Evaluation of MAGIC Sea Ice Classifier on 61 Dual-polarization RADARSAT-2 Scenes

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Motivation

- Automated ice classification has many benefits:
  - » Very high detail (pixel level)
  - » Process large data sets (especially important for future)
  - » Consistency (no inter-operator bias)
  - » Automated analysis for typical scenes - leaves complex scenes and validation to experts
- MAGIC sea ice classifier is new and complex and requires validation
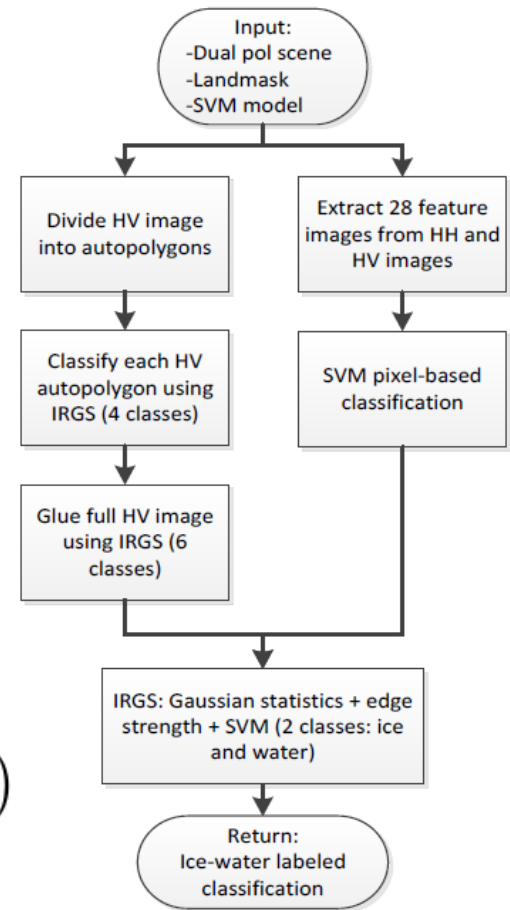
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MAGIC System (MAp Guided Ice Classification)

- Software for developing, testing, sharing, and using image processing algorithms

- Accessible GUI interface for complex algorithms

- Primarily developed for sea ice

- This study used the MAGIC system to evaluate one of its main algorithms: IRGS+SVM sea ice classifier

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MAGIC Algorithm: IRGS+SVM

- (Leigh et al. 2014)
- Combination of classifiers
- Takes RS-2 scene as input
- Returns binary ice-water labelled scene

$$E = \sum_{i \in R} \left[V_G(x_i) + V_S(x_i) \right] + \sum_{\langle i,j \rangle \xi} V_E(x_i, x_j)$$

Input:
- Dual pol scene
- Landmask
- SVM model

Divide HV image into autopolygons

Extract 28 feature images from HH and HV images

Classify each HV autopolygon using IRGS (4 classes)

SVM pixel-based classification

Glue full HV image using IRGS (6 classes)

IRGS: Gaussian statistics + edge strength + SVM (2 classes: ice and water)

Return: Ice-water labeled classification

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IRGS (Iterative Region Growing using Semantics)

- Initially developed for sea ice (Yu and Clausi, 2008)
- Classification with arbitrary labels
- Spatial context - Region based
- Merges based on Gaussian statistics and edge strength
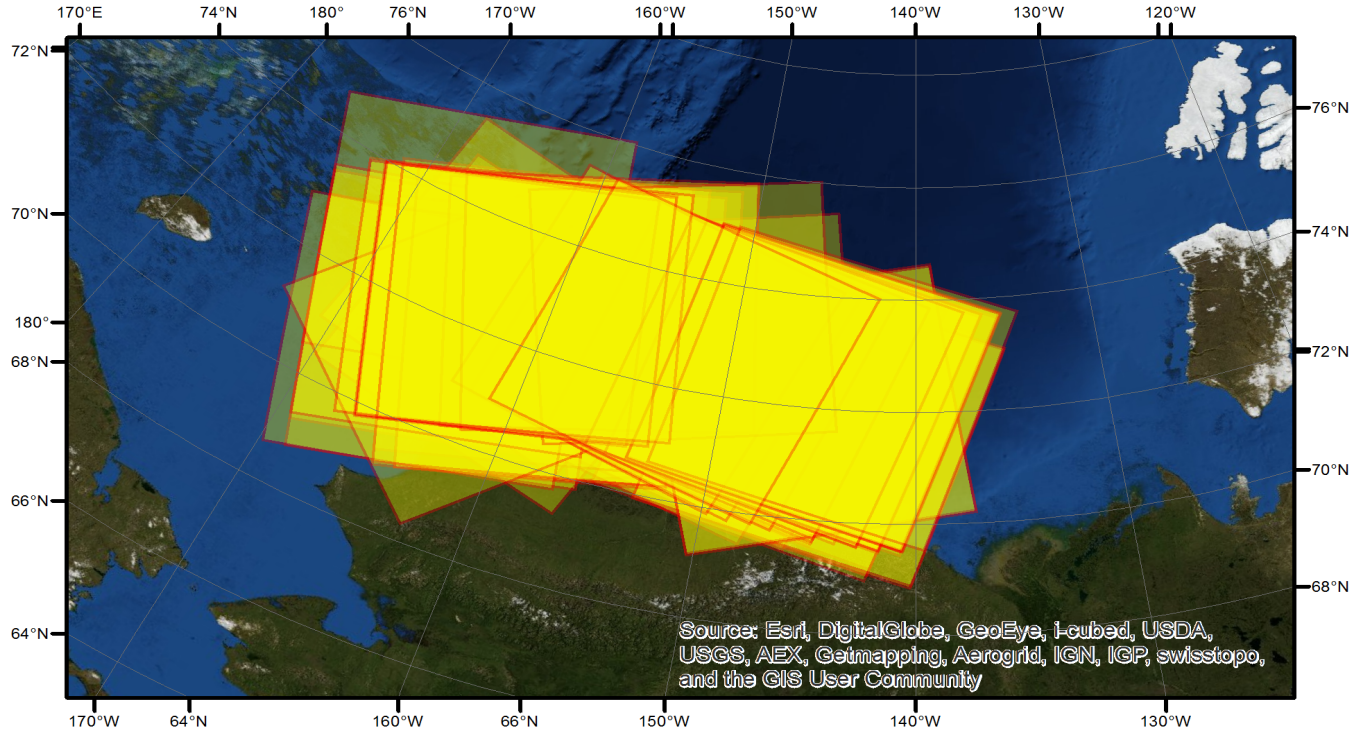- Only HV pol

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SVM (Support Vector Machine)

- Provides ice-water labels
- Models non-linear nature of ice vs water discrimination boundary
- 28 features, primarily texture from HH and HV pols
- Leave-one-out training/testing

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Data Set

- 61 scenes

- RADARSAT-2 scanSAR Wide

- 10,000 by 10,000 pixels at 50m resolution

- Dual pol HH, HV

- HH has strong incidence angle effects

- April 2010 – Nov 2011

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Location

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Ground Truth

- Created manually using MAGIC PEF (Performance Evaluation Framework)

- Reference expert ice charts when available
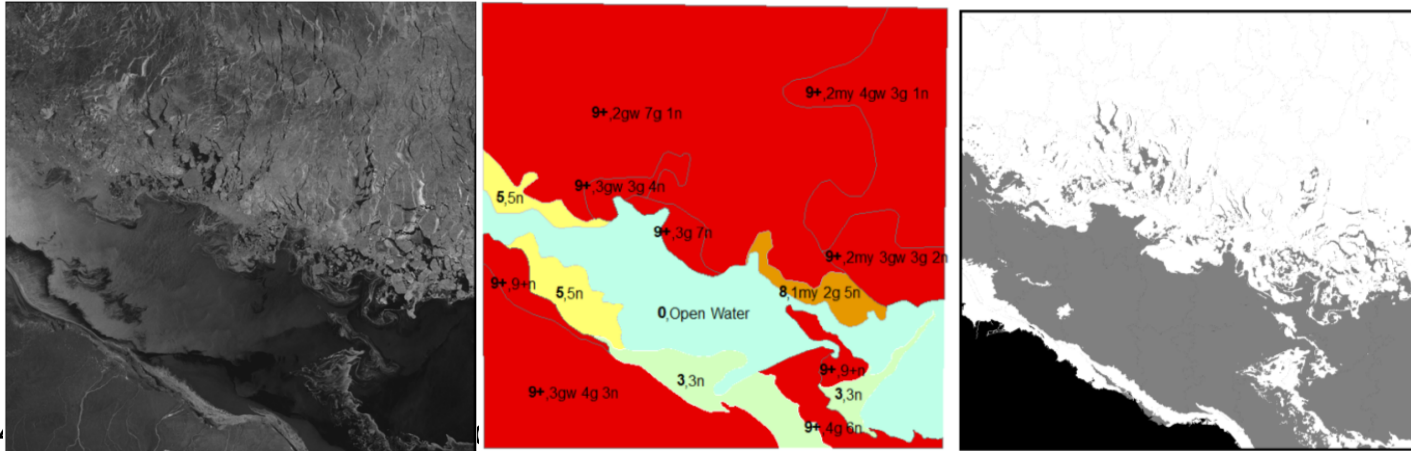
Results

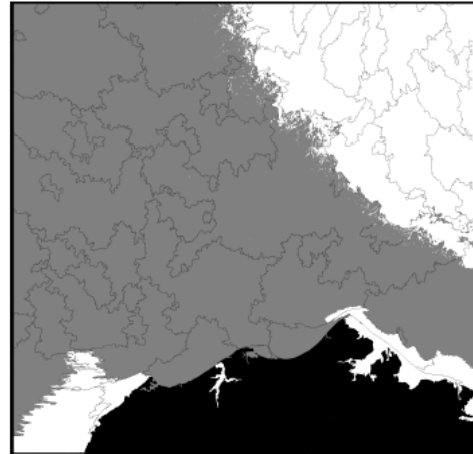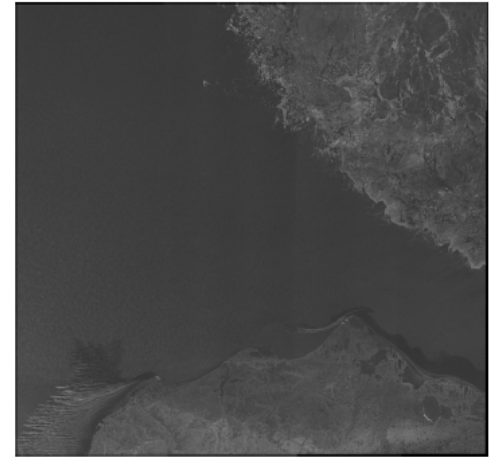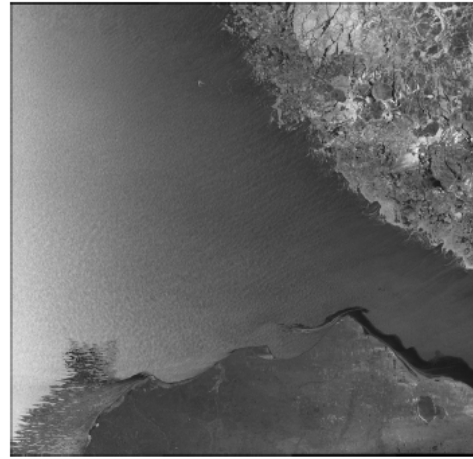- Overall accuracy: 95.8%

- Classification speed: ~22 min per scene

- Over 90% of scenes are over 90% accurate

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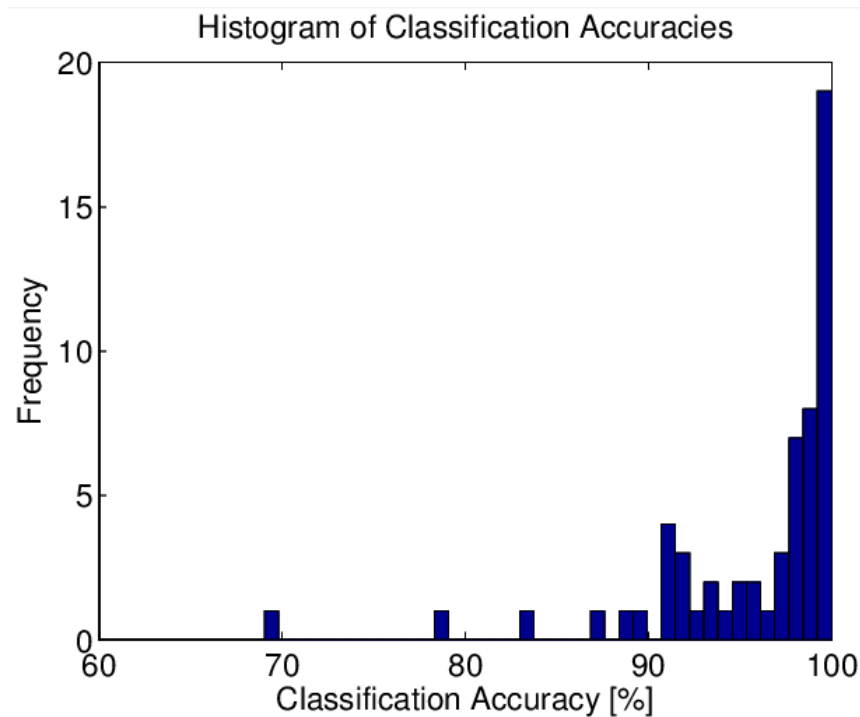
Sample Result

- [HH] [HV]
  [ground truth] [result]

- Wind-roughened water

- Dark ice response

- Accuracy: 95.9%

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Conclusion

- MAGIC maintains high accuracy (>95%) through challenging circumstances:
    - » New data set
    - » Wind-roughened water
    - » Incidence angle
    - » Across seasons and years
- Under consideration by CIS for operational purposes

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Thank You

Questions?

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