Progress Report on Improvement of Air Quality Model Aloft Performance

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Presented to:
CCOS Technical Committee
Sacramento, CA
September 14, 2006

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Overview

- Proposed Phase 1 Improvements
- Evaluation Process
- Results
- Modeling Domain Issue
- Recommendations

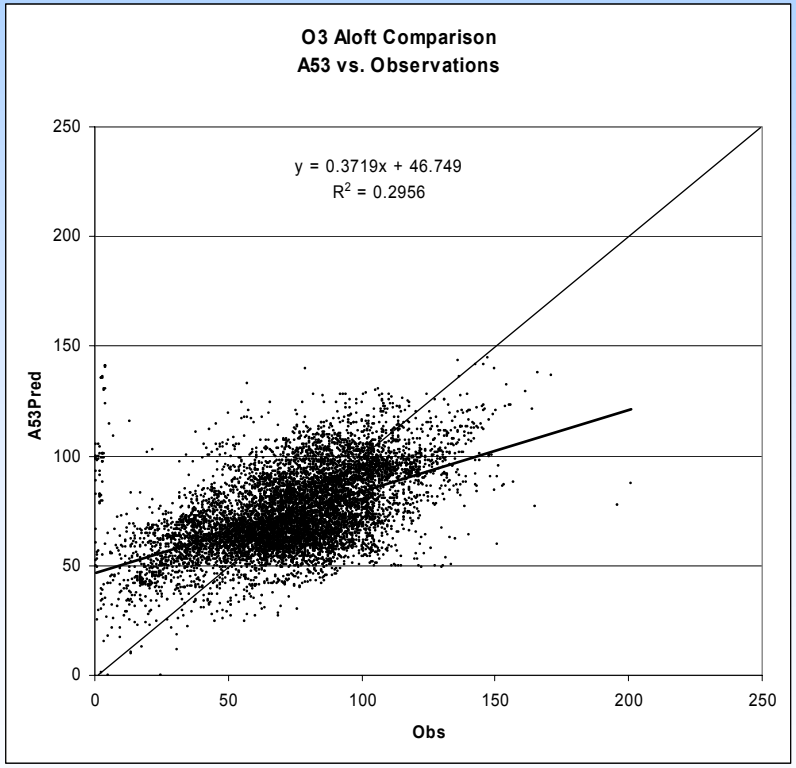
Proposed Phase 1 Improvements

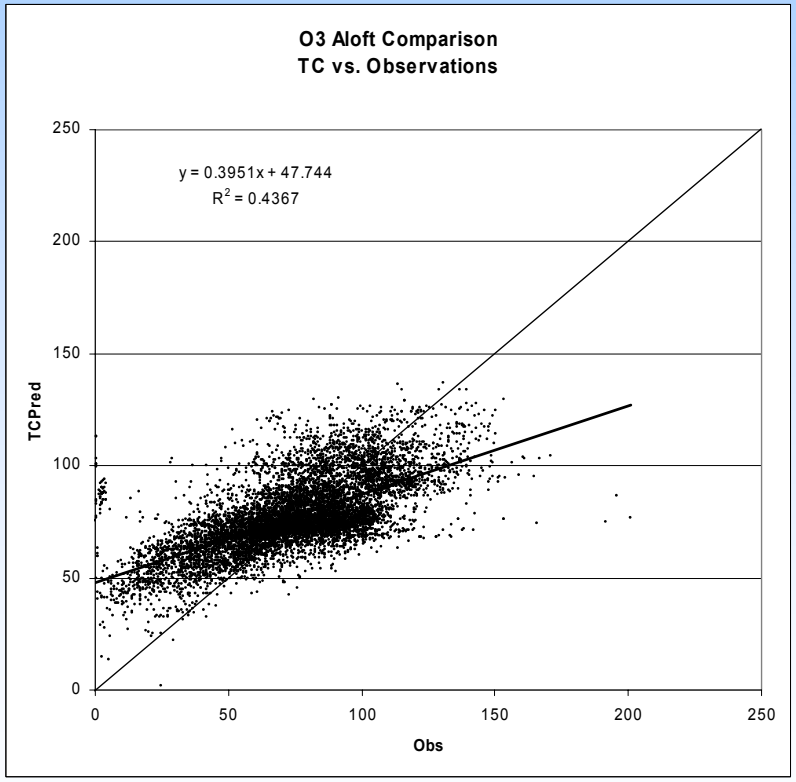
- Meteorology (MM5)
- Vertical Structure
- Nighttime Mixing
- Photolysis Rates
- Wildfire Emissions
- Anthropogenic and Biogenic Emissions
- Emphasis on July-August 2000 Episode

Evaluation Process

- Aloft Model Performance for Ozone
  - Hourly Averages for Grid Cells
  - Scatter Plots
  - Correlation
- Inert Tracer Simulations for Meteorology Changes
- Vis5D Animations of Ozone & Inert Tracers
- Difference Plots
- Ground Level Model Performance

Model Performance Aloft





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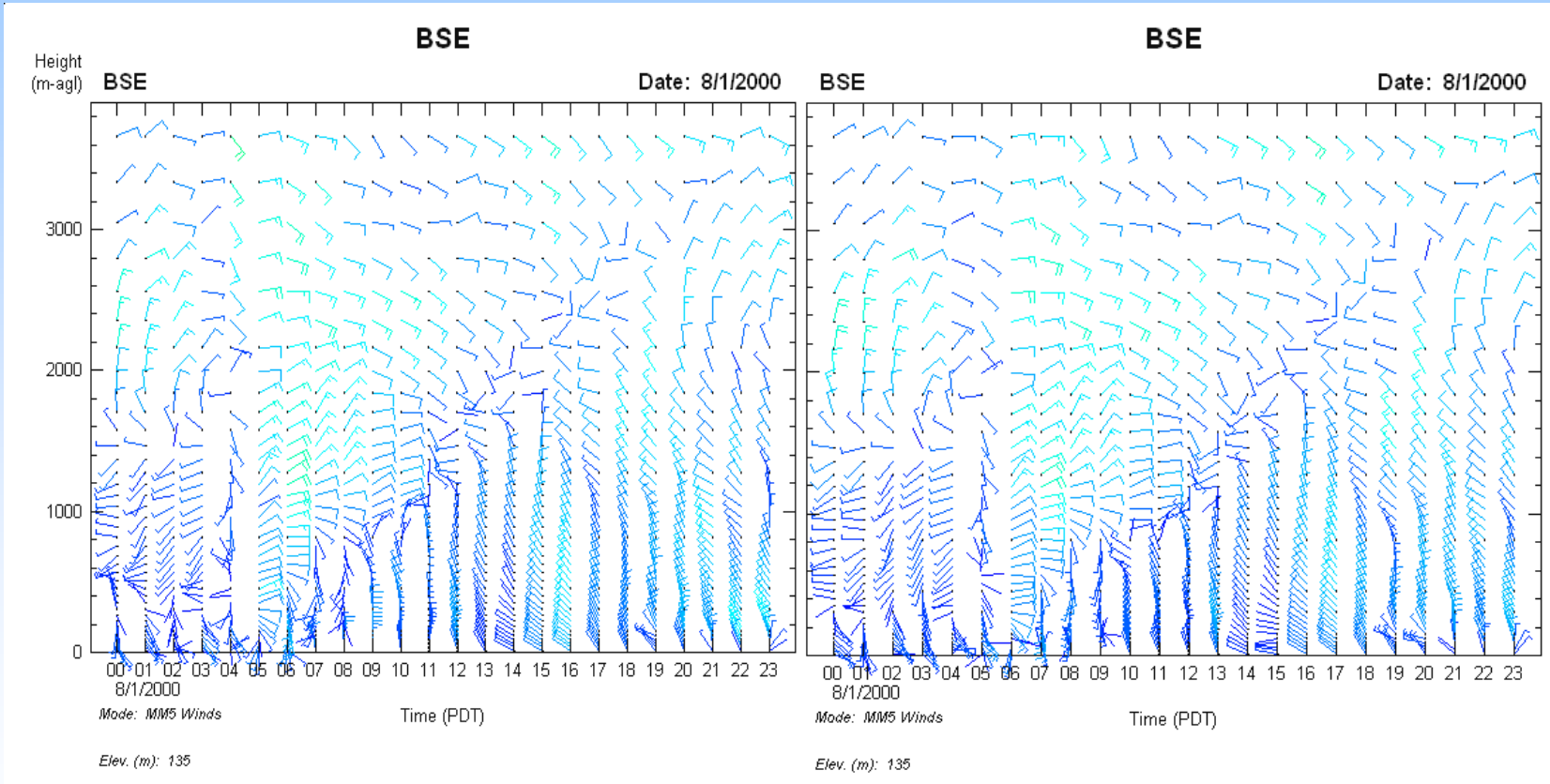
Results

- Completed
  - Meteorology (MM5)
  - Vertical Structure
  - Nighttime Mixing
  - Photolysis Rates
- In Progress
  - Wildfire Emissions
  - Emission Inventory Improvements

Meteorology

- NOAA's "Best" Simulation
  - Not our requested simulation
    - No hourly average output
    - Interpolated observation FDDA
- Results
  - Not much change in performance or flow structure
  - Vertically interpolated observation nudging did not obscure or significantly weaken return flows

Winds



Original

New

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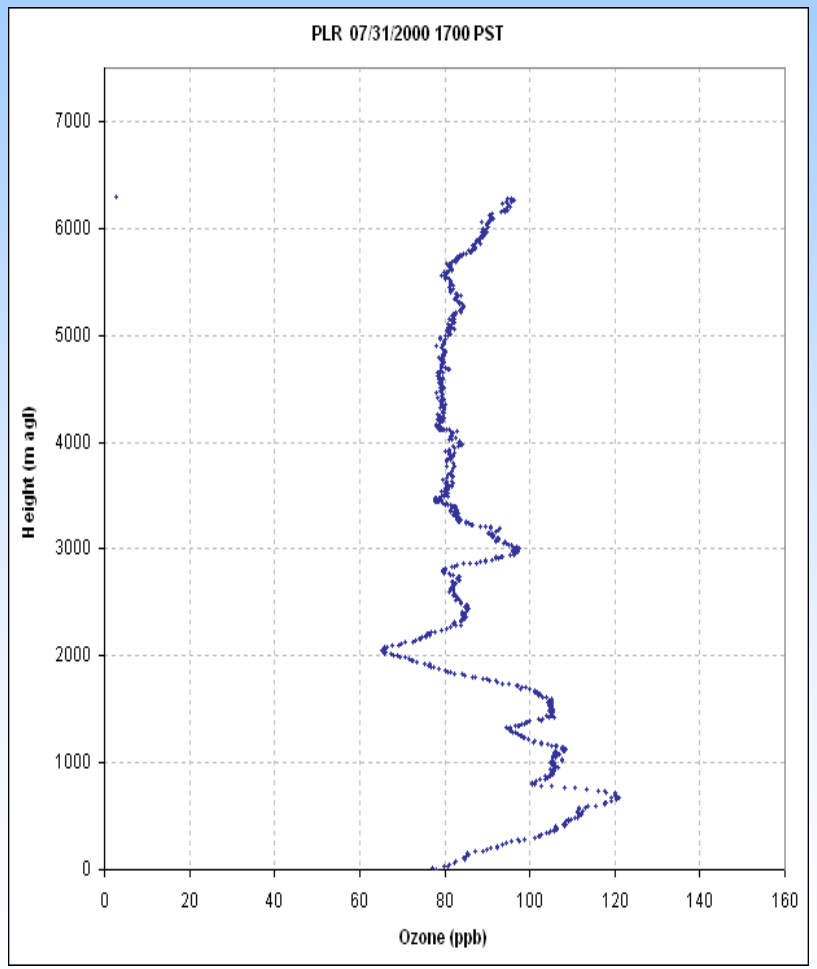
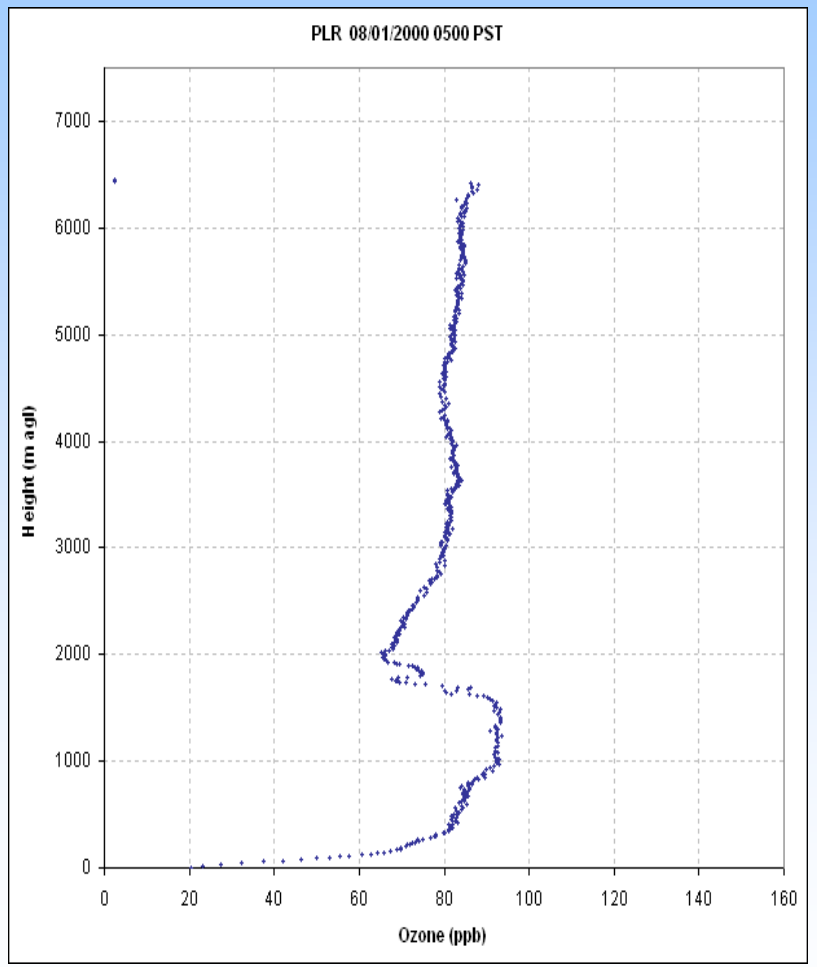
Vertical Structure

- CAMx and MM5 layers matched in first 2 km
- 38 Layers
- Results
  - Better vertical resolution of winds in CAMx
  - Little change in net circulation
- Transport through boundaries aloft

Ozonesondes





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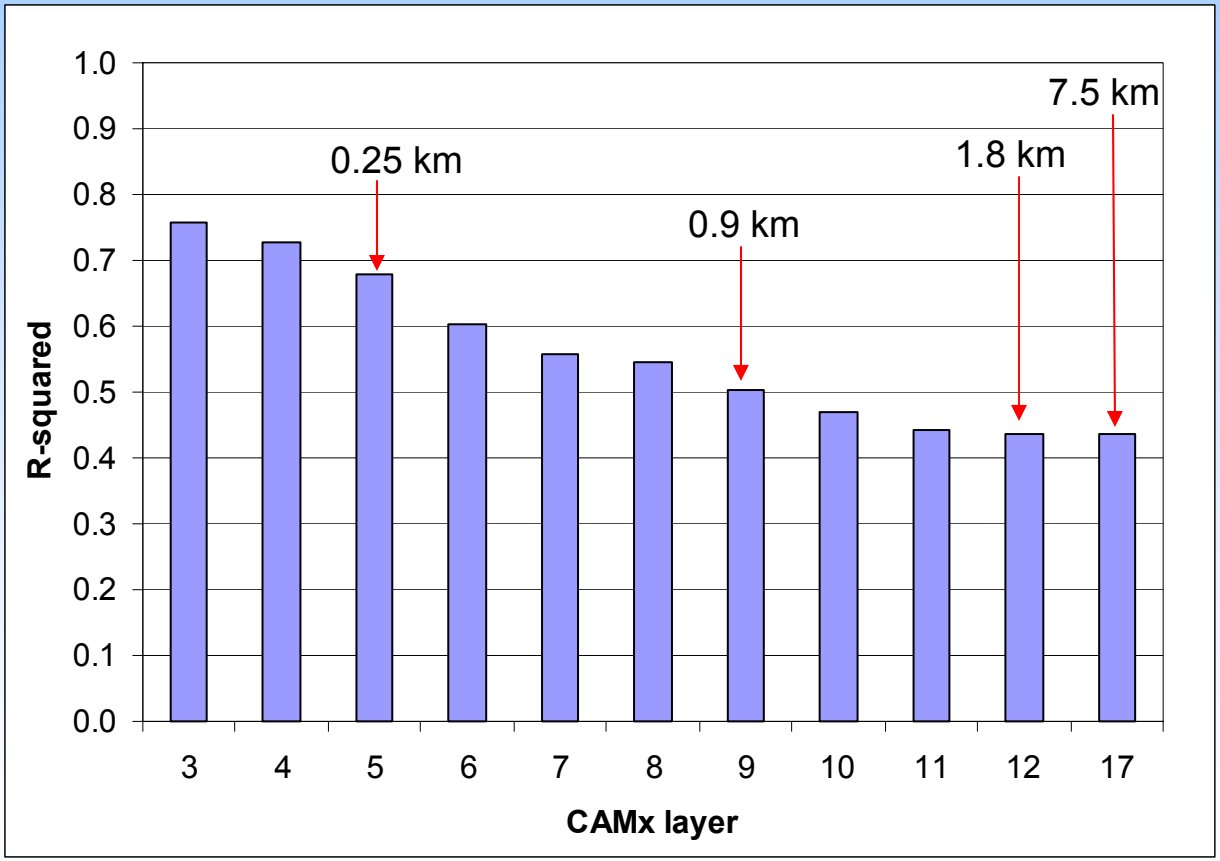
Ozone Correlation by Level



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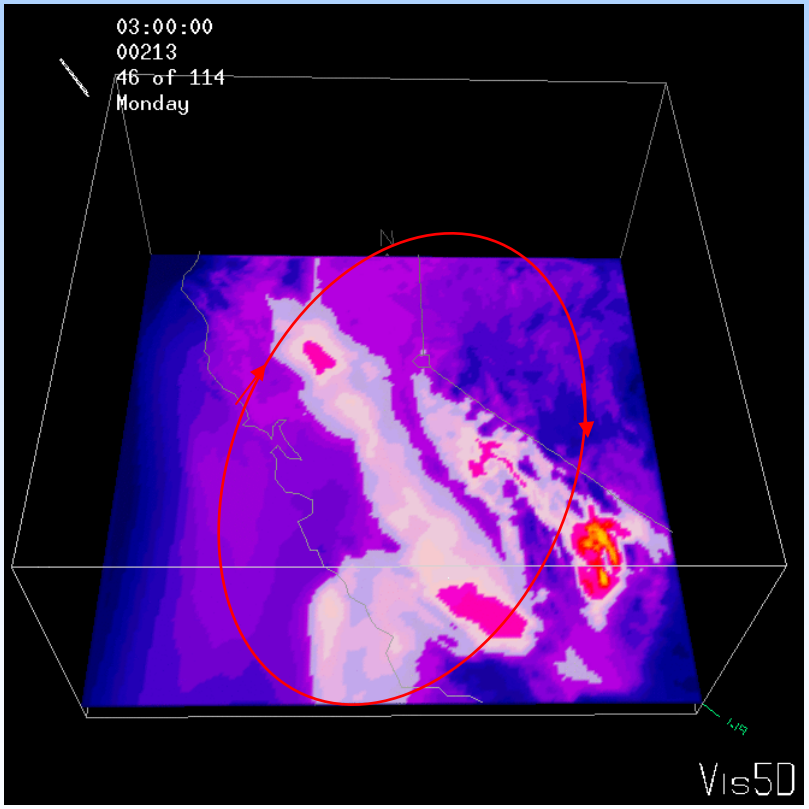
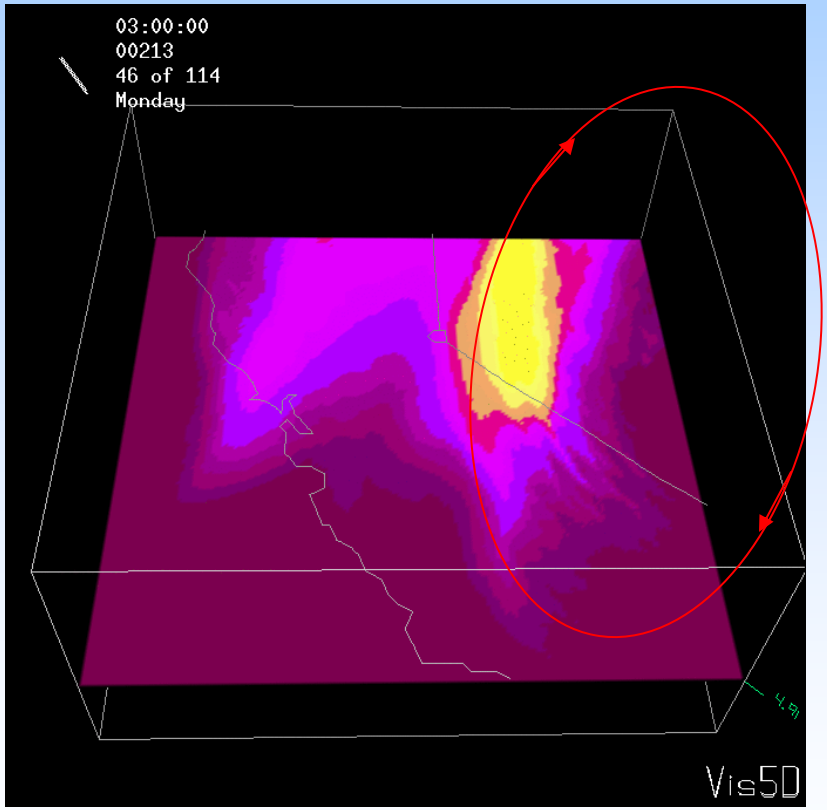
Ozone Transport Through Boundaries

Monday, July 31, 2000



1.3 km



5.0 km

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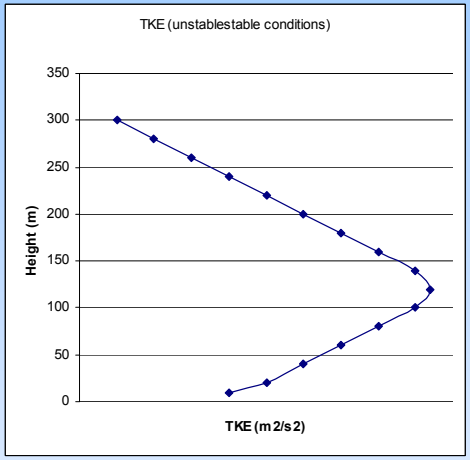
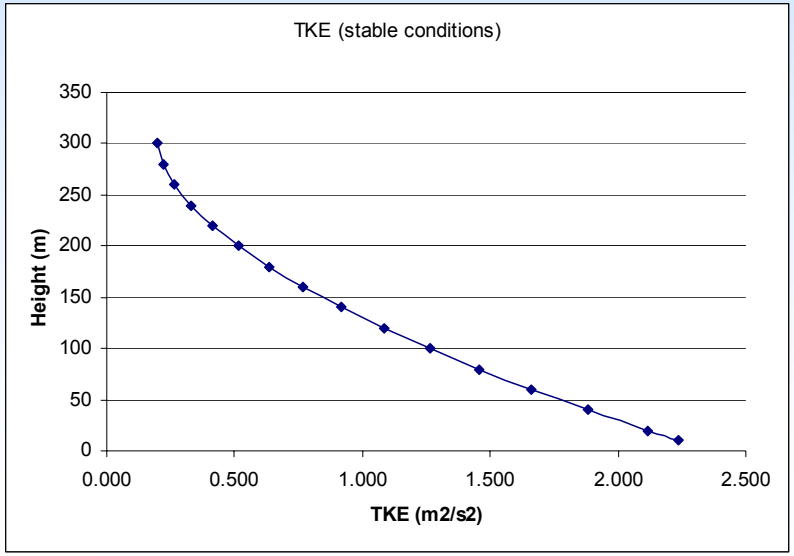
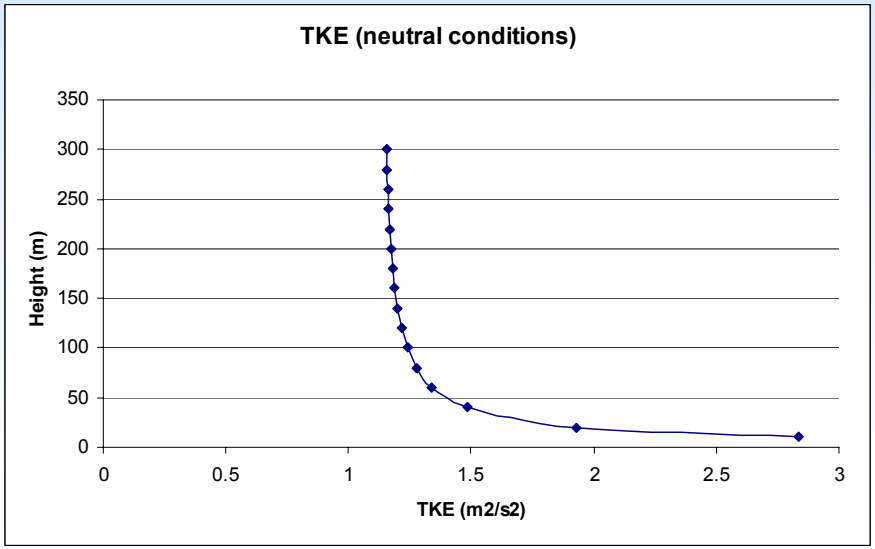
Nighttime Mixing

- Mechanical Mixing Model
  - Neutral and stable: van Ulden and Holtslag (1985)
- TKE profiles
  - Near neutral : Zhang et al. (1996)
  - Stable: Lenschow et al. (1988)

TKE Profiles







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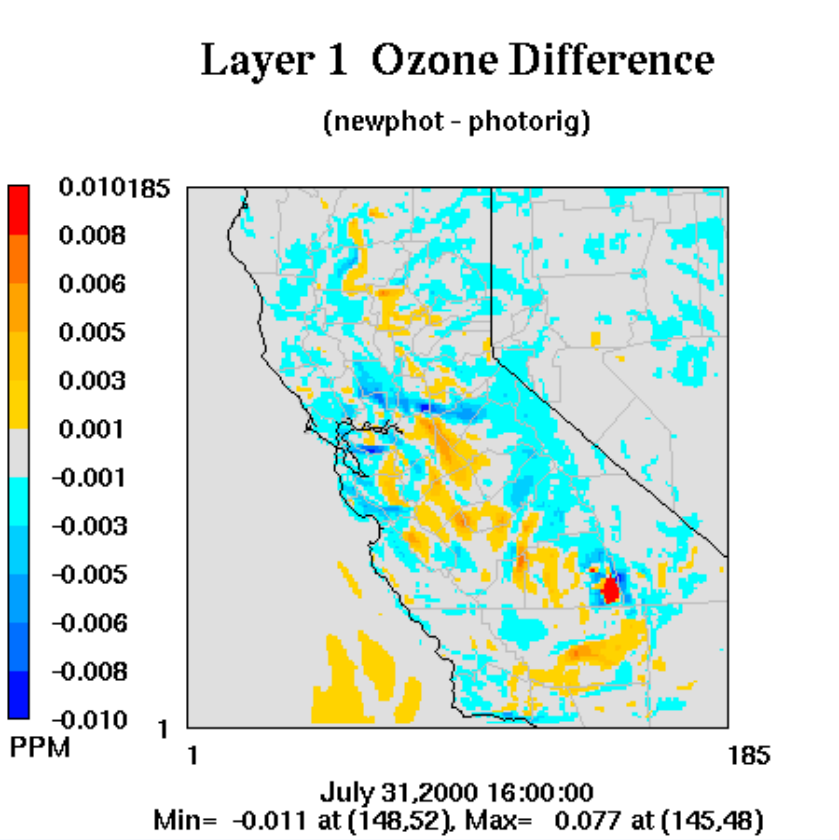
Nighttime Mixing Issues

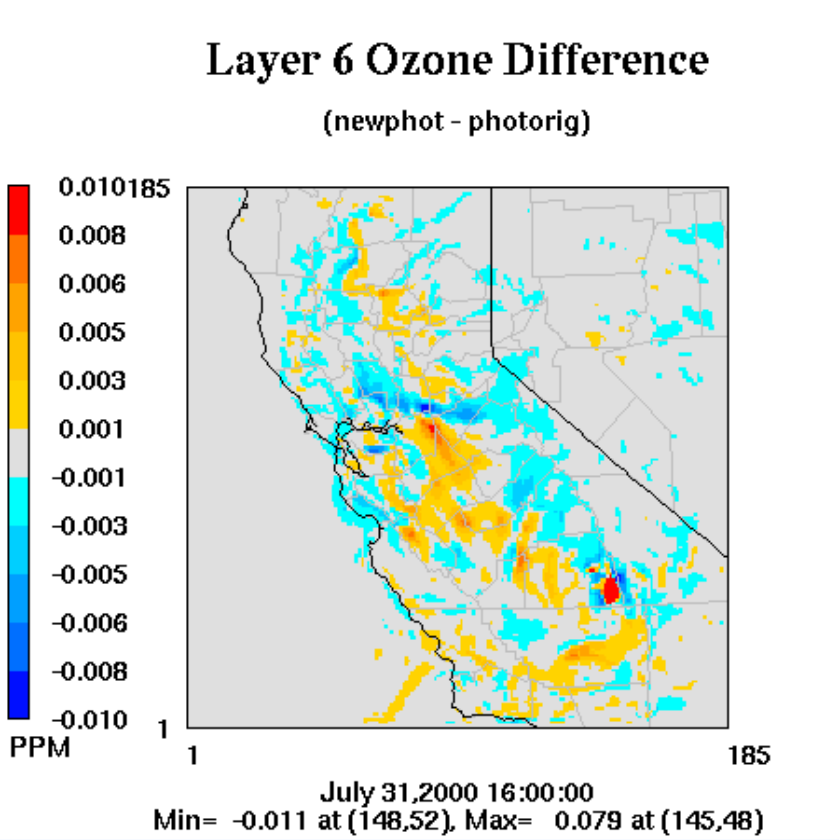
- Surface roughness and friction velocity
- Fire emissions
- Recirculation

Alternate Photolysis Rates

- Modified CAMx 4.31 to read in terrain elevations and calculate layer heights above mean sea level (MSL)
- April 2006 release of TUV 4.01 allows levels to be specified
- Pseudo-spherical two-stream delta-Eddington scheme
- Increased number of photolysis levels in CAMx from 11 to 27

Spatial Differences – New Photolysis





Case photorig: Photolysis rates used in TC simulation

Case newphot: Terrain-corrected photolysis rates

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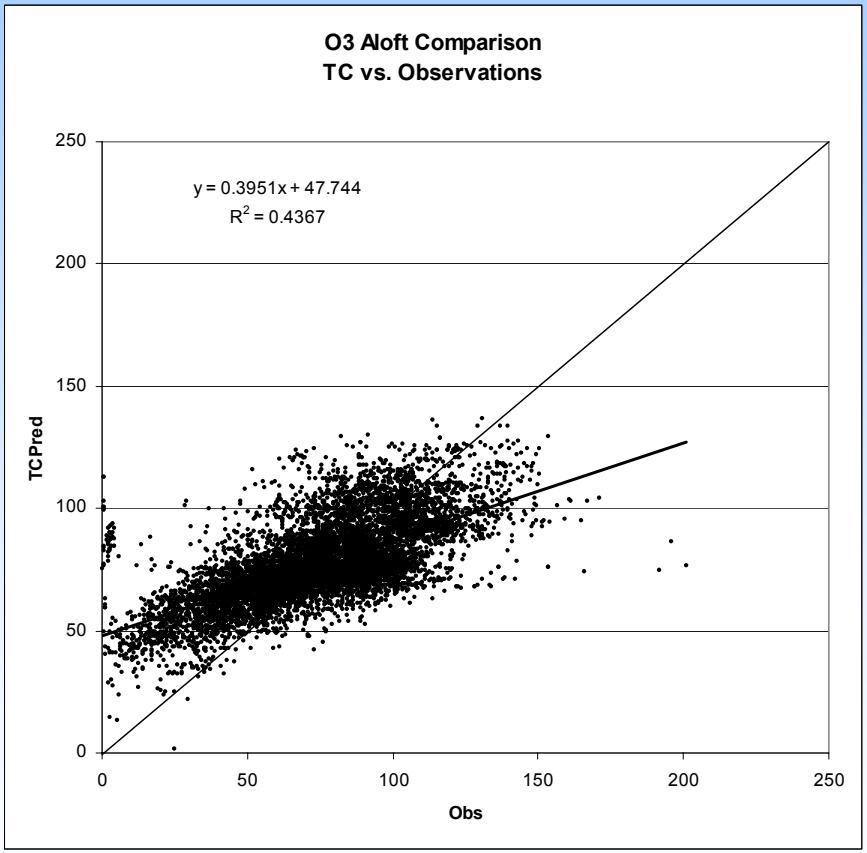
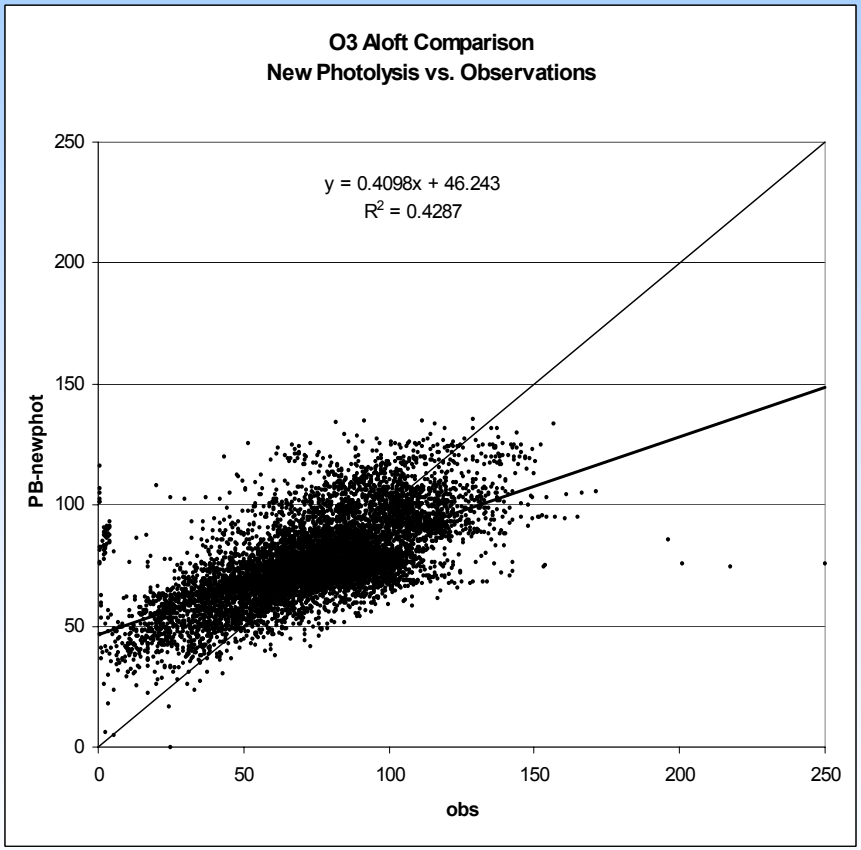
MPE Aloft – New Photolysis





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Wildfire Emissions

- Smoldering emissions
  - First Order Fire Effects Model
  - Dominate VOC emissions from fires
  - Diurnal variations
  - Post burn smoldering
  - Issues with establishing defensible profiles
- Stack parameters and plume rise
  - Plume rise:
    2 km (intended) vs. > 10 km calculated in CAMx
  - Default stack parameters: T=295 ˚K and V=4 m/s

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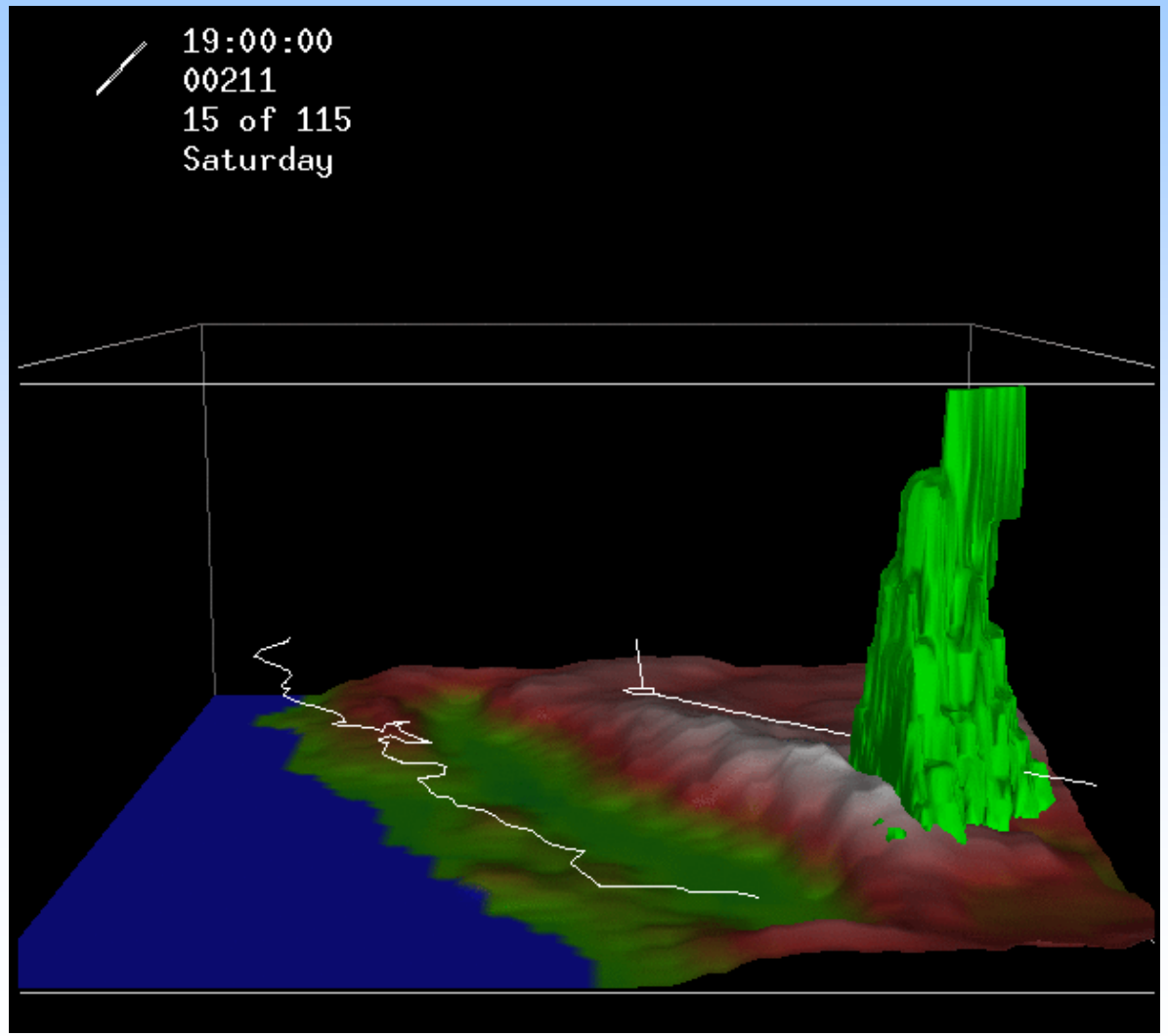
Wild Fire Tracers



16 km

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On-Road EI Improvements

- Heavy-duty diesel vehicle miles traveled (VMT) distributed based on vehicle activity rather than vehicle registrations
- Adjustments made to heavy-duty diesel emission factors
- Modifications to the speed correction factors for heavy-duty diesel vehicles
- High idle emission rates for heavy-duty diesel vehicles included
- Diesel fuel correction factors incorporated
- The impact of ethanol in gasoline on evaporative emissions accounted for
- Addition of areas into the Enhanced Smog Check program

Off-Road EI Improvements

- Updates to equipment populations and activity data in the OFFROAD model (lawn and garden equipment, pleasure craft, etc.)
- Locomotive inventory updated to reflect growth from goods movement at ports
- Emissions from cargo handling equipment (CHE) at ports and rail yards estimated
- Moved to consistent statewide approach for estimating emissions from commercial marine vessels

EI Improvements

- Biogenic Emissions
- Acquired improved EI for Emissions Reconciliation Project
- Have not yet obtained or prepared model-ready emissions and compared them to original model-ready emissions

Modeling Domain

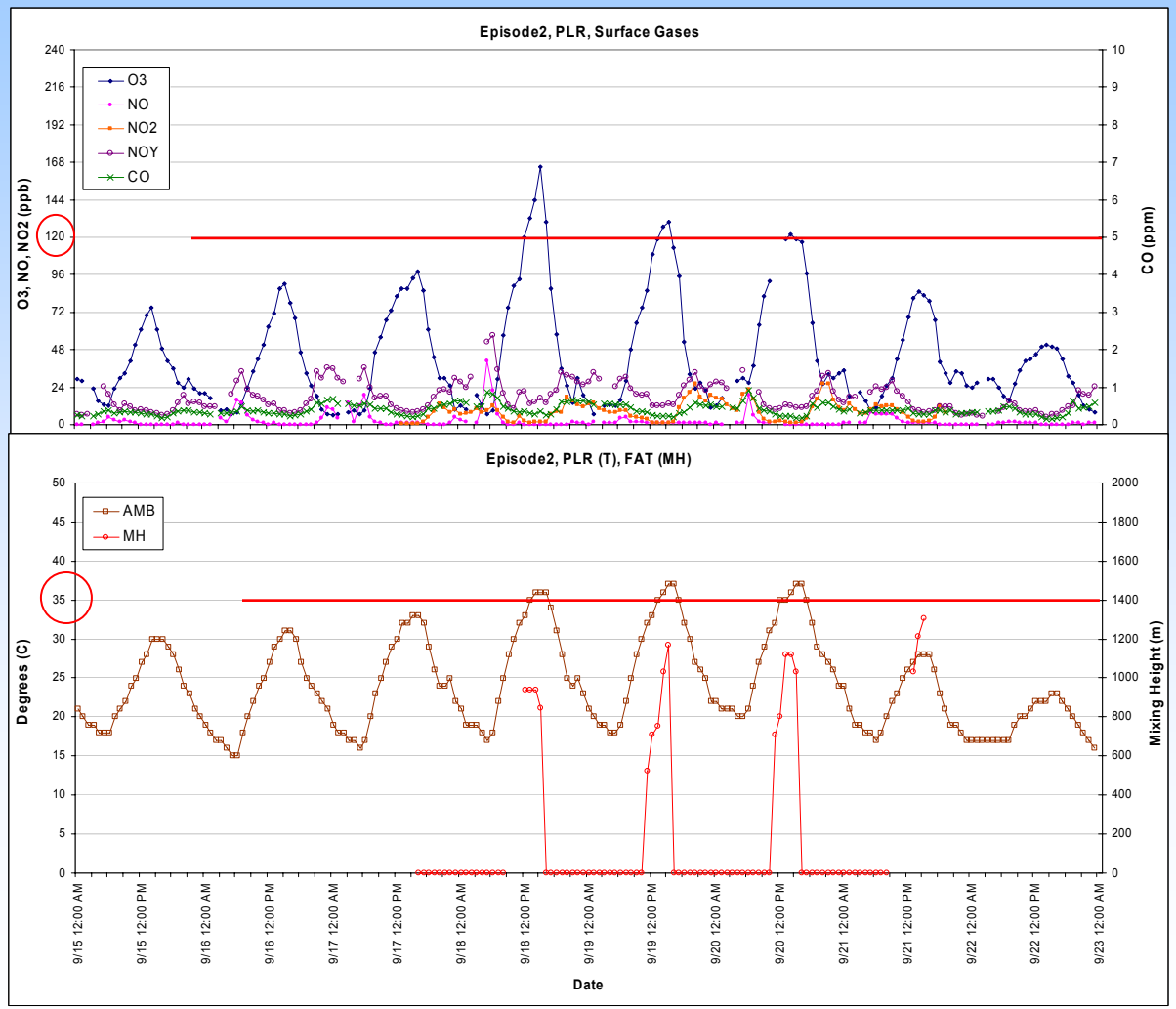
- Transport ozone and tracers out through southern and western boundaries
- SJVAQS 1990
- Animations:

  ftp://ftp.sonomatech.com/public/CCOS/CCOS-Animations.htm

September 2000 Episode

- MM5 temperature bias
- No new MM5 simulations
- Biogenic emissions in southern SJV

High Ozone Day Temperatures



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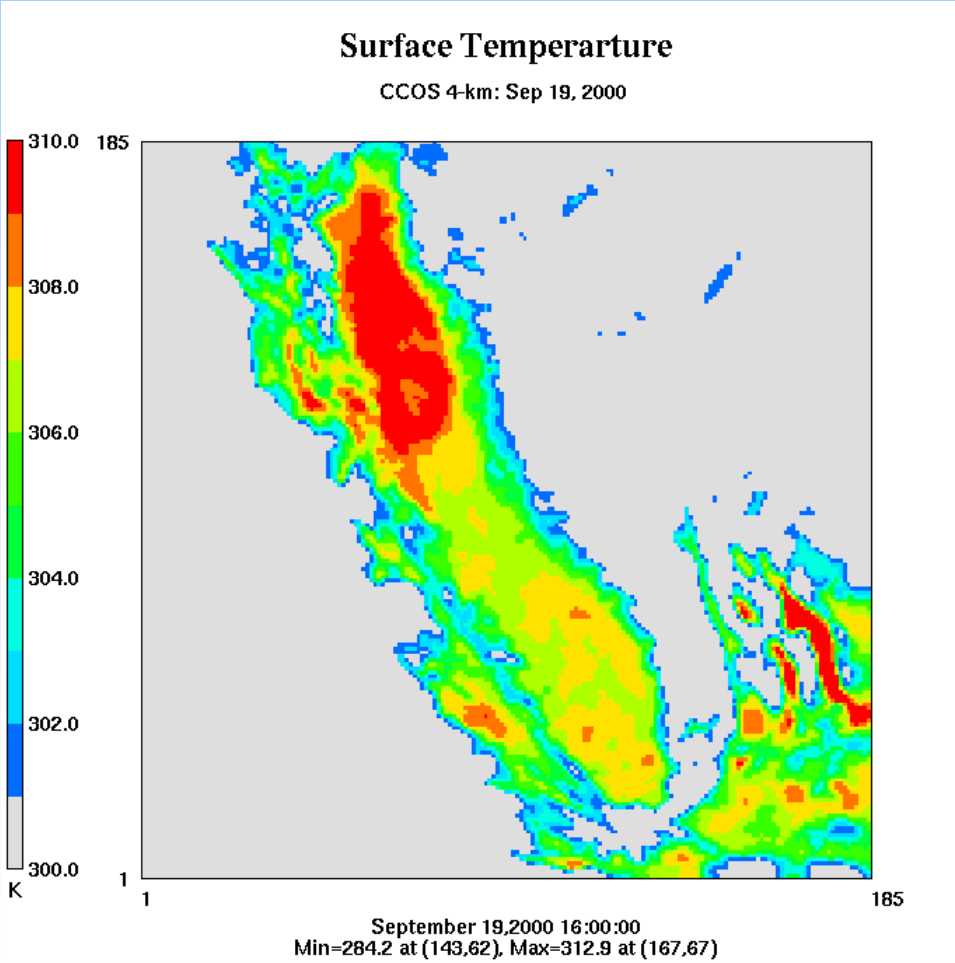
Maximum Predicted Temperatures



September 19, 2000

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Recommendations

- Correct stack parameters on wild fires
- Implement new emission inventory
- Nest CCOS domain within a larger regional 12-km domain

Questions?

References

A.P. Van Ulden, A.A.M. Holstlag, Estimation of atmospheric boundary layer parameters for diffusion applications, J. *Climate Appl. Meteor.*, 24:1196, 1985

Lenschow, D.H., X.S. Li, and C.J. Zhu, Stably stratified boundary layer over the Great Plains. Part I: Mean and turbulent structure, *Bound.-Layer Meteor.*, 42, 95-121, 1988.

Zhang, C., D.A., Randall, C.-H., Moeng, M. Branson, M. Moyer, and Q. Wang, A surface parameterization based on vertically averaged turbulence kinetic energy, *Mon. Wea. Rev.*, 124, 2521-2536, 1996.