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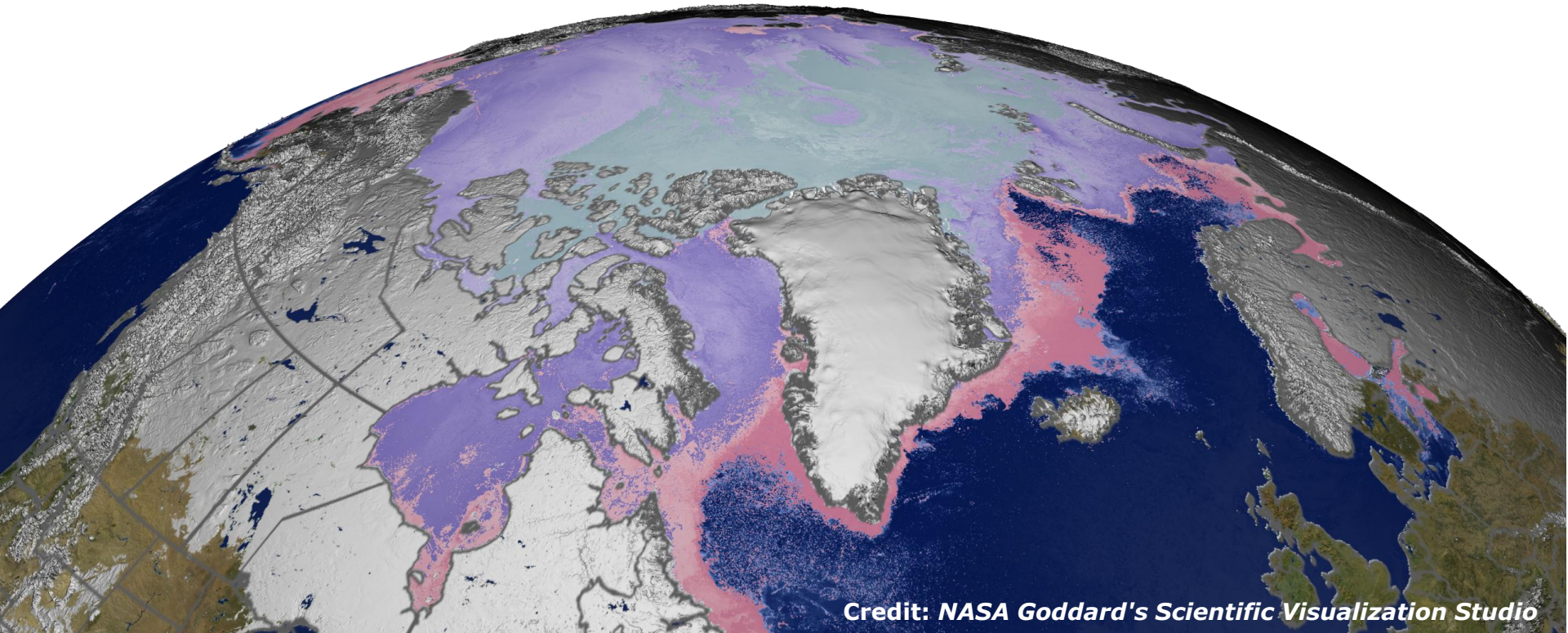
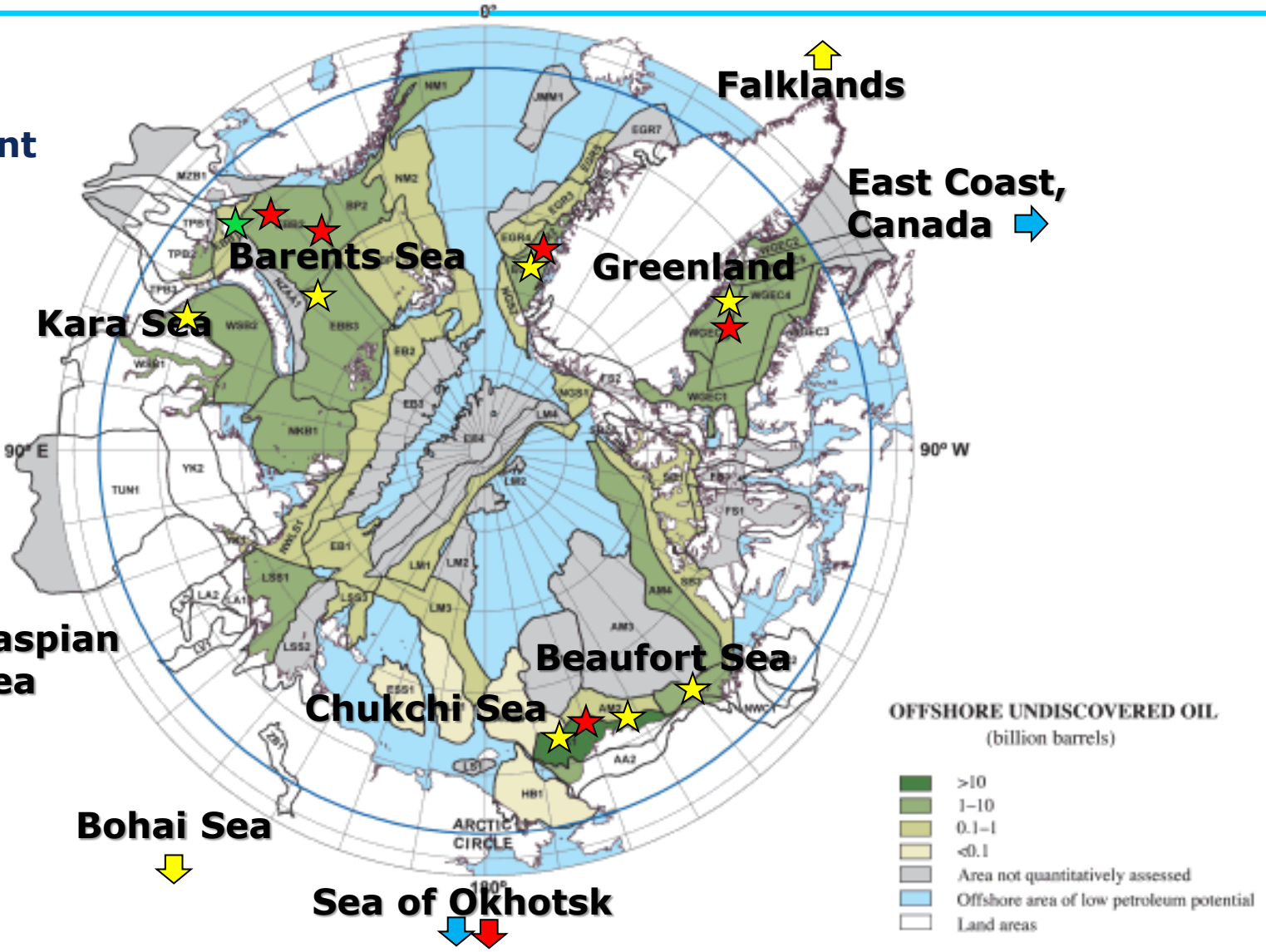
Application of Earth Observation to the O&G industry in the Arctic

Kim Partington



O&G in ice-prone regions

- Production
- Development
- Exploration
- Pre-license



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Source

- D. Power, K. Partington and W. Spring, ”The Use of Satellite-Based Ice Information in the O & G Sector:
  - Phase 1 Requirements and Current Practices” (complete)
  - Phase 2: The Use of Satellite-Based Ice Information in the O&G Sector: Phase 2 Guidelines (approved by OGP, not yet started)

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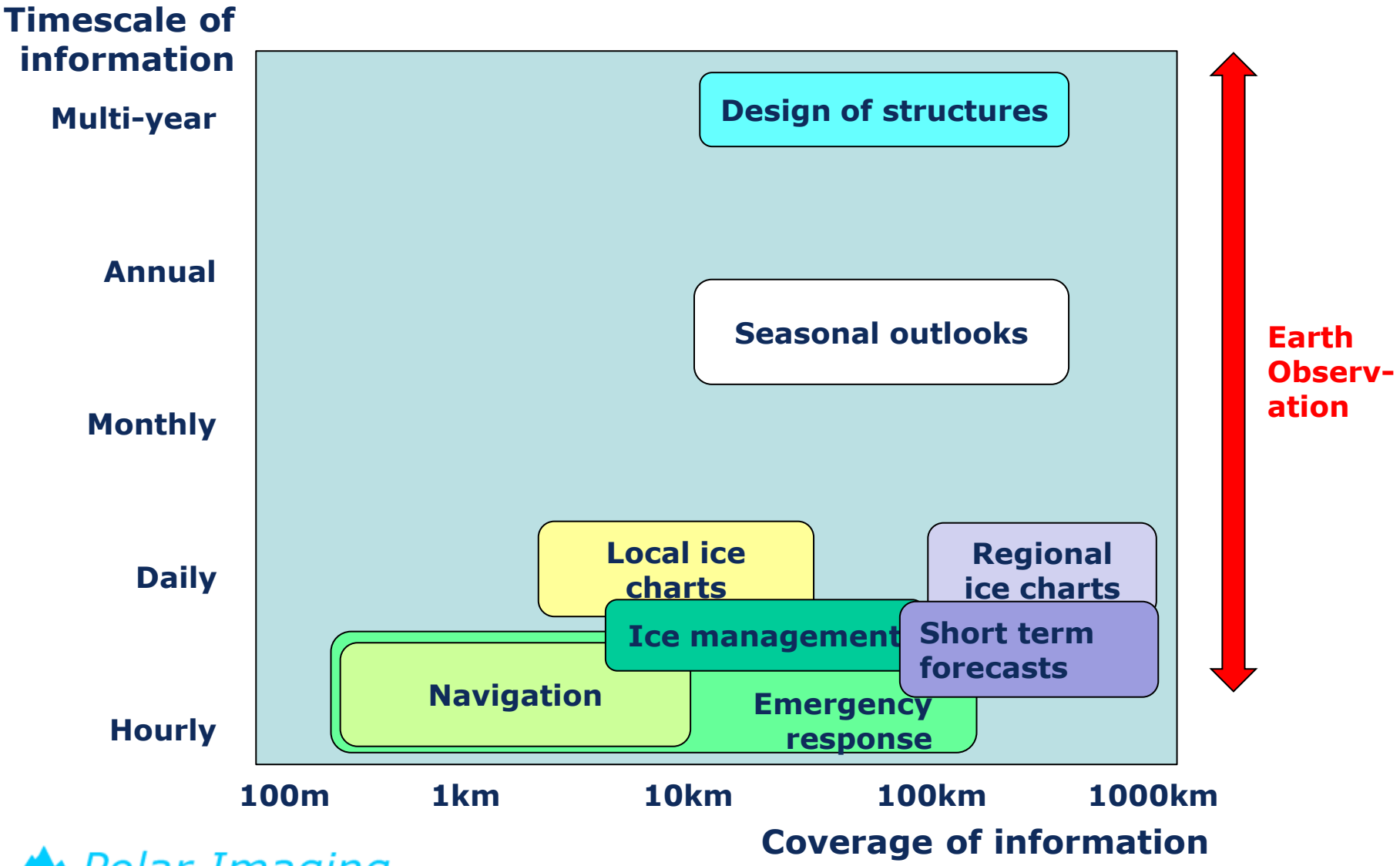
EO applications for Arctic O&G



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EO Applications: design of offshore structures: ISO 19906

- Description
  - Defining design criteria for structures in ice
- Opportunities
  - Huge EO archives
- Challenges
  - Huge EO archives
  - How to process?
  - Custom tools?
  - Build future archives with processing and "discovery" in mind

Parameter		Northern Okhotsk Sea Magadan Region		Southern Okhotsk off NE Sakhalin Island		Southern Okhotsk off SW Sakhalin Island	
		Average annual value	Range of annual values	Average annual value	Range of annual values	Average annual value	Range of annual values
Sea ice occurrence	First ice	15 Oct	10 to 30 Oct	1 Nov	25 Oct to 10 Nov	30 Oct	25 Oct to 20 Nov
	Last ice	30 June	10 June to 15 July	30 May	20 May to 25 Jun	30 April	20 Apr to 30 May
Level ice (FY)	Landfast ice thickness (m)	1,3	1,1 to 1,6	1,13	1,06 to 1,21	0,6	0,45 to 0,85
	Floe thickness (m)	1,3	1,1 to 1,6	0,9	0,7 to 1,3	0,9	0,8 to 1,20
Rafted ice	Rafted ice thickness (m)	2,2	1,9 to 2,9	2,40	2,00 to 3,30	1,1	1,0 to 2,5
Rubble fields	Sail height (m)	4,0	3,3 to 5,1	5,1	4,4 to 6,0	5,0	4,5 to 6,0
	Length (m)	N/a	N/a	110	80 to 160	100	70 to 150
Ridges (FY)	Sail height (m)	4,8	3,9 to 5,4	6,2	5,4 to 8,1	5,5	4,5 to 7,0
	Keel depth (m)	16,0	12,0 to 20,0	20,7	19,8 to 23,2	17	16 to 20
Stamukhi	Water depth range (m)	0 to 20	0 to 20	0 to 26	0 to 26	0 to 20	0 to 20
	Sail height (m)	8,0	6,0 to 10,0	11,5	9,3 to 18,0	6,0	5,5 yo 8,0
Ice movement	Speed nearshore (m/s)	0,6	0 to 1,0	1,79	1,60 to 2,01	1,1	0,9 to 1,4
	Speed offshore (m/s)	0,5	0 to 1,0	1,60	1,5 to 1,8	1,0	0,9 to 1,4

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EO Applications: design of offshore structures: ISO 19906

Satellite data application to descriptive overview of ice environment

Satellite data application to probability functions for number of ice-structure interactions

Ice environment for the development location

Structural design concept Fixed or floating facility

Define ice action scenarios

For each scenario

Estimation of expected number of ice-structure interaction events and their duration

Determination of action values

Employ extremal analysis to assign probability distribution to ice actions on the structure

Provide representative actions for design

Ice conditions

Operational conditions ice management and disconnection capabilities

Ice properties and strength

Ice morphology

Environmental driving forces

Satellite data application to probability functions relating to determination of action values

The Molikpaq platform, February 2009, Sakhalin-2 project, courtesy Sakhalin Energy

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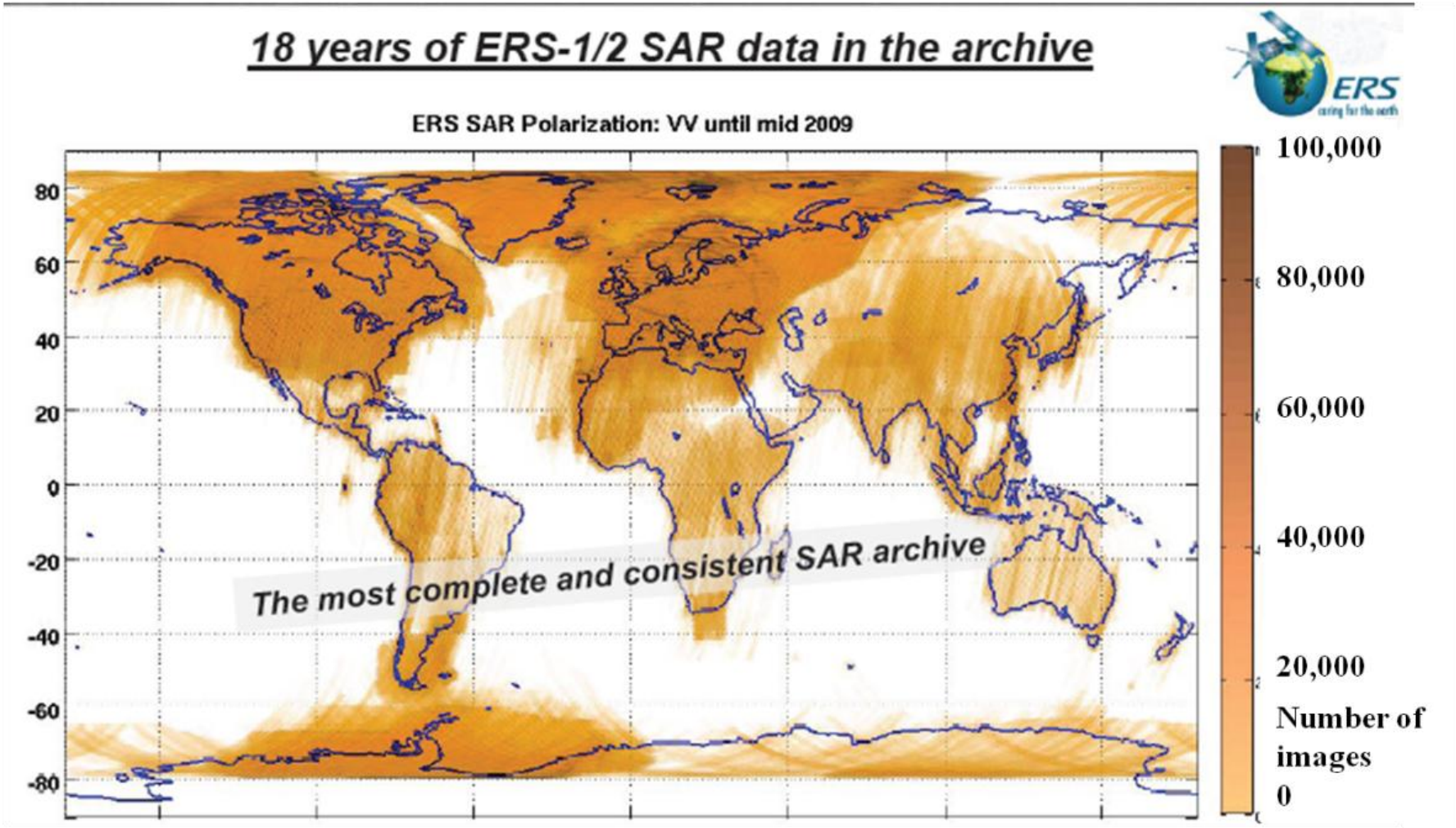
Courtesy ESA

EO Applications: design of offshore structures: ISO 19906



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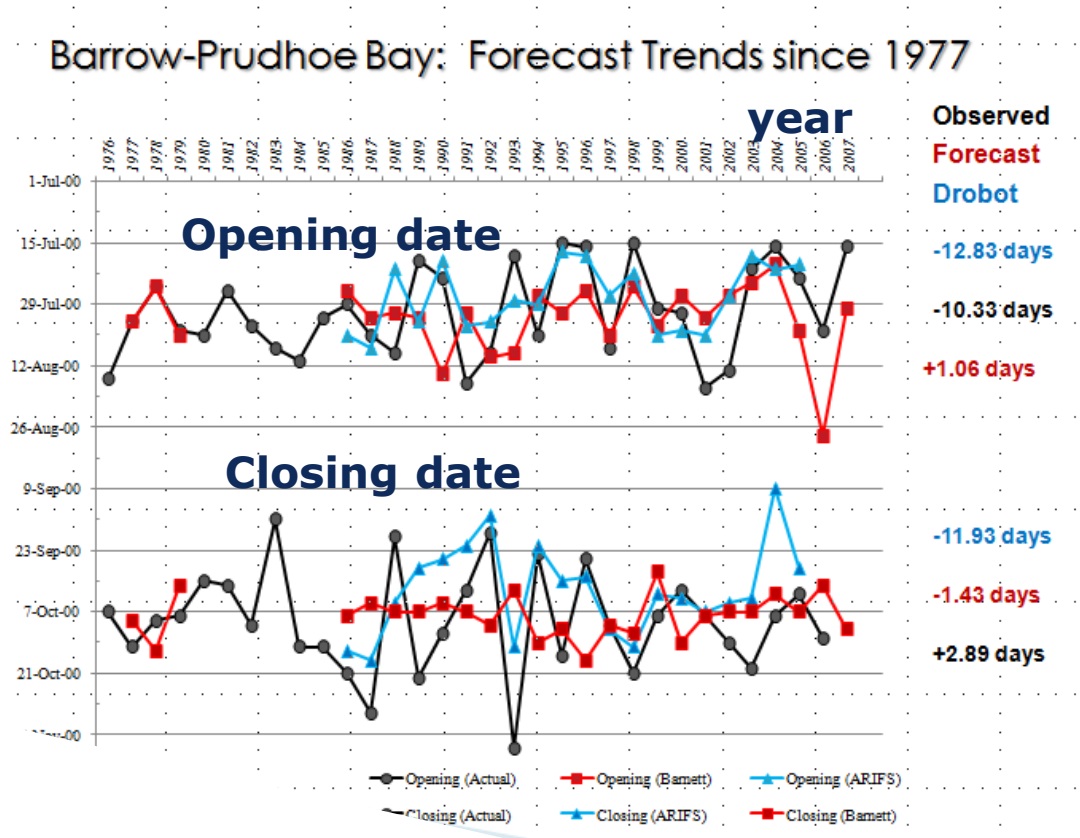
EO Applications: seasonal outlooks

- Description
  - Provision of updated outlook through the year, e.g for dates of ice opening/closing
- Opportunities
  - Seasonal outlooks important for planning operations
  - Reflect huge costs of equipment and vessels, and particularly "idle" vessels
  - Earth observation one of several inputs – archive and new data
- Challenges:
  - Climate is changing – past is poor guide to future
  - Scale mismatch – climate signals vs. opening/closing dates of ice



Courtesy T. Arbetter & S. Drobot

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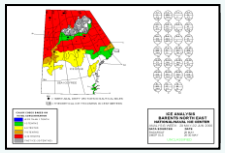
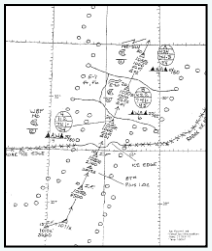
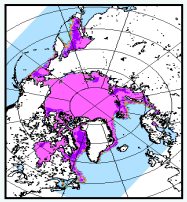
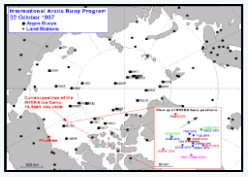
Custom regional ice charts for strategic overview of the ice environment

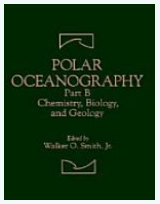
Background and Ancillary Observations


Previous ice chart

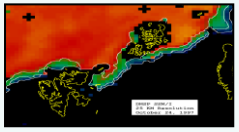

Reconnaissance


Model forecasts

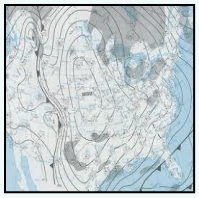

In situ data

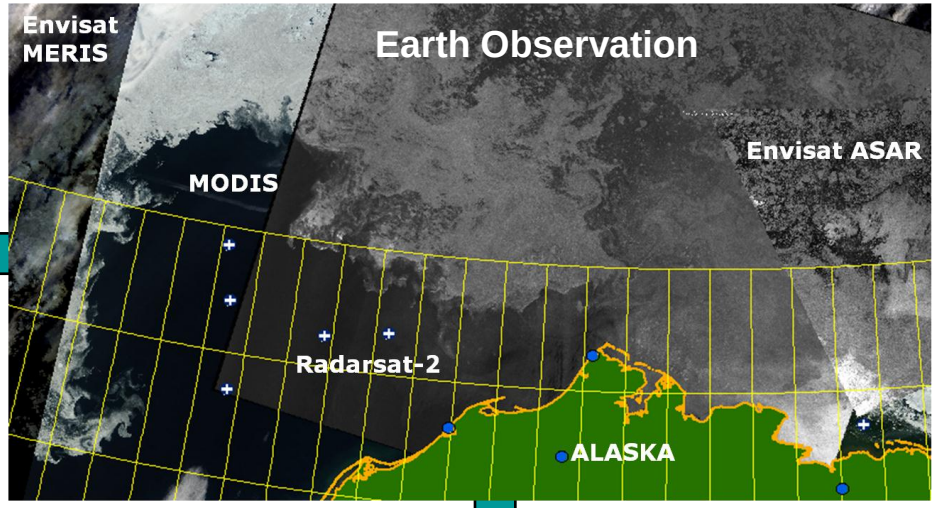


Fundamentals


Passive microwave

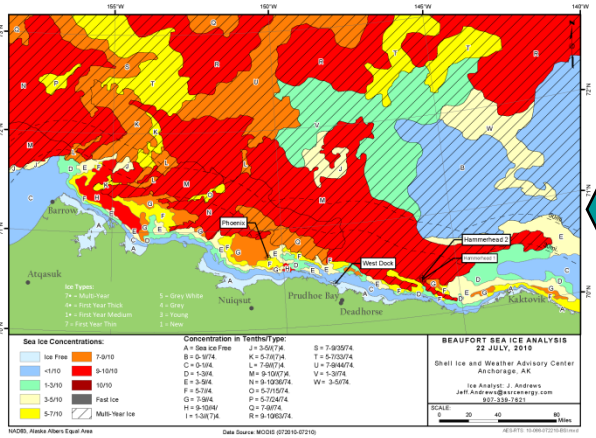

Ice climatology

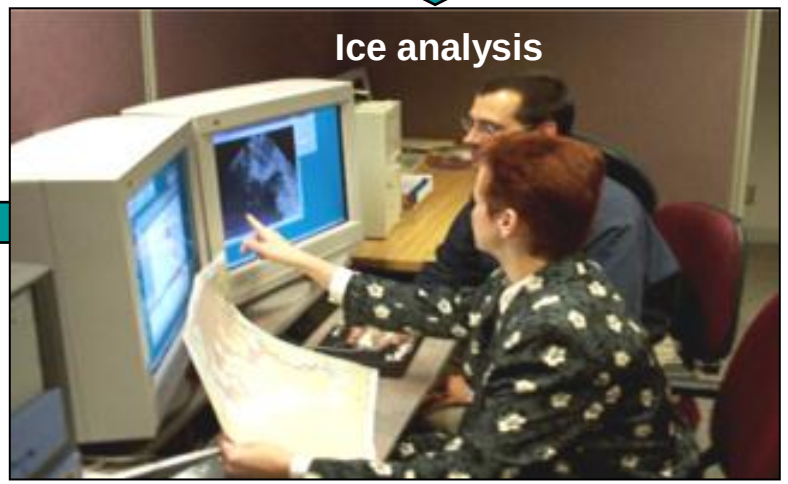

Weather forecasts



Envisat © ESA 2010, Radarsat-2 © MDA 2010 and MODIS courtesy NASA

Ice chart and forecast





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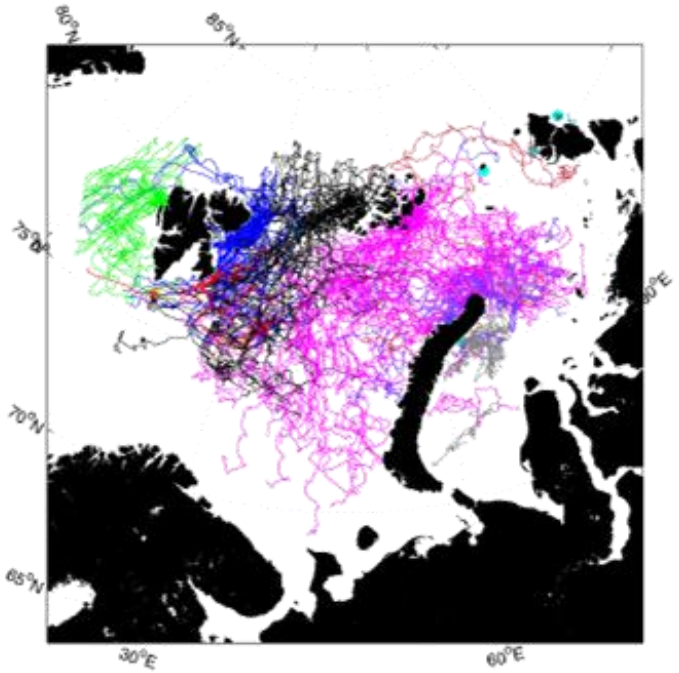
EO applications: custom regional ice charts

- Opportunities
  - EO is ideally suited to regional ice charting
  - Mature application
  - A growing requirement as O&G activities become more widespread around the Arctic
  - National ice services do not in general provide adequate temporal and spatial resolution charts
- Challenges
  - Ice analysis remains essentially a skilled, manual activity
  - Shortage of trained personnel
  - Analysis sensitive to quality of high latitude weather information
  - Continuity and reliability of data is critical
  - Delivery timing critical

EO applications: ice management

- Description
  - Monitoring of ice hazards "upstream" of operations,
  - Alert system for hazard detection
  - Coverage areas defined upstream of valuable assets and defined by ice management plan
- Opportunities
  - Will be increasingly required as O&G moves towards production
- Challenges
  - Extremely costly to do this properly using EO
  - Failed detections extremely serious



Modeled iceberg trajectories for 2003. The colours indicate different origin sites (Keghouche et al., 2010).

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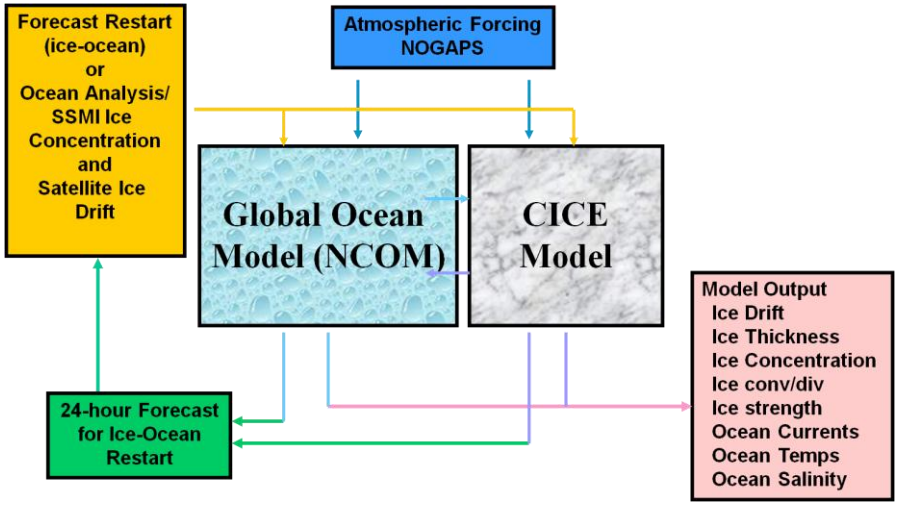
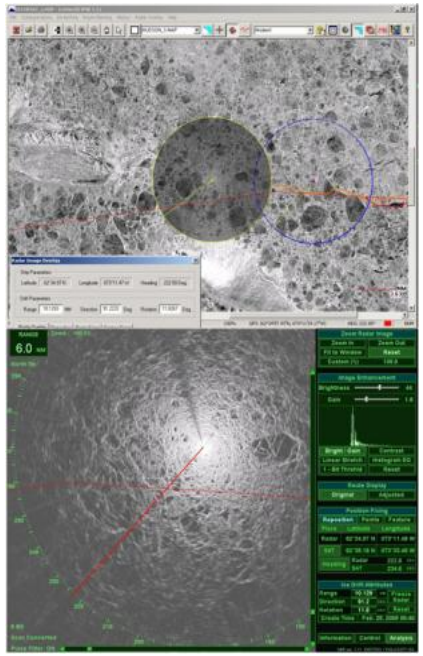
EO applications: short term forecasting

- Description
  - Forecasts up to (say) ~72 hrs, updated twice daily
  - Guidance to operations, routing, etc.
- Opportunities:
  - Of potential huge benefit to the range of Arctic users, not just O&G
- Challenges
  - Numerous...
  - Few in situ observations in the Arctic
  - Complexity of data assimilation (need to understand data errors)
  - Practical issues of near real time forecasting with EO data
  - etc



EO applications: navigation

- Description
  - Vessel-based navigation through ice, integrated with on-board systems
- Opportunities
  - Earth observation has excellent revisit capabilities
  - Data delivery times are getting very good
  - EO input to IMO Polar Code?
- Challenges
  - Near real time multi-mission planning
  - Flexible data tasking
  - Cost of data for tactical use
  - High latitude comms
  - On-vessel expertise



IceNav system courtesy Enfotec

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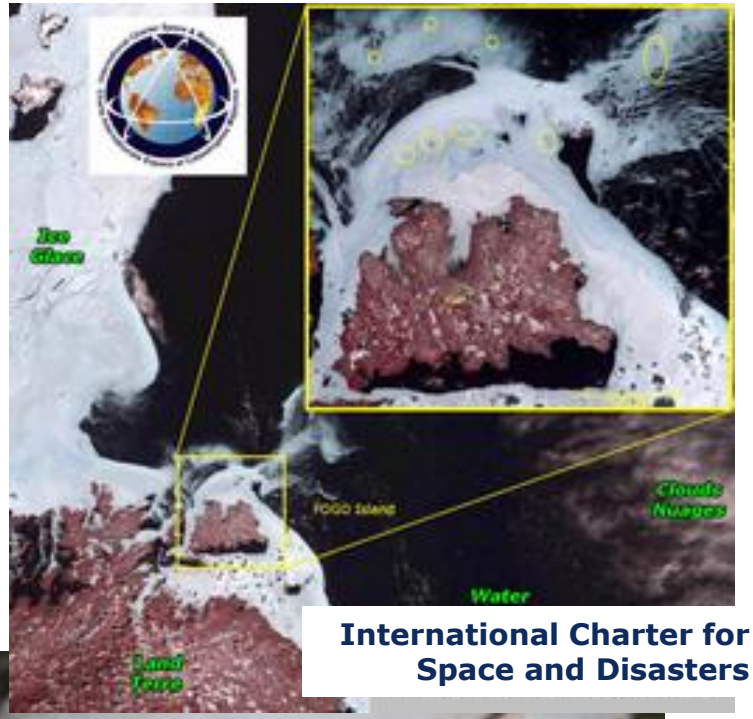
EO Applications: Local Ice Charting

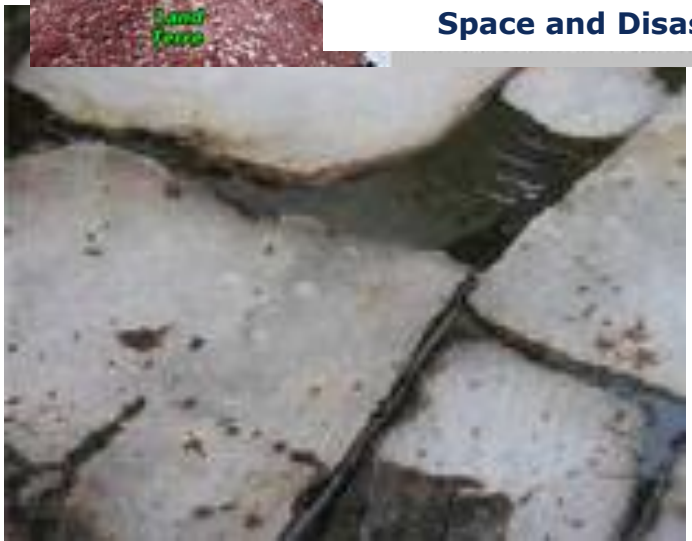
- Description
  - Information on local ice conditions to support a particular operational task, such as access to facilities.
- Opportunities
  - High resolution SAR, OPT
  - New configurations (bistatic insar, polarimetry, etc)
- Challenges
  - Information required is pushing the limits of EO information content (topography, grounding, ridge orientation and density, etc.)

EO Applications: emergency response

- Description
  - Readiness for emergency support including oil spill response
- Opportunities:
  - O&G industry is currently reviewing its oil spill response capability
  - All space technologies critical - positioning, EO and comms
- Challenges (for use of EO)
  - Detection of oil in ice – which sensors will work?
  - High latitude comms
  - Flexible sensor tasking
  - Coordination of multiple satellite sensors



International Charter for Space and Disasters



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Summary: EO for Arctic O&G

- Opportunities
  - O&G is at an early stage of lifecycle in the Arctic – demands for EO will grow
  - Industry is acutely aware of its need to be seen to be using all technologies to operate safely as well as efficiently
- Challenges
  - Measurements
    - Ice thickness (in NRT)
    - Oil in ice
    - Hazards (e.g. Icebergs in sea ice, stamukha)
  - Data Access
    - Coordinated and optimised from across multiple satellite missions
    - Adequate lead and lag times for near real time
    - Information extraction from archives
  - Integration of EO with other technologies: satcoms, positioning, marine radar, etc.
  - Availability of skilled personnel

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