

# A global and operational precipitation product from weather satellites: Espresso

Sylvain Le Moal Direction of operations for weather forecasting Meteorological Satellite Center



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### Collaborative work:

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Berthomier, Léa, and Laurent Perier. 2023. "Espresso: A Global Deep Learning Model to Estimate Precipitation from Satellite Observations" *Meteorology* 2, no. 4: 421-444. https://doi.org/10.3390/meteorology2040025





















### **GPM Core Observatory**

- GPM Microwave Imager
- Dual-frequency Precipitation Radar: Ka-Band (35.5 GHz) Ku-Band (13.6 GHz)

- Orbit duration: 1 h 30
- 16 daily swaths since 2014
  - Rainfall rate measurement in mm/h





### DATASET

- 21,000 samples
- Combining: rainfall, VIS 0.6 μm, IR
  10.8 μm, IR 12 μm, WV 6.2 μm
- From **2018 to 2022**
- Size: 512 x 512 pixels
- Spatial resolution: 0.045° ~5 km

- Careful selection to keep samples with enough rainfall (especially heavy rain)
- Worldwide coverage between latitudes [70°S / 70°N]
- 2018-2021 samples to train the deep neural network
- 2022 samples as test set for evaluation



### **Deep learning experimental framework**

#### **Input features**





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Position on globe







## Comparison with other operational products

Producer	Name	Coverage	Spatial resolution	Frequency	Availability delay
METEO-FRANCE	ESPRESSO	~ World (FOV of GEO sat.)	5 km	15 min.	Real time
NASA	GPM IMERG	World	10 km	30 min.	4 hours
NOAA	GLOBAL HYDRO ESTIMATOR	World limited to 65°N/65°S	4 km	1 hour	Real time
NOAA	GOES-R SERIES QPE	GOES-E Space view	2 km at nadir	10 min.	Real time
UNIV. of CALIFORNIA	PERSIANN/PDIR-NOW	World limited to 60°N/60°S	4,4 km	1 hour	Real time
EUMETSAT H SAF	P-IN-SEVIRI HSAF	MSG 0° Space view	3 km at nadir	15 min.	Real time
JAXA	GSMAP10 km	World	10 km	30 min.	Real time



### **Comparison with other operational products**





#### **FSS: Fraction Skill Score**

Compares estimated and true frequencies of event in a 20 km neighbourhood. Best score = 1

#### RÉPUBLIQUE FRANÇAISE Liberté Égalité France Rence Double blind study









- We built a **global deep learning precipitation estimate** from worldwide satellite radar data.
- Strong performance across the globe

Rainfall (mm/h)

- Performances are **comparable to or are better than IMERG**.
- Espresso is **operational** and produces **real time**, **worldwide** estimations every **15 minutes**.
- Estimations are accessible to French forecasters and army, especially where radars are not available.



