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Subtropical Jet Extension and the First Atmospheric River of the 2026-2027 Super El Ni o

Atmospheric River * El Ni o-Southern Oscillation * Integrated Water Vapor Transport

Synoptic Setup: Gulf of Alaska Troughing Meets Equatorial Moisture

Operational medium-range ensemble guidance from the National Oceanic and Atmospheric Administration (NOAA) and the Center for Western Weather and Water Extremes (CW3E) at the Scripps Institution of Oceanography has identified the season's first landfalling atmospheric river (AR) along the North American West Coast, projected to arrive between November 11 and November 16, 2026 . The corridor of concentrated horizontal water vapor transport forms as a persistent upper-tropospheric high-pressure ridge over the eastern North Pacific migrates eastward, allowing a deep baroclinic low-pressure trough descending from the Gulf of Alaska to phase with a subtropical moisture plume north of Hawaii.

Unlike early-autumn cold fronts that deliver brief, localized coastal showers, this mid-November system taps directly into a warm tropical moisture reservoir preconditioned by the developing 2026-2027 Super El Ni o . Across the Sacramento Valley and the western slopes of the Sierra Nevada, hydrometeorological projections indicate 45 to 60 millimeters (~1.8 to 2.4 inches) of precipitation within a 24-to-48-hour window -- roughly equivalent to Sacramento's entire climatological November rainfall norm (~52 mm) -- while high-altitude basins above the 2,300-meter freezing isotherm are forecast to accumulate 0.6 to 1.2 meters of early-season snowpack.

Thermodynamic Coupling: How a Super El Ni o Reorganizes the North Pacific Waveguide

In operational climate diagnostics, an El Ni o episode crosses the "Super El Ni o" threshold when three-month running mean sea surface temperature (SST) anomalies in the equatorial Ni o-3.4 region (5 deg N-5 deg S, 170 deg W-120 deg W) reach or exceed +2.0 deg C above the climatological baseline, a regime previously observed during the benchmark 1982-1983, 1997-1998, and 2015-2016 events. As weakened equatorial trade winds allow the western Pacific warm pool to surge eastward via downwelling oceanic Kelvin waves, the resulting reduction in the equatorial zonal SST gradient triggers a large-scale reorganization of tropical deep convection .

Enhanced cumulonimbus latent heat release over the central and eastern equatorial Pacific intensifies the meridional Hadley circulation , exporting upper-tropospheric angular momentum poleward and accelerating the wintertime subtropical jet stream at the 200-hectopascal (~12 km) level. Through the Pacific-North American (PNA) teleconnection pattern , stationary Rossby wave trains deepen the Aleutian Low and extend the North Pacific storm track eastward and equatorward toward California (Payne & Magnusdottir, 2014). Simultaneously, anomalously warm eastern Pacific sea

surface temperatures elevate boundary-layer specific humidity according to the Clausius-Clapeyron relation , which increases atmospheric saturation vapor pressure (e s) by approximately 6.5% to 7.0% per degree Celsius of warming (Lavers et al., 2015).

Quantifying Atmospheric River Intensity: Integrated Water Vapor Transport (IVT)

To evaluate whether an approaching plume will function primarily as a beneficial water-supply recharge event or a flood hazard, hydrometeorologists compute Eulerian Integrated Water Vapor Transport (IVT) -- the vertical integral of horizontal moisture flux from the surface (1,000 hPa) to the upper troposphere (300 hPa):

IVT = (1 / g) 300 hPa 1000 hPa q * V h dp

where g is gravitational acceleration (9.81 m s 2), q is specific humidity (kg of water vapor per kg of moist air), and V h is the horizontal wind vector (m s 1) within pressure layer dp . Concentrated within the pre-cold-frontal low-level jet at 850 to 925 hPa (1.0-1.5 km altitude), an atmospheric river typically measures only 400 to 600 kilometers in width but transports moisture fluxes comparable to 10 to 25 times the liquid discharge of the Mississippi River.

Under the Ralph et al. (2019) Atmospheric River Scale adopted by CW3E and the National Weather Service, landfalling systems are classified into five tiers (AR Cat 1 through AR Cat 5) by combining peak 3-hour mean IVT with the continuous duration over which IVT remains at or above the 250 kg m 1 s 1 threshold:

| AR Scale Category | | Peak 3-Hr IVT (kg m 1 s 1) | | Standard Duration (24-48 hr) | | Duration Adjustment (<24 hr / >48 hr) | | Primary Hydrometeorological Impact |

| AR Cat 1 (Weak) | | 250 - 499 | | Cat 1 | | Sub-AR (<24 hr) / Cat 2 (>48 hr) | | Primarily beneficial: soil moisture wetting & early snowpack recharge |

| AR Cat 2 (Moderate) | | 500 - 749 | | Cat 2 | | Cat 1 (<24 hr) / Cat 3 (>48 hr) | | Mostly beneficial; localized urban drainage & burn-scar runoff |

| AR Cat 3 (Strong) | | 750 - 999 | | Cat 3 | | Cat 2 (<24 hr) / Cat 4 (>48 hr) | | Balance of beneficial reservoir inflow & mainstem river flood watch |

| AR Cat 4 (Extreme) | | 1,000 - 1,249 | | Cat 4 | | Cat 3 (<24 hr) / Cat 5 (>48 hr) | | Mostly hazardous: widespread levee stress, debris flows & high snow levels |

| AR Cat 5 (Exceptional) | | >= 1,250 | | Cat 5 | | Cat 4 (<24 hr) / Cat 5 (>48 hr) | | Primarily hazardous: basin-wide inundation & multi-day AR family clustering |

Orographic Uplift, Freezing Levels, and Antecedent Soil Storage

When a low-level moisture conveyor intersects the coastal ranges and the northwest-to-southeast-oriented Sierra Nevada barrier at a nearly perpendicular angle, mechanical forced ascent cools the moist air parcel at the moist adiabatic lapse rate (~4.5 to 5.5 deg C km 1), condensing water vapor into intense orographic precipitation . Because dry early-November watershed soils across the Sacramento and San Joaquin basins retain high infiltration capacity and low antecedent soil moisture, a single short-duration AR Cat 1 to AR Cat 2 system (~350-650 kg m 1 s 1

over 24-36 hours) acts primarily as a beneficial "wetting storm" rather than a catastrophic flood generator (Dettinger, 2013).

However, historical hydroclimate records from the 1982-1983 and 1997-1998 Super El Ni o winters demonstrate that early-November landfalls serve a critical hydrological priming role. Once cumulative autumn precipitation saturates the upper 0.5 to 1.0 meter of montane regolith and fills soil pore space, subsequent winter atmospheric river families arriving in December through February experience runoff coefficients exceeding 60% to 80%. Furthermore, when subtropical moisture plumes carry elevated equivalent potential temperatures (e), the 0 deg C freezing isotherm rises above 2,500 to 3,000 meters, converting high-elevation snow accumulation areas into rain-producing catchments and accelerating peak hydrograph discharge into downstream Central Valley flood-control reservoirs.

Observational Telemetry and Winter Outlook

To reduce trajectory and intensity errors in 3-to-7-day landfall forecasts, CW3E and the NOAA Aircraft Operations Center conduct targeted Atmospheric River Reconnaissance (AR Recon) missions using Air Force Reserve WC-130J and NOAA Gulfstream IV-SP aircraft. By deploying GPS dropsondes across the northeast Pacific waveguide to sample vertical profiles of water vapor mixing ratio (q) and low-level jet wind shear, data assimilation into the Global Forecast System (GFS) and European Centre for Medium-Range Weather Forecasts (ECMWF) models improves coastal precipitation skill by 10% to 20%. As the November 11-16 system inaugurates the 2026-2027 wet season, hydrological monitoring will focus on how rapidly watershed storage transitions from soil-moisture deficit recovery to active flood-control operations ahead of peak winter El Ni o forcing.

References & Primary Sources

* [1] Ralph, F. M., Rutz, J. J., Cordeira, J. M., Dettinger, M., Anderson, M., Reynolds, D., Schick, L. J., & Smallcomb, C. (2019). A scale to characterize the strength and impacts of atmospheric rivers. Bulletin of the American Meteorological Society, 100(2), 269-289. -- https://doi.org/10.1175/BAMS-D-18-0023.1

* [2] Payne, A. E., & Magnusdottir, G. (2014). Dynamics of landfalling atmospheric rivers over the North Pacific in 30 years of MERRA reanalysis. Journal of Climate, 27(18), 7193-7217. -- https://doi.org/10.1175/JCLI-D-14-00034.1

* [3] Lavers, D. A., Ralph, F. M., Waliser, D. E., Gershunov, A., & Dettinger, M. D. (2015). Climate change intensification of horizontal water vapor transport in CMIP5. Geophysical Research Letters, 42(13), 5617-5625. -- https://doi.org/10.1002/2015GL064270

* [4] Dettinger, M. D. (2013). Atmospheric rivers as drought busters on the U.S. West Coast. Journal of Hydrometeorology, 14(6), 1721-1732. -- https://doi.org/10.1175/JHM-D-13-02.1

* [5] Center for Western Weather and Water Extremes (CW3E), Scripps Institution of Oceanography, UC San Diego (2026). Atmospheric River Scale & North Pacific IVT Reconnaissance Outlooks. -- https://cw3e.ucsd.edu/