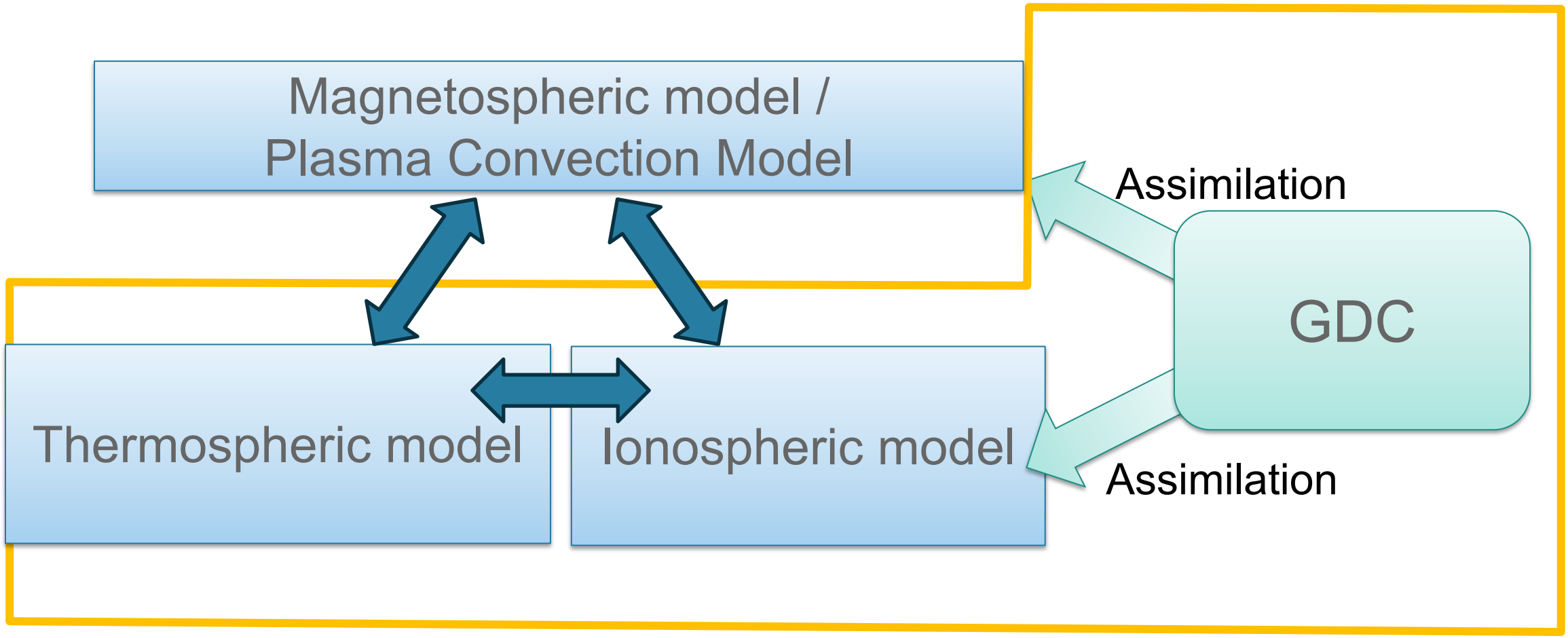
Capability of ITM data assimilation with GDC mission: Preliminary Study

Chih-Ting Hsu[*1], Tomoko Matsuo[2], Jefferey Anderson[3], Helen Kershaw[3], Nick Dietrich[2], Jia Yue[4], Min-Yang Chou[4], Yuta Hozumi[4], and Katherine Garcia-Sage[4]

[1]NCAR/HAO, [2]CU Boulder, [3]NCAR/CISL, [4]NASA/GSFC

This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.

ITM modeling and data assimilation



OSSE using DART/TIE-GCM system for GDC mission

DART/TIE-GCM system

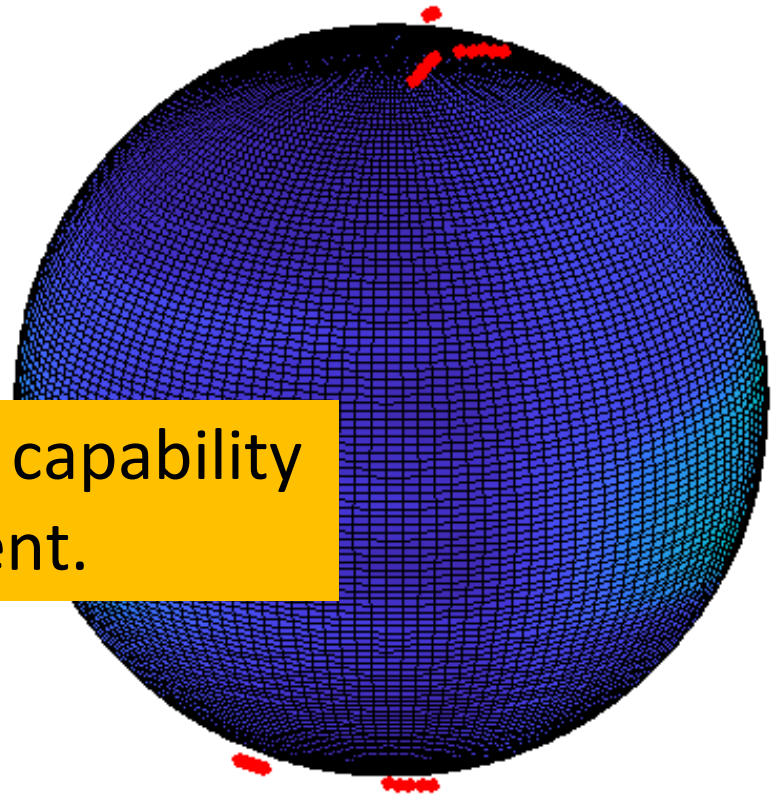
- DART is the facility for software that provide environment of ensemble data assimilation environment for the community.

- TIE-GCM is the numerical model of the thermos
latitude
with per

- A new version of DART/TIE-GCM is recently released (Manhattan version).

GOAL: Evaluate the potential of model capability when constraining by GDC measurement.

GDC mission



GDC measurements in this study

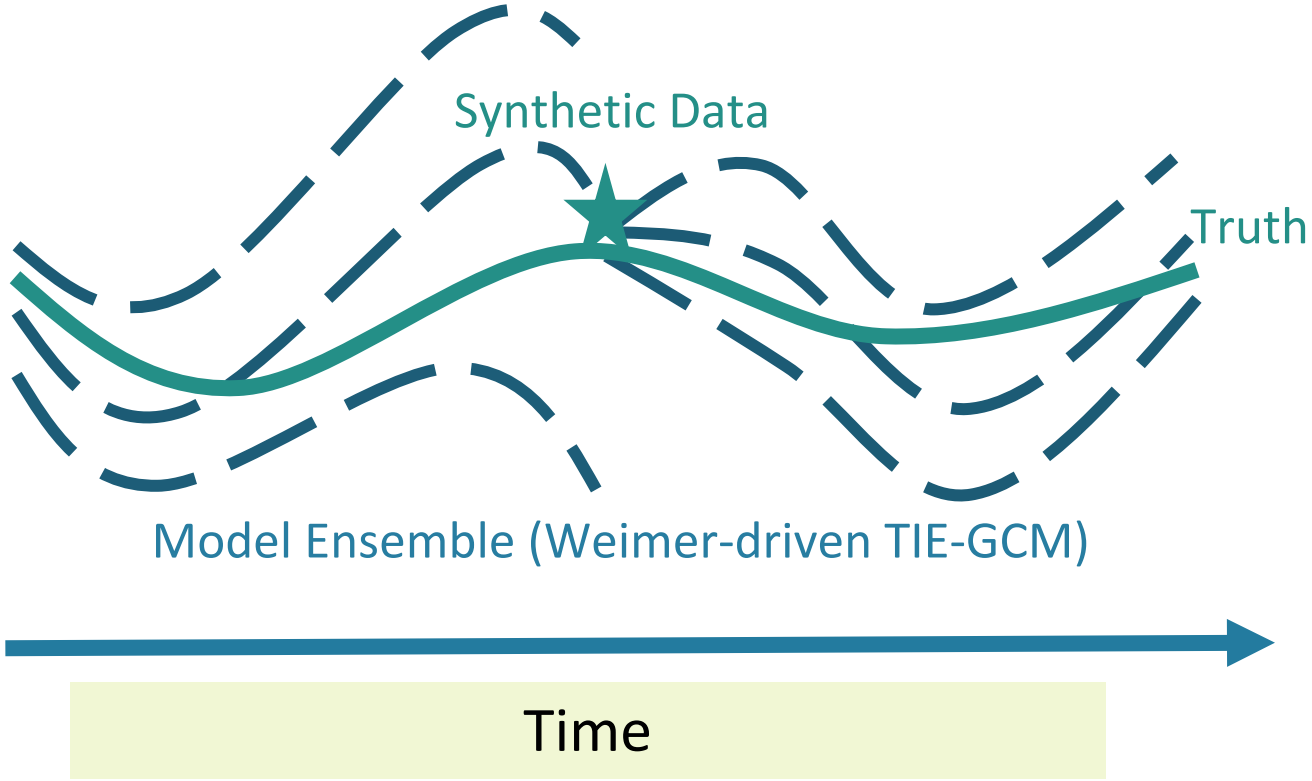
$$\mathbf{v}_{i,\parallel} = \left[\mathbf{b}\cdot\frac{1}{\nu_{in}}\left(\mathbf{g}-\frac{1}{\rho_i}\nabla(P_i+P_e)\right)+\mathbf{b}\cdot\mathbf{v}_n\right]\mathbf{b}$$

$$\mathbf{v}_{i,\perp} = \frac{\mathbf{E}\times\mathbf{B}}{|B|}$$

AMGeO

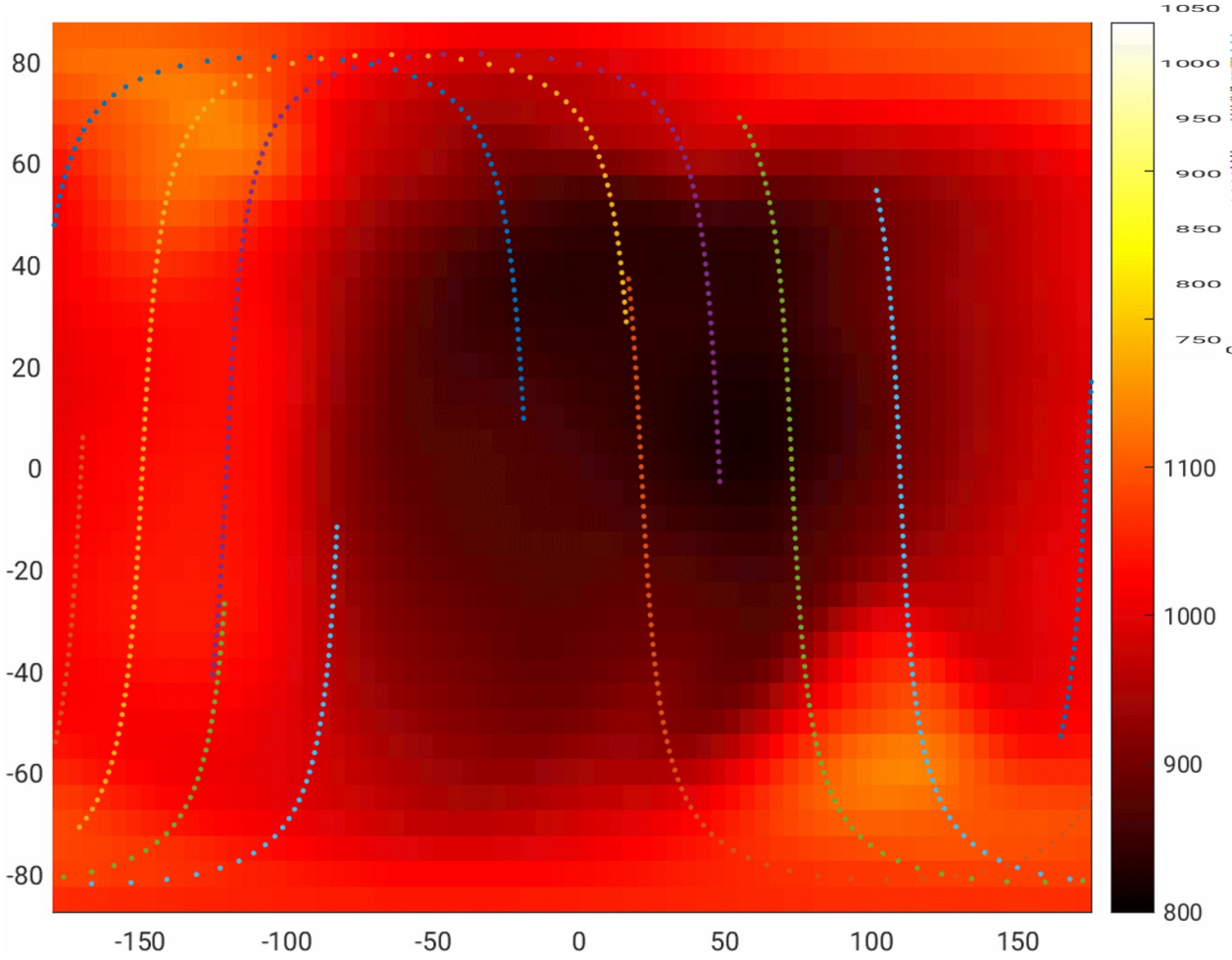
Physical Parameter						
	MoSAIC	CAPE	AETHER	NEMISIS	TPS	PROFILE
~~Thermal ion velocity~~	~~✓~~				~~✓~~	
Thermal plasma density	✓				✓	
Thermal ion temperature	✓		✓		✓	
Thermal ion composition	✓				✓	
Neutral wind	✓					
Neutral gas number density	✓					
Neutral gas temperature	✓					
Neutral gas composition	✓					
Auroral electron energy		✓				
Auroral ion energy		✓				
~~Small scale electric field~~			~~✓~~			
~~Small scale thermal plasma density~~			~~✓~~			
Thermal electron temperature			✓			
~~Magnetic field~~				~~✓~~		
~~Electron density~~						~~✓~~

Observing System Simulation Experiment for 2013 St Patrick's storm day

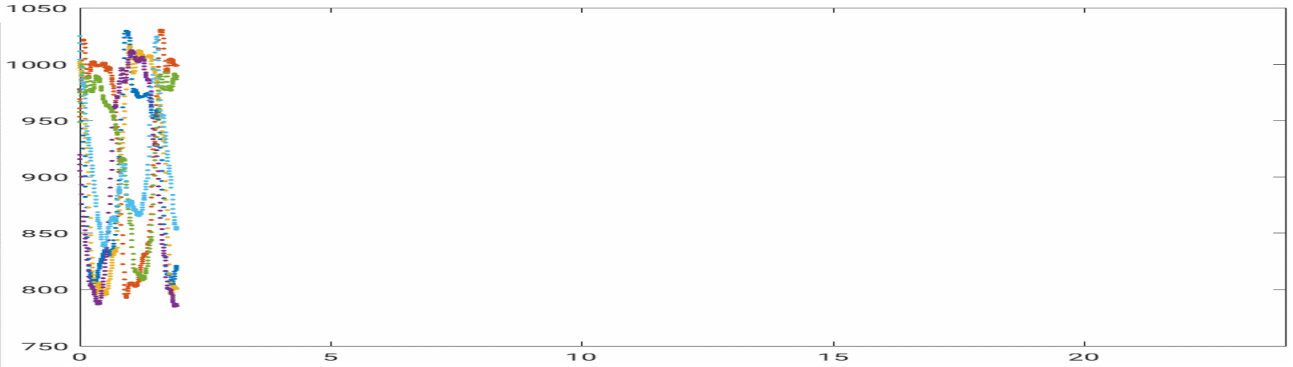


Truth VS Synthetic Data (Temperature)

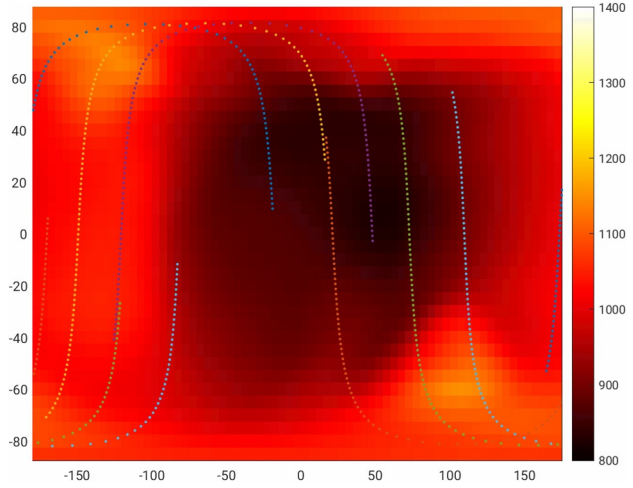
Truth used to sample synthetic data



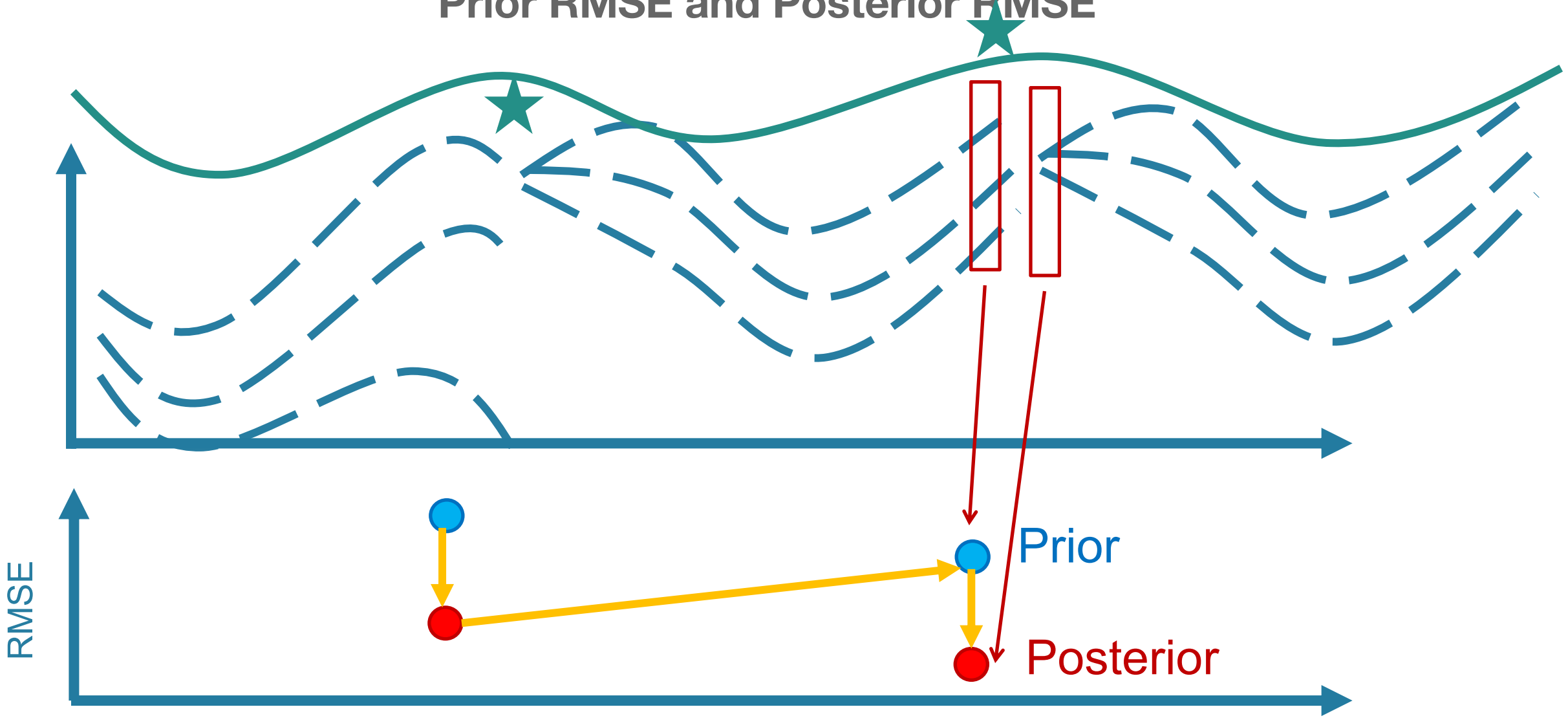
Synthetic Data



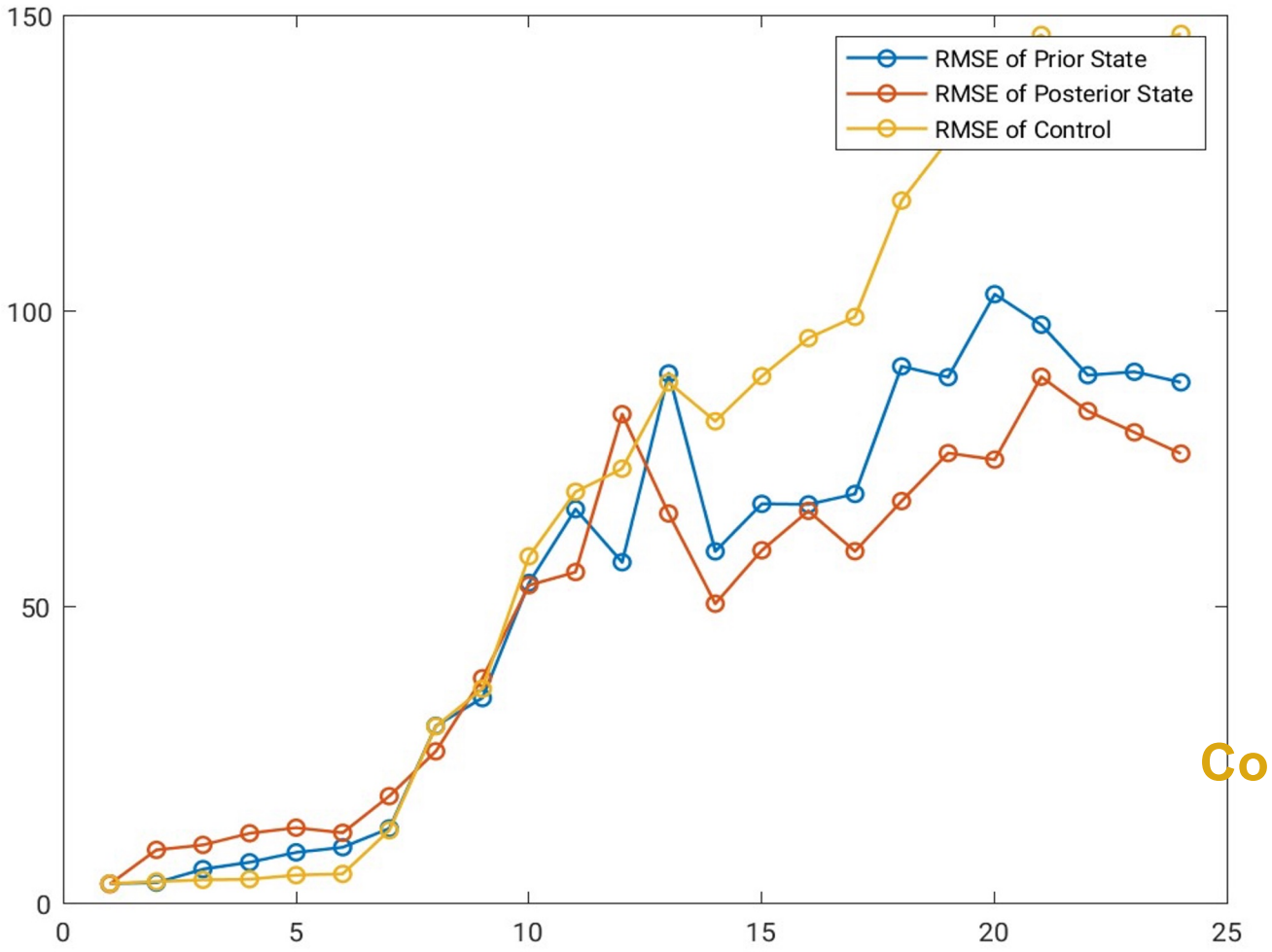
Control Run



Prior RMSE and Posterior RMSE



Impact of data assimilation on neutral temperature



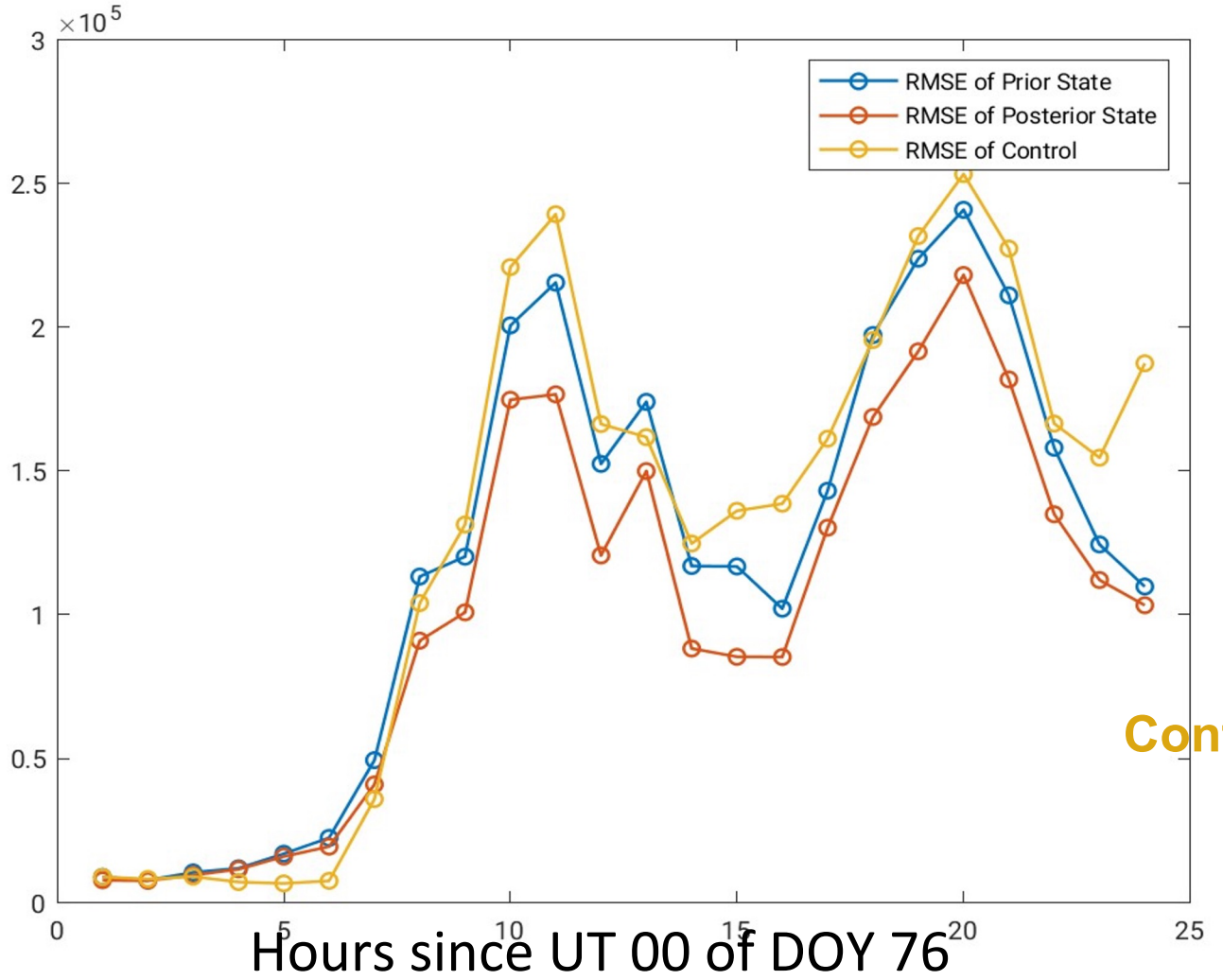
Hours since UT 00 of DOY 76

Control > Prior > Posterior

Summary and Future work

1. Preliminary OSSE results with GDC synthetic measurements show a promise of making a significant impact on the ionosphere and thermosphere weather monitoring during a geomagnetic storm case.
2. More OSSEs under different geophysical conditions are required to determine the impact of assimilating GDC measurements into TIE-GCM on IT weather monitoring.
3. GDC+Dynamic will help constrain the vertical structure of our system.
4. The latest version of DART+TIE-GCM (https://github.com/NCAR/DART) under CCMC on-boarding process.
5. Incorporate the AMGeO data assimilation capability into the system to build up a complete data assimilation system.

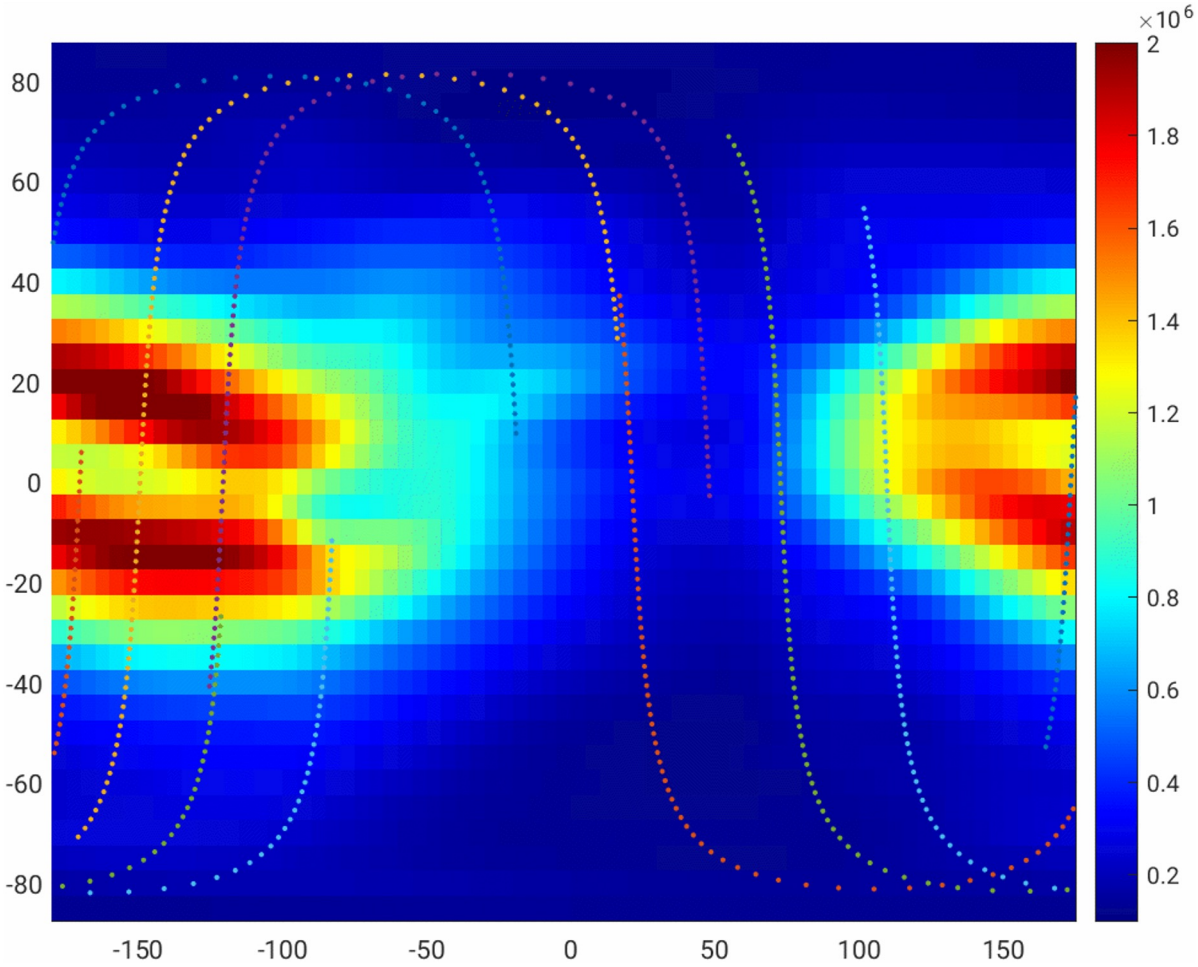
Impact of data assimilation on Atomic Oxygen Ion Density



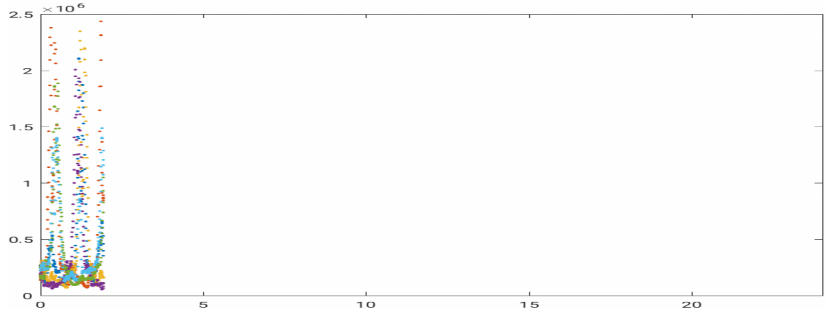
Control > Prior > Posterior

Truth VS Synthetic Data (Atomic Oxygen Ion Density)

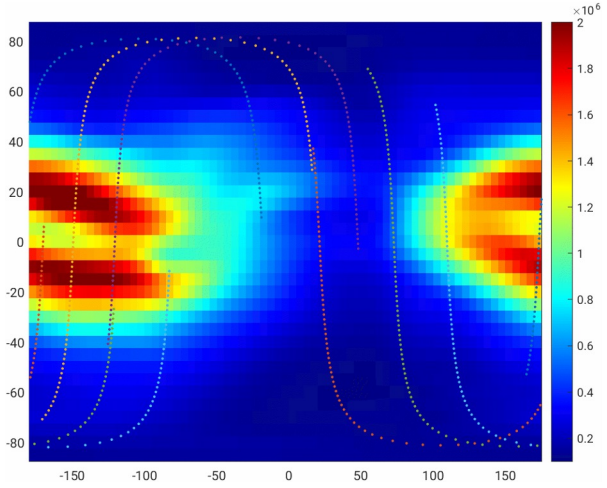
Truth used to sample synthetic data

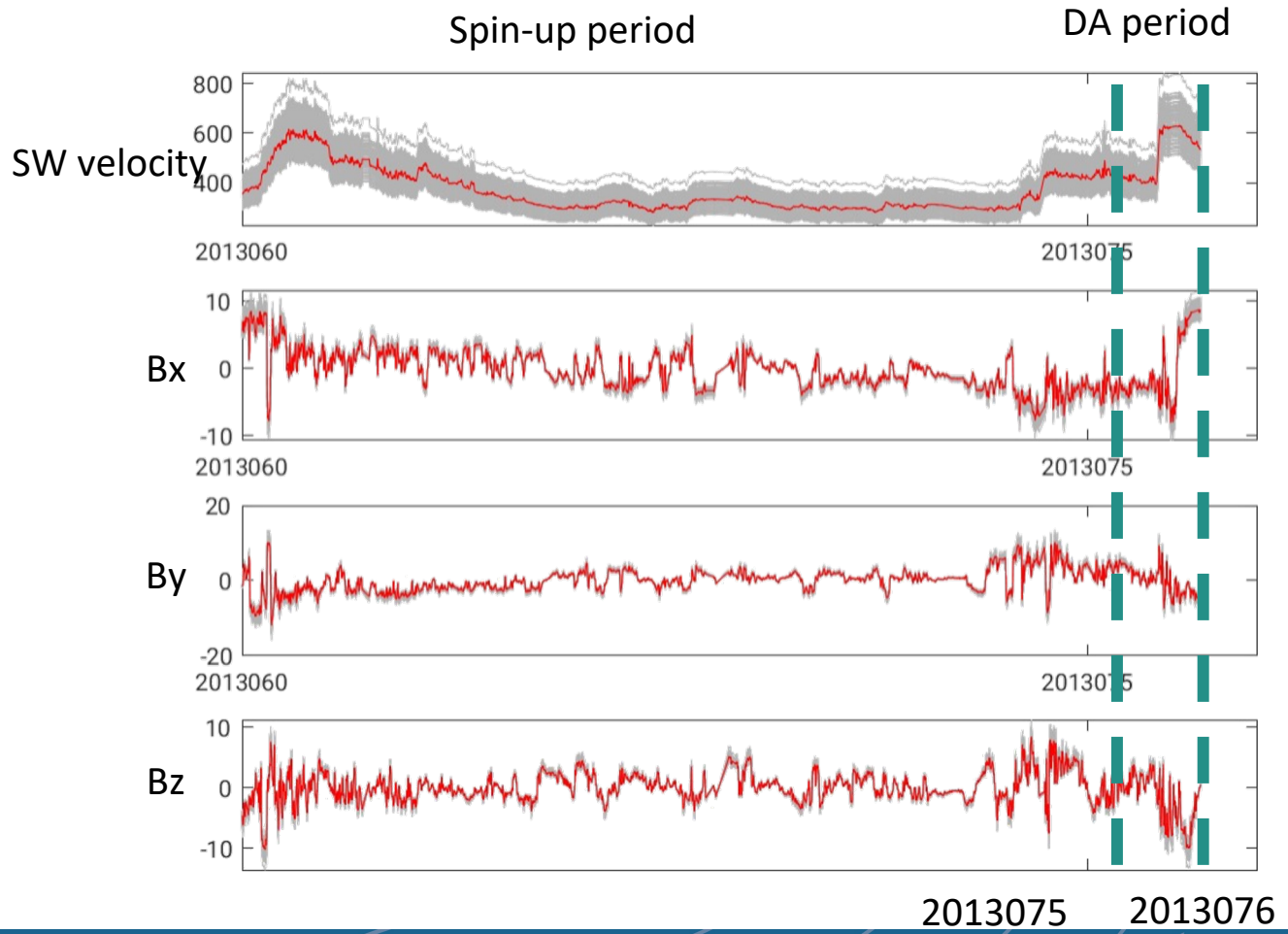


Synthetic Data



Control Run




Spin-up period
DA period
SW velocity
800
600
400
2013060
2013075
Bx
10
0
-10
2013060
2013075
By
20
0
-20
2013060
2013075
Bz
10
0
-10
2013075
2013076