GLIMPSE: A GLobal Ionosphere Modeling Prediction and Specification Environment

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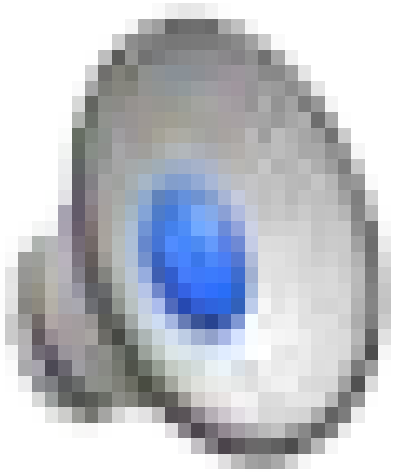
What can we say regarding the study of the Ionosphere, Thermosphere, and Magnetosphere (ITM)?

- **"Even though it may not be very important, does not mean its not difficult"**
  - **Anonymous Space Physicist**
- **"Well, why is it so hard"**
  - **Cyber/Intelligent Systems person at CEDAR meeting Santa Fe**
- **Its hard because….**
- **Study of the ITM SHOULD be important**



Why should study of the ITM Matter?

- **First order physics: Energy and momentum transport throughout the medium**
  - **Energy and momentum input from the Sun**
  - **Stored energy and momentum from solid Earth, Oceans**
  - **ITM is the buffer between Solar energy inputs from above and Energy transport out and up from below**

- **Understanding the overall Earth's energy and momentum sources, sinks and transport IS IMPORTANT**

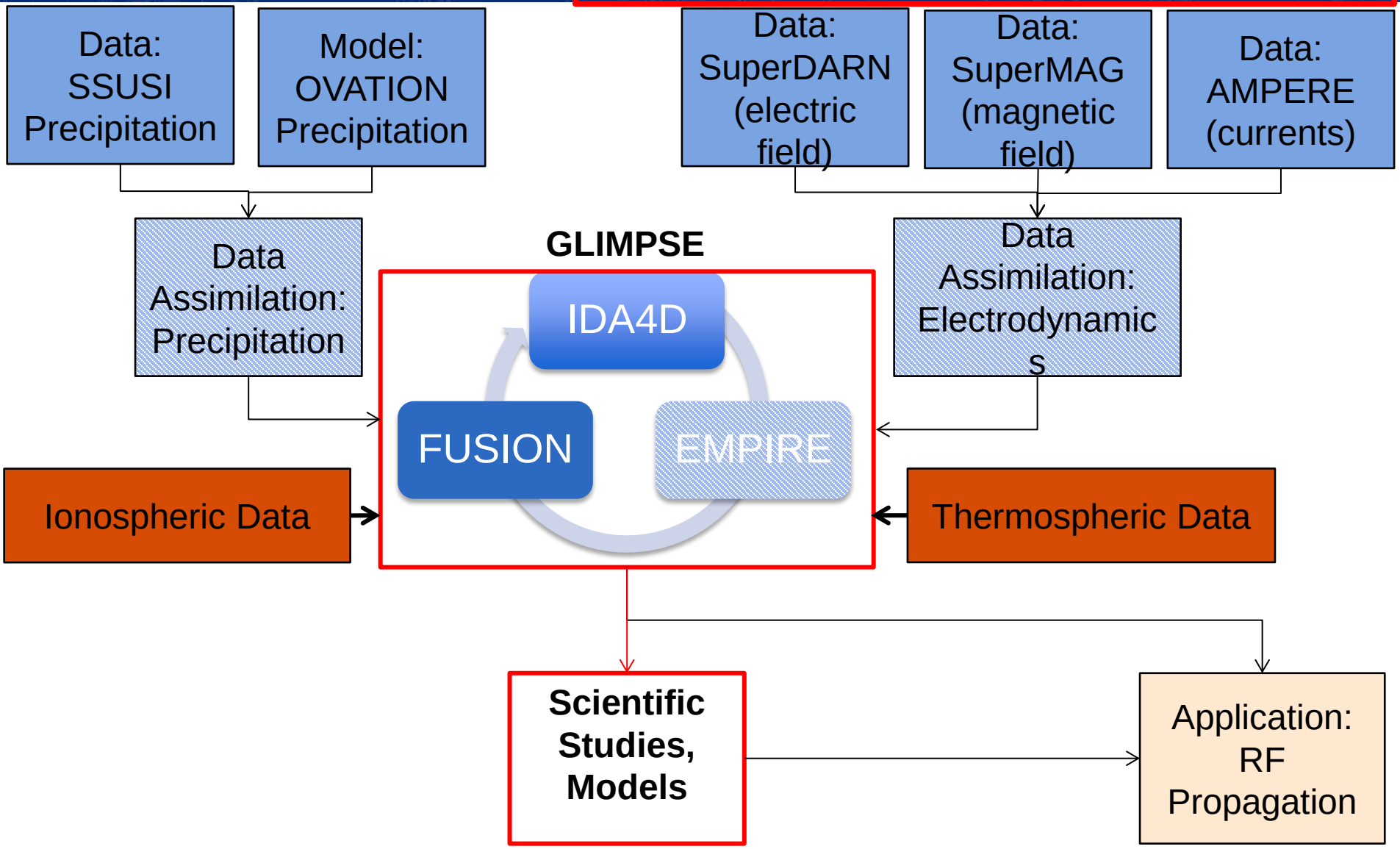
- **And understanding ITM is a necessary and important piece of understanding the Earth's overall energy and momentum flow**

What Research Do we need to carry out to understand the Energy and Momentum Dynamics of ITM

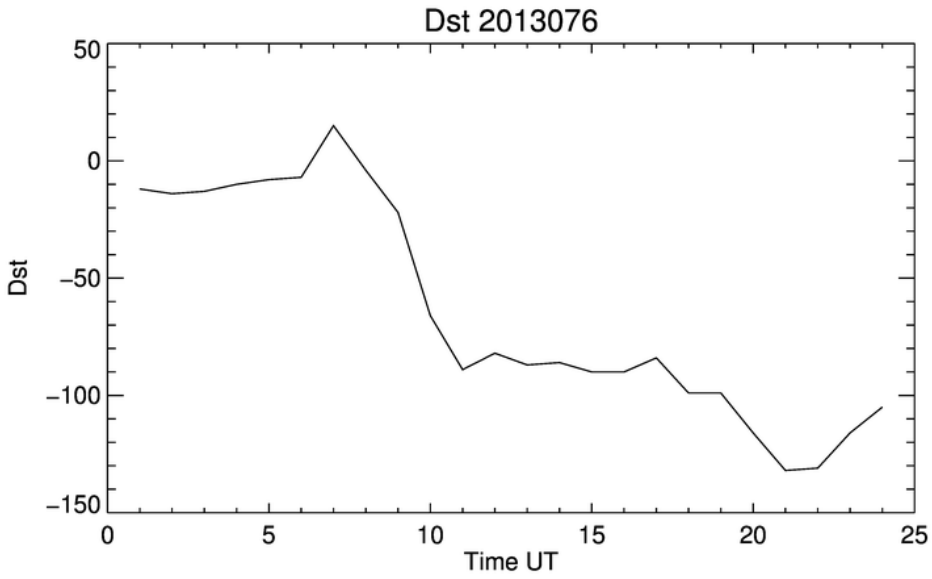
- **Theory**
  - **Our fundamental laws of behavior**
  - **Test**
- **Modeling**
  - **Mathematical / numerical approximations to theory**
  - **Validate / understand approximations**
- **Measurements / observations**
  - **Realistic representation of errors**
  - **Space-time resolution**
  - **QC**
- **Combine/ compare measurements with models**
  - **Data assimilation is only one technique**
  - **Data comparisons / validation**
  - **Principal component analysis**
- **New measurements and observations**

Overall GLIMPSE Environment

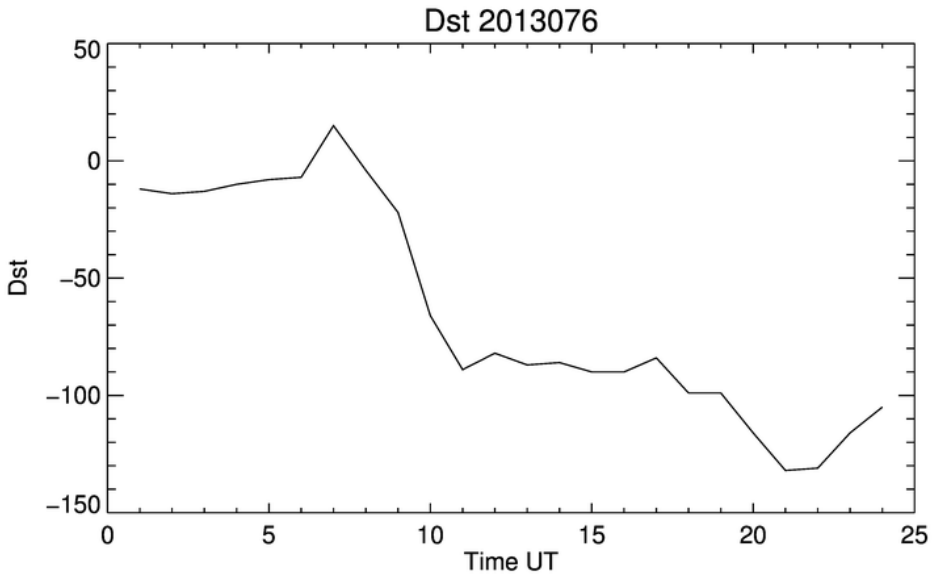
MAIN OBJECTIVE:
Accurate nowcasts/short forecasts (1-3 hours) of large scale and medium-scale ionosphere density



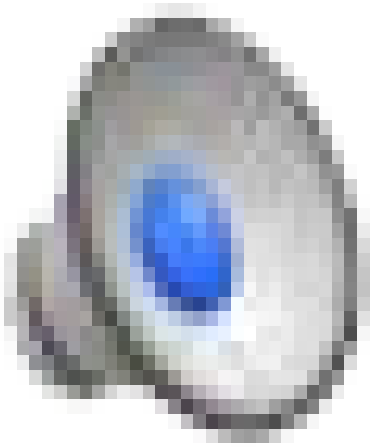
IDA4D: 2013076 VTEC



IDA4D 2013076: Data Coverage



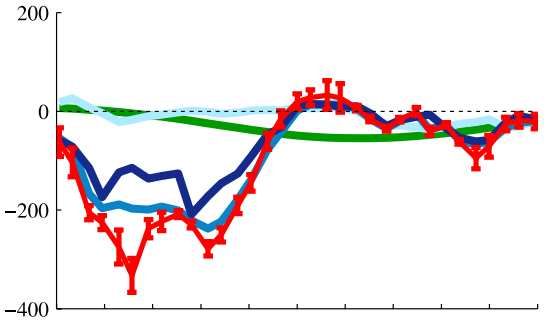
Fusion / IDA4D example

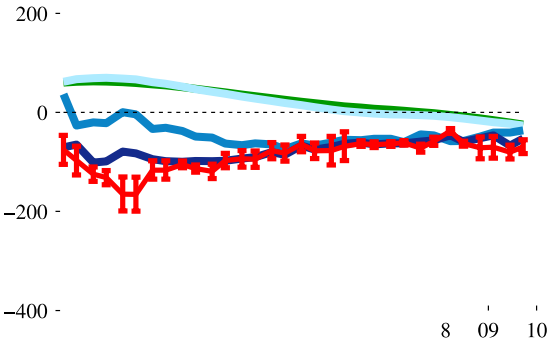


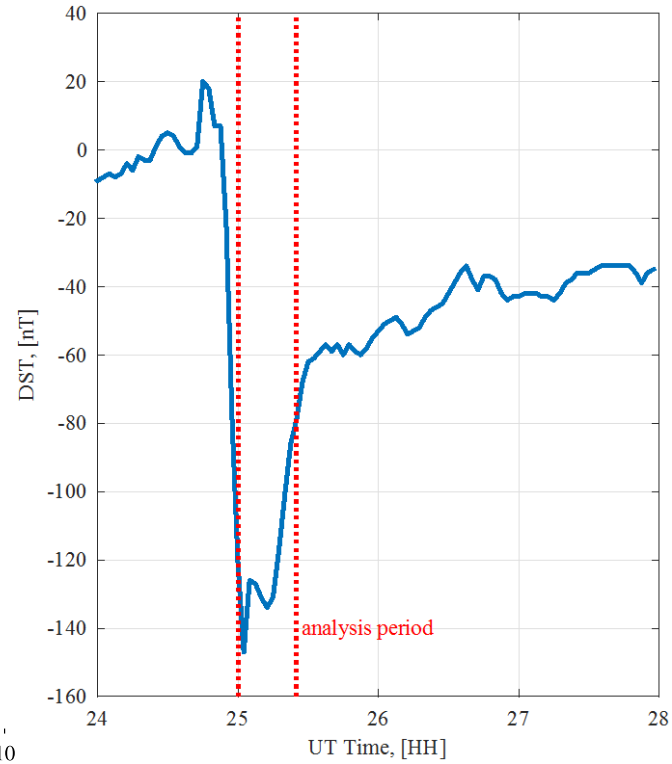
FUSION

- First principle model of electron density
- Empirical models for production, loss, neutral winds, diffusion, ExB drifting
- Currently production, loss, field aligned diffusion and low-latitude ExB drifting
- Future: high latitude ExB, precipitation

EMPIRE Comparisons to FPI Measurements: October 25, 2011







Daniel S. Miladinovich, Seebany Datta-Barua, Gary S. Bust, and Jonathan J. Makela, Assimilation of Thermospheric Measurements for Ionosphere-Thermosphere State Estimation, *submitted to Radio Science, 2016*

Where to go next: ITM an important and complex system

- **Models / modelers:**
  - **What are the MOST IMPORTANT missing pieces in models that limits ability to accurately predict observations of ITM?**
  - **What measurements are the needed; on what spatial and temporal scales**
- **Instruments / data:**
  - **Design ground and space based observations in a coherent integrated fashion**
  - **Spatial / temporal distributions that are necessary to modelers**
- **Data-model Fusion**
  - **New technique / methods that to obtain a better understanding of the ITM system**
- **Focus:**
  - **Have a focus on the problems we want to solve**
  - **Big first order physics problems; specific applications**
- **GLIMPSE:**
  - **One small part of the overall ITM system in a consistent and understandable manner**
- **Let us eliminate the Elephants**