

## Semi-realtime testing of the Japanese earthquake early warning system in CWA

Da-Yi Chen

Seismological Center, Central Weather Administration

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## Contents



- Seismic network in CWA
- Current status of the EEW system
- Challenge of the EEW system
- Architecture of the IPFx system
- Performance of the IPFx system



• Future work



## Seismic Network in CWA



#### CWBSN+ real-time TSMIP

#### **TSMIP**



## **Public notifications of the EEW**

2022/03/23 01:41:41 歷史重演

👷 中央氣象局地震速報訊息 (Ver. 2.1.0.0)

2022/03/23 01:41:59

臺北市中正區

Q X ? A 💷

![](_page_3_Picture_1.jpeg)

![](_page_3_Picture_2.jpeg)

強震即時警報

預估 S波 26 秒後 抵送

☆ 震央

現地

預估 震度

#### ▲ CWB Earthquake app

![](_page_3_Figure_4.jpeg)

#### 緊急警報

(PWS)

[地震速報 Earthquake Alert]03/23 01:41左 右花東地區發生顯著有威地震,慎防強烈搖 晃,就近避難「趴下、掩護、穩住」,氣象 局 · Felt earthquake alert. Keep calm and seek cover nearby. CWB

▲ TV program interruption notifications

![](_page_4_Picture_0.jpeg)

![](_page_4_Picture_1.jpeg)

#### About 10 seconds for issuing alarms by the Public Warning System

![](_page_4_Figure_3.jpeg)

CWB EARTH	Q	JAKE REPO	RI
Earthquake No.: 11	1108	6	
Origin time (Taiwar 9/17/2022 21:41:	1 Sta 19.	andard Time: GMT 1	+8)
Epicenter: 23.08°N	I, 12	21.16°E,	
i.e. 36.4 km N of	Tait	ung County Hall	
Focal depth: 8.6 ki	m		
Magnitude (ML): 6.	6		
Local Largest Inter	nsity	r:	
Taitung County	6+	Penghu County	2
Hualien County	5+	Taoyuan City	2
Kaohsiung City	5-	Hsinchu City	2
Nantou County	4	Taipei City	2
Tainan City	4	Keelung City	1
Chiayi County	4		
Yunlin County	4		
Pingtung County	4		
Chiayi City	4		
Changhua County	3		
Taichung City	3		
Miaoli County	3		
Yilan County	3		
Hsinchu County	3		
New Taipei City	3		

![](_page_4_Picture_5.jpeg)

Origin Time: 2022.09.17 21:41:19

Warning Time: 2022.09.17 21:41:29

Warning area: Hualien and Taitung

Approximately 689,000 people received.

#### 預估接收人數 ≈ 689,000 (以2022/09/17 21:40資料推估)

發送時間	發佈內容	發佈單位	CMSP
2022/09/17 21:41:29.880	[地震速報 Earthquake Alert]09/17 21:41左右臺東地區發生顯著有感地震,慎 防強烈搖晃,就近避難「趴下、掩護、穩住」,氣象局。Felt earthquake alert. Keep calm and seek cover nearby. CWB	中央氣象局	5

## **Challenge for the EEW system**

![](_page_5_Picture_1.jpeg)

#### False alarm in the EEW system

#### 國家級警報18日示警南部地震卻無感 氣象局:2 起同時發生導致誤判

2022/9/19 16:09 ( 9/19 16:53 更新 )

![](_page_5_Picture_5.jpeg)

![](_page_5_Figure_6.jpeg)

# 告警類型地震速報發佈時間2022/09/18 20:44:47告警內容[地震速報 Earthquake Alert]09/18 20:44左右南部地區發生顯著<br/>有感地震,慎防強烈搖晃,就近避難「趴下、掩護、穩住」,氣<br/>象局。Felt earthquake alert. Keep calm and seek cover<br/>nearby. CWB告警範圍南投縣、彰化縣、雲林縣、嘉義市、嘉義縣、臺南市

## False alarm in the EEW system

![](_page_6_Picture_1.jpeg)

7

![](_page_6_Figure_2.jpeg)

#### CWB EARTHQUAKE REPORT

Earthquake No.: 111134 Origin time (Taiwan Standard Time: GMT+8): 9/18/2022 20:44:37.2 Epicenter: 23.14°N, 121.19°E, i.e. 42.4 km N of Taitung County Hall Focal depth: 4.5 km Magnitude (ML): 4.3

Local Largest Intensity:

Taitung County	4
Hualien County	4
Nantou County	2
Kaohsiung City	1
Yunlin County	1

Changhua County 1

![](_page_6_Figure_8.jpeg)

![](_page_6_Picture_9.jpeg)

#### Two earthquakes were merged into one

![](_page_7_Picture_1.jpeg)

![](_page_7_Figure_2.jpeg)

## **IPFx method for multiple event**

![](_page_8_Picture_1.jpeg)

The extended integrated particle filter (IPFx) method

A special feature of the IPFx method is the smart phase association algorithm. During a period of active seismicity, such as that immediately following a large earthquake, phases from multiple earthquakes co-occur.

![](_page_8_Figure_4.jpeg)

## **IPFx method for rapid response**

![](_page_9_Picture_1.jpeg)

The extended integrated particle filter (IPFx) method

The event was detected 4 s after the origin time, i.e., three stations were triggered within 4 s, and the maximum estimated SI exceeded the public warning threshold in 2 s.

![](_page_9_Figure_4.jpeg)

(Yamada and Chen, 2022)

## Semi-realtime IPFx system in CWA

![](_page_10_Picture_1.jpeg)

The extended integrated particle filter (IPFx) method

![](_page_10_Figure_3.jpeg)

![](_page_11_Picture_1.jpeg)

#### 2024/01/15,08:37:54.6\_23.15\_120.56\_14.3km\_M3.7\_SI1.1\_14/0/0\_0

![](_page_11_Figure_3.jpeg)

![](_page_12_Picture_1.jpeg)

2024/01/15,08:37:54.6\_23.15\_120.56\_14.3km\_M3.7\_SI1.1\_14/0/0\_0

![](_page_12_Figure_3.jpeg)

![](_page_13_Picture_1.jpeg)

#### 2024/01/17,19:07:37.9\_23.72\_121.47\_16.7km\_M3.2\_SI0.9\_17/0/0\_0

![](_page_13_Figure_3.jpeg)

![](_page_14_Picture_1.jpeg)

![](_page_14_Figure_2.jpeg)

![](_page_14_Picture_3.jpeg)

![](_page_15_Picture_1.jpeg)

![](_page_15_Figure_2.jpeg)

![](_page_16_Picture_1.jpeg)

#### 2023/09/05,12:13:47.6\_22.14\_120.94\_4.3km\_M6.6\_SI3.2\_14/2/0\_0

![](_page_16_Figure_3.jpeg)

## **Future Work**

![](_page_17_Picture_1.jpeg)

1. Generate tp-ts-table from velocity structure

- 2. Check the GMPE to compute SI
- 3. Move toward real-time operation

![](_page_17_Figure_5.jpeg)

## **Future Work**

![](_page_18_Picture_1.jpeg)

1. Generate tp-ts-table from velocity structure

- 2. Check the GMPE to compute SI
- 3. Move toward real-time operation

![](_page_18_Figure_5.jpeg)

![](_page_18_Figure_6.jpeg)

## **Future Work**

![](_page_19_Picture_1.jpeg)

Generate tp-ts-table from velocity structure
Check the GMPE to compute SI
Move toward real-time operation

![](_page_19_Figure_3.jpeg)

![](_page_20_Picture_0.jpeg)

## Thank you for your listening.

![](_page_20_Picture_2.jpeg)