MINISTRY OF SCIENCE AND TECHNOLOGY
VIETNAM ATOMIC ENERGY INSTITUTE

5th Annual Meeting on ASEAN Network on Nuclear Power Safety Research (ASEAN NPSR)

The water dispersion simulation of Cesium-137 from air deposition source in the Gulf of Tonkin

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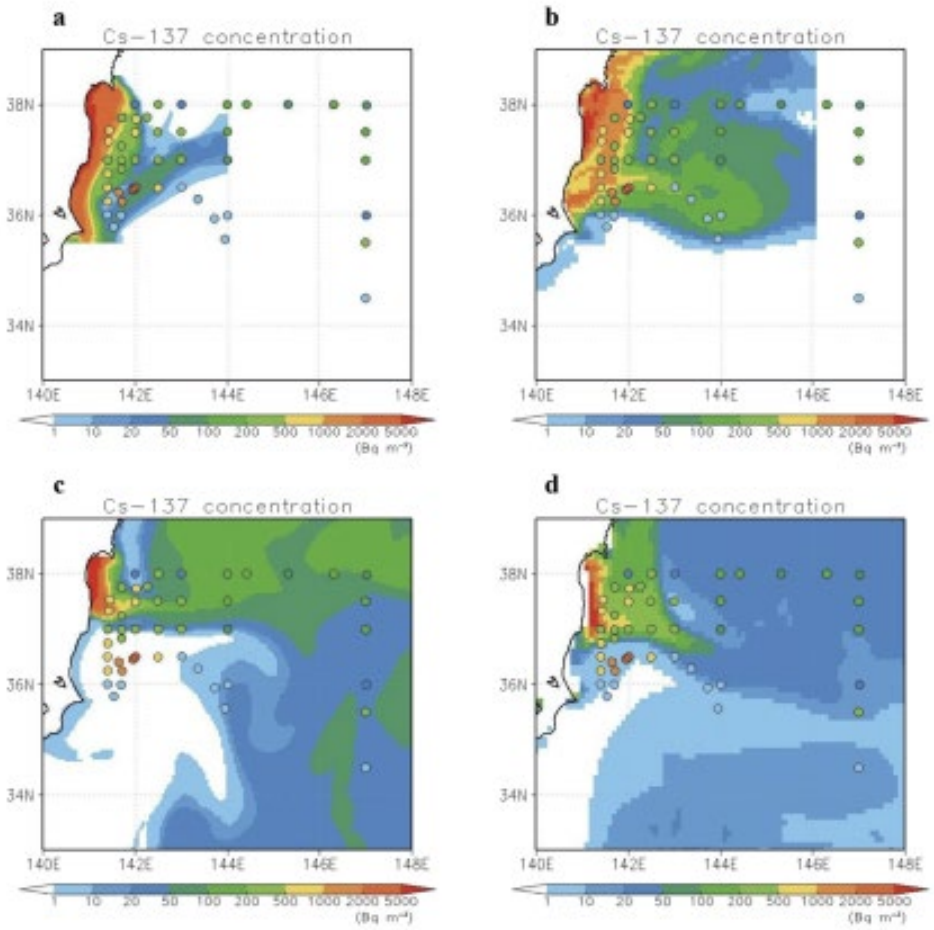
Content

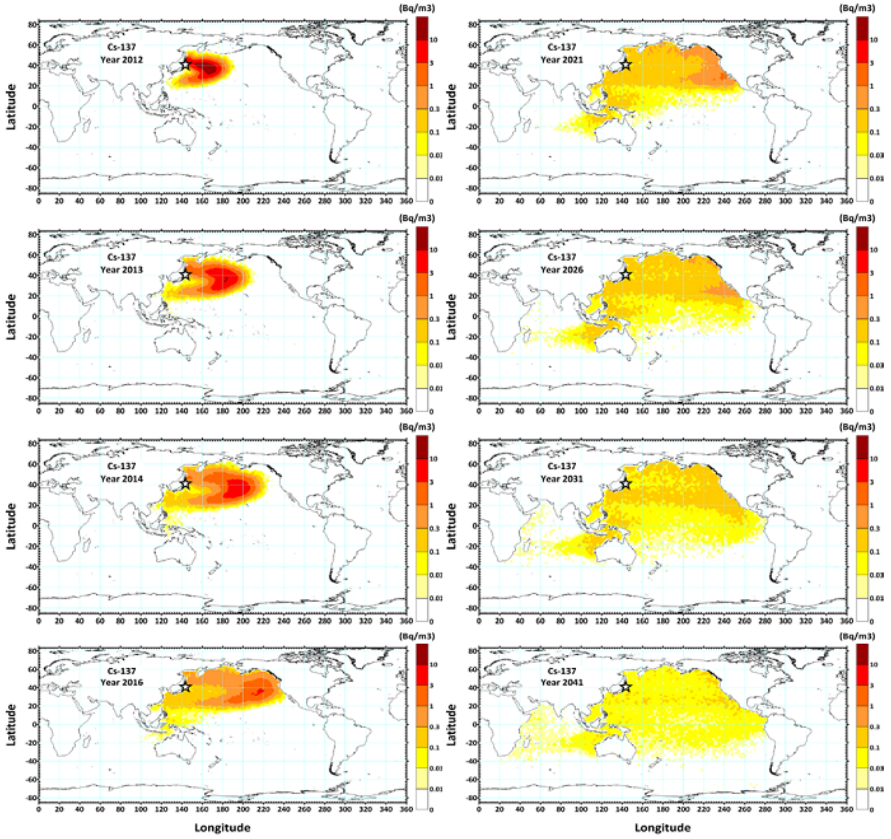
- Simulation studies of radiation dispersion in water from the Fukushima incident.
- Existing problems of radioactivity dispersion simulation in the water.
- Testing the radioactivity dispersion in water by combination of Flexpart and Delft-3D for a hypothetical accident at the Phong Thanh Nuclear Power Plant.
- Our future research.

Simulation studies of radiation dispersion in water from the Fukushima incident

H. Kawamura et al. / Journal of Environmental Radioactivity 180 (2017) 36–58



M. Nakano, P.P. Povinec / Journal of Environmental Radioactivity 111 (2012) 109–115

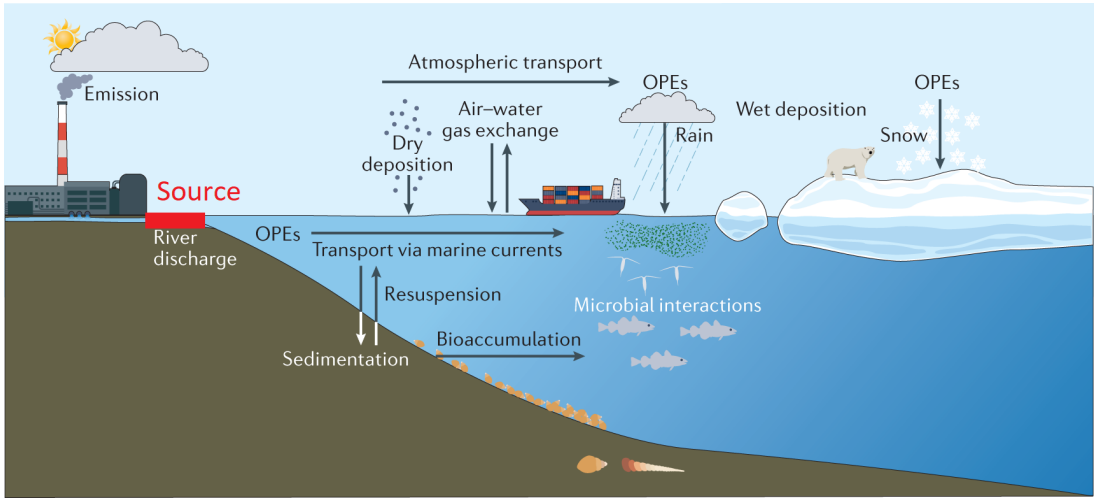


Water dispersion in water from point source (direct discharge)

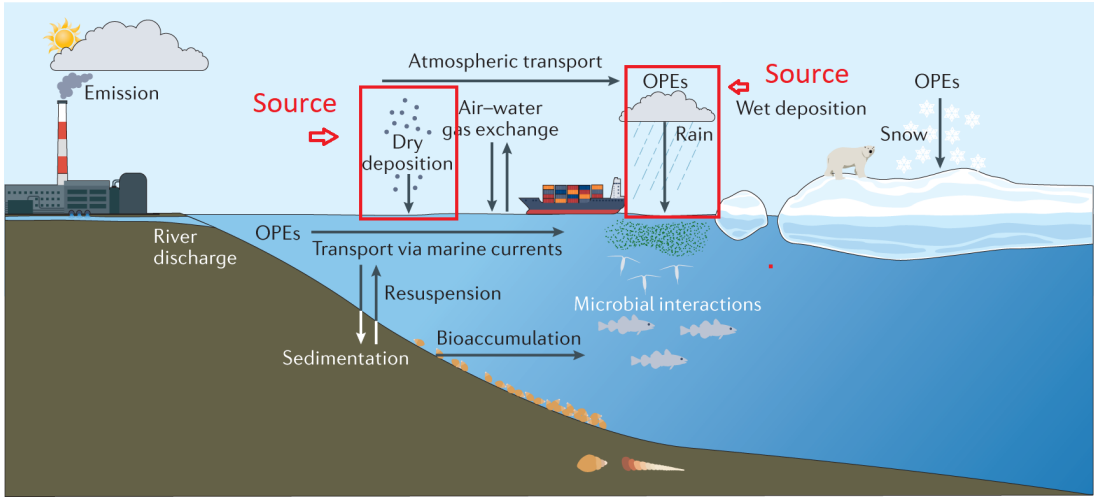
Existing problems of radioactivity dispersion simulation in the water

- **Scenarios:**
  - Direct discharge into the sea (Three Miles Island).
  - Deposition from the air into the sea (Chernobyl, Kyshtym).
  - Both direct discharge and deposition from the air into the sea (Fukushima).
- **Source term:**
  - Release source from a starting point
  - Release source from an areas

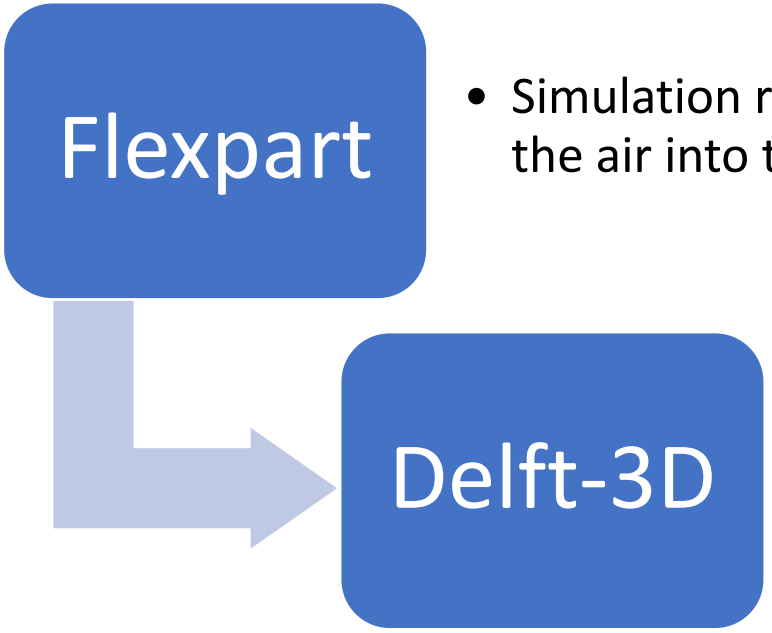
Direct discharge into the sea



Deposition from the air into the sea



Testing the radioactivity dispersion in water by combination of Flexpart and Delft-3D for a hypothetical accident at the Phong Thanh Nuclear Power Plant.



- Simulation radioactive deposition from the air into the sea

- Simulation radioactive dispersion in the sea

Progress in Nuclear Energy 135 (2021) 103718

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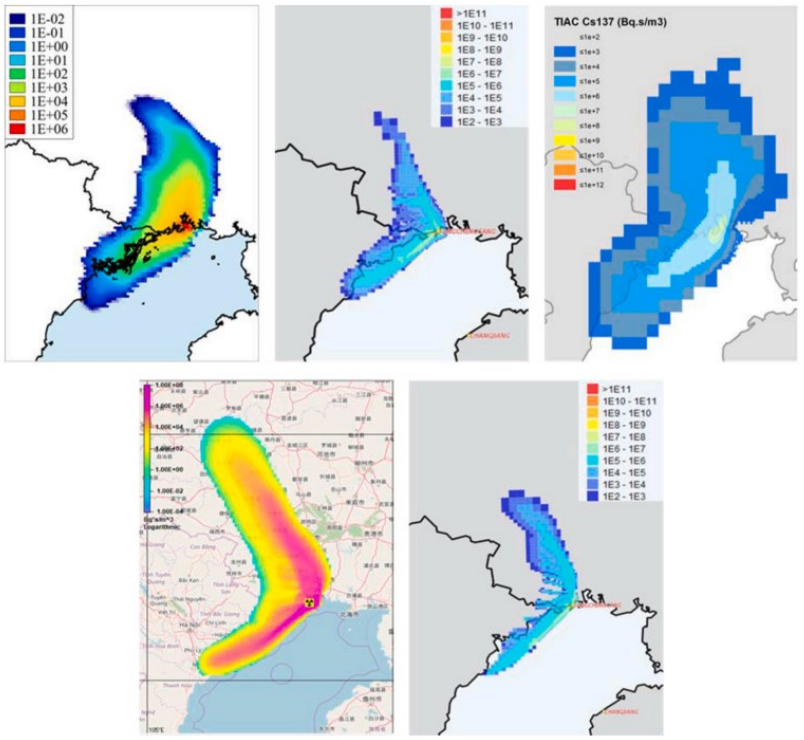
journal homepage: http://www.elsevier.com/locate/pnucene

Inter-comparison of transboundary atmospheric dispersion calculations: A summary of outputs from the ASEAN NPSR benchmark exercise

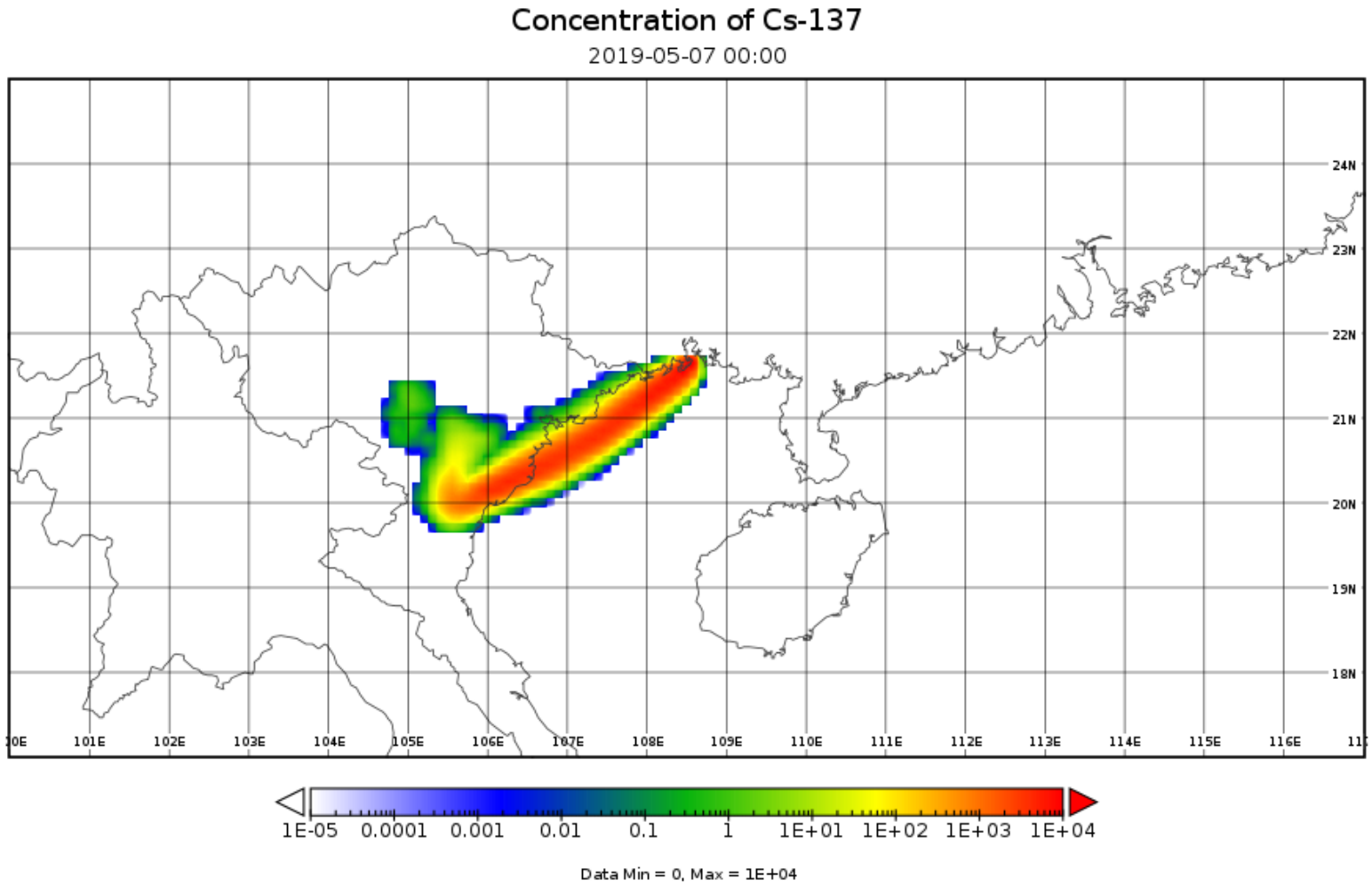
Kampanart Silva [a,*], Piyawan Krisanungkura [b], Narakhan Khunsrimek [c], Wasin Vechgama [d], Tang Jia Hao [e], Vitesh Krishnan [e], Pham Kim Long [f], Tom Charnock [g], Somboon Rassame [d], Tay Bee Kiat [h], Chung Keng Yeow [e], Hoang Sy Than [f], Nguyen Hao Quang [f], Pham Duy Hien [f]



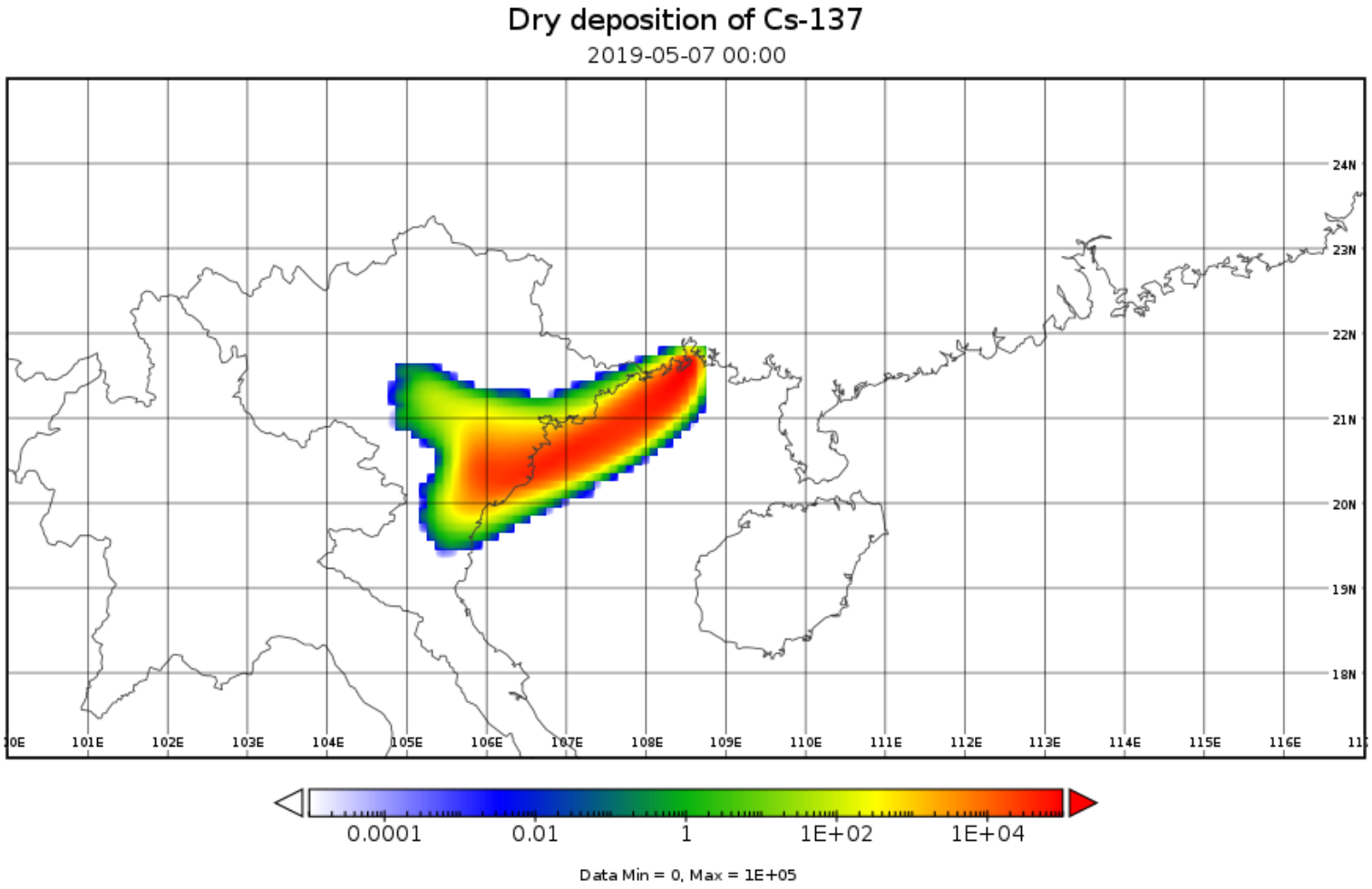
The **Scenarios**:

- Level 7 according to INES scale at Phong Thanh Nuclear Power Plant
- Release 10 PBq Cs-137/24h in the air

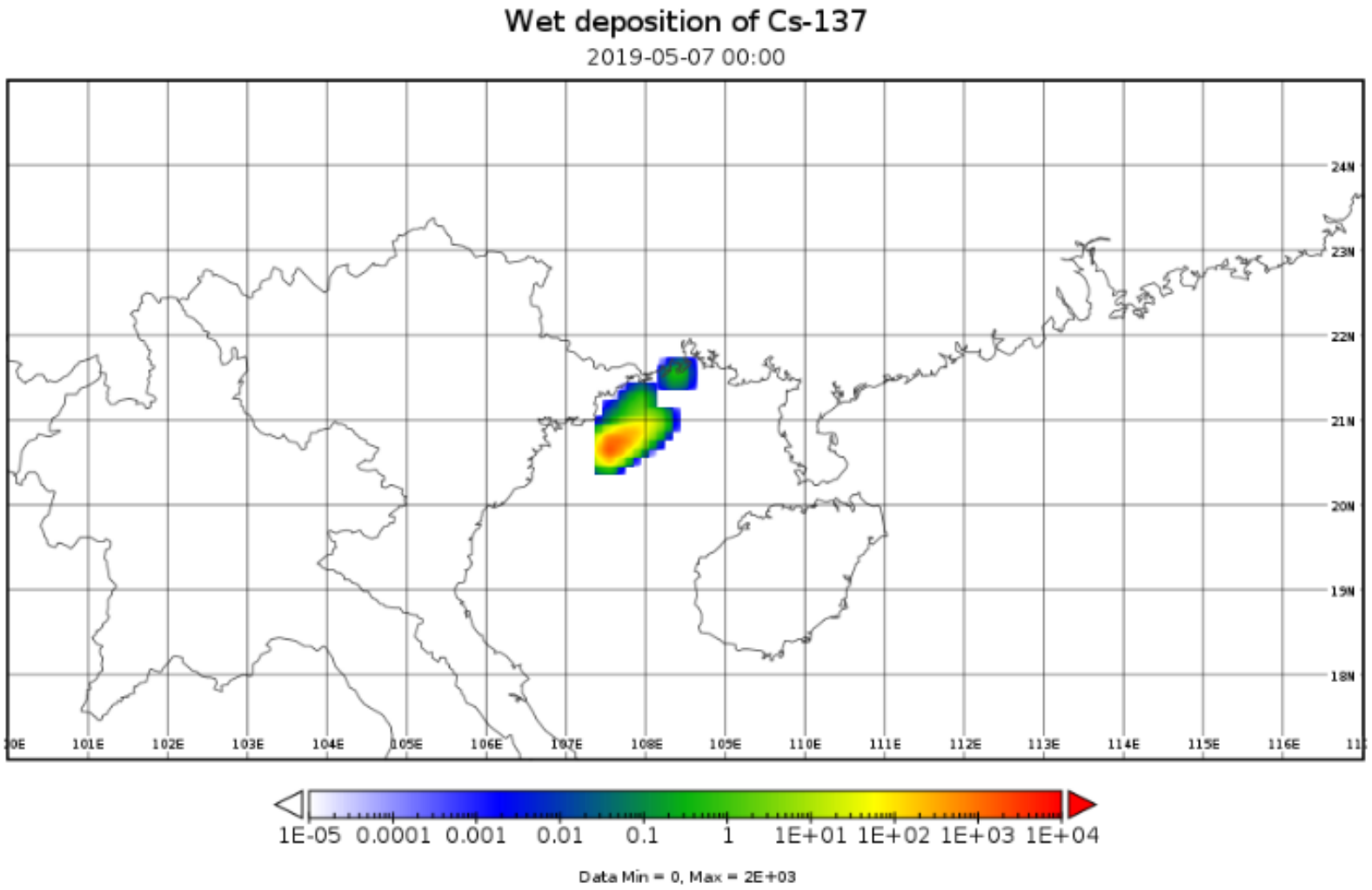
Flexpart


Concentration of Cs-137
2019-05-07 00:00
24N
23N
22N
21N
20N
19N
18N
101E
102E
103E
104E
105E
106E
107E
108E
109E
110E
111E
112E
113E
114E
115E
116E
1E-05
0.0001
0.001
0.01
0.1
1
1E+01
1E+02
1E+03
1E+04
Data Min = 0, Max = 1E+04

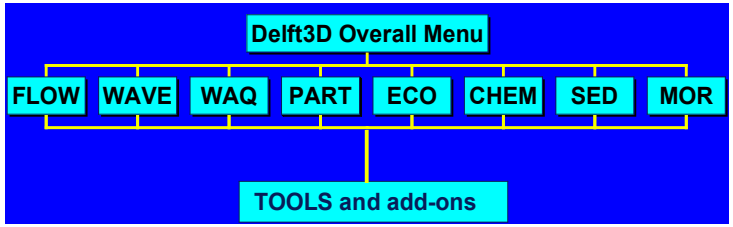
Flexpart

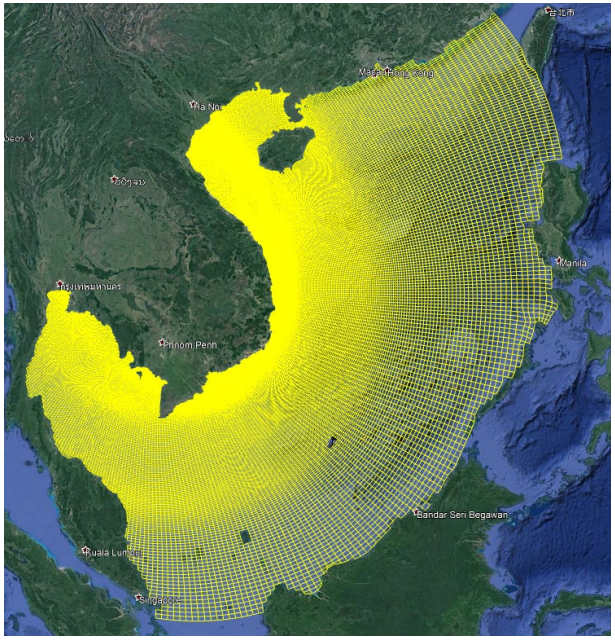

Dry deposition of Cs-137
2019-05-07 00:00
24N
23N
22N
21N
20N
19N
18N
101E
102E
103E
104E
105E
106E
107E
108E
109E
110E
111E
112E
113E
114E
115E
116E
0.0001
0.01
1
1E+02
1E+04
Data Min = 0, Max = 1E+05

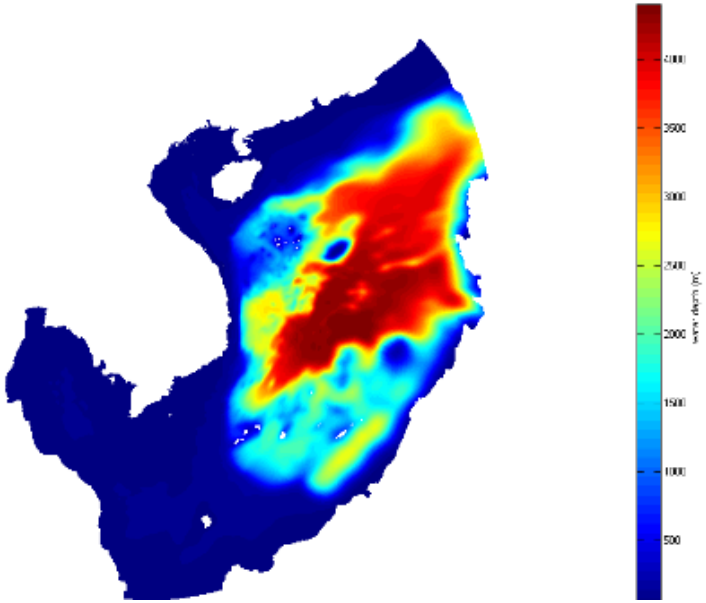
Flexpart


Wet deposition of Cs-137
2019-05-07 00:00
24N
23N
22N
21N
20N
19N
18N
101E
102E
103E
104E
105E
106E
107E
108E
109E
110E
111E
112E
113E
114E
115E
116E
1E-05 0.0001 0.001 0.01 0.1 1 1E+01 1E+02 1E+03 1E+04
Data Min = 0, Max = 2E+03

Delft-3D



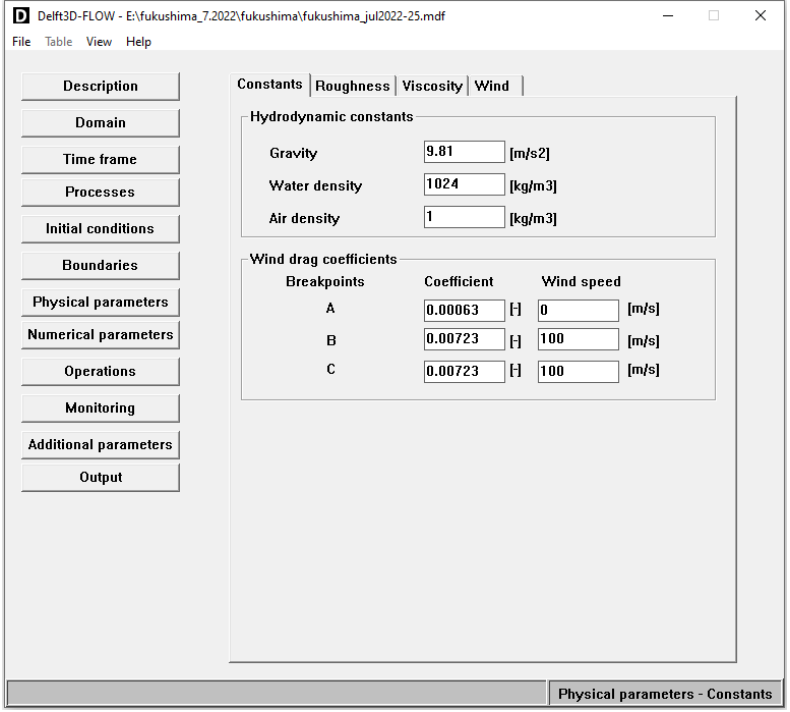


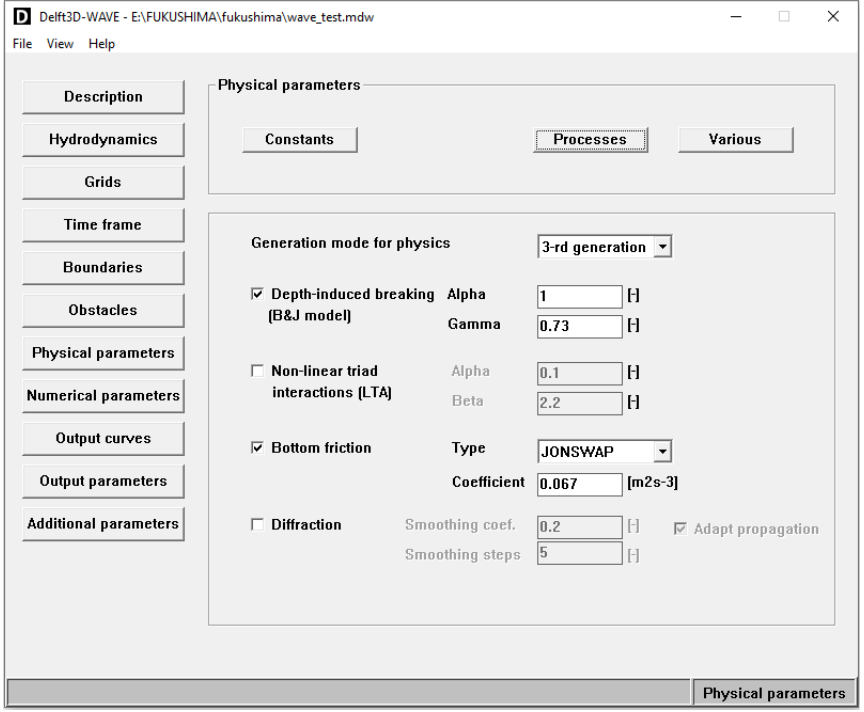


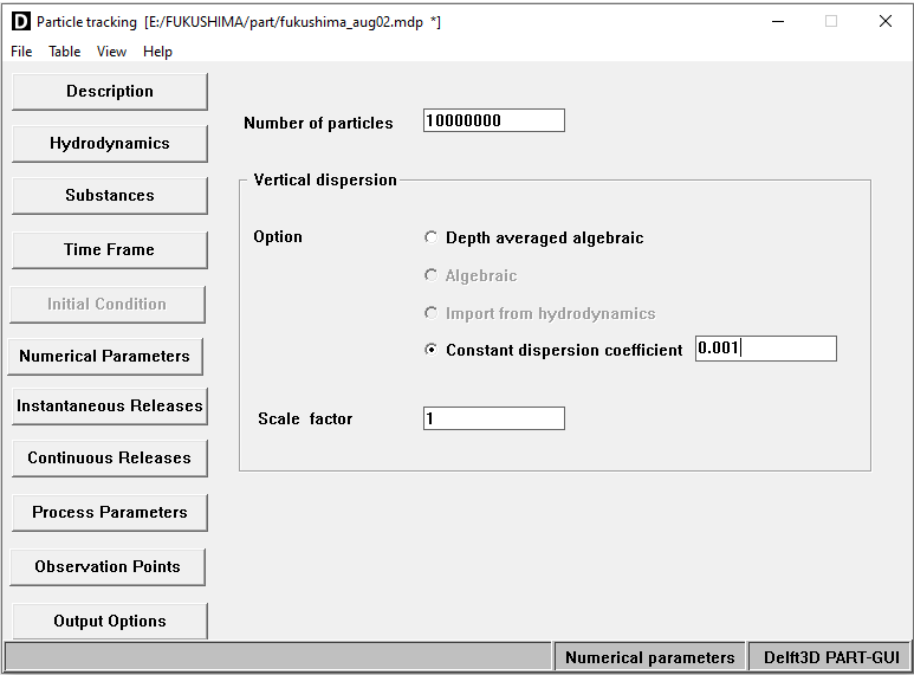
Geography: GEBCO-08
River Hydrology
Tides: FES2014, LEGOS, CLS
Meteorology: NCEP

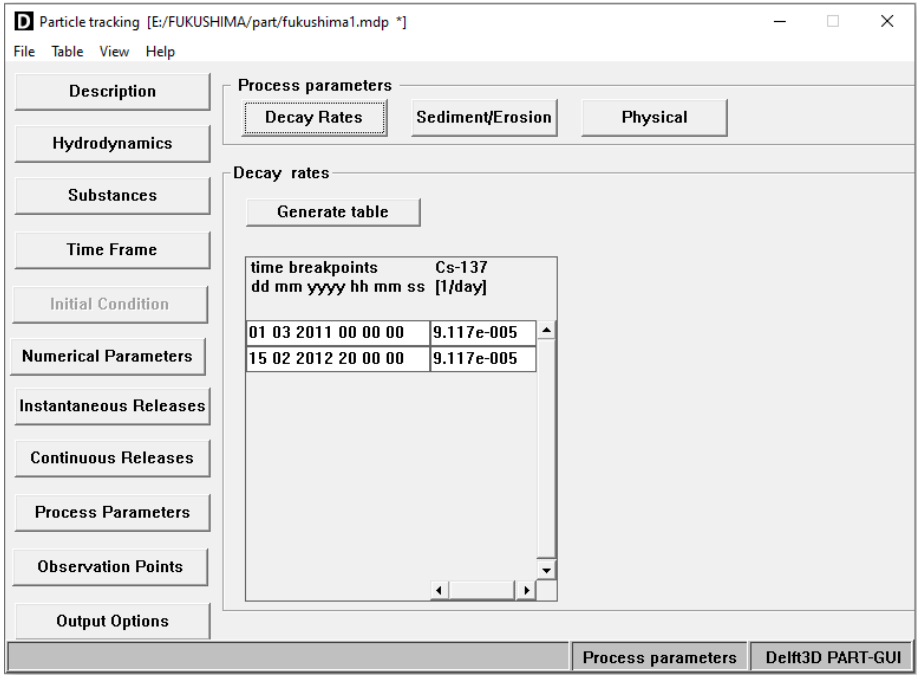
Delft3d-Flow
Delft3d-Wave
Delft3d-Sed
Delft3-Waq

- $A = \lambda . N = \lambda . \frac{m . N_A}{M}$
  - $A\,(Bq) = 3{,}21415 \times 10^{12} \times m\,(g)$
  - $A\,(Bq) = 3{,}21415 \times 10^{15} \times m\,(kg)$

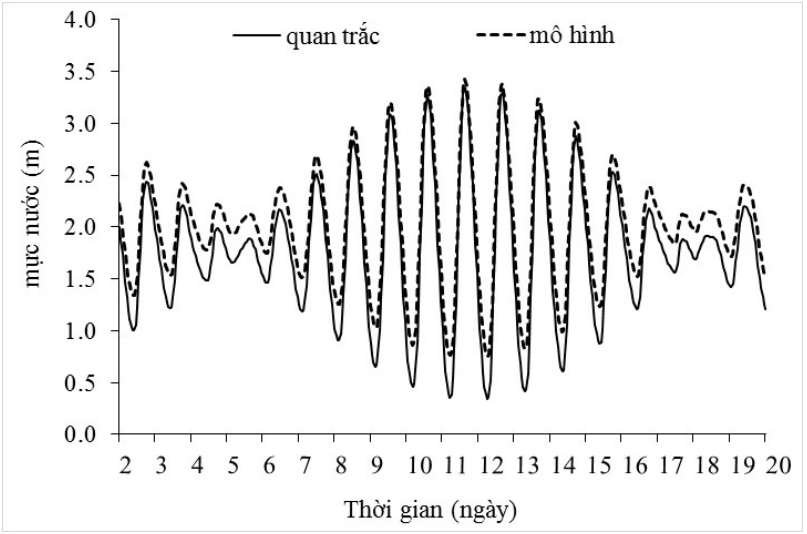

Delft3D-FLOW - E:\fukushima_7.2022\fukushima\fukushima_jul2022-25.mdf
File Table View Help
Description
Domain
Time frame
Processes
Initial conditions
Boundaries
Physical parameters
Numerical parameters
Operations
Monitoring
Additional parameters
Output
Constants Roughness Viscosity Wind
Hydrodynamic constants
Gravity 9.81 [m/s2]
Water density 1024 [kg/m3]
Air density 1 [kg/m3]
Wind drag coefficients
Breakpoints Coefficient Wind speed
A 0.00063 [-] 0 [m/s]
B 0.00723 [-] 100 [m/s]
C 0.00723 [-] 100 [m/s]
Physical parameters - Constants


Delft3D-WAVE - E:\FUKUSHIMA\fukushima\wave_test.mdw
File View Help
Description
Hydrodynamics
Grids
Time frame
Boundaries
Obstacles
Physical parameters
Numerical parameters
Output curves
Output parameters
Additional parameters
Physical parameters
Constants Processes Various
Generation mode for physics 3-rd generation
Depth-induced breaking (B&J model) Alpha 1 [-] Gamma 0.73 [-]
Non-linear triad interactions (LTA) Alpha 0.1 [-] Beta 2.2 [-]
Bottom friction Type JONSWAP Coefficient 0.067 [m2s-3]
Diffraction Smoothing coef. 0.2 [-] Adapt propagation
Smoothing steps 5 [-]
Physical parameters

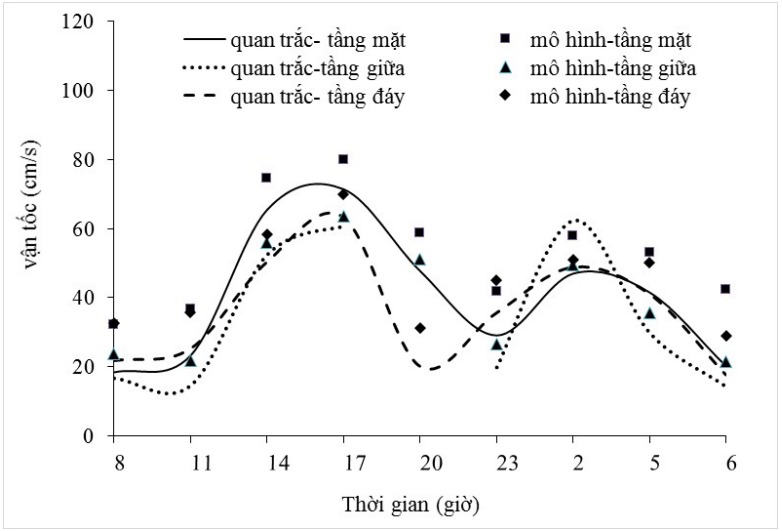

Particle tracking [E:/FUKUSHIMA/part/fukushima_aug02.mdp *]
File Table View Help
Description
Hydrodynamics
Substances
Time Frame
Initial Condition
Numerical Parameters
Instantaneous Releases
Continuous Releases
Process Parameters
Observation Points
Output Options
Number of particles 10000000
Vertical dispersion
Option
Depth averaged algebraic
Algebraic
Import from hydrodynamics
Constant dispersion coefficient 0.001
Scale factor 1
Numerical parameters
Delft3D PART-GUI


Particle tracking [E:/FUKUSHIMA/part/fukushima1.mdp *]
File Table View Help
Description
Hydrodynamics
Substances
Time Frame
Initial Condition
Numerical Parameters
Instantaneous Releases
Continuous Releases
Process Parameters
Observation Points
Output Options
Process parameters
Decay Rates Sediment/Erosion Physical
Decay rates
Generate table
time breakpoints dd mm yyyy hh mm ss
Cs-137 [1/day]
01 03 2011 00 00 00 9.117e-005
15 02 2012 20 00 00 9.117e-005
Process parameters
Delft3D PART-GUI

Verify hydrodynamic simulation results

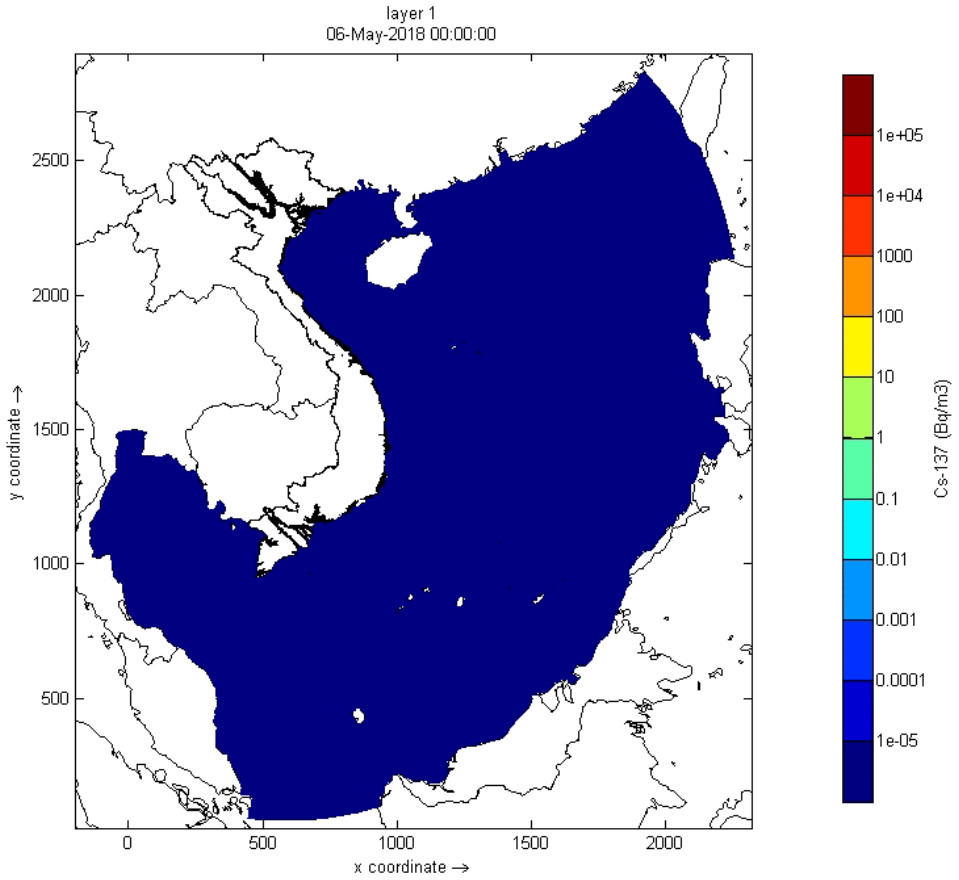


Comparison the seawater level simulated from the model and observed at Hon Ngu hydrographic station (8/2018)



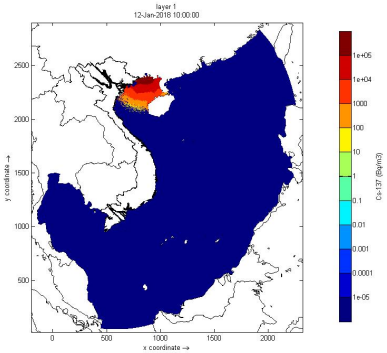
Comparison of the flow velocity simulated from the model and observed in the coastal area of Thanh Hoa. (8/2018)

Test Results

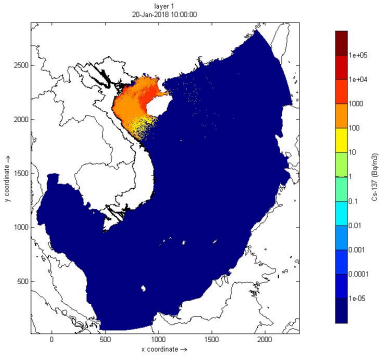


Release 2 PBq Cs-137

Direct discharge into the sea

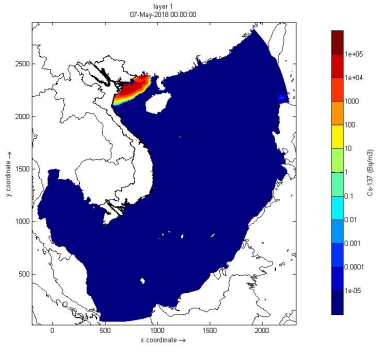


a) 7 days after accident

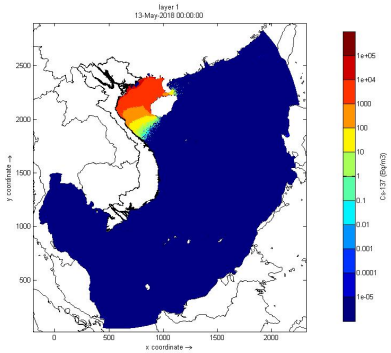


b) 15 days after accident

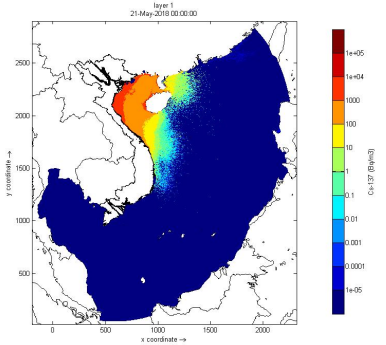
Deposition from the air into the sea



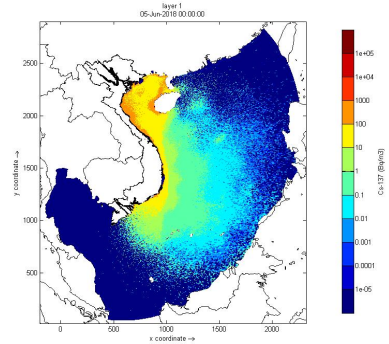
a) 1 day after accident



b) 7 days after accident



c) 15 days after accident



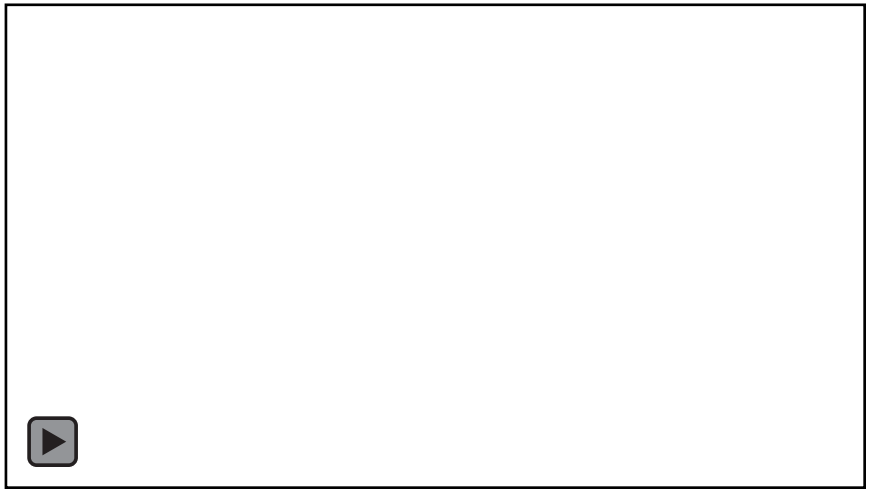
d) 30 days after accident

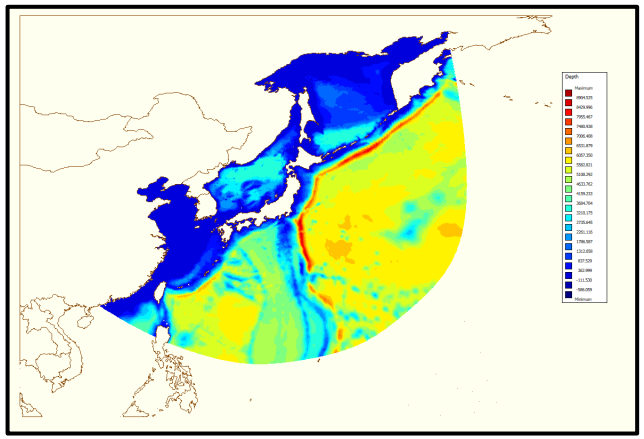
Conclusion

- Cs-137 travel faster in scenarios of deposition from the air than direct discharge .
- Combining Flexpart and Delft-3D will better simulate the dispersion in the water environment.

Future work

- Verify the combined model through parameters such as diffusion coefficient, total emissions,…





Thank you for your attention