Mesoscale Modeling in Coastal Complex Terrain for the Application of Photochemical Modeling

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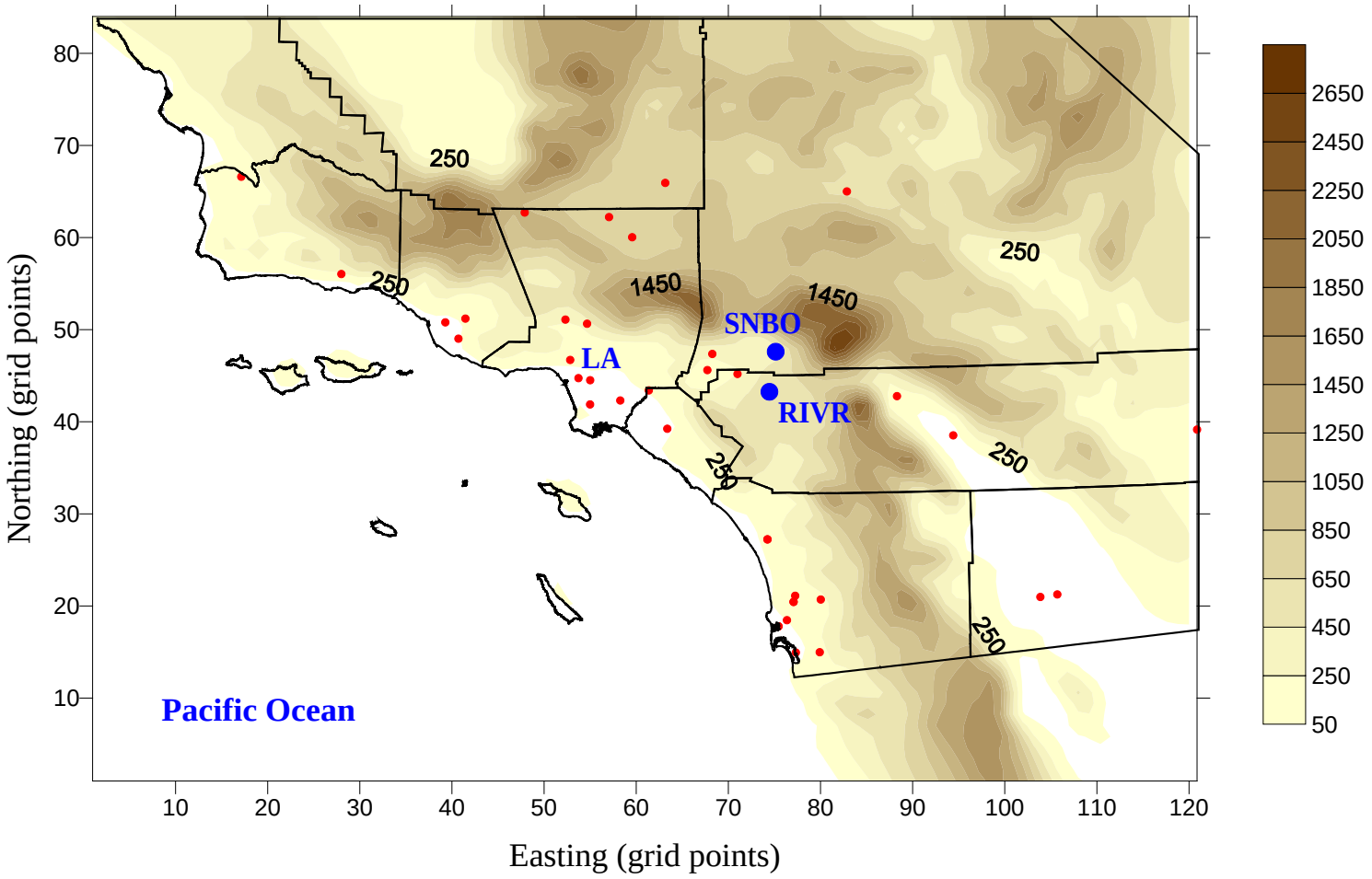
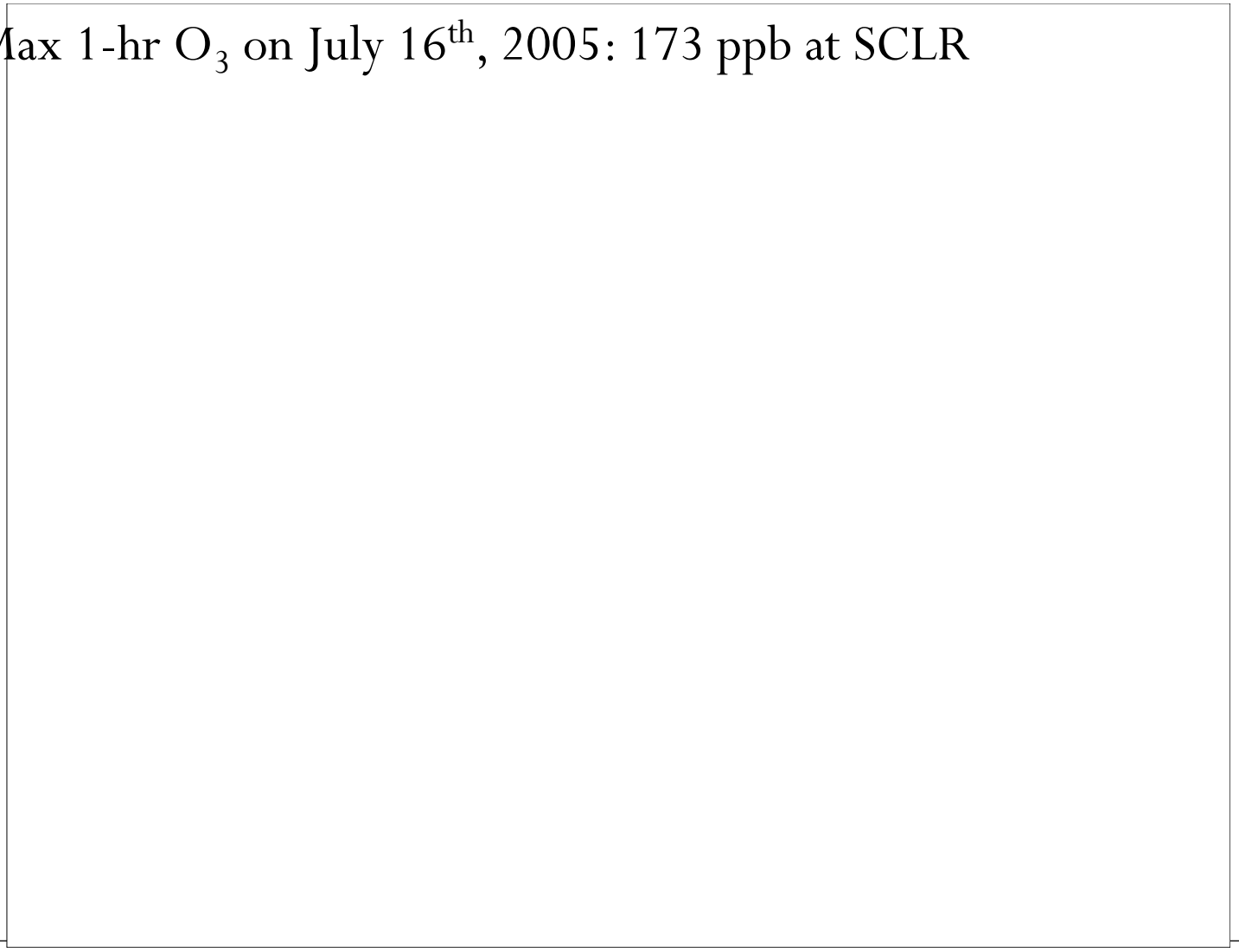
Sang-Mi Lee
South Coast Air Quality Management District
21865 Copley Dr, Diamond Bar, CA 91765-4182

Topography in the South Coast Air Basin

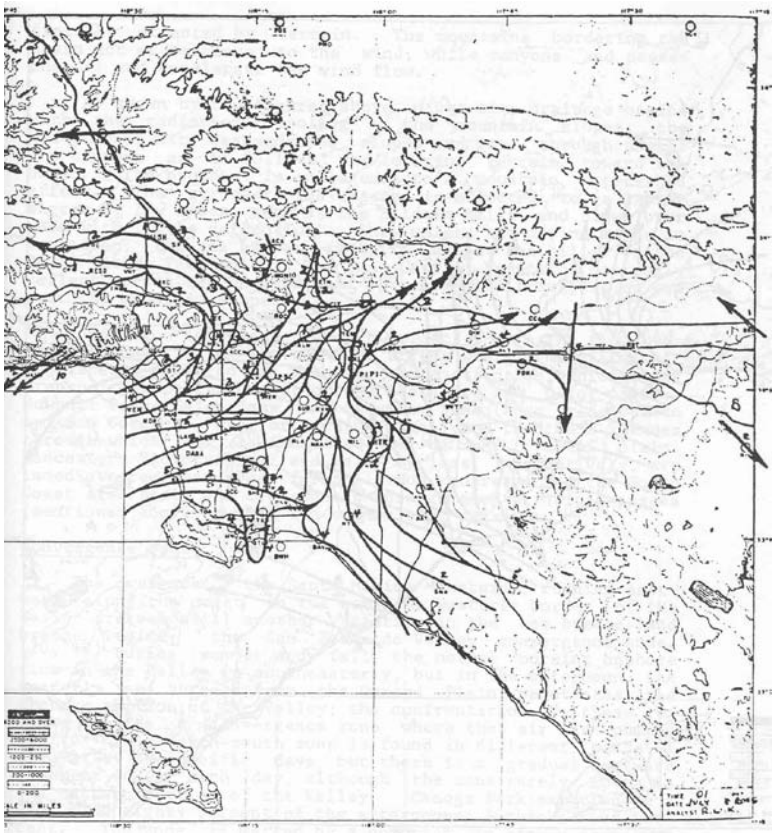


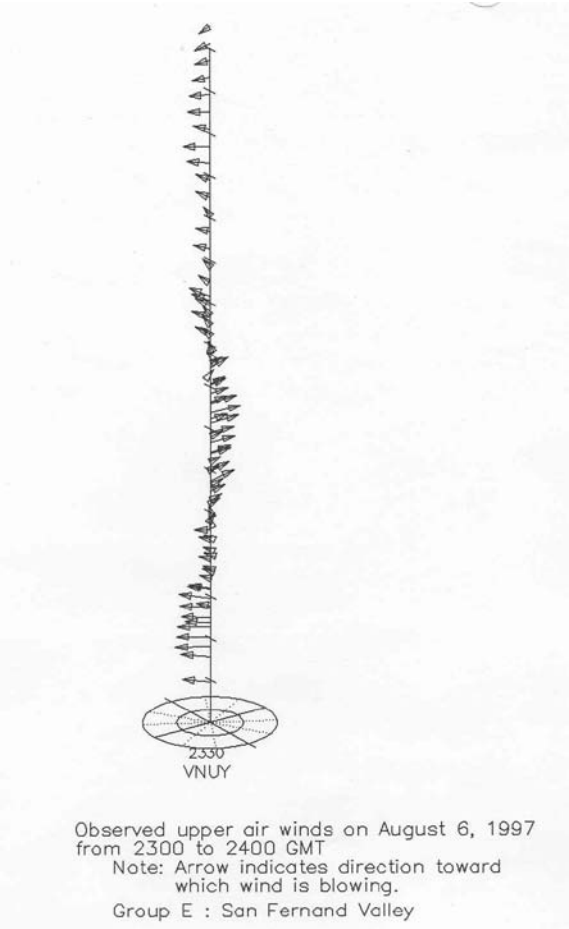
Ozone double peak pattern

Max 1-hr O_3 on July 16th, 2005: 173 ppb at SCLR



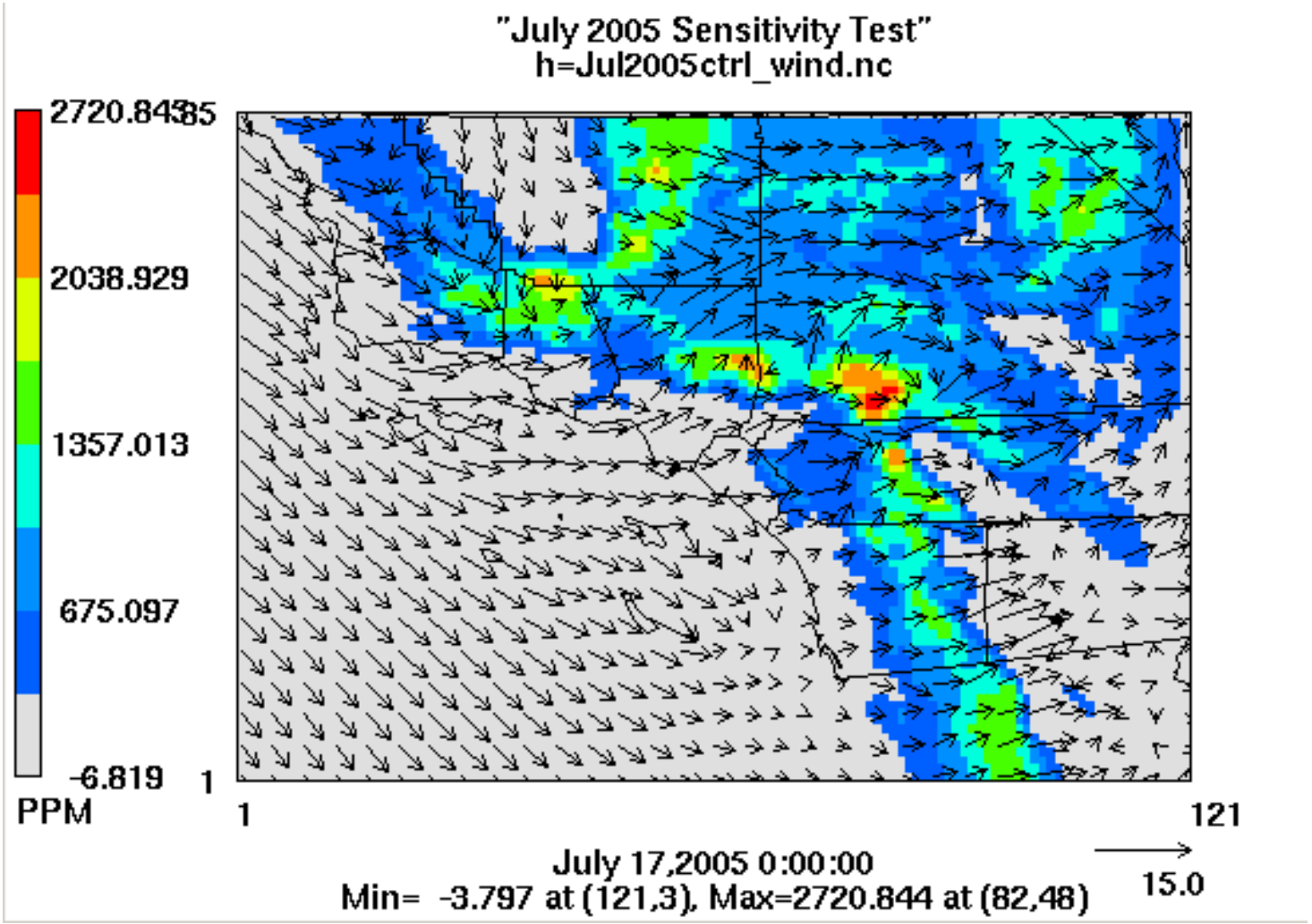
Flow Characteristics





The most frequent basin wind flow during July at 0100 PST (A Climatological Air Quality Profile, California South Coast Air Basin)

Typical Met Model Simulation Results



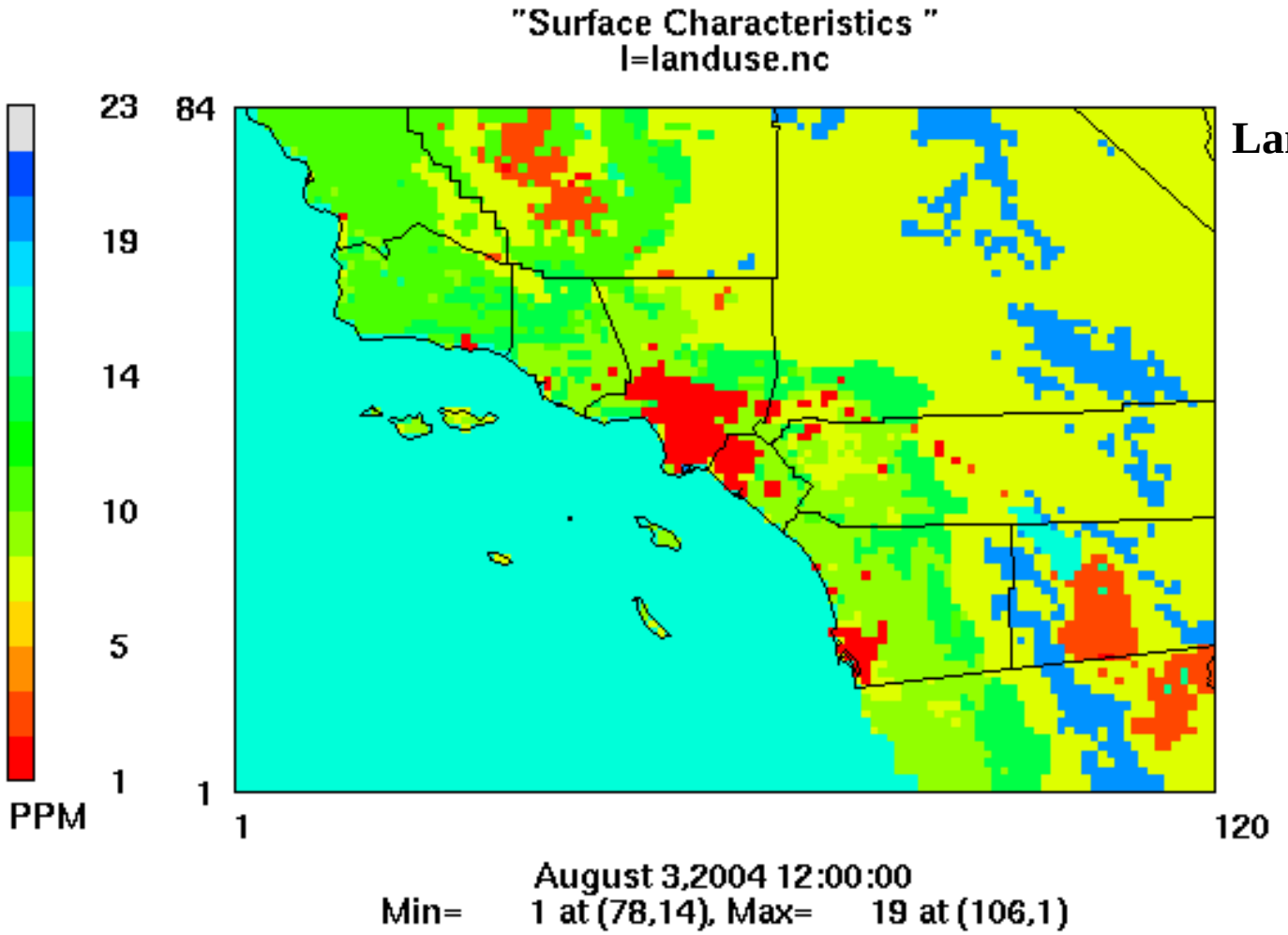
Configuration for Numerical Simulation

- First guess field: Eta 212 grid analysis output
- Three domains of which grid distances are 36, 12, and 4 km, respectively
- The number of grids in the inner most domain: (121,85)
- The number of vertical layers = 34 with the lowest layer at approximately 20 m agl
- Non-Local mixing PBL, 5 layer soil model, no cumulus parameterization, and cloud radiation scheme for the innermost domain.

Proposed Methodology

- Update Land Use
- Soil moisture availability
- Nudging surface observational winds into the innermost domain

WRF Default Land Use (Δx=5 km)



Land Cover Index

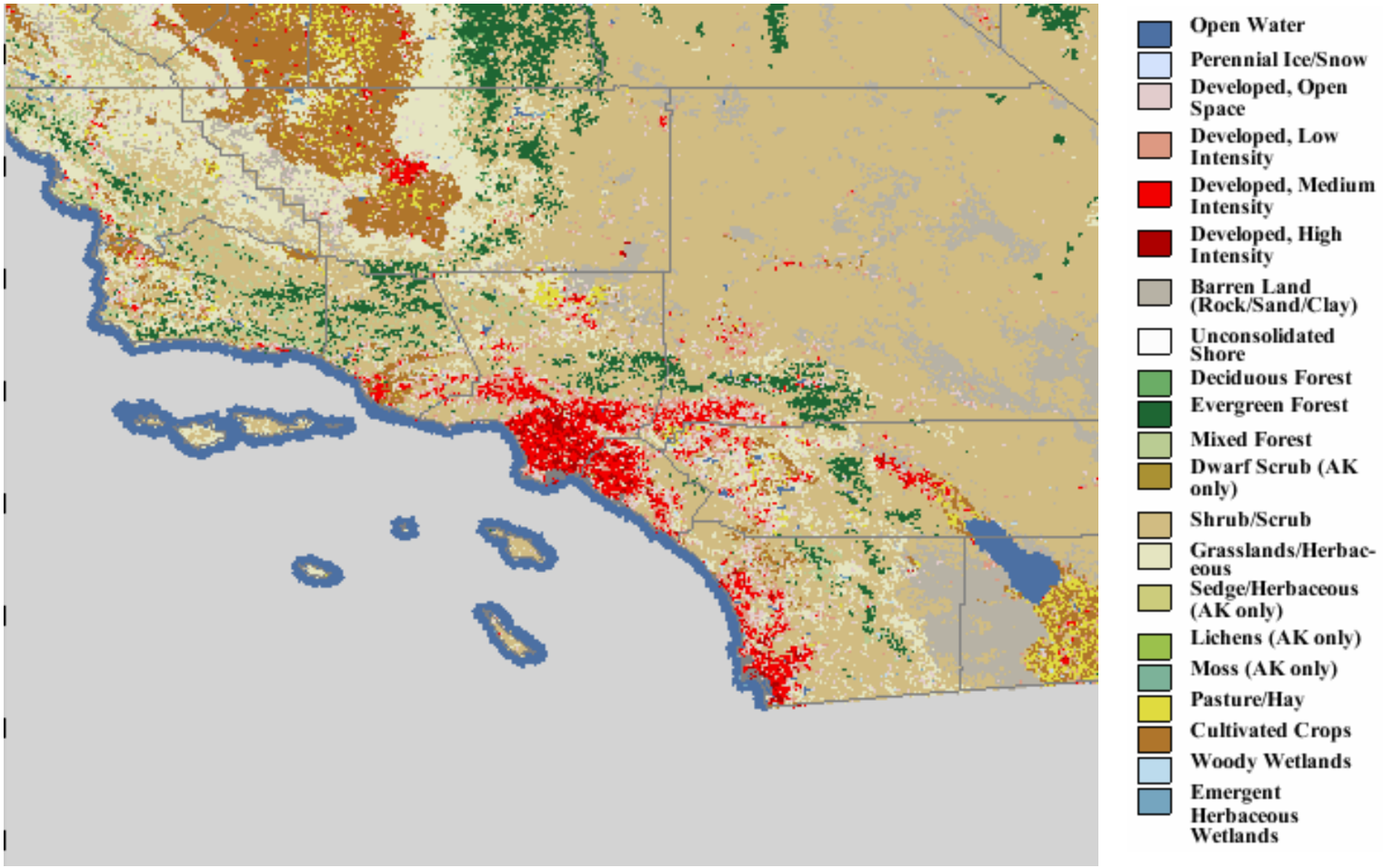
1: Urban

7: Grassland

8: Shrubland

9: Mixed Shrub/Grass

National Land Cover Data 2001

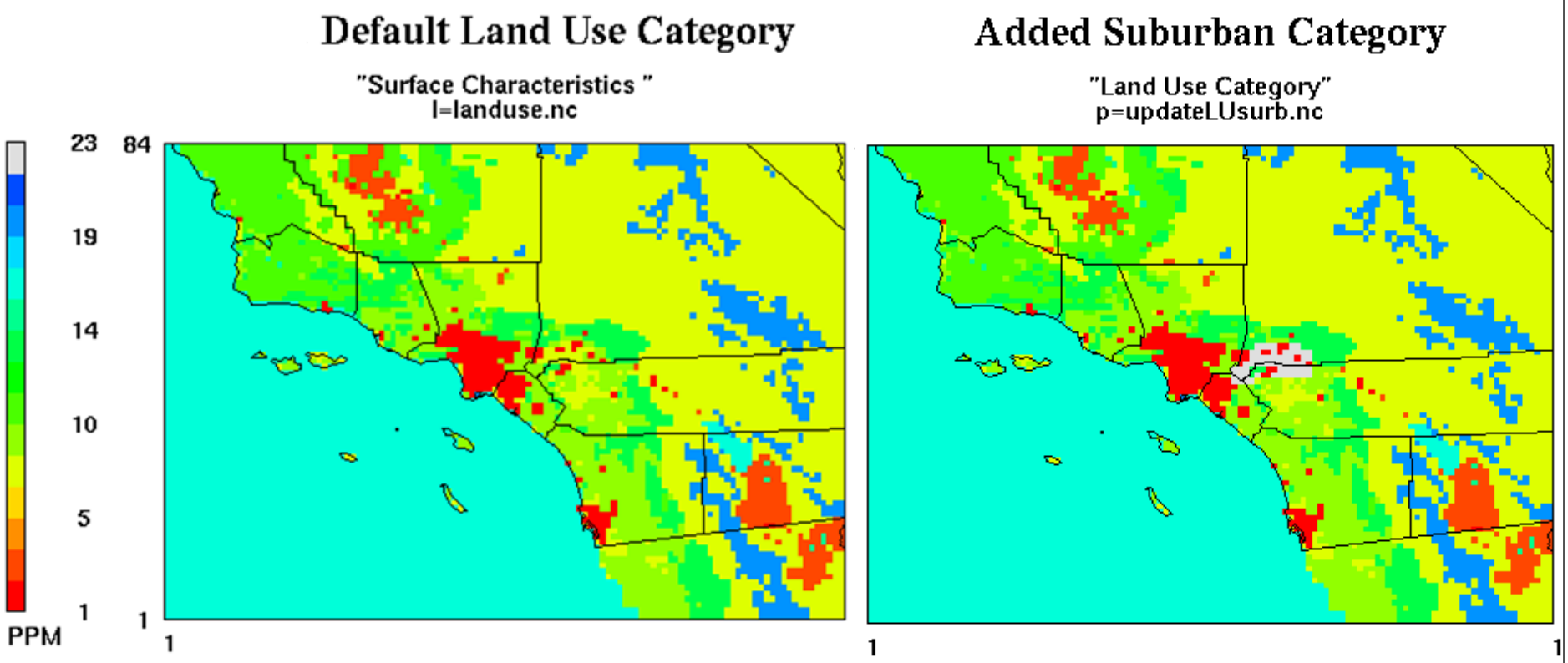


NOAA Southern Coastal California Land Cover/Land Use 2000

Available Land Cover Database

- USGS National Land Cover Database: 2001 & 2006
- Pacific Coast Land Cover from NOAA: 2001 & 2006
  - Developed – high intensity
  - Developed – medium intensity
  - Developed – low intensity
  - Developed – open space
- NOAA Southern Coastal California Land Cover/Land Use 2000
  - Commercial/industrial
  - High-intensity urban residential
  - Low-intensity urban residential
  - Suburban residential
  - Rural residential

Added Suburban Category



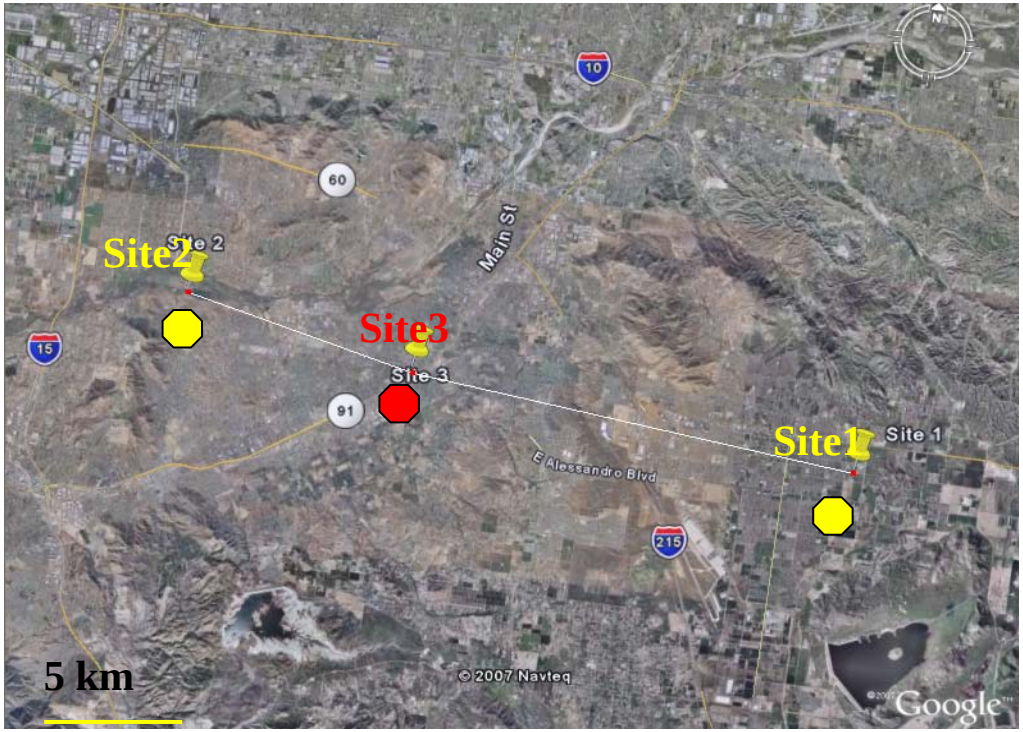
Surface Characteristics

- Soil moisture availability
  - Chen et al. 2001: additional term to account for water usage in urban area
  - TAPM simulation for LA area indicated the need to increase soil moisture content (paper in preparation).
- Surface roughness length
  - Average building height in suburban LA: 7-14 m (Grimmond and Oke, 1999)
- Albedo
- Surface Emissivity
- Thermal Inertia

Urban Energy Balance Experiment

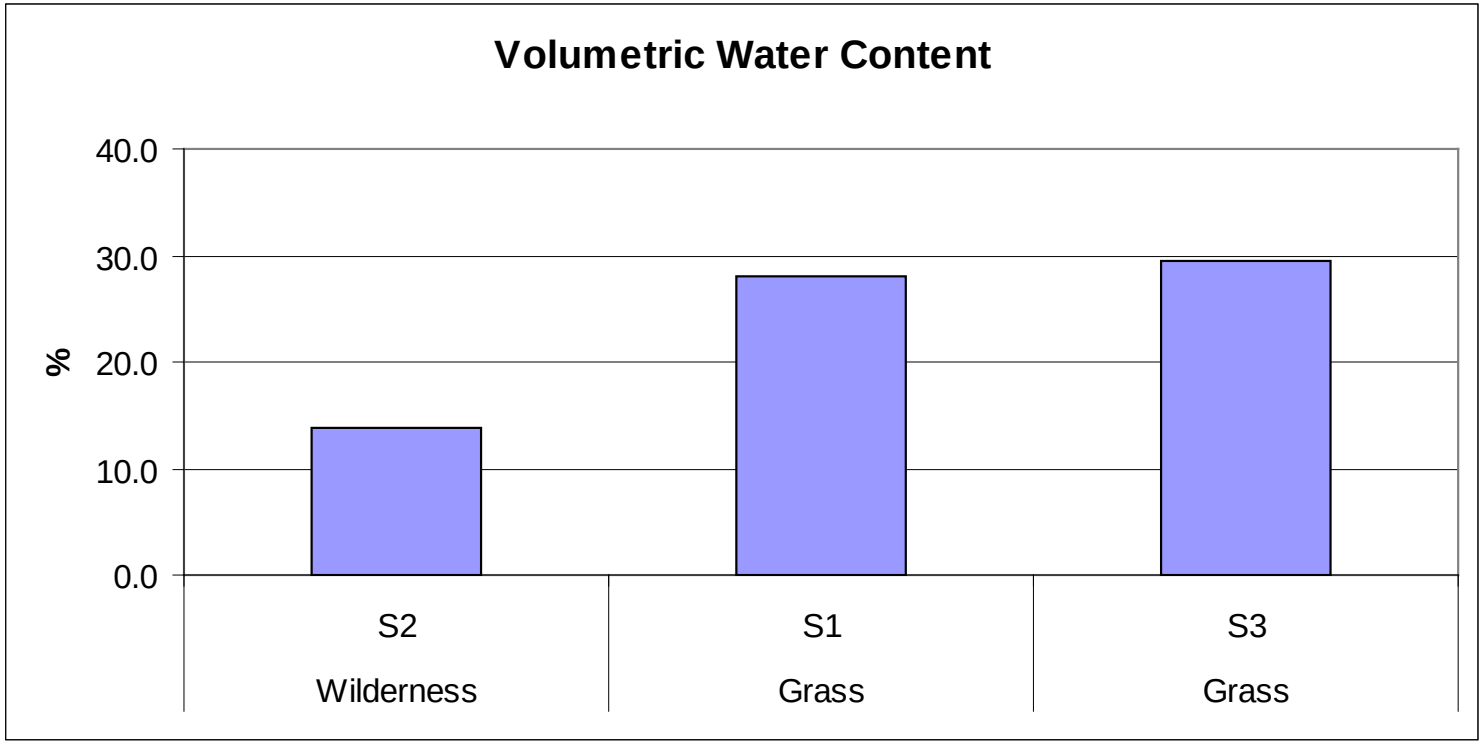
Riverside, CA in Apr 2007 (Princevac et al, 2007)

- Site 1:
  - Grass with irrigation
  - 18 km downstream of an urban
- Site 2:
  - Wilderness
  - 9 km upstream of an urban area
- Site 3:
  - Urban grass with irrigation



Riverside Urban Energy Balance Experiment

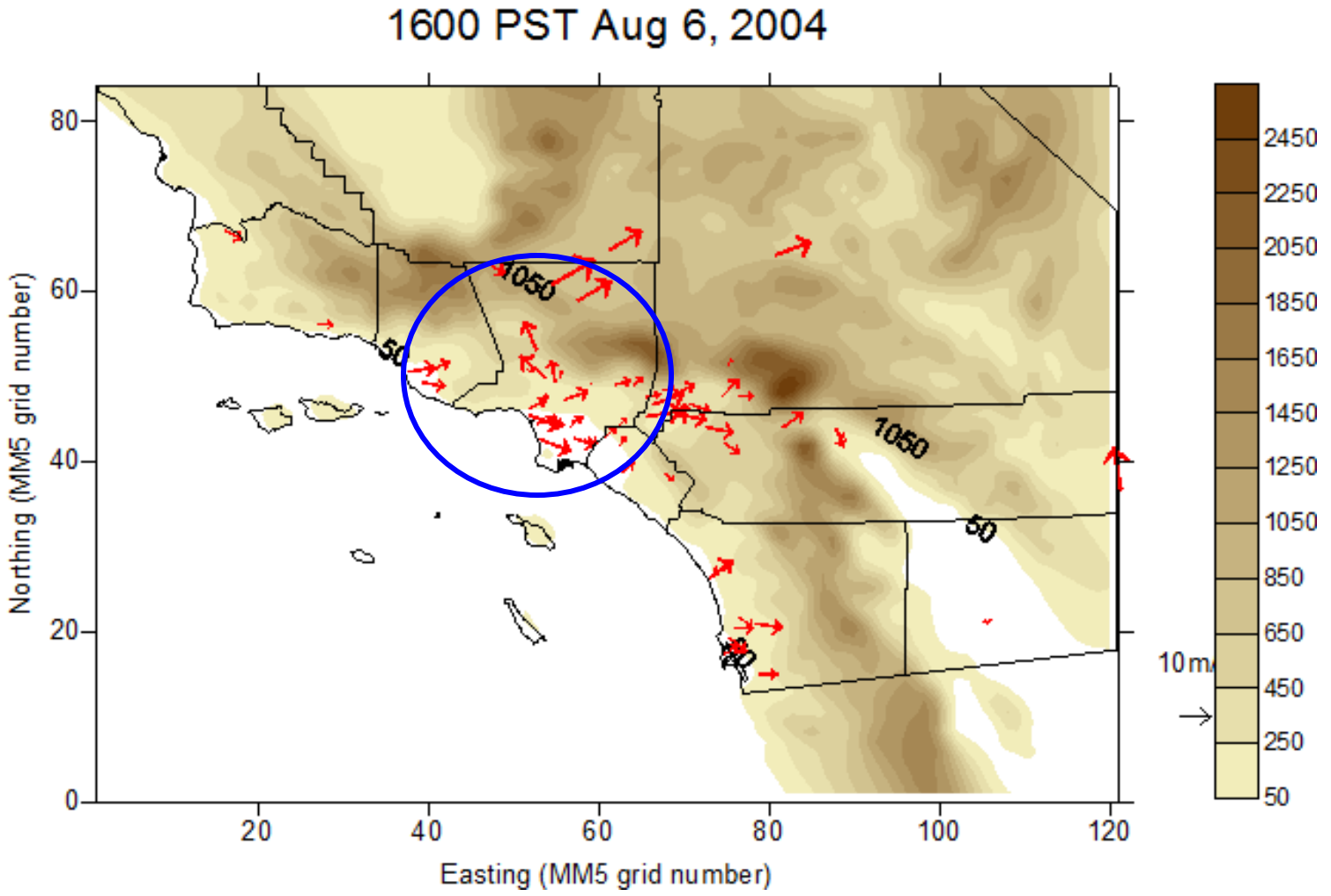
Averaged Volumetric Water Content



Physical Parameters

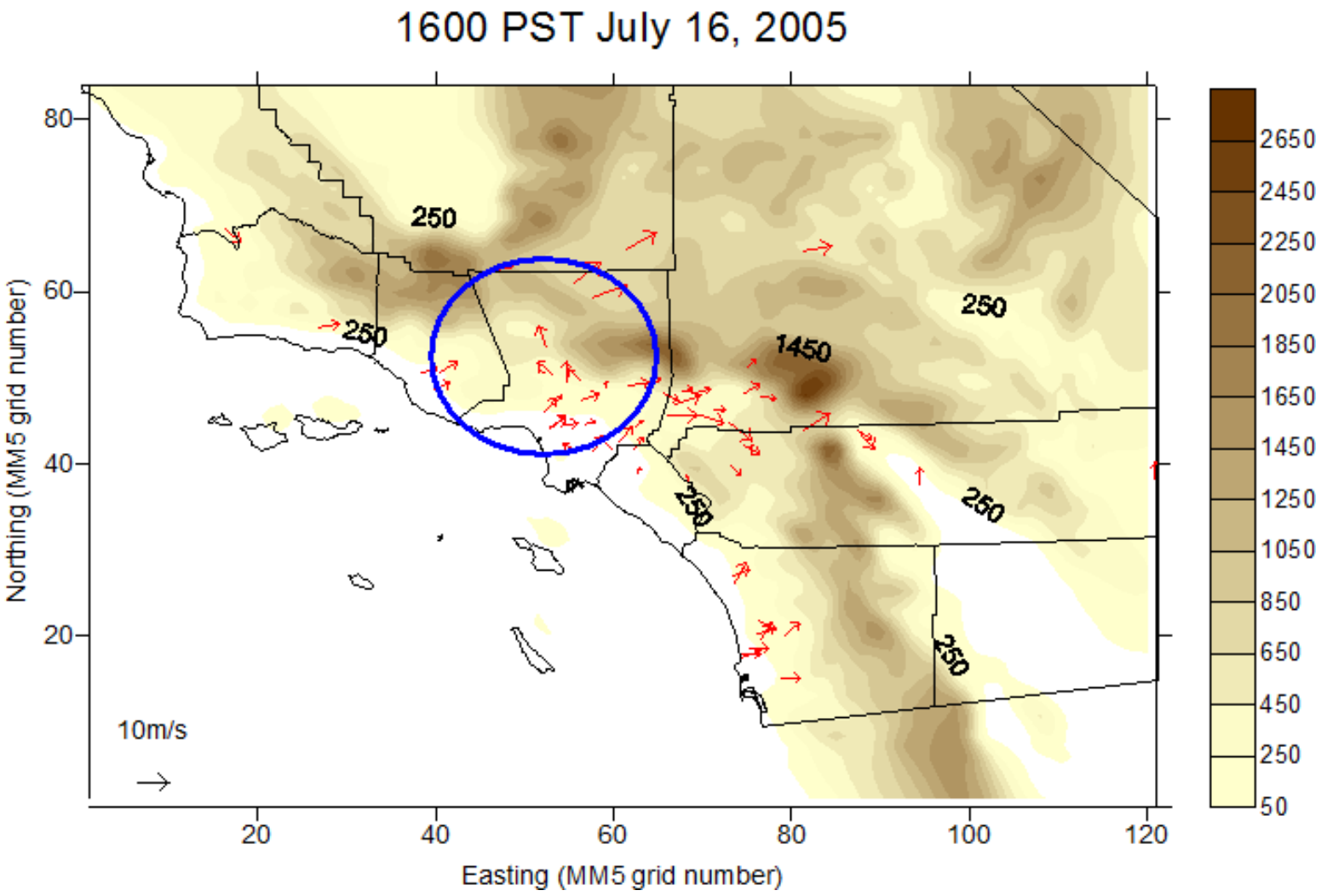
	Albedo	Soil Mositure Availability	Surface Emissivity	Surface Roughness Length	Thermal Inertia
	(%)	(%)	(% at 9 μm)	(m)	(cal cm-2 K-1s-1/2)
Urban	15	10	88	0.80 →1.50	0.03
Subruban	17	30	90	0.70	0.03
Grassland	19	15	96	0.12	0.03
Shrubland	22	10	90	0.10	0.03

Nudging observational wind field

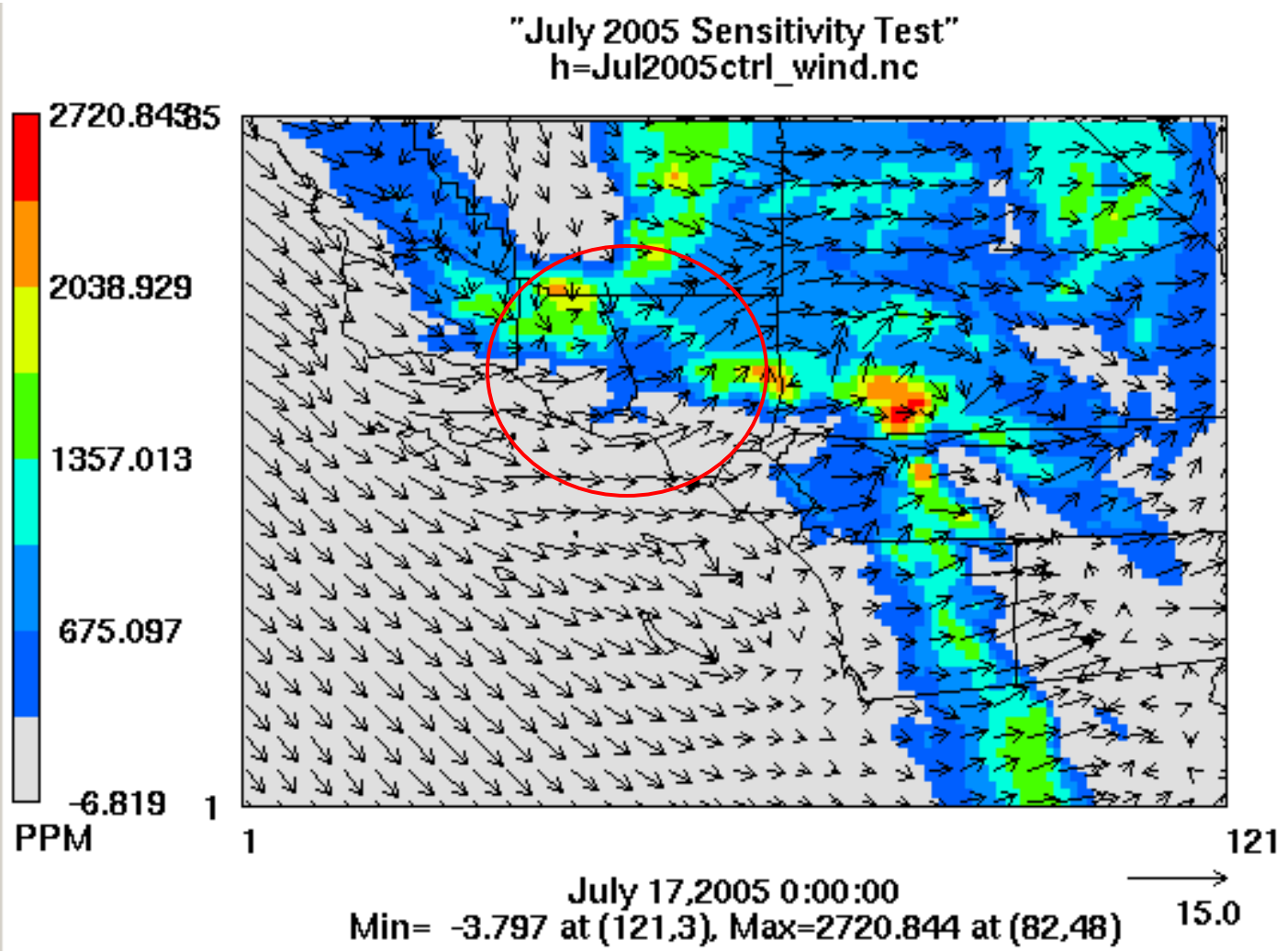


Modeling Results

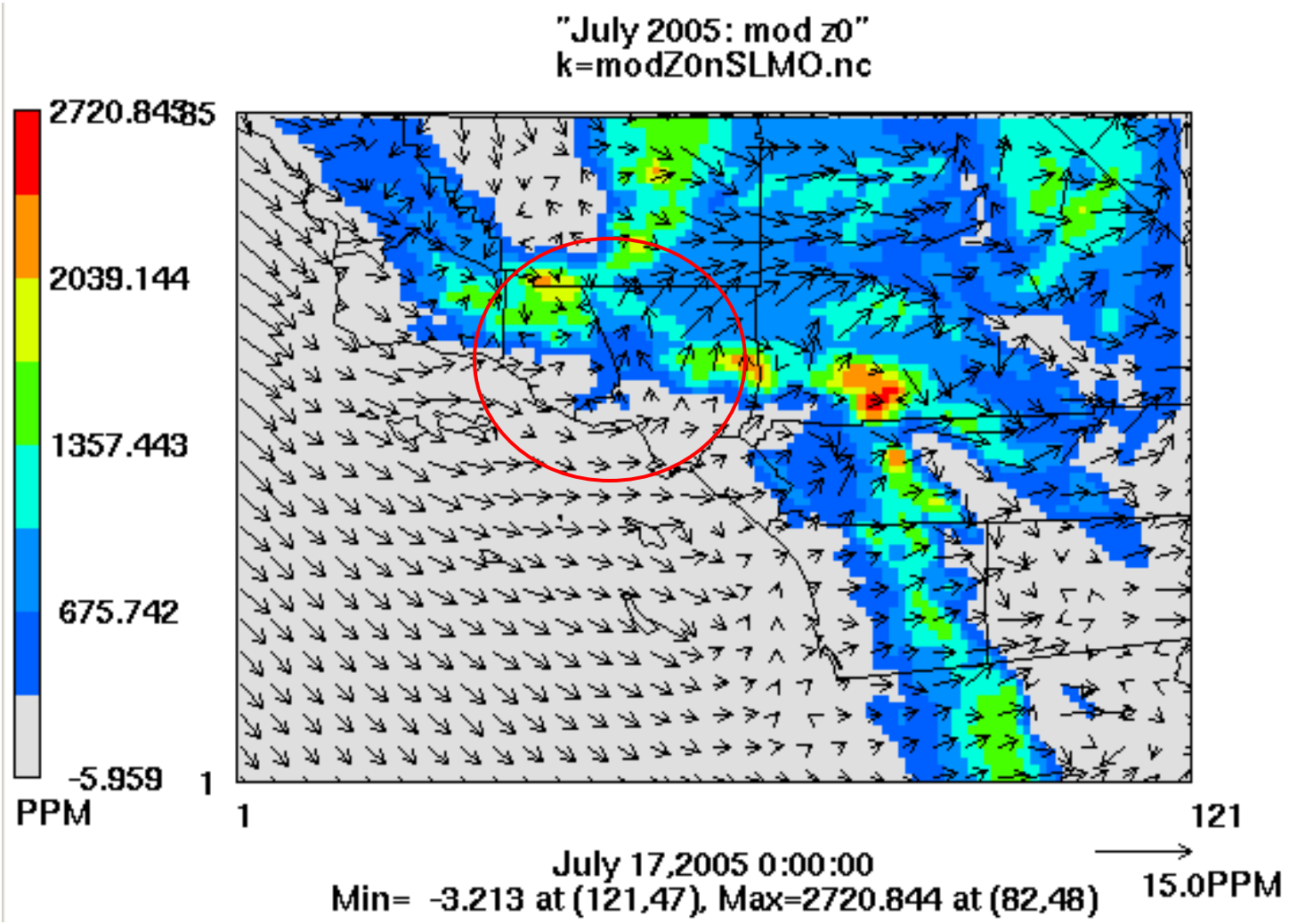
Observed Surface Wind Field



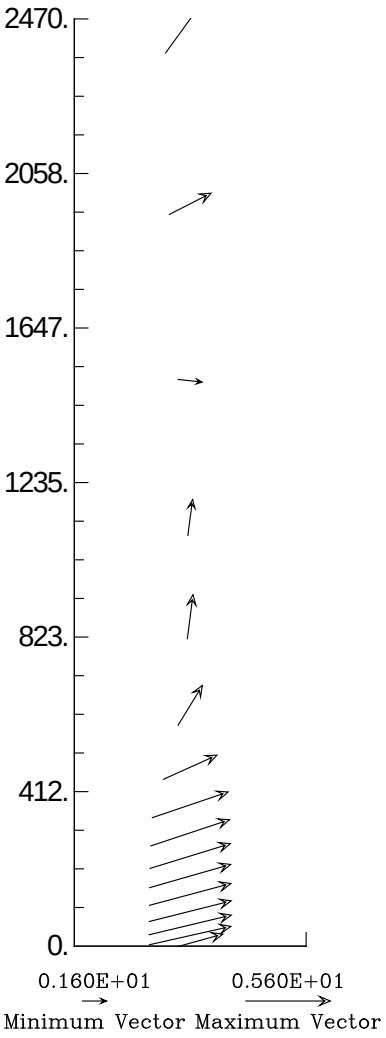
Default Run


"July 2005 Sensitivity Test"
h=Jul2005ctrl_wind.nc
2720.84385
2038.929
1357.013
675.097
-6.819
PPM
1
1
121
July 17,2005 0:00:00
Min= -3.797 at (121,3), Max=2720.844 at (82,48)
15.0

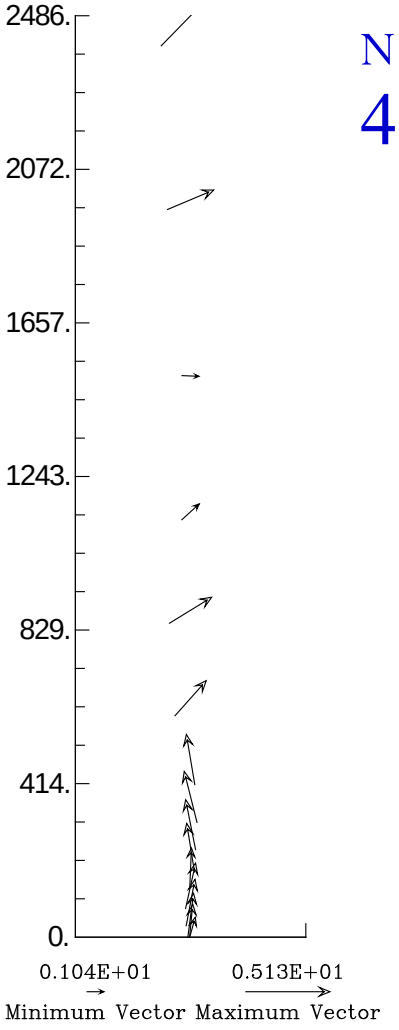
Modified Run



Predicted Wind Profiles:
0000 UTC July 17, 2005



Base

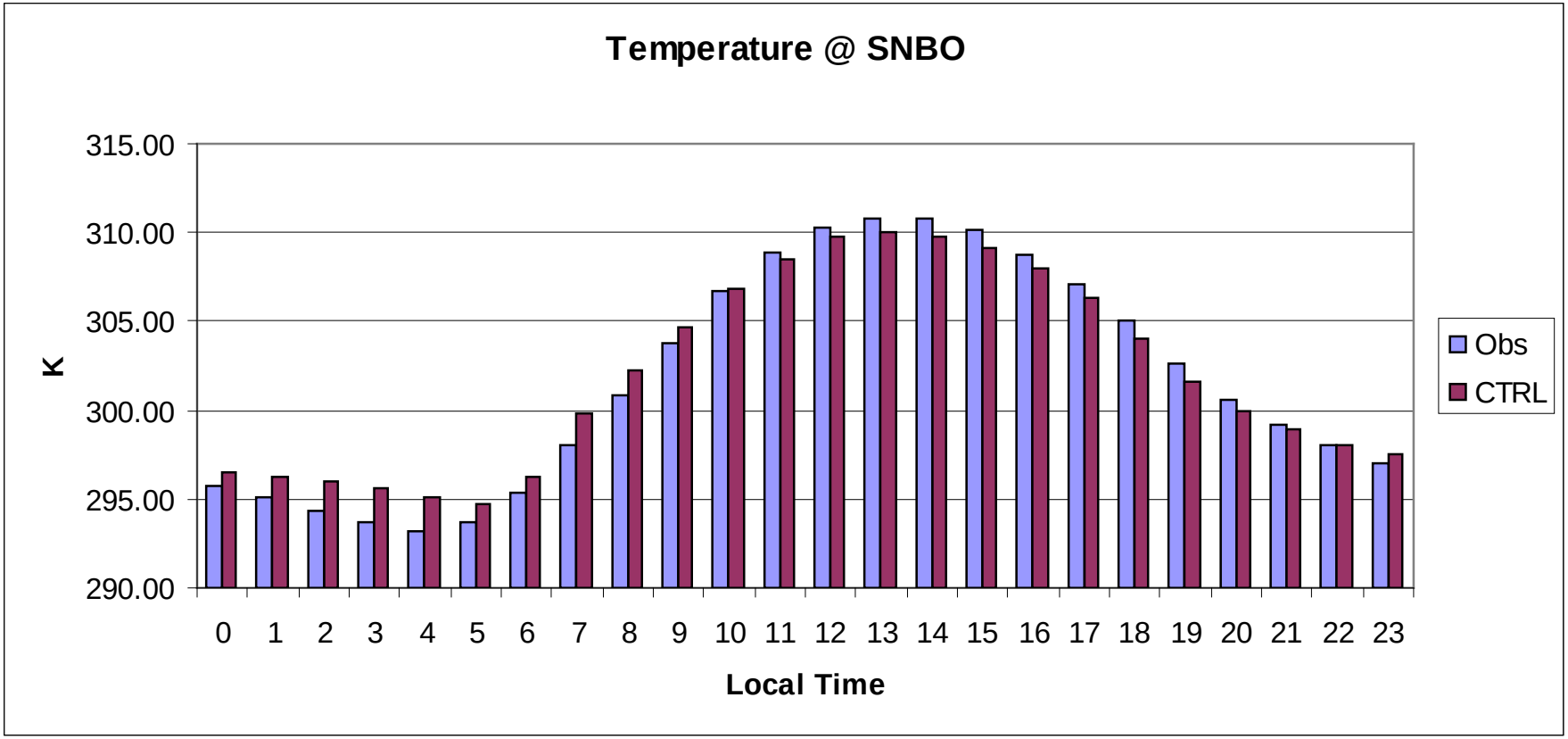


N

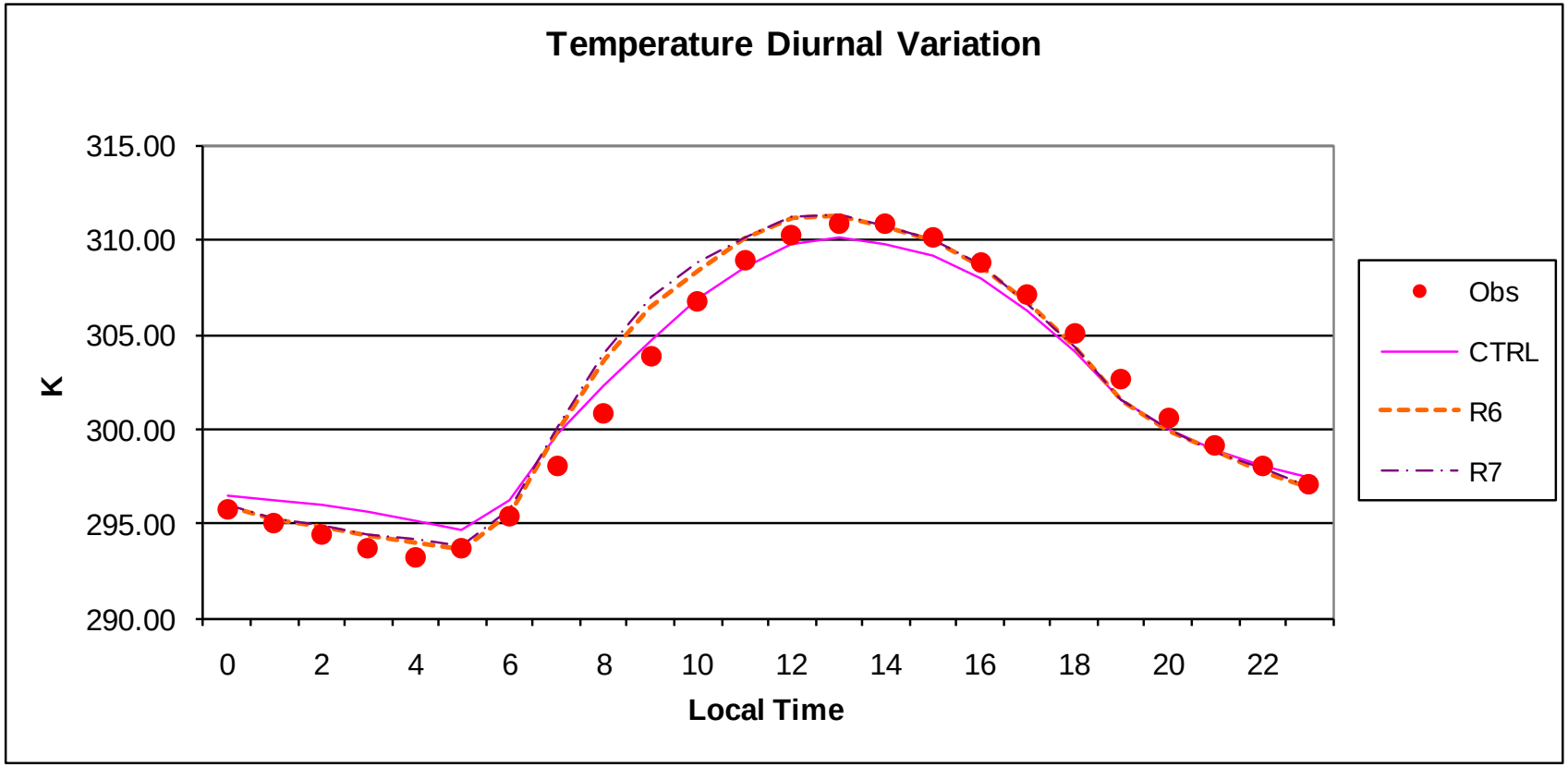
4

Modified

Diurnal Variation of Temperature

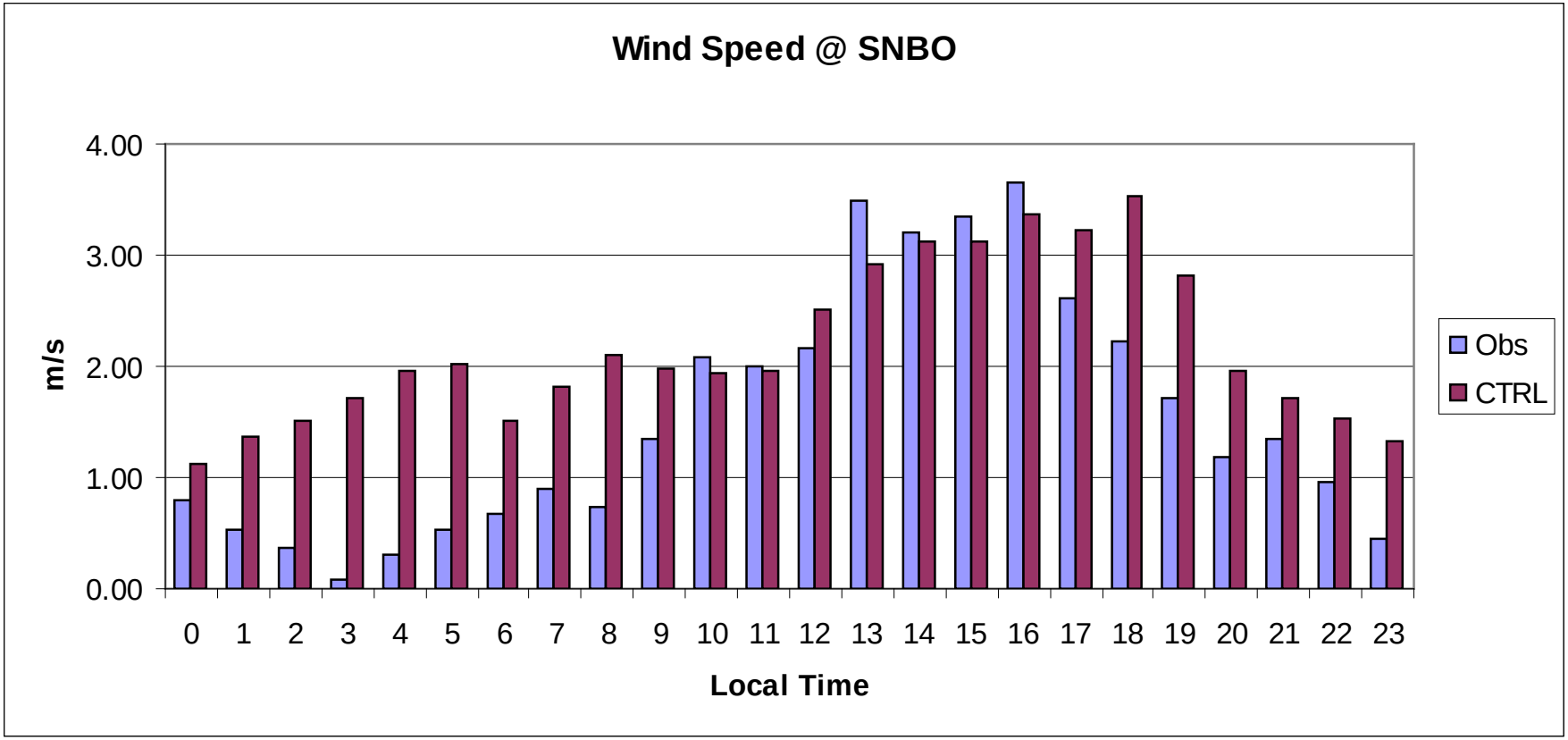


2 m Temperature at SNBO

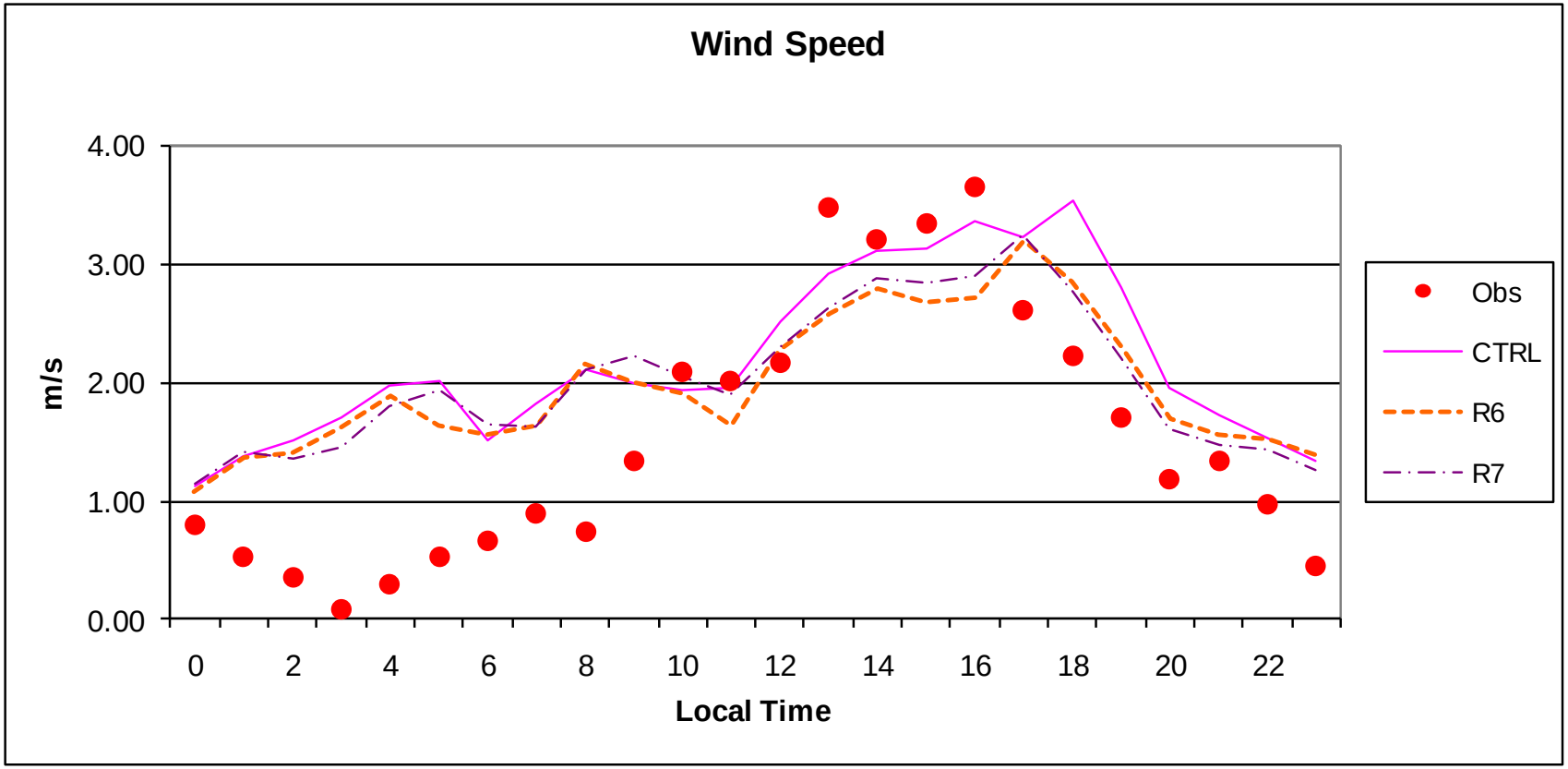


R6: Suburban, $z_{0\ urb}$ = 1.5 m, $z_{0\ suburb}$ = 0.7 m, $z_{0\ w}$ = 0.1 cm
R7: Expanded Urban, default LU params

Diurnal Variation of Wind



10 m Wind Speed at SNBO



R6: Suburban, $z_{0\ urb}$ = 1.5 m, $z_{0\ suburb}$ = 0.7 m, $z_{0\ w}$ = 0.1 cm
R7: Expanded Urban, default LU params

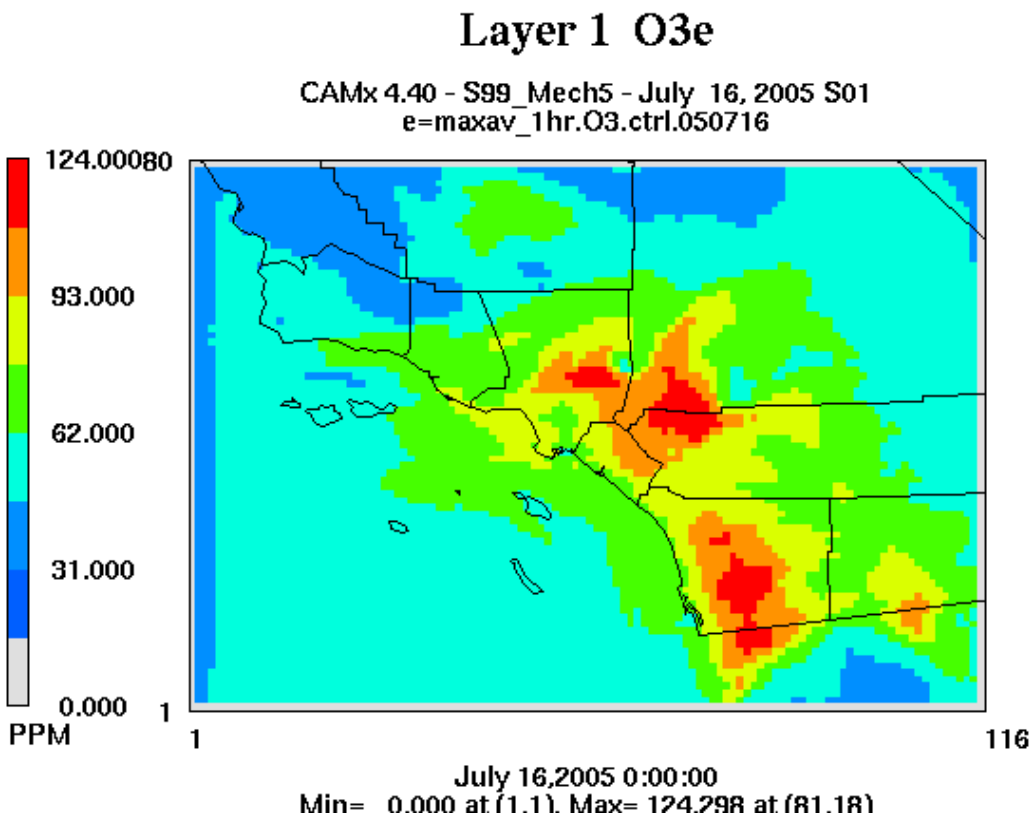
Air Quality Simulations

CAMx Configuration

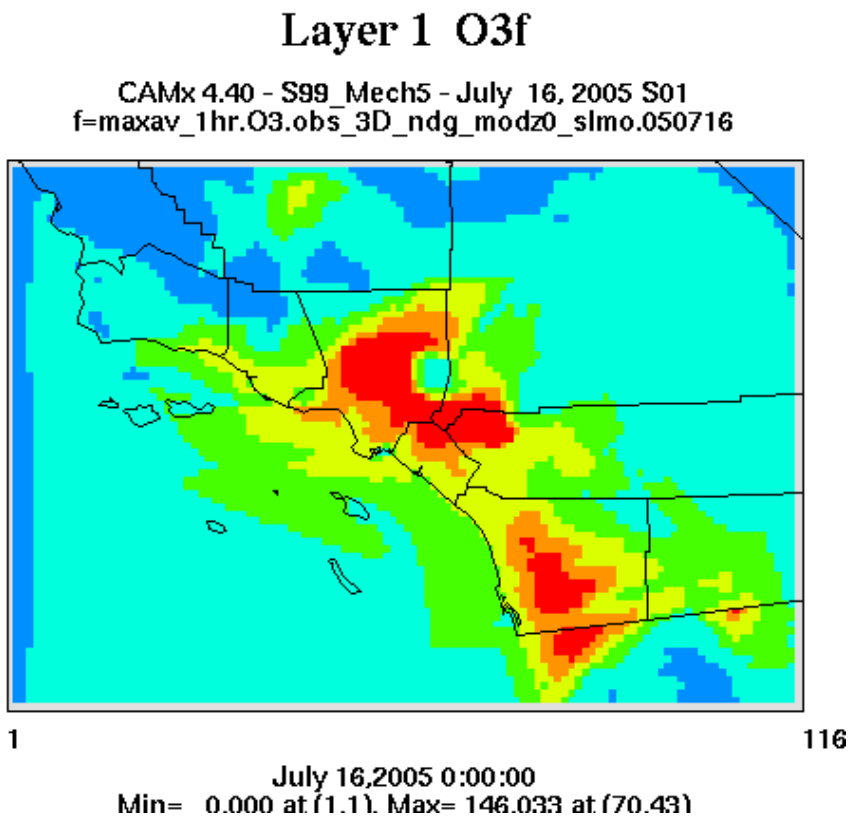
- CAMx/SAPRC99 version 4.4
- Number of grids: 116 X 80
- Horizontal grid spacing of 5 km
- Vertical layer collapsing: from 30 to 16 layers
  - The first layer approximately at 35 m agl
  - The domain top at 5000 m
- Vertical diffusivity: OB70 w/ Kv patch
- Minimum diffusivity coefficient = 1.0 m^2/s

Ctrl vs. Mod: Jul 2005 Case

Control Run

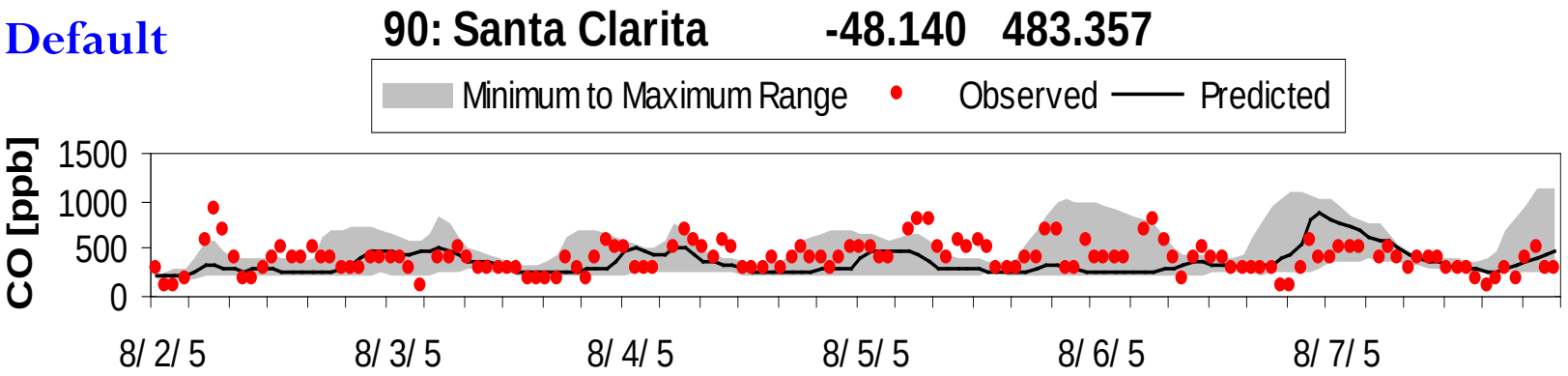


Modified Run

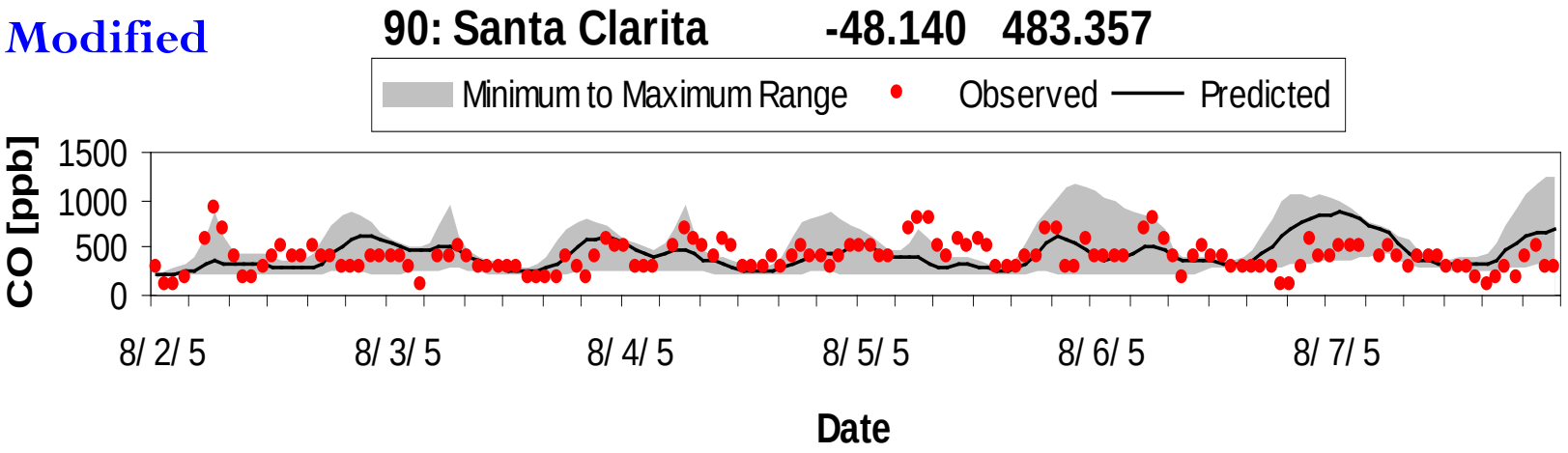


CO Timeseries: Santa Clarita Area

Default

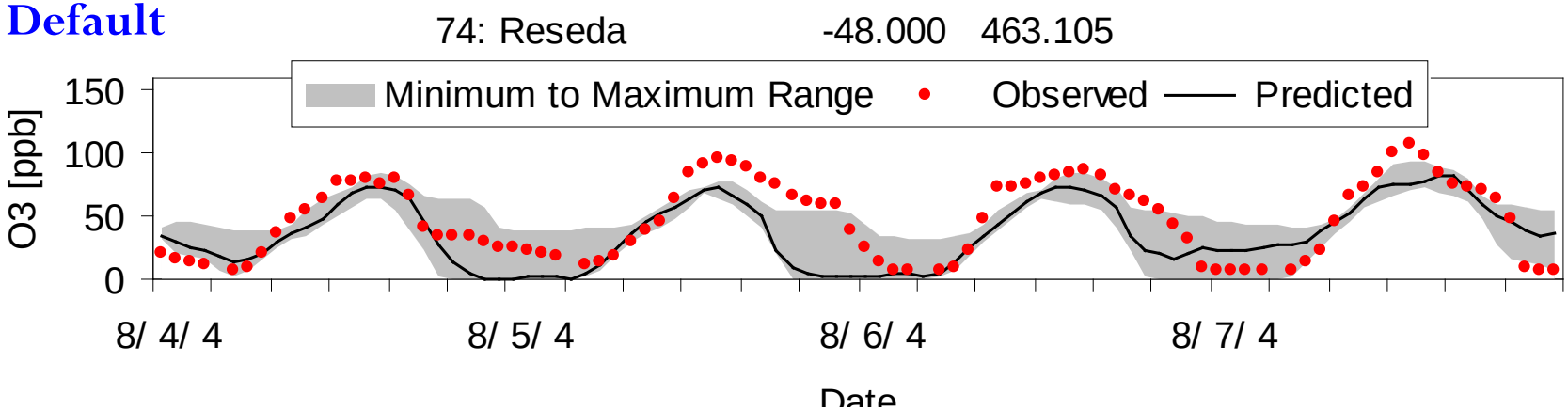


Modified

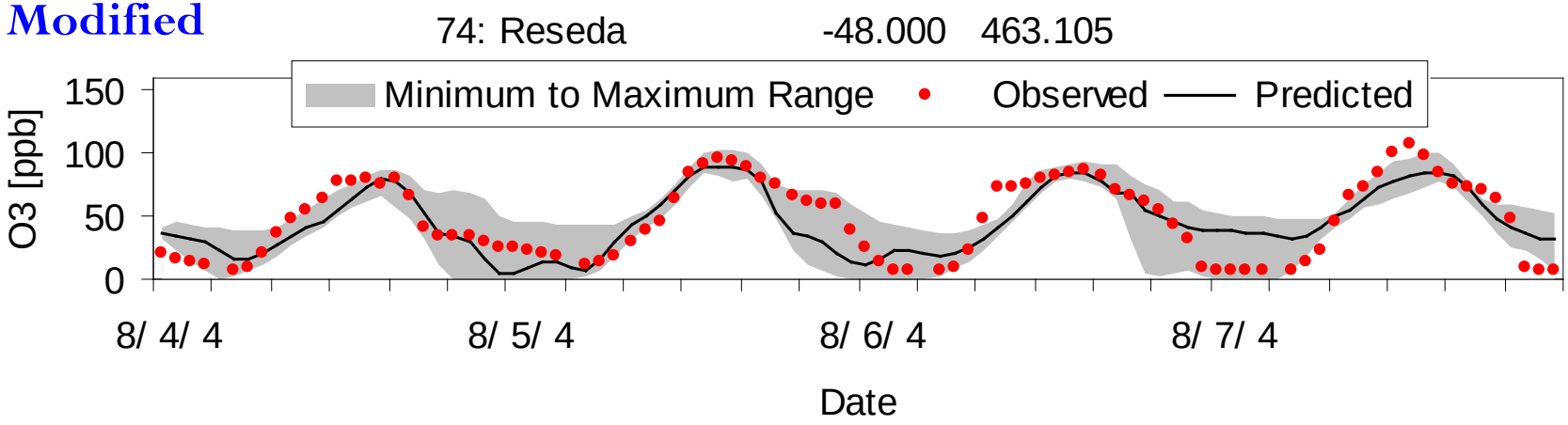


Ozone Timeseries: Santa Clarita

Default



Modified



Summary

- The methodologies used to improve flow turning toward Santa Clarita area were:
  - Updated land use with suburban category
  - Update soil moisture content
  - Surface observational nudging
- The modified run showed improved wind predictions and temperature diurnal variation.
- Air quality concentrations were better resolved by the improved wind fields.