

# Pre-earthquake oscillating and accelerating patterns in the Lithosphere-Atmosphere-Ionosphere coupling (LAIC) before the 2022 Luding (China) Ms6.8 earthquake

Xuemin Zhang<sup>1,\*</sup>, Angelo De Santis<sup>2,\*</sup>, Jing Liu<sup>1</sup>, Saioa A. Campuzano<sup>2,3</sup>, Na Yang<sup>1</sup>, Gianfranco Cianchini<sup>2</sup>, Xinyan Ouyang<sup>1</sup>, Serena D'Arcangelo<sup>2</sup>, Muping Yang<sup>4</sup>, Mariagrazia De Caro<sup>2</sup>, Xinyan Li<sup>5</sup>, Cristiano Fidani<sup>2</sup>, Hong Liu<sup>1</sup>, Martina Orlando<sup>2,6</sup>, Lei Nie<sup>1</sup>, Loredana Perrone<sup>2</sup>, Alessandro Piscini<sup>2</sup>, Lei Dong<sup>1</sup>, Dario Sabbagh<sup>2</sup>, Maurizio Soldani<sup>2</sup> and Pan Xiong<sup>1</sup>

1 Institute of Earthquake Forecasting, China Earthquake Administration, Beijing, China.

2 Istituto Nazionale di Geofisica e Vulcanologia (INGV), Rome, Italy

3 Department of Physics of the Earth and Astrophysics, Universidad Complutense de Madrid (UCM), Spain.

4 Liaoning Earthquake Agency, Shenyang, China

5 Earthquake Agency of Ningxia Hui Autonomous Region, Yinchuan, China

6 Dipartimento di Scienze, Università Roma TRE, Rome, Italy

\* Corresponding authors: zxm@ief.ac.cn; angelo.desantis@ingv.it

## Supplementary Material

**Table S1.** Columns from left to right: types of instrument or analysis, anomalous parameter, its occurrence in terms of date and progressive day w.r.t. the time of the earthquake occurrence. Among all anomalies, those in **bold** are ionospheric that are probably due to a direct electromagnetic coupling, because they occur before atmospheric or ground anomalies. All other anomalies are probably due to the diffusive/delayed coupling.

Instrument	Parameter	Date	$\Delta T/d$
Seismol. analysis	R-AMR	01/11/2019	-1039
Ground EM analysis	$\rho_s$	01/01/2021	-612~0
Seismol. analysis	<i>b</i> -value	17/11/2021	-292
Seismol. analysis	R-AMR	20/05/2022	-120
<b>Swarm LAP</b>	<b>Ne</b>	<b>08/06/2022</b>	<b>-89</b>
<b>Swarm magnetom.</b>	<b>Y</b>	<b>14/06/2022</b>	<b>-83</b>
<b>CSES HPM</b>	<b>X,Y,Z</b>	<b>14/06/2022</b>	<b>-83</b>
Ground EM analysis	ELF B	15/06/2022	-82
<b>Swarm LAP</b>	<b>Ne</b>	<b>21/06/2022</b>	<b>-76</b>
<b>Swarm LAP</b>	<b>Ne</b>	<b>25/06/2022</b>	<b>-72</b>
<b>Swarm LAP</b>	<b>Ne</b>	<b>26/06/2022</b>	<b>-71</b>
<b>Swarm magnetom.</b>	<b>Y</b>	<b>29/06/2022</b>	<b>-68</b>
<b>Swarm magnetom.</b>	<b>Y</b>	<b>28/06/2022</b>	<b>-67</b>
<b>Swarm magnetom.</b>	<b>Y</b>	<b>03/07/2022</b>	<b>-64</b>
<b>CSES HPM</b>	<b>B</b>	<b>03/07/2022</b>	<b>-64</b>
Atm. analysis	OLR	07/07/2022	-60
<b>CSES LAP</b>	<b>Ne</b>	<b>09/07/2022</b>	<b>-58</b>
<b>CSES HPM</b>	<b>X,Y,Z</b>	<b>10/07/2022</b>	<b>-57</b>
<b>CSES LAP</b>	<b>Ne</b>	<b>12/07/2022</b>	<b>-55</b>
<b>Ionosonde</b>	<b>h'Es, foEs, foF2</b>	<b>13/07/2022</b>	<b>-54</b>

<b>CSES SCM</b>	<b>B at 250 Hz</b>	<b>14/07/2022</b>	<b>-53</b>
Atm. analysis	OLR	15/07/2022	-52
<b>CSES HPM</b>	<b>X,Y,Z</b>	<b>16/07/2022</b>	<b>-51</b>
<b>CSES LAP</b>	<b>Ne</b>	<b>21/07/2022</b>	<b>-46</b>
<b>CSES HPM</b>	<b>X,Y,Z</b>	<b>03/08/2022</b>	<b>-33</b>
<b>CSES LAP</b>	<b>Ne</b>	<b>09/08/2022</b>	<b>-27</b>
<b>CSES SCM</b>	<b>B at 250 Hz</b>	<b>12/08/2022</b>	<b>-24</b>
Atm. analysis	AEF	14/08/2022	-22
Atm. analysis	AEF	15/08/2022	-21
Atm. analysis	OLR	21/08/2022	-15
<b>CSES HPM</b>	<b>X,Y,Z</b>	<b>23/08/2022</b>	<b>-13</b>
<b>CSES LAP</b>	<b>Ne</b>	<b>23/08/2022</b>	<b>-13</b>
Atm. analysis	AEF	23/08/2022	-13
Atm. analysis	AEF	24/08/2022	-12
Atm. analysis	SKT	24/08/2022	-12
CSES HPM	X,Y,Z	24/08/2022	-12
GPS	GIM TEC	24/08/2022	-12
Swarm magnetom.	Y	24/08/2022	-12
CSES HPM	X,Y,Z	25/08/2022	-11
Swarm magnetom.	Y	25/08/2022	-11
Particle Detector	CR	25/08/2022	-11
CSES SCM	B at 250Hz	26/8/2022	-10
GPS	TEC	26/8/2022	-10
GPS	GIM TEC	26/08/2022	-10
Ionosonde	foF2	26/08/2022	-10
Particle Detector	CR	26/08/2022	-10
LAP of CSES	Ne	27/08/2022	-9
Particle Detector	CR	27/08/2022	-9
Particle Detector	CR	01/09/2022	-4
Particle Detector	CR	02/09/2022	-3
Particle Detector	CR	03/09/2022	-2