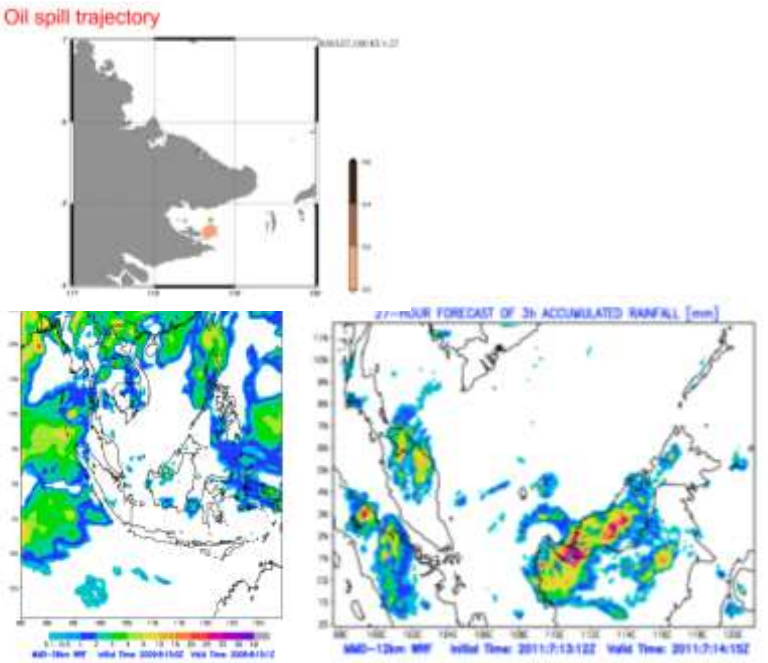
PREDICTION OF OIL SPILL TRAJECTORY WITH THE MMD-JMA OIL SPILL MODEL



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MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION

Content

Introduction

A total of 121 oil pollution cases in Malaysia had been reported between 2009 and December 2015. Fortunately, majority are small-scale.

The collision of tanker Nagasaki Spirit resulting in the discharge of approximately 13 000 tons of crude oil into the marine waters just off the coast of Sumatra and the northern resort island of Malaysia – Sep 1992

300 tonnes of oil spills after Malaysia ship collision – January 2017

Malaysia tackles 3km-wide tanker oil spill near Singapore – June 2017

Role of MMD

The Malaysian Meteorological Department(MMD) is the sole agency tasked with monitoring weather conditions and earthquake activities.

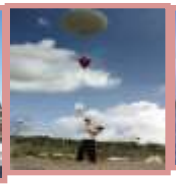
Forecasts/warnings of weather conditions are issued to assist the disaster management agencies to make informed decisions.

One of the important functions of MMD is to assist in oil spill contingency operation.

Weather Monitoring & Forecasting System


Radar Stations


Satellite Receiver

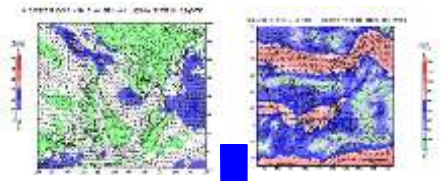

Upper Air Stations

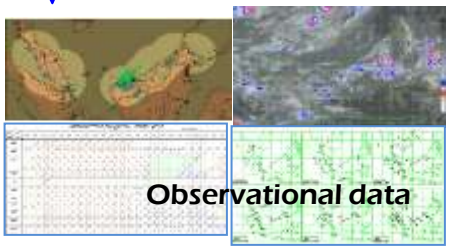

Tide Gauges


Web Cam


AWS & MET Stations

Global NWP Models



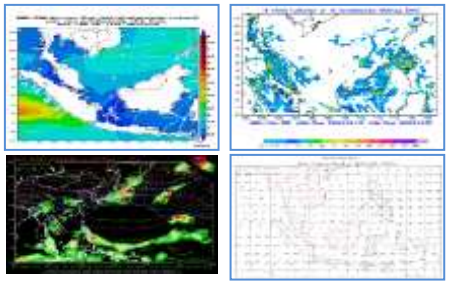

Observational data

Analysis

Data Collection


Meteorological Office

Analysis


Regional WRF-NWP & Marine Model


Disaster Management Agencies

Weather Forecast/Warning


Public


Aviation


Civil Defence


Media


Shipping & Fishery

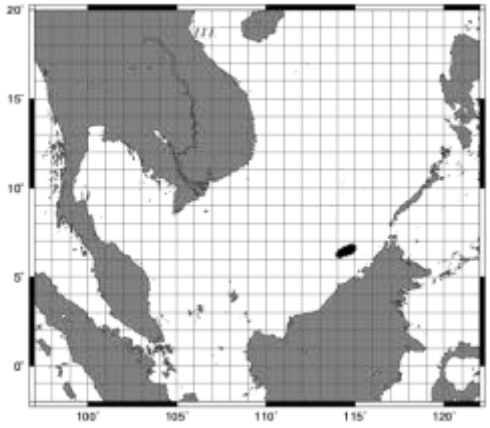

Agriculture


Oil & Gas

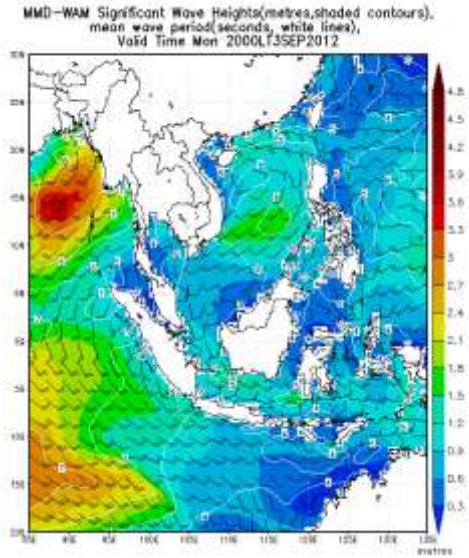

Sports & Recreation

Marine Numerical Models

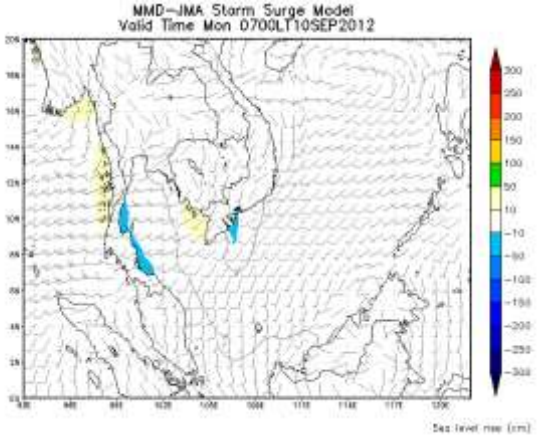
MMD-JMA Oil Spill Model



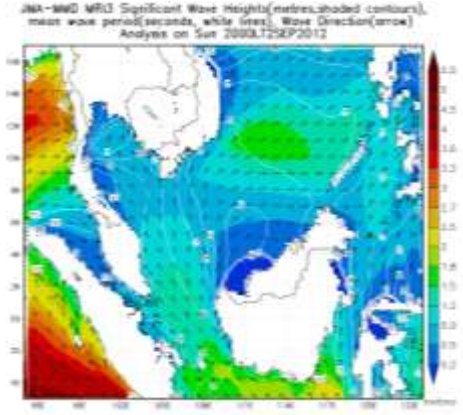
MMD-WAM Wave Model



MMD-JMA Storm Surge Model



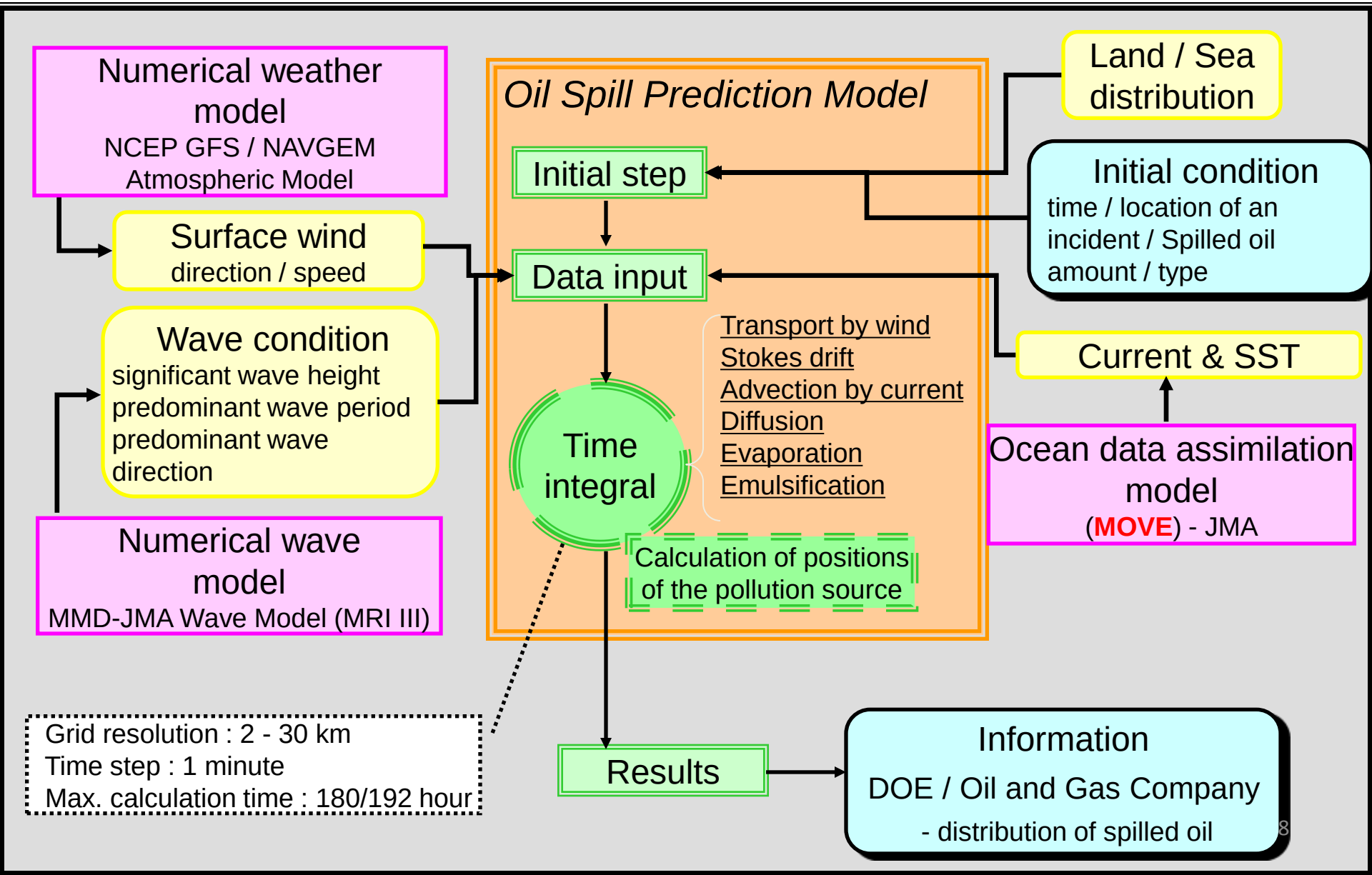
MMD-JMA MRI III Wave Model



MMD-JMA Oil Spill Model (MJOSM)

- Developed by Japan Meteorological Agency (JMA)
- Written in FORTRAN 90
- Adapted for use in the Malaysian Meteorological Department in November 2010 (with permission of JMA)
- MJOSM is run as required (event-based)

Outline of the MJOSM



Ocean Processes in MJOSM

- **Only six main processes are considered:**

Advection and Horizontal Diffusion

Advection

- Determined by the surface flow of the Wind U = (u,v)
- "3%" rule is used – Surface flow = 0.025% of wind speed and the angle of 15˚
- Stokes Drift effect from the wave is also considered with deep water formula simplification
- Ocean current effect is considered using the Ocean Comprehensive Analysis System

Horizontal Diffusion

- Diffusion treatment by Elliot (1986)
- Diffusion of parcel estimation by Random Walk Method

Vertical Diffusion and Sinking , and Evaporation

Vertical Diffusion and Sinking

- Sheer mechanism by Eliiot (1986)
- Depends on oil particle size (Buoyancy)
- The oil drop motion – whether it remains in surface or sinking is determined

Evaporation

- Evaporation rate is determined empirically, Fingas (1997)
- Logarithmic or root profile
- The constant coefficients were determined by experiment
- Coefficients from oil data catalogue by Environment Canada are used

Emulsification & Floating of Spill Source

Emulsification

- MJOSM uses emulsification formula from Mackay et al. (1980) and Reed (1989)

Floating of spill source

- It is necessary to consider the movement of the spill source
- The air/sea floating ratio of the source is used to determined its movement by wind and current force of the ocean

Inputs for MJOSM

1. Model Configuration and Forecast Data

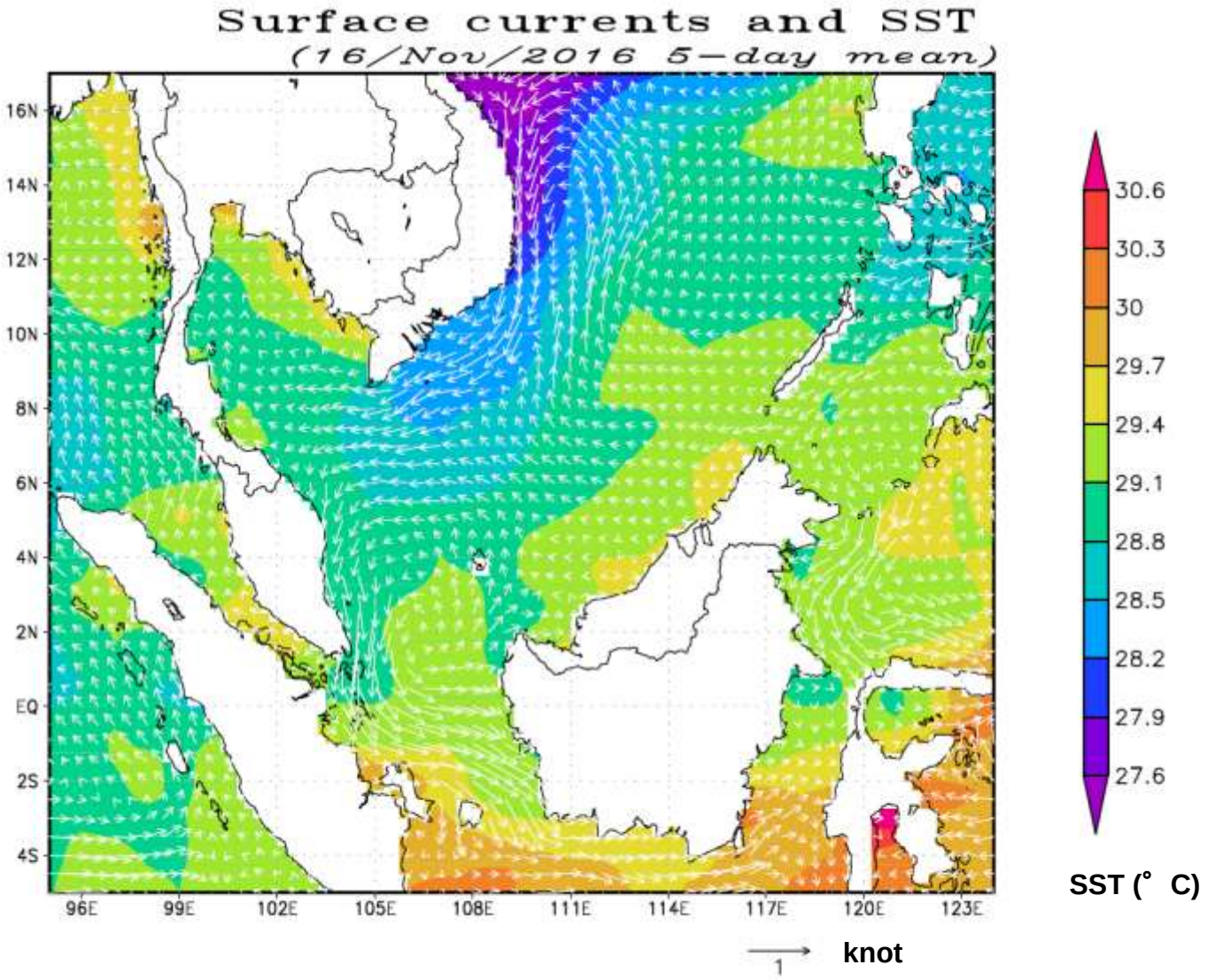
• Wind(NCEP GFS / NAVGEM), wave from MMD-JMA MRI III and Current & Sea Surface Temperature (MOVE – JMA)

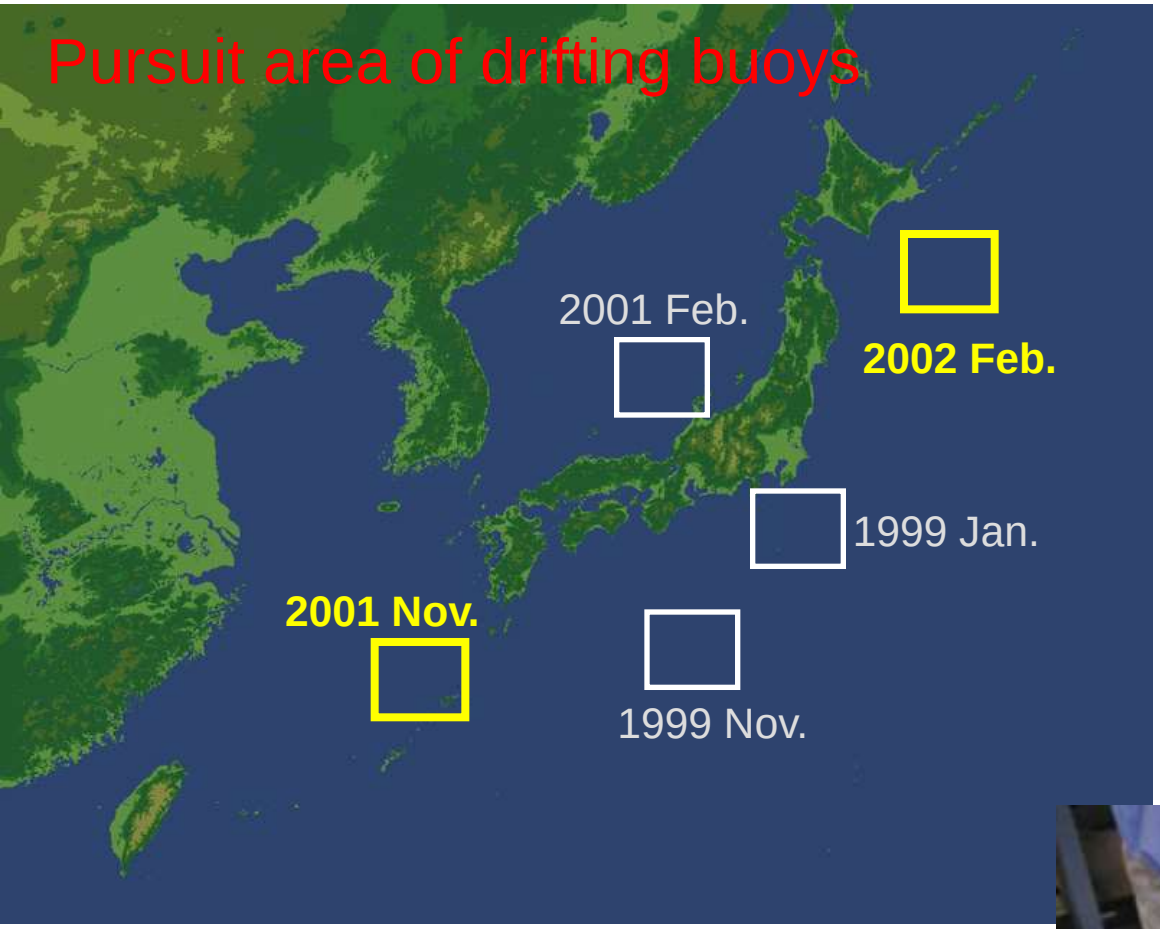
• Number of grid points
• Domain
• Resolution
• Output time steps
• Forecast time of oil spill trajectory

2. Incident info : from DoE or other agency

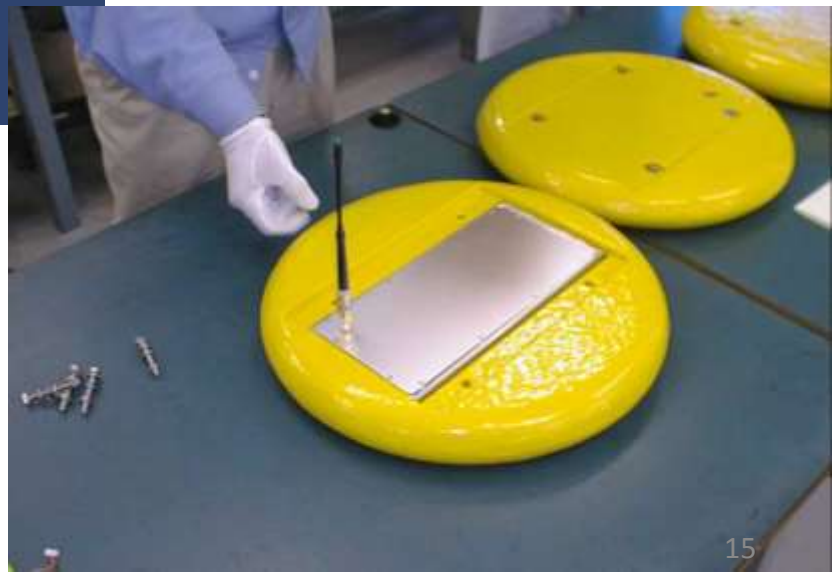
• Coordinates of oil spill----→ needs to be updated
• Date and time of occurrence
• Amount of spill(kl)
• Rate of spill(kl/h)
• Type of oil

Output from Ocean Current Model JMA-MOVE





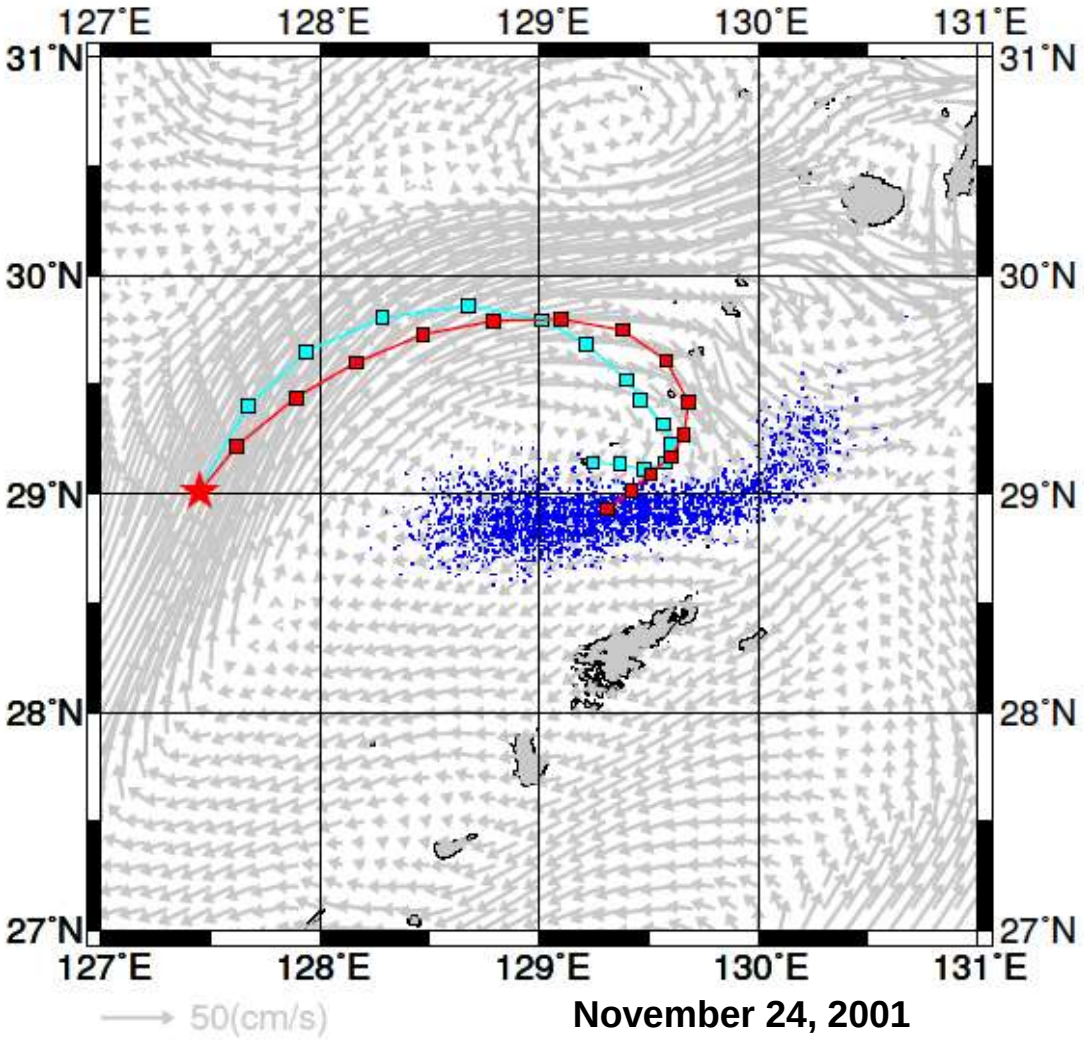
Verification by JMA using *Drifting Buoy*



<u>Standard : drifting buoy for oil spill tracking</u>

radius : 20 cm
thickness : 5 cm
weight : 4 kg
material : expanded polyester

Verification of Oil Spill Model



November 24, 2001

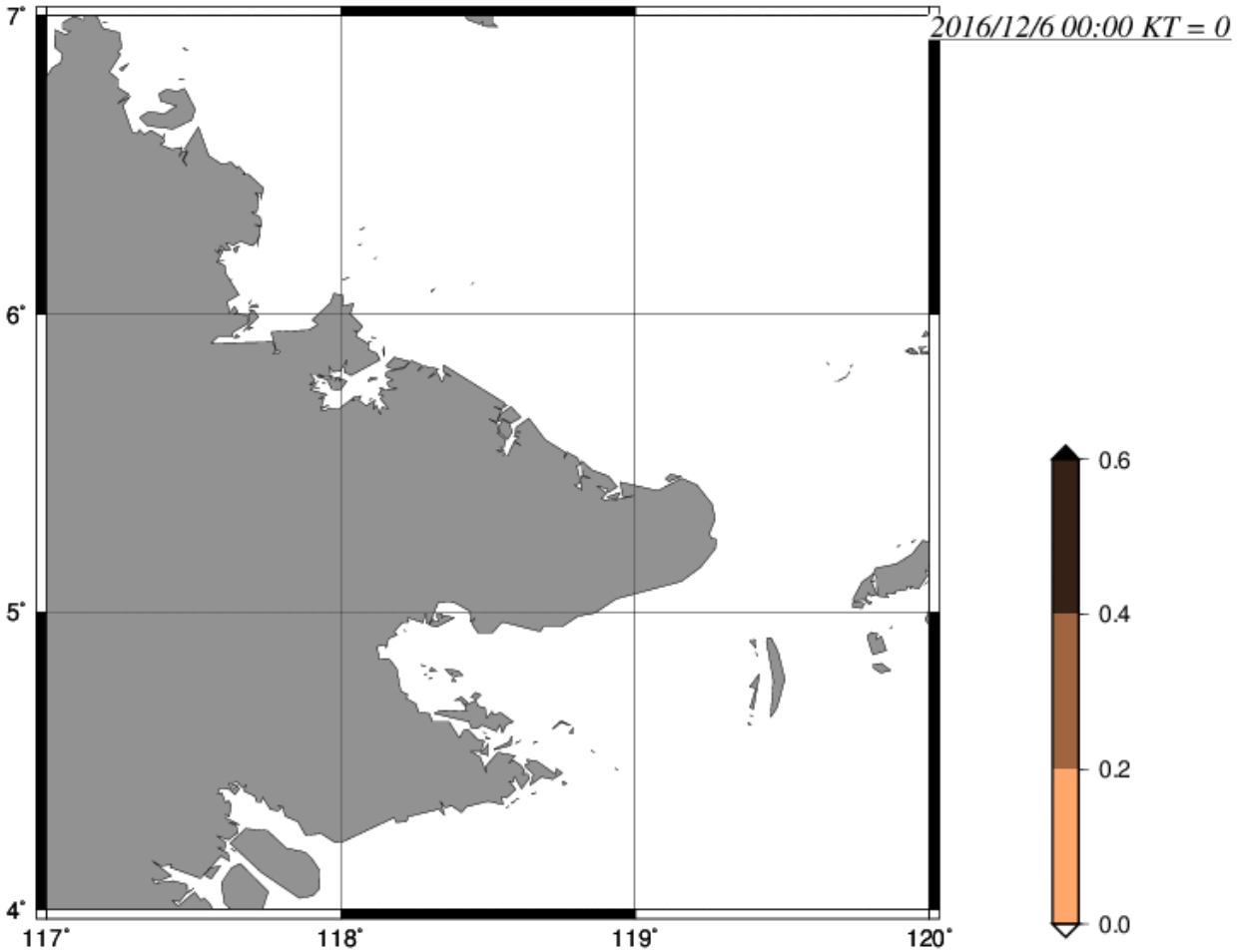
MJOSM can be used to predict “drifting object trajectory” when “diffusion process” is not considered - Useful for marine SAR .

: track of oil pursuit buoy

: simulation of MOVE-WNP and Oil Spill Model

Graphical Outputs

- Oil spill trajectory



Way Forward

1. **Use high resolution data from numerical weather prediction model(MMD-WRF) as inputs.**

2. **Use more in-situ observational data to calibrate MJOSM.**

3. **Run regional current model as input into MJOSM for a more realistic forecast.**

4. **Run multiple scenarios using different wind, wave and current inputs.**

Conclusion

• MJOSM is an open source modelling software.

•Close collaboration with JMA since 2008 helps MMD in operationalising MJOSM.

•MMD is always ready to provide forecast of oil spill and drifting object trajectory based on the correct and the latest information:

- •Location
- •Time
- •Amount
- •Type

TERIMA KASIH