SIPN workshop
NCAR, Boulder
1-2 April 2014

Data assimilation with sea ice models

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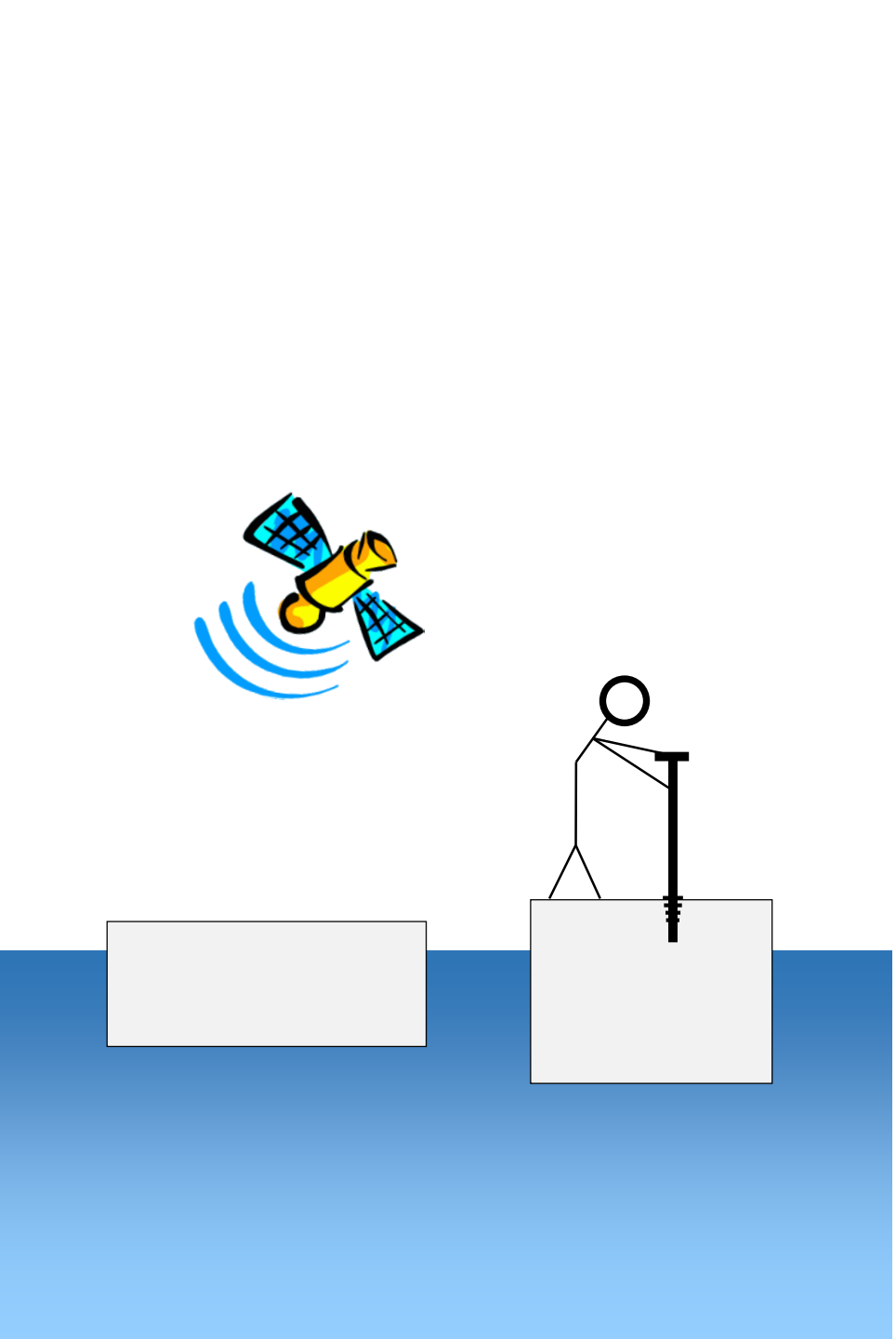
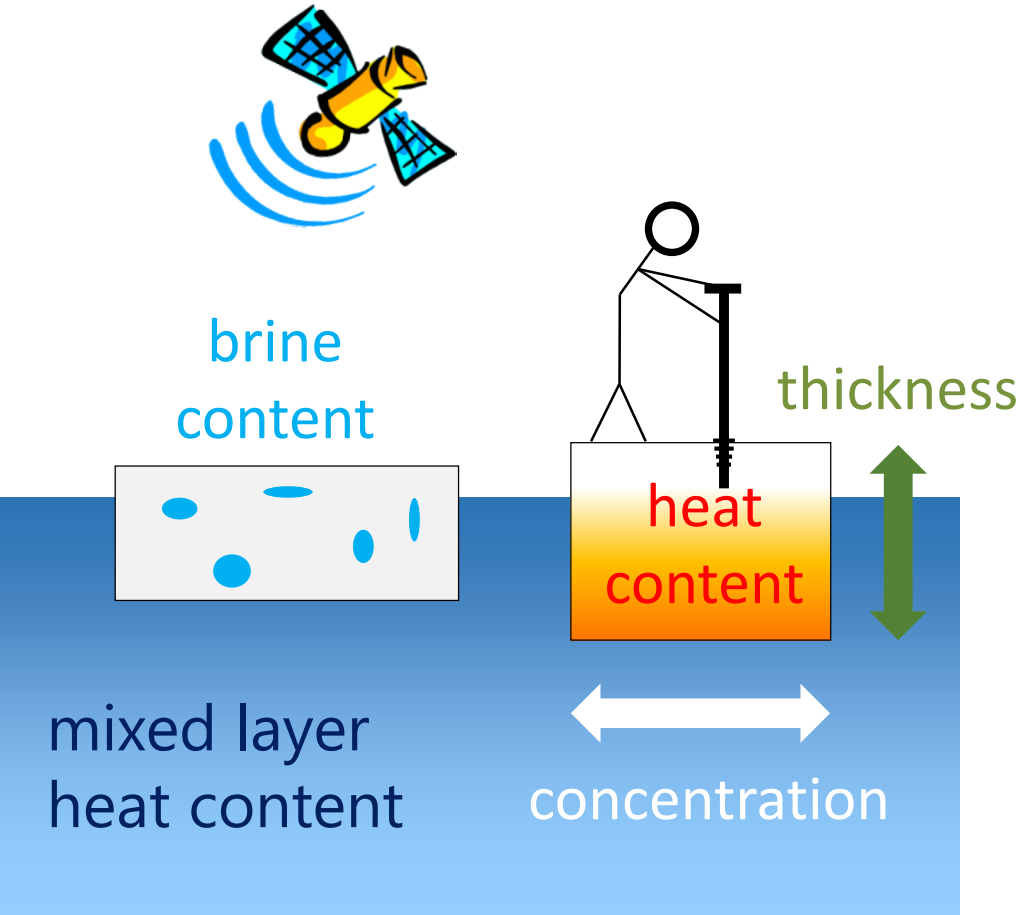
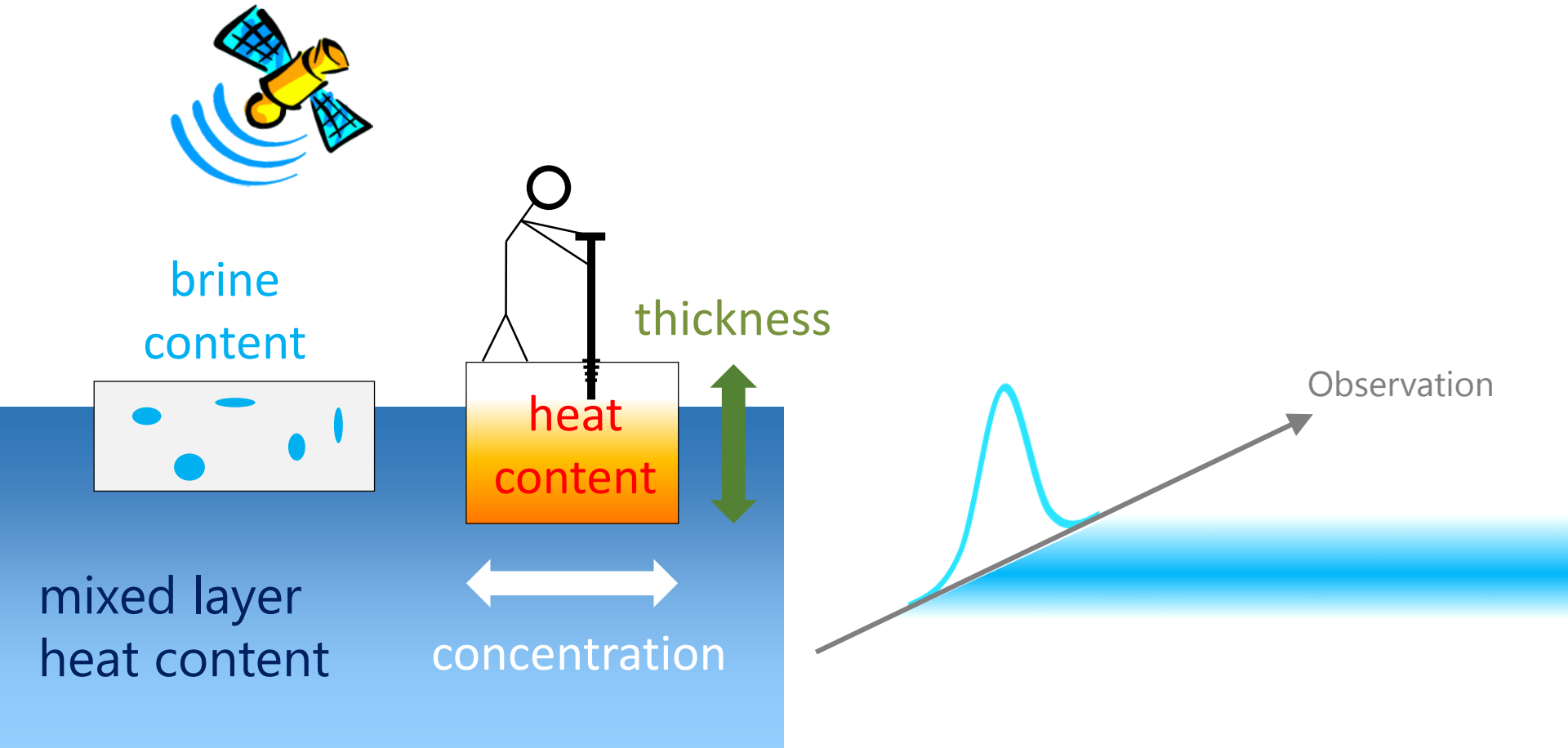
Université catholique de Louvain




brine
content
thickness
heat
content
mixed layer
heat content
concentration


brine
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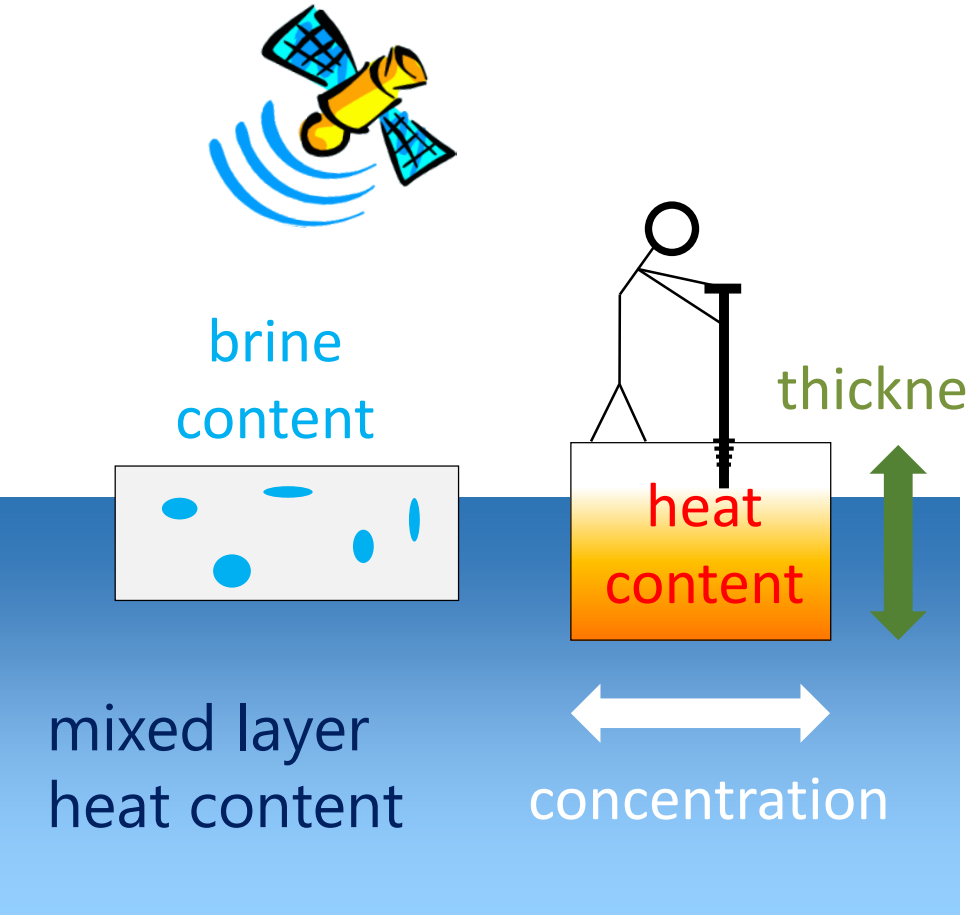
Observation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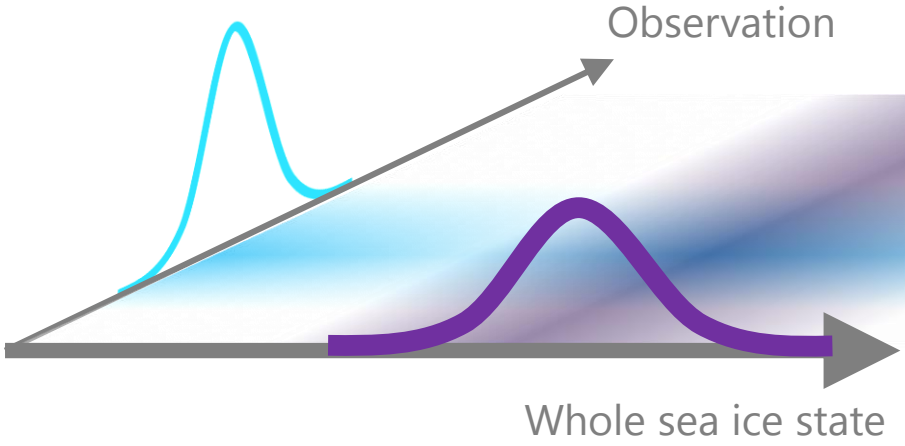
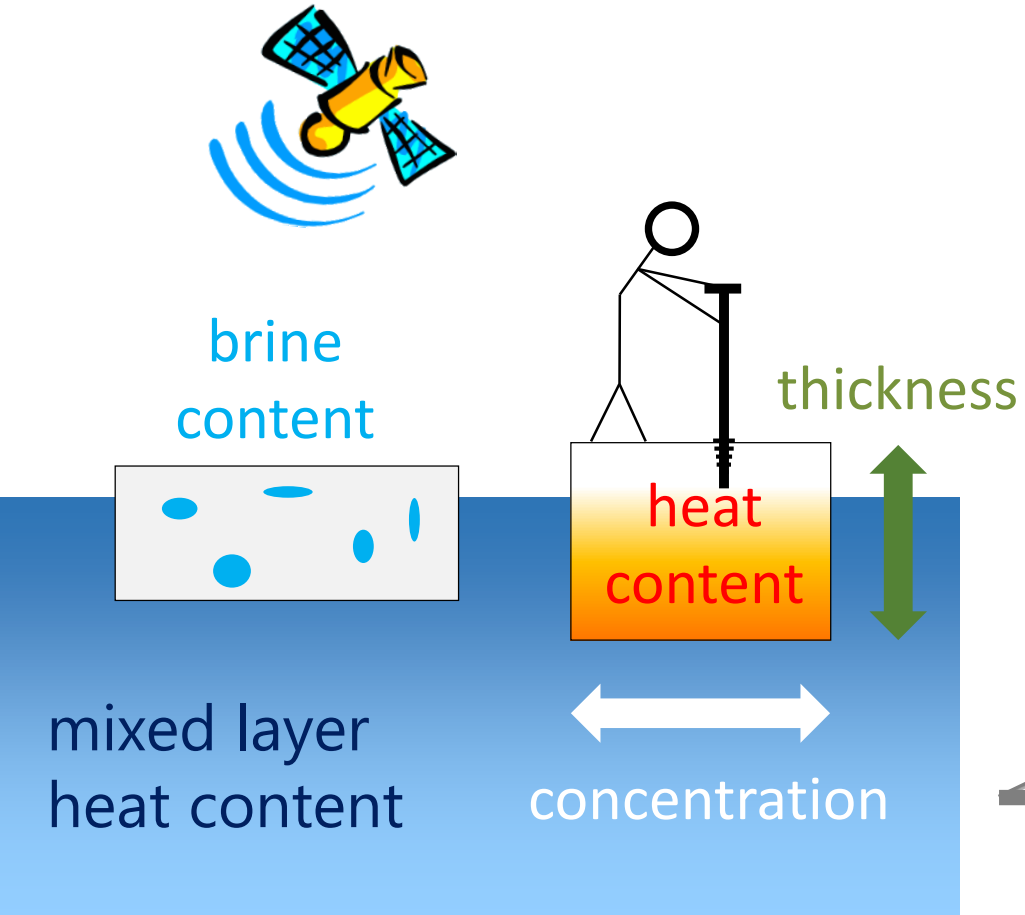
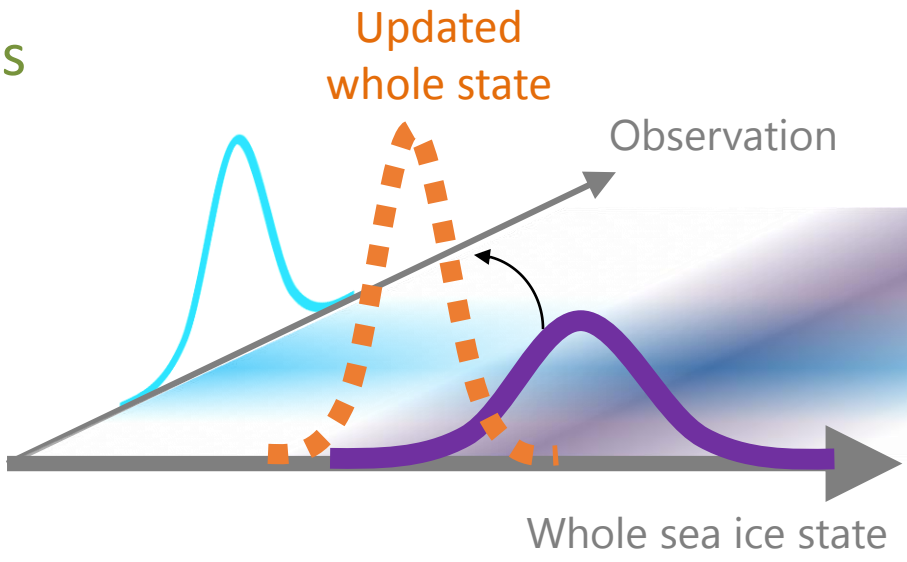

Observation
Whole sea ice state

Data assimilation consists in optimally updating the whole sea ice state, given partial observations





1. Simple sea ice model

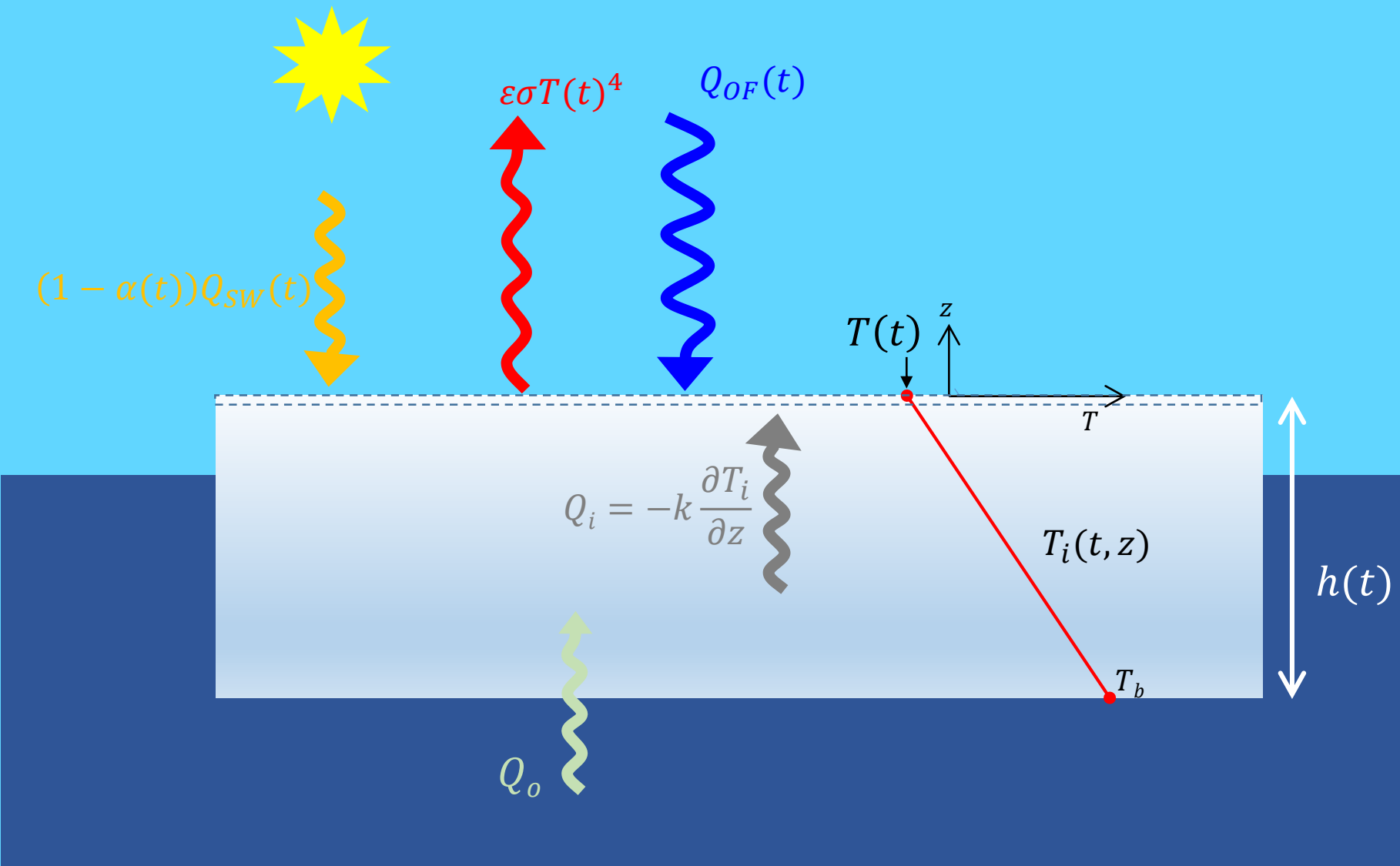
2. Comprehensive sea ice model

1. Simple sea ice model

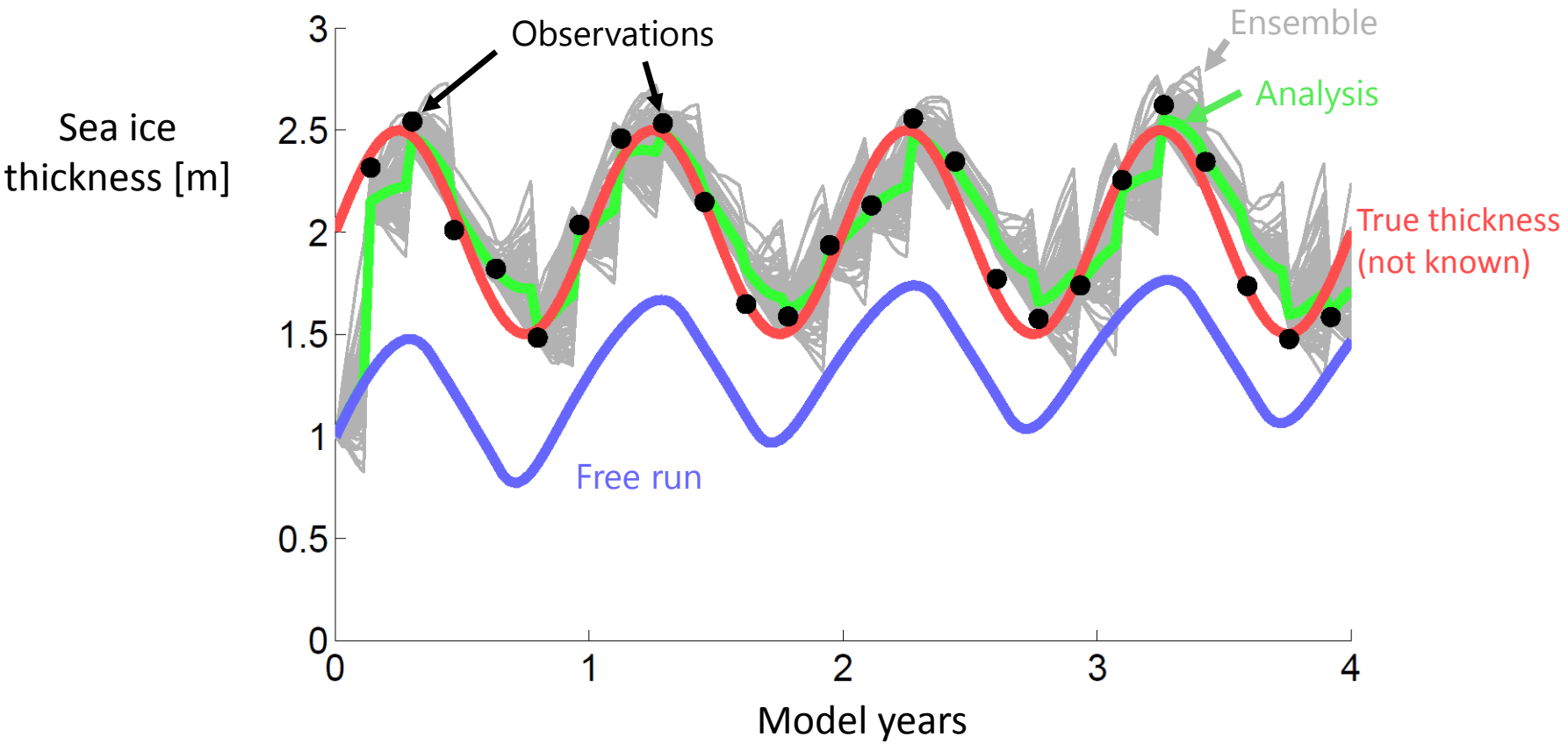
2. Comprehensive sea ice model

2-variable sea ice model

[Semtner, 1976; Notz, 2005]



The easy part: updating the observed variable



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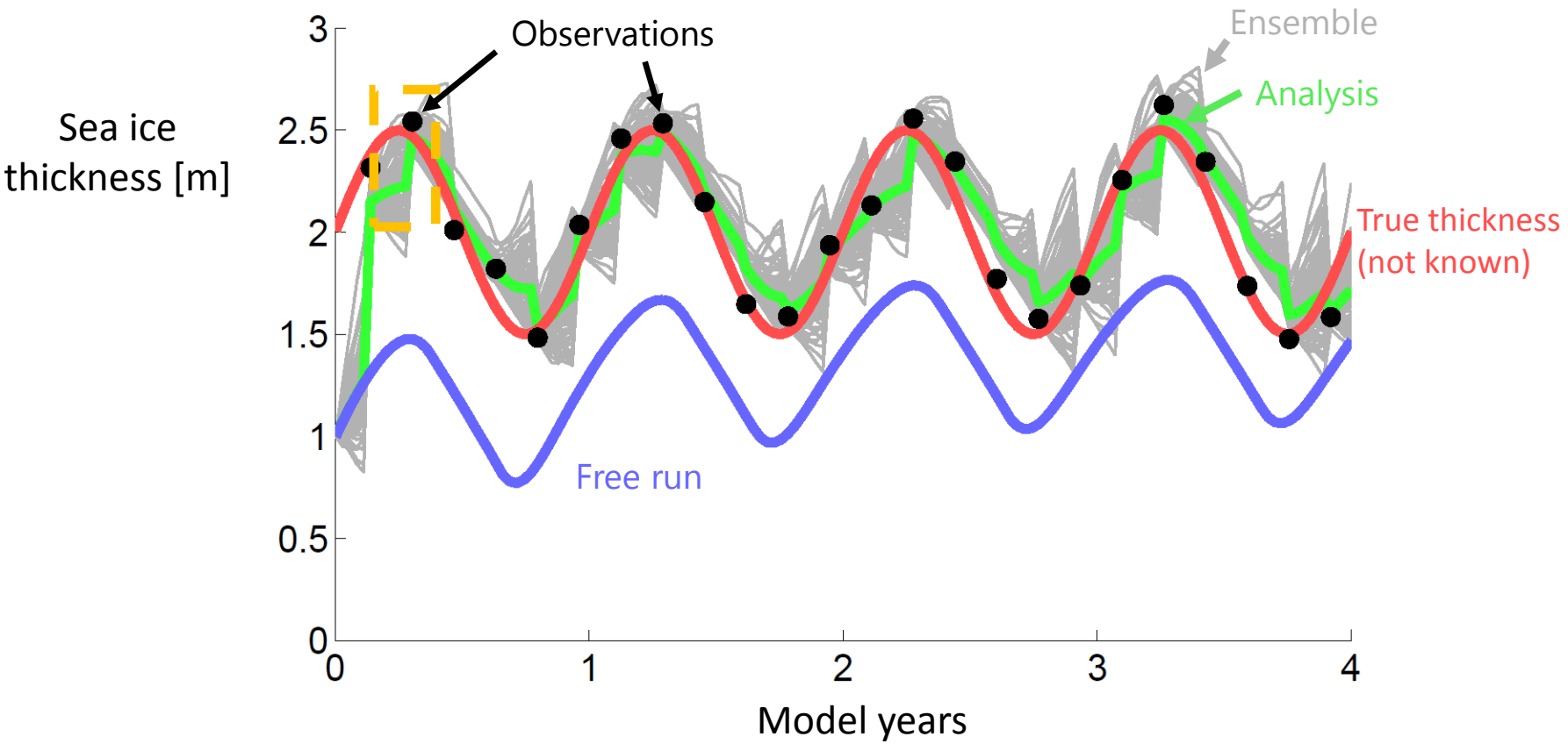
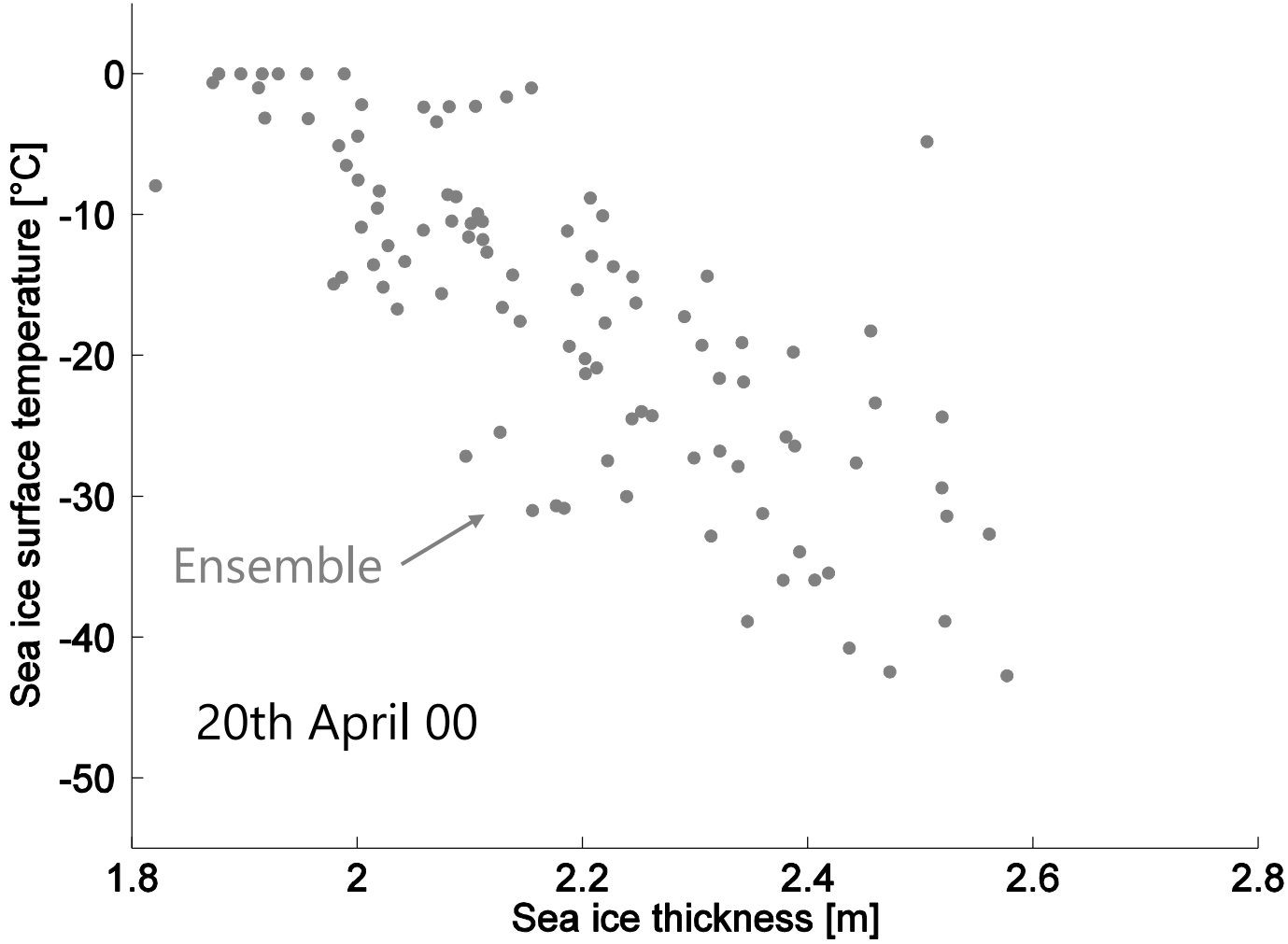


The tricky part: updating the other variable



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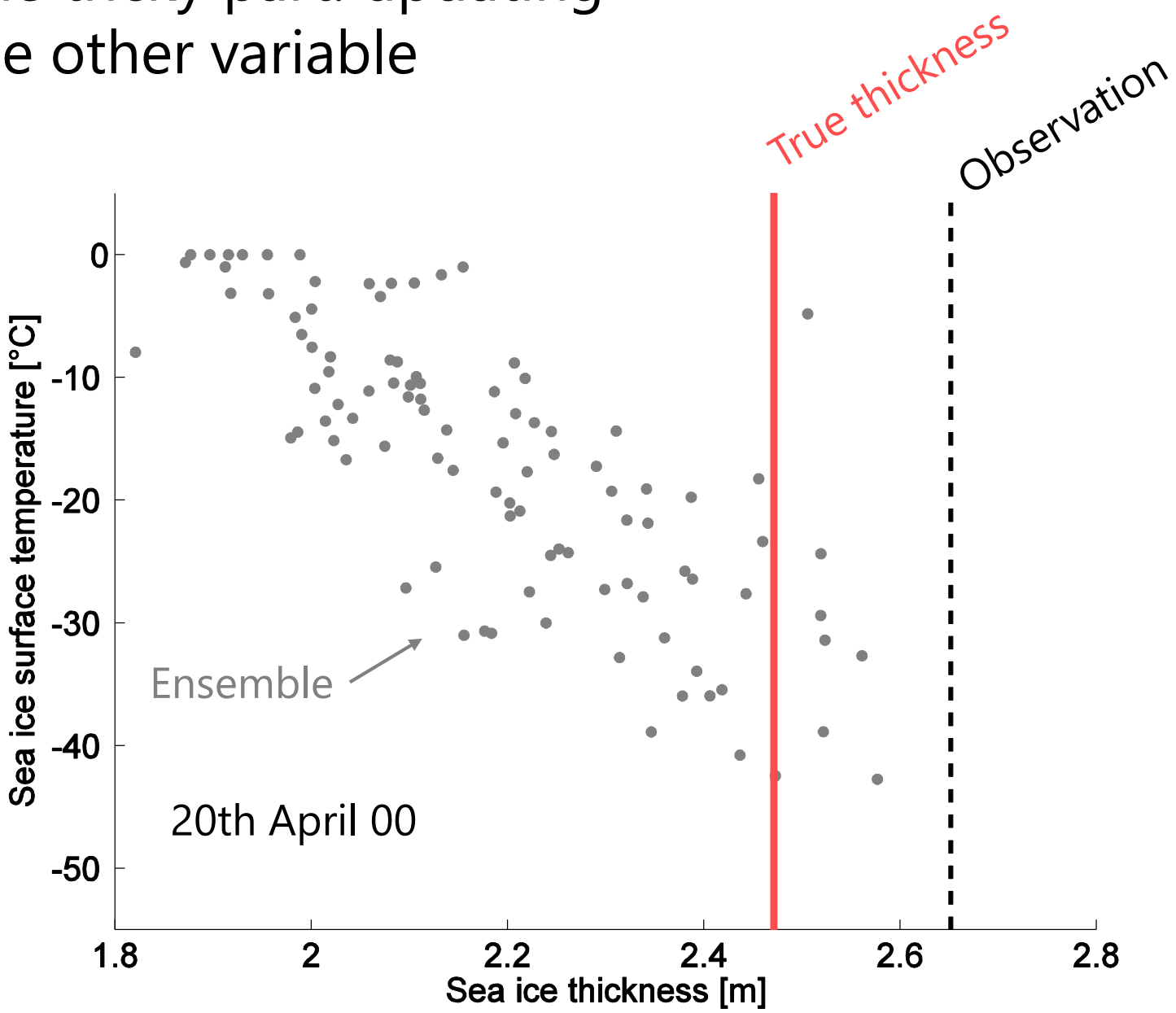
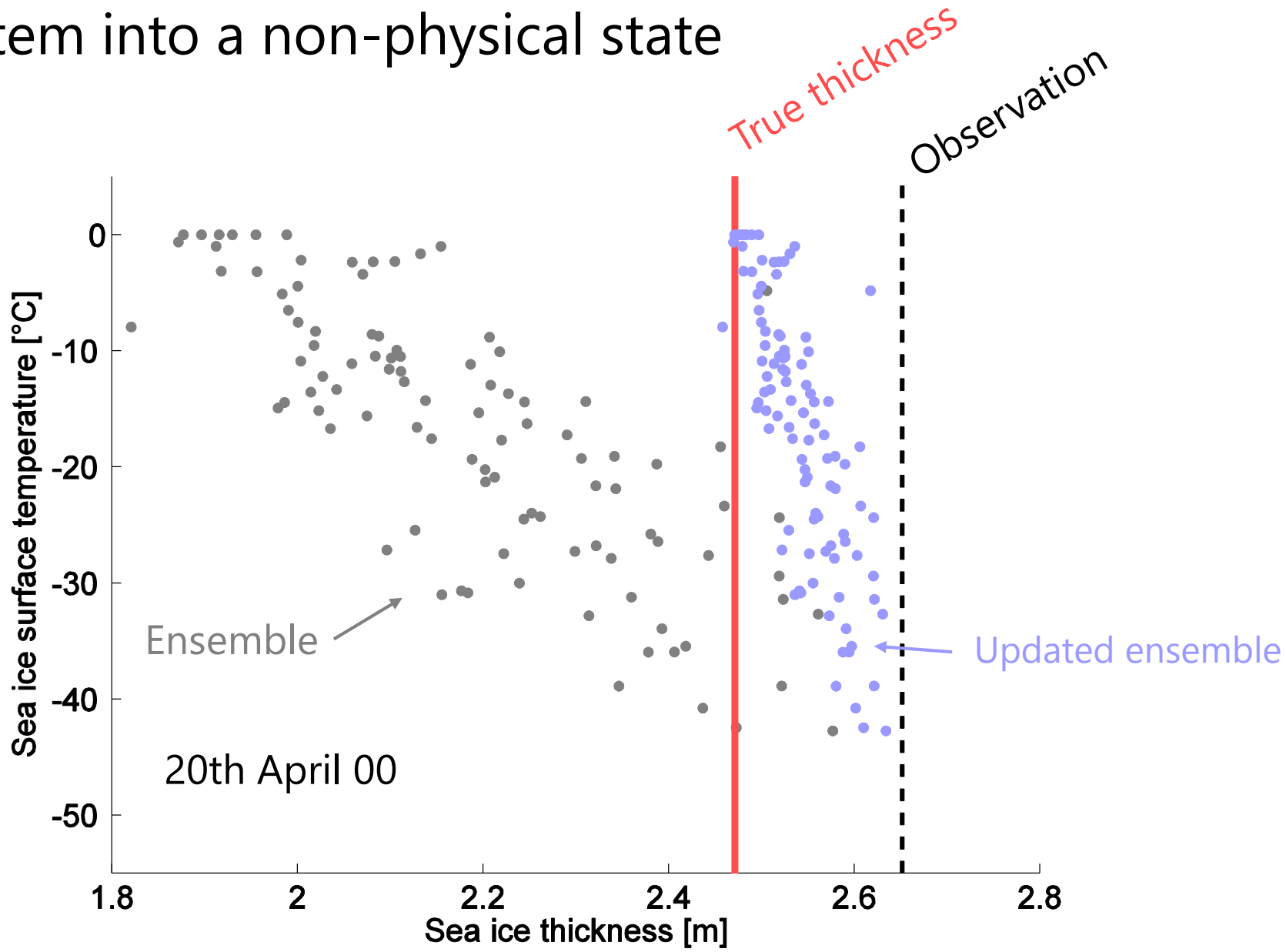
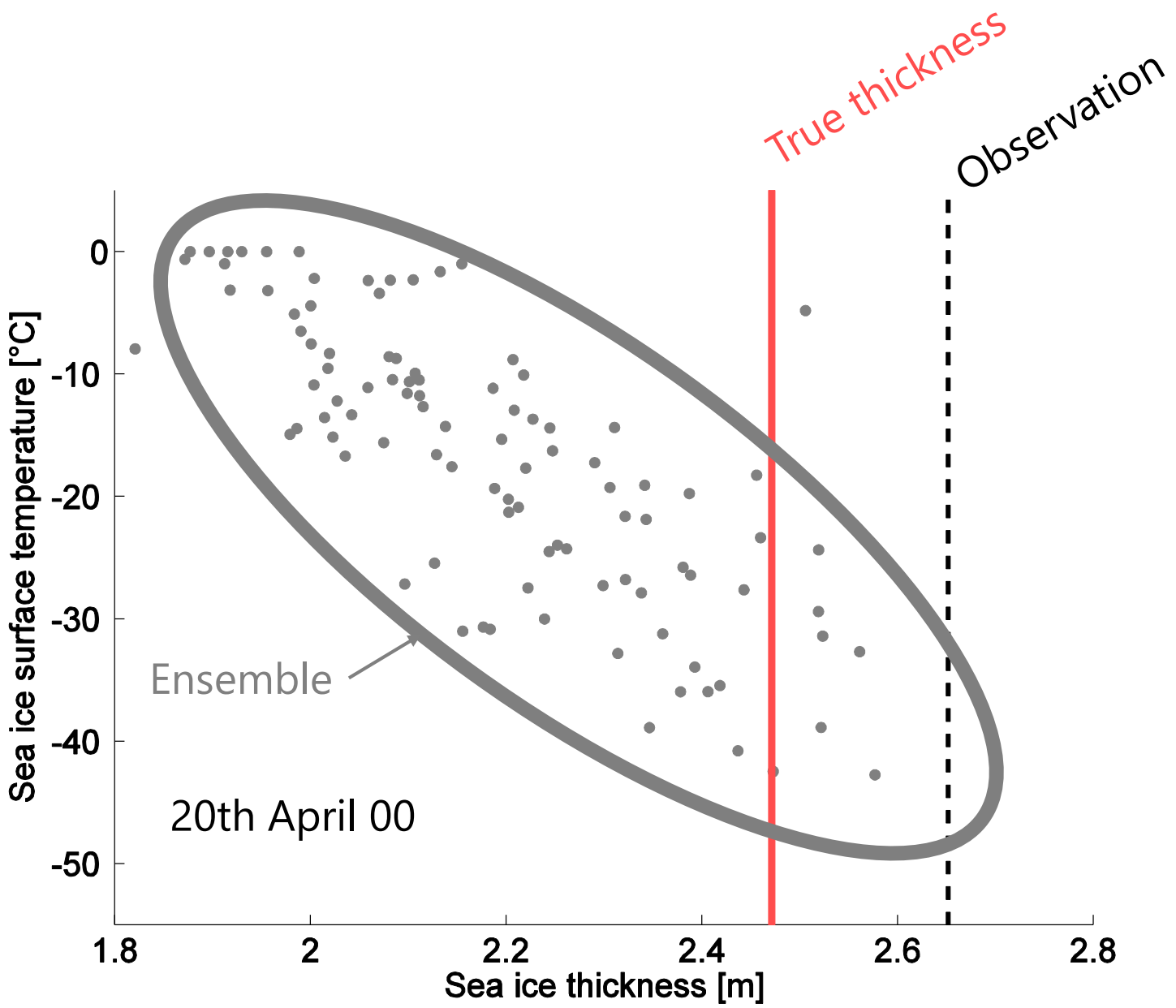
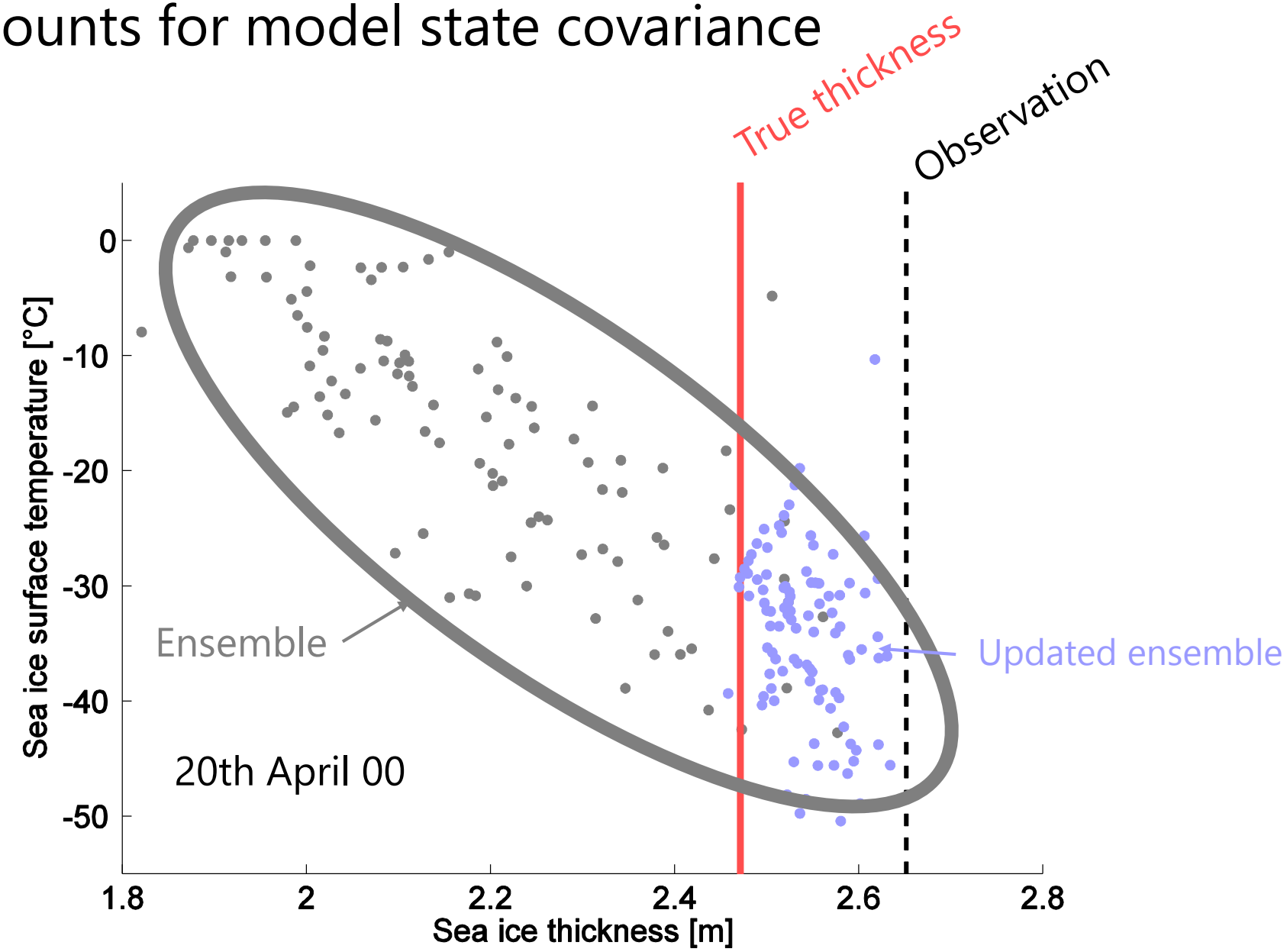


Primitive nudging may bring the system into a non-physical state




True thickness
Observation
Ensemble
20th April 00
Sea ice surface temperature [°C]
0
-10
-20
-30
-40
-50
1.8
2
2.2
2.4
2.6
2.8
Sea ice thickness [m]

Multivariate data assimilation accounts for model state covariance



1. Simple sea ice model

The update of the whole state should be consistent with the model dynamics

2. Comprehensive sea ice model

1. Simple sea ice model

The update of the whole state should
be consistent with the model dynamics

2. Comprehensive sea ice model

Given a comprehensive ocean-sea ice model and observations of total ice concentration,

- How to update concentration in individual categories?
- How to update fields that hold sea ice memory?
- How to keep model dynamics as balanced as possible?

Model: NEMO-LIM3 [Madec, 2008; Vancoppenolle et al., 2009]
Observations: SMMR/SSM-I ice concentration [Eastwood et al., 2011]

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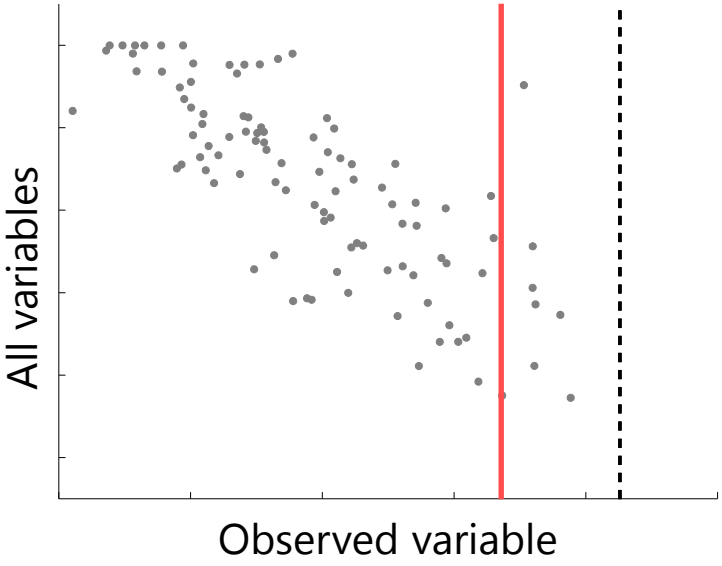
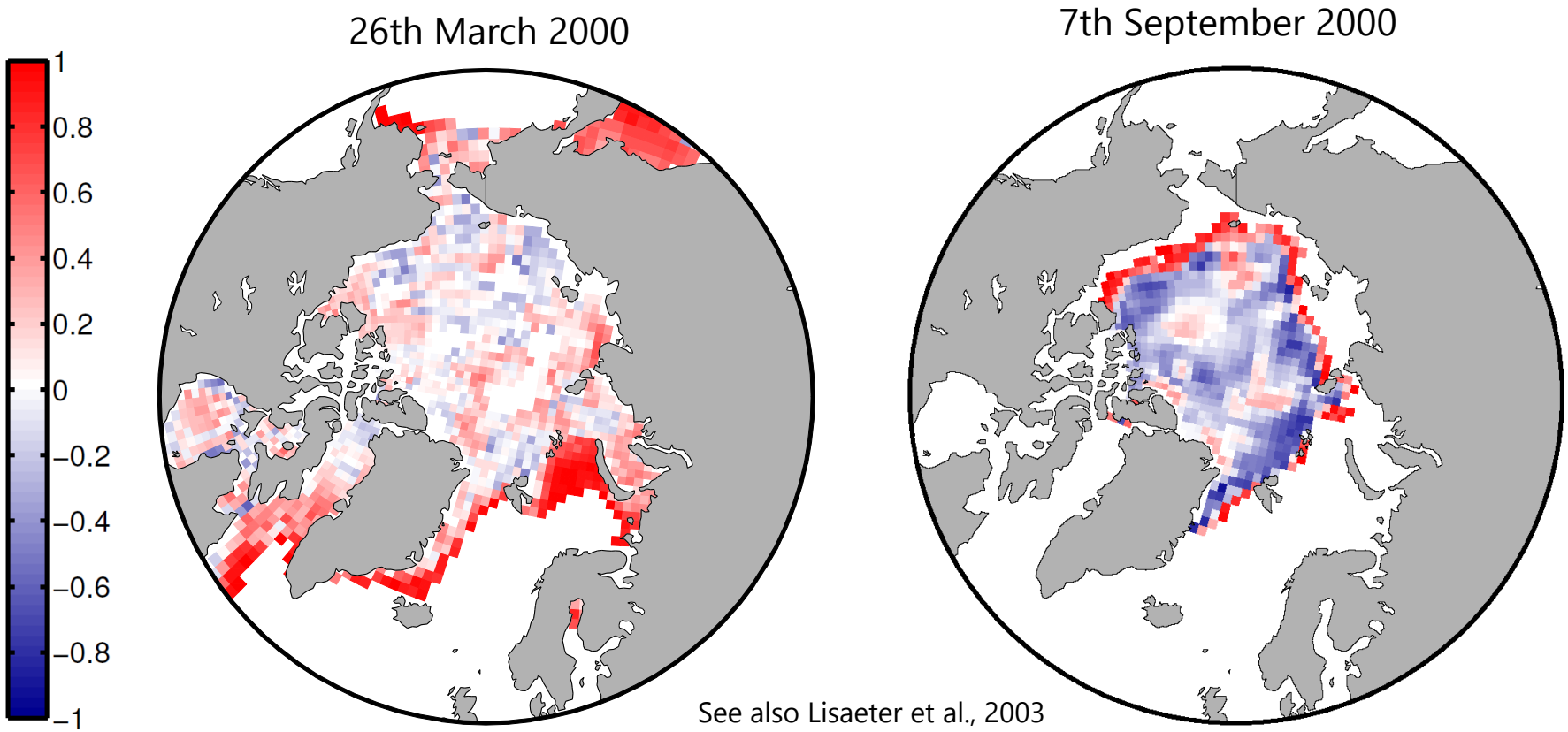


Model: NEMO-LIM3 [Madec, 2008; Vancoppenolle et al., 2009]
Observations: SMMR/SSM-I ice concentration [Eastwood et al., 2011]

Covariances are space- and time-dependent!

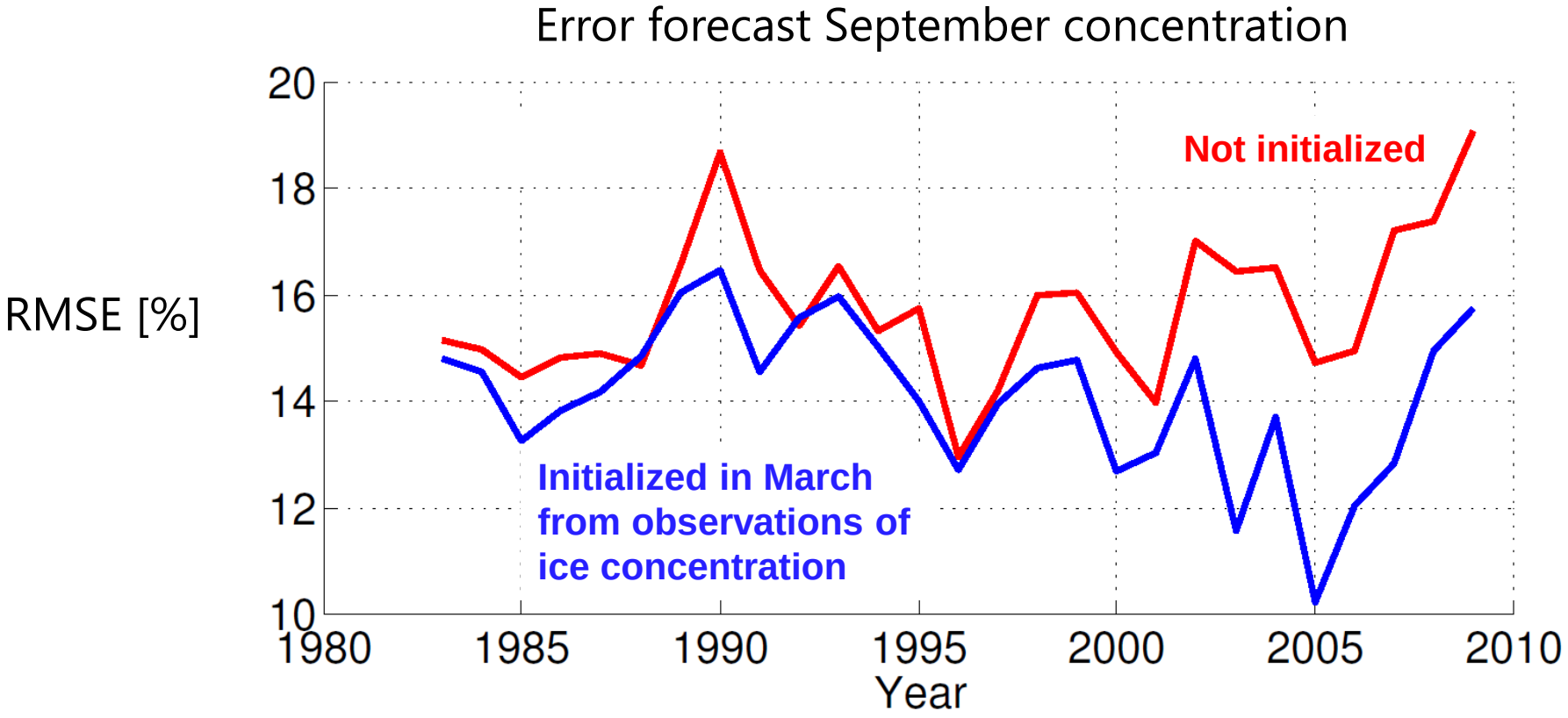
Correlation (concentration, thickness)

N=25, air surface temperature + winds perturbed



See also Lisaeter et al., 2003

Initialization from sea ice concentration improves seasonal Arctic predictions



1. Simple sea ice model

The update of the whole state should
be consistent with the model dynamics

2. Comprehensive sea ice model

Multivariate data assimilation is promising
for seasonal Artic sea ice predition

Take home message

In data assimilation for sea ice prediction, the update of the whole sea ice state is

- necessary
- not obvious
- worthwile

Thank you!

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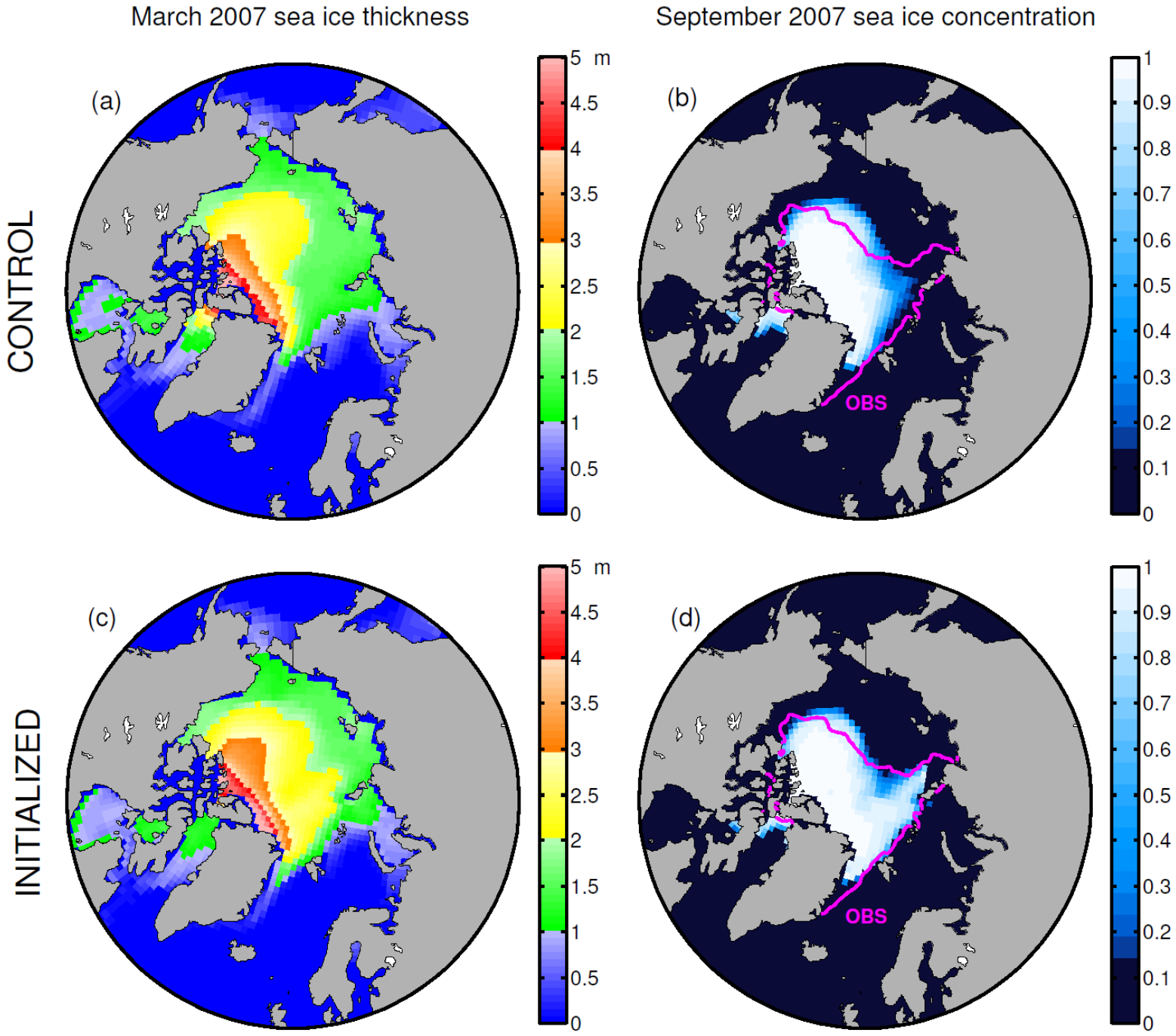
March 2007 sea ice thickness
September 2007 sea ice concentration
CONTROL
INITIALIZED
(a)
(b)
(c)
(d)
OBS
OBS
5 m
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0