Jason-2 OGDR accuracy and precision validation for ocean forecasting

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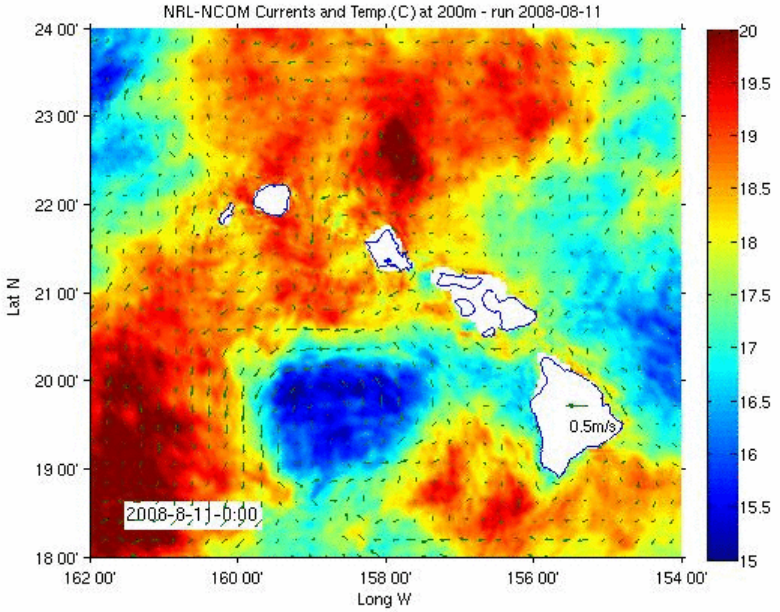
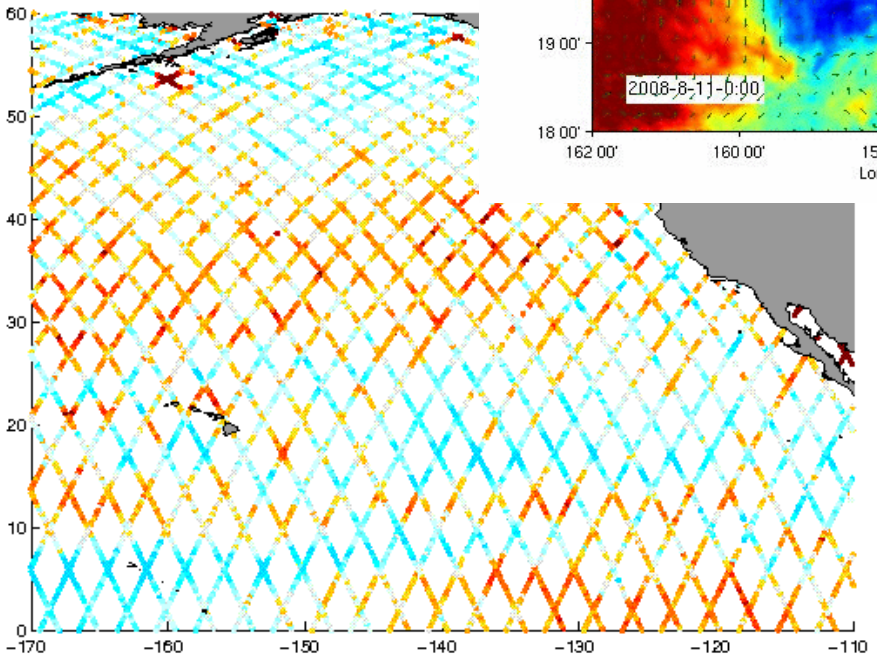
Lamar Russell (Naval Oceanographic Office)

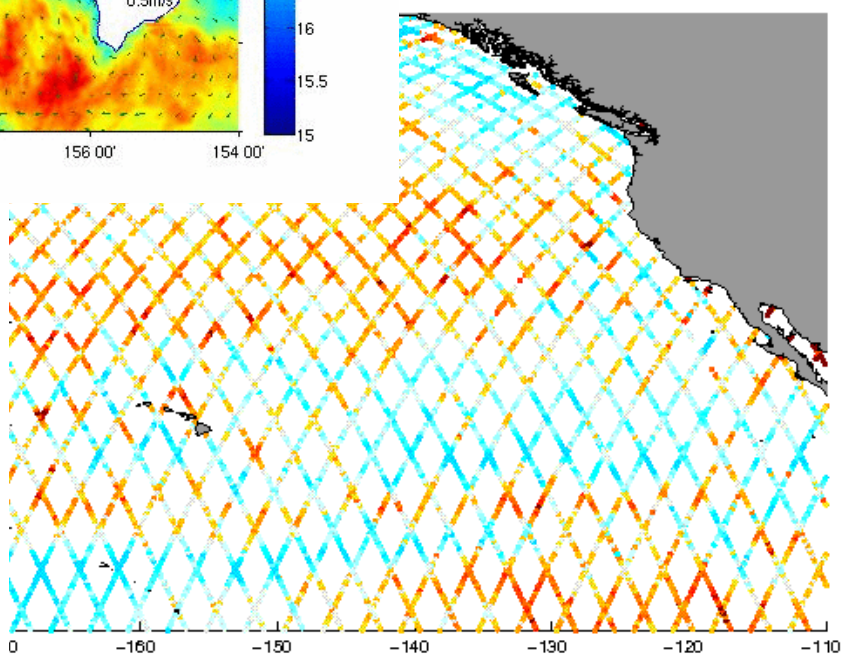
Jason-1 OGDR vs Jason-2 IGDR, head-to-head smackdown



Jason-1

Jason-2





Documented requirements, the widely admired NPOESS IORD-II

THE JOINT STAFF
WASHINGTON, D.C. 20318-8000

JROCM 005-02
14 Jan 02

JOINT REQUIREMENTS
OVERSIGHT COUNCIL

MEMORANDUM FOR THE UNDER SECRETARY OF DEFENSE FOR
ACQUISITION, TECHNOLOGY AND LOGISTICS

Subject: National Polar-orbiting Operational Environmental Satellite System (NPOESS) Integrated Operational Requirements Document-II

The Joint Requirements Oversight Council (JROC) reviewed and approved the NPOESS Integrated Operational Requirements Document-II and validated the Milestone B Key Performance Parameters (KPPs). The JROC considers the KPPs as essential to meet the NPOESS mission need.

PETER PACE
General, United States Marine Corps
Vice Chairman
of the Joint Chiefs of Staff

Documented requirements, the widely admired NPOESS IORD-II

4.1.6.6.7 Sea Surface Height/Topography (DOC)/(DoD). Sea surface height is the topography of the ocean surface with respect to the Earth's reference ellipsoid in a well-maintained terrestrial reference frame. Its variability is associated with mesoscale, basin scale, and global scale (DOC only) ocean phenomena. The requirements below apply under both clear and cloudy conditions. Note: following terminology is altimeter-specific. See Glossary Part II for terms and definitions specific to Sea Surface Height..

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution		
1. Satellite Nadir Resolution	15 km	2 km
2. Horizontal Reporting Interval	1 km	0.2 km
3. Closest Point to Shore	10 km	3 km
b. Measurement Precision	3 cm	2 cm
c. Measurement Accuracy		
1. Mesoscale	6 cm	4 cm
2. Basin Scale	5 cm	3 cm
3. Global Scale	4 cm	2 cm
d. Exact Repeat Period	20 days	10 days
e. Equatorial Track Spacing	$\leq$ 165 km	$\leq$ 50 km
f. Latency		
1. Mesoscale	24 hr	3 hr
2. Basin Scale	3 days	2 days
3. Global Scale	3 months	2 months
g. Geographic Coverage	66S to 66N latitude	85S to 85N
h. Long Term Stability (after calibration)	1 mm yr^{-1}	0.5 mm yr^{-1}

Documented requirements, the widely admired NPOESS IORD-II

Measurement Precision *(For Sea Surface Height EDR)*

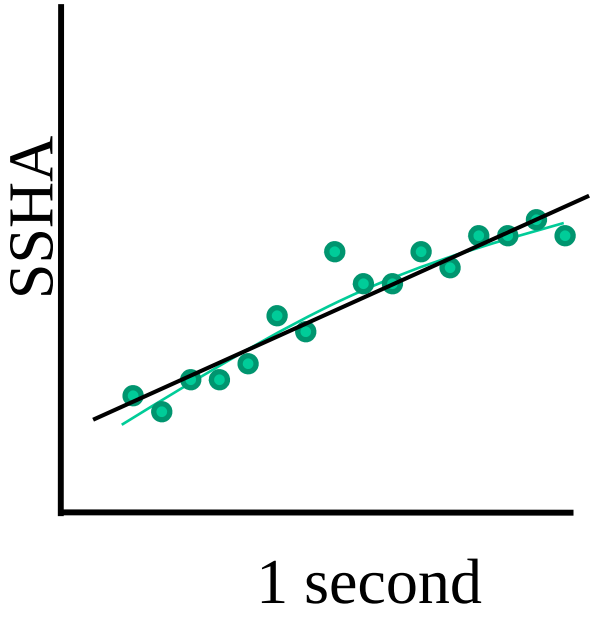
The standard deviation from a linear fit to data at the Horizontal Reporting Interval within the Nadir Resolution cell. Precision does not include measured range corrections (wet troposphere, ionosphere), model-based corrections (dry troposphere, sea state bias), or radial orbit determination.

Measurement Accuracy *(For Sea Surface Height EDR)*

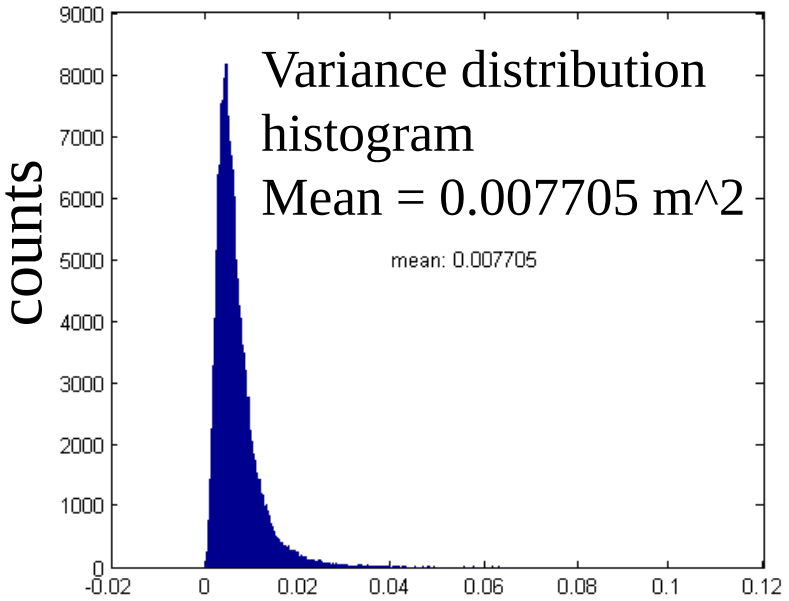
Based on an average over the Nadir Resolution cell. Accuracy includes radial orbit determination as well as measured range corrections (wet troposphere, ionosphere) and model-based corrections (dry troposphere, sea state bias). The required accuracy and timeliness for Coastal/Mesoscale may be obtained by high-pass filtering the sea height profiles to remove radial orbit error, which has scales greater than 10,000 km. Note that the sea surface height data will be used to derive tidal constituent amplitudes/phases as well as to observe semiannual, annual, and interannual ocean signals. Consideration must therefore be given to the temporal sampling interval as it relates to tidal aliasing. See "On the choice of orbits for an altimetric satellite to study ocean circulation and the tides", J. Geophys. Res., 92, 11693-11707, 1987.

Jason-2 relative to NPOESS IORD-II Precision Requirement

During a 1-second time period, 20 observations are taken. The variance about a linear fit provides an estimate of sensor noise



05Aug2008 to 19Aug2008 (14 days total)
824,582 individual one second observations.
Of these, 521,388 are over water with no sensor flags set in the OGDR.
1.96 cm RMS noise. Meets NPOESS threshold and objective (3 cm and 2 cm).



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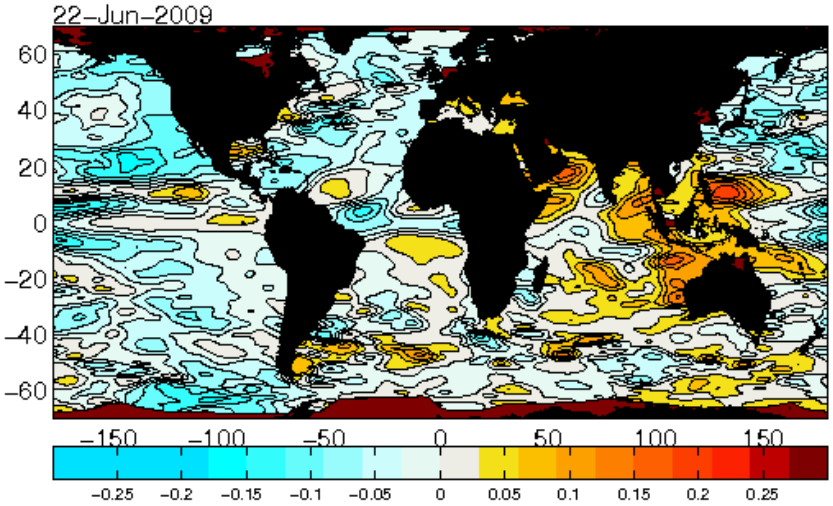
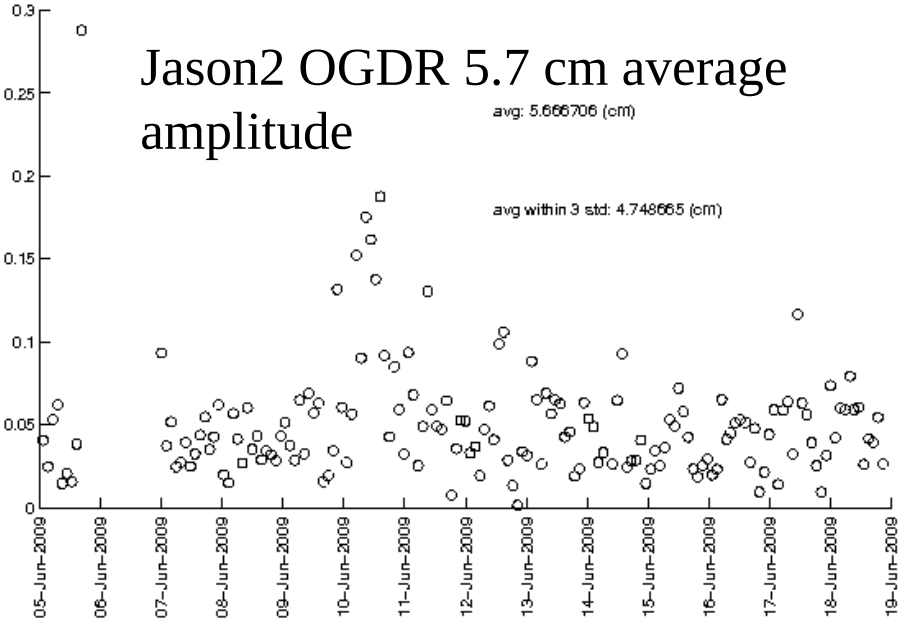
Orbit Correction Estimate

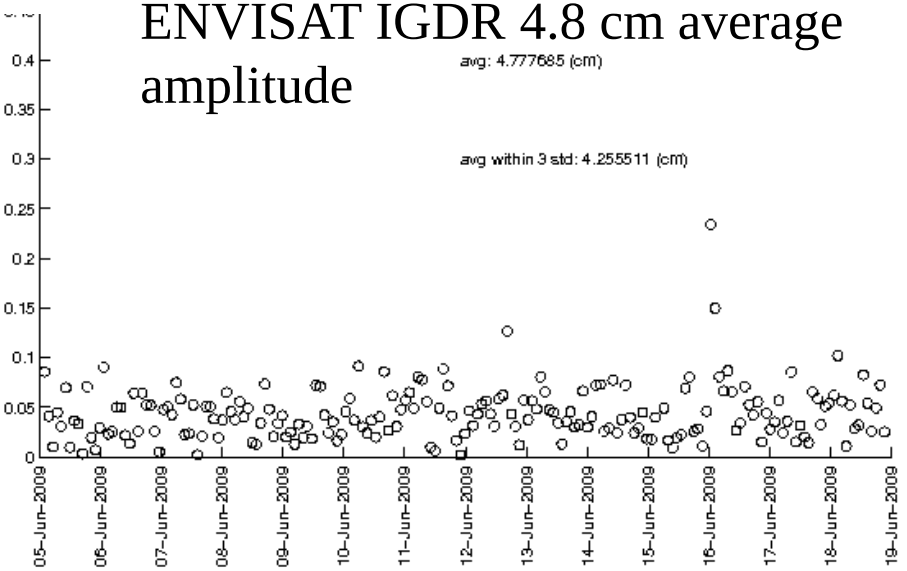
- Largescale interpolation provides first estimate assuming orbit errors are uncorrelated between revolutions
- 1 cycle per revolution orbit error estimated for each full revolution and removed
- Maintains annual steric though not mean sea level rise



Jason2 OGDR 5.7 cm average amplitude



ENVISAT IGDR 4.8 cm average amplitude

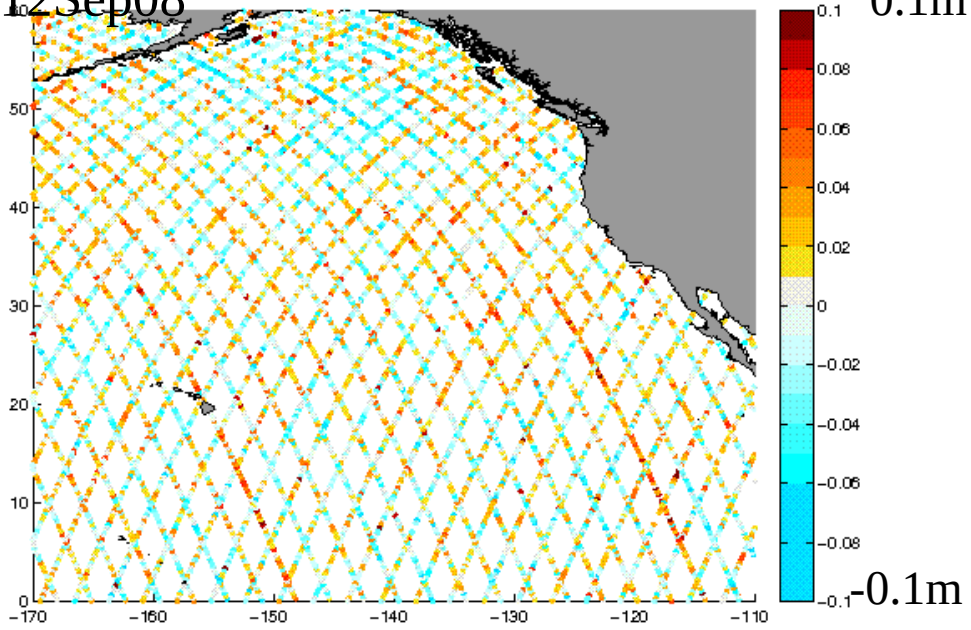


Jason-2 OGDR relative to NPOESS IORD-II Accuracy Requirement

Systems Capabilities	Thresholds	Objectives
1. Mesoscale	6 cm	4 cm
2. Basin Scale	5 cm	3 cm

Method 1: Compare to a known SSH observation, Jason-1 IGDR SSHA difference (J2-J1) after full processing (corrections, QC, orbit error removal)

Jason-2 OGDR – Jason-1 IGDR SSHA, 12Sep08



Global bias = 0.0002 m
RMS = 3.19 cm

05Aug2008 to 19Aug2008 (14 days)
14,000 crossover observations

If error characteristics are equivalent between the two systems, the error of each is then 2.26 cm (lower bound).

Meets NPOESS threshold and objectives for mesoscale and basin scale.

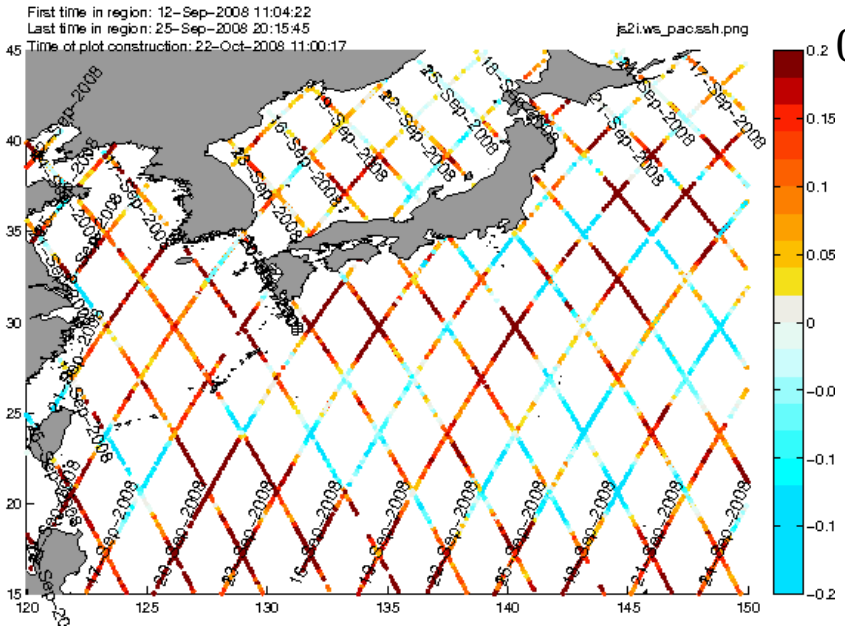
However, there are correlated errors in corrections

Jason-2 OGDR relative to NPOESS IORD-II Accuracy Requirement

Systems Capabilities	Thresholds	Objectives
1. Mesoscale	6 cm	4 cm
2. Basin Scale	5 cm	3 cm

Method 2: Crossover evaluation, Compare SSHA obs at points where satellite crosses itself. Due to oceanographic variability, this value is larger than measurement accuracy and is thus an upper bound.

SSH anomaly, Jason-2 OGDR, 12Sep08

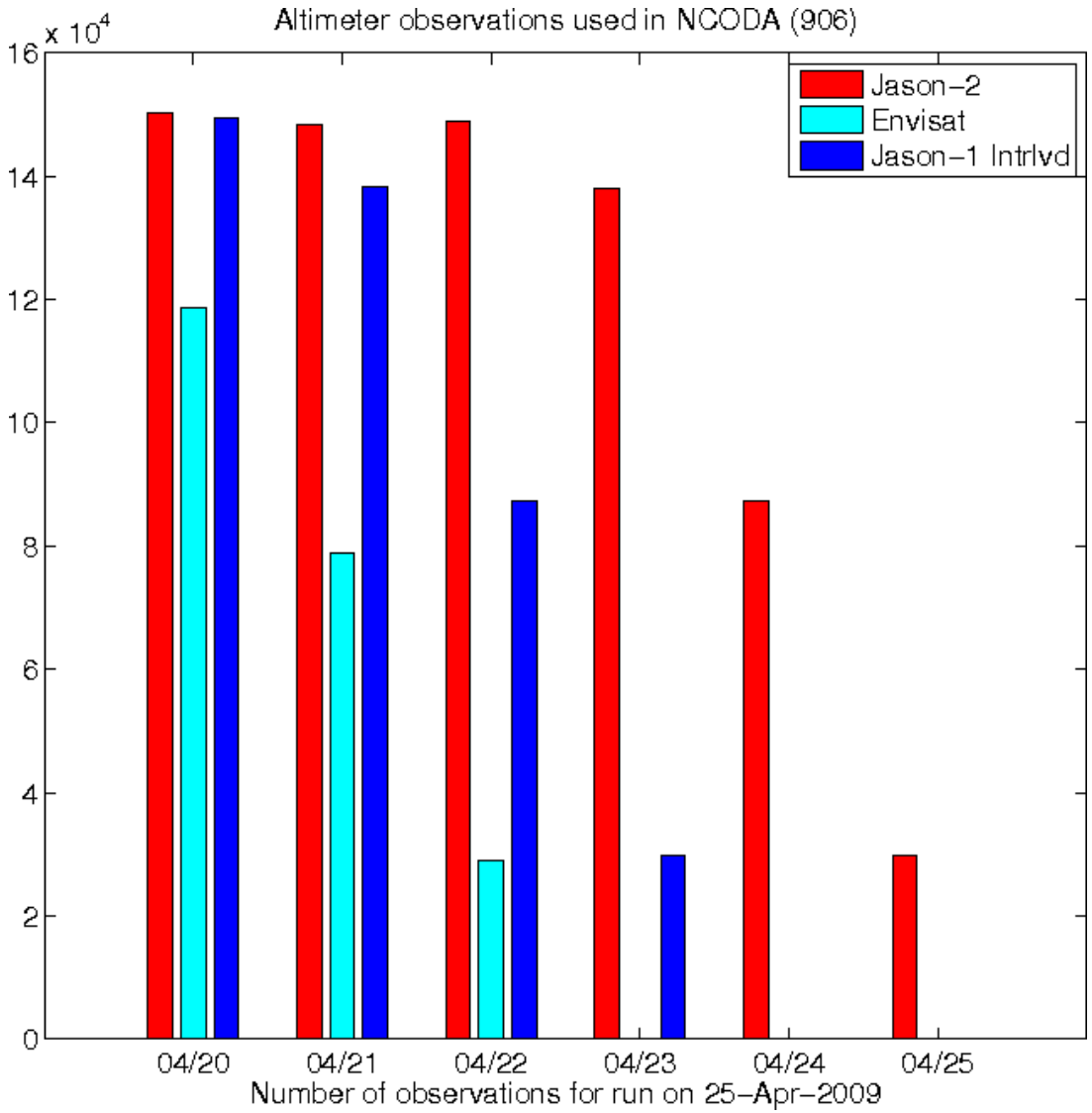


0.2m

-0.2m

05Aug2008 to 19Aug2008 (14 days total)
14,000 crossover observations
Jason-1 IGDR = 7.68 cm
Jason-2 OGDR = 7.76cm
Assuming error characteristics are same along ascending and descending passes,
Jason-1 = 5.43 cm noise (upper bound)
Jason-2 = 5.49 cm noise (upper bound)
Meets NPOESS IORD-II Mesoscale threshold

Relative Latency

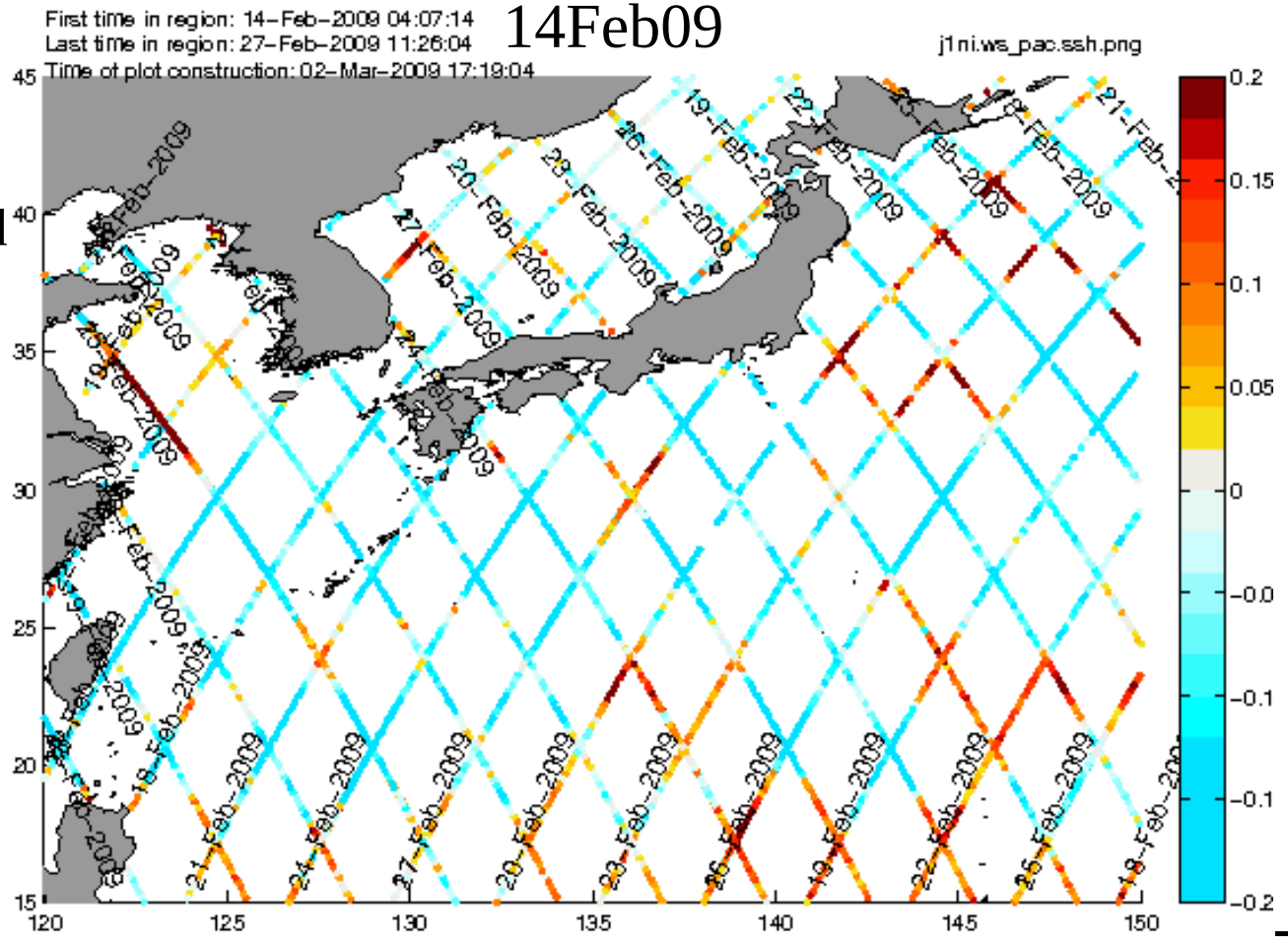


Number of data points from prior days used in the 25 Apr 2009 global assimilation from available data streams.

Jason-1 Interleaved

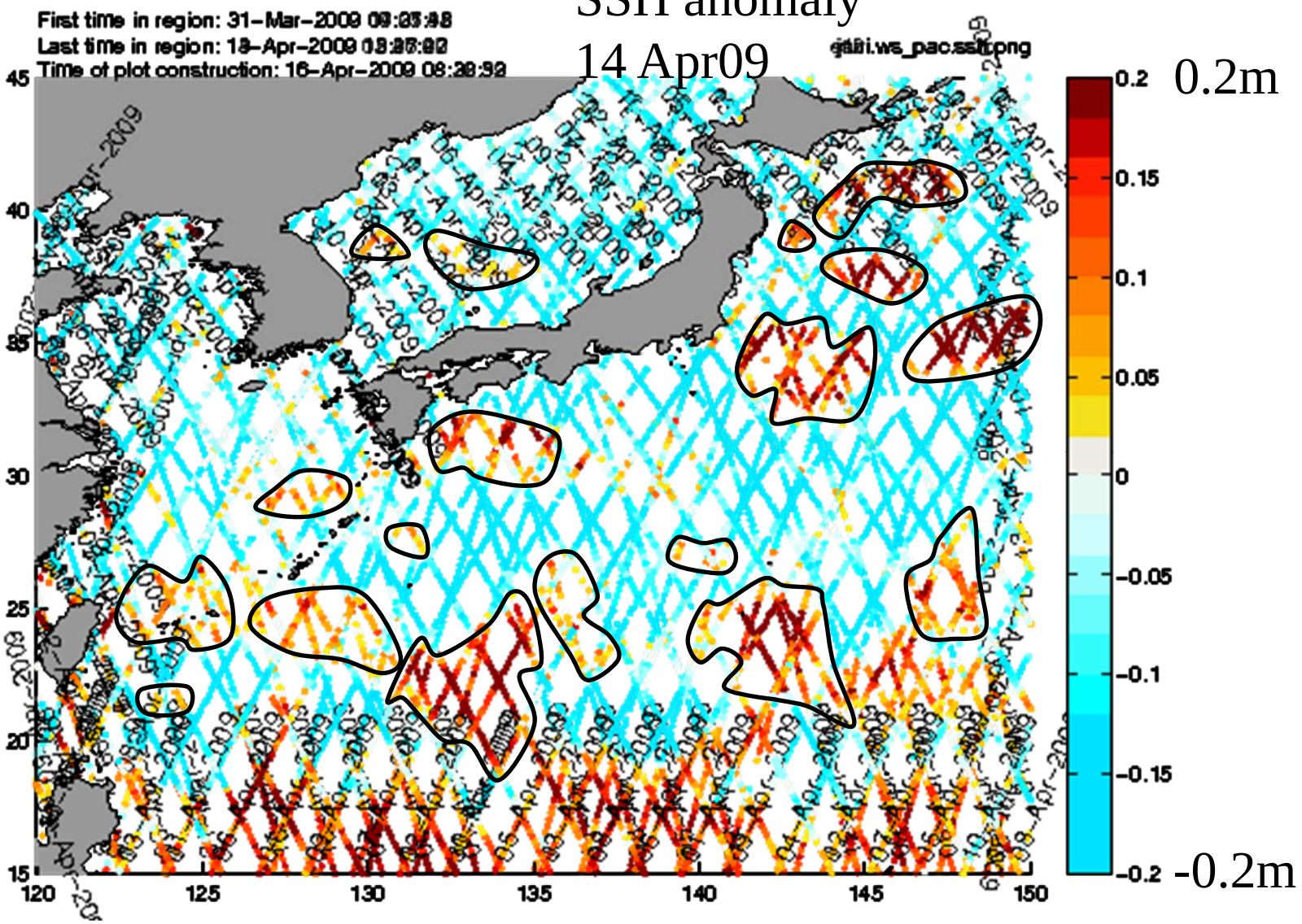
- Jason-1 satellite moved within orbit plane to sample ground tracks shifted in space
- Mean sea surface deviation from CLS already computed based on TOPEX interleaved data set
- Requires implementation of a new mission within ALPS and definition of reference time for data stream

SSH anomaly, Jason-1 interleaved
14Feb09



Jason-1 Interleaved, Jason-2, ENVISAT

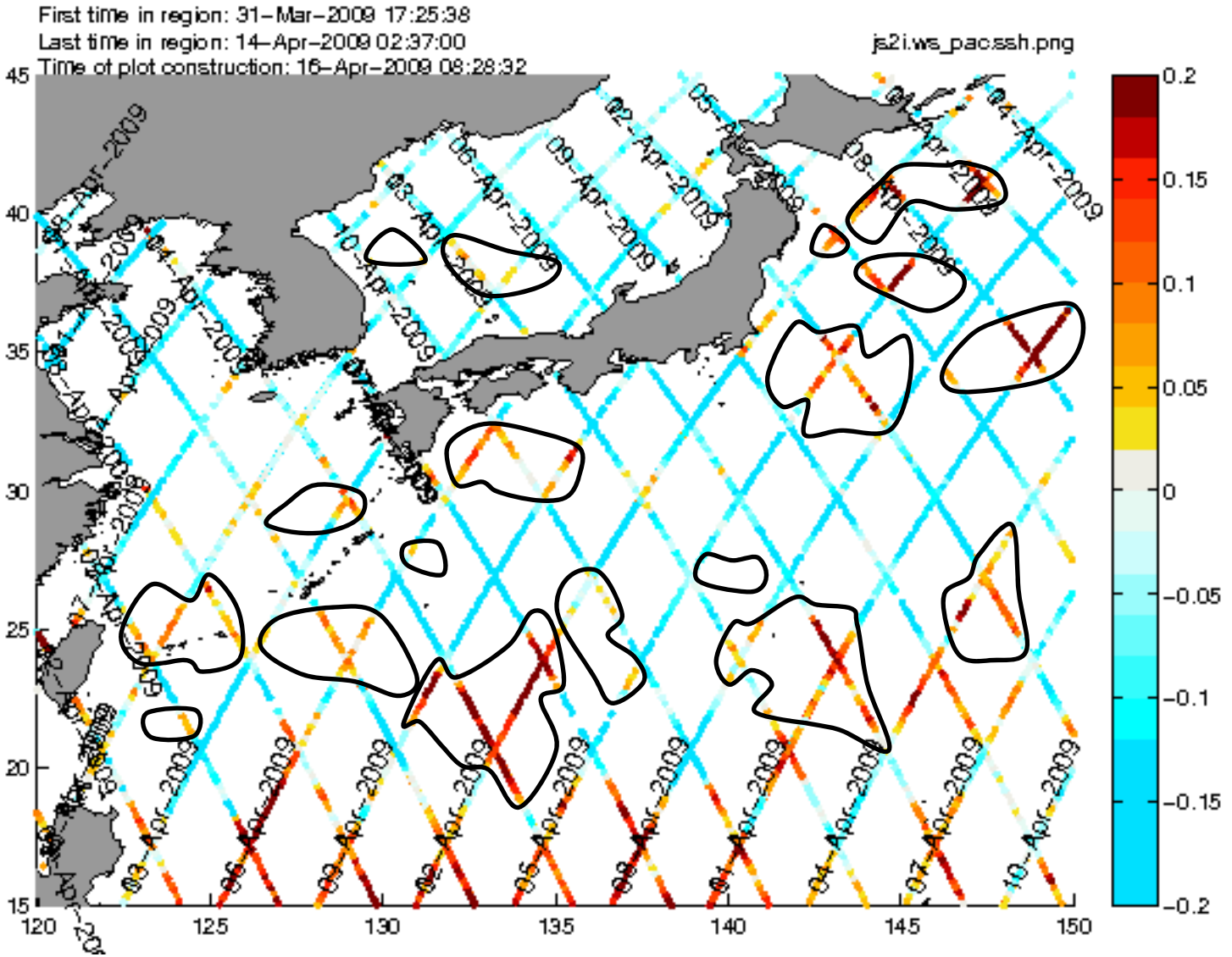
SSH anomaly
14 Apr09



0.2m

-0.2m

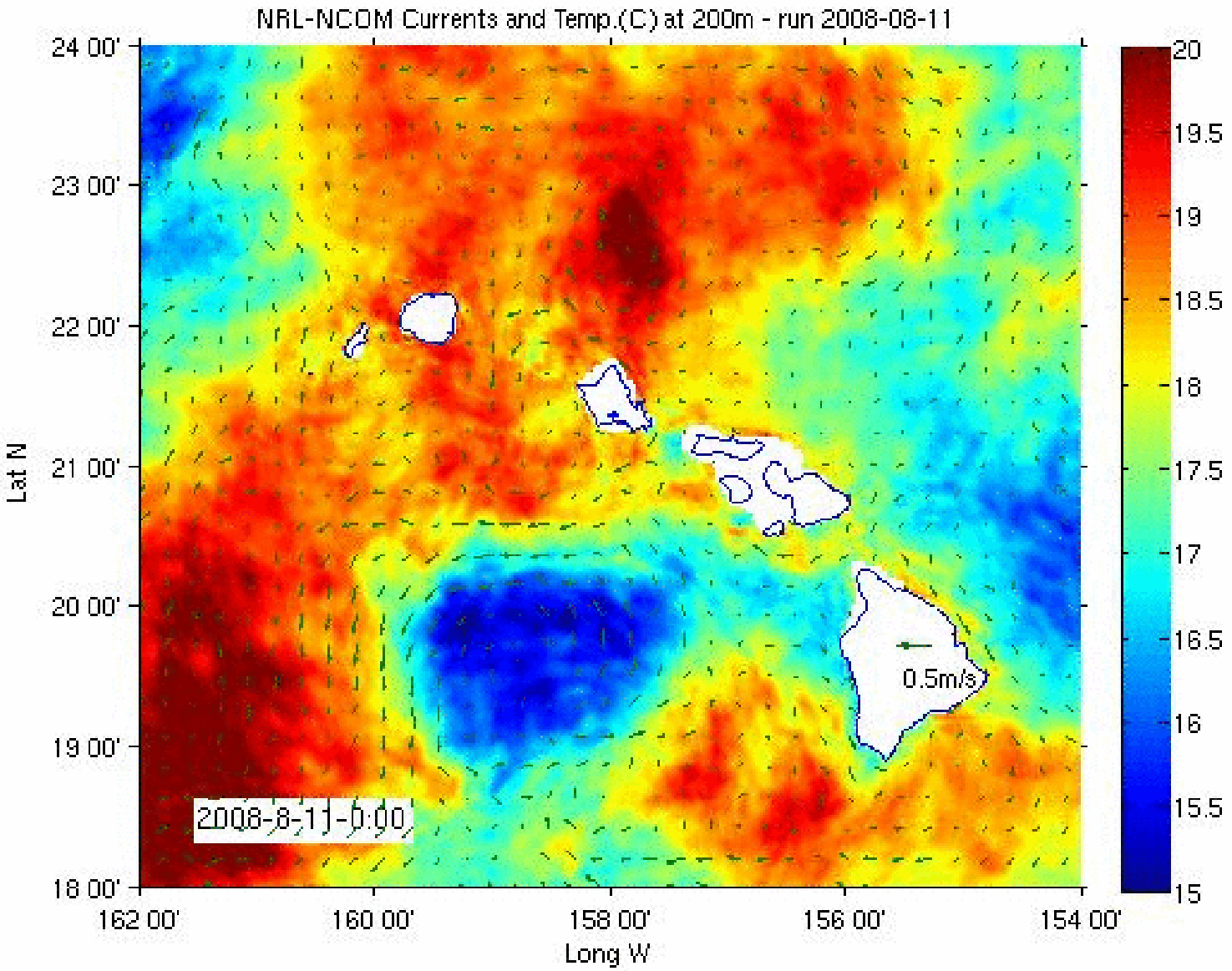
Jason-2


First time in region: 31–Mar–2009 17:25:38
Last time in region: 14–Apr–2009 02:37:00
Time of plot construction: 16–Apr–2009 08:28:32
js2i.ws_pac.ssh.png
45
40
35
30
25
20
15
120
125
130
135
140
145
150
0.2
0.15
0.1
0.05
0
−0.05
−0.1
−0.15
−0.2

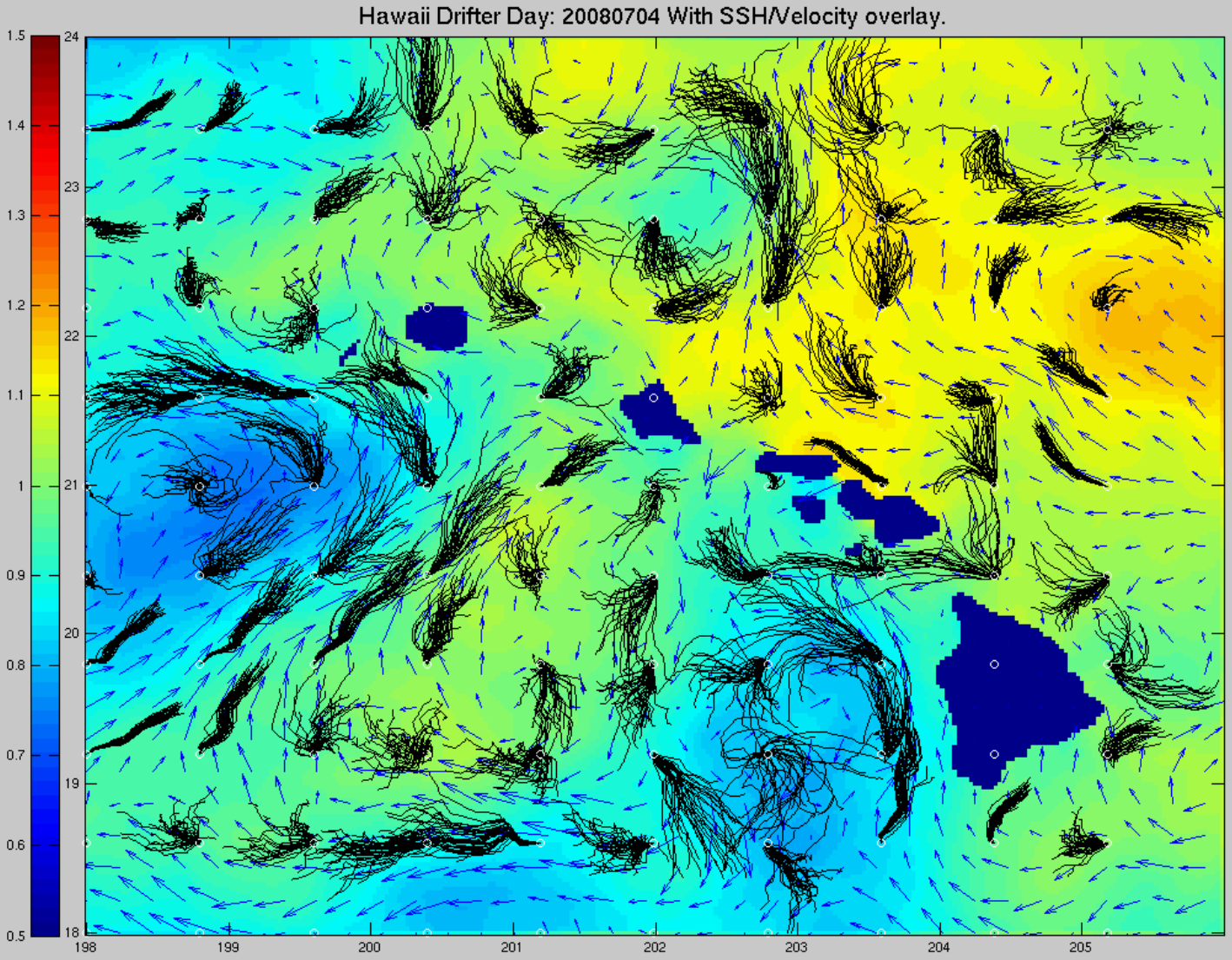
2m

.2m

Jason-1 interleaved and Jason-2 IGDR impact



32 Ensemble constrained by ET analysis variance



Impact of tandem mission through variance reduction

- Daily assimilation cycle computes analysis variance based on forecast error variance and data distribution
- Ensemble variance is set to match the analysis variance
- Forecast error variance in several inferred parameters (buoy drift, sound speed characteristics, …) are constructed
- These can relate back to operational requirements (predicting buoy drift to within 5km over 36 hours, …)