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# A statistical analysis of geomagnetic storms and selected storm effects on Earth atmosphere currents

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- •Step development of Geomagnetic Storm
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### INTRODUCTION: GEOMAGNETIC STORMS

- 1. To determine the statistical of geomagnetic storm during solar cycle 24.
- 2. To study selected storm effect on EEJ and GIC current.

Disturbance of Earth magnetosphere



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#### INTRODUCTION



### Equatorial Electrojet (EEJ) Currents

- In the E layer of the Earth's ionosphere, there is a strong current flowing in the eastward directed known as the Equatorial Electrojet (EEJ) Current [Chapman et al., 1951]
- Produce geomagnetic interference and can be detectable in the geomagnetic data variation from equatorial region.

### Geomagnetic Induced Currents (GIC)



Image source:Roberta Tozzi et. al.,2019

• Space weather drives electric currents and magnetic fields in Earth's atmosphere. This rapid changes in the geomagnetic field cause GIC.

### METHODOLOGY



#### **Dst Index**

World Data Center for Geomagnetism, Kyoto

Dst (Provisional) March 2015 WDC for Geomagnetism, Kyoto (nT) - 100 - 200 - 300 - 400 - 500 6 11 16 21 26 31 1

### EEJ current

Ground magnetometer from MAGDAS network

Sector	Code	Station	GG Coordinate		Magnetic Coordinate	
		Name	Latitude	Longitude	Latitude	Longitude
Asia	DAV	Davao	7.00	125.40	-2.22	197.90
	MND	Manado	1.44	124.84	-7.80	197.63
	PRP	Pare Pare	-3.60	119.40	-12.38	190.75

### **GIC current**

Ground magnetometer from INTERMAGNET network

Sector	Code	Station Name	GG Coordinate		Magnetic Coordinate	
			Latitude	Longitude	Latitude	Longitude
Rusia	YAK	Yakutsk	61.57	129.39	52.45	196.53
	IRT	Irkutsk	52.29	104.29	42.24	177.05
China	BMT	Beijing Ming Tombs	40.24	116.21	30.34	187.22

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### **RESULT & DISCUSSION**

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Year	Moderate	Intense	Severe
2009	1	0	0
2010	9	0	0
2011	13	3	0
2012	23	8	0
2013	22	3	0
2014	17	1	0
2015	33	8	1
2016	19	3	0
2017	10	2	0
2018	7	1	0
2019	2019 6		0
TOTAL	160	29	1
		190	

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### **RESULT & DISCUSSION**



- Category: Intense
- 2 Step development of geomagnetic storm
- Long recovery
- SSC (35nT) start 21 June 2015 (1600UT)



- Initial: AE start, dH/dt increase with small value, EUEL increase
- Main phase: AE and dH/dt maximum.
- *dH/dt at YAK station higher than IRT and BMT station*
- EUEL appearance of CEJ, EUEL less than -5nT, 2h

### CONCLUSION

- Occurrence of Geomagnetic storm during solar cycle 24 are classified according to intensity from moderate, intense and severe.
- All the geomagnetic storm that been identified also are classified to it number step of geomagnetic storm development.
- Increase in GIC reading, higher occurs in high latitude area.
- Disturbance of EEJ current in equatorial region occurs during geomagnetic storm but interrupted during daytime of the local time only.
- The EEJ current is related to the GIC, indicating that there is a chain of currents from high latitude areas to the equator.

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#### MOTIVATION

#### PAST STUDIES

- 1. Only statistic of geomagnetic storms for complete solar cycle 23. [Rathore et al., 2012]
- 2. Study of geomagnetic storm and its effects to geomagnetic induced current (GIC) at different latitude but not considering using the same range of longitude. [Ansor et al., 2020]
- 3. Study effect of solar activity on ionospheric current system during geomagnetic storm in 2014 when there is intense geomagnetic storm during 2015. [Hamid et. Al, 2021]

### <u>OBJECTIVE</u>

- 1. To determine the statistical of geomagnetic storm during solar cycle 24.
- 2. To study selected storm effect on EEJ and GIC current.

#### INTRODUCTION



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### **Past Studies & Objective**

#### <u>Rathore et al.</u> 2012

Study on statistic of Sunspot and geomagnetic storms during solar cycle 23

#### Ansor et al. 2020

Study of geomagnetic storm and its effects to geomagnetic induced current (GIC) at different latitude

#### Hamid et al. 2021

Study effect of solar activity on ionospheric current system during geomagnetic storm in 2014

### **OBJECTIVE**

To study a statistical analysis of geomagnetic storms and their effect on Earth atmosphere currents for solar cycle 24.



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**Figure 2.** Examples include (**a**) MCEJ and ACEJ at DAV on 24 January 2018, and (**b**) PSD at DAV on 10 August 2017.

- after dusk (18:00–21:00 LT) and introduced as post-sunset depletion (PSD).
- morning CEJ (MCEJ, 06:00–11:00 LT)
- afternoon CEJ (ACEJ, 13:00–18:00 LT)
- CEJ could be identified when the EUEL value <-5 for ≥2h

[Nur Izzati Mohd Rosli et al., 2022]