

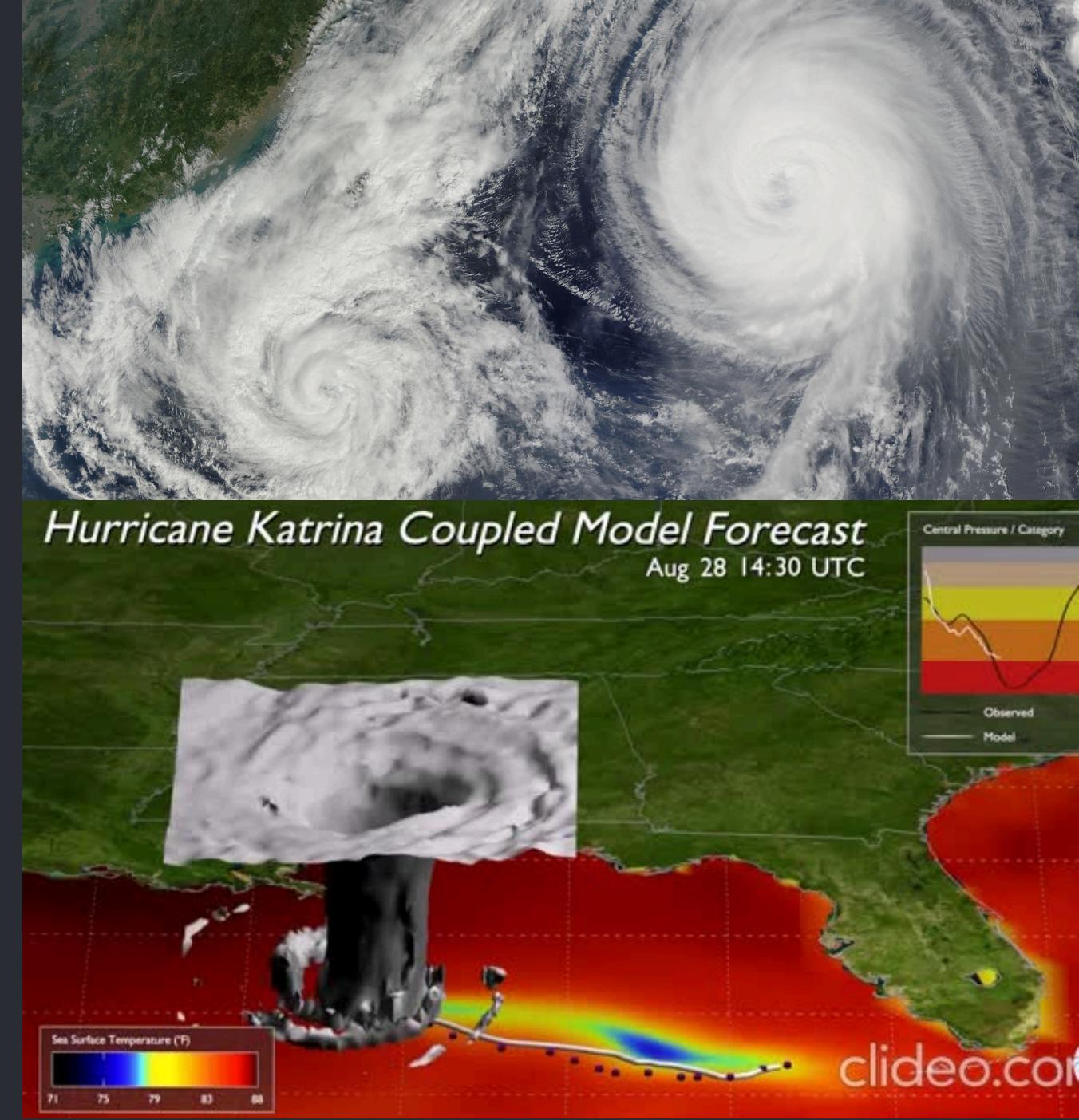
# Meet our Team :

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## Transport Phenomenon In Hurricanes

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Hurricane Boyzzz

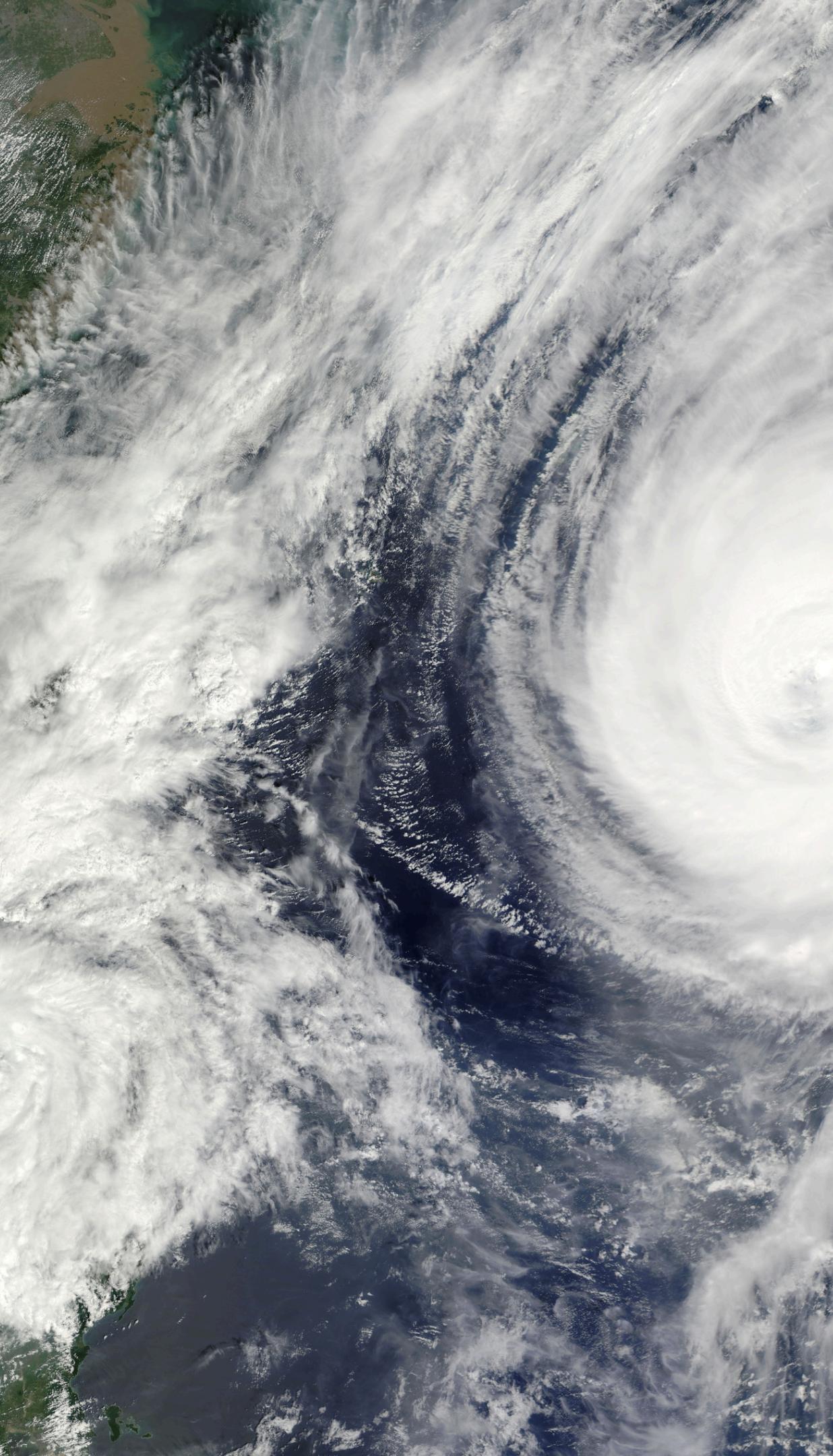
# Significance of Topic

- Hurricanes can disrupt airflow, temperature control, and pollutant dispersion.
- Improves storm intensity and impact predictions for better preparedness.
- Supports the development of advanced early warning systems.

## Relevance to the Audience

- Hurricanes cause significant damage to coastal communities, infrastructure, and economies.
- Enhances climate adaptation strategies and resilience planning.
- Reduces long-term socio-economic impacts from hurricane-related disasters.





## Prior Approaches

### 1. Hurricane Weather Research and Forecasting Model (HWRF Model)

- Strength:
  - High accuracy in forecasting hurricane track and intensity.
- Weakness:
  - Requires significant computational resources

### 2. Hybrid Coordinate Ocean Model (HYCOM)

- Strength:
  - Accurately simulates complex ocean dynamics and heat exchange.
- Weakness:
  - Limited in capturing atmospheric interactions.

## Limitations in Existing Research

### 1. Inadequate Modeling of Complex Interaction

### 2. Inaccuracies in Vertical Moisture and Heat Flux Modeling

# Assumptions and Model Construction

## 1 Simplifying Assumptions

- Initial vapor dispersed within a fixed radius.
- Midlatitude influences are disregarded .
- Vapor dispersion decreases with height,  $dr/dh < 0$
- Factory disturbance influences hurricane trajectory path
- Winds follow global patterns for hurricane movement.
- Air modeled as incompressible for easier calculations.

## 2 Modelling Process

Incorporation of Models Like:-

- **SLOSH Model (Sea, Lake, and Overland Surges from Hurricanes)**
- **Gaussian Dispersion Model**
- **HYCOM (Hybrid Coordinate Ocean Model) with wave modeling**
- **PWP (Price-Weller-Pinkel) Mixed Layer Model**

# Equations ?

$$C(x, y, z) = \frac{Q}{u\sigma_z \sqrt{2\pi}} e^{-\frac{y^2}{2\sigma_y^2}} \left[ e^{-\frac{(H_r-H_e)^2}{2\sigma_z^2}} + e^{-\frac{(H_r+H_e)^2}{2\sigma_z^2}} \right]$$

$$S = \frac{P_o - P_c}{\rho g} + \frac{\tau L}{\rho g h} + k \cdot H_s + S_{other}$$

$$wave = \iint_A 5 \rho_a u_{\star a}^2 dx dy$$

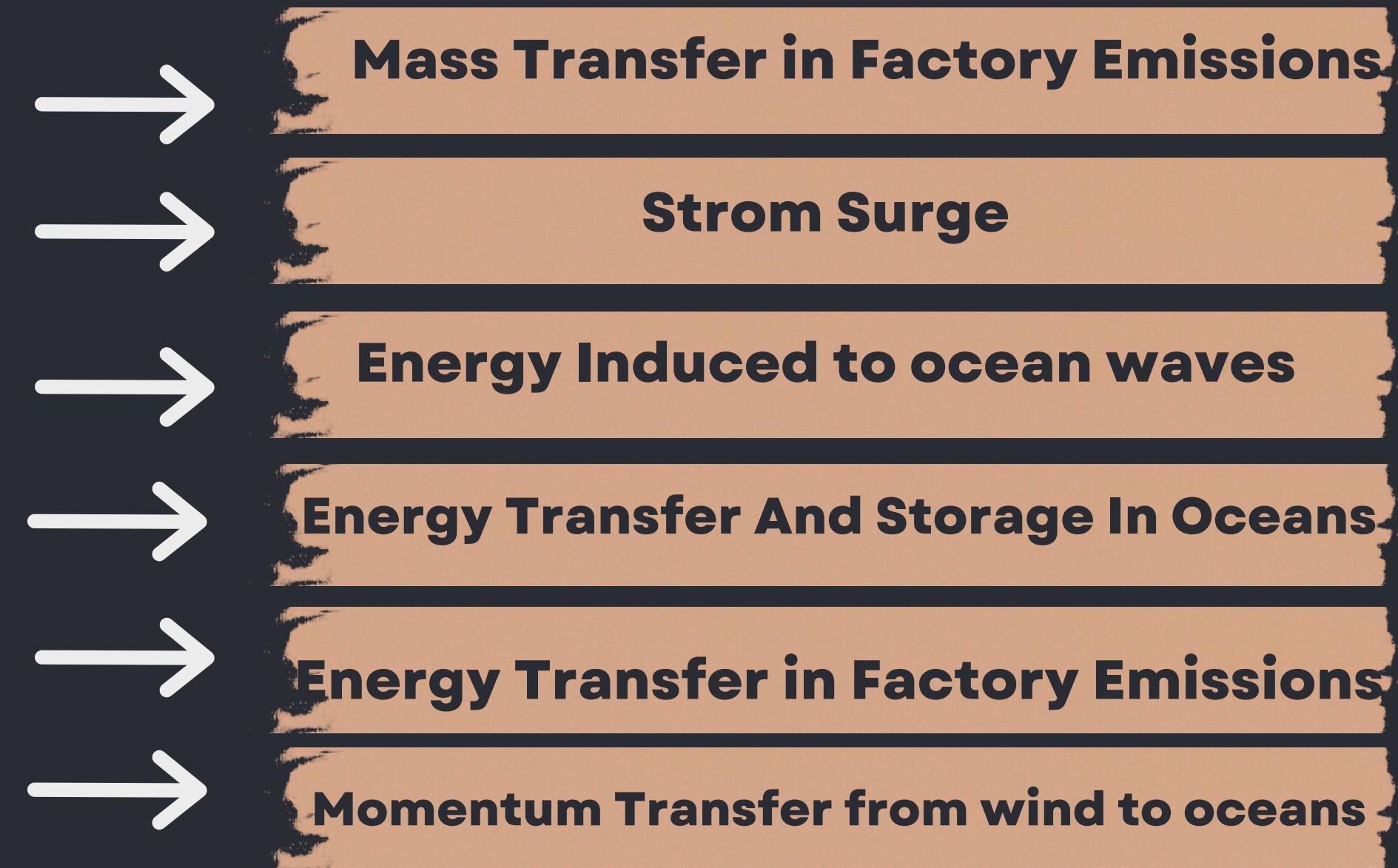
$$\frac{dh}{dt} = \frac{2\rho_0 m (\tau/\rho_0)^{3/2}}{\rho_0 g a h (T_s - T_h)} = G$$

$$\rho c_p \left( \frac{\partial T}{\partial t} + \mathbf{v} \cdot \nabla T \right) = k \nabla^2 T + Q_{soot/creosote}$$

$$\frac{\partial u}{\partial t} - f v = - \frac{1}{\rho_0} \frac{\partial p}{\partial x} + \frac{\tau_w^x - \tau_R^x}{\rho_0 h_1}$$

## Important Phenomena

Focused on turbulent mixing, evaporation, precipitation due to their significant roles in driving hurricane intensity and dynamics.



## Selection Criteria

Included processes that have strong observational and theoretical support in influencing storm development; excluded minor or poorly understood processes like momentum transfer to soots.

# Sensitivity Analysis



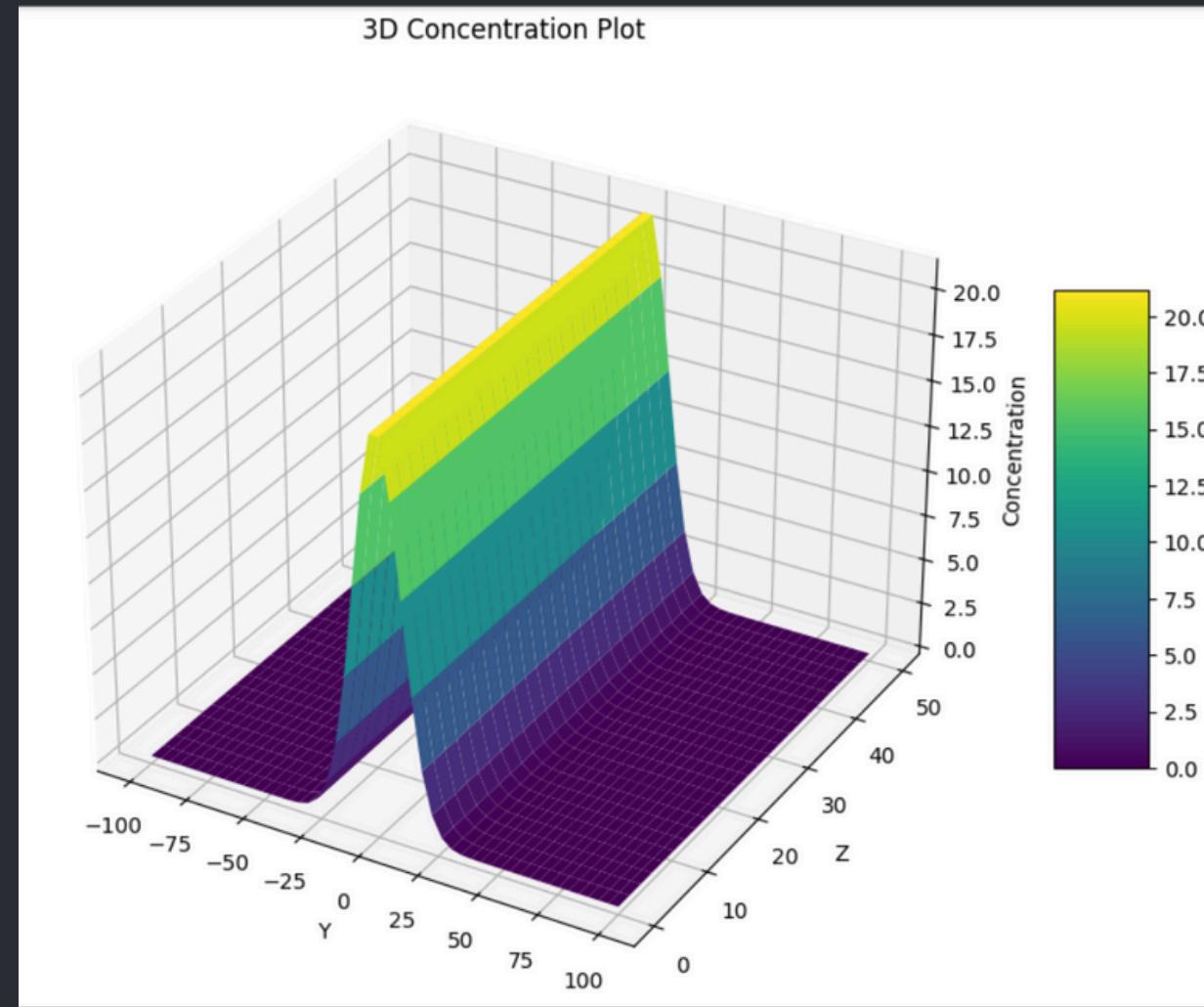
## Most Sensitive Parameters From The Equations are :

- Soot/Creosote Force Terms for equation of Energy Transfer in Factory Emissions
- Air Friction Velocity for equation of Energy Induced to ocean waves
- Surface Temperature for equation of Energy Transfer And Storage In Oceans

## Uncertain Parameters :

- Soot/Creosote Force Terms
- Density Of Air
- Temperature At A depth Of  $h$  for equation of Energy Transfer And Storage In Oceans
- Specific Heat Humidity At Sea Surface

# Analytical results



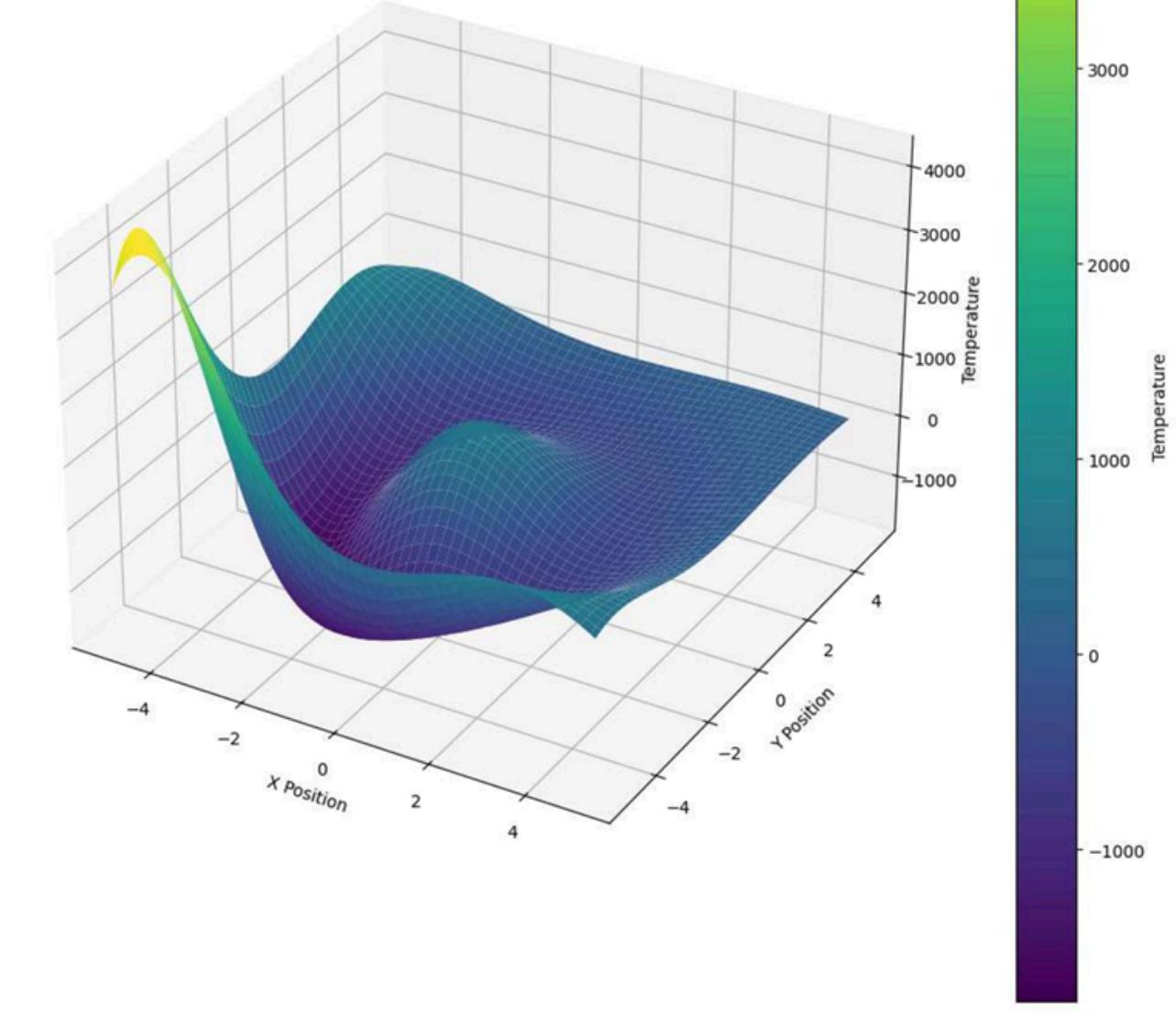
Graph between concentration vs distance from factory For Gaussian Dispersion Model.

Concentration decreases exponentially with distance from source

$$\rho c_p (\mathbf{v} \cdot \nabla T) = k \nabla^2 T + Q_{soot/creosote}$$

At steady state:  $\mathbf{v} \cdot \nabla T = \frac{k}{\rho c_p} \nabla^2 T + \frac{Q_{soot/creosote}}{\rho c_p}$

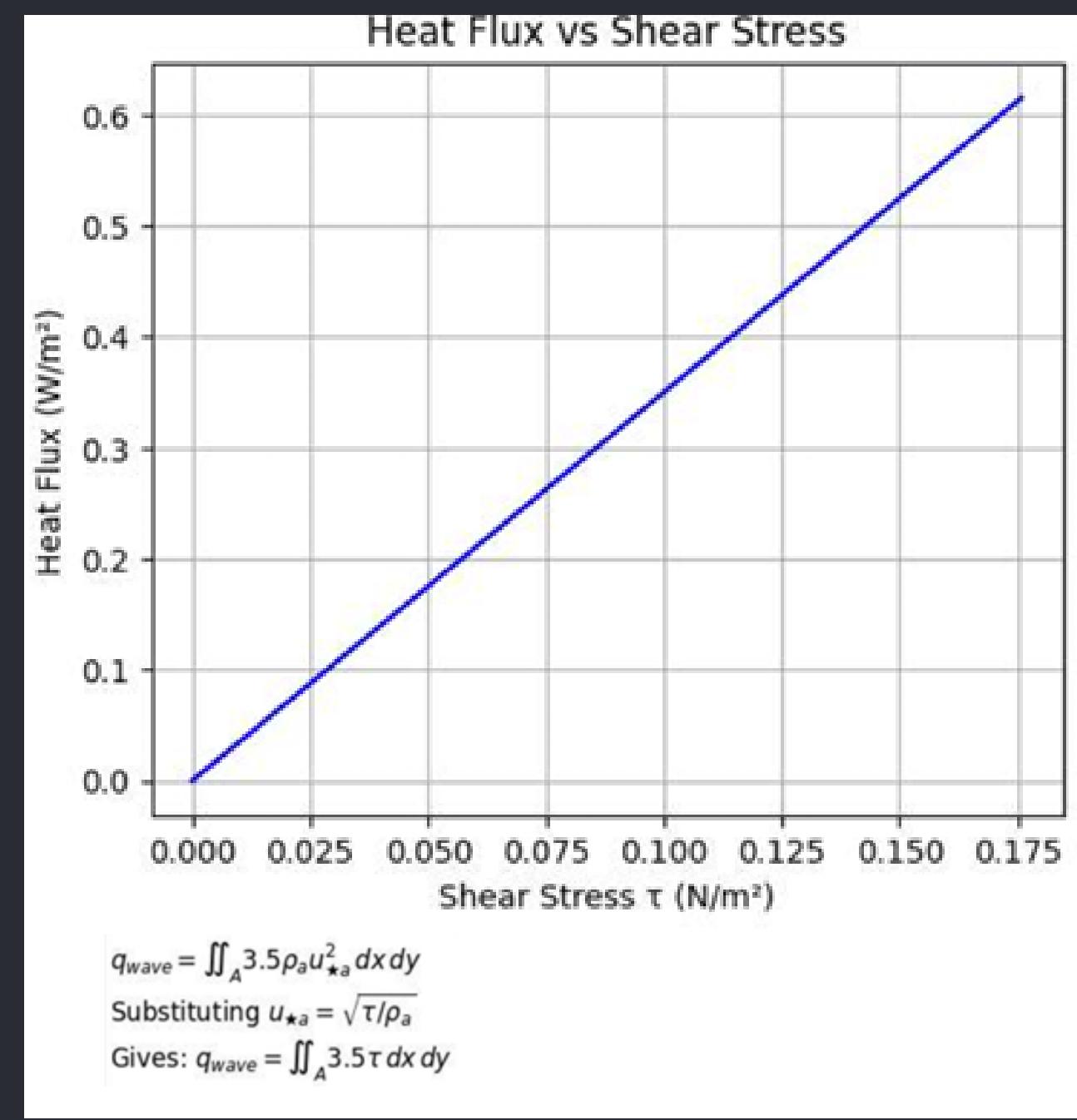
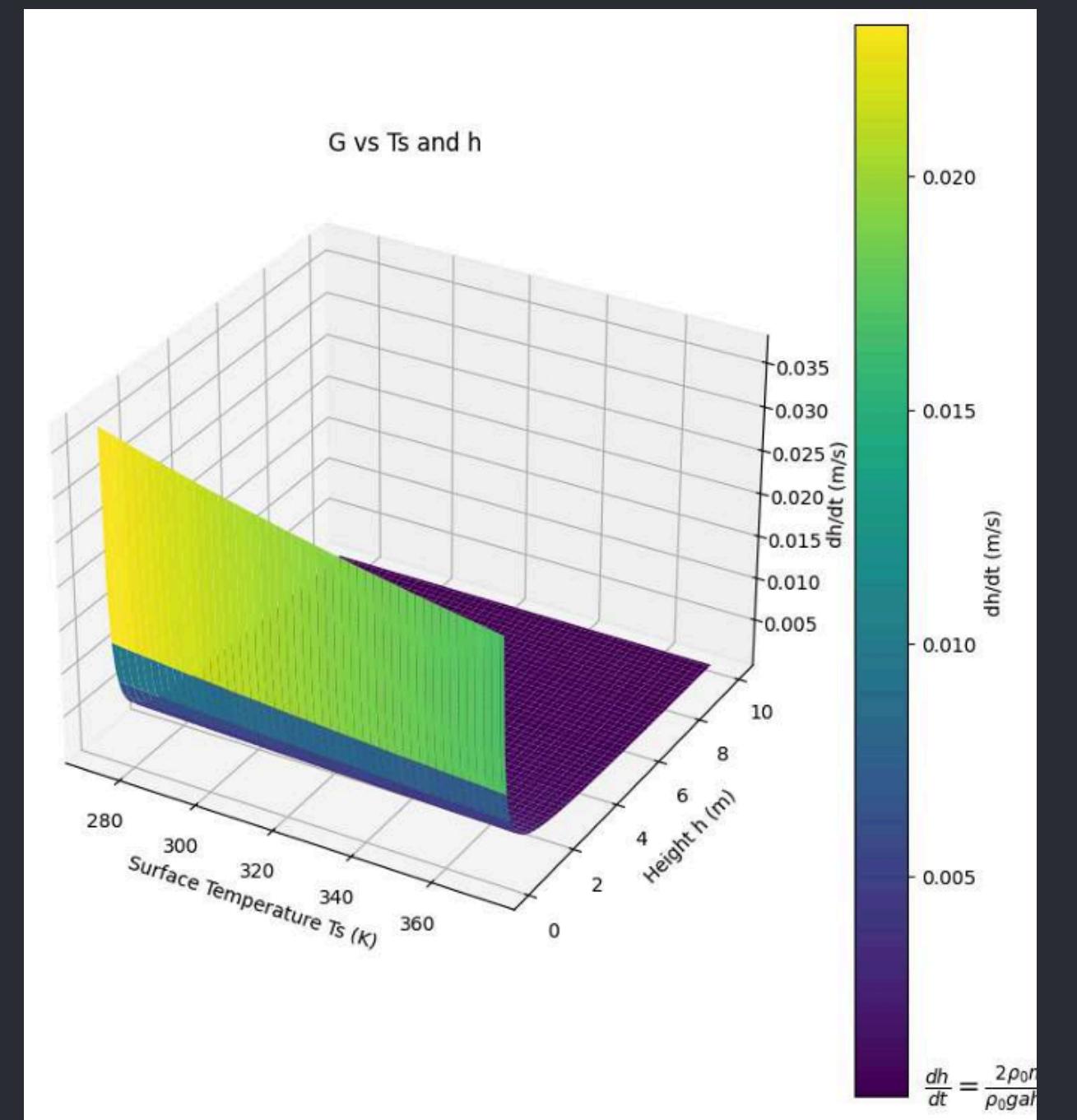
3D Temperature Distribution at Steady State



Graph between Temperture vs distance from factory

Temperature decay pattern in radial direction

Asymmetric distribution suggesting directional heat transfer



Graph shows relationship between surface temperature (Ts) and height (h) with respect to the rate of change ( $dh/dt$ )

Higher rate occurs at High Ts and Lower Heights  
 Lower Rates occur at Lower Ts and Greater Heights

HYCON Model Assumes that Heat Flux and Stress Are Related Linearly.

Graph between Energy Transfer From Hurricanes to oceans vs Shear stress for HYCON Model



## Lessons Learnt From Project

We learned about storm surge and its powerful role in transporting pollutants, as it pushes toxins and debris inland.

How hurricane winds and turbulence spread particulate matter and chemicals.

We Learnt Using AI Tools and Reading Research Papers and Analyzing The Problem.

## Conclusion and Way Forward

**Add More Equations To refine Our Model to Clear Much Of Our Assumptions.**

**Incorporate Machine Learning Techniques And Create Our Own Hurricane System Model.**

**Using The Predictions From Hurricane Model System to Mitigate Challenges Of Peoples.**

**Studying More About Storm Surge And Its Adverse Effects.**

