1918
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A descriptive analysis of the linkage between the vertical stratification and current oscillations in the Gulf of Finland

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Outline

- Aim and background
- General description of wind, stratification, and currents
- Vertical flow structure
- Current velocity spectra
- Conclusions

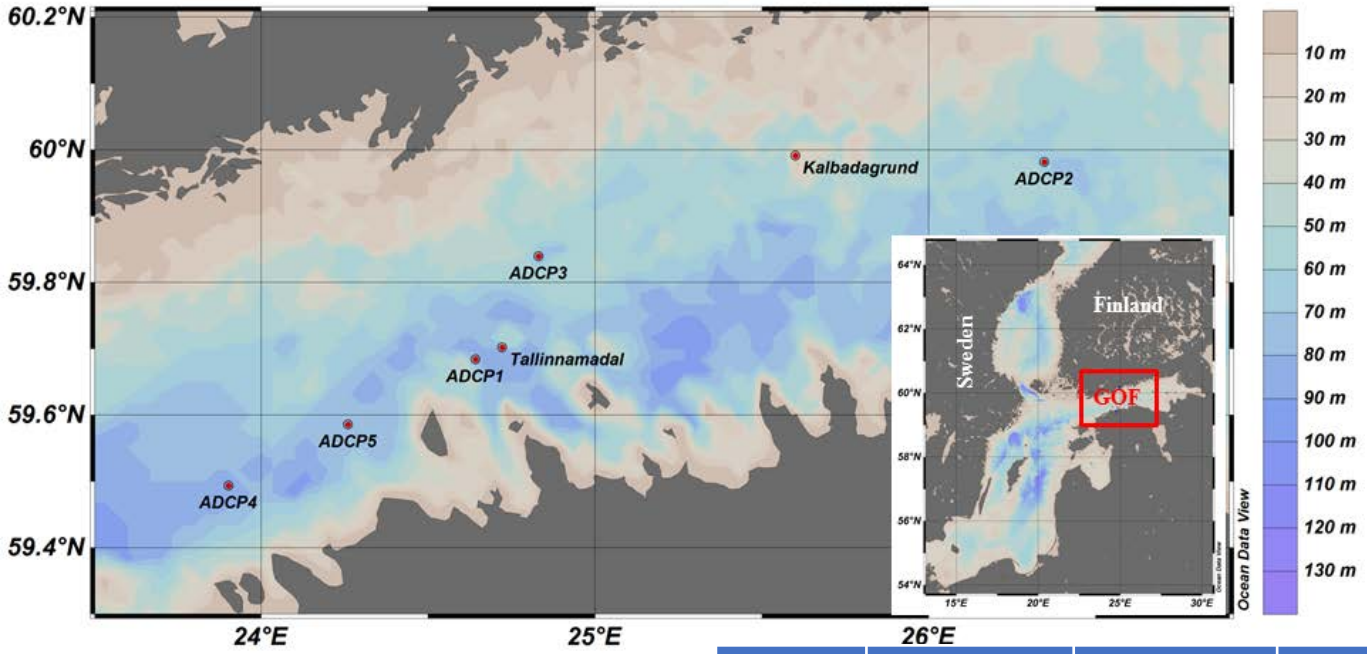
Aim and background

The Gulf of Finland is a **stratified estuary with** depth up to 115 m.
Vertical stratification in the gulf is variable and exhibits a clear seasonality.
Two pycnoclines exist– **seasonal thermocline** (at about 15-25 m depth) and **quasi-permanent halocline** (60-80 m).

The aim of this study was to examine the following hypotheses:

- one-, two- and three-layer flow regimes can occur in the gulf depending on the wind forcing and stratification
- Strong current shear is linked to the two pycnoclines
- There are differences in the kinetic energy spectra in different layers when a layered flow structure has been realized.

Data and Location



Time-series 2010-2014
Bottom-mounted ADCP (Teledyne RDI, 300 kHz); vertical resolution of 2 m and temporal resolution 10 minutes

Vertical profiles from the monitoring cruises 2010-2017
Proflies acquired by an SBE 19*plus* V2 CTD probe (resolution 4 Hz); pre-processed data with vertical step of 0.5 db

Depl. nr	Longitude	Latitude	Period	Bin depth range (m)	Sea depth (m)
ADCP1	24°37.5'	59°41.0'	01.06.2010-31.08.2010	9-79	84
ADCP2	26°20.8'	59°58.8'	30.09.2010-28.10.2010	8-62	67
ADCP3	24°49.9'	59°50.3'	13.07.2011-05.09.2011	9-73	78
ADCP4	23°54.1'	59°29.6'	21.12.2011-09.05.2012	10-86	91
ADCP5	24°15.6'	59°35.1'	09.12.2013-06.05.2014	10-82	87

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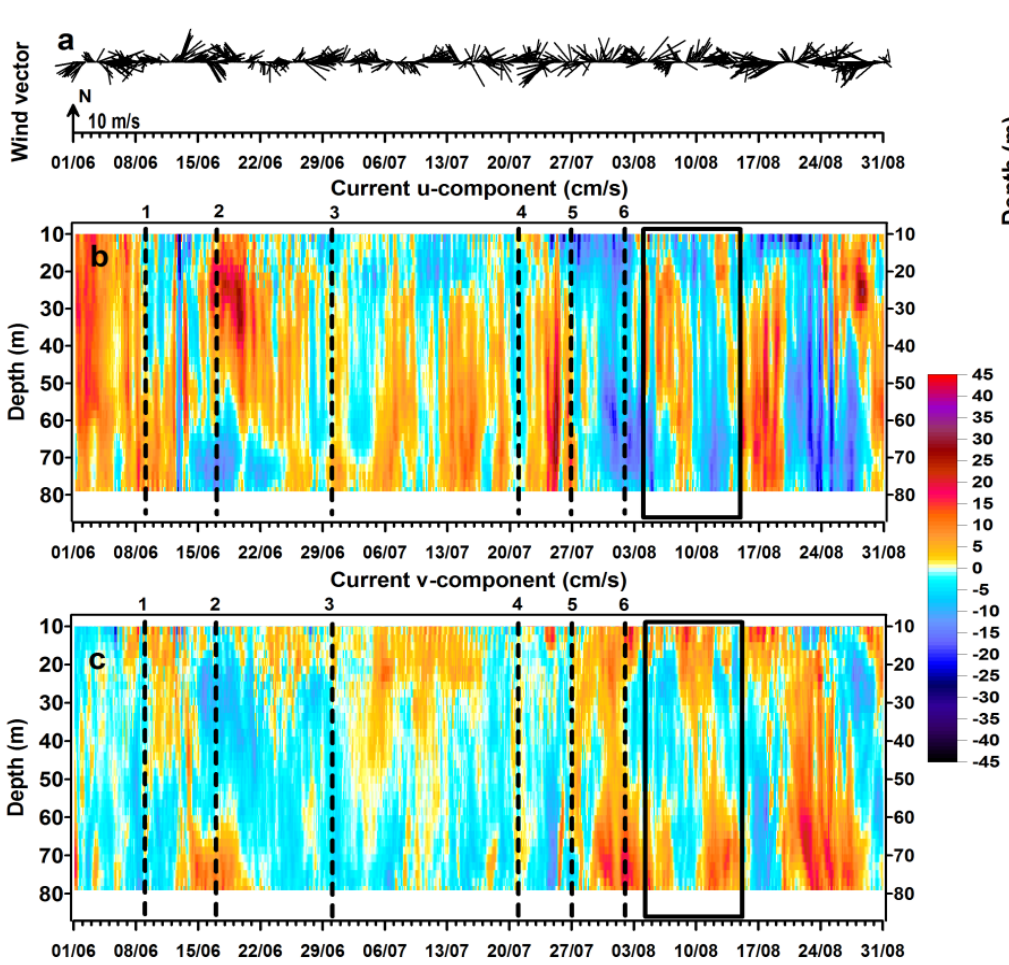
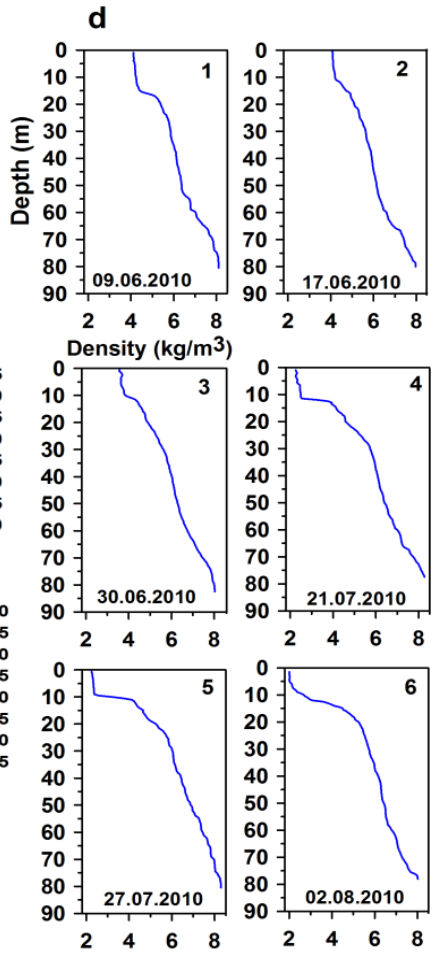
Summer 2010



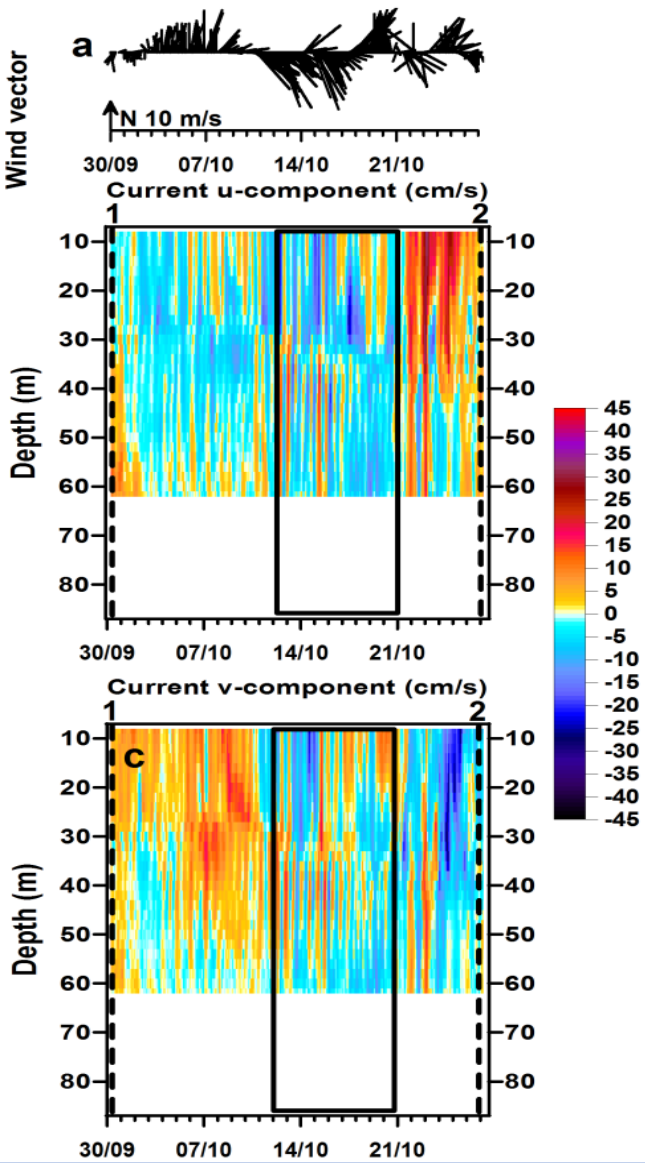


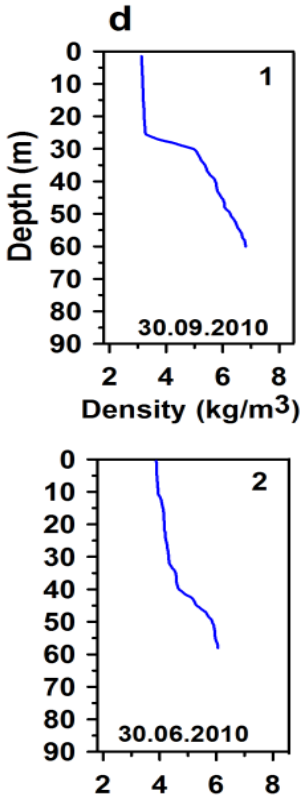
Average wind speed 5.8 m s^{-1}

Presence of the seasonal thermocline at 15 – 25 m depth.

Presence of the quasi-permanent halocline.

Autumn 2010



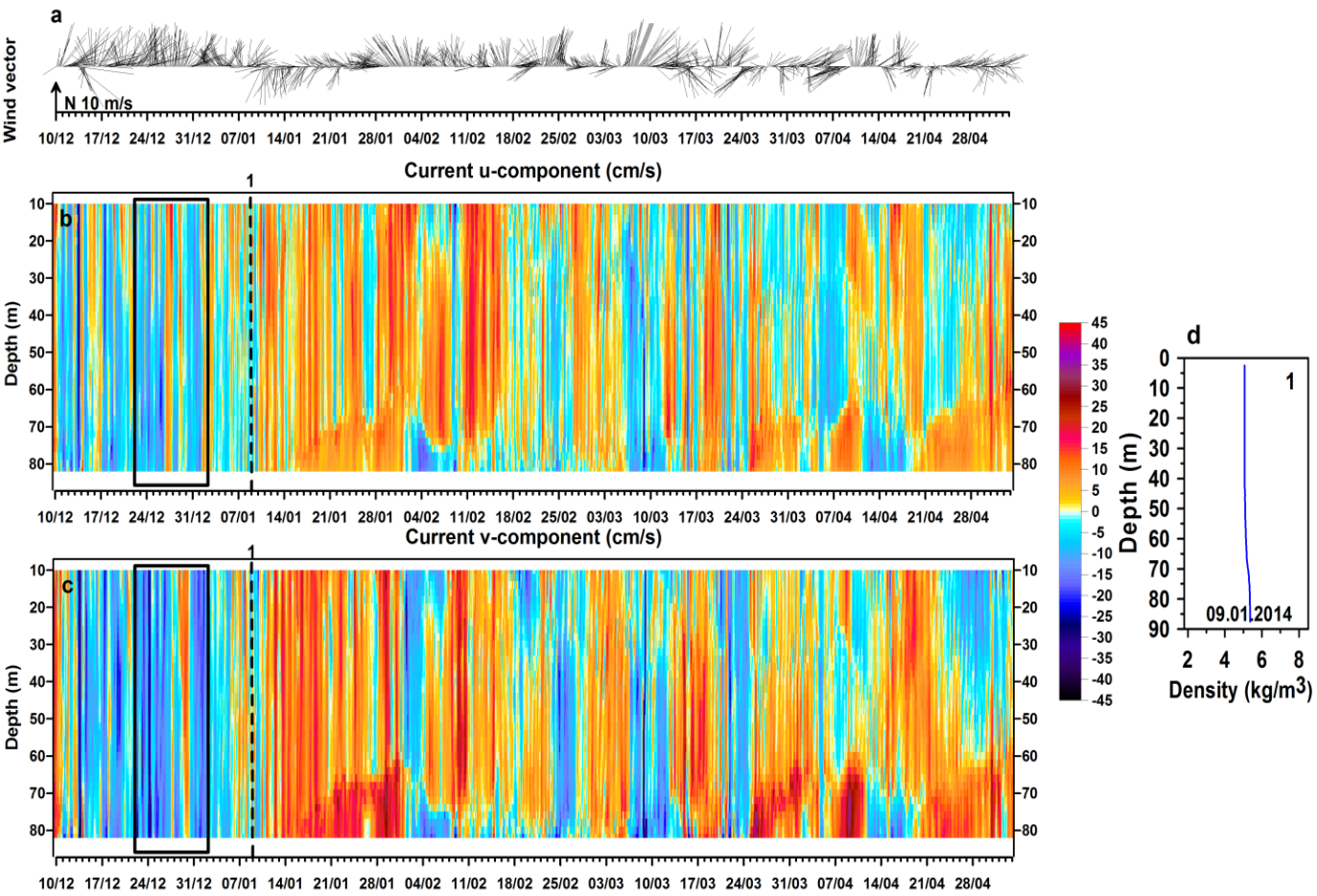


Average wind speed was 5.7 m s^{-1}

Deepest available bin 62 m was shallower than the location of the quasi – permanent halocline.

Weakening and deepening of thermocline from 25-30 m to 40-50 m.

Winter – spring 2013/2014



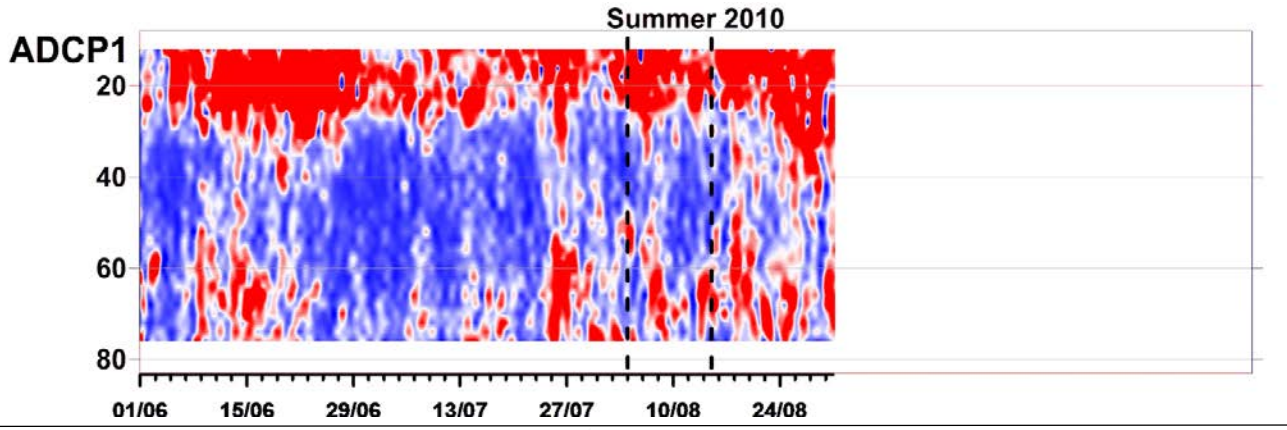
Average wind speed 8.5 m s^{-1}

Strong south-westerly winds in December – January.

Weakly stratified conditions in December – January.

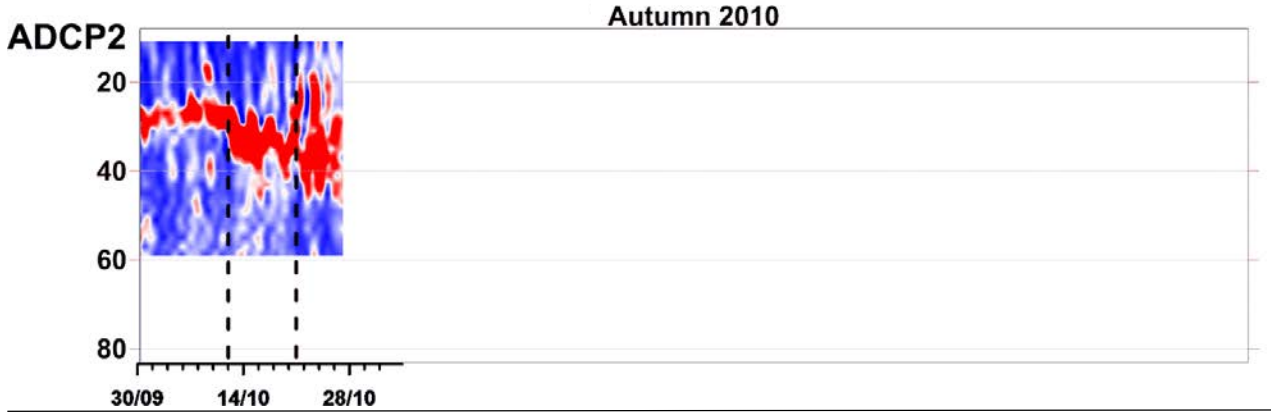
Three- layer stratification at the end of the measurements

Current shear square (in 10^{-4} s^{-2})

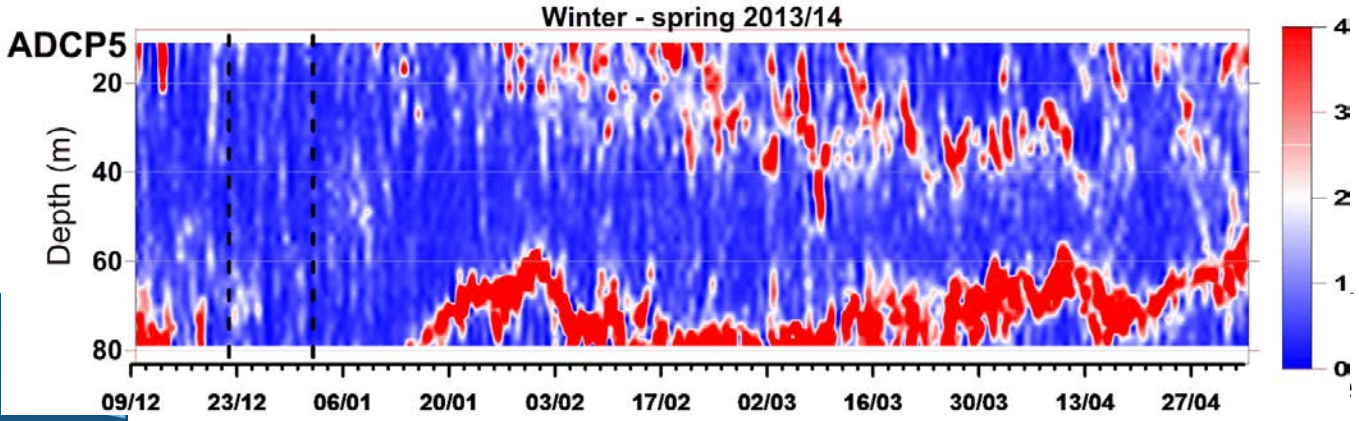


Shear maximum in the seasonal thermocline.

Occasionally observed maximum at the halocline depth.

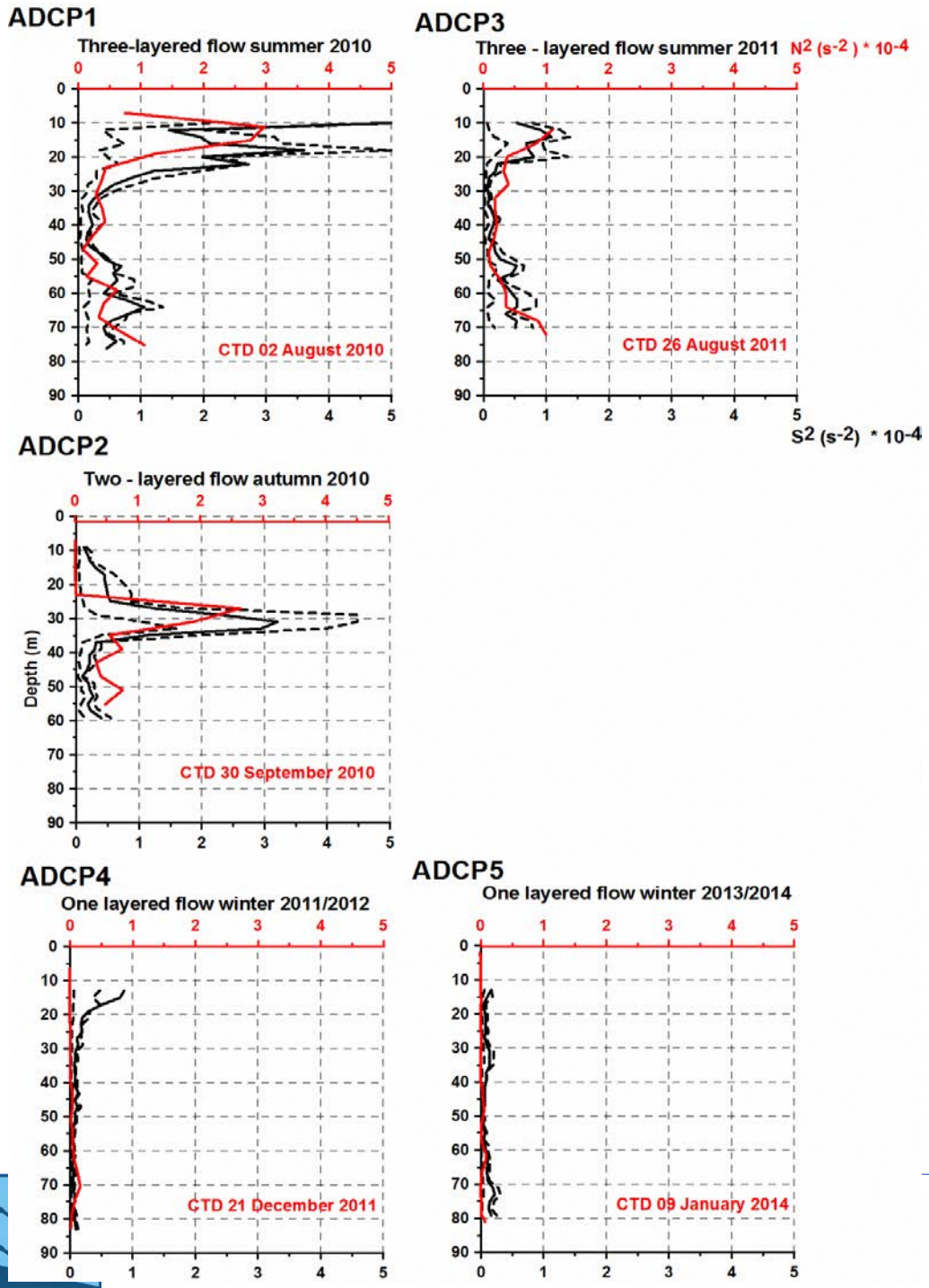


Measurements in autumn 2010 showed two-layer flow structure



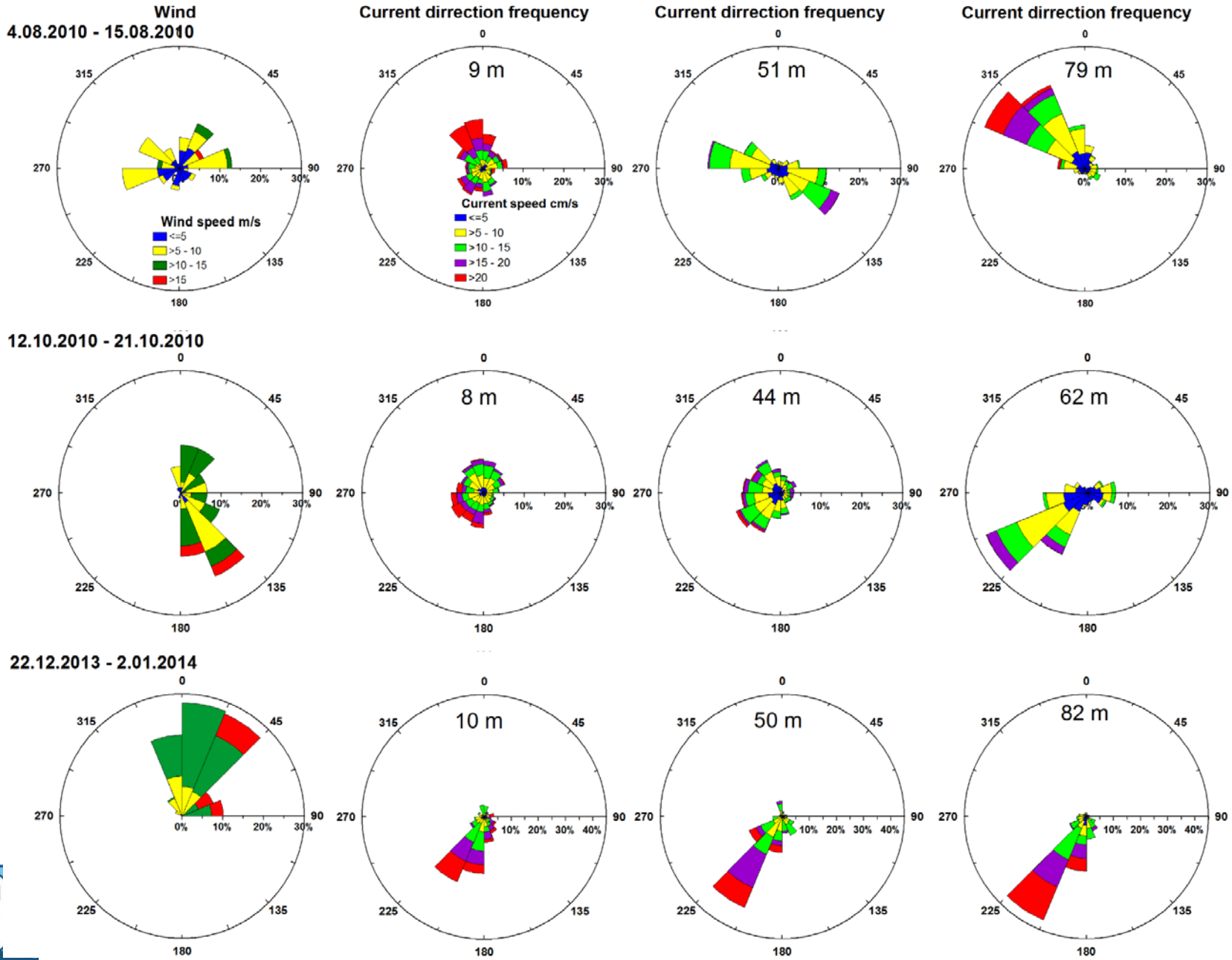
Weak current shear in December – January.

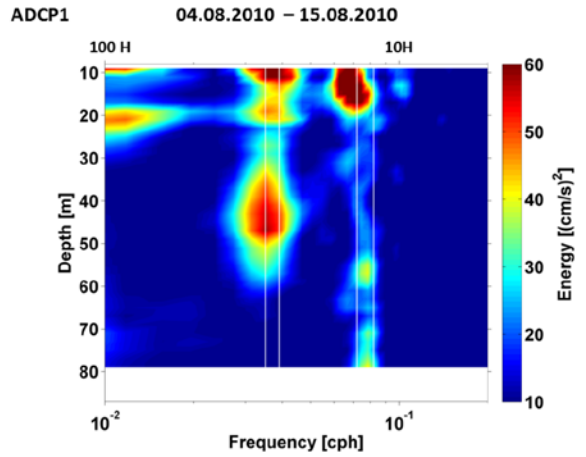
Strong current shear in the halocline.

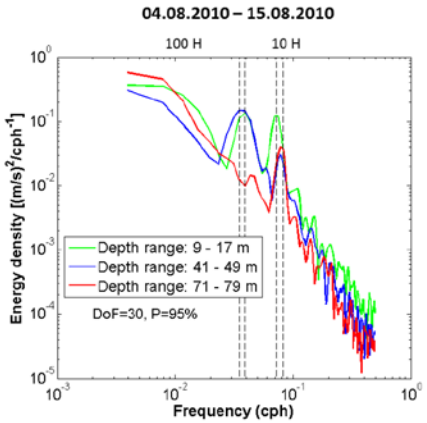


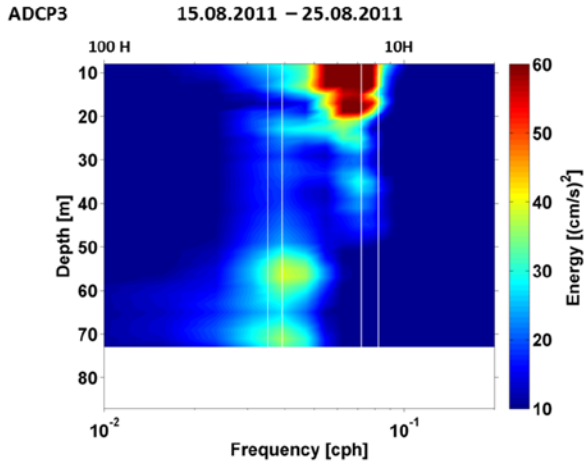
Median (black solid lines) **current shear square (S^2)** distribution and typical **Brunt-Väisälä frequency square (N^2)** profiles (red solid lines) for selected periods

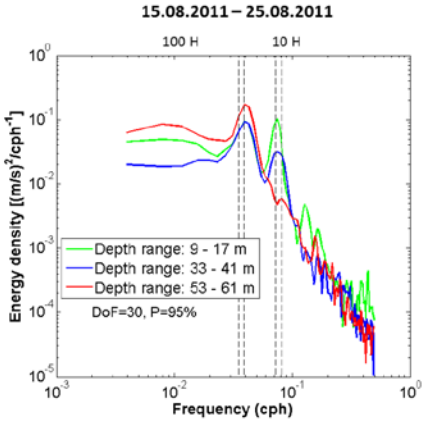
Wind roses and current roses

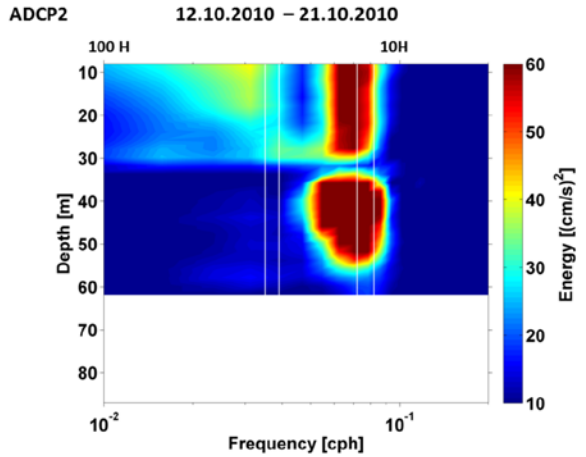


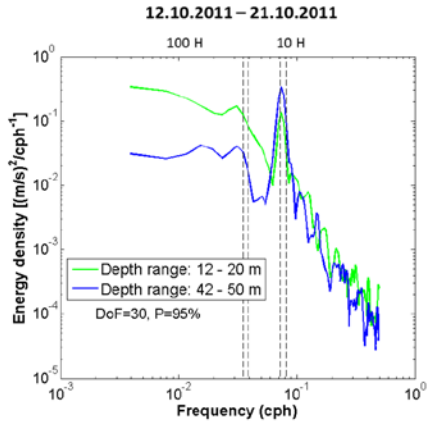












Current velocity spectra

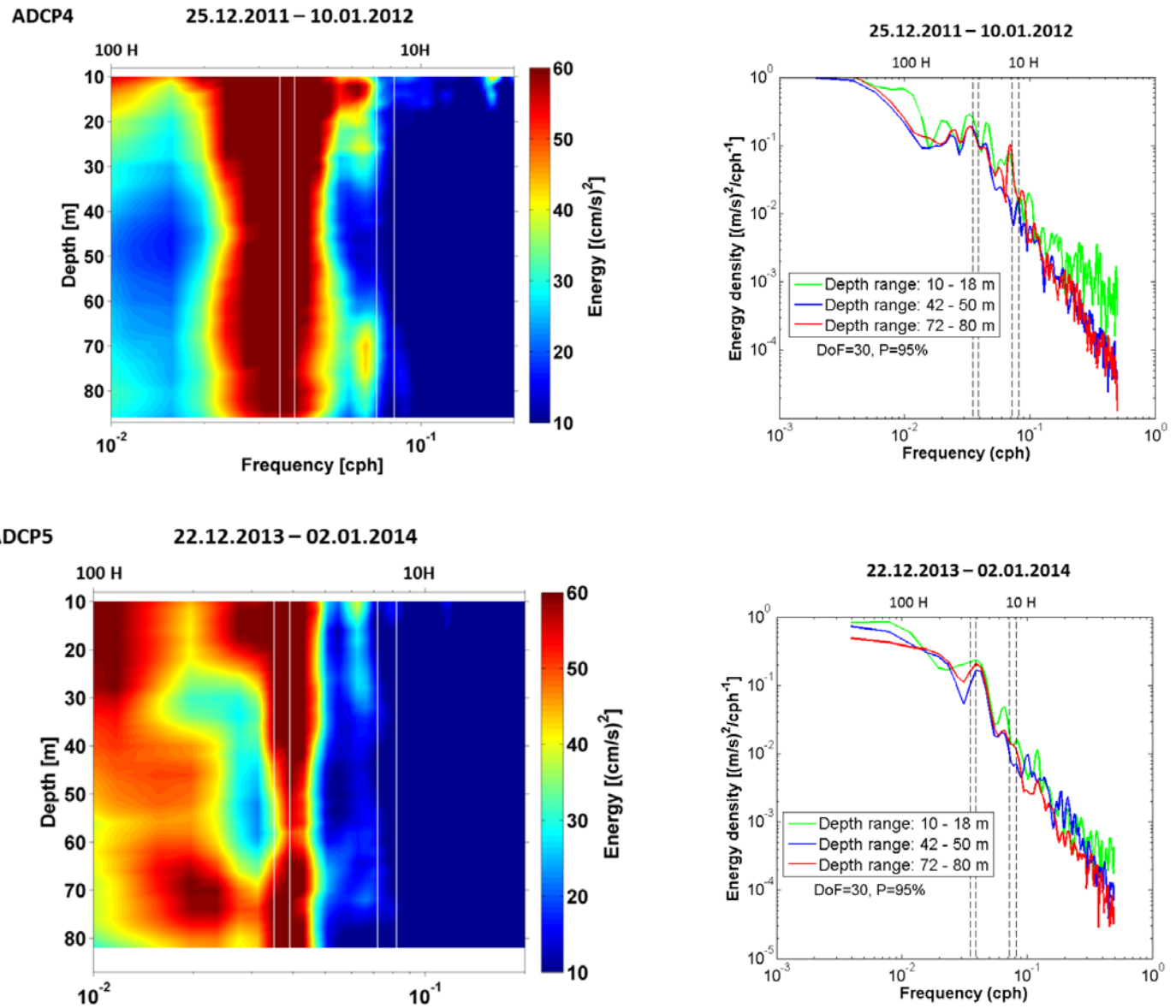
BSD – Broad semi-diurnal
BD – Broad diurnal

(**Left column**) Vertical distributions of kinetic energy spectra

(**Right column**) Depth-averaged kinetic energy density for the upper, intermediate, and near-bottom layer

Vertical lines indicate the oscillation periods of 28.6 h, 25.6 h, 13.9 h, and 12.42 h.

Current velocity spectra



Conclusions

- One-, two- or three-layer current structure might occur in the Gulf of Finland. The realization of the exact regime depends on the wind forcing and stratification.

- This layered flow structure emerges as both the local shear maxima in certain layers and the differences in the kinetic energy spectra of currents between the vertical layers.

- Stratification strength parameter – the Brunt-Väisälä frequency shows that the water column during the selected winter period was almost mixed. Vertical locations of stronger density stratification in the other periods – in summer and autumn 2010 roughly match with the current shear maxima.

- We showed that the frequency composition differed between the seasons mainly due to the vertical stratification as well as between the layers during a selected period.

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Thank you for your attention!

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Participation in the conference was supported by ASTRA “TTÜ arenguprogramm aastateks 2016-2022” DAR16024 (2014-2020.4.01.16-0032).