

Study: Color Coding of Large Value Ranges

Welcome and thank you for your interest in participating in this study!

The aim of the study is to compare colormaps used to visualize data with large value ranges (e.g. from 10^{-8} to 10^{-2}).

Please remove any external influences on your study participation.

By the fact that the response-time is also measured, it is important that you answer as quick as possible, but without losing carefulness.

Participation in the study is voluntary and anonymous and you can stop at an time at your request. In this case, your data will be deleted and not included in the evaluation.

There are 49 questions in this survey.

General Information about yourself.

During the study, we will show you several scatterplots visualizing the ice water content in clouds with questions to answer.

This requires sufficient screen space of 13" or more. It is therefor recommended that you conduct this study on a computer screen.

Please also disable the dark mode of the screen if used.

If possible, please conduct a monitor test prior to the start of the study at:

<https://www.eizo.de/monitortest/>

Have you followed the instructions and ran the screen test?

*

Please choose **only one** of the following:

☐ yes

☐ no

☐ partial

Please write your answer here:

Please specify your gender. *

Please choose **only one** of the following:

- ☐ male
- ☐ female
- ☐ divers
- ☐ prefer not to say

Wich expertise do you have? *

Please choose **only one** of the following:

- ☐ study in (business-)mathematics
- ☐ study in computer science
- ☐ study in meteorology
- ☐ study in geology
- ☐ study in geography
- ☐ study in social sciences
- ☐ study in physics

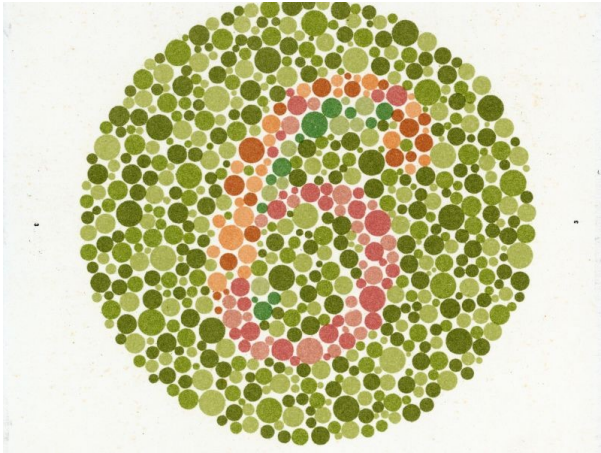
☐ Other

How old are you? *

Please choose **only one** of the following:

- ☐ <20
- ☐ 20-30
- ☐ 30-40
- ☐ 40-50
- ☐ 50-60
- ☐ >60
- ☐ prefer not to say

Wich number do you see in the following picture?

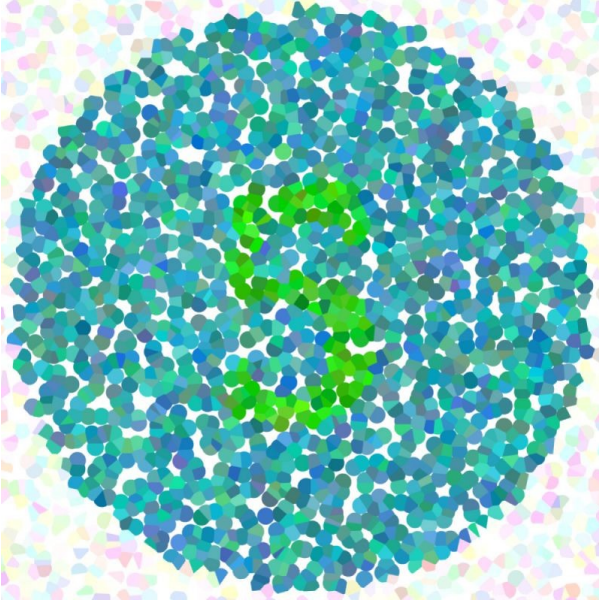


*

Please choose **only one** of the following:

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8
- ☐ 9
- ☐ don't know

Wich number do you see in the following picture?



*

Please choose **only one** of the following:

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8
- ☐ 9
- ☐ don't know

Study Introduction and Training

The visualizations analyzed in the study are scatterplots. These will differ in the data shown and the color scales used.

The images show a regular grid of measurement data over a period of one day up to an altitude of 12km.

There will be four different type of tasks:

- Overview of the data
- Comparison of different days
- Reading of values
- Comparison of different data points

An example for each of these task types follows so that you can familiarize yourself with the questions.

(Loading the images for the questions may take a moment!)

The color scales used in the study are **logarithmically** scaled.

Therefore the logarithmic notation is briefly repeated.

In the notation, a distinction is made between **exponent** and **mantissa**.

In the following two example numbers, the mantissas are marked in red and the exponents in blue.

Because of the negative exponents, the number on the left is the greater value.

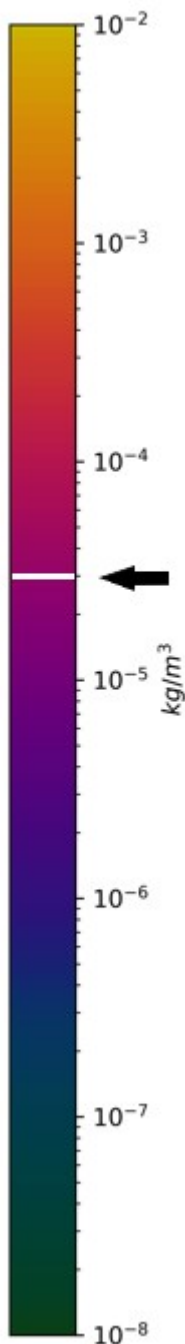
$$\textcircled{3} \cdot 10^{\textcircled{-2}}$$

$$\textcircled{5} \cdot 10^{\textcircled{-8}}$$

In addition to the logarithmic scaling, the color scales are fixed to the range 10^{-8} to 10^{-2} . However, that doesn't mean the data exhausts the full range of values in each visualization.

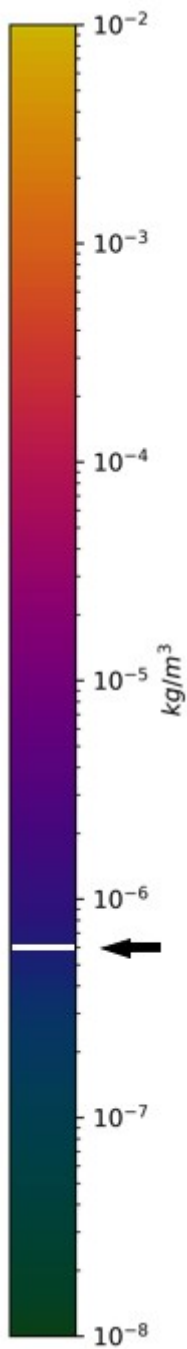
This example should help to read the color scales correctly.

The mantissa of the marked value is 3 and the exponent -5 (→ value $3 \cdot 10^{-5}$).



Please enter the mantissa and the exponent of the marked value.

Please always enter the minus sign for the exponents.



*

❗ Only numbers may be entered in these fields.

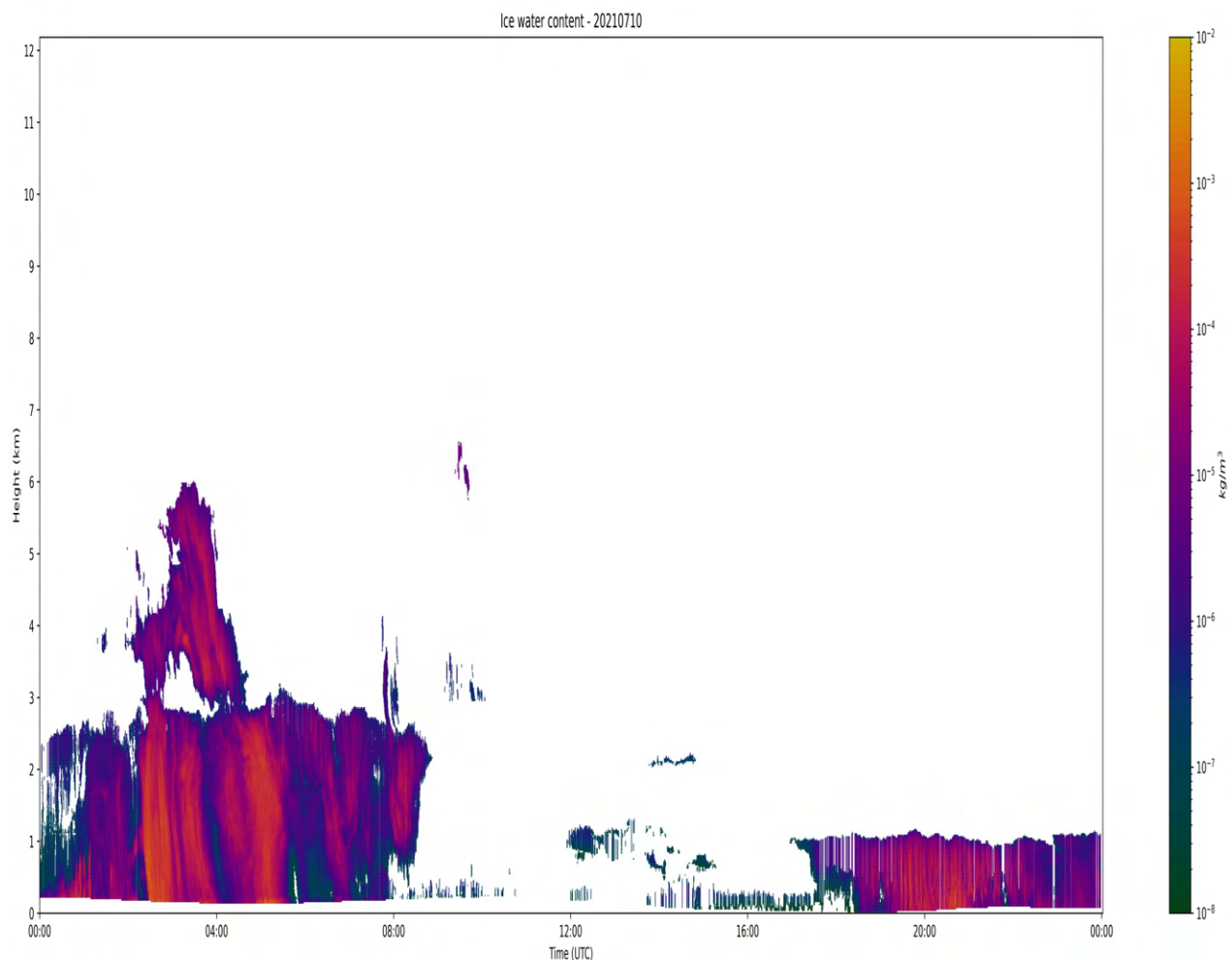
	value
exponent	<input type="text"/>

	value
mantissa	<div></div>

The overview tasks are about what information is recognizable when you take a first look at the visualization. For this purpose, the orders of magnitude (i.e. exponents of the logarithmic representation) are asked for. For example:

What are the exponents of the **smallest** and **greatest** values contained in the data?

And how confident are you about your answer on a scale from **1 (very unconfident)** to **5 (very confident)**?



★

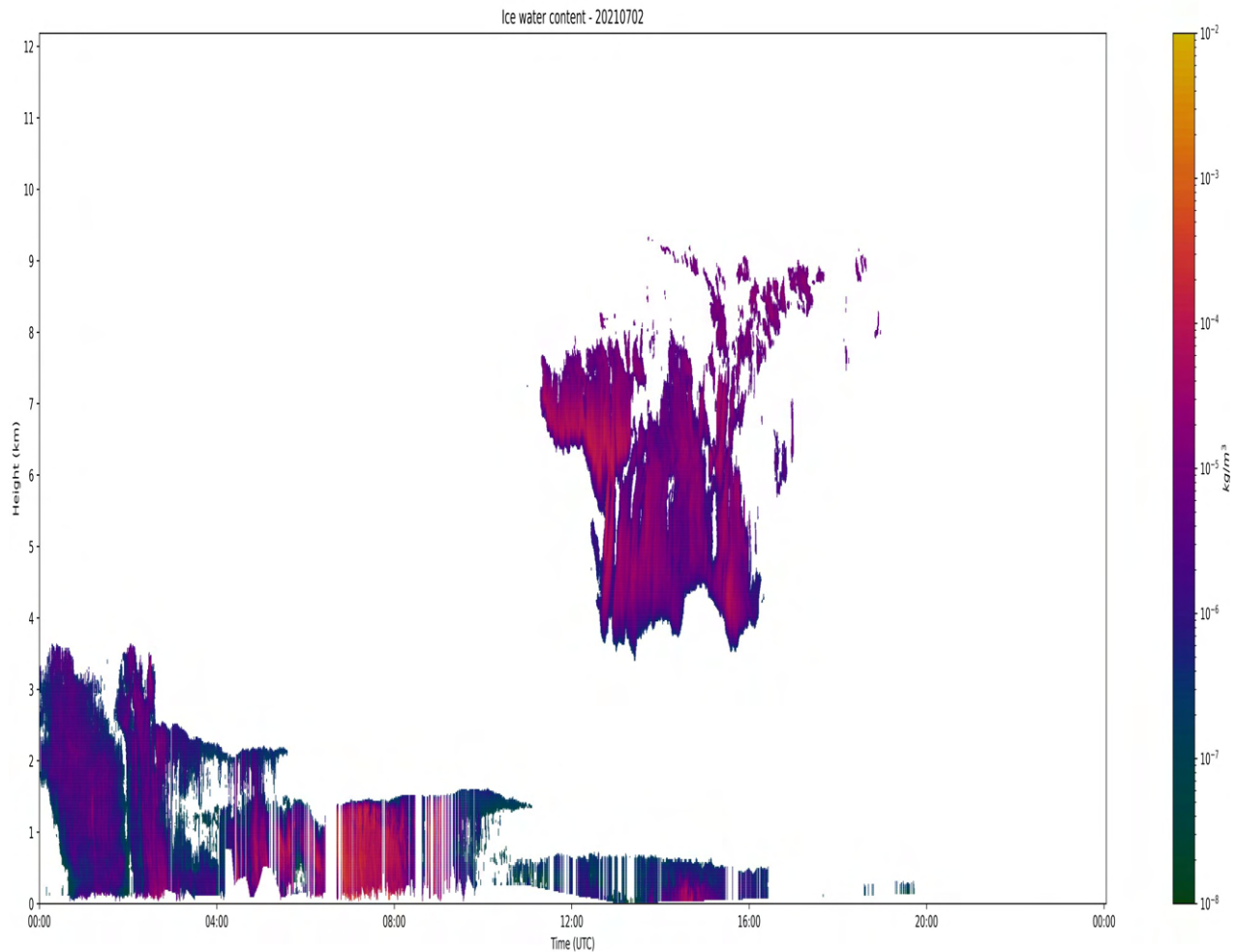
❗ Only numbers may be entered in these fields.

	smallest value	greatest value
exponent	<input type="text"/>	<input type="text"/>

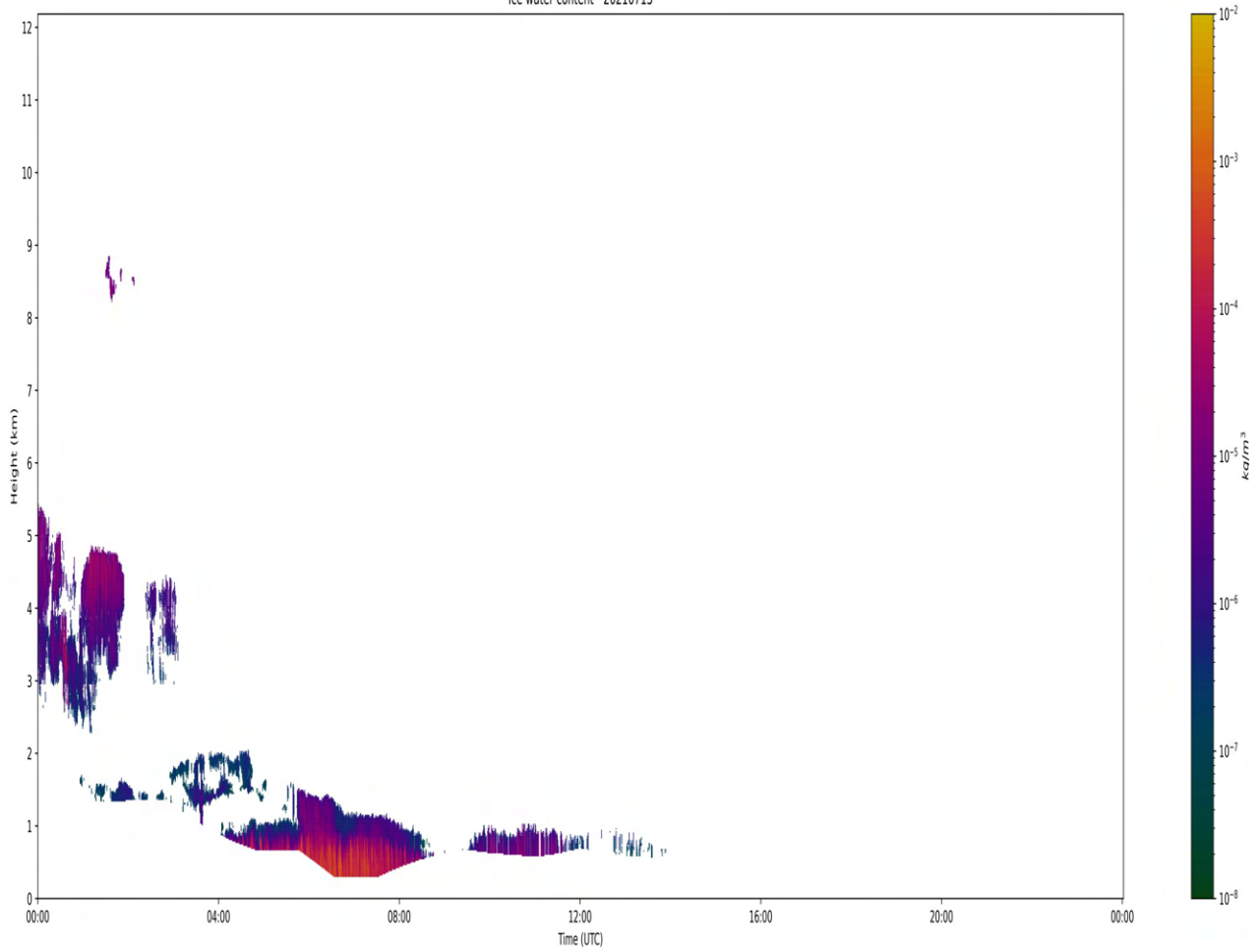
	smallest value	greatest value
confidence		

The daily comparison tasks serve to compare two different days. Therefore it is asked for the day with the largest value contained:

Wich day contains the highest value?



Ice water content - 20210713



*

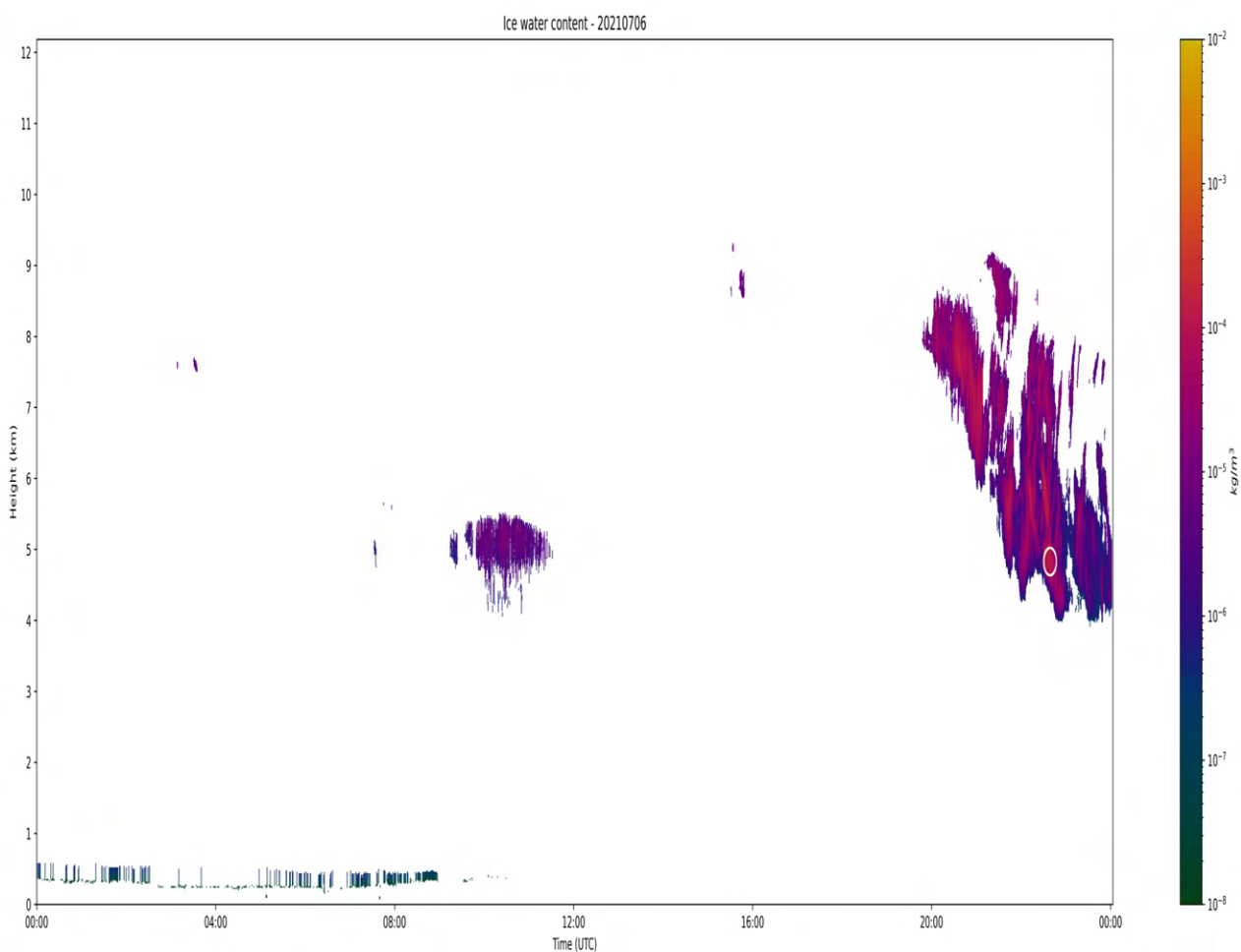
Please choose **only one** of the following:

- ☐ both
- ☐ 20210702
- ☐ 20210713
- ☐ don't know
- ☐ cannot be determined

In the reading tasks, the value of the data point marked with the yellow circle should be identified. Therefore, a range in which the value lies should be delimited as precisely as possible. This is done by specifying the exponent and mantissa of the minimum and maximum value of the range.

In which range does the value highlighted in yellow lies?

And how confident are you about your answer on a scale from 1 (very unconfident) to 5 (very confident)?



★

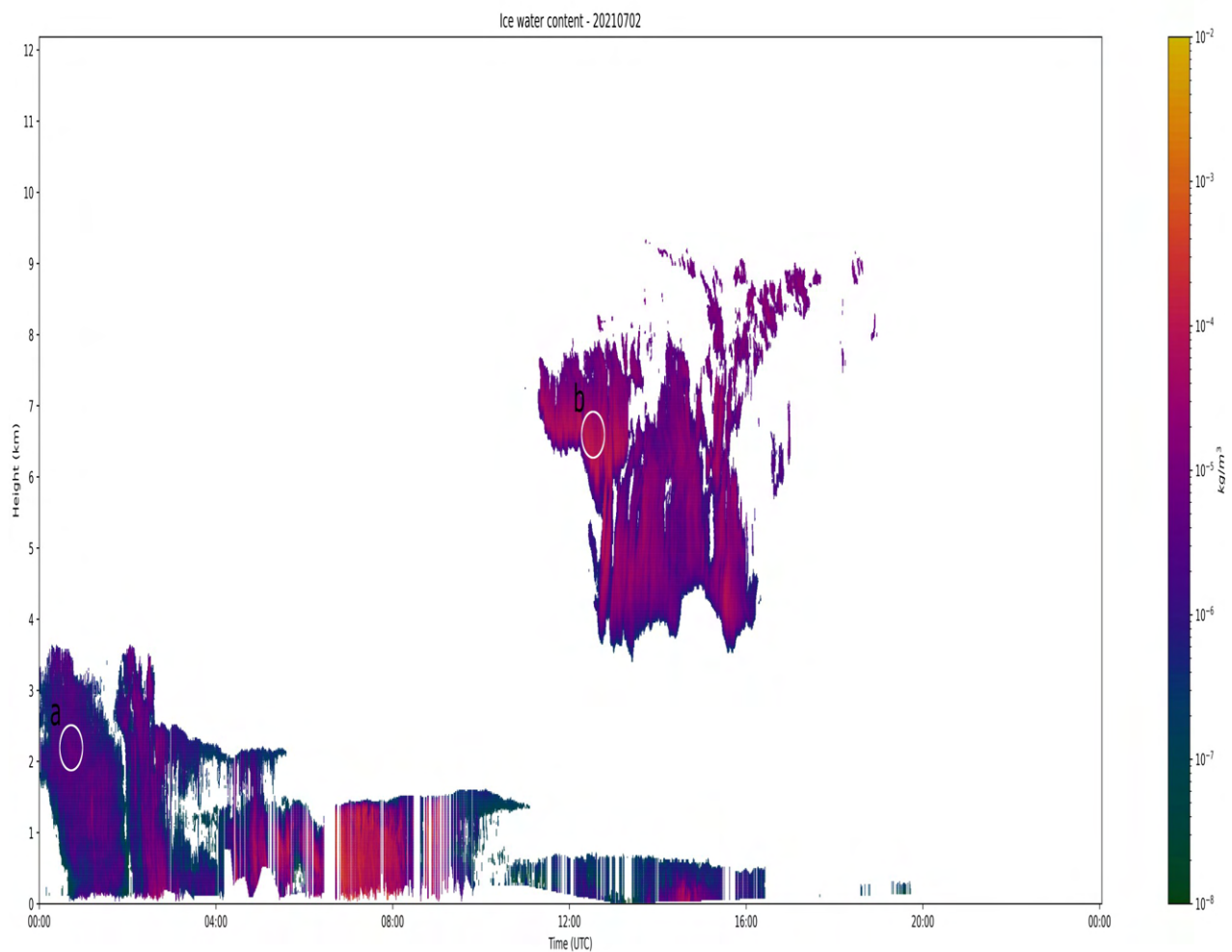
⚠ Only numbers may be entered in these fields.

	minimum value	maximum value
exponent	<input type="text"/>	<input type="text"/>

	minimum value	maximum value
mantissa	<div></div>	<div></div>
confidence exponent	<div></div>	<div></div>
confidence mantissa	<div></div>	<div></div>

In the value comparison tasks, two data points of a data set are compared with each other.

Which of the marked data points has the greater value?



★

Please choose **only one** of the following:

- ☐ equal
- ☐ a
- ☐ b
- ☐ don't know
- ☐ cannot be determined

The training is over now.

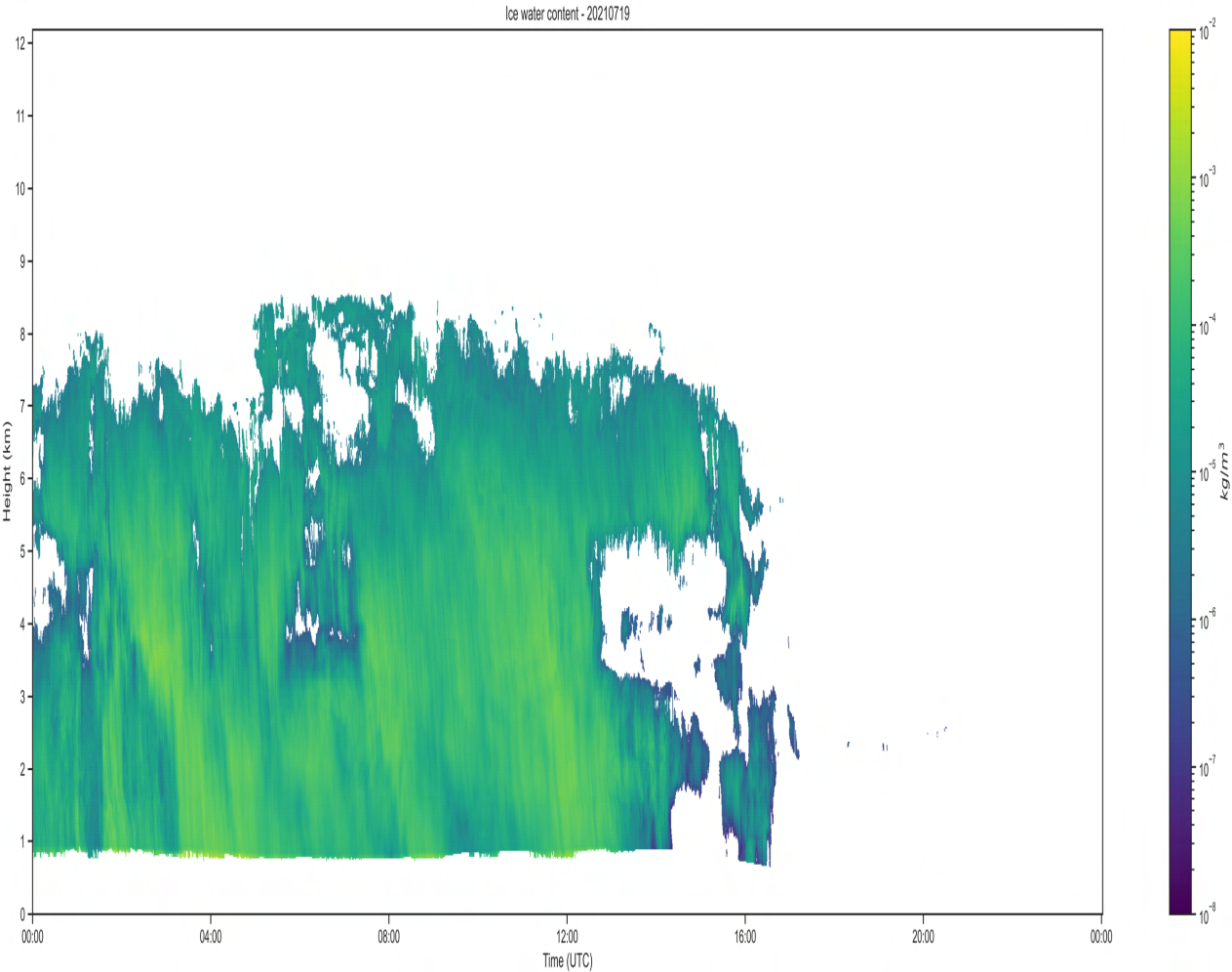
The actual study, including time measurement, begins on the next page.

Overview-Taks

The following questions are intended to query an initial overview of the data.

What are the exponents of the **smallest** and **greatest** values contained in the data?

And how confident are you about your answer on a scale from **1 (very unconfident)** to **5 (very confident)**?



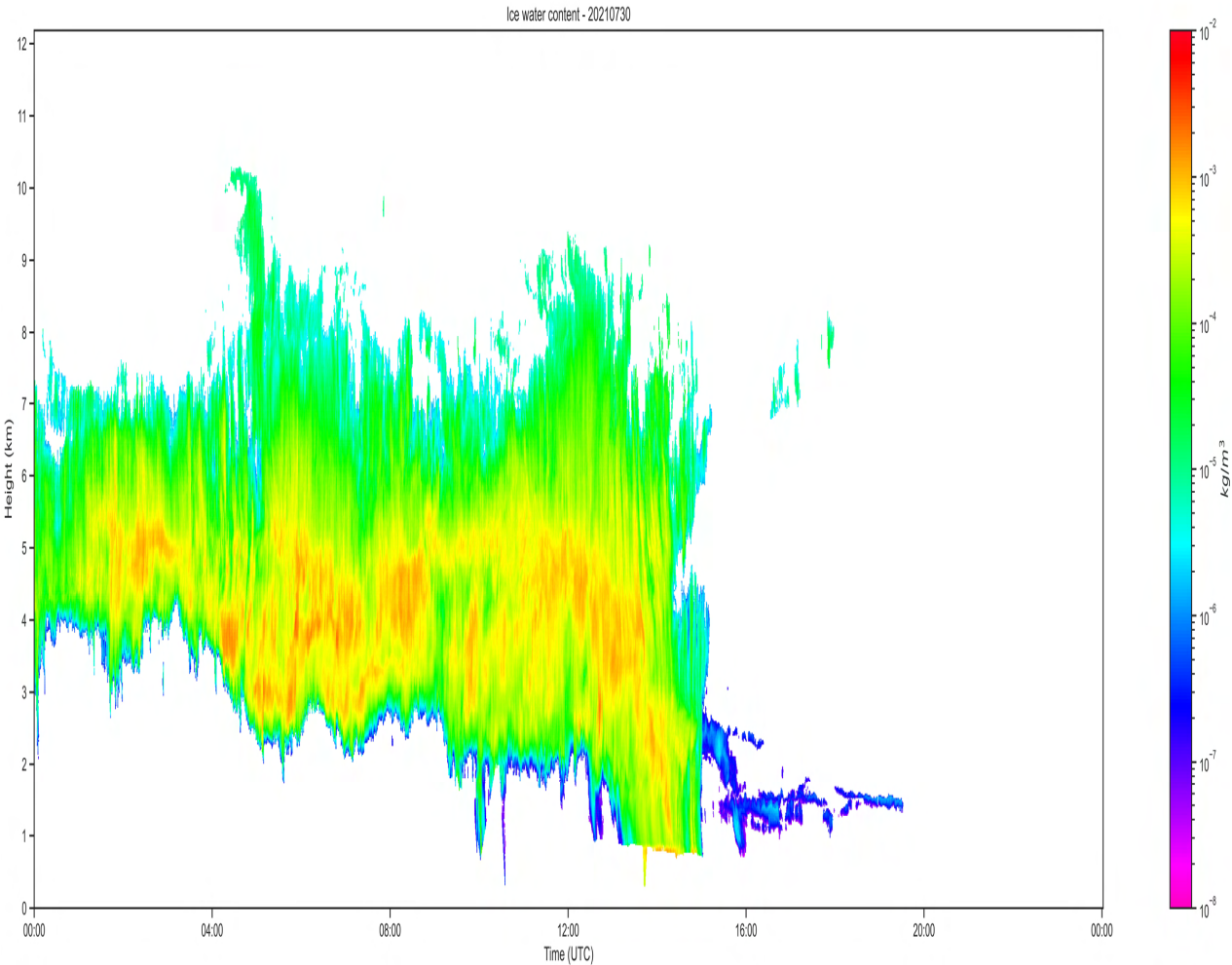
★

ⓘ Only numbers may be entered in these fields.

	smallest value	greatest value
exponent	<input type="text"/>	<input type="text"/>
confidence	<input type="text"/>	<input type="text"/>

What are the exponents of the **smallest** and **greatest** values contained in the data?

And how confident are you about your answer on a scale from **1 (very unconfident)** to **5 (very confident)**?



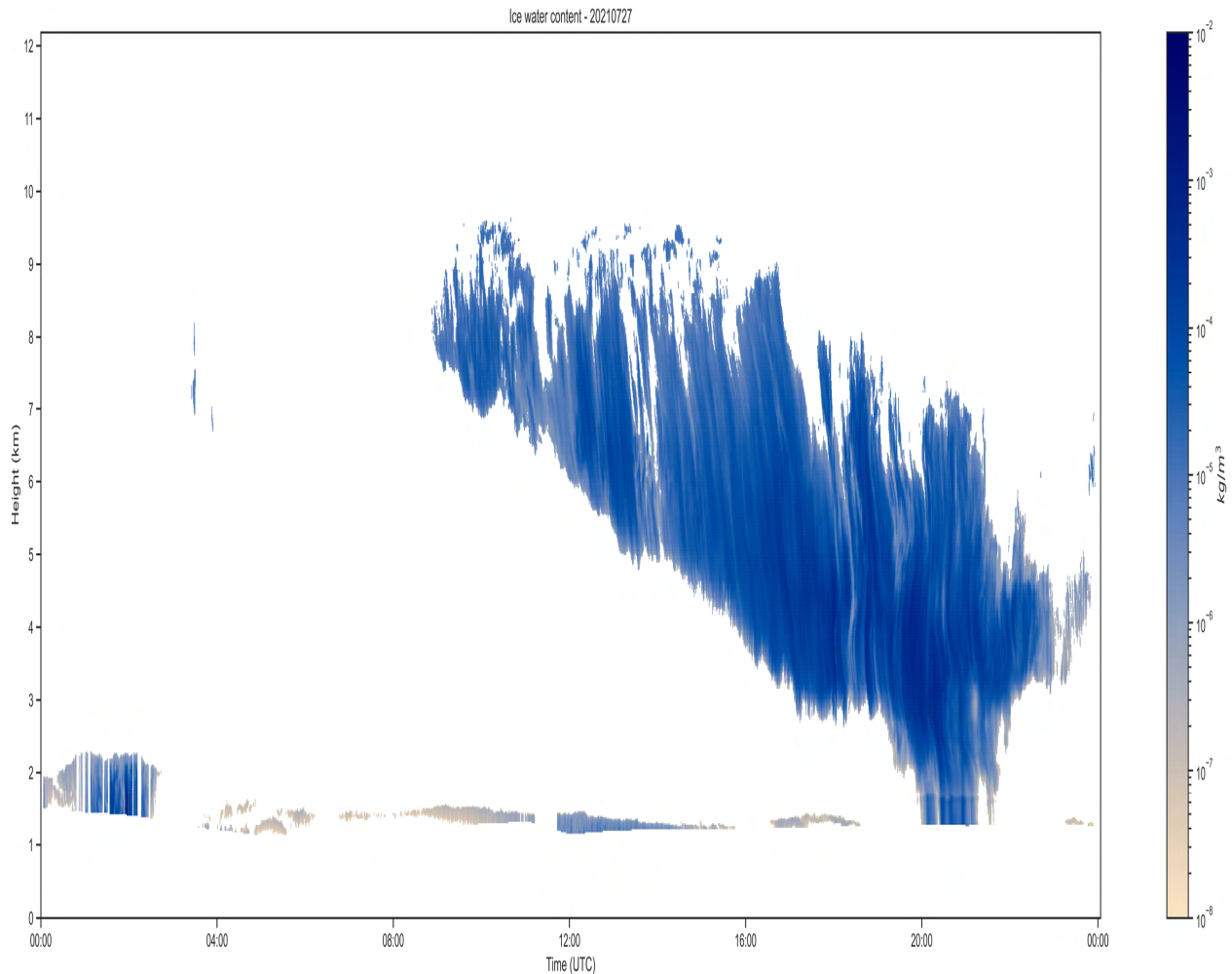
★

❗ Only numbers may be entered in these fields.

	smallest value	greatest value
exponent	<input type="text"/>	<input type="text"/>
confidence	<input type="text"/>	<input type="text"/>

What are the exponents of the **smallest** and **greatest** values contained in the data?

And how confident are you about your answer on a scale from **1 (very unconfident)** to **5 (very confident)**?



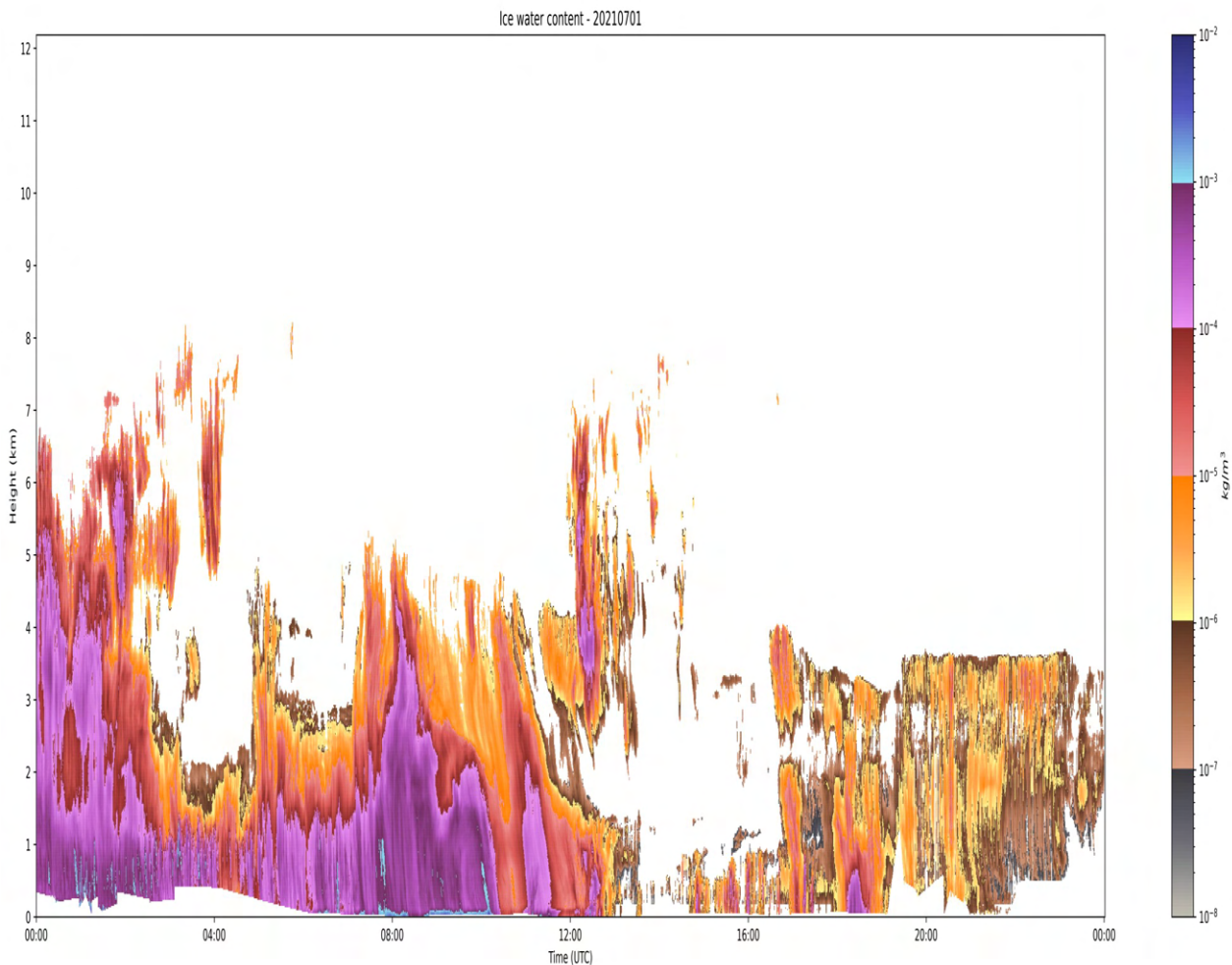
★

❗ Only numbers may be entered in these fields.

	smallest value	greatest value
exponent	<input type="text"/>	<input type="text"/>
confidence	<input type="text"/>	<input type="text"/>

What are the exponents of the **smallest** and **greatest** values contained in the data?

And how confident are you about your answer on a scale from **1 (very unconfident)** to **5 (very confident)**?



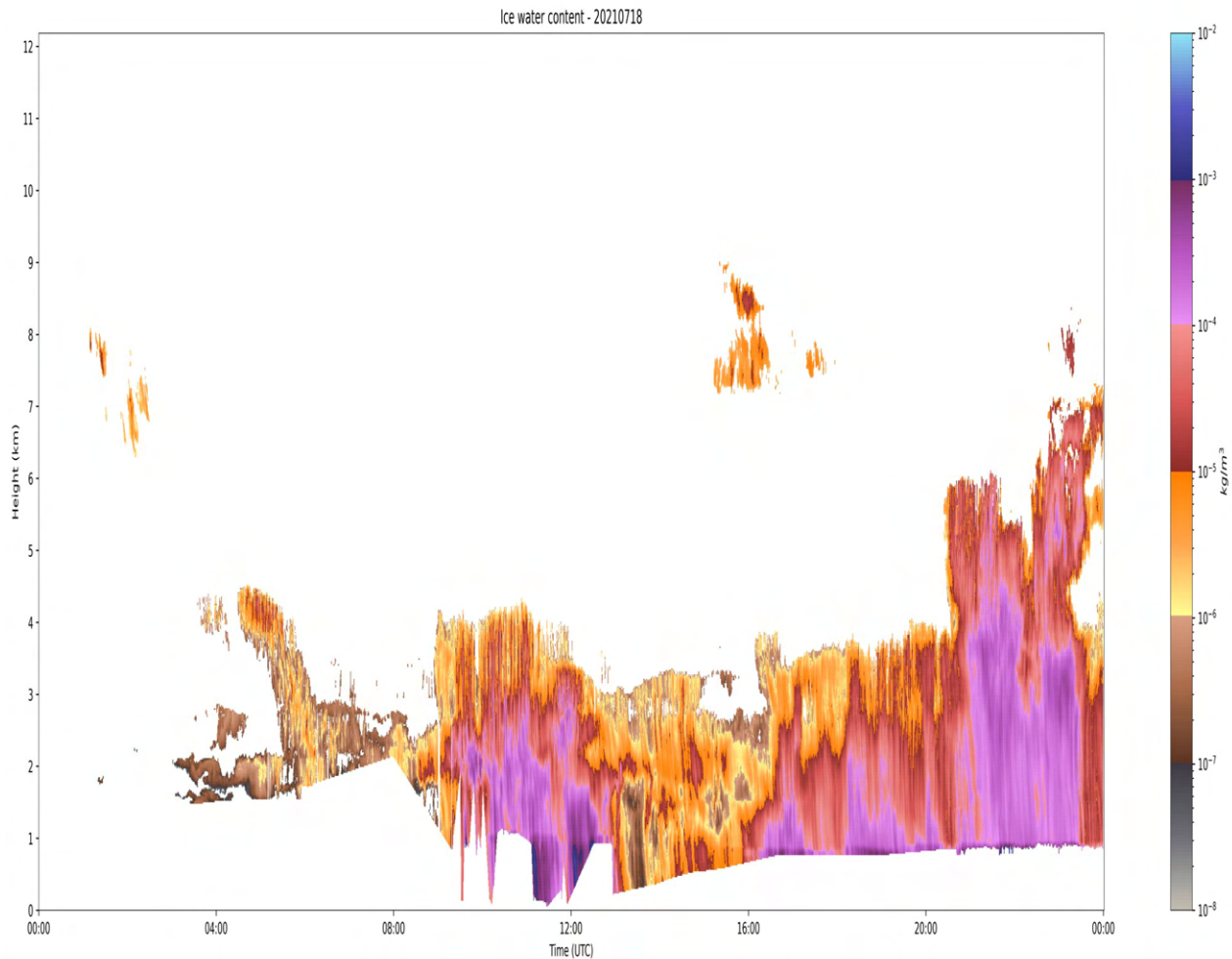
*

❗ Only numbers may be entered in these fields.

	smallest value	greatest value
exponent	<input type="text"/>	<input type="text"/>
confidence	<input type="text"/>	<input type="text"/>

What are the exponents of the **smallest** and **greatest** values contained in the data?

And how confident are you about your answer on a scale from **1 (very unconfident)** to **5 (very confident)**?



*

ⓘ Only numbers may be entered in these fields.

	smallest value	greatest value
exponent	<input type="text"/>	<input type="text"/>
confidence	<input type="text"/>	<input type="text"/>

Break

This is a short break. Take a moment to calm down and after the time has expired, please answer the question on the following page.

You will be automatically redirected to the next page after the time has expired.

Wich date is the earliest? *

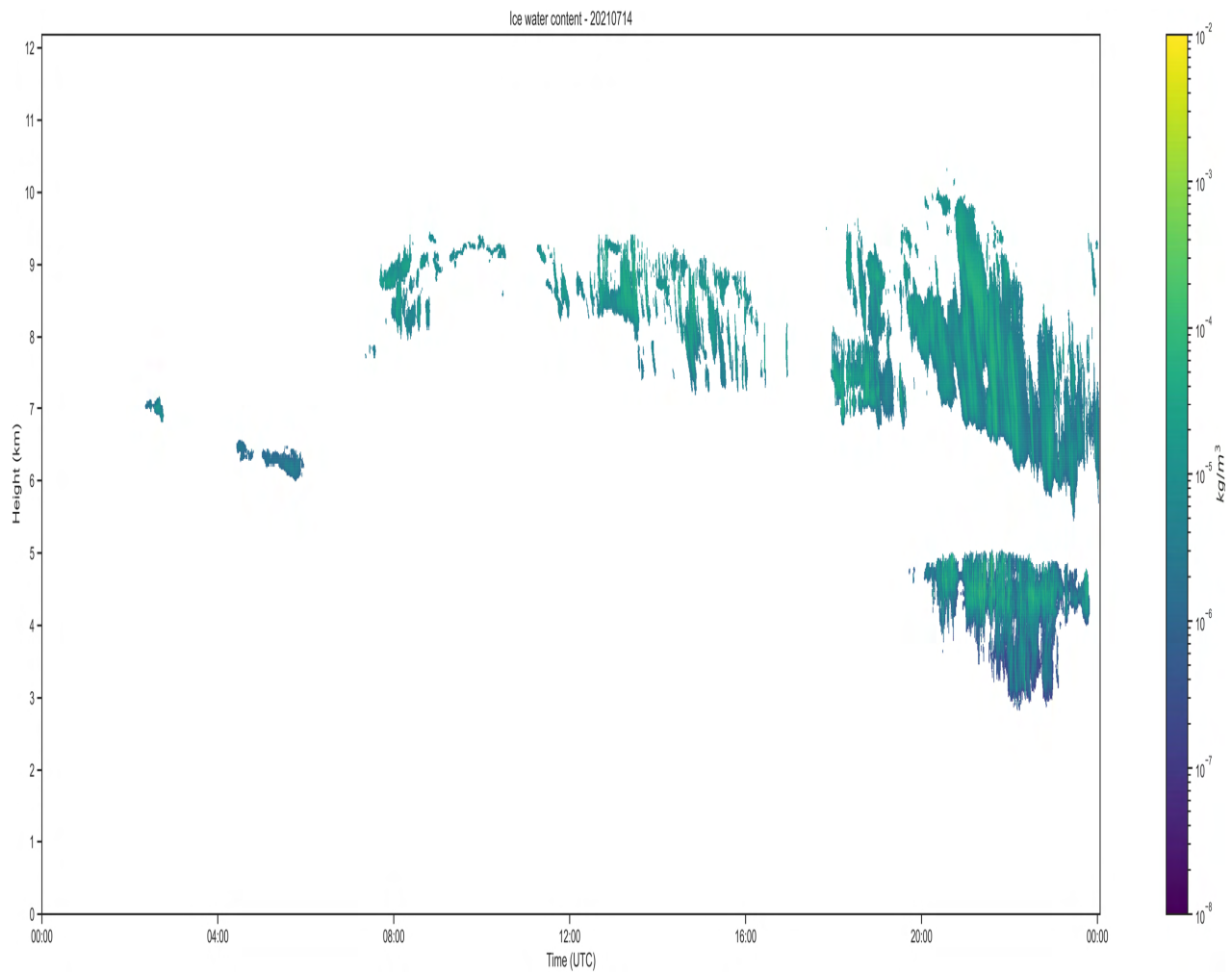
Please choose **only one** of the following:

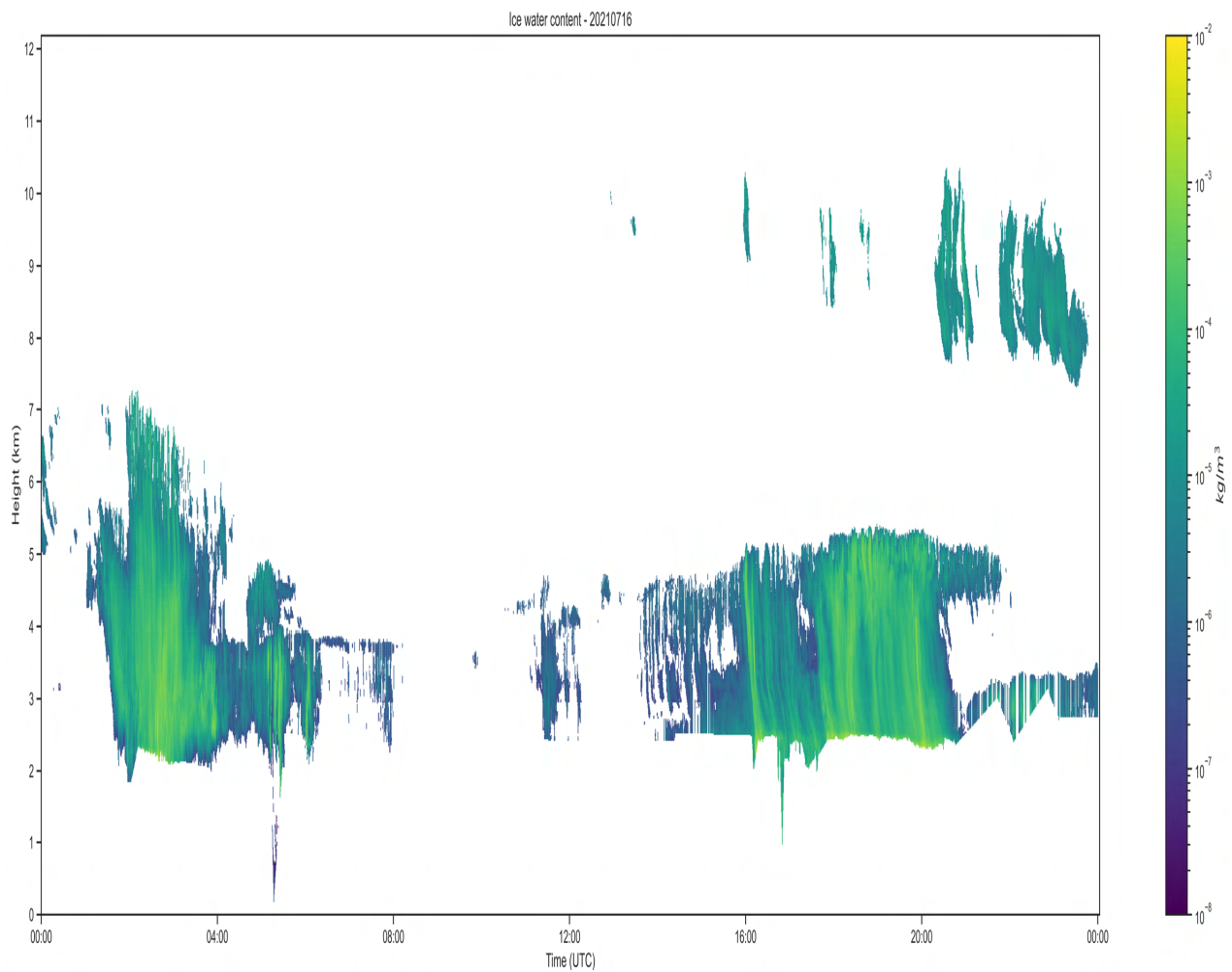
- ☐ 20211123
- ☐ 20210712
- ☐ 20220204

Daily Comparison-Tasks

The following questions compare the data of two different days.

Wich day contains the highest value?



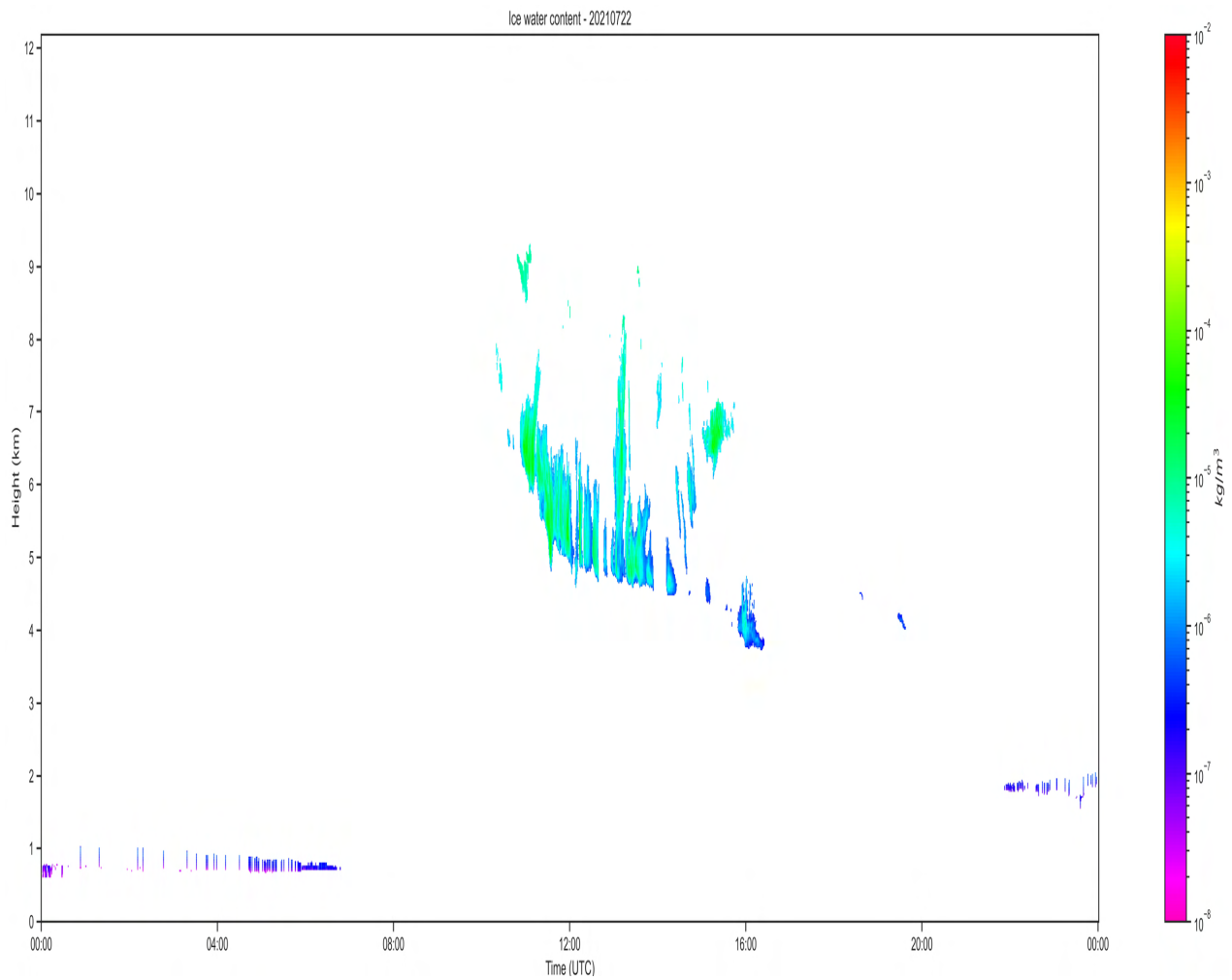


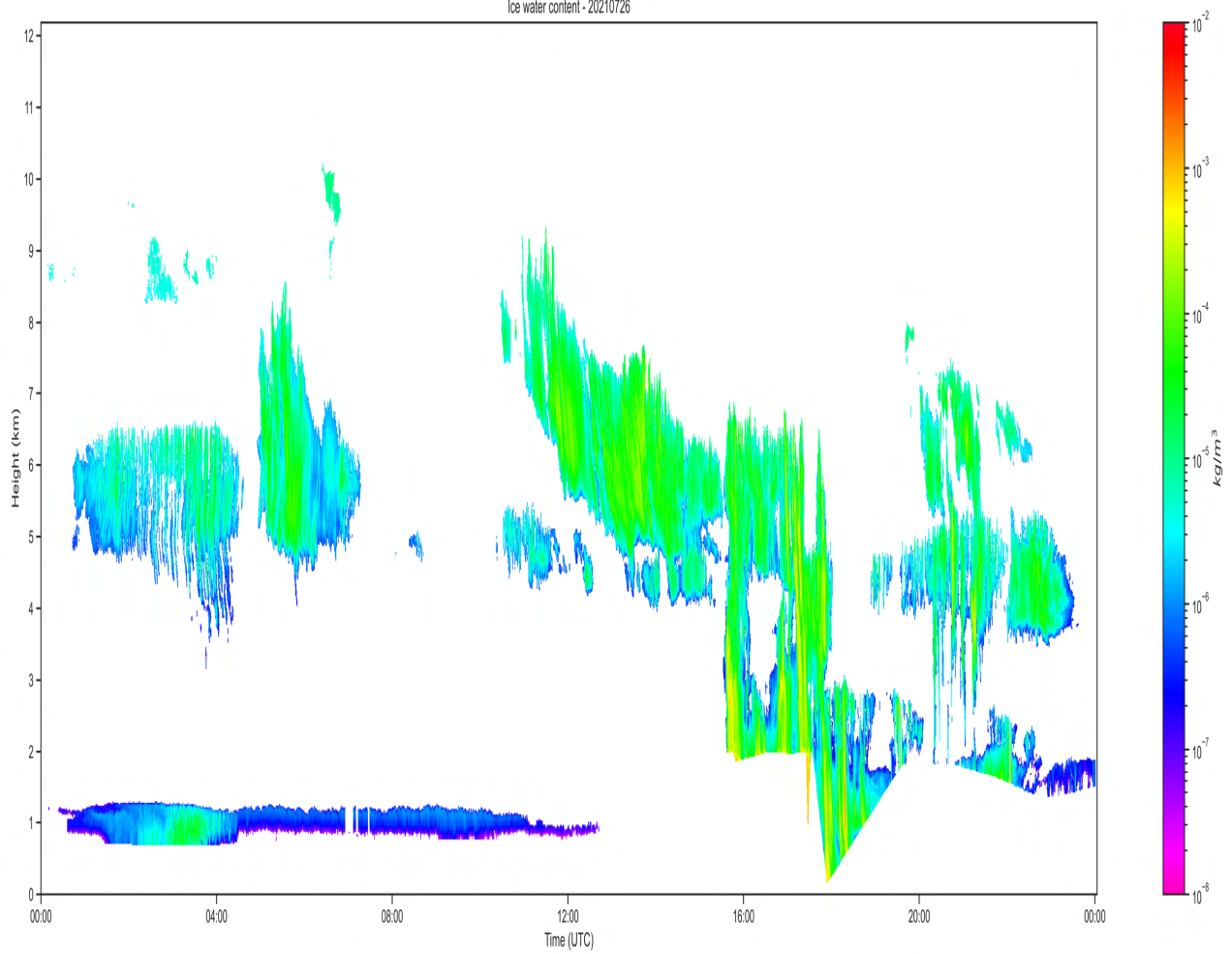
*

Please choose **only one** of the following:

- ☐ both
- ☐ 20210714
- ☐ 20210716
- ☐ don't know
- ☐ cannot be determined

Wich day contains the highest value?



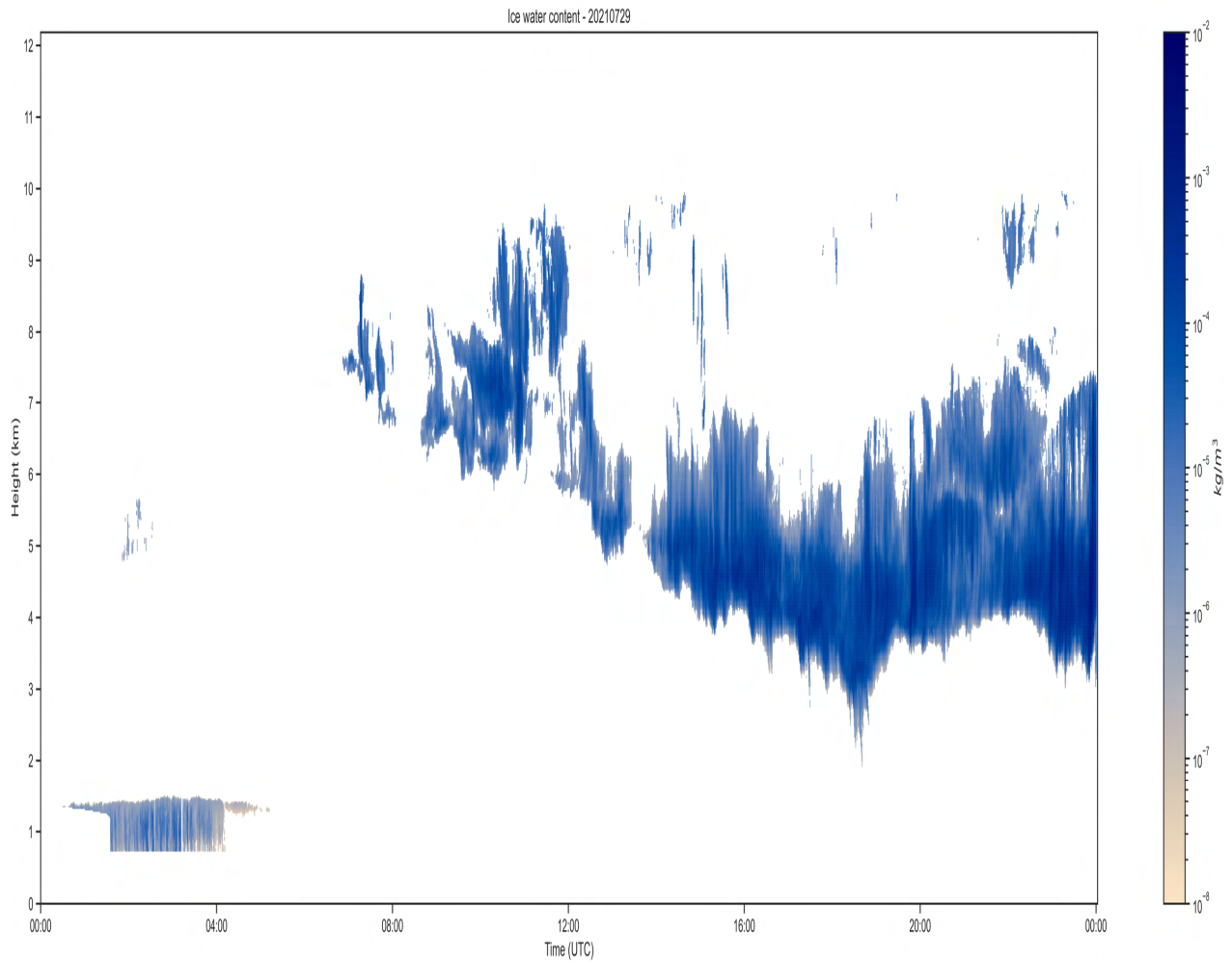


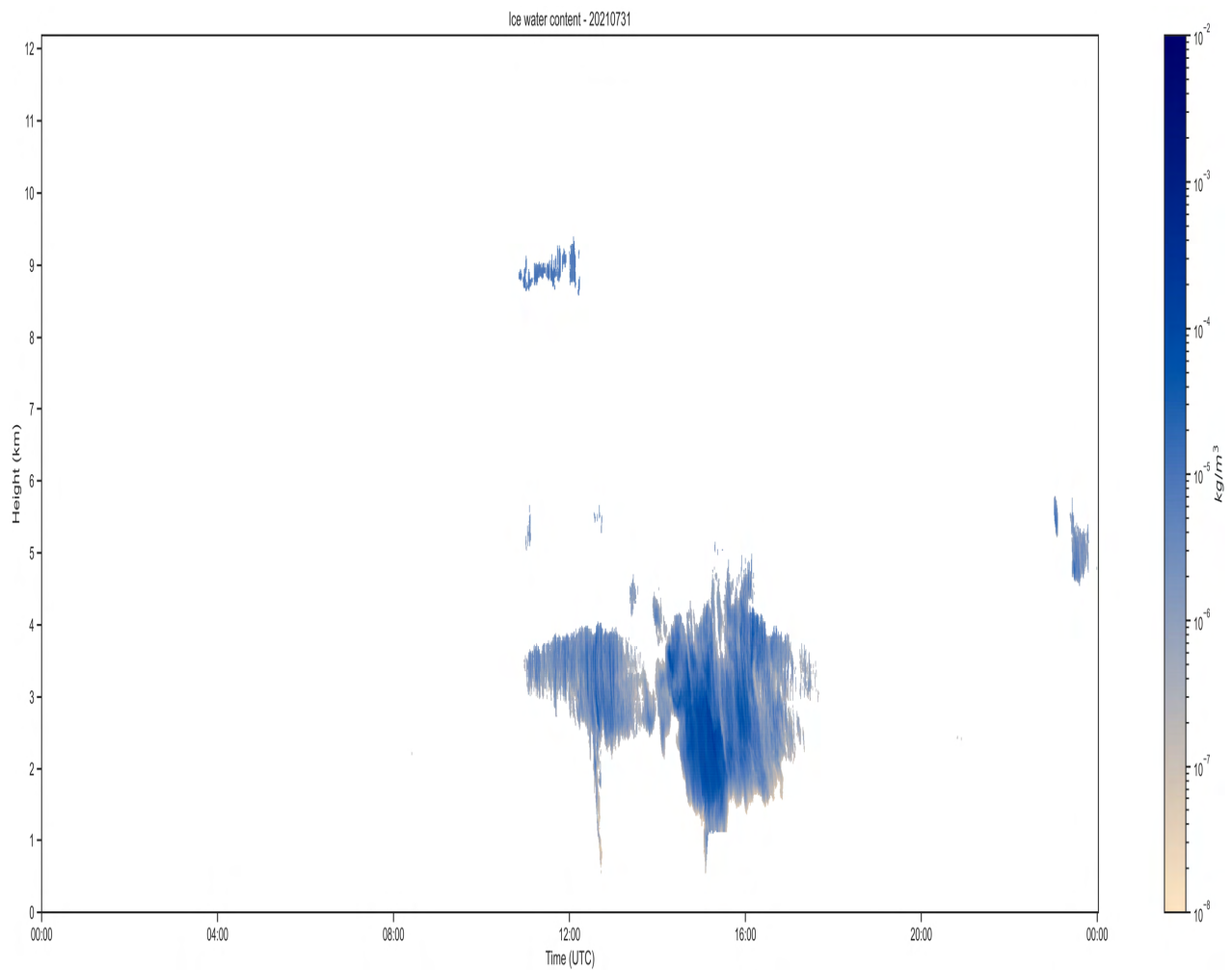
★

Please choose **only one** of the following:

- ☐ both
- ☐ 20210722
- ☐ 20210726
- ☐ don't know
- ☐ cannot be determined

Which day contains the highest value?



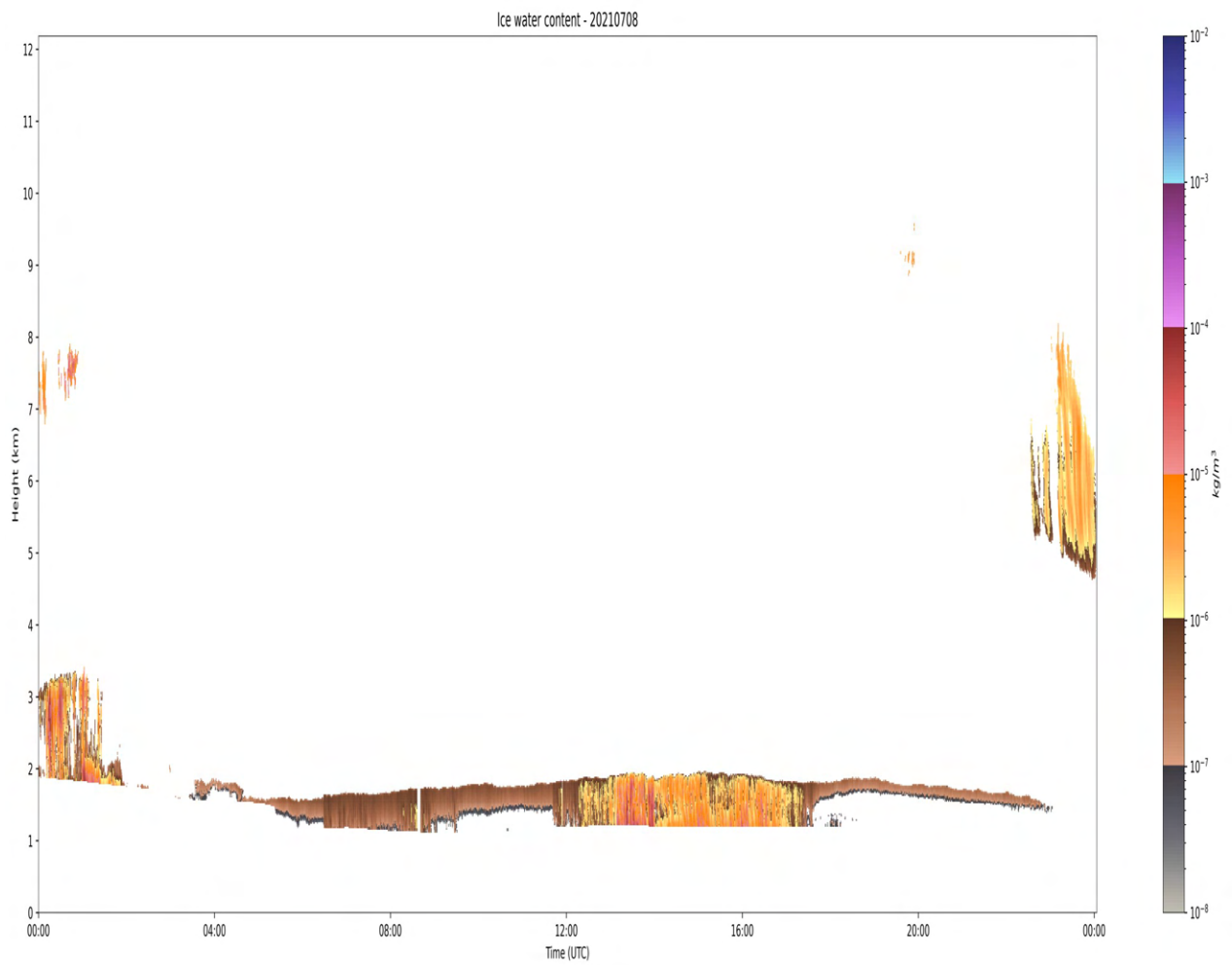


★

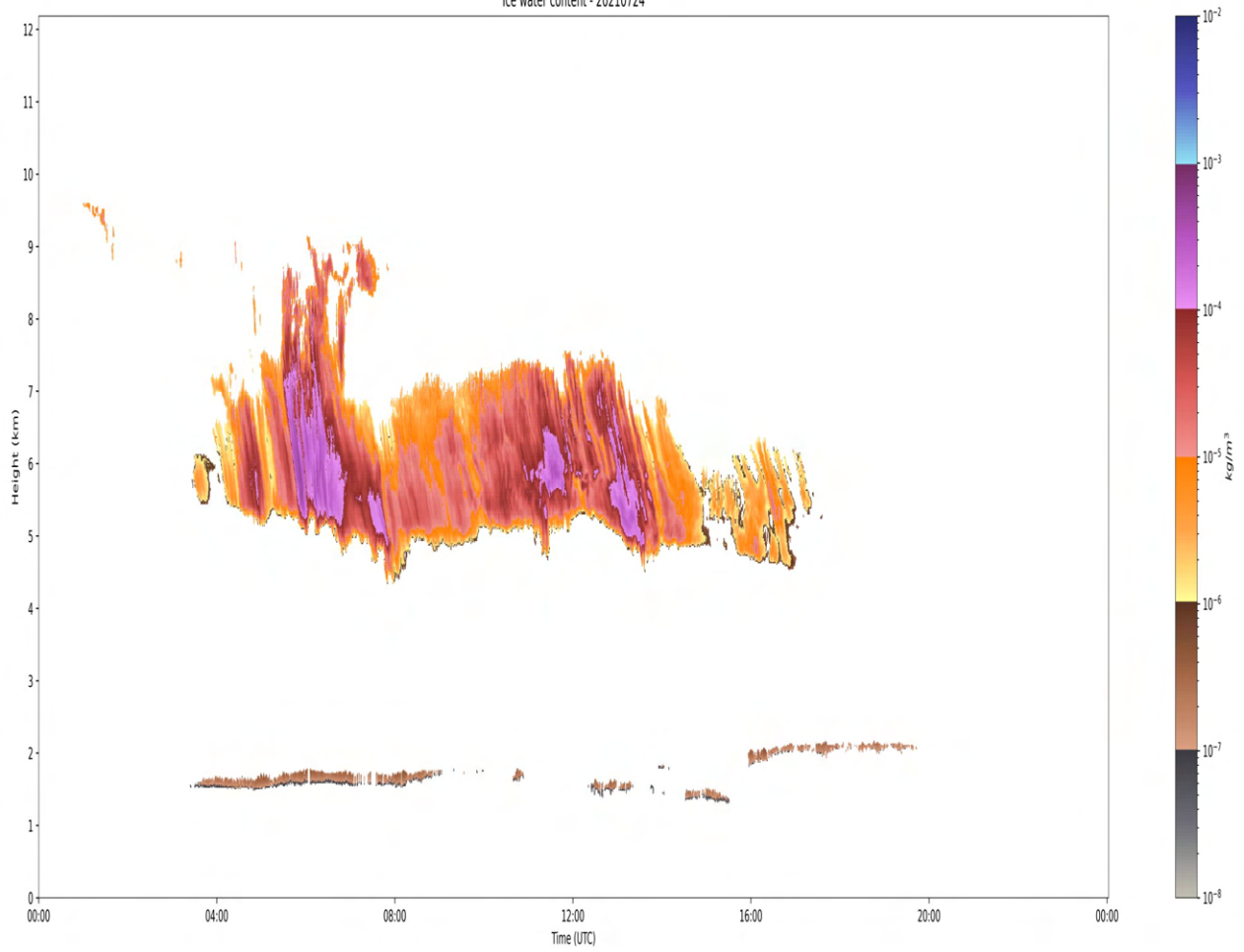
Please choose **only one** of the following:

- ☐ both
- ☐ 20210729
- ☐ 20210731
- ☐ don't know
- ☐ cannot be determined

Which day contains the highest value?



Ice water content - 20210724

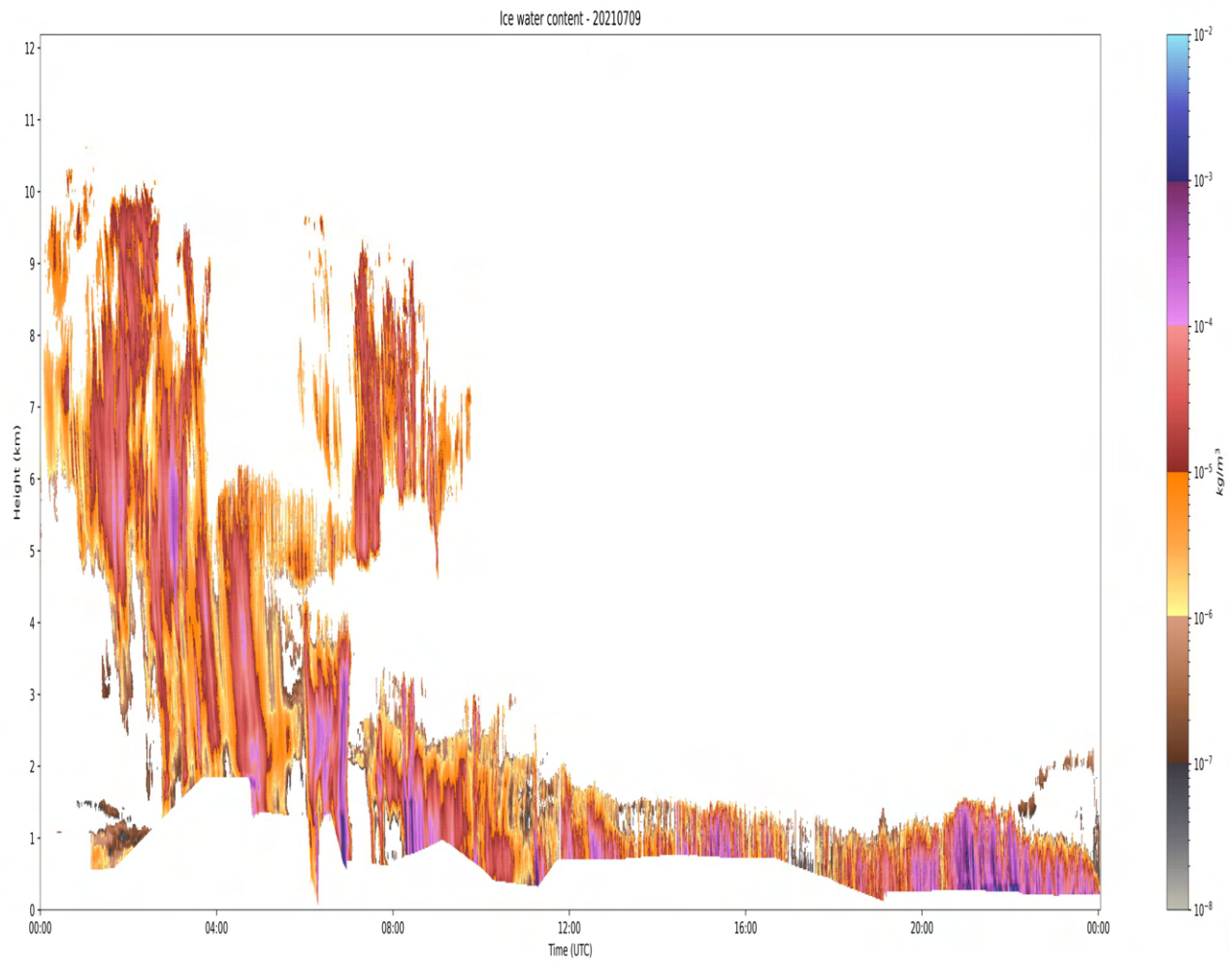


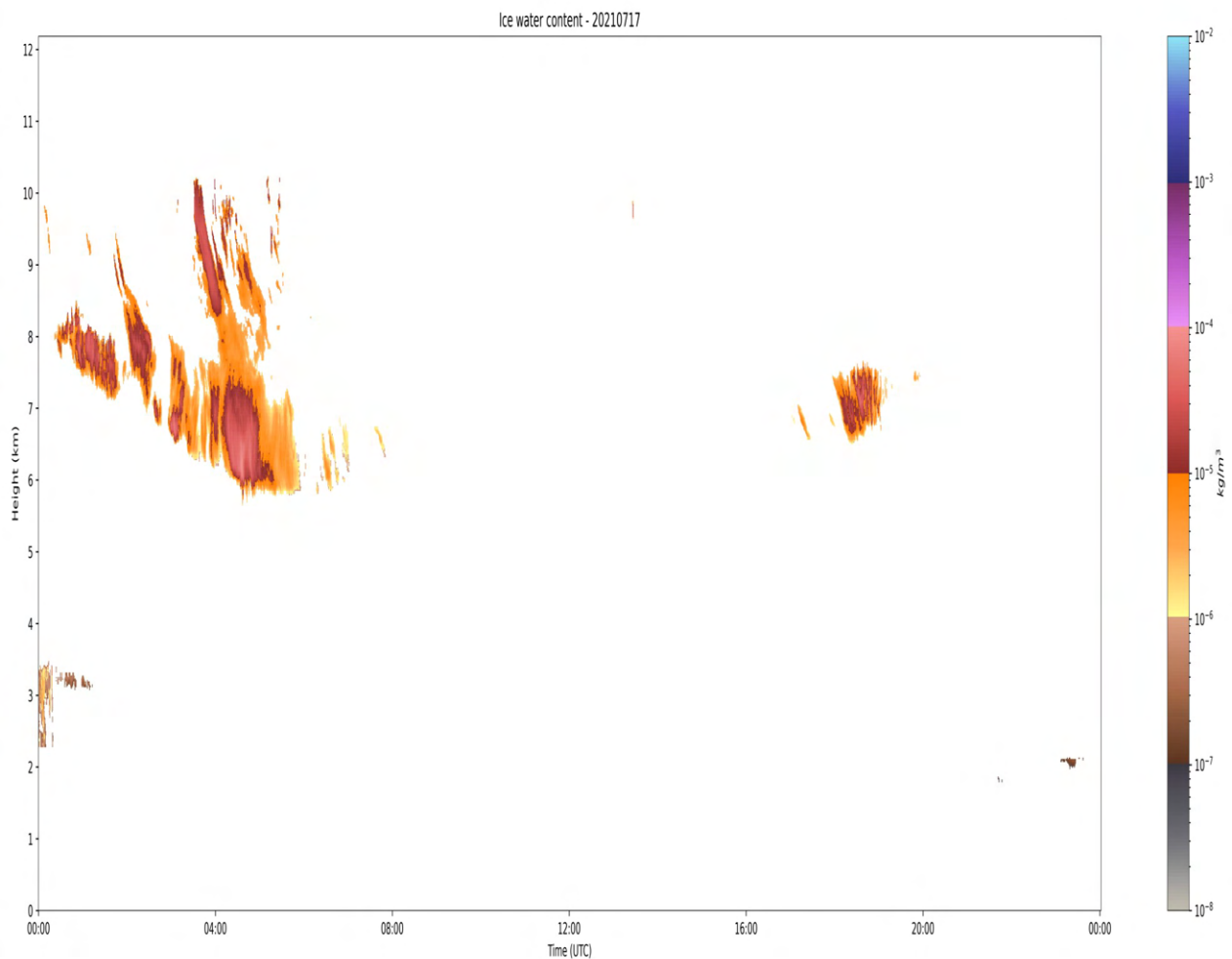
*

Please choose **only one** of the following:

- ☐ both
- ☐ 20210708
- ☐ 20210724
- ☐ don't know
- ☐ cannot be determined

Which day contains the highest value?





*

Please choose **only one** of the following:

- ☐ both
- ☐ 20210709
- ☐ 20210717
- ☐ don't know
- ☐ cannot be determined

Break

This is a short break. Take a moment to calm down and after the time has expired, please answer the question on the following page.

You will be automatically redirected to the next page after the time has expired.

Please select the greatest value. *

Please choose **only one** of the following:

☐ 0

☐ $2 \cdot 10^3$

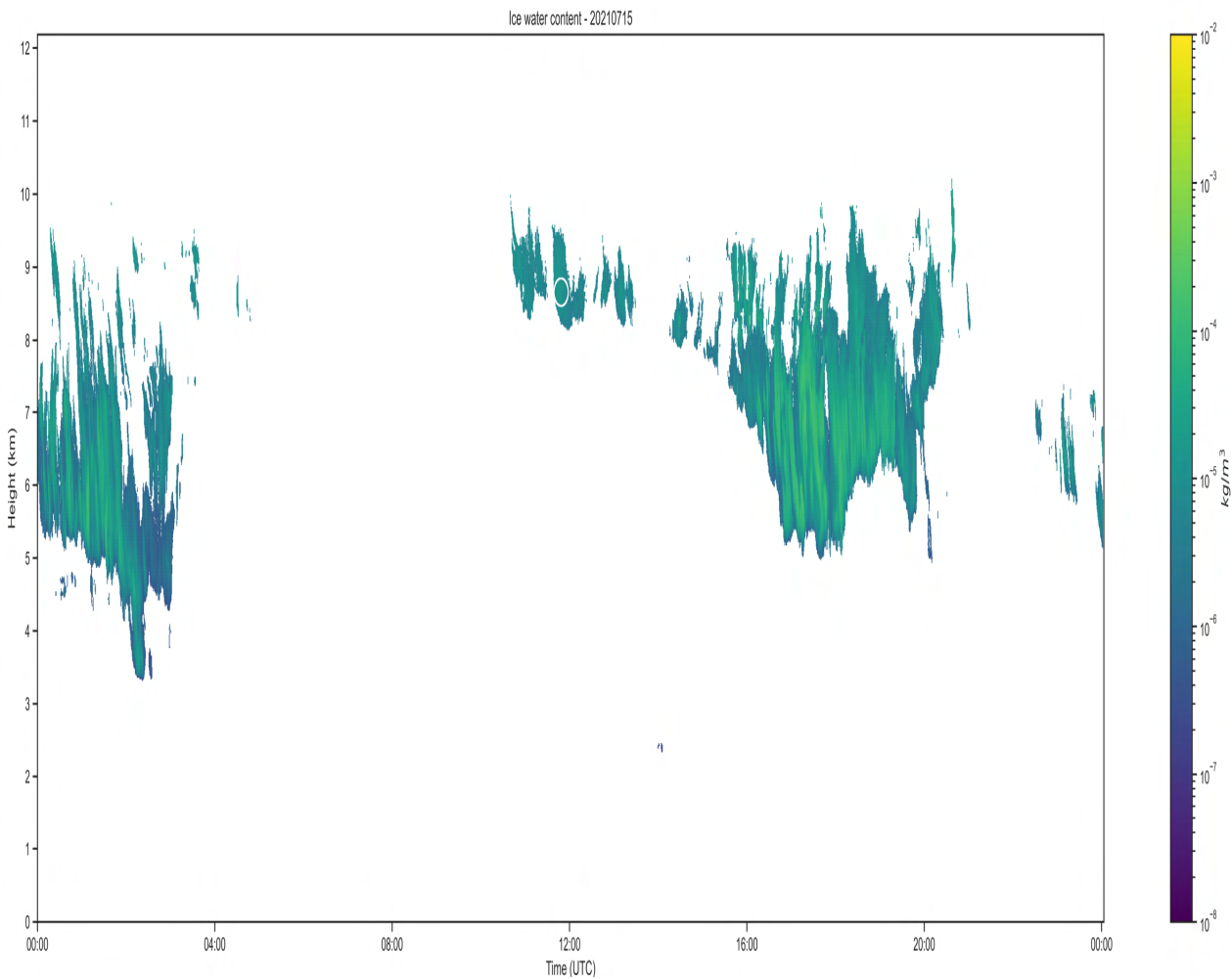
☐ $5 \cdot 10^{-2}$

Identification-Tasks

The following tasks are about recognizing individual values as precisely as possible.

Please indicate the range in which the value of the marked data point lies as precisely as possible.

How confident are you about your answer on a scale from 1 (very unconfident) to 5 (very confident)?



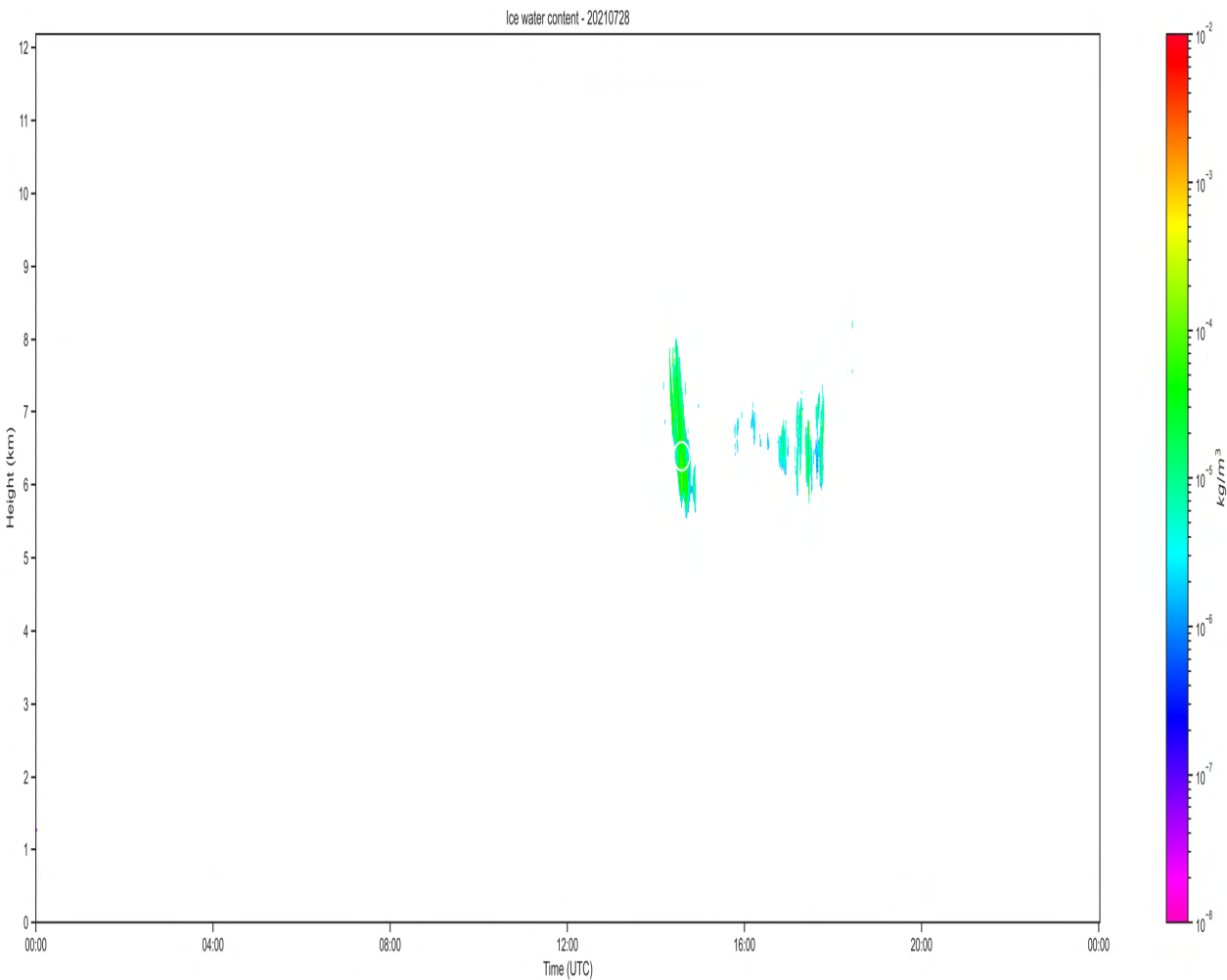
★

ⓘ Only numbers may be entered in these fields.

	minimum value	maximum value
exponent	<input type="text"/>	<input type="text"/>
mantissa	<input type="text"/>	<input type="text"/>
confidence exponent	<input type="text"/>	<input type="text"/>
confidence mantissa	<input type="text"/>	<input type="text"/>

Please indicate the range in which the value of the marked data point lies as precisely as possible.

How confident are you about your answer on a scale from 1 (very unconfident) to 5 (very confident)?



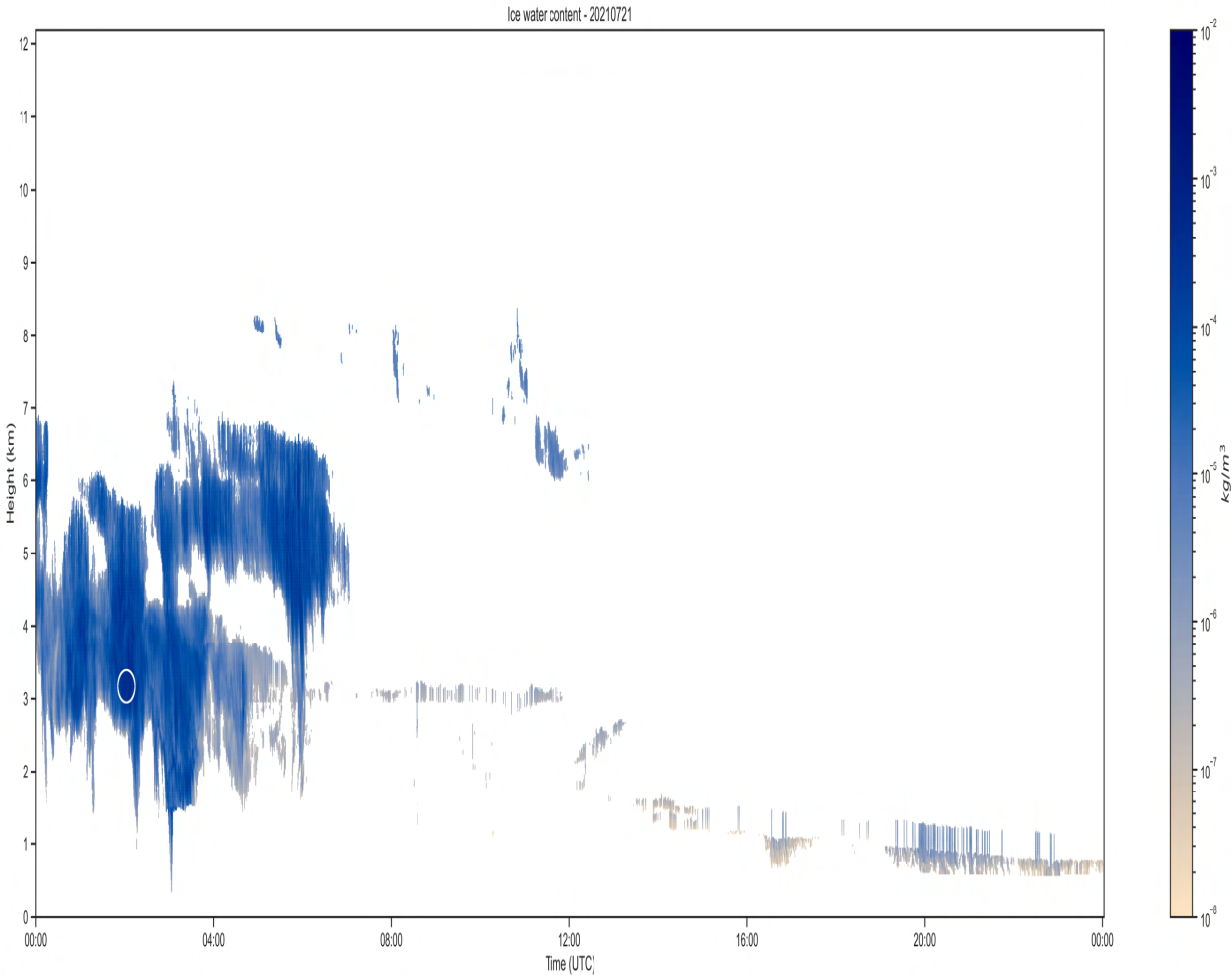
*

i Only numbers may be entered in these fields.

	minimum value	maximum value
exponent	<input type="text"/>	<input type="text"/>
mantissa	<input type="text"/>	<input type="text"/>
confidence exponent	<input type="text"/>	<input type="text"/>
confidence mantissa	<input type="text"/>	<input type="text"/>

Please indicate the range in which the value of the marked data point lies as precisely as possible.

How confident are you about your answer on a scale from 1 (very unconfident) to 5 (very confident)?



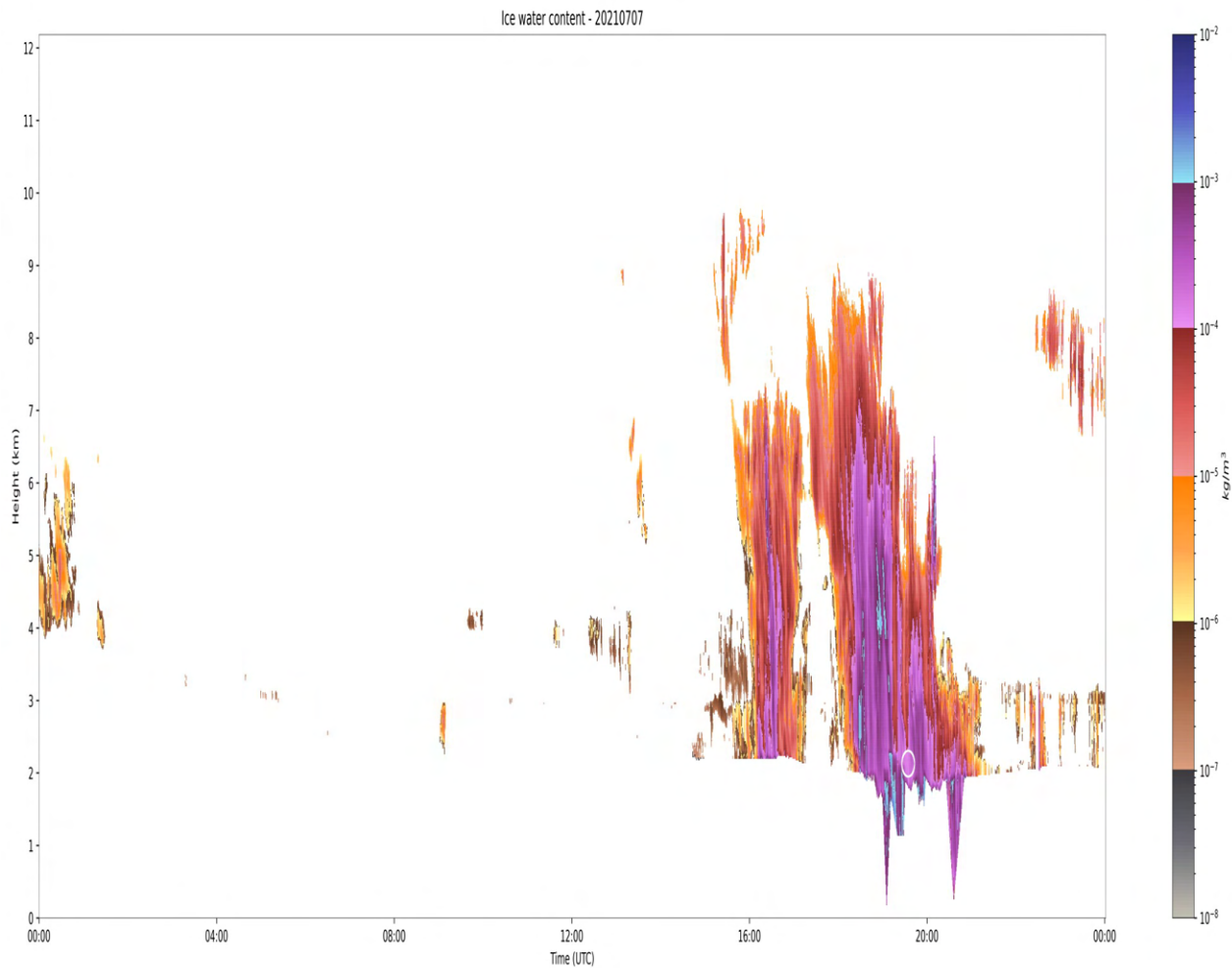
★

❗ Only numbers may be entered in these fields.

	minimum value	maximum value
exponent	<input type="text"/>	<input type="text"/>
mantissa	<input type="text"/>	<input type="text"/>
confidence exponent	<input type="text"/>	<input type="text"/>
confidence mantissa	<input type="text"/>	<input type="text"/>

Please indicate the range in which the value of the marked data point lies as precisely as possible.

How confident are you about your answer on a scale from 1 (very unconfident) to 5 (very confident)?



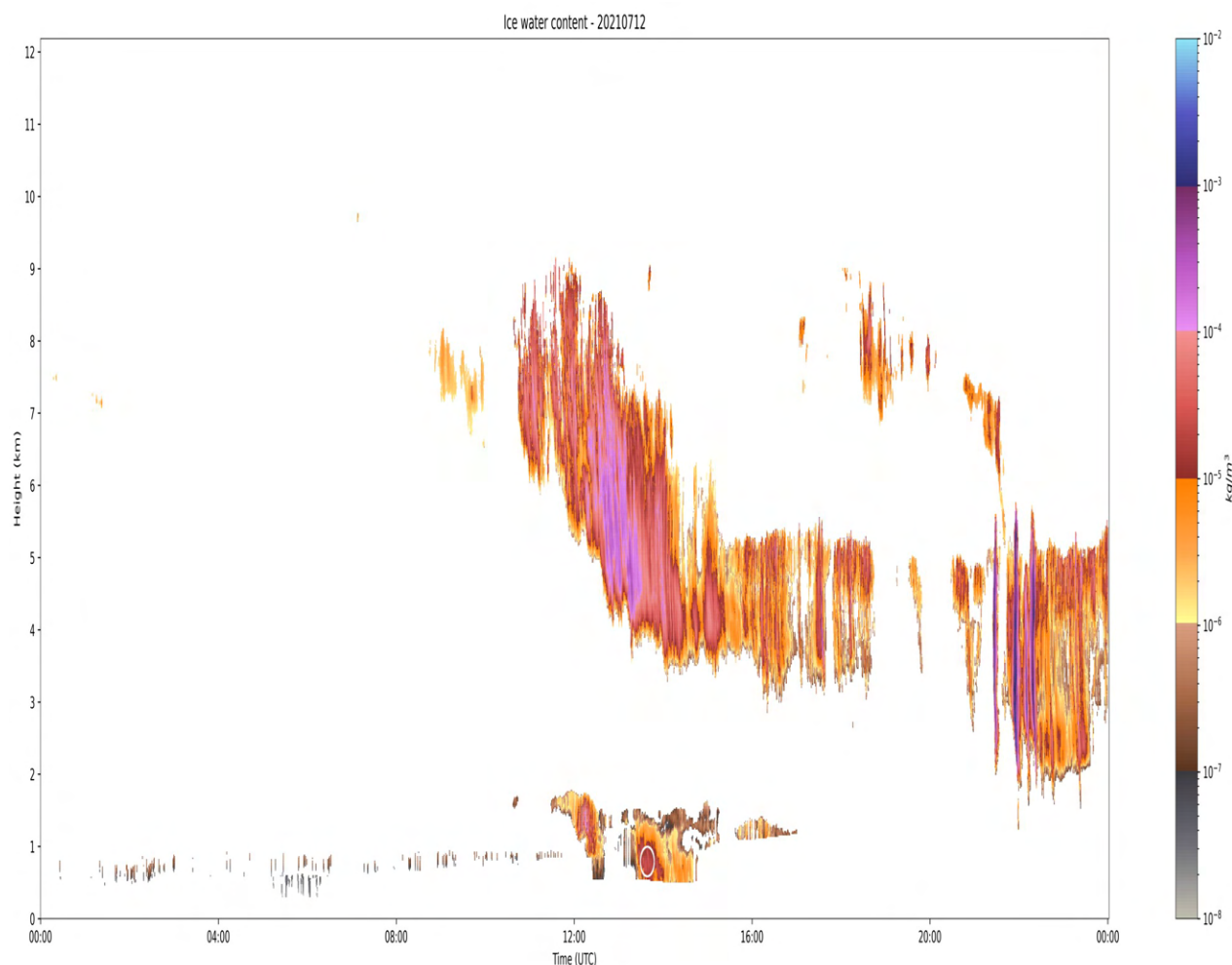
★

❗ Only numbers may be entered in these fields.

	minimum value	maximum value
exponent	<input type="text"/>	<input type="text"/>
mantissa	<input type="text"/>	<input type="text"/>
confidence exponent	<input type="text"/>	<input type="text"/>
confidence mantissa	<input type="text"/>	<input type="text"/>

Please indicate the range in which the value of the marked data point lies as precisely as possible.

How confident are you about your answer on a scale from 1 (very unconfident) to 5 (very confident)?



★

❗ Only numbers may be entered in these fields.

	minimum value	maximum value
exponent	<input type="text"/>	<input type="text"/>
mantissa	<input type="text"/>	<input type="text"/>
confidence exponent	<input type="text"/>	<input type="text"/>
confidence mantissa	<input type="text"/>	<input type="text"/>

Break

This is a short break. Take a moment to calm down and after the time has expired, please answer the question on the following page.

You will be automatically redirected to the next page after the time has expired.

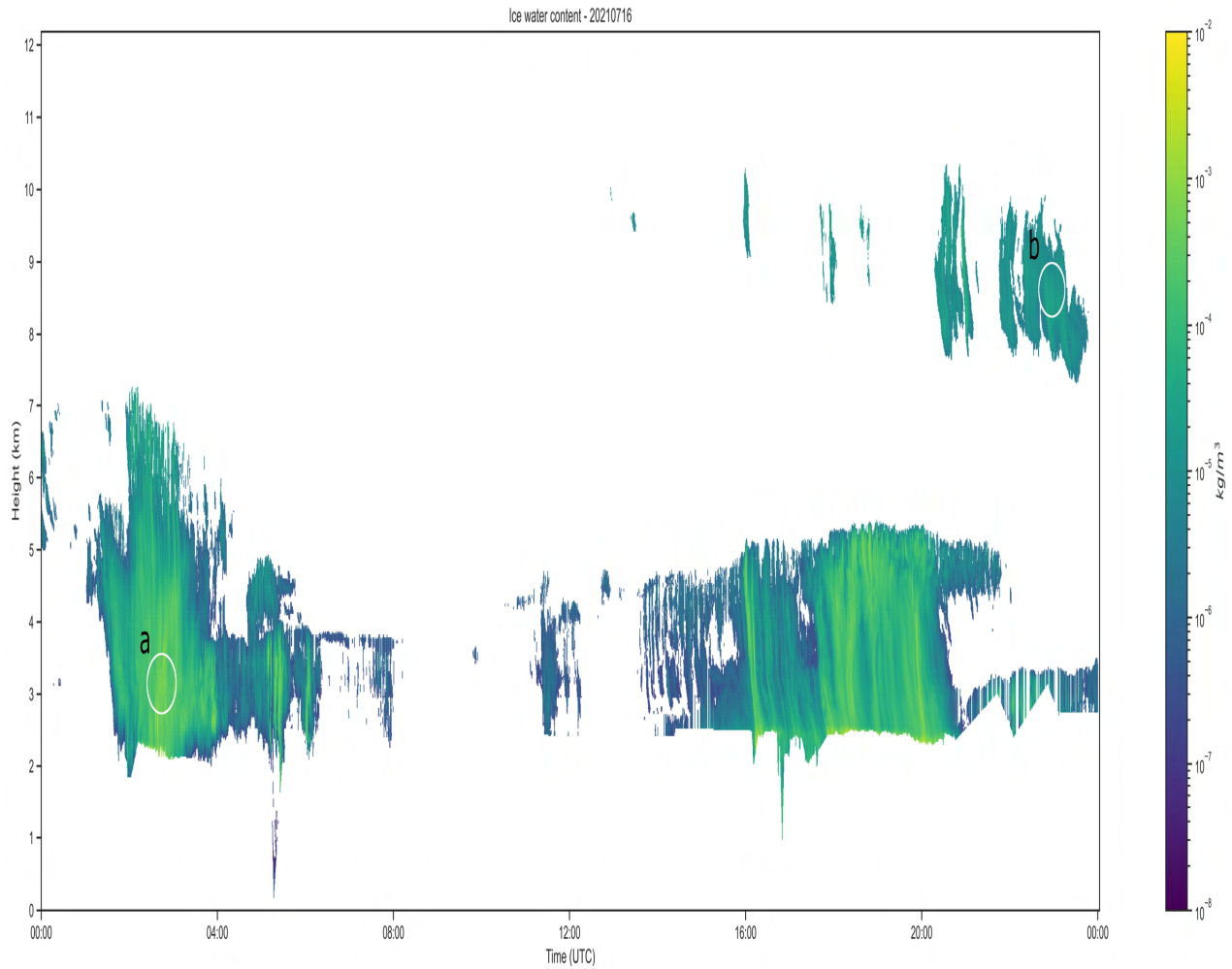
What date is today? *

Please write your answer here:

Value Comparison-Tasks

These questions compare the values of two different data points.

Which of the marked data points has the greater value?

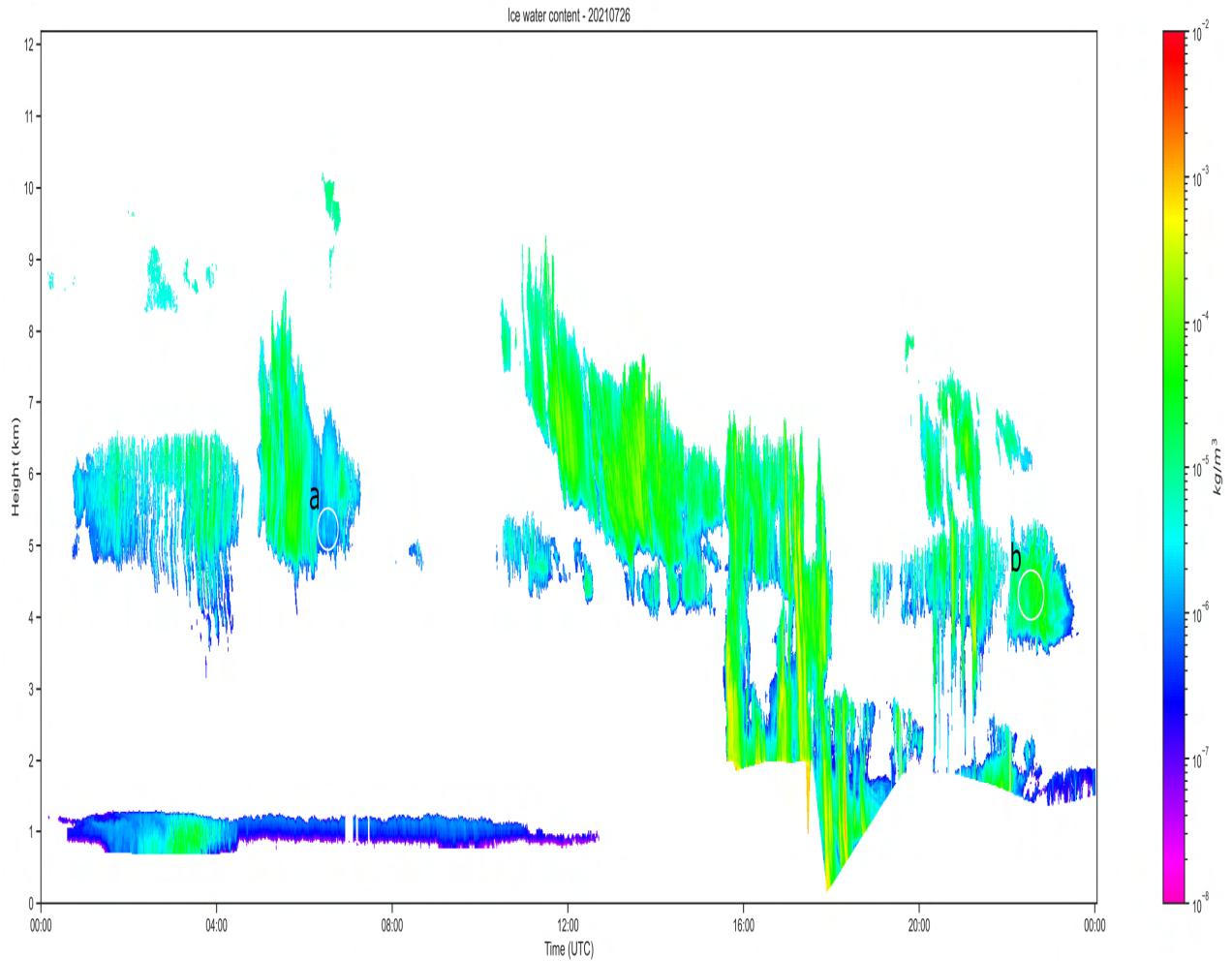


*

Please choose **only one** of the following:

- ☐ equal
- ☐ a
- ☐ b
- ☐ don't know
- ☐ cannot be determined

Which of the marked data points has the greater value?

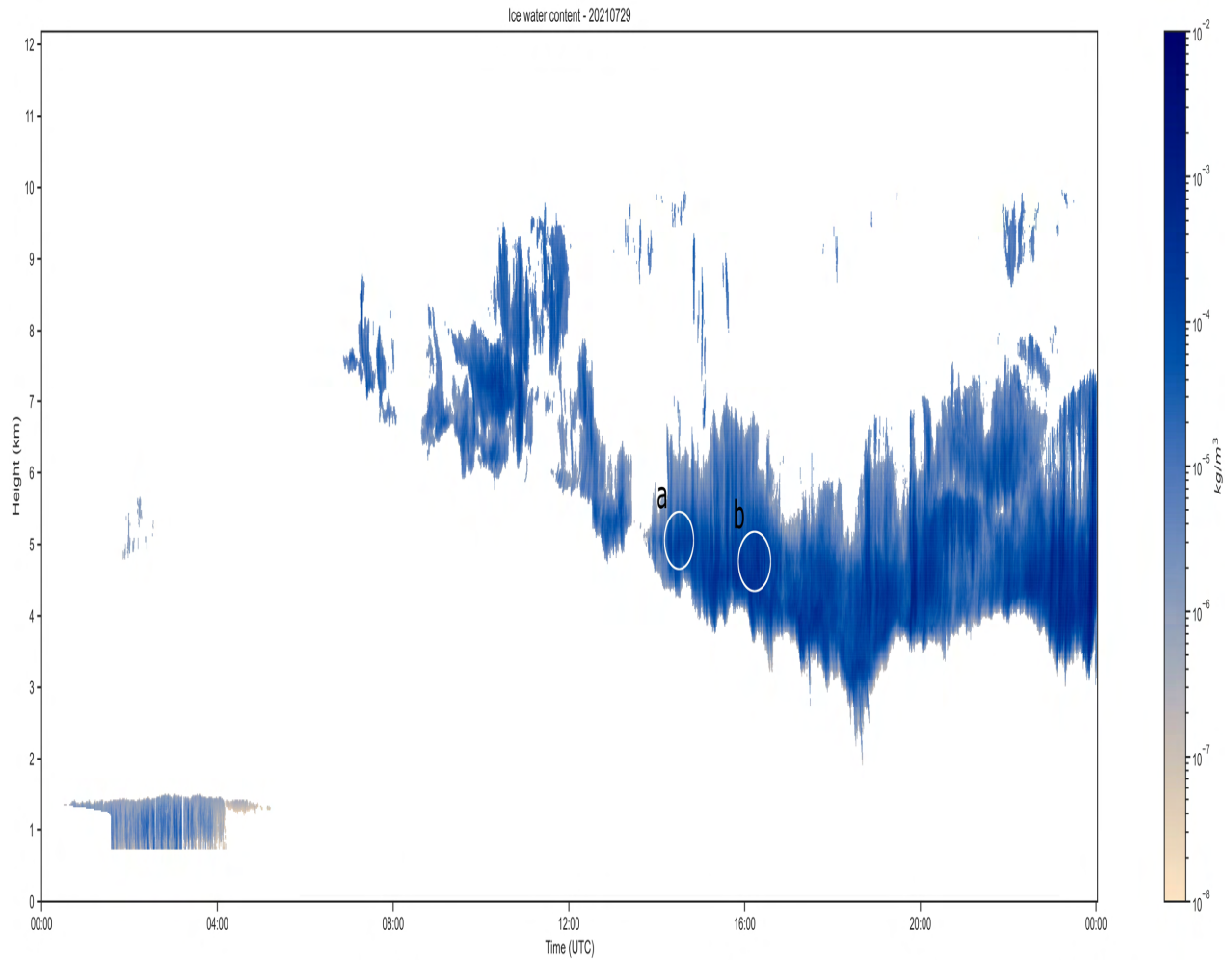


*

Please choose **only one** of the following:

- ☐ equal
- ☐ a
- ☐ b
- ☐ don't know
- ☐ cannot be determined

Which of the marked data points has the greater value?

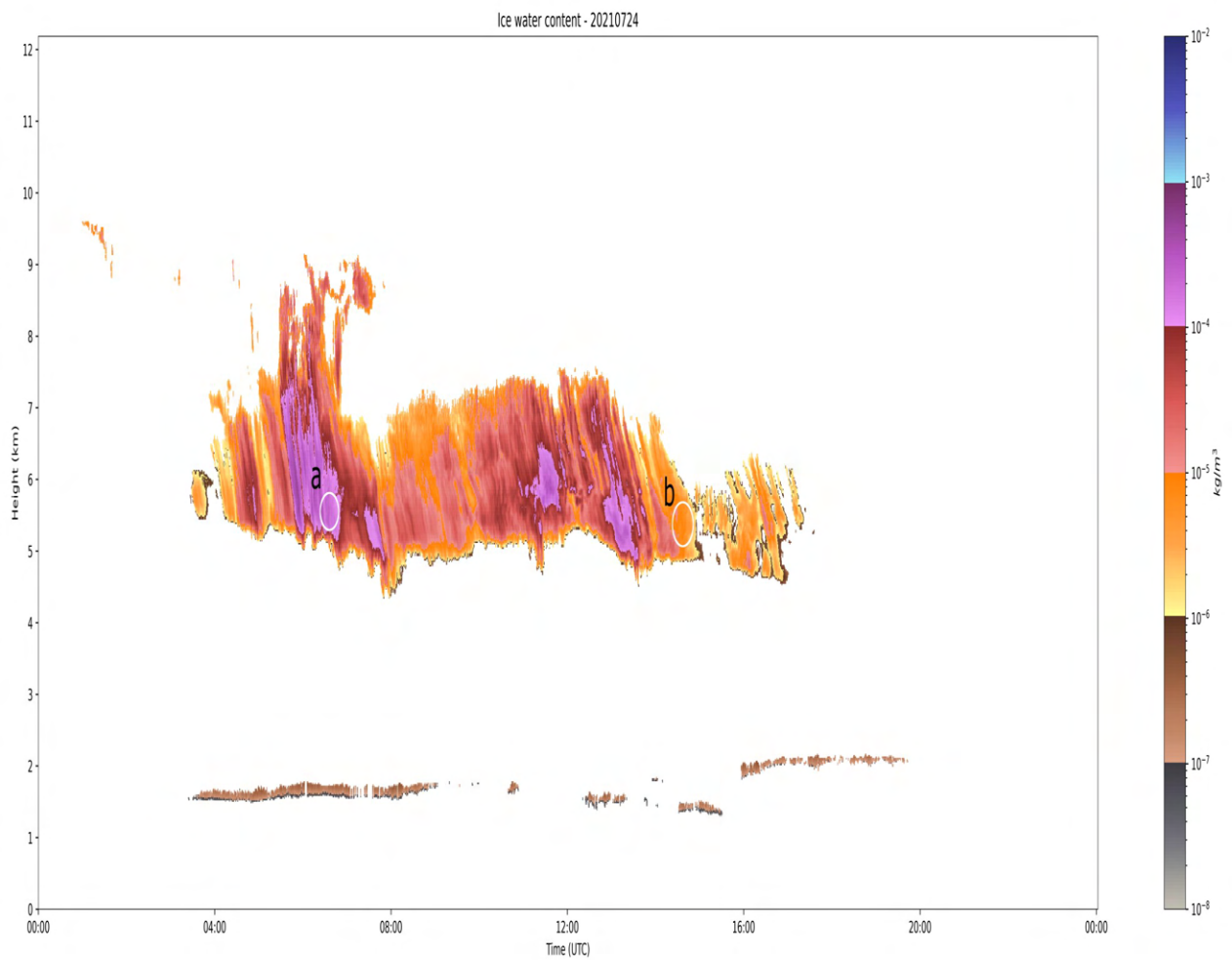


*

Please choose **only one** of the following:

- ☐ equal
- ☐ a
- ☐ b
- ☐ don't know
- ☐ cannot be determined

Which of the marked data points has the greater value?

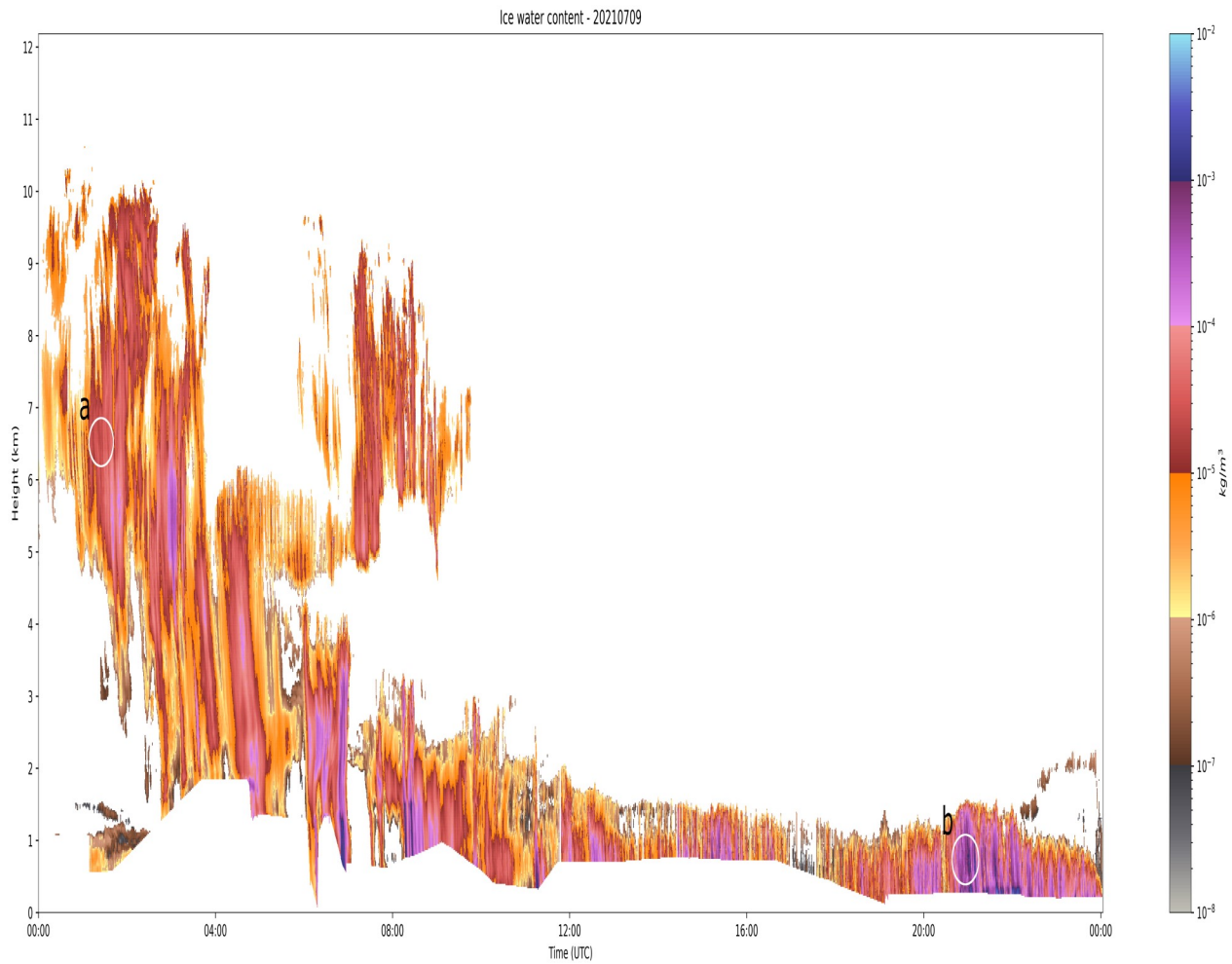


*

Please choose **only one** of the following:

- ☐ equal
- ☐ a
- ☐ b
- ☐ don't know
- ☐ cannot be determined

Which of the marked data points has the greater value?



*

Please choose **only one** of the following:

- ☐ equal
- ☐ a
- ☐ b
- ☐ don't know
- ☐ cannot be determined

Feedback

Personal opinion.

If you have any comments or information that you have not yet been able to write down, you can do so here. This could be, for example, the following:

- Which colormap did you find particularly appealing?
- ...

Please write your answer here:

Were there any questions or other things in the study that you had particular difficulties with?

Please write your answer here:

If you have a meteorological background:

Which types of tasks would you find interesting in addition to those asked in this study?

Please write your answer here:

Thank you for participating in this study!

02-13-2022 – 23:59

Submit your survey.

Thank you for completing this survey.