Variation of N_mF_2 and h_mF_2 deduced from DPS-4 over Multan (Pakistan) and their comparisons with IRI-2007 & IRI-2012 during the deep solar minimum between 23rd and 24th solar cycles

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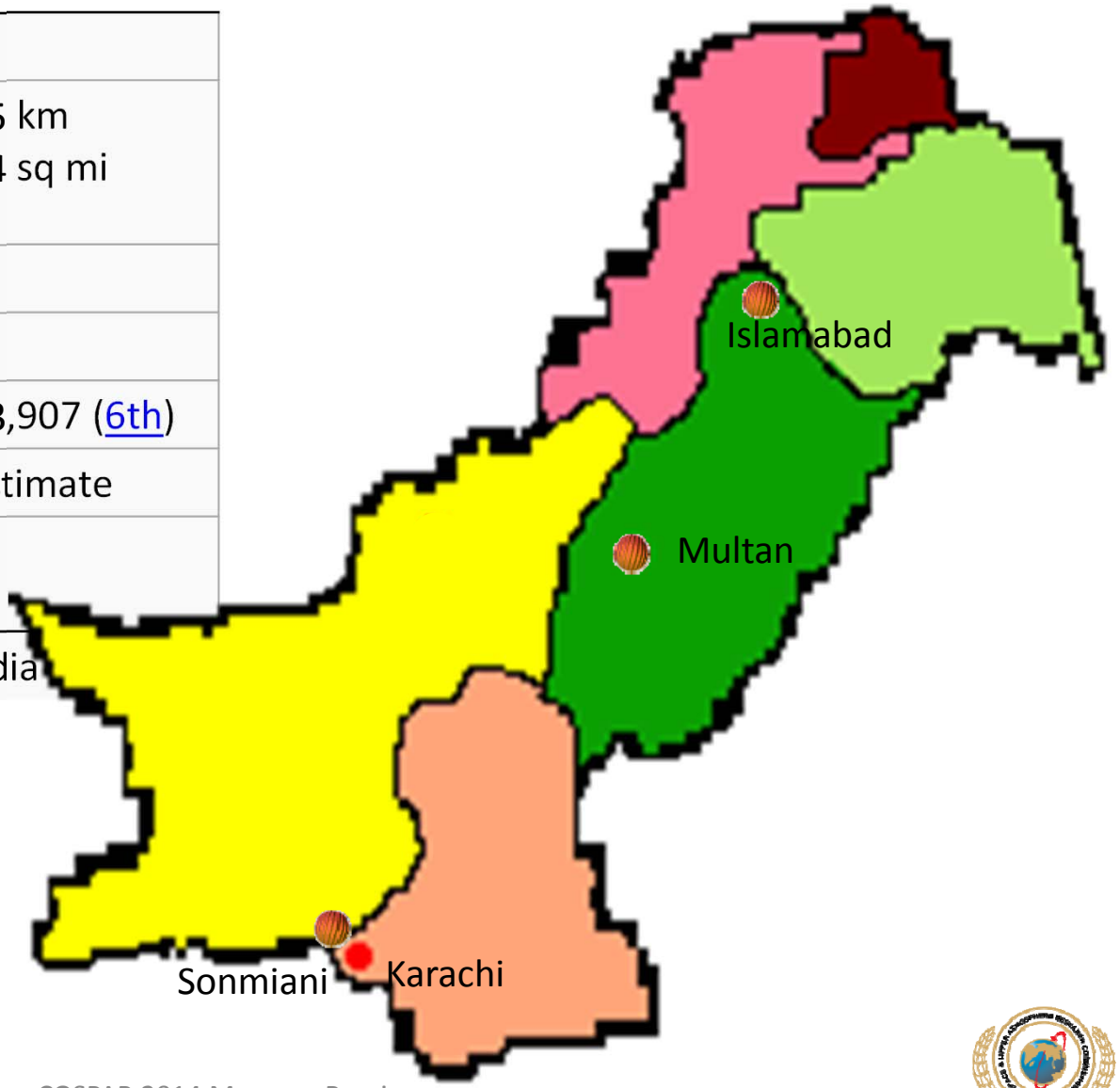
Space Weather Monitoring in Pakistan

Area		
-	Total	796,095 km 307,374 sq mi
-	Water (%)	3.1
Population		
-	2014 estimate	186,693,907 (6th)
Time Zone		2013 estimate
-	PST (PKT)	UTC+5

Wikipedia



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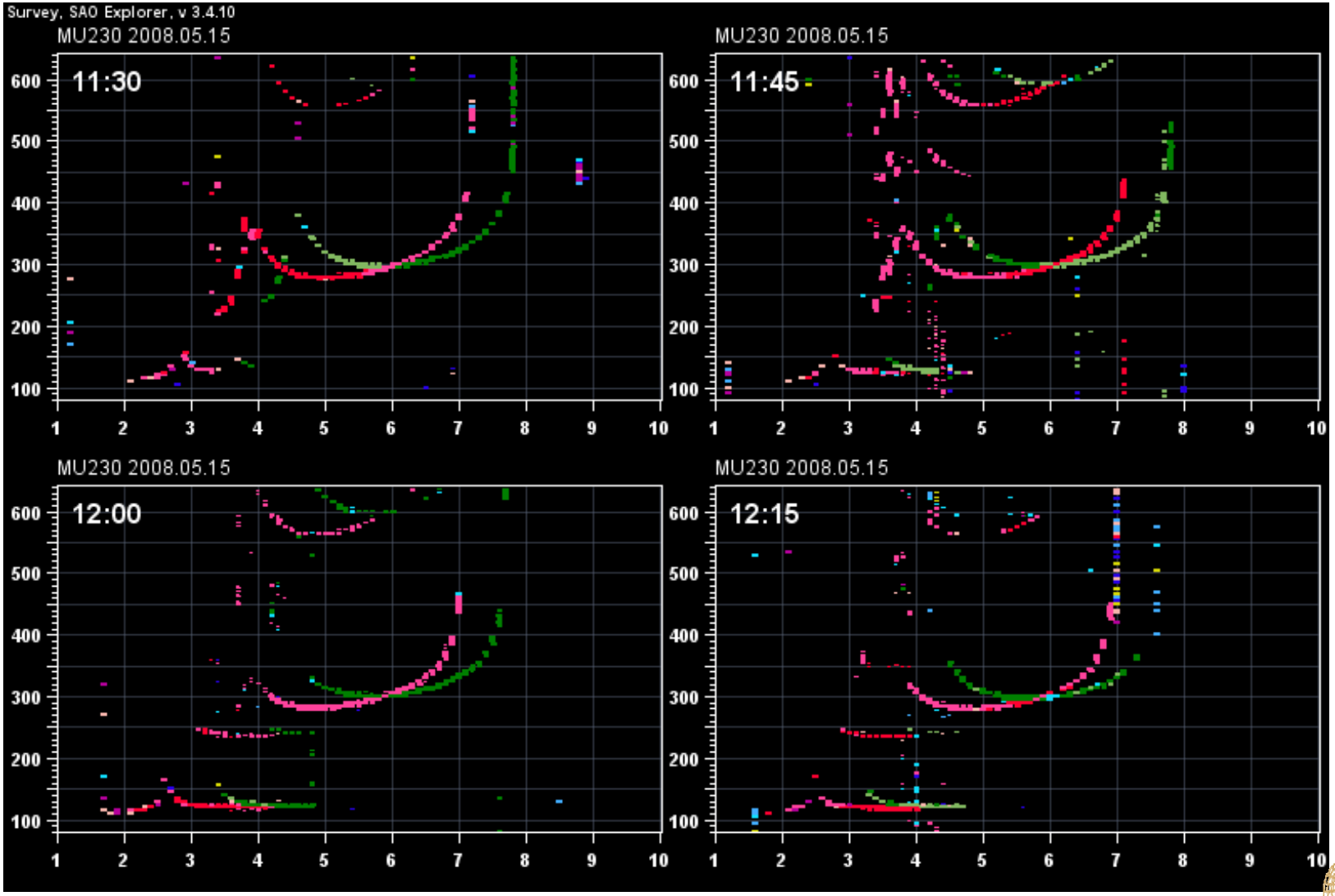
Pakistan - at GIRO

History of Multan Station

- An ionospheric station was established at Multan in the vicinity of Bahauddin Zakaria University in 1987 to cover the east-central part of the country. An old PIR-9 was shifted to Multan
- DPS-4 was installed at Multan in April 2008

From analogue to digital

Some initial ionograms



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Foreword

Digisonde DPS-4 data of Multan(geog coord. 30.18^{o}N, 71.48^{o}E) is being reported for the first time. The variations in F_2-layer peak electron density N_mF_2 and its height h_mF_2 have been studied during the deep solar minimum between 23rd and 24th solar cycles along their comparisons with IRI-2007 & IRI-2012 predications.

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Introduction

- The recent solar minimum was different
  - as it lasted for longer than the usual and
  - it was a deep solar minimum
- Period of study May 2008 – Apr 2009 (SSN<4)
- The two objectives of present study are
  - reporting the Multan DPS-4 data and
  - their comparison with two versions of IRI

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Methodology

- N_mF_2 is calculated from the critical plasma frequency, f_oF_2, of the F_2-layer by

$$N_mF_2\ (el\text{-}m^{-3}) = 1.24 \times 10^{10} \times (f_oF_2/MHz)^2$$

- h_mF_2 values are obtained from SAO-X which are based upon true height profile inversion algorithm.
- For the investigation of F_2-layer behaviours under deep solar minimum, the data under geomagnetic quiet-conditions from May 2008 to April 2009 are selected

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IQD & IDD

10 International Quietest Days (Q1-Q10) and 5 International Most Disturbed Days (D1-D5)

Month	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	D1	D2	D3	D4	D5
2008	MAY	17	14	15	18	09	12	26	27	11	13	05	03	21	28	30
2008	JUNE	13	10	05	22	11	12	04	09	21	23	15	26	14	16	07
2008	JULY	19	08	07	09	02	25	03	31	20	29	23	12	13	22	14
2008	AUGUST	25	02	26	24	30	05	29	28	04	22	09	18	10	19	17
2008	SEPTEMBER	13	12	29	21	24	11	23	02	28	26	04	15	08	07	16
2008	OCTOBER	09	18	25	24	27	17	07	08	10	14	11	29	03	02	30
2008	NOVEMBER	22	21	03	14	18	13	05	19	06	04	25	08	09	26	16
2008	DECEMBER	01	02	09	29	14	30	18	21	20	28	06	31	05	23	04
2009	JANUARY	12	22	23	11	24	28	07	18	25	17	03	26	19	01	31
2009	FEBRUARY	08	02	17	10	19	13	26	09	06	07	14	04	27	15	24
2009	MARCH	02	07	09	18	06	23	01	31	29	28	13	14	08	25	15
2009	APRIL	04	23	02	30	07	03	28	14	26	29	09	11	18	10	12

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Methodology

- The modelled values h_mF_2 and N_mF_2 are predicted by the IRI-2007 and IRI-2012
- h_mF_2 is modelled through its close correlation with the propagation factor $M(3000)F_2$
- Mapping options

Parameters	IRI-2007	IRI-212
N_mF_2	CCIR, URSI	CCIR, URSI
h_mF_2	CCIR	CCIR

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Methodology

- It is noted that the IRI uses ionosphere-effective IG_{12} to predict N_mF_2 (f_oF_2) and the sunspot number, R_{z12} for h_mF_2
- Moreover, the observed A_p and $F_{10.7}$ indices are used in the IRI modelling for month-to-month variability
- Since the ionosphere can be disturbed even under quiet magnetic conditions, therefore monthly hourly observed and modelled data under geomagnetic quiet-conditions are applied in this study

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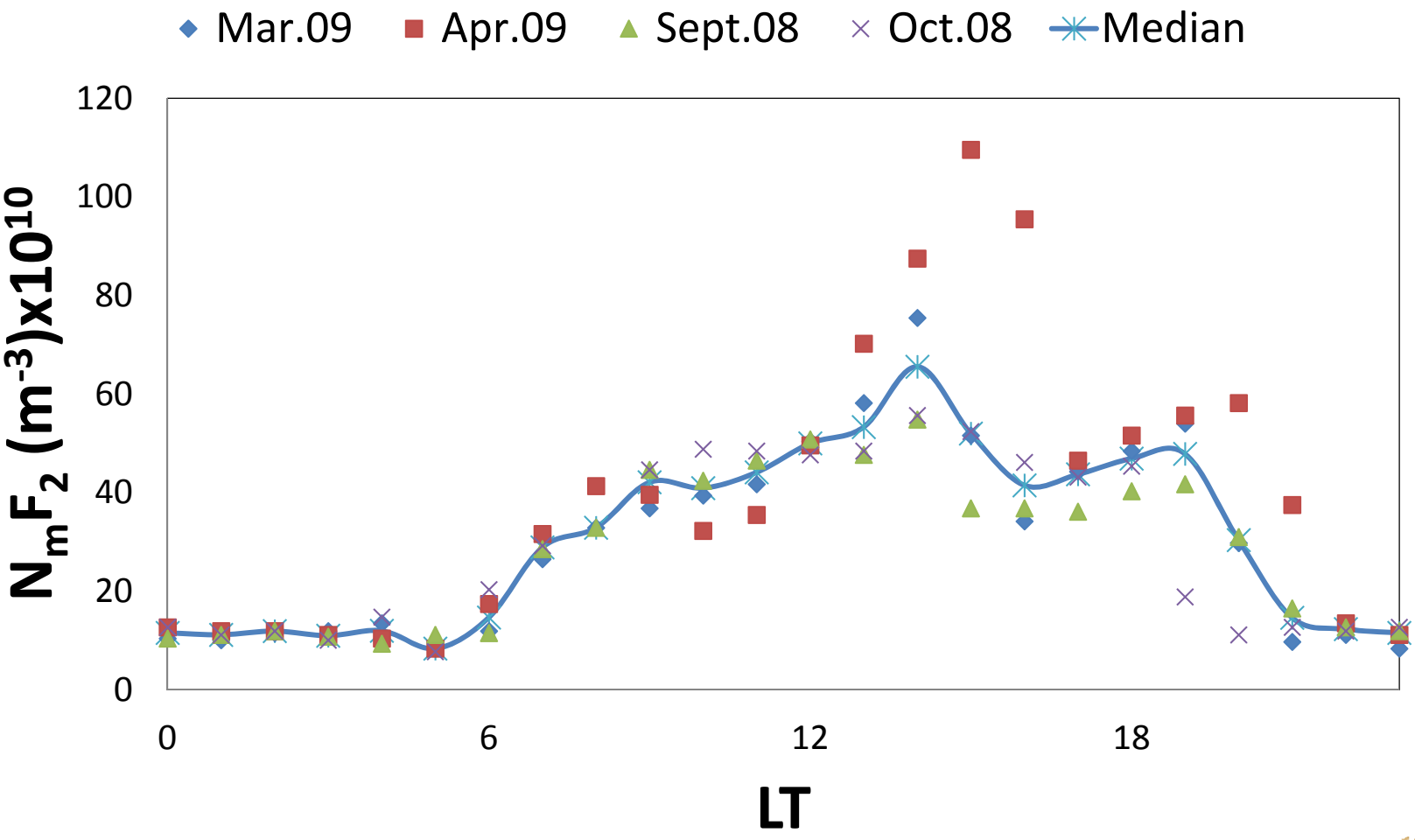
N_mF_2 over Multan for Equinox



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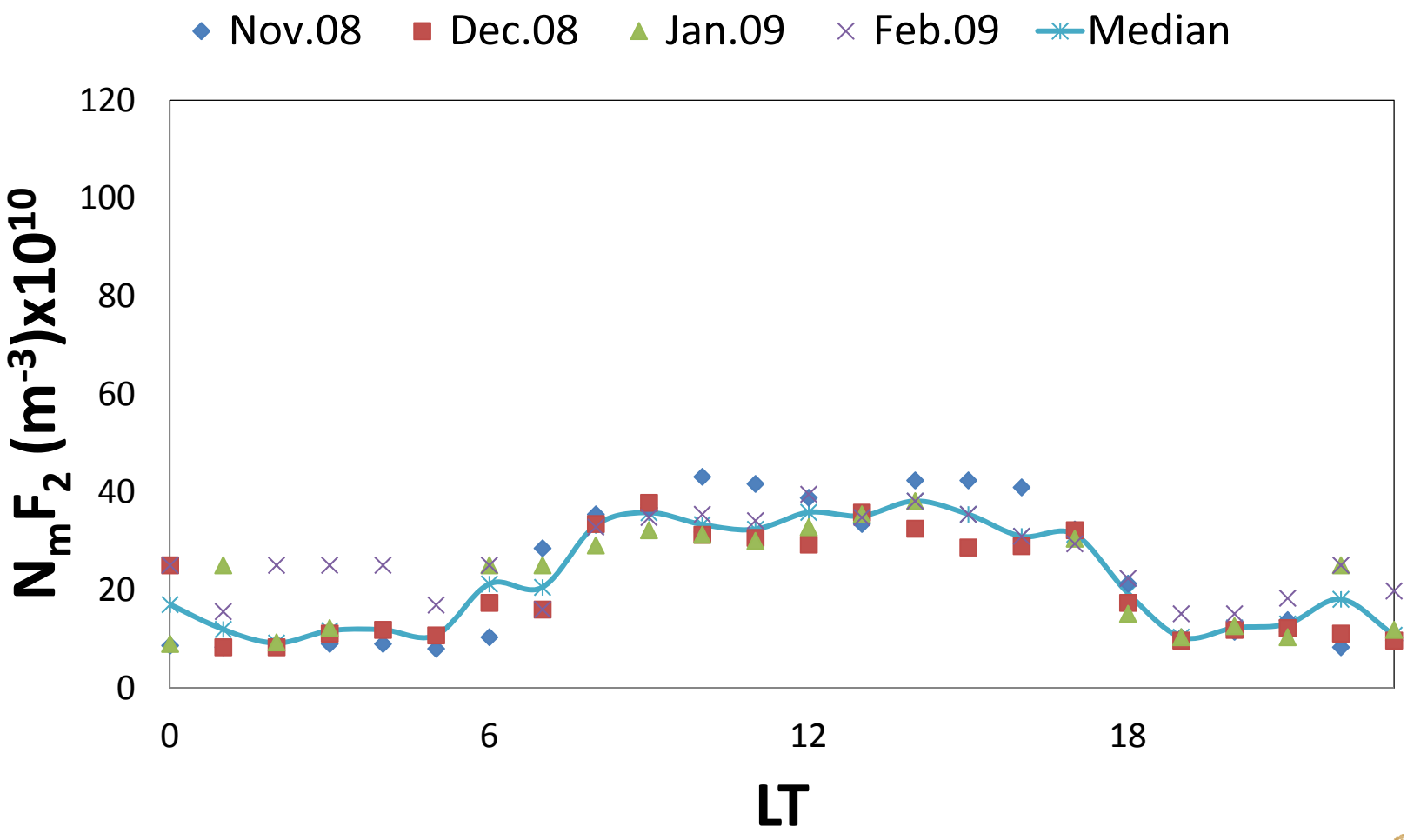
N_mF_2 over Multan for Winter



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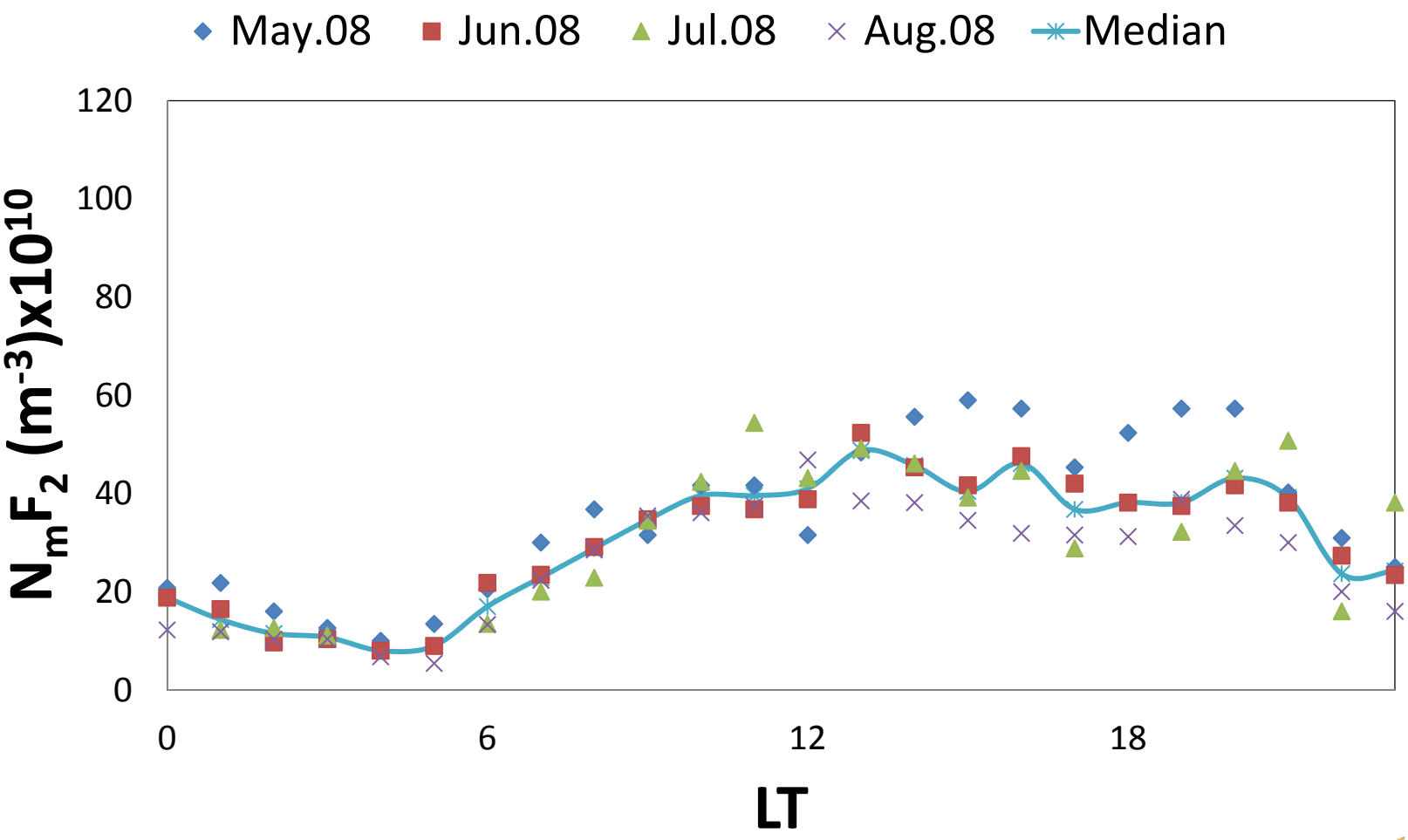
N_mF_2 over Multan for Summer



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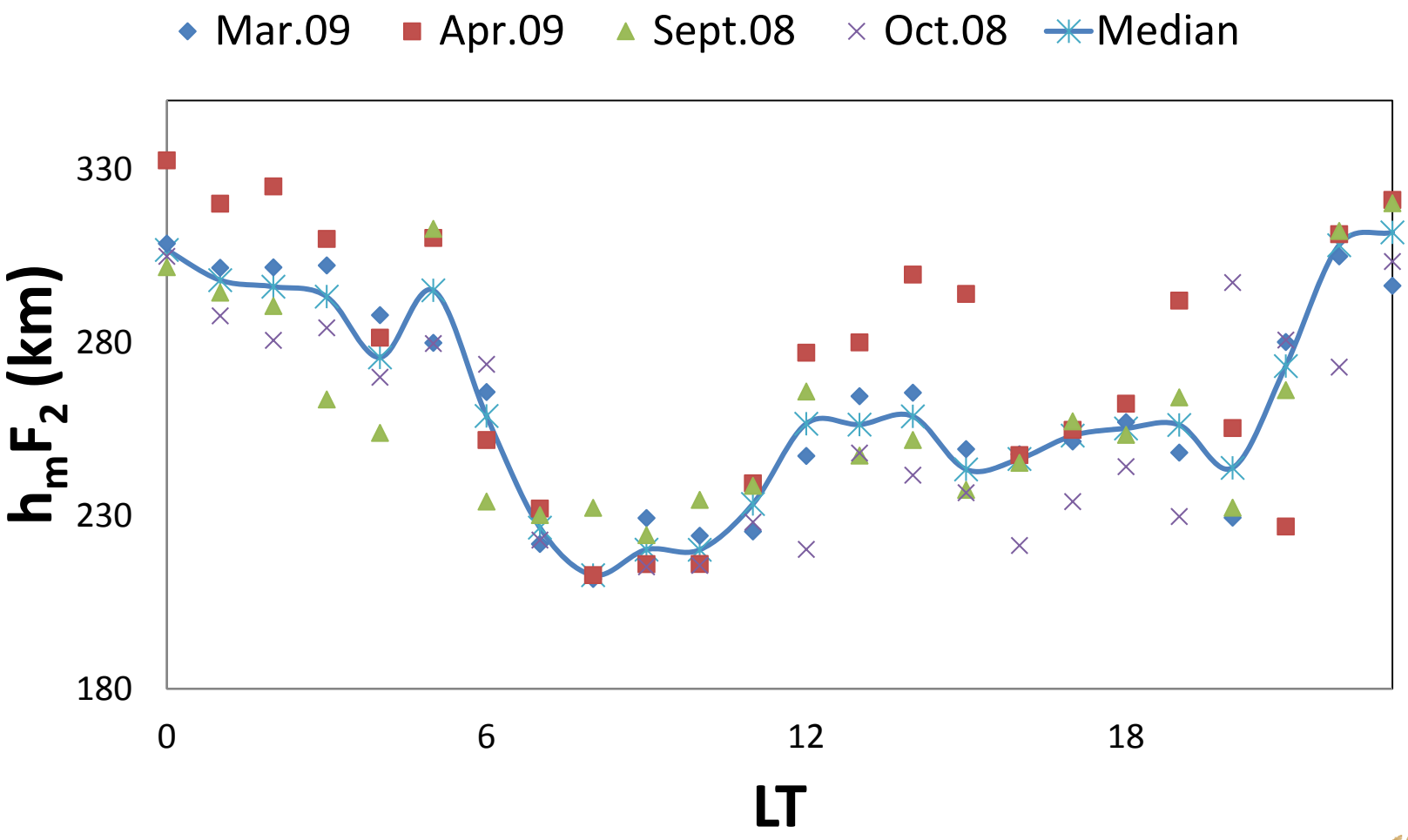
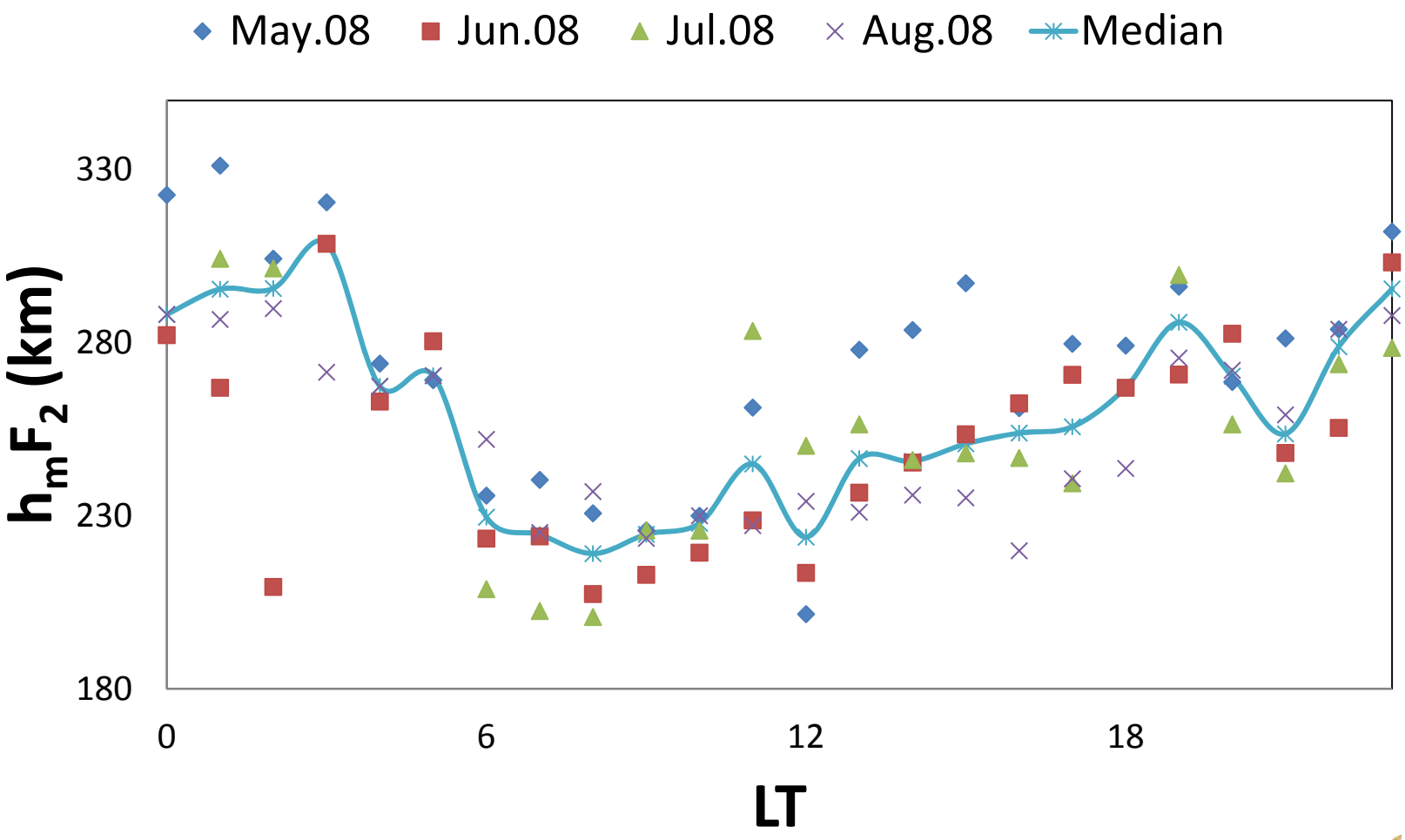
h_mF_2 over Multan for Equinox



h_mF_2 over Multan for Winter



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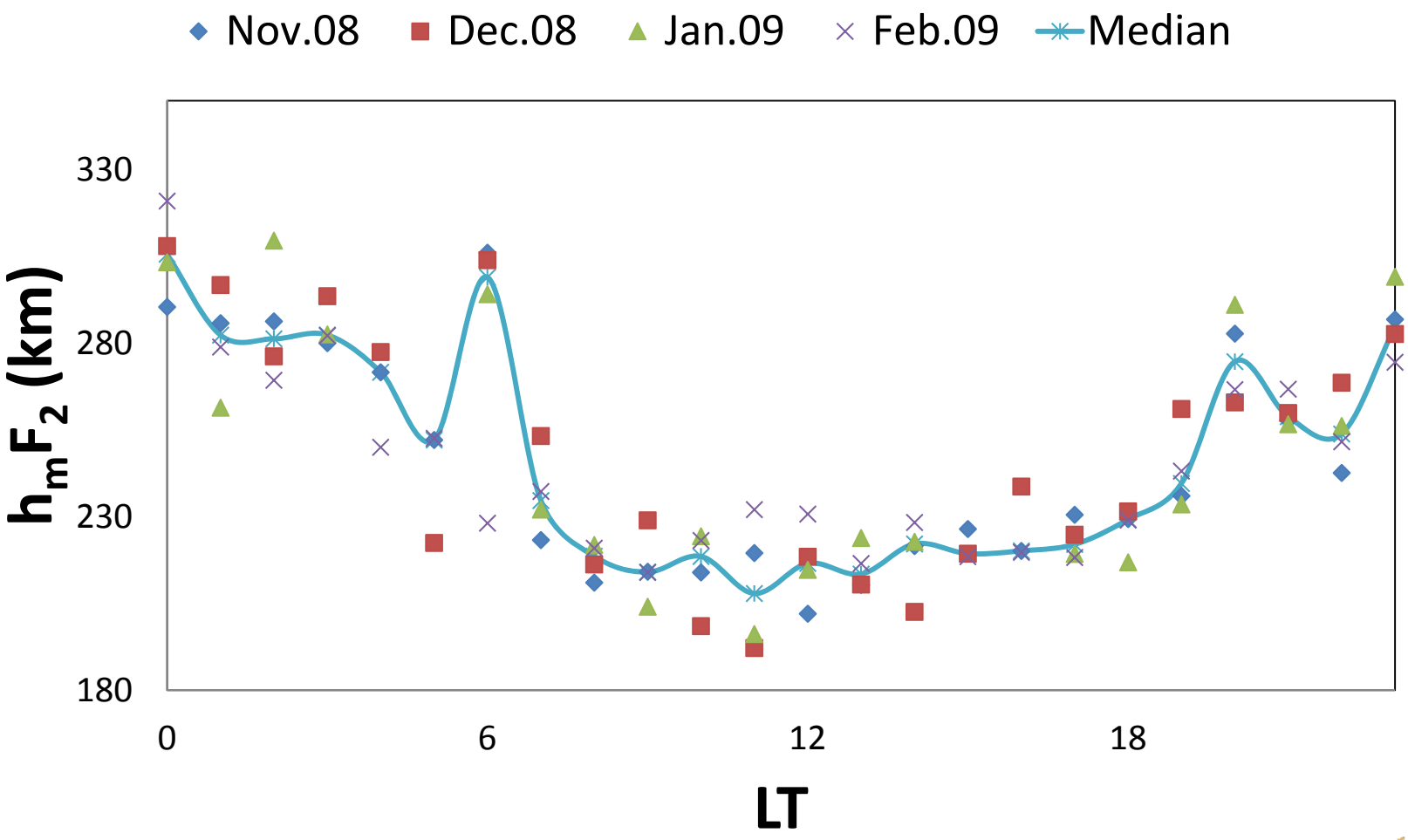
h_mF_2 over Multan for Summer



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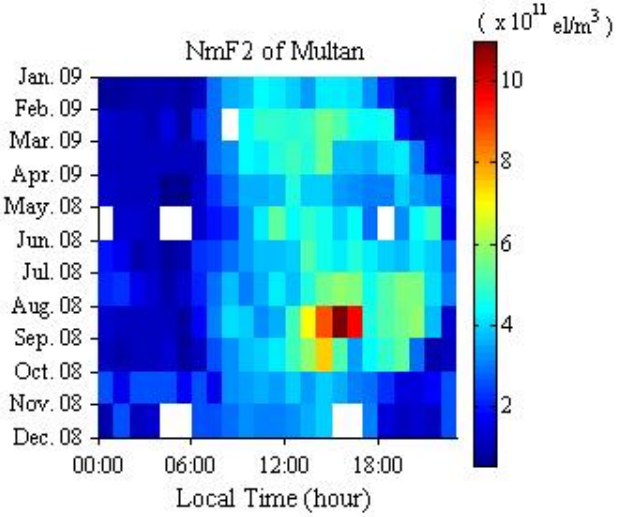
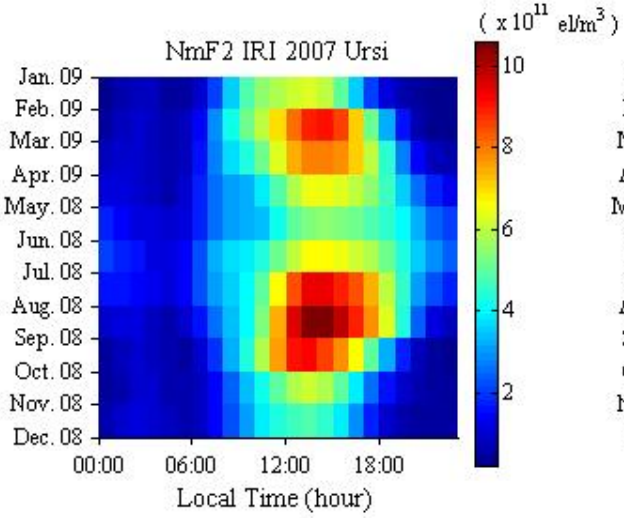
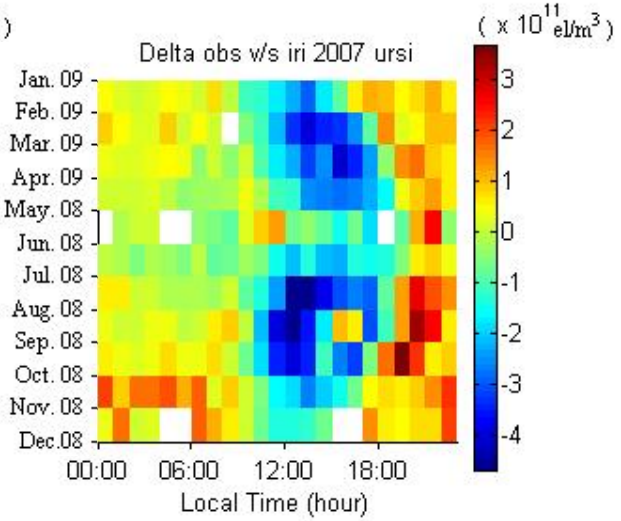
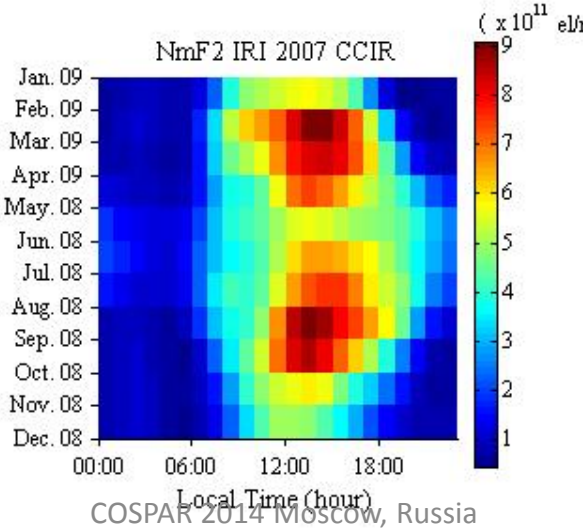
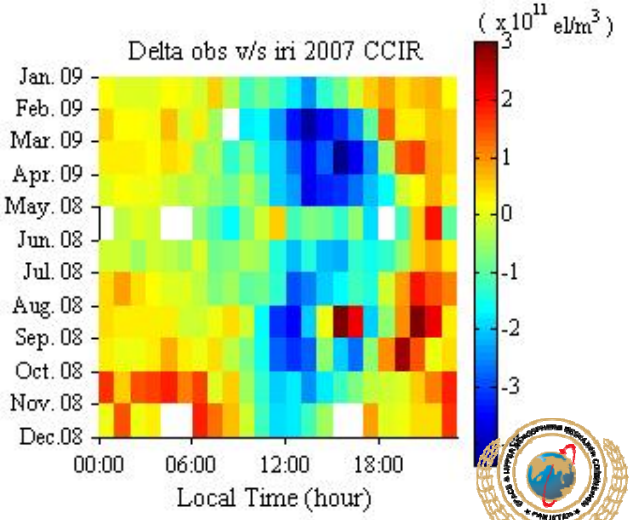
N_mF_2 comparison with IRI-2007











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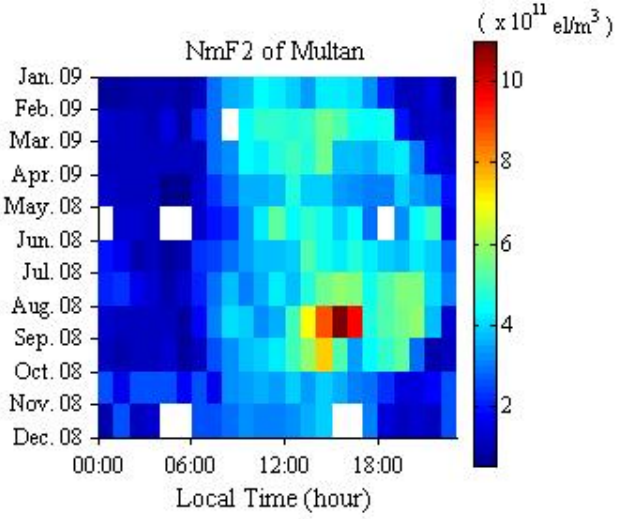
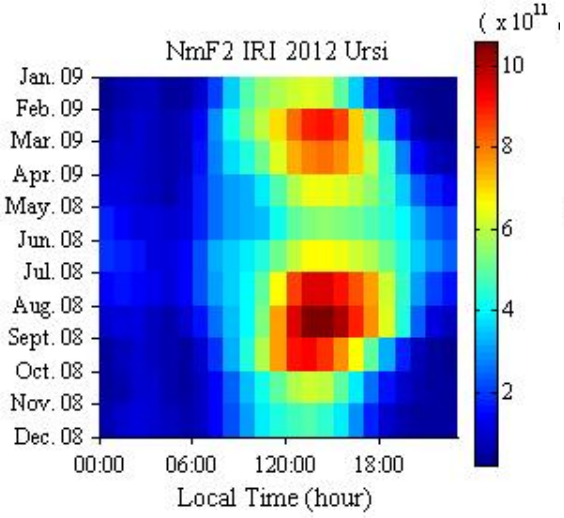
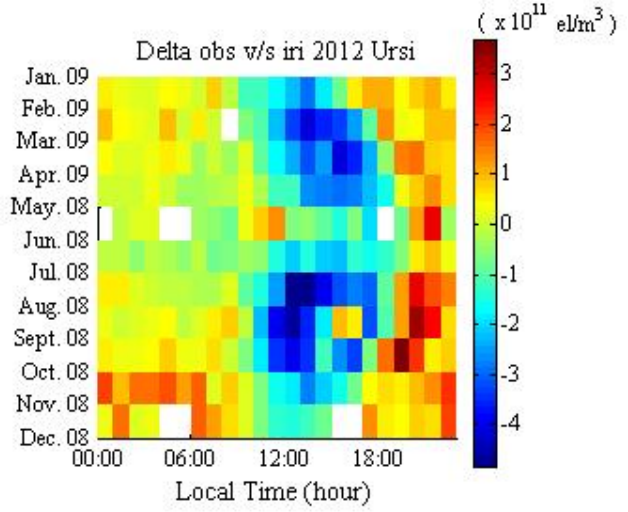
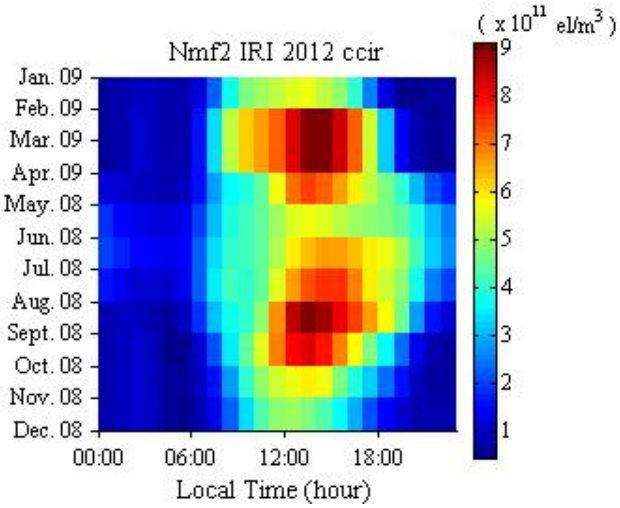
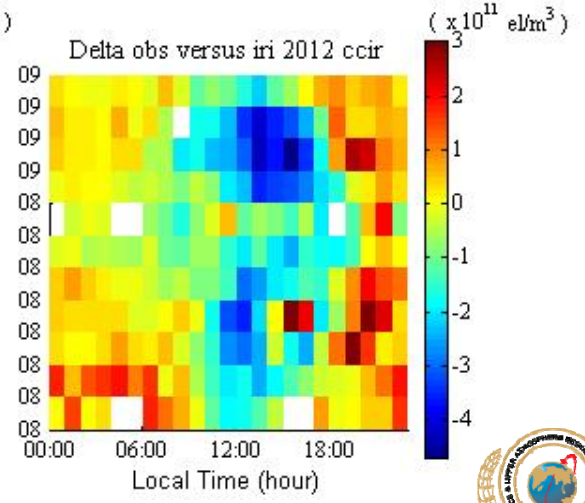
N_mF_2 comparison with IRI-2012











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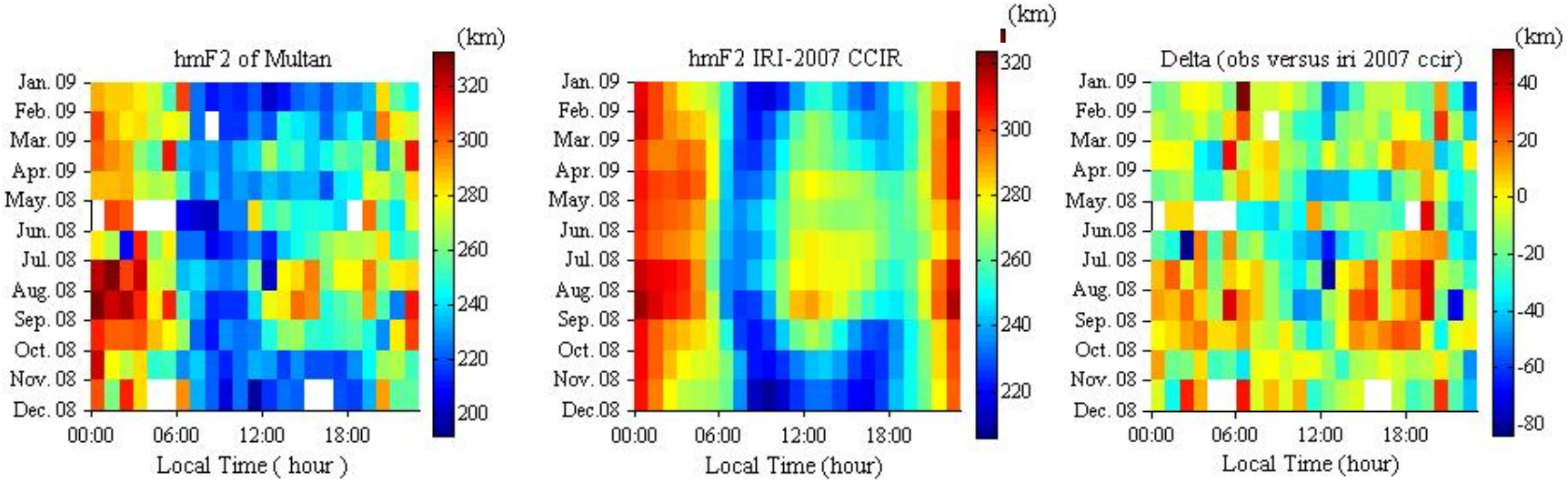
h_mF_2 comparison with IRI-2007



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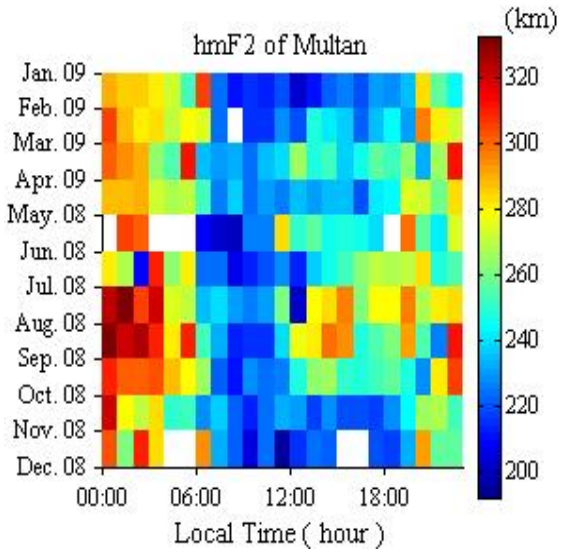
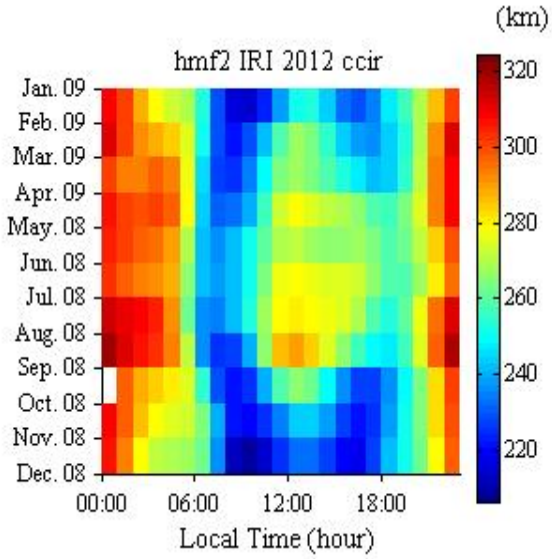
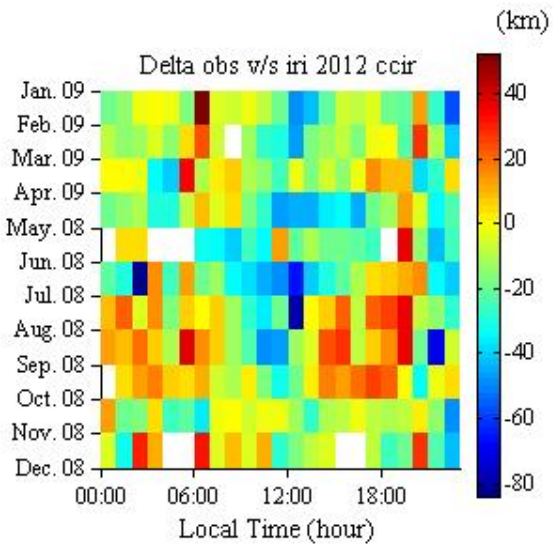
h_mF_2 comparison with IRI-2012







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Results & Conclusion

- The observation results show that the N_mF_2 values are greater and smaller during daytime and nighttime, respectively.
- The h_mF_2 observations show sunrise peaks along with some prominent pre-sunrise peaks in some months.
- Seasonal variations show that the daytime N_mF_2 are greater in the equinox and summer months, while the daytime h_mF_2 are slightly greater in the equinox and winter months.
- Comparison of observations with IRI (next slide)

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Results & Conclusion

- The observed h_mF_2 values are closer to IRI-2007 than to IRI-2012.
- The NmF2 of URSI map of IRI-2012 agrees well with the observations in equinox.
- The IRI-2007 agrees better with the N_mF_2 observations for winter and summer than IRI-2012, whereas IRI-2012 is closer to the observations for equinox months.

- Since Multan lies at the verge of low and mid-latitude and hence both E×B drifts and thermospheric winds are affecting the location

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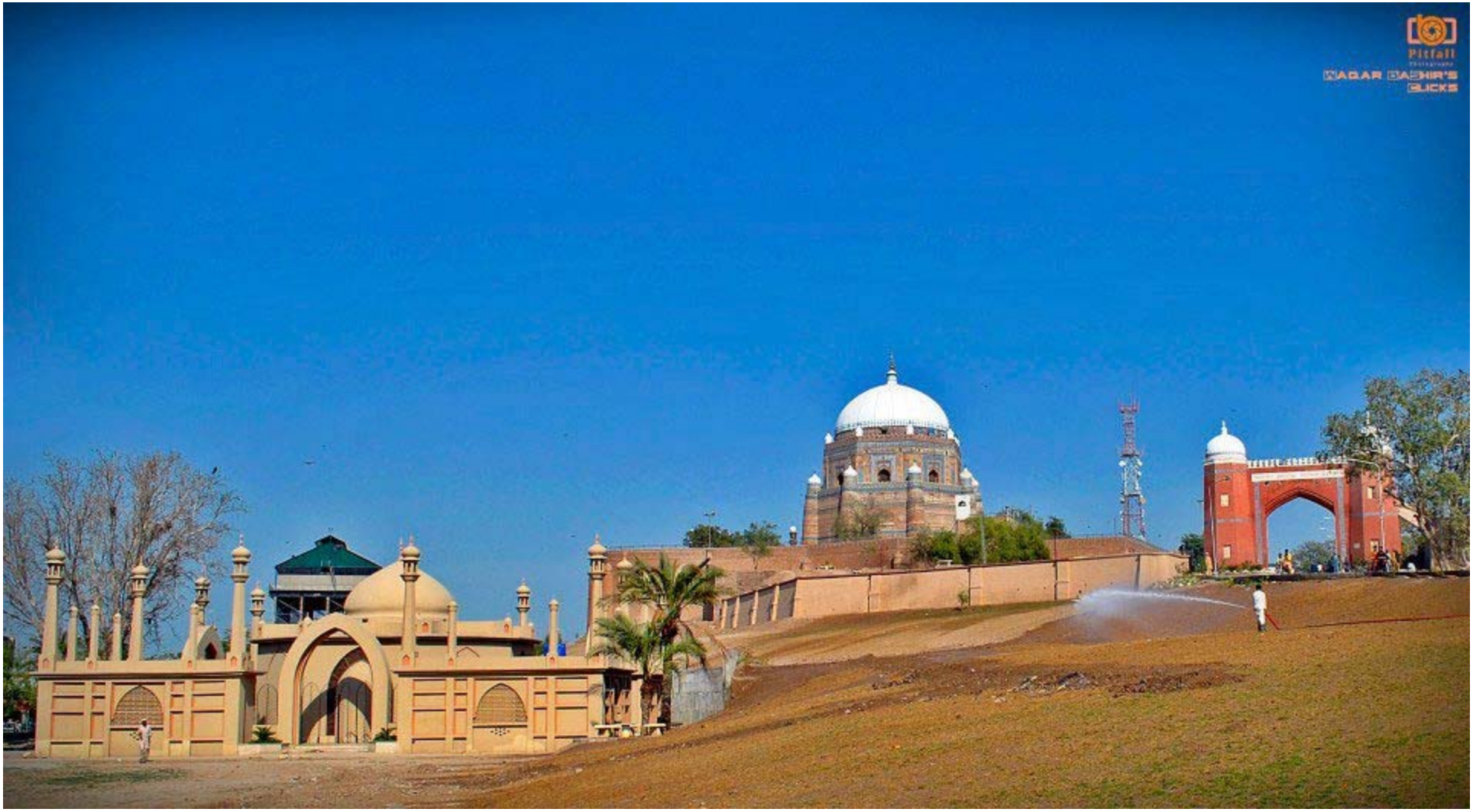

спасибо

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