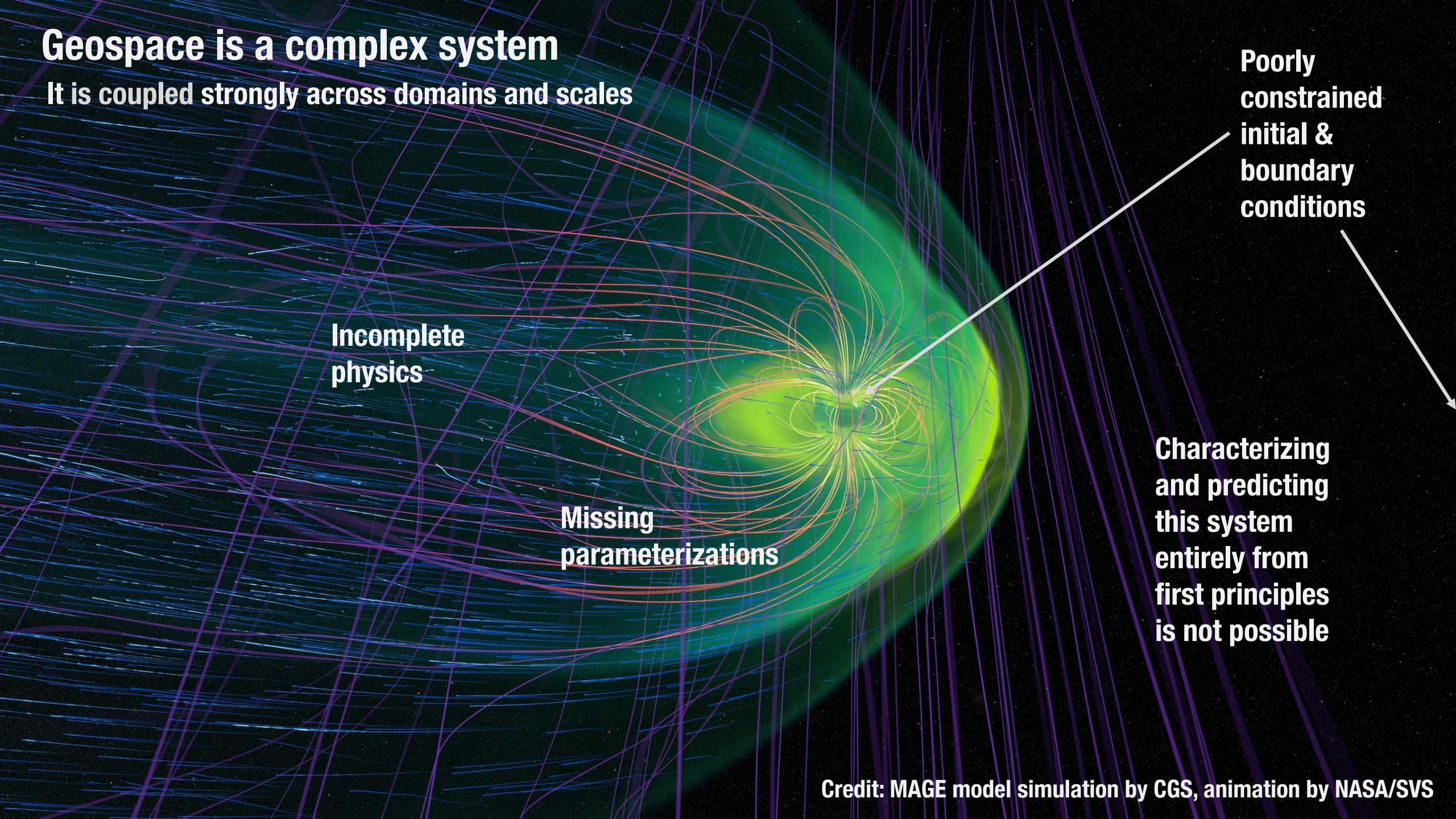
JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

Space Weather Gap Filling

Space Weather Council Meeting

Slava Merkin
JHU/APL
NASA DRIVE Center for Geospace Storms, Director


Geospace is a complex system
It is coupled strongly across domains and scales
Poorly constrained initial & boundary conditions
Incomplete physics
Missing parameterizations
Characterizing and predicting this system entirely from first principles is not possible
Credit: MAGE model simulation by CGS, animation by NASA/SVS

Challenges of data assimilation in global geospace

Getting used to the idea of data-model fusion (gray-box modeling)

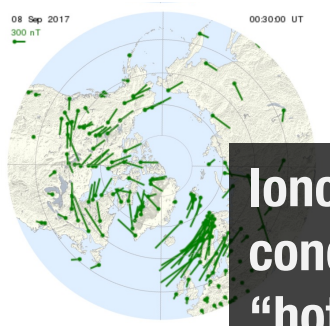
- Our models are incomplete
- Our data is insufficient
- We need to (re)invent data assimilation

Challenges of data assimilation in global geospace

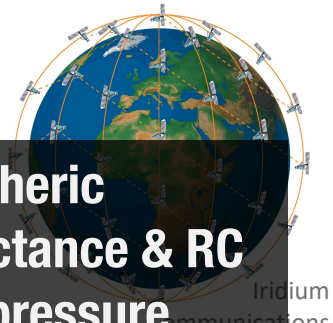
Getting used to the idea of data-model fusion (gray-box modeling)

- Use spacecraft constellations and remote-sensing
- Leverage better near-Earth coverage
- Leverage historical data
- Use all of the above to:
  - Improve model initial & boundary conditions
  - Rectify model incompleteness (i.e., supply missing physics)
  - Develop data ingestion/assimilation methods to achieve data-model fusion

SuperMAG

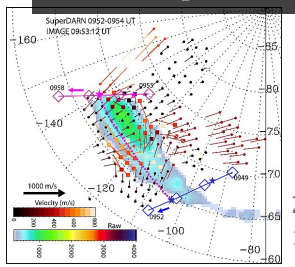


AMPERE



Ionospheric conductance & RC "hot" pressure

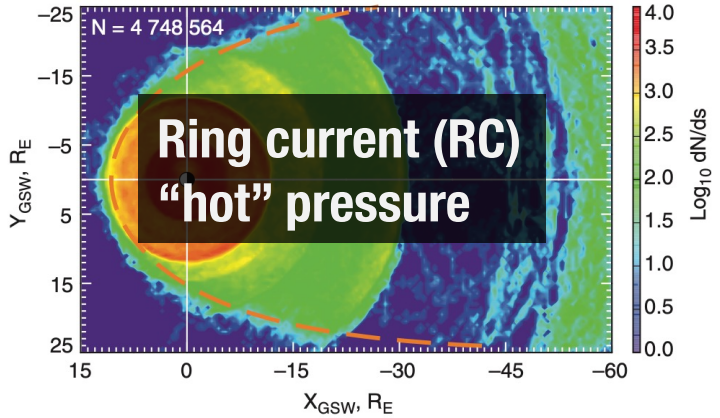
Iridium Communications Inc.



SuperDARN+
DMSP+
IMAGE

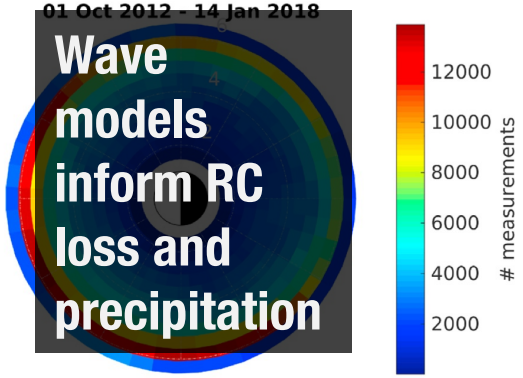
Zou et al. (2009)
10.1029/2008JA013449

Historical magnetometer data (Tsyganenko et al. 2021)



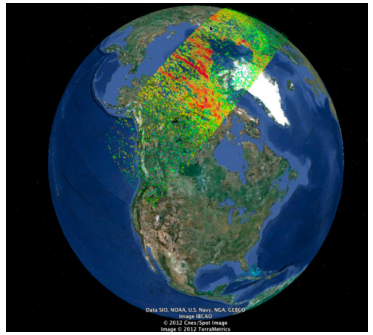
10.1002/9781119815624.ch39

Historical Van Allen Probes data (Wang et al. 2019)



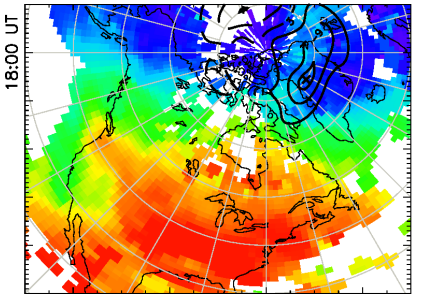
10.1029/2018JA026183

DMSP/SUSSI



sussi.jhuapl.edu

GPS TEC



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