GW019

Improvement of the algorithm for the derivation of sea-ice velocity from AMSR2 data

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Current ice-motion dataset

Period	1994 -	2003 – 2011, 2012 -		
Season	Winter（Dec−Apr）	Winter（Dec−Apr）		Summer（May−Nov）
Sensor	SSM/I 85.5 GHz	AMSR-E, AMSR2 36GHz	AMSR-E, AMSR2 89GHz	AMSR-E, AMSR2 19GHz
Resolution	75 km	60 km	30km	60 km
Time step	Daily	Daily	Daily	Daily

- Analyses of sea ice processes

  Kimura and Wakatsuchi (2001, 2004, 2011), Kimura (2004, 2007), Baba et al. (2006), Fukamachi et al. (2006), Nihashi et al. (2012), Kimura et al. (2013, 2020), Nakata et al. (2015), Mizobata et al. (2016), Holland and Kimura (2016), Toyota and Kimura (2018), Petty et al. (2018), Maeda et al. (2020), Kimura et al. (2020) etc.

- Numerical model studies

  Uotila et al. (2014), Sumata et al. (2014), Toyoda et al. (2021)

- Marine biology

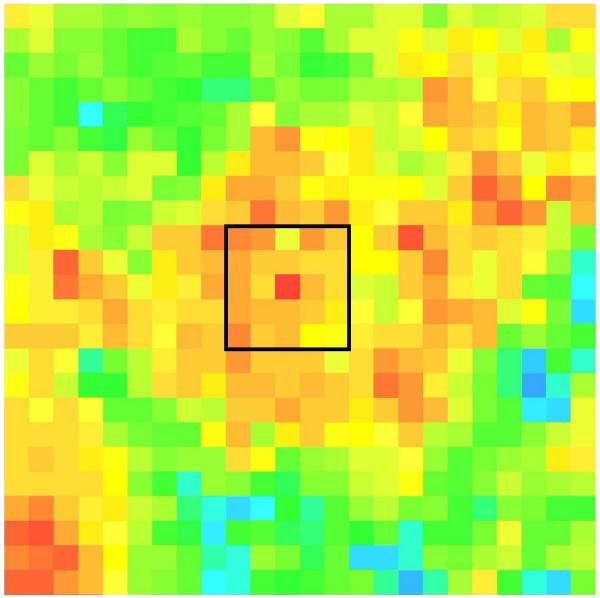
  Meguro et al. (2004), Tison et al. (2020)

- Paleoceanography

  Sakamoto et al. (2005)

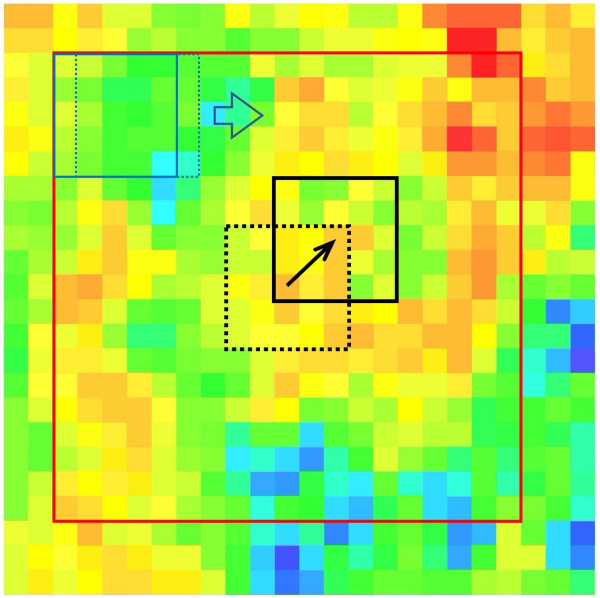
How to detect the ice movement

day A

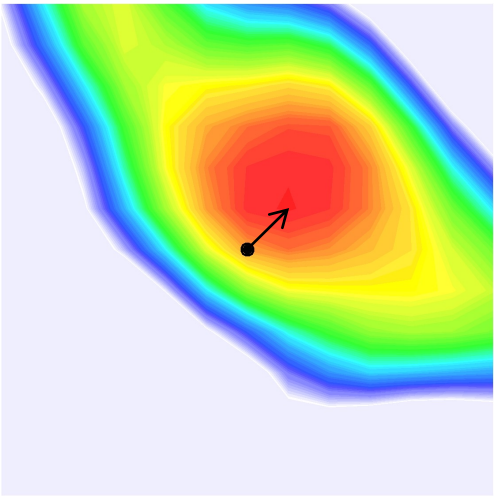


Template window = 5 x 5 pixel
= 50 x 50 km

day A+1



Search area = 19 x 19 pixel
= 190 x 190 km



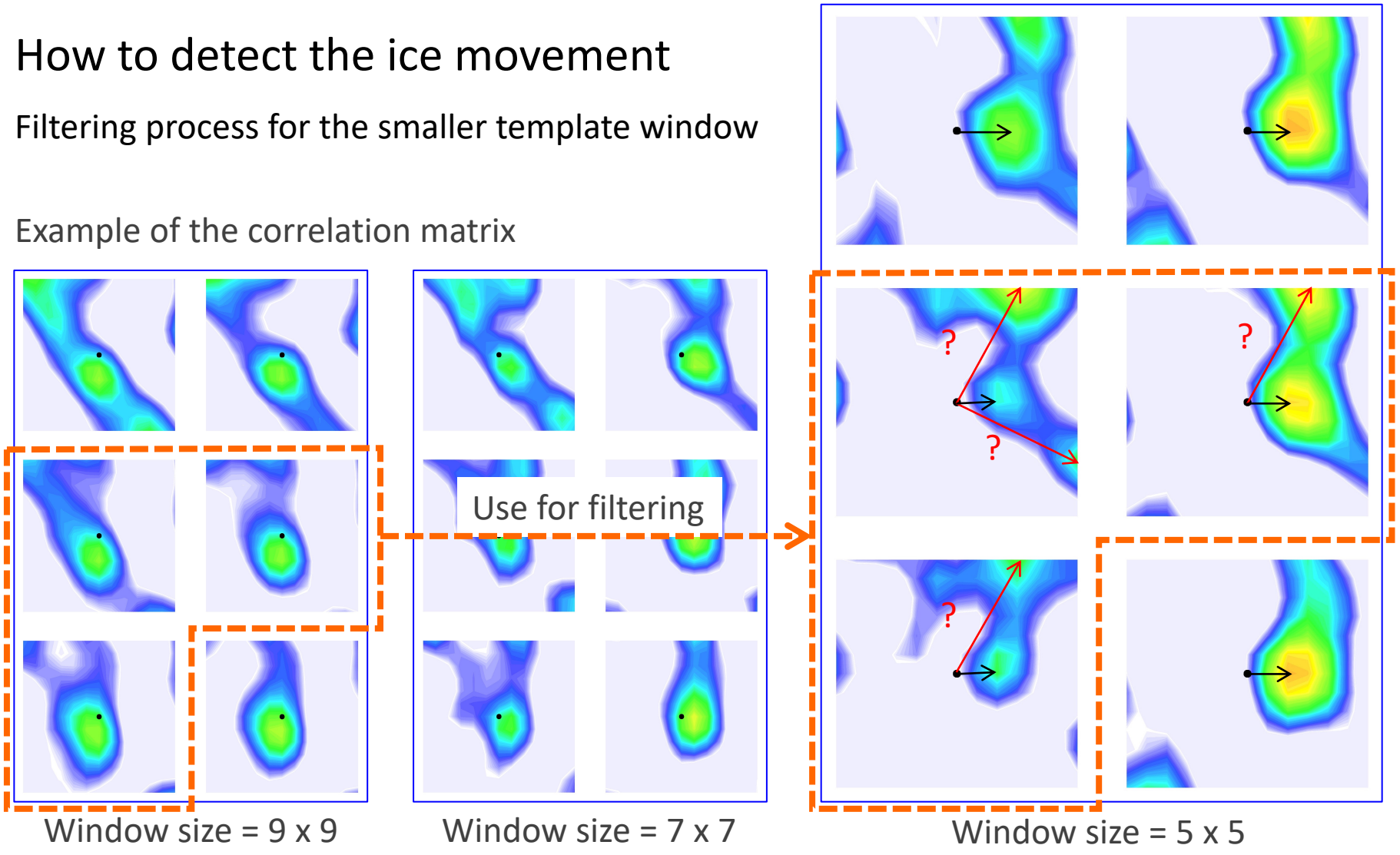
Matrix of
correlation coefficient

1. Tentative ice vector is derived on an interval of 1 x 1 pixel (10 x 10 km).
2. False vectors are eliminated based on the maximum correlation coefficient and consistency with the neighboring vectors.
3. Ice velocity on 5 x 5 pixel resolution is calculated as a mean value of up to 25 vectors.

How to detect the ice movement

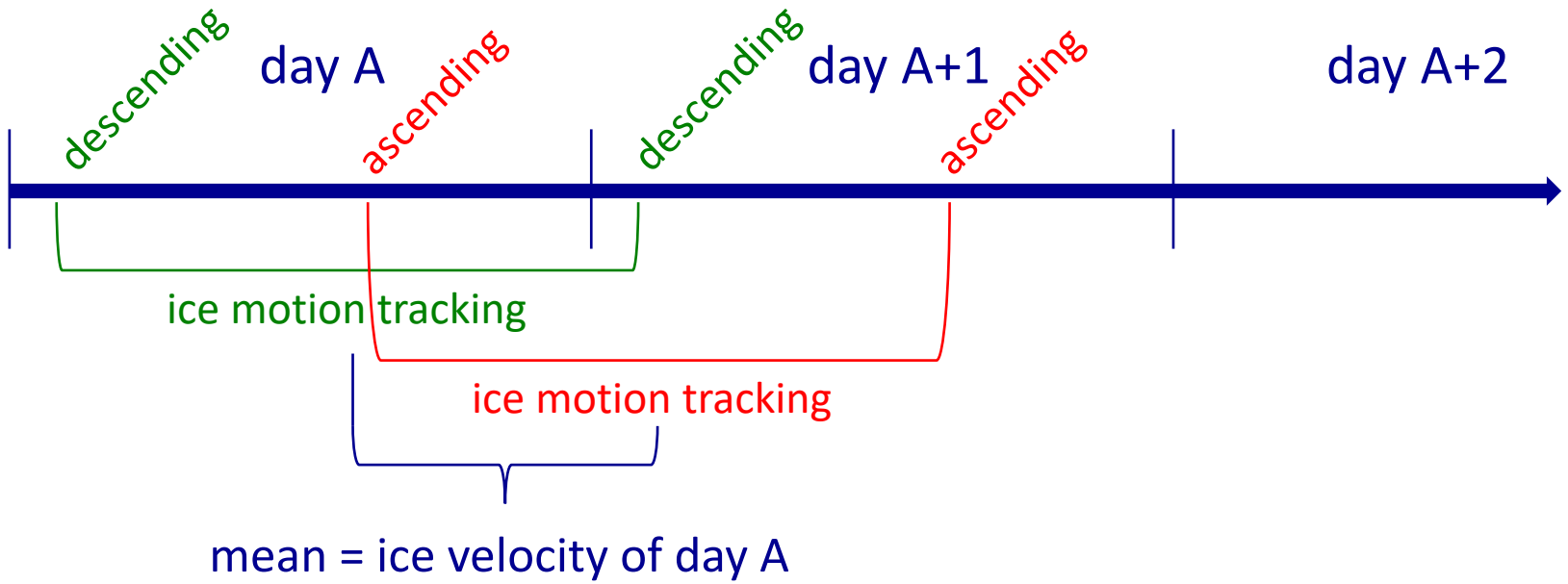
Filtering process for the smaller template window

Example of the correlation matrix



1. Tentative ice vector is derived based on 9 x 9 pixel template window.
2. Ice vector is derived based on 5 x 5 pixel window by using the 9 x 9 vector as reference of filtering.

How to calculated the daily ice motion: time step

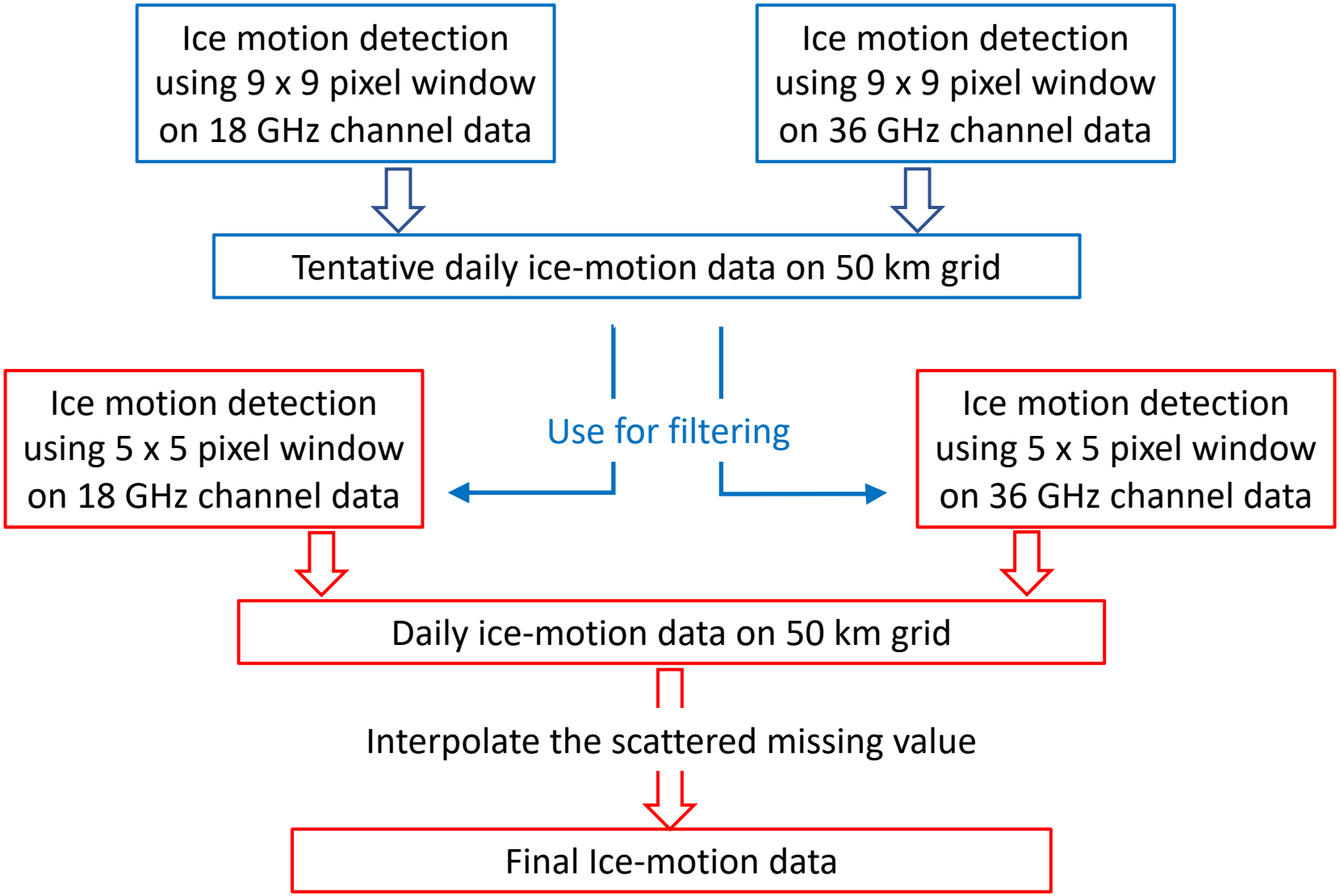


Daily mean Ice velocities on 9 x 9 pixel and 5 x 5 pixel resolution are calculated as a mean value of four results from

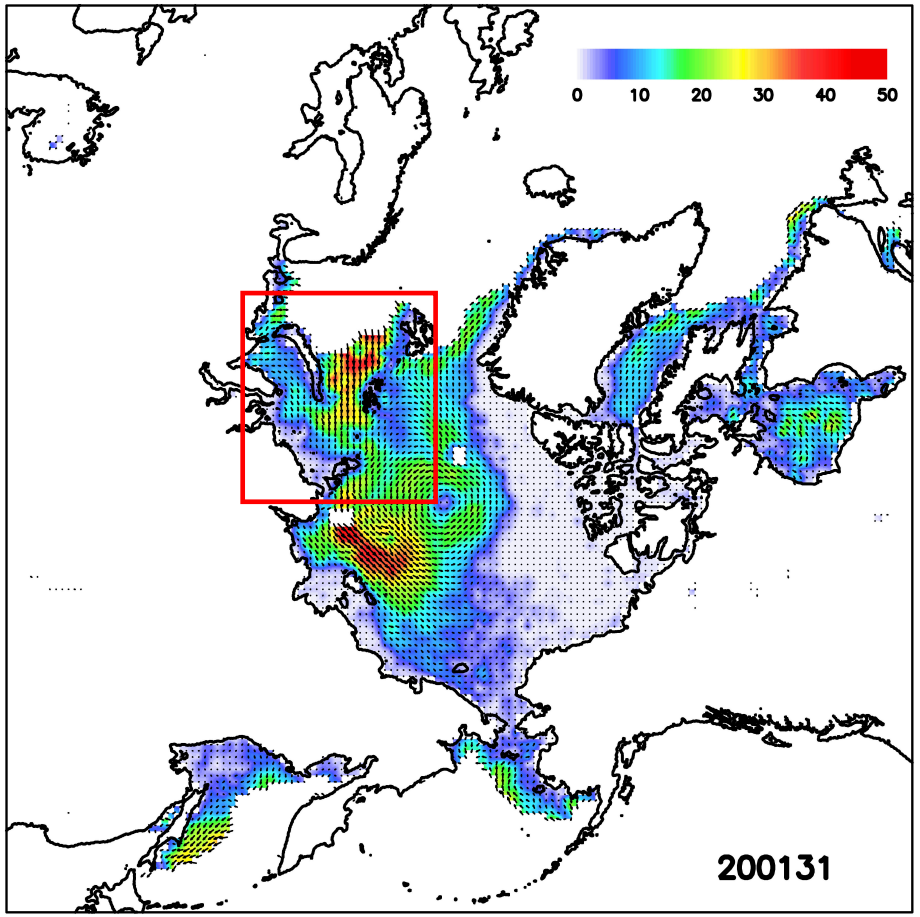
descending data of vertical polarization channel
descending data of horizontal polarization channel
ascending data of vertical polarization channel
ascending data of horizontal polarization channel

Both 36GHz and 19GHz channels are used for all seasons

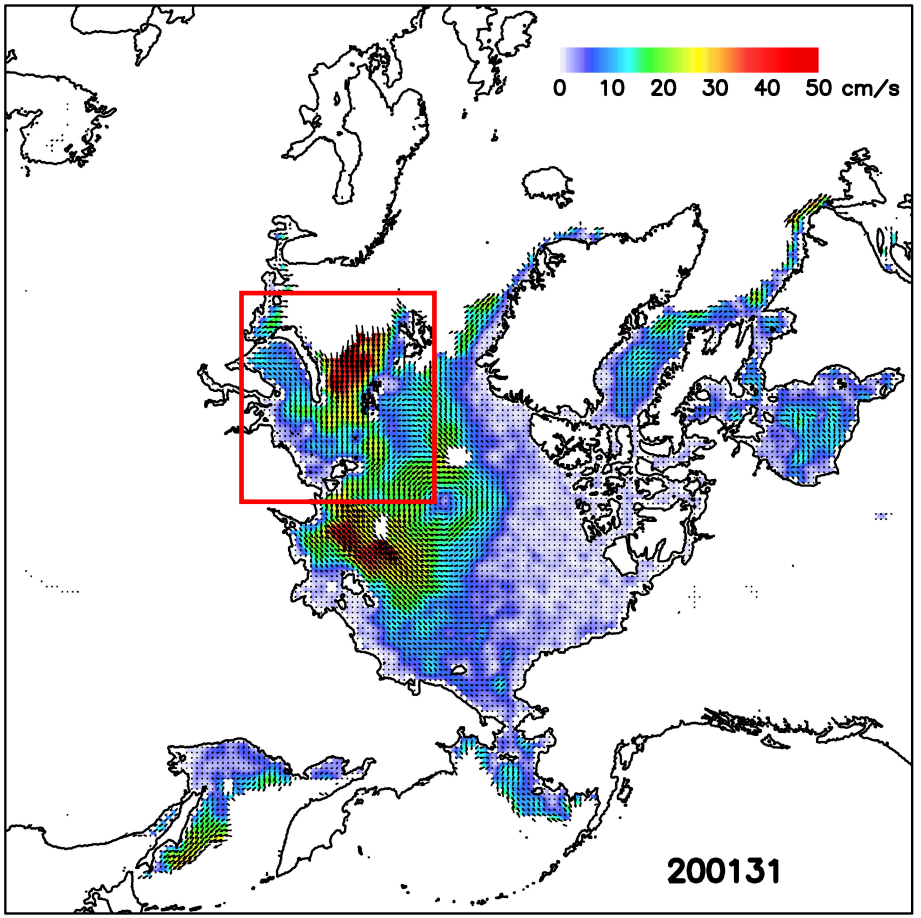
Procedure of the calculation



Derived ice motion (January 31, 2020)



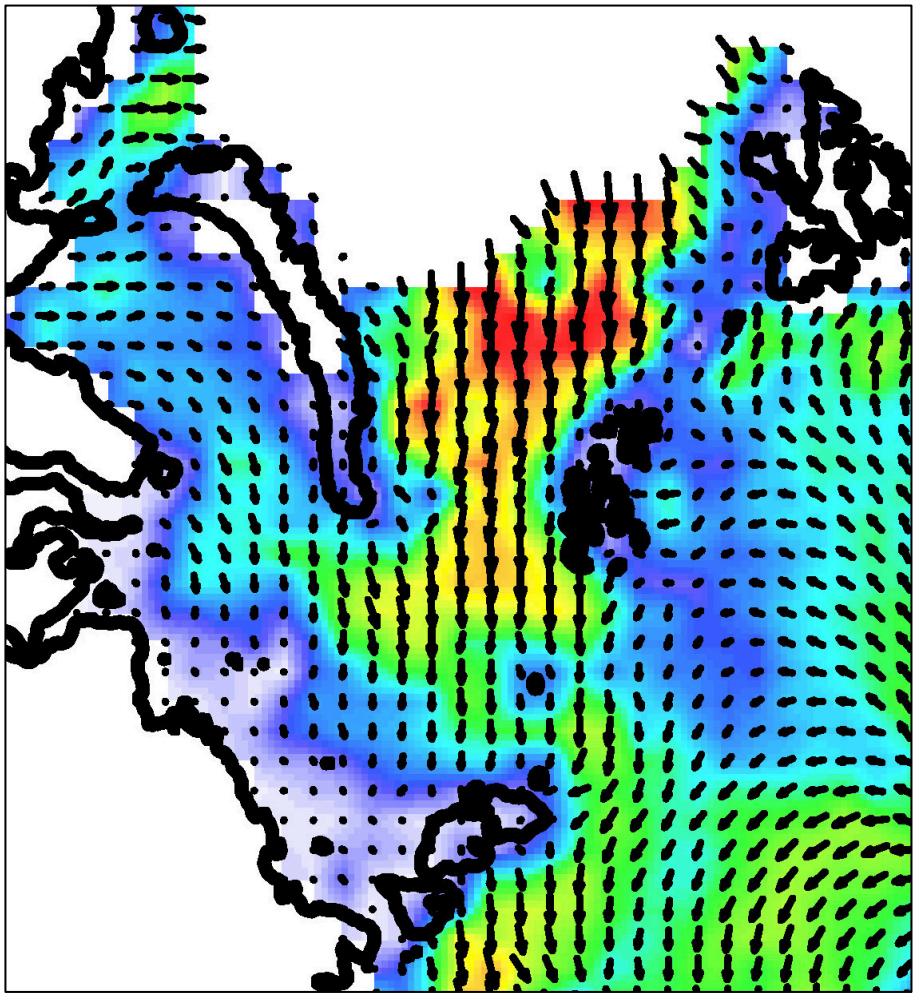
Old data (60 km resolution)



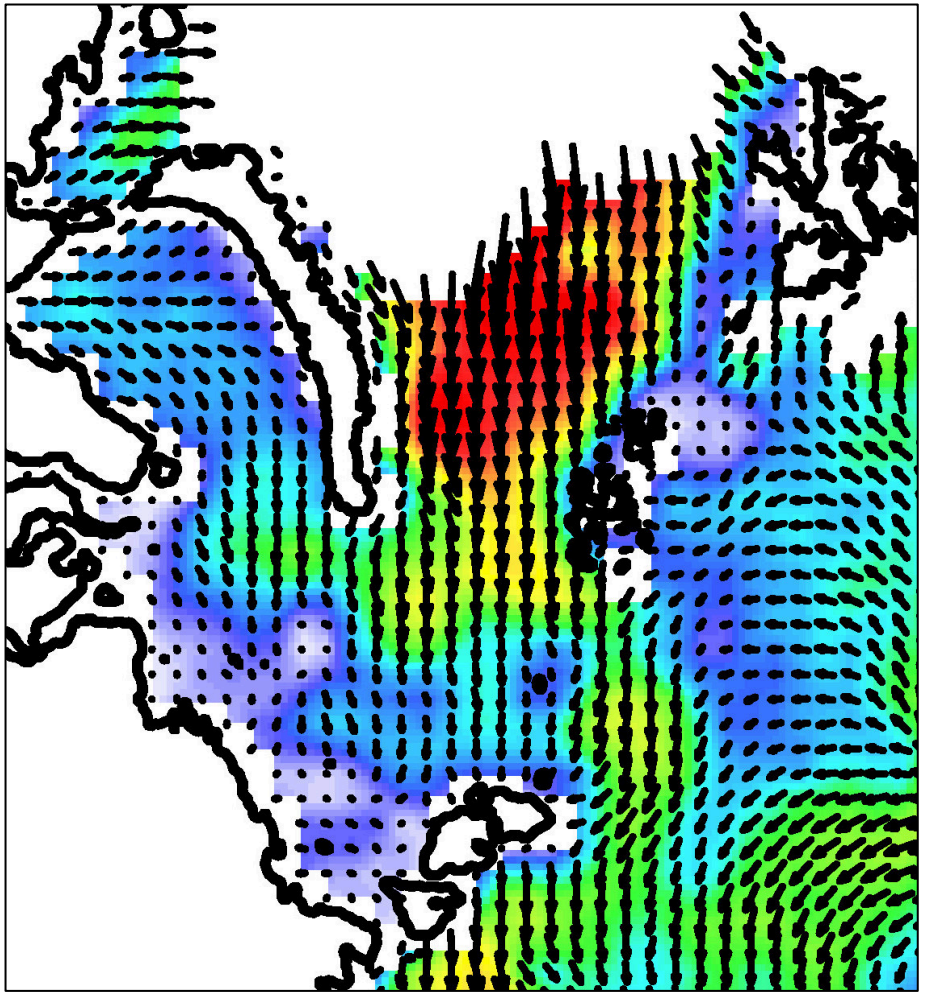
New data (50 km resolution)

New data can detect the smaller-scale ice motion.

Derived ice motion (January 31, 2020)



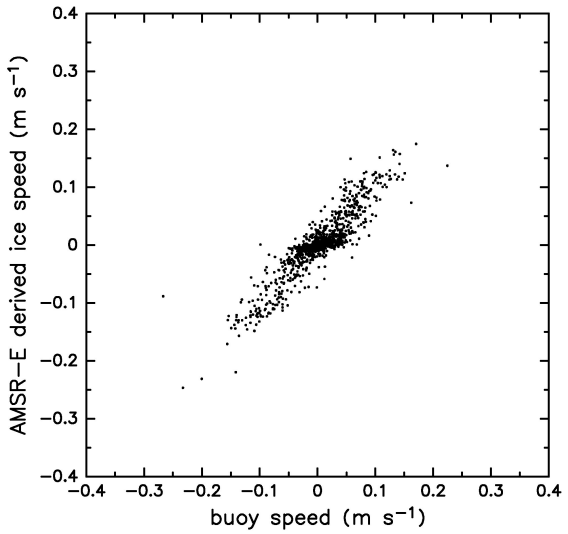
Old data (60 km resolution)

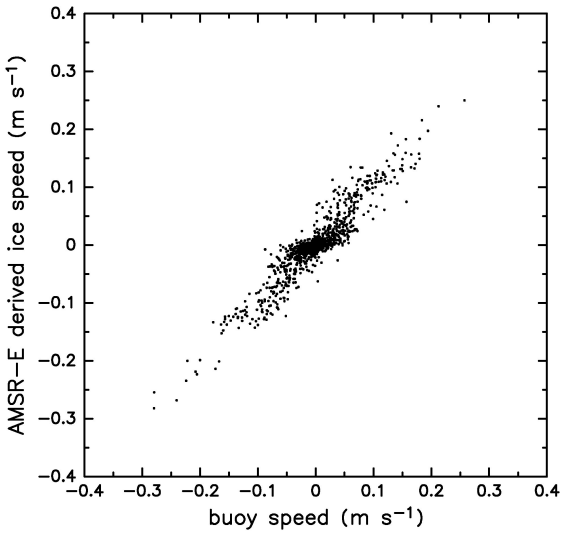


New data (50 km resolution)

New data can detect the smaller-scale ice motion.

Comparison between the derived ice motion and buoy motion Winter (January-March of 2008)





Old data

n=1232

x-direction

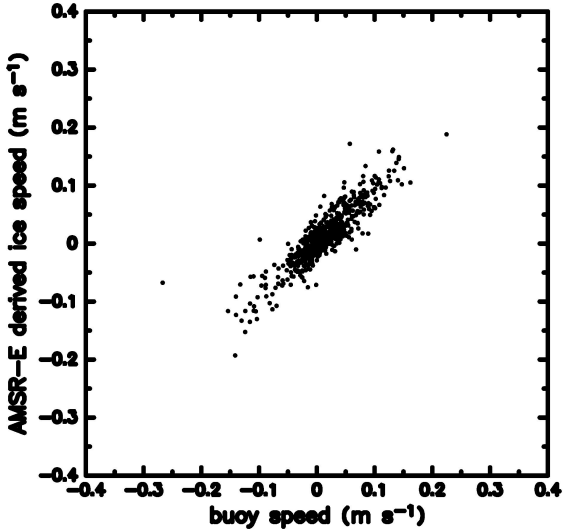
r=0.908

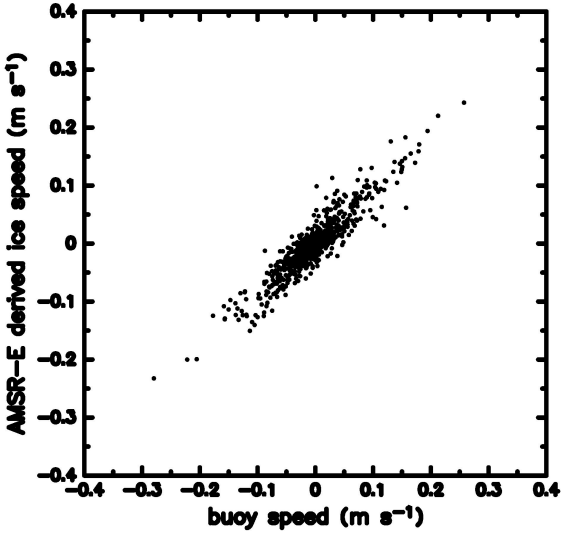
rms error = 1.49cm/s

y-direction

r=0.935

rms error = 1.46cm/s





New data

n=889

x-direction

r=0.886

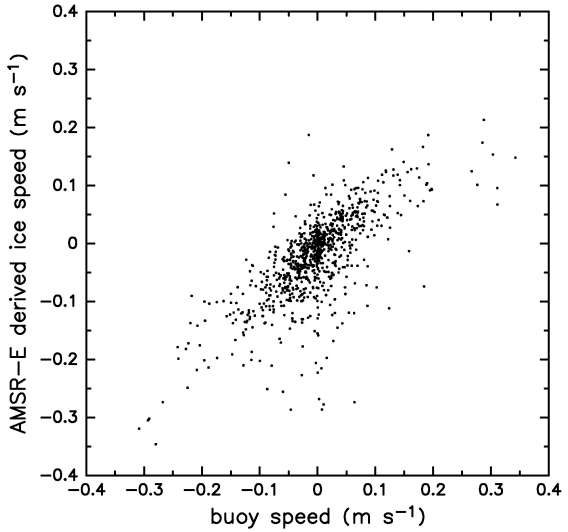
rms error = 2.26cm/s

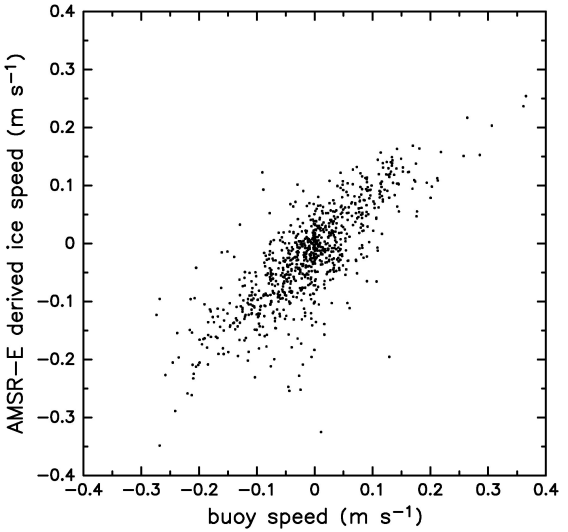
y-direction

r=0.924

rms error = 1.87cm/s

Comparison between the derived ice motion and buoy motion Summer (June-August of 2008)





Old data

n=874

x-direction

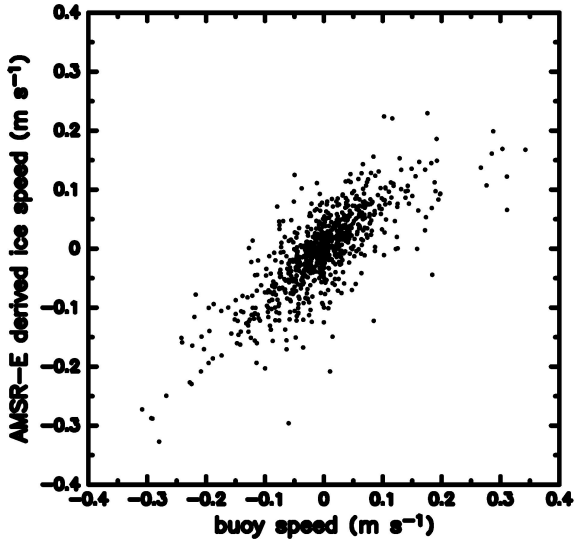
r=0.676

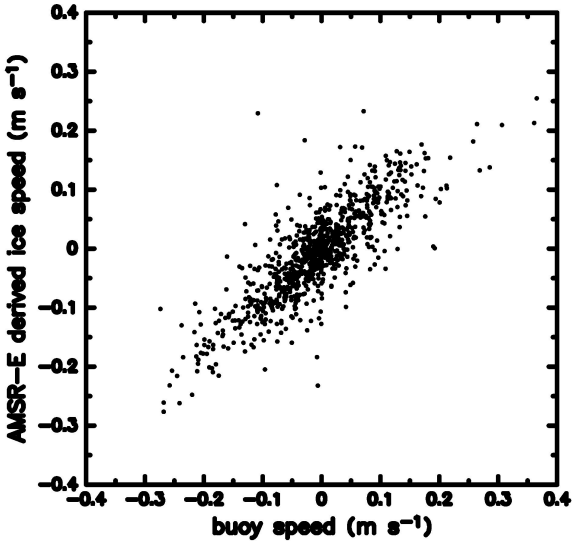
rms error = 4.09 cm/s

y-direction

r=0.785

rms error = 4.01 cm/s





New data

n=892

x-direction

r=0.732

rms error = 3.42cm/s

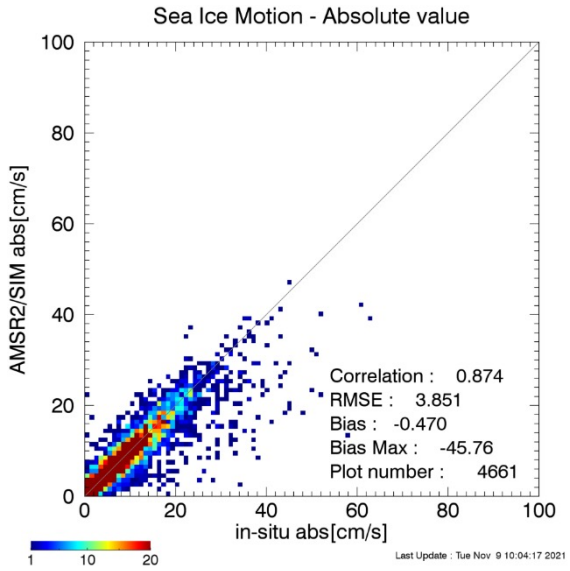
y-direction

r=0.824

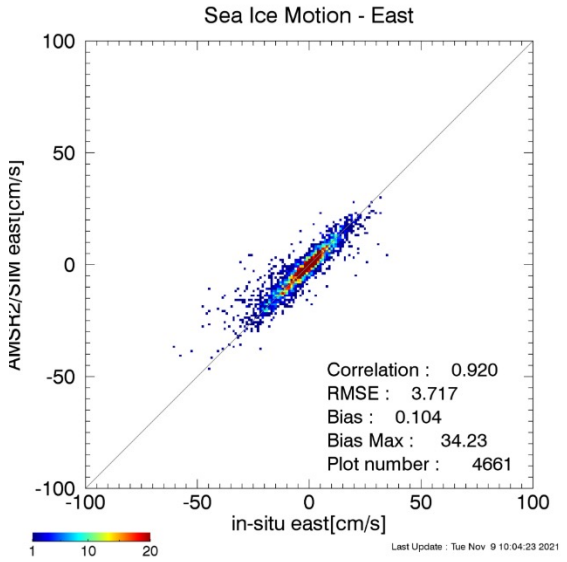
rms error = 3.44cm/s

Validation results by JAXA Team (Yoshizawa et al.)
Winter ice velocity vs Buoy motion

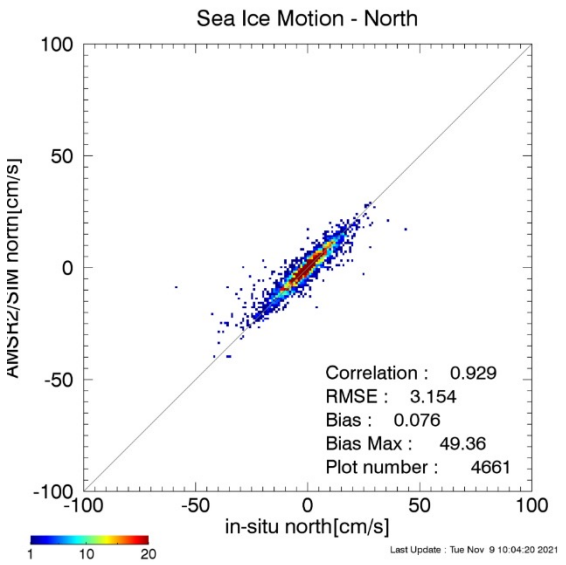
Speed



Zonal speed



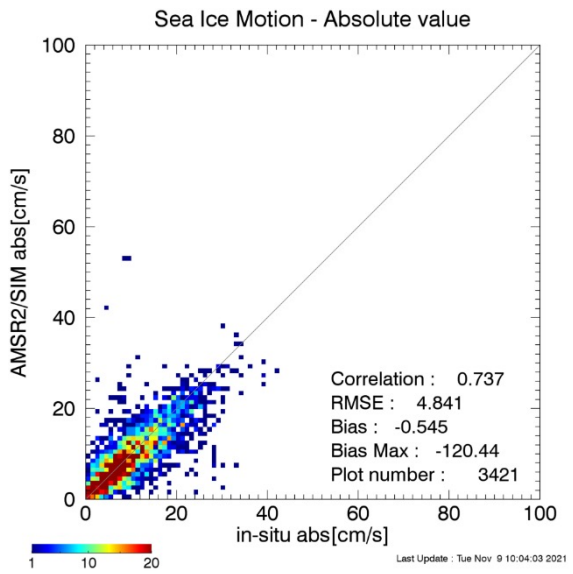
meridional speed



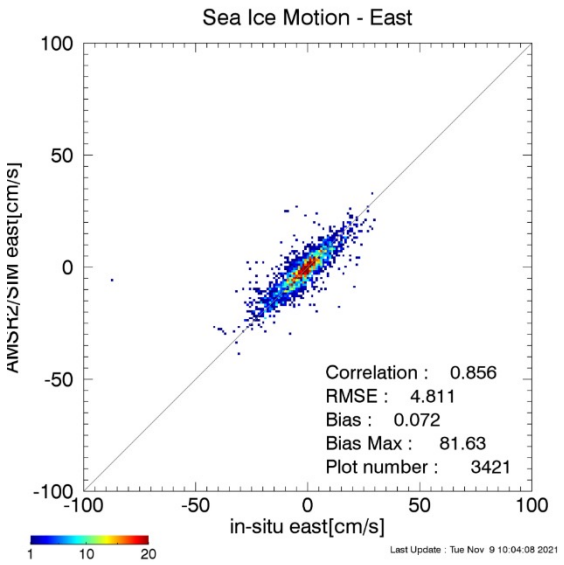
	Bias	RMSE
zonal speed	0.104	3.717
meridional speed	0.076	3.154
speed	-0.470	3.851

Validation results by JAXA Team (Yoshizawa et al.)
Summer ice velocity vs Buoy motion

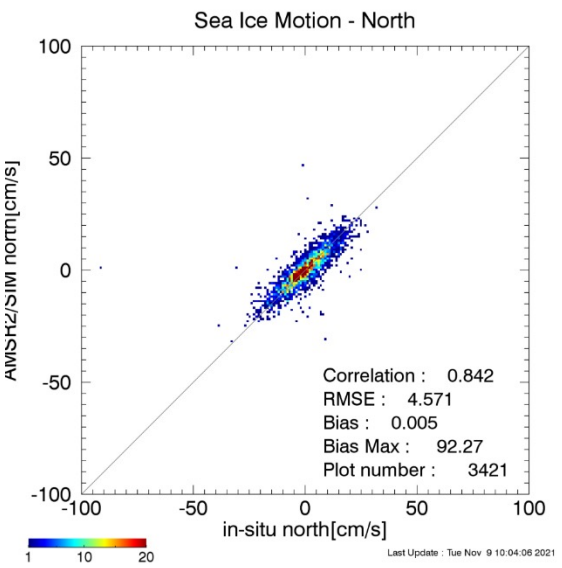
Speed



Zonal speed



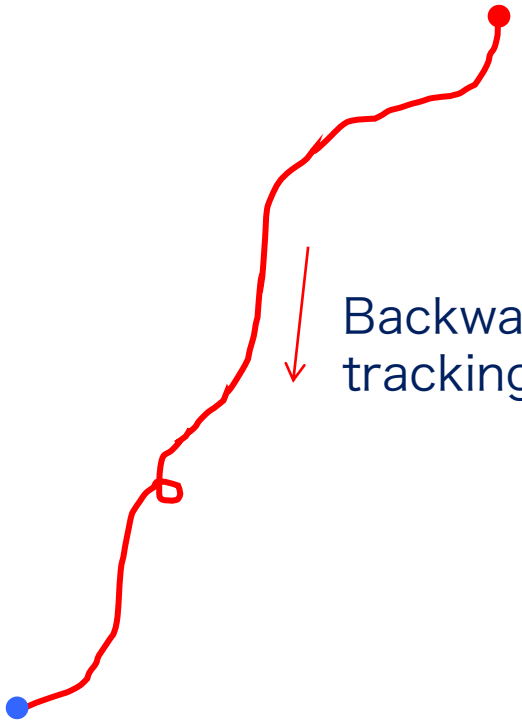
meridional speed



	Bias	RMSE
zonal speed	0.072	4.811
meridional speed	0.005	4.571
speed	-0.545	4.841

Application work

Backward tracking of sea ice motion to the ice formation



We can identify

- Age (in day)
- Traveling distance
- Category of the birthplace
- History of ice divergence/convergence
- History of heat budget
- History of extreme weather event

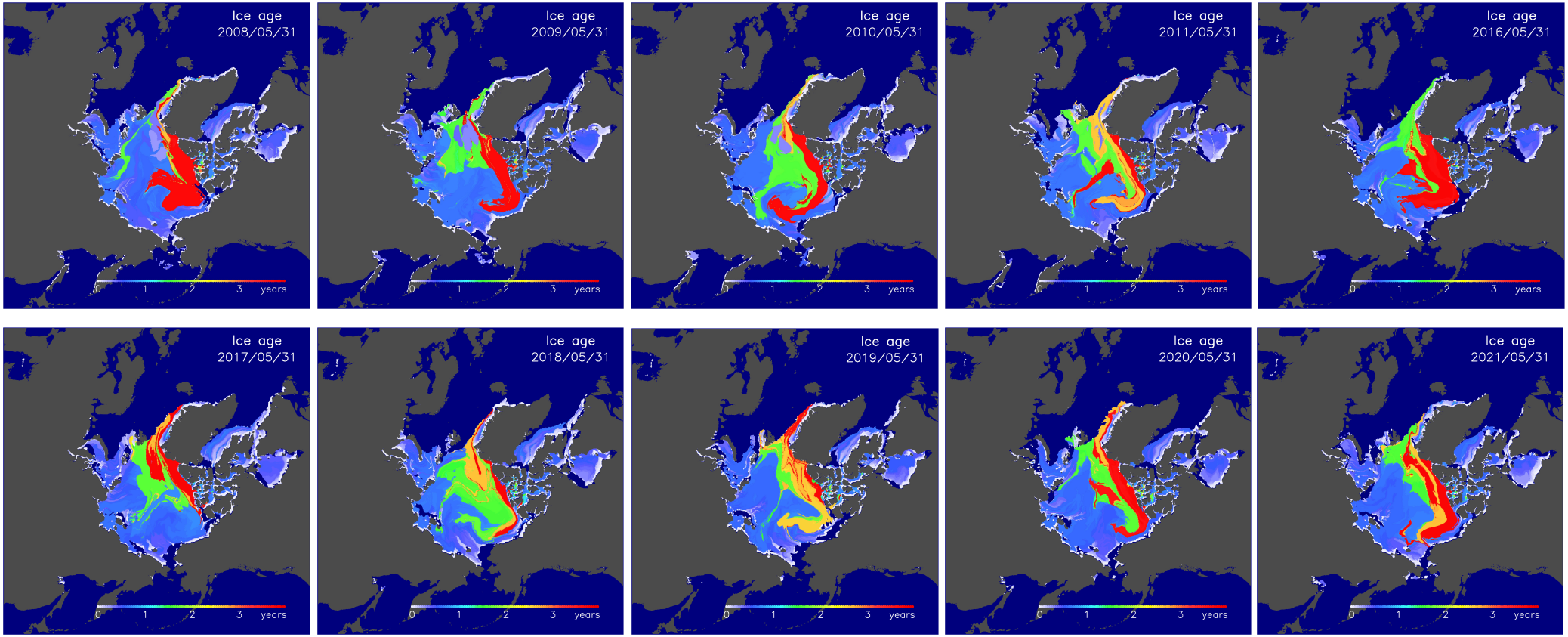
of the specific sea ice.

Ice formation =
when ice concentration at the particle position goes below 15%.

※In the real situation, thermodynamic ice growth occurs during the ice traveling. The derived history is the history of the oldest ice around the point.

Application work

Age of sea ice derived by backward tracking of sea ice



Result

We are now able to derive the ice motion with
50 km resolution without lowering the accuracy.

New data is useful to update the method of application works.