Short-period internal waves in tidal seas on various types of shelf according to *in situ* and satellite observations

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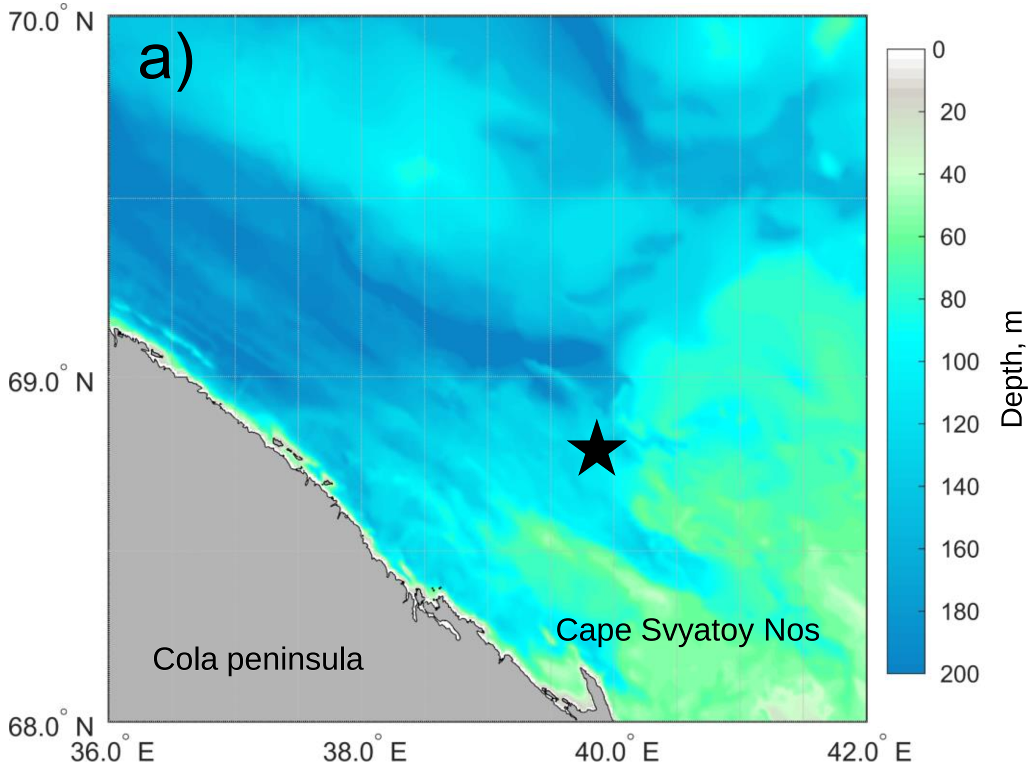
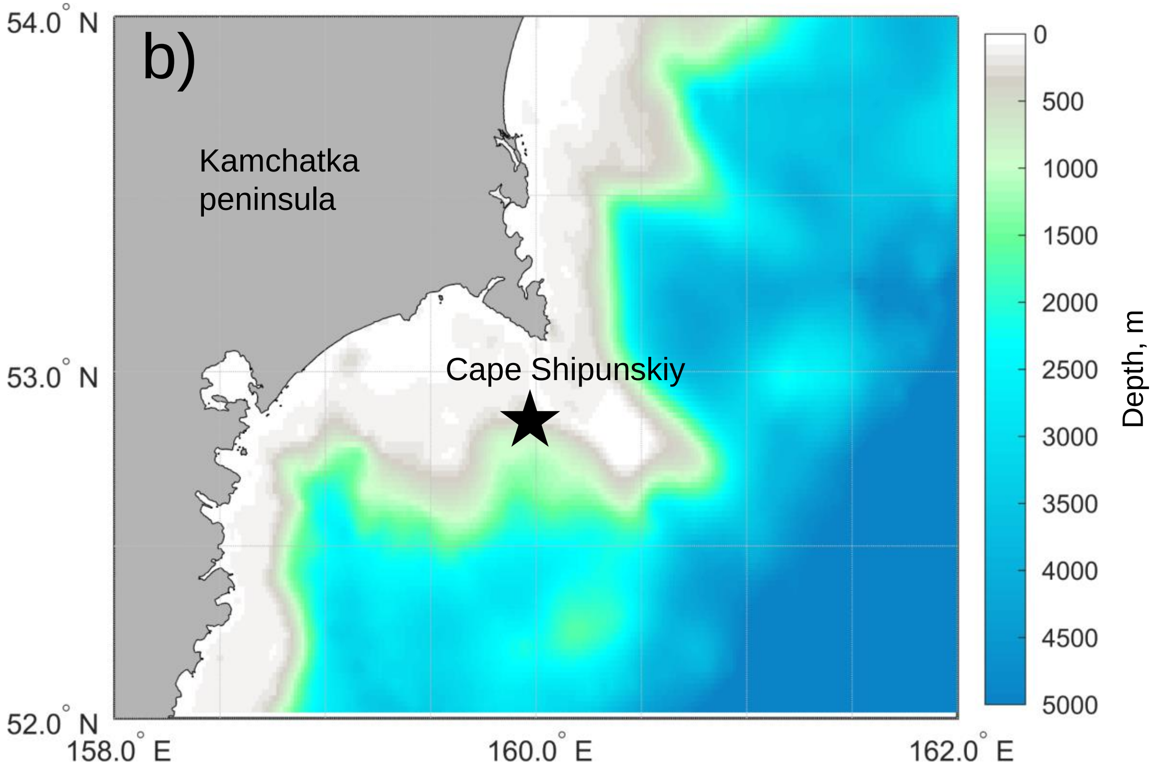
Regions under study



Average bottom slope: 4 m/km

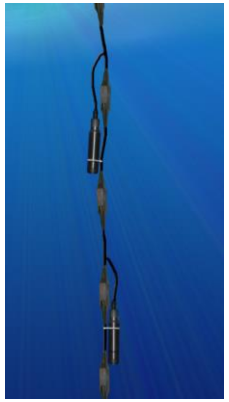


Average bottom slope: 100 m/km

Regions of in situ measurements:
a) –in the Barents Sea in August 2016;
b) –in the Avacha Bay in August – September 2018.

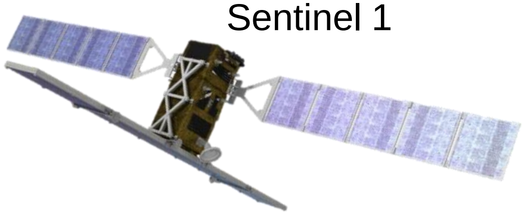
Materials and methods

CTD-probe SBE-25

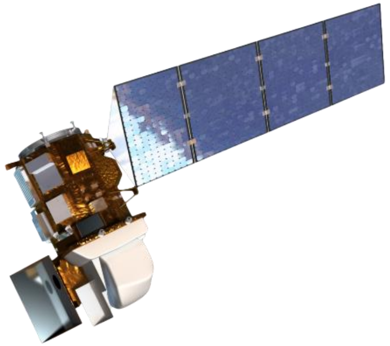


Thermistor chain PME

In situ measurement equipment



Sentinel 1



Landsat 8

Sentinel 2

Satellite observations

Phase speed of NLIW's by in situ measuremens (Kozlov et al., 2014):

$$c = \sqrt{g \frac{\Delta\rho}{\rho} \frac{h_1 (H - h_1)}{h_1 + (H - h_1)}}$$

Phase speed of NLIW's by in satellite observations (Kozlov et al., 2014):

$$c = \sqrt{\frac{g}{k} \frac{\Delta\rho}{\rho} \frac{1}{\mathrm{cth}(kh_1) + \mathrm{cth}(k(H - h_1))}}$$

g – gravity acceleration,
$\Delta\rho = \rho_2 - \rho_1$,
ρ_2 – density of lower layer
ρ_1 – density of upper layer,
$\rho = (\rho_2 + \rho_1)/2$,
H – total water depth,
h_1 – thickness of upper layer,
k - $2\pi/\lambda$, λ – wavelength.

Ursell parameter (Serebryanyy, 1985):

$$\sigma^2 = \frac{\alpha}{\beta} \eta (\lambda / 2)^2$$

$$\alpha = \frac{3}{2} c \frac{1 - h_1 / h_2}{h_1} \qquad \beta = \frac{c h_1 h_2}{6}$$

Tidal body force criterium (Pichon, 2013):

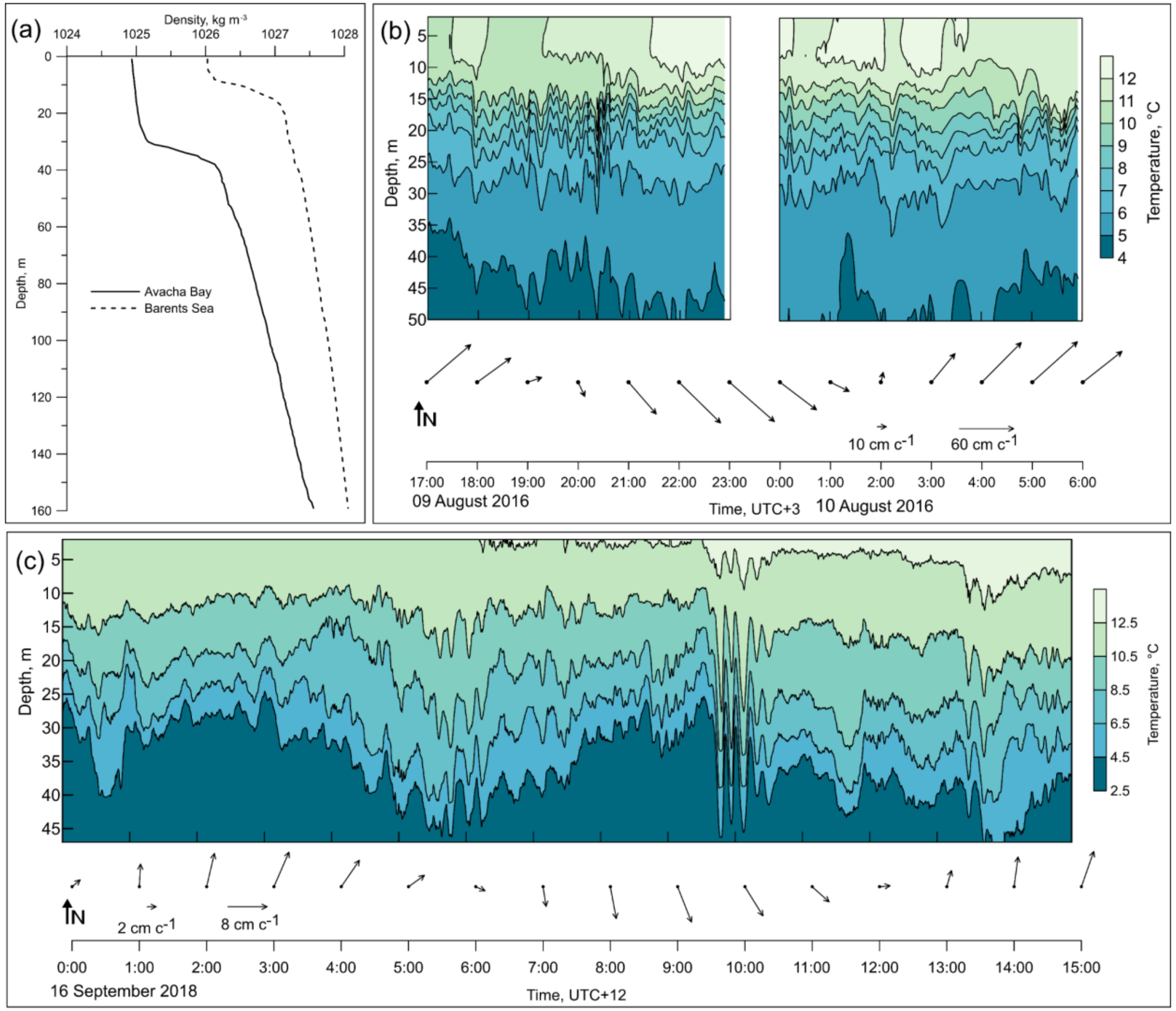
$$TBF = \frac{2\pi N^2}{\omega} \left[Q_x \frac{\partial H}{\partial x} + Q_y \frac{\partial H}{\partial y} \right]$$

Internal Froude number (Jackson et al., 2012):

$$Fr = \frac{V_m}{c}$$

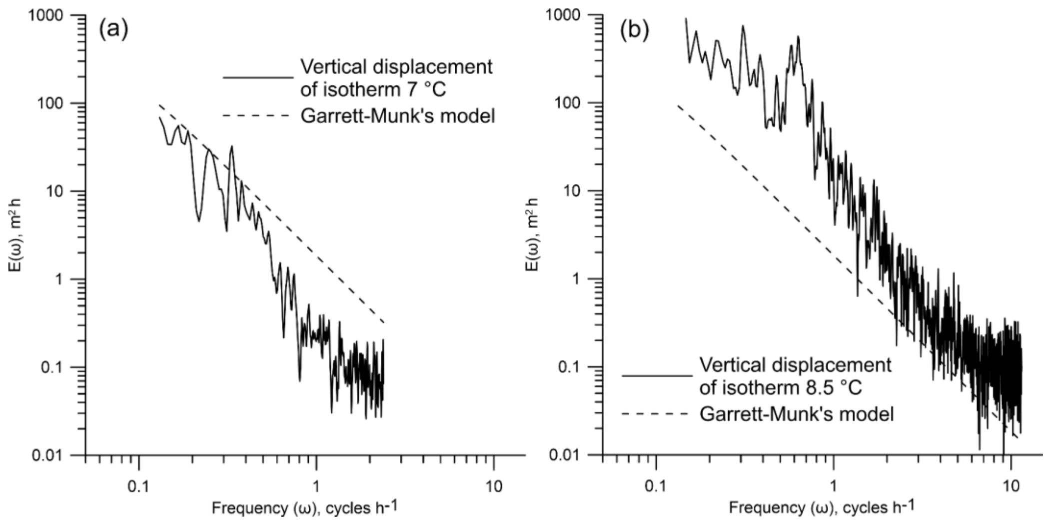
η – amplitude of NLIW's,
h_2 – thickness of lower layer,
N^2 – Brunt-Vaisala frequency,
ω – tidal frequency,
Q_x and Q_y – zonal and meridional amplitude of tidal flux,
dH/dx and dH/dy – zonal and meridional topography gradient,
V_m – magnitude of tidal current.

NLIW's characteristics by in situ observations



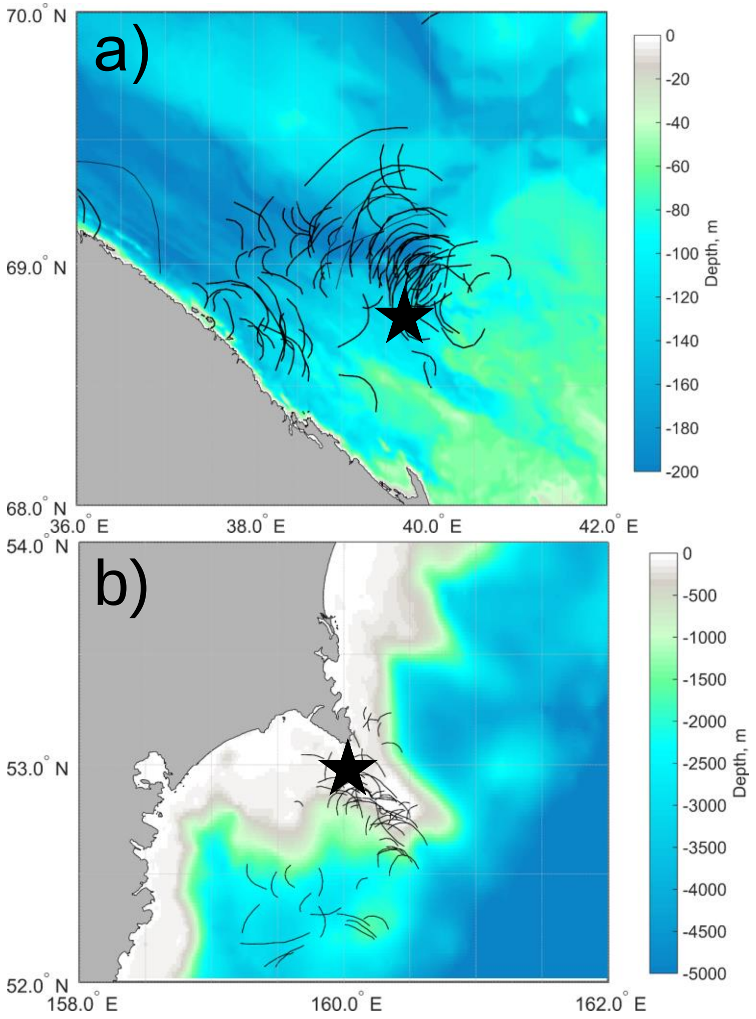
a) – profiles of vertical density distribution according to CTD data
b) – recording of isotherm fluctuations and tidal currents of the M2 harmonic for the Barents Sea;
c) – Recording of oscillations of isotherms and tidal currents of the M2 harmonic for the Avacha Bay.

Characteristic	Barents Sea	Avacha Bay
η, m	4	8
c, m/s	0.57	0.65
σ^2	15	28



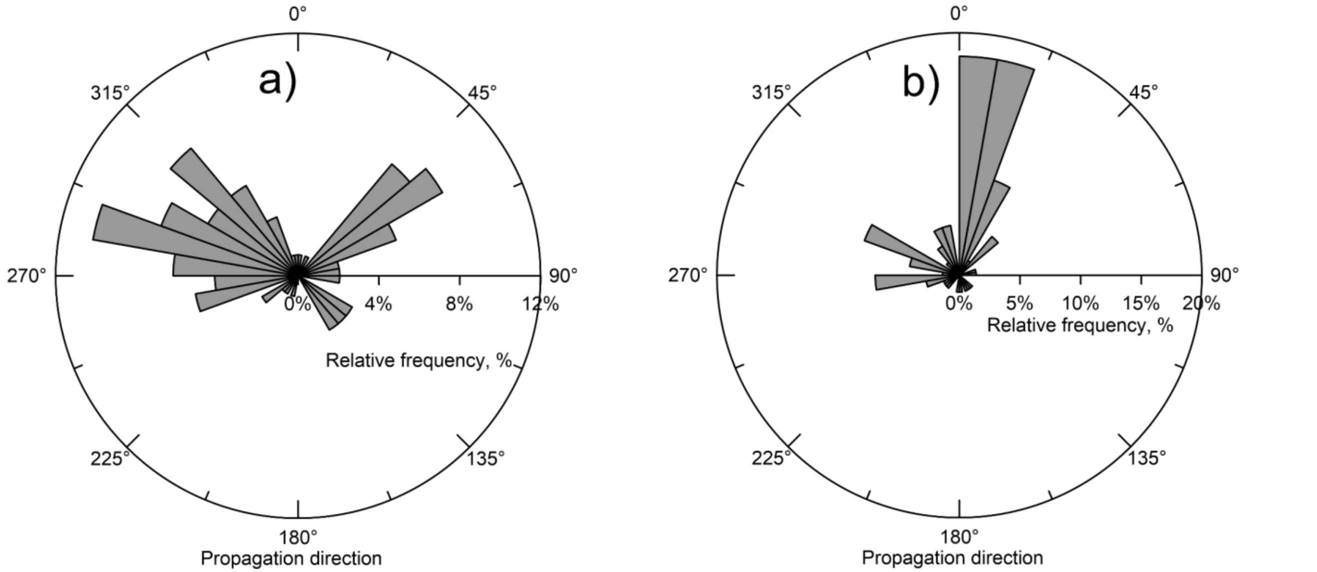
The spectrum of vertical displacements of isotherms in the pycnocline layer, combined with the theoretical Garrett-Munk spectrum:
a) –in the Barents Sea;
b) –in the Avacha Bay.

NLIW's characteristics by satellite observations



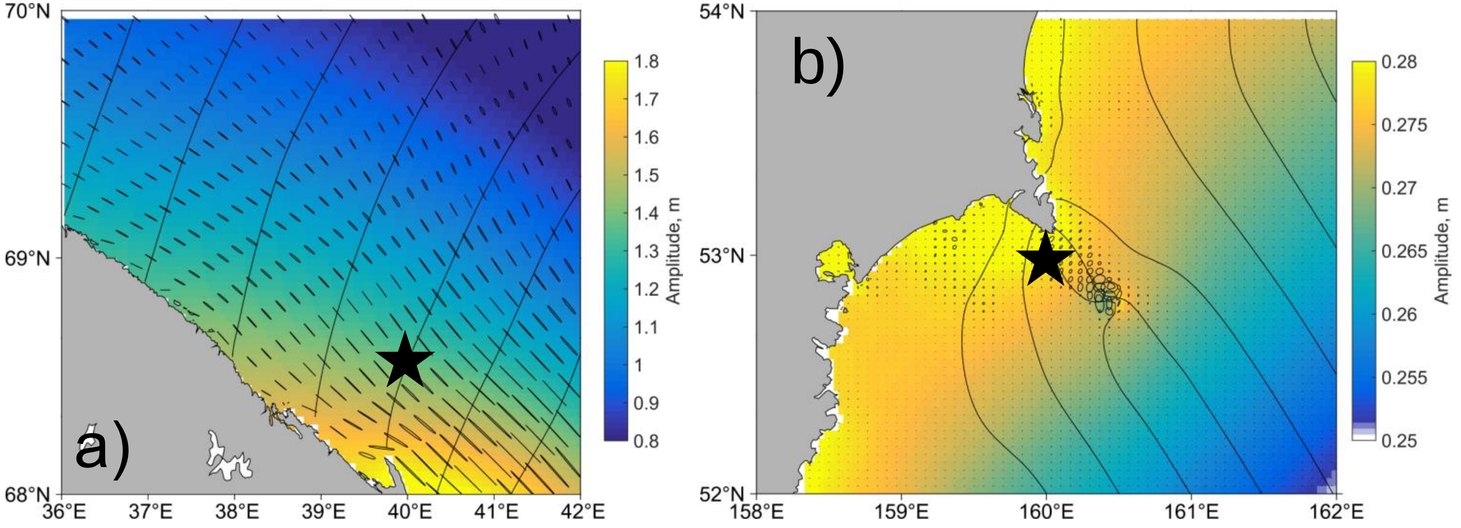
Position of the manifestations of NLIW's according to satellite observations:
a) in the Barents Sea;
b) in the Avacha Bay.

Characteristic		Barents Sea	Avacha Bay
Total number of NLIW's manifestations		93	72
Wavelength, m	average	800	400
	maximum	1900	800
Length of leading crests, km	average	26	14
	maximum	50	39
c, m/s satellite/in situ		0.6/0.65	0.51/0.57



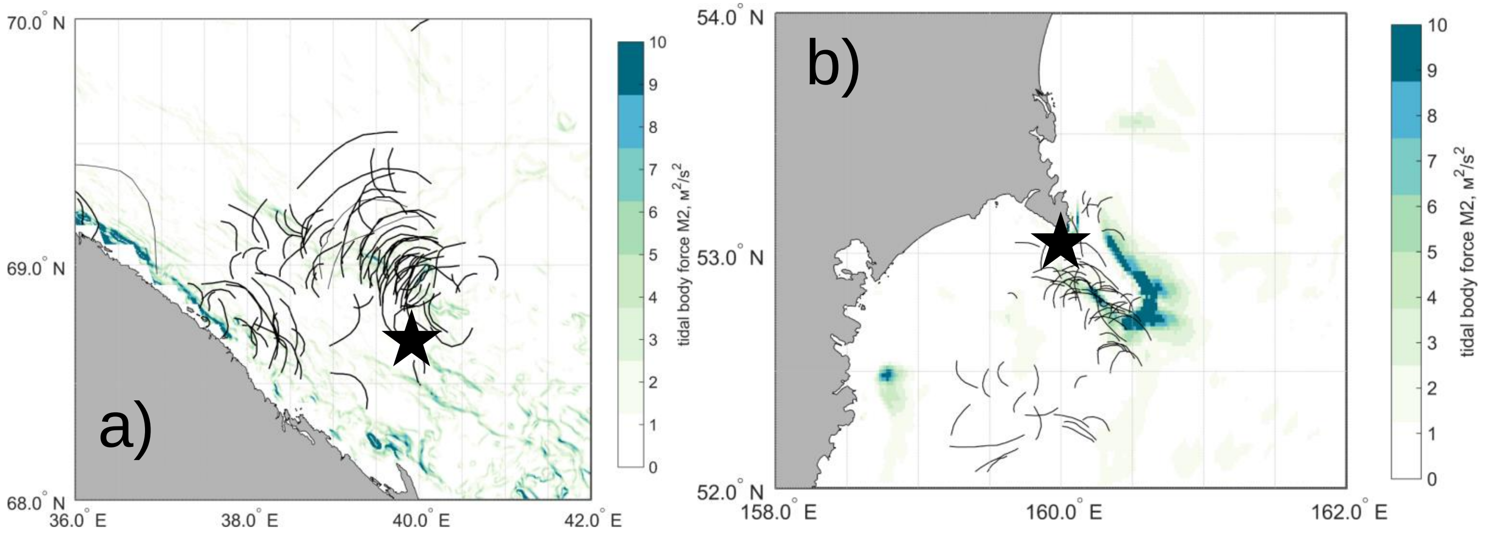
Circular histograms of the propagation directions of the NLIW's manifestations:
a) in the Barents Sea; b) in the Avacha Bay

Possible mechanism of NLIW's generation



Isoamplitudes and isophases of level fluctuations and ellipses of tidal currents by TPXO9 atlas [Egbert and Erofeeva, 2002]:
a) for Barents Sea; b) for Avacha bay

Near the points of in situ measurements:
for Barents sea Fr≈1
for Avacha bay Fr≈0.6



Tidal body force for the harmonics M2:
a) in the Barents Sea; b) in the Avacha Bay.

Possible mechanism of generation

In the Barents Sea – lee-wave generation (Jackson et al., 2012)

In the Avacha bay – disintegration of internal tide (Jackson et al., 2012)

Thank you for your attention!

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