Open Analytics Control Tower (OACT)

Open-source, public-data decision support for supply-chain disruption risk

State-Level Supply Chain Resilience Prototype (S.257-aligned)

Yuan-Jiun (David) Sung, *Principal Investigator* · Co-Contributors: Yidan (Lena) Hu, *Lead Data Scientist* · Laisi (Maggie) Ma, *Deployment & DevOps Lead* · Hao He, *Data Engineering Lead*

UC Open 2026 Berkeley, California
April 22–23, 2026

Why This Matters

- **The Threat:** California logistics face extreme weather like atmospheric-river clusters—cascading failures often emerge from temporal clustering and soil saturation rather than a single storm day.
- **The Target:** OACT protects the "Missing Middle" (mid-sized operators lacking large-carrier analytics) **and equips government agencies to triage emergency resources.**
- **The Objective:** Predict functional infrastructure disruptions—not just weather—and explain operational risk in plain language with auditable evidence.
- **The Policy Alignment:** S.257-aligned architecture delivering open, reproducible workflows for **state-level** preparedness, prioritization, and mitigation.

What Is Real Today: OACT v0.1

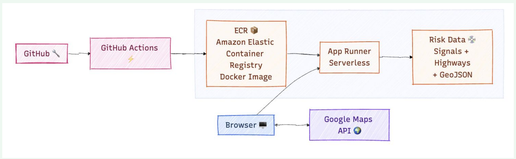
- **End-to-end replay of real extreme events:** Validated on the **January 2023 California Atmospheric River sequence**, reconstructing evolving county-level daily risk signals.
- **Operational risk scoring for system disruption:** A supervised model estimates the probability of entering a high-impact outage state, driven by compound atmospheric and hydrologic conditions. Historical validation achieves ~0.85 accuracy and 0.73 recall on outage events, enabling early identification of high-risk counties.
- **Real-time ready data and modeling pipeline:** Designed to transition from historical reanalysis (ERA5) to forecast-driven inputs (NOAA GFS), supporting a 24–72 hour operational decision window.
- **Compound risk captured through system-level drivers:** 23 engineered variables structured into five categories — Atmospheric Forcing, Antecedent Conditions, Hydrologic Response, Temporal Clustering, and Exposure Modifiers — enabling detection of multi-day failure dynamics.

Why This Is More Than a Prototype

- **100% Open, Deployable Public-Data:** Built entirely on open data feeds, enabling adoption by any U.S. state agency without vendor lock-in.
- **Fully reproducible system:** Containerized pipelines transform multi-source signals into a unified county-by-date risk panel, scalable across time and regions.
- **Auditable evidence trails for every decision:** Each risk alert includes a complete provenance bundle (data sources, drivers, model outputs), supporting compliance and independent review
- **From signals to decisions, not just predictions:** The system connects **data ingestion → risk scoring → explanation → action**, bridging analytics and real-world operations

Independent, reproducible, and ready for public-sector evaluation.

System Structure



State-Ready Open Source Blueprint

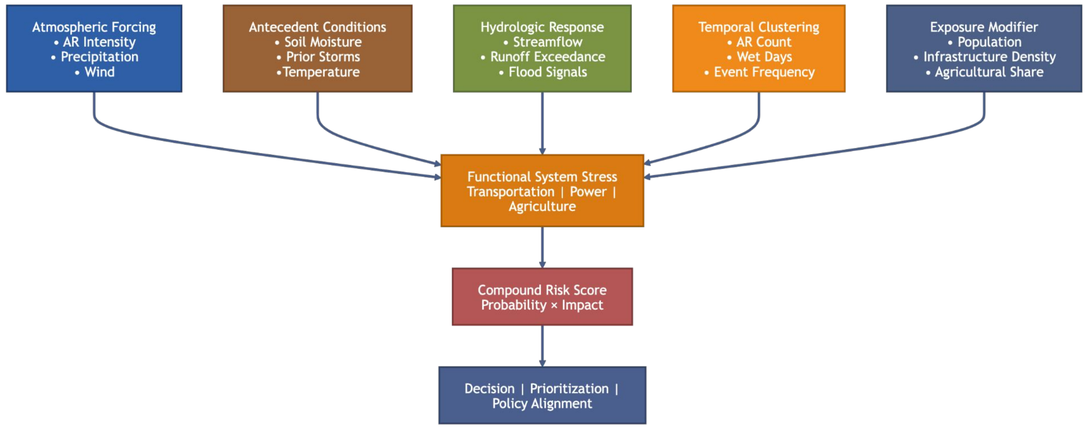
- **OACT is an open-standard, MIT-licensed reference architecture** — fully reproducible and deployable by any U.S. state agency or SME coalition, with **no vendor lock-in** (GitHub available for contributors).
- A multi-stage Docker build packages the risk engine, geospatial data, and highway corridor overlays into a single portable image stored in **AWS ECR.** This ensures bit-for-bit reproducibility across development, staging, and production environments.
- Deployment follows a secure, **auditable CI/CD pipeline**: CI/CD enforces code review, commit-pinned builds, and serverless deployment (AWS), ensuring **traceability and minimal attack surface**, and AWS App Runner provides serverless compute with automatic HTTPS, zero-config scaling, and no direct server access surface
- The architecture is designed as a state-ready turnkey solution: a deployment requires only an AWS account and a Google Maps API key. All evidence chains are logged with decision IDs for federal audit compliance.

Core Message

OACT turns public extreme-weather signals into explainable risk decisions for under-served supply chains and government emergency planners.

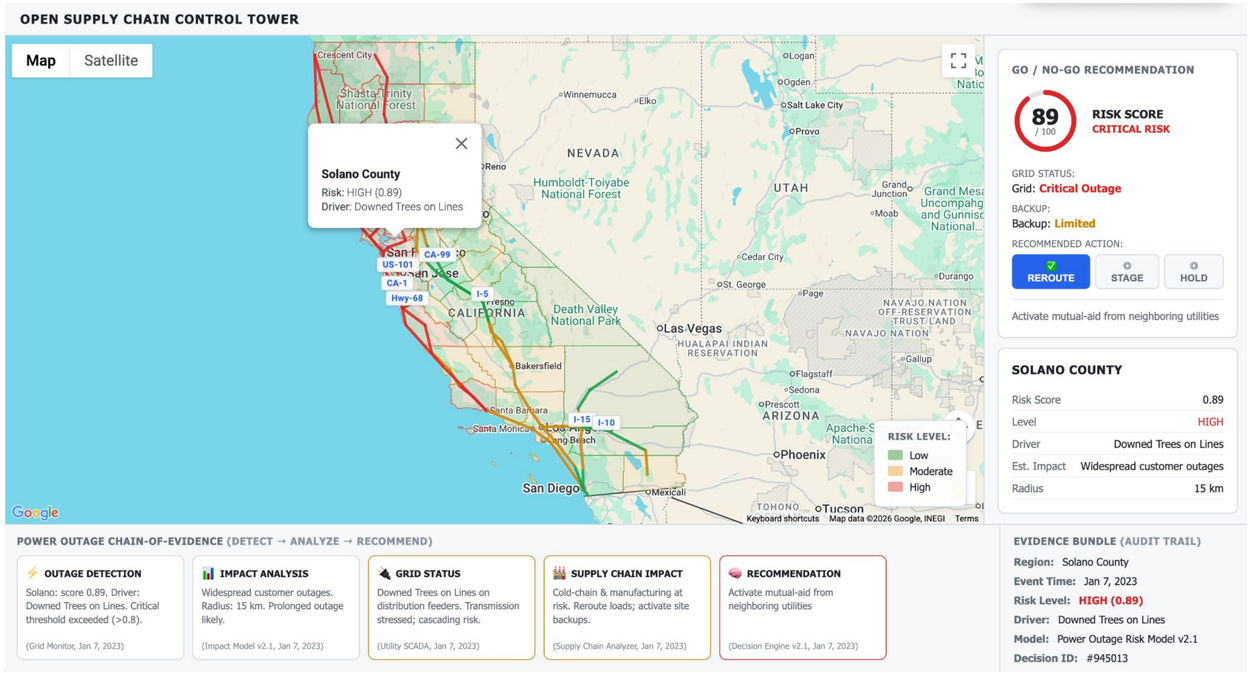
Live System Output: Central Valley Atmospheric River Protocol (Jan 2023 Replay)

OACT v0.1 validated core logic



Transparent compound-risk formulation: probability × impact, with interpretable driver categories that remain visible to operators and reviewers.

Current deployed interface with evidence chain



Live prototype shown. Currently validated: county-level power disruption scoring and evidence-chain explanation. Route-action buttons shown as interface roadmap elements.

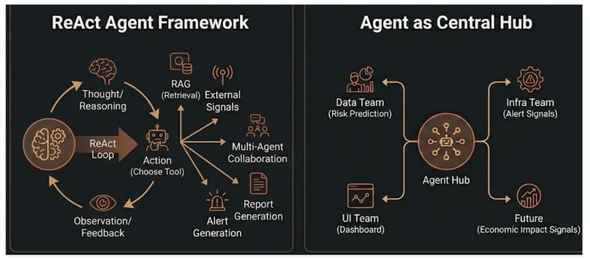
How OACT Works

- **A continuous control tower for risk intelligence:** OACT operates as a **6-stage loop** to enable continuous tracking of evolving infrastructure risk:

Monitor → Detect → Investigate → Alert → Decide → Validate

- **From passive signals to actionable alerts:** The system ingests public environmental and infrastructure data and detects **compound risk sequences**, triggering investigation when system stress emerges.
- **Agentic investigation with evidence grounding:** A state-machine–based reasoning layer links machine learning model outputs to traceable evidence bundles (sources, timestamps, key drivers), ensuring explainability and auditability.
- **Risk scoring and escalation:** County-level "system stress" is continuously monitored, with escalation states driven by model outputs.
- **Human-centered decision interface:** Risk signals are translated into interpretable heat maps and decision panels, supporting GO / NO-GO operational decisions.
- **End-to-end traceability and validation:** Every run generates provenance logs (data, model version, timestamps) and supports post-event validation and impact tracking.

AI Implementation



- **Central hub across system components:** OACT is designed to connect risk data, models, UI, and infrastructure by AI Agent as a central hub
- **AI generates risk reports and alerts:** Converts risk signals into structured reports and automated email notifications
- **Explains risk through drivers and recommendations:** Surfaces key drivers and suggested actions, turning scores into decisions

Demo + preprint

Demo URL

https://avtmbfenap.us-east-1.awsapprunner.com/

Preprint: SSRN 6256558
GitHub: http://bit.ly/4tVrAzR

Scan for live demo, preprint, code, poster PDF, and contact.