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A Prolonged Moist Winter Storm over the Central Rockies: Storm Overview and Forecast Challenges

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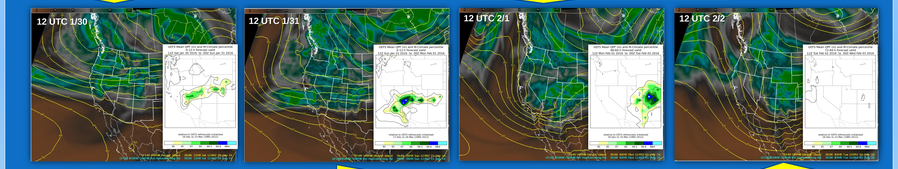
Forecast Overview

- A powerful storm impacted the central Rockies on 30 January through 2 February 2016
- A warm and deep Atmospheric River supplied ample moisture for significant precipitation
- This three-part storm presented unique forecast challenges:
  - Positioning of a strong cold front played a critical role in forecast snow amounts and snow levels
  - Upper level support lagged behind surface features compromising forecasted frontal position
- Total snowfall was more uniform over the mountains but varied widely over the valleys
  - Mountain areas received 30 to 90 cm (1 to 3 feet) of snow
  - Valleys received 10 to 46 cm (4 to 18 inches) of snow, but southern valleys were over-forecasted

Forecast GFS Storm Evolution

- Complex storm developing over the western US
- Prolonged atmospheric river event was taking shape
- Baroclinic zone stalled over northern Utah and Colorado

- Main wave deepened over Desert Southwest
- Warmer southwest flow pushed baroclinic zone north
- Precipitation favored southwest slopes
- Snow levels climbed to mid-slopes due to warming



- Baroclinic zone shifted to the Four Corners
- Colder air mass spread south with front
- Main wave approached California coast

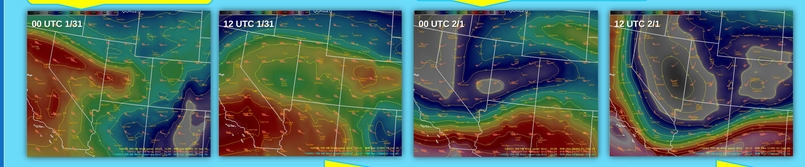
- Trough passage east of the Continental Divide
- Strong cold advection in northwest flow
- Efficient snow production zone

500 hPa heights (yellow) and 850-500 hPa relative humidity (imaged)
Inset: GEFS Mean QPF and M-Climate Ensembles

Jet Stream Winds

- Nose of jet pushes across Utah

- First jet exits across Wyoming
- Main jet amplifies and digs southward, causing front to lift north of the Four Corners as main low moves into Great Basin

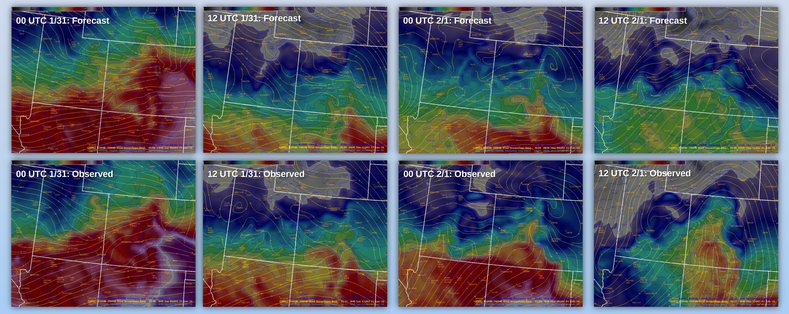


- First jet impacts northern UT/CO
- Main jet pushes toward Four Corners region

- Strongest jet pushed south as upper level low drops south and strengthens

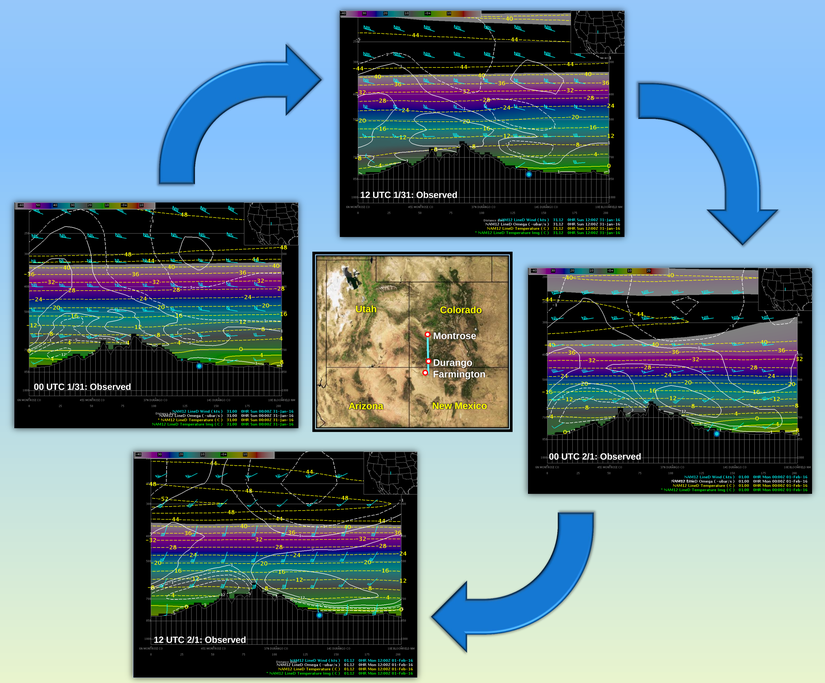
Observed analysis of NAM12 300 hPa wind speed (imaged) and winds (orange)

Forecast and Analysis of Frontal Evolution



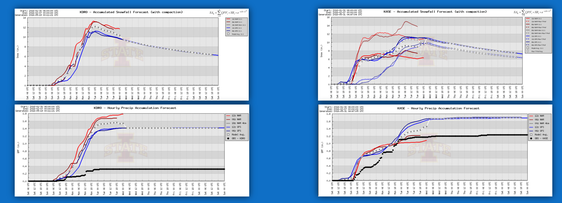
NAM12 850-700 hPa streamlines (yellow) & thickness (imaged)
Top: Forecast from 00 UTC 30 January, 24-h, 36-h, 48-h and 60-h forecasts
Bottom: Observed analysis of 850-700 hPa streamlines (yellow) & thickness (imaged)

Depth and Extent of Cold and Warm Air

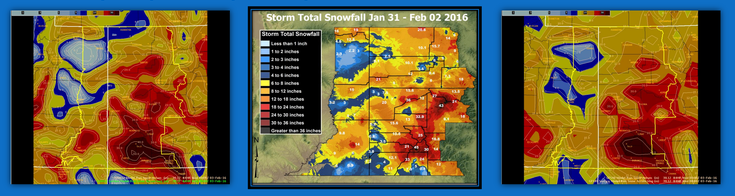


Cross Section from Montrose, CO to Farmington, NM (blue dot signifies location of Durango, CO): Observed analysis of NAM12 temperatures (imaged and yellow contours), winds (cyan), vertical velocity (white)

Forecast Precipitation and Observations



Meteogram of Durango-KDRO (left) and Aspen-KASE (right): snowfall (top) and precipitation (bottom) accumulation forecast in inches



NAM12 84-h total snow accumulation in inches (left), observed snowfall for eastern Utah and western Colorado (center), and GFS40 84-h total snow accumulation (right) through 2 February 2016

Discussion

- Three distinct phases of the storm
  - Phase 1: Frontal Stage (30th through midday 31st)
    - Forcing for precipitation associated with the front
    - The atmosphere was "primed" with moisture due to an Atmospheric River event
    - The front moved swiftly south overnight to the Four Corners region
  - Phase 2: Southwest Flow/Strong Dynamics (midday 31st into the 1st)
    - Main wave with strong jet support moved into Great Basin
    - Cold air in place but snow levels rose in southwest flow
    - Heavy snowfall across most mountain locations, favoring southwest-facing slopes
  - Phase 3: Northwest Flow/Cold Advective regime (1st and 2nd)
    - Favored northwest-facing slopes
    - Efficient snow production
- Main Forecast Challenges
  - The front stalled across the north during the daytime hours on the 30th
    - Model trend: too fast with frontal progression during daytime hours
  - Snow forecast overdone over southern valleys (forecast: 8 to 14 inches; observed: 2 to 6 inches)
    - Cold front and resultant forcing stalled to the north on the 30th
    - Upper low and southwest flow pushed baroclinic zone to the north on the 31st
    - Rain-snow line issues
    - Unfavorable northwest flow developed on the 1st and 2nd