

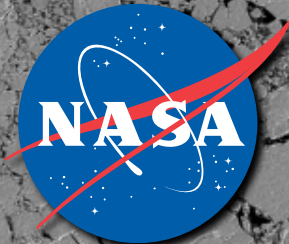
NASA's ICESat-2 and NISAR Missions: Cryospheric Science

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University of Washington*

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Two NASA missions w/ dedicated Cryospheric Science components



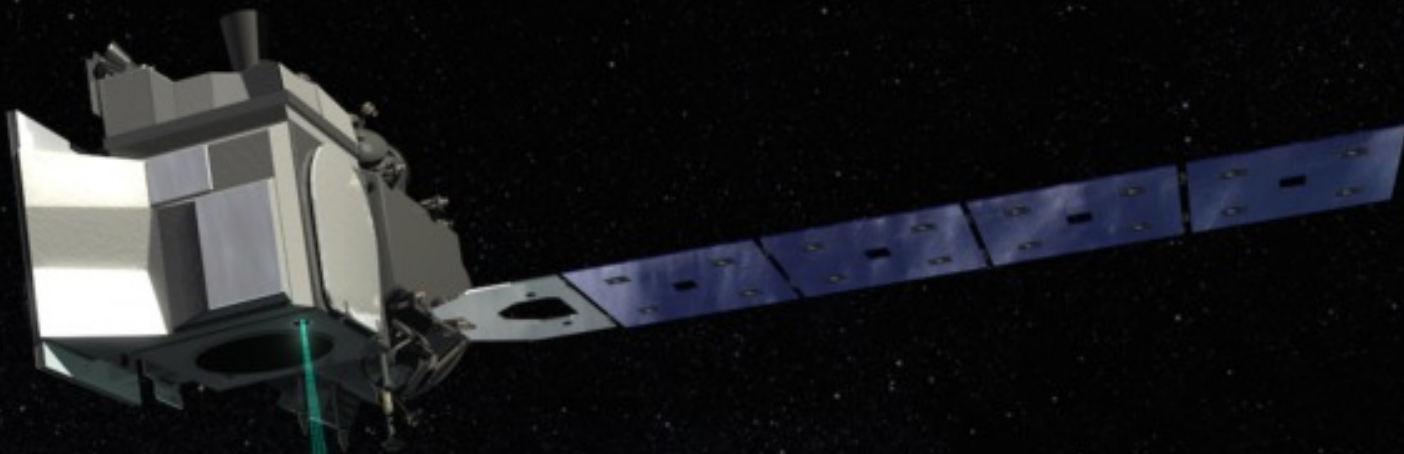
- **ICESAT-2 (launch: Oct, 2017)**
 - **Sea Ice: freeboard and thickness**
 - **Sea Surface Height: ice-covered and polar oceans**
 - **Ice Sheet: elevation and elevation changes**

Ablation, accretion, accumulation

- **NISAR (NASA-ISRO partnership, 2020)**
 - **Sea Ice: small-scale ice motion, ice type**
 - **Ice Sheet, stream, and outlet glaciers: surface velocity**

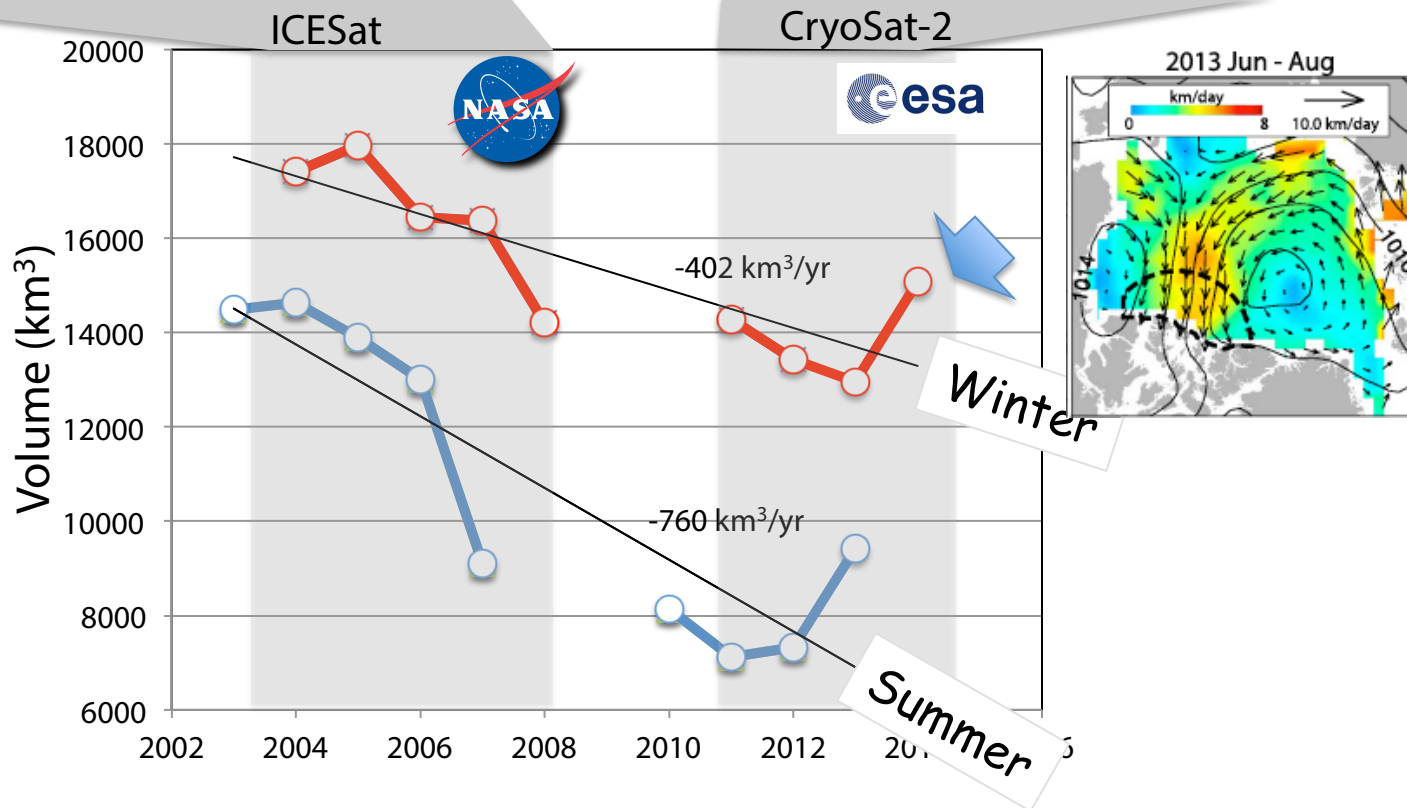
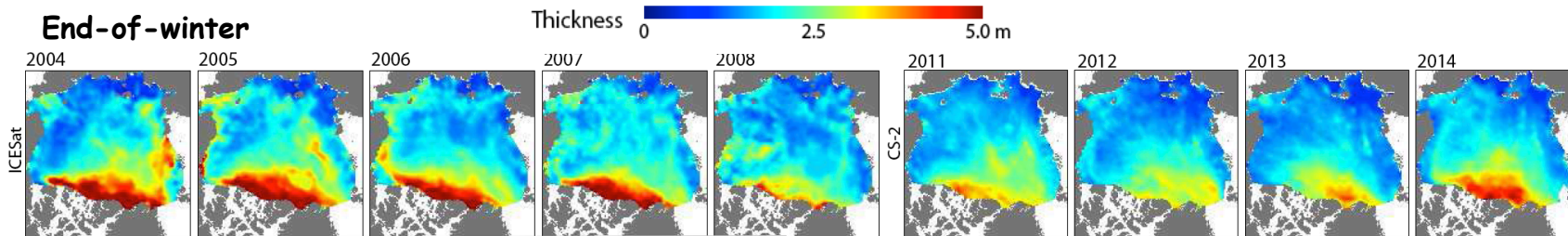
Dynamics and Kinematics

NASA ICESat-2 Altimetry Mission



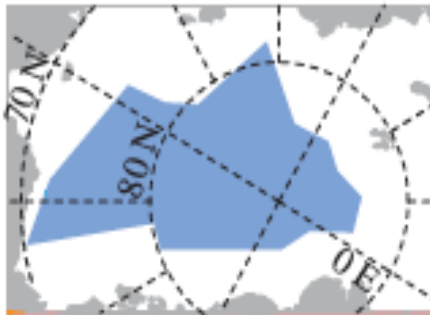
ICESat-2
ICE, CLOUD, AND LAND ELEVATION SATELLITE-2

6 beams
14 m spots
0.7 m separation



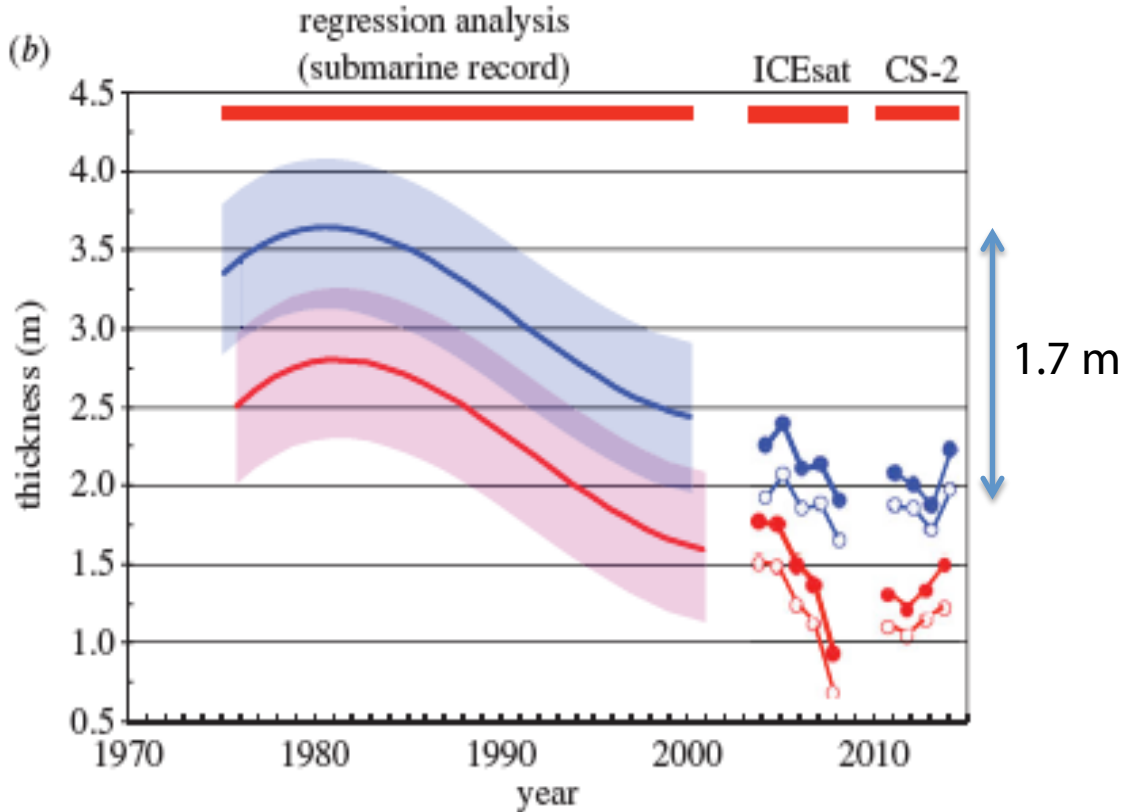
Kwok and Cunningham (2015)

(a)

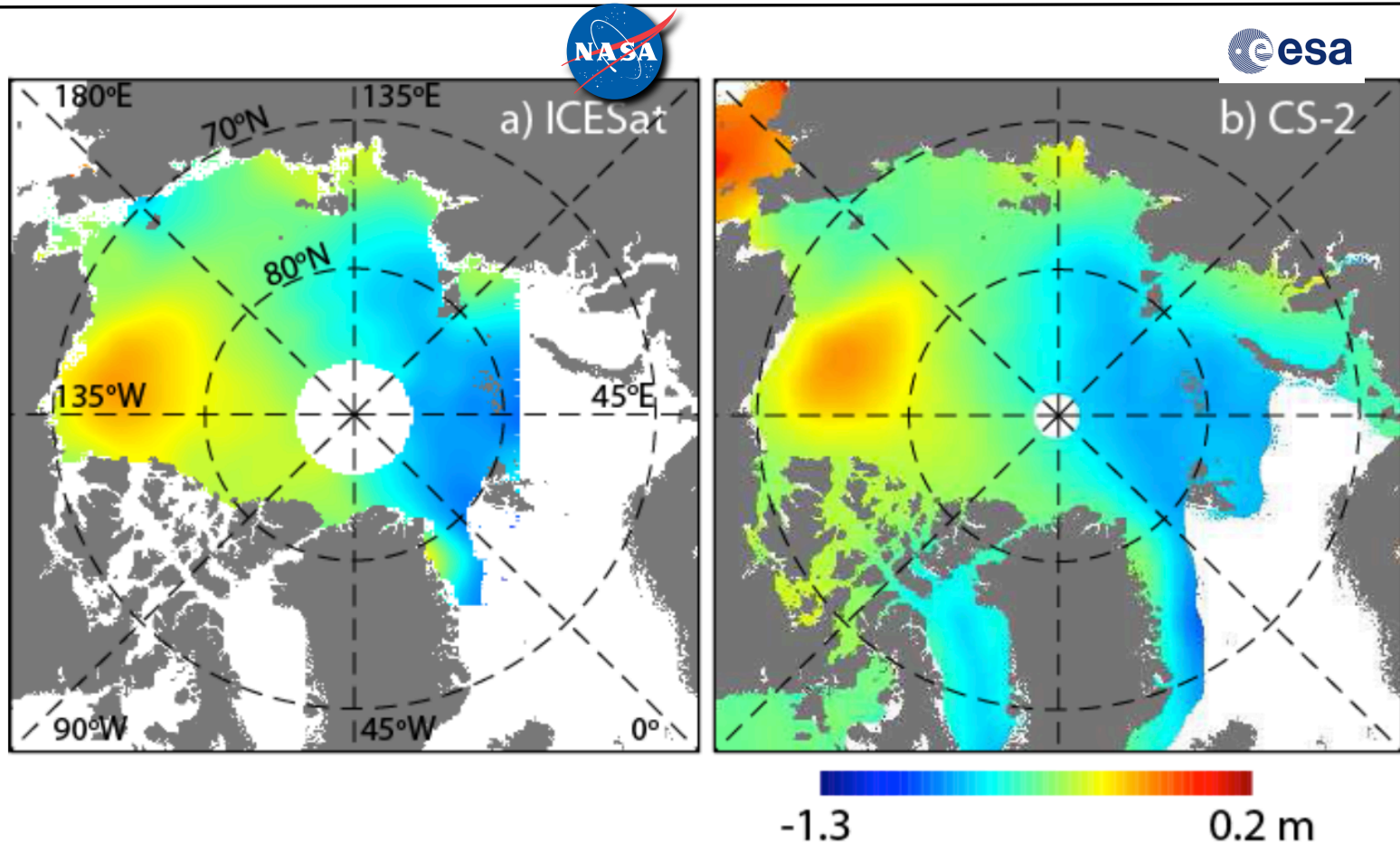


- Feb–Mar ($1\rho_i$)
- Feb–Mar ($2\rho_i$)
- Oct–Nov ($1\rho_i$)
- Oct–Nov ($2\rho_i$)
- Feb–Mar (RA)
- Oct–Nov (RA)

(b)



Kwok and Cunningham (2015)

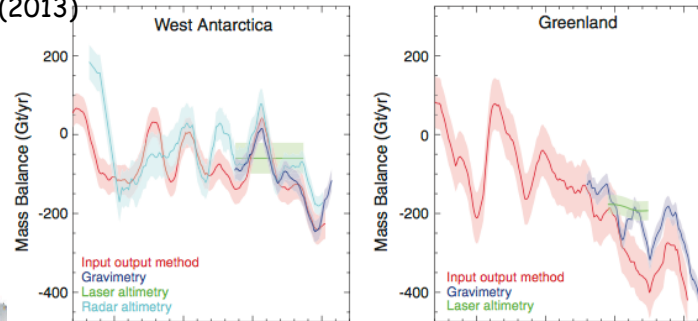


Kwok and Morison (2015)

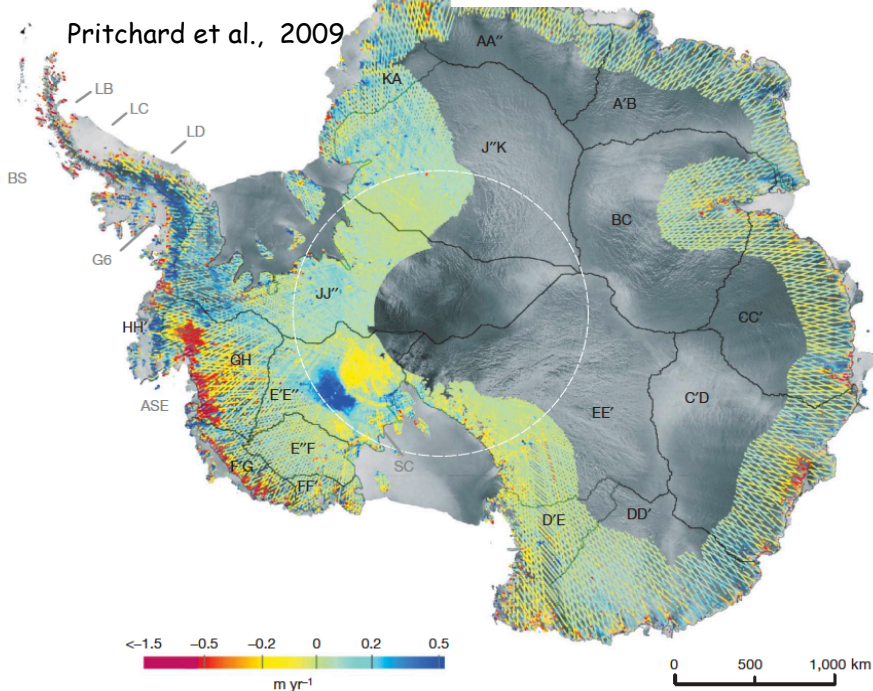
Ice Sheet - elevations changes (mass loss and sea level)



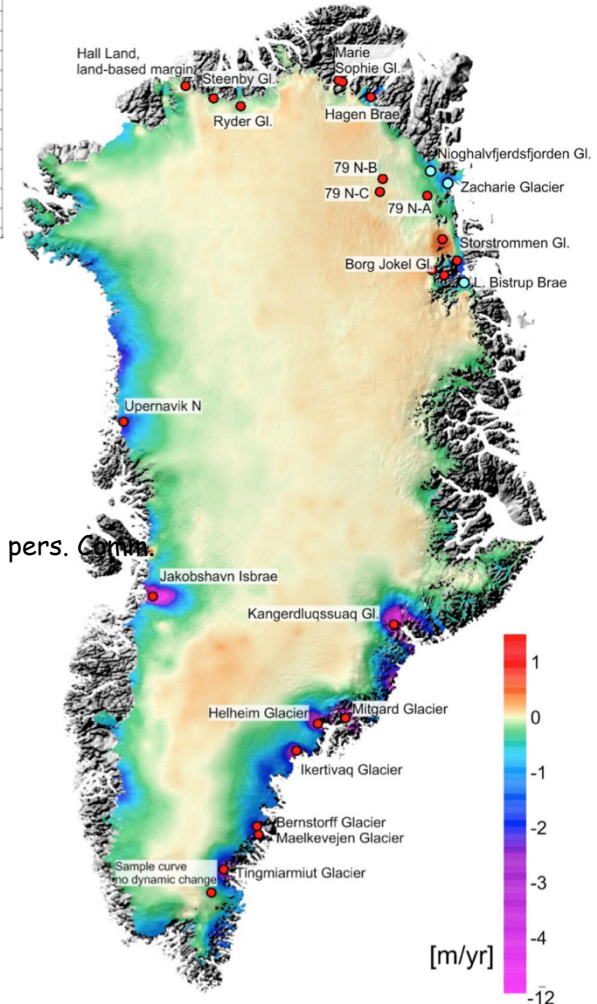
Shepherd et al. (2013)



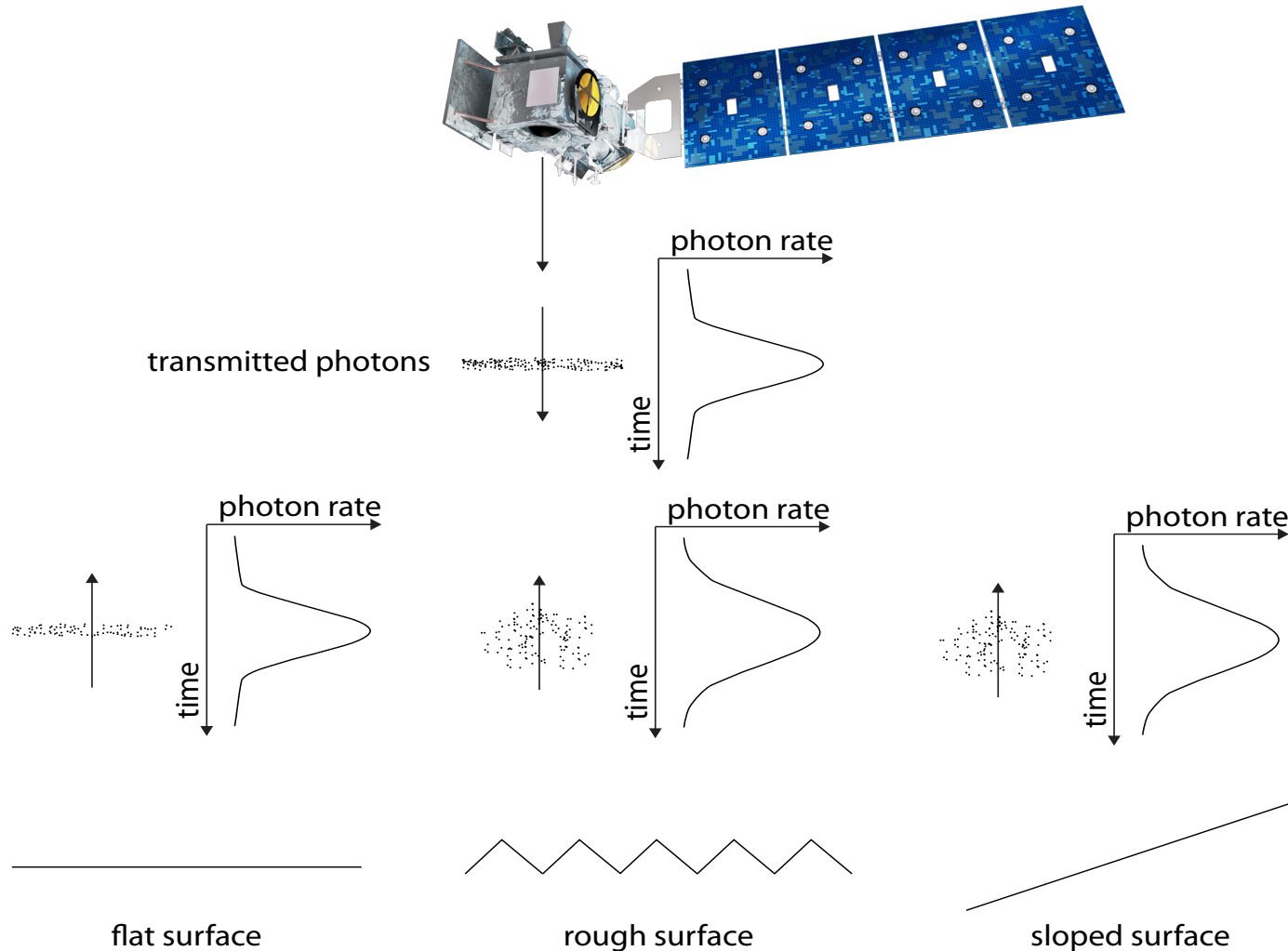
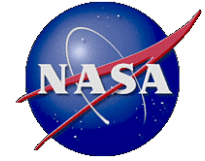
Pritchard et al., 2009



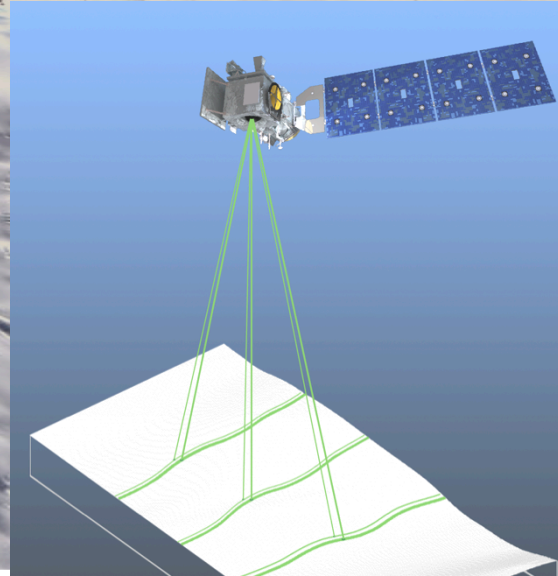
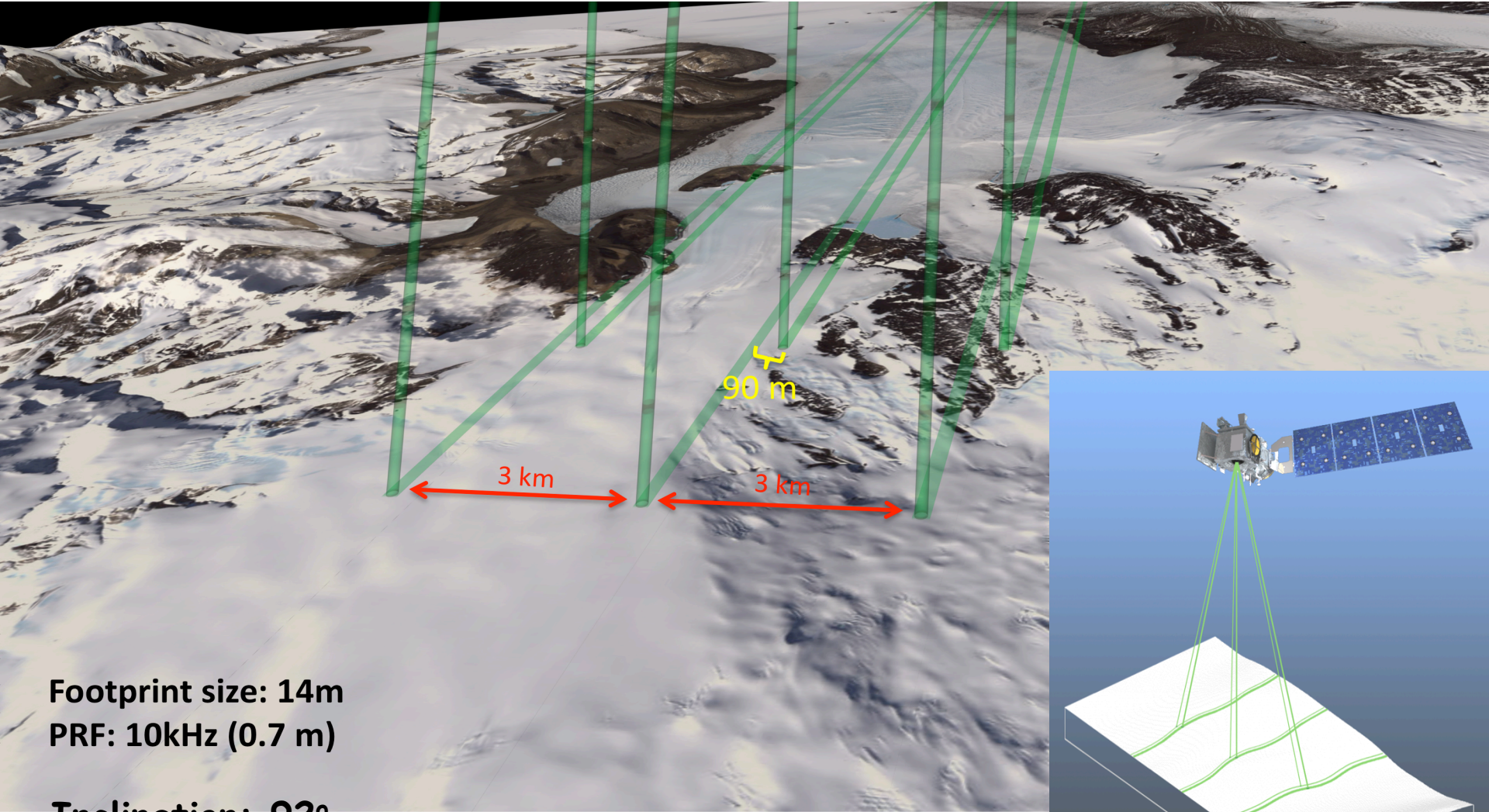
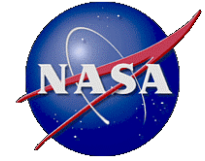
Csatho, pers. Comm.



Photon Counting Altimetry Roundtrip timing of photons

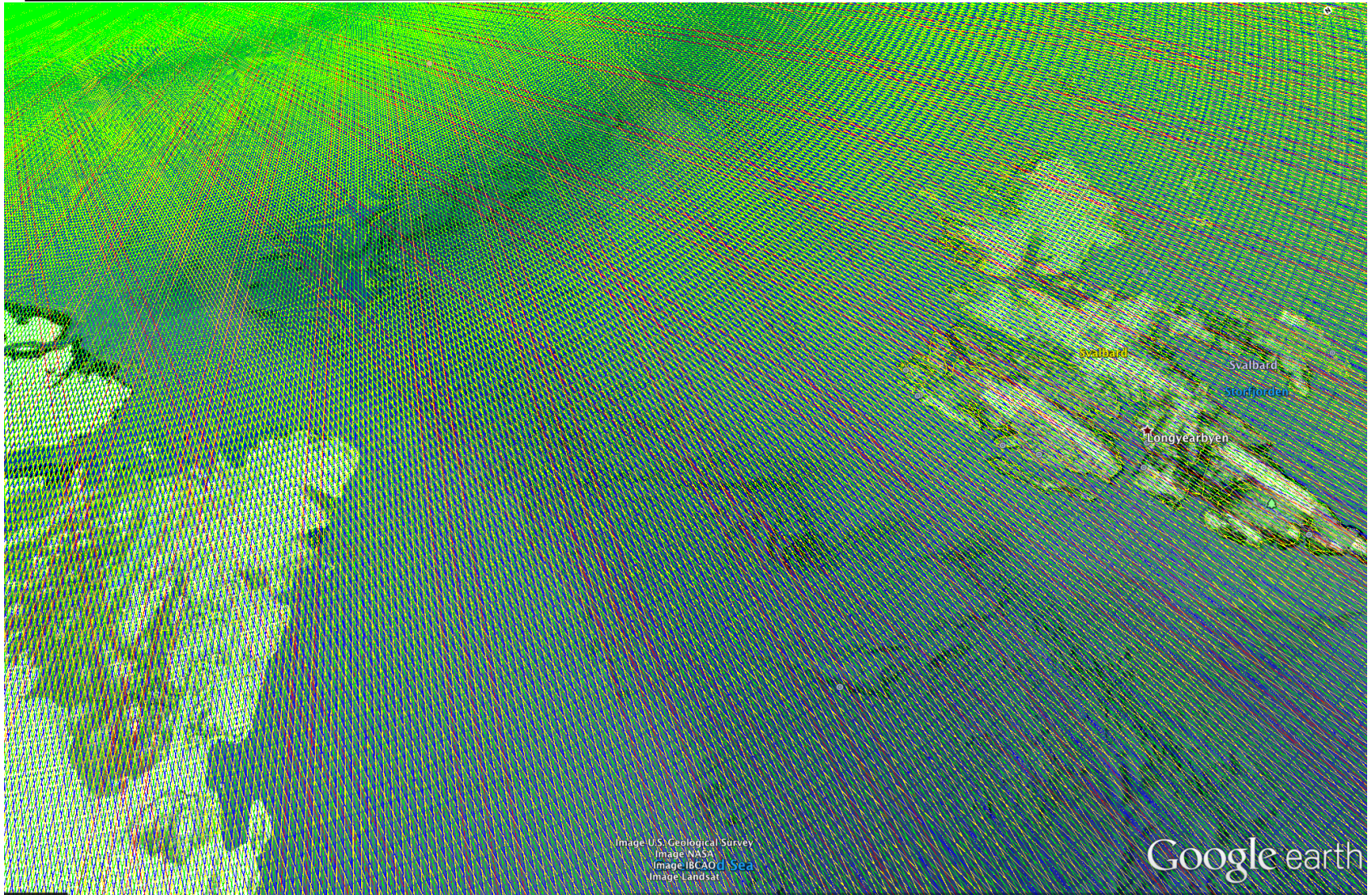


Profiling Configuration



Footprint size: 14m
PRF: 10kHz (0.7 m)

Inclination: 92°



Two NASA missions: Cryospheric Science



- **ICESAT-2 (launch: Oct, 2017)**
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- **NISAR (NASA-ISRO partnership, 2020)**
 - **Sea Ice: small-scale ice motion, ice type**
 - **Ice Sheet, stream, and outlet glaciers: surface velocity**

Dynamics and Kinematics

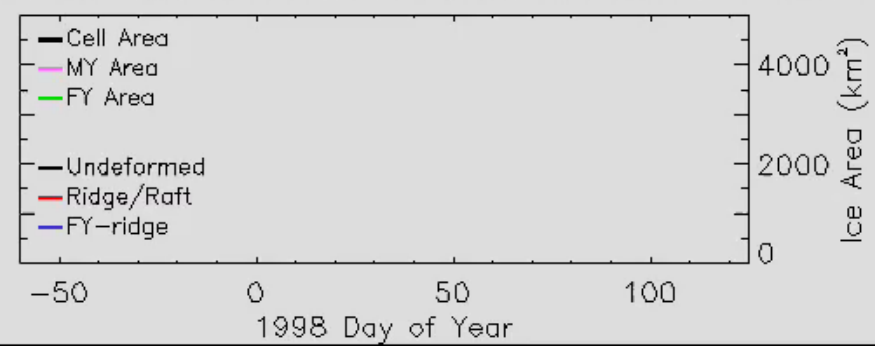
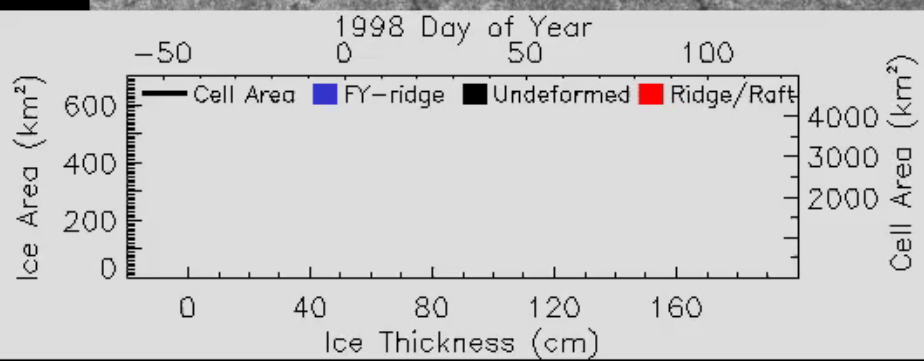
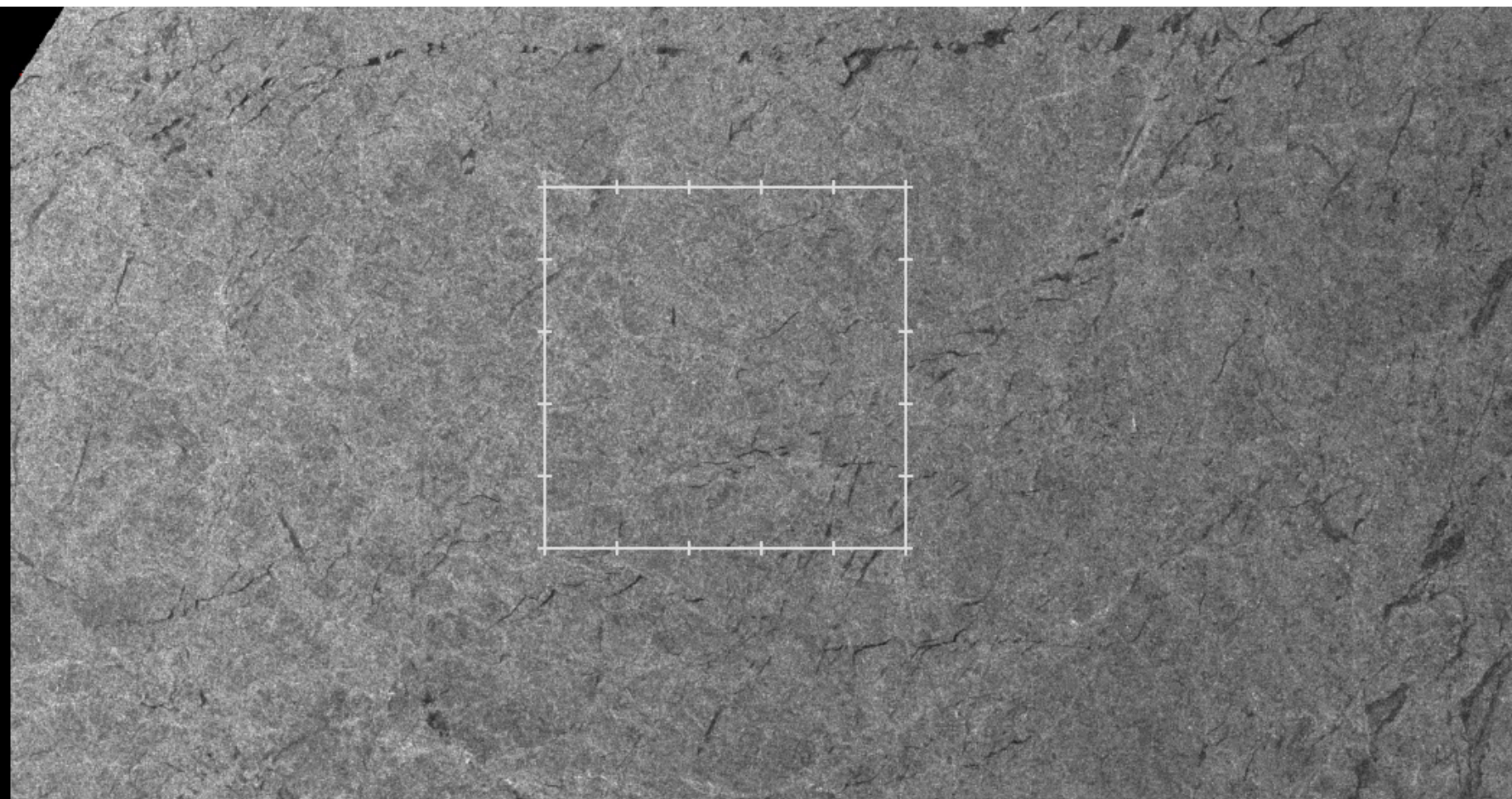
NASA-ISRO SAR Mission (NISAR)

A dedicated U.S. and Indian InSAR mission, in partnership with ISRO, optimized for studying hazards and global environmental change.

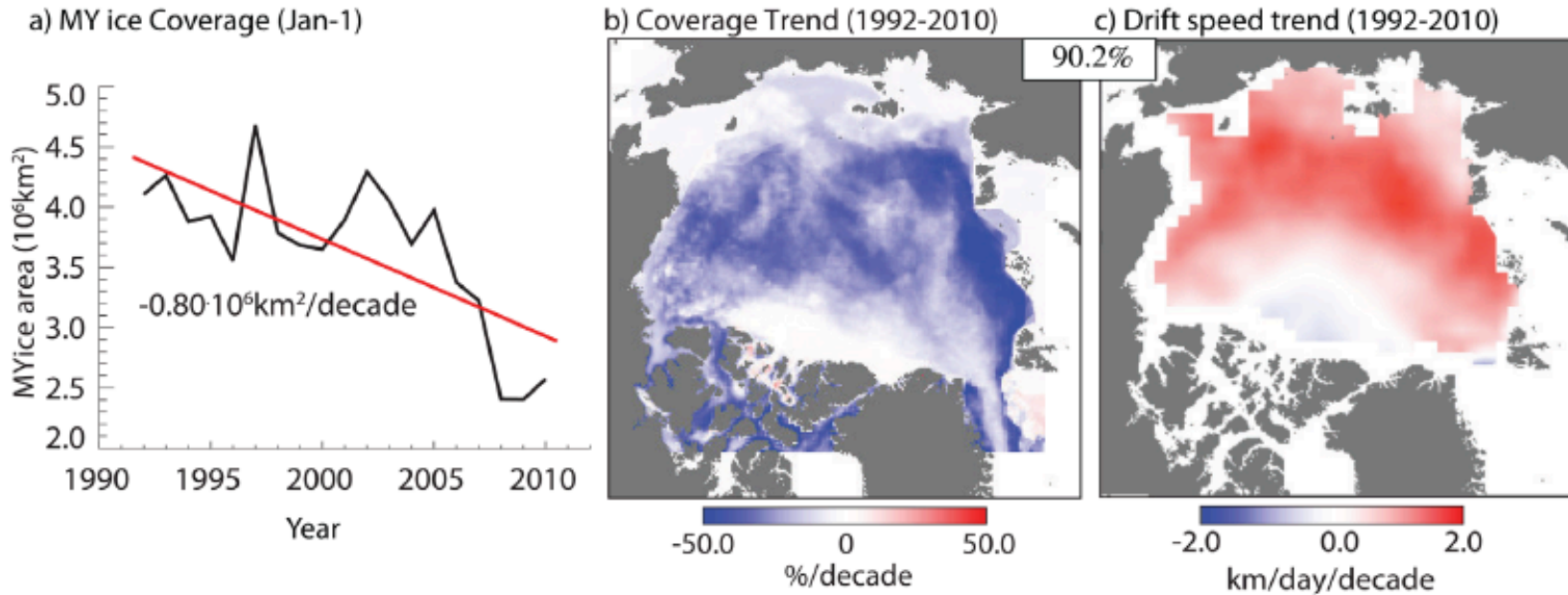
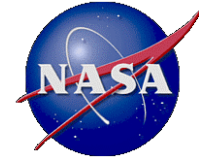


104355256 1997 307.70938

GC

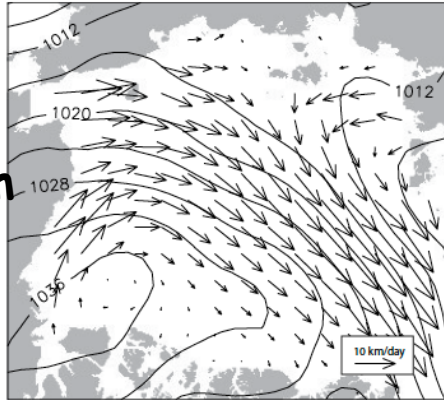


Ice is more responsive to wind forcing

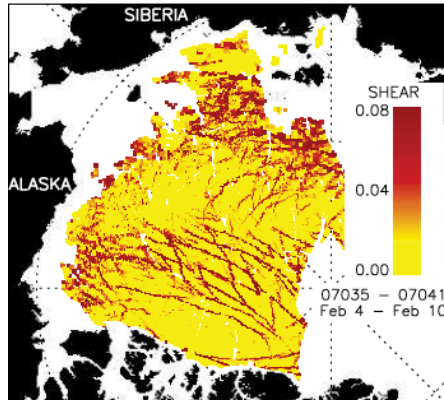


SAR

Sea Ice Motion and Deformation

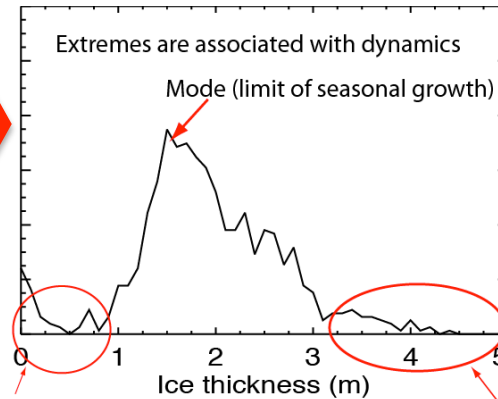


$\sim 10^2$ km



$\sim 10^2$ m

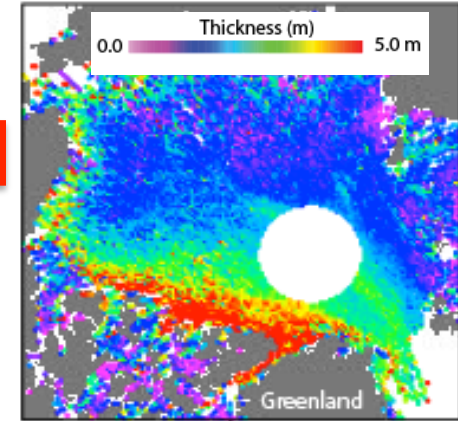
Ice Thickness distribution



New ice in openings

Ridges and rafted ice

Sea Ice Thickness

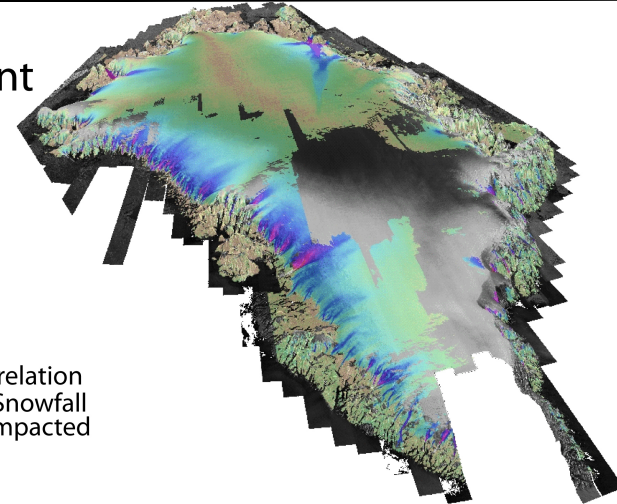
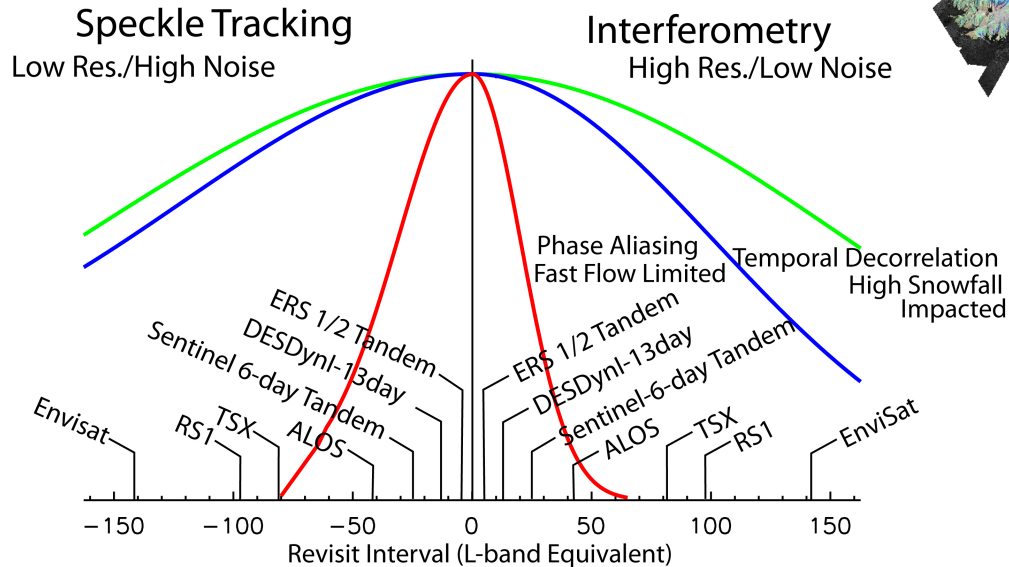


Sea Ice Motion

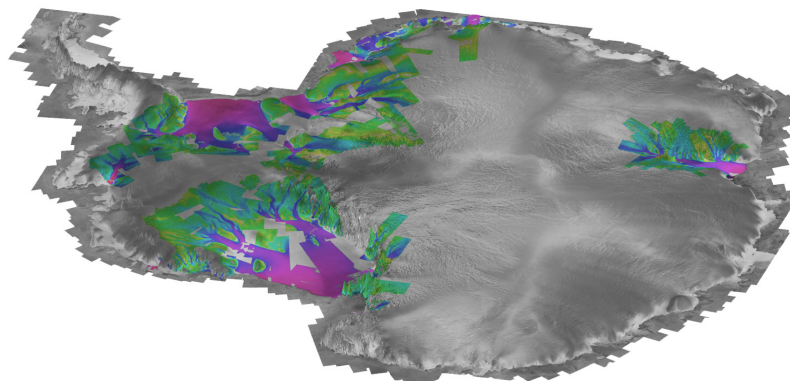
- Circulation changes, export and regional redistribution of sea ice
- Small-scale motion for quantifying deformation-relation thickness changes
- Volume storage due to ridging

NISAR: Ice sheet, ice Stream, outlet glacier velocities

Qualitative Likelihood of Successful Measurement



Joughin (NISAR document 2014)



Slow Ice Sheet Flow (0 to 100 m/yr)
Moderate Tributary Flow (100 to 400 m/yr)
Fast Ice Stream/Glacier Flow (400 to 15,000 m/yr)

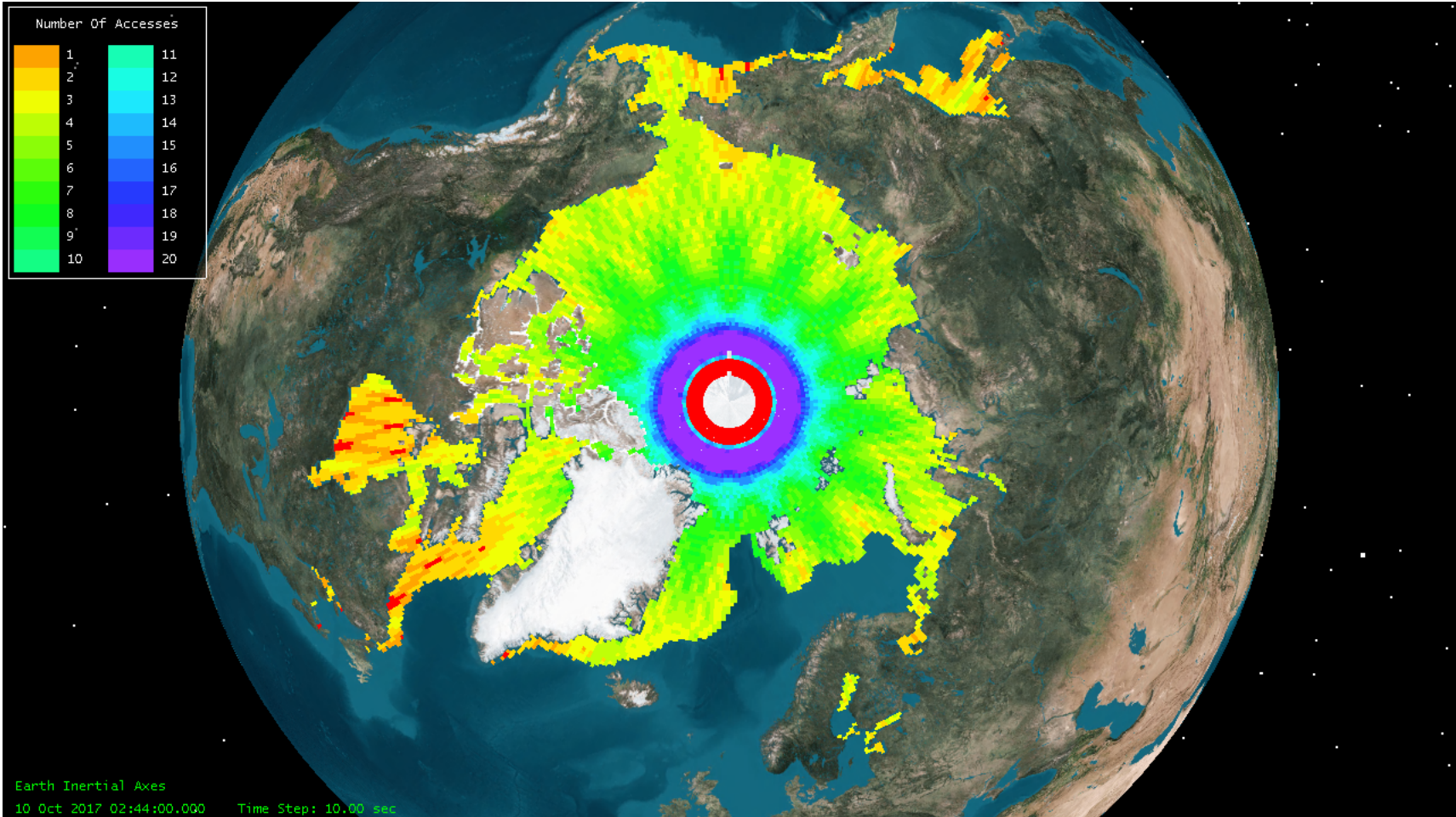
Two radars

	<u>S-band</u>	<u>L-band</u>
Orbit	747 km with 98° inclination	
Repeat Cycle	12 days	
Time of Nodal Crossing	6 AM / 6 PM	
Frequency	3.2 GHz ± 37.5 MHz	1.257 GHz ± 40 MHz
Available Polarimetric Modes	Single Pol (SP): HH or VV Dual Pol (DP): HH/HV or VV/VH Compact Pol (CP): RH/RV Quasi-Quad Pol (QQP): HH/HV and VH/VV	SP: HH or VV DP: HH/HV or VV/VH CP: RH/RV Quad Pol (QP): HH/HV/VH/VV
Available Bandwidths	10 MHz, 25 MHz, 37.5 MHz, 75 MHz	5 MHz, 20 MHz, 40 MHz, 80 MHz (Additional 5 MHz iono band for 20 & 40 MHz modes at other end of pass-band)
Swath Width	> 240 Km	>240 Km
Spatial Resolution	6.4m (Az); 2m-6m (SI-Ra)	6.9m (Az); 1.9m-30m (SI-Ra)
Incidence Angle Range	33 - 47 deg	33 - 47 deg
Noise Equivalent σ°	-20 dB swath average (baseline) -17 dB(Threshold)	-20 dB swath average

50 m for sea ice motion



Coverage: 8-day repeat (preliminary)



- Support
 - Monitoring changes
 - Process understanding
 - Model improvements/validation
 - Assimilations into models
- Shorter time scales (days/months)
 - Understand connections to global weather
 - Short term forecasts (operational uses) - initial states
- Longer-time scales (interannual to decadal)
 - Climate projections: (initial states)

(Goal is to Contribute to Arctic Observing Network)

Thank you!



Photo by N. Untersteiner