GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

Inventory MOVES with Hourly Meteorology for Use in Air Quality Models

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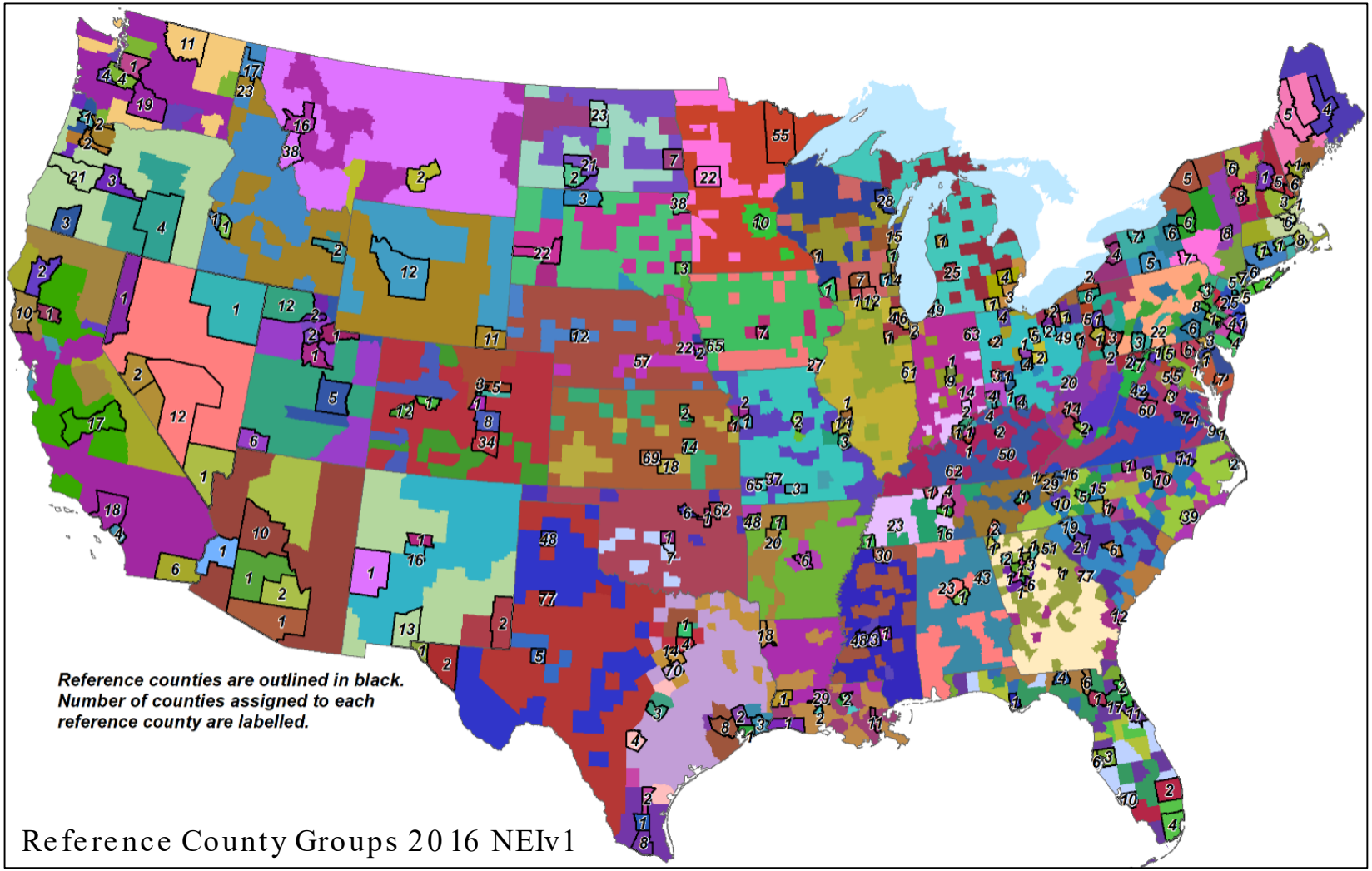
BACKGROUND

- On-road mobile is a significant source of ozone precursors (NOx and VOCs)
- MOVES can be run in inventory mode or rate mode to generate on-road emissions
- EPA uses SMOKE-MOVES (rate mode) to generate gridded on-road emissions for photochemical grid models
  - The SMOKE-MOVES method requires many simplifying assumptions
  - Few states can run SMOKE-MOVES since it is resource intensive

SMOKE-MOVES

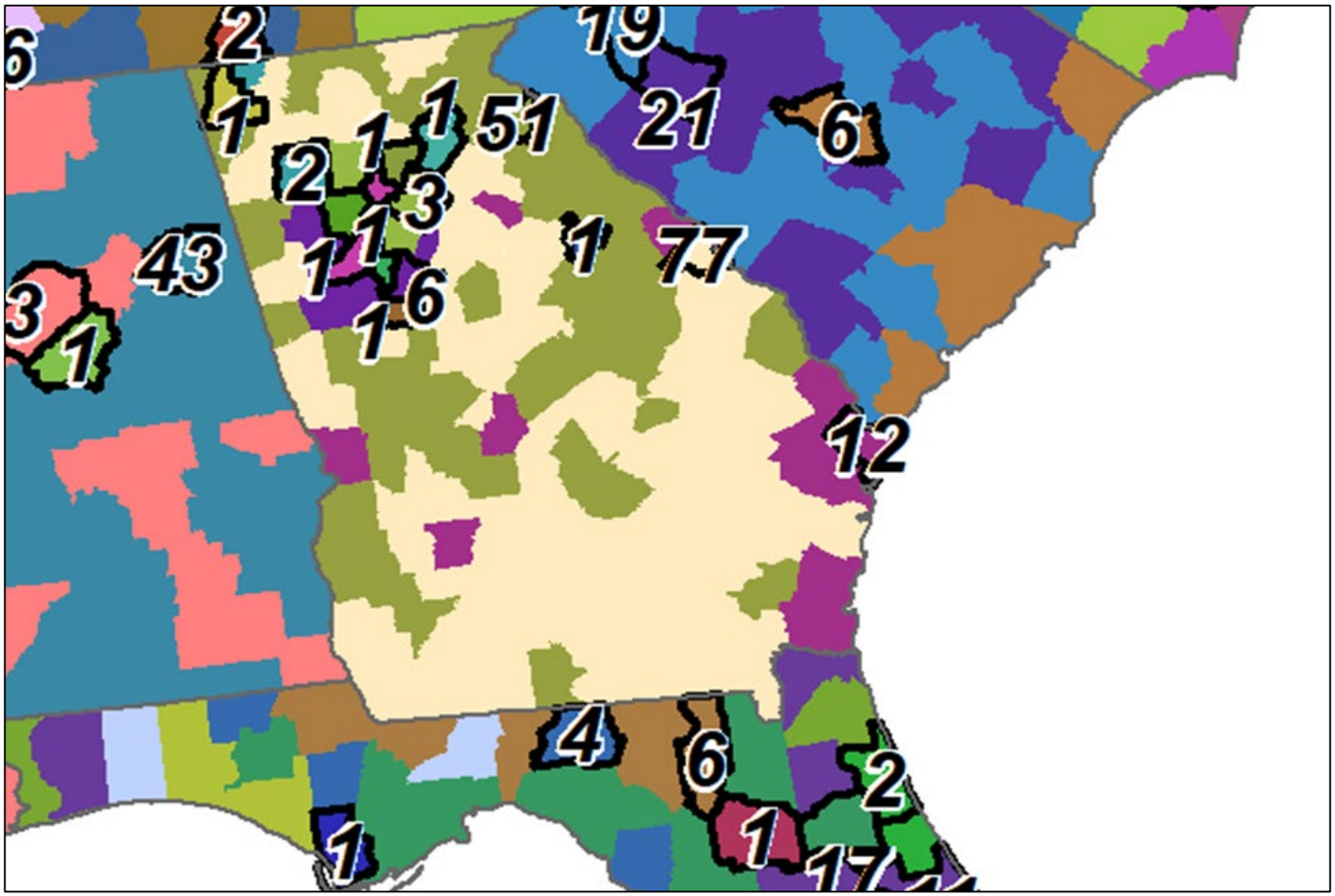
- Emissions = (County-level Activity) x (Emission Factor)
- County-level Activity: VMT, vehicle pop, starts, & hoteling
- Emission Factors (EF) tables are developed for representative counties by running MOVES in rate mode
  - Representative counties: fleet age, I/M program, fuel blends, & ramp fractions
  - RPD (vehicle/road type, T, RH, speed, fuel month etc.), RPP, & RPV
  - 2 fuel seasons (winter/summer)
- EFs for a county are calculated from the precomputed EF tables for the corresponding representative county
  - Hourly meteorology at grid cell level from WRF
  - Speed, month, day, hour, vehicle and road type, & pollutant

REPRESENTATIVE COUNTIES (CONUS)



Reference County Groups 2016 NEIv1

REPRESENTATIVE COUNTIES (GA)



Reference County Groups 2016 NEIv1

SMOKE-MOVES

Current approach: SMOKE RatePerDistance processing steps

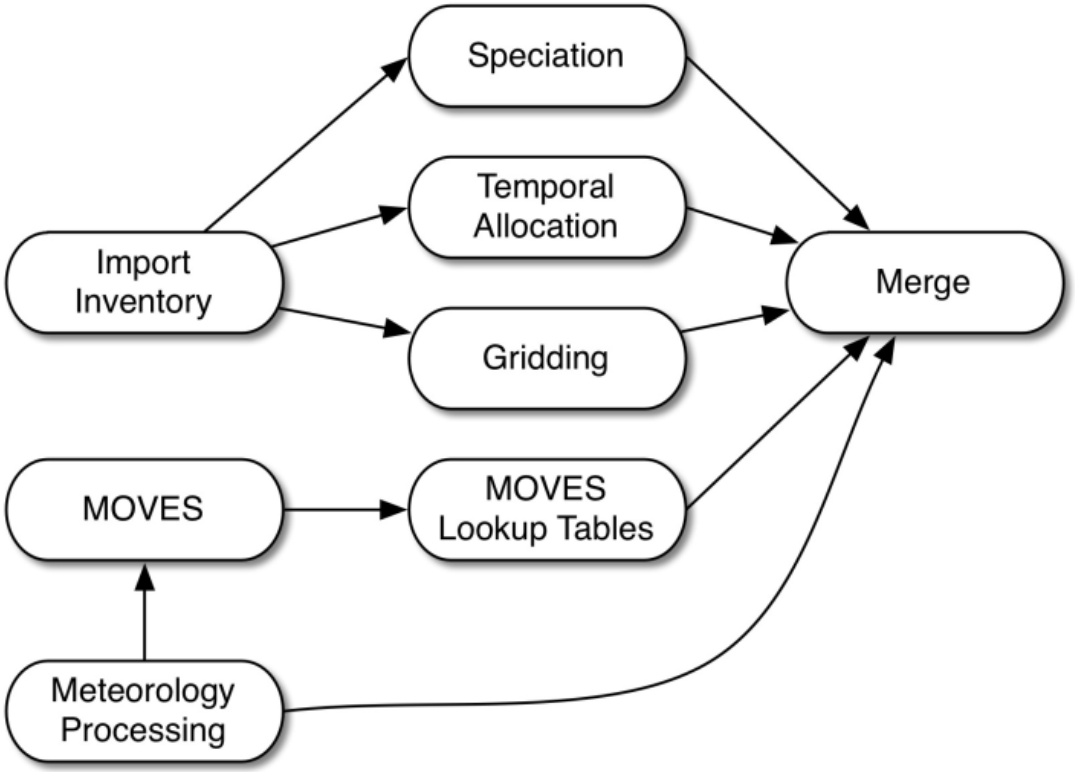


Figure obtained from *SMOKE v3.7 manual*

PURPOSE

- **PART 1** - Demonstrate "Inventory MOVES" (MOVES in inventory mode) can run like SMOKE-MOVES when using hourly meteorology instead of monthly average diurnal meteorology
  - Eliminates the one simplifying assumption associated with Inventory MOVES
  - Inventory MOVES is easier for states to work with
- **PART 2** - Process hourly Inventory MOVES emissions through SMOKE to generate gridded inputs for photochemical grid models

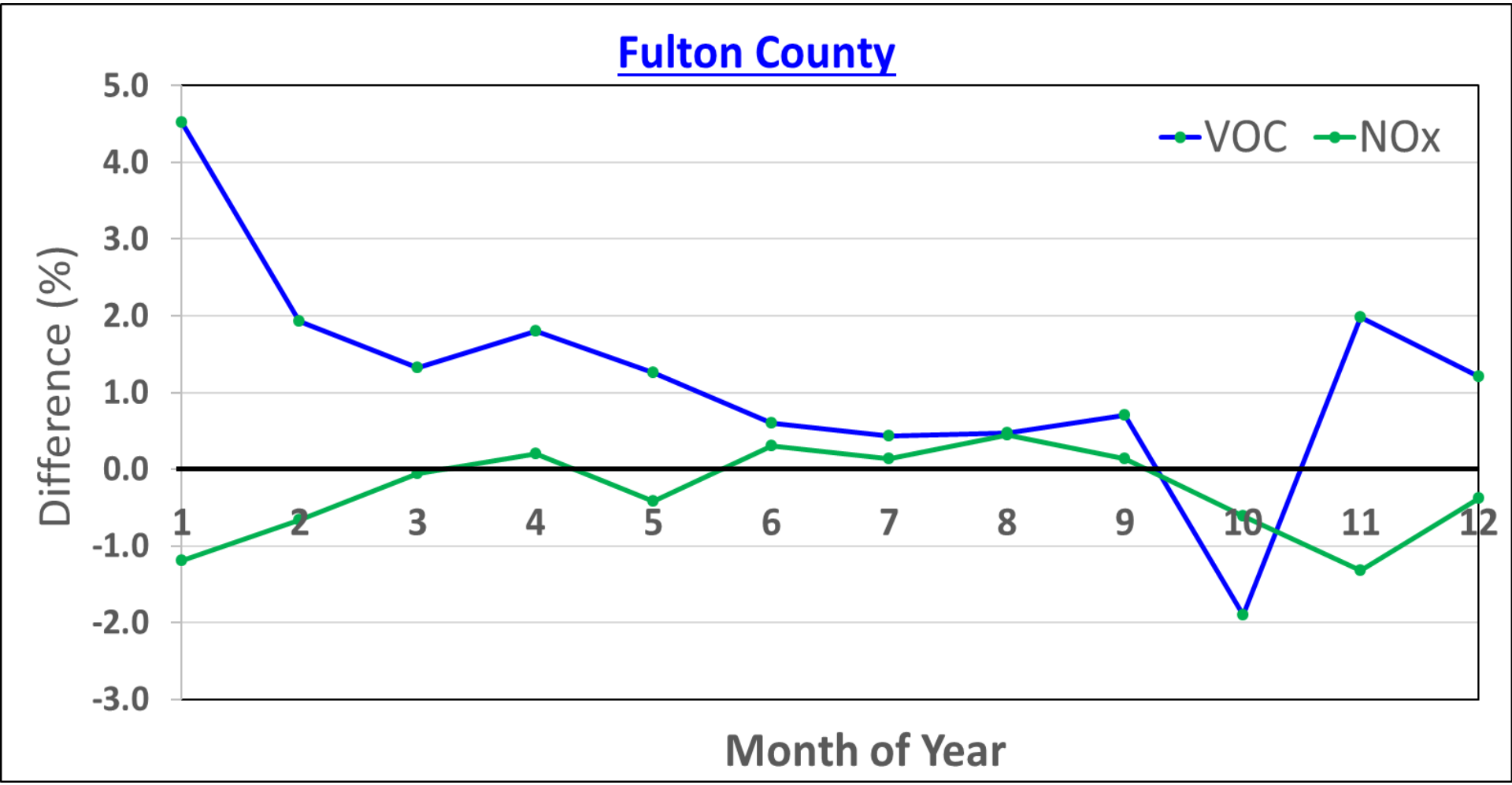
INVENTORY MOVES

- Tested Inventory MOVES with 2014NEIv2 inputs for 3 ozone nonattainment counties in Georgia
  - **Case 1**: Used monthly diurnal meteorology (M-MET)
  - **Case 2**: Used hourly meteorology (H-MET) for each day of the year
- Meteorology from nearby monitoring stations was provided by EPA
- County level input databases directly used
  - No fuel season simplification for transition months (April/October)
  - Average speed distributions weighted over 16 bins

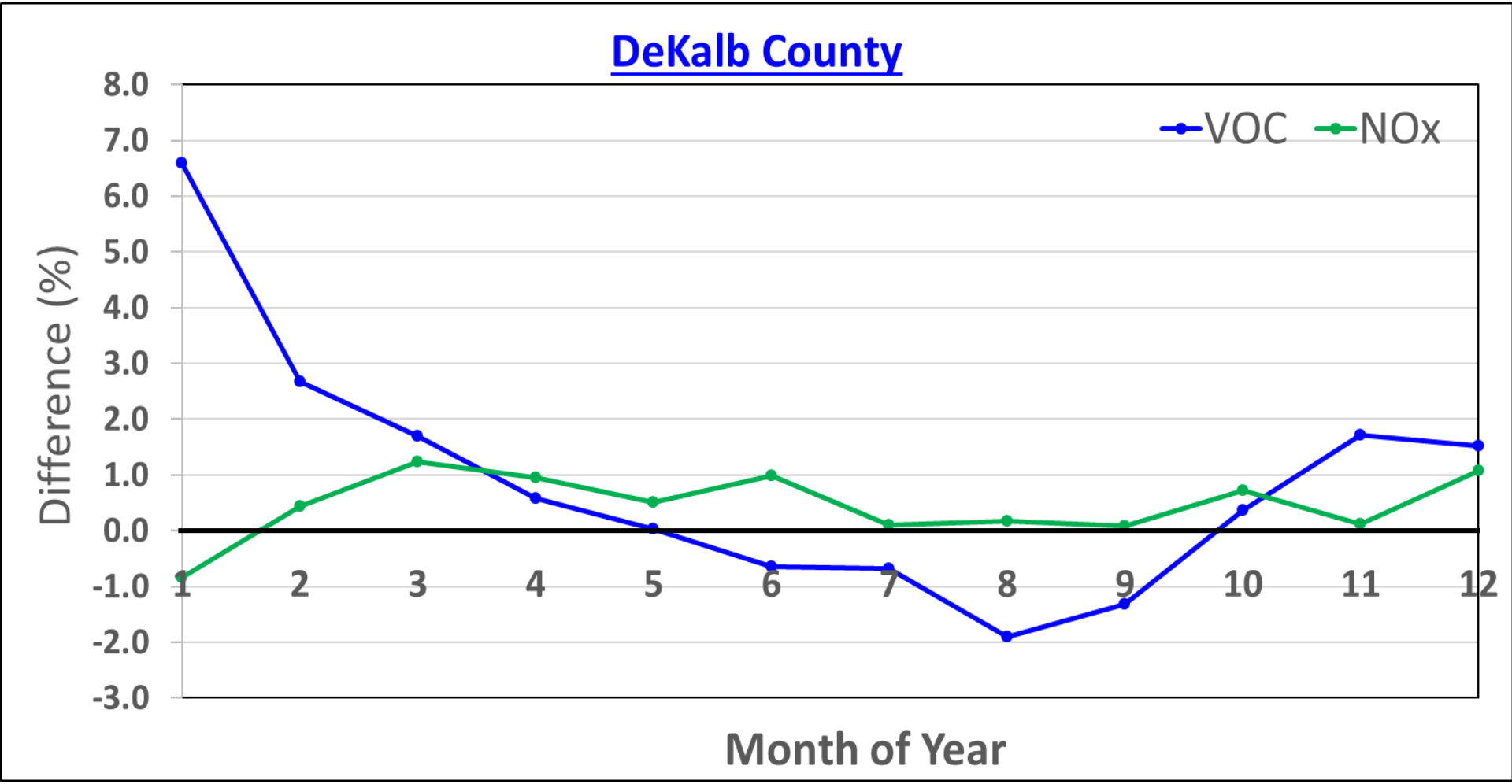
H-MET minus M-MET % Difference: Annual Differences

	Total Annual (2014) NO_X Emissions			Total Annual (2014) VOC Emissions		
	Hourly (TPY)	Monthly (TPY)	Difference (%)	Hourly (TPY)	Monthly (TPY)	Difference (%)
Fulton	12,228.6	12,264.8	**0.29**	5,630.0	5,565.7	**1.16**
DeKalb	8,412.8	8,373.7	**0.47**	3,607.1	3,578.4	**0.01**
Cobb	7,825.4	7,798.3	**0.01**	3,939.2	3,932.3	**0.18**

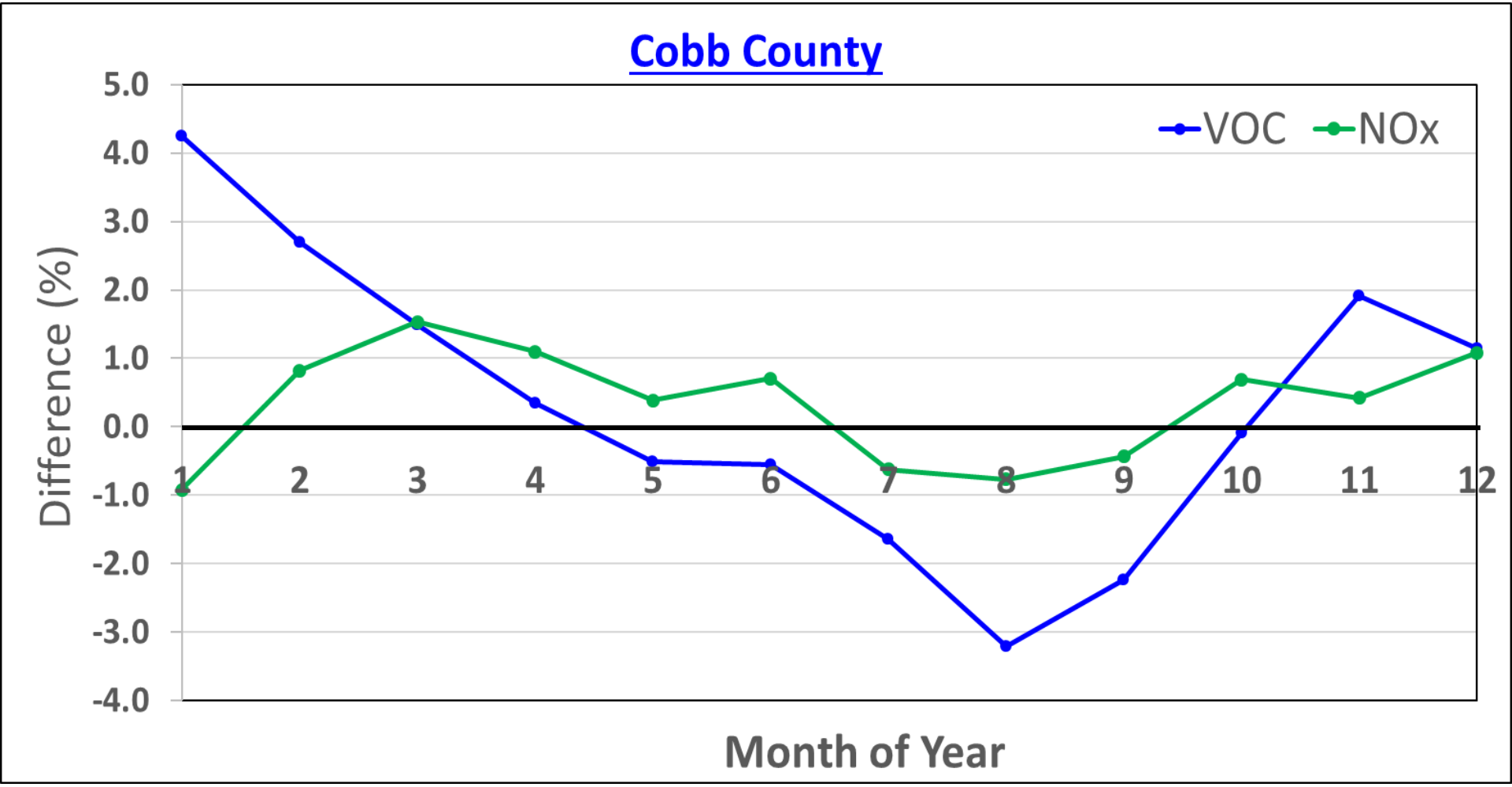
H-MET minus M-MET % Difference
Fulton County, GA



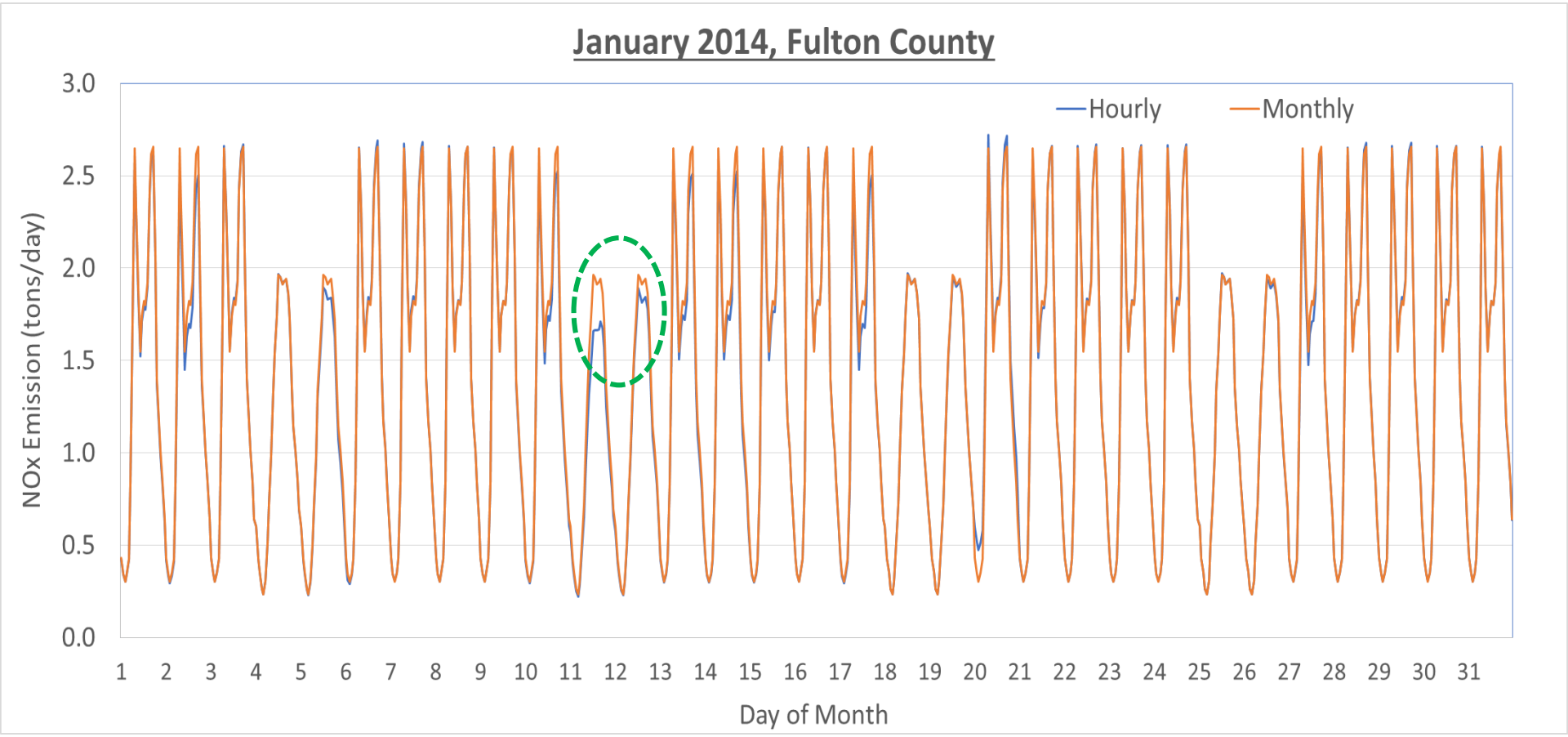
H-MET minus M-MET % Difference
DeKalb County, GA



H-MET minus M-MET % Difference
Cobb County, GA

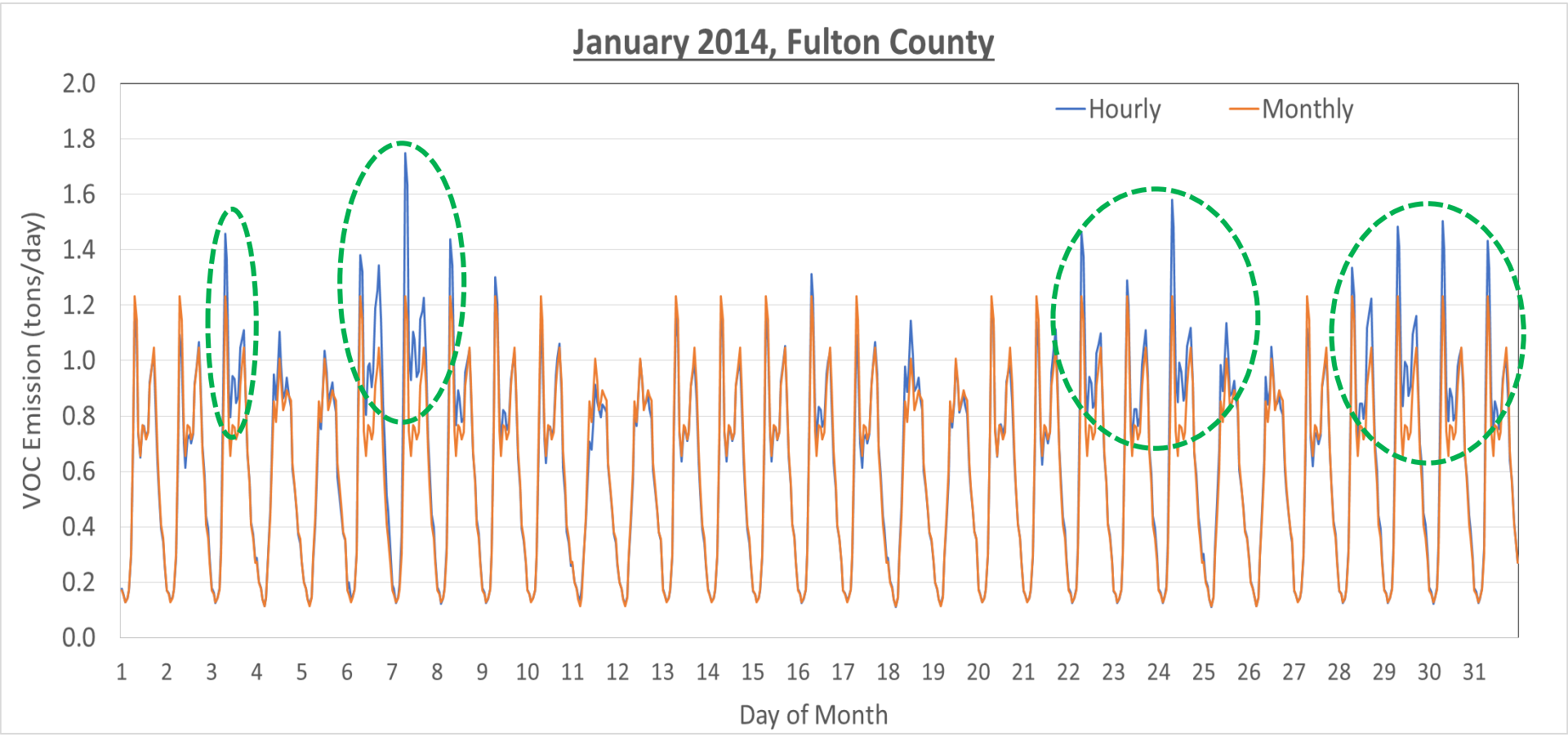


H-MET vs. M-MET NOx Emissions



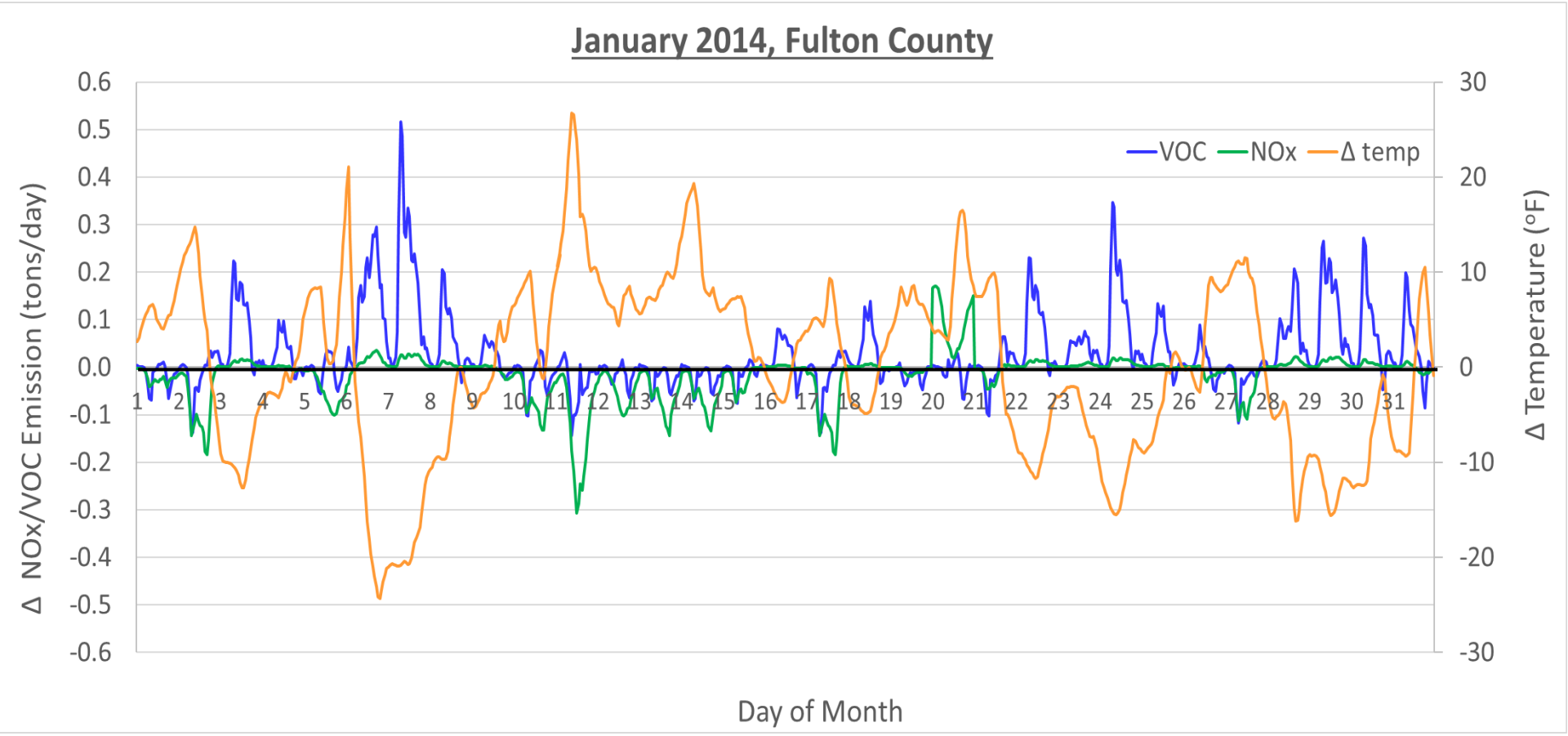
Difference = -1.2%

H-MET vs. M-MET VOC Emissions

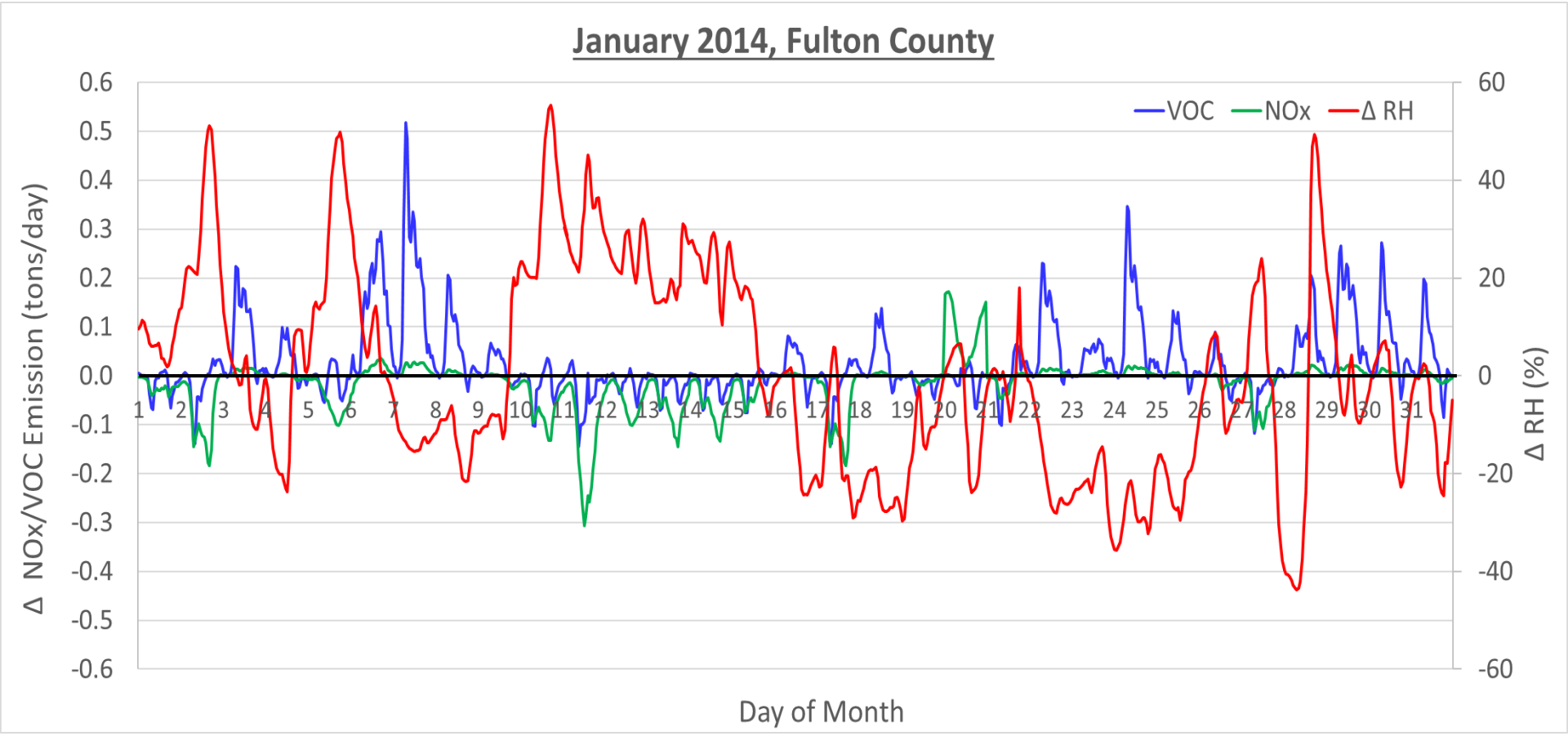


Difference = 4.52%

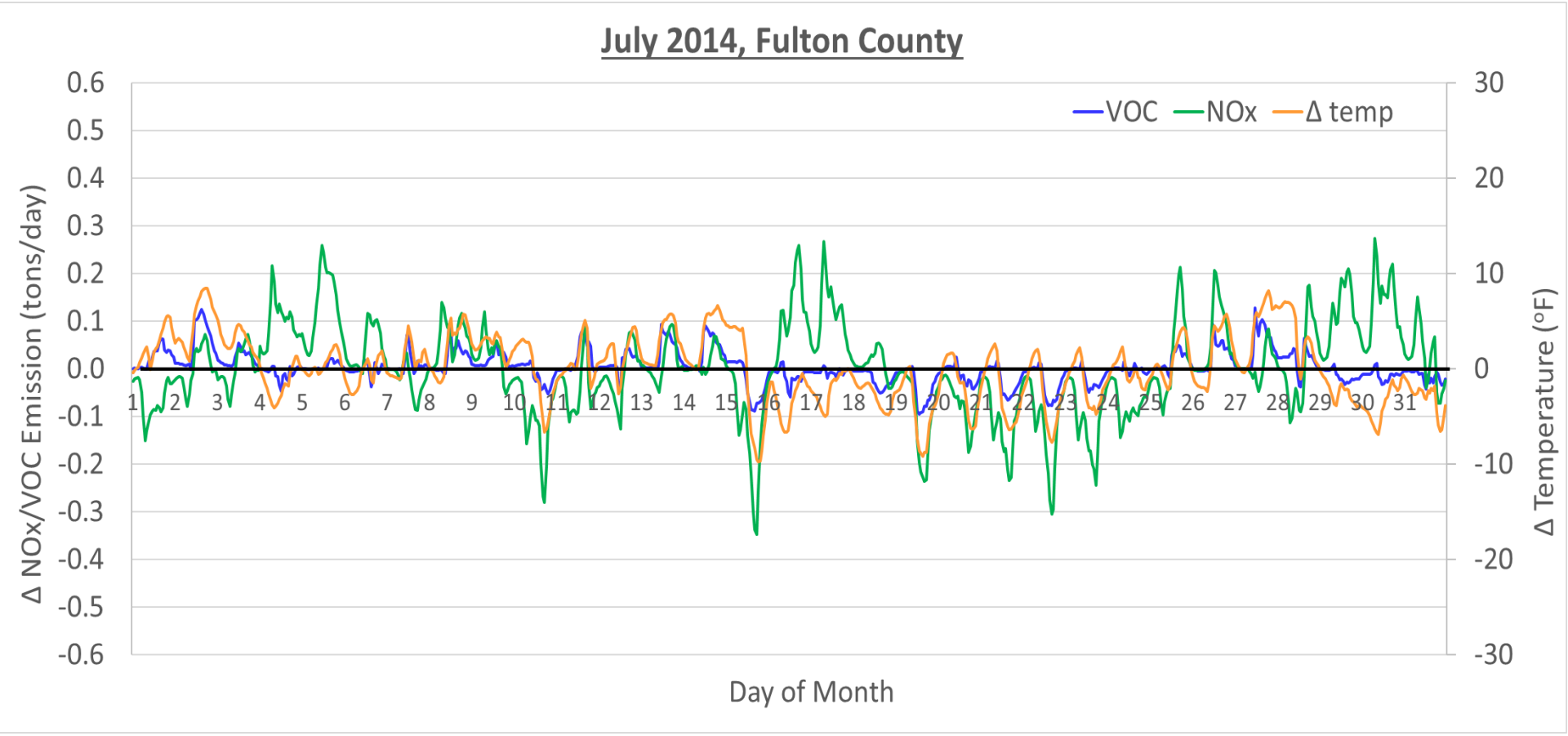
H-MET minus M-MET NOx and VOC Emissions vs. Δ Temp



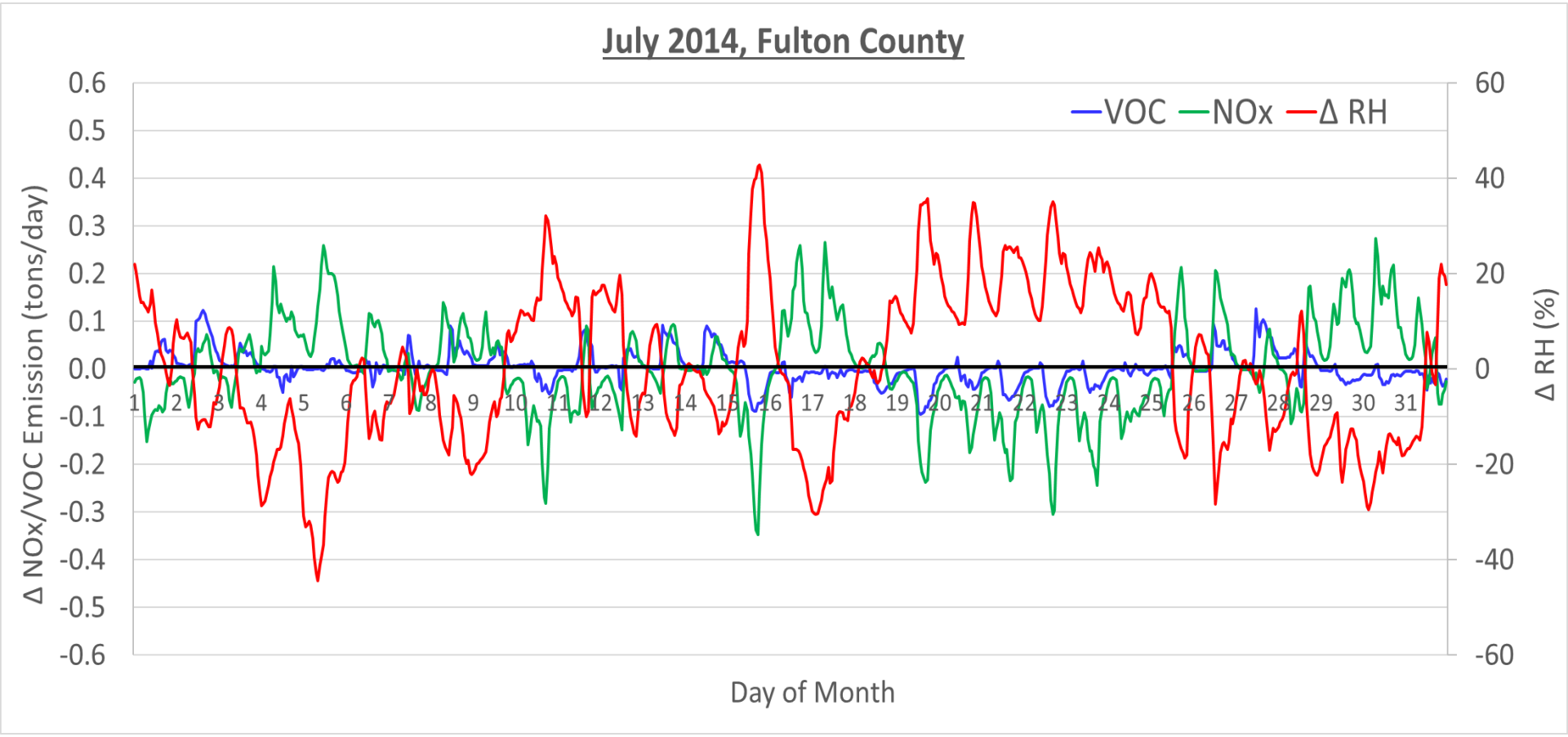
H-MET minus M-MET NOx and VOC Emissions vs. Δ RH



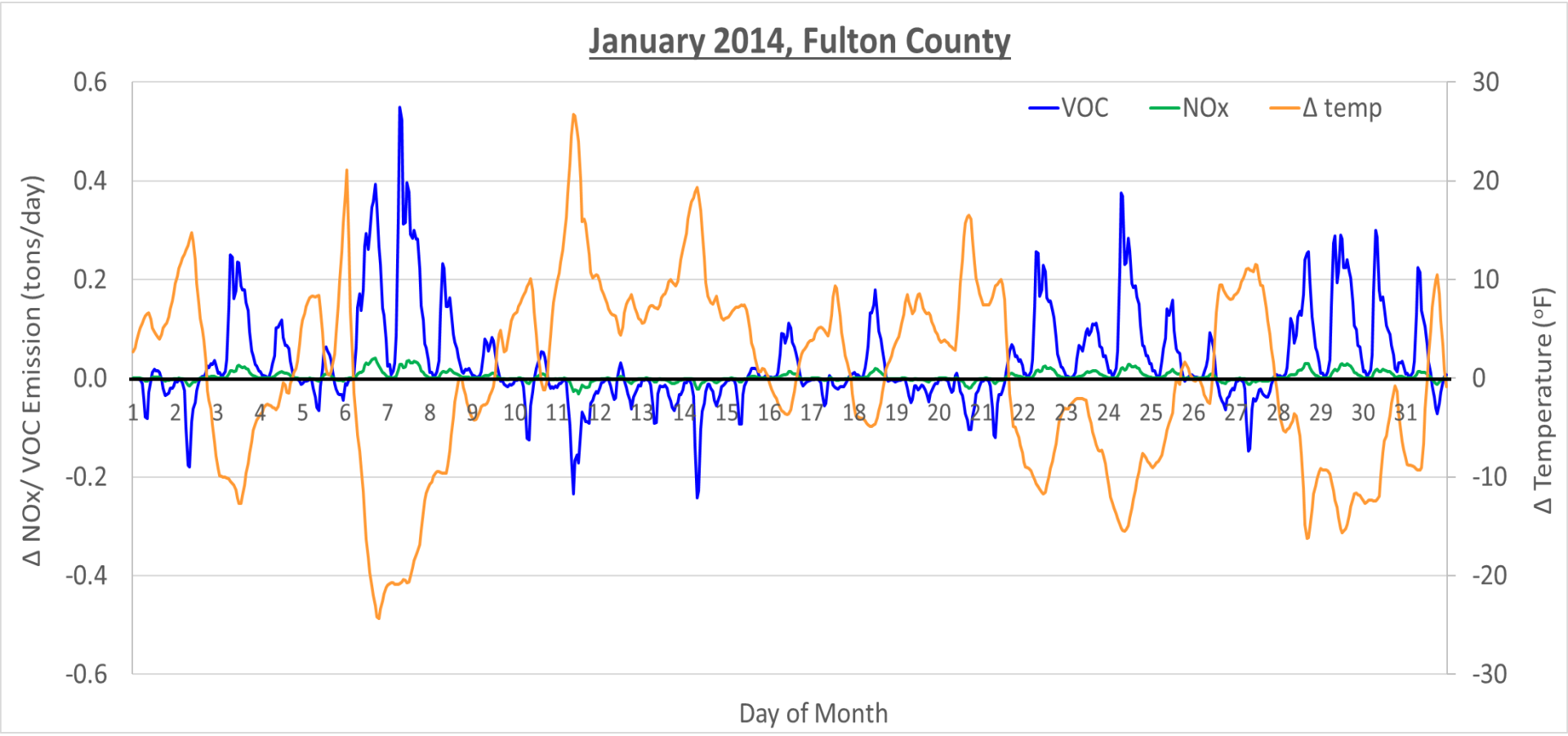
H-MET minus M-MET NOx and VOC Emissions vs. Δ Temp



H-MET minus M-MET NOx and VOC Emissions vs. Δ RH



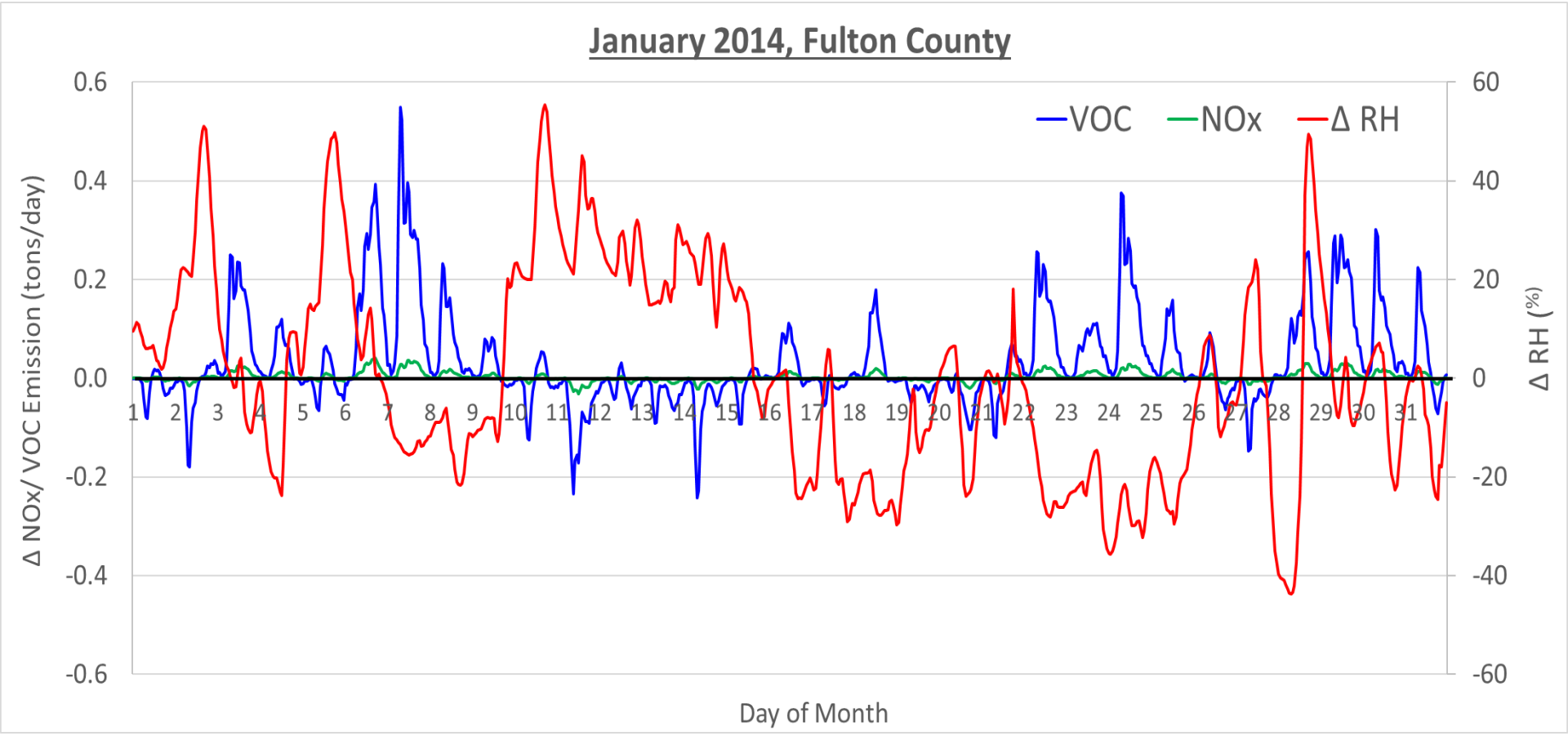
H-MET minus M-MET NOx and VOC Start Emissions vs. Δ Temp



NOx Difference = 1.8%

VOC Difference = 13.0 %

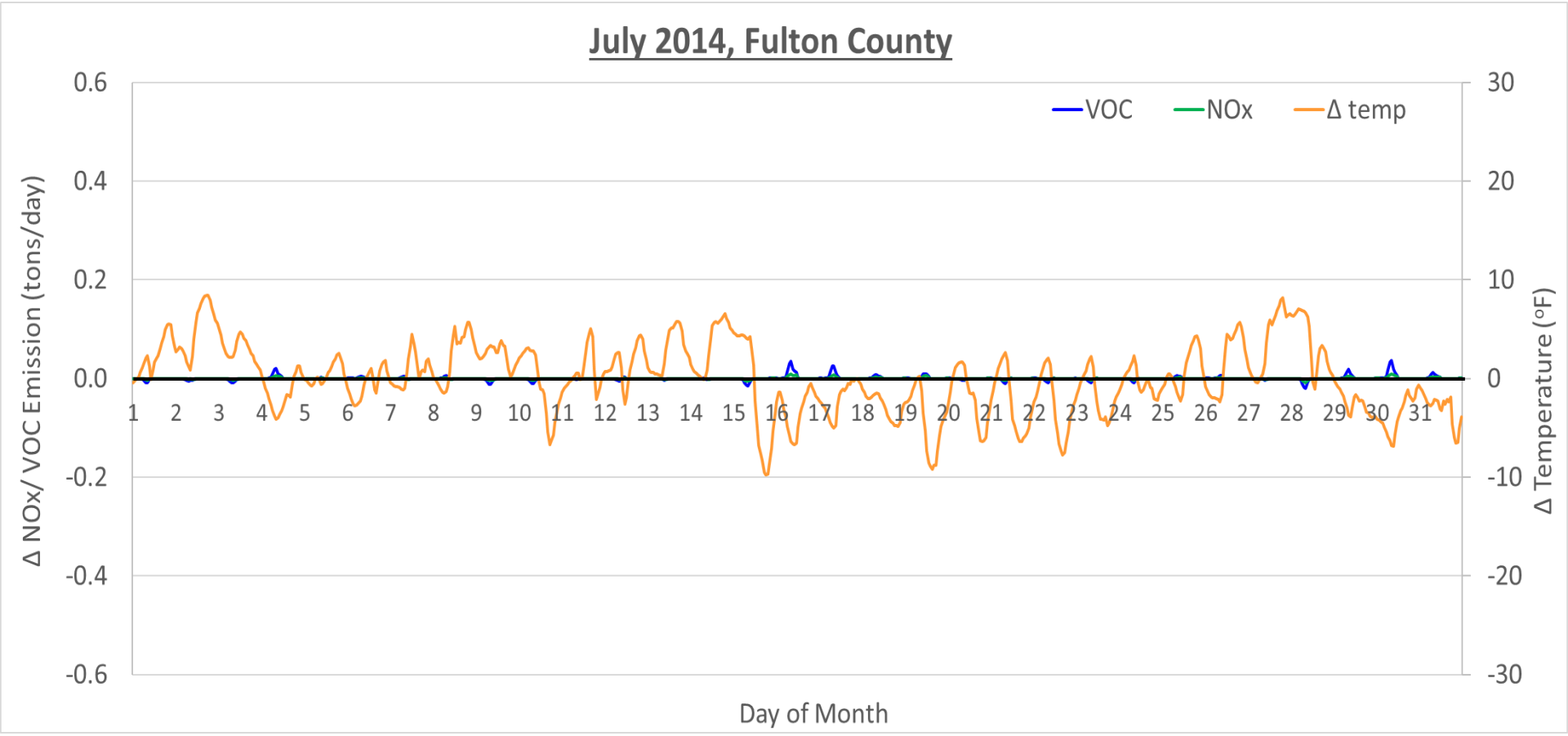
H-MET minus M-MET NOx and VOC Start Emissions vs. Δ RH



NOx Difference = 1.8%

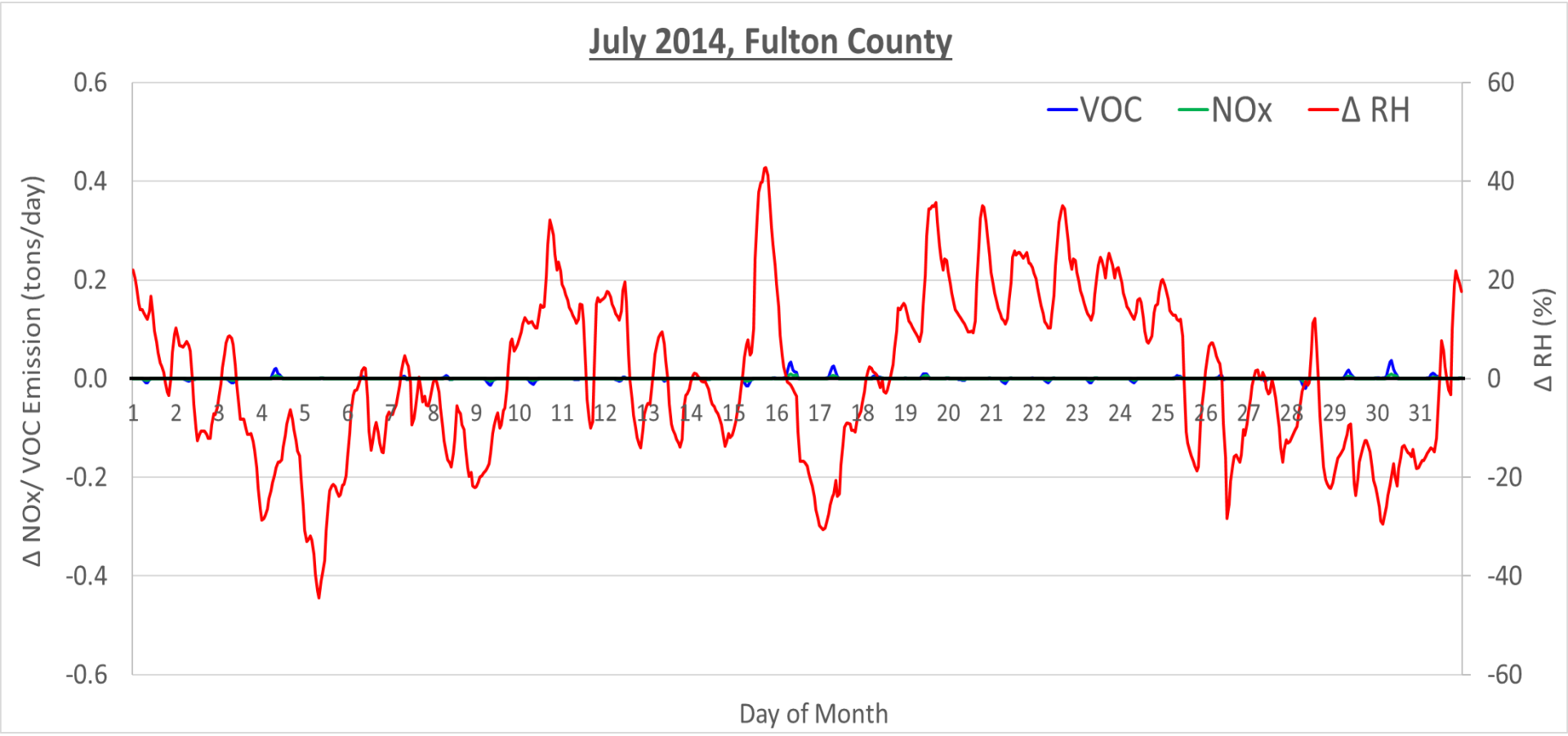
VOC Difference = 13.0 %

H-MET minus M-MET NOx and VOC Start Emissions vs. Δ Temp



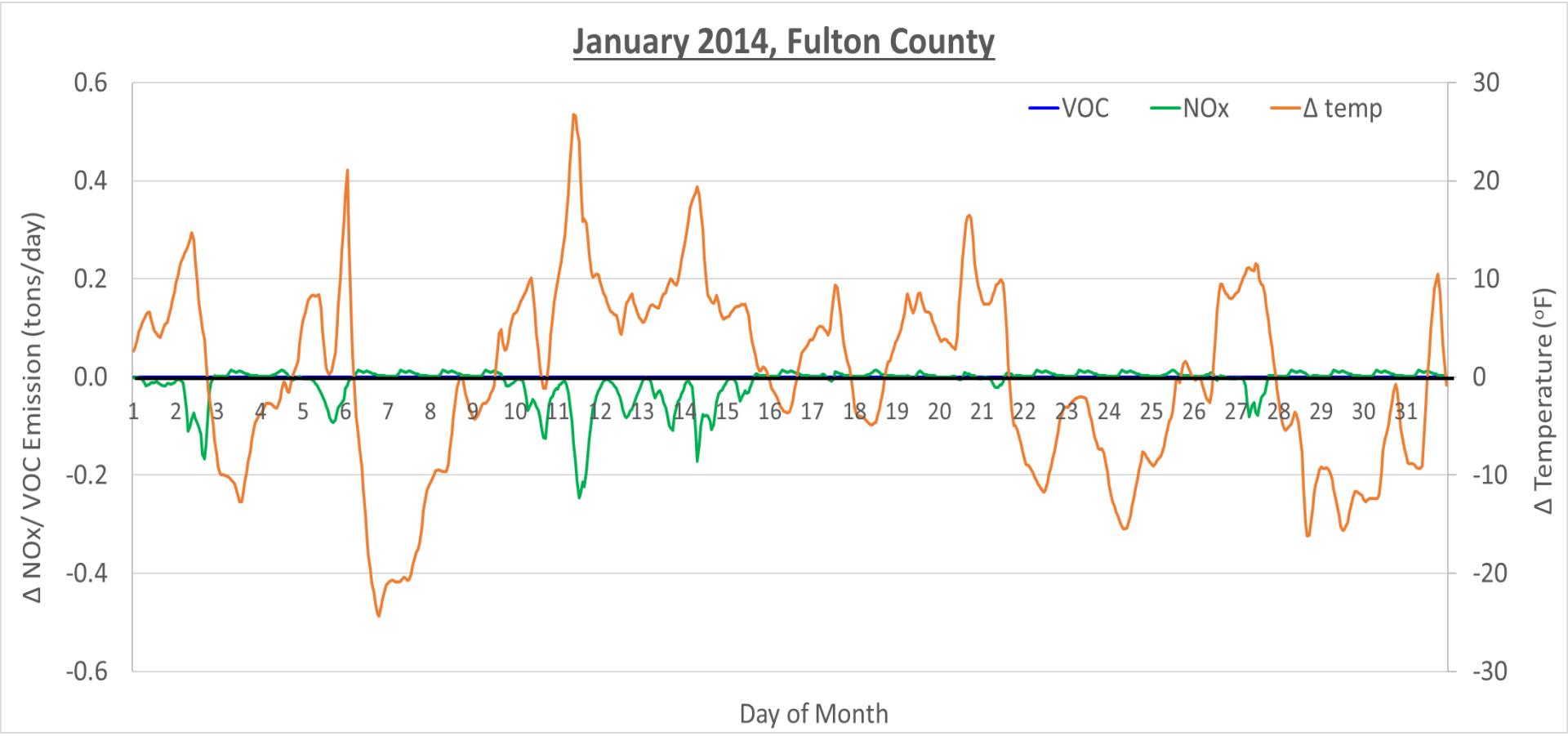
NOx Difference = 0.1%
VOC Difference = 0.2 %

H-MET minus M-MET NOx and VOC Start Emissions vs. Δ RH



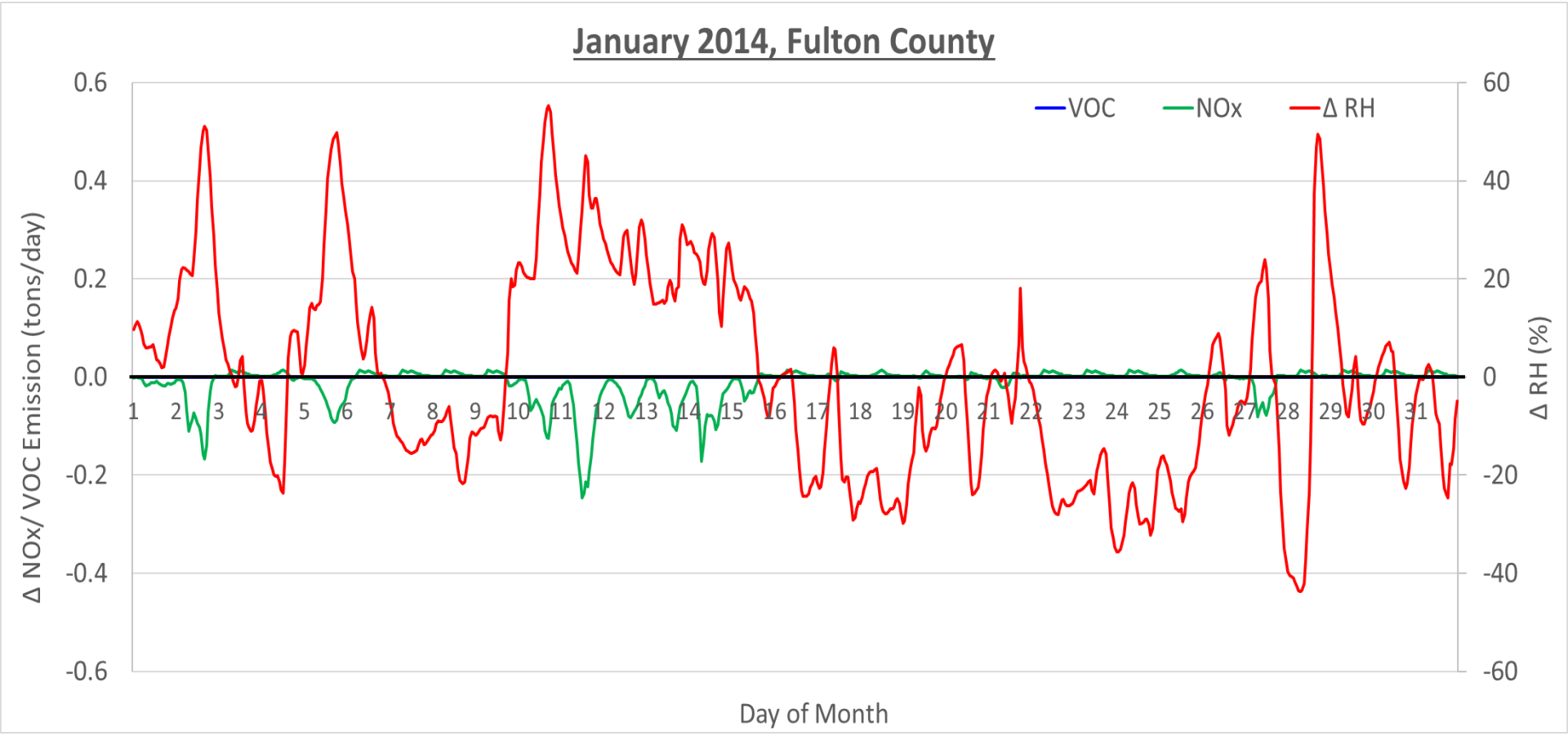
NOx Difference = 0.1%
VOC Difference = 0.2 %

H-MET minus M-MET NOx and VOC Running Emissions vs. Δ Temp



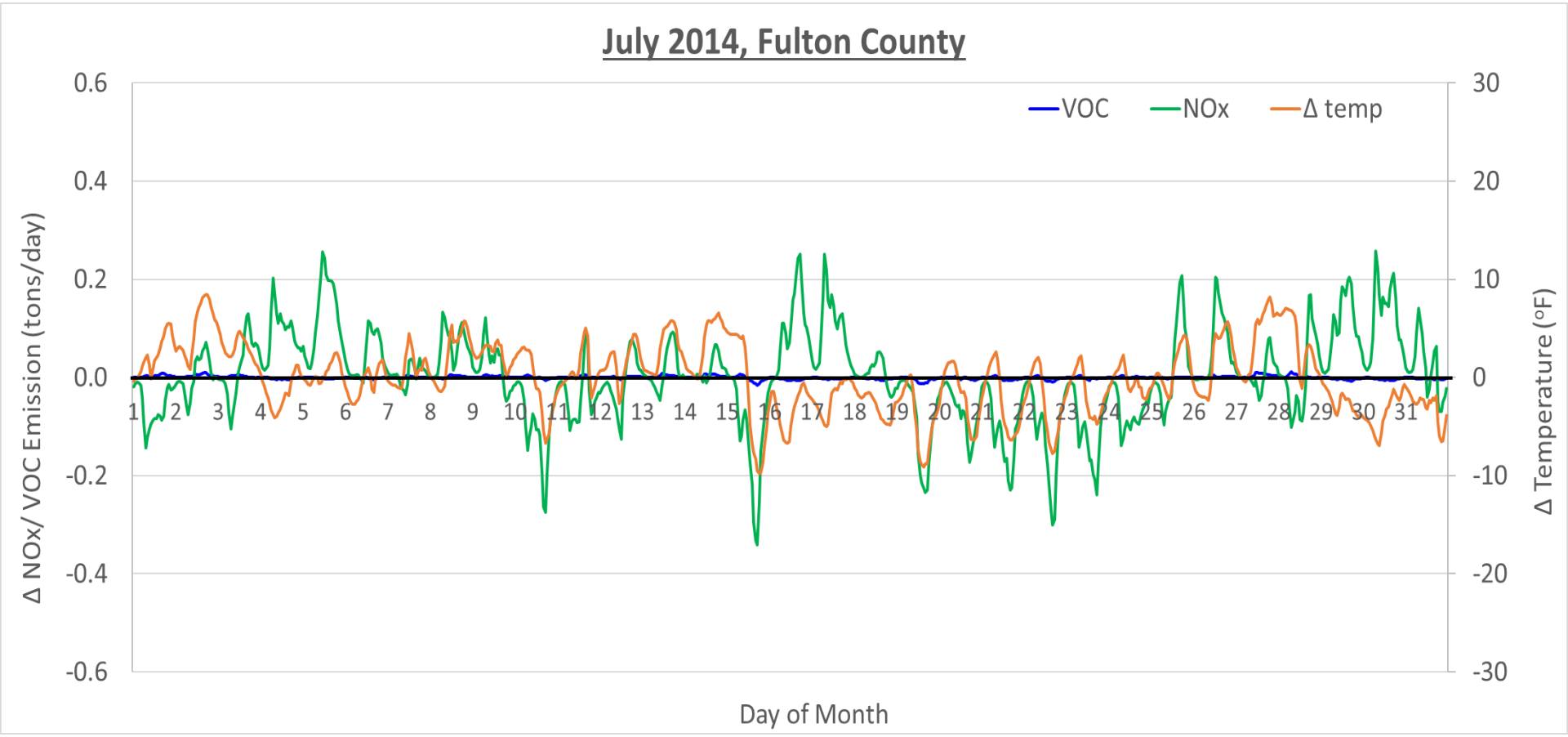
NOx Difference = -1.1 %
VOC Difference = 0.0 %

H-MET minus M-MET NOx and VOC Running Emissions vs. Δ RH



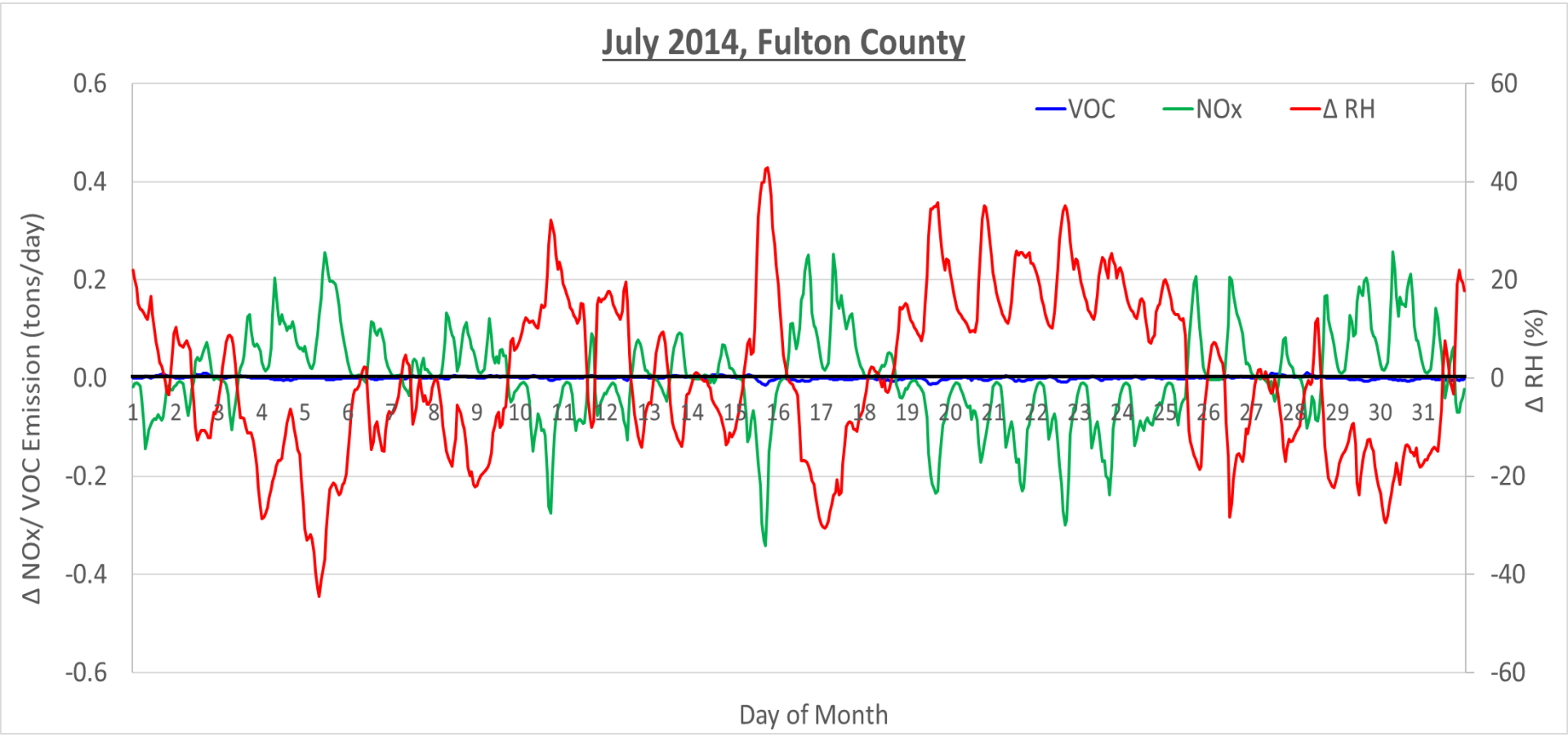
NOx Difference = -1.1 %
VOC Difference = 0.0 %

H-MET minus M-MET NOx and VOC Running Emissions vs. Δ Temp



NOx Difference = 0.3 %
VOC Difference = -0.1 %

H-MET minus M-MET NOx and VOC Running Emissions vs. Δ RH



NOx Difference = 0.3 %
VOC Difference = -0.1 %

NO_x EMISSIONS DIFFERENCES BETWEEN H-MET AND M-MET

- NOx monthly averaged emission differences between H-MET and M-MET were < 2% for all counties and months
  - No seasonality
- NOx hourly emission differences were up to ~15% impact on specific hours
  - Biggest differences were due to relative humidity impacts on running emissions in the summer months
  - Temperature is not a significant factor

VOC EMISSIONS DIFFERENCES BETWEEN H-MET AND M-MET

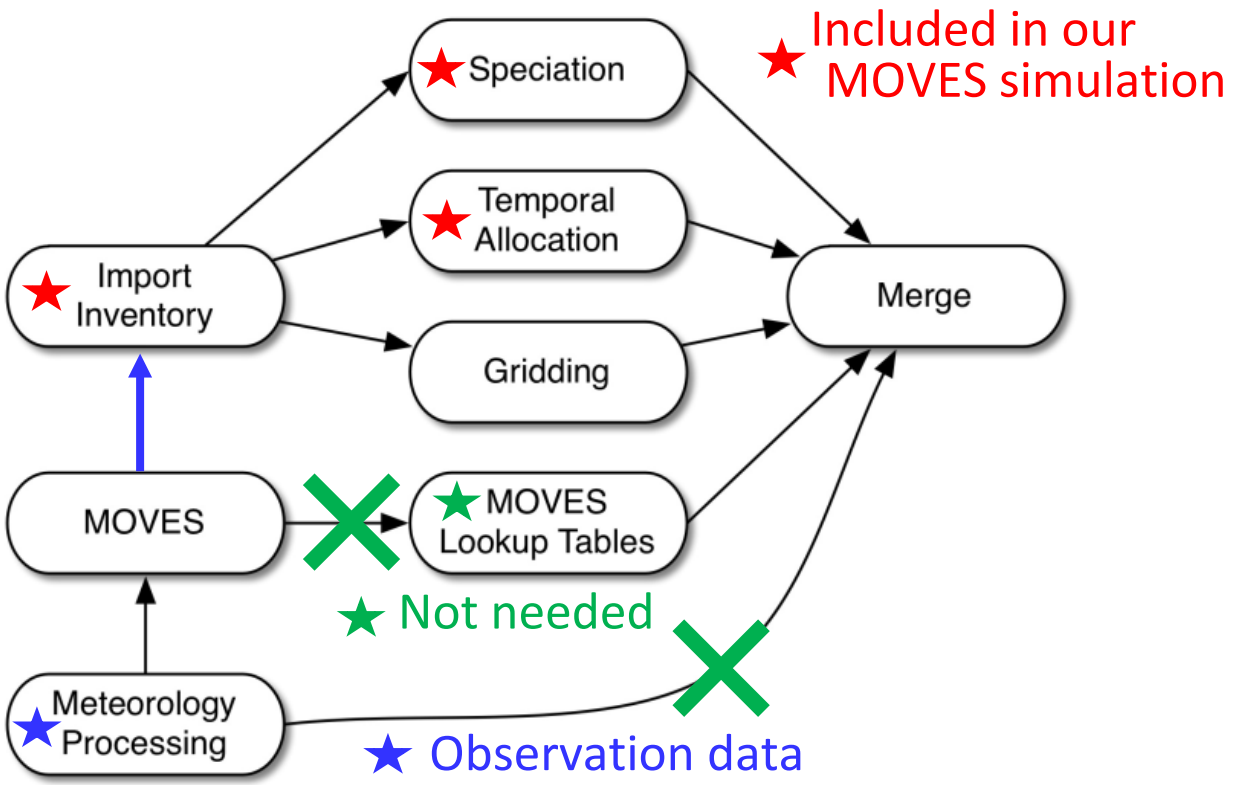
- VOC monthly averaged emission differences between H-MET and M-MET were < 3.3% for all counties and months
  - EXCEPT for January (up to 6%)
- VOC hourly emission differences were up to 20-30% impact on specific hours
  - Biggest differences were due to temperature impacts on start emissions ("cold starts") in the winter months
  - RH is not a significant factor

NEXT STEPS

- Run MOVES in inventory mode for 4 additional ozone nonattainment counties in Georgia
- Analyze additional pollutants
  - PM, CO, NH_3, and SO_2
- Look at emission comparisons for 2017 NEI
- Process hourly Inventory MOVES emissions through SMOKE ("MOVES-SMOKE") to generate gridded inputs for photochemical grid models
  - See next two slides

MOVES-SMOKE vs. SMOKE-MOVES

Current approach: SMOKE RatePerDistance processing steps



MOVES-SMOKE APPROACH

MOVES county-level hourly output → SMOKE spatial allocation (i.e., gridding) → Hourly gridded emissions for photochemical modeling

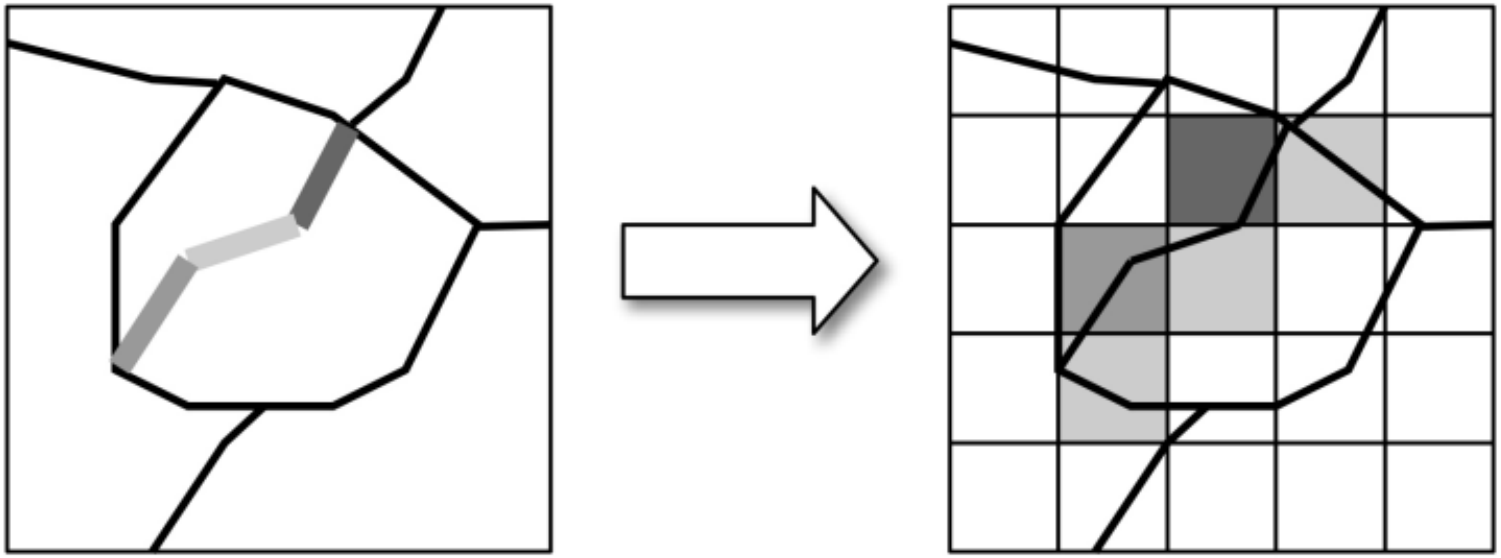


Figure obtained from *SMOKE v3.7 manual*

CONCLUSIONS

- Hourly VOC emissions are sensitive to temperature in the winter due to start emissions (cold starts)
- Hourly NOx emissions are sensitive to RH in the summer due to running emissions
- The "Gold Standard" should be Inventory MOVES runs with hourly meteorology from observations
  - GA EPD feels that running Inventory MOVES (MOVES-SMOKE) is preferred to running SMOKE-MOVES since there are no additional simplifying assumptions and observed meteorology is more accurate than modeled meteorology
- If resource are limited, can apply hourly meteorology to nonattainment/maintenance counties and monthly diurnal meteorology to the remaining counties
  - GA EPD "Hybrid Approach"

CONTACT INFORMATION

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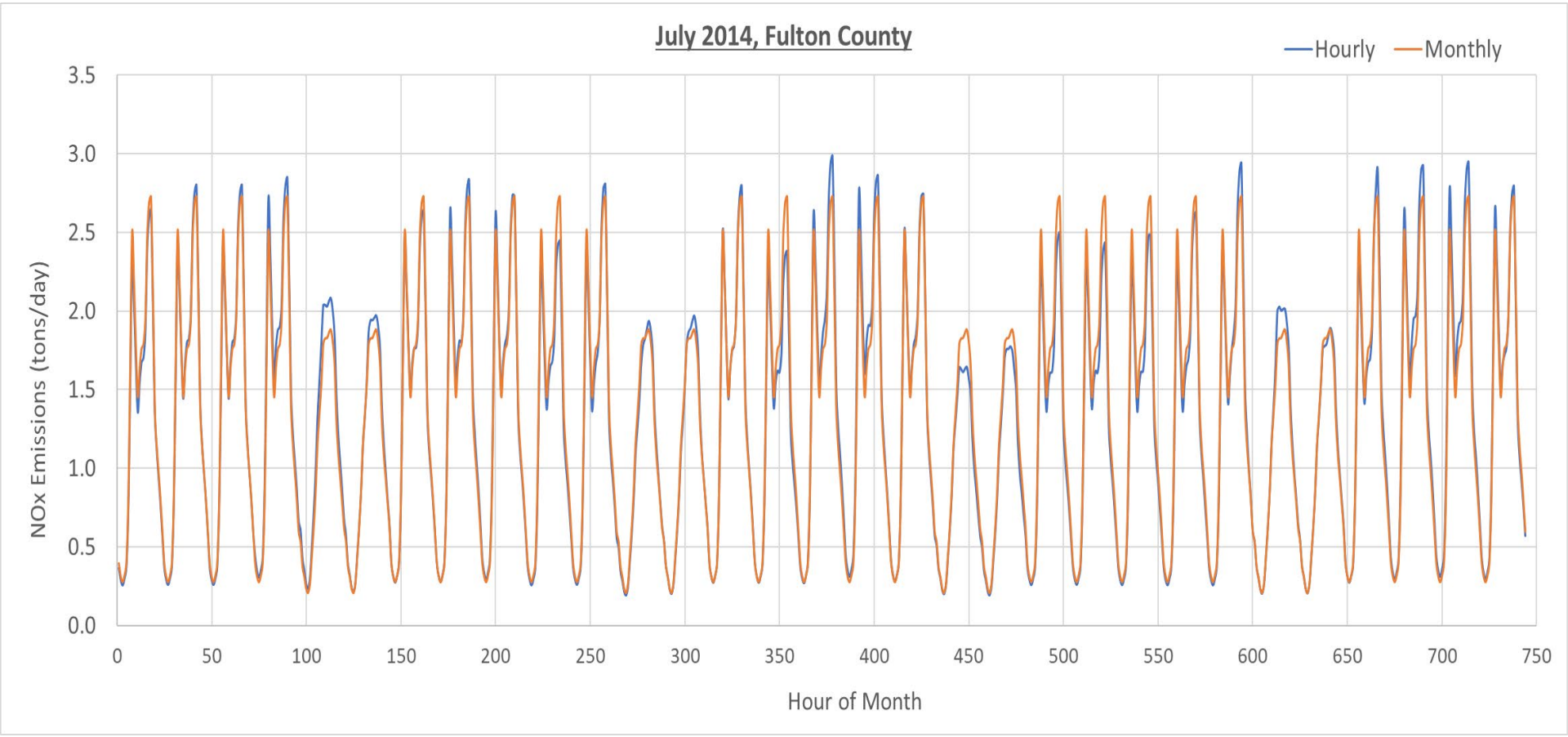
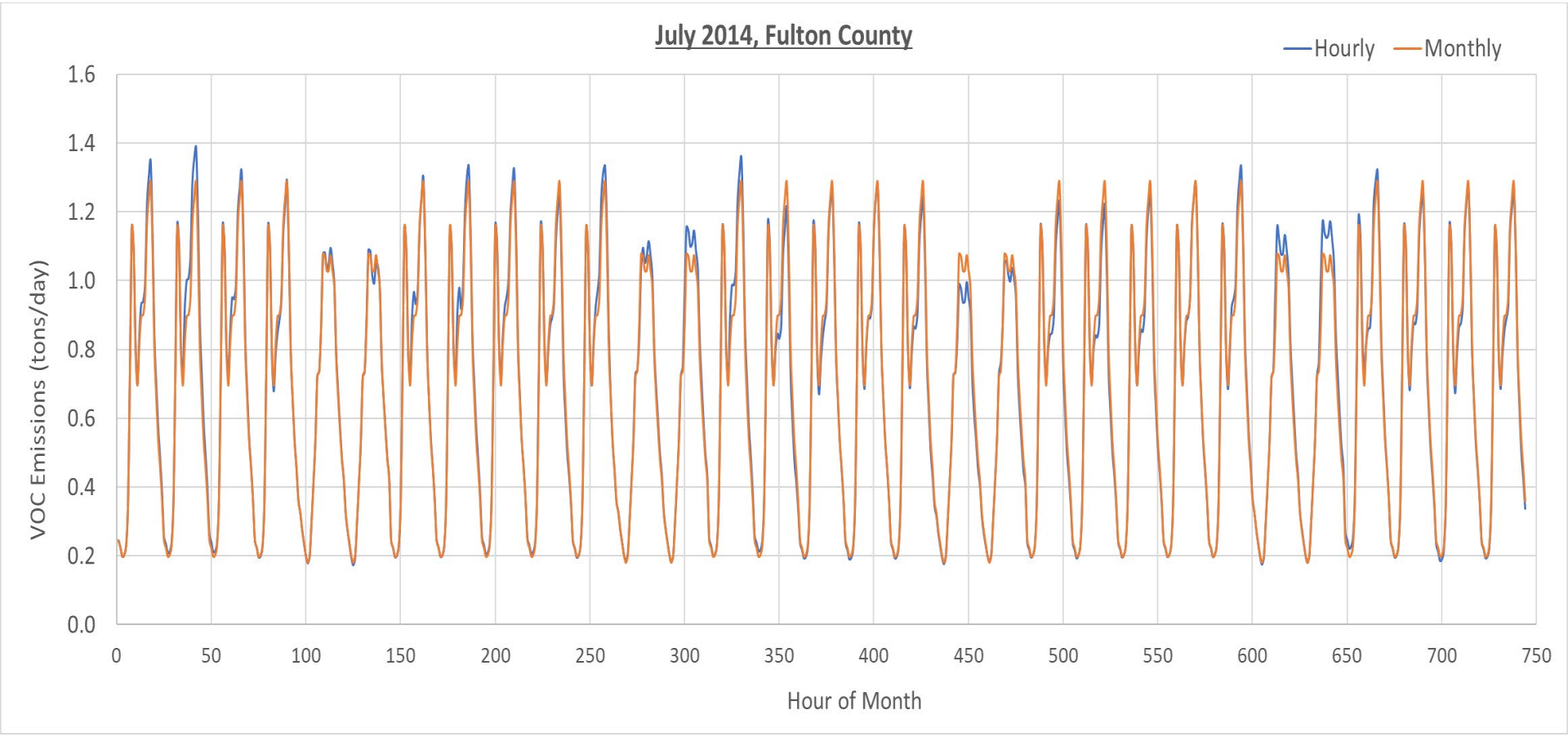
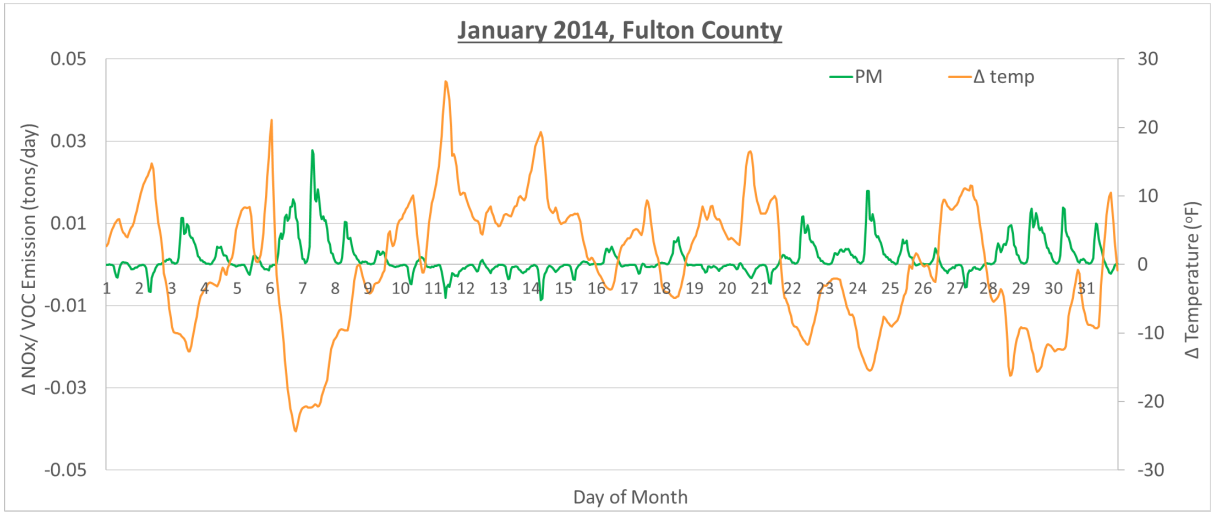
EXTRA SLIDES

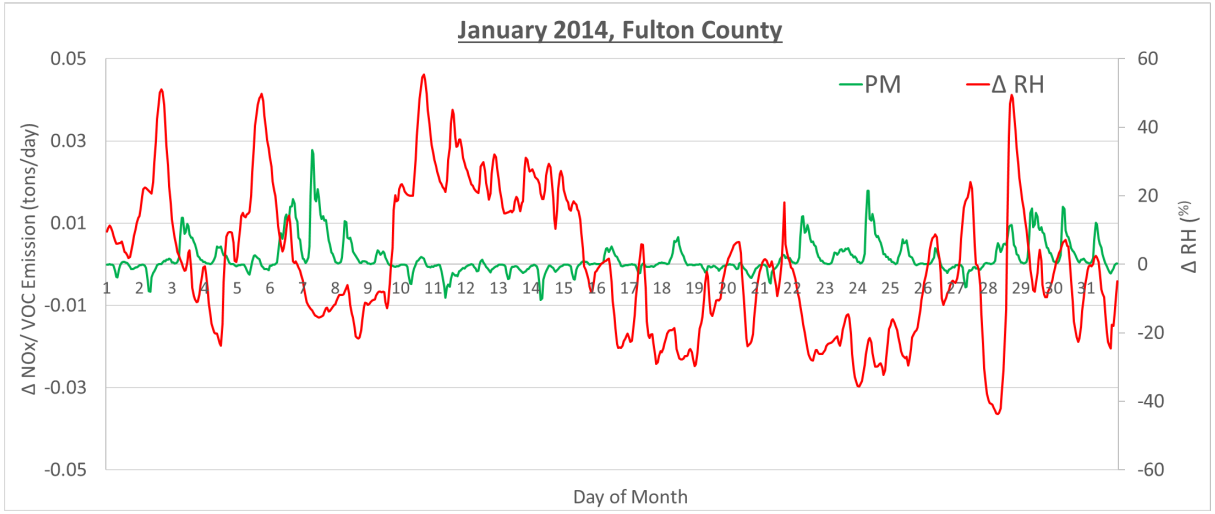
H-MET vs. M-MET NOx Emissions



H-MET vs. M-MET VOC Emissions




January 2014, Fulton County
PM
Δ temp
Δ NOx/ VOC Emission (tons/day)
Δ Temperature (°F)
Day of Month


January 2014, Fulton County
PM
Δ RH
Δ NOx/ VOC Emission (tons/day)
Δ RH (%)
Day of Month