Look at comments to follow slides

Water and chlorophyll circulations modeling on water area of Aniva gulf according to oceanographic data of the 2002 year

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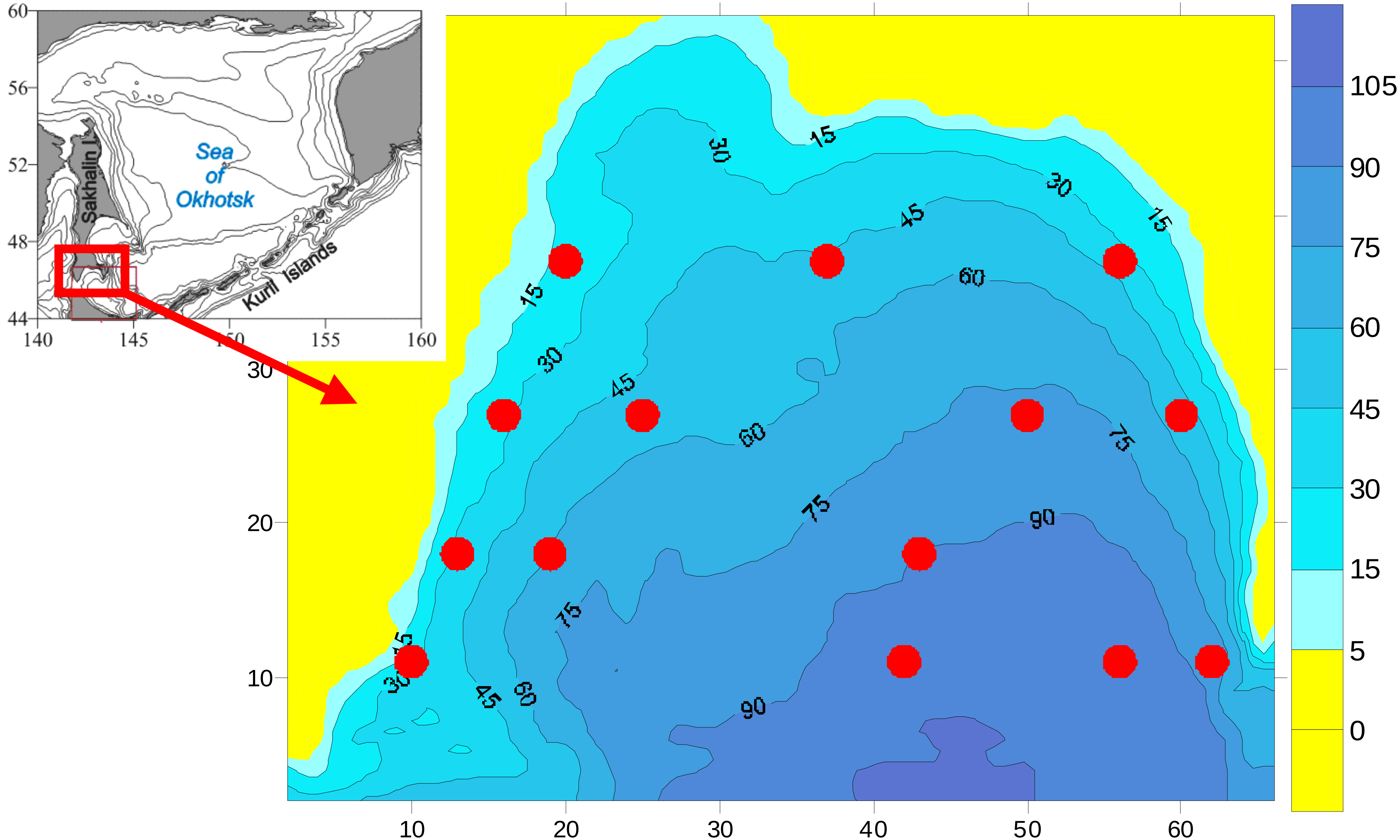
Distribution depth in the region of Aniva bay



POM parameters

Boundary condition for physical model

Grid:

IM = 67

JM = 54

KB = 5

KDZ = {1, 1, 3, 5, 5}

DelX=2700

Model:

Mode = 3

DTE = 1

ISPLIT = 30

DTI = 30

Day = 60

Surface:

$$\omega(0) = 0$$

$$\frac{K_H}{D}\frac{\partial T}{\partial \sigma} = -< w_T >, \frac{K_H}{D}\frac{\partial S}{\partial \sigma} = -< w_S >$$

Bottom:

$$\omega(-1) = 0$$

$$\frac{K_H}{D}\frac{\partial T}{\partial \sigma} = 0, \frac{K_H}{D}\frac{\partial S}{\partial \sigma} = 0$$

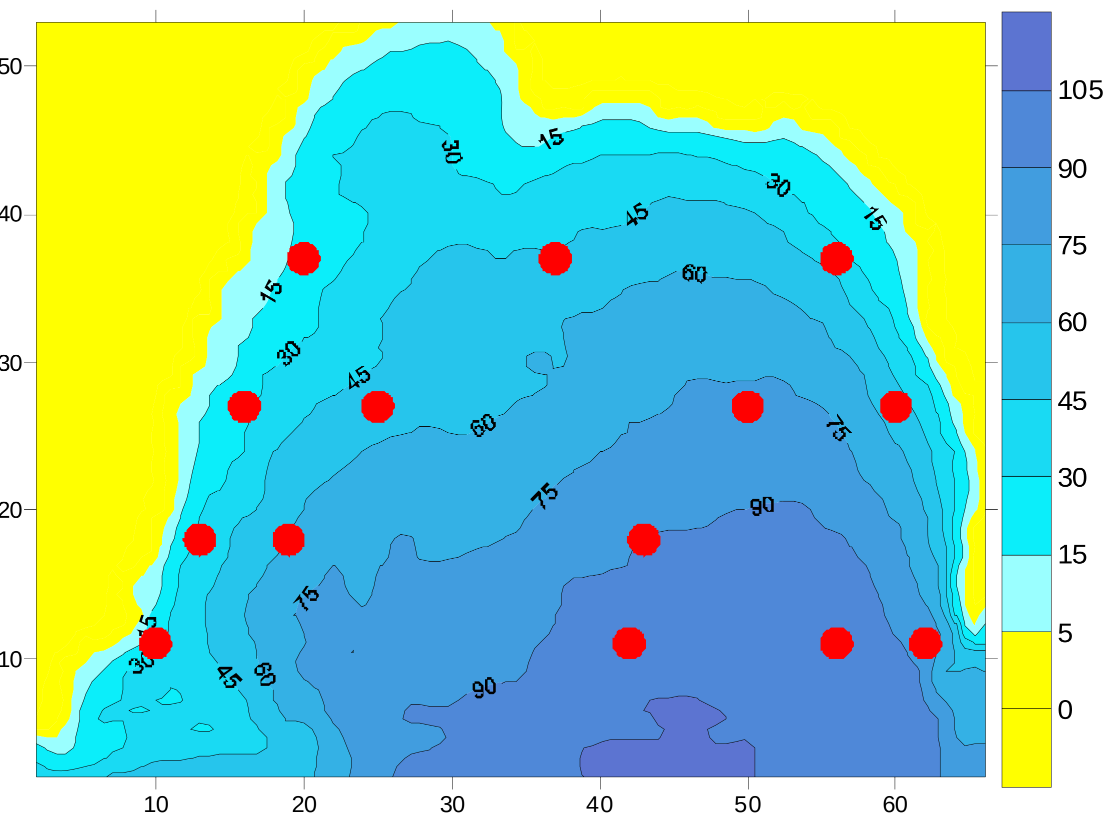
Stations information about initial parameters

11-12 April 2002

20-21 June 2002

07-09 August 2002

30-31 October 2002



Physical parameters:

- Temperature
- Salinity

Biology parameters:

Concentration of:

- NH4 [mkmole/l]
- NO2+NO3 [mkmole/l]
- Norg [mkmole/l]
- P-PO4 [mkmole/l]
- Porg [mkmole/l]
- Chlr-a [mkg/l]

Atmosphere characteristics for Southern Kurile strait's region

Period	Atmosphere pressure hectoPa	Air temperature, °C	Humidity, %	Nebulosity, %	Wind direction	Wind velocity, m/s	Radiation, cal/sm^2 per hour
April	1010.4	1.2	79	65	S	0.8	18.81
May	1009.2	5.6	80	72	S	1.5	23.32
June	1008.6	10	86	77	SSE	2	25.33
July	1008.1	14.5	89	81	SSE	2.1	23.99
August	1009.3	16.9	88	76	S	1.7	20.97
September	1010.4	13.7	83	60	SSW	1	15.95
October	1013.2	7.4	78	54	W	0.7	11.1
November	1013.4	-0.4	75	57	NW	1.6	6.55

Note: Radiation level doesn't use in calculation.

Ecological model

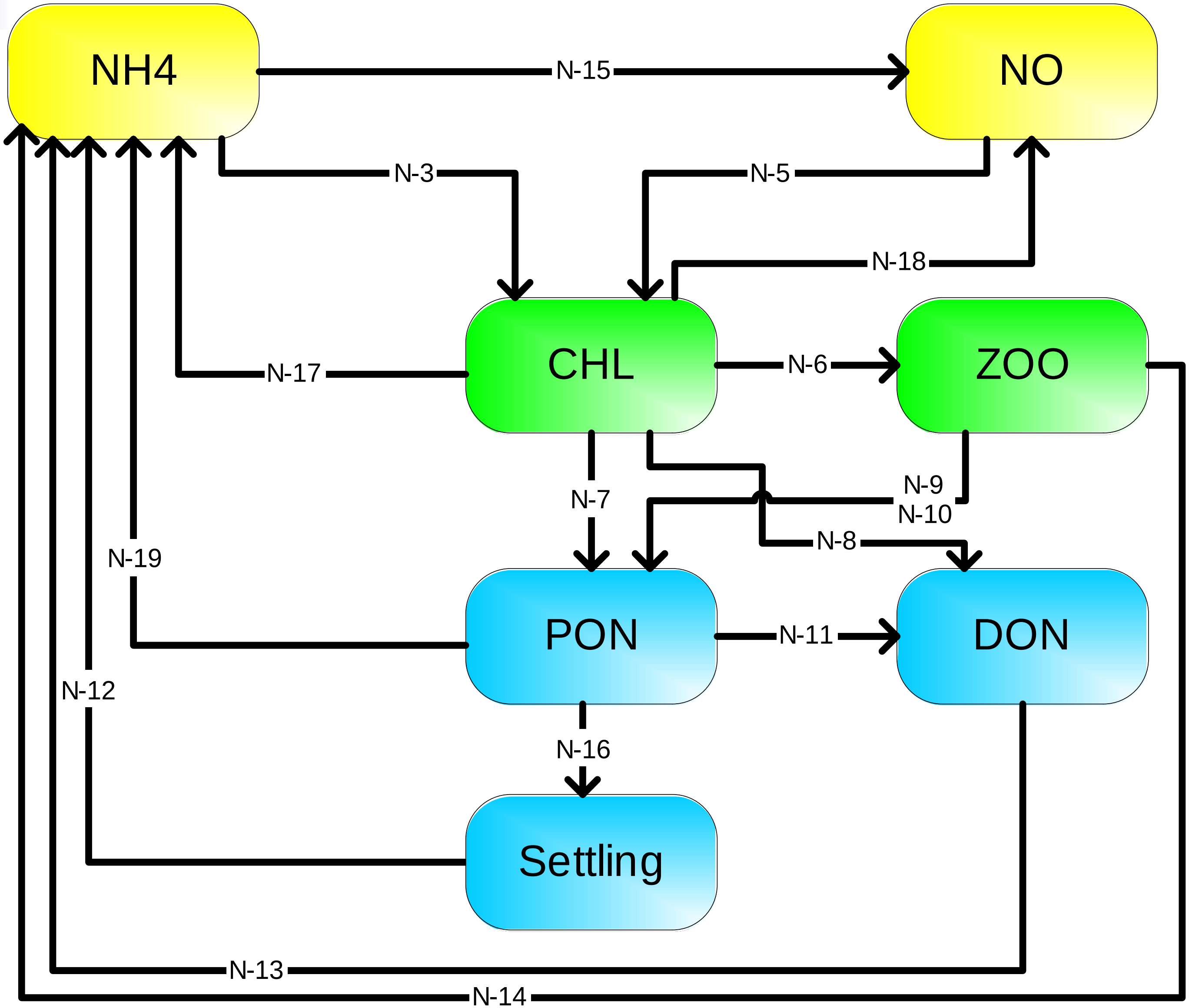
Ecological algorithm based on algorithm of ecological-physical model for station PAPA–KKYS (Kawamiya M., 1995). Also, we add phosphorus cycle (base on KKYS-model for ecosystem Akkeshi (Oshima Y., 1999)).

$$\Delta_{CHL} = F_{physic} + F_{ecological}$$

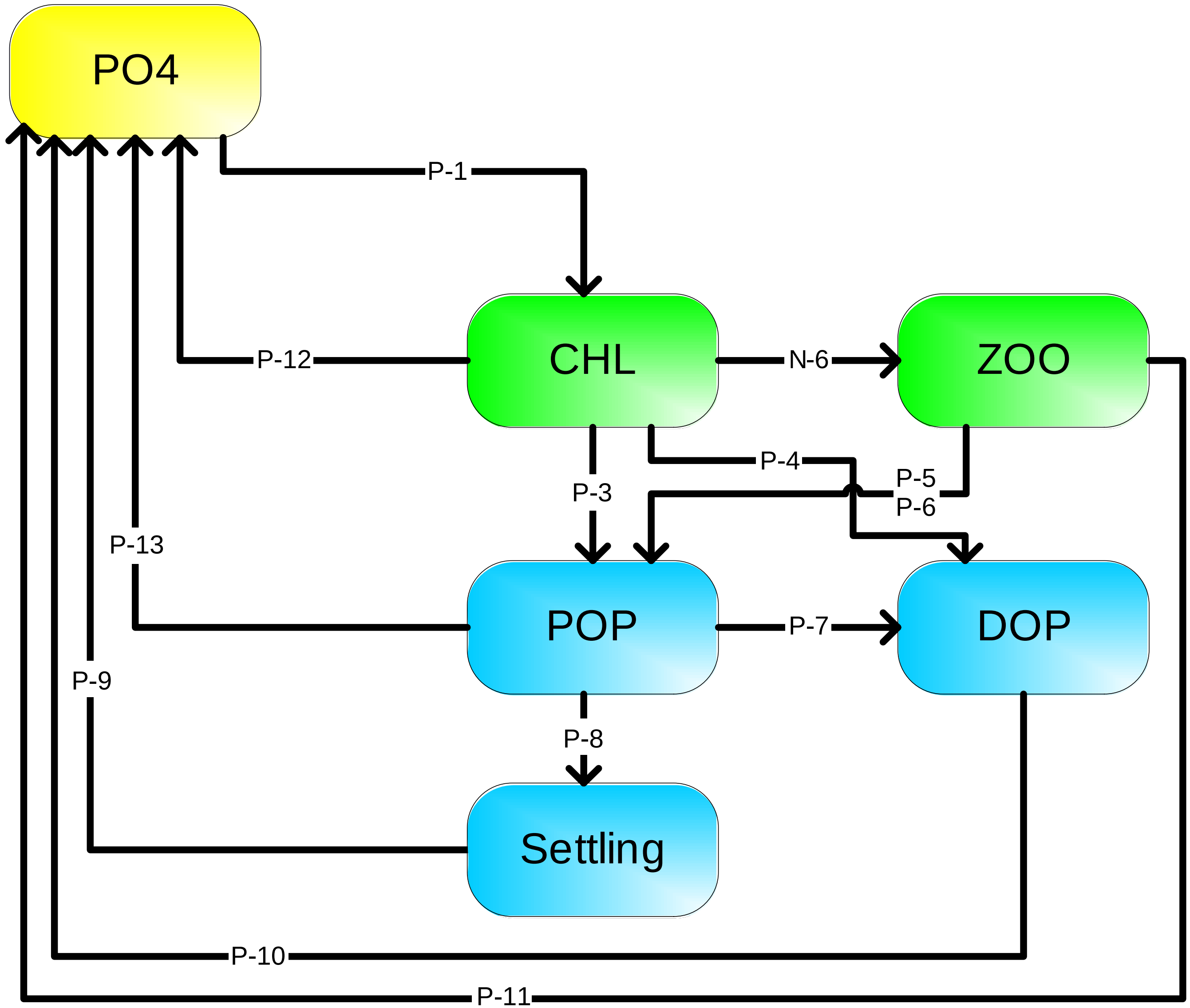
$\mathbf{F_{physic}}$ – physic function: diffusion dispersion, advection transportation of flows;

$\mathbf{F_{ecological}}$ – ecological function: takes part in photosynthesis, Zooplankton grazing, Extracellular Excretion , Respiration.

Interaction between components of ecological model (nitrogen cyrcle)



Interaction between components of ecological model (phosphorus cyrcle)



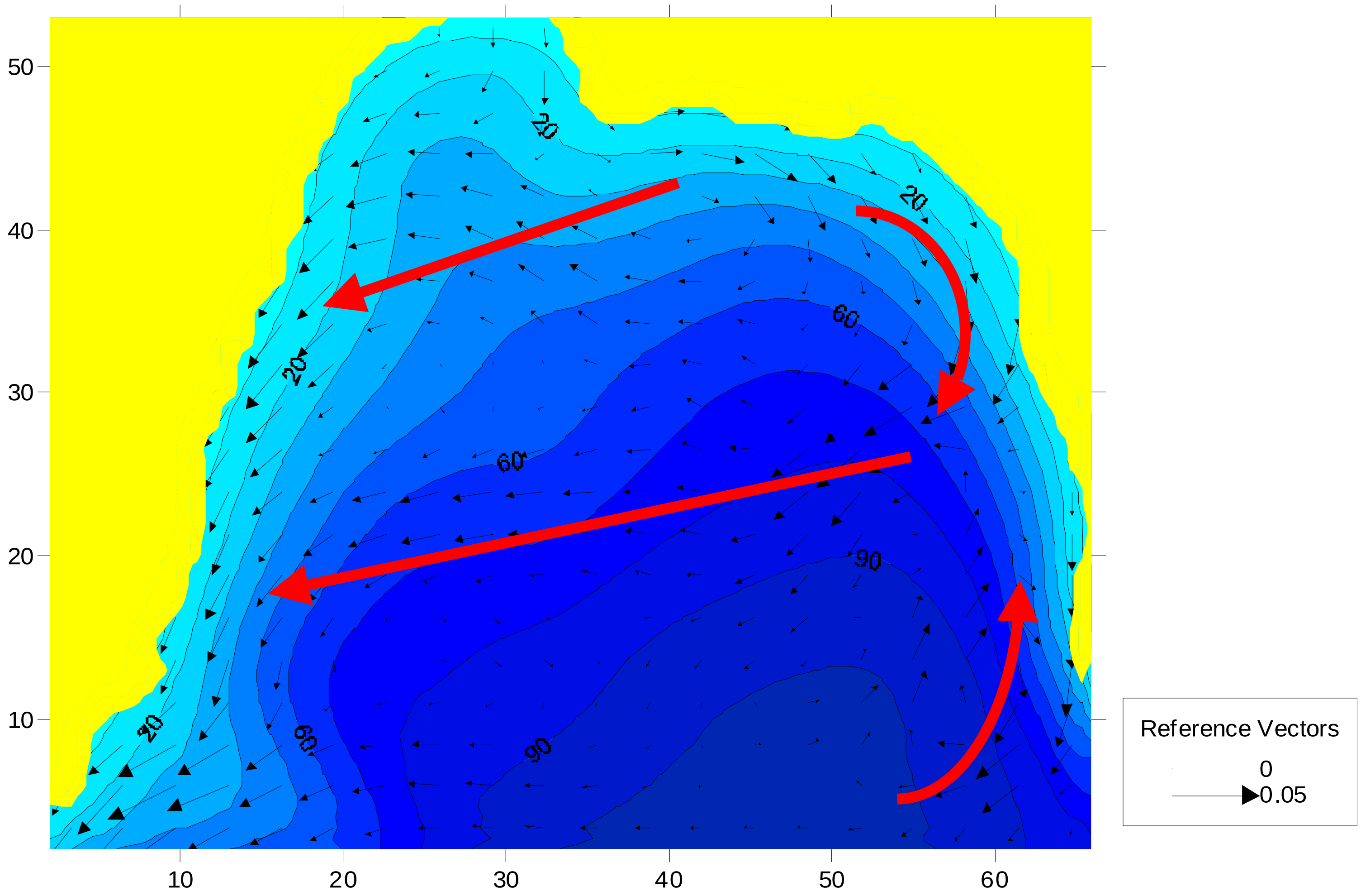
Mathematic equation for ecological model

Process number	Mathematic equation
	$R^{CHL}_{N\to C} = 0.146$, $R^{CHL}_{P\to N} = 0.0645$ – decomposition rate for phytoplankton, ZOO – zooplankton concentration.
N-3	Consumed NH_4 for photosynthesis [Mol N/(litre·day)] $RREP = \frac{CONS_{NH}}{CONS_{NO} + CONS_{NH}}$ $\Delta = GPP \cdot RREP \cdot R^{CHL}_{C} \cdot R^{CHL}_{N\to C}$ RREP – part NH_4 in no organic compounds.
N-5	Consumed NO-group for photosynthesis [Mol N/(litre·day)] $RNEW = \frac{CONS_{NO}}{CONS_{NO} + CONS_{NH}}$ $\Delta = GPP \cdot RNEW \cdot R^{CHL}_{C} \cdot R^{CHL}_{N\to C}$ RNEW – part NH_3 in no organic compounds (RNEW+RREP = 1).
N-6	Zooplankton grazing [μg Chl-a/(litre·day)] $\Delta = \frac{GRAZ}{R^{CHL}_{C}}$
N-7	Mortality Phytoplankton and Fragmentation to PON [μMol N/(litre·day)] $\Delta = DCPOM \cdot R^{CHL}_{C} \cdot R^{CHL}_{N\to C}$
N-8	Extracellular Excretion [μMol N/(litre·day)] $\Delta = DCDOM \cdot R^{CHL}_{C} \cdot R^{CHL}_{N\to C}$
N-17	Respirated Part of NH4 by Phytoplankton [μMol N/(litre·day)] $\Delta = RES \cdot RREP \cdot R^{CHL}_{C} \cdot R^{CHL}_{N\to C}$
N-18	Respirated Part of NO by Phytoplankton [μMol N/(litre·day)] $\Delta = RES \cdot RNEW \cdot R^{CHL}_{C} \cdot R^{CHL}_{N\to C}$

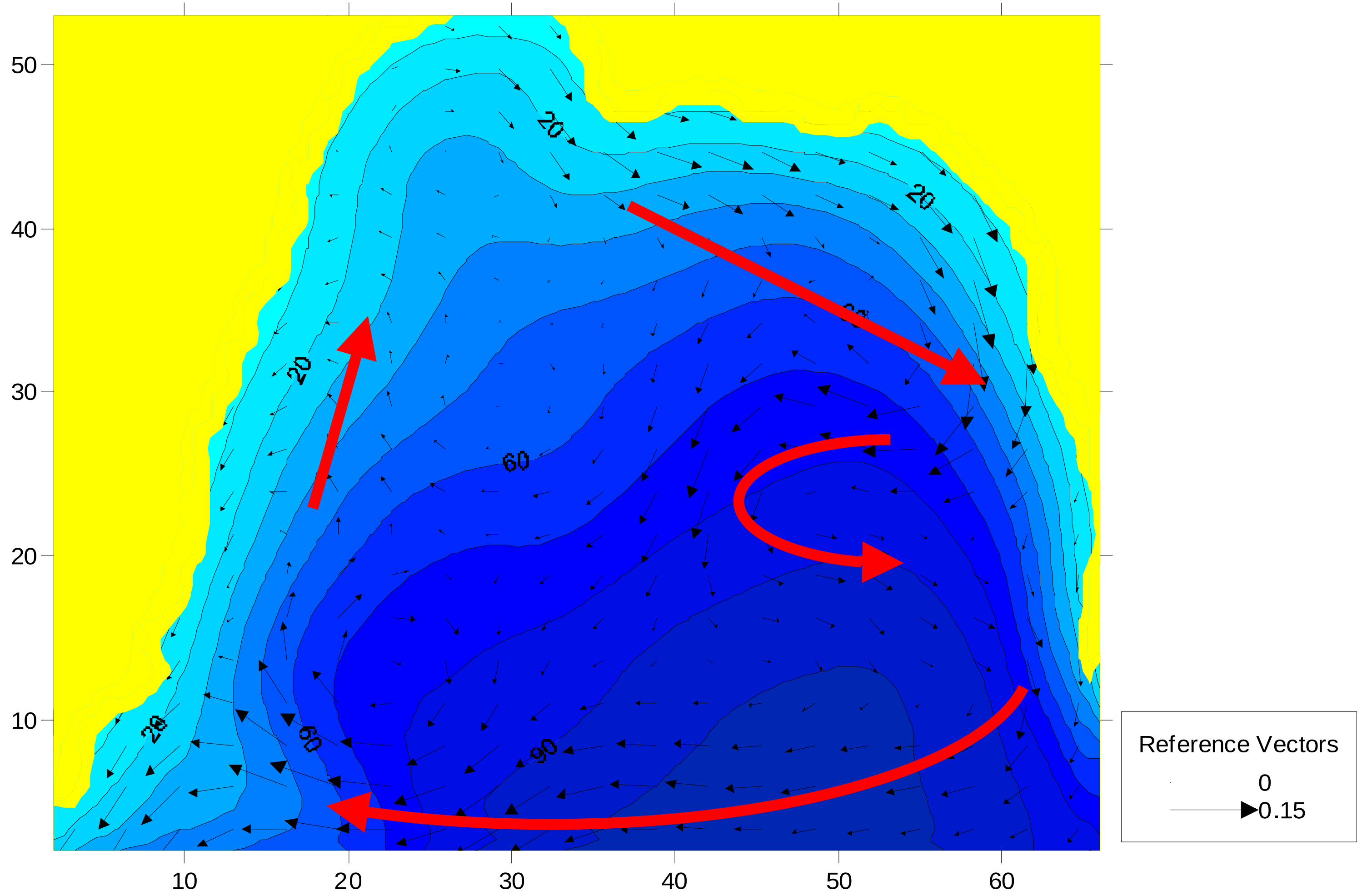
Mathematic equation for ecological model (continuation)

Process number	**Mathematic equation**
P-1	Consumed P-group for photosynthesis [μMol P/(litre·day)] $\Delta = GPP \cdot R_{C}^{CHL} \cdot R_{N \to C}^{CHL} \cdot R_{P \to N}^{CHL}$
P-3	Mortality Phytoplankton and Fragmentation to POP [μMol P/(litre·day)] $\Delta = DCPOM \cdot R_{C}^{CHL} \cdot R_{N \to C}^{CHL} \cdot R_{P \to N}^{CHL}$
P-4	Extracellular Excretion [μMol P/(litre·day)] $\Delta = DCDOM \cdot R_{C}^{CHL} \cdot R_{N \to C}^{CHL} \cdot R_{P \to N}^{CHL}$
P-12	Respirated Part of PO by Phytoplankton [μMol P/(litre·day)] $\Delta = RES \cdot R_{C}^{CHL} \cdot R_{N \to C}^{CHL} \cdot R_{P \to N}^{CHL}$

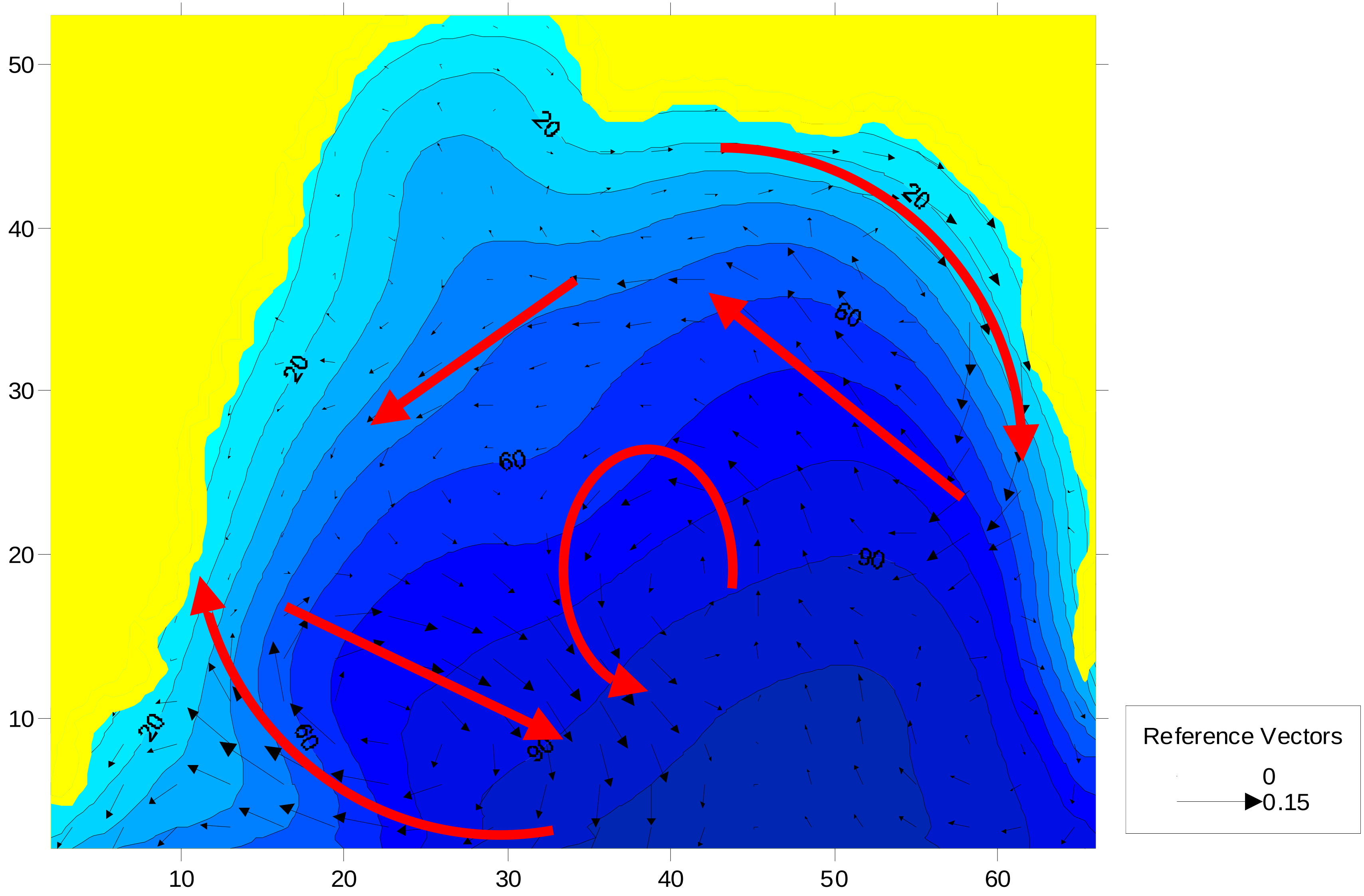
Field of surface flows (period: April-June)



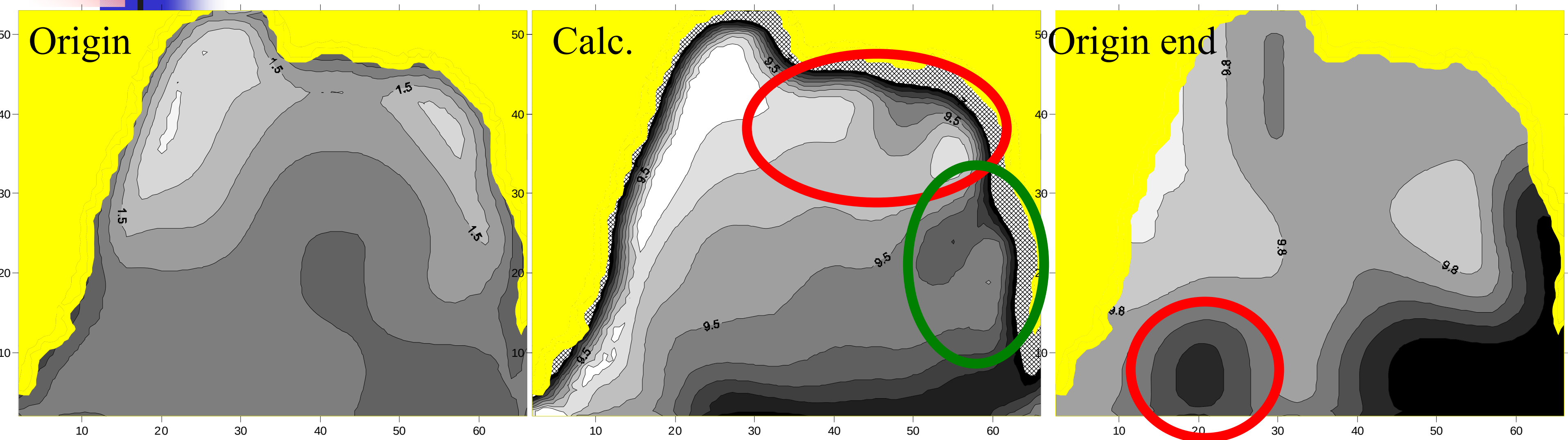
Field of surface flows
(period: June-August)



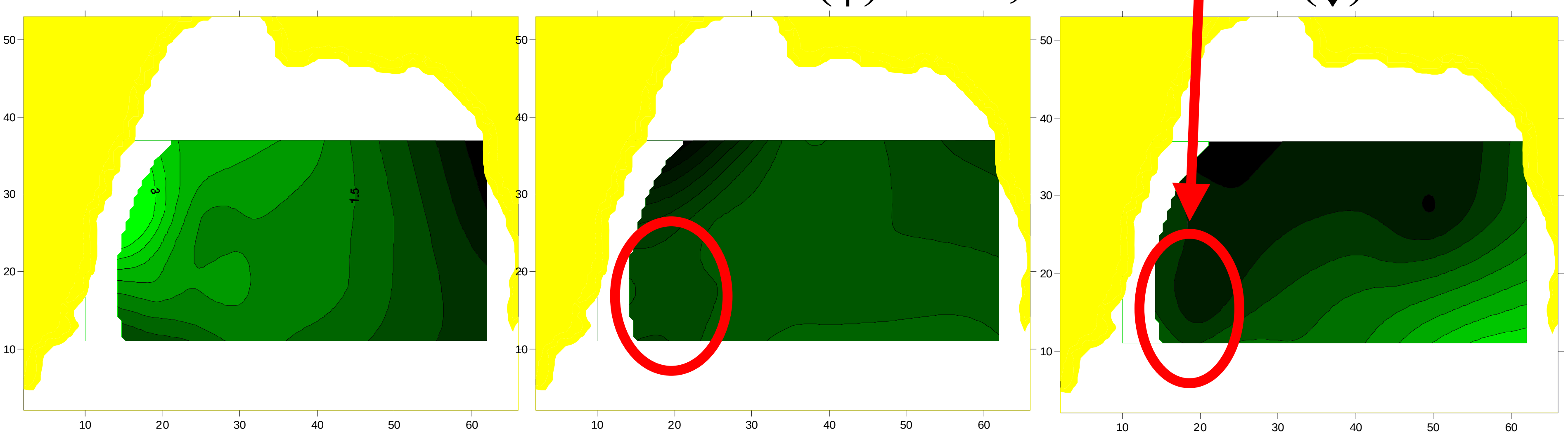
Field of surface flows
(period: August-October)



Modeling of surface terms (modeling time – April-June)



correlation coefficient: for T (↑) **0.63**, for CHL-a(↓) **0.47**



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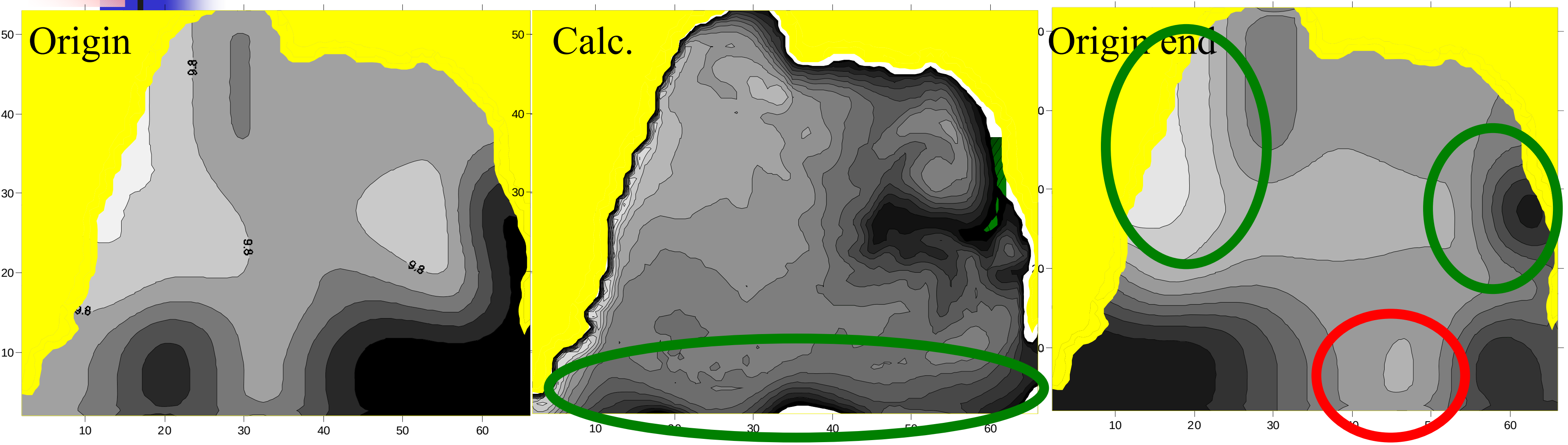
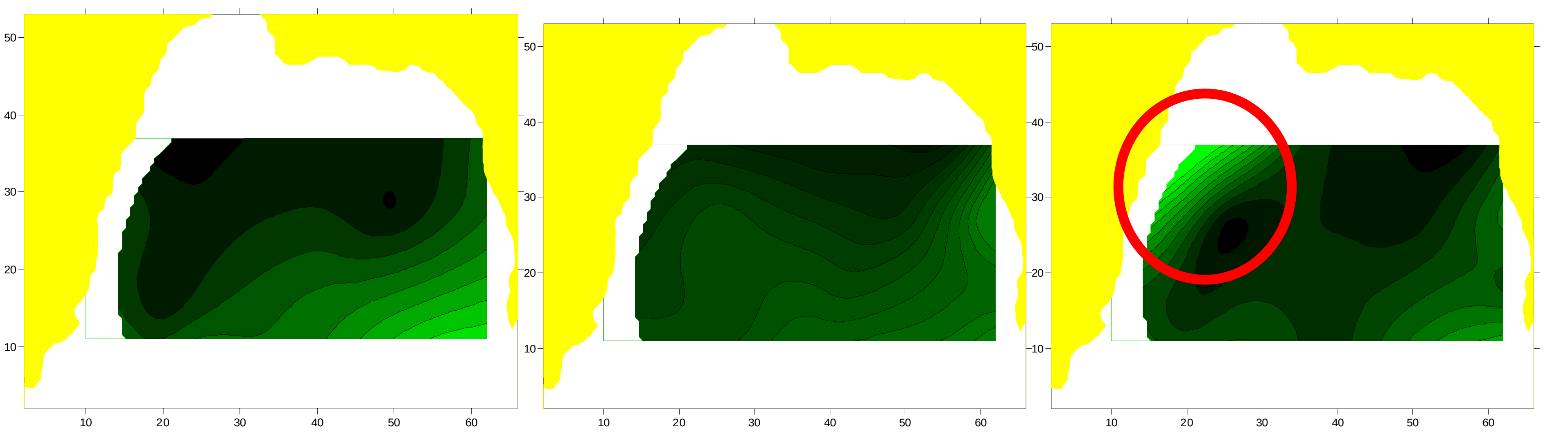
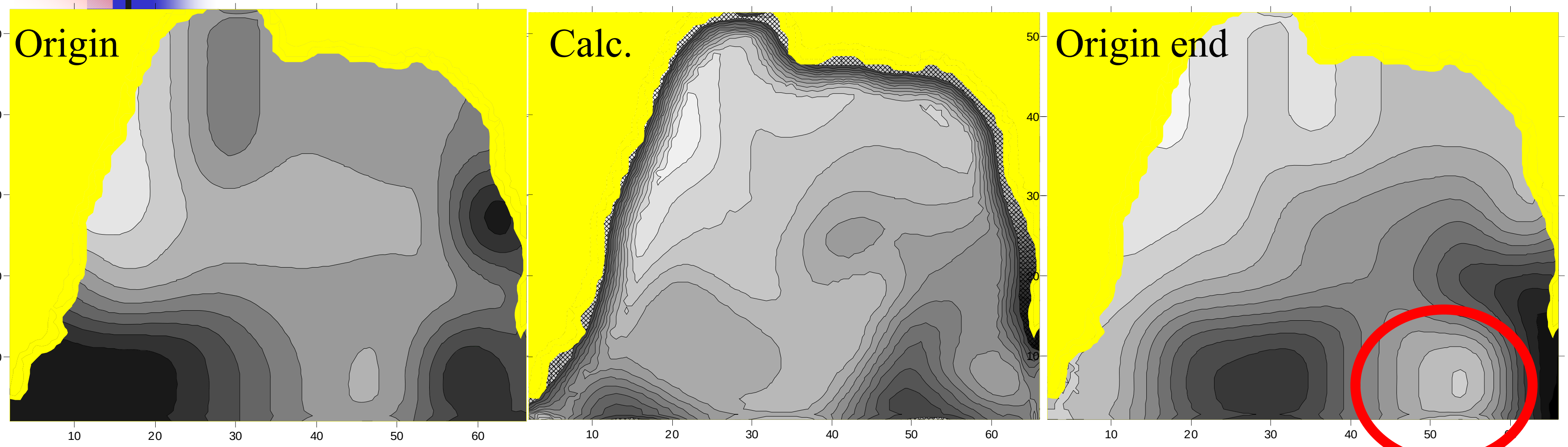


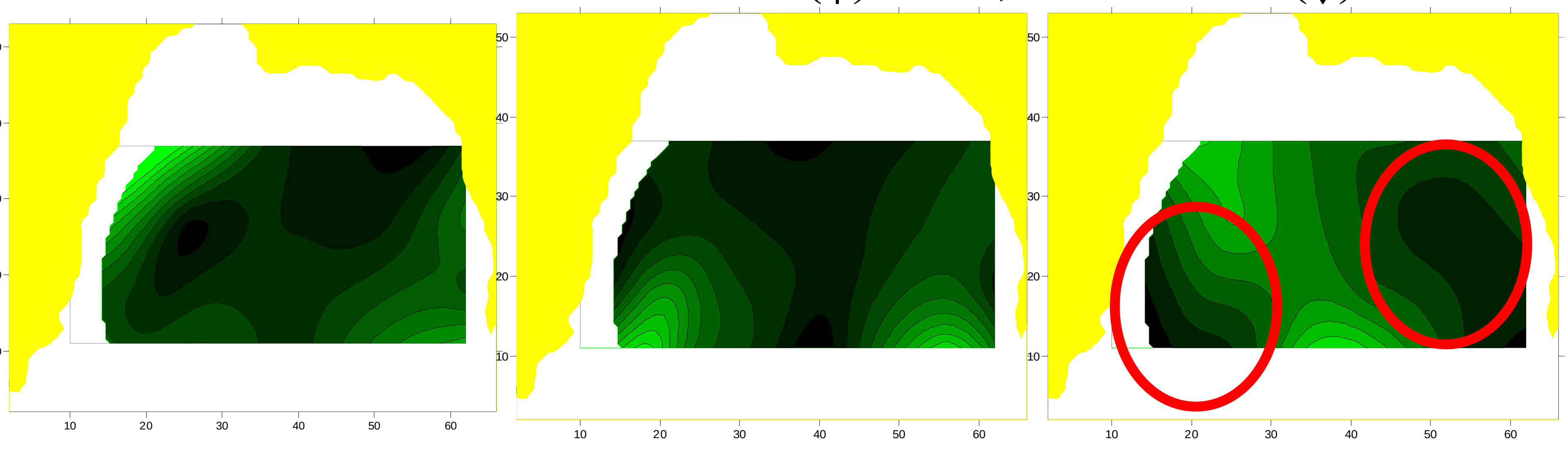
correlation coefficient: for T (↑) **0.51**, for CHL-a(↓) **0.19 (0.79)**



Modeling of surface terms (modeling time –August-October)



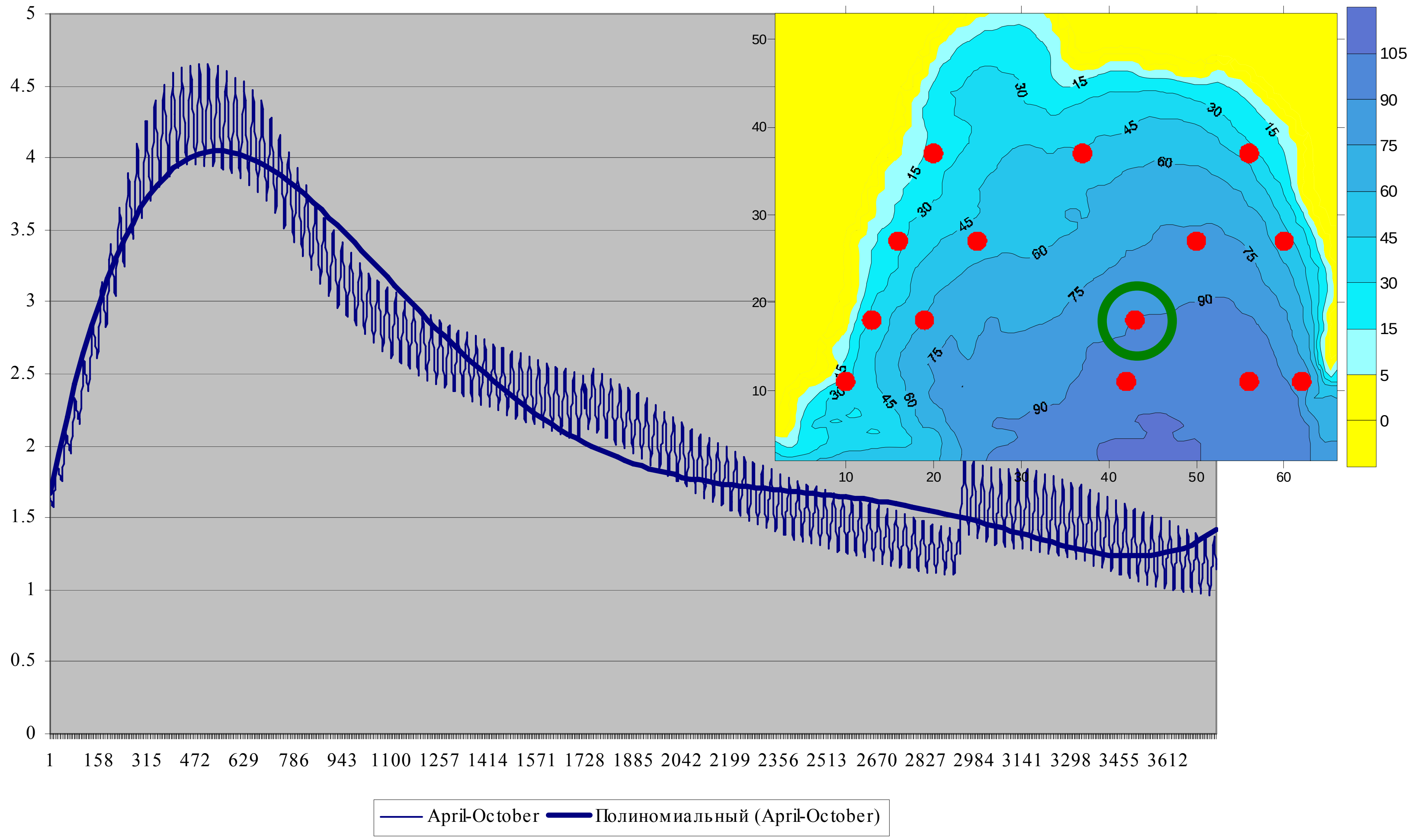
correlation coefficient: for T (↑) **0.71**, for CHL-a(↓) **-0.24**



Correlation coefficient for bottom distributions

Chlorophyll		Temperature	
April	0.84	April	0.88
June	0.73	June	0.91
August	0.88	August	0.85

Modification CHL-a concentration (data from one station)



Summary

- Using POM model for calculation of hydrodynamic parameters in Aniva gulf is correctly.
- Time changing of chlorophyll concentration can calculate of POM model.
- (for future) For accurate calculation need:
    - Use global currents (Soya, East-Sakhalin)
    - Use river flows.
    - Use correct biology parameters for Aniva gulf.

Acknowledgement

Prof. Michio J. KISHI conducted the seminars about programs of hydrodynamic and ecological numerical models.

Thanks for your attention.
Your question, please.

Slide 1
Aniva gulf locate on south Sakhalin Island. It is sickle-shaped with open south boundary. Maximum depth is 125 meters, as bottom is a part of continent shelf. Aniva gulf is very important for island economic. A great deal bioresources produce in this area of water. For example, salmon, shrimp, sea scallop and other.
We used POM model for change of concentration chlorophyll calculate. Characteristic parameters were following.

Slide 3
Modeling grid was consisted of 67 by 54 square cells with linear size 2700 meters. We were used 5 vertical layers with proportion 1:1:3:5:5. Numerical calculus had performed in a three-dimensional prognostic routine. Modeling time was 60 days. The internal mode time step was 1 second; the external mode time step was 30 seconds.
Our algorithm was used this follow boundary condition. A vertical velocity was zero in the first layer. Horizontal flows were depended of the wind on a water surface. "Slip"condition had oh the bottom. It means that vertical velocity was zero in the last layer. The velocities normal to land boundaries was set to zero. The landward tangential velocities in the horizontal friction terms were set to zero also.

Slide 4
Hydrodynamic and biology parameters were defined from data of oceanographic researching by SakhNIRO. Researching period shows on this frame. We used line interpolation for calculating distribution's fields on all area Aniva gulf.

Slide 5
Atmospheric characteristics were statistic average and their values you can see. Their parameters didn't change during specific month. Solar radiation is very important for chlorophyll study. And we developed model of solar radiation. Calculating data errors were less 5 percents, and we calculated with day and night.

Slide 6
The algorithm of ecological POM was based on the algorithm of an ecologic-physic model for the PAPA–KKYS station. Our algorithm was added phosphorus cycle with analog of the KKYS-model for Akkeshi ecosystem. Basic parameters our ecological model was analog of the KKYS-model parameters.
The task our research was consisted in calculating of distribution chlorophyll with considering ecological process. Temporality modification of the chlorophyll concentration described follow equation: $\Delta CHL = Fphysic + Fecologic$, where
Fphysic – function of temporally modification chlorophyll concentration, depend on physical process (diffusion and advective transfers),
Fecologic – function of temporally modification chlorophyll concentration; depend on ecological process (takes part in photosynthesis, Zooplankton grazing, Extracellular Excretion, Respiration).

Slide 7
Follow figures presents interplay between zooplankton and other ecological components (nitrogen and phosphorus cycles).
Follow table demonstrates ecological processes interplaying between chlorophyll concentration and other ecological components. Process number in the table conforms to process number in the previous figures.

Slide 9
Also, you can see main mathematic equation for chlorophyll concentration changing.

Slide 11
Water circulation has a anticyclone eddy in spring and autumn and a cyclone eddy in summer. Program calculates follow main surface currents. We had a weak anticyclone eddy in June. May bee, it is moment of flows reconstruction. Cyclone eddy has on area of gulf in August. And, it reconstructs again in October.
Follow, we see results modeling of temperature and chlorophyll concentration.

Slide 14
April-June
Program didn't calculate main body of cold water on east of south boundary. We had right prognosis about inflow water with low temperature. But, real inflow was bigger, and calculating temperature on north of gulf were less real temperature. Correlation coefficient between calculate and real data is 0.63. It shows good rating of our prognosis in center of Aniva gulf. Incorrect temperature prognosis reduce to make second main body chlorophyll concentration on west of gulf. Correlation coefficient is 0.47 on all gulf's area.

Slide 15
June-August
The model was shown cold waters on south boundary. But, we can't calculate main body of warm water. Also, we predict cold water in center of east coast. More warm water locates on west-northern part of Aniva gulf. Temperature correlation coefficient is 0.51.
Modeling results was shown that concentration chlorophyll decrease from east coast to gulf center. But, west data doesn't coordinate with original data. We mean that it is consequence of river flows. Correlation coefficient for chlorophyll is 0.19 on all gulf's area. But, if four western stations result clear, correlation coefficient for chlorophyll increase to 0.79.

Slide 16
August-October
Program didn't calculate main body of cold water on east of south boundary. It is reason incorrect modeling of chlorophyll time changing. Note, temperature distribution on gulf area calculated correct. Temperature correlation coefficient is 0.71. Correlation coefficient for chlorophyll is -0.24.

Slide 17
We have low changing distributions in bottom layer. Correlation coefficients for bottom layer show on this frame. All distributions are good coordinate.

Slide 18
In this figure you can see time changing of chlorophyll concentration from April to October on one station.

Slide 19
Summary this work is follow.
Using POM model for calculation of hydrodynamic parameters in Aniva gulf is correctly.
Time changing of chlorophyll concentration can calculate of POM model.
(for future) For accurate calculation need:
Use global currents (Soya, East-Sakhalin)
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