COASTAL TRAPPED DIURNAL TIDAL WAVES OBSERVED ALONG THE SOUTH KURIL ISLANDS

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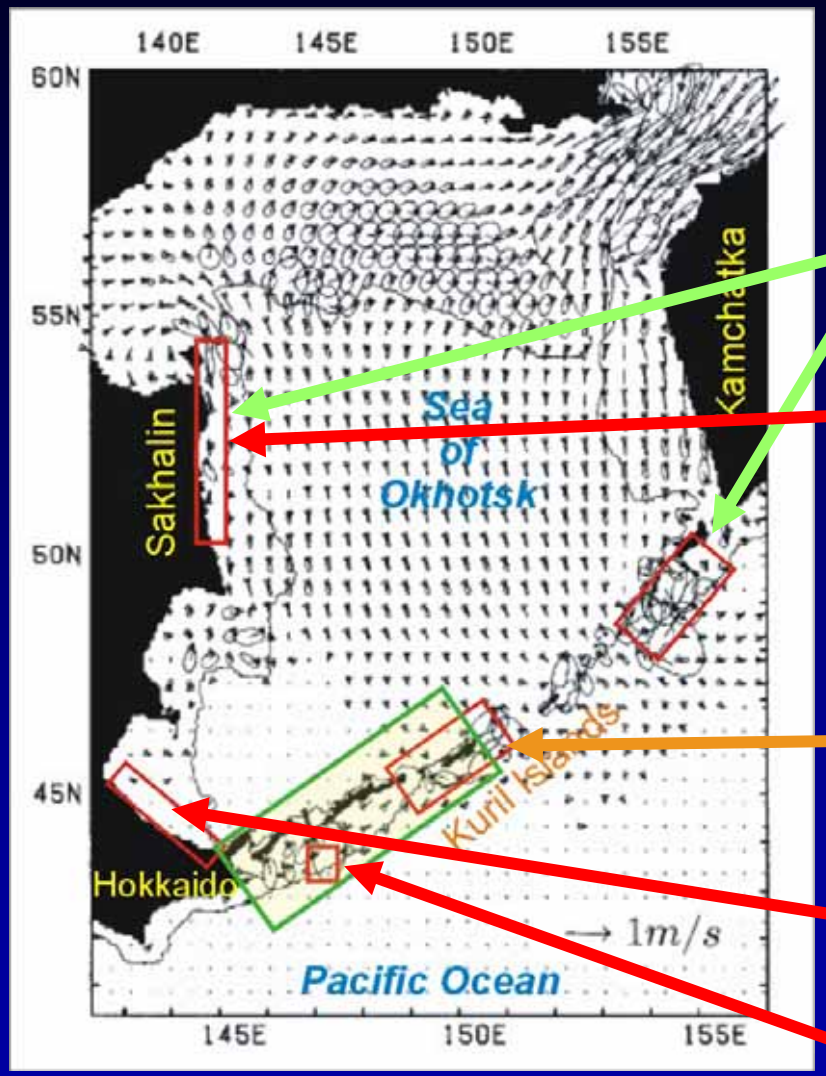
Observations of diurnal continental shelf waves and coastal trapped waves



Simulated currents
(from *Nakamura et al.* [2000])

Altimetry
Shevchenko and Romanov, PICES, 2007

Currents, ice drift, drifters
Rabinovich and Zhukov, 1984;
Putov and Shevchenko, 1998;
Ohshima et al., 2002; *Shevchenko et al.*, 2004; *Ono et al.*, 2007

Drifters
Rabinovich and Thomson, 2001;
Ohshima et al.; 2005

Currents
Odamaki, 1994

Bottom currents
Efimov and Rabinovich, 1980;
Kovalev and Rabinovich, 1980

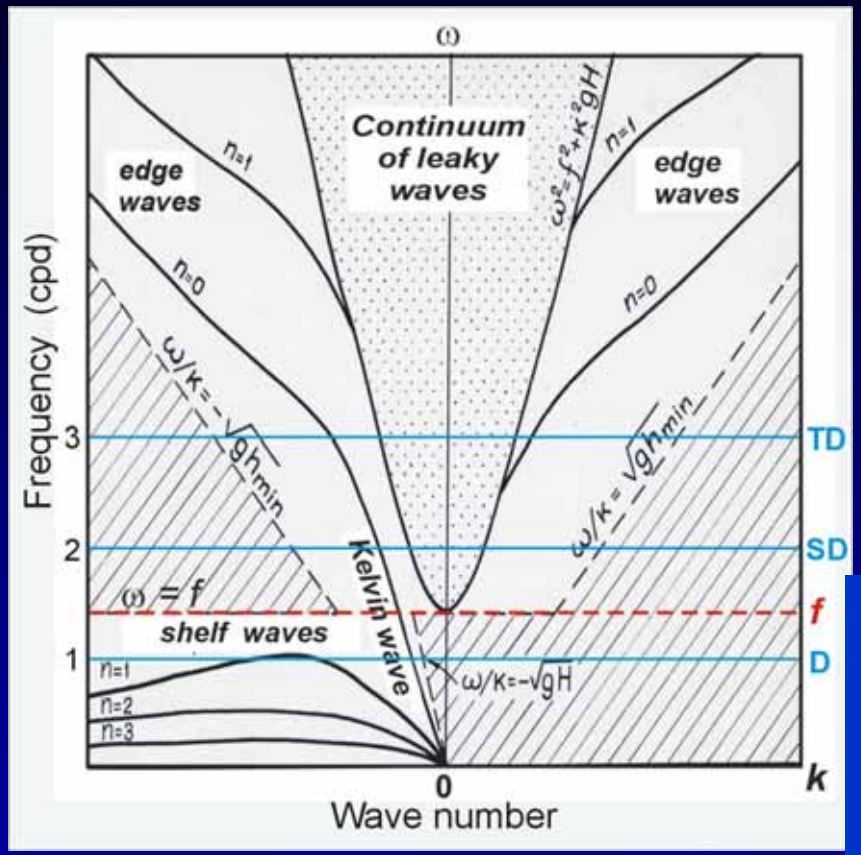
Physics and properties

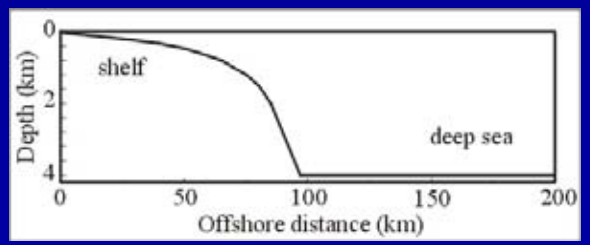
Gravity waves: *Kelvin, Poincare (leaky), edge (Stokes)*

Quasigeostrophic (gyroscopic) waves: *continental shelf waves*

Potential vorticity conservation

$$\frac{\zeta + f}{h} \rightarrow constant$$





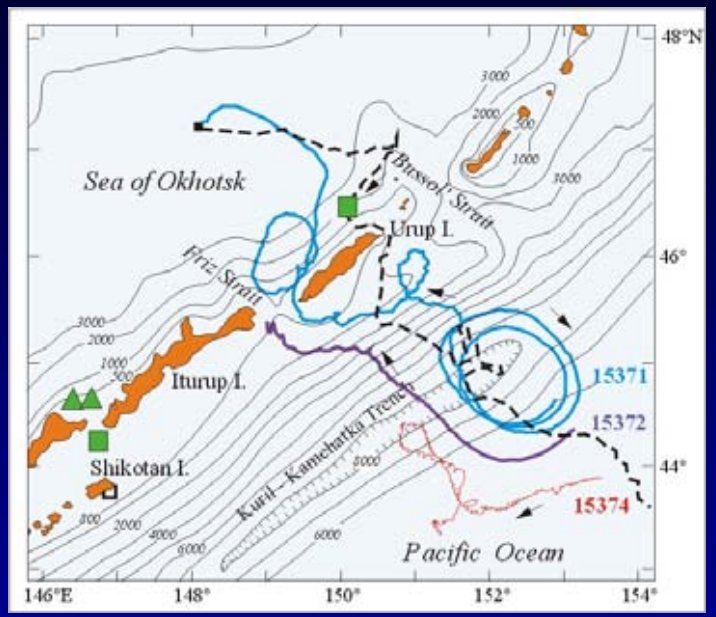
CSW: *Robinson*, 1964

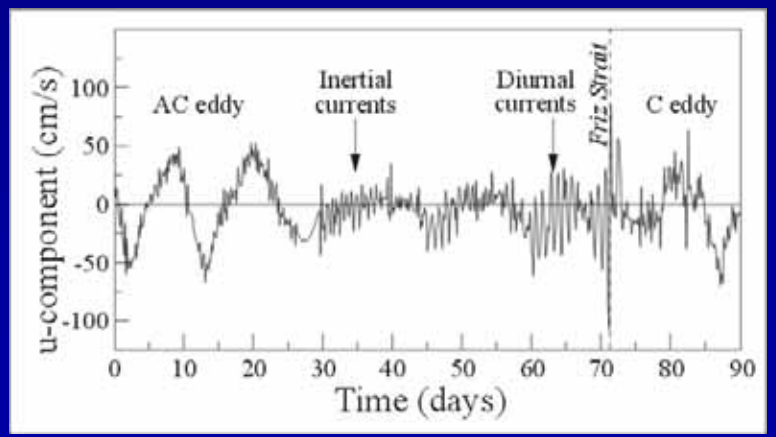
Diurnal (tidal) CSW: *Cartwright*, 1969;
Rabinovich and Efimov, 1980;
Crawford and Thomson, 1982, 1984;
Daifuku and Beardsley, 1983; etc.

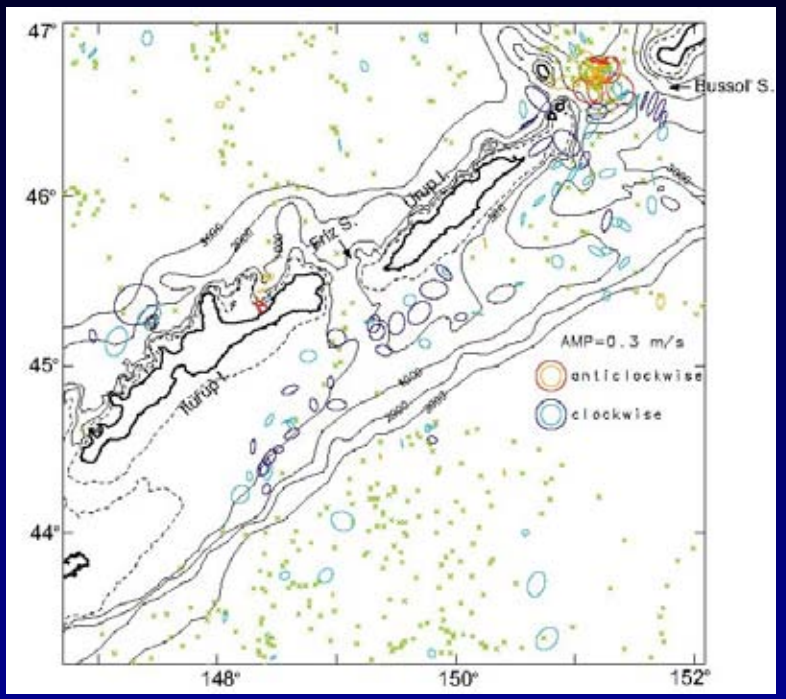
Kelvin wave: z = 30 cm, U = 3 cm/s

CSW: z = 3 cm, U = 30 cm/s

Drifter observations of diurnal coastal trapped waves near the Kuril Islands







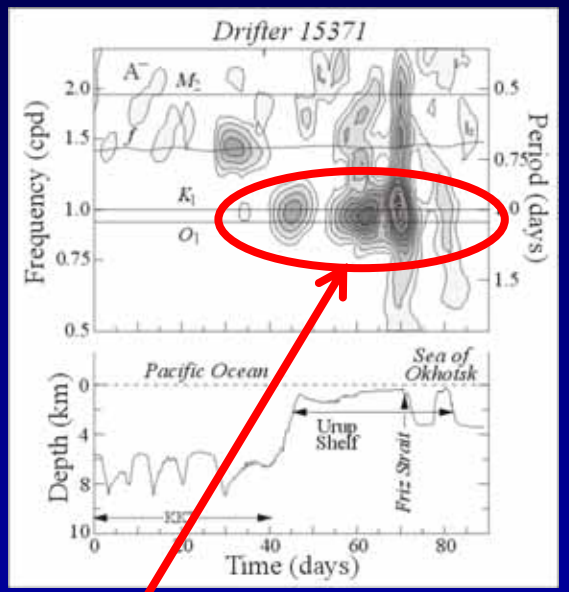
Ohshima et al., 2005

15-m drifters

Rabinovich and Thomson, 2001

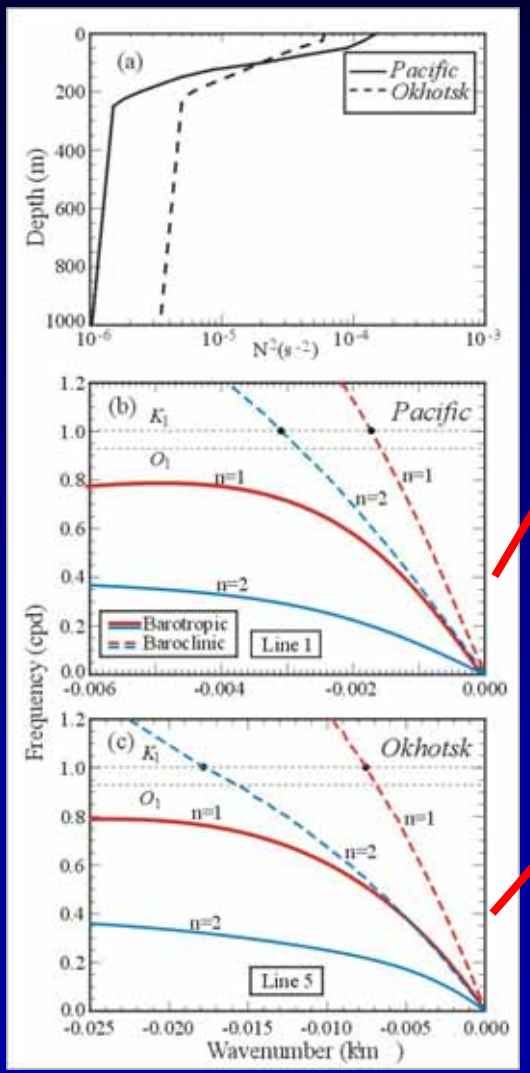
Numerical modeling of coastal trapped waves for the Pacific and Okhotsk shelves

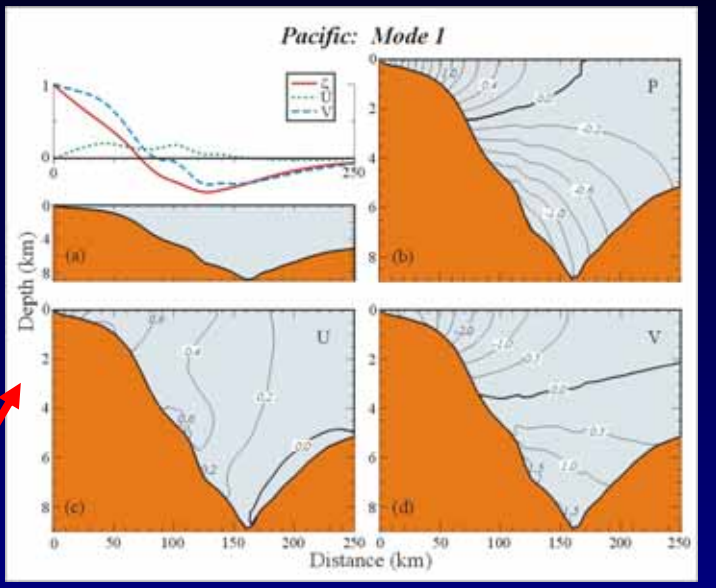
Wavelet current plot

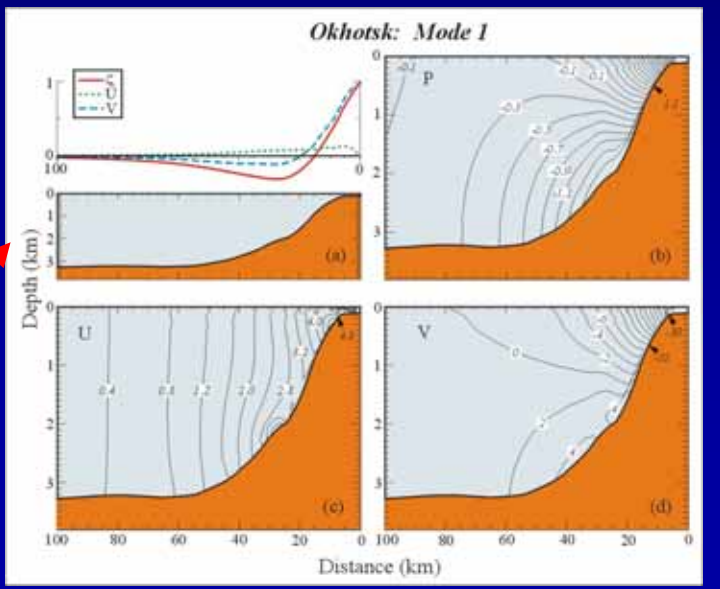


Depth profile

CTW



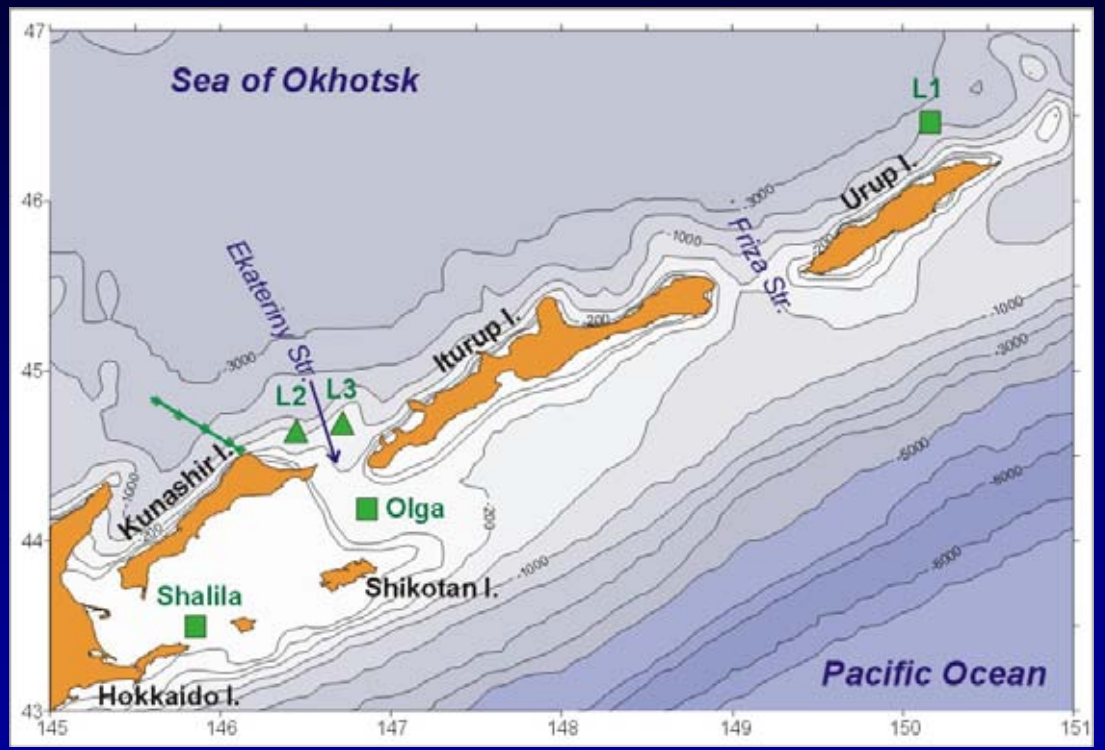




Rabinovich and Thomson, 2001

Modes

ADCP and RCM observations of currents
near the South Kuril Islands



(1) **Olga**: *Sontec Argonaut*
4.08.2004 – 03.07.2005
T = 334 d; *h* = 35 m (200)

(2) **Shalila**: *Sontec Argonaut*
14.05.2005 - 23.10.2004
T = 168 d; *h* = 20 m (22)

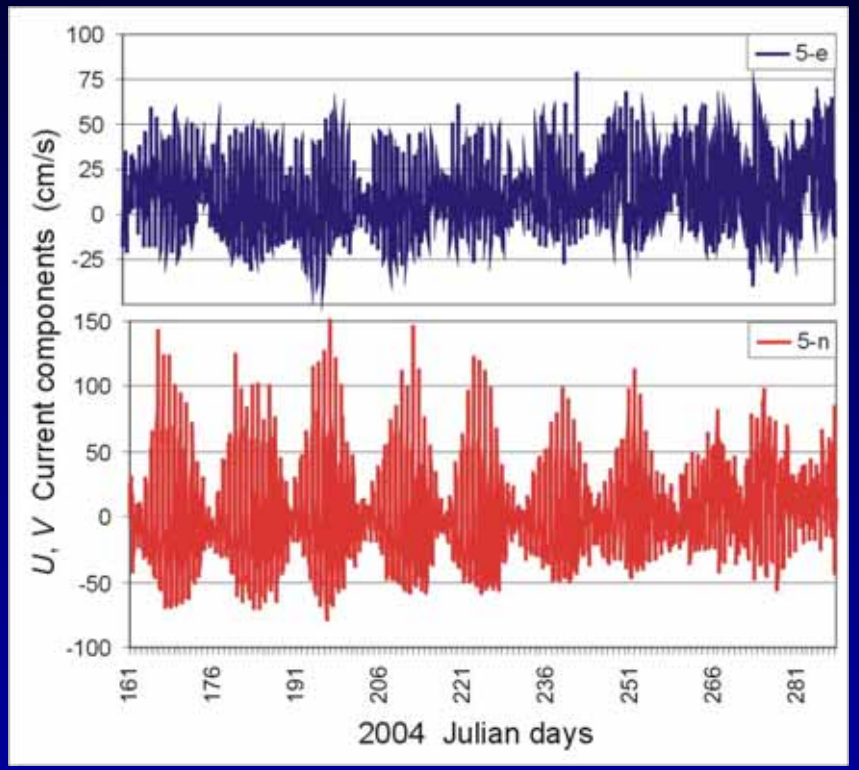
(3) **Leya-1**: *Sontec Argonaut*
28.02.2003 – 19.11.2003
T = 265 d; *h* = 30 m (110)

(4) **Leya-2**: *ADP*, 15 depths
(8, 16, 24,…,120 m)
10.06.2003 – 15.10.2003
T = 127 d

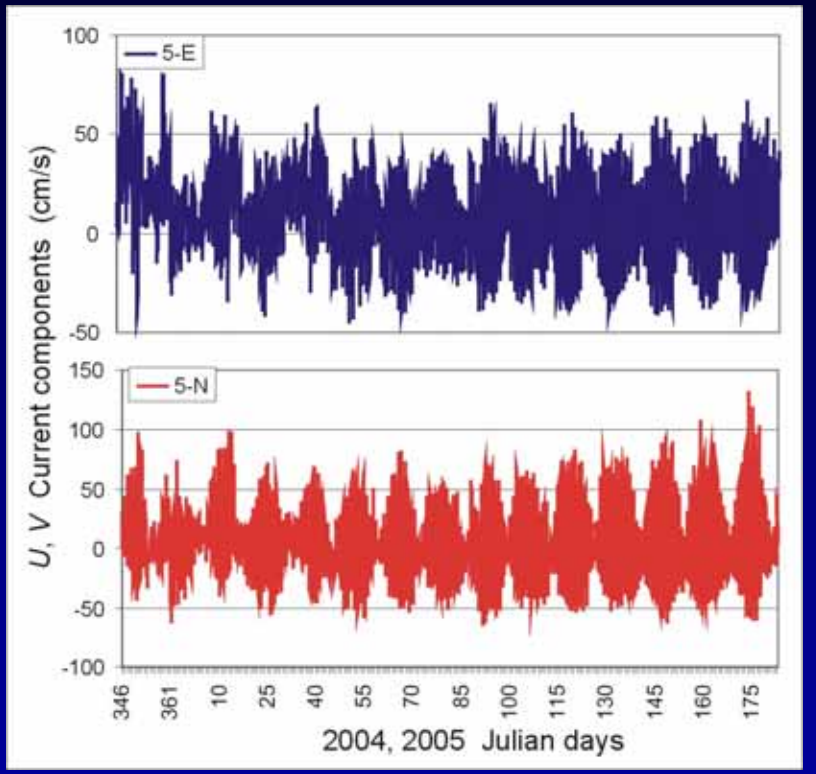
(5) **Leya-3**: *ADP*, 15 depths
(8, 16, 24,…,120 m)
11.12.2004 30.06.2005
T = 200 d

Observations

Leya-2 (80 m)



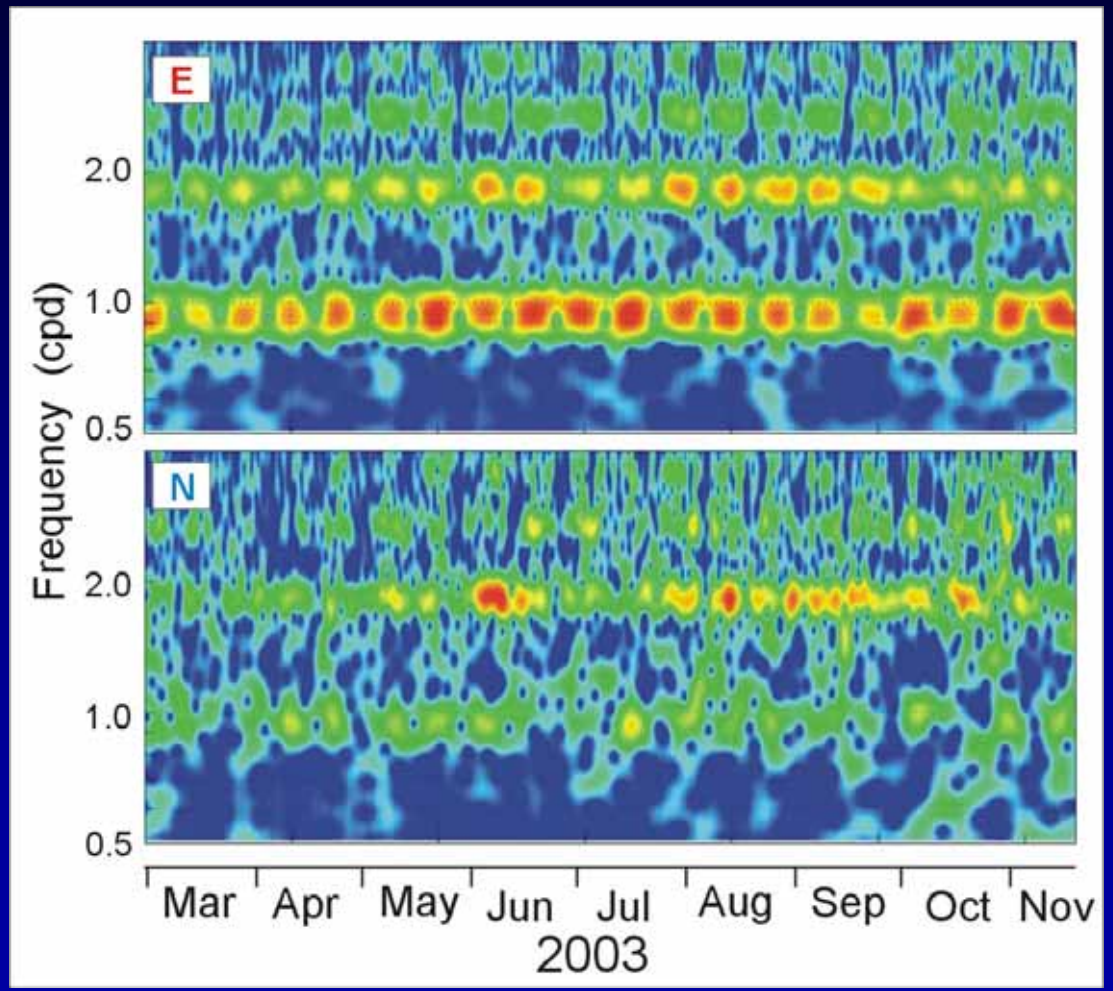
Leya-3 (80 m)



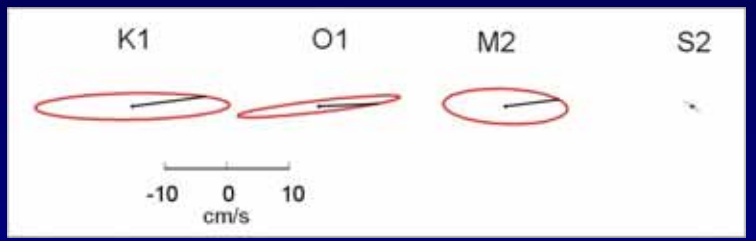
(1) Strong dominance of diurnal tidal currents (from top to bottom)
(2) Significant fortnightly cycle
(3) Anisotrophic character of tidal currents
(4) Periods of “suppressed tides”

Leya-1 (30 m): NW shelf of Urup Island

Wavelet *f-t* diagrams



Tidal ellipses
(integrated over the observational period)

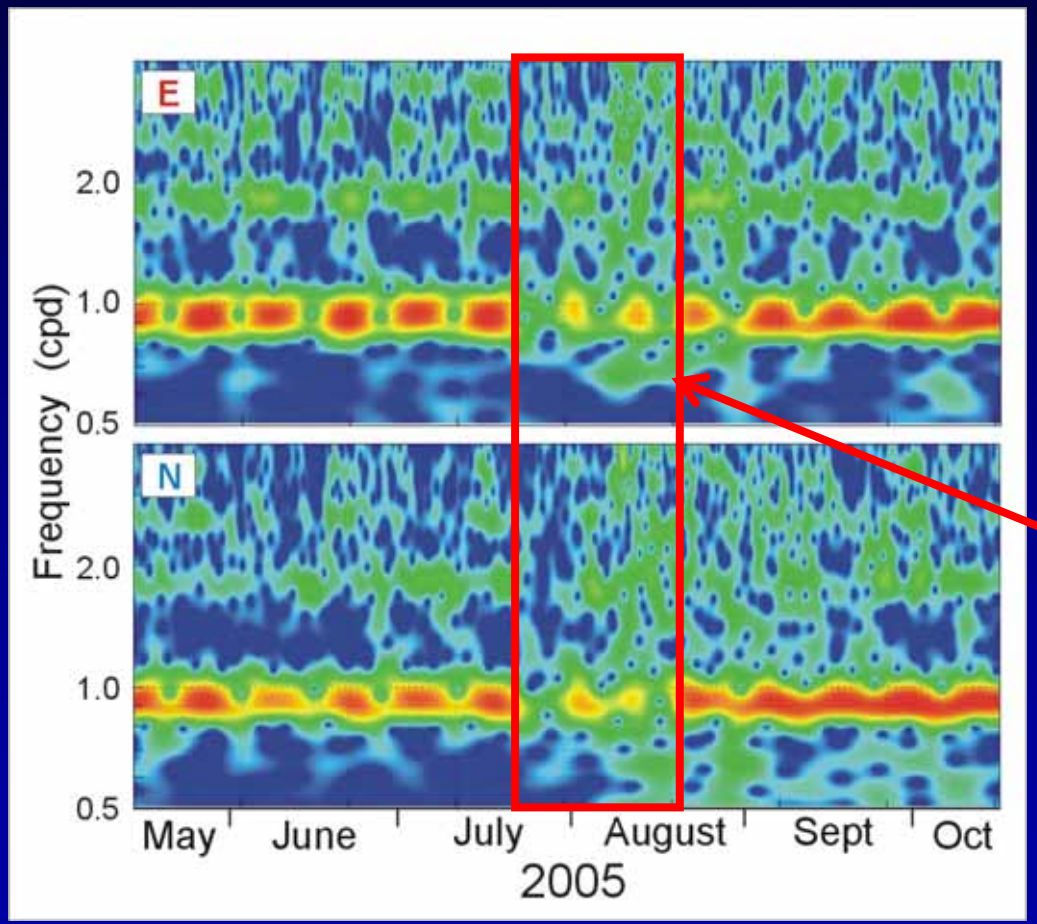


Diurnal (K1, O1) currents are:

- Strongly dominant
- Almost rectilinear
- Steady

Shalila (20 m): Bottom currents on the shelf of Tanfilieva Island (Habomai Is)

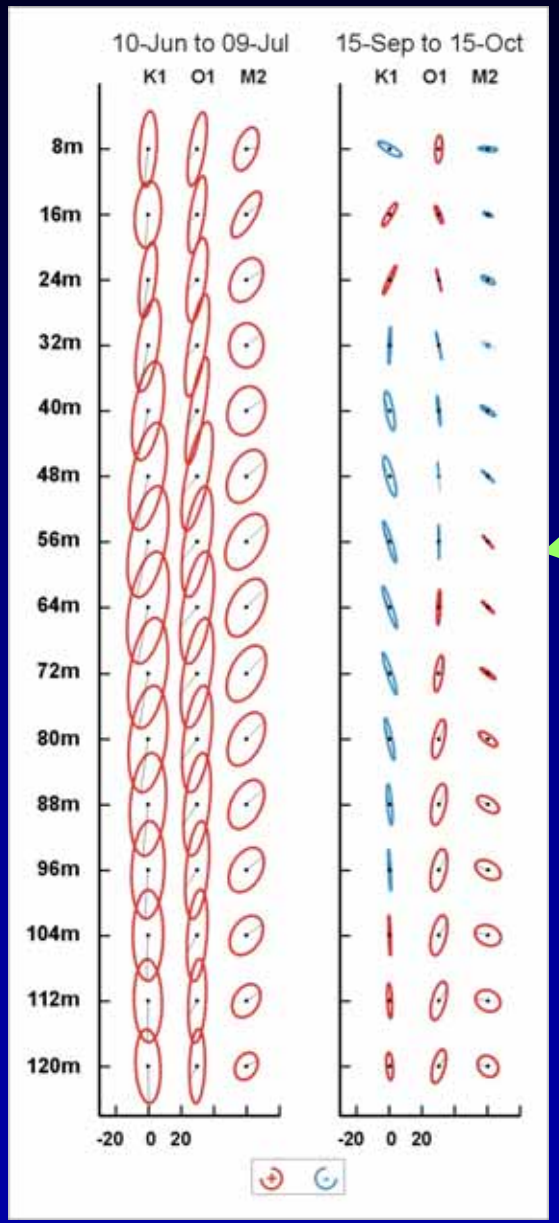
Wavelet *f-t* diagrams

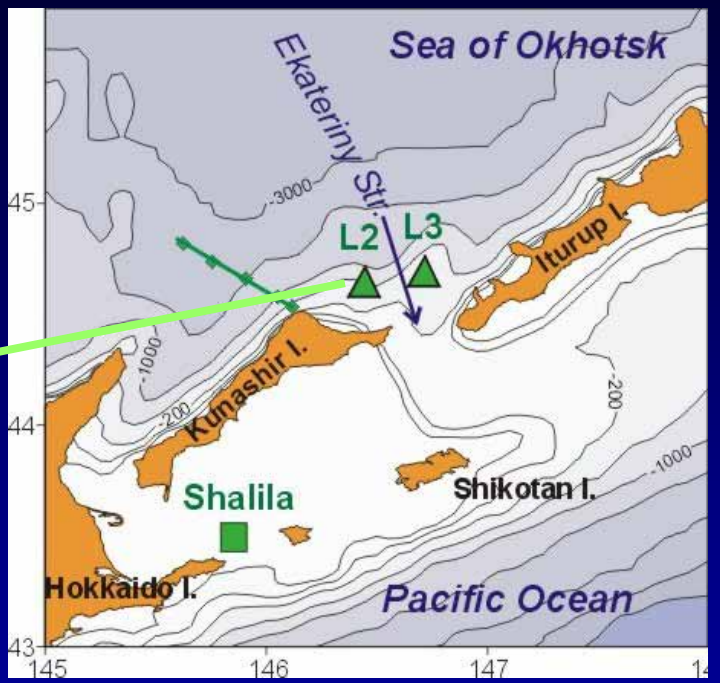


Strongly dominant diurnal currents

"Tidal suppression"

Leya-2: ADP currents in Ekateriny Strait (2003)

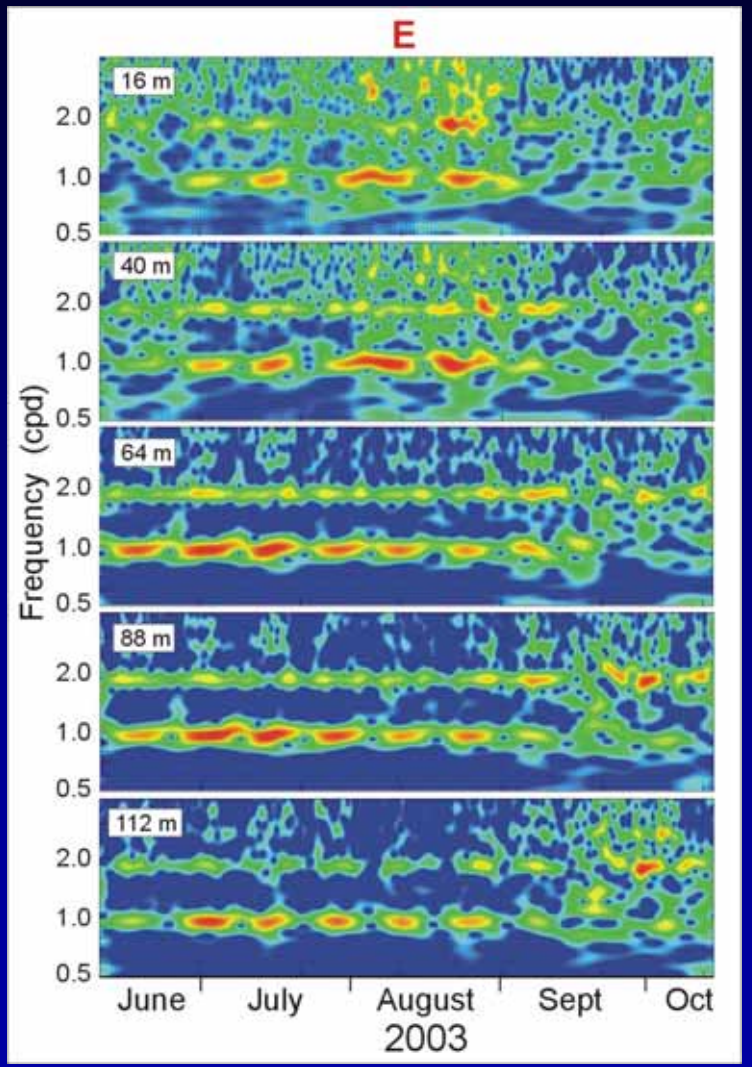


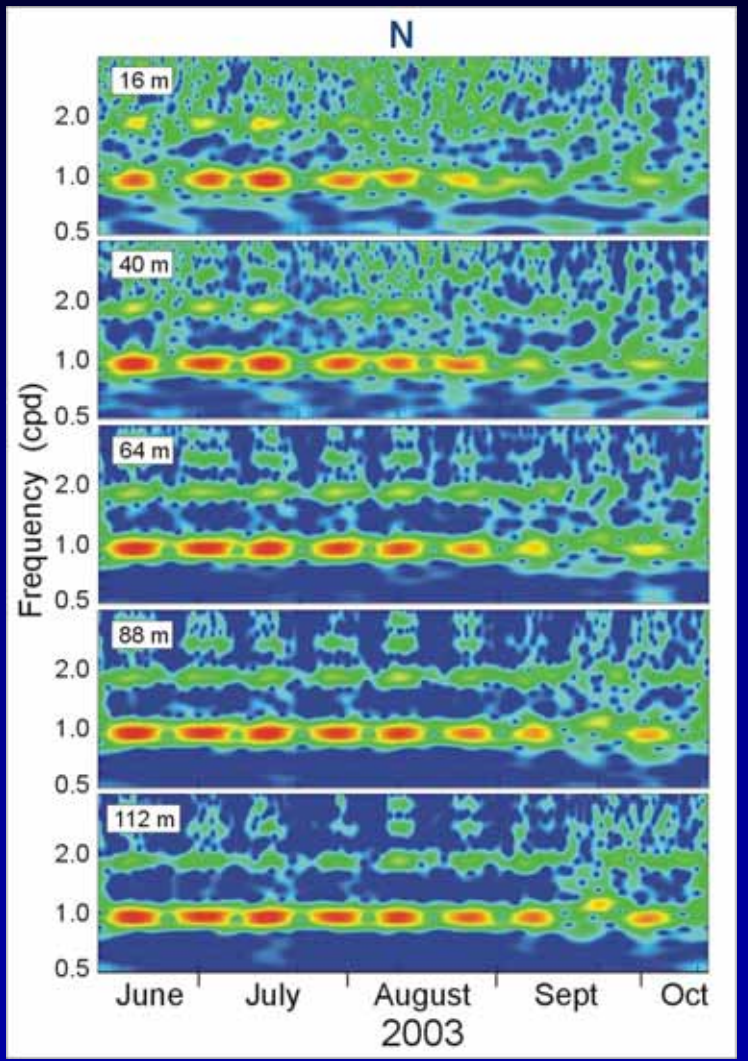


Top-to-bottom tidal ellipses for June-July and September-October, 2003

Leya-2: ADP currents in Ekateriny Strait (2003)

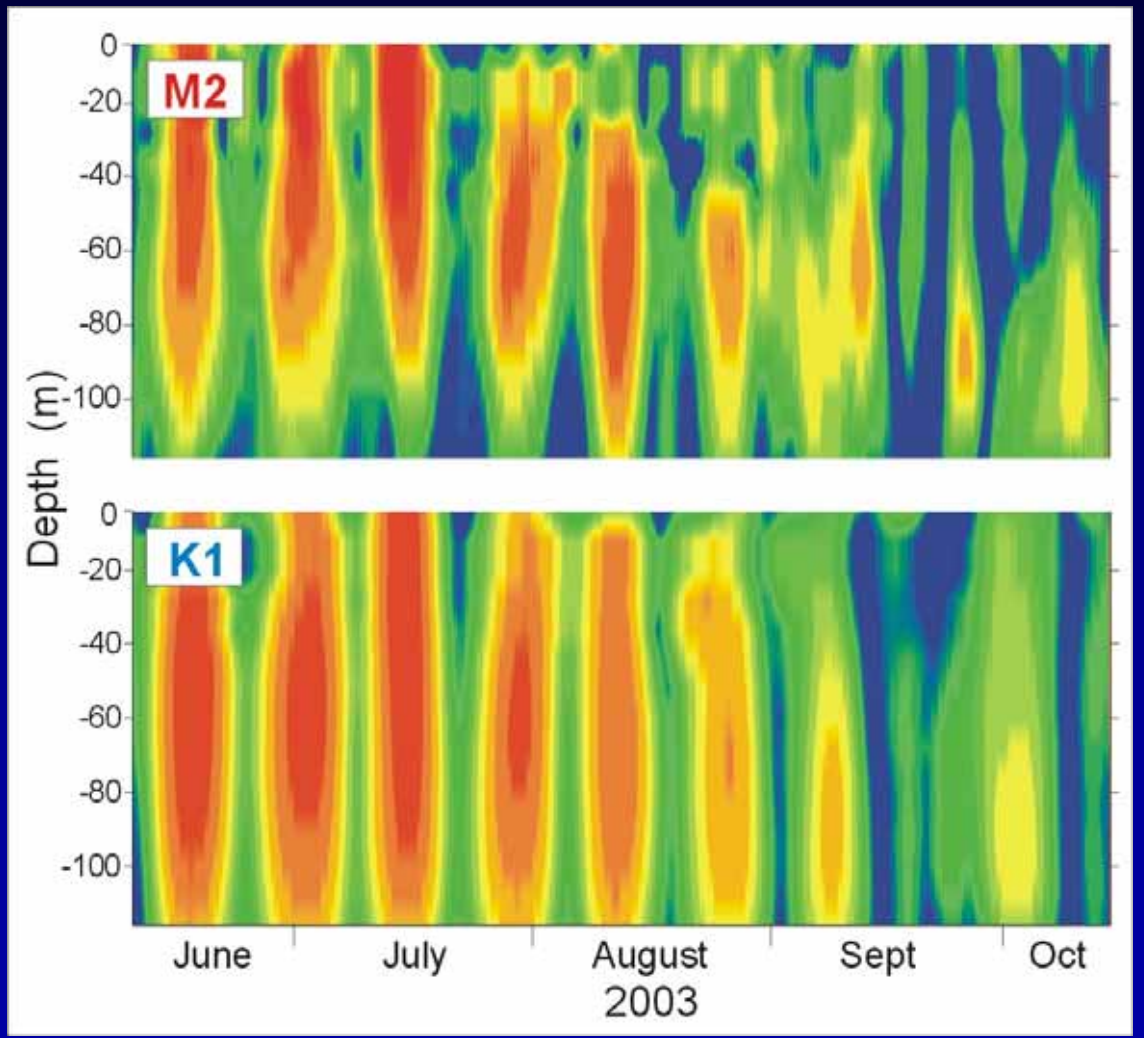
Wavelet *f-t* diagrams





Leya-2: ADP currents in Ekateriny Strait (2003)

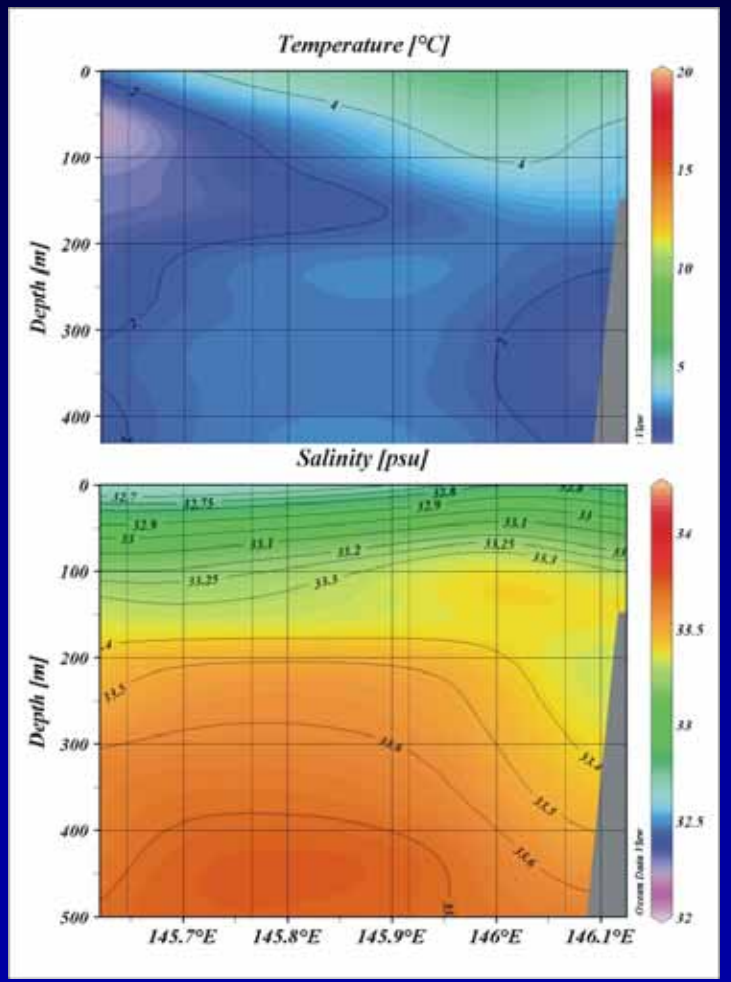
Time-vertical changes of tidal energy



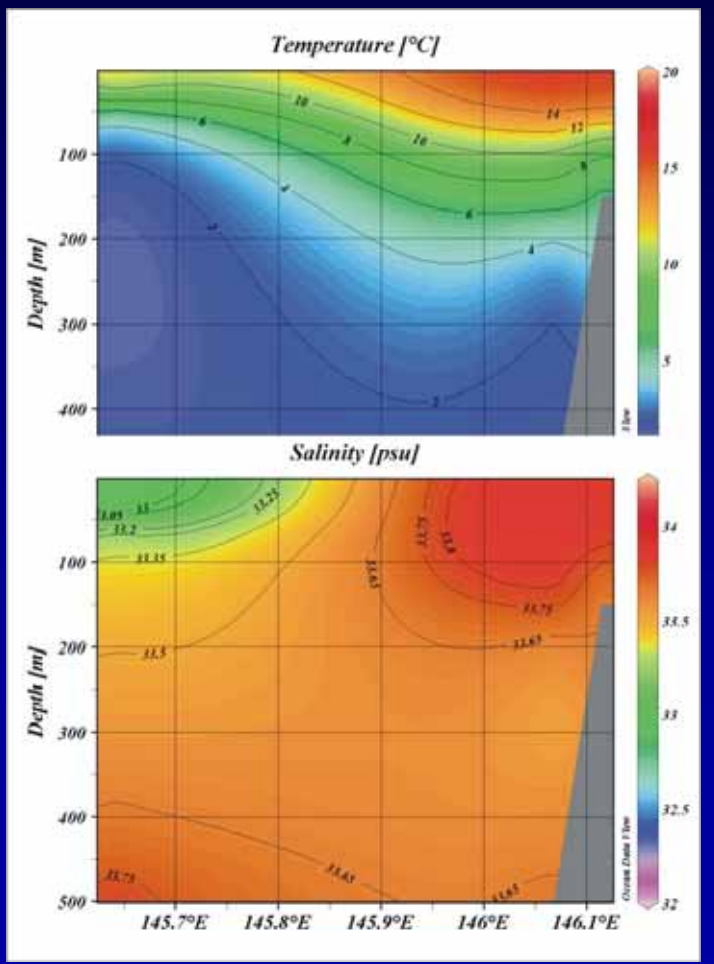
Leya-2: ADP currents in Ekateriny Strait (2003)

Temperature and salinity cross-sections

June

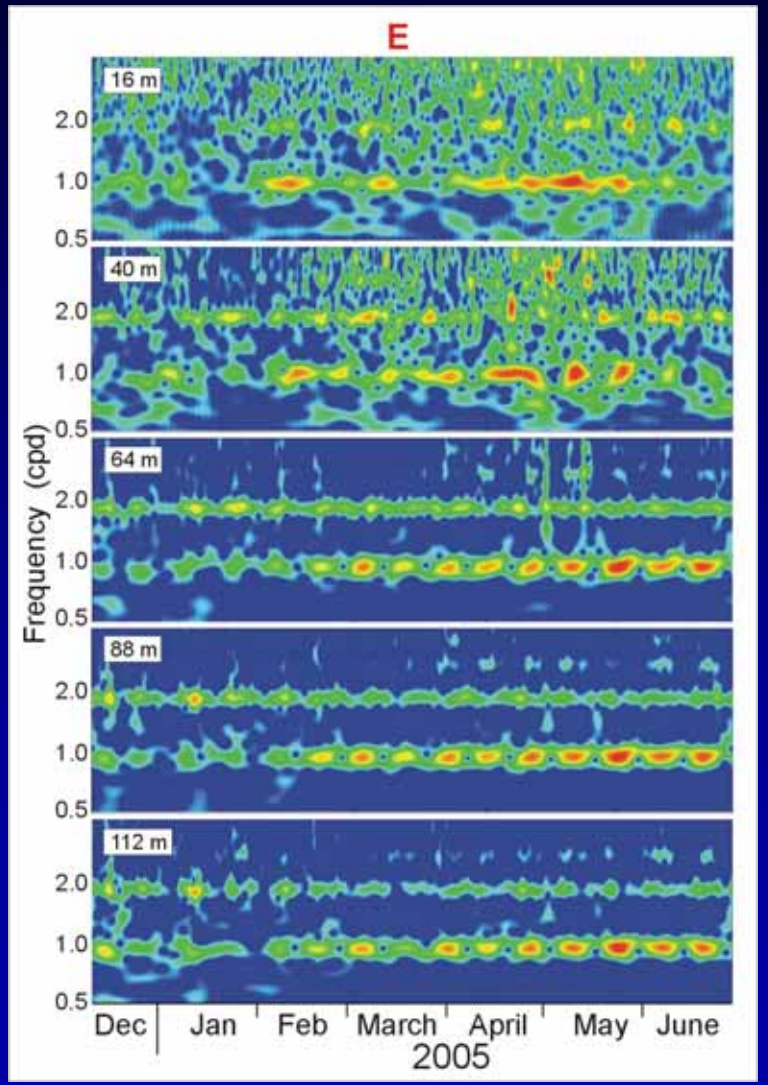


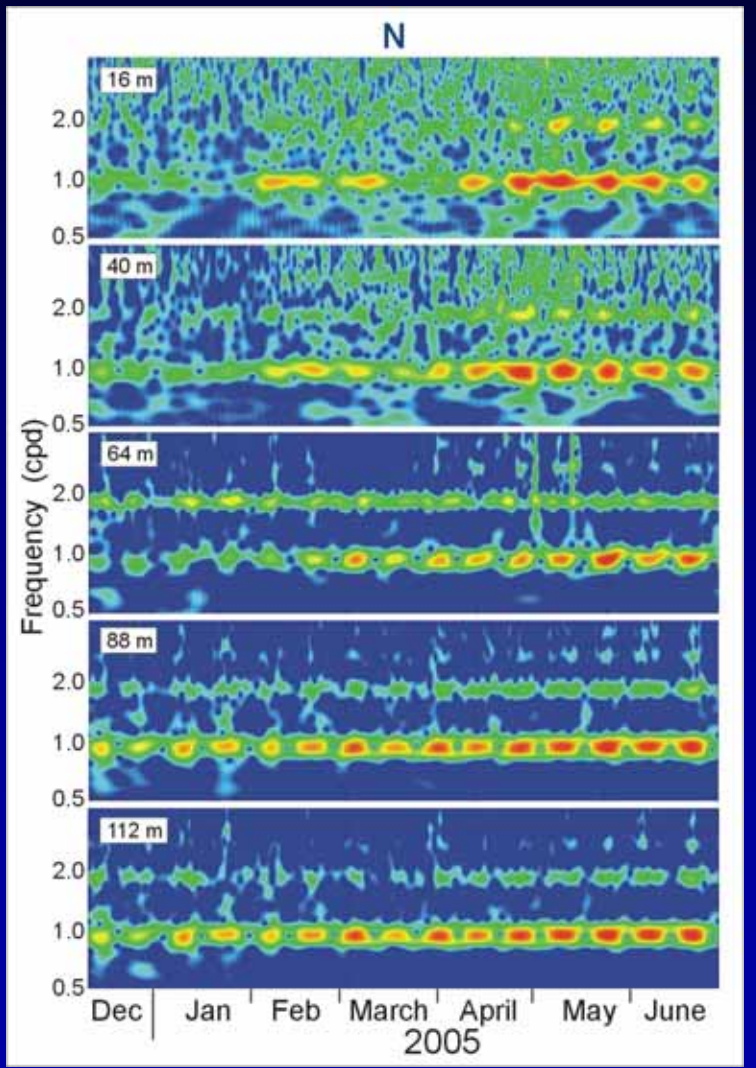
September



Leya-3: ADP currents in Ekateriny Strait (2004-2005)

Wavelet *f-t* diagrams





Summary

- Long-term observations of currents near the South Kuril Islands reveal strong diurnal tidal currents, which dominate all other types of motions in this region.

- The observations and results are in good agreement with drifter observations and numerical models in this region and support the conclusion that diurnal currents in this region are associated with coastal trapped waves.

- Diurnal tidal currents are close to uniform in the vertical (with only 20-30% variation) and relatively stable in time, but…

- **There are periods of “tidal suppresion” (one-two months duration), which are highly correlated with changes in stratification and mean flow.**

- **However the exact mechanism for this “suppression” is still a puzzle…**


La Fine