

Integrating air quality with afforestation and reforestation efforts

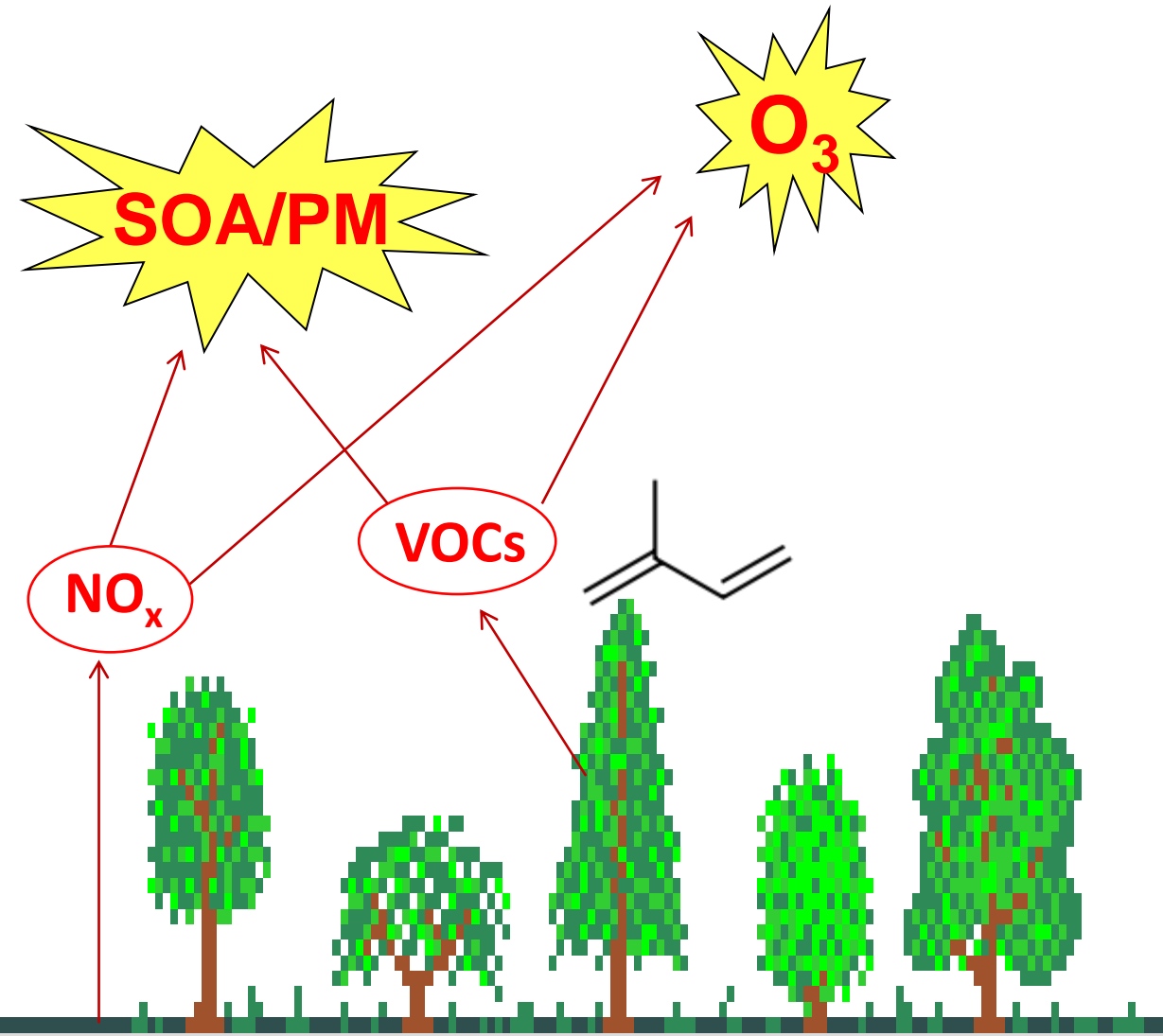
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Some trees could cause air pollution



Genus ^a	Common name	Isoprene		Monoterpenes	
		Emission rate	Reliability ^b	Emission rate	Reliability ^b
<i>Eucalyptus</i>	Eucalyptus	70.0	Genus	3.0	Genus
<i>Liquidambar</i>	Sweetgum	70.0	Genus	3.0	Genus
<i>Nyssa</i>	Black gum	70.0	Genus	0.6	Genus
<i>Quercus</i>	Oak	70.0	Genus	0.2	Genus
<i>Robinia</i>	Black locust	70.0	Genus	0.2	Genus
<i>Casuarina</i>	Beefwood	70.0	Genus	0.1	Genus
<i>Platanus</i>	Sycamore	70.0	Genus	0.1	Genus
<i>Populus</i>	Poplar	70.0	Genus	0.1	Genus
<i>Salix</i>	Willow	70.0	Genus	0.1	Genus
<i>Cupaniopsis</i>	Carrotwood	44.9	Genus	0.0	Genus
<i>Koelreuteria</i>	Goldenrain tree	44.9	Family	0.0	Family
<i>Cercidiphyllum</i>	Katsura tree	39.4	Order	1.6	Order
<i>Rhamnus</i>	Buckthorn	36.9	Genus	0.0	Genus
<i>Serenoa</i>	Saw palmetto	35.0	Genus	0.1	Genus
<i>Myrtus</i>	Myrtle	30.0	Genus	0.0	Genus
<i>Ficus</i>	Fig	22.9	Genus	0.2	Family
<i>Berberis</i>	Barberry	22.2	Family	0.0	Family
<i>Mahonia</i>	Mahonia	22.2	Family	0.0	Family
<i>Nandina</i>	Heavenly bamboo	22.2	Genus	0.0	Genus
<i>Melaleuca</i>	Melaleuca lilac	22.1	Family	0.0	Family
<i>Syzygium</i>	Jambolan plum	22.1	Family	0.0	Family
<i>Hamamelis</i>	Witch-hazel	17.7	Genus	3.0	Family
<i>Eucommia</i>	Hardy rubber tree	19.7	Superorder	0.8	Superorder
<i>Picea</i>	Spruce	14.0	Genus	3.0	Genus
<i>Callistemon</i>	Bottlebrush	14.1	Genus	0.0	Genus
<i>Sabal</i>	Cabbage palmetto	14.0	Genus	0.1	Genus
<i>Phoenix</i>	Date palm	13.9	Genus	0.0	Genus
<i>Maclura</i>	Osage-orange	11.5	Family	0.2	Family
<i>Eugenia</i>	Eugenia	10.2	Genus	0.0	Genus
<i>Pistacia</i>	Pistache	0.0	Genus	7.9	Genus
<i>inus</i>	Smoketree	0.0	Family	3.4	Family
<i>inus</i>	California peppertree	0.0	Genus	3.4	Genus

"Trees cause more pollution than automobiles do." -- Ronald Reagan, 1981

We know this is not true; but we also know there is a reason he said that

Nowak et al. (2002)

But this is not in the mind of some most important people

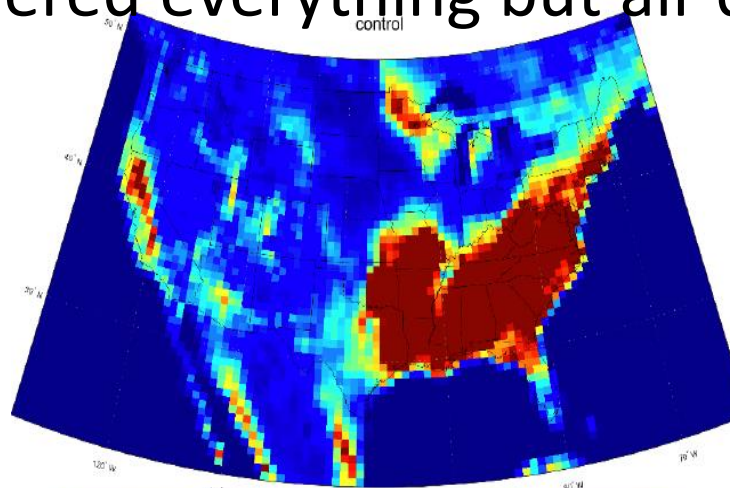
- MANY agencies/organizations working on afforestation/reforestation projects;
> 1 billion trees/yr planted.

→ Q: What kind of trees to plant?

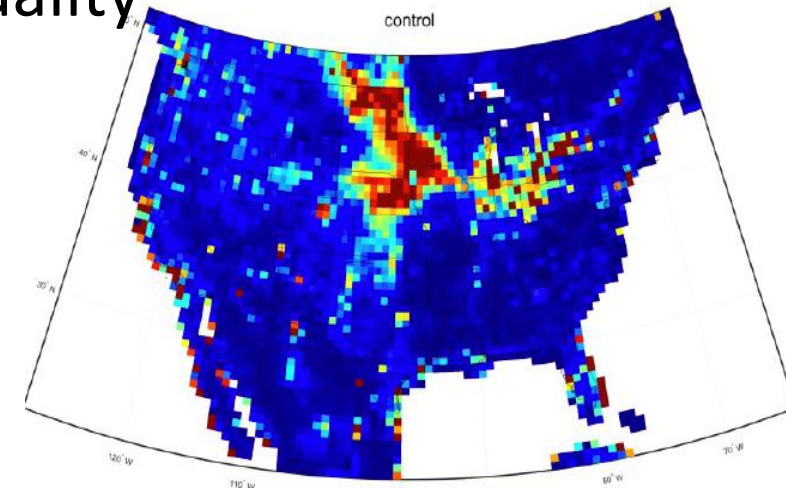
- A survey of leaders from >10 organizations showed very few of them are aware of the biogenic VOCs and none of them have ever considered the potential impacts on air quality when deciding what kind of trees to plant.

→ A: They have considered everything but air quality

- Why this is the case?



July monthly average biogenic isoprene emissions in $\text{ng}/\text{m}^2/\text{s}$ from GEOS-Chem



The ratios of NO_x emissions over isoprene emissions in mole $\text{NO}_x/\text{mole C}$

Can we make it a little bit easier for them?

Chemical Name	Lifetime, in years	ODP (WMO 2006)	ODP2 (40 CFR 82)	ODP1 (Montreal Protocol)	GWP (WMO 2006)	GWP4 (SROC)	GWP3 (40 CFR 82)	GWP2 (TAR)	GWP1 (WMO 2002)
Group I (from section 602 of the CAA)									
CFC-11 (CCl3F) Trichlorofluoromethane	45	1	1	1	4750	4680	4000	4600	4680
CFC-12 (CCl2F2) Dichlorodifluoromethane	100	1	1	1	10890	10720	8500	10600	10720
CFC-113 (C2F3Cl3) 1,1,2- Trichlorotrifluoroethane	85	1	0.8	0.8	6130	6030	5000	6000	6030
CFC-114 (C2F4Cl2) Dichlorotetrafluoroethane	300	1	1	1	10040		9300	9800	9880
CFC-115 (C2F5Cl) Monochloropentafluoroethane	1700	0.44	0.6	0.6	7370		9300	7200	7250

www.epa.gov

Air Pollution Potential:

$$APP_{X,j} = \frac{\sum_{i=1}^n \frac{\partial X}{\partial (VOC_i)} * EF_{i,j} * LAI_j}{\sum_{i=1}^n \frac{\partial X}{\partial (VOC_i)} * \overline{EF}_i * \overline{LAI}}$$

U.S. regions	Northwest	Midwest	Northeast	Southwest	Southeast
$\frac{\partial O_3}{\partial (Isoprene)}$ in ppbv/(ug/m ² /s)	39.1	93.1	40.0	42.3	13.7
$\frac{\partial SOA}{\partial (Isoprene)}$ (ug/m ³)/(ug/m ² /s)	2.4	6.7	3.6	2.0	2.6

Deliverables/expected products

The APP App



region	season	tree species	pollutant
Boston	Winter Summer	Eucalyptus Sweetgum Black gum Oak Black Locust Beefwood Poplar Willow Carrotwood Goldenrain Katsura Buckthorn Barberry	Ozone PM

APP = 10



APP = 1.1



Oak

EF(isoprene)=70;
EF(monoterpenes)=0.2



APP = 0.5



APP = 0.9

Maple

EF(isoprene)=0.1;
EF(monoterpenes)=1.6