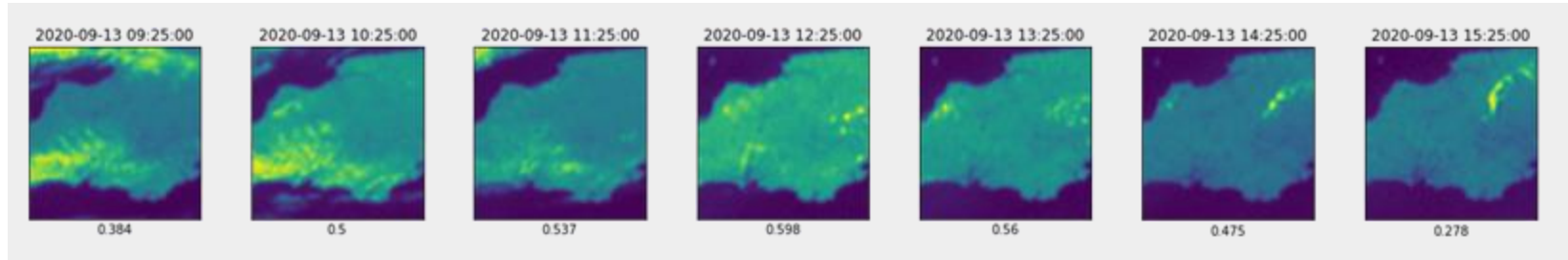


Comparing the carbon costs and benefits of low-resource solar nowcasting



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

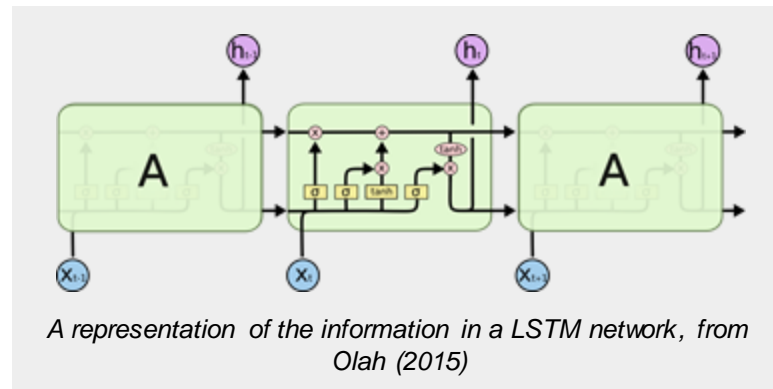
OCF has been working with National Grid since 2019 to develop better forecasts



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)

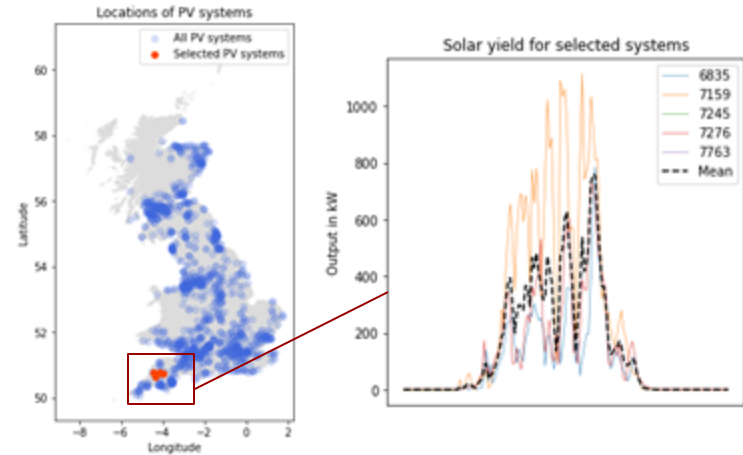
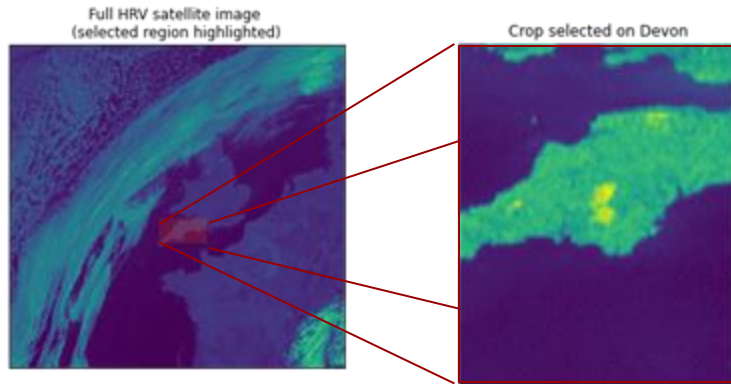


Research hypotheses

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

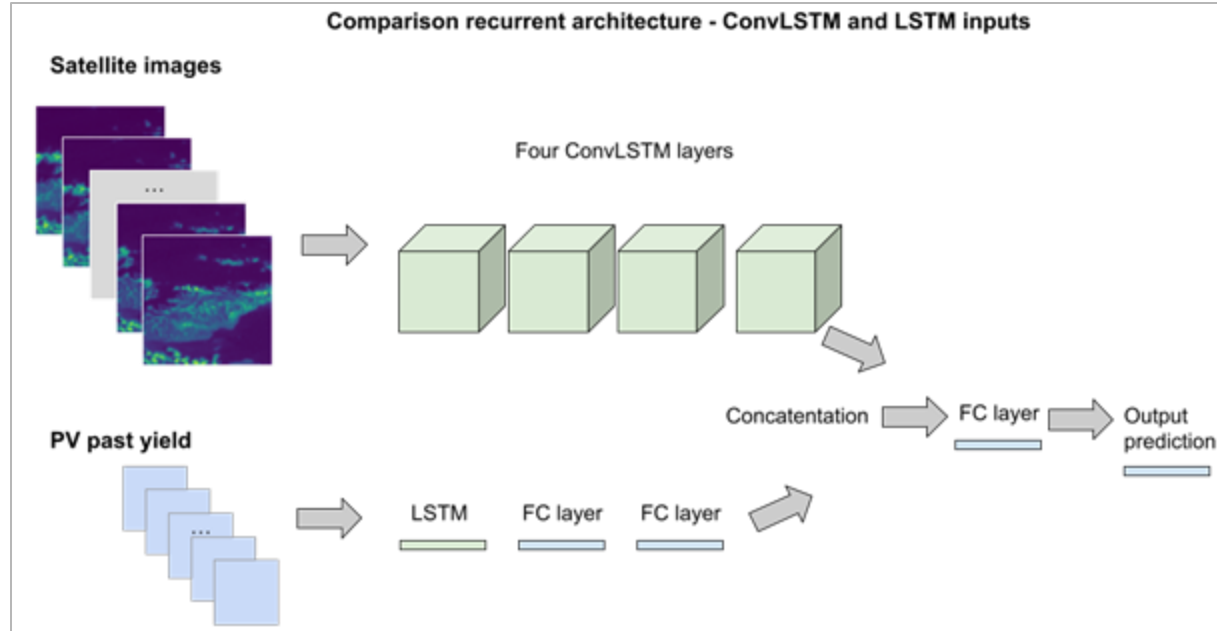
Datasets

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

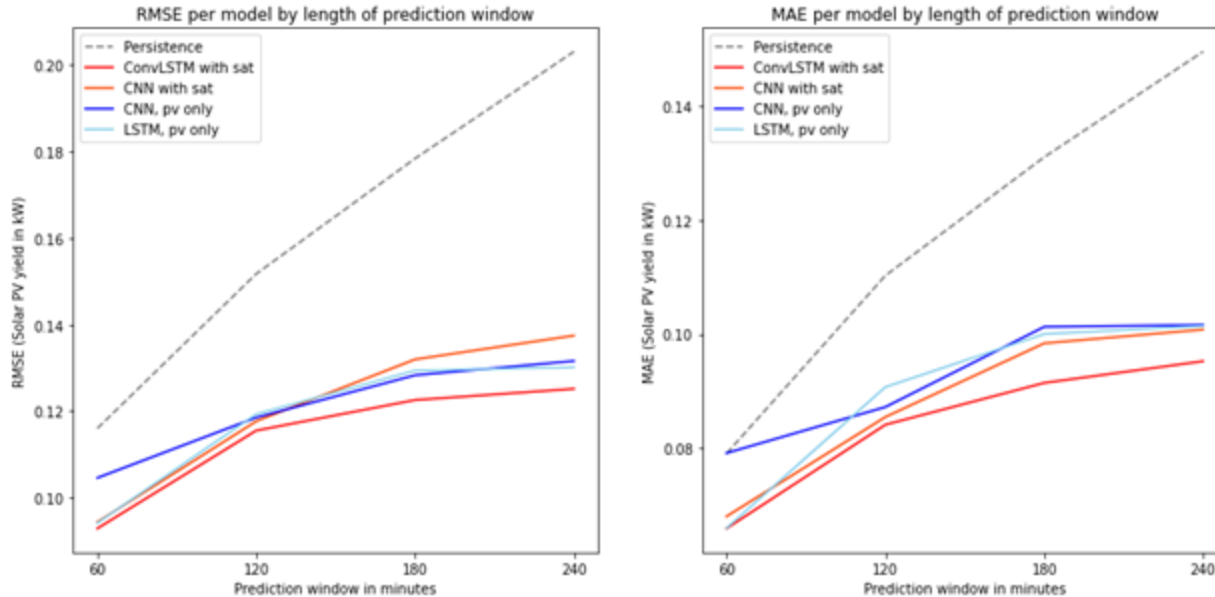


*European Organisation for the Exploitation of Meteorological Satellites

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
Emissions generated (tonnes), assuming 0.21 kgCO₂ eq/kWh	0.0108	0.152

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