

*AN EXTREME RAINFALL DETECTION SYSTEM
BASED ON BOTH NEAR REAL-TIME
AND FORECAST RAINFALL MEASUREMENTS*

Paola Mazzoglio *, Francesco Laio, Simone Balbo, Piero Boccardo

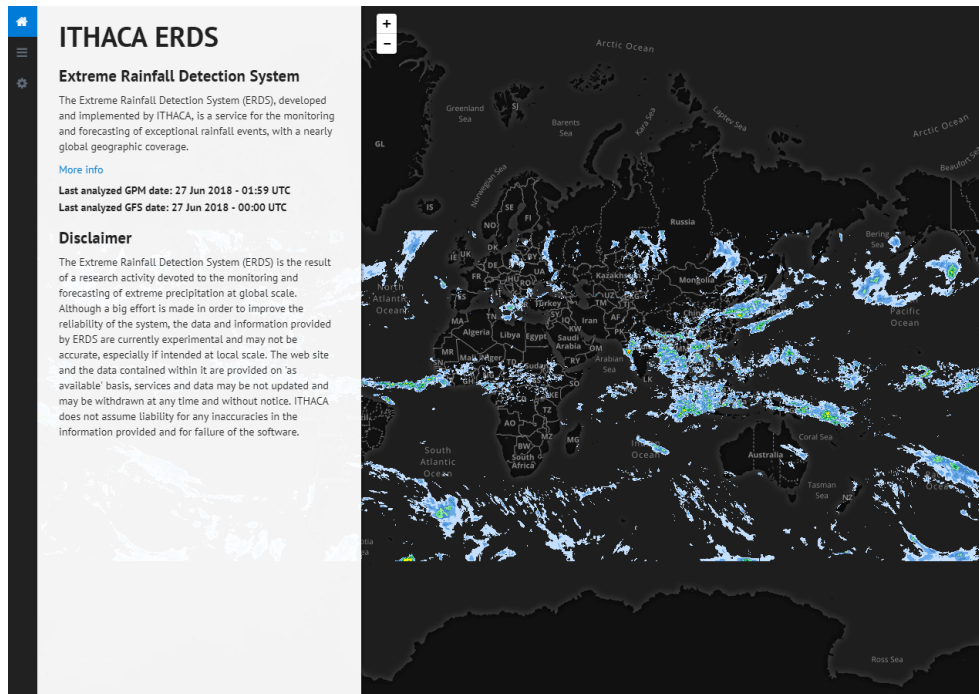
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ERDS – EXTREME RAINFALL DETECTION SYSTEM

erds.ithacaweb.org

MONITORING AND FORECASTING OF EXCEPTIONAL RAINFALL EVENTS



ITHACA ERDS

Extreme Rainfall Detection System

The Extreme Rainfall Detection System (ERDS), developed and implemented by ITHACA, is a service for the monitoring and forecasting of exceptional rainfall events, with a nearly global geographic coverage.

[More info](#)

Last analyzed GPM date: 27 Jun 2018 - 01:59 UTC
Last analyzed GFS date: 27 Jun 2018 - 00:00 UTC

Disclaimer

The Extreme Rainfall Detection System (ERDS) is the result of a research activity devoted to the monitoring and forecasting of extreme precipitation at global scale. Although a big effort is made in order to improve the reliability of the system, the data and information provided by ERDS are currently experimental and may not be accurate, especially if intended at local scale. The web site and the data contained within it are provided on 'as available' basis, services and data may be not updated and may be withdrawn at any time and without notice. ITHACA does not assume liability for any inaccuracies in the information provided and for failure of the software.

EARLY WARNING SYSTEM
DESIGNED TO IDENTIFY
HYDROMETEOROLOGICAL EVENTS

FLOODS - FLASH FLOODS
CONVECTIVE STORMS
TROPICAL STORMS
HURRICANES - CYCLONES

WEB GIS APPLICATION

OPEN SOURCE ENVIRONMENT

30-31 May 2019-Sofia

NEAR REAL-TIME RAINFALL MONITORING

INPUT DATA

NASA GPM (Global Precipitation Measurement)

IMERG (Integrated Multi-satellite Retrievals for GPM) products

TEMPORAL COVERAGE

from 12 March 2014 to nowadays

SPATIAL COVERAGE

60° N – 60° S

TEMPORAL RESOLUTION

30 minutes

SPATIAL RESOLUTION

0,1° x 0,1°

NEAR REAL-TIME RAINFALL MONITORING

INPUT DATA

NASA GPM (Global Precipitation Measurement)

IMERG (Integrated Multi-satellite Retrievals for GPM) products

THREE DIFFERENT VERSIONS OF HALF-HOURLY DATA

early run (4 hours latency)

late run (12 hours latency)

final run (3 months latency)

NEAR REAL-TIME RAINFALL MONITORING

INPUT DATA

NASA GPM (Global Precipitation Measurement)

IMERG (Integrated Multi-satellite Retrievals for GPM) products

THREE DIFFERENT VERSIONS OF HALF-HOURLY DATA

early run (4 hours latency)

~~late run (12 hours latency)~~

~~final run (3 months latency)~~



near real-time flood risk
monitoring applications

NEAR REAL-TIME RAINFALL MONITORING

INPUT DATA

NASA GPM (Global Precipitation Measurement)

IMERG (Integrated Multi-satellite Retrievals for GPM) products



RAINFALL AMOUNT EVALUATION



ALERTS EVALUATION

IDENTIFICATION OF AREAS POTENTIALLY AFFECTED BY HYDROLOGICAL DISASTERS

RAINFALL FORECASTING

INPUT DATA

NOAA - NCEP GFS (Global Forecast System) deterministic weather prediction model

0,25° x 0,25° spatial resolution

90° N – 90° S spatial coverage



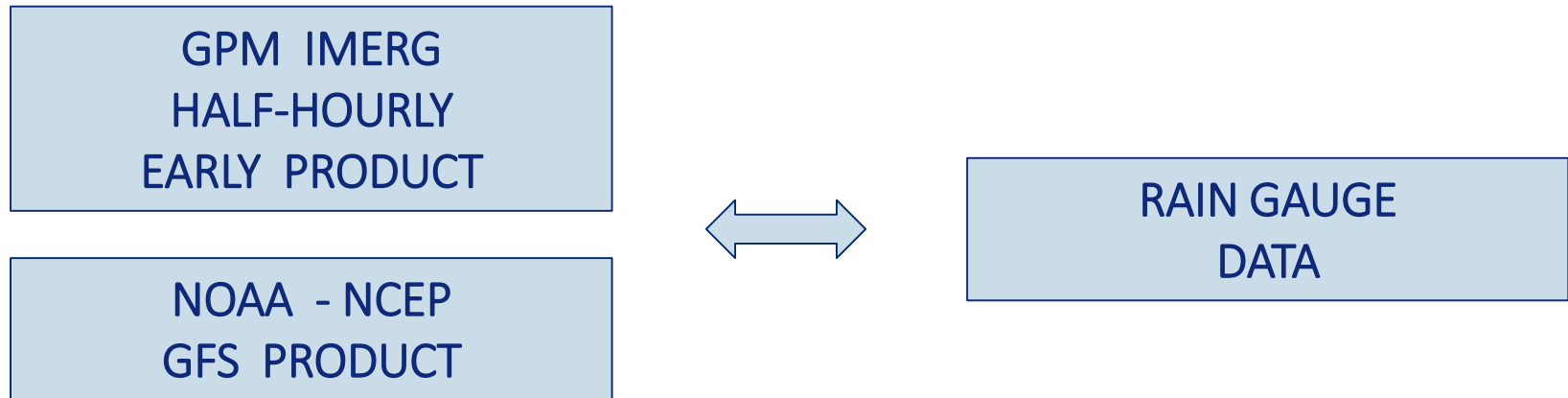
RAINFALL AMOUNT EVALUATION



ALERTS EVALUATION

IDENTIFICATION OF AREAS THAT WILL POTENTIALLY BE AFFECTED
BY HYDROLOGICAL DISASTERS

INPUT DATA ACCURACY EVALUATION

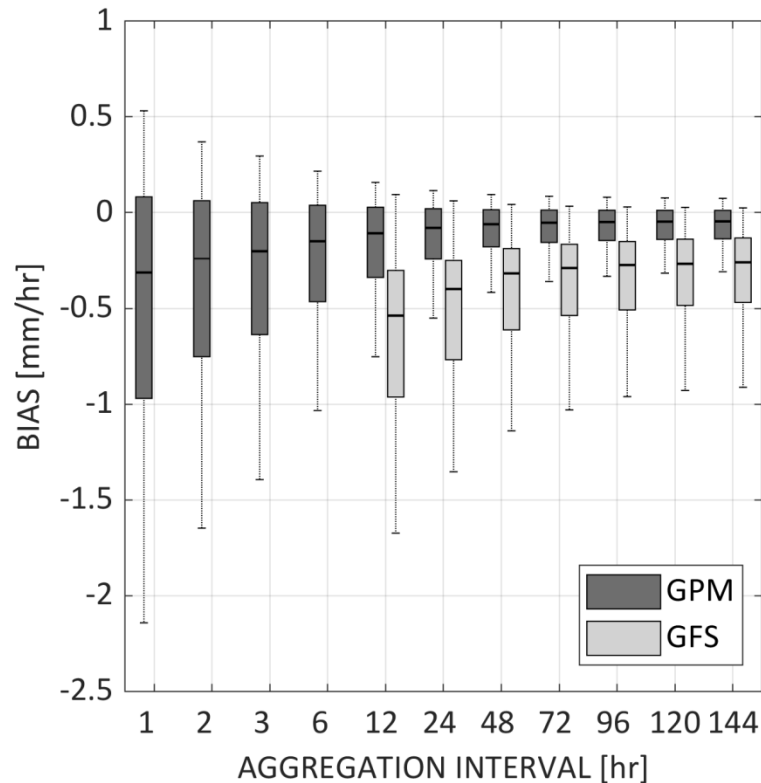


DIFFERENT CLIMATIC ZONES
(50 LOCATIONS)

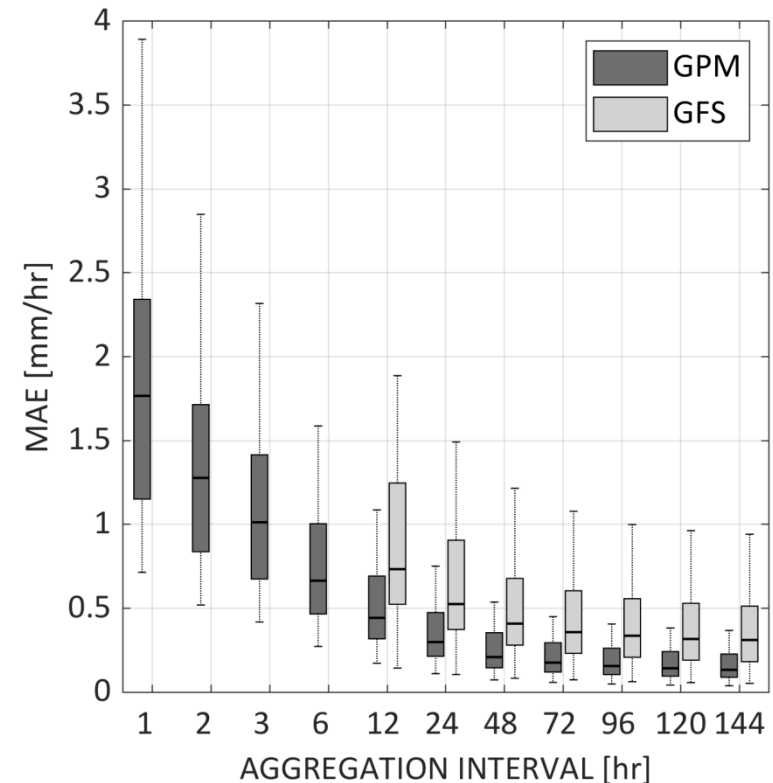
15 January 2015 – 30 April 2017

INPUT DATA ACCURACY EVALUATION

STANDARD CONDITIONS



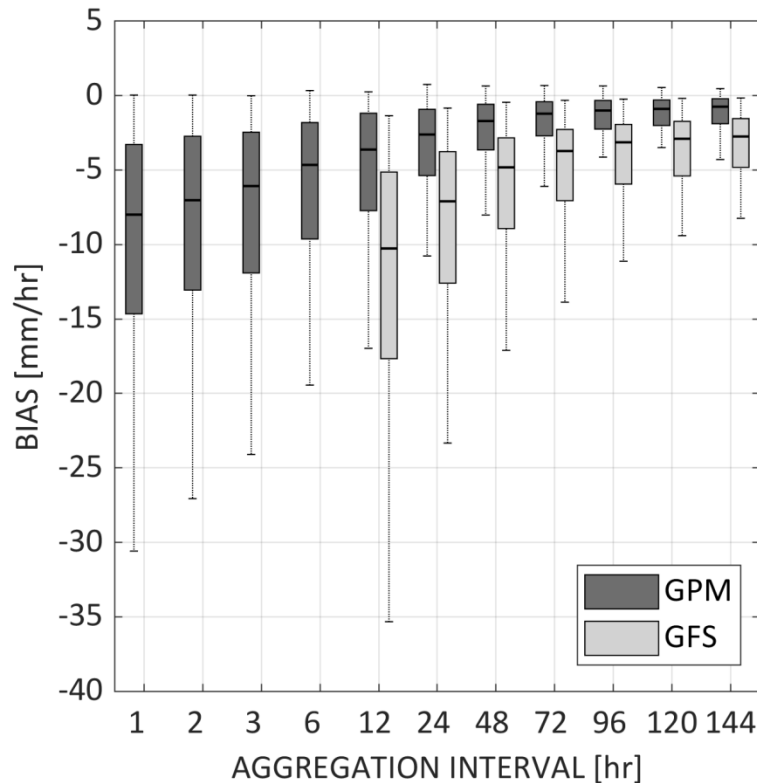
$$\text{BIAS} = \frac{1}{n} \sum_{t=1}^n [R_{\text{ESTIMATOR}}(t) - R_{\text{GAUGE}}(t)]$$



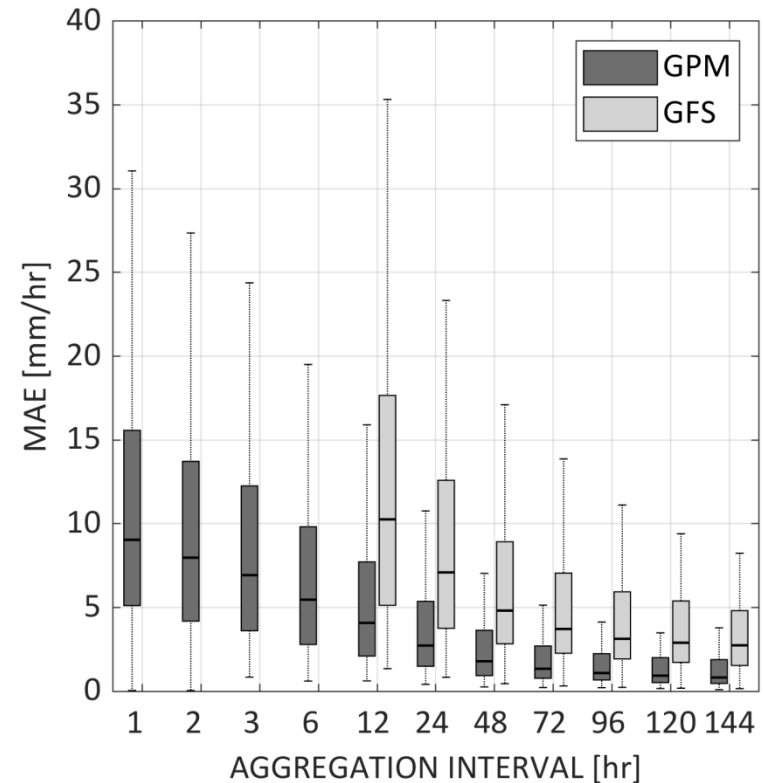
$$\text{MAE} = \frac{1}{n} \sum_{t=1}^n [|R_{\text{ESTIMATOR}}(t) - R_{\text{GAUGE}}(t)|]$$

INPUT DATA ACCURACY EVALUATION

HEAVY RAINFALL CONDITIONS (99th percentile)



$$\text{BIAS} = \frac{1}{n} \sum_{t=1}^n [R_{\text{ESTIMATOR}}(t) - R_{\text{GAUGE}}(t)]$$



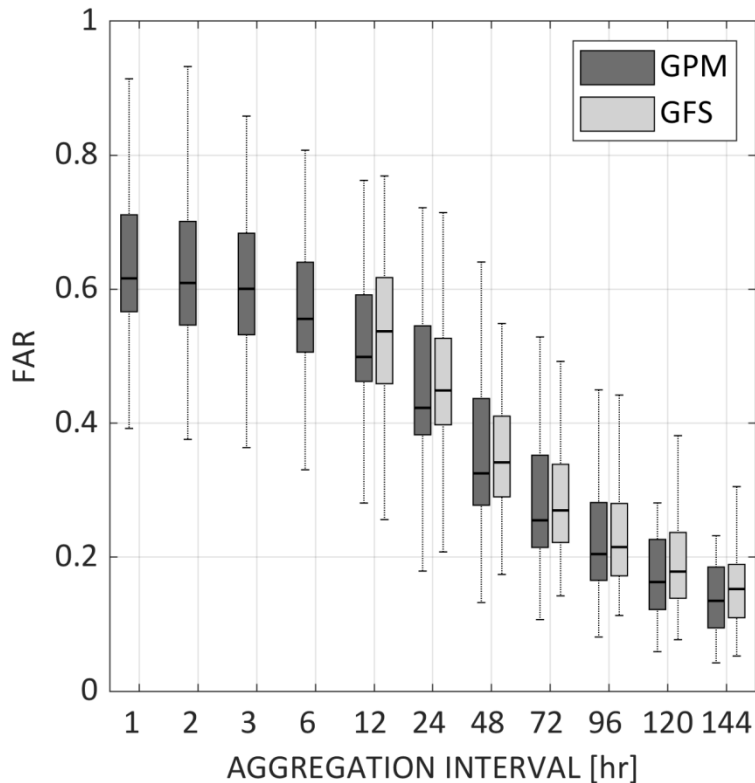
$$\text{MAE} = \frac{1}{n} \sum_{t=1}^n [|R_{\text{ESTIMATOR}}(t) - R_{\text{GAUGE}}(t)|]$$

INPUT DATA ACCURACY EVALUATION

		RAIN GAUGE		
		= 0 mm/hr	> 0 mm/hr	
ESTIMATOR (GPM or GFS)	= 0 mm/hr	CORRECT NEGATIVES (A)	MISSES (B)	ESTIMATED NON EVENTS
	> 0 mm/hr	FALSE ALARMS (C)	HITS (D)	ESTIMATED EVENTS
		OBSERVED NON EVENTS	OBSERVED EVENTS	

INPUT DATA ACCURACY EVALUATION

STANDARD CONDITIONS

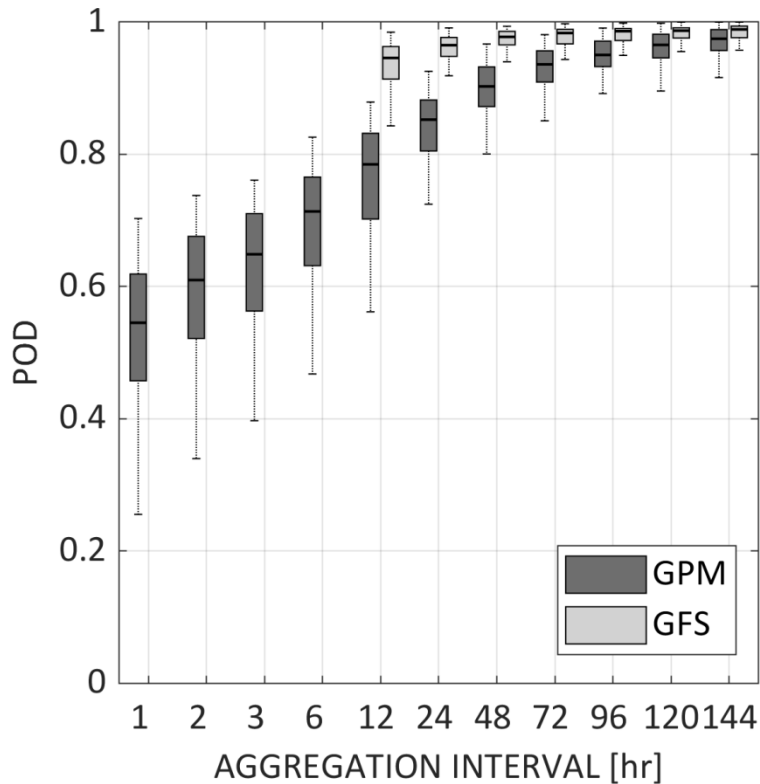


$$FAR = \frac{\text{FALSE ALARMS}}{\text{HITS} + \text{FALSE ALARMS}}$$

		RAIN GAUGE		
		= 0 mm/hr	> 0 mm/hr	
ESTIMATOR	= 0 mm/hr	CORRECT NEGATIVES (A)	MISSES (B)	ESTIMATED NON EVENTS
	> 0 mm/hr	FALSE ALARMS (C)	HITS (D)	ESTIMATED EVENTS
		OBSERVED NON EVENTS	OBSERVED EVENTS	

INPUT DATA ACCURACY EVALUATION

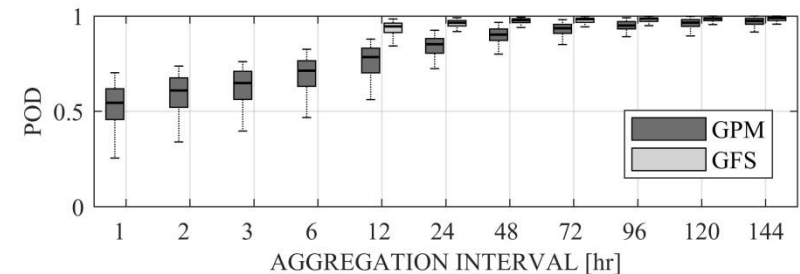
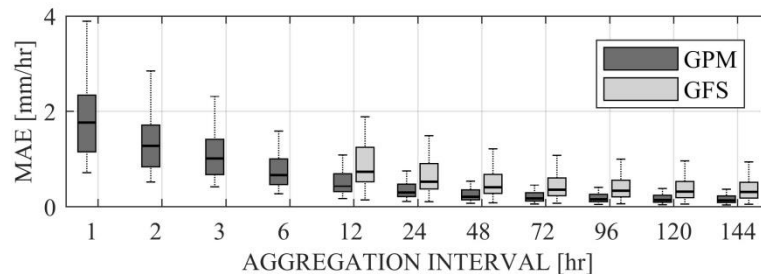
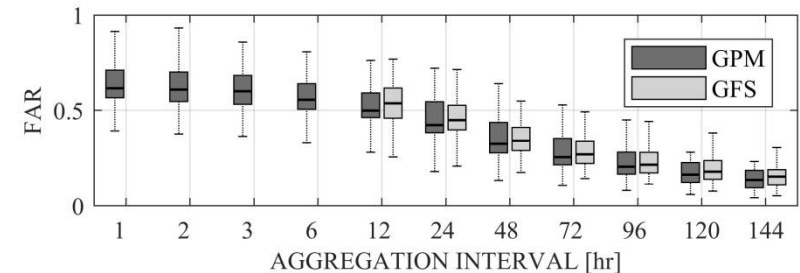
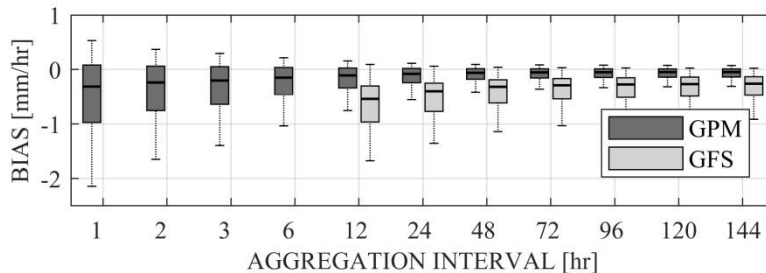
STANDARD CONDITIONS



$$POD = \frac{HITS}{HITS + MISSES}$$

		RAIN GAUGE		
		= 0 mm/hr	> 0 mm/hr	
ESTIMATOR	= 0 mm/hr	CORRECT NEGATIVES (A)	MISSES (B)	ESTIMATED NON EVENTS
	> 0 mm/hr	FALSE ALARMS (C)	HITS (D)	ESTIMATED EVENTS
		OBSERVED NON EVENTS	OBSERVED EVENTS	

INPUT DATA ACCURACY EVALUATION STANDARD CONDITIONS

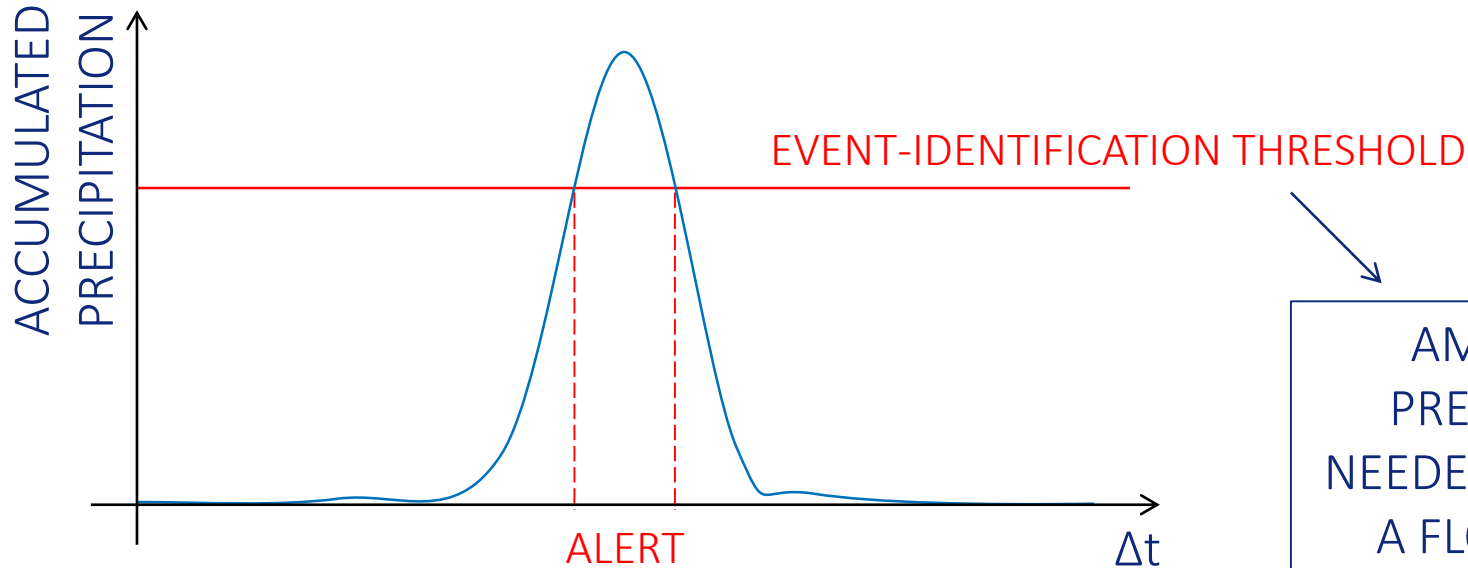


< 12 HOURS

HIGH VALUE OF BIAS, MAE, FAR

POD NOT ACCEPTABLE

EXTREME RAINFALL DETECTION METHODOLOGY



AMOUNT OF
PRECIPITATION
NEEDED TO TRIGGER
A FLOOD EVENT
INDUCED BY
EXTREME RAINFALL

EXTREME RAINFALL DETECTION METHODOLOGY

APPLICABLE AT GLOBAL SCALE

DEVELOPED CONSIDERING COUNTRIES AFFECTED BY AT LEAST

1 **HYDROMETEOROLOGICAL DISASTER**



EMDAT
RELIEFWEB
FLOODLIST

AGGREGATION INTERVALS

12h – 24h – 48h – 72h – 96 h

EXTREME RAINFALL DETECTION METHODOLOGY

24 HOURS AGGREGATION INTERVAL			
% OF MEAN ANNUAL PRECIPITATION	LOWER AND UPPER BOUND [mm]	ID EVENTS	$\frac{\text{FALSE ALARMS}}{\text{ID EVENTS}}$
...	...		
8%	120 - 210		
9%	100 - 190		
9%	100 - 210		
9%	100 - 230		
9%	100 - 250		
9%	100 - 300		
9%	100 - 350		
9%	100 - 400		
...	...		
...	...		

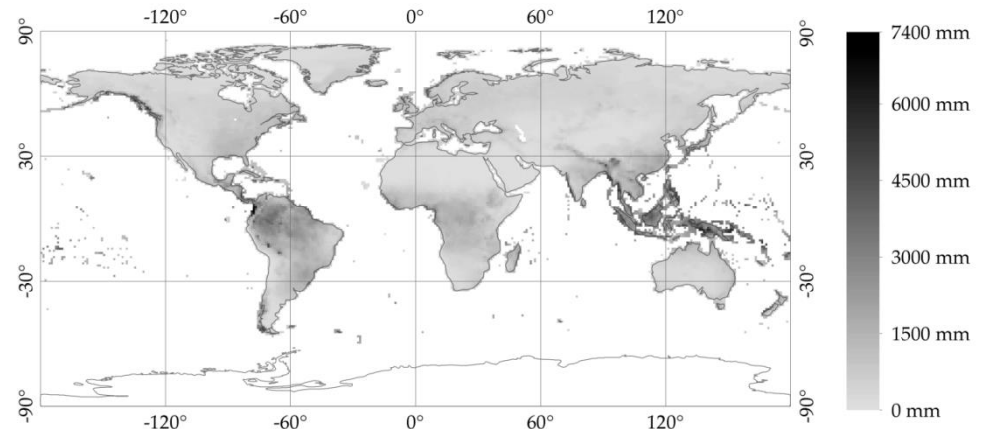
EXTREME RAINFALL DETECTION METHODOLOGY

$$T = T.R. \cdot p_{T.R.}$$

where:

- T represents the threshold;
- $T.R.$ represents the total rainfall (i.e., the mean annual rainfall calculated using 10 years of GPCC data);
- $p_{T.R.}$ is a parameter representing the fraction of the total rainfall leading to the extreme event identification.

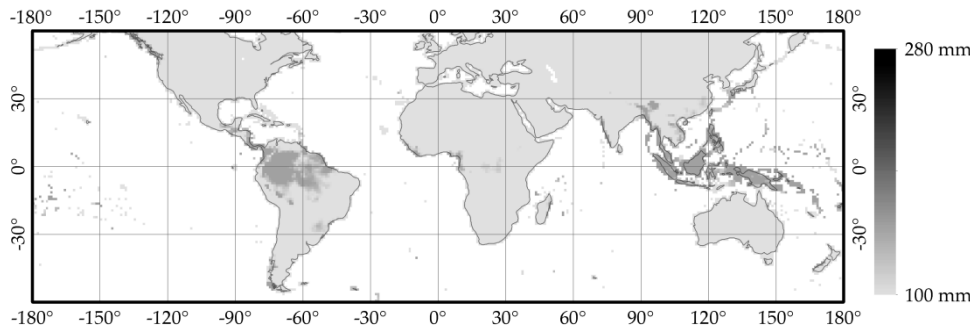
MEAN ANNUAL PRECIPITATION
CALCULATED USING
10 YEARS OF GPCC
MONTHLY MONITORING PRODUCTS



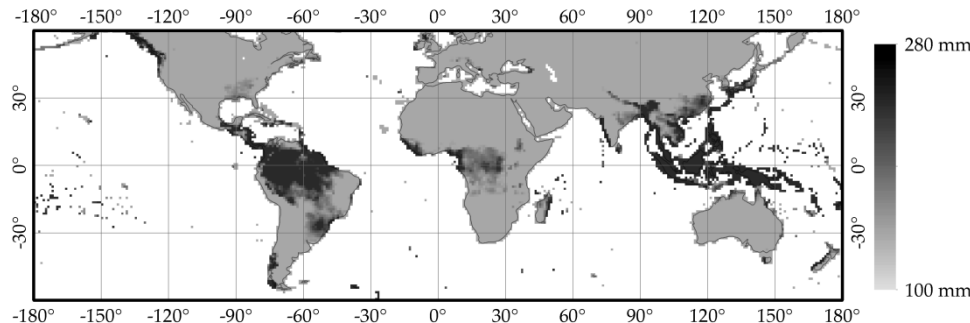
EXTREME RAINFALL DETECTION METHODOLOGY

24 HOURS AGGREGATION INTERVAL			
% OF MEAN ANNUAL PRECIPITATION	LOWER AND UPPER BOUND [mm]	ID EVENTS	$\frac{\text{FALSE ALARMS}}{\text{ID EVENTS}}$
...	...	...	...
8%	120 - 210	137	22,96
9%	100 - 190	140	26,28
9%	100 - 210	140	25,21
9%	100 - 230	137	25,53
9%	100 - 250	137	25,31
9%	100 - 300	136	25,36
9%	100 - 350	136	25,35
9%	100 - 400	136	25,35
...	...	...	...
...	...	...	...

EXTREME RAINFALL DETECTION METHODOLOGY



THRESHOLD VALUES CALIBRATED ON GPM DATA
ADOPTED FOR THE 12-HOURS AGGREGATION INTERVAL



THRESHOLD VALUES CALIBRATED ON GPM DATA
ADOPTED FOR THE 48-HOURS AGGREGATION INTERVAL

THE WHOLE STUDY IS DESCRIBED
IN DETAIL IN:

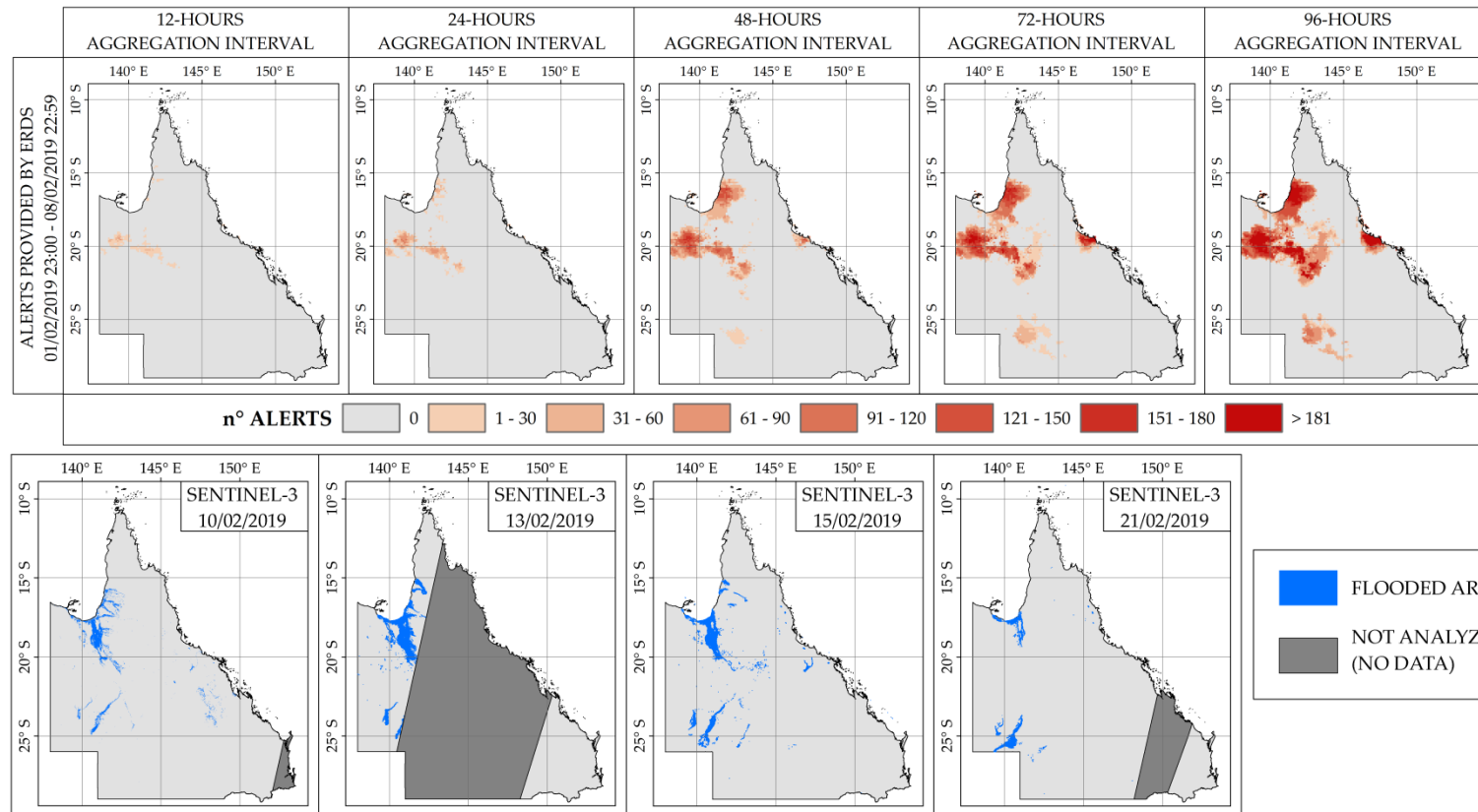
**Improving an Extreme Rainfall
Detection System with GPM
IMERG data.**

Paola Mazzoglio, Francesco Laio,
Simone Balbo, Piero Boccoardo,
Franca Disabato.

Remote Sensing, 2019, 11, 677

doi.org/10.3390/rs11060677

8th Bulgarian-Austrian Seminar



Assessment of an Extreme Rainfall Detection System for flood prediction over Queensland (Australia).

Paola Mazzoglio, Francesco Laio, Constantin Sandu, Piero Boccardo

3rd International Electronic Conference on Remote Sensing (ECRS-3). 22 May 2019 – 06 June 2019.

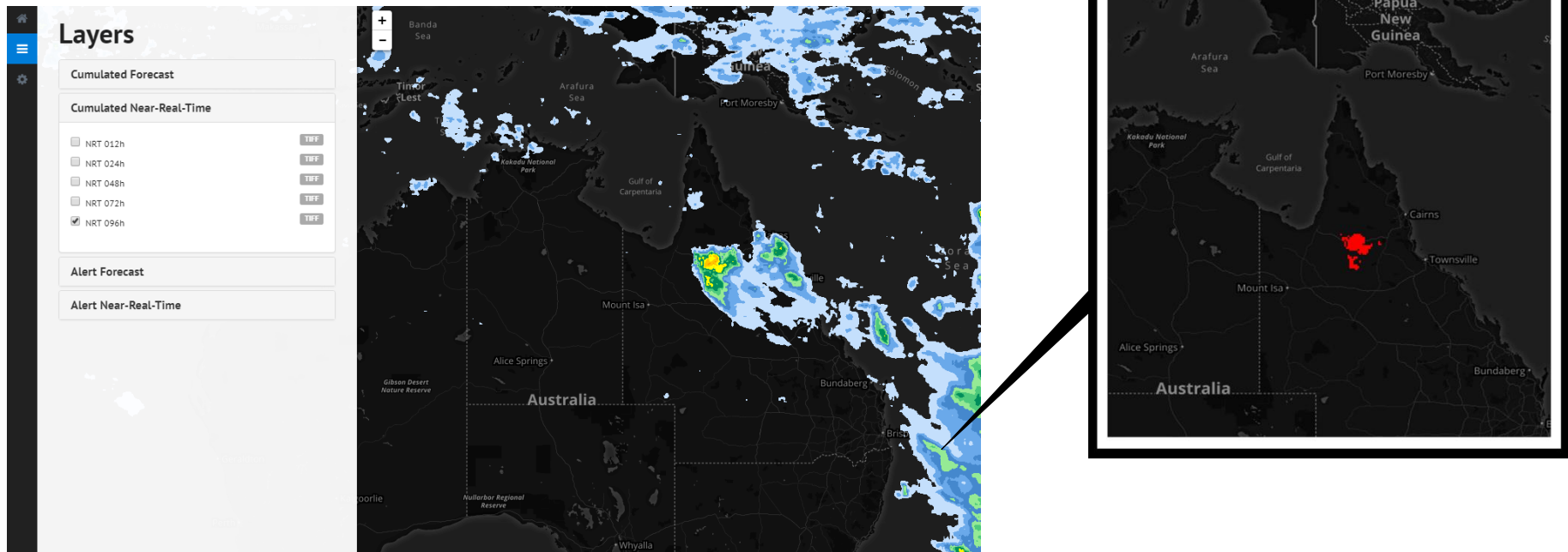
10.3390/ECRS-3-06187

ecrs-3.sciforum.net

30-31 May 2019-Sofia

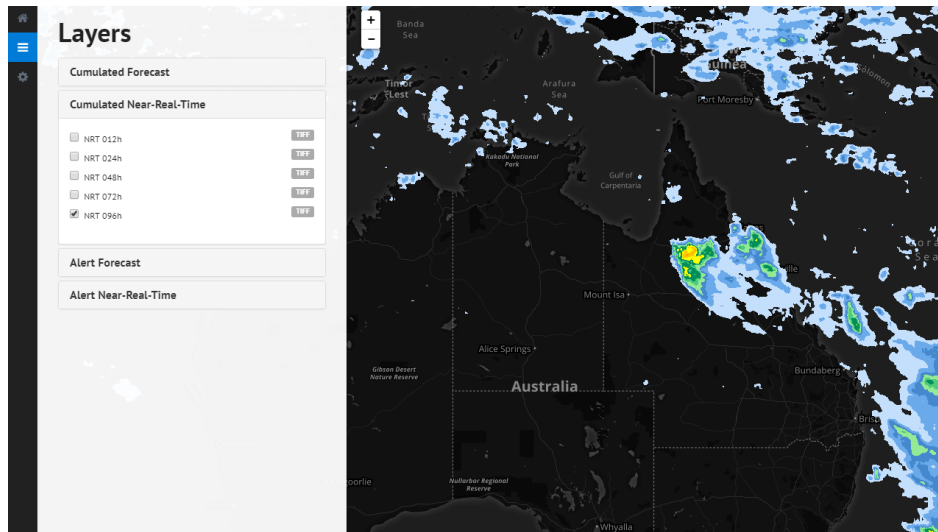
ERDS - CURRENT VERSION

The outcomes of this work is supporting the development of the updated version of ITHACA Extreme Rainfall Detection System (ERDS).



ERDS - CURRENT VERSION

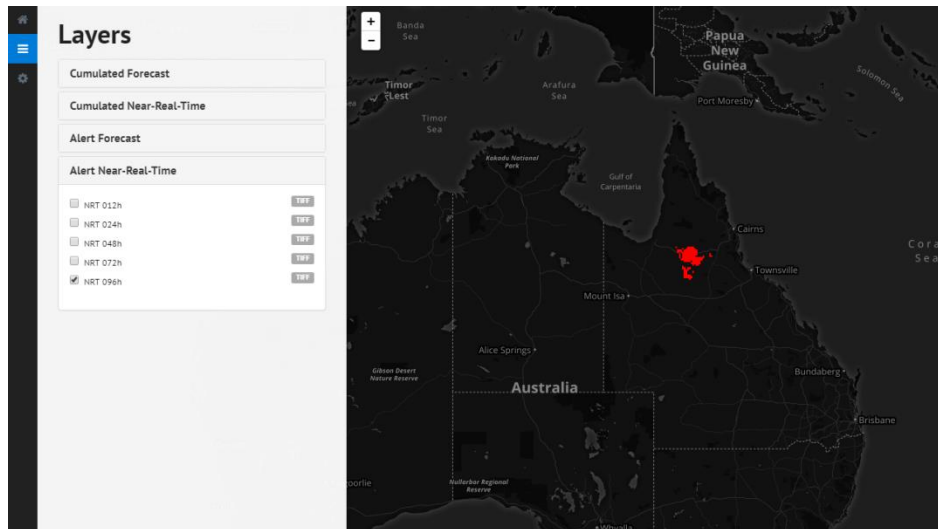
GPM IMERG EARLY RUN DATA



NEAR REAL-TIME CUMULATED RAINFALL
12 hr – 24 hr – 48 hr – 72 hr – 96 hr

ERDS - CURRENT VERSION

GPM IMERG EARLY RUN DATA



NEAR REAL-TIME CUMULATED RAINFALL
12 hr – 24 hr – 48 hr – 72 hr – 96 hr



NEAR REAL-TIME ALERTS OVER LAND
12 hr – 24 hr – 48 hr – 72 hr – 96 hr

60°N – 60°S

0,1° x 0,1° SPATIAL RESOLUTION

HOURLY UPDATE

30-31 May 2019-Sofia

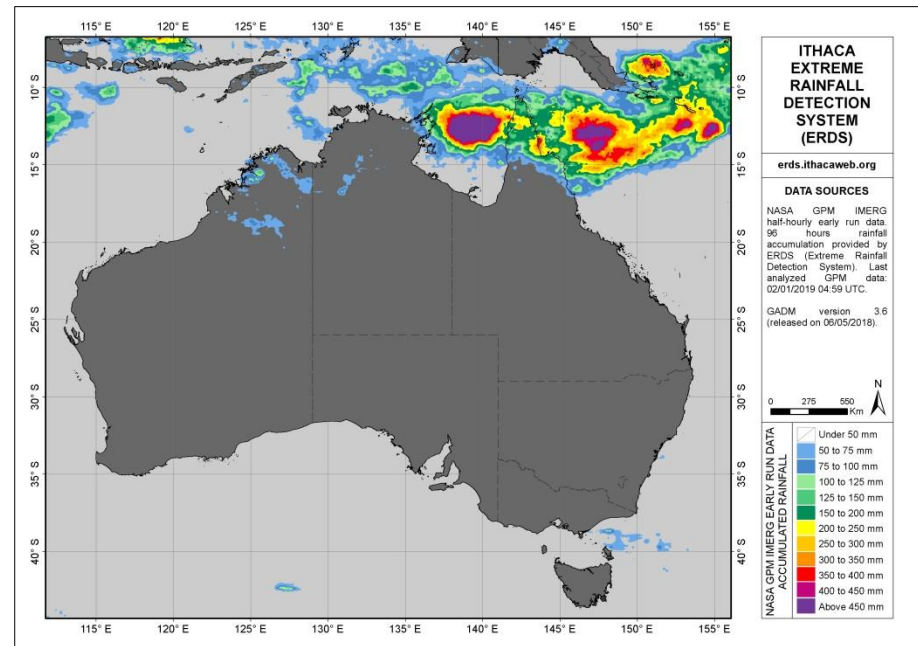
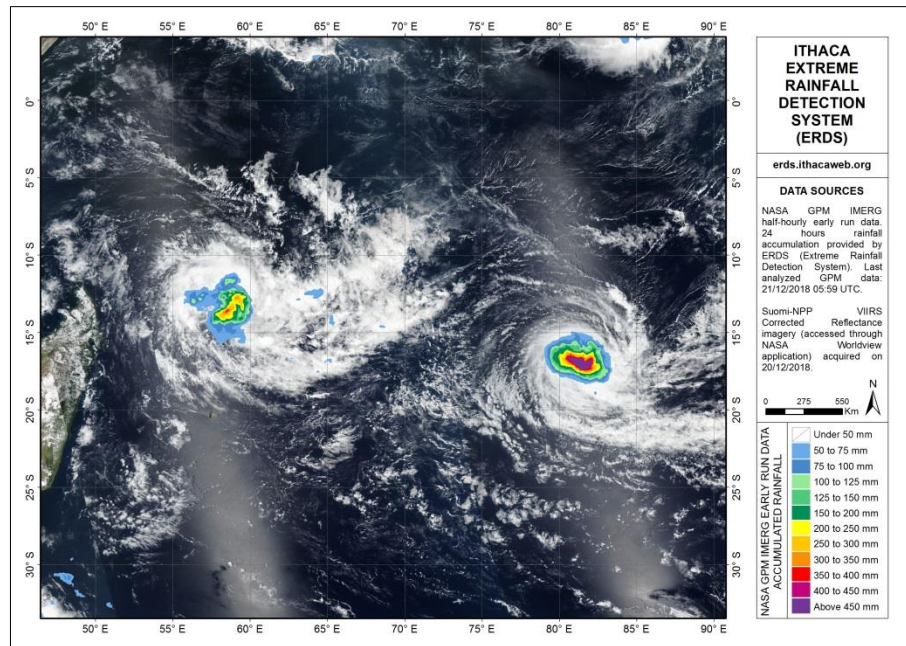
ERDS - CURRENT VERSION

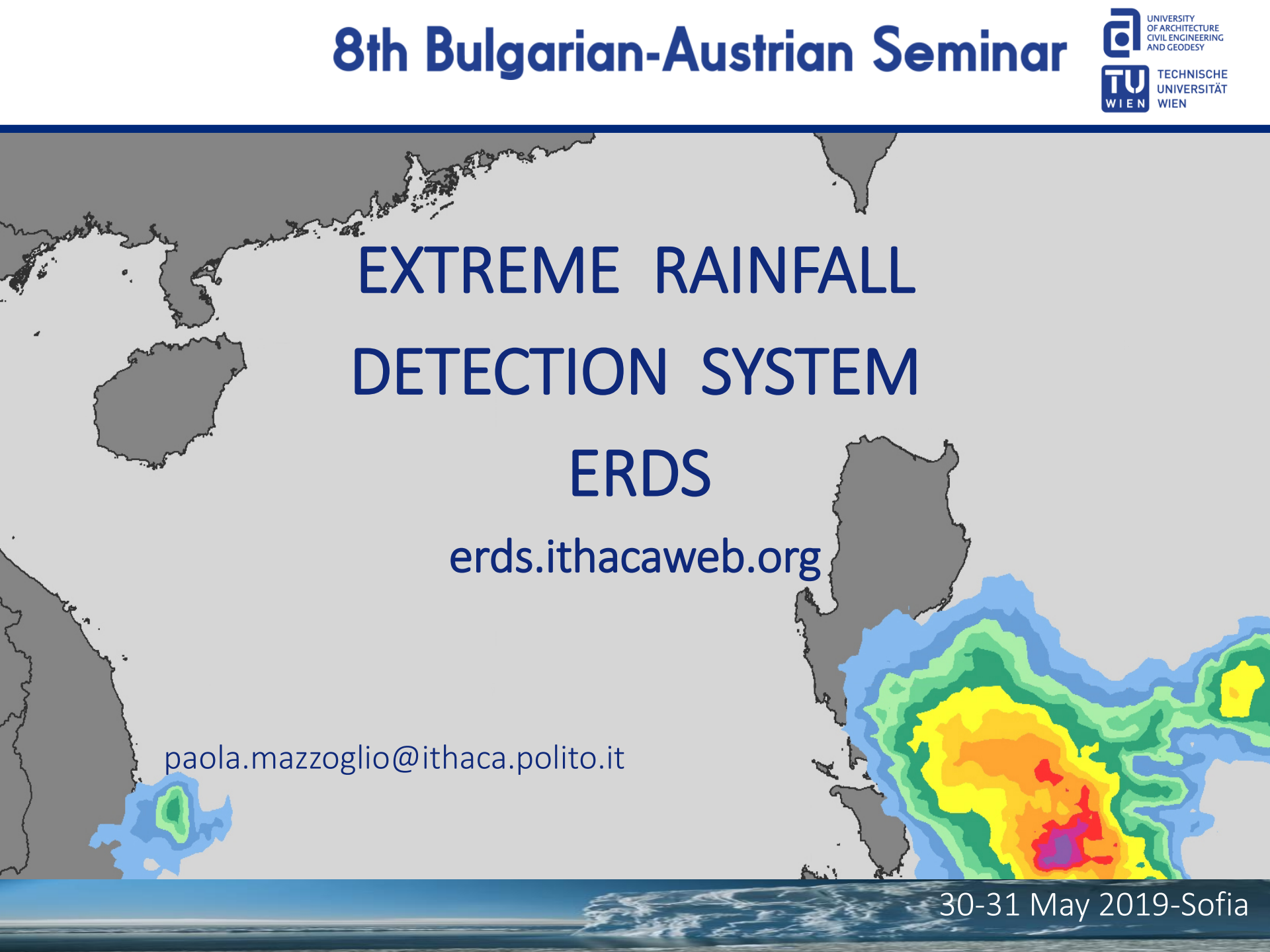
- ☒ RAINFALL FORECASTING BASED ON NOAA GFS DATA
- ☐ HEAVY RAINFALL ALERTS BASED ON NOAA GFS DATA
UNDER DEVELOPMENT (feature available in the next months)
- ☐ EVALUATION OF AFFECTED POPULATION
UNDER DEVELOPMENT (feature available in the next months)
- ☐ RESEARCH OF OTHER RAINFALL DATASETS
- ☐ MAPPING ACTIVE CYCLONES TRACKS
- ☐ FLOODED AREAS EVALUATION

ADDITIONAL INFO



@ithaca_erds





EXTREME RAINFALL DETECTION SYSTEM ERDS

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30-31 May 2019-Sofia