CRPAQS TC Meeting 12/5/2005 Meteorology / Transport

Presented by:

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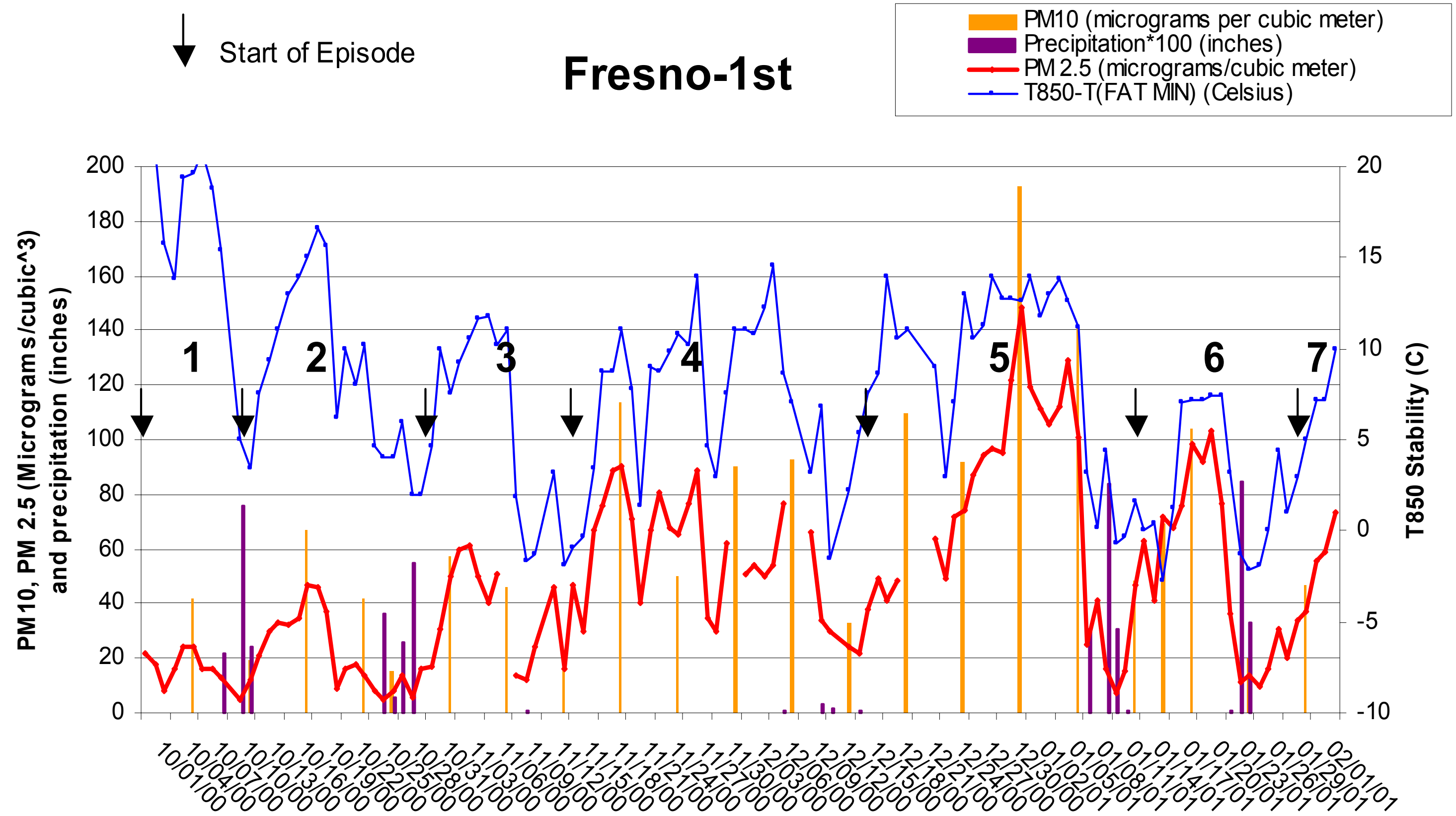
Overview

- CRPAQS Meteorological Analysis
- Task 3.3, Subtask 1 –Transport and Dispersion Under Light and Calm Winds
- Task 3.3, Subtask 3 – Measurements of Gustiness
- Task 3.3, Subtask 4 – Vertical Structure of Relative Humidity
- Task 3.3, Subtask 5 – Spatial and Temporal Extent of Fogs
- Task 5.2 - Transport and Dispersion During Wintertime Particulate Matter Episodes in the SJV

CRPAQS Meteorological Analysis –SJV District



CRPAQS Episode Event Table

Episode Number	Date	PM10* Maximum	PM2.5# Maximum	T850 Stability (^{0}C)	Minimum (^{0}F)	500 MB Height	Episode Duration (days)
1	10/1-10/12	42(6th)	24(6th)	2.4	63	578	**12**
2	10/13-10/30	67(18th)	47(18th)	6.8	54	578	18
3	10/31-11/15	57(2nd)	61(4th)	2.3	47	575	17
4	11/16-12/15	114(20th)	90(20th) 89(28th)	9.3(20th) 6.2(28th)	35(20th) 46(28th)	576(20th) 572(28th)	28
5	12/16-01/12	193(1st)	148(1st)	12.6	32	574	26
6	01/13-01/27	104(19th)	103(21st)	3.9(19th) 6.8(21st)	38(19th) 33(21st)	571(19th) 569(21st)	15
7	01/28-02/03	47(31st)	73(3rd)	3.9(31st) 6.1(3rd)	34(31st) 39(3rd)	568(31st) 580(3rd)	**7**

Episode Pattern Recognition

- Mid-Tropospheric ridges (850 and 925 MB) tend to indicate stable events
- 500 MB ridge off the West Coast, results in general subsidence
- Strong surface high positioned over the Intermountain Region, resulting in offshore flow
- Weak surface pressure gradient

Summary of Findings

- Long duration episodes
- Nitrate buildup
- Majority fine fraction
- Holiday carbon signature

Task 3.3, Subtask 1 – Transport & Dispersion Under Light and Calm Winds - T&B Systems

- Strong vertical wind gradients are present during light and calm winds.
- Air parcel trajectories "meander" over a 24 hour period within or very close to a radius of 43 km from the site.
- Angiola exhibited the greater up-valley and cross-valley flux most noticeable in the morning.
- During the afternoon, Lemoore was up-valley, whereas Visalia and Angiola measured down valley fluxes.

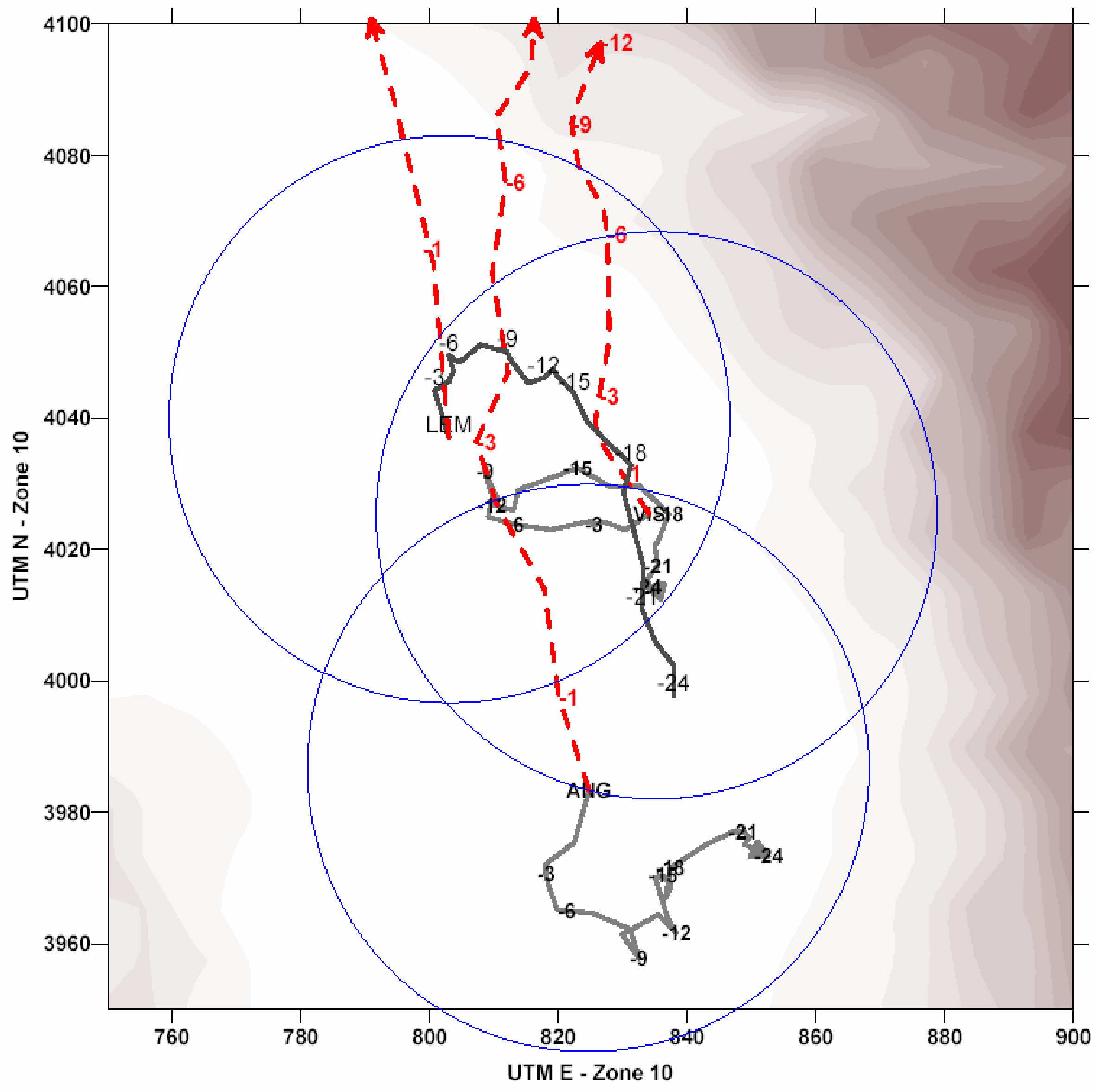


Figure 4. Air Parcel Backtrajectory at 220m-agl (black/solid lines) and 1000m-agl (red/broken lines) From Angiola and Visalia on January 8, 2001. (Labels are hours prior to end point. Circles depict an operational 24-hr trajectory uncertainty based on a maximum accuracy of 0.5 m/s)

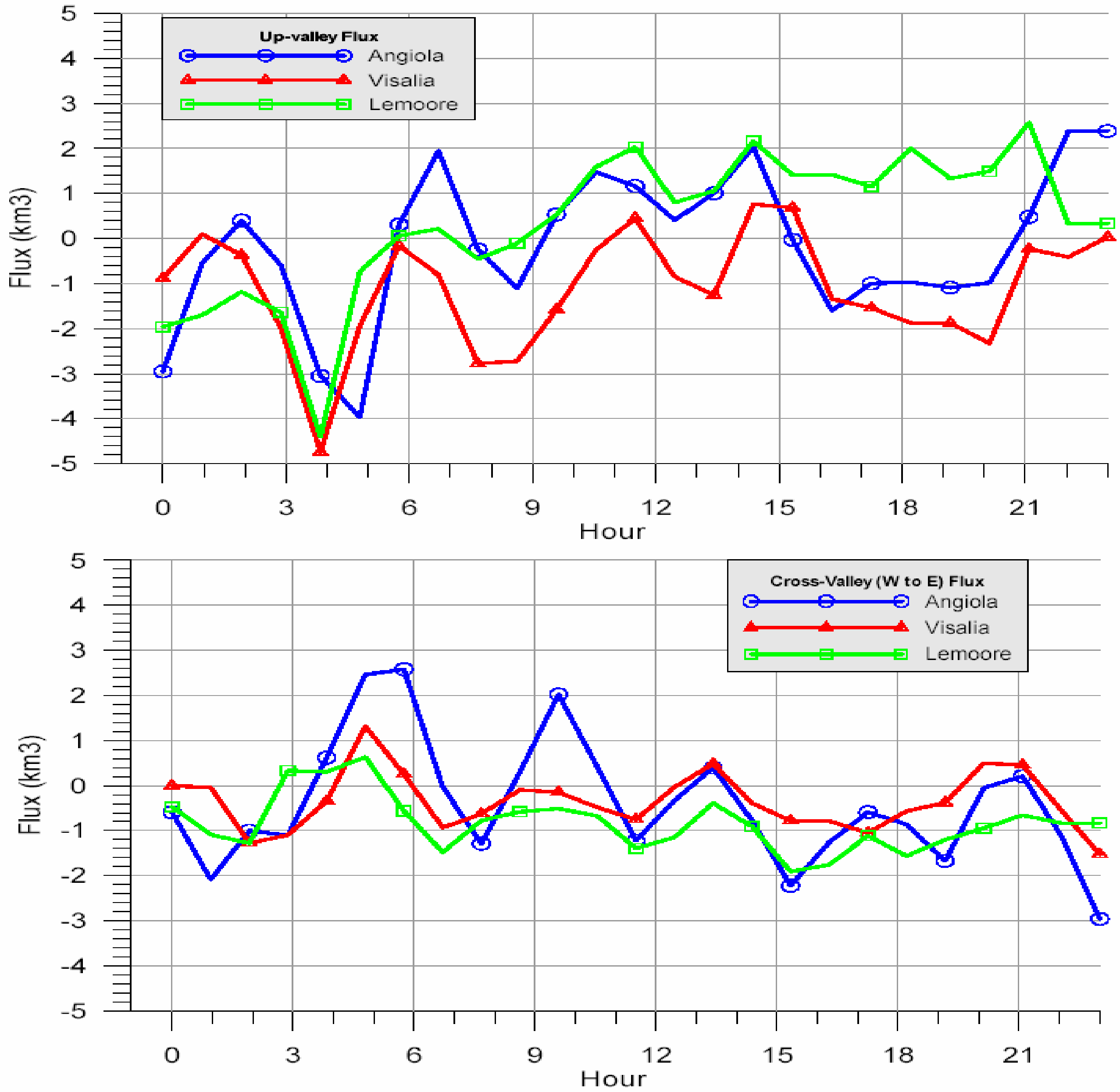


Figure 5. Diurnal Flux (Normalized) within Boundary Layer (<500m) on January 8, 2000
Along-Valley (top panel) and Cross-Valley (bottom panel)

Task 3.3, Subtask 3 – Measurement of Gustiness - T&B Systems

- Winds at speeds of approx. 8 m/s or greater can contribute to coarse particle concentrations.
- Wind Gustiness plays a relatively small role in generating fugitive dust.
- High wind speeds and gusts are rare in most of the CRPAQS study area.

Task 3.3, Subtask 3 – Measurement of Gustiness - T&B Systems

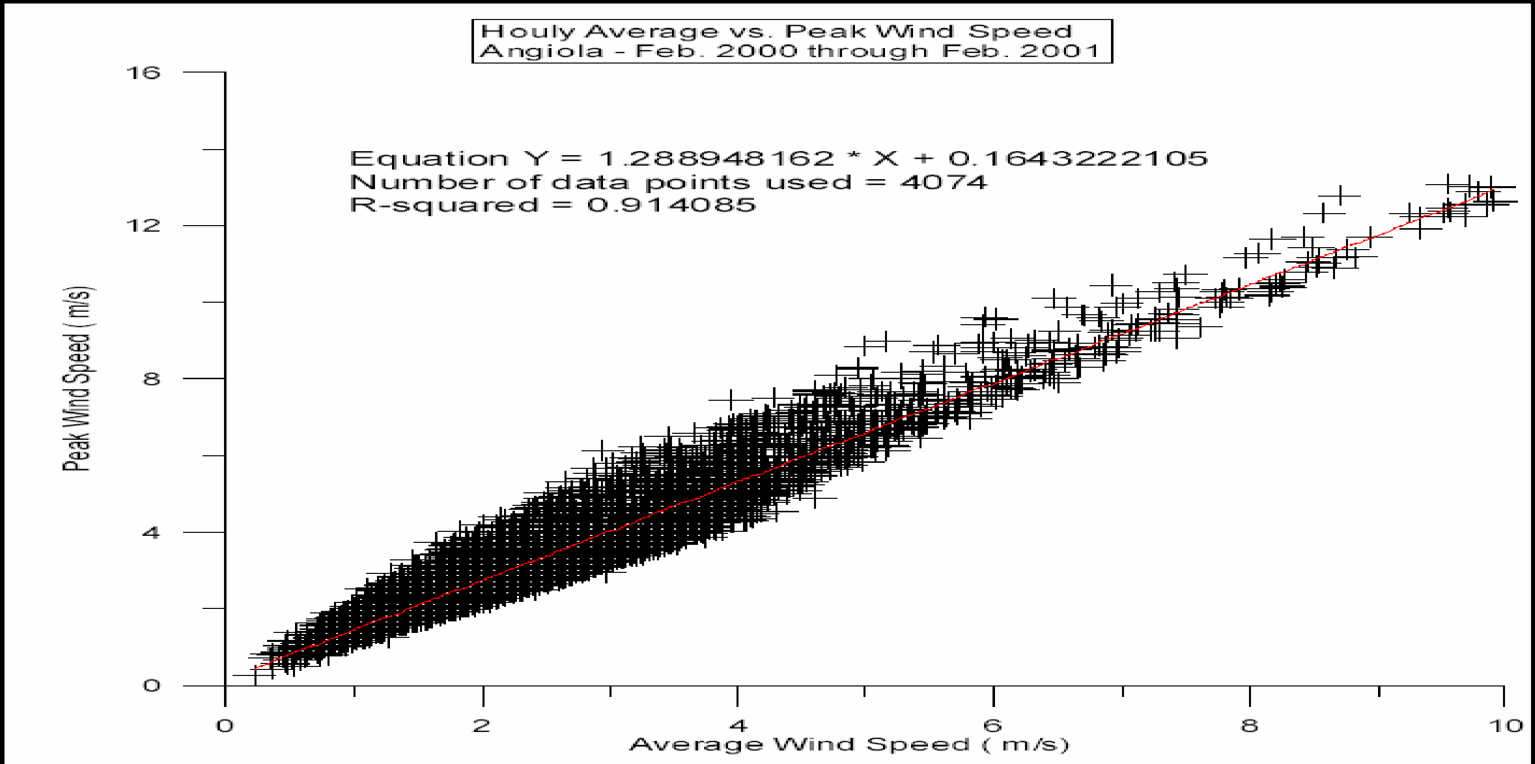


Figure 1. Comparison of Hourly Average Wind Speed and Peak Wind Speed

Wind Gusts are about 28% higher than average wind speed.

Table 1. Angiola Hourly Particulate Mass / Wind Speed Frequency Distributions

Coarse Mass	Average Hourly Wind Speed (m/s)										
ug/m^3	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10	Total
0 - 49	166	700	840	628	268	75	44	15	8	2	2746
50 - 99	27	120	196	191	61	27	13	11	3	4	653
100 - 149	5	14	23	30	4	2	5	3	3	3	92
150 - 199	1	2	6	4	2	2			5		22
200 - 249	1	1	1	2			1			1	7
250 - 299	2	1		2						1	6
300 - 349	1			1					1		3
350 - 399			1				1		1	1	4
800 - 849	1										1
Total	204	838	1067	858	335	106	64	29	21	12	3534
% > 100 ug/m^3	5.4%	2.1%	2.9%	4.5%	1.8%	3.8%	10.9%	10.3%	47.6%	50.0%	3.8%
Avg. Conc. (ug/m^3)	39.2	29.6	35.2	40.2	35.7	39.0	49.1	49.5	114.2	128.8	36.6

Coarse Mass	Hourly Wind Speed Gust (m/s)														
ug/m^3	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10	10 - 11	11 - 12	12 - 13	13 - 14	Total
0 - 49	28	383	672	676	416	259	170	69	43	14	9	4	1	2	2746
50 - 99	6	65	121	183	121	60	35	24	13	11	7	4	3		653
100 - 149	1	8	17	25	16	8		3	1	6	2	2	3		92
150 - 199	1		4	5	2	2	1	2			3	2			22
200 - 249	1	1	1	1		1				1			1		7
250 - 299	1	1	1	1	1								1		6
300 - 349	1				1							1			3
350 - 399			1							1			1	1	4
800 - 849	1														1
Total	40	458	817	891	557	330	206	98	57	33	21	13	10	3	3534
% > 100 ug/m^3	15.0%	2.2%	2.9%	3.6%	3.6%	3.3%	0.5%	5.1%	1.8%	24.2%	23.8%	38.5%	60.0%	33.3%	3.8%
Avg. Conc. (ug/m^3)	74.4	29.0	32.2	37.3	37.9	37.4	34.0	41.7	35.7	70.4	70.5	103.9	147.2	139.0	36.6

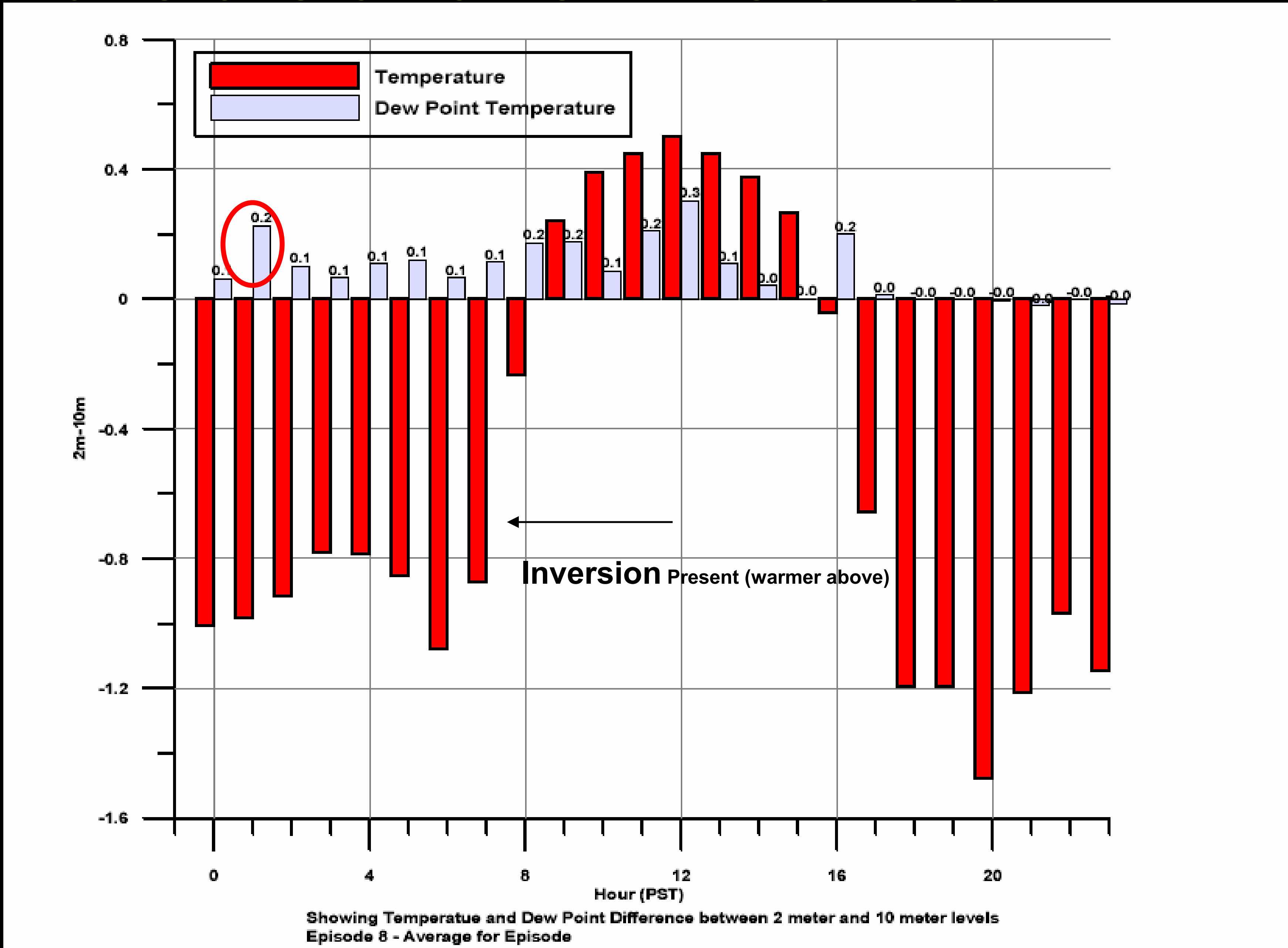
Fine Mass	Average Hourly Wind Speed (m/s)										
ug/m^3	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10	Total
0 - 49	163	712	1005	839	332	103	64	29	21	12	3280
50 - 99	33	100	48	14	2	3					200
100 - 149	8	23	14	4	1						50
150 - 199		3		1							4
Total	204	838	1067	858	335	106	64	29	21	12	3534

Fine Mass	Hourly Wind Speed Gust (m/s)														
ug/m^3	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10	10 - 11	11 - 12	12 - 13	13 - 14	Total
0 - 49	33	372	711	845	553	329	204	96	57	33	21	13	10	3	3280
50 - 99	7	65	86	34	3	1	2	2							200
100 - 149		20	18	11	1										50
150 - 199		1	2	1											4
Total	40	458	817	891	557	330	206	98	57	33	21	13	10	3	3534

Task 3.3, Subtask 4 – Vertical Structure of Relative Humidity - T&B Systems

- RH was generally the lowest during the daytime in response to warmer ambient temperatures.
- By late in the afternoon, RH increased to values often in the 90 – 100 % range from midnight to daybreak.
- RH in the lower 10 meters is relatively constant during the day when the layer is well mixed.

Bakersfield Tower Differences



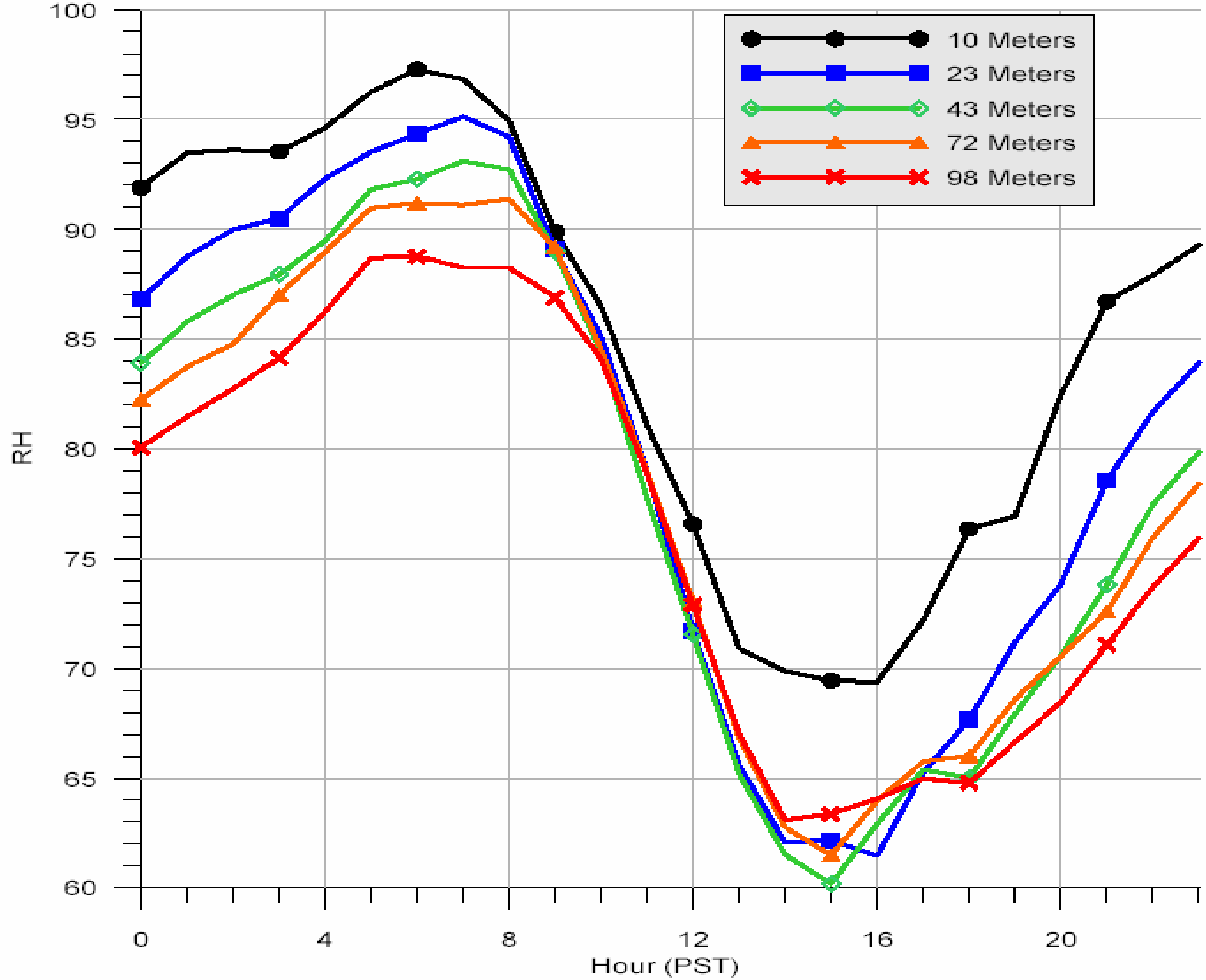


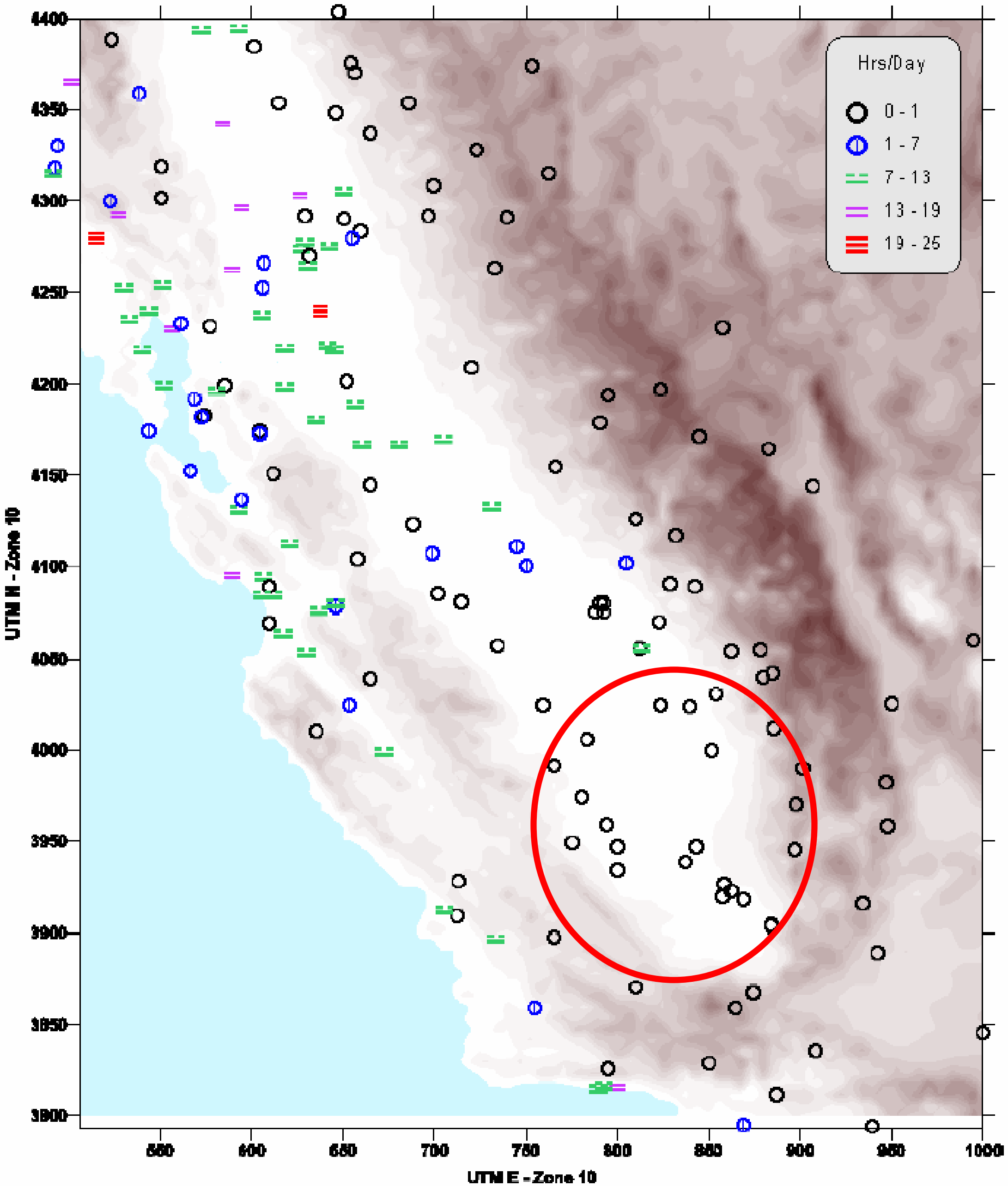
Figure 3. Average Diurnal Relative Humidity Measured on Angiola Tower December 2000, excluding storm events

Task 3.3, Subtask 5 – Spatial and Temporal Extent of Fogs - T&B Systems

- Presence of fog when surface relative humidity exceeded 95 %
- Significant differences between the CRPAQS Winter Intensive Operating Periods.
- Any direct relationship between PM loading and fog intensity and area distribution was not evident.
- RH was generally lower on the days when the highest PM levels were observed.

Task 3.3, Subtask 5 – Spatial and Temporal Extent of Fogs - T&B Systems

- 12/15 – 12/18: RH infer that fog was extensive, except in Bakersfield where fog occurred only occasionally.
- 12/26 –12/28: From Angiola north, fog was frequent, with light fog in the southern SJV
- 01/04 – 01/07: Sporadic in the southern half of the Valley, where PM loading was the greatest. Extensive heavy fog in the Delta.
- 01/31-02/03: moderate to persistent fog was evident in Modesto / Merced areas, in the Sierra foothills, and Tulare Lake basin.



Number of Hours Rh > 95 Percent 1/7/01

Needs further discussion. – T&B Systems

- 1- Transport and dispersion under light and calm winds – did not examine a period within one of the CRPAQS winter intensives because Lemoore wind profiler was not operational.
- 4- Vertical Structure of Relative Humidity – The RH was not analyzed for low RH days.

Since the CRPAQS data base does not include sensor height above the ground and RH sensors are not mounted at any standard height, a comparison amongst various sites was not conducted.

Needs further discussion. (Part 2) – T&B Systems

- 5- Spatial and Temporal Extent of Fogs – High resolution satellite pictures were not obtained real-time during the field study, and were cost-prohibited after the fact; could not determine the occurrence of fog.

  Limitation of determining the relationship between PM loading, fog intensity, and areal distribution through chart comparison.

- What changes are needed in long-term and short-term meteorological monitoring?

Task 5.2 - Transport and Dispersion During Wintertime Particulate Matter Episodes in the SJV – STI

1. Does inter-basin or intra-basin transport of pollutants occur during PM episodes?
2. What is the relationship between synoptic- and regional-scale meteorology and inter- and intra-basin wintertime transport?
3. How do primary particles generated in urban areas arrive in non-urban areas and in other downwind urban areas under low wind speed / stagnant conditions?

Task 5.2 - Transport and Dispersion During Wintertime Particulate Matter Episodes in the SJV - STI

4. Do nocturnal jets and eddy circulations exist during wintertime PM episodes and do they play a role in dispersing material throughout the SJV?
5. How does the diurnal evolution of boundary layer height (e.g., mixing height), winds, and ventilation vary during episodes and non-episodes and in different regions of the SJV?

Task 5.2, 1. Does inter-basin or intra-basin transport of pollutants occur during PM episodes?

Trajectory and Dispersion analysis showed:

- Little inter-basin transport occurred between the north, central, and south SJV.
- Intra-basin transport was strongest in the NV and Sacramento sub-regions, with trajectories showing transport across the Delta to the SFBA. NO evidence of transport from the SFBA into the SJV

Figure 9. Twenty-four hour forward trajectories initialized twice daily at 35 m agl from (a) December 25, 2000, at 0600 PST through December 29, 2000, at 0600 PST and (b) January 4, 2001, at 0600 PST through January 8, 2001, at 1500 PST.

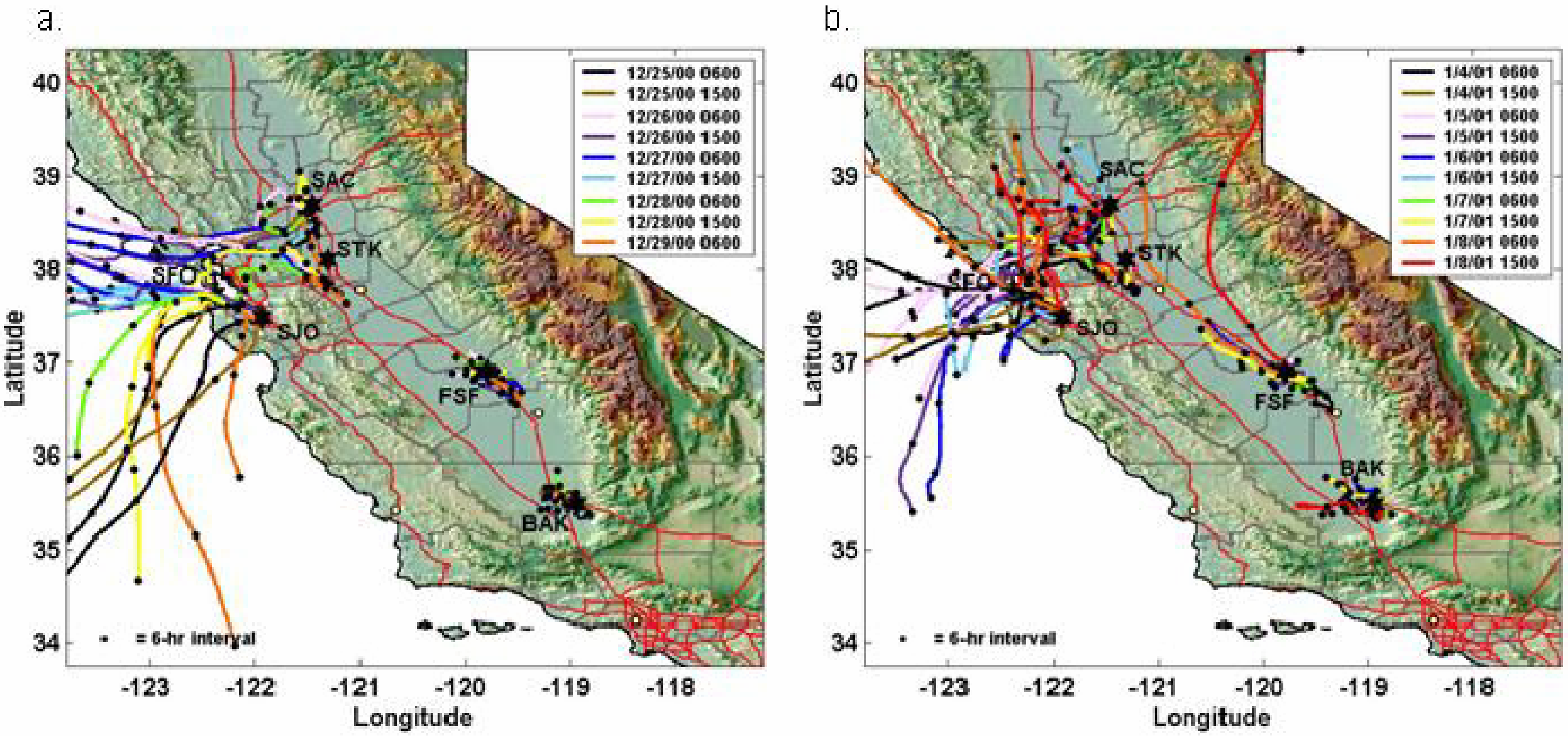


Figure 10. Twenty-four hour forward trajectories initialized twice daily at 450 m agl from (a) December 25, 2000, at 0600 PST through December 29, 2000, at 0600 PST and (b) January 4, 2001, at 0600 PST through January 8, 2001, at 1500 PST.

Task 5.2, 2. What is the relationship between synoptic- and regional-scale meteorology and inter- and intra-basin wintertime transport?

- Direct relationship – An upper level ridge of high pressure dominating the upper-air weather pattern on episode days in the northern, middle, and southern SJV for 91%, 68%, and 76% of the time, respectively.

Task 5.2, 3. How do primary particles generated in urban areas arrive in non-urban areas and in other downwind urban areas under low wind / stagnant conditions?

- Observational data show that PM2.5 concentrations can be high throughout the entire SJV, including rural areas.
- The meteorological and dispersion modeling of emissions from the five largest population centers does not fully address this regional nature.
- Motor vehicle emissions outside the five major populations centers, as well as emissions from smaller cities, industrial sources, and agricultural activities, are likely contributors to the widespread occurrences of elevated PM2.5 concentrations.

Task 5.2, 4. Do nocturnal jets and eddy circulations exist during wintertime PM episodes and do they play a role in dispersing material throughout the SJV?

- There was no evidence of strong nocturnal jets or eddy circulations significantly influencing pollutant transport in the SJV.

Task 5.2, 5. How does the diurnal evolution of boundary layer height (e.g., mixing height), winds, and ventilation vary during episodes and non-episodes and in different regions of the SJV?

- On non-episode days, the mean boundary layer winds were approx. double those measured on episode days.
- Mean daily mixing heights were lower on episode days than on non-episode days from approximately 0900-1700 PST.
- The peak afternoon mixing heights, which occurred between 1400-1500 PST, were approximately 1.5 to 2 times higher on non-episode days than on episode days.

Task 5.2, 5. How does the diurnal evolution of boundary layer height (e.g. mixing height), winds, and ventilation vary during episodes and non-episodes and in different regions of the SJV?

- On non-episode days, the mean boundary layer winds were approx. double those measured on episode days and exhibited more consistent diurnal pattern compared to episode days.
- Resulting ventilation index was 2.5 to 4 times greater on non-episode days compared to episode days.

Figure 4. Mean diurnal mixing heights on episode and non-episode days for the NV, MV, and SV from November 15, 2000, through January 31, 2001.

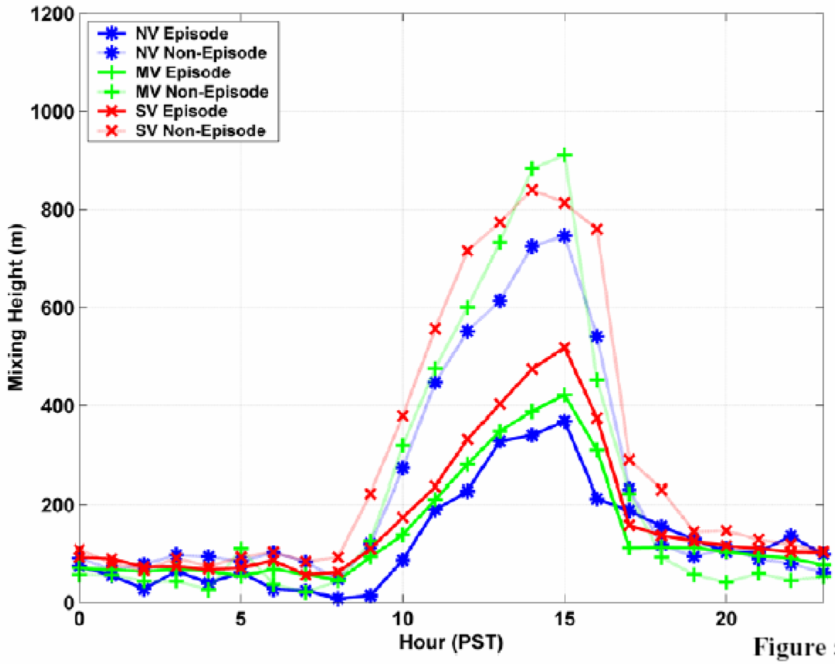
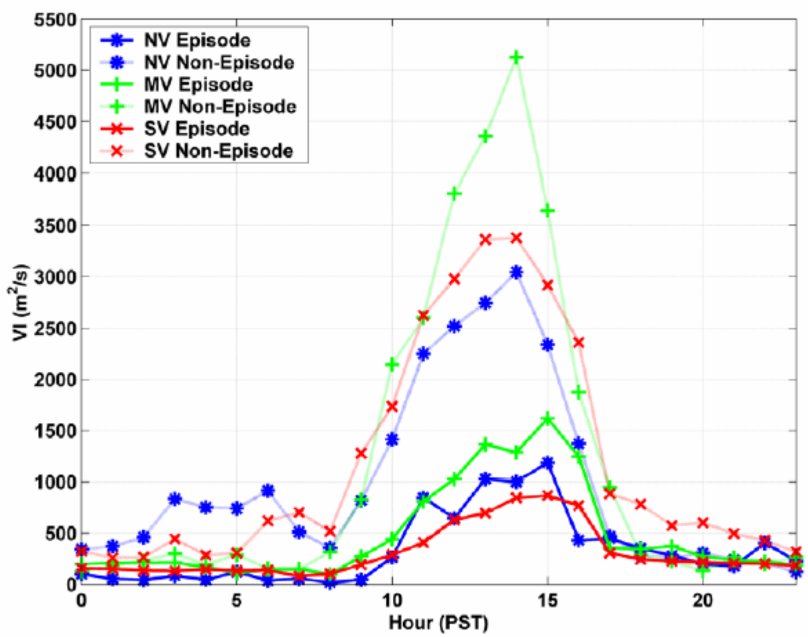


Figure 5. Mean diurnal ventilation index on episode and non-episode days for the NV, MV, and SV from November 15, 2000, through January 31, 2001.



Needs further discussion. – STI

- What is the role of advection versus diffusion under low wind conditions?
- What is the limitation of using T(v) – Virtual Temperature in gauging mixing heights / depths?
- The meteorological and dispersion modeling of emissions from the five largest population centers does not fully address the regional nature of PM2.5.

Needs further discussion. (Part 2) – STI

- How did the trajectory analysis account for terrain?

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