MODARIA WG10

Modelling of marine dispersion and transfer of radionuclides accidentally released from land-based facilities.

Interim meeting

- University of Seville, Spain. 17-19 June, 2015
- Participants from Rep. of Korea, Japan, Ukraine, Norway, Spain
- Discussions:
  - Last Fukushima exercise: final results
  - Final report
  - Preparation of papers
  - Plans for MODARIA-II
  - Joint meeting with WG3

WG 10 results

- R. Periáñez, R. Bezhenar, M. Iosjpe, V. Maderich, H. Nies, I. Osvath, I. Outola, G. de With (2015). A comparison of marine radionuclide dispersion models for the Baltic Sea in the frame of IAEA MODARIA program. Journal of Environmental Radioactivity 139, 66-77.

- R. Periáñez, I. Brovchenko, C. Duffa, K.T. Jung, T. Kobayashi, F. Lamego, V. Maderich, B.I. Min, H. Nies, I. Osvath, M. Psaltaki, K.S. Suh (2015). A new comparison of marine dispersion model performances for Fukushima Dai-ichi releases in the frame of IAEA MODARIA program. Journal of Environmental Radioactivity 150, 247-269.

- R. Periáñez, R. Bezhenar, I. Brovchenko, C. Duffa, M. Iosjpe, K.T. Jung, T. Kobayashi, F. Lamego, V. Maderich, B.I. Min, H. Nies, I. Osvath, I. Outola, M. Psaltaki, K.S. Suh, G. de With. An overview of marine pollution modelling activities in IAEA (International Atomic Energy Agency) MODARIA program: lessons learnt from the Baltic Sea and Fukushima scenarios. Submitted to Marine Pollution Bulletin.

- R. Periáñez, R. Bezhenar, I. Brovchenco, Byung-Il Min, C. Duffa, M. Iosjpe, K. Jung, T. Kobayashi, Kyung-Suk Suh, F. Lamego, V. Maderich, H. Nies, I. Osvath, I. Outola, M. Psaltaki, G. de With. MODARIA Marine Transport Modelling. In International Expert Meeting on Assessment and Prognosis in Response to a Nuclear or Radiological Emergency. Vienna, 20-24 April 2015.

- WG-10 Final Report: Draft finished

WG10 scenarios on accidental releases in the marine environment

1) Fukushima releases in the Pacific Ocean

- Intercomparison of hydrodynamic submodels
- Intercomparison of dispersion models

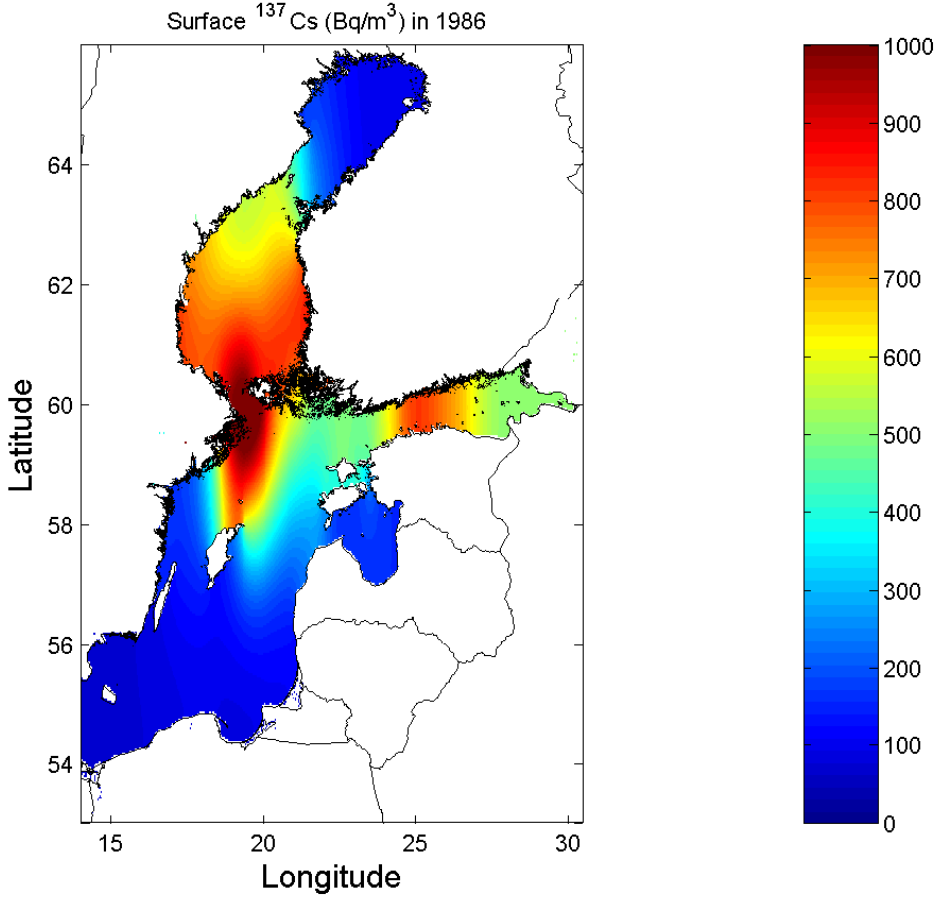
2) The Baltic Sea: modelling Chernobyl fallout

- Results provided by 4 models:
    - NRPA box model
    - POSEIDON box model
    - USEV hydrodynamic model
    - THREETOX hydrodynamic model
- Results compared with HELCOM database measurements

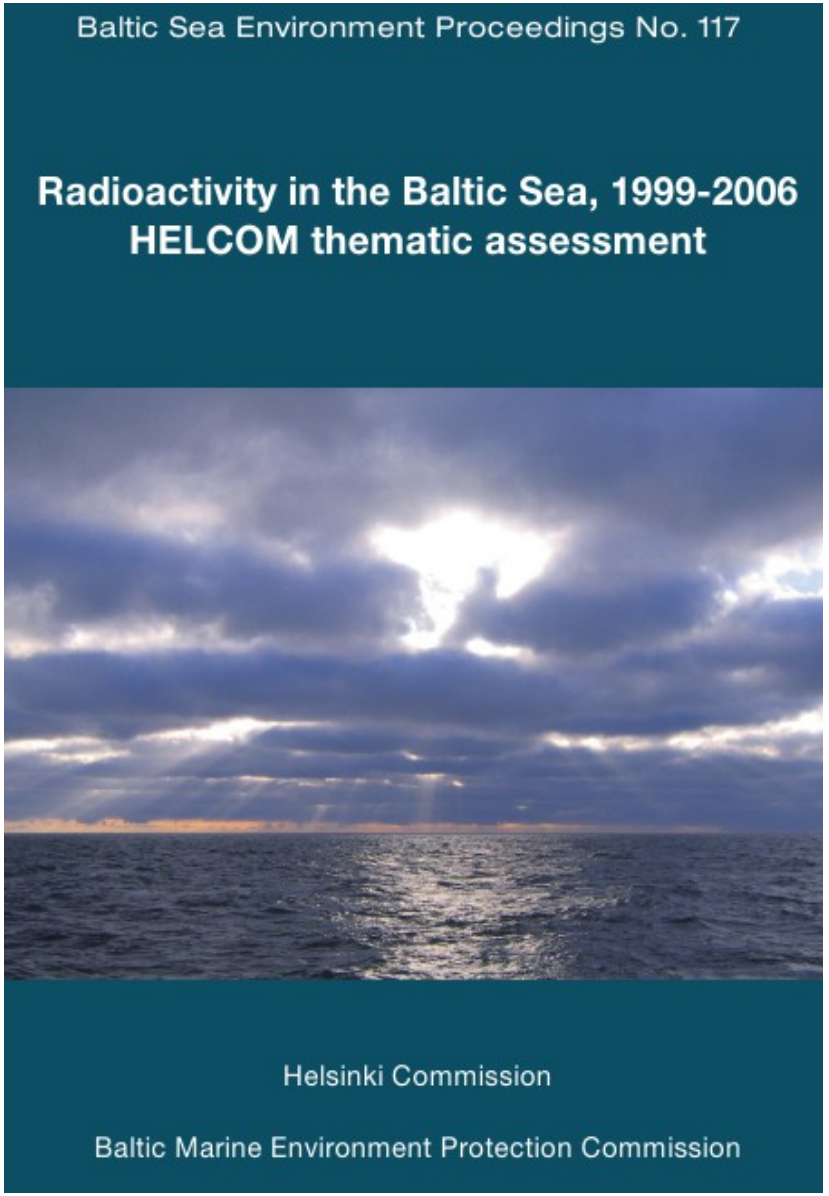
Baltic Sea scenario

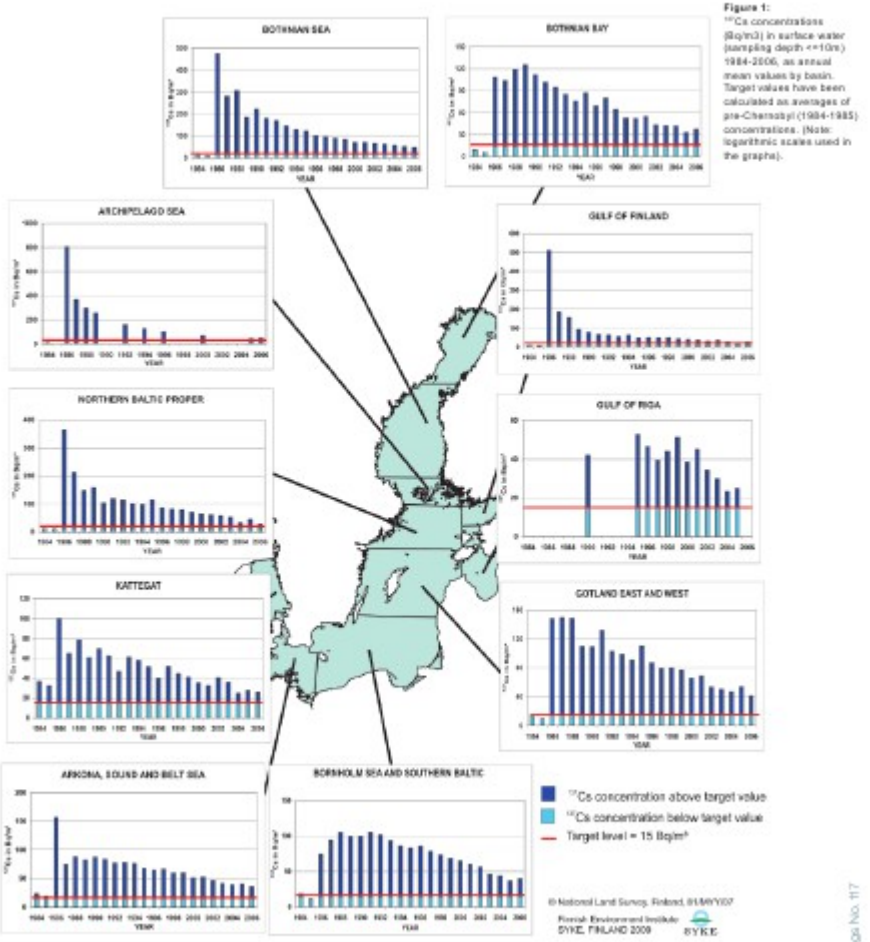
5 year of calculation from October 31, 1986

- Maps of 137-Cs concentration in surface water and sediments in October 31, 1991
- Time series of 137-Cs inventories in the water column and bed sediments
- Time series of concentrations in water and sediments at selected locations
- Mean concentrations in water and sediments in several sub-basins



Model results compared with HELCOM data



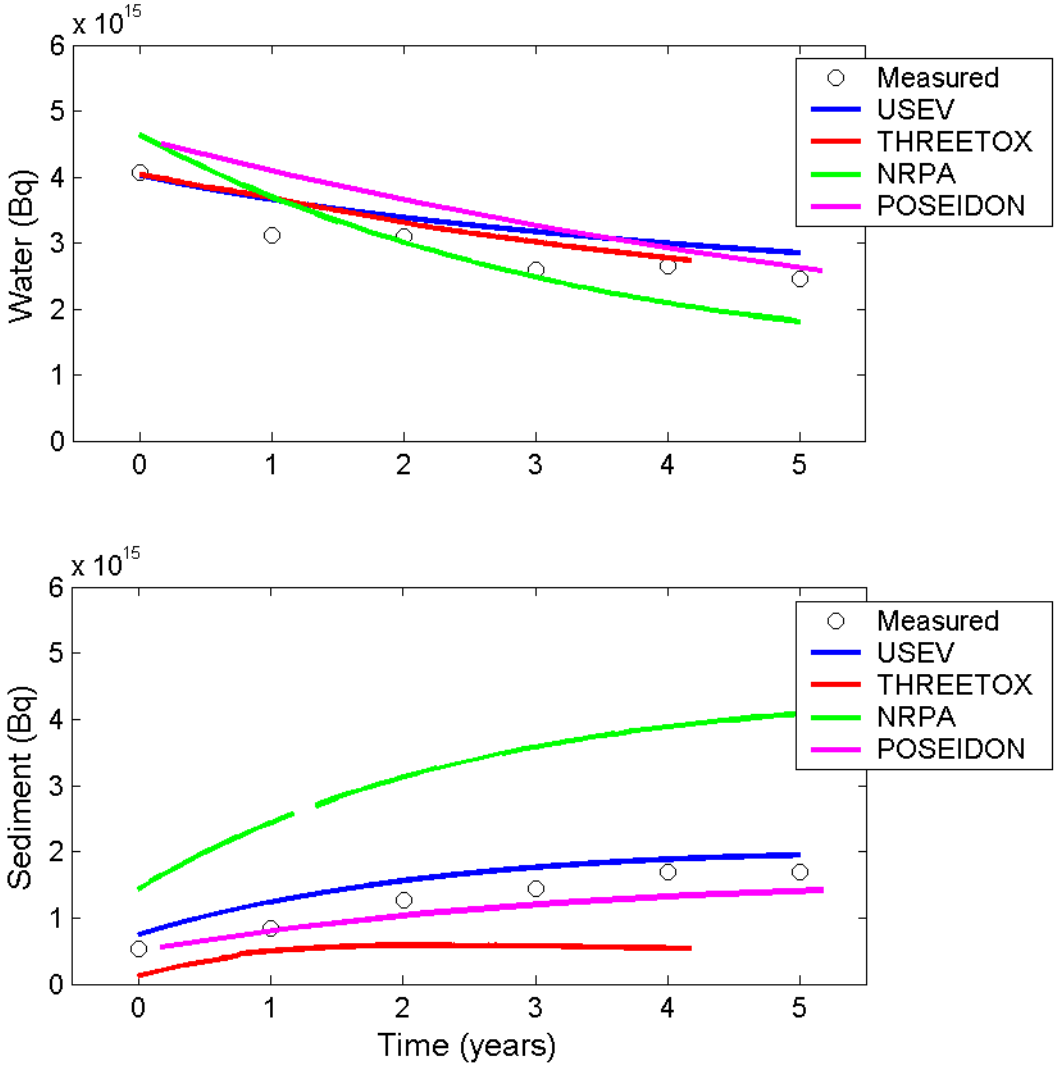


Applied models

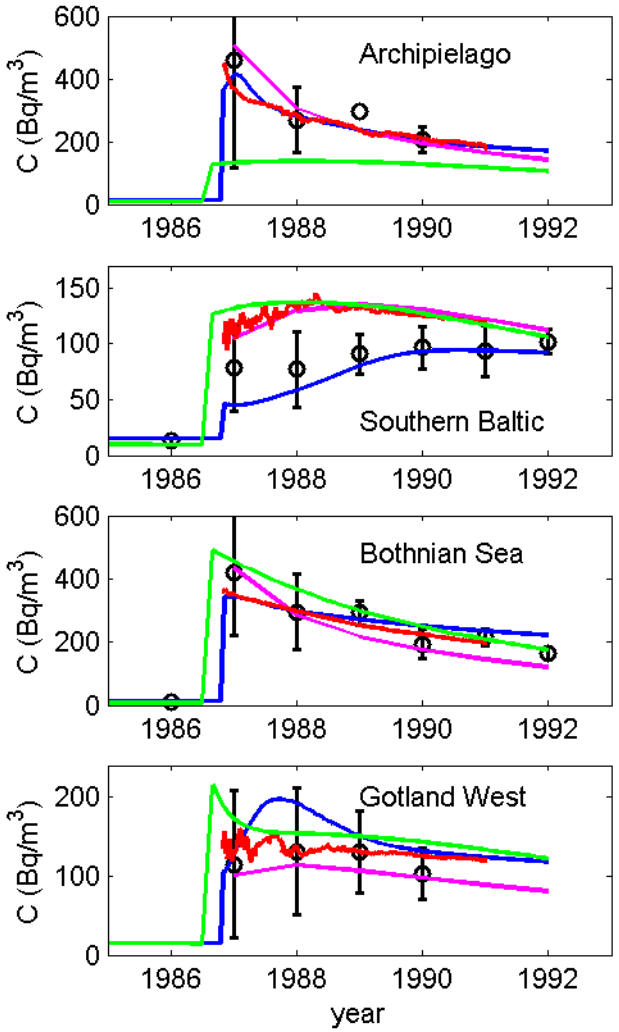
- POSEIDON box model
- NRPA box model
- THREETOX: 3D hydrodynamic model
- USEV: 2D depth-averaged model, forced with annual mean wind

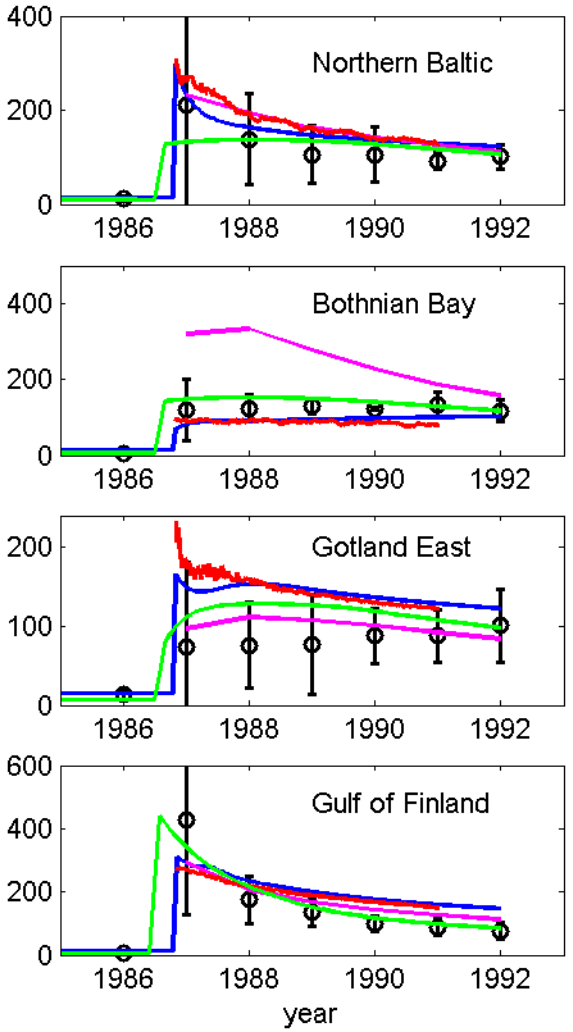
Water/sediment interactions included in all models

Inventories in the Baltic



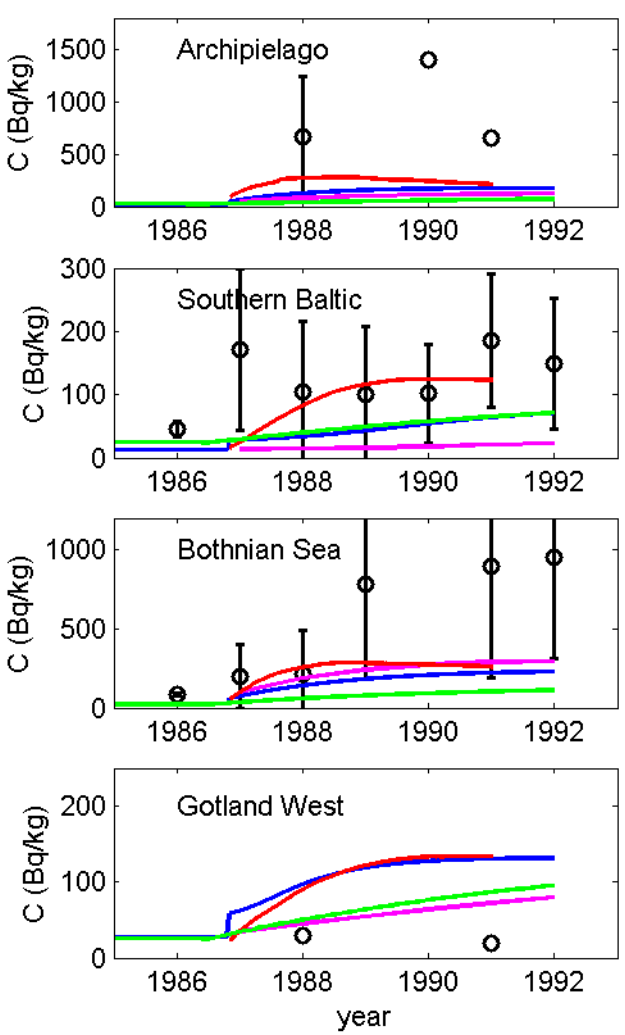
Calculated and measured concentrations in water

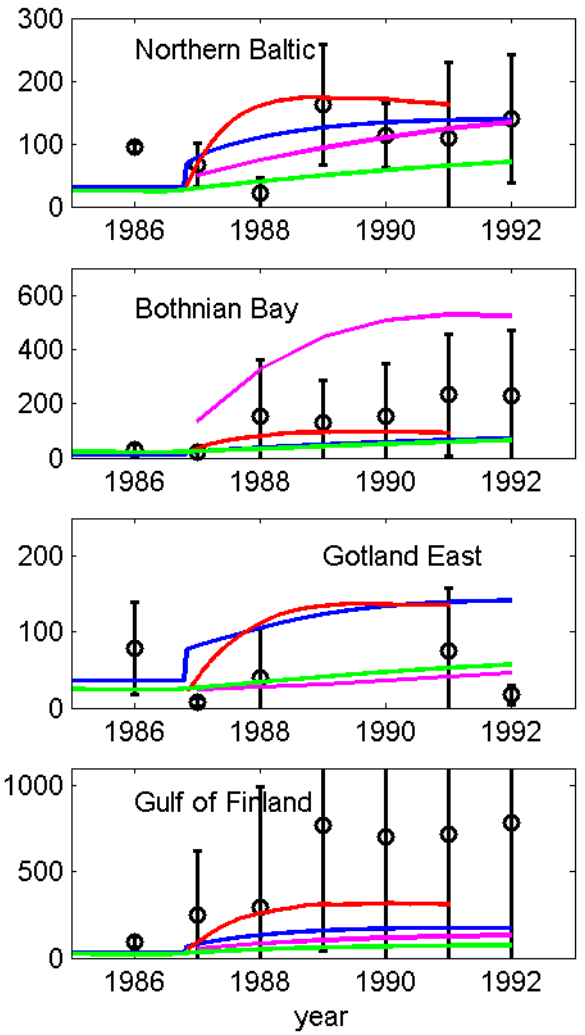




Magenta: POSEIDON
Red: THREETOX
Green: NRPA
Blue: USEV

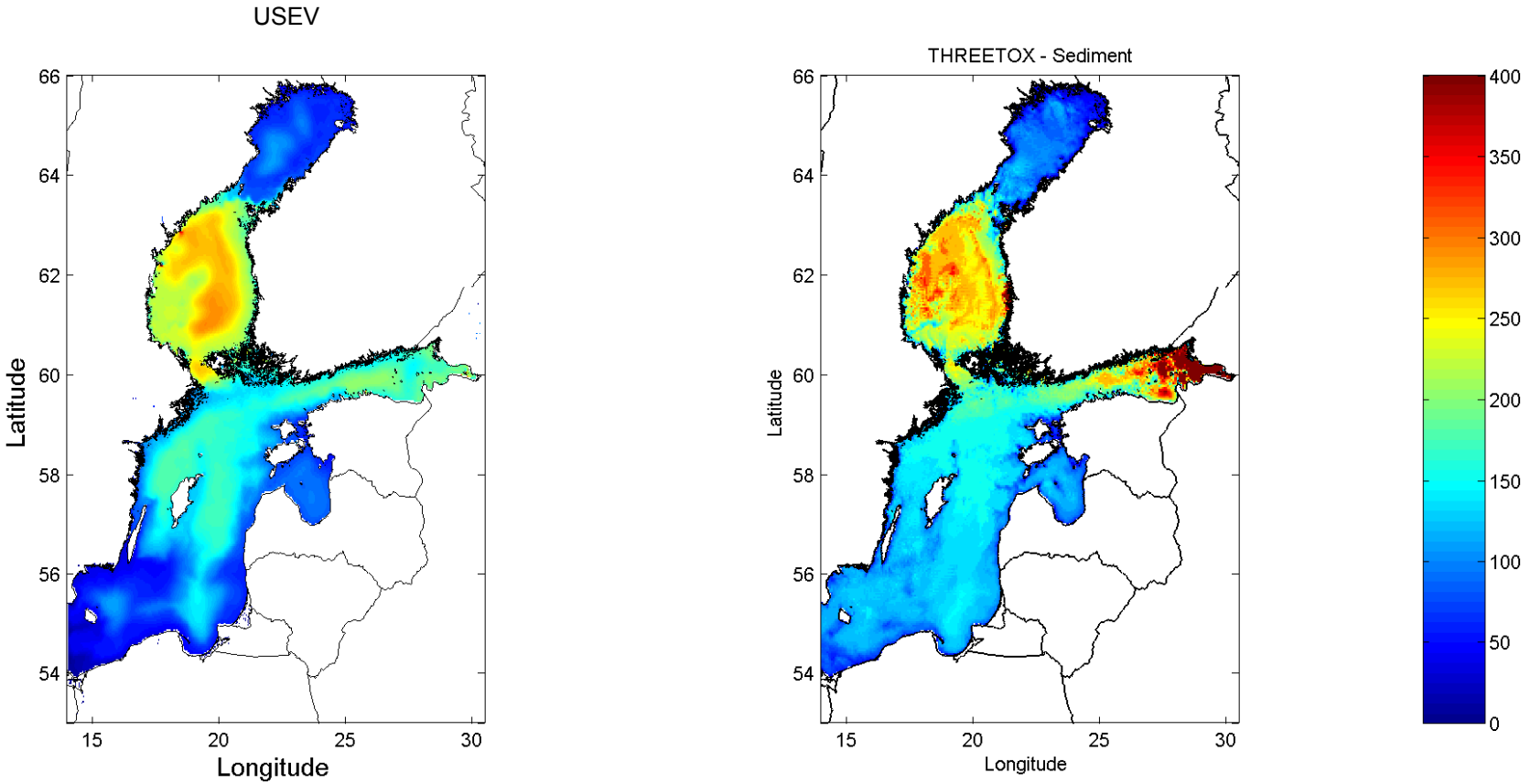
Calculated and measured concentrations in sediments





Magenta: POSEIDON
Red: THREETOX
Green: NRPA
Blue: USEV

Concentrations in sediments (Bq/kg) after 5 years



Fukushima: participating models

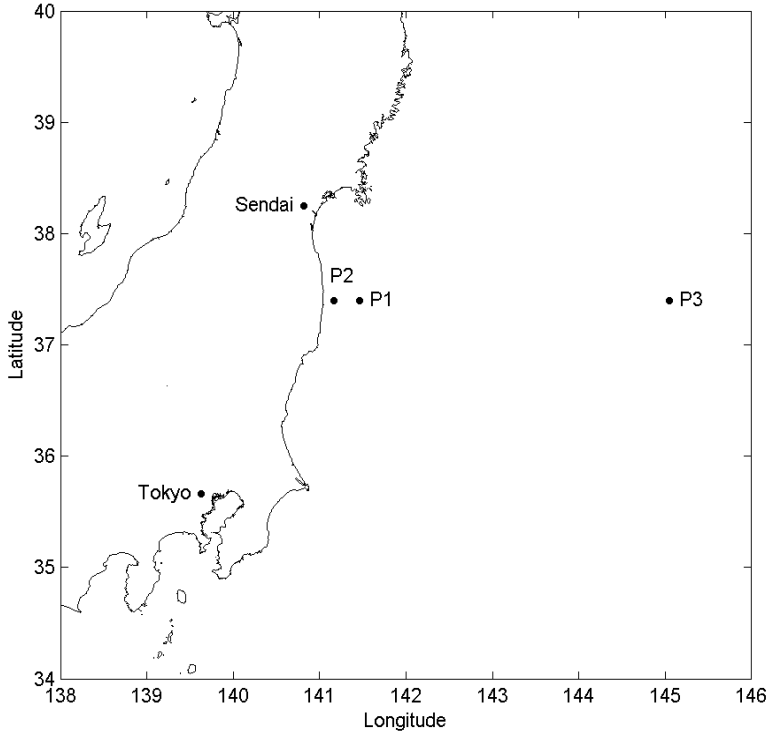
Institute	Scale	Circulation	Model type
KAERI	Regional, global	NCOM, JCOPE2	Lagrangian
JAEA	Local, regional, global	Kyoto University	Lagrangian
Univ. Tolouse	Regional	Own, NCOM bound. cond.	Eulerian
Univ. Seville	Local	JCOPE2, HYCOM	Eulerian
IEN, Brasil	Local	Own	Eulerian
NTUA, Greece	Local	Own	Eulerian
IMMSP/KIOST Ukraine	regional	Own, HYCOM bound. cond.	Eulerian and Lagrangian

All models are three-dimensional dynamic models

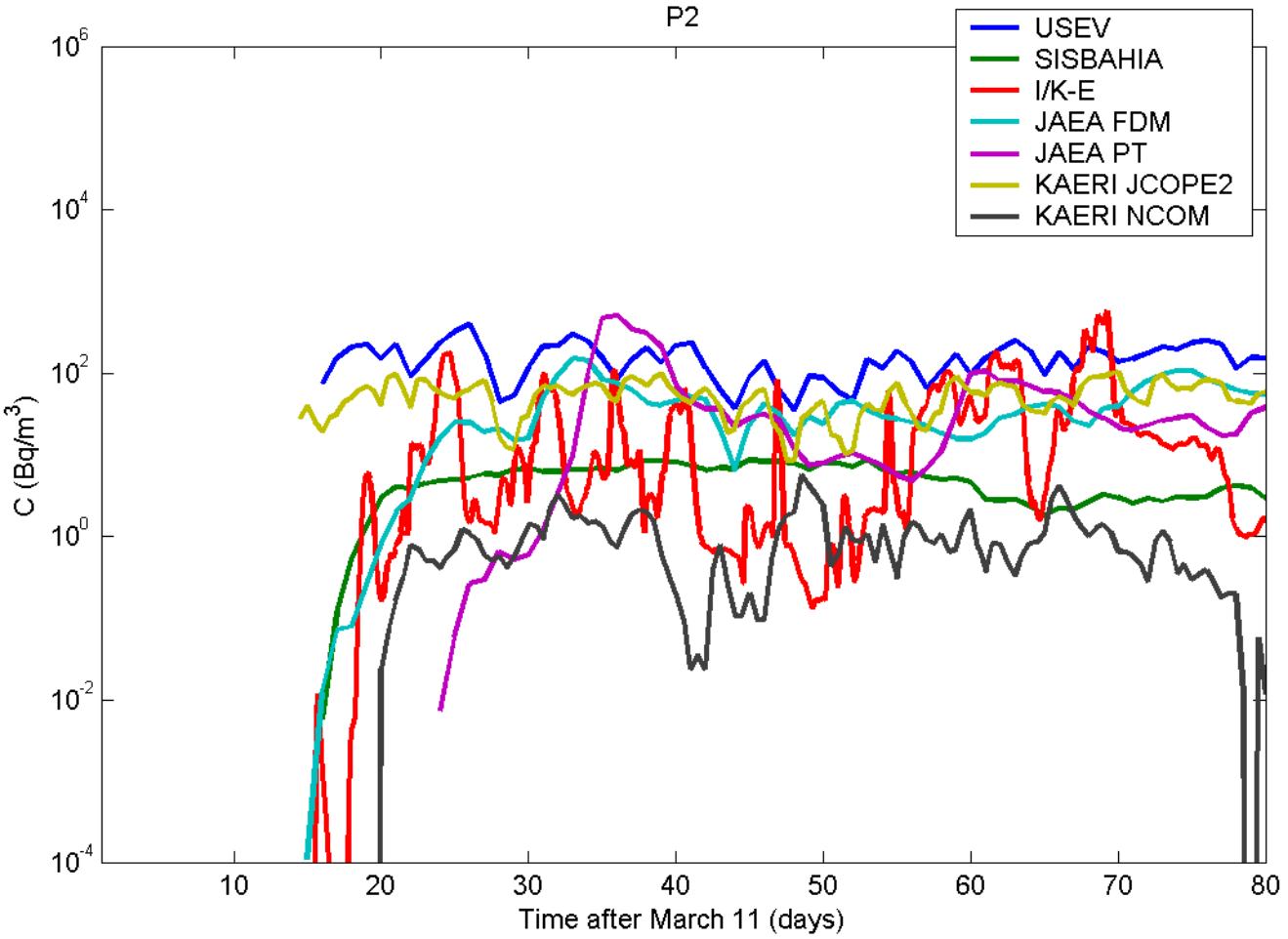
Fukushima first modelling exercise

Constant release (hypothetical magnitude) of a perfectly conservative radionuclide (no water/sediment interactions)

Compare time series of concentrations at the sea surface for the period March 11-May 30



Results



Each team uses its own hydrodynamics

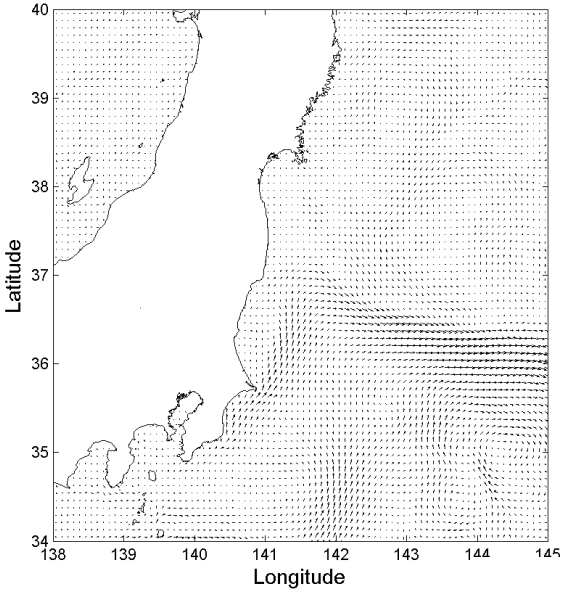
Constant hypothetical release

Conservative radionuclide

What is happening?

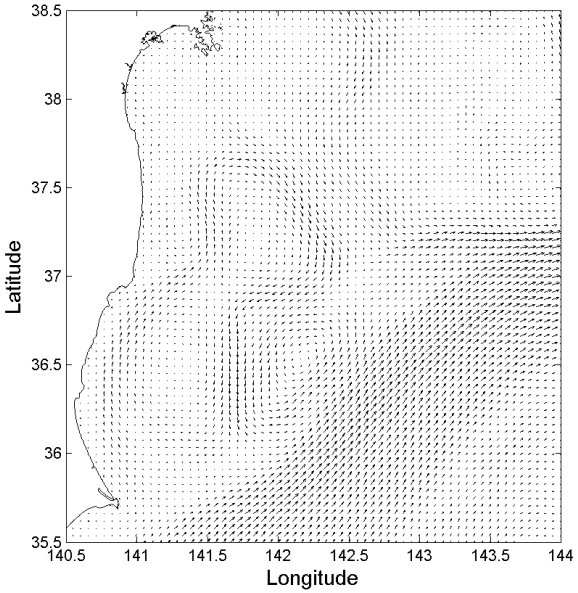
- Baltic Sea: very different models and similar results
- Fukushima: similar models and different results
- A marine dispersion model consists of two sub-models:
  - Hydrodynamic sub-model
  - Dispersion sub-model (transport by currents, turbulent mixing, water/sediment interactions)
- Let´s try to know the origin of discrepancies: model harmonization

Current field examples, April 30th (sea surface)

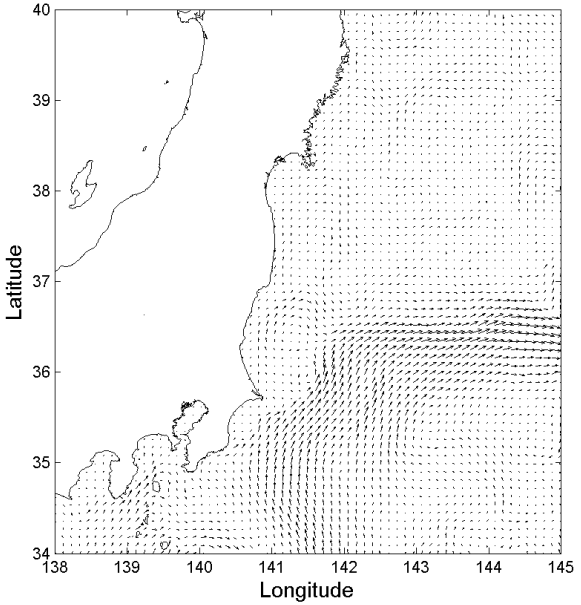


JCOPE2

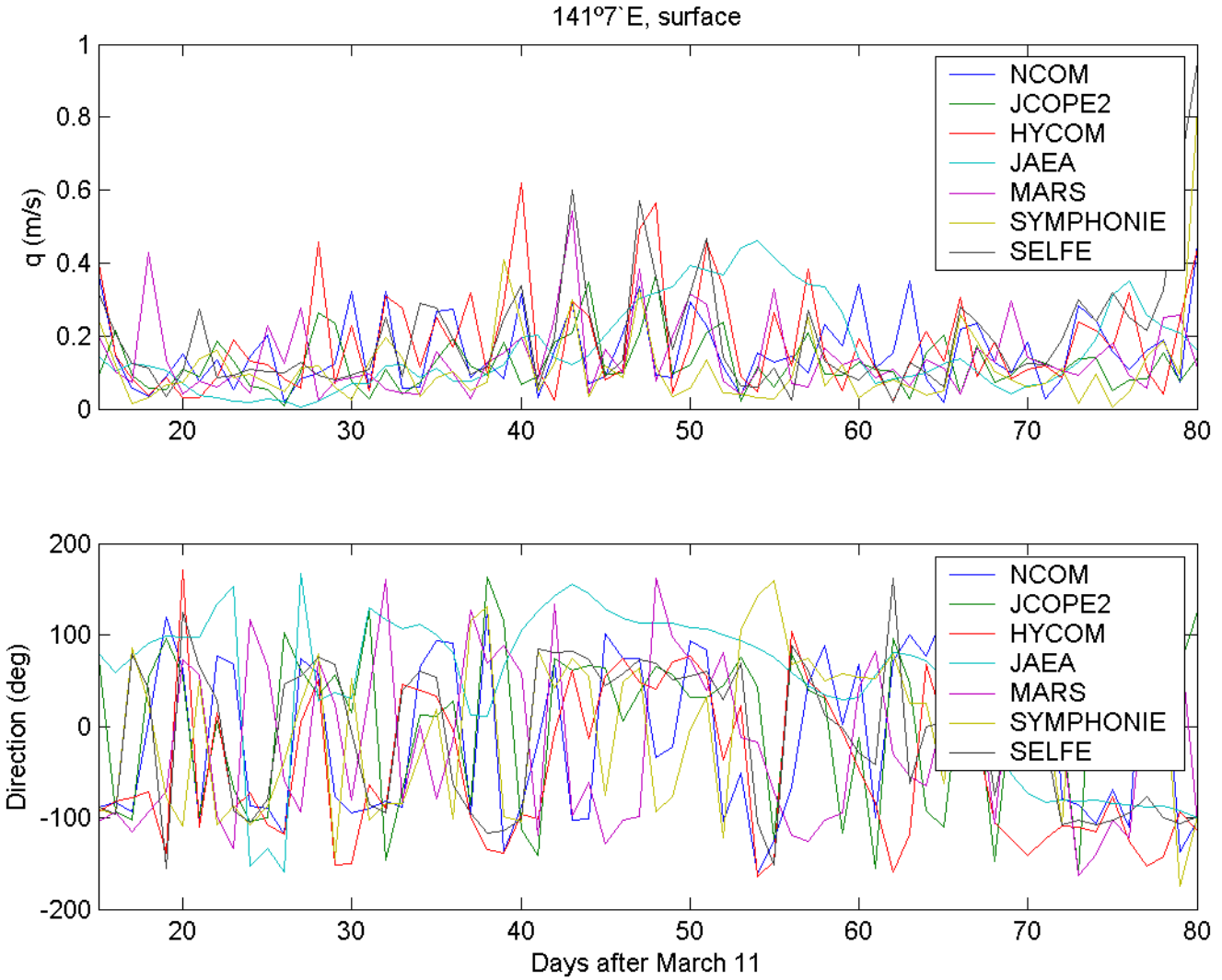
Kyoto Univ.



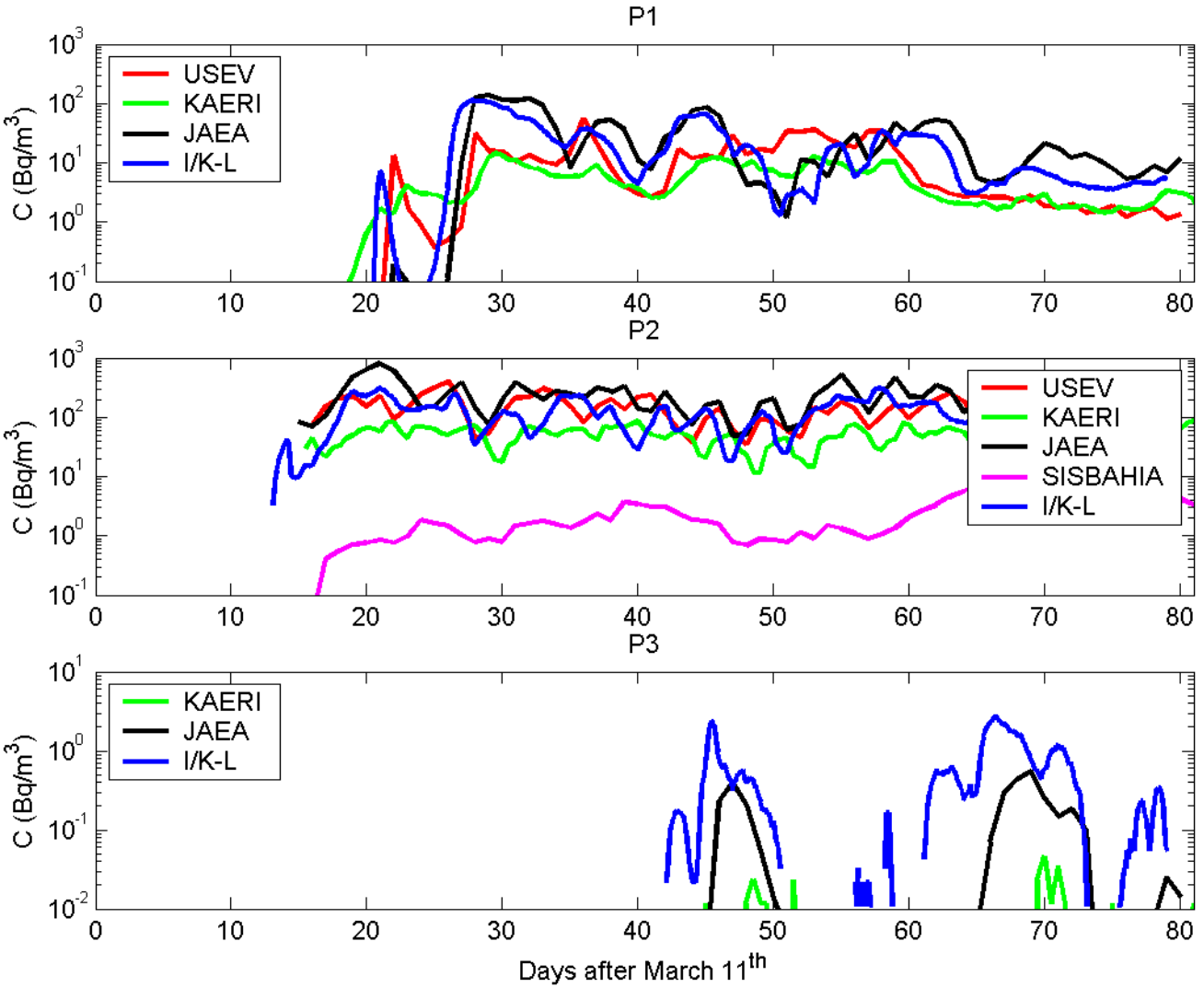
NCOM



Time series of currents



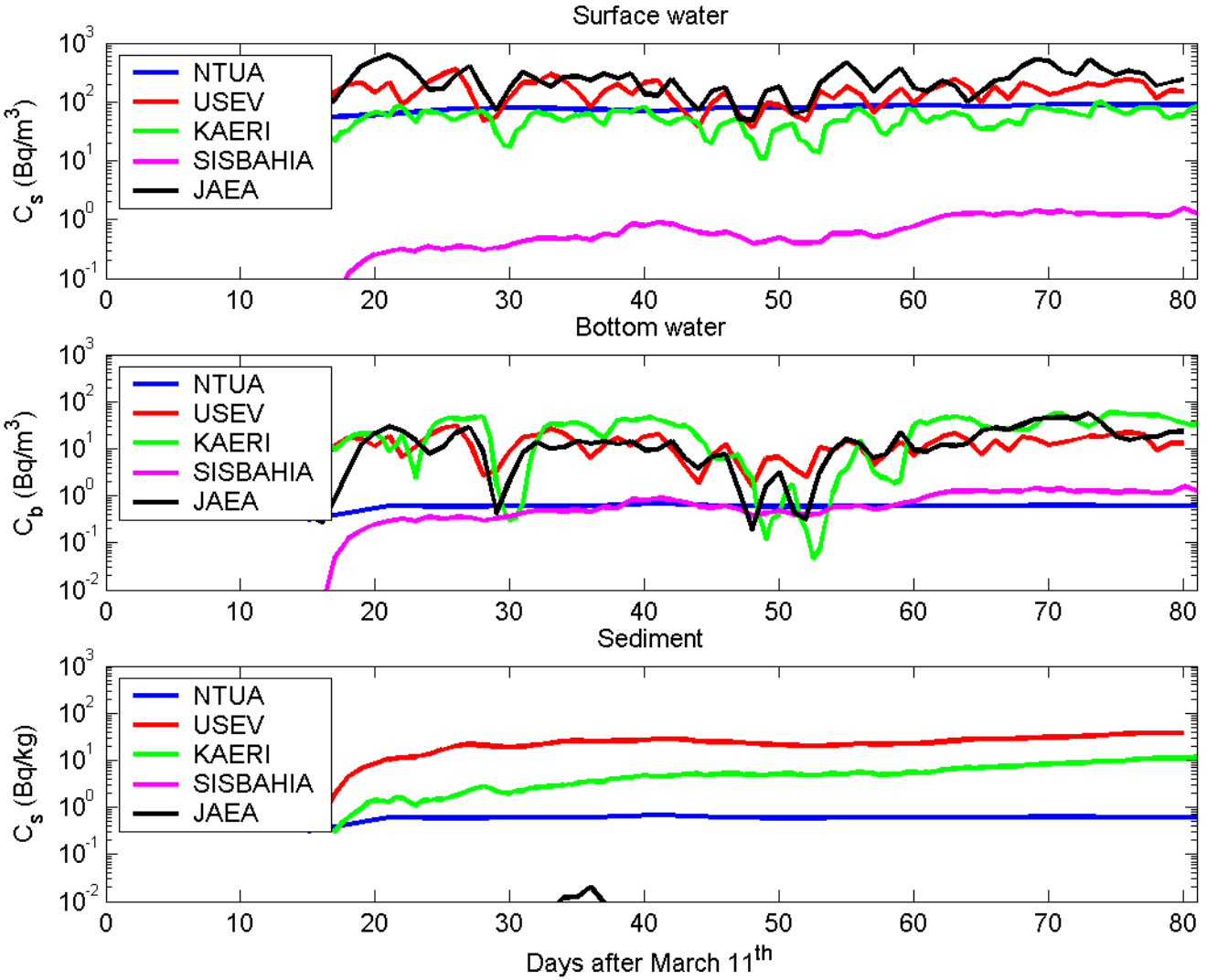
Exercise 2: tracer



All models use JCOPE2 model circulation

Same constant hypothetical release

Exercise 2: 137-Cs (water/sediment interactions included)



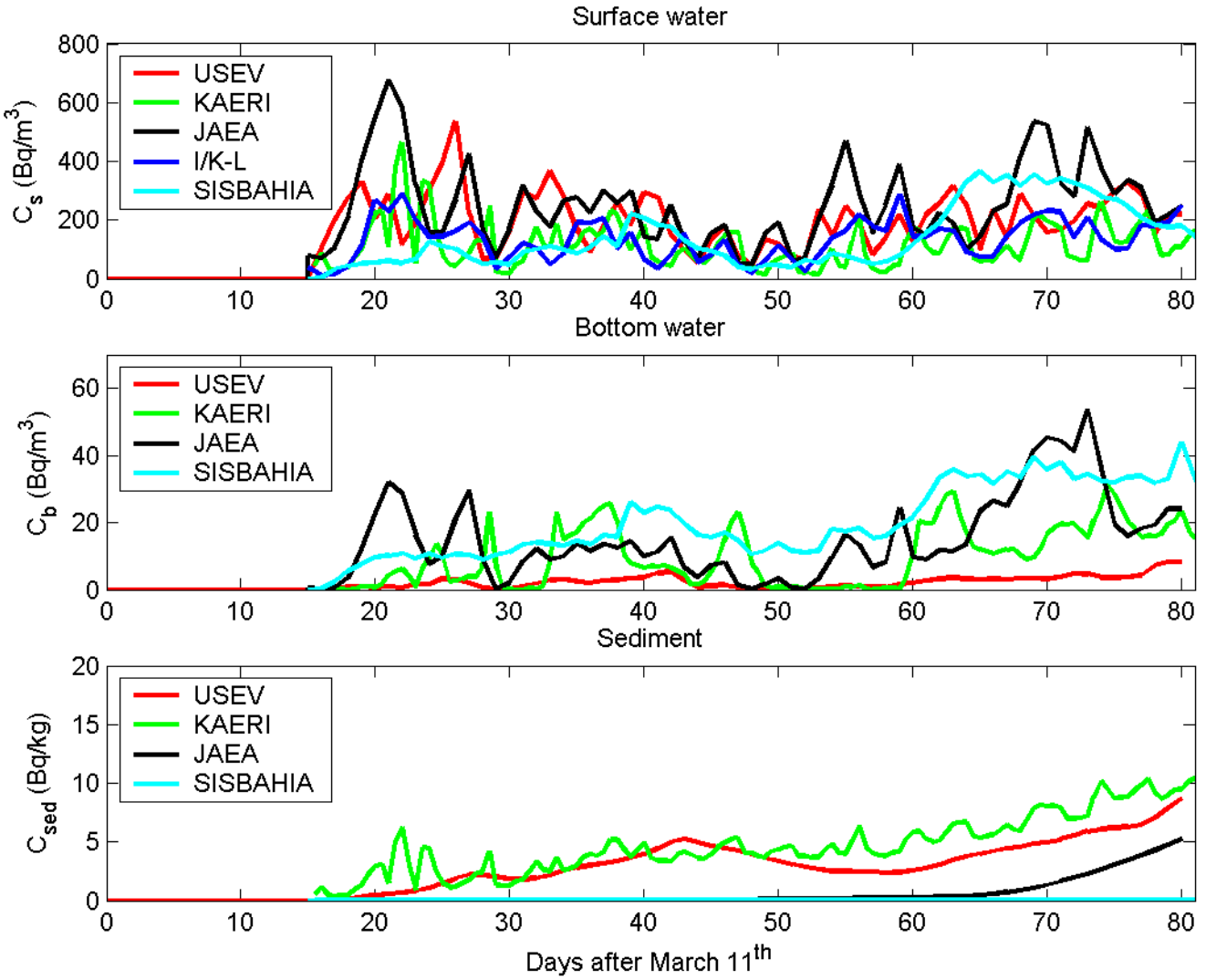
P2

Exercise 3

- Same circulation
- Exactly the same bathymetry
- Same diffusion coefficients
- Same adsoption/desorption parameters

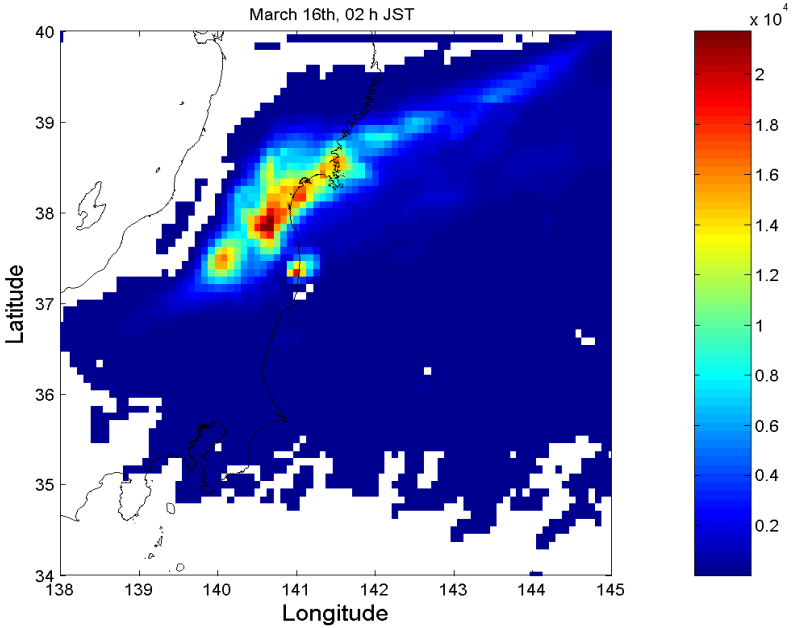
- *In the case of a tracer, results do not significantly improve with respect to exercise 2. The main reason of discrepancy between models is water circulation*

Exercise 3: 137-Cs



P2

Next step: comparisons with measurements (exercise 4)

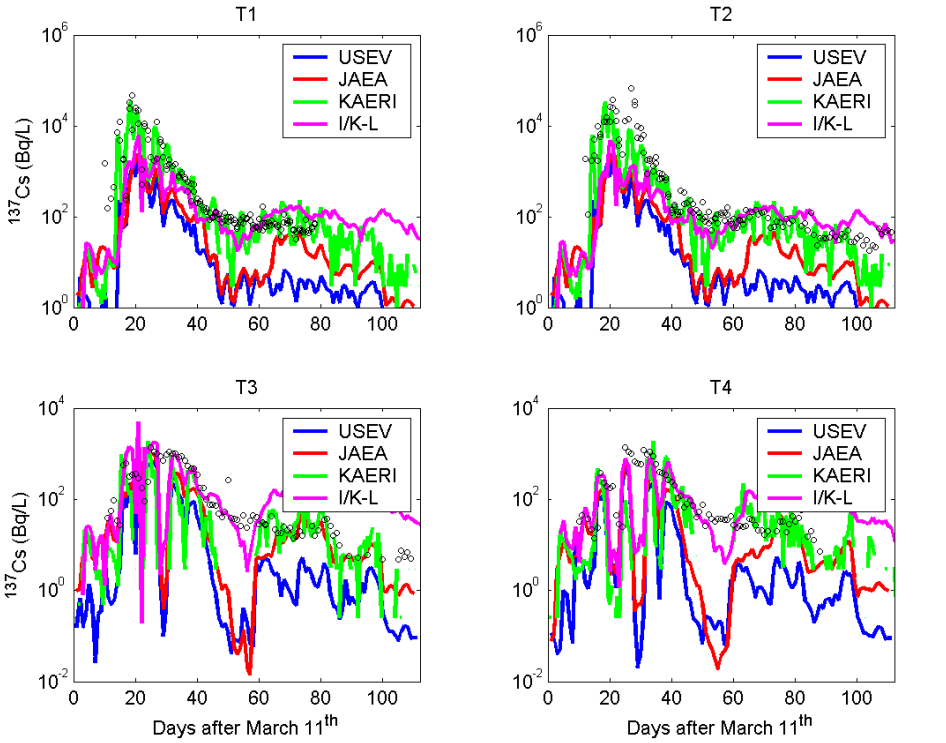


Atmospheric deposition: from atmospheric dispersion models

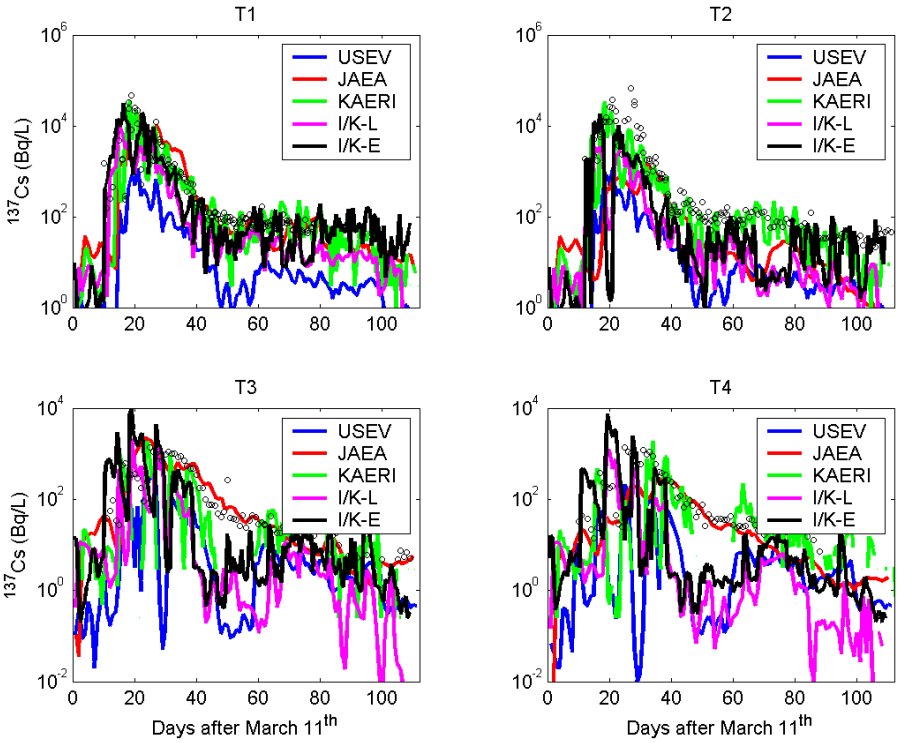
Direct releases: reconstructed from TEPCO measurements in the release area

Points sampled by TEPCO

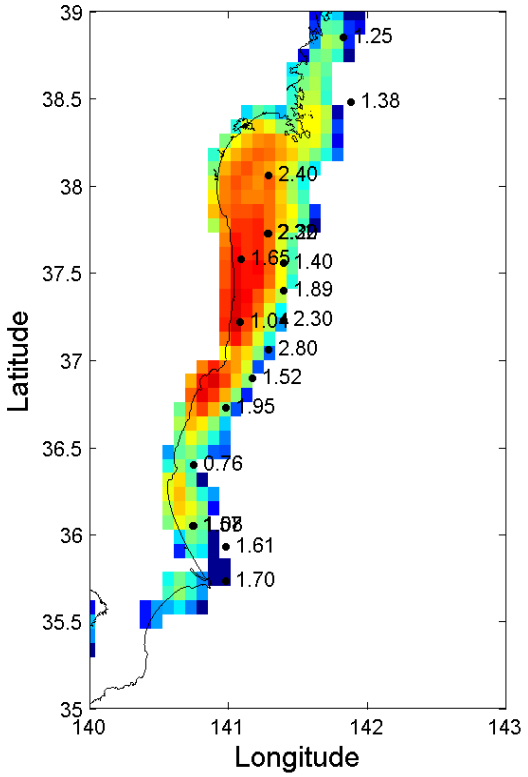
Exercise 4a (same circulation, parameters)



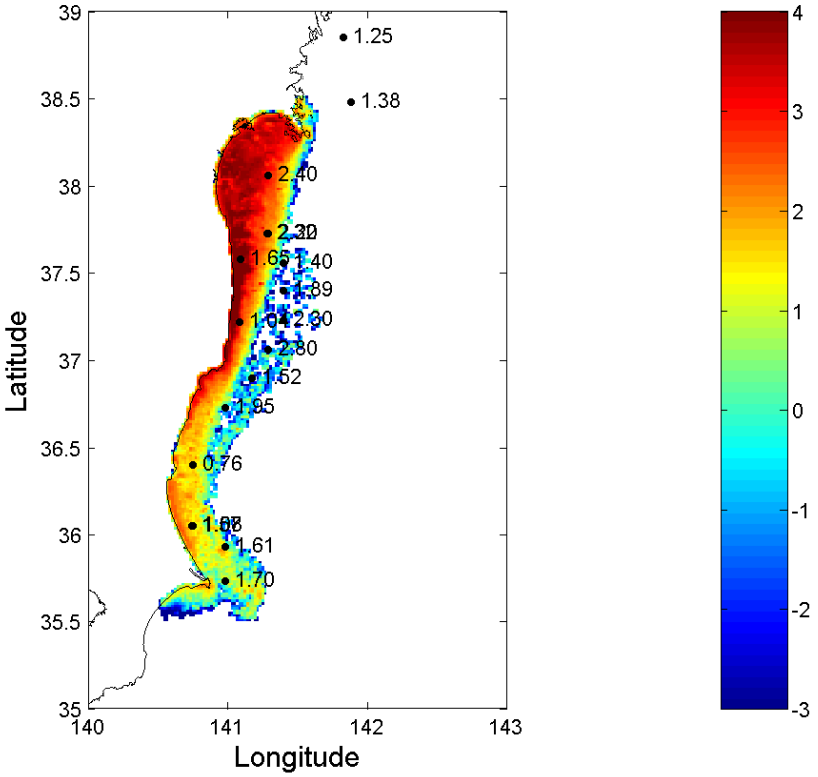
Exercise 4b (modeler expertise)



Concentrations in sediments (Bq/kg)



JAEA-4a
(JCOPE2)



JAEA-4b
(Univ. Kyoto)

Conclusions

- Dispersion models are robust tools (consistent results in the Baltic), but:
- Large differences in model output occur in highly dynamic systems, with strong and variable currents (model harmonization required in Fukushima)
- This highlights the difficulties in developing operative models for decision-making support in these dynamic environments
- Further research in this field is required (MODARIA-II?)

Plans for this week

- Final report
- Further discussions on MODARIA-II possible topics