Uncertainties in Prescribed Forest Fire Emission Inventories and Their Impact on Air Quality Modeling

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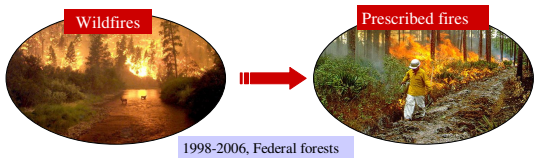
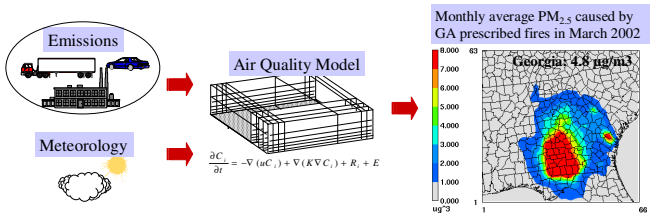
Prescribed forest fires



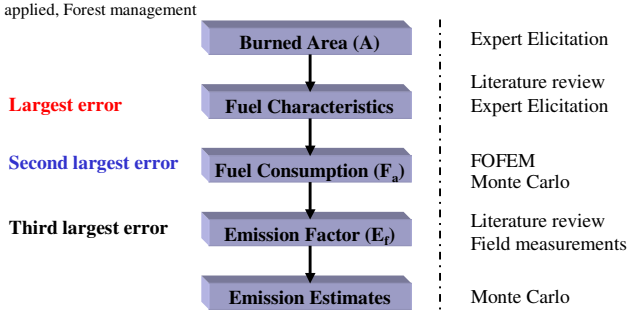
Source-oriented air quality modeling (MM5/SMOKE/CMAQ)



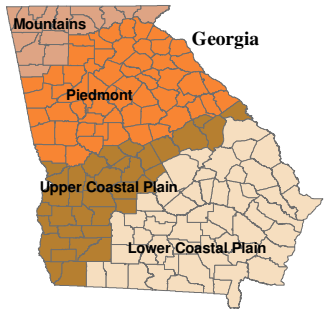
Uncertainty quantification method

Prescribed Forest Fires Emission $E = A \times F_a \times E_f$

Factors impact emissions: Fuel conditions, Weather, Topography, The way fires are applied, Forest management



Fuel characteristics by physiographic regions



Variables	Mountain	
	Mode[3]	UC (factor)[4]
Fuel loading (tons/acre)[2]		
Litter	0.35	3
1-hr wood	1.5	2
10-hr wood		
100-hr wood		
1000-hr wood	0.2	1.5
Duff	3	2
Herbaceous		
Shrub	0.2	10
Fuel moisture (%)		
10-hr wood	12	1.6
1000-hr wood	20	1.3
Duff	75	1.5
Other		
1000-hr percent Rotten (%)	10	1.6
Duff depth (inches)	0.7	3

Fuel consumption uncertainties[1] (tons/acre)

Region	Fraction (%)[2]	Flaming		Smoldering	
		Mode[3]	UC (factor)[4]	Mode[3]	UC (factor)[4]
Mountain	1	2.6	1.9	1.6	1.9
Piedmont	12	3.1	1.6	1.9	1.6
Upper Coast	42	4.3	1.4	2.6	1.4
Lower Coast	44	7.3	1.3	4.5	1.3

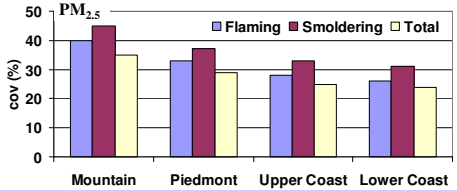
[1] Log-normal distribution is assumed for fuel consumption (tons/acre) uncertainties.
[2] Fraction refers to fraction of prescribed forest fires in specific region.
[3] Mode refers to the nominal value.
[4] UC refers to uncertainty range (includes 95% of data) between (Mode / Factor) and (Mode x factor).

Emission factor uncertainties (lbs/ton of fuel consumed)

	Flaming		Smoldering		Andreae
	Mode	UC (factor)	Mode	UC (factor)	mean ± std
CO	81.9	1.9	265	1.9	214±74
VOC	7.0	2.4	22.5	2.4	11.4±9.2
NO_x	6.2	1.7	2.2	3.4	6±2.8
NH_3	0.301	4.8	0.996	4.1	2.8±1.6
SO_2	0.0624	4.9	0.207	4.1	2
PM_{10}	11.7	1.6	26.3	1.7	
$PM_{2.5}$	9.9	1.6	22.3	1.7	26±14

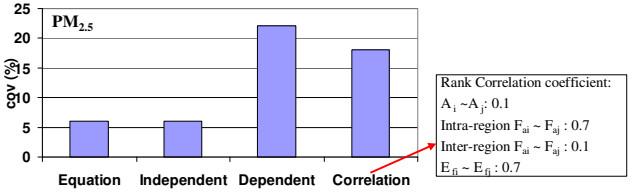
Lognormal distribution, 95% CI: (Mode / UC , Mode x UC)
Based on literature review and field measurements of prescribed fires in Georgia

Uncertainties in individual emission estimates

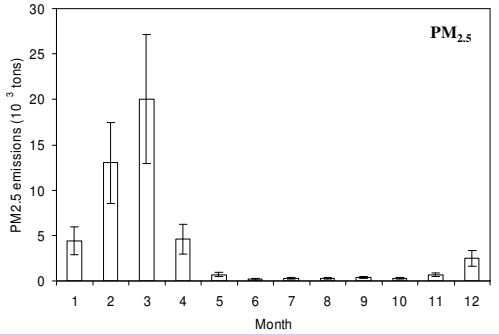


Uncertainties in total emission estimates for March 2002

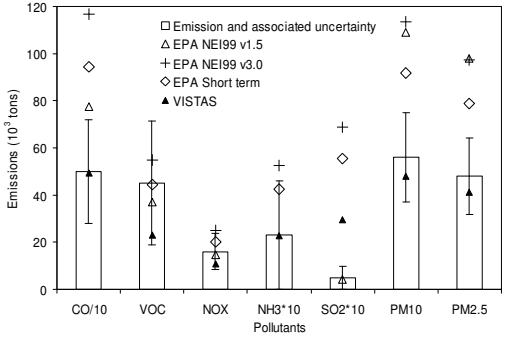
$E_{monthly} = \sum_i E_i = \sum_i A_i \times (F_{af_i} \times E_{ff_i} + F_{as_i} \times E_{fs_i})$ → Equation $UC^2_{E_{monthly}} = \sum_i UC^2_{E_i}$



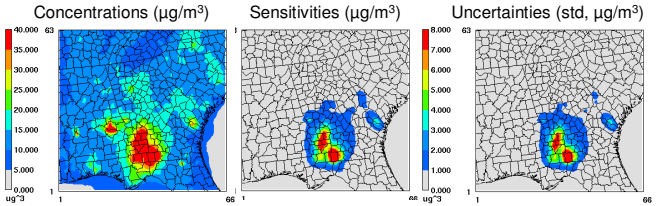
Uncertainties in monthly emissions during 2002



Uncertainties in annual emissions during 2002



Uncertainties in simulated $PM_{2.5}$ concentrations



Georgia: 19 μg/m³, std: 1.4 μg/m³

$PM_{2.5}$ non-attainment area in Georgia: 16 μg/m³, std: 0.39 μg/m³

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