РОССИЙСКАЯ АКАДЕМИЯ НАУК
Институт проблем безопасного развития атомной энергетики

RUSSIAN ACADEMY OF SCIENCES
Nuclear Safety Institute (IBRAE)
Hydrometeorological Centre of Russia

Application of regional hydrodynamic model WRF-ARW and compute code NOSTRADAMUS to simulate transport of radioactive impurities in the atmosphere using the NPP Fukushima-1 accident as an example. Project system to forecast emergency spread of radionuclides in the atmosphere for operating Russian nuclear power plants (PARRAD)

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IRKUTSK, ENVIROMIS-2012

The main tasks of scientific and technical support of emergency response

Engineering, scientific and technical support of Emergency Situation (ES) Commission, **Emergency response centers** (SCC of Rosatom, CC of Rosenergoatom et all):

- Analysis, forecast of ES development and evaluation of ES scale
- Development of recommendations on emergency situation management
- Development of recommendations on mitigation of consequences

IBRAE RAS TCC Objectives

- Im Evaluate and forecast basic characteristics of a radioactive release source;
- Predict environmental contamination taking into account the radiation monitoring data;
- Assess and forecast public exposure doses;
- Elaborate recommendations on public and environmental protection;
- Assess the efficiency of protective measures and optimize them for specific conditions taking into account radiological, economic and social conditions

24 experts
14 on-duty
5 groups
23 models/systems

Fiber-optic communication lines, satellite communication, ISDN
Diesel-generator unit

NOSTRADAMUS

Lagrangian trajectory atmospheric dispersion model allows:

•to take into account 3D meteorological fields

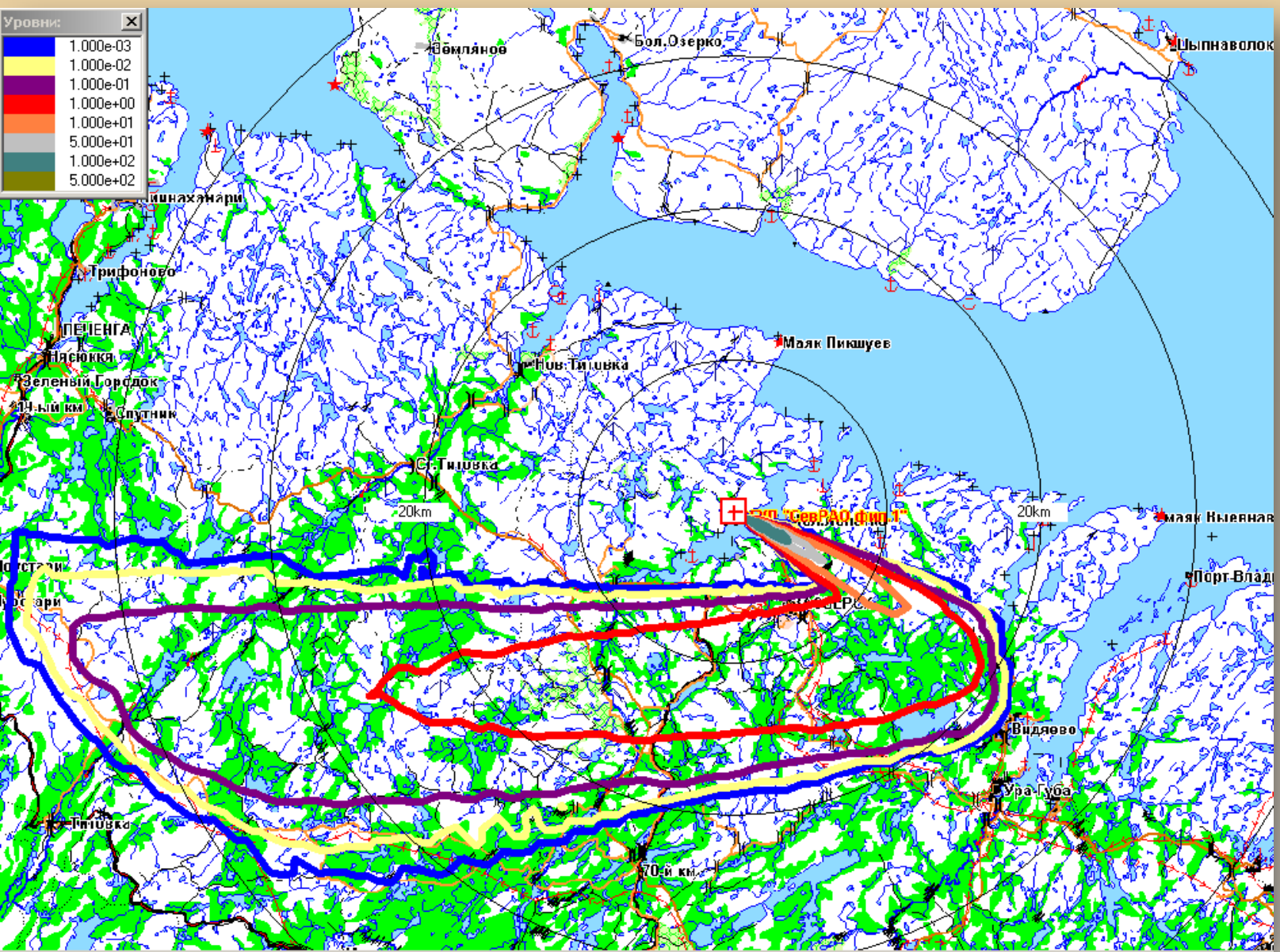
•to simulate progression of radiation situation with time dependant atmospheric conditions and source terms

•to take into account local relief and local precipitation

•to calculate deposition rate of aerosol particles taking into account size distribution

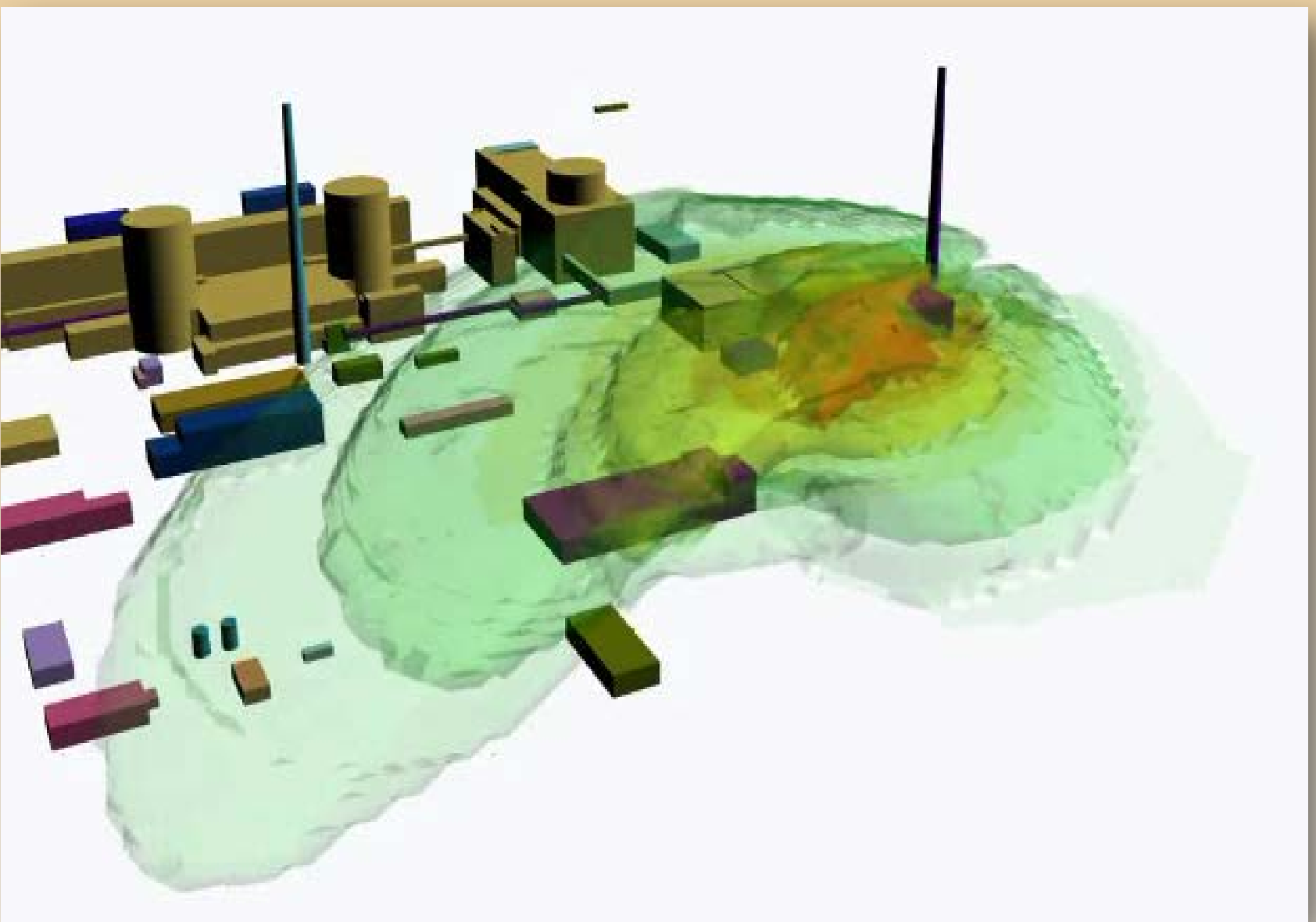
• to calculate the different kinds of dose data base on radionuclide properties (dose rate conversion factors for more than 150 nuclides)

Decision-making support system for radiation incidents and accidents

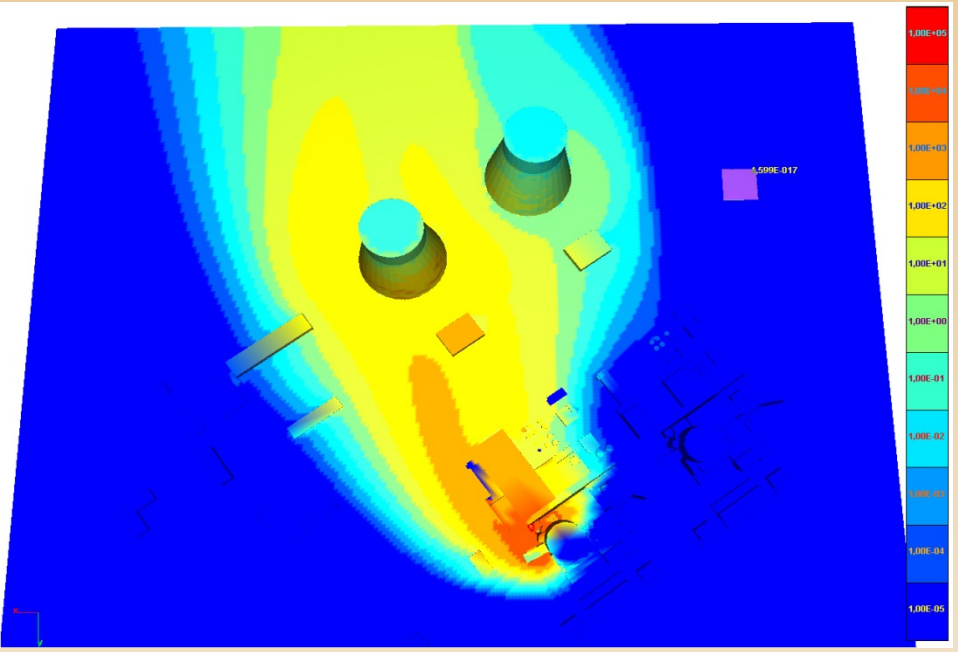


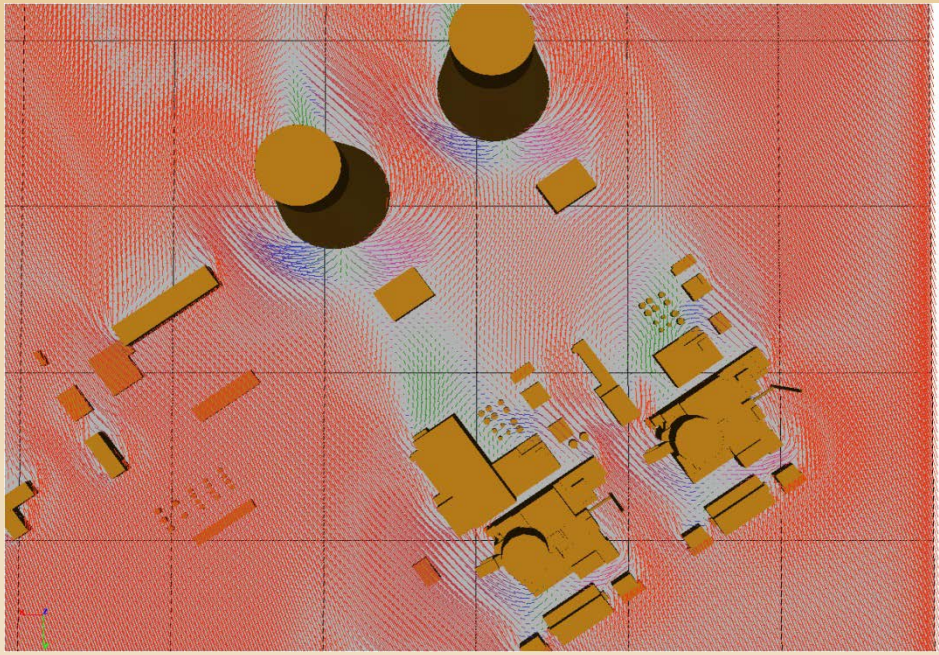
3D simulator for training

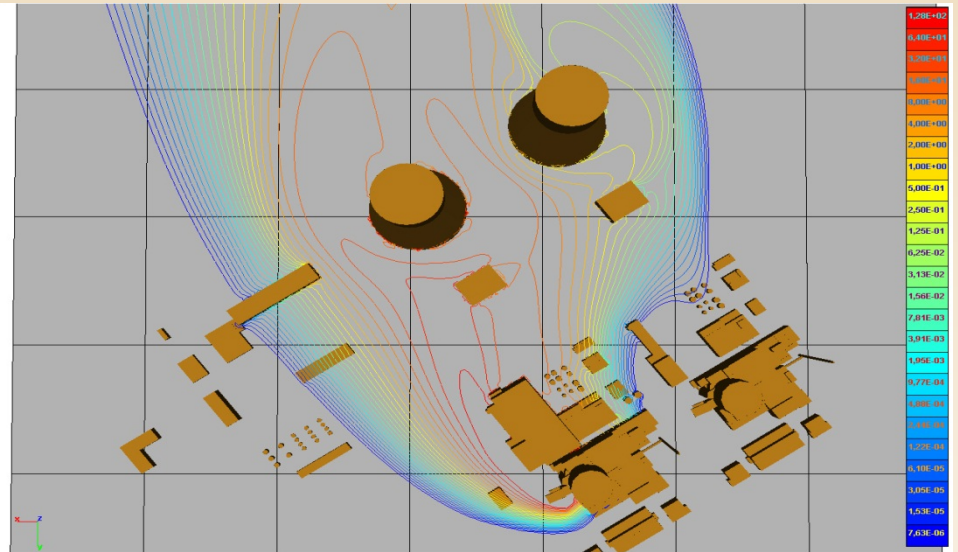
CFD modeling of atmospheric dispersion. Concentration in air

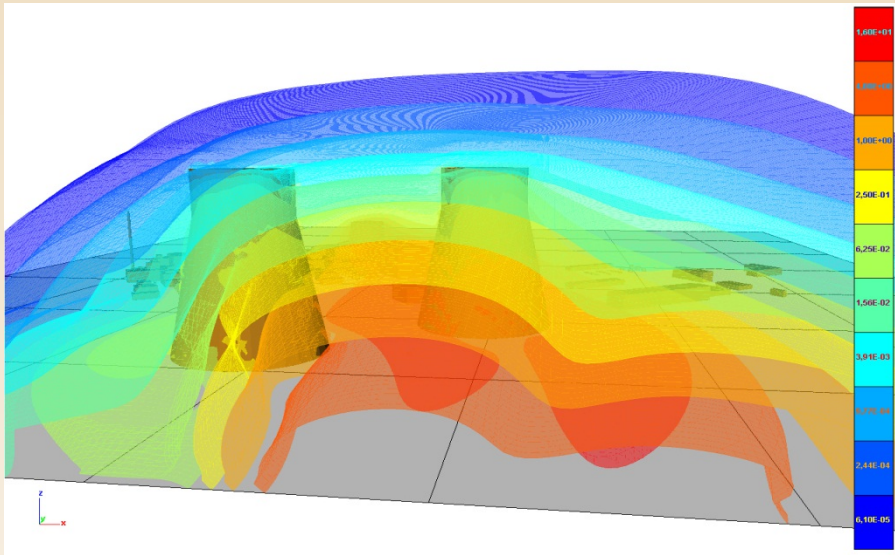


CFD modeling of atmospheric dispersion. Concentration, dose









The forecasting of the radiation environment in Japan and Far East of Russia formed as a result of accident at the Fukushima-1 NPP

11 march 2011 the earthquake was happened in Japan and Far East of Russia

This fact was the reason for danger of accidents at NPP stations at east coast of Japan

TCC IBRAE RAS

1. From 13.00 11 of March 2011 TCC NSI RAS has been working in the activation mode with all the staff round-the-clock.

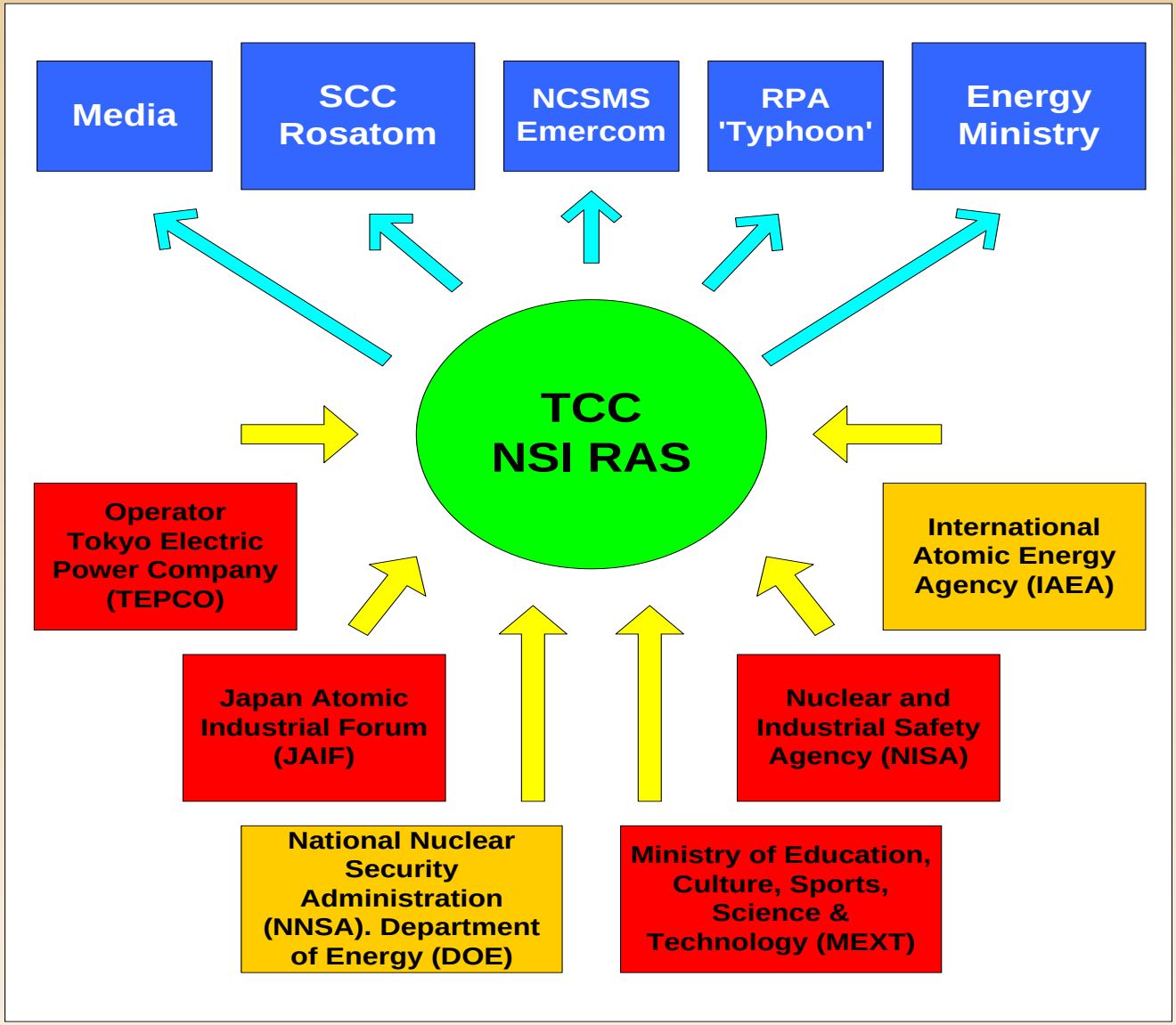
2. According to regulations TCC provides support for NCSMS Emercom on the following tasks:

   – Predictions for the Japan NPP situation evolution (in coordination with ROSATOM);

   – Predictions for the radiation state in area of Fukushima Daiichi and Daini power plants in case of unfavorable scenarios of situation evolution;

   – Predictions for the radiation state on the territory of Russian Federation in case of unfavorable scenarios of situation evolution (in coordination with RPA ‘Typhoon’).

24-hour information gathering and distribution scheme of TCC on the Fukushima Daiichi accident



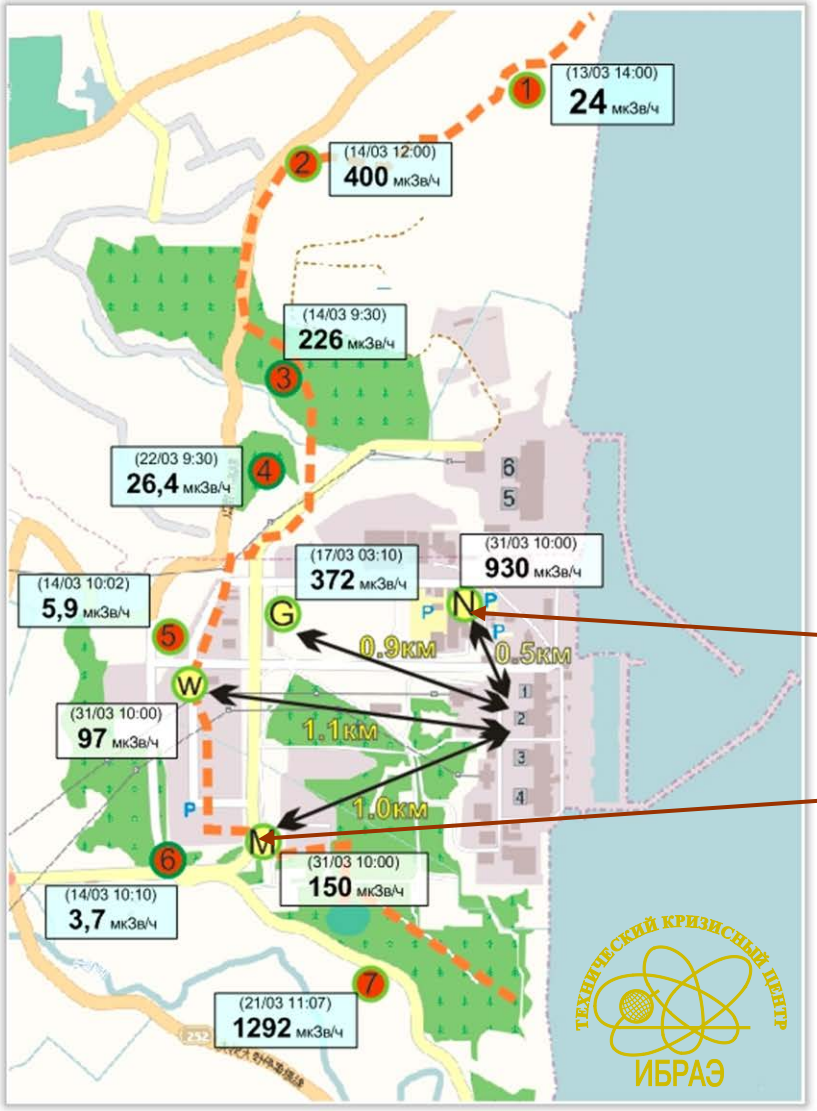
SOURCE ESTIMATION

SOCRAT – The System Of Codes for Realistic Analysis of Severe Accidents

The development of the integrated code system was started in 1999 due to request of Russian design institutions for safety assessments of VVER-1000 NPPs constructed in China and India

In 2010 the SOCRAT code has been certified for safety analysis of VVER type reactors by Russian nuclear regulatory body (Rostechnadzor)

Radiation situation near NPP Fukushima-1

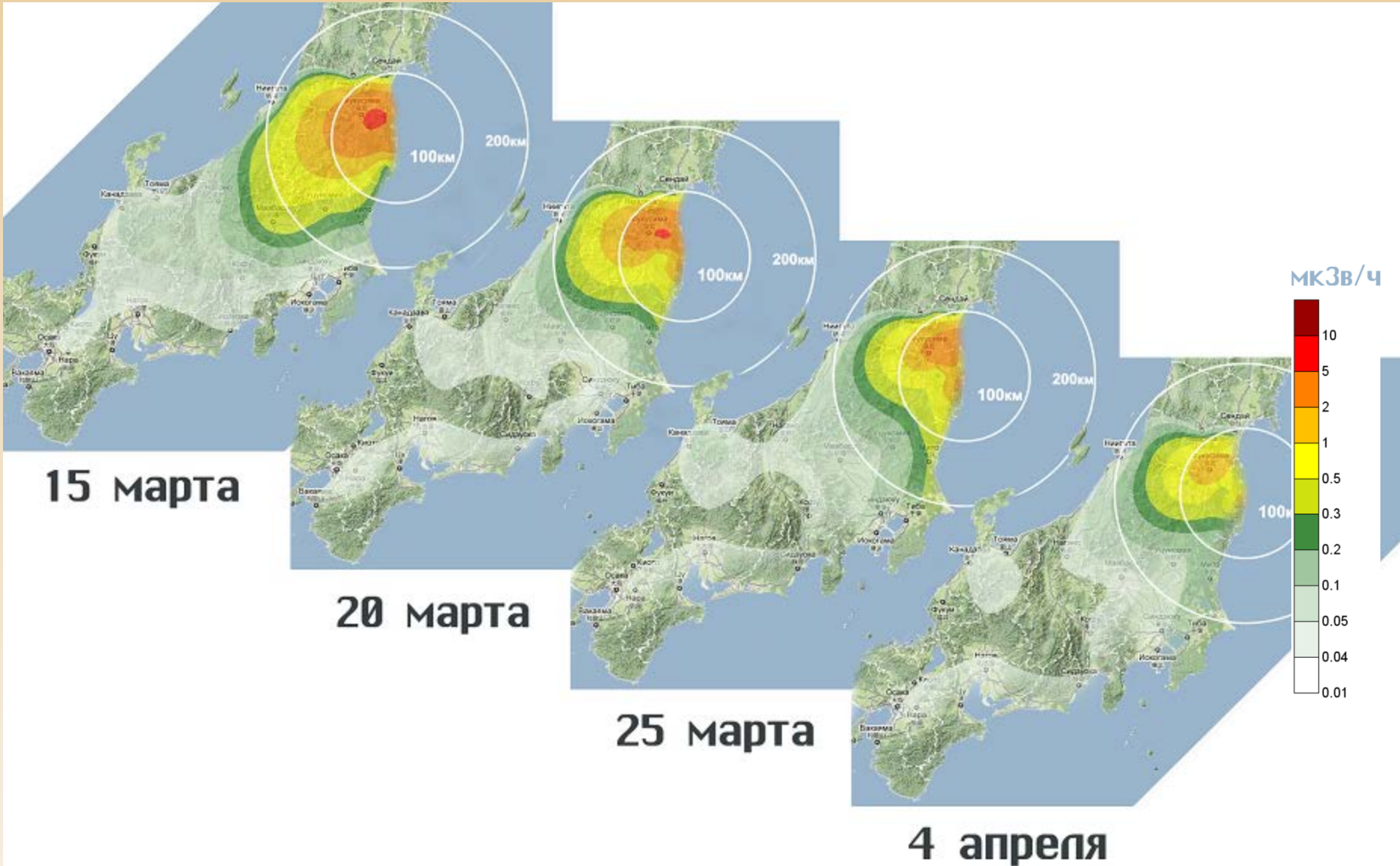


dose upper level for personal 250 mSv

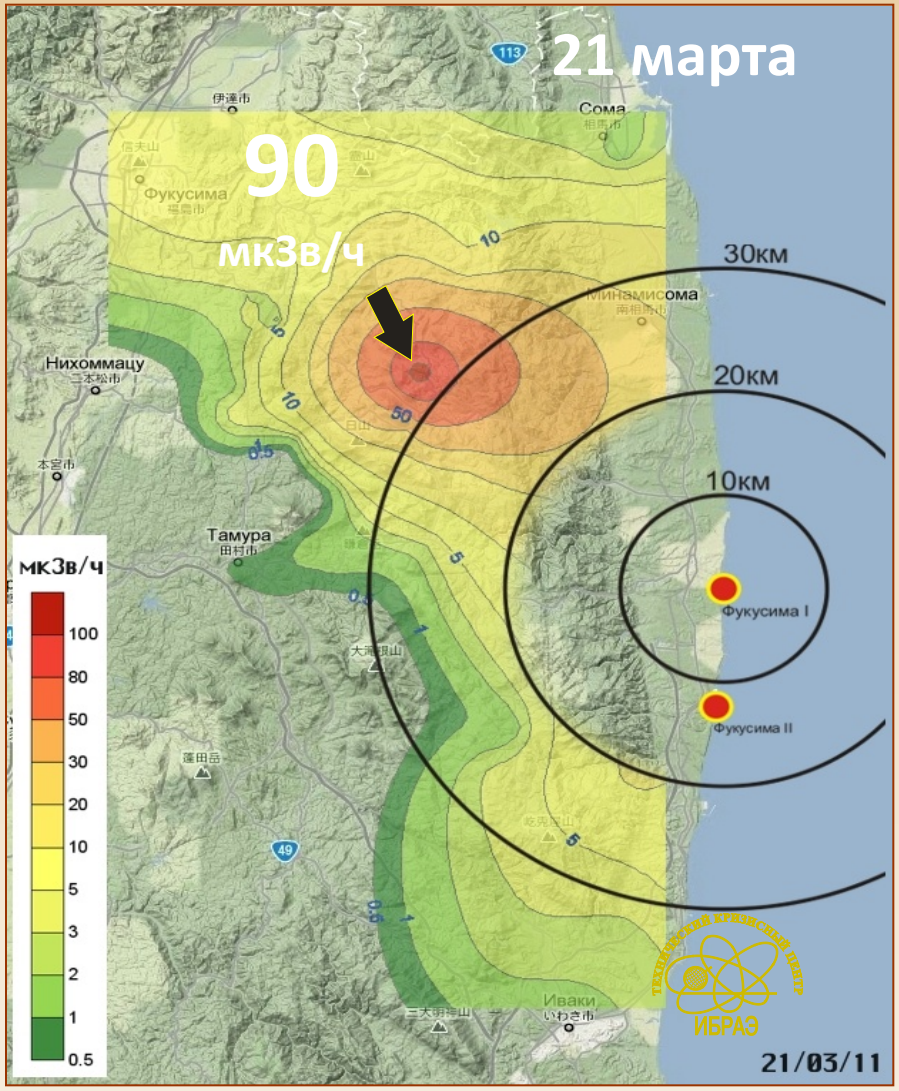
270 hours

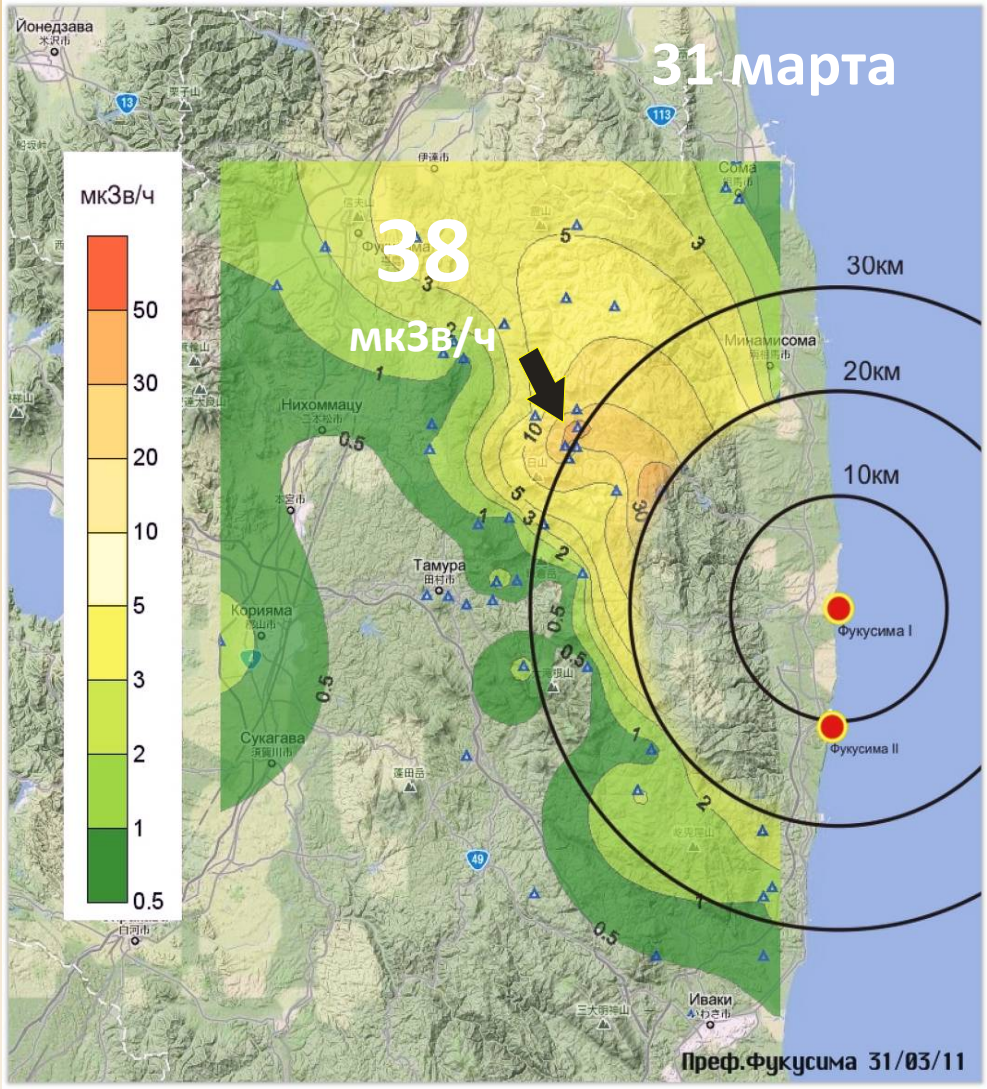
1600 hours

Radiation situation in Japan in March and April, 2011



More detail radiation situation (microSv/h) more from 20км from the source. 21 and 31 march



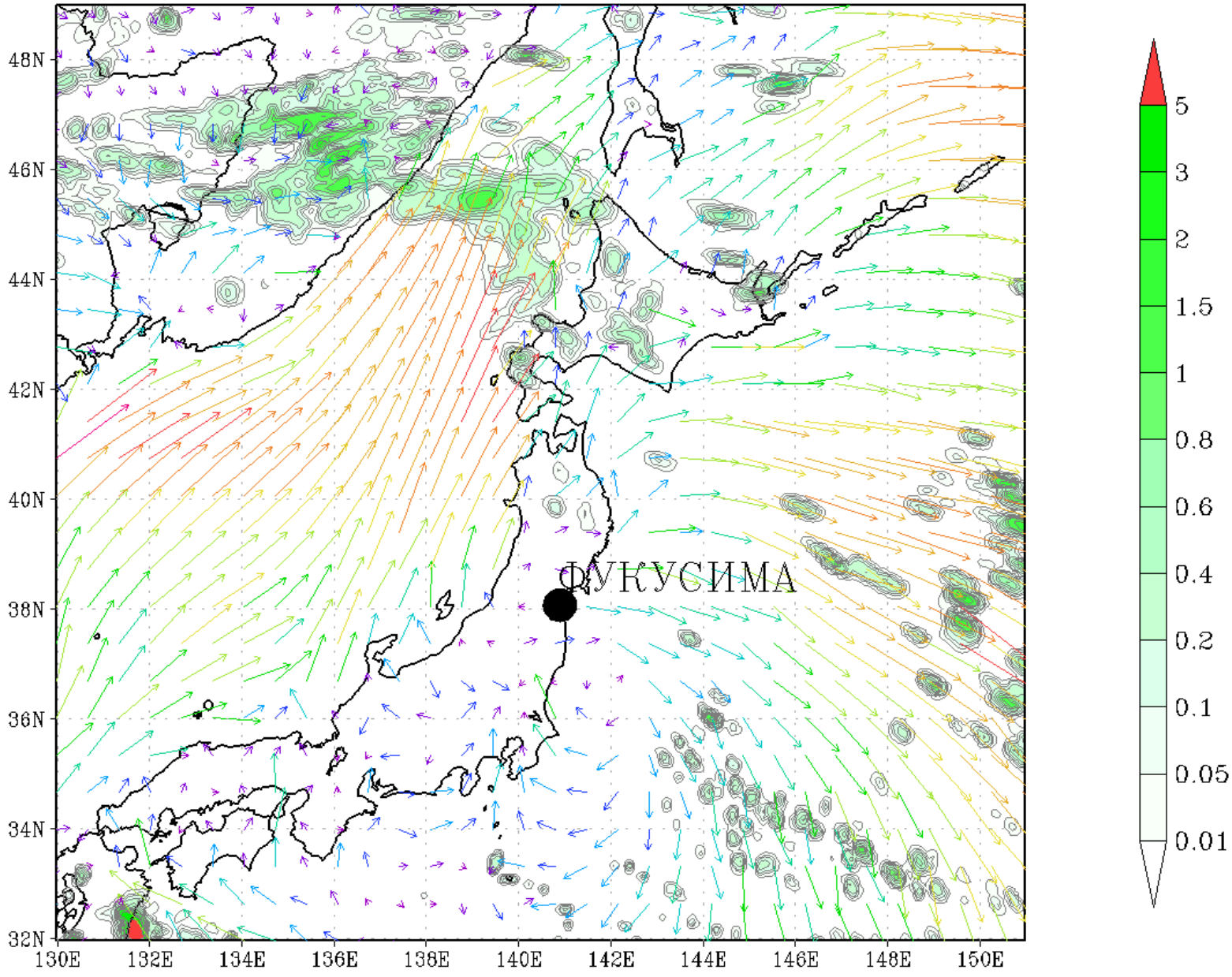


Meteorology

There was observed complex meteorological situation on NPP Fucushima-1 in the time period from 11 to 20 march, changes in velocity direction and magnitude has been very fast, atmospheric front passing was observed.

The wind (10m) and precipitation rate is below

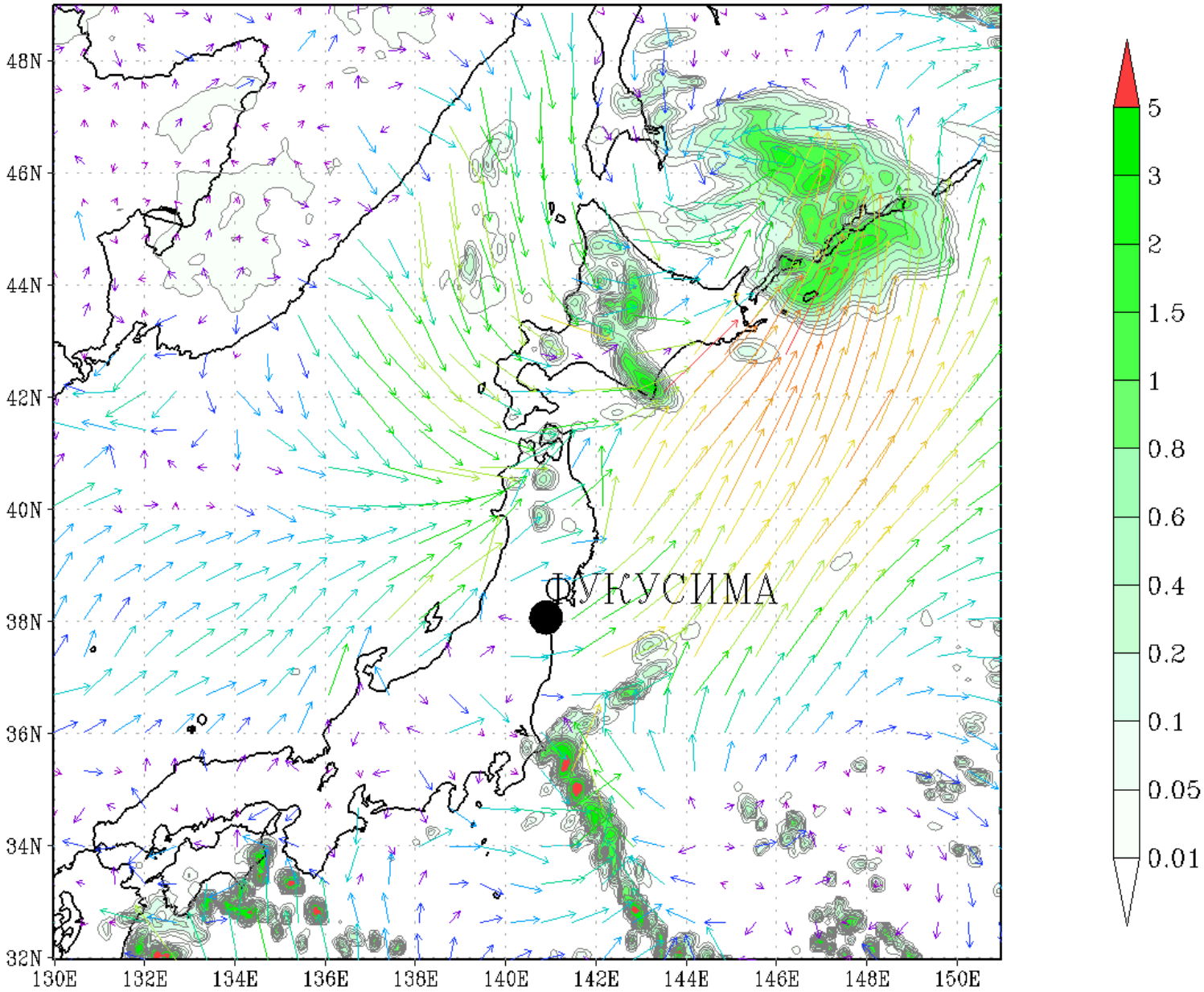
Осадки (мм/час) и ветер на 10 м.
09 часов 12 марта 2011 г. (Гринвич)



GrADS: COLA/IGES

2011-04-01-08:09

Осадки (мм/час) и ветер на 10 м.
22 часов 12 марта 2011 г. (Гринвич)



GrADS: COLA/IGES

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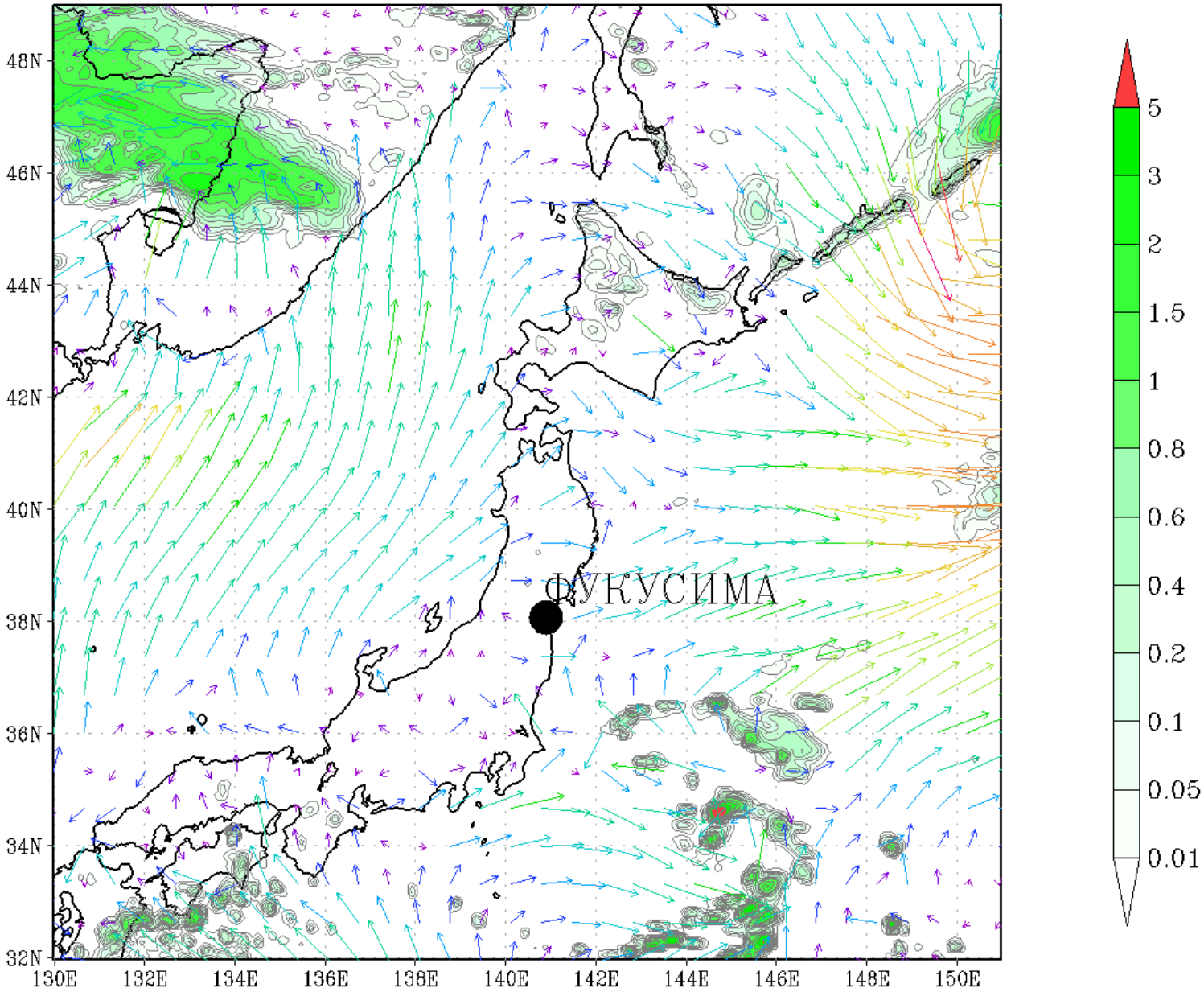
Осадки (мм/час) и ветер на 10 м.
08 часов 13 марта 2011 г. (Гринвич)



GrADS: COLA/IGES

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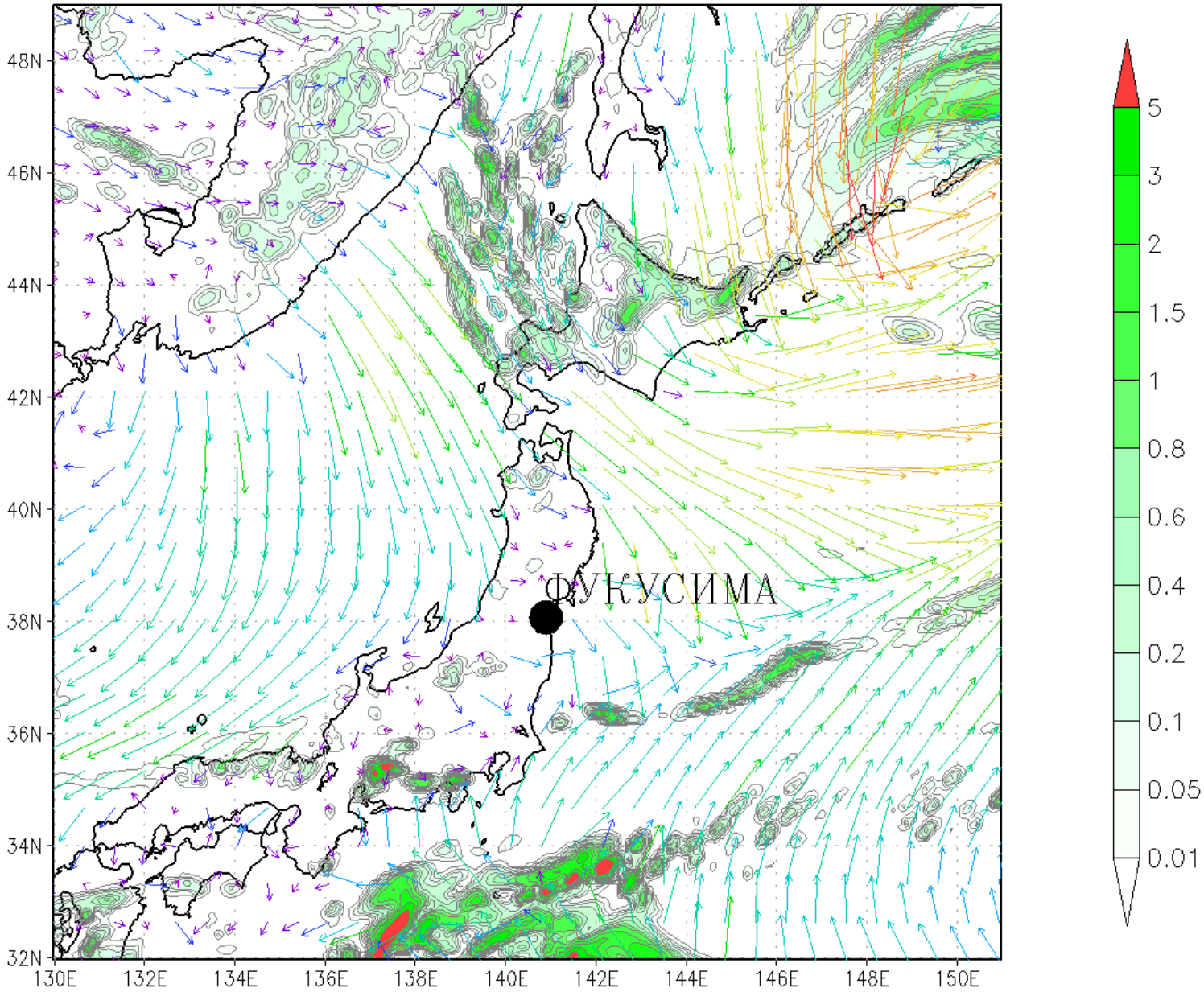
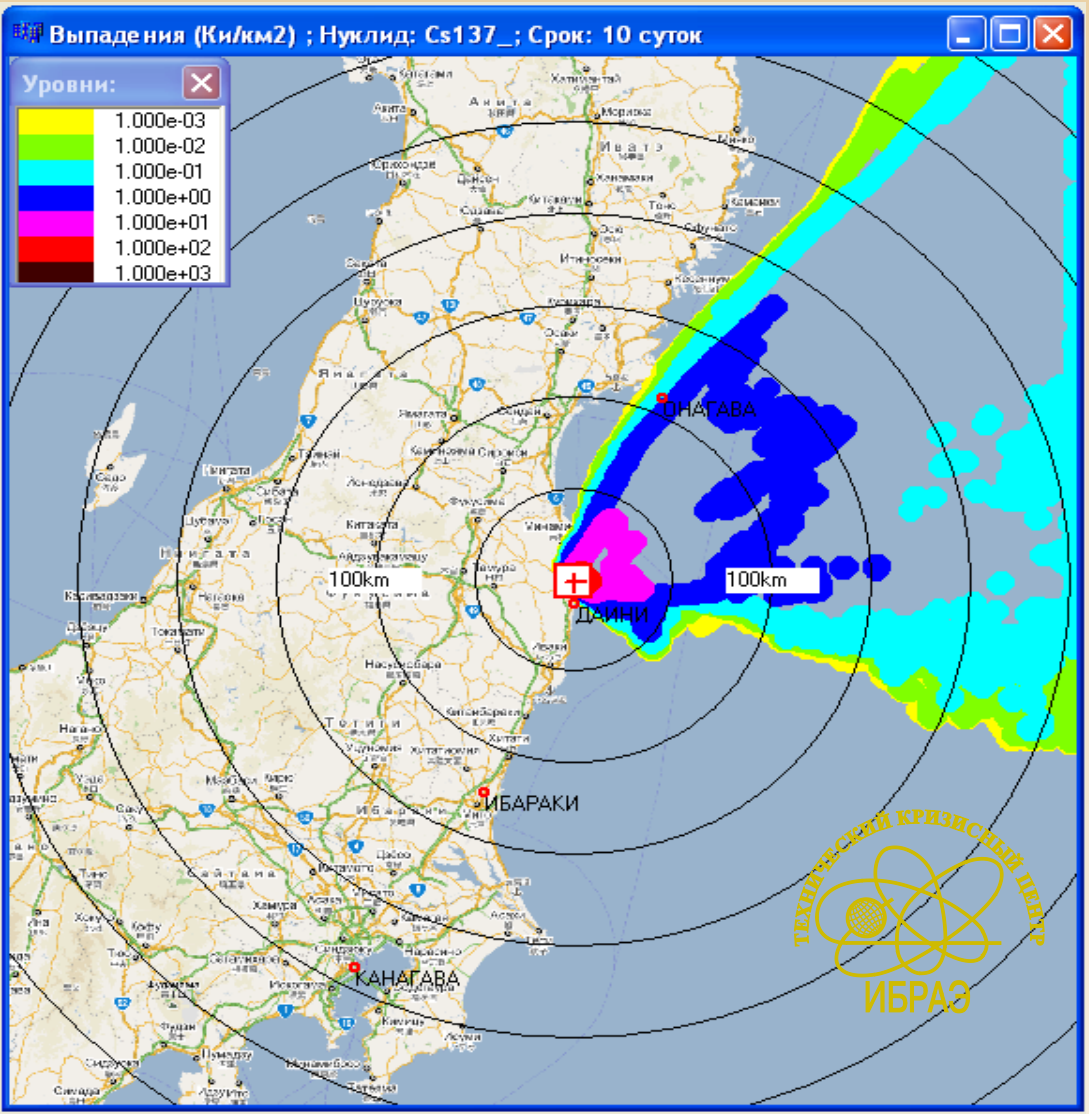
Осадки (мм/час) и ветер на 10 м.
12 часов 14 марта 2011 г. (Гринвич)



Prognoses of nuclide pollution until 14 march (WRF-ARW AND NOSTRADAMUS)



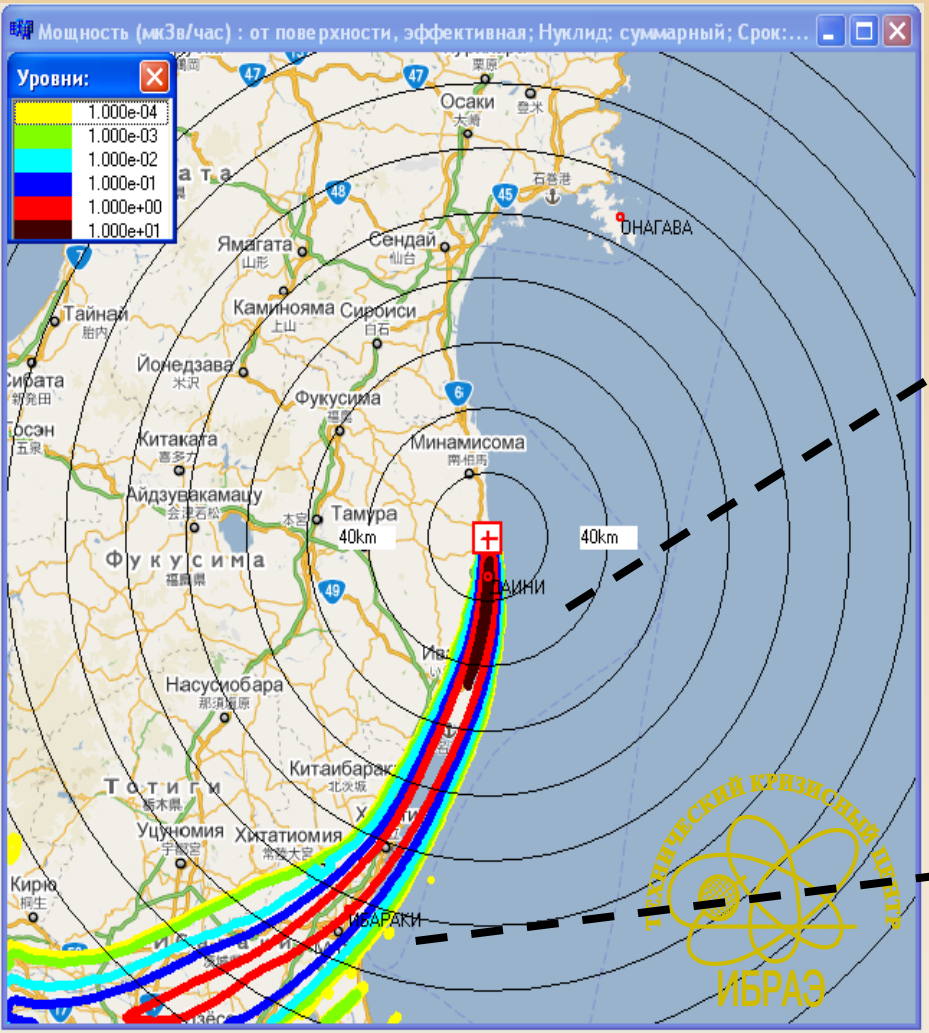
The modeling result:
Japan terrestrial territory hasn't been exposed any **considerable radiation pollution** as a result of hydrogen explosions on block-1 and block-3 of the Fucushima-1

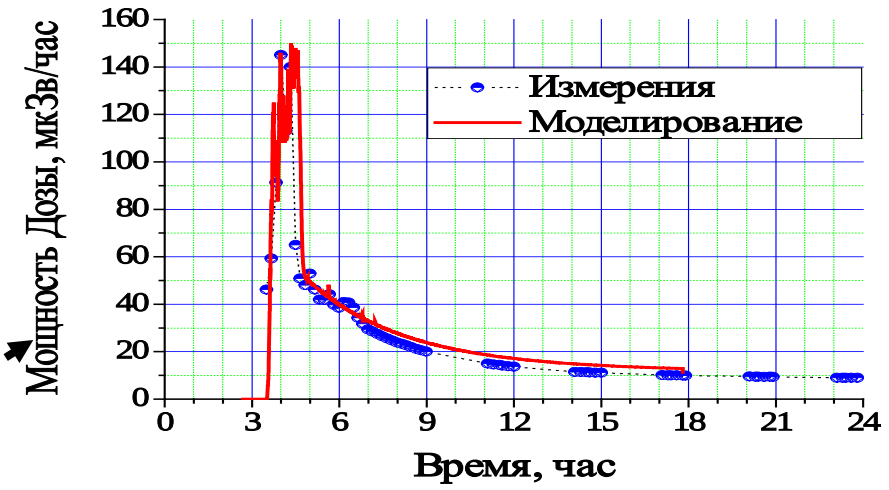
Estimation for the emergency discharge source and inhabitants' dose in Japan

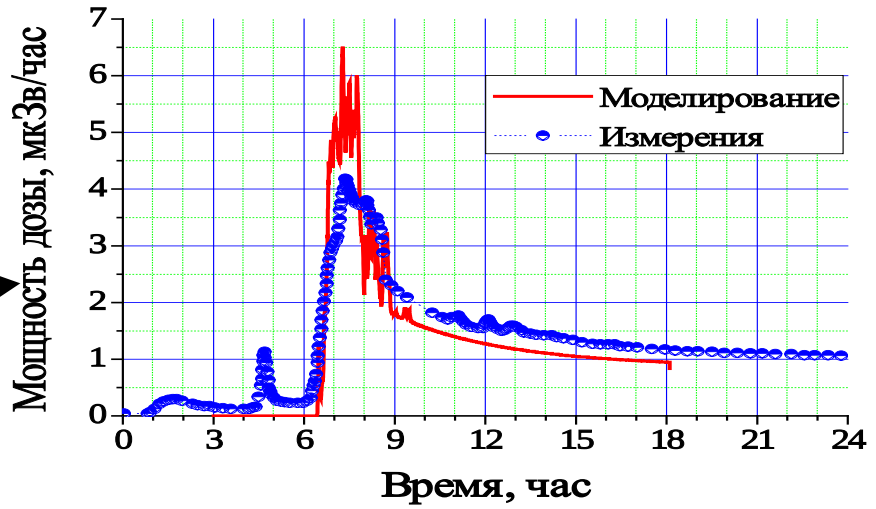
- Estimation of the emergency discharge source for radioactive aerosols and gases to the environment (radionuclide transfer model, weather data was calculated with the aid of regional hydrodynamical model WRF-ARW)

- Estimation of inhabitants' dose values in Japan based on the radiation monitoring data (MEXT) and results of aerogamma survey (NNSA, DOE)

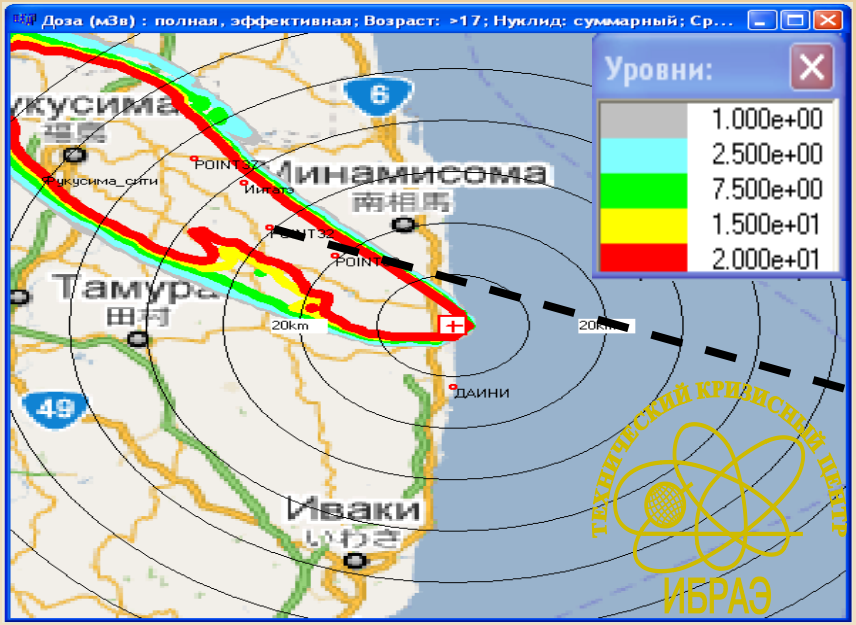
S0 CALLED «SOUTH TRACE».
Dose power (microSv/hour)

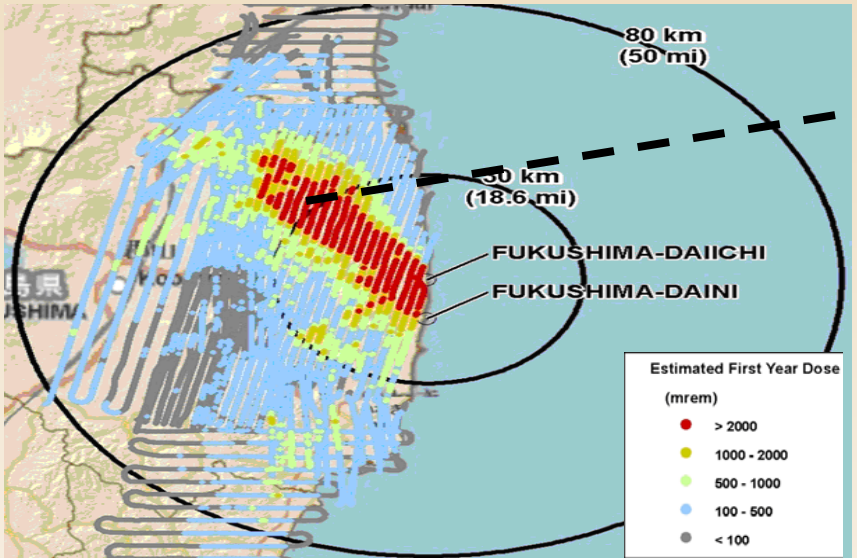

Мощность (мкЗв/час) : от поверхности, эффективная; Нуклид: суммарный; Срок:...
Уровни:
1.000e-04
1.000e-03
1.000e-02
1.000e-01
1.000e+00
1.000e+01
Осаки
ОНАГАВА
Ямагата
Сендай
Тайнай
Каминояма
Сироиси
Йонедзава
Фукусима
Минамисома
Китаката
Айдзувакамацу
Тамура
40km
40km
Насусиобара
Китаибараки
Тотиги
Уцуномия
Хитатиомия
Кирю
ИБРАЭ



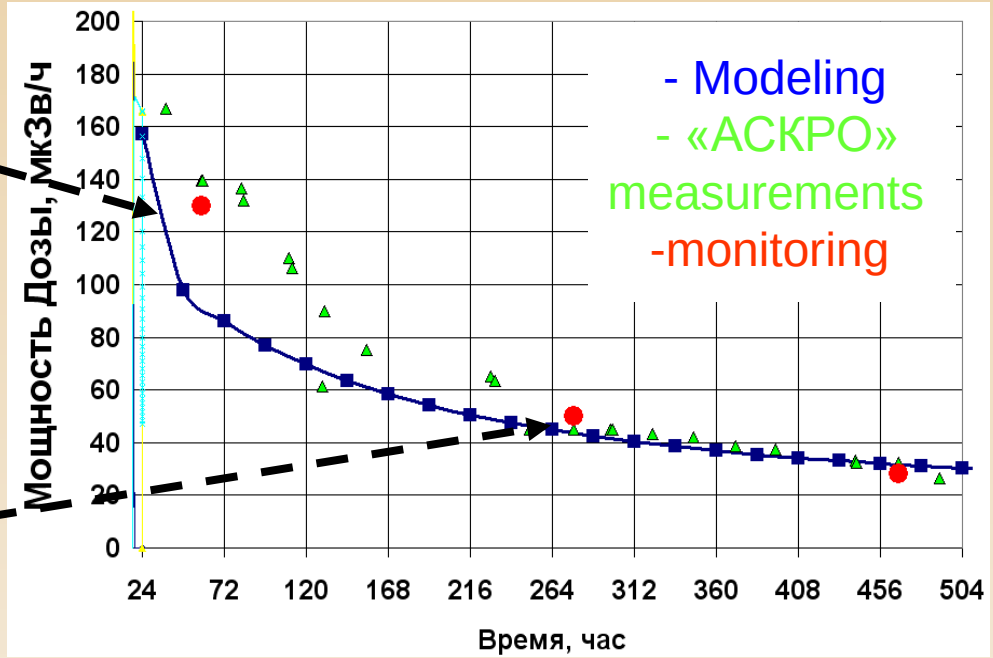


S0 CALLED «NORTH-WEST TRACE»

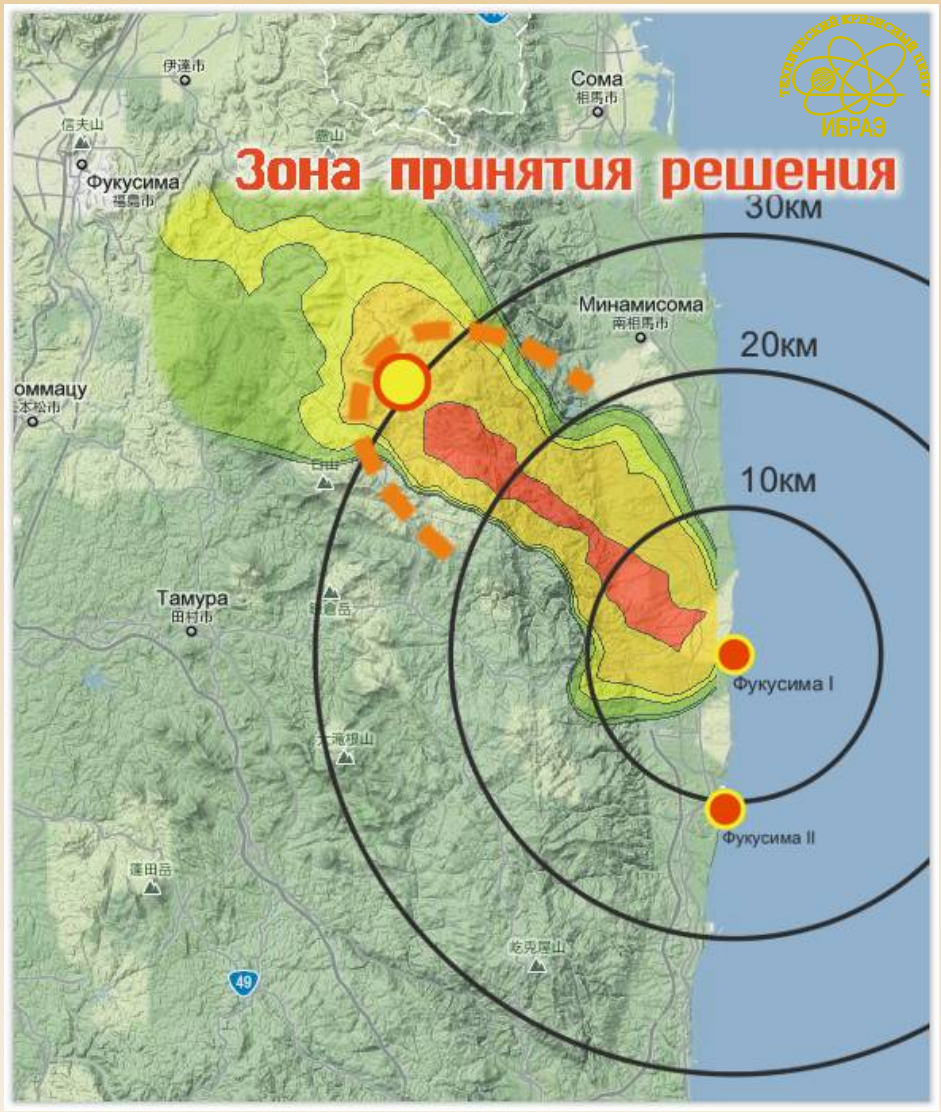




Model result (dose power) end data



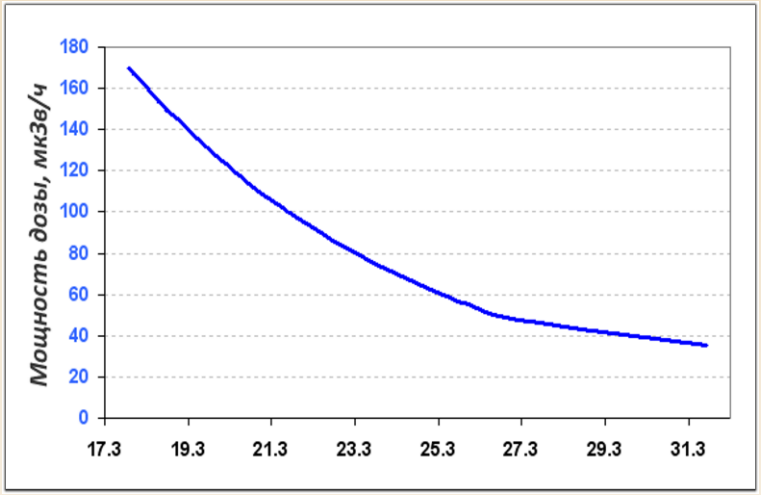
Оценки доз и обоснование принятия решений по контрмерам в префектуре Фукусима, муниципалитет Иитате



Доза за 15 дней ~ 30 мЗв
Доза за 2011 год ~ 150 мЗв

Критерии принятия решений по защите населения (в том числе и эвакуации):
Россия 50 ÷ 500 мЗв за первый год
МКРЗ 20 ÷ 100 мЗв оптимизация
МКРЗ более 100 мЗв - рекомендуются защитные мероприятия

Динамика изменения радиационной обстановки в точке наблюдения



Estimation of I-131 и Cs-137 realize in atmosphere

	Estimation of source, Bq			
	source 15 march	NISA	NSC	ЧАЭС
I-131	$2*10^{17}$	$1.3*10^{17}$	$1.5*10^{17}$	$1.8*10^{18}$
Cs-137	$3*10^{16}$	$6.1*10^{15}$	$1.2*10^{16}$	$8.5*10^{16}$
all	$1.4*10^{18}$	$3.7*10^{17}$	$6.3*10^{17}$	$5.2*10^{18}$

NPP Fucushima-1 accident has **7^{th}** INES level according with preliminary estimations of NISA and NSC.

Radiological consequences estimation and NSI RAS experts recommendations

- There aren't any reasons for evacuation outside the 20km zone around the NPP Fucushima-1. Chernobyl tragedy show that the unreasonableness in the radiological point protective measures (evacuation) can provoke increasing of psychological, social and economical consequences
- Radiation situation in Russian Federation (Far East) not require any measures to protect population

NOSTRADAMUS + WRF-ARW(regional scale) = PARRAD

PARRAD

The project system for express forecast of radiation situation in the near zone of the Russian nuclear power plants based on both the WRF-ARW model and the NOSTRADAMUS code

The PARRAD system provides the accumulation of permanent assessments of the quality of its functioning as whole and individual subsystems for further iterative improvement. The system will operate at the Technical Crisis Center (TCC) of IBRAE RAN. The pilot version of the system is implemented for the Sverdlovsk Region in the 100-km area of the Beloyarsk NPP

Conclusions

The following tasks were successfully accomplished by the TCC specialists during the emergency work on the Fukushima Daiichi accident:

- *Determination of the contamination risks for the Russian Far East region. Radiation situation there won't require any measures to take*
- *Prediction for the emergency processes development on the units of the NPP*
- *Estimation for the discharge sources to the environment*
- *Inform the media and the public with the actual, topical and scientifically valid information about the incident and its consequences for the humanity and environment*
- *Provide the 24-hour scientific-technical support for the NCSMS Emercom and SCC Rosatom*

The main – it is quite necessary to improve the meteorological support to emergency response

An attempt to solve this problem information modeling system PARRAD

THANK YOU
FOR
ATTENTION