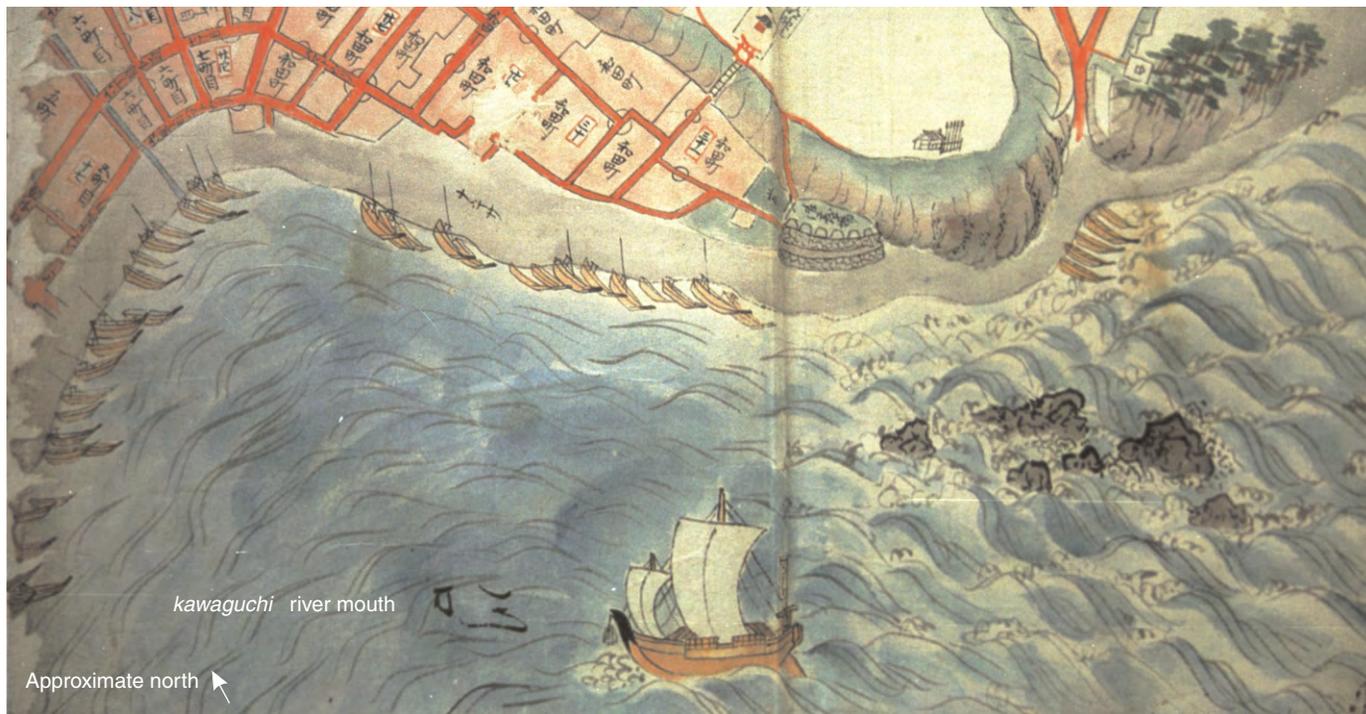


# Nakaminato 那珂湊



At Nakaminato, pictured above in 1842, seagoing boats unloaded Edo-bound cargo that continued to the shogun's capital on inland waterways.

**Ōuchi-ke "Go-yōdome,"** a family's collection of documents on shipwrecks, describes the loss of 28 metric tons of rice from a boat that drifted into rocks at Isohama on January 28, 1700. In 2004 a local historian, Satō Tsugio, compared two writings of the boat captain's name. Ōuchi Yoshikuni (left) represented the family.



THE PICTURE MAP of Nakaminato, above, was made by Watari Kizaemon in Tenpō 13 (1842) and published in Ansei 4 (1857). Map courtesy of the city office of Hitachinaka, Ibaraki Prefecture.

ŌUCHI-KE "GO-YŌDOME," a single volume of 1,390 pages, contains writing from many hands. One hand, probably no earlier than 1735, compiled all the material on wrecks between 1700 and 1735, according to Satō Tsugio, an authority on Mito-han documents. The volume's entire contents, along with reports on 14 other Edo-period shipwrecks, have been printed by Nakaminato Shishi Hensan I'inkai (1993). In this modern volume the 1700 wreck is number 55, pages 81-83.

THE MAPS OPPOSITE are derived from modern sources. The middle map is from Kawana (1984, p. 6, 20) and Kaizuka and others (2000, p. 21). The lowest map is from 1:25,000-scale maps by Kokudo Chiri'in ("Hitachinaka" 1999; "Isohama" 2001) except for the former entrance to Naka River, which is from a 1:200,000-scale map by Rikuchi Sokuryōbu, 1885 (Meiji 18).

THE RICE BOAT went aground at "Hakoiso" (p. 69, column 6). The place name denotes the shore south of the Naka River mouth on a map from 1845 (Tempō 15). The rocks in the photo at right include a group called "Hakoiso" on a fishers' sketch map from Ōarai in 2004.

## Main points

High waves on the morning of January 28, 1700, prevented a boat from entering the river-mouth port of Nakaminato. A storm that evening drove the boat to a rocky shore near Isohama village (map, lower right). Lost were all the boat's cargo—28 metric tons of rice—and two of the crew (p. 68-69, 71).

Officials of Mito-han certified the losses in response to a petition (p. 70). The certificate and petition were copied into a family's collection of documents about Edo-period wrecks near Nakaminato (opposite).

The morning high waves probably represent ordinary ocean swells that were opposed at the river mouth by the ebb currents of a long-lasting tsunami (p. 72-75).

## Setting

The river mouth at Nakaminato afforded access to inland waterways that conveyed cargo to metropolitan Edo (p. 31, 61). The waterways followed valleys that the sea covered 6,000 years ago. A prehistoric people, the Jomon, fringed this former sea with piles of clam shells (dots, right).

To reach Nakaminato, Edo-period sailors threaded a rocky constriction north of a sand spit (lower map at right, picture map at left). Additional rocks awaited boats that drifted south toward Isohama, a name that means “rocky beach” (photo below).

Nakaminato served as the main port in Mito-han. The rice boat came from another domain, Nakamura-han (upper map). The lost rice belonged to the Nakamura daimyo. Villagers from Isohama towed the wreck for salvage but failed to recover any of the rice.

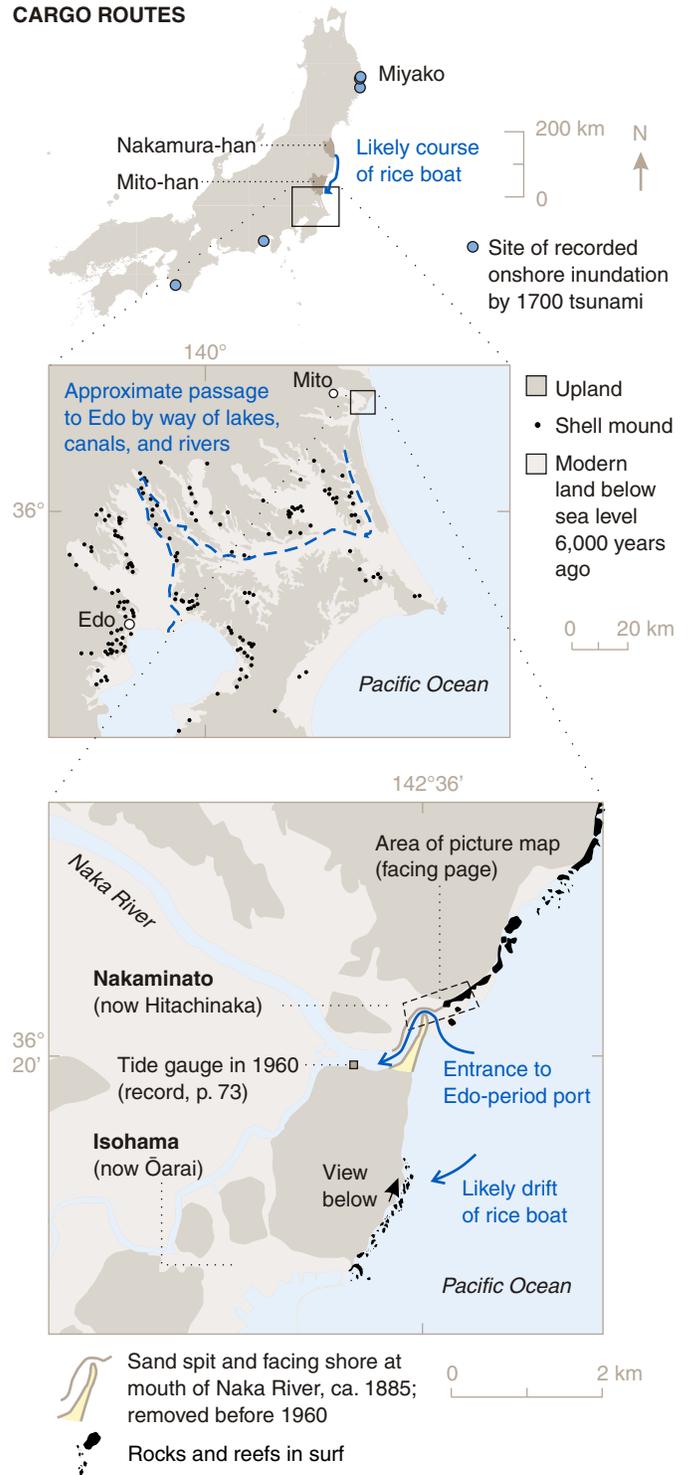
## Documents

The boat captain, two local villagers, and two other men petitioned local officials to certify the accident. The petition and the resulting certificate make up “Ura shōmon no koto” (*ura*, port; *shōmon*, certificate; p. 70-71). A headnote states that 470 bails of rice were lost. Next, a narrative explains the loss in the words of headmen from Isohama village. The certificate concludes with a signed statement by representatives of the senior ministers of Mito-han.

The earliest extant copy appears in a family volume, Ōuchi-ke “Go-yōdome” (*go-yō*, official business; *tome*, records). The volume (opposite) contains documents on 131 shipwrecks near Nakaminato between 1670 and 1832.

**Rocks break fair-weather surf** near former Isohama.

## CARGO ROUTES

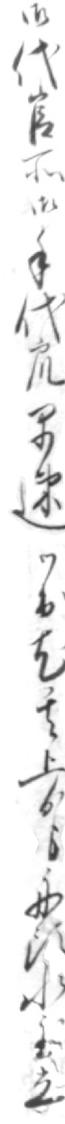
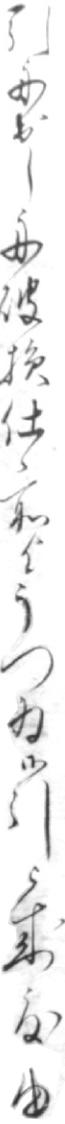


# Account in Ōuchi-ke “Go-yōdome” 大内家『御用留』の記述

A BOAT LADEN WITH RICE—470 bales belonging to the daimyo of Nakamura-han—approached the Mito-han port of Nakaminato around 8 a.m. (columns 1-2). High waves held the boat offshore, where the crew cast anchor (3). Still offshore that evening, the crew bailed half the rice during an

evening storm (4-5). But the storm broke the anchor lines and drove the boat to a rocky shore near Isohama village (5-6). Two of the crew perished (7).

Afterwards, villagers from Isohama and Nakaminato collected and returned, to surviving crew, articles that had

|  |   |   |   |  |   |  |
|--|---|---|---|--|---|--|
| <p>14</p>  <p><i>mōsa zu sōrō</i><br/>failed.</p> <p><i>sono tame</i><br/>For these reasons,</p> <p><i>ura shōmon</i><br/>the port certificate</p> <p><i>kudan no gotoshi</i><br/>is as stated herein.</p> | <p>13</p>  <p><i>on-idashi</i><br/>made available</p> <p><i>narare sōrō</i><br/>ordered</p> <p><i>aida utsu tame</i><br/>and for salvaging</p> <p><i>hiki mōshi sōrō</i><br/>towed</p> <p><i>tokoro ni</i><br/>at that time.</p> <p><i>o-kome</i><br/>The rice</p> <p><i>ippyō mo</i><br/>even one bale</p> <p><i>hikiage</i><br/>recover</p> | <p>12</p>  <p><i>o-daikansho</i><br/>district magistrate's office</p> <p><i>o-tedaishū</i><br/>junior officials</p> <p><i>sassoku on-ide</i><br/>promptly came and inspected</p> <p><i>mottomo sono ue</i><br/>and naturally they</p> <p><i>yori mo</i><br/>also from</p> <p><i>sendō kako</i><br/>the captain and crew</p> <p><i>tachiai</i><br/>witnessed</p> | <p>11</p>  <p><i>ōserare sōrō aida</i><br/>as has been mentioned.</p> <p><i>Mito o-yakusho e</i><br/>Main office of Mito-han to,</p> <p><i>uttae mōshi soraeba</i><br/>was petitioned</p> <p><i>on-kōri o-bugyō</i><br/>the district magistrate</p> | <p>10</p>  <p><i>hikifune idashi</i><br/>a tugboat was made available,</p> <p><i>fune hason tsuka-matsuri sōrō</i><br/>the damaged boat</p> <p><i>tokoro nite utsu tame</i><br/>where for salvaging</p> <p><i>on-hiki nararetaki</i><br/>wanted to tow,</p> <p><i>yoshi</i><br/>it was reported,</p> | <p>9</p>  <p><i>tokoro ni</i><br/>when</p> <p><i>Isohama Isohama</i></p> <p><i>narabini</i><br/>and</p> <p><i>Minato-mura</i><br/>Minato village</p> <p><i>ryō shuku</i><br/>the two villages</p> <p><i>tachiai nite</i><br/>witnessed by</p> <p><i>harai mōshi sōrō yoshi</i><br/>were attended to, it was reported.</p> <p><i>katsu mata</i><br/>Furthermore,</p> | <p>8</p>  <p><i>mōshi'ide sōrō ni tsuki</i><br/>was reported because.</p> <p><i>ninsoku ōzei</i><br/>Hands many</p> <p><i>dashi</i><br/>were supplied,</p> <p><i>fune</i><br/>the boat</p> <p><i>sho dōgu</i><br/>scattered belongings</p> <p><i>tori-atsume</i><br/>were gathered,</p> <p><i>aiwatashi mōsu</i><br/>were returned</p> |
|--|---|---|---|--|---|--|

Subject marker *wa* written as *ha* (1, 6); object marker *o* as *wo* (7).

Sound change at word juncture: *dōryō* for *tōryō* (1), *doki* for *toki* (2), *gakari* for *kakari* (3).

12, *kako*—The boat's crew. Printed as *mizu-nushi* (literally, water-owner) in Nakaminato Shishi Hensan I'inkai (1993, p. 82).

Honorific language: *o-* in terms of rice (1, 6, 13), and government offices and titles (11, 12); *on-* in *on-kōri* (11), *on-ide* (12), and *on-idashi* (13); *go-* in *go-dōryō* (1). Formal *sōrō* (3, 5, 7, 8, 9, 10, 11, 13, 14), *mōsu* (6). Humble *tsukamatsuri* (3, 5, 10).

6, *Hakoiso*—*hako*, box; *iso*, rock (note, p. 66; photo, p. 67).

7, *yoshi...motte*—Reported by the captain, Kambe'e, through the Isohama villager, Gon'emon. Kambe'e is also the likely source of the second-hand information marked by *yoshi* in column 5.

washed ashore (8-9). Officials of Mito-han, from a district magistrate's office, oversaw a fruitless attempt to find the rice bales (11-14) and certified the accident (14).

The full document, reproduced on the next two pages, contains this narrative as part of a certificate issued to two

samurai of unstated affiliation. The narrative's authors, all from Isohama, were a pair of boat headmen, Hei'emon and Rokuza'emon; the village headman, Sakubei; and two village assistant headmen, Heisaku and Jiza'emon.

| 7                                      | 6  | 5  | 4   | 3  | 2   | COLUMN 1  |
|--|--|--|---|--|---|---|
| 上舟方<br>funakata<br>the boat's<br>crew  | 吹流<br>fuki-<br>nagasare<br>drifted.          | 浜沖<br>minato oki<br>nite<br>offshore                                     | 同夜<br>dōya<br>That night  | 仕所<br>tsuka-<br>matsuri<br>sōrō<br>tokoro ni<br>At that<br>time, | 七日<br>nanuka ni<br>on the 7th<br>day        | 右相<br>migi wa<br>At right                         |
| 舟方<br>ryō-nin<br>two persons           | 心<br>Hakoiso to<br>Hakoiso                   | 舟荷<br>uchini<br>threw over-<br>board,                                    | 五時<br>itsutsu sugi<br>yori<br>from the<br>hour of five<br>onwards | 浪高<br>nami<br>waves<br>takaku<br>high                            | 船<br>shussen<br>the boat<br>departed.       | 相<br>Sōma<br>Danjō<br>sama<br>Lord<br>Sōma        |
| 舟方<br>aihate<br>were killed,           | 中<br>mōsu<br>tokoro<br>a place<br>called     | 仕由<br>tsuka-<br>matsuri<br>sōrō yoshi<br>it was<br>reported.             | 大風<br>daifū'u<br>strong wind<br>and rain                          | 舟<br>fune<br>the boat  | 同日<br>dō<br>Same                            | 正<br>kokonuka<br>9th day                          |
| 舟方<br>sōrō yoshi<br>it was<br>reported | 中<br>nite<br>at,<br>o-kome<br>wa<br>the rice | 舟<br>mottomo<br>However,   | 大波<br>ō-nami<br>big waves   | 港<br>minato e<br>to the port                                     | 朝<br>asa no<br>morning<br>of                | 米<br>o-kome<br>rice                               |
| 舟方<br>sendō<br>Captain                 | 米<br>mōsu ni<br>oyoba-zu<br>not only         | 舟<br>ikarizuna<br>anchor<br>ropes  | 舟<br>kotoni<br>especially   | 入<br>iri sōrō<br>enter   | 時<br>itsutsudoki<br>at the hour<br>of five  | 米<br>go-dōryō<br>the<br>domain<br>men-<br>tioned  |
| 舟方<br>Kambe'e<br>Kambe'e,              | 舟<br>fune<br>the boat                        | 舟<br>uchikirare<br>became<br>broken,                                     | 舟<br>yue<br>because of  | 事<br>gi<br>the matter  | 時<br>tōryō<br>the<br>domain                 | 米<br>Ukedo-<br>hama<br>nite<br>at Ukedo<br>harbor |
| 舟方<br>tōsonjuku<br>this village        | 舟<br>uchi-<br>yaburare<br>badly<br>damaged;  | 舟<br>fune<br>the boat<br>tōson<br>chinai e<br>to this<br>village<br>area | 舟<br>nangi ni<br>oyobi<br>it became<br>severe,                    | 事<br>makari<br>nara-zu<br>was<br>unable to,                      | 時<br>Nakano-<br>minato<br>Nakano-<br>minato | 米<br>tsumitate<br>loaded,                         |
| 舟方<br>Gon'emon o<br>Gon'emon           | 舟<br>sonoue<br>moreover,                     |  | 舟<br>o-kome<br>the rice   | 事<br>funagakari<br>makari ari<br>sōrō<br>anchored                | 時<br>omote ni<br>beside                     | 米<br>saru<br>last                                 |
| 舟方<br>motte<br>through                 |  |  | 舟<br>kahan<br>more than<br>half                                   | 事<br>tokoro ni<br>then.  | 時<br>chakusen<br>the boat<br>reached.       | 米<br>saru<br>last                                 |

2, *tōryō Nakanominato*—Mito-han's Nakaminato.

4-5, *ō-nami...uchini*—The crew jettisoned cargo in hopes of saving the ship.

5, *tōson chinai*—The boat drifted to the area of Isohama, home of the narrative's authors and of two of the certificate's petitioners, Kichirōemon and Gon'emon (p. 70).

1, *tsumitate*—The rice was loaded onto a boat.

1-2, *saru nanuka ni*—On the most recent 7th day before the headnote date (24th day, 12th month, Genroku 12; p. 70). Similarly, *dō kokonuka* in column 2 means the most recent 9th day.

2 and 4, *itsutsudoki*—About 8 o'clock in the morning (column 2) or evening (4); see page 46.

← NOTES. Column 1, *migi...o-kome*—The rice mentioned previously; itemized, p. 71.

1, *Sōma Danjō sama*—Sōma Masatane served as 5th daimyo of Nakamura-han in 1679-1702.

1, *go-dōryō Ukedo-hama*—Ukedo-hama (literally, Ukedo Beach) was the southernmost of four ports in Nakamura-han (Satō, 1988, p. 167).

# Certified loss 浦証文 事故の証明

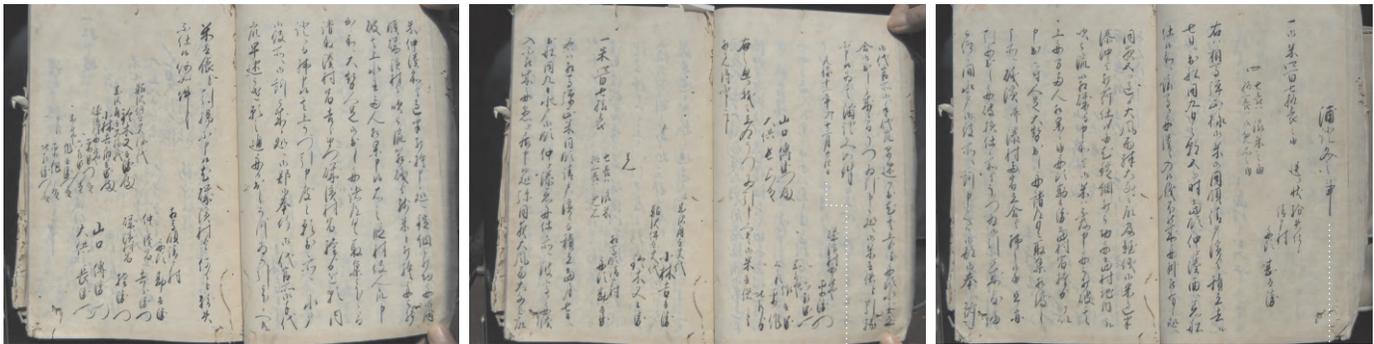
Like a police report on a car crash, a harbor certificate verified the shipwreck.

OBLIGATIONS AWAITED the captain who lost cargo at sea while bound for the Morioka-han port of Kuwagasaki. On arrival he was to inform port officials of the loss. He would then petition them for a port certificate, *ura shōmon*, that could absolve his crew of responsibility while clearing the way for insurance claims.

Similarly in the Mito-han port of Nakaminato, the shipwreck started by the 1700 tsunami resulted in a petition and certificate (below). The petitioners included not just the

captain but also villagers from Nakaminato and Isohama, along with two men we call samurai because they have family names. They addressed their joint petition to officials of Mito-han and Isohama village. In response, village headmen affirmed the accident and han officials, having made an inspection of their own, issued the certificate.

As copied into *Ōuchi-ke* "Go-yōdome," this *ura shōmon* contains both the petition and the certificate. Each mentions the "high waves" we ascribe to the 1700 tsunami (p. 73).



**Petitioners**

Samurai  
山口 大供  
長 傳  
Peasants  
Villagers  
長 傳  
Kambe'e  
Kichirōemon  
Gon'emon  
Yamaguchi Den'emon  
Ōtomo Chōemon

**Certification by Mito-han**

aimie  
mosazu sōrō  
could not be found.

Migi no tōri  
As stated at right

ware ware  
tachiai  
we witnessed

utsu tame  
hiki mōshi  
sorae  
for salvage towed

**Date, equivalent to**  
February 12, 1700

Genroku  
Genroku  
jūninen u  
12th year  
(Rabbit Year)  
jūnigatsu  
12th month  
nijūyokka  
24th day

**Document title**

ura  
Port  
shōmon  
no koto  
certificate

**Mito-han officials**  
Kobayashi and Suzuki, on behalf of senior ministers (*karō*) Okazawa and Ayuzawa, endorsed the village officials' account by appending the certification at right.

Ayuzawa Idayū  
dai  
by his deputy  
Suzuki Matabe'e

Okazawa Kakudayū  
dai  
by his deputy  
Kobayashi Kichibei

**Captain Kambe'e** hailed from Ukedo, Nakamura-han (p. 67). His boat may have resembled the bale-laden one below.

sendō  
captain  
Kambe'e  
Kambe'e  
[mis-written here as Jimbei]

The certificate begins by itemizing the loss of 470 bales of rice (right). Those bales probably looked like the ones that burly men fill, cinch, lift, and carry in the Hokusai sketches below. Each bale, with a volume of one *hyō* (*i-ppyō*), probably weighed close to 60 kilograms (130 pounds).

Two and a half bales made up one *koku*. A unit of volume, the *koku* measured such quantities as the capacity of freighters. But it also measured wealth and status—the amount of rice granted annually to a samurai (the 50-*koku* stipend of the former merchant, Moriai Chūzaemon, p. 53), and the officially expected agricultural yields that ranked daimyo domains (examples, below right).

|                               |                   |   |   |
|-------------------------------|-------------------|---|---|
|                               | uchi<br>including |   | o-kome<br>Rice                          |
| jūsan-byō wa<br>13 bales      | 七表                | nana-hyō wa<br>7 bales                        | yonhyaku<br>nanaji-ppyō<br>470 bales of |
| go-mengoku<br>tax-exempt rice | 浪米                | rōmai<br>rice to be consumed<br>[by the crew] | no yoshi<br>it was<br>reported          |
| no yoshi<br>it was reported   | 由                 | no yoshi<br>it was<br>reported                |   |

We interpret 表 as 俵, 浪 as 粮. *byō* and *ppyō* are variants of *hyō*.

“Men baling rice” From a book of sketches by Katsushika Hokusai (1760-1849).



**REPUTED YIELDS OF DAIMYO DOMAINS**

|                                     |   |   |
|-------------------------------------|---|---|
| Morioka-han<br>100,000 <i>koku</i>  |    |    |
| Nakamura-han<br>60,000 <i>koku</i>  |    |    |
| Mito-han<br>280,000 <i>koku</i>     |   |    |
| Wakayama-han<br>555,000 <i>koku</i> |  |  |



ON CERTIFICATION OF SHIPWRECKS, see Miyako-shi Kyōiku Iinkai (1981, p. 498-519) and wrecks 49 and 56 in Nakaminato Shishi Hensan Iinkai (1993).

BOAT AND YIELDS from “Nihon kaisan chōriku zu,” 1694 (p. 30-31), courtesy of the East Asian Library, University of California, Berkeley.

“MEN BALING RICE” from “Hokusai manga” (“The sketches of Hokusai”), v. 3, page 6r. Woodblock-printed album published in 1850 by Eirakuya Tōshirō and Kadomaruya Jinsuke. Courtesy of The Art Institute of Chicago, image 761.952.

## Fair-weather waves 好天下の高波

The 1700 tsunami in Japan began without a storm but may have continued into one.

THE SUN WAS SHINING from Morioka to Wakayama the day before the 1700 tsunami approached Japan (the 7th day, below). On the 8th day, as the tsunami crossed the Pacific (p. 74-75), skies remained fair over Morioka and Wakayama while snow fell in Edo. Rain or snow fell widely on the 9th day, but mainly in the evening and not at Morioka or Nikkō.

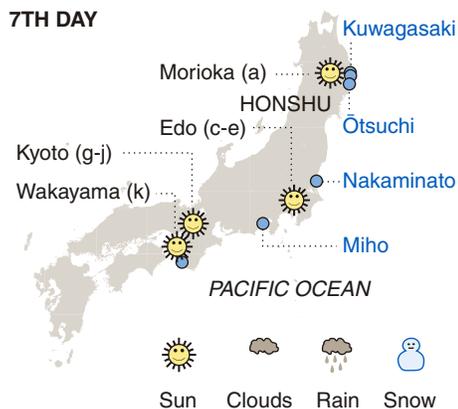
Most of these weather observations come from diaries.

Some are official journals—from castle towns, a shrine, a temple, and Edo mansions (p. 61). Others were kept by court aristocrats in the imperial capital, Kyoto.

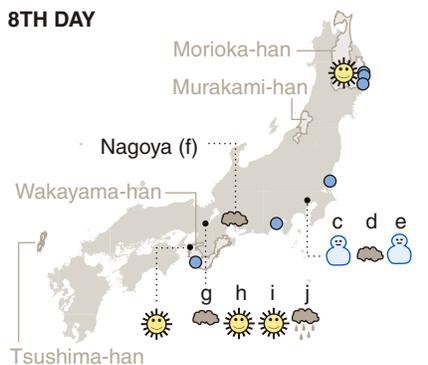
Among narratives of the 1700 tsunami, only the Nakaminato rice-boat story mentions weather—a storm that arrived 12 hours after the crew first encountered “high waves” as they tried to enter port.

### Weather observations

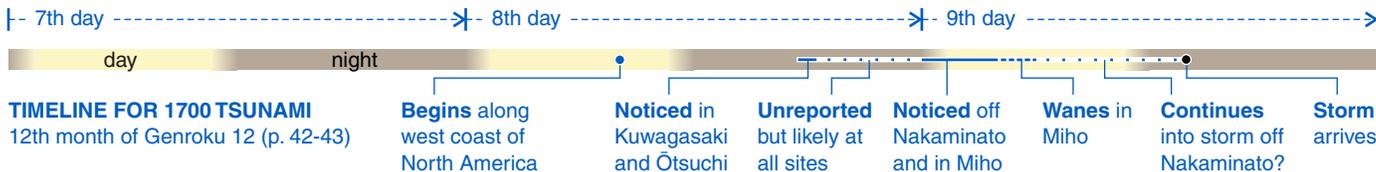
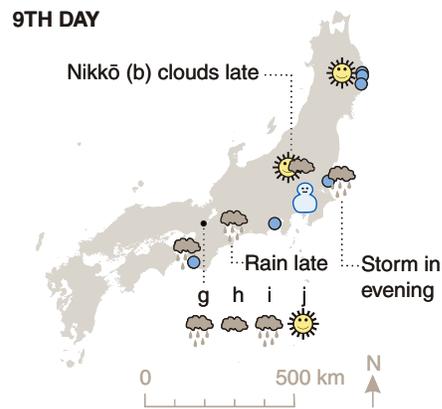
#### 7TH DAY



#### 8TH DAY



#### 9TH DAY



### Weather observers

| LOCATION  | DIARY AND WRITER   |
|-----------|--|
| a Morioka | “ <b>Morioka-han zassho</b> ” Administrators of Morioka-han (p. 44, 60).   |
| b Nikkō   | “ <b>Shake gobansho nikki</b> ” Officials of shrine for the grave of Tokugawa Iyasu (shogun, p. 41).   |
| c Edo     | “ <b>Gokokuji nikki</b> ” Buddhist monks.  |
| d Edo     | “ <b>Sakakibara-ke Edo hantei nikki</b> ” Officials at an Edo mansion of the Sakakibara family, which then ruled Murakami-han. Diary started 1651, continued to 1866; 553 volumes. For map of Edo mansions of daimyo like the Sakakibara, see pages 61 and 106.  |
| e Edo     | “ <b>Tsushima-han Edo hantei mainikki</b> ” Official diary of an Edo mansion of the Sō family, daimyo of Tsushima-han.   |
| f Nagoya  | “ <b>Ōmu rōchū ki</b> ” Asahi Bunzaemon Shigeaki, floor-mat manager ( <i>tatami bugyō</i> ) of Nagoya castle. The castle was headquarters of one of the three main branches of the Tokugawa family. As the caged parrot ( <i>ōmu rōchū</i> ) in the book’s title, Asahi says he wrote exactly what he heard. |
| g Kyoto   | “ <b>Kinsumi-kyō ki</b> ” Shigenoi Kinsumi, court aristocrat and scholar.  |



| LOCATION   | DIARY AND WRITER  |
|------------|---|
| h Kyoto    | “ <b>Kinmichi ki</b> ” Ōgimachi Kinmichi, court aristocrat and Shinto scholar.                          |
| i Kyoto    | “ <b>Tokudaiji hinami</b> ” Tokudaiji Kōzen, court aristocrat.  |
| j Kyoto    | “ <b>Sadamoto-kyō ki</b> ” Nonomiya Sadamoto, court aristocrat and scholar.                             |
| k Wakayama | “ <b>Miura-ke nikki</b> ” Miura-family head serving as a karō (senior minister; p. 44) of Wakayama-han. |

WEATHER OBSERVATIONS are lacking from Nikkō on the 7th and 8th days, and from Nagoya on the 7th day. Observations differ in Edo on the 8th day, in Kyoto on the 8th and 9th days. All were first compiled in Tsuji and others (1998, p. 8), where Ueda mislocated observation g in Ise (80 km south of Nagoya). e — All Korean trade sanctioned by the Tokugawa shogunate passed through Tsushima-han (Totman, 1993, p. 76-77). f — Printed by Nagoya-shi Kyōiku I'inkai (1965-1969). Nagoya castle contained 50,000 m<sup>3</sup> of lumber and stood until World War II (Totman, 1989, p. 62; Naito and Hozumi, 2003, p. 52, 63). Sketch from “Nihon kaisan chōriku zu,” 1694 (p. 30), courtesy of East Asian Library, University of California, Berkeley.

JAPAN’S WINTER STORMS “cause ship disasters as well as damage along the coast due to wind waves” (Arakawa and Taga, 1969, p. 128). They are not typhoons, which instead hit Japan in summer and fall (p. 83).

## Waves raised by an opposing current

The morning “high waves” that held the rice boat offshore probably originated as incoming ocean swells that met river-mouth backwash of a long-lasting tsunami.

Several accounts refer to the 1700 tsunami as a tide (p. 40). The Miho headman, for instance, reports that the water came in “something like a very high tide” about seven times between dawn and about 10 a.m. (“the hour of four”). The headman further notes that the water drained “with the speed of a big river” (p. 79, columns 3-4).

Such tide-like currents impressed eyewitnesses to the 1960 tsunami at Nakaminato. They estimated incoming velocities at 7 knots (about 3.5 meters per second) and described the outflow as even faster.

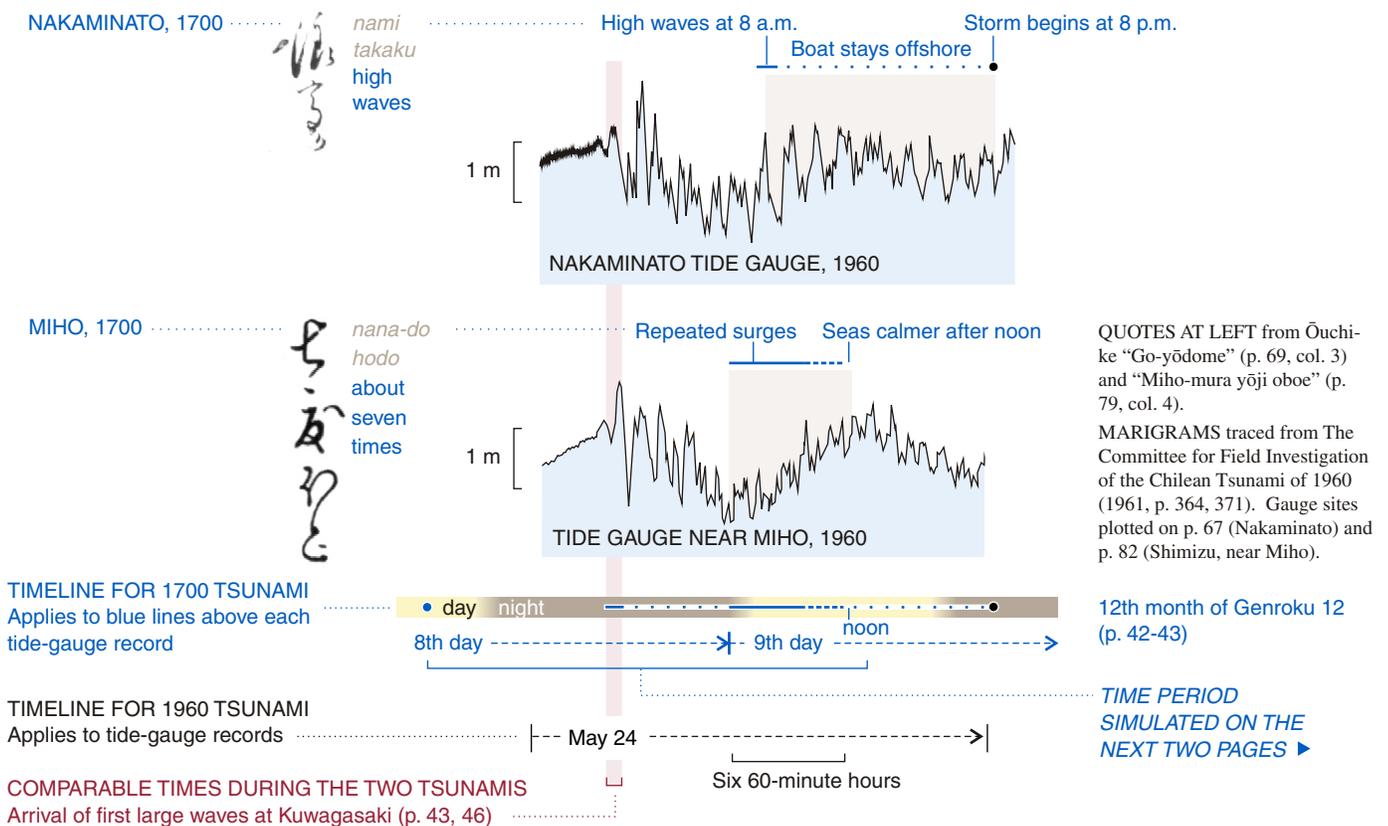
Strong ebb currents heighten incoming ocean waves on river-mouth bars. An Oregon boating manual warns, “If you are trapped outside a rough bar on an ebb tide, it is wise to lay to and wait” until a rising tide produces an inflowing current.

The 1700 tsunami probably produced strong ebb currents that heightened waves at 8 a.m. off Nakaminato. Such currents should not have resulted from the astronomical tide, which was rising at that hour from Kuwagasaki to Tanabe (p. 83). But the tsunami, at Miho, was then producing intermittent, swift outflow. Similar outflow from the port of Nakaminato probably raised the “high waves” that eventually led to the rice boat’s demise.

The tsunami likely continued raising river-mouth waves through the morning and perhaps into the early evening. It disturbed seas at Miho until noon (p. 79, columns 4-5). Together with the coming storm it may explain why the rice boat stayed off Nakaminato throughout the day.

An outsize tsunami can go on for 24 hours or more. The 1960 tsunami lasted that long (marigrams below and p. 46). Similarly in a computer model, the 1700 tsunami disturbs the Pacific Ocean for an entire day (next two pages).

## Duration of tsunami wave trains in 1700 and 1960



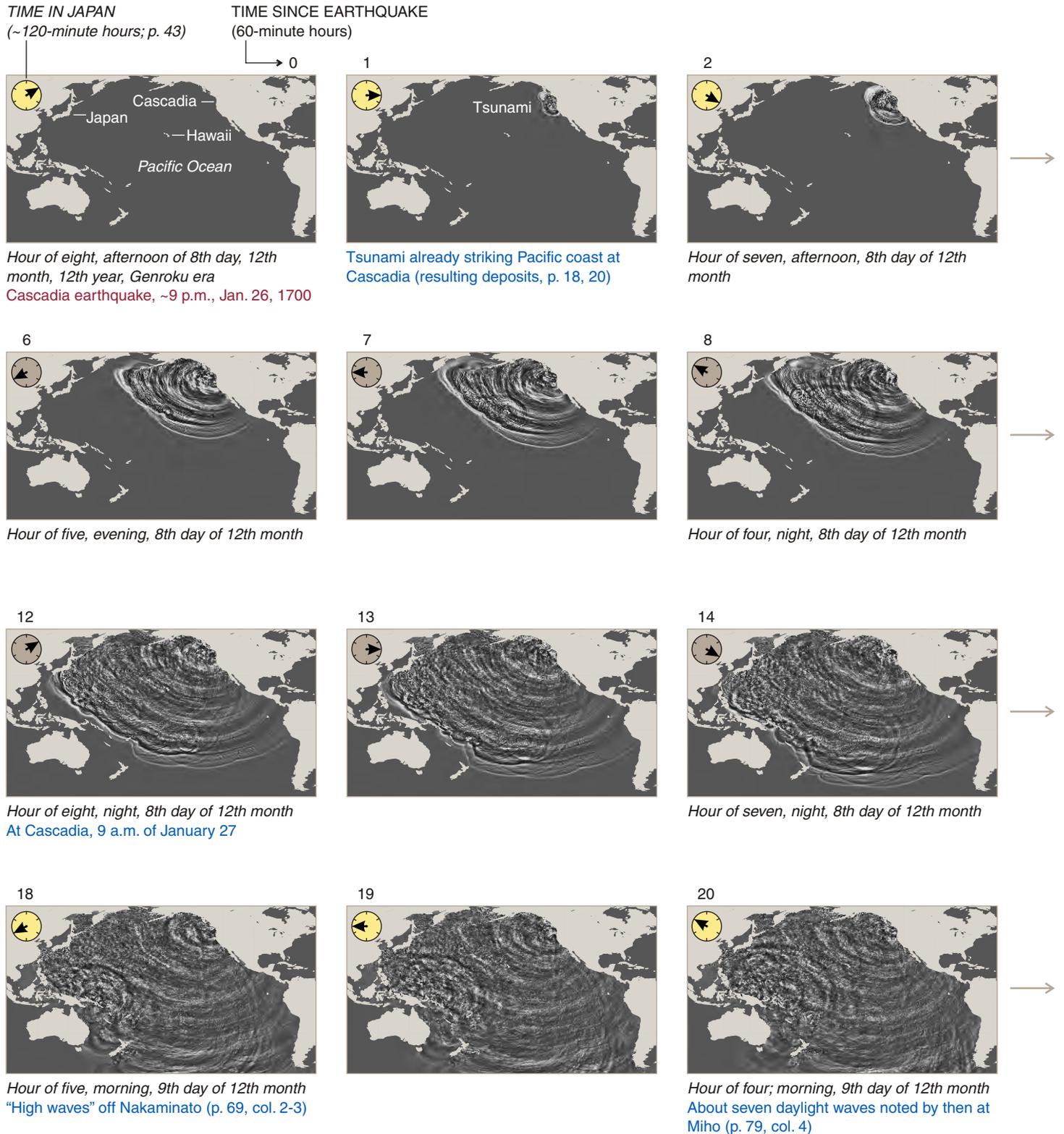
**CURRENTS.** Toba and Taka (1961, p. 309) summarize eyewitness accounts of currents at Nakaminato during the 1960 tsunami. The Oregon boating manual offers little comfort for the latter-day Kambei who becomes “trapped outside a rough bar with a southwester developing 40-knot or better winds... If possible, run to another port with more favorable bar conditions” (Oregon Sea Grant and Oregon State Marine Board, 1999, p. 8-9). On the bar off the mouth of the Columbia River (river location, p. 22), wave height oscillates at tidal periods and peaks during ebb currents, which at this bar commonly exceed 2 meters per

second. During a five-day series of measurements, ebb currents raised incoming waves of 3 meters to heights as great as 7 meters (González, 1984).

**WAVE PERIODS.** During a typical wave of the 1960 tsunami at Nakaminato (above), the crest-to-trough fall in water level amounted to 1 meter and took an hour or two. In contrast, the port’s astronomical tides change water levels by no more than 1.8 m in six hours, as judged from extreme tides 20 km south of Nakaminato (at Kashima; Maritime Safety Agency, 1998).

# Simulated waves 津波のシミュレーション

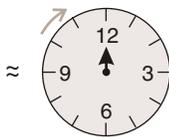
In a computer model, a long-lasting 1700 tsunami engulfs the Pacific.



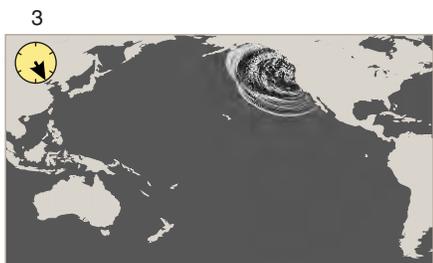
IN THE DEEP OCEAN a tsunami's waves have little height but great crest-to-crest length. As they enter shallow water the waves slow down and stack up. In

the model above, the 1700 tsunami rarely rises more than 0.5 m as it crosses the Pacific but builds against Japanese shores to heights as great as 5 m (p. 99).

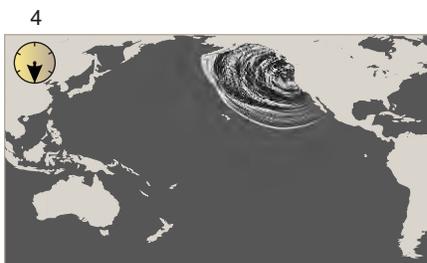
Traditional  
(p. 43)



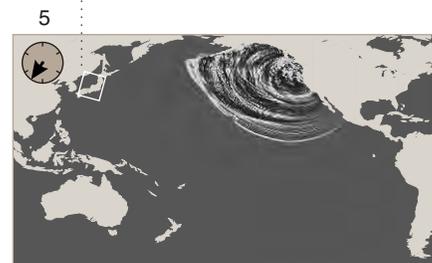
Modern



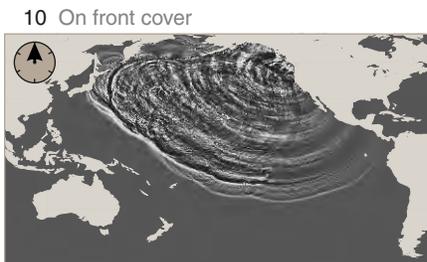
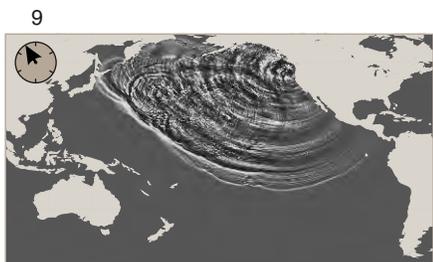
At Cascadia, midnight of January 26-27



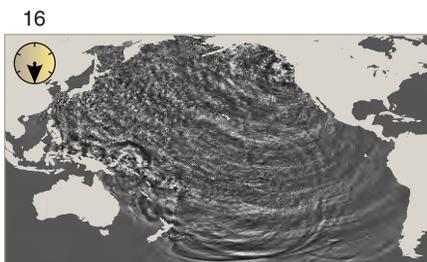
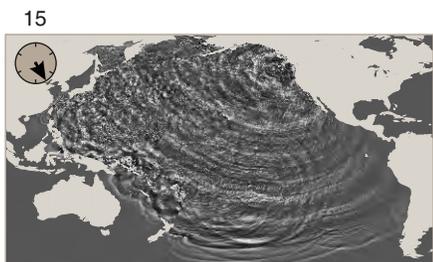
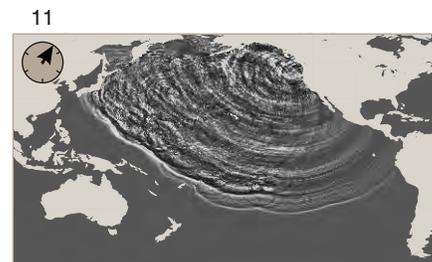
Hour of six, dusk, 8th day of 12th month



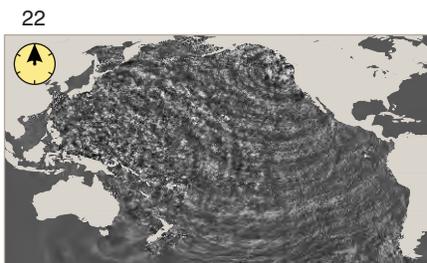
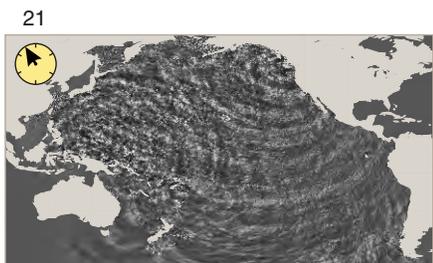
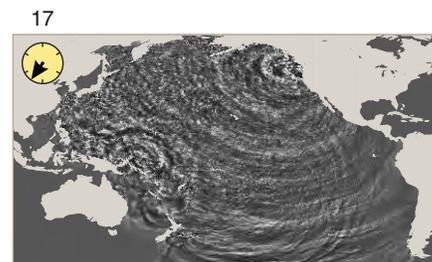
Tsunami front passes Hawaii



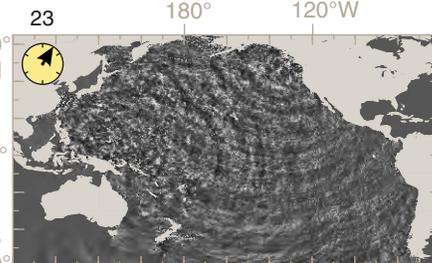
Hour of nine, midnight, 8th day of 12th month  
Tsunami noticed at Kuwagasaki and Ōtsuchi  
(p. 39, column 2; 60, col. 1)



Hour of six, dawn, 9th day of 12th month  
Tsunami noticed at Miho and at Tanabe  
(p. 79, col. 1; 86, col. 1)



Hour of nine, noon, 9th day of 12th month  
Seas calming at Miho (p. 79, col. 5) but  
probably still rough at Nakaminato (p. 73)



THE MODEL depicts the tsunami from a Cascadia earthquake of magnitude 9.0 with a fault rupture 1,100 km long (p. 98-99; Satake and others, 2003).

ANIMATED VERSION of the model:  
<http://www.agu.org/apend/jb/2003JB002521/2003JB002521-animation.gif>