LHD Project Research Collaboration
of NIFS (National Institute for Fusion Science)

Study on

Behavior of Environmental Tritium and Assessment of Influence on Environment

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NATIONAL INSTITUTE FOR FUSION SCIENCE *NIFS*

The NIFS is engaged in basic research in fusion plasma in order to create the sun on earth and to actualize nuclear fusion generation, which generates new source of energy that is safe and environmentally friendly.

Major axes in the research

Physical research regarding generation and confinement of high temperature, high density plasmas with using superconducting Large Helical Device, LHD

Simulation science research using super computer

Engineering research for fusion reactor
Safety and environmental research.

BACKGROUND

1. **Although Nuclear fusion facilities, such as ITER, are expected to require about 2000 PBq of tritium for their "fuel", only a small part of these tritium may be released from the facilities.**

Nuclear fusion plant（核融合炉）

D (^{2}H) ： T (^{3}H) → neutron (14MeV) ＋ ^{4}He

↓

n : Ｌｉ → T (^{3}H)

1. **In the D-D experiment which NIFS plans, the tritium of 55.5 GBq/year will be produced. NIFS plans a tritium release to the environment to become below 3.7 GBq / year.**

1. **It is necessary to guarantee the safety of released tritium.**

   To understand the tritium behavior in the environment,

   To show that there is not a significant increase of individual dose

   To send the safe and relieved information to the public.

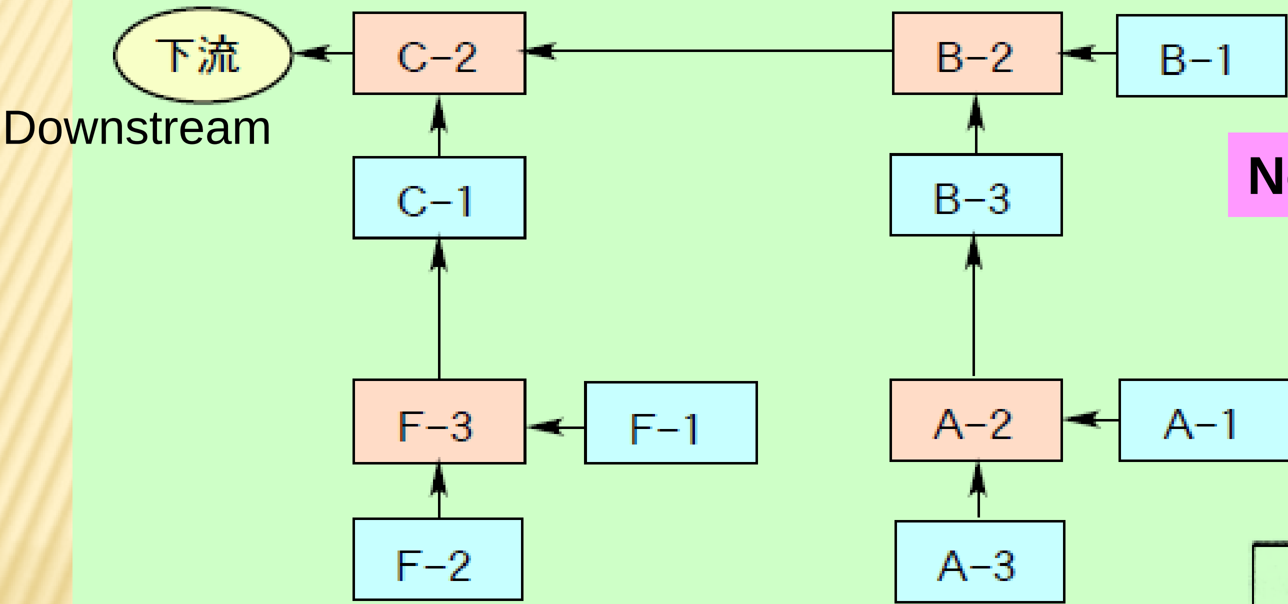
Subjects that we are focusing on:
1) Behavior of Environmental Tritium
2) Assessment of Influence on Environment

Because the tritium concentration of the environment level is about 1 Bq/l in Japan, to see a significant difference, we need high-precision measurement.

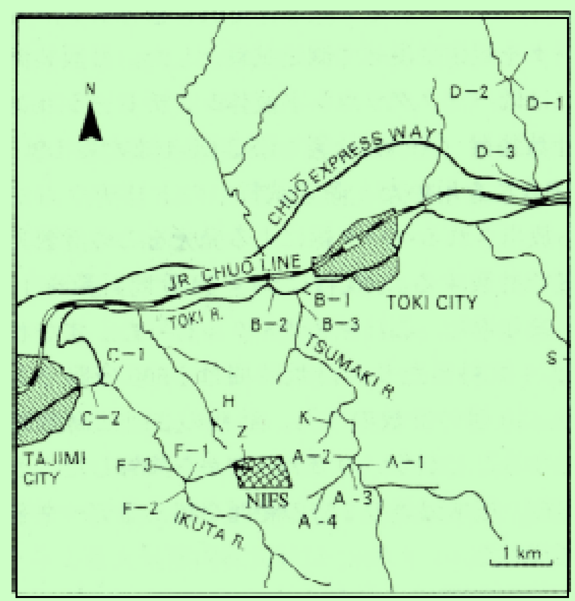
METHODS

(1) water sample ･･ 2L
(2) distillation twice
(3) enrichment with an electrolytic enrichment system
(XZ001-1, and XZ001-2, Permelec electrode Ltd.)
enrichment factor of 8.18 and 8.01 times
1000ml → 60ml
(4)LSC counting (LB-5, Aloka Ltd.)
50 ml of the enriched water + 50 ml of scintillation cocktail
(Ultima GOLDTM LLT, Perkin Elmer) in a Teflon vial.

Compartment model (former)



Network of River

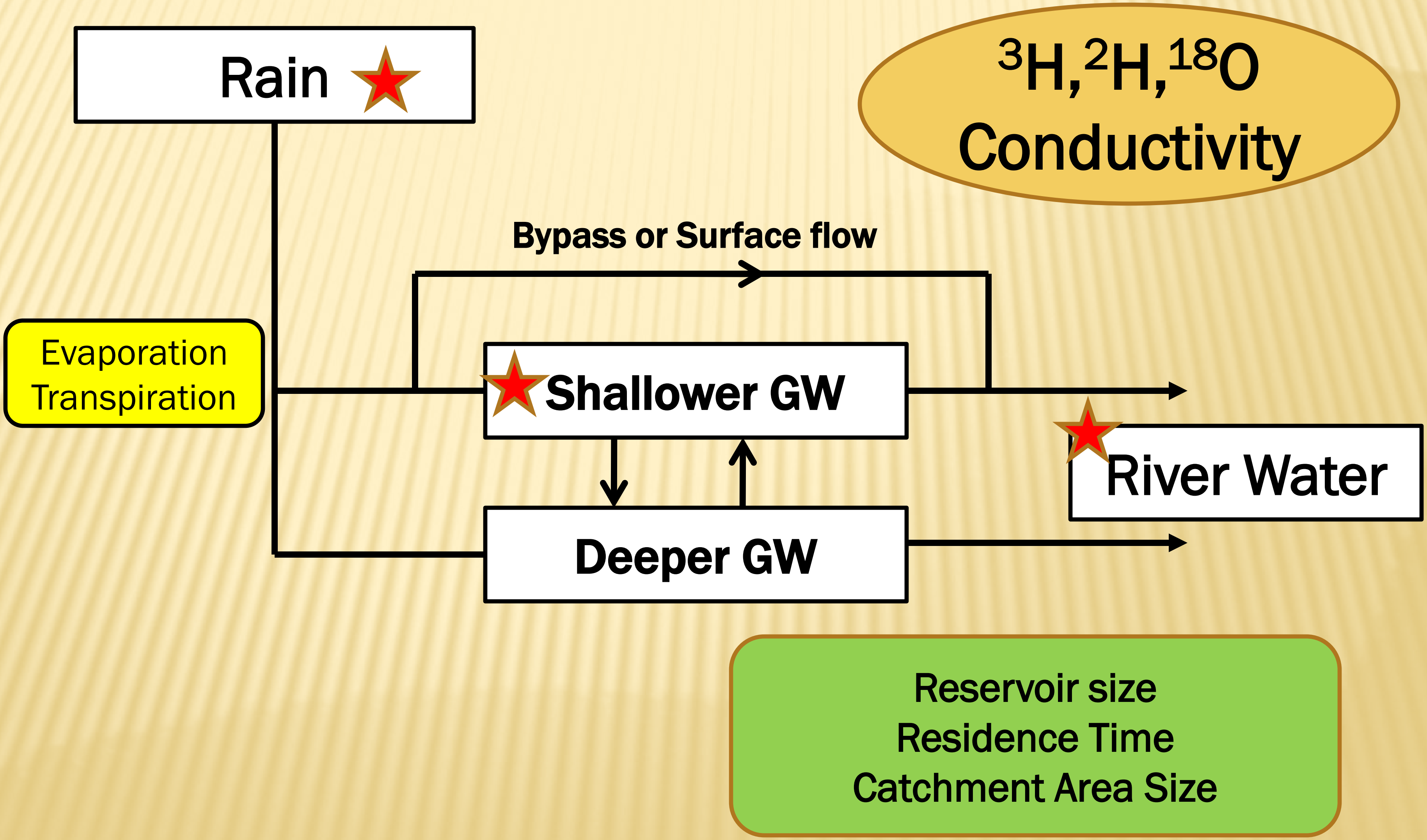


year estimate → each rain event

The improvement of the model

Spread out to the vertical direction.

COMPARTMENT MODEL



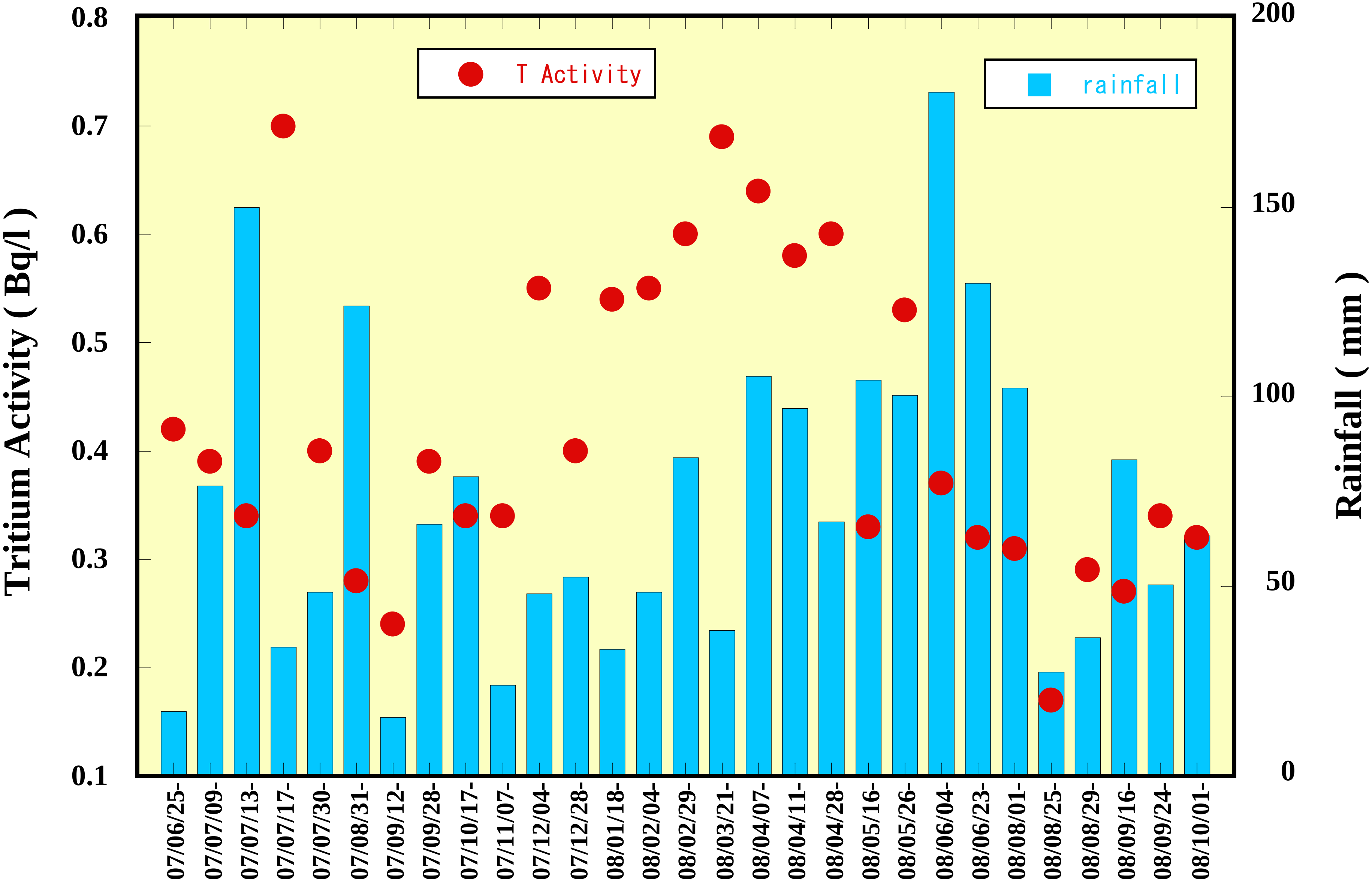
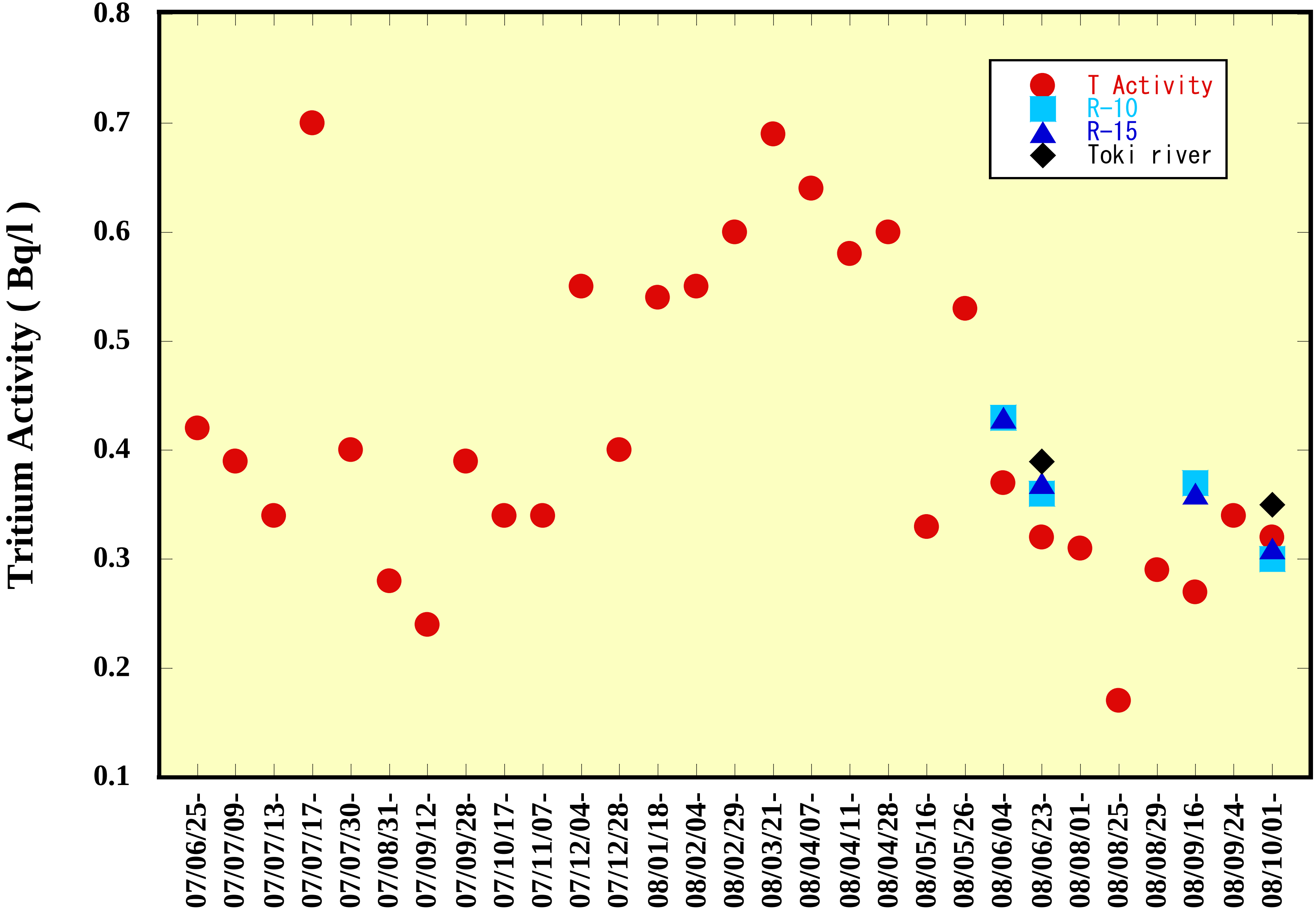


Fig. 1 Tritium Activity in rain at NIFS site (07/06/25 - 08/10/31)



Tritium Activity (Bq/l)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
T Activity
R-10
R-15
Toki river
07/06/25-
07/07/09-
07/07/13-
07/07/17-
07/07/30-
07/08/31-
07/09/12-
07/09/28-
07/10/17-
07/11/07-
07/12/04-
07/12/28-
08/01/18-
08/02/04-
08/02/29-
08/03/21-
08/04/07-
08/04/11-
08/04/28-
08/05/16-
08/05/26-
08/06/04-
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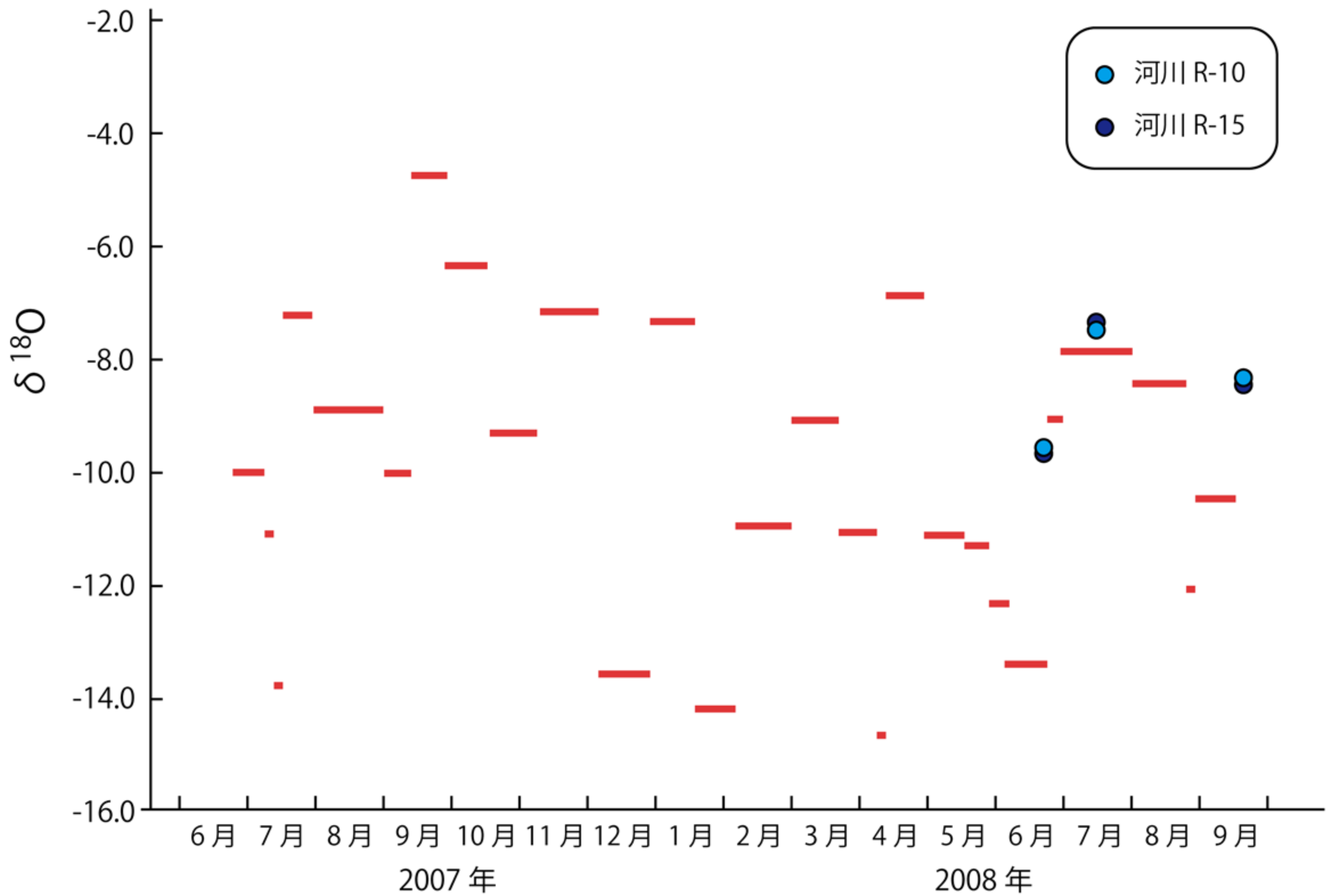
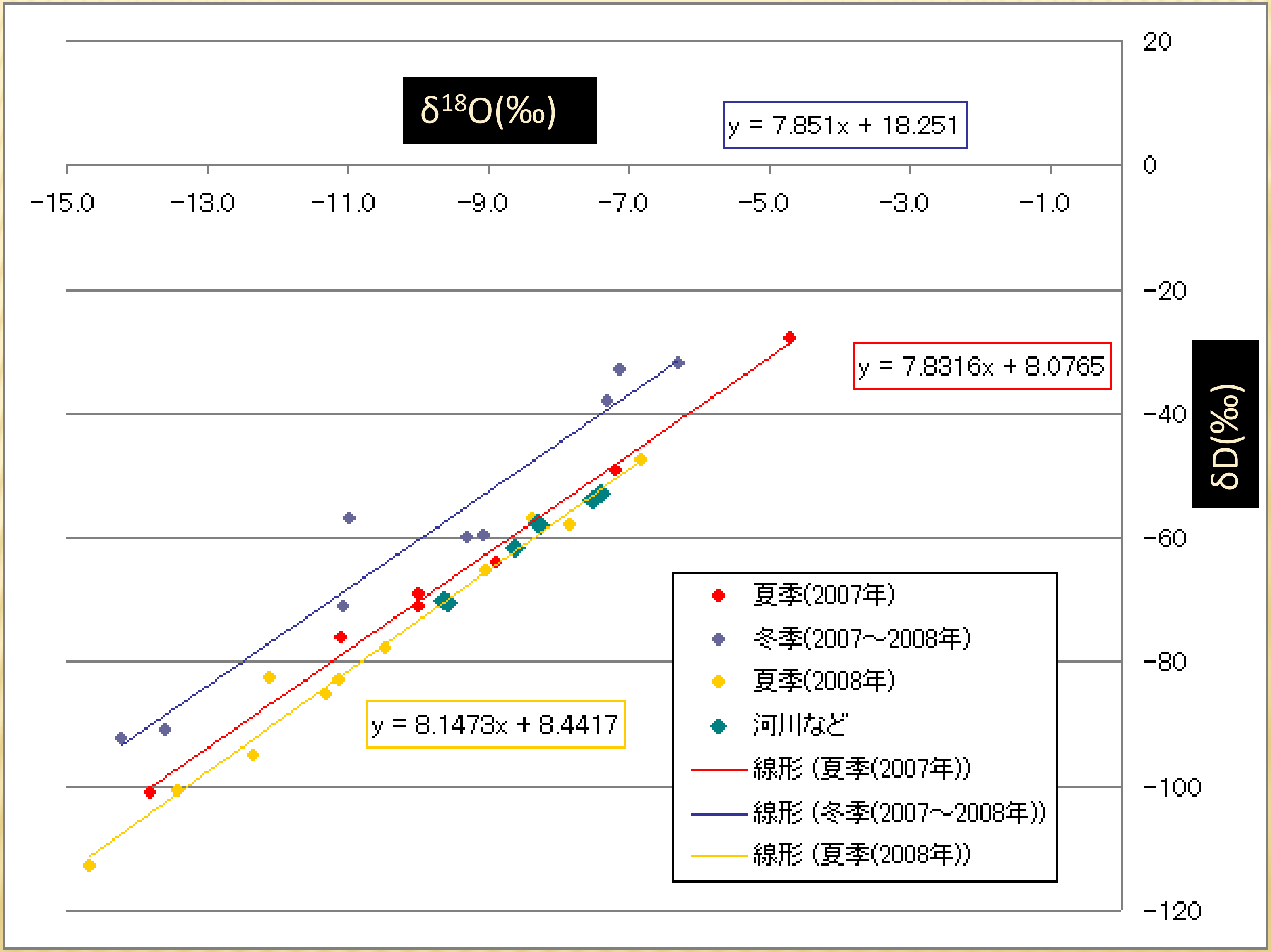
08/09/16-
08/09/24-
08/10/01-

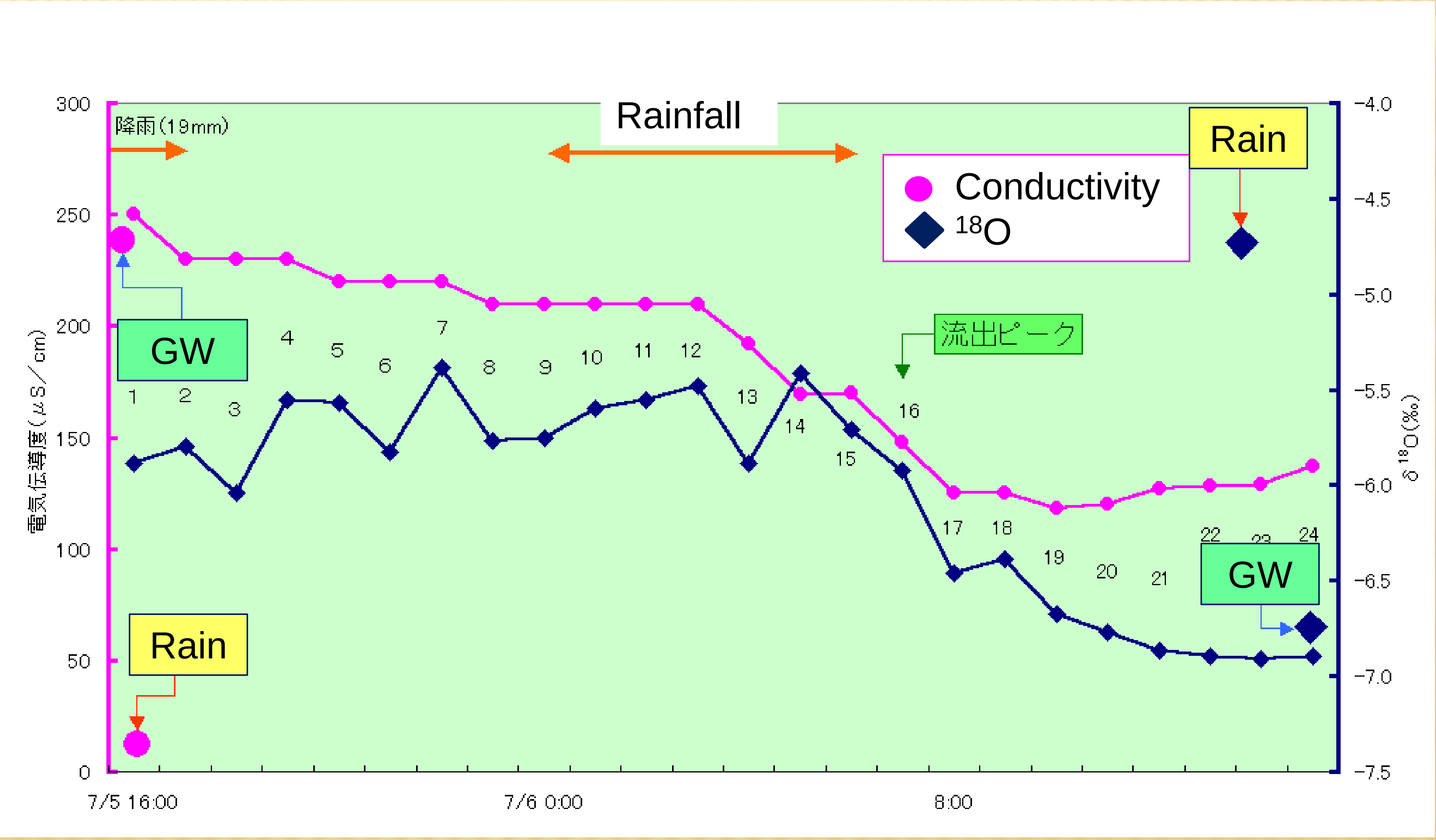


河川 R-10
河川 R-15
δ 18O
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
-16.0
6 月 7 月 8 月 9 月 10 月 11 月 12 月 1 月 2 月 3 月 4 月 5 月 6 月 7 月 8 月 9 月
2007 年
2008 年



δ18O(‰)
δD(‰)
y = 7.851x + 18.251
y = 7.8316x + 8.0765
y = 8.1473x + 8.4417
-15.0
-13.0
-11.0
-9.0
-7.0
-5.0
-3.0
-1.0
20
0
-20
-40
-60
-80
-100
-120
夏季(2007年)
冬季(2007~2008年)
夏季(2008年)
河川など
線形 (夏季(2007年))
線形 (冬季(2007~2008年))
線形 (夏季(2008年))

The relationship between the oxygen isotopic-ratio and the conductivity (Measurement of 1 hour by hour in case of the rainfall) Example



Separation of outflow component

Q:outflow　C:concentration of tracer

t : total　g : groundwater　d : direct flow

$$Q_t = Q_g + Q_d \qquad (1)$$

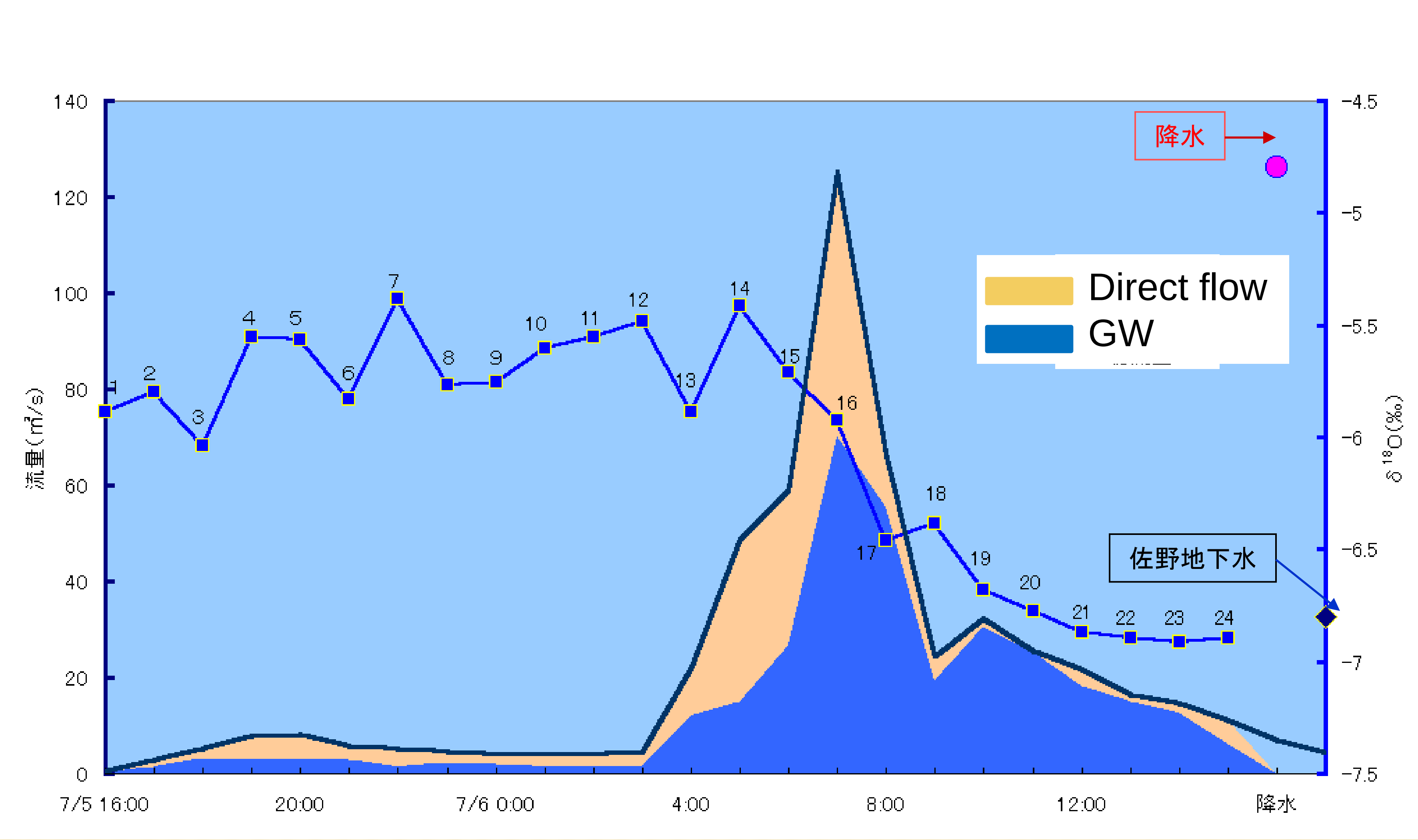
mass balance equation of tracer

$$Q_t C_t = Q_g C_g + Q_d C_d \qquad (2)$$

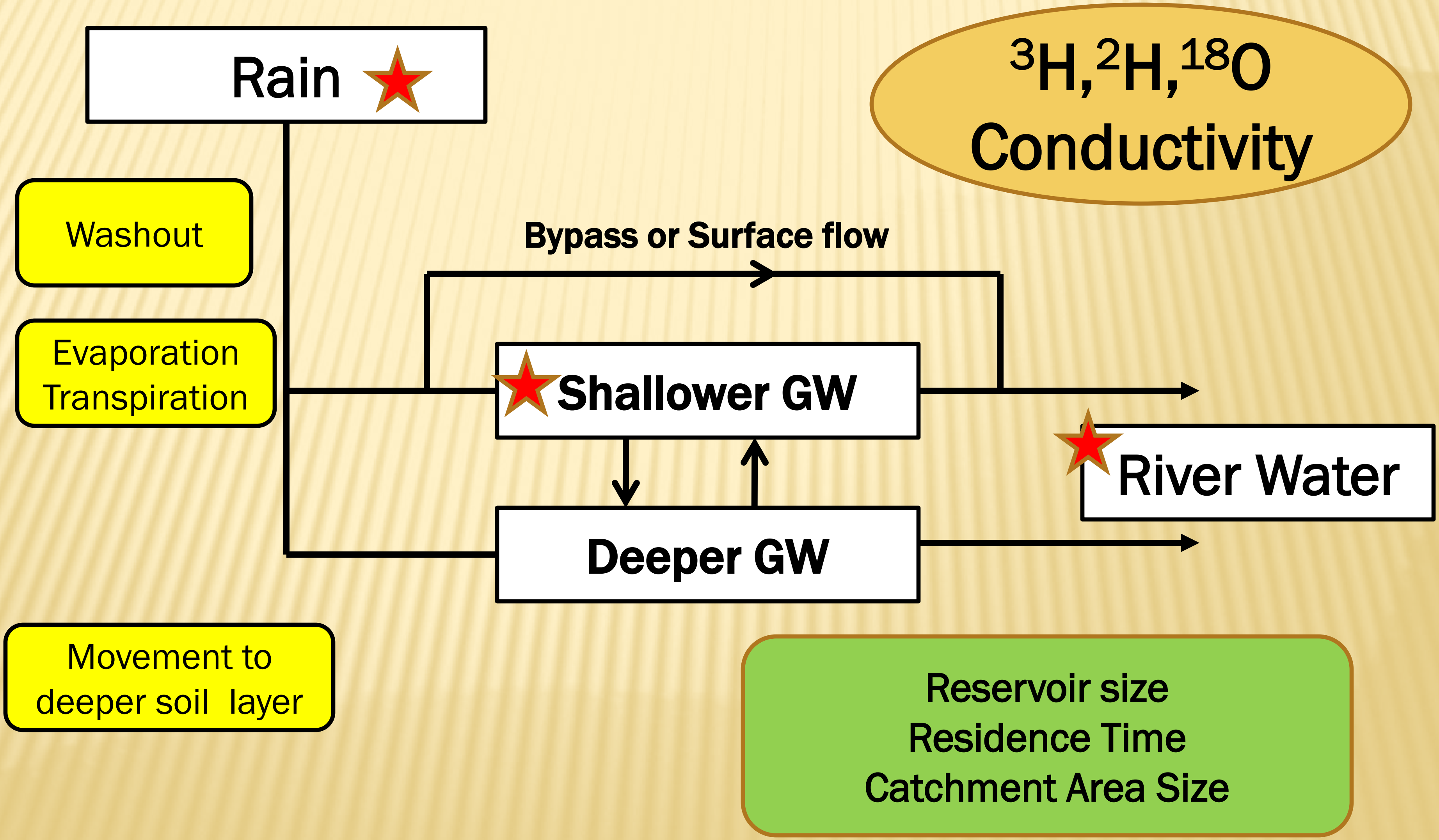
from（1） and（2）

$$Q_g = Q_t \left(\frac{C_t - C_d}{C_g - C_d} \right) \qquad (3)$$

The example of the component separation by the oxygen isotopic-ratio



COMPARTMENT MODEL



THANK YOU VERY MUCH FOR YOUR KIND ATTENTION

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