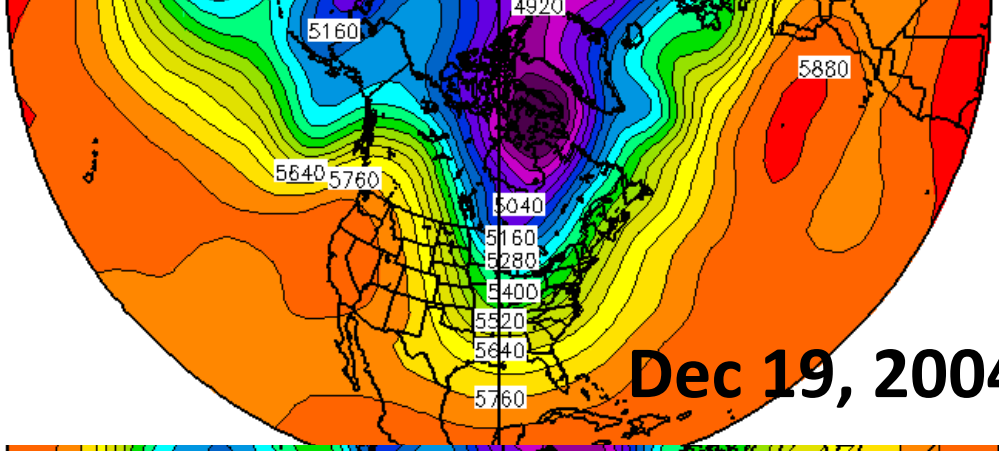
- Snow is concurrent with countrywide arctic outbreak
- Most cases associated with stationary or retrograding troughs



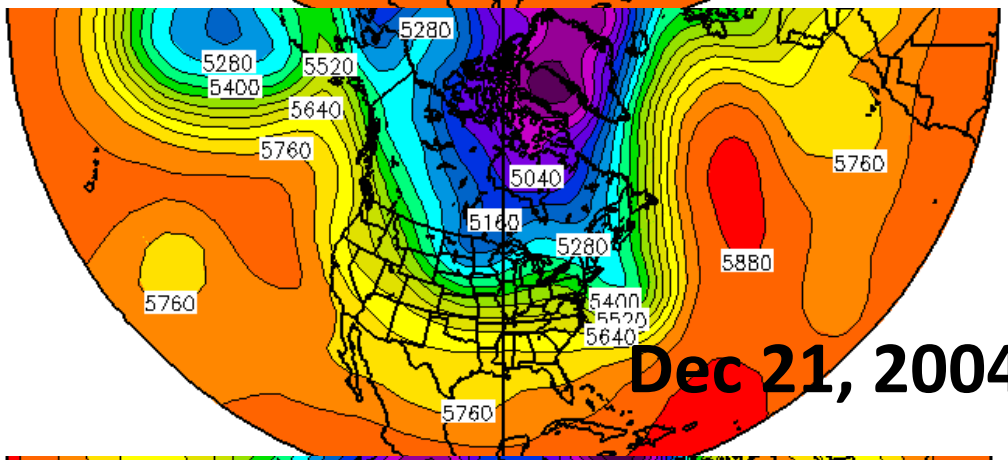
T-48 hrs **T-24 hrs** **Time of event**

Full Latitude Trough

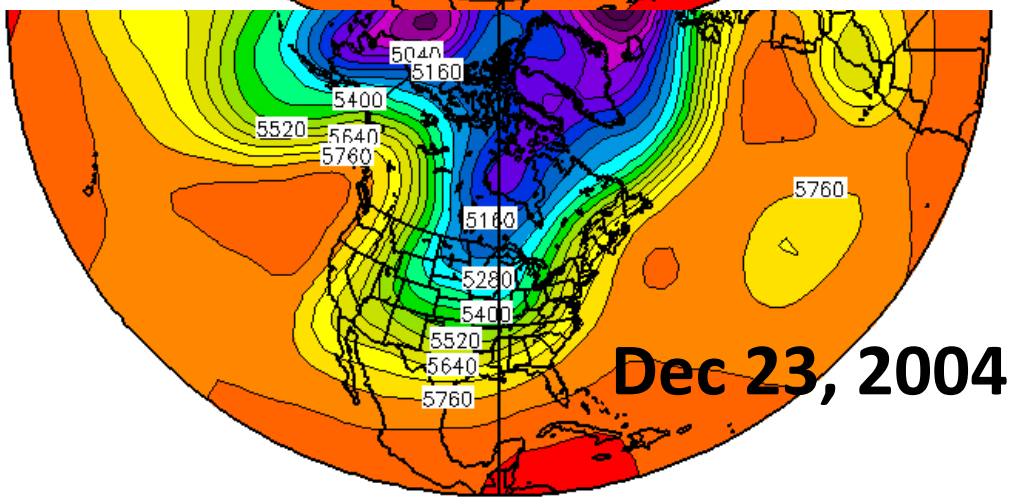
- Associated with very cold temperatures
- Most significant temperature anomalies of all patterns
- Moisture very limited
- Lowest average maximum snowfall



Dec 19, 2004



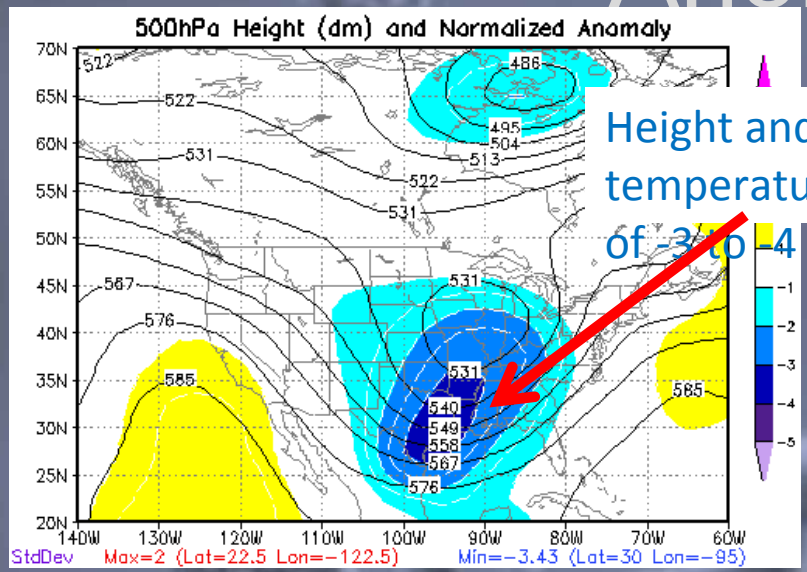
Dec 21, 2004

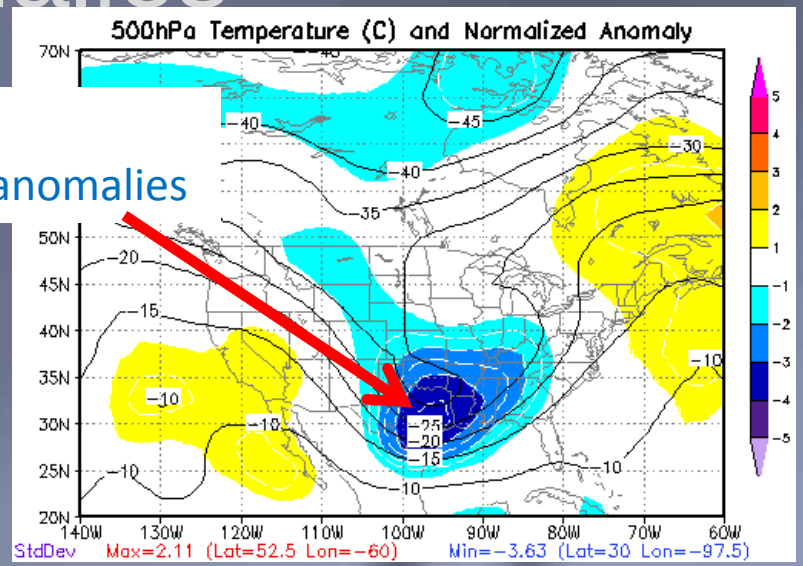


Dec 23, 2004

Example of a snow event with a retrograding long wave trough

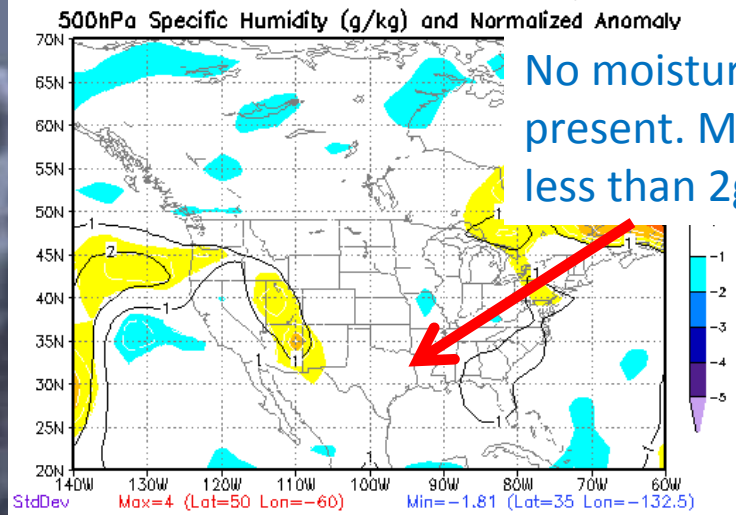
Typical Full Latitude Trough Anomalies

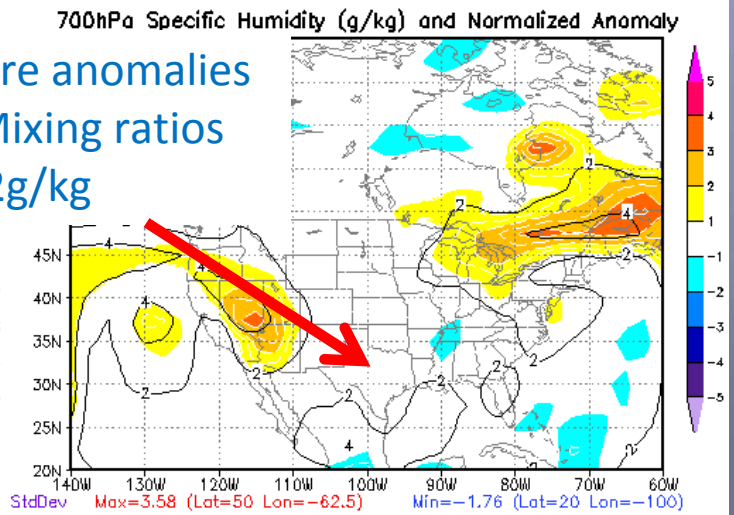




Height and temperature anomalies of -3 to -4

Analysis Valid 00Z15DEC1983





No moisture anomalies present. Mixing ratios less than 2g/kg

Full Latitude Trough Summary

- Cold temperatures seem to compensate for limited moisture
- Forecasters should watch for cold, deep, slowly retrograding long wave troughs
- If trough can bring 700 mb mixing ratios of 2 g/kg into play then watch out for snow

Forecasting Summary

- Classify the forecast system into one of the synoptic patterns presented
  - Comparison of height, temperature, and moisture parameters and anomalies between model forecasts and our averages can aid in classification
  - Find what parameter is usually the limiting factor for that pattern
    - Cold temps?
    - Moisture?
    - Placement of features?
  - Use pattern's climatological snowfall history to aid forecast

Forecasting Summary

- No correlation between intensity of snow storm and the standardized anomalies as a whole
- Use standardized anomalies to help classify the strength of the system within that synoptic type

Questions?

- Acknowledgements:

  Greg Patrick and Daniel Huckaby