SEA ICE LEADS

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• Leads are elongated fractures in the sea ice cover. They form under atmospheric and oceanic stresses (Smith et al., 1990).

• Leads provide a source of heat and moisture to the Arctic atmosphere (Alam and Curry 1995, Maykut, 1987).

(From earthobservatory.nasa.gov)
Objective

• Identify the spatial and temporal distributions of sea ice leads (fractures) in the Arctic
• Study trends in the lead distributions and properties (concentration, width, and orientation)

Image credit: National Ice Center
2003 - 2017: MODIS (AQUA & TERRA)

- January - April
- 10 polar regions
  - Beaufort Sea
  - Chukchi Sea
  - Canada Basin
  - Central Arctic
  - Laptev Sea
  - North Pole
  - Nansen Basin
  - Kara & Barents Sea
  - GIN Seas
  - Baffin Bay
Algorithm Description

- Data Collection
  - Cloud Mask
  - Ocean Mask
  - Ice Concentration
  - Composite Granules

- Leads Detection
  - Region Identification
    - Sobel Filter
    - Preliminary Shape Tests
      - Hough Transform
        - Short Hough Line
          - Hough Line Region
            - Lead Characterization
              - Region Identification
                - Lead Branch Processing
                  - Lead Branch Edge Calculations
                    - Lead Branch Output
                      - Leads Products

- Sub-region Test
  - Symmetric Test
    - Circular Test
      - Cloud Test
        - Width Test
          - Segment Width Test
            - Lead Branch Output
              - Leads Products

Adapted from Key et al. (1993 and 1994)
• VIIRS consistent along-swath resolution results in better ice concentration retrievals
  – More detail in sea ice concentration results in more leads detected
Leads Detection

- VIIRS detects more leads in regions where MODIS scan angles are greater than 30°

- Lead detect appears as red the day it is detected.
- To show movement, leads fade from white to black on days it is not detected

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VIIRS
MODIS
MODIS Leads Characterization

- Identify object start and end point
  - Length (great-circle distance)
  - Orientation (shown)
- Area
  - Pixel count x pixel resolution
- Width
  - Area/length
Annual Trends

- Slight decreasing trend in MODIS leads area
- Improved spatial coverage from VIIRS will help detect more leads where MODIS has poor spatial coverage

Leads Trend
$-6.1 \times 10^{-4} \text{ km}^2/\text{km}^2/\text{year}$
Summary

- 15 year archive
- Ongoing work
  - Investigate trends
  - Write documentation
- Future steps
  - Real-time product
  - Extend algorithm to VIIRS

Cloud coverage
- Blue/green
Leads
- Red on the day of detection
- Fade from white to grey