ConvLSTM Architectures for meteorological nowcasting based on satellite imagery

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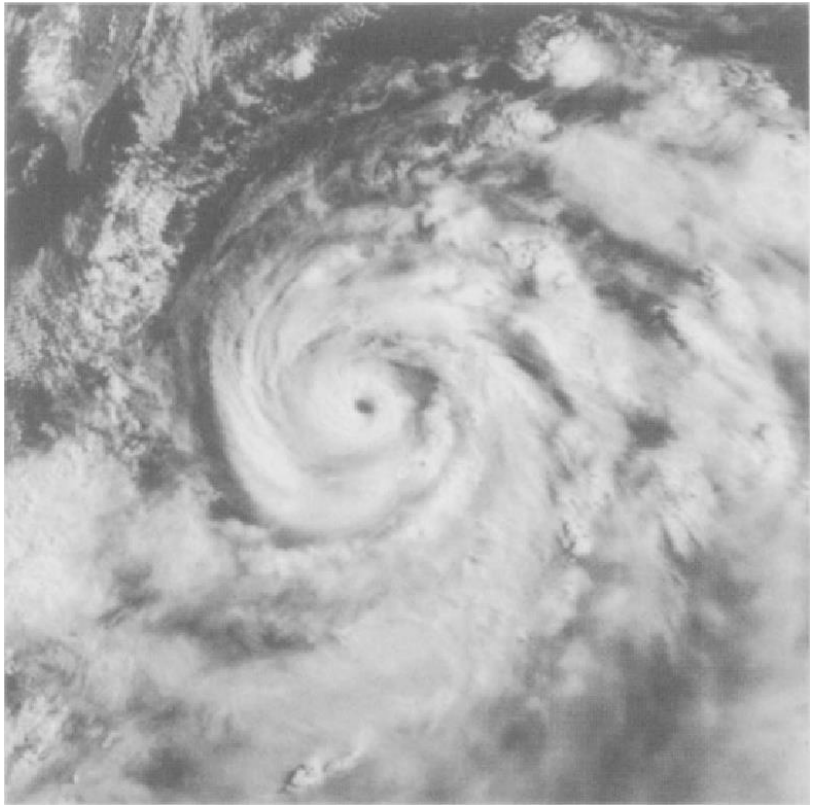
Predicting the weather: fighting the Butterfly Effect

- Chaotic behaviour
- Fluid dynamics
- Turbulence
- Extremely computationally expensive + coping with chaos

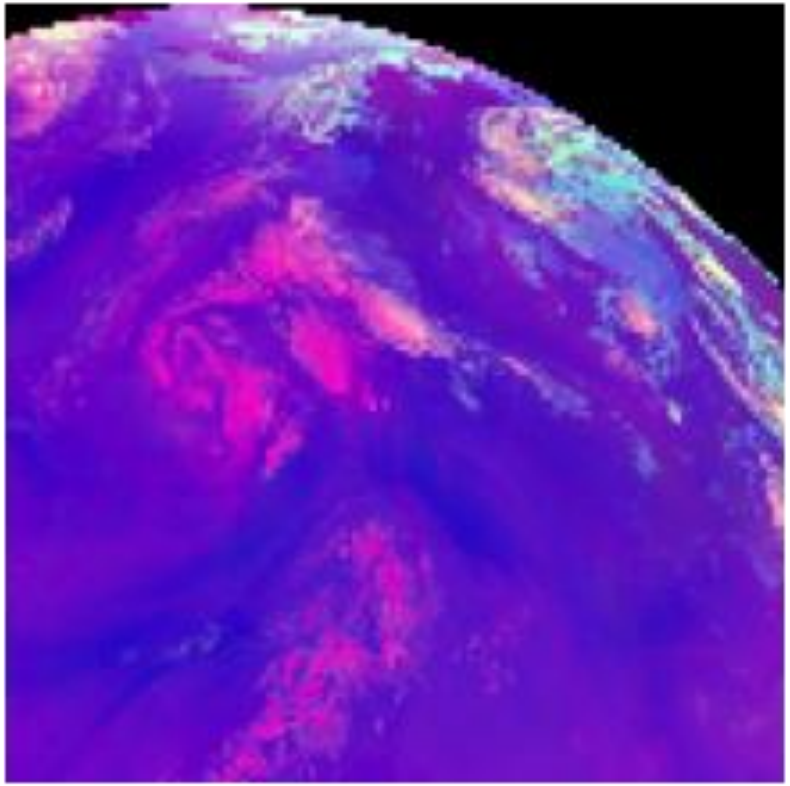


Importance of Nowcasting in the context of more frequent Severe Convective Storms in Europe

- Germany, last week, storm causes devastating tornadoes
- Significant increase of severe meteo phenomena in Europe in recent years
- Can ML models predict SCSs?

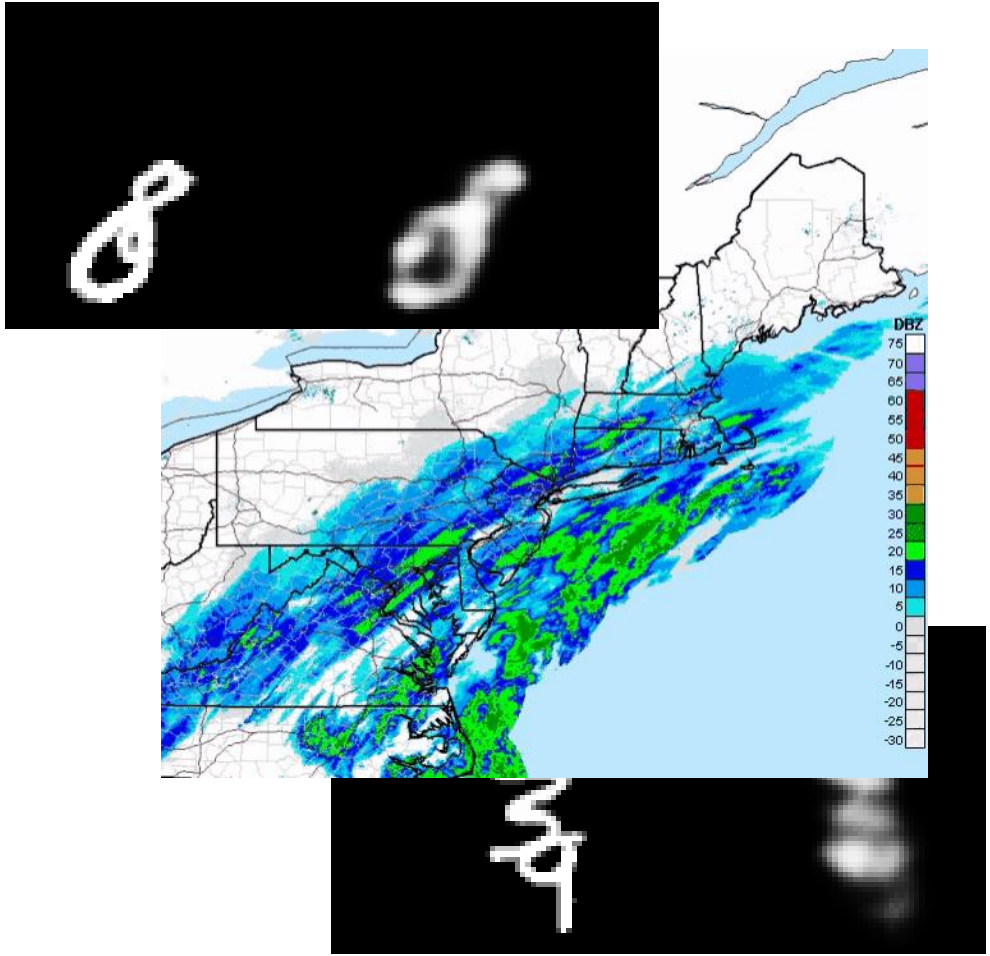
Data Model:

- Satellite imagery from the EUMESAT Meteosat-11 satellite covering Europe and Africa
- Continuous stream of images (one every 15 minutes)
- Meteo product employed: Convection RGB
- Focus on Europe

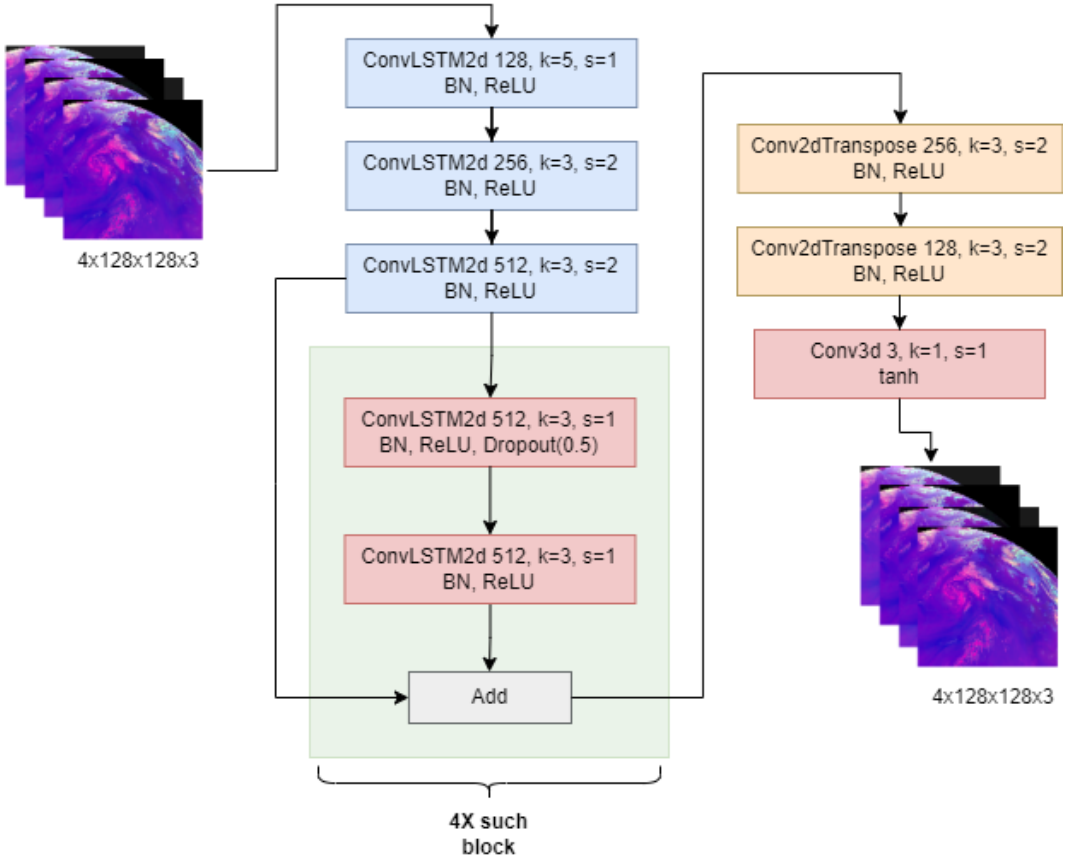


Why ConvLSTM?

- Works very well on temporal progressions of data
- Models well slightly organized movement in chaotic contexts
- Simple and straightforward DL architecture, best fit for a temporal progression of high res imagery



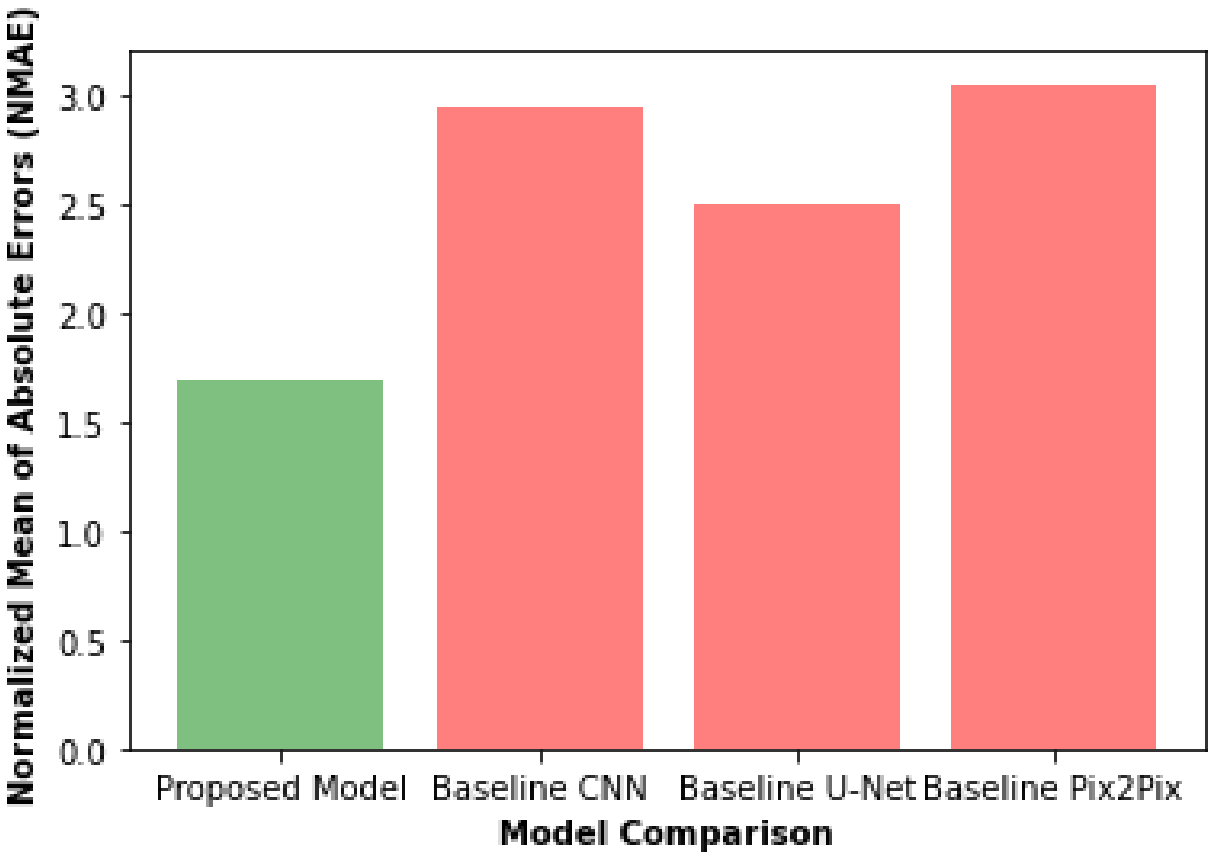
Proposed Architecture



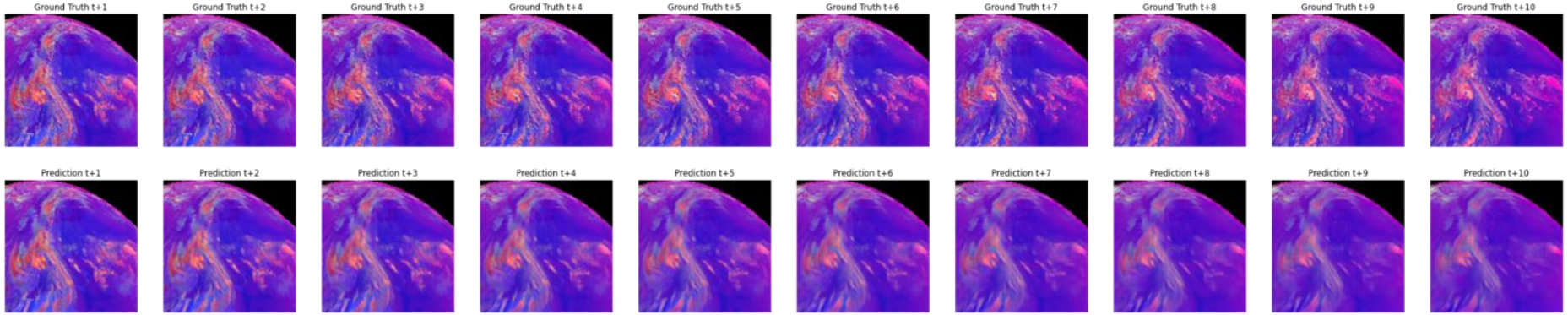
Performance Evaluation

- Baseline CNN:
- Baseline U-Net:
- Baseline Pix2Pi GAN:

Model	MAE	NMAE	MSE	Training (epochs/iterations)
ProposedModel	**0.0169**	**1.6991**	**0.0012**	40 epochs
Baseline CNN	0.0295	2.9464	0.0029	32 epochs
Baseline U-Net	0.0251	2.5097	0.0022	40 epochs
Baseline Pix2Pix	0.0305	3.0523	0.0035	40000 iterations


Normalized Mean of Absolute Errors (NMAE)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Proposed Model
Baseline CNN
Baseline U-Net
Baseline Pix2Pix
Model Comparison

Obtained result on satellite imagery



Conclusions and future improvements

- The ConvLSTM model adapts well to the nowcasting based on satellite imagery problem
- The obtained performances need to be evaluated not only from a numerical perspective but, more importantly, from a meteorological perspective
- Further effort should be employed on adapting the input parameters to more accurate nowcasting needs