Air Force Research Laboratory

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Statistics of High-Latitude Neutral Density Maxima

Cheryl Huang[1], Yanshi Huang[2,3], Yi-Jiun Su[1] and Eric Sutton[1]

[1]AFRL

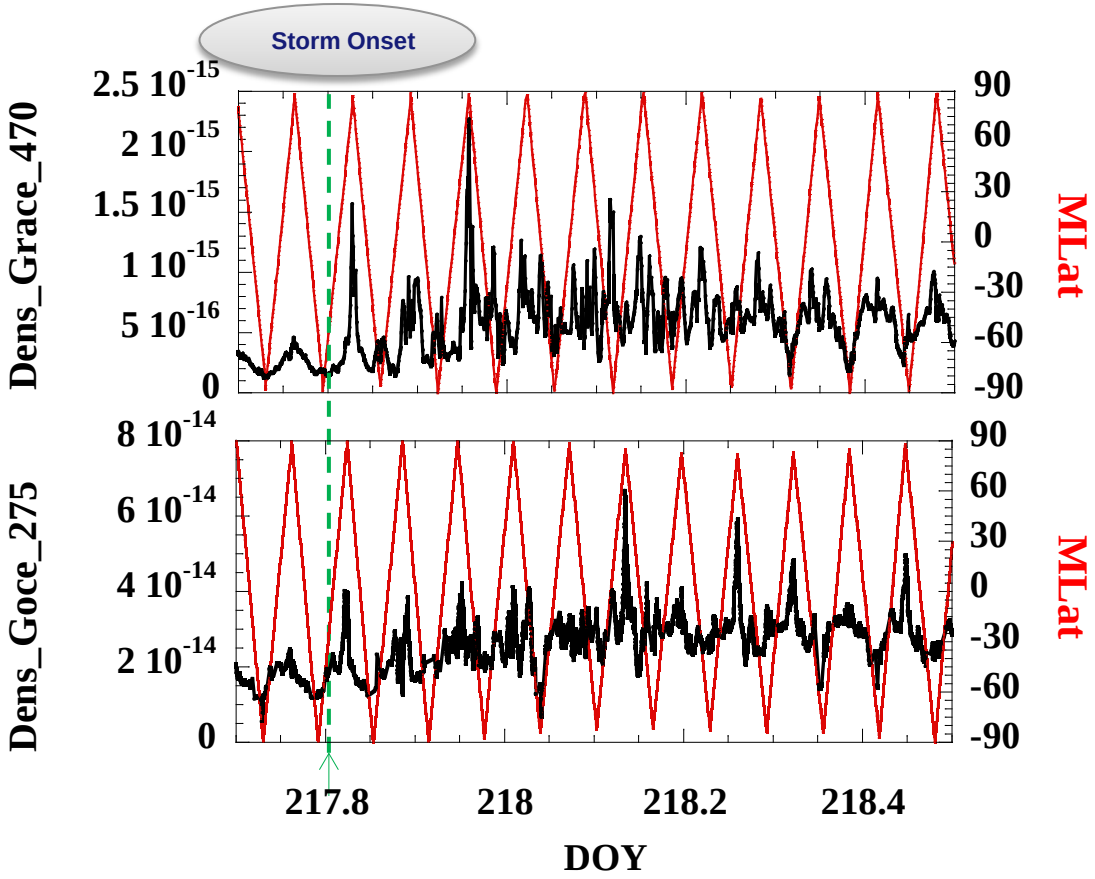
[2] U. New Mexico

[3] COSMIAC

MIT Coupling
24 June 2015
CEDAR

Thermospheric Response to Magnetic Storm Onset

GRACE, GOCE Observations - 5 August 2011



Shortly after storm onset, transient localized maxima in neutral density are observed at high latitudes – evidence of rapid Joule heating.

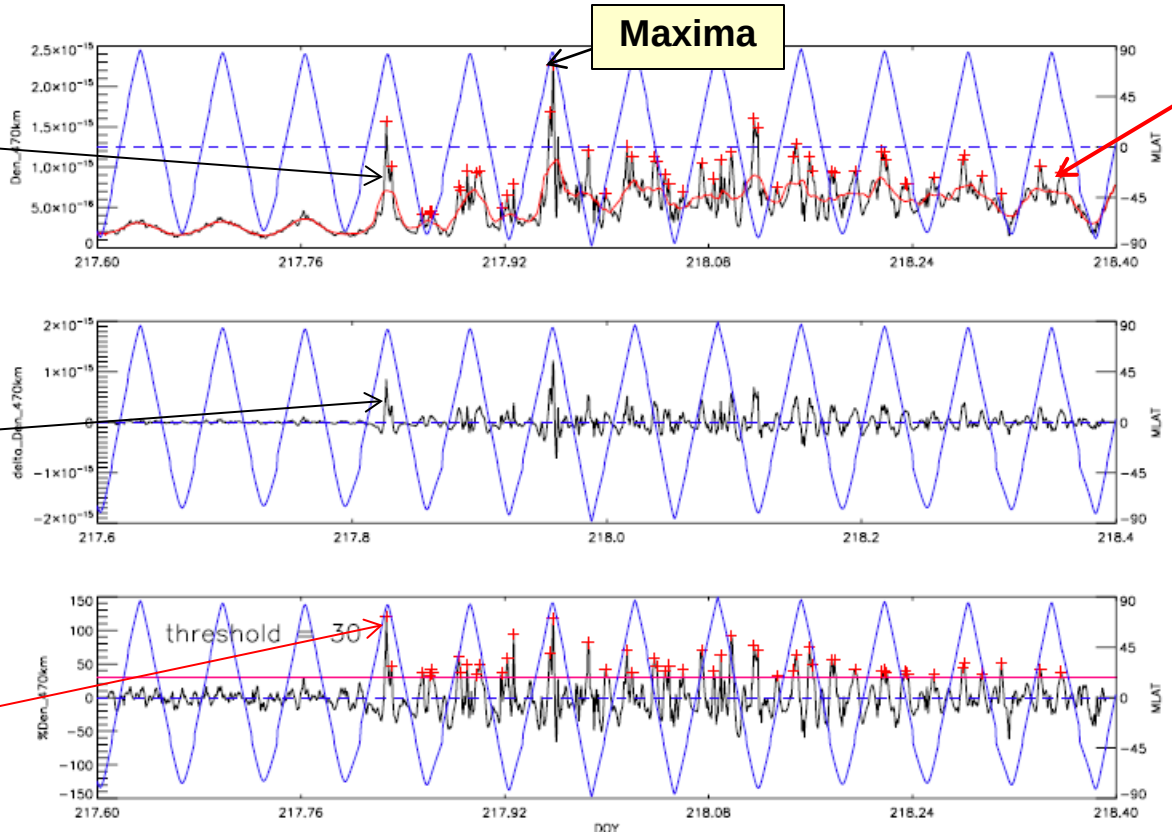
Carry out statistical analysis of accelerometer data from CHAMP, GRACE.

Neutral Density Maxima
August 2011 Storm

GRACE Original data

Residuals = $\rho_{orig} - \rho_{mean}$

Maxima = 30% above mean



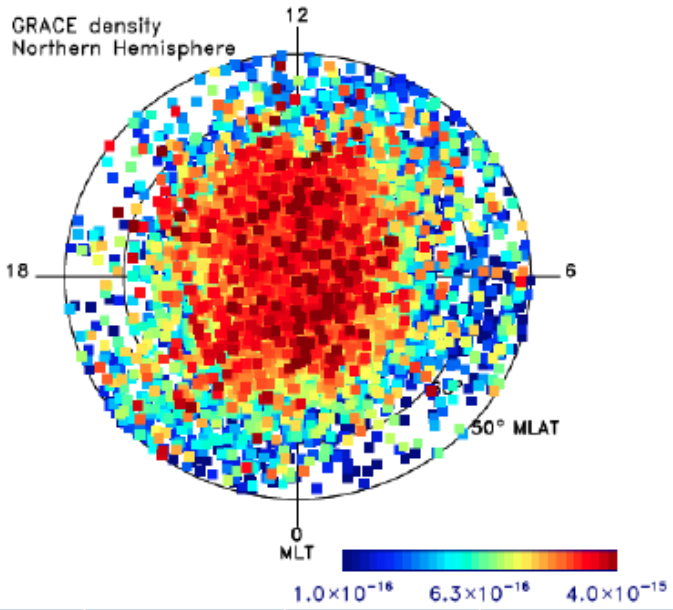
Maxima in the observed neutral densities are defined as follows:

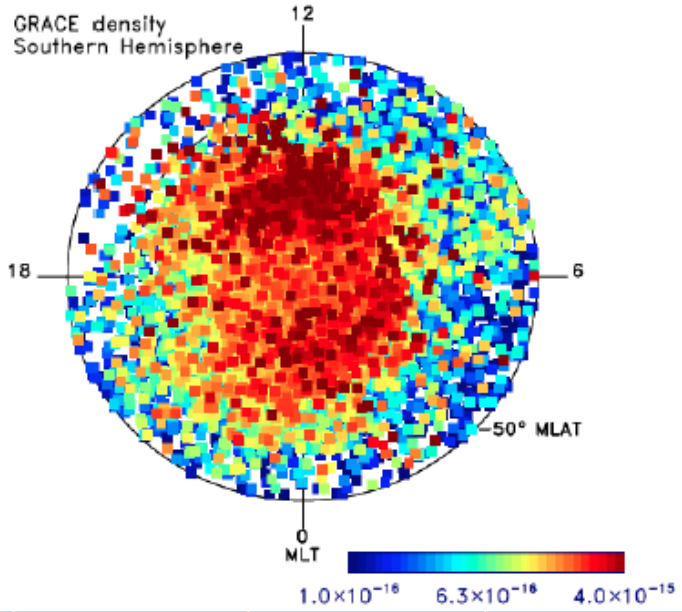
1. **A running mean over 23 minutes or about 90º MLat is applied to the data;**
2. **Densities larger than a fixed percentage above the mean are selected as maxima.**

We use 30% as a default value for our selected maximum values unless stated otherwise.

GRACE Density Maxima 2002-2012

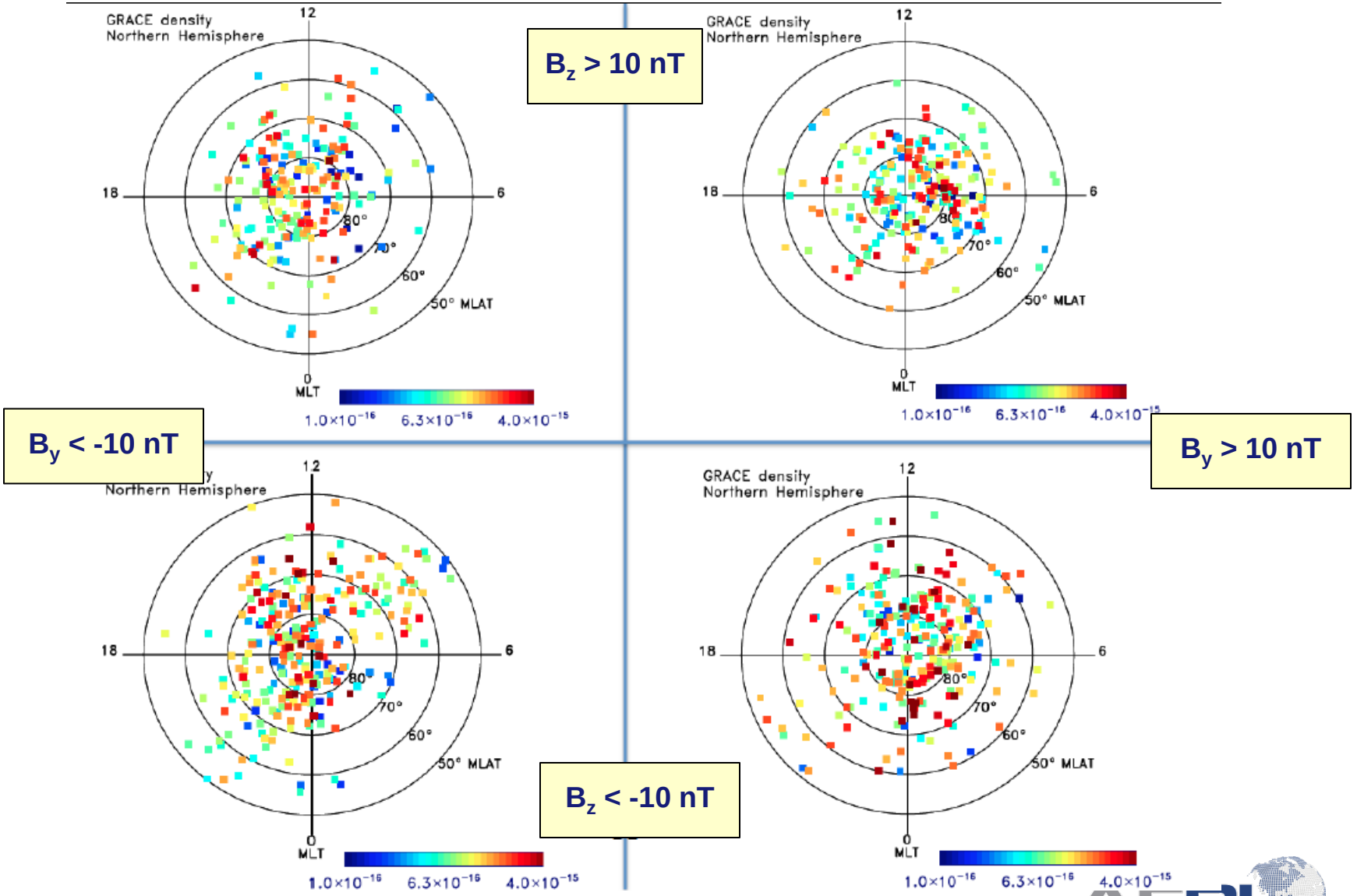
GRACE density peaks (2002-2012)



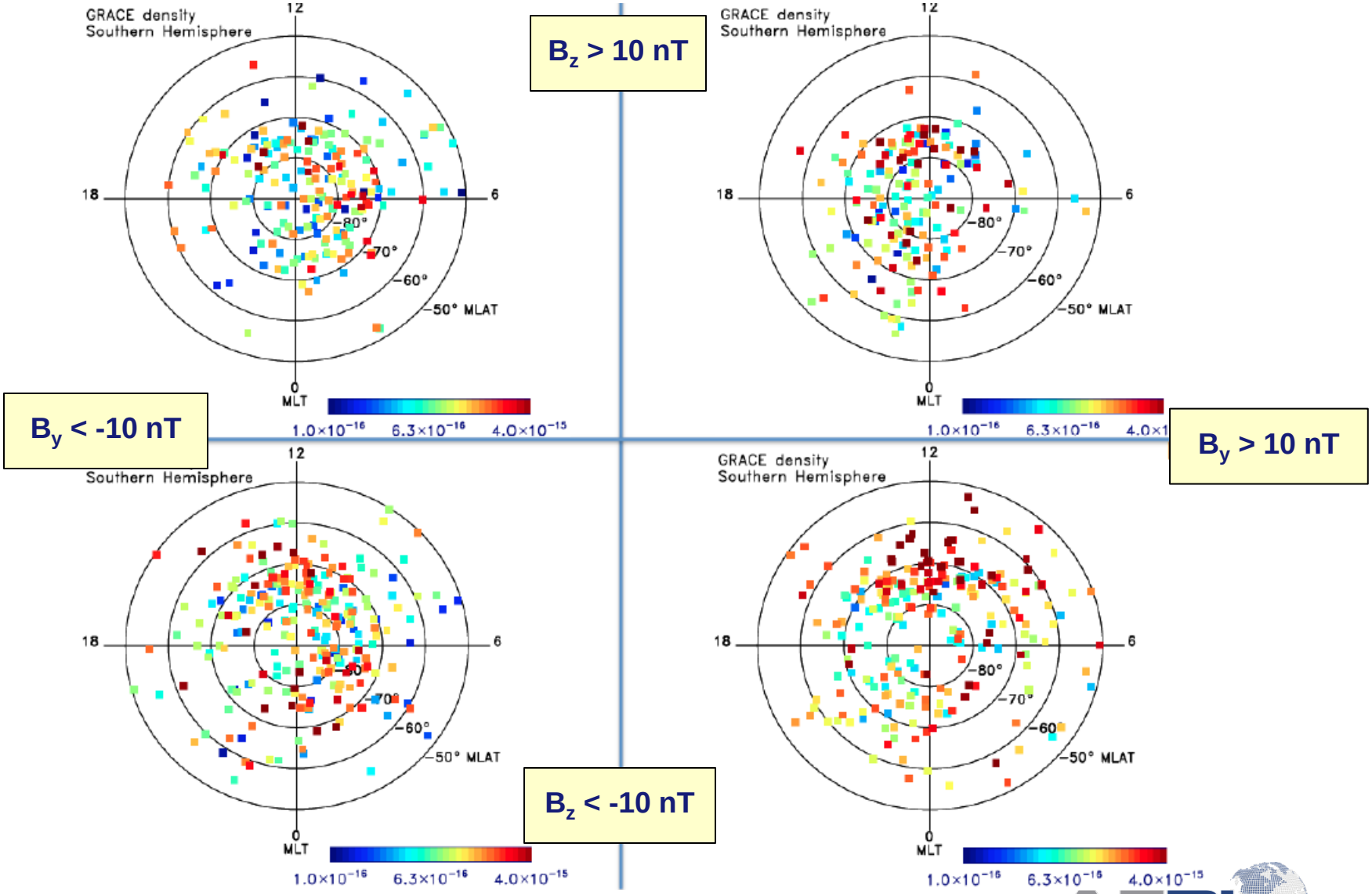


NH	mlat	mlt	By	Bz	press	symh
Avg	78.0287	11.8976	0.0121133	-0.574007	2.63860	-14.5636
Median	(79.7668)	(11.9107)	(-0.0764350)	(-0.450000)	(1.97510)	(-10.1172)
Std.Dev.	[7.16712]	[6.71248]	[4.95462]	[4.13746]	[2.69172]	[23.7880]
SH	**mlat**	**mlt**	**By**	**Bz**	**press**	**symh**
Avg	-74.7061	11.5906	-0.128408	-0.627343	2.62389	-15.5745
Median	(-75.7735)	(11.6888)	(-0.193360)	(-0.536006)	(2.00833)	(-11.0000)
Std.Dev.	[7.41058]	[6.43517]	[4.91406]	[4.27948]	[2.66937]	[25.2021]

Dependence of GRACE NH Neutral Density Maxima on IMF B_y, B_z

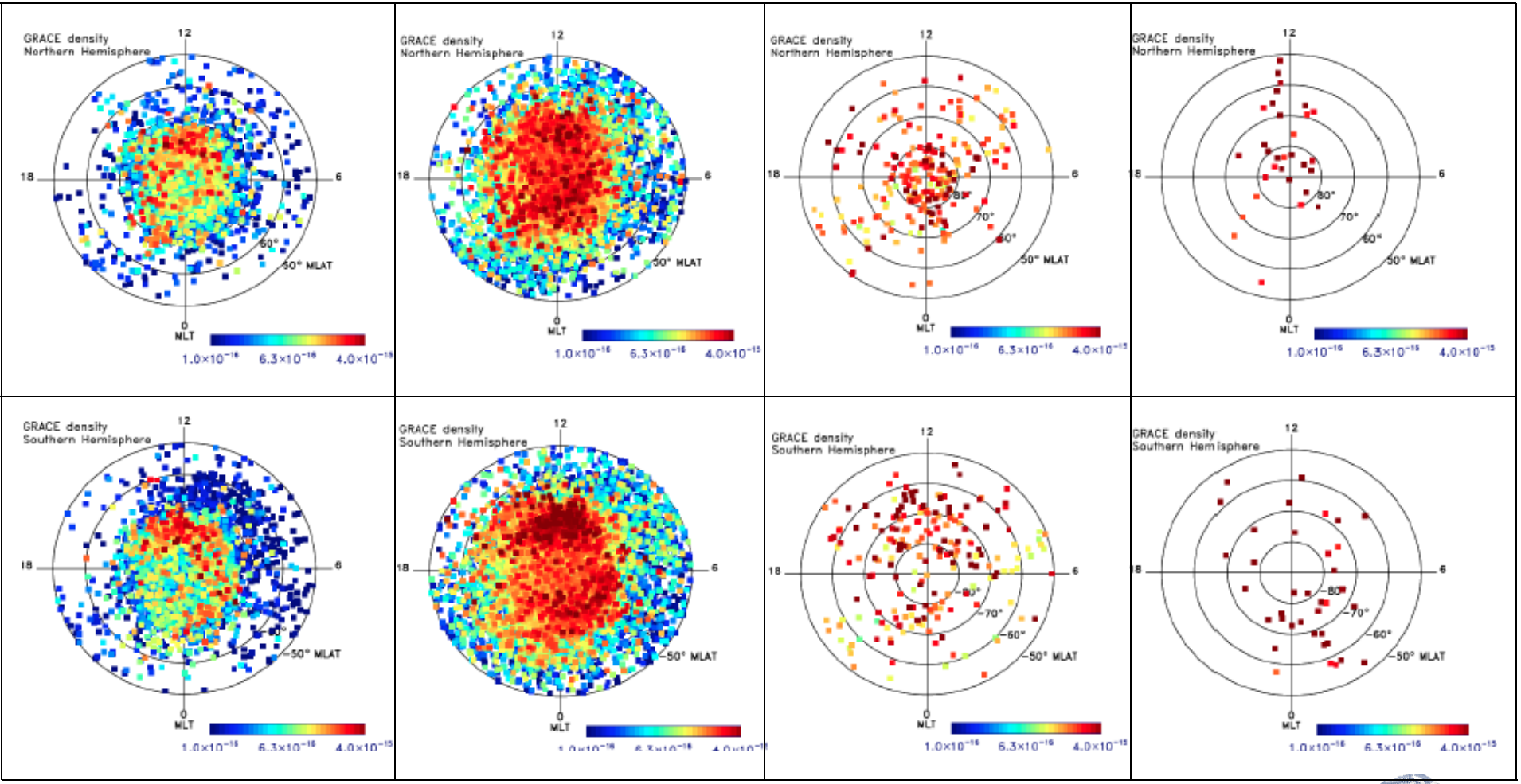


Dependence of GRACE SH Neutral Density Maxima on IMF B_y, B_z



GRACE Neutral Density Maxima
Dependence on SymH

SymH $\geq$0 nT	0$>$SymH $\geq$-100 nT	-100$>$SymH $\geq$-200 nT	SymH $<$-200 nT

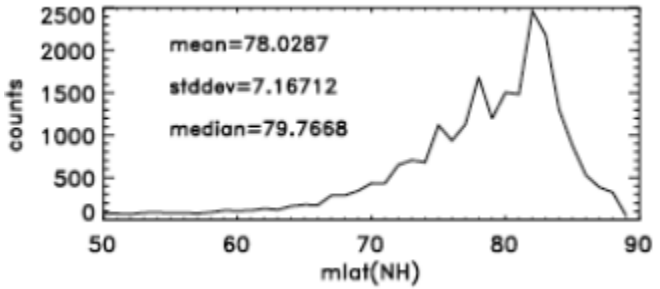


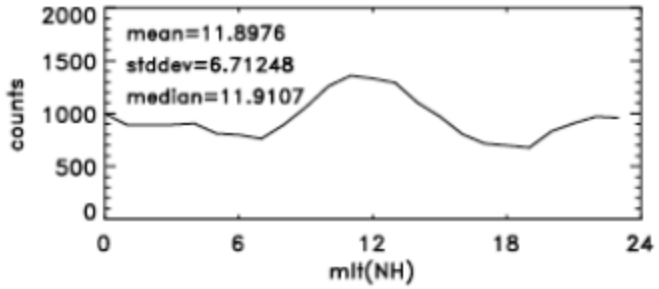
GRACE Neutral Density Maxima

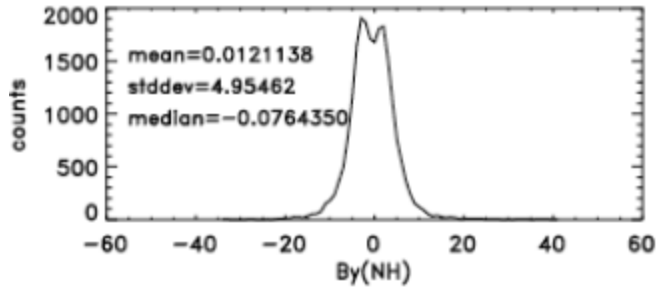
MLat, MLT Distributions

IMF B_y Dependence

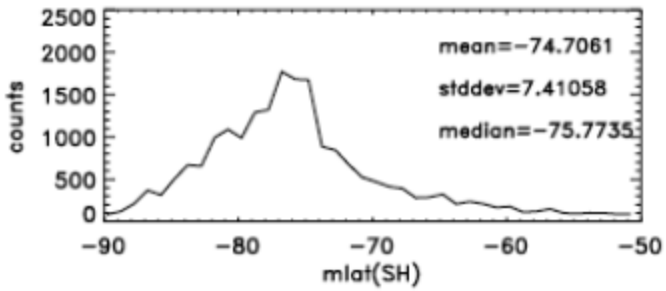
Northern Hemisphere

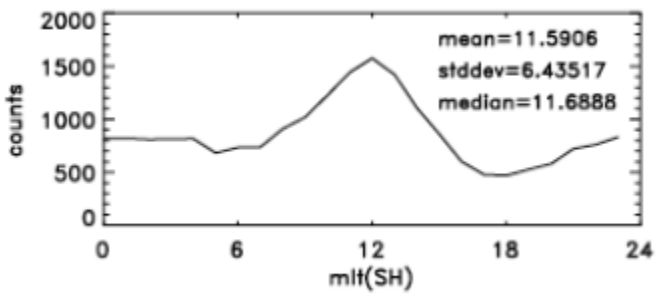


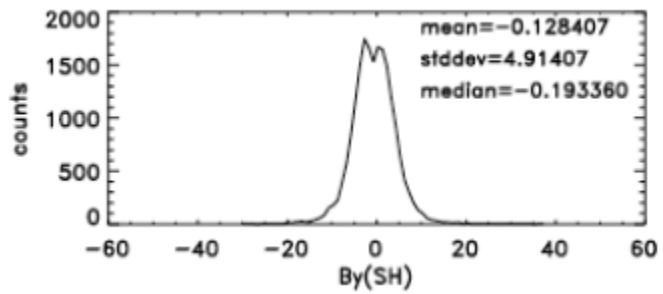




Southern Hemisphere







Conclusions

- **CHAMP results are very similar to GRACE (see CEDAR-GEM Modeling Challenge, Thursday morning) . The main difference between CHAMP and GRACE is that there are fewer maxima at CHAMP than at GRACE possibly due to CHAMP's initial and subsequent lower altitudes = higher ambient density.**

- **The maxima occur predominantly at polar latitudes under all conditions.**

- **The average MLat in both datasets in the NH is 78º, in the SH it is -75º, with standard deviation of about 7º in both hemispheres. Average MLT is 11.5-12, with standard deviation of about 6 hours.**

- **There appears to be a hemispheric asymmetry in both CHAMP and GRACE data, with a stronger cusp feature in the SH in both datasets.**

- **The spatial distribution of neutral density maxima is NOT the same as spatial distribution of Poynting flux and NOT the same as ion temperature measured by DMSP. Energy dissipation and Joule heating of ions and neutrals are not simple linear processes.**