Capability of SWOT
to Measure Surface Water Storage Change

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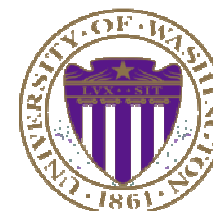[1] School of Earth Sciences, Ohio State University

[2] LEGOS

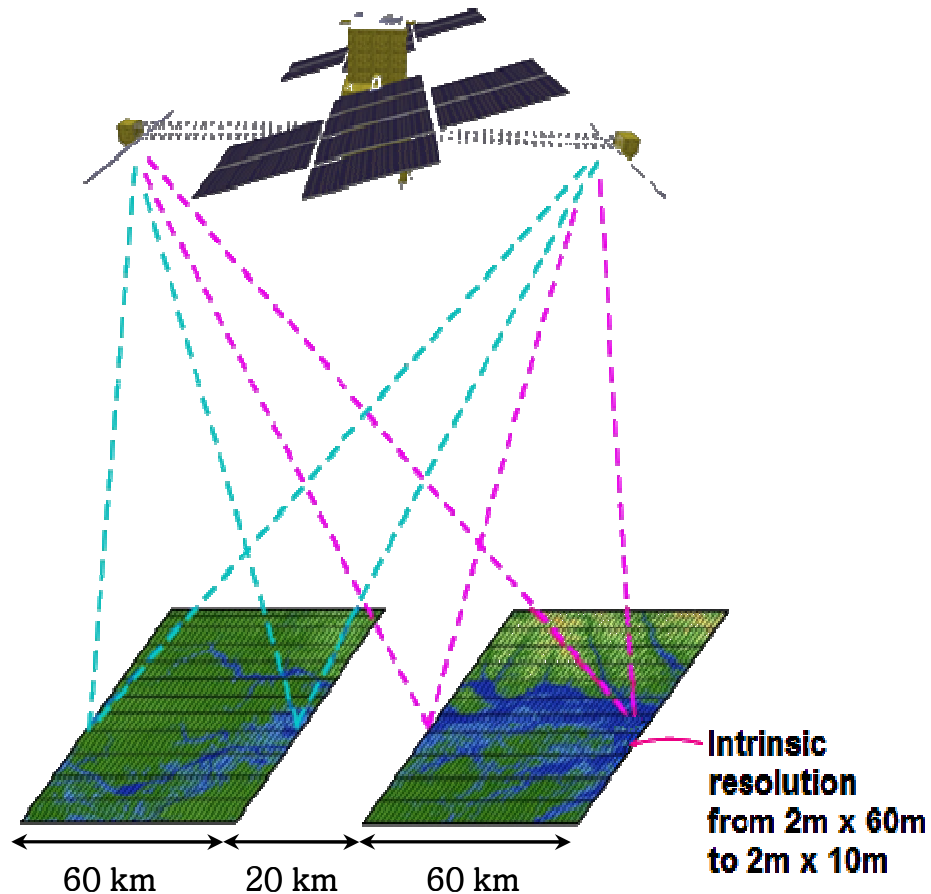[3] Dpt. of Civil & Env. Eng., University of Washington

[4] Byrd Polar Research Center, Ohio State University

[5] JPL

[6] Department of Geography, UCLA

SWOT mission

60 km   20 km   60 km

Intrinsic resolution from 2m x 60m to 2m x 10m

- SWOT= Surface Water and Ocean Topography (NASA/CNES)

- **Wide swath altimeter** (KaRIN= Ka-band Radar Interferometer)

- Launch ~**2019**

- Life time **3-5 years**

- 2 orbits:

  - **Fast sampling phase**: 3 day 78° orbit (during 3 months)
  - **Nominal phase**: 22 day 78° orbit

- Water elevation maps (100m pix. siz.)

1. **Global lake storage change seen by SWOT**

2. **SWOT storage change accuracy for Arctic lakes**

1. **Global lake storage change seen by SWOT**

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Methodology

- Purpose :
  - estimate a global relationship between lake area and lake storage change,
  - estimate % of storage change SWOT could see.

- Global relationship between lake area (A) and the number of lake with this area (N) from a power law: $N = \alpha \cdot A^{\beta}$ (Downing et al., 2006).
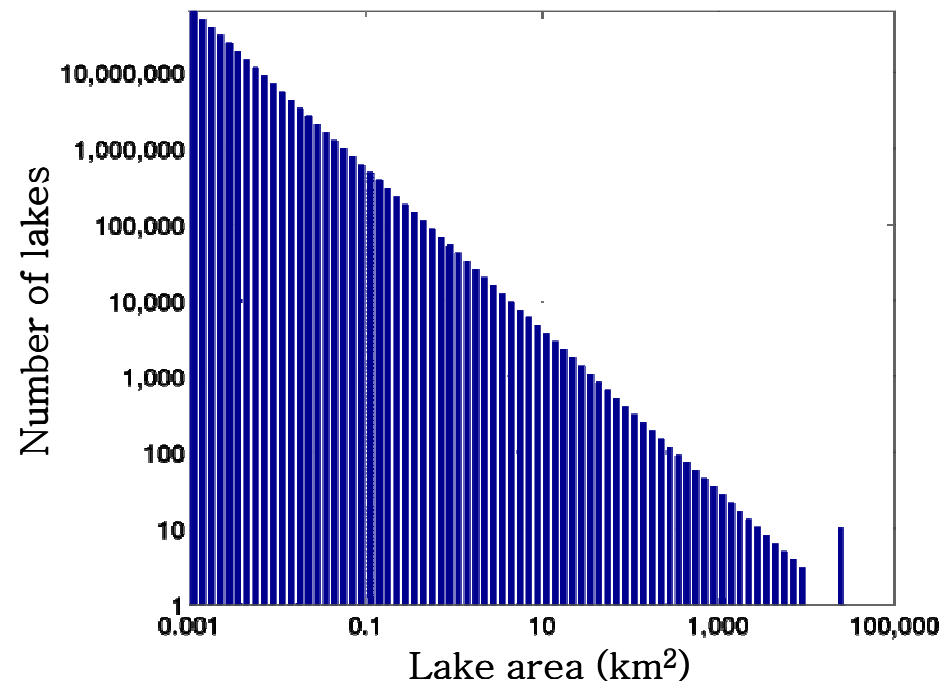
Methodology

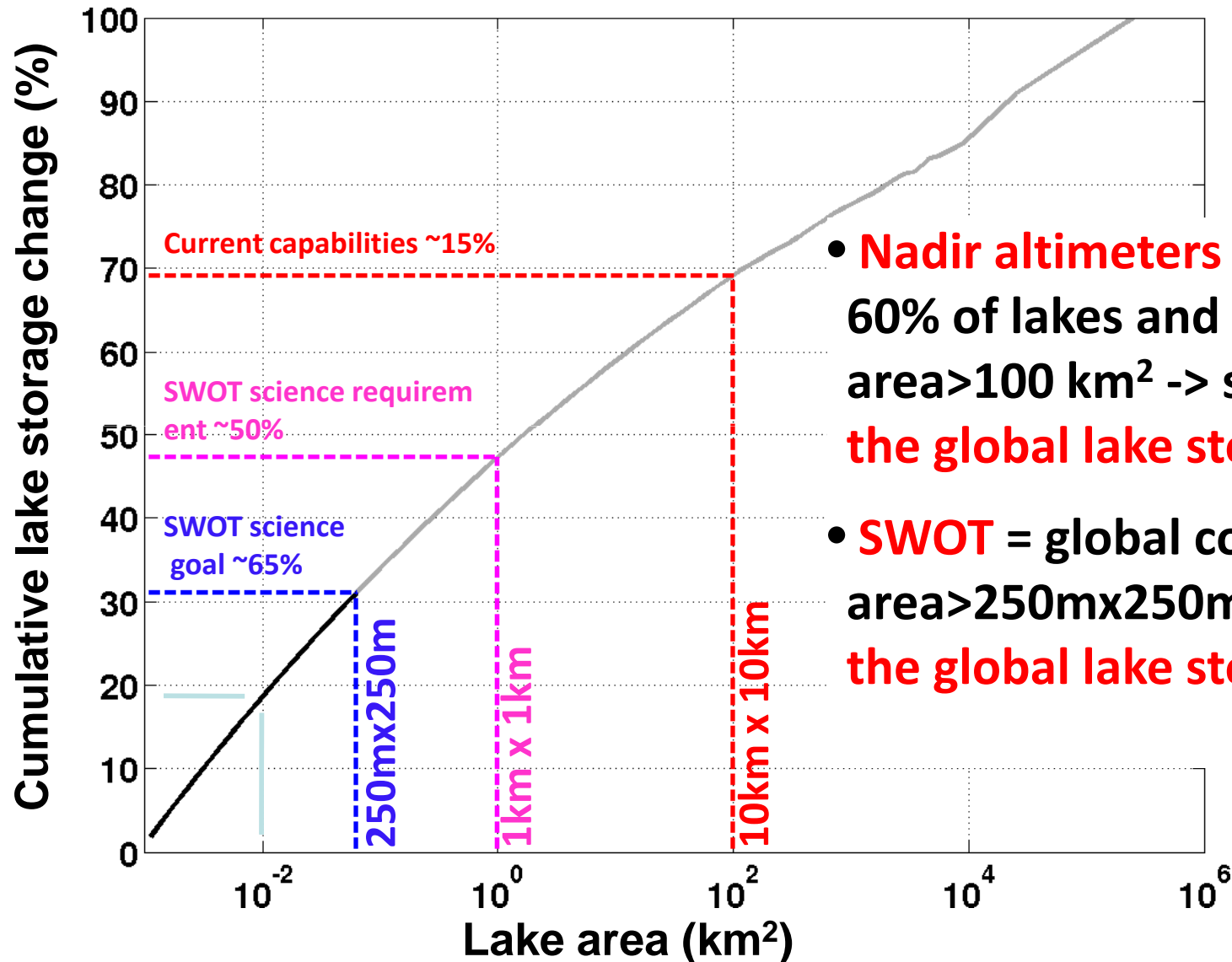- Lake yearly water height variation (dh) (~200 lakes)
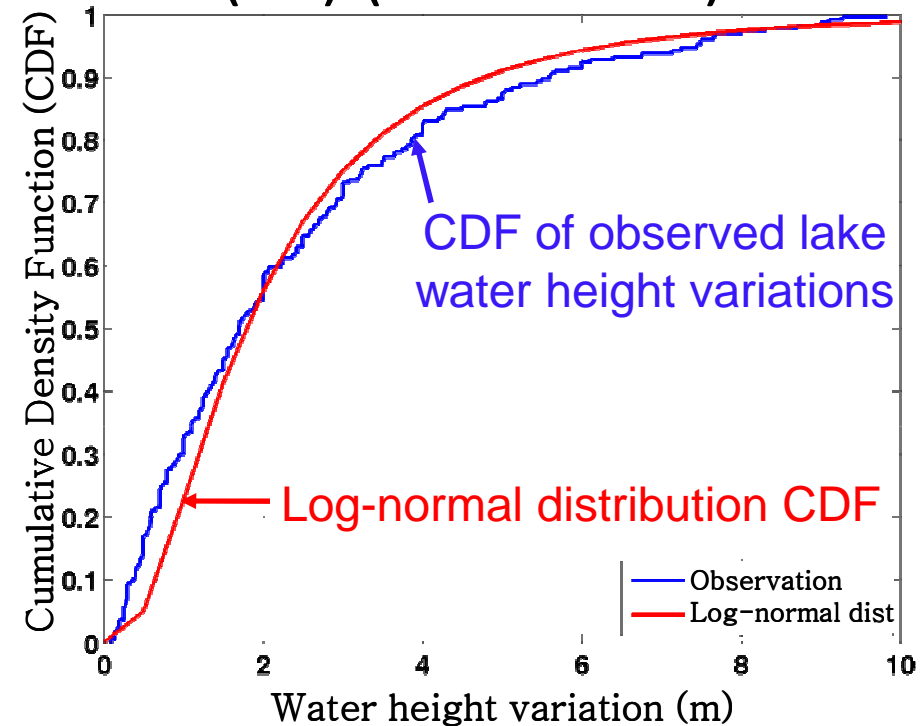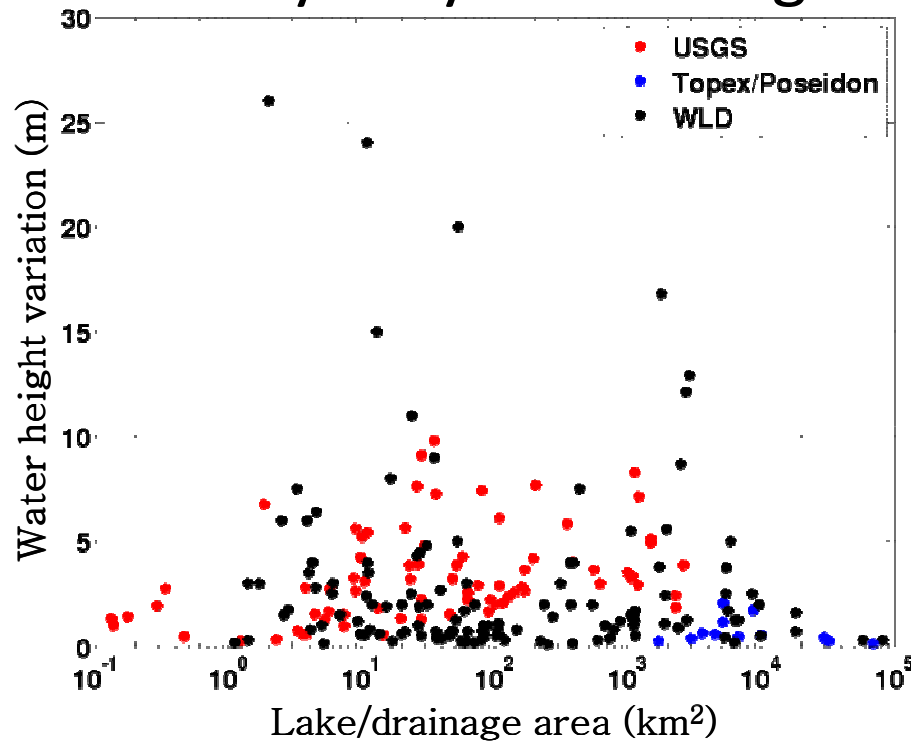
-> Lake water height variation follows a log-normal distribution

- Total storage change (dS_i) for lakes with area=A_i:

$$dS_i = A_i \cdot \sum_{j=1}^{N_i} dH_i(j)$$

- N_i = number of lakes with area A_i
- dH_i from log-normal distribution

Results

Nadir altimeters miss more than 60% of lakes and can see area>100 km² -> see only **15% of the global lake storage change**

SWOT = global coverage and see area>250mx250m -> see **65% of the global lake storage change**
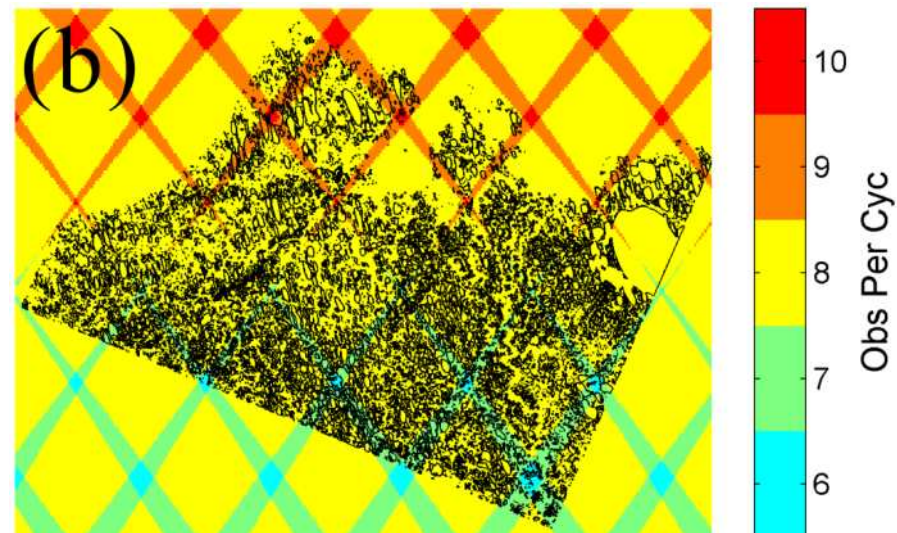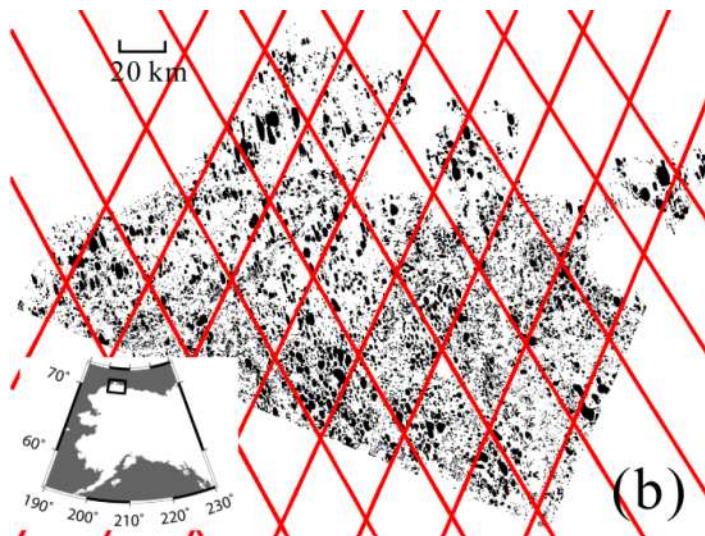
Biancamaria et al., IEEE JSTARS, 2010

1. Global lake storage change seen by SWOT

2. **SWOT storage change accuracy for Arctic lakes**

Study Areas and satellite ground tracks
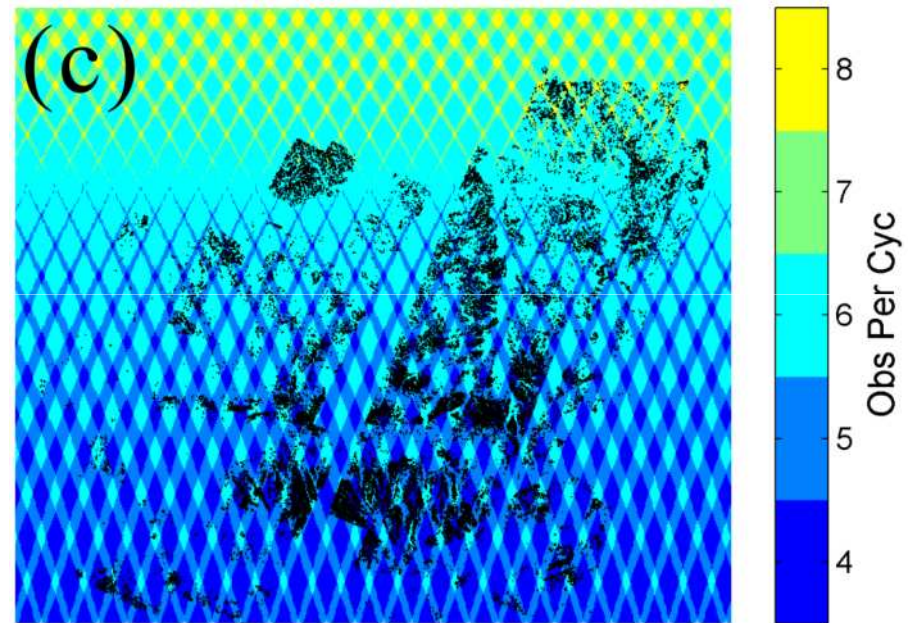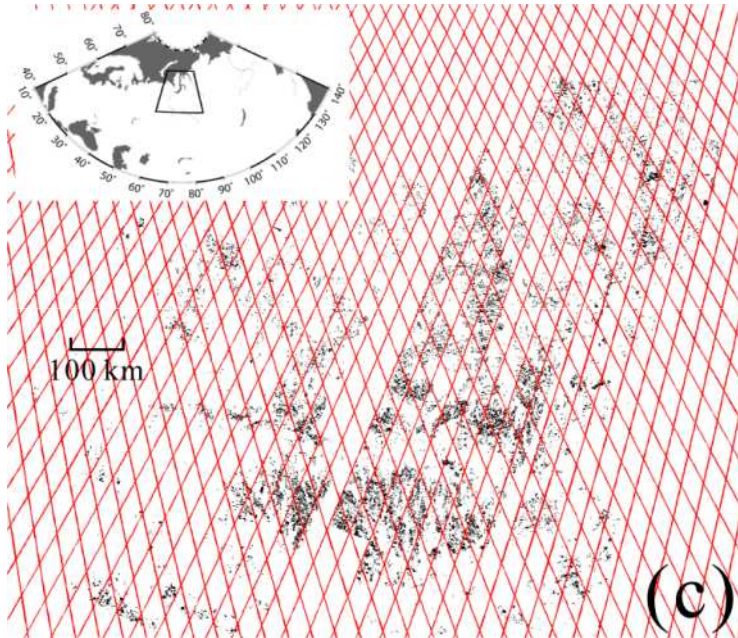
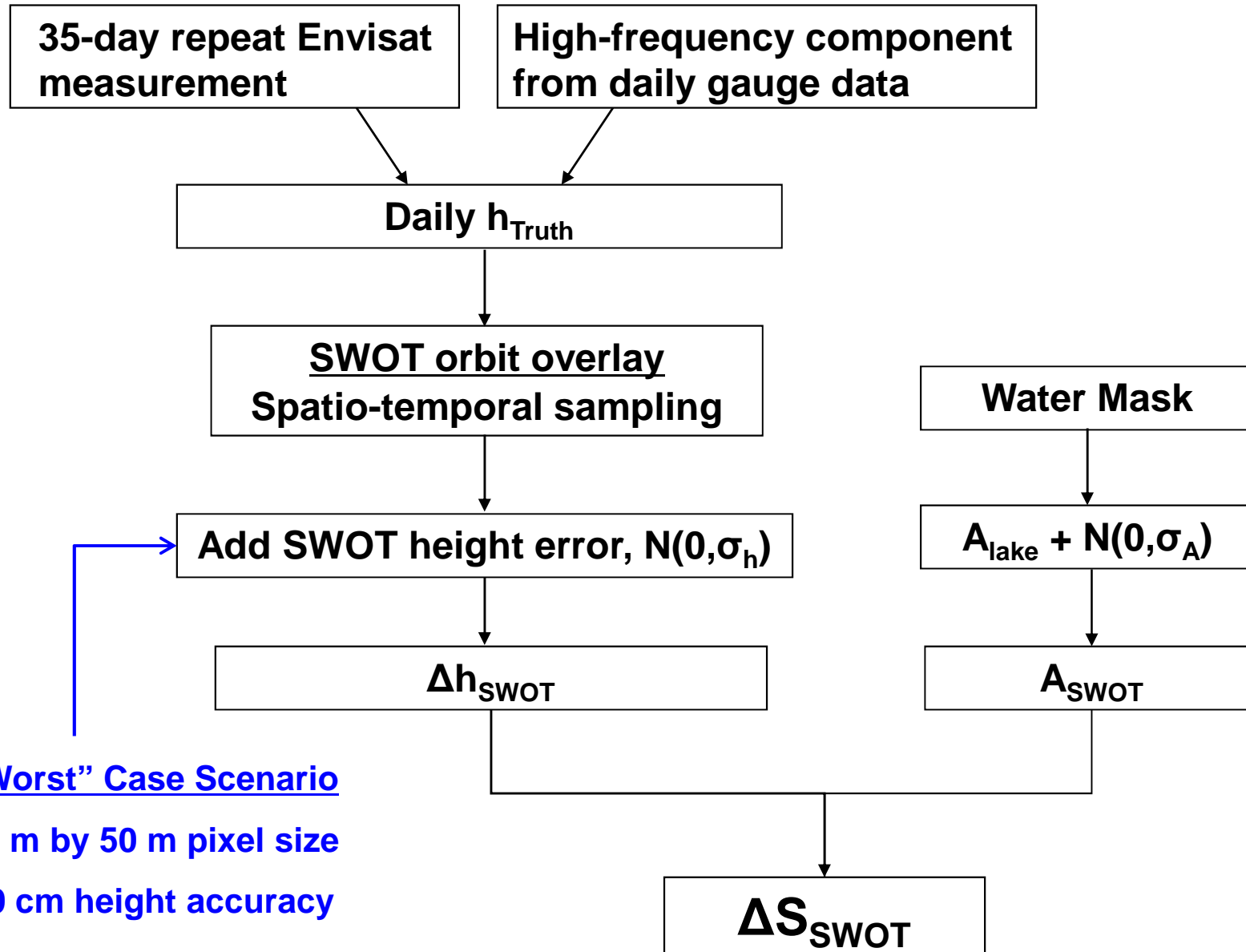Peace-Athabasca Delta (PAD):
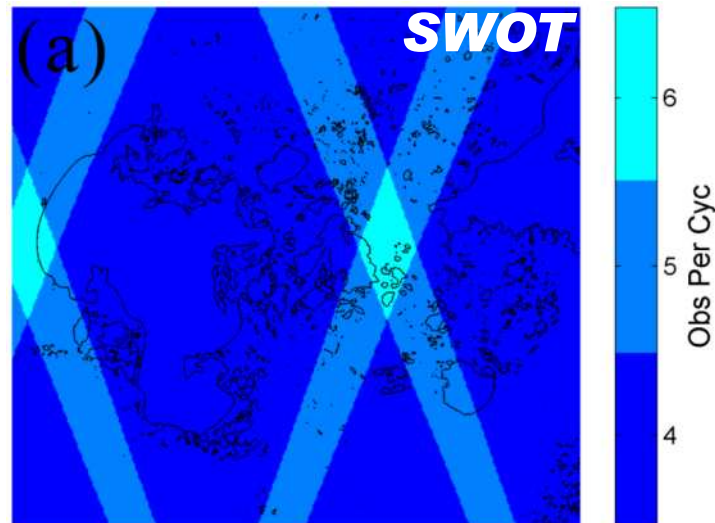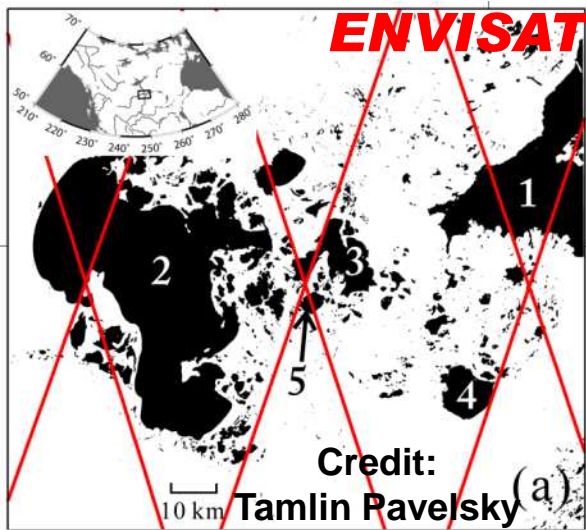
Alaskan Lakes:
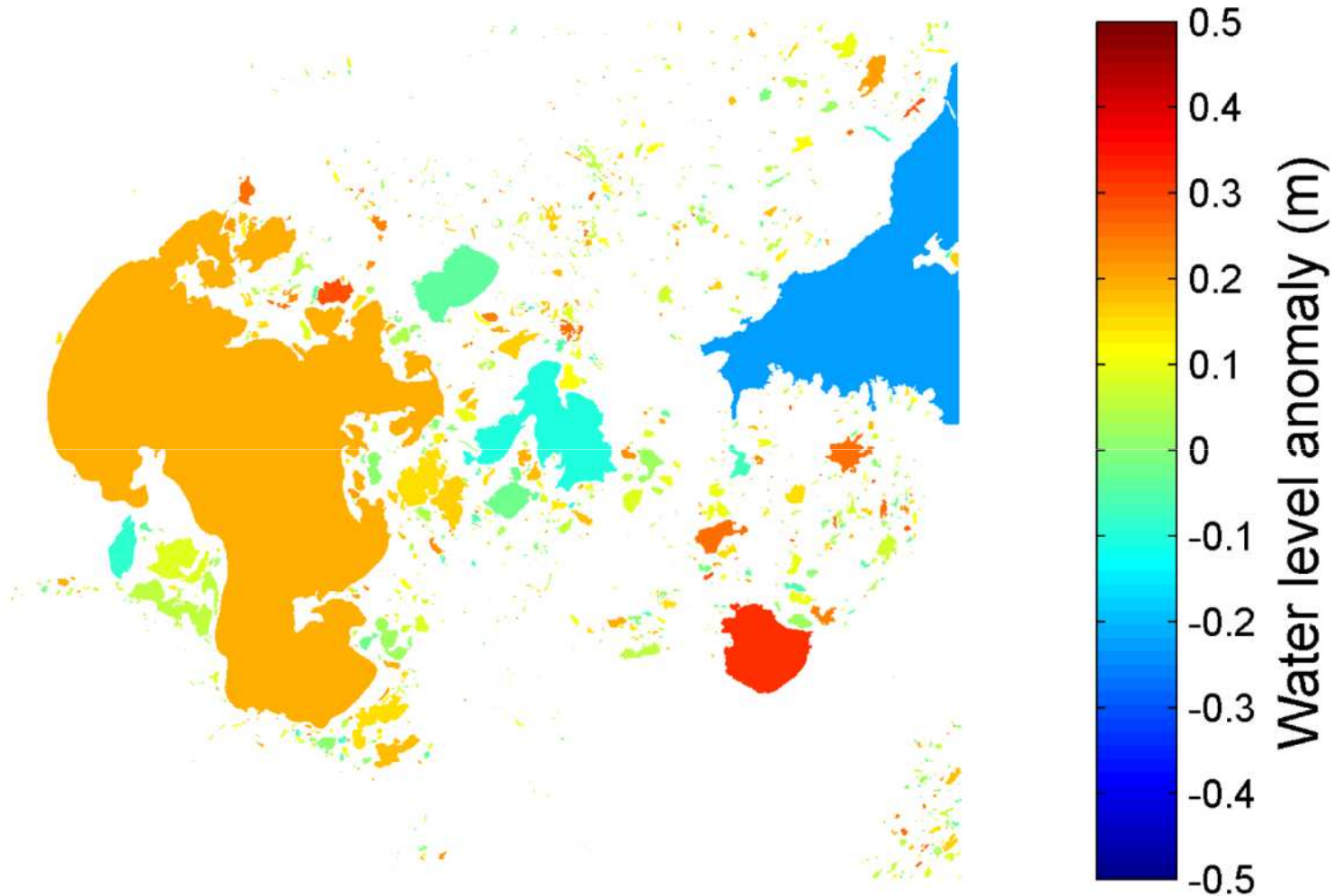
Study Areas and satellite ground tracks

West Siberian Lakes:

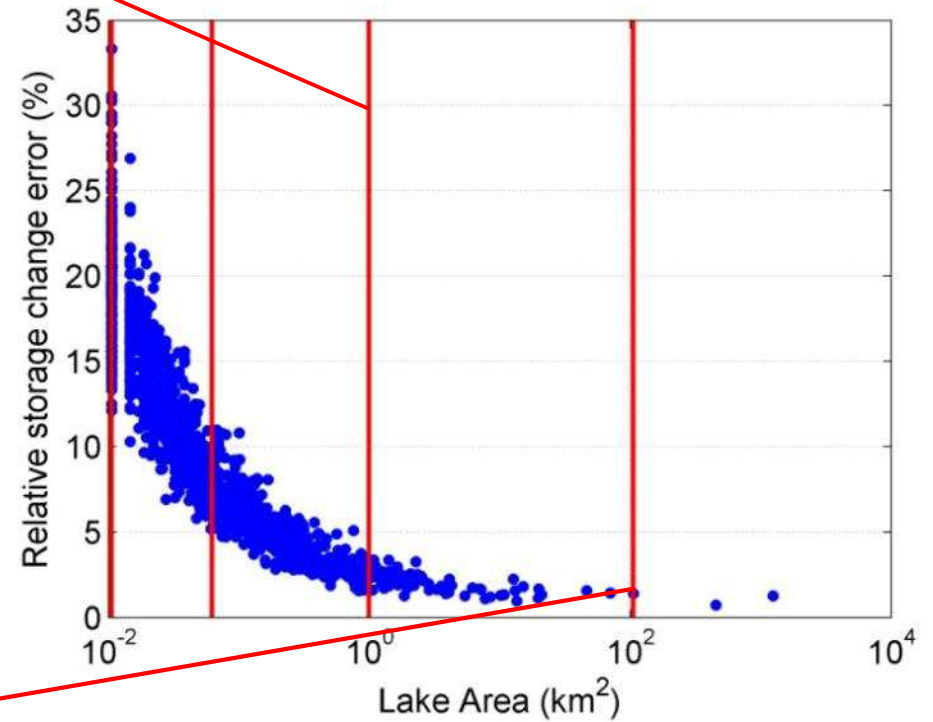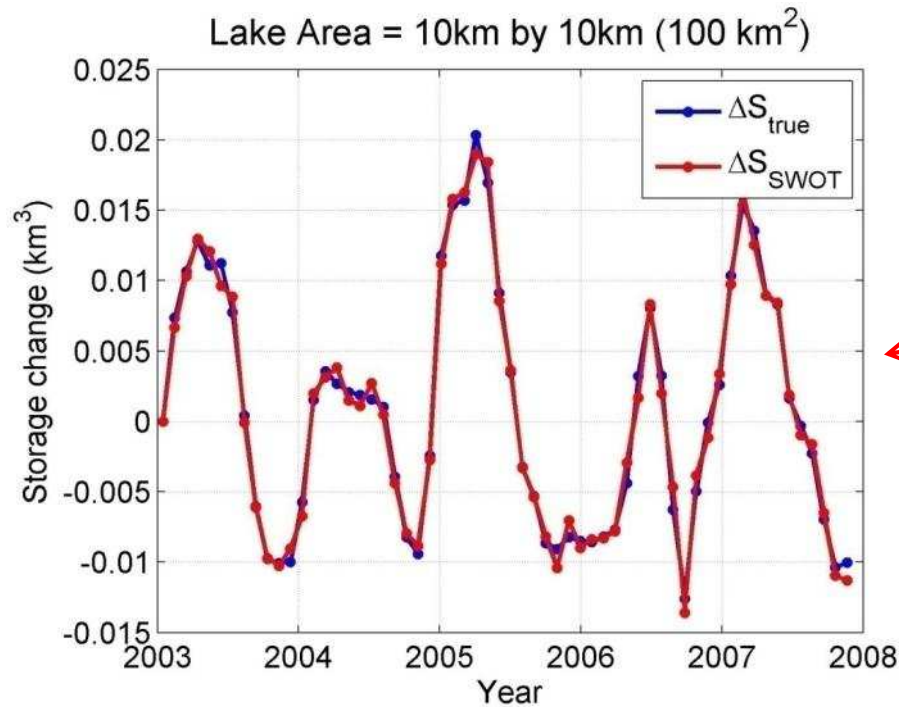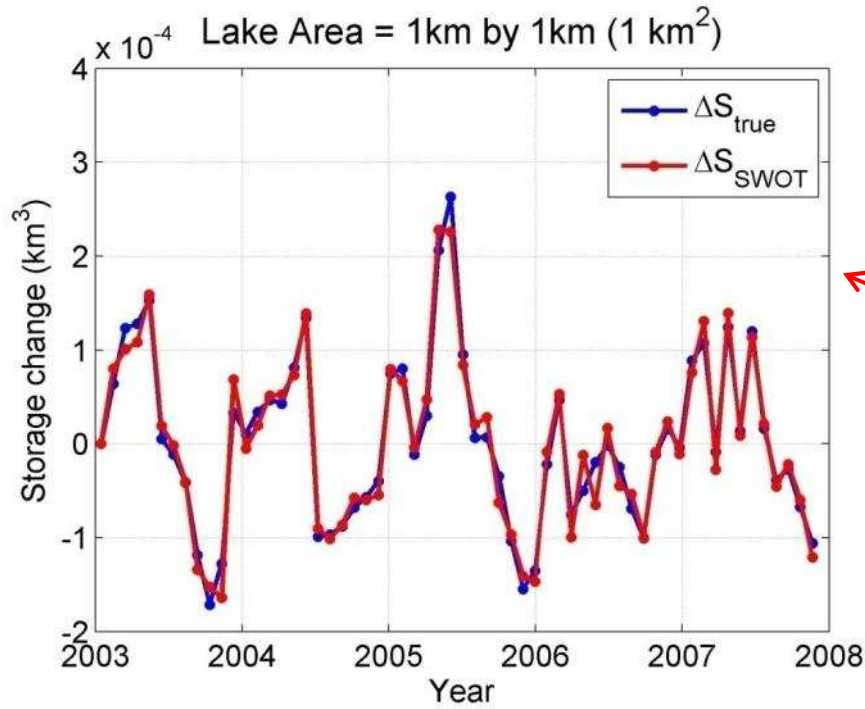# Procedure to estimate SWOT storage change error

Created "True" Height Anomaly

Water elevation anomaly at Day 120 (or April 30, 2002) over PAD

SWOT Ability to Observe Storage Change

Results from PAD

Height errors and areal errors vary with lake area

SWOT Ability to Observe Storage Change
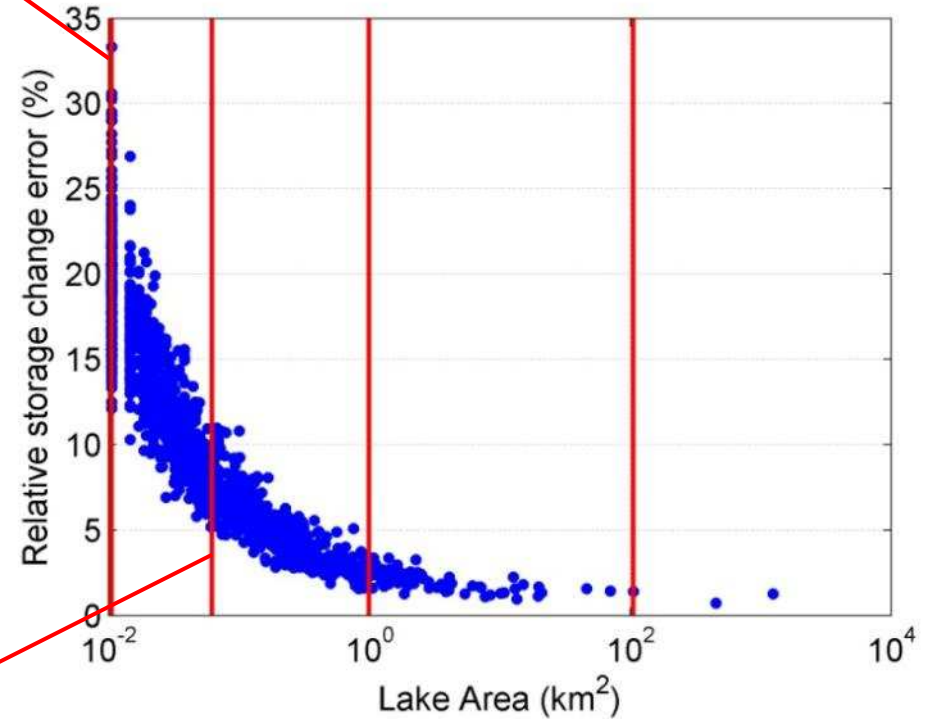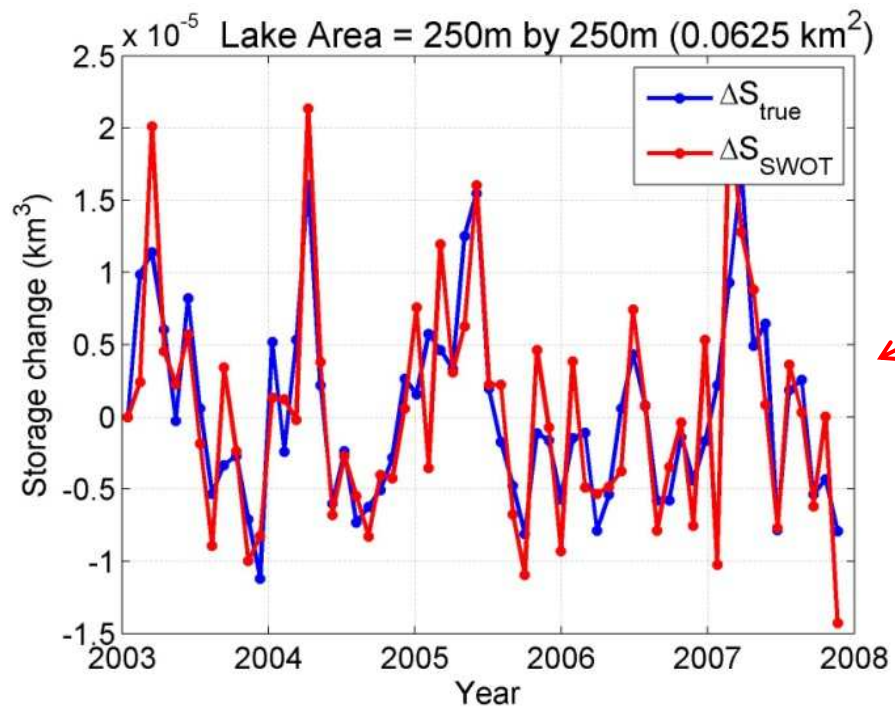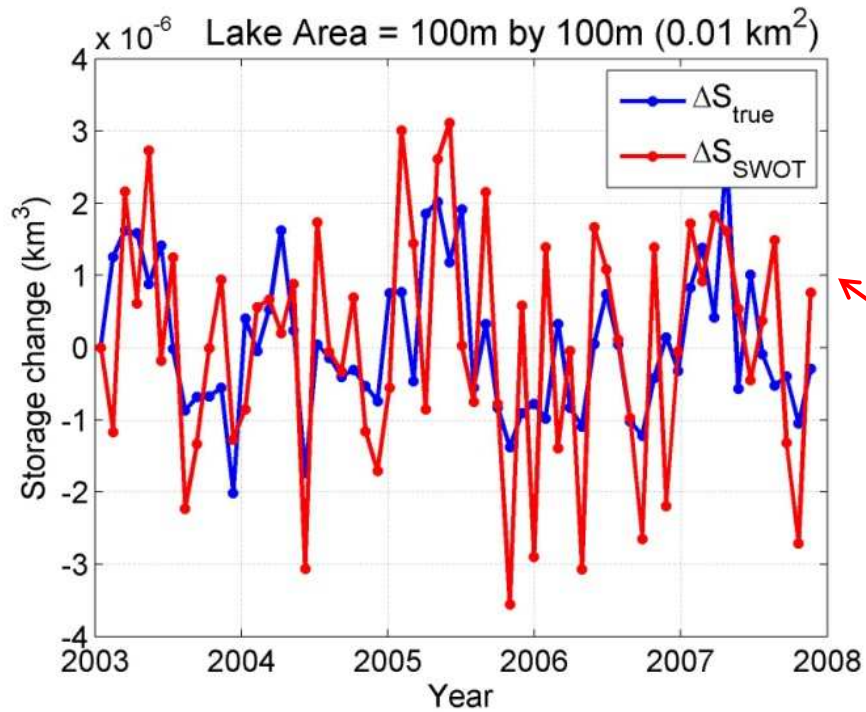
Results from PAD

SWOT Storage Change Error with Different Orbits

Storage change error (%)	PAD	Alaska	Siberia
22-day 78° orbit	**8.9**	**12.8**	**5.4**
21-day 78° orbit	9.1	14.4	5.3
15-day 78°orbit	9.1	12.1	5.1
22-day 74° orbit	8.5	10.1	5.1
21-day 74° orbit	8.4	9.9	5.0
15-day 74° orbit	8.3	9.7	4.9

Results

- **SWOT storage change accuracy is controlled by lake size.**
  monthly error < 5 % for lakes larger than 1 km²
  ~20% for 1 hectare sized lakes

- **SWOT storage change measurements are relatively _insensitive_ to orbital inclination or repeat period.**

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SWOT Repeat Observations

Peace-Athabasca Delta

Cover: Lee et al. IJRS 2010

Rapid Communications now in _Remote Sensing Letters_

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Conclusions

- **More than 65% of yearly global storage change seen by SWOT.**

- **SWOT storage accuracy: monthly errors < 5% for lakes > 1 km^2.**

Acknowledgements