ADEP
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Significant Relative Quiescence along the western end part of Kuril subduction zone more than 5 years

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§1. History of Relative Quiescence

• Matsu' ura(1986) found "Quiescence and its Recovery prior some Large Aftershock" (physically a main shock in the adjacent area of the first main shock.) from Omori-Utsu (normal aftershocks).

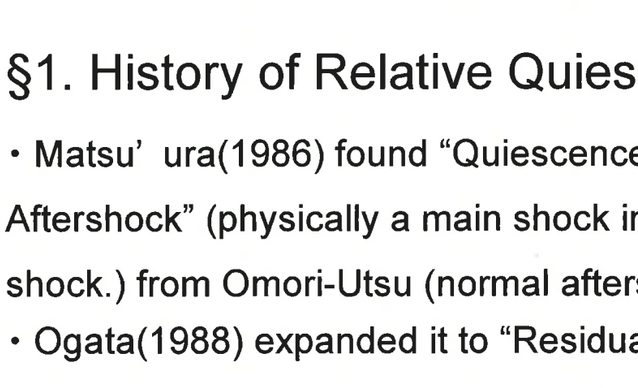
• Ogata(1988) expanded it to "Residuals from ETAS a few years before Large Earthquakes (Relative Quiescence from NORMAL STATE)" in off Tohoku area.

• Matsu' ura(2008) reported unusual Relative Quiescence (> 3σ) off Tohoku area from 1998-2008, which is the largest and the longest since 1885, when Japanese Observation started. After its recovery, we have M9.0 earthquake on the March 11th, 2011.

In the most quiet period (2007), no M≧5.0 occurred for 10 months (very unusual for Tohoku).

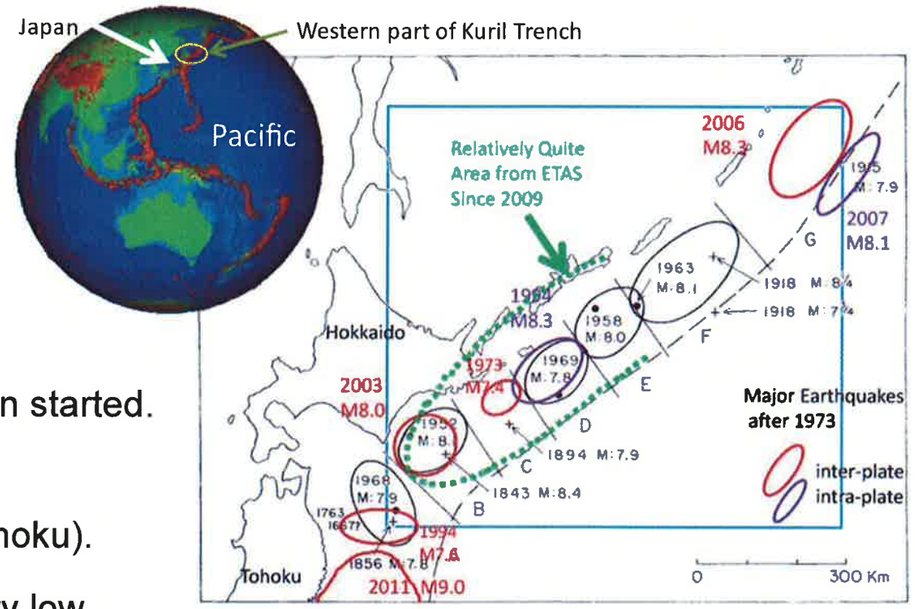
• At present, off Eastern part of Hokkaido (=Westernmost part of Kuril trench) shows very low seismicity even in raw data.

Here I checked the significance of it from ETAS w/AIC.



We chose M5.7 for the threshold.

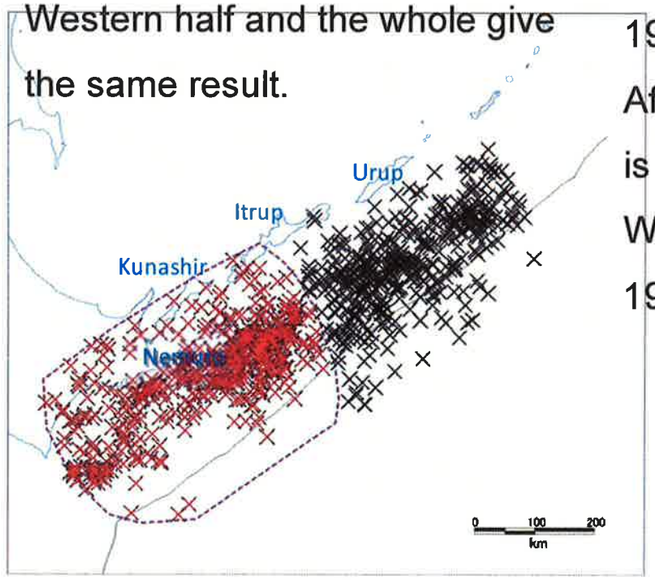
§2. Place and Data

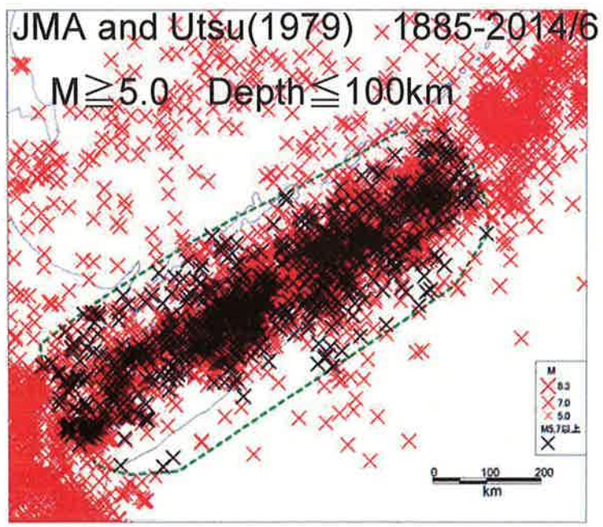


Source Regions of Large Earthquakes along the western part of Kuril trench
Add to Utsu(1972)

M≧5.7 in analysed area

Western half and the whole give the same result.





Even we have a data, 1885-1923 detectability is poor.

After WWSSN starts, M≧5.7 is available.

We mainly analyze 1965-2014/06 M≧5.7

§3. Significance check Method

- $\lambda_o(t) = \mu + \sum_i^N \kappa \exp\{\gamma(M_i - M_{th})\} / (t - t_i)^p$
- $\lambda_q(t) = \begin{cases} \mu_o + \sum_i^N \frac{\kappa \exp\{\gamma(M_i - M_{th})\}}{(t-t_i)^p} & where\ t \le T_c \\ \mu_q + \sum_i^N \frac{\kappa \exp\{\gamma(M_i - M_{th})\}}{(t-t_i)^p} & where\ t > T_c \end{cases}$

If AIC(λ_o)>AIC(λ_q)+Penalty(N), Quiescence is significant.

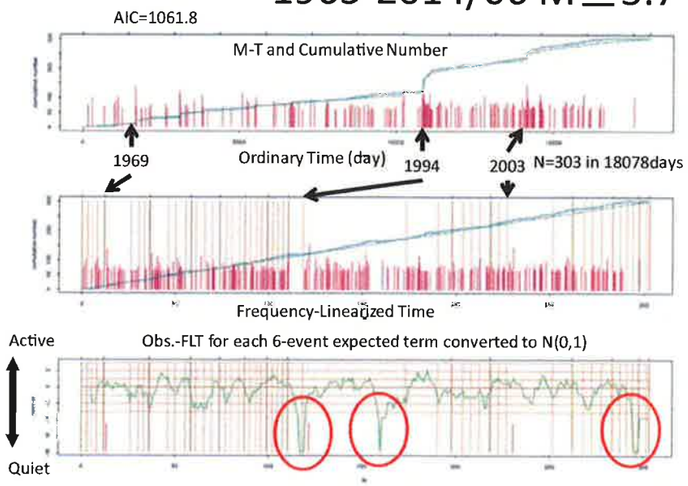
- $\lambda_{q'}(t) = \begin{cases} \mu_o + \sum_i^N \frac{\kappa \exp\{\gamma(M_i - M_{th})\}}{(t-t_i)^p} & where\ t \le T_c \\ \mu_{q'} & where\ t > T_c \end{cases}$

If $\{T_c, T_e\}$ are short, AIC($\lambda_{q'}$) should be checked.

§4. Result

Npar	Penalty	Tc	AIC+ Penalty	μ × 10 ^ 3	μq × 10 ^ 3	κ × 10^3	γ	c × 10^3	P
5	N/A	-	1061.8	5.75	—	5.70	2.50	10.00	1.00
6	2.62	2005/1/1	1070.3	6.00	0.01	3.58	2.71	4.00	0.95
6	2.62	2006/1/1	1064.2	6.11	2.71	5.91	2.46	9.25	1.00
6	2.62	2007/1/1	1065.2	5.95	2.94	5.61	2.50	9.24	0.99
6	2.62	2008/1/1	1063.3	6.21	1.93	5.78	2.50	10.00	1.00
6	2.62	2009/1/1	1062.0	6.32	0.62	4.64	2.60	9.26	0.99
6	2.62	2010/1/1	1060.5	6.36	0.0062	5.77	2.53	9.86	1.00
6	2.62	2011/1/1	1058.7	6.74	2.15E-09	5.35	2.54	11.10	1.02
6	2.62	2011/3/11	1059.2	6.67	2.14E-09	5.45	2.54	11.00	1.02
		w/o ETAS after Tc							
6	2.62	2009/1/1	1061.6	6.32	4.48	5.87	2.50	9.73	1.00
6	2.62	2010/1/1	1059.9	6.32	3.05	5.87	2.50	9.77	1.00
6	2.62	2011/1/1	1056.5	6.34	0.783	5.40	2.52	9.77	1.00
6	2.62	2011/3/11	1057.0	6.32	0.828	5.69	2.51	9.88	1.00

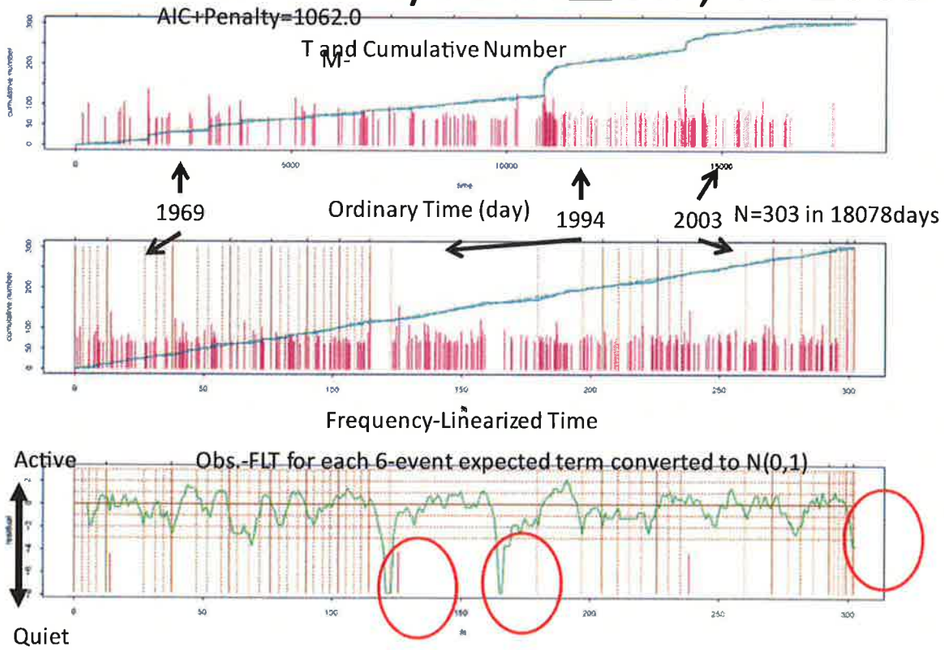
1965-2014/06 M≧5.7



Data and the model w/o μ change.

- Since 2009, the seismicity of this are is low.
- After M9.0 in 2011 along the Japan trench, it became even lower.

1965-2014/06 M≧5.7, Tc=2009



Data and the model w/ myu changed at 2009.
Quiescence became even stronger after 2011.

§5. Conclusions

- The Significant Relative Quiescence is ongoing since 2009 in the westernmost part of Kuril Trench.
- The similar Quiescence, which lasted a decade, followed by 3-year long recovery, existed before 2011 M9.0 off Tohoku event.
- The area includes the part near the Nemuro Peninsula, where a gap was pointed out in 1972.
- We might not be able to see Recovery before a large event, because the after effect of M9.0 off Tohoku might mask it.
- Japan and Russia should be aware of the high risk of Tsunami around this area for several years.