Flash Flood Forecasting Over Complex Terrain

With an Assessment of the Sulphur Mountain NEXRAD in Southern California

Sponsor Briefings

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Statement of Task

- Describe overall strategy of NEXRAD radars in support of the NWS flash flood warning and forecast mission and discuss strengths and weaknesses of the system for operations in complex terrain;
- Assess the availability, performance, and capability of the Sulphur Mountain NEXRAD to aid forecasters at LOX in providing flash flood warnings and forecasts
- Assess how the Sulphur Mountain radar's location affects its capability to detect low-level storm events (i.e., below 6000 ft);
- Provide conclusions about strengths and weaknesses, make recommendations to improve accuracy and timeliness of flash flood warnings for LA and Ventura Counties, including plausible alternative approaches for flash flood forecasting; and
- Identify lessons that could benefit forecasters, facility planners, and decision makers as they deal with other NEXRAD installations and similar instruments deployed in the future.

Overarching Finding

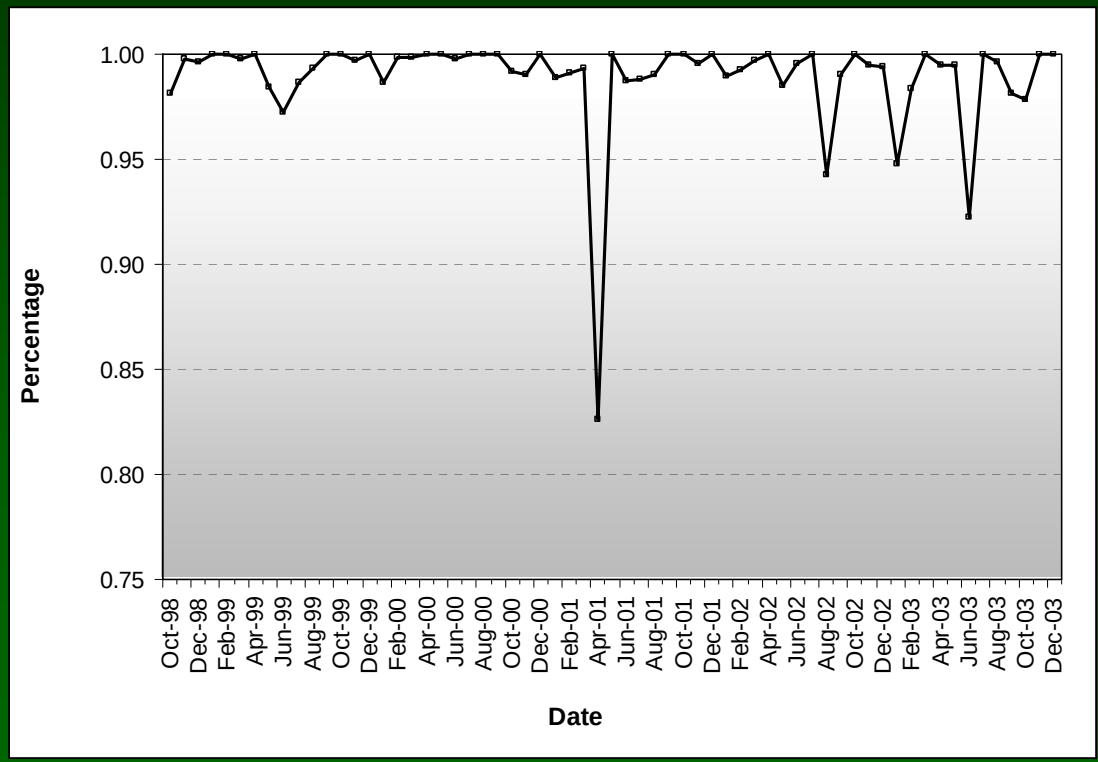
The Sulphur Mountain radar:

- is appropriately sited to detect approaching storms while avoiding problems with anomalous propagation of the radar signals
- is amply functional (in terms of availability)
- has provided crucial support to LOX forecasters

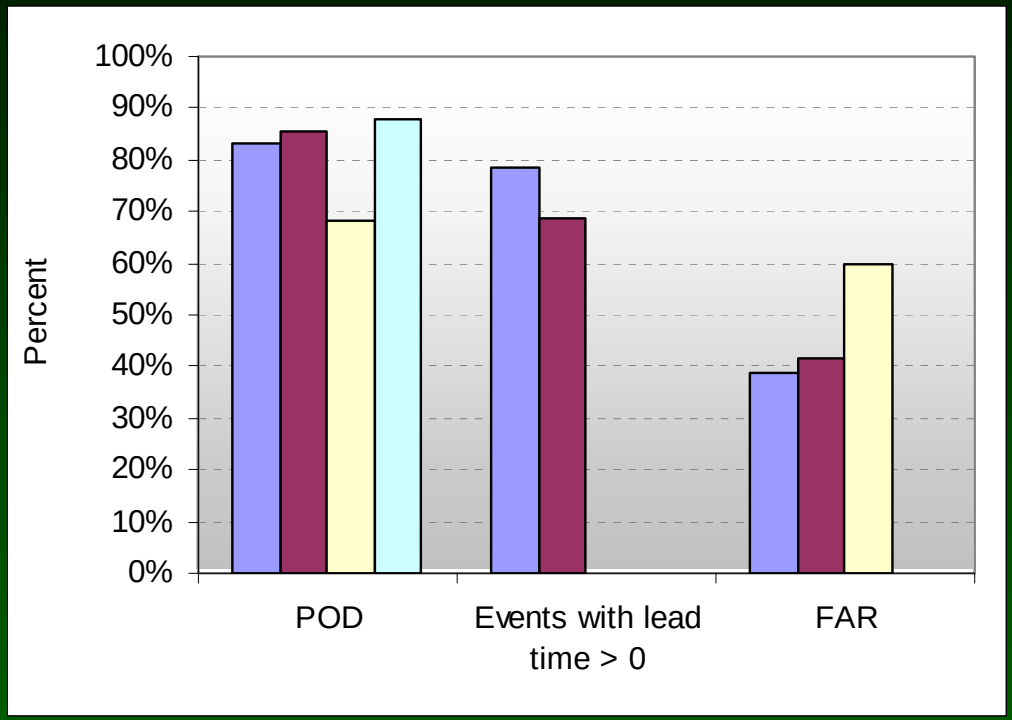
Availability is Sufficient

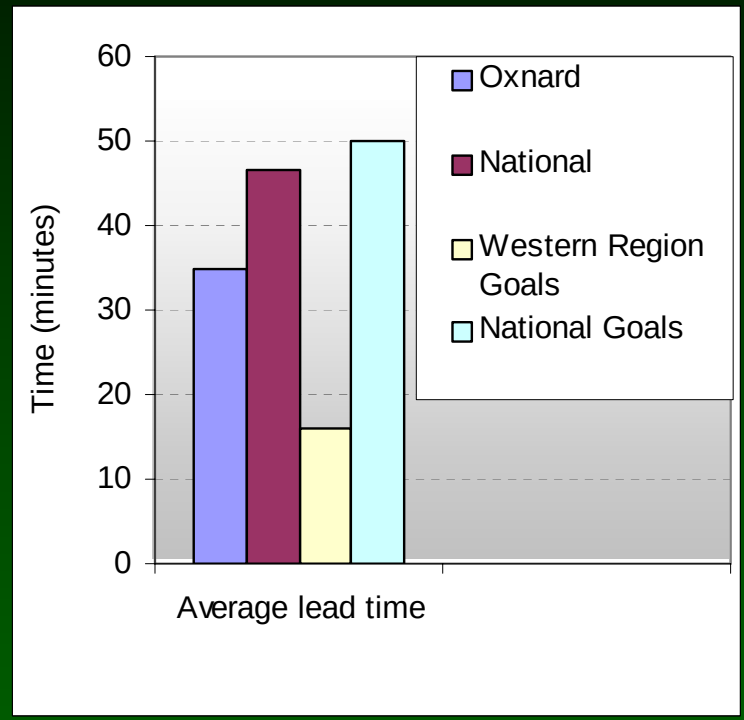
October 1998 - December 2003

- monthly average availability below 96.2 % requirement only 4 months out of 63
- availability averaged over this entire time period was 98.9 percent



LOX's Warning Record Excellent





1996-2003 data

Reconciliation of Flash Flood Warning Databases

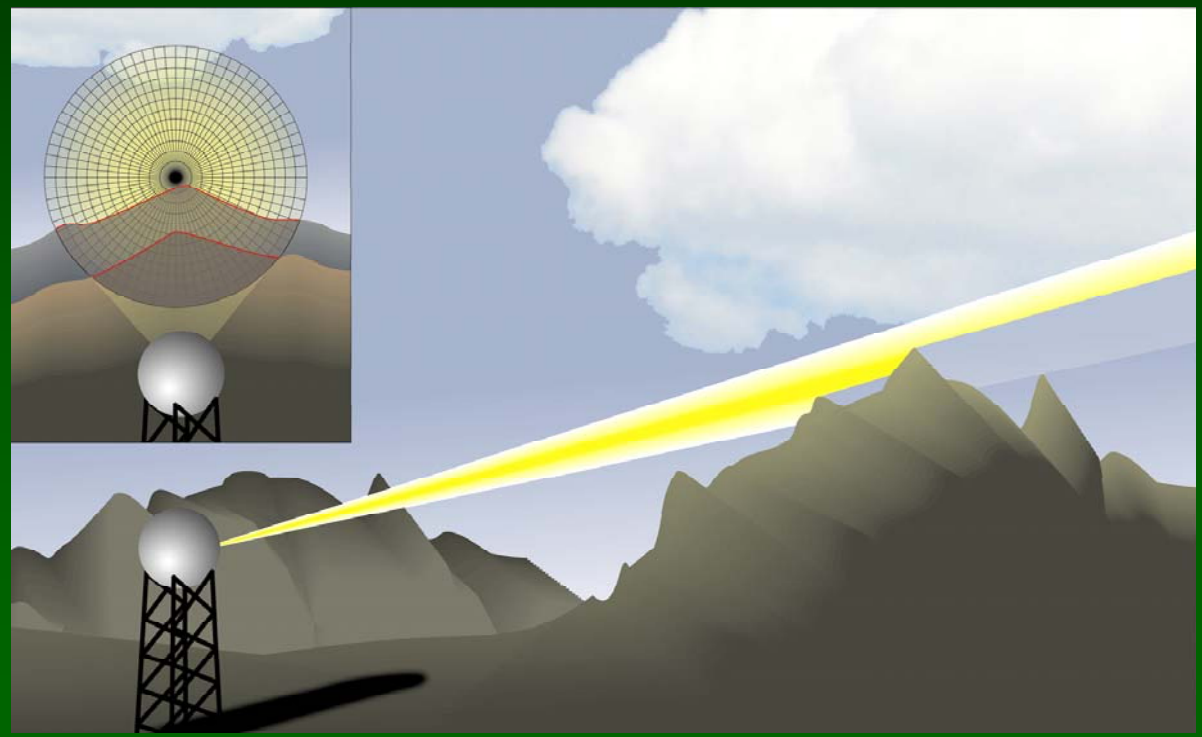
- Numerous discrepancies among GAO's, NWS Headquarter's, and LOX's databases
  - number of events
  - timing of indicated events and warnings
- GAO report did not consider that:
  - warnings have expiration times
  - it's common to issue updates, modifications, extensions to existing warnings

Committee has no means to reconcile all discrepancies → concludes that GAO report NOT useful indication of LOX performance

Calculating SM Coverage

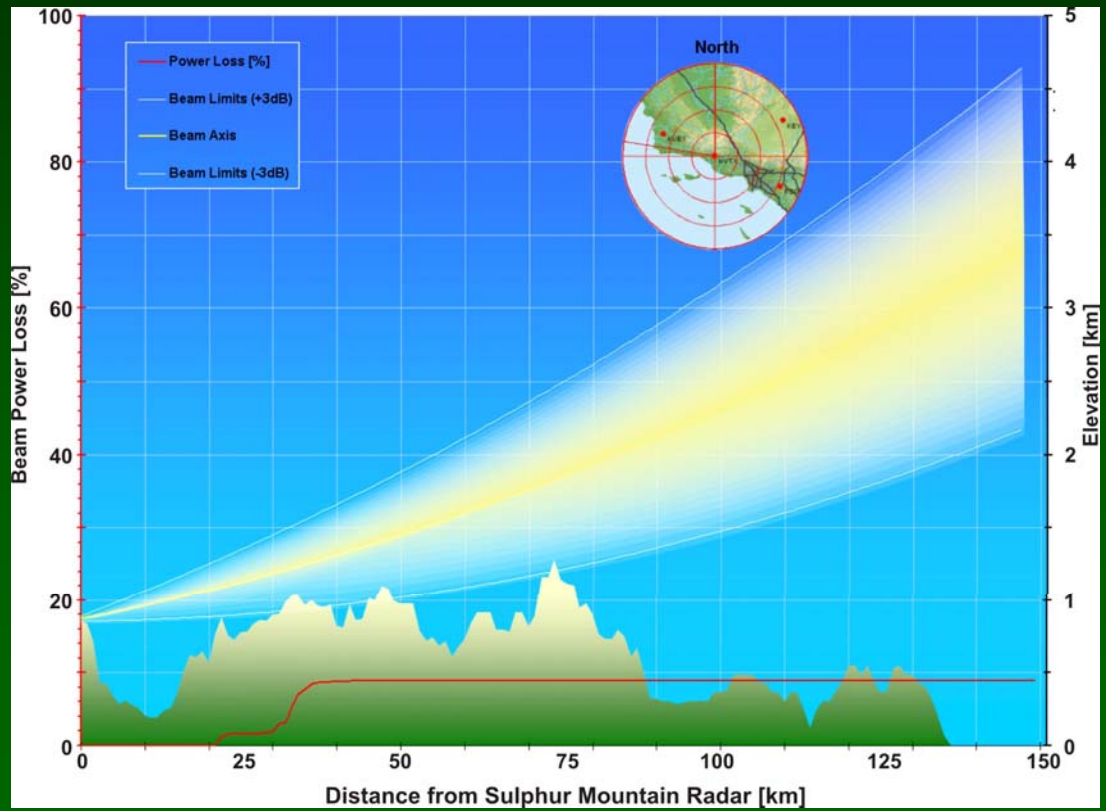
Committee's calculations:

- High resolution (30-meter) terrain data
- Standard propagation of radar beam
- Consider full, 3D beam structure
  - not just beam axis (as in prior studies)



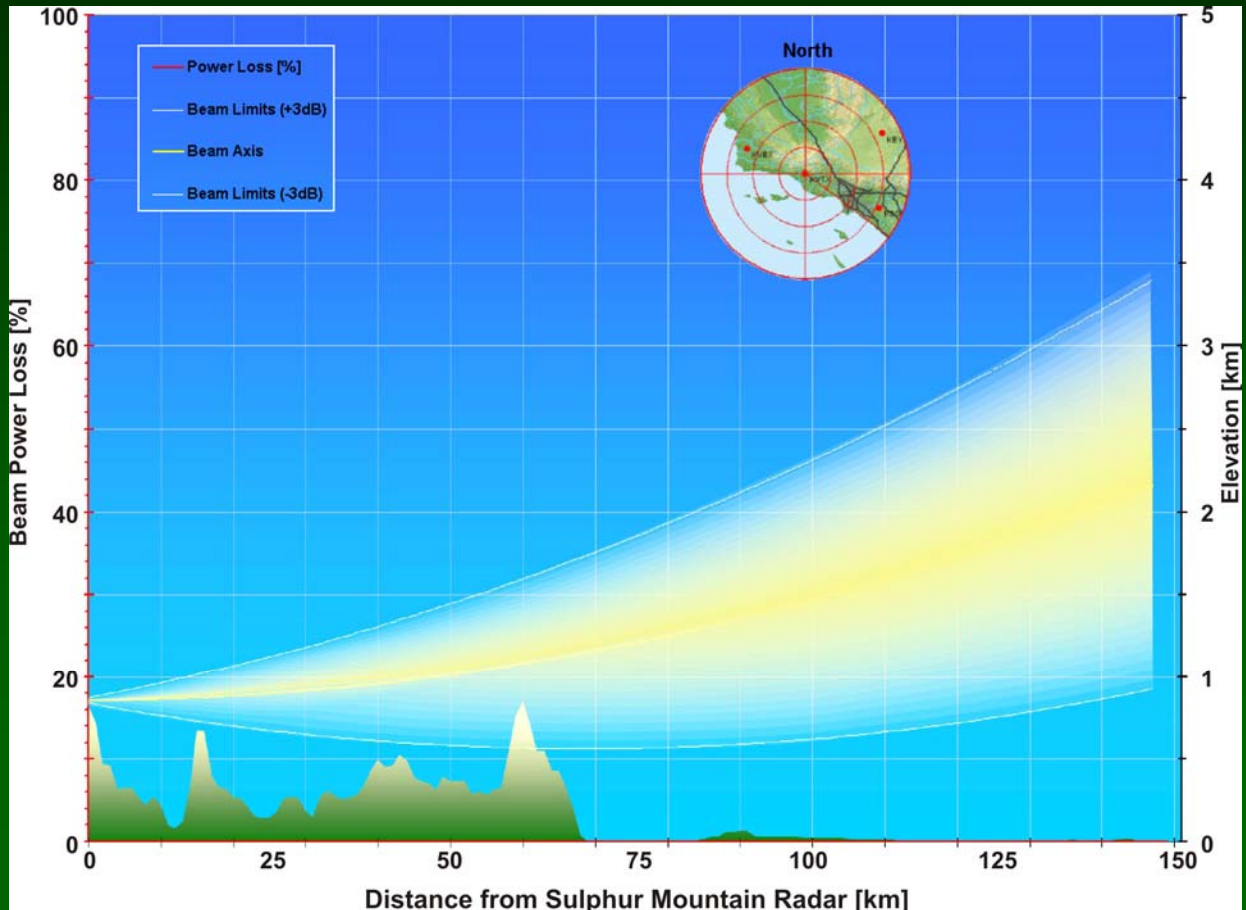
Coverage Below 6000 ft

- At 0.5° elevation angle:
  - Sulphur Mountain radar beam axis goes above 6000 ft at range of 75 km
  - BUT lower half of radar beam still below 6000 ft (and able to detect precipitation) out to about 125 km



Coverage Below 6000 ft

- At 0.0° elevation angle:
  - axis coverage out to 125 km

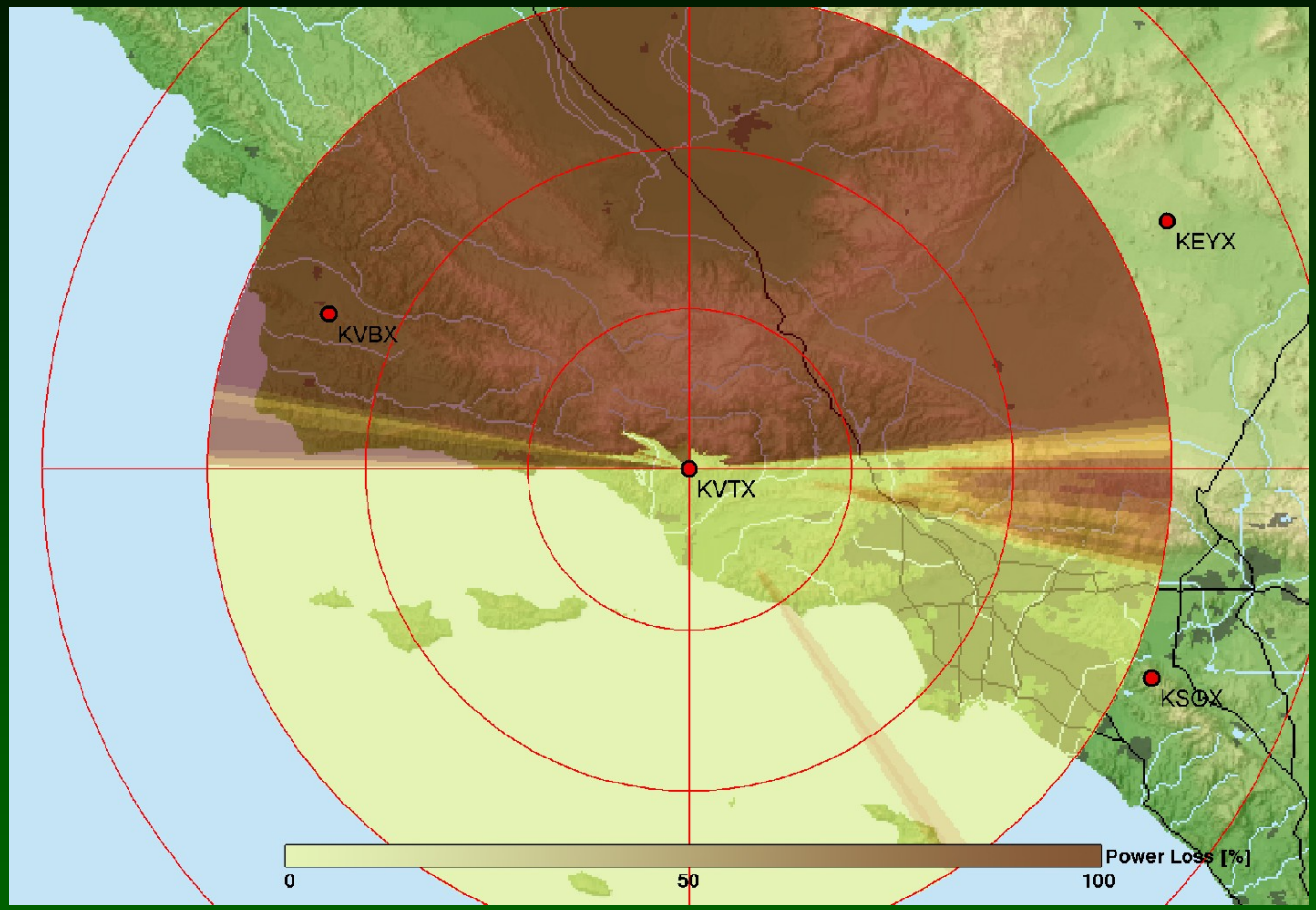


Radar Beam & Terrain Viewer

http://dels.nas.edu/basc/nexradsm/radar_beam_and_terrain_viewer.html

- Microsoft Excel application, soon to be Flash animation
- 0.5°, 0.0 °, and -0.5° at all 360° azimuths

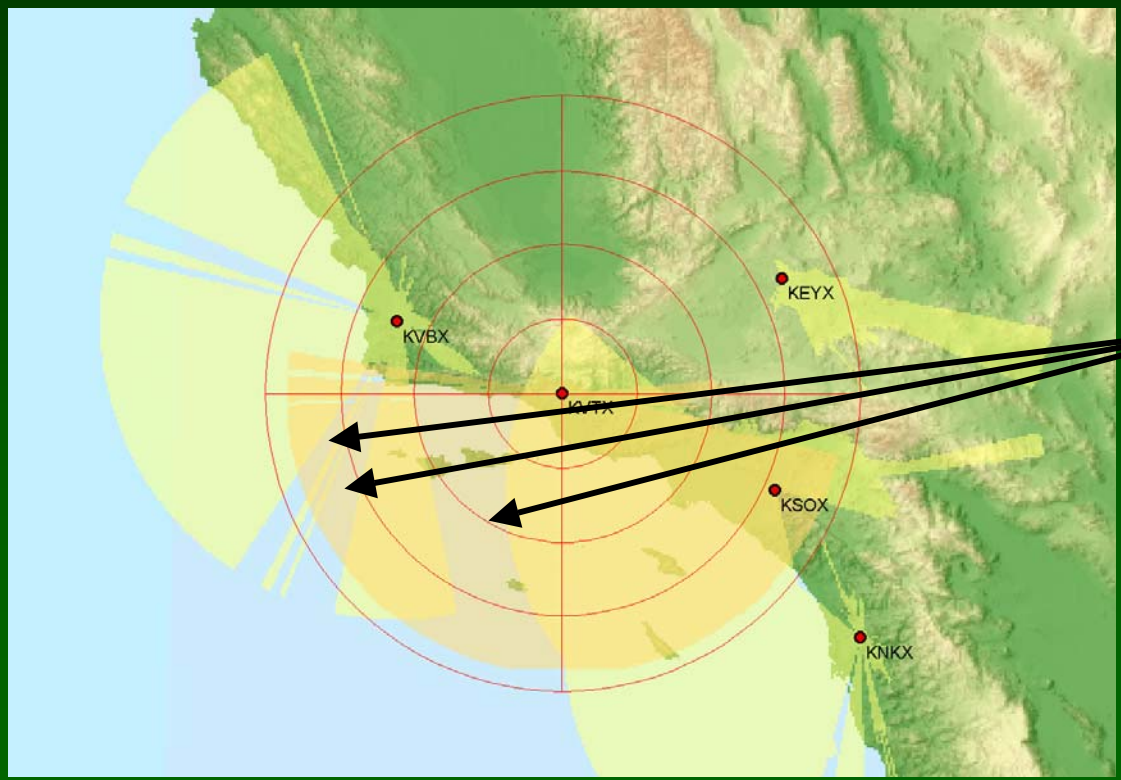
Power Loss at 0.0°



Darker colors indicate greater power loss

SM Provides Crucial Coverage

- Simpler calculations
  - high resolution terrain data, full width of radar beam, but only shows completely blocked coverage (i.e., no partial blockage)



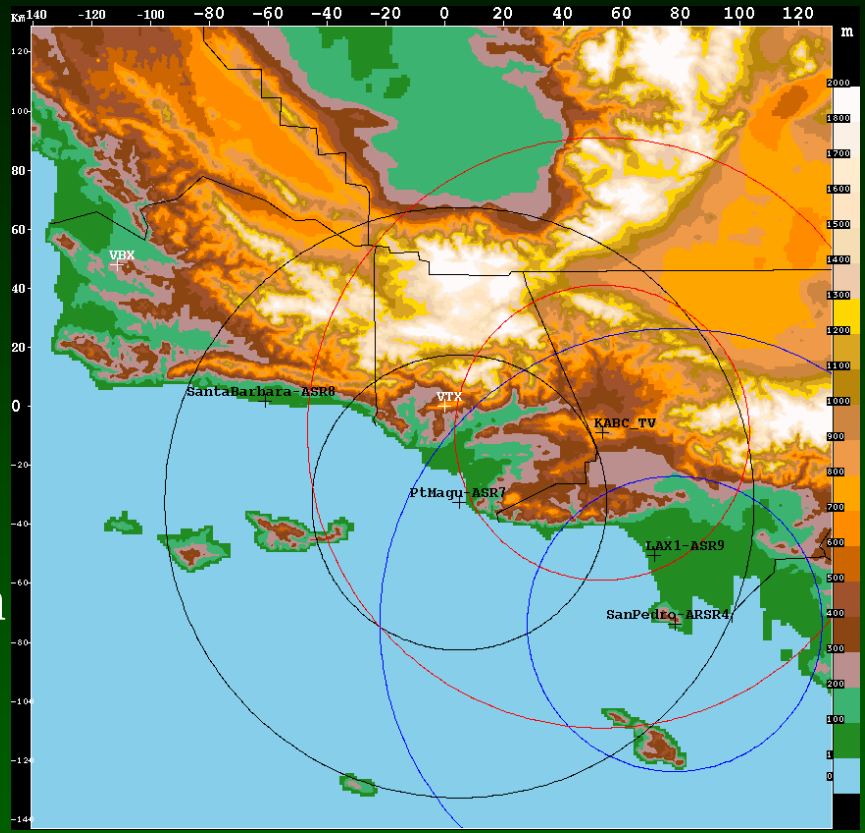
Coverage ONLY from Sulphur Mountain NEXRAD

Enhancing Radar Coverage

1. The NWS should improve nationwide NEXRAD coverage of low-level precipitation and wind, especially for elevated radar sites in complex terrain, through the adoption of a modified scan strategy that will allow scanning at lower elevation angles.

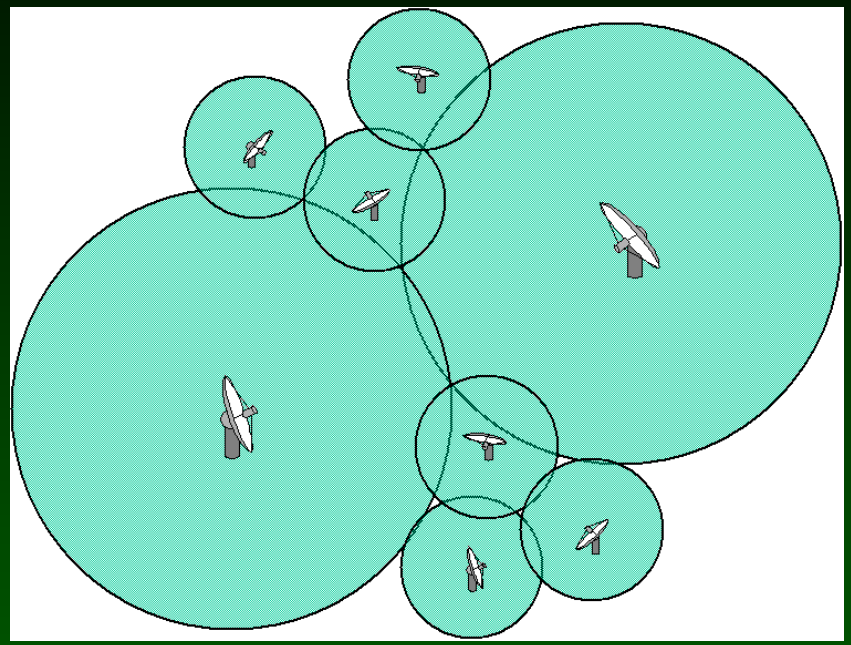
Enhancing Radar Coverage

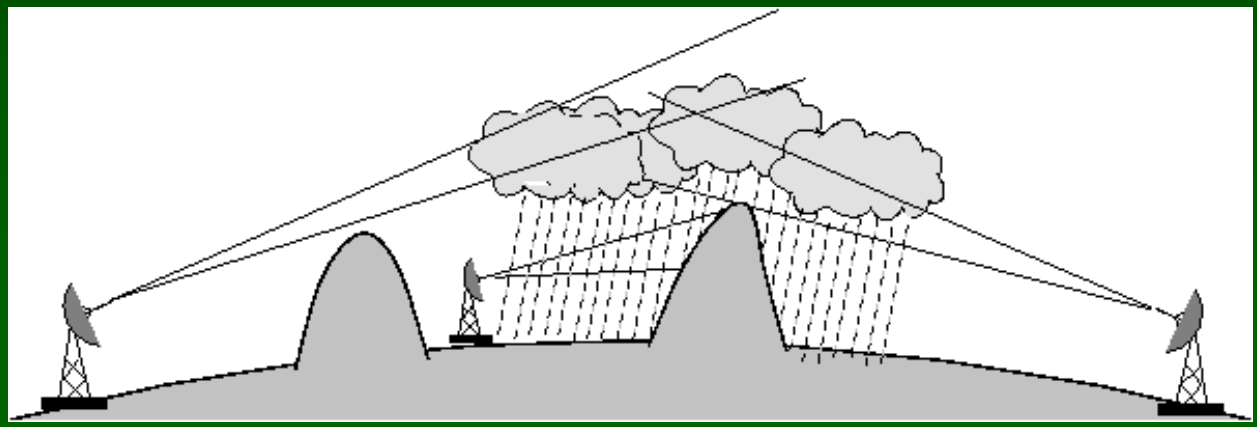
2. All available regional real-time weather radar data should be made accessible to the NWS WFOs, including FAA and DoD NEXRAD radars; FAA Terminal Doppler Weather Radars and other surveillance radars equipped to provide weather-echo data; local television station Doppler radars; and operational radars from other organizations.



Enhancing Radar Coverage

3. The NWS should consider augmenting the NEXRAD network with additional short-range radars to improve observation of low-level meteorological phenomena.





Improving NWS Warning and Evaluation Processes

1. NWS Weather Forecast Offices nationwide, including the Los Angeles-Oxnard Weather Forecast Office, should continue to expand their collaborative efforts with key stakeholders (e.g., county, police, and emergency management officials) to enhance the effectiveness of flash flood forecasts, watches, and warnings.
2. Evaluation of flash flood warnings should be based on their contributions to improved decision making and should employ metrics that take account of the magnitude and scale of the events and the increasing specificity of the warnings. The NWS should improve the database of flash flood events and warnings to include more complete and accurate listings of both warnings and events.

Guiding Future Directions

1. To increase the accuracy and lead time of flash flood forecasts and warnings, the NWS should continue to implement new technologies and techniques including (a) the Flash Flood Monitoring and Prediction program at all Weather Forecast Offices, (b) polarimetric modifications to NEXRAD, (c) data assimilation systems that integrate radar and other operational datasets into coupled hydrometeorological and hydrological models, and (d) data fusion systems.
2. In addition to the original NEXRAD siting considerations, future siting of radars in complex terrain should include detailed assessments of coverage in areas at risk for flash flooding.