ARC3O
An **Arc**tic **O**cean **O**bservation **O**perator for 6.9 GHz

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Related publications:

The Arctic Ocean Observation Operator for 6.9 GHz (ARC3O) – Part 1: How to obtain sea-ice brightness temperatures at 6.9 GHz from climate model output, *The Cryosphere Discussions, in review.*

The Arctic Ocean Observation Operator for 6.9 GHz (ARC3O) – Part 2: Development and evaluation, *The Cryosphere Discussions, in review.*

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What you should take home…

The relationship between real, observed and simulated sea-ice concentration is ambiguous due to **observational uncertainty**

We have developed an observation operator to circumvent observational uncertainty introduced by retrieval algorithm.

- Although the climate model output is simple, we are able to construct a realistic **observation operator for the Arctic Ocean at 6.9 GHz**

Easy to apply to any climate model output!

- Differences **between simulated and measured brightness temperatures** are mainly linked to differences **between simulated and real sea-ice concentration** => evaluation of **retrieval algorithms** and **climate model** possible

Outlook: ARC3O can be used for first guess in data assimilation
Deeper insight possible through extension of ARC3O to other frequencies

We have developed an observation operator to circumvent observational uncertainty introduced by retrieval algorithms

Click below on the section you are interested in to read more

Overview

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2 Our solution

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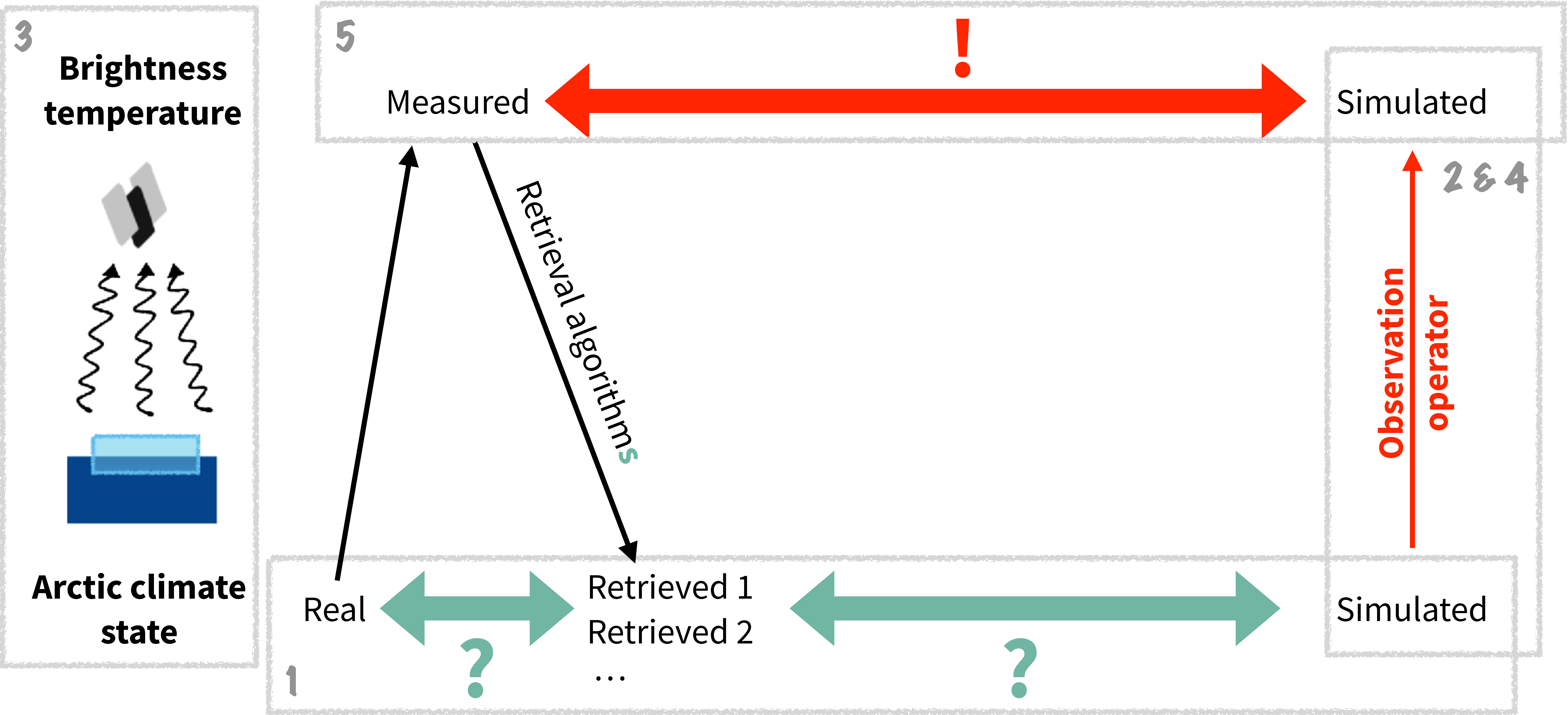

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The problem: The presence of several observational products (e.g. for sea-ice concentration) is a challenge for climate model evaluation…

Observational products of sea-ice concentration are retrieved from microwave brightness temperatures. But different retrievals result in different sea-ice concentration products.

This is a problem for the evaluation of climate models, see figure below

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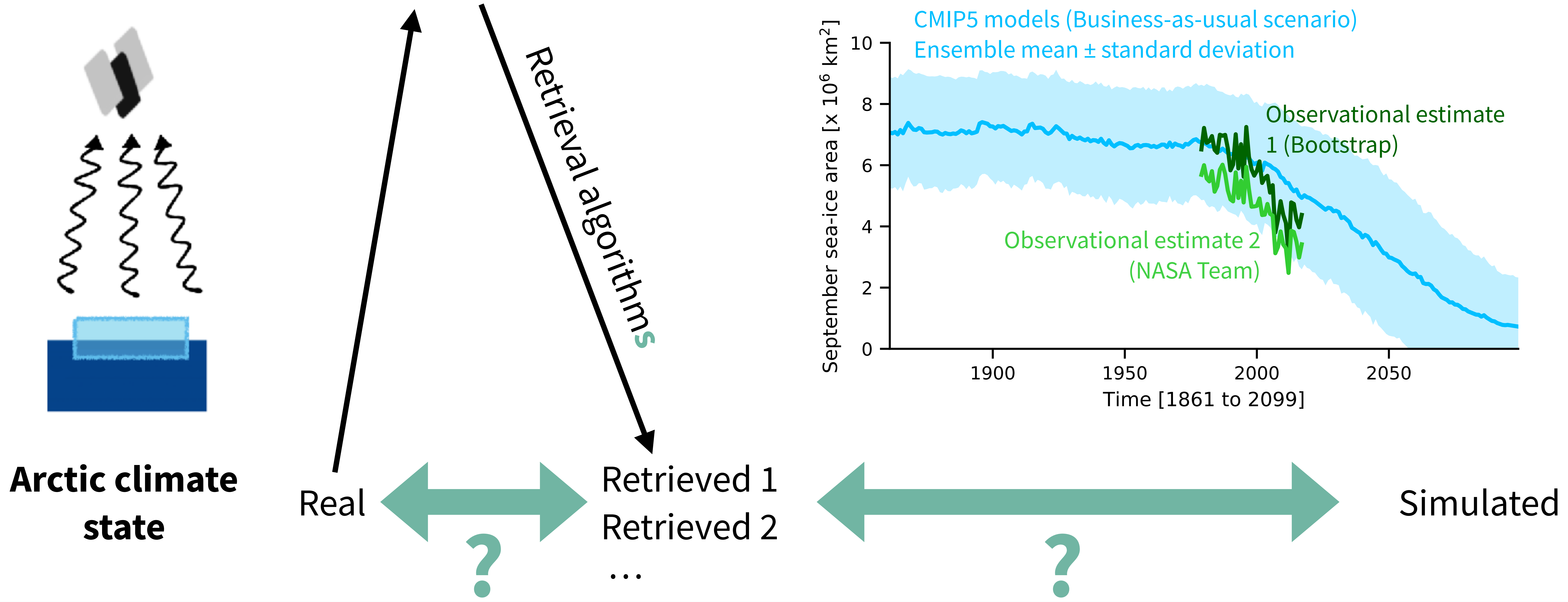
Brightness temperature

Measured



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Our solution: An observation operator to circumvent observational uncertainty

Previous approaches of observation operators for the Arctic Ocean focussed on winter and a variety of frequencies [Scott et al., 2012; Richter et al. 2018]
***NEW HERE**: 6.9 GHz, applicable to climate model output, all seasons*

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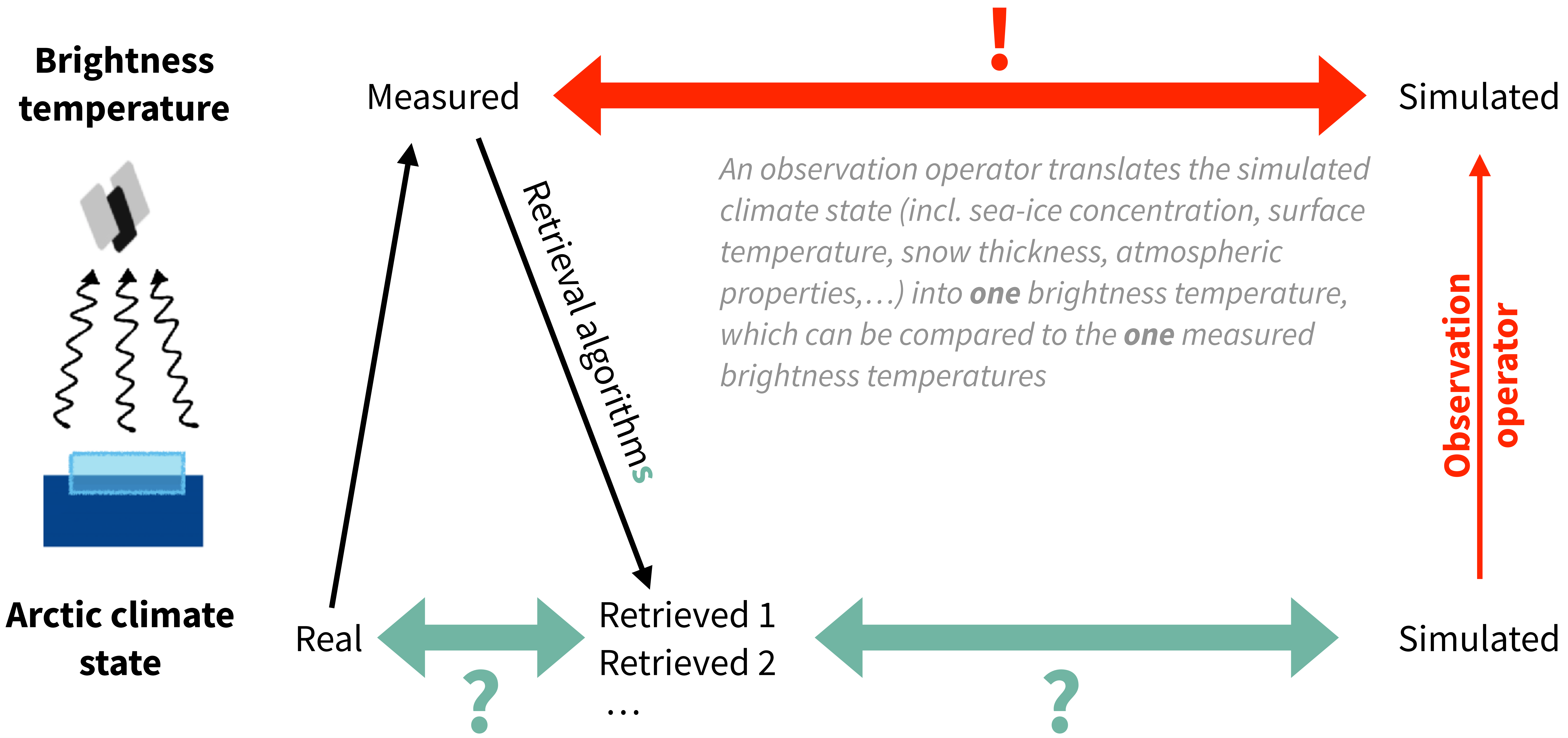

*An observation operator translates the simulated climate state (incl. sea-ice concentration, surface temperature, snow thickness, atmospheric properties,…) into **one** brightness temperature, which can be compared to the **one** measured brightness temperatures*

Some basics: What to consider when simulating Arctic Ocean brightness temperatures at 6.9 GHz

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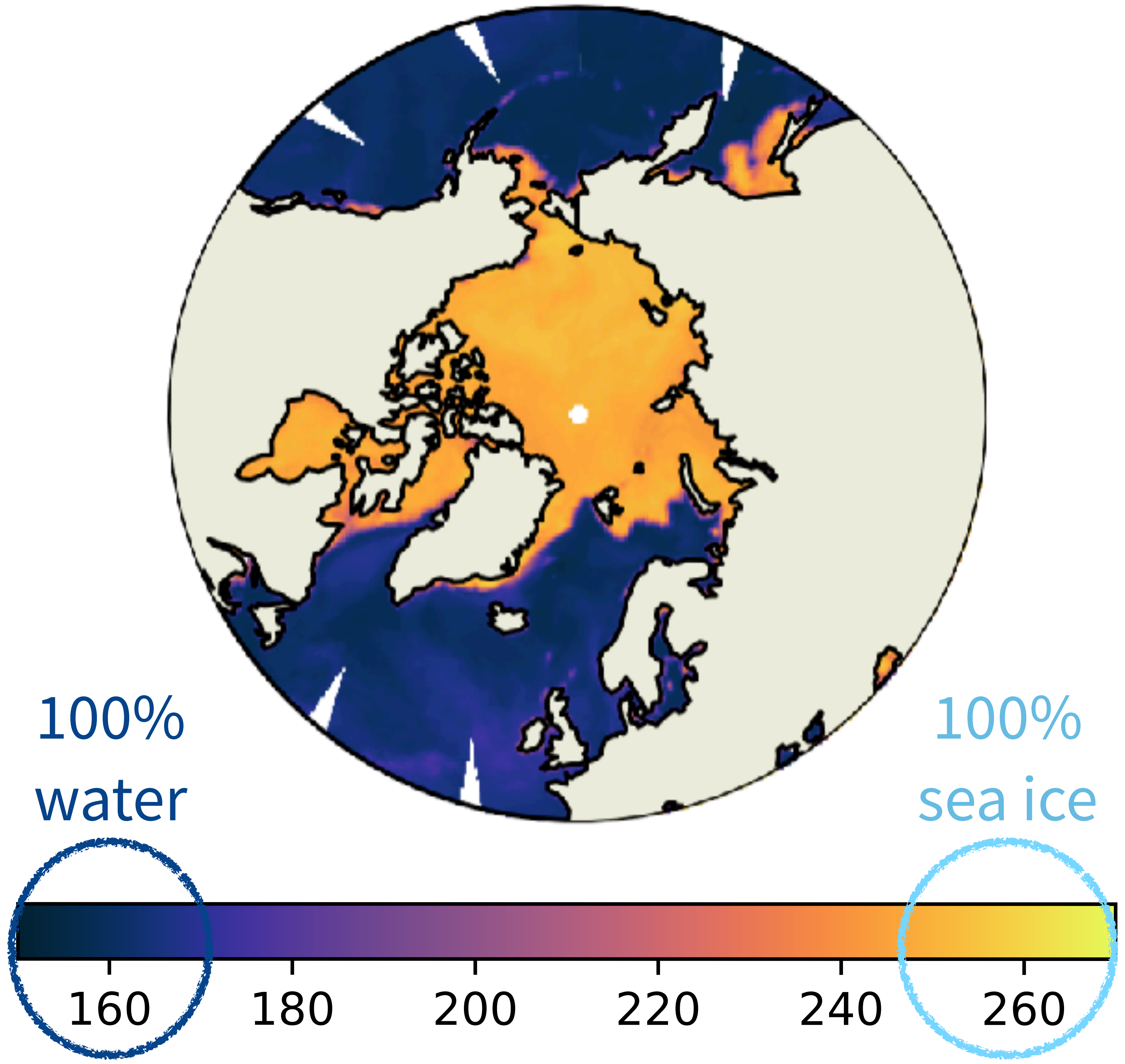
Brightness temperature T_b depends on frequency and type of medium

Why 6.9 GHz?
High contrast between water and ice
Low scattering inside the ice
Effect of dry snow is small
Effect of atmosphere is small

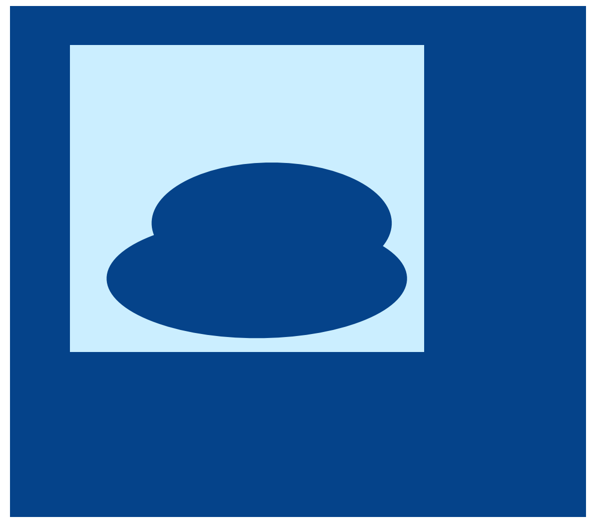
11.01.2004



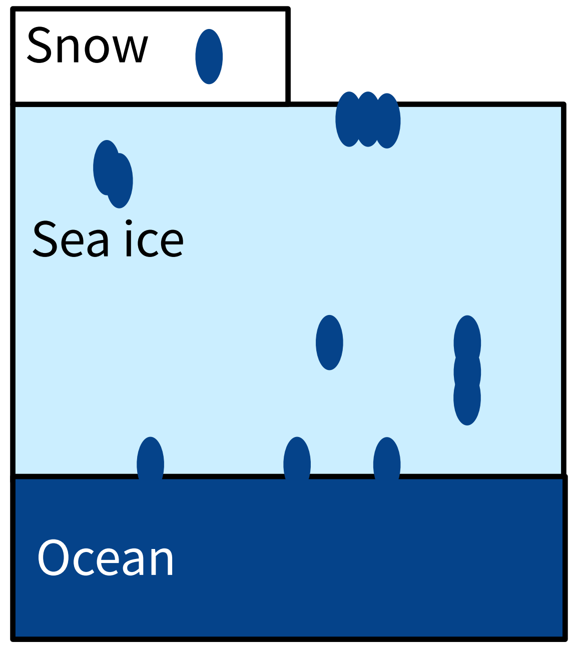
Brightness temperature measured from space by AMSR-E at 6.9 GHz [K]

A Song of Ice and Water

Surface distribution of ice and water matters



Vertical distribution of water inside the ice matters



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More details in: The Arctic Ocean Observation Operator for 6.9 GHz (ARC3O) – Part 1: How to obtain sea-ice brightness temperatures at 6.9 GHz from climate model output, *The Cryosphere Discussions*, *in review.*

The method: The workflow of the Arctic Ocean Observation Operator based on climate model output and microwave emission models

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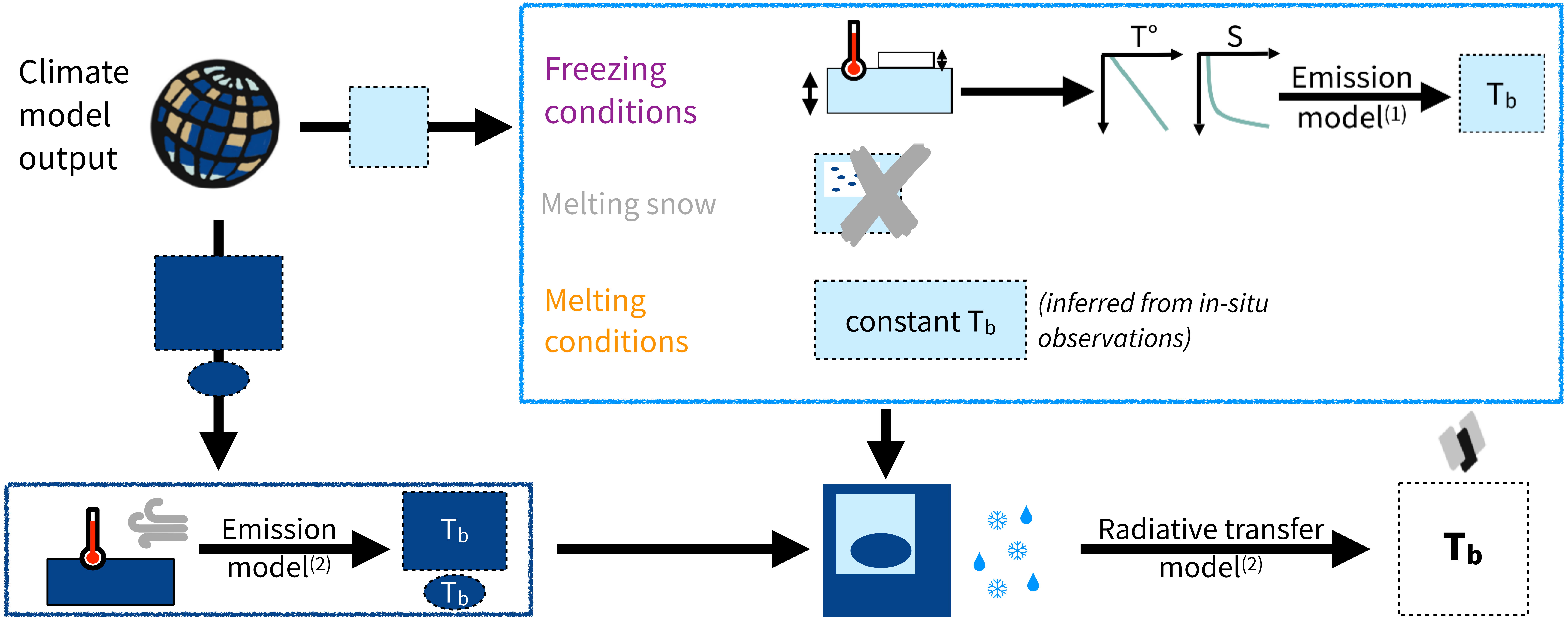

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(1) MEMLS: Wiesmann and Mätzler [1998], Tonboe et al. [2006], modif. by Burgard

(2) AMSR Ocean algorithm by Wentz and Meissner [2000], modif. by Burgard

Results: Simulated and measured brightness temperatures agree well in cold seasons and less well in summer.

Differences in cold seasons mainly driven by sea-ice concentration choice for assimilation. Differences in summer also depend on simulated melt-pond fraction.

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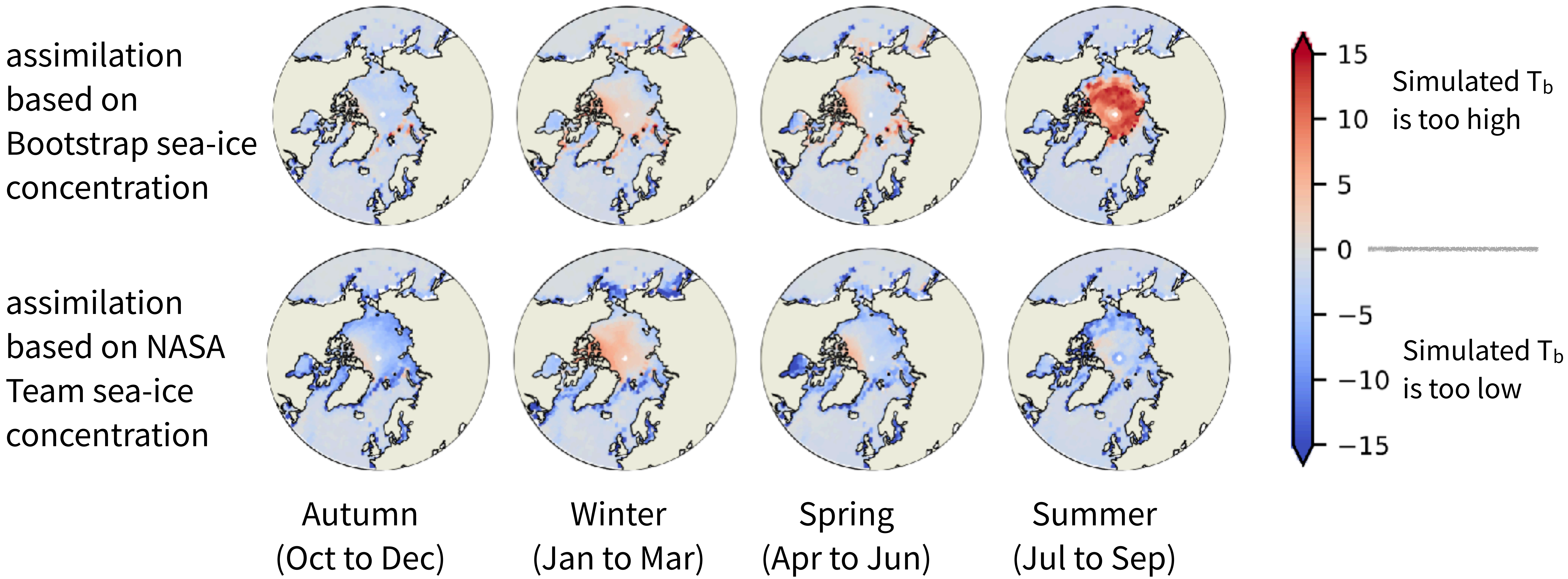
Difference between simulated[(1)] and measured[(2)] brightness temperature [K]



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(1) Two assimilation runs by MPI-ESM-LR nudged to Bootstrap sea-ice concentration and NASA Team sea-ice concentration
(2) Measured by AMSR-E from space