SMAP/SMOS observations of unusual wintertime intrusions of salty/fresh water into the Gulf of Maine

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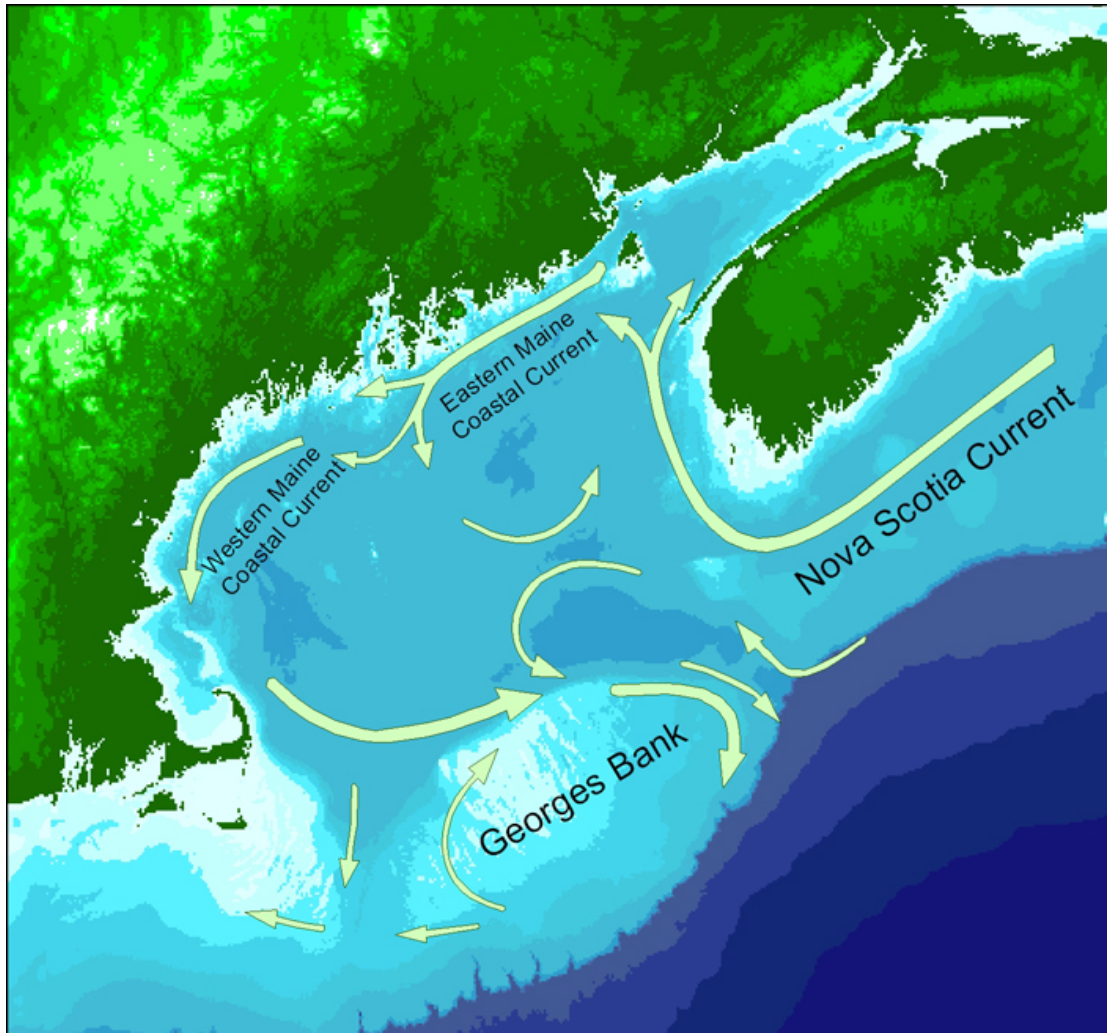
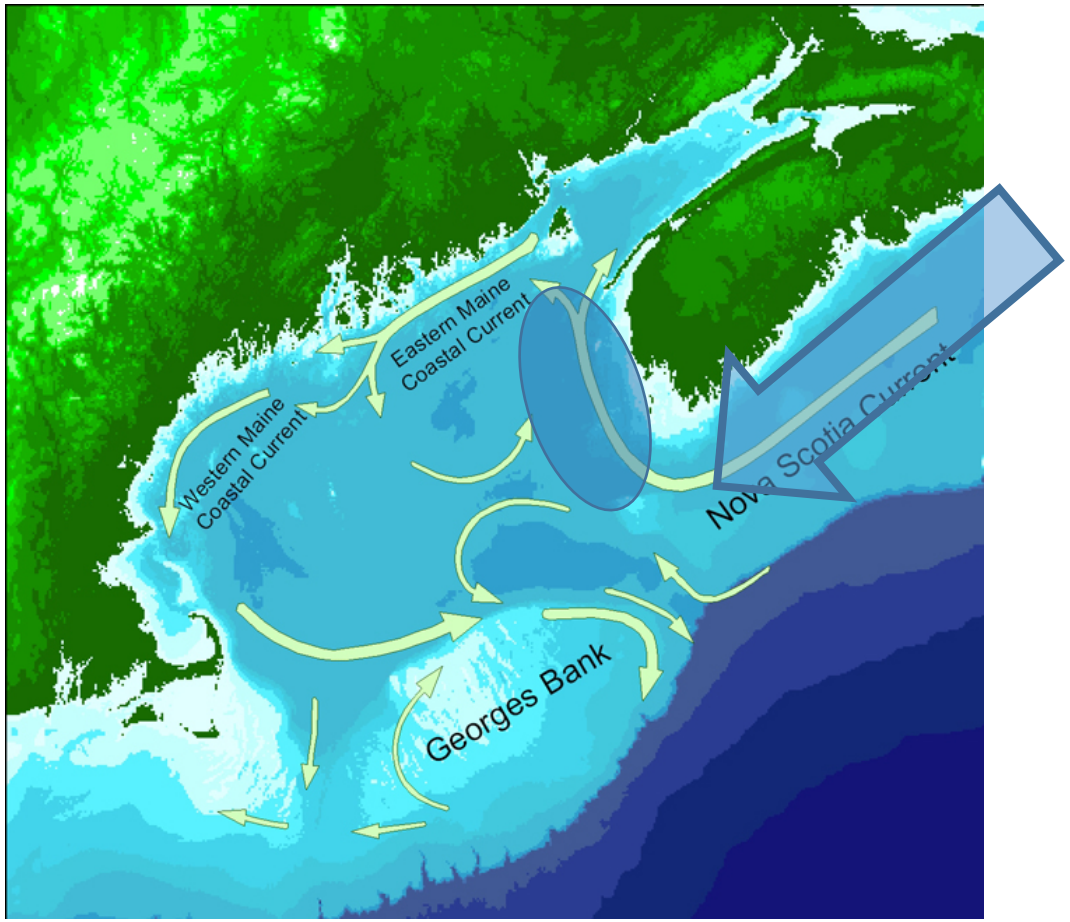
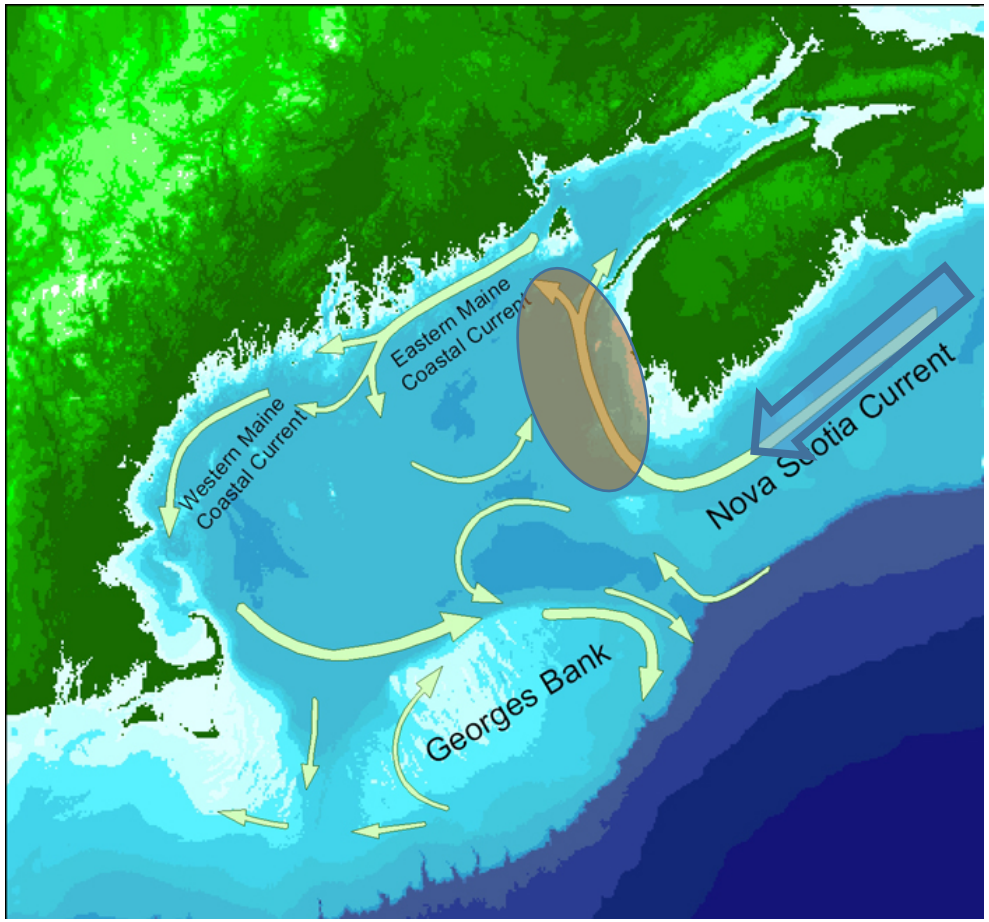
Supported by the NASA/OSST

Gulf of Maine circulation and salinity



Salt anomaly produced by stronger/weaker Scotian Shelf Current (SSC)

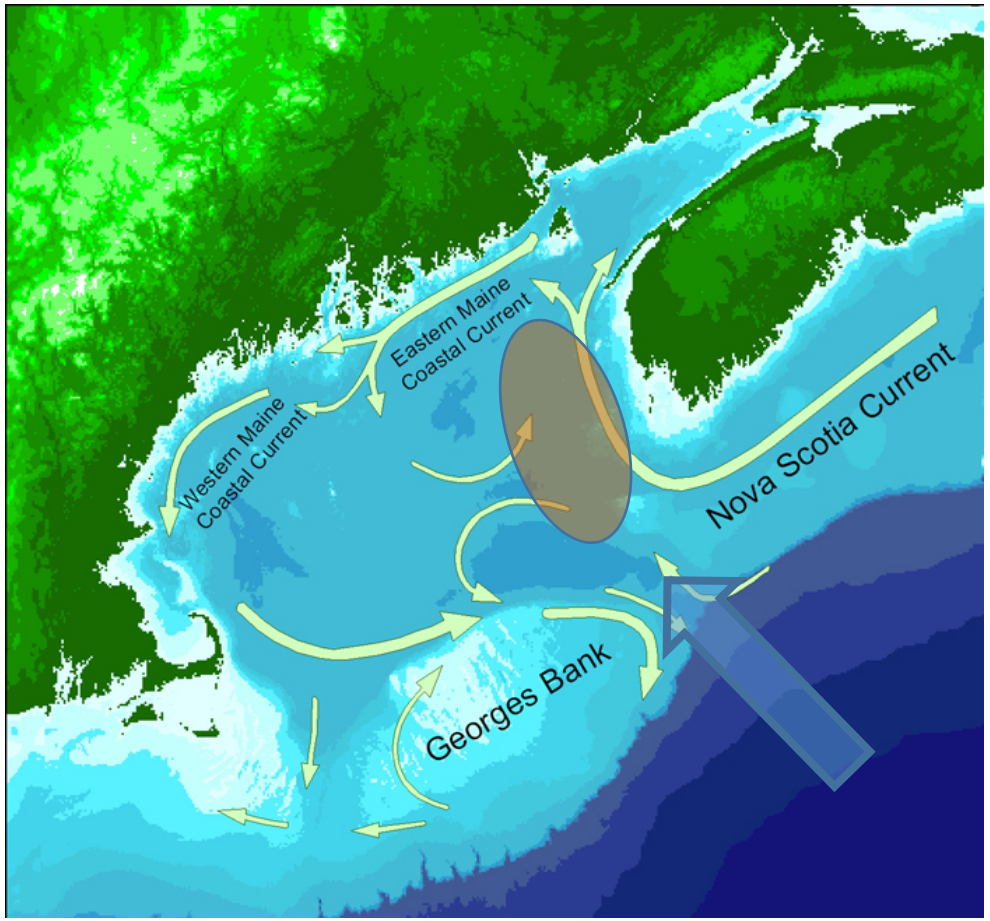




Li, Y., Ji, R., Fratantoni, P. S., Chen, C., Hare, J. A., Davis, C. S., & Beardsley, R. C. (2014). Wind-induced interannual variability of sea level slope, along-shelf flow, and surface salinity on the Northwest Atlantic shelf. *Journal of Geophysical Research: Oceans*. https://doi.org/10.1002/2013JC009385

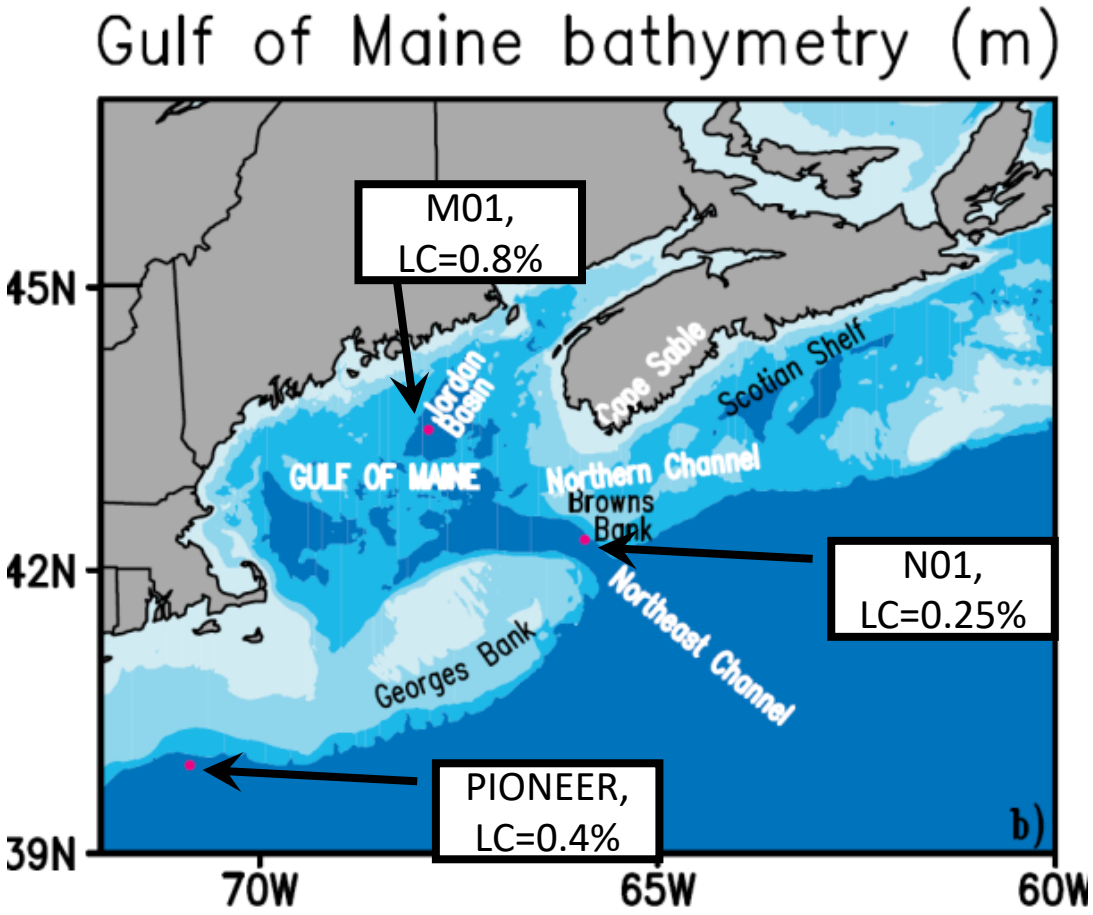
Feng, H., Vandemark, D., & Wilkin, J. (2016). Gulf of Maine salinity variation and its correlation with upstream Scotian Shelf currents at seasonal and interannual time scales. *Journal of Geophysical Research: Oceans*. https://doi.org/10.1002/2016JC012337

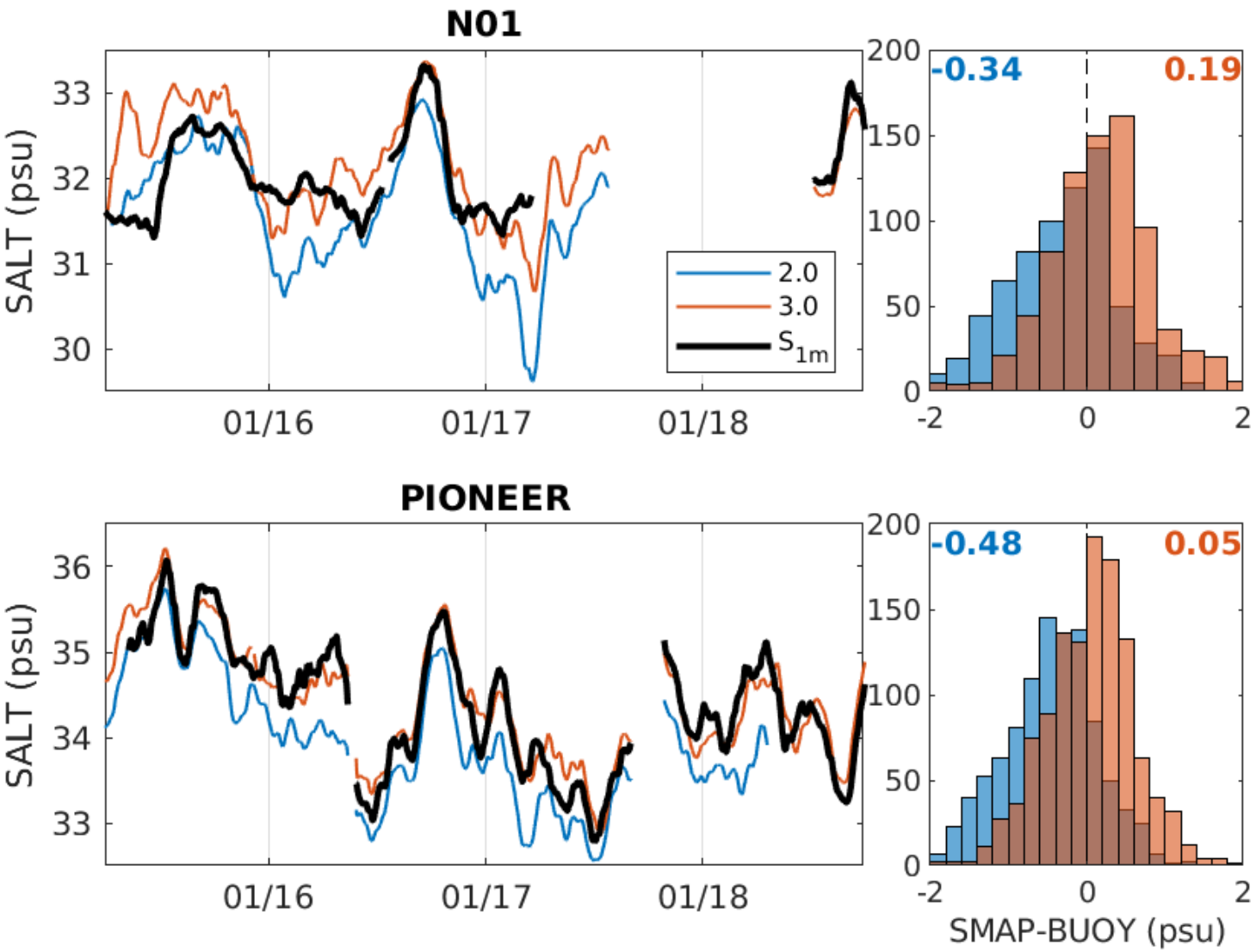
Salt anomaly produced by warm slope water impinging through Northeast Channel



Grodsky, S. A., Vandemark, D., Feng, H., & Levin, J. (2018). Satellite detection of an unusual intrusion of salty slope water into a marginal sea: Using SMAP to monitor Gulf of Maine inflows. *Remote Sensing of Environment*, *217*(November 2018), 550–561. https://doi.org/10.1016/J.RSE.2018.09.004

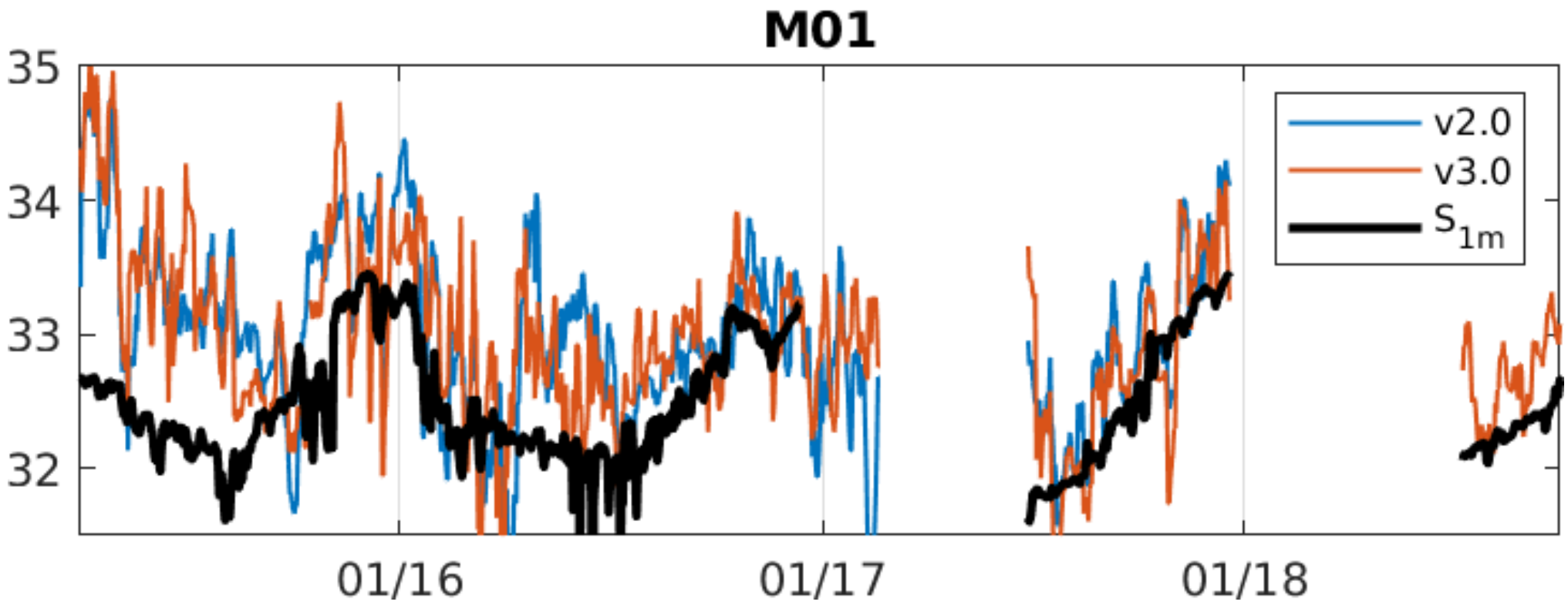
SMAP biases in the Gulf of Maine



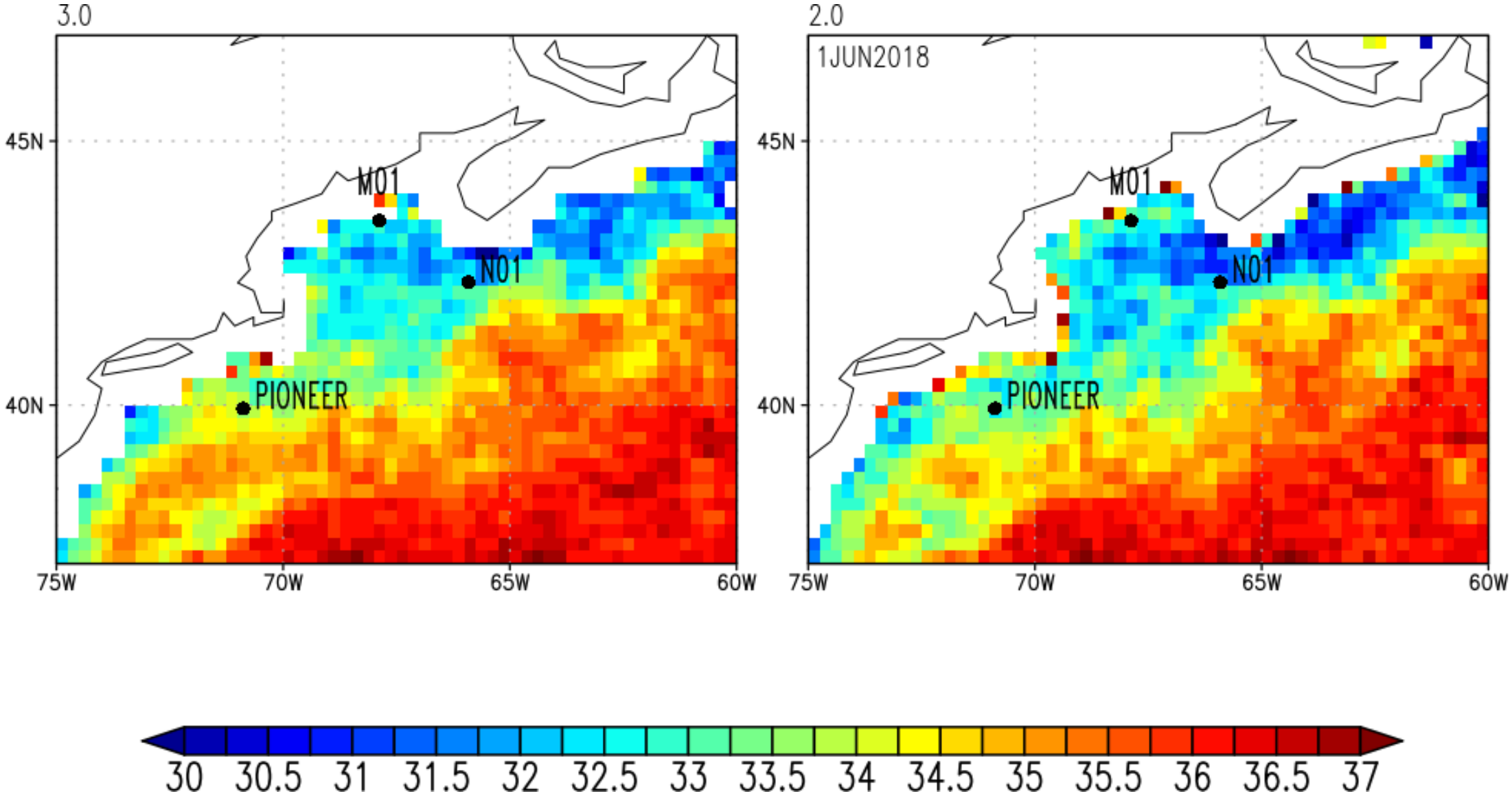


Grodsky, S. A., Vandemark, D., & Feng, H. (2018). Assessing Coastal SMAP Surface Salinity Accuracy and Its Application to Monitoring Gulf of Maine Circulation Dynamics. *Remote Sensing 2018, Vol. 10, Page 1232*, *10*(8), 1232. https://doi.org/10.3390/RS10081232

Closer to coast (LC~=0.8%), the land contamination overestimation bias is still present. RESS investigates cases LC>~1%.



Concurrent SMAP SSS v3.0 (left) and v2.0 (right)



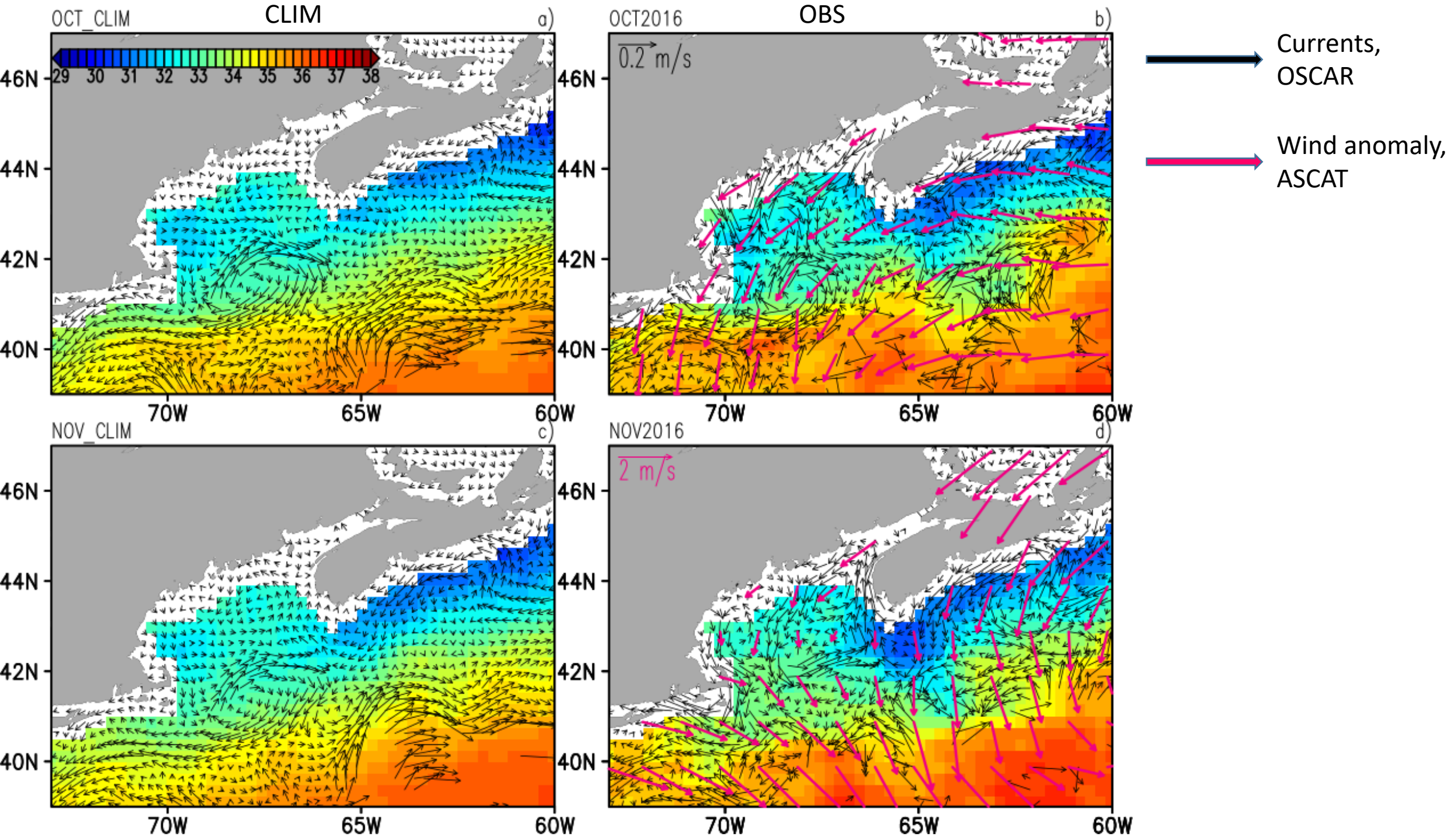
SMAP v2.0 biases in the Gulf of Maine (continued)

- SSS bias has two components:
- (i) cold SST (strong winds?) negative bias (amplifies in winter);
- (ii) Land contamination bias (positive @ LC>0.5%), negative (@ 0.2%<LC<0.5%).
- Both bias components are seasonally dependent.
- SSS anomaly eliminates both the real seasonal cycle and the seasonally-dependent bias component.

Fresh anomaly 2016-17

SMAP RESS v2.0 (left column)
SMOS LOCEAN debiased (right column)

Time


CLIM
OBS
OCT_CLIM
a)
29 30 31 32 33 34 35 36 37 38
OCT2016
b)
0.2 m/s
NOV_CLIM
c)
NOV2016
d)
2 m/s
46N
44N
42N
40N
70W
65W
60W
Currents, OSCAR
Wind anomaly, ASCAT

2107-18 salty event

SMAP RESS v2.0 (left column)
SMOS LOCEAN debiased (right column)

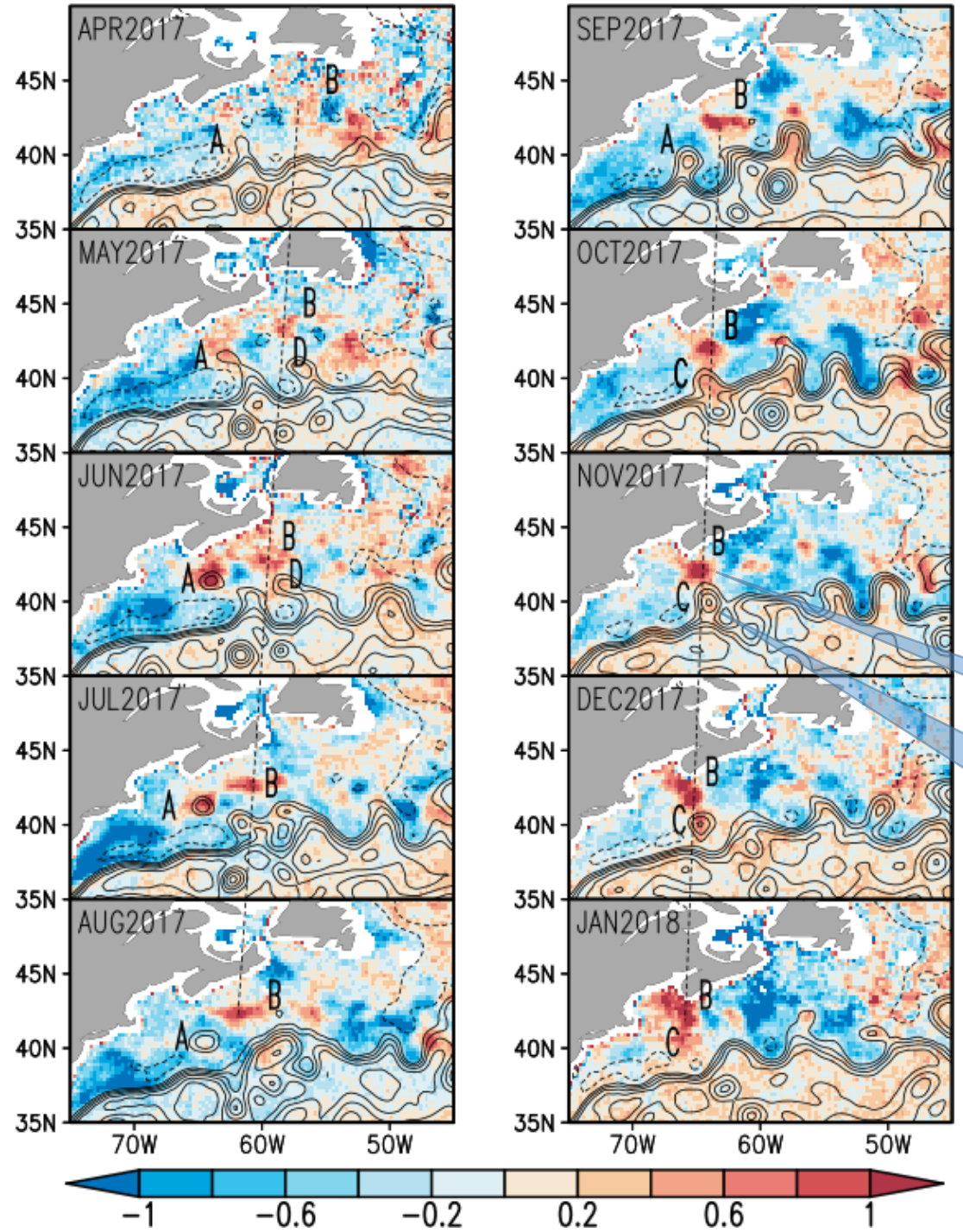
Salty feature B

Time

Anomalous salinity (SSSA) along dashed red line

Salty feature B is detectable for about half a year as it propagated southwestward along shelf break

Temporal evolution of the salty anomaly



- Salty anomaly ‘B’ propagates southwestward along the shelf break and interacts with Gulf stream meanders
- In October-December, 2017, the salty feature ‘B’ approaches the Gulf of Maine
- Its entrance to the Gulf is coincident with the presence of Gulf Stream warm meander ‘C’, which probably forced the salty feature ‘B’ into the Gulf

Salty feature ‘B’

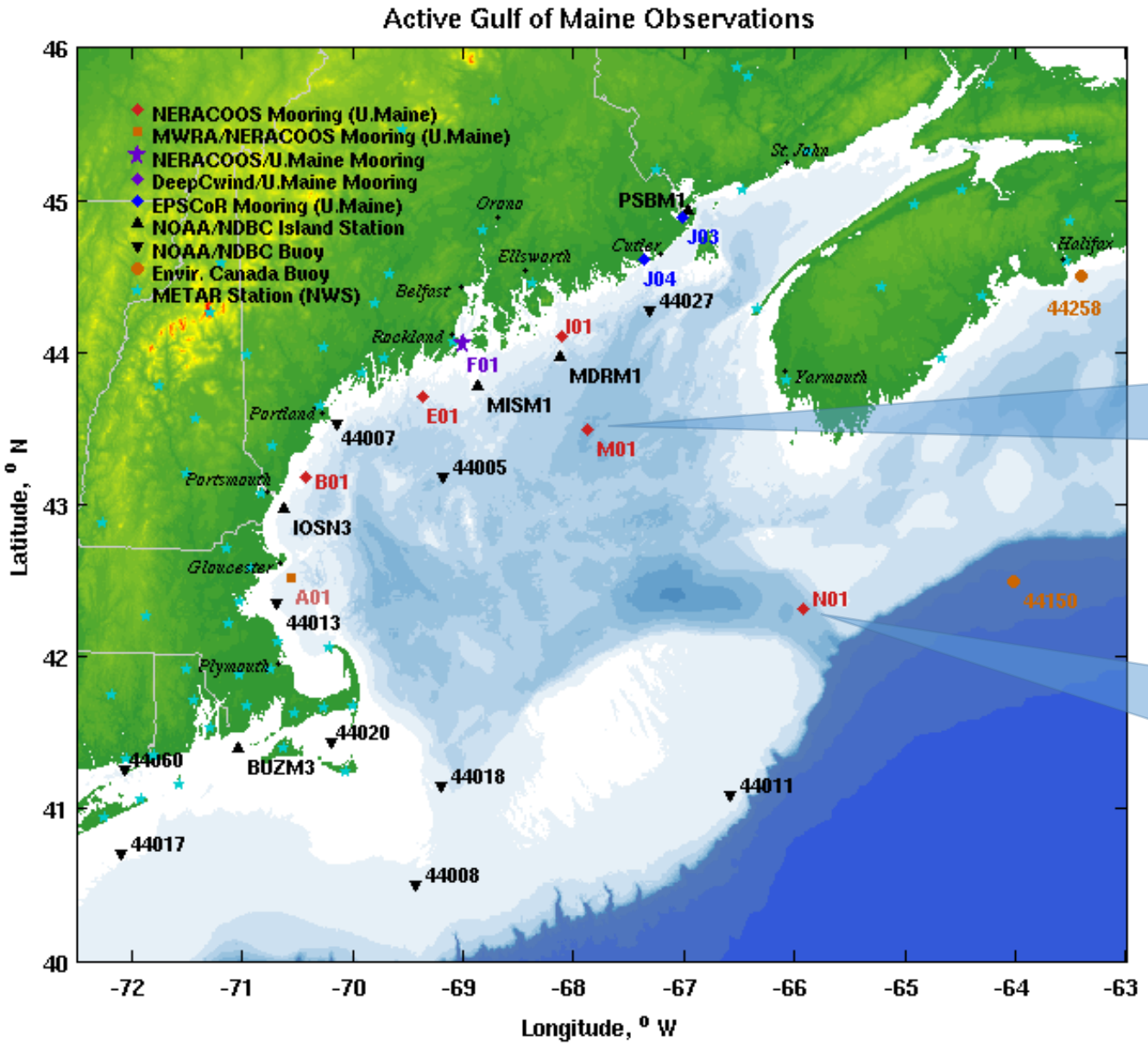
SSH high, warm meander ‘C’

SSSA – shading
SSH - contours

Salty feature ‘B’

SSH high, warm meander ‘C’

SMAP SSS validation



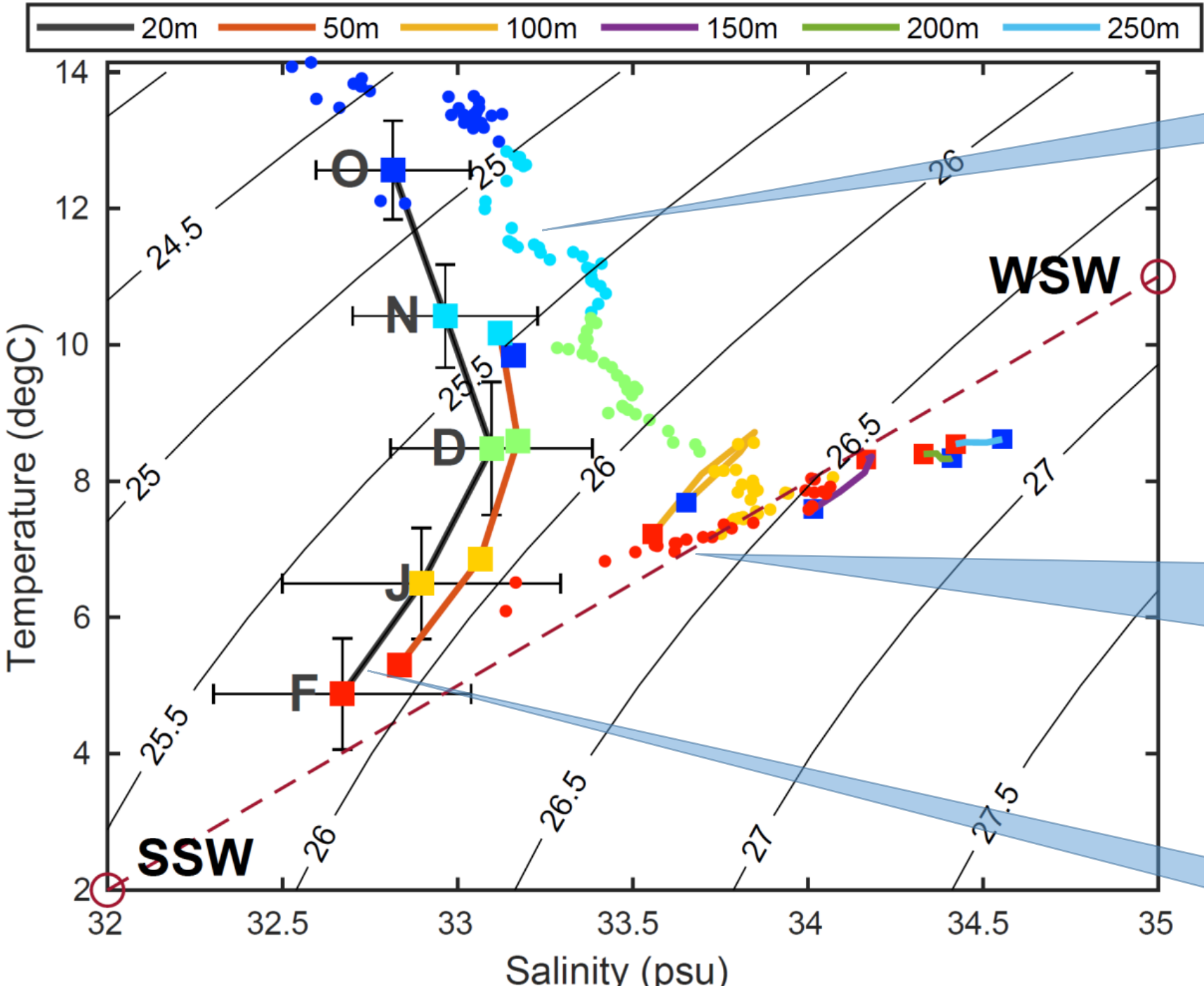
Active

No data

SMAP SSSA agrees well with buoy M01 salinity anomalies (z=20m and 50m). Near surface (z=1m) buoy data were missing.

Salty feature ‘B’ produced the largest salty anomaly in 15 year buoy M01 records

1m 20m 50m 100m 150m SMAP



2017-18 October to February T/S at z=20m

During the peak of the salty event T/S data at z 20m fall on the mixing line between Scotian Shelf Water (SSW) and Warm Slope Water (WSW), which is normally present only at depths below 100m.

Seasonal cycle of T/S from October to February

Summary and future research

- 10-month down the shelf break migration of salty feature was monitored by SMAP. This feature was the source of near-surface modified Warm Slope Water advected onto the shelf and into the Gulf of Maine (GoM) in fall-winter of 2017-18.
- This salty inflow is confirmed by GoM buoy M01 that indicates a surface-trapped feature, z<=50m, (not extending below 100 m).
- SMAP SSS is a complimentary tool (to SST and ocean color) for monitoring shelf-slope exchanges and their impacts on the local ecosystems. This analysis was made possible by the strong SSSA (~1 psu). Weaker SSSA in cold SST may not be detectable.
- Spatio/temporal data from satellite SSS, SST, and altimetry offer an insight into the evolution of shelf-break anomalies and their interactions with Gulf Stream meanders.
- Future work will focus on modeling and data synthesis to understand the dynamics of this particular intrusion and quantifying the role of Gulf Stream meanders.