Ice Defense Basics

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Ice Defense in general

- The process of enabling an operation to proceed in defined ice conditions
- Protect vessels and structures from ice
- Create time windows of safety for operational steps
- Generate information upon which to base decisions
- Manage the ice

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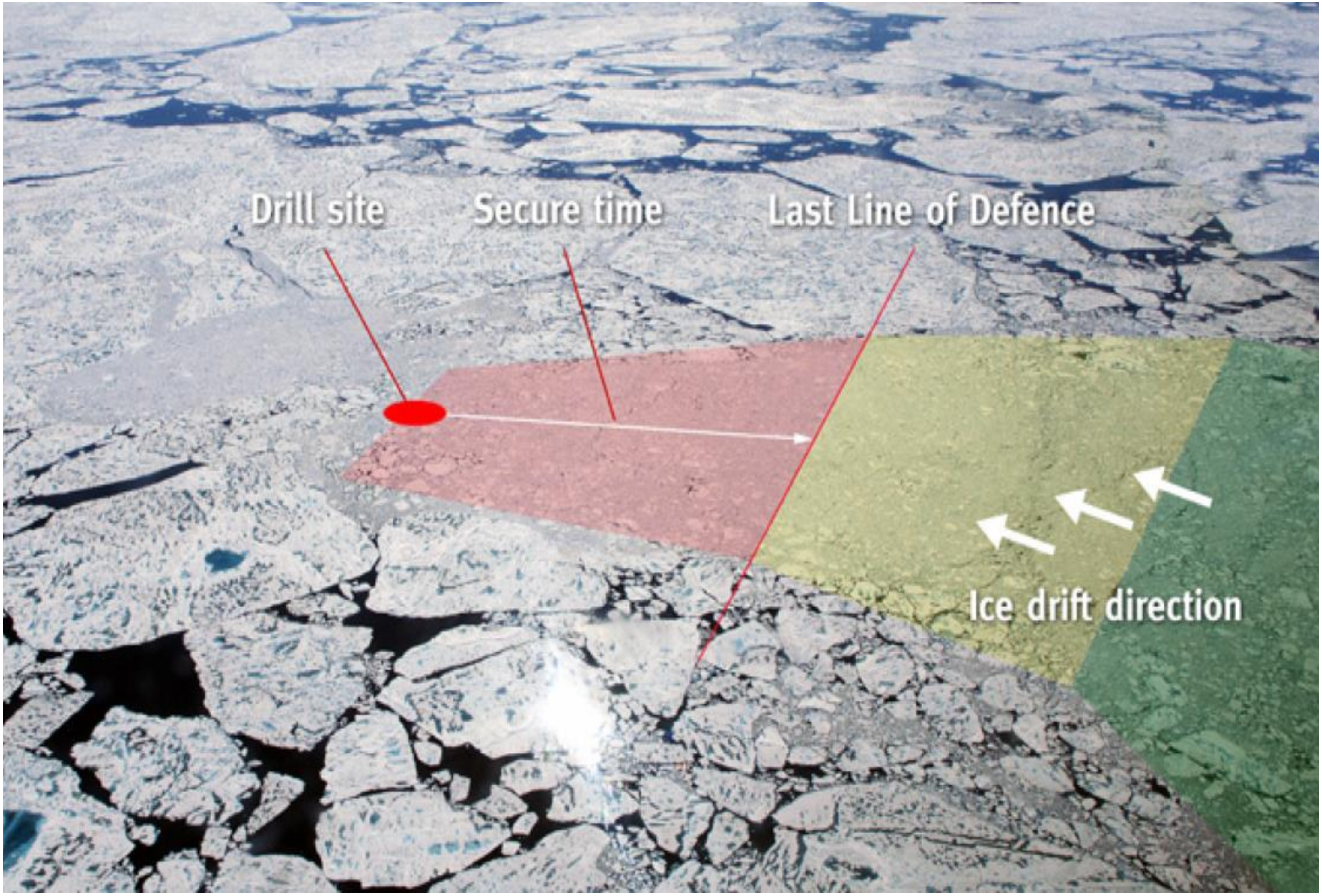

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Ice

- New Ice, or First Year Ice
  - Frozen the same season
  - Fairly level
- Old Ice
  - Survived a summer
  - Ridged, less salt content, stiffer
- Multi-year Ice
  - Survived several summers
  - Heavily ridged, less salt, stiffer, concrete

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Forecasts

- Strategic Planning Forecast
- Operational Planning Forecast
- ”Nowcast”

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Strategic Planning Forecast

- Time frame of one week
- General ice movements, reasonable detail
- Large objects
- Satellite imagery
- Statistical reference data

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Operational Planning Forecast

- Time frame of 72 hrs
- Aimed at plan execution
- Detailed and covers smaller objects
- Creates time windows
- Issued frequently in order to update progress
- Local data in addition to remote data
- Basis for direct operational decisions

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Nowcast

- Real time
- Time frame up to 6 to 8 hrs
- Very high detail
- Local data is fed in as control loop
- Uses sensors in the immediate area coupled with other data

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Last Line of Defense

- When not preperly managed ice reaches this line, operations must be stopped in a controlled manner
- Defined in time, not distance
- The operation's ability to disconnect in a controlled manner is important
  - When the Last Line of Defense is broken, the operations manual defines what happens next

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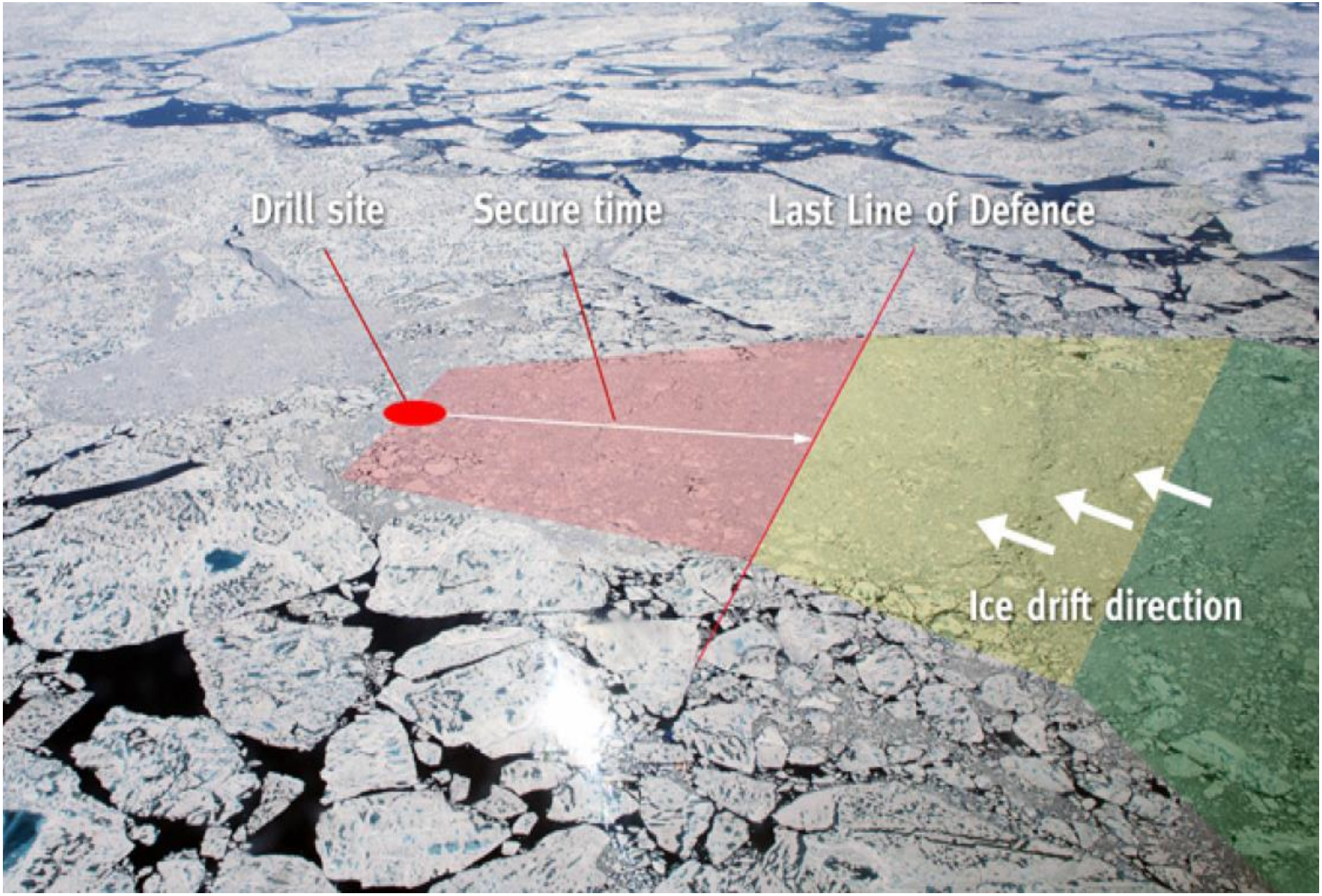
Secured Time

- The zone inside the Last Line of Defense
- All ice is managed to acceptable levels for the operational parameters
- For an operation with zero ice tolerance, this is a zone free of ice objects
- For an operation with ice tolerance, this is a zone with all ice meeting safe criteria



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”Open Water”

- Tricky definition...
- Ice cover less than 1/10
- When you are in an area with ice, and in the middle of it, the local conentration is always 10/10!
- *Thus, an ”open water” operation in an area where ice can intrude must be considered an ice operation.*

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Ice Cover < 1/10 --- Open Water

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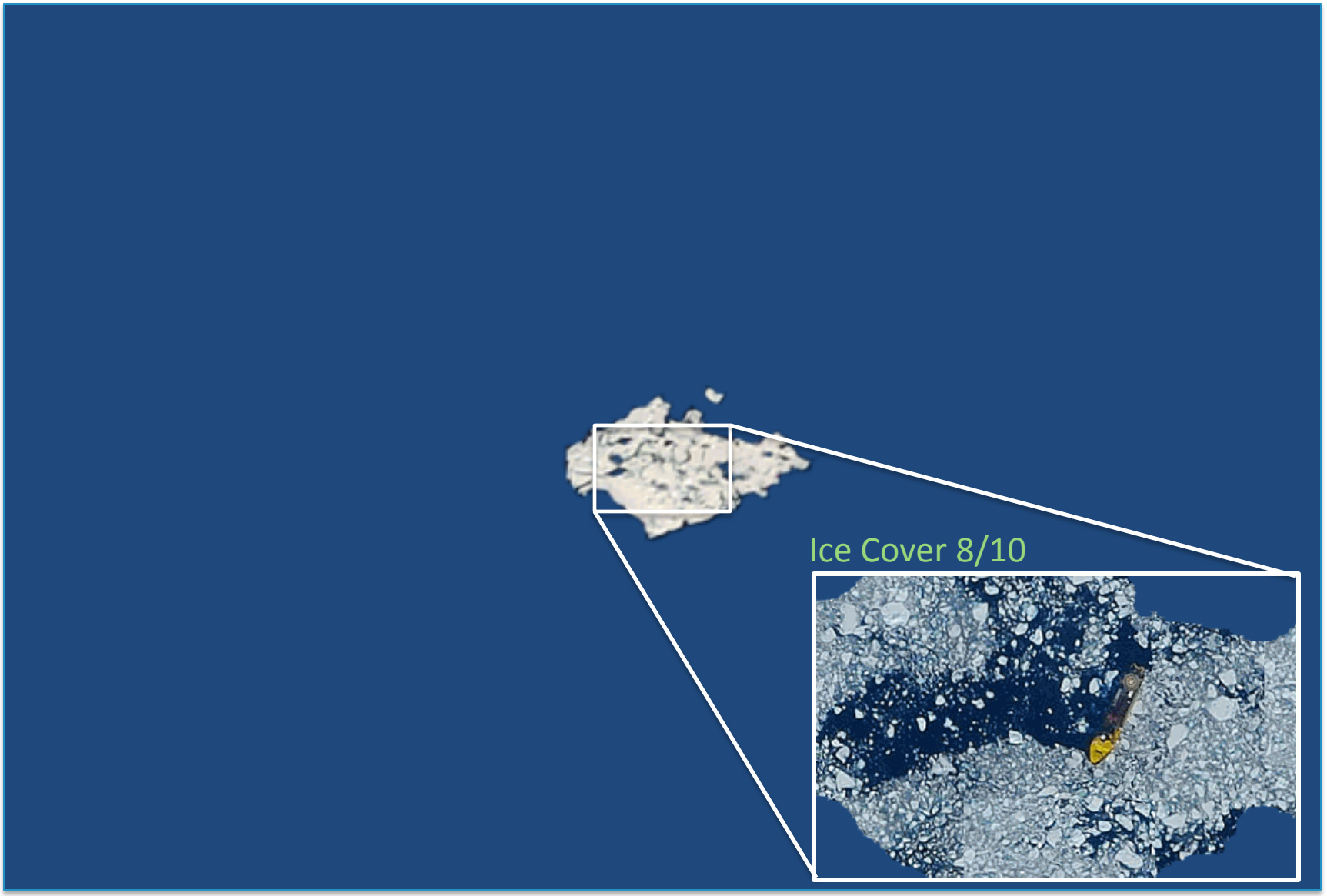

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”Open Water”

- A plan to abandon upon ice intrusion is not feasable and gives no margins
- Means for mitigation must instead be present
- Drill equipment must be evaluated for minor ice impacts and acceptance levels determined

Ice Defense Operational Phases

- Strategic Planning
  - Anything beyond 24 hrs
- Operative Planning
  - 2 to 24 to 72 hrs
- Ice Monitoring
  - Real time data
  - Immediate actions

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Experience

- We have performed this kind of ice defense over the years with evolving techniques
  - Arctic Ocean 96
  - ACEX 2004
  - Agave 2007
  - NEGC 2008
  - Fram Strait 2010

Lessons earned

- Satellite imagery is good for planning, less so for actual operations
- Meteorology is a very important factor in getting accurate forecasts
- Long T-times can never be guaranteed
- Procedures for reasonable disconnects must exist

Lessons learned

- Accurate ice forecasting is a local thing
  - The forecast can vary at such short distances as 10nm
- Accurate local ice monitoring is essential
- Fleet control must exist
- Integration is the word

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