Assessment for dioxins concentration using a distributed multimedia model with two-layer atmosphere

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Background

POPs (hazardous chemical substances) has strong persistence. Even if its discharge is regulated, it is accumulated into environment over a long time.
Therefore, POPs affect human health and ecosystem for a long time.

To evaluate the exposure of POPs, the fate model is one of the useful tools.

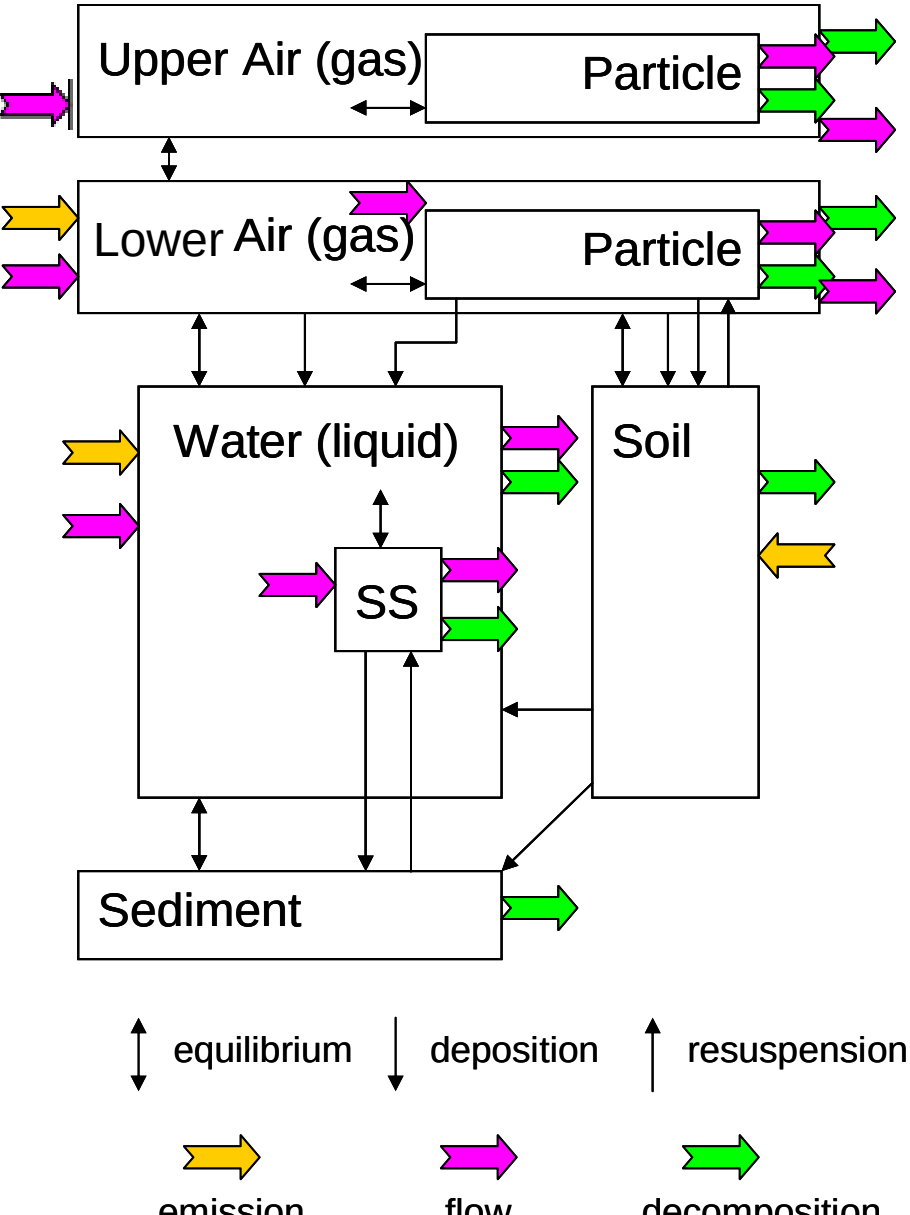
For POPs with strong persistence, multimedia model consisting of atmosphere, water body, soil, sediment and so on is practical.

Aim

Usual multimedia model consists of only a few boxes. Therefore the mean concentration in the target area can be evaluated but the distribution of concentration can't be evaluated.

In this study, the distributed multimedia model was developed to evaluate the distribution of dioxin concentration. Additionally atmosphere (one of multimedia) was divided into two layers and its validity was examined by comparing with measured data.

Multimedia Model



- ✓ **Mass transfer**
  - **atmosphere-water**
  - **gas-particle**
  - **liquid-SS**
- ✓ **Sedimentation, deposition**
  - **atmosphere to soil**
  - **water to sediment**
- ✓ **Re-suspend**
  - **soil to atmosphere**
  - **sediment to water**
- ✓ **Advection**
  - **Atmosphere / water body**

Multimedia Model

Chemical substance

Number of medis(8)

$$\frac{dM(i)}{dt} = f_{emi}(i) + f_{\deg}(i) + \sum_{j=1}^{MN} f_{eq}(i,j) + \sum_{j=1}^{MN} f_{dprs}(i,j) + f_{fl}(i)$$

Emission flux

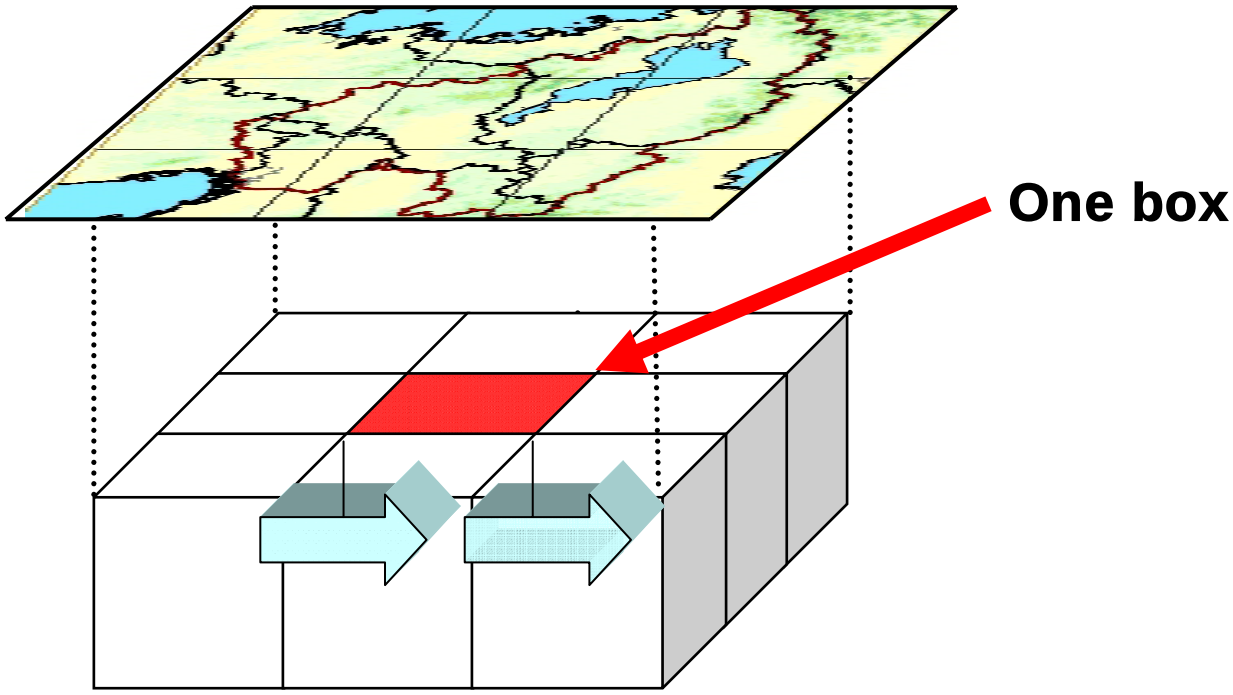
Degradation flux

Mass transfer flux between media

Sedimentation, deposition, and re-suspend flux

Advection flux

Distributed multimedia model



One box model can't consider advection by air flow and by water current. But the distributed multimedia model consisting of a lot of boxes can consider advection by air flow and by water current.

In one box, several physical transfer processes except for advection process are considered.

Calculation condition

Target substance: Dioxin

Representative substances of POPs

Target area: Yodo River basin

9000 meshes size:1km X 1km

Calculation period:1960 to 2035

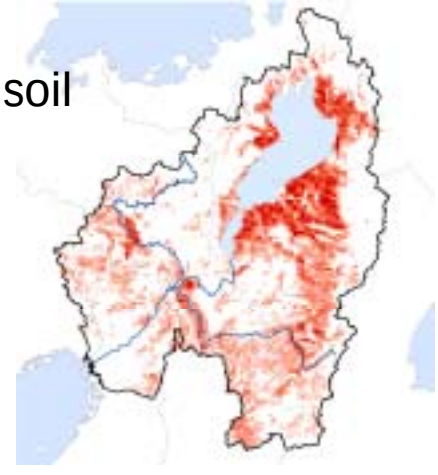
Input data

Emission

Estimation of annual dioxin emission to atmosphere, to river and to soil

Atmosphere

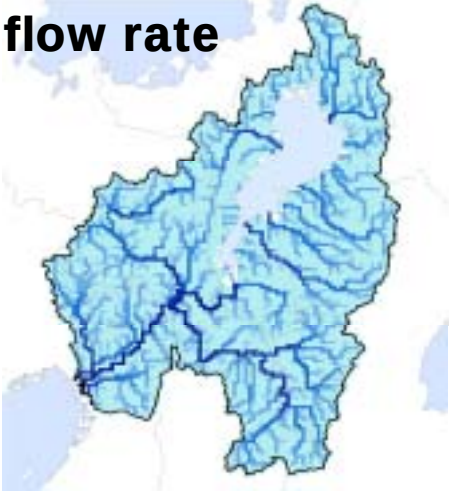
soil



Hydrological data

Annual river flow rate was Calculated by using hydrological model.

flow rate



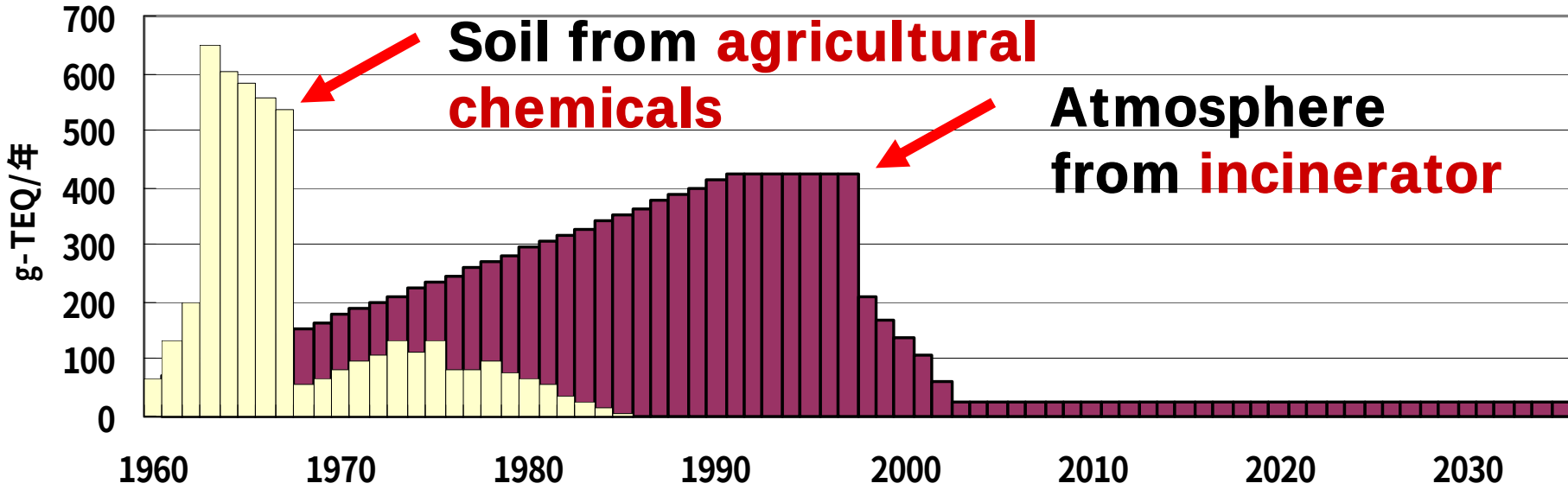
Meteorological data

Precipitation data from SPD

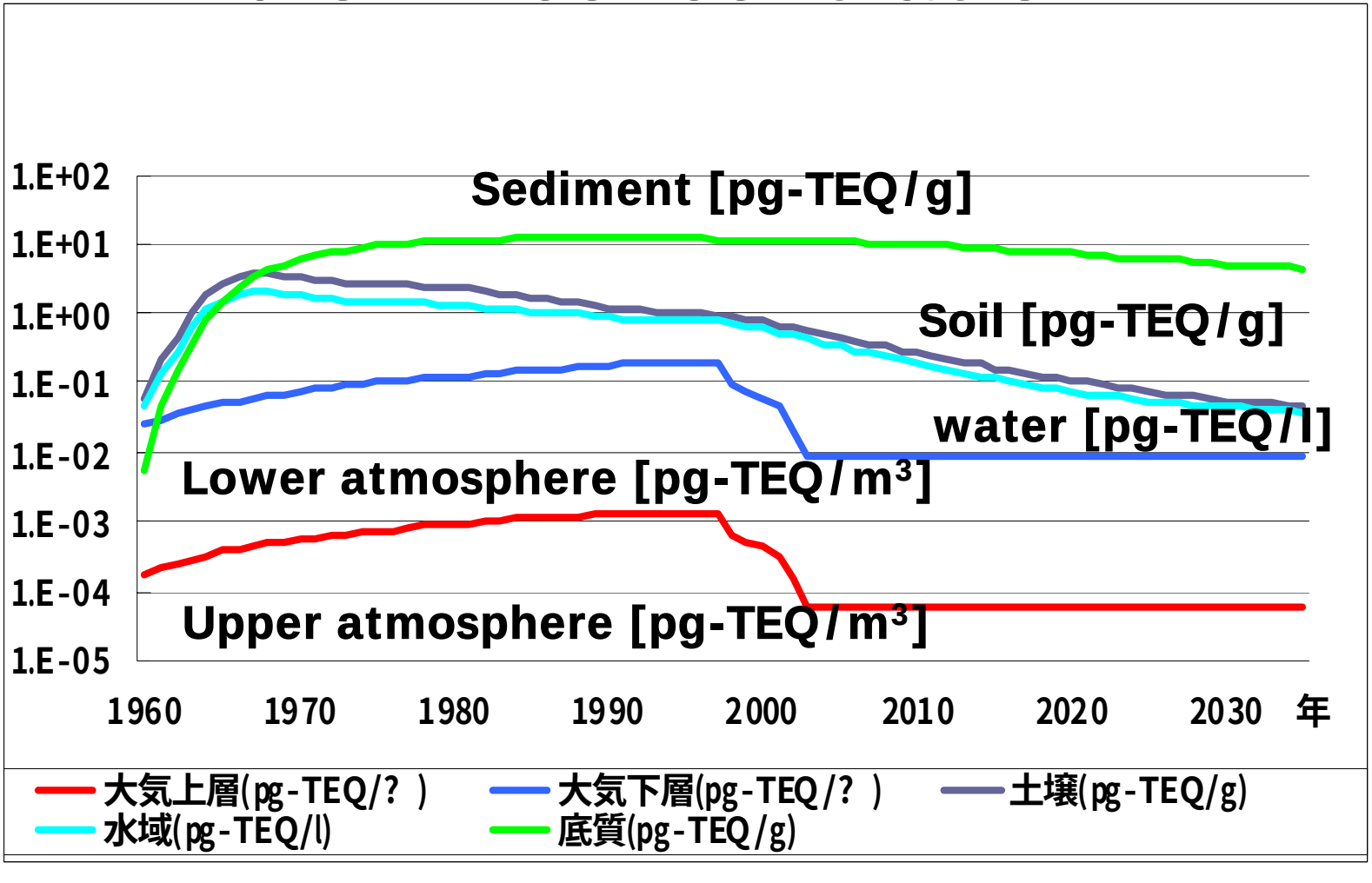
Wind speed and wind direction data from GPV data

Input data

Emission of dioxin

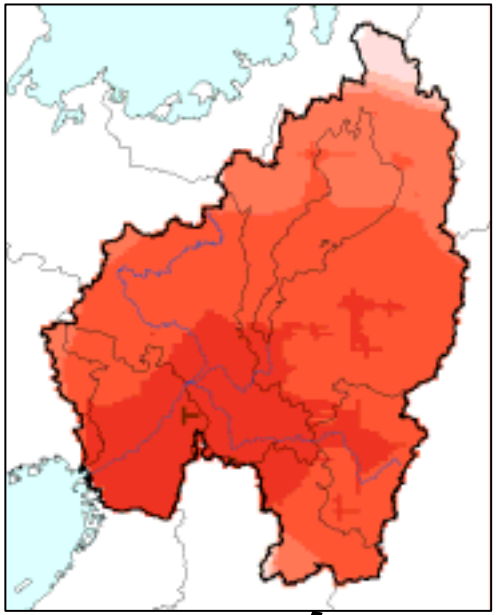


dioxin concentration

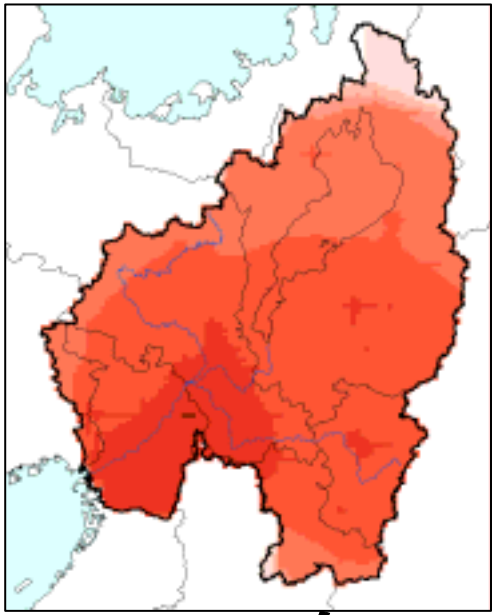


ioxin concentration increased from 1960s. It in soil and water decreased
rom the end of 1960s because of the prohibition of agricultural chemicals. It
n atmosphere decreased from the end of 2000s because of new regulation o

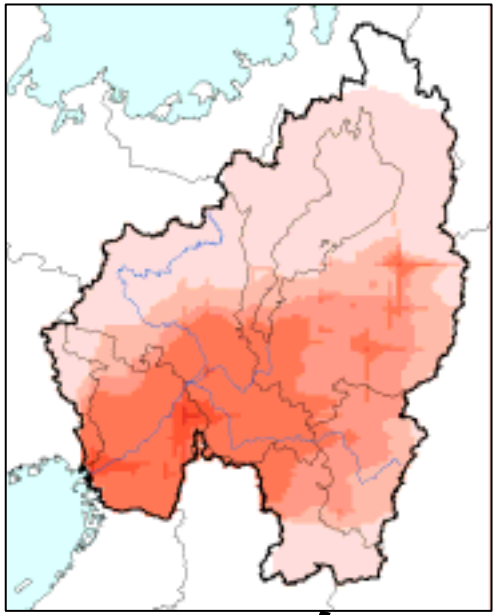
Dioxin concentration in lower atmosphere



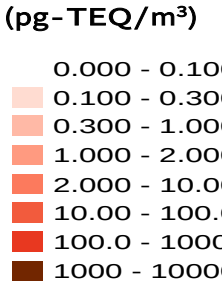
1970年



2000年

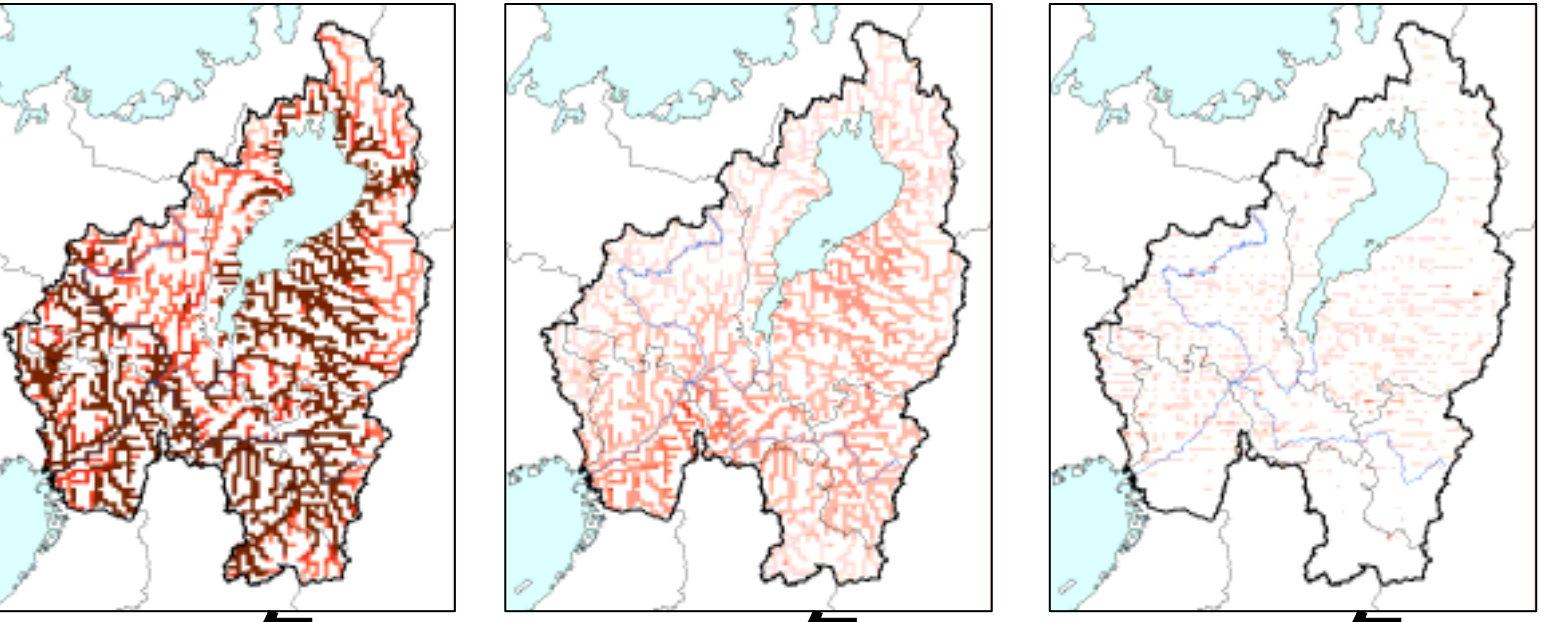


2035年



- High concentration in urban area (Yodo River downstream region)
- Because of new regulation of incinerator, concentration decreased

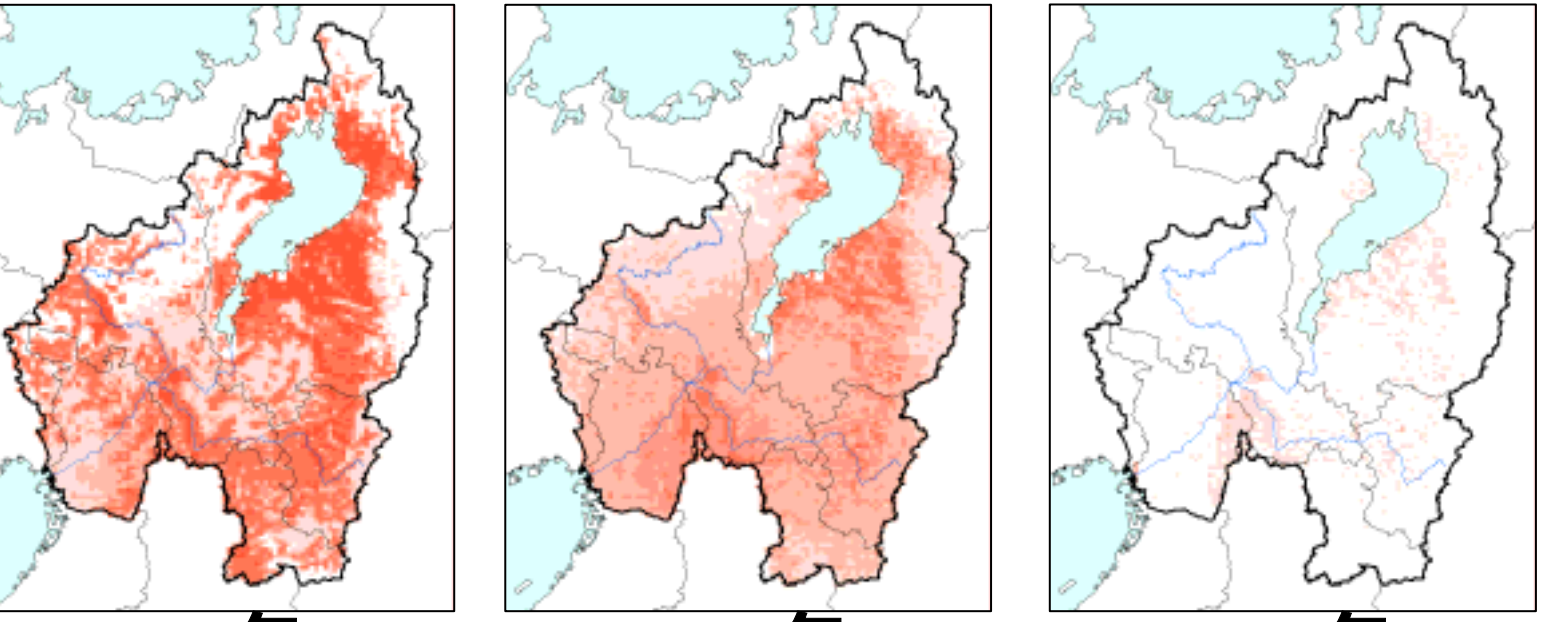
Dioxin concentration in water body



1970年　2000年　2035年

- High concentration in urban area (Yodo River downstream region)
- High concentration in paddy field

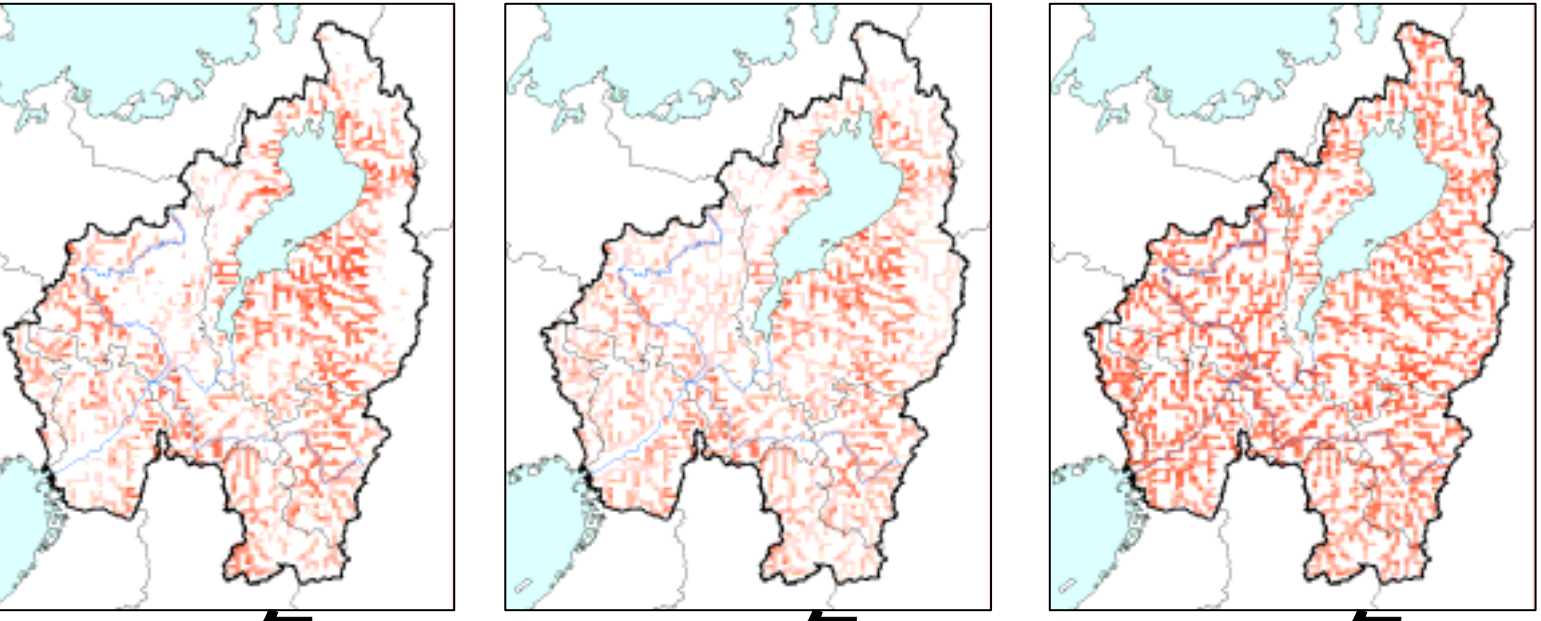
Dioxin concentration in soil



1970年　2000年　2035年

□High concentration in the west part of Lake Biwa because of use of agricultural chemicals

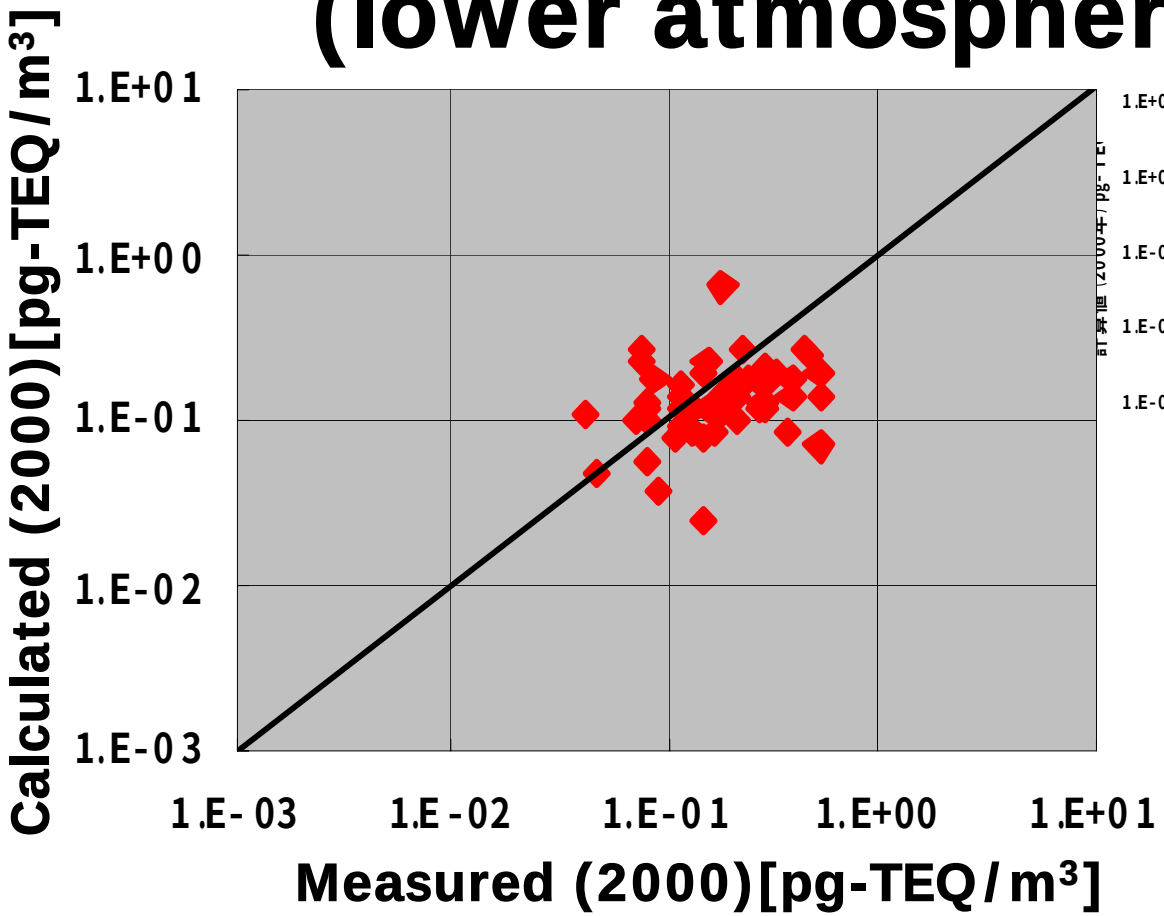
Dioxin concentration in sediment

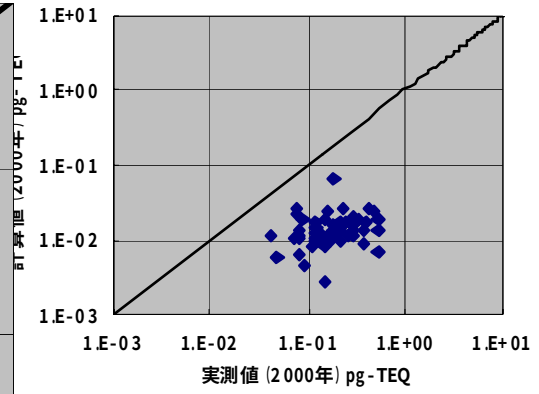


1970年　2000年　2035年

□Concentration is increasing year by year by sifting to sediment from soil and water body

Comparison with measured data (lower atmosphere)

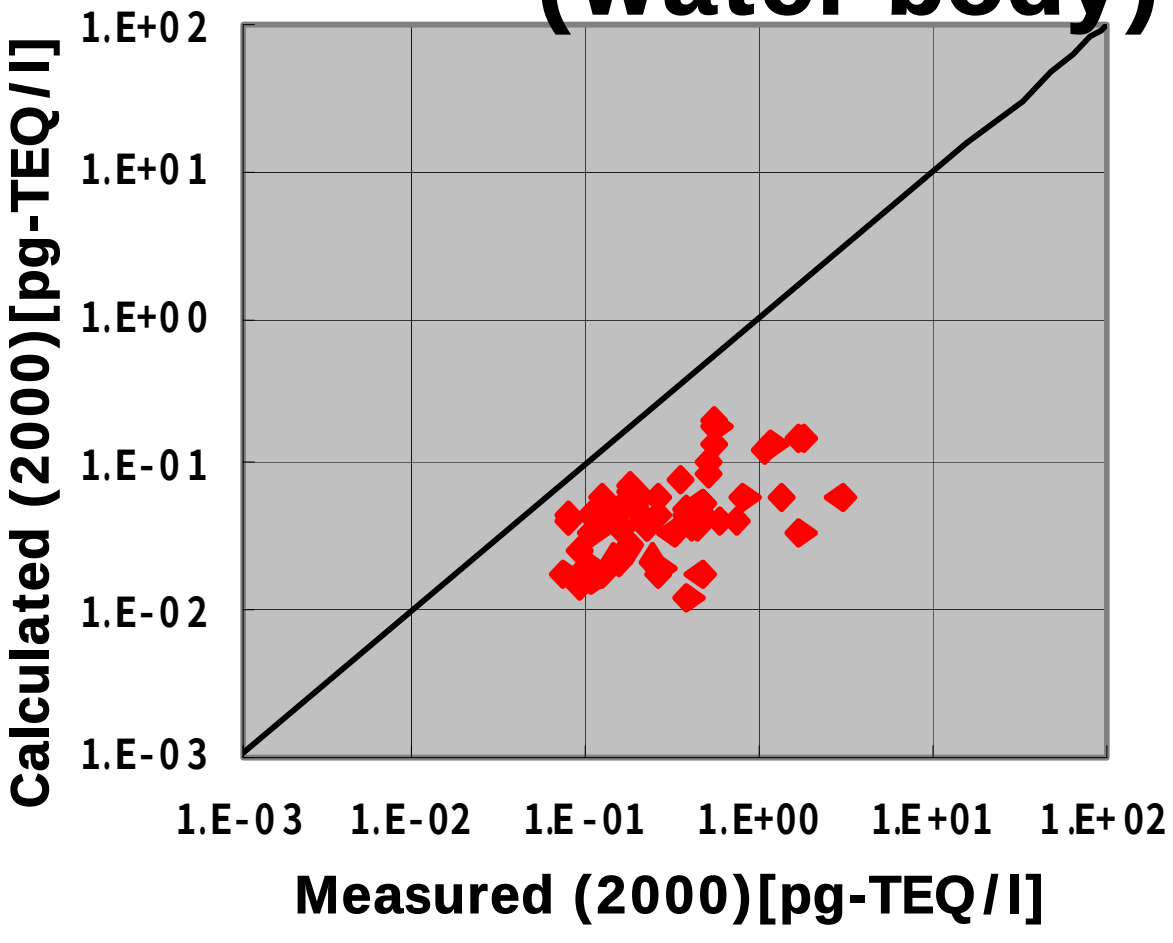


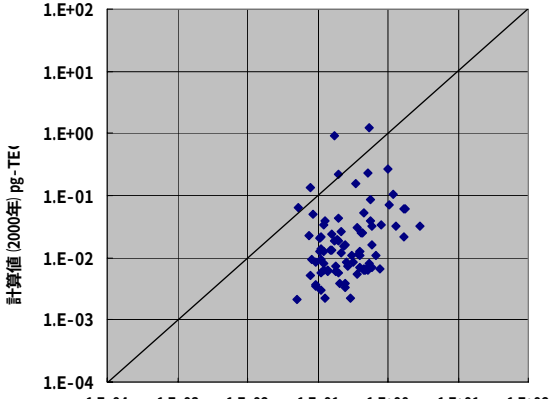


Atmospheric one layer

- Atmospheric two layer enhanced the validity of the distributed multimedia model.

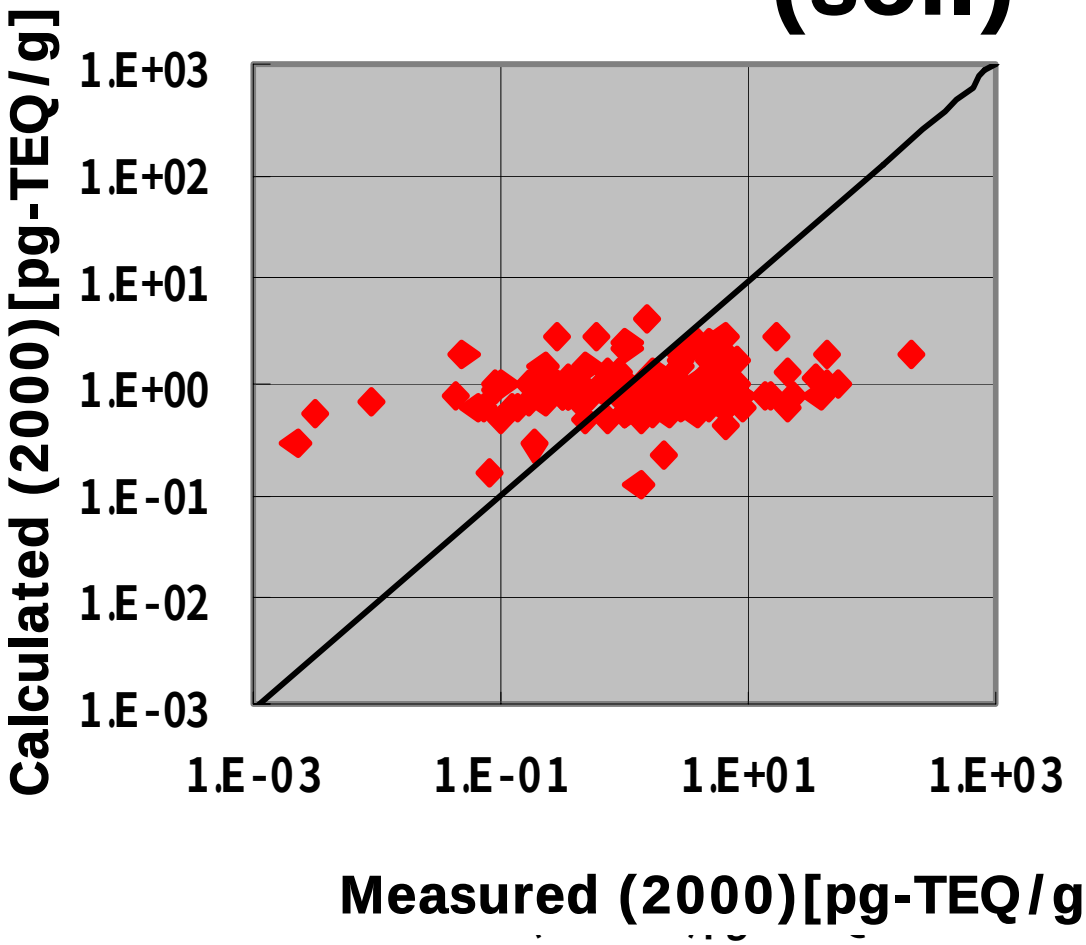
Comparison with measured data (water body)

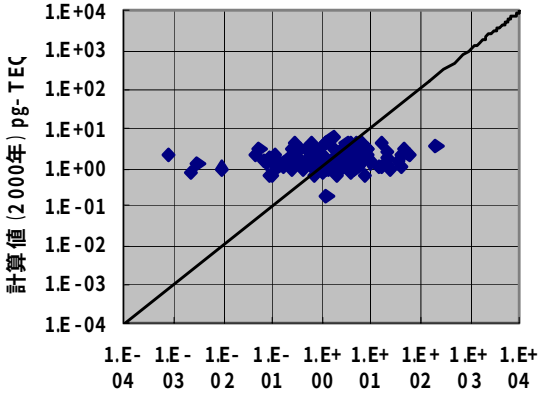




Atmospheric one layer

Comparison with measured data (soil)

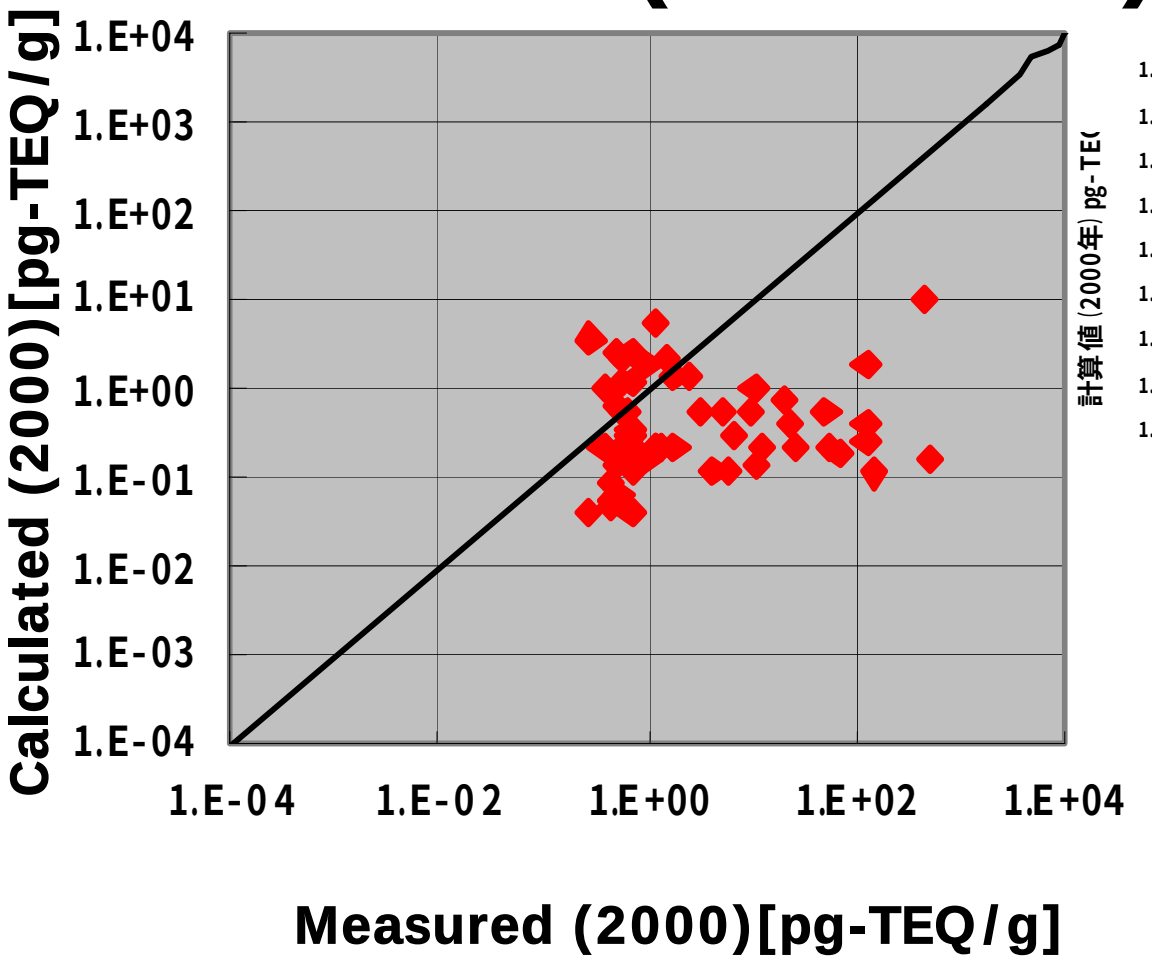


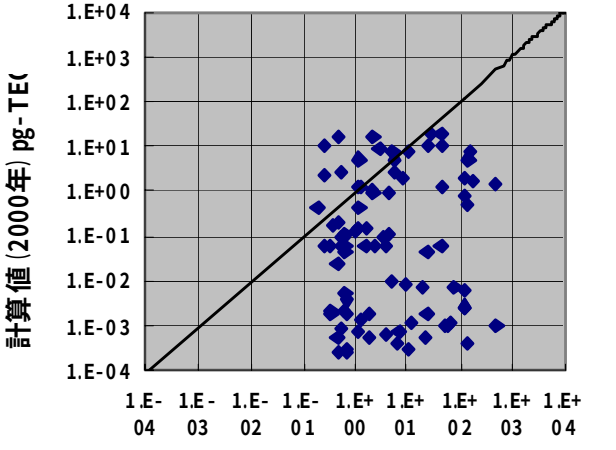


Atmospheric one layer

- The measured data varies in the wide range.

Comparison with measured data (sediment)





Atmospheric one layer

Conclusions

The distributed multimedia model with two layer atmosphere was developed to evaluate the distribution of dioxin concentration.
Dioxin concentration in atmosphere and in soil decreased due to the new regulation of incinerator and the prohibition of agricultural chemical. But dioxin concentration in sediment didn’t dramatically change due to strong persistence.
The comparison of the calculated results and the measured data showed that two layer atmosphere enhanced the validity of the distributed multimedia model.

Thank you for your attention.