Effects of Different Meteorological Treatments on Inventory MOVES – Virginia Examples

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MARAMA MOVES Workgroup conference call
September 10, 2013

Background

- Georgia (Di Tian/James Boylan) presented on August 12th MARAMA MOVES Workgroup call a study on emissions using MOVES inventory mode with different meteorological inputs
- Follow-up studies are needed to see whether similar conclusions can be drawn for other geographical regions and meteorological regimes

Approach

- **Follow GA study with VA county-specific 2011 MOVES inputs**
- **Expand the study scope to include three major VA counties and six different months in 2011**
- **Obtain detailed (hourly) meteorological data from NCDC/NOAA Integrated Surface Data – Lite (ISD) website** http://www.ncdc.noaa.gov/oa/climate/isd/index.php?name=isd-lite

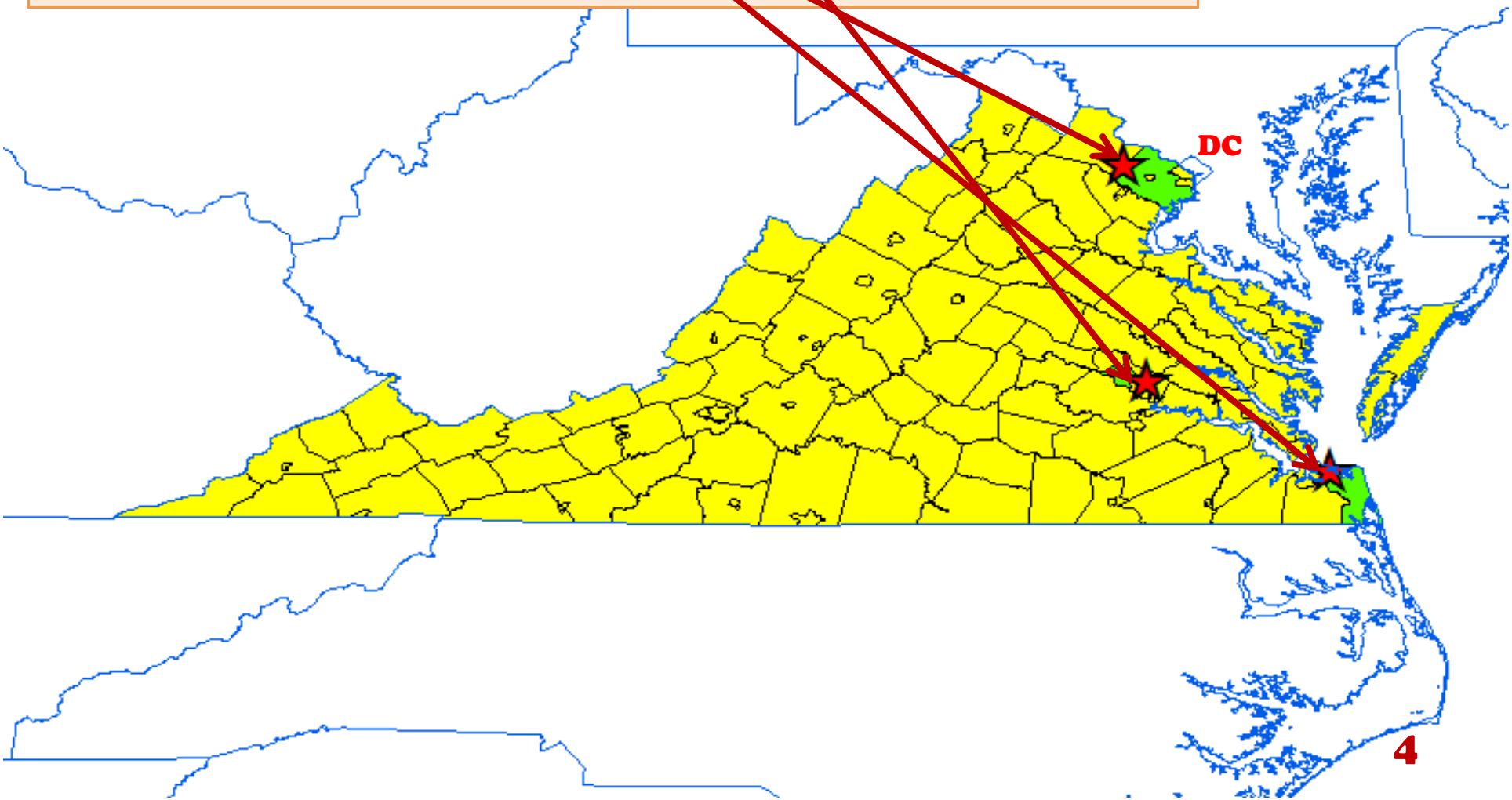
  (recommended by Winston Hao of NY)
- **Conduct MOVES runs in inventory mode with two sets of meteorology**

  -- hourly meteorology (~SMOKE-MOVES practice)

  -- monthly averaged meteorology (~MOVES practice)
- **No change to all other MOVES inputs (identical to those submitted for 2011 NEI)**

Counties Selected and Meteorological Stations

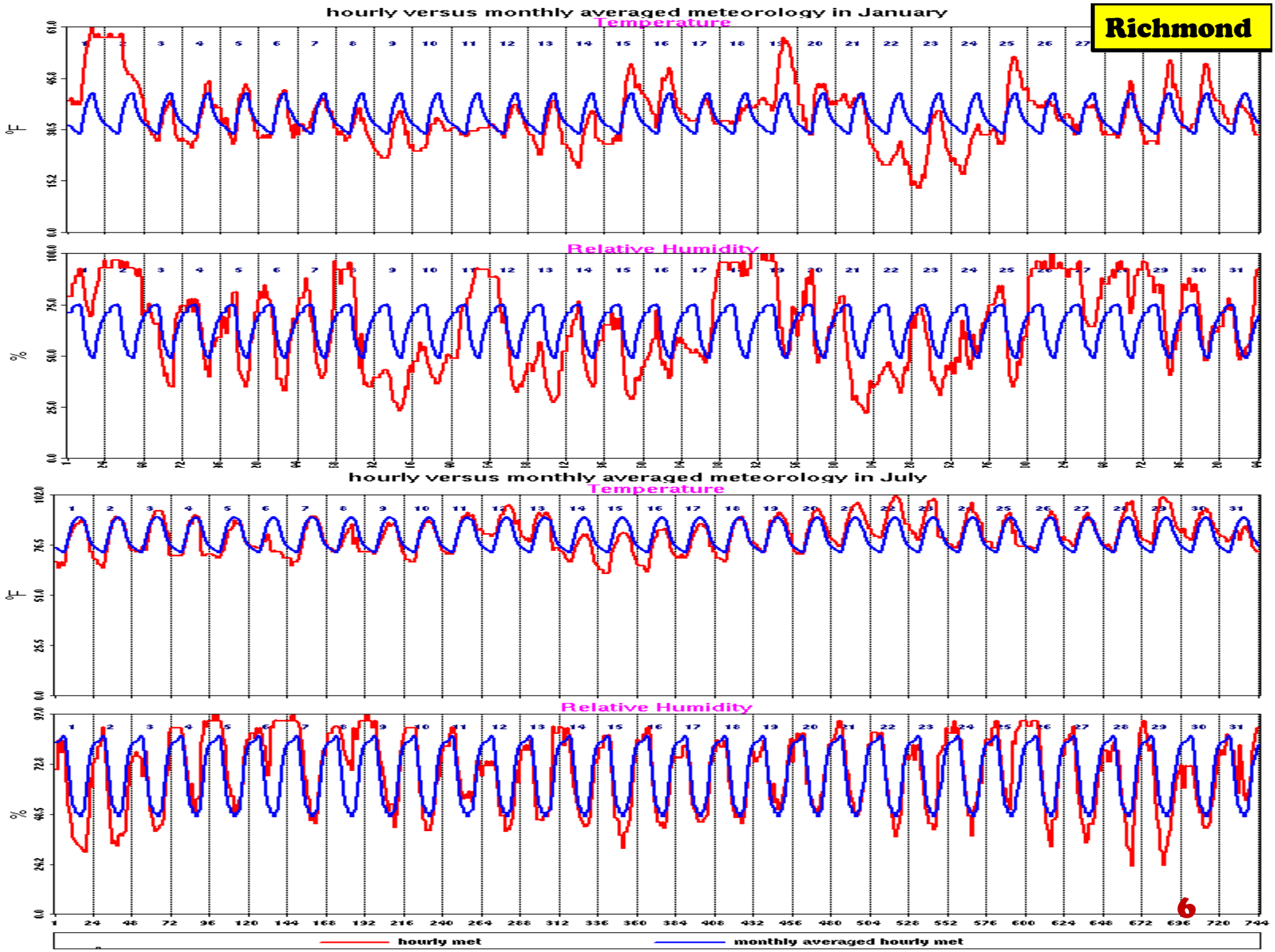
County	Nearby Met Station	Months Selected
(1) Richmond	KRIC (Richmond Airport)	January and July
(2) Fairfax	KIAD (Dulles Airport)	February and August
(3) Virginia Beach	KORF (Norfolk Airport)	April and October



MOVES Setup

- Inventory mode
- 30 (or 31) MOVES runs for 30 (or 31) sets of hourly met
- One MOVES run for monthly averaged met
- Total of 31 (or 32) MOVES runs per county per month
- No output aggregation (i.e. hourly)
- Both weekday and weekend (dayID 2 and dayID 5) included in runspec
- Weekday or weekend extraction according to calendar date

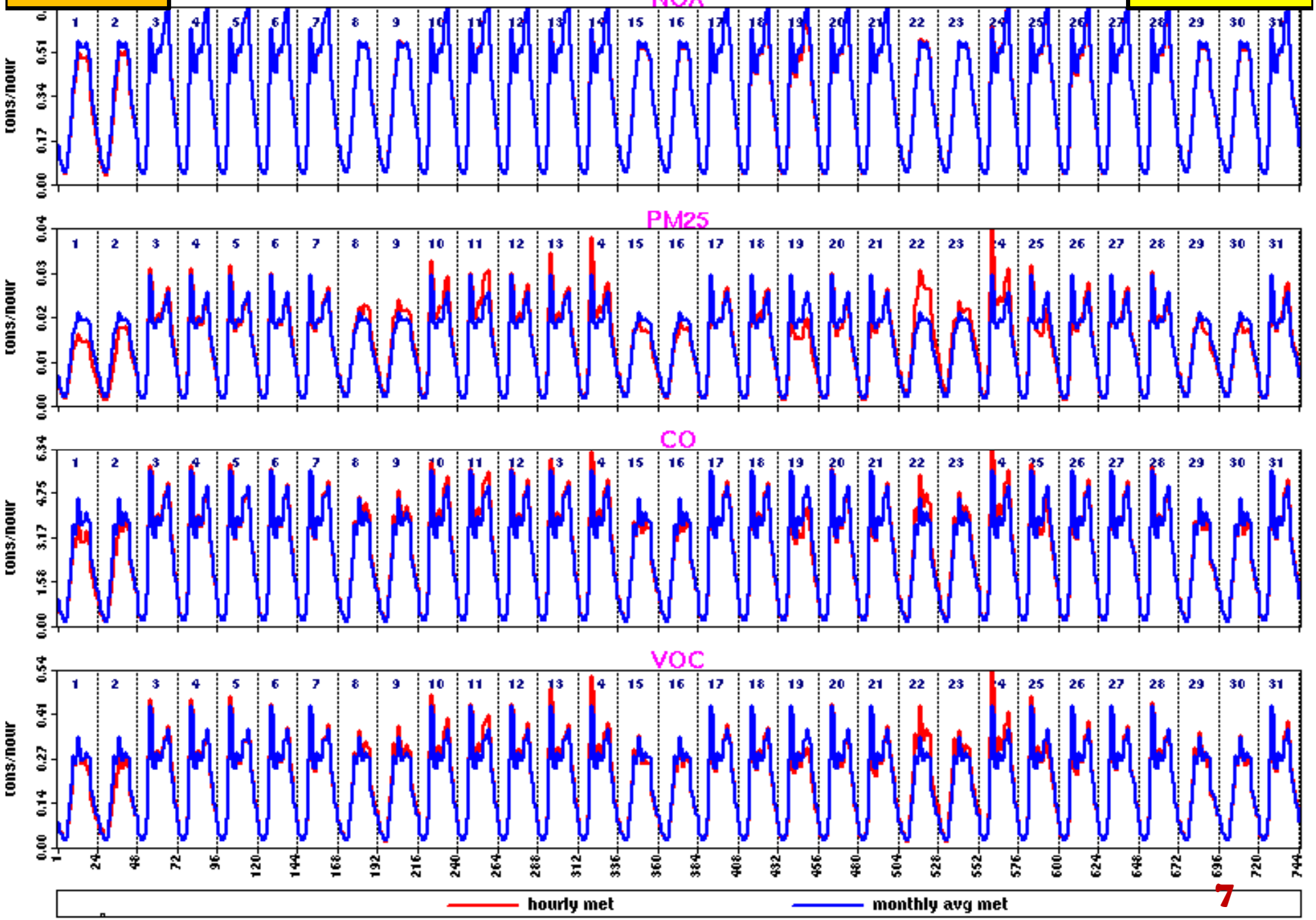
January 12, 2011 ⇒ Wednesday ⇒ weekday numbers extracted
July 16, 2011 ⇒ Saturday ⇒ weekend numbers extracted

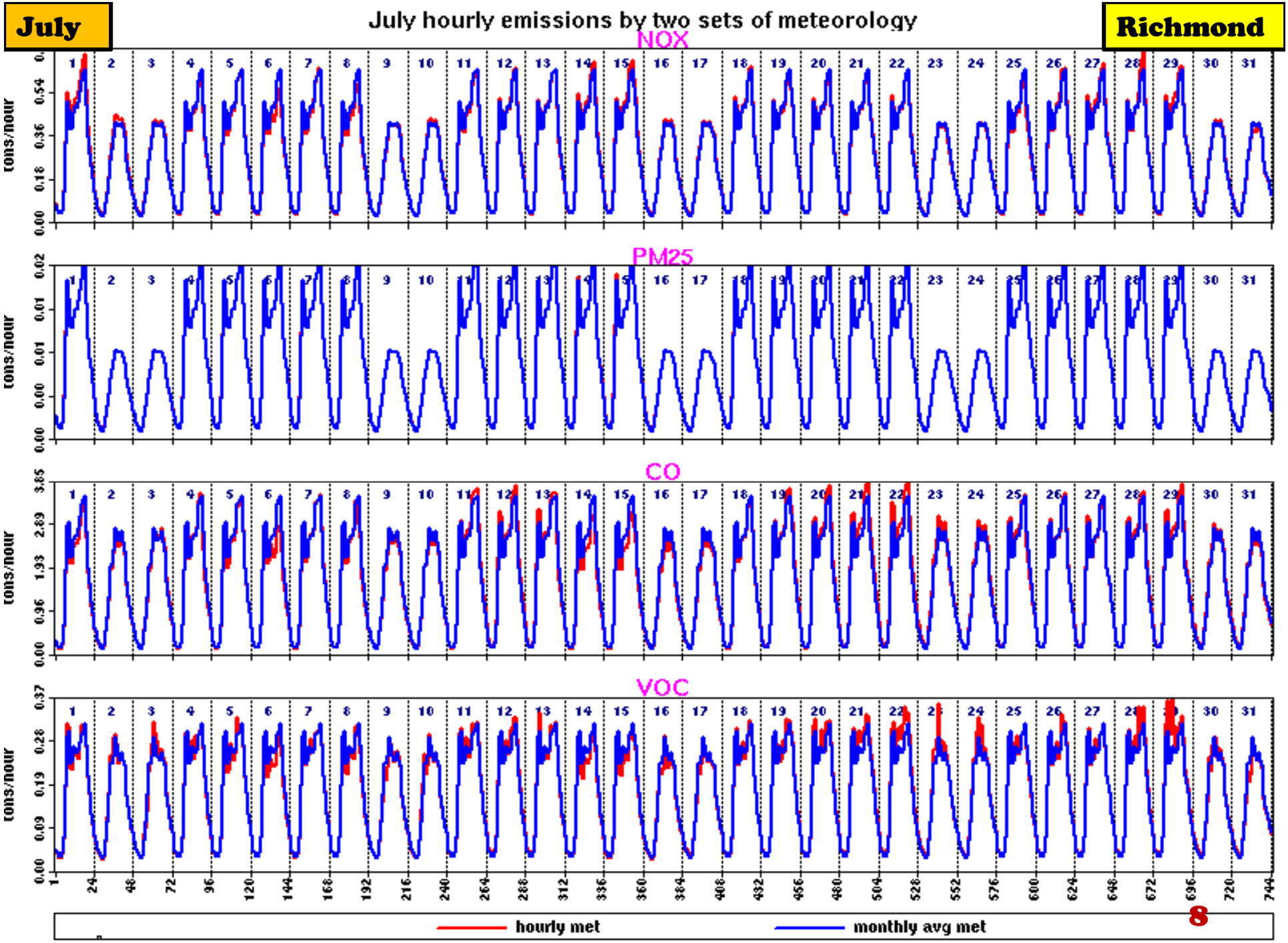

Richmond
hourly versus monthly averaged meteorology in January
Temperature
°F
Relative Humidity
%
hourly versus monthly averaged meteorology in July
Temperature
°F
Relative Humidity
%
hourly met
monthly averaged hourly met

January

January hourly emissions by two sets of meteorology

Richmond

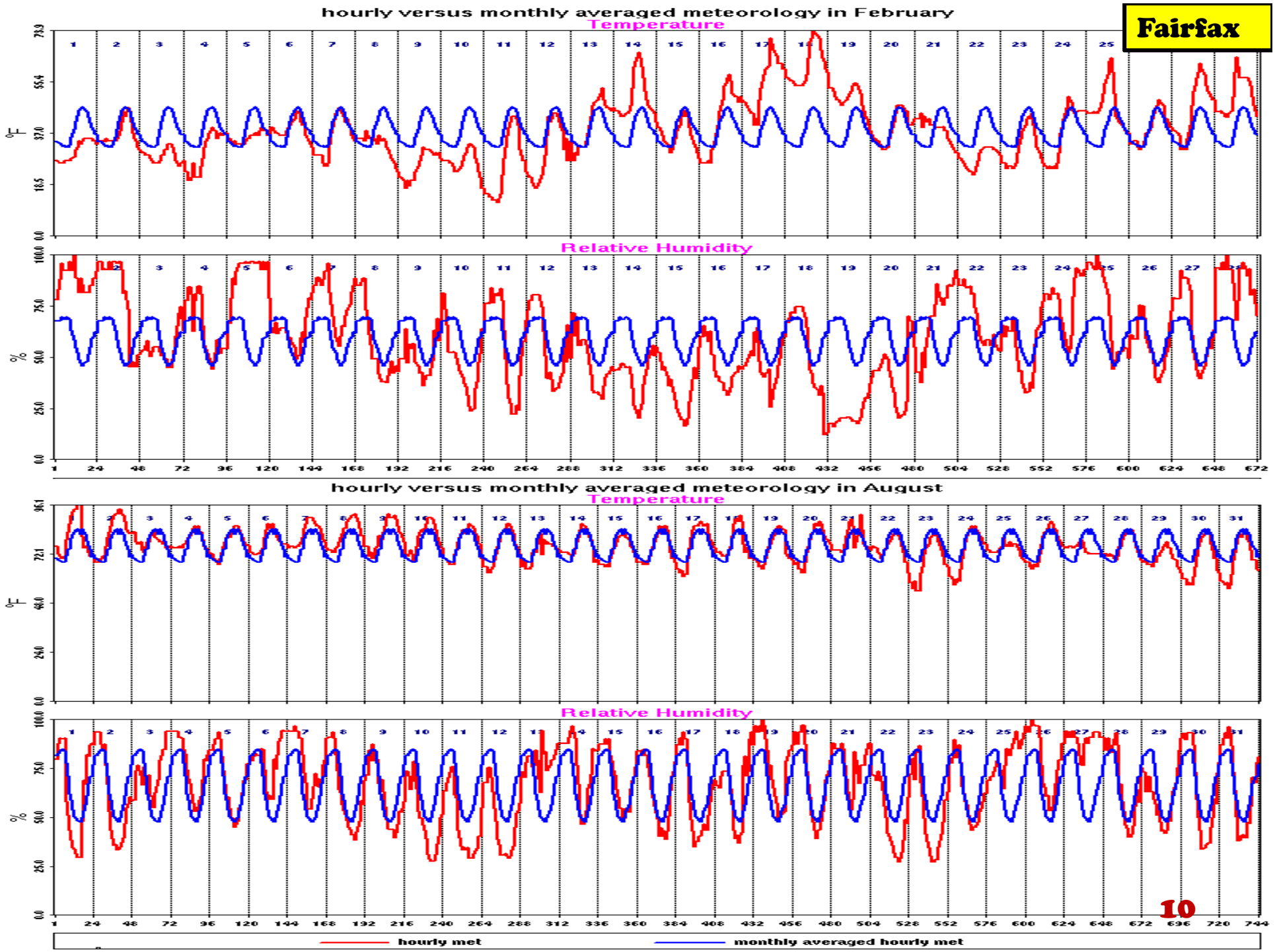



July
July hourly emissions by two sets of meteorology
Richmond
NOX
PM25
CO
VOC
tons/hour
hourly met
monthly avg met

Richmond Comparison (2011 January/July)

MOVES Run	CO	NH3	NOX	PM10	PM25	SO2	VOC
January Hourly met (tons)	1971.56	6.48	256.95	13.33	10.10	1.57	150.68
January Monthly met (tons)	1965.46	6.48	258.74	13.12	9.90	1.57	148.02
Difference (tons)	6.09	0.00	-1.78	0.21	0.19	0.00	2.66
Difference (%)	0.3%	0.0%	-0.7%	1.6%	2.0%	0.0%	1.8%
July Hourly met (tons)	1261.39	6.99	219.11	9.02	5.97	1.53	129.80
July Monthly met (tons)	1259.06	6.99	218.17	9.01	5.96	1.53	128.23
Difference (tons)	2.32	0.00	0.94	0.01	0.01	0.00	1.57
Difference (%)	0.2%	0.0%	0.4%	0.1%	0.2%	0.0%	1.2%

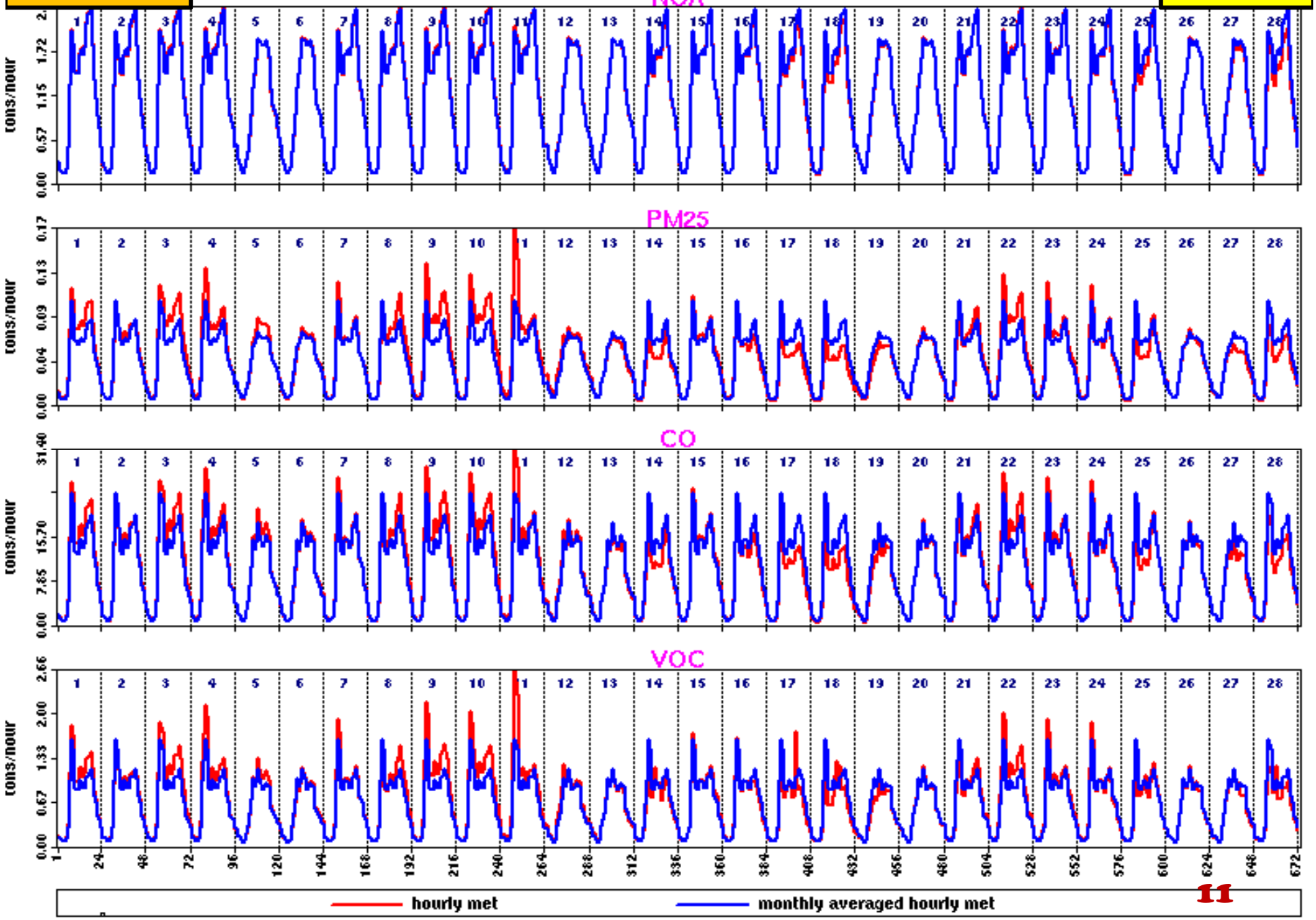
-- Differences are very small for all pollutants between two sets of meteorology
-- The largest difference percentage-wise are VOCs and PM in winter month


Fairfax
hourly versus monthly averaged meteorology in February
Temperature
°F
Relative Humidity
%
hourly versus monthly averaged meteorology in August
Temperature
°F
Relative Humidity
%
hourly met
monthly averaged hourly met

February

February hourly emissions by two sets of meteorology

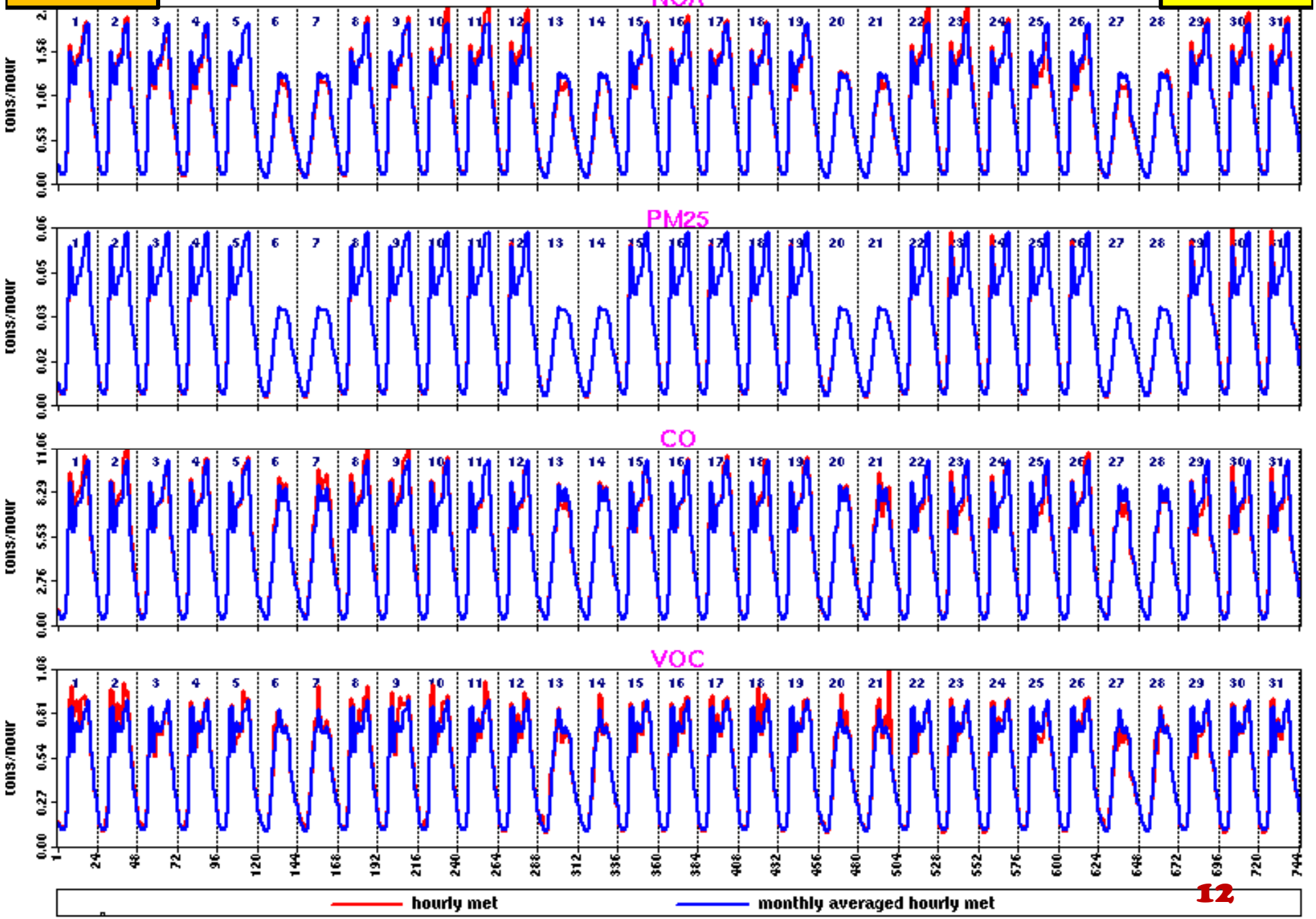
Fairfax



August

August hourly emissions by two sets of meteorology

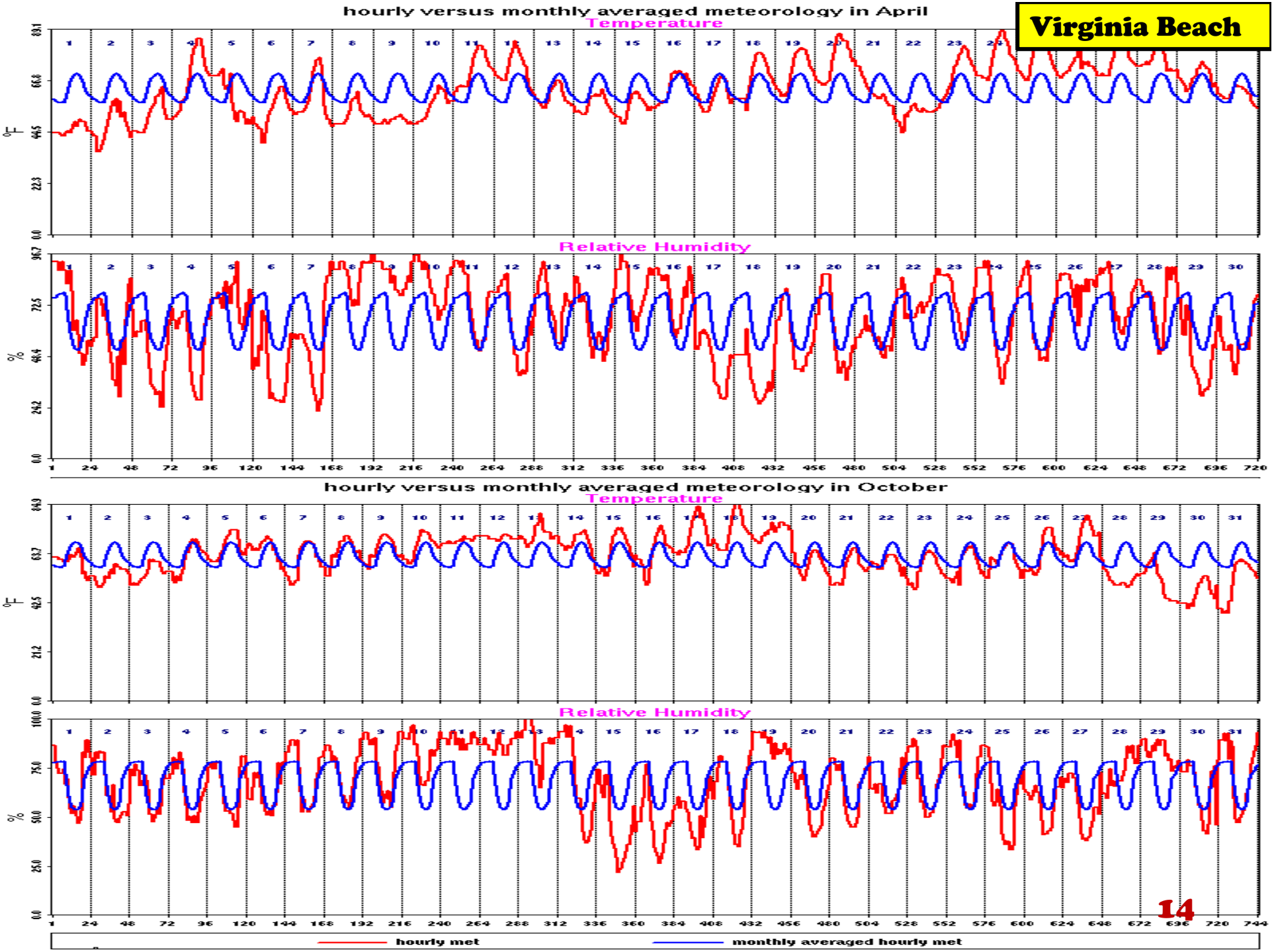
Fairfax



Fairfax Comparison (2011 February/August)

MOVES Run	CO	NH3	NOX	PM10	PM25	SO2	VOC
February Hourly met (tons)	7165.96	28.01	778.95	45.57	32.91	7.20	482.28
February Monthly met (tons)	7080.45	28.01	785.82	44.25	31.69	7.19	457.98
Difference (tons)	85.51	0.00	-6.87	1.33	1.22	0.01	24.30
Difference (%)	1.2%	0.0%	-0.9%	3.0%	3.9%	0.1%	5.3%
August Hourly met (tons)	3796.56	29.03	698.27	33.34	21.31	7.43	375.88
August Monthly met (tons)	3756.87	29.03	695.24	33.24	21.22	7.42	368.75
Difference (tons)	39.69	0.00	3.04	0.10	0.09	0.01	7.13
Difference (%)	1.1%	0.0%	0.4%	0.3%	0.4%	0.2%	1.9%

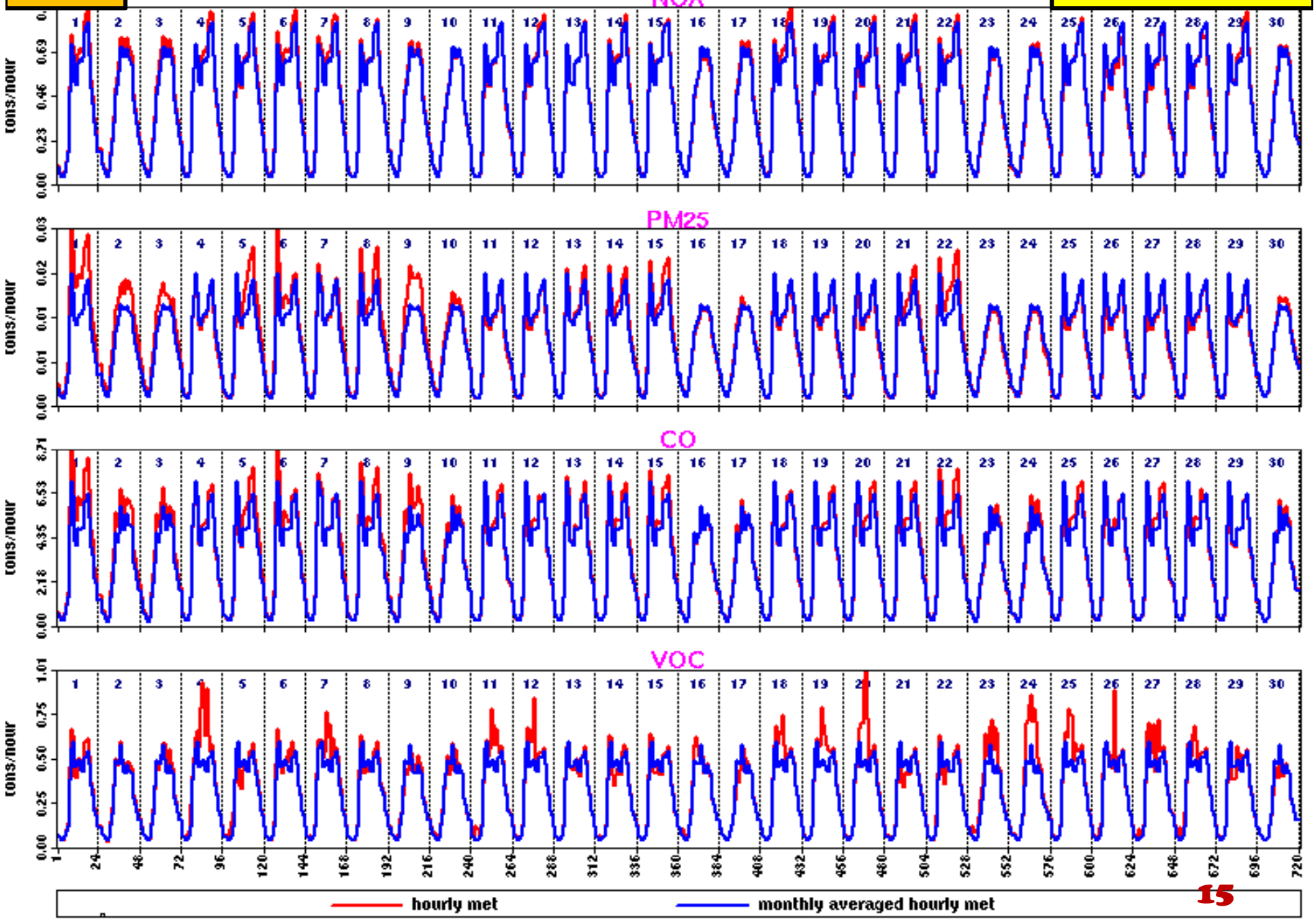
-- Differences are very small for all pollutants between two sets of meteorology
-- The largest difference percentage-wise are VOCs and PM in winter month


Virginia Beach
hourly versus monthly averaged meteorology in April
Temperature
°F
Relative Humidity
%
hourly versus monthly averaged meteorology in October
Temperature
°F
Relative Humidity
%
hourly met
monthly averaged hourly met

April

April hourly emissions by two sets of meteorology

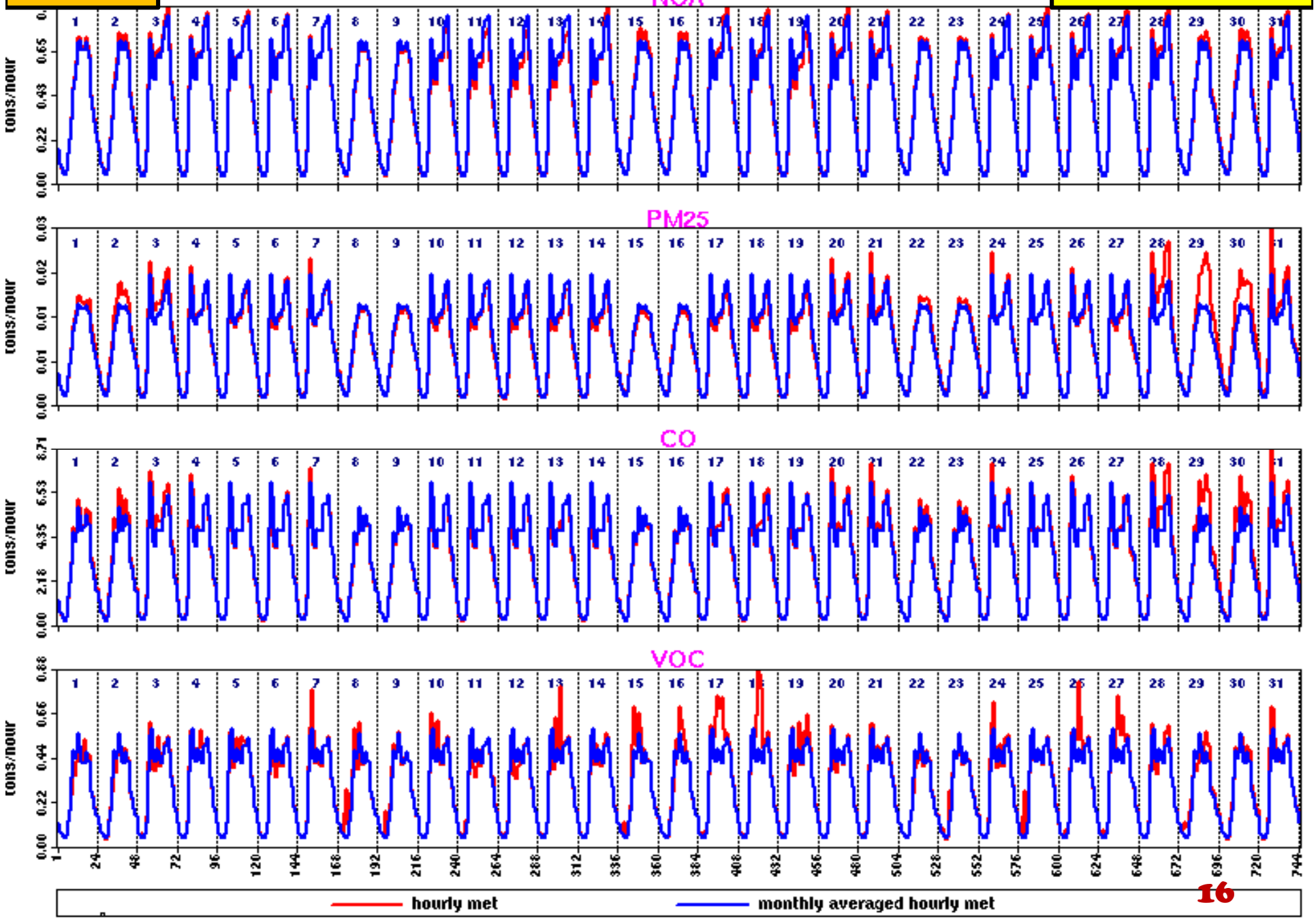
Virginia Beach



October

October hourly emissions by two sets of meteorology

Virginia Beach



Virginia Beach Comparison (2011 April/October)

MOVES Run	CO	NH3	NOX	PM10	PM25	SO2	VOC
April Hourly met (tons)	2612.91	10.02	314.02	12.67	7.81	2.46	247.11
April Monthly met (tons)	2460.77	10.02	309.03	12.28	7.45	2.42	227.23
Difference (tons)	152.14	0.00	4.99	0.39	0.36	0.04	19.88
Difference (%)	6.2%	0.0%	1.6%	3.2%	4.9%	1.7%	8.7%
October Hourly met (tons)	2568.57	9.90	312.38	12.55	7.74	2.41	239.15
October Monthly met (tons)	2497.01	9.90	310.04	12.36	7.57	2.39	227.97
Difference (tons)	71.56	0.00	2.34	0.18	0.17	0.02	11.18
Difference (%)	2.9%	0.0%	0.8%	1.5%	2.2%	1.0%	4.9%

-- Differences are very small for all pollutants between two sets of meteorology
-- The largest difference percentage-wise are VOCs and PM2.5/PM10

Summary

- Differences in monthly emissions between hourly meteorology and monthly averaged meteorology are very small for all pollutants
- Three major VA counties and six different months in 2011 all show similar trends of minor differences
- Largest differences percentage-wise are VOCs and PM in winter months

Conclusions

- GA study has been independently verified by VA using NOAA hourly meteorological measurements and 2011 VA county-specific MOVES inputs
- Meteorology affects emissions but, in comparison to other factors, its impact alone should not cause significant differences in emission estimates
- Many methodologies implemented in SMOKE-MOVES have greatly deviated from MOVES original design:

  -- county grouping (resolution reduced)

  -- non-local, non-county-specific MOVES data

  -- SCC flaws, averaged RH, inconsistent speed treatment
- MOVES in inventory mode can be and should be used to evaluate SMOKE-MOVES approach

  -- Differences in the approaches are understood and should be taken into consideration in evaluation

Recommendations

- Implement new SCC algorithm as soon as possible
- Adopt hybrid approach suggested by GA, which is the best method currently available
  - -- Daily hourly met data for non-attainment counties and monthly met data for attainment counties
- Refine and automate inventory MOVES approach outlined in GA/VA study

  (missing data at NOAA site are difficult to deal with)
- Revise SMOKE to receive inventory MOVES hourly emissions
- Phase out the use of representative counties
- Parallelize MOVES calculations to reduce processing time