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WAVE STRUCTURE OF TIDAL MOTIONS NEAR THE NORTH KURIL ISLANDS AS REVEALED FROM SATELLITE ALTIMETRY MEASUREMENTS

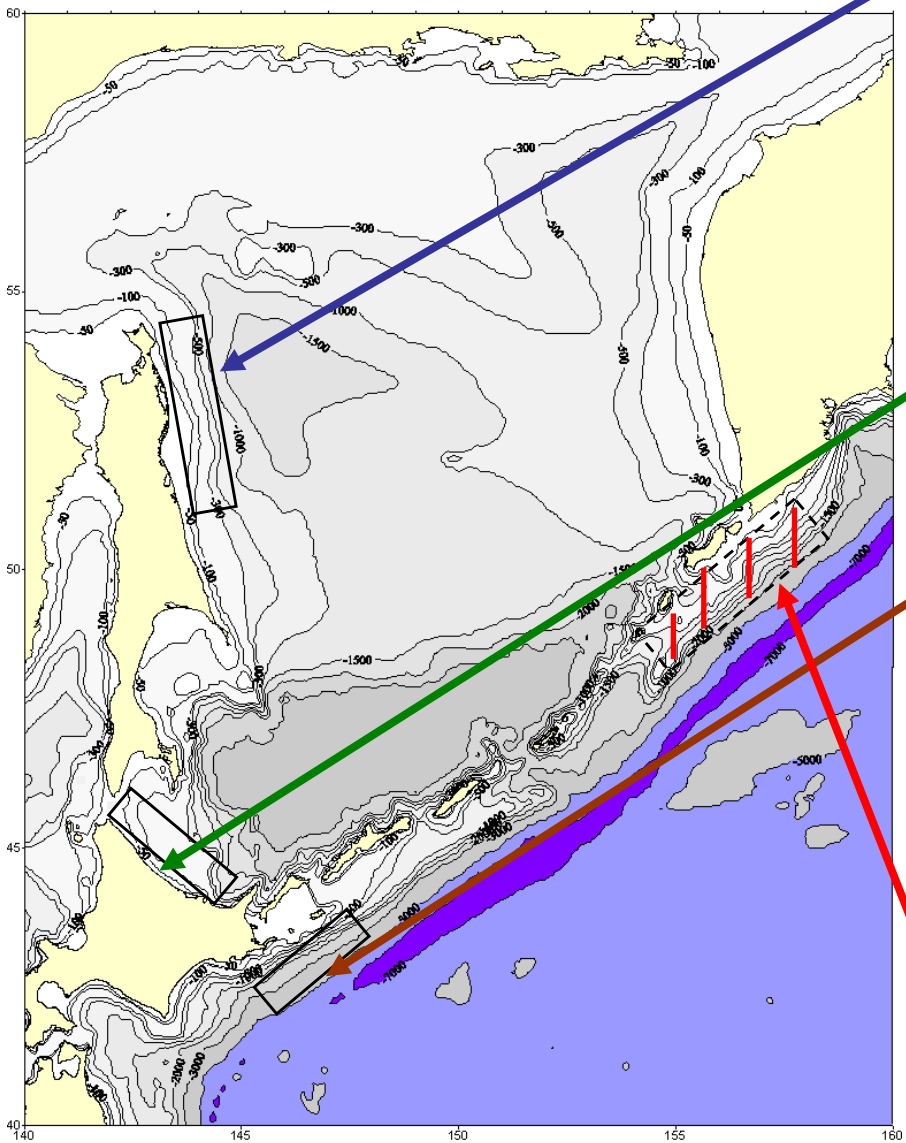
(ALTIMETRY OBSERVATIONS OF DIURNAL SHELF WAVES NEAR SAKHALIN AND THE NORTH KURIL ISLANDS)

George Shevchenko[1]
and Alexander Romanov[2]

Shelf waves at diurnal frequencies cause strong tidal currents, intensive energy dissipation and small-scale variations of diurnal amplitudes and phases.

The question: Can we use satellite altimetry data to detect and examine diurnal shelf waves?

Areas where diurnal shelf waves are found:



Northeastern Sakhalin shelf [*Rabinovich and Zhukov*, 1984; *Putov and Shevchenko*, 1998; *Ohshima et al*., 2002; *Shevchenko et al*., 2004; *Thomson et al*., 2007]

Northern Hokkaido shelf [*Odamaki,* 1994]

Southern Kuril shelf [*Efimov and Rabinovich*, 1980; *Kovalev and Rabinovich*, 1980]

Central Kuril shelf (CTW) [*Nakamura et al*., 2000; *Rabinovich and Thomson*, 2001]

Northern Kuril shelf (present study)

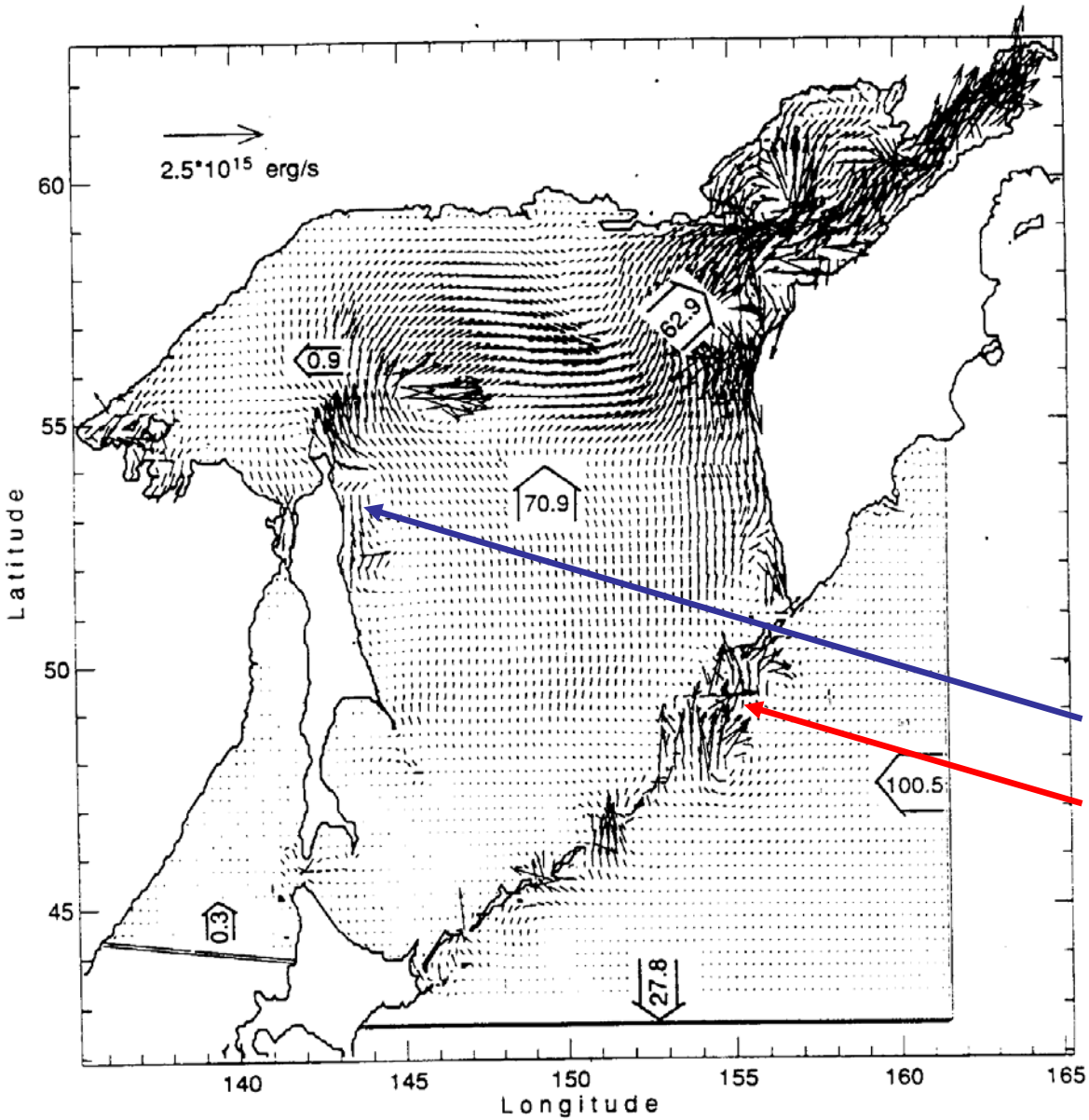
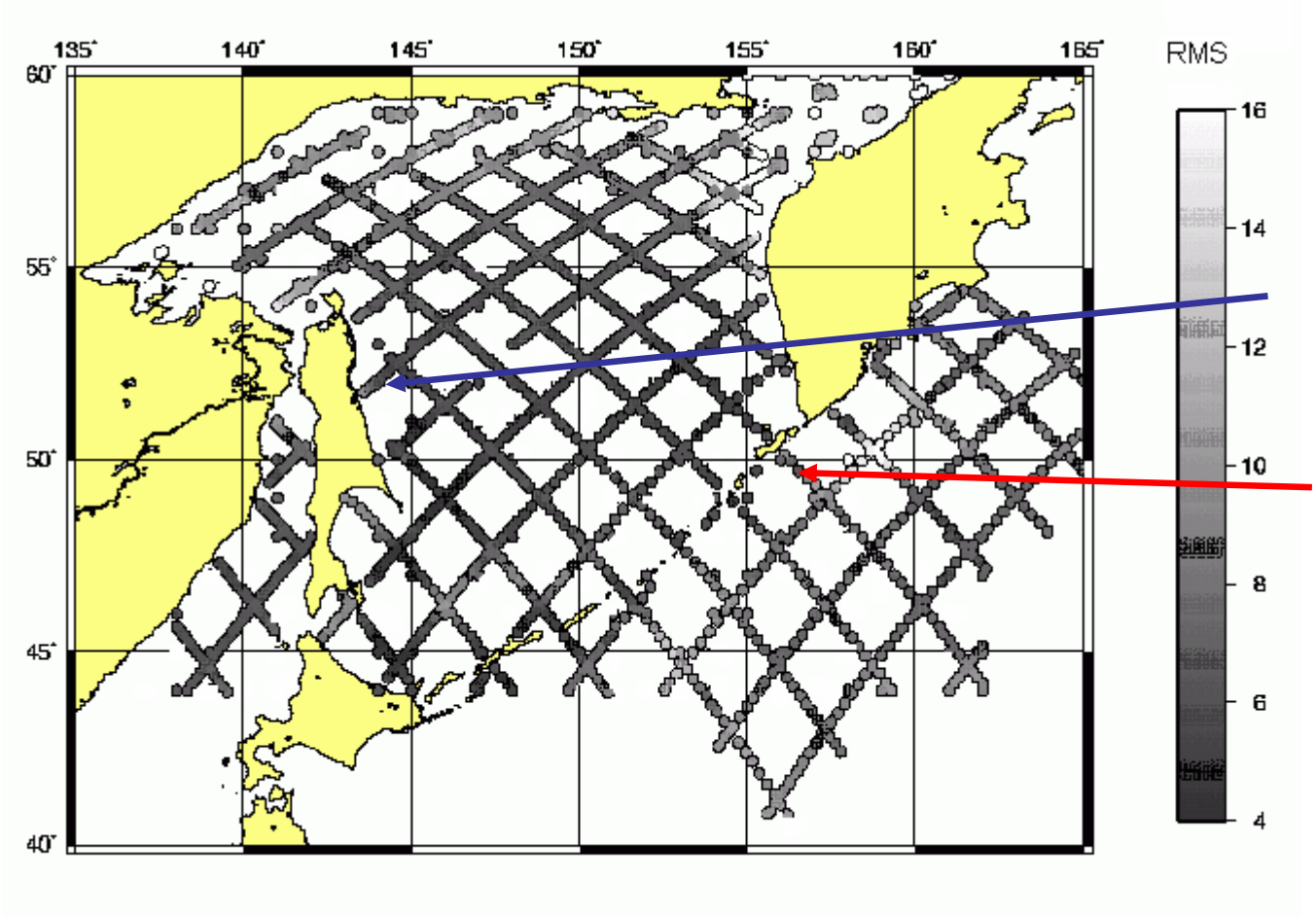


FIG. 8. Tidal energy flux for K_1 wave. Large arrows show the net energy flux through transects. The values inside arrows should be multiplied by 10^{16} erg s^{-1}.

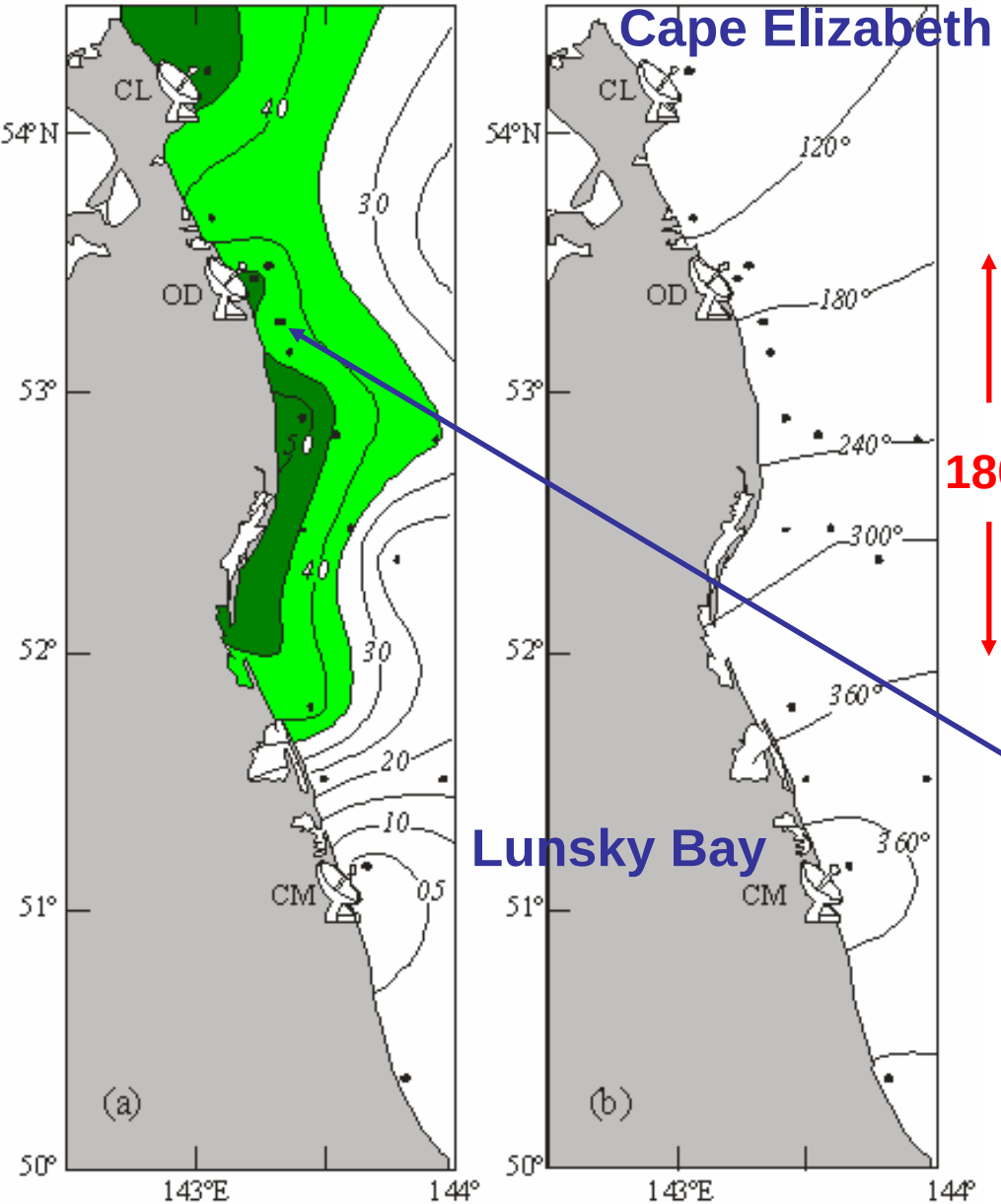
Tidal energy flux for K1 wave [*Kowalik and Polyakov*, 1998]

Areas of strong tidal currents and significant tidal energy dissipation



Obtained K1 and O1 amplitudes and phases were used

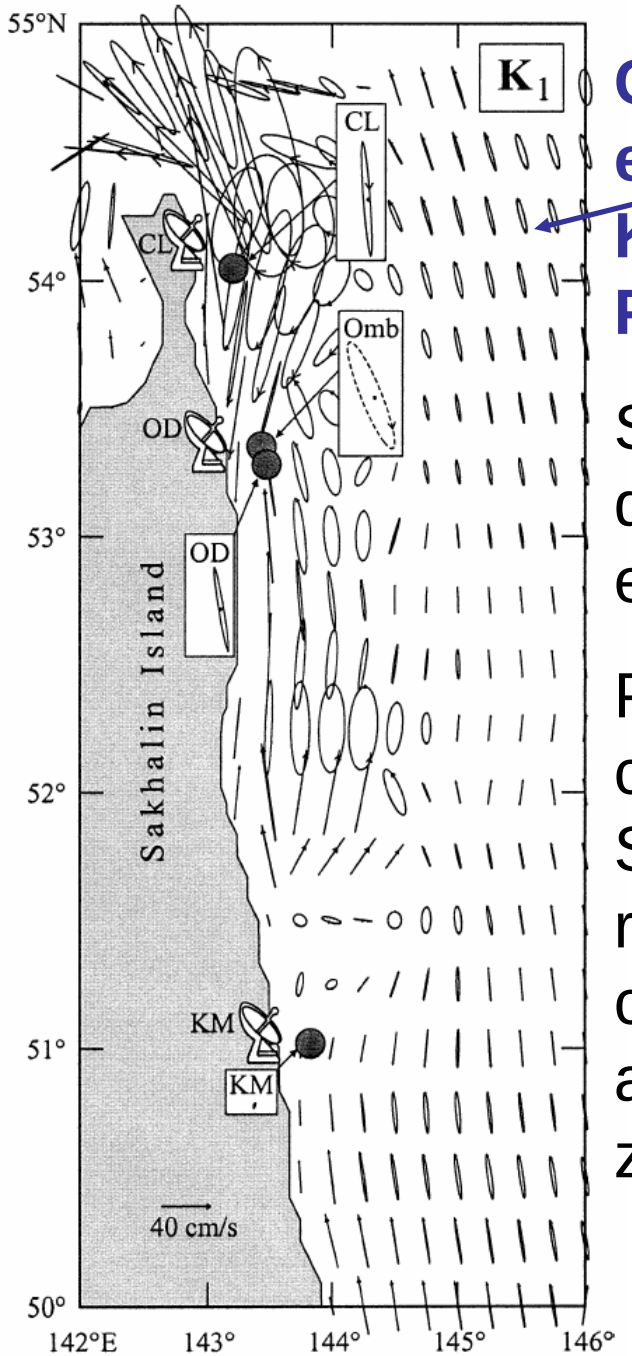
Topex\Poseidon sub-satellite tracks where altimetry data (1993-2002) were used to determine tidal wave amplitudes and phases [*Shevchenko, Romanov,* 2004].



180°

Spatial variations of K1 amplitude and phase of the north-directed velocity component on the northeastern Sakhalin based on current (30 moorings) and ice-drift (3 coastal radar stations) measurements [*Shevchenko et al.*, 2004]

Strong diurnal currents in the narrow nearshore zone between Cape Elizabeth and Lunsky Bay

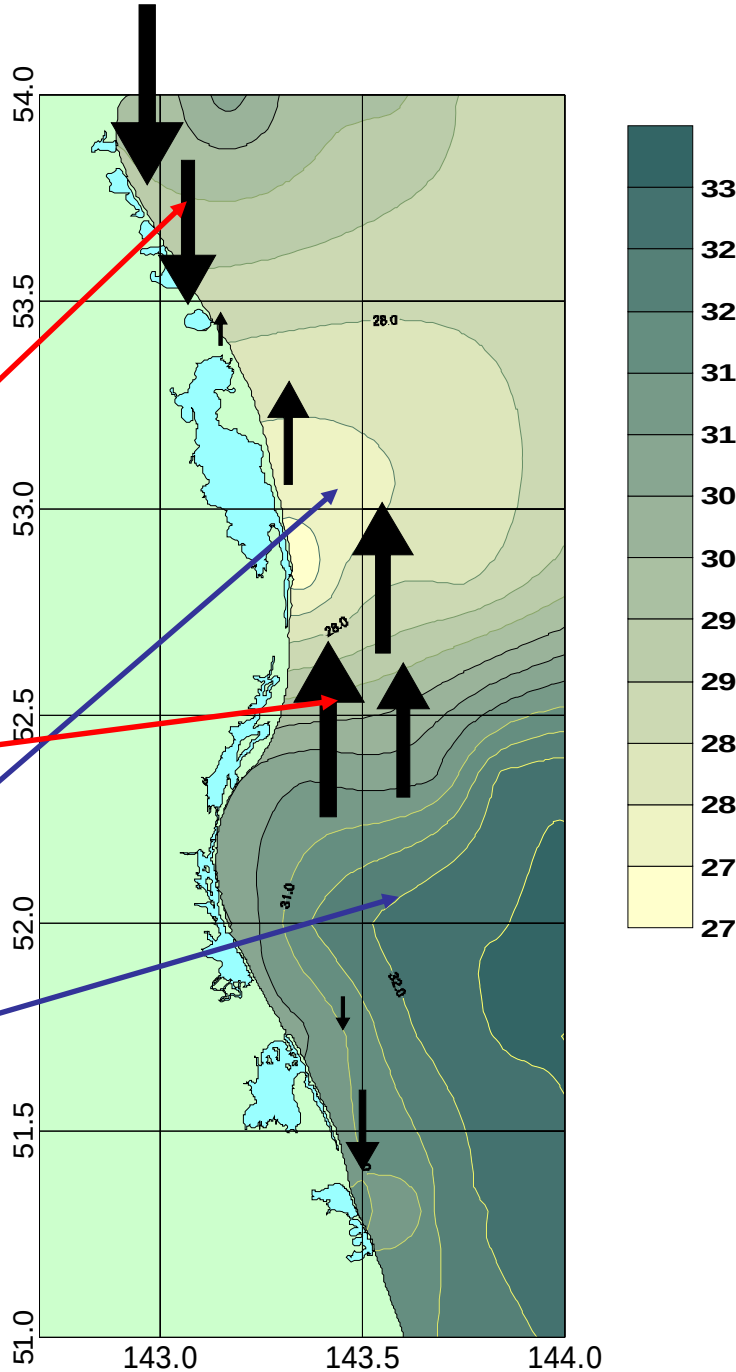


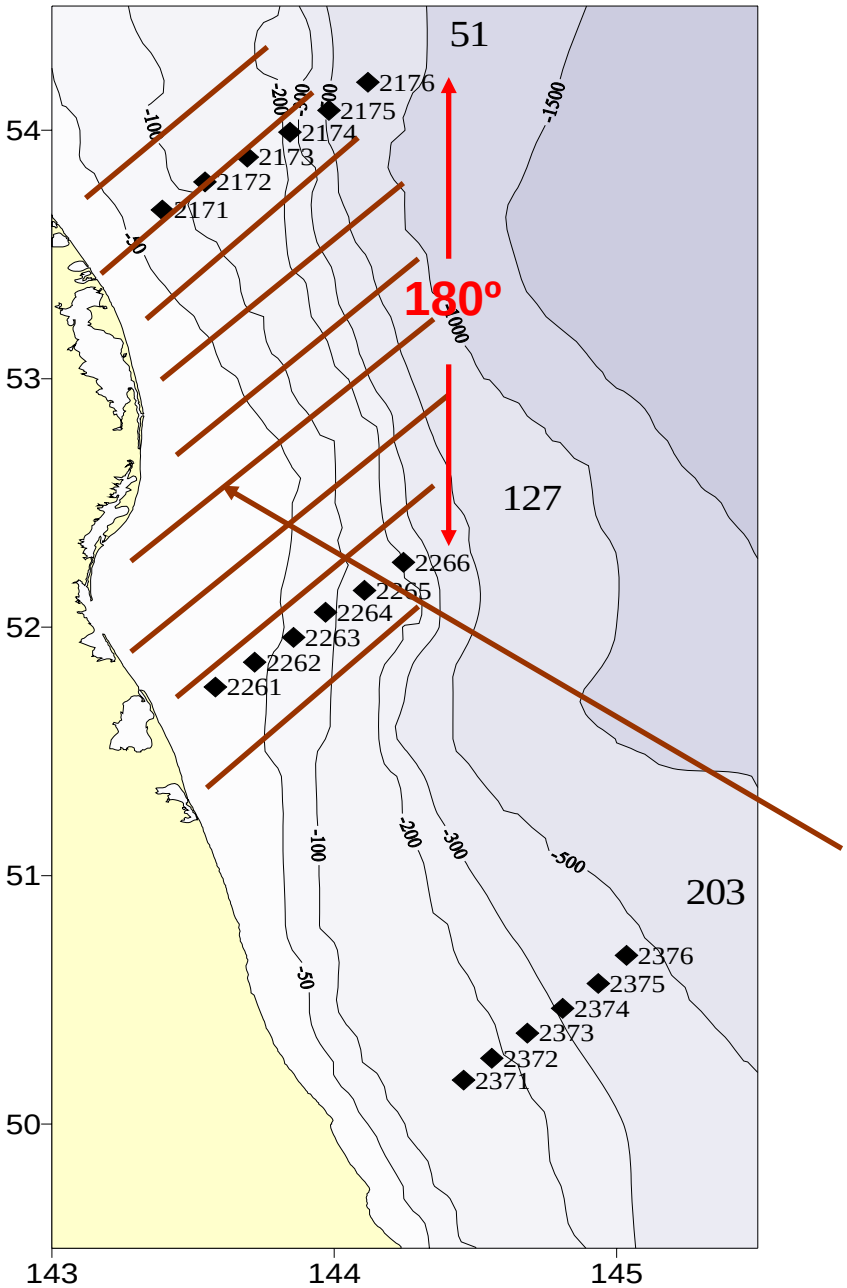
Computed K1 tidal ellipses [from Kowalik and Polyakov, 1998]

Spatial salinity distribution during ebb tides.

Predicted tidal currents.

Shelf waves are responsible for the current divergence and convergence zones

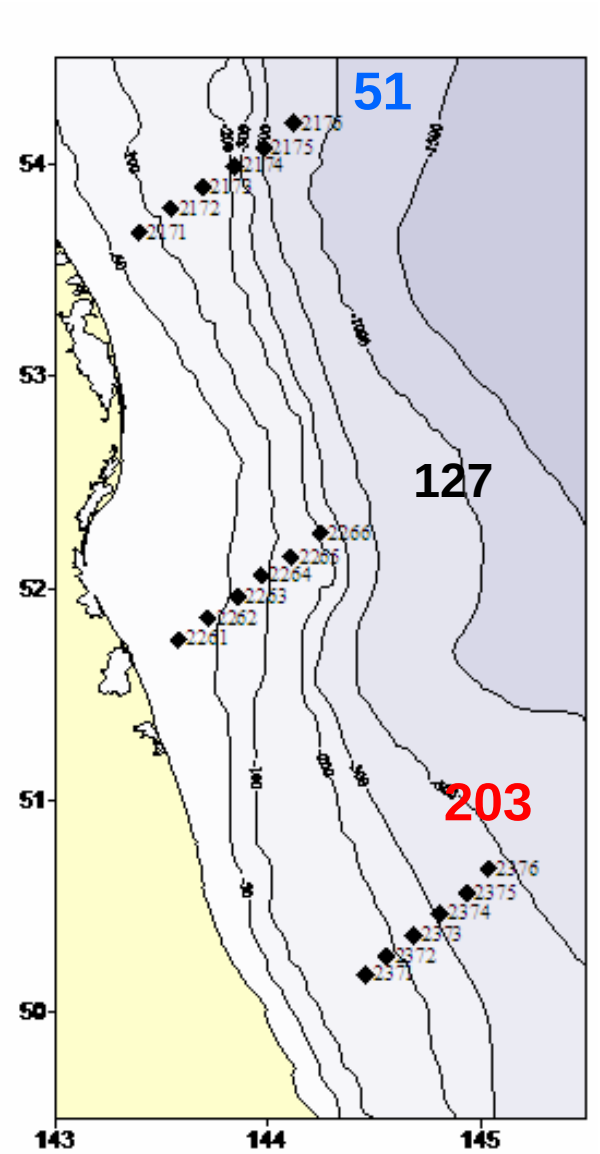


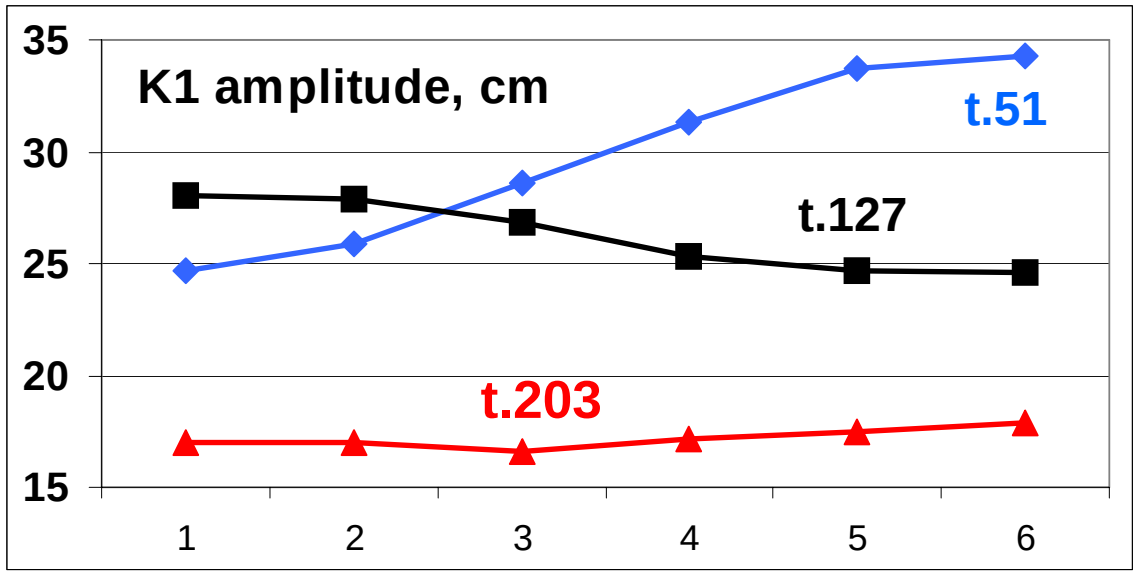


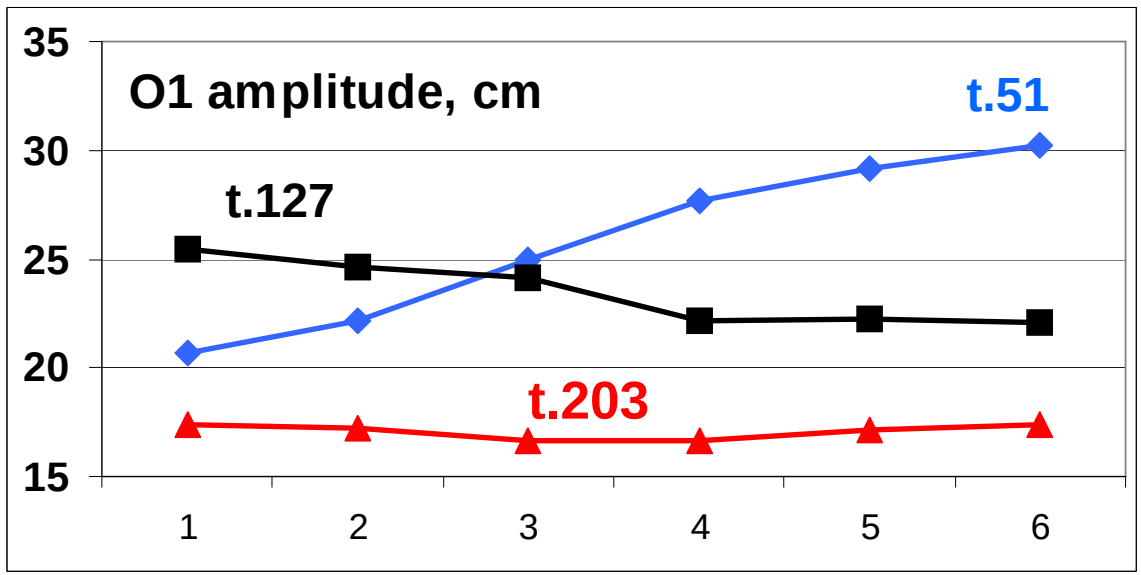
Ascending TP tracks (51, 127 and 203) crossing northeastern shelf of Sakhalin Island.

Area of shelf waves

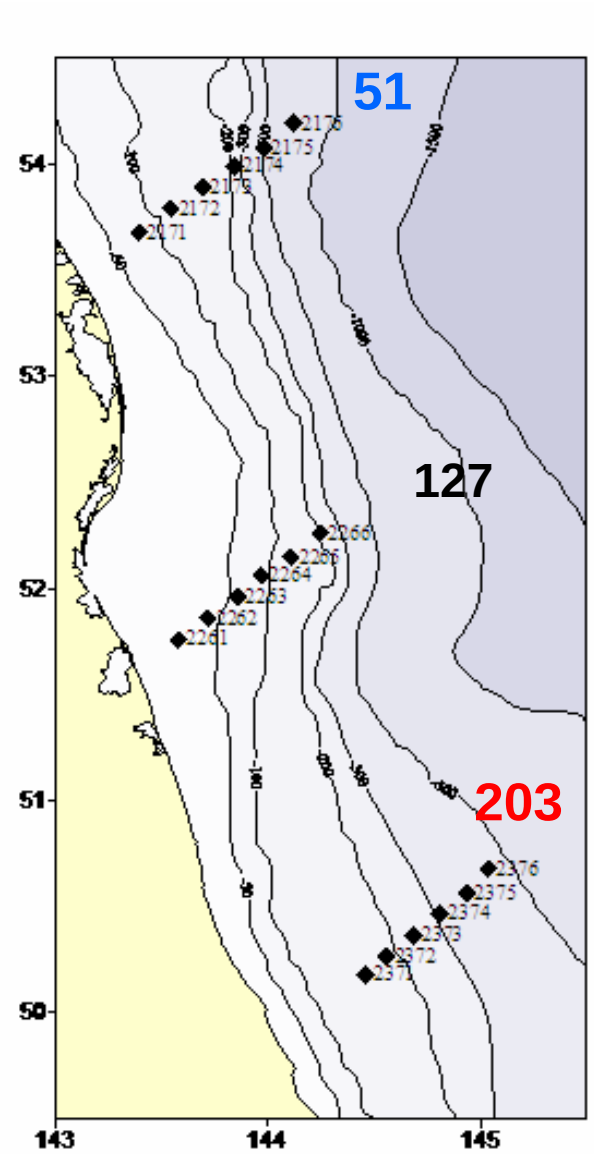
K1 and O1 amplitude variability on the northeastern Sakhalin shelf

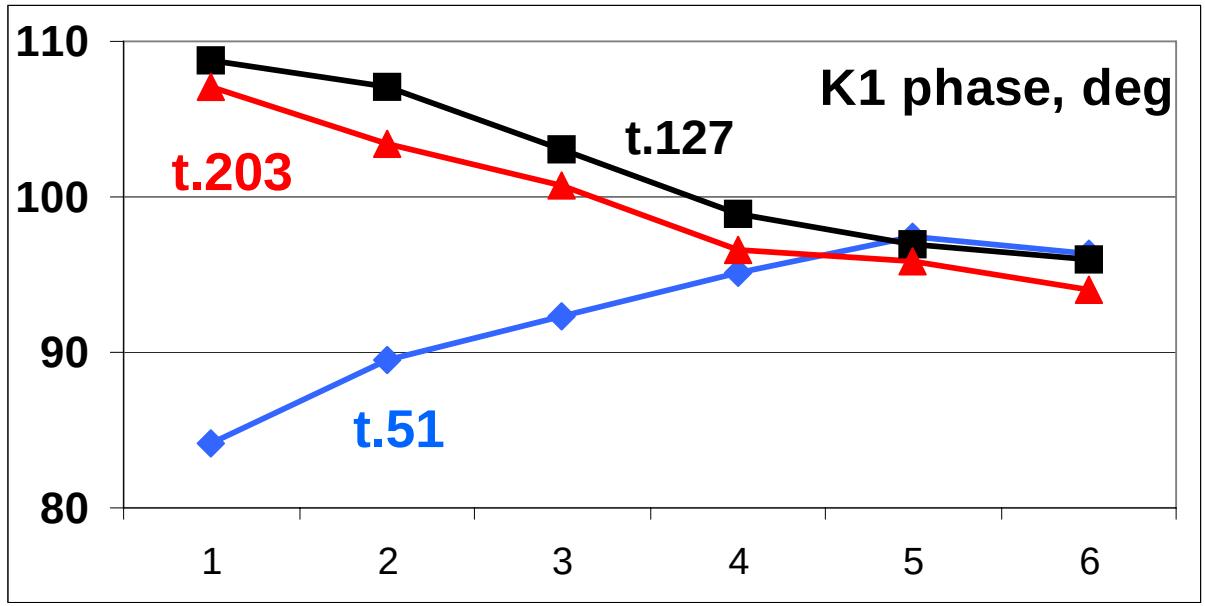


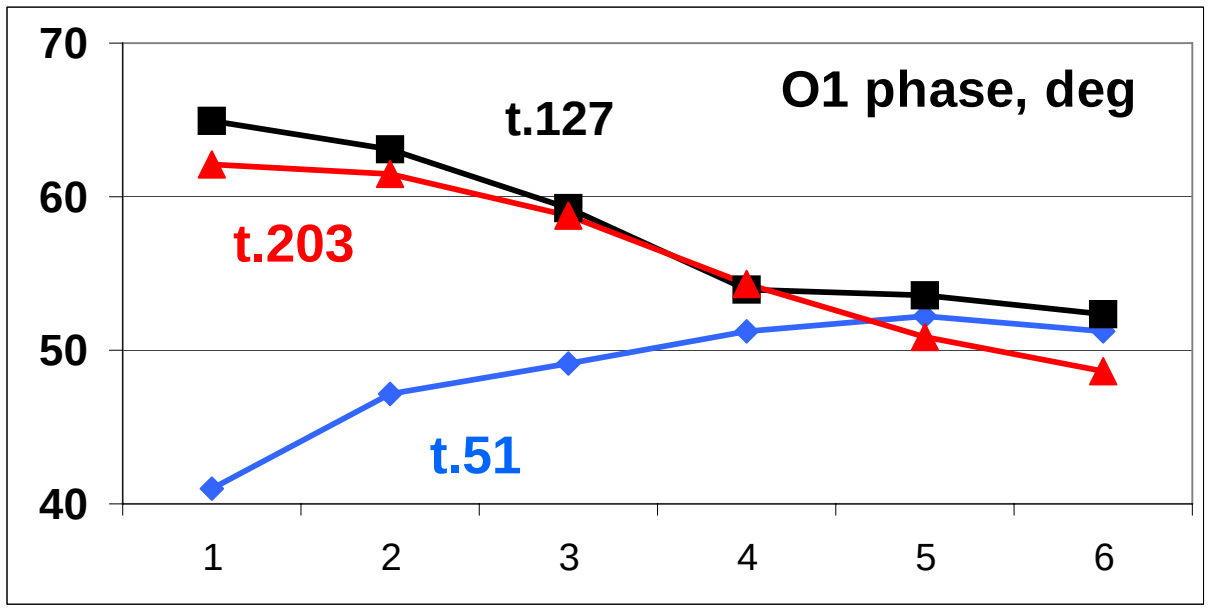




K1 and O1 phase variability on the northeastern Sakhalin shelf



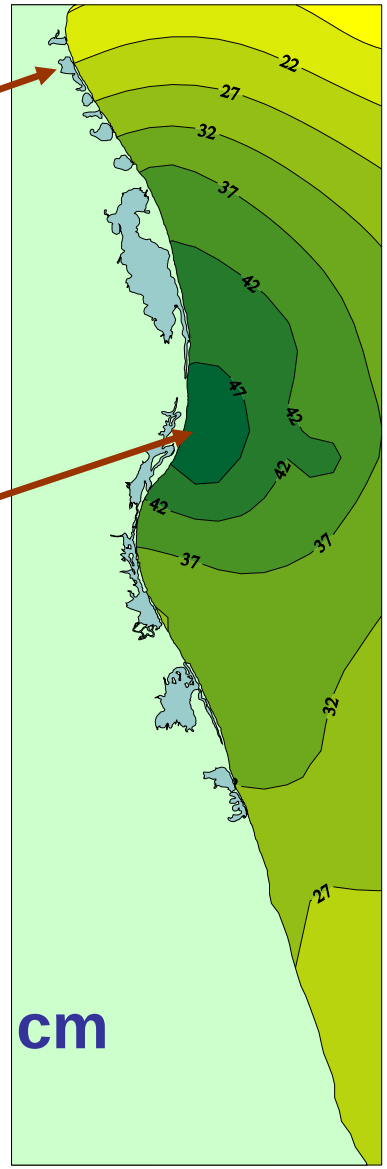




K1 sea level amplitude and phase distribution on the base of coastal and mooring observations [*Putov, Shevchenko*, 1998]

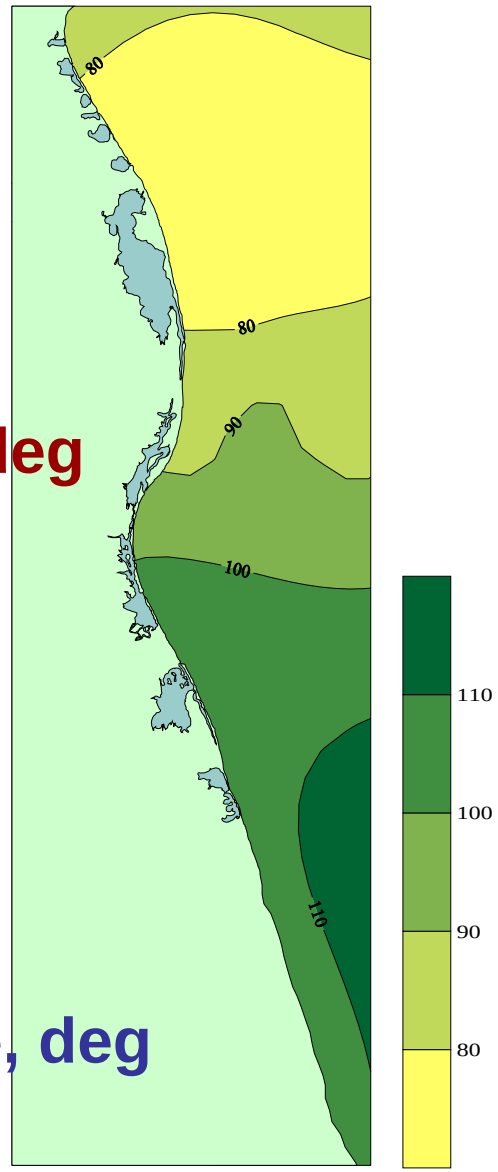
Negative contribution of shelf wave

Positive contribution of shelf wave

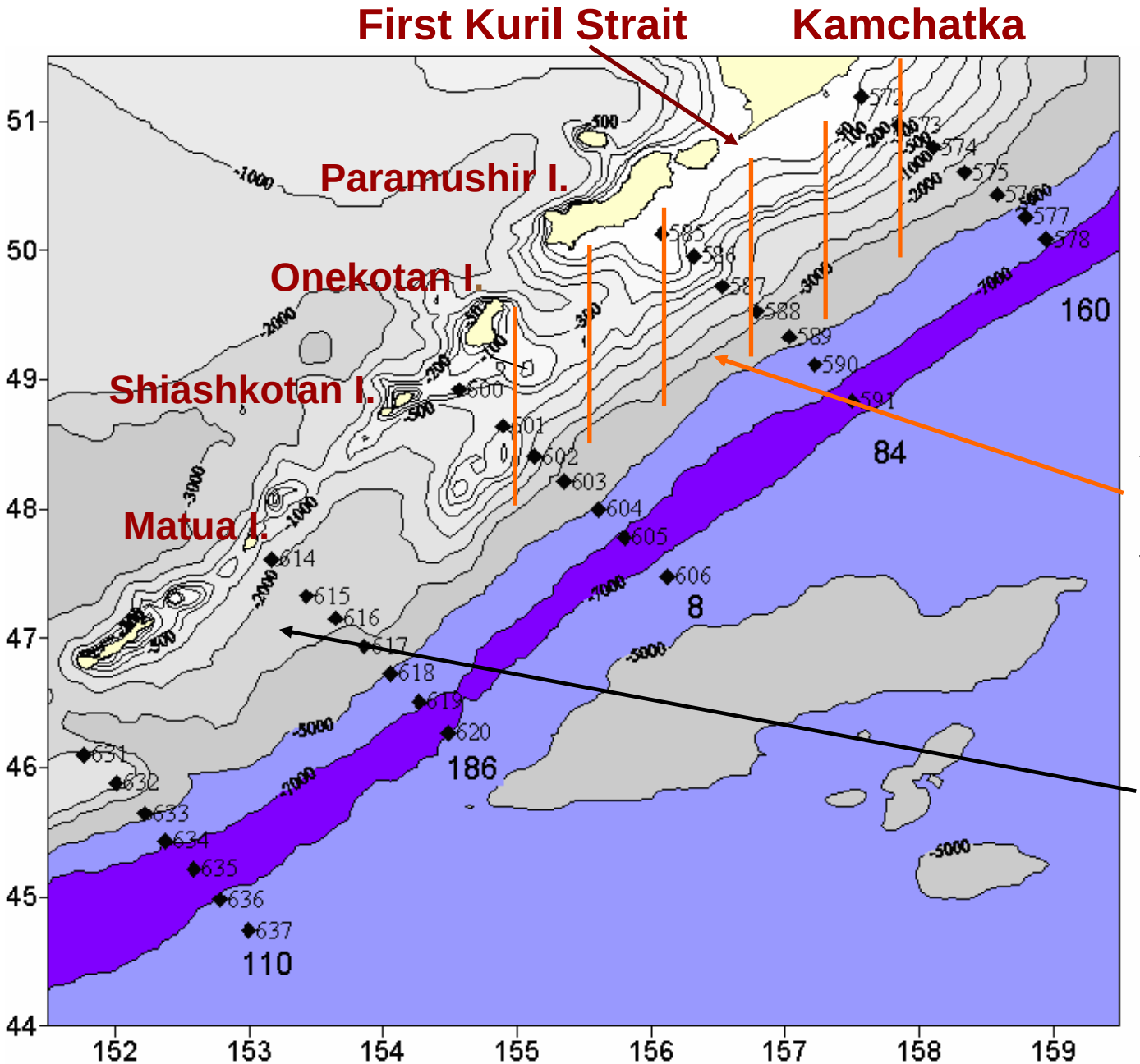


Amplitude, cm

≈ 25 deg



Phase, deg

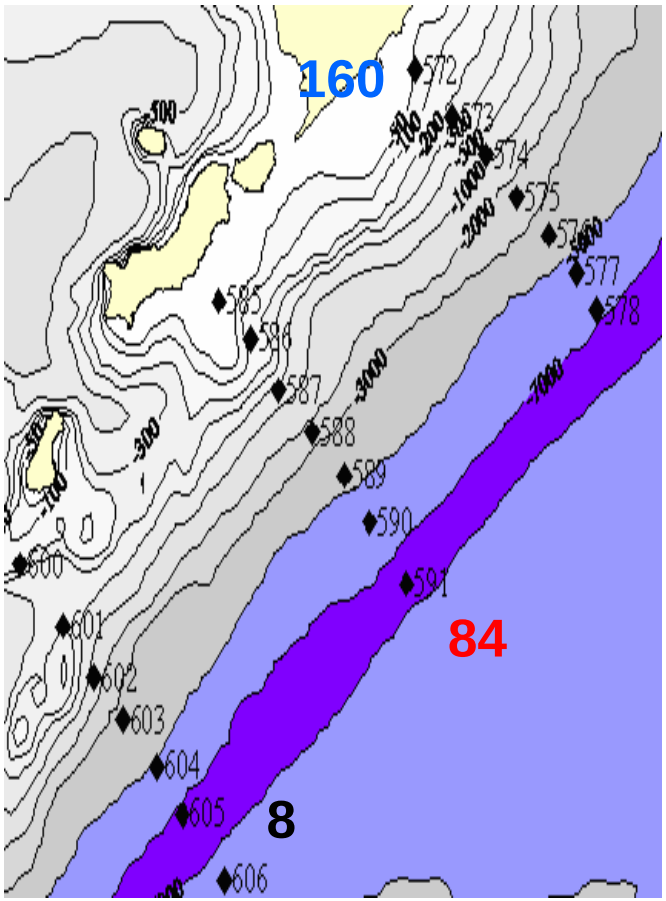


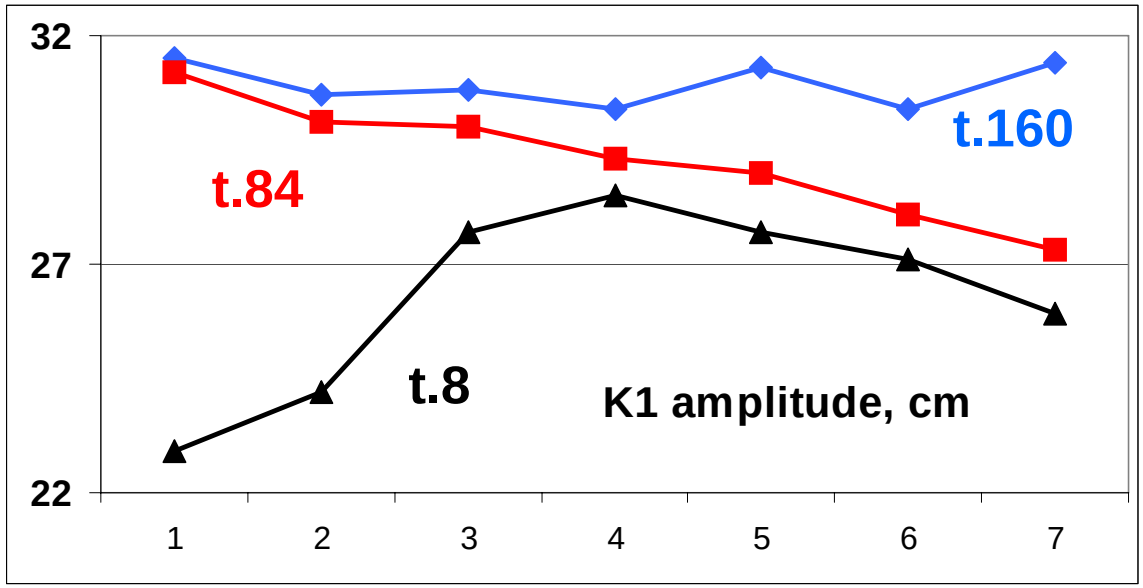
Descending T/P tracks (160, 84, 8 and 186)

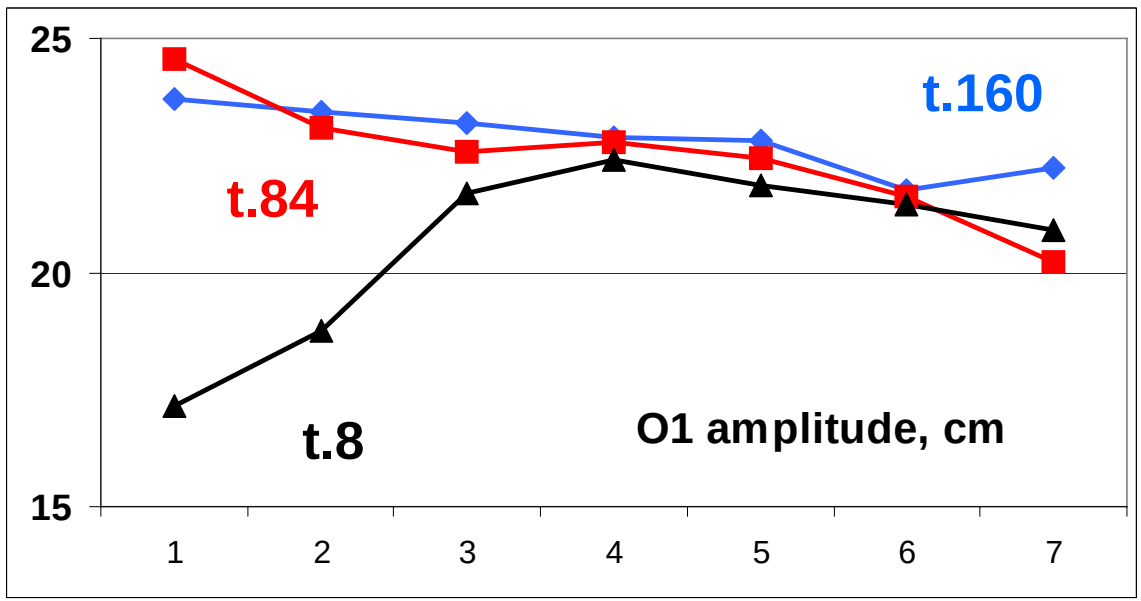
Assumed area of diurnal shelf waves

Shelf is too narrow and deep

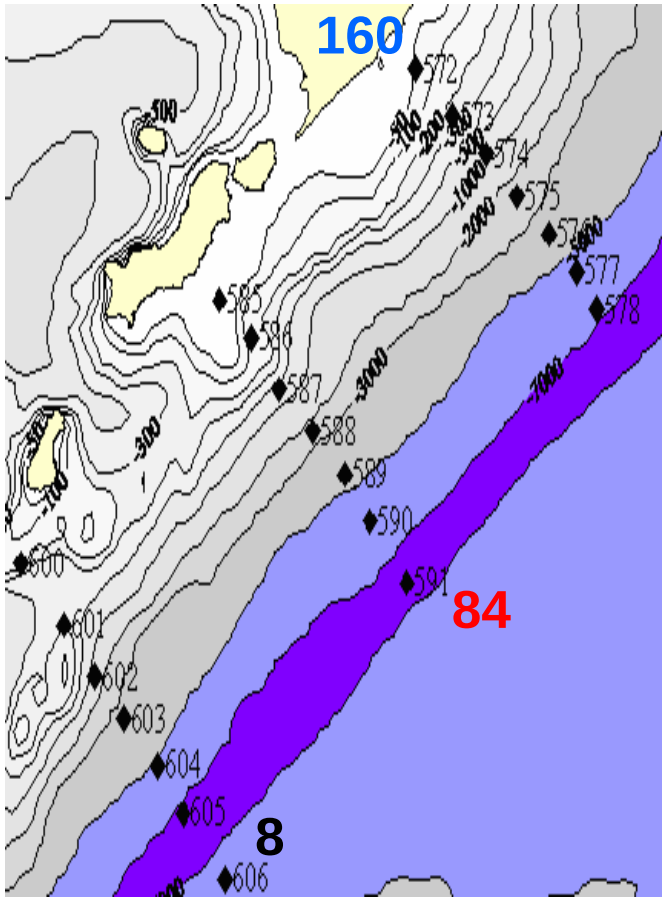
K1 and O1 amplitude variability on the North Kuril shelf

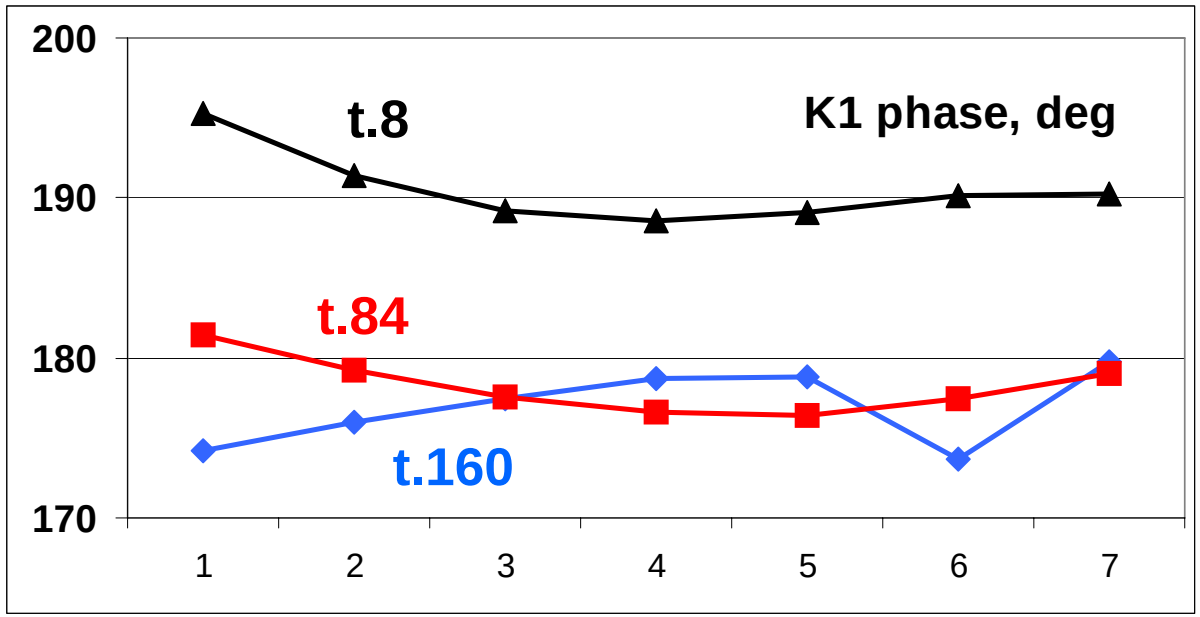


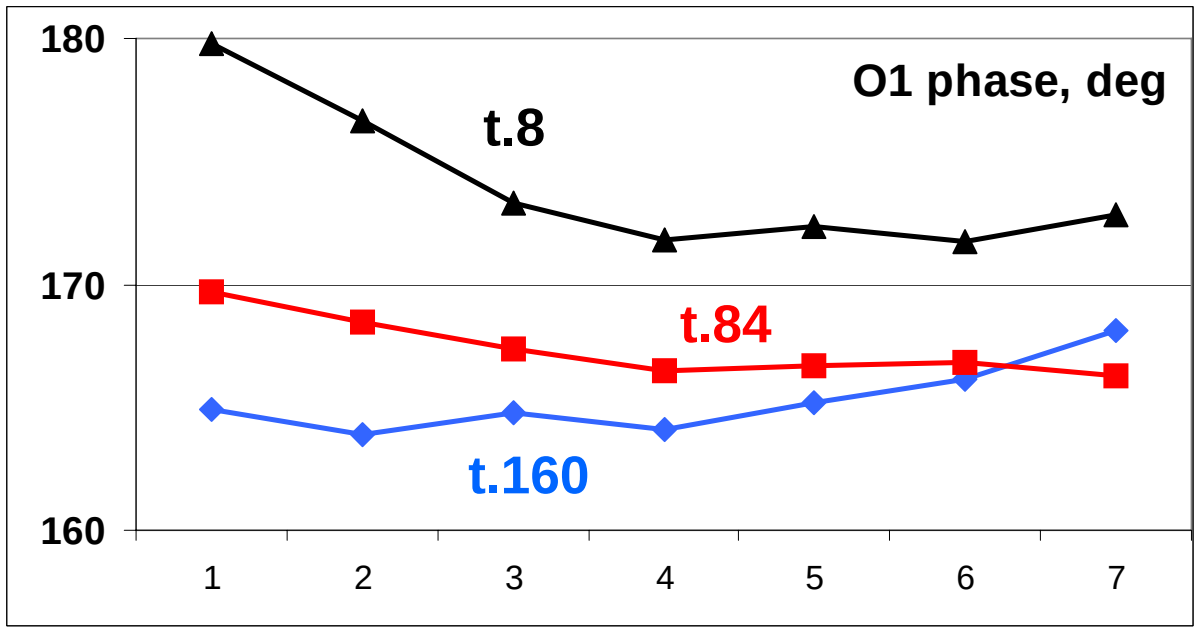




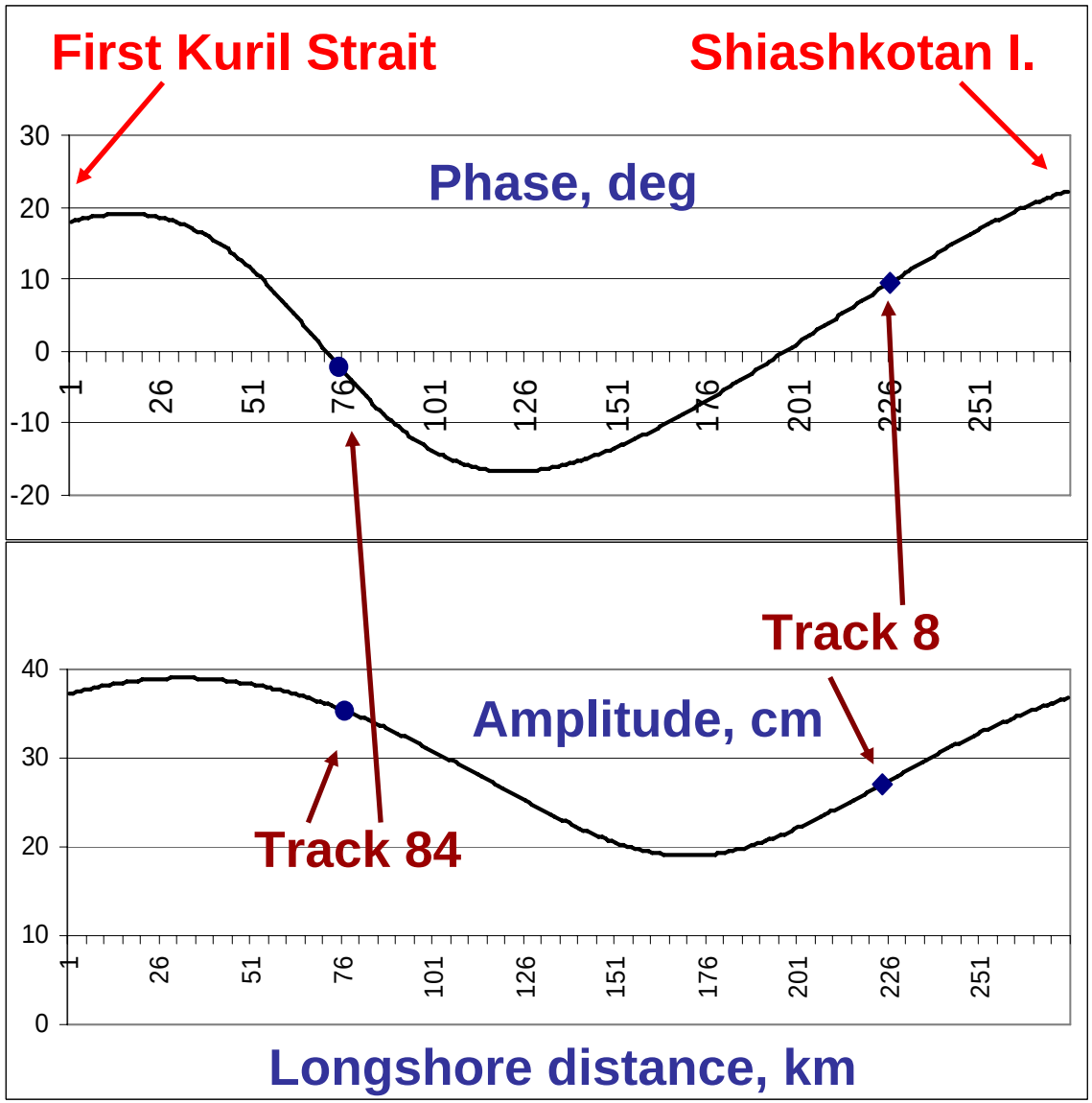
K1 and O1 phases variability on the North Kuril shelf







K1 wave structure as combination of Kelvin and shelf waves



Shelf wave parameters:

Wavelength: 274 km
Phase speed: 11.4 km/h
Level amplitude: 10 cm
Current speed: 31 cm/s

Kelvin wave parameters:

Wavelength: 21000 km
Phase velocity: 880 km/h
Level amplitude: 30 cm
Current speed: 2 cm/s

Conclusions

We found increasing and decreasing K1 and O1 amplitudes along TP tracks 51 and 127 and significant phase shift between these tracks on the northeastern Sakhalin shelf.

Similar amplitudes and phases variations were found on the shelf of the North Kuril Islands (TP tracks 84 and 8). We consider these results as evidence of diurnal shelf waves in this area.

Estimations of diurnal shelf wave level and velocity amplitudes are not exact enough. We consider results obtained as a preliminary finding. To obtain more exact estimations, we need mooring current measurements in this area.