LINGKAGE BETWEEN LANDS AND OCEANS THROUGH WATER AND MATERIAL FLOWS BY RIVERS AND CLIMATE CHANGE IMPACTS

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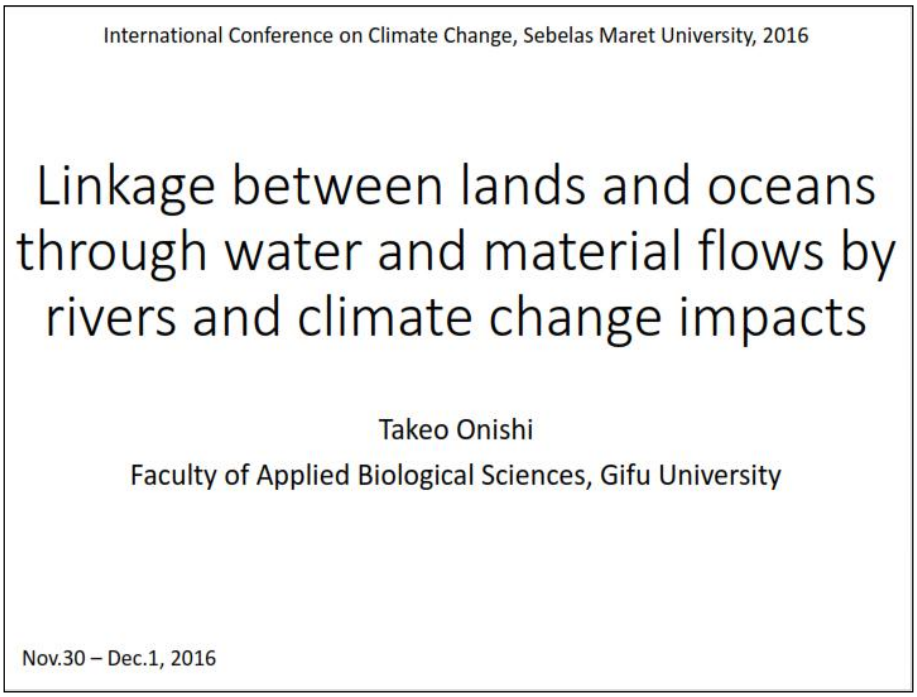
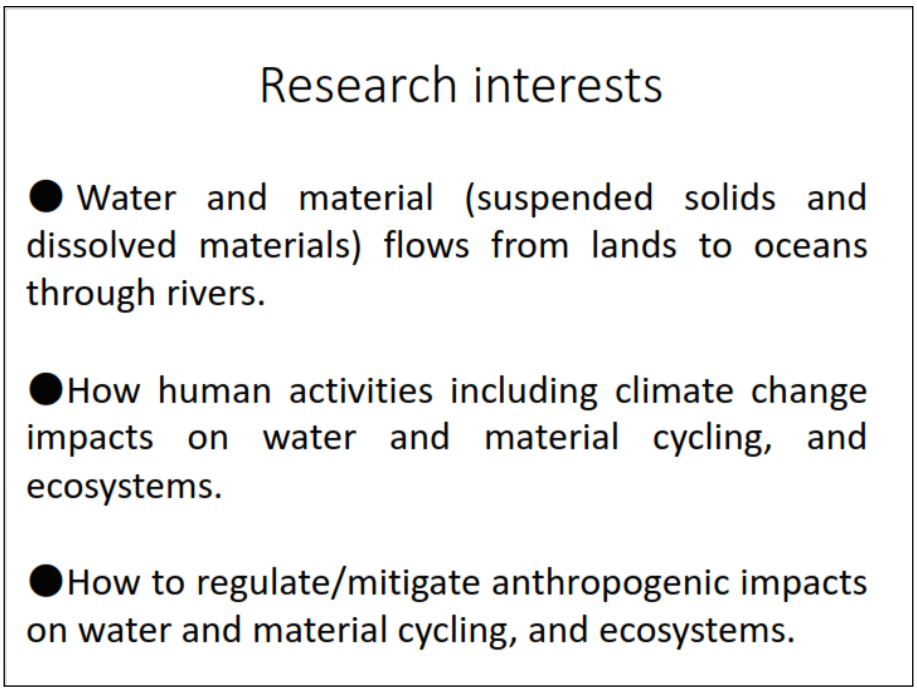
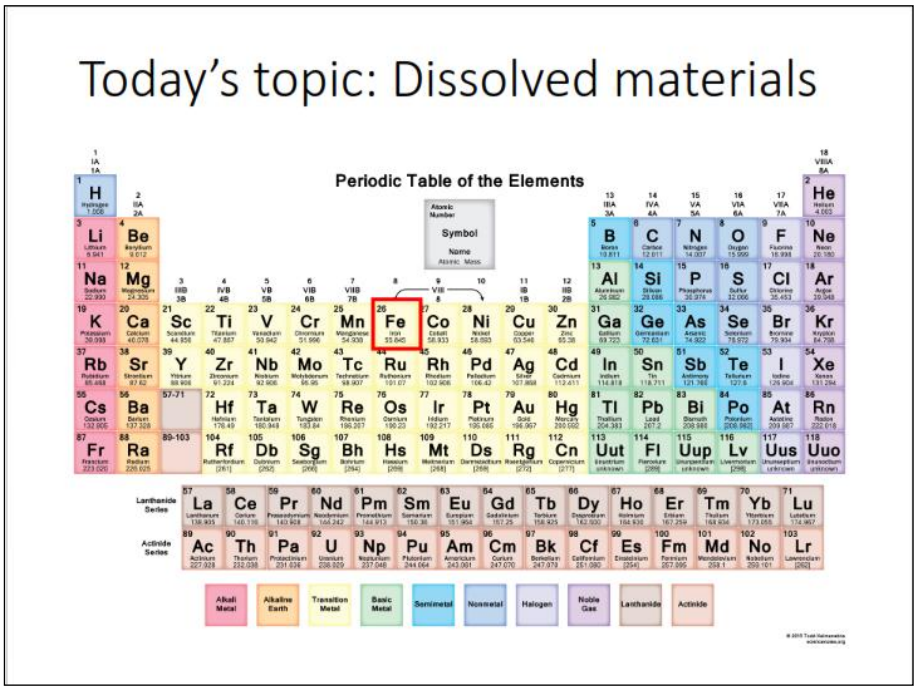
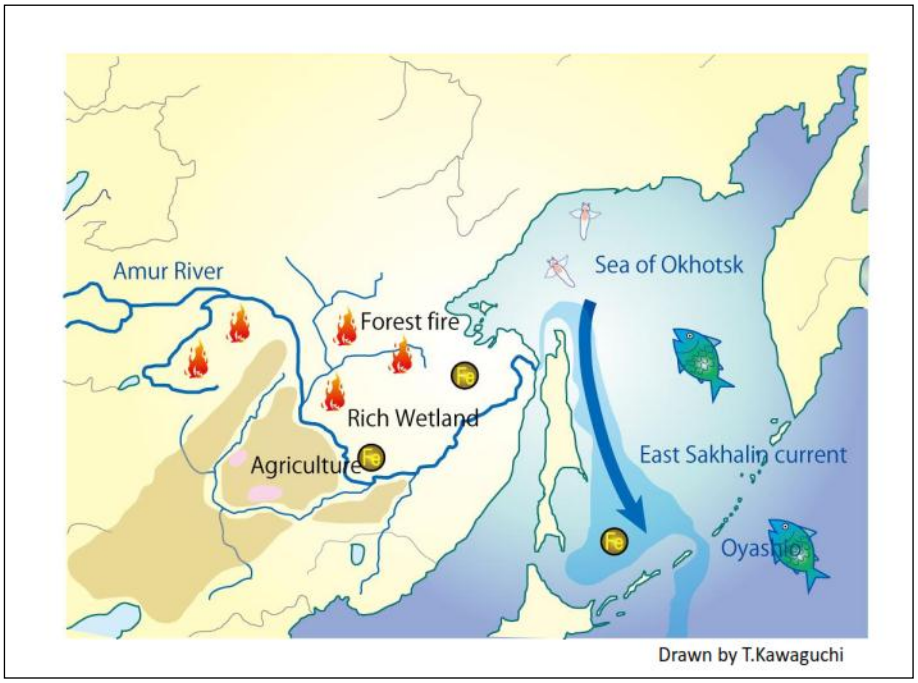
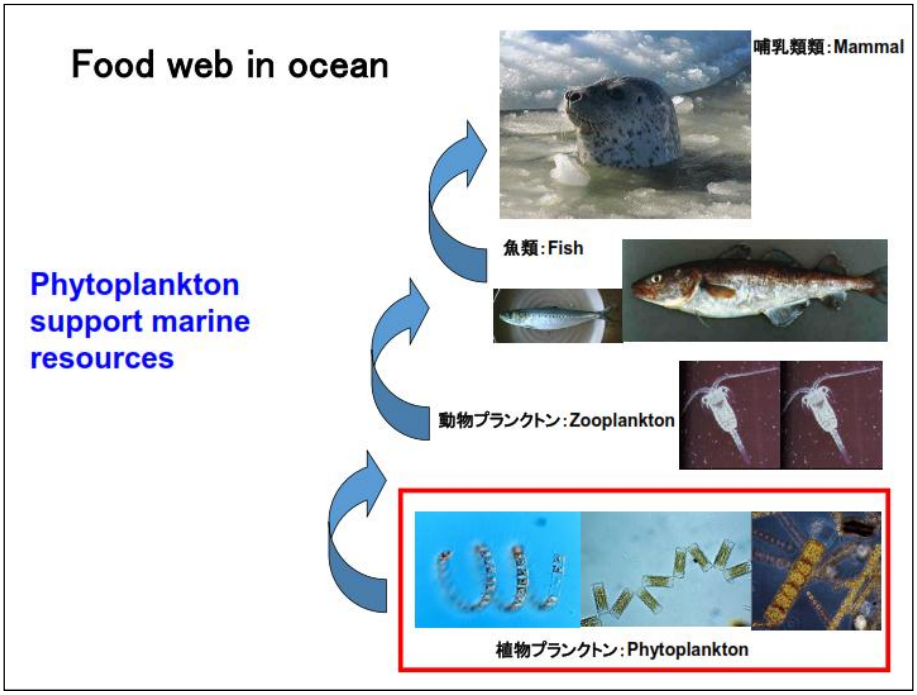
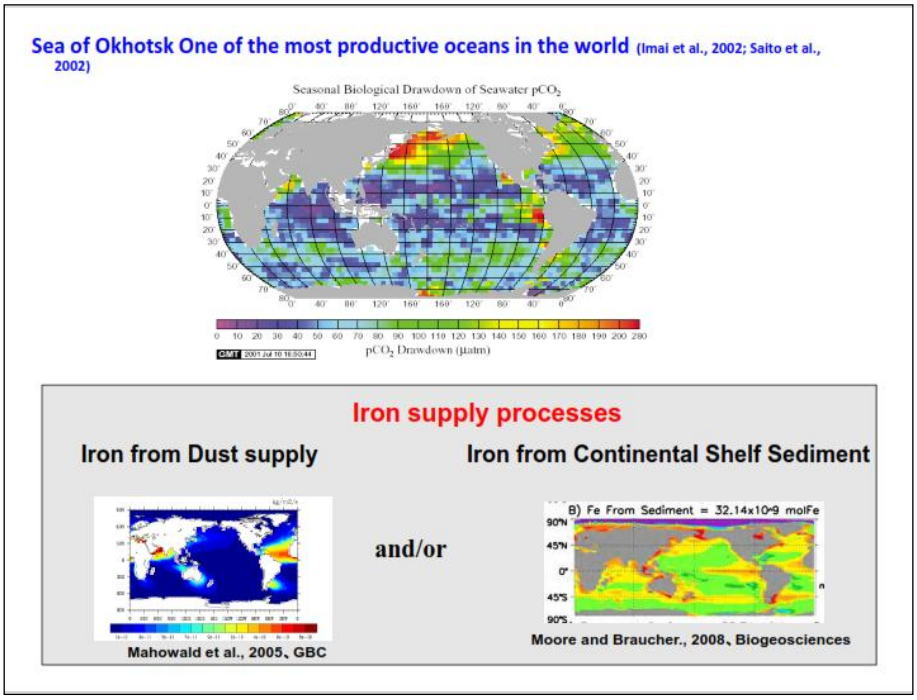


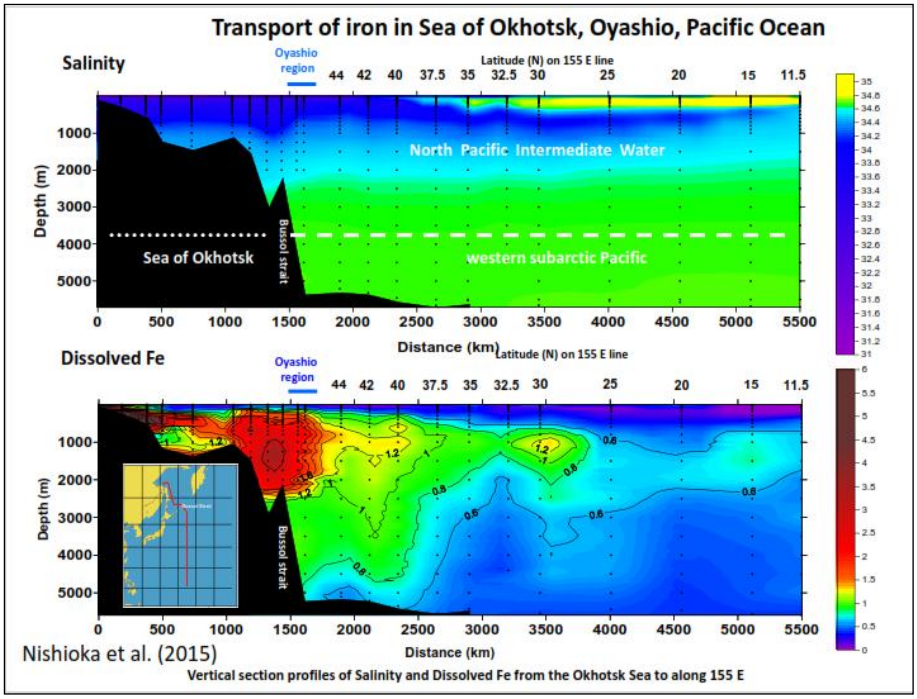


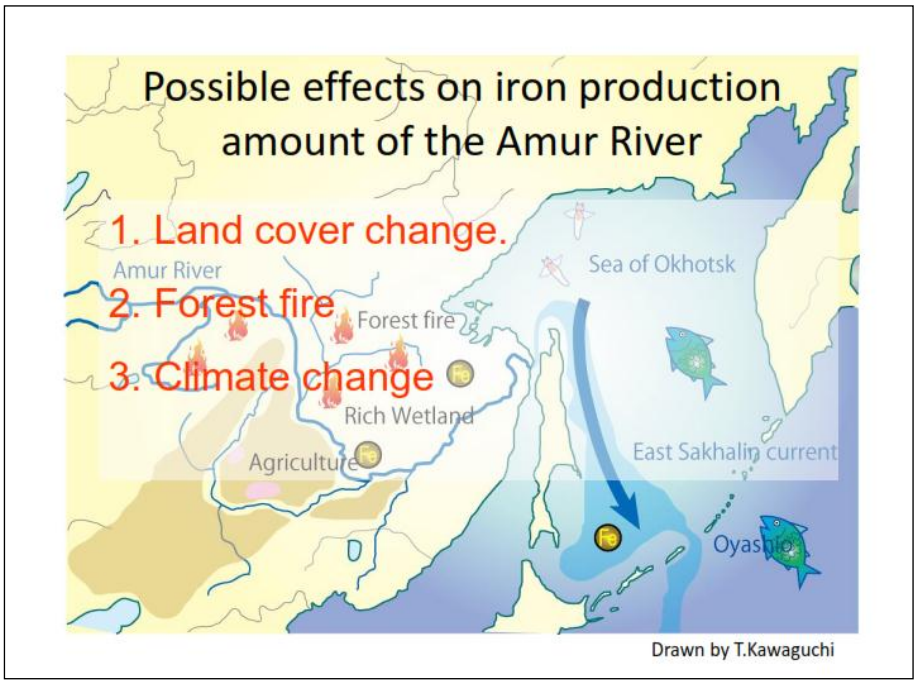

Today's topic: Dissolved materials
Periodic Table of the Elements
Fe
Lanthanide Series
Actinide Series


Amur River
Forest fire
Rich Wetland
Agriculture
Sea of Okhotsk
East Sakhalin current
Oyashio
Fe
Drawn by T.Kawaguchi


Food web in ocean
哺乳類類:Mammal
魚類:Fish
Phytoplankton support marine resources
動物プランクトン:Zooplankton
植物プランクトン:Phytoplankton


Sea of Okhotsk One of the most productive oceans in the world (Imai et al., 2002; Saito et al., 2002)
Seasonal Biological Drawdown of Seawater pCO2
pCO2 Drawdown (µatm)
Iron supply processes
Iron from Dust supply
Iron from Continental Shelf Sediment
and/or
Mahowald et al., 2005、GBC
Moore and Braucher., 2008、Biogeosciences


Transport of iron in Sea of Okhotsk, Oyashio, Pacific Ocean
Salinity
Oyashio region
Latitude (N) on 155 E line
North Pacific Intermediate Water
Sea of Okhotsk
Bussol strait
western subarctic Pacific
Depth (m)
Distance (km)
Dissolved Fe
Nishioka et al. (2015)
Vertical section profiles of Salinity and Dissolved Fe from the Okhotsk Sea to along 155 E


Possible effects on iron production amount of the Amur River
1. Land cover change.
2. Forest fire
3. Climate change
Amur River
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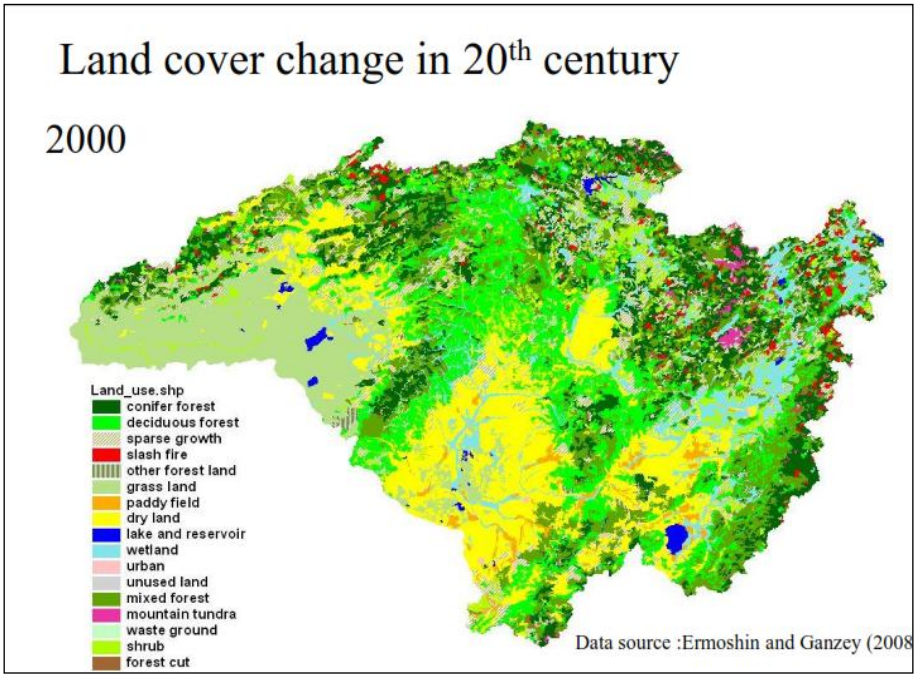
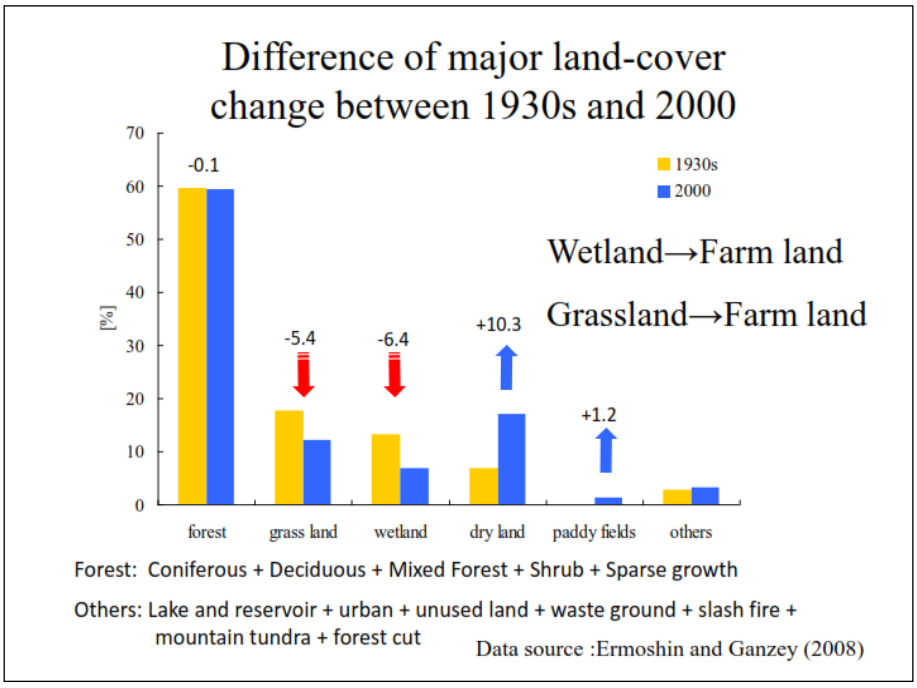
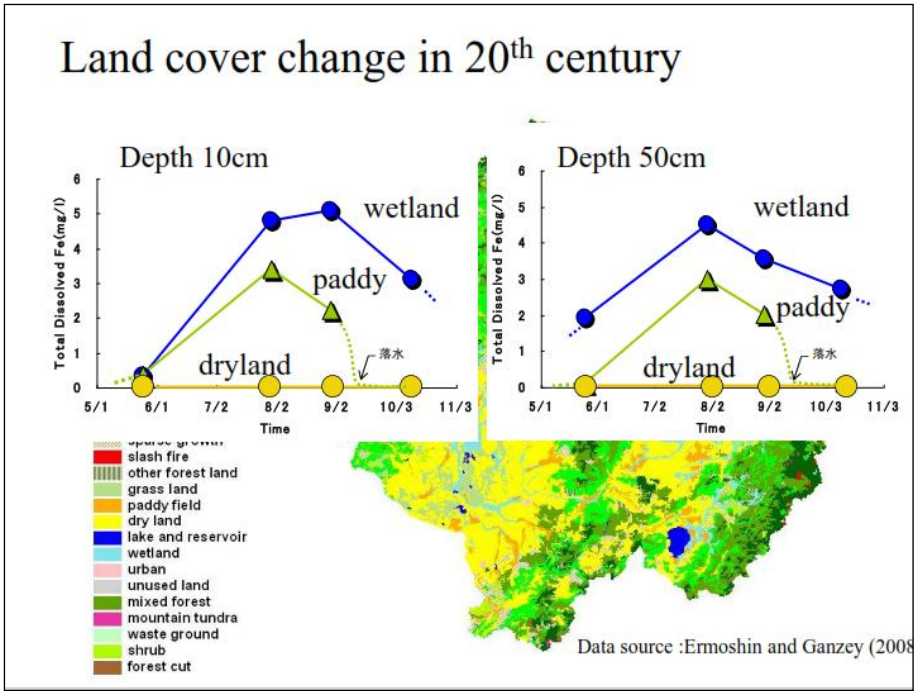
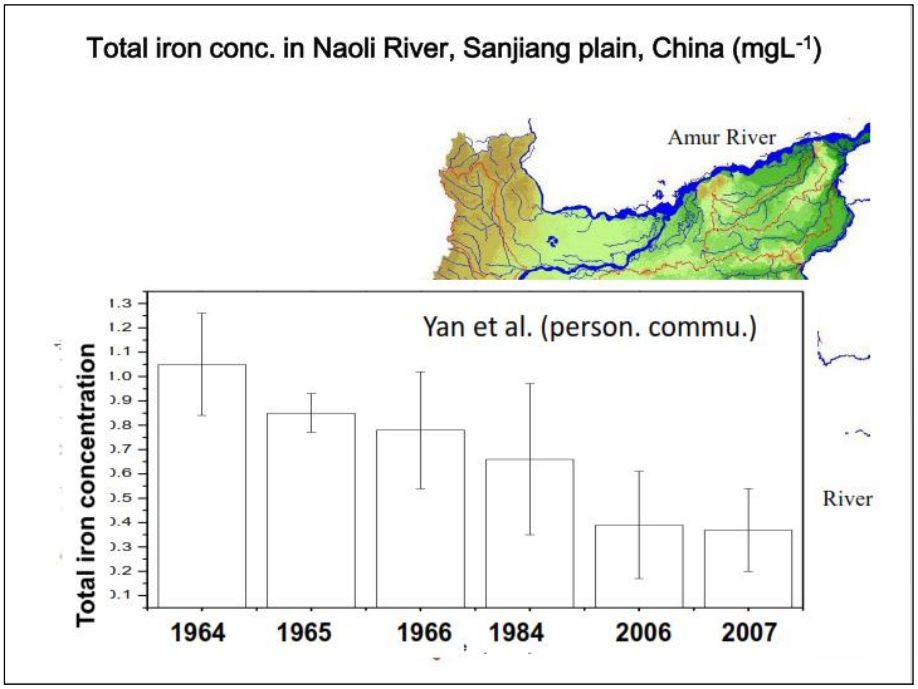
Sea of Okhotsk
Rich Wetland
Agriculture
East Sakhalin current
Oyashio
Drawn by T.Kawaguchi

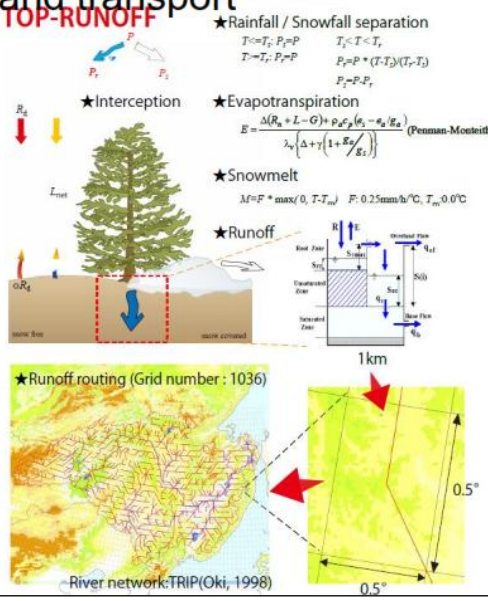

Land cover change in 20th century
2000
Land_use.shp
conifer forest
deciduous forest
sparse growth
slash fire
other forest land
grass land
paddy field
dry land
lake and reservoir
wetland
urban
unused land
mixed forest
mountain tundra
waste ground
shrub
forest cut
Data source :Ermoshin and Ganzey (2008


Difference of major land-cover change between 1930s and 2000
70
60
50
40
30
20
10
0
[%]
-0.1
-5.4
-6.4
+10.3
+1.2
1930s
2000
Wetland→Farm land
Grassland→Farm land
forest
grass land
wetland
dry land
paddy fields
others
Forest: Coniferous + Deciduous + Mixed Forest + Shrub + Sparse growth
Others: Lake and reservoir + urban + unused land + waste ground + slash fire + mountain tundra + forest cut
Data source :Ermoshin and Ganzey (2008)

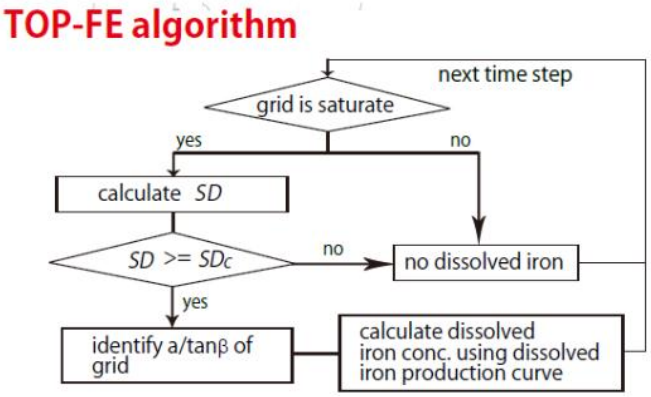

Land cover change in 20th century
Depth 10cm
Depth 50cm
wetland
paddy
dryland
落水
Total Dissolved Fe(mg/l)
Time
5/1
6/1
7/2
8/2
9/2
10/3
11/3
slash fire
other forest land
grass land
paddy field
dry land
lake and reservoir
wetland
urban
unused land
mixed forest
mountain tundra
waste ground
shrub
forest cut
Data source :Ermoshin and Ganzey (2008

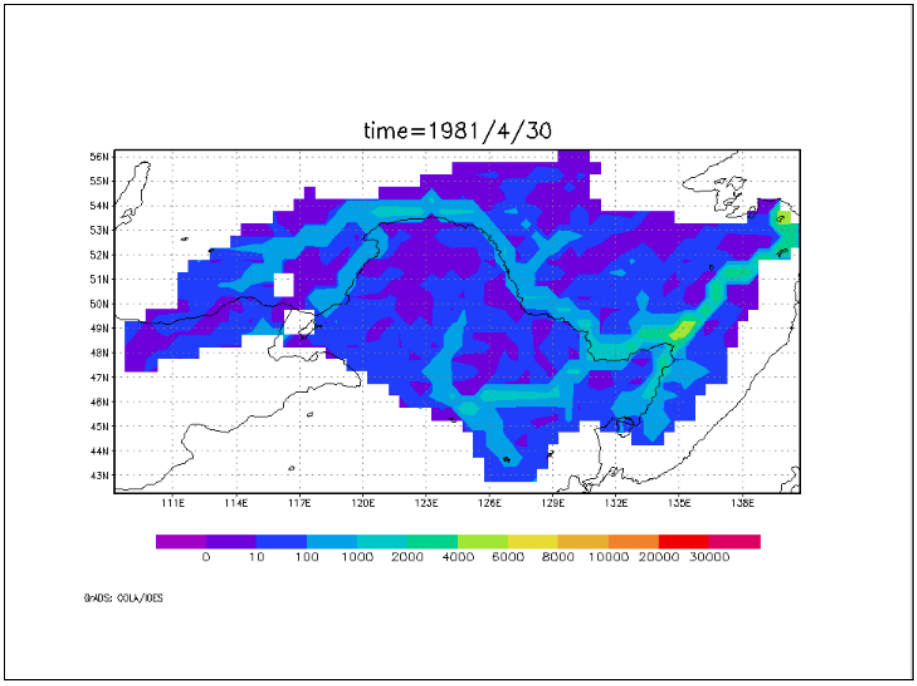

Total iron conc. in Naoli River, Sanjiang plain, China (mgL-1)
Amur River
Yan et al. (person. commu.)
Total iron concentration
River
1964
1965
1966
1984
2006
2007

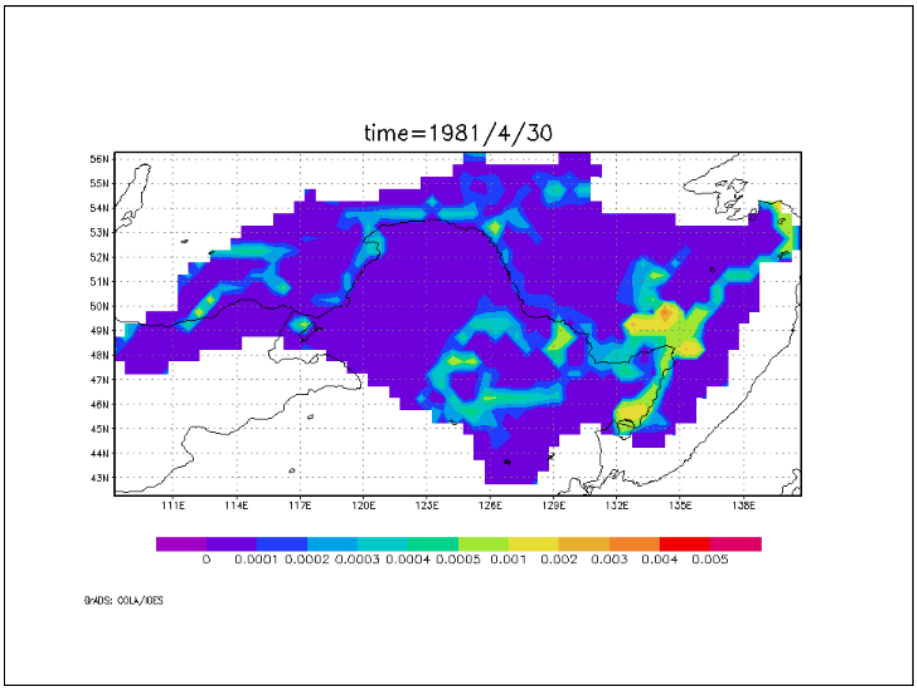
Combination of hydrological model and iron production and transport

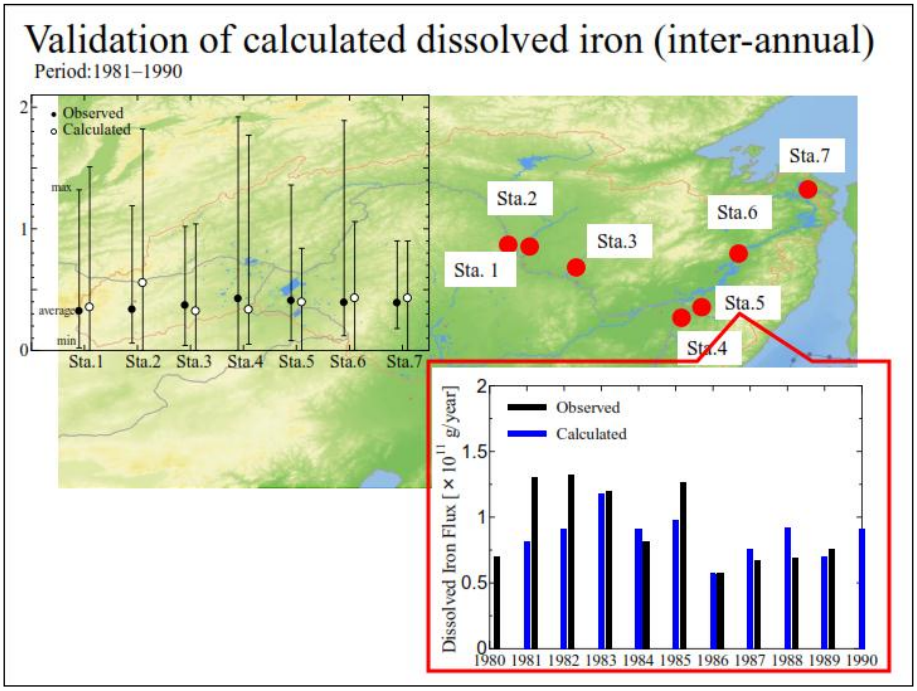


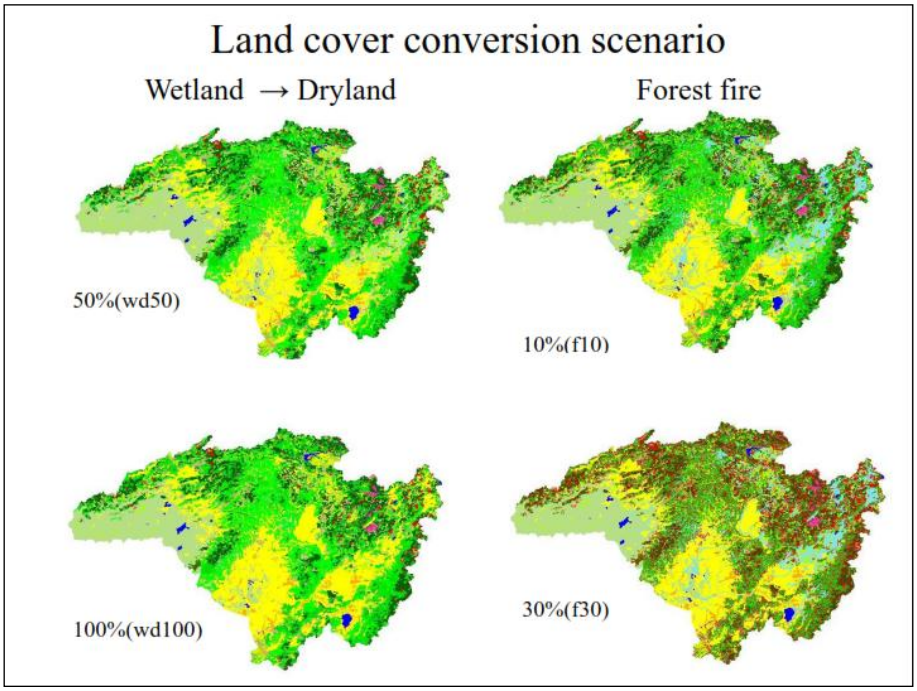
Modeling of dissolved iron production mechanism

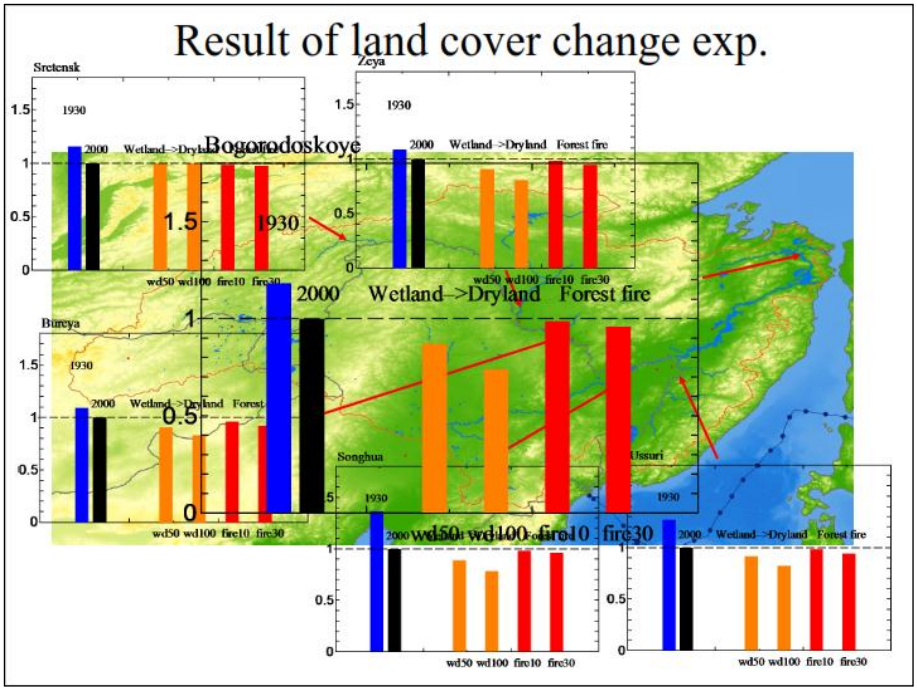


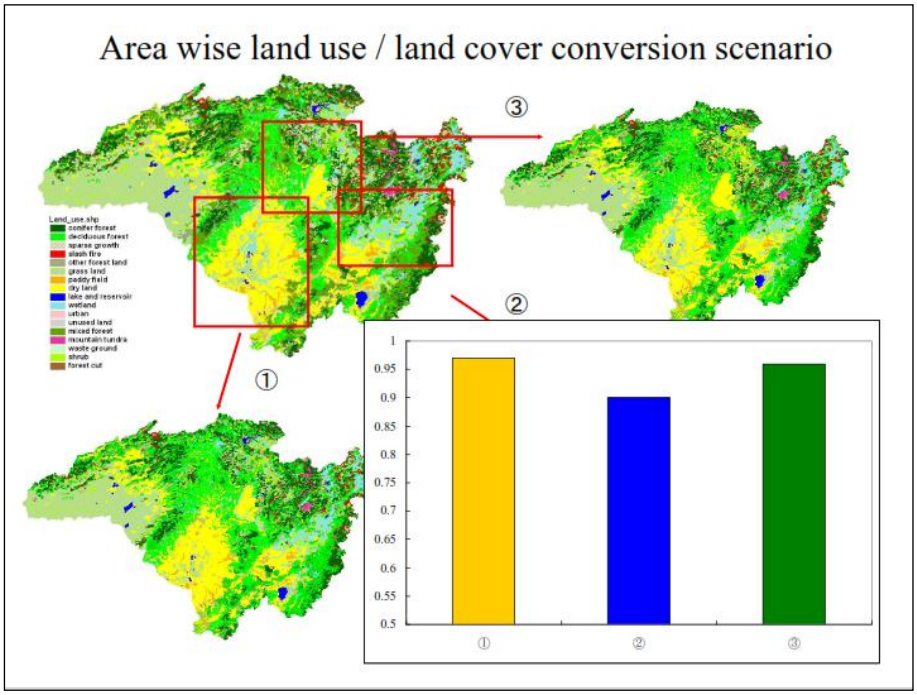

time=1981/4/30
56N
55N
54N
53N
52N
51N
50N
49N
48N
47N
46N
45N
44N
43N
111E
114E
117E
120E
123E
126E
129E
132E
135E
138E
0
10
100
1000
2000
4000
6000
8000
10000
20000
30000
GrADS: COLA/IOES


time=1981/4/30
56N
55N
54N
53N
52N
51N
50N
49N
48N
47N
46N
45N
44N
43N
111E
114E
117E
120E
123E
126E
129E
132E
135E
138E
0
0.0001
0.0002
0.0003
0.0004
0.0005
0.001
0.002
0.003
0.004
0.005
GrADS: COLA/IOES


Validation of calculated dissolved iron (inter-annual)
Period:1981–1990
Observed
Calculated
max
average
min
Sta.1
Sta.2
Sta.3
Sta.4
Sta.5
Sta.6
Sta.7
Sta. 1
Sta.2
Sta.3
Sta.4
Sta.5
Sta.6
Sta.7
Observed
Calculated
Dissolved Iron Flux [× 10^11 g/year]
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990


Land cover conversion scenario
Wetland → Dryland
Forest fire
50%(wd50)
10%(f10)
100%(wd100)
30%(f30)

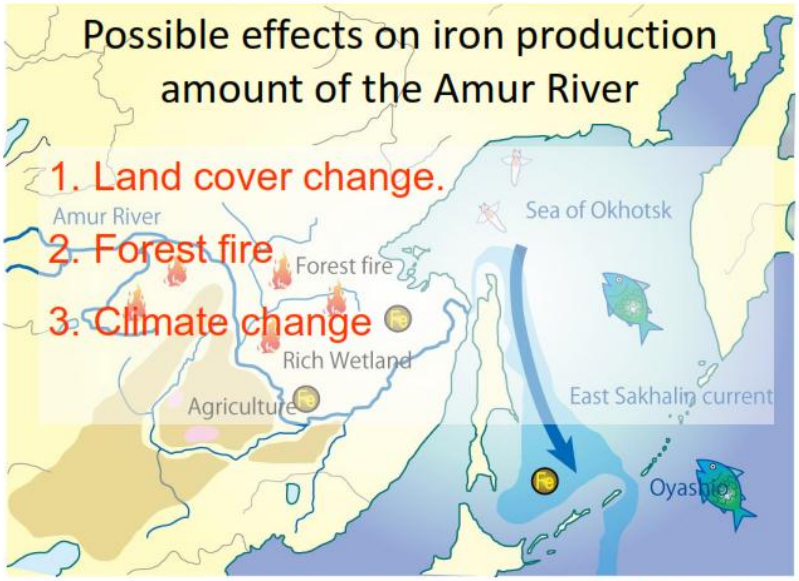

Result of land cover change exp.
Sretensk
Zeya
Bureya
Songhua
Ussuri
Bogorodoskoye
1930
2000
Wetland ->Dryland
Forest fire
wd50 wd100 fire10 fire30


Area wise land use / land cover conversion scenario
①
②
③

Conclusion

- Hydrological model incorporating dissolved iron producing mechanism is constructed.
- Constructed model is successful in simulating monthly discharge, and annual / monthly dissolved iron flux.
- Dissolved iron flux in 1930s' might be 20% higher than present according to the wetland decrease.
- If the all wetland is converted to agricultural land, dissolved iron flux will decrease about 40% compared to present.
- Wetland in the lower part of the Amur River might be playing an important role in producing dissolved iron.

Fish Breeding forest
魚附林：Uo-Tsuki-Rin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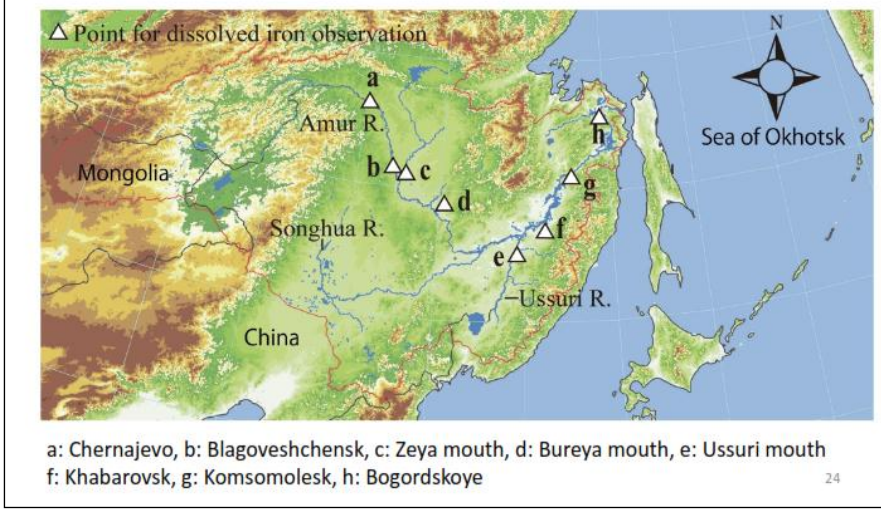
Long-term trend of dissolved iron concentration in the Amur River
△ Point for dissolved iron observation
a
Amur R.
b
c
d
Songhua R.
e
f
g
h
Ussuri R.
Mongolia
China
Sea of Okhotsk
N
a: Chernajevo, b: Blagoveshchensk, c: Zeya mouth, d: Bureya mouth, e: Ussuri mouth
f: Khabarovsk, g: Komsomolesk, h: Bogordskoye
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Dataset specification

- Source: ROSHYDROMET
- Period: 1960 - 2007
- Frequency: 1-2/month (Except for winter)
- Method:
  - ✓ Pretreatment: Whatman GF/F, pH < 2 with HCl
  - ✓ colorimetric method with 1,10-phenantroline
- Notice: Some part of suspended form of dissolved iron might be included.

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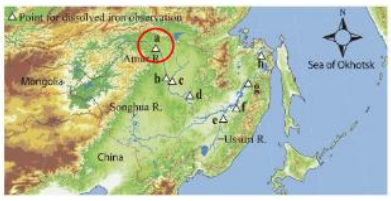
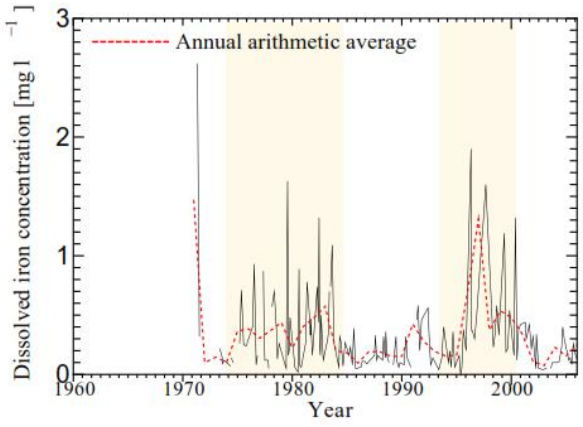


●Chernajevo
(Main course of the Amur River)



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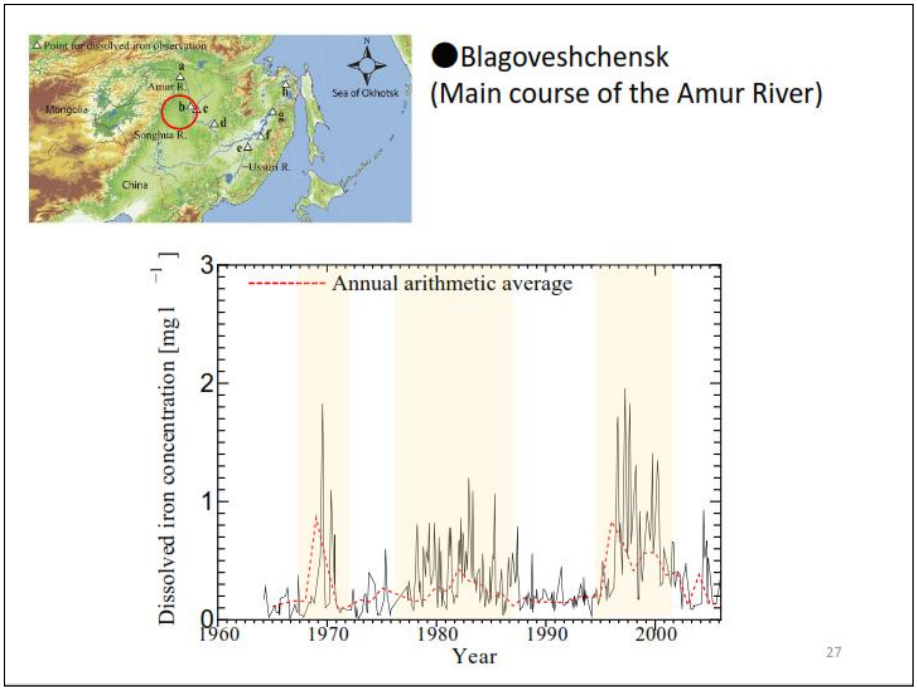
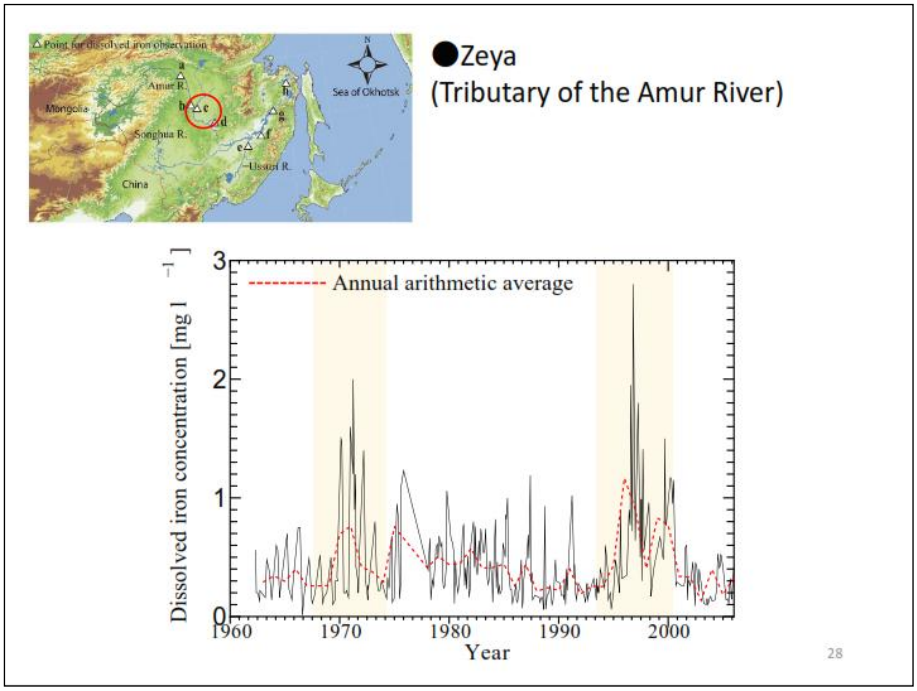
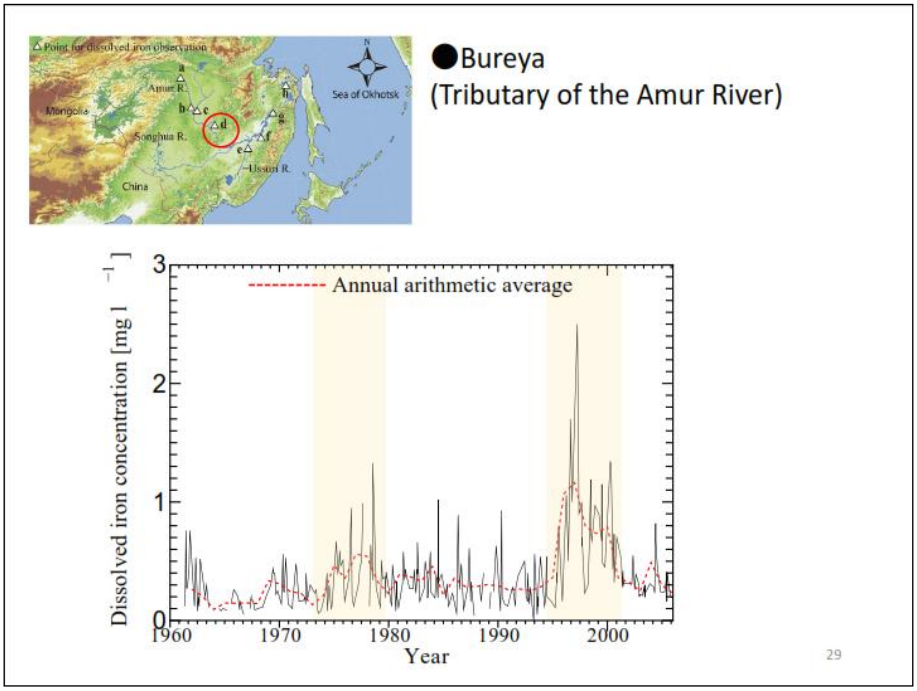
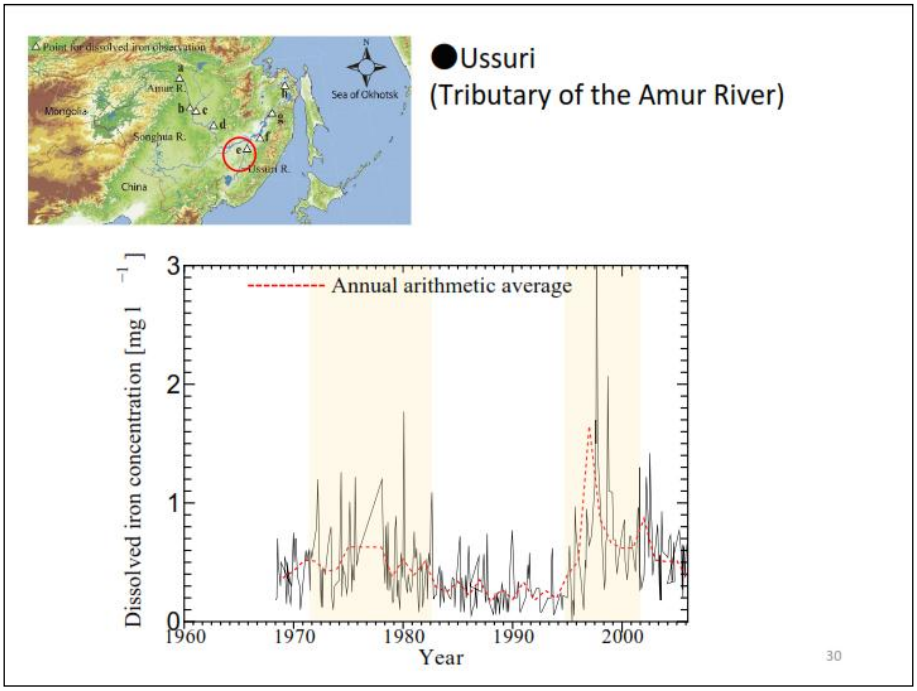
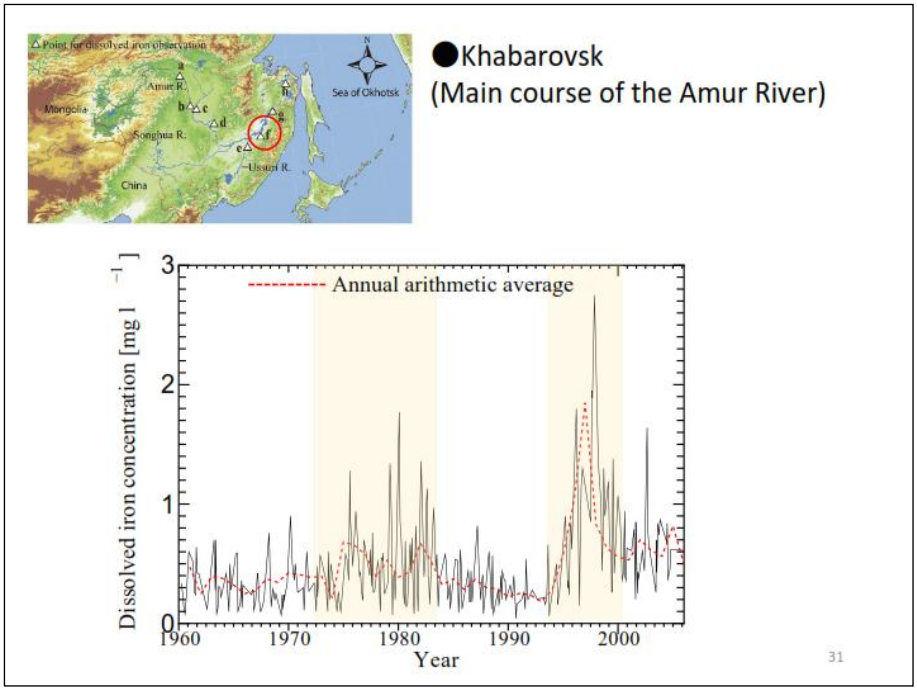
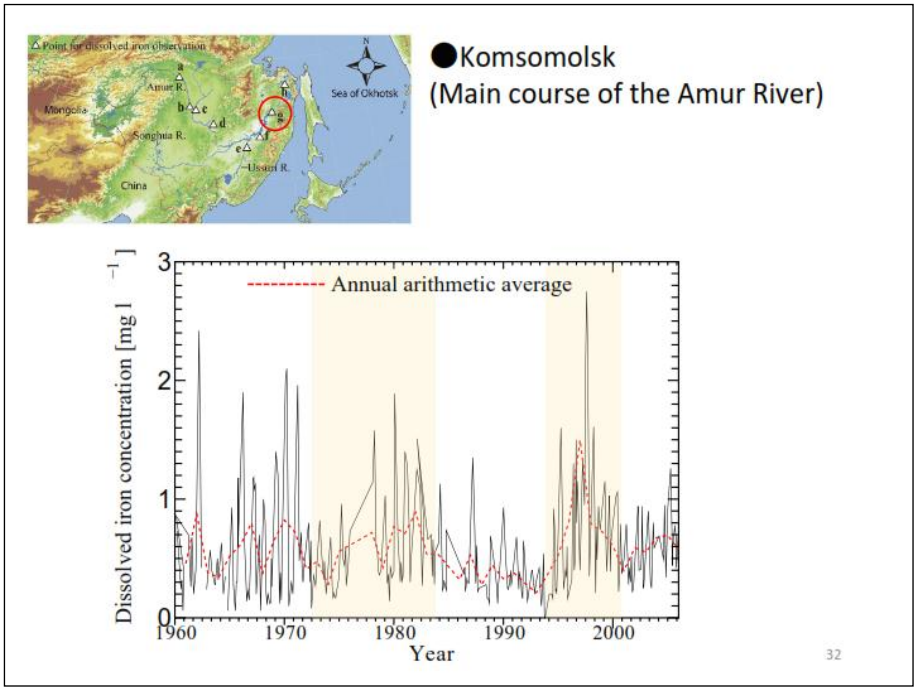

Point for dissolved iron observation
Amur R.
Mongolia
Songhua R.
China
Ussuri R.
Sea of Okhotsk
N
Blagoveshchensk
(Main course of the Amur River)
Annual arithmetic average
Dissolved iron concentration [mg l⁻¹]
Year
1960
1970
1980
1990
2000
0
1
2
3
27

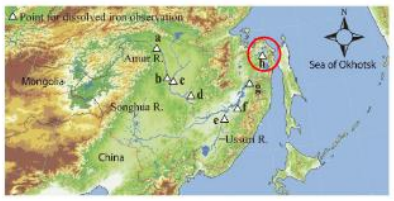

Point for dissolved iron observation
Amur R.
Mongolia
Songhua R.
China
Ussuri R.
Sea of Okhotsk
N
Zeya
(Tributary of the Amur River)
Annual arithmetic average
Dissolved iron concentration [mg l⁻¹]
Year
1960
1970
1980
1990
2000
0
1
2
3
28


Point for dissolved iron observation
Amur R.
Mongolia
Songhua R.
China
Ussuri R.
Sea of Okhotsk
a
b
c
d
e
f
g
h
Bureya
(Tributary of the Amur River)
Annual arithmetic average
Dissolved iron concentration [mg l⁻¹]
Year
1960
1970
1980
1990
2000
0
1
2
3
29

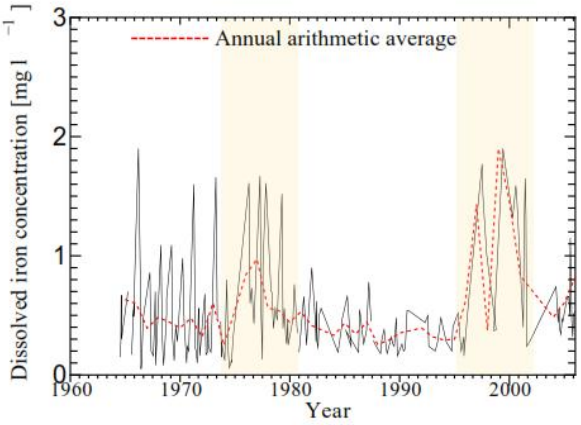

Point for dissolved iron observation
Amur R.
Mongolia
Songhua R.
China
Ussuri R.
Sea of Okhotsk
Ussuri
(Tributary of the Amur River)
Annual arithmetic average
Dissolved iron concentration [mg l⁻¹]
Year
1960
1970
1980
1990
2000
0
1
2
3
30


Point for dissolved iron observation
Amur R.
Mongolia
Songhua R.
China
Ussuri R.
Sea of Okhotsk
a
b
c
d
e
f
g
h
N
Khabarovsk
(Main course of the Amur River)
Annual arithmetic average
Dissolved iron concentration [mg l⁻¹]
Year
0
1
2
3
1960
1970
1980
1990
2000
31


Point for dissolved iron observation
Amur R.
Mongolia
Songhua R.
China
Ussuri R.
Sea of Okhotsk
a
b
c
d
e
f
g
h
N
Komsomolsk
(Main course of the Amur River)
Annual arithmetic average
Dissolved iron concentration [mg l⁻¹]
Year
0
1
2
3
1960
1970
1980
1990
2000
32



●Bogordskoye
(Main course of the Amur River)



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Common characteristics of dissolved iron in the Amur River

- At every stations, largest peak were recorded in late 1990s'
- At many stations, a several peaks were recorded periodically. 1970-1980, late 1990s'
- Long-term variation of dissolved iron might be governed by large scale phenomena.

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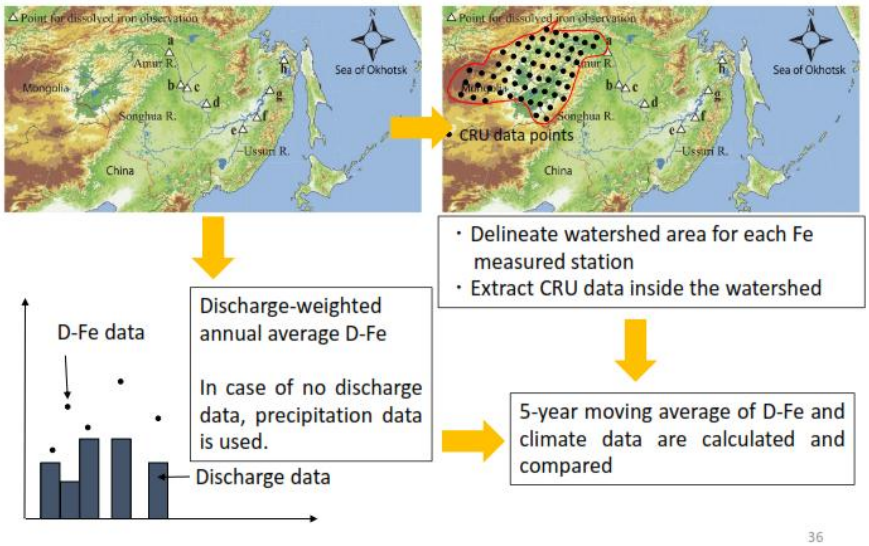
Correlation analysis with climate conditions

Dataset specification

- ☐CRU TS v. 3.24 (Harris et al, 2014)
- ✓Spatial resolution: 0.5° (approx. 50km × 50km)
- ✓Time resolution: monthly
- ✓Period: 1901 – 2002
- ✓Method: Statistical interpolation of observed climate data
- ✓Variables: pre, tmp, tmx, tmn, dtr, vap, cld, wet, frs
- ☐Correlation analysis
- ✓Average values of watershed area of Khabarovsk
- ✓Temperature, Precipitation

Harris, I., Jones, P.D., Osborn, T.J. and Lister, D.H. (2014), Updated high-resolution grids of monthly climatic observations - the CRU TS3.10 Dataset. International Journal of Climatology 34, 623-642 35

Analysis procedure by figure



Discharge-weighted annual average D-Fe

In case of no discharge data, precipitation data is used.

・Delineate watershed area for each Fe measured station
・Extract CRU data inside the watershed

5-year moving average of D-Fe and climate data are calculated and compared

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Result

Table Pearson's correlation coefficients between dissolved iron concentration at the Khabarovsk station and temperature and precipitation

	3year		5year	
	Temperature	Precipitation	Temperature	Precipitation
DJF	0.34	0.06	0.41	0.11
MAM	0.40	0.30	0.45	0.37
JJA	0.50	-0.39	0.69	-0.49
SON	0.10	-0.14	0.19	-0.08
Jan.	0.18	0.54	0.22	0.64
Feb.	0.44	-0.21	0.53	-0.31
Mar.	0.13	0.41	0.15	0.47
Apr.	0.52	-0.20	0.56	-0.21
May	0.38	0.40	0.51	0.48
Jun.	0.34	-0.09	0.52	-0.25
Jul.	0.62	-0.38	0.86	-0.40
Aug.	0.19	-0.16	0.28	-0.24
Sep.	0.07	-0.33	0.34	-0.36
Oct.	-0.06	0.58	-0.03	0.67
Nov.	0.18	-0.29	0.21	-0.31
Dec.	0.14	-0.13	0.20	-0.14

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Temperature of July and discharge weighted annual dissolved iron concentration

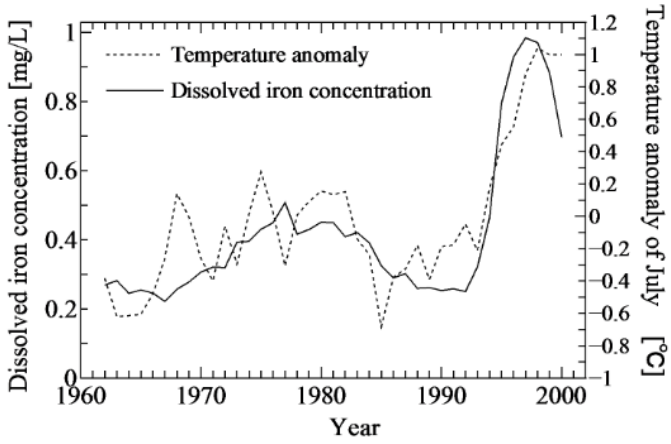

Figure Trends of dissolved iron concentration at Khabarovsk and July temperature of its watershed in 5 year moving average values

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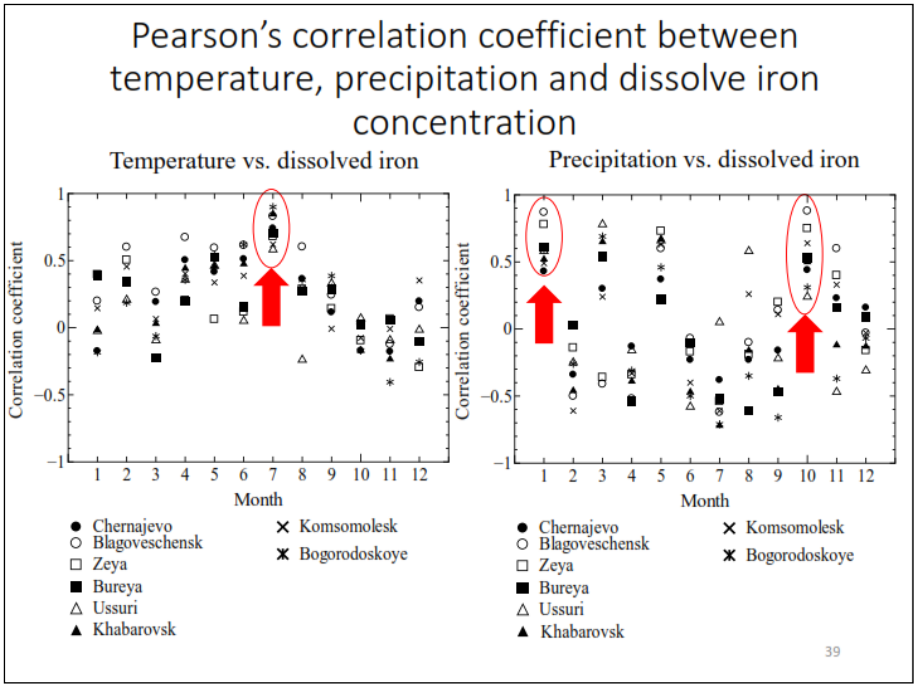
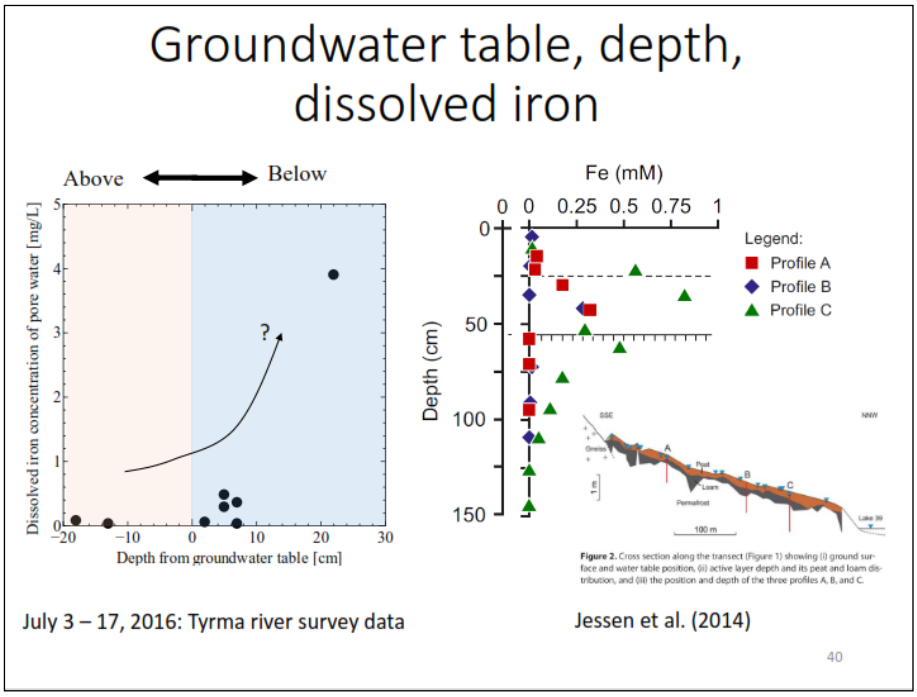
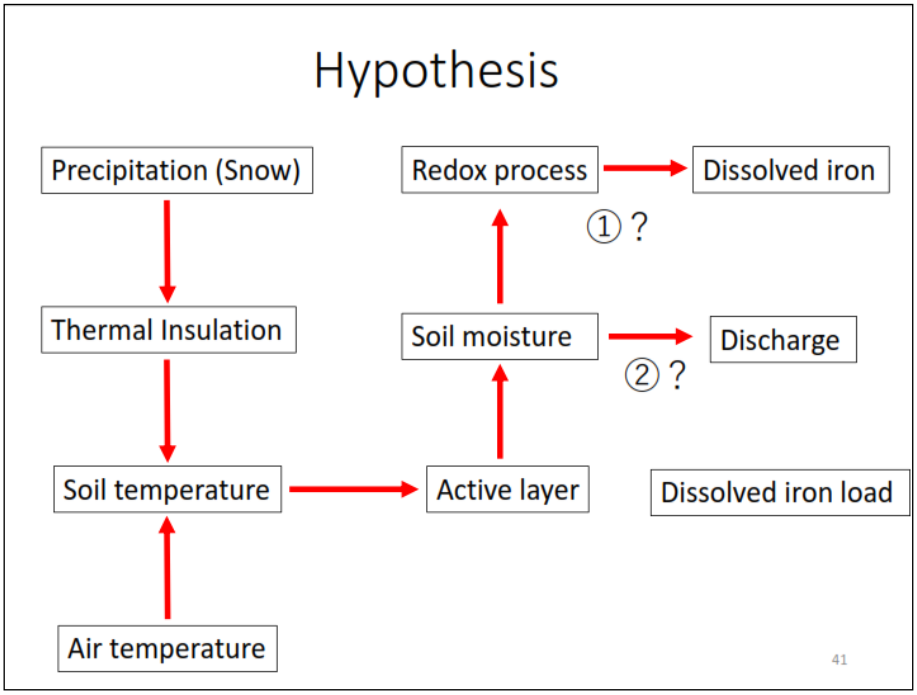

Pearson's correlation coefficient between temperature, precipitation and dissolve iron concentration
Temperature vs. dissolved iron
Precipitation vs. dissolved iron
Correlation coefficient
Month
Chernajevo
Blagoveschensk
Zeya
Bureya
Ussuri
Khabarovsk
Komsomolesk
Bogorodoskoye
39


Groundwater table, depth, dissolved iron
Above
Below
Dissolved iron concentration of pore water [mg/L]
Depth from groundwater table [cm]
?
Fe (mM)
Depth (cm)
Legend:
Profile A
Profile B
Profile C
July 3 – 17, 2016: Tyrma river survey data
Jessen et al. (2014)
40


Hypothesis
Precipitation (Snow)
Redox process
Dissolved iron
① ?
Thermal Insulation
Soil moisture
Discharge
② ?
Soil temperature
Active layer
Dissolved iron load
Air temperature
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