




Development of Oil and Gas Spatial Surrogates and Monthly Temporal Profiles for 2014

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Acknowledgments

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Overview of the Presentation

- Introduction/Background Information
- Project Goals
- Data Sources
- Data Compilation
- Data Products
 - Spatial Surrogates
 - Monthly Temporal Profiles



Introduction/Background Information

- Oil and gas exploration and production sources can vary significantly by year.
- Typically, oil and gas emissions are annual county-level estimates (some states provide point source emissions).
 - For air quality modeling, these county-level estimates need to be allocated to grid cells that are often smaller than a county.
 - Additionally, annual emissions need to be temporally allocated to hourly values for air quality modeling.



Project Goals

- Develop 4-km gridded spatial allocation factors (i.e., spatial surrogates) for oil and gas sources
 - Develop spatial surrogates to represent year 2014
 - 15 surrogates previously developed for year 2011
 - Include additional source categories
 - Coalbed Methane (CBM) now separated out
 - Include Alaska
- Develop monthly temporal profiles
- Update hierarchy for gap-filling of spatial surrogates





Data Sources

- Drilling Info (DI) Desktop's HPDI
 - 3rd-party vendor compiling oil and gas data from state databases
 - In accordance with the EPA's licensing agreement, well-level data is proprietary, but derived products, such as aggregation at the county-level, are acceptable for public dissemination and use in the tool.
 - Provides data in a standardized format
 - Individual well locations, production information, drilling information, and well completion information
 - Most states were updated through 2014



Data Sources

- Oil and Gas Commission Websites
 - Arizona, Idaho, Illinois, Indiana, Kentucky, Missouri, Nevada, Oregon, Pennsylvania, Tennessee
 - Information retrieved varied, but included well locations, spud counts, well depths, production, produced water, and well completions



Data Attributes Compiled

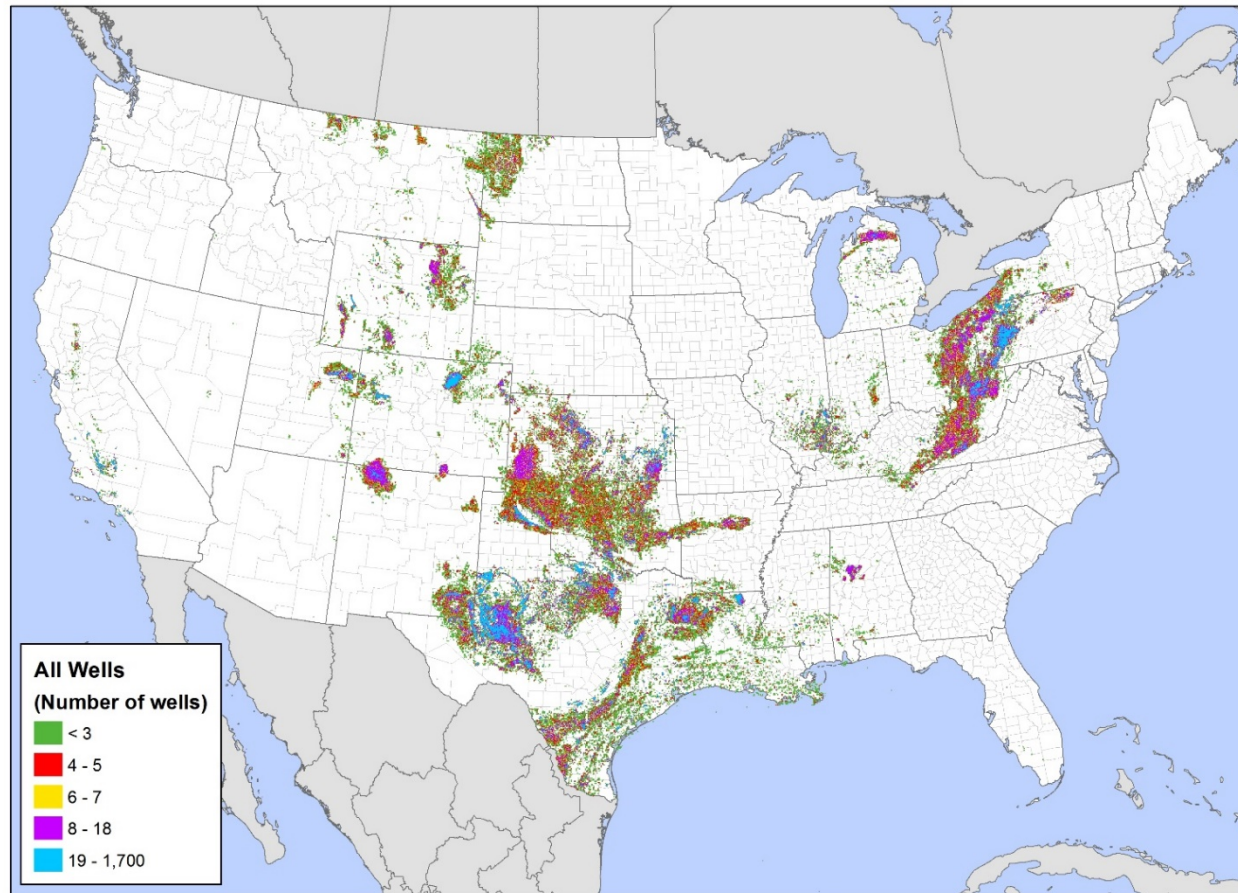
Associated Gas Production	*Condensate Production – Gas Wells	*Spud Counts – CBM Wells
*CBM Production	Feet Drilled	*Spud Counts – Gas Wells
*CBM Well Counts	*Natural Gas Production	Spud Counts – Oil Wells
Completions – All Wells	Natural Gas Well Counts	Total Exploratory Wells
*Completions – CBM Wells	Oil Production	Total Production Wells
*Completions – Gas Wells	Oil Well Counts	Total Wells
Completions – Oil Wells	Produced Water – All Wells	Unconventional Well Completions
*Condensate Production – CBM Wells	Spud Counts – All Wells	

BOLD = New source category for the 2014 NEI

* = For the 2011 NEI, natural gas and CBM were combined

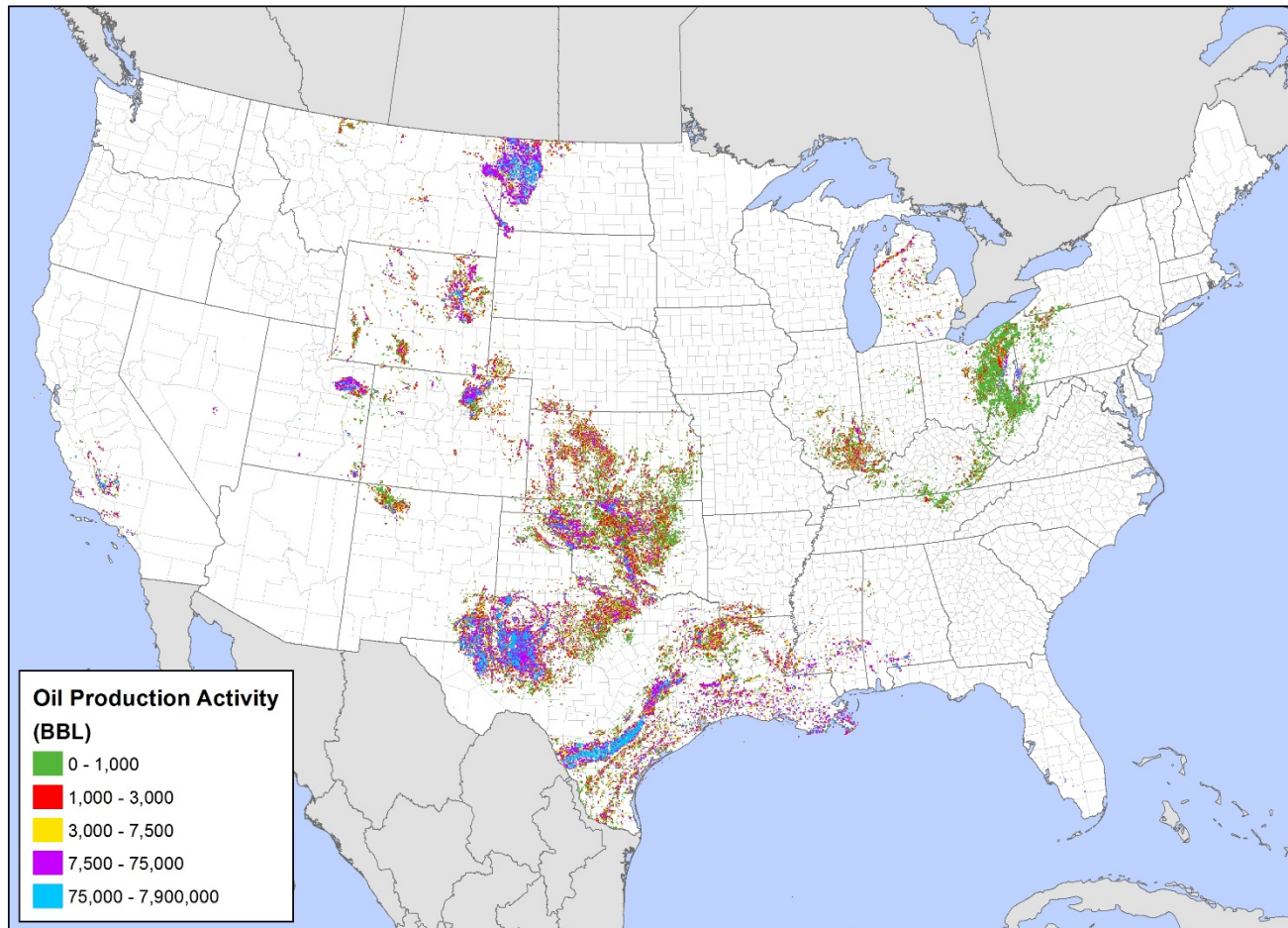


Count of All Wells in the Continental U.S.



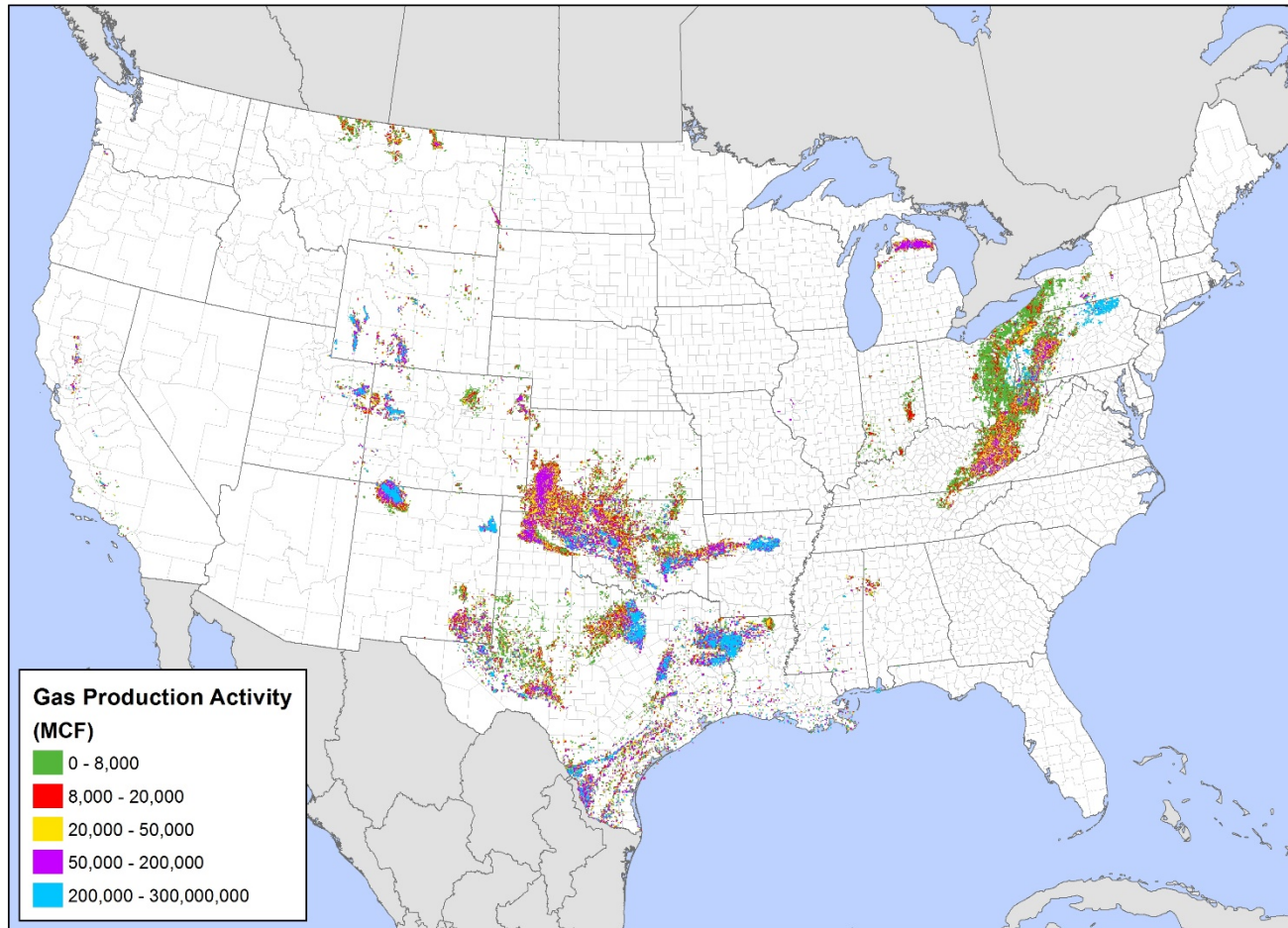
Note: this image is derived from individual wells from HPDI and state oil and gas commission websites.

Oil Production Activity in the Continental U.S.



Note: this image is derived from individual wells from HPDI and state oil and gas commission websites.

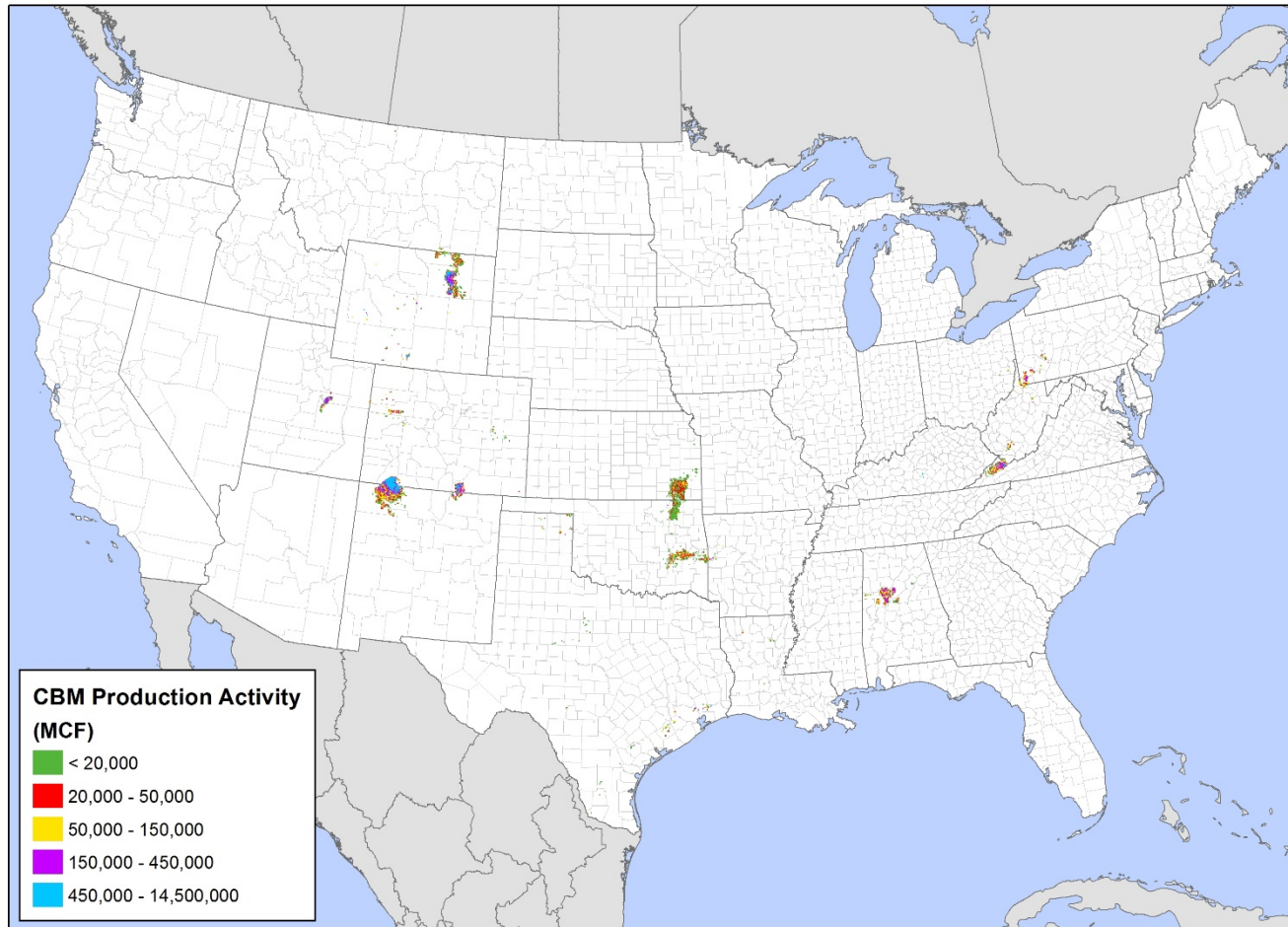
Gas Production Activity in the Continental U.S.



Note: this image is derived from individual wells from HPDI and state oil and gas commission websites.



CBM Production Activity in the Continental U.S.



Note: this image is derived from individual wells from HPDI and state oil and gas commission websites.



Data Compilation

- For the 2014 Oil and Gas Tool, over one million oil, gas, and CBM wells compiled into an Access database.
- Coverage:
 - 34 states
 - 2011 NEI: 33 states
 - 1,158 counties
 - 2011 NEI: 1,168 counties

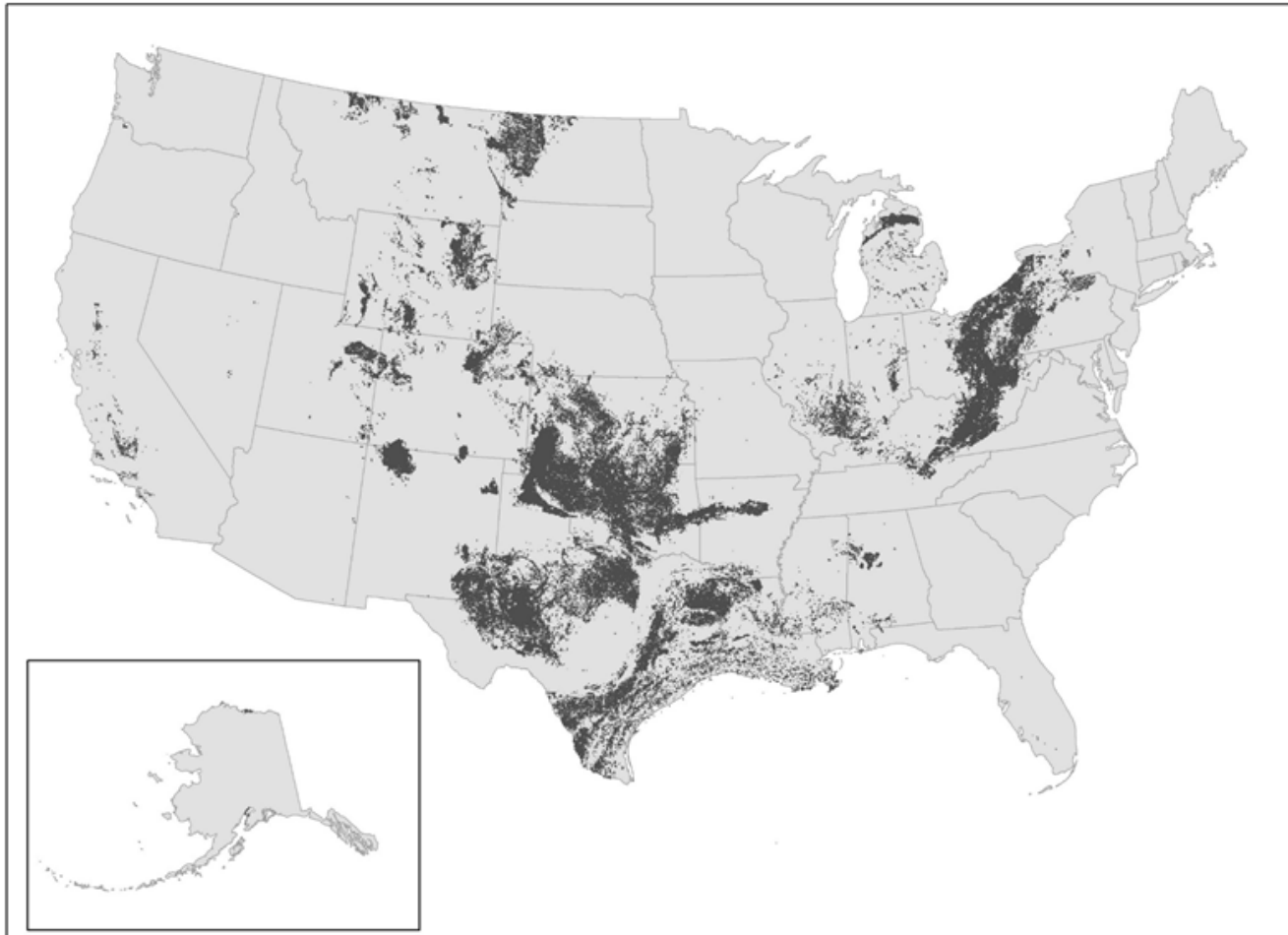


Data Compilation

- Each well and corresponding data attribute was assigned to both 2-km and 4-km grid cells
- By default, each well and attribute were summed to the 2-km grid cell.
 - If less than 3 wells were in the 2-km grid cell, then the wells were summed to its 4-km grid cell to preserve the proprietary data resolution.
- GIS shapefiles were “mashed” together using 2-km cells where possible and coarser 4-km grid cells where needed



Resulting 2-km and 4-km Well “Mashups”



Note: this image is derived from individual wells from HPDI and state oil and gas commission websites.



Surrogate Development – 4-km files

- Using GIS software, assign wells to 4-km grid cell
- Sum attribute activity data to the county- and 4-km grid cell level
- Sum attribute activity data to the county-level
- Divide summed county- and 4-km grid cell activity data by the summed county-level activity to calculate 4-km level spatial surrogate fractions



Examples of Spatial Surrogate Factors

$$\text{Value} = \frac{\text{sum of attribute in grid cell}}{\text{sum of attribute in county}}$$

Surr ID	County	Col	Row	Ratio	Comment
698	24001	1070	553	1.000000	1 / 1
698	24023	1058	540	0.750000	3 / 4
698	24023	1059	541	0.250000	1 / 4
Surr ID	County	Col	Row	Ratio	Comment
696	24001	1070	553	1.000000	6,266 / 6,266
696	24023	1058	540	0.825889	11,076 / 13,411
696	24023	1059	541	0.174111	2,335 / 13,411

Ratio fractions sum to 1 for each county → a ratio=1.0 would mean all emissions for the county are in a single grid cell



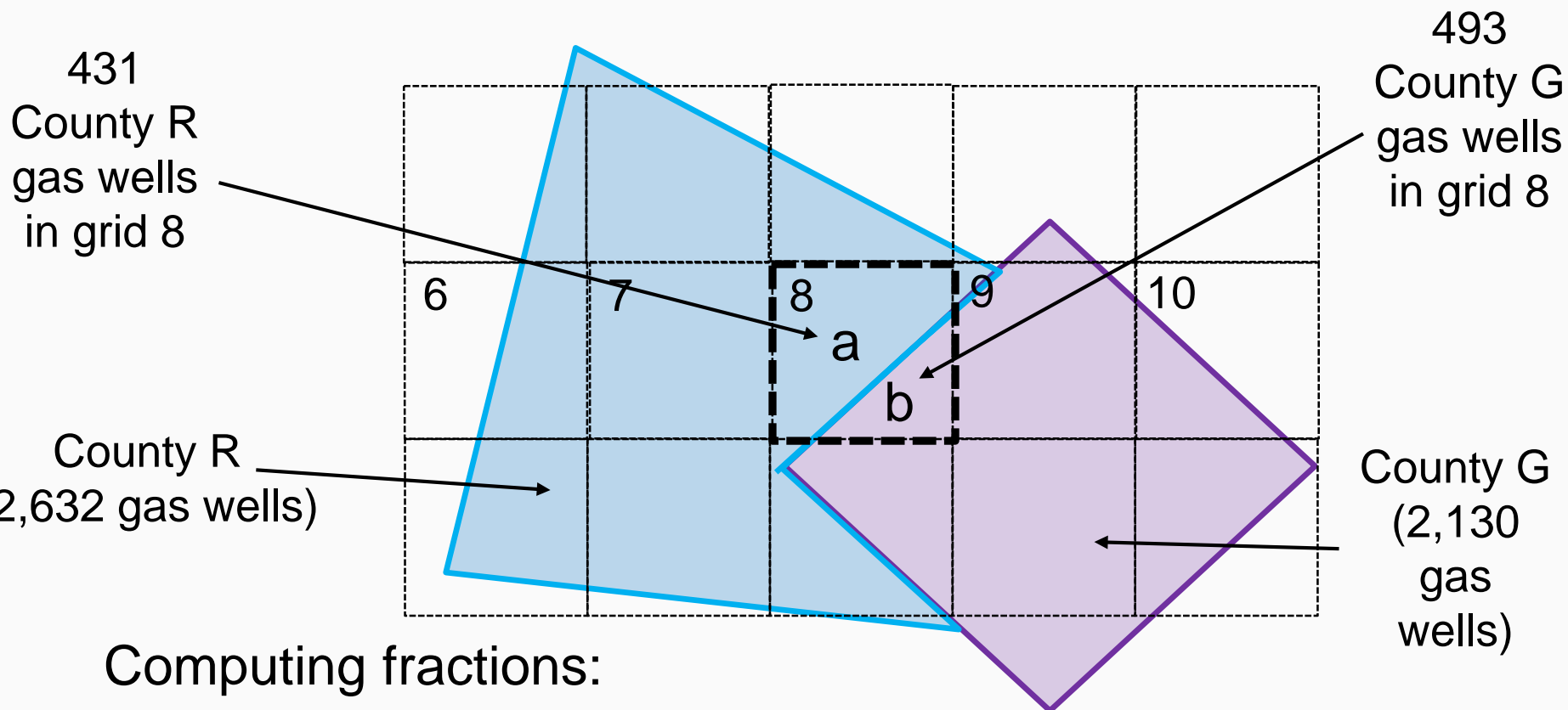
Spatial Surrogate Usage – 4-km files

Example:

- County R reports 25 tpy CO from 4-stroke rich burn wellhead compressors from 2,632 natural gas wells.
- In an adjacent county, County G reports 15 tpy CO from 2,130 natural gas wells for the same source category.
- The two counties share one similar 4-km grid cell (8) on the border.
 - County R has 431 natural gas wells in grid cell 8
 - County G has 493 natural gas wells in grid cell 8



Spatial Surrogate Usage – 4-km files



Computing fractions:

$$a = 431/2632 = 0.164$$

$$b = 493/2130 = 0.231$$



Example Surrogate Application

Step 1

County R, grid cell 8 CO emissions = $25 \text{ tpy} * 0.164 = 4.1 \text{ tpy}$

Step 2

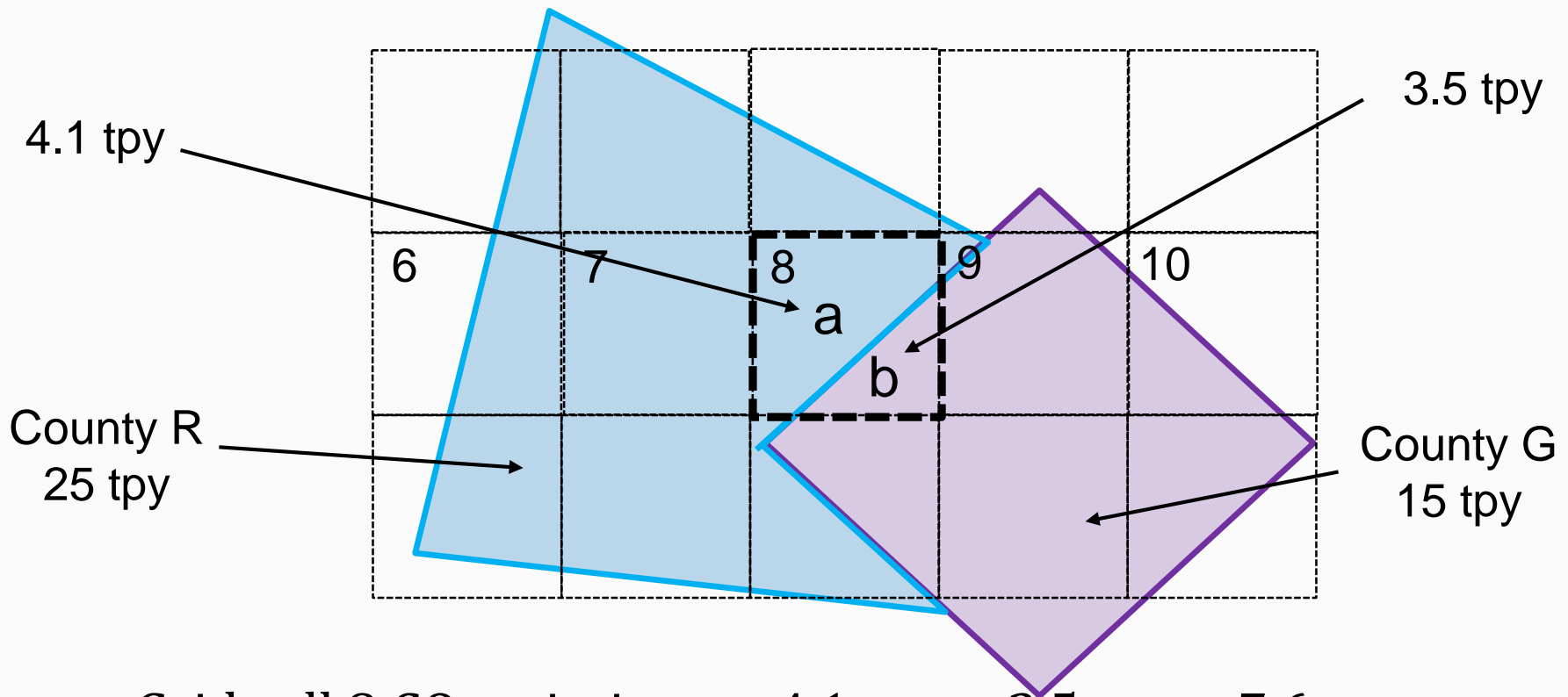
County G, grid cell 8 CO emissions = $15 \text{ tpy} * 0.231 = 3.5 \text{ tpy}$

Step 3

Grid cell 8 CO emissions = $4.1 \text{ tpy} + 3.5 \text{ tpy} = 7.6 \text{ tpy}$



Spatial Surrogate Usage – 4-km files



Grid cell 8 CO emissions = 4.1 tpy + 3.5 tpy = 7.6 tpy



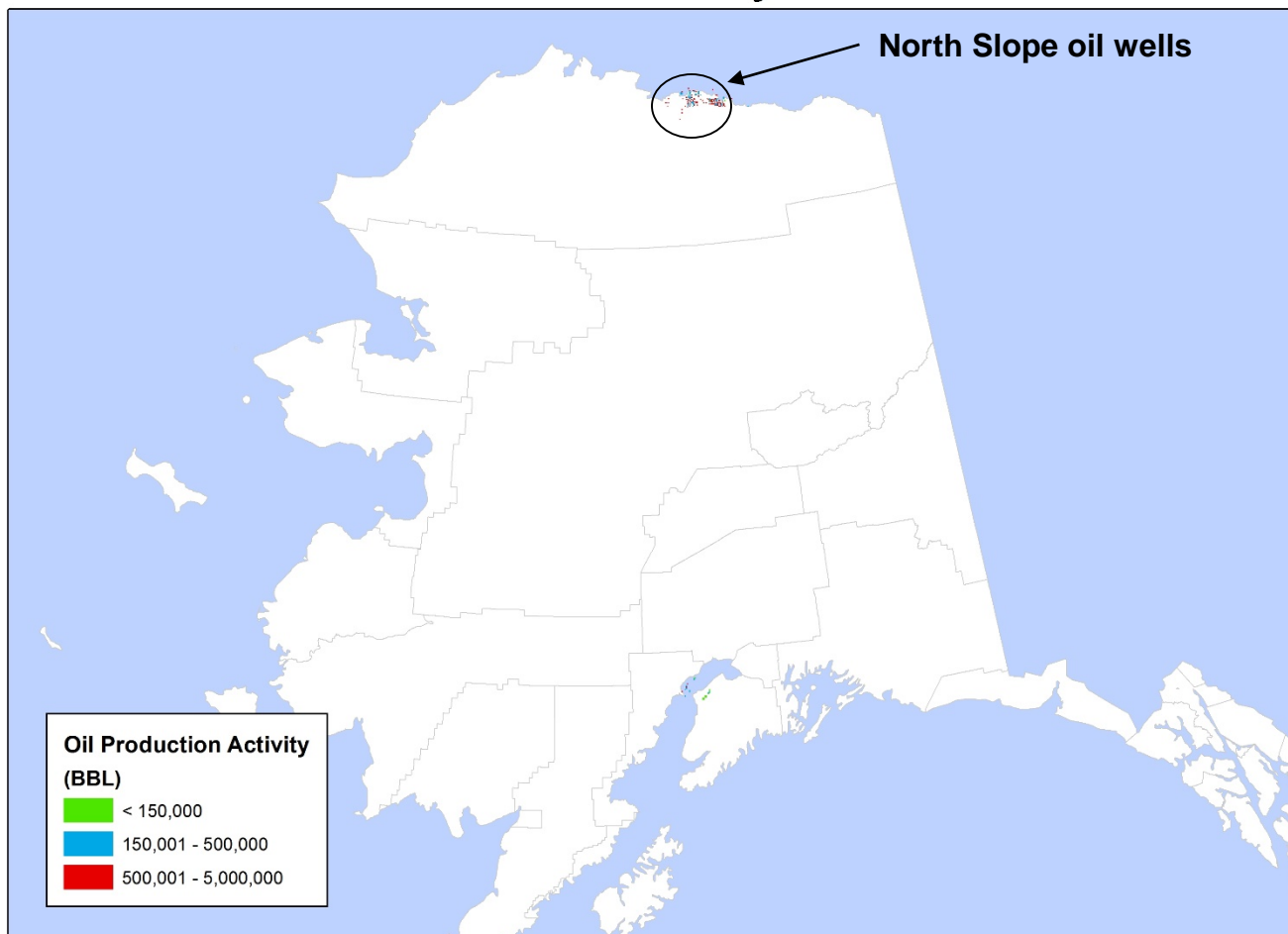
Alaska Spatial Surrogates Developed*

Associated Gas Production	Natural Gas Production	Spud Counts – Gas Wells
Completions – All Wells	Natural Gas Well Counts	Spud Counts – Oil Wells
Completions – Gas Wells	Oil Production	Total Exploratory Wells
Completions – Oil Wells	Oil Well Counts	Total Production Wells
Condensate Production – Gas Wells	Produced Water – All Wells	Total Wells
Feet Drilled	Spud Counts – All Wells	

* = No CBM wells or hydraulically-fractured wells in Alaska



Oil Production Activity in Alaska





Monthly Temporal Profile Development

- Developed monthly temporal profiles for 54 Oil and Gas SCCs for all oil and gas counties.
- The majority of the attribute data is at the monthly level
 - Sum attribute activity data to the monthly timeframe
 - Sum attribute activity data to the annual timeframe
 - Divide summed monthly activity data by the summed annual activity to calculate monthly temporal factors

FIPS	SCC	J	F	M	A	M	J	J	A	S	O	N	D
56000	2310021601	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.0	0.0



Each Spatial Surrogate has a Hierarchy for Gap-filling

Oil Production (primary surrogate)



Oil Well Counts



Total Producing Wells



Completions Oil Wells



Spud Oil Wells



Total Wells



Rural Land Area

Gap-filling is used when an attribute is not available in a county – this keeps emissions from being dropped



Summary

- Increased refinement of spatial surrogates for the 2014 NEI
 - 4-km spatial surrogates based on allocations to 2-km and 4-km cells
 - Splitting of natural gas and CBM
 - Alaska
- Monthly temporal profiles for 54 SCCs and 1,158 counties
- Updated hierarchy for gap-filling for all 23 surrogates



Thanks!

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