The Northern Nevada Left-Moving Supercell of June 5th, 2009

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1. Introduction

An upper level low moved northeast across Nevada on June 5th, 2009. Deep convection occurred on the north side of this upper low, which included a left-moving "weakly supercellular" thunderstorm. During the afternoon of June 5th, the storm impacted Orovada, Nevada, a small town in Humboldt County in the northwestern part WFO Elko's county warning area (Fig. 1). Hail up to one inch in diameter, reaching a depth of 2-3 inches (Fig. 2), was reported by a store owner in Orovada as a result of this severe storm, along with flash flooding that caused roadway and building damage. No other severe weather reports were received in northern Nevada that day, nor were there any rainfall reports from surface observing stations or COOP observers exceeding four-tenths of an inch.

Severe thunderstorms, especially supercells, are a rarity across northern Nevada based on thunderstorm climatology information (Doswell et al. 2005). Therefore, for a left-moving supercell to be observed in the Great Basin makes this case even more unique. This paper will examine the synoptic and mesoscale environments that led to the development of this severe thunderstorm and also the radar characteristics that suggest this left-moving storm was a weak supercell.

Figure 1: Topographical map of northern Nevada (Google, 2009).

Figure 2: Hail accumulation at the Sawtooth Station convenience store in Orovada, Nevada on 5 June 2009 (photo courtesy of JoAnn Vice).

2. Synoptic and Mesoscale Overview

On June 5th, 2009, the 1200 UTC water vapor imagery showed a well-defined upper low centered over the central California Coast with the GFS analyzing a strong 125-knot jet streak rounding the base of the upper low (Fig. 3). Downstream of the upper low was a strong mid and upper level ridge axis that stretched the length of the Rocky Mountains. The upper low began to shear apart and lift northeastward by the afternoon as the main jet energy transferred to the east side of the low and it began to encounter resistance from the downstream ridge axis. This allowed the core of the upper low to position itself over northern Nevada during the afternoon.

Visible satellite imagery during the morning hours indicated clear skies over eastern Humboldt County until 1600 UTC. Meanwhile, a thick veil of clouds was seen across the western half of the county at the same time. The edge of the clouds served as a nice differential heating boundary across northwest Nevada, and initiated the destabilization of the atmosphere near the area of concern. Surface temperatures (°F) underneath the clouds ranged from the 40s to low 50s at 1600 UTC, while surface temperatures east of the cloud edge were in the upper 50s to low 60s. Cumulus development began along this boundary around 1700 UTC. LAPS surface analysis during the early afternoon hours showed a 1004 mb surface low developing over northwest Nevada, specifically Humboldt County. Streamline analysis of the surface winds at this time also indicated a

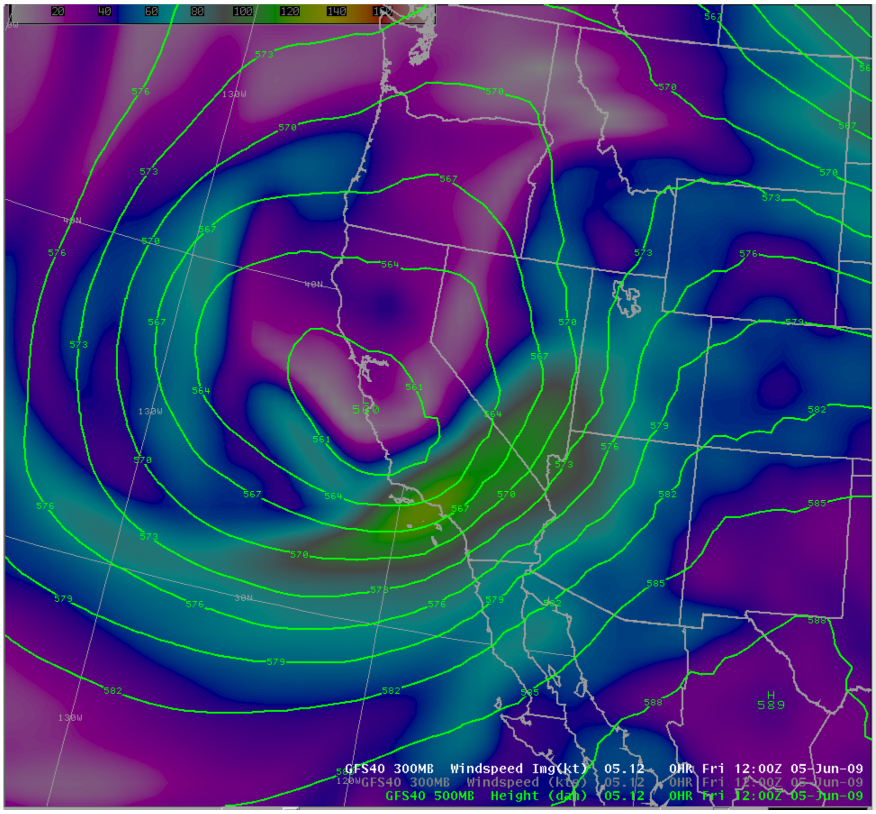

Figure 3: GFS 12Z analysis on 5 June 2009. Image is 300 mb wind speed (kts) and contours are 500 mb geopotential heights (dam).

convergence boundary over northern Humboldt County. It was in the vicinity of this boundary where thunderstorms were first initiated.

3. Mesoscale Discussion

Examination of the LAPS analysis at 2000 UTC on June 5th indicated an unstable environment in place over Orovada, Nevada. A relatively high CAPE value of 700 J/kg (Fig. 4) was noted as well as a lifted index of -3.0 C and a 0-6 km bulk shear value of 25 to 30 kts. Further examination indicated the freezing level was around 7,000 feet AGL with sufficient CAPE in the hail growth zone of -10°C to -30°C and a steep mid-level lapse rate around 8.0 °C/km. According to the LAPS analysis, the amount of available moisture present in the sounding, precipitable water values of 0.50 to 0.60 inches, was slightly above the climatological normal for June across northern Nevada.

Since the event was on the north side of the upper low, the 0-6 km bulk shear vector had an east to west orientation suggesting a left-moving supercell would move southward and a right-moving supercell northward. The internal dynamics (ID) method was applied to hodographs taken from model data on the 5th of June. The ID method is a dynamically based method for predicting supercell motion and has been found to be superior to all other methods (Bunkers et al. 2000). The method uses only a hodograph and is Galilean invariant, meaning that "storm motion is the same, relative to the vertical wind shear, no matter where the vertical wind shear profile is positioned with respect to the origin of the

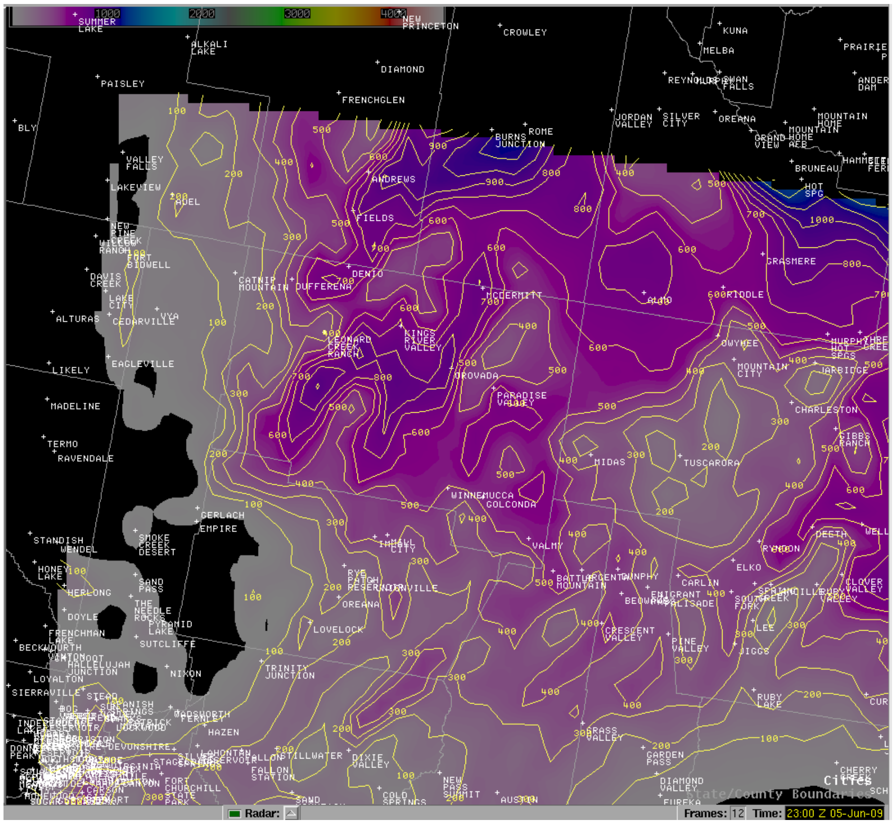

Figure 4: LAPS analysis of CAPE (J/kg) at 20Z on 5 June 2009.

	NAM Bufr (KWMC)	NAM12	RUC20	LAPS	Observed
Storm Dir (deg)	351	26	52	7	360
Storm Speed (kts)	11	14	11	4	7

Table 1: Storm motion data based on the ID method. All model data are from a point 10 miles north of Orovada, except the NAM Bufr data, which are taken from Winnemucca, NV (KWMC). All models are valid at 20Z except the NAM12, which is valid at 21Z.

hodograph.” The method was found to be especially more accurate in atypical environments due to the Galilean invariance. For the case presented in this paper, the predicted storm motions for left-moving supercells by the ID method vary by about 60˚ and 10 knots (Table 1). Hodographs from model and analysis data valid on the afternoon of June 5th, 2009 indicate that deep easterly flow existed north of the upper low (Fig. 5). The low level west winds become easterly by around 3 km and continue to be easterly up through 10 km. As indicated by Table 1 and Figure 5 (see V_{LM} in Fig. 5), the models/analyses suggested a southerly movement for anticyclonic/left-moving supercells.

5. Radar Analysis

Radar analysis showed that a thunderstorm with weak anticyclonic rotation developed around 2019 UTC in north-central Humboldt County. This storm drifted

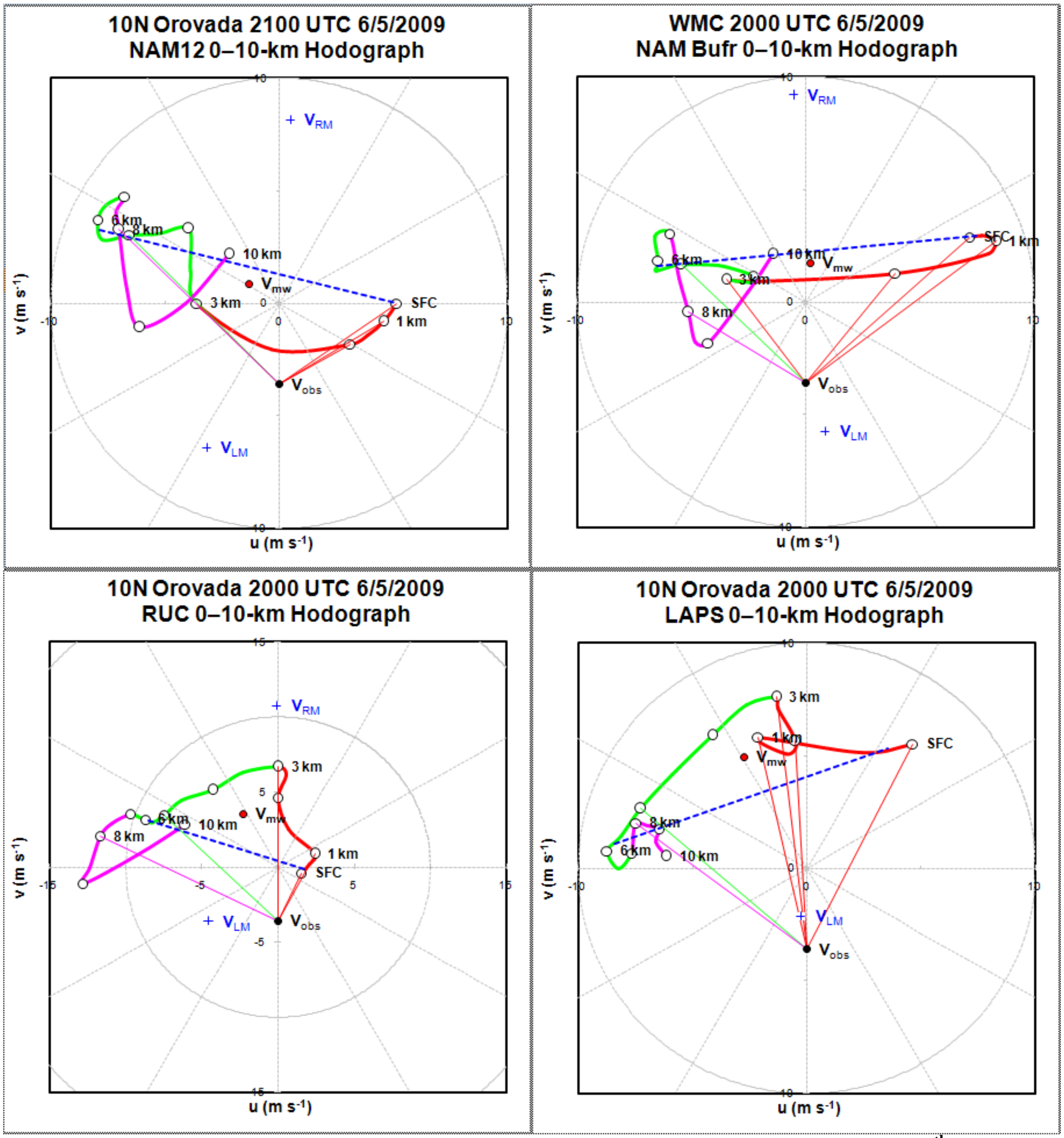

Figure 5: Hodographs from model and analysis data valid on the afternoon of June 5th, 2009

slowly south from 2115 through 2129 UTC when it merged with another developing anticyclonic cell (Fig. 6). After the two cells merged, radar trends indicated the resultant thunderstorm strengthened and increased in (anticyclonic) rotational velocity. By 2143 UTC (Fig. 7), the new thunderstorm was centered over Orovada and nearing its peak in regards to rotational velocity. The maximum rotational velocity of around 25 knots with a width of 2.9 nm was detected at 2147 UTC. Also, the maximum reflectivity of 67 dBZ was detected at 2157 UTC. These signatures corresponded well with spotter report times of hail and flash flooding. Rotation within the storm disappeared at 2211 UTC and the storm itself dissipated shortly thereafter.

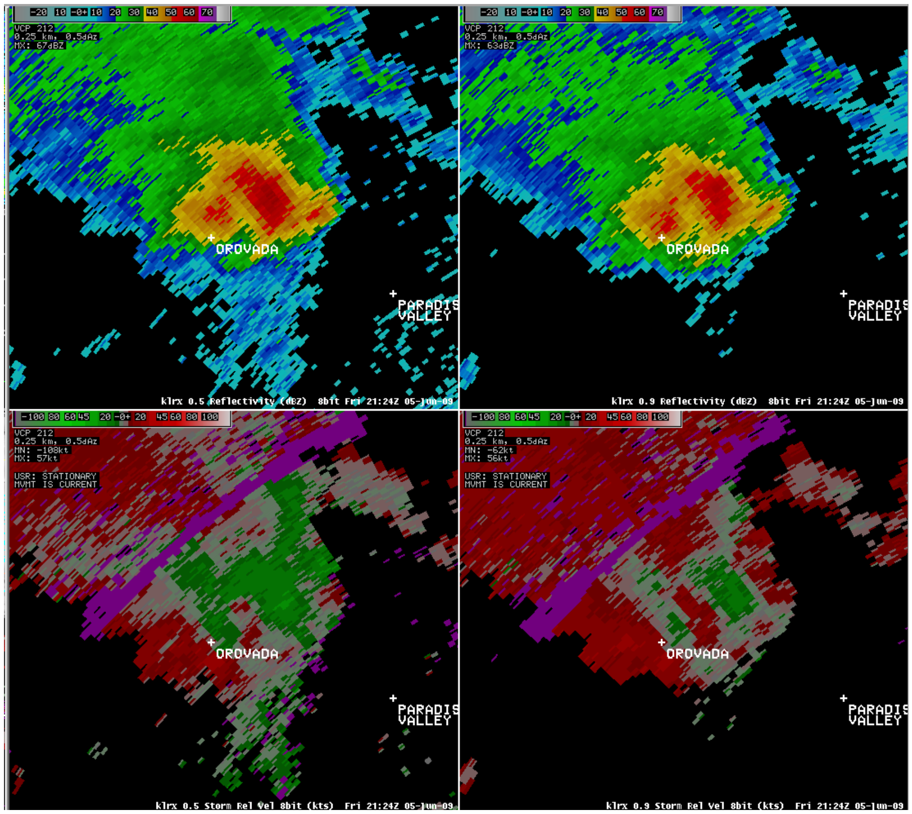

Figure 6: KLRX Radar imagery at time of cell merger (2124 UTC). Upper left: 0.5 deg reflectivity, upper right: 0.9 deg reflectivity, lower right: 0.9 velocity, lower left: 0.5 velocity.

6. Discussion

The thunderstorm that produced severe weather in this event was a low-end, low-topped, supercell with a mesocyclone falling in the "minimal" category (Fig. 8). The rotational velocity was around 25 knots at a range of 70 nm and was seen for four volume scans (2143 UTC through 2157 UTC). Although the storm was low-topped, with echo tops of 25-30 kft AGL, the depth of the rotation was around 10,000 feet (approximately one-third of the storm's depth). Also, it is arguable that the height of the lowest scan limited the full examination of the storm, and that the depth of the rotation may have been seen as deeper if lower scans were available. Therefore, based on the depth of the rotation (~1/3 of the storm's depth of rotation/circulation), the strength of the rotation (~25 knots), and persistence (14 min), this storm can be classified as a left-moving supercell with a minimal mesocyclone (Bunkers et al., 2009).

Based on the review of this case, it is evident that this storm had deviant motion (close to that anticipated for a left-moving supercell), had weak anticyclonic rotation, and produced severe weather in the forms of large hail and flash flooding. This case emphasizes the fact that radar operators will benefit from having a heightened awareness of storms that are distinct by displaying deviant motion and having signs of rotation. If any storm can be classified as a supercell, it automatically gives the radar operator a

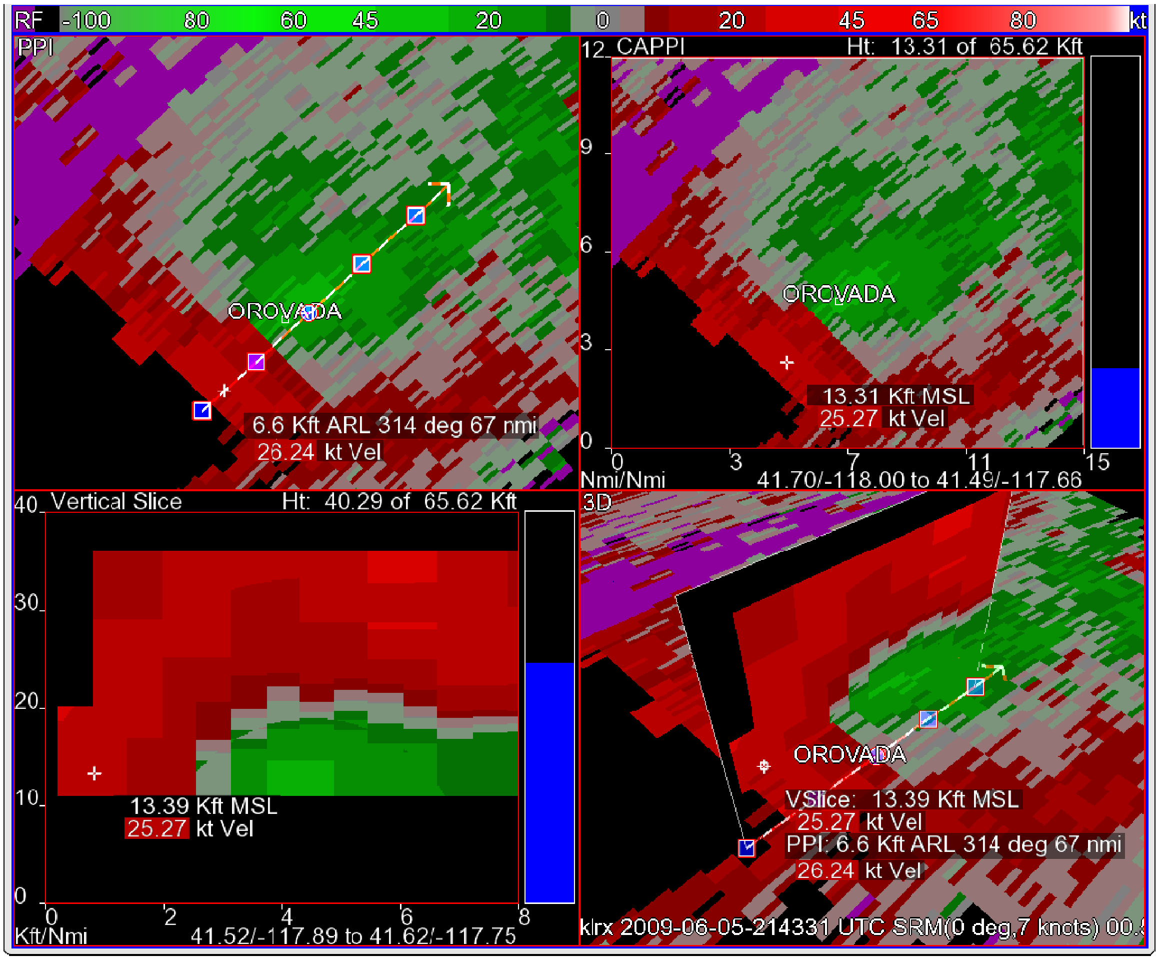

Figure 7: KLRX storm relative velocity (SRM) imagery using from 2143 UTC. Upper left: 0.5 deg, upper right: CAPPI SRM at 13.31 kft MSL, lower right: 3-D cross section, lower left: cross section (storm motion was south at 7 knots).

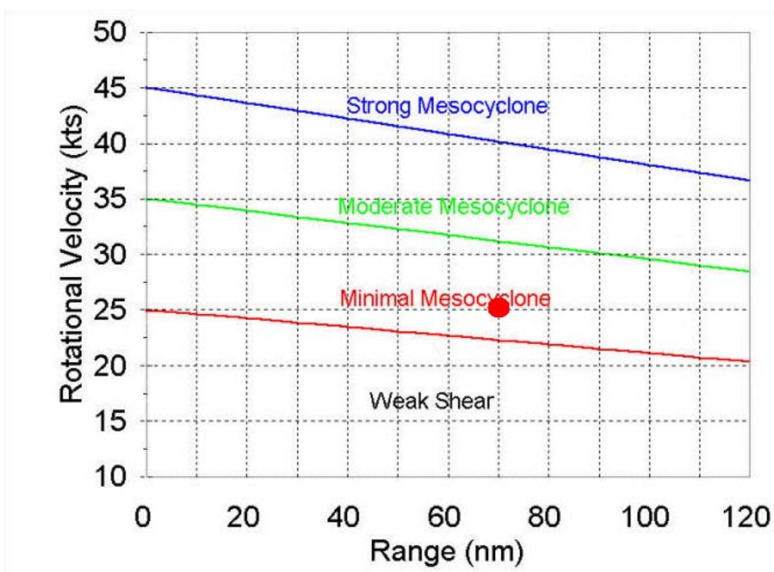

Figure 8: Nomogram for classifying the strength of 3.5 nm-wide mesocyclones (Andra et al. 1994).

conceptual model of the storm's characteristics, threats, and potential longevity, which can be helpful for warning decision making.

7. Acknowledgements

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8. References

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