Avance de Tesis Doctoral

CLAUDIO ITURRA
TUTOR DR. MARCUS SOBARZO

JUNIO 24, 2022

- ACTIVIDADES RECIENTES

OLD DOMINION
UNIVERSITY
Visa & Immigration Service Advising

March 17, 2022

To Whom It May Concern:

This letter certifies that Mr. Claudio Andres Iturra Ulloa (**N0032203321**) is a J-1 Exchange Visitor under the category of Short-Term Scholar at Old Dominion University. Mr. Iturra Ulloa conducts research for his doctoral thesis project in Oceanography at the Department of Ocean and Earth Sciences on the invitation of Dr. John Klinck. He began his research on October 4, 2021 and will complete it on April 4, 2022.

Thank you for your assistance.
Sincerely,

Delgerjargal Betcher

Delgerjargal Betcher, International Student Advisor, DSO/ARO
Visa & Immigration Service Advising

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Universität Hamburg
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TRR 181

UHH · CEN Centrum für Erdsystemforschung und Nachhaltigkeit
Bundesstr. 53, 20146 Hamburg

To whom it may concern

Lea Diederichsen

Project Coordinator TRR 181 "Energy Transfers in Atmosphere and Ocean"

Universität Hamburg, CEN
Theoretical Oceanography
Bundesstr. 53, 20146 Hamburg

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18.02.2022

Certificate of Attendance

This certificate of attendance is presented to **Claudio Iturra** who participated in the course **Ocean/Atmosphere Time Series Analysis: Theory and Practice** with lecturer Dr. Jonathan Lilly (Planetary Science Institute). The course took place January 10 - 21, 2022.

Description of activity: This course introduced students to classical as well as cutting-edge techniques for analysing time series in oceanographic, atmospheric science, and climate applications. Beginning with a solid understanding of the link between time-domain and frequency-domain analyses, they proceeded from simple smoothing, to Fourier spectral estimation, to time-frequency methods such as the continuous wavelet transform, to stochastic modelling using random processes, and other more advance topics.

Students brought with them a dataset of their choice that they investigated in detail. A final project consisted of applying the methods taught in the course to this dataset, and interpreting the results.

Course participants receive 5 ECTS.

Lea Diederichsen

Coordinator of the Research Training Group ENERGY

CENTER FOR COASTAL PHYSICAL OCEANOGRAPHY

OLD DOMINION UNIVERSITY

- ACTIVIDADES RECIENTES

UCSC

XLI Congreso de Ciencias del Mar 2022

Sociedad Chilena de Ciencias del Mar

CERTIFICADO

Se le confiere el presente certificado a:

Claudio Iturra Ulloa

En su calidad de instructor del curso "**Análisis y presentación de datos oceanográficos utilizando Júpyter y Matlab"** que se impartió como parte de las actividades del XLI Congreso de Ciencias del Mar "*Las Ciencias del Mar en tiempos de cambio*", en la Universidad Católica de la Santísima Concepción, Campus San Andrés, Concepción, Chile.

Dra. Paola González-Kother
Presidenta Comité Organizador
XLI Congreso de Ciencias del Mar

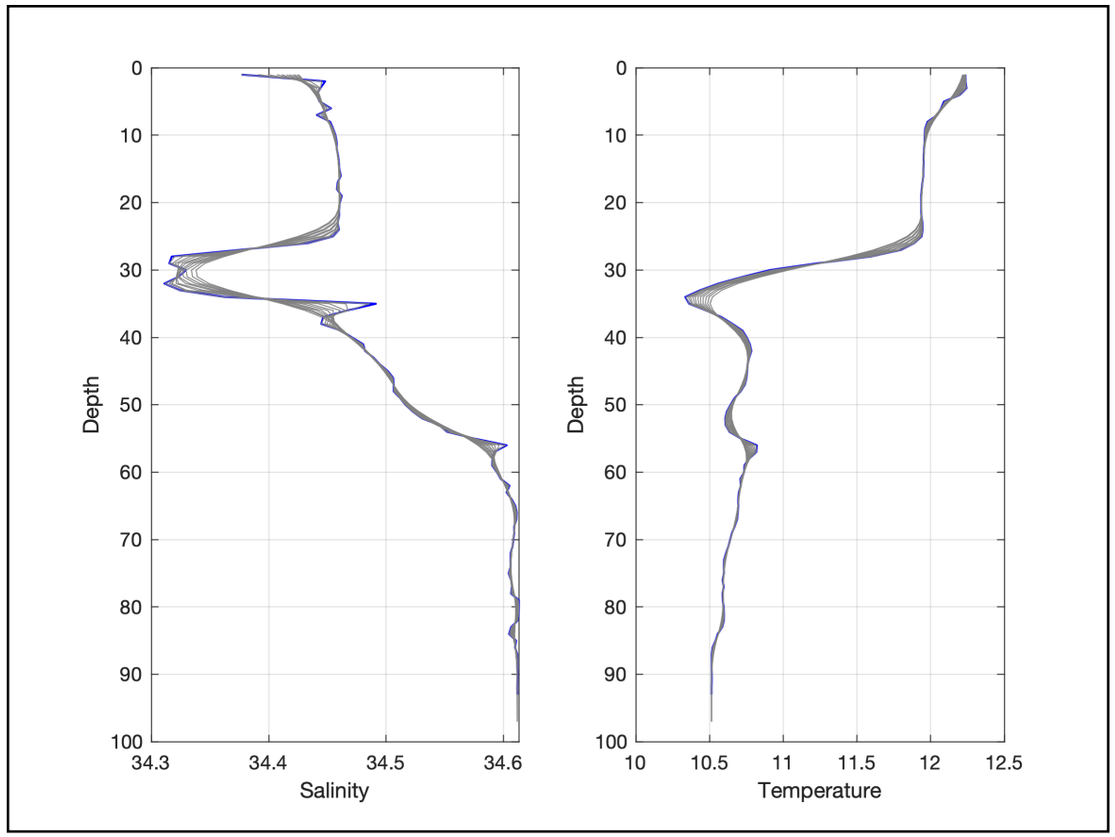
Dr. Marcelo Oliva Moreno
Presidente
Sociedad Chilena de Ciencias del Mar

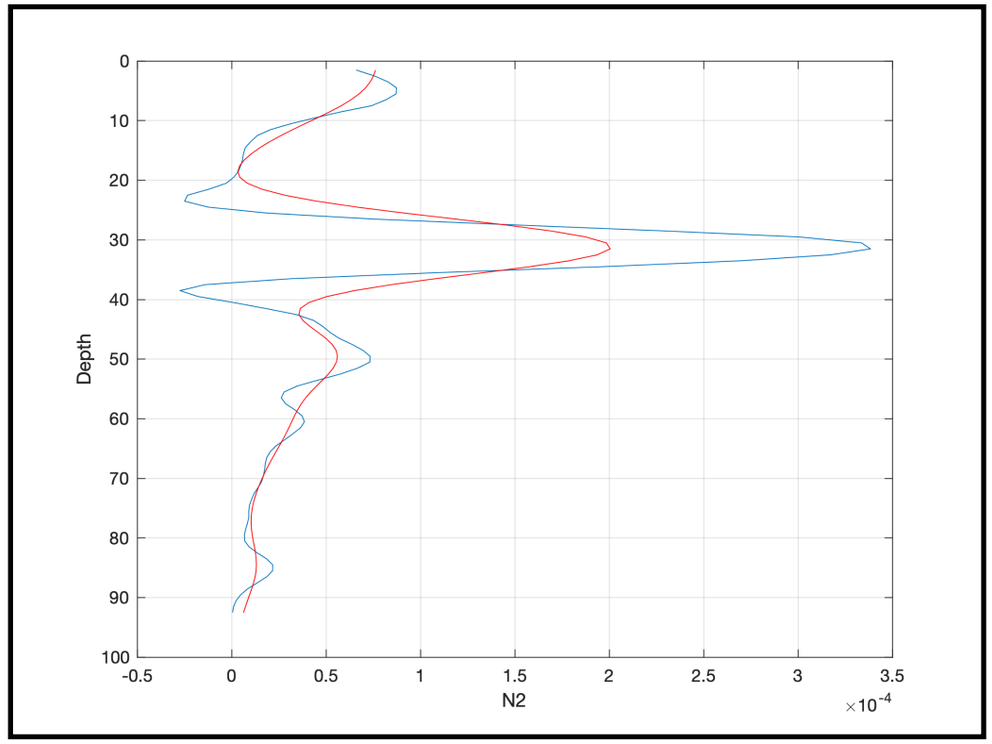
Concepción, Chile. 23-27 mayo 2022

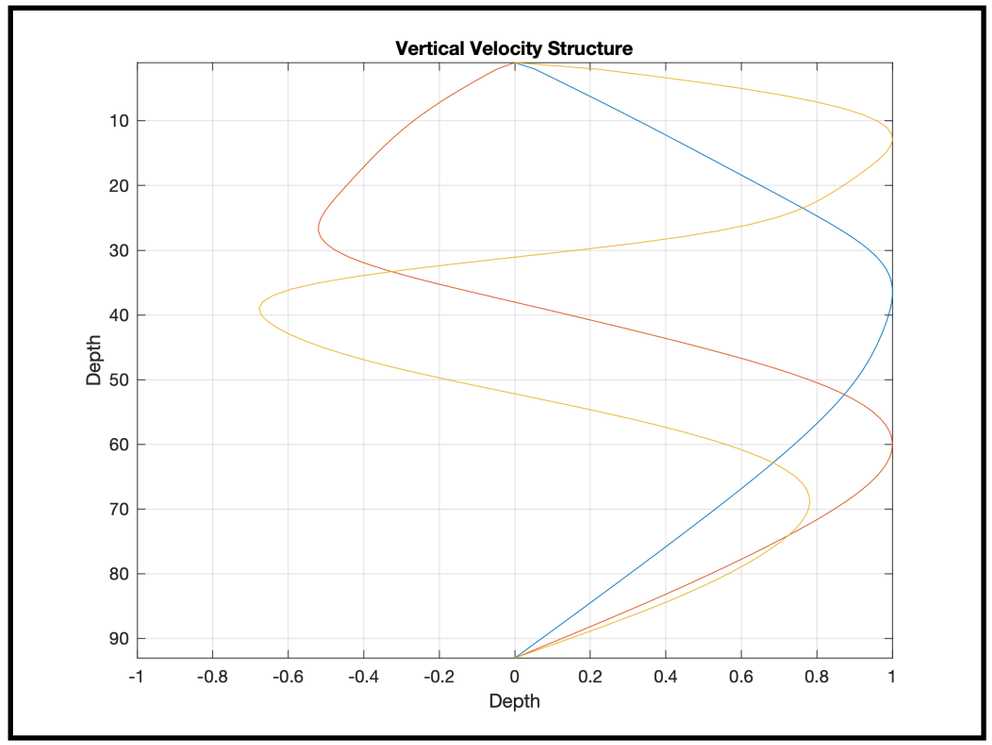
VE RI TAS

HARVARD UNIVERSITY

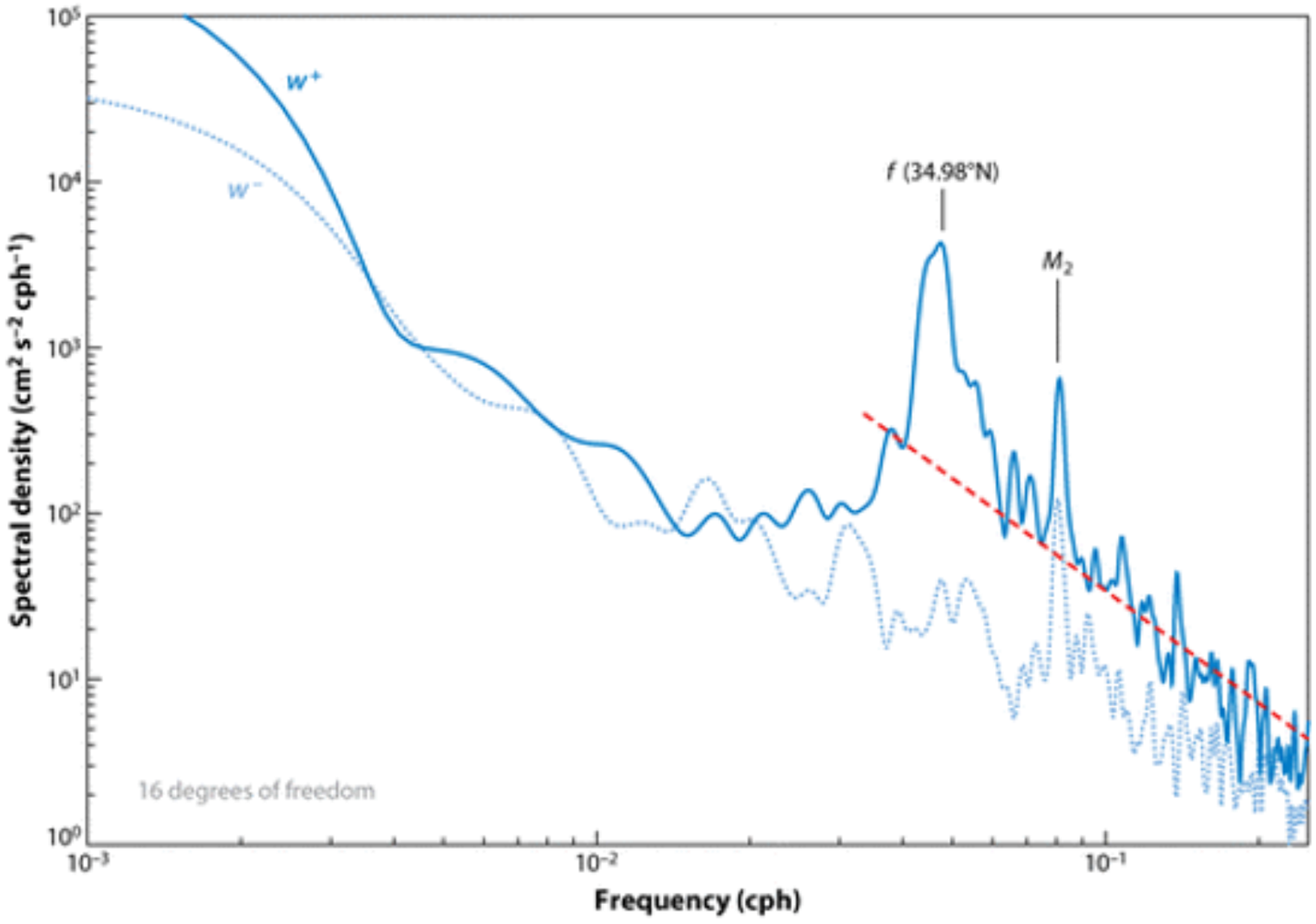
- Circulación Sub-inercial
- Circulación Baro clínica (Modos Baro clínicos) y su relación con el viento
- Circulación Inercial
- Circulación Super-Inercial
- Ecuación de agua someras y modelo Slab
- ROMS

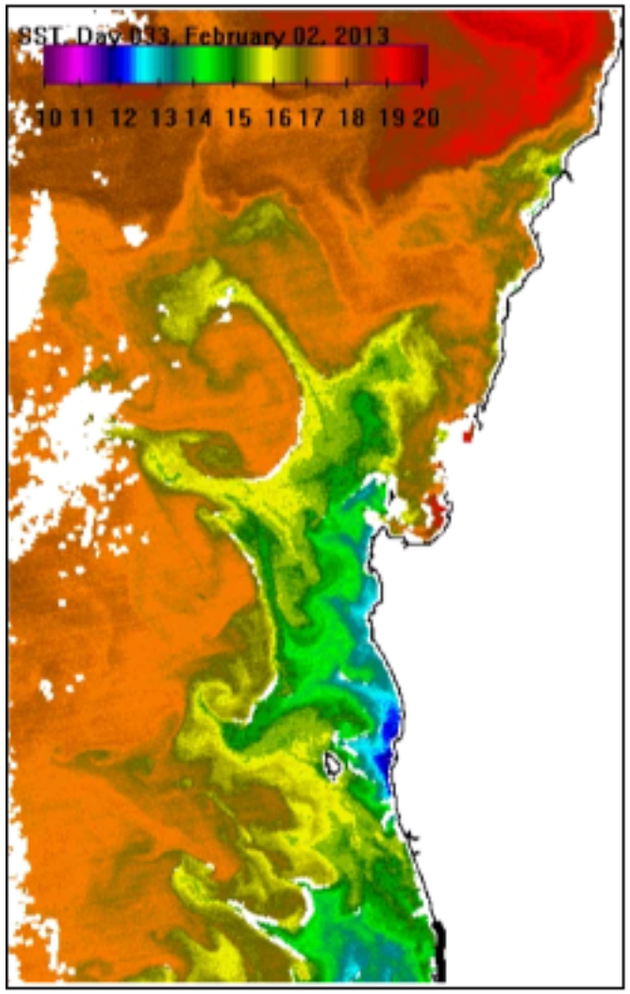


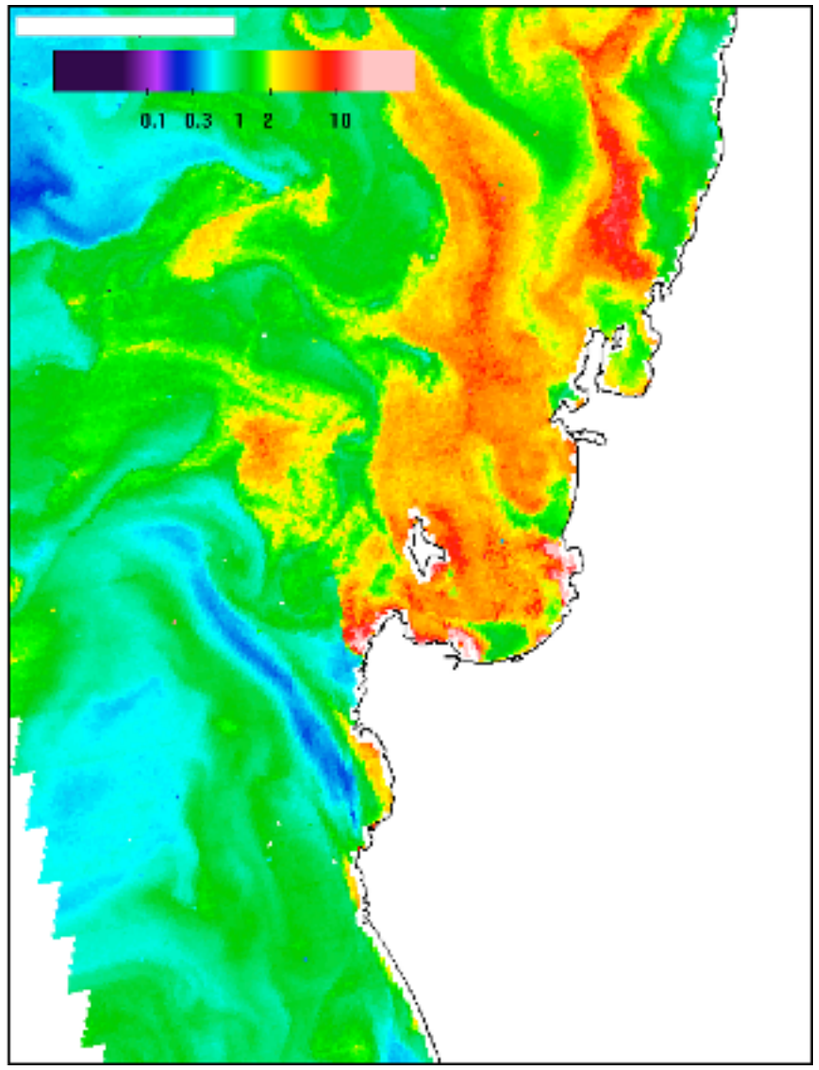


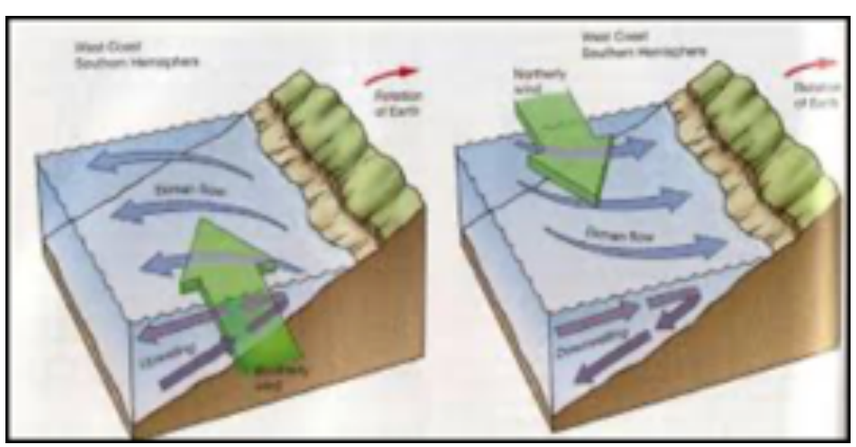


Research


10^5
10^4
10^3
10^2
10^1
10^0
w^+
w^-
f (34.98°N)
M_2
16 degrees of freedom
Spectral density (cm² s⁻² cph⁻¹)
10^{-3}
10^{-2}
10^{-1}
Frequency (cph)


SST, Day 033, February 02, 2013
10 11 12 13 14 15 16 17 18 19 20


0.1 0.3 1 2 10

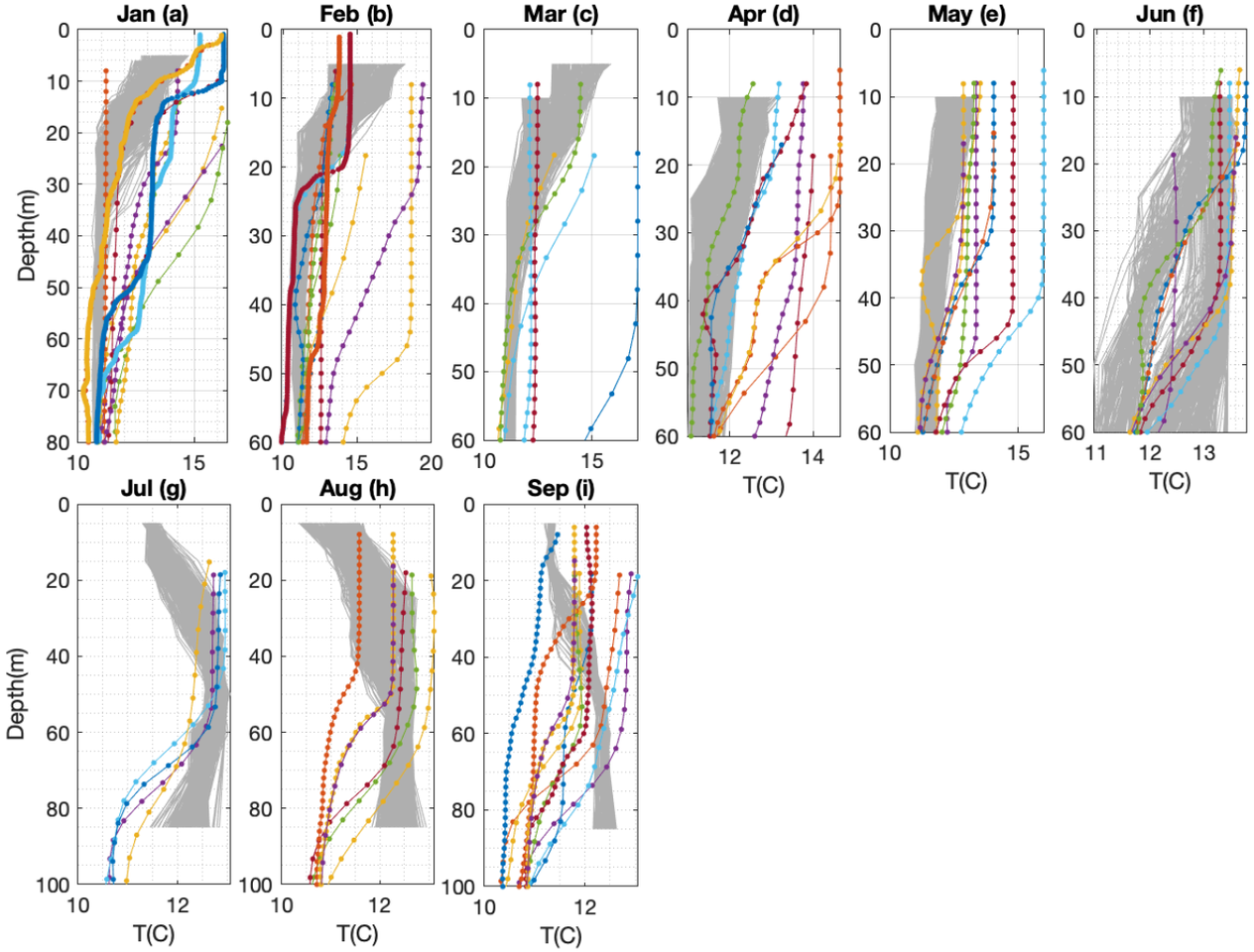

West Coast
Southern Hemisphere
Rotation of Earth
Zonal flow
Upwelling
Northerly wind
West Coast
Southern Hemisphere
Rotation of Earth
Ekman flow
Downwelling

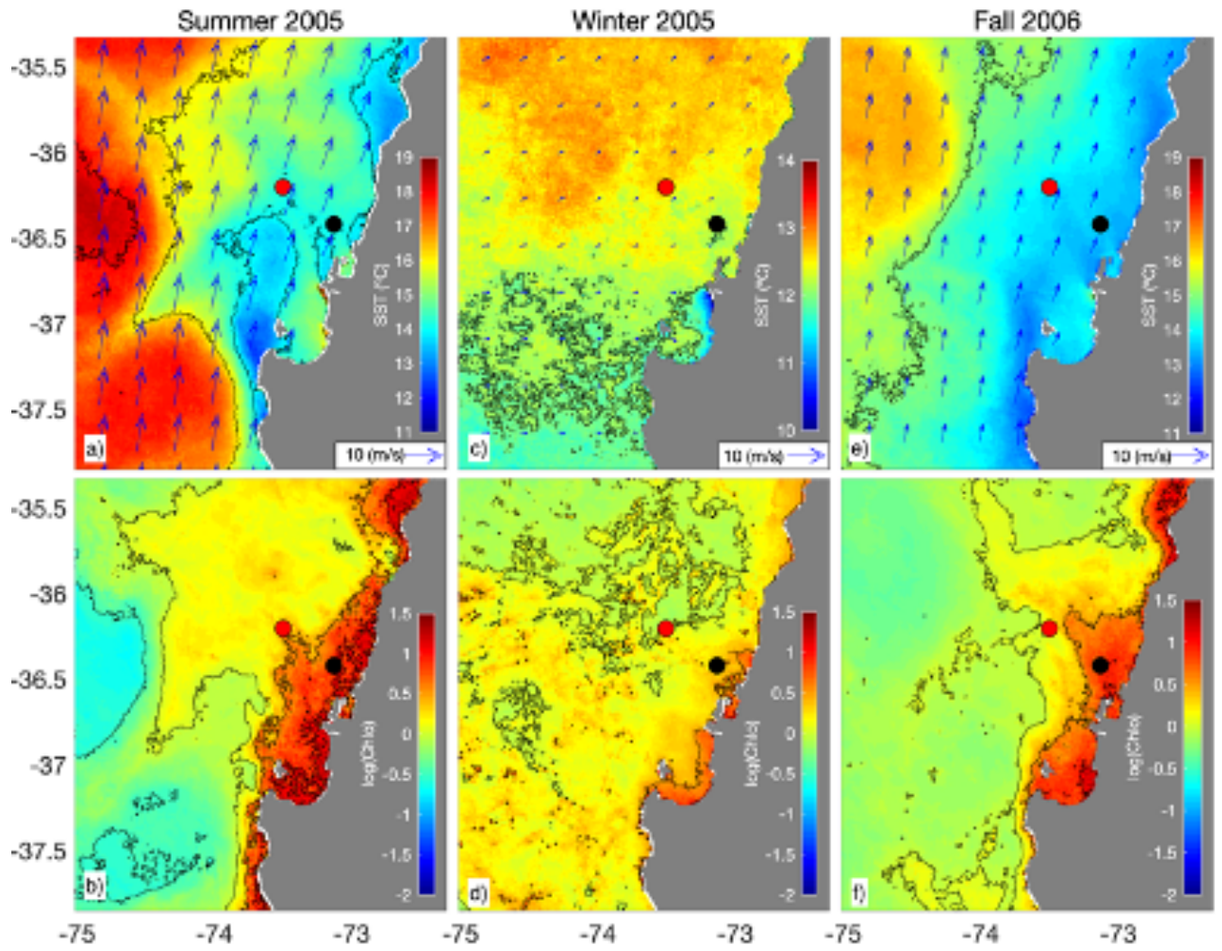
Variability of sub-inertial, tidal and near-inertial currents over the shallow shelf of Concepción, Chile.

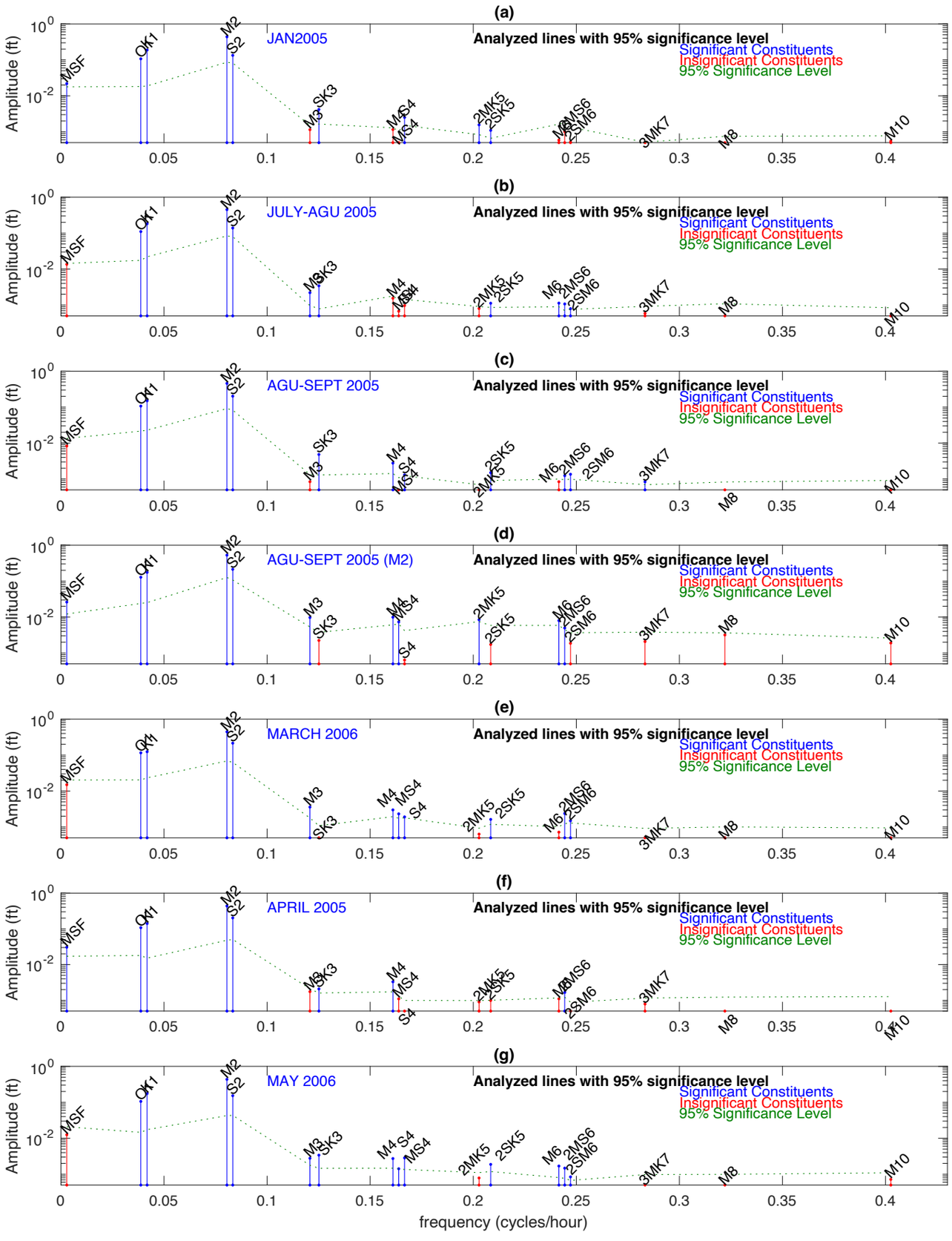
Claudio Iturra, Universidad de Concepcion, Chile.
Marcus Sobarzo, Universidad de Concepcion, Chile.

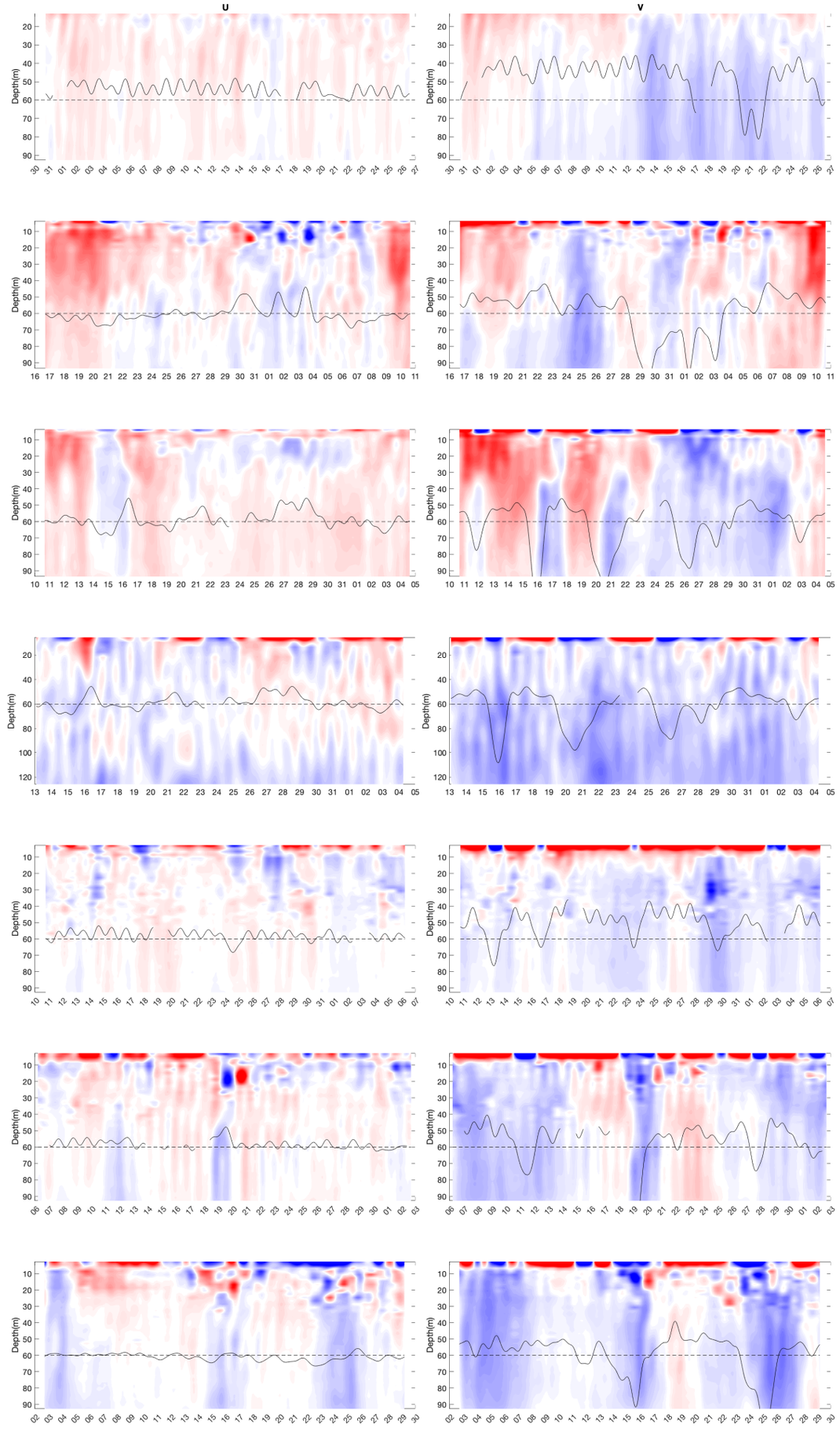
Abstract

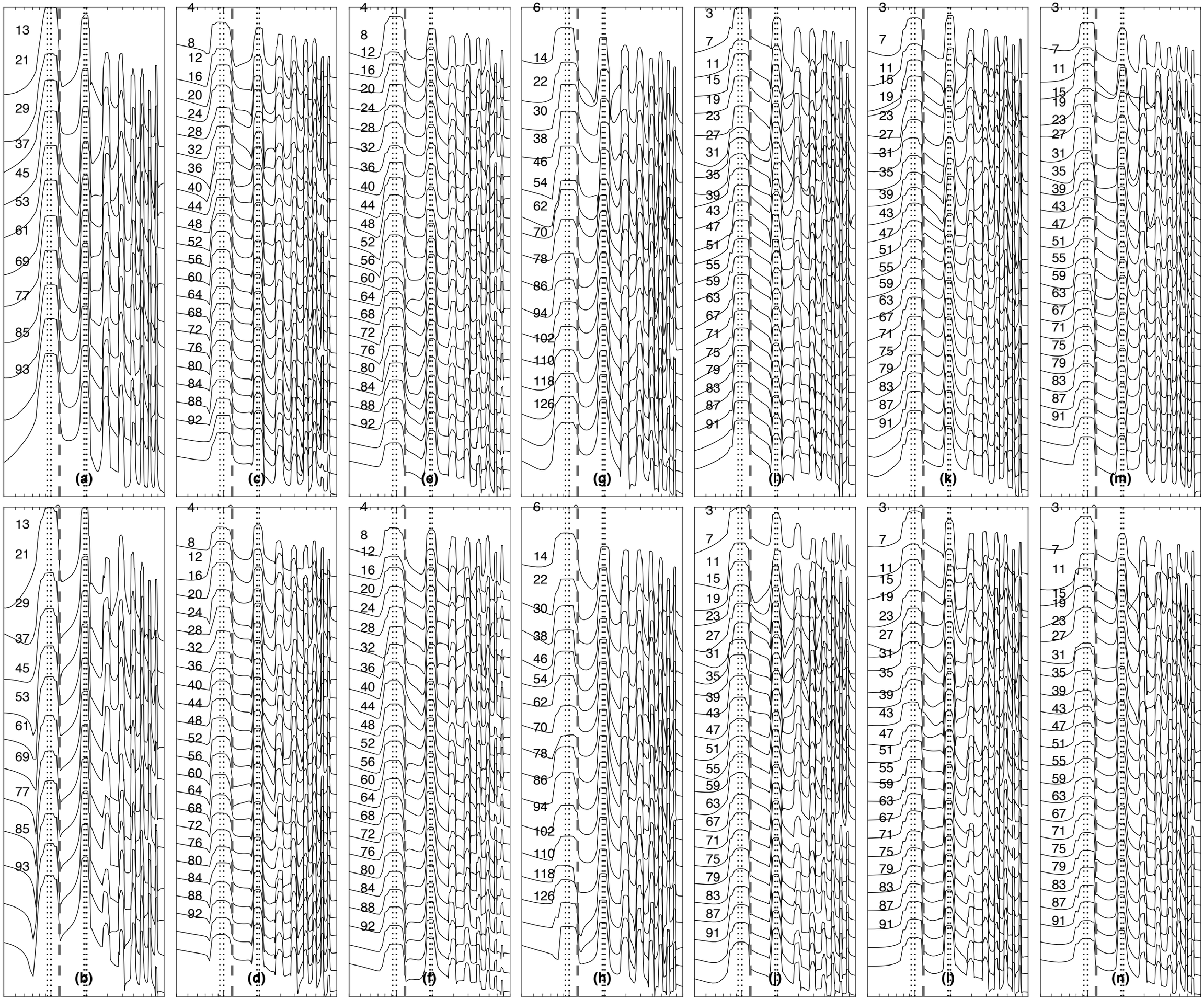
This observational study describes the sub-inertial, tidal and near-inertial circulation over the shallow shelf of Concepcion during the months of January, July and August of 2005, and during March, April and May of 2006. The costal circulation is investigated using current velocity and bottom pressure observations from a mooring located at 40 kilometers from the coast of Concepcion. Additionally, an ADCP mooring located at 60 kilometers from the coast was used to describe the current circulation during a short period during winter season. CTD/ Argo vertical profiles, and thermistors chain was used to describe the vertical variability and stability of the water column during upwelling, relaxations events, storms and strong-weak near inertial current events. A composite of sea surface temperature data from satellite with a resolution of 700 meters was used to describe the mesoscale dynamics forced by different wind patterns along the study area. Sub-inertial circulation was analyzed removing the tides, stationary multi-cycles, shallow water component and inertial motions from the current velocity (u+iv). Harmonic analysis with nodal correction was used to extract the tidal frequencies from the raw current data. Near-inertial motions (which includes a contribution from the diurnal tide at this latitude) was extracted from the tide residual velocity using a narrowband filtering based in the wavelet analysis, the analysis extracted only the energy associated with anticlockwise motions close to the local inertial peak. Circulation forced by the winds was also evaluated using Ekman Theory (Ekman Transport and Ekman Spiral) and a Slab Model, with the purpose to evaluate the variability of the theorical circulation forced by the wind and their relationship with the current data from moorings. Wind data from the Carriel-Sur weather station, Hualpen weather station, and wind from satellite sensor was using to evaluate the theorical circulation forced by the wind. Tidal amplitude, near inertial and sub/super-inertial variability was evaluates using rotary spectral analysis.


Jan (a)
Feb (b)
Mar (c)
Apr (d)
May (e)
Jun (f)
Jul (g)
Aug (h)
Sep (i)
Depth(m)
T(C)


Summer 2005
Winter 2005
Fall 2006
SST (°C)
10 (m/s)
log(Chl-a)
-35.5
-36
-36.5
-37
-37.5
-75
-74
-73


(a)
JAN2005
Analyzed lines with 95% significance level
Significant Constituents
Insignificant Constituents
95% Significance Level
(b)
JULY-AGU 2005
(c)
AGU-SEPT 2005
(d)
AGU-SEPT 2005 (M2)
(e)
MARCH 2006
(f)
APRIL 2005
(g)
MAY 2006
Amplitude (ft)
frequency (cycles/hour)
MSF
O1
M2
S2
M3
SK3
M4
MS4
S4
2MK5
2SK5
M6
2MS6
2SM6
3MK7
M8
M10


U
V
Depth(m)


(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)
(k)
(l)
(m)
(n)

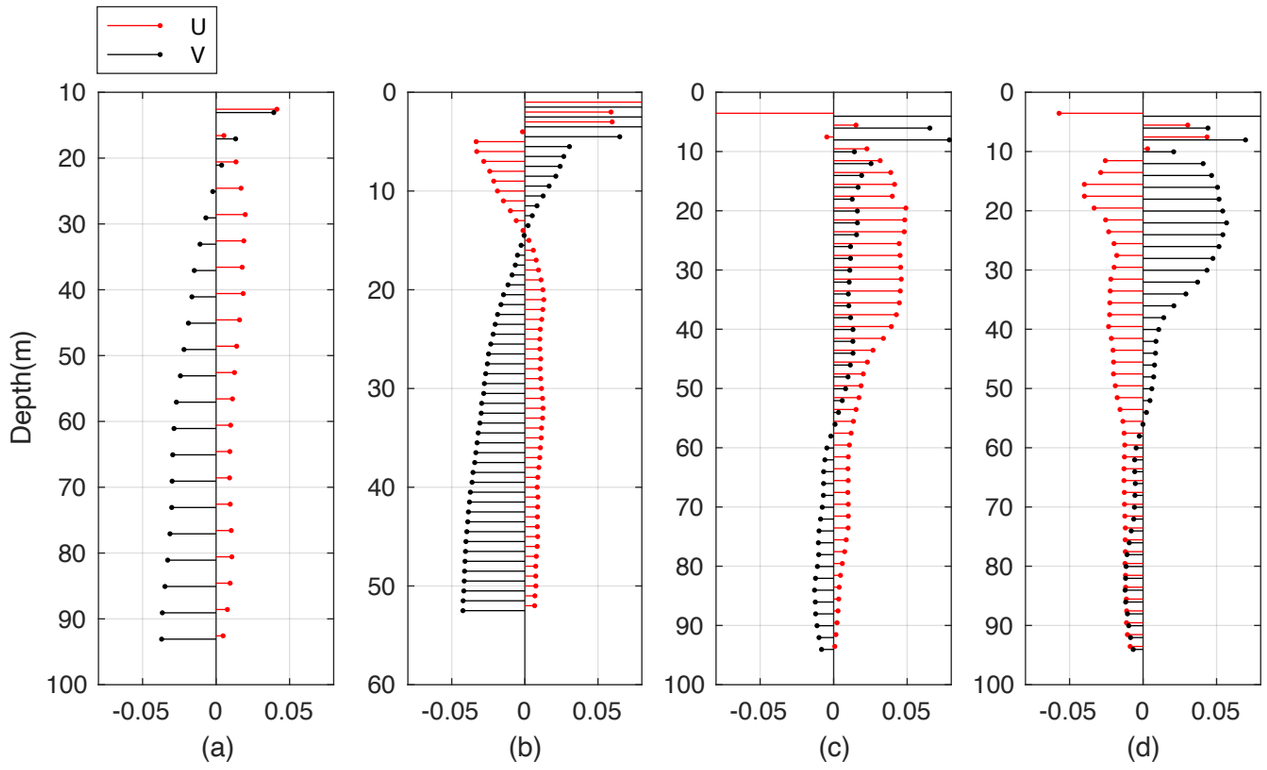


Figure 007. Vertical profiles of the Total Current Velocity at the location L1 except for panel (c) located at L2. Each panel represent an average of approximately 30 days of data during the month of January(a-b), July(c), August(d) and September(e) of 2005, and March(f), April(g) and May(h) of 2006.

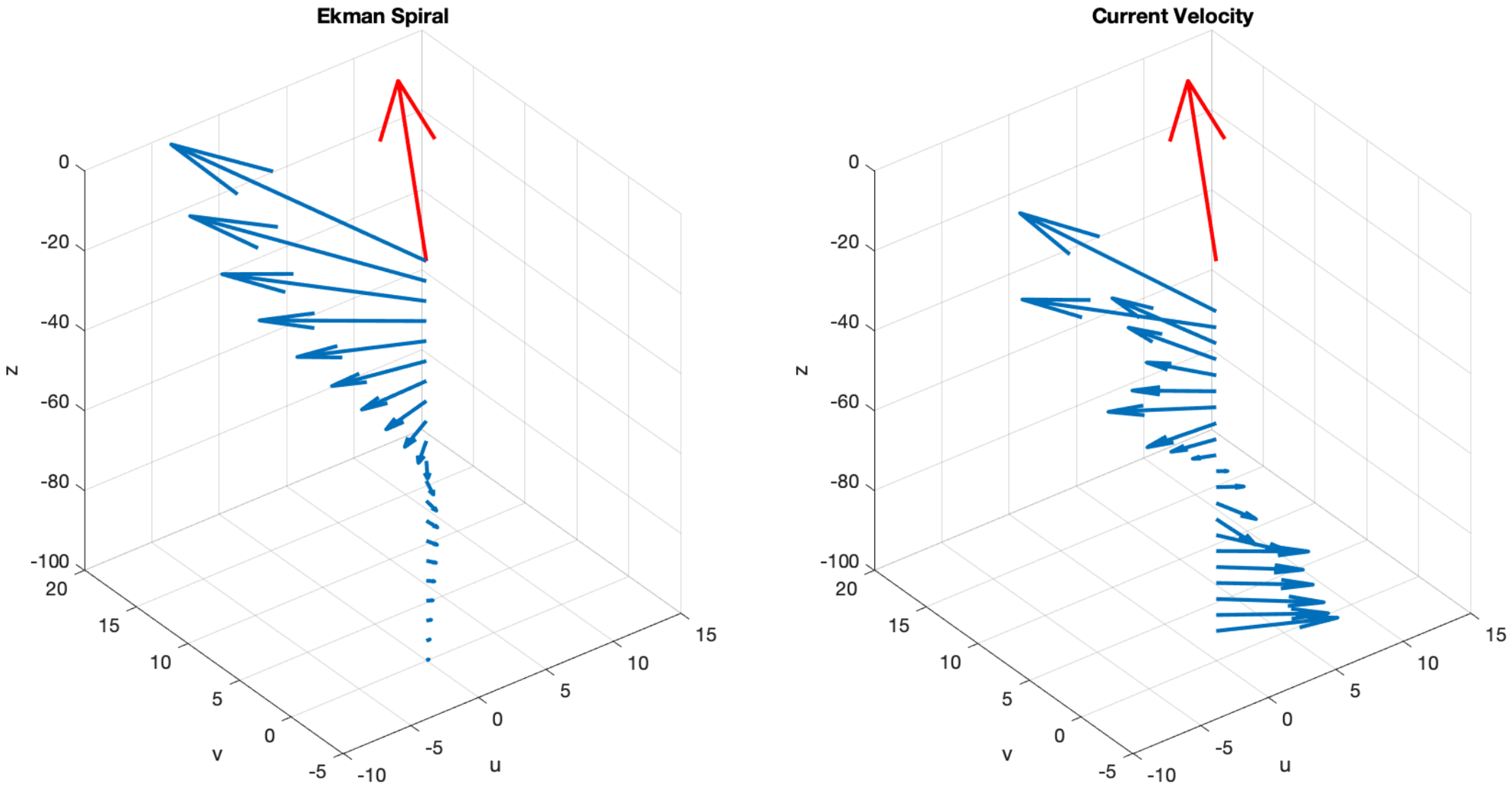
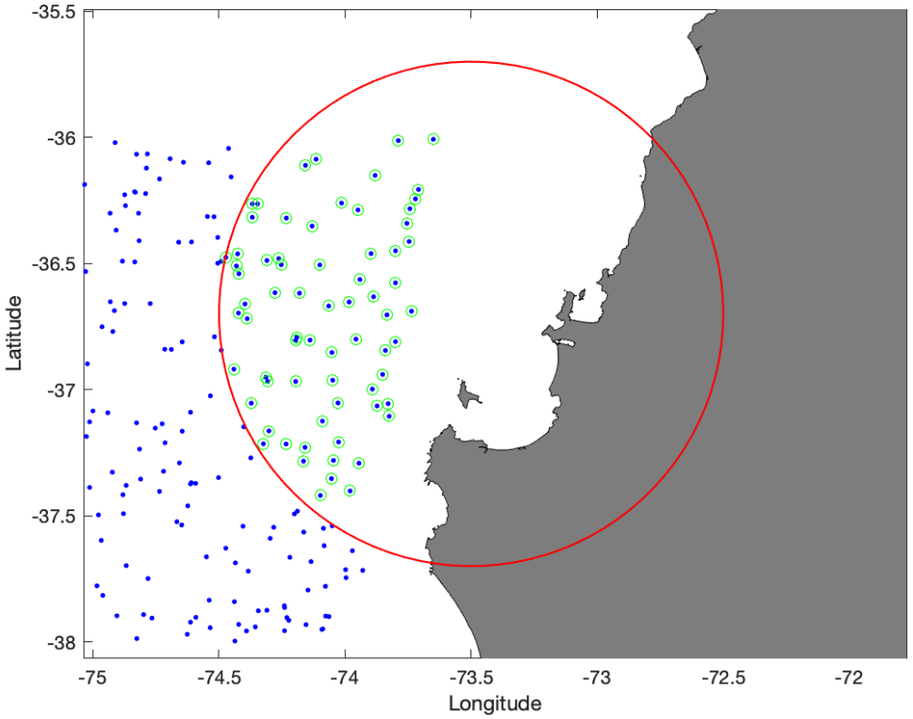
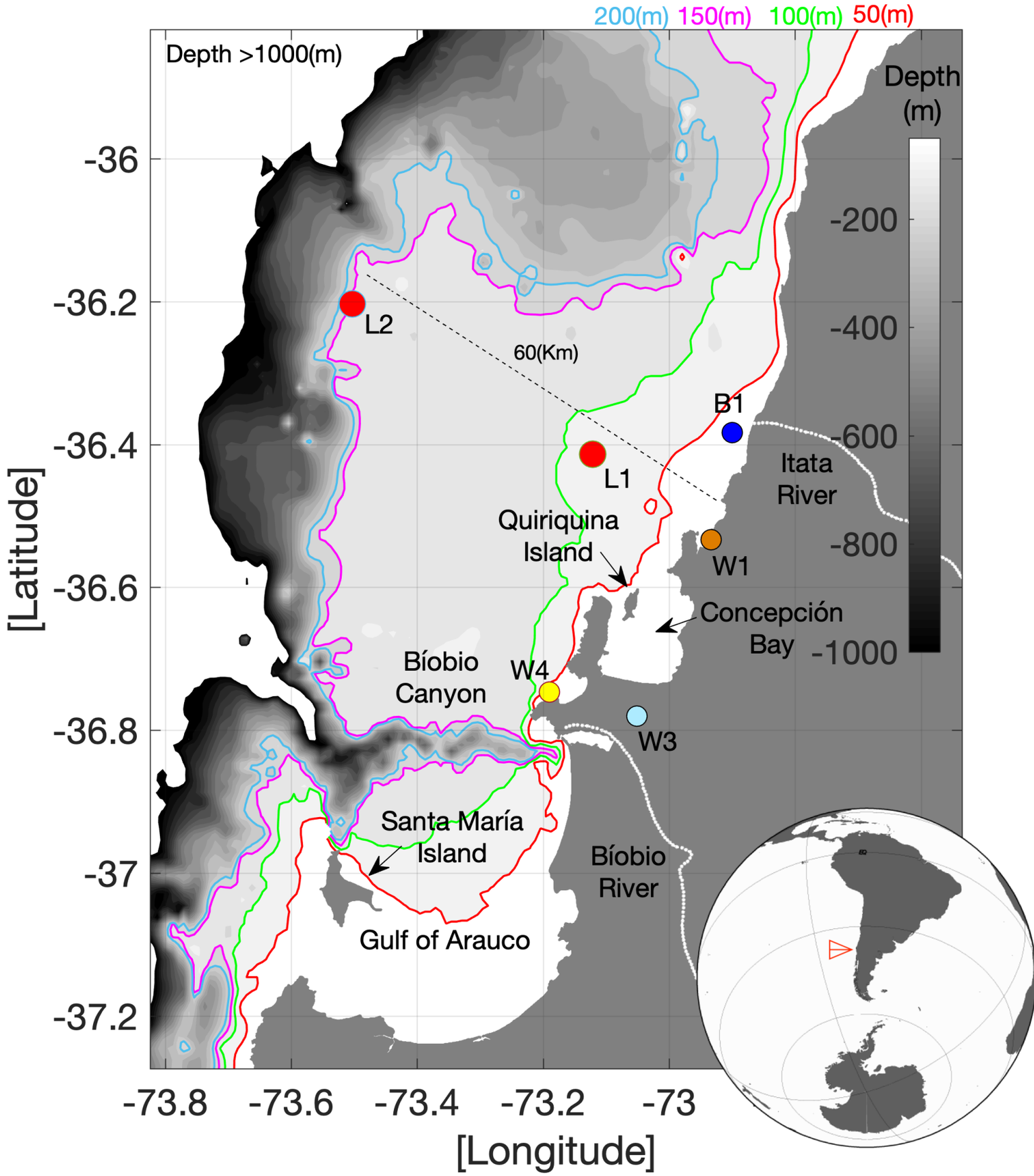


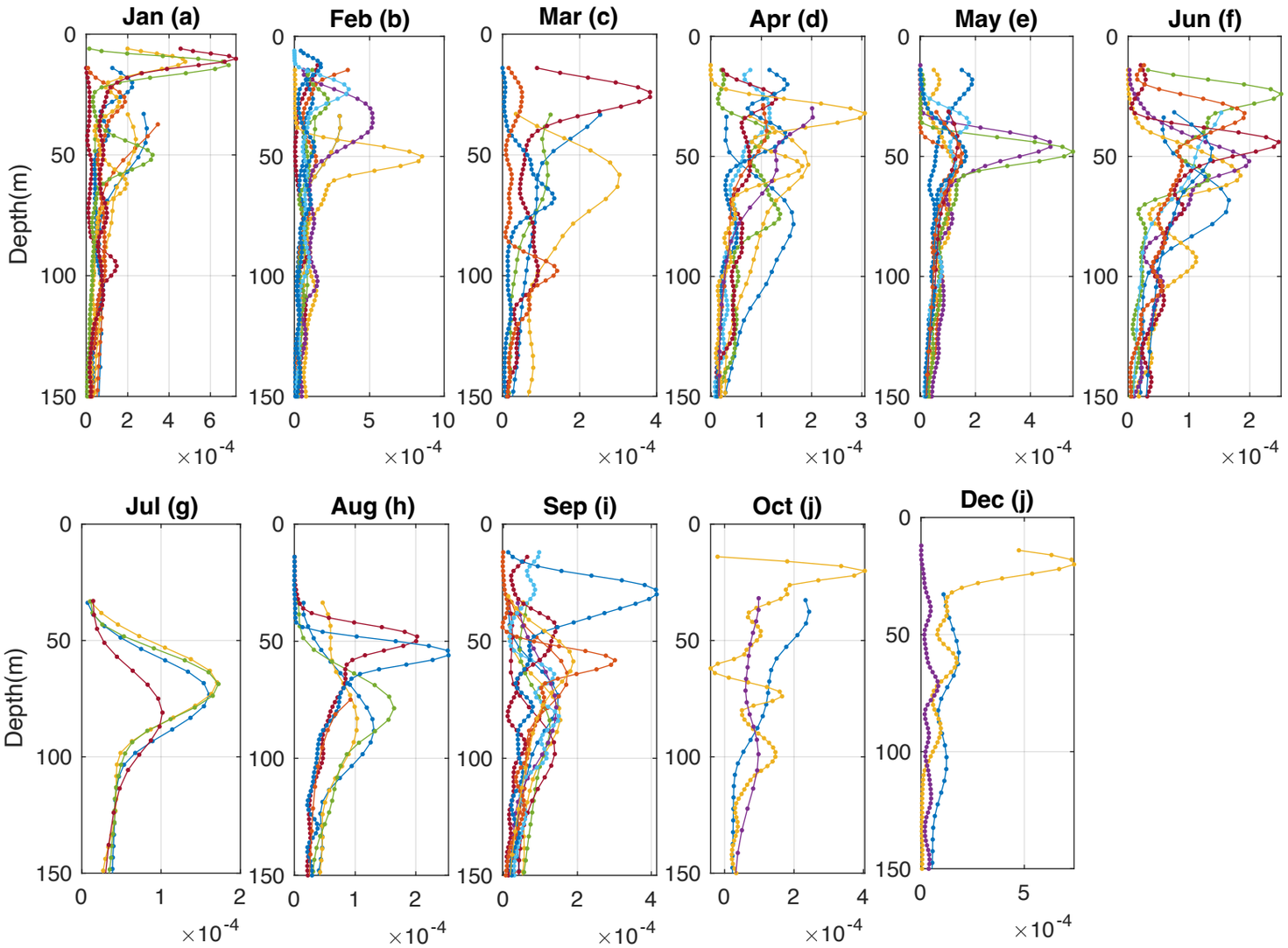
Figure 005 Panel (a) represent the theorical Ekman spiral estimated with winds from the Carriel-Sur weather station (red arrow) and water column parameters from hydrographic data. Panel (b) represent the current velocity and direction obtained from a mooring at the location L1. The data represent the current velocity and winds of one specific measurement during January 1, 2005, at 12 PM. The residual between the current and the Ekman vertical current/spiral is evaluated to understand the variability of the deep current (below 50 meter) not forced by the surface wind during the year 2005-2006.

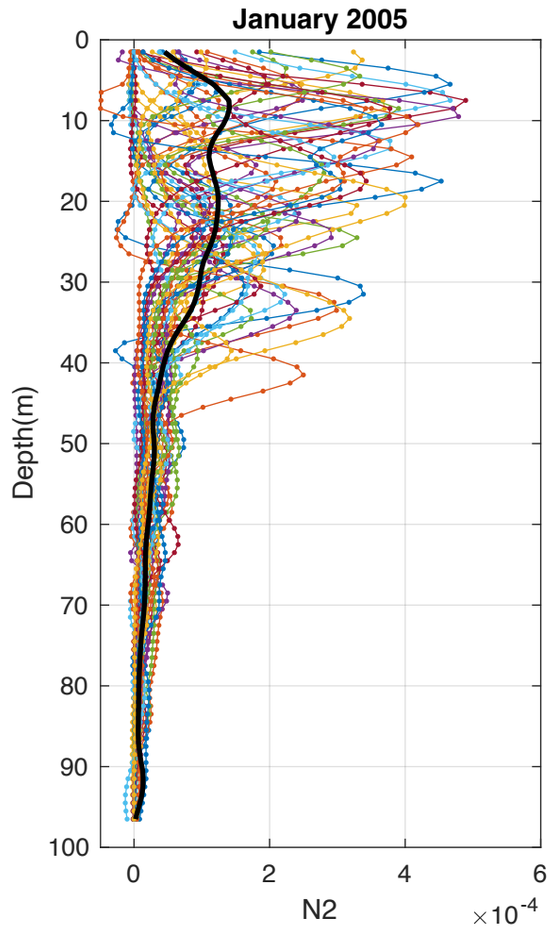
Variability of Near-inertial internal waves over the shelf of Concepcion, Chile.
Claudio Iturra, Universidad de Concepcion, Chile.
Marcus Sobarzo, Universidad de Concepcion, Chile.
Journal of Marine Science and Engineering

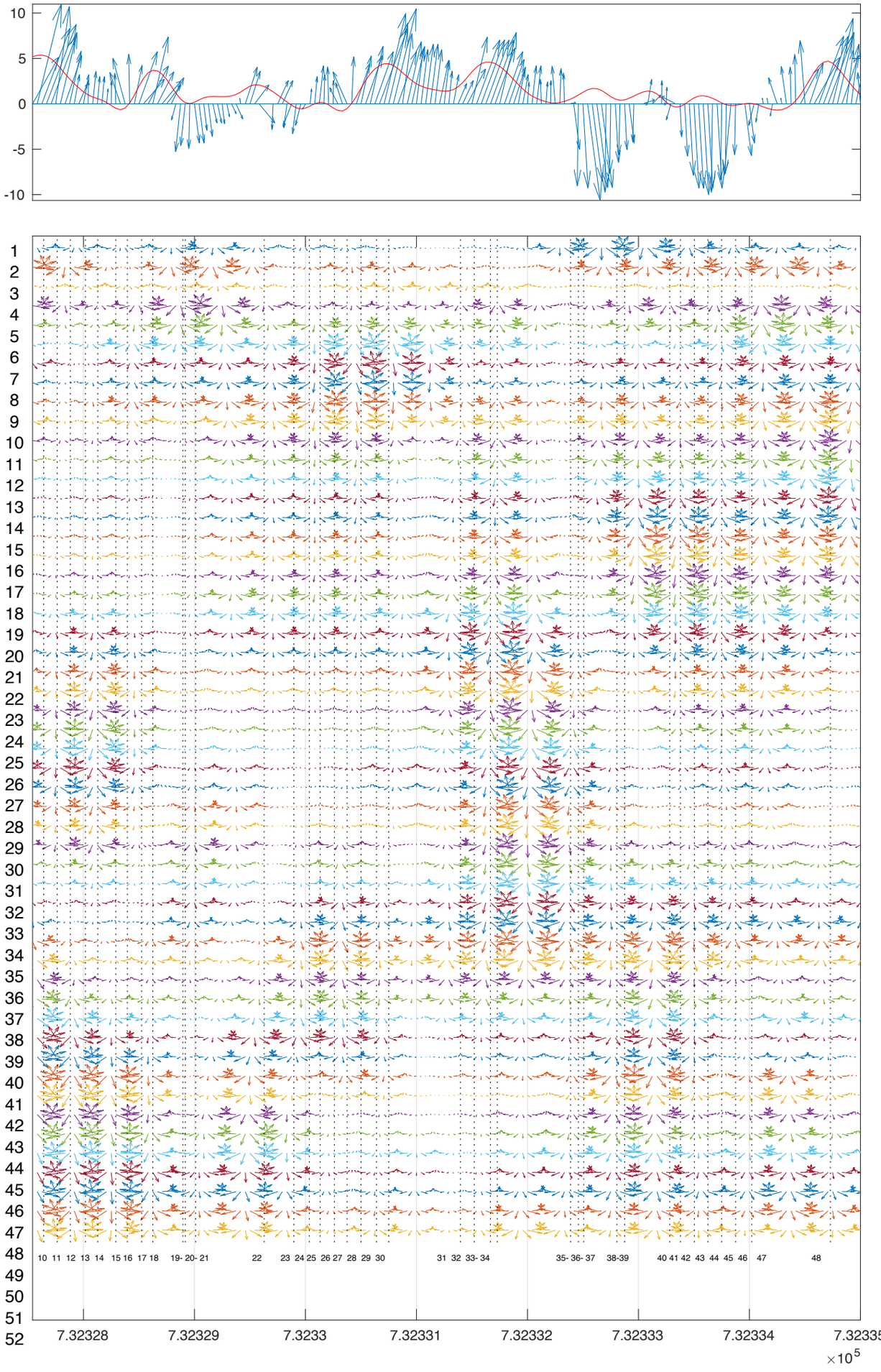
This observational study describes the variability of near-inertial waves (NIWs) over the shallow shelf of Concepcion, Chile. Rotary spectrum analysis of the hourly current velocity time series measured at 100- and 150-meters depth reveled the prevailing anti-clockwise component of the motions near the local inertial frequency for all depths. Rotary spectral analysis and progressive vector diagrams of the current velocity shows that the peak of inertial waves was shifted to higher and lower frequencies through the months of the year. The inertial peak of energy is stronger during the months of summer and winter, and during summer the inertial peak surrounds the diurnal tide K1 at the location of the mooring, intensifying the near inertial energy band. During winter season the maximum intensifications of NIWs was found describing faster inertial current velocities and inertial radius. Strong wind pulses forces by local storms during winter transfer a significant amount of energy to the upper ocean, strong rotational current are detected below the firth thermal layer of the upper ocean.

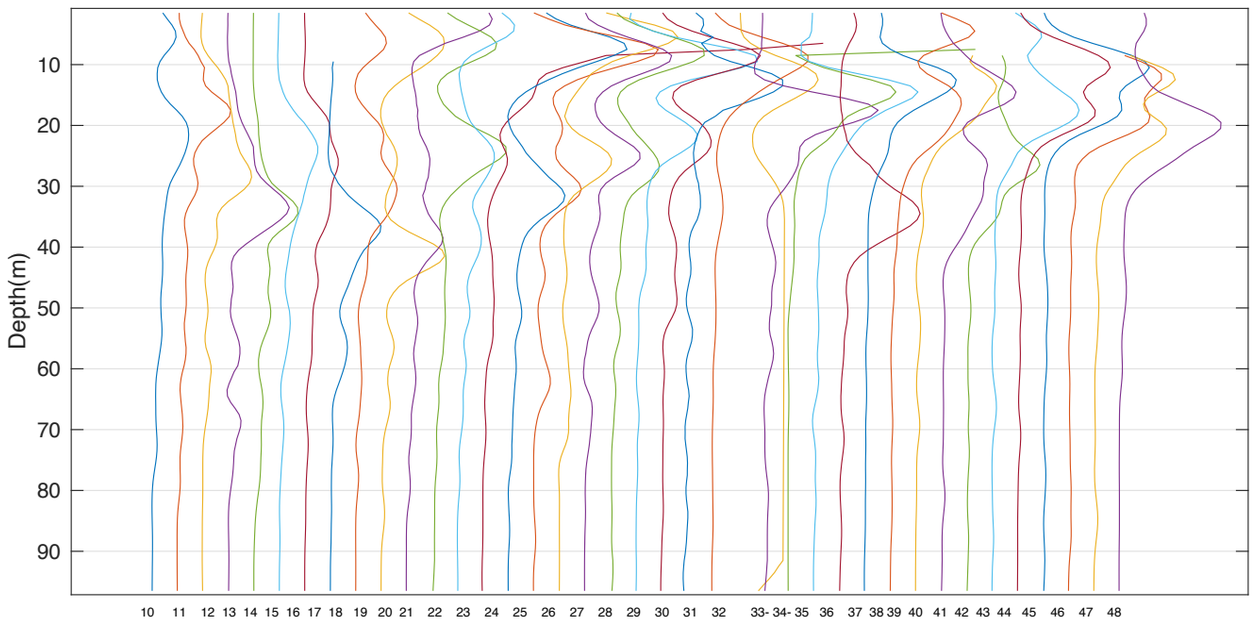

-35.5
-36
-36.5
-37
-37.5
-38
Latitude
-75
-74.5
-74
-73.5
-73
-72.5
-72
Longitude


200(m)
150(m)
100(m)
50(m)
Depth >1000(m)
Depth (m)
-200
-400
-600
-800
-1000
-36
-36.2
-36.4
-36.6
-36.8
-37
-37.2
[Latitude]
L2
60(Km)
L1
B1
Itata River
Quiriquina Island
W1
Concepción Bay
Bíobio Canyon
W4
W3
Santa María Island
Bíobio River
Gulf of Arauco
-73.8
-73.6
-73.4
-73.2
-73
[Longitude]

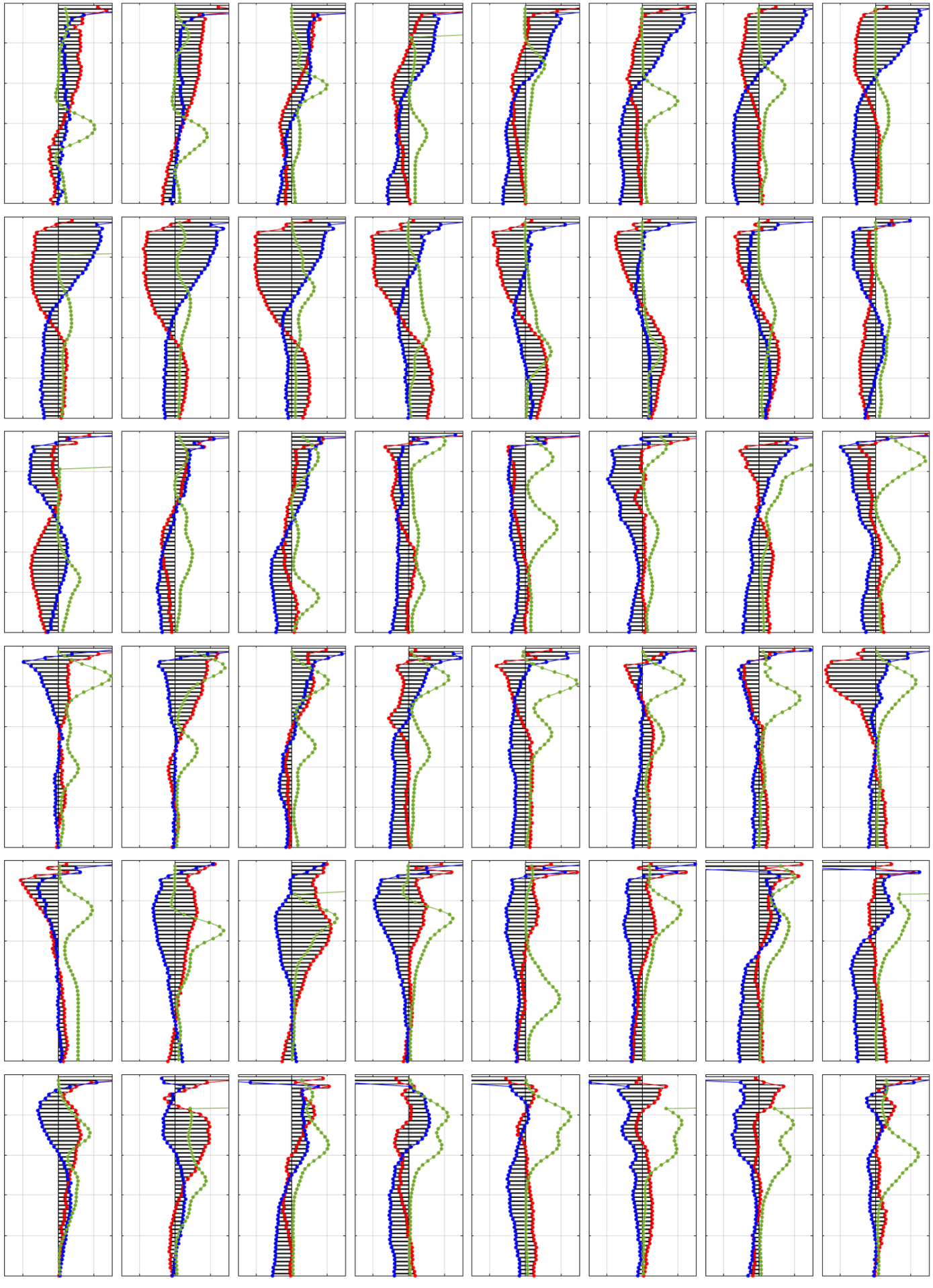

Jan (a)
Feb (b)
Mar (c)
Apr (d)
May (e)
Jun (f)
Jul (g)
Aug (h)
Sep (i)
Oct (j)
Dec (j)
Depth(m)
0
50
100
150
×10^-4


January 2005
Depth(m)
0
10
20
30
40
50
60
70
80
90
100
N2
×10^-4


10
5
0
-5
-10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
10 11 12 13 14 15 16 17 18 19- 20- 21 22 23 24 25 26 27 28 29 30 31 32 33- 34 35- 36- 37 38-39 40 41 42 43 44 45 46 47 48
7.32328
7.32329
7.3233
7.32331
7.32332
7.32333
7.32334
7.32335
×10^5


Depth(m)
10
20
30
40
50
60
70
80
90
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33- 34- 35 36 37 38 39 40 41 42 43 44 45 46 47 48

N2



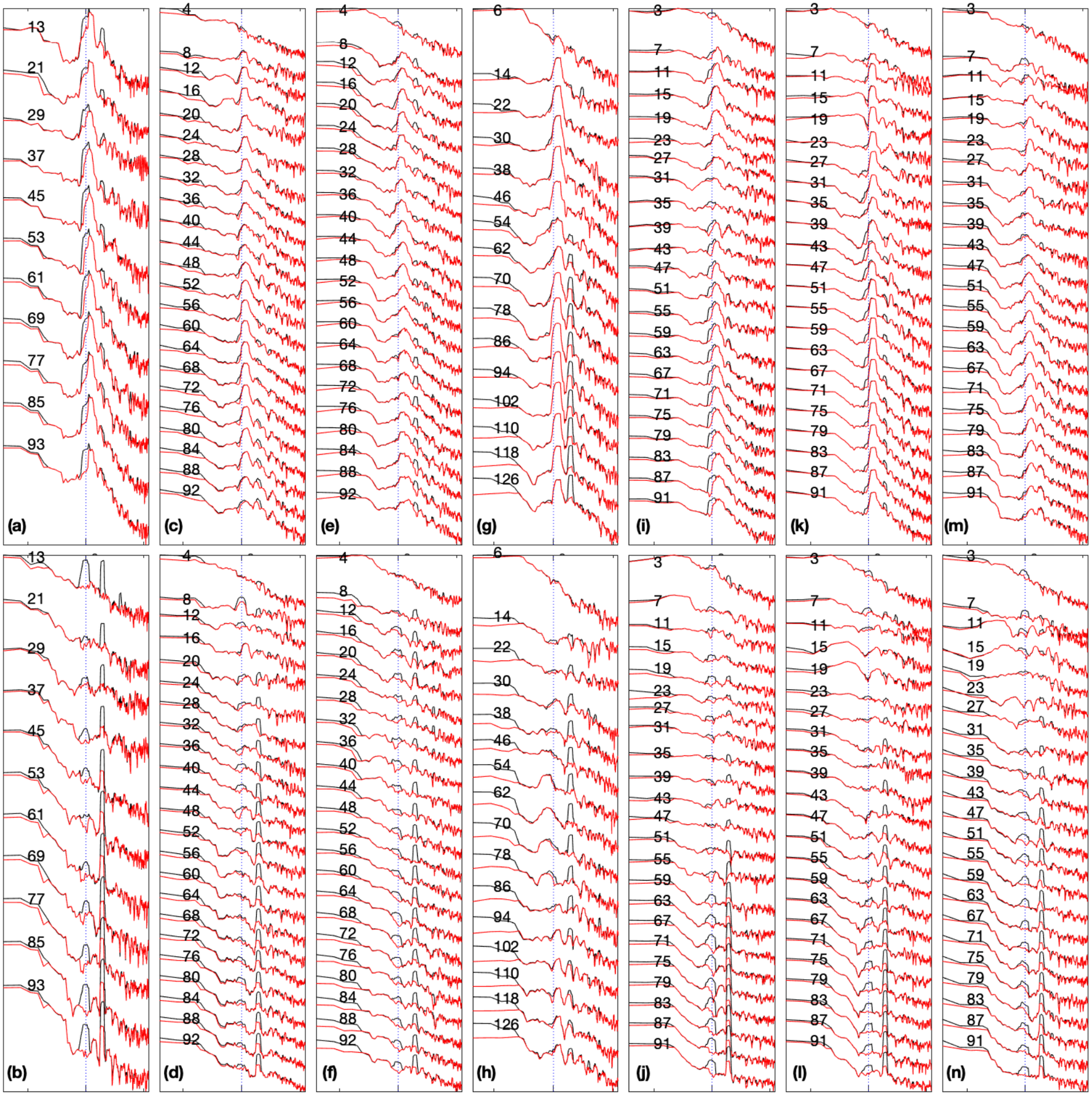
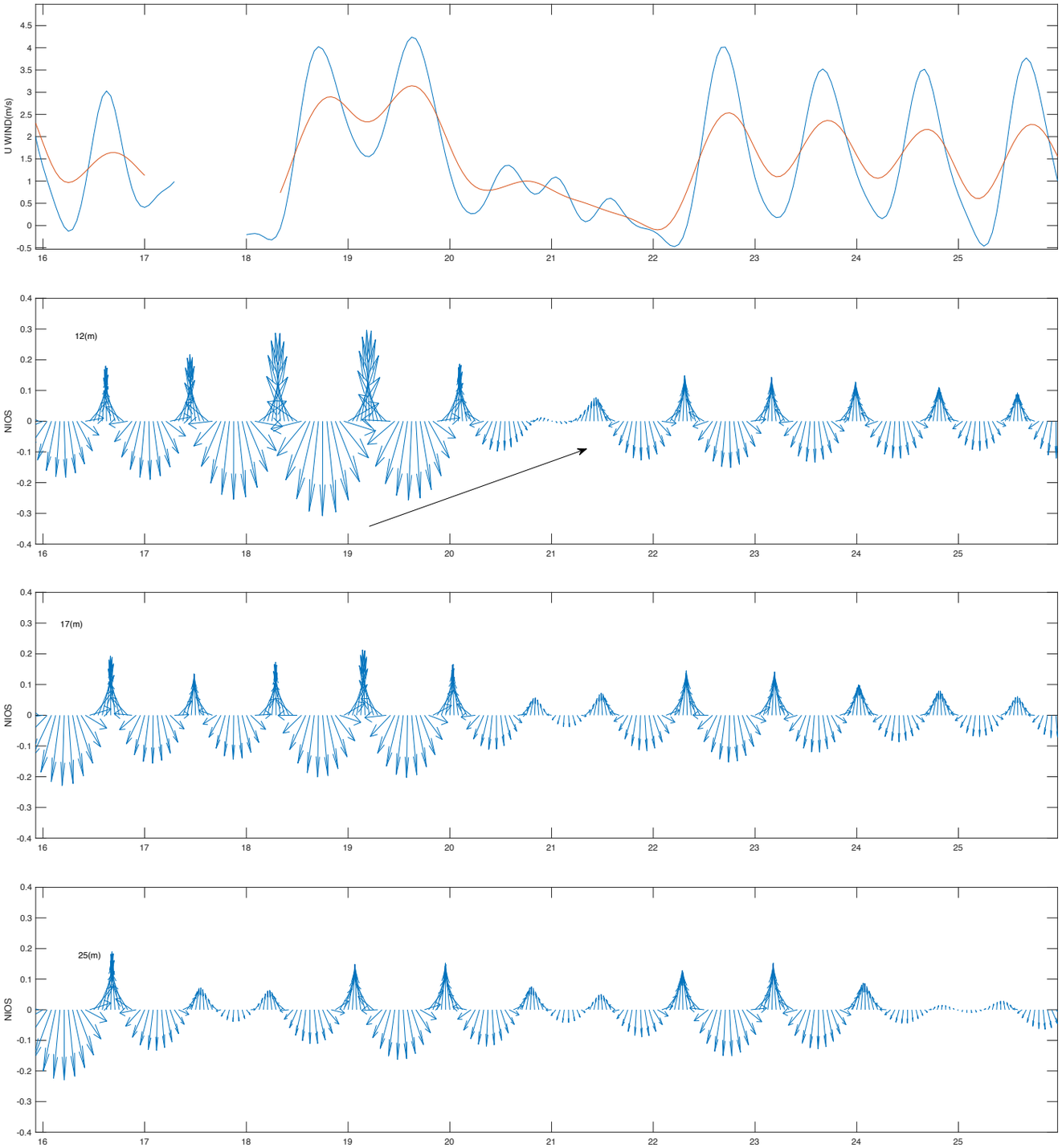
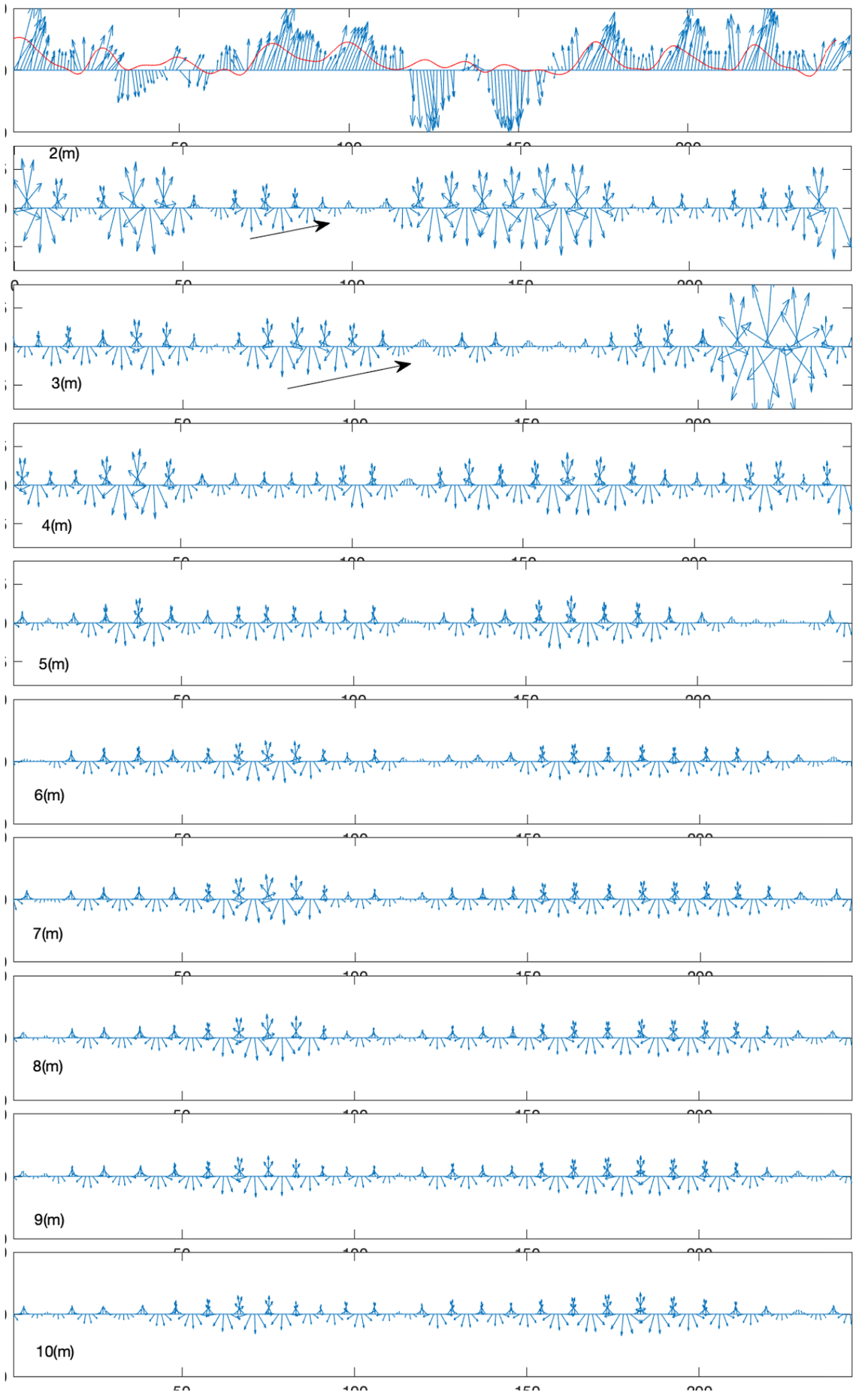
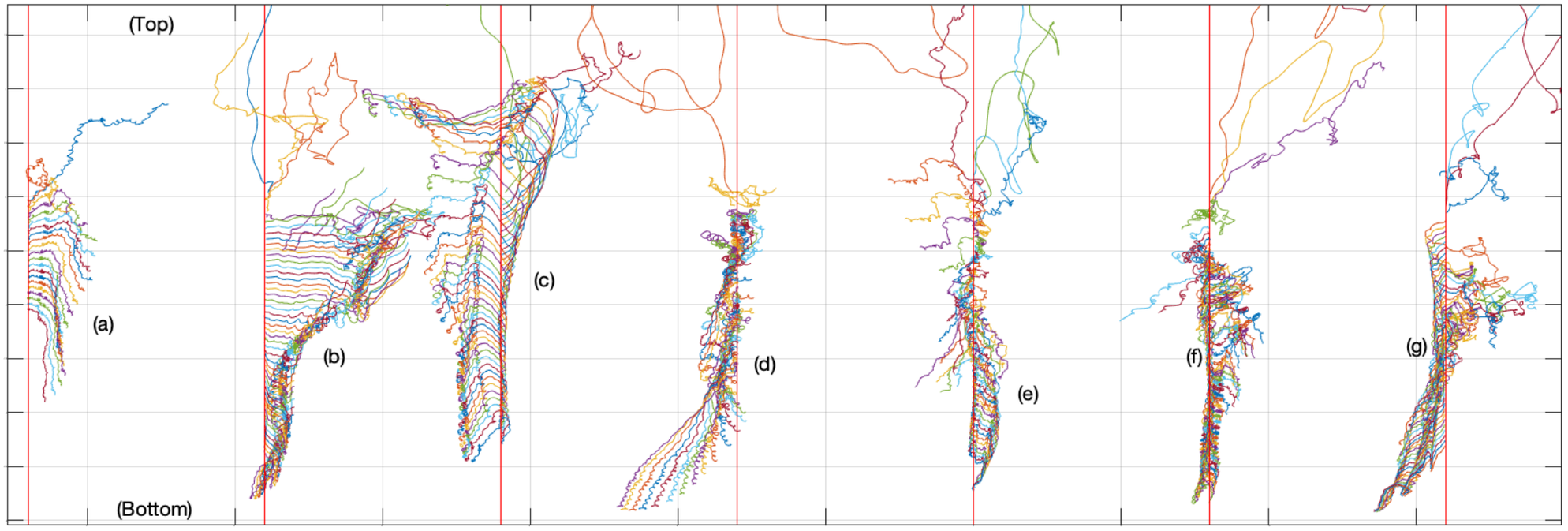
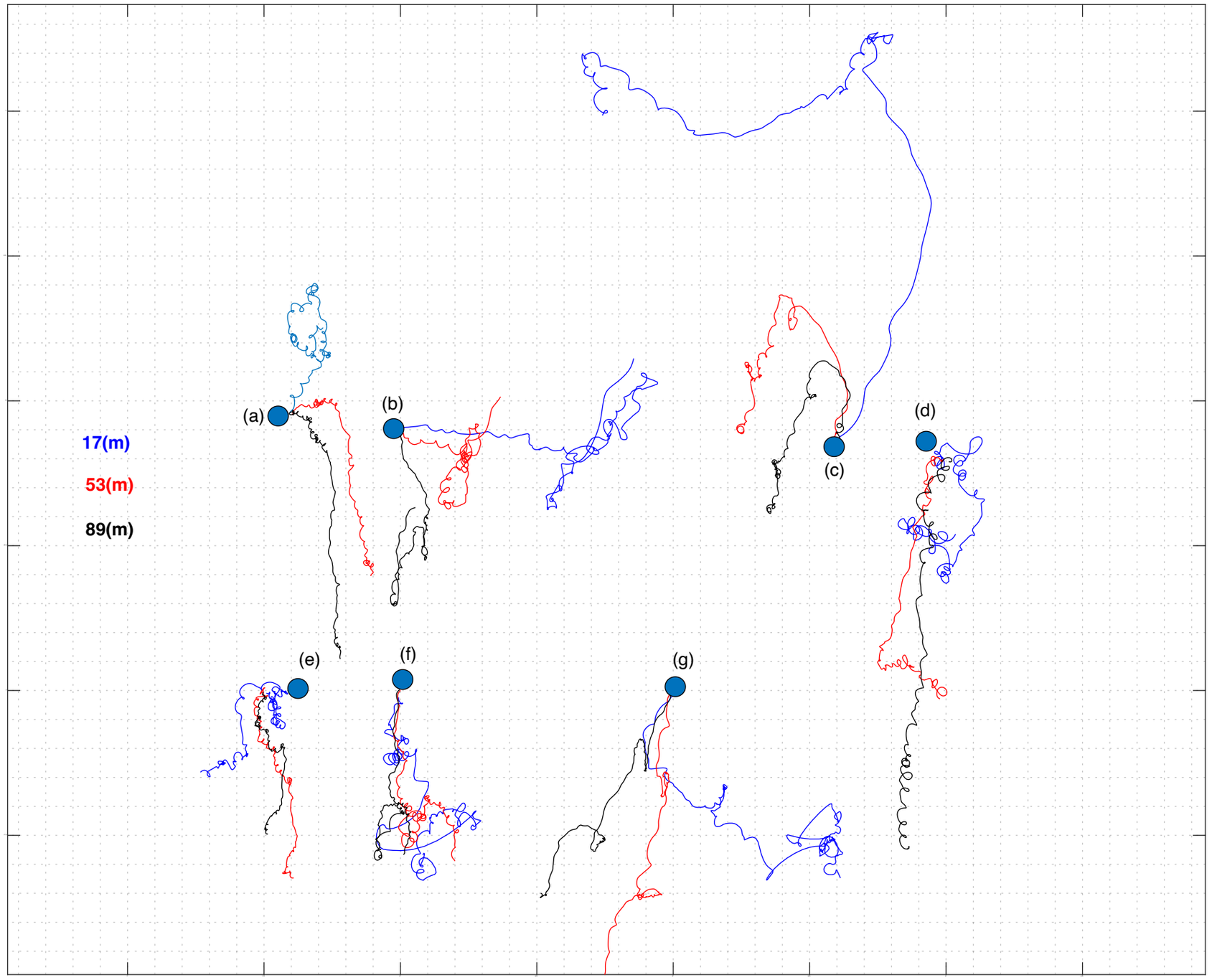


Figure 005. Negative (panels a, c, e, g, I, k, m) and positive (panels b, d, f, h, j, l, n) rotary spectra of the current velocities (u+iv) using the P = 4 as a multitaper estimate. Numbers in the left side of each panels represent the depth of the velocity measurement. The measurements correspond to the location L1 at 40 kilometers from the coast, except for the panels g-h that correspond to the location L2 at 60 kilometers from the coast. Black color lines indicate the raw current meter velocity, and red color lines represent the residual current (without tides).


U WIND(m/s)
NIOS
12(m)
17(m)
25(m)


2(m)
3(m)
4(m)
5(m)
6(m)
7(m)
8(m)
9(m)
10(m)


(Top)
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(Bottom)


17(m)
53(m)
89(m)
(a)
(b)
(c)
(d)
(e)
(f)
(g)

Observation and simulation of Near Inertial Waves over the shallow shelf of Concepcion
Claudio Iturra, Universidad de Concepcion, Chile.
John Klinck, Old Dominion, USA.
Marcus Sobarzo, Universidad de Concepcion, Chile.
Journal of Marine Science and Engineering

Abstract

Near inertial waves were analytical evaluated using the slab model (Pollard and Millar, 1970) and the shallow water equation. The synthetical inertial current were correlated with near inertial waves detected by two ADCP mooring located at 40 and 60 kilometers from the coast of Concepcion, Chile. Analytical solutions to the inertial waves were forced by simulated wind, generated by the principal harmonic components of the wind stress from the Carriel sur weather station. Rotary spectral analysis was used to evaluate the amplitude of the significant frequencies of the wind during the season of summer and winter. Multiples phase angle of the wind forcing, wind decay rate, surface roughness coefficient and e-folding times in conjunction with the vertical density structure of the water column were used to simulate near inertial waves and their amplitude and decay in the upper ocean.