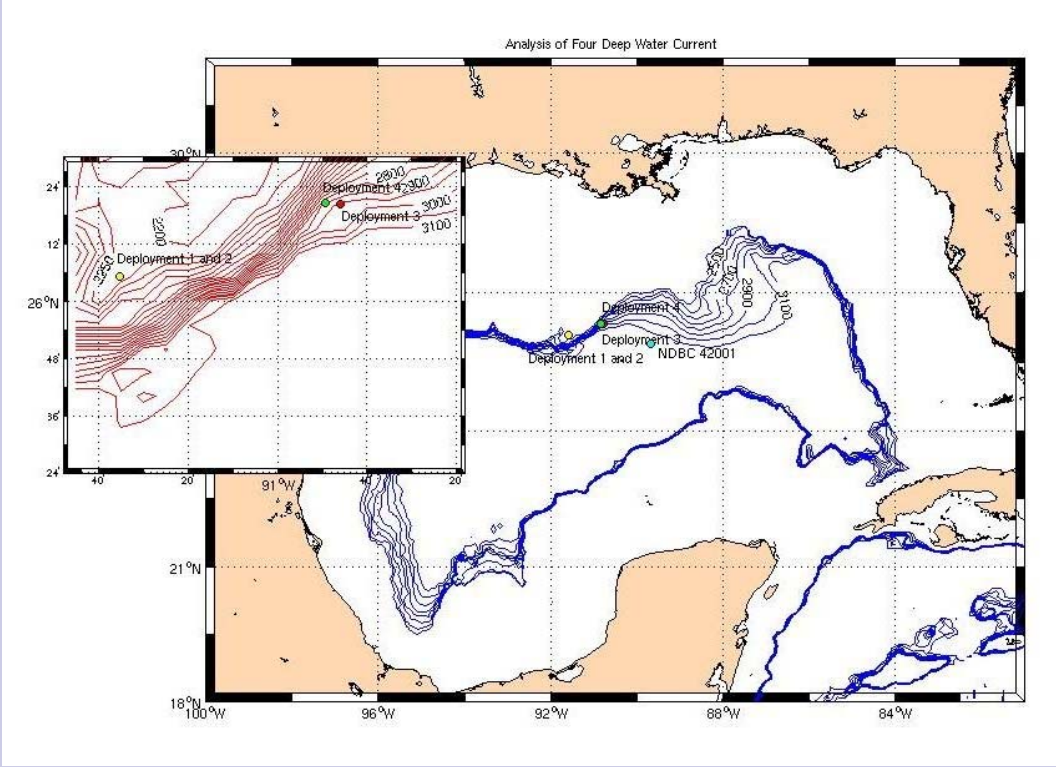
Characteristics of Deep Water Currents along the Sigsbee Escarpment

Kevin P. McKone
Nan Walker
Eddie Weeks
Coastal Studies Institute and
Department of Oceanography & Coastal Science
Louisiana State University

LSU Deepwater Deployments

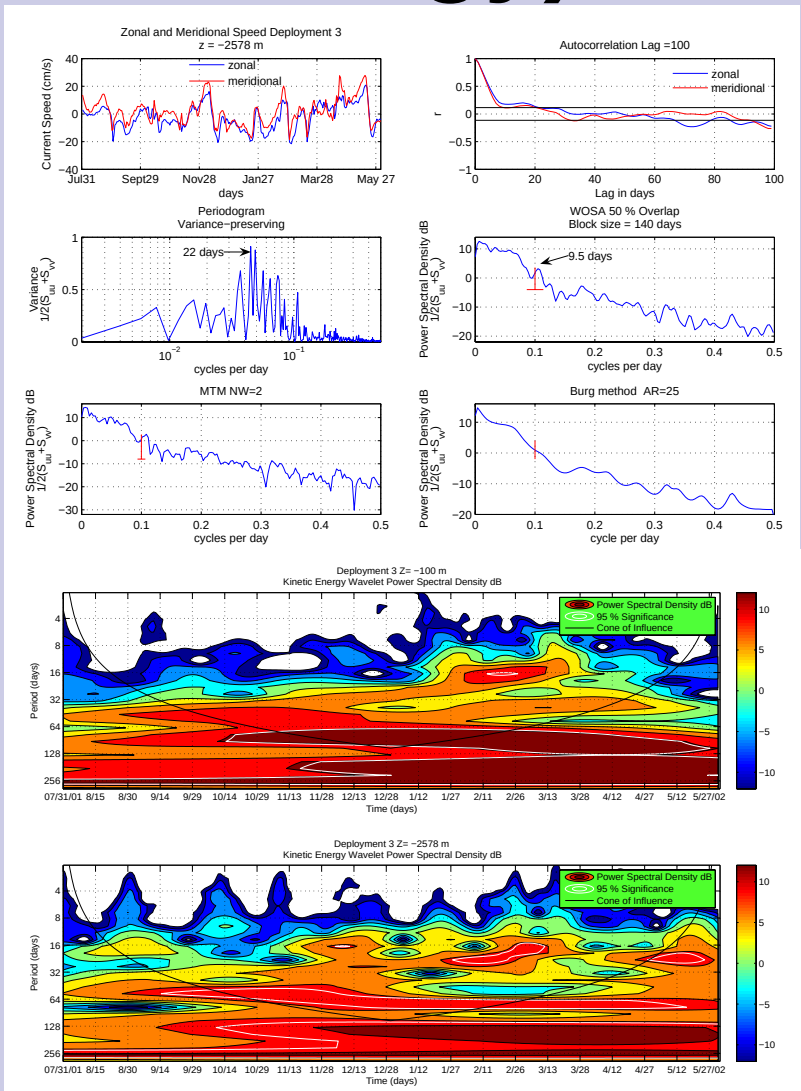
- Deployment 1 and 2
  - 16 Feb 2000– 29 Jul 2000

    30 Jul 2000 – 5 May 2001
  - 26º 05.171 N 91º 35.354 W
- Deployment 3
  - 31 Jul 2001 – 2 Jun 2002
  - 26º 20.22 N 90º 45.9343 W
- Deployment 4
  - 17 Apr 2003 – 11 Apr 2004
  - 26º 20.56 N 90º 49.467 W



Multiple Methods of Spectral Analysis (Kinetic Energy)

- Periodogram (Variance Preserving)
- Welch's method (WOSA)
- Multitaper method (MTM)
- Autoregressive (AR)
- Wavelet Analysis



Wavelet Analysis

$$W(b,a) = \frac{1}{a^{2}} \int \psi^{*}\left(\frac{t-b}{a}\right) s(t)\,dt$$

- $a^{-1/2}$ is a normalization factor
- b is the position (translation)
- a is the scale or dilation of the wavelet
- s(t) is the time series
- Ψ^{*} is the complex conjugate of the wavelet

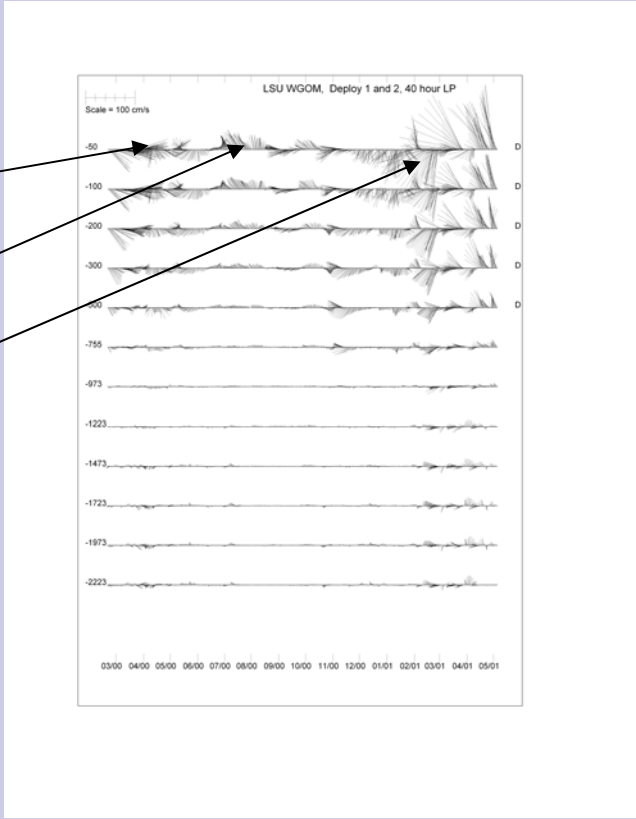
More Wavelet

- Torrence, C. and G.P. Compo. 1998. A practical guide to wavelet analysis. Bull. Amer. Met. Soc. 79:61–78
- Morlet
- Chi Square
- Significant at the 5% level (95% Confidence)

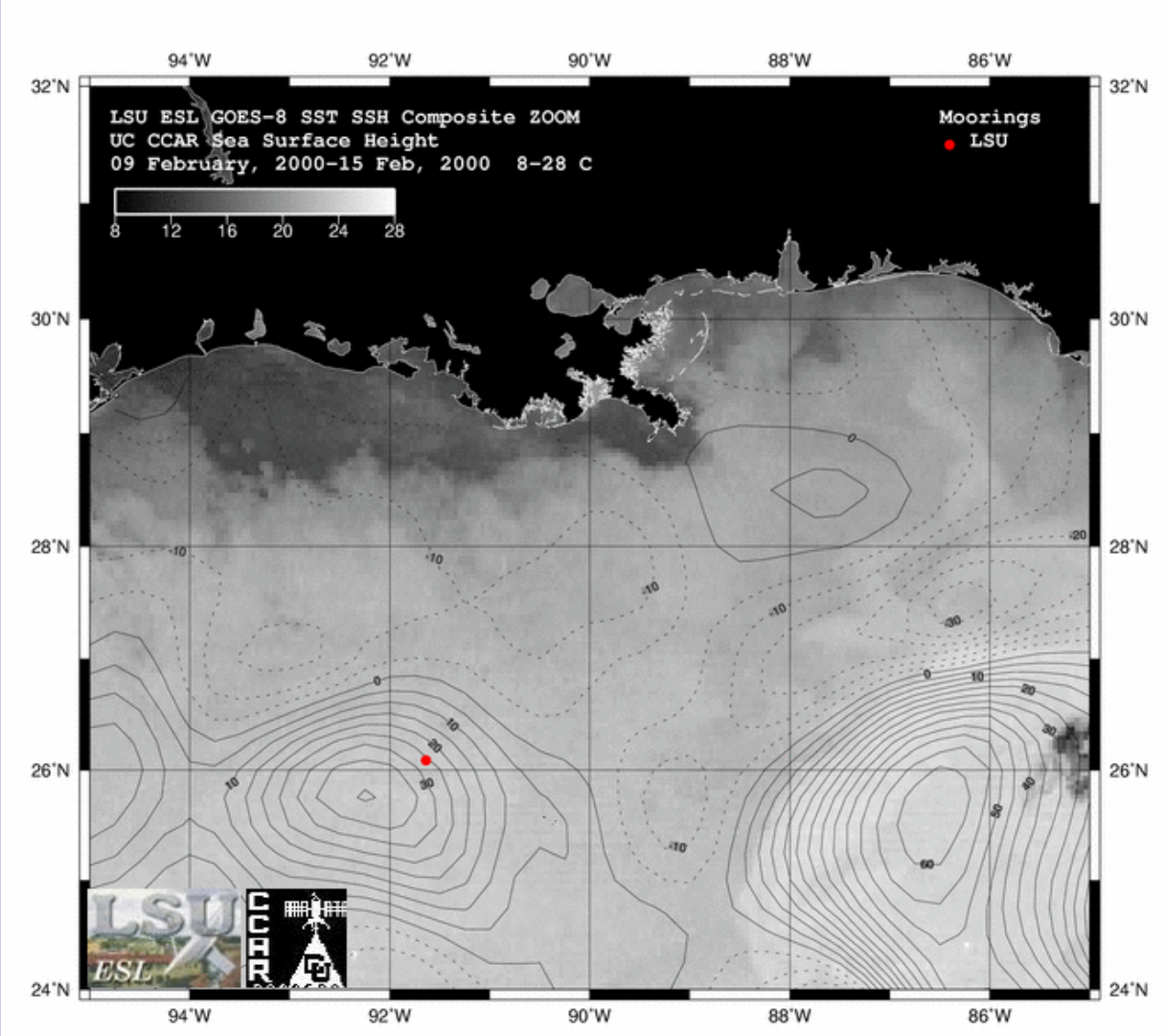
Deployment 1 and 2

16 Feb 2000 – 29 Jul 2000
30 Jul 2000 – 5 May 2001
26º 05.171 N 91º 35.354 W

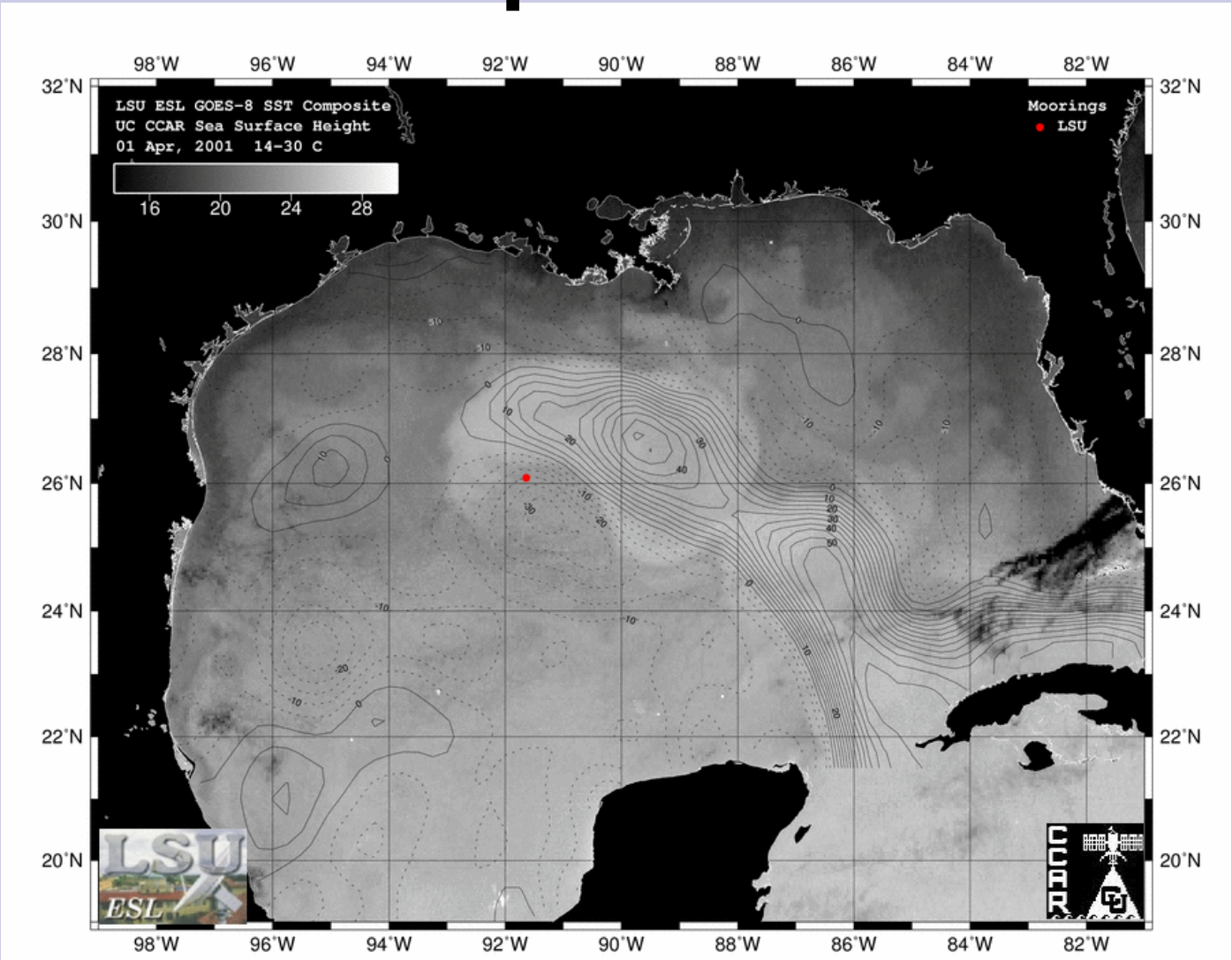
- Plateau above Sigsbee Escarpment
- Maximum water depth 2124 m
- Affected by eddy
  - Juggernaut (Feb 2000 – Mar 2000)
  - Kinetic (Jun 2000 – Jan 2001)
  - Millennium (Feb 2001 – Mar 2001)
  - Cold core cyclone
    (Mar 2001 – 20 Apr 2001)



Eddy Juggernaut
15 February 2000

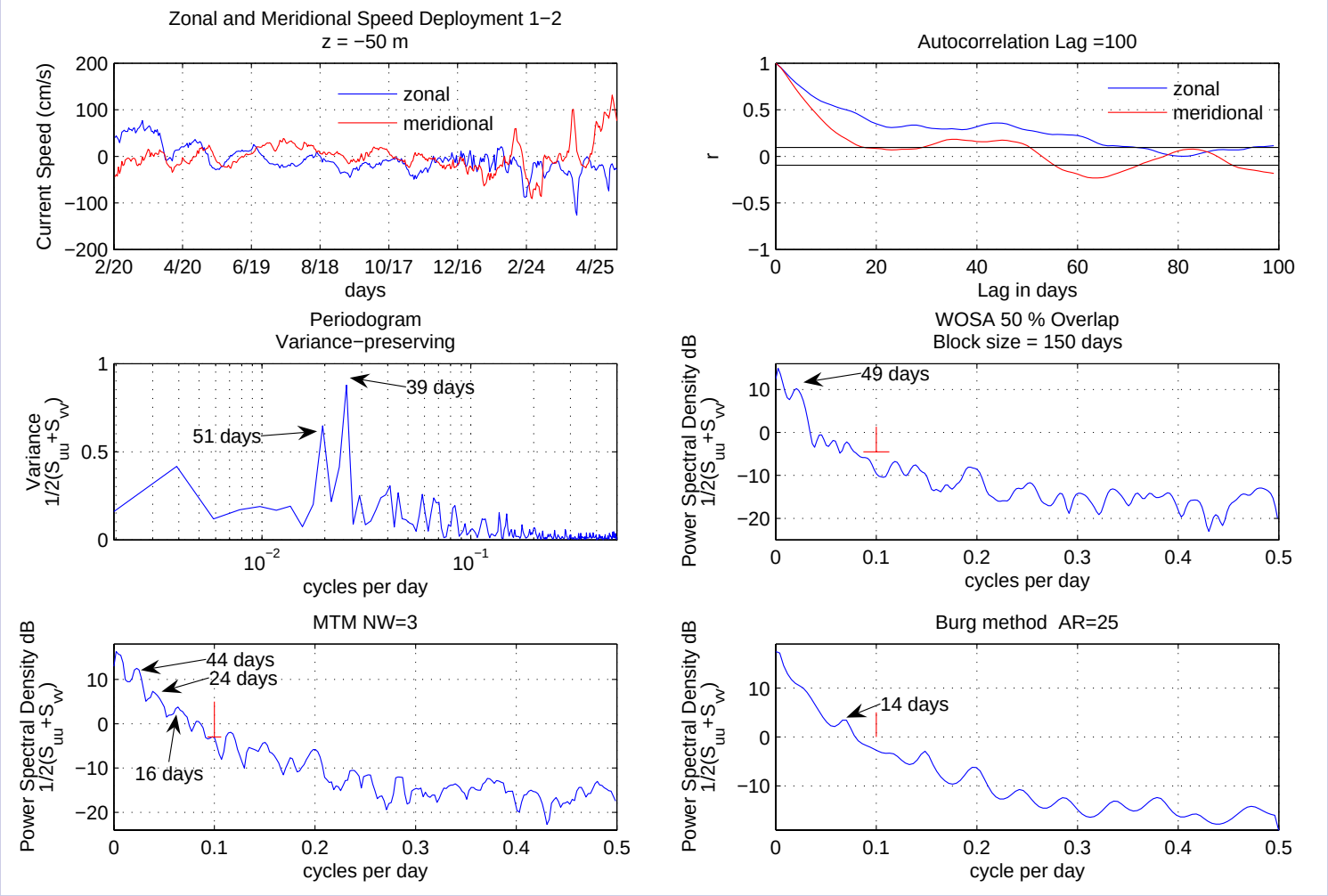


Eddy Millennium/Frontal Cold Core
1 April 2001



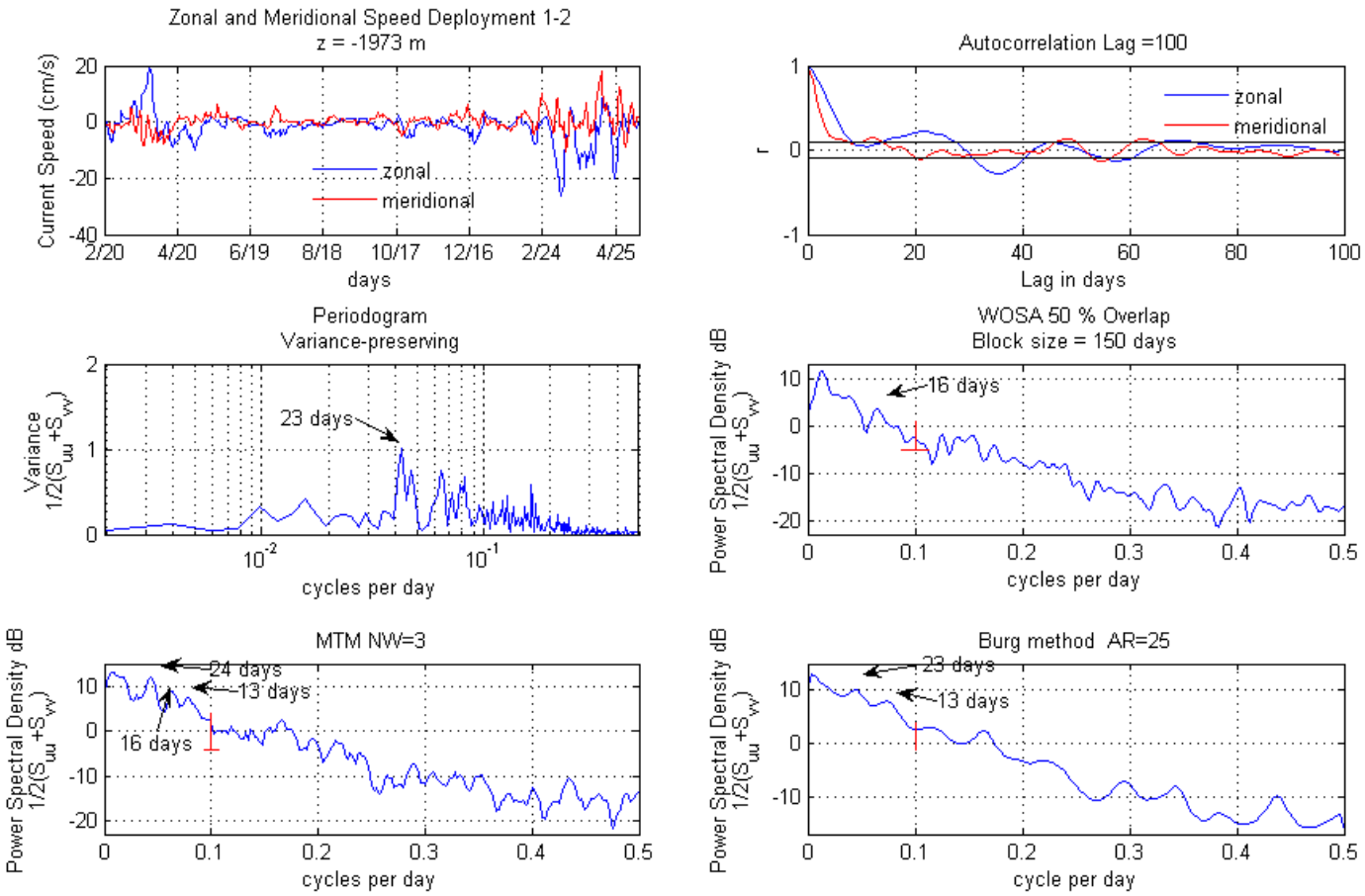
Multiple Methods of Spectral Analysis

D1D2 z = -50 m



Multiple Methods of Spectral Analysis

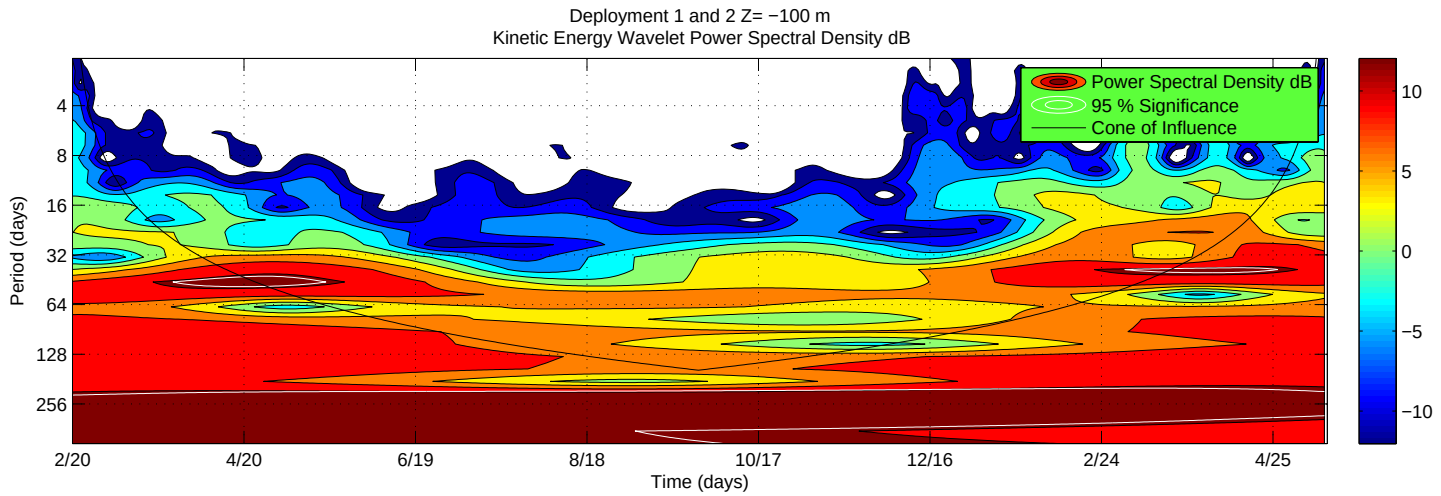
D1D2 z = -1973 m

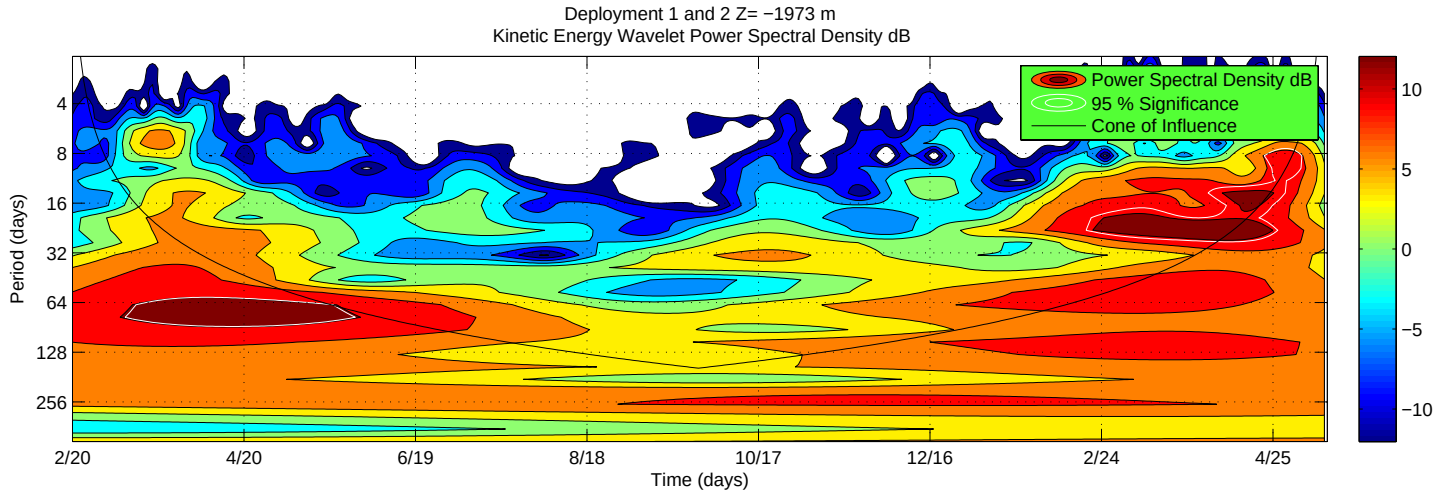


Wavelet Analysis D1D2

Localized Variations of Power in a Time Series

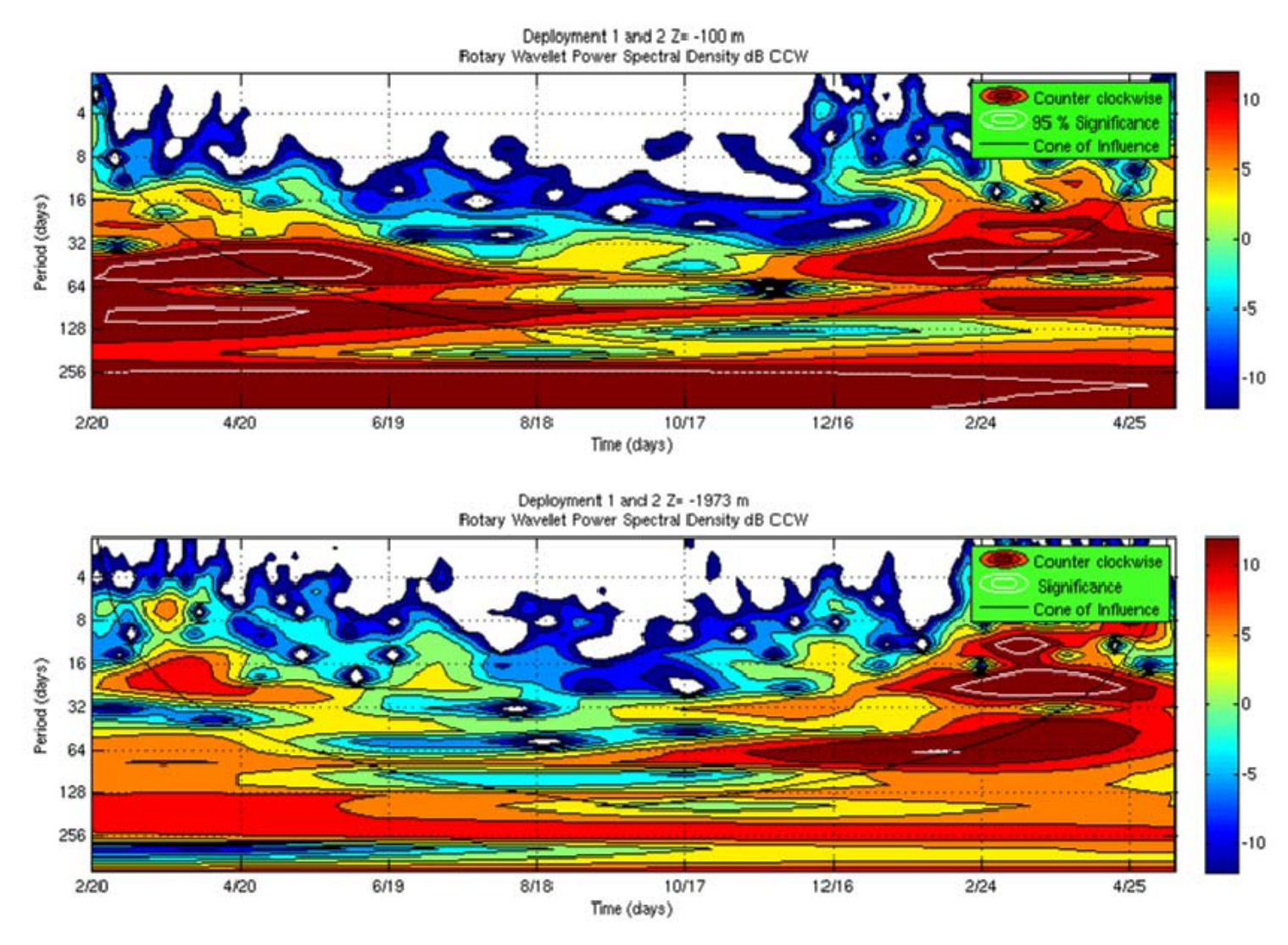
Click to see video





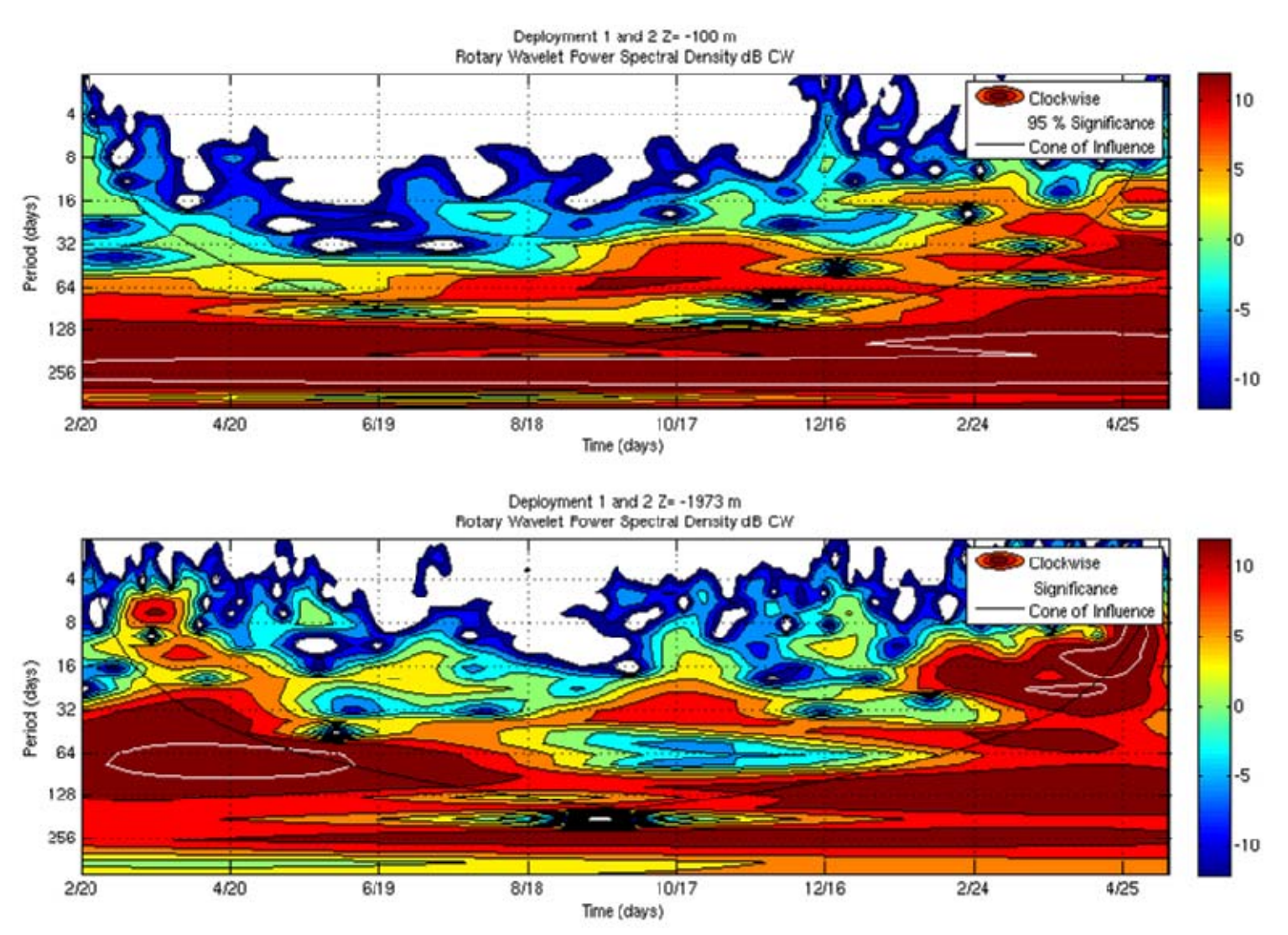
Wavelet Deployment 1 and 2

Rotary CCW 100 m-1973 m



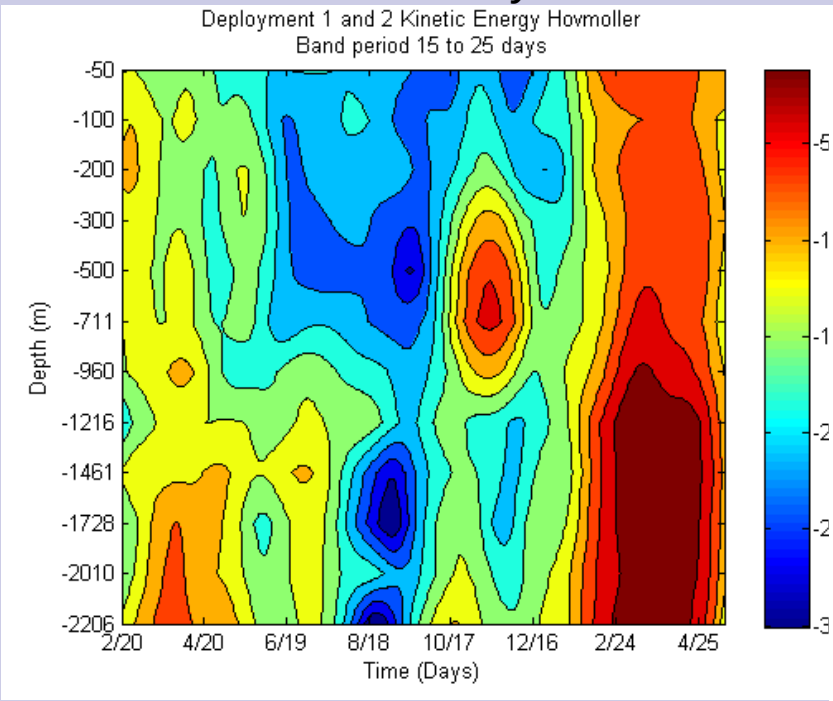
Wavelet Deployment 1 and 2

Rotary CW 100 m-1973 m

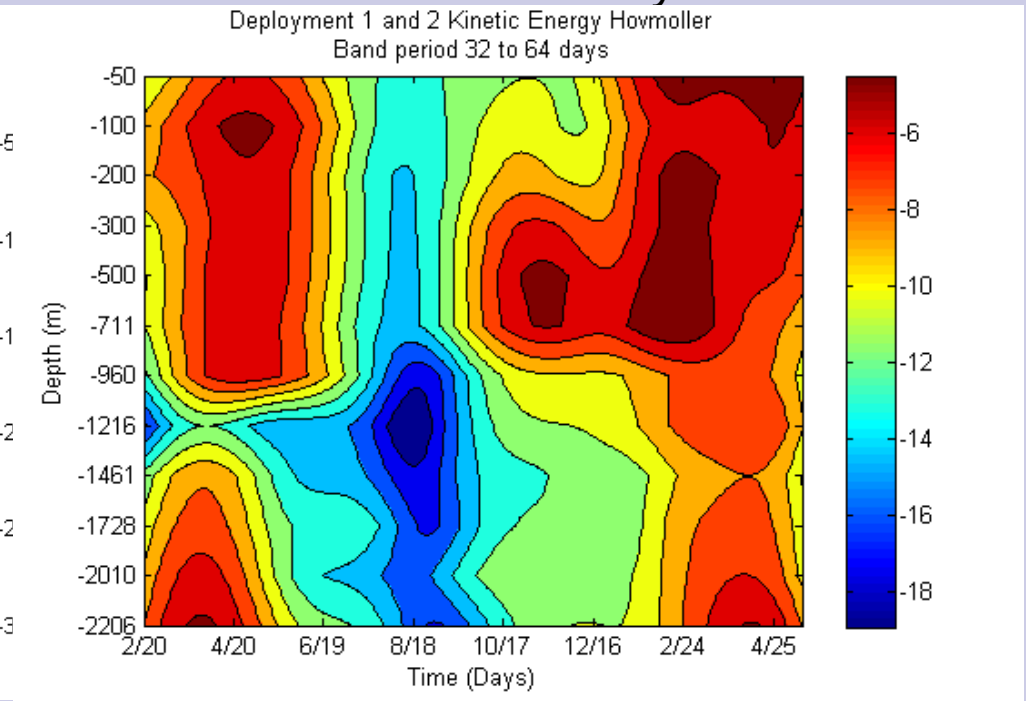


Wavelet
Hovmöller D1D2

15–25 days



32–64 days



Deployment 1 and 2
z = -50 m

Multiple Methods Signals (days)	1st half	2nd half	Wavelet (days)	Eddies
51–49	Not Seen	Not Seen	50–40 (ccw) 1 Mar 00–1 Jun 00	Juggernaut South Mooring 1 Mar 00–1 May 00
44	44	44	44 (ccw) 1 Feb 01–1 May 01	Millennium 1 Feb 01–1 Mar 01 Cold Eddy 1 Mar 01–20 Apr 01
24(w)	20	16	20 (weak ccw)	Cold Eddy 1 Mar 01–20 Apr 01

Deployment 1 and 2

z = -1973 m

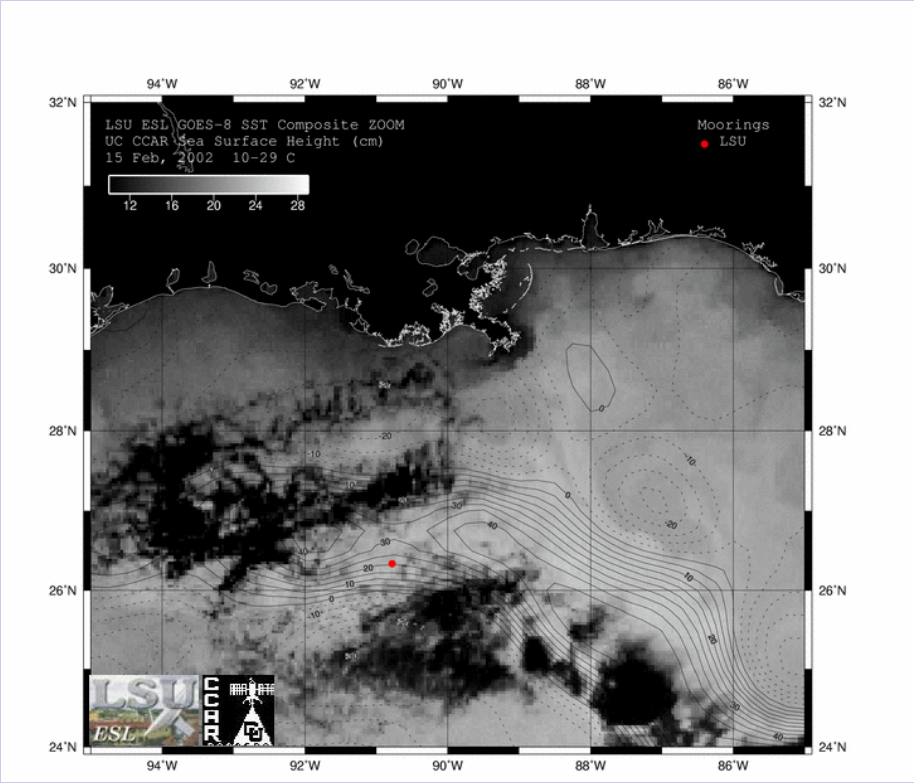
Multiple Methods 20 Feb 00– 5 May 01	1st half 20 Feb 00– 27 Sep 00	2nd half 27 Sep 00– 4 May 01	Wavelet (days)	Eddies
73(w)	73(s)	73(w)	CW 1 Mar 00– 1 Jun 00 (cone of influence)	Juggernaut 1 Mar 00– 1 May 00
23(s)	24(w)	22(s)	Equal CW and CCW 1 Feb 01– 30 Apr 01	Millennium 1 Feb 01– 1 Mar 01 Cold Eddy 1 Mar 01– 20 Apr 01

Deployment 1 and 2 Summary

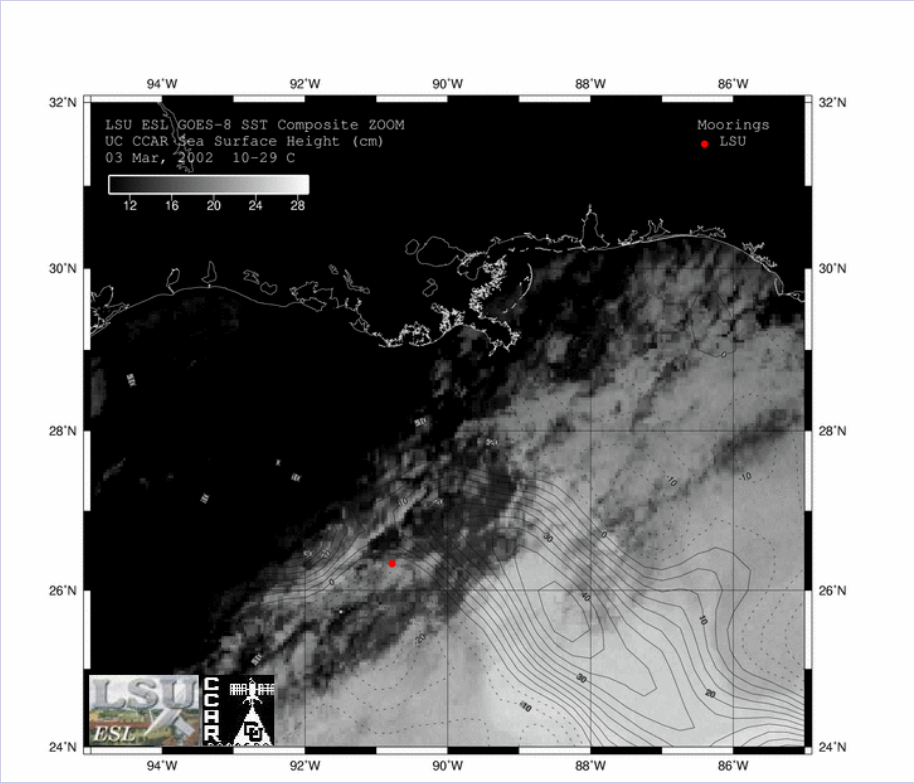
- 20 April 2000 Frequency shift 40 cpd to 70 cpd
  - Surface CCW (Cold Core Eddy)
  - Change to CW at ~1000 m
- 1 April 2001 40 cpd upper 900 m
  - CCW
  - Cold Eddy at surface
- 1 April 2001 20 cpd whole water column
  - Weak CCW surface
  - Weak CCW at depth

Deployment 3
Cold Core Frontal Eddy

15 February 2002

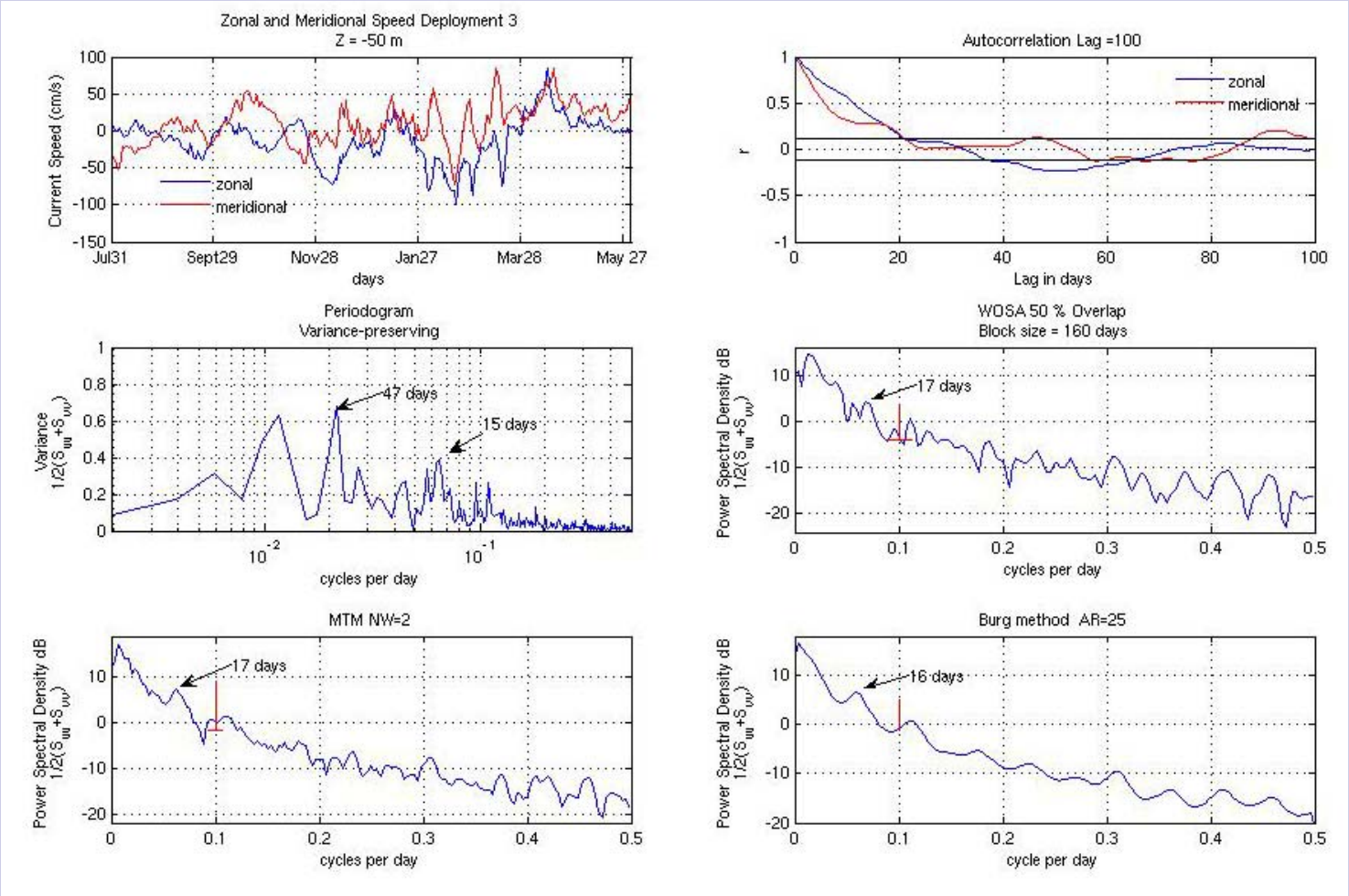


3 March 2002



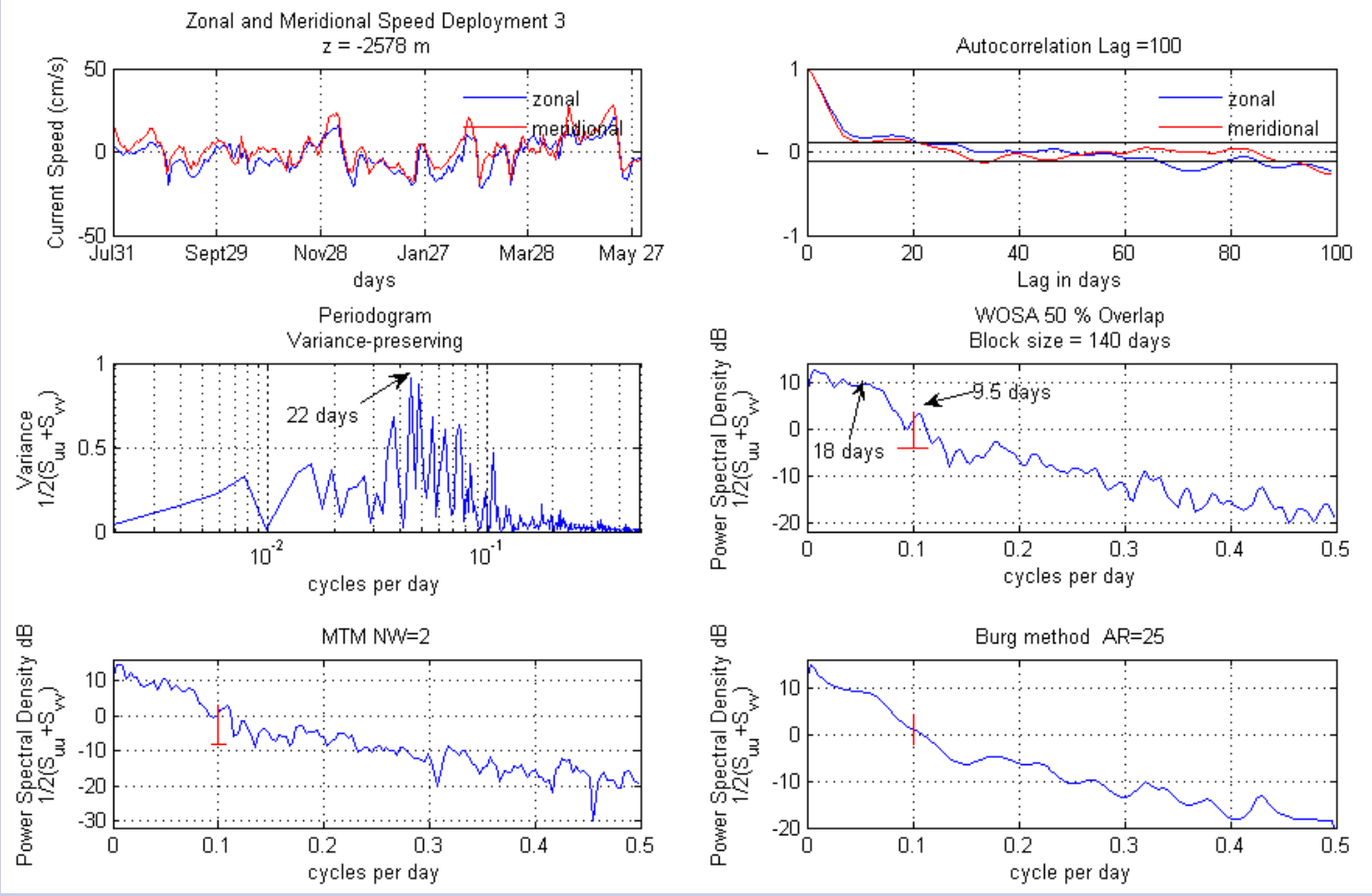
Multiple Methods of Spectral Analysis

D3 z = -50 m



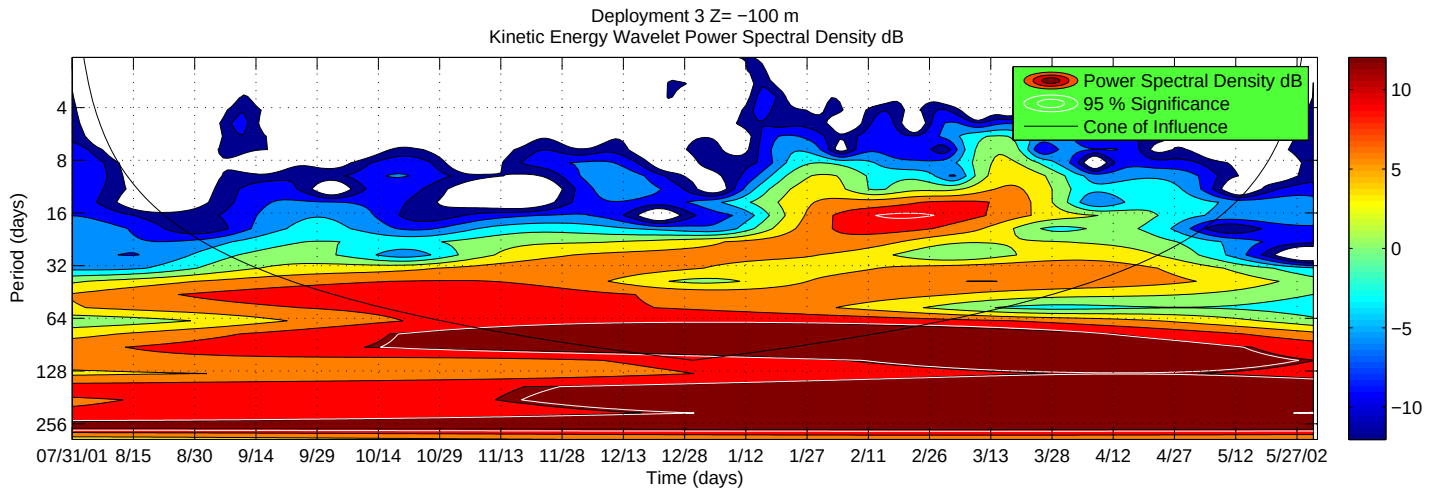
Multiple Methods of Spectral Analysis

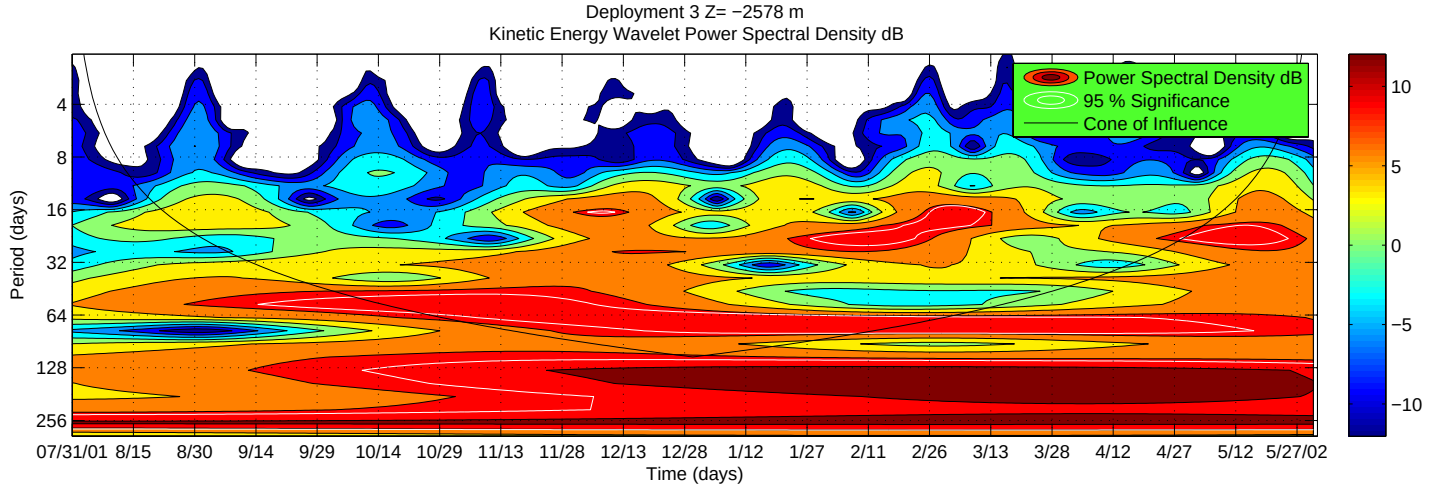
D3 z = -2578 m



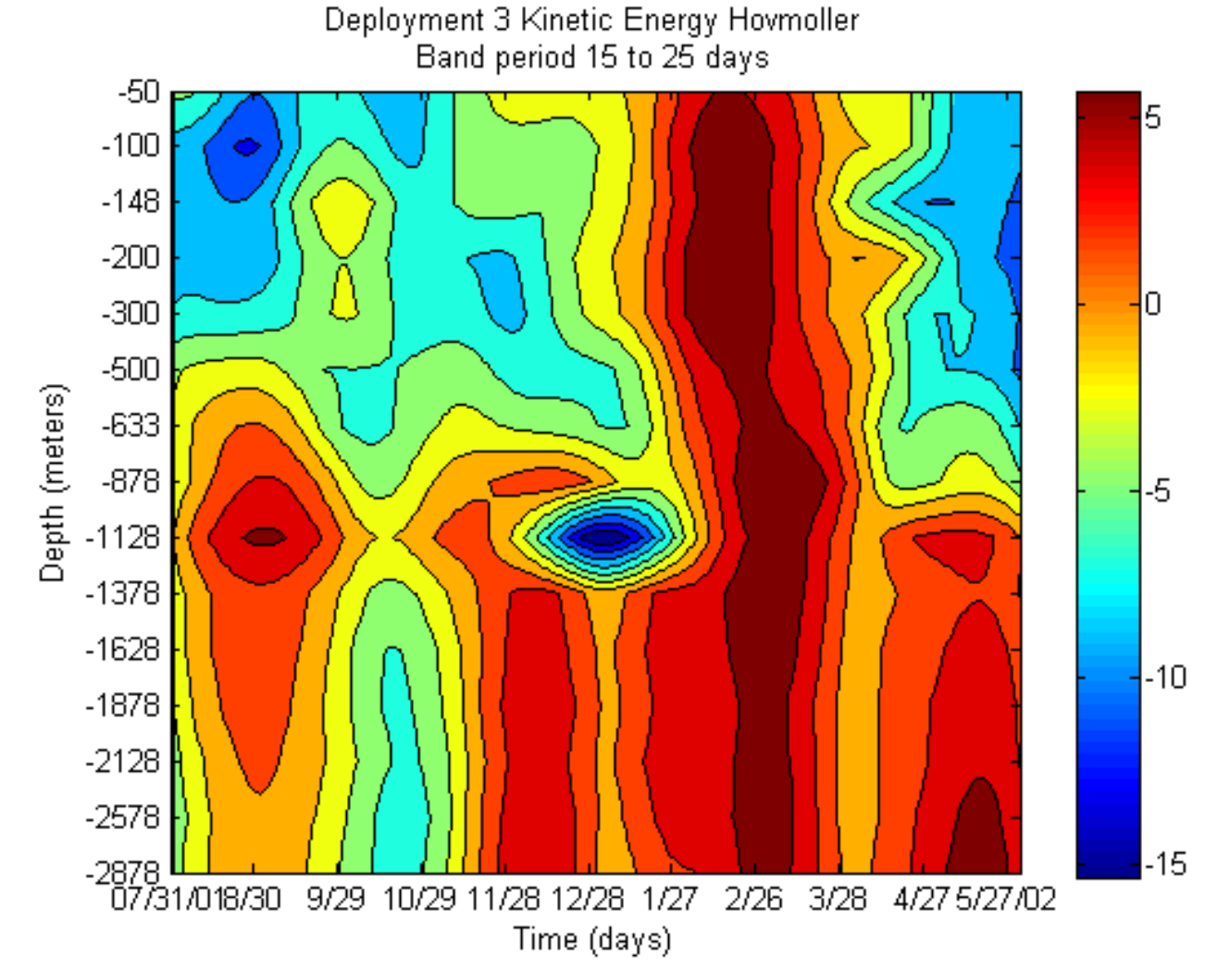
Deployment 3 Wavelet

Click to see video

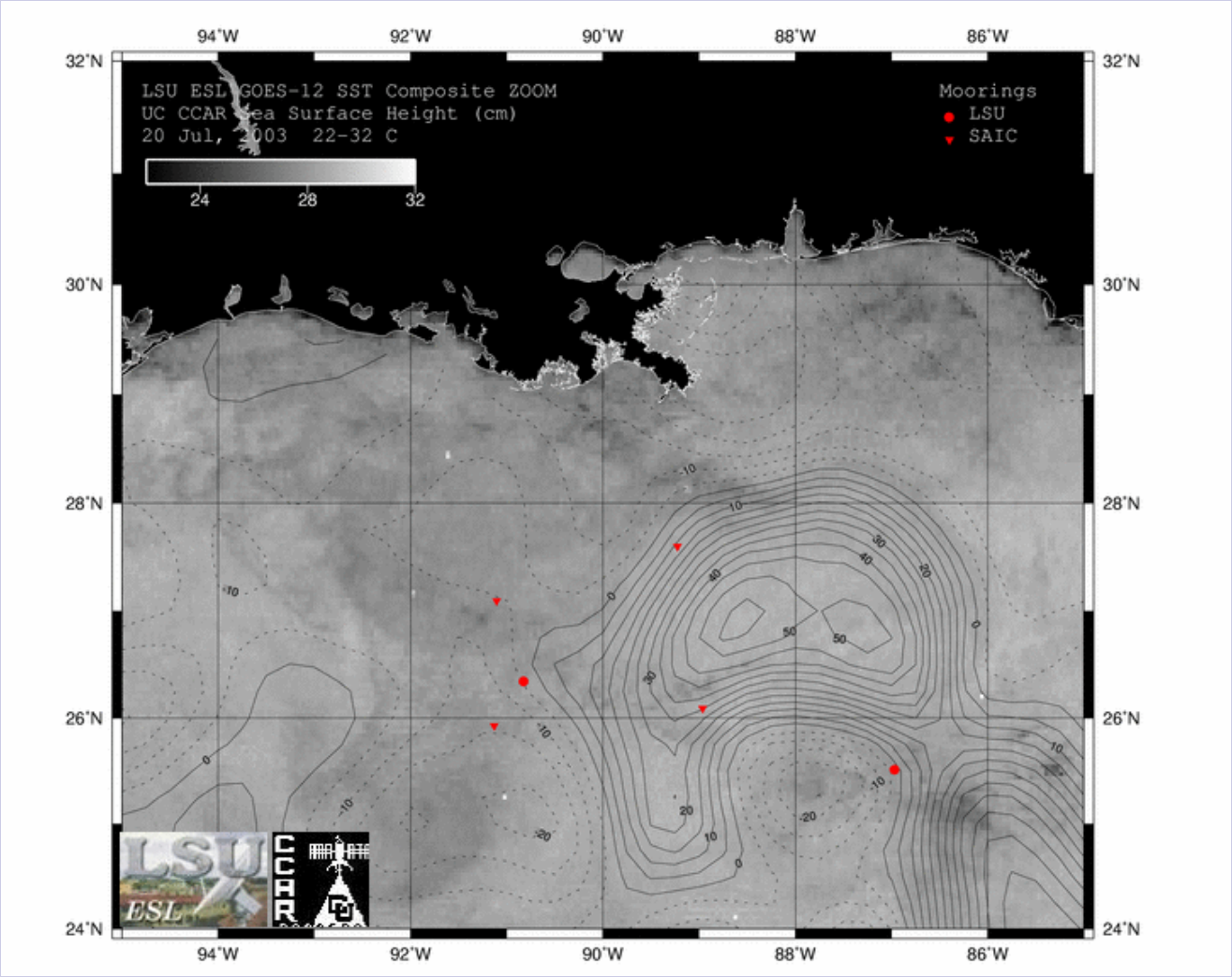




Wavelet Hovmöller
Deployment 3, 15 – 25 days

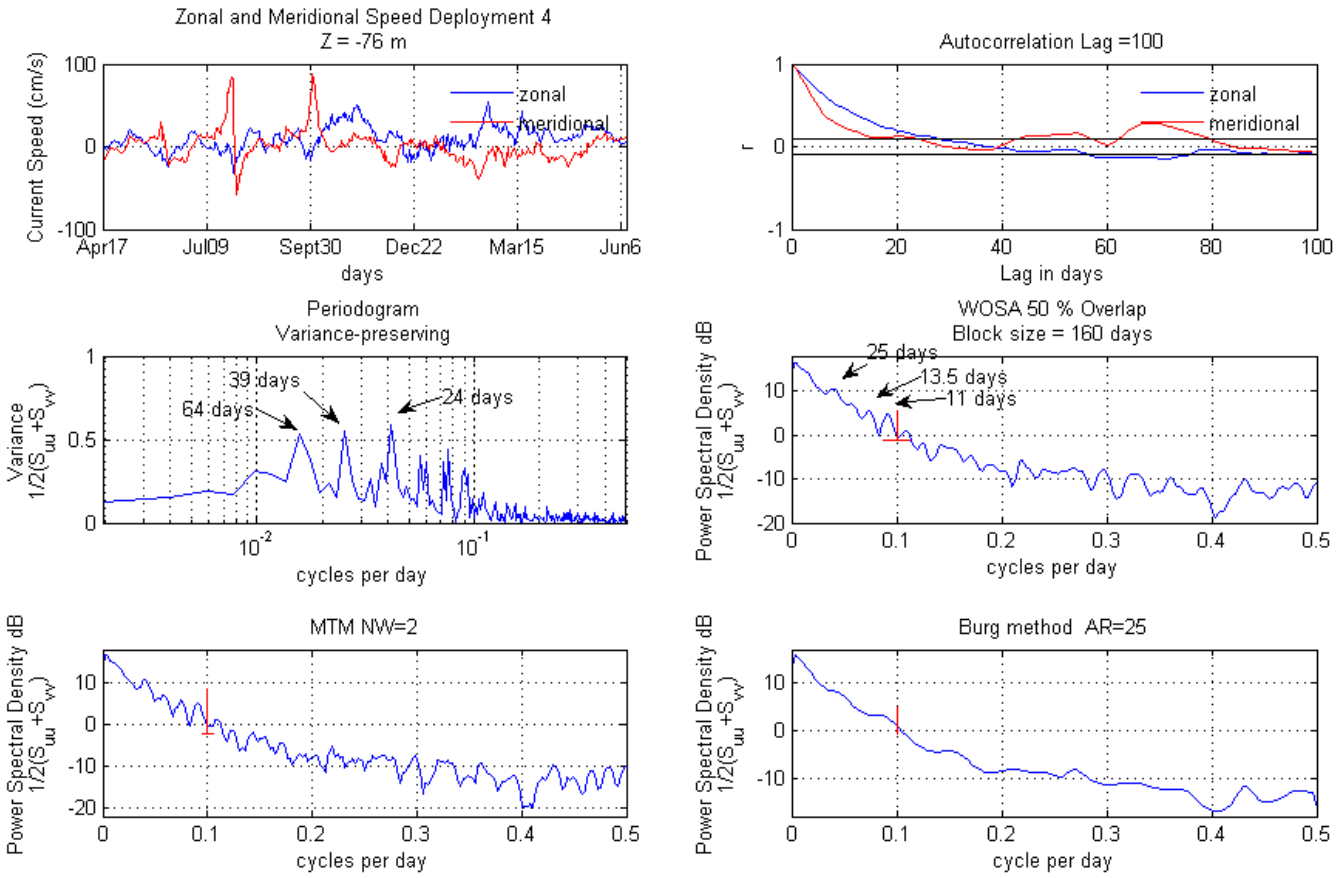


Deployment 4
Frontal Eddy 20 July 2003



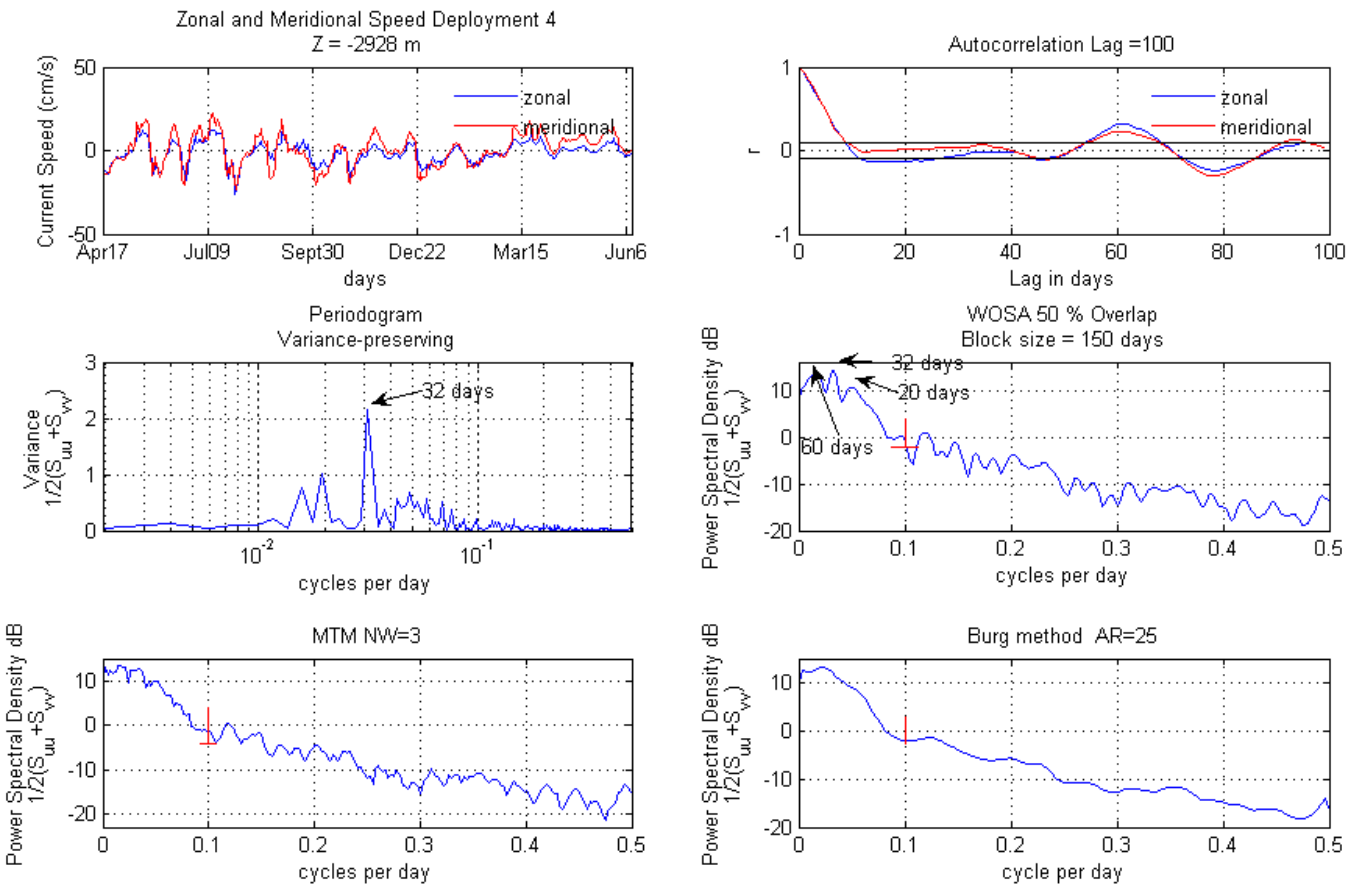
Multiple Methods of Spectral Analysis

D4 z = -76



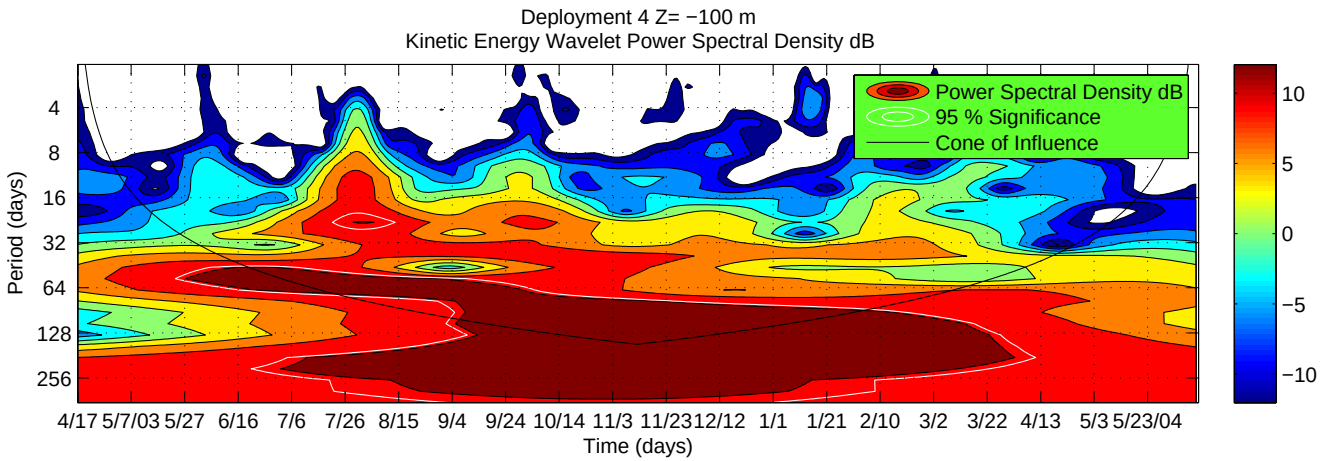
Multiple Methods of Spectral Analysis

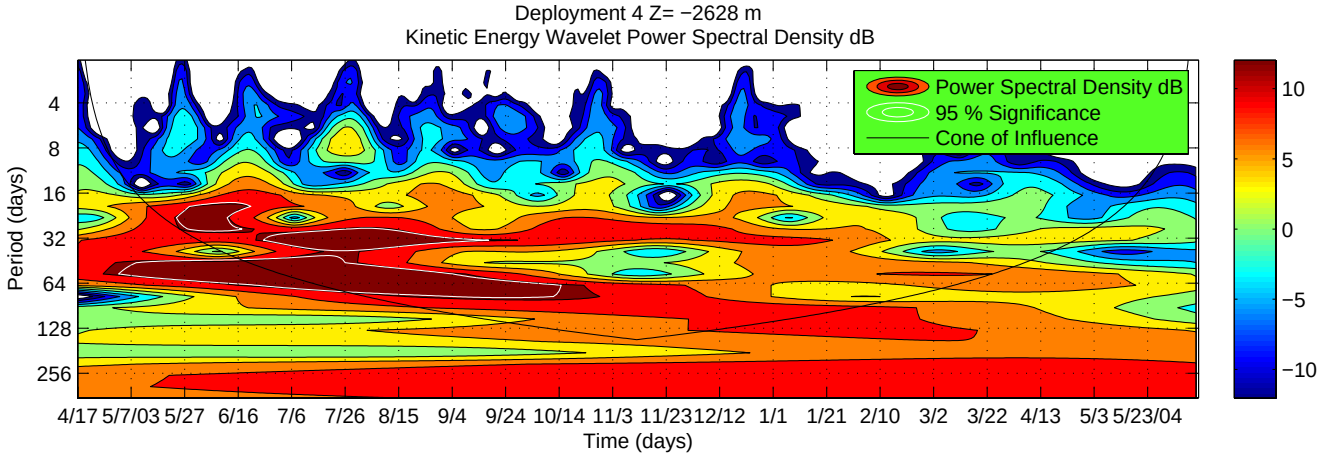
D4 z = -2928 m



Deployment 4 Wavelet

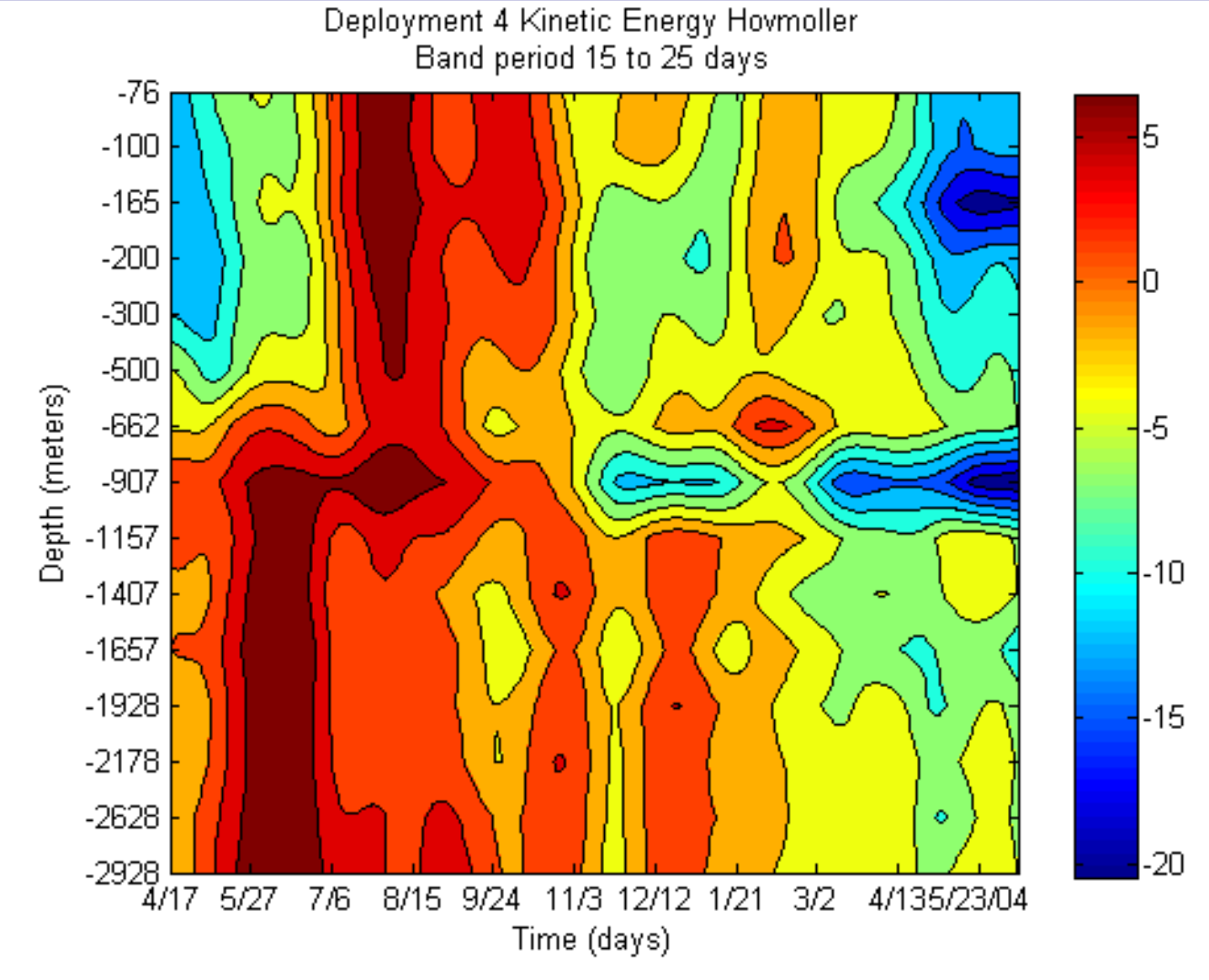
Click to see video





Wavelet Hovmöller

Deployment 4, 15 – 25 days



Summary

- Frontal cyclonic eddies are producing energy at depth.
- Energy is in the 20–30 cpd period.