# Improving sea ice algorithm for AMSR-2

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# 1. Objectives

- To optimize the parameters of AMSR-E Bootstrap Algorithm(ABT) for AMSR2.
- To validate the sea ice concentration accuracy of the standard product of AMSR2 derived with ABT.
- To develop the thin ice algorithm for AMSR2.

# 2. Algorithm Modification from AMSR-E to AMSR2

| | AMSR-E | AMSR2 |
|---|---|---|
| Input Data | L1B（Brightness Temp., No resampling） | L1R（Brightness Temp. resampled to 18GHz footprint size） |
| Tie point calculation areas | Ascending & Descending for NP and SP (four) | Ascending, Descending and total for NP and SP (six) |
| Land mask | PI provided land mask (25km) | Land mask calculated from L1R product. (18GHz footprint size) 3x3 land filter |
| Weather filter | Globally fixed threshold | Zone adjustment (TBD) |

18GHz footprint size : 14×22(km)

# 3. Parameter tuning

(1)Tie point

(2) Land filter

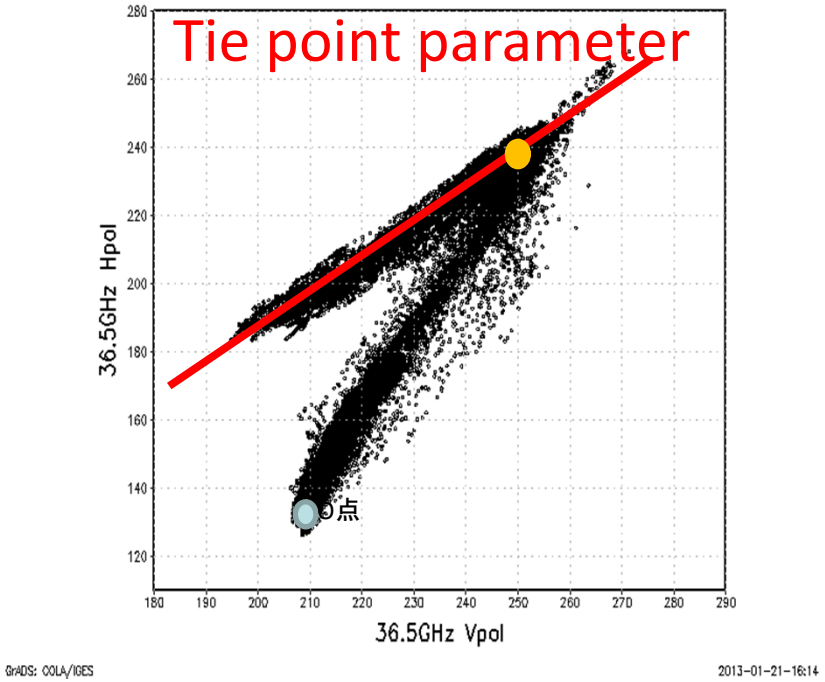
(3) Land mask expansion

(4)Weather filter

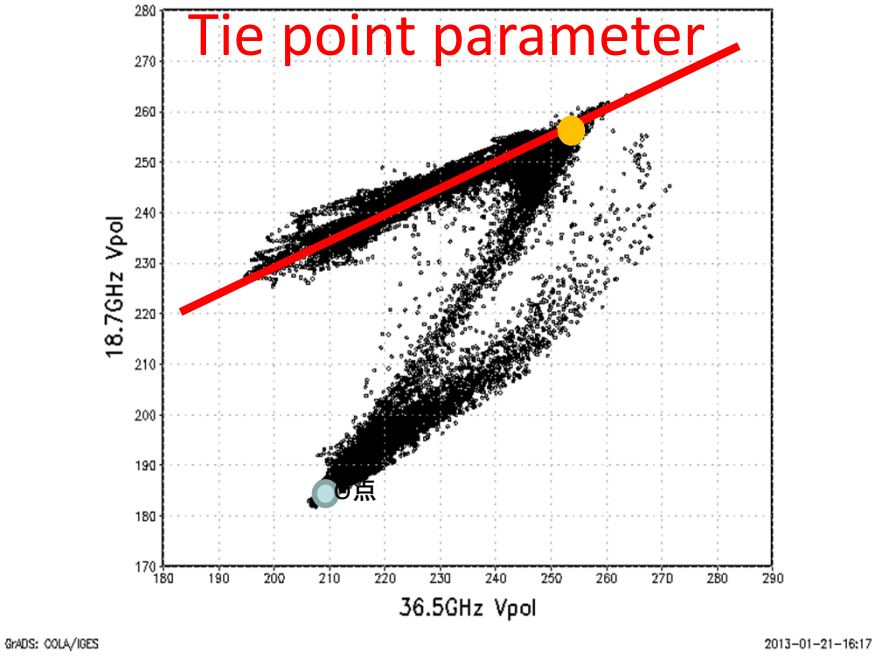
# (1)Tie point

Tie point parameters:

Slope and Off Set of 100% ice concentration line



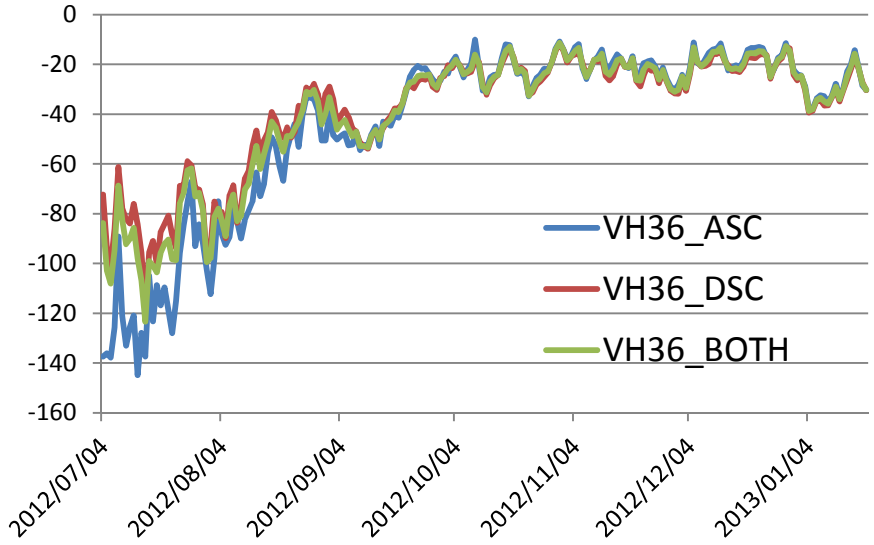

36.5GHz V vs 36.5GHz H
(VH36)



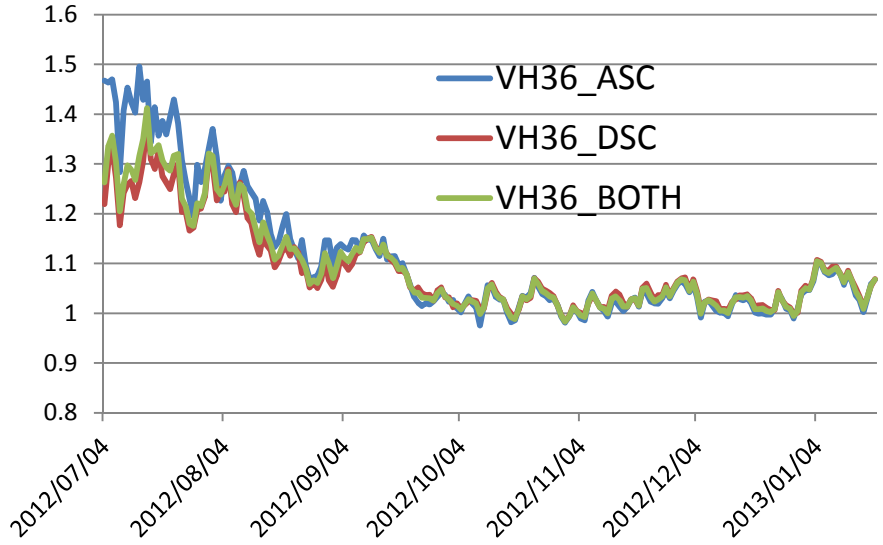

36.5GHz V vs 18.7GHz V
(V1836)

# ① Northern Hemisphere Tie Point Parameters

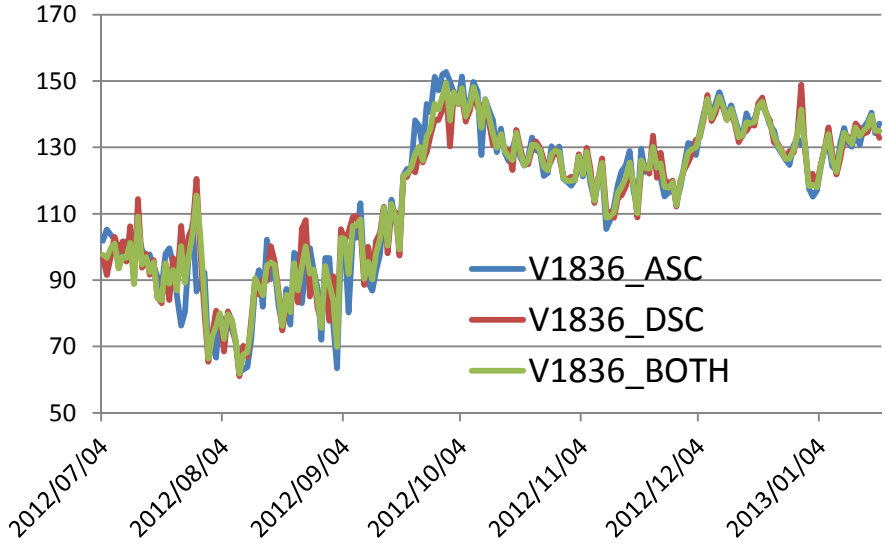
## VH36 Offset



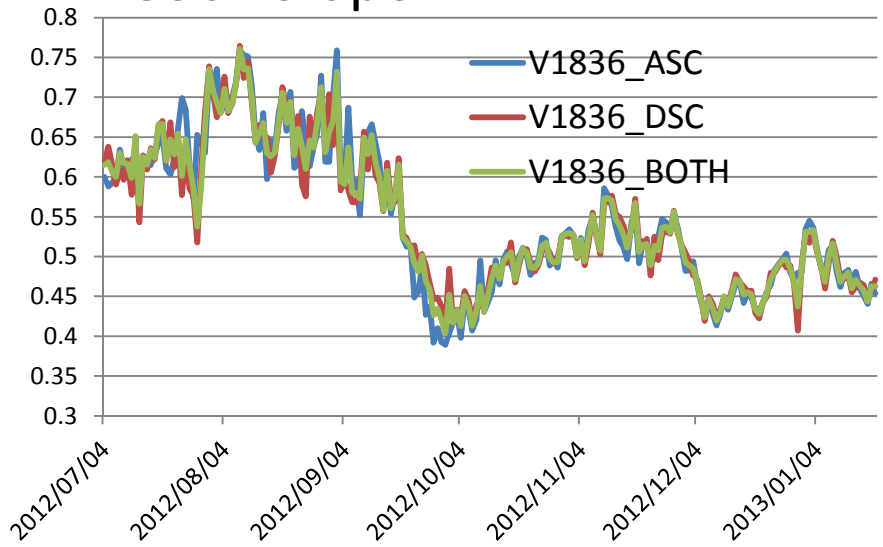

## VH36 Slope




## V1836 Offset

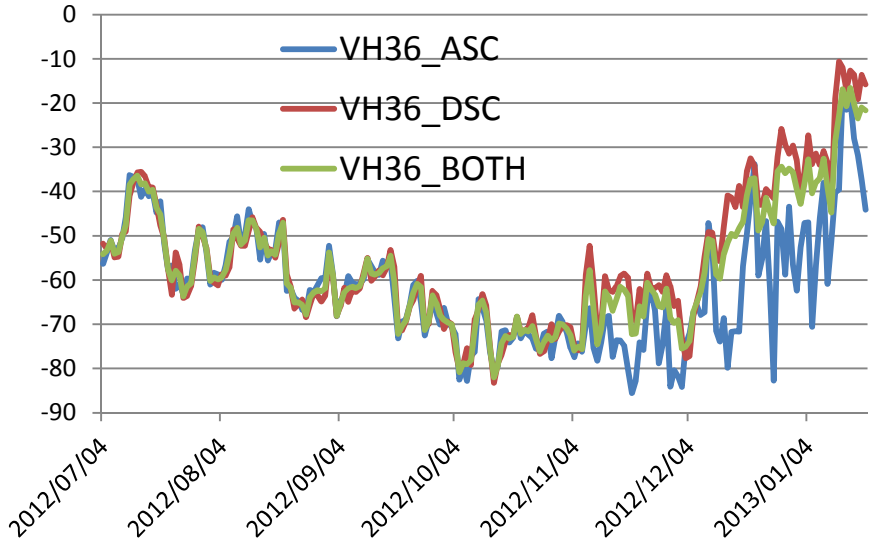



## V1836 Slope

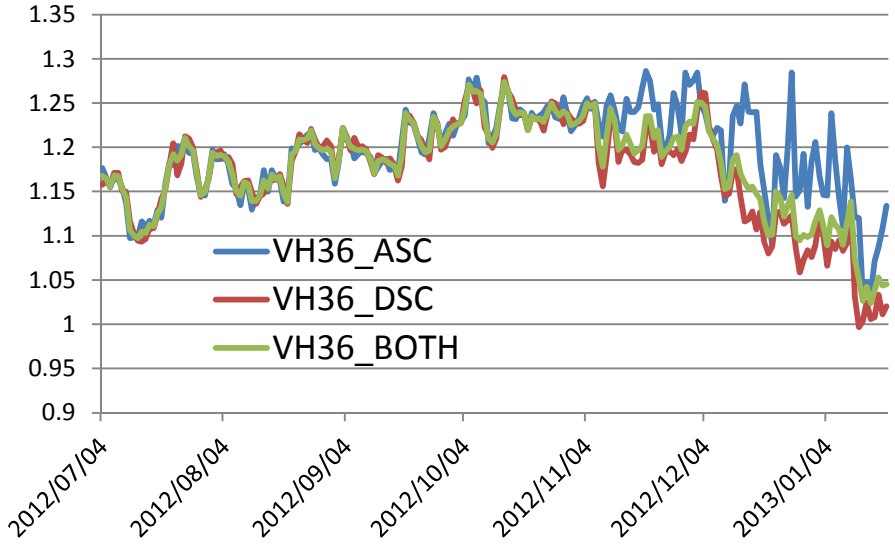


# ② Southern Hemisphere Tie Point Parameters

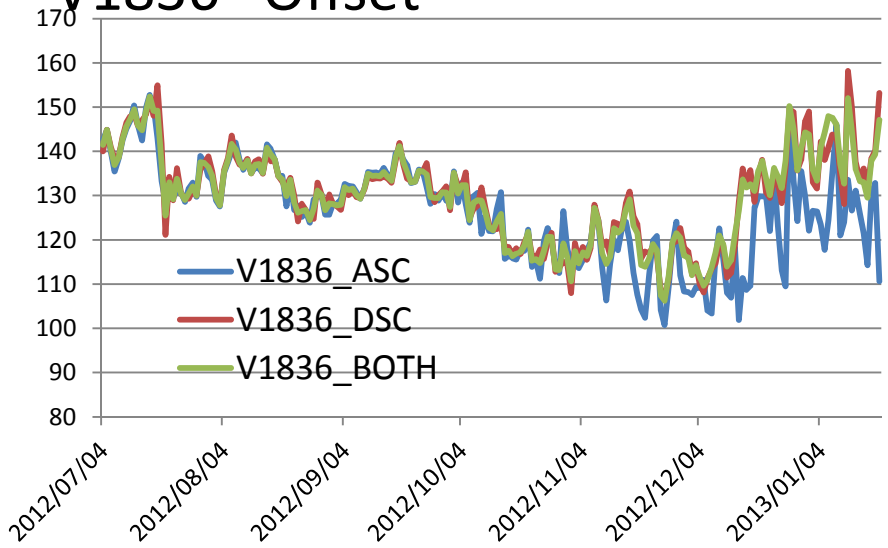
## VH36 Offset



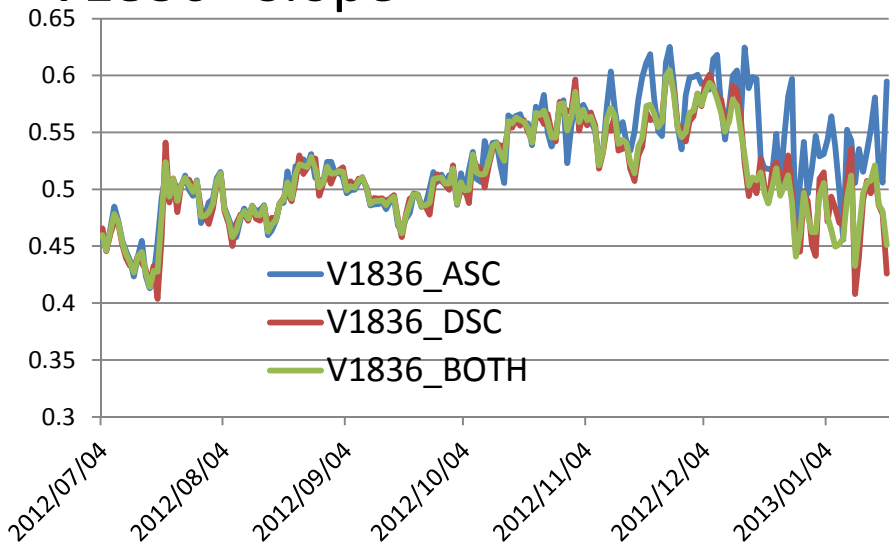

## VH36 Slope




## V1836 Offset

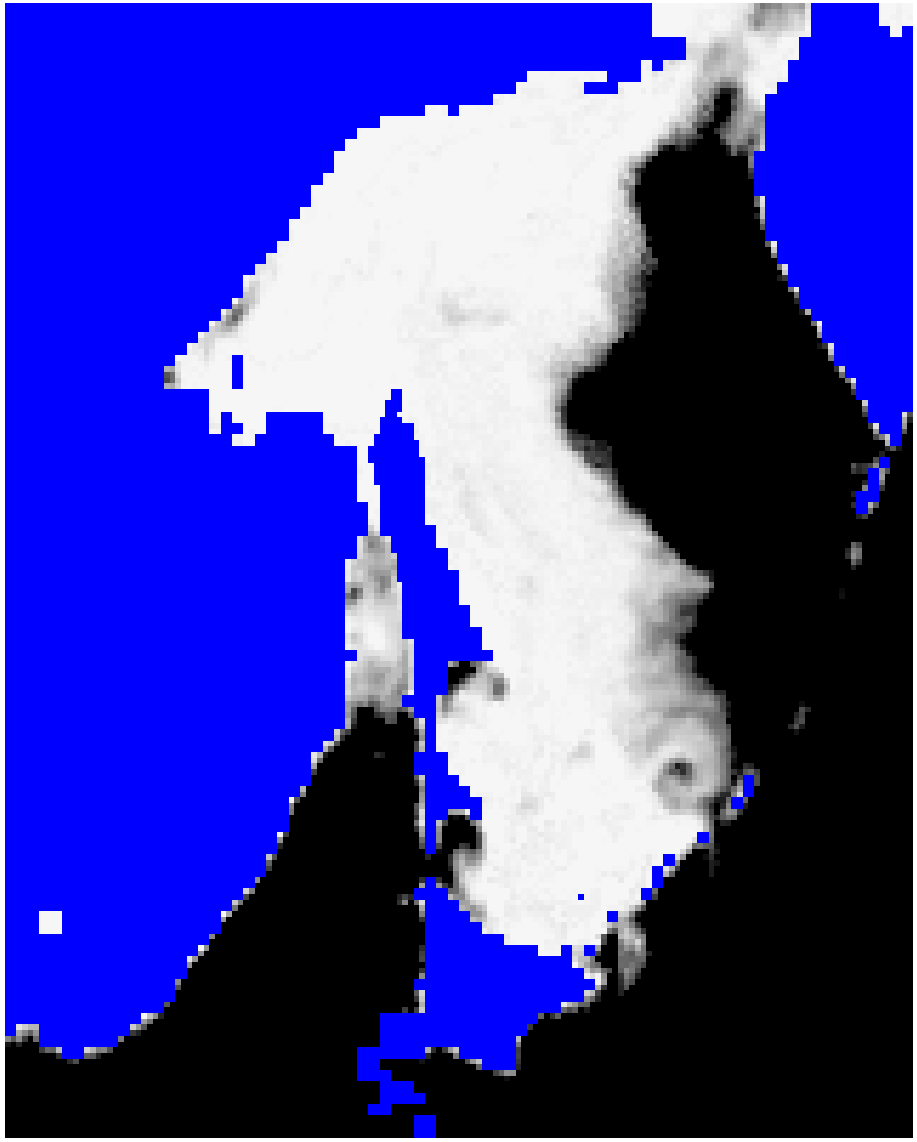



## V1836 Slope

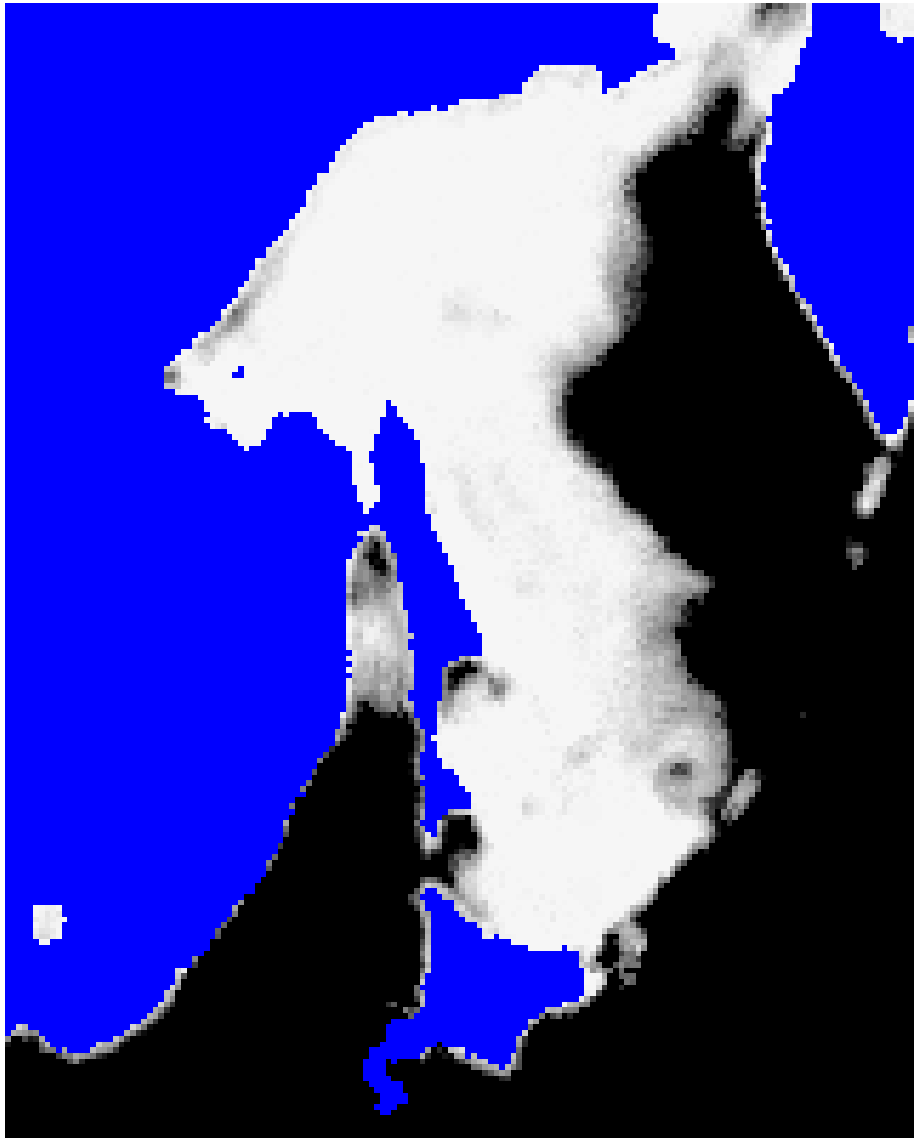


# Land Effect

21.Mar.2003



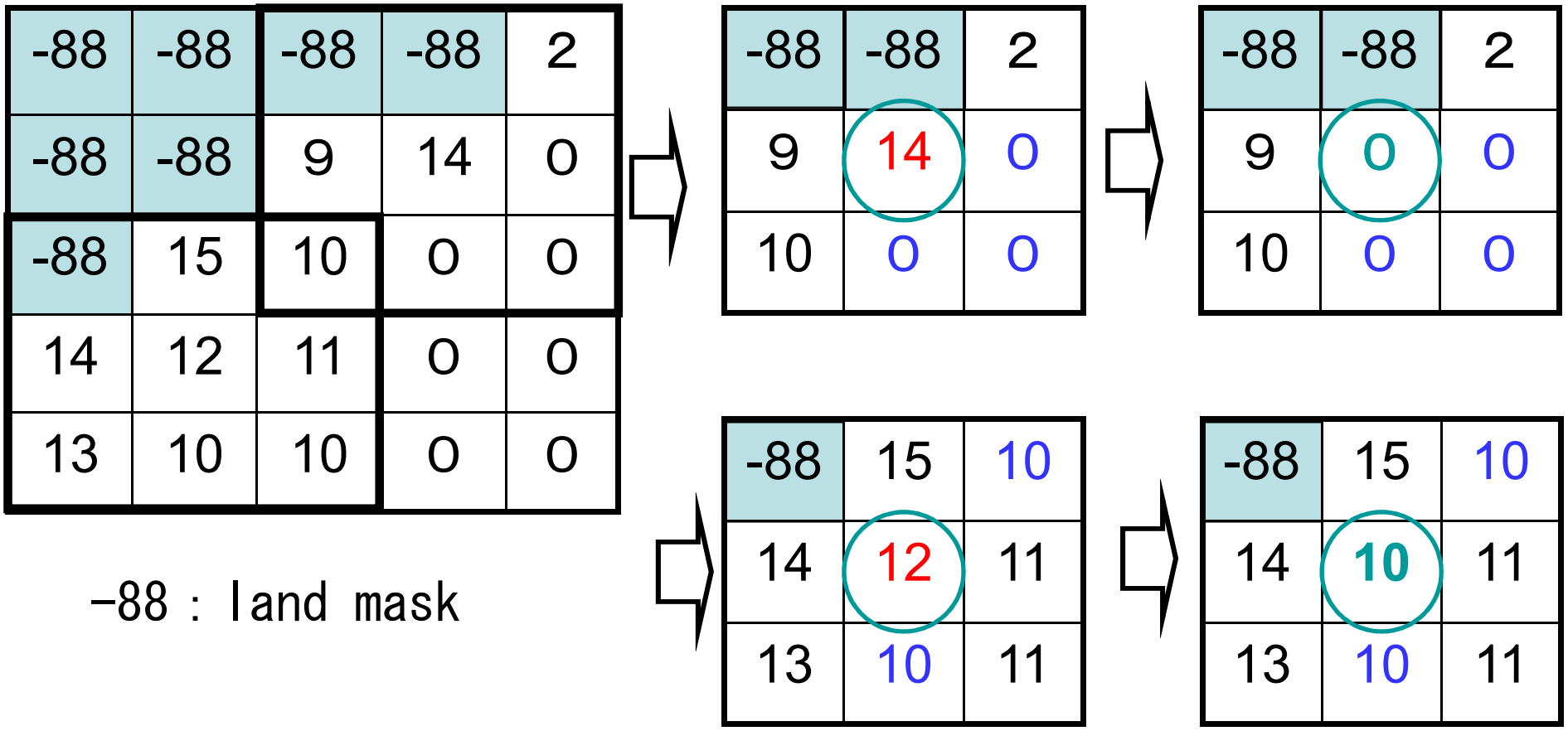
ABT



NASA Team2

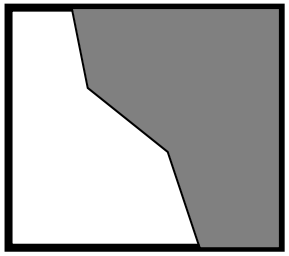
# (2) Land Filter

Land filter is a filter with a size of 3 x 3 pixels.
If at least one of the 3 x 3 pixels is land mask, then the ice concentration of the center pixel will be changed to the smallest ice concentration among the 3 x 3 pixels. (Cho et al., 1996)

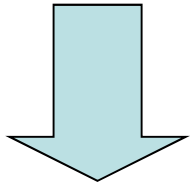


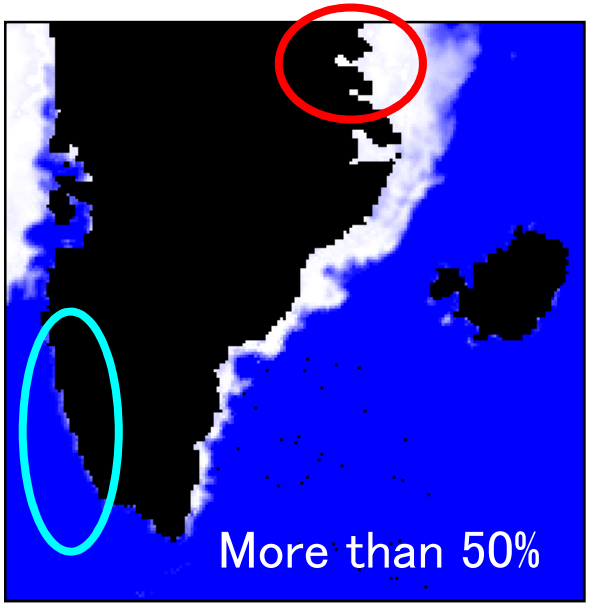
# (3) Land mask expansion

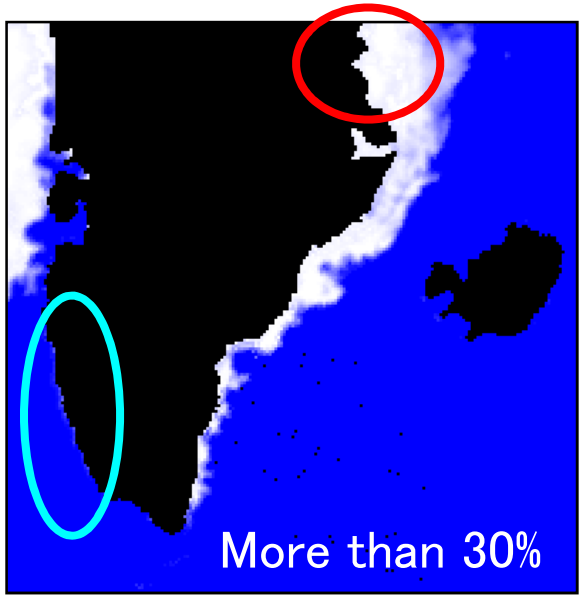
Greenland
March 15, 2003

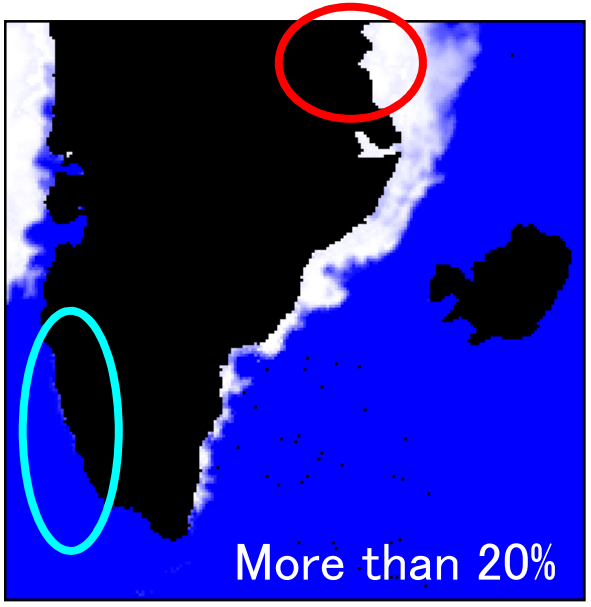


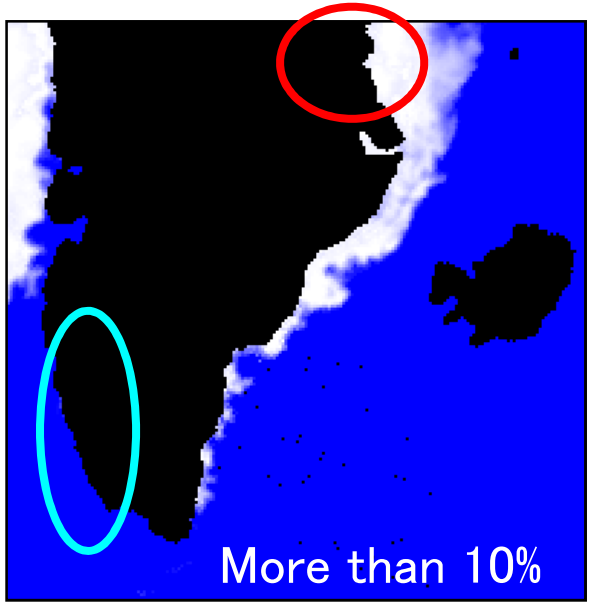
More than 50%





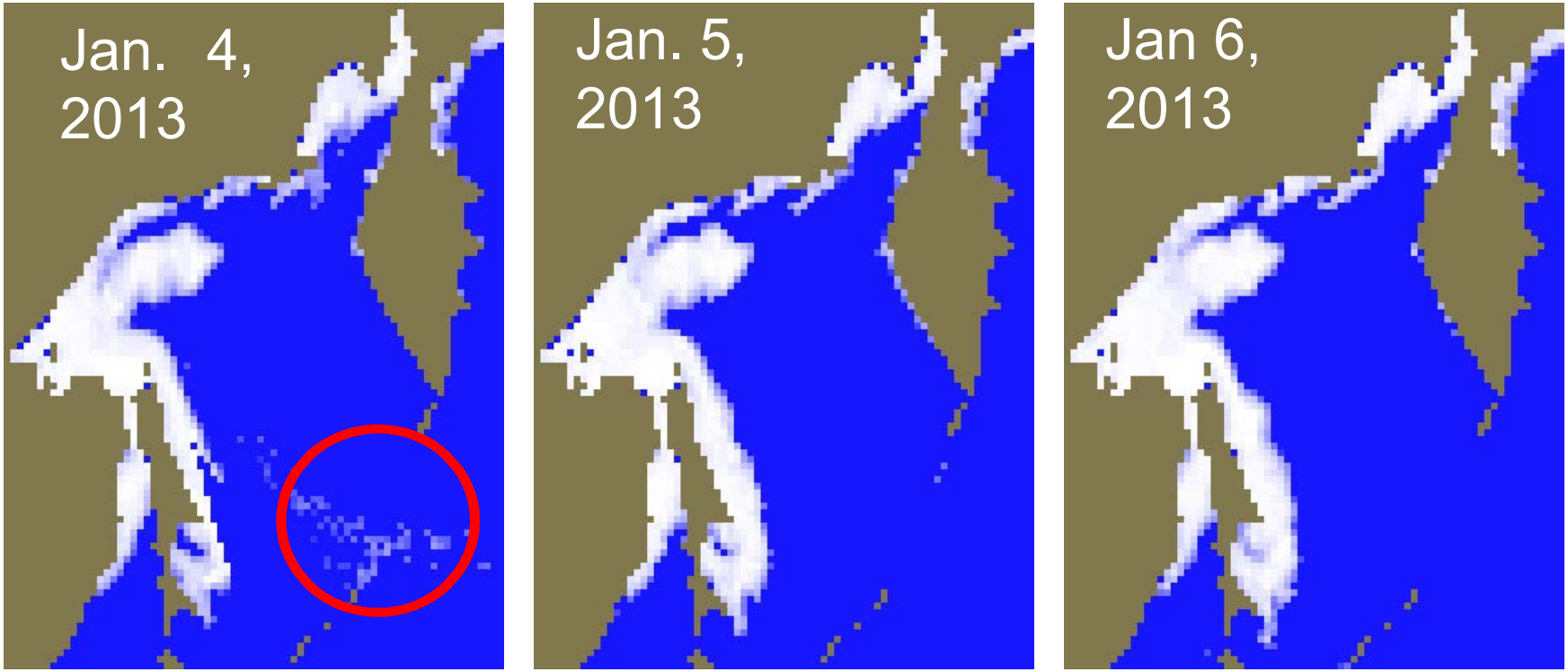



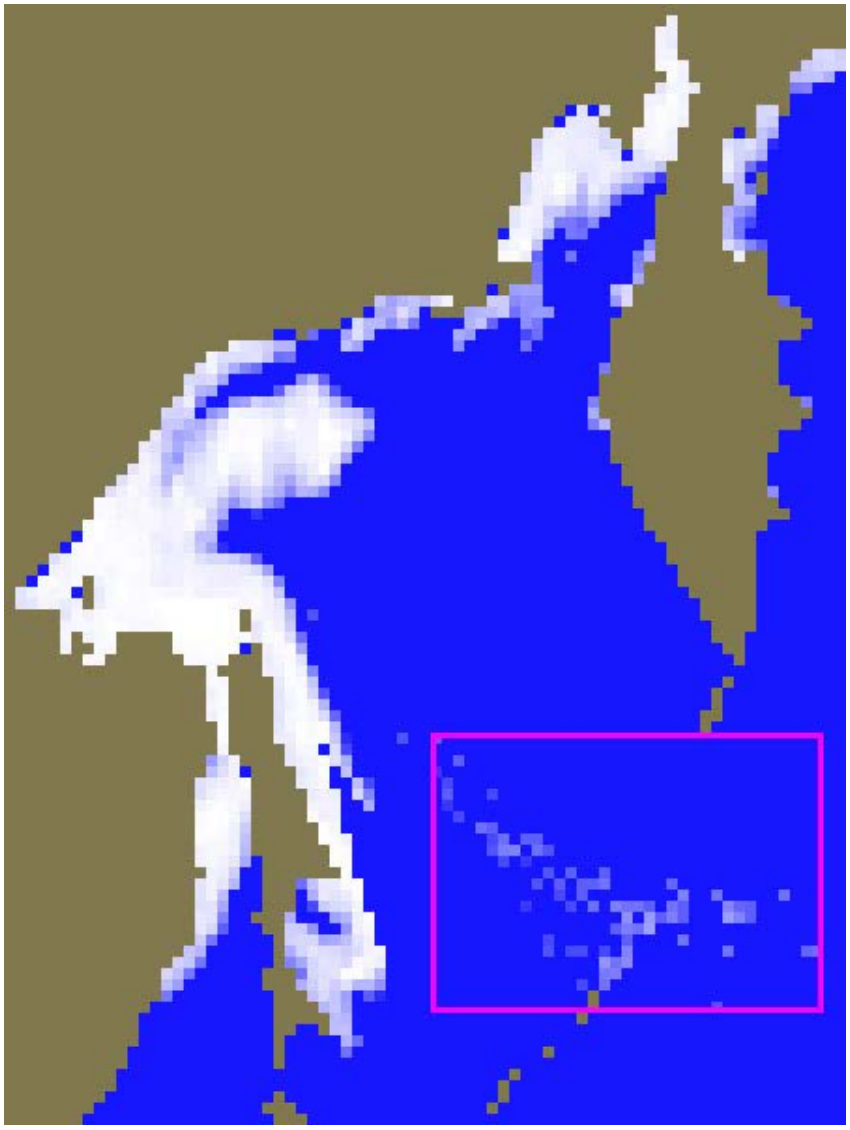
# (4) Weather Filter

- Due to the heavy cloud /water vapor etc, sometimes open water area are estimated as sea ice area.
- Reduction of the weather effects are necessary for improving the accuracy of calculating sea ice area.

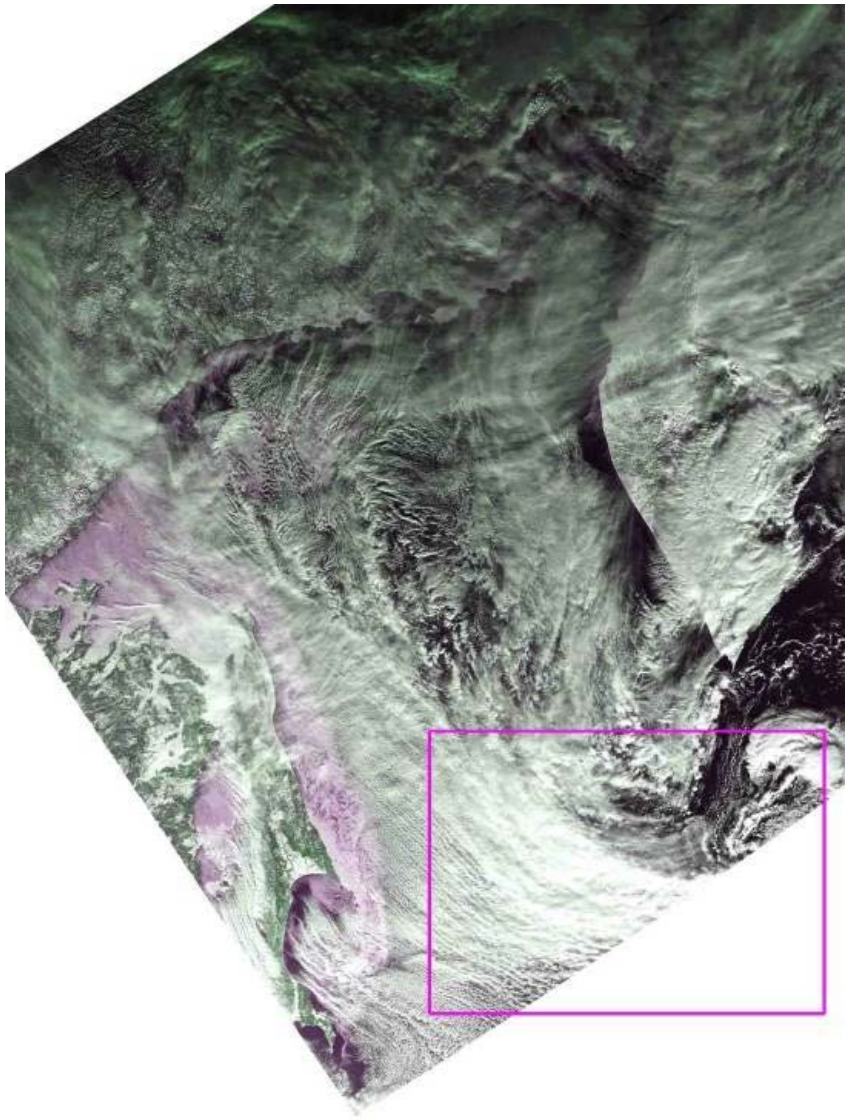



Sea ice concentration images (from AMSR2)

# AMSR2 and MODIS images(Jan. 4, 2013)



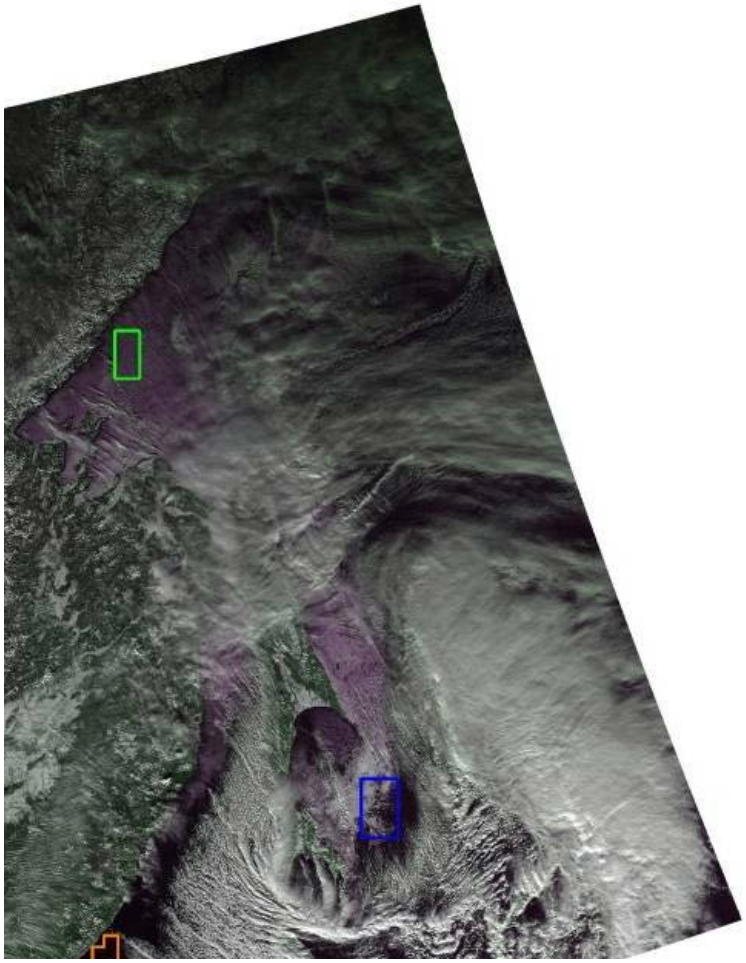
AMSR2 IC image



MODIS image

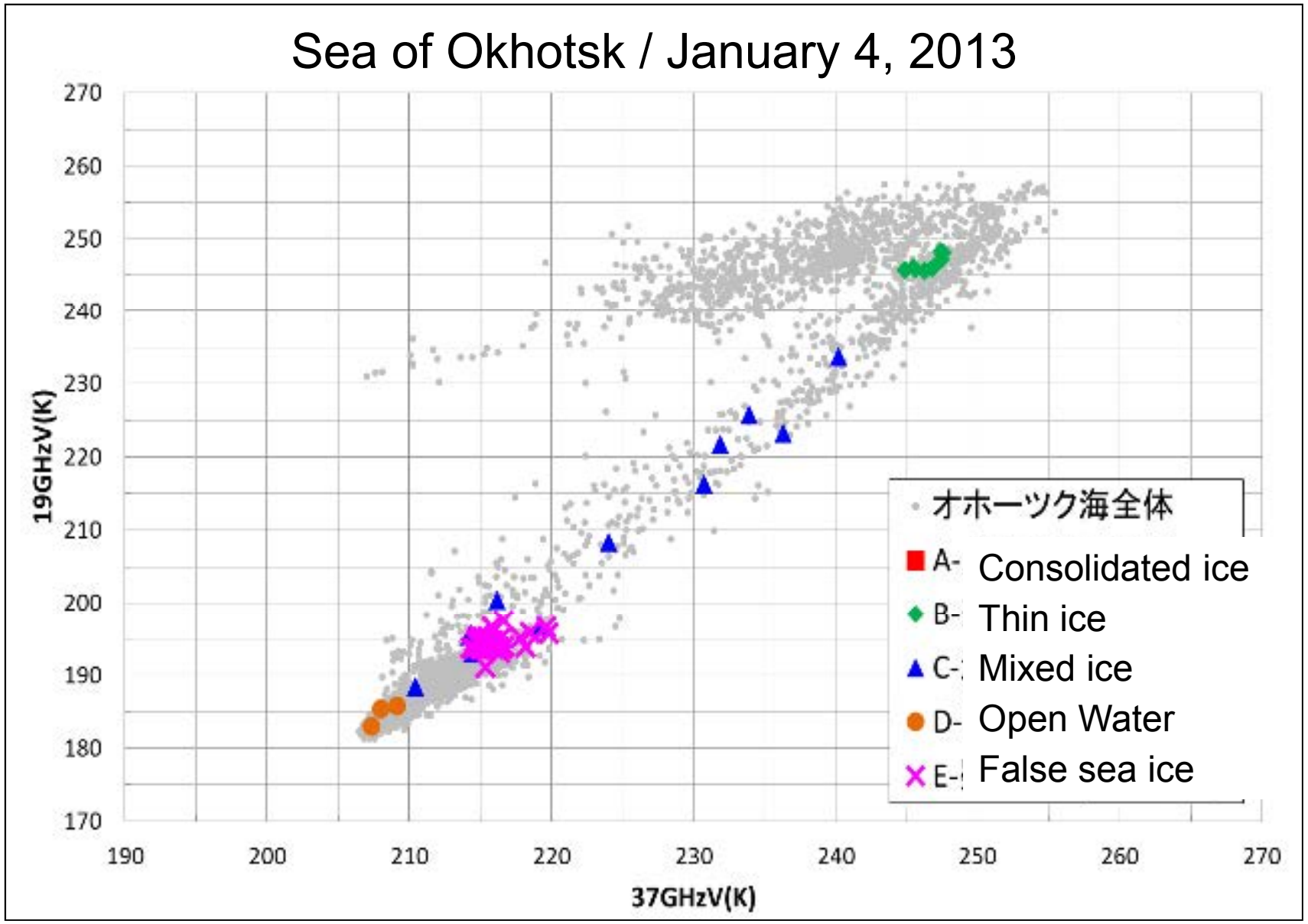
# AMSR2 and MODIS images(Jan. 6, 2013)

AMSR2 IC image

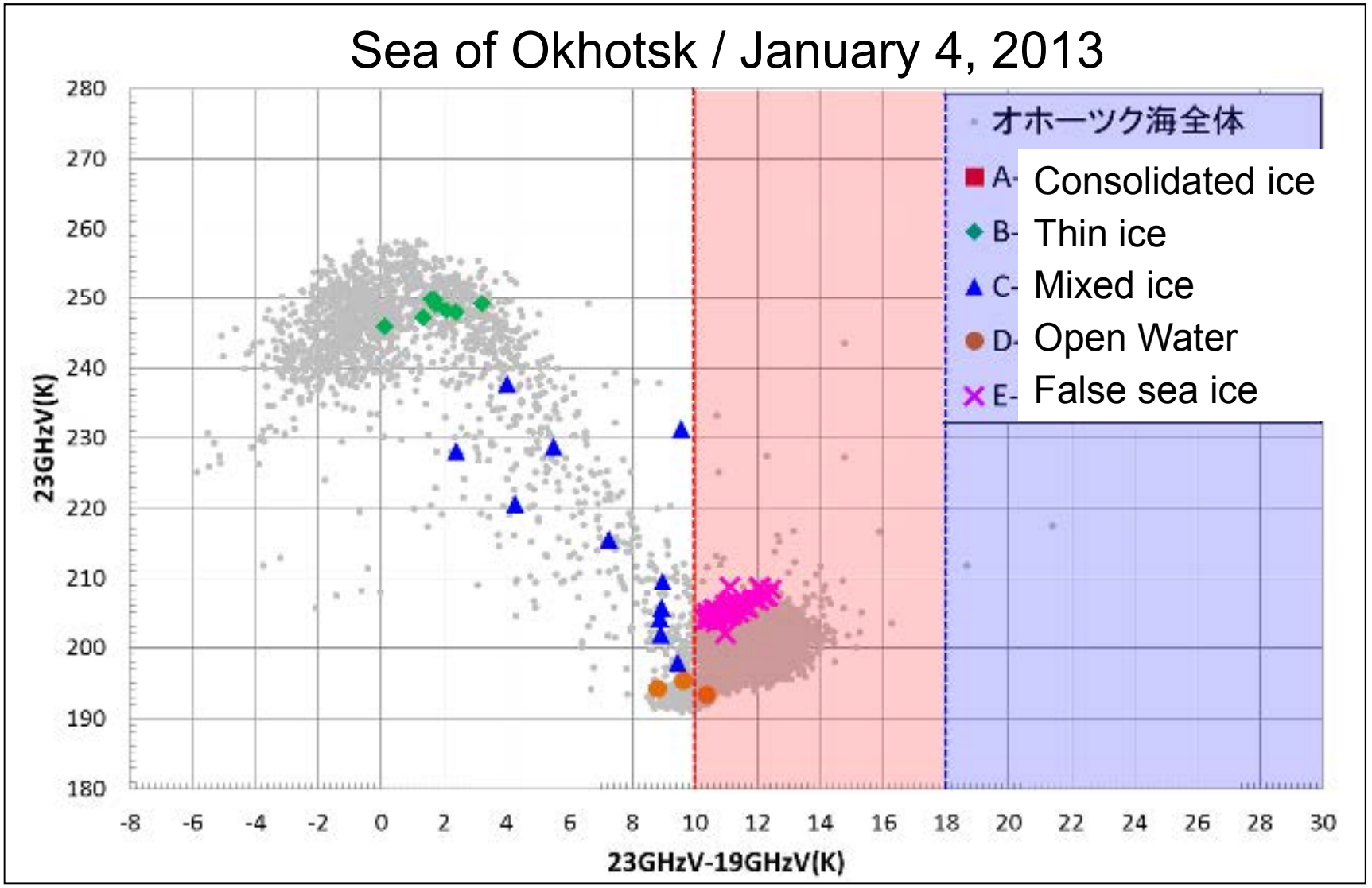


MODIS image

# ABT 37GHzV vs 19GHzV



# Weather Filter Adjustment



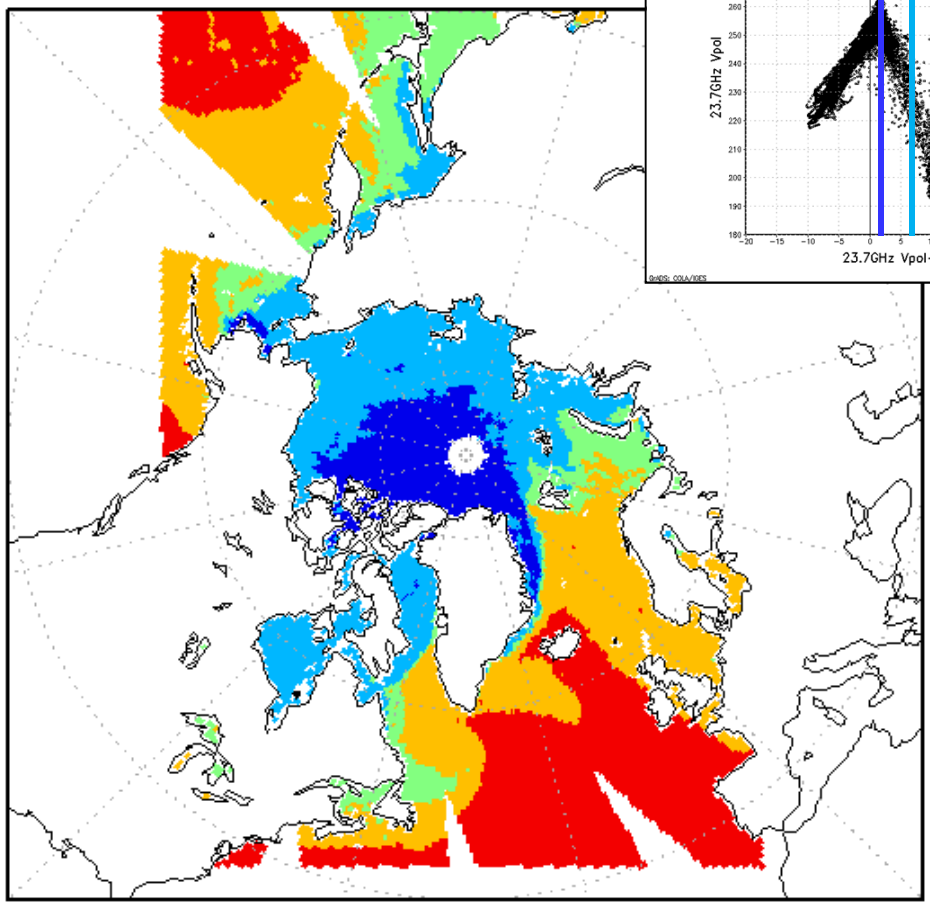

TB23V-TB19V>18K → 10K～12K

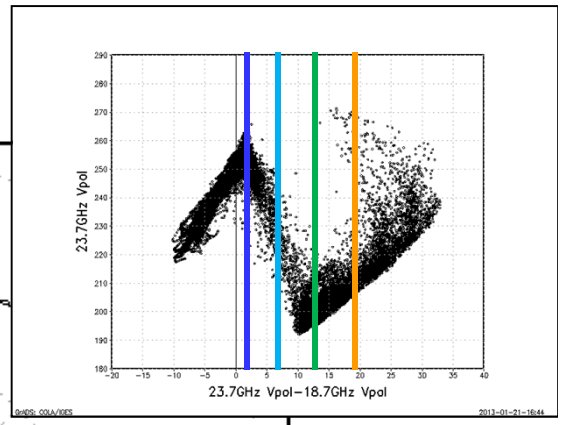
# Weather filter threshold evaluation for Northern Hemisphere(Jan. 15, 2013)

Ice concentration

GrADS: COLA/IGES

0% 100%



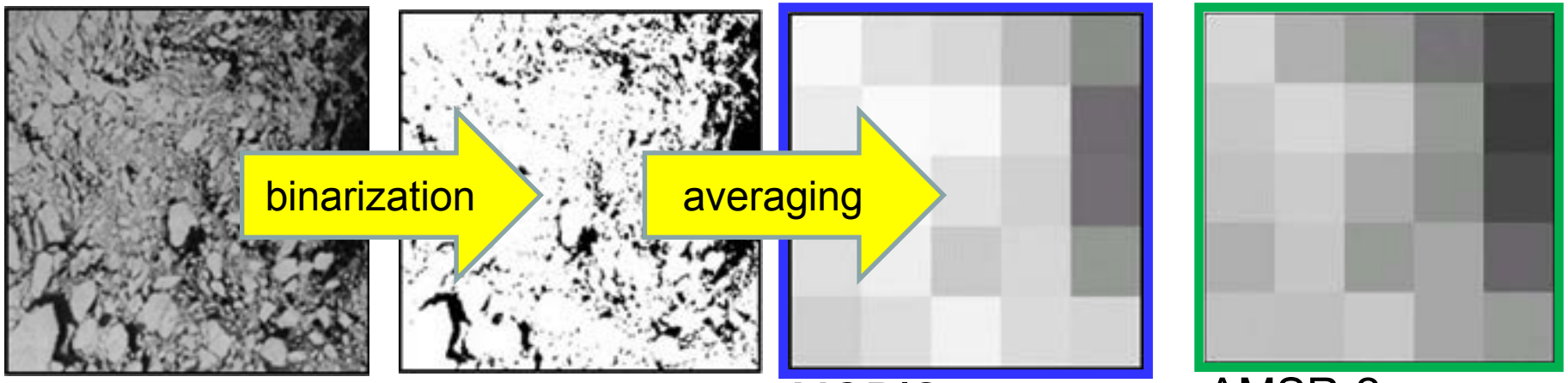



18
12
6
0

TB23V-TB19V>18K → 12K

01−21−16:48

# 4. Sea ice concentration validation with MODIS data



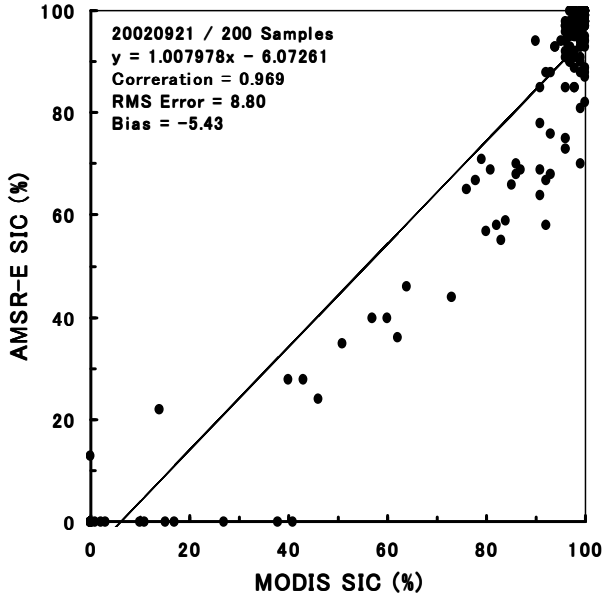

MODIS Ch1 data
IFOV=250m

Binarized data
IFOV=250m

MODIS
Ice Concentration
IFOV=25Km

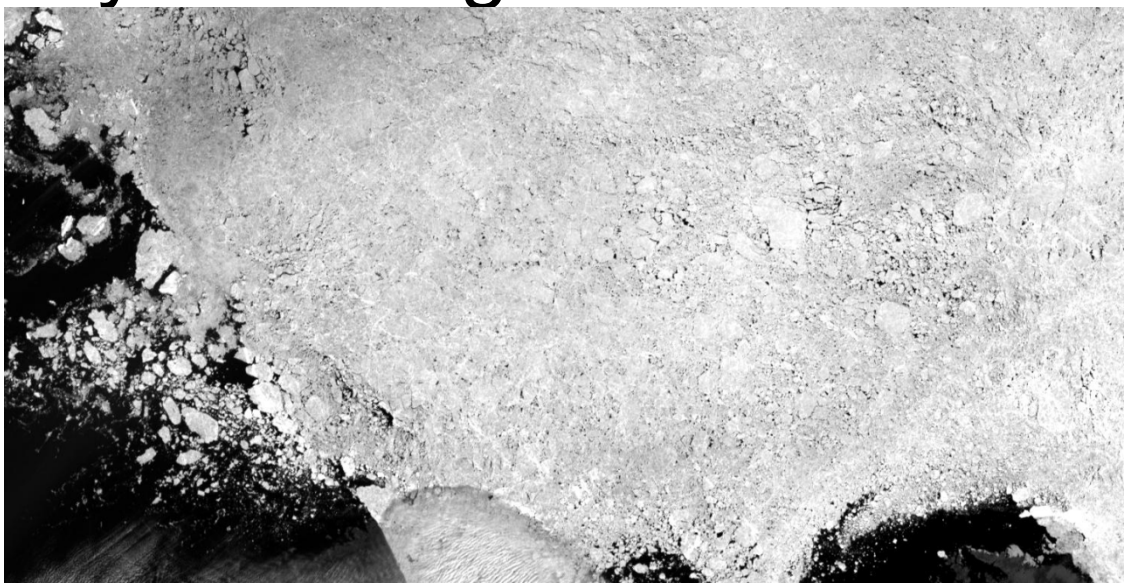
AMSR-2
Ice Concentration
IFOV=25Km

Antarctic : Amundsem Sea



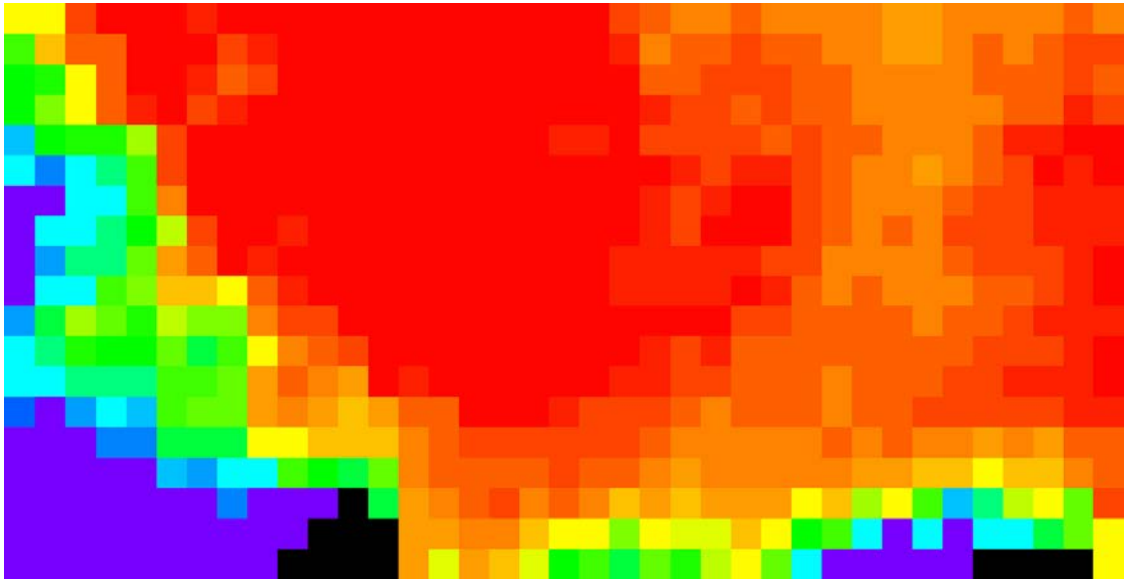

Comparison

# Difficulty of setting threshold level of binarization

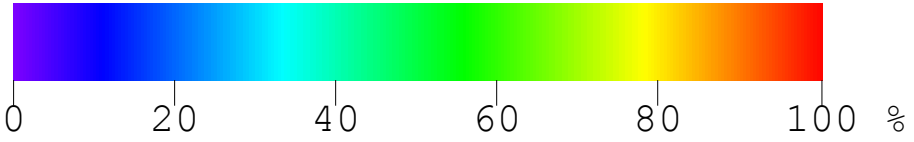


July 28, 2012
Archipelago
Islands

MODIS b1



AMSR2 IC



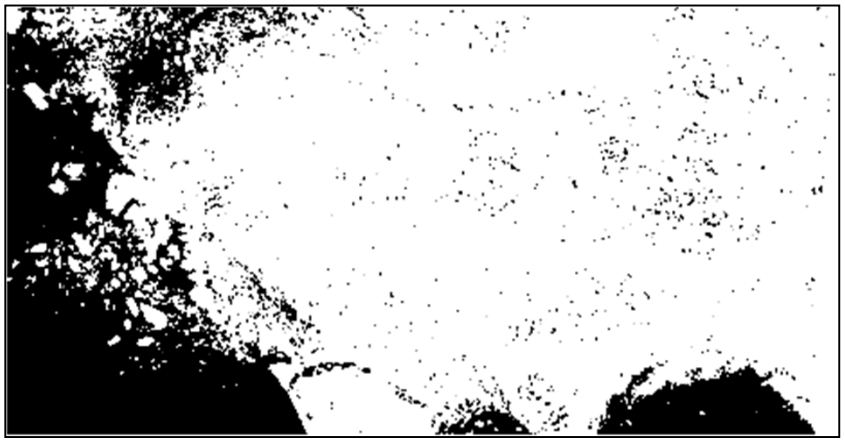
# Difficulty of setting threshold level of binarization

MODIS b1,  July 28, 2012  Archipelago Islands

**Original**

**Ice > ref 10%**

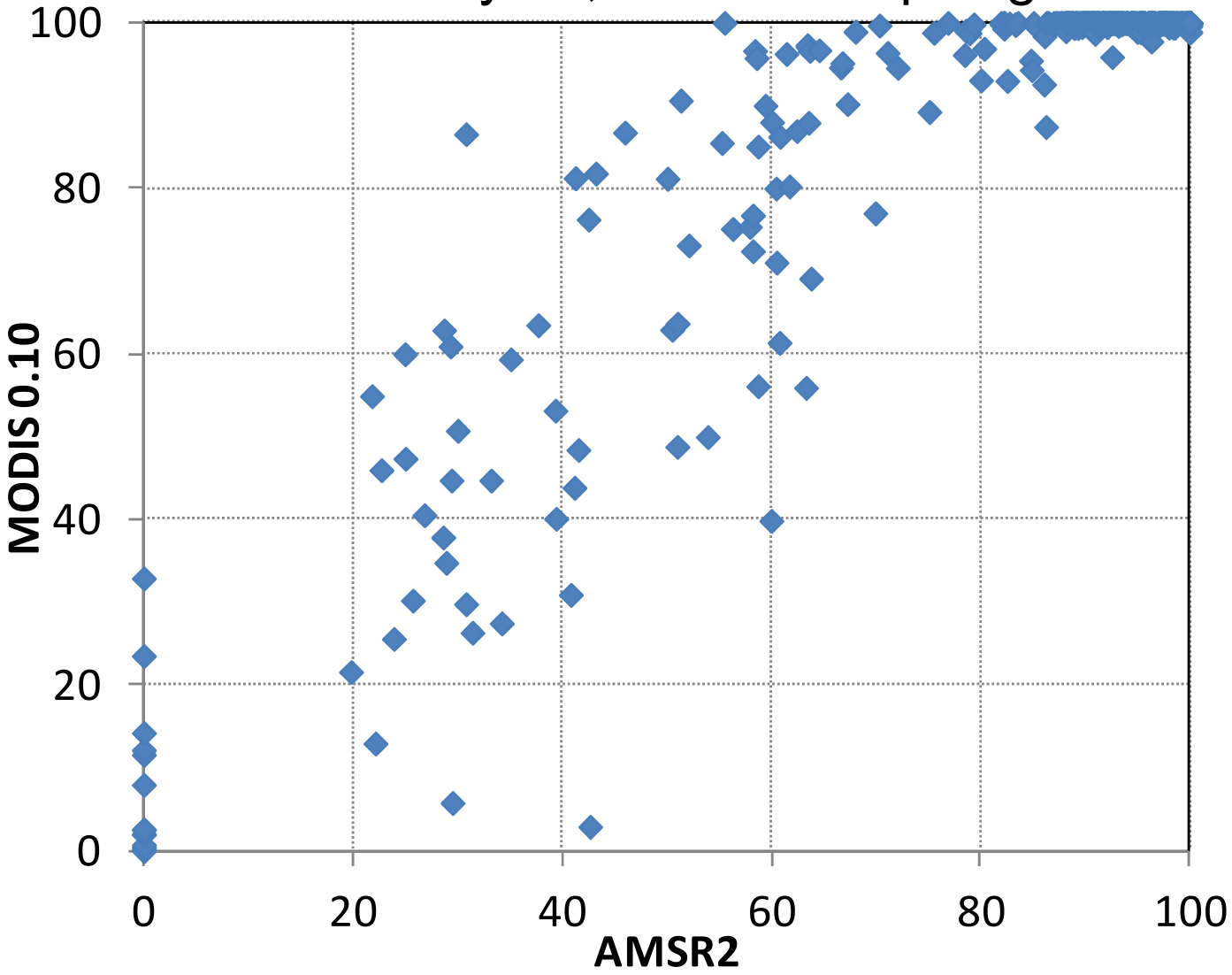
**Ice > ref 20%**



**Ice > ref 30%**

# AMSR2 vs. MODIS band1: 10%

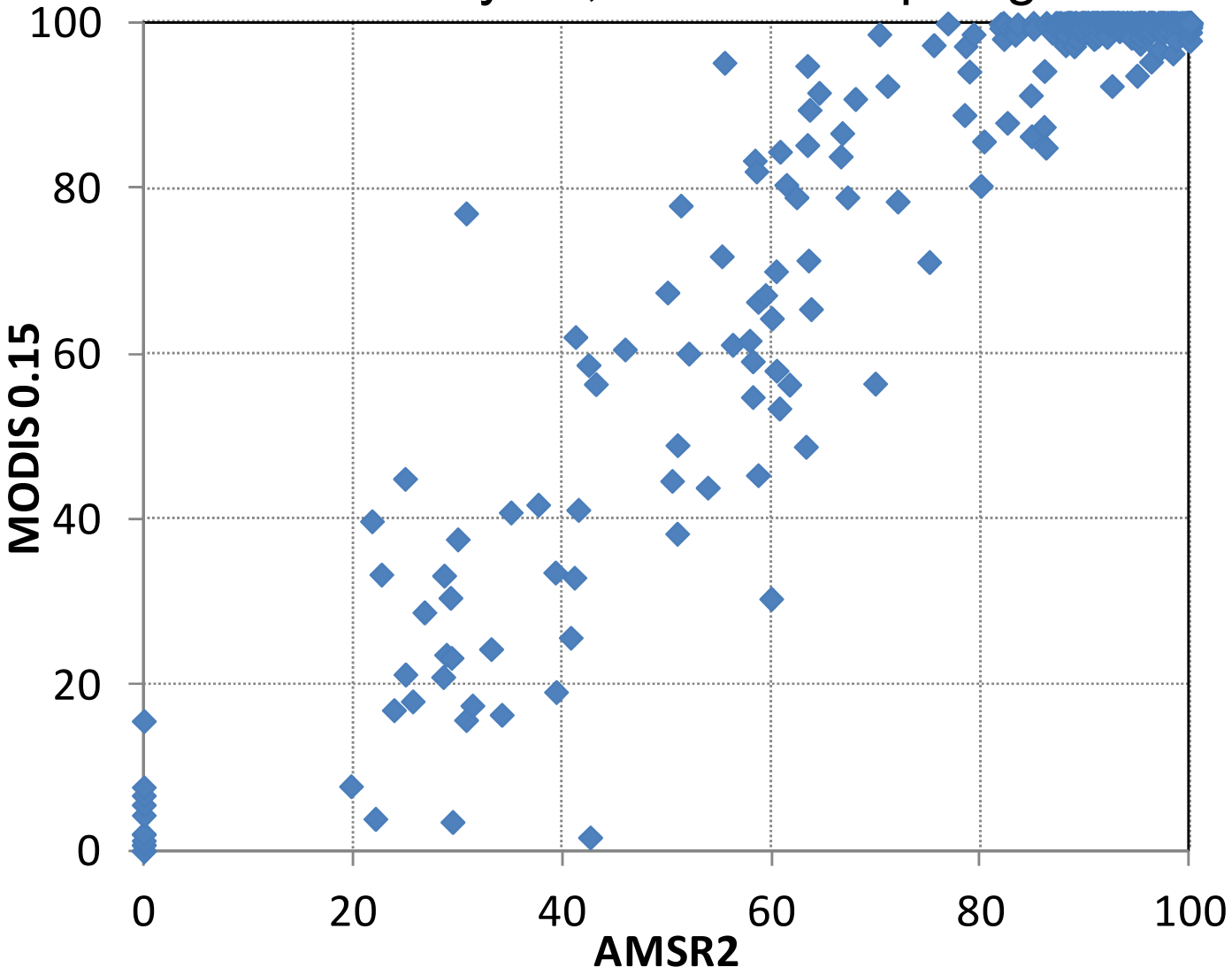
July 28, 2012 Archipelago Islands




| Bin | RMSE | N |
|---|---|---|
| 0-100% | 0.119 | 20 |
| 0- 25% | 0.961 | 27 |
| 25- 50% | 0.515 | 42 |
| 50- 75% | 0.309 | 42 |
| 75-100% | 0.071 | 503 |

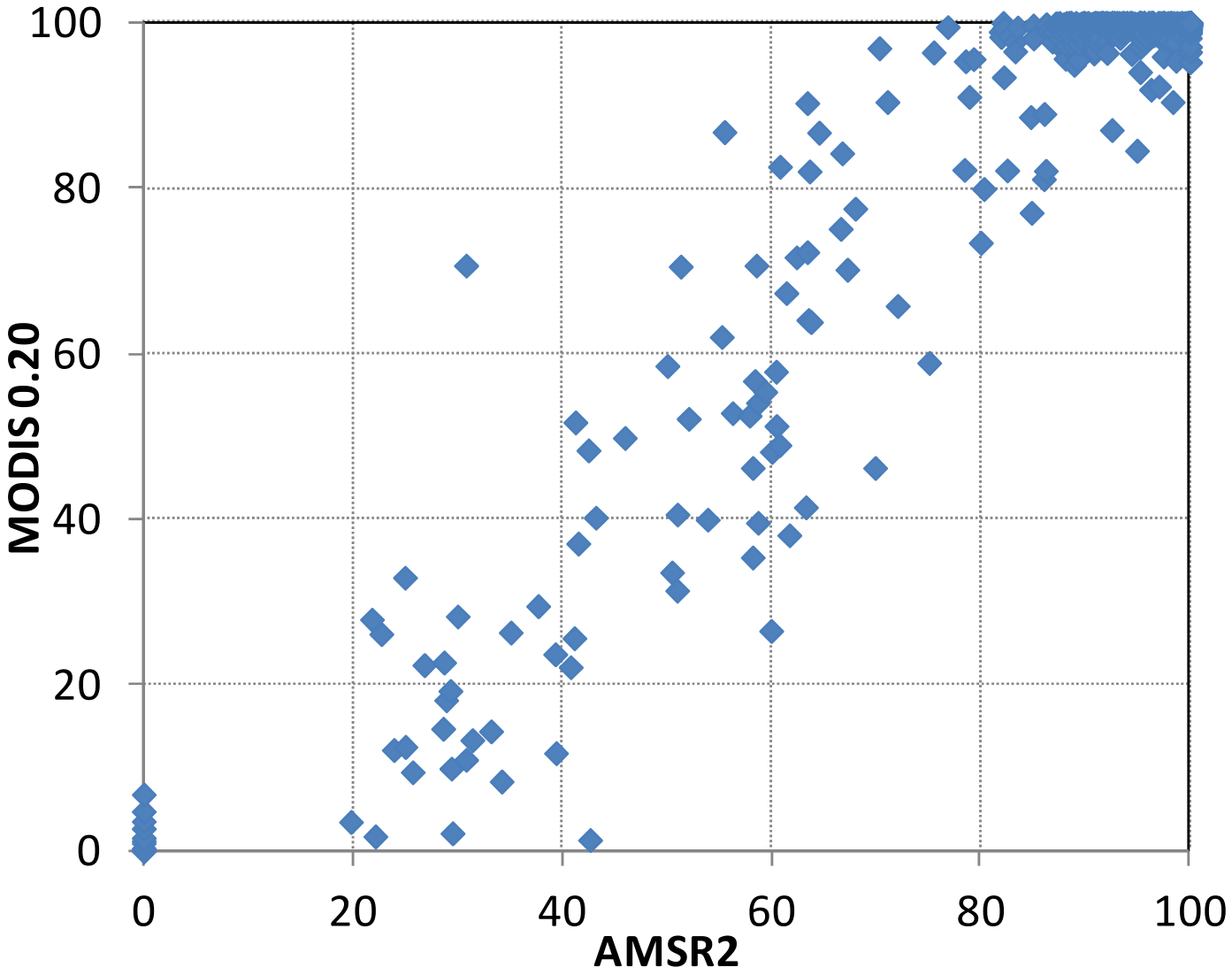
# AMSR2 vs. MODIS band1: 15%

July 28, 2012 Archipelago Islands




| Bin | RMSE | N |
|---|---|---|
| 0-100% | 0.095 | 592 |
| 5- 95% | 0.135 | 306 |
| 1-99% | 0.112 | 426 |
| 0- 25% | 0.972 | 27 |
| 25- 50% | 0.517 | 42 |
| 50- 75% | 0.252 | 42 |
| 75-100% | 0.067 | 503 |

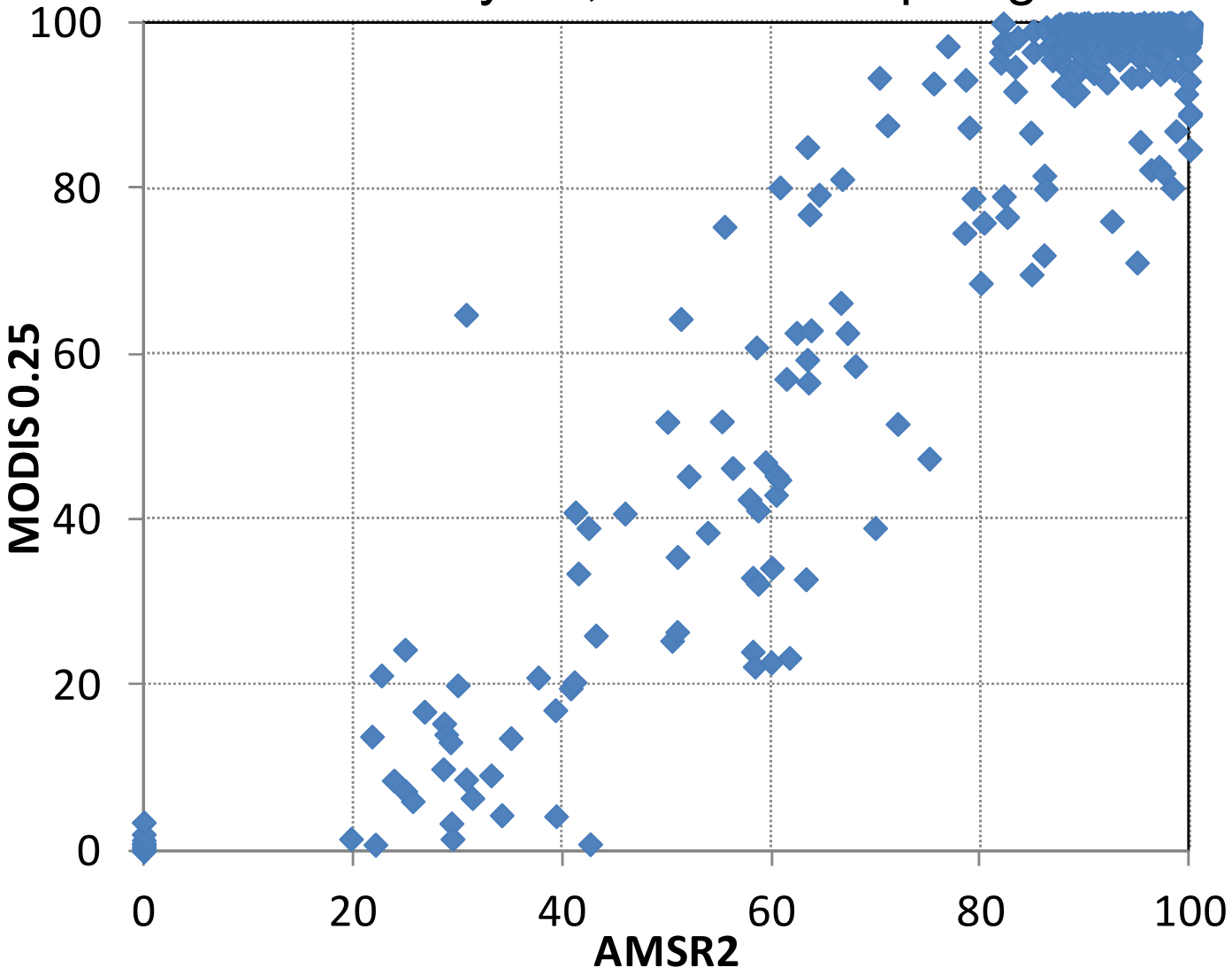
# AMSR2 vs. MODIS band1: 20%




| Bin | RMSE | N |
|---|---|---|
| 0-100% | 0.093 | 592 |
| 5-95% | 0.134 | 307 |
| 1-99% | 0.110 | 426 |
| | | |
| 0- 25% | 1.131 | 27 |
| 25- 50% | 0.761 | 42 |
| 50- 75% | 0.262 | 42 |
| 75-100% | 0.065 | 503 |

# AMSR2 vs. MODIS band1:25%

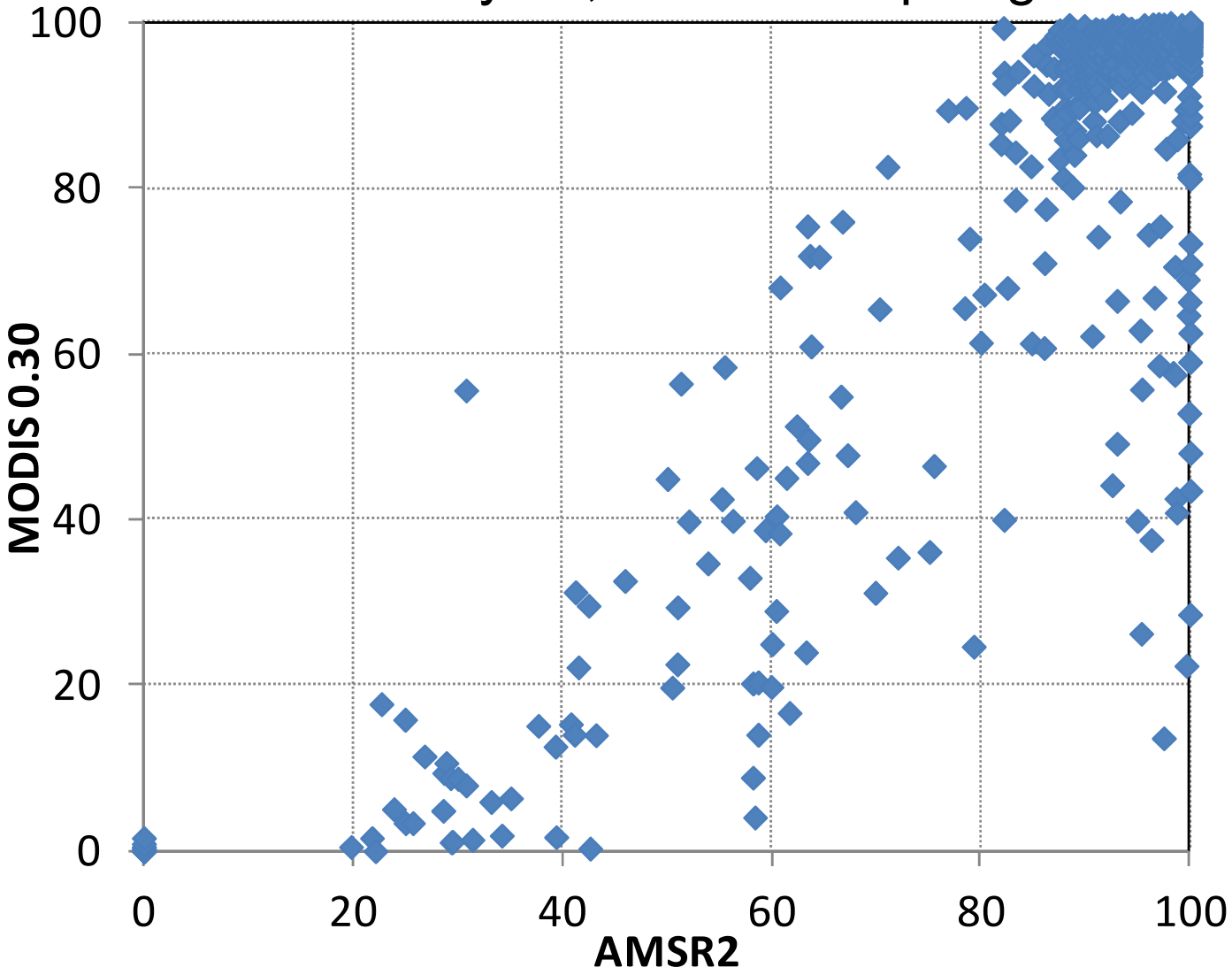
July 28, 2012 Archipelago Islands




| Bin | RMSE | N |
|---|---|---|
| 0-100% | 0.104 | 592 |
| 0- 25% | 1.866 | 27 |
| 25- 50% | 1.224 | 42 |
| 50- 75% | 0.378 | 42 |
| 75-100% | 0.064 | 503 |

# AMSR2 vs. MODIS band1:30%

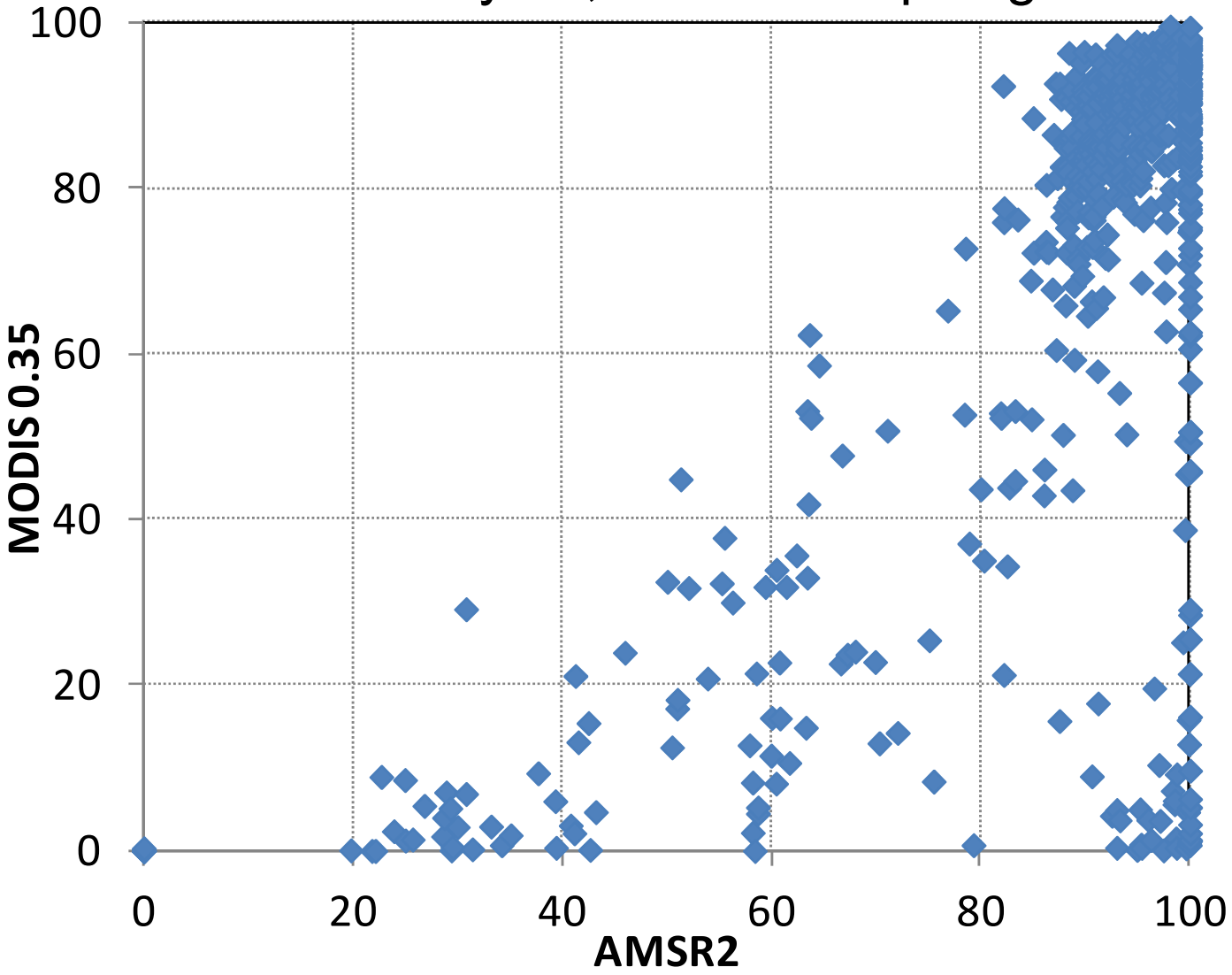
July 28, 2012 Archipelago Islands




| Bin | RMSE | N |
|---|---|---|
| 0-100% | 0.184 | 592 |
| 0- 25% | 4.183 | 27 |
| 25- 50% | 2.053 | 42 |
| 50- 75% | 0.627 | 42 |
| 75-100% | 0.143 | 503 |

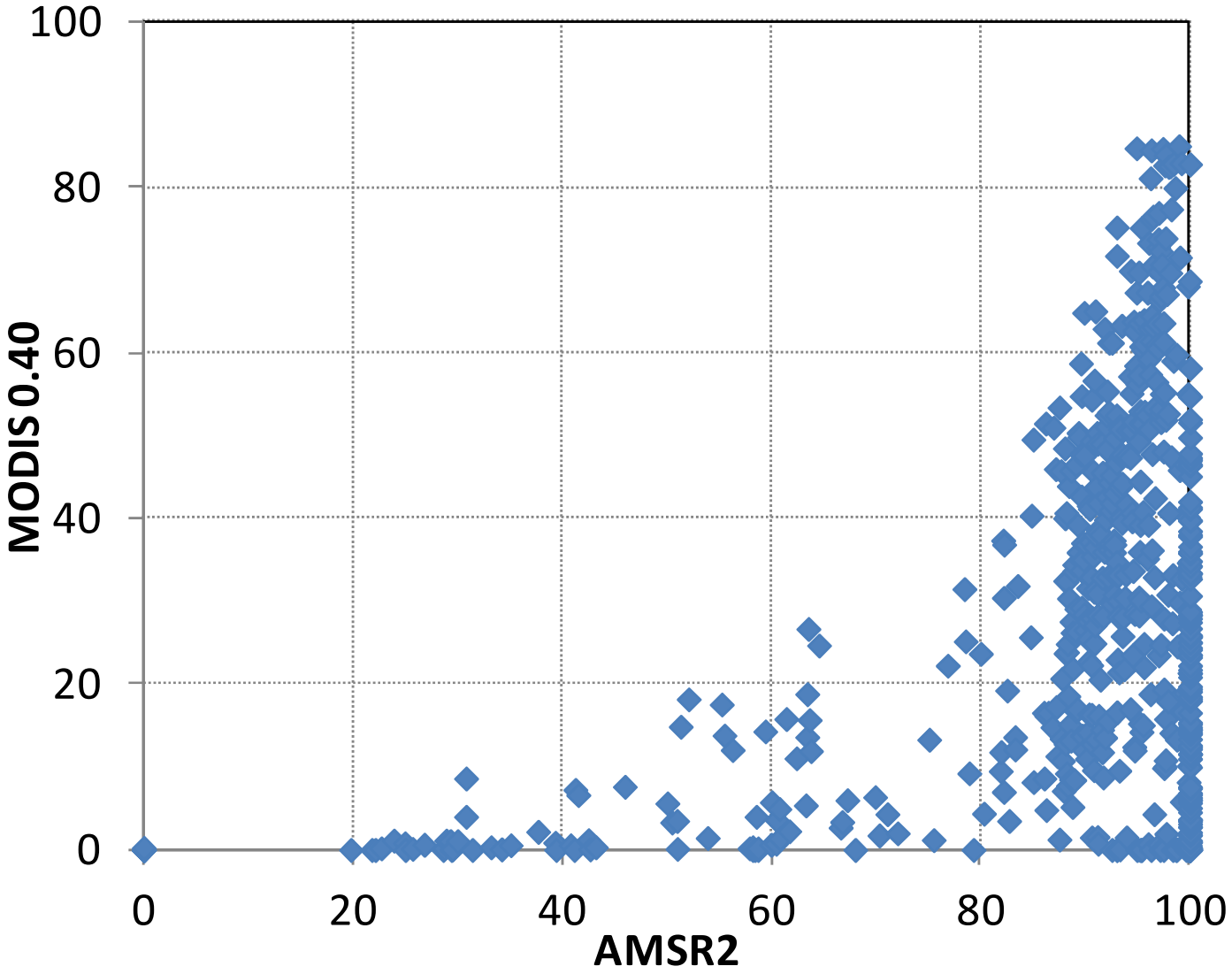
# AMSR2 vs. MODIS band1:35%

July 28, 2012 Archipelago Islands



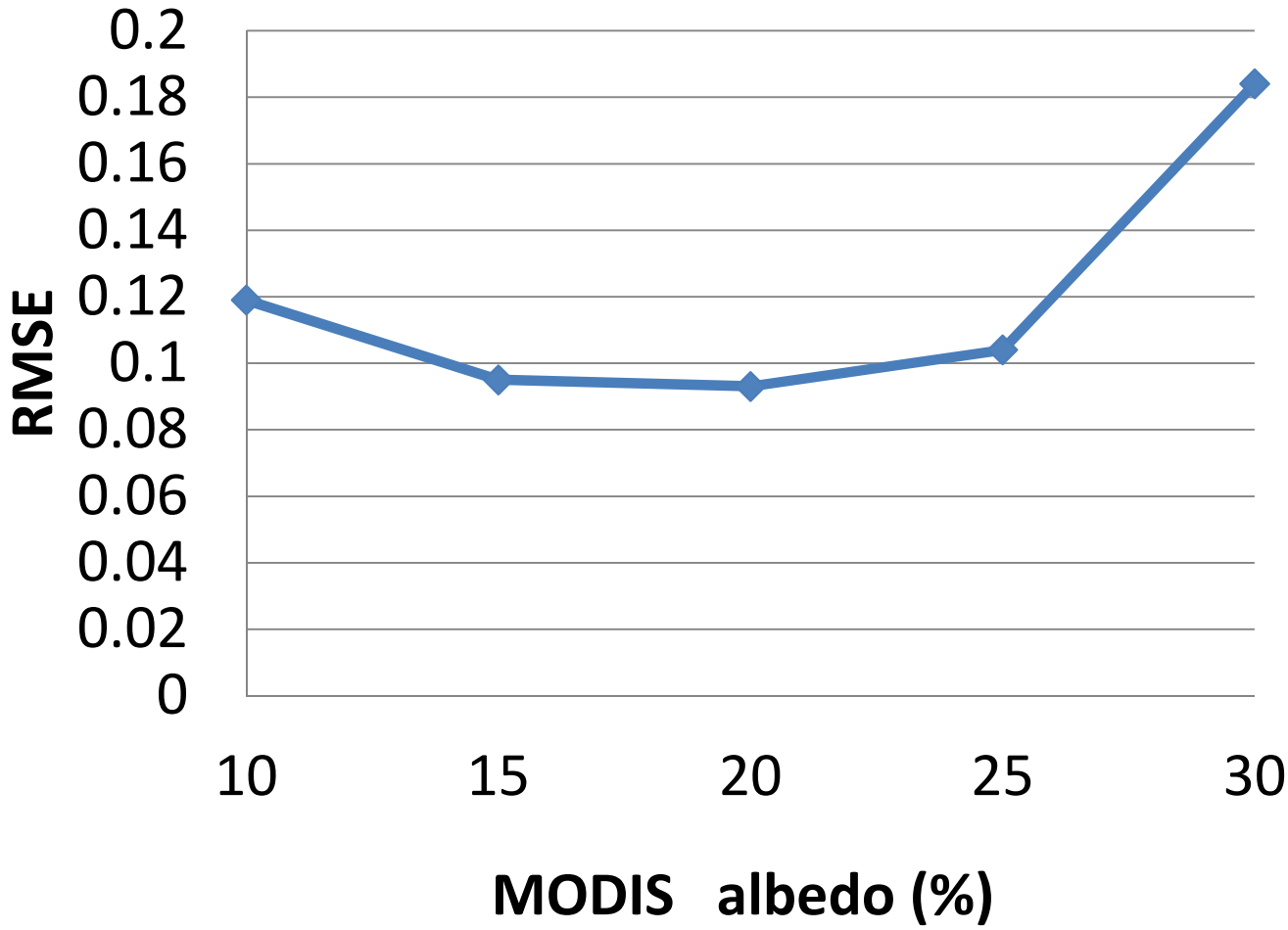

| Bin | RMSE | N |
|---|---|---|
| 0-100% | 0.464 | 592 |
| 0- 25% | 10.37 | 27 |
| 25- 50% | 4.645 | 42 |
| 50- 75% | 1.471 | 42 |
| 75-100% | 0.407 | 503 |

# AMSR2 vs. MODIS band1:40%



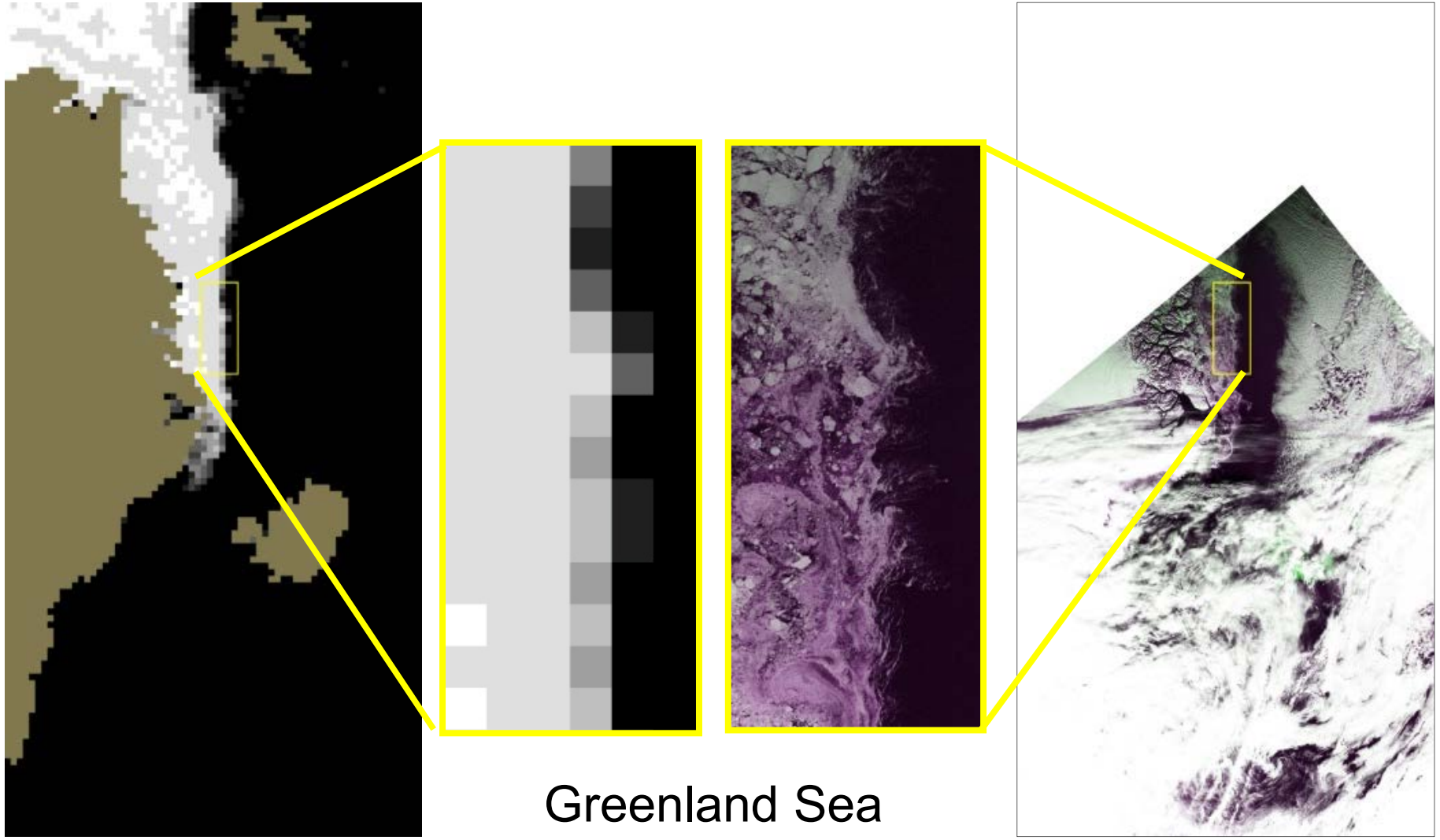

| Bin | RMSE | N |
|---|---|---|
| 0-100% | 2.333 | 592 |
| 0- 25% | 102.5 | 27 |
| 25- 50% | 20.28 | 42 |
| 50- 75% | 7.608 | 42 |
| 75-100% | 2.125 | 503 |

# MODIS albedo threshold level evaluation for extracting sea ice area




July 28, 2012 Archipelago Islands

# Ice concentration validation with MODIS data

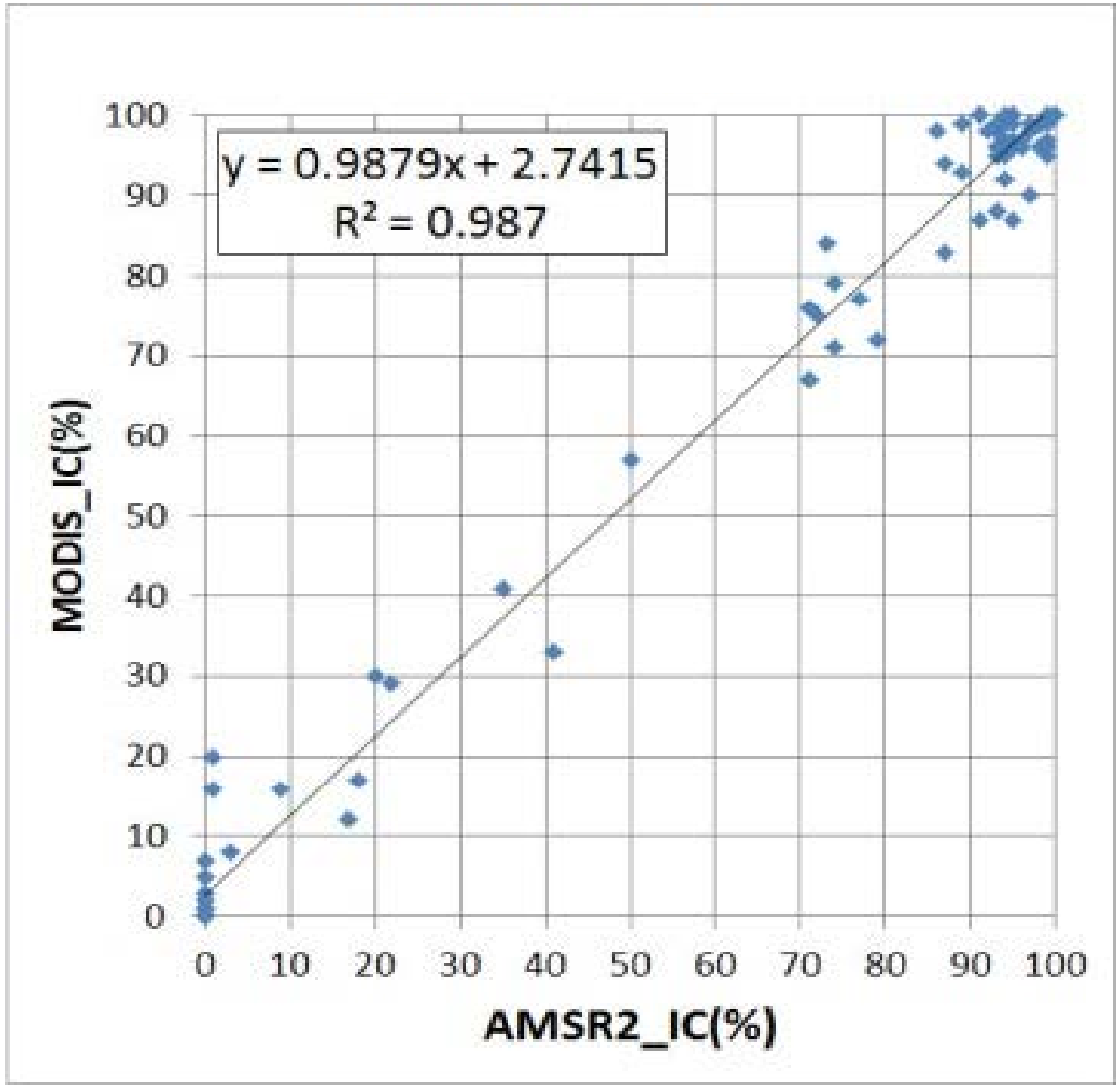


AMSR2

Greenland Sea
October 23, 2012

MODIS

# Ice concentration comparison of MODIS and ASMR2

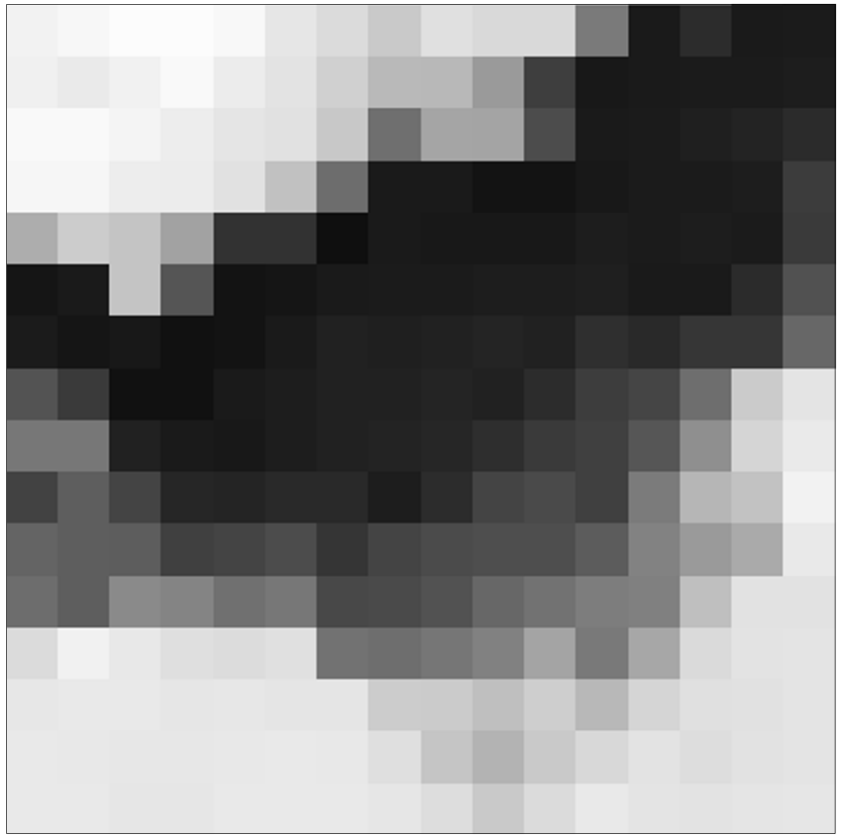



Greenland Sea
October 23, 2012

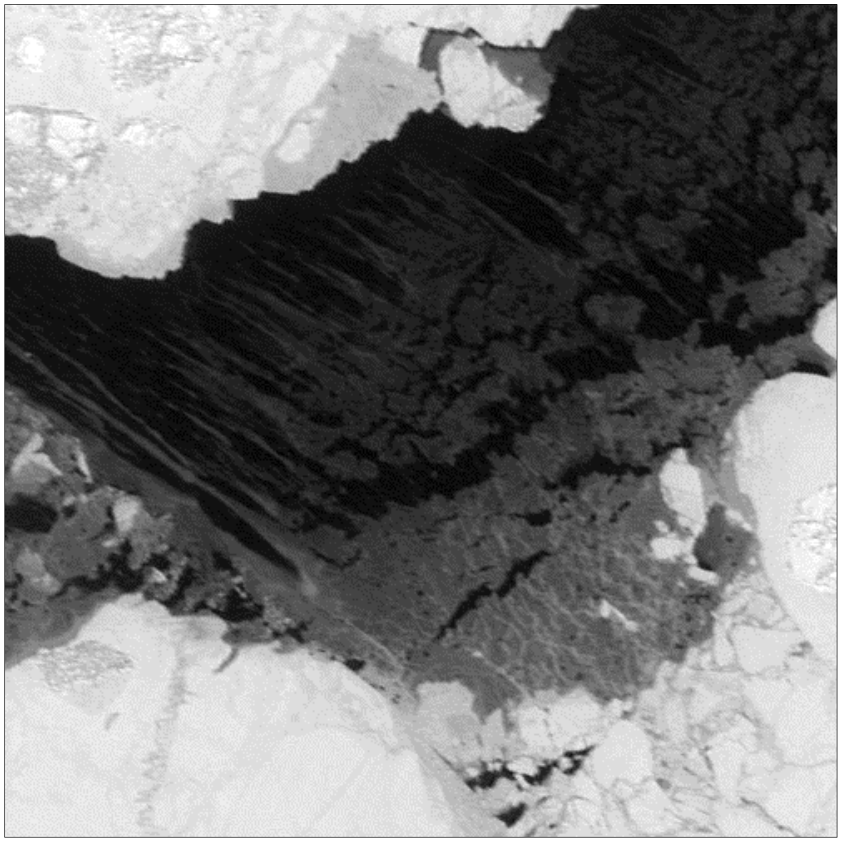
# Specifications of RSI and MODIS

| Sensor | Band | Wavelength | IFOV | Swath |
|---|---|---|---|---|
| RSI (FORMOSAT2) | PAN | 0.45-0.90μm | 2m | 24km |
| | 1 | 0.45-0.52μm | 8m | |
| | 2 | 0.52-0.60μm | | |
| | 3 | 0.63-0.69μm | | |
| | 4 | 0.76-0.90μm | | |
| MODIS (Aqua) | 1 | 0.620-0.670μm | 250m | 2330km |
| | 2 | 0.841-0.876μm | | |

# Comparison of MODIS and RSI images
# February 9, 2012



(a) MODIS Band1



(b) RSI Band3

Best threshold level  for extracting “open water” from MODIS data does not mean the open water area are really extracted.

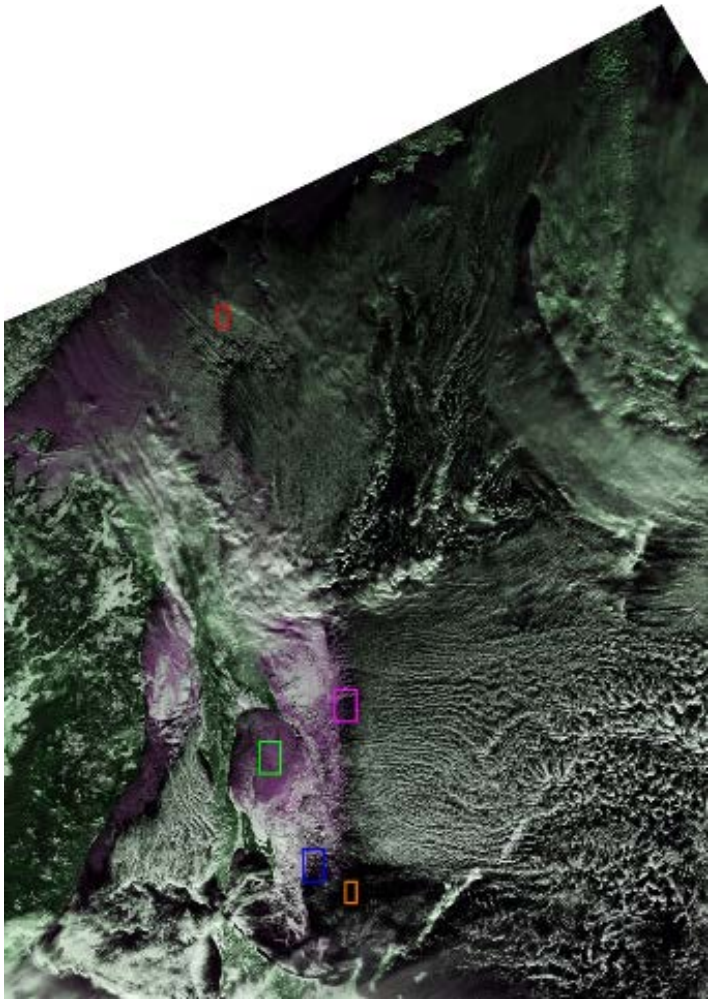
# 5. Thin ice algorithm development

〈 Preconditions 〉

- Utilize MODIS data for extracting “thin sea ice” for validation.
- Considering the difficulty of discriminating thin sea ice from thick sea ice in the low ice concentration areas, we try to extract only the sea ice area with 90% or higher sea ice concentration.
- The target will be focused only to seasonal sea ice zones to reject the influence of multi-year ice.

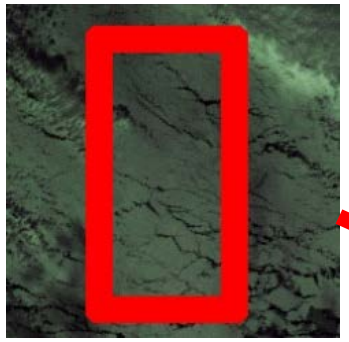
# Comparison of AMSR2 and MODIS images

AMSR2 IC image



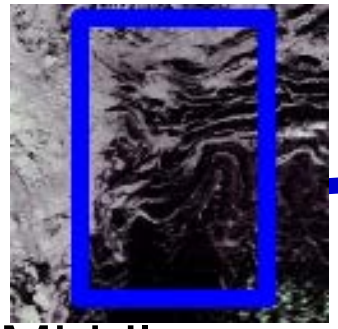
MODIS image
(Ch1:R&B Ch2:G)

# Test area extraction

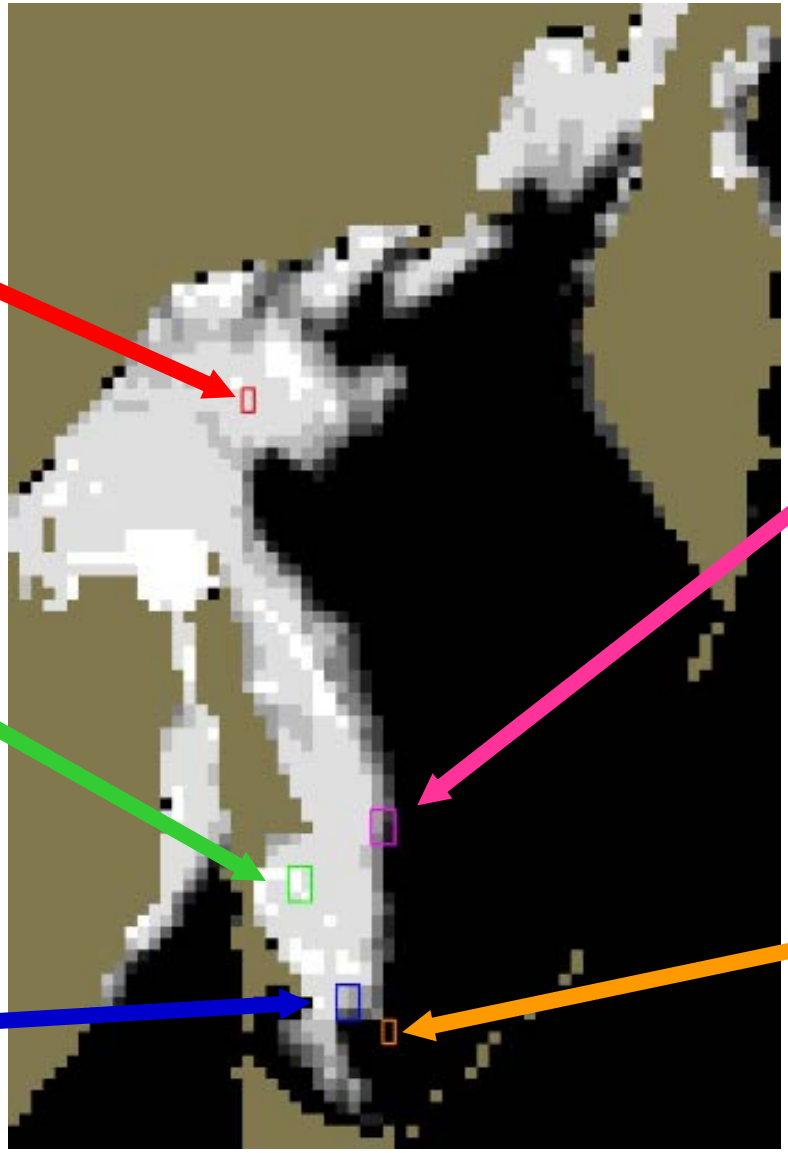


Consolidated ice

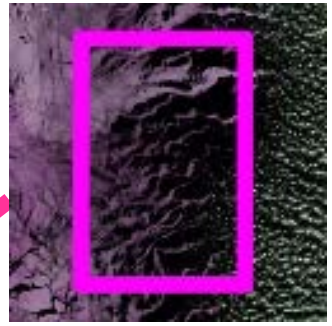
Thin ice



Middle concentration ice



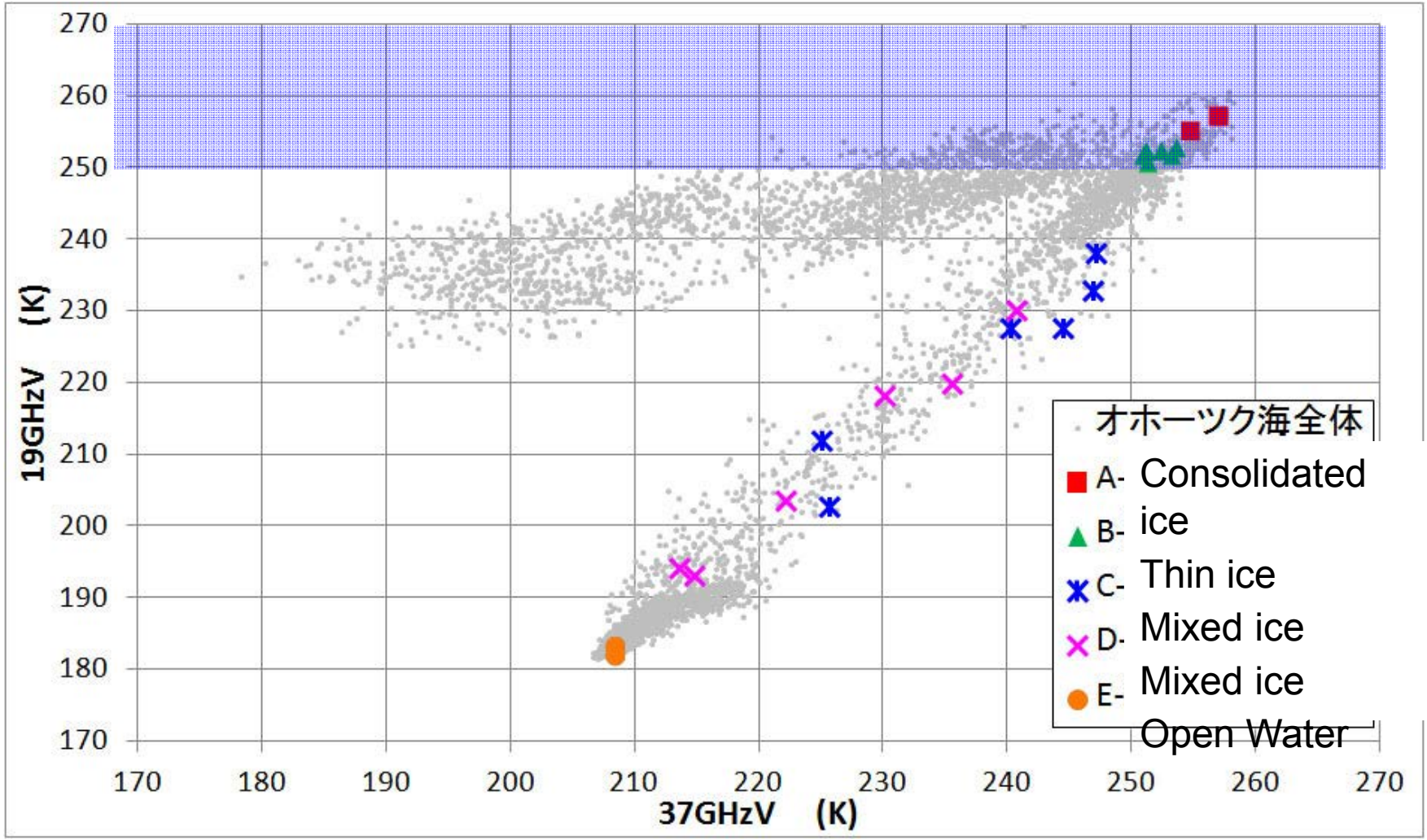
AMSR2 January 14, 2012



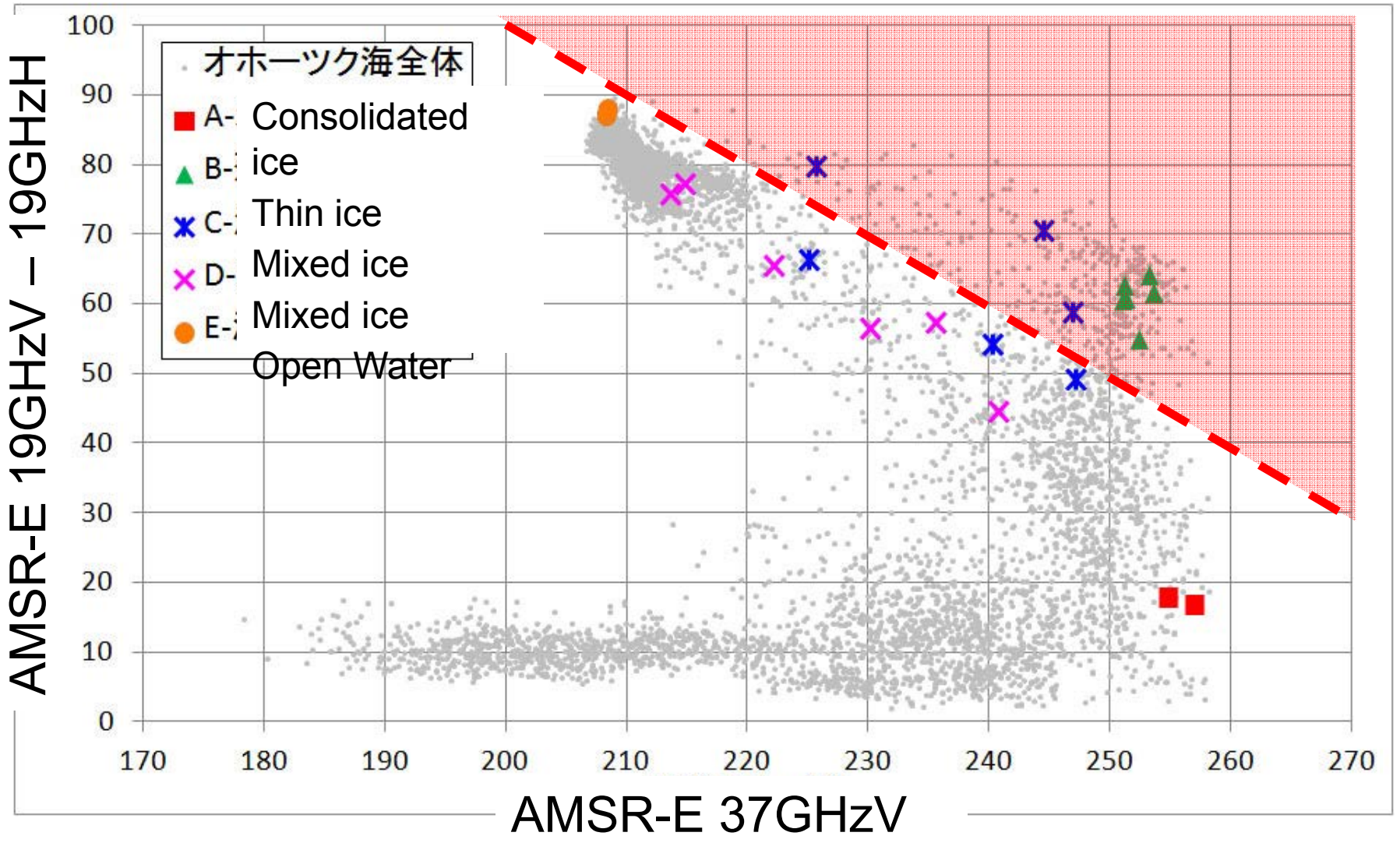
Middle concentration ice

Open water

# 19GHz vs 37GHz

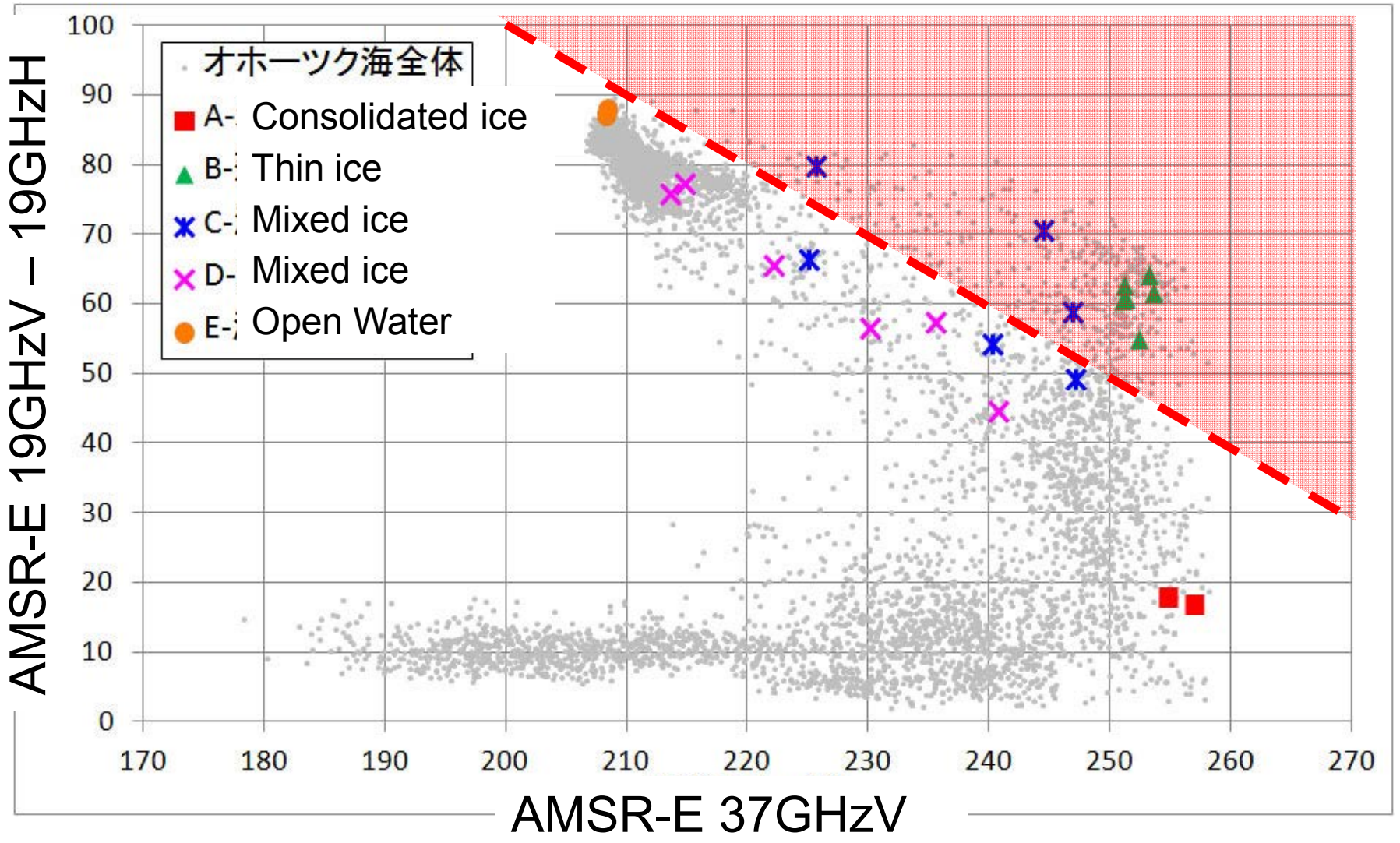


# 19GHz(V-H) vs 37GHz

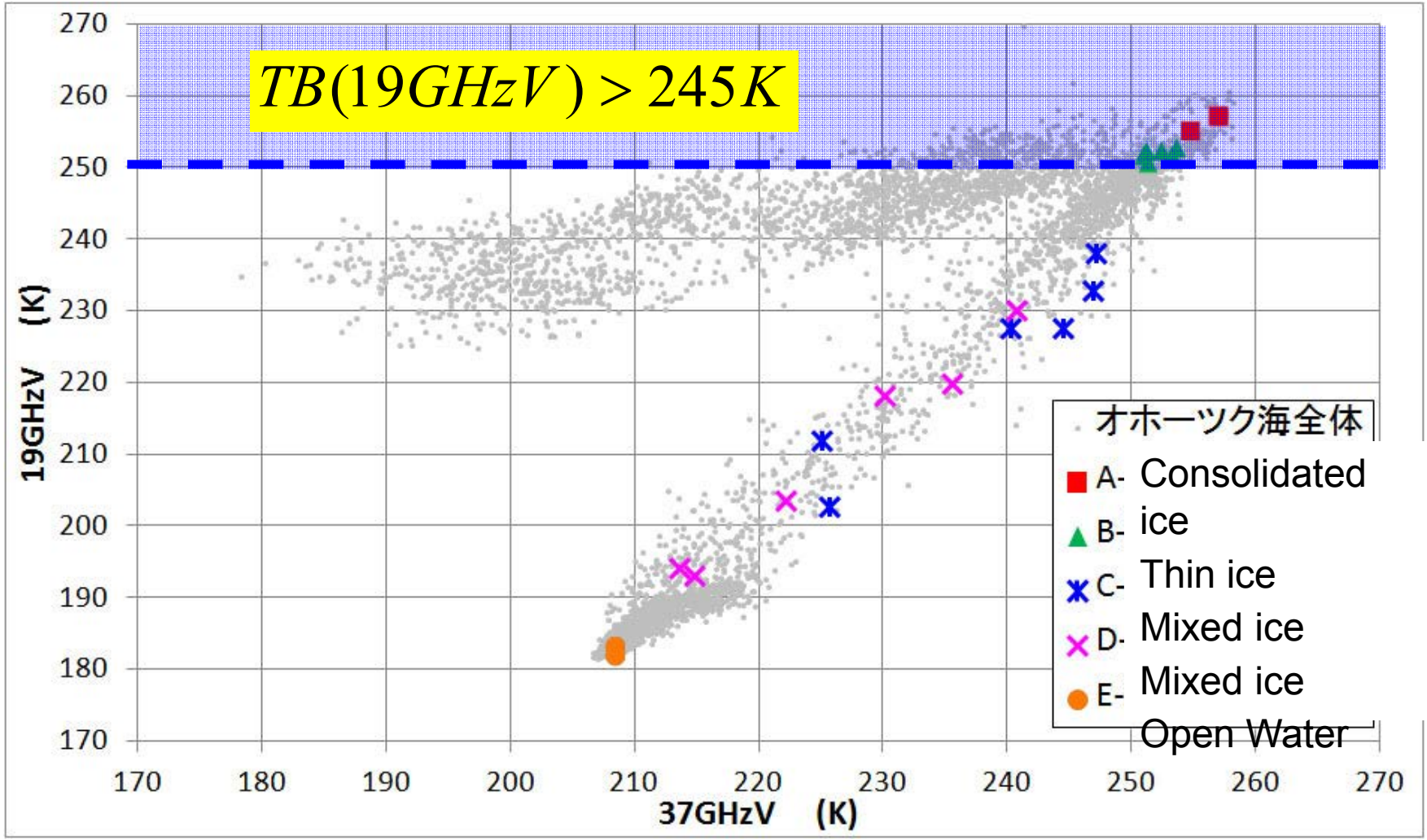


# 19GHz(V-H) vs 37GHz

$$TB(19GHzV - 19GHzH) > -TB(37GHzV) + 300K$$

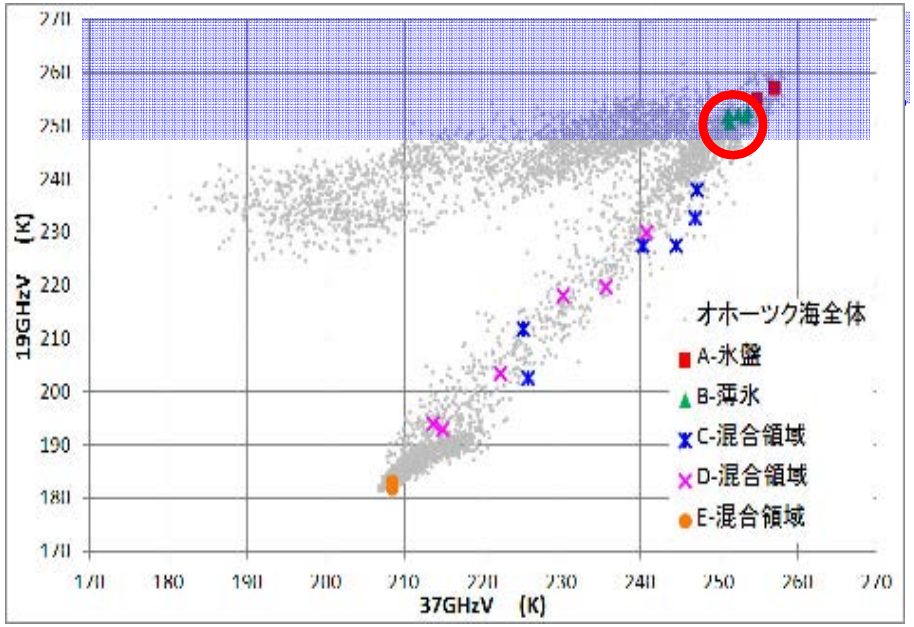


# 19GHz vs 37GHz

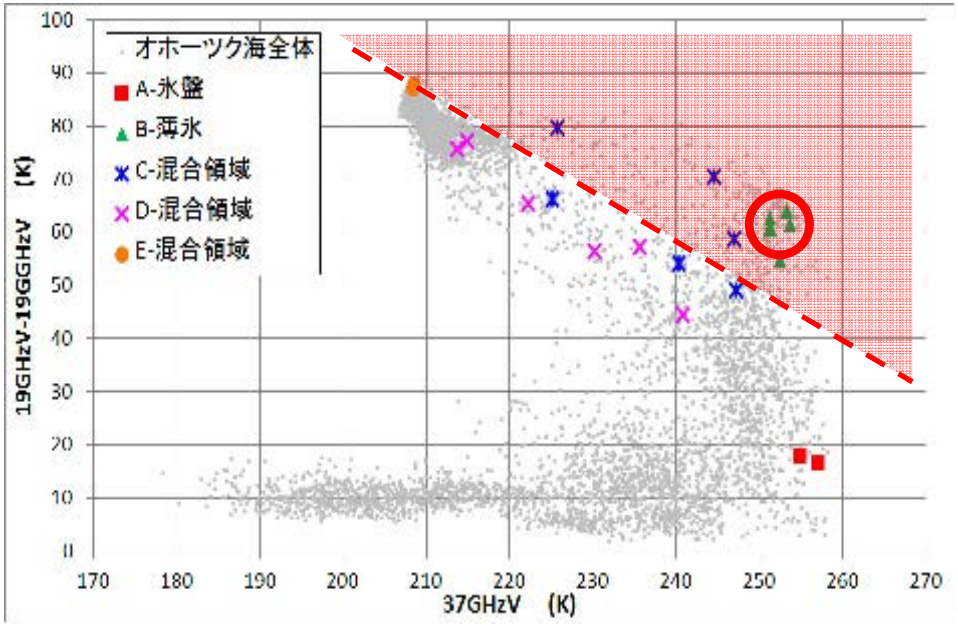


# Thin sea ice extraction algorithm

$$TB(19GHzV) > 245K$$
$$TB(19GHzV - 19GHzH) > -TB(37GHzV) + 300K$$



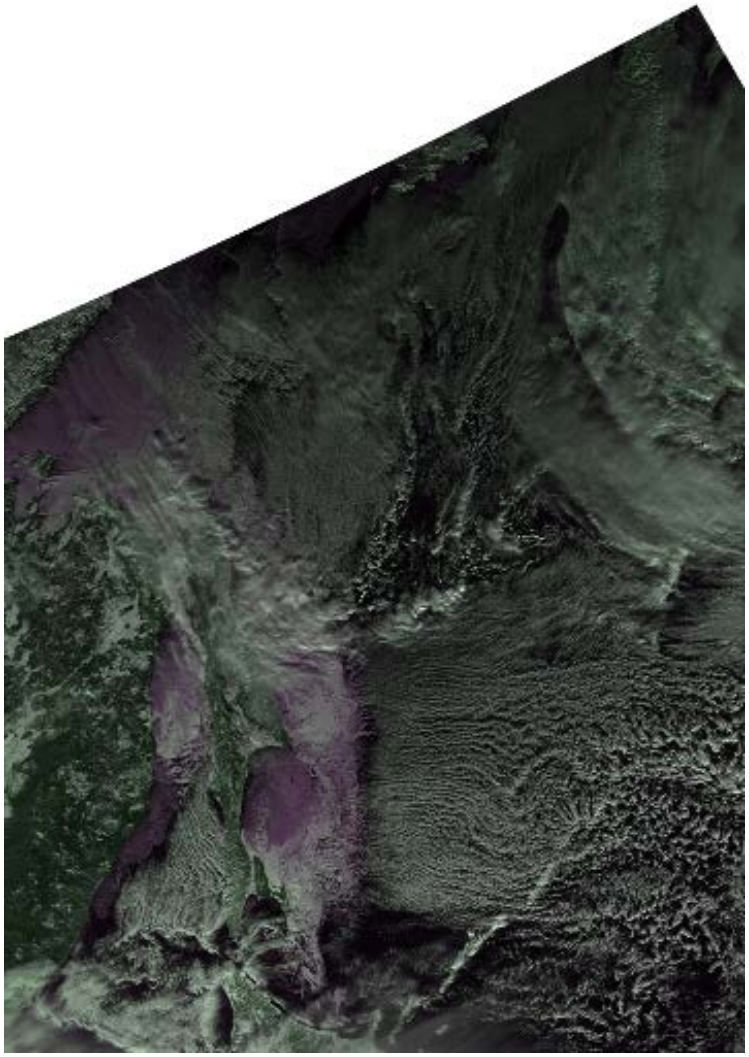

19GHzV vs 37GHzV




19GHzV-19GHzH vs 37GHzV

# Results （January 14, 2013）

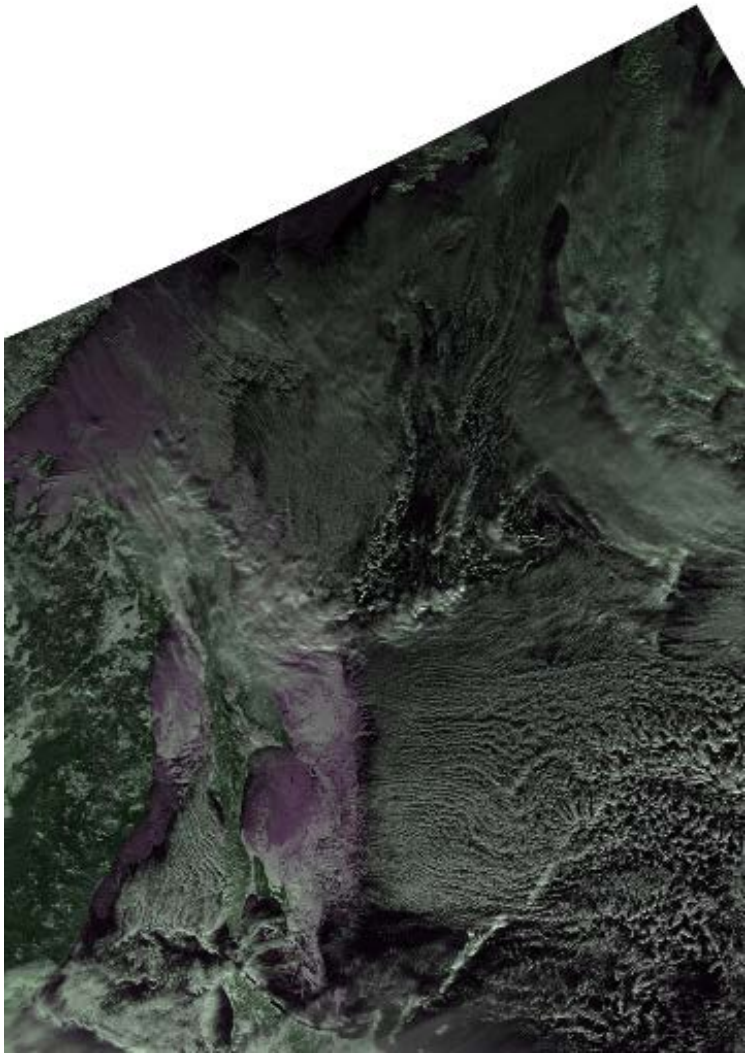
AMSR2 IC image



MODIS image(B1:R&B B2:G)

# Results （January 14, 2013）

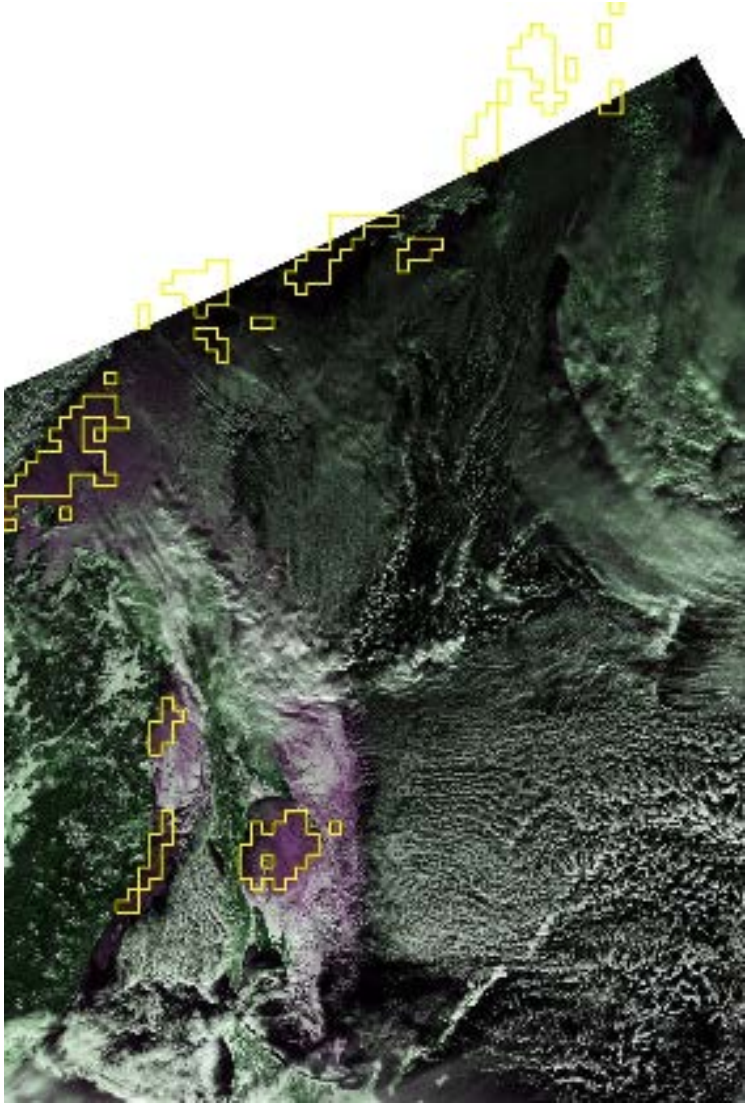
AMSR2 IC image



MODIS image(B1:R&B B2:G)

# Results （January 14, 2013）

AMSR2 IC image



MODIS image(B1:R&B B2:G)

# Conclusion

- The method for validating the sea ice concentration accuracy of ABT with MODIS and RSI data was specified.
- The ways to tune parameters for optimizing the IC accuracy were listed.
- The new thin ice algorithm for AMSR-2 using (19GHzV – 19GHzH) vs 37GHz V domain showed good performance in the initial phase study.