



**ASME**  
**ES 2024**  
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on Energy Sustainability

# Hydrogen Leak Modeling for Development of Smart Distributed Monitoring Under Unintended Releases

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# Outline

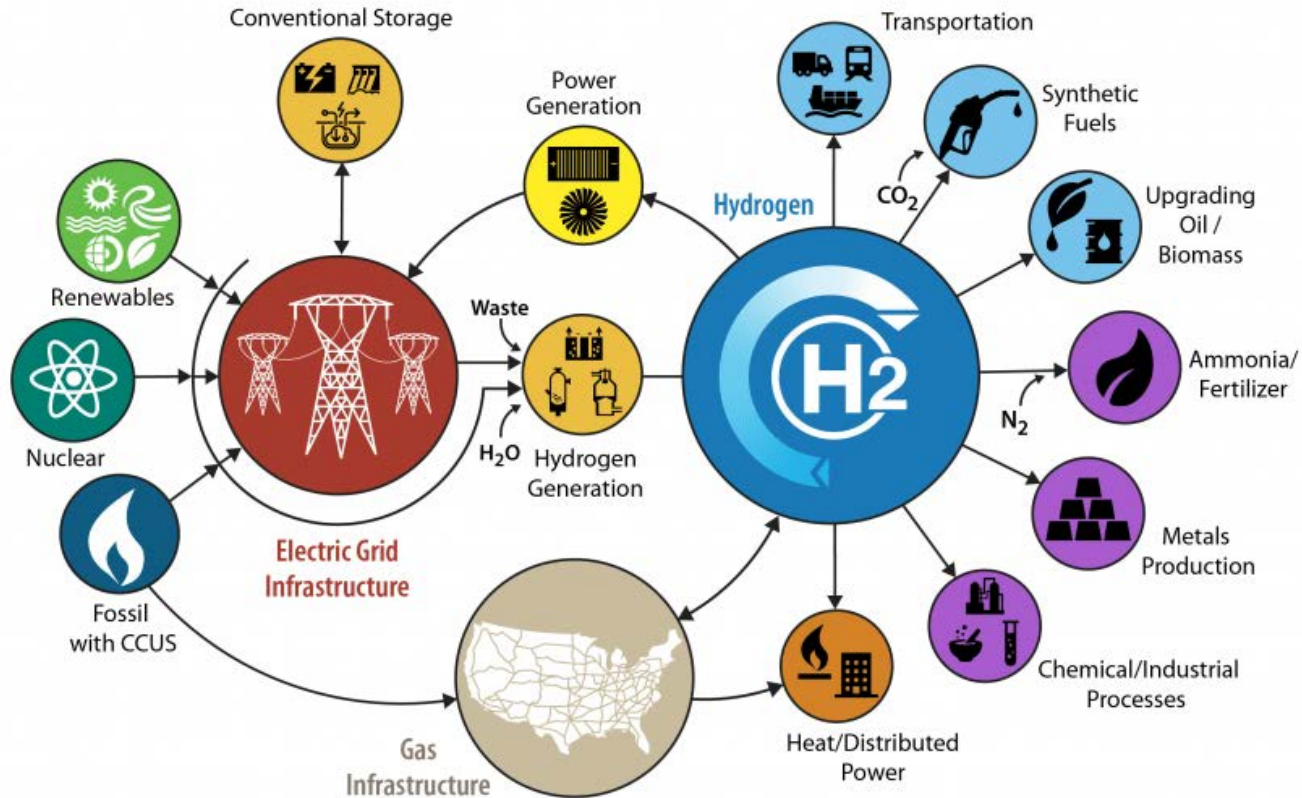
## Motivation

Modeling development

Results

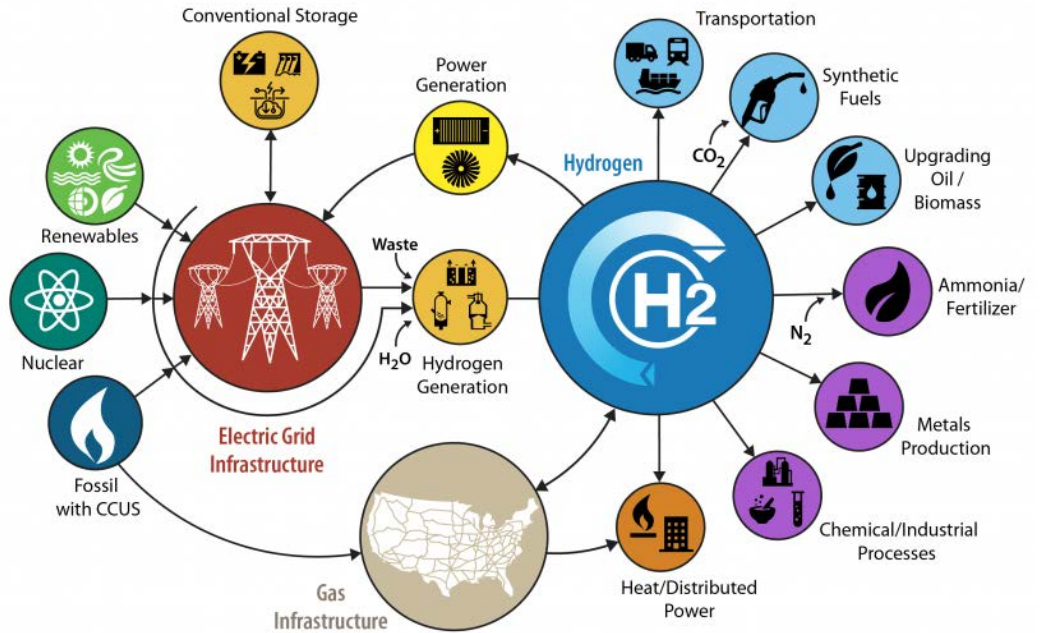
Next Steps

# Motivation



Source: [US Department of Energy, H2@Scale](#)

# Motivation



## Important safety questions:

1. If a hydrogen leak occurs, where does it go and in what concentrations? How much hydrogen was lost?
2. Where should facilities place sensors to detect leaks? How many sensors?
3. Many, many more...

# Motivation

## Important safety questions:

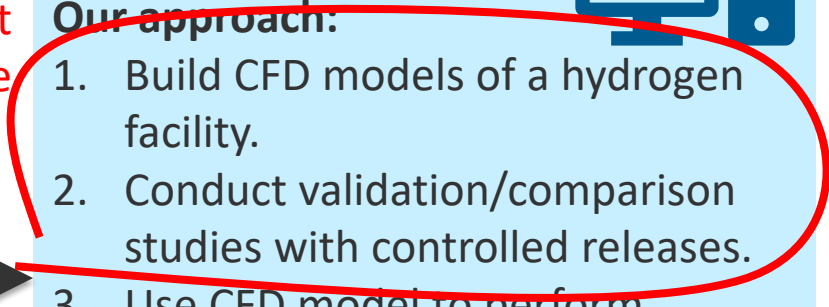
1. If a hydrogen leak occurs, where does it go and in what concentrations? How much hydrogen was lost?
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Current  
stage

## Our approach:

1. Build CFD models of a hydrogen facility.
2. Conduct validation/comparison studies with controlled releases.
3. Use CFD model to perform hydrogen dispersion scenario analysis.
4. Use CFD results to inform answers and safety guidance.





# Outline

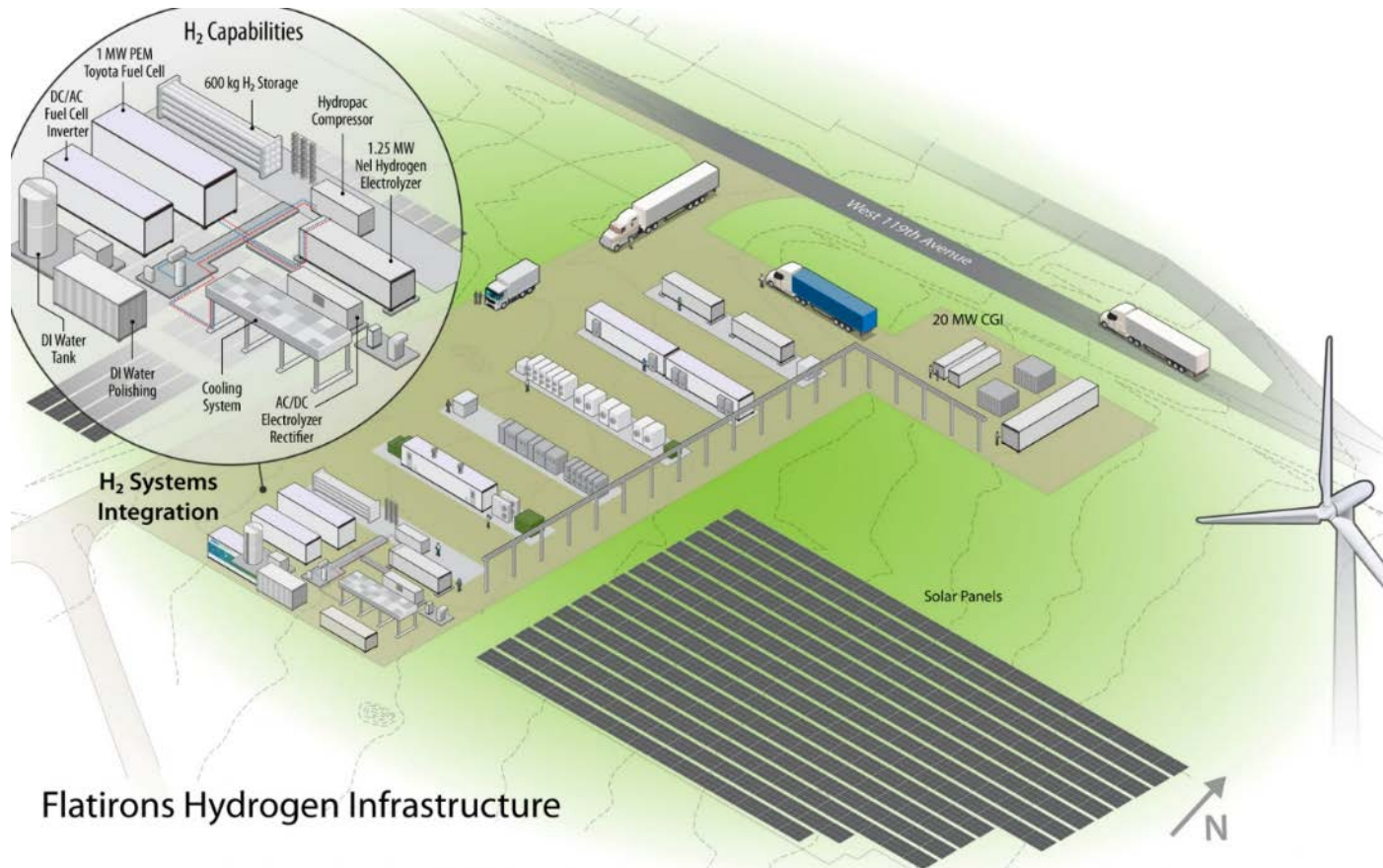
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**Modeling development**

Results

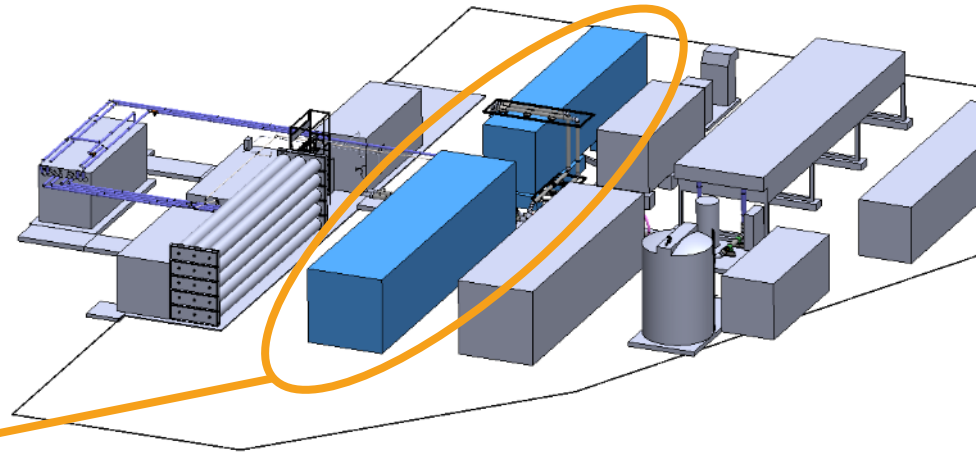
Next Steps

# Model development – ARIES Facility



Flatirons Hydrogen Infrastructure

# Model development – ARIES Facility



Release rate: 27 kg/hr  
Avg. ambient pressure: 0.84 bar  
100% hydrogen at release



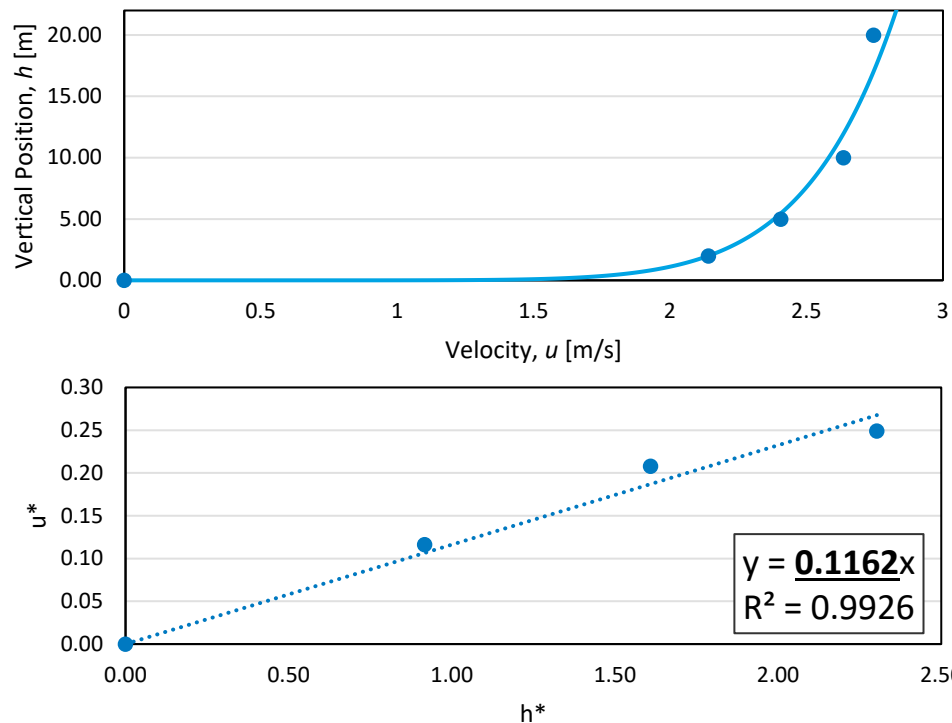
# Model development – Wind

- Wind typically follows a power law relationship with distance from ground:

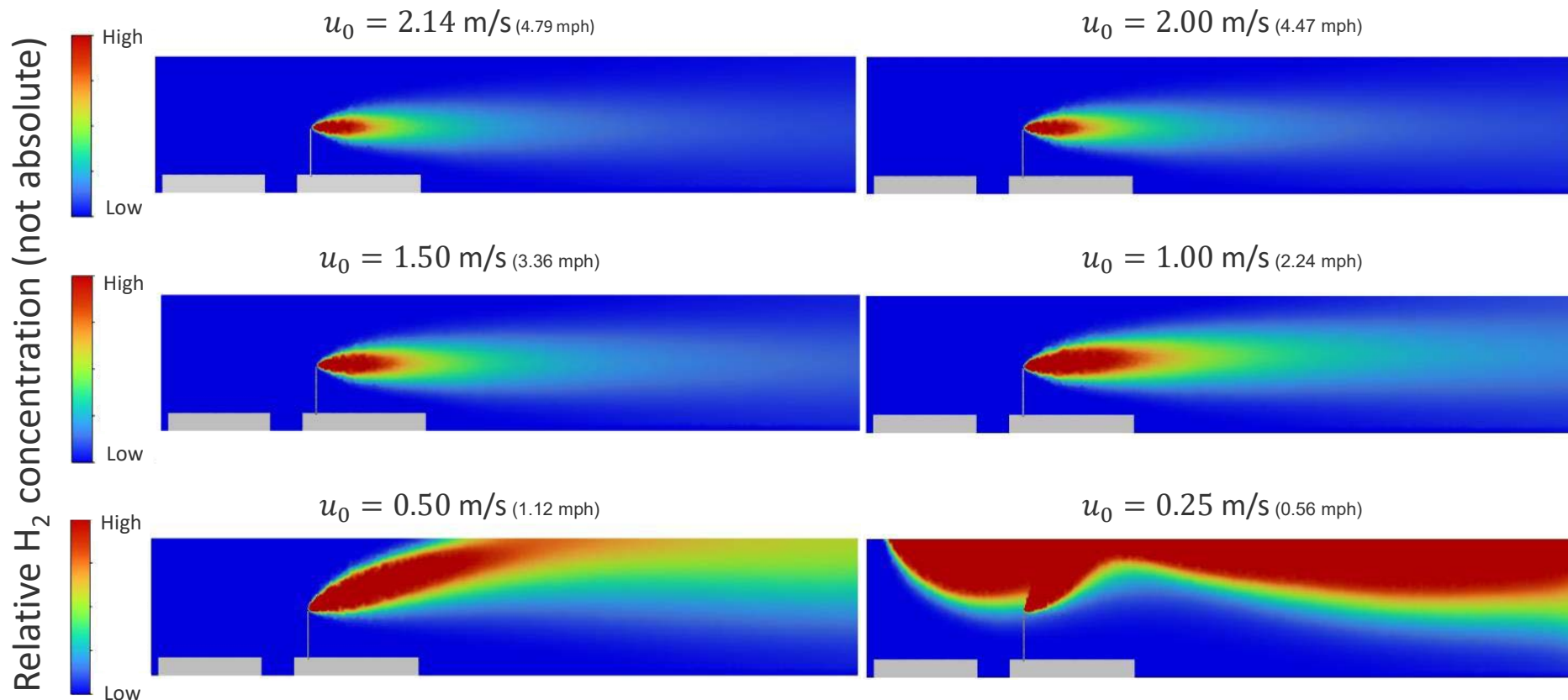
$$u = u_0 \left( \frac{h}{h_0} \right)^\beta$$

- Measurement points speed at for 2, 5, 10, 20, and 50 m available.
- Calculate beta from linear regression:

$$\ln \left( \frac{u}{u_{2m}} \right) = \beta \ln \left( \frac{h}{h_{2m}} \right) \rightarrow u^* = \beta h^*$$

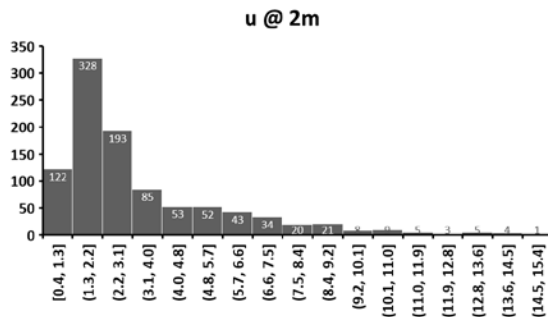
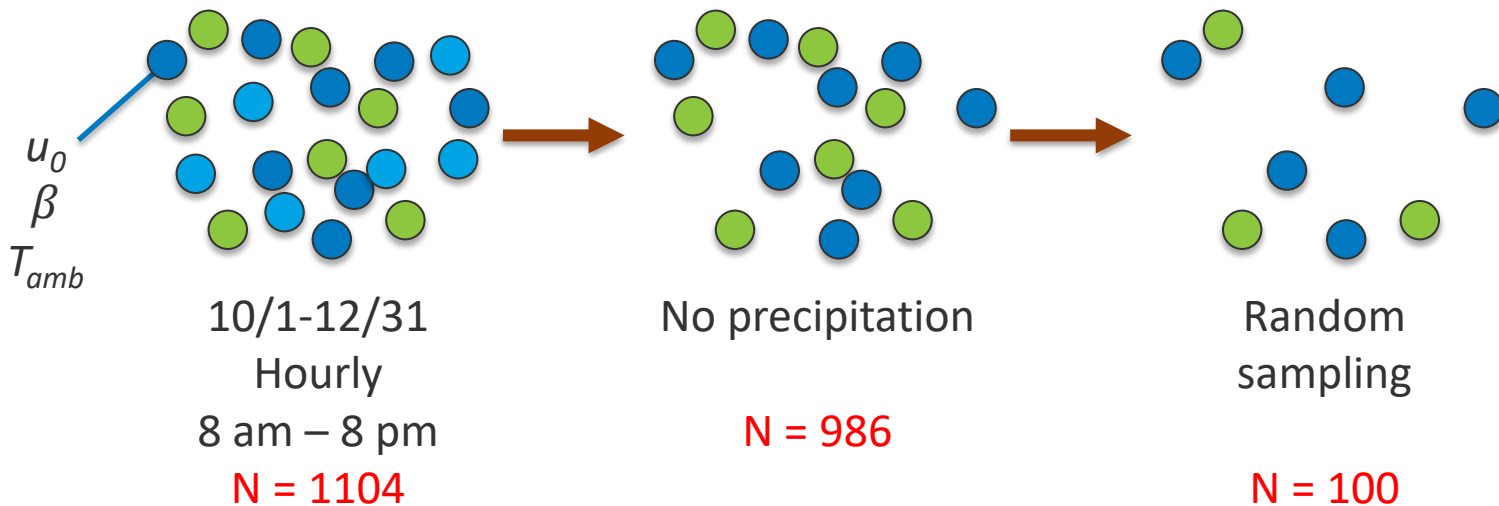


# Model development – Wind



Wind speed greatly impacts the influence of buoyancy of hydrogen on dispersion.

# Model development – Wind



Using wind measurement data, we can create site-specific wind conditions.



# Outline

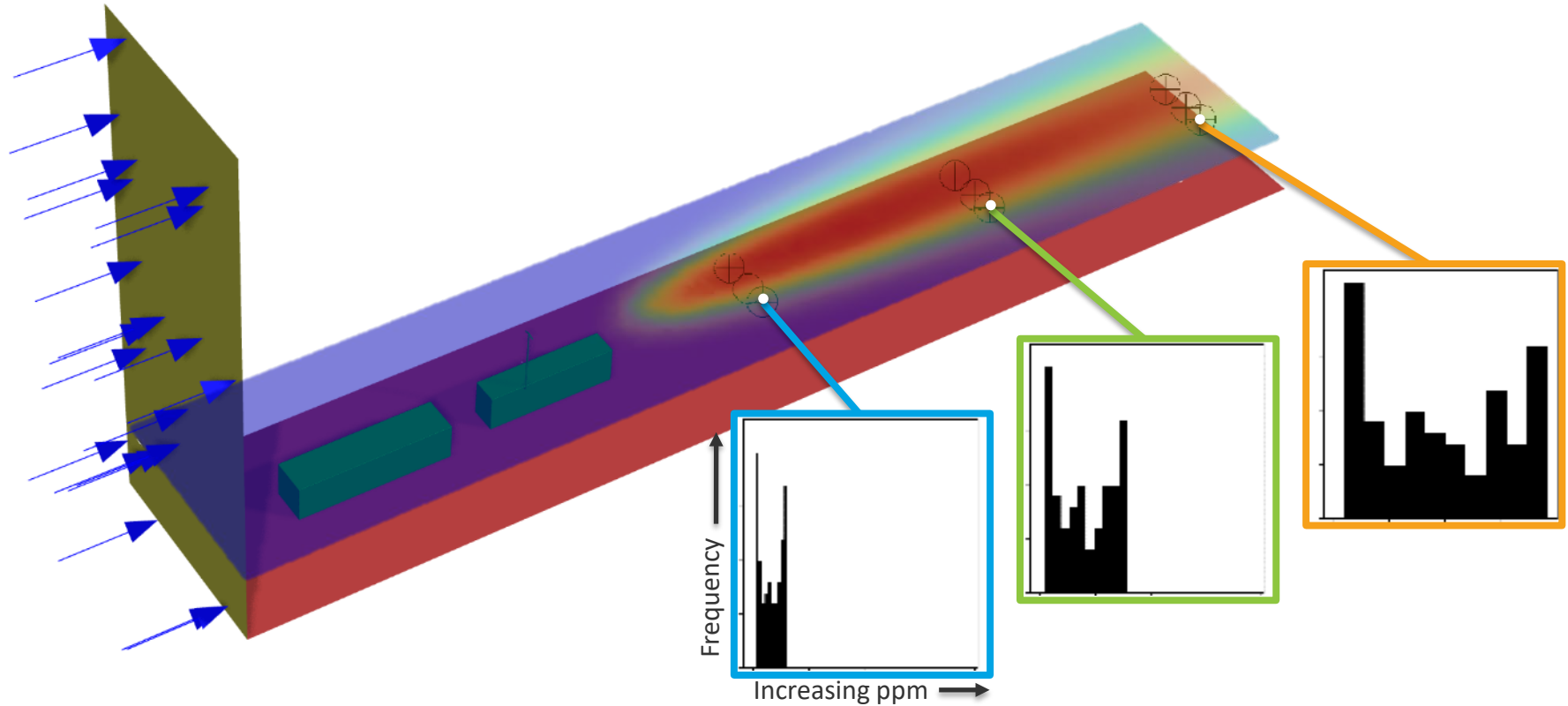
Motivation

Modeling development

**Results**

Next Steps

# Results



Characterized dispersion statistically.





# Outline

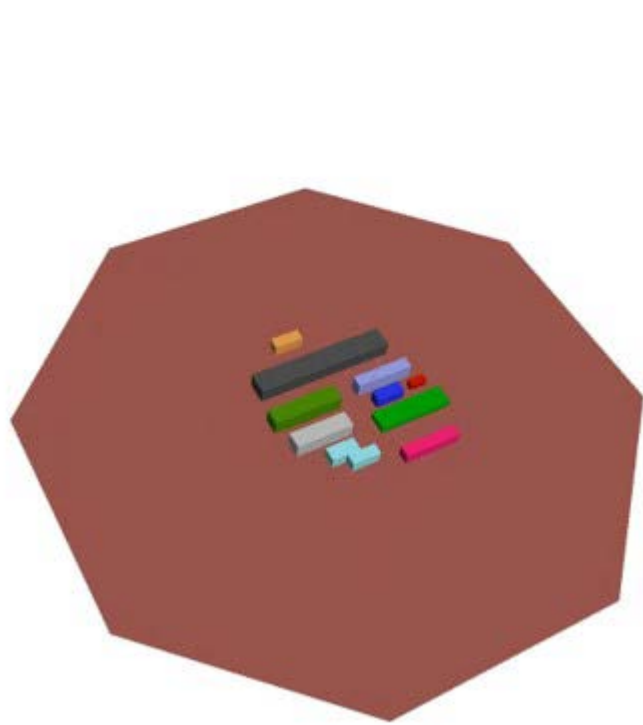
Motivation

Modeling development

Results

**Next Steps**

# Next Steps



**Site-agnostic**

**Site-optimization**

**Site-specific**

Validation, site-specific, site-optimized, and site-agnostic work planned.



A satellite view of Earth at night, showing the curvature of the planet and the glowing lights of cities and continents. The sun is visible on the left horizon, creating a bright glow and lens flare effect.

# Thank you! Questions?

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