Critical Review of Mobile Emissions from EPA 2011 NEI: Part One – Virginia Example

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presented on January 13, 2014

Background

- EPA released 2011 NEI version1 inventory on September 30, 2013 (the night before the government shutdown)
- The 2011 NEI will be the base inventory used for future air quality modeling by EPA in policy rulemakings such as Tier 3 and transport analyses
- The 2011 NEI version1 inventory is currently under review by states

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)

  * a 5th dataset, 2011 EPA NEI draft, is available for comparison also (see page 12)

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 /age distribution	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.

* Four additional operational differences have been found recently:
(1) extended idling; (2) control programs; (3) fuel inputs; (4) MOVES versions.
* An additional in-house SMOKE MOVES (VDEQ 12RepC EPAadj) was conducted (see slide 18).

Review Category

- (1) NOx comparison of "self-representing" counties among all 4 available datasets
- (2) State-wide NOx comparison by county among all 4 available datasets
- (3) State-wide comparison of all pollutants for Inventory MOVES and 2011 NEI v1 SMOKE-MOVES
- (4) Special NOx comparison by county with extended idling

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 used)
- Allows 1-to-1 direct county comparison with few complications
- Ideal for isolating impacts and investigating model differences

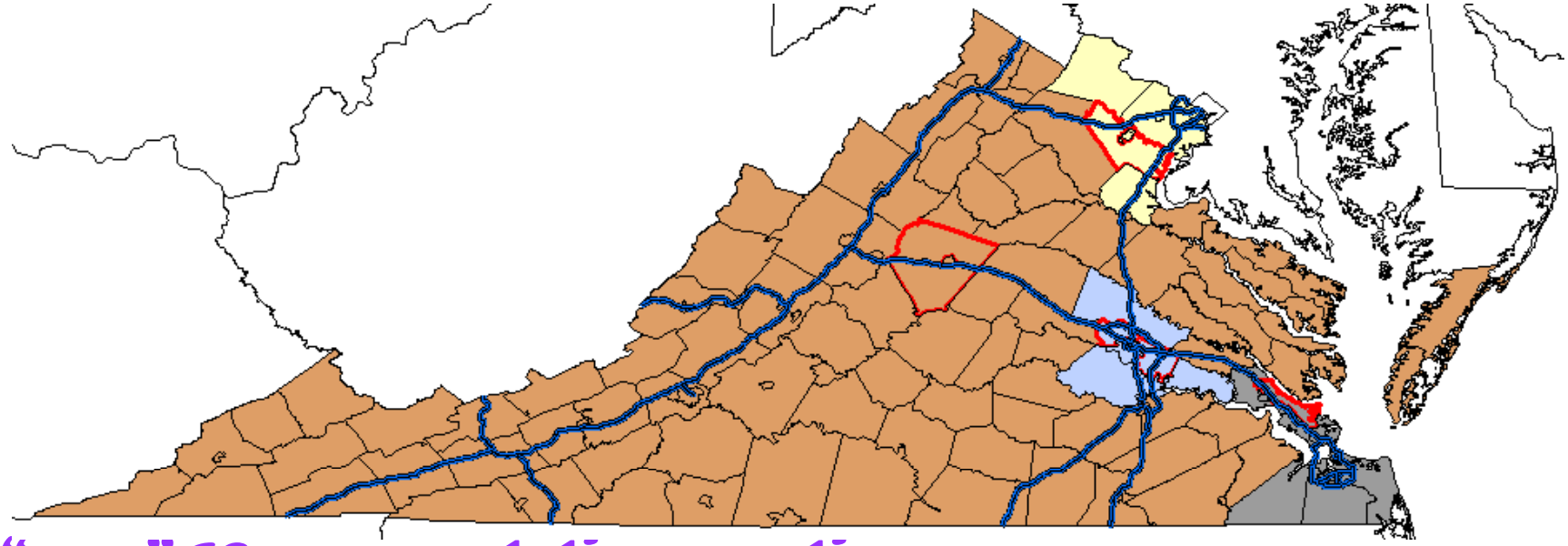
Eliminating grouping and aggregation, only 3 operational differences remain between the two modes:

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

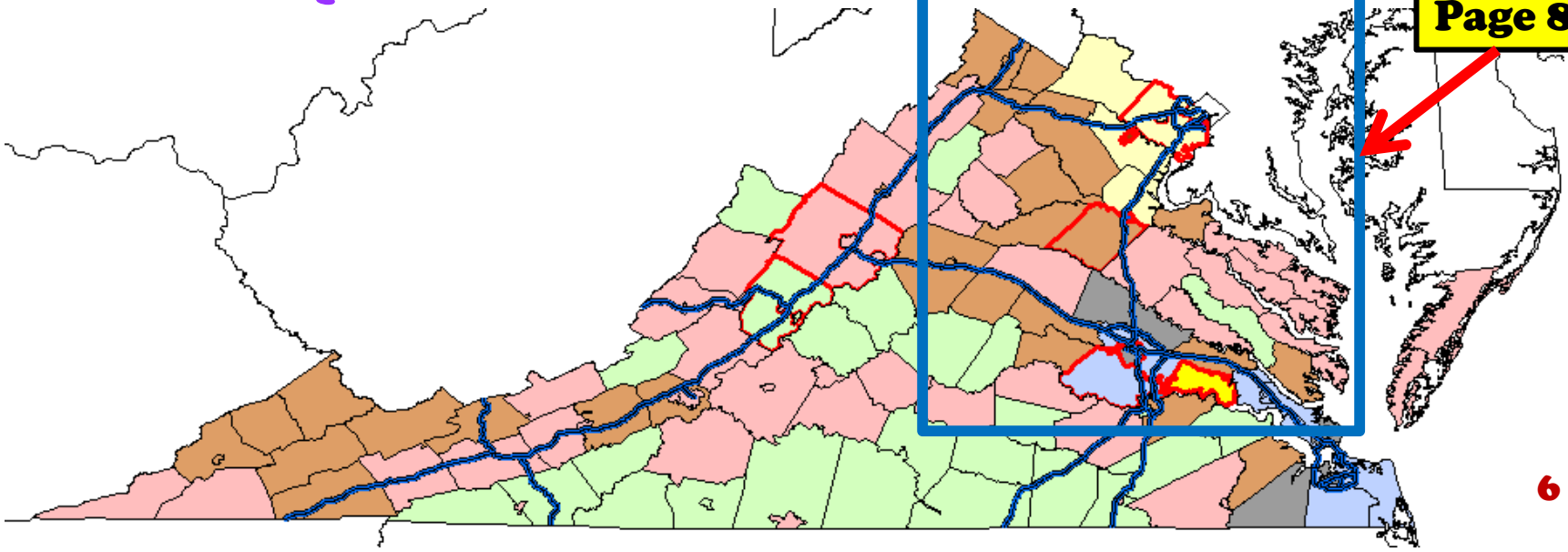
-- Meteorology has been shown to have only a minor impact on emission estimates;
-- When the new SCC algorithm is implemented, uncertainty associated with (2) will be eliminated .

Representative Counties for VA

- "old" 4 representative counties



- "new" 12 representative counties



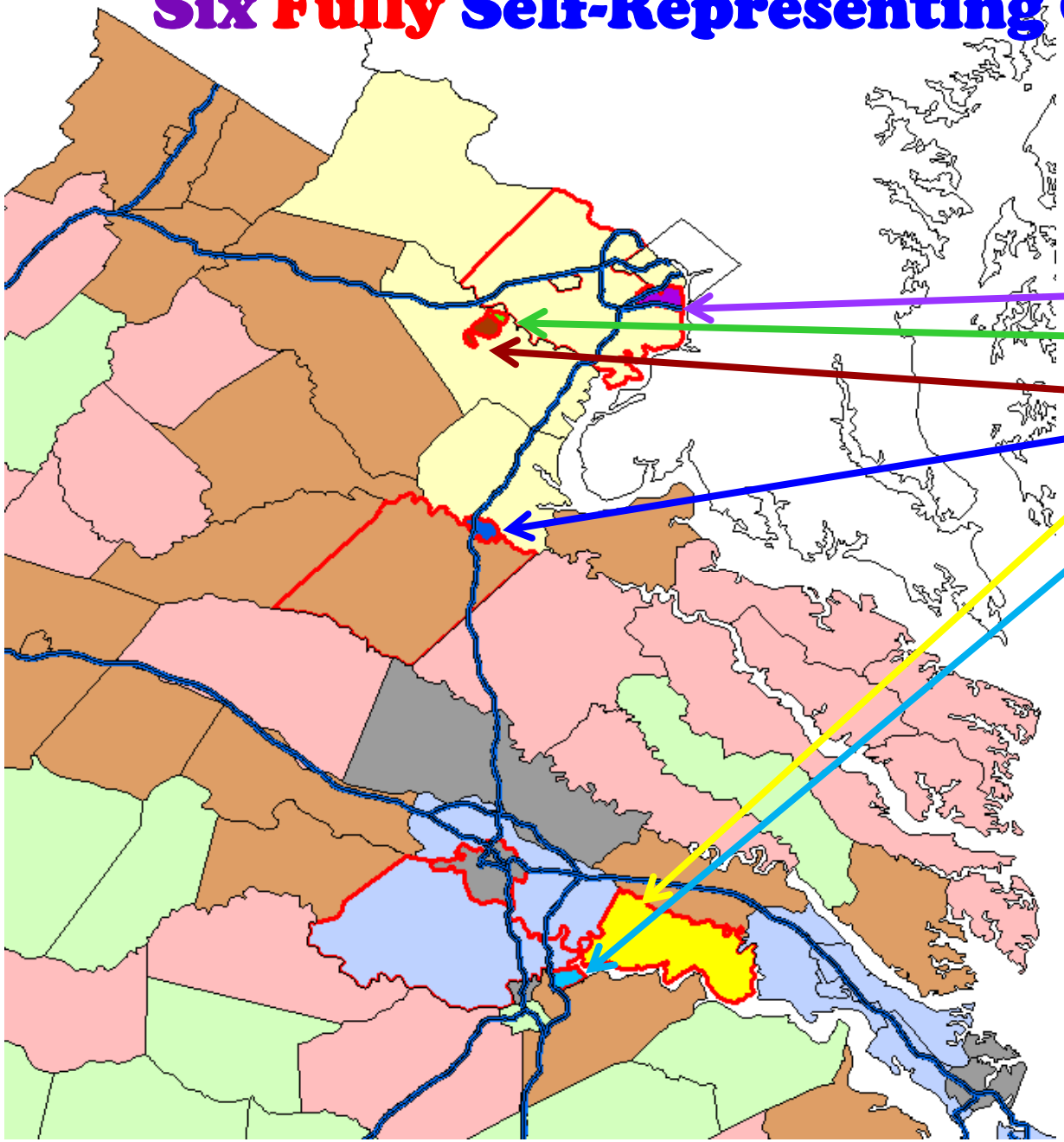
Self-Representing County

Self-representing counties can be further divided into:

- **(1) Representative county which represents no other counties but itself (fully self-representing)**
- **(2) Representative county which represents not only itself but also a group of other counties (i.e., "regular" representative or semi self-representing)**

Representative county	Activity used
(1) Fully self-representing	County-specific
(2) Semi self-representing	Aggregated over the group

Six Fully Self-Representing Counties



6 self-representing counties:

- Alexandria
- Manassas
- Manassas Park
- Fredericksburg
- Charles City County
- Hopewell

Comparison for Representative Counties

2011 Annual NOx (tons/year), % = (SMOKE-MOVES – VDEQ INV) / VDEQ INV

(1) Fully Self-Representing Counties

FIPS	County	(1)VDEQ INV	(2)VDEQ 4RepC	(3)VDEQ 12RepC	(4)EPA NEI v1
51510	Alexandria	750	799 (7%)	743 (-1%)	746 (-1%)
51630	Fredericksburg	642	768 (20%)	611 (-5%)	712 (11%)
51683	Manassas	348	286 (-18%)	316 (-9%)	339 (-3%)
51670	Hopewell	273	215 (-21%)	268 (-2%)	270 (-1%)
51036	Charles City	193	154 (-20%)	189 (-2%)	184 (-4%)
51685	Manassas Park	62	49 (-20%)	61 (-2%)	61 (-2%)

(2) Semi Self-Representing Counties

FIPS	County	(1)VDEQ INV	(2)VDEQ 4RepC	(3)VDEQ 12RepC	(4)EPA NEI v1
51059	Fairfax	9028	9025 (0%)	9050 (0%)	9540 (6%)
51041	Chesterfield	4719	4702 (0%)	4477 (-5%)	4694 (-1%)
51163	Rockbridge	3690	2751 (-25%)	3021 (-18%)	4957 (34%)
51015	Augusta	3632	3606 (-1%)	3589 (-1%)	3806 (5%)
51760	Richmond City	2943	2635 (-10%)	2801 (-5%)	2898 (-2%)
51177	Spotsylvania	2538	2680 (6%)	2459 (-3%)	2161 (7%)

-- Green columns used county specific activity data. Tan columns used aggregated activity data.

-- Additional information on Rockbridge is on page 20.

Summary of Representative County Comparison

- 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 for self-representing counties
- The fact that EPA NEI v1, which supposedly used activities with no aggregation, fares worse for the semi self-representing counties indicates other factors (extended idling, controls, fuels, and/or MOVES versions) are in play

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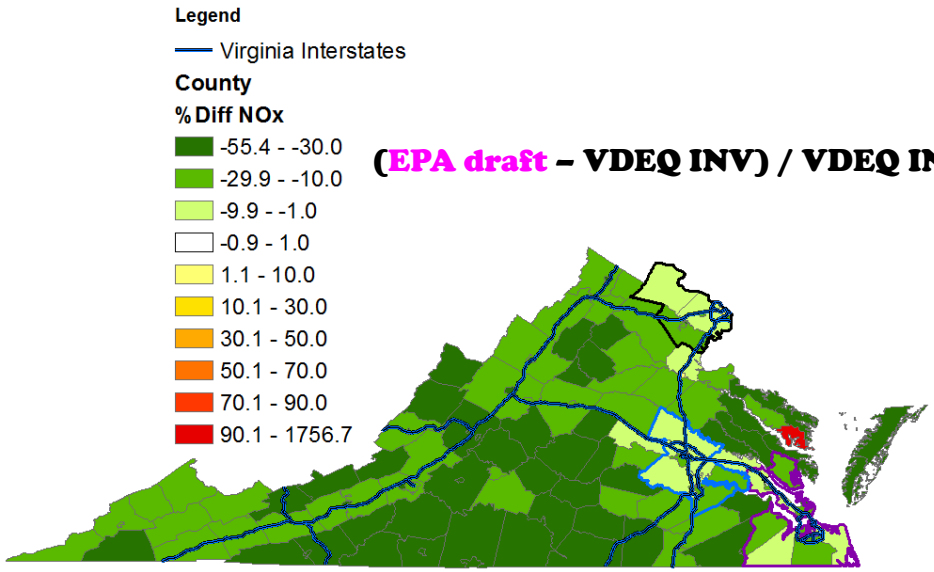
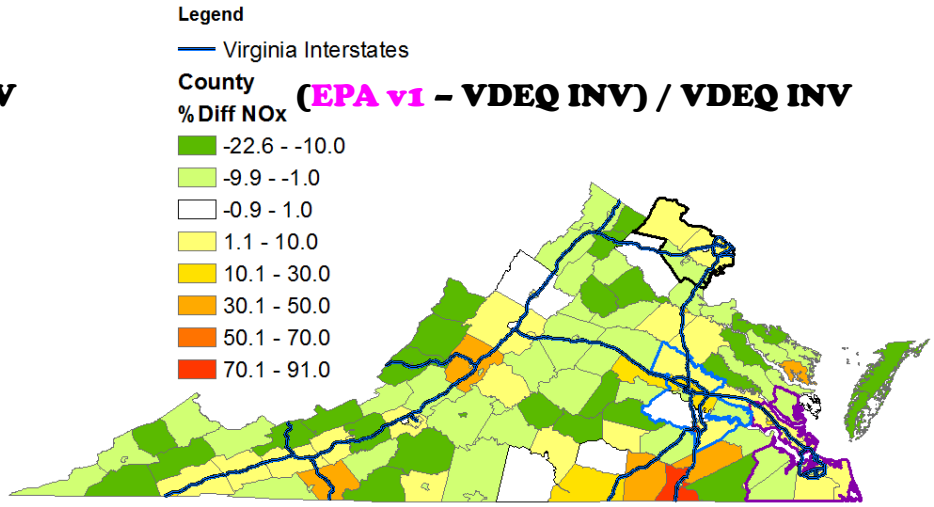
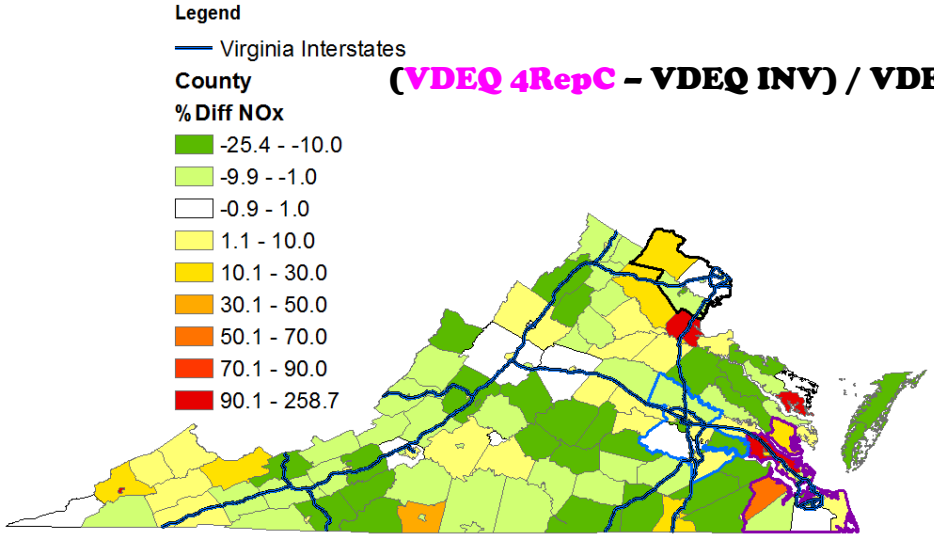
State-wide NOx Comparison



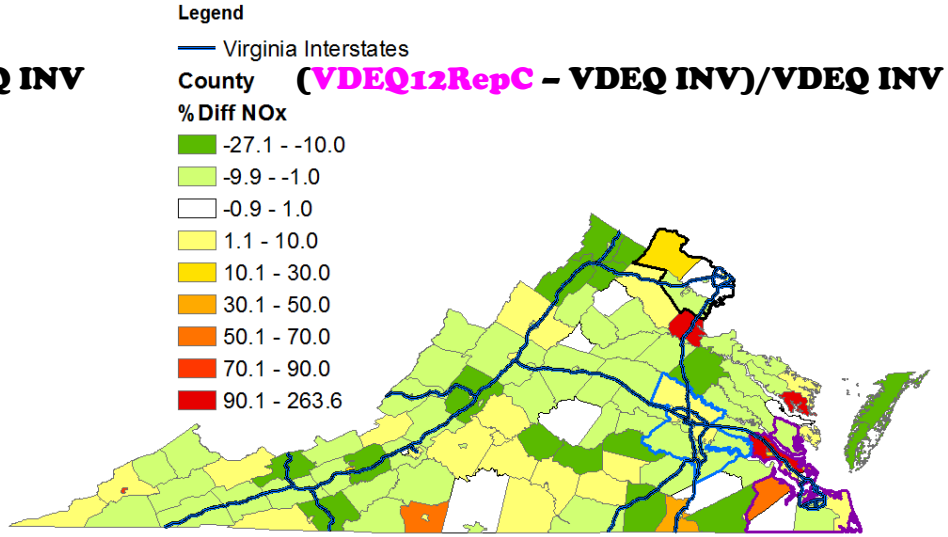
(EPA draft – VDEQ INV) / VDEQ INV



(EPA v1 – VDEQ INV) / VDEQ INV



(VDEQ 4RepC – VDEQ INV) / VDEQ INV



(VDEQ12RepC – VDEQ INV)/VDEQ INV

Three sensitive areas are outlined in different colors:
(1) Northern VA O3 non-attainment (black);
(2) Richmond O3 maintenance (blue);
(3) Hampton Roads O3 maintenance (purple).

State-wide NOx Comparison

- EPA draft, which used out-of-state counties to represent home state, shows extremely poor agreement with MOVES inventory mode
- EPA v1 is an improvement over the draft
- Both 12 rep county runs (VA in-house and EPA) show better agreement with inventory MOVES than 4 rep county run
- Large differences remain, mostly along major interstates

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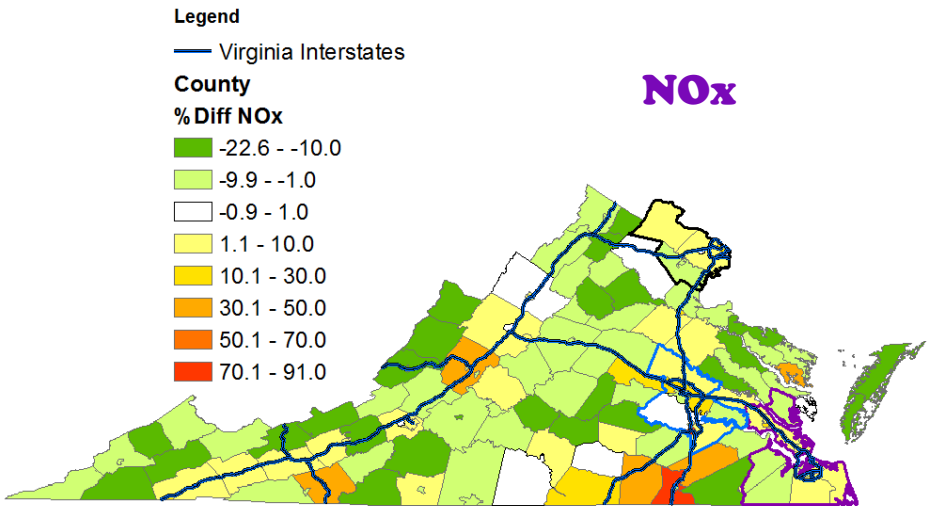
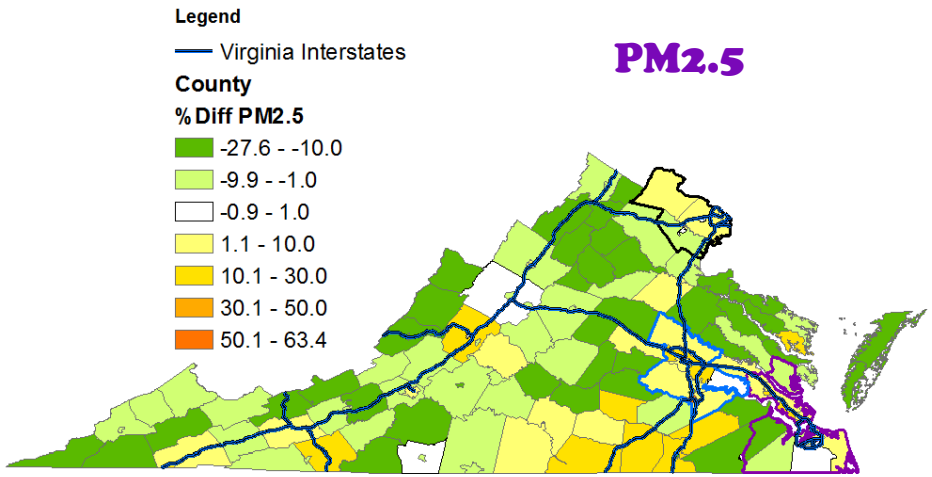
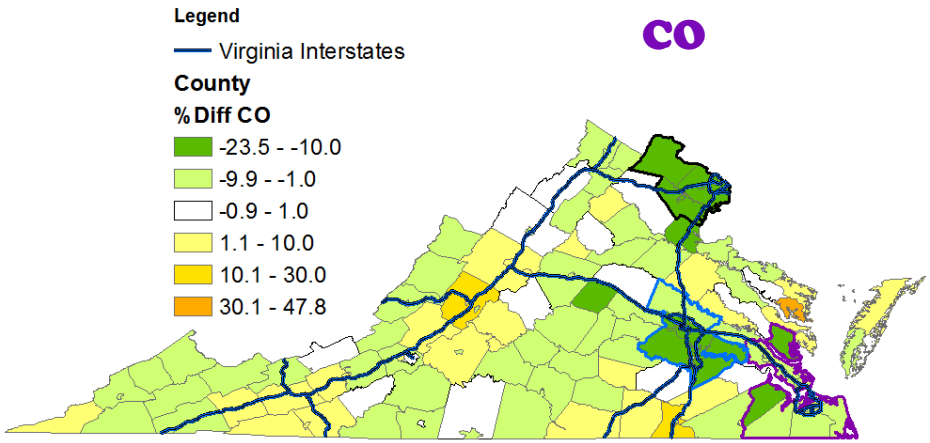
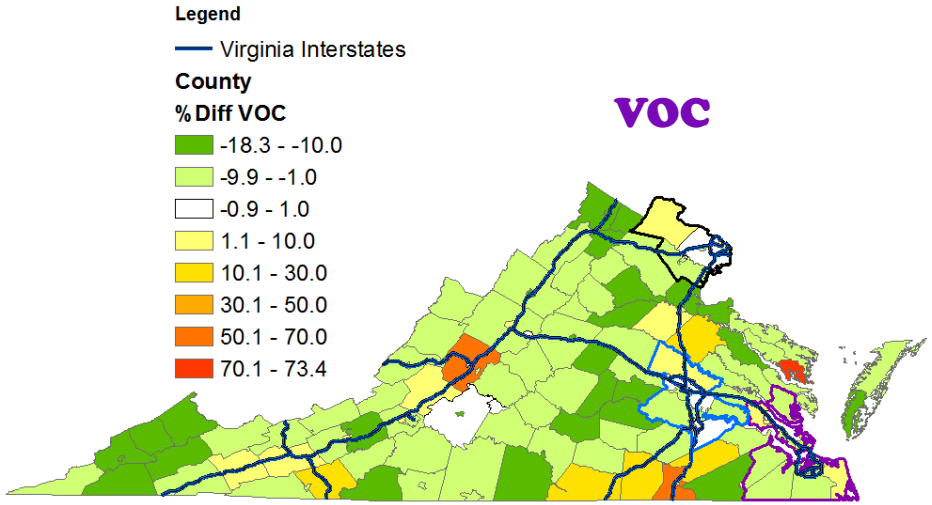
State-wide Comparison (all pollutants)

(EPA v1 – VDEQ INV) * 100 / VDEQ INV



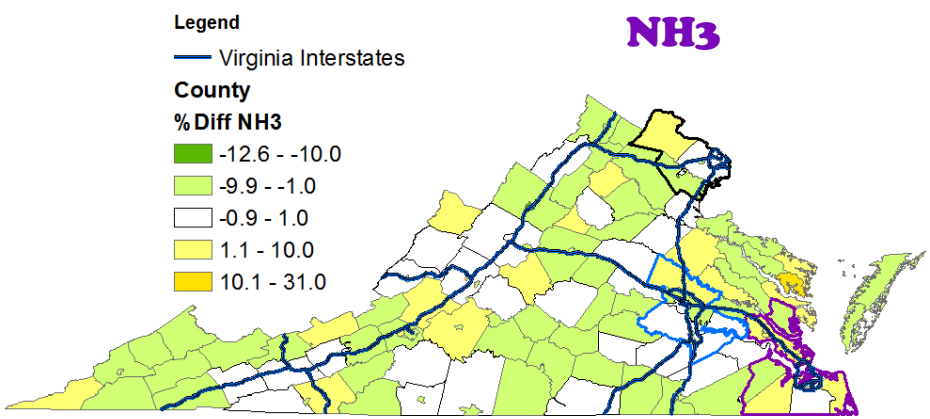


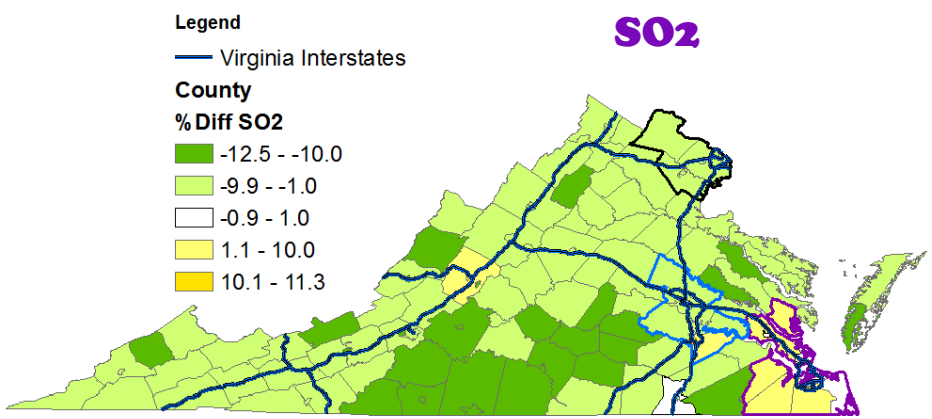




State-wide Comparison (all pollutants)

(EPA v1 – VDEQ INV) * 100 / VDEQ INV





- EPA v1 of the NEI is generally within +/- 30% of inventory MOVES
- A good portion of the counties for all pollutants are within +/- 10%
- The larger positive differences tend to occur in counties with interstates
- Pollutant-wise, species of less temperature dependence (NH_3, SO_2, CO) agree better with inventory MOVES

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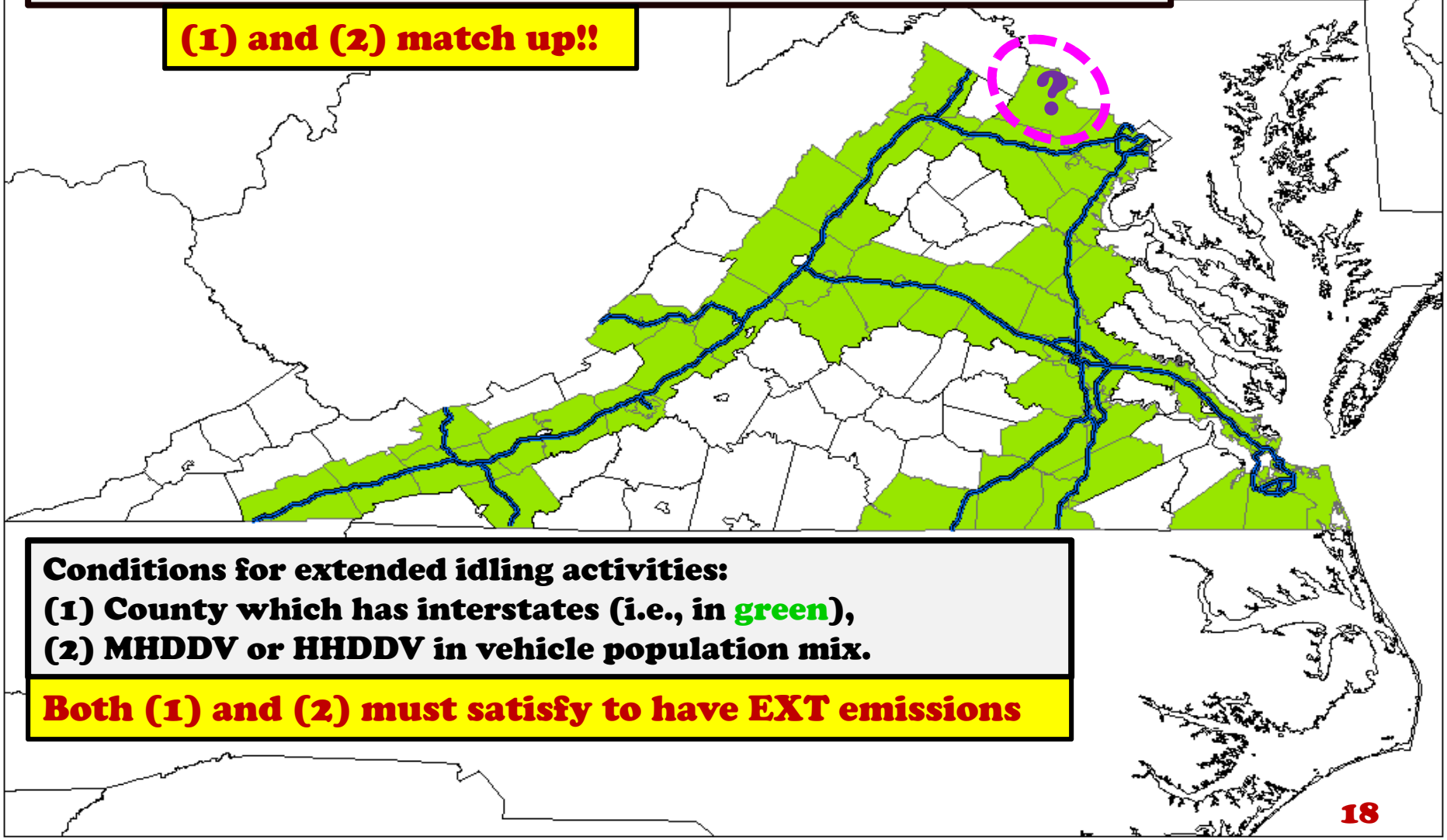
Extended Idling (EXT) County Map

The map was constructed by overlapping:
(1) Interstates GIS shape files (from VDOT),
(2) MOVES default ZONE table where idleAllocFactor is non-zero.

(1) and (2) match up!!



Conditions for extended idling activities:
(1) County which has interstates (i.e., in green),
(2) MHDDV or HHDDV in vehicle population mix.

Both (1) and (2) must satisfy to have EXT emissions

Special Comparison – Extended Idling

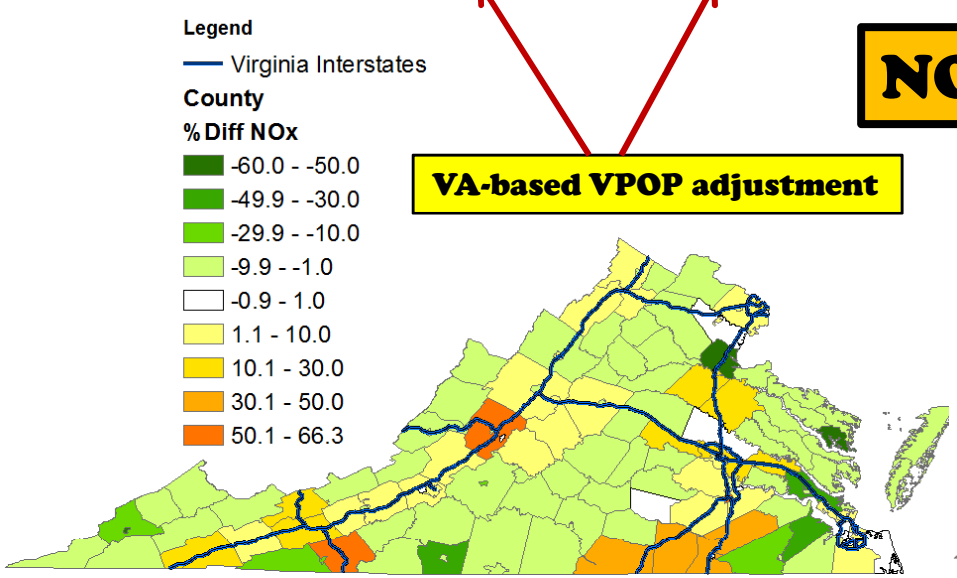
- 2011 NEI version1 "adjusted" extended idling emissions in SMOKE using VPOP-adjustment factors
- VA followed the practice in its original SMOKE-MOVES (denoted by VDEQ 12RepC) with adjustment factors which were derived from state-wide VPOP
- EPA later clarified adjustment factors in 2011 NEI version1 were based on nation-wide VPOP
- Nation-wide and state-wide VPOP adjustment factors by county in VA differ by 100 fold
- VA conducted a revised SMOKE-MOVES run (denoted by VDEQ 12RepC EPAadj) with EPA's adjustment factors (i.e., using nation-wide VPOP posted on 2011 NEI CHIEF website)

Special Comparison – Extended Idling

NOx

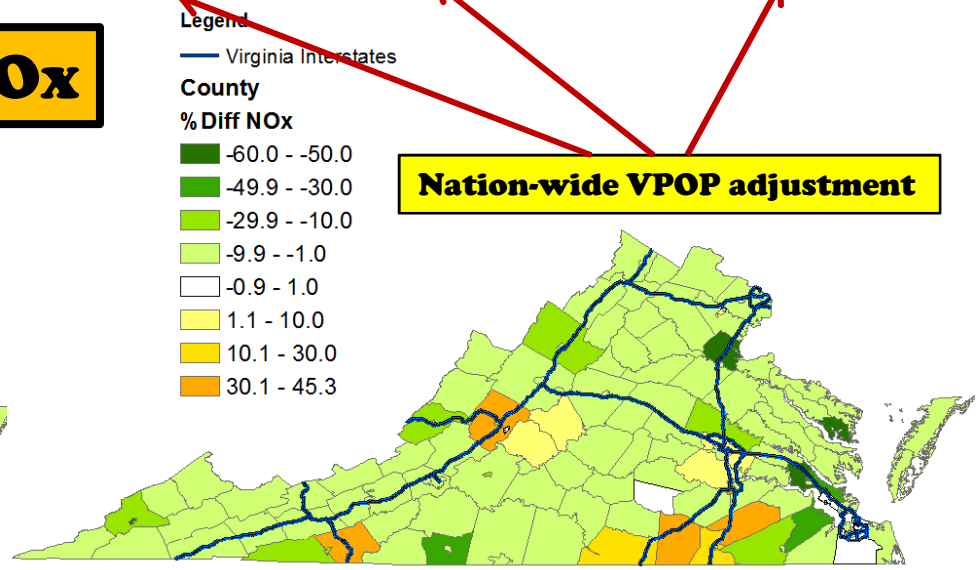
(EPA v1 – VDEQ12RepC) /VDEQ12RepC

VA-based VPOP adjustment

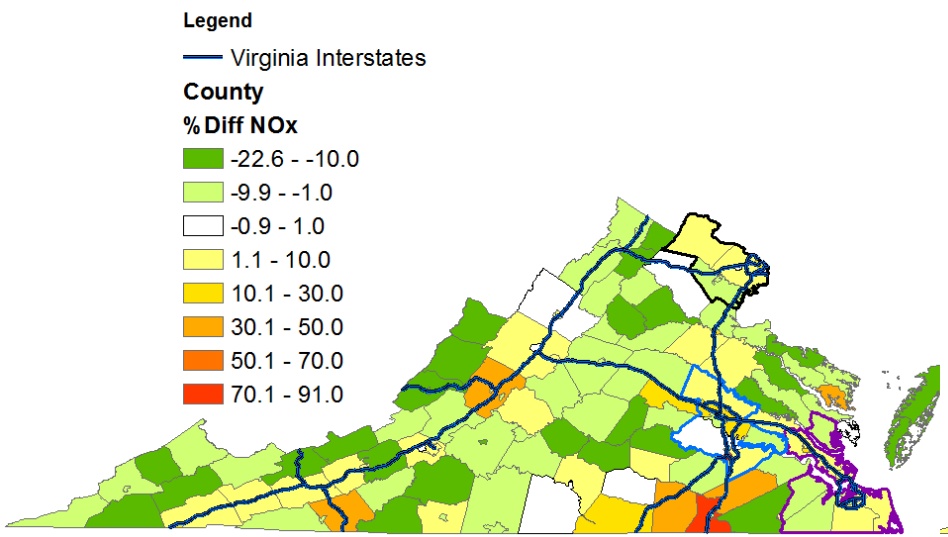


(EPAv1 – VDEQ12RepC EPAadj)/VDEQ12RepC EPAadj

Nation-wide VPOP adjustment

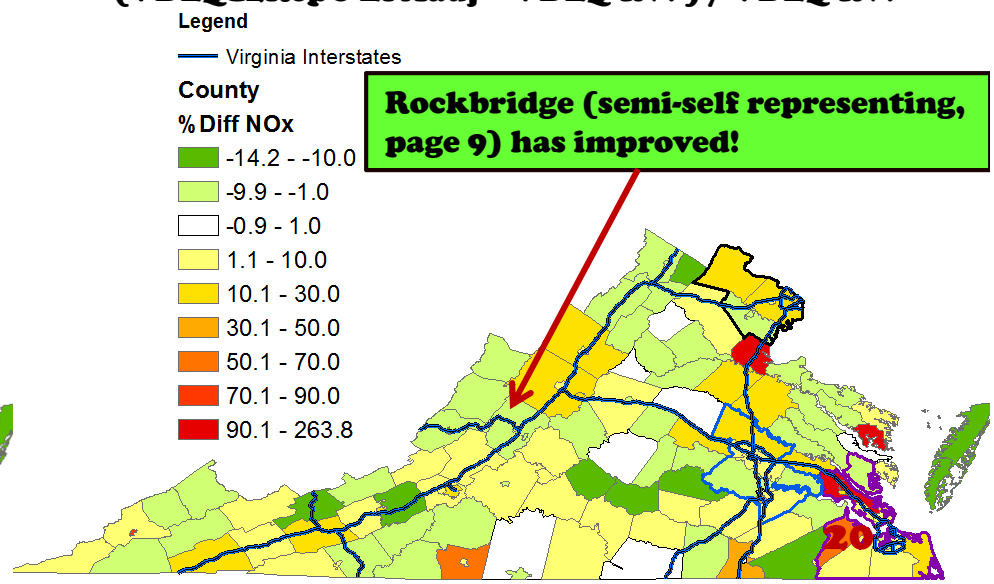


(EPA v1 – VDEQ INV) / VDEQ INV



(VDEQ12RepC EPAadj – VDEQ INV) / VDEQ INV

Rockbridge (semi-self representing, page 9) has improved!



Special Comparison – Extended Idling

- Higher adjustment factors based on nation-wide VPOP in EPA v1 result in higher county emissions along interstates than state-wide based in VDEQ 12RepC (shown in top left panel)
- Using EPA's adjustment factors, VDEQ 12RepC EPAadj emissions along interstates move closer to EPA v1 emissions (shown in top right panel)
- Changes between nation-wide and state-wide adjustments are along interstates only. Counties with no interstates remain unchanged
- VDEQ 12RepC EPAadj (with EPA's adjustment factors) has improved NOx estimates along interstates over VDEQ12RepC, and in fact, has become the best of three in-house SMOKE-MOVES runs in comparison to inventory MOVES (VDEQ INV) (shown in bottom right panel)

Summary on Extended Idling

- EPA adjustment factors based on nation-wide VPOP agree better with inventory mode than adjustment factors based on state-wide VPOP
- Nation-wide VPOP is therefore needed to correctly adjust extended idling emissions
- States (or SMOKE-MOVES users) have no way of obtaining nation-wide VPOP (which possibly need to include CA portion as well!)
- EPA has thus far offered no answer to this issue
- Virginia is designing additional study to examine extended idling

Question: what is the rationale for the adjustment??

Conclusion

- More representative counties yield better agreement with inventory MOVES than fewer representative counties
- SMOKE-MOVES emission estimates without county groupings are very close to inventory MOVES
- Despite an improvement over the draft, EPA's 2011 NEI version1 still deviates greatly from inventory MOVES, mostly along major interstates
- Minor pollutants of less temperature dependence (NH_3, SO_2) agree better with inventory MOVES
- Extended idle adjustment factors based on nation-wide VPOP yield better agreement along interstates than adjustment factors based on state-wide VPOP
- Extended idle adjustment method based on nation-wide VPOP cannot be implemented by states (or SMOKE-MOVES users) without access to EPA nation-wide VPOP data