A Study on Self-Representing County in MOVES and SMOKE-MOVES

Kristen Stumpf, Jin-Sheng Lin, and Sonya Lewis-Cheatham
Virginia Department of Environmental Quality

MARAMA MOVES Workgroup conference call
October 8, 2013

Background

- MOVES can be run in 2 different modes – inventory mode (Inventory MOVES) and lookup table/emission rate mode (SMOKE-MOVES)
- The 2 modes make some compromises:
  - -- Inventory MOVES compromises in meteorology by using monthly averaged profiles (as opposed to detailed hourly profiles)
  - -- SMOKE-MOVES compromises in spatial variability by using representative counties (as opposed to individual county)
- GA and VA have shown meteorology compromise in Inventory MOVES to be minor in emission estimates
- EPA released 2011 NEI version1 inventory on September 30, 2013. The inventory is currently under review

Available Datasets for Comparison

- (1) 2011 Inventory MOVES for 134 VA counties
- (2) 2011 SMOKE-MOVES with 4 representative counties
- (3) 2011 SMOKE-MOVES with 12 representative counties
- (4) 2011 EPA NEI version1 (SMOKE-MOVES with 12 representative counties)

Operational differences among available datasets

	(1) VDEQ INV	(2) VDEQ 4RepC	(3) VDEQ 12RepC	(4) EPA NEI v1
Organization	VA DEQ	VA DEQ	VA DEQ	EPA
Operation Mode	inventory	lookup table	lookup table	lookup table
Spatial Resolution	individual county	4 representative counties	12 representative counties	12 representative counties
Meteorology	monthly avg. met	pseudo WRF	pseudo WRF	gridded WRF
VMT/VPOP	county specific	aggregated	aggregated	no aggregation
Speed Treatment	fractional VHT (vehicle hour traveled)	constant speed by SCCs	constant speed by SCCs	unknown

-- Pseudo WRF, developed by Winston Hao of NY, is a combination of observational and analytical fields of met data
-- Activity aggregation summarizes data over all counties represented by representative county
-- Adding average vehicle age to representative county selection criteria increased number of counties from 4 to 12.

Motivation

- VA has used 4 representative counties to conduct SMOKE-MOVES modeling for 2007BY and 2011BY
- After reevaluation, EPA in May 2013 finalized a scheme of representative county for 2011 NEI
- The scheme calls for 12 representative counties for Virginia
- 6 of the 12 "new" representative counties represent only themselves (i.e., they are not grouped with other counties)

Self-Representing!

How will comparisons fair among model runs for self-representing counties?

- Review EPA 2011 NEI and compare the 6 counties not grouped with other counties first

Self-Representing is Special …

- No county grouping or activity aggregation for SMOKE-MOVES
- Identical model inputs between Inventory MOVES and SMOKE-MOVES (i.e., individual, county-specific data are used)
- Allow 1-to-1 direct county comparison with few complications
- Ideal for isolating impacts and investigating model differences

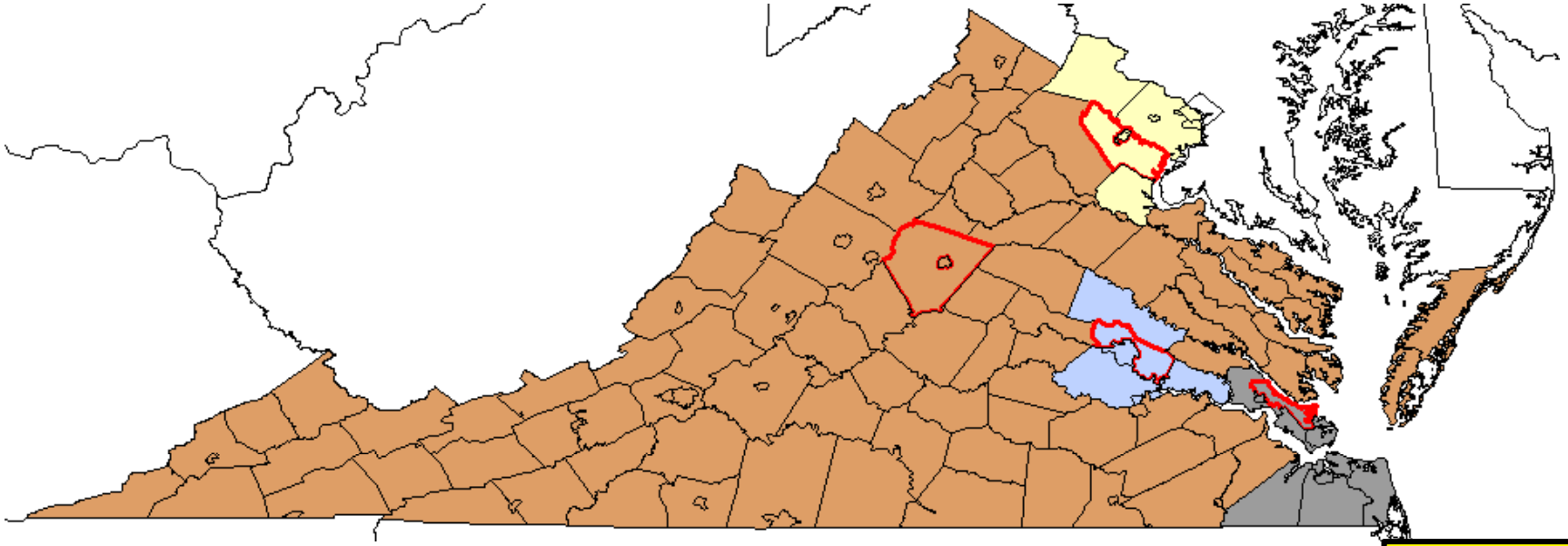
Eliminating grouping and aggregation, only 3 operational differences remain between the two operation modes:

Operational Difference	Inventory MOVES	SMOKE-MOVES
(1) meteorology	monthly averaged met	hourly gridded WRF
(2) VMT/VPOP activity	VMT by HPMS; VPOP by MOVES source types	activity allocation by SCCs
(3) speed treatment	Fractional VHT (vehicle hour traveled)	Constant (averaged) or hourly speed profiles

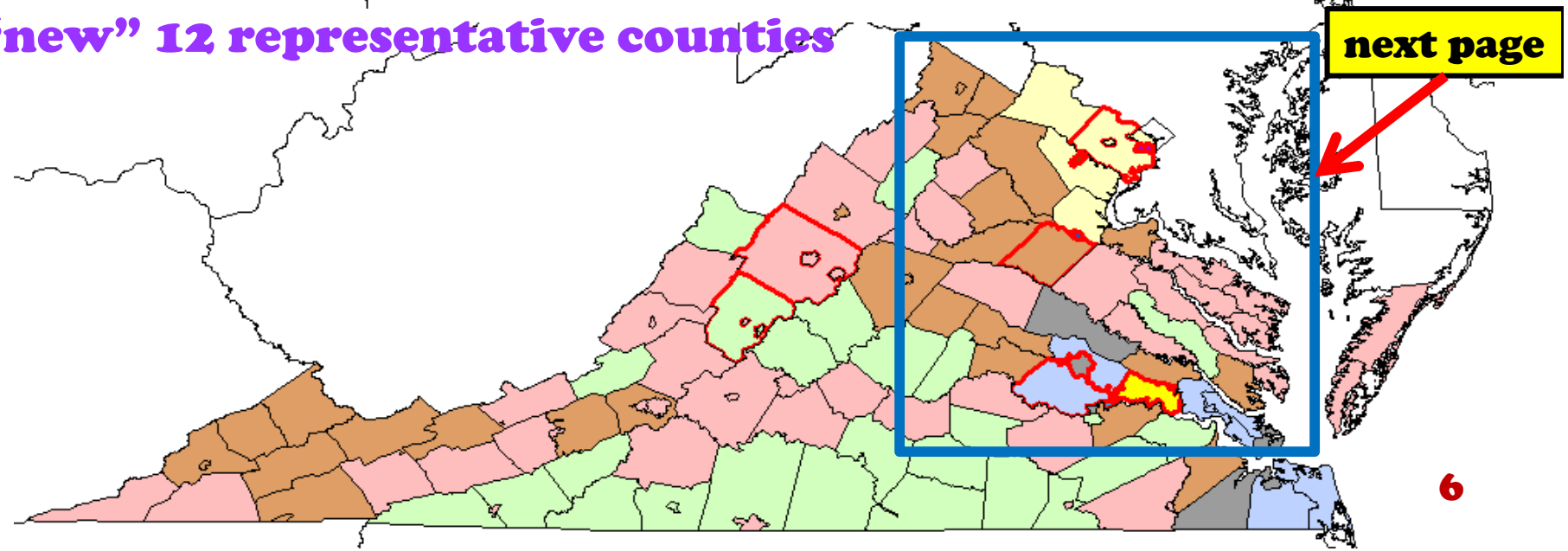
-- Meteorology has been shown to have only a minor impact on emission estimates;
-- Should the new SCC algorithm be implemented, uncertainty by (2) would be eliminated

Representative Counties for VA

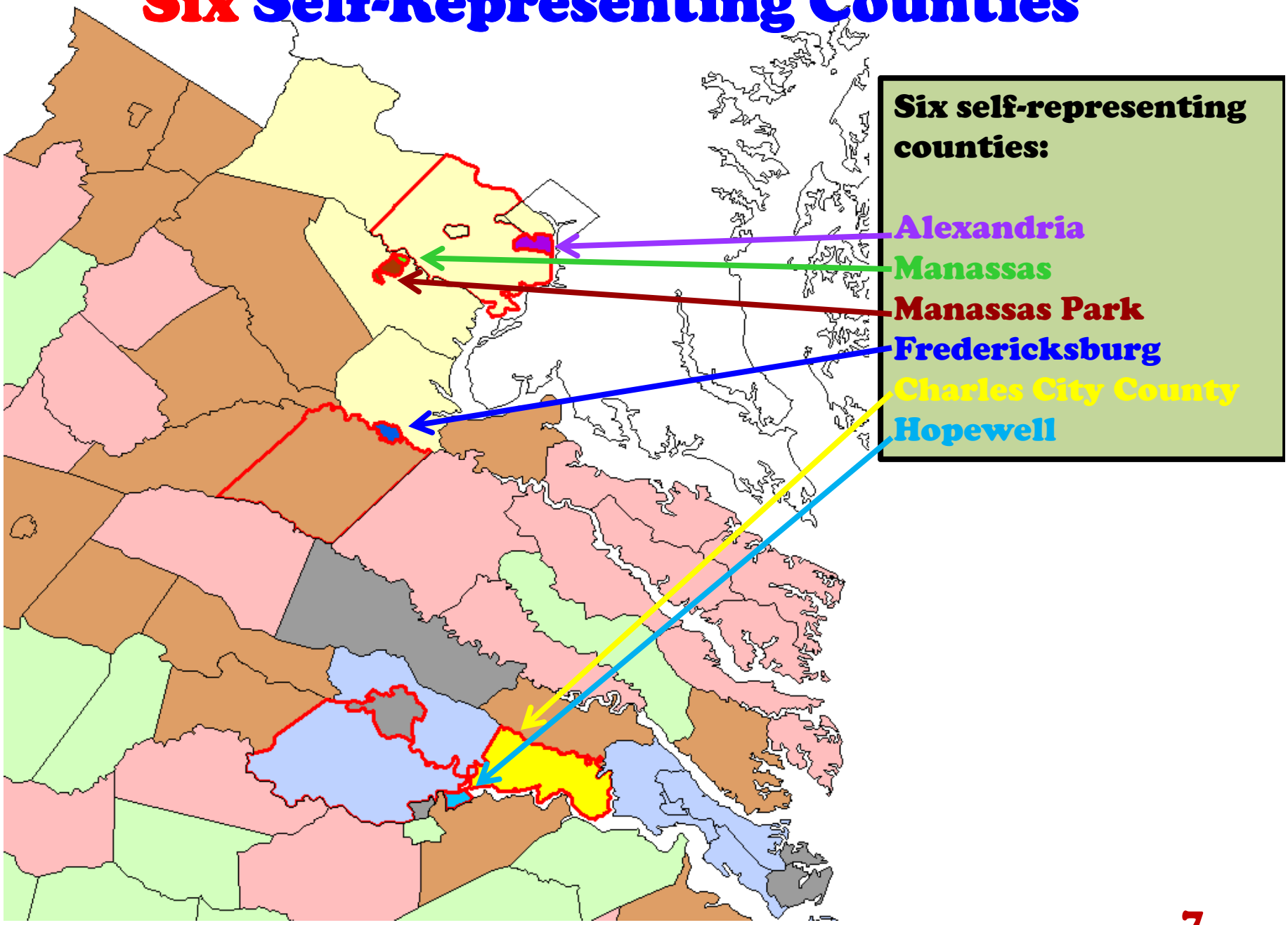
- "old" 4 representative counties



- "new" 12 representative counties



Six Self-Representing Counties



Comparison for Self-Representing Counties

2011 Annual NOx (tons/year)

FIPS	County	(1)VDEQ INV	(2)VDEQ 4RepC	(3)VDEQ 12RepC	(4)EPA NEI v1
51510	Alexandria	749.92	799.02 (+49.1)	743.38 (-6.54)	746.08 (-3.84)
51630	Fredericksburg	642.20	767.71 (+125.51)	611.02 (-31.18)	712.24 (+70.0)
51683	Manassas	347.82	286.04 (-61.78)	316.27 (-31.55)	338.97 (-8.85)
51670	Hopewell	272.53	214.76 (-57.77)	268.38 (-4.15)	270.17 (-2.36)
51036	Charles City	192.67	153.89 (-38.78)	188.53 (-4.14)	184.13 (-8.54)
51685	Manassas Park	61.92	49.35 (-12.57)	60.54 (-1.38)	60.69 (-1.23)

NOT self-representing
(i.e., estimated from county grouping)

* Difference from Inventory MOVES (run 1) are in parenthesis;
* NOx in run 2, which is not self-representing, are very different from the other 3 runs;
*The 3 self-representing runs (EPA 2011 NEI version1 included) all estimate similar (some nearly identical) NOx.

VDEQ_4RepC (which is not self-representing, i.e, with county grouping) combined non-county-specific emission rates (estimated from representative county) with county-specific activities (VMT/VPOP) for emission totals.

Summary

- SMOKE-MOVES with county grouping deviates from inventory MOVES and introduces uncertainties
- SMOKE-MOVES without county grouping estimate emissions that are very close to inventory MOVES
- These findings are confirmed by EPA's 2011 NEI version1
- Inventory MOVES is the best approach available and should be used to evaluate SMOKE-MOVES

Conclusions

- **Examination on self-representing counties has further confirmed previous findings:**

  -- Effect of meteorology is minor

  -- 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 is the best approach available and should be used to evaluate SMOKE-MOVES**

Recommendations

- Implement new SCC algorithm as soon as possible
- States are encouraged to run MOVES in inventory mode for comparison
- Adopt GA-suggested hybrid approach in inventory mode, which accounts for hourly peaks deemed important for air quality modeling
  - -- 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 (completed and available?)
- Phase out the use of representative counties
- Parallelize MOVES calculations to reduce processing time