Monitoring Upwelling with Coastal Altimetry: A Feasibility Study

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OCEANS AND ATMOSPHERE
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Coastal altimetry products

Off the shelf

- RADS 1Hz SLA
- PISTACH – Jason-2, 20Hz near-real-time but no longer funded

Boutique products – available on request

- PEACHI from AVISO, 40Hz (AltiKa)
- ALES so far only J-2
- CTOH/LEGOS- T/P, J1, J2, GFO & Envisat

- PEACHI +

Corrections to be wary of in the coastal region

Tides: global tide models may not model the coastal regions well
insufficient knowledge of bathymetry/coarse grid

HF DAC: high-frequency dynamic atmosphere correction
removes the barotropic component of the ocean's response to wind at periods shorter than 20 days
deep ocean correction to avoid aliasing
on the shelf -> barotropic coastal trapped waves
=> distortion of one of the important processes on the shelf: baroclinic CTWs

Long-wave error / orbit error: consistency across the altimeters used

Overview

Aim: Evaluate PEACHI SLA in an upwelling region

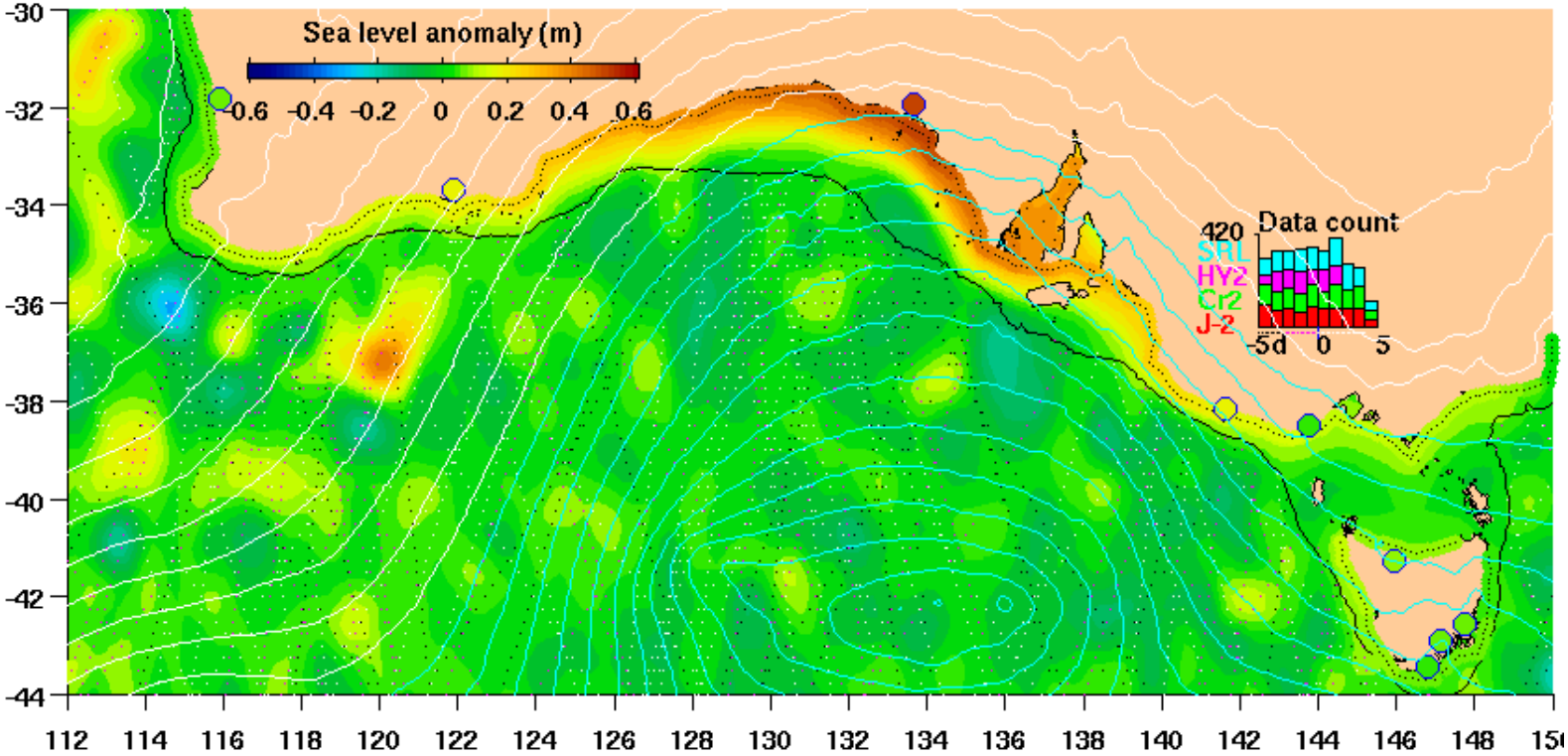
Can we get a reliable estimate of the cross-shelf sea level set-down caused by upwelling?

Motivation: To extend ocean gridded sea level onto the coast where possible.

Difficulty: Co-located, in-situ observations

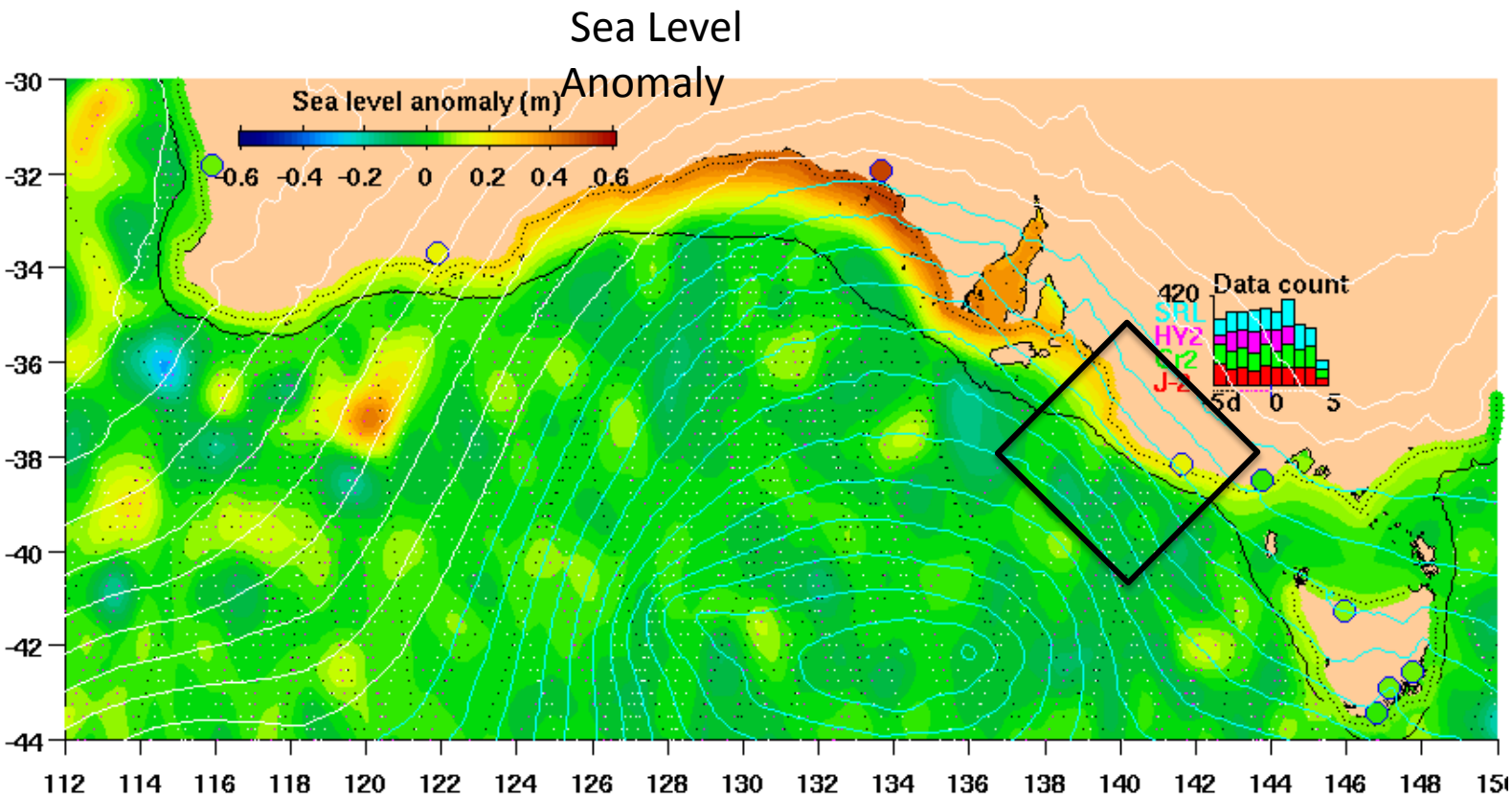
The Great Australian Bight

Sea Level Anomaly



- Southern Australia - Gridded Sea Level Anomaly
- Tide gauge data is included in the mapping
- Coastal Trapped Waves occur routinely - propagate W to E

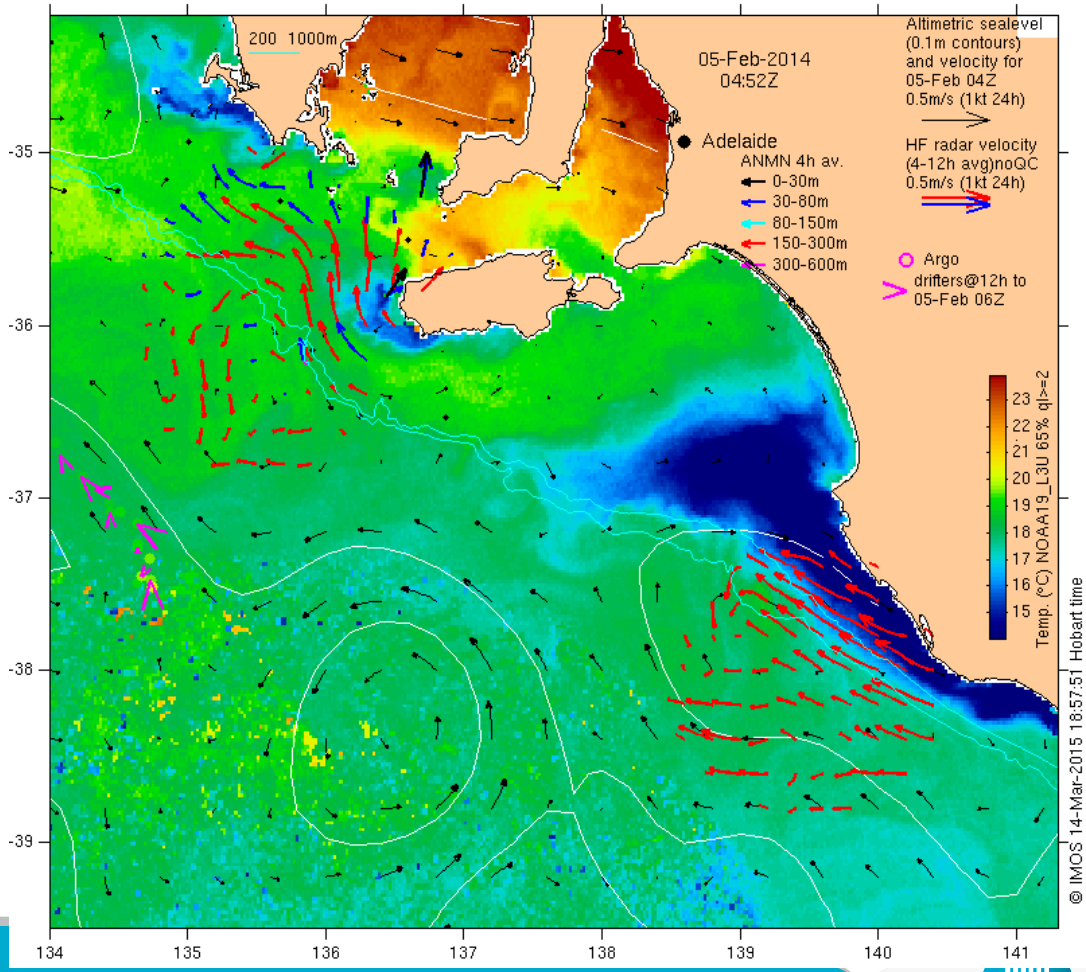
The Great Australian Bight



- Upwelling occurs where the shelf narrows – Bonney Coast
- Forced by large high pressure systems- occurring in the summer

Upwelling off the Bonney Coast

- most productive upwelling location in Australia
- Supporting a diverse eco-system from pilchards to whales
- 2-4 events each summer
- Associated with winds to the NW which reverse the usual SE flow
- A large scale event lasting a few days - so each event will be sampled by a number of AltiKa tracks

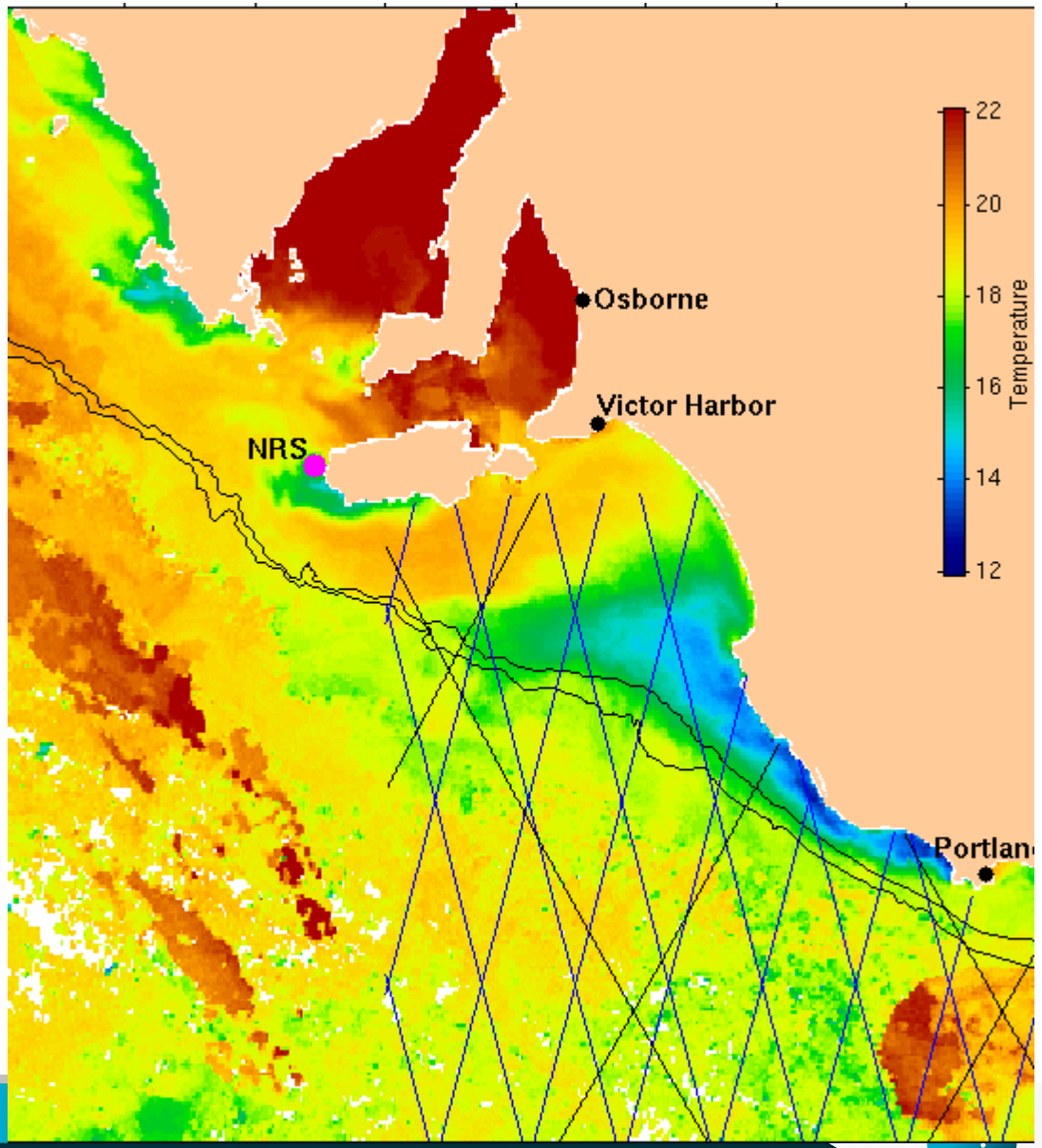


PEACHI: Jason-2 and Altika 2013-2014

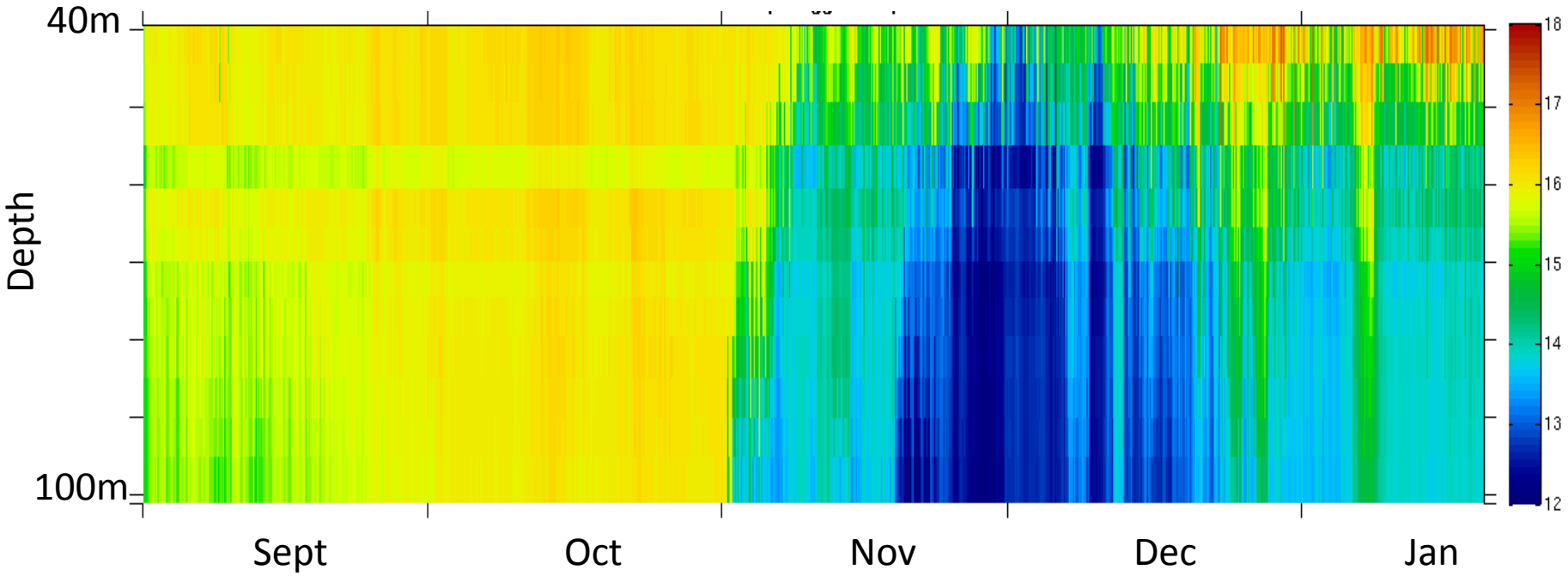
PEACHI tracks
Span the upwelling region

Tide gauge locations:
Osborne – in Gulf St Vincent
Victor harbor
Portland – just east of upwelling

NRS – mooring off Kangaroo Is
Observations of temperature
near the shelf break/canyon



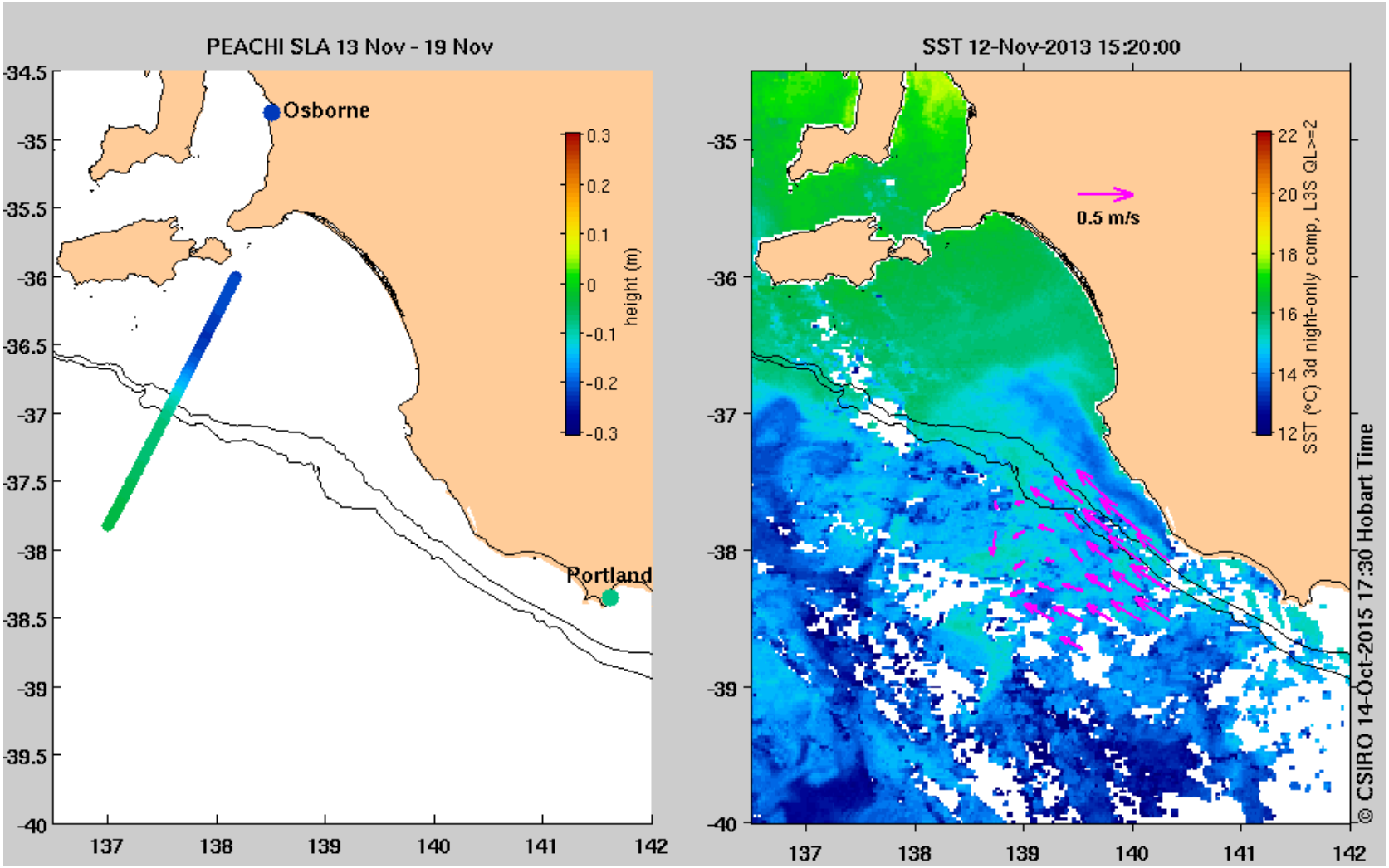
Upwelling: mid November to mid December



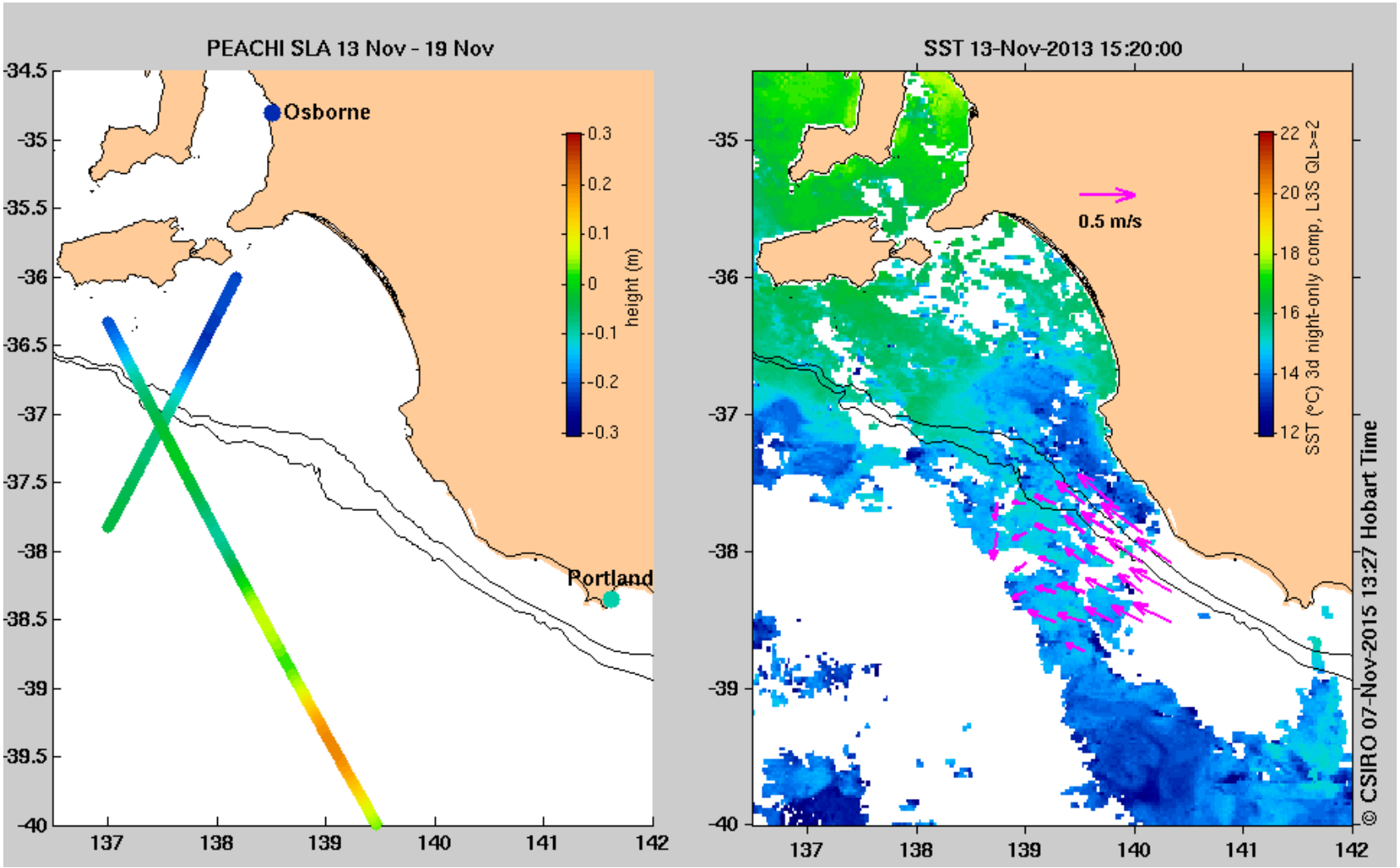
NRS Water Column Temperature Observations

- Observations just west of Kangaroo Island, 45-95m in 100m of water
- Cold water intrusions begin early November and peak late November and early December

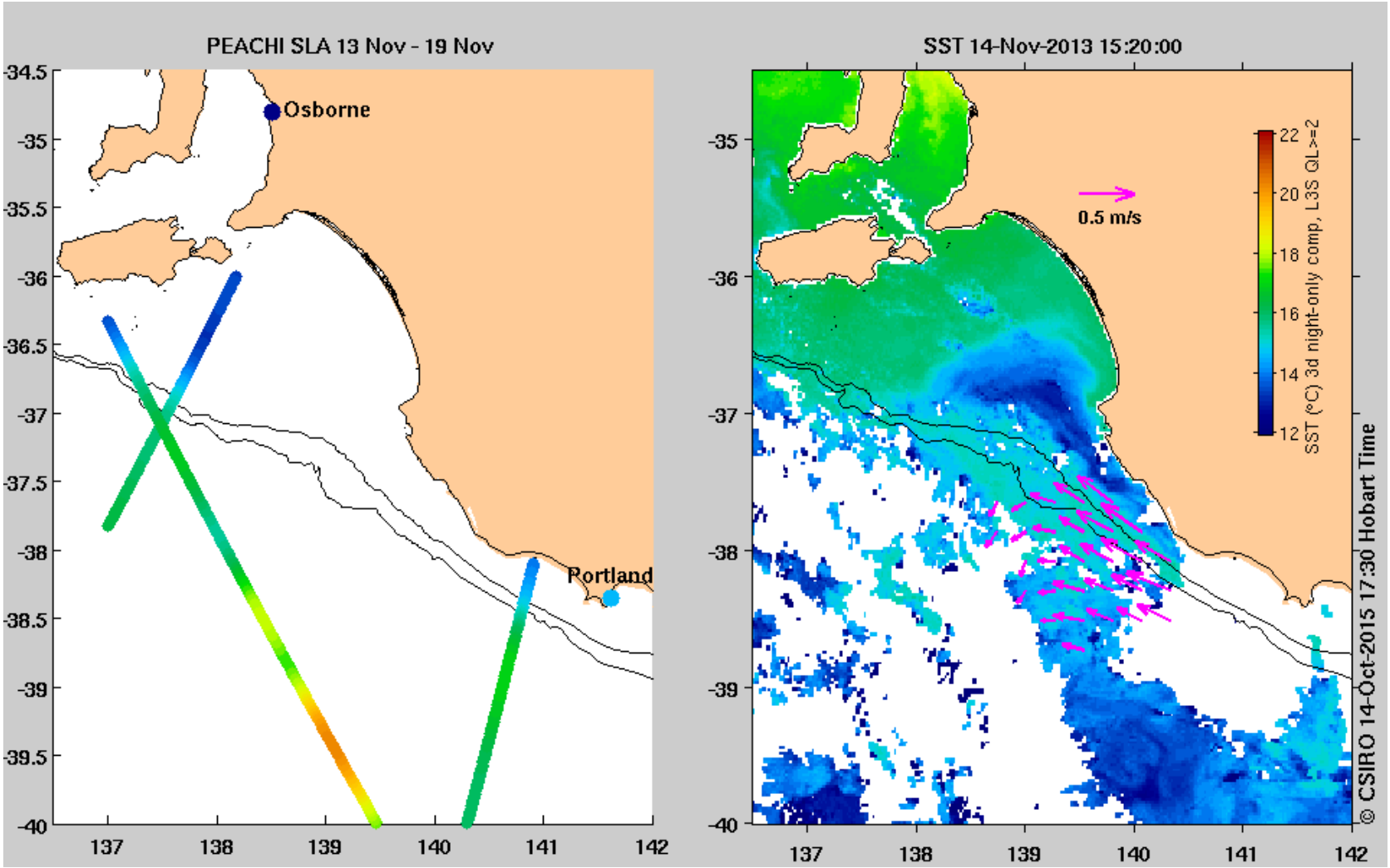
SLA 12 NOV 2013 SST



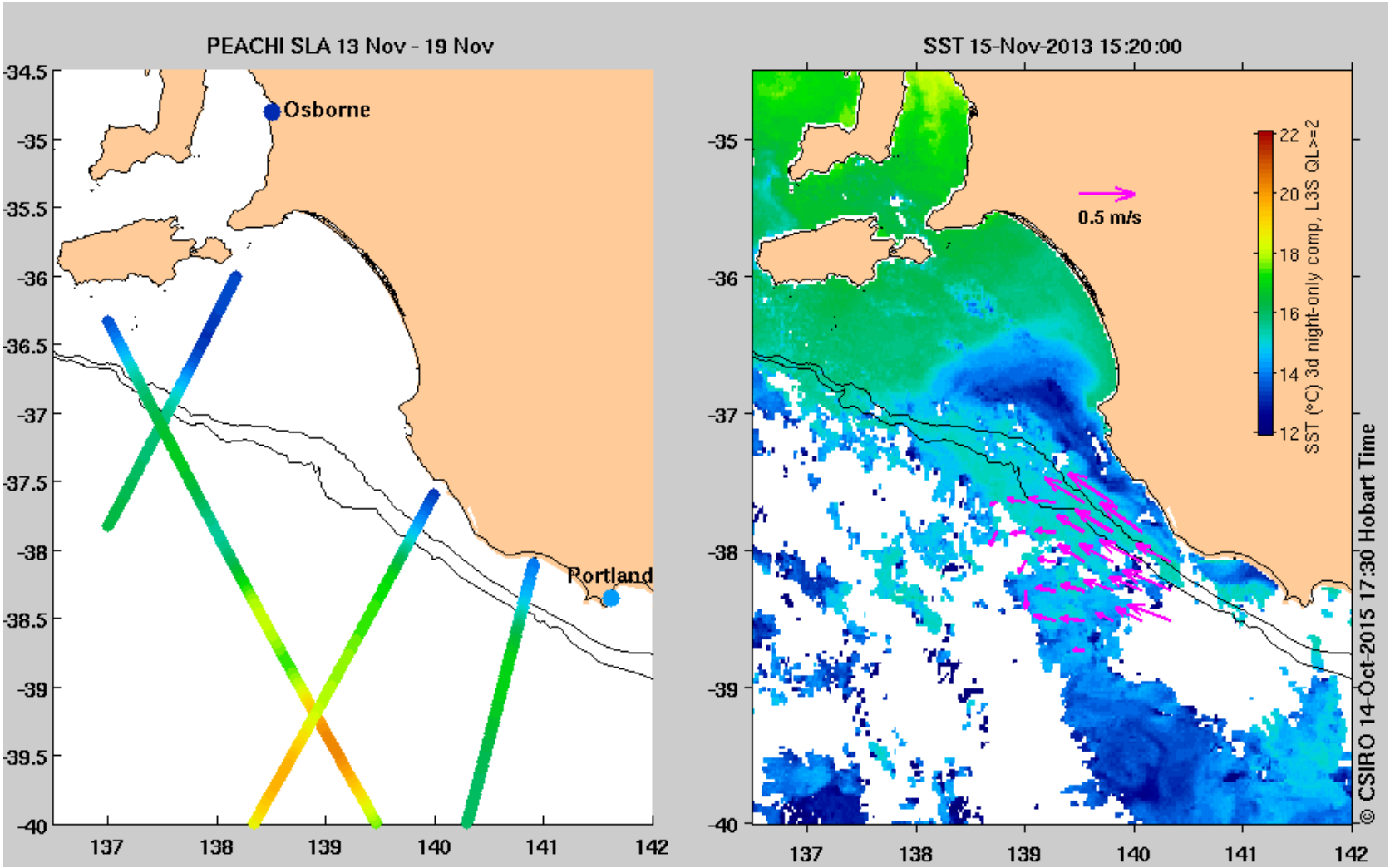
SLA 13 NOV 2013 SST



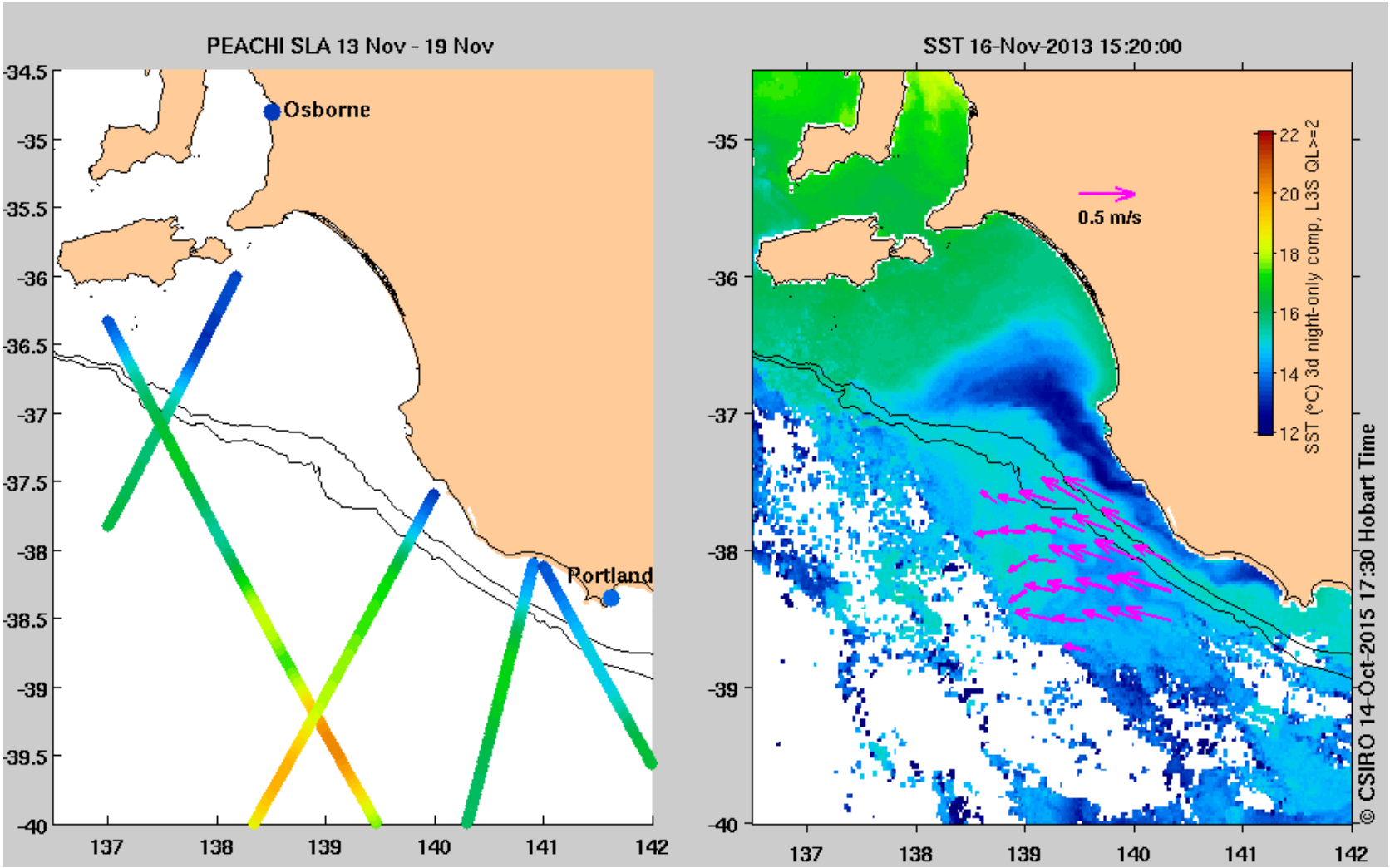
SLA 14 NOV 2013 SST



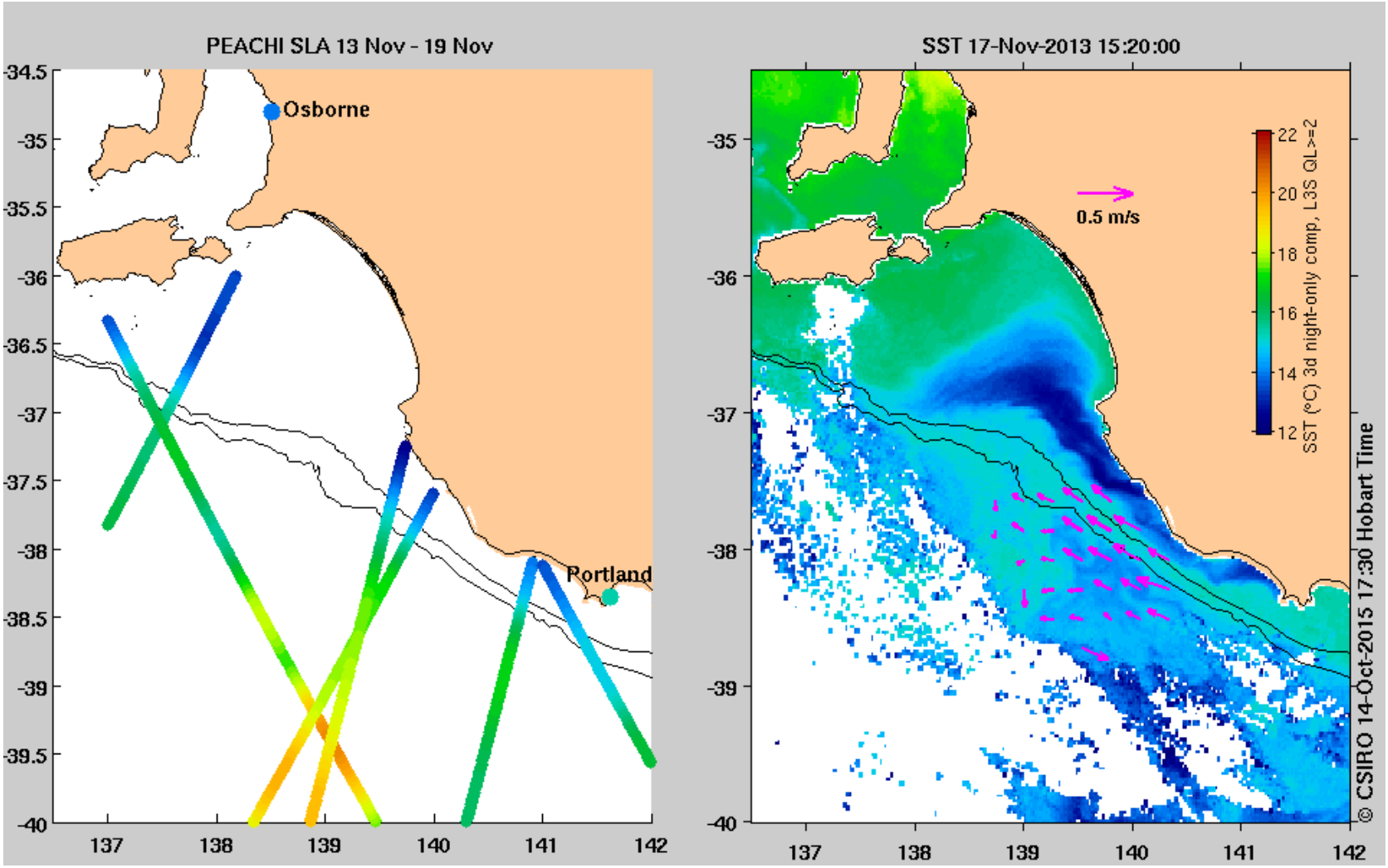
SLA 15 NOV 2013 SST



SLA 16 NOV 2013 SST



SLA 17 NOV 2013 SST



The PEACHI SLA signal

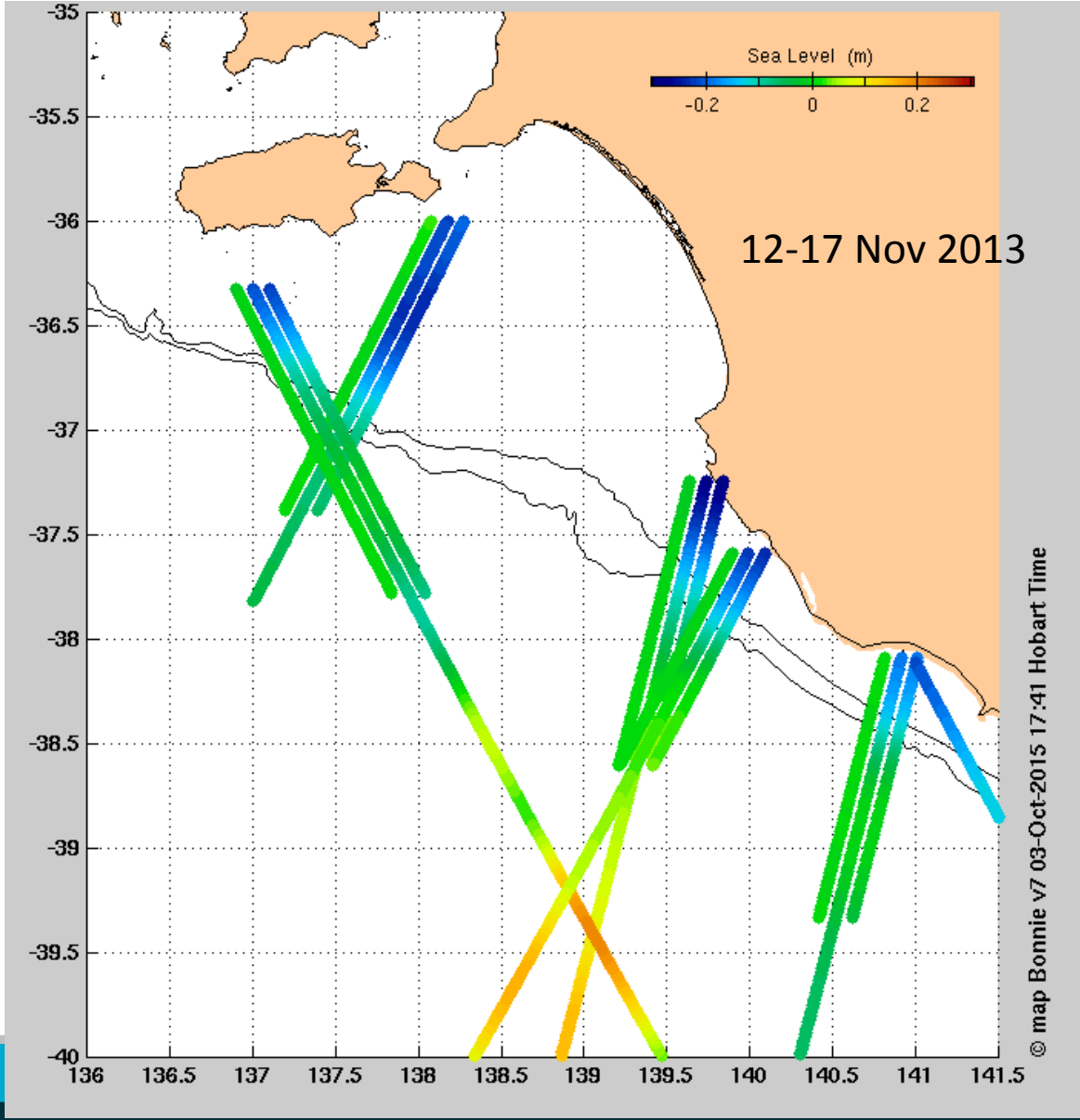
- self consistent over a period of days
- cross-shelf structure is as we would expect for upwelling

But…

- Could it be an artifact of a correction eg tidal correction or DAC?
- How accurate are the SLA estimates?
- Can we compare PEACHI SLA with the available tide gauge data?

- What about non-upwelling periods?

Tidal Correction Error, PEACHI SLA, Adj. SLA



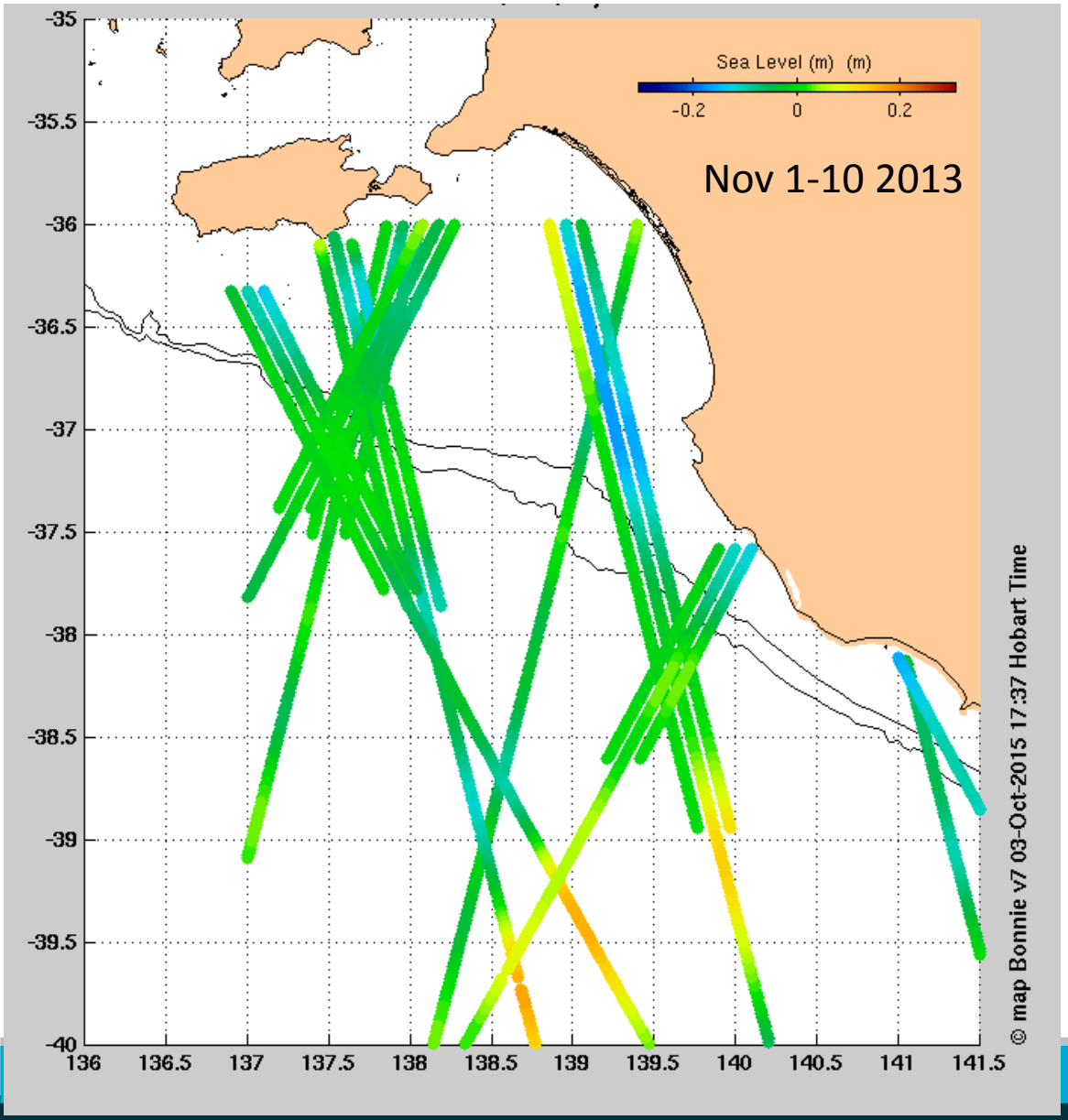
To test the tidal corrections

1. Ran a 5km grid model of the region getting good agreement with observed tide gauge tidal signal at Portland

2. Estimated the tidal correction for each pass and differenced that correction with FES2012 corrections – that difference is indicated on the left

3. The error in the tidal corrections for this time period were found to be near zero

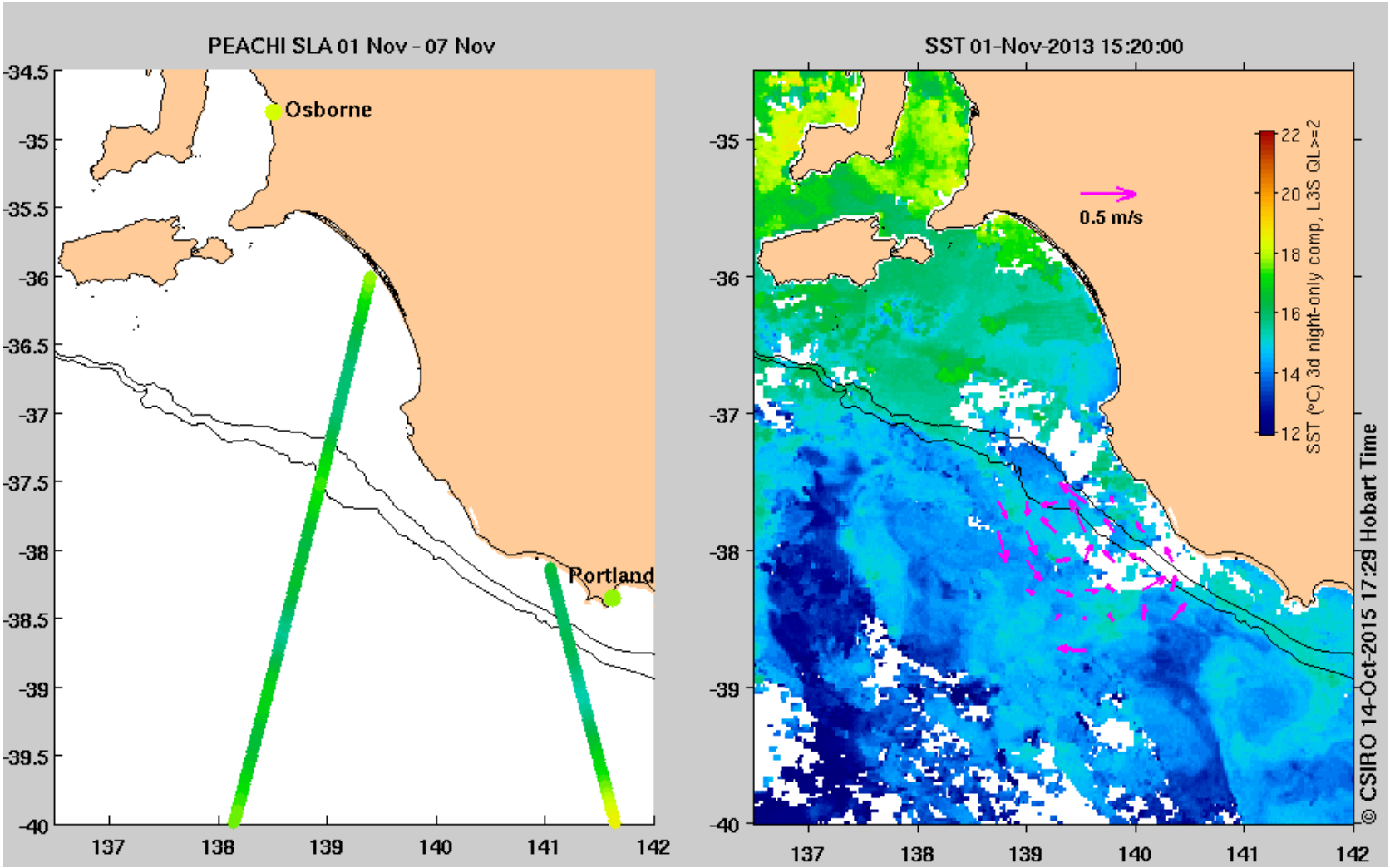
Tidal Correction, PEACHI SLA, Adj. SLA



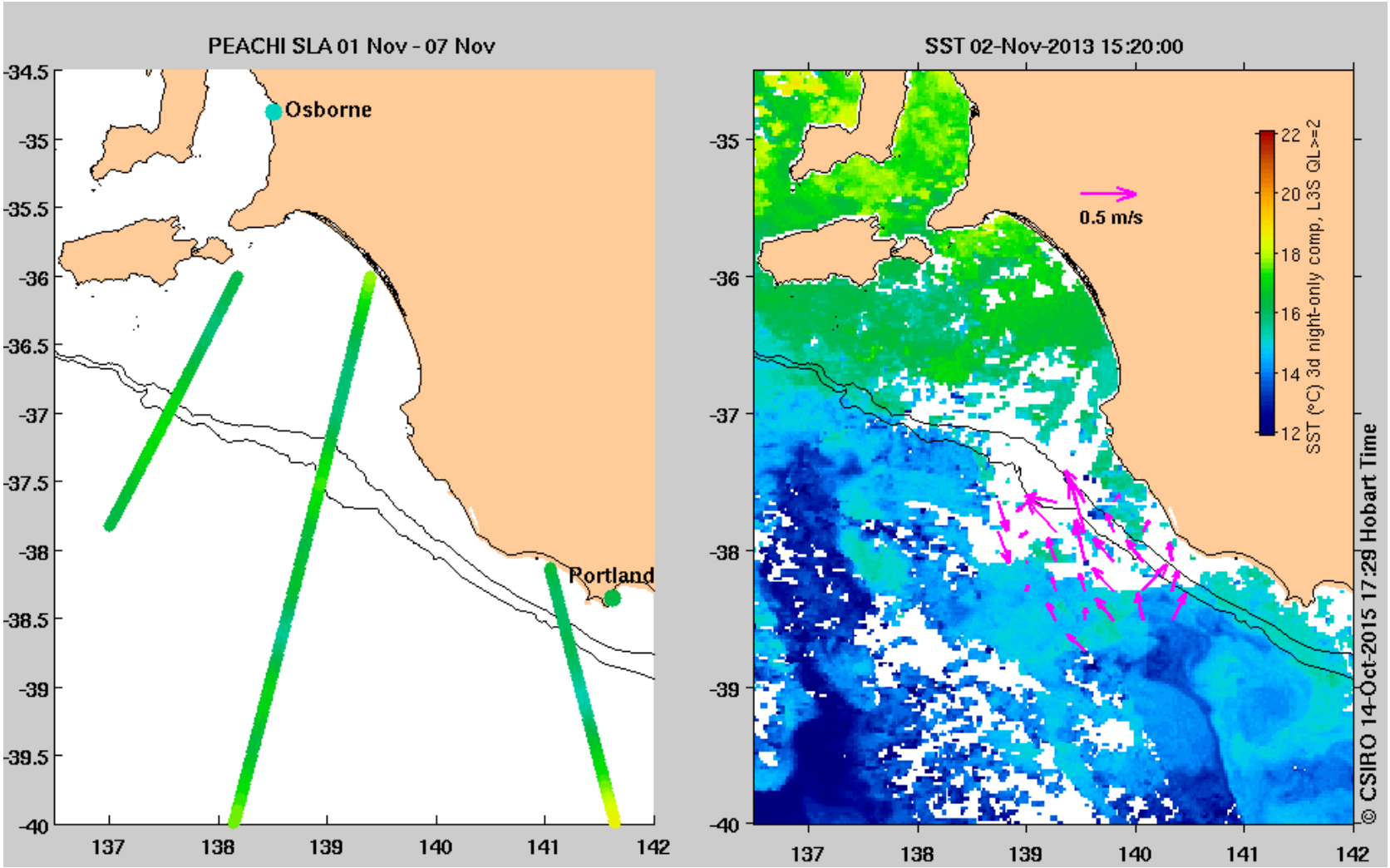
There were a few occasions where the tidal correction was found to be in error

The spatial structure of the error was quite different to that of the upwelling surface signal

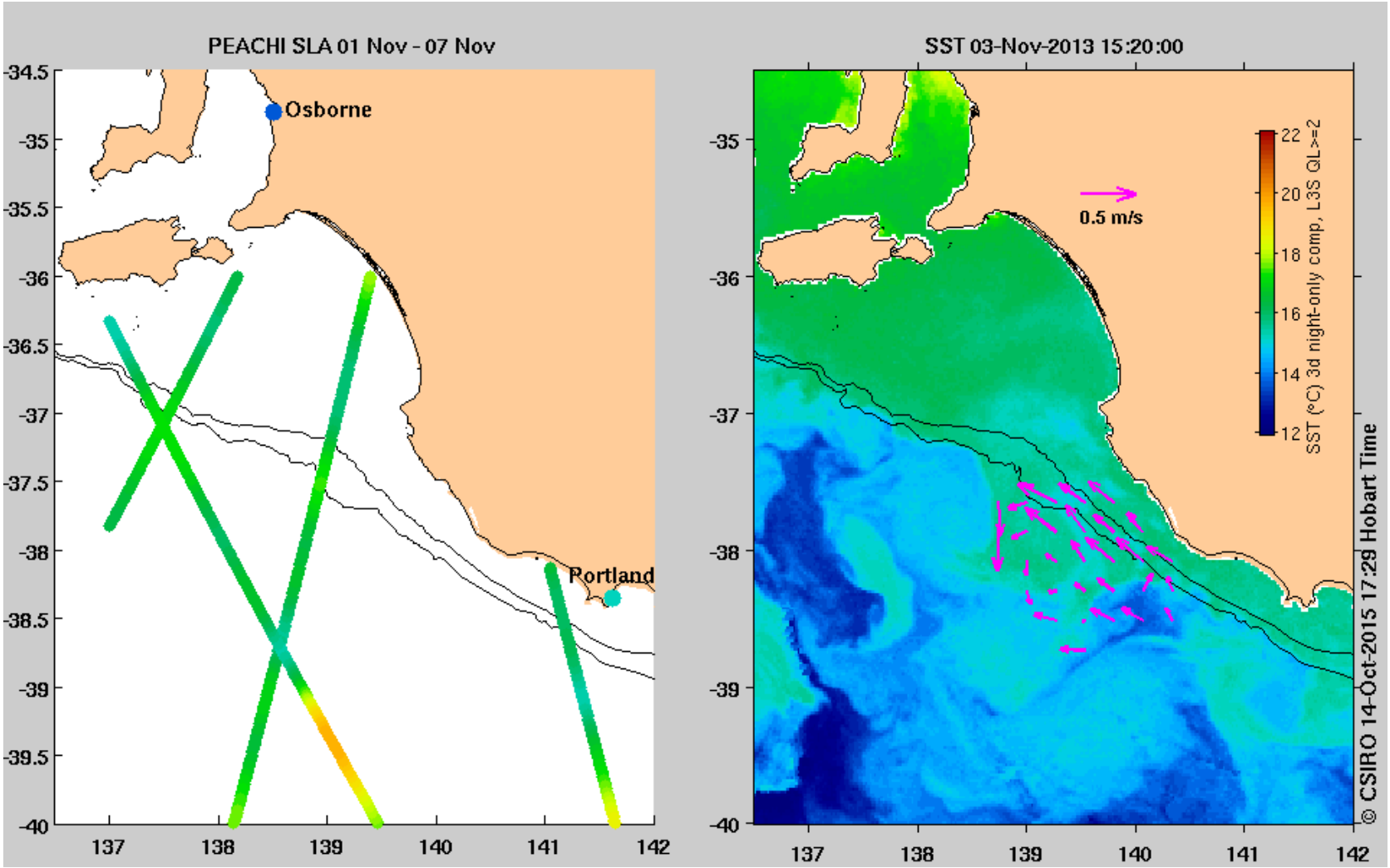
SLA 1 NOV 2013 SST



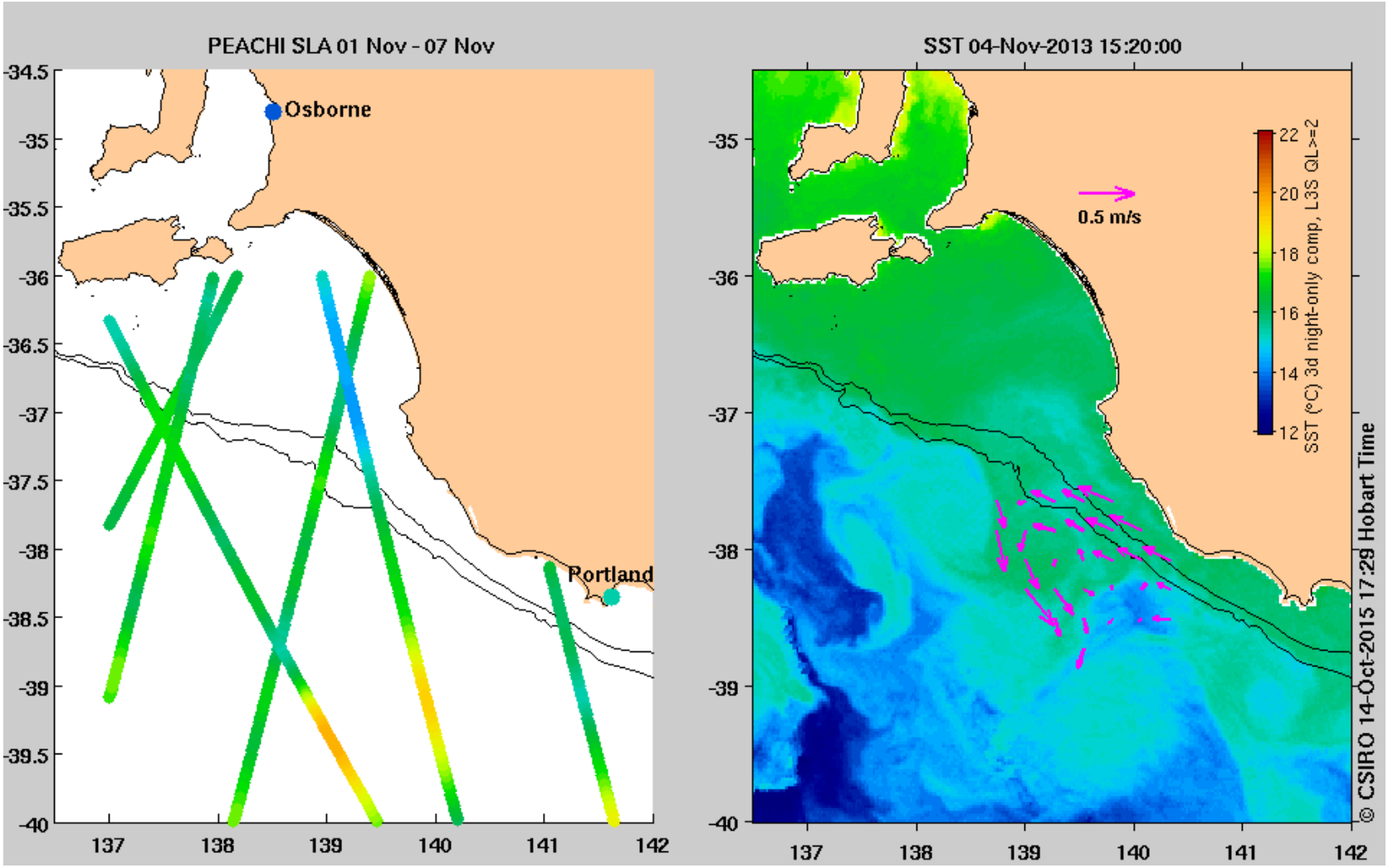
SLA 2 NOV 2013 SST



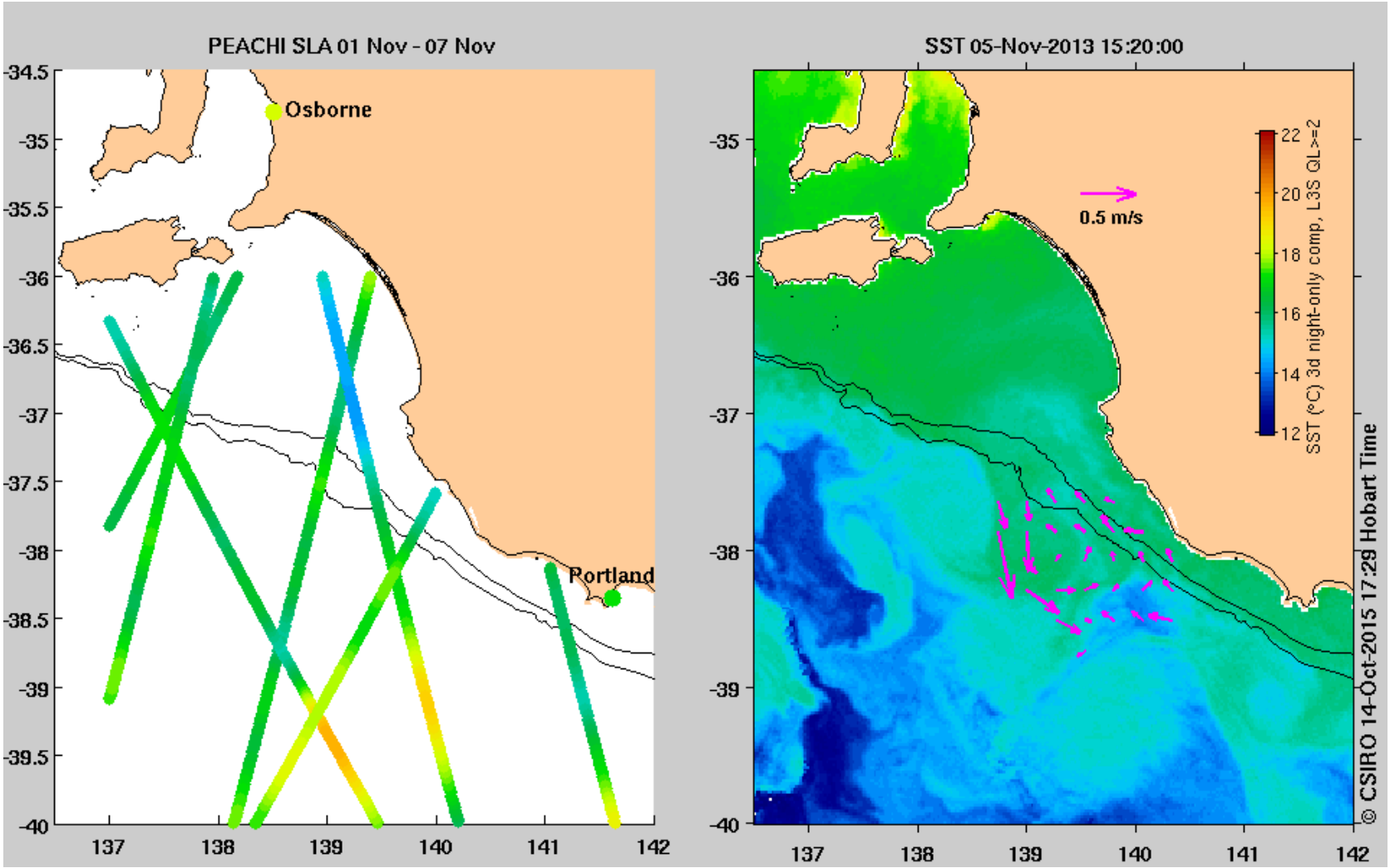
SLA 3 NOV 2013 SST



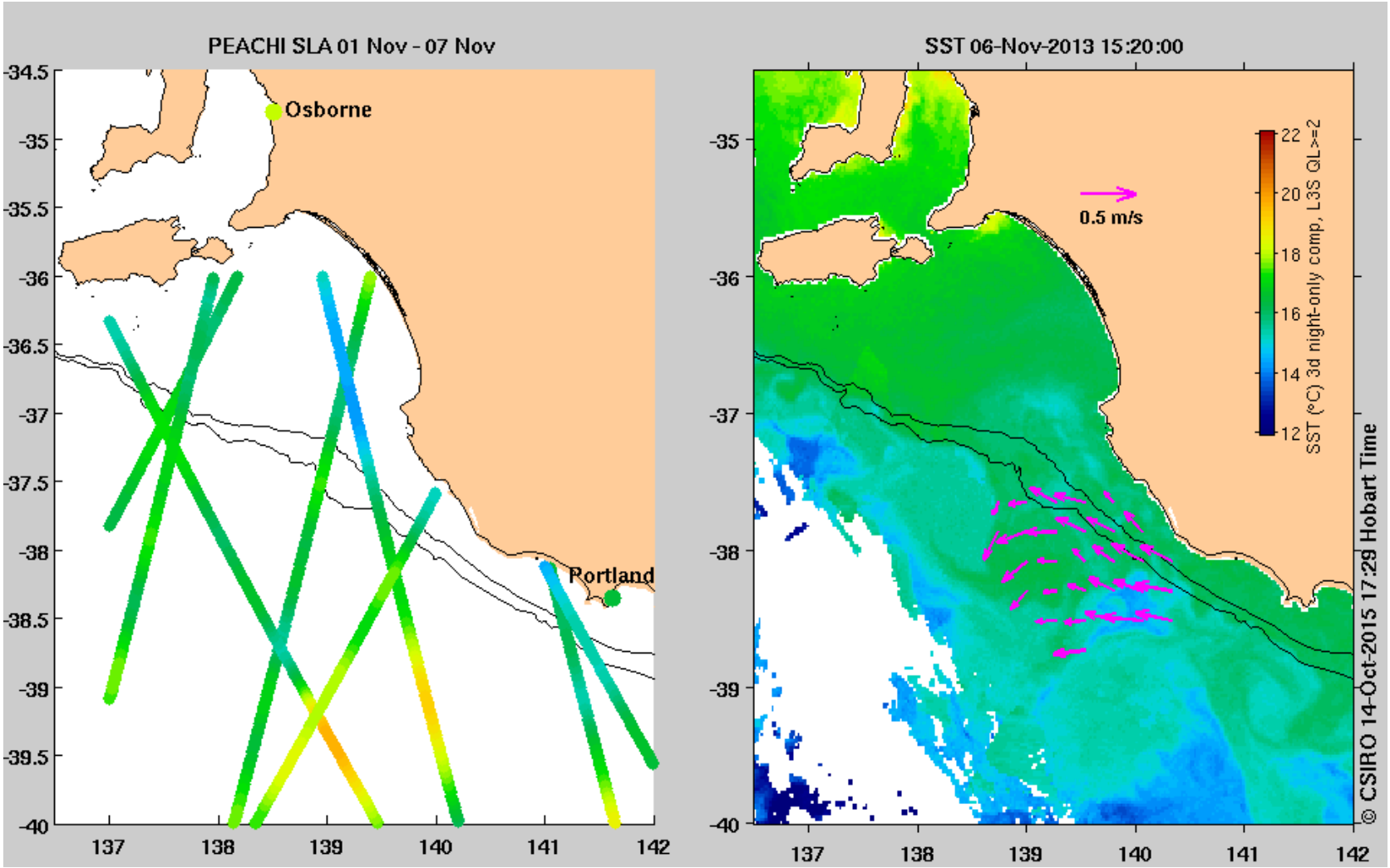
SLA 4 NOV 2013 SST



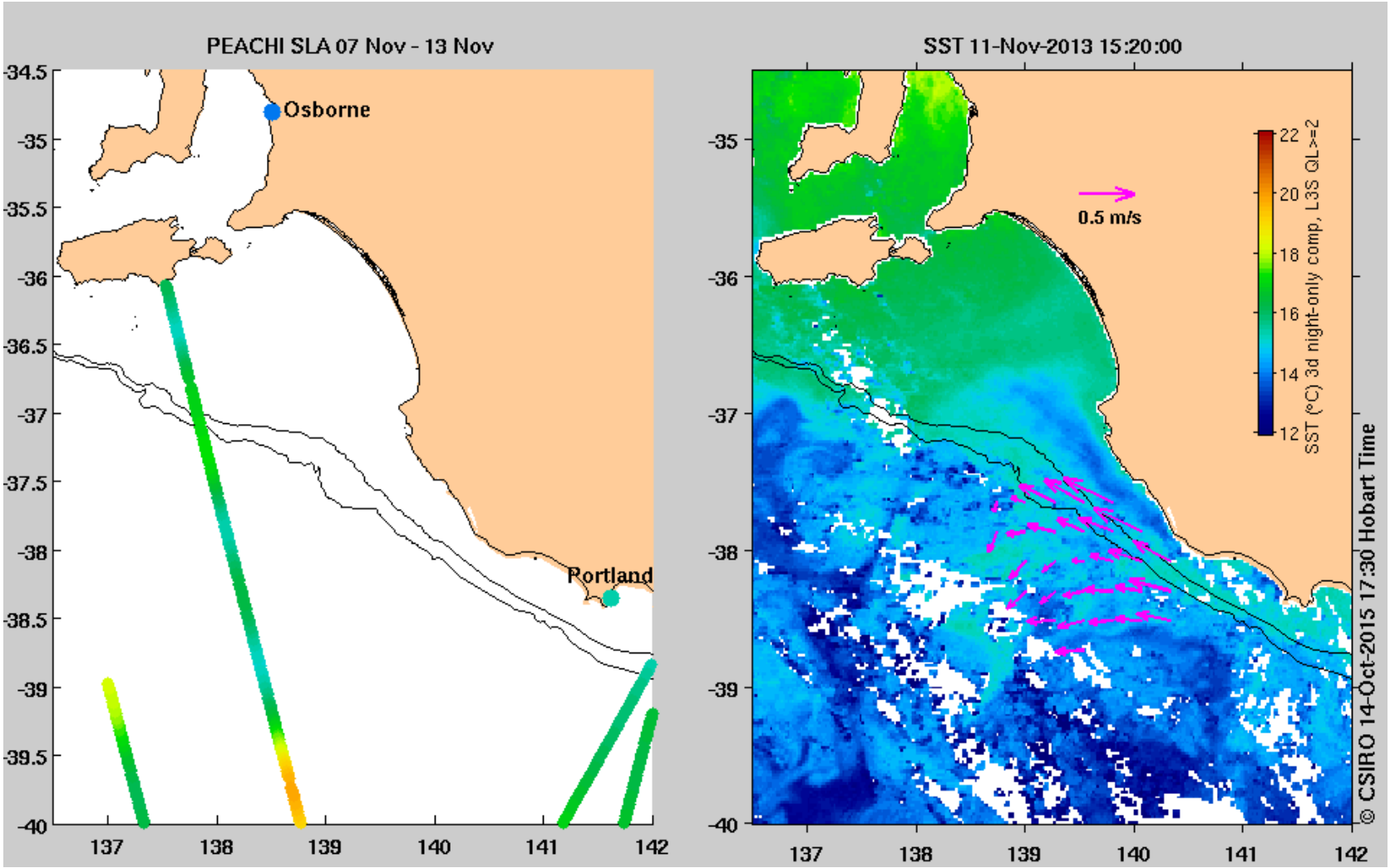
SLA 5 NOV 2013 SST



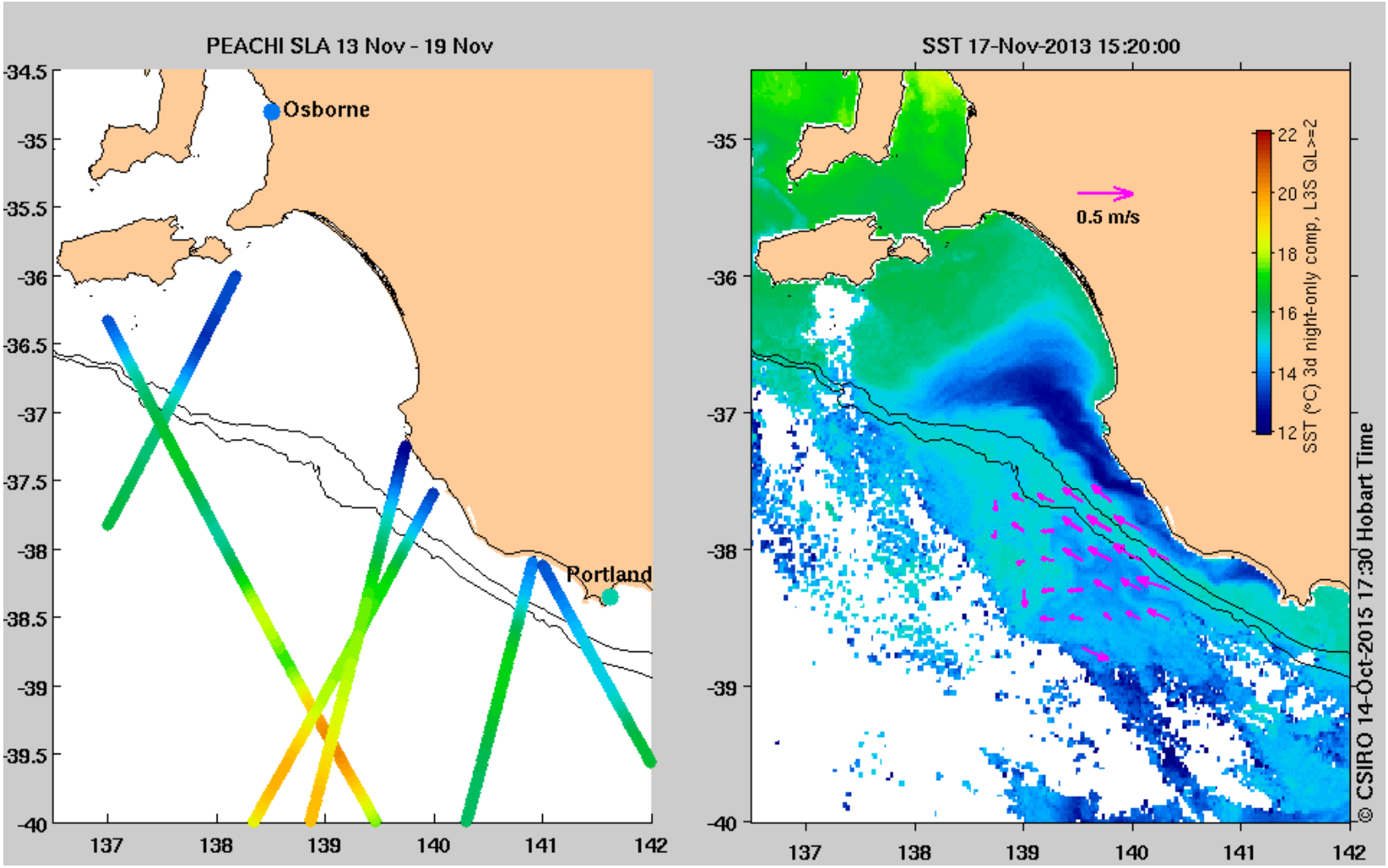
SLA 6 NOV 2013 SST



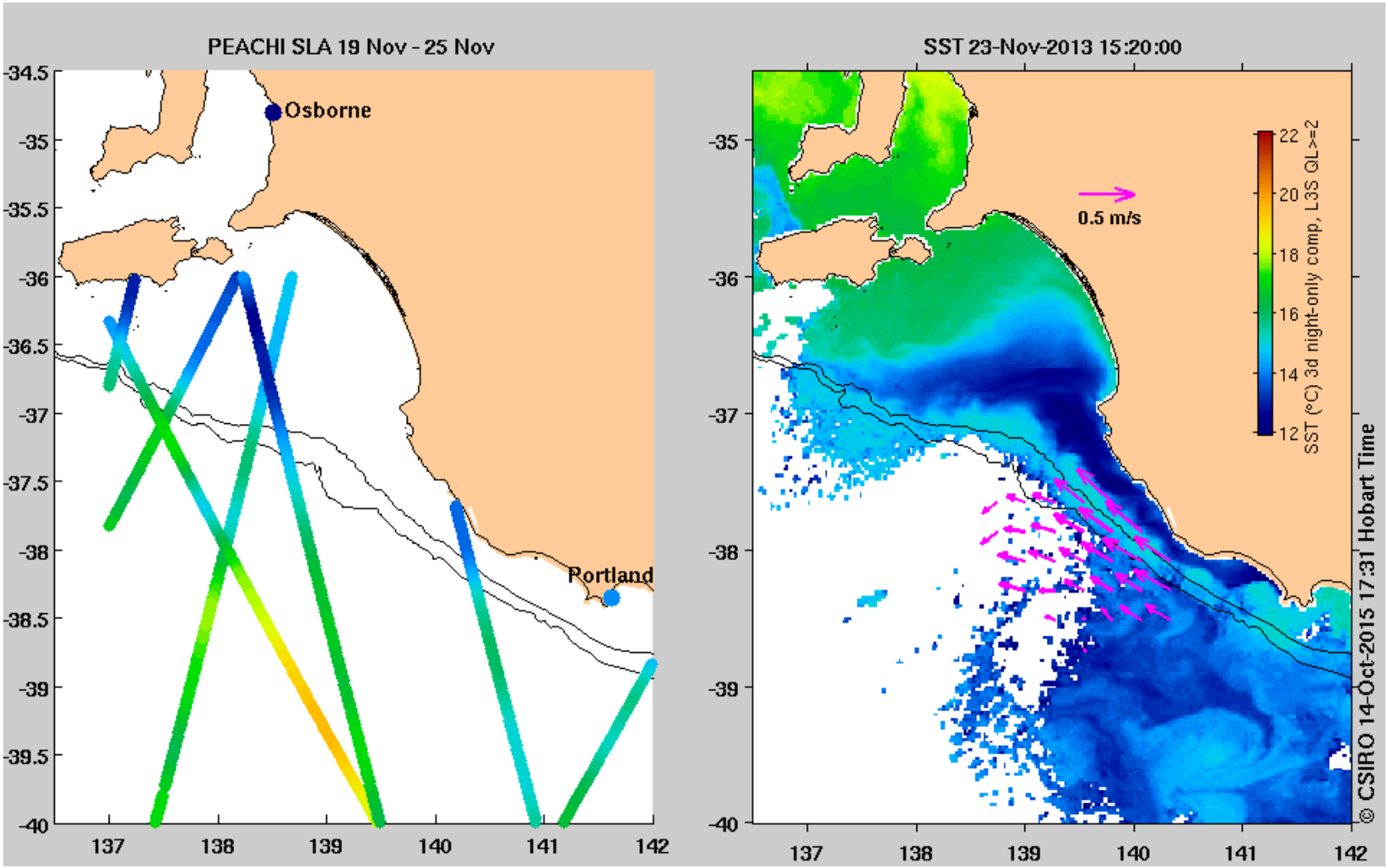
SLA 11 NOV 2013 SST



SLA 17 NOV 2013 SST

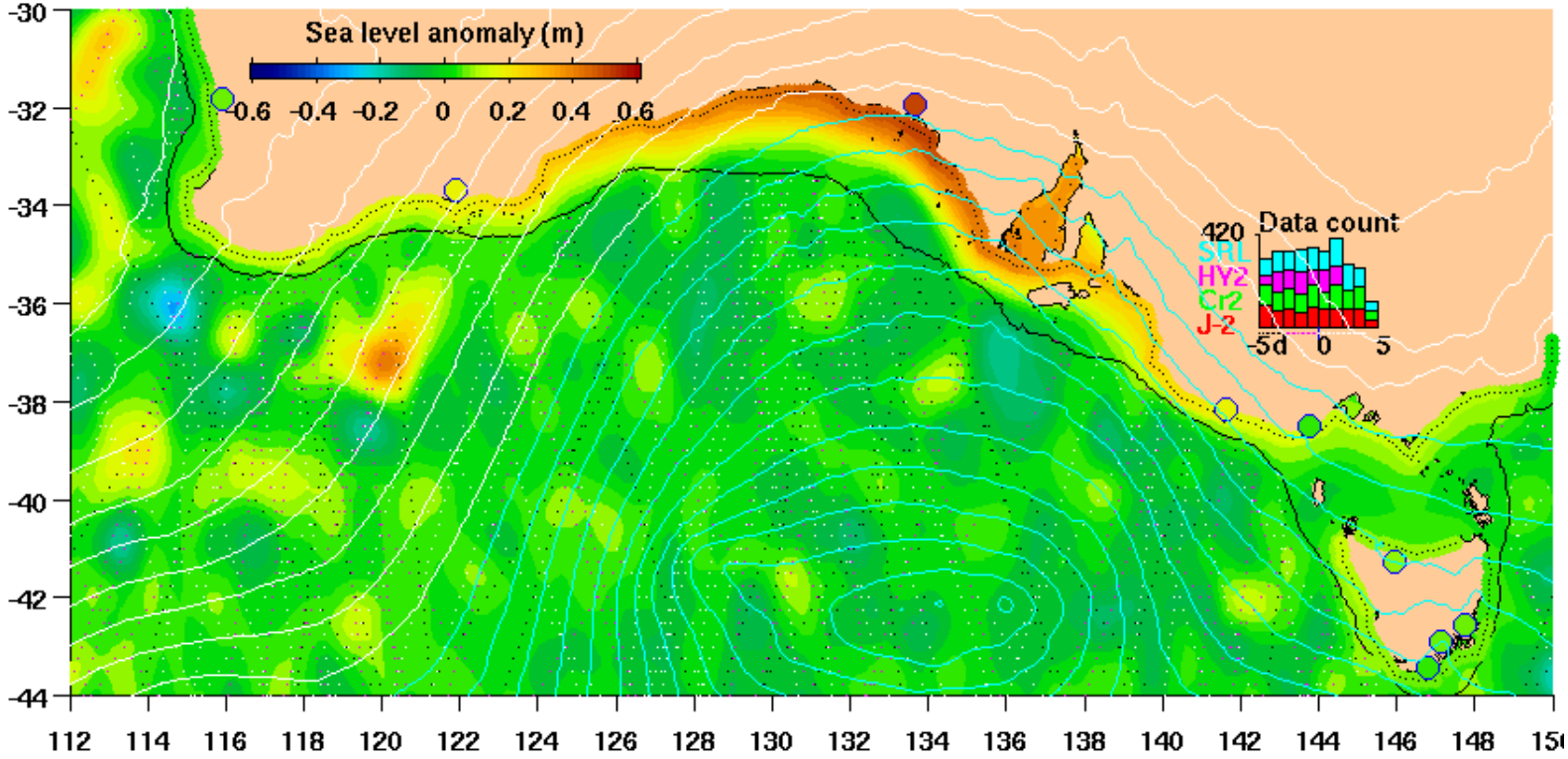


SLA 23 NOV 2013 SST



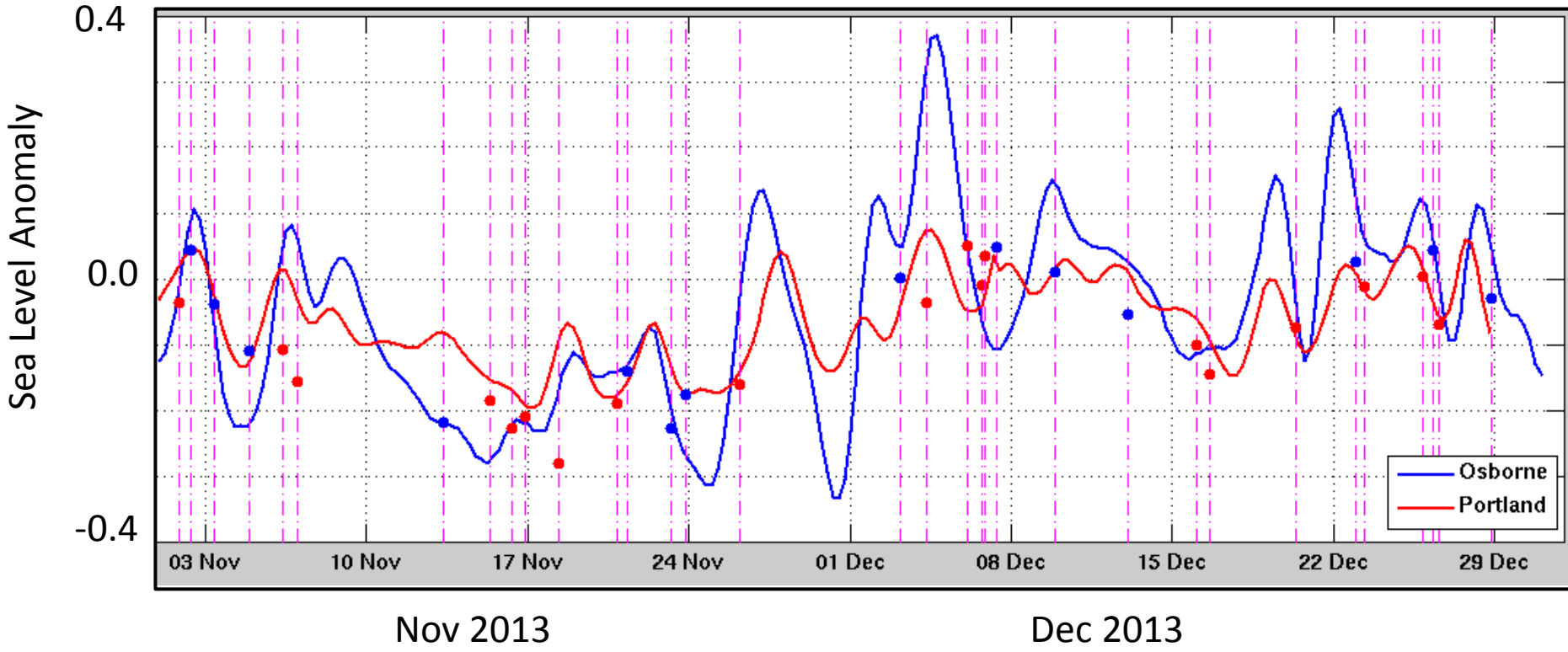
The Great Australian Bight

Sea Level Anomaly



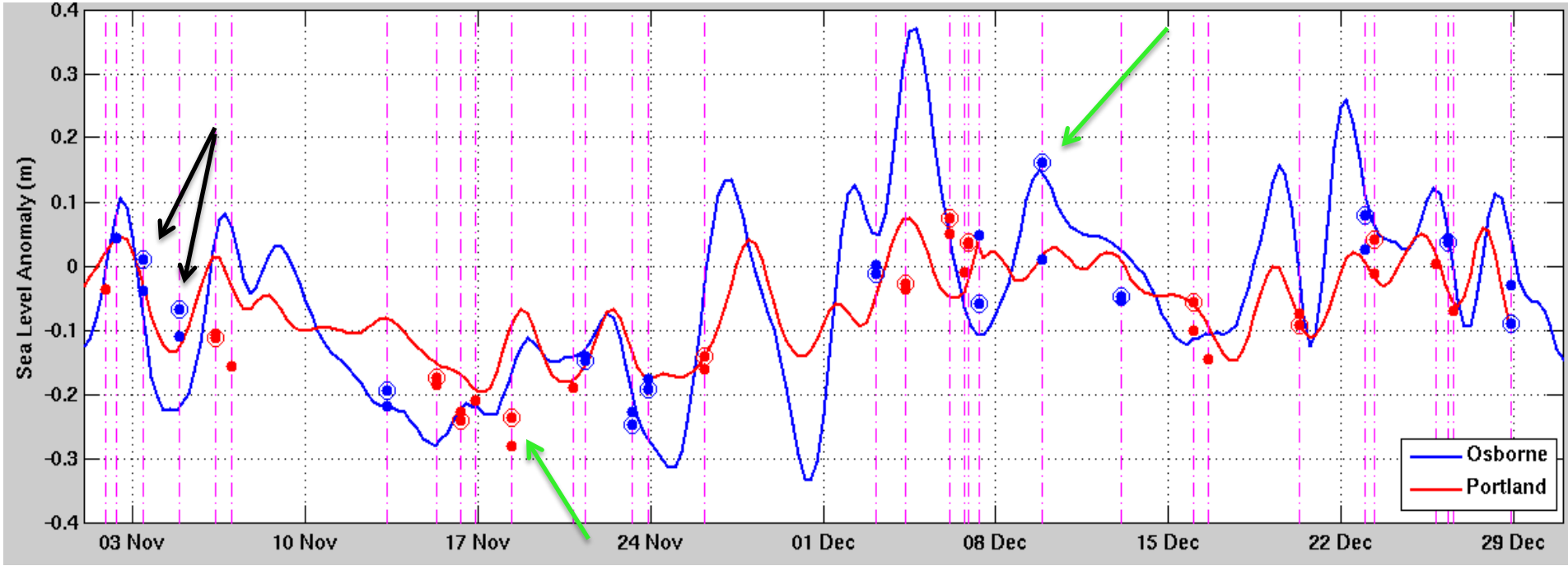
CTWs – coastal trapped waves have a large amplitude on this shelf
HF DAC – high frequency dynamic atmosphere correction

Tide gauge SLA v 'coastal' PEACHI SLA



- Very rough comparison – up to 200km distance between TG and track
- Dots indicate PEACHI SLA closest to the coast
- Perfect agreement = blue dot on blue line or red dot on red line
- Good enough = dots between the two lines

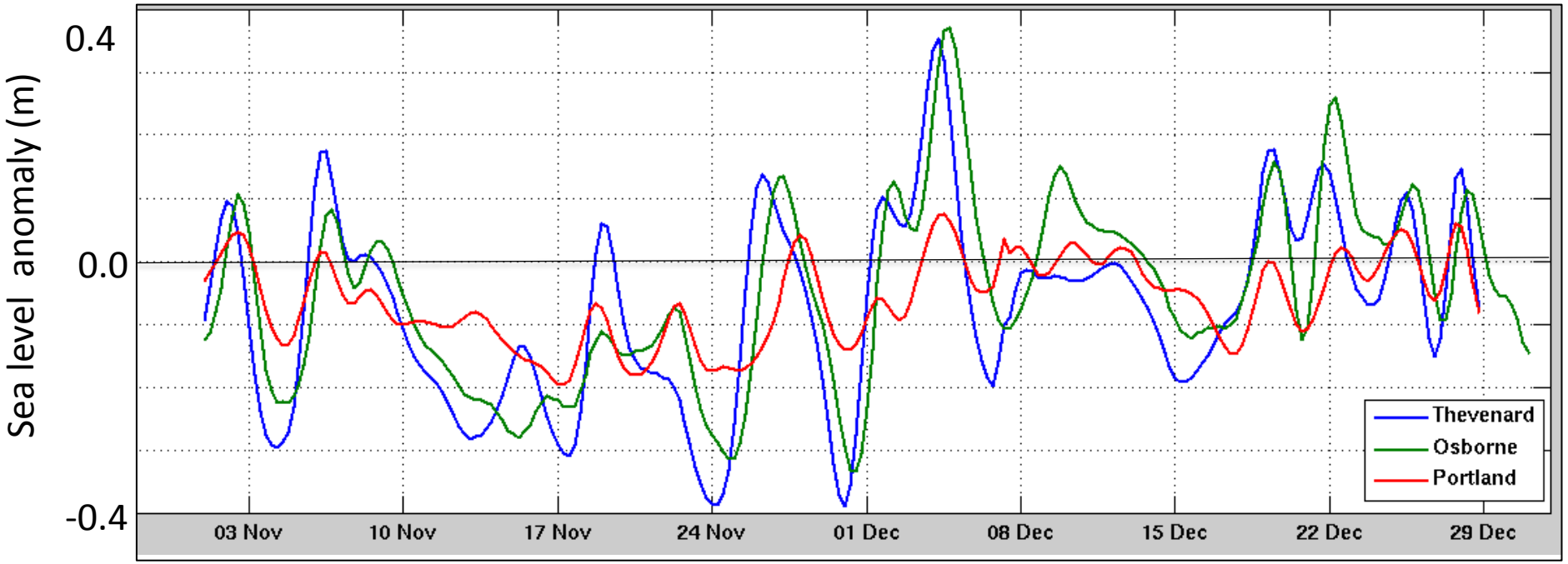
Correct the tide and add back the HF DAC



The ‘adjusted’ SLA is sometimes better - and sometimes worse

But during upwelling the PEACHI SLA is close to tide gauge SLA

Low Pass Filtered Tide Gauge SLA – 2013



- Thevenard (blue) at head of the bight - far west of Bonney Coast
- Osborne (green) to west of the upwelling region, in Gulf St Vincent
- Portland (red) at eastern end

- Thevenard & Osborne are well correlated
- Portland highs and lows are much weaker than Osborne

- Neither tide gauge exactly represents the region

Conclusions

- Upwelling events off the Bonney Coast are well represented using coastal altimetry - and by extension other low frequency (3d +) coastal processes
- Having multiple altimeters is essential however for complete sampling of the shelf
- Requires care in the choice of corrections

Thank you

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