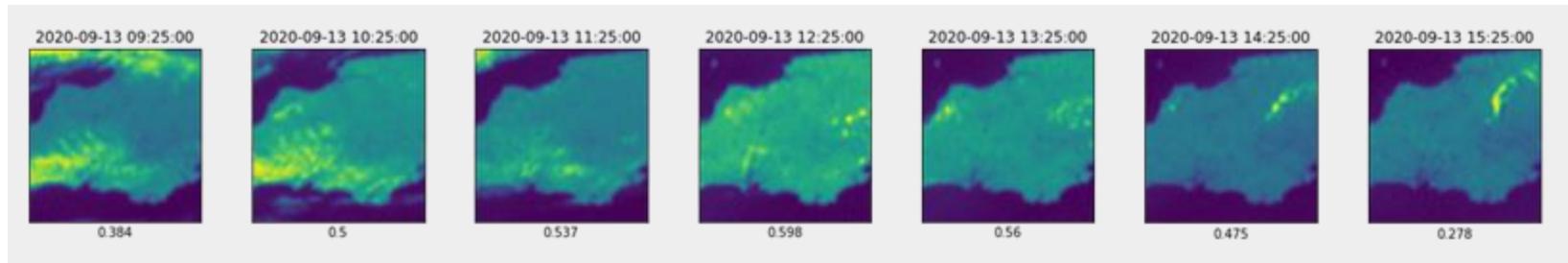


# Comparing the carbon costs and benefits of low-resource solar nowcasting



Ben Dixon, María Pérez-Ortiz, Jacob Bieker



# Motivation

- Climate change is an important problem
- Decarbonising requires integrating renewables
- Solar PV yield is uncertain due to clouds
- National Grid keeps gas reserves spinning in case of unanticipated drops in supply
- Improved **short-term solar PV forecasts** would reduce spinning-gas buffer

OCF has been working with National Grid since 2019 to develop better forecasts

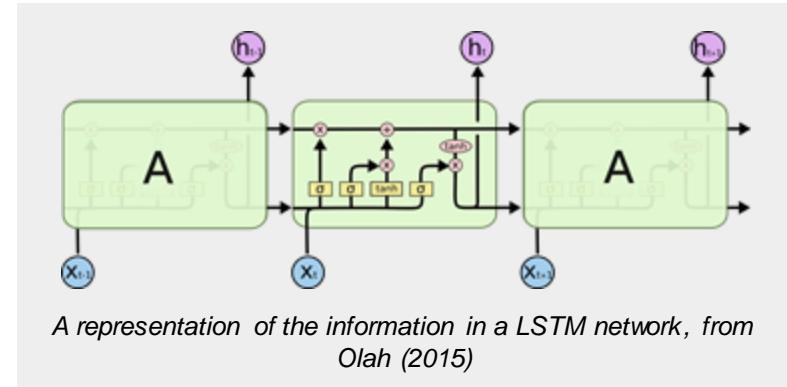


*The UK's Energy National Control Centre*

# Related work

## Machine learning and weather forecasting

- Numerical weather prediction (1960-today)
- Recurrent neural networks (~1985)
- Long short-term memory (LSTM) (1997)
- Convolutional neural networks (1998)
- ConvLSTMs (2015)
- GANs (2018)

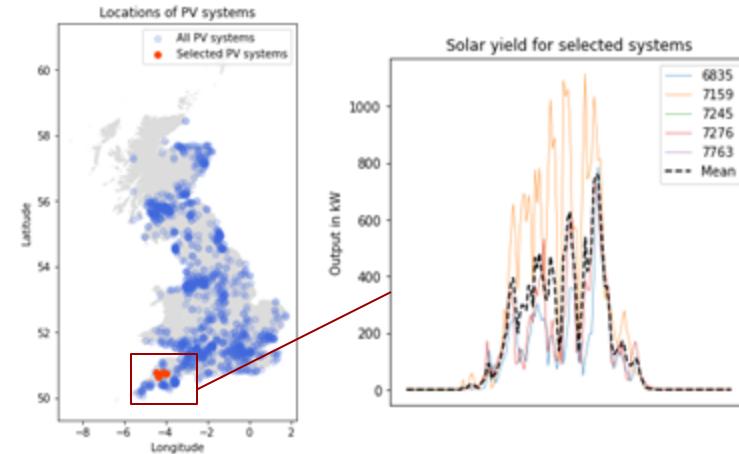
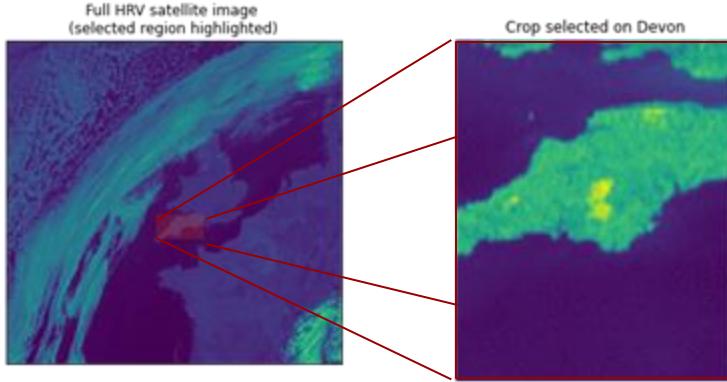


## Research hypotheses

- Can low-resource models such as CNNs and ConvLSTMs produce accurate forecasts?
- Can such models deliver sufficient benefits to justify their carbon cost?

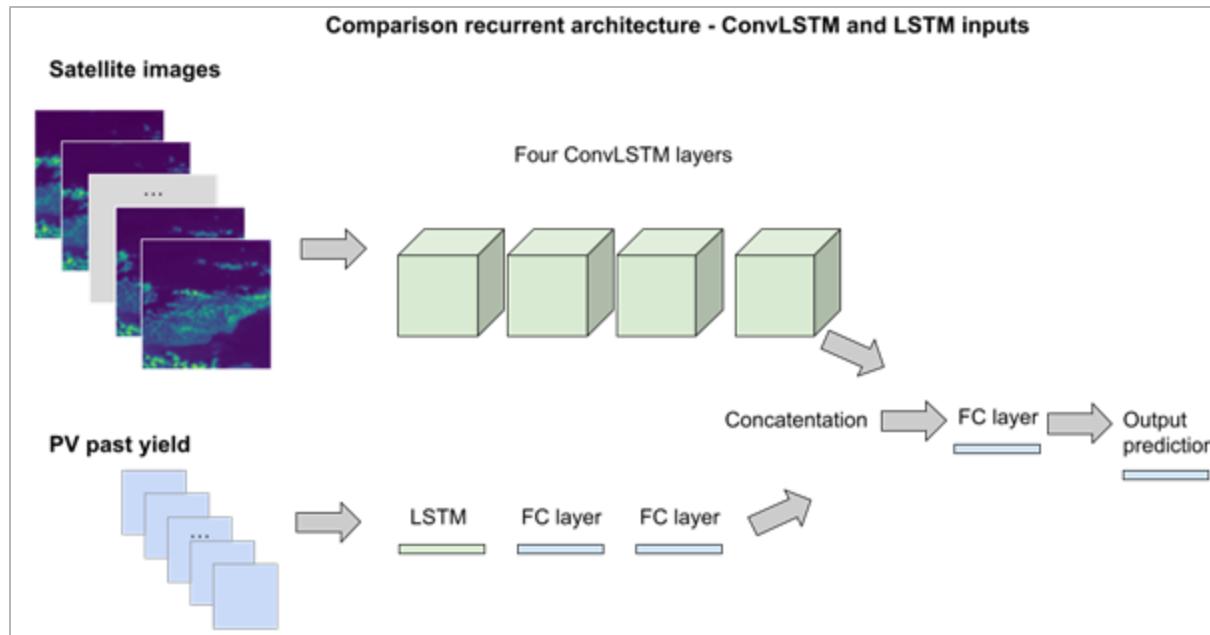
# Datasets

- Satellite images** - 5 minute intervals, UK region (EUMETSAT\* and OCF)
- Solar photovoltaic readings** - 5 minute intervals, 1300 stations, in watts (OCF)

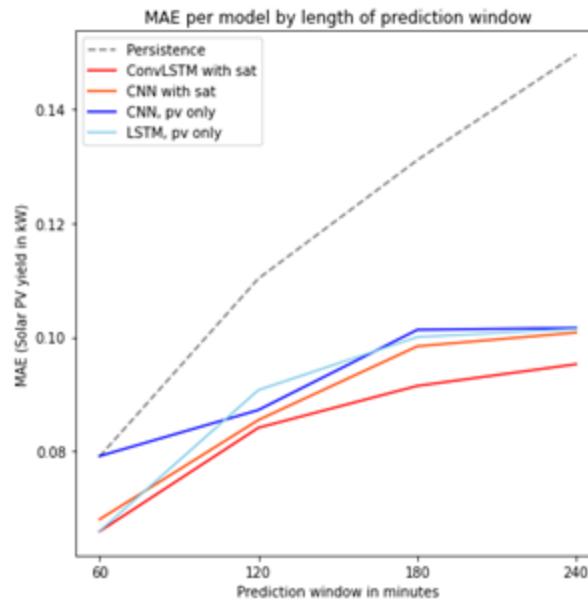
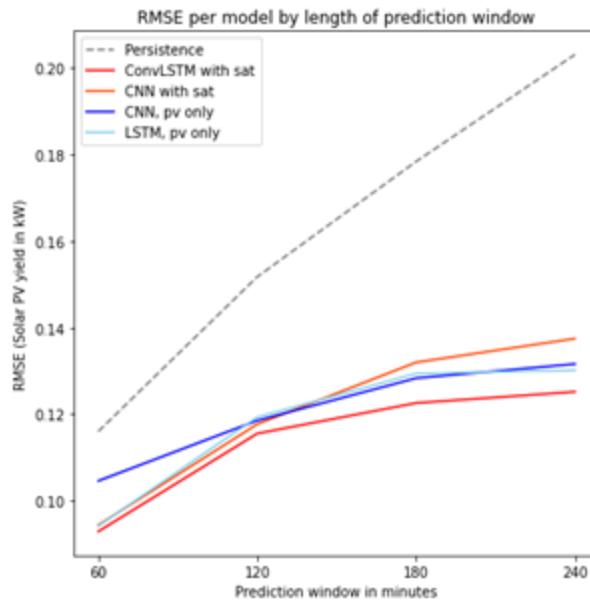


\*European Organisation for the Exploitation of Meteorological Satellites

# Task : predict a sequence of future PV readings



# Results and evaluation of hypotheses



# Emissions costs and benefits

## Generated

	Conv3D	ConvLSTM
Time to train model (s)	916.39	673.11
Time for inference, one forecast (s)	0.16	2.21
Implies: Total time for year (training + 1686,300 * inferences) (hrs)	75	1024
<b>Emissions generated (tonnes), assuming 0.21 kgCO2 eq/kWh</b>	<b>0.0108</b>	<b>0.152</b>

## Reduced

- Harder to estimate
- UK energy supply from solar is expected to rise from 2% today to 7% by 2050
- Per gigawatt hour, a solar plant generates 1 / 2000th of the emissions of a gas turbine
- We pessimistically assume models are 0.1% better than the current standard, and only in 0.05% of cases we may be able to turn off gas-reserves
- Implies a reduction of we may be looking at a reduction of around 5500 tonnes of CO2 annually.

# Conclusion

- Low-resource models are able to significantly outperform persistence forecasts
- Even under pessimistic assumptions, clear potential carbon benefit from more accurate forecasts
- Further analyses are needed to understand the benefit that larger and deeper models could bring
- More in depth understanding of current strategies implemented by grid operators globally needed