Mike’s buoys in the Pacific Arctic

1. SASSIE
2. SIZRS
3. Arctic Heat

“hydrobuoys”

Remote sensing: next year!

Michael Steele
University of Washington
(NASA) **SASSIE: Salinity And Stratification at the Sea Ice Edge** (2021-2024)


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Google:
“nasa sassie”
(NASA) **SASSIE: Salinity And Stratification at the Sea Ice Edge**
(2021-2024)


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Google: “nasa sassie”

- **SMAP satellite validation**

- **How close to the ice** can satellite SSS go?

- How does salinity influence **ice advance**?

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• **SMAP satellite validation**

• How close to the ice can satellite SSS go?

• How does salinity influence **ice advance**?
NASA SASSIE: Salinity And Stratification at the Sea Ice Edge (2021-2024)

2022 field campaign
2022 field campaign: Three main phases

- **August:** melt
- **September:** transition
- **October:** freeze-up

- **Wave gliders**
- **Ship & aircraft**
- **Satellite, modeling**
- **Buoys & floats**
2022 field campaign: Three main phases

August: melt

- Ice
- Ice
- Ice
- Meltwater layers
- Ship & aircraft
- Wave gliders

September: transition

October: freeze-up

- Growing Ice
- Buoys & floats
- Satellite, modeling
- 11 buoys
- 7 floats

Mike:
Open water - ice transition in early September 2022

~ 2-3 psu salinity gradient across the ice edge

Salinity within the sea ice is more uniform

Strong spatial variability south of the ice edge

SSS from buoys & Wave Gliders

SSS from the ship

Approx ice edge
Open water - ice transition in early September 2022

~ 2-3 psu salinity gradient across the ice edge

Salinity within the sea ice is more uniform

Strong spatial variability south of the ice edge

Data public at JPL’s PO.DAAC by spring 2023
SASSIE 1st Buoy: SVP-S2-SBE (Sep 9 – Oct 23)

Nominal Temperature Sensor Depth (m):
- SST (0.14 m)
- Hull CT (0.44 m)
- CTD (5 m)

Fall cooling from 2.5°C → freezing
### SASSIE 1st Buoy: SVP-S2-SBE (Sep 9 – Oct 23)

**Nominal Temperature Sensor Depth (m):**
- 0.14
- 0.44
- 5.0

**Nominal Salinity Sensor Depth (m):**
- 0.38
- 5.0

**Description:**
- **Isothermal surface cooling**
- **Isohaline**
- **S-stratif.**

**Coincident cooling + stratification**

[Map of Alaska with SASSIE buoy path]

[Graph showing temperature and salinity time series from Sep 9 to Oct 23, with intervals marked for QC clean-up and surface cooling.]
SASSIE 1st Buoy: SVP-S2-SBE (Sep 9 – Oct 23)

Salinity

Nominal Salinity Sensor Depth (m)

isohaline

S-stratif.

calm
calm
daily displacement

Velocity

10 min velocity

Velocity
SASSIE 1st Buoy: SVP-S2-SBE (Sep 9 – Oct 23)

Salinity

S-stratif.

calmish?!

daily displacement

Velocity

10 min velocity

daily displacement

Nominal Salinity Sensor Depth (m)

0.38

5.0

Isohaline

Oct 19

SVP-S2-SBE (Sep 9 – Oct 23)
SASSIE 1st Buoy: SVP-S2-SBE (Sep 9 – Oct 23)

Salinity

Death of a buoy

Ocean pressure

3.5 m ridging
SASSIE 1st Buoy: SVP-S2-SBE (Sep 9 – Oct 23)

Death of a buoy
- all buoys in ice now
- some still reporting
3rd buoy deployed:
UpTempO-S9 *(Sep 10– Oct 25)*
3rd buoy deployed: UpTempO-S9 (Sep 10–Oct 25)
3rd buoy deployed: UpTempO-S9 (Sep 10–Oct 25)

- Utqiagvik
- Surface cooling
- Warm subsurface intrusions (sPW?)
- Freezing
3rd buoy deployed:
UpTempO-S9 (Sep 10–Oct 25)

(ONR) **SIZRS**: Seasonal Ice Zone Reconnaissance Surveys

(SIZ: winter: icy; summer: ice-free)

**2012-2024**

*Synoptic monthly* surveys (June-Oct) across frontal boundaries to study:

- *ice/ocean* circulation
- *air-sea* exchange
(ONR) **SIZRS: Seasonal Ice Zone Reconnaissance Surveys**

(SIZ: winter: icy; summer: ice-free)

2012-2024

**AxCTD & AxCP**

- James Morison
- John Guthrie
- Zheng Liu
- Axel Schweiger

**Atmos. sondes**

- Michael Steele
- Ignatius Rigor

**Buoys**

**Synoptic monthly** surveys (June-Oct) across frontal boundaries to study:

- **ice/ocean circulation**
- **air-sea exchange**

psc.apl.uw.edu/research/projects/sizrs/
(ONR) **SIZRS**: Seasonal Ice Zone Reconnaissance Surveys

(SIZ: winter: icy; summer: ice-free)

Coast Guard C130

Kodiak, AK

Fairbanks

Alaska

Canada

Beaufort Sea

Makarov Basin

Chukchi Sea

Utqiagvik

Fairbanks

Kodiak

1º latitude

150ºW “main line”

BG745

BG77

80ºN

70ºN

140ºW

120ºW

140ºW

Mould Bay

Canada

120ºM
(ONR) **SIZRS**: Seasonal Ice Zone Reconnaissance Surveys

(SIZ: winter: icy; summer: ice-free)

Coast Guard C130

Kodiak, AK

Fairbanks

Alaska

Canada

Chukchi Sea

Beaufort Sea

BGEP surveys

1º latitude

150°W “main line”
(ONR) SIZRS: Seasonal Ice Zone Reconnaissance Surveys

(SIZ: winter: icy; summer: ice-free) 2012-2024

- monthly
- synoptic
- air-ice-ocean
2022 SIZRS UpTempO T-string (Oct 12 – Nov 14)

surf cooling < T_{freezing}
2022 SIZRS UpTempO T-string (Oct 12 – Nov 14)

Ocean pressure

OCEAN PRESSURE AND SEA LEVEL PRESSURE
This plot shows the ocean pressure(s) from the barometers placed at nominal depths (blue), and sea level pressure in red.

Nominal Temperature Sensor Depth (m)

surf cooling

wind

< $T_{freezing}$

20 db

40 db

60 db

uplift

30 m uplift!
1st SIZRS UpTempO buoy deployment
August, 2013

...reporting in 4-48 hours
SIZRS buoy deployment via C130 aircraft
SIZRS buoy deployment October, 2022
Mike’s hydrobuoys in the literature

- **Li, Ding, Steele, Schweiger** (Nat Commun., 2022)
- **Banzon, Smith, Steele, Huang, Zhang** (J. Tech., 2020)
- **Minnett et al. incl. Steele** (Rem. Sens. Environ., 2019)
- **Fournier, Lee, Tang, Steele, Olmedo** (Rem Sens., 2019)
- **Moore, Schweiger, Zhang, Steele** (GRL, 2018)
- **Castro, Wick, Steele** (Rem. Sens. Environ., 2016)

**Validation/improvement of:**

- **satellite SST**
- **satellite SSS**
- **models**
- **Upper ocean warming/freshening**
2016-2021:
• usually ~ 3 flight periods/summer

Expendables & floats
Summer heat predicts fall ice advance
(NOAA) Arctic Heat II

Calvin Mordy & Jiaxu Zhang (PMEL / CICOES)

2016-2021:
• usually ~ 3 flight periods/summer

☞ Expendables & floats
☞ Summer heat predicts fall ice advance

2022:
• June + July/Aug with APL/SIZRS team collaboration
2016-2021:
- usually ~ 3 flight periods/summer

- Expendables & floats
- Summer heat predicts fall ice advance

2022:
- June + July/Aug with APL/SIZRS team collaboration

2023 ➔:
- Seeking funding
- Likely focused on Pacific Water circulation
2022 Accomplishments

- **June Flights**
  - Deployed 8 AXBTs along DBO3 shortly after ice retreat.
  - Deployed 3 microSWIFT wave buoys off Prudhoe Bay in collaboration with Maddie Smith (APL)

- **July-August Flights**
  - Deployed 24 AXBTs (AOC) and 7 AXCTDs (APL) across the shelf break.
  - Deployed ~30 dropsondes in collaboration with Zheng Liu (APL).
  - Test run of the Lidar observational system LATIS in collaboration with John Gutherie (APL).
APL’s microSwift

- Iridium
- GPS
- Alkaline C-cells
- Surface waves

- Deployed off ships, docks, Arctic Heat II (2022)
  - Lifetime: several days

- Jim Thomson (surface waves)
- Alex deKlerk (engineer)
APL’s microSwift-TS

- Iridium
- GPS
- Alkaline C-cells
  - Surface waves
  - SST
  - SSS

Jim Thomson (surface waves)
Alex deKlerk (engineer)
Mike Steele (SST/SSS)
+ APL engineering support
APL’s microSwift-TS

- Iridium
- GPS
- Alkaline C-cells
- Surface waves
- SST
- SSS

2023:
- Deploy via Arctic Heat II
- Lifetime: 1-3 months (hopefully!)

- Jim Thomson (surface waves)
- Alex deKlerk (engineer)
- Mike Steele (SST/SSS)
- + APL engineering support
Summary

• Hydrobuoys for SST, SSS, upper ocean

• Ship or air-deploy

• Lots of form factors!

Thank you
September cruise: Five major “plays”

Open water (two plays)

Heavy ice cover (one play)

Open water/ice transition (two plays)