Sunspot Activity Dependence of Ionospheric Variability in the Low Latitude

[1]IKUBANNI, Stephen O., [2]ADENIYI, Jacob O.

[1]Landmark University, P.M.B. 1001, Omu- Aran Kwara State, Nigeria.
[2]University of Ilorin, P.M.B. 1515, Ilorin, Kwara State, Nigeria.

E-mail: *stevewolex1@yahoo.com*

19th International Beacon Satellite Symposium (BSS 2016) @ ICTP, Trieste, Italy (27th June – 1st July)

Outline

- Introduction
- Previous works
- Motivation
- Observations
- Conclusion

Introduction

- Non-inclusion of variability data in empirical models is a source of error in long-term predictions.

- Day-to-day deviation of ionospheric parameters from the monthly average has been the theme of several scientific articles.

- Quantitative description of ionospheric variability is one of the priorities of Ionospheric Physics (Bilitza *et al.*, 2004, *ASR*).

- Ionospheric variability highest near the F2 peak (Oladipo *et al.*, 2008).

- Variability at all sectors and latitudes of the EIA increases as solar control of the ionosphere diminishes (Bilitza *et al.*, 2004, Akala *et al.*, 2011)
    - Nighttime variability higher
    - Generally, variability increases with decreasing sunspot activity

Previous Works

Variability at

(a) Dakar (14.8°N, 17.4°W, dip 11.4°N)

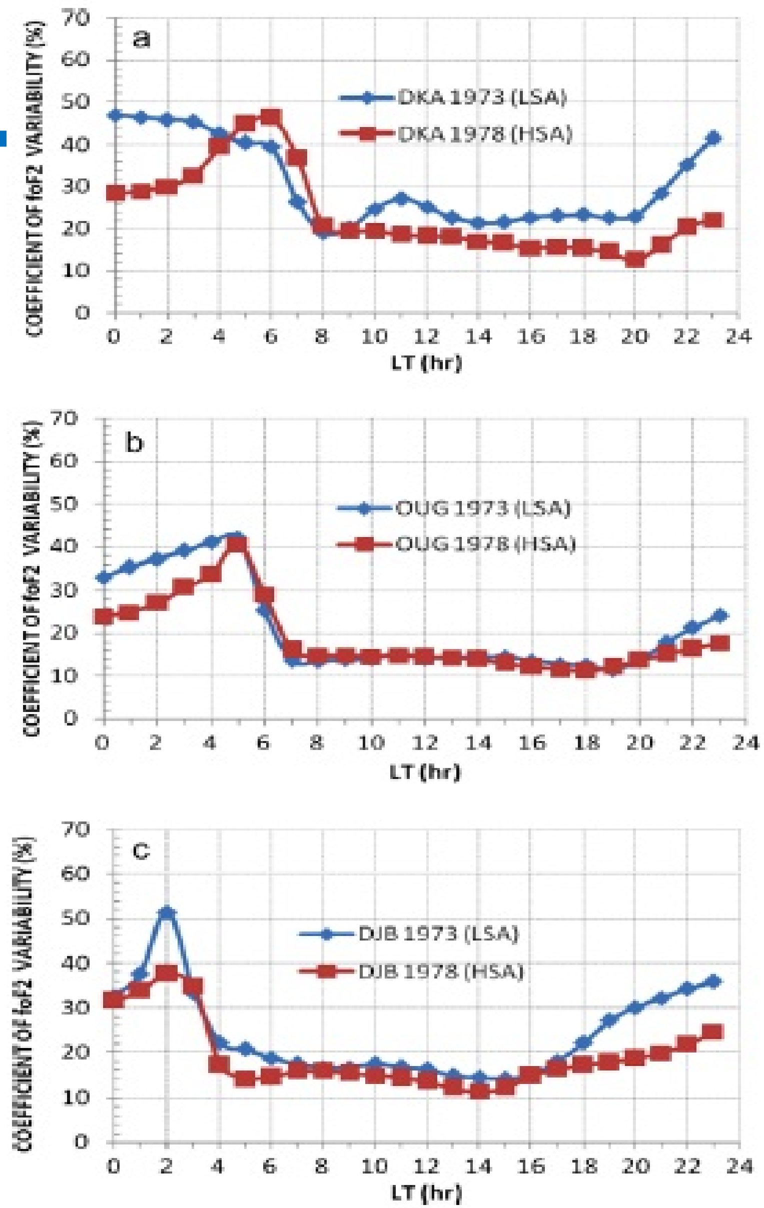
(b) Ouagadougou (12.4°N, 1.5°W, dip 2.8°N)

(c) Djibouti (11.5°N, 42.8°E, dip 7.2°N)

HSA – 1978 (Rz = 93) (Max. of SC21)

LSA – 1973 (Rz = 38) (Descending phase SC21)

Akala *et al.* (2010) (Figure4), *ASR*



Variability at

(a) Manila (14.7°N, 121.1°E, dip 14.7°N)

(b) Okinawa (26.3°N, 127.8°E, dip 36.8°N)

(c) Vanimo (2.7°S, 141.3°E, dip 22.5°S)

Asian sectors.

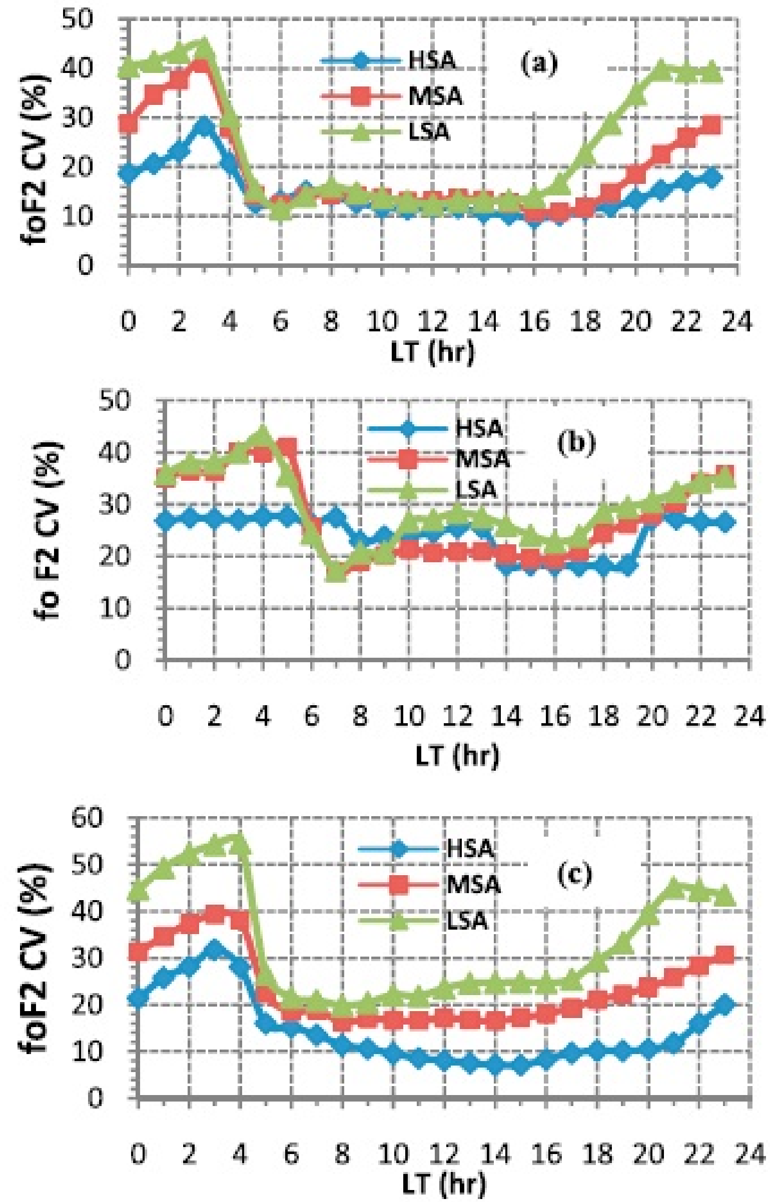
HSA – 1989 (Rz= 158) (Max. of SC22)

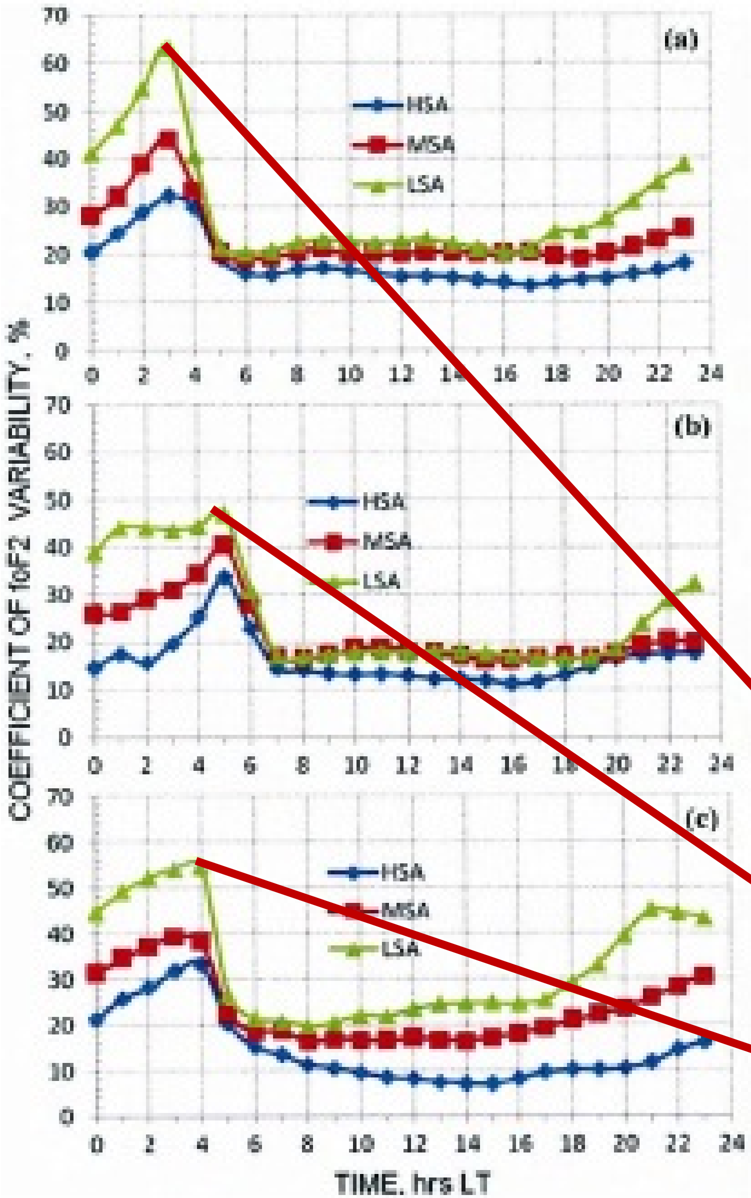
MSA – 1983 (Rz = 67)

(Descending phase SC21)

LSA – 1986 (Rz = 13)

Akala *et al.* (2010) (Figure 8), *JGR*





Variability at

(a) Huncayo (12.0°S, 75.3°W, dip 1.8°N)

(b) Ouagadougou (12.4°N, 1.5°W, dip 2.8°N)

(c) Vanimo (2.7°S, 141.3°E, dip 22.5°S)

American, African and Asian sectors respectively.

HSA – 1979 (Rz12 = 156) (Max. of SC21)

MSA – 1983 (Rz12 = 67)(Descending phase SC21)

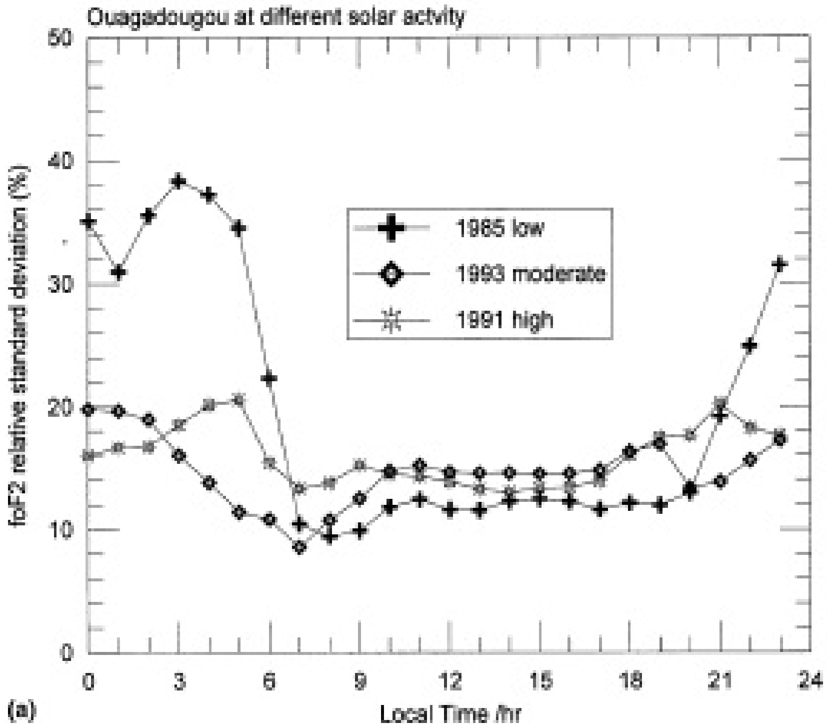
LSA – 1986 (Rz12 = 13)

Akala *et al.* (2011) (Figure 4), *IJRSP*

0300LT

0500LT

0400LT



Variability at Ouagadougou

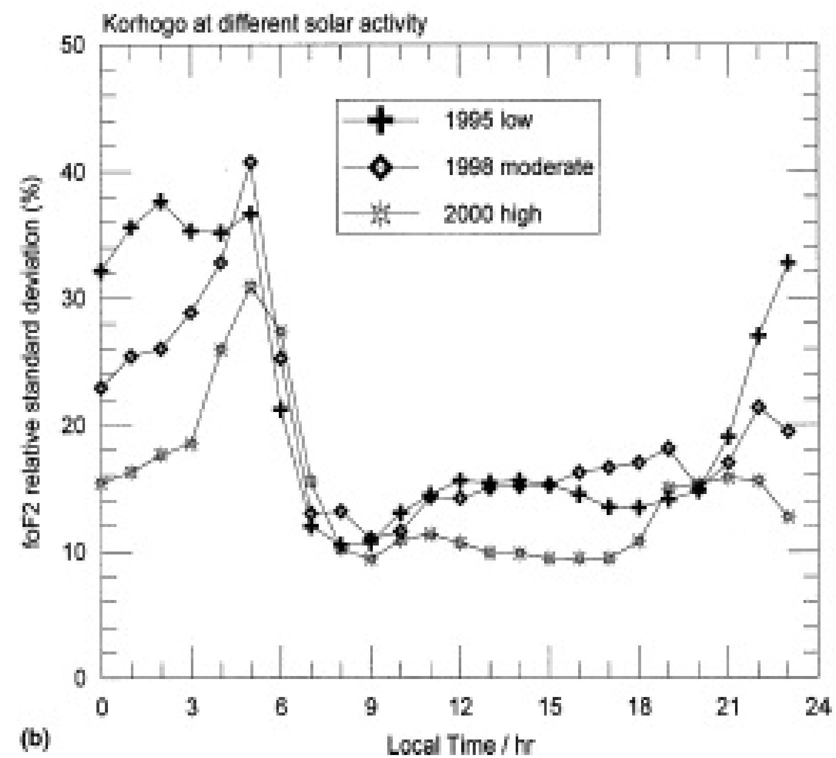
(MSA and HSA – "descending phase SC22"
LSA – "ascending phase")

HSA – 1991 (Rz = 146)
MSA – 1993 (Rz = 55) (Descending phase SC22)
LSA - 1985 (Rz = 18)

Variability at Korhogo

(LSA, MSA and HSA – "ascending phase SC23")

HSA – 2000 (Rz = 120)
MSA – 1998 (Rz = 64) (Ascending phase SC22)
LSA - 1995 (Rz = 18)



Bilitza *et al.* (2004) (Figure 4), *ASR*

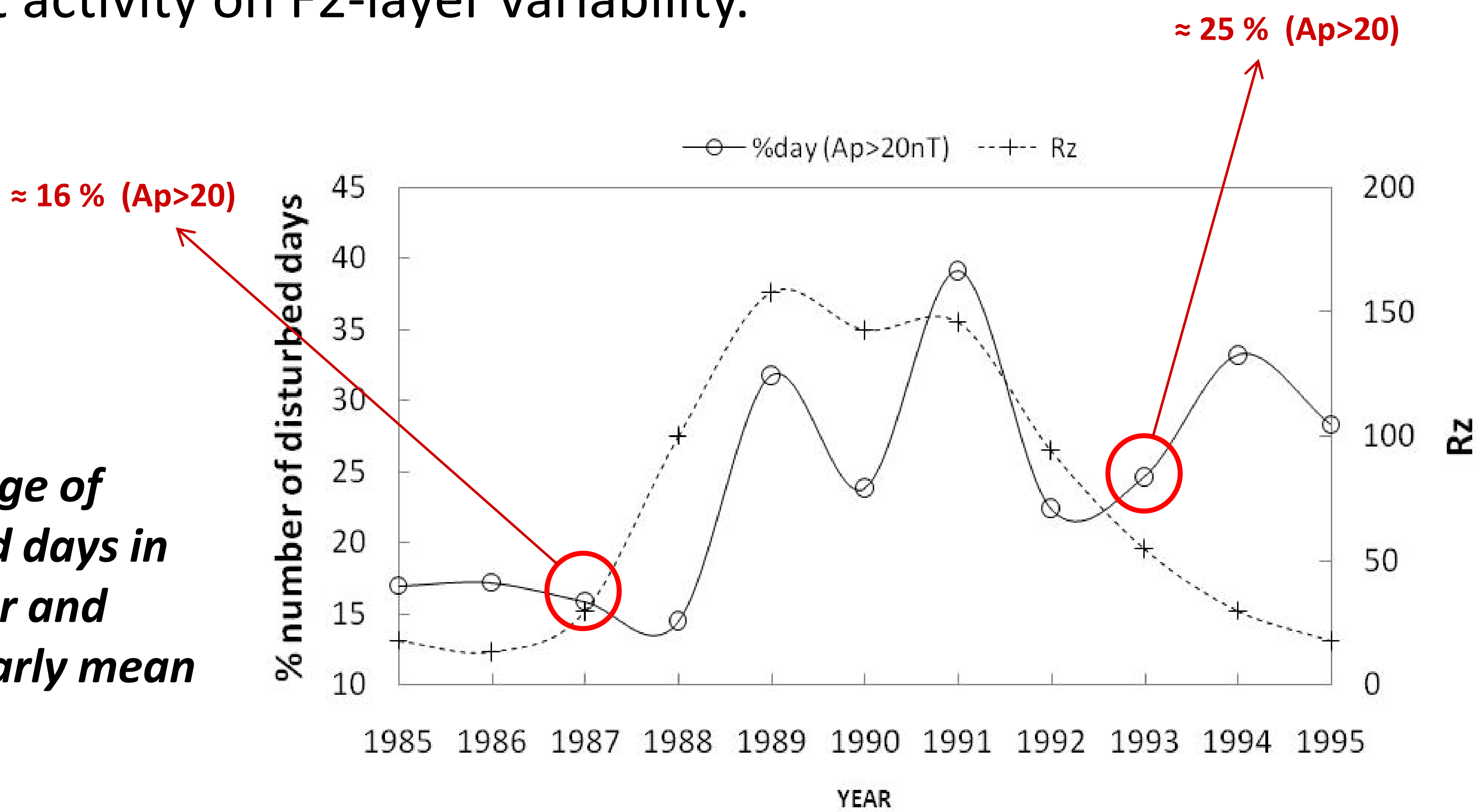
- F2-layer variability largely attributable to geomagnetic activity and complimented by meteorological sources from the lower levels (Rishbeth and Mendillo, 2001, *JASTP*)

- Differences in diurnal foF2 variation during the ascending and descending phases due to different sources of geomagnetic disturbance (Ouattara and Amory-Mazaudier, 2012, *JASTP*)

- Mean *Ap* increases with *F10.7*, descending phases of solar cycles more active than the ascending phases (Cliver *et al.*, 1996, *JGR;* Rishbeth and Mendillo, 2001, *JASTP*)

Motivation

To investigate the ascending/descending phase asymmetry of sunspot activity on F2-layer variability.



Percentage of disturbed days in each year and F10.7 yearly mean

Approach

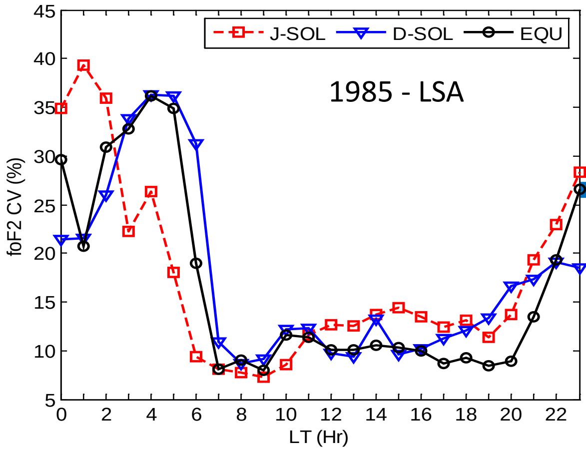
- Ouagadougou Ionosonde
  (12.4^{o}N,1.5^{o}W, dip ~ 3^{o}),
  [solar cycle 22]

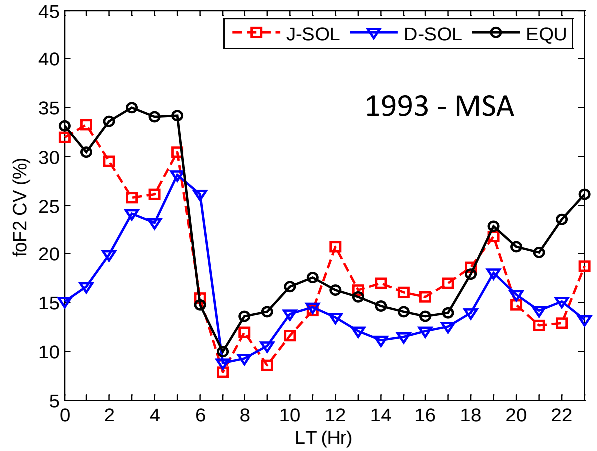
YEAR	Rz	PHASE
1985	18	Minimum
1987	29	Ascending Phase
1993	55	Descending Phase
1989	158	Maximum

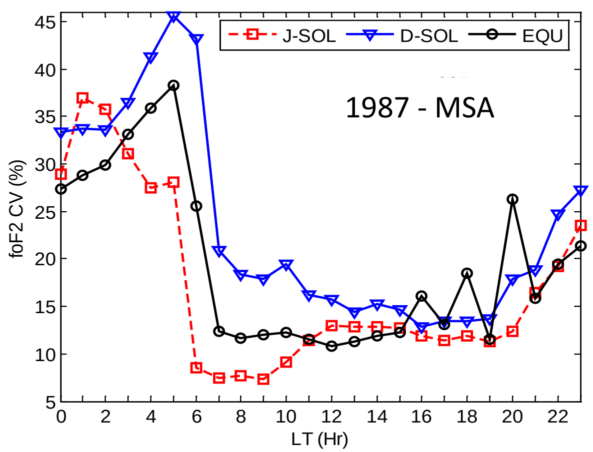
→ LSA (1985, Minimum)
MSA (1987, Ascending Phase; 1993, Descending Phase)
→ HSA (1989, Maximum)

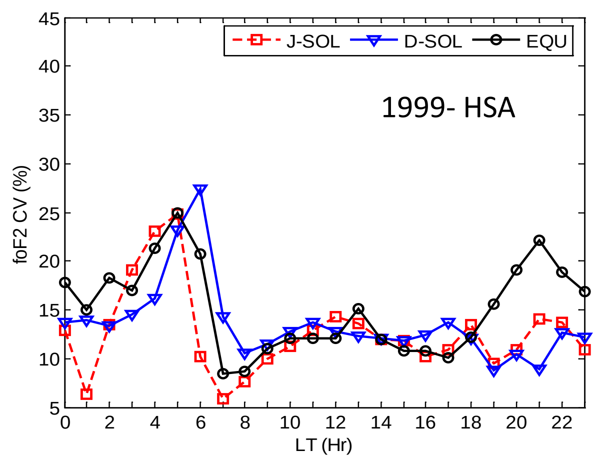
Classification according to (Ouattara and Amory-Mazaudier 2012, *SWSC*)

Results







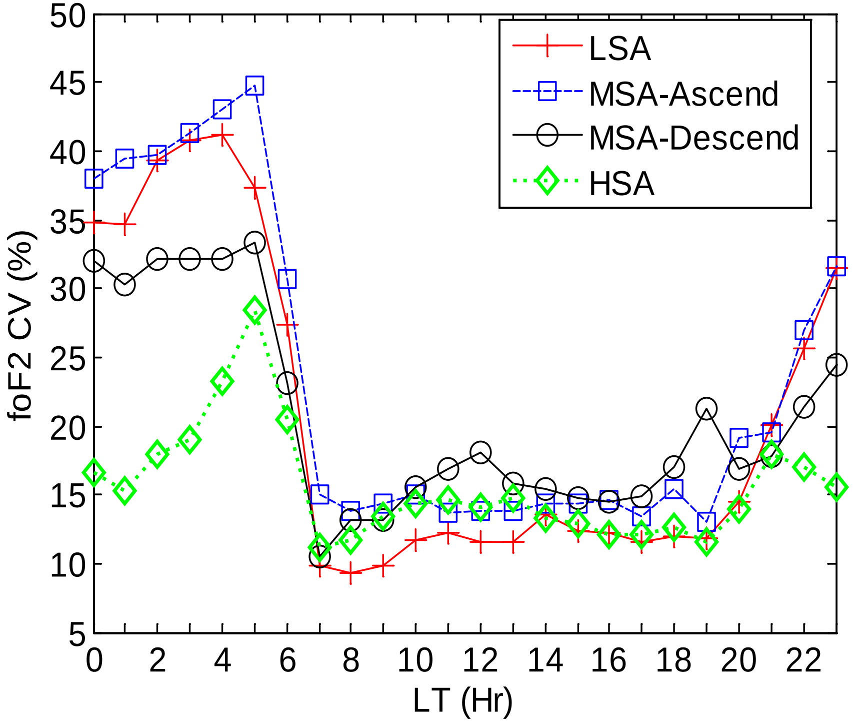


- **J-season (J-sol)**
May, June, July, August

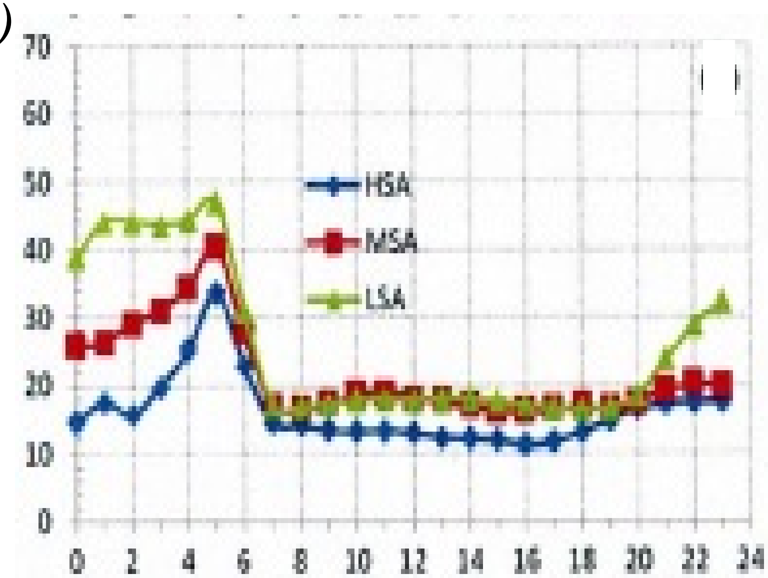
- **D-season (D-sol)**
(November, December, January, February)

- **Equinox (Equ)**
(March, April, September, October)

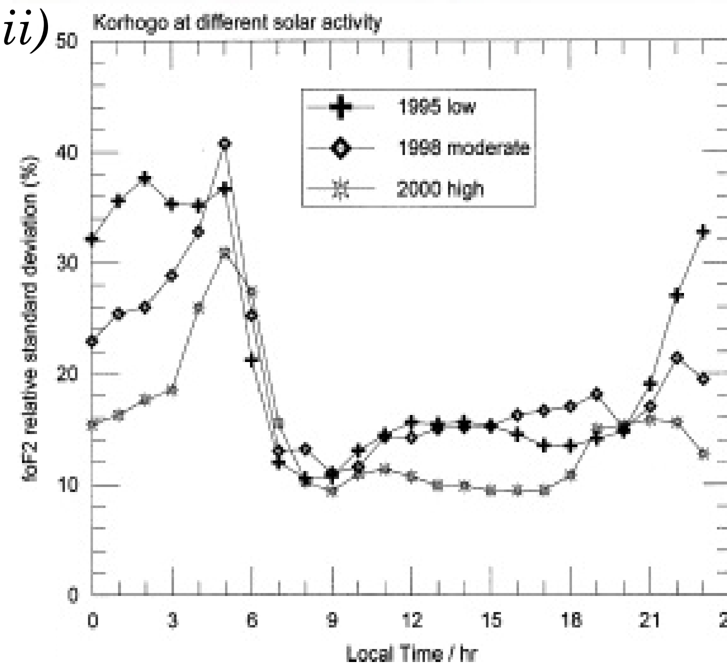
(i)



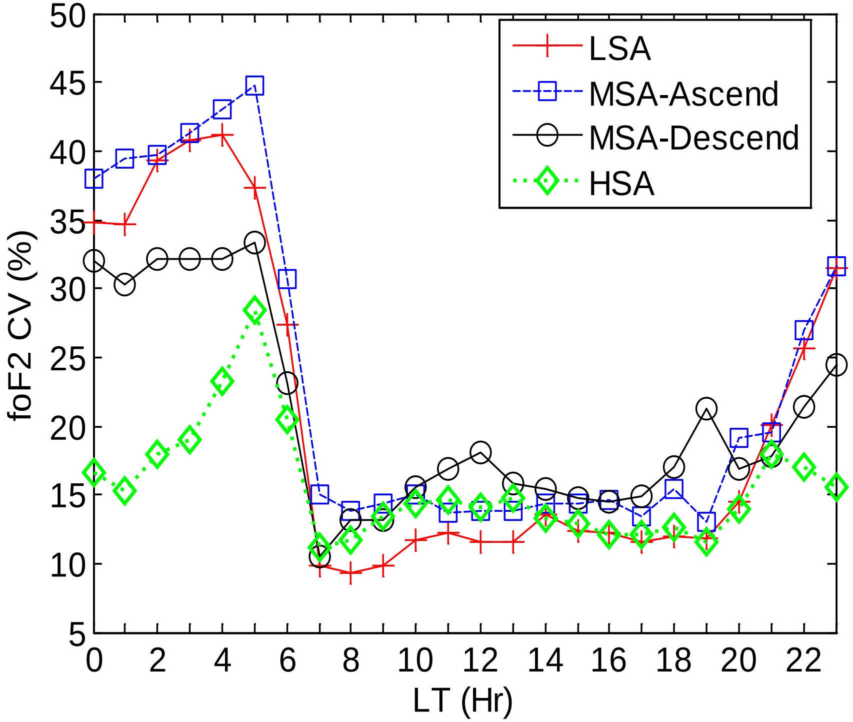
(ii)



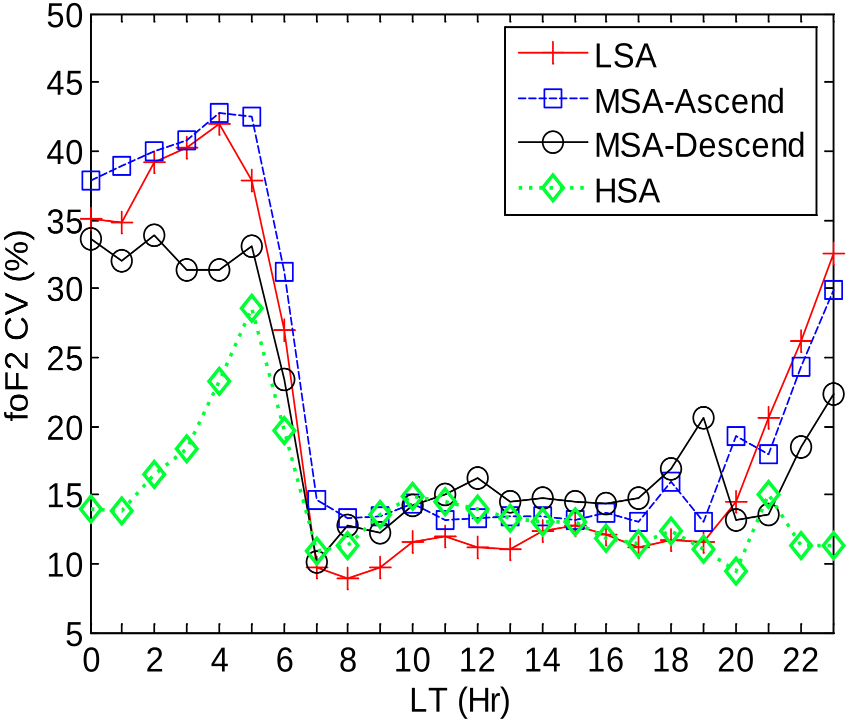
(iii)



foF2 variability at Low-latitude
(i) SC22 – Left panel (this work)
(ii) SC21 – Right Upper panel (Akala *et al.,* 2011)
(iii) SC 23 – Right Lower panel (Bilitza *et al.,* 2004)



All daily data



Excluding days with Ap ≥ 20

Conclusion

- Variability higher during daytime than nighttime in all the seasons and solar activity levels
- There is no consistent seasonal pattern in the variability
- Minimum variability consistently observed around 0700 LT irrespective of the season and solar activity phase
- Consistent with previous works, foF2 variability increases with decreasing sunspot number in the descending phase.
- The increasing foF2 variability with decreasing sunspot number may not be observable considering the year of MSA in the ascending phase.
- The asymmetry seems to be more pronounced in the D-season

R. Hanbaba, *Centre National d'Etudes des Telecommunications, Lannion, France*