# Current Status of Ionospheric Data Assimilation at JHUAPL

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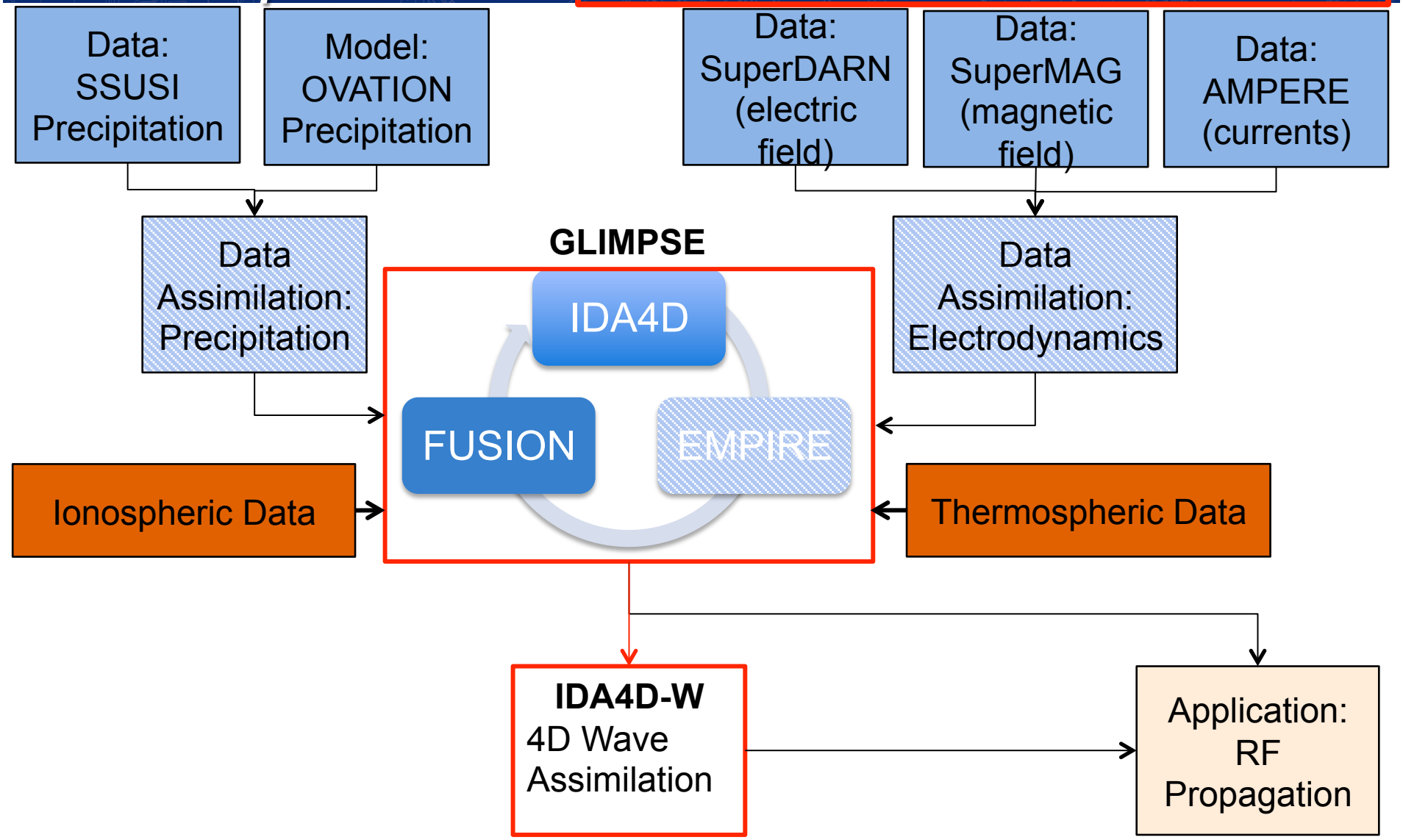
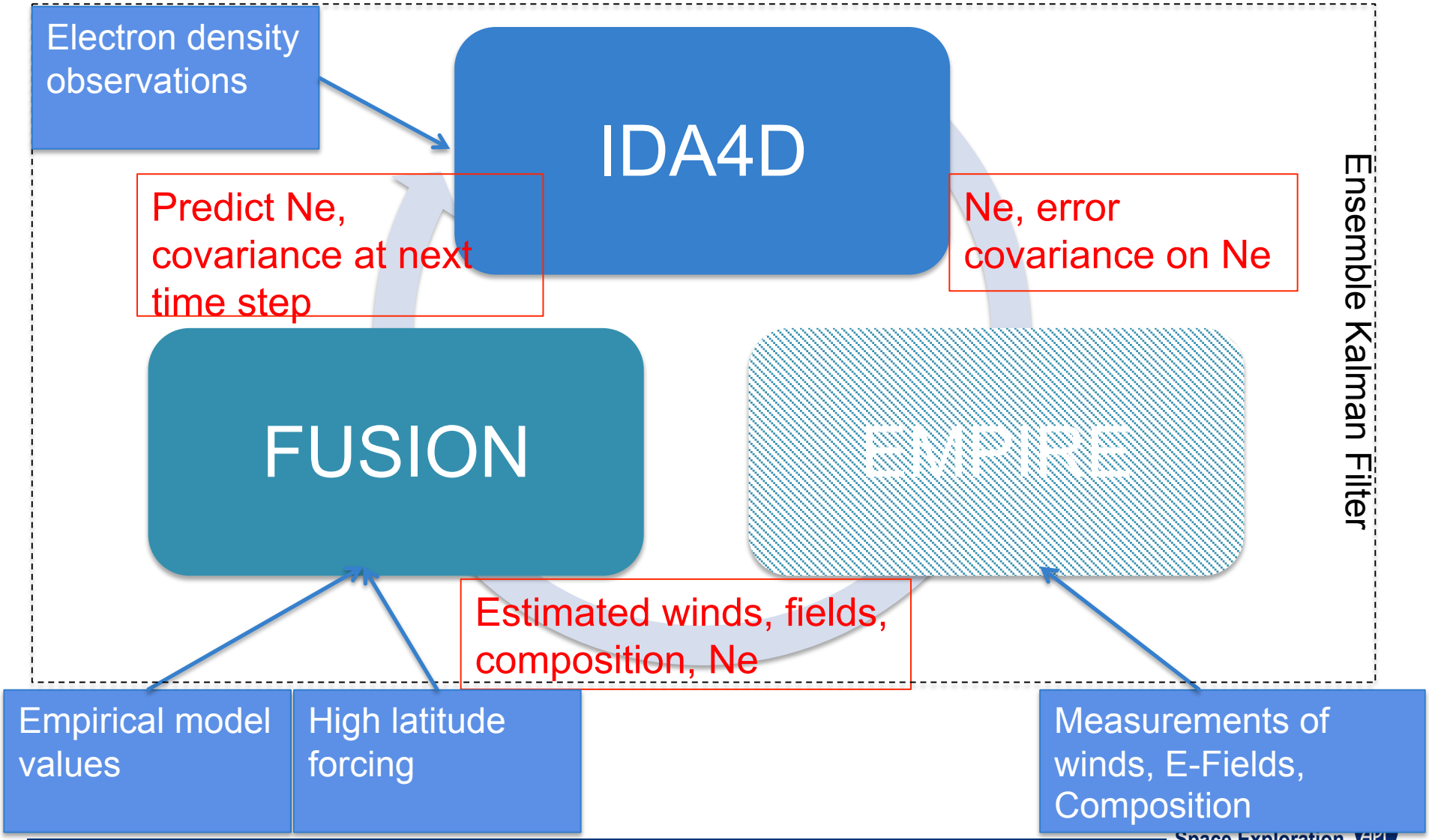
# *Electro-Magnetic Propagation Interaction with Ionosphere*

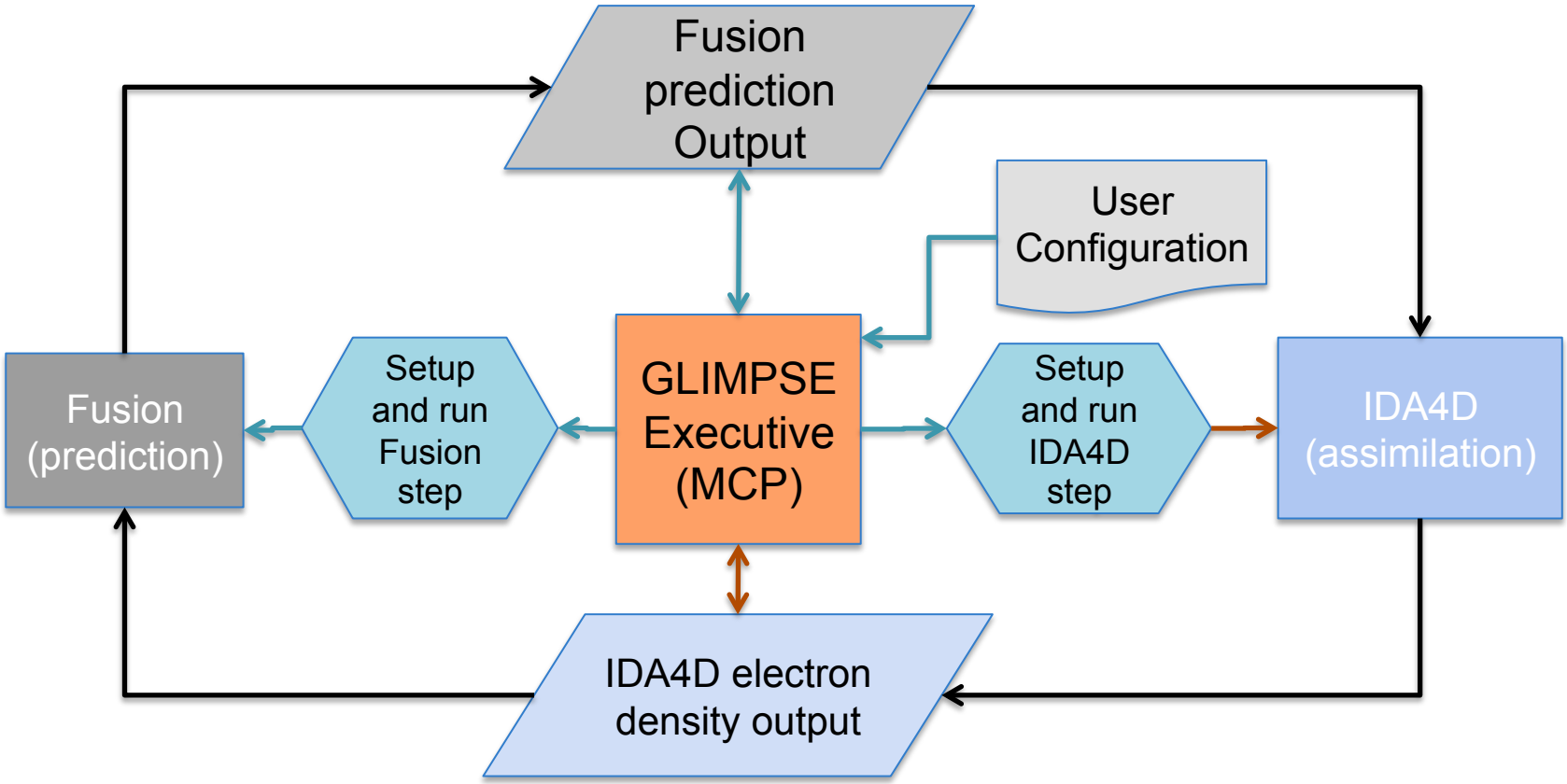
**MAIN OBJECTIVE:**
Nowcasts/short forecasts (1-3 hours) of large scale and medium-scale ionosphere in support of RF applications



# GLobal Ionosphere, Modeling, Prediction and Specification Environment (GLIMPSE)

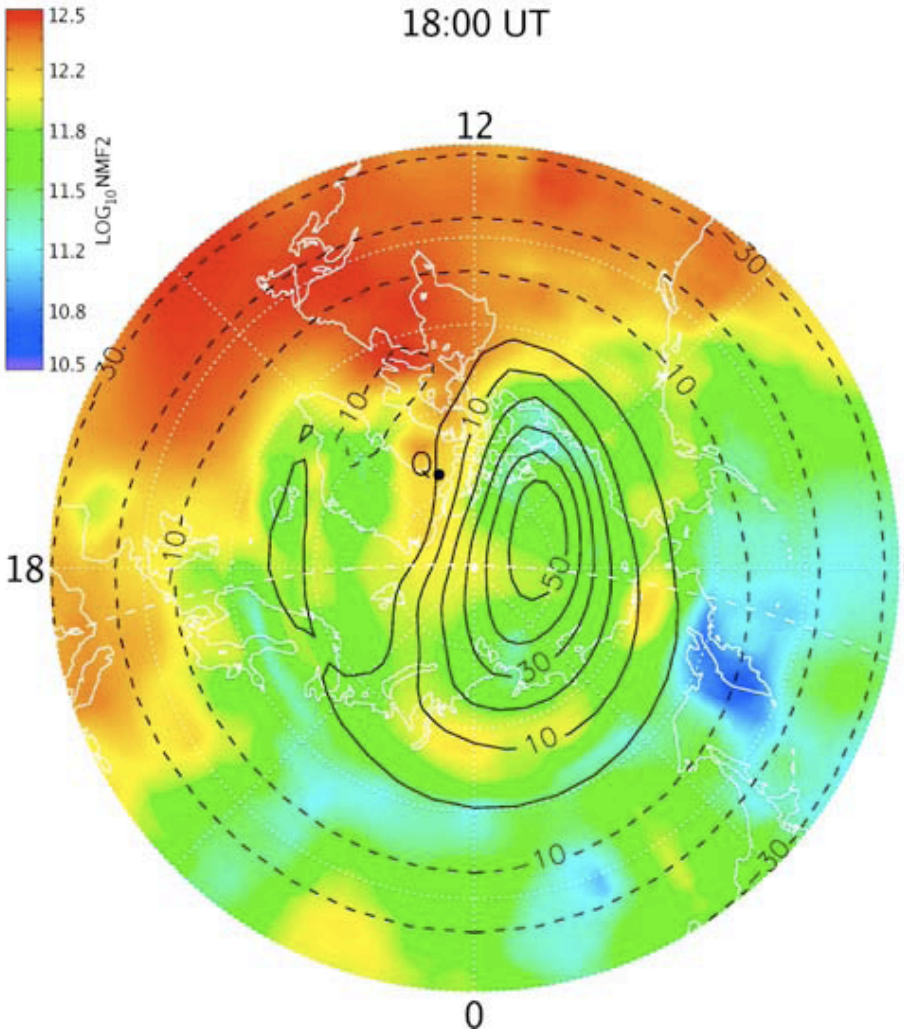


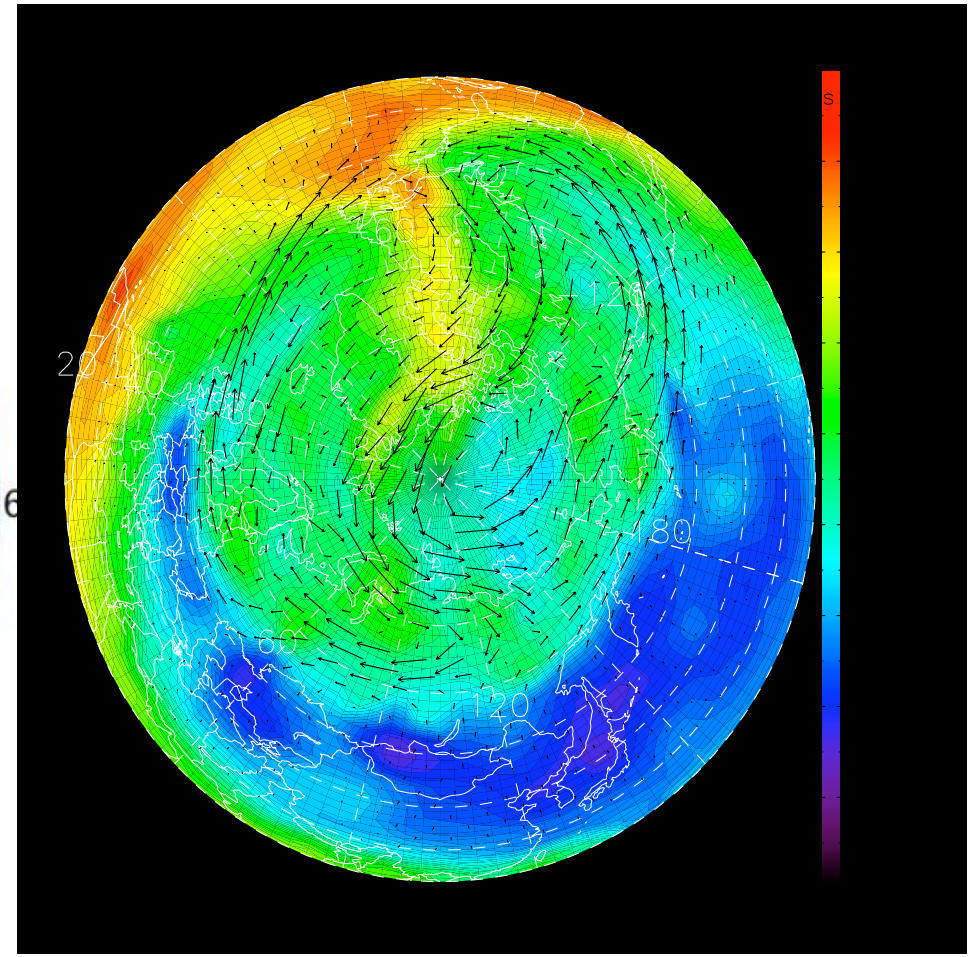
# GLIMPSE operation



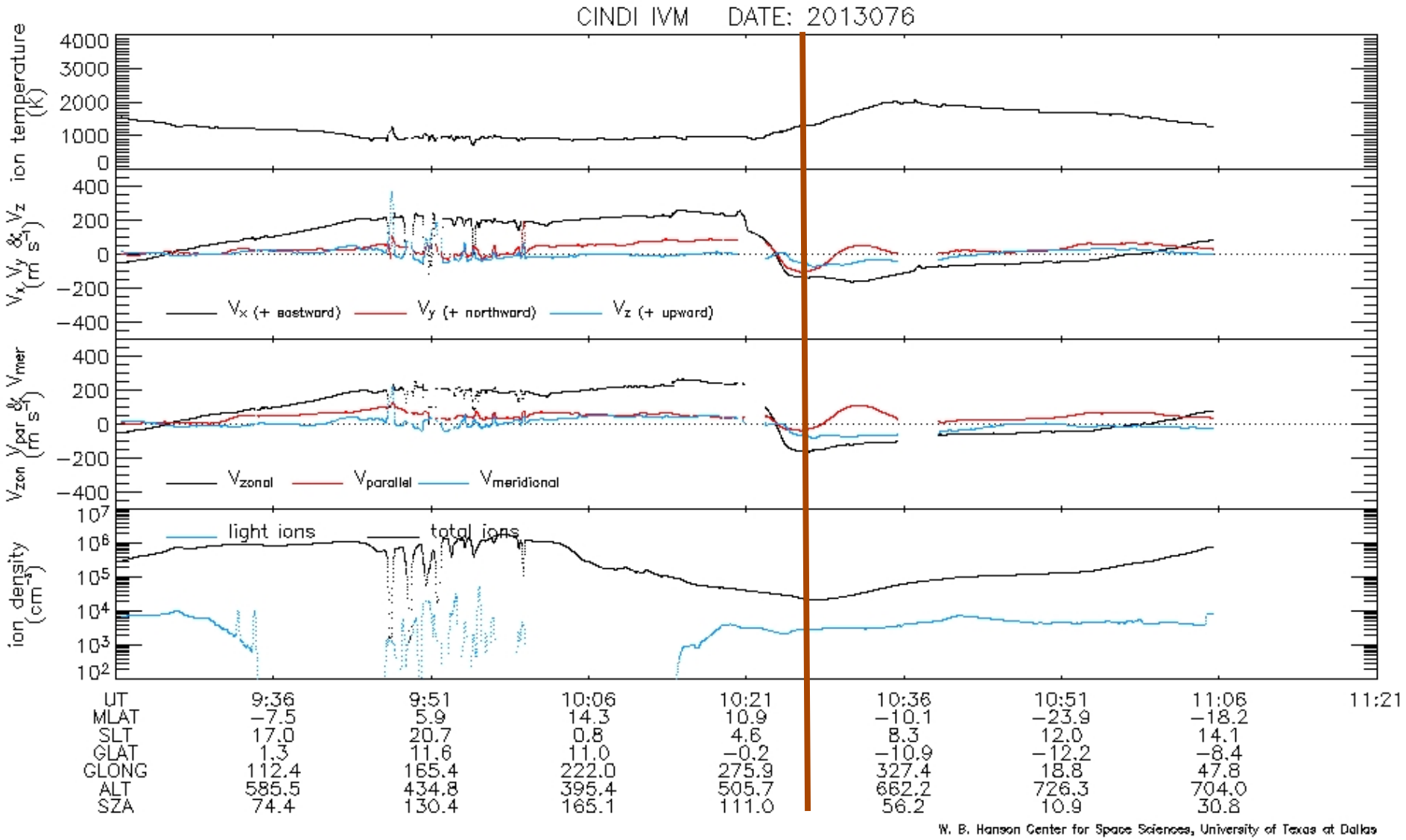

- **GLIMPSE Executive runs single assimilation and prediction steps in IDA4D and fusion.**
- **GLIMPSE tracks times and inputs, then feeds these to IDA4D and fusion**
- **Overall parameters of the run (time interval, resolution, data sources, etc., are specified in the GLIMPSE user configuration file**

# *IDA4D:* Fast moving patches and tongues of ionization can severely impact RF applications in the VLF, HF, VHF, UHF frequency bands



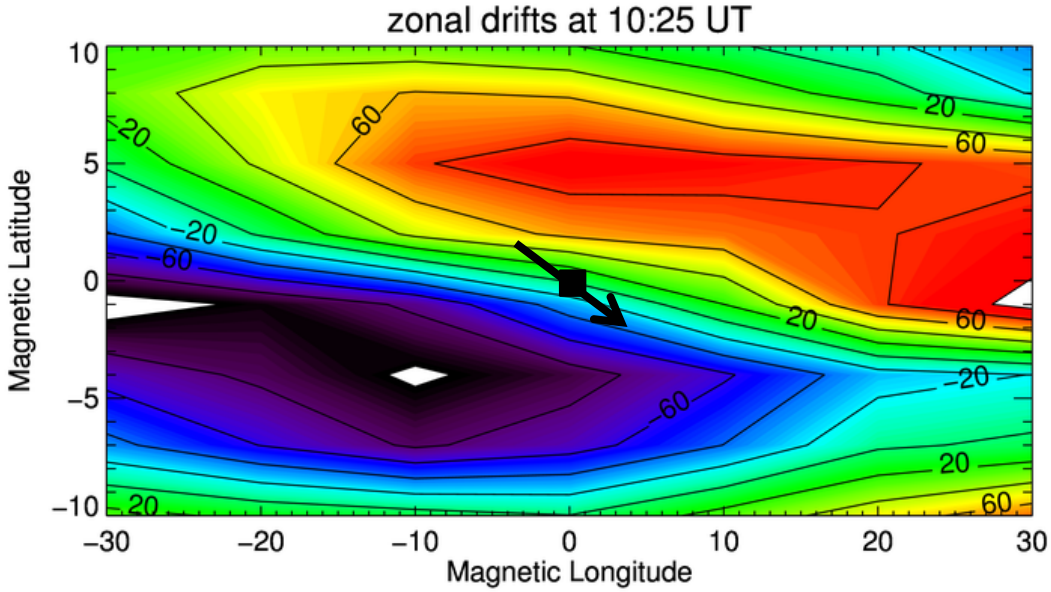



# EMPIRE: CINDI IVM for March 17, 2013

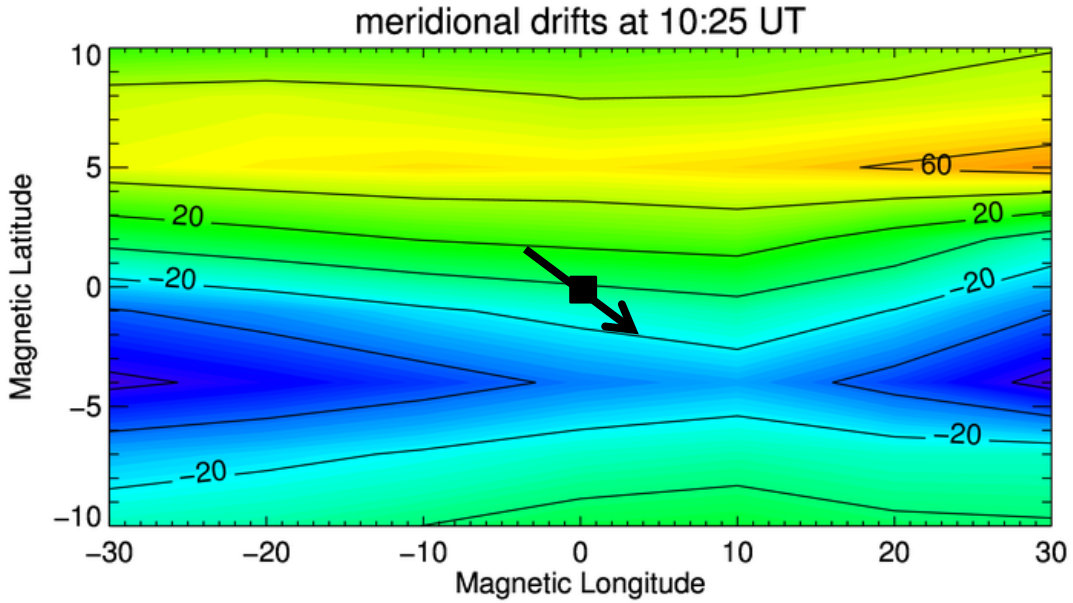


# EMPIRE:

Data assimilative estimation of neutral winds, composition and electric fields help to ***forecast electron density 1-3 hour***s into the future for RF applications




*Zonal and meridional drifts near C/NOFS location at ~ 10:25 UT*



# End to End Medium Scale Ionospheric Wave Corrections

GLIMPSE Inputs

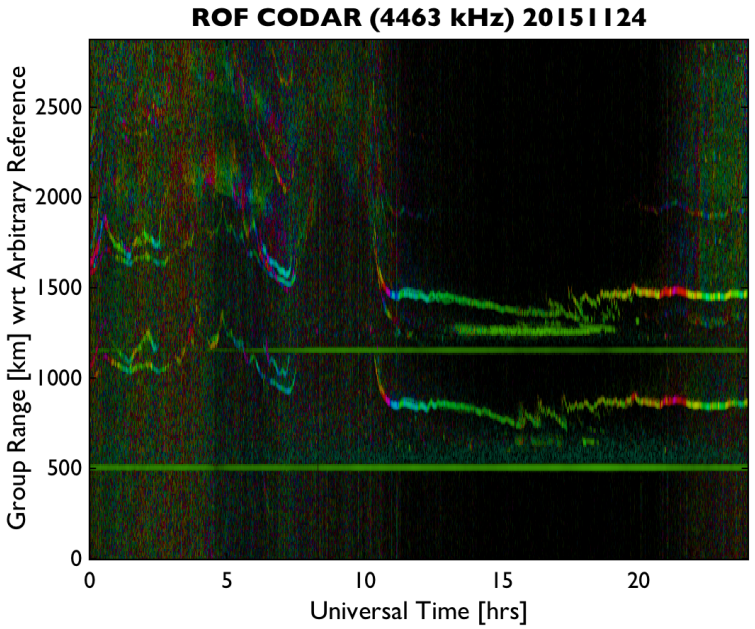
GLIMPSE

Large scale density

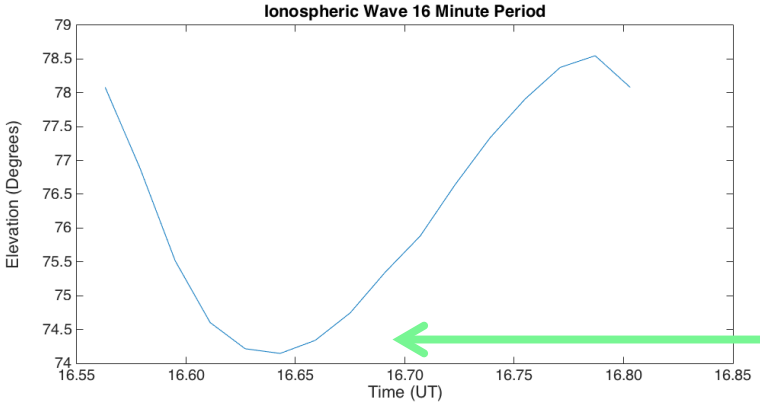
Wave Observations:
Oblique HF
Ionosondes
GPS
Neutral (FPI)

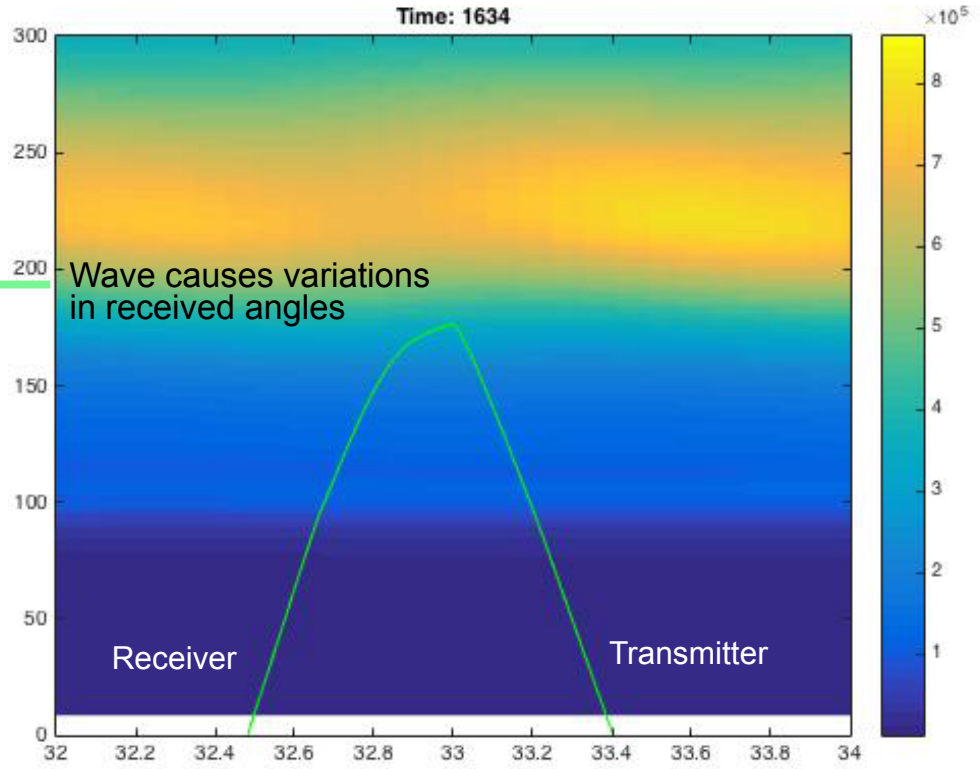
Ionospheric Wave Model (TID)

Correction to HF/VHF/UHF application



# *IDA4DW-high res:* Very accurate estimation of the 3D time evolving ionospheric wave field is required for HF and low-VHF RF applications




Bottom-side waves seem to be always present.

Independent of solar activity, time of day, geographic location

Goal: Accurate knowledge impacts correction to HF/RF systems as well as planning / decisions

# Status

- **IDA4D**
  - Written in F90 for most part
  - Installation
  - Linux redhat distributions
  - All necessary libraries are in the distribution
  - Set 1 environmental variable
  - Type make – wait 1 hour or so depending on speed of computer
  - Python script to configure and set up directory for run
  - Multiple scripts to download and process data
- **EMPIRE**
  - Written in MATLAB
  - Runs in a “research” mode
  - Currently being coupled to GLIMPSE
- **FUSION**
  - Solves for electron density
  - Production, loss, diffusion
  - Winds, precipitation and electric fields to be added
- **IDA4DW-high-res**
  - Full 4D estimator of waves developed in research mode
  - Use of HF data, GPS
- **GLIMPSE**
  - FUSION and IDA4D have been coupled and sample results
  - Beginning testing and validation

# Near Future Plans

- **IDA4D**
  - Get bottom-side HF estimation working again
    - New improved ray-tracer
    - Angles of arrival, doppler in addition to group delay
  - Ingest SSUSI auroral products
- **FUSION**
  - Add winds, precipitation and electric field modeling
- **GLIMPSE**
  - Couple EMPIRE to IDA4D and FUSION
  - Ingest APL high latitude drivers
    - AMPERE FAC
    - SuperDARN electric fields
    - SuperMAG
    - SSUSI precipitation