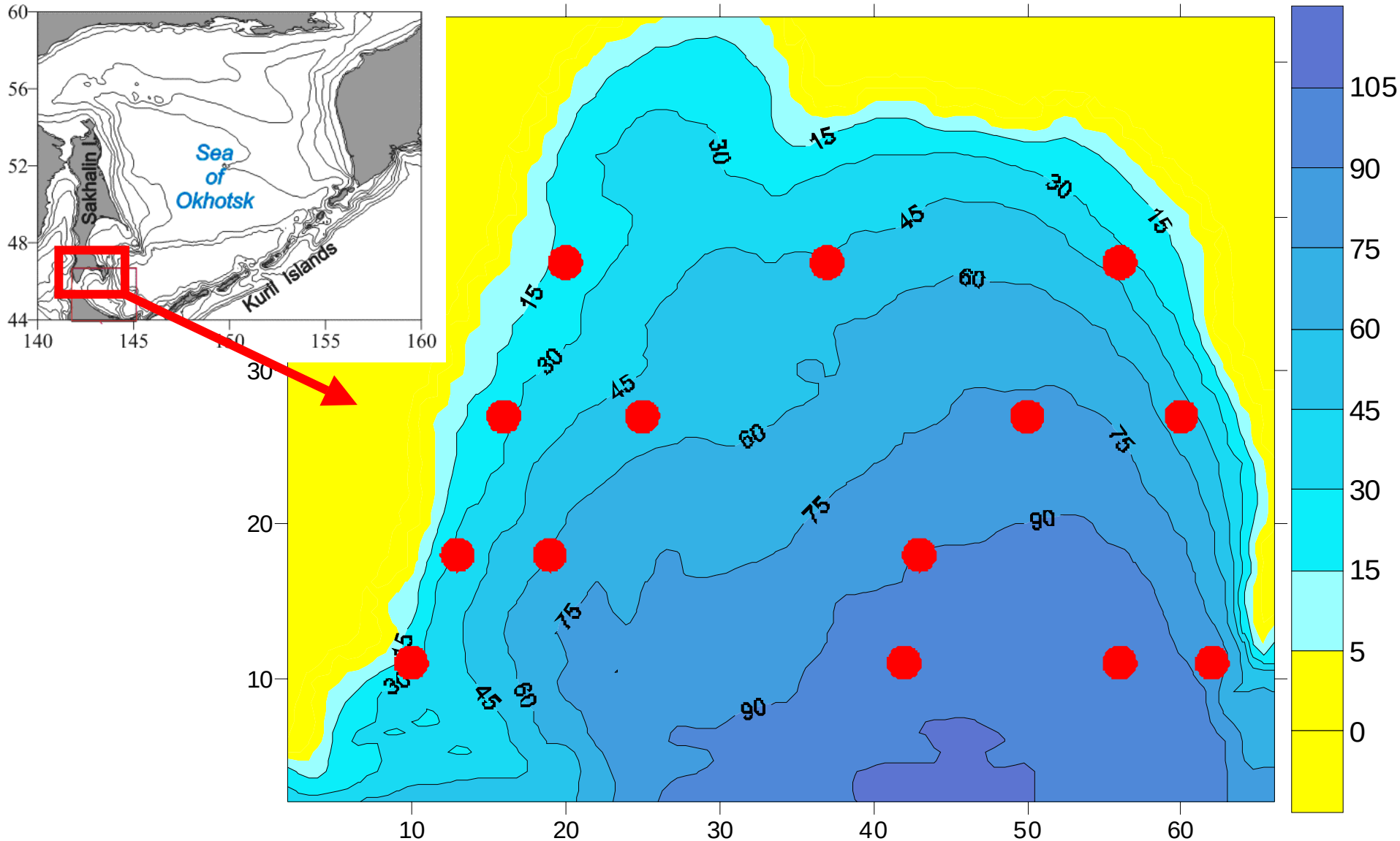
Water and chlorophyll circulations modeling on water area of Aniva gulf according to oceanographic data of the 2002 year

Dr. **Yuri Yu. Nikonov**
Valeriy N. Chastikov
Ludmila Yu. Gavrina
Sakhalin Research Institute of Fisheries and Oceanography

Distribution depth in the region of Aniva bay



POM parameters

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

Boundary condition for physical model

Surface:

$$\omega(0) = 0$$

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

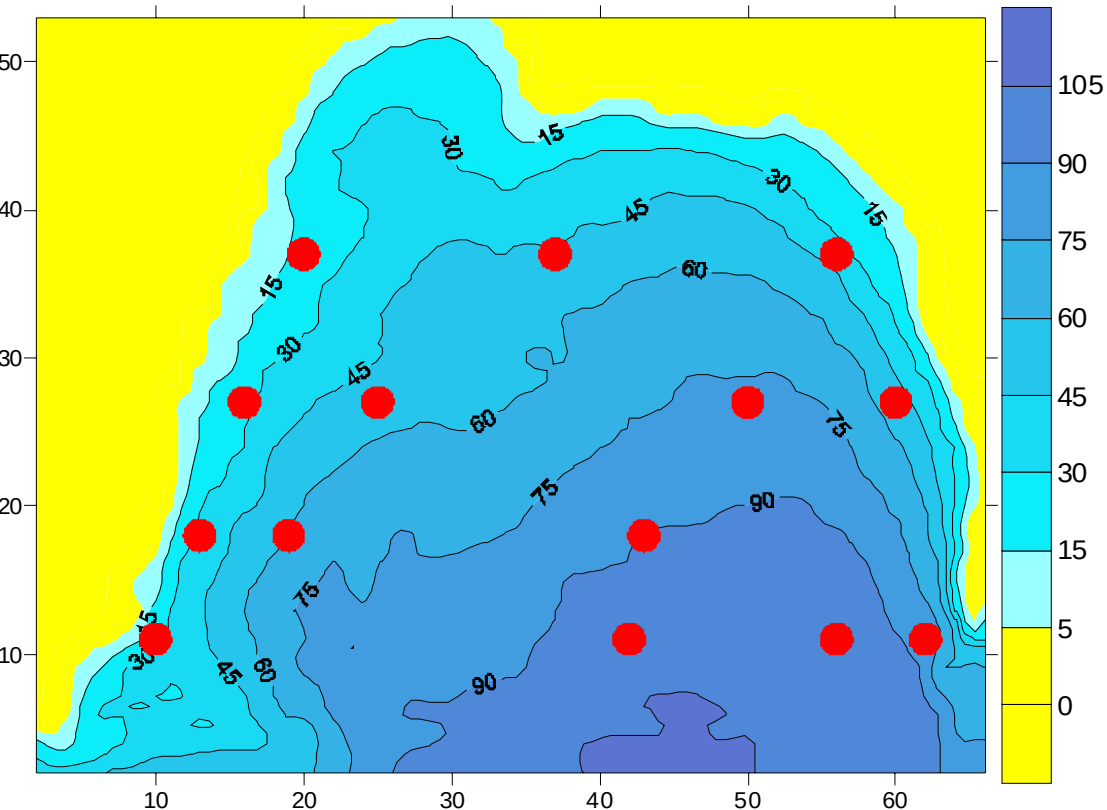
Bottom:

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

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

Stations information about initial paremeters

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

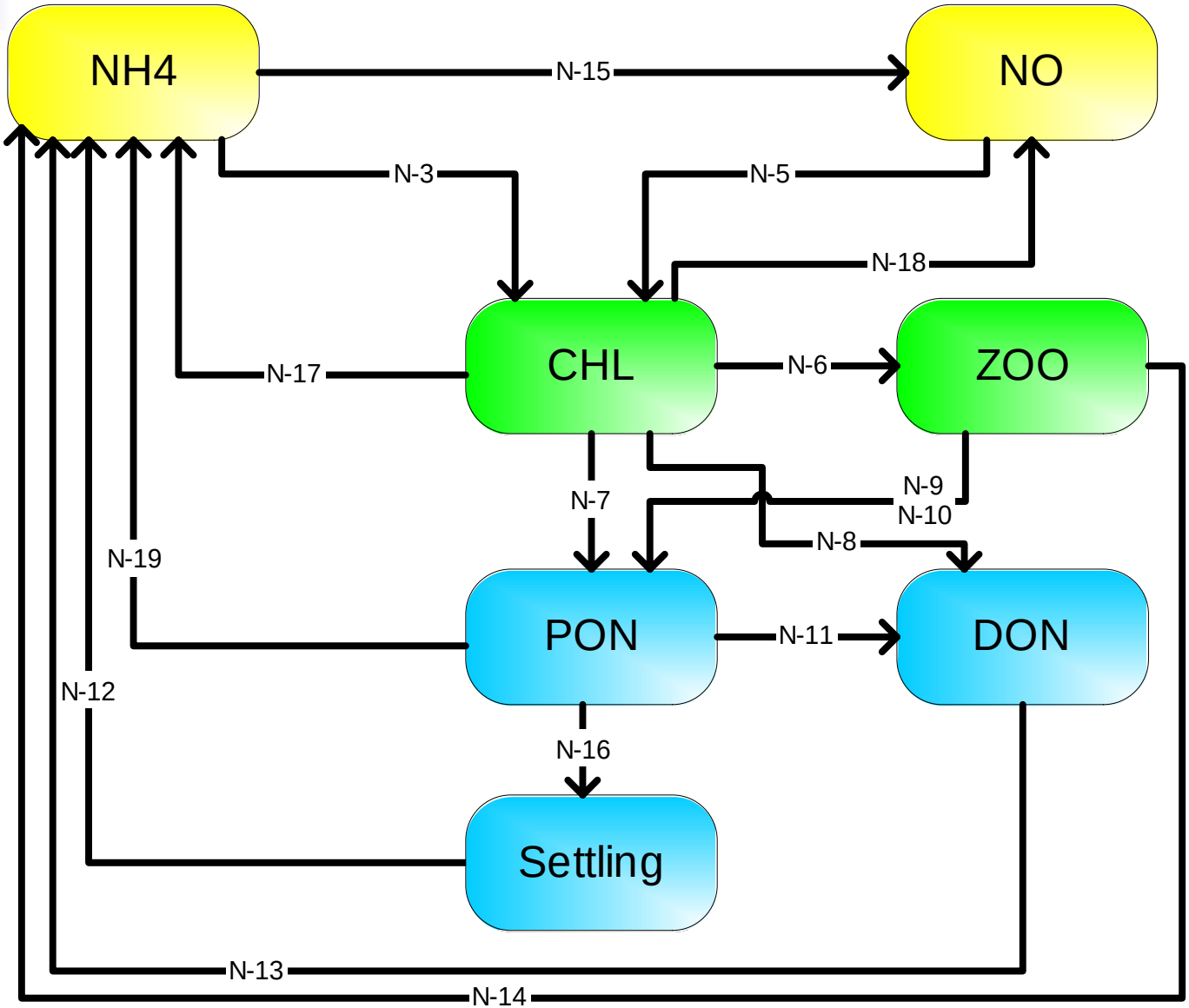
Ecological algorithm based on algorithm of ecological-physical model for station PAPA–KKYS (Kawamiya M., 1995). Also, we add phosphorus cycle (base on KKYS-model for ecosystem Akkeshi (Oshima Y., 1999)).

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

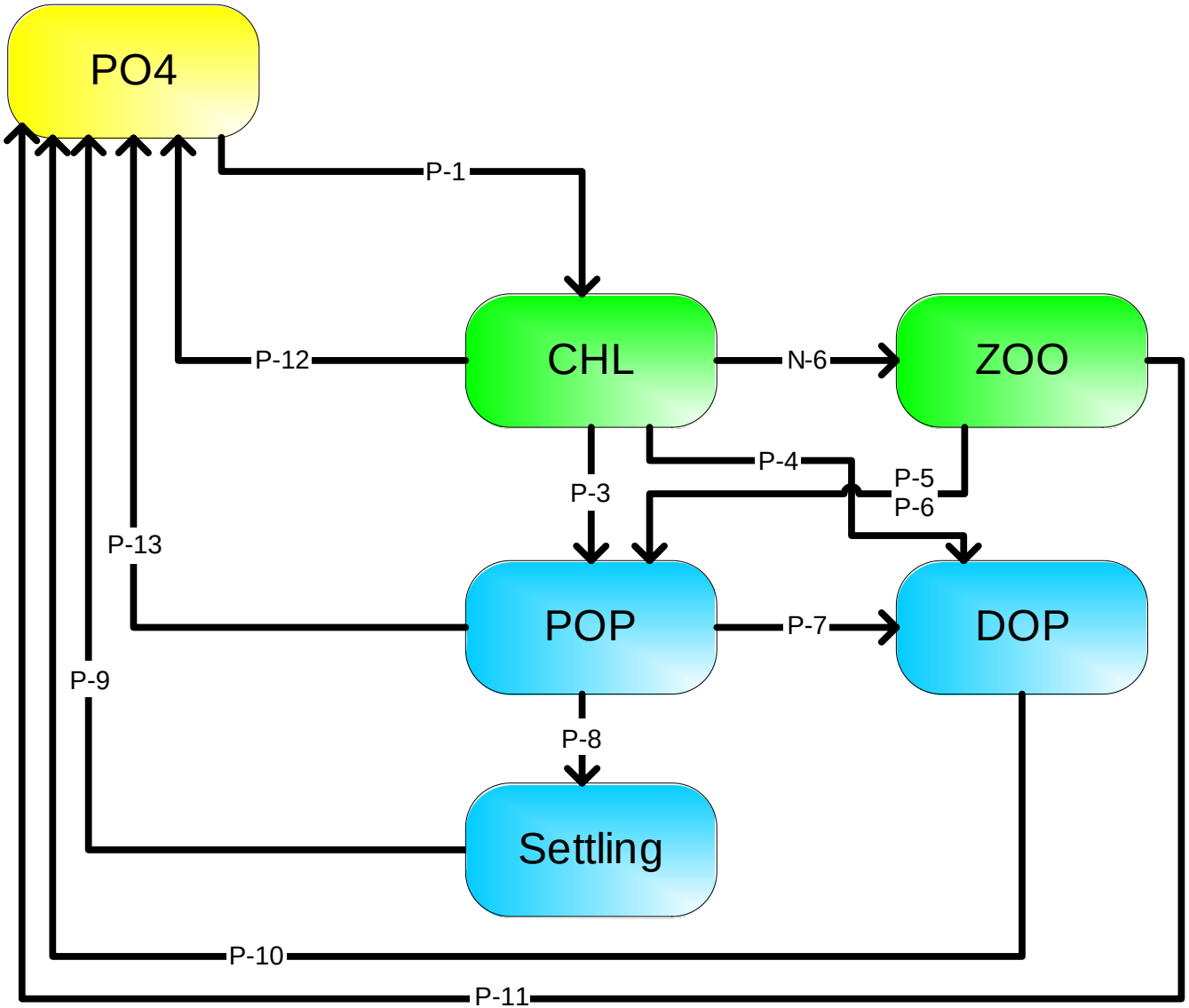
F_{physic} – physic function: diffusion dispersion, advection transportation of flows;

$F_{ecological}$ – 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)



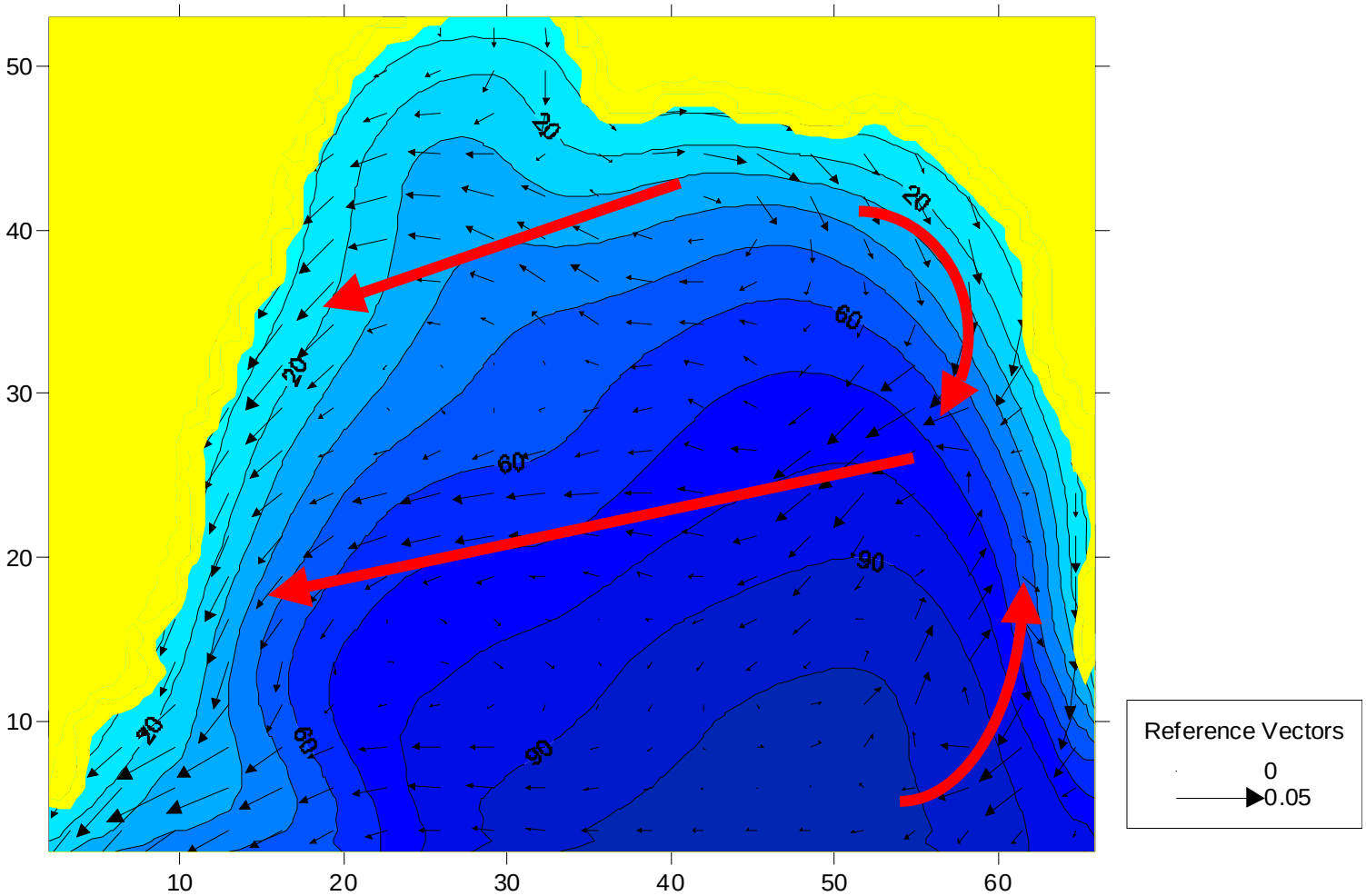
Mathematic equation for ecological model

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)] $\Delta = RES \cdot RNEW \cdot R^{CHL}_{C} \cdot R^{CHL}_{N\to C}$

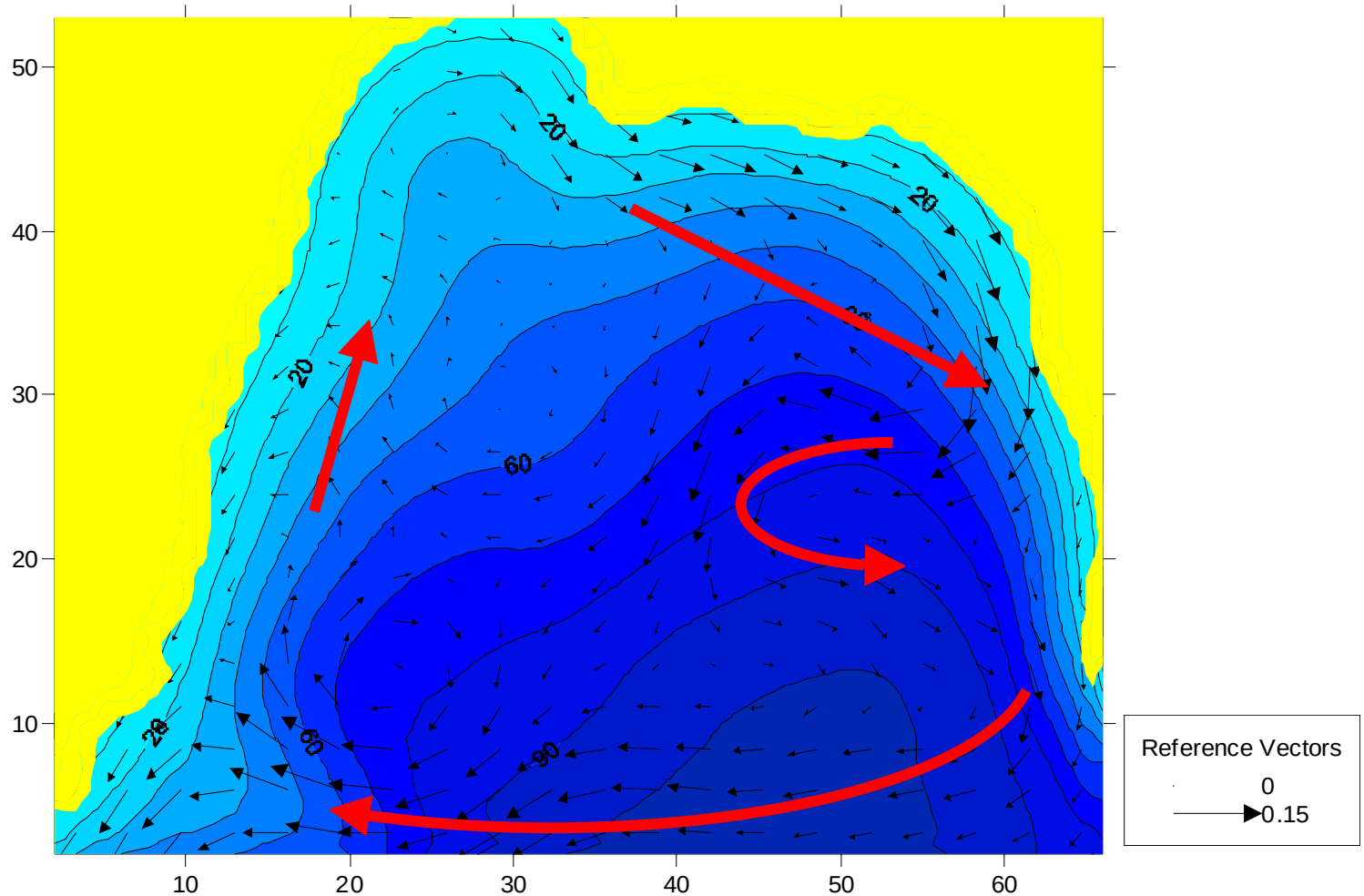
Mathematic equation for ecological model (continuation)

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)] $\Delta = RES \cdot R_C^{CHL} \cdot R_{N\to C}^{CHL} \cdot R_{P\to N}^{CHL}$

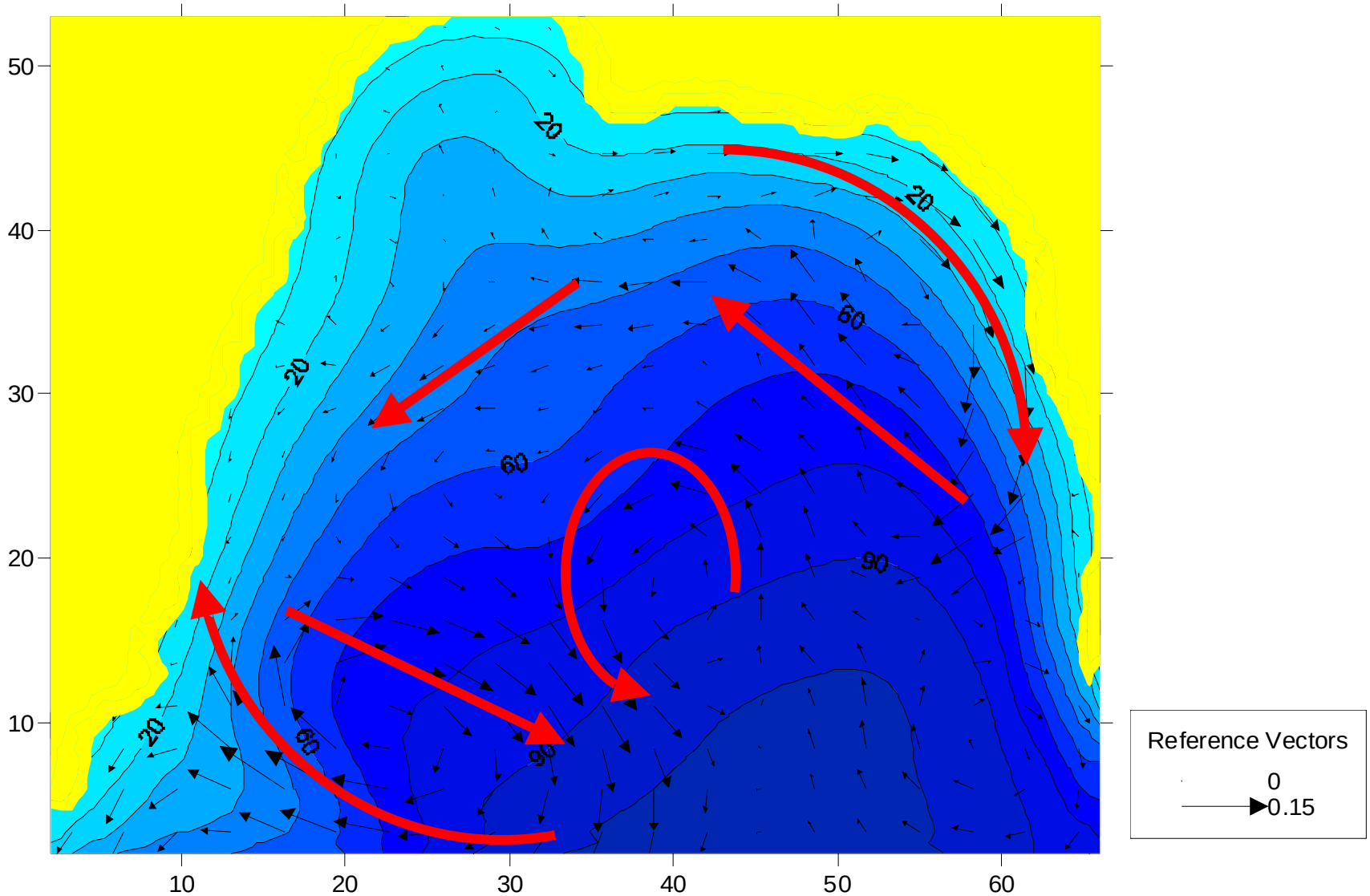
Field of surface flows (period: April-June)



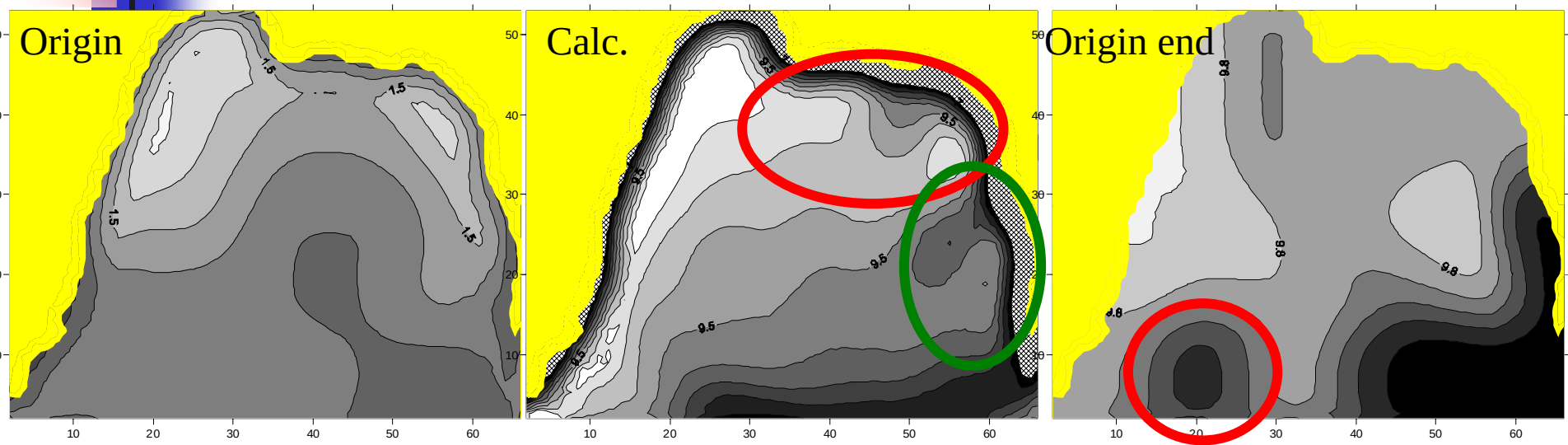
Field of surface flows (period: June-August)



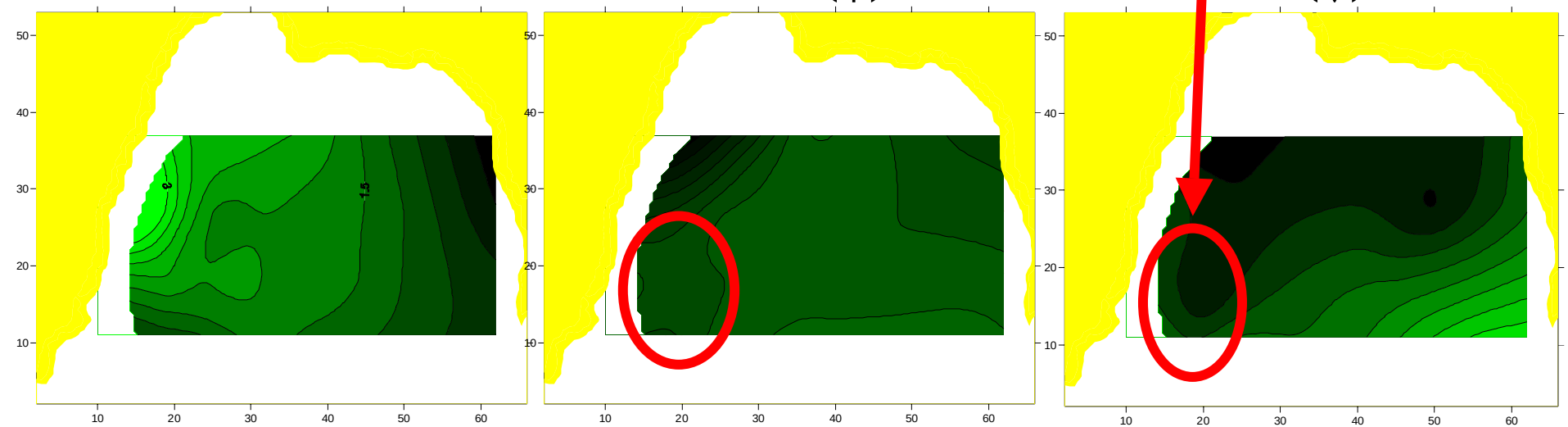
Field of surface flows (period: August-October)



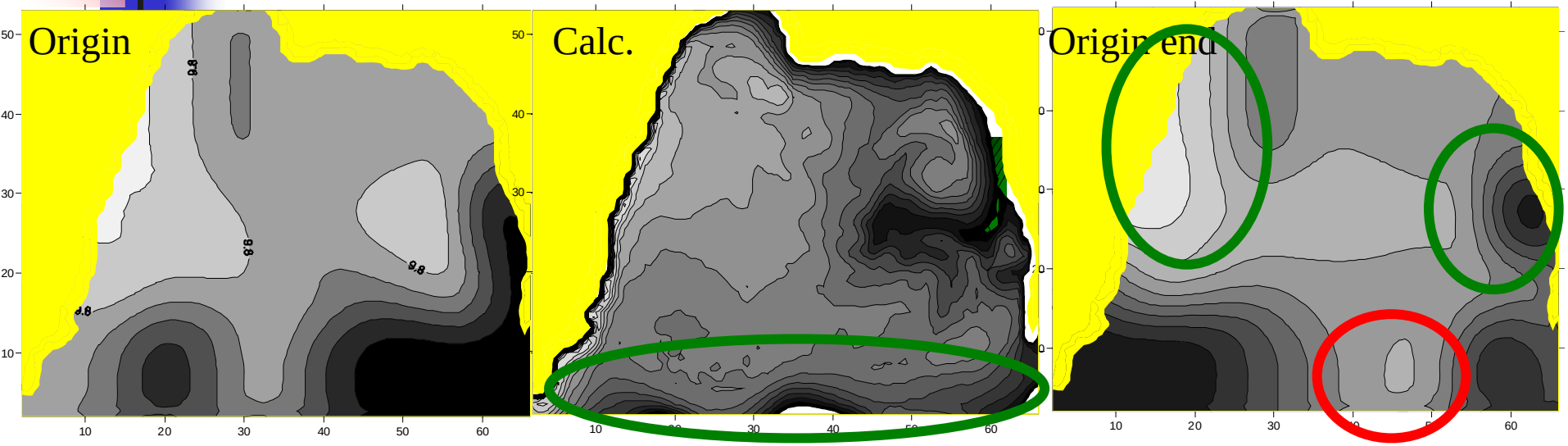
Modeling of surface terms (modeling time – April-June)



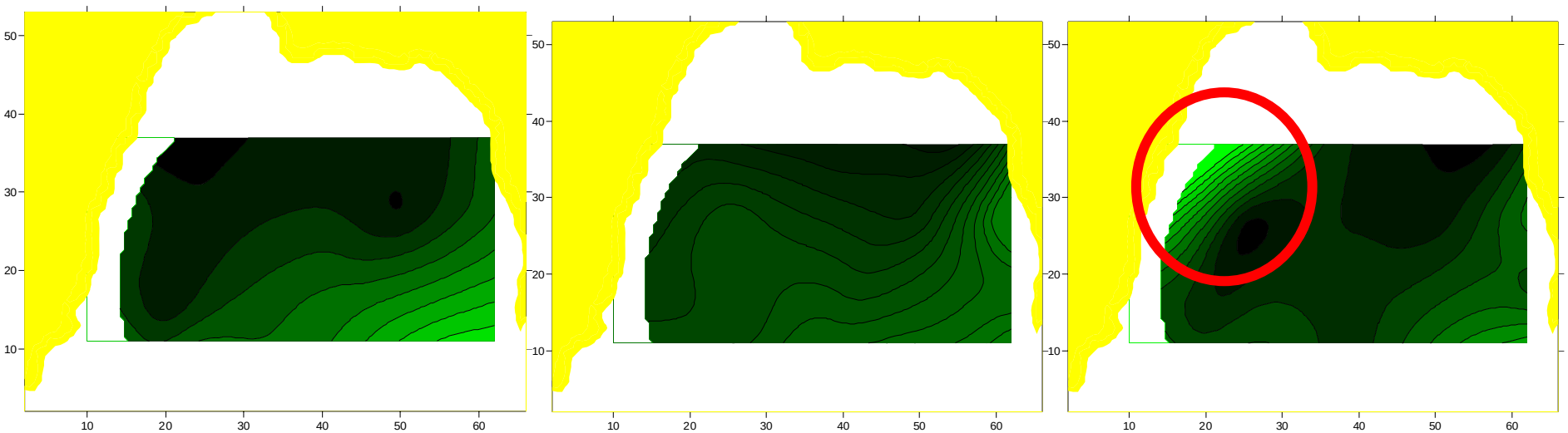
correlation coefficient: for T (↑) **0.63**, for CHL-a(↓) **0.47**



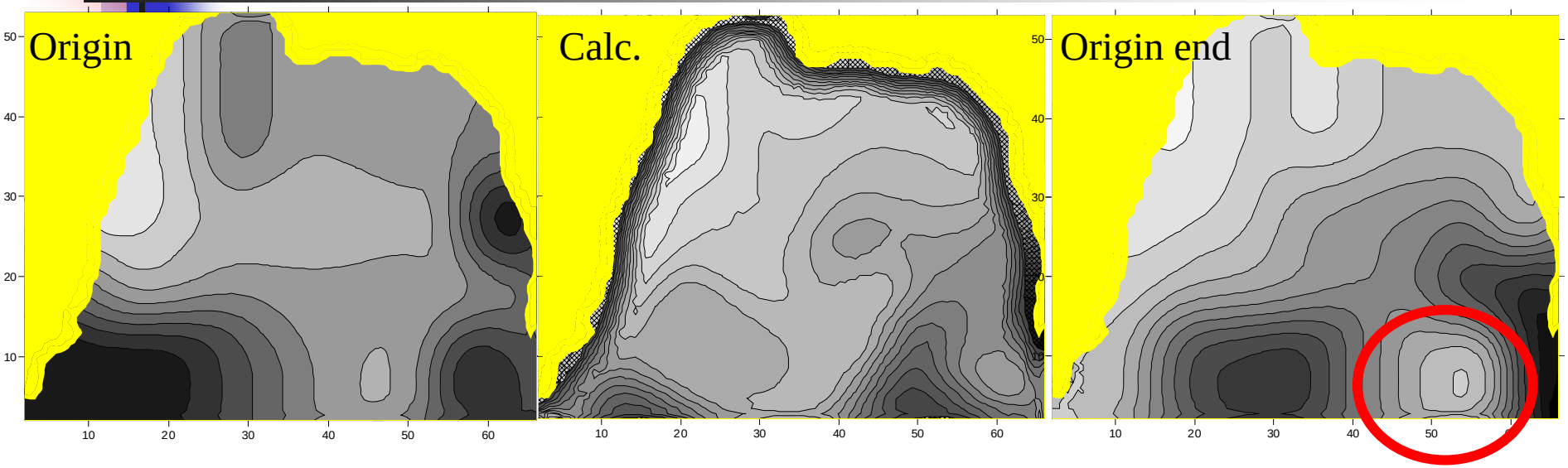
Modeling of surface terms (modeling time – June-August)



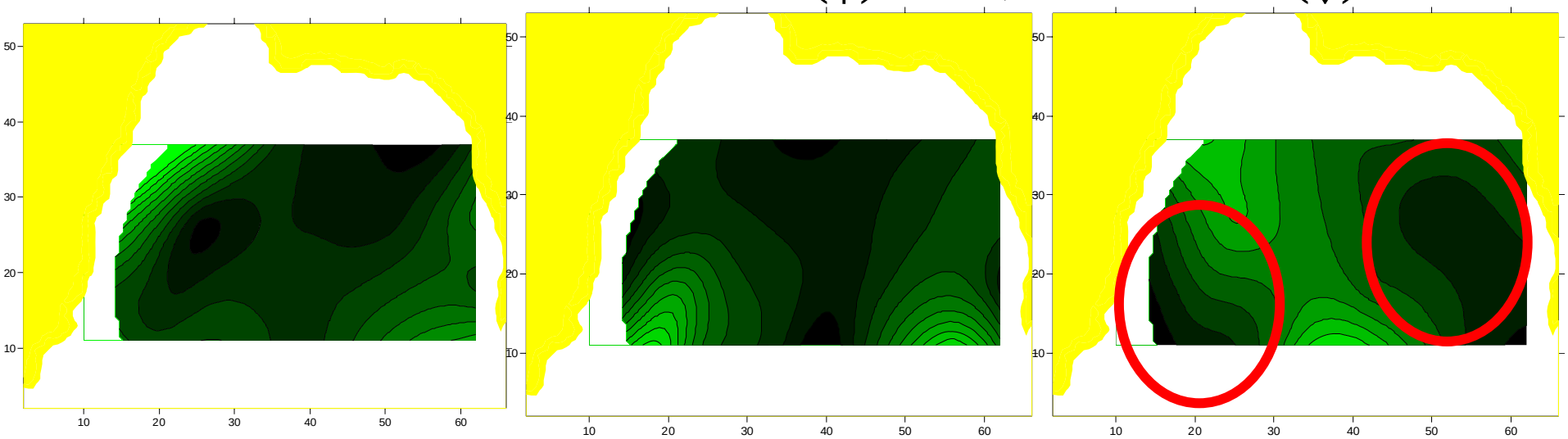
correlation coefficient: for T (↑) **0.51**, for CHL-a(↓) **0.19 (0.79)**



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



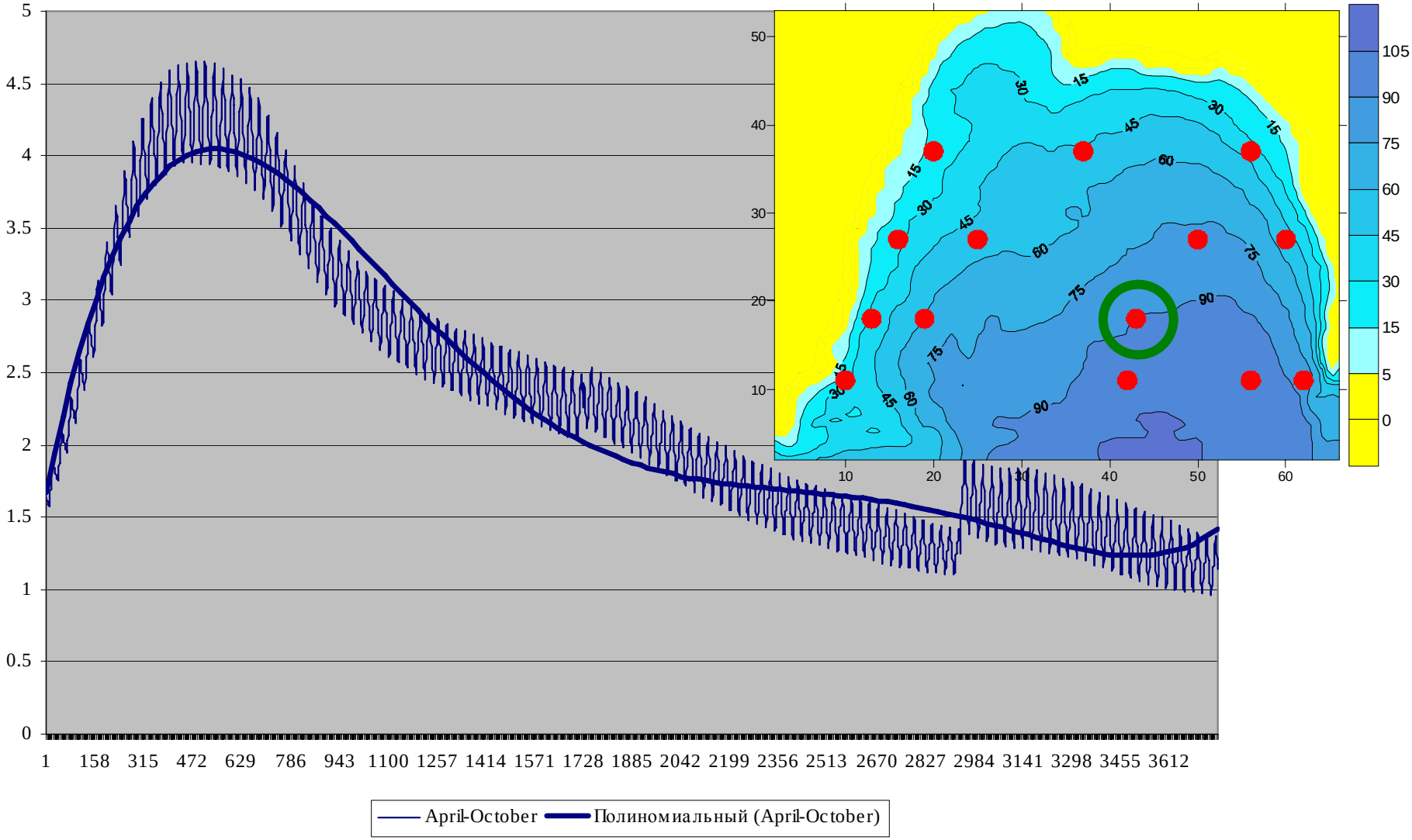
correlation coefficient: for T (↑) **0.71**, for CHL-a(↓) **-0.24**



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.