# Request for VIIRS Sea Ice Characterization EDR and Sea Ice Concentration IP Provisional Maturity

Provisional Effectivity Date: 15 October 2012 (MX 6.4)

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# Outline

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- Sea Ice Characterization EDR and Ice Concentration IP Requirements
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# VIIRS Sea Ice Characterization EDR and Ice Concentration IP Product Users

- U.S. Users
  - NSIDC, National Snow Ice Data Center
  - NIC, National/Naval Ice Center
  - OSPO, Office of Satellite and Product Operations
  - STAR, Center for Satellite Applications and Research
  - GSFC, NASA/Goddard Space Flight Center Hydrological Sciences Branch
  - NWS, National Weather Service, including the Alaska Ice Desk
  - CLASS, Comprehensive Large Array-data Stewardship System

- User Community
  - Navigation
  - Emergency Management
  - Operational Weather Prediction
  - Climate Research
  - DOD

# Provisional EDR Maturity Definition

- Product quality may not be optimal
- Incremental product improvements are still occurring
- Version control is in affect
- General research community is encouraged to participate in the QA and validation of the product, but need to be aware that product validation and QA are ongoing
- Users are urged to consult the EDR product status document prior to use of the data in publications
- Ready for operational evaluation

# VIIRS Sea Ice Characterization EDR L1RD Requirements

## Sea Ice Characterization (SIC)

“Sea ice age is defined as the time that has passed since the formation of the surface layer of an ice-covered region of the ocean. The sea ice characterization EDR provides an ice age class. Sea ice concentration, which is the fraction of a horizontal cell covered by ice, is an intermediate product (IP)”

# VIIRS Sea Ice Characterization EDR L1RD Requirements (Continued)

Sea Ice Characterization Requirements from L1RD version 2.4

| EDR Attribute | Threshold | Objective |
|---|---|---|
| **a. Vertical Coverage** | Ice Surface | Ice Surface |
| **b. Horizontal Cell Size**<br>**1. Clear**<br>**2. All weather** | <br>1.0 km<br>No capability | <br>0.5 km<br>1 km |
| **c. Mapping Uncertainty, 3 sigma**<br>**1. Clear**<br>**2. Cloudy** | <br>5 km<br>No capability | <br>0.5 km<br>1 km |
| **d. Measure Range**<br>**1. Ice Age**<br><br><br>**2. Ice Concentration** | <br>Ice Free, New Young, all other ice<br><br><br>0/10 to 10/10 | Ice free, Nilas, Gray White Grey, White, First Year Medium, First Year Thick, Second Year, Multiyear, Smooth and Deformed Ice<br><br>0/10 to 10/10 |
| **e. Measurement Uncertainty**<br>**1. Probability of Correct Typing (Ice Age)**<br>**2. Ice Concentration** | <br>70%<br>Note 1 | <br>90%<br>5% |
| **f. Refresh** | At least 90% coverage of the global every 24 hours (monthly average) | 6 hrs |
| **g. Geographic coverage** | All Ice-covered regions of the global ocean | All Ice-covered regions of the global ocean |

Notes:
1. VIIRS produces a sea ice concentration IP in clear sky conditions, which is provided as an input to the ice surface temperature calculation

# Summary of VIIRS Sea Ice Concentration IP

- Product and Algorithm Processing Summary
- History of Algorithm Changes/Updates
- Provisional Maturity Evaluation
- Provisional Justification Summary
- Conclusions

# Summary of the VIIRS Sea Ice Conc. IP

- The VIIRS Sea Ice Concentration IP consists of retrieved ice concentration at VIIRS Imagery spatial resolution (375 m @ nadir), for both day and night, over oceans pole ward of 36$^o$ N and 50$^o$ S latitude.
- The Ice Concentration algorithm computes ice fractions based on ice and water tie points determined from VIIRS I1 (0.64 µm and I2 (0.865 µm) reflectance and surface temperature from the VIIRS Surface Temperature IP.
- VIIRS Surface Temperature IP is determined using the VIIRS I5 (11.5 µm), M15 (10.8 µm ) and M16 (12.0 µm) bands.
- Ice/water thresholds are determined from the local minimum of the distribution of reflectance and temperature. Ice and water tie points are derived from the local maxima of the reflectance and temperature distribution within a sliding search window centered on each pixel.
- Inputs are TOA reflectance (VIIRS I1 and I2 bands) and Surface Temperature IP at VIIRS imagery resolution. Cloud and quality information input are provided by the Ice Quality Flags and IP, Ice Weights IP
- Outputs Ice Concentration IP and Reflectance/Temperature IP

# Summary of the VIIRS Sea Ice Conc. IP Algorithm Inputs

*NPOESS xDRs & IPs*

VIIRS 375m SDR
VIIRS Ice Quality Flags IP
VIIRS Ice Weights IP
VIIRS Surface Temperature IP

*Auxiliary Data*

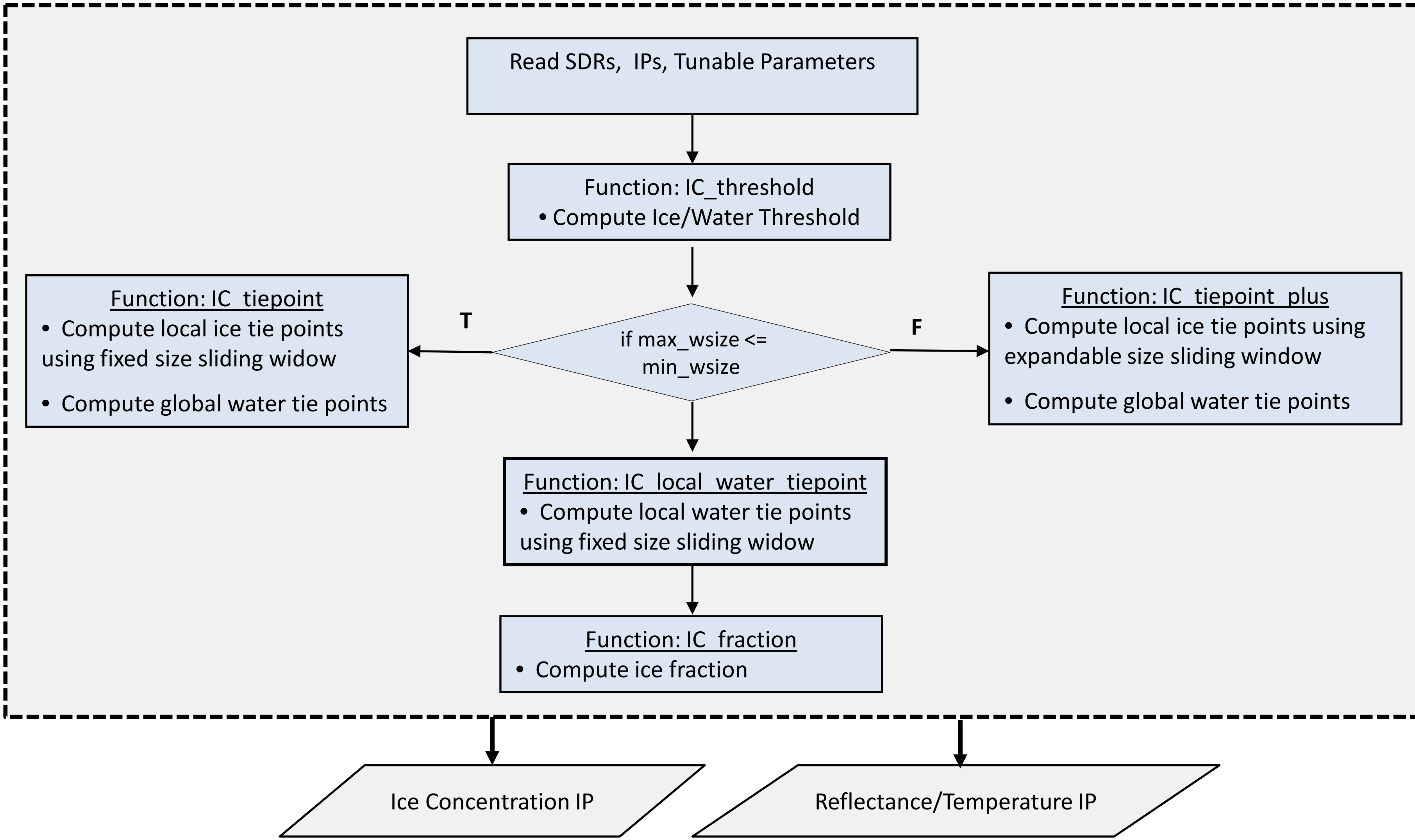
VIIRS Ice Concentration Tunable Parameters

Sea Ice Concentration IP

*Output EDRs & IPs*

VIIRS Sea Ice Concentration IP
VIIRS Reflectance/Temperature IP

# Summary of VIIRS Sea Ice Conc. IP Processing Flow



# History of Algorithm changes/updates

| Date | Update/DR# | Reason | Status |
|---|---|---|---|
| 04-09-2013 | DR 7139 | Correct Sea Ice Conc. OAD flow chart figure | Request closure with Beta Maturity 474-CCR-13-0945 |
| 12-13-2012 | DR 5017 | RTN Sev2 PCR Ice IPs Maneuver | open |
| 11-27-2012 | DR 4987 | Sea Ice Quality/Ice Concentration IP: Additional quality checks for identifying regions with potential VCM cloud leakage | open |
| 10-17-2012 | DR 4959 | Sea Ice Conc. Tie Point Fill Fix | open |
| 01-19-2012 | DR 4524 | OAD for VIIRS Sea Ice Concentration (SIC) Intermediate Product (IP) Mx6 Updates (ECR-ALG-0034) (CDRL A031) | open |
| 12-08-2010 | DR 4129 | Ice concentration weights not initialized before final ice concentration calculation | open |
| 07-17-2009 | DR 2863 | Latency impact due to valid point count methodology | Deferred for re-evaluation |
| 07-17-2009 | DR 2936 | Ice Surface Temp and IST use different emissivities for ice | Plan in place (next slide) |

# Path Forward Recommendation for DR 2936

Comparison of IST and Surface Temperature IP (ST IP) regression coefficients indicate that the IST coefficients currently implemented on the IDPS system are valid. However, inspection has revealed the ST IP split window coefficient value associated with view zenith angle dependence was erroneously set to 0.

The review also uncovered a sign error in the ATBD equation (second line from the top, page 34). However, the code implementation is correct.

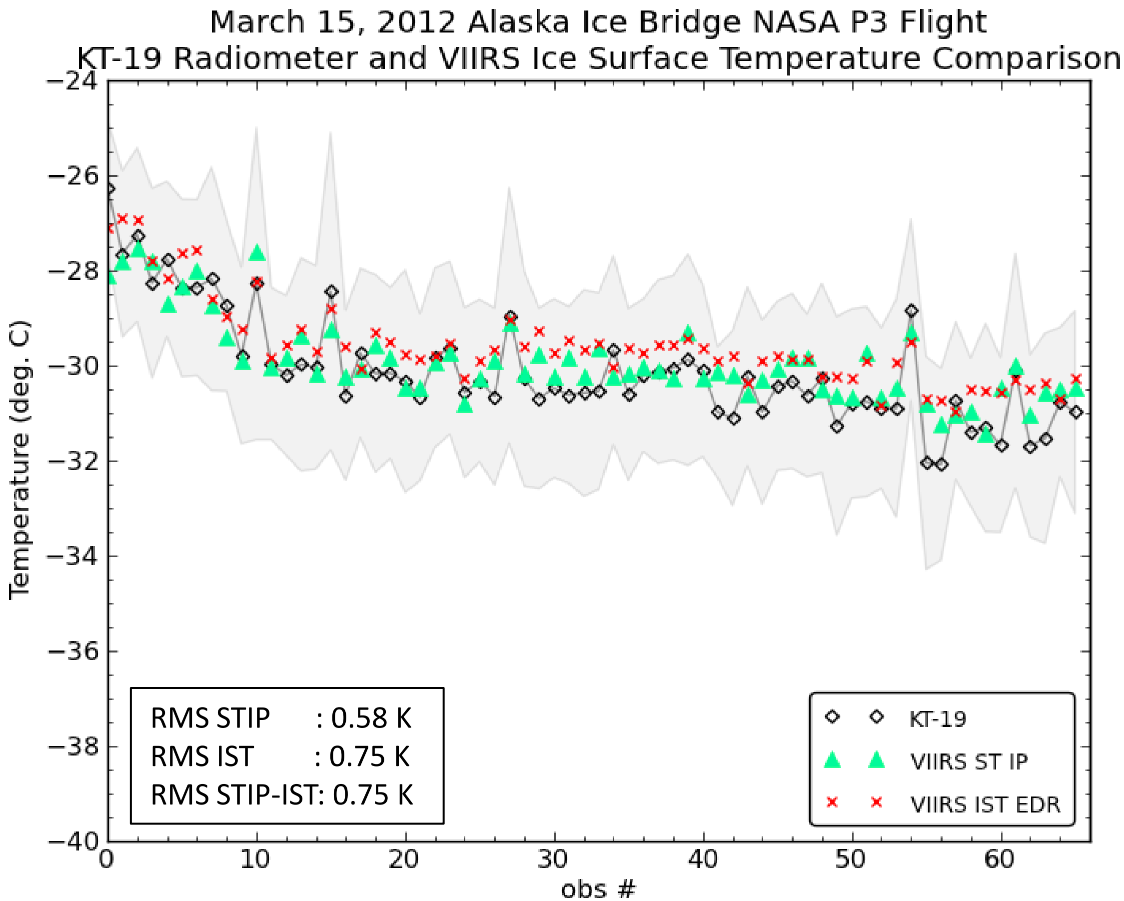
Proposed path forward actions

1. Deliver updated STIP coefficients to close out DR 2936
2. Open DR to correct the IST ATBD equation appearing in the ATBD. The Equation should be t11 = tI + (1-f)D instead of t11 = tI - (1-f)D

# Path Forward Recommendation for DR 2936

- Surface Temperature intermediate product (IP) and the VIIRS Ice Surface Temperature (IST) EDR were producing significantly different (1-3 degrees) temperatures over sea ice for early 2012 data
- The correct Surface Temperature IP regression coefficients were also delivered in 2010 but were implemented with the MX 5.0 build before the launch of NPP
- The IDPS MX 6.0 build, implemented on August 10, 2012 which included corrected IST regression coefficients that were delivered in 2010
- The two products are in much closer agreement now, as illustrated in a comparison with IceBridge aircraft data over the Arctic Ocean where the IST EDR was reprocessed with the corrected coefficients (see next slide)

# Surface Temperature IP vs IST EDR




Surface Temperature IP, IST EDR, and IceBridge KT-19 temperatures over the western Arctic Ocean for March 2012.

# Status of Upstream Products

- Ice Concentration IP performance is directly dependent on VIIRS Imagery resolution SDRs and the VIIRS Surface Temperature IP. It is also dependent on the VIIRS Cloud Mask IP, and AOT IP through the Ice Quality Flags IP and Ice Weights IP
  - VIIRS SDR Cal and Geo products reached provisional maturity in March, 2013.
  - VIIRS Cloud Mask IP reached provisional maturity in February, 2013
  - VIIRS Aerosol Optical Thickness reached beta maturity in September 2012 and provisional in March 2013
  - VIIRS Surface Temperature IP path forward plan in place (DR 2936, see slide 12)

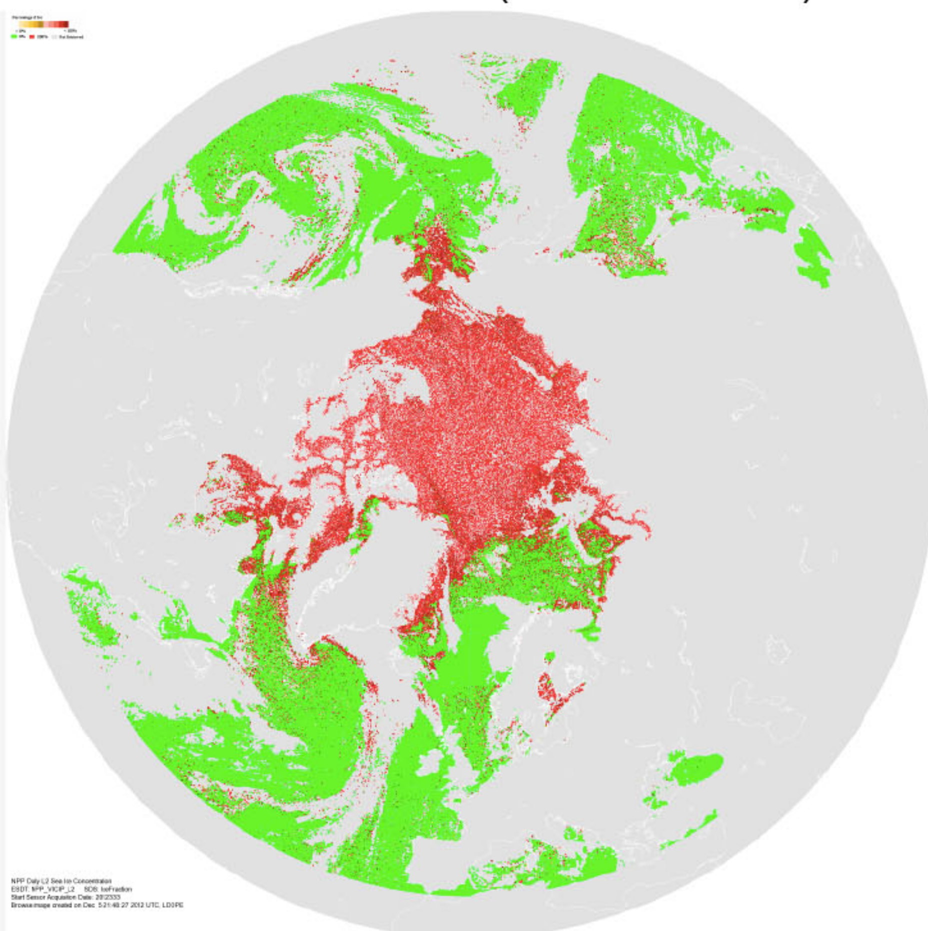
# Provisional Maturity Evaluation

- Provisional Maturity Evaluation Approaches
  - Visualizations of daily global VIIRS Sea Ice Concentration and comparison with passive microwave ice concentration
- Criteria:
  - Our analysis has focused on the Beaufort Sea, but other regions in the Arctic and Antarctic, as well as global coverage, have been analyzed for one or more days.

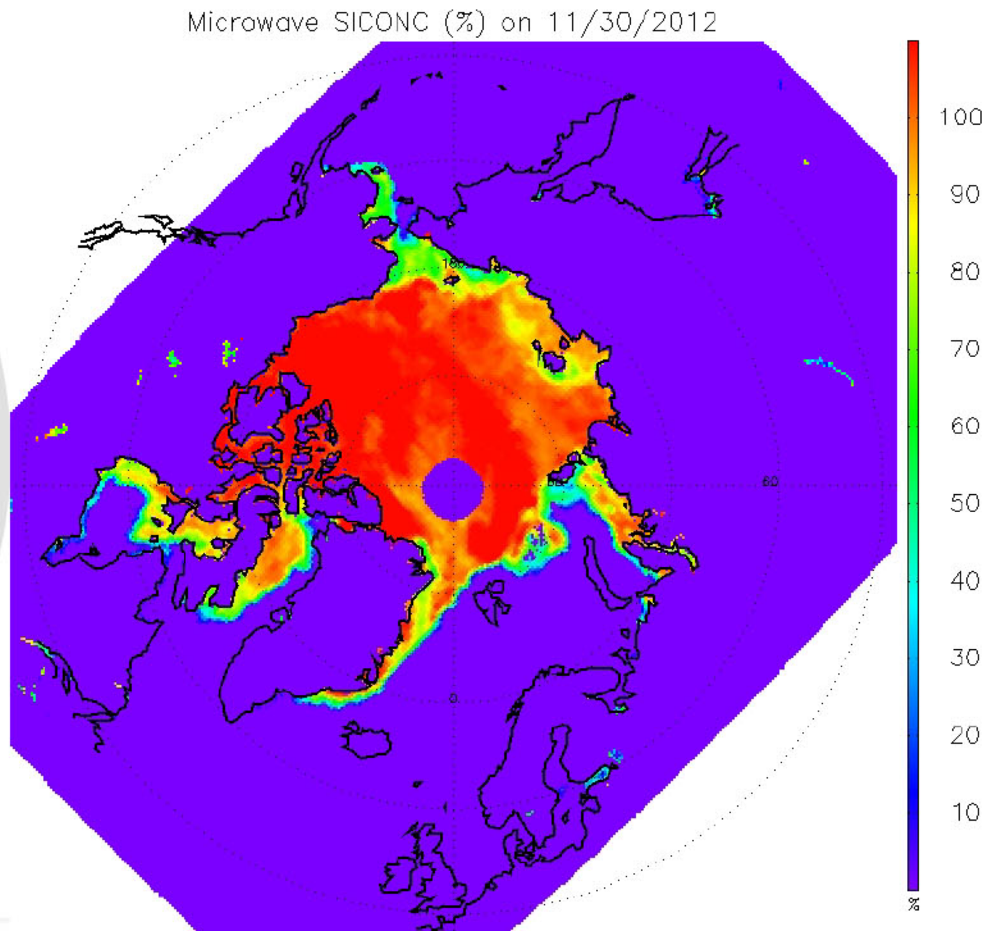
# Provisional Maturity Evaluation – Comparison of VIIRS Ice Conc. to Passive Microwave

VIIRS sea ice concentration IP is retrieving false sea ice over lower-latitude ocean areas.

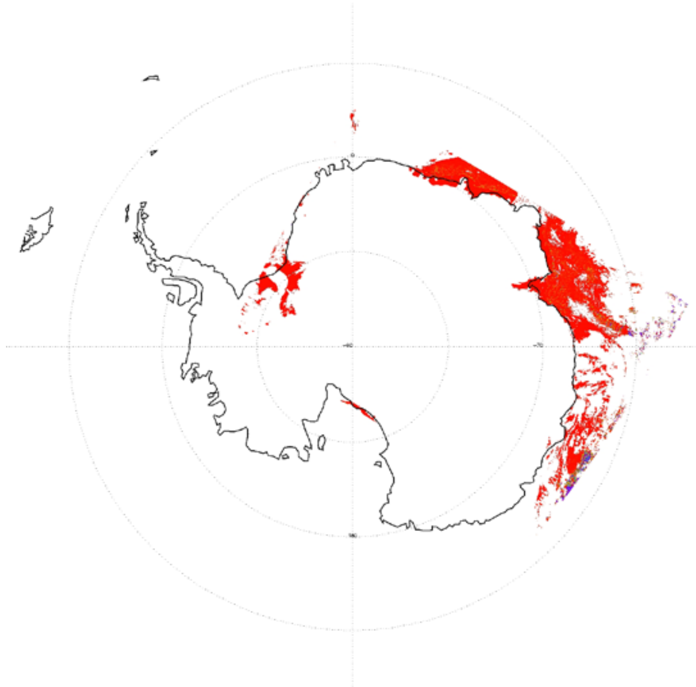
VIIRS Sea Ice Fraction (from Land PEATE)

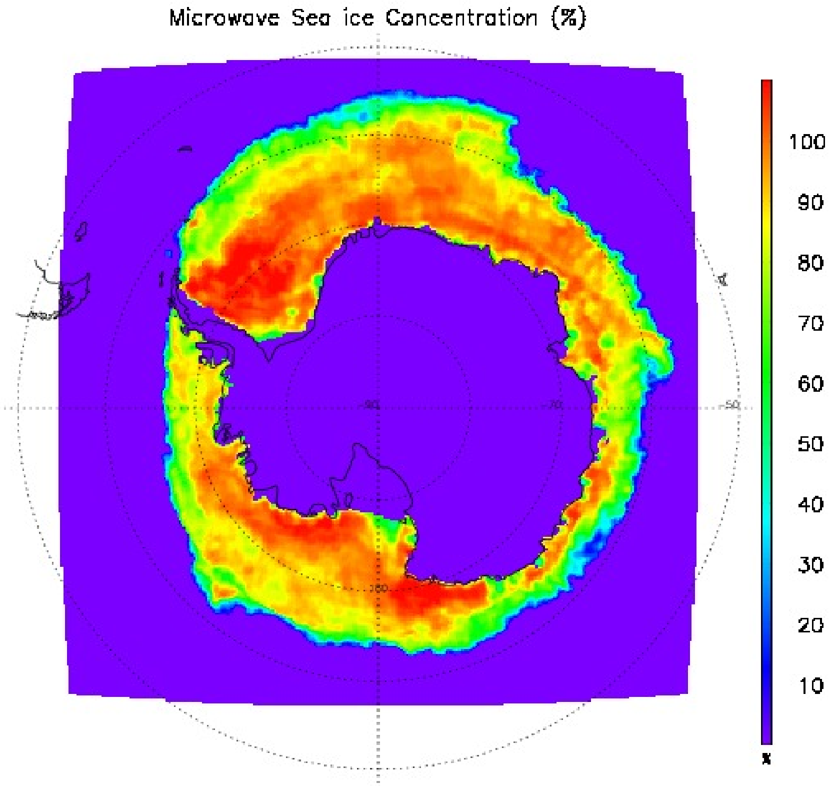


Sea Ice Concentration from SSMIS passive microwave



# Provisional Maturity Evaluation – Comparison of VIIRS Ice Conc. to Passive Microwave

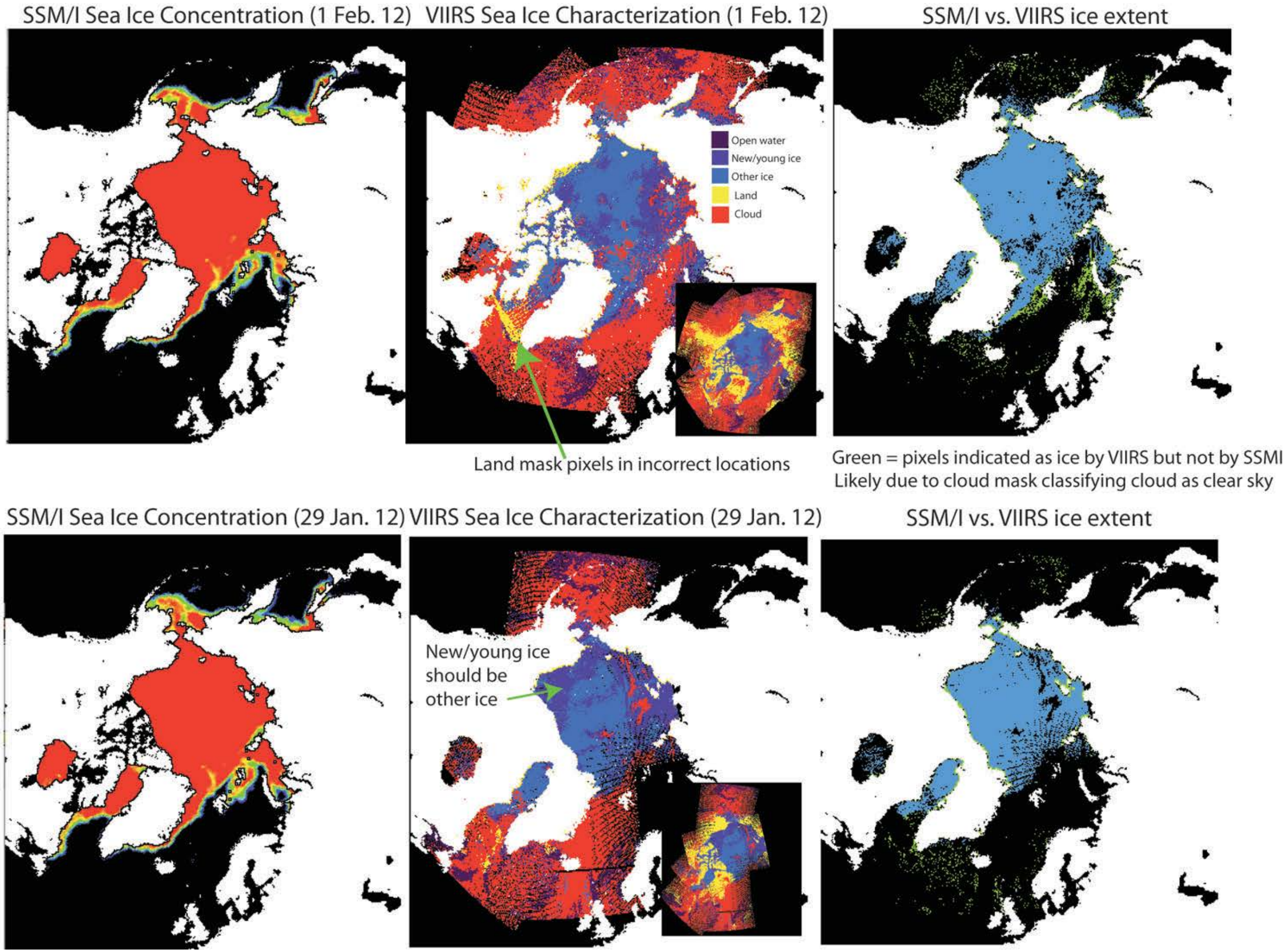




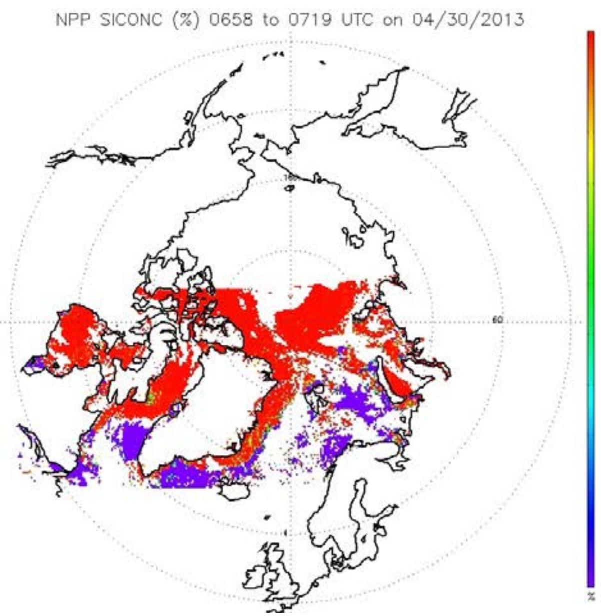

VIIRS Sea Ice Concentration IP (left) vs. SSM/I Ice Concentration (right) for 10/12/2012, Antarctica.

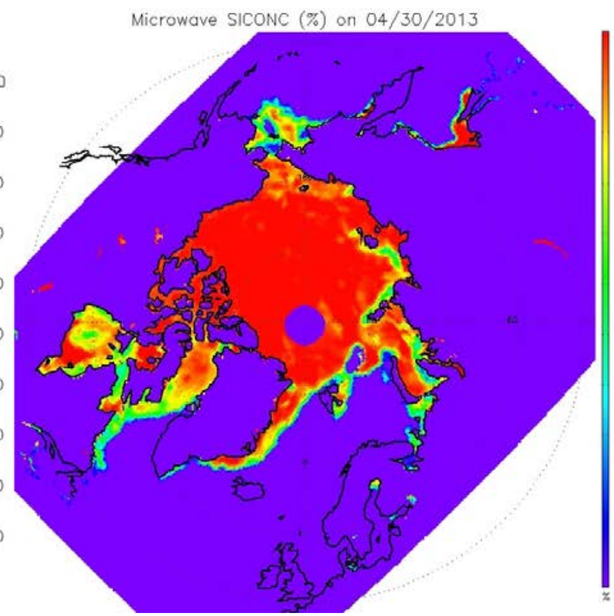
# Provisional Maturity Evaluation – Comparison VIIRS Ice Conc. Passive Microwave

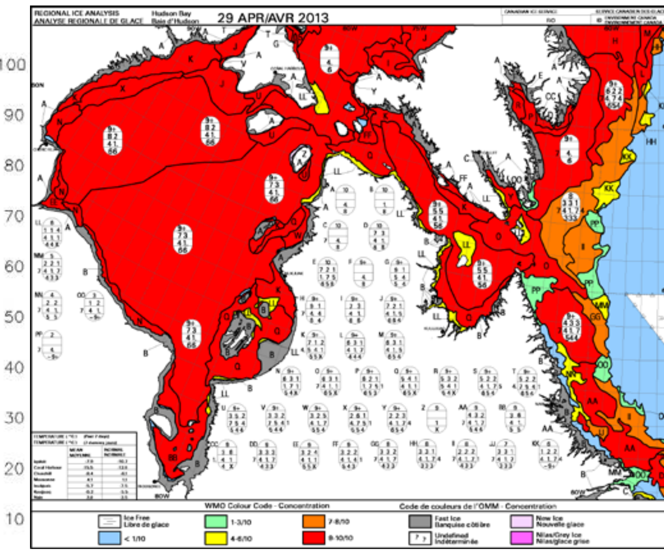
Sea ice extent is realistic, but with some false ice over open water, misclassification of new/young vs. other ice (in SIC EDR), and some misplacement of land values



# Provisional Maturity Evaluation – Comparison of VIIRS Ice Conc. to Passive Microwave and Ice Chart

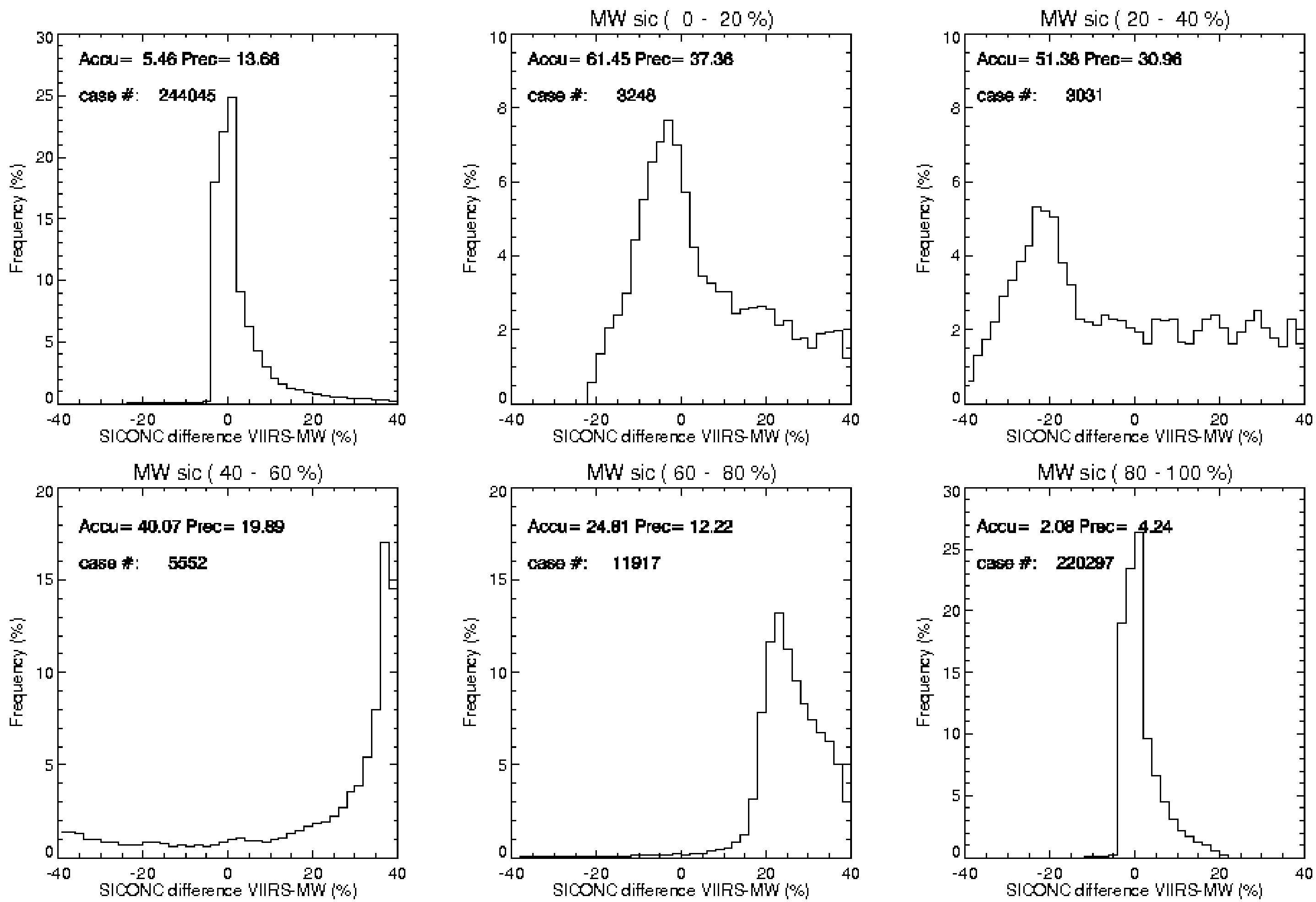



Sea ice concentration from Suomi NPP VIIRS IP (upper left), from the SSMIS using NASA team algorithm (center) on April 30, 2013, and from the weekly ice chart on April 29th 2013 from the Canadian Ice Service (upper right).

# Provisional Maturity Evaluation – Comparison of VIIRS Ice Concentration to Passive Microwave




Histogram of sea ice concentration differences of Suomi NPP VIIRS and Microwave using NASA team algorithm in February 2013 in the Arctic for all cases (upper left), and cases with Microwave sea ice concentration in the ranges 0-20%, 20-40%, 40-60%, 60-80%, and 80-100%. Measurement accuracy (Accu) and measurement precision (Prec) are indicated for each bin.

# Provisional Justification Summary

**Users are urged to consult the EDR product status document prior to use of the data in publications**

– The product has known flaws (see caveats slides later in this presentation), but these products are of sufficient quality to justify use by a broader community

– Most of the issues

- VIIRS Sea Ice Concentration IP contains retrievals over false ice. The SST team has reported instances of missing ice.  Some of the false ice retrieved by the VIIRS Sea Ice Concentration IP has been linked to a cloud leakage from a VIIRS Cloud Mask (VCM) which is still maturing and out of date (not updated daily) Grid-VIIRS-Snow-Ice-Cover-Rolling Tiles that affects the VCM performance.
- Significant discontinuities, false and missing ice have been observed transitioning from day to night. Nighttime performance is poorer than daytime.
- Ice Concentration performance bias exists but is expected to improve with additional quality checks, algorithm quality checks and maturation of the VCM and updated Surface Temperature IP regression coefficients

# Caveats for Operational VIIRS Ice Concentration IP (additional issues)

- Known problems and proposed technical solutions
  - False ice frequently observed near cloud edges.
    - Implementation of additional quality checks (extended cloud adjacency) in the Sea Ice Concentration IP for future builds beyond MX 9.0 should mitigate this problem
  - Performance of VCM cloud confidence for night is still not fully characterized. Unusually large confidently clear regions suggestive of VCM cloud leakage at night has been observed.
  - Significant discontinuities in ice concentration evident at 85 deg SZA transition between day/night for VCM and Ice Concentration to thermal based retrievals.
    - Such errors may be reduced with subsequent VIIRS Cloud Mask updates. However, such discontinuities will always remain.
  - Ice Concentration biases
    - Investigate and adjust tunable parameters associated with computation of ice tie points
    - Possible minor performance improvement after update of Surface Temperature IP regression coefficients (DR 2936)
  - Minor discontinuities related to ice tie points evident in the ice concentration
    - DR 4959 implementation of running mean based fallback tie points are likely to mitigate this problem

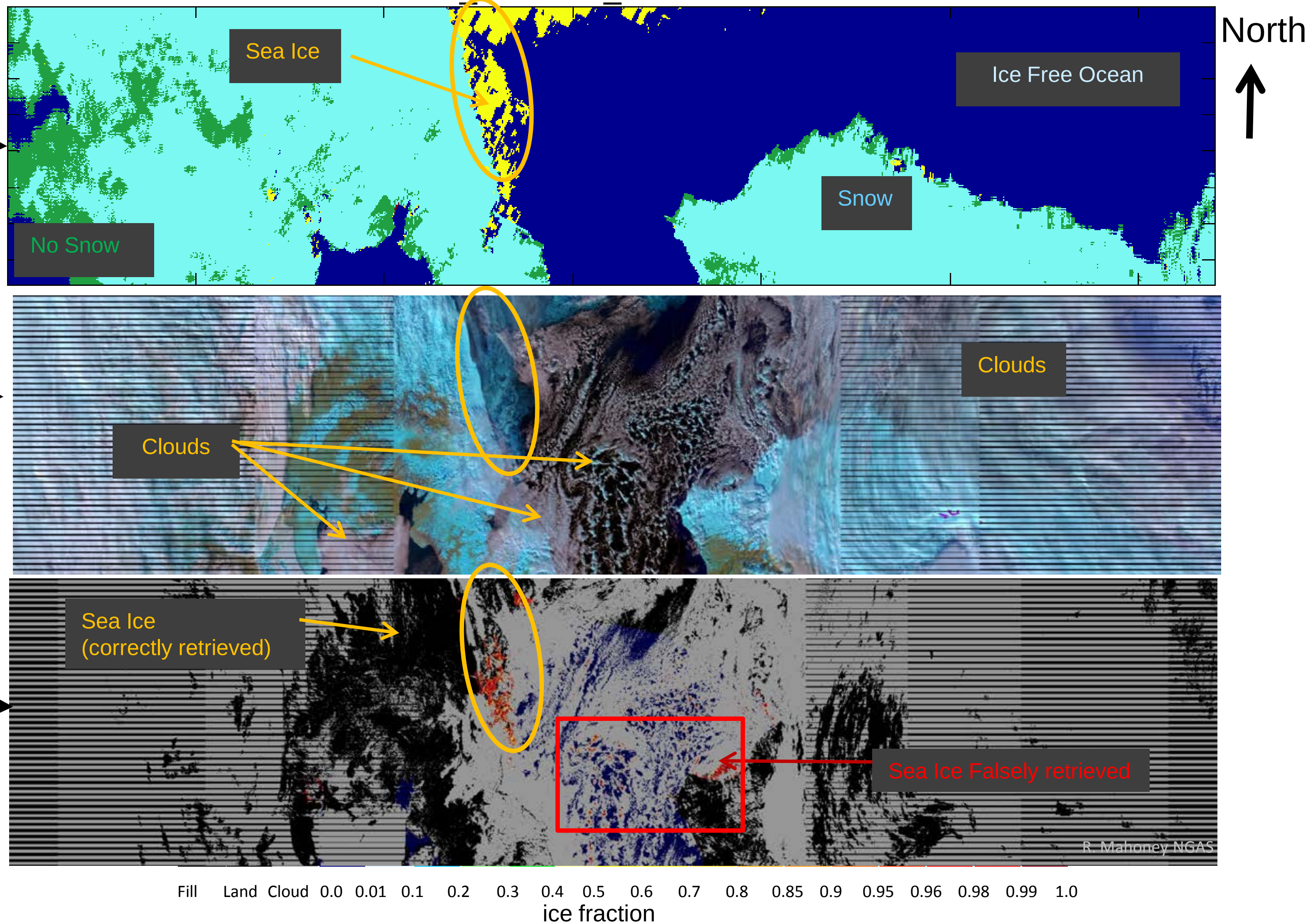
# Caveats for Operational Ice Concentration IP
# False Ice Observed near scattered clouds

d20121017_t2311272_e2312514

NOAA Global Automated Multisensor Snow/Ice

False Color VIIRS SDR Imagery

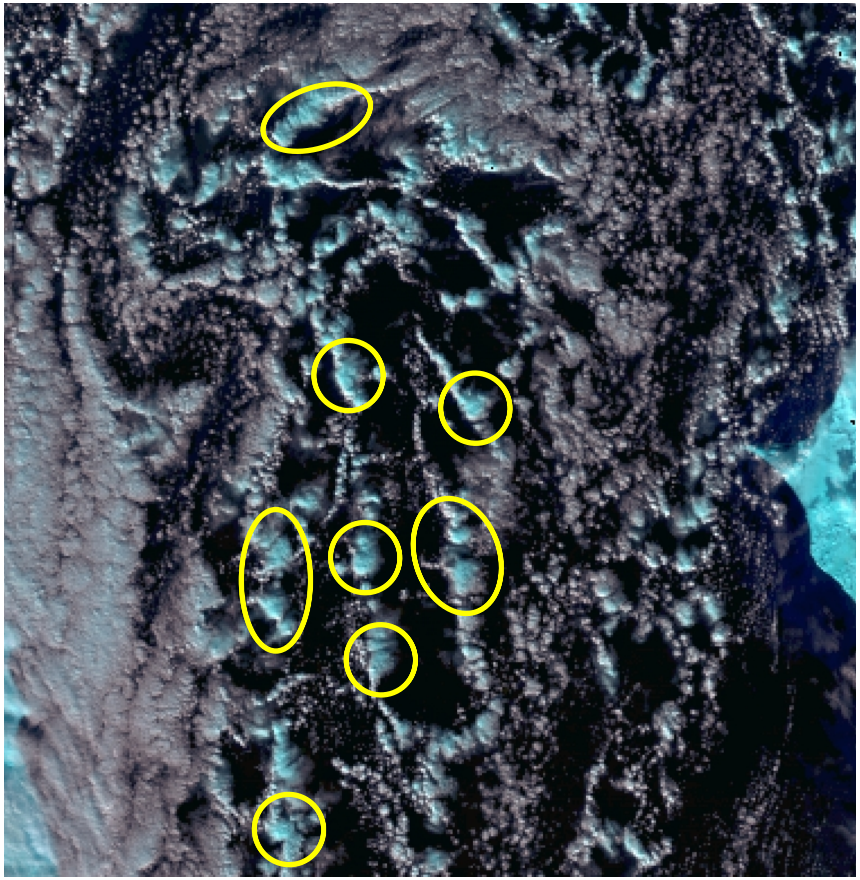
VIIRS Sea Ice Conc. IP



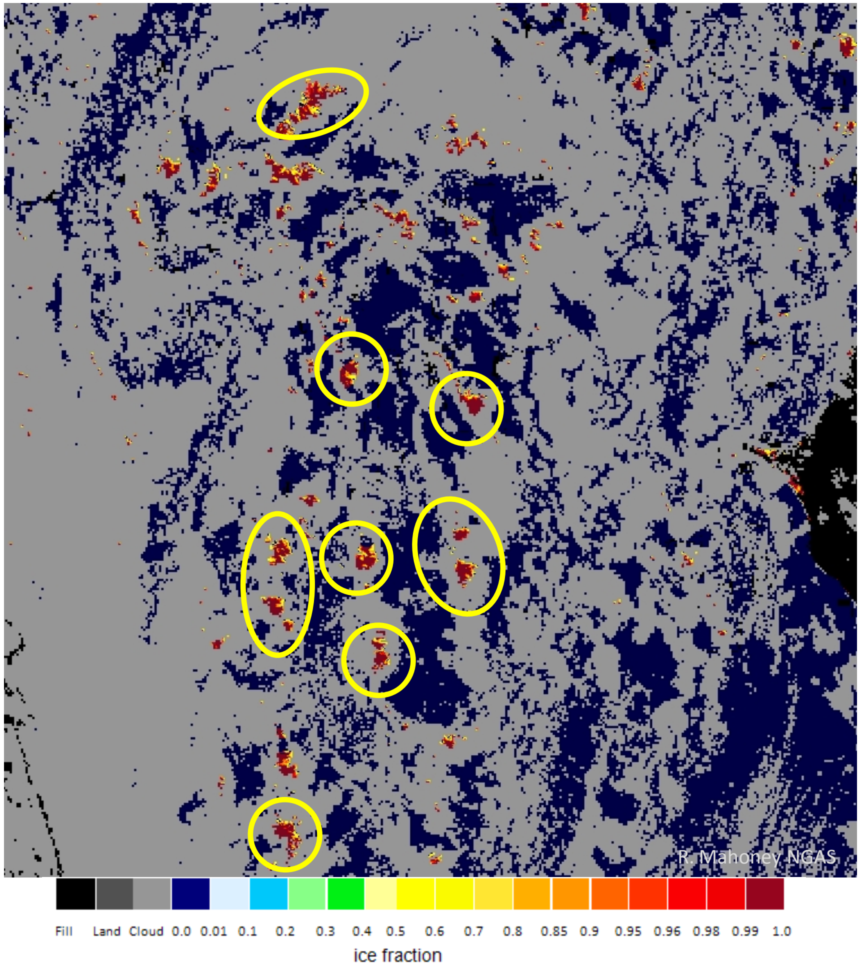

False ice is observed in regions with scattered clouds for Chukchi Sea/Beaufort Sea scene.

# Caveats for Operational Ice Concentration IP
# False Ice Observed near scattered clouds

False color VIIRS SDRs

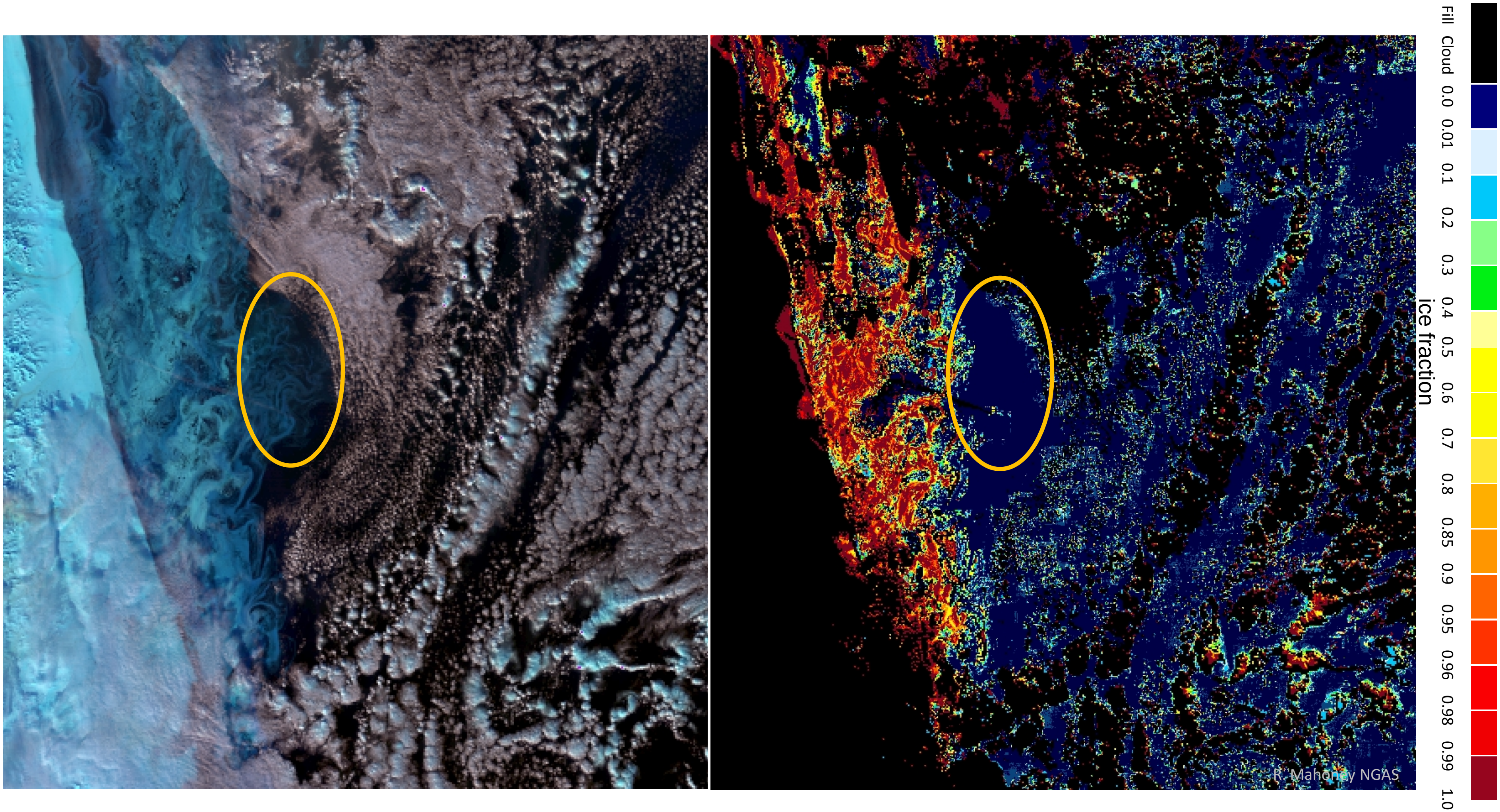


VIIRS Sea Ice Conc. IP



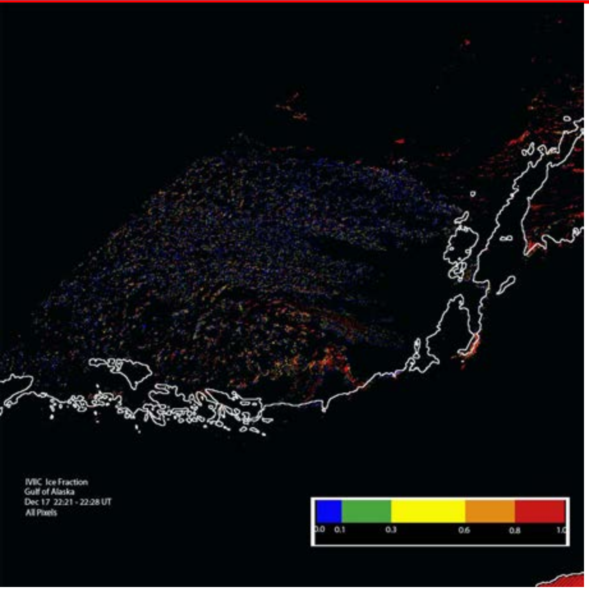

False color of VIIRS SDR reflectance (Red: M10, Green: M7, Blue: M5) for zoomed region (left). False ice shown by the yellow circled regions (right) correspond to clouds misclassified as confidently clear by the VCM and suggests additional quality checks are required in the Ice Concentration IP for extended cloud adjacency and significant partial cloudy regions.

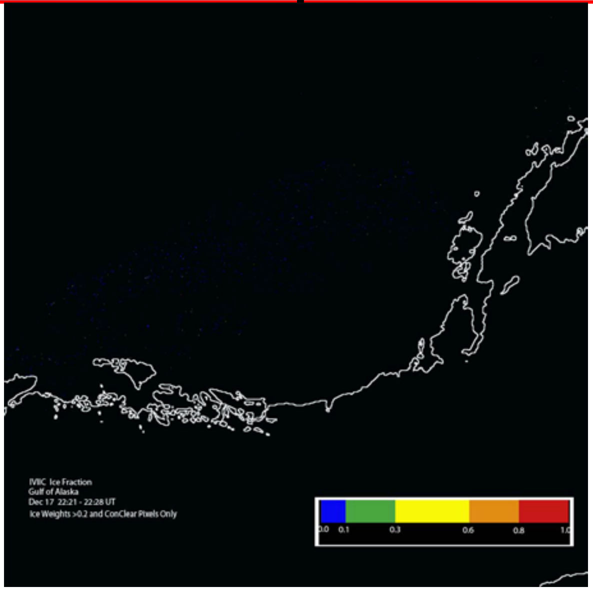
# Caveats for Operational Ice Concentration IP Observed Missing Sea Ice

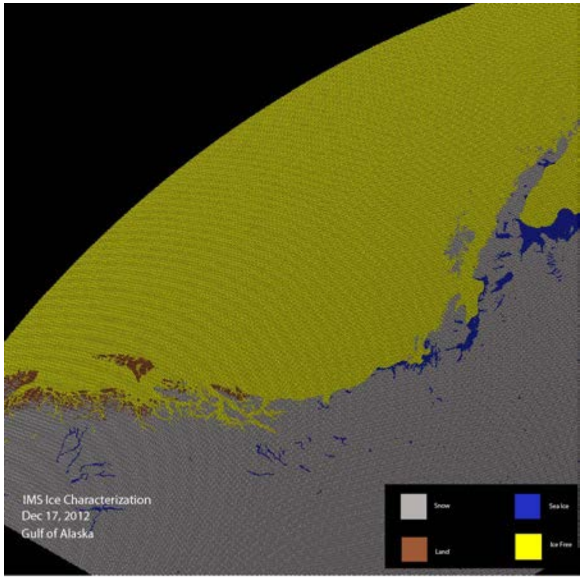



Some regions of missing sea ice have been observed in the VIIRS Ice Concentration IP for thin ice as shown in the circled region. False ice near clouds area also seen and for low ice fractions

# Provisional Maturity Evaluation - test to improve SIC IP

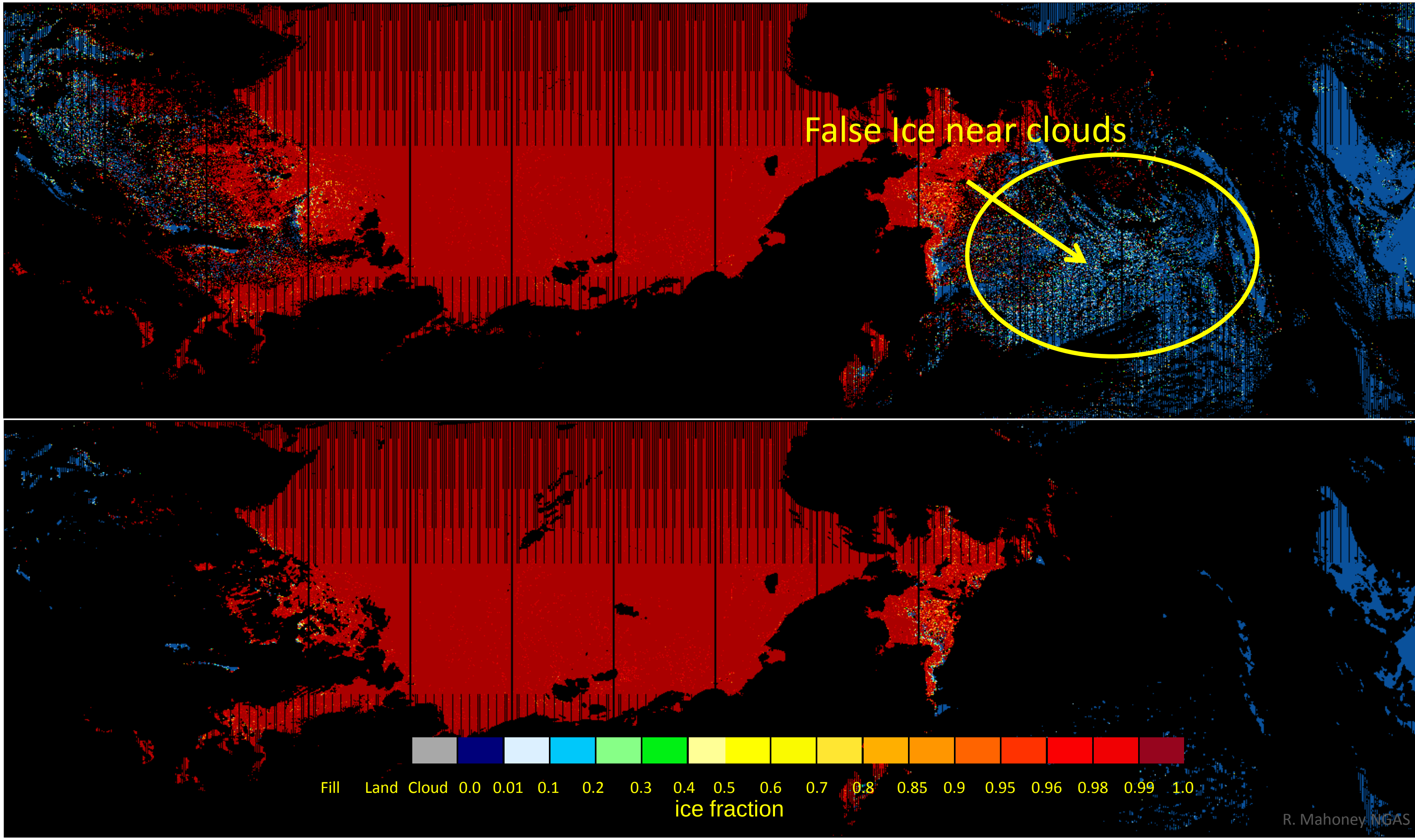



12/17/12: False ice (left) in Gulf of Alaska, removed (center) in local test after applying threshold for ice concentration weights. IMS ice data (right), showing absence of sea ice in this region (all ice-free).

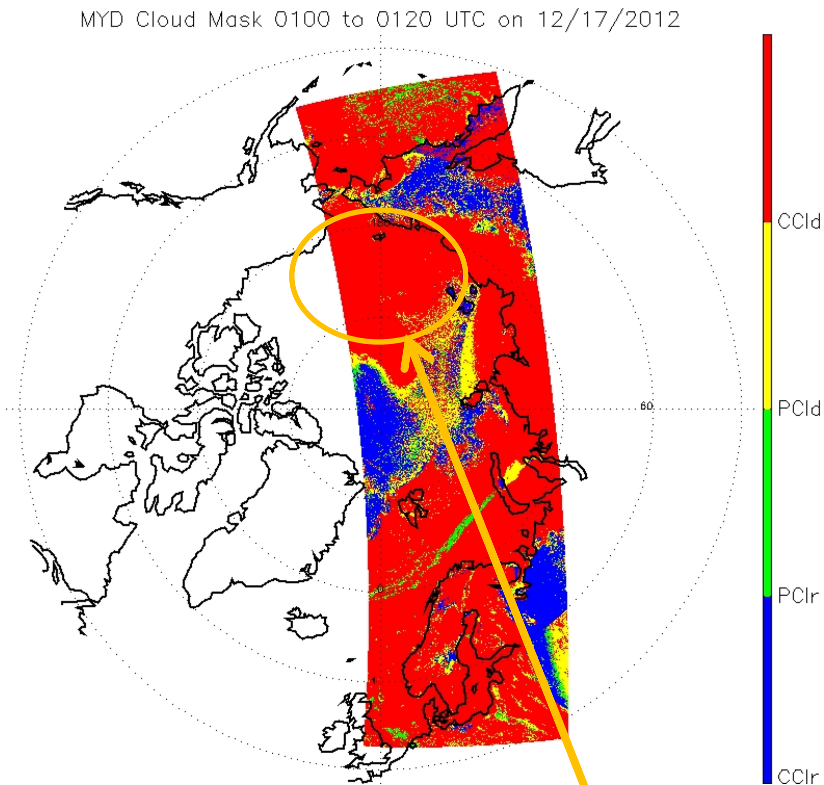
# Provisional Maturity Evaluation - Sliding Window Cloud Filtering Test



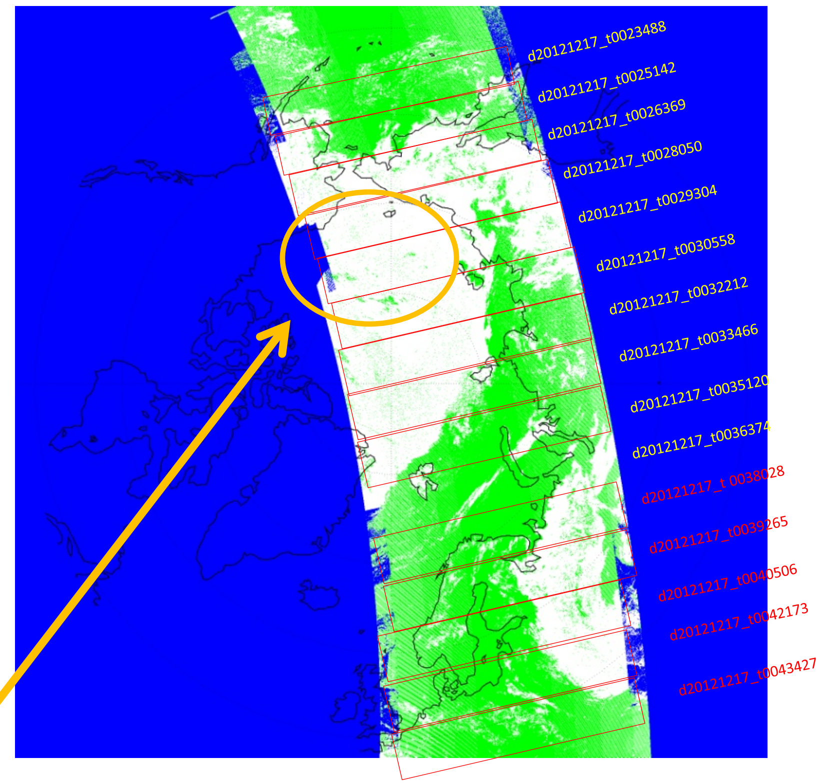

Results of partial cloudy filter tests for mosaic of VIIRS Sea Ice Concentration IP granules for Arctic 12-18-2012. Upper figure shows unfiltered ice concentration IP and lower figure shows results after application of a 15% non-confidently clear tie point search window filter. Further tests are required to determine the benefits and drawbacks of such an approach as an additional quality check in the Ice Concentration IP.

# VIIRS/MODIS Cloud Confidence Discrepancy Observed in Night Arctic Scenes

MODIS Cloud Mask 17 Dec . 2012 (0100-0120)




VIIRS Cloud Mask 17 Dec . 2012 (0023-0047)



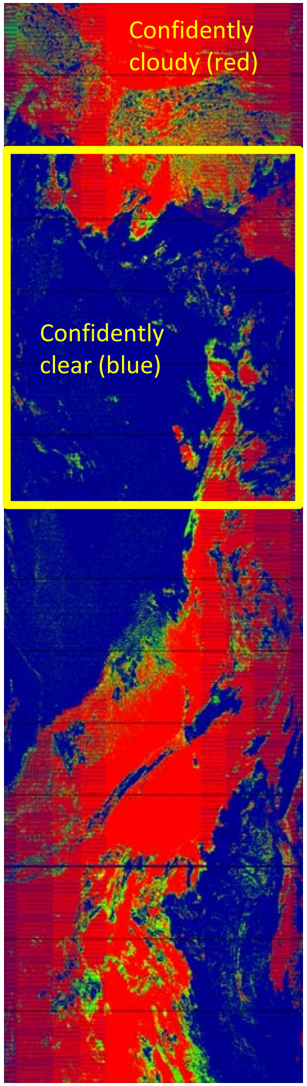

Red = Conf. Cldy.
Blue = Conf. Clear

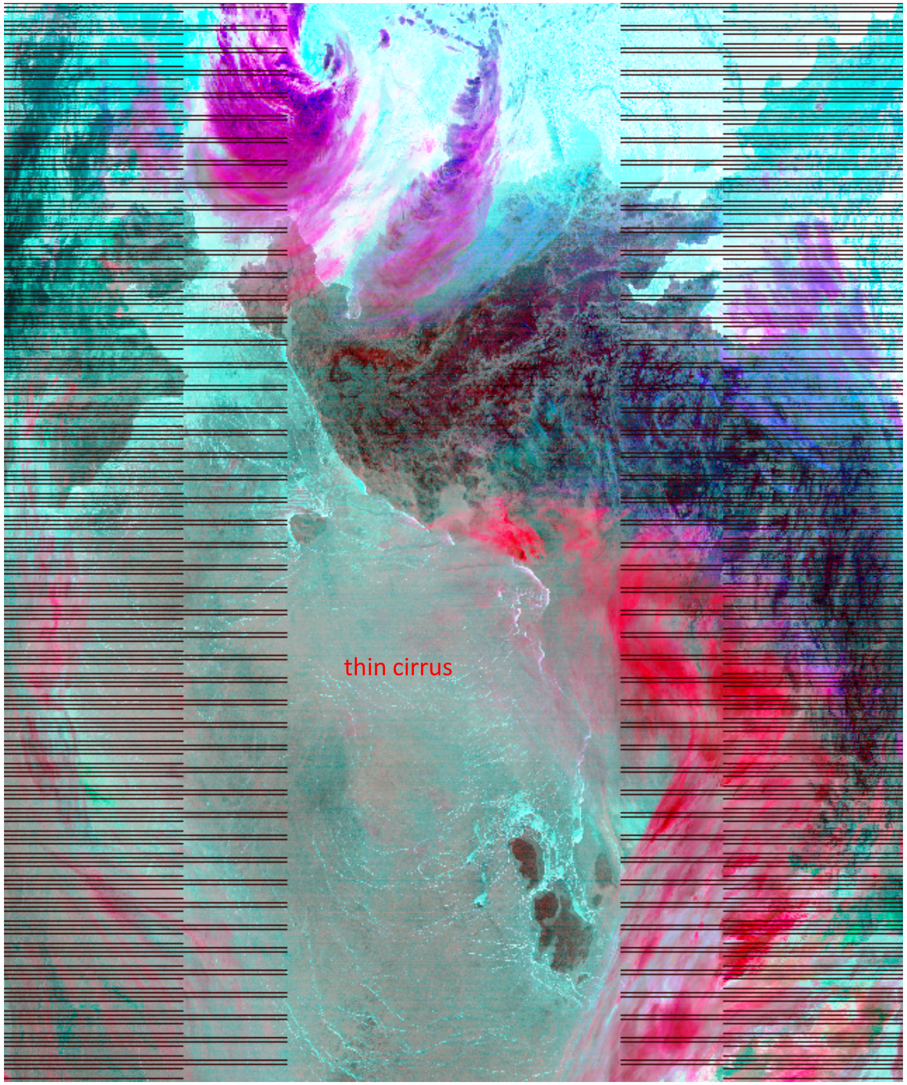
Region of discrepancy

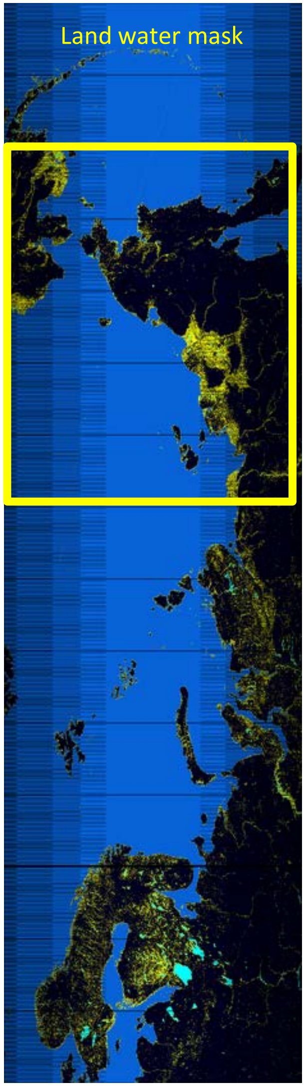
Confidently Cloud = Green
Confidently Clear = White

Large region shown by MODIS cloud mask as confidently cloudy is shown as confidently clear in the VCM.

# VIIRS SDR False Color Brightness Temperature Difference and Brightness Temperatures (Red: M15-M16, Green: M16, Blue: M12)




VCM misses many area s of cloud but appears to correctly show some areas of clear regions when compared to MODIS cloud mask.   Clouds identifiable in thermal band difference imagery above suggests VCM night performance improvements may be possible based on IR thresholding techniques.

# Additional Supporting Documentation

- TIM Meetings and Presentations
  - Cal/Val Team Meeting, April 2012
  - DR 4987 Sea Ice Concentration IP: Poor Performance Near Cloud Edges,  January 3, 2013
- Monthly/weekly reports
  https://groups.ssec.wisc.edu/groups/jpss/cryosphere/reports
- NPP Science Team, Land Report, 12/12/2012

# Future Plans and Issues

- We are working to get these changes into the IDPS
  - DR 7139, 4959, 4987, 4129, 7139
- Detailed performance characterization requires:
  - Further qualitative and quantitative comparisons with independent ice concentration sources
- Major actions for the provisional maturity justification and schedule
  - Implementation of additional quality checks and associated quality flags (MX 9.0)

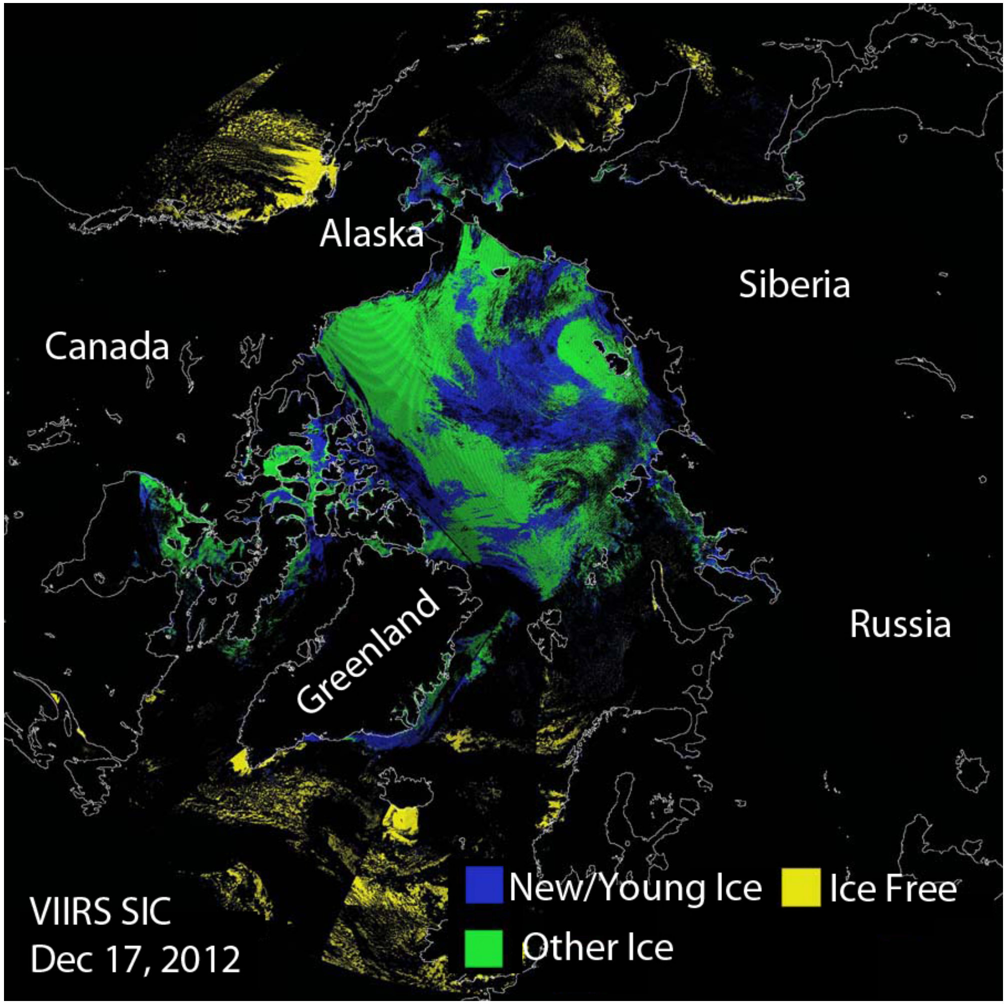
# Conclusion

- VIIRS Sea Ice Concentration IP has met the provisional maturity stage based on the definitions and the evidence shown
  - It exceeds the definition of provisional in most cases
  - Off-line IP product performance appears to be of sufficient quality for use by the Sea Ice Age EDR to identify ice to be classified as well as for Ice Surface Temperature EDR to identify sea ice for retrievals
- Some issues have been uncovered during validation and solutions are being evaluated.

# Summary: VIIRS Sea Ice Characterization EDR

- Summary of Sea Ice Characterization (SIC) EDR
- History of Algorithm Changes/Updates
- Provisional Maturity Evaluation
- Provisional Justification Summary
- Caveats of Operational VIIRS SIC EDR
- Conclusions

# VIIRS Sea Ice Characterization



# Summary of VIIRS Sea Ice Characterization EDR

- The VIIRS Sea Characterization EDR (Ice Age) consists of ice classifications for *Ice Free*, *New/Young* and *Other Ice* at VIIRS moderate spatial resolution (750 m @ nadir), for both day and night, over oceans poleward of 36$^{o}$N and 50$^{o}$S latitude.

- New or Young ice is discriminated from thicker ice (Other Ice) by a threshold ice thickness of 30 cm. Discrimination of New/Young ice from thicker ice is achieved by two algorithms:
  1. Energy (heat) balance based retrieval for night and high solar zenith angles
  2. Reflectance/ice thickness retrieval using modeled Sea Ice Reflectance LUT for daytime

- Inputs: Ice Reflectance/Temperature IP, Ice Quality Flags IP, AOT IP, granulated ancillary surface wind speed, surface air pressure, surface air temperature and surface air specific humidity. Modeled Snow Depth/Sea Ice Climatology LUT, modeled sea ice reflectance LUT, sea ice spectral albedo and broadband albedo LUTs, atmospheric transmittance LUT

- Heritage: No operational Visible/IR heritage. AVHRR research heritage (Comiso and Massom 1994, Yu and Rothrock 1996 and Wang et al. 2010)

# Summary of the VIIRS Characterization EDR (Ice Age) Algorithm Inputs

*NPOESS xDRs & IPs*

VIIRS 375m TC GEO
VIIRS 750m TC GEO
VIIRS Ice Quality Flags IP
VIIRS Ice Weights IP
VIIRS Ice Concentration IP
VIIRS Ice Refl./Temp. IP
VIIRS Surface Temperature IP
OMPS Tot. Col. Ozone  1st gues IP

*Auxiliary Data*

VIIRS Ice Age Tunable Parameter File
Sea Ice Modeled Refl. and  Shortwave BB Albedo  LUT
Snow-Depth-Ice-Thickness Climatology LUT
Atmos. Broadband Transmittance LUT

*Ancillary Data*

NCEP Gran. Anc. Sfc. Air Temp.
NCEP Gran. Anc. Sfc. Air Pressure
NCEP Gran. Anc. Sfc. Wind Speed
NCEP Gran. Anc. Sfc. Specific Humidity
NCEP Gran. Anc. Precipitable Water

Sea Ice
Characterization
(Ice Age)  EDR

*Output EDRs & IPs*

VIIRS Sea Ice Age EDR

# Summary of VIIRS Sea Characterization EDR (Ice Age) Algorithm Overview

## Reflectance Threshold Branch (Day Region Algorithm)

- Input ice tie point reflectance (I1, I2), VCM IP, AOT IP
- Input granulated NCEP gridded precipitable water, total ozone fields
- Obtain snow depth for each ice thickness bin obtained from climatology modeled snow depth/ice thickness LUT
- Retrieve ice thickness from sea ice reflectance LUT using ice tie point reflectances, modeled snow depth, AOT, precip. water and solar and satellite view geometry
- Classify by comparing retrieved ice thickness to 30 cm ice thickness threshold

## Energy Balance Branch (Terminator and Night Region Algorithm)

- Input Ice Temperature Tie Point IP
- Input granulated NCEP gridded surface fields (sfc.P, sfc air temp, specific hum. etc…)
- Compute snow depth for 30cm ice thickness threshold from heat/energy balance
- Classify by comparing computed and climatology LUT snow accumulation for a 30 cm ice thickness threshold

**The Snow-Depth-Ice Thickness Climatology LUT contains:**

- predicted snow accumulation depths for modeled ice thickness threshold growth times based on monthly climatology surface air temperatures and precipitation rates

# History of Algorithm changes/updates

| Date | Update/DR# | Reason | Status |
|---|---|---|---|
| 2/27/2013 | DR 7068 | RTN Sev2 PCR (VIIRS-SIC-EDR fill conditions not applied to both fields in the EDR) | open |
| 02-03-2011 | DR 4197 | Sea Ice Model based problems | Future Re-Evaluation |
| 07-17-2009 | DR 2844 | Sea ice age ATBD does not meet scientific standards | open |
| 07-17-2009 | DR 2723 | Snow-depth-on-sea-ice-LUT | To be re-evaluated |
| | | | |

# Ice Age Day (reflectance based) Algorithm Dependencies on Ancillary Data and LUTs

| Data Type | Description |
|---|---|
| O3 | NCEP granulated Total Col. Ozone |
| PW | NCEP granulated Precip.Water |
| Snow Depth/Ice Thickness Climatology LUT | Modeled snow depth accumulation as a function of ice thickness (based on computed ice thickness growth time from long term monthly NCEP climatology precip. rate and surface. air temp) |
| Sea Ice Reflectance LUT | Sea Ice reflectance (RTM modeled) for I1, I2 as a function of :<br>ice thickness, snow depth, precip. water ,<br>total ozone, aot , aerosol model(2),<br>solar zenith, relative azimuth, sat. view zenith |

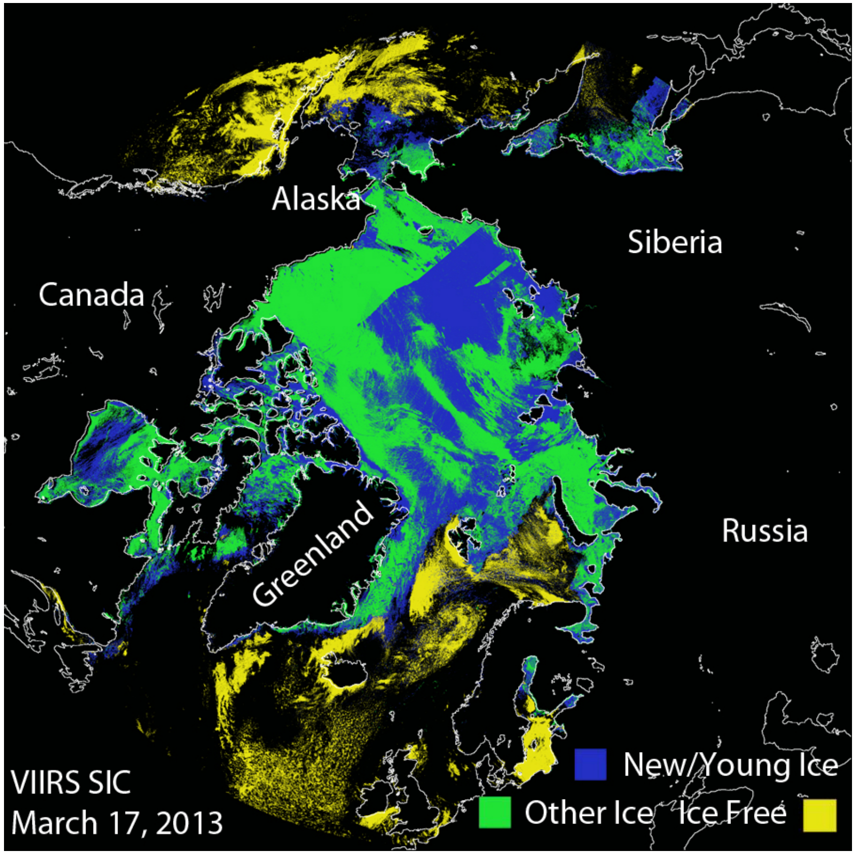
Discontinuities in the ice age sometimes observed aligned along 0.5 deg. lat/lon boundaries are strongly suggestive of sensitivity to the NCEP granulated ancillary fields.

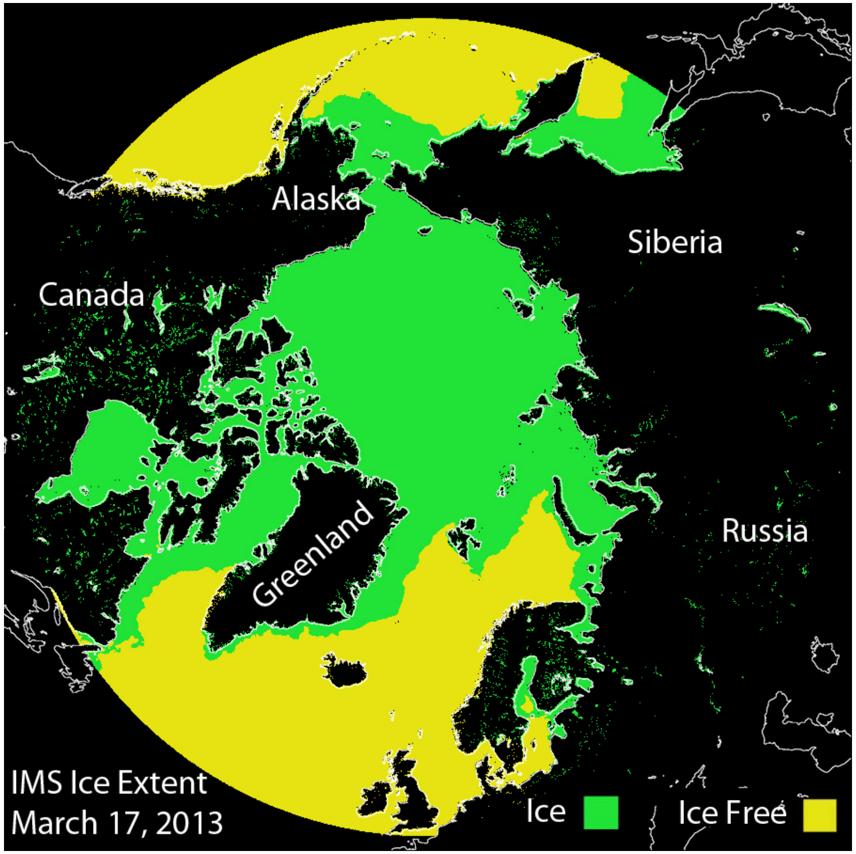
# VIIRS Sea Ice Characterization EDR Provisional Maturity Evaluation

- Provisional Maturity Evaluation Approaches
  - Our analysis has focused on the Beaufort Sea, but other regions in the Arctic and Antarctic, as well as global coverage, have been analyzed for one or more days
  - Comparison of Summer Sea Ice Characterization (SIC) EDR to ice coverage shown by 4-km IMS data
    - At this time of year, all ice should be “other ice” (not new/young) so comparison is possible
  - Manual inspection of SIC EDR images in specific regions and globally
  - Comparison of SIC EDR ice classification to National Ice Center charts
  - Comparisons to limited amount of airborne ice thickness data

# VIIRS Sea Ice Characterization EDR Provisional Maturity Evaluation

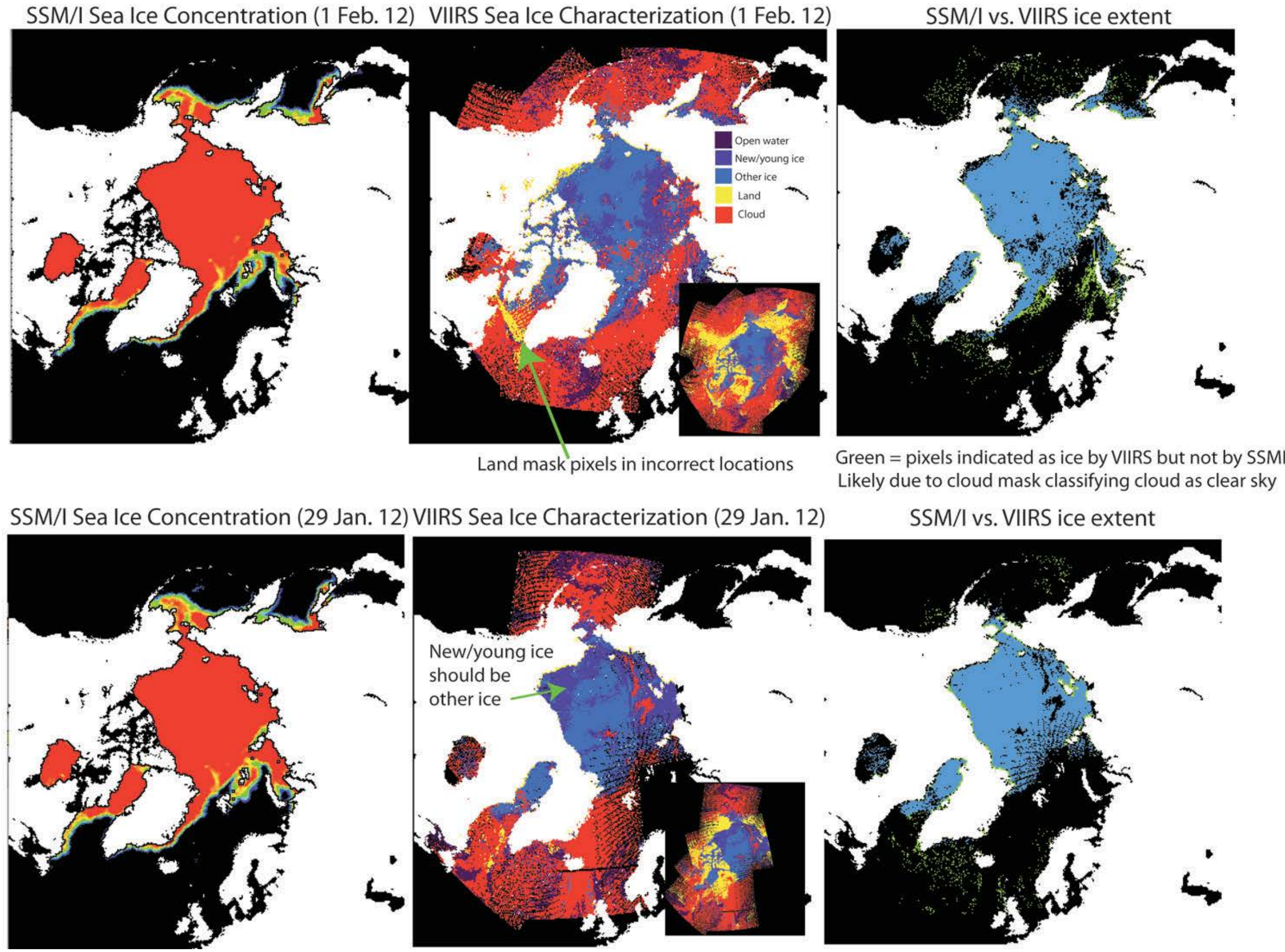
SIC EDR (left) vs. IMS Ice Extent (right). Ice coverage is similar, but new/young ice is too extensive (as seen by manual interpretation).



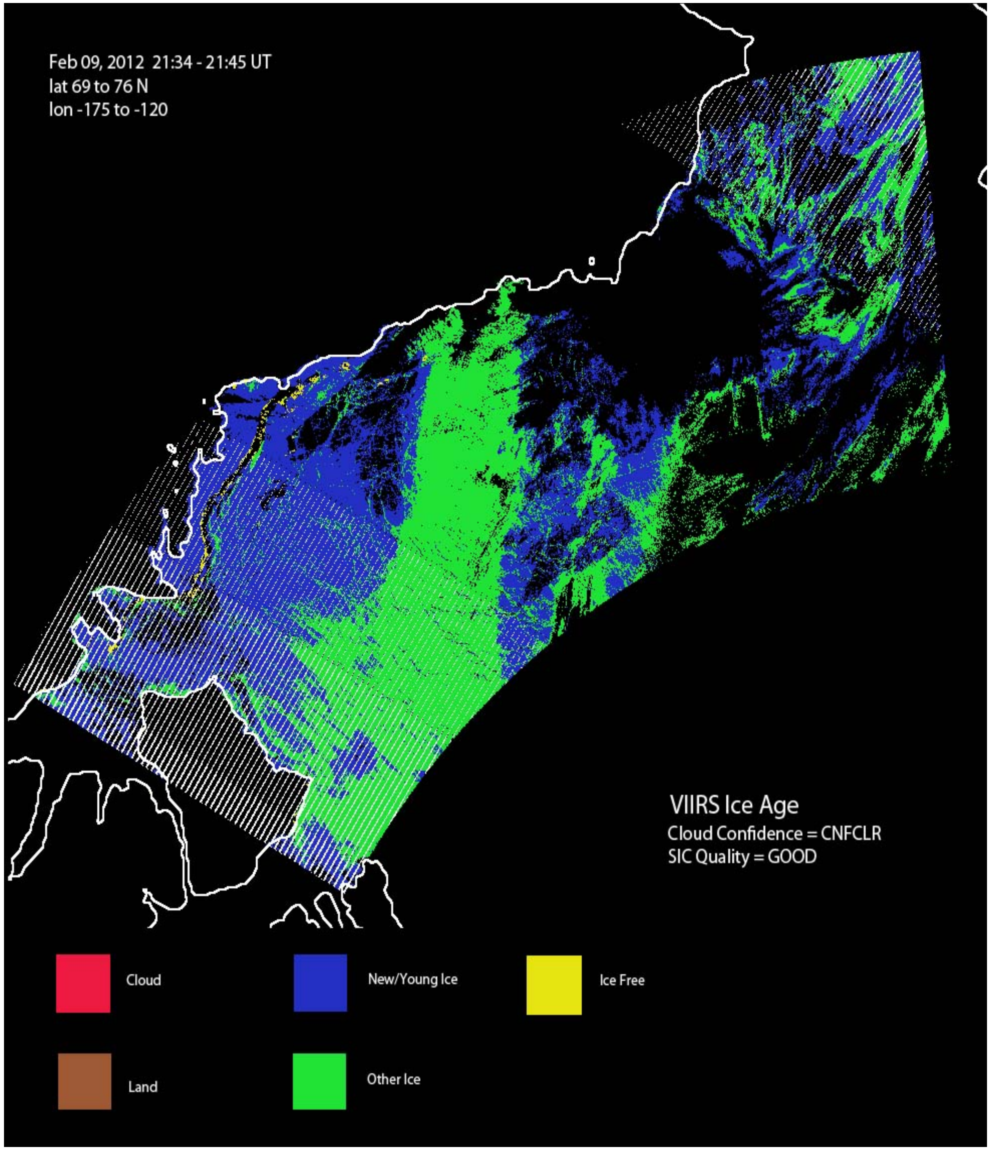
# Provisional Maturity Evaluation VIIRS Sea Ice Characterization EDR vs. Passive Microwave

*Sea ice extent is realistic, but with some false ice over open water, misclassification of new/young vs. other ice, and some misplacement of land values.*



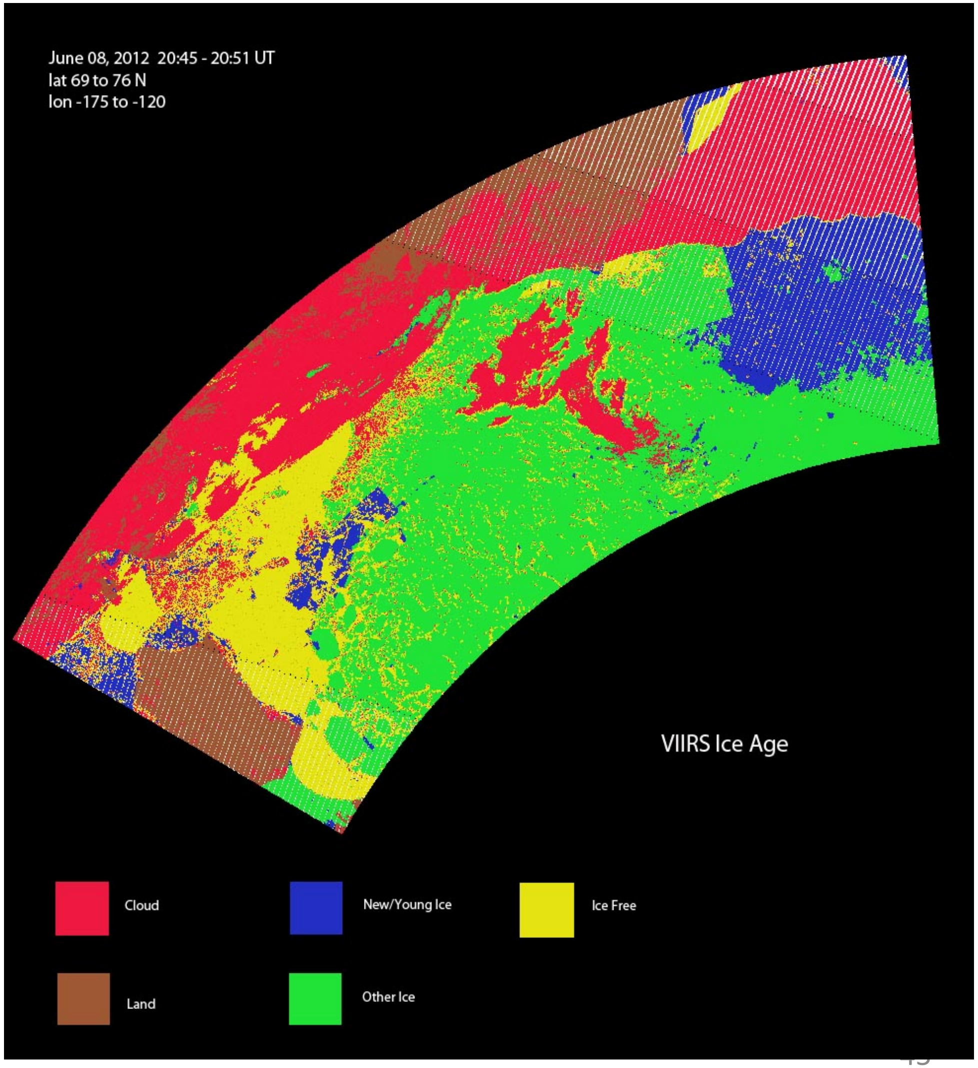
# Provisional Maturity Evaluation
# Ice Type Misclassification Due to Cloud

*VIIRS SIC on Feb 9, 2012 in the Beaufort Sea for VIIRS cloud mask confidently clear and good SIC quality flag data. New/Young ice (in blue) on left is misclassified, likely due to the presence of cloud.*



# Provisional Maturity Evaluation
# Misclassification during melt season

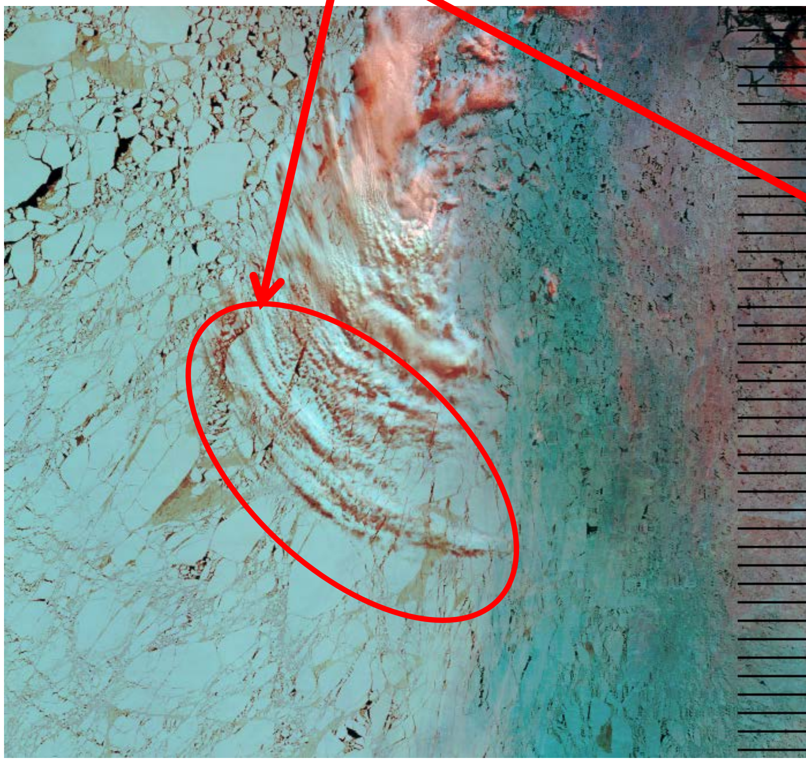
*SIC EDR for June 8, 2012, Beaufort Sea. New/Young ice (blue) is misclassified. It should not exist in June.*

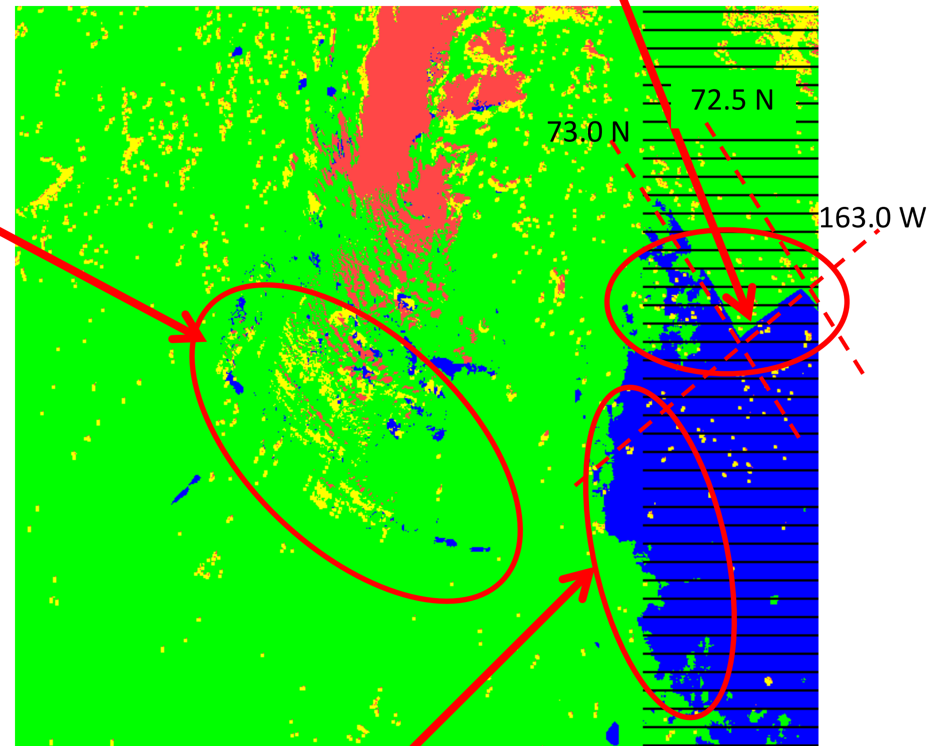


# VIIRS Sea Ice Characterization EDR Anomalies over Beaufort Sea (June 8, 2012)

**Some misclassification evident due to VCM IP cloud leakage and cloud shadows**

**Discontinuities detected along lat/lon boundaries spaced 0.5 deg.**



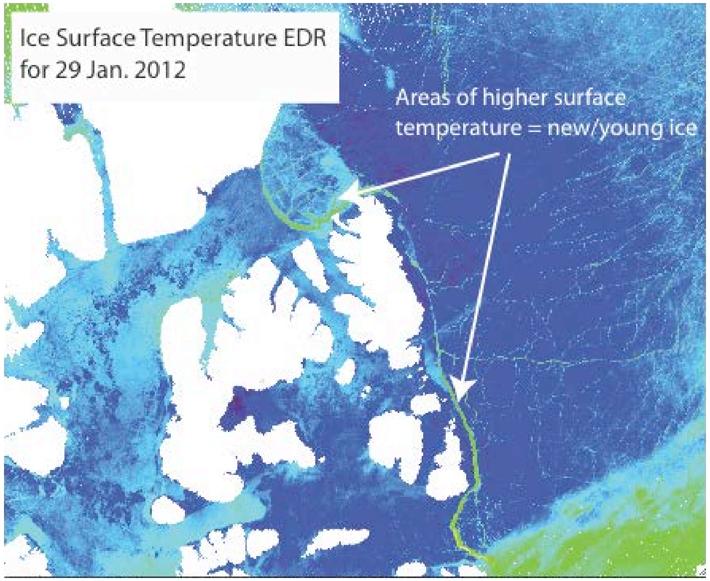



**Large region misclassified where ice tie point reflectance values drop below ~ 0.53**

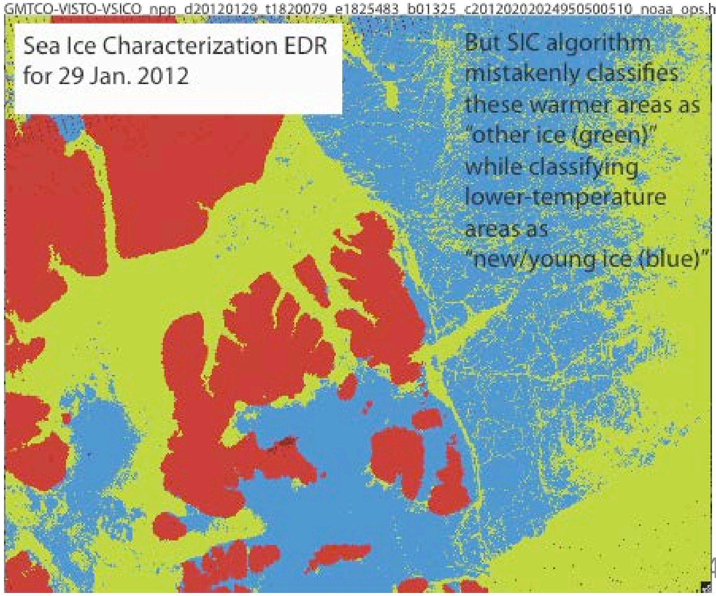
Discontinuities that align along 0.5 steps of latitude and longitude are evident as shown along the dashed lines are strongly suggestive of sensitivity to the NCEP precipitable water field. The reflectance based day algorithm has dependencies on the coarse resolution , gridded NCEP ancillary fields for precipitable water and total column ozone. In addition the algorithm also has a dependency on the climatological snow accumulation depth/ice thickness LUT (modeled using 2.5 deg. surface air and precipitation rate climatology data) .

# Provisional Maturity Evaluation
# Ice Type Misclassification

Winter scenes show misclassification of new/young ice and other ice. Sea ice "leads" consisting of relatively warm and thin ice should be classified as new/young ice. SIC winter scenes examined instead show some of this ice as "other ice" while thick, cold ice is mapped to "new/young ice" in some locations.



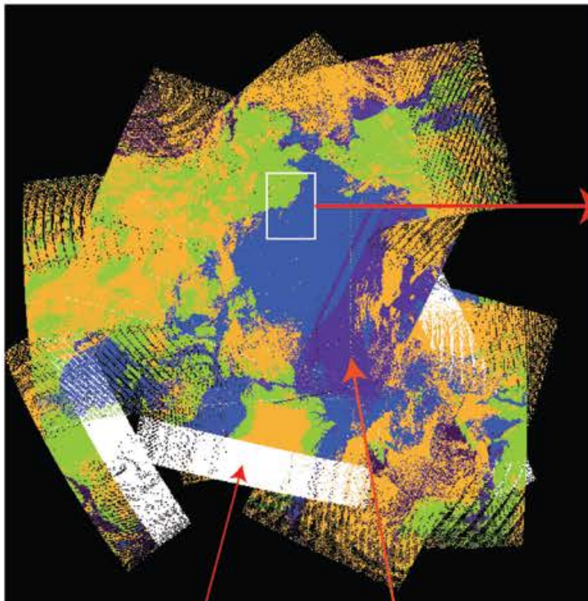

GMTCO-VISTO-VSICO_npp_d20120129_t1820079_e1825483_b01325_c20120202024950500510_noaa_ops.h5



# Provisional Maturity Evaluation
# Ice Type Misclassification

Ice type misclassification: Suggests that new/young ice vs. other ice classification may be working relatively well for daytime passes, but not for nighttime.

Sea Ice Characterization (30 March 12)

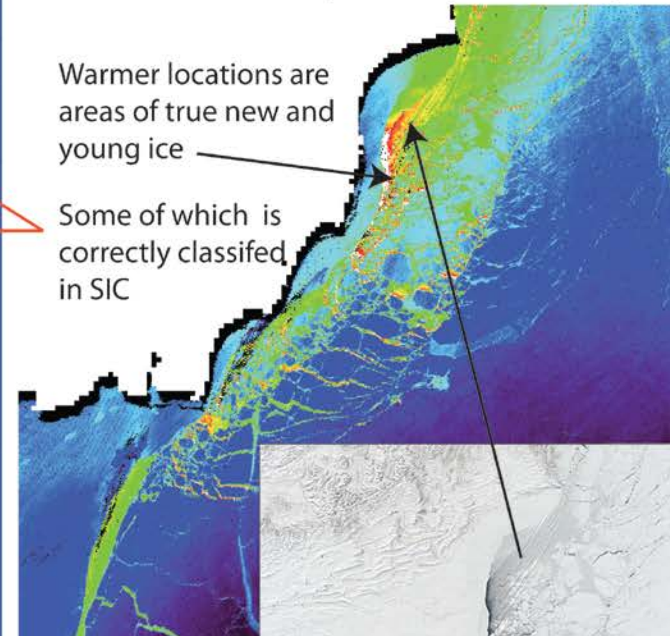


data value = 254 (ice free). Should be data value =1 (ice free) to be consisent with other values.

Large area incorrectly classified as new/young ice

New/young ice
All other ice
Cloud
Land

VIIRS Ice Surface Temperature (30 March 12)




# Provisional Maturity Evaluation
# SIC EDR vs. MODIS Ice Extent

SIC EDR is compared to MODIS over sea ice during the melt period, when only "other ice" is expected.

Beaufort Sea, July 23, 2012

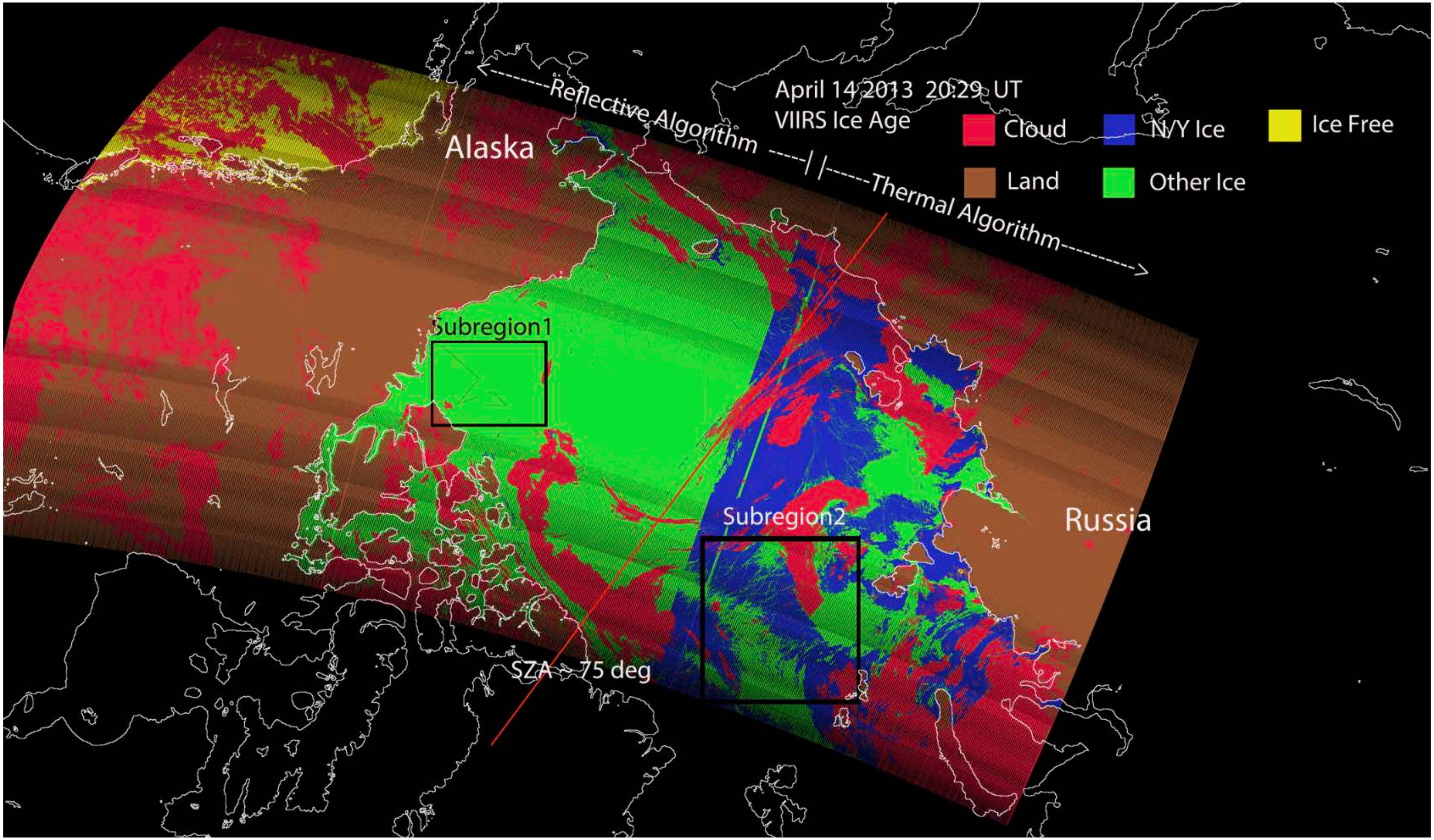
**NOTE BOTTOM ROW**

**ALLCLD**=No Cloud Cover Quality Flag Filter
**ALLQUAL**=No Ice Quality Flag Filter
**CNFCLR**=Only Pixels with Confidently Clear Cloud Cover Flag
**GOOD**=Only pixels with Good Ice Quality Flag

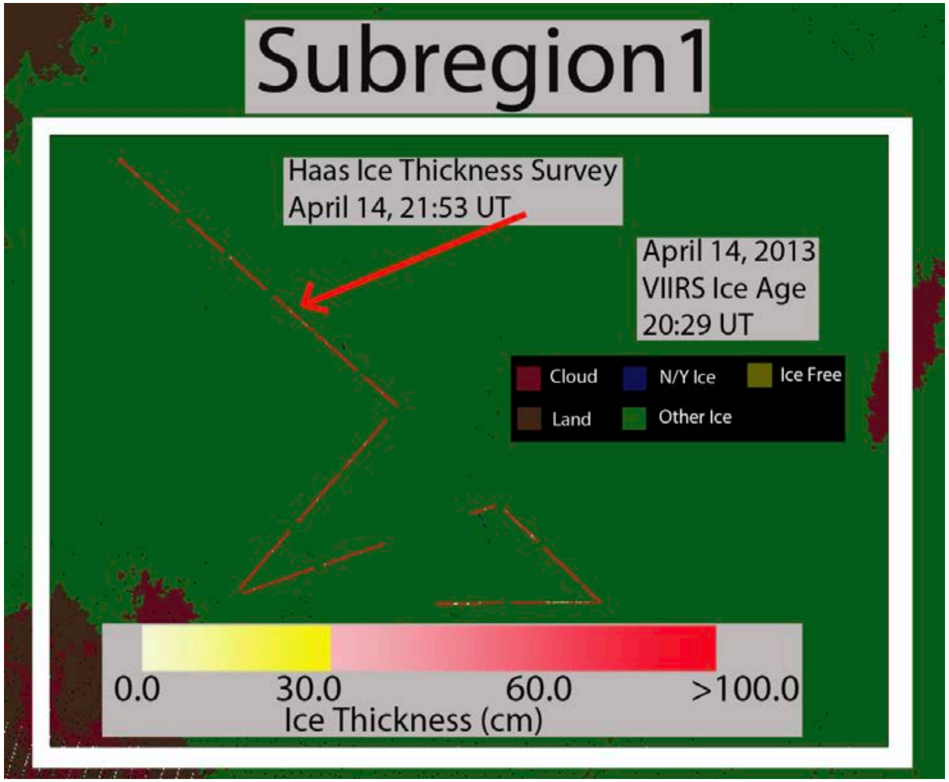
| | ALLCLD ALLQUAL #1 | ALLCLD GOOD #2 | CNFCLR ALLQUAL #3 | CNFCLR GOOD #4 |
|---|---|---|---|---|
| MODIS Ice Pix | 63252 | 27889 | 40190 | 27889 |
| VIIRS Ice Pix | 45136 | 32458 | 33368 | 32458 |
| VIIRS New/Young Ice Pix | 42708 (94.6%) | 31867 (98.2%) | 32485 (97.4%) | 31867 (98.2%) |
| VIIRS Other Ice Pix | 2428 (5.4%) | 591 (1.8%) | 883 (2.6%) | 591 (1.8%) |
| Ice Agree | 30695 (48.5%) | 27608 (99.0%) | 27902 (69.4%) | 27608 (99.0%) |
| MODIS Ice Free Pix | 83064 | 59067 | 62080 | 59067 |
| VIIRS Ice Free Pix | 109187 | 61632 | 80778 | 61632 |
| Ice Free Agree | 74192 (89.3%) | 58511 (99.1%) | 61479 (99.0%) | 58511 (99.1%) |
| MODIS ICE VIIRS Cloud | 15599 | N/A | N/A | N/A |
| MODIS Ice VIIRS Free | 16958 | 281 | 12288 | 281 |
| Ice Type Classification Accuracy* | 5.4% | 1.8% | 2.6% | 1.8% |

** note: all pixels with good ice quality are confidently clear, so columns 2 & 4 are identical.*

# Provisional Maturity Evaluation Note Sub Region 1 – Airborne Ice Thickness Data



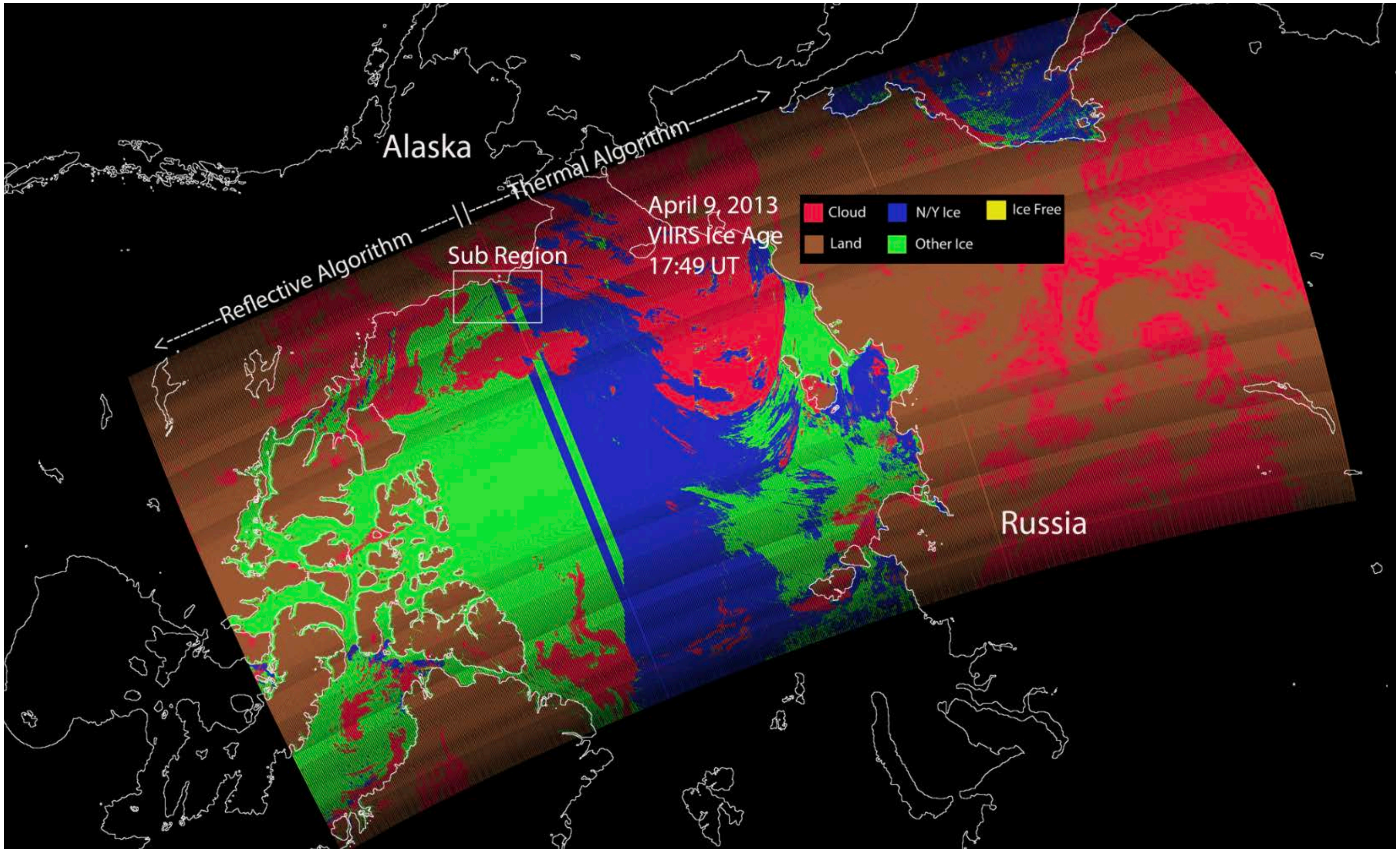
# Provisional Maturity Evaluation Airborne Ice Thickness Data




**Thickness (cm) courtesy of C. Haas: Airborne EM & Lidar**

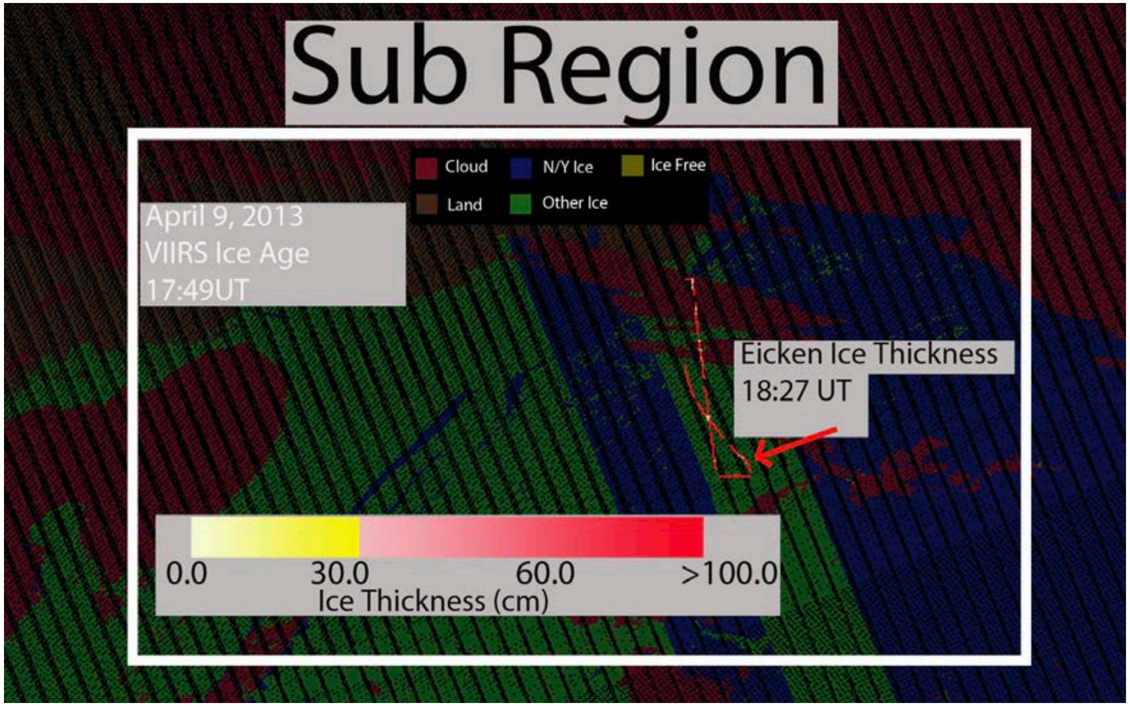
- **All ice for VIIRS SIC EDR is "other ice" (> 30 cm)**
- **1004 airborne data points: 99% > 30 cm (in agreement with VIIRS SIC EDR)**

# Provisional Maturity Evaluation
# note Sub Region - Airborne Ice Thickness Data -



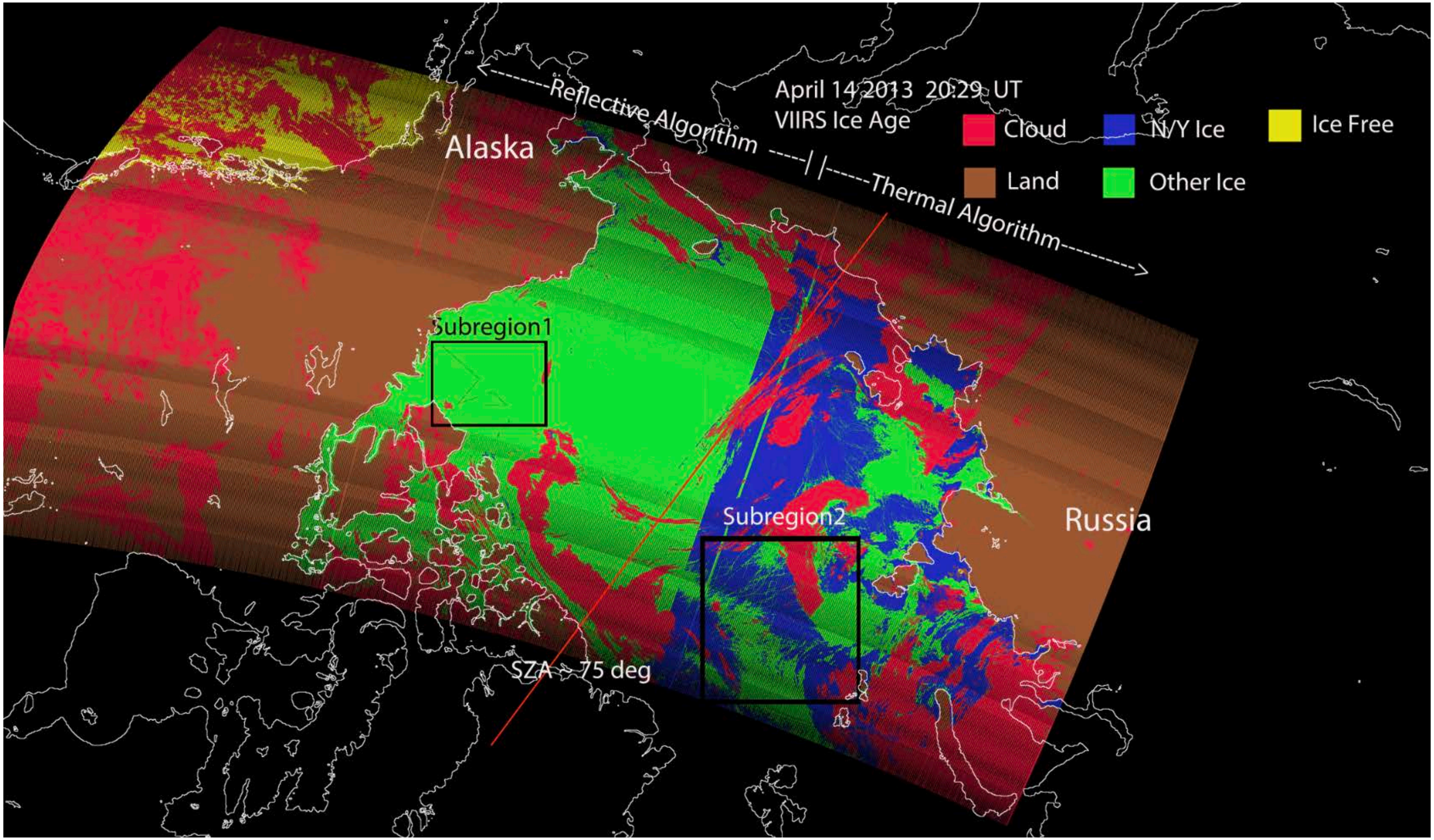

**Also note classification issues transitioning from VIIRS SIC EDR daytime (reflective) to nighttime (thermal) algorithm.**

# Provisional Maturity Evaluation
# Airborne Ice Thickness Data



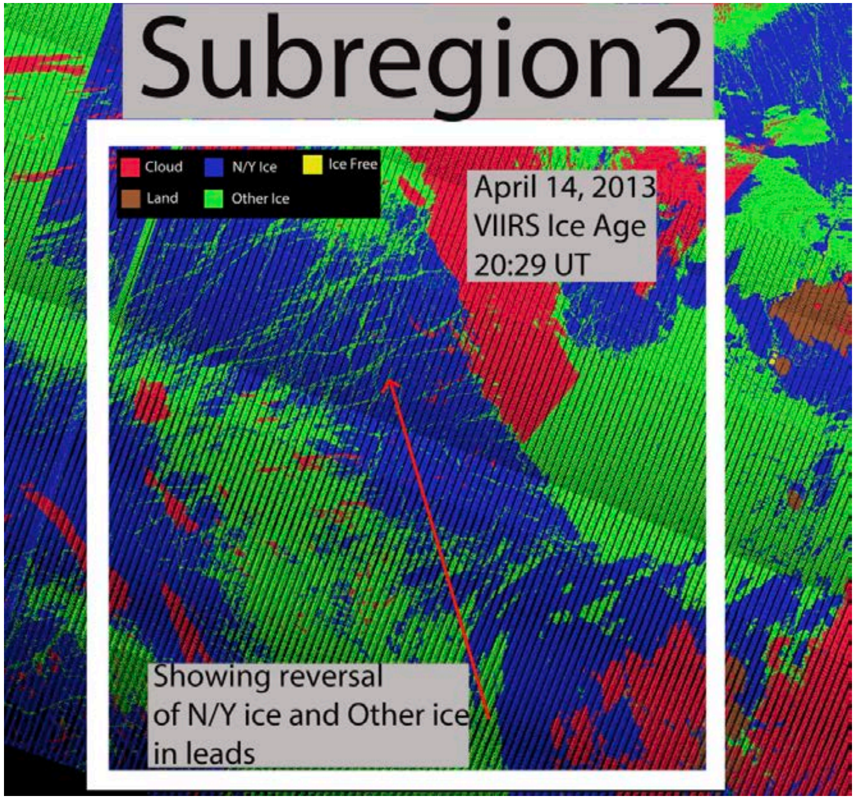

- **SIZONET data (Eicken et al.)**
- **Airborne EM & Lidar, same system used by Haas et al. (2007)**
- **Note: this is quicklook data and has not been qc'd, so will be used as a future data source for validation.**
- **Before QC, classification accuracy is 42% correct (VIIRS SIC vs Aircraft data)**
- **Note that aircraft validation data is VERY limited (In this survey, only 130 points collected)**

# Provisional Maturity Evaluation
# Note Sub Region 2 – Test of Validation Algorithm

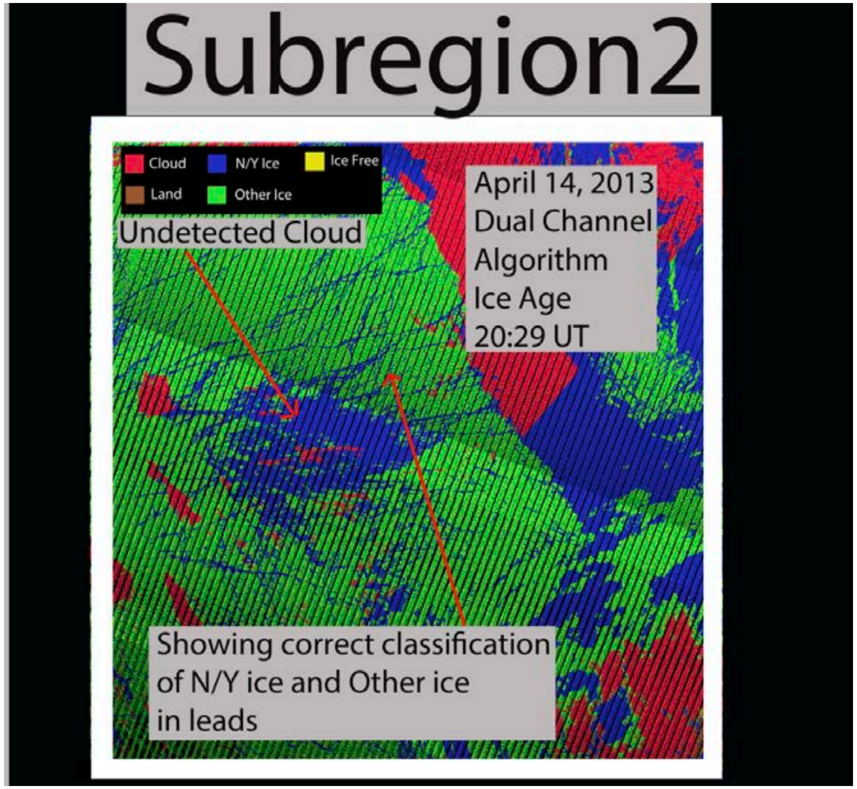


# Provisional Maturity Evaluation
# Test of Simplified Daytime Algorithm for Validation

- **Leads misclassified as "other ice"**
- **Ice surrounding leads misclassified as "new/young ice"**




**Using a simple M7 / IST "dual channel algorithm," areas of new/young and other ice are identified, assisting with estimates of classification accuracy.**



# Provisional Justification Summary

## Version control is in affect

- IDPS build number: Mx6.7 and earlier for validation results
- ATBDs are accurate, up-to-date and consistent with the product running.

## General research community is encouraged to participate in the QA and validation of the product, but need to be aware that product validation and QA are ongoing

- Cryosphere SIC EDR team has evaluated IDPS EDR products available from CLASS. Users can access and read the products and the product compares reasonably with the heritage satellite snow map products

# Provisional Justification Summary

**Users are urged to consult the EDR product status document prior to use of the data in publications**

- Sea Characterization EDR performance is dependent on VIIRS Imagery resolution SDRs and the VIIRS Surface Temperature IP tie points.
- It is also dependent on the VIIRS Cloud Mask IP, and AOT IP through the Ice Quality Flags IP and Ice Weights IP, and NCEP ancillary surface data. Dependencies on LUTs include LUTs for model TOA snow/ice reflectance, broadband albedo, atmospheric transmittance and a modeled climatology based snow depth/ice thickness LUT.

  - VIIRS SDR Cal and Geo products reached provisional maturity in Mar. 2013
  - VIIRS Cloud Mask IP reached provisional maturity in Feb. 2013
  - VIIRS Aerosol Optical Thickness reached beta maturity in Sep. 2013
  - VIIRS Surface Temperature IP path forward plan in place (DR 2936, slide 12)

# Provisional Justification Summary

- Criteria: Product is not appropriate as the basis for quantitative scientific publication studies and applications
  - The product has known flaws (see caveats slides later in this presentation). It is clearly not suitable for use in publications.

# Caveats for Operational VIIRS Sea Ice Characterization EDR

- Known problems and proposed technical solutions
  - In general, significant discontinuities in ice classification between New Young and Other Ice have been observed in the granule level mapped composite data.
    - Proposed solution: Investigate and mitigate sensitivity of retrievals to NCEP ancillary data inputs. Mitigation strategies include use of parameterizations or climatology
  - Ice classification discontinuities are very evident near the terminator region where the algorithm transitions from the day reflectance based algorithm to the night energy balance based algorithm
    - Proposed solution: Nighttime algorithm could be revised to utilize a local sliding IST window. For example, if the IST for the pixel is greater than the mean plus a threshold of the IST in the moving window, then it would be re-classified as new/young ice. )
    - Proposed solution: Investigate whether there is a problem with the solar energy flux term used by the heat balance for solar zenith angles between 80° and 90° and correct the implementation if necessary.
  - The snow depth thresholds based on the snow accumulation depth/ice thickness climatology LUT are problematic
    - Proposed solution: LUT generation logic requires modification to correct climatologically unrealistic values of snow accumulation depth identified the current LUT
    - Proposed solution: Investigate use of ancillary precipitation to derive snow depth and compute an ice thickness based on that snow depth. Dependence on the problematic SnowDepth/IceThickness Climatology LUT can then be eliminated.

# Caveats for Operational VIIRS Sea Ice Characterization EDR (additional issues)

- False ice is frequently observed near cloud edges
  - Proposed solution: Implement additional quality checks for extended cloud adjacency and partly cloudy conditions within the ice tie point search window in the Sea Ice Concentration IP and pass quality flag to Sea Ice Characterization EDR
- Ice misclassifications occur due to low opacity clouds or ice fog, particularly during nighttime
  - Proposed solution: Assistance from VCM to improve cloud vs. ice detection
- Thin ice in small leads are evident in SDR imagery are sometimes not detected and are classified as thicker “Other ice”
  - Proposed solution: Investigate using VIIRS SDR reflectance and Surface Temperature IP value at each pixel for retrievals instead of the ice tie point
  - Proposed solution: Add an ice temperature threshold hold test to the day reflectance algorithm as a consistency check for the day, reflectance based retrievals
- Lower reflectance of melting sea ice appears to cause the SIC EDR to indicate New/Young Ice, although this type of ice cannot be present this time of year.
  - Proposed solutions: Define and utilize melt season period where New/Young ice cannot exist. Could do this by date/latitude or possibly with IST or NCEP air temp input. During this time, ALL ice would be classified as “other ice”
  - Investigate reflectance and temperature thresholds used in the algorithm
  - Investigate and mitigate sensitivity of retrievals to NCEP ancillary data inputs
  - Change the category “New/Young Ice” to “Thin Ice”. Thin ice can occur, through melt, in the warm season.

# Additional Supporting Documentation

- TIM Meetings and Presentations
  - Cal/Val Team Meeting, April 2012
- Monthly/weekly reports
  https://groups.ssec.wisc.edu/groups/jpss/cryosphere/reports

# Future Plans and Issues

- We are working to get these changes into the IDPS
  - Implement additional quality checks for extended cloud adjacency and partly cloudy conditions within the ice tie point search window in the Sea Ice Concentration IP

- Detailed performance characterization requires:
  - Analysis of sensitivity of retrievals to NCEP ancillary data inputs and snow depth on sea ice

- Major actions for the provisional maturity justification and schedule
  - Revision, testing and implementation of SIC EDR Nighttime Algorithm, possibly utilizing a local sliding IST window. *Fall 2014?*
  - Revision, testing and implementation of SIC EDR Daytime Algorithm to possibly include:
    - » Redefine the category to be thin ice (< 30 cm) or define a melt season period where New/Young ice cannot exist, or utilize IST checks to assist with ice type definition *Mid-2014?*
    - » Use of ancillary precip. field to improve snow depth estimates and to derive ice age based on ice thickness computed from snow depth. *Mid-2014?*

# Conclusion

- VIIRS Sea Ice Characterization EDR has met the provisional maturity stage based on the definitions and the evidence shown
- Some issues have been uncovered during validation and solutions are being evaluated.