Climate Hack
UC Berkeley

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Goal: Save the environment!

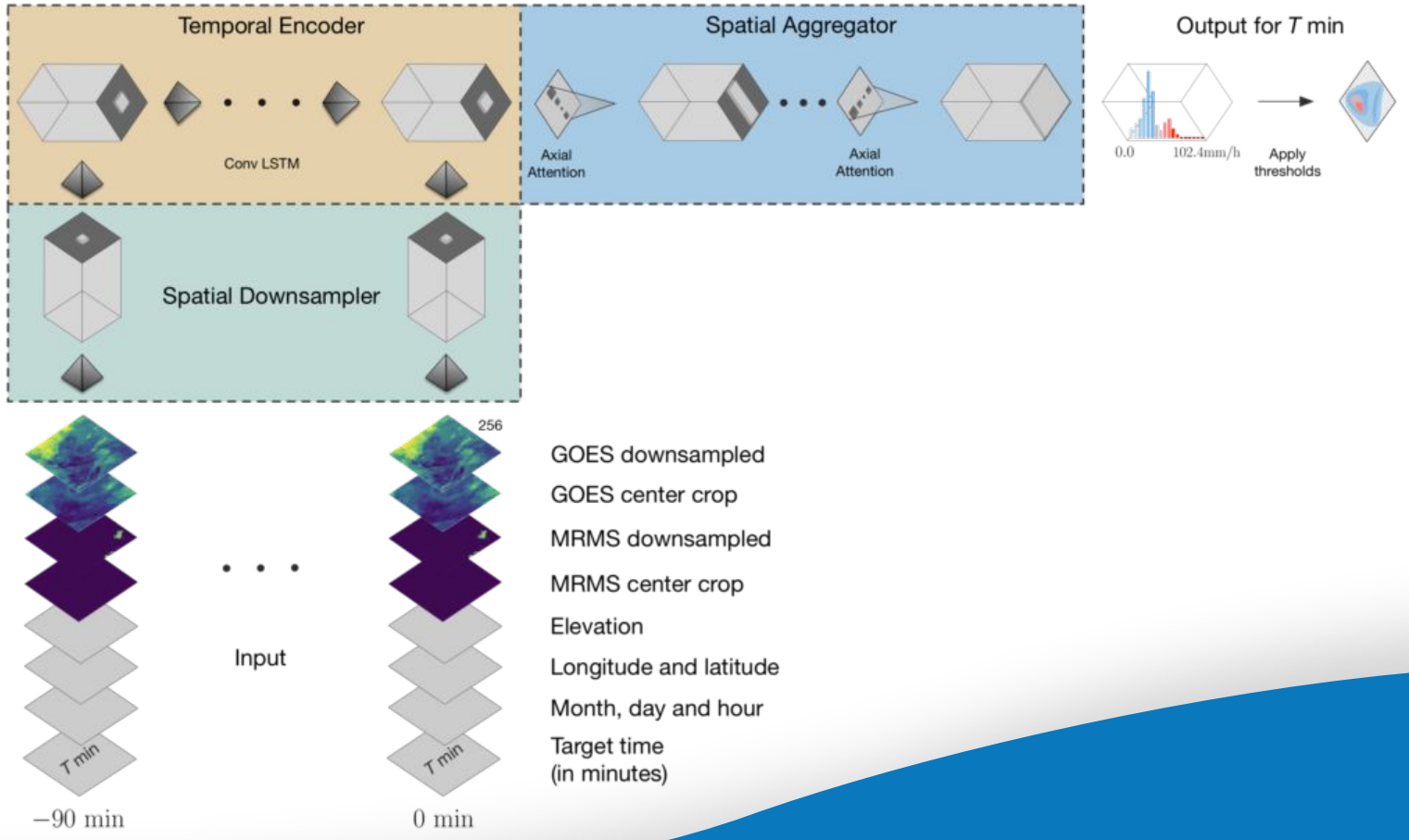
Input: 1 hour of 128x128 satellite images (12 frames)

Output: 2 hours of 64x64 satellite images (24 frames)

Impact: Knowing which regions aren't covered by clouds lets us balance the energy grid, so we can seamlessly switch between fossil fuel sources and solar photovoltaic power production. This way, we can schedule grids to optimize PV generation and reduce fossil fuel usage, ultimately decreasing CO2 emissions.

Model and Motivations

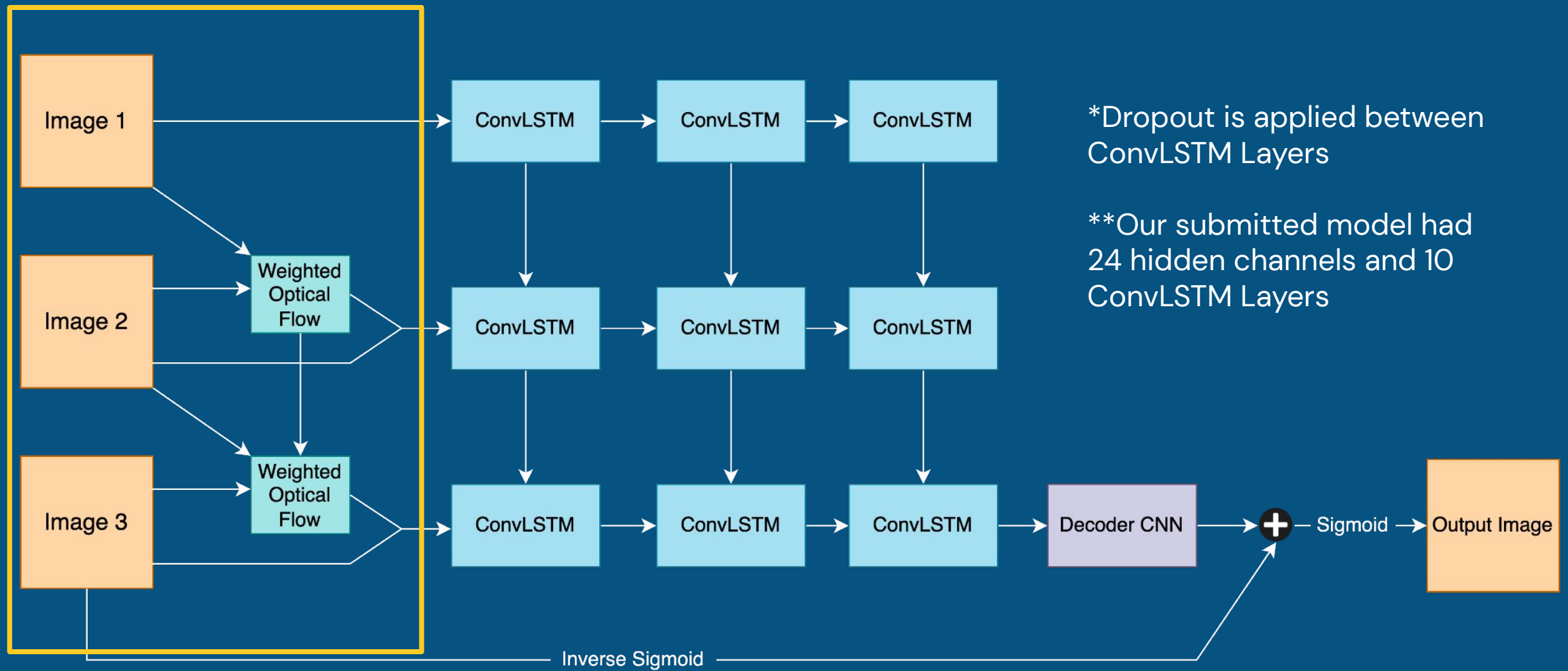
State of The Art: MetNet



MetNet: A Neural Weather Model for Precipitation Forecasting

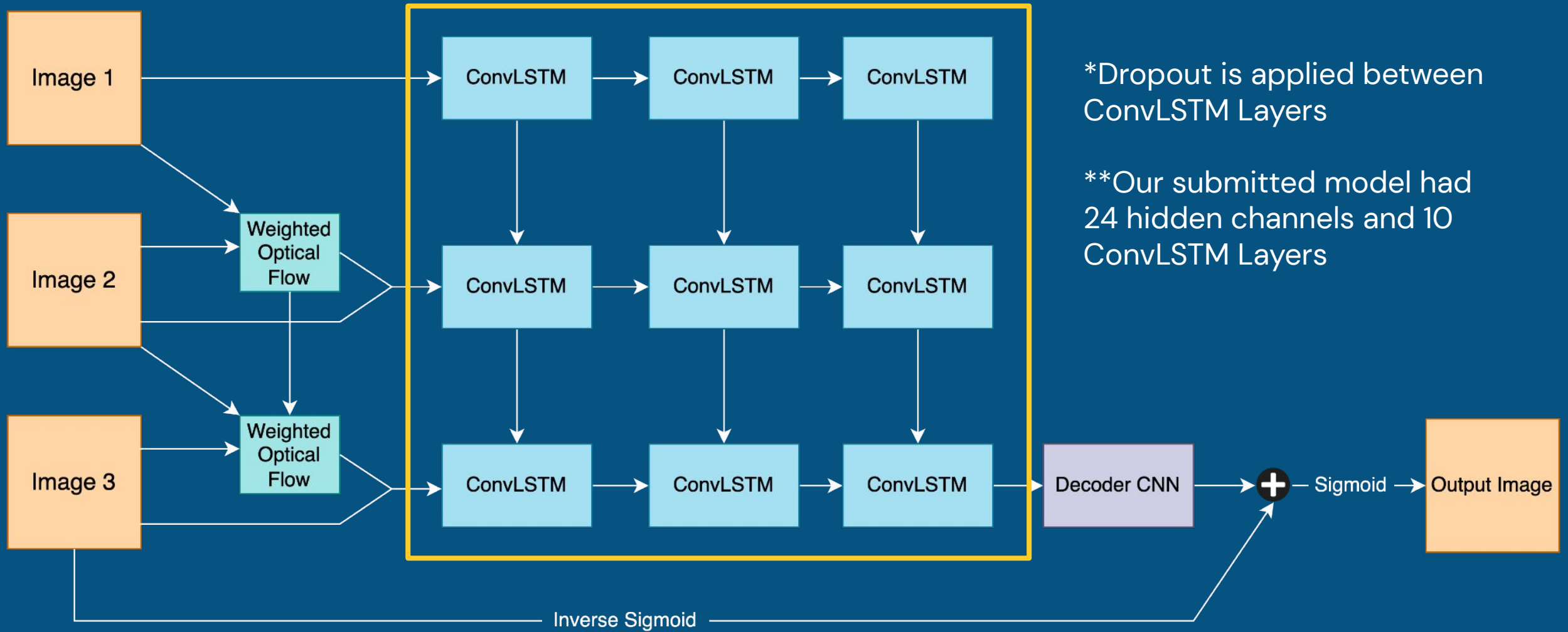
Performance Objectives

- Create a simple, flexible model
- Mitigate overfitting



*Dropout is applied between ConvLSTM Layers

**Our submitted model had 24 hidden channels and 10 ConvLSTM Layers



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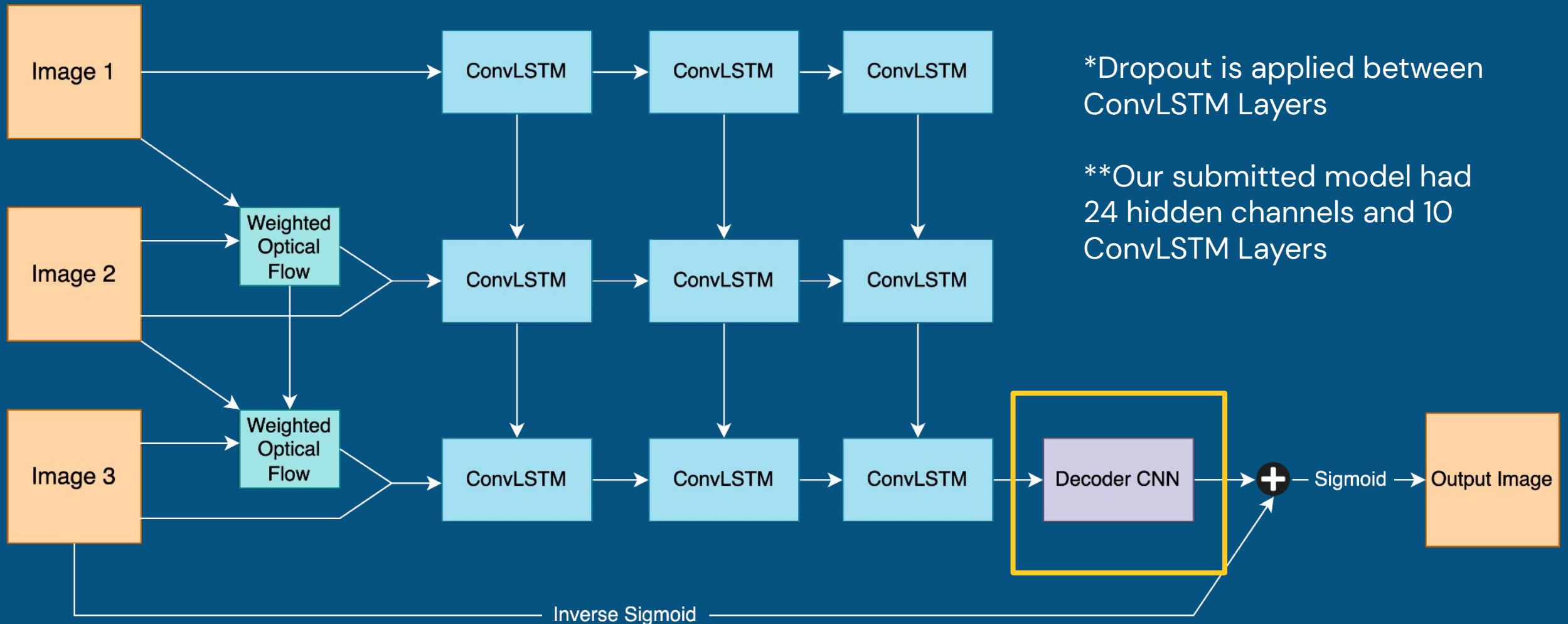

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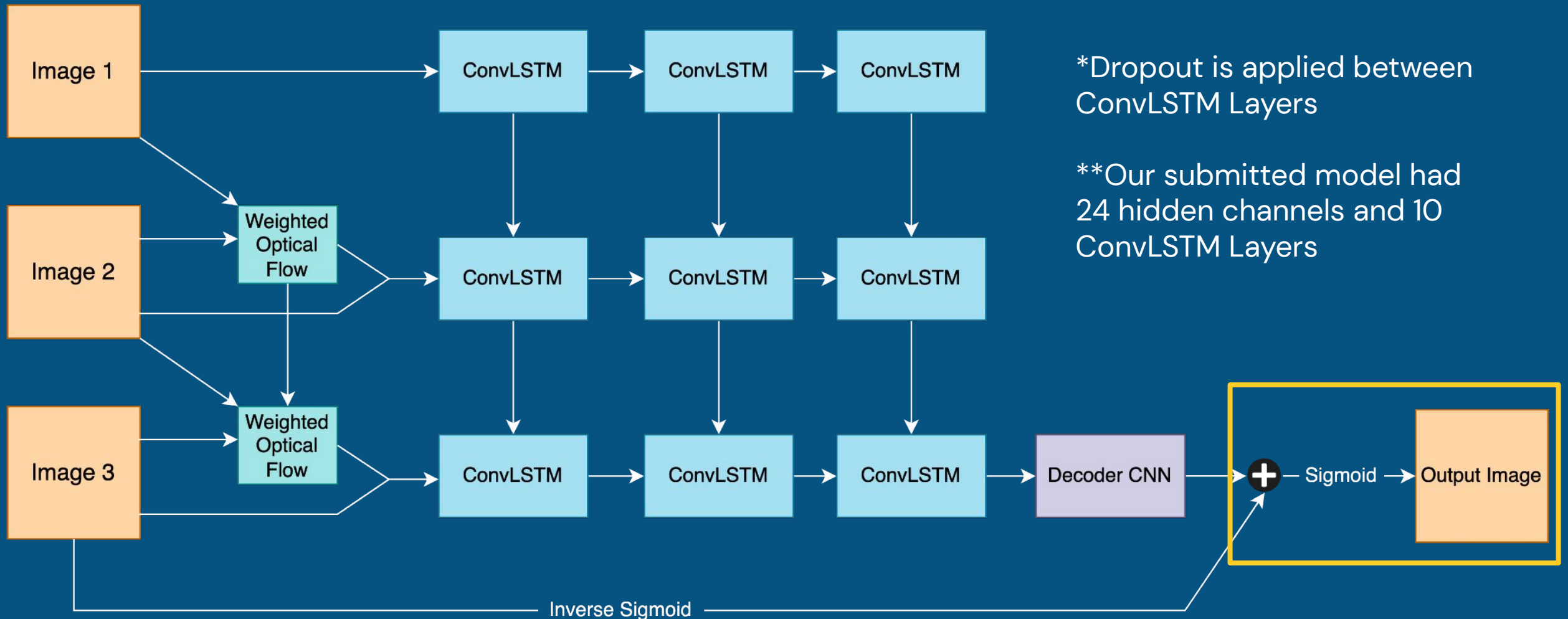

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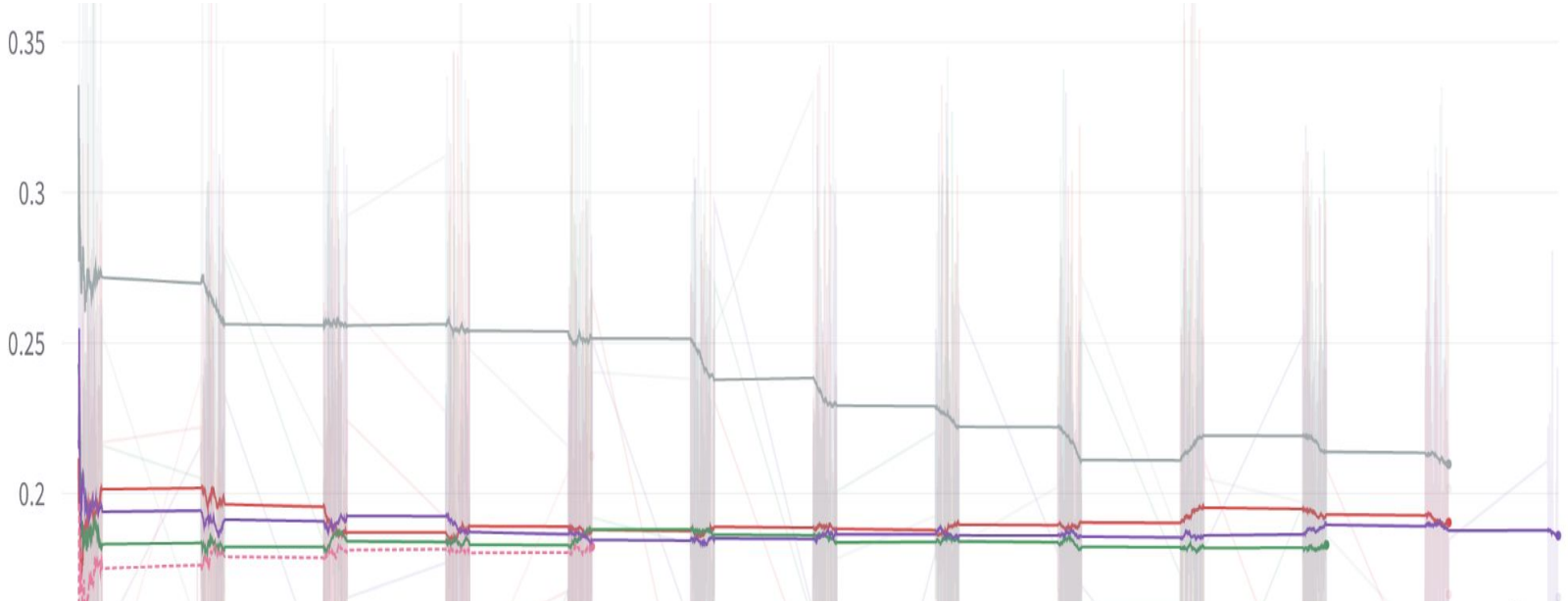


Data and Training

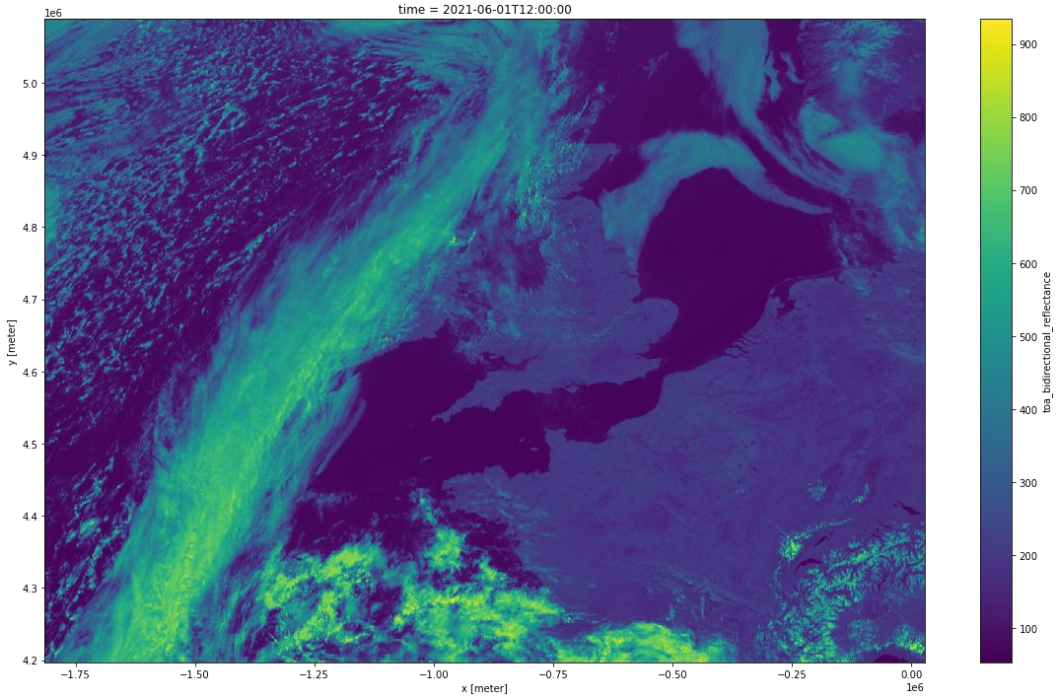
Dataset

- **Source:** EU Meteorological Geo-stationary Sateltite's (EUMETSAT) Spinning Enhanced Visible and InfraRed Imager Rapid Scanning Service
- **Provider:** Open Climate Fix
- **Content:**
  - January 2020 - November 2021
  - Images taken every 5 minutes
  - Image Dimensions: 1,843×891 pixels

Data Pre-Processing

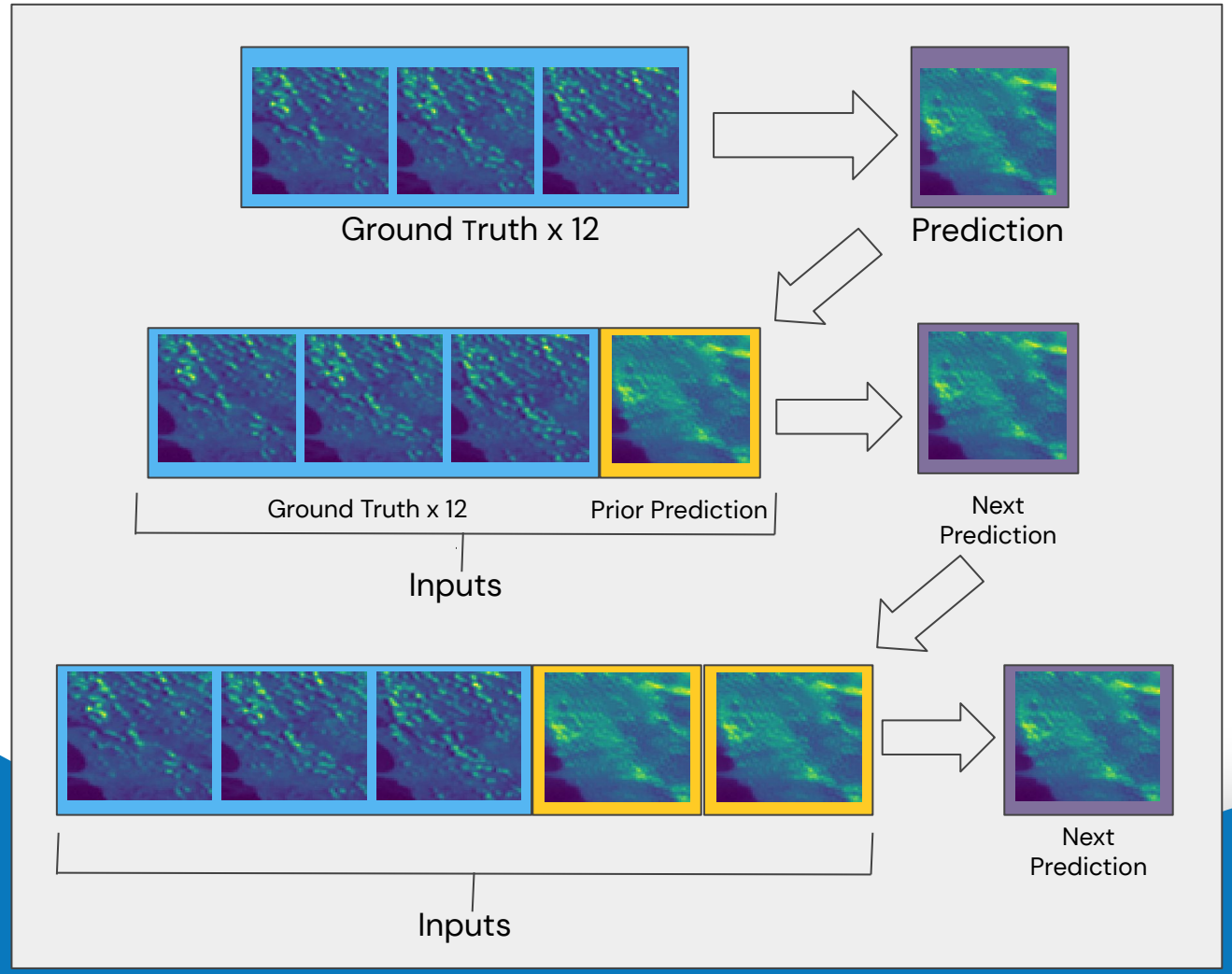
- Only training on England: 400x325
  - $550 \leq x \leq 950$
  - $375 \leq y \leq 700$
- Only training during the day
  - 9:00 AM - 4:00 PM (85 timestamps)
- Selecting 128x128 subsection
  - Dividing each image into 6 equal blocks, randomly finding 128x128
- 24 sequential images

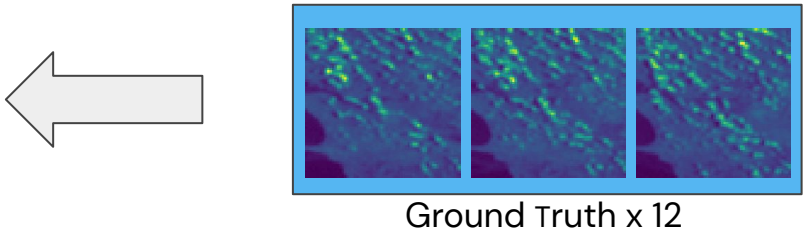
Training Data

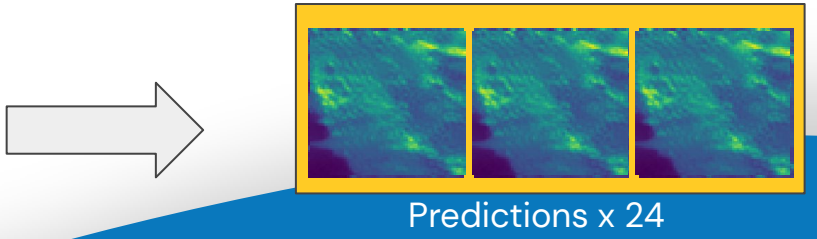


- Stratified Random Samples to account for missing winter data
- 6 random subsections per region;
  3 random time intervals per subsection

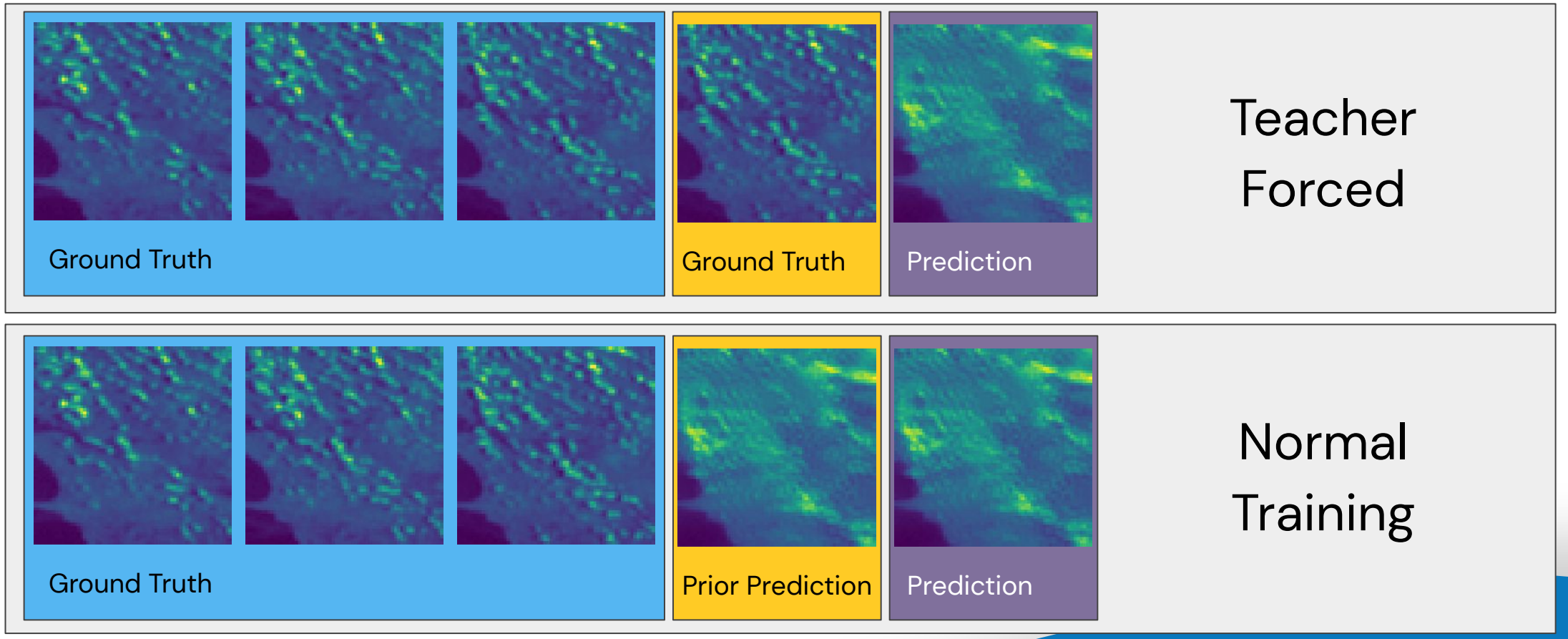
Iterative Next Frame Prediction





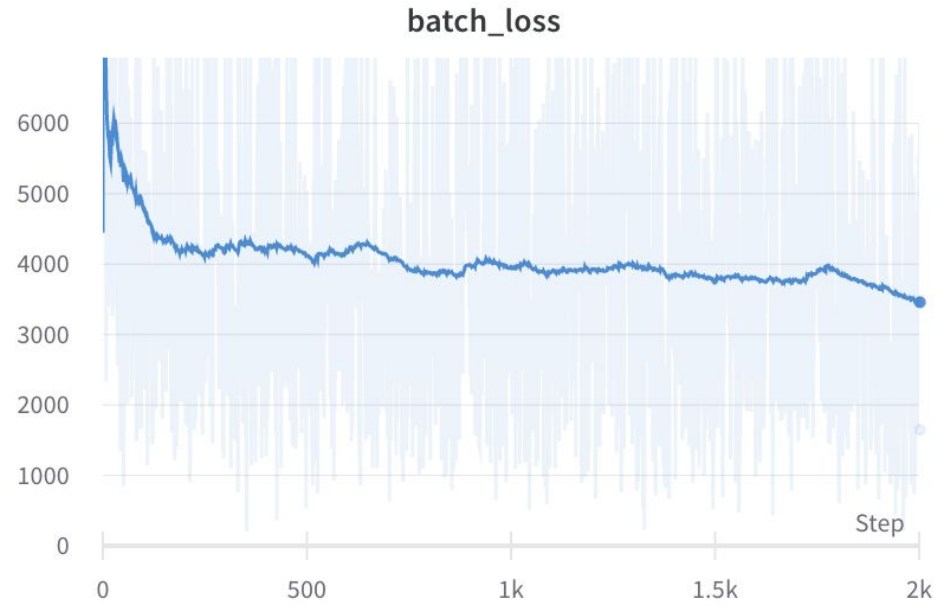


Training Technique: Teacher Forcing



Efficient Training

- Training on MSE first, then MS-SSIM



- Mixed Precision Training
  - Both 16 bit ints & 32 bit floats

1

V100 GPU

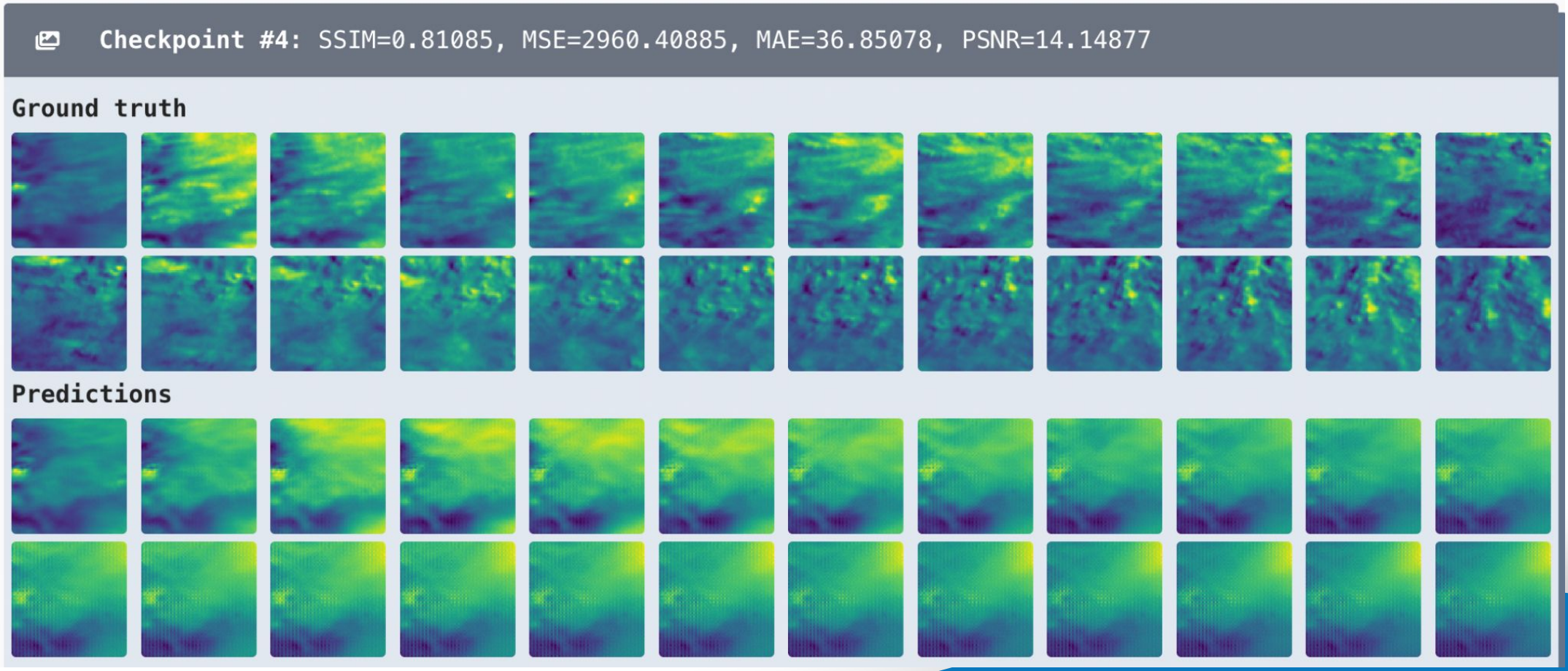
10

HOURS

Simple, Flexible, Efficient

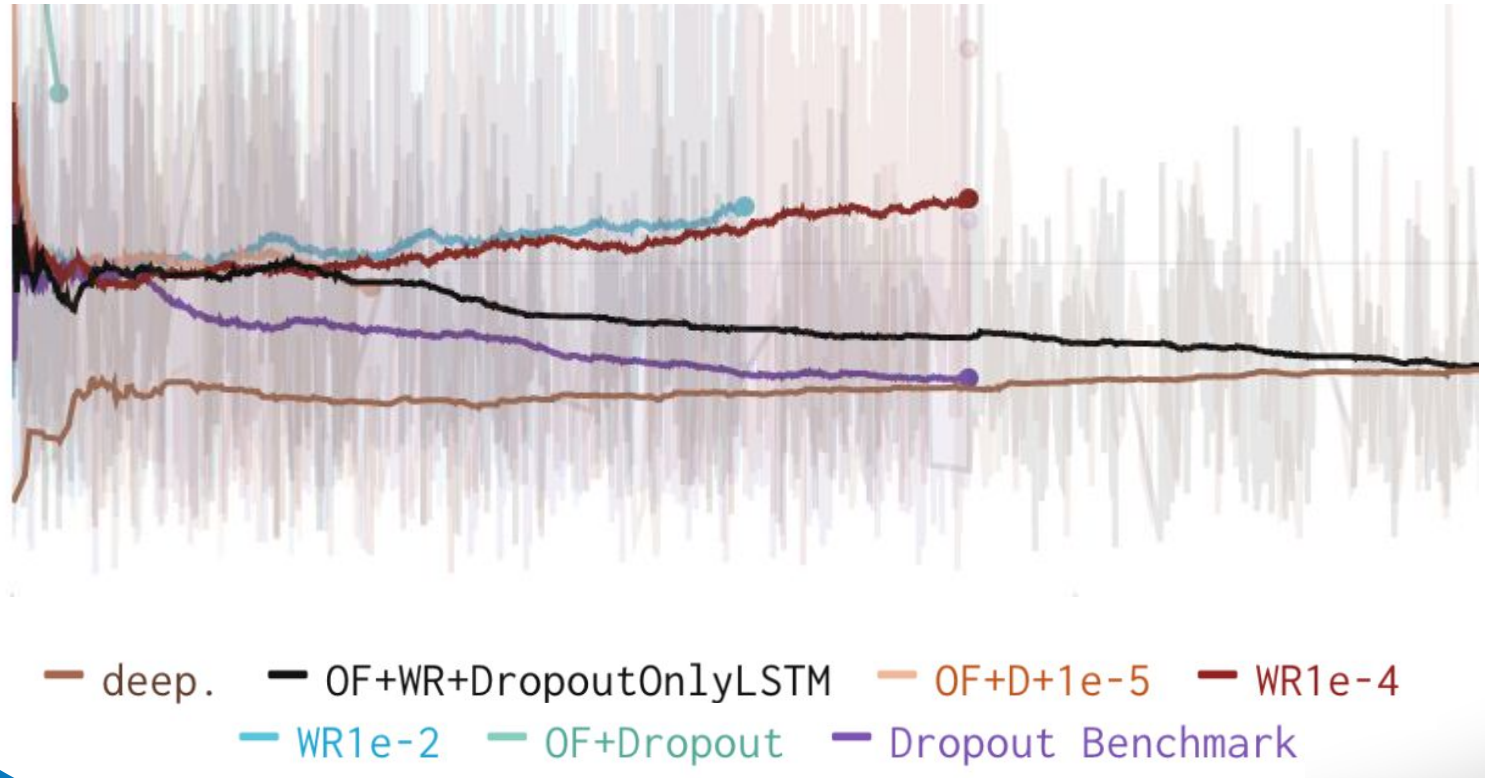
Reflection

Final Submission



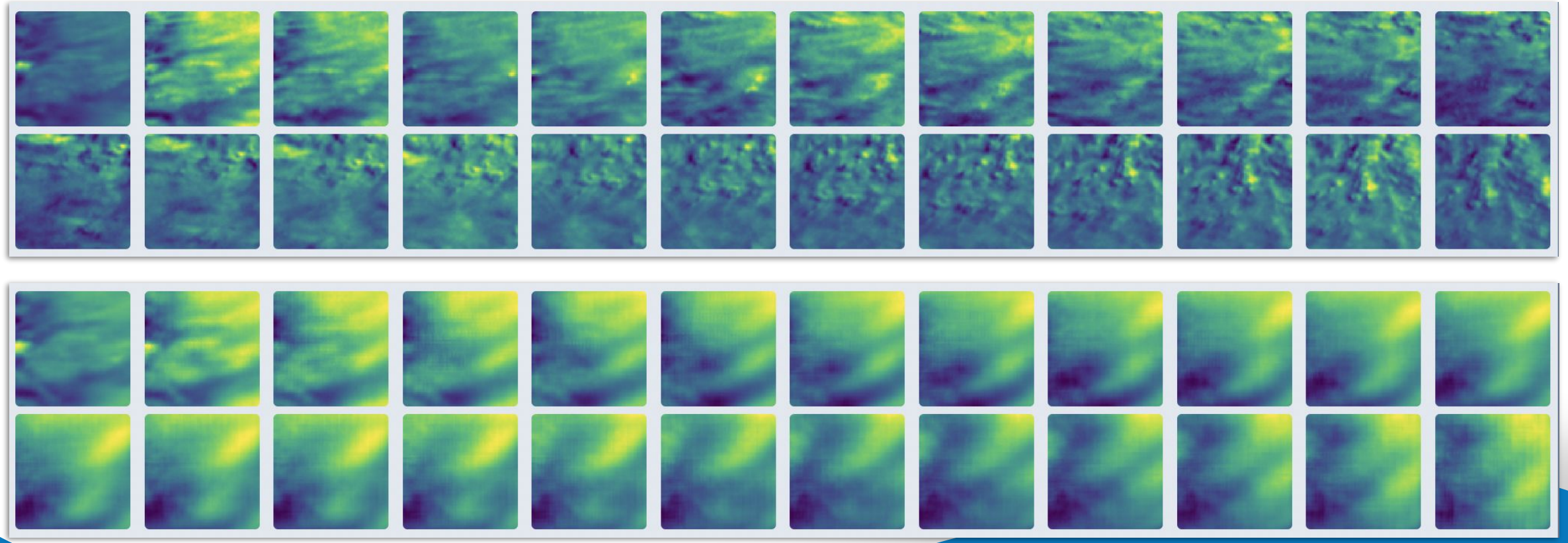
0.767 | UC Berkeley

Overfitting Prevention



- Dropout
  — tuned to probability 0.2
- Weight Regularisation
  — tuned to decay 1e-5

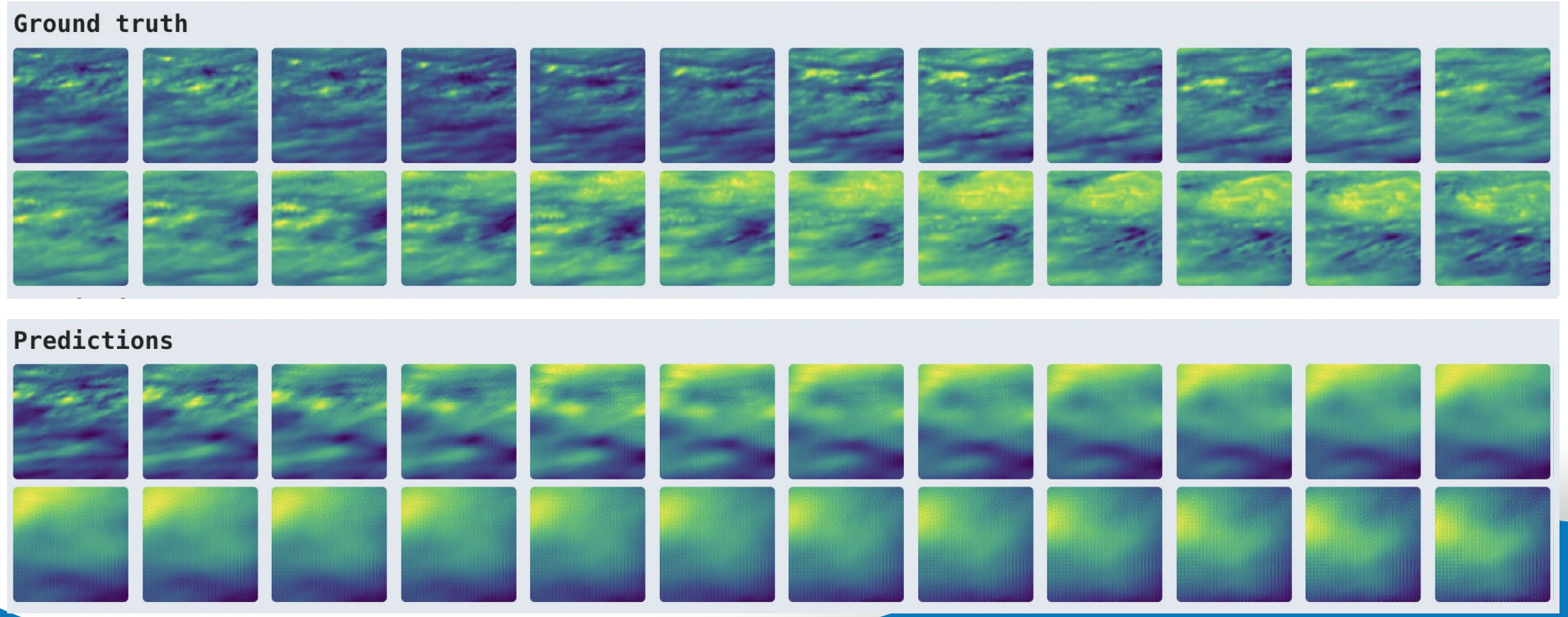
Weak Links: Loss Functions



MS-SSIM ~ 0.88 MSE ~ 1200

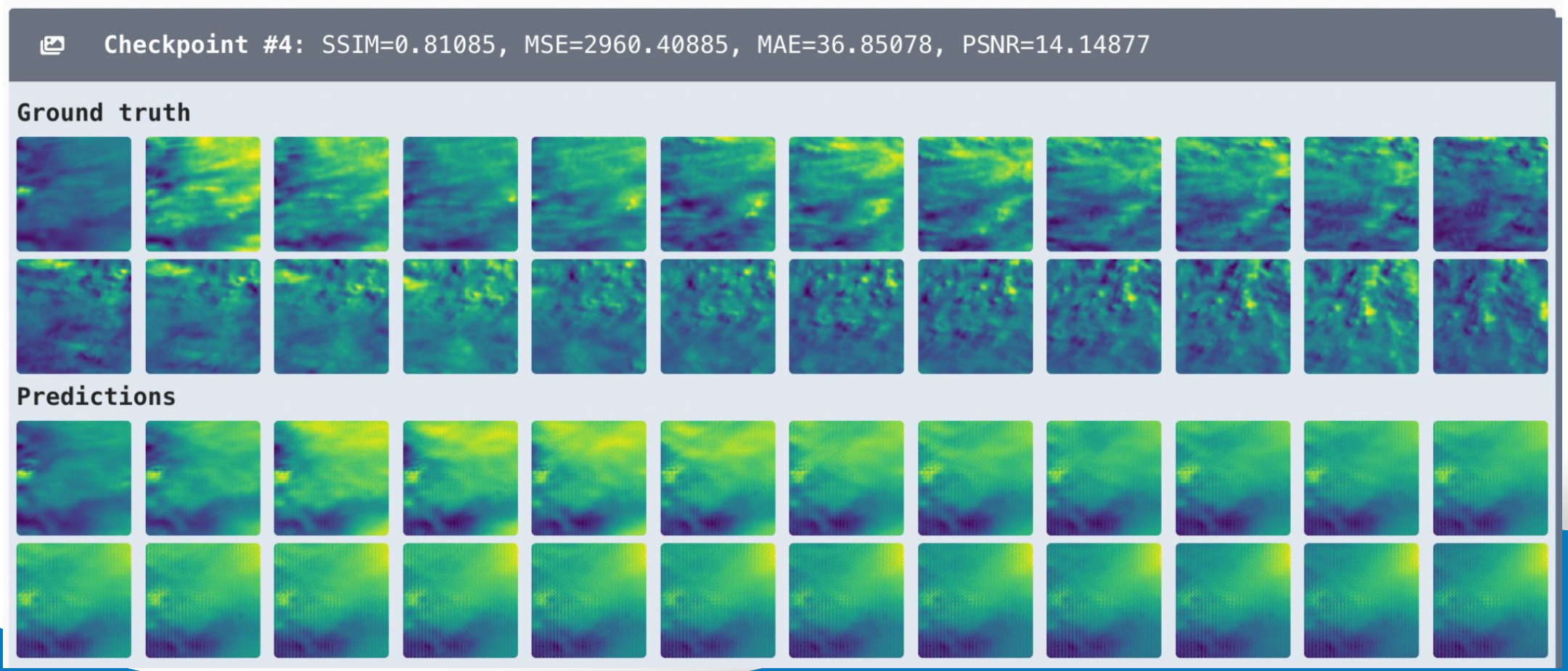
Perceptually, not that great

Weak Links: Need More Attention?



SSIM=0.79487, MSE=3675.01943, MAE=39.92123, PSNR=11.9574

Repaired Links: Increased Depth



Future Potential

Depth
— Added CLSTM layers seriously mitigate the weak link

Attention
— Better avoided for a simple, easily customizable model
— Could add it at this stage for significant performance boost, but still a relatively low total compute requirement

More Perceptual Loss
— Newer perceptual metrics like Frequency Domain-Based Perceptual Loss (FLDP - linked here)

ConvLSTM :

0.62 MS-SSIM Accuracy

SpatioTemporal Encoder-Decoder Model:

0.77 MS-SSIM Accuracy

A truly open-source, customizable model with the scope to perform wonders in the real world.

Thank you!