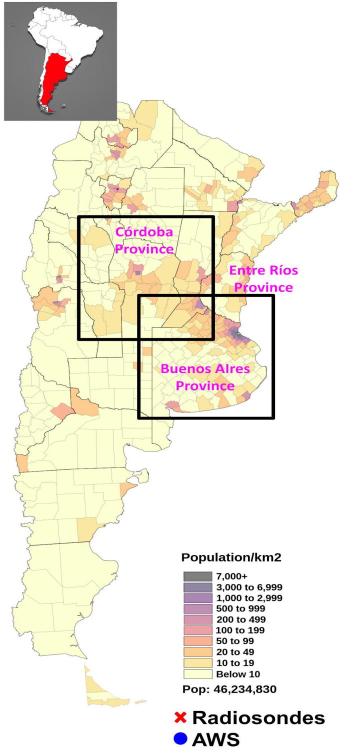
Servicio Meteorológico Nacional Argentina

Current AI Projects at the National Weather Office of Argentina

Maximiliano A. Sacco
Department of Environmental Modeling and Remote Sensing

Current State of AI Integration in Meteorology at SMN

First Steps in Machine Learning

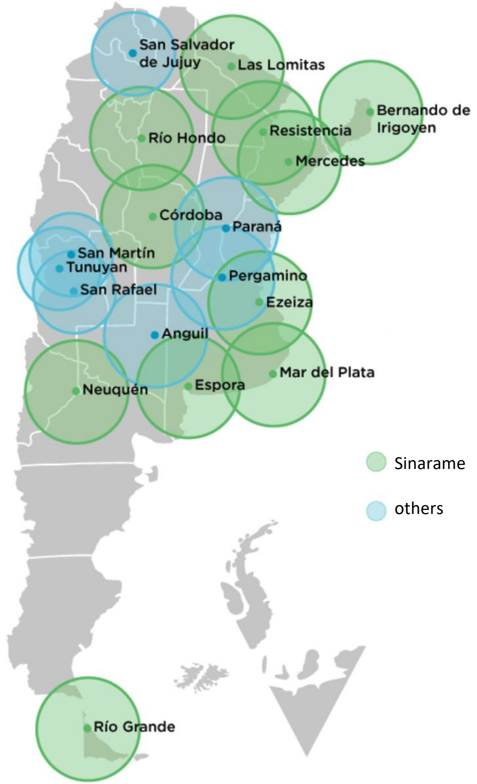


Critical Resource Constraints

- Computational Infrastructure:
  - Before Clementina XXI (2025) there was no GPU installed SMN data center..
  - Current capacity allows 4km 20 members WRF ensembles.
- Training Data Limitations:
  - SINARAME Radar Network: 8 years of operationally quality-controlled reflectivity data
  - High-Resolution WRF: 5 years of archived forecasts (2019–present, 4km resolution).
  - Surface weather station

Ongoing AI/ML Initiatives

- Nowcasting:
- Quantitative Precipitation Estimation (QPE):
- Probabilistic Forecasts and Uncertainty Quantification:



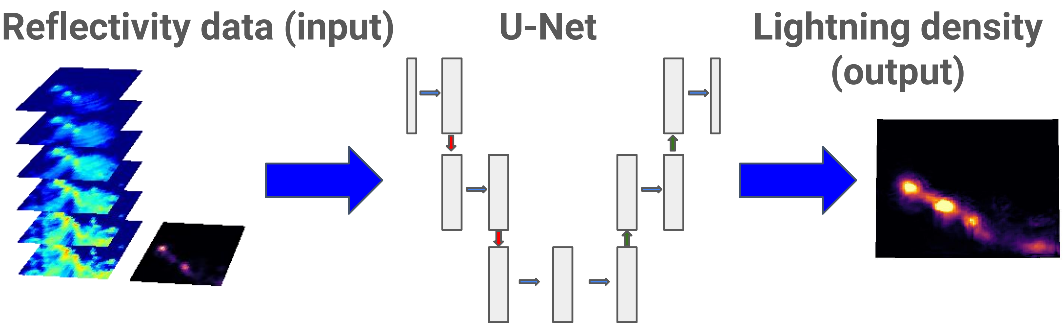
Towards ensemble-based lightning data assimilation

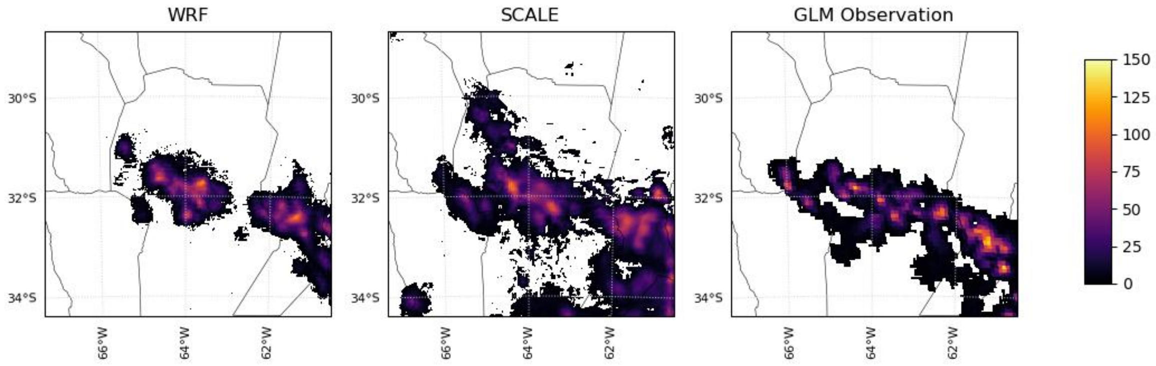
F. Cutraro, M. Dillon, J. Ruiz

Motivation: Develop a machine-learning-based observation operator for the assimilation of GOES-16 lightning density observations.

The network represents the relationship between the spatial distribution of the radar reflectivity and the lightning density and is trained using weather radar data from the Argentinean radar network co-located lightnin density from the GOES-16.

Preliminary results show a good performance of the network using the numerically simulated reflectivity by mesoscale models such as WRF and SCALE.





Probabilistic Forecasts and Uncertainty Quantification

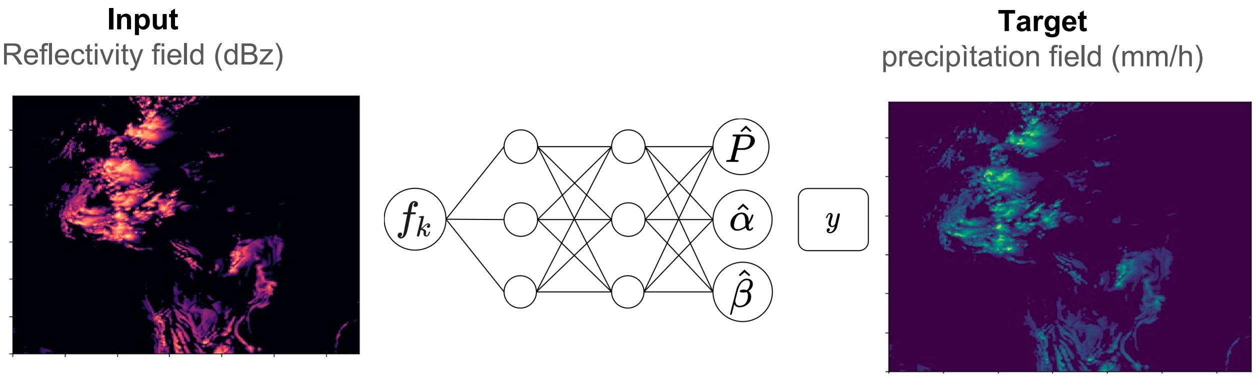
Motivation

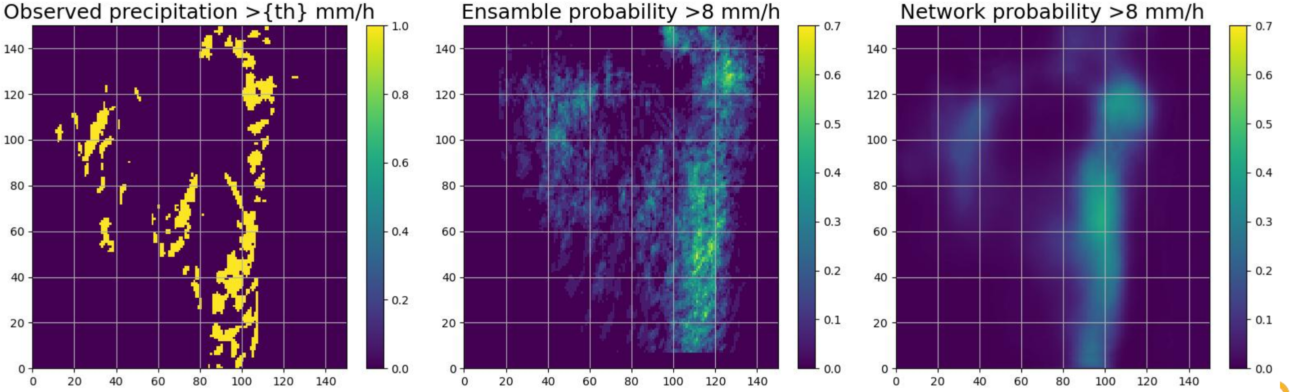
Goal: Estimate gamma distribution parameters per pixel to model precipitation probability.

Approach: Neural network trained to predict gamma parameters.

- **Input**: Reflectivity field (NWP data)
- **Target**: Radar-derived precipitation field (Marshall-Palmer transform)

Results: The neural network produces smoother and more continuous precipitation probability fields than model ensembles, while effectively correcting systematic biases in the NWP output.





PREVENIR
Forecast and Warning of Flash Flood Events

CONICET UNNE IMIT

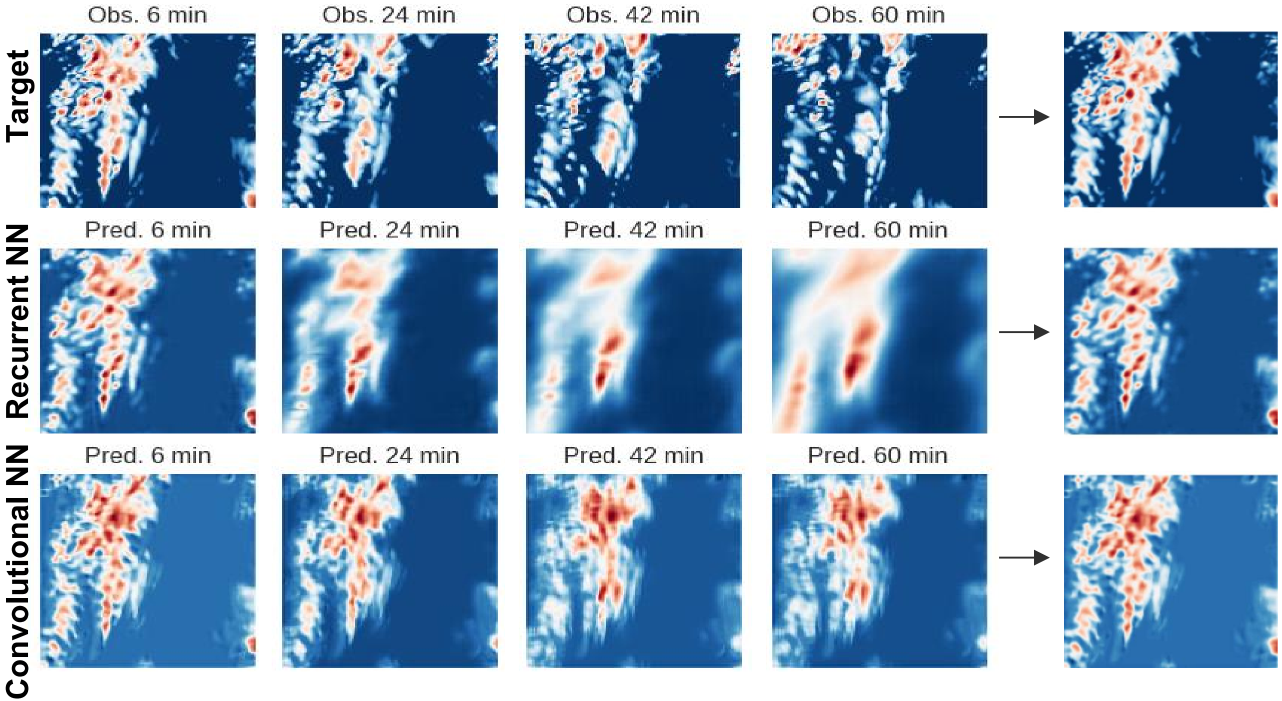
Machine learning-based nowcasting

A. Aguirre, M. Pulido, S. Otsuka

Motivation: Develop and evaluate a fully data-driven forecasting model based on deep neural networks.

Preliminary experiments using numerically simulated reflectivity data produce promising results.

Different architectures are being compared in order to find the most appropriate network design for this task.

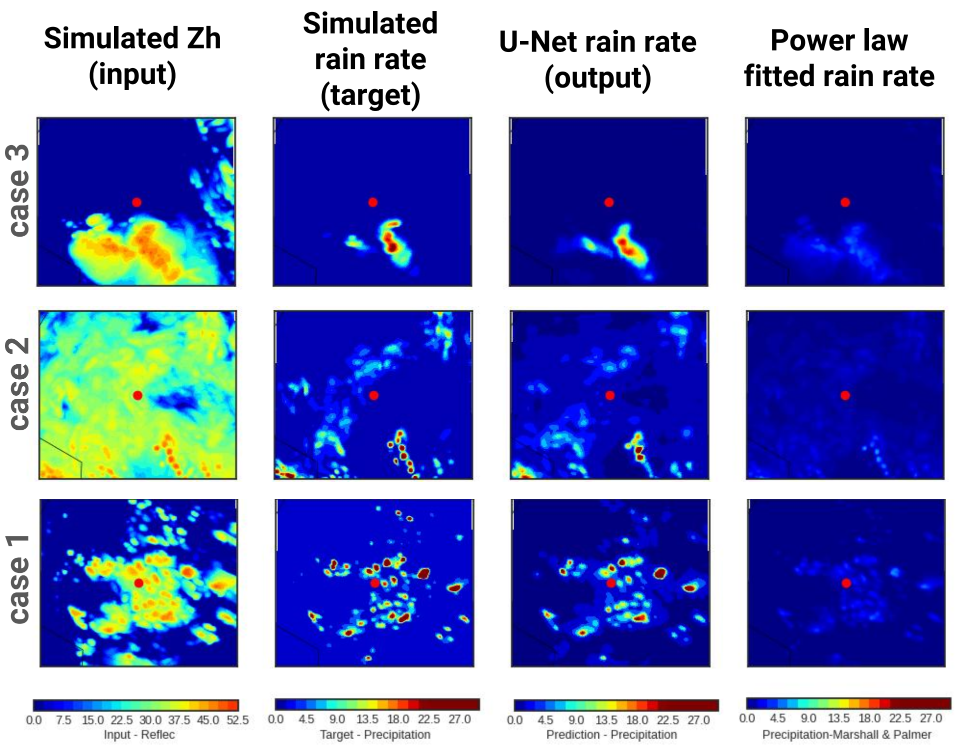


RQPE - Development of machine learning methods for radar QPE

P. Fernandez, M. Pulido, J. Ruiz

Motivation: Improve the radar-based precipitation estimation using the full spatial structure of the reflectivity field and a machine learning-based model.

Preliminary experiments using numerically simulated reflectivity and precipitation distributions have been used (WRF model simulations of several precipitation events with 2 km horizontal resolution). A U-Net model has been trained using the simulated data.



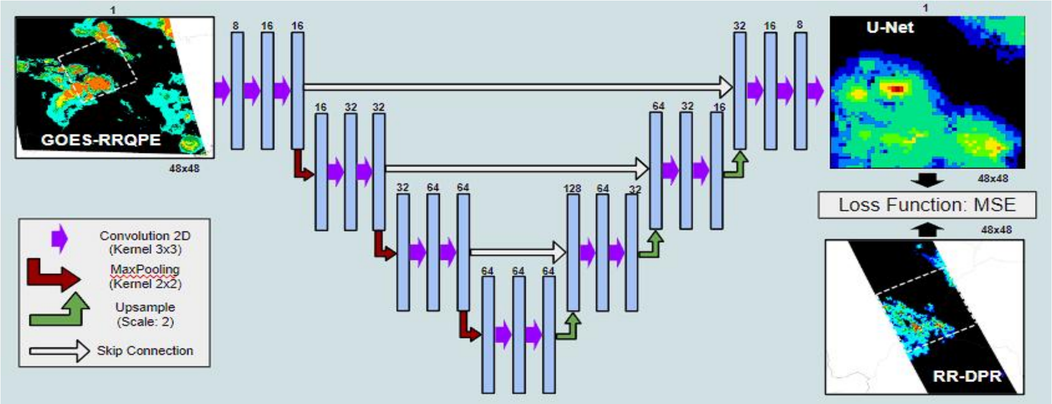
SQPE - Evaluation and optimization of machine learning methods to correct GOES-16 precipitation estimates

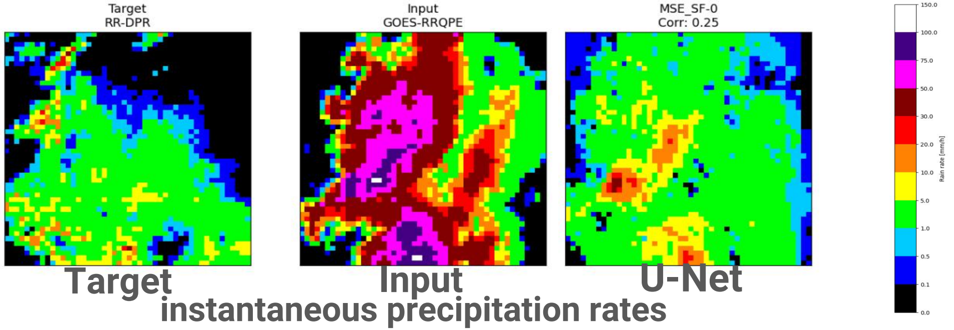
S. Gonzalez, P. Negri, L. Vidal, J. Ruiz

Motivation: Develop machine learning models that can correct systematic errors present in current IR-based precipitation estimates from GOES-16.

A U-Net model is used to model the systematic biases in the GOES-16 real-time precipitation algorithm (available every 10 minutes with a 2-km horizontal resolution).

The network is trained against the Dual Frequency Precipitation Radar on board of the GPM satellite.





Forecasting Dengue Fever Outbreaks Based on Meteorological Factors with RandomForest

Data for training the model and run the models in operational mode (**all predictors with 2 weeks lag**):

- Soil water storage
- Precipitation
- Minimum temperature (Tmin)
- Number of consecutive days with Tmin below threshold
- Dengue cases for the own dengue outbreak

More data (real time):

- Epidemiological
- Meteorological
- Water Balance

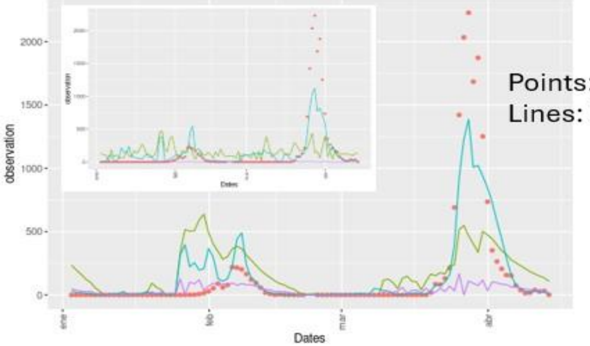
Data (training):

- Epidemiological
- Meteorological
- Water Balance

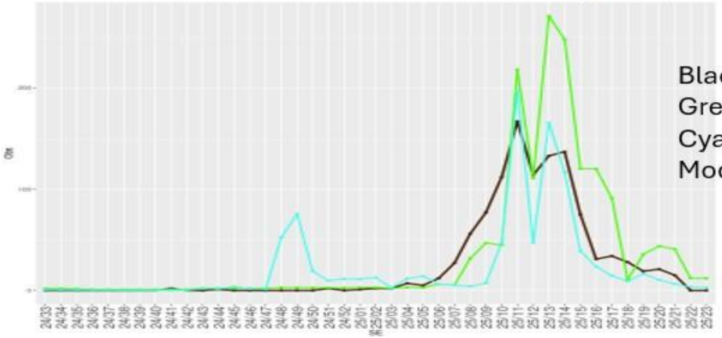
Model → Trained Model → Operative Model

Output variable (by week): Dengue cases of outbreak

Improvement of models when the soil water storage predictor is used:



Points: observation
Lines: Models



Black: observation
Green: Random Forest
Cyan: General Linear Model

Next Steps

- Conclude active development projects and deploy operational-ready solutions (mid 2026 finalize PREVENIR project)
- Establish an AI Office for Meteorology to:
  - Document and integrate machine learning efforts across departments
  - Establish uniform evaluation standards and best practices
  - Build and maintain certified training data repositories
  - Implement technical review processes to ensure project feasibility

Thank you for your attention

Servicio Meteorológico Nacional Argentina

Ministerio de Defensa República Argentina

Dorrego 4019 (C1425GBE) Buenos Aires . Argentina
Tel: (+54 11) 5167-6767 . smn@smn.gob.ar

www.smn.gob.ar