Air Force Research Laboratory

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High-Latitude Neutral Density Maxima

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CEDAR-GEM Modeling Challenge
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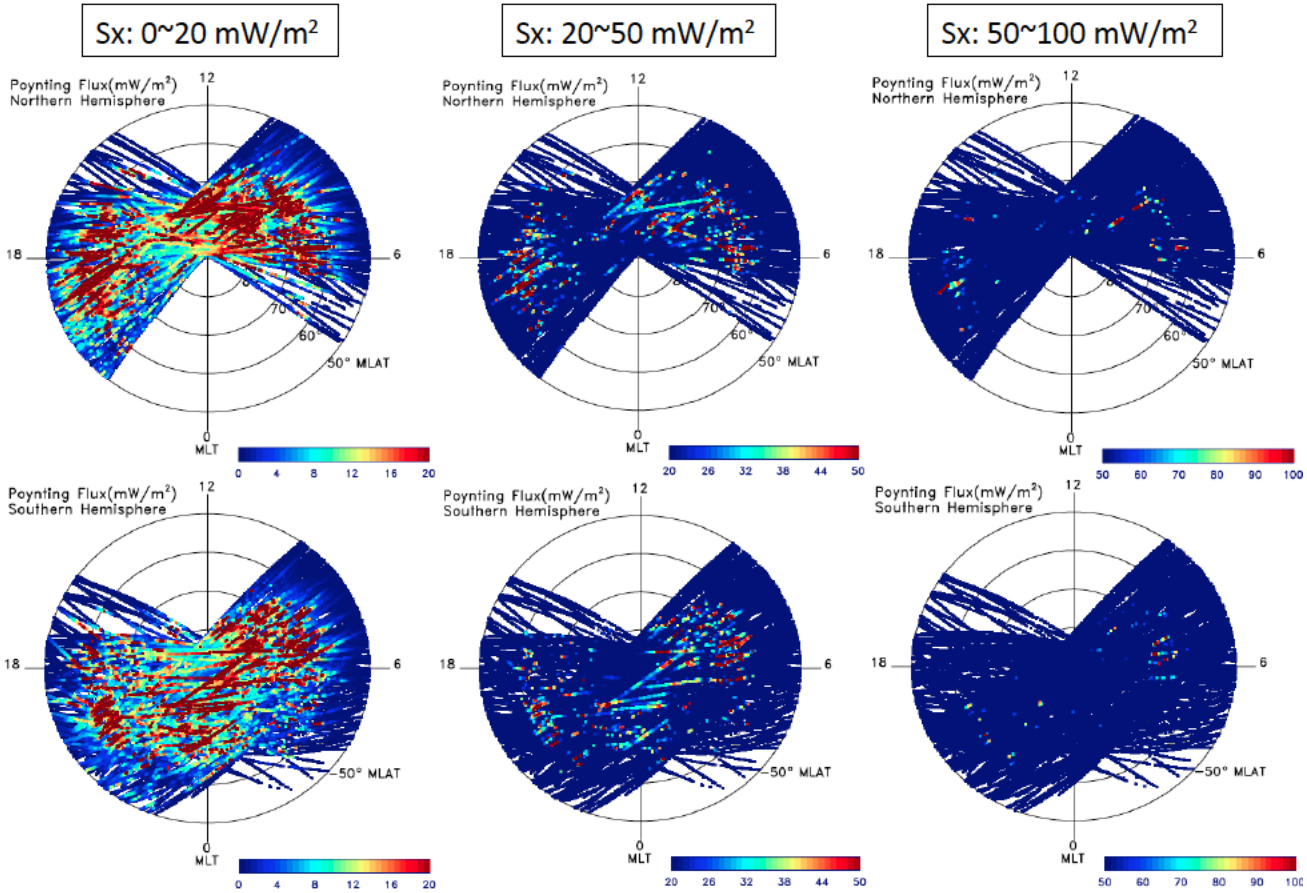
Motivation: Poynting Flux Observations



Measured Poynting flux during the main phases of 14 moderate (-100 > SymH ≥ -200 nT) magnetic storms. Significant energy is deposited into the polar cap during these events.

How is satellite drag affected?

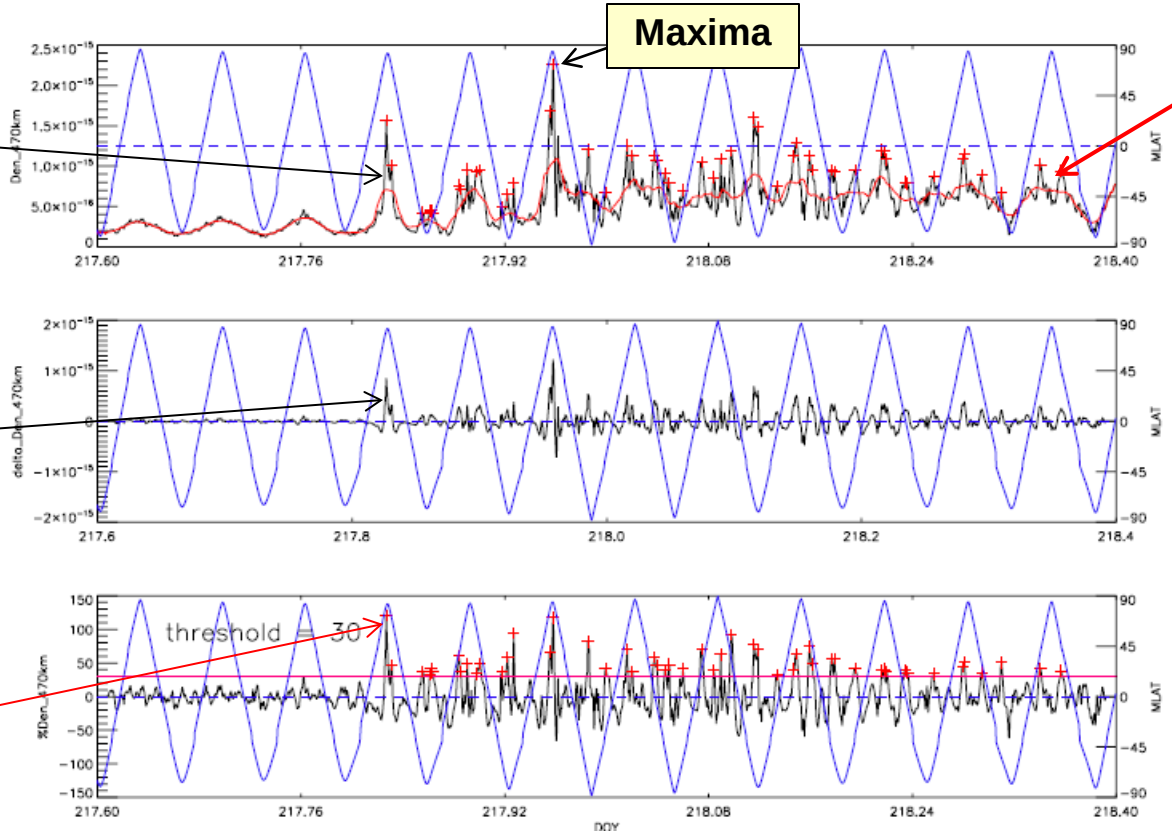
Analyze accelerometer data for neutral density statistics at high latitudes.

Neutral Density Maxima
August 2011 Storm

GRACE Original data

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

Maxima = 30% above mean



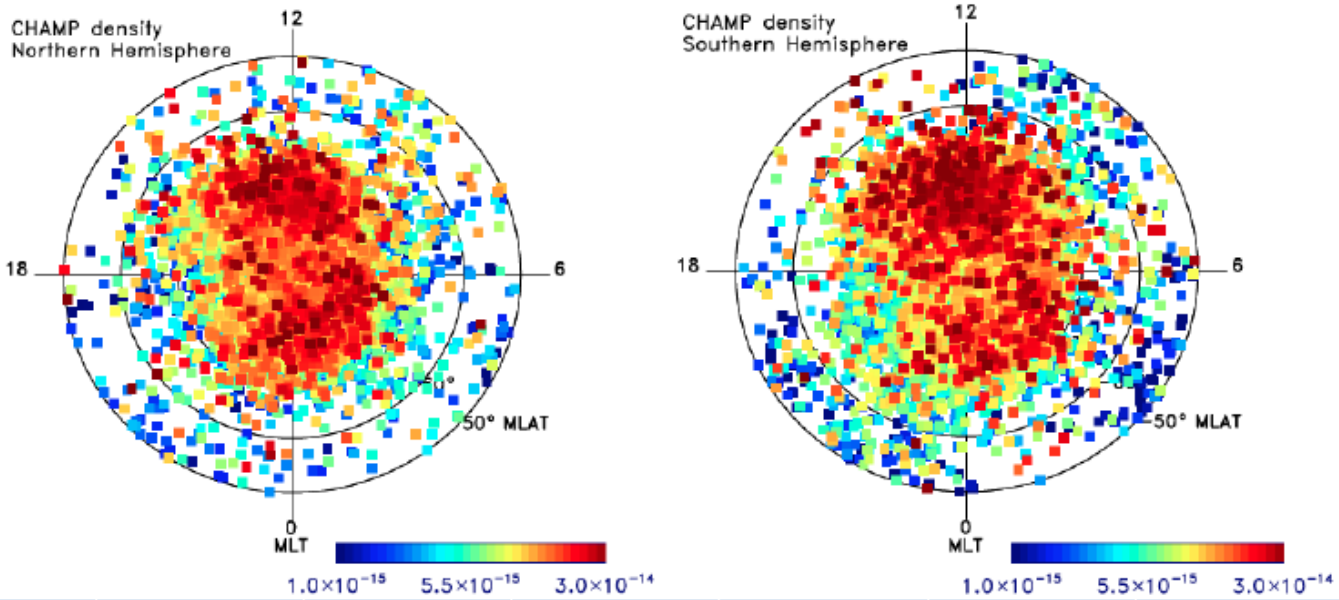
Maxima in the observed neutral densities are defined as follows:

1. **A running mean over 23 minutes or about 90 degrees 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.

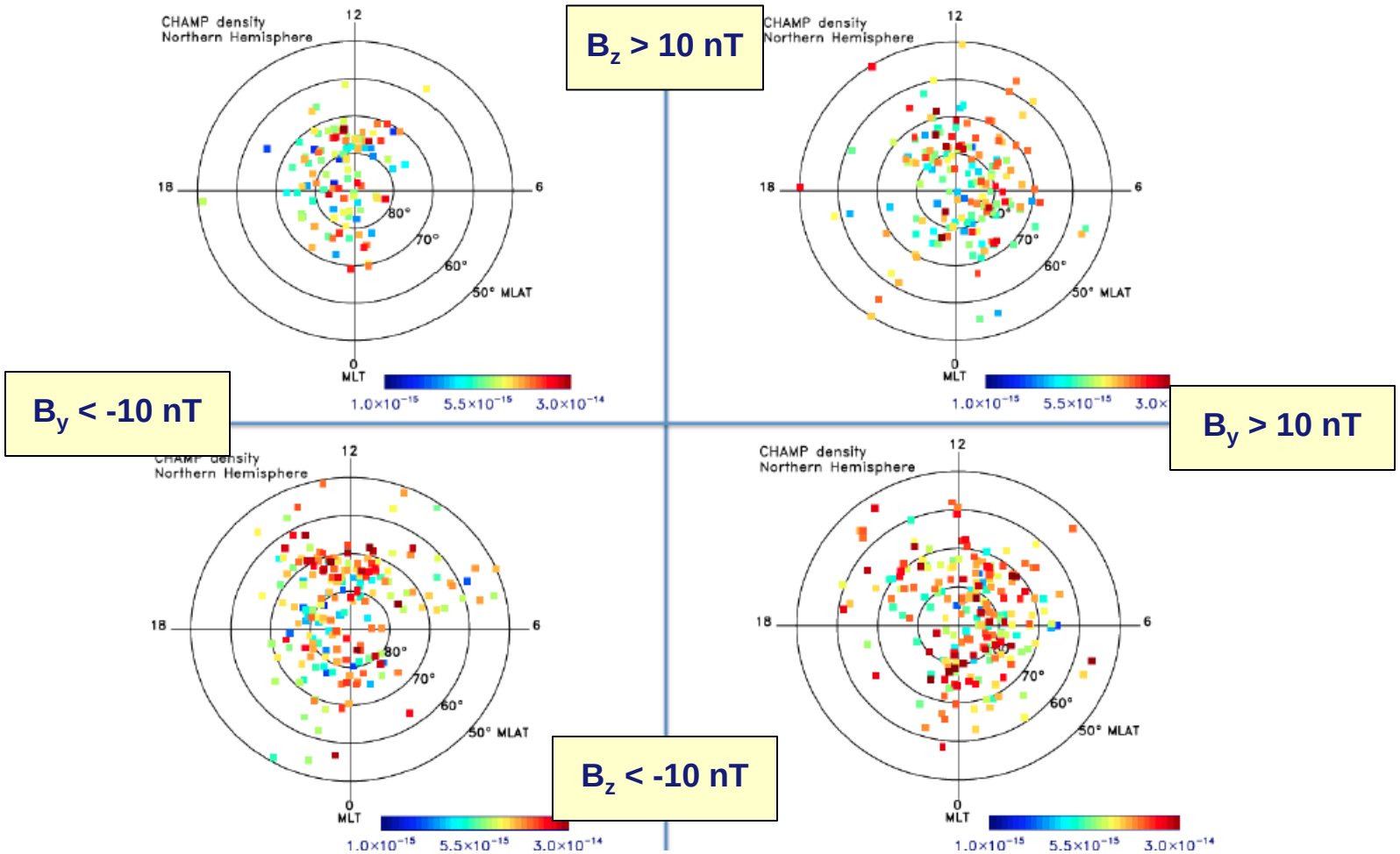
CHAMP Density Maxima 2002-2012

CHAMP density peaks (2001-2010)

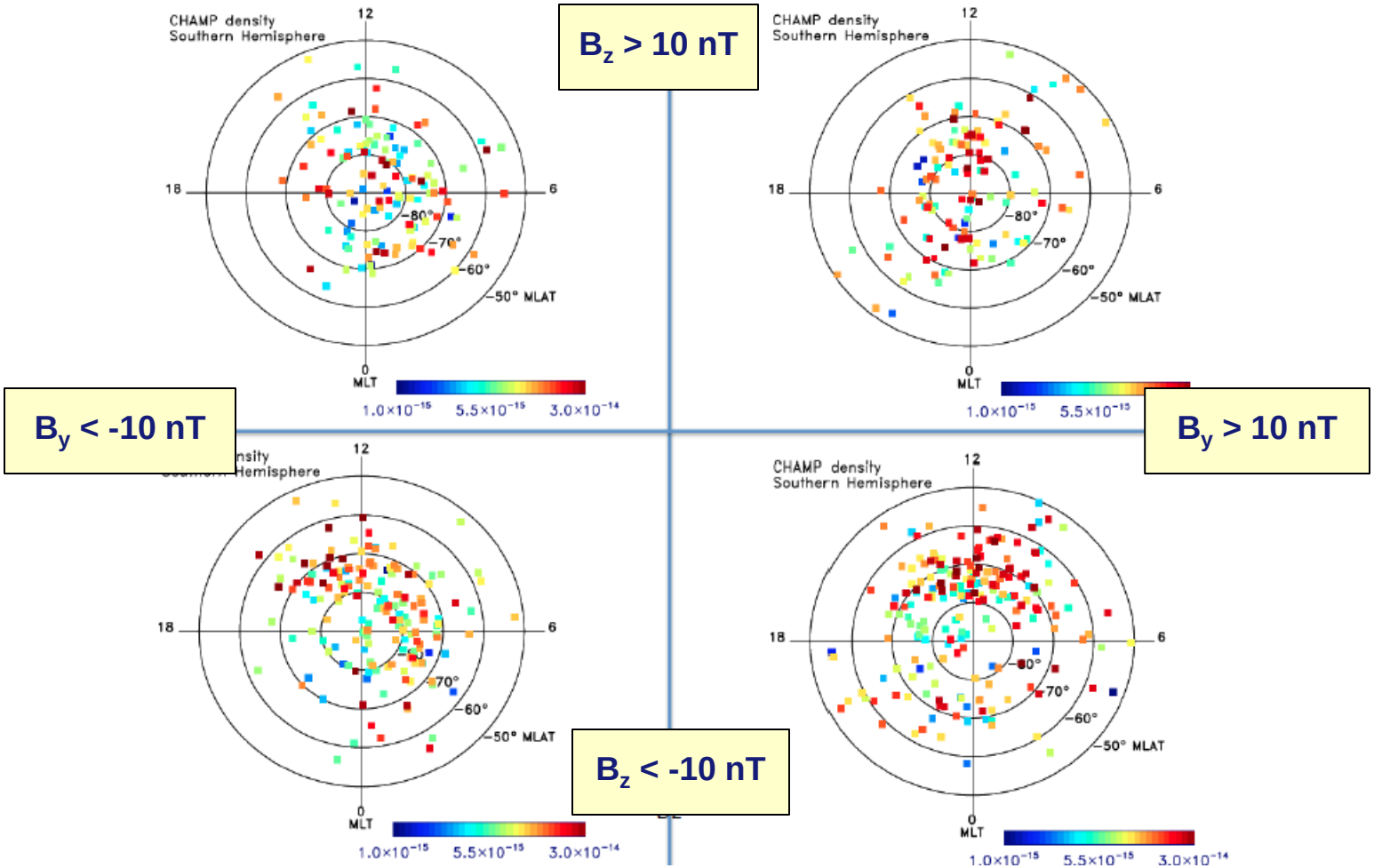


NH	mlat	mlt	By	Bz	press	symh
Avg Median Std.Dev.	77.9017 (78.8369) [6.47307]	11.5333 (11.8193) [6.44474]	0.273008 (0.206940) [5.89326]	-1.07810 (-0.888067) [5.08598]	3.08227 (2.26153) [3.54243]	-19.3991 (-13.7544) [29.4629]
SH	**mlat**	**mlt**	**By**	**Bz**	**press**	**symh**
Avg Median Std.Dev.	-74.9906 (-75.8858) [7.04789]	11.5913 (11.7887) [6.28633]	0.311202 (0.391993) [6.18883]	-1.28847 (-1.13011) [5.11734]	3.24850 (2.45352) [3.50458]	-22.6188 (-16.7627) [31.3097]

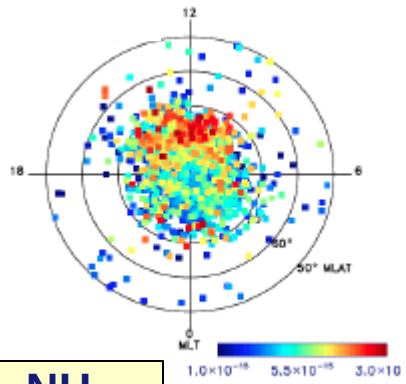
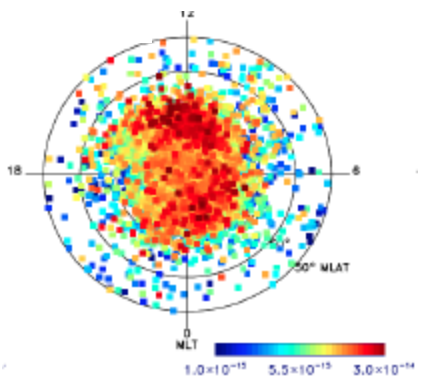
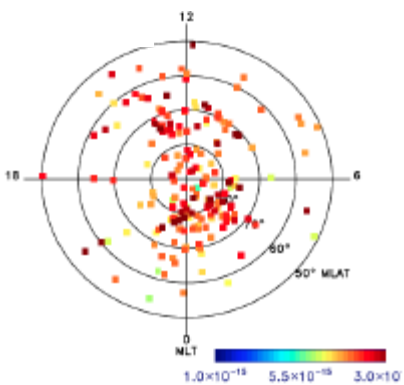
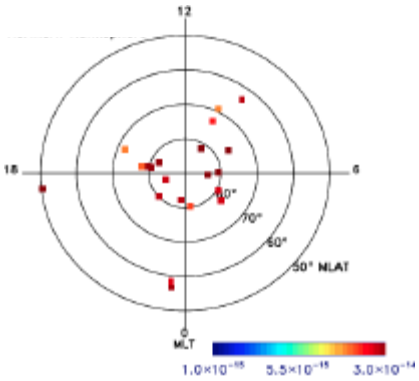
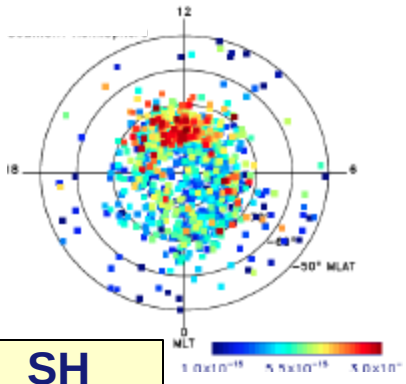
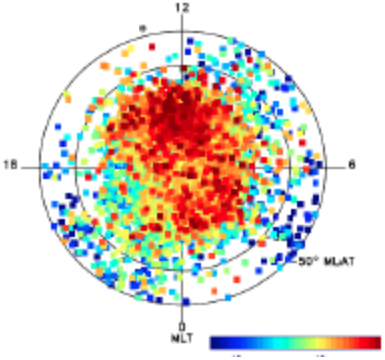
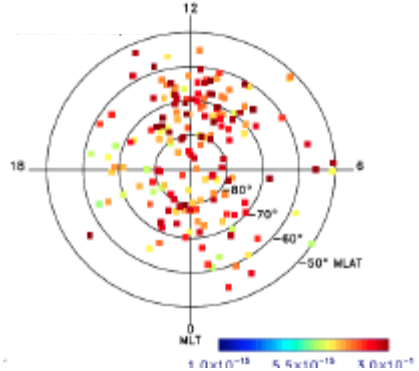
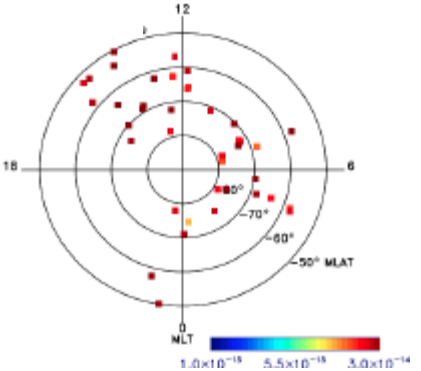
Dependence of CHAMP NH Neutral Density Maxima on IMF B_y, B_z



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



CHAMP Neutral Density Maxima
Dependence on SymH

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

NH

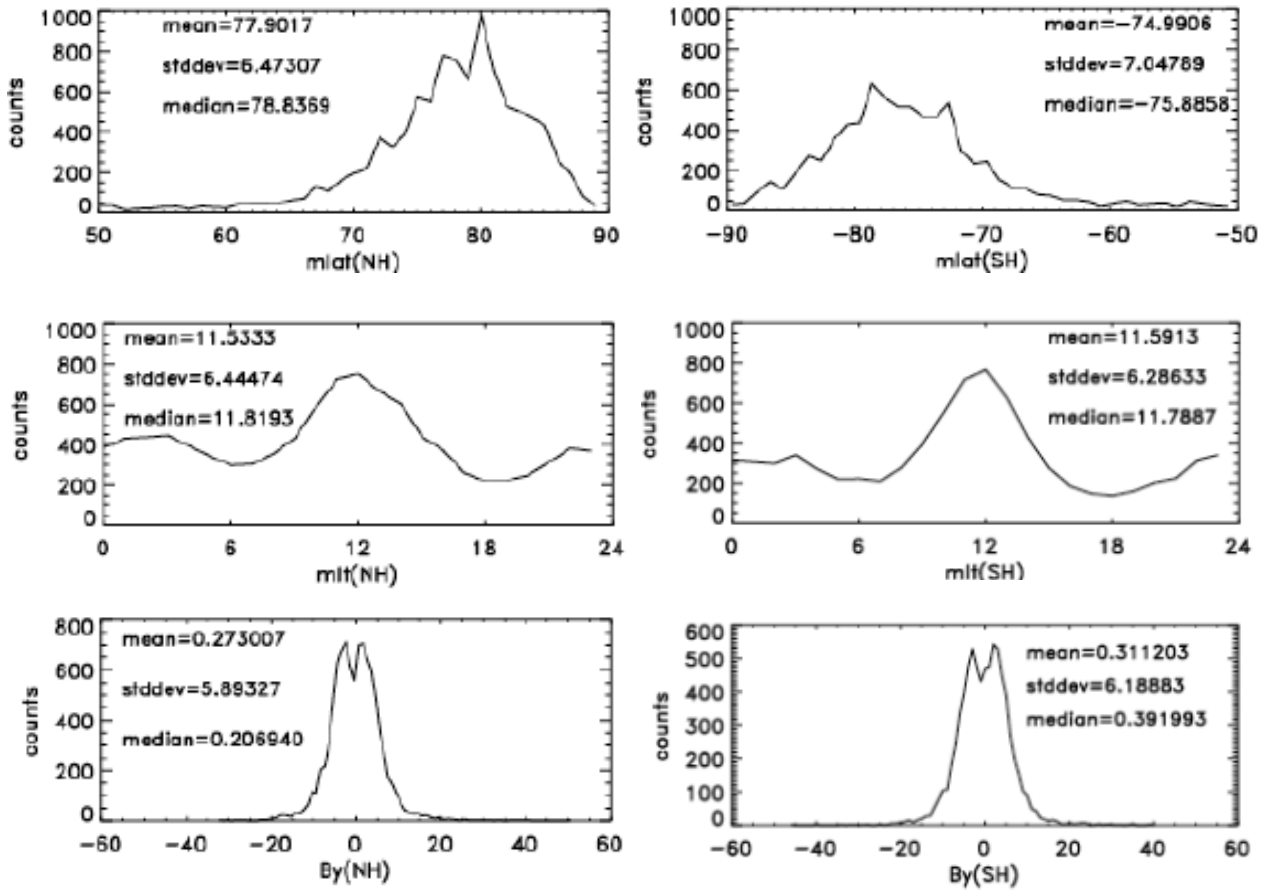
SH

CHAMP Neutral Density Maxima

MLat, MLT Distributions

IMF B_y Dependence

Northern Hemisphere | **Southern Hemisphere**



Conclusions

- **GRACE results are very similar to CHAMP (shown in MLT Coupling Workshop). 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 6.5-7º in both hemispheres. Average MLT is 11.5 – 11.6, with standard deviation of 6.3-6.4 hours.**
- **The preponderance of heated neutrals at polar latitudes implies that drag will be affected significantly in this region at low and moderate levels of activity. Currently this is not predicted in most models.**
- **Challenge: improve predictions of (1) locations of neutral density Joule heating; (2) timing of energy transfer to neutrals during storms.**