Earthquake prediction is a quite difficult problem, and generally it is impossible to predict great earthquakes using current technology.

However, for the anticipated Tokai Earthquake there are some special circumstances for detection of precursory phenomena because of its special geographical feature.

As a challenging project, we have been monitoring the crustal activity by deploying dense observation networks around the region, and trying to predict the Tokai Earthquake.
In the summer of 2005,

- Strain meters recorded crustal movement in the Tokai region.
- That event raised the question of whether we should issue a warning, which resulted in several tense days for us.

In this presentation,

I will explain what we did and what we considered over several days, and what we learned from the event.
JMA Prediction Scheme for Tokai Earthquake

= Early detection and identification of pre-slip

- “Something strange is observed and hence an earthquake may be impending!”

Reliable prediction information is impossible except for pre-slip.

Criteria for identifying pre-slip

- Changes are explained by a thrust event at the plate interface of the focal region, and
- Changes at different sites are correlated in time series, and
- Tendency of acceleration of changes is recognized.

Emphasis on geodetic data, especially strain meters
Assumed focal region of Tokai Earthquake

Strain stations in operation for criteria for earthquake information
Corrections of disturbances in volumetric strain data

Example at Fujieda station of JMA
2003/11/01 00:00 -- 2003/12/01 00:00

- Raw data
- Tide component
- Tide correction
- Atmospheric Pressure
- Pressure correction
- Precipitation correction
- Precipitation
Strain change on July 20-22, 2005

Strain change
2005/07/15 10:00 -- 2005/07/25 10:00

Gamagori
(Precipitation)
Sakuma-1(N135E)
Sakuma-2(N045E)
Sakuma-3(N000E)
Sakuma-4(N090E)

Identification of crustal deformation source from these changes

Slight change
No Precipitation

contraction
extension
Identification of crustal deformation source
- Possibility of slip between plates -

Interpreted by a slip equivalent to an Mw5.8

Changes are not due to a source in assumed focal region of Tokai earthquake.
Epicentral distribution of low-frequency earthquake (tremors)
Low-frequency earthquakes and strain changes on July 20-22, 2005

Strain change
2005/07/15 10:00 -- 2005/07/25 10:00

Gamagori
(Precipitation)
Sakuma-1(N135E)
Sakuma-2(N045E)
Sakuma-3(N000E)
Sakuma-4(N090E)
Hamakita-1(N004E)
Hamakita-2(N094E)
Hamakita-3(N229E)
Hamakita-4(N139E)

No. of Low-Frequency Earthquakes at Aichi Pref.

Low-Frequency Earthquakes occurred simultaneously with strain changes.
Locations of low-frequency earthquakes and candidates for slow slip

Candidates for locations of slow slip

Epicenters of low-frequency earthquakes
Epicentral Distribution of Low-Frequency Earthquakes in Western Japan
Durations of Low-Frequency Earthquakes and Strain Change

Strain change

2005/07/15 10:00 — 2005/07/25 10:00

Gamagori

(Precipitation)
Sakuma-1(N135E)
Sakuma-2(N045E)
Sakuma-3(N000E)
Sakuma-4(N090E)
Hamakita-1(N004E)
Hamakita-2(N094E)
Hamakita-3(N229E)
Hamakita-4(N139E)

No. of Low-Freq. Earthquakes at Aichi Pref.

No direct relation with Tokai earthquake

Short-term slow slip

Often observed in Western Japan
Summary

• Observed slight strain changes

• Crustal deformation source is far from Tokai earthquake source area
• Accompanying low-frequency earthquakes  
  Often observed in Western Japan

• No direct relation with Tokai earthquake

• Judgment from viewpoint of detection and identification of pre-slip based on physical consideration
• Successful observation of actual slip at plate boundary in nearly real time

Something anomalous has been found and hence an earthquake may occur.
No!
Another Example on December 13-25, 2004

Strain change

2004/12/13 16:00 -- 2004/12/25 00:00

Gamagori

(Precipitation)

Sakuma-1(N135E)

Sakuma-2(N045E)

Sakuma-3(N000E)

Sakuma-4(N090E)

No. of Low-Freq. Earthquakes at Aichi Pref.

Exp. 1.0E-07 strain  10 count/hour

20 hPa
80 mm/hour
200 ml
Thank you!

Acknowledgments:
Data from NIED, universities, and others as well as JMA are used for hypocentral catalog
Space-time distribution of Low Freq. Earthquakes
# Earthquake Prediction in Tokai Area

—Criteria for Prediction Information—

## Information about Tokai Earthquake

<table>
<thead>
<tr>
<th>Information</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokai Earthquake Report</td>
<td>Issued when the possibility of precursory phenomenon to the Tokai earthquake cannot evaluated immediately. (For example, significant changes are detected at least at one strain site in the Tokai area, or notable seismic activity occurred in the expected seismic source region.)</td>
</tr>
<tr>
<td>Tokai Earthquake Advisory</td>
<td>Issued when the possibility of precursory phenomenon is regarded as enhanced. (For example, significant changes at two strain sites in the Tokai area are not contradictory to pre-slip.)</td>
</tr>
<tr>
<td>Tokai Earthquake Warning</td>
<td>Issued when the Tokai earthquake is regarded as likely to occur soon. (For example, significant changes at more than three sites in the Tokai area are found to be due to pre-slip.)</td>
</tr>
</tbody>
</table>

- **Pre-slip only**
- **According to certainty**
- **more than 1.5 times of usual fluctuation**
- **Emphasis on strain meters**
Before occurrence of earthquake, decoupling between plates begins to occur and slow slip starts, that is *pre-slip*.
Mechanism of Tokai Earthquake Generation

Strain approaches to the marginal state and subduction continental plate is slowed down.

Continental plate is pull down due to subduction of Philippine Sea plate and strain is accumulated in the crust.

Eventually, decoupling between both plates begins to occur and slow, precursory slip starts.

Strain change

Upheaval

Decoupling

Continental plate

Philippine Sea plate

Coupled region

Less subsidence

Strain approaches to the marginal state and subduction continental plate is slowed down.

Finally, earthquake occurs.

Tsunami

EQ