
*Integrity ★ Service ★ Excellence*

# A Data Assimilation Scheme for Driven Systems

**Thursday, June 23, 2016**

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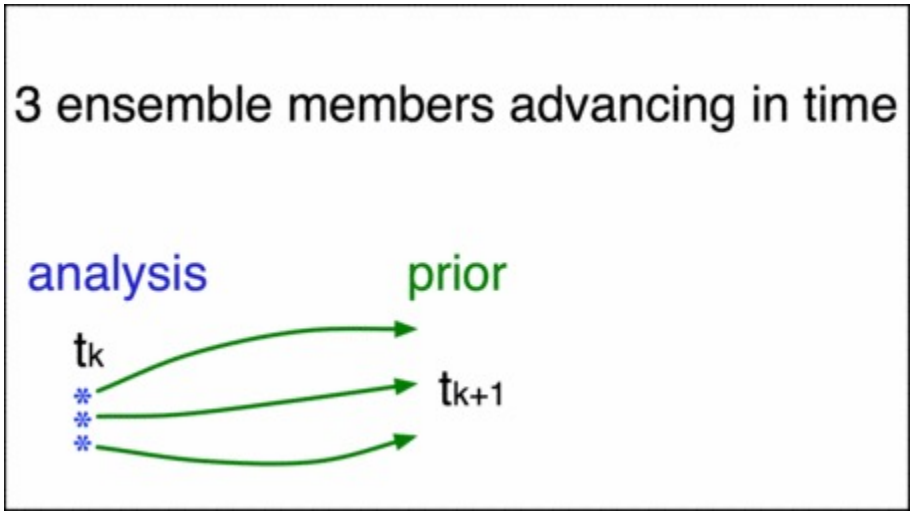
# System Characteristics:

## Global thermospheric densities / Satellite drag

- Highly driven and dissipative
- Highly variable
- Response timescales ranging minutes to weeks
- Sparsely observed

# EnKF-Based Data Assimilation




credit: NCAR/DAReS

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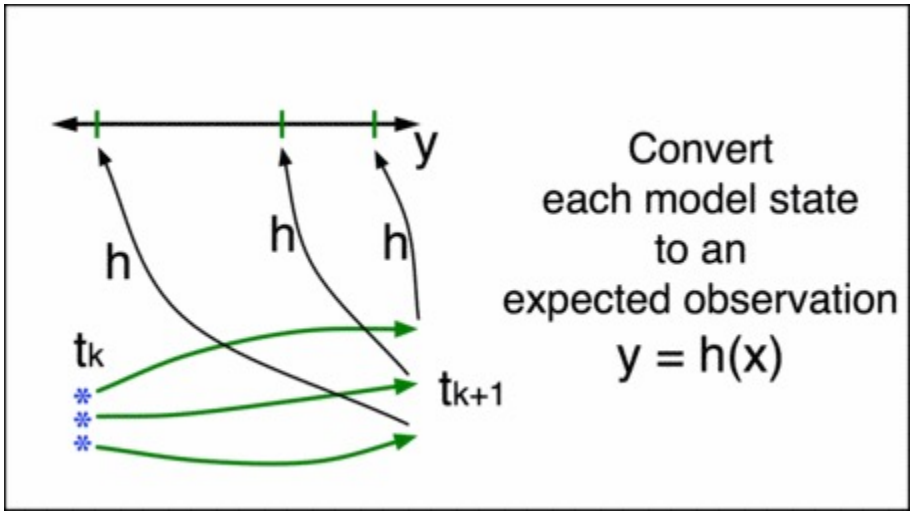


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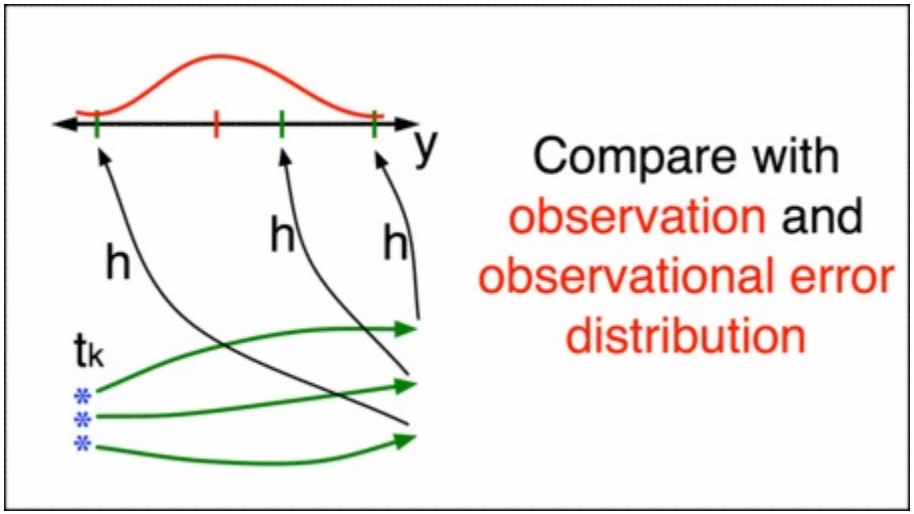


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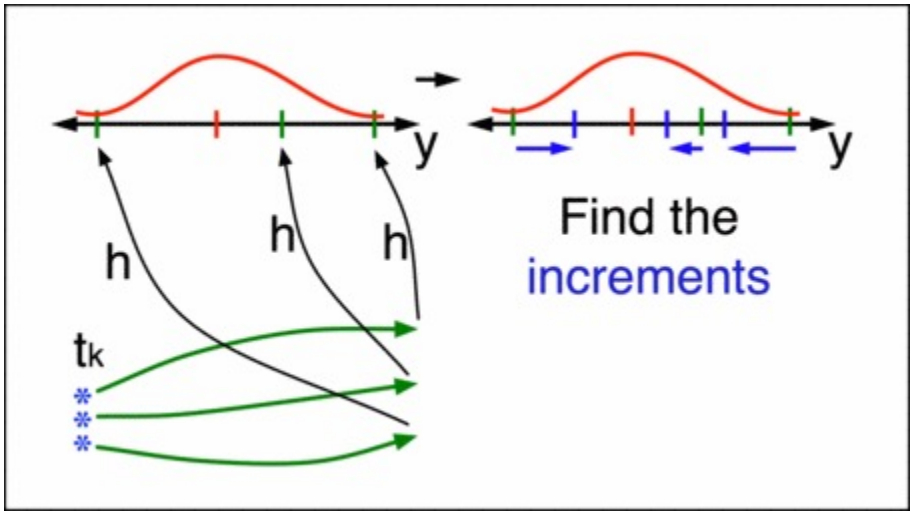


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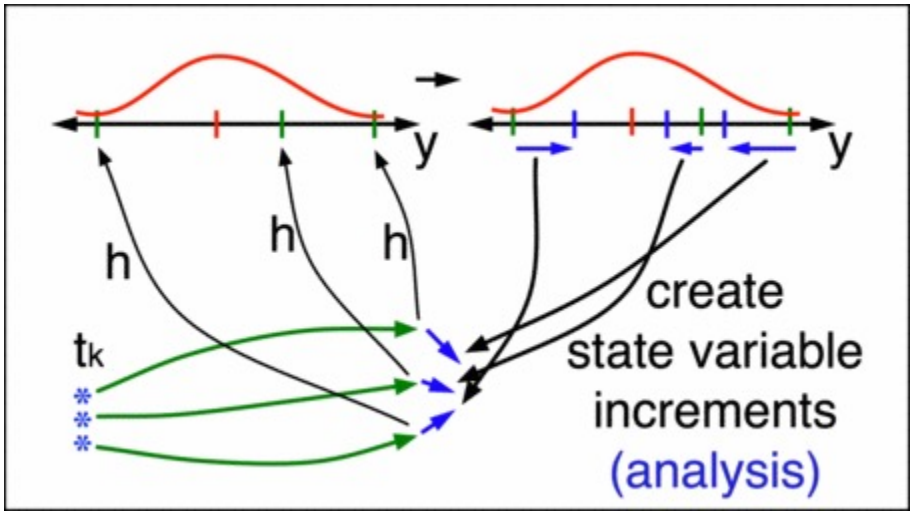


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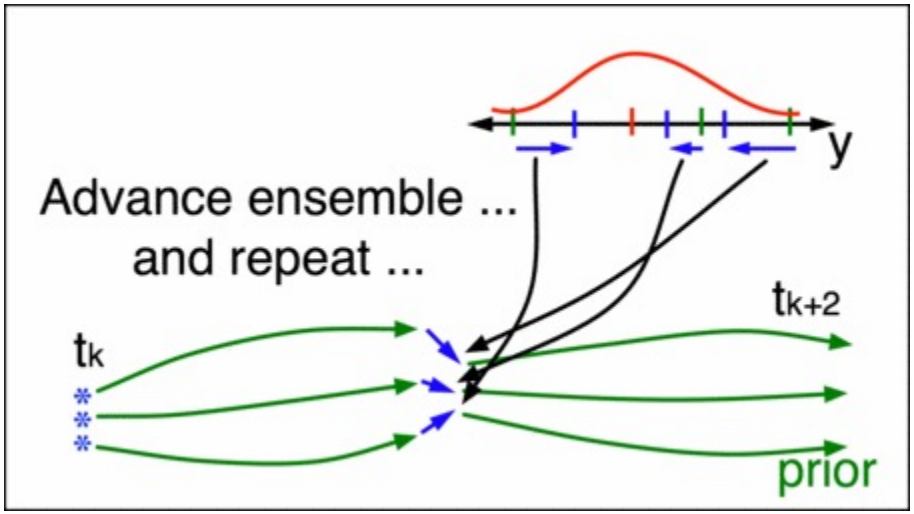



credit: NCAR/DAReS

# Synthetic Data Assim. Scenario:

- Recreate the Driver Estimation Scenario from Matsuo et al, 2013
- Apply the new “IRIDEA” technique

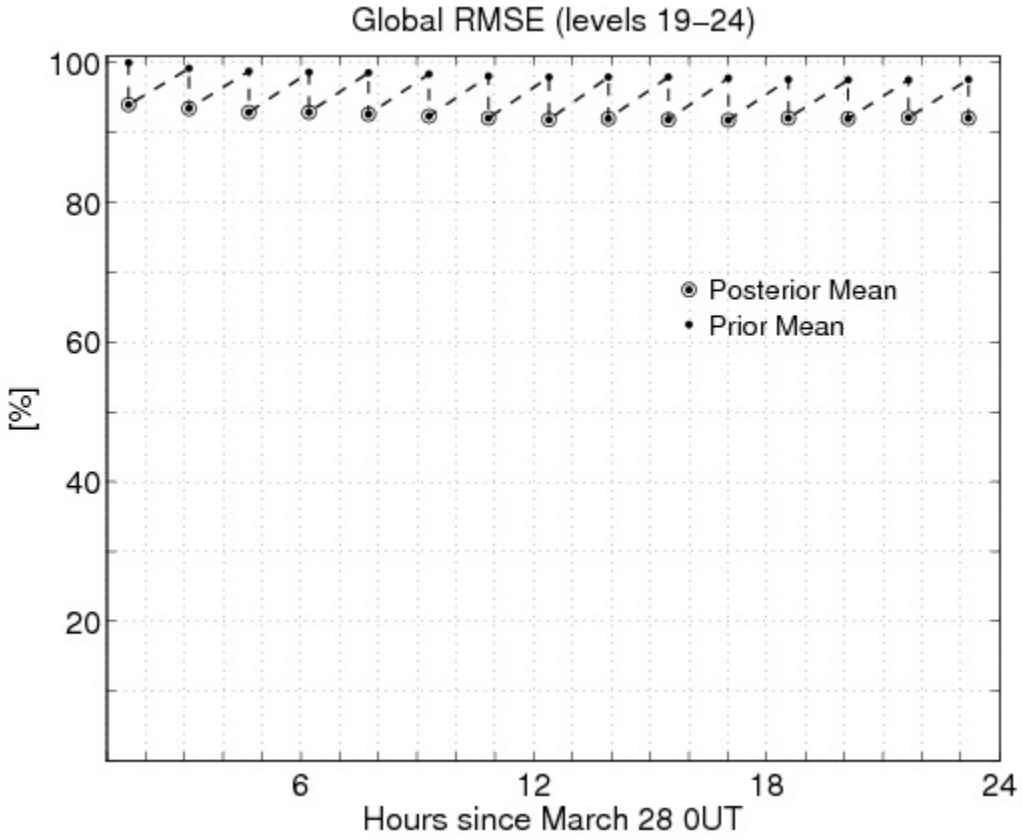
**28 March 2002**

- DA initialized with a priori $F_{10.7}$ = 175
- Control Run (26-29 March 2002): $F_{10.7}$ = 200

**Synthetic Data ingested:**

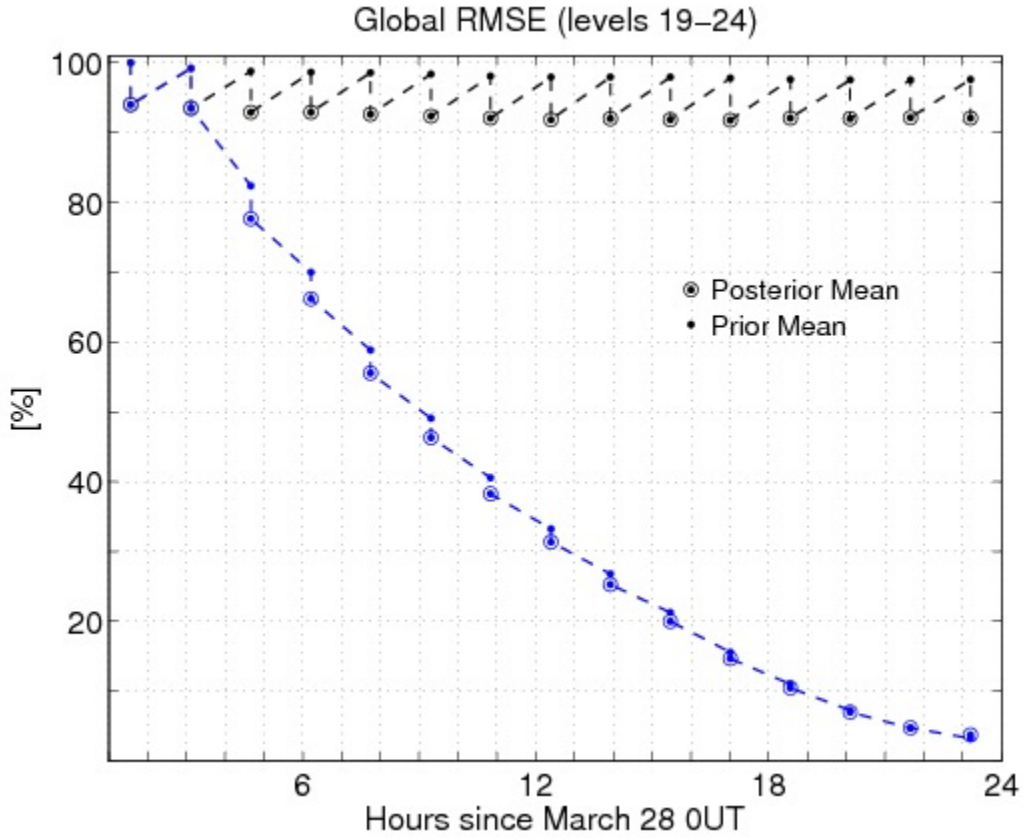
- Neutral density sampled on the orbit of CHAMP from the Control Run

# EnKF w/out Driver Estimation



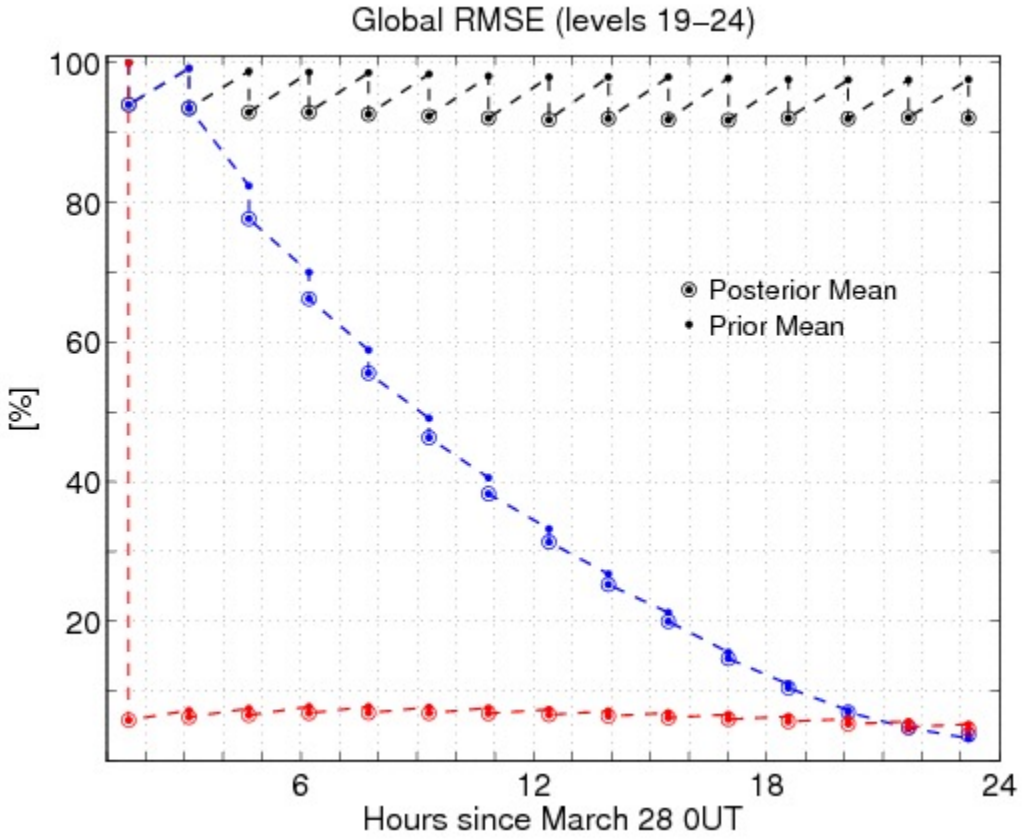

Matsuo et al, 2013

# EnKF w/ Driver Estimation




Matsuo et al, 2013

# Iterative Re-Initialization, Driver Estimation & Assimilation (IRIDEA) filter



# EnKF vs. IRIDEA :

**IRIDEA:**

**Iterative Re-Initialization, Driver Estimation & Assimilation**

- In the presence of data, IRIDEA estimates a driver retrospectively
- The physical model is then re-run "far into the past" (e.g. ~1 day when estimating $F_{10.7}$)
- Sizes of the state vector ($N_{state}$) and covariance matrix $(N_{state})^2$ are small
- Number of required "ensemble members" is also small ($2N_{state}+1$)
  - Daily F10.7 only: $2N_{state}+1 = 3$
  - Additional 2 3-hr Kp values: $2N_{state}+1 = 7$

# Assimilation of Real Data:

**Extend previous example to include estimation of a 1-day forcing history:**

- a daily F10.7 value
- the 3 most recent 3-hr Kp values

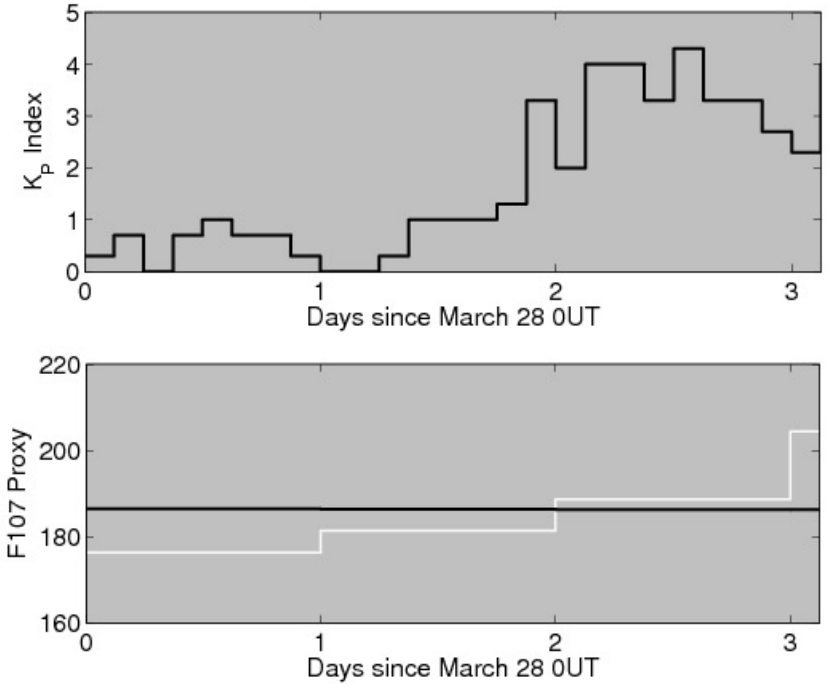
**DA initialized with a priori of:**

- $F_{10.7}$ = 150,
- Kp = 3.0

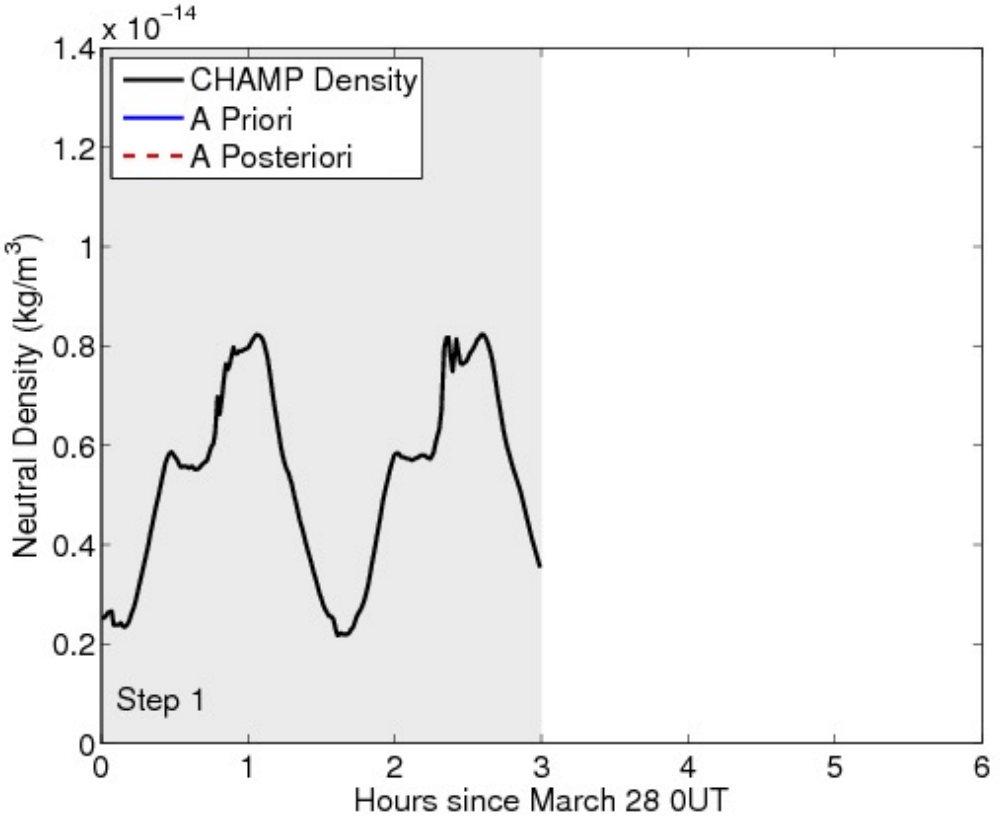
**Data ingested:**

- Neutral density from the CHAMP satellite

**28-30 March 2002**



# Data/Model Comparison



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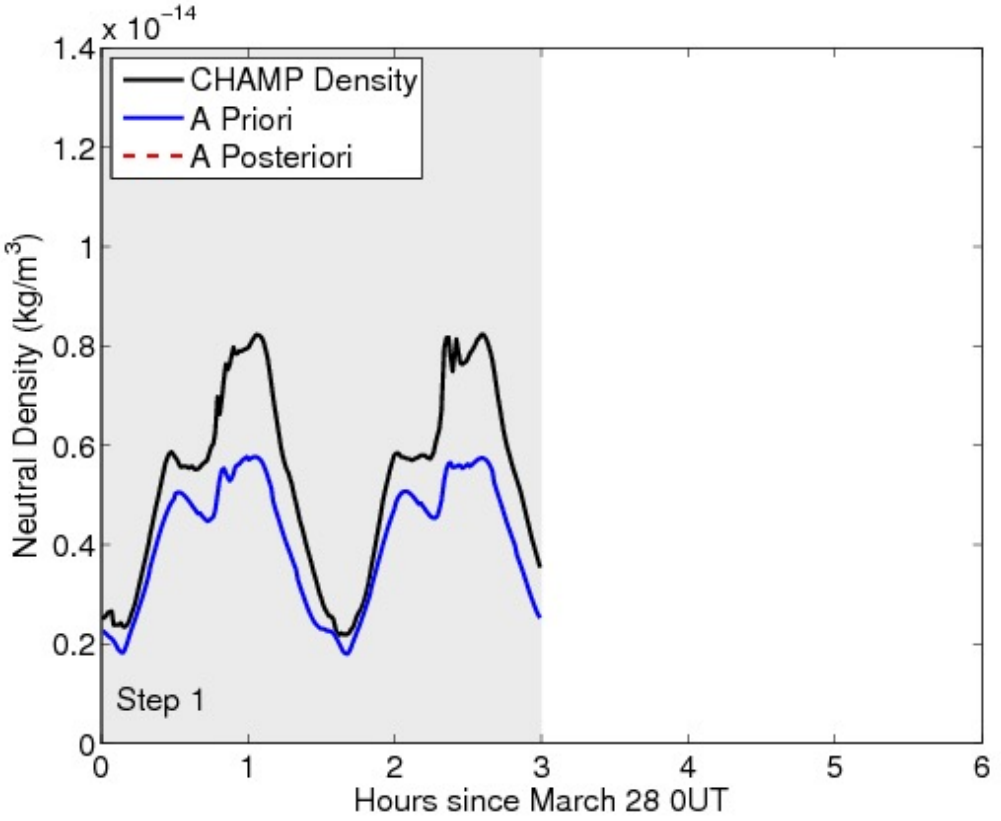

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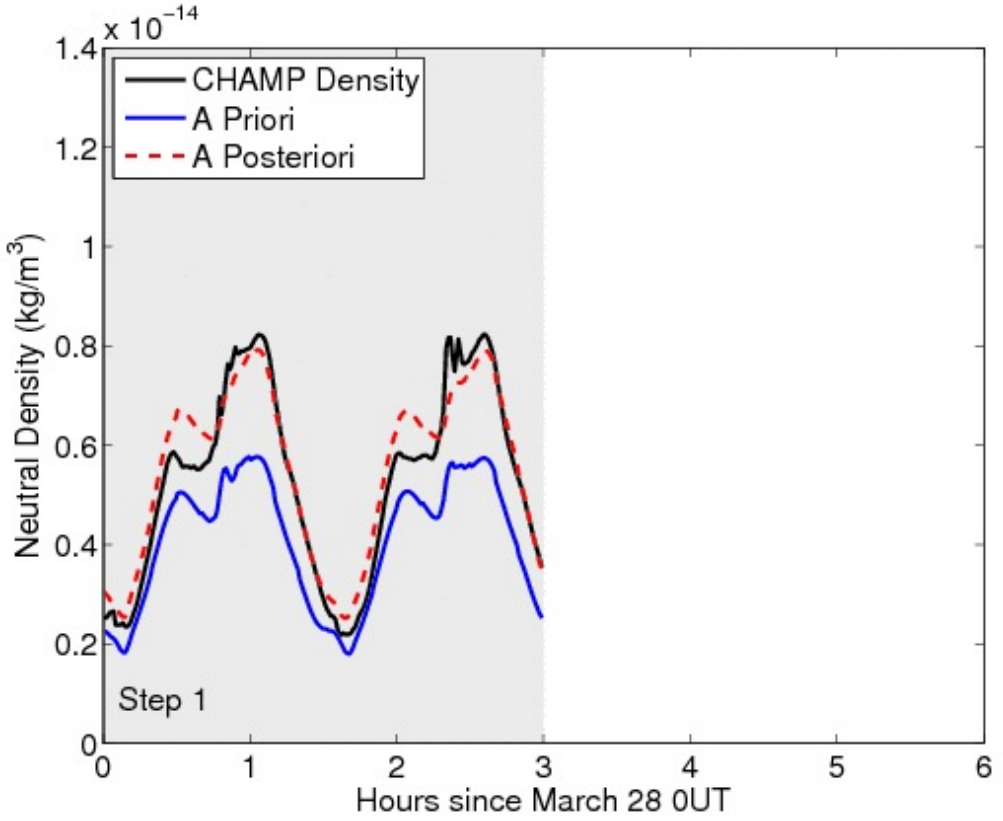

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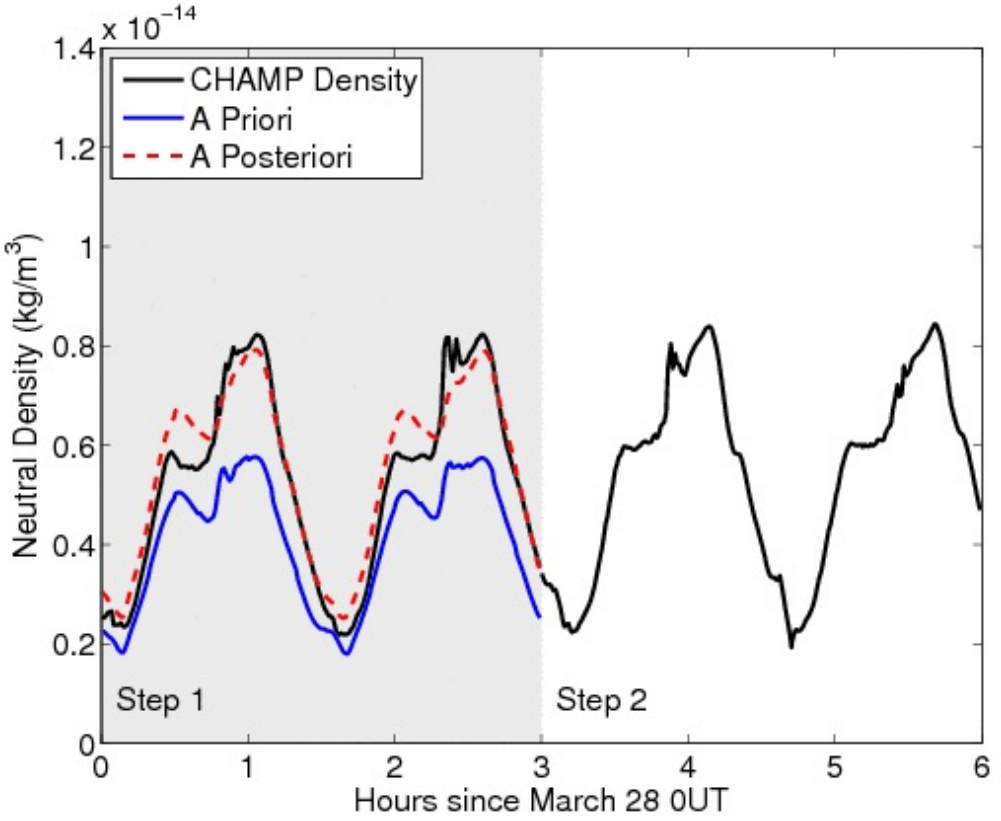

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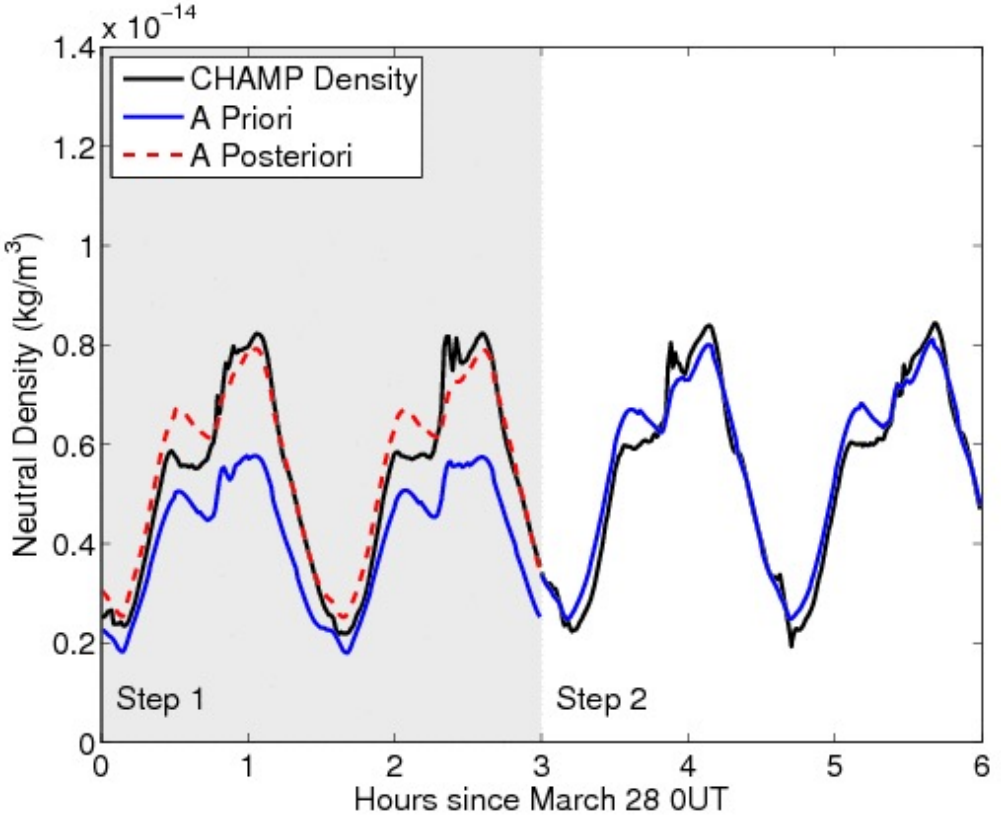

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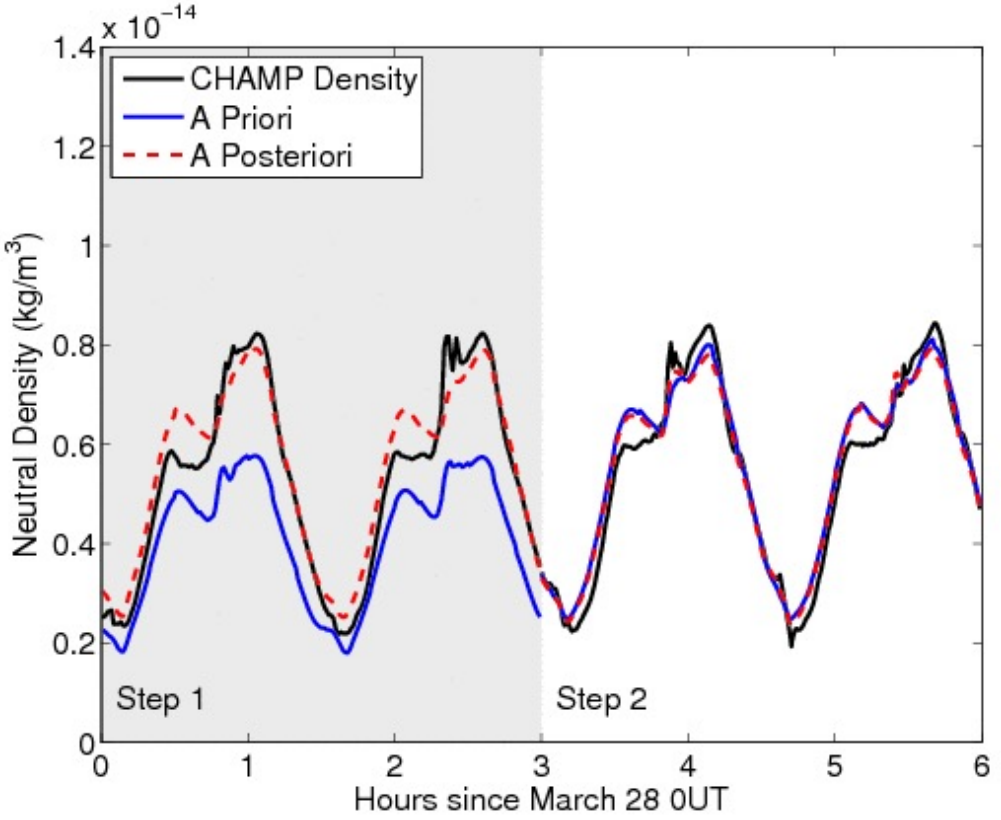

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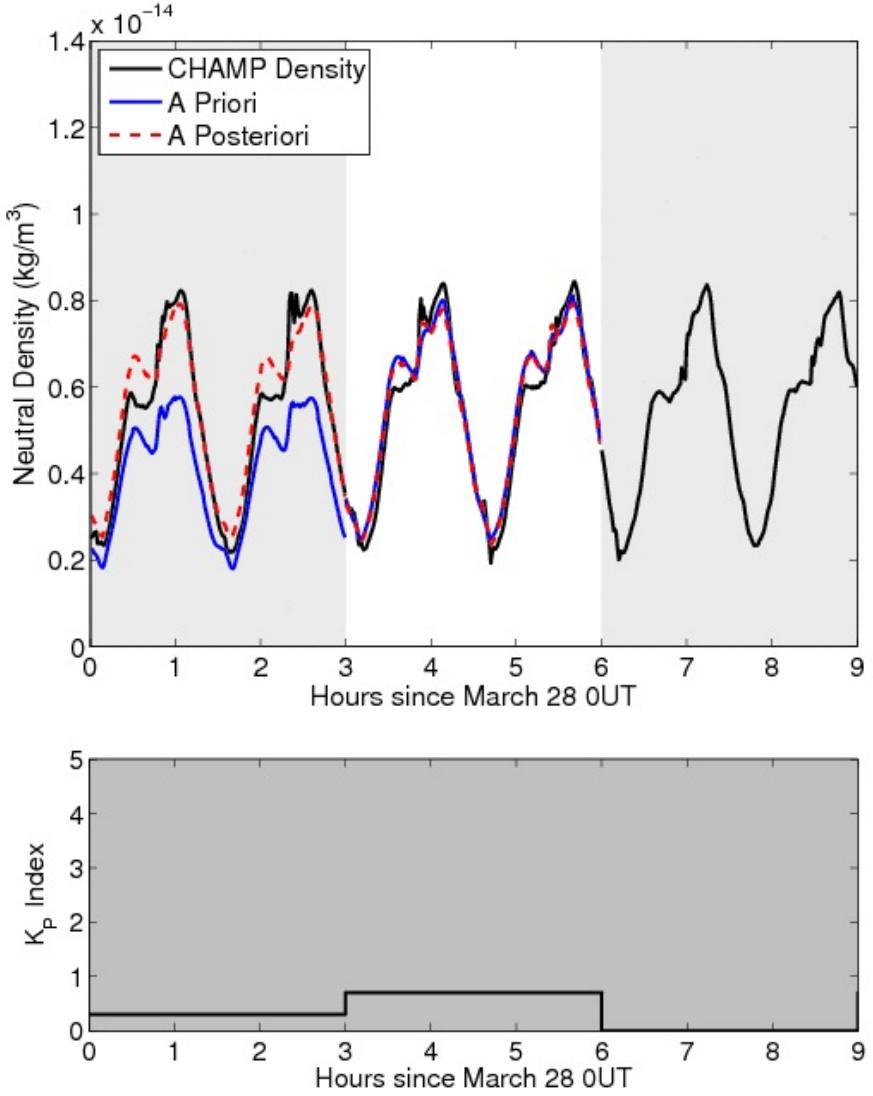

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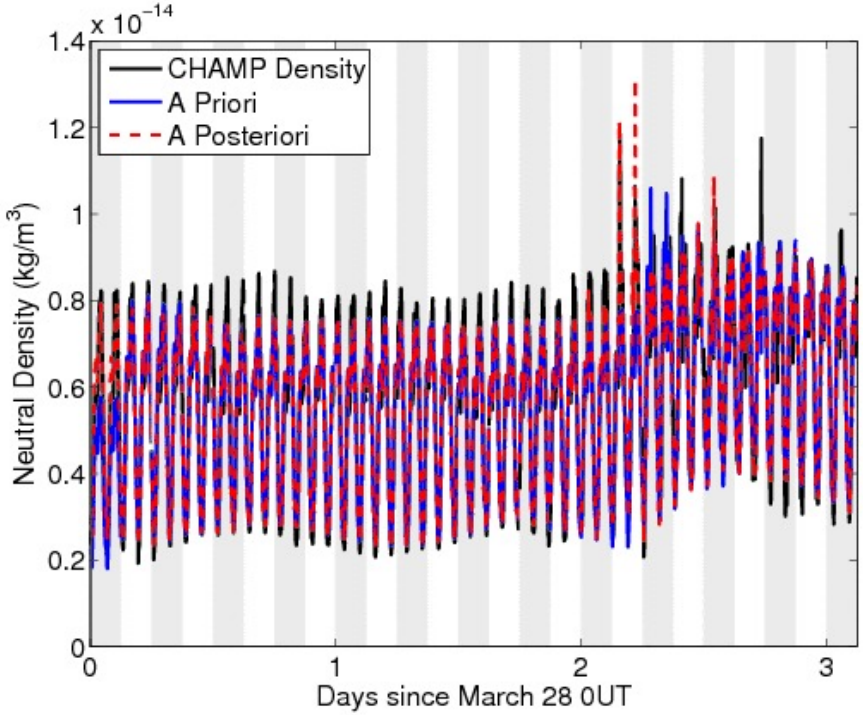
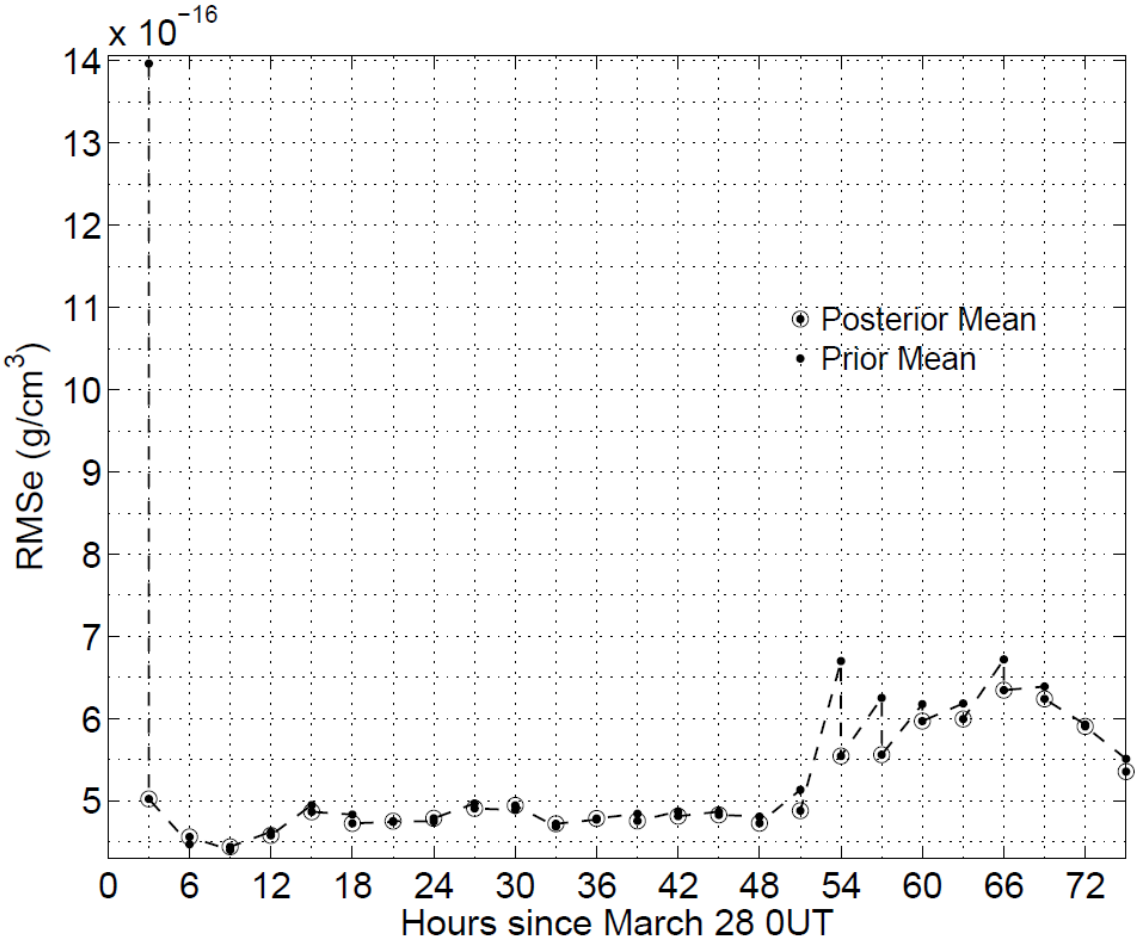


# Data/Model RMS Error

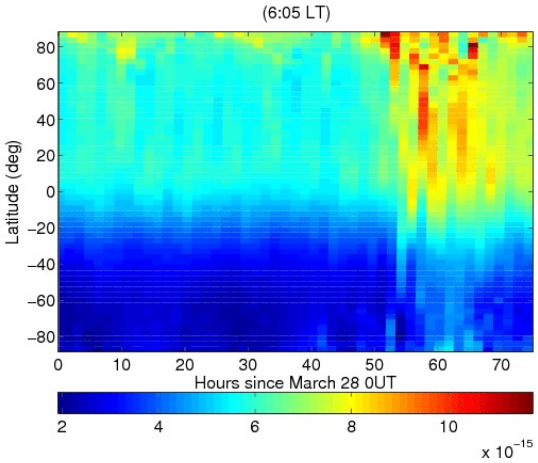
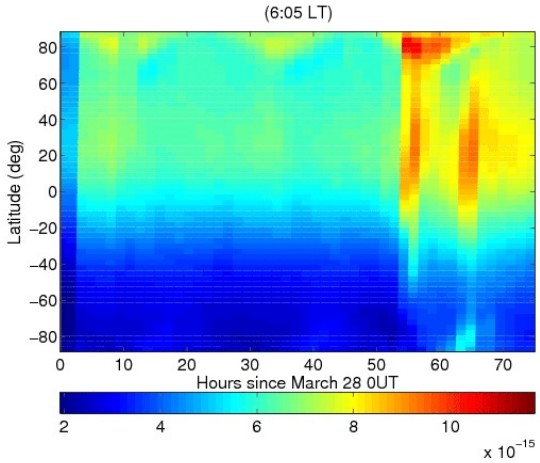
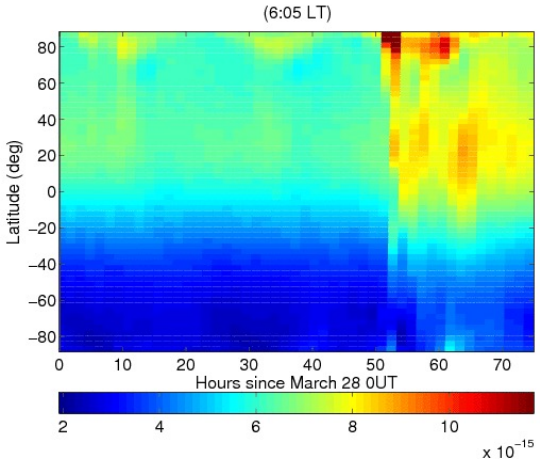
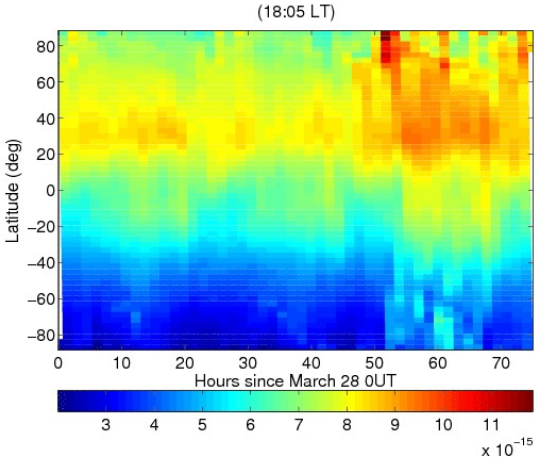
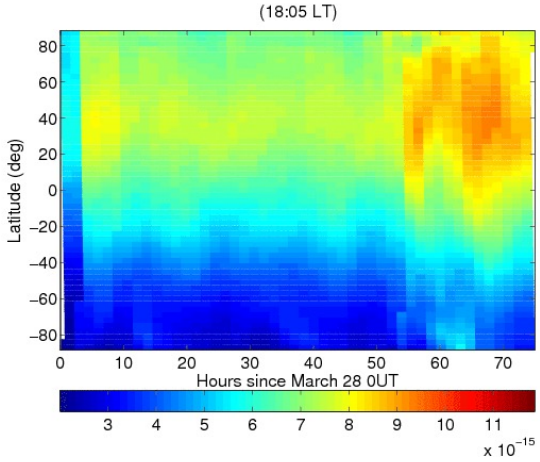
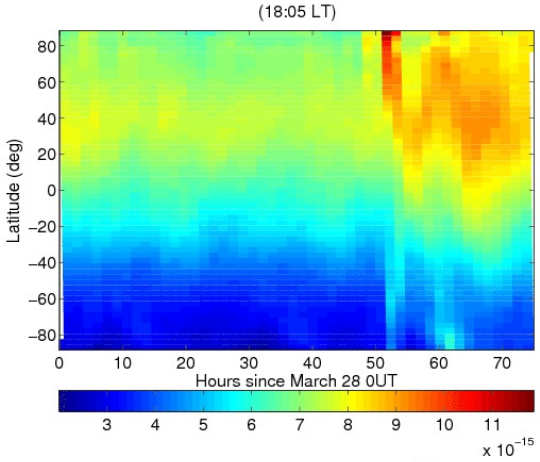


# Summary / Questions

- The new IRIDEA technique seems to outperform the conventional EnKF method*
- How to couple this ‘short-term’ technique with ones that are longer-term (e.g. eddy diff. estimation and RCMR)?
- How to link the estimated drivers with forecasted values?

*only 2 cases have been run so far

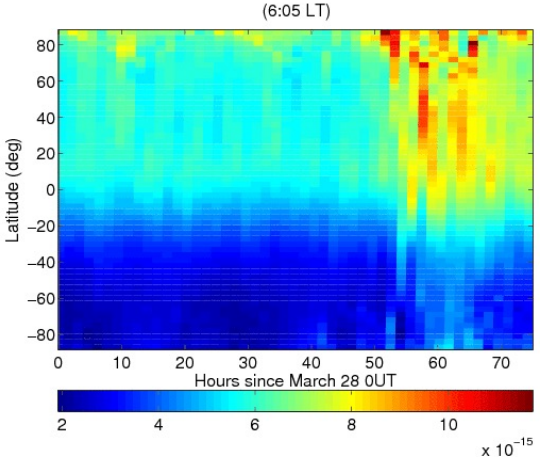
# Backup Slides

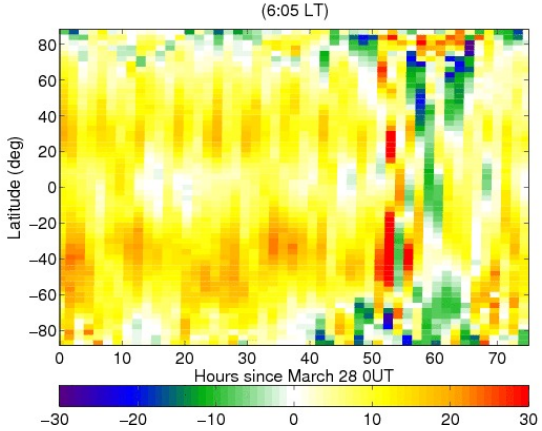
| | CHAMP Data | Prior | Posterior |
|---|---|---|---|
| 6:05 LT |  |  |  |
| 18:05 LT |  |  |  |

## CHAMP Data

## % Difference (Model/Data)

6:05 LT

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