

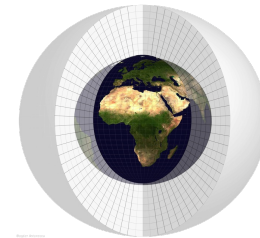
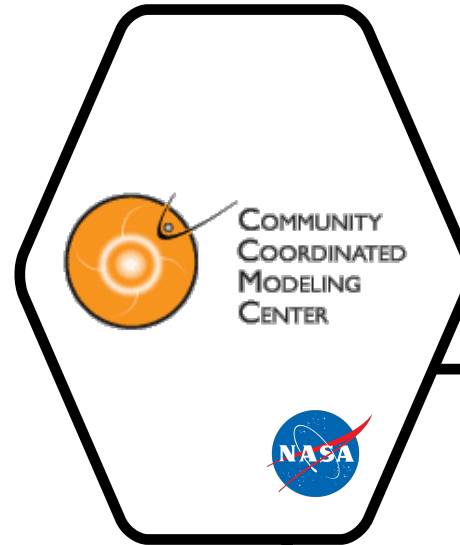
Geospace Data Assimilation Capabilities for CCMC

October 2021 – September 2022

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University of Colorado Boulder

Jeff Anderson (Co-PI)
Helen Kerhaw, Ben Johnson
NCAR CISL

Chih-Ting Hsu (Collaborator)
NCAR HAO



<https://www.hao.ucar.edu/modeling/tgcm>

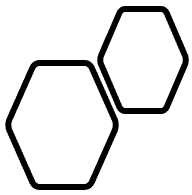


<https://amgeo.colorado.edu>

NCAR | DART

<https://dart.ucar.edu>





DART Ensemble Data Assimilation Software Tools



[About](#) [Research](#) [Documentation](#) [Tutorials](#)

[Get DART](#)

DATA ASSIMILATION FOR THE ENTIRE EARTH SYSTEM

Use ensemble DA techniques with geophysical models spanning the earth system.

USE DATA FROM ANY SOURCE, TEST MANY ALGORITHMS

Assimilate any suitable observations. Swap out filter and inflation algorithms with ease.

LEARN ON LAPTOPS, RUN ON SUPERCOMPUTERS

Compile without MPI for conceptual models or with MPI for GCMs on supercomputers.

DART's benefit to the community

Models supported

25+

Publications

200+

ASP postdocs

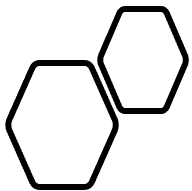
8

Supported models

Lower Atmosphere	Upper Atmosphere	Ocean	Cryosphere	Land Surface	Hydrology	Conceptual
CAM	WACCM	POP	CICE	CLM	WRF-Hydro	Lorenz '63, '84, '96, '05
WRF	GITM	ROMS		NOAH, NOAH-MP		Ikeda
WRF-Chem	Open GGCM	MITgcm-ocean				B-grid
MPAS-Atmosphere	TIE GCM	MPAS-ocean				SQG
AM2	ROSE	FESOM				9-variable

<https://dart.ucar.edu/>

<https://github.com/NCAR/DART>

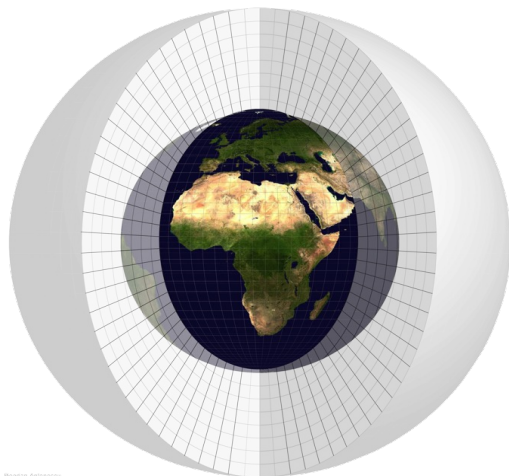


DART-TIEGCM Software Tools

Many many users of DART and TIEGCM; ~10 DART-TIEGCM users

[Dietrich, Matsuo, and Hsu, SW, 2022, Hsu, Matsuo et al., JGR, 2021; Matsuo and Hsu, AGU Monograph 2021, Chen et al., PEPS, 2019; Rajesh et al., JGR, 2017; Chen et al., GRL, 2017; Chen et al., TAOS, 2017; 6 more papers prior to 2017]

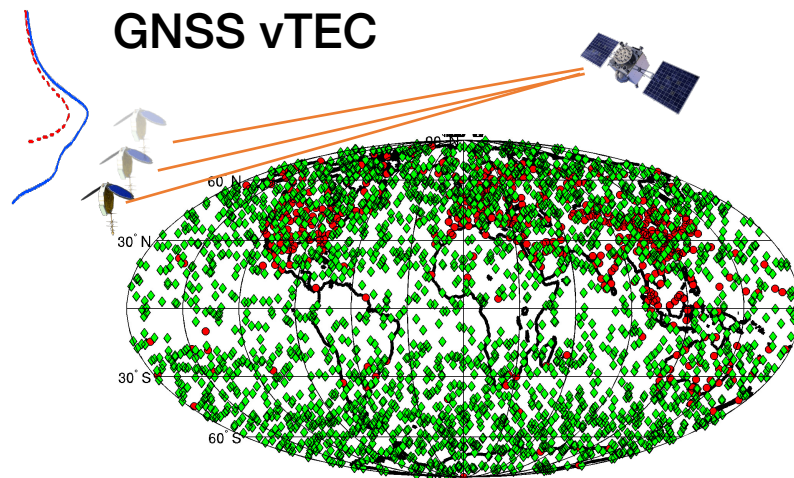
DART-TIEGCM



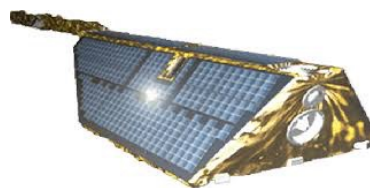
Wagner Ambrose



COSMIC RO EDP + Ground-based GNSS vTEC



CHAMP mass density



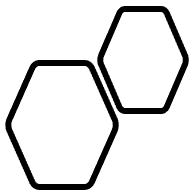
TIMED GUVI O/N2



<https://dart.ucar.edu/>
<https://github.com/NCAR/DART>

Supported by NSF and AFOSR

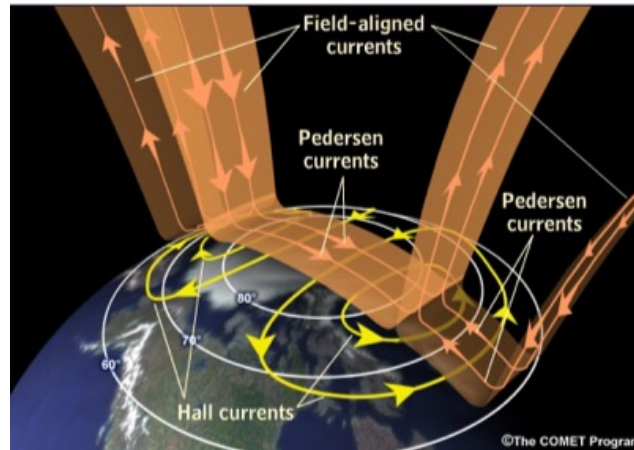




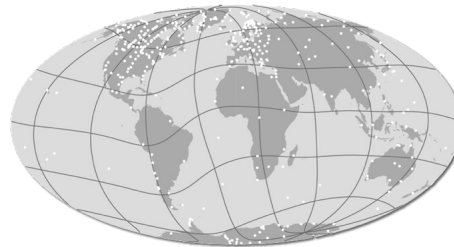
AMGeO Assimilative Mapping Software Tools

100+ AMGeO users

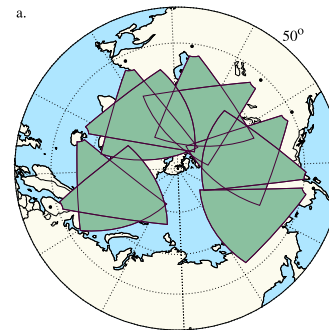
[Svaldi, Matsuo, Kilcommons and Gallardo-Lacourt, JGR, 2022; Li, Matsuo, and Kilcommons, JGR, 2022; Hsu, Matsuo et al., JGR, 2021; Cantrall and Matsuo, AMT, 2021; Matsuo, 2020; AMGeO Collaboration, 2019]



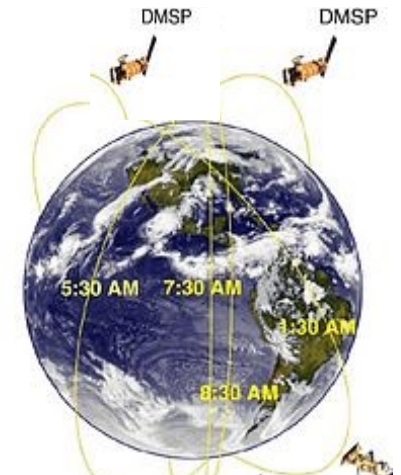
<http://ampere.jhuapl.edu/>



<http://supermag.jhuapl.edu/>



<http://vt.superdarn.org/>



<http://ssusi.jhuapl.edu/>

<https://amgeo.colorado.edu/>

Supported by NSF



EarthCube AMGeO Project Team Members

CU Boulder

Tomoko Matsuo (PI)
Liam Kilcommons (Lead Developer)
Willem Mirkovitch (Developer)

Virginia Tech

Mike Ruohoniemi (Institutional PI)
Shibaji Chakraborty (Postdoc)

JHU/APL

Brian Anderson (Institutional PI)
Sarah Vines (Co-I)
Larry Paxton (Co-I)

NASA-GSFC

Liz Macdonald (Collaborator)
Katie Garcia-Sage (Collaborator)

SRI

Asti Bhatt (Collaborator)

NOAA-NCEI

Rob Redmon (Collaborator)

GFZ Potsdam

Claudia Stolle (Collaborator)



Assimilative Mapping of Geospace Observations

Collaborative data science tool for high-latitude geospace observations

Rules of the Road »



EarthCube

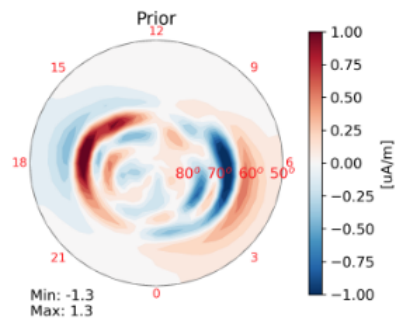
Making AMGeO Maps

SuperDARN Assimilation

SuperMAG Assimilation

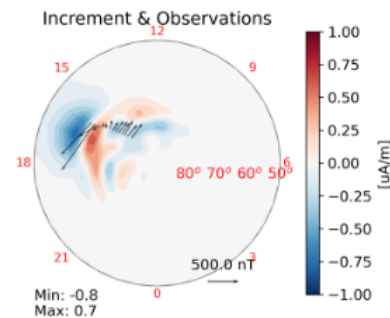
SuperDARN & SuperMAG

Iridium Assimilation



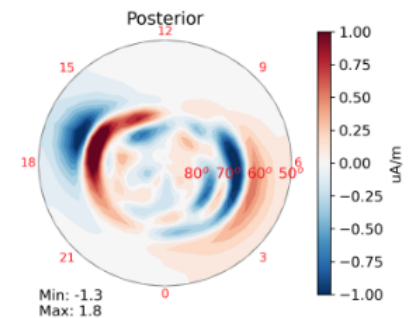
Prior Model

+



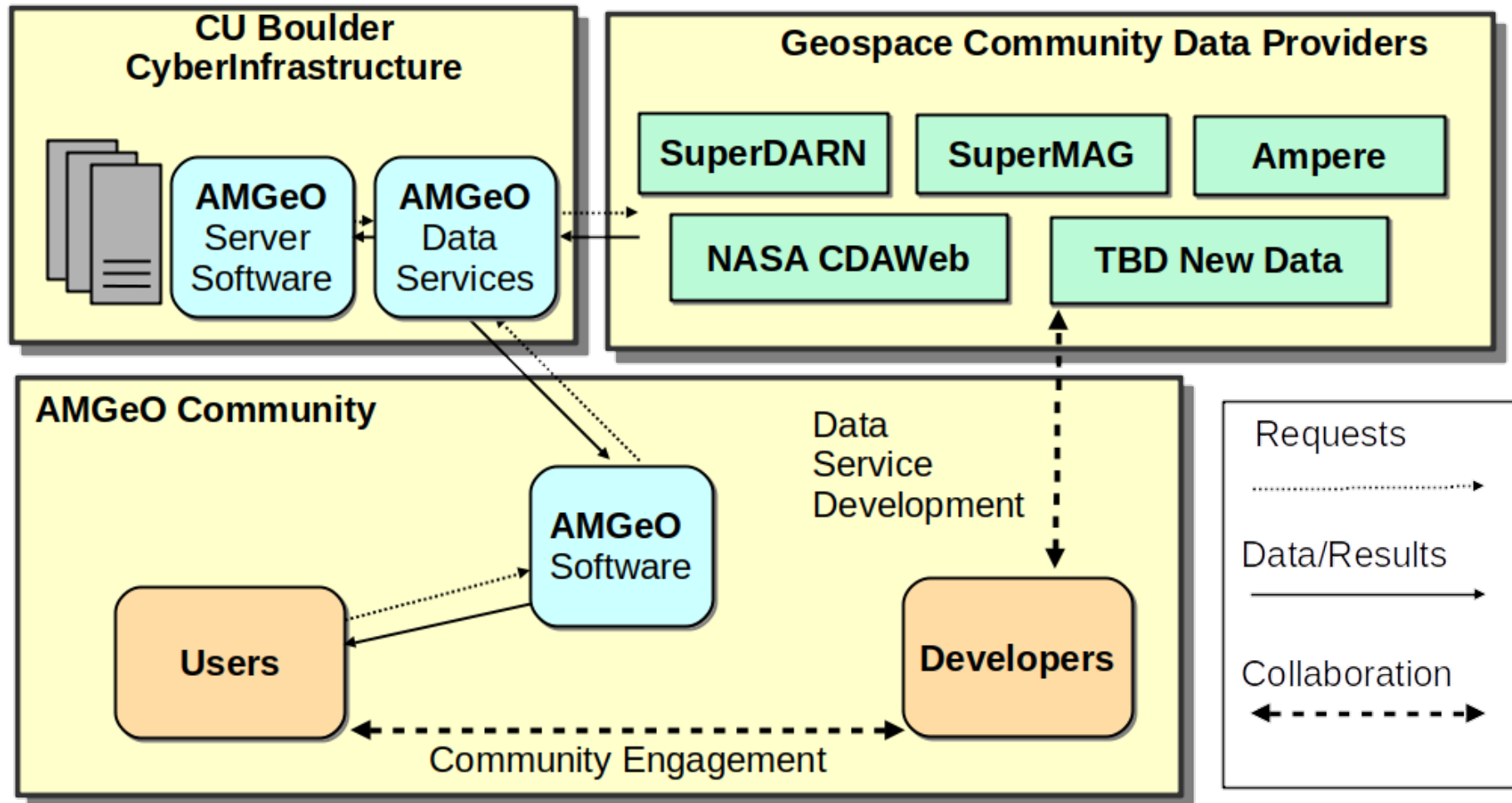
Data Impact

=



AMGeO Map

AMGeO v2 – software & web application





Starting repository: AMGeO-Collaboration/Earthcube-Workshop-2022/HEAD

Your launch may take longer the first few times a repository is used. This is because our machine needs to create your environment.

← → ↻ notebooks.gesis.org/binder/jupyter/user/amgeo-collabora-e-workshop-2022-yaabqg2/tree

jupyter

Visit repo

Copy Binder link

Quit

Files

Running

Clusters

Select items to perform actions on them.

Upload

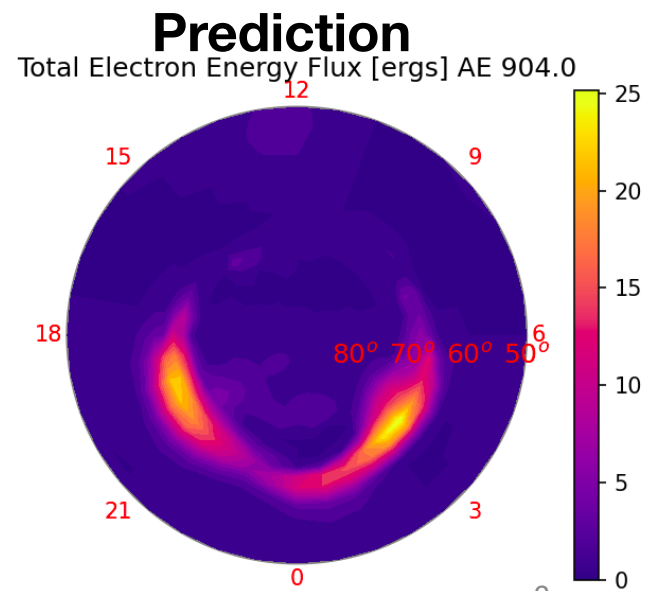
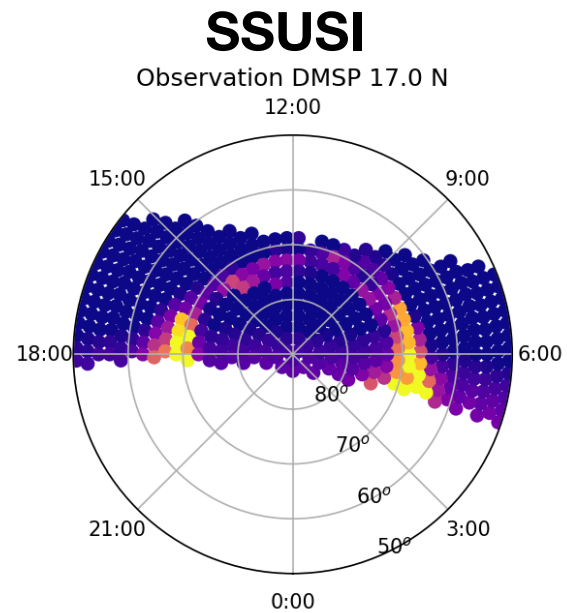
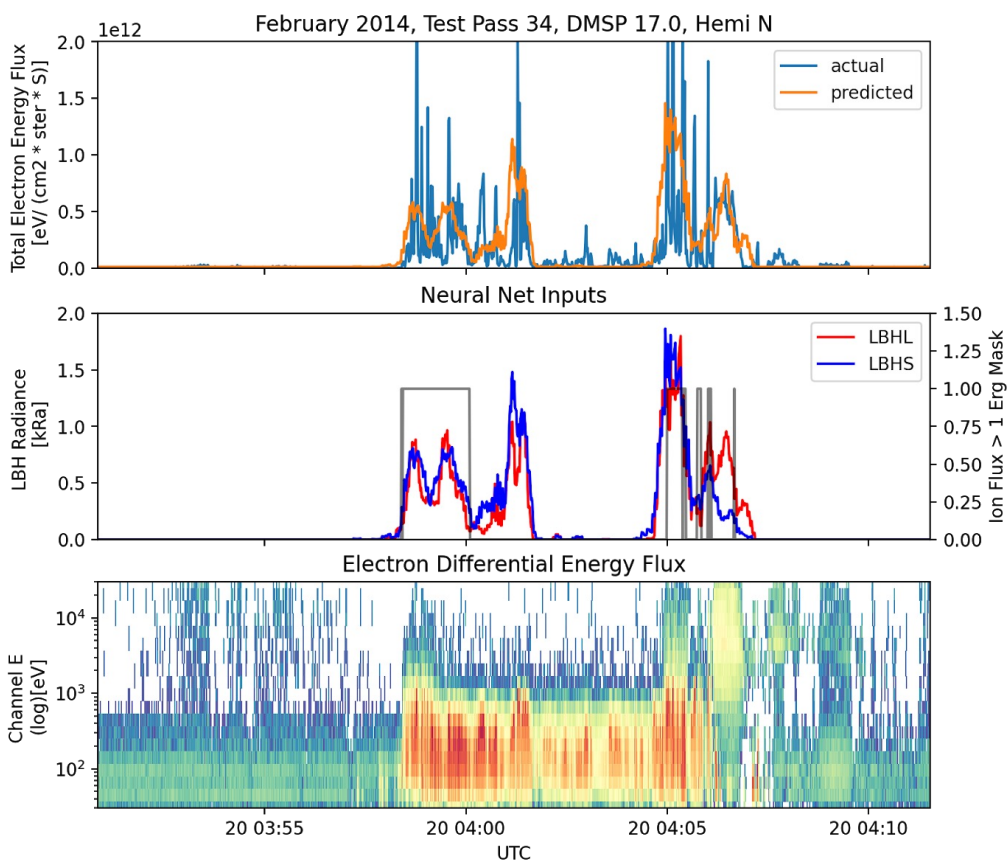
New ▾

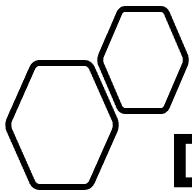


<input type="checkbox"/> 0 ▾	📁 /	Name ▾	Last Modified	File size
<input type="checkbox"/>	📁 amgeo_out		16 days ago	
<input type="checkbox"/>	📄 AMGeO-Notebook.ipynb		16 days ago	2.16 kB
<input type="checkbox"/>	📄 Exercise-1.ipynb		16 days ago	90.4 kB
<input type="checkbox"/>	📄 Exercise-2.ipynb		16 days ago	34.7 kB
<input type="checkbox"/>	📄 Exercise-3.ipynb		16 days ago	7.19 MB
<input type="checkbox"/>	📄 util.py		16 days ago	4.08 kB

Recent EarthCube Efforts Auroral Conductance

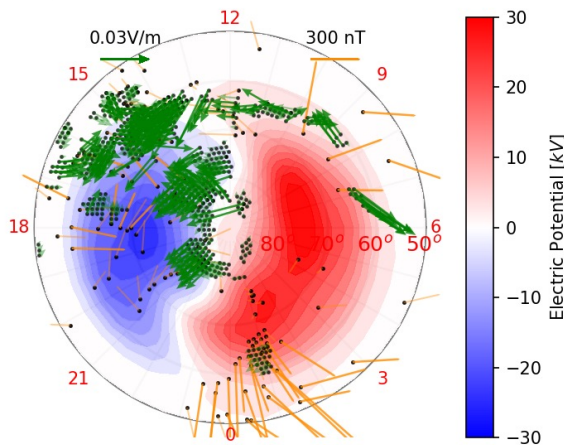
Neural Network + PCA + Assimilative Mapping



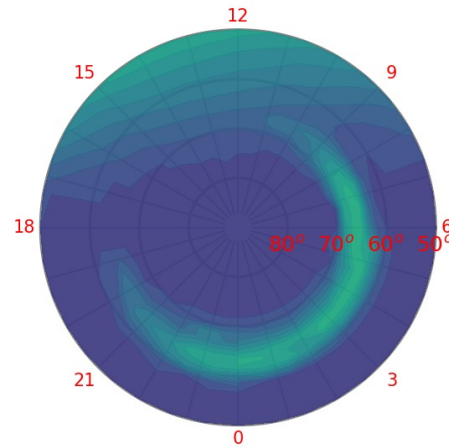


TIEGCM Magnetospheric Drivers Determined by AMGeO and Other sources

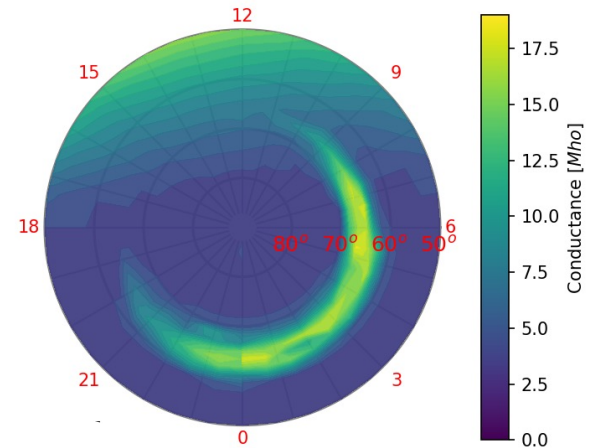
Assimilative Mapping of Geospace Observations
03/17/2015 23:00
By: -8.59 nT, Bz: -17.70 nT, Solar Wind Speed: 553.30 km/s



Electrostatic Potential



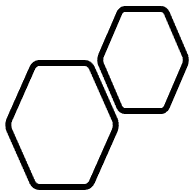
Hall Conductance



Pedersen Conductance

Additional Parameters included in TIEGCM driver files

- Auroral electron precipitation average energy and total energy flux maps (from Ovation Prime model)
- Hemispheric power
- Cross-polar-cap electric potential
- Cusp location in magnetic latitude and local time (from Frey et al empirical model, based on IMAGE data)



Big Picture For CCMC Project



Request a run



Both CU-Boulder and NCAR teams will work together to DART-TIEGCM and AMGeO to test DART-TIEGCM AMGeO workflow *for a hypothetical OSSE case study with in-situ data*, produce the documentation and user guides, and deliver docker files that can be installed on CCMC's AWS server



Existing DART-TIEGCM software currently used at CU Boulder will be updated to be compatible with the latest DART (Manhattan) version for performance improvement and improved software support.



AMGeO software will be updated to produce TIEGCM input files that are interoperable with DART-TIEGCM.

NCAR | DART

AMGeO