Validation and Application of Jason-1 and Envisat Significant Wave Heights

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Motivation

PART I

- Current operational Bureau wave model assimilates Jason H_s only
- Envisat is received in real-time
- Potential to expand data assimilation (DA) scheme
- Need a bias correction scheme for each altimeter

PART II

- Expand model verification scheme to include altimeter observations as well as buoy observations *(prelim)*

Method

PART I

- Validate altimeter H_s against in situ buoy data
  - Accumulate co-locations over several years
  - Find best fit between datasets

PART II

- Use corrected altimeter data for evaluation of changes to the wave model
  - Increase directional resolution
  - Expand data assimilation scheme
- Compare altimeter H_s and model H_s within 10^ox10^o boxes

Conclusions

PART I

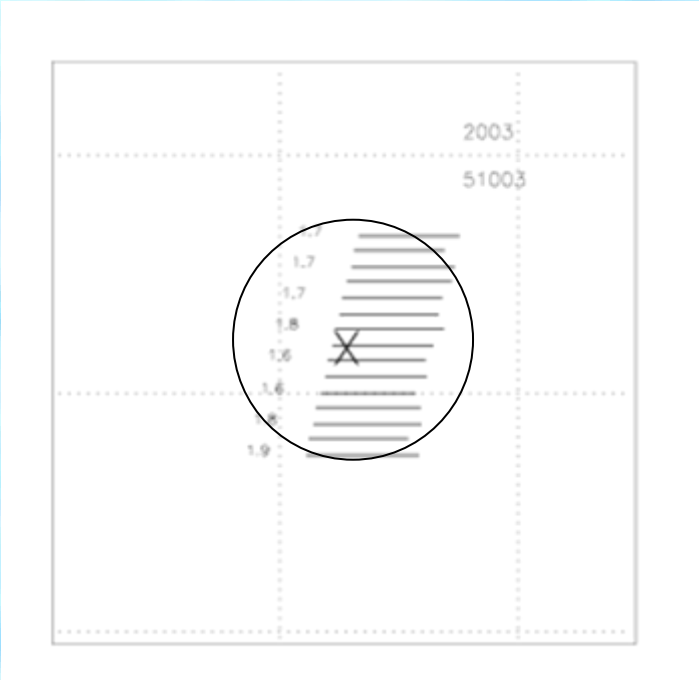
- Validation of Jason and Envisat NRT data streams
  - Jason: no correction
  - Envisat: linear correction, 8% improvement
- MEDS H_s ~ 90% NDBC H_s

PART II

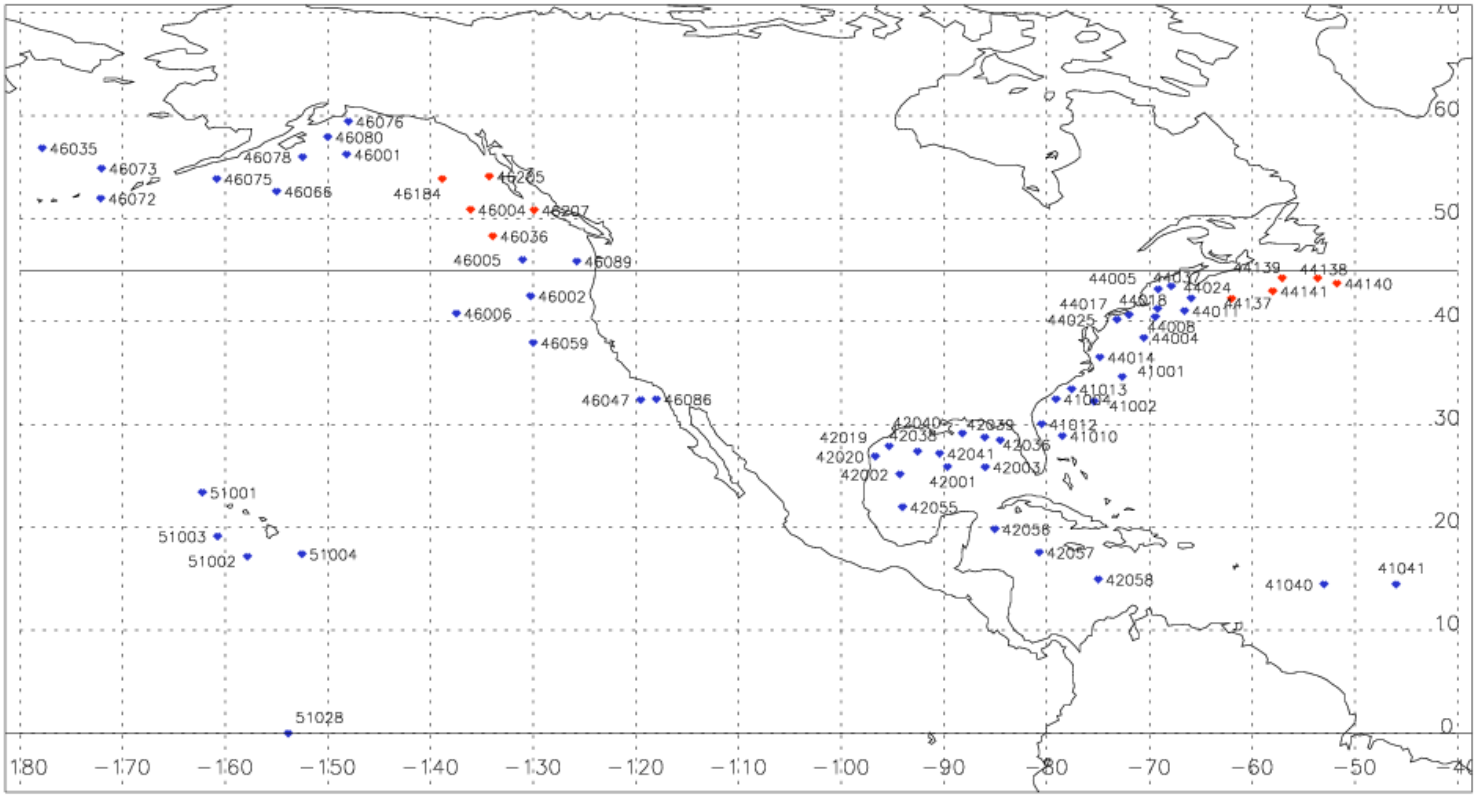
- Model bias varies significantly over globe
- To ensure improvements in both short-range forecasts and long range forecasts, need to incorporate both directional resolution increase and expanded DA

PART I: Altimeter validation

Method



- Stringent co-location criteria
- Buoys
  - Hourly observations
  - > 50km away from land
- Gather all satellite observations within 50 km radius for a given pass
- Determine mean - remove outliers - recalculate mean
- Linearly interpolate hourly buoy observations to overpass time



- Initial results indicated significant differences between buoy networks
- Decision was made to use only NDBC buoys

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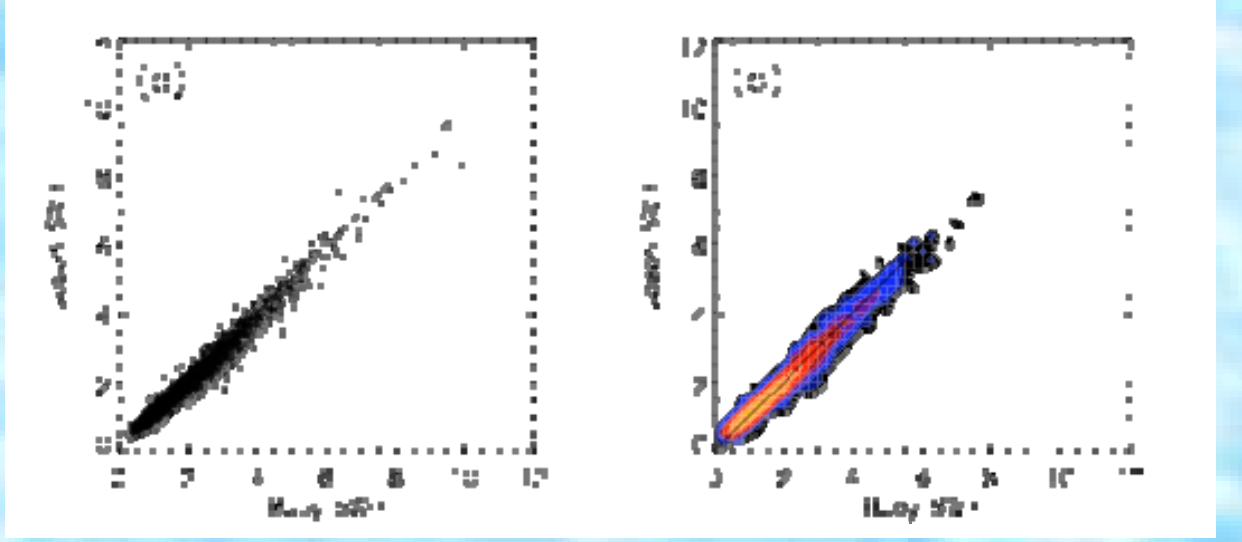
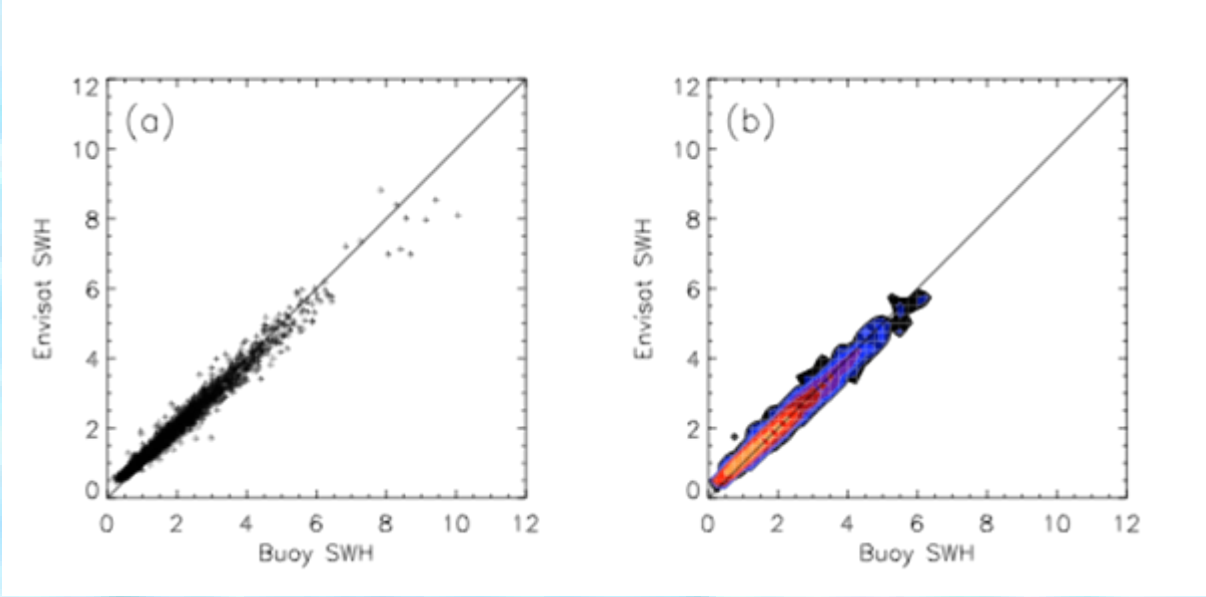
Jason-1
Jan 2002 - Apr 2006
3452 co-locations



Envisat
Apr 2003 - Apr 2006
2157 co-locations



Results

- Examined several correction schemes - bias correction, linear correction, branched linear
  - Jason–1: No correction required
  - Envisat: Linear correction

$$H_s^{adj} = 1.085 \times H_s^{FD} - 0.213$$

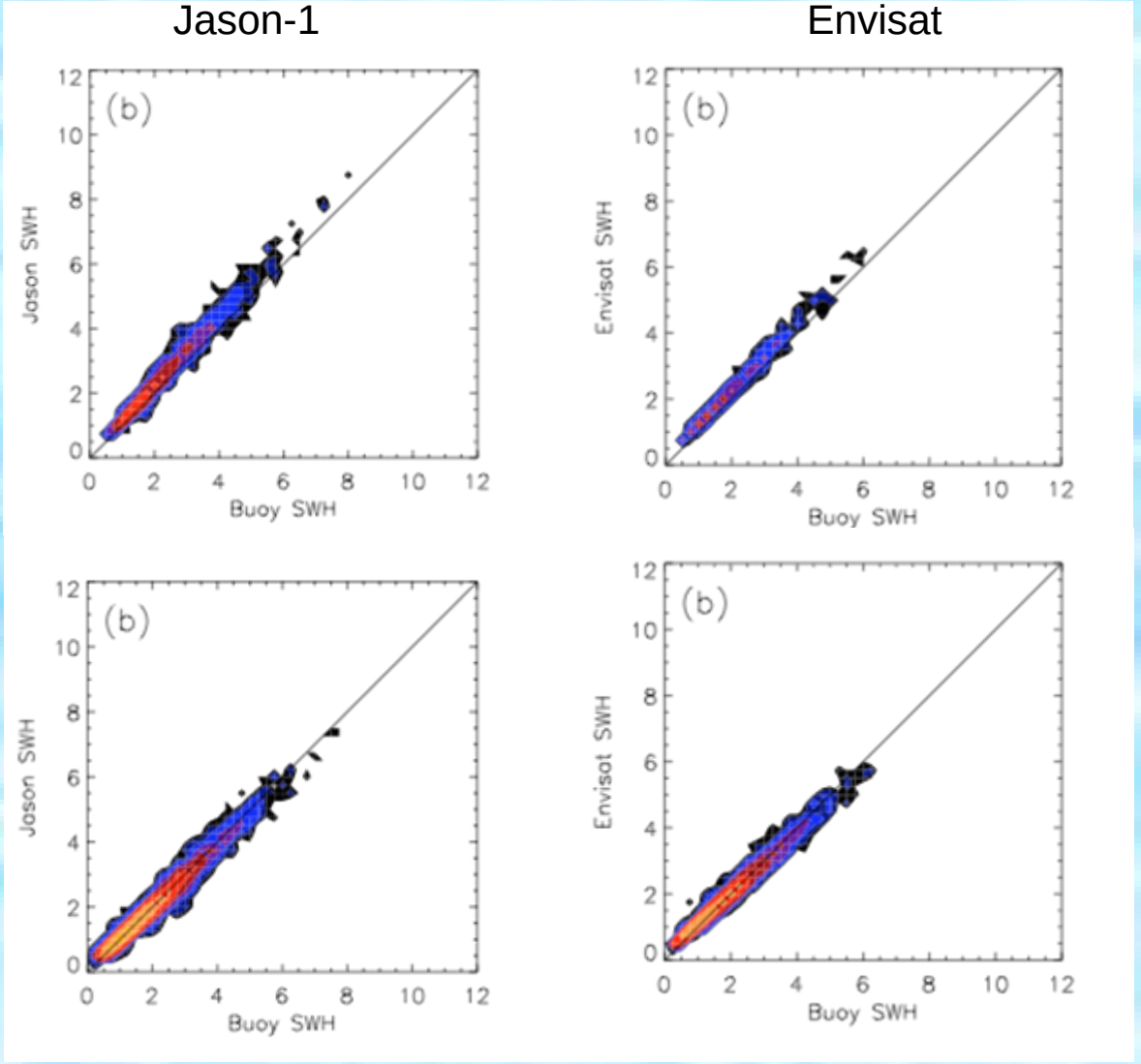
	Jason-1	Envisat	Envisat corrected
Bias	0.010	0.036	0.000
R	0.983	0.986	0.986
RMS	0.229	0.219	0.202
SI	0.110	0.106	0.099

⟵ 8% improvement

Buoy Networks

MEDS

NDBC



Bias values: Satellite - buoy

	NDBC	MEDS
Jason-1	-0.01	0.27
Envisat	0.04	0.28
Jason-1	0.03	0.26
Envisat	0.04	0.24
ERS-2	-0.14	0.03
TOPEX	-0.01	0.19
Jason-1	-0.12	0.09
Envisat	0.07	0.24

Our values

J. Bidlot

P. Queffeulou

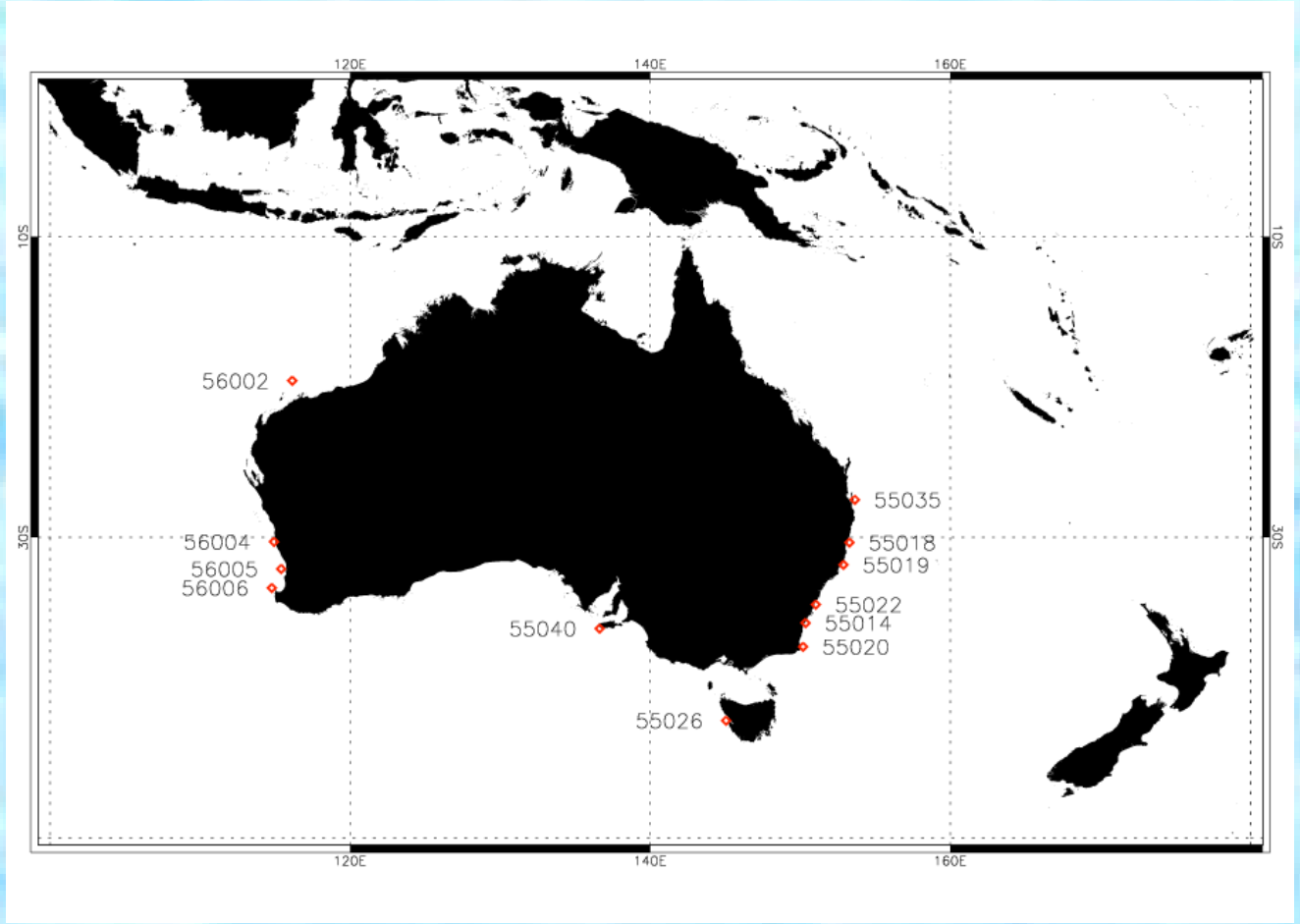
$$H_s^{MEDS} = 0.9 \times H_s^{NDBC}$$

PART II: Model verification

Model verification

- Use adjusted altimeter data and buoy data to evaluate wave model changes
  - Increase directional resolution (30^o to 15^o)
  - Assimilate Envisat H_s in addition to Jason H_s
- 6 model runs – January 2005
  - Noassim-12
  - Noassim-24
  - **Jason-12**
  - Jason-24
  - Both-12
  - Both-24

Buoy verifications



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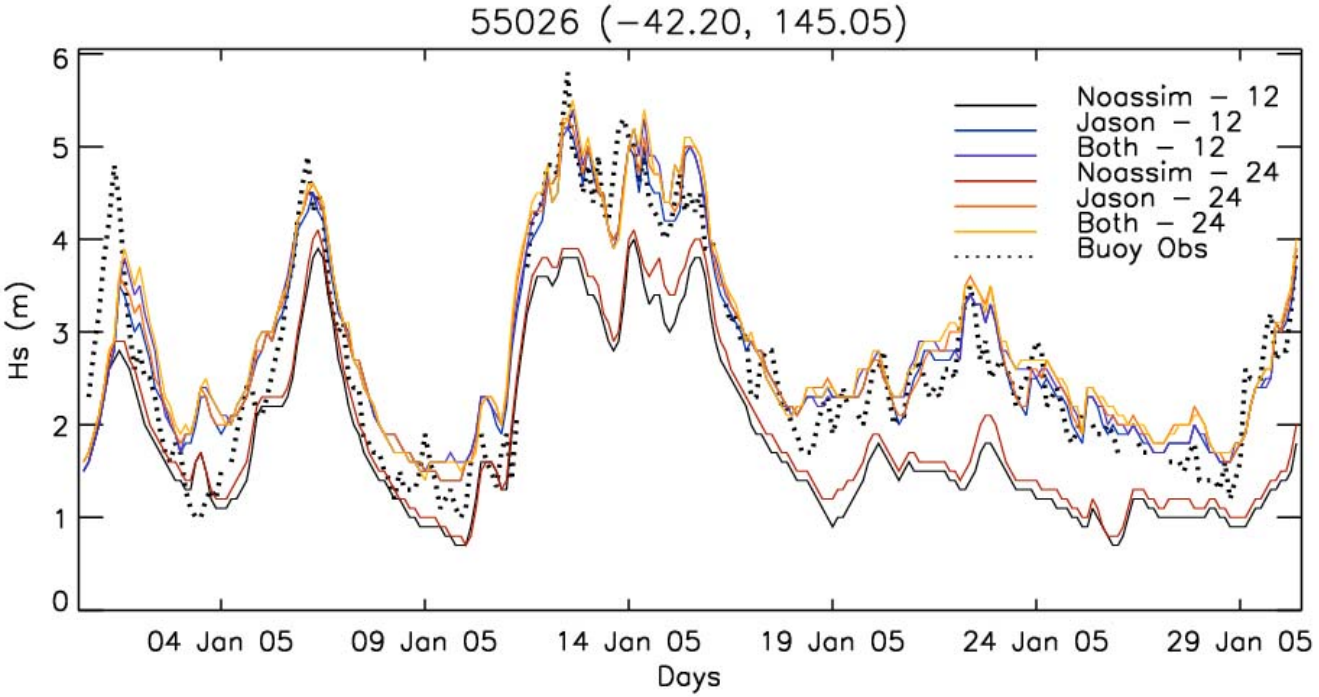

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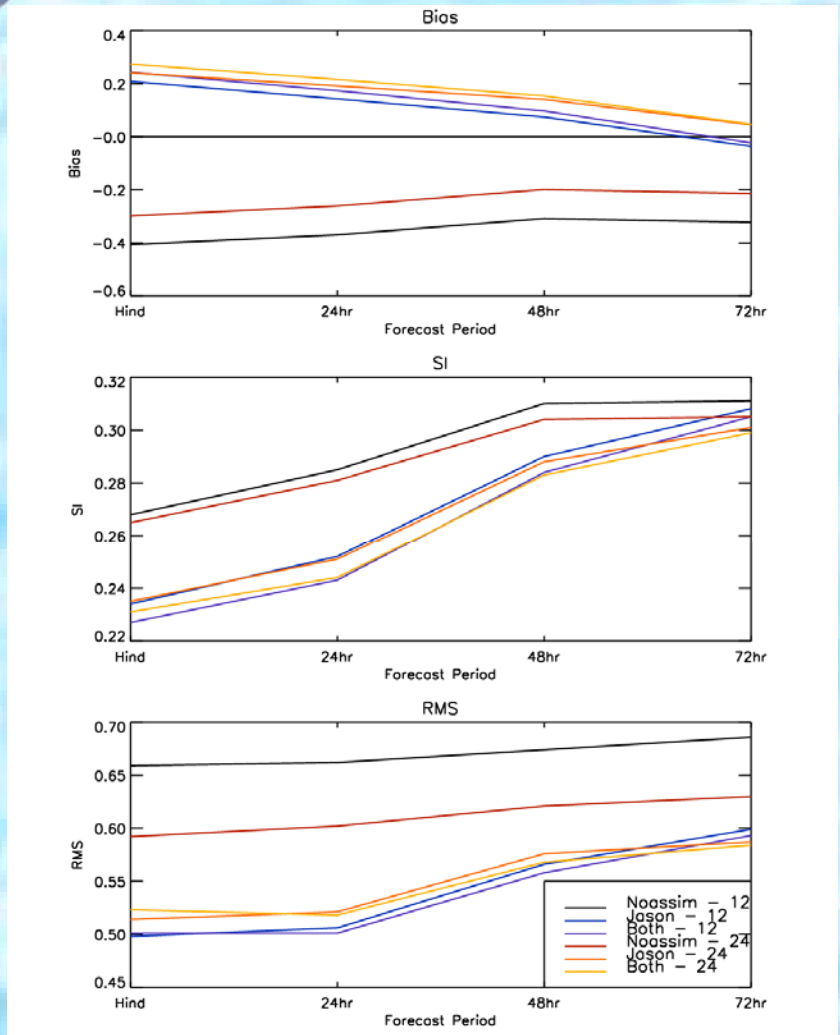

- Bias:
  - Noassim-12 to Noassim-24
  - Positive for DA cases
- SI:
  - DA reduces SI
- RMS dominated by bias
  - Most weight on SI
- Short range: DA
- Long range: Directional resolution

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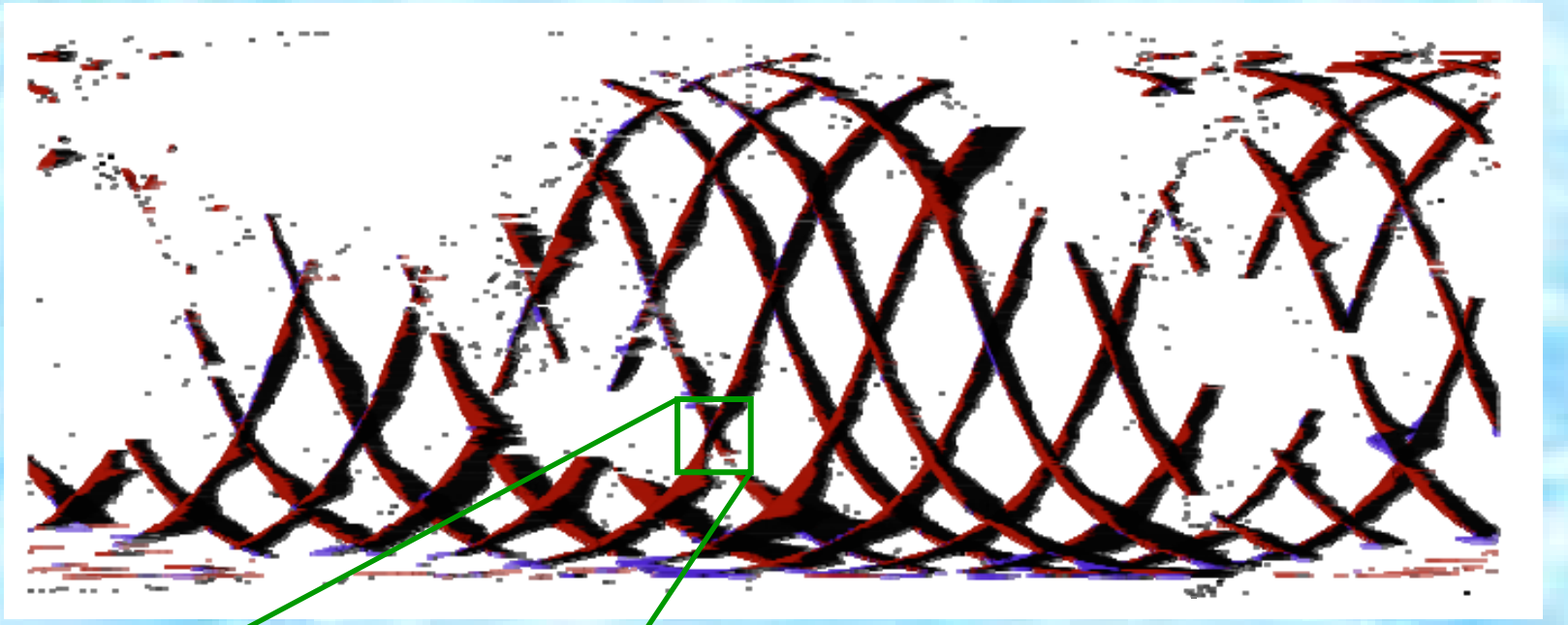
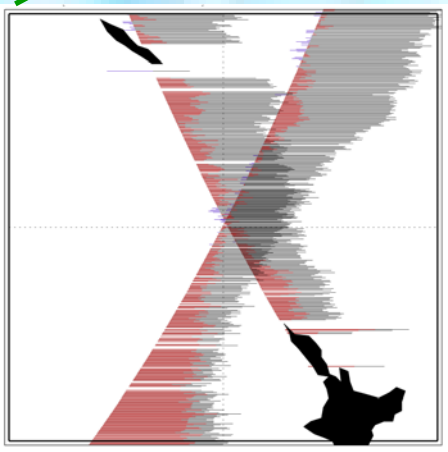
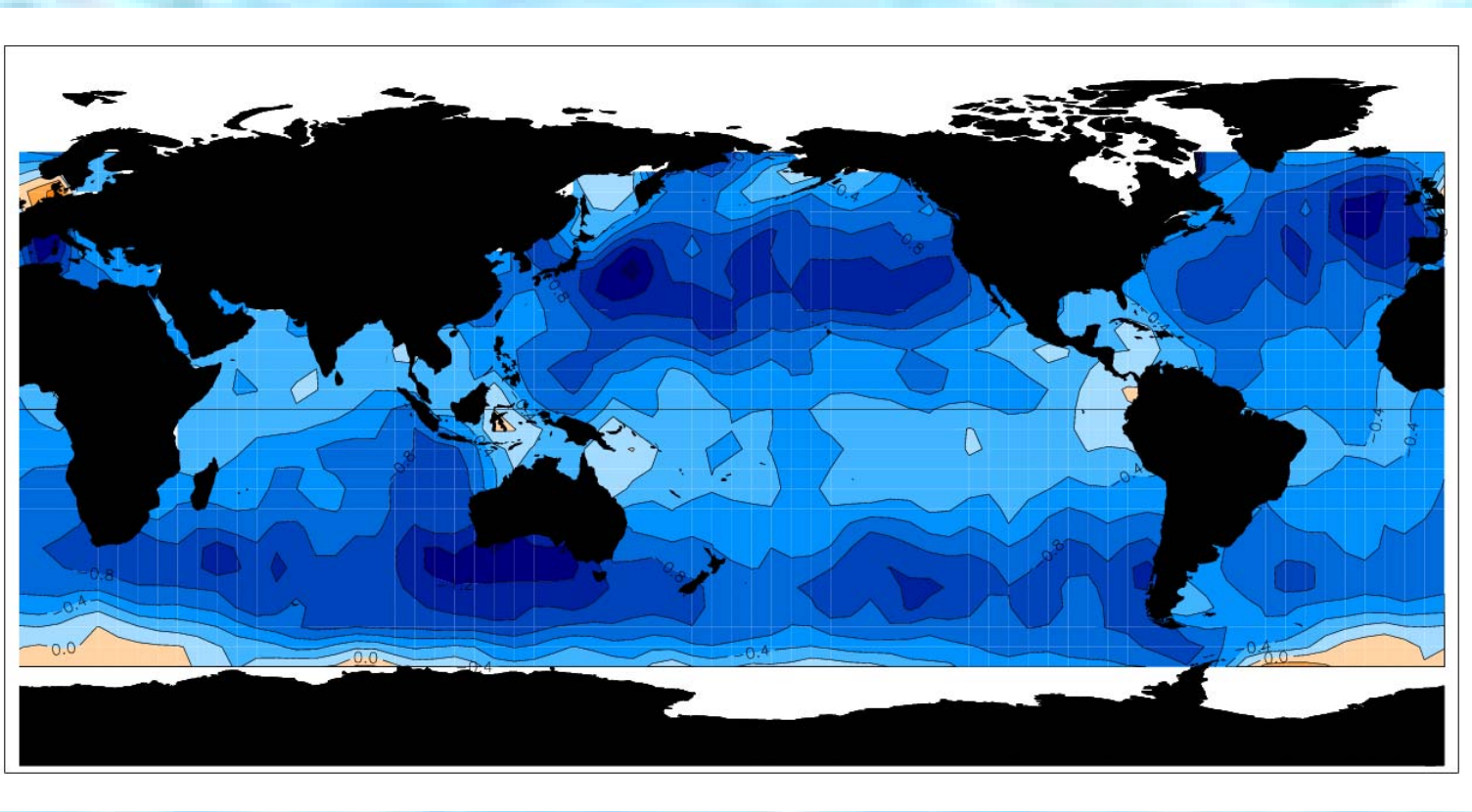
Altimeter verifications



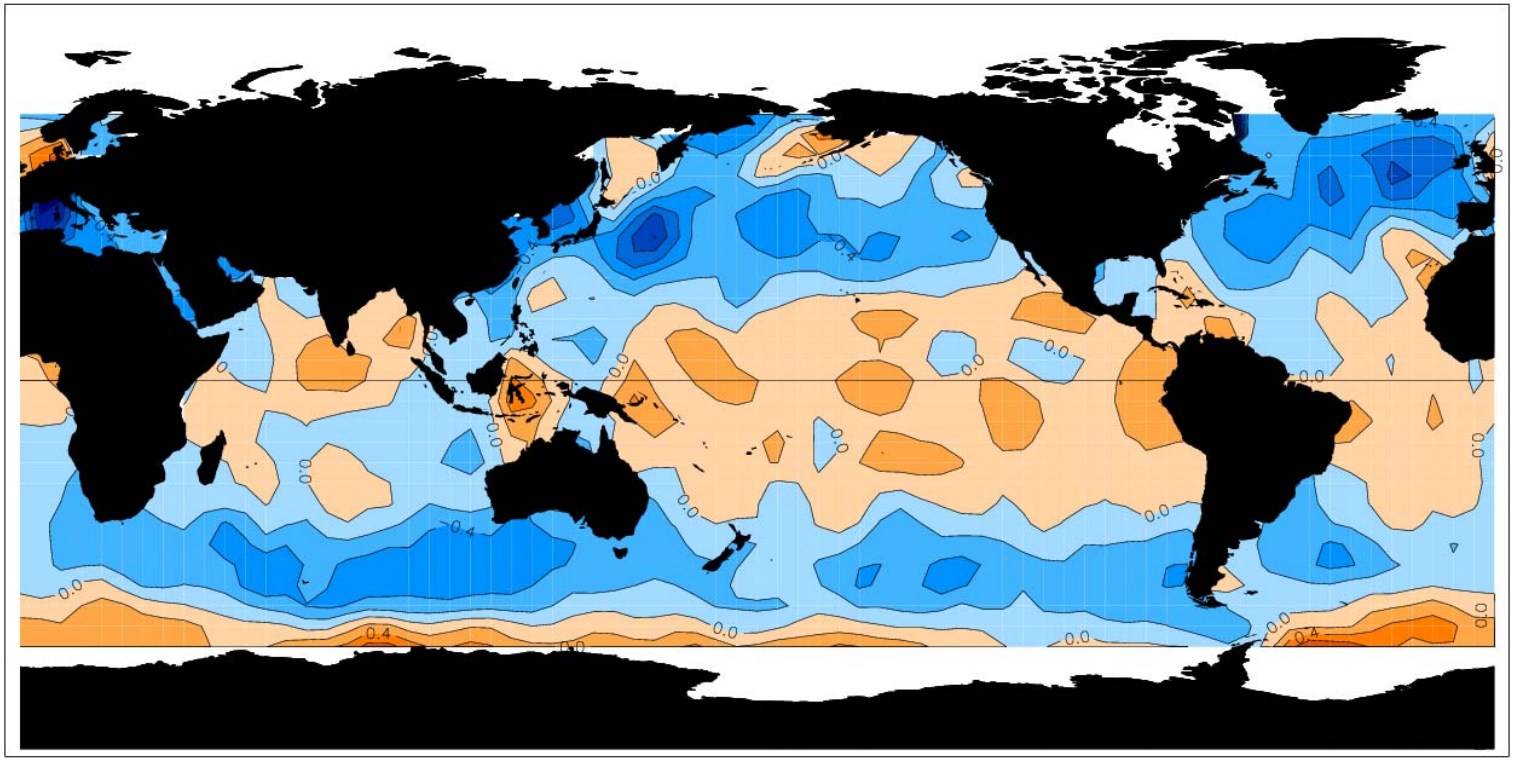


- 10^o x 10^o boxes
- Model H_s interpolated to alt observation location
- Stats calculated for each box
- Scales of variability

Bias, 24-hr, Noassim-12

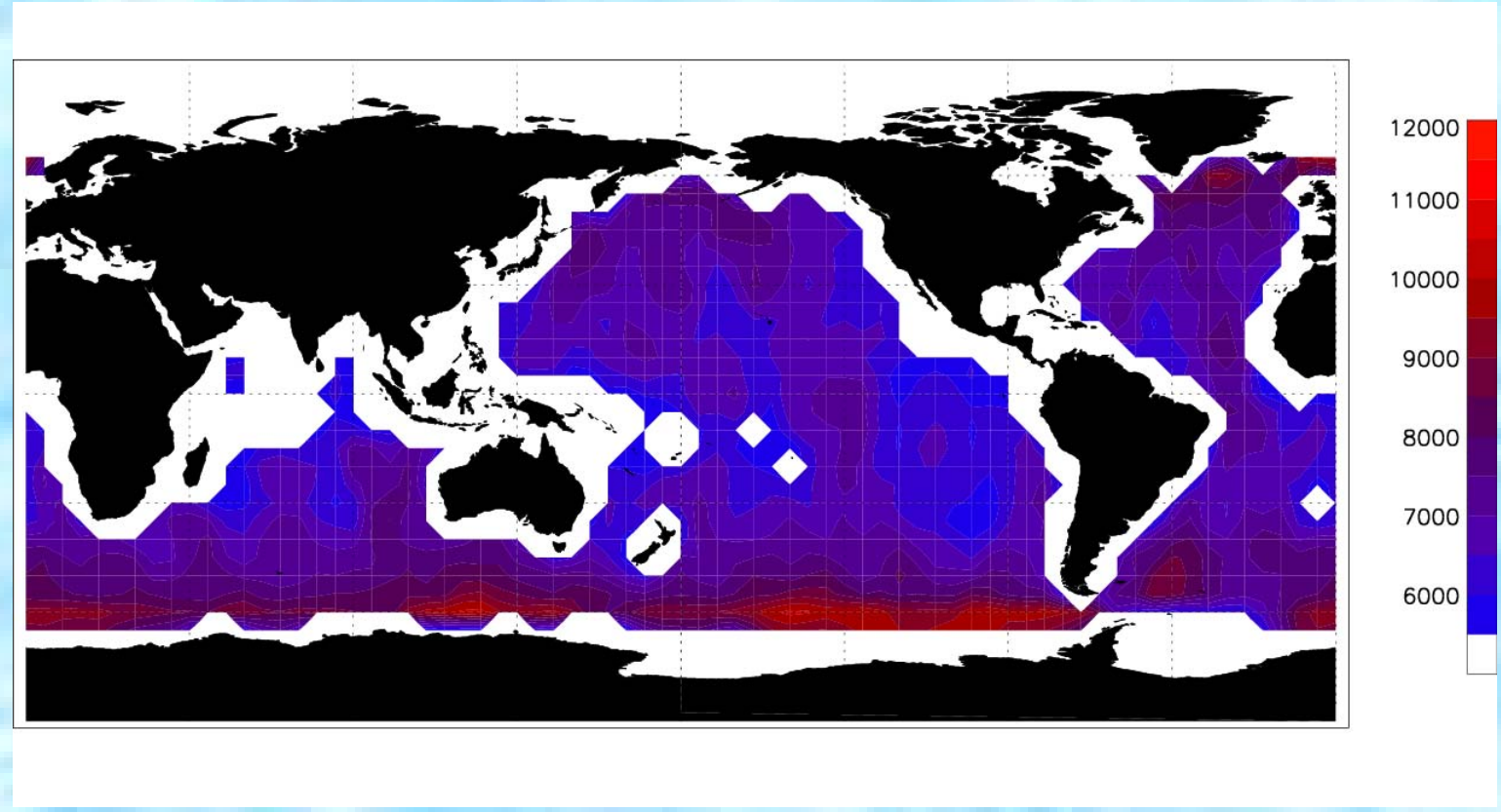


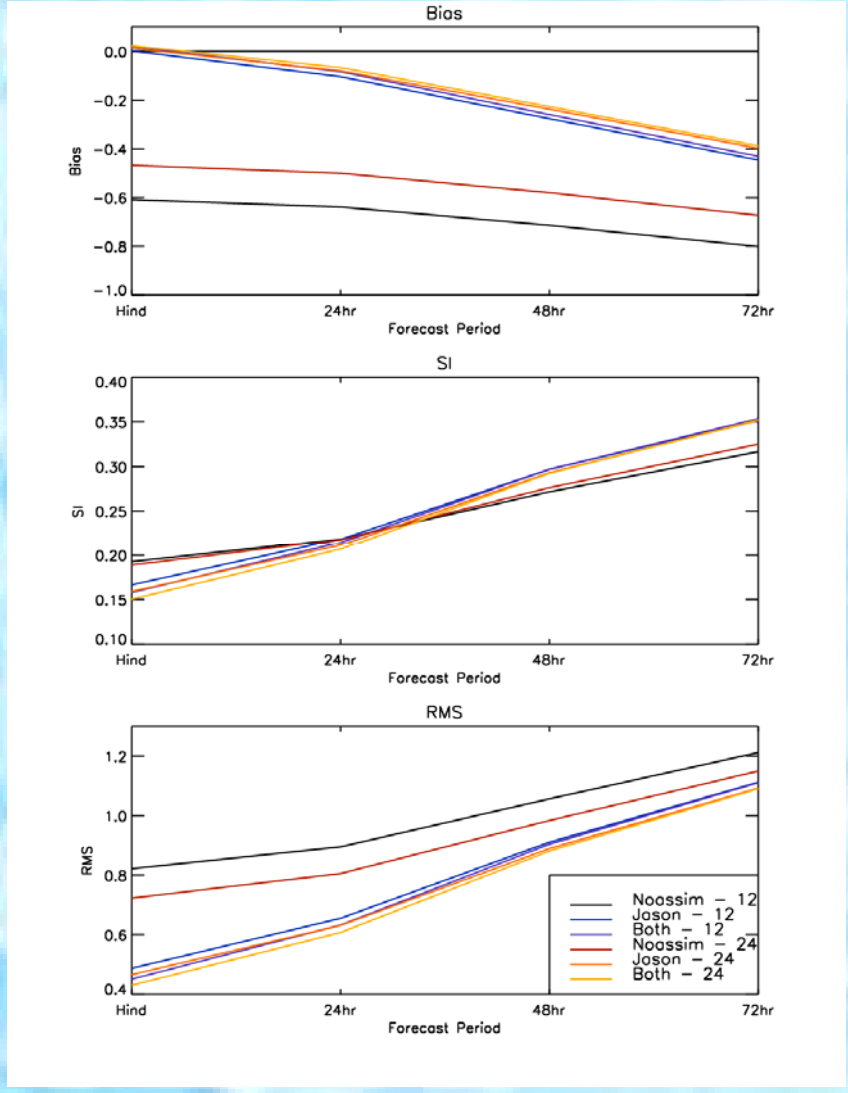
Bias, 24-hr, Both-12



- Determine summary statistics over globe
- Options:
  1. Calculate stats over globe
  2. Average statistics over boxes
- Option 1 will give higher weighting to high latitude regions due to denser observations
- Option 2 will give higher weighting to high latitude regions due to width of boxes
  - Weight box according to latitude

Number of observations





- Bias:
  - DA cases ~0
  - Noassim-12 to Noassim-24
- SI:
  - Long-range, best case is Noassim-12
- Little difference between DA cases

Computational Usage

Run	*User time (sec)*	*Memory size (MB)*
Noassim_12	430	1296
Noassim_24	838	2512
Jason_12	*664*	*1312*
Jason_24	1070	2528
Both_12	1110	1312
Both_24	1324	2528

- 12-hour hindcast and 72-hour forecast
- SX-6 single processor only
- Requirements for resolution increase and DA increase are equal
- Requirements for both are not much more than requirements for one

Summary

- Validation of Jason and Envisat NRT data streams
  - Jason: no correction
  - Envisat: linear correction, 8% improvement
- MEDS H_s ~ 90% NDBC H_s
- Used buoy and altimeter data to assess changes to model configuration
  - Increase in directional resolution
  - Expansion of DA system to include Envisat
- To ensure improvements in both short-range forecasts and long range forecasts, need to incorporate both
- Further work:
  - Improve model/buoy comparisons
  - Improve model/altimeter comparisons