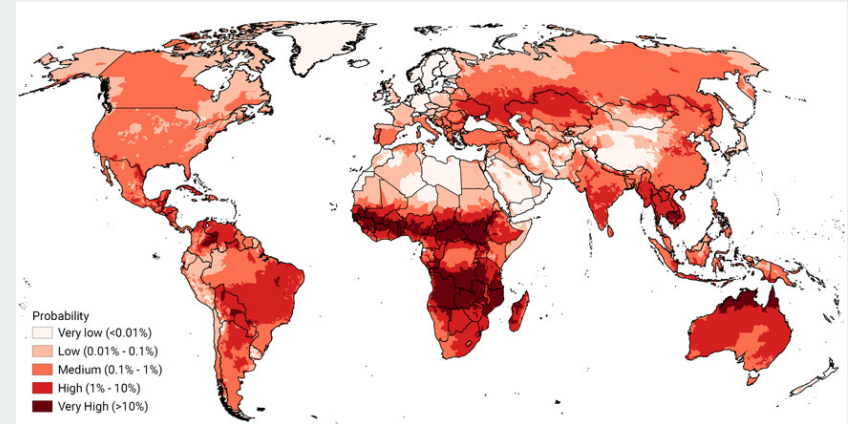Imperial College London

Reduced order modelling and latent data assimilation for wildfire probability prediction

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Supervisors: Sibo Cheng and Matthew Kasoar

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1. Introduction:

- Wildfires: sudden and vegetation, environment, eco-system damage

- Wildfires ↔ Environment

- Simulation Models: Earth System Models, Dynamic Global Vegetation Models
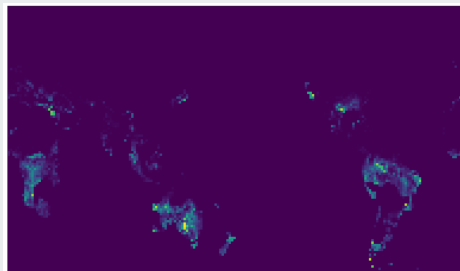
- JULES-INFERNO

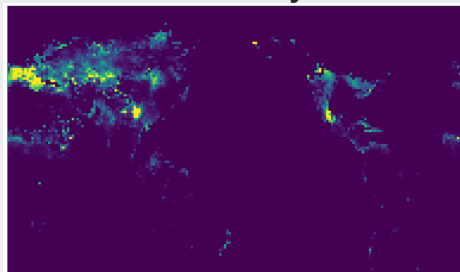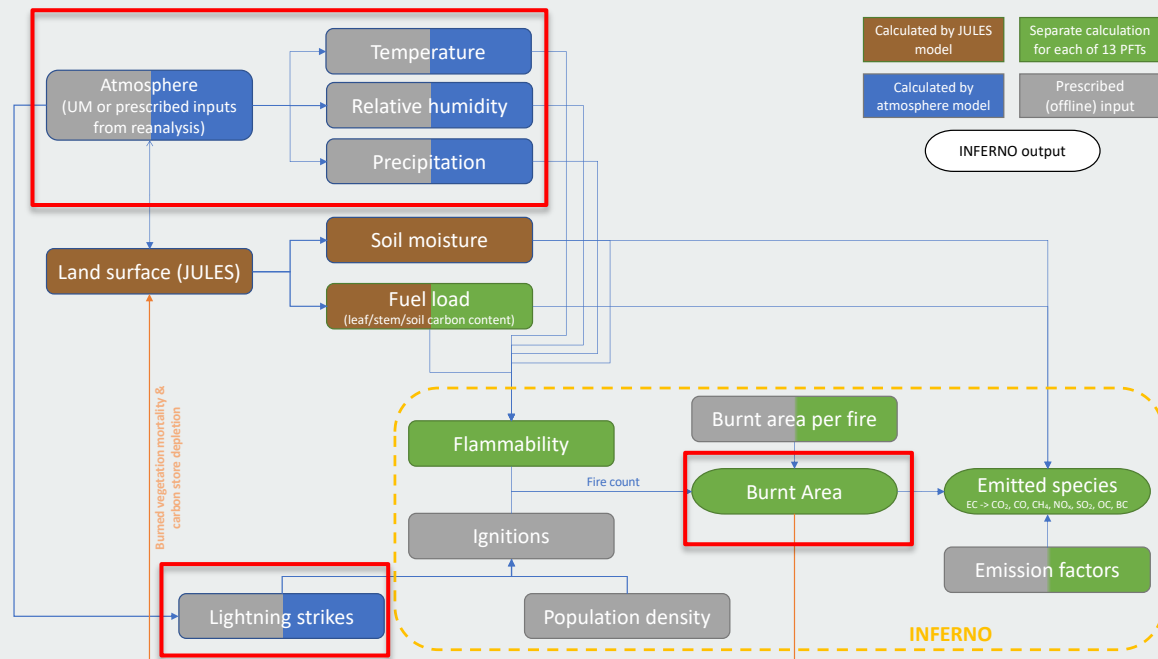[1] "Wildfire Risks and Costs for Companies," *MSCI ESG Research*, Mar, 23, 2022, https://www.msci.com/www/blog-posts/wildfire-risks-and-costs-for/03160787147.

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2. Motivation and Objective
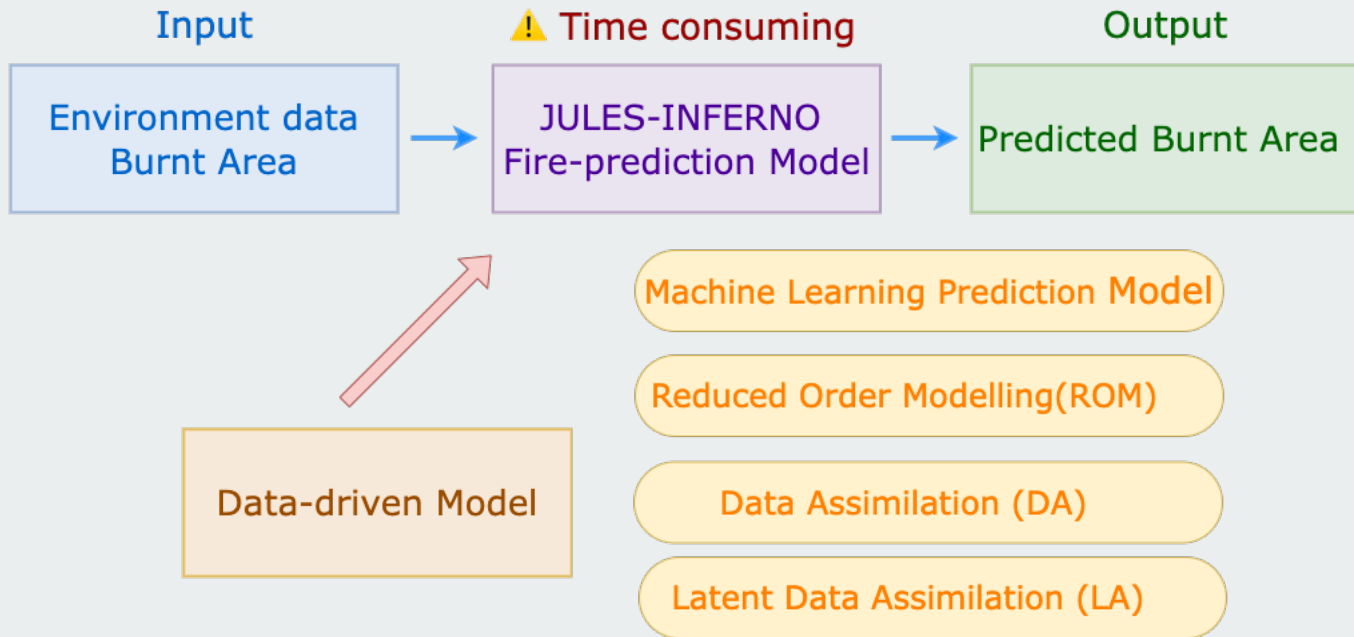
# 3. JULES-INFERNO

January

July

[2] M. Kasoar, personal correspondence

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4. Methodology – Data Set

- JULES-INFERNO: 1961-1990, collected monthly

- Climate variables: each one with 360 snapshots (30*12)

- 5 Fire sets (P1, P2, P3, P4, P5): all sets were driven from same climate with different initial internal states, and each one with 360 snapshots

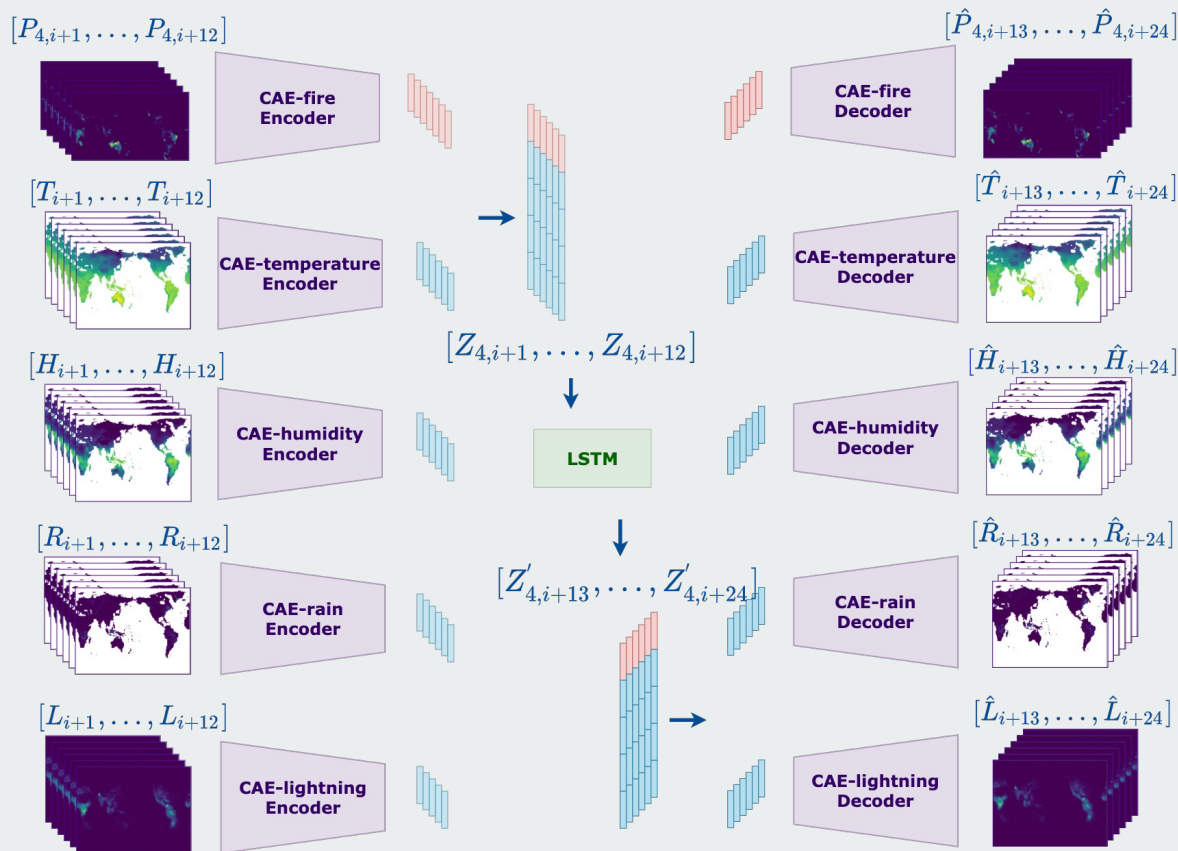- Training set: P1, P2, P3   Test set: P4, P5 (unseen scenarios)

4. Methodology - ROM

- PCA: Linearly
- CAE: combination of AutoEncoder and Convolutional Neural Network

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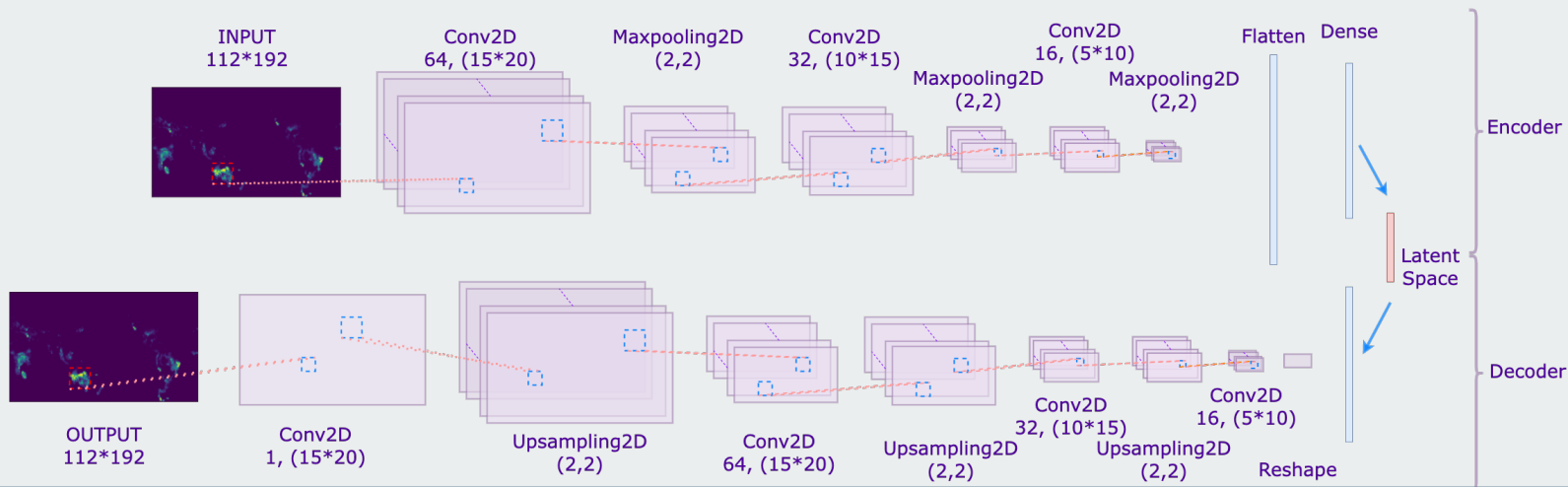
4. Methodology - Prediction

- Enhance dataset: shifting the initial time

- Iterative prediction: current predictive result as the input of next prediction
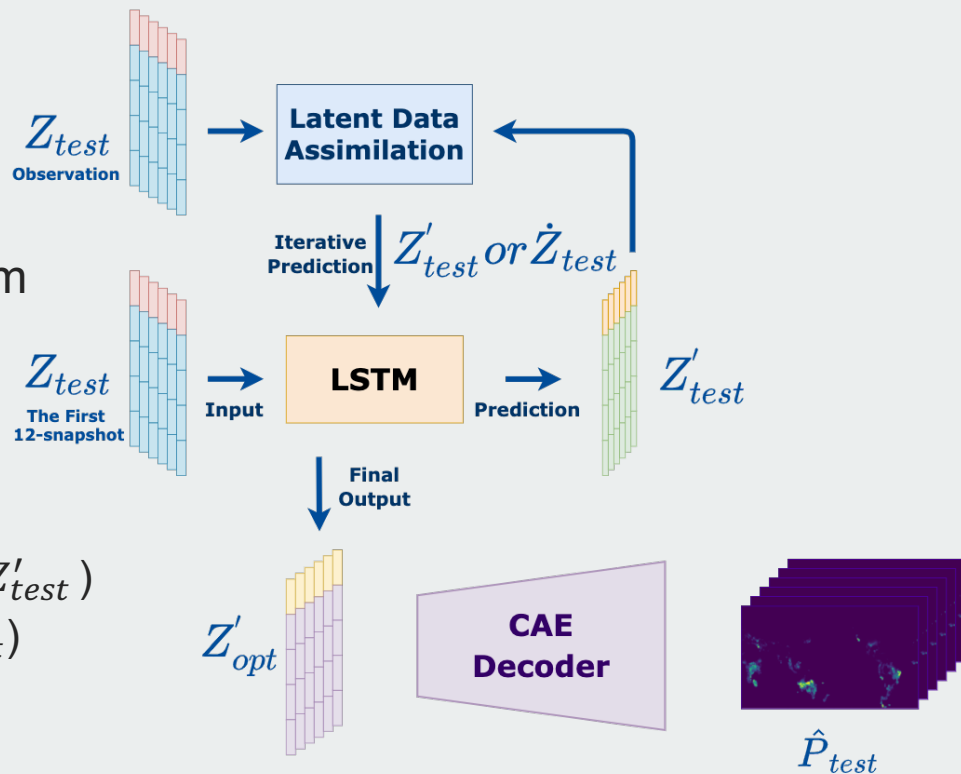
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4. Methodology - LA

- More stable and accurate long-term prediction
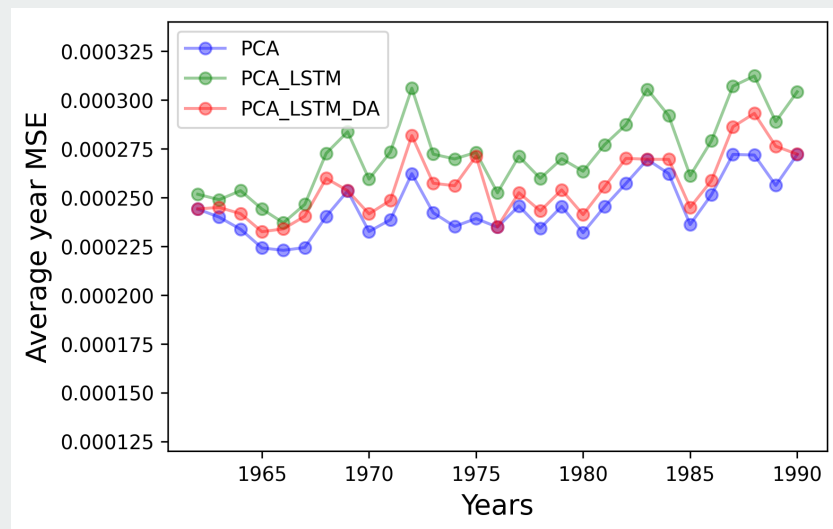
- Reduce the parameters

Background latent vector (predicted data Z'_{test})
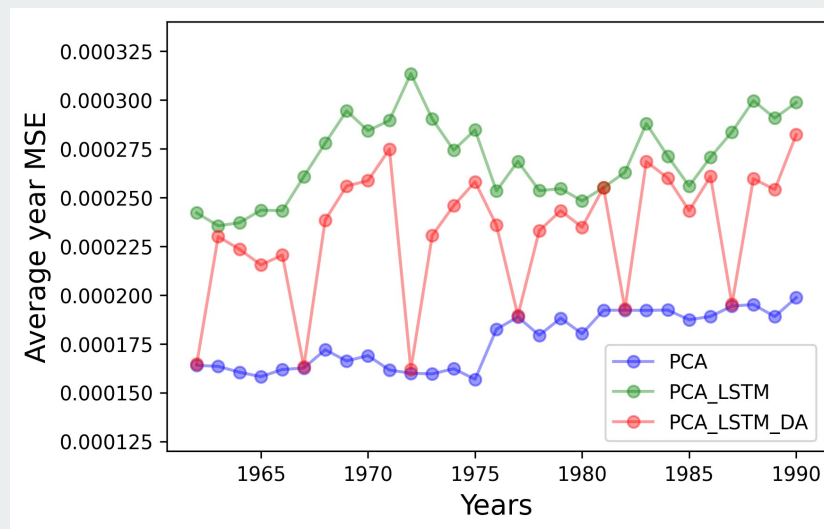Observation latent vector (actual data Z_{test})
Analysis latent vector (optimal data $\dot{Z}_{test}$)

Diagram labels:
Z_{test} Observation → Latent Data Assimilation
Iterative Prediction Z'_{test} or $\dot{Z}_{test}$
Z_{test} The First 12-snapshot → Input → LSTM → Prediction → Z'_{test}
Final Output
Z'_{opt} → CAE Decoder → $\hat{P}_{test}$

5. Results and Discussion
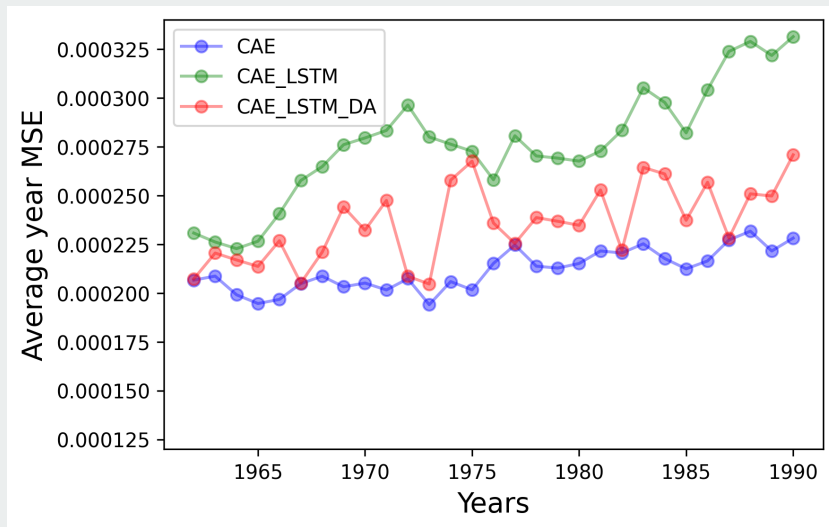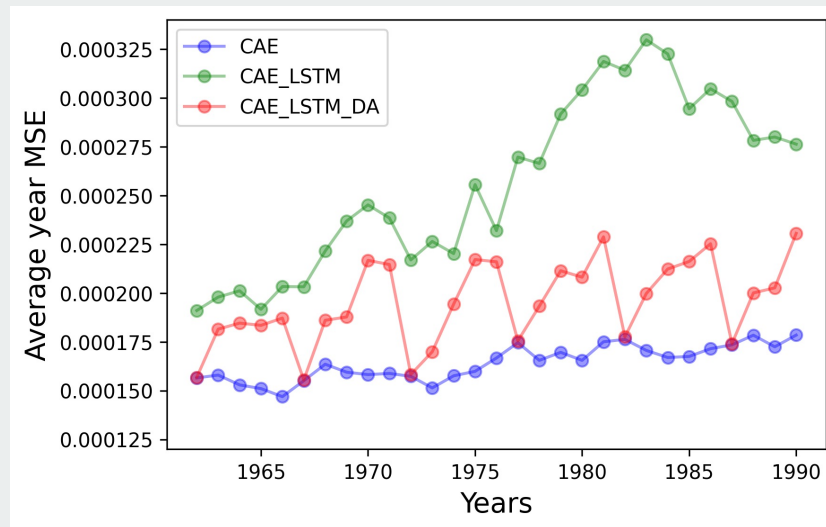
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20-dimensional PCA based Model   100-dimensional PCA based Model

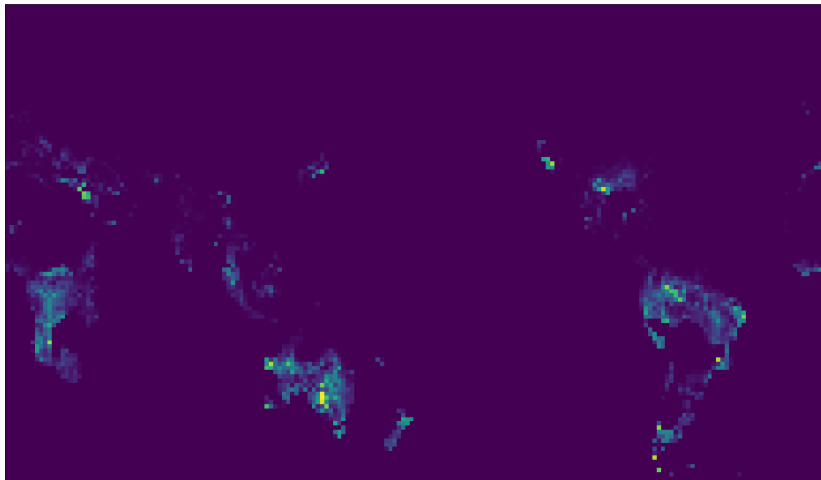# 5. Results and Discussion

20-dimensional CAE based Model

100-dimensional CAE based Model

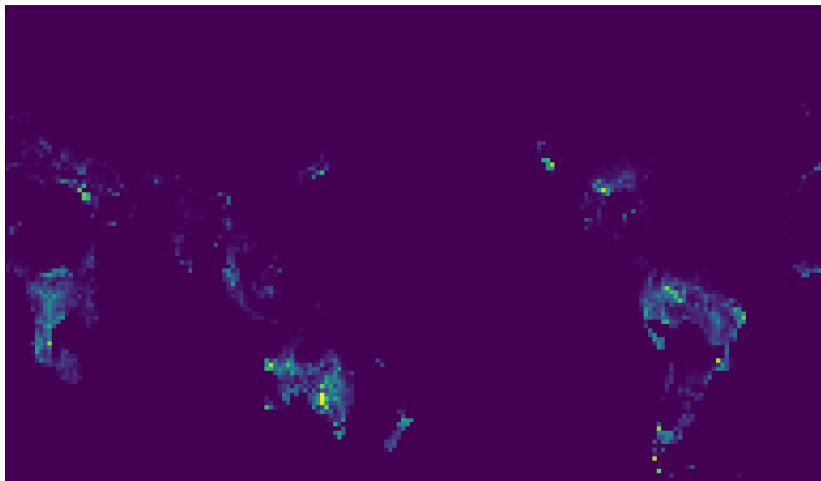**Imperial College London**

5. Results and Discussion

Original wildfire data

100-dimensional CAE based Model

5. Results and Discussion

Original wildfire data

After LA

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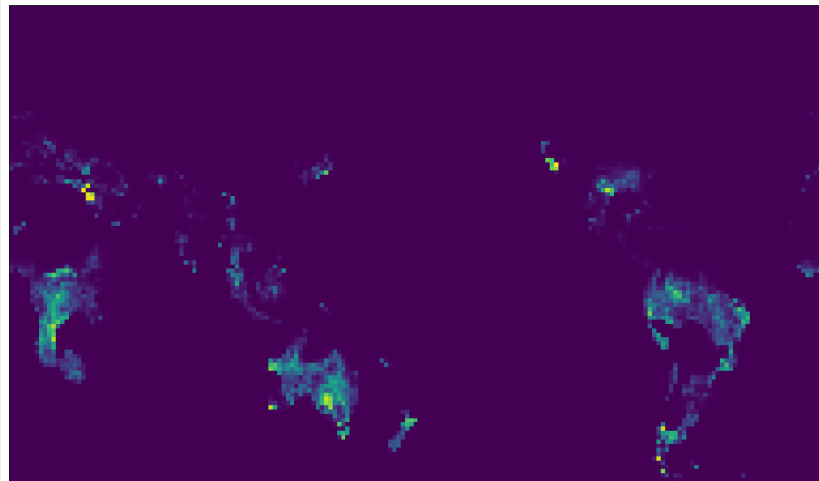
6. Conclusion and Future Works

- **Contributions**

1. Surrogate Model for fire prediction
2. ROM construction
3. Optimize by LA for unseen scenarios

- **Future Works**

1. Apply real wildfire data
2. Apply in other climate change scenarios

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Thank You!

I am willing to answer your questions.