Verification Statistics for the NCEP WRF Pre-Implementation Test. Part 1: Deterministic Verification of Ensemble Members

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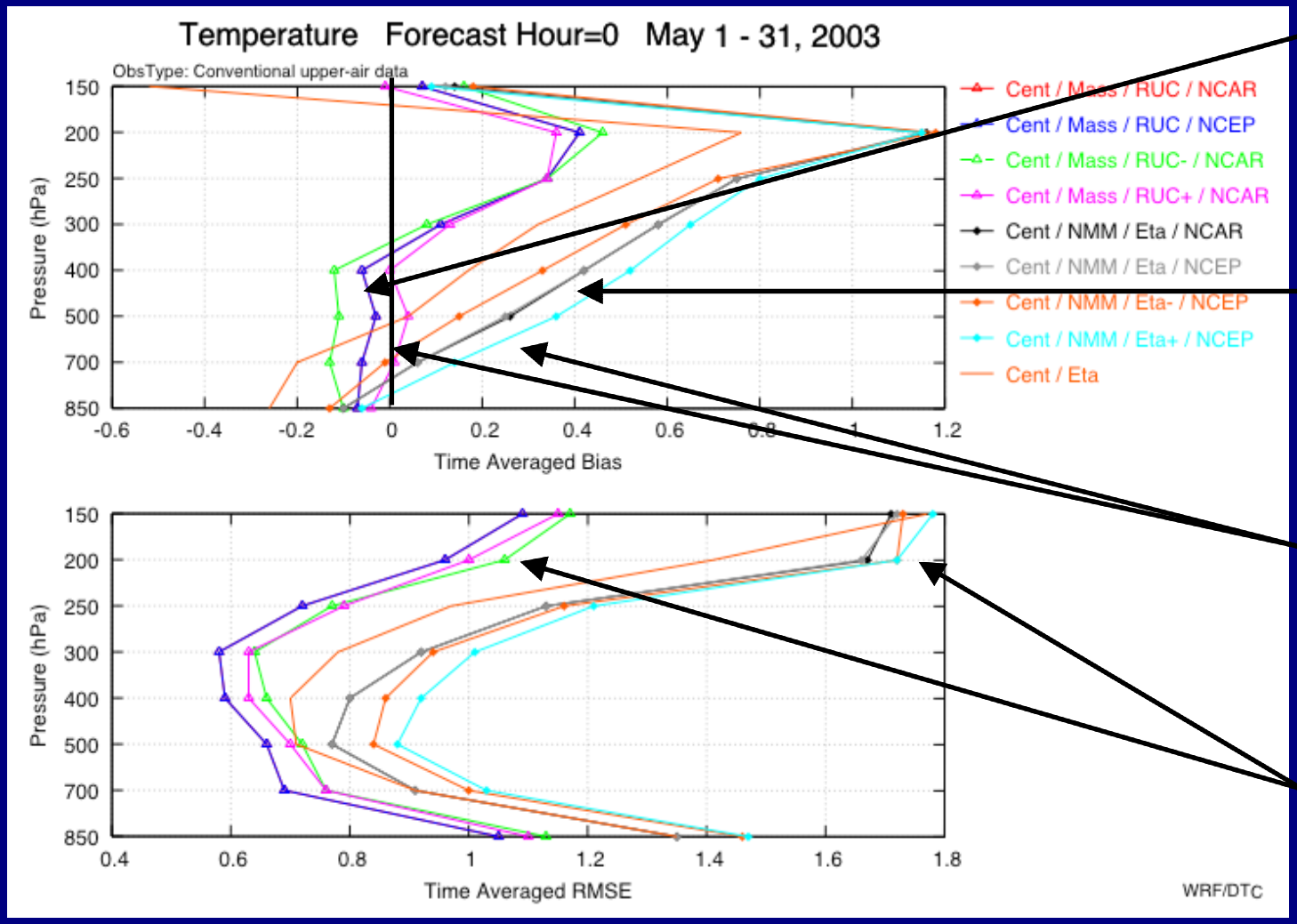
Topics

- Initial Conditions
- Forecast
  - Vertical Profiles
    - Temperature
    - Wind
    - Relative Humidity
  - Surface
    - Temperature
    - Sea Level Pressure
    - Relative Humidity

Focus: main features and grouping

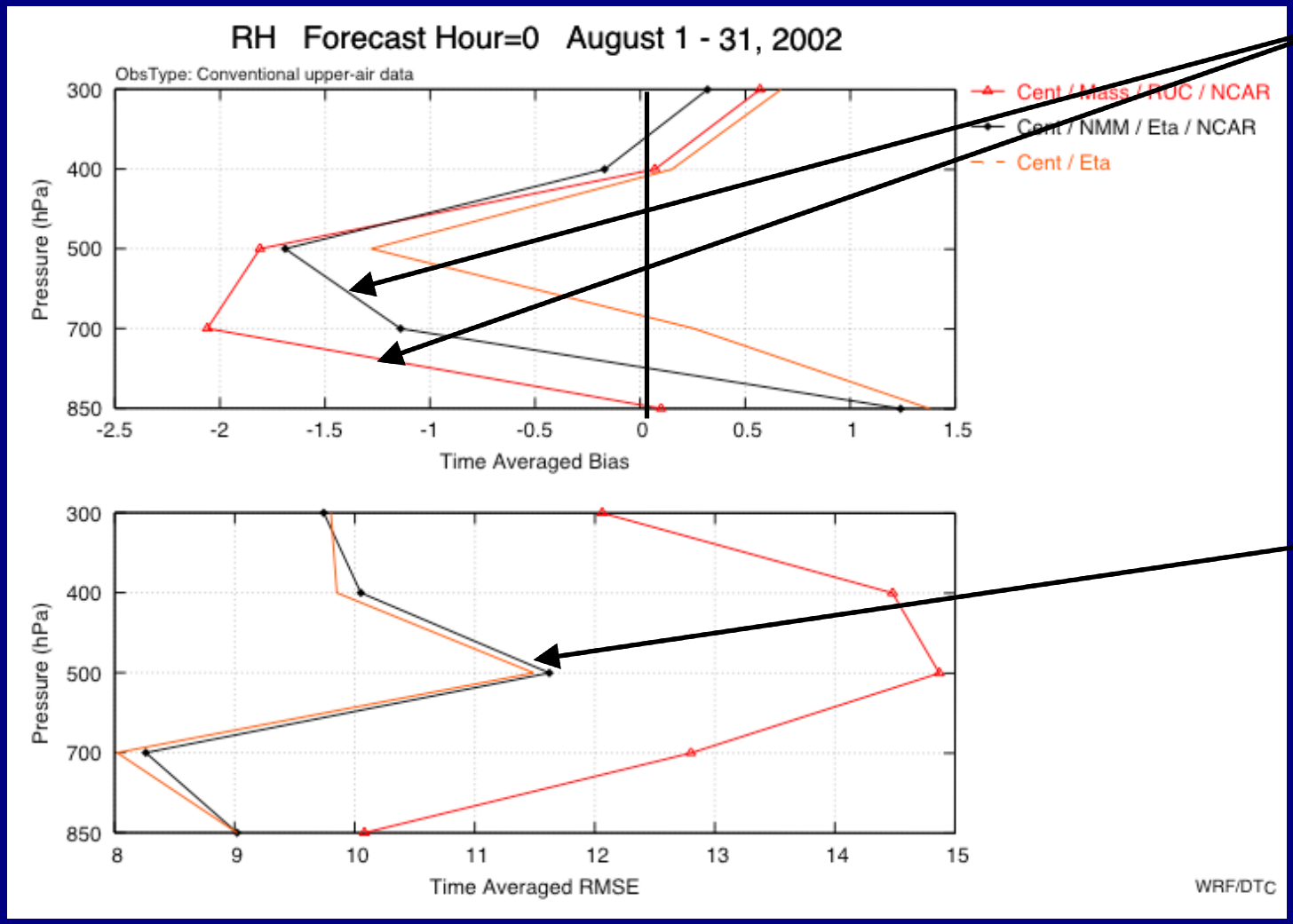
Initial Conditions: Temperature May - Central



- EM initializations do not vary with physics swap
- Same for NMM
- At t=0, breeding pair has bias encompassing baseline (?250)
- Breeding of EM, NMM IC causes diversity

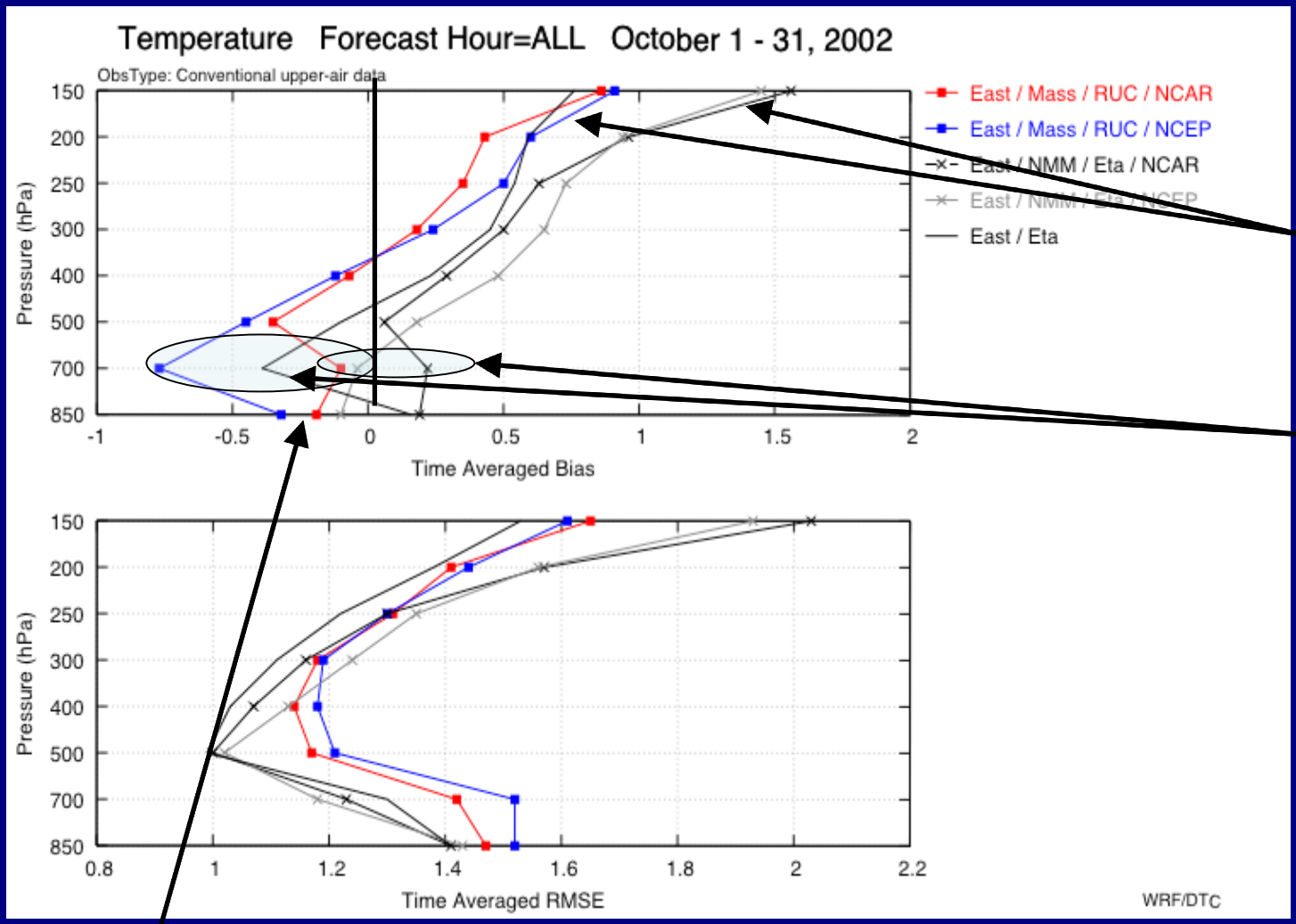
- EM has smaller Temperature bias and RMSE than NMM
- This is true for winds too, but not for relative humidity

Initial Conditions: Relative Humidity August - Central



- EM, NMM dry at midlevels
- NMM has better fit to obs then EM

Forecast: Temperature October - East

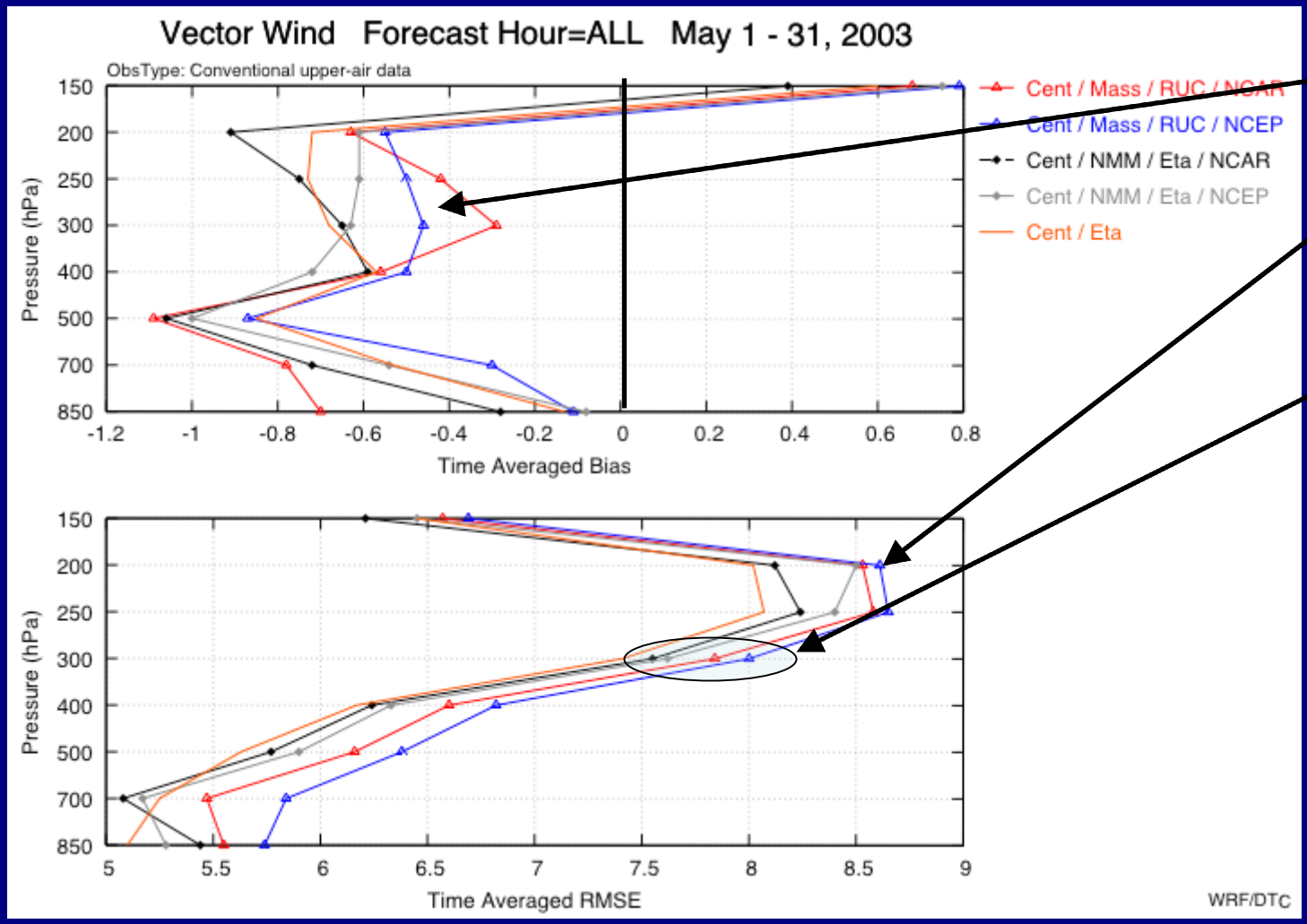


- EM bias to the left
- Primary grouping by dynamical core
- Physics important at low levels

Most seasons/domains have a cold bias at low level and a warm bias aloft
In winter, NMM has a warm bias at 850 hPa.

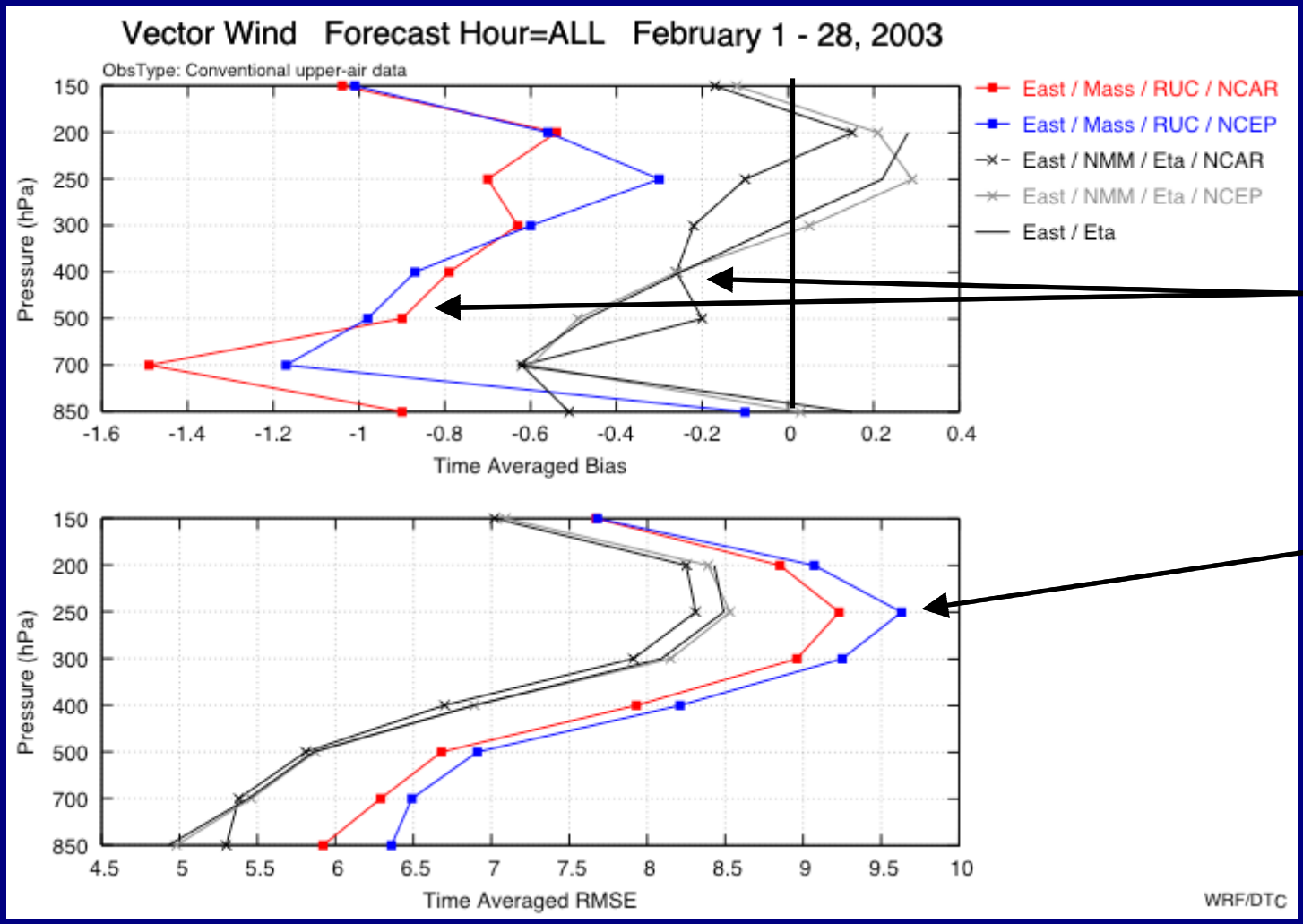
Forecast: Vector Wind

May - Central



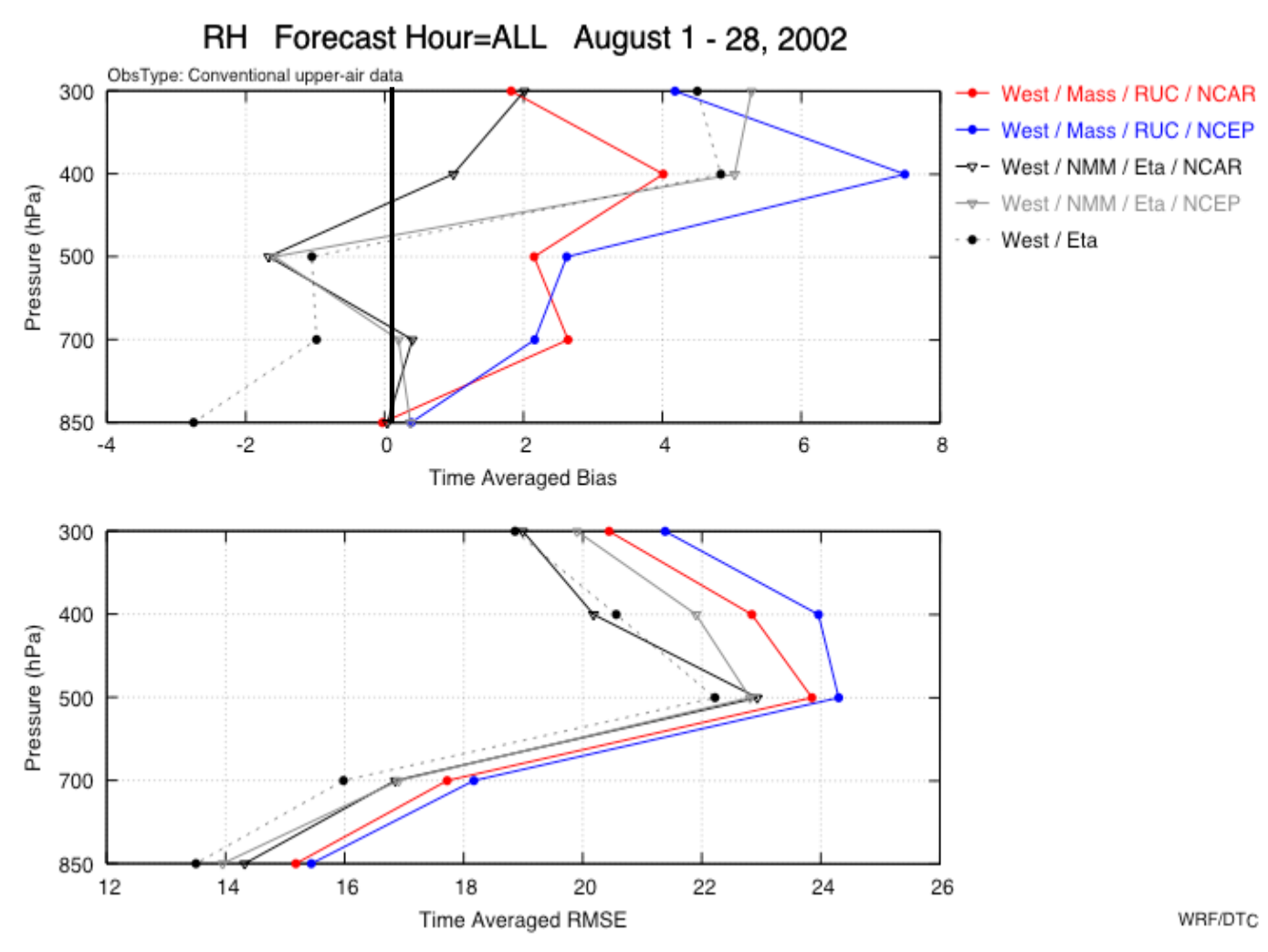
- Bias is mostly negative
- Large errors at jet level
- No obvious grouping in all seasons but winter

Forecast: Vector Wind February - East



- Winter: grouping by dynamical core
- Large errors at jet level

Forecast: Relative Humidity August - West



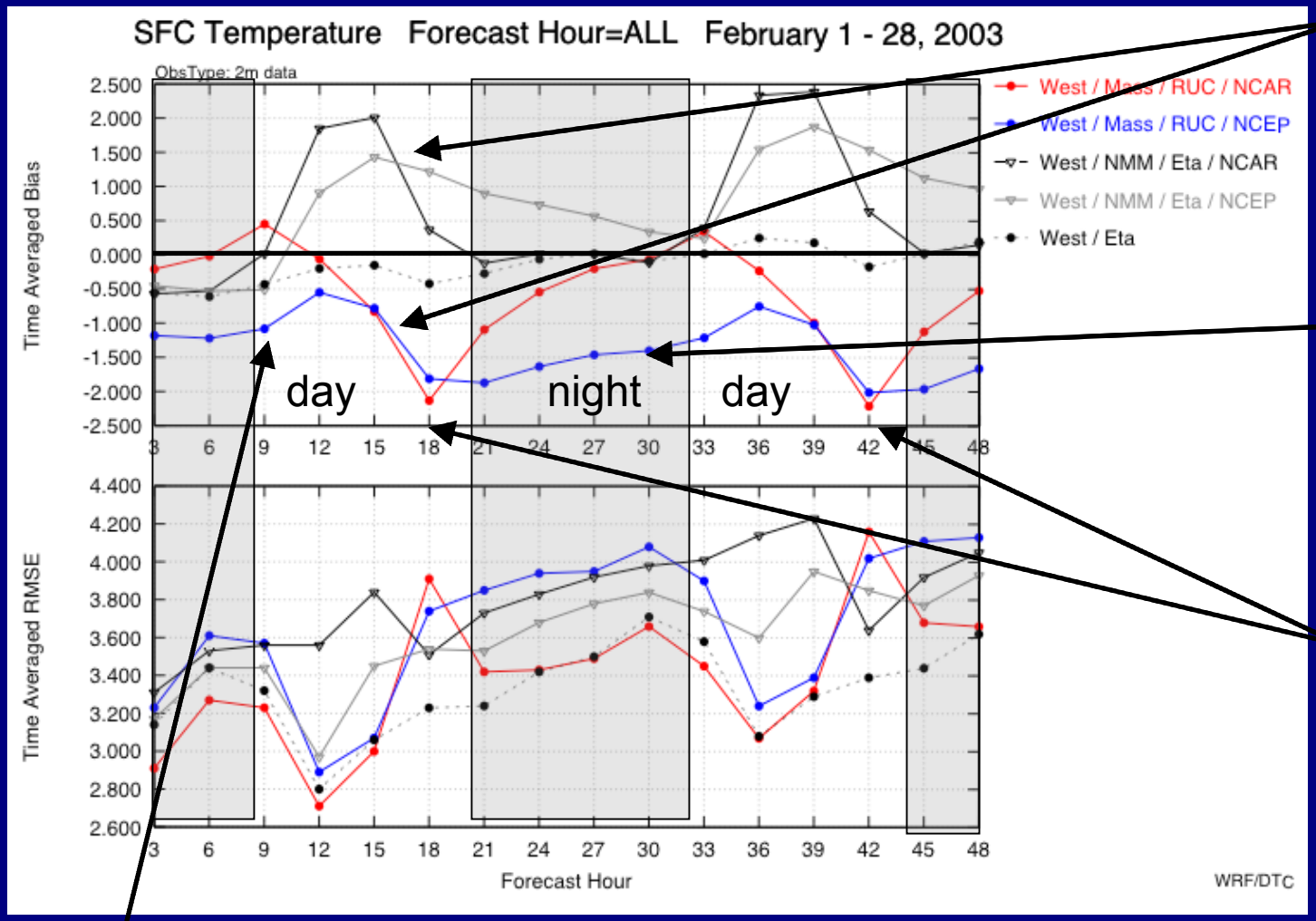
RH is the variable with largest variability among seasons and domains

- $Bias_{850}$= all close
- $Bias_{700}$= dyn core
- $Bias_{500}$= dyn core
- $Bias_{400}$= phys
- $Bias_{300}$= phys
- … but varies with season/domain

- RH: only field for which physics leads to obvious grouping at upper levels (cumulus transport?)

- RMSE smallest at 850, max at midlevels and reduce upwards (exception Winter E, errors large at 850 hPa)

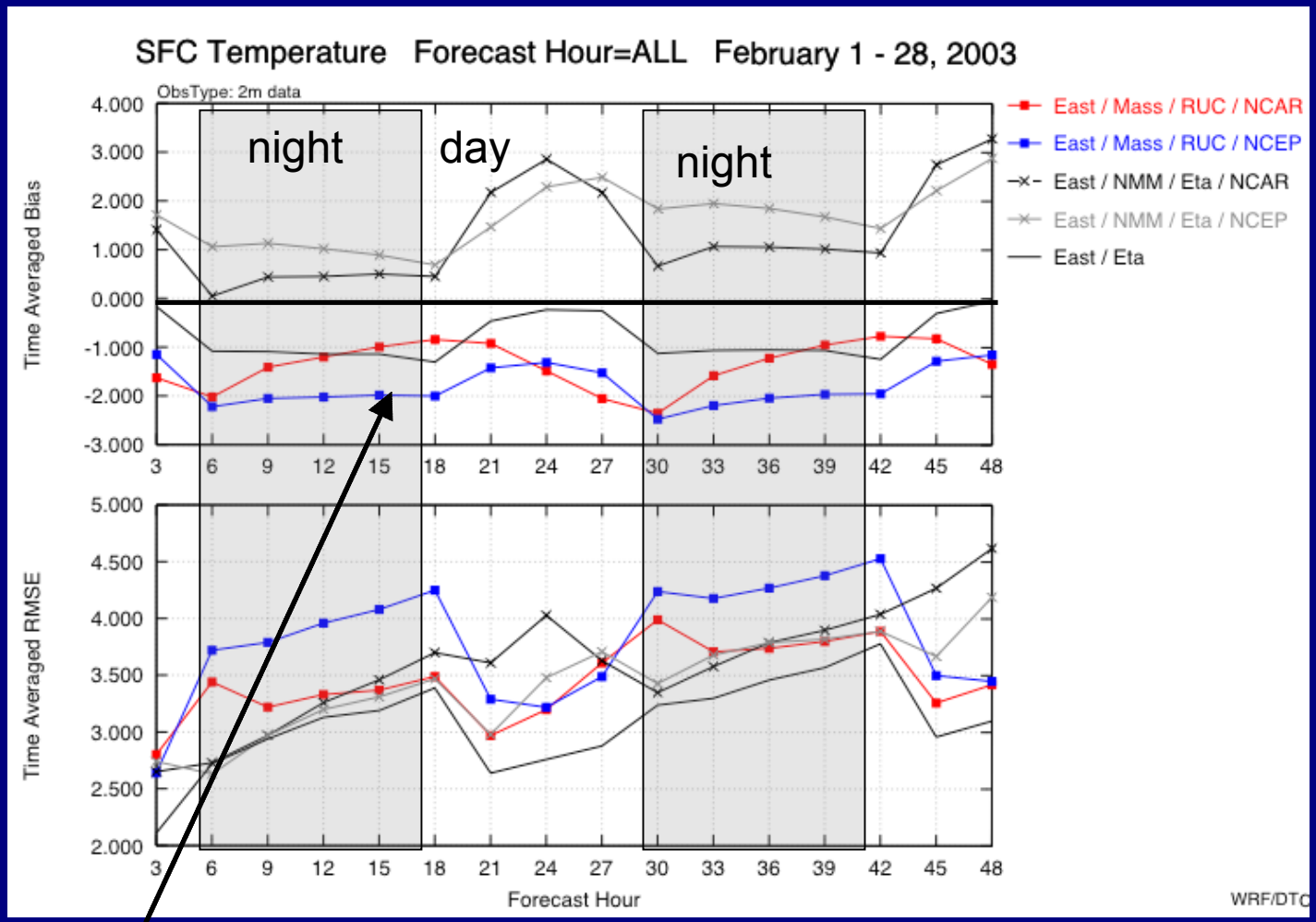
Forecast: 2m Temperature February - West



- Bias: Grouping by dynamic core - especially daytime.
- Physics swaps causes member to differentiate from group - esp. night.
- Diurnal cycle: at T_{MAX}, EM cold, NMM warm.

- Swapped physics is not between parent models
- Physics causes large differentiation
- No obvious grouping in RMSE

Forecast: 2m Temperature February - East



Bias:

Diurnal oscillation is less evident for **all variables** in E domain

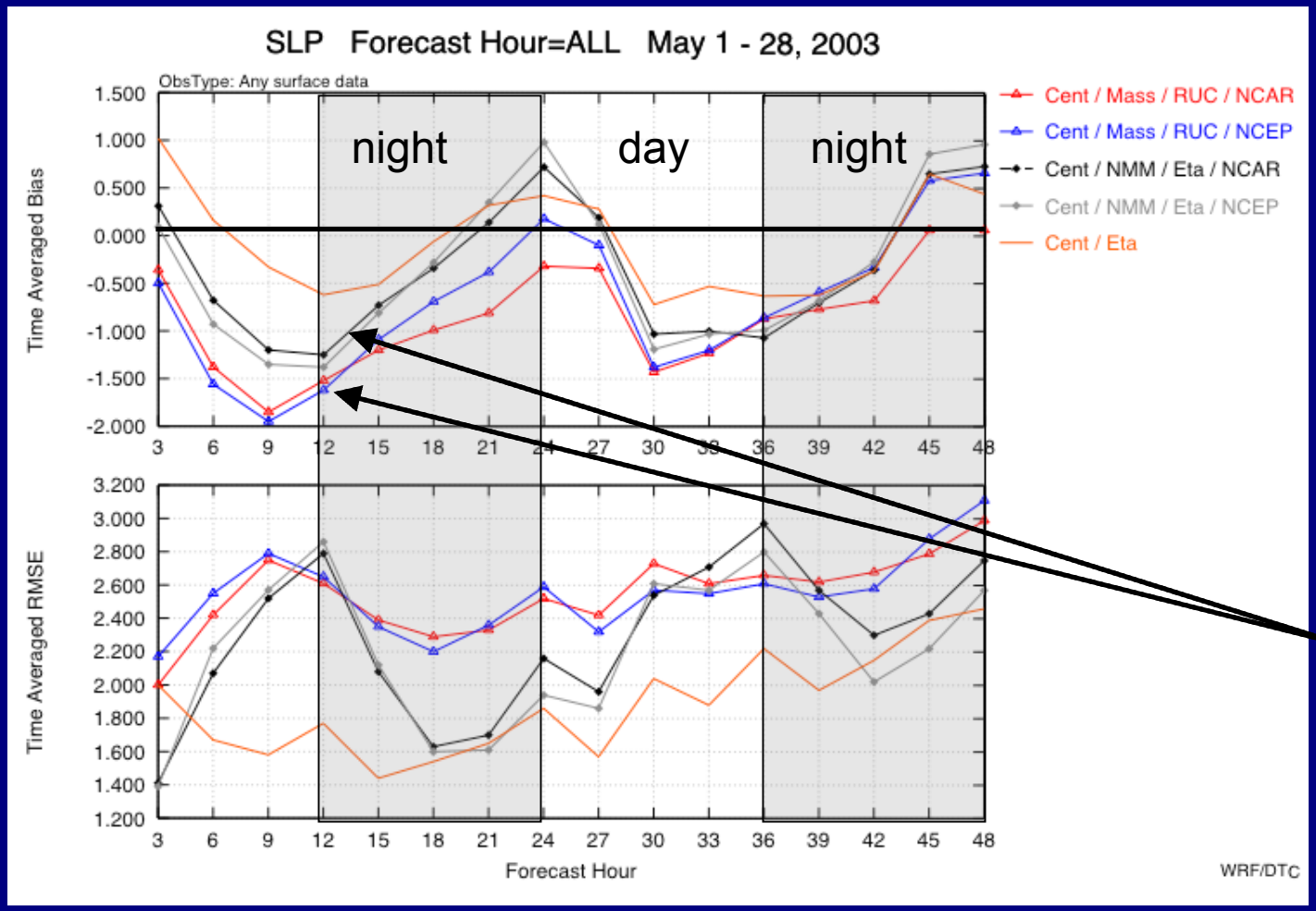
Obvious grouping by dynamic core

All forecast times, EM cold, NMM warm.

- Swapped physics is not between parent models
- Physics causes smaller differentiation

Forecast: Sea Level Pressure

May - Central

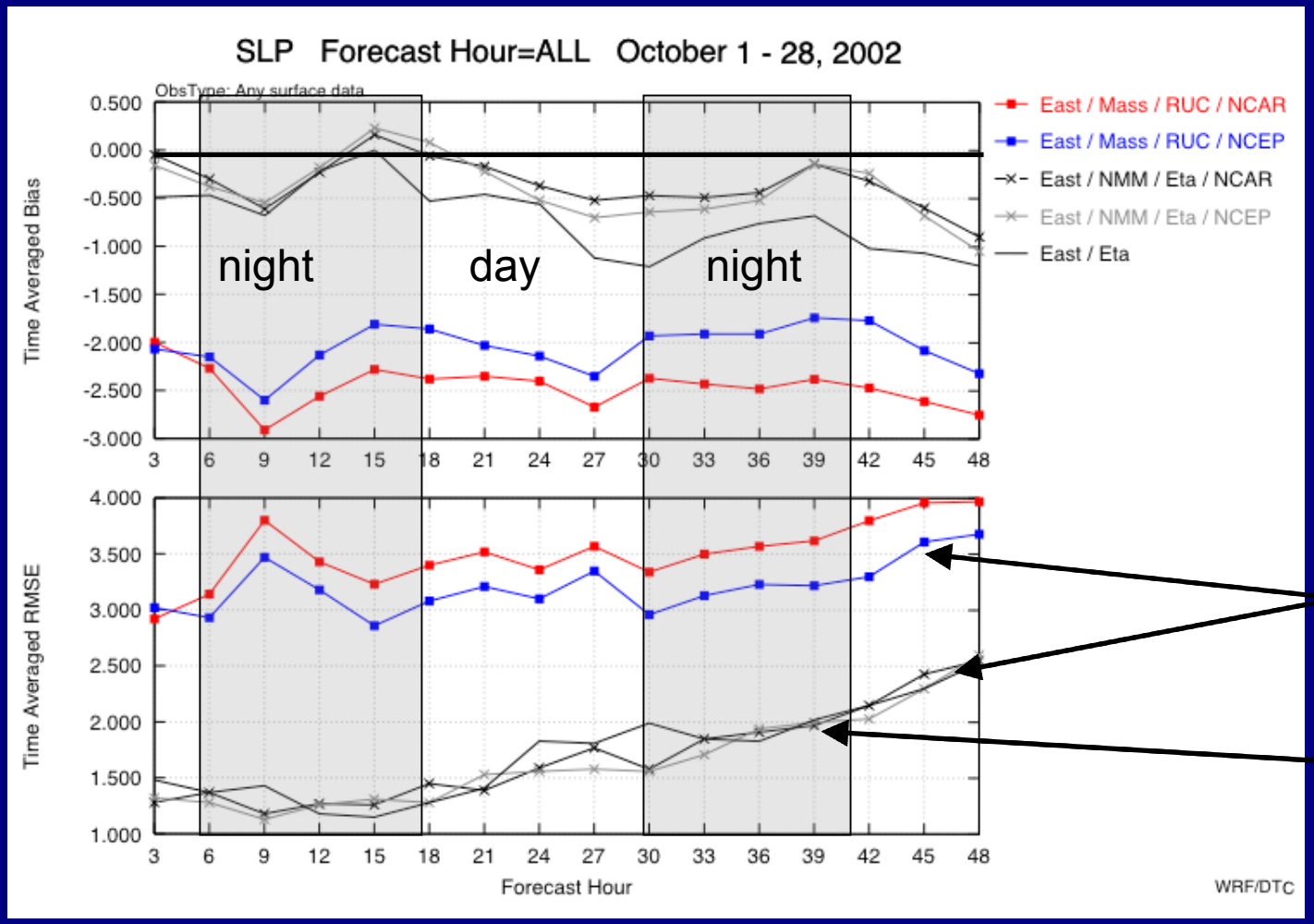


Bias:

- Most models underpredicted SLP.
- All domains but E: diurnal cycle with SLP low at T_{max} at SLP high at T_{min}
- Grouping by dynamic core

ETA overall lowest RMSE

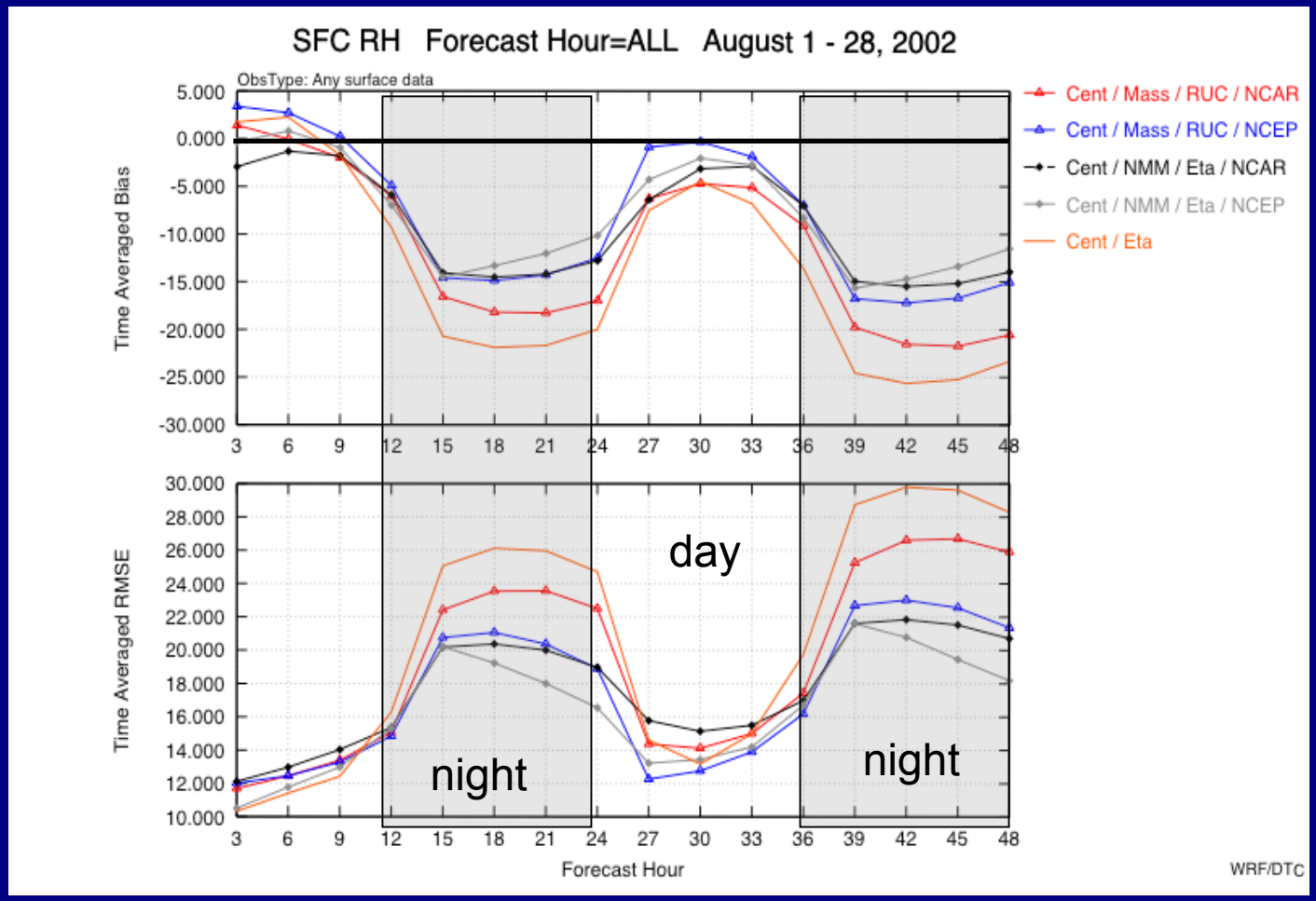
Forecast: Sea Level Pressure October - East



Bias:

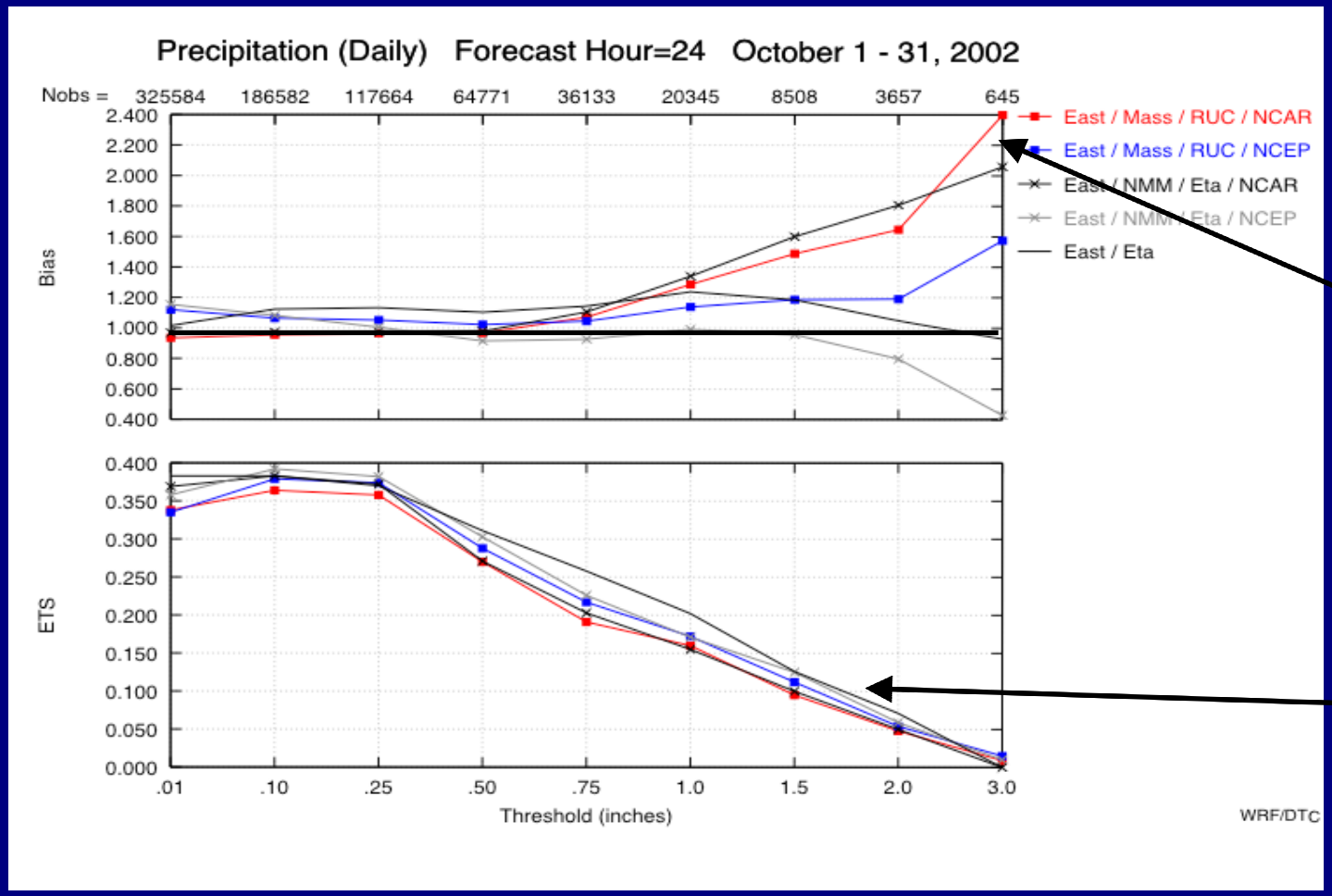
- E domain: no diurnal cycle
- Most models underpredicted SLP, but NMM closer to zero bias
- Strong grouping by dynamic core
- Error grows with time

Forecast: Surface Relative Humidity August - Central



- Strong diurnal cycle in most seasons/domains
- Underprediction by all models, especially at night
- Not obvious grouping

Forecast: 24 hr acc Precipitation October - East



Bias:

- Grouping by physics
- NCAR physics (K-F convection) overpredicts at high thresholds (or is it lack of mesoscale obs?)
- ETS similar for all models, except on W domain, where ETA is best

Summary

- Initial Conditions
  - Bias/RMSE near zero in low-mid trop, positive bias at 200 hPa
  - EM has better fit to observations in all variables, except RH
  - Remarkable result, since ETA uses its own assimilation system
  - Shows that RUC analysis has strong fit to RAOBS

- Upper Air
  - Results group mostly by dynamical core/IC.
  - Temperature
    - Cold bias at low levels, warm above.
    - Physics grouping in lower troposphere (PBL scheme?)
  - Wind
    - Mostly underprediction.
    - Largest errors at jet level.
    - In winter, grouping by dynamical core.
    - Other seasons, no grouping.
  - RH
    - Smaller errors at low and upper levels; largest errors at 500 hPa.
    - Physics grouping in upper troposphere (cumulus transport?)

- Surface
  - Temperature
    - Diurnal cycle, except E.
    - At Tmax, EM too cold, NMM too warm - group by dynamical core.
    - At night, physics plays a role.
    - Physics swap does not follow parent models.

  - Sea Level Pressure
    - Diurnal cycle, except E.
    - Grouping by dynamical core
  - RH
    - Strong diurnal cycle in most seasons/domains
    - Underprediction, especially at night
    - Not obvious grouping

Other material

Physics Options

	EM	NMM
RA_LW_PHYSICS	RRTM	GFDL (ETA)
RA_SW_PHYSICS	Dudhia	GFDL (ETA)
BL_SFCLAY_PHYSICS	Monin-Obukhov	Monin-Obukhov (Janic ETA
BL_PBL_PHYSICS	MREF scheme	Mellor-Yamada-Janjic (ETA) TKE scheme
CU_PHYSICS	Kain-Fritsch (new ETA)	Betts-Miller-Janjic
NRADS	100	200
NRADL	100	200