NGOTP Upstream Environmental Technology Review

EP-18
Science-Based Methods to Assess Risks Attributable to Petroleum Residues Transferred from Soil to Vegetation

Partners:

ChevronTexaco Energy Research and Technology Company
Petroleum Environmental Research Forum (PERF 99-13)
School of Public Health, University of California, Berkeley
Environmental Toxicology, University of California, Davis
Lawrence Berkeley National Laboratory

DISCLAIMER

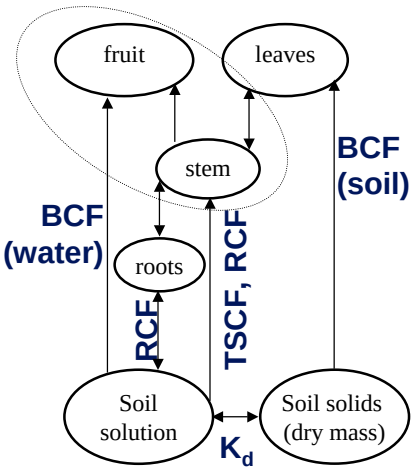
Motivation

- **Increasing use of risk based decisions at contaminated sites**
- **Uncertainties about accumulation in foodchain:**
  - > **highly conservative screening models and**
  - > **exceedingly low risk-based soil cleanup levels**
- **Existing data constrains theory & models**
  - > **distinction among plant and soil types**
  - > **accounting for key loss mechanisms**

Objective

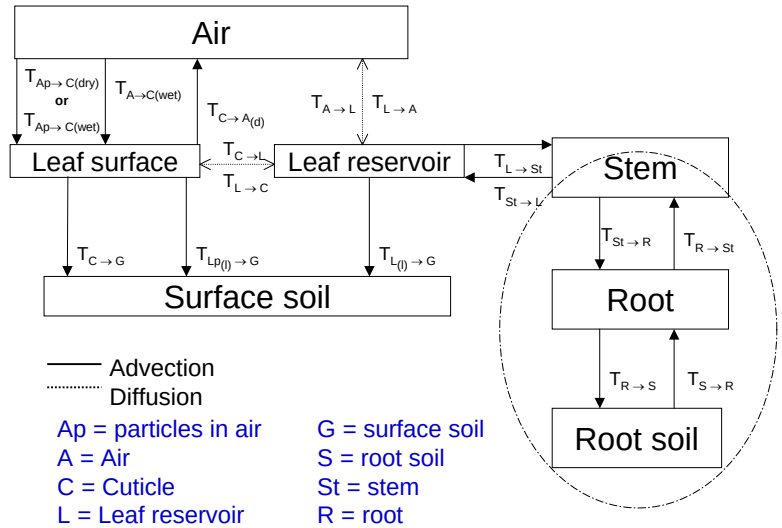
- **Evaluate existing models of plant uptake for chemicals relevant to E&P sites**
- **Identify and fill data gaps using controlled chamber experiments**
- **Revise existing models or develop new model specific to petroleum hydrocarbons**

Concentration Ratio Models



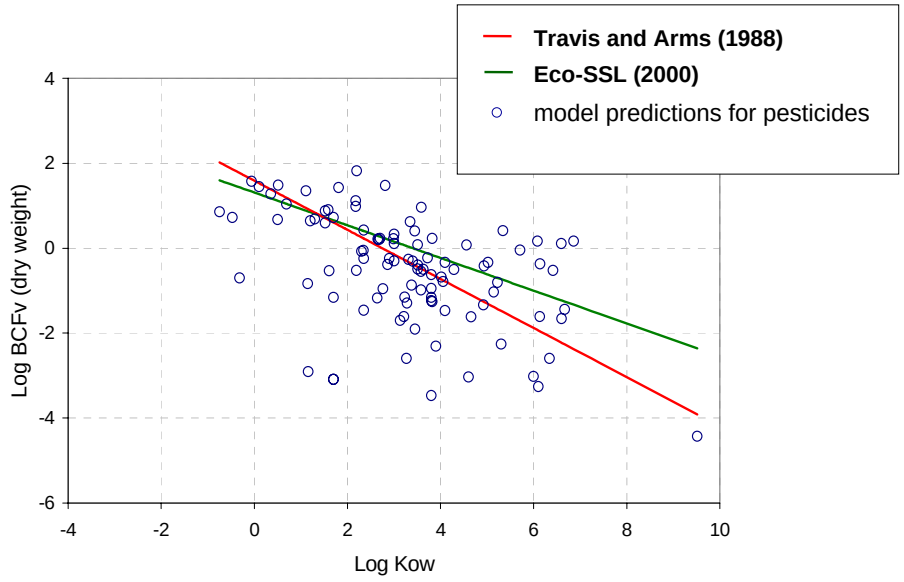
BCF:	Bioconcentration factor
SCF:	Stem concentration factor
RCF:	Root concentration factor
TSCF:	Transpiration stream concentration factor
K_d:	Soil/water partition coefficient

Mass Balance Models

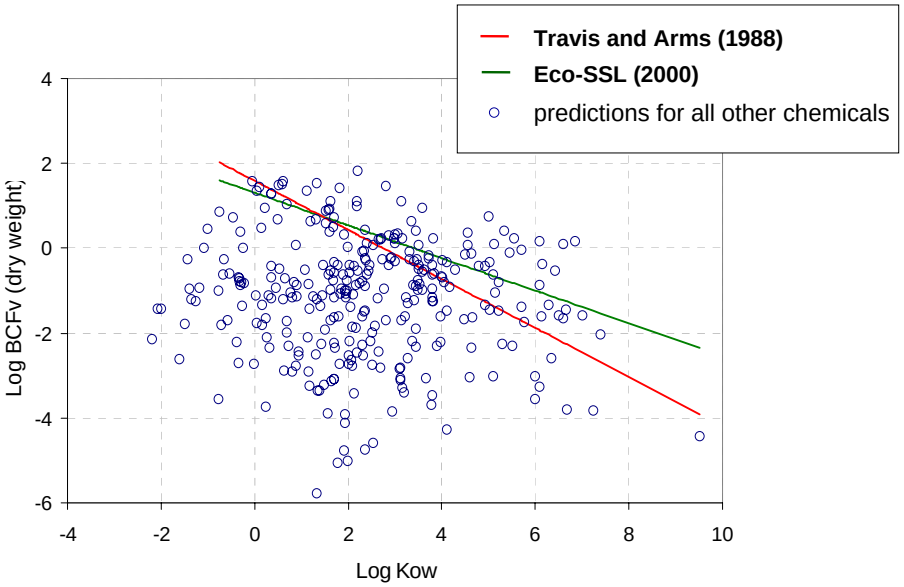


Ap = particles in air
A = Air
C = Cuticle
L = Leaf reservoir
G = surface soil
S = root soil
St = stem
R = root

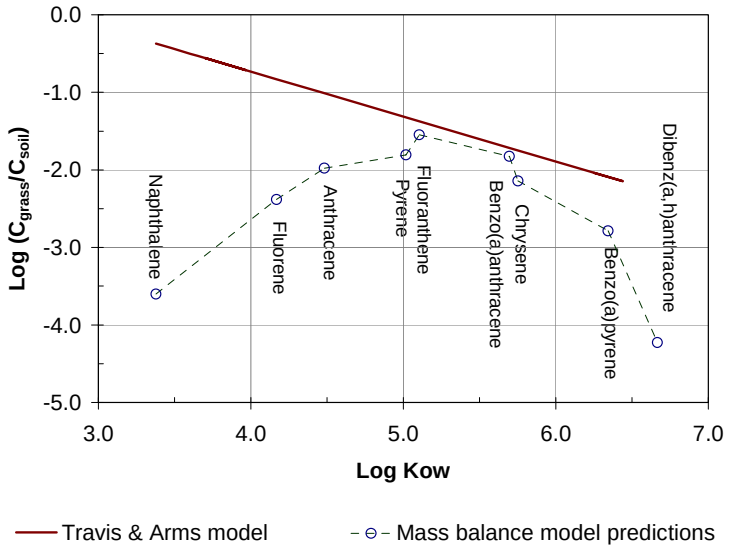
Model Comparison



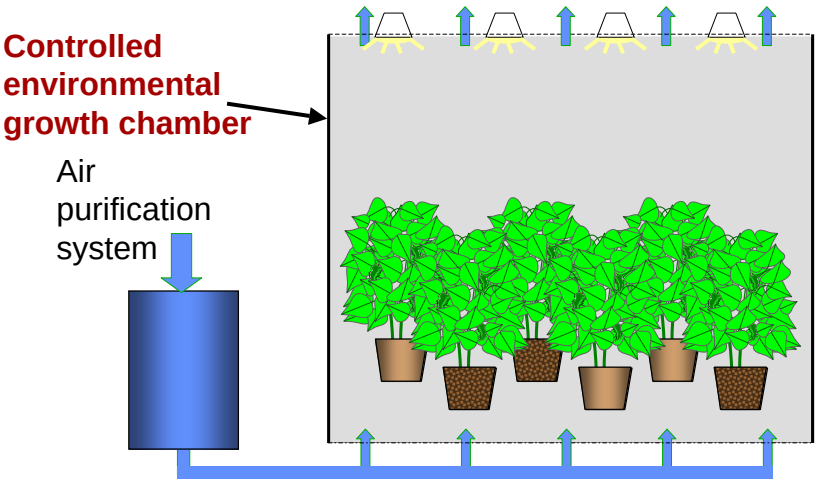
Extended to All Chemicals



Model Comparison for PAHs



Method Overview



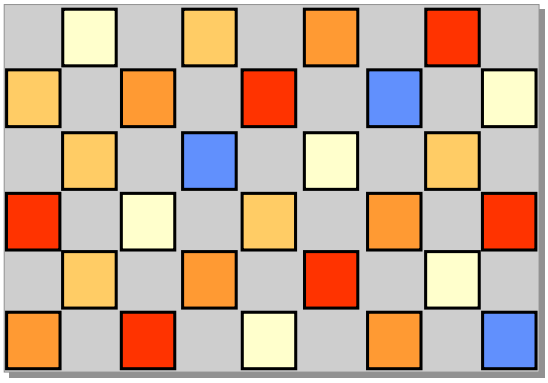
Plant and Soil Selection

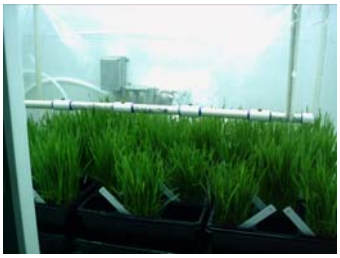
Lifetime Average Daily Intake of Foods

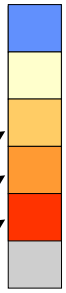
Food Category	$g_{[fresh\ weight]}$ / *Kg*day*
Leafy produce	0.56
Exposed produce	2.16
Protected produce	1.92
Root produce	1.21
Total Grain	16.1
Vegetable based fat/oil	4.9
Meat	2.07
Dairy	6.57
Fish	0.34
Eggs	0.30

- total grain ~ 75% wheat
- Surrogate for animal feed and forage
- Relevant to E&P sites
- Agricultural sandy loam soil

Soil matrix (PAHs)



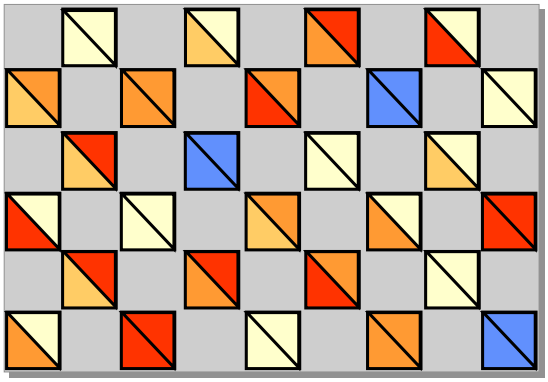


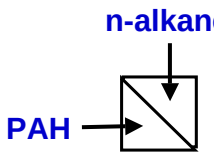


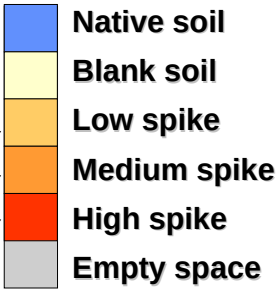
Native soil
Blank soil
Low spike
Medium spike
High spike
Empty space

~ 50 µg/Kg$_{[dry\ mass]}$
~500 µg/Kg$_{[dry\ mass]}$
~5000 µg/Kg$_{[dry\ mass]}$

Soil Matrix (PAH + n-alkanes)







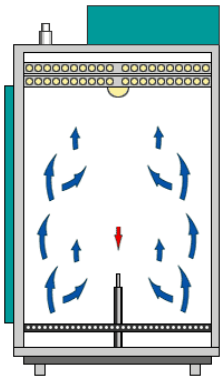
~ 500 µg/Kg$_{[dry\ mass]}$

~5000 µg/Kg$_{[dry\ mass]}$

~50000 µg/Kg$_{[dry\ mass]}$

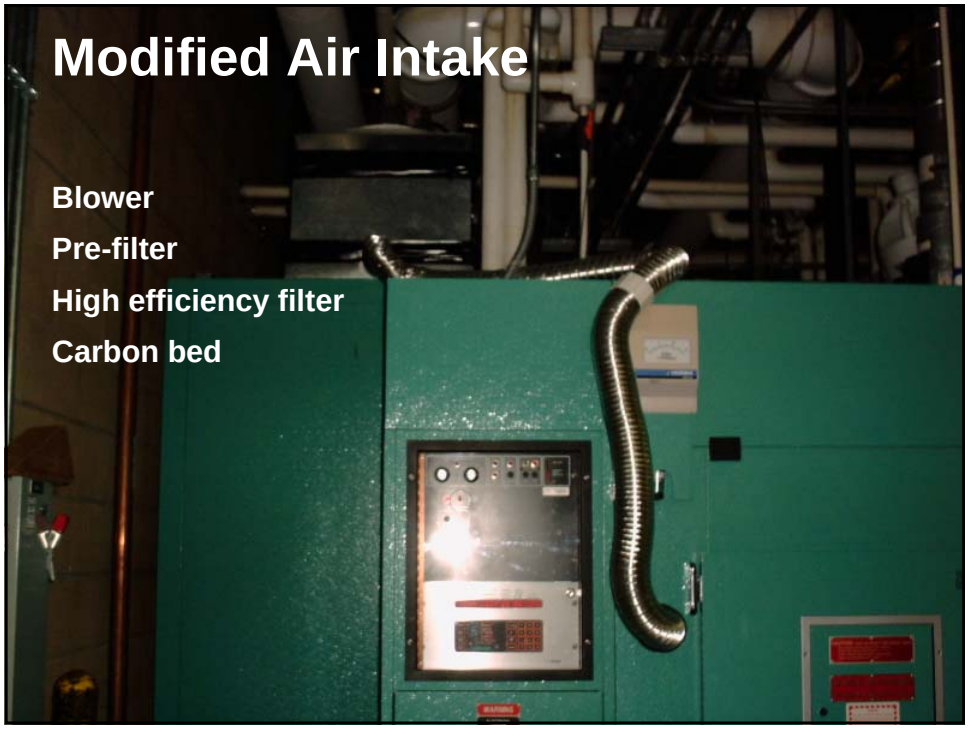
Experimental chamber

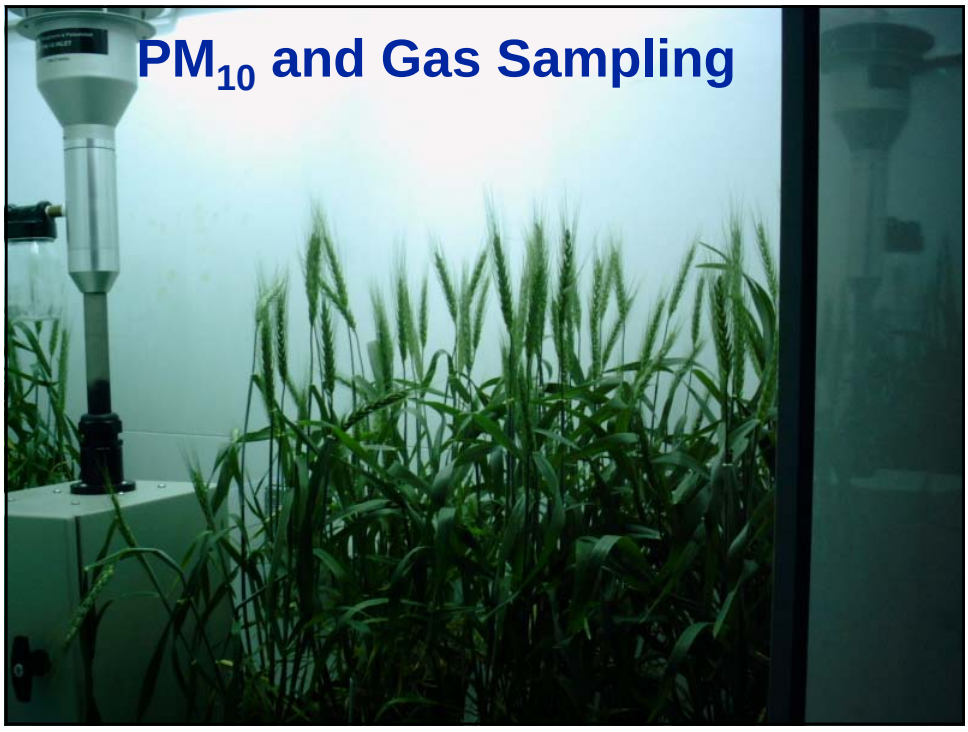
UC Davis Controlled Environment Facility



Automated System Controls

Humidity, light intensity, day/night cycling, nutrient irrigation, air exchange rate

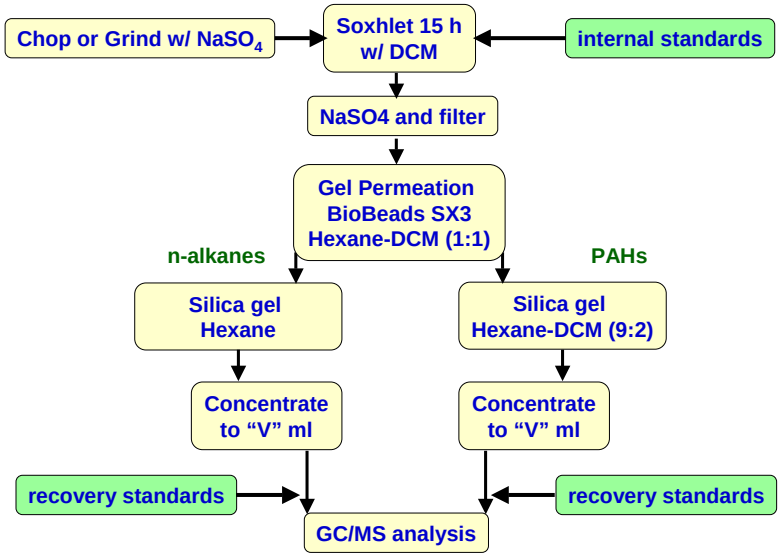

Modified Air Intake
Blower
Pre-filter
High efficiency filter
Carbon bed


PM10 and Gas Sampling

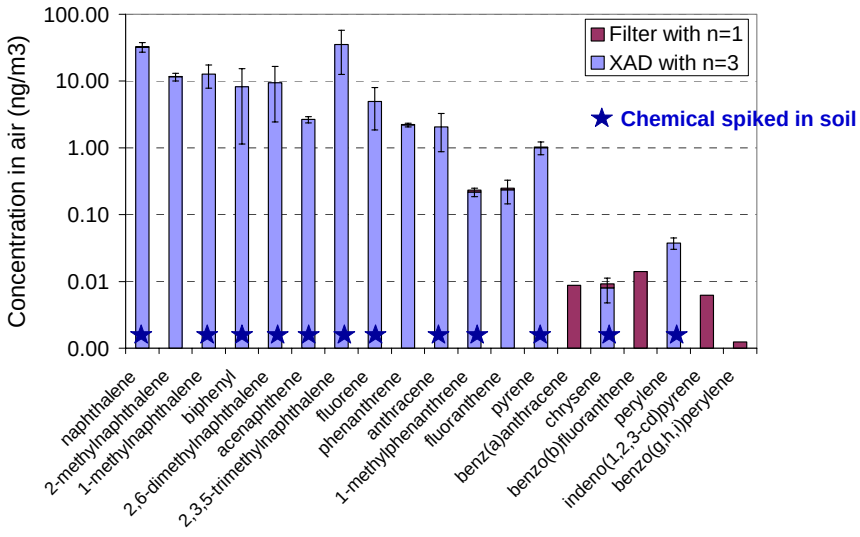
Nutrient Irrigation Mist


UC Davis
Controlled Environment Facility

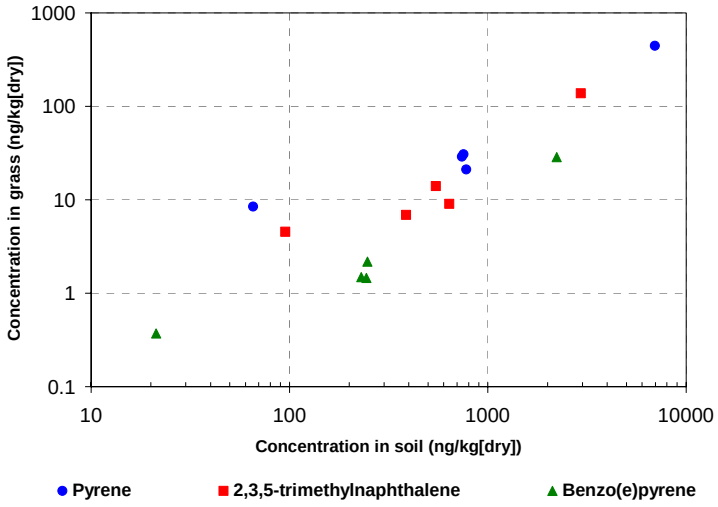
Soil & Plant Extraction and Analysis



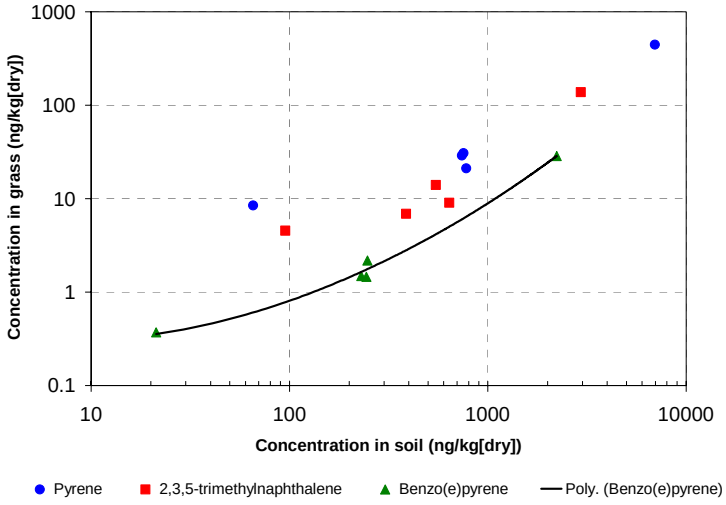
Air Concentration Results (PAHs)



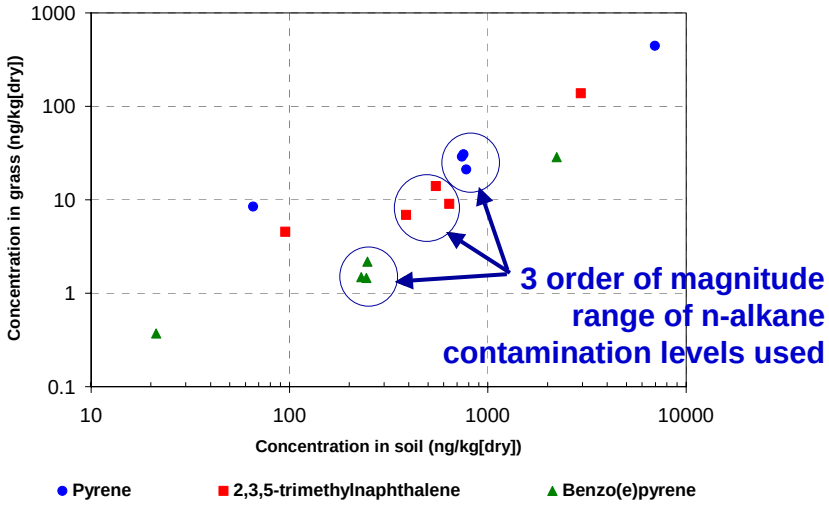
Grass/Soil Results (PAHs)



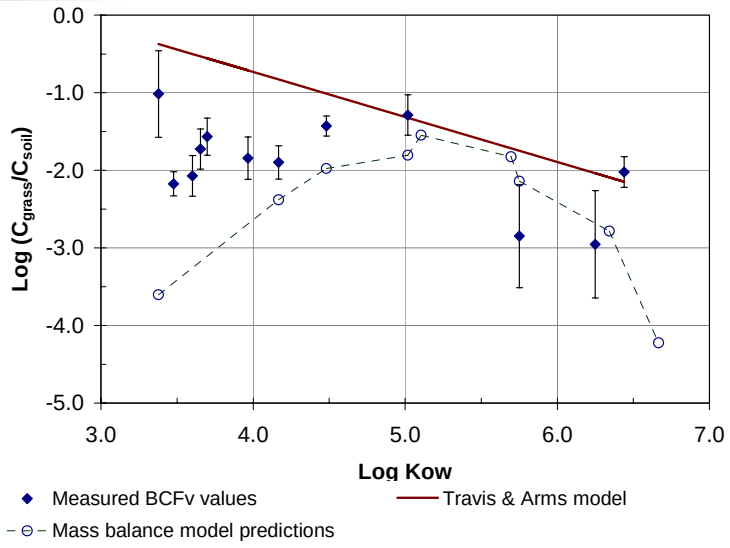
Grass/Soil Results (PAHs)



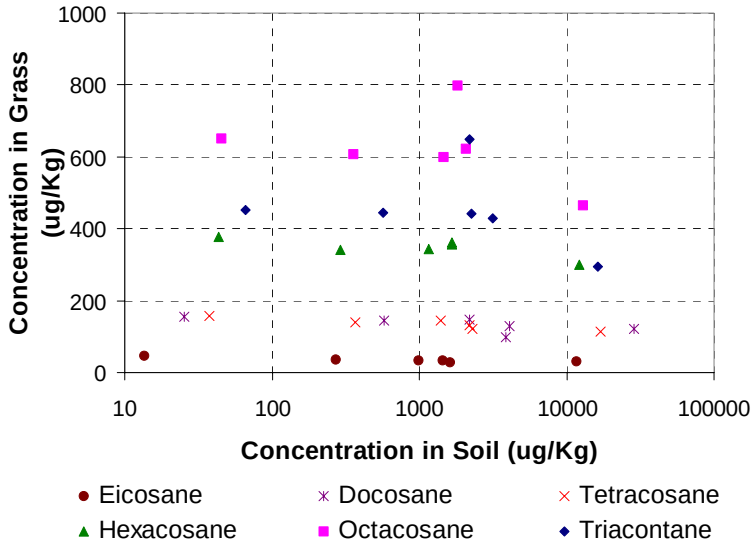
Influence of n-alkane contamination



Measured BCF_{grass} Results (PAHs)



Concentration ratios for n-alkanes



Concluding remarks

- **Both measured and predicted BCFs for PAHs do not appear to be linear on Kow**
- **Both measured and predicted BCFs for PAHs lower than Travis and Arms model, particularly at high and low Kow**
- **Elevated levels of n-alkanes do not influence BCF for PAHs**
- **n-alkanes do not seem to accumulate in above-ground vegetation**

The Authors gratefully acknowledge the assistance of

Paul Kuzmicky, Kelsie Takasaki, Annie Zhu and Eve Kwan

This work was supported by the Assistant Secretary for Fossil Energy, Office of Fossil Energy, of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.