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Results and features of seismic forecasting experiments for Kamchatka and Japan regions

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Results for the Kamchatka zone

- Zone covering Kamchatka peninsula and Okhotsk sea
- 6 prediction for all M7+ earthquakes since 2002
- 5 earthquakes were **deep focus** events

		Real EQ/Prediction				
№	EQ date	Location – depth		Date of prediction	M7.6, 20	
	Predicted date	Predicted location	Magnitude		and the states	
1	17.11.2002	Okhotsk Sea - 459 km	7.3	11.11.2002		
	before 12.12.2002	Kamchatka	7.3+			
2	20.04.2006	Koryakia - 22km	7.6	12.04.2006	MI8.3, 2013	
	before 19.04.2006	Kamchatka or Kuril islands	6.0+		M7 3 200	
3	05.07.2008	Okhotsk Sea - 632 km	7.7	16.06.2008	M7 7 2008/7	
	before 14.07.2008	Kamchatka	6.5+,7.0+		Mir.ir, 2000/1	
4	24.11.2008	Okhotsk Sea - 492 km	7.3	12.11.2008	M7.7, 2012	
	before 01.12.2008	Kamchatka or Kuril islands	7.1+			
5	14.08.2012	Okhotsk Sea - 582 km	7.7.	31.07.2012	M7 3 2002	
	before 17.08.2012	Kamchatka or Kuril islands	7.0+	51.07.2012	all Bases, 2002to	
6	24.05.2013	Okhotsk Sea - 598 km	8.3	20.05.2013		
	before 16.06.2013	Kamchatka	7.4+			

All events were predicted 1-3 weeks before the actual EQ took place.

Doda et al. 2015 - Results and features of seismic forecasting experiments



MCHATK

Predictions as registered documents

Addressee: Russian Expert Council on Earthquake Prediction and Seismic Hazard Assessment (REC, Chairmans: Dr. A.V. Nikolaev (ex-), Dr. E.A. Rogozhin)

> В Российский экспертный совет по прогнозу землетрясений и оценке сейсмической опасности

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> > > Председателю РЭС чл.-корр. РАІ А.В. Николаеву

Копия: начальнику Центра "Антистихия" МЧС І В.Б. Болову

Уважаемый Алексей Всеволодович!

Прошу пролонгировать наш прогноз по Камчатке или/и Японии

Данная процедура предусмотрена "Положением о РЭС" и

Уважаемый Алексей Всеволодович! Представляю прогноз сильного землетрясения в Курило-Камчатской зоне: до 1 декабря 2008 г. с вероятностью 0.7 возможно землетрясение на юге Ка

Копия:

чатки с магнитудой М7.1+.

Федеральное государственное унитарное предприятие

«РОССИЙСКИЙ НАУЧНО-ИССЛЕДОВАТЕЛЬСКИЙ ИНСТИТУТ

КОСМИЧЕСКОГО ПРИБОРОСТРОЕНИЯ» НАУЧНЫЙ ШЕНТР ОПЕРАТИВНОГО МОНИТОРИНГА ЗЕМЛИ

перспективной системы наземно-космического мониторинга.

Прогноз разработан экспертами НЦ ОМЗ и инновационного фонда "Подземн

тонным, электротеллурическим и ионосферным признакам. Часть из них представ на в Приложении

аномалии в классах геофизических признаков 25-27 июля и сейсмомагн прогноза не более 2-х раз суммарно до 28 суток со дня окончания действия началы го прогноза. меридианы запуска.

> Л.Дода 12.11.2008 г.

августа 2012 г. с прежними параметрами. электрические технологии" (ПЭТ), г. Петропавловск-Камчатский, в рамках прове, ния совместных сейсмопрогнозных и мониторинговых экспериментов по отрабо

Подготовка ЗМТ зарегистрирована в лито-атмо-ионосфере по облачным, п "Методикой прогноза землетрясений" при наличии достаточных ус

Такими условиями являются: выявленные облачные сейсмоиндик Наши методики прогнозирования ЗМТ предусматривают пролонгирован

Главный специалист, член РЭС

6, N189

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Председателю РЭС

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Е.А. Рогожину

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AGUE, CZECH REPUBLIC GUE CONGRESS CENTR JUNE 22 - JULY 2, 2015 В Российский экспертный совет по прогнозу землетрясений

и оценке сейсмической опасности от члена РЭС Доды Леонида Николаевича телефон: (495) 600-33-21, e-mail: l.doda@mail.ru

> Председателю РЭС, чл.-корру РАН А.В. Николаеву

Копия: Директору Координационного прогностического центра ИФЗ РАН Е.А. Рогожину Начальнику Центра "Антистихия" МЧС России В.Р. Болову

Уважаемый Алексей Всеволодович!

Прошу пролонгировать наш сейсмопрогноз по Камчатке от 26 апреля 2013 г., срок действия которого истек 19 мая, до 16 июня 2013 г.

Параметры прогноза остаются прежними: магнитуда M(6.6-7.2)±0.2; потенциальная зона – прямоугольник с центром (52N 159E)±(4°N 3E).

В соответствии с прогнозом у восточного побережья Камчатки 19 мая 2013 г. произошло землетрясение магнитудой Мв = 6.2 (ГФС РАН), а также вблизи Петропавловска-Камчатского 19.05.2013 магнитудой Mв = 5.8.

Опасность возникновения более мощных ЗМТ в отмеченной зоне сохраняется. Мониторинг геофизических признаков в Курило-Камчатской зоне продолжается.

Л. Дода 20.05.2013 20.05.2013 31.0

MO3 PAH » HO.S 5.200



127490, г. Москва, ул. Декабристов, вл. 51, стр. 25

№ 2620-3/47 от 12.11.2008

[Прогноз землетрясения]

hpur men 12. 11. 08 Finansingen og kanen aven

2008

2012





Results for Japan zone

- About 3 years of monitoring (since August 2011)
- Total 18 earthquakes with M6.3+ till the end of May 2015
- 14 EQs have predictions
- Several events were missing because monitoring was not conducted

					Date of	Dates or End of
				Predicted	Prediction	Predicted
Nº	Date	Magnitude	Region Name	Magnitude	Statement	Time-frame
1	2015-05-12	6.8	NEAR EAST COAST OF HONSHU	6.5-7.0	19.04.15	10.05.15
2	2015-02-20	6.3	OFF EAST COAST OF HONSHU	no monitoring		
3	2015-02-16	6.8	NEAR EAST COAST OF HONSHU	no monitoring		
4	2014-07-11	6.5	OFF EAST COAST OF HONSHU	7.0+	21.06.14	14.07.14
	2014-06-29	6.2,	VOLCANO ISLANDS,			
5	2014-06-30	6.2	BONIN ISLANDS	7.0	21.06.14	07.07.14
6	2014-03-13	6.3	KYUSHU	6.5±0.2	06.03.14	16.03.14
7	2014-03-02	6.5	RYUKYU ISLANDS	7.5+	16.01.14	25.02.14
8	2013-10-25	7.1	OFF EAST COAST OF HONSHU	7.1+	09.09.13	25.10.13
9	2013-09-04	6.5	IZU ISLANDS	no monitoring		
10	2013-02-02	6.9	HOKKAIDO	missing		
11	2012-12-07	7.3	OFF EAST COAST OF HONSHU	7.0+	03.12.12	15.12.12
12	2012-06-17	6.4	NEAR EAST COAST OF HONSHU	6.5-7.0	15.06.12	04.07.12
13	2012-05-20	6.3	OFF EAST COAST OF HONSHU	7.0+	15.03.12	16.05.12
14	2012-03-14	6.9	OFF EAST COAST OF HONSHU	7.0+	16.02.12	15.03.12
						01.01.2012 or
15	2012-01-01	7.0	IZU ISLANDS	7.1±0.2	07.12.11	08.01.2012
					05.10.2011	
16	2011-11-08	6.9	OKINAWA ISLAND	7.1±0.2	Www	15.11.11
17	2011-09-16	6.7	NEAR EAST COAST OF HONSHU	7.6+	17.08.11	13.09.11
18	2011-08-19	6.3	NEAR EAST COAST OF HONSHU	7.6+	03.08.11	17.08.11

All predictions except №16 are supported by official documents submitted to REC

Some details about correlation of predicted and real event magnitudes are discussed on the following slides



Ds is the date of geoeffective event

Η

Place: Geomagnetic-meridional directivity of seismic process, 7^o zones

$$\lambda = \pm \gamma \varphi + (\lambda_s - 45^\circ j),$$

 $j = i + 1$ при $k(i + 1) - k(i) \ge 2, \quad i = 0 - 8$
 $\gamma = \text{tgl } 1^\circ \sim 0.19$

Doda L.N., Natyaganov V.L., Stepanov I.V. An empirical scheme of short-term earthquake prediction. Doklady Akademii Nauk, 2013, Vol. 453, No.5, pp.551–557

No citings yet! Even critical

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Empirical scheme of short-term earthquake-prediction (SCOME's scheme):

Date: so-called D-trigger effect of geomagnetic disturbances "Earthquakes are born at the Sun"

$$D_* = D_s + \left[\left(7 \vee 14 \vee 21 \right) \pm 2 \right] + 27n$$





Cloud seismotectonic indicators (CSIs)

- Potential EQ magnitude estimate, verification of potential EQ zones
- Generalization of works of Shou (EQ clouds) and L.Morozova (linear cloud anomalies)
- Some correlation with LAIC concept (Ouzunov, Pulinets et al.)
- Theoretical models of formation are developed by Dr. Natyganov

$$M = \ln \frac{L}{L_0}$$

Similarity to well-known Dobrovol'skiy equation

M=6 L≈400 km M=7 L≈1000 km

Potential magnitude estimate accuracy is ±0.2



Doda L.N., Natyaganov V.L., Stepanov I.V. *An empirical scheme of short-term earthquake prediction*. Doklady Akademii Nauk, 2013, Vol. 453, No.5, pp.551–557



Examples of cloud seismotectonic indicators





Examples of cloud seismotectonic indicators

M 8.4 - OFF W COAST OF NORTHERN SUMATRA - 2012-04-11 08:38:35 UTC+ M 8.0 - OFF W COAST OF NORTHERN SUMATRA - 2012-04-11 10:43:09 UTC



Basic prediction technology

After each strong enough geomagnetic disturbance

- Calculate potential dates
- Prepare seismomagnetic meridians map
- Check potential 7^o zones for cloud seismotectonic indicators



Works on global scale! Devil in details": many seismomagnetic meridians, many potential zones, not all meridians launch earthquakes (only about 30% of them are seismoeffective)



Seismotectogenesis concept

Generalization of empirical scheme

Main idea: incorporation of physically-interrelated geophysical parameters (ground-data and space-data) in the prediction scheme

Additional idea: use data having separate processing technology with successful predictions In the past

<u>Special gravimetry data</u> (Tula State University, Dr. O.V. Martynov, S.Shopin)
 Martynova M., Martynov O. Physico-mathematical base and monitoring system for the earthquake forecast (M>6), its place and time. *Proceedings of First European Conference on Earhquake Engineering and Seismology 2006*.
 3-6 September 2006, Geneva, Switzerland, pp.3294–3300

• <u>Protonic migration data</u> (Distant School "Cosmo-Meteo-Tectonics", V. Bobrovskiy) Bobrovskiy V.S. The results of subterranean electric measurements on Kamchatka as global effects of proton tectogenesis: damaging earthquakes in Indonesia and China. *Recent Progress on Earthquake Geology*, 2011, 257 p., pp.189-248

• <u>Radon data (several sources)</u>





1. Doda L.N., Dushin V.R., Natyaganov V.L., Smirnov N.N., Stepanov I.V. Earthquakes forecasts following space- and ground-based monitoring. Acta Astronautica, 69 (2011), pp. 18–23

2. Doda L.N., Malashin A.A., Natyaganov V.L., Stepanov I.V. Seismotectonics and ground–space monitoring of natural disasters precursors in the Earth. Acta Astronautica, 109 (2015), pp. 254–263

3. Doda L., Novikova N., Pakhomov L., Stepanov I. Space monitoring of earthquake precursors (Kosmicheskij monitoring predvestnikov zemletryasenij). Science in Russia (Nauka v Rosii), 2009. №6, pp. 30–37.– In Russian

Specific of Japan zone

- Lowering of predicted magnitudes
- Anomalous ring-cloud structures (ARCS) in the form of concentric circles
- ARCS observed regular enough in Japan zone in last years



Active geophysical experiments of forced tectonic stress release? Some natural processes, associated with annular lithospheric structures (Kopnichev, Sokolova, Doklady Earth Sciences, 2011)?



Pre-Tohoku ARCS



Satellite image of 19 Feb 2011, Meteor-M, channels 1,2,3

Found retrospectively



Suggested impact point

ARCS

What is the nature of this? MHD (Gharm polygon)-like? Electromagnetic?

Doda L.N. et al. Ground-space monitoring and forecast of megaearthquake in Japan on 11 March 2011 (Nazemno-kosmicheskiy monitoring i prognoz megazemletryaseniya v Yaponii 11 marta 2011 g) // Science and technological developments (Nauka i tehnologicheskie razrabotki) ,2011. Vol.90. № 1. pp.35-44.- In Russian



16.05-19.05 – Seismic swarm near Kamchatka, >30 EQs





Protonic data, Cosmo-Meteo-Tectonics

	Эдс, му	19.05.2014 ~09:0	20).05.2014 ~02:00	
-27.62					
-39.98					
-52.35					
-64.71		19.05.2014 18	3:44 M6.2		
-77.08					
-89.44					20.4
-101.81					20.0
-114.17					19.0
126.54			m		The
-138.90 19.05 00:0	.2013 0:00	19.05.2013 12:00:00	20.05.2013 00:00:00	20.05.2 12:00	2013 1:00 nex



20.05.2013 – CSI over Kamchatka, M=ln2500 ~7.8±0.2 19.05.2013-20.05.2013 – Proton anomalies The process of EQ preparation is not over, next potential dates 22-24.05

Okhotsk sea EQ of May 2013 – Stage 2



Extraordinary strongest deep-focus Okhotsk Sea earthquake occurred on May 24.

Earthquake confirmed the workability of Prediction scheme.



Conclusions



1. Obtained result shows **principal** short-term predictability of Earthquakes. The main question is **what accuracy can be obtained**. Ultimately, this problem needs further theoretical and experimental investigation.

2. Empirical scheme (SCOME's scheme) for short-term earthquake predictions works, which is confirmed by several successful predictions <u>having official registration</u>.

3. However, at present time problem of short-term earthquake prediction with accuracy, necessary for emergency measures such as mass evacuation is not obtained. Undoubtfully, at present time these predictions may be used only as <u>warning</u> signals for authorities and must be discussed by community professionals.

4. But presented research shows the direction along which the solution would be found. Presented successful predictions support this statement.

5. Obtained experience shows the **great difficulties in cooperation even with Russian researchers**. At out point of view, this is the biggest problem in this field of research.

6. We are open for cooperation and information exchange. Interested researches are welcome.



Thank you for your attention!

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