

# Riassunto Performance Nowcasting della precipitazione

4 / 11/ 2021



SCIENCE • AWARENESS • BEHAVIOURS

METTA, S., VON HARDENBERG, J., FERRARIS, L., REBORA, N., AND PROVENZALE, A.: PRECIPITATION NOWCASTING BY A SPECTRAL-BASED NONLINEAR STOCHASTIC MODEL. JOURNAL OF HYDROMETEOROLOGY, 10(5), 1285-1297, [HTTPS://DOI.ORG/10.1175/2009JHM1120.1](https://doi.org/10.1175/2009JHM1120.1), 2009

SILVESTRO, F. AND REBORA, N.: OPERATIONAL VERIFICATION OF A FRAMEWORK FOR THE PROBABILISTIC NOWCASTING OF RIVER DISCHARGE IN SMALL AND MEDIUM SIZE BASINS, NAT. HAZARDS EARTH SYST. SCI., 12, 763-776, [HTTPS://DOI.ORG/10.5194/NHESS-12-763-2012](https://doi.org/10.5194/nhess-12-763-2012) , 2012B.

SILVESTRO, F., REBORA, N., CUMMINGS, G., AND FERRARIS, L.: EXPERIENCES OF DEALING WITH FLASH FLOODS USING AN ENSEMBLE HYDROLOGICAL NOWCASTING CHAIN: IMPLICATIONS OF COMMUNICATION, ACCESSIBILITY AND DISTRIBUTION OF THE RESULTS. J. FLOOD RISK MANAGE., [HTTPS://DOI.ORG/10.1111/JFR3.12161](https://doi.org/10.1111/jfr3.12161) , 2015A

GARVIN R. CUMMINGS, DOCTORAL DEGREE IN ENGINEERING IN SYSTEMS MONITORING AND MANAGEMENT OF ENVIRONMENTAL RISKS  
– CYCLE XXVI FLOOD SCENARIOS AND RAINFALL NOWCASTING: TOWARDS BUILDING A RELIABLE FLOOD NOWCASTING PROCEDURE FOR SMALL AND VERY SMALL BASINS (2015)

POLETTI, M. L., SILVESTRO, F., DAVOLIO, S., PIGNONE, F. & REBORA, N. 2019 USING NOWCASTING TECHNIQUE AND DATA ASSIMILATION IN A METEOROLOGICAL MODEL TO IMPROVE VERY SHORT RANGE HYDROLOGICAL FORECASTS. HYDROLOGICAL EARTH SYSTEM SCIENCES, 23, 3823–3841. [HTTPS://DOI.ORG/10.5194/HESS-23-3823-2019](https://doi.org/10.5194/hess-23-3823-2019)

RAPPORTI SEMESTRALI CONVENZIONE DPC-CIMA WP5.1, IN PARTICOLARE ANNI 2020-2021

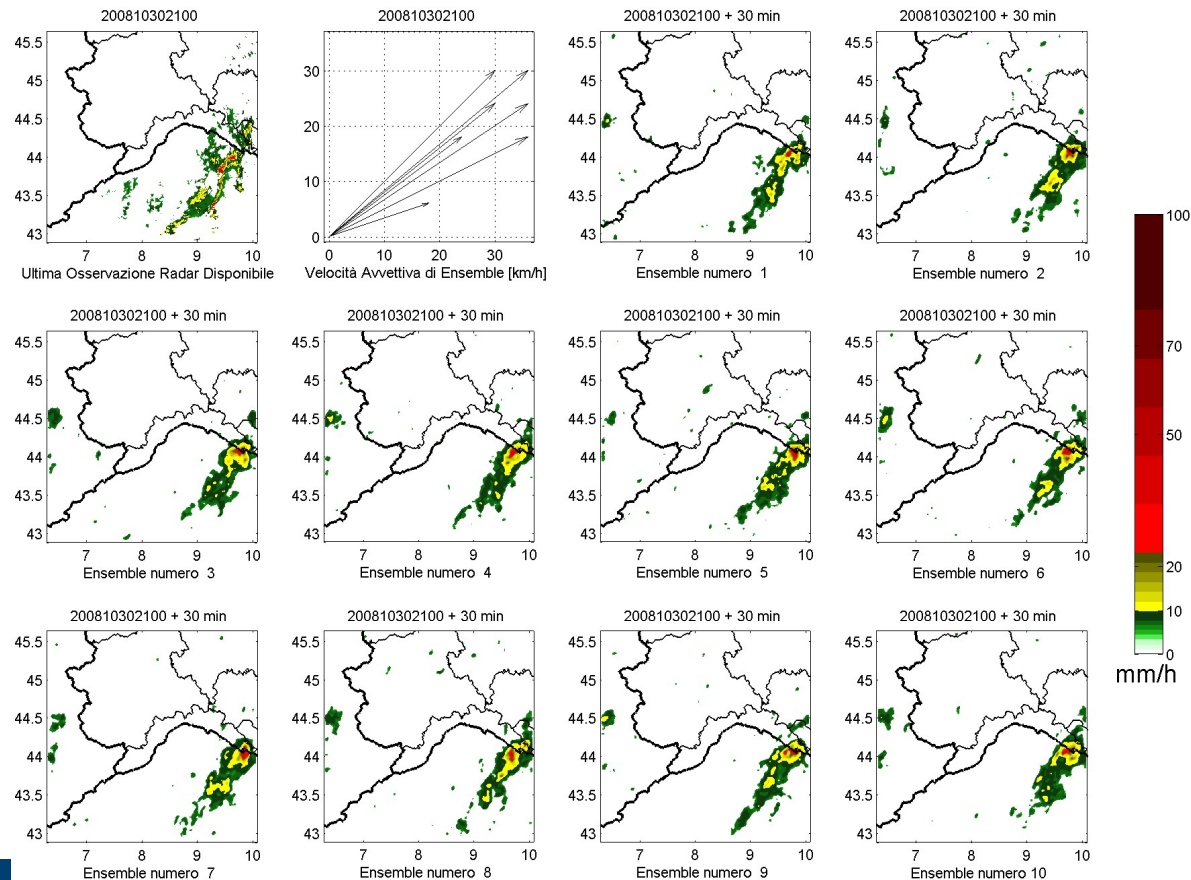
## A COSA SERVE?

Previsione meteorologica (pioggia) a  
**brevissimo termine**



Fino a **1 - 2 ore a seconda del tipo**  
**di evento**

- E' utile in caso di eventi di  
**precipitazione intensa**  
**caratterizzati da strutture anche**  
**persistenti, nonché per eventi**  
**maggiormente stratiformi**





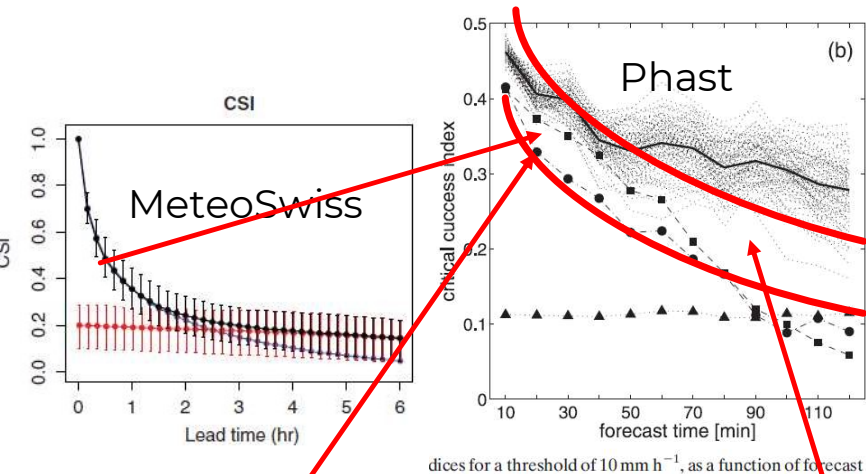
Gestione dell'incertezza previsionale

## Ensemble nowcasting

## NOWCASTING – PHAST

Si basa su un modello stocastico (**PhaSt**) in grado di generare, a partire dalle osservazioni radar più recenti (**SRIadj**), un insieme di possibili realizzazioni del campo di precipitazione a brevissimo termine con update frequente (**ogni 10 minuti**).

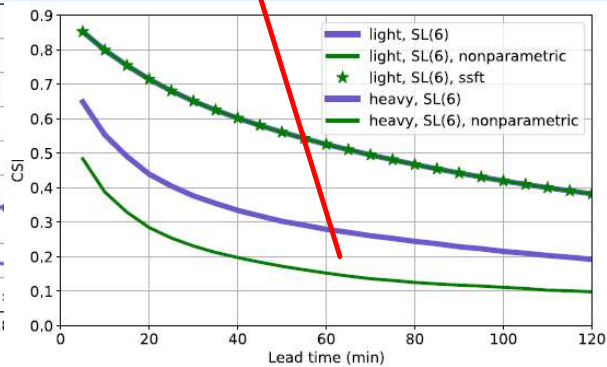
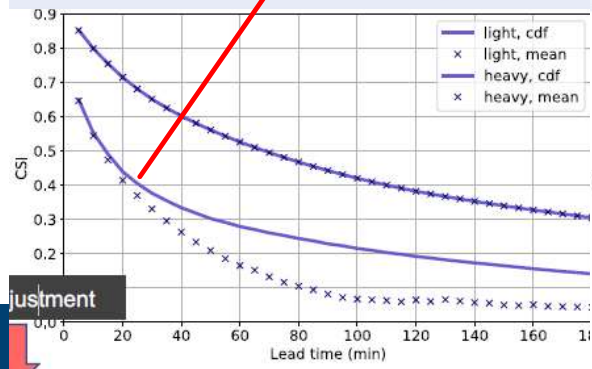
- Trasformazione del campo osservato tramite FFT (Trasformata di Fourier)
- Evoluzione delle fasi nello spazio spettrale (Langevin + componente stocastica)



indices for a threshold of  $10 \text{ mm h}^{-1}$ , as a function of forecast

SPROG parameters: Prob Matching @ light ( $0.1 \text{ mmhr}^{-1}$ ) and heavy ( $5.0 \text{ mmhr}^{-1}$ )

STEPS parameter: SL and masking



- Trasformata inversa (FFT-1) per ottenere N ensemble di campi di pioggia previsti

adjustment

## Il prodotto operativo

- Gli scenari di precipitazione vengono cumulati ottenendo mappe di pioggia **sulle successive 1 e 2 ore.**
- Vengono ordinati i valori su ogni pixel e viene poi considerato un certo percentile.
- Se consideriamo il percentile 100%, di fatto consideriamo ovunque il peggior scenario

Per costruzione, maggiore è il percentile e maggiormente il prodotto è cautelativo, andando a considerare per ogni punto nello spazio la potenziale condizione peggiore

Il sistema è funzionante in modalità pre-operativa tempo reale da fine 2019.

# NOWCASTING PHAST – CALCOLO SCORES

Calcolo scores su circa 60 eventi selezionati fra Luglio 2018 – Dicembre 2019

Scores da letteratura per verifica previsione:



Utilizzo matrice contingenza

		Observed	
		Yes	No
Forecasted	Yes	True Positive (Hit)	False Positive (False Alarm)
	No	False Negative (Miss)	True Negative (Blank)

- Critical Success Index - CSI

$$CSI = \frac{Hit}{Hit + False\ Alarm + Miss}$$

- Probability of Detection - POD

$$POD = \frac{Hit}{Hit + Miss}$$

- Accuracy - ACC

$$ACC = \frac{Hit + Blank}{Hit + False\ Alarm + Miss + Blank}$$

- False Alarm Rate - FAR

$$FAR = \frac{False\ Alarm}{Hit + False\ Alarm}$$

# NOWCASTING PHAST – CALCOLO SCORES

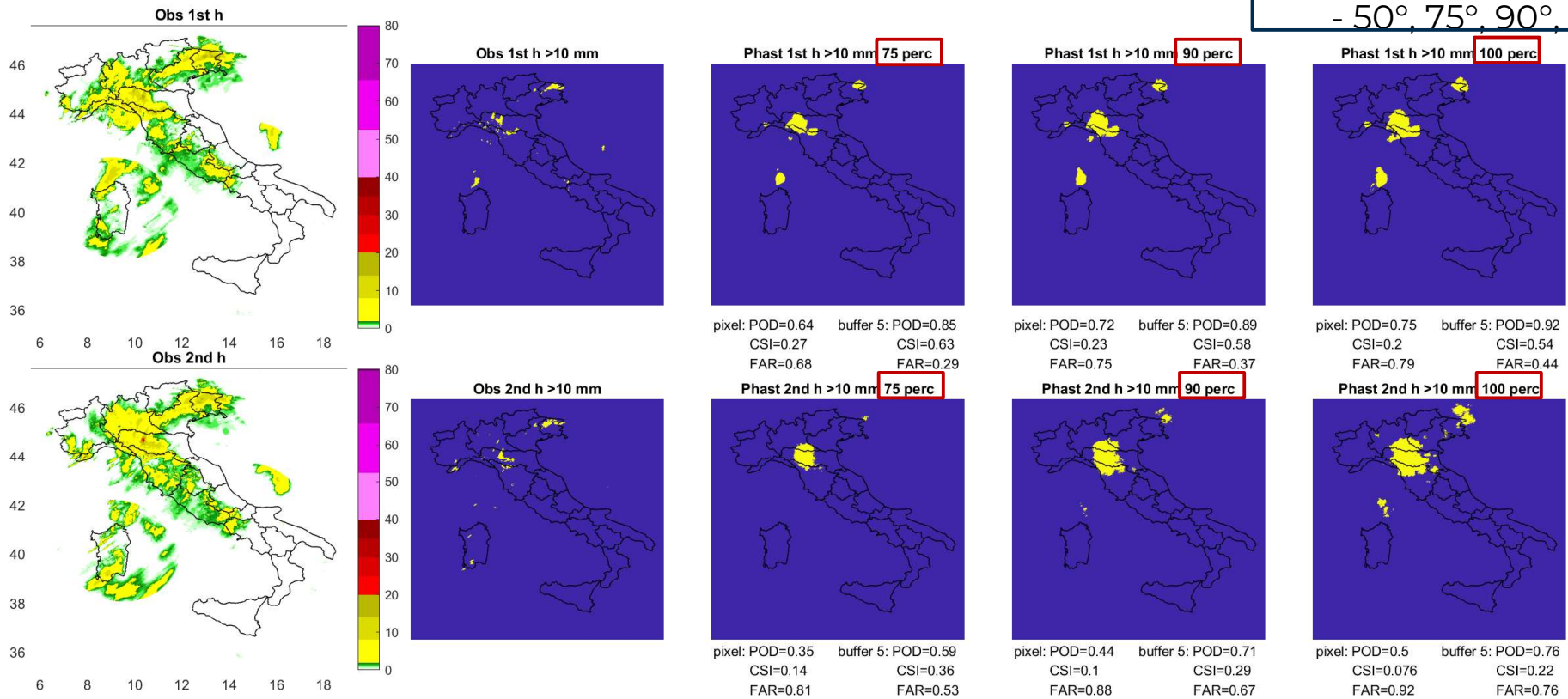
Calcolo scores su circa 60 eventi selezionati fra Luglio 2018 –

Dicembre 2019

Calcolati su diverse soglie di pioggia oraria

Calcolati per diversi percentili:  
- 50°, 75°, 90°, 100°

Observation - Phast Forecast 2019-02-02 @ 00:00 10 mm threshold



# NOWCASTING PHAST – CALCOLO SCORES

Calcolo scores su Hindcast di circa **60 eventi**  
 selezionati fra Luglio 2018 – Dicembre 2019  
 (finestre temporali 12 – 48 ore)

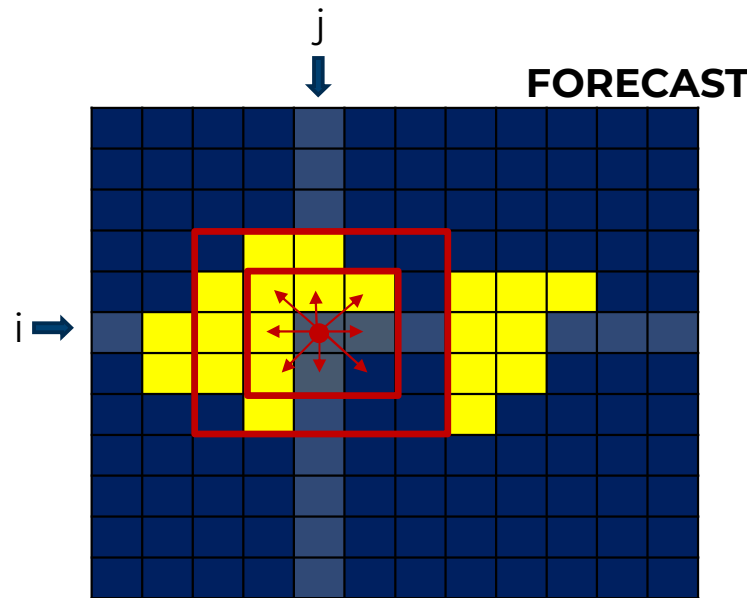
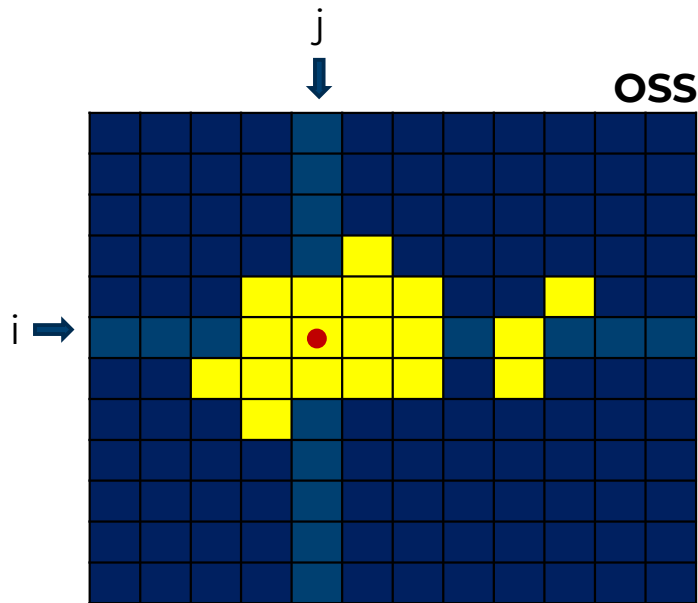
⚠ **Confronto pixel a pixel** → “double penalty effect”

*Anthes, 1983  
 Gilleland et al. 2009  
 Lovat et al., 2020*

Calcolati su diverse soglie orarie

Calcolati per diversi percentili:  
 - 50°, 75°, 90°, 100°

Calcolati pixel a pixel o con buffer di 2, 3, 5, 7 km





# NOWCASTING PHAST - CALCOLO SCORES

Matrice contingenza

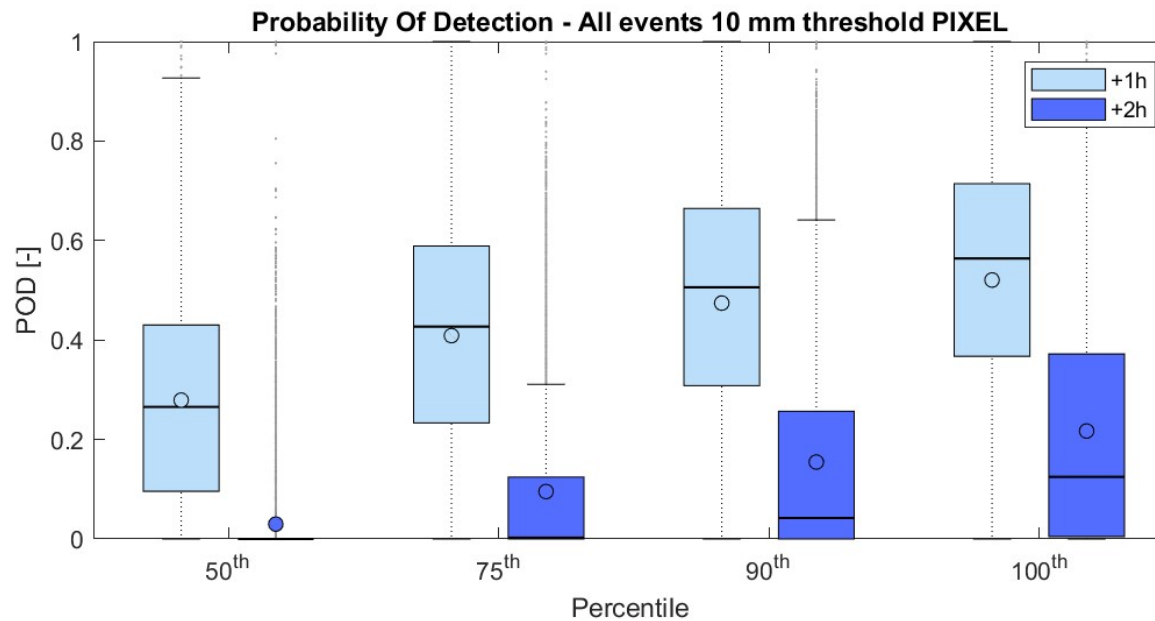
		Observed	
		Yes	No
Forecasted	Yes	True Positive (Hit)	False Positive (False Alarm)
	No	False Negative (Miss)	True Negative (Blank)

Probability of Detection -  
POD

$$POD = \frac{Hit}{Hit + Miss}$$

Soglia: 10mm

Confronto pixel a pixel



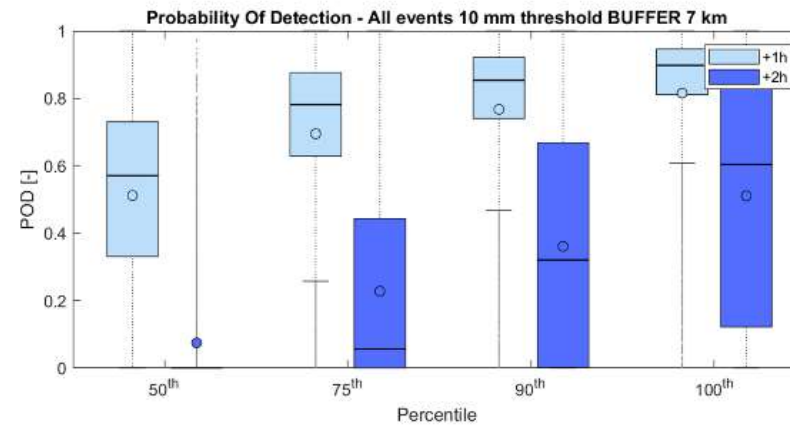
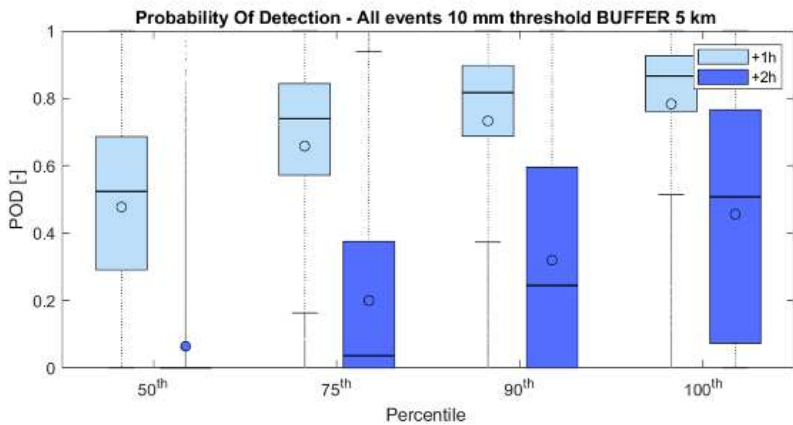
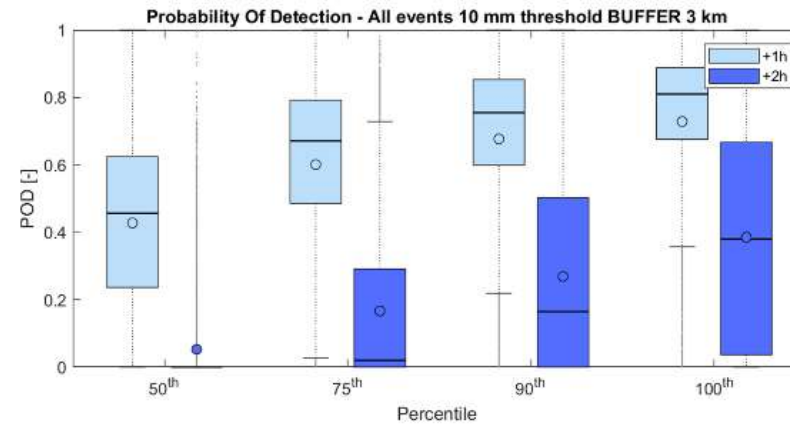
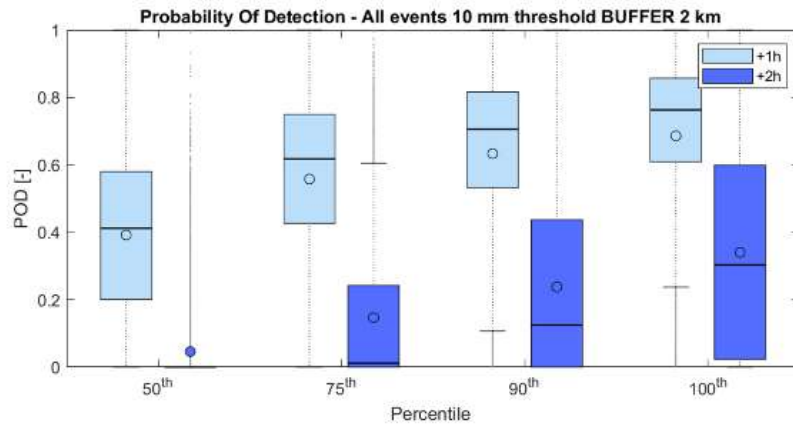
Soglia: 10 mm

Buffer 2-3-5-7 km

# NOWCASTING PHAST – CALCOLO SCORES

Probability of Detection - POD

$$POD = \frac{Hit}{Hit + Miss}$$

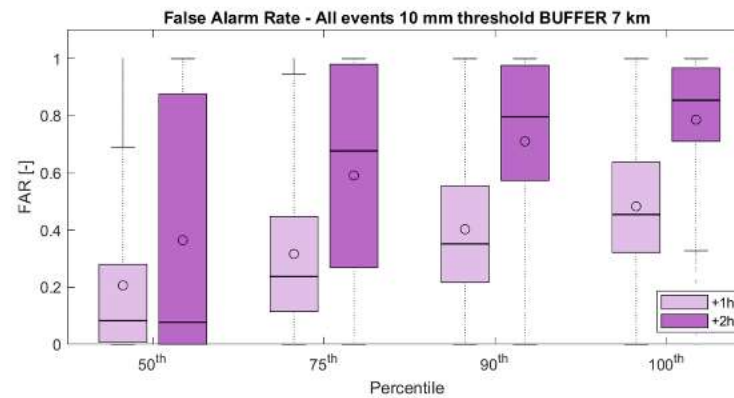
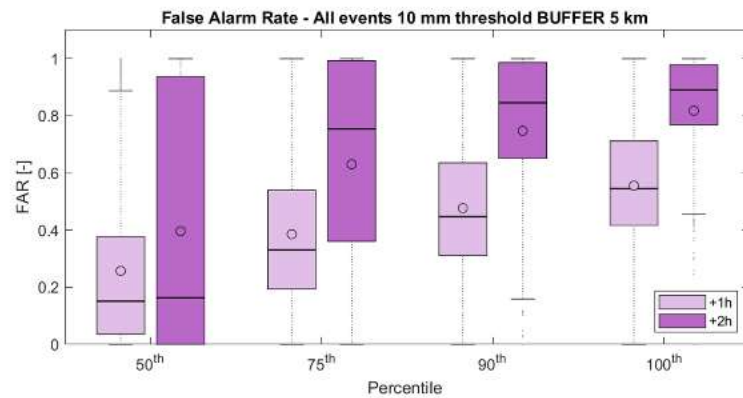
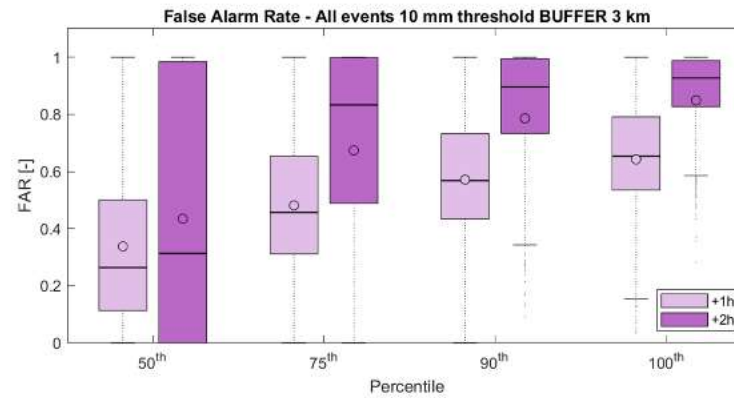
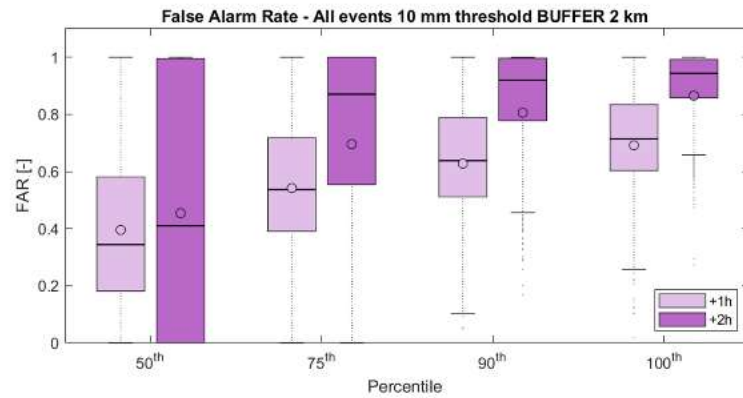


Soglia: 10 mm

Buffer 2-3-5-7 km

## NOWCASTING PHAST – CALCOLO SCORES

$$\text{False Alarm Rate - FAR} \quad FAR = \frac{\text{False Alarm}}{\text{Hit} + \text{False Alarm}}$$

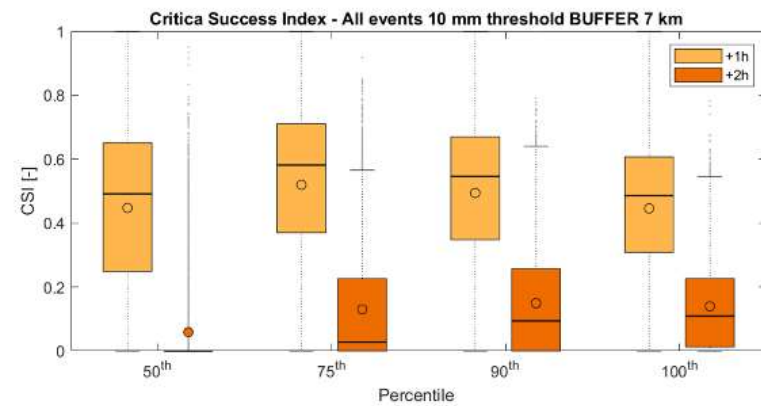
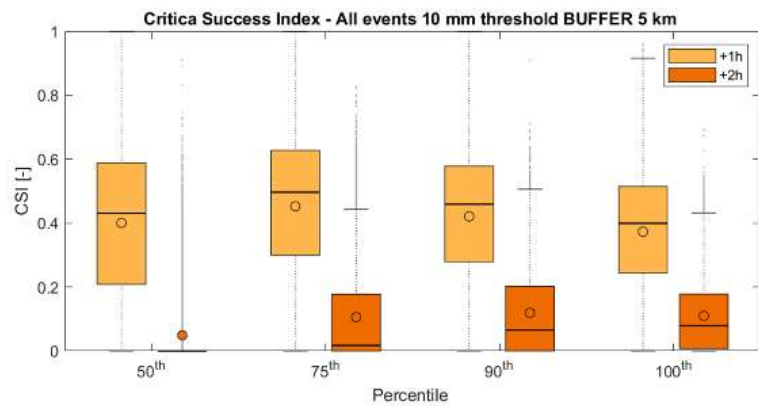
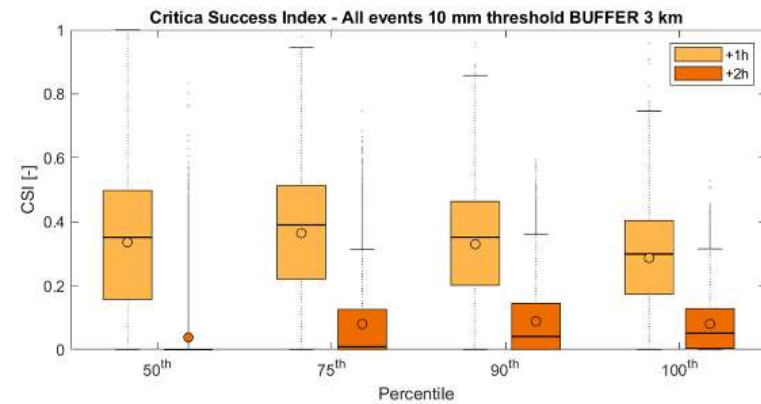
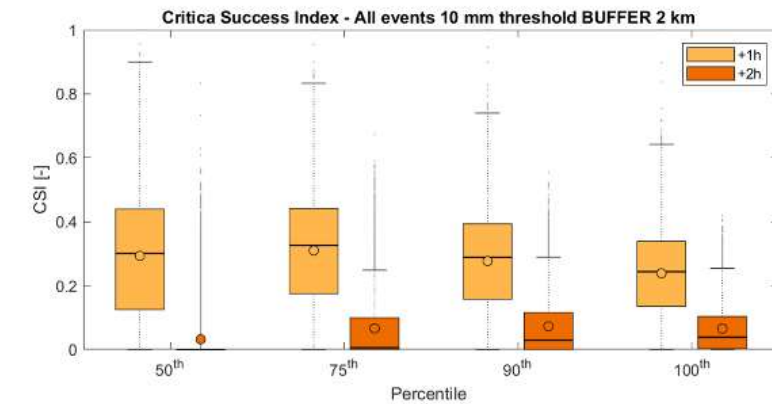


Soglia: 10 mm

Buffer 2-3-5-7 km

## NOWCASTING PHAST – CALCOLO SCORES

$$\text{Critical Success Index } CSI = \frac{\text{Hit}}{\text{Hit} + \text{False Alarm} + \text{Miss}}$$



# NOWCASTING PHAST – CALCOLO SCORES

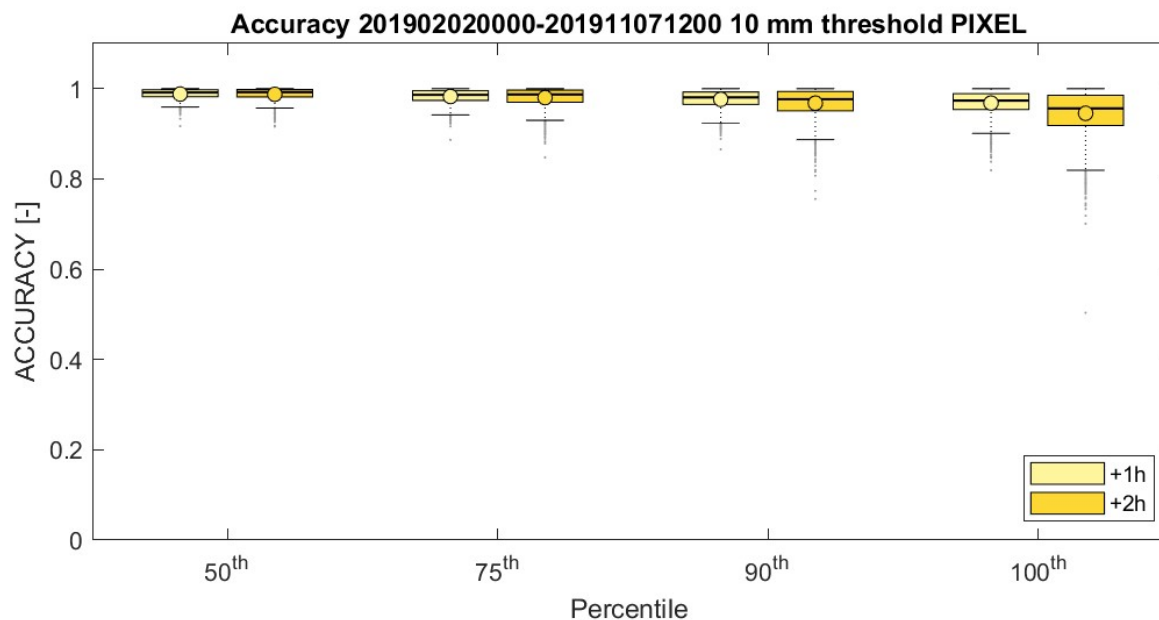
Matrice contingenza

		Observed	
		Yes	No
Forecasted	Yes	True Positive (Hit)	False Positive (False Alarm)
	No	False Negative (Miss)	True Negative (Blank)

**ACCURACY**  $ACC = \frac{Hit + Blank}{Hit + False Alarm + Miss + Blank}$

Soglia: 10mm

Confronto pixel a pixel

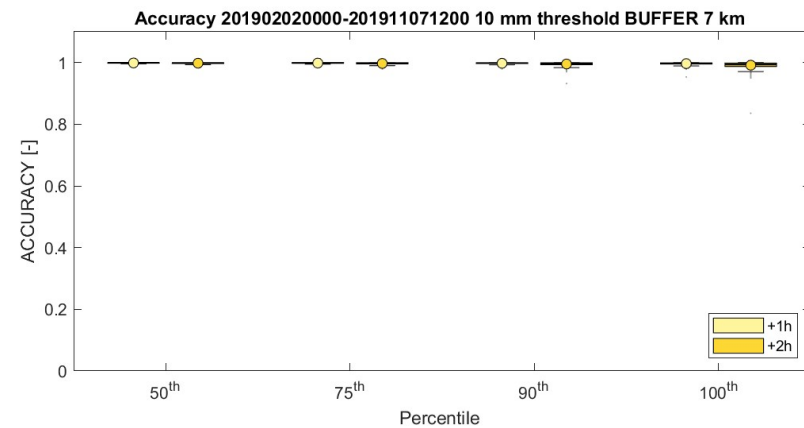
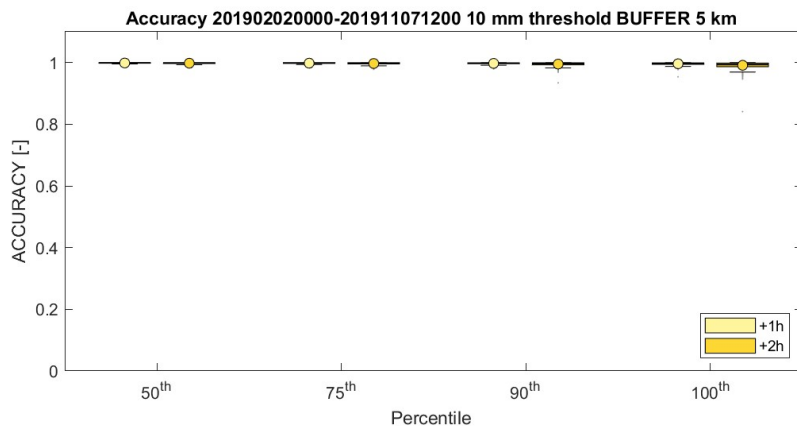
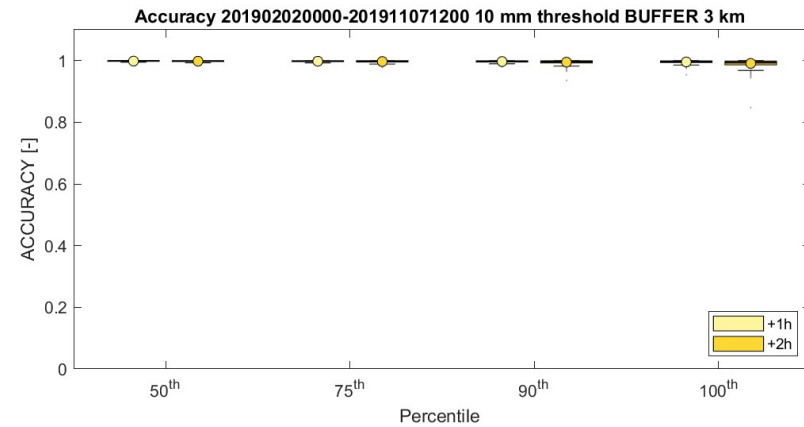
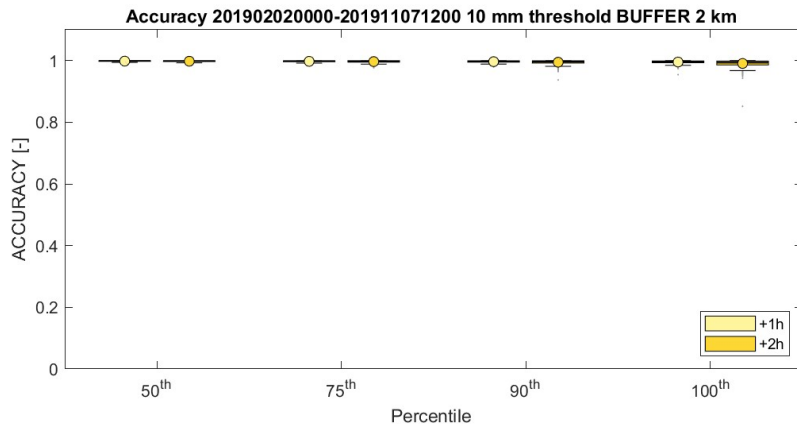


Soglia: 10 mm

Buffer 2-3-5-7 km

# NOWCASTING PHAST – CALCOLO SCORES

$$\text{ACCURACY } ACC = \frac{\text{Hit} + \text{Blank}}{\text{Hit} + \text{False Alarm} + \text{Miss} + \text{Blank}}$$



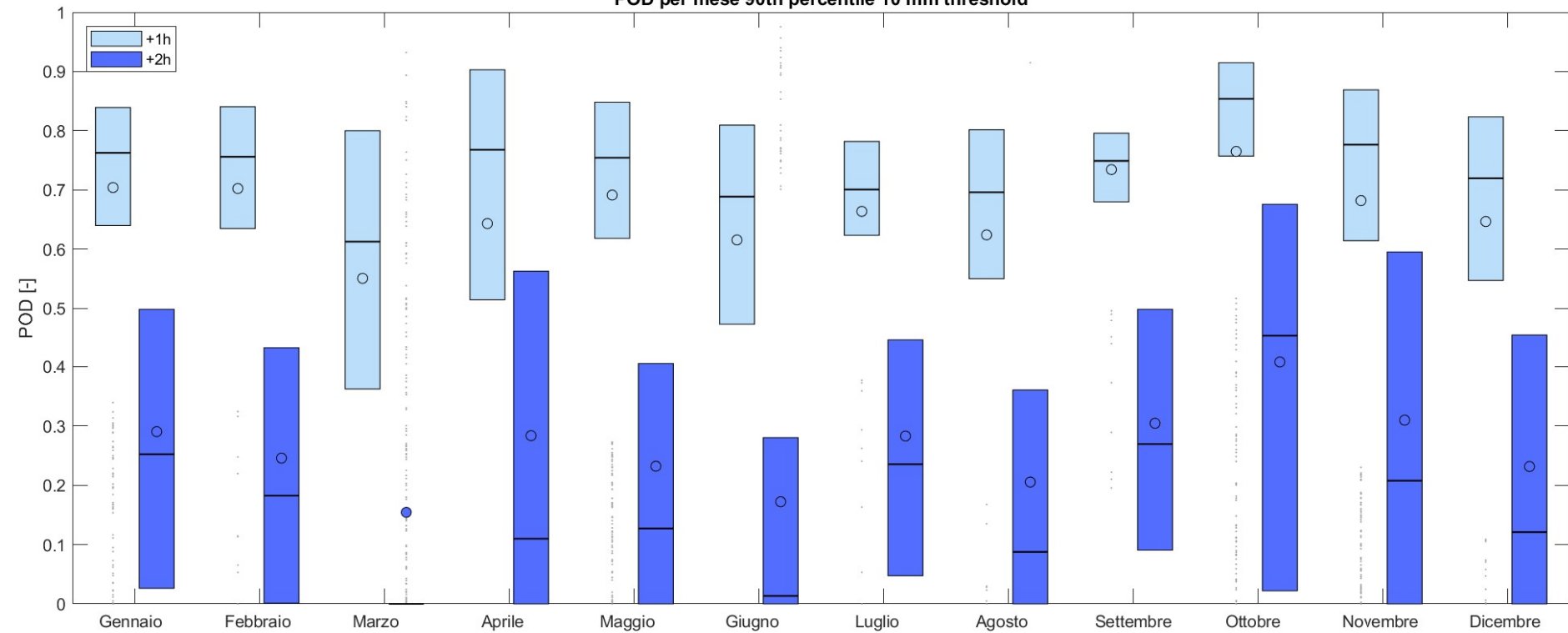
# NOWCASTING PHAST – CALCOLO SCORES

Probability of Detection  
- POD

Soglia 10 mm – 3 km  
buffer

Analisi scores per  
mese

POD per mese 90th percentile 10 mm threshold

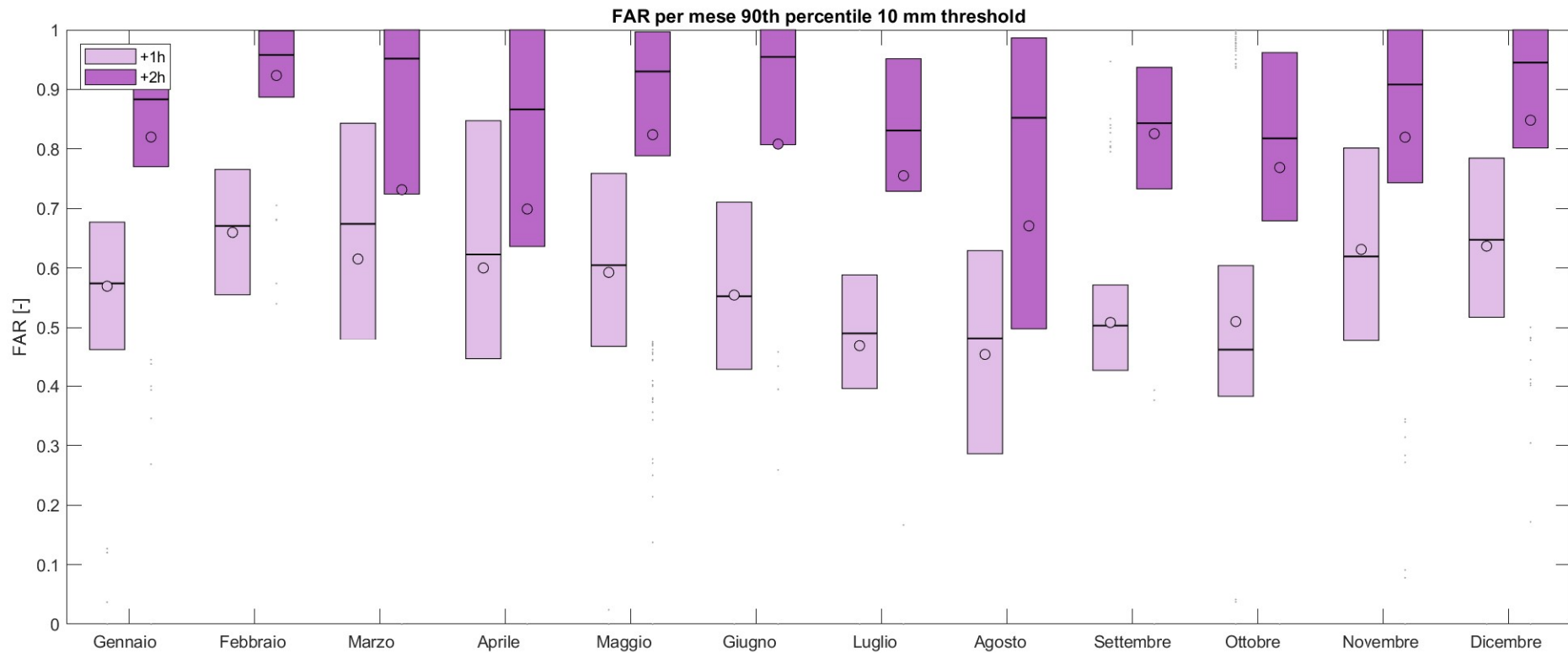


# NOWCASTING PHAST – CALCOLO SCORES

False Alarm Rate  
- FAR

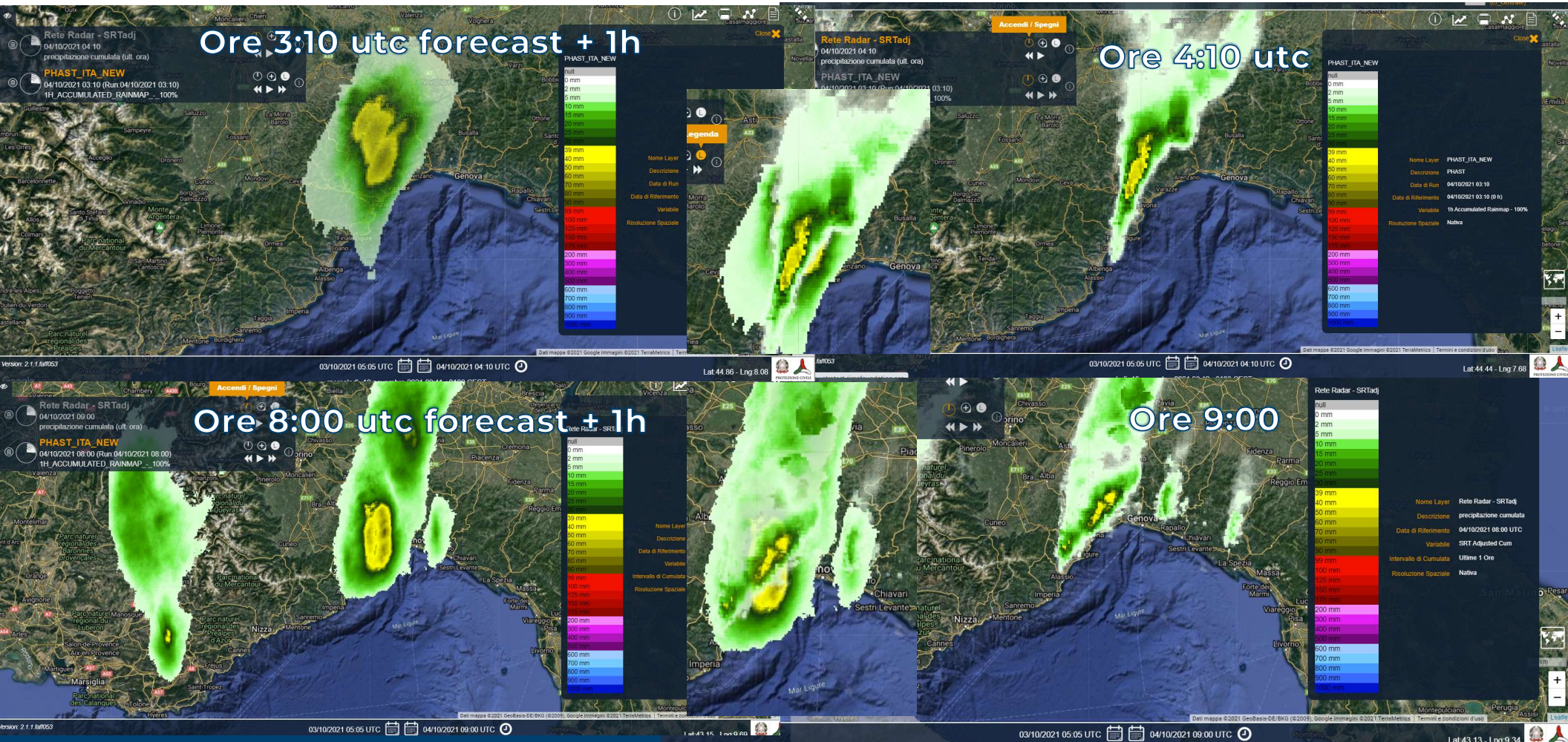
Soglia 10 mm – 3 km buffer

Analisi scores per  
mese

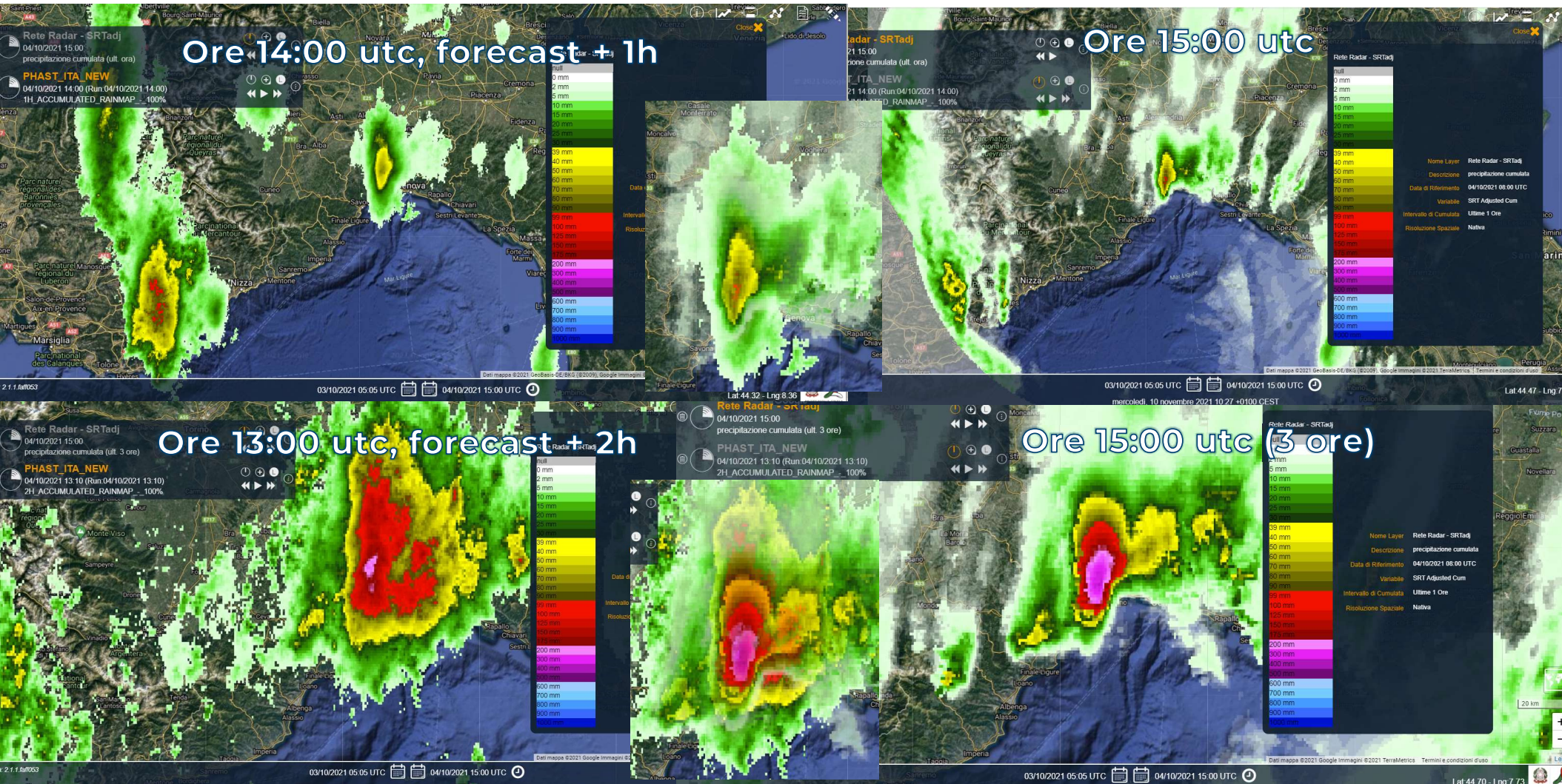




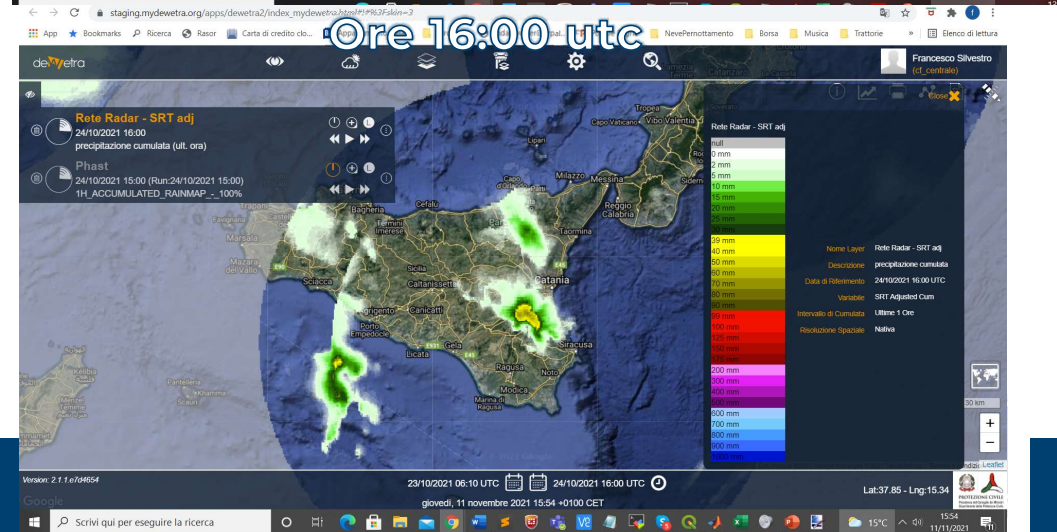
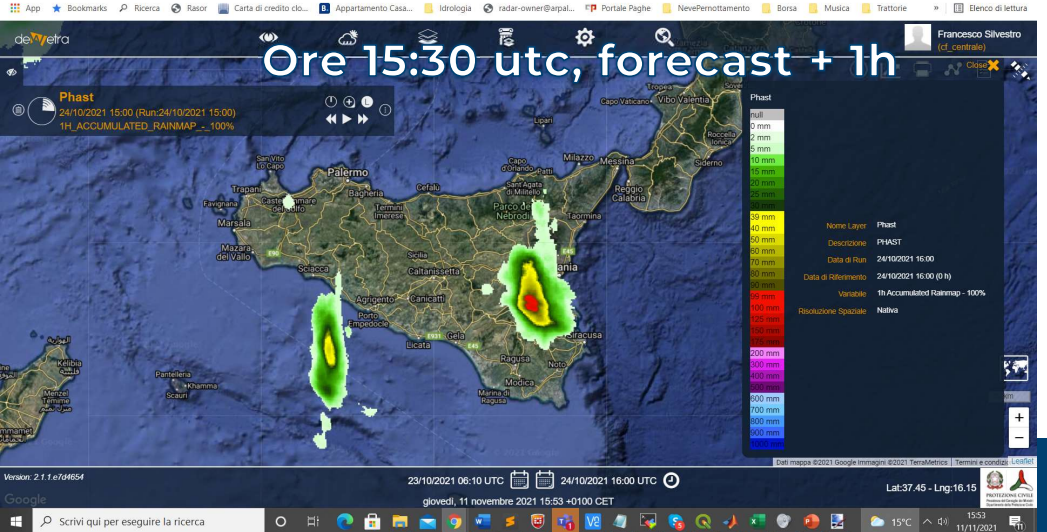
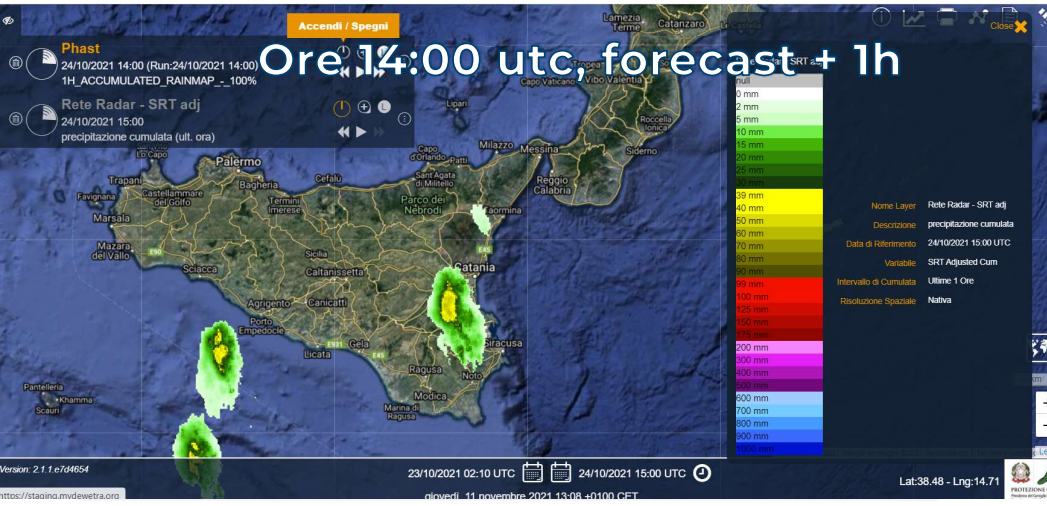
# 4/10/2021 esempi a 1 h



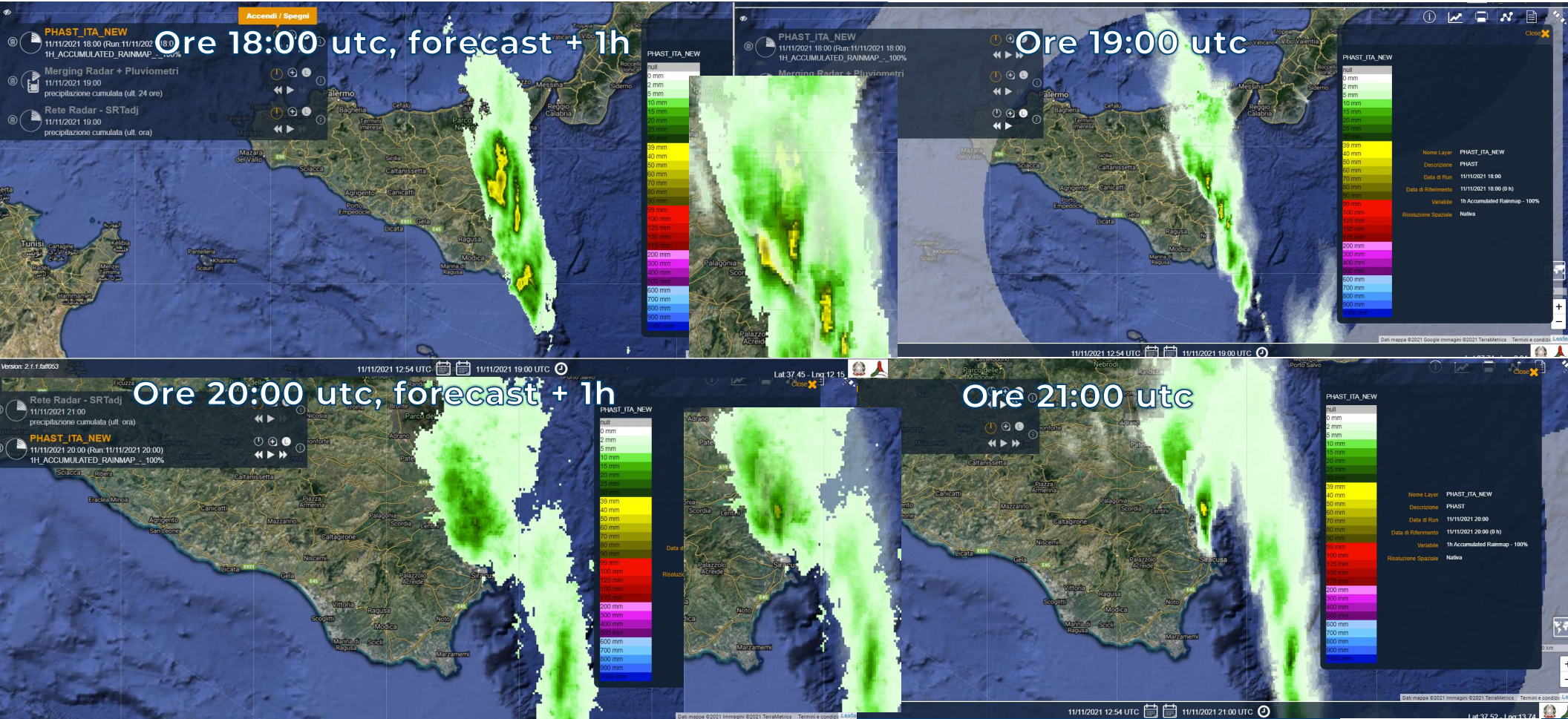
# 4/10/2021 Esempio a 1 h e +2 h



# 24/10/2021 Esempio a 1 h



# 11/11/2021 Esempio a 1 h



- 1) DISCRETE PERFORMANCE NELL'INDIVIDUARE GLI EVENTI DI PRECIPITAZIONE ANCHE DI DIFFERENTE TIPO E IN DIFFERENTI STAGIONI;
- 2) PERFORMANCE DECADONO TENDENZIALMENTE NELLA SECONDA ORA
- 3) PRODOTTO PER COSTRUZIONE CAUTELATIVO, CERCARE DI NON PERDERE EVENTI A SCAPITO DI QUALCHE FALSO ALLARME IN PIÙ, ANCHE SE CONSIDERANDO UNA TOLLERANZA DI QUALCHE KM TALE PROBLEMA SEMBRA RIDURSI
- 4) FUNZIONAMENTO IN LINEA CON ALTRI SISTEMI ANALOGHI, VANTAGGIO DALL'APPROCCIO PROBABILISTICO
- 5) GESTIONE DELL'INCERTEZZA PORTA AD ALLARGARE LEGGERMENTE LE AREE MAGGIORMENTE COLPITE, MA NELL'ARCO DI POCHI KM
- 6) PRODOTTO PRE-OPERATIVO UTILIZZAVA PERCENTILI 50 E 100 FINO ALLA PRIMA METÀ 2021, A SEGUITO DEI RISULTATI DELL'ANALISI E' STATO SOSTITUITO IL PERCENTILE 50 CON 80 (INTORNO AL PERCENTILE CHE MASSIMIZZA IL CSI)



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