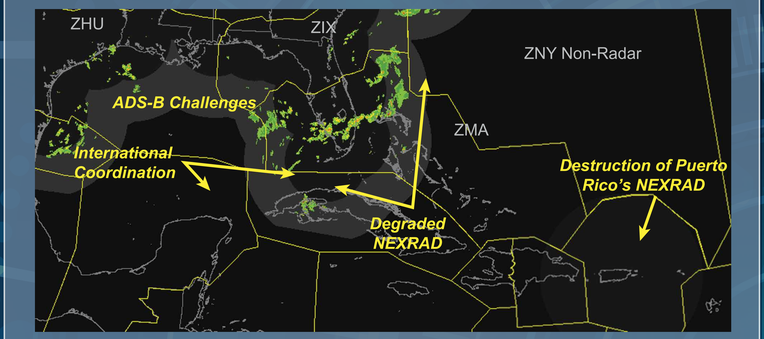
Creating Synthetic Weather Radar Images Using Convolutional Neural Networks

Christopher J. Mattioli, Mark S. Veillette, Haig Iskenderian, Eric P. Hassey, Patrick M. Lamey: Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, MA

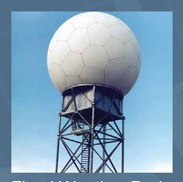
Limited Weather Radar over Caribbean

The Caribbean region represents over a million square kilometers of offshore U.S. airspace and supports nearly 17% of all U.S. outbound passengers. Air traffic demand in the Caribbean is expected to grow rapidly by 5-6% per year over the next decade, and the lack of weather radar coverage in this airspace will continue to be a major hurdle for safe and effective air traffic control.



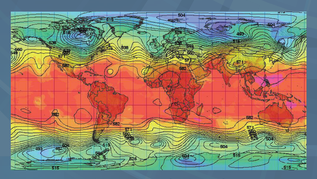
Data Sources for Synthetic Weather Radar

Regions without weather radar have varying areas and times of data coverage. The challenge is to combine these data sources to create a radar-like depiction of weather.

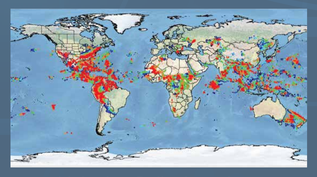

Fixed Weather Radar


Geostationary Satellite


Surface Observations

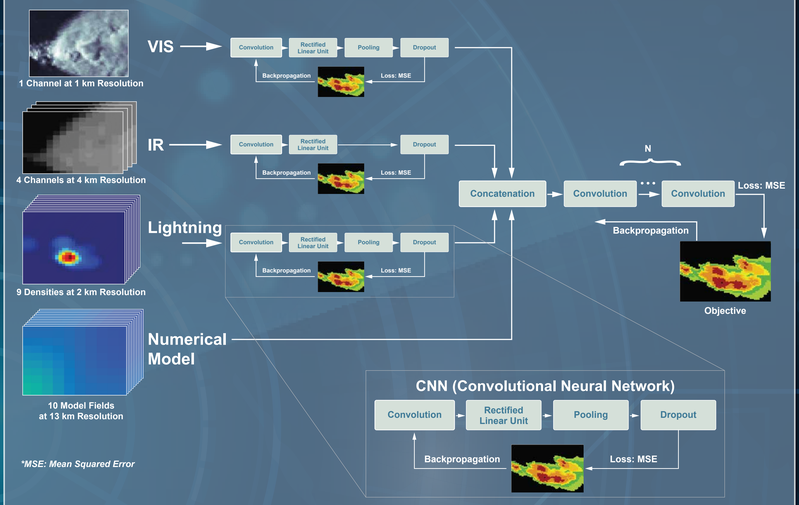

Numerical Model


Low-Earth Orbiting Satellite

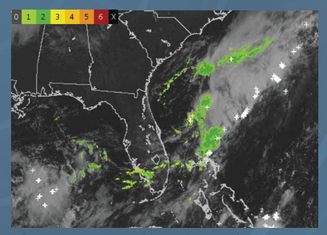

Lightning Strike Locations

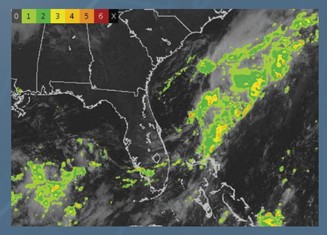
Synthetic Weather Radar

- The Synthetic Weather Radar (SWR) capability is a system that creates radar-like mosaics of precipitation intensity and echo tops beyond the range of current weather radar
- At its core, this capability makes use of a Convolutional Neural Network (CNN) trained with truth sources over land
- Its architecture is that of a directed acyclic graph (DAG) where multiple output layers contribute to the loss

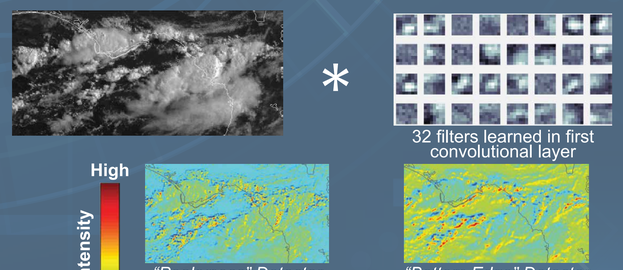


*MSE: Mean Squared Error


Current extent of weather radar cannot represent hazardous weather offshore indicated by lightning flashes (white markers).

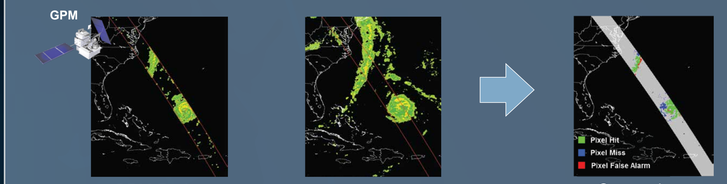

SWR applied to the same case is able to fill in the precipitation outside the range of the radar.

Learned Features for Visible Satellite

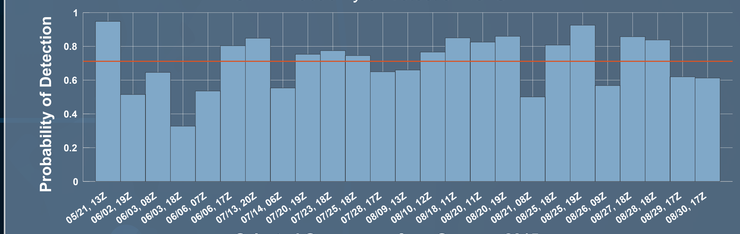


Quantitative Capability Evaluation

MIT Lincoln Laboratory routinely performs quantitative evaluations of the synthetic weather radar against land-based NEXRAD radar and space-based radar from NASA's Global Precipitation Measurement (GPM) mission Core Observatory satellite.

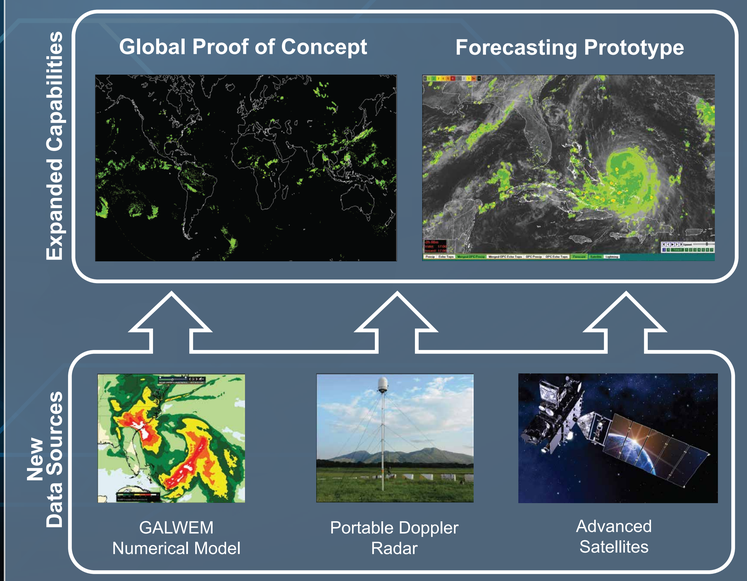


SWR Probability of Detection vs. GPM



Probability of Detection (POD) = #Hits / (#Hits + #Misses)

Global Expansion and Forecasting for DoD



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