# *Research Overview – Off-site Movement*

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**Presented by: Naresh Pai**

# Off-site Movement (OSM) Topics

- Spray Drift Measurements
  - factors; summary of field studies
- Equivalency with Traditional Application Platforms
- Mathematical Model
  - Inform exposure component for environmental / ecological risk assessment

# *Spray Drift from Field Trials*

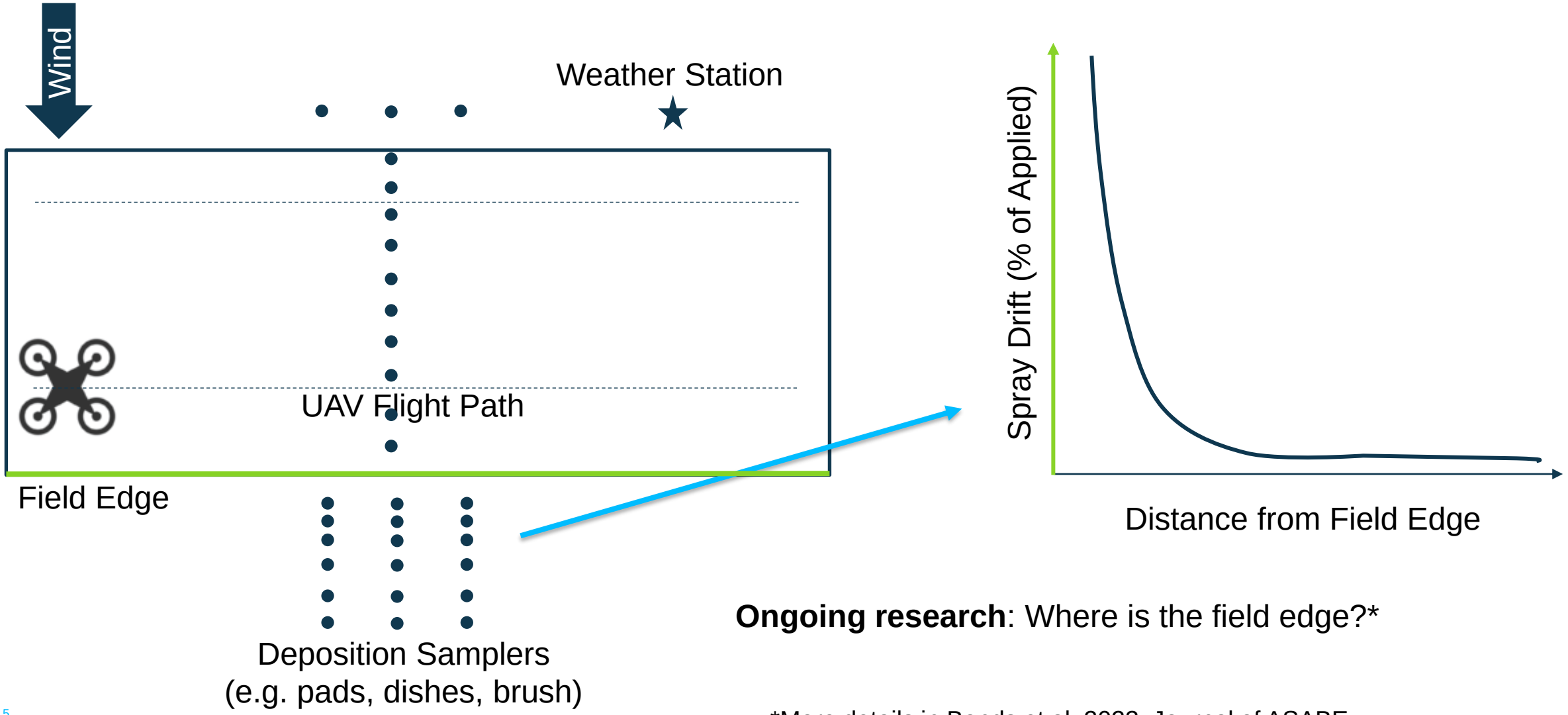
# Why Measure Off-site Movement (OSM) in Field Trials?

Off-site movement data provides key information to conduct risk assessments

- Measuring off-site movement is important to better understand effects of:
  - Different platforms (hardware)
  - Application parameters
  - Environmental conditions
- Important to setup robust label conditions and recommend best management practices

# How do we measure off-site movement?

Simple illustration of a UAV spray drift field study and typical results



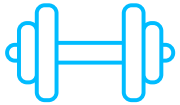

**Ongoing research**: Where is the field edge?*

*More details in Bonds et al. 2023, Journal of ASABE

# What are the factors that affect off-site movement?

## Hardware

Number of rotors



Payload

Forward speed

## Application


Release height

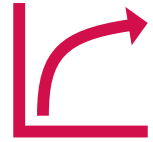
Droplet size

Swath Offset

## Environmental

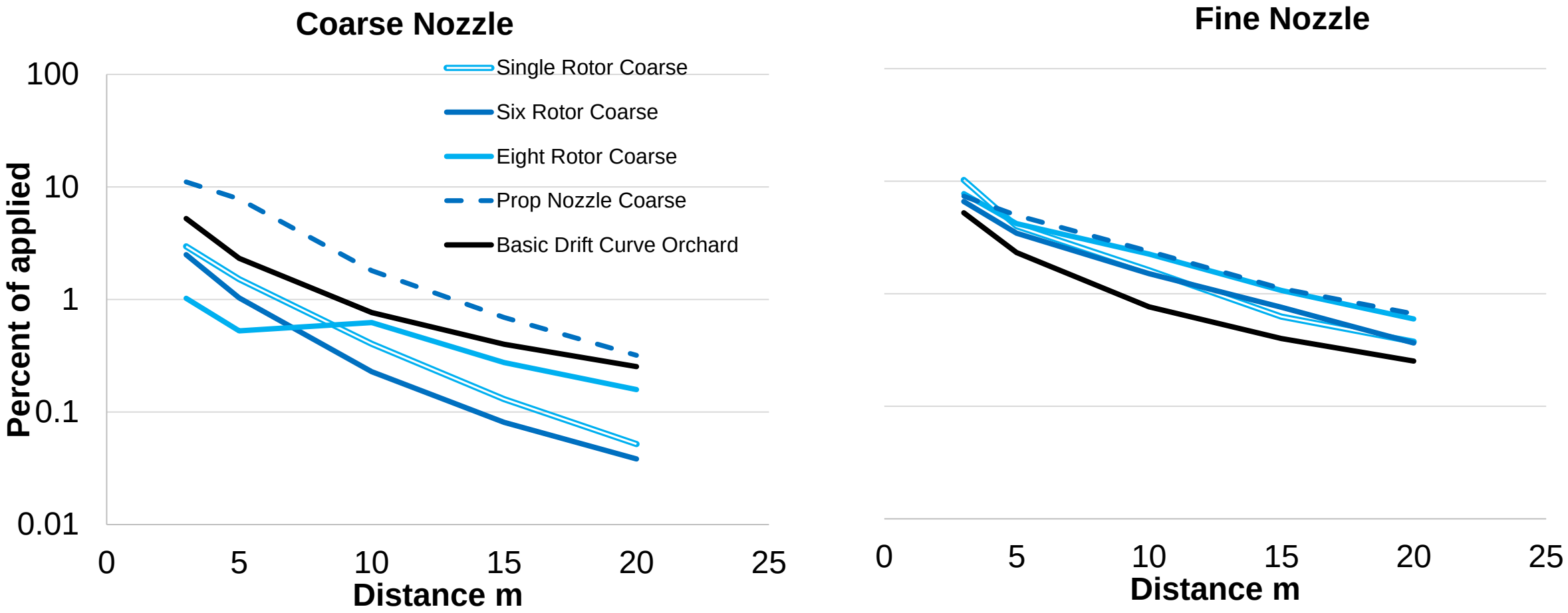
Wind

Temperature



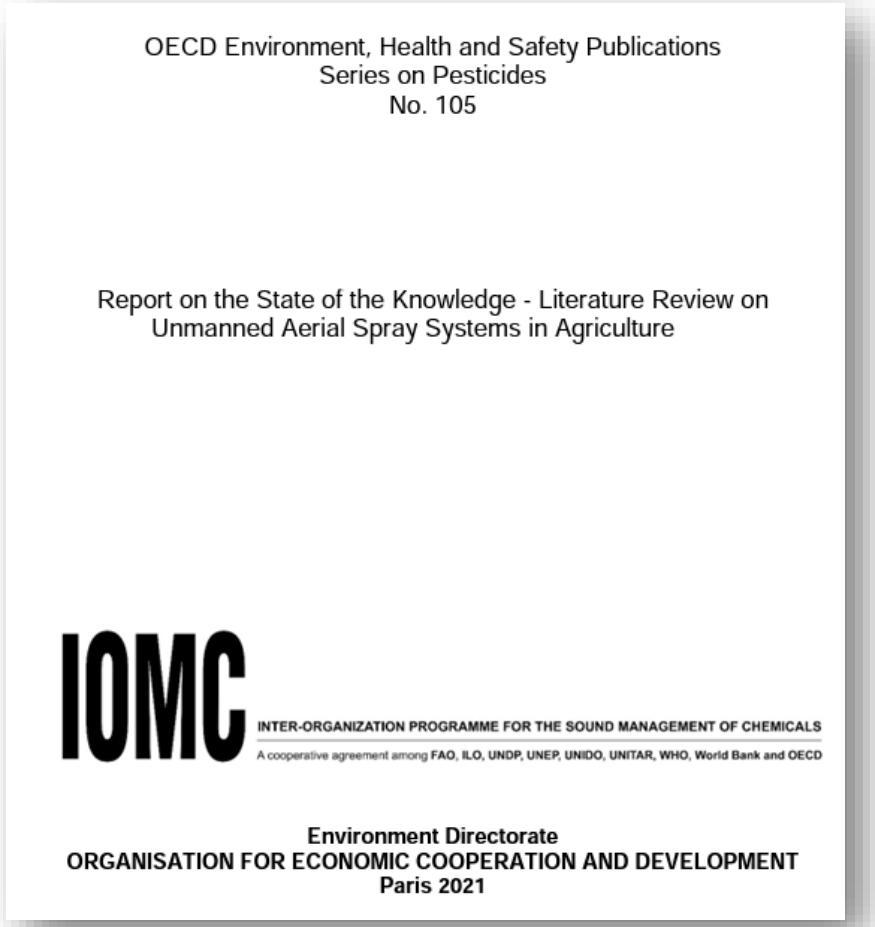
Inversion

# Effect of Rotor and Droplet Size on Off-Site Movement*




*Data from Germany (Herbst et al., 2019)

# Other Resources Related to Spray Drift

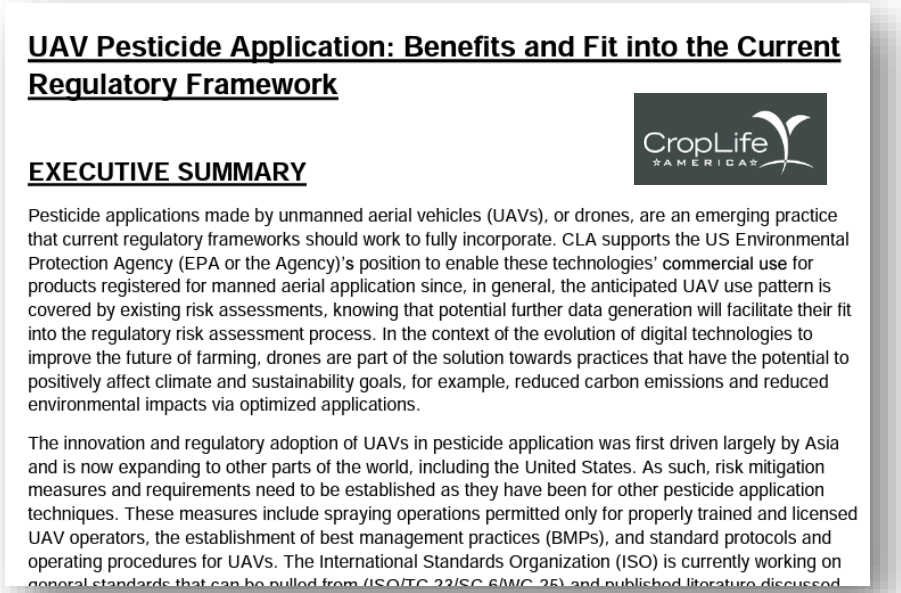


OECD Environment, Health and Safety Publications
Series on Pesticides
No. 105

Report on the State of the Knowledge - Literature Review on Unmanned Aerial Spray Systems in Agriculture

IOMC
INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS
A cooperative agreement among FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD

Environment Directorate
ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT
Paris 2021



**UAV Pesticide Application: Benefits and Fit into the Current Regulatory Framework**

CropLife AMERICA

**EXECUTIVE SUMMARY**

Pesticide applications made by unmanned aerial vehicles (UAVs), or drones, are an emerging practice that current regulatory frameworks should work to fully incorporate. CLA supports the US Environmental Protection Agency (EPA or the Agency)'s position to enable these technologies' commercial use for products registered for manned aerial application since, in general, the anticipated UAV use pattern is covered by existing risk assessments, knowing that potential further data generation will facilitate their fit into the regulatory risk assessment process. In the context of the evolution of digital technologies to improve the future of farming, drones are part of the solution towards practices that have the potential to positively affect climate and sustainability goals, for example, reduced carbon emissions and reduced environmental impacts via optimized applications.

The innovation and regulatory adoption of UAVs in pesticide application was first driven largely by Asia and is now expanding to other parts of the world, including the United States. As such, risk mitigation measures and requirements need to be established as they have been for other pesticide application techniques. These measures include spraying operations permitted only for properly trained and licensed UAV operators, the establishment of best management practices (BMPs), and standard protocols and operating procedures for UAVs. The International Standards Organization (ISO) is currently working on general standards that can be pulled from (ISO/TC 23/SC 6/WG 25) and published literature discussed

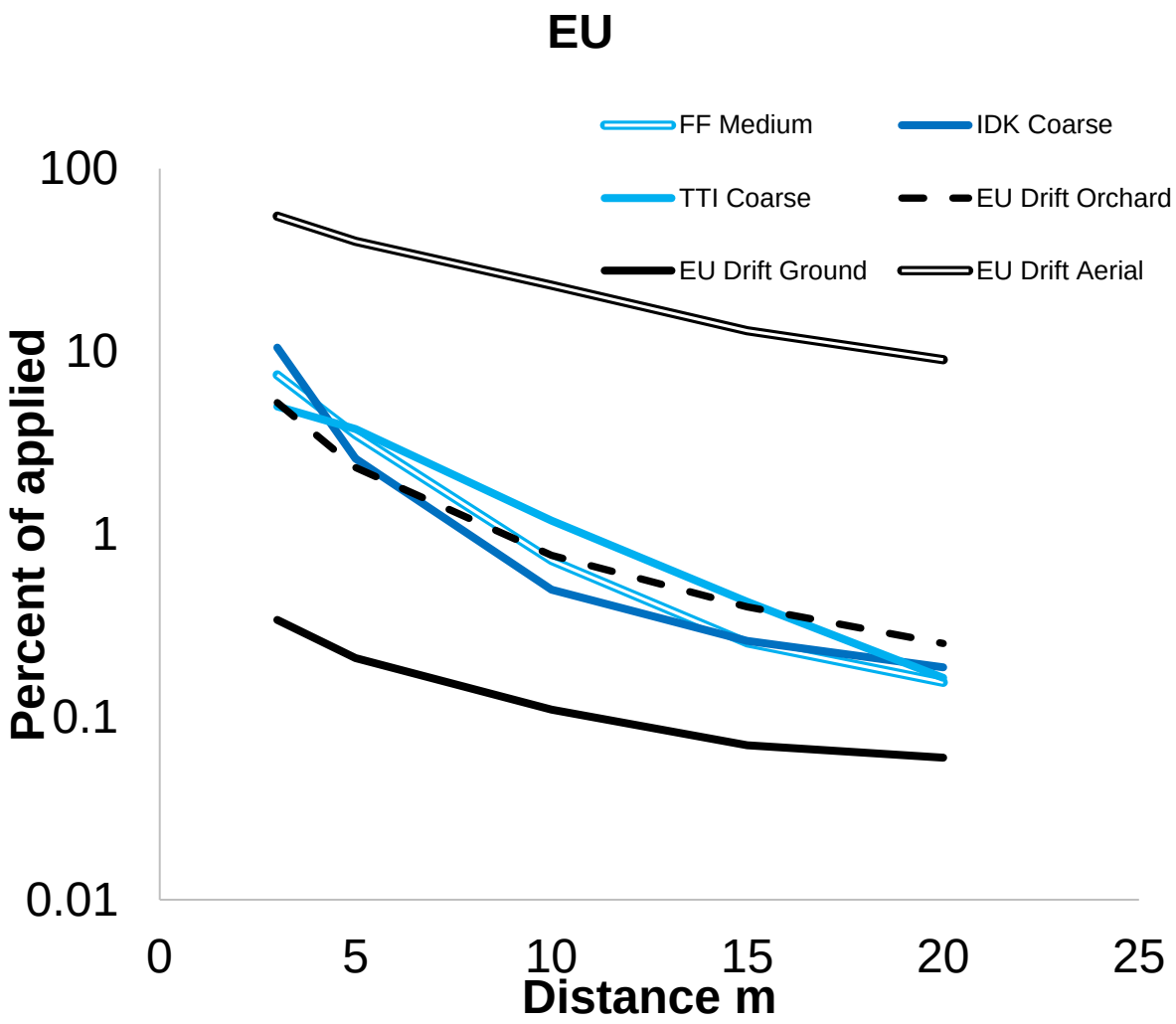
- Drift Database Project (CLA) – Dr. Jane Bonds
- USDA spray drift trials and publications – Dr. Dan Martin
- UAPASTF drift trials – Greg Watson, Ben Brayden
- Auburn University trials – Dr. Steve Li

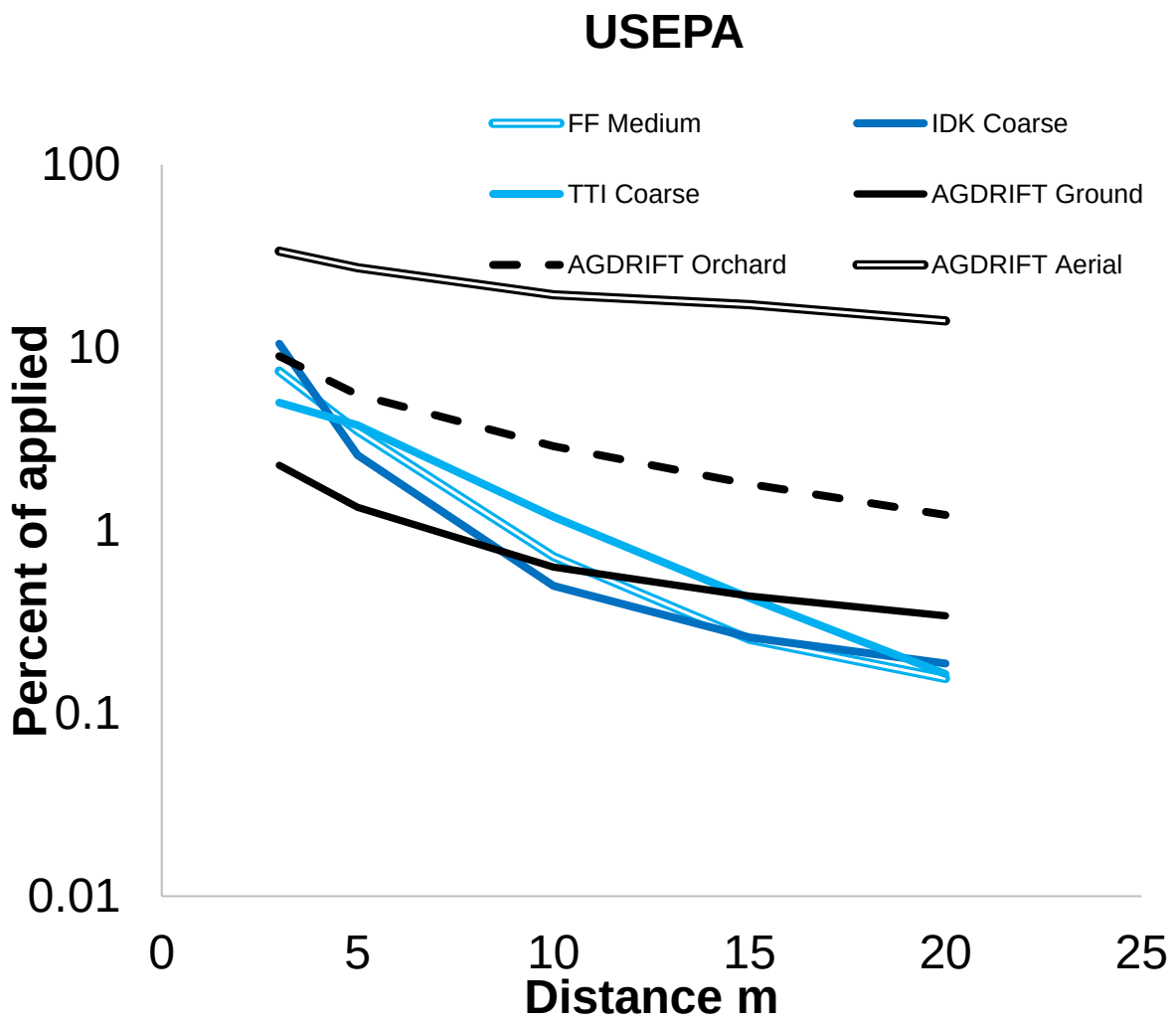
# *Equivalency to Traditional Application Platforms*

# Why develop equivalency?

- Spray drift from ground, airblast, and airplane sprayers well understood
- Standard drift curves established by regulators
- Useful for risk assessments and approve labels
- Equivalency allows for level setting
- Need to ensure data used for comparison is robust

# UAV Spray Drift Higher Than Ground, Lower Than Aerial, Similar to Airblast




*Data from US (Bonds et al., 2023, in review)

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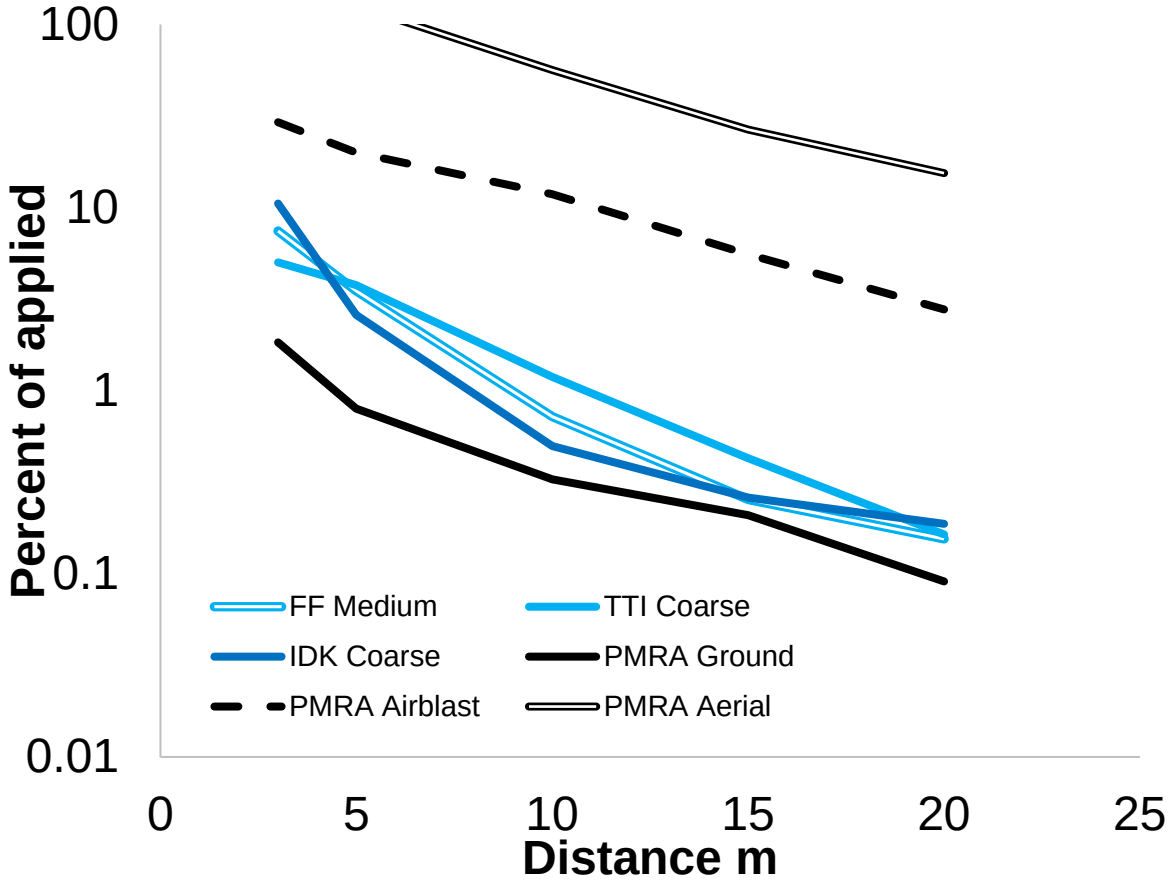
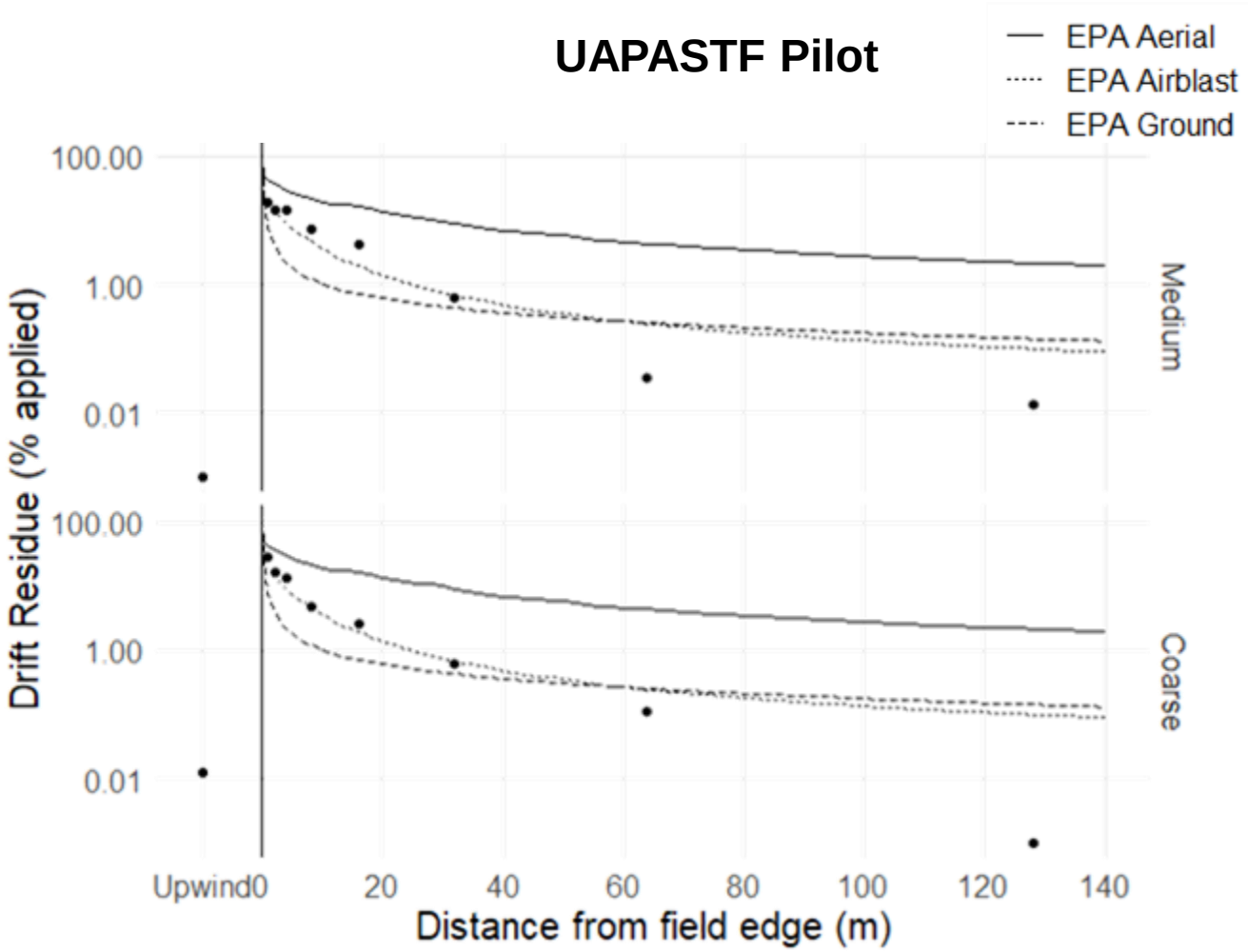


# *Mathematical Model Performance*

**Inform exposure component for environmental / ecological risk assessment**

# Why do we need mathematical models for drone OSM?

- Field data represents a single environmental snapshot
- Mathematical models predict OSM under a range of conditions
- Mechanistic models exist for ground and aerial applications
- For drones- early stages of development and testing
- Useful for environmental / ecological risk assessments

# AGDISPpro

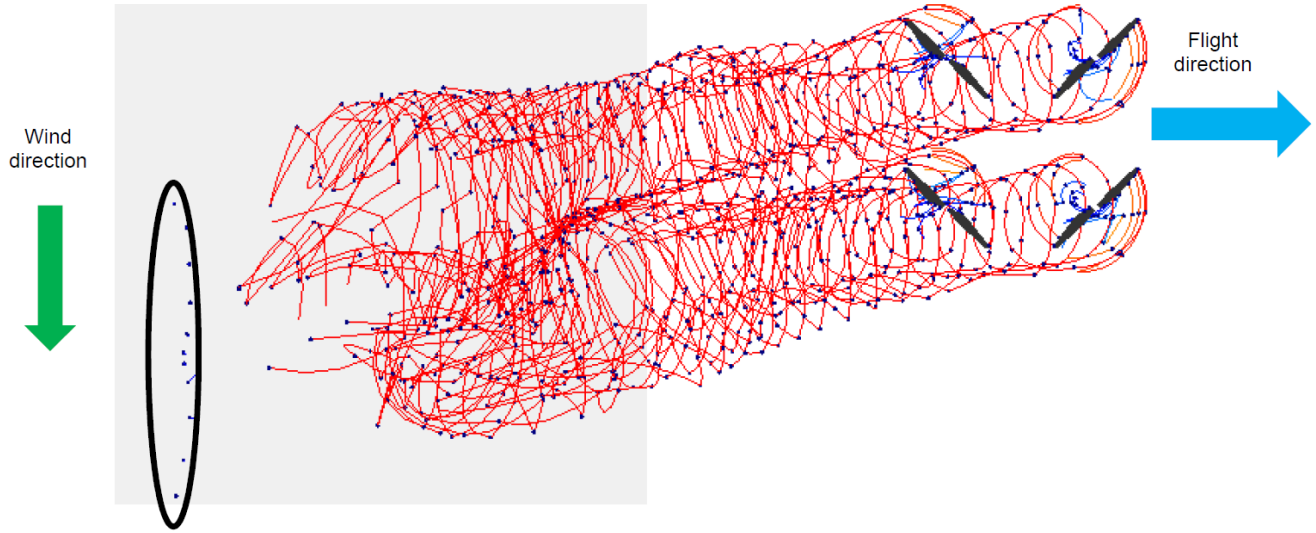
## CHARM
(Comprehensive Hierarchical Aeromechanics Rotorcraft Model)

- Develops the 3D velocity flow field

+

## AGDISP
(AGricultural DISPersal)

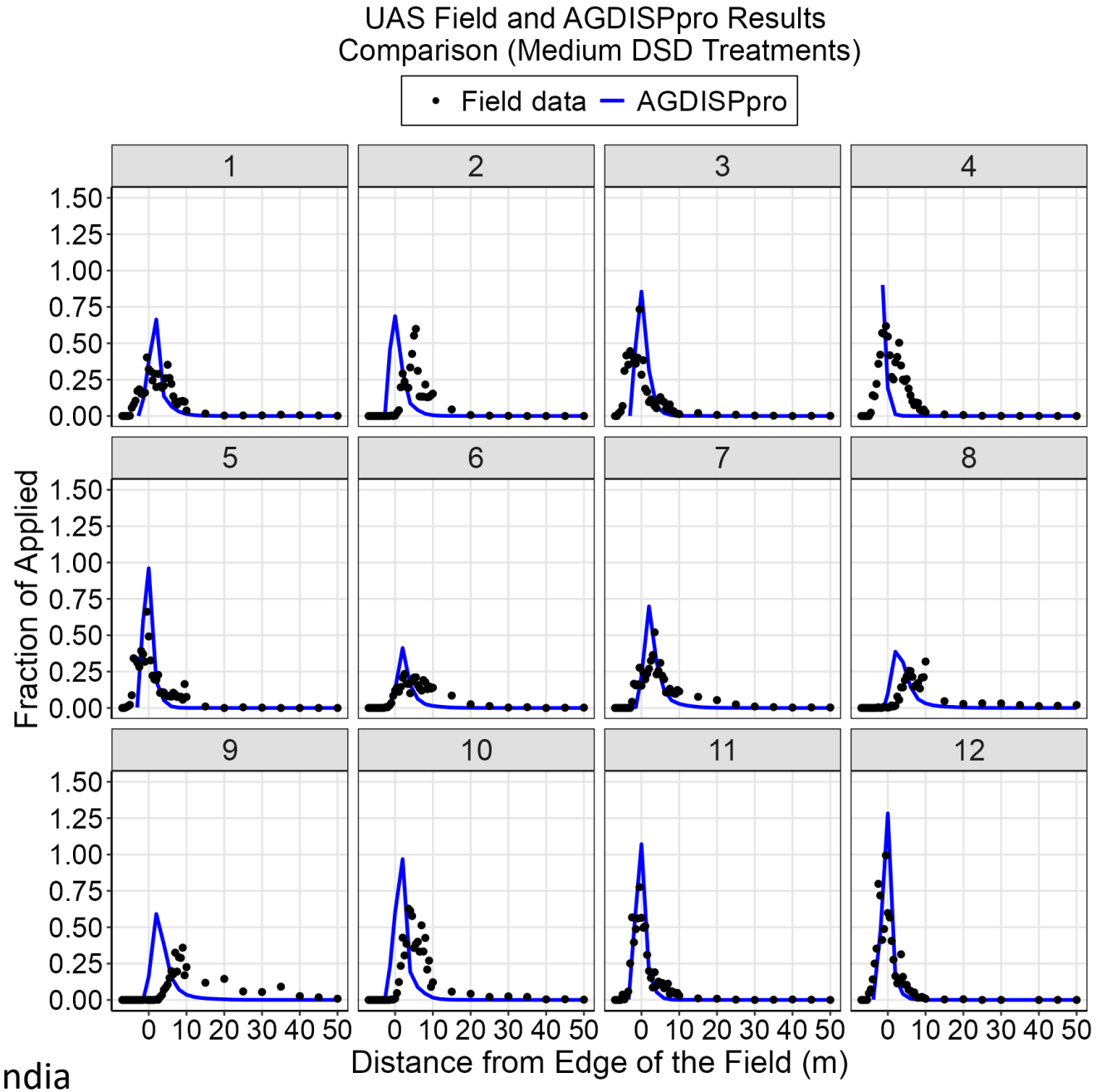
- Tracks the release of droplets through this field




Teske, M.E. et al. 2018, PREDICTION OF AERIAL SPRAY RELEASE FROM UAVS, Transaction of ASABE, Vol. 61(3): 909-918

# Model Comparisons

- Model simulations compared with USDA field trial
- Modeled depositions match the field measurements very well*




*Jane Tang et al., 2023, IUPAC 15th ICCPC, New Delhi, India

# Summary – Research Overview, Offsite Movement

## *Spray Drift*

- **Exposure data continues to be generated**
  - Focus on understanding parameters
  - Drift database continues to grow
- **Collaborations by key stakeholders'**
  - OECD WPP Drone Subgroup
  - UAPASTF
  - CLA
  - USDA/EPA/PMRA/APVMA/HSE
  - Academia
- **Important to have regulator engagement in developing exposure estimates**

## *Equivalency*

- **Comparisons with traditional platforms**
  - Leverage tools and understanding from historical drift research
- **Initial data shows that UAV drift**
  - Lower than aerial
  - Higher than ground
  - Similar to airblast
- **Important to continue to monitor this as new data becomes available**

## *Modeling*

- **Initial AGDISPpro comparison are promising**
  - Good match against USDA trial
- **Robust and validated model will aid risk assessments**
- **Government / regulator resources required for developing exposure models**

*Thank you!*