Estimating Fumigant Buffer Zones for Bystanders by Air Dispersion Modeling

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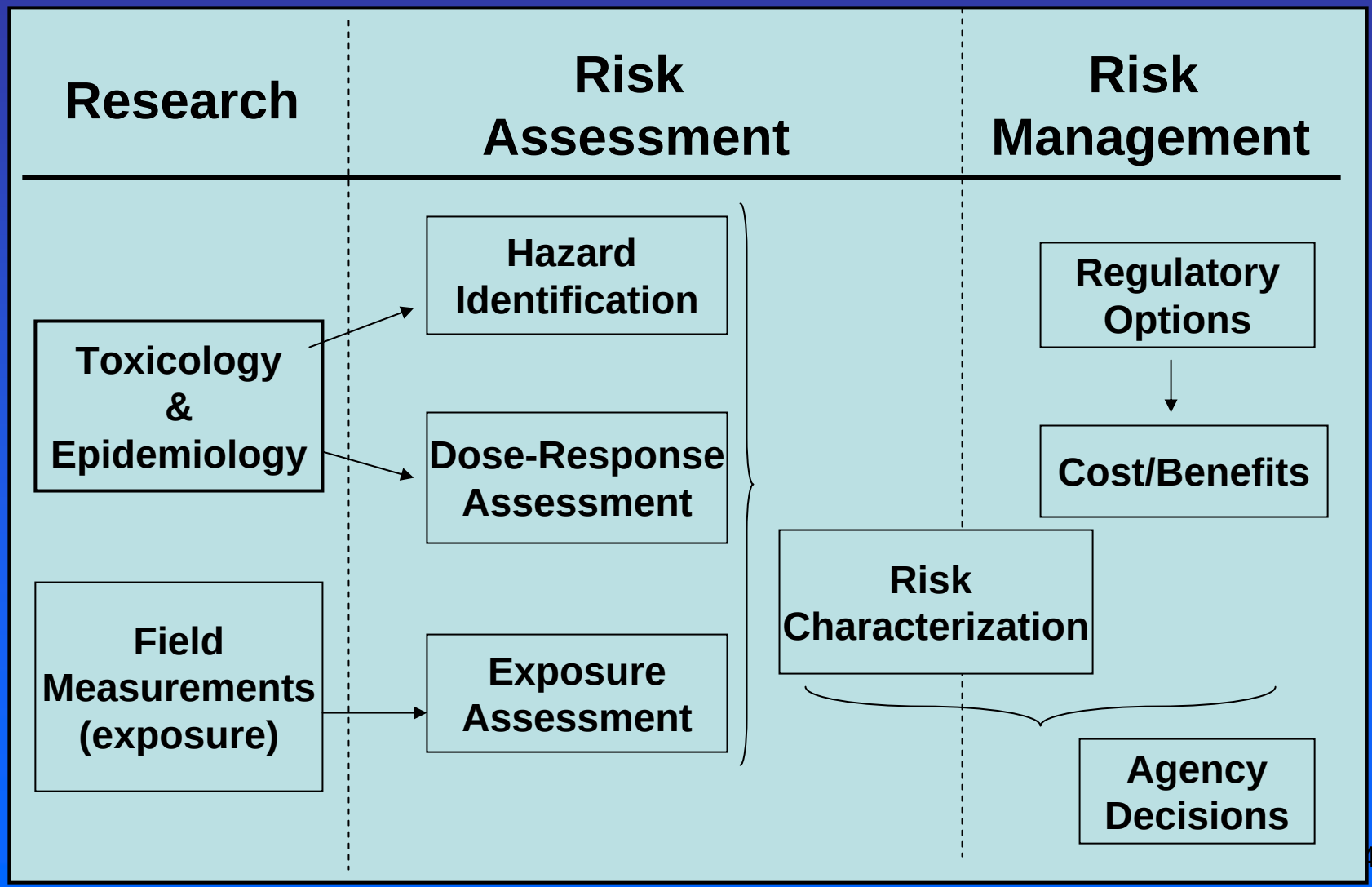
Bystanders Can Be Exposed to Fumigants Post-Application

Fumigant Applications

- In California, buffer zones have been established for methyl bromide that restrict entry around a field after application
  - Purpose is to mitigate inhalation exposures to bystanders
- EPA and California are currently evaluating the potential need for buffer zones for other fumigants

Risk Assessment Process



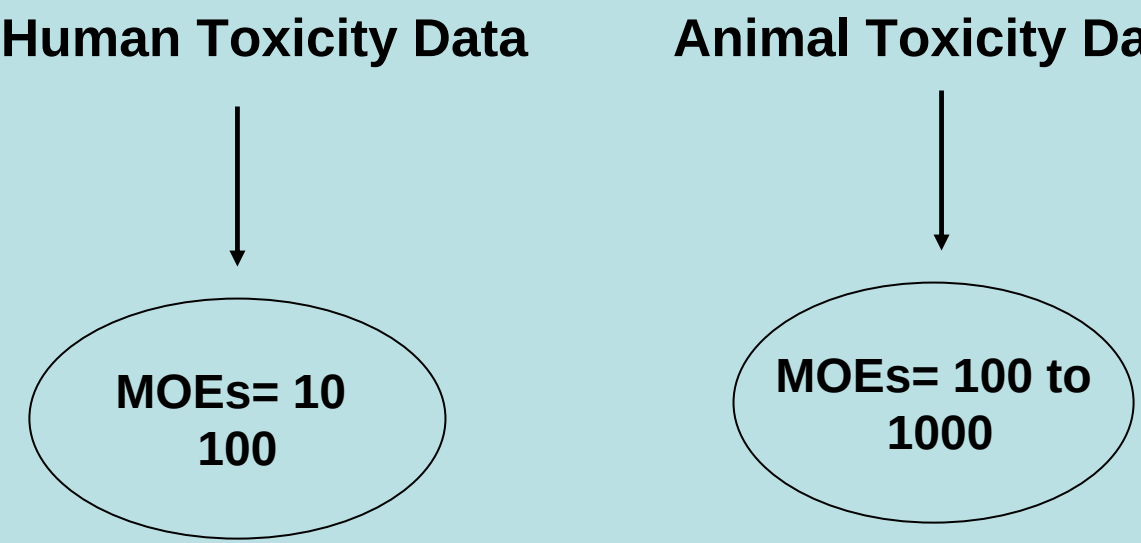
What Do Risk Managers Need to Know About Bystander Exposures?

- What is the distribution of concentrations downwind of the application?
- What criteria might be used to establish a protective buffer zone?
- What are the exposures and risks at the perimeter of any proposed buffer zone?

How Does EPA Evaluate Noncancer Risks

Margin of Exposure = HEC/Exposure

HEC = Human Equivalent Concentration with no effects



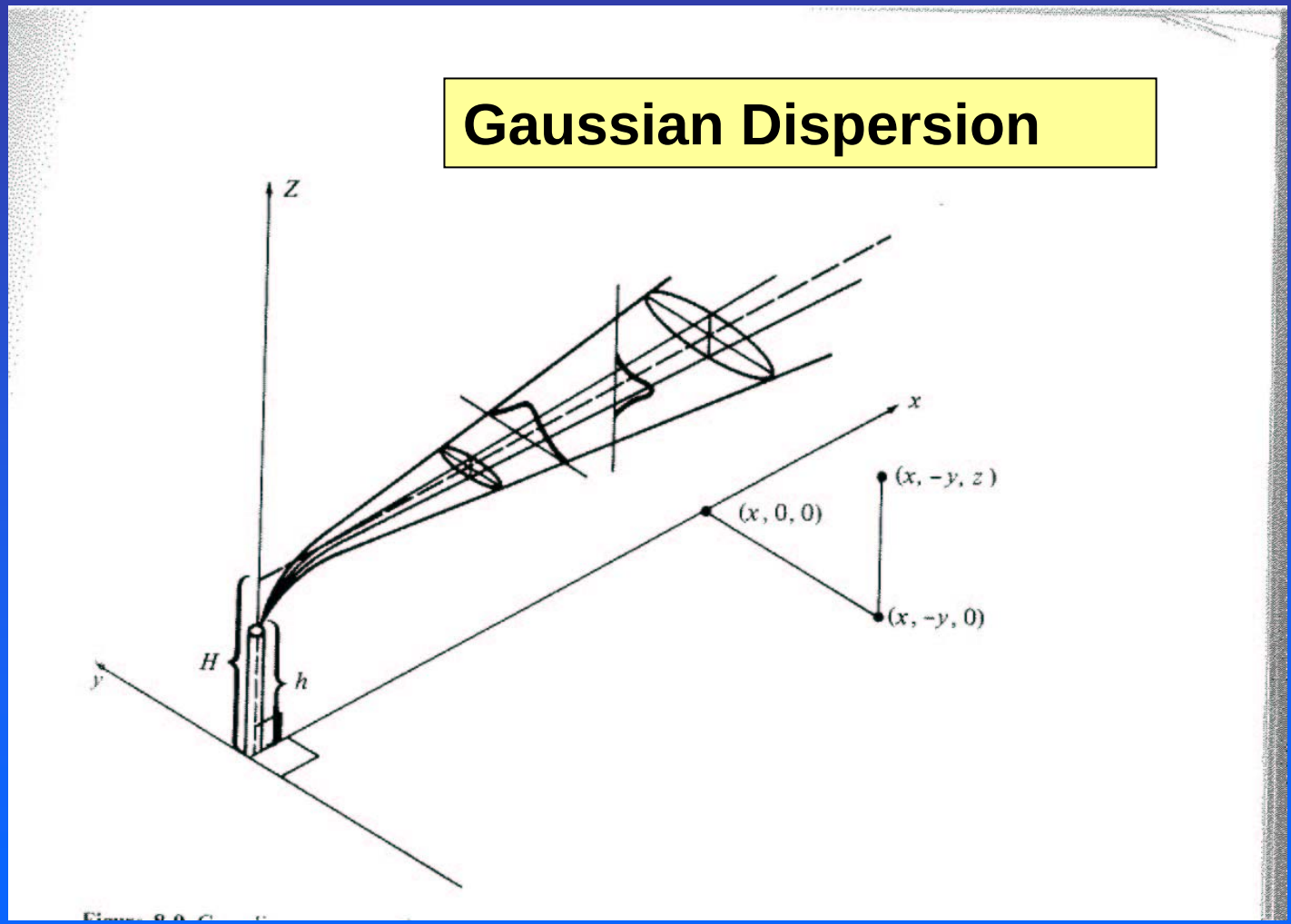
3 Models Have Been Developed to Assist Risk Managers for Bystander Exposure

- Each model has been reviewed by EPA's FIFRA Science Advisory Panel
  - Probabilistic Exposure and Risk model for FUMigants (PERFUM)
    - Acute exposures
  - Fumigant Emission Modeling System (FEMS)
    - Acute exposures
  - SOil Fumigant Exposure Assessment System (SOFEA)
    - Chronic exposures + acute exposures

PERFUM Case Study: Iodomethane

- Pre-plant soil biocide
  - Activity against insects, plant parasitic nematodes, soil borne pathogens, and weed seeds
- MIDAS™: iodomethane + chloropicrin
  - 98:2, 50:50, 33:67, 25:75 formulations
- May be used for growing strawberries, fresh market tomatoes, peppers, perennial crop ornamentals, nurseries, cut flowers, turf, and tree and vines.

Core of Exposure Estimation Methodology: *Air Dispersion Modeling*



What Does a Dispersion Model Do?

- Estimate concentrations at any location around a source
  - Derives hourly concentrations
  - Can be averaged over longer periods

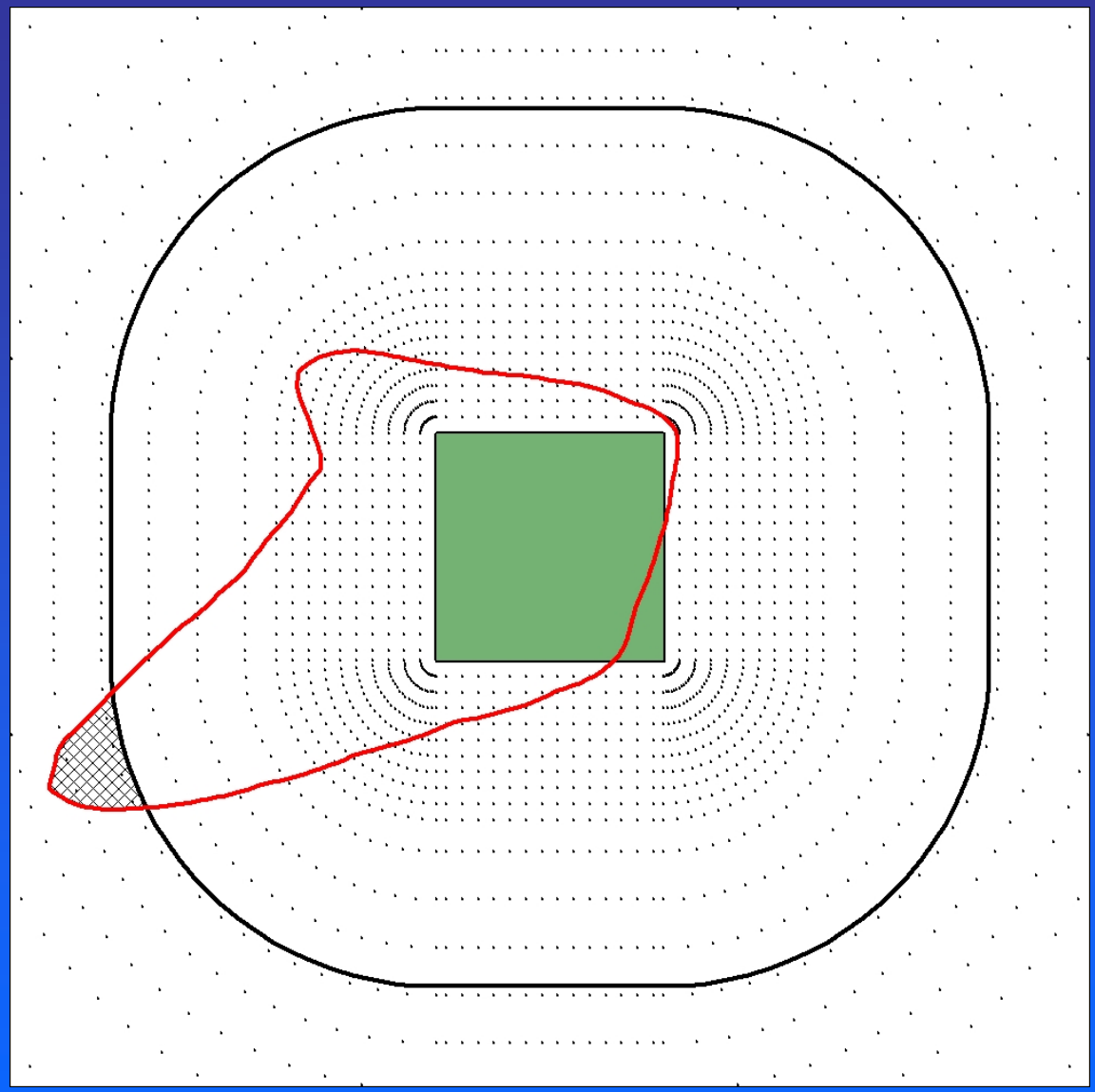
- Input requirements
  - Source dimensions
  - Flux rate (mass per area per time)
  - Characterization of meteorology
    - Wind speed, wind direction, and atmospheric stability on an hourly basis

PERFUM Approach

- Run ISCST3 with 5 years of historical meteorological data
  - Generate 5-year set of daily average concentrations
  - Different than running for a continuously emitting source
- Estimate concentrations in all directions around the field
  - Exposure probability
- Use measured diurnal profile of flux rates
  - Start time of application is a critical variable

Probability of Exposure:

red line shows reference concentration; black line shows hypothetical buffer zone)



Options for Setting a Buffer Zone

Option	Description
Whole field approach	Set buffer zone based on an upper-percentile of whole field concentration distribution
Maximum daily concentration approach	Set buffer zone based on an upper-percentile of maximum concentration distribution

PERFUM Features

- **Full percentile distributions of buffer lengths for whole field and maximum concentration profiles**
  - **1st to 99th percentile, 99.9, 99.99th percentiles**
- **Repeats calculations for up to 10 user-supplied application rates**
  - **Takes advantage of linearity between flux and concentration in ISCST3**
  - **Useful for developing buffer zone tables**

PERFUM Features

- Can use any acute averaging time <=24 hours (and factor of 24)
- Accommodates up to 15 days of off-gassing data
- Outputs buffer zones on a monthly basis for seasonal analysis
- Over 60 error messages to assist user in properly entering input data

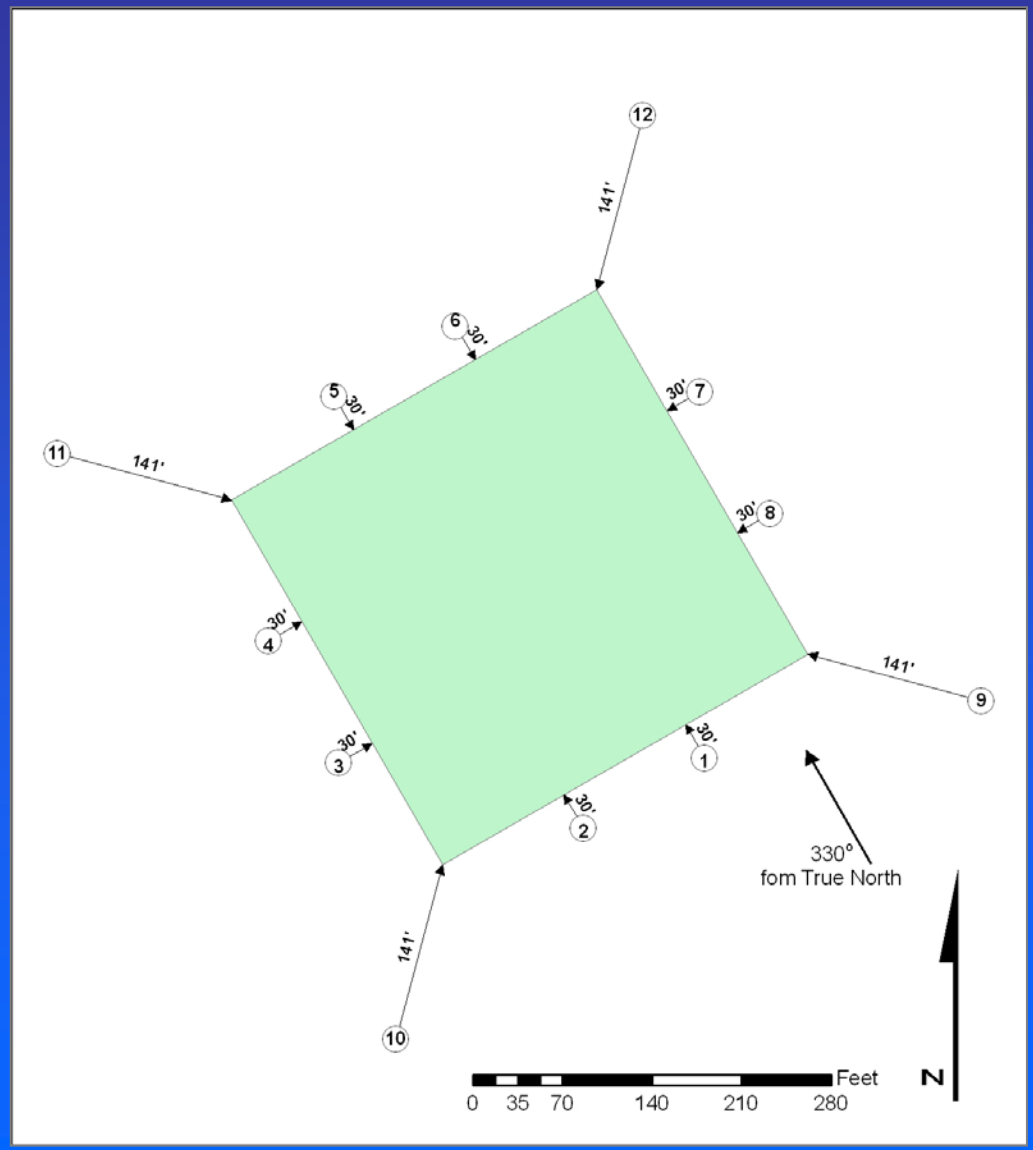
Key Conservative Assumptions to Bear in Mind

- Calculations assume that bystander spends 24 hours following application at the perimeter of the buffer zone

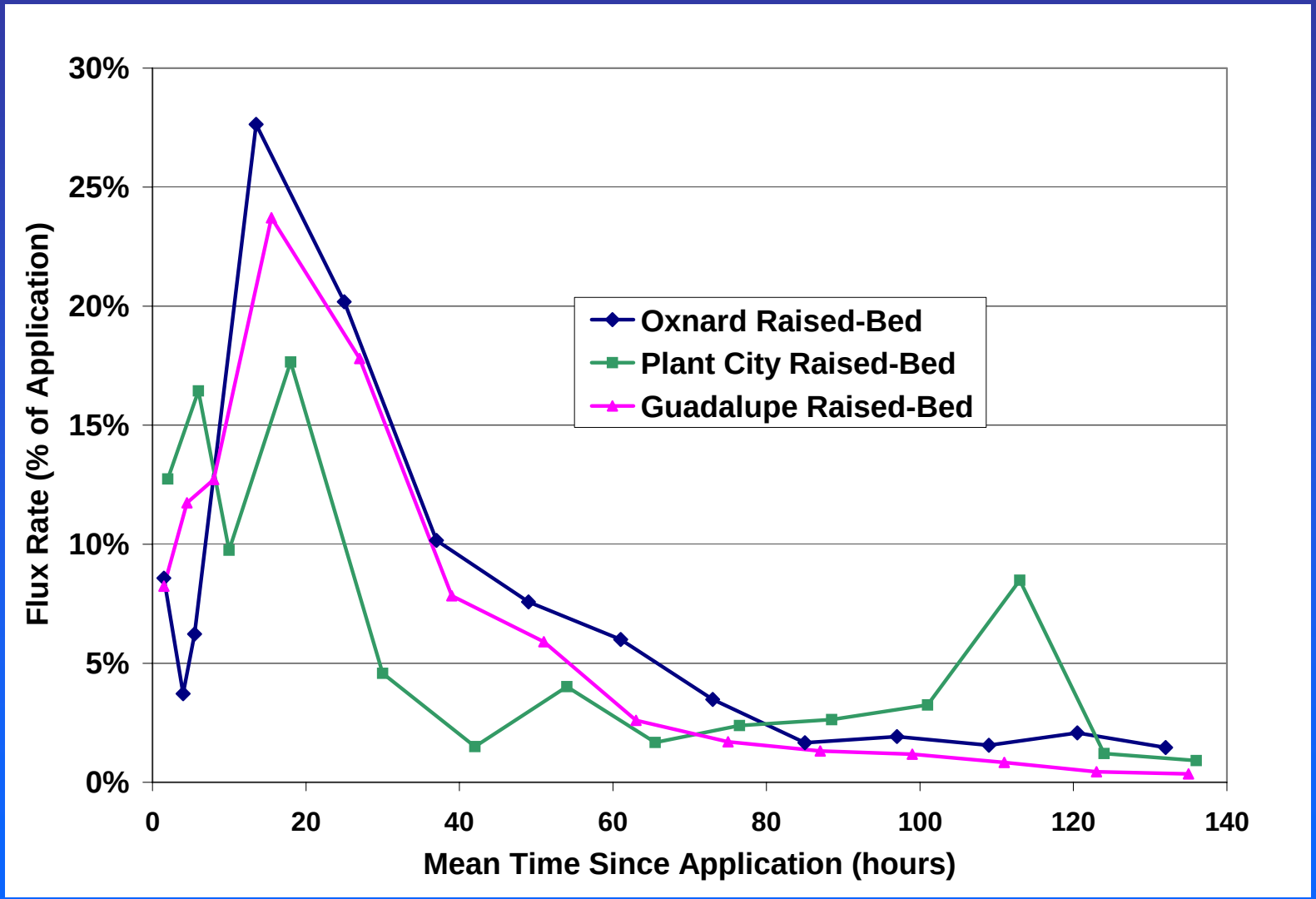
- Calculations assume that bystander is either outdoors for 24 hours OR indoor exposure is the same as the outdoor exposure

Measuring Flux Rates in the Field

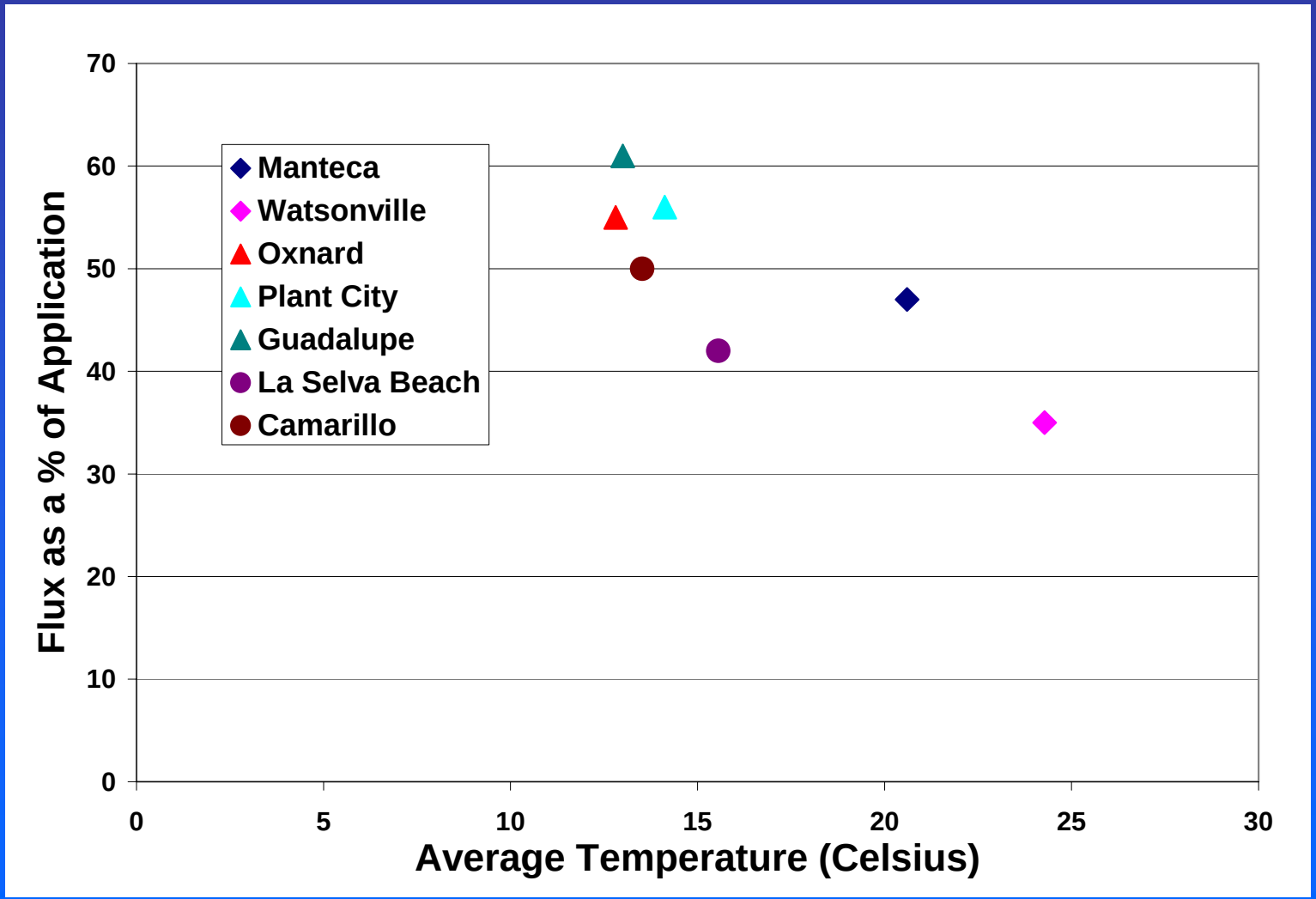
Example Field Dimensions and Sampling Locations (Camarillo Drip Irrigation Study)



Raised Bed Study Flux Rates for Iodomethane



Ambient Temperature Not a Significant Factor



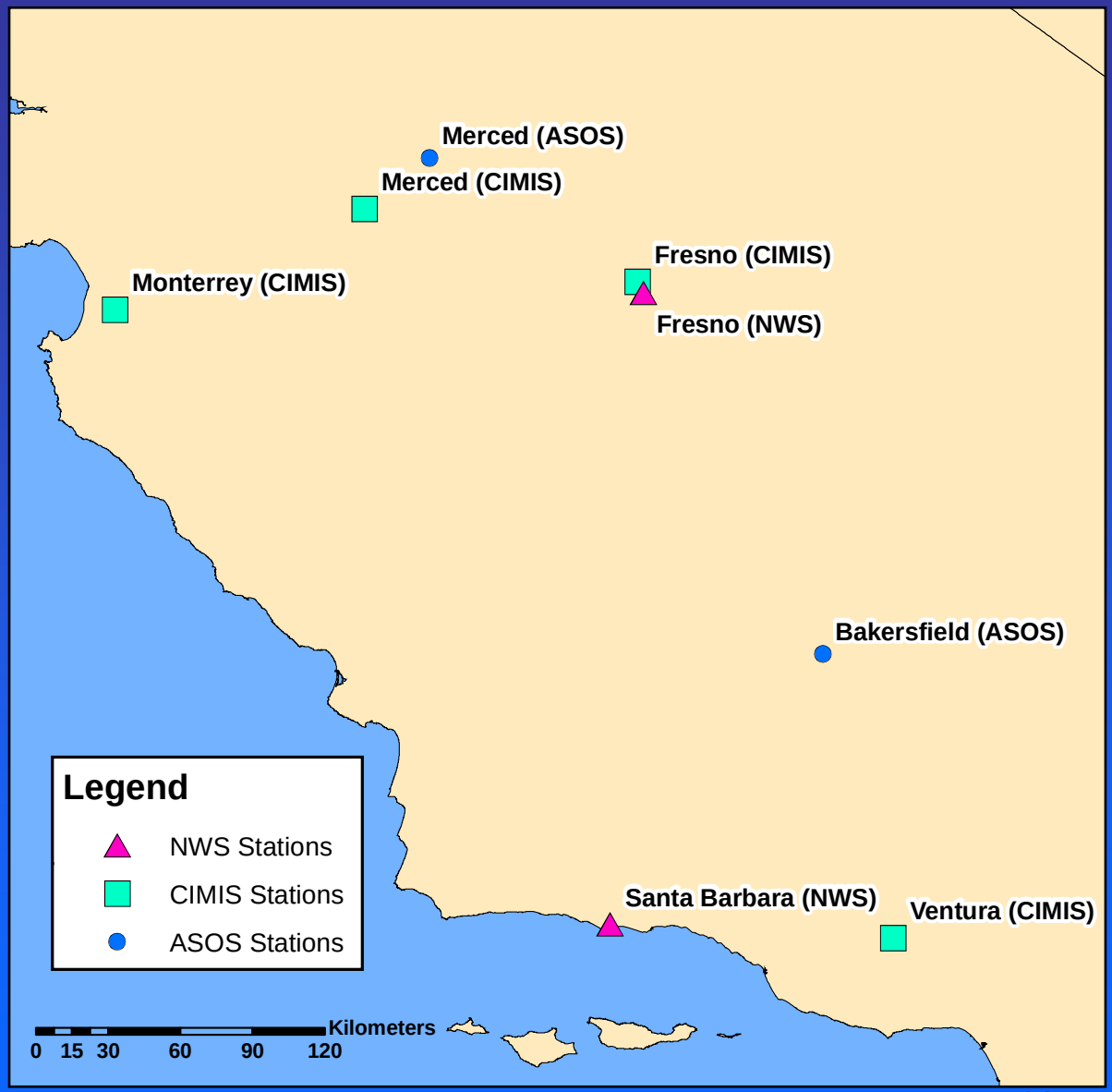
Summary of Emission Ratios for First 24 Hours for Iodomethane

Application Method	Study Name	Percent of Application Emitted in First 24 Hours
Flat Fume	Manteca	47%
	Watsonville	35%
Raised Bed	Oxnard	55%
	Plant City	56%
	Guadalupe	61%
Drip Irrigation	La Selva Beach	42%
	Camarillo	50%

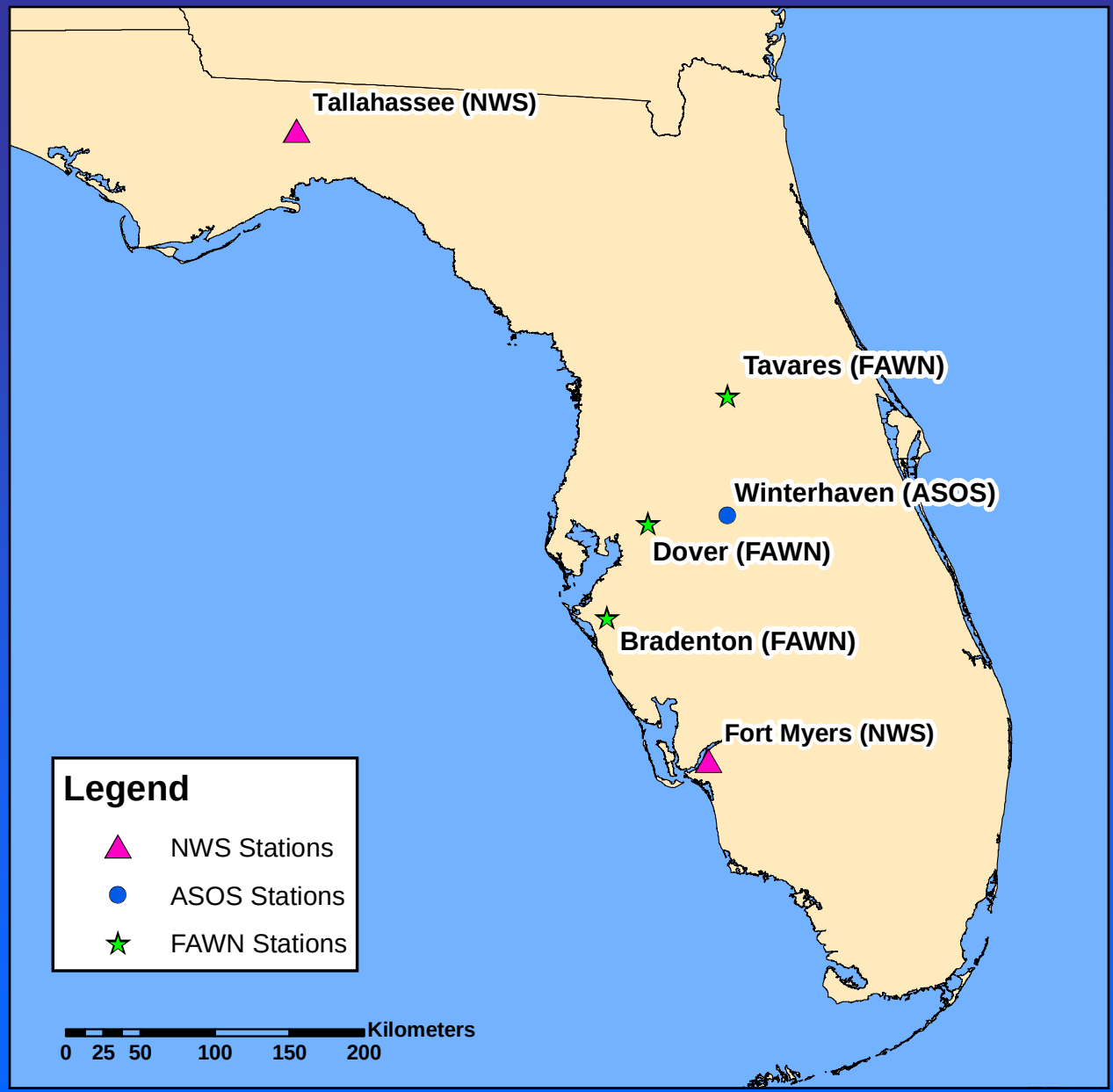
Potential Factors Influencing Buffer Zones

- Toxicity
  - Averaging time
  - Severity of endpoint
- Flux rate
  - Type of application
  - Chemical
- Meteorological data
  - Use area
- Diurnal profile
  - Start of application
- Field size

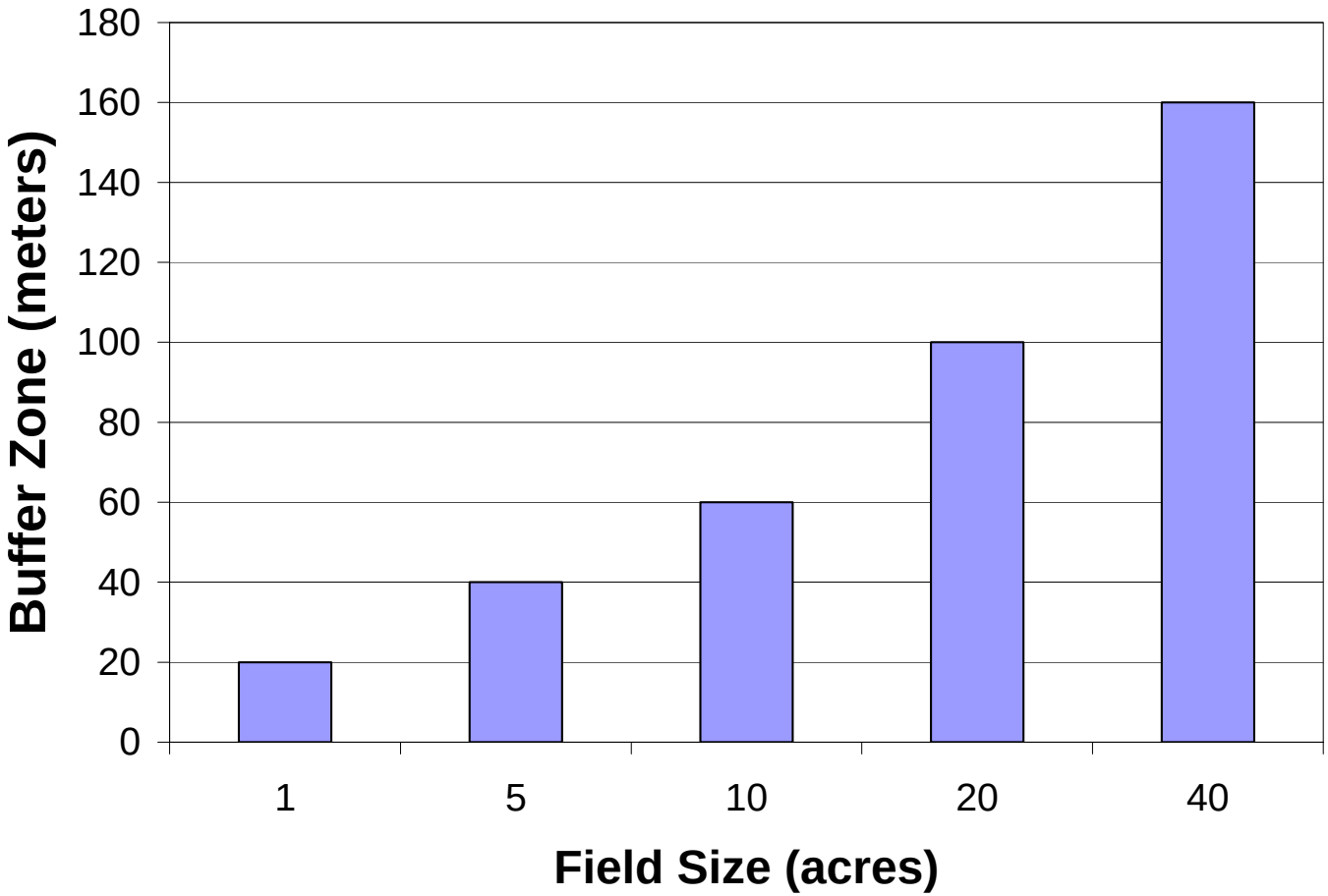
Stations in California



Stations in Florida

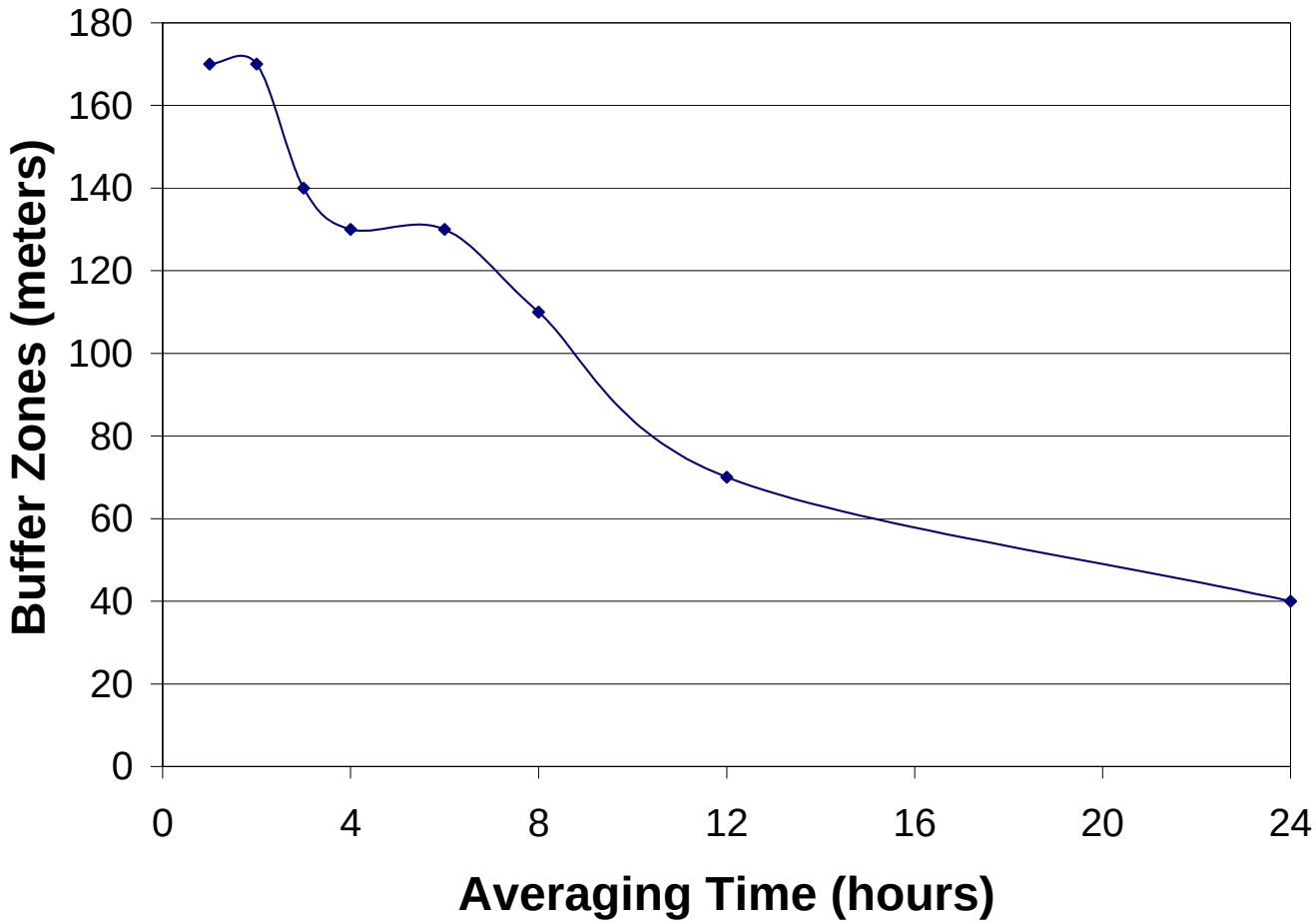


Potential Iodomethane Buffer Zones by Field Size



HEC=12 mg/m^3, UF=30

Potential Buffer Zones by Toxicity Averaging Period (5 acre field)



HEC=12 mg/m^3, UF=30

Margin of Exposure Program

- **PERFUM_MOE is an additional tool designed for risk management**

$$MOE = NOEL(HEC) / Exposure$$

- **For a given buffer zone distance, it calculates the distribution of margins of exposure (MOE) at the perimeter of the buffer zone**
  - **Estimates the severity of any exceedances above the MOE goal at the upper percentiles**

Conclusions

- Bystander exposure is an emerging issue for the regulation of fumigants
- Several models have been developed to address risk assessment issues associated with bystander exposure
- Various fumigant properties will influence buffer zones
  - Flux rates, toxicity, toxicity averaging period, field sizes, growing areas

Sources of Uncertainty and Areas for Future Research

- Estimation of flux rates
- Characterization of meteorology in the growing areas
- Air dispersion estimates
- Indoor versus outdoor exposure
- Time activity assumptions
- Potential for exposure from multiple fields
- Variation of exposure and application likelihood by season