OSSE Evaluation of Targeted Ocean Observing Strategies for Improving Ocean Forecast Model Initialization

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OMOC Ocean OSSE System

- **Joint AOML/CIMAS Ocean Modeling and OSSE Center**
  - Key overarching goal:
    - Use OSEs and OSSEs to assess the impact of existing and new observing systems for improving the ocean analyses used to initialize ocean forecast models
      - Assessments will cover a wide range of oceanographic problems (oil and marine debris forecasting, ocean climate monitoring, hurricane forecasting, …)
  - Initial goal related to hurricane forecasting:
    - Determine the optimum mix special targeted observations (airborne, profiling drifters, surface floats, gliders,…) that will maximize error reduction in ocean analyses used to initialize ocean forecast models and also used for ocean response studies
      - Complements the atmospheric OSSE effort at AOML designed to improve vortex initialization in coupled TC forecast models
- **OMOC ocean OSSE system**
  - Rigorously evaluated to provide valid impact assessments
    - Takes advantage of rigorous evaluation and calibration techniques developed for atmospheric OSSEs that have not yet been completely implemented for the ocean

Key OSSE Design and Evaluation Steps

1. **NR Requirements**

   The NR model must reproduce the climatology and variability associated with ocean phenomena of interest.

2. **DA System Ocean Model Requirements**

   Differences ("errors") between the DA and NR models must have similar magnitude and properties as errors between the NR and the true ocean.

3. **Simulation of Synthetic Observations**

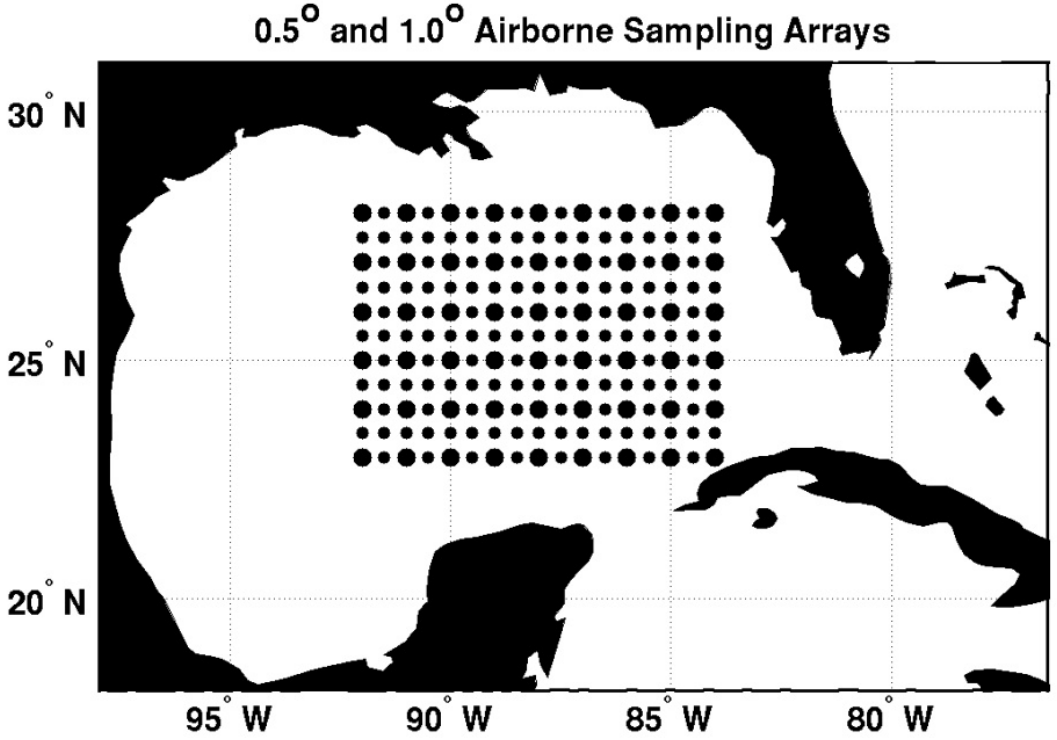
   Realistic errors must be added

4. **System Evaluation and Calibration**

   OSSE system errors and biases must be identified and quantified by comparing OSSEs to reference OSEs, and the system must be calibrated if necessary.

Examples of OSSE Results

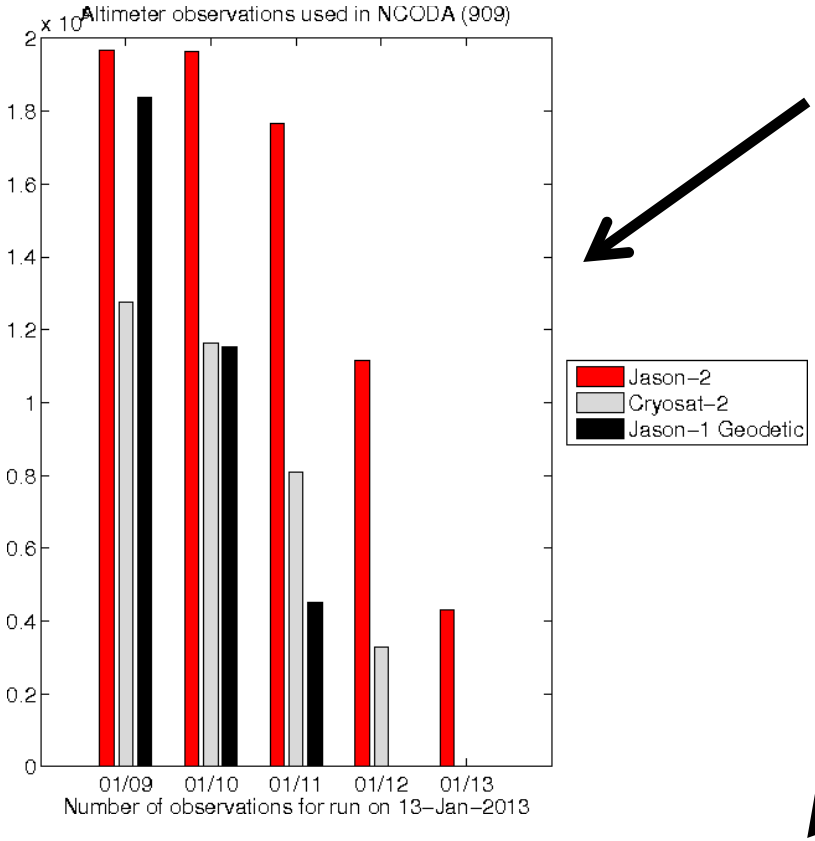
- **Initial OSSEs focus only on targeted airborne profile surveys**
- **Two questions:**
  - 1. Impact of delayed transmission to the GTS
  - 2. Impact of horizontal resolution
    - 0.5 degree versus 1.0 degree



Strategy for Addressing Question 1 (delayed availability of observations)

- **Near-real-time analysis system**
  - Analysis procedure
    - First guess is the analysis produced at t = -4 days
      - Assumed that nearly all observations are present by t = -3 days
    - DA system then run with daily updates over 4 days to produce the current analysis
  - Experiments
    - Initialized on 1-May 2010
      - Fields provided by an experiment that assimilated all observations except airborne profiles on a daily update cycle
    - Produced analysis for 5 May 2010
  - Four-day analyses are then run at 7-day intervals
    - 8 May, 15 May, … through October 2010
  - Different delays in airborne profile availability are tested for impact

Transmission Delays to GTS



Transmission delays for the three available altimeters on 13 January 2012 (from NRL-Stennis)

Transmission delays used for all synthetic observations except airborne profiles in the experiments designed to address question 1. These choices were designed to approximate actual delays for different observing systems.

Delay (day)	Lag Hour	Altim. Jason-1	Altim. Envisat	Altim. Jason-2	MCSST	Drifter SST	Buoy SST	Ship SST	Ship XBT
0	0-24					X	X		
-1	24-48			X	X	X	X	X	X
-2	48-72		X	X	X	X	X	X	X
-3	72-96	X	X	X	X	X	X	X	X

Experiments for Answering Question 1

Experiment	Synthetic Instruments Assimilated	Time Delay for Airborne Obs.
NODA	None (unconstrained)	N/A
NOP3	All except airborne obs.	N/A
DELAY1	All including 1000 m AXCTD at 0.5° resolution	0 and 1 day lags (two daily missions over previous 48 hours)
DELAY2	All including 1000 m AXCTD at 0.5° resolution	0 day lag (single daily mission over previous 24 h)
DELAY3	All including 1000 m AXCTD at 0.5° resolution	1 day lag (single daily mission over previous 24-48 h)
DELAY4	All including 1000 m AXCTD at 0.5° resolution	2 day lag (single daily mission over previous 48-72 h)

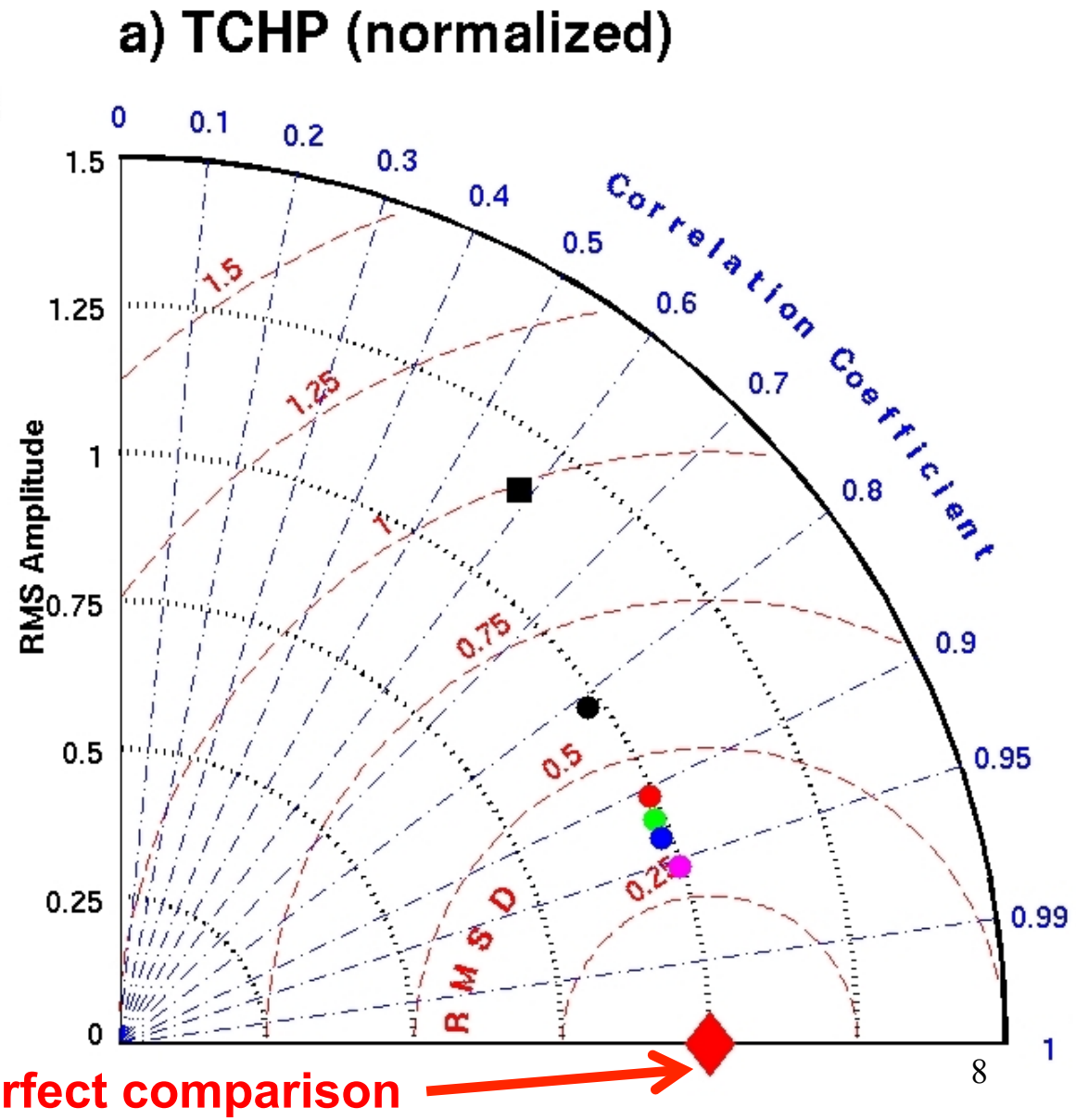
Question 1, Thermodynamical Variables

Airborne assimilation experiments

- 2 day lag
- 1 day lag
- 0 day lag
- 0 and 1 day lag

Other experiments

- Unconstrained
- Airborne observations denied



Perfect comparison

Question 1, Thermodynamical Variables

Airborne assimilation experiments

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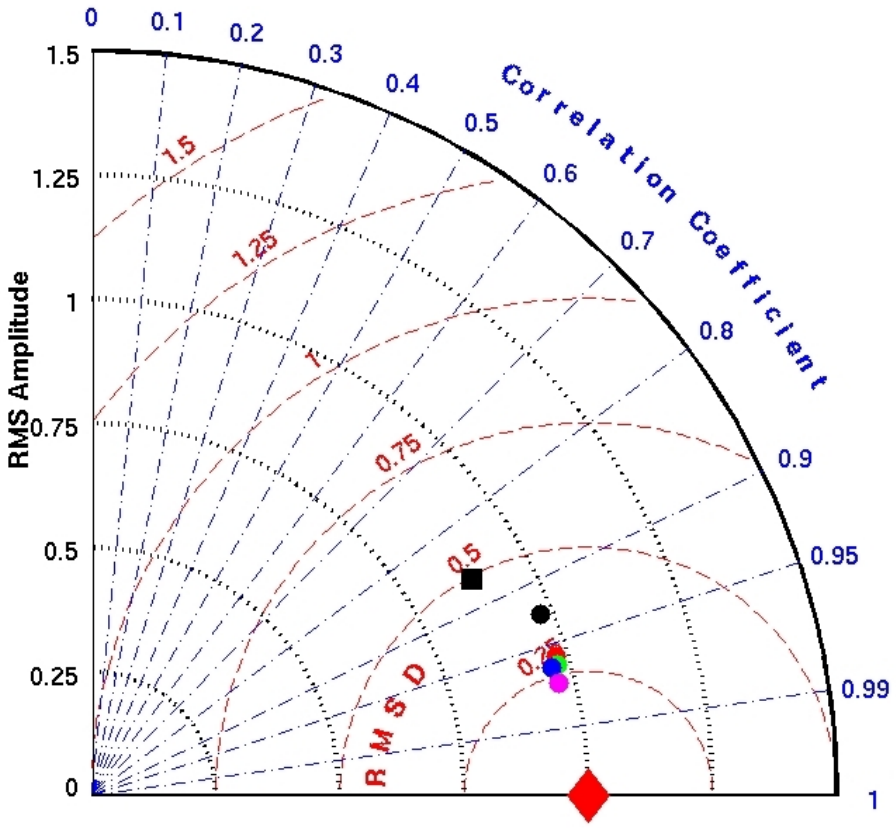
- 1 day lag
- 0 day lag
- 0 and 1 day lag

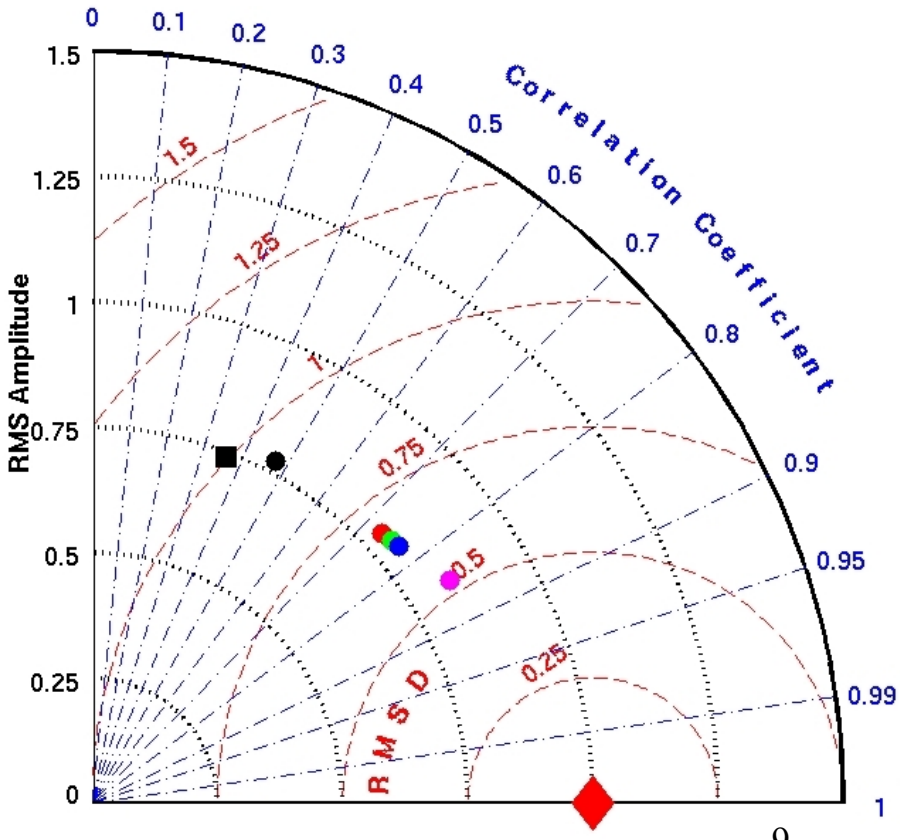
Other experiments

- Unconstrained
- Airborne observations denied

b) SST (normalized)



c) SSS (normalized)



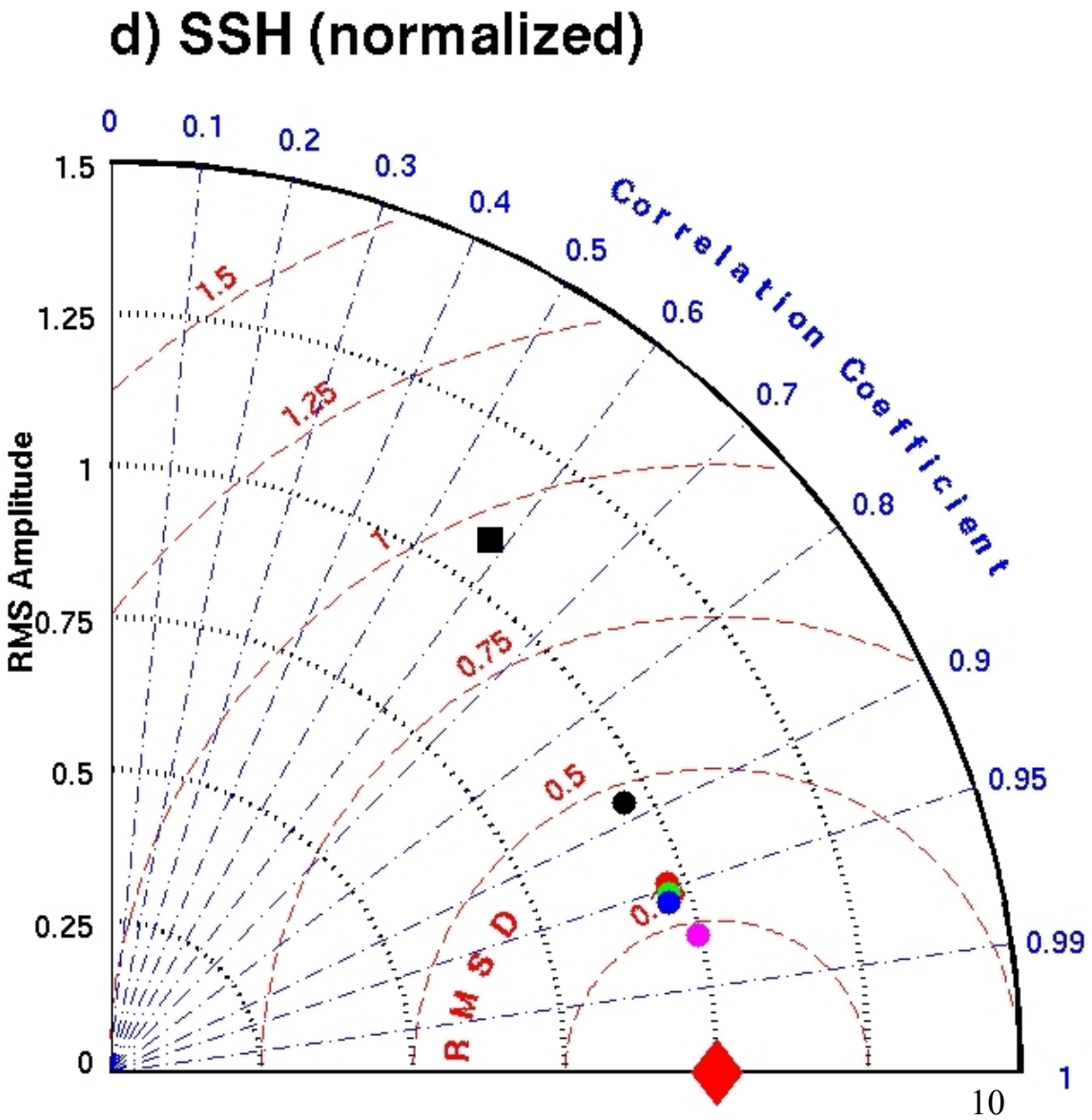
Question 1, Dynamical Variables

Airborne assimilation experiments

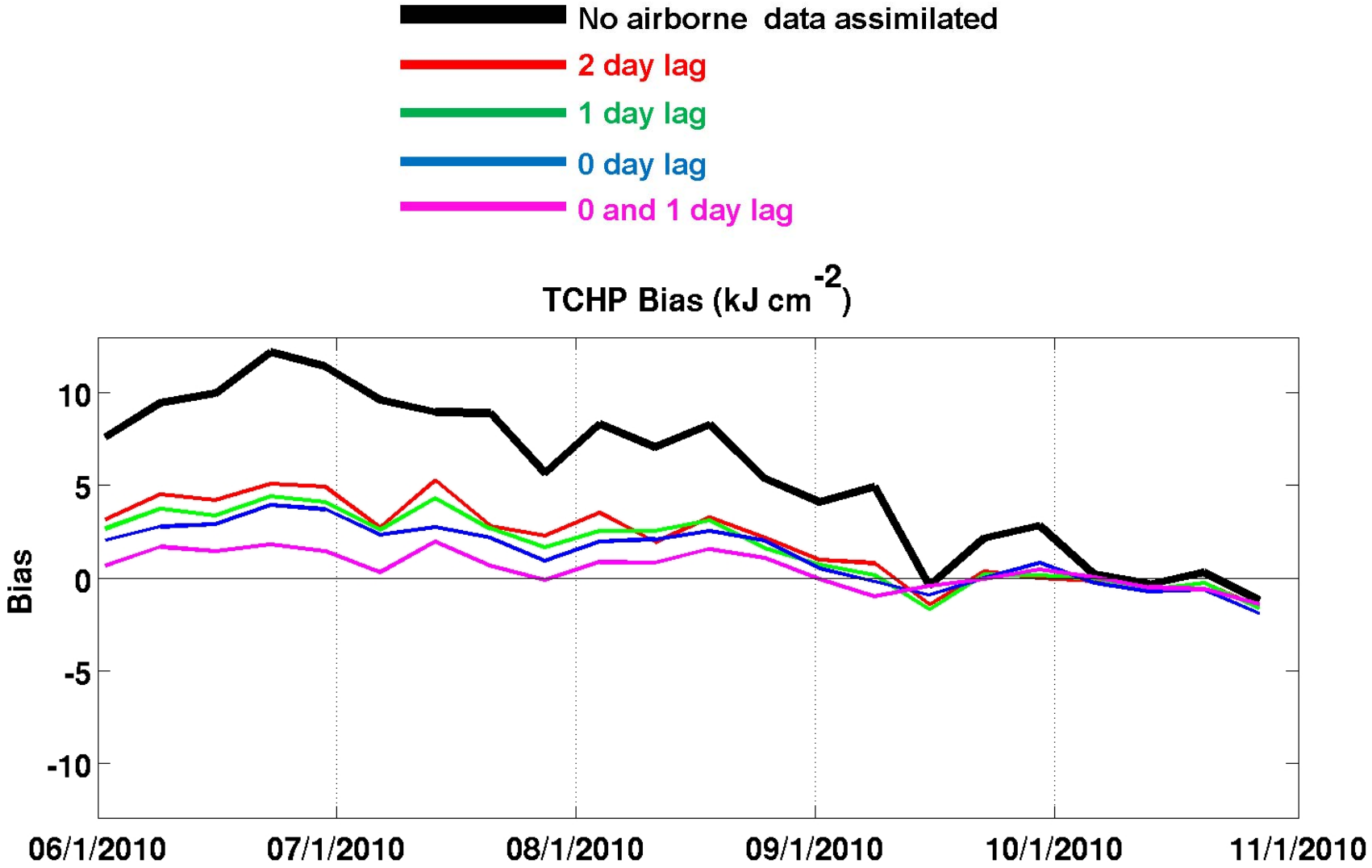
- 2 day lag
- 1 day lag
- 0 day lag
- 0 and 1 day lag

Other experiments

- Unconstrained
- Airborne observations denied



Question 1, TCHP Bias Correction



Experiments for Addressing Question 2 (horizontal resolution)

Experiment	Synthetic Instruments Assimilated	Horizontal Resolution of Airborne Surveys
NODA	None (unconstrained)	N/A
NOP3	All except airborne obs.	N/A
RES1	All with 1000 m AXCTD	0.5º
RES2	All with 1000 m AXCTD	1.0º

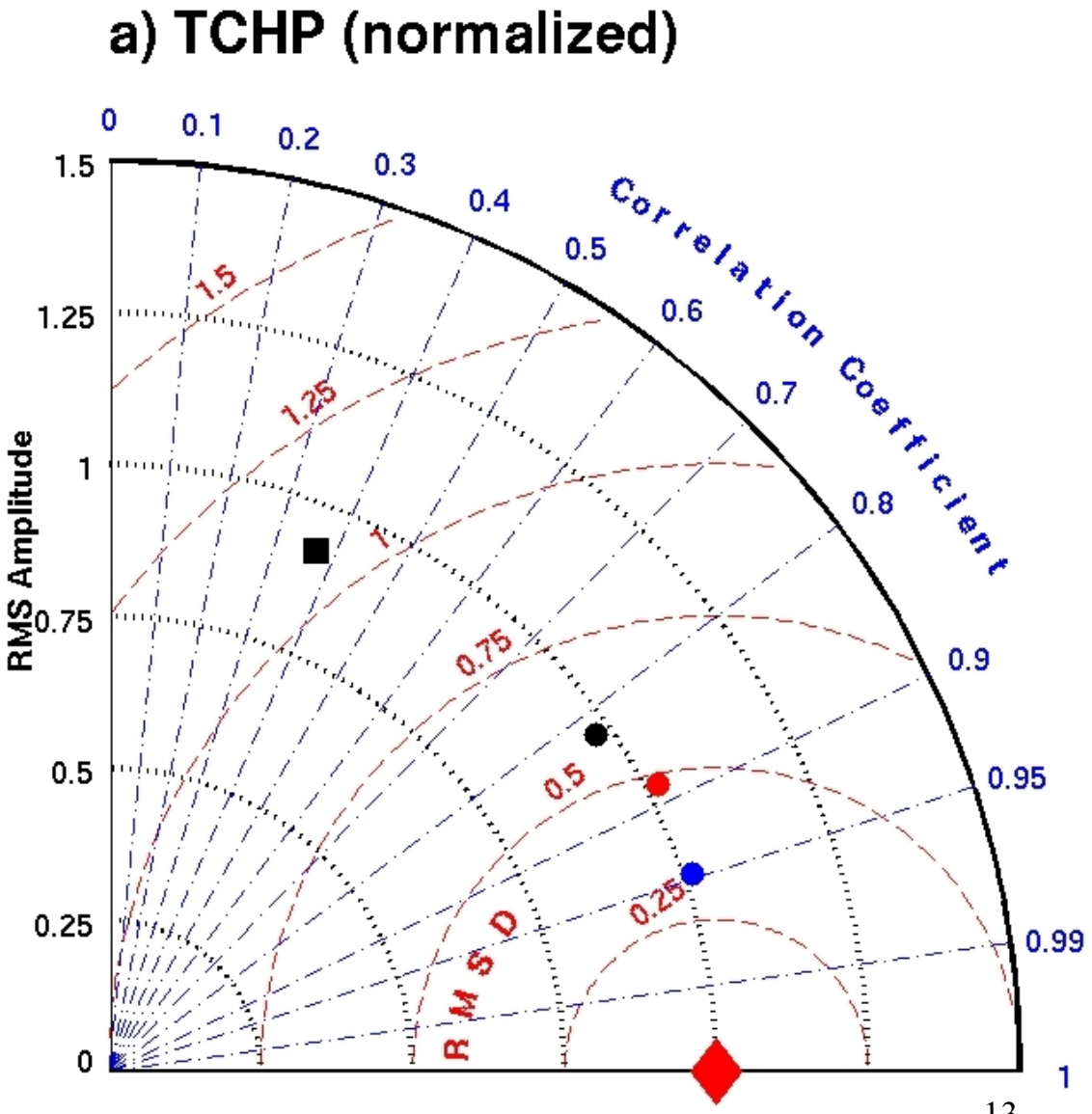
Question 2, Thermodynamical Variables

Airborne assimilation experiments

- 1000 m AXCTDs; 1.0º resolution
- 1000 m AXCTDs; 0.5º resolution

Other experiments

- Unconstrained
- Airborne observations denied



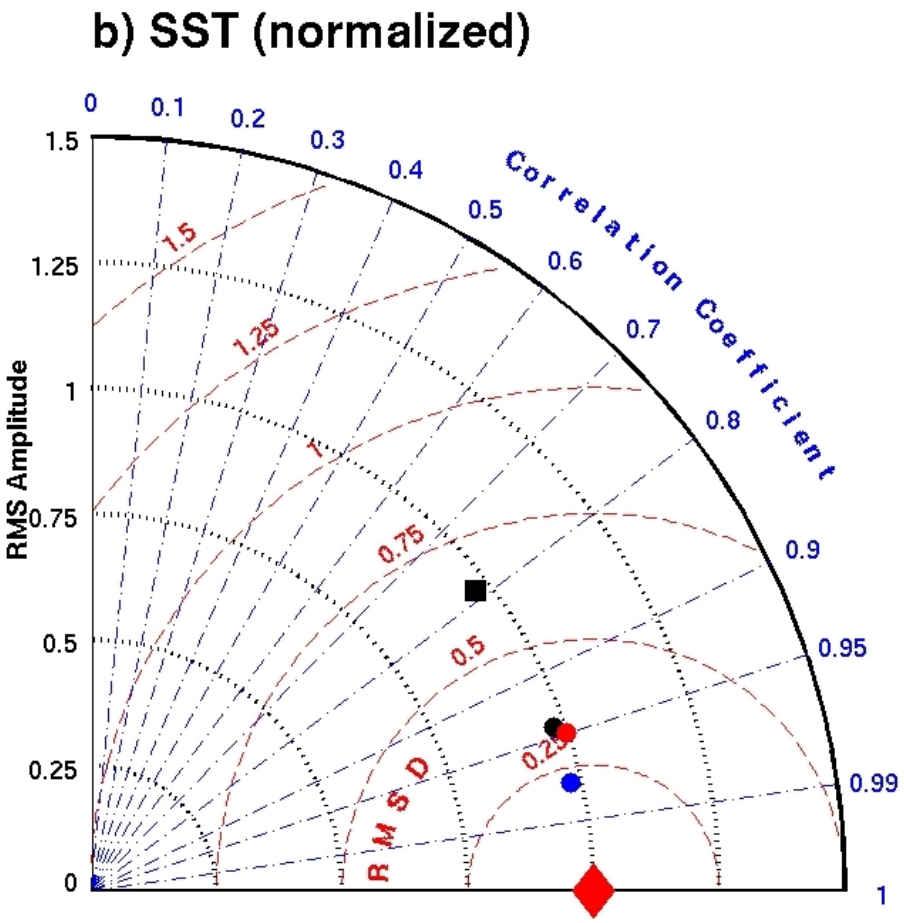
Question 2, Thermodynamical Variables

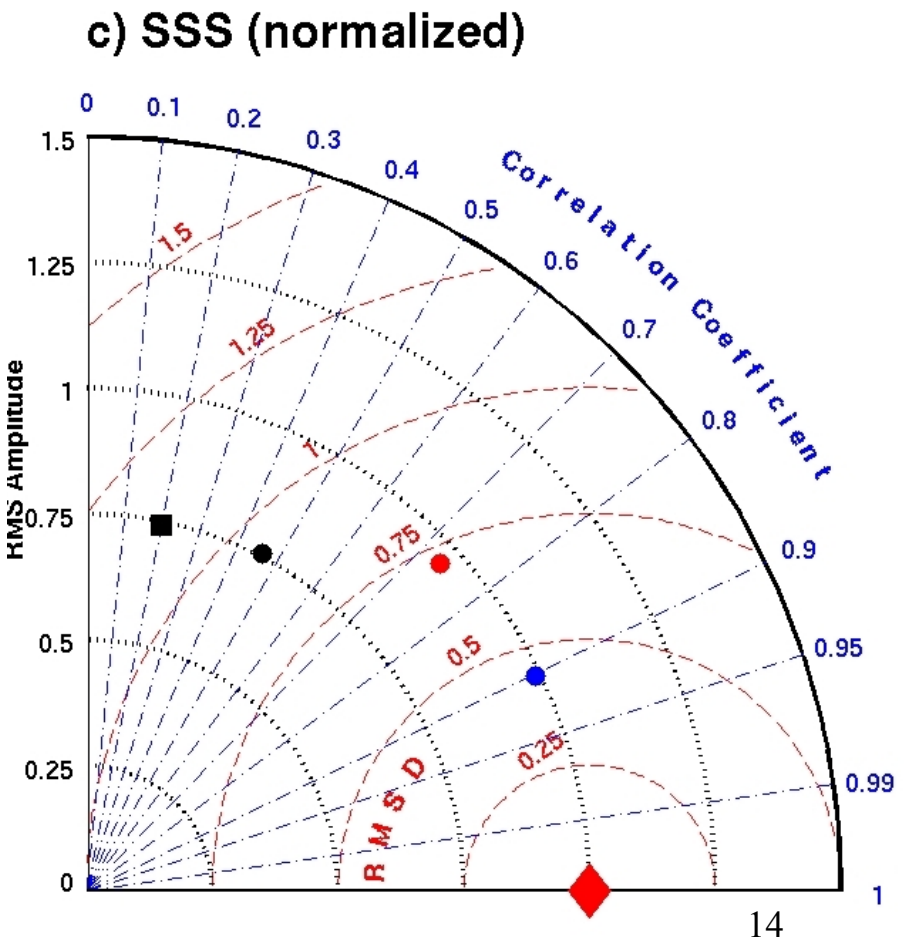
Airborne assimilation experiments

- 1000 m AXCTDs; 1.0º resolution
- 1000 m AXCTDs; 0.5º resolution

Other experiments

- Unconstrained
- Airborne observations denied





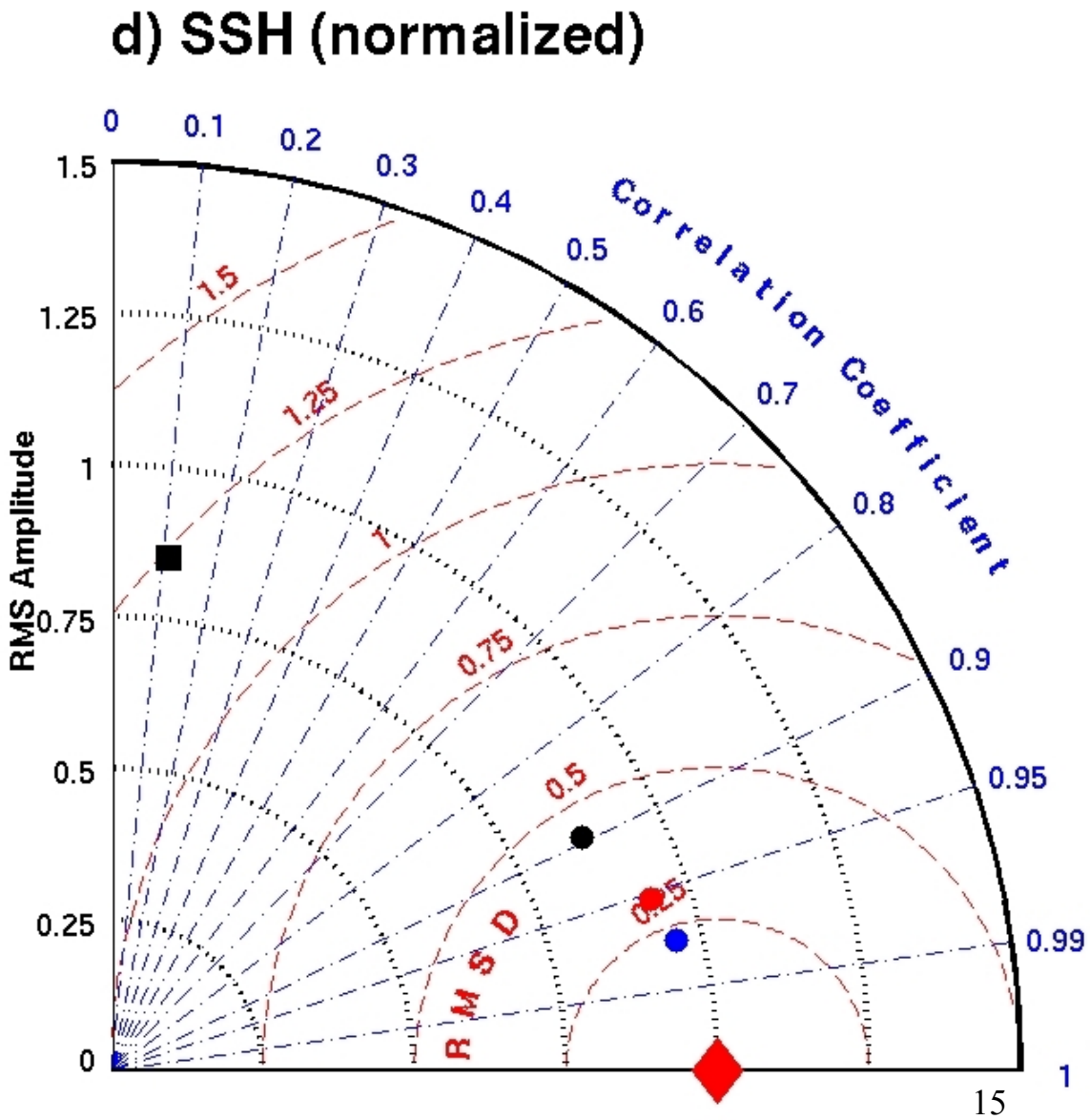
Question 2, Dynamical Variables

Airborne assimilation experiments

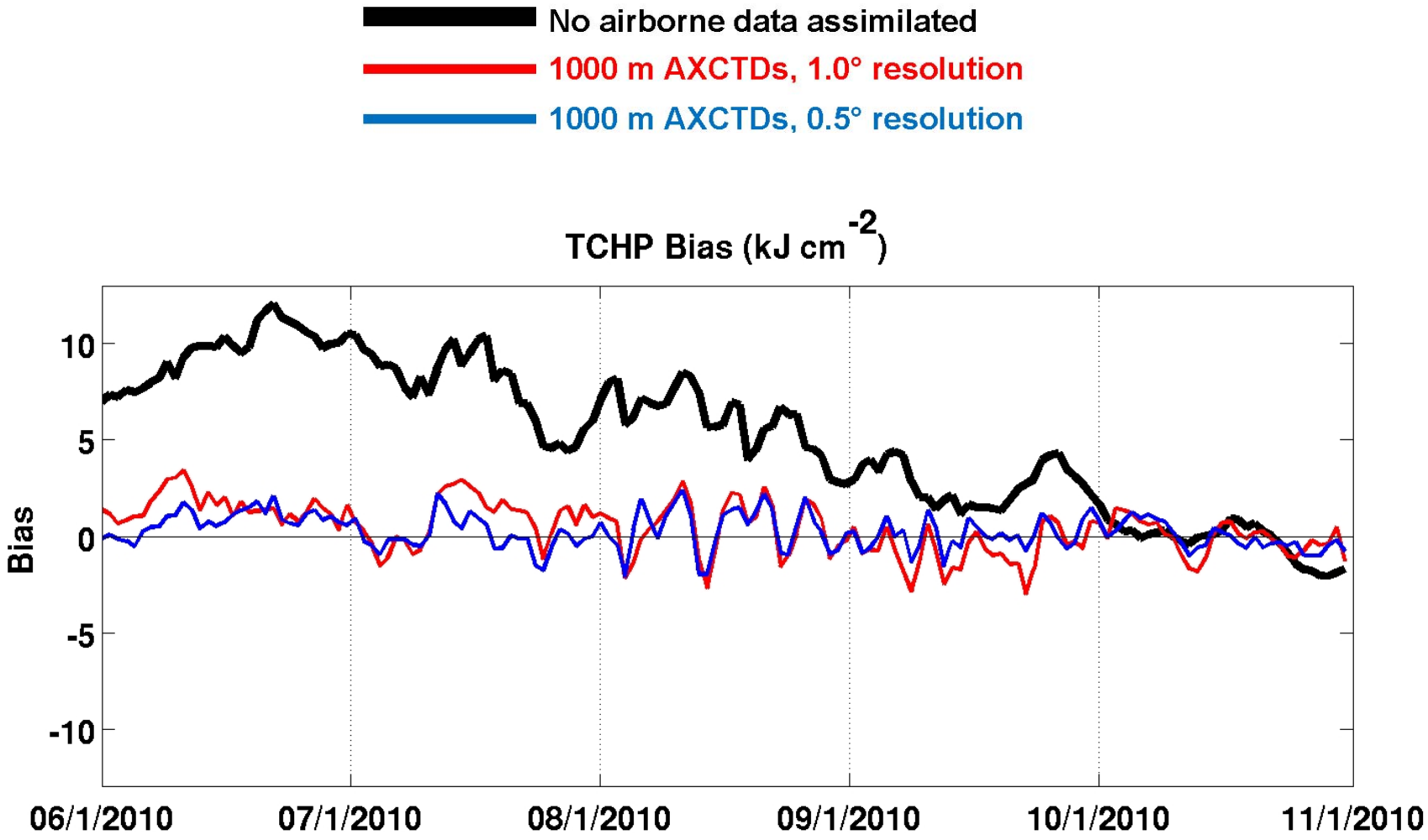
- 1000 m AXCTDs; 1.0º resolution
- 1000 m AXCTDs; 0.5º resolution

Other experiments

- Unconstrained
- Airborne observations denied



Question 2, TCHP Bias Correction



Next Steps (hurricanes)

- **Complete the 2010 study**
- **Set up the OSSE system for the 2012 hurricane season**
- **Evaluate the extensive set of observations collected for hurricane Isaac**
  - Important to evaluate observing system impacts before, during, and after storm passage
  - Perform OSEs to evaluate different components of the Isaac dataset
  - Perform OSSEs to test alternate observing strategies