The 13th International workshop on wave forecasting and hind casting
and 4th Coastal Hazards Symposium
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An Approach for Tough Navigation Sea Information

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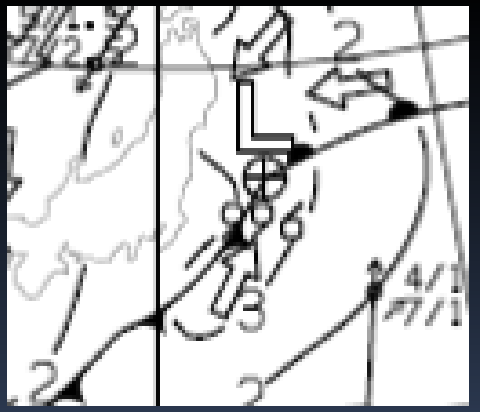
Motivation

Sea state gives strong influence to voyaging vessels. In usual, wave heights are commonly used to express sea state. However, complicated sea state is quite dangerous and tough for voyaging vessels and fishing activities.

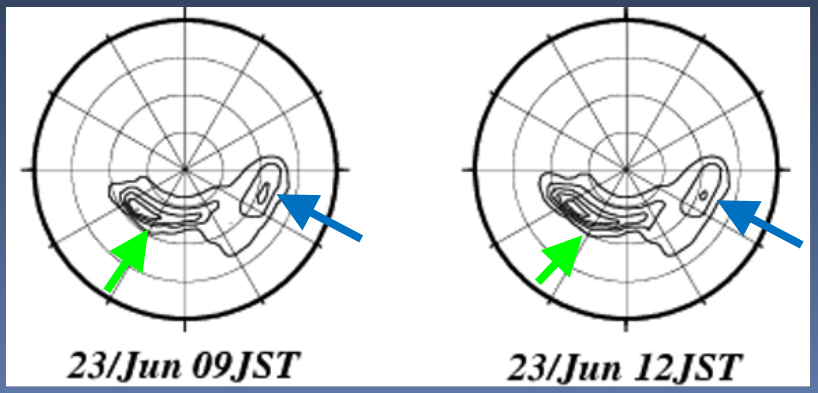
A fishing boat accident
(23 June 2008)
A fishing boat of 135 gross tonnage overturned.
4 dead, 13 missing

Location of the accident



Wave analysis chart (AWPN)
(00UTC on 23 June, 2008)

- A low pressure system moved eastward and was located in the sea off Inubo-saki at 09JST on 23.
- Wave heights of 2 to 3 m were analyzed in the south of the low pressure center., although the wave height of **3m is not so dangerous** for fishing boats of 100 gross tonnages.
- By referring the wave spectra at the accident point, spectra indicate that there were several wave components. It is supposed that this could be the main reason of overturn, although it is circumstantial.



Wave spectra

→ JMA is now developing some practical information on “tough navigation area”.

Method

- **As a “tough navigation area”, the following two situation are considered:**
  1. Multiple wave simultaneously exist
  2. Waves are influenced by currents and become high.

- Areas are detected qualitatively
  - ✓ It is difficult to define multiple-wave area quantitatively with some reliability.
  - ✓ Wave height enhancements by current are not so large and modified area is not easily recognized.

- Detected areas are marked in wave charts
  - ✓ Simple and practical information
  - ✓ Clearly understandable in radio facsimile map

Summary

- **JMA is going to issue some information on tough navigation areas. As tough navigation areas, two situation are considered:**
  1. Multiple wave simultaneously exist
  2. Currents against waves exist and enhance wave heights.

- **Current status of development**
  - Wave components detection (spectrum partitioning)
  - Definition of area detection are almost fixed.
  - By testing real cases, definition will be modified.
  - We have concrete product images but not yet fixed.

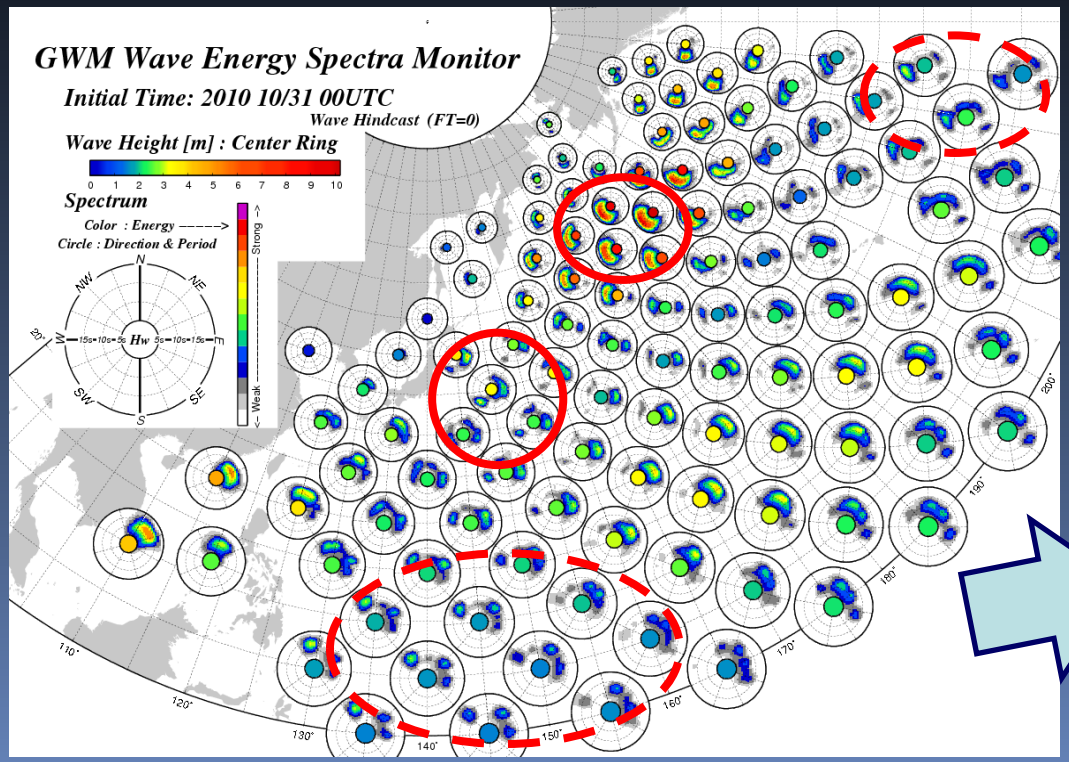
- **Horizontal scale is considered in products**
  - ✓ **A multiple wave area: marked in wave charts for NW Pacific**
  - ✓ **Current effected area: marked in wave charts for Sea around Japan**

multiple wave region

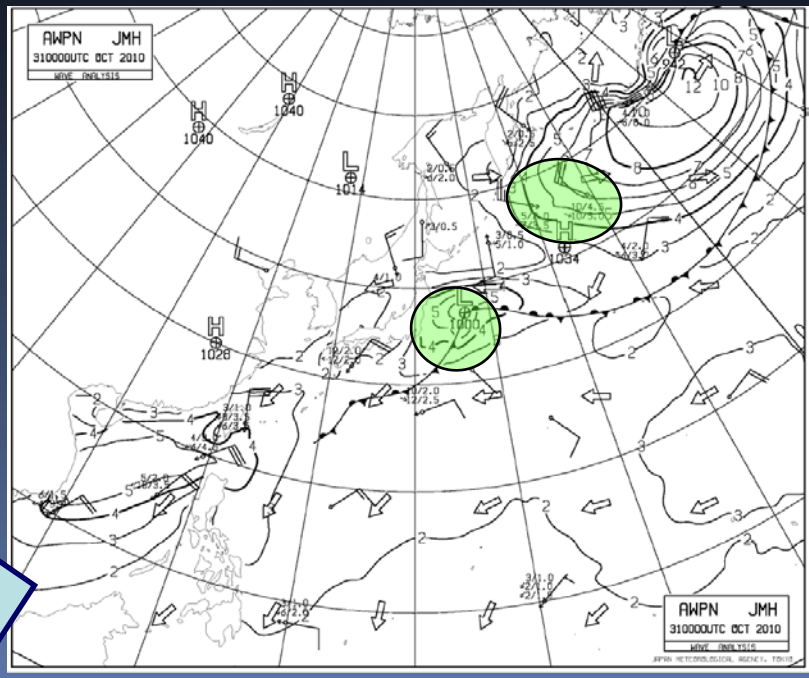
Definition

1. Significant wave height $H_w > 1.2$m
2. Several waves exist: H_{w_i}, $i = 1, 2, \cdots$
   (derived from wave partitioning)
3. Some wave components have comparable wave height (energy):
   $H_{w\_i} / H_{w\_1} > 0.6$ $i = 2, 3, \cdots$

※ exclude the component direction angle is within 30 degree

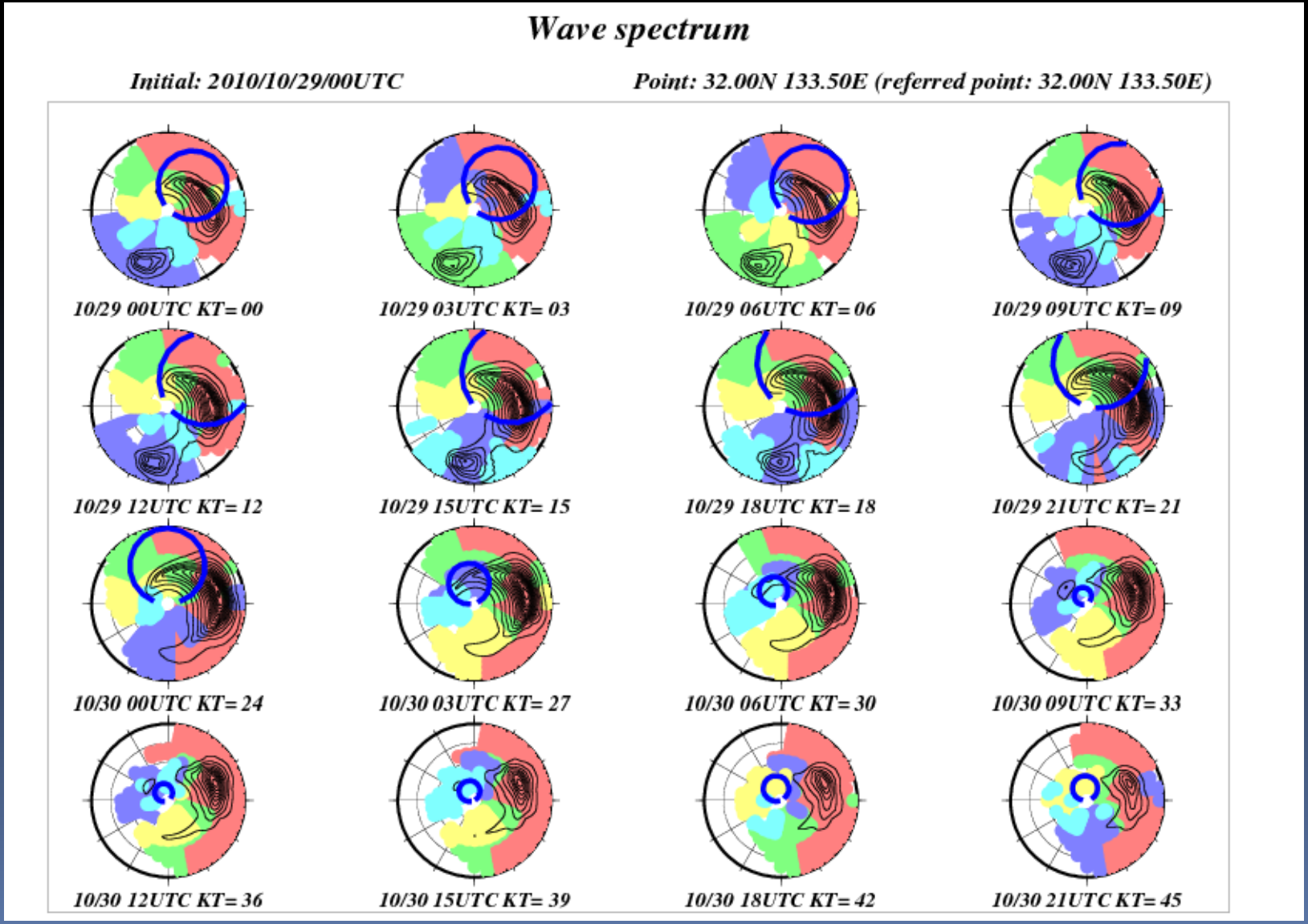


Wave spectra (components)



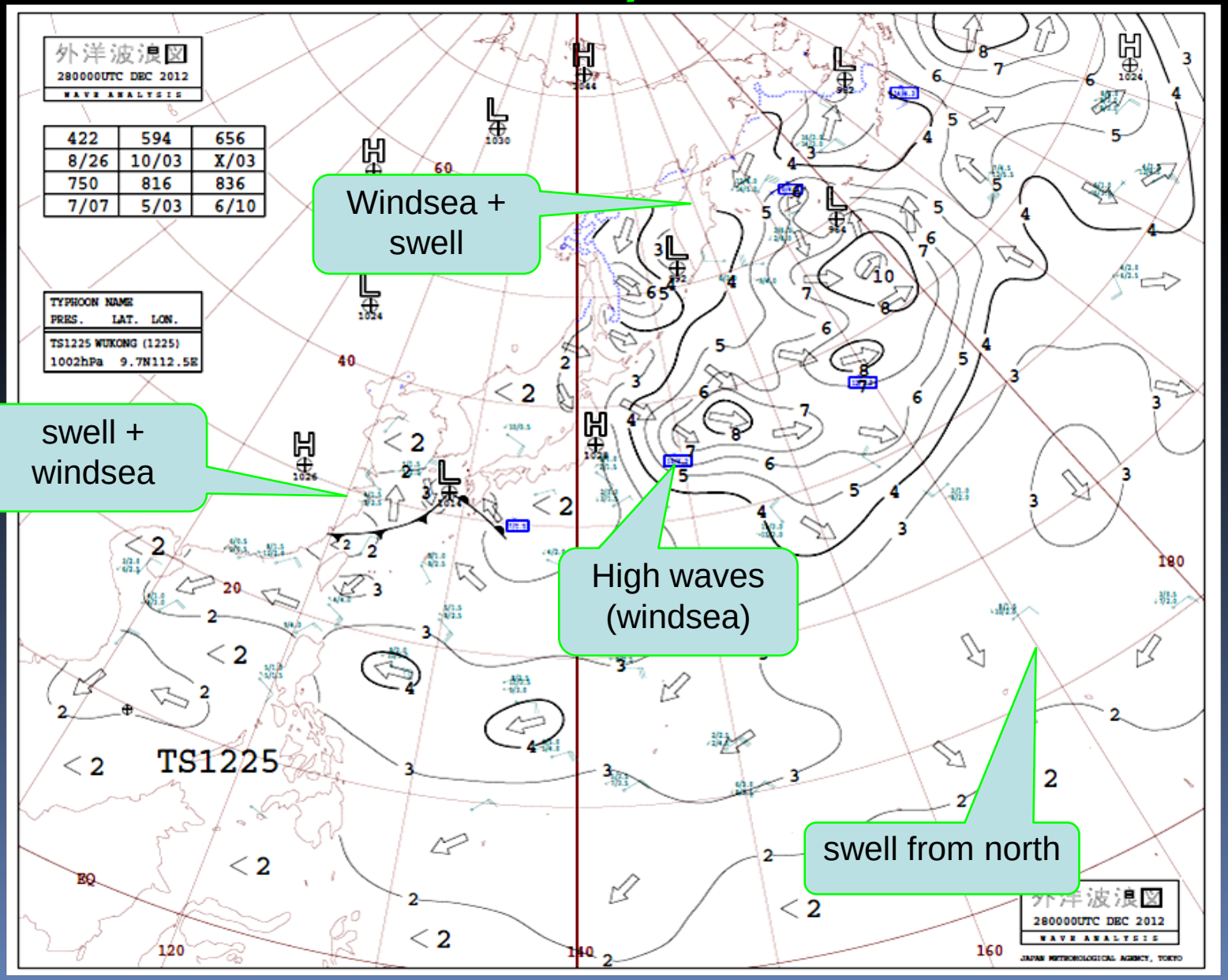
The area is marked in wave chart

Wave partitioned components



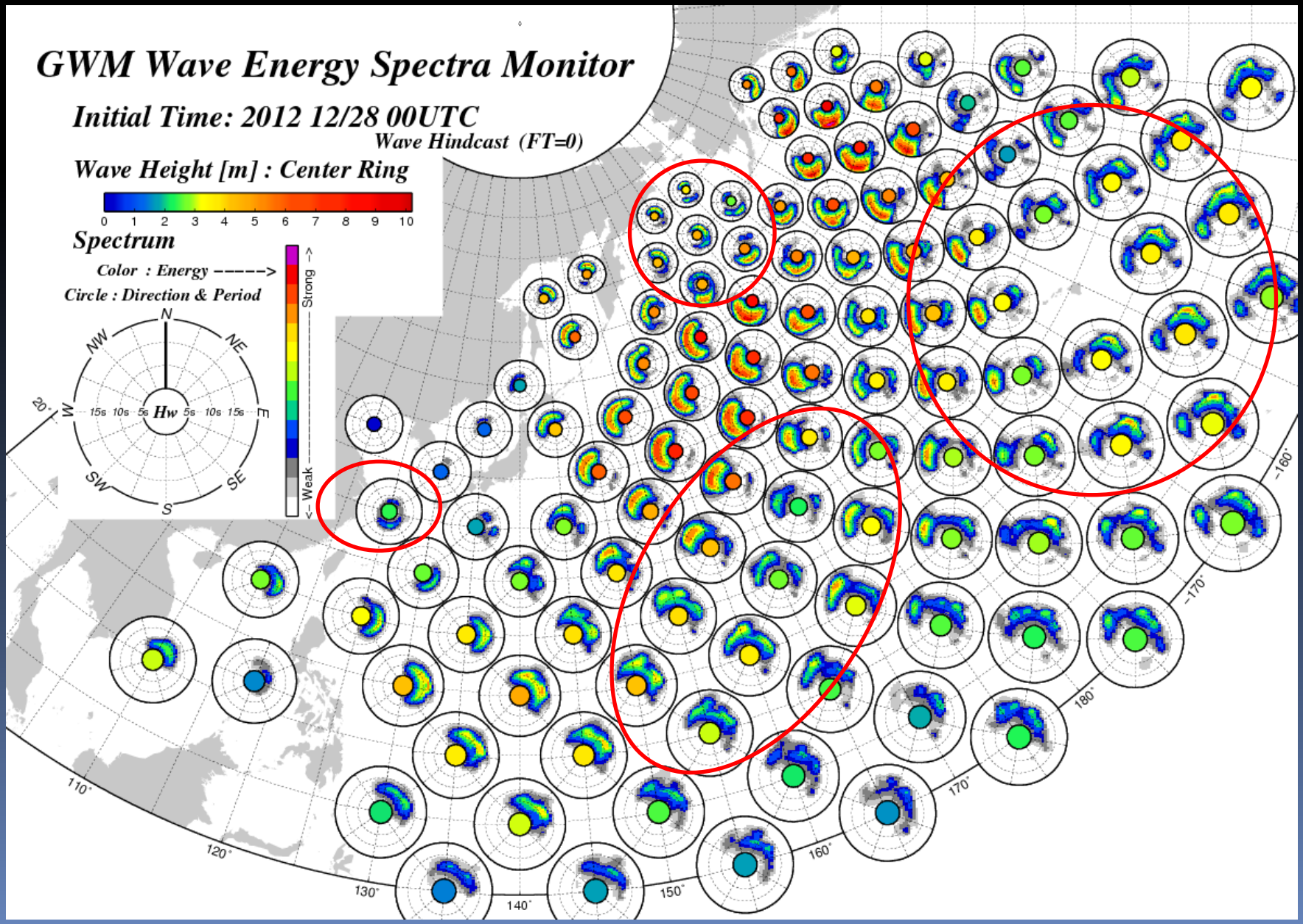
Contours indicate wave energy.
From the largest component, area is marked by red, green, blue, yellow, and aqua.
(The Blue thick line indicate current partition method.)

Wave Analysis Chart

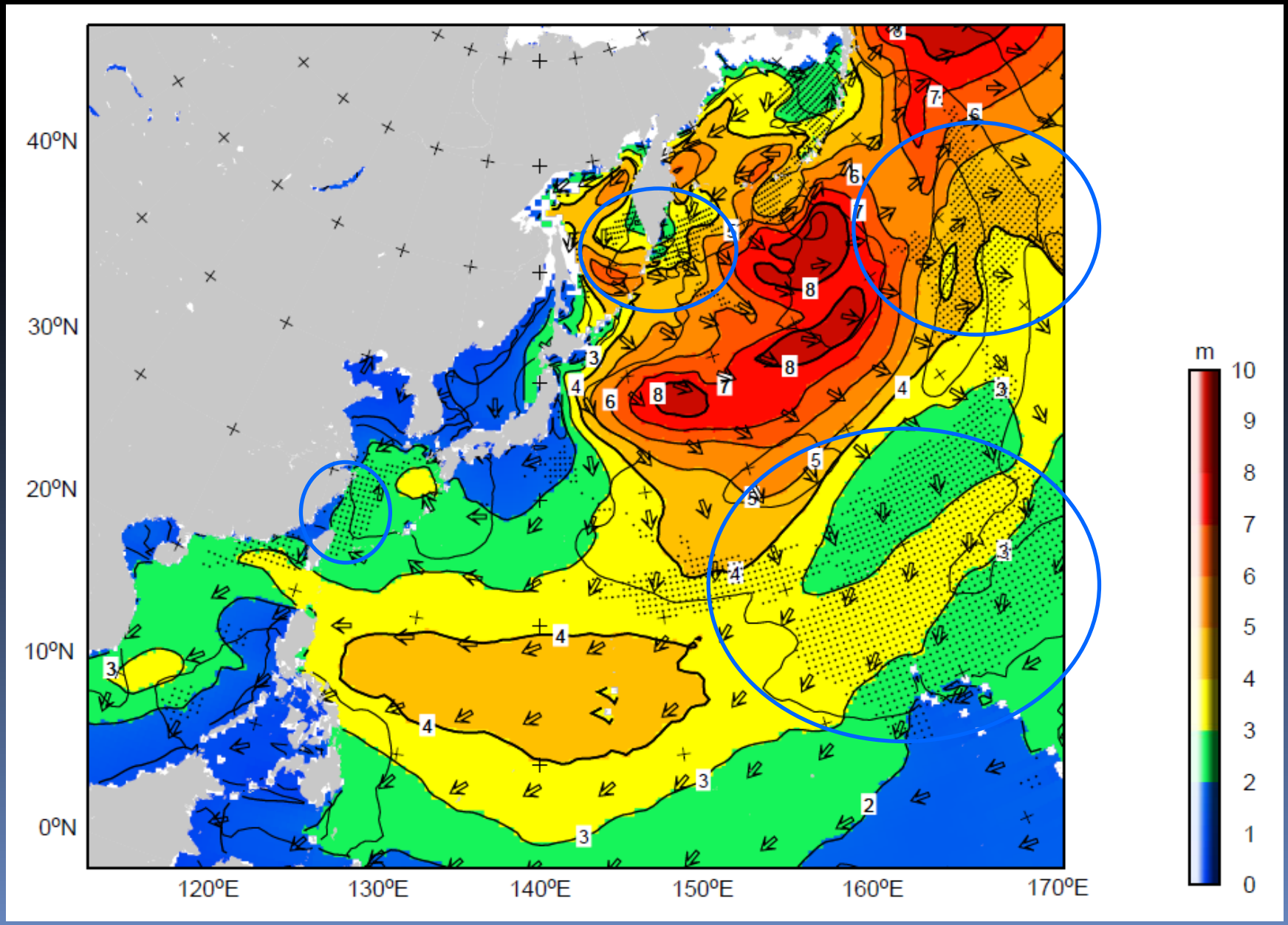


00UTC on 28/DEC/2012

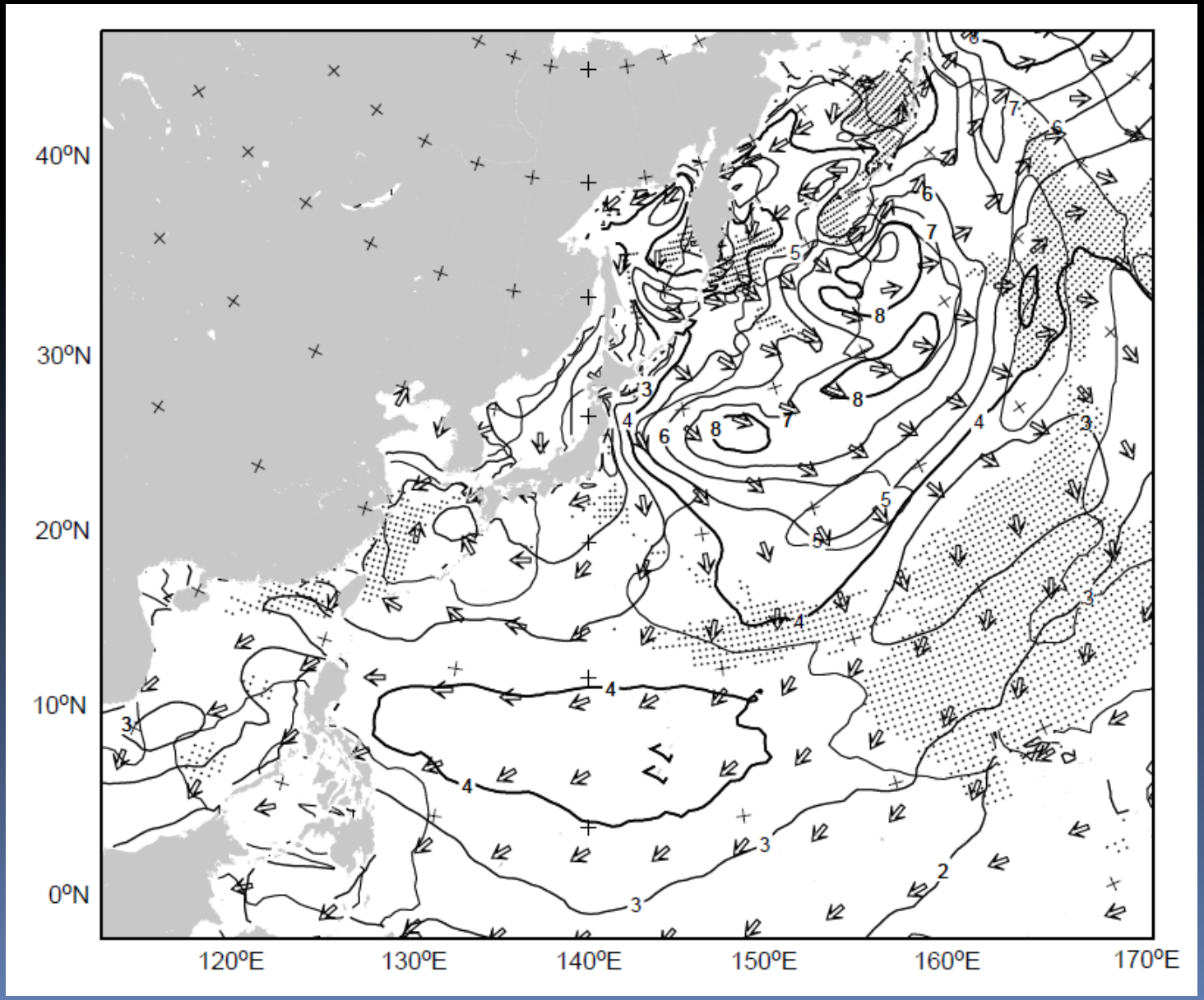
全球波浪モデルの波浪スペクトル



An image map with multiple wave area



A fax map image

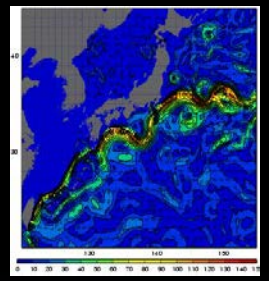


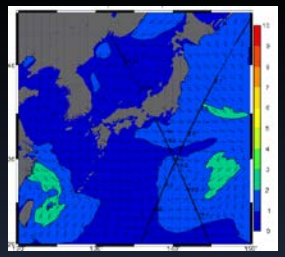
Detailed fax image will be further modified.

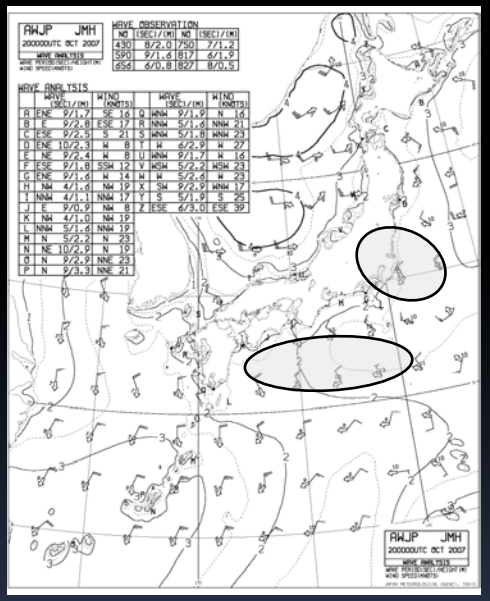
Current effect on waves

1) Refer current data and wave data
2) Calculate relative current speed to wave
3) Estimate wave height modification

The area wave height becomes 10 % higher than the original value will be marked.







Wave height modifications by currents

For deep water wave

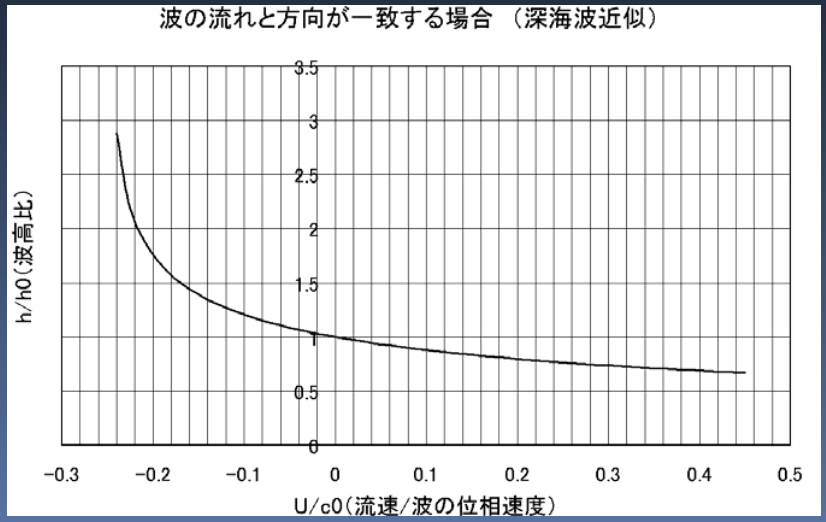
$$\frac{h}{h_0} = \sqrt{\frac{2}{1+\frac{4U}{c_0}+\sqrt{1+\frac{4U}{c_0}}}}$$

h: modulated wave height,

h_0 : original wave height

U: relative current speed (to wave),

c_0: phase speed of wave

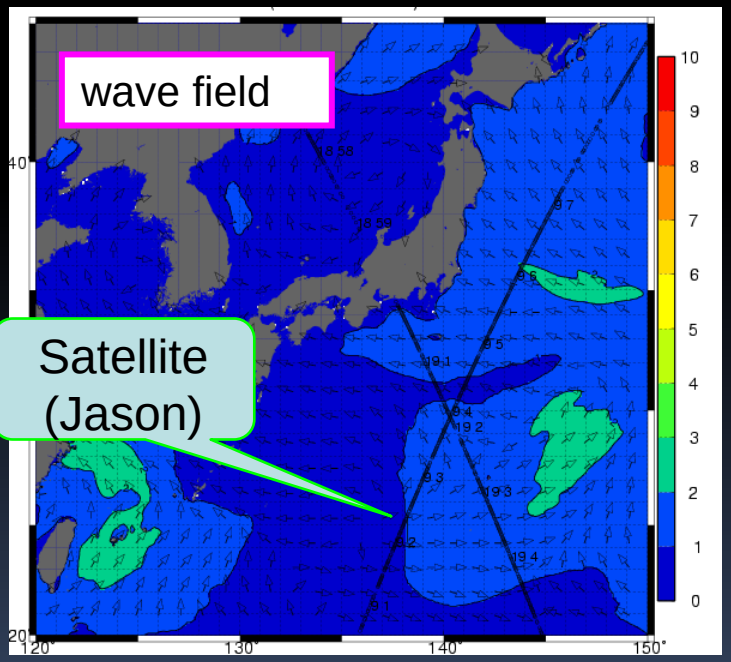


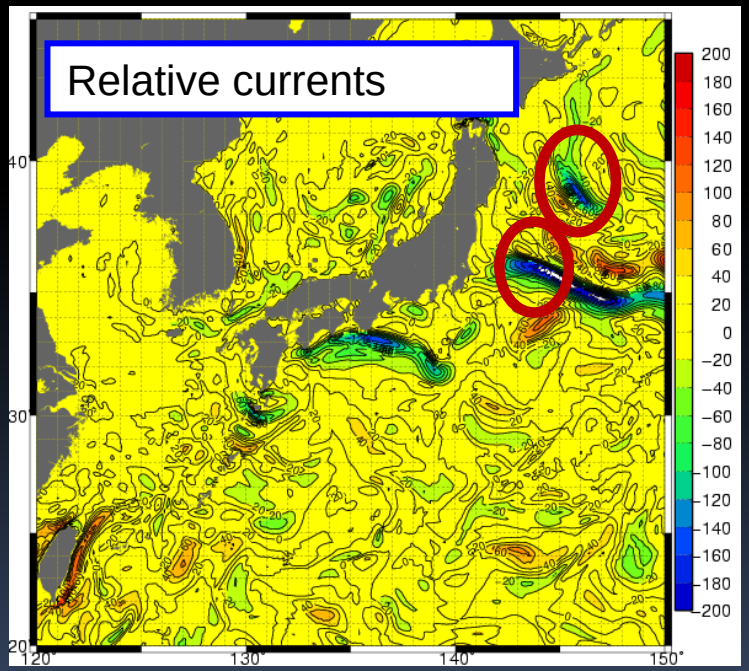
Wave heights become larger when

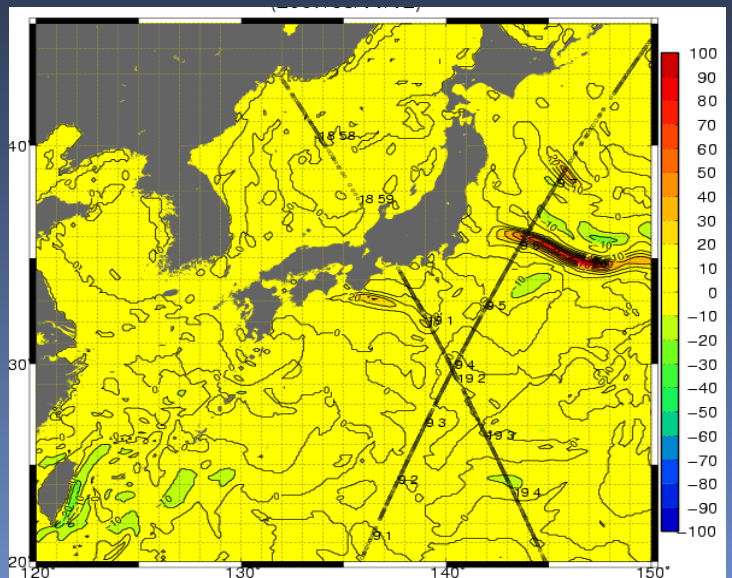
a. against current speed is large

b. small phase speed (short waves)

Validation: (12 UTC on 11/Jun/2007)





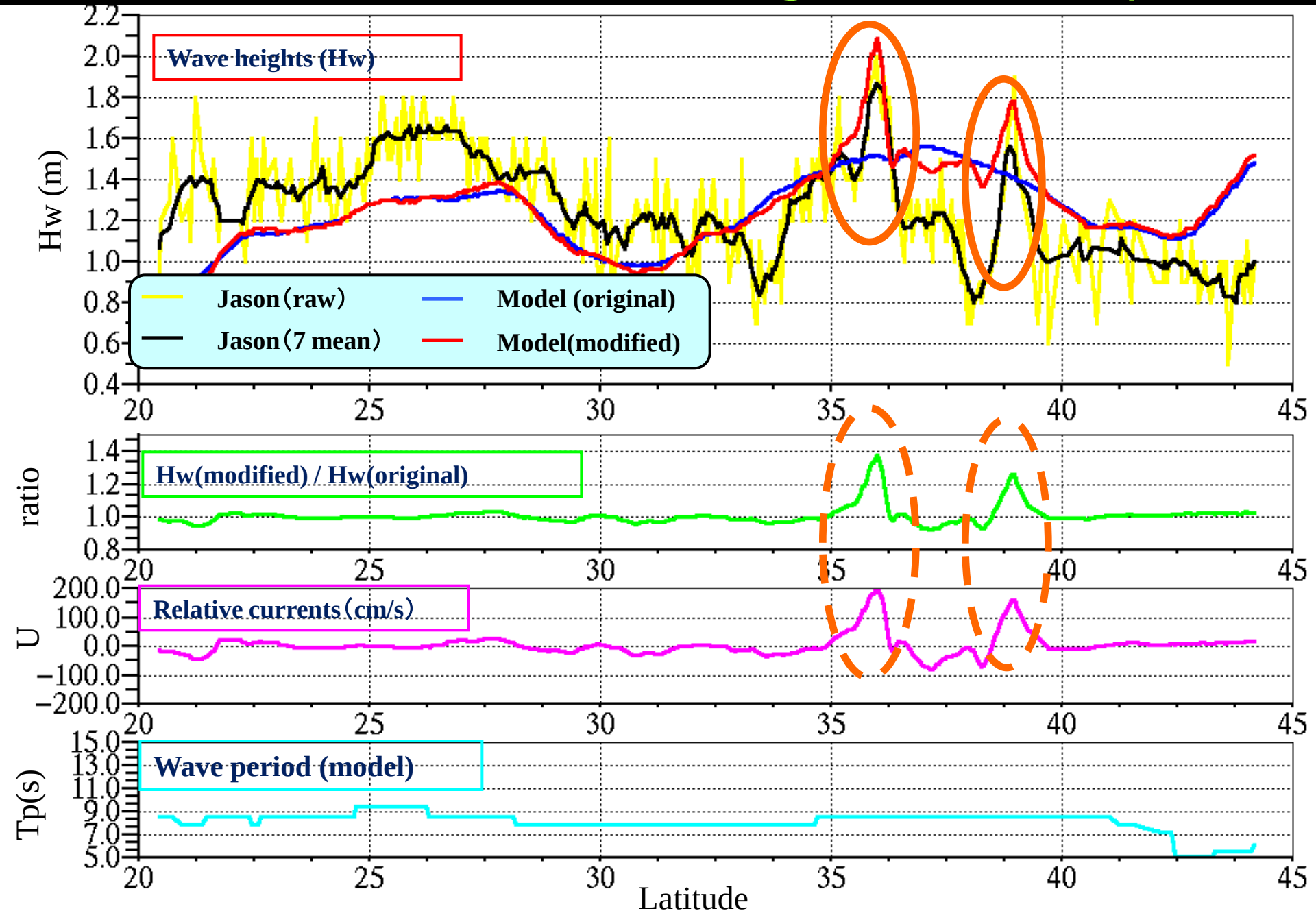


Modified wave height values by currents

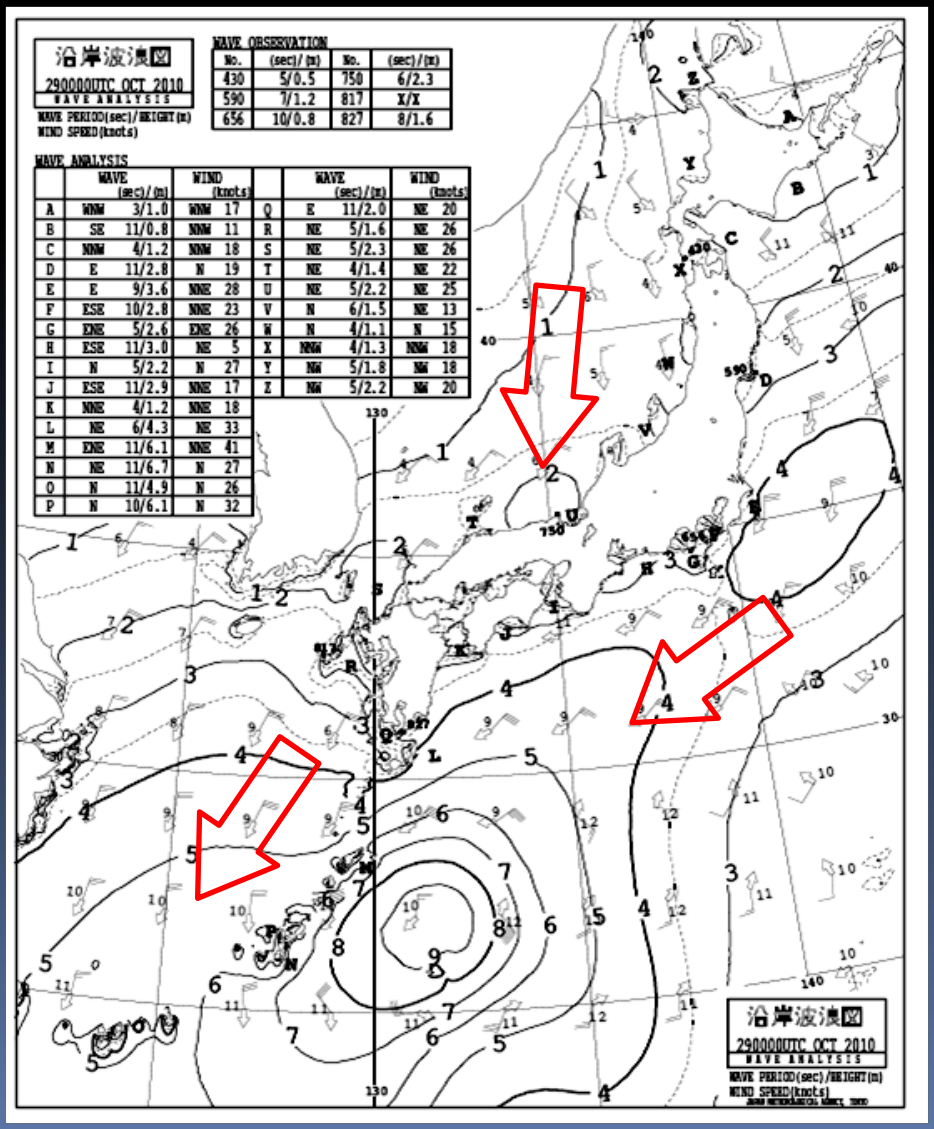
Wave heights are modified in strong current, but it is not so apparent…

→ Mark the modified area explicitly.

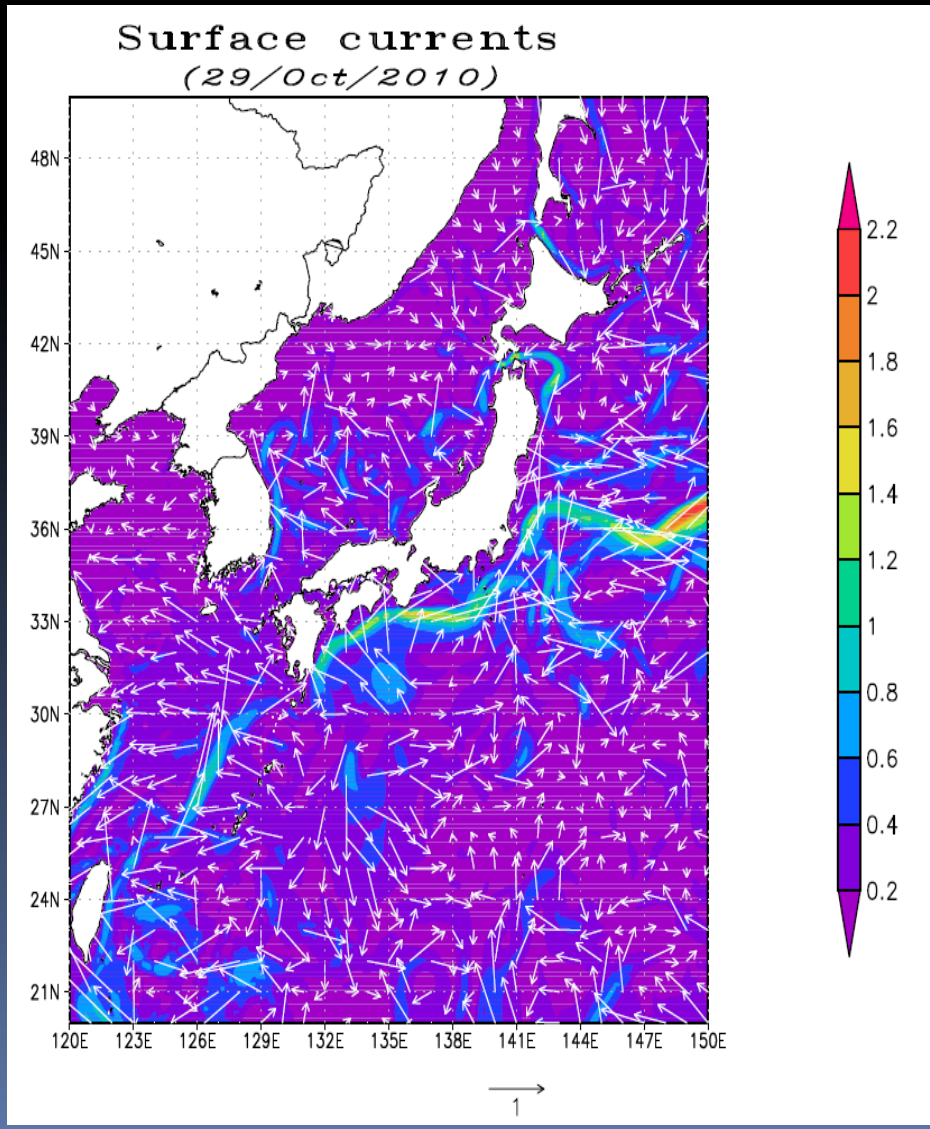
Modification results along a satellite path



Wave and current conditions

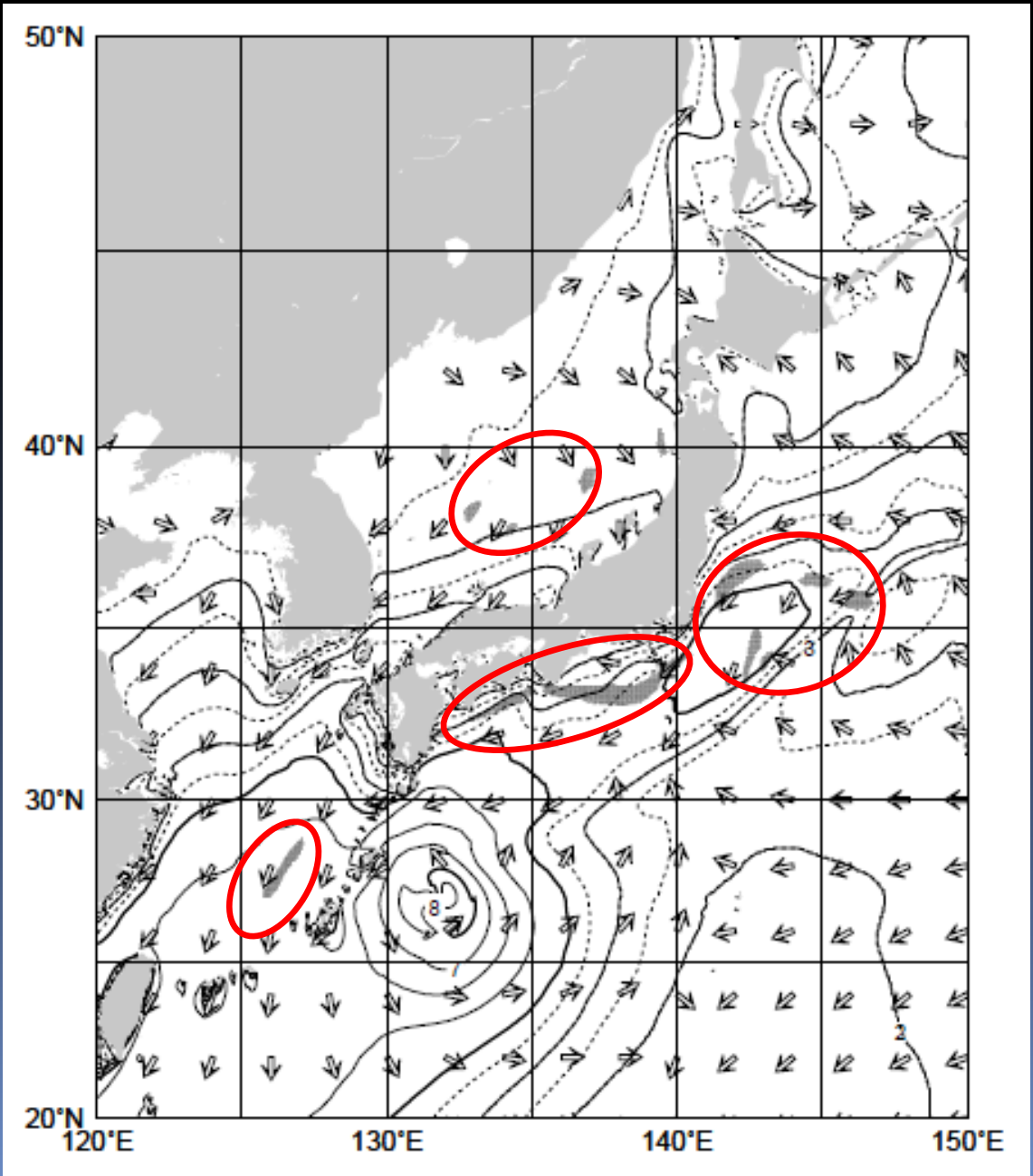


Coastal Wave Chart
（00UTC on 29/OCT/2010）



Surface currents of MOVE-WNP
（ 29/OCT/2010 ）

An Image chart with current influence



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Further developments

◆On contents

- Effectiveness of qualitative information
- Reasonability of thresholds
- Targets of information (huge vessels ⇔ small boats)

◆The way of information issue

- Map styles, information format etc…

We would like to start issuing the information in a few years.

Thank you!