



IA for water
A joint RAINSMORE/SWOT workshop on the use of Artificial Intelligence for time series and images processing for Hydrometeorological applications,

24th-28th of october 2022 - Fortaleza, Brasil

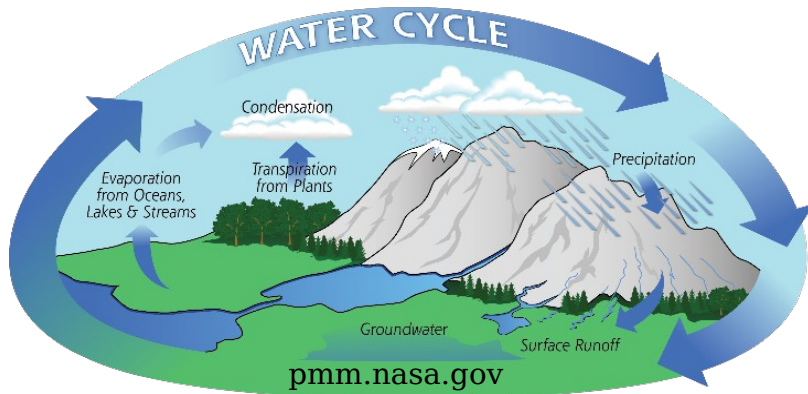


Why and how studying Extreme rainfall, limits of usual estimation / prediction models

Rômulo A. J. Oliveira (IRD/Hydro-Matters)



The Precipitation!

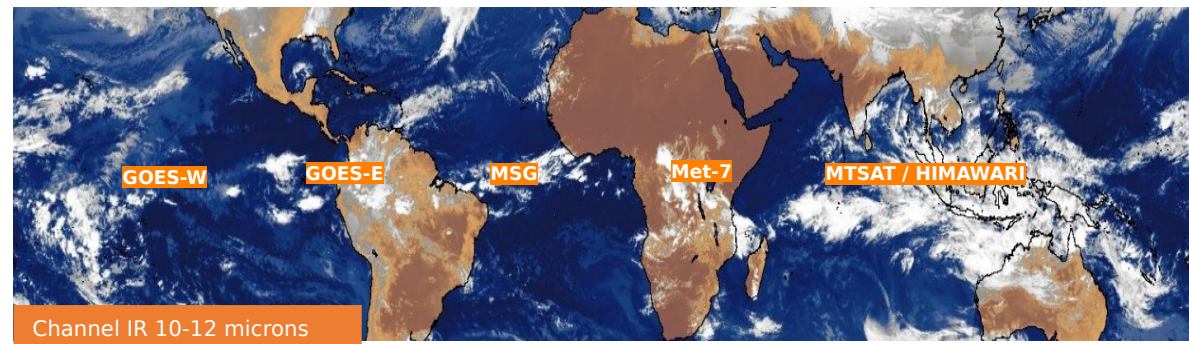
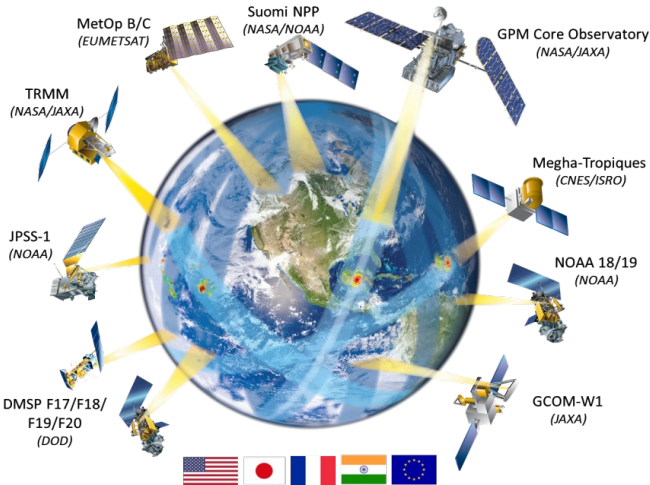


- Precipitating Systems
- Climatological studies
- Extremes
- Hydrology

Satellite Estimates

- The Global Precipitation Measurement (GPM)
- Geostationary Satellites observations

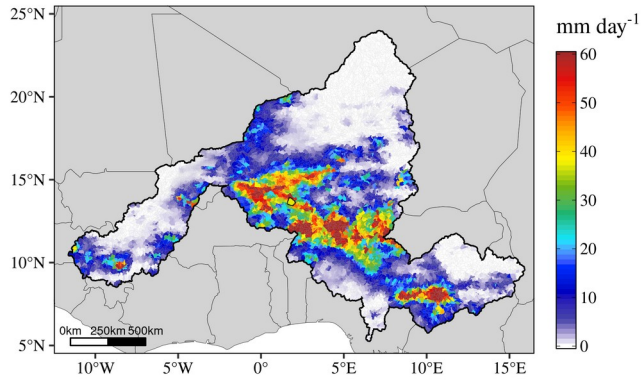
GPM Constellation Status



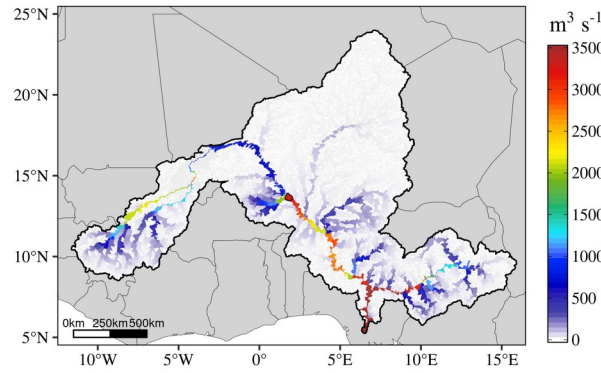
Hydrological monitoring

- Near-real time satellite precipitation products

Precipitation (R): 2020-08-25
IMERG.F V06



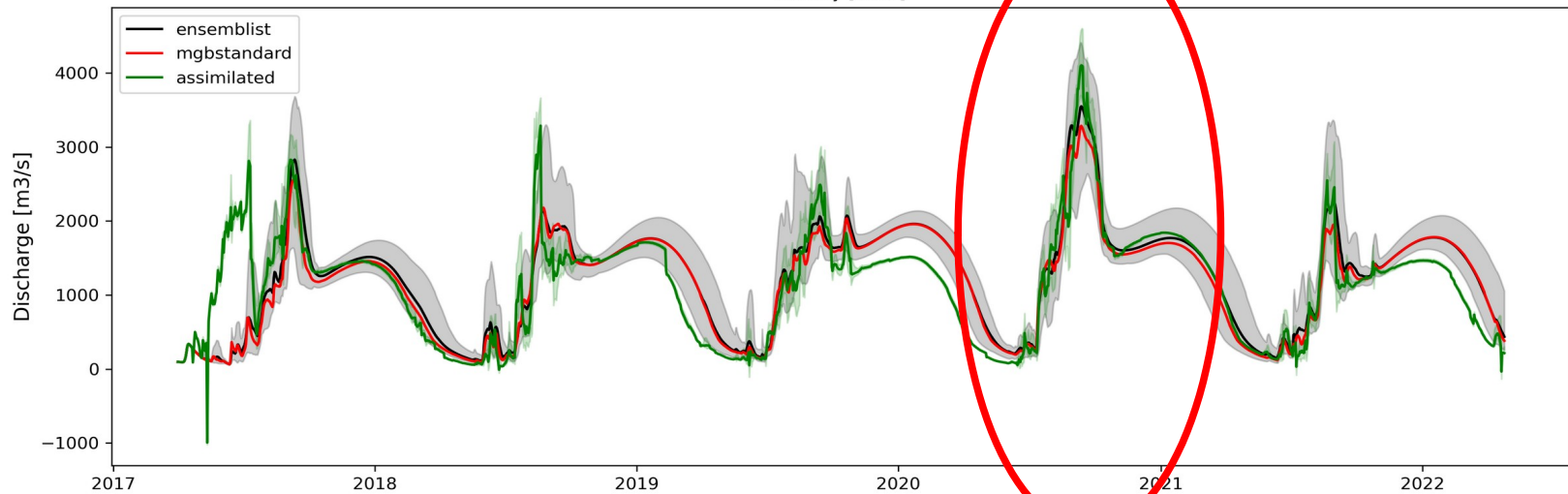
Discharge (Q): 2020-08-25
IMERG.F V06



Niamey, Niger - 2020



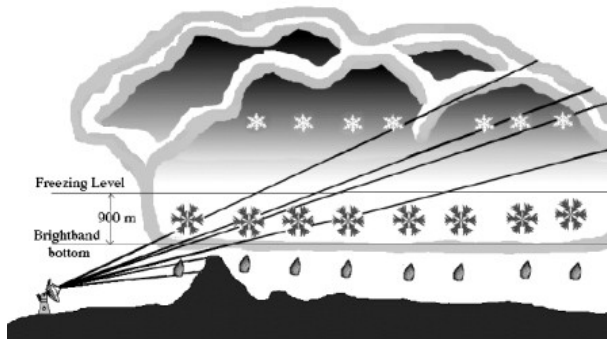
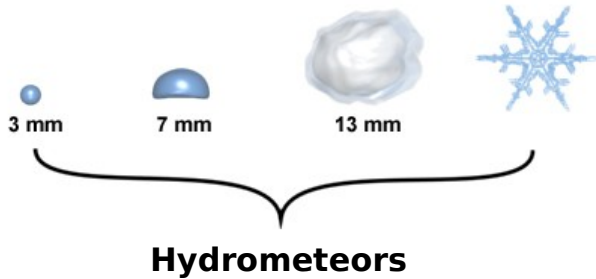
Niamey [4307]



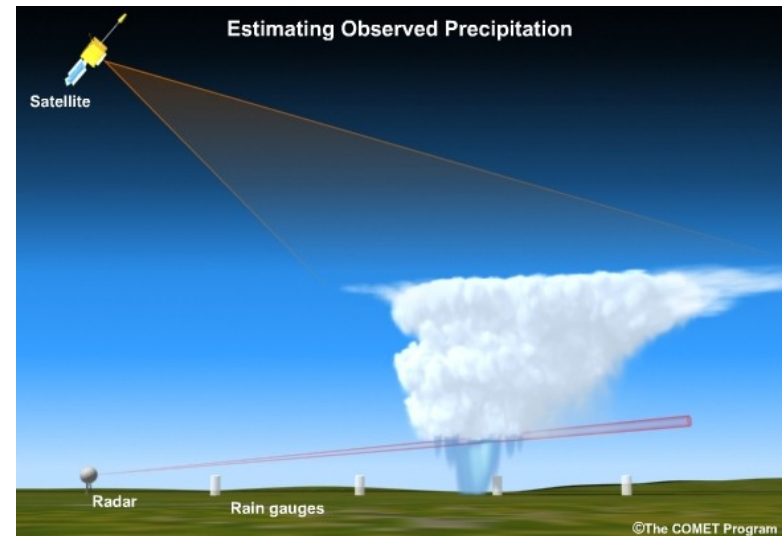
Large variability

Spatial-temporal /vertical / intensity

❖ Microphysical Scale



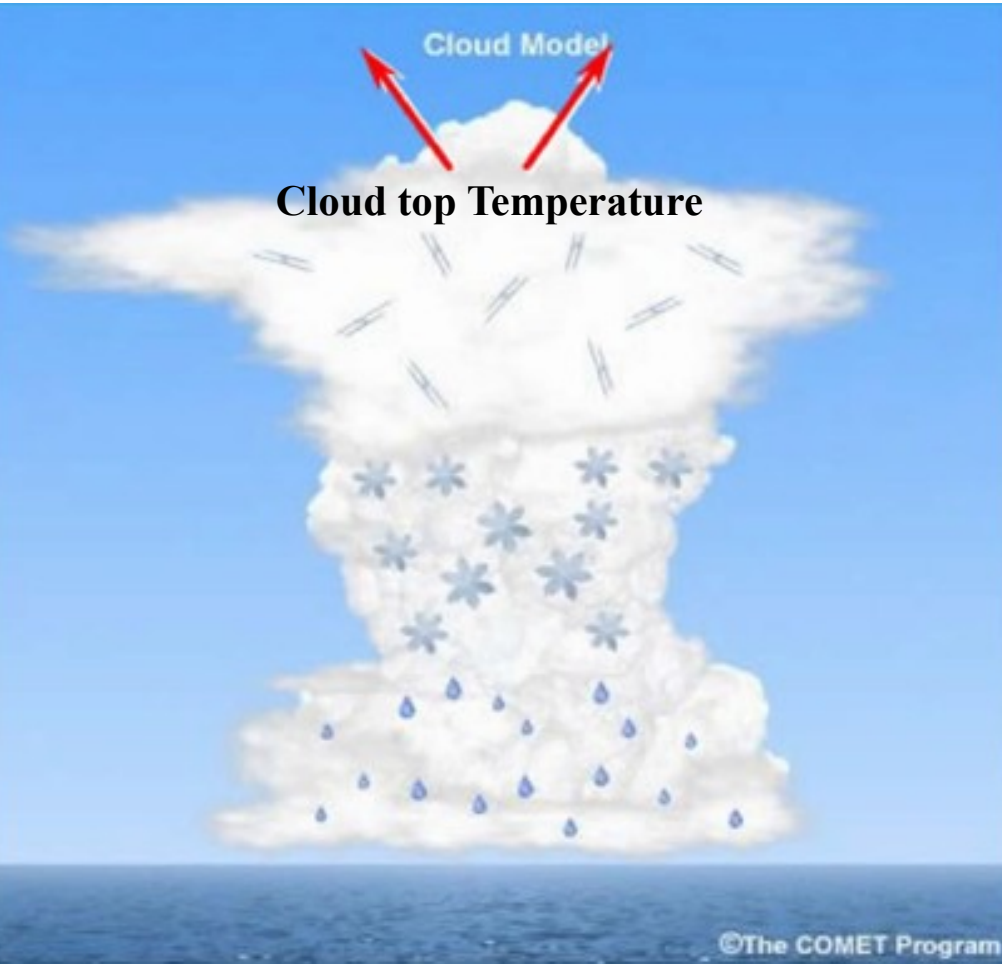
- Detailed Characterization of Precipitation
 - Remote sensing instruments



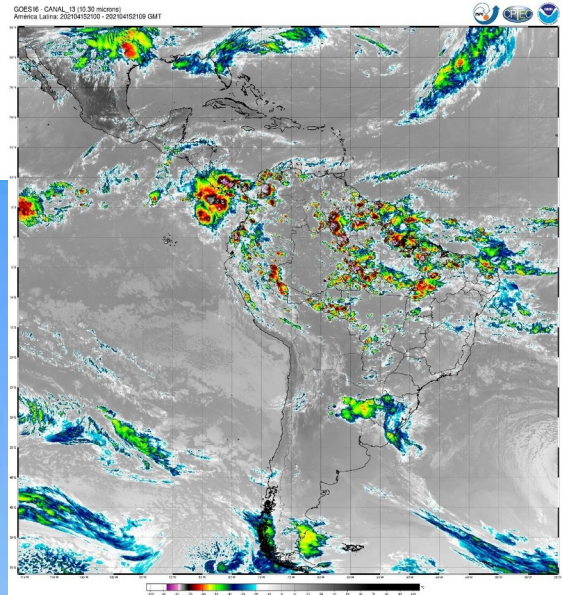
Complex
Multi-scale (time and space) – Intermittent
Difficult to observe and quantify

❖ Rainfall estimation from satellite - The techniques

Infrared (IR)



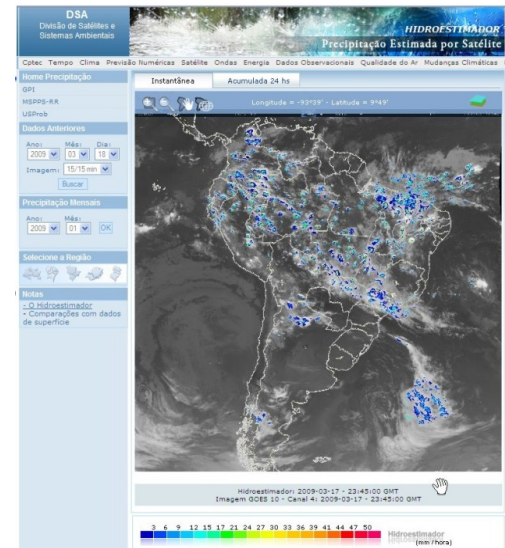
GOES-16 (10.3 μ)
Brightness Temperature (K)



Example:

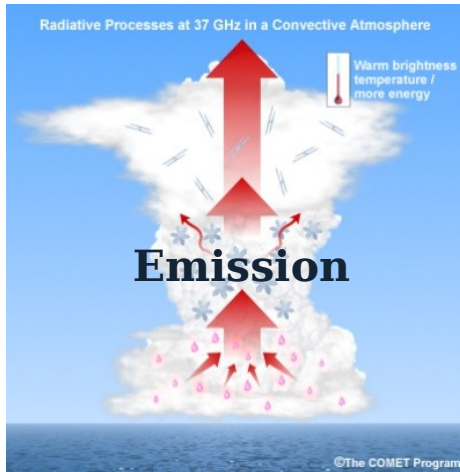
Hidroestimador
(CPTEC/INPE)

Also eumetsat
products



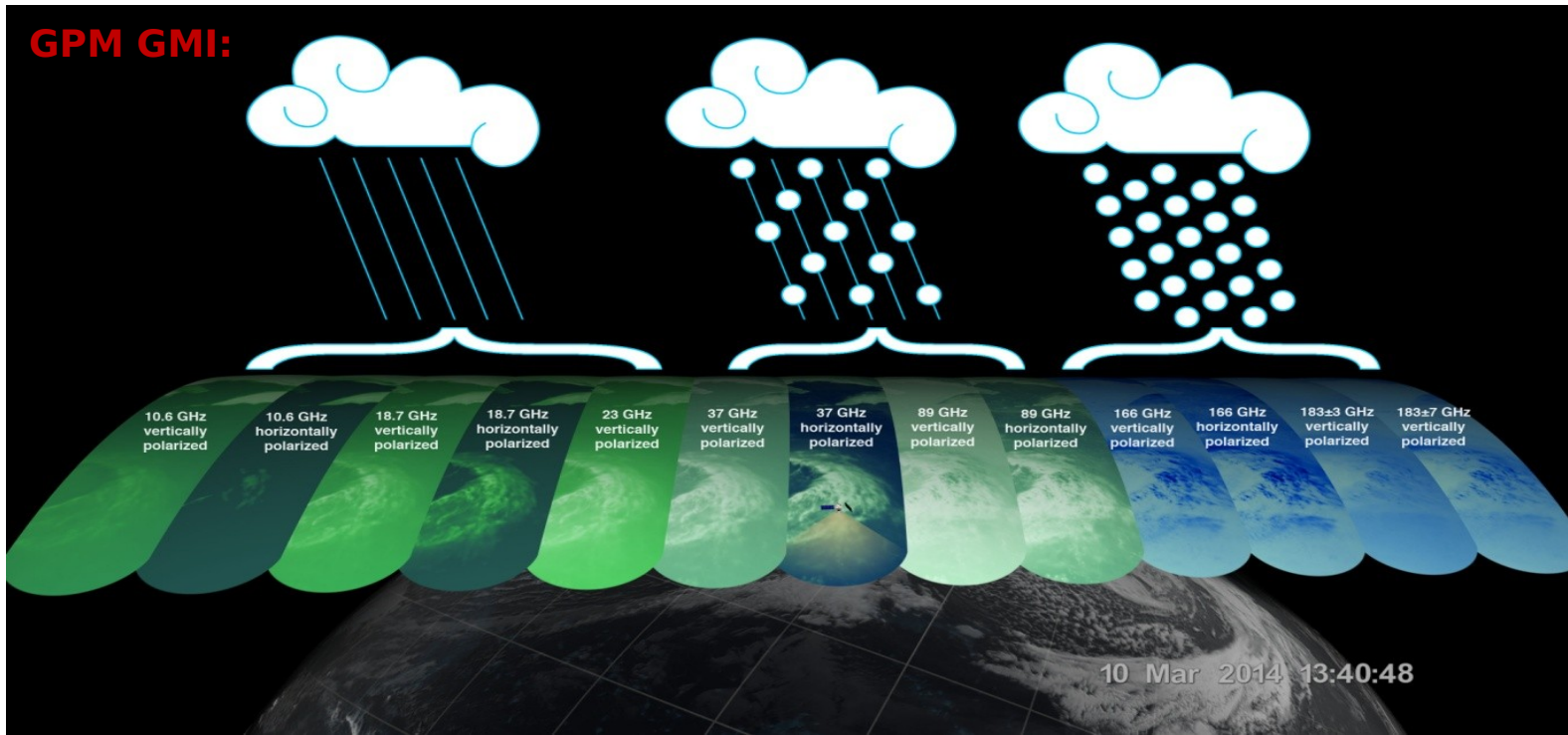
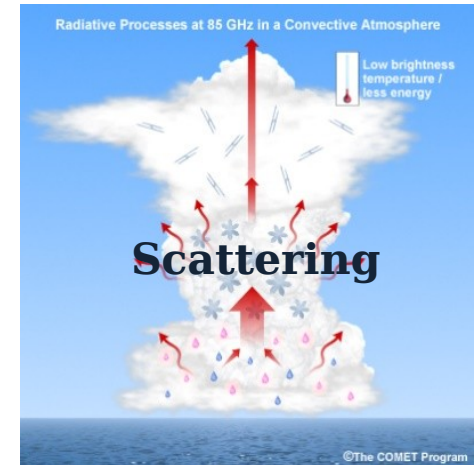
❖ Rainfall estimation from satellite - The techniques

Low Frequencies
< 60 GHz



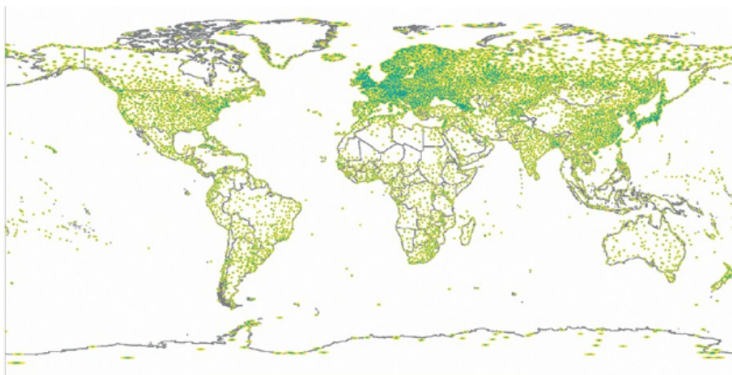
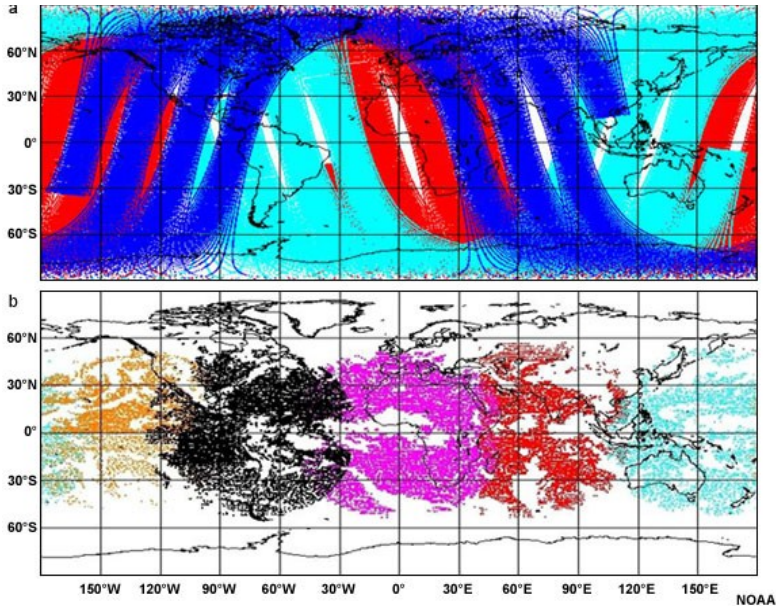
Passive
Microwave
(PMW)

High Frequencies
>60 GHz



❖ Rainfall estimation from satellite - Gridded / Regular time step

Level 3-4 - A variety of products based on satellite available !!



0 10 25 50 100 km
Distance from nearest gauge

MW+IR Combination

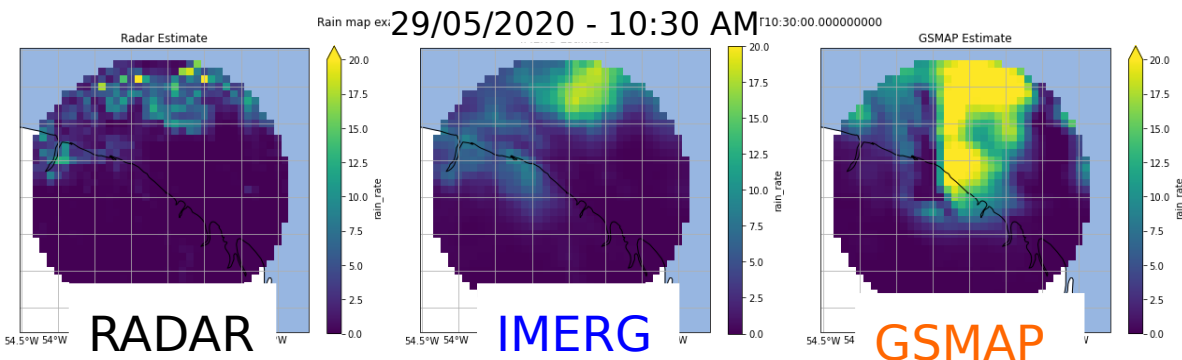
e.g.,:
CMORPH.RAW, IMERG.Early/Late, TAPEER,
TMPA RT, GSMaP, PERSIANN, GIRAFE

Combination MW+IR
+
Rain-gauges

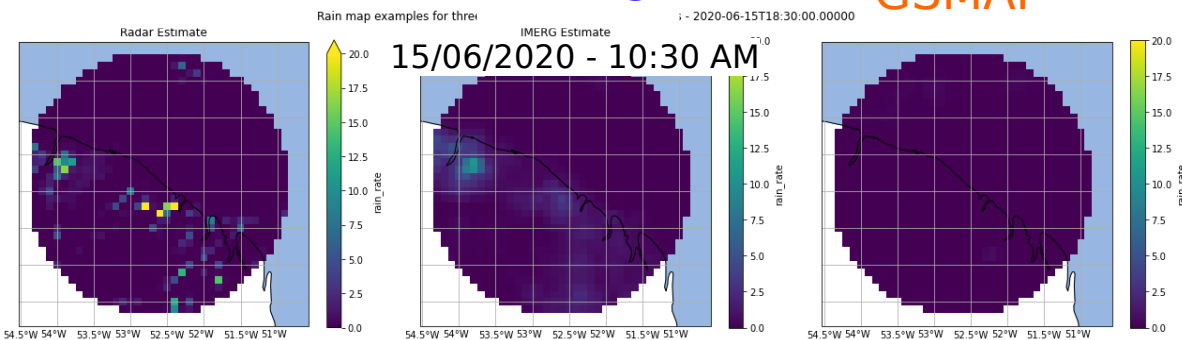
e.g.,:
CMORPH.CRT, IMERG.Final, MSWEP,
TMPA V7, GSMap.Gauge.

❖ Quantitative Assessments / Validation ?

Lack of high resolution (kilometric / sub-hourly) and quality checked rain maps for validation
Especially in the Tropics

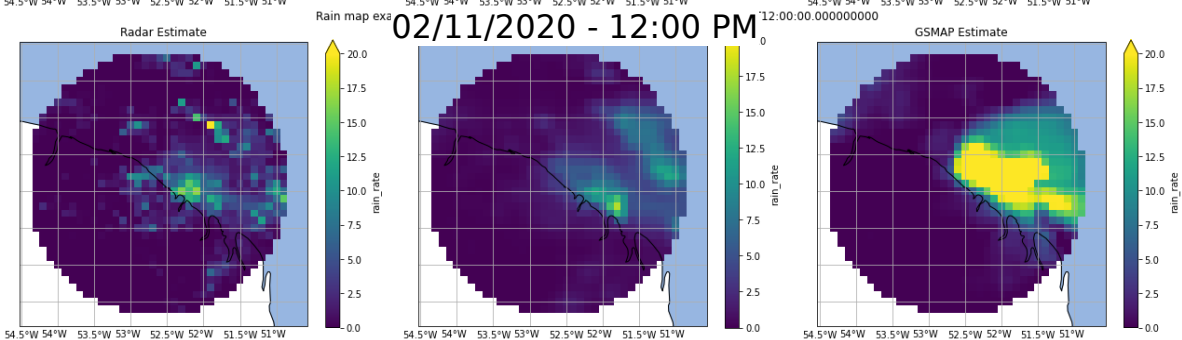


Zambrana, Gosset et al. IPWG 2022
Assessment of high resolution products against weather radar in French Guyana



Analysis:

- Coherent to the naked eye
- Satellite estimates are smoother
- Spotty, high intensity rain very difficult to see with satellite
- Differences among algorithms (GSMAP / IMERG same input data ...)

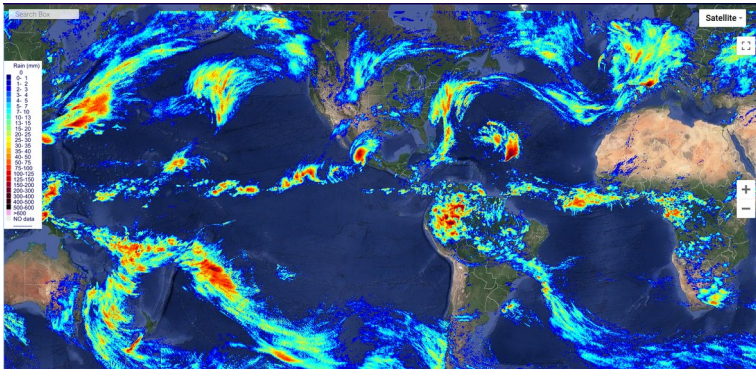


❖ Actual and next

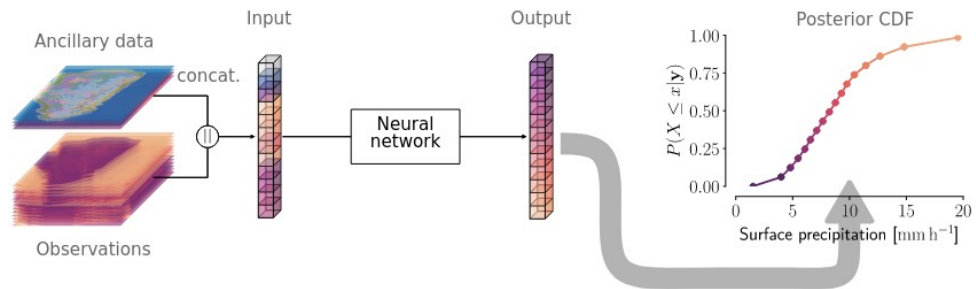
- ❑ **Rainfall Estimation from Satellite – Significant Evolution/improvement since the early days**
 - Multiple satellite-based precipitation products
 - Algorithms greatly improved thanks to better understanding of the microphysics – Combination with models (Bayesian approach ; assimilation etc..)
- ❑ **Current limitations**
 - Products still uncertain at their highest resolution
 - Represent the structure of precipitation (e.g., extremes) - L2 → L3
 - Real time / Mountainous regions / coastal areas (warm rain) still need improvement

New algorithms based on IA

> PERSIANN (Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks)



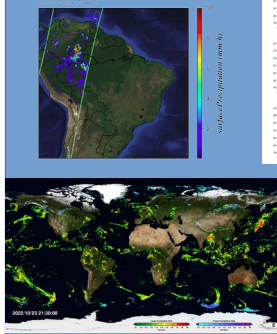
> GPROF-NN (Goddard Profiling Algorithm Neural Networks)



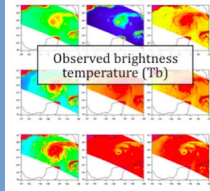
❖ Physical variables/products/instruments

Satellite

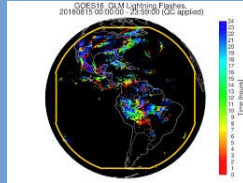
Precipitation estimates (L2-L3)



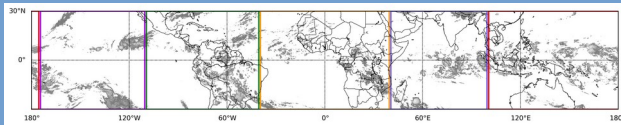
Multi-channel radiances



Lightning (GLM)

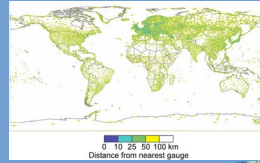


Cloud Top BTs

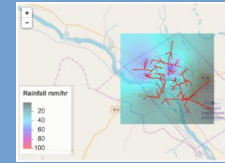


In-situ Observation

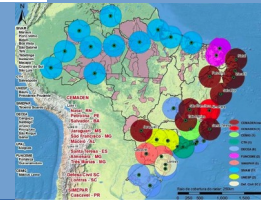
Multi-temporal Rain-gauges records



MW-Link antenna

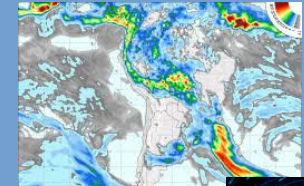


Radar

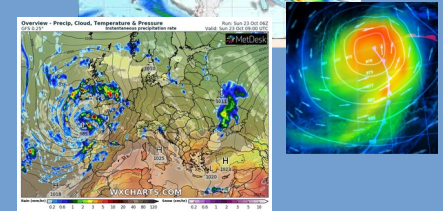


Numerical model

Variables

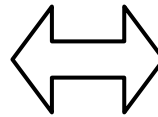
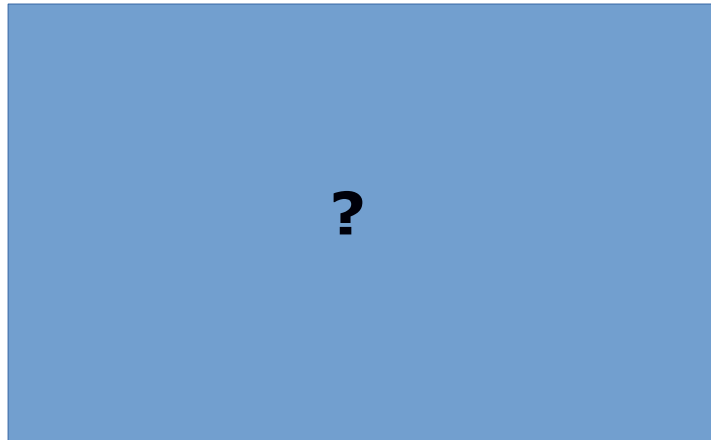


Products

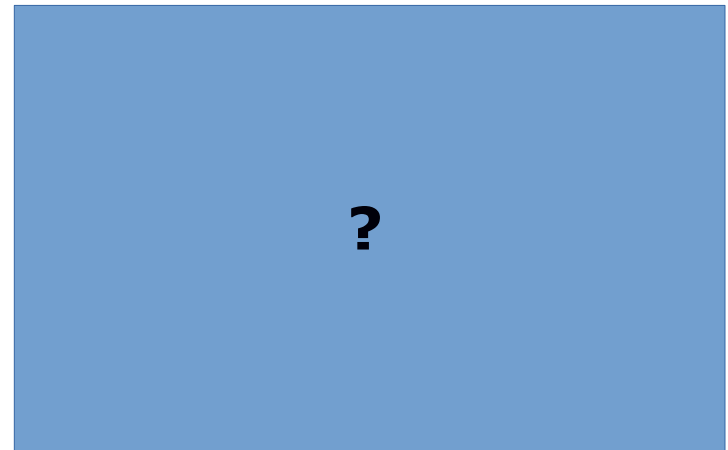


The technique (AI)

Precipitation estimates
Object detection



Precipitation
nowcasting/forecast





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Thank you
Merci - Obrigado

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24/Oct/2022