

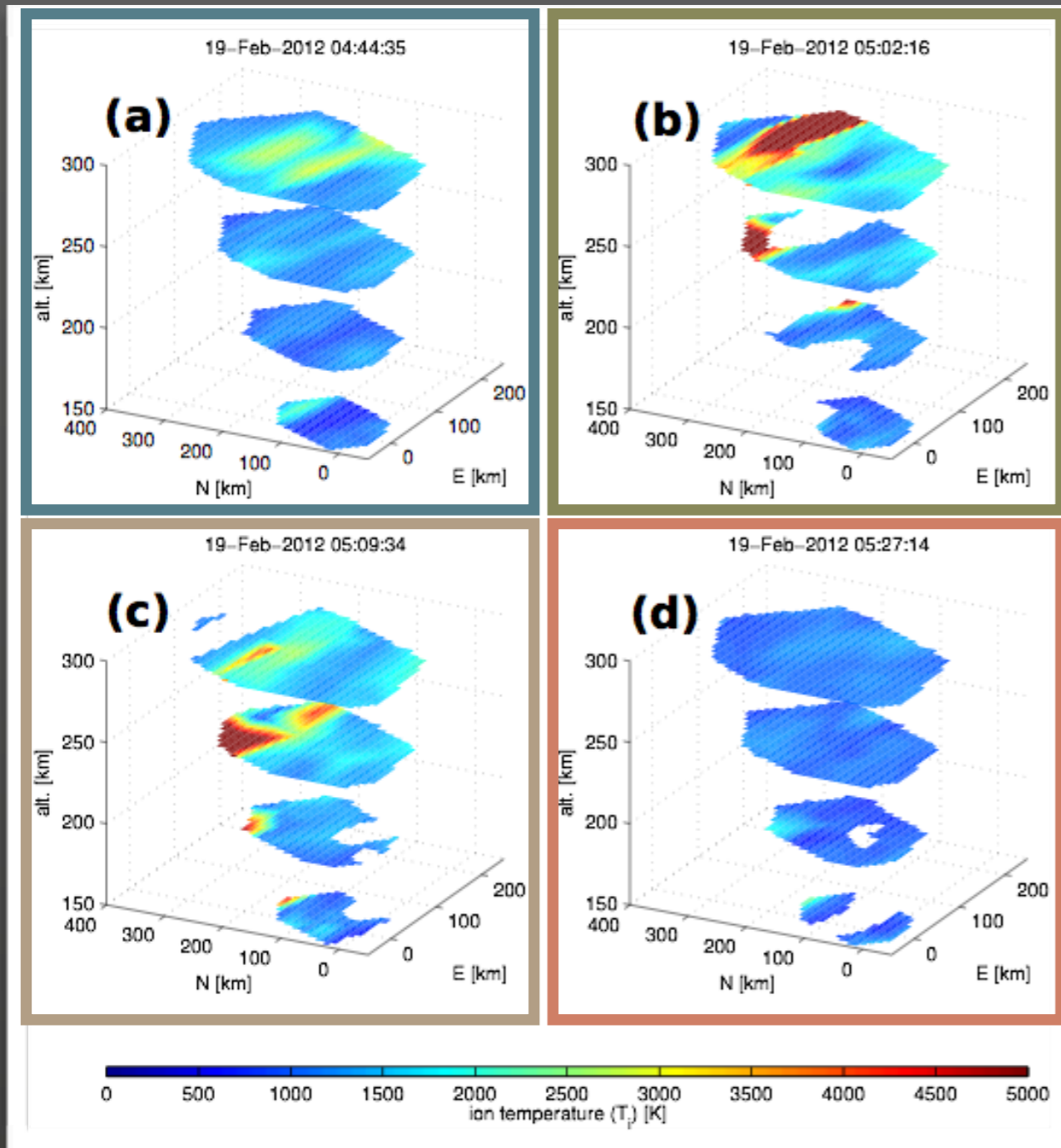
# Interfacing Models and Data (from Sounding Rocket Campaigns)

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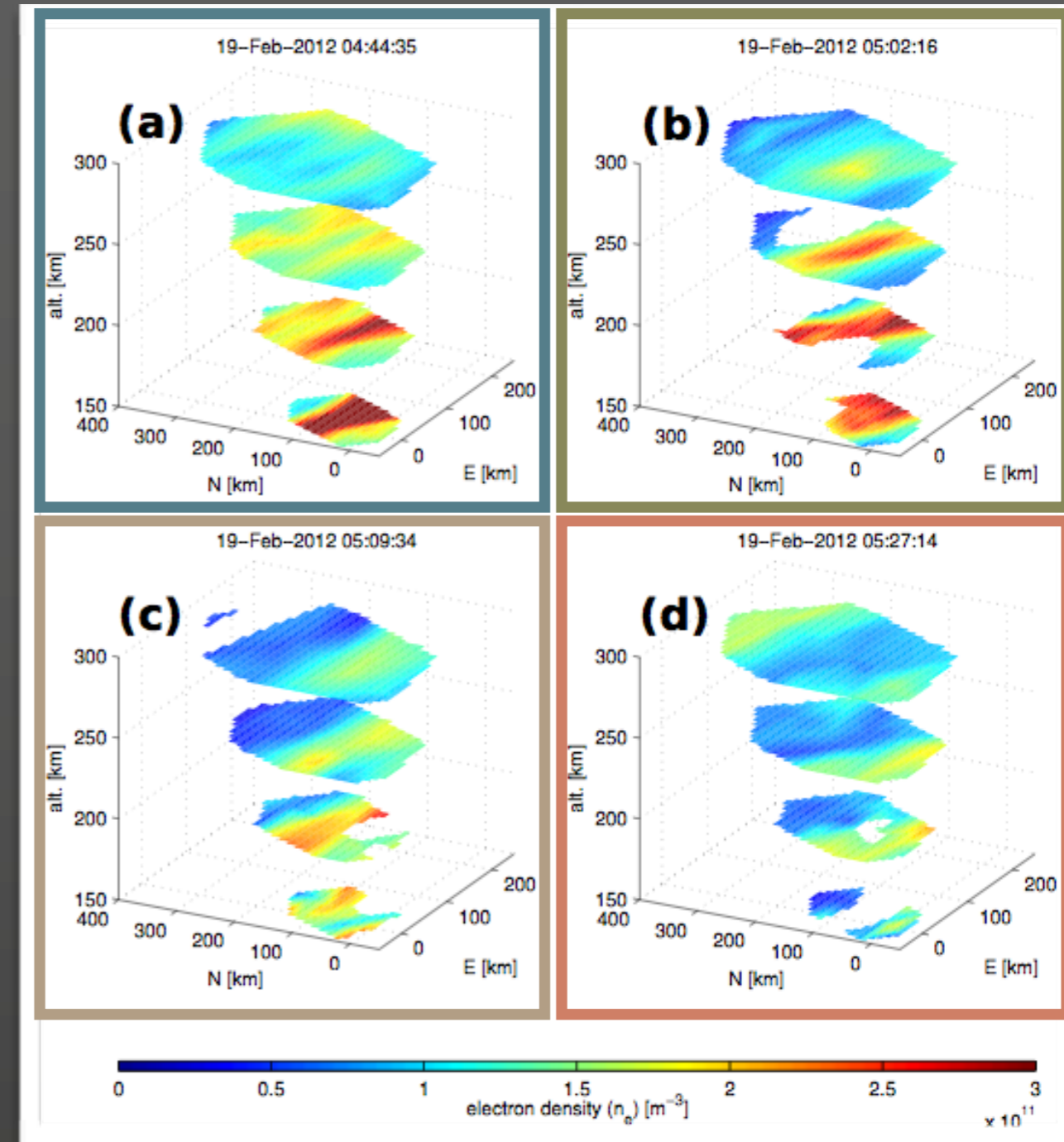
M. Zettergren, K. Lynch, D. Hampton, M. Nicholls, D. Rowland, J. Klenzing, M. Burleigh, R. Albarran and many others

*research supported by NASA grants  
NNX14AH07G and NNX15AJ08G and NSF  
grants AGS-1339537 and AGS-1255181*

## ion temperature



## plasma density

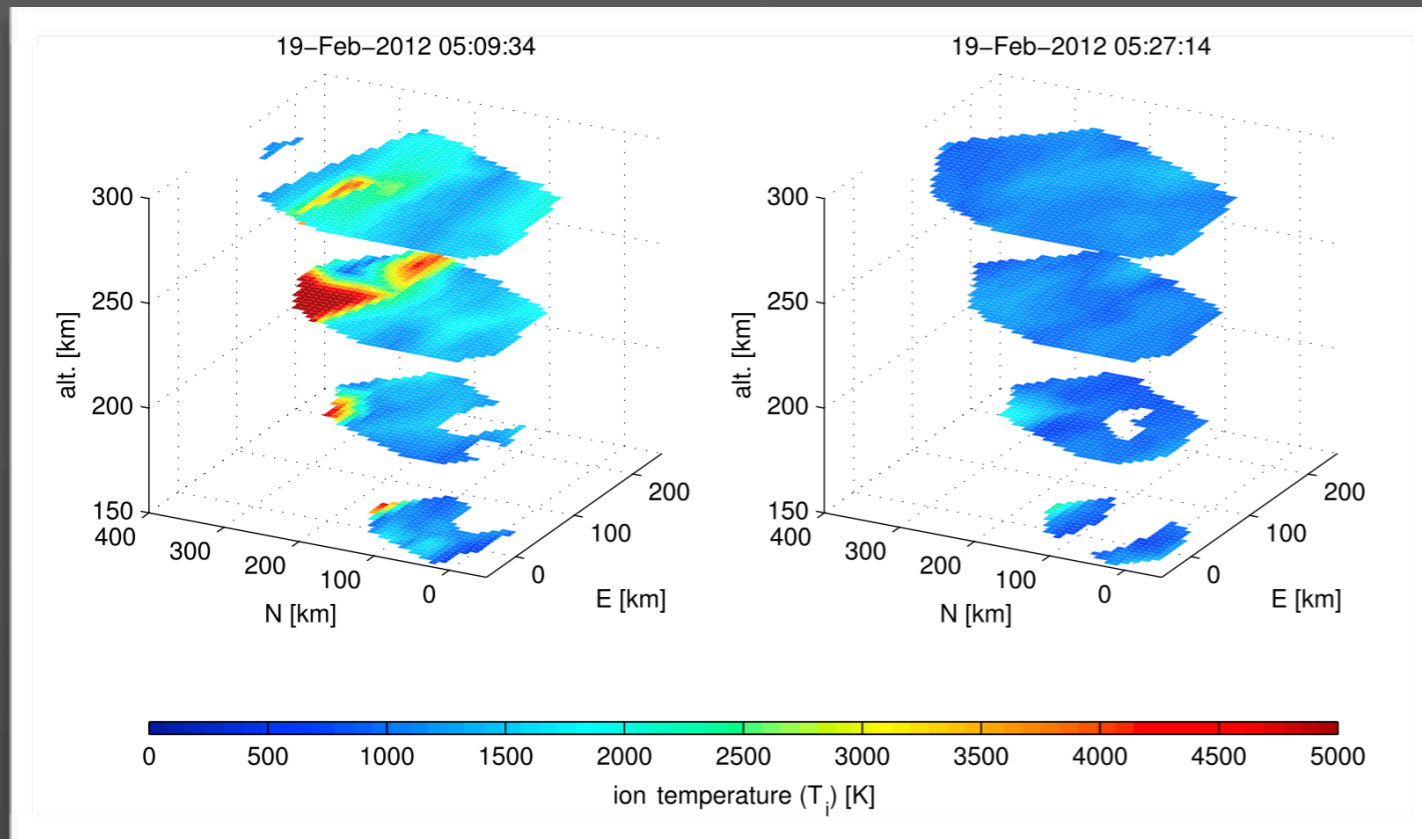


Zettergren et al, 2014

Observed plasma characteristics  
during cavity formation

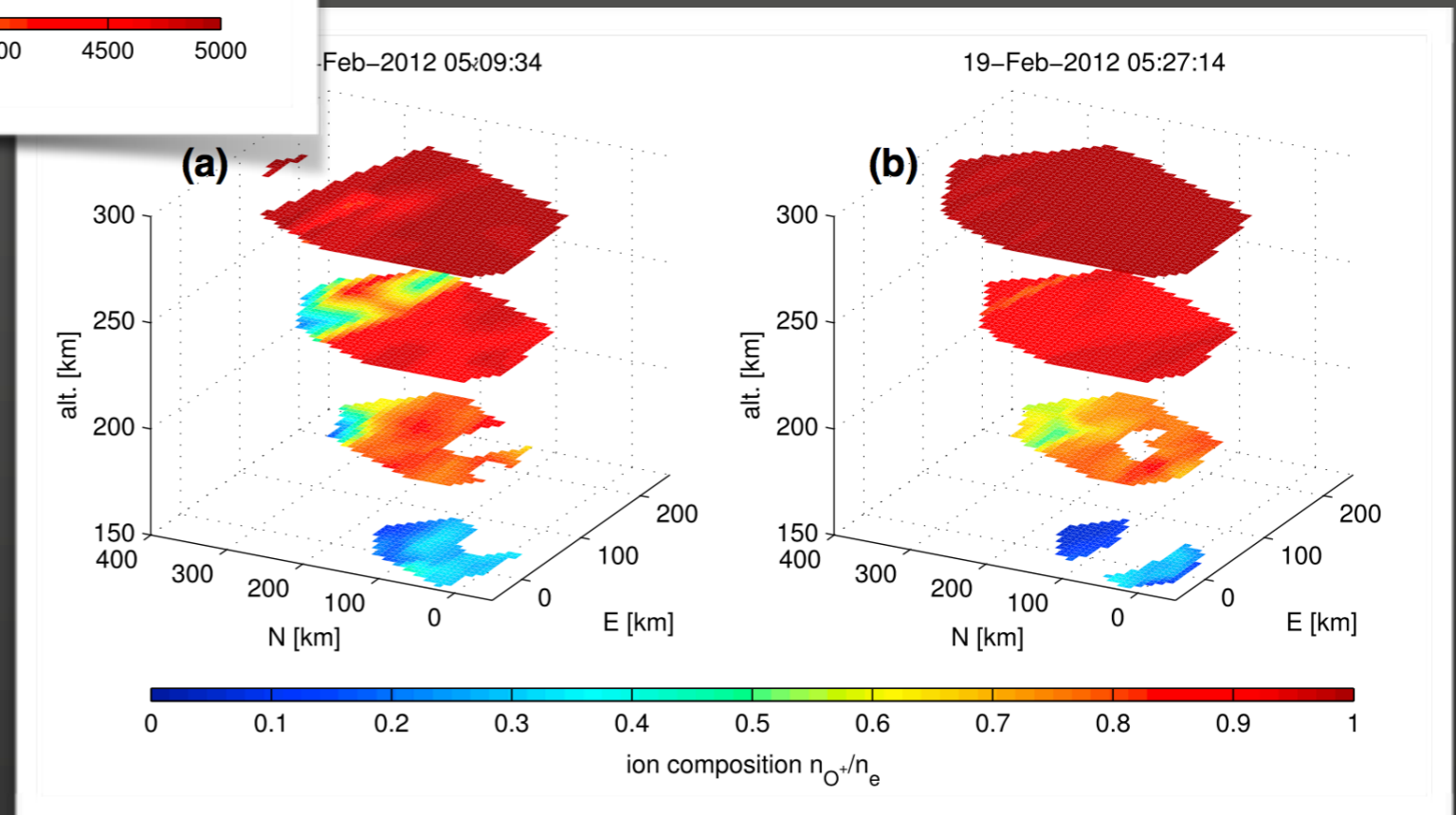
Measurements from the Poker Flat Incoherent Scatter Radar (PFISR) during the MICA sounding rocket campaign, BUT NOT TO BE TRUSTED (anisotropy likely)

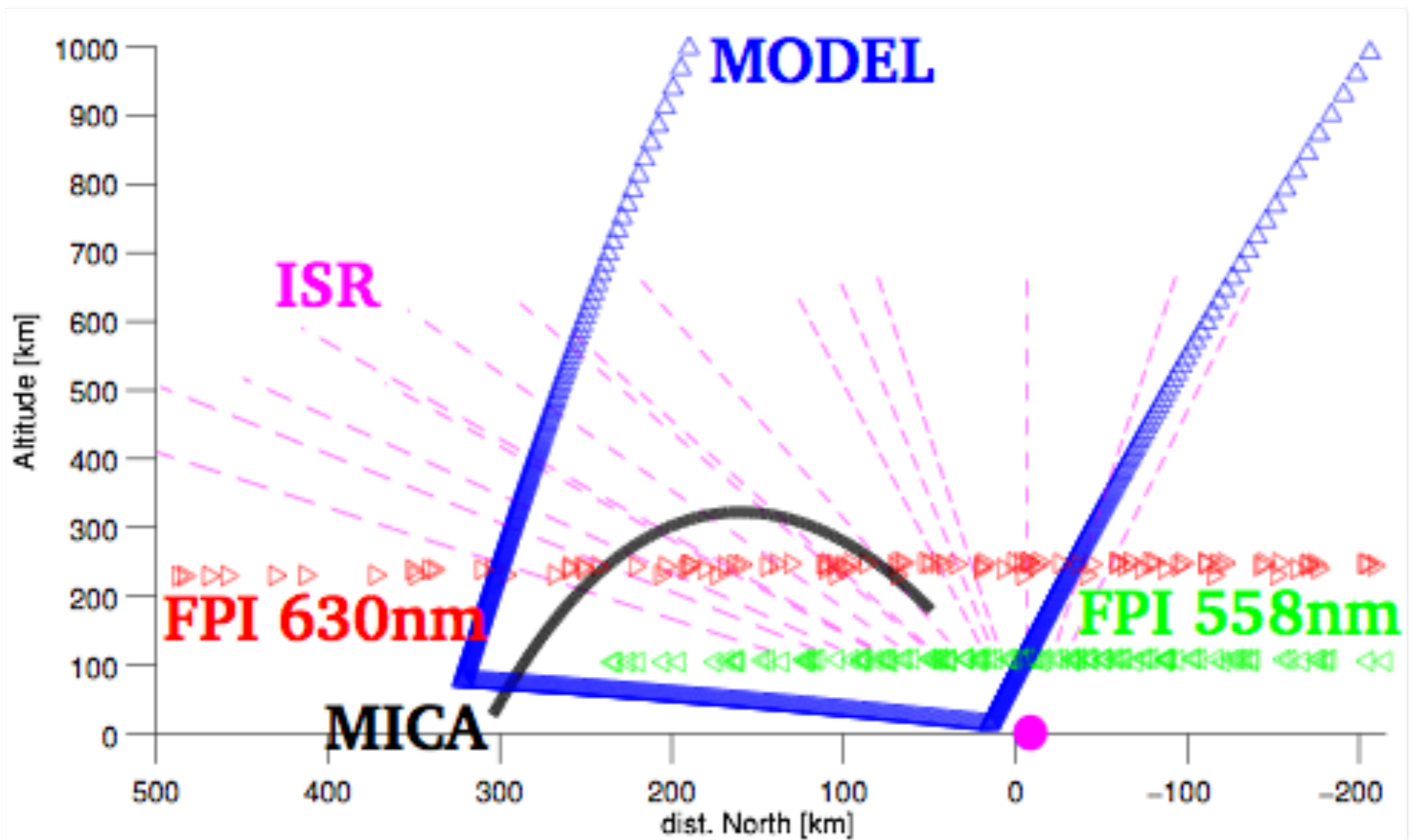
# Using models to constrain ion composition (IDC)



*Algorithm proposed by Richards et al (2010) - electron density estimates used to iterate a chemical model of ionosphere to equilibrium*

*Results roughly consistent with theoretical expectations...*

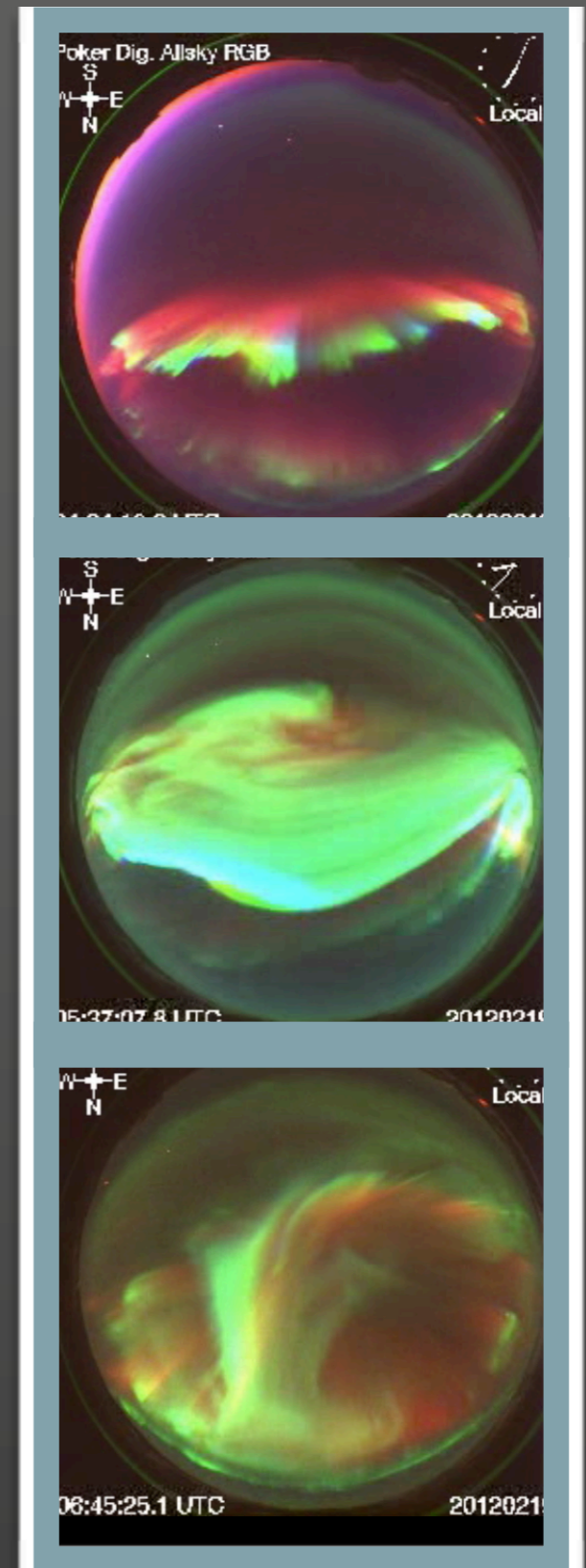
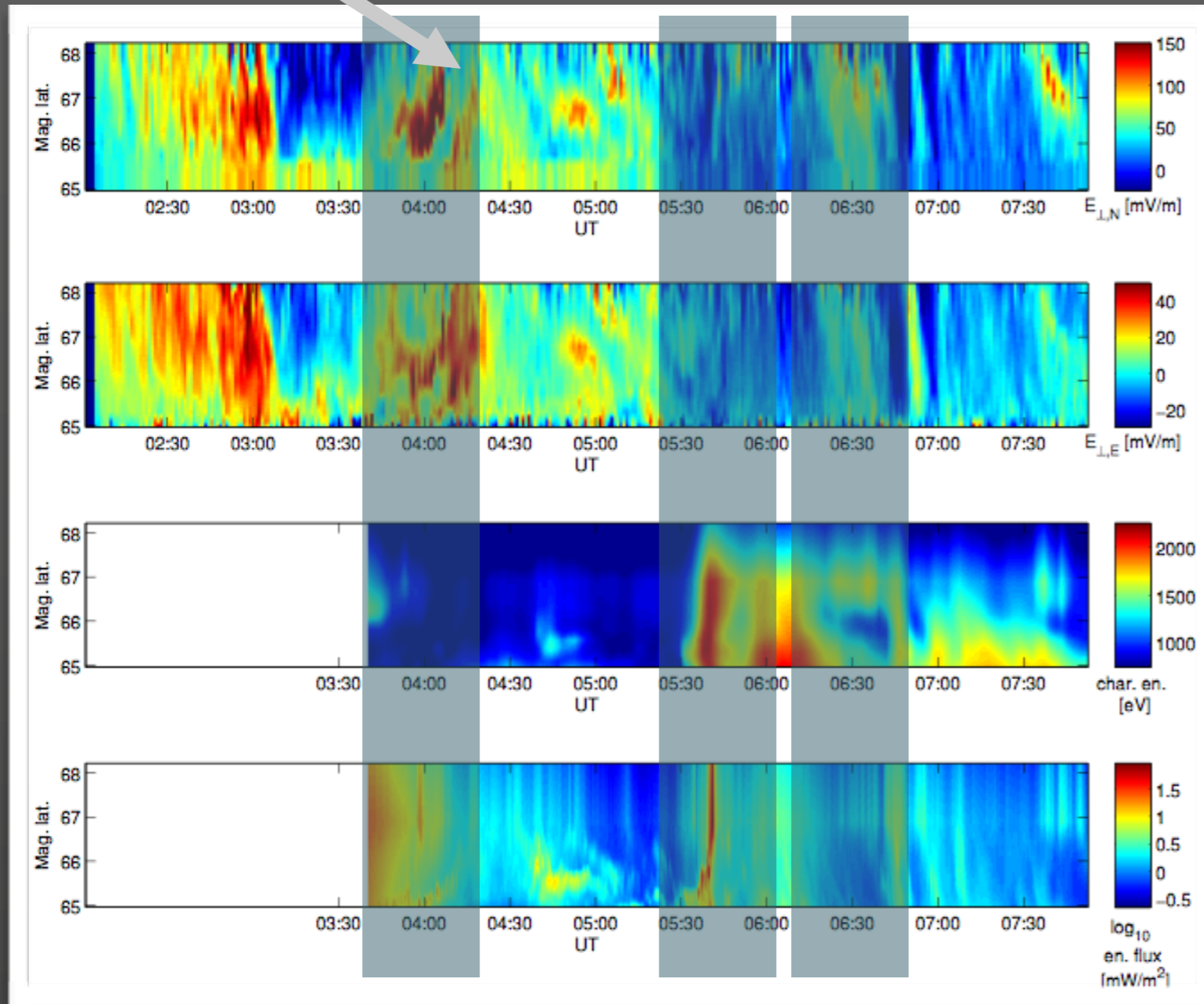




Case studies modeling conditions during cavity observations

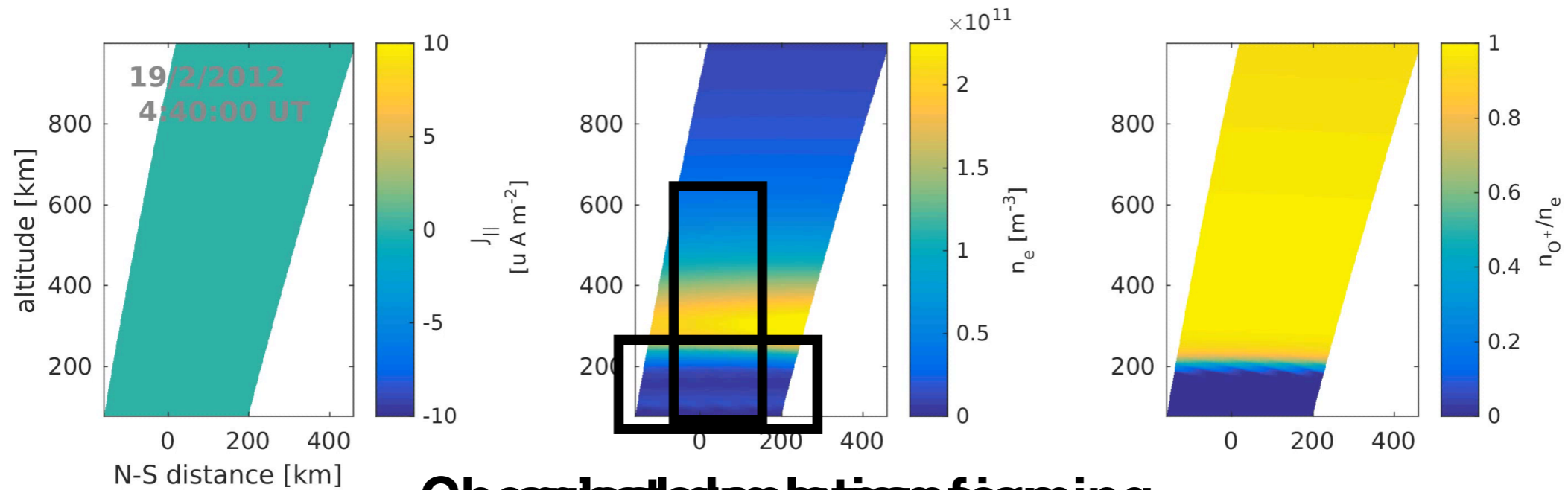
From MICA campaign (2/19/2012) study of density cavity formation processes (Zettergren et al, 2014)

about 170 mV/m

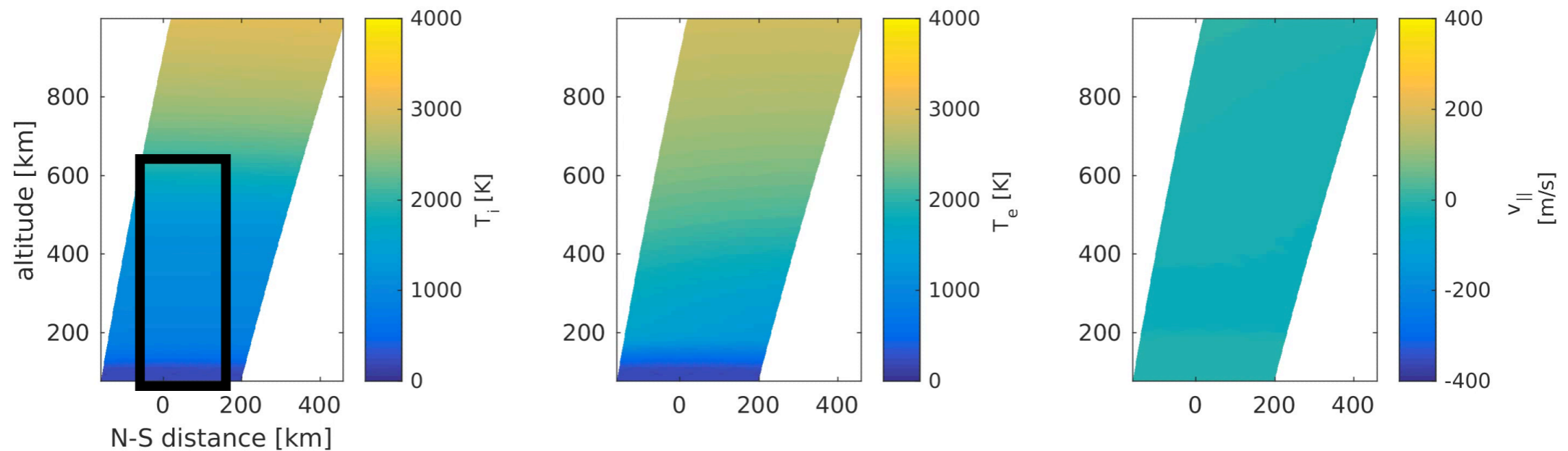


Observation-driven case study: Feb. 19 2012

Observations converted to estimates of model inputs (boundary and initial conditions)



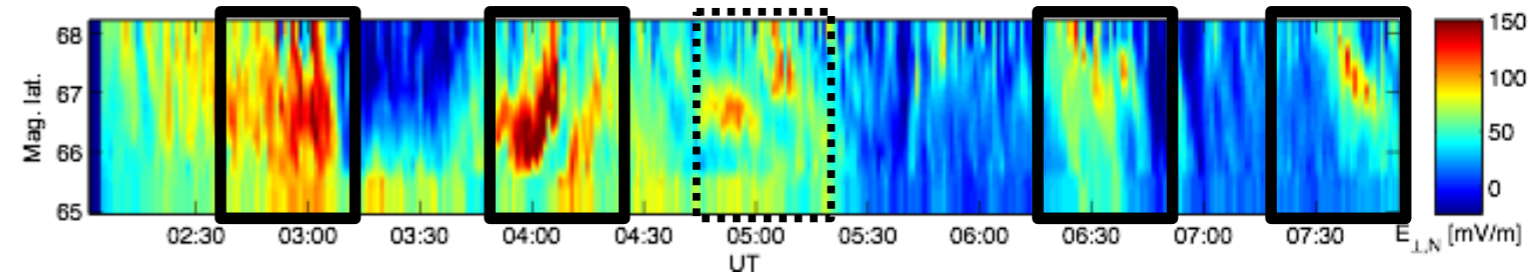
## Chesapeake depletion forming



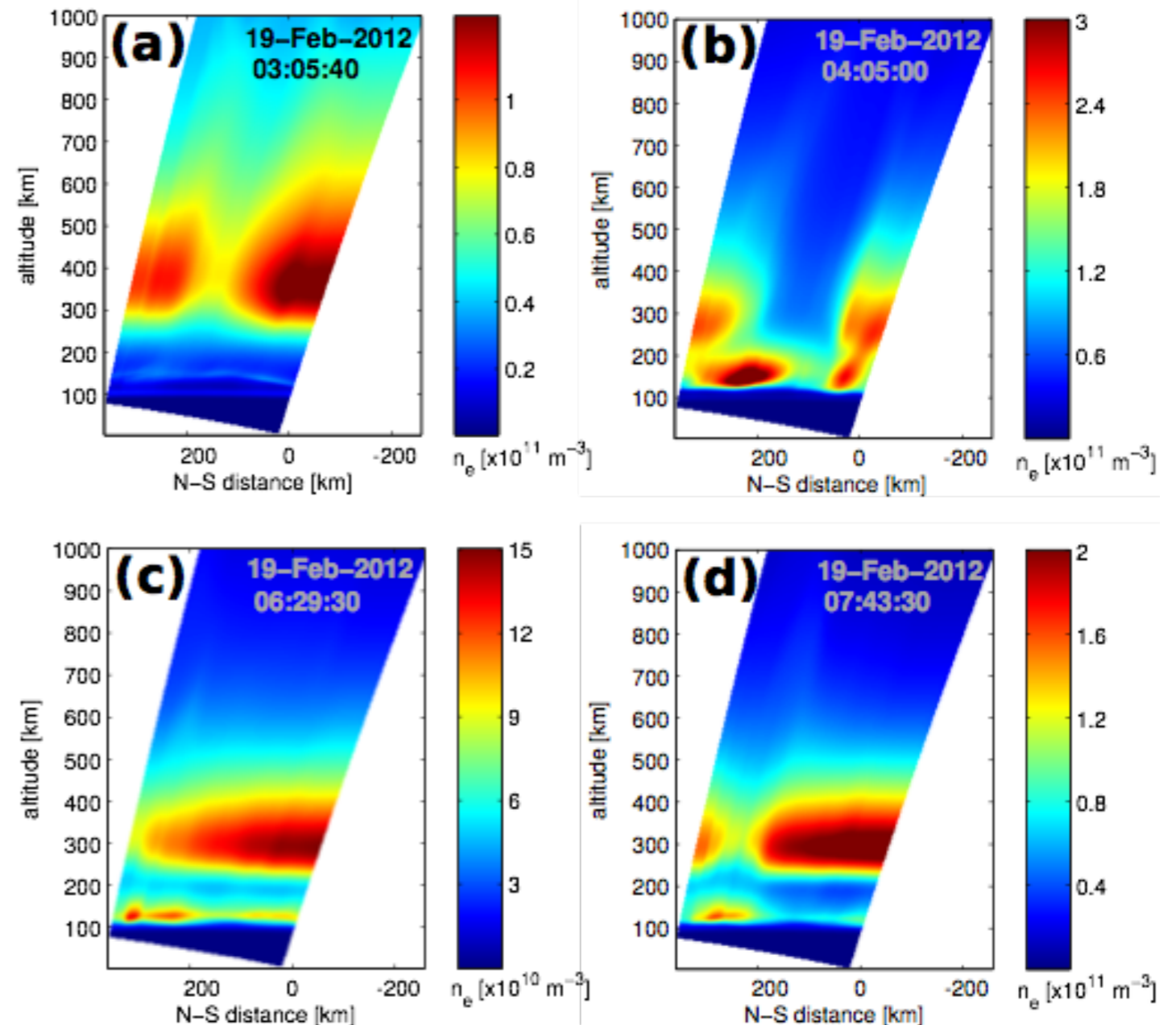
Time-dependent character of ionospheric response near launch time

*Transient* electric field sources can generate *long-lasting* density cavities lasting until launch (~ 5:41 UT)

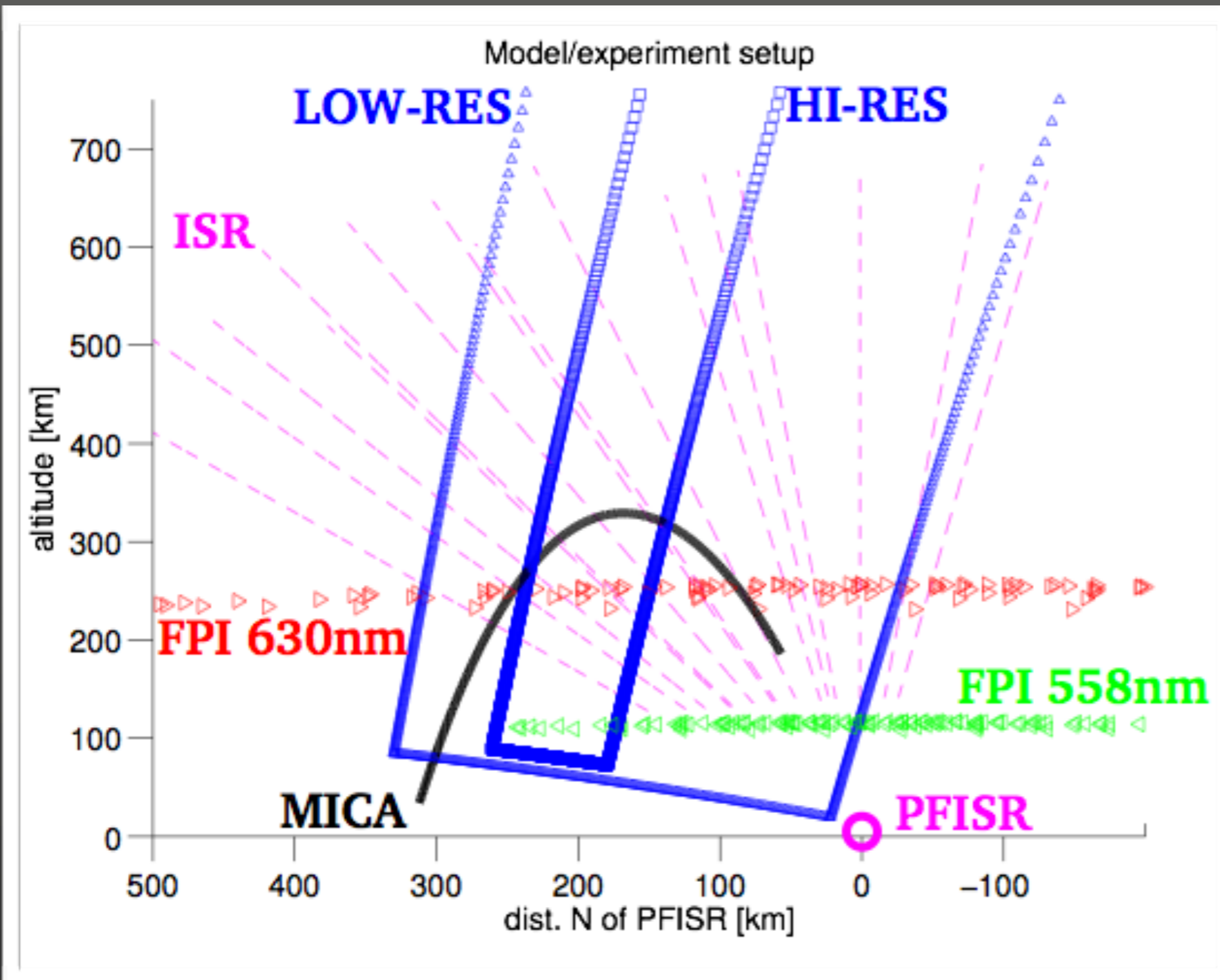
# Poker Flat ISR (PFISR) measurements of density cavitation



- Each field intensification in electric field data is associated with density depletion
- Several such examples observed during experiment - these may be a systematic occurrence during active conditions
- Model results reproduce timing and rough depth and size of cavity
- **Model decomposition shows these are due to molecular ion generation and enhanced recombination - i.e. they do not have observed depth without the frictional heating process**



# Multiscale (data-driven) modeling

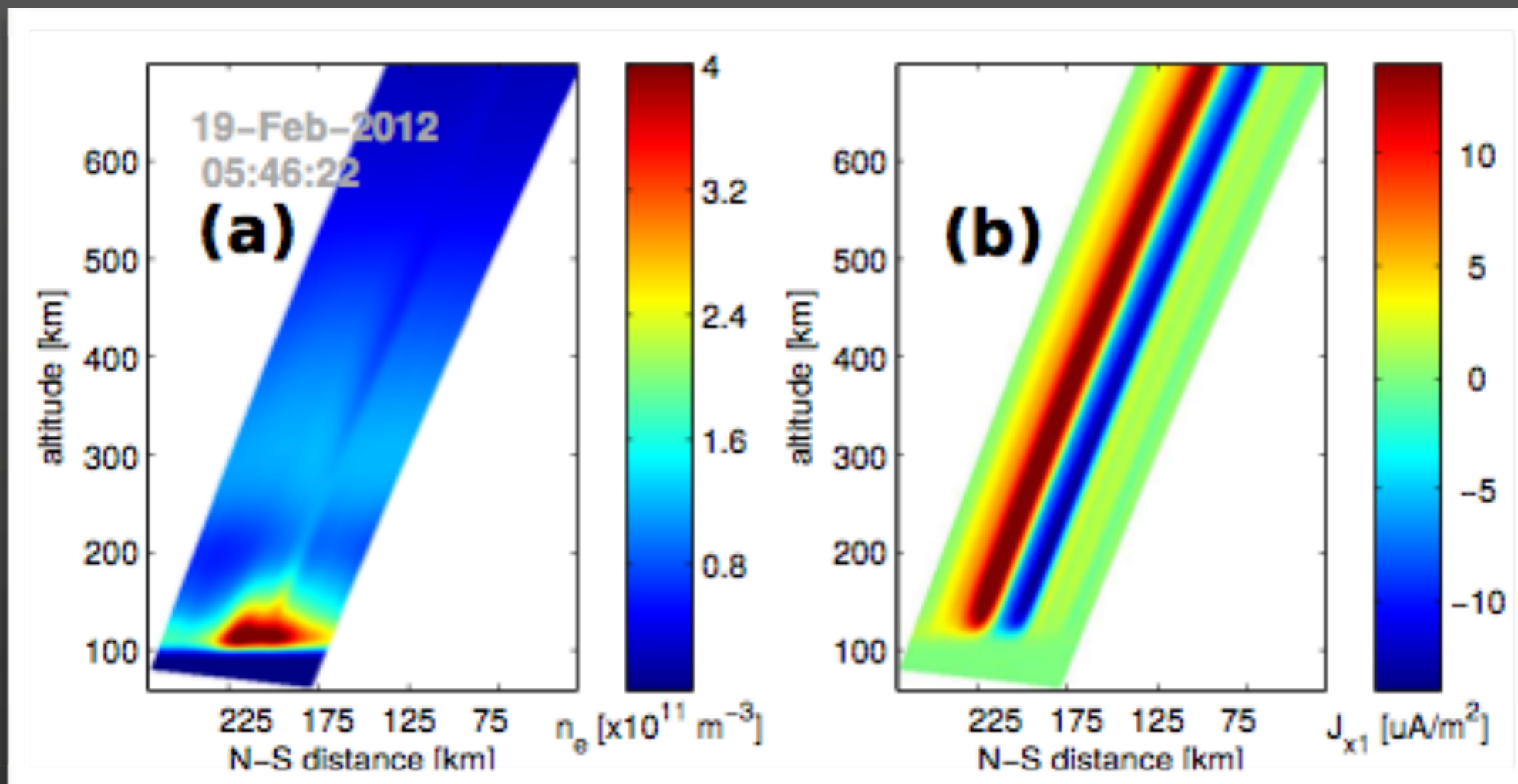


*Winds estimated  
from FPI data*



# Current density and impact of resolution

- Driven with in situ electric fields
- Precipitation derived from narrowfield blueline
- Initial conditions derived from mesoscale model state at time of rocket launch

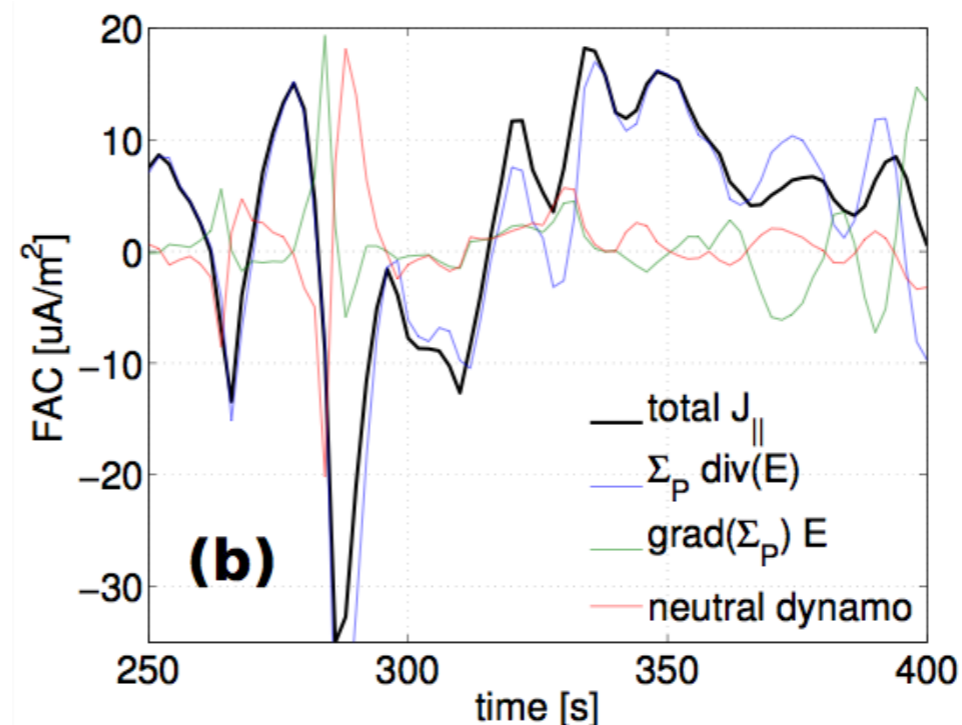
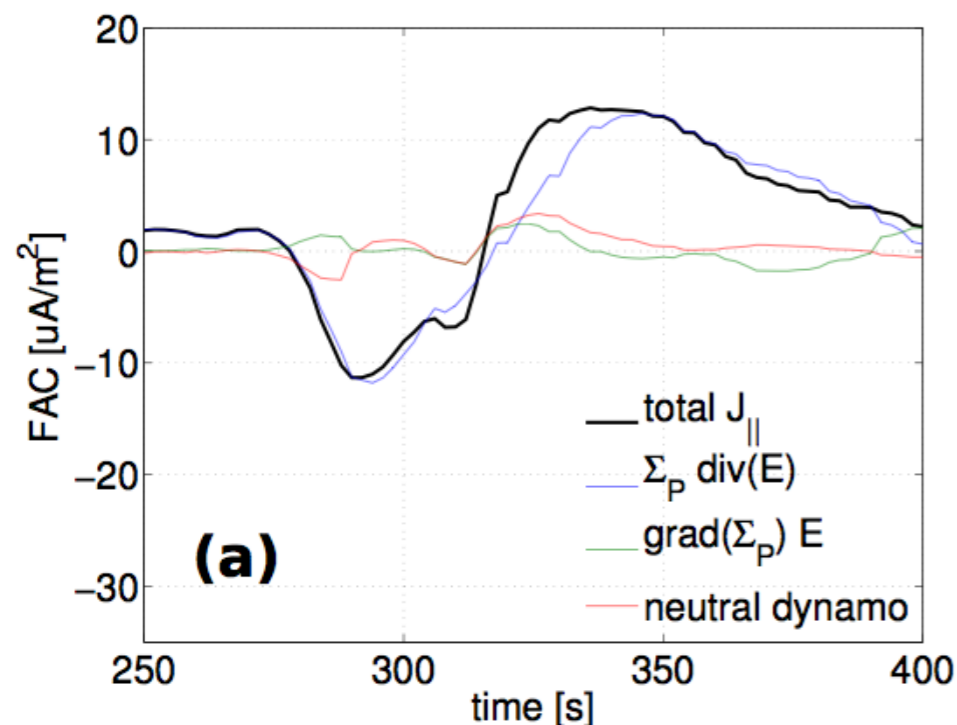
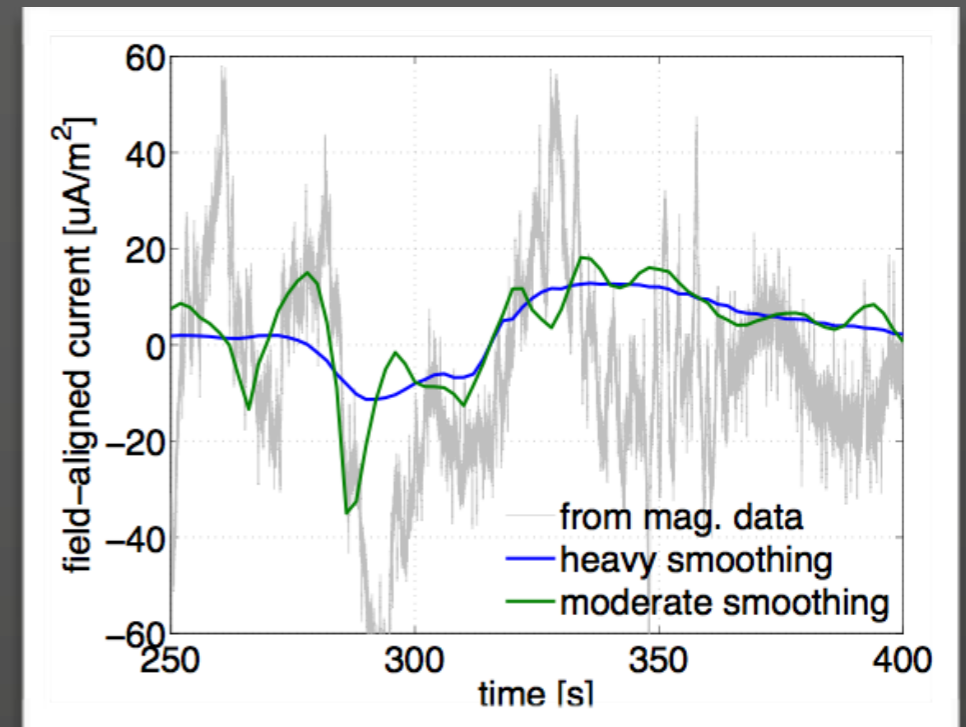


*Current density a factor of ~10 larger than mesoscale time*

# Smaller-scale perspective

## Rocket "flown" through model

Current densities show rough agreement with magnetometer data - even at the smallish scales indicating that the field and precipitation measurements are roughly consistent.



Breakdown into different contributors suggests a possible role for neutral winds

# Comments

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- When constrained suitably with data models can provide crucial insight into causal chain of processes leading to, e.g., density cavities.
- *Work underway - new data and more sophisticated models*
  - *Bi-Maxwellian fluid model (Burleigh and Zettergren, 2016) to look at temperature anisotropies during ISINGLASS sounding rocket flight (Meghan has a related talk tomorrow in the “” session)*
  - *3D, Maxwellian runs, coupled with GLOW, to look at current density structures using ISINGLASS data*
  - *Kinetic modeling of ion outflows observed during VISIONS (R. Albarran has a poster on this work)*
- **Future:**
  - ***How can we move beyond simple (but worthwhile) combinations of models and data?***
  - ***What rigorous assimilative algorithms might be applied with sounding rocket-style data sets?***
  - ***Collaborations welcome!***