Coordinated multi-platform Lagrangian observations during SPURS-2

(overview & early results)

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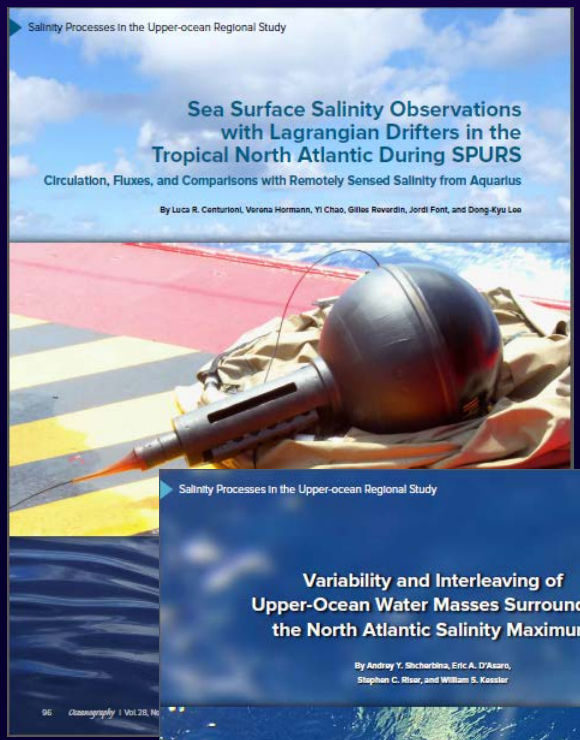
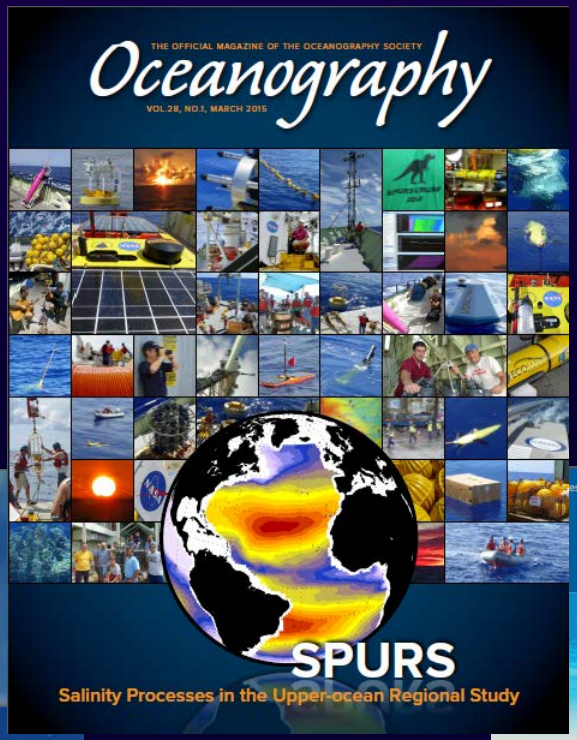
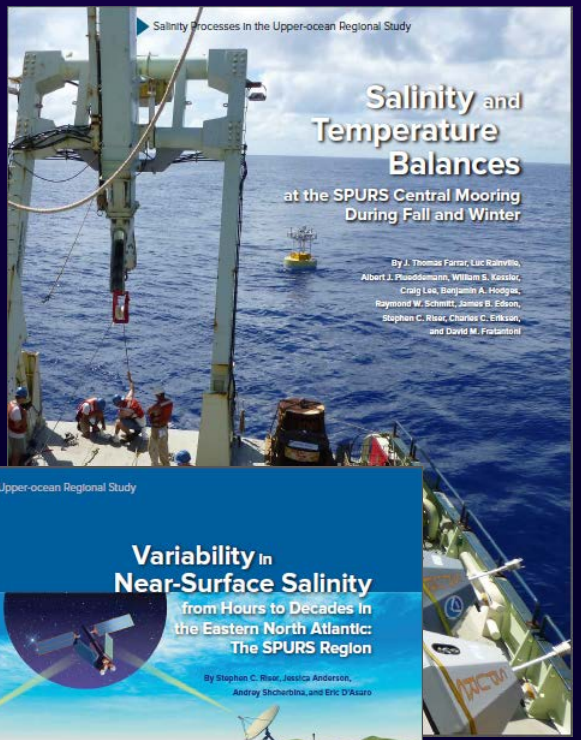
& SPURS-2 team

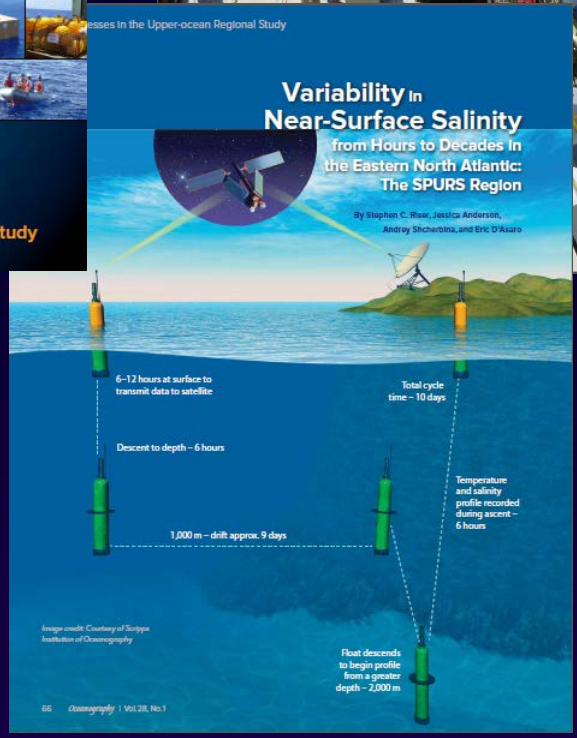
Autonomous platforms in SPURS-1

Profiling floats, Surface drifters, Seagliders, Wave Gliders









SPURS-2: Coordinated Eulerian+Lagrangian Work

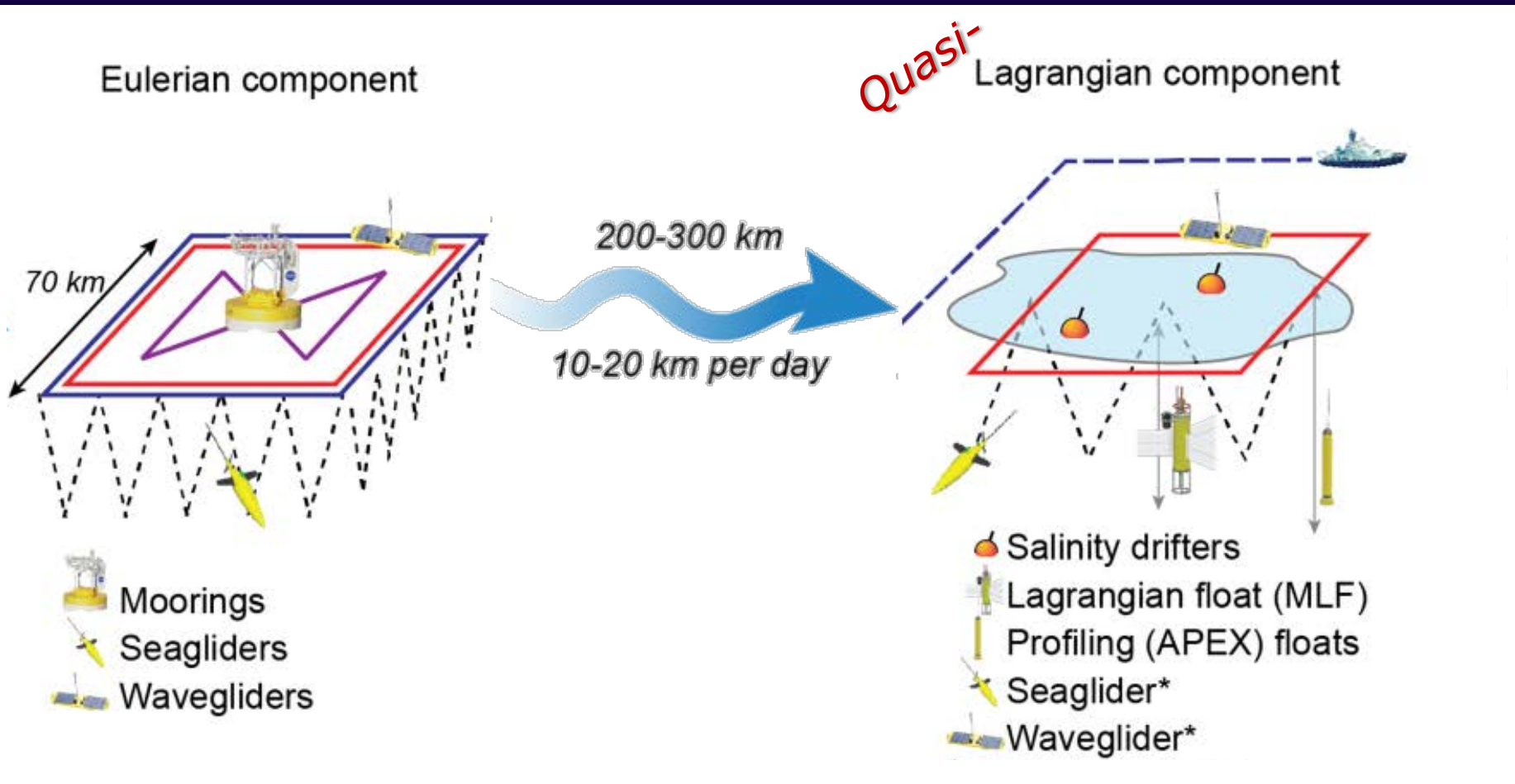


Fig. 1 General concept for Eulerian and Lagrangian components of SPURS-2.

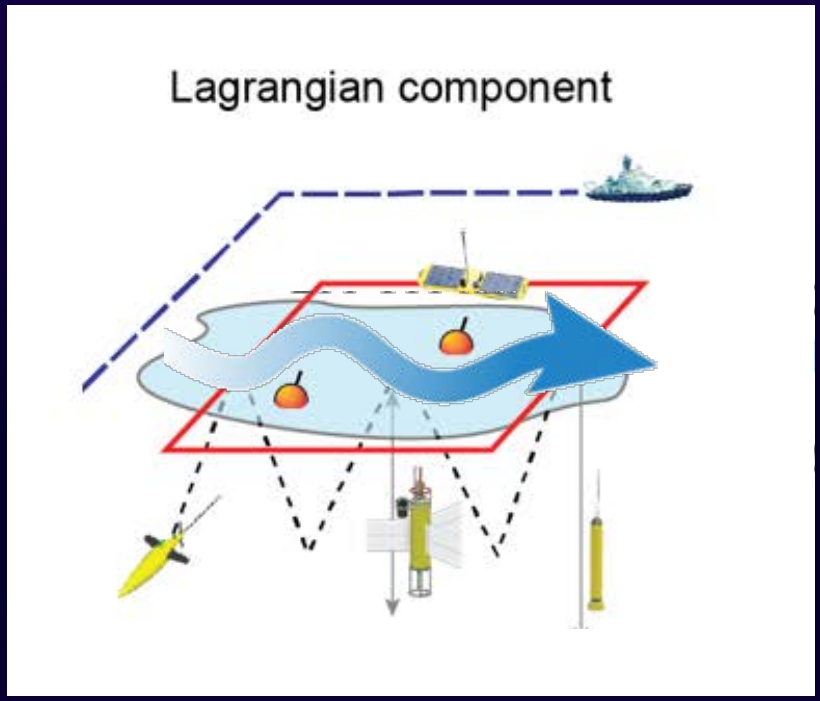
Motivation for Lagrangian-frame sampling

If you can't beat 'em, join 'em.

- Synoptic sampling virtually impossible
- Minimizes advective terms:

$$\frac{\partial S}{\partial t} + \mathbf{U}\nabla S = \cdots$$

- Natural for studying…
  - ⇝ dispersion
  - ⇝ tracer evolution
  - ⇝ small-scale processes



SPURS 2 scientific questions

Adapted from Farrar et al. (2014) white paper

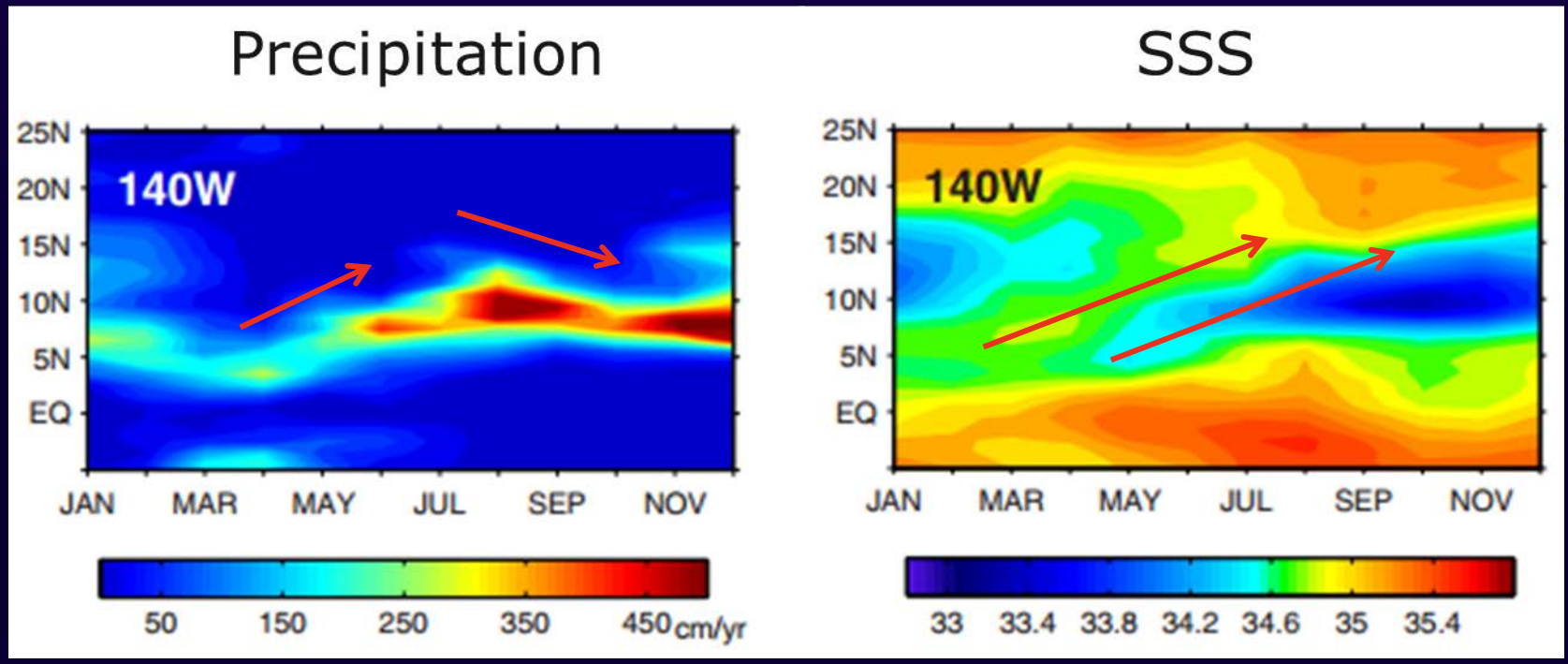
- Where does the freshwater go?
- Puddle-to-basin connection
- Horizontal and vertical variability
- Local and non-local effects of FW flux on the ocean
- SSS feedbacks on the atmosphere

All lend themselves to Lagrangian investigation!

Large-scale evolution of FW signature

Currents: annoyance or signal?

P_{max} and S_{min} move differently (Yu, 2014):

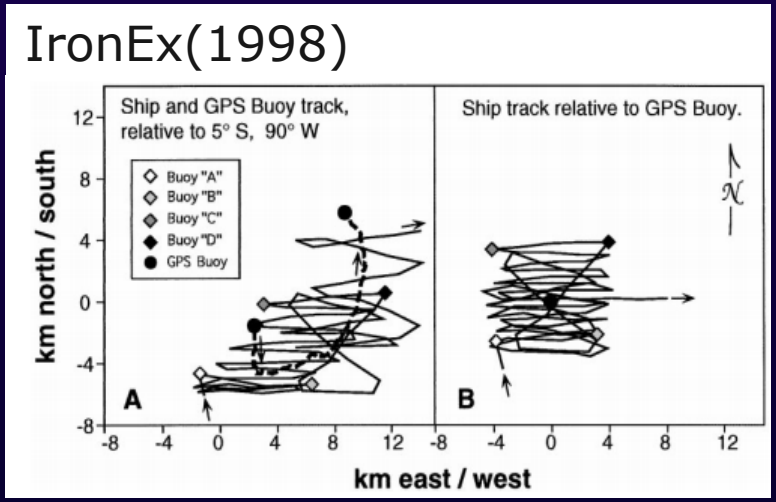


Why? Ekman advection + FW forcing…

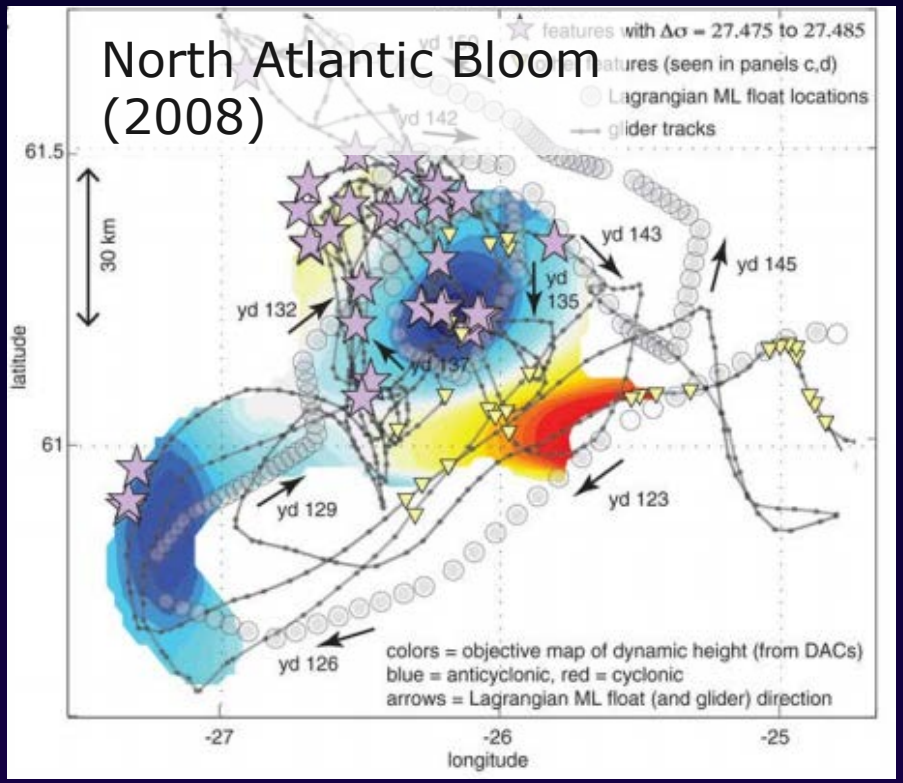
- Details of Lagrangian evolution
- Fate of FW anomaly beyond ITCZ
- Vertical structure of the Ekman flow, shallow overturning cell
- Transition between salt- and temperature-dominated regimes

History of Lagrangian-frame experiments

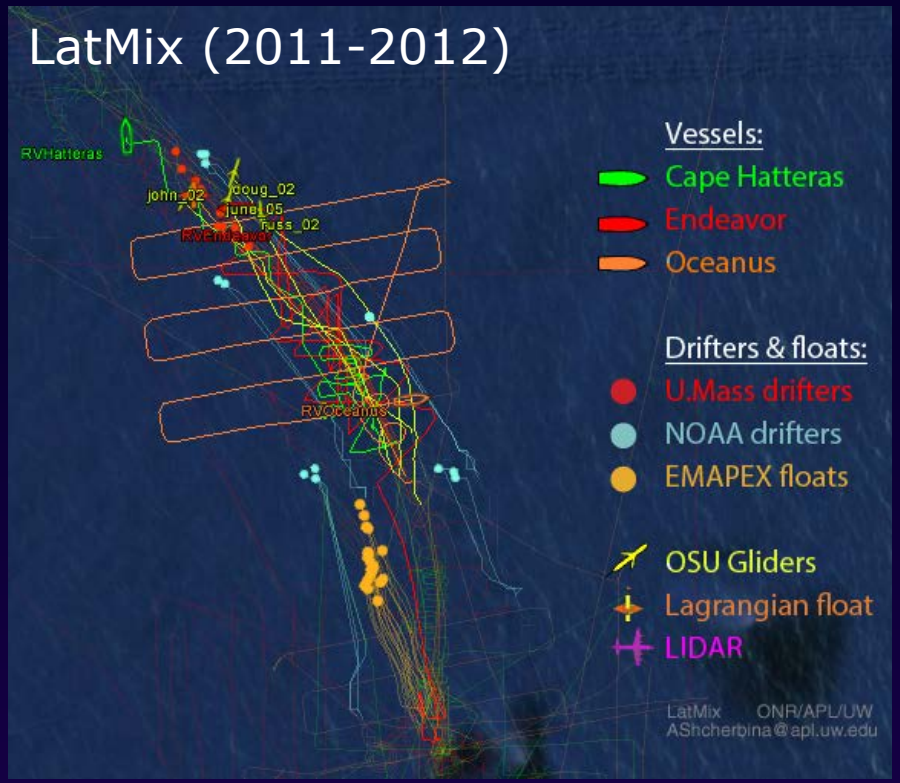
IronEx(1998)



North Atlantic Bloom (2008)



LatMix (2011-2012)



SPURS-2 coordinated Lagrangian drift

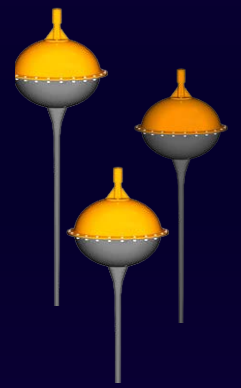
A mix of >20 instruments, fully-Lagrangian and driveable

Lagrangian float
2xCTD, Surface TS, PAL, ADCP
0 – 100m
A. Shcherbina et al.

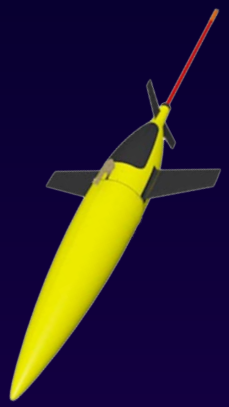
APEX ARGO float 1(22)
CTD, Surface TS, PAL
0 – 2,000m
S. Riser et al.

Wave Glider 1(3)
2xCTD, Wind, T_{air}
B. Hodges et al.

AOML Drifters 3(6)
2xCTD
D. Volkov et al.



SIO Drifters 18(100?)
CTD, Waves (some)
L. Centurioni et al.

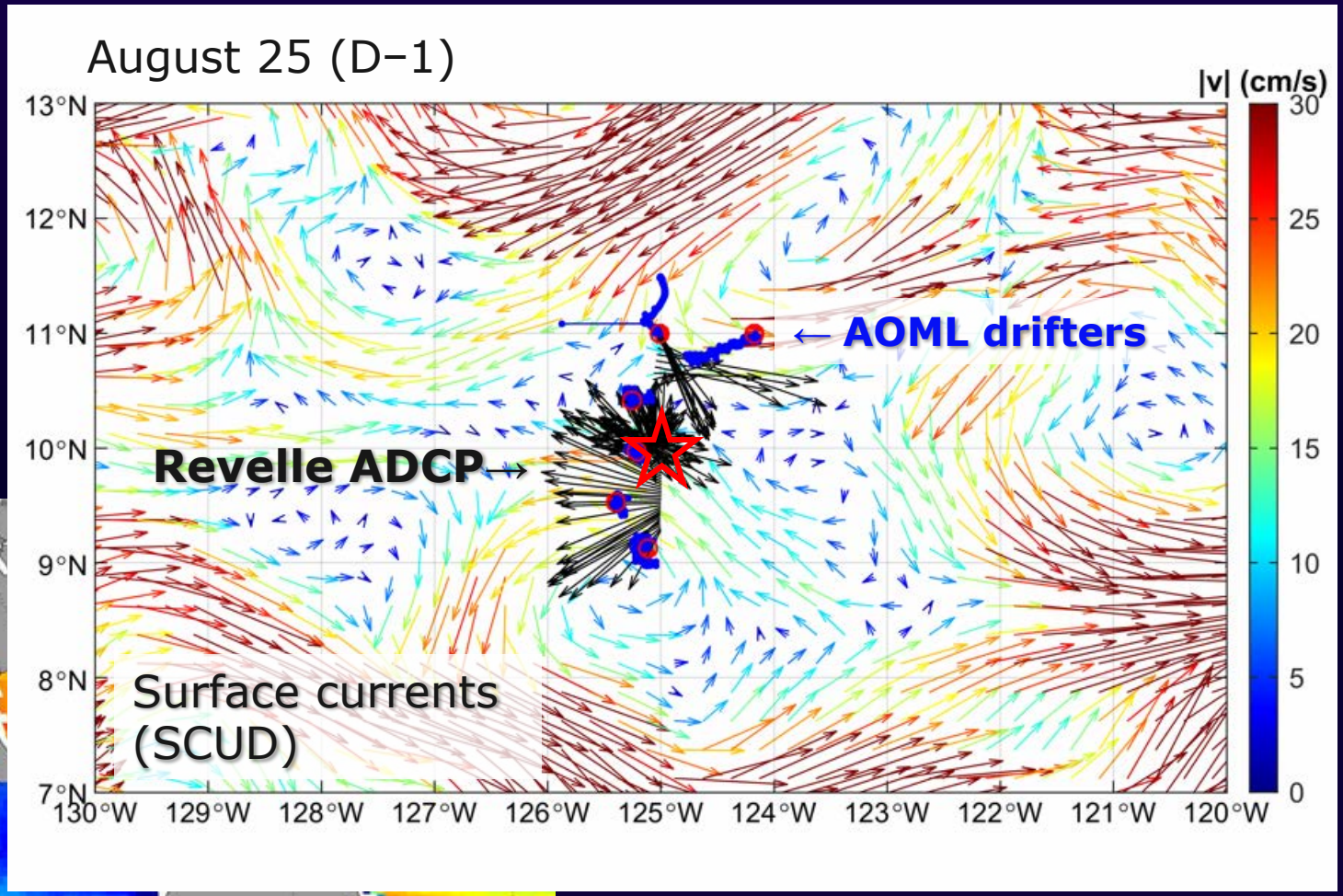


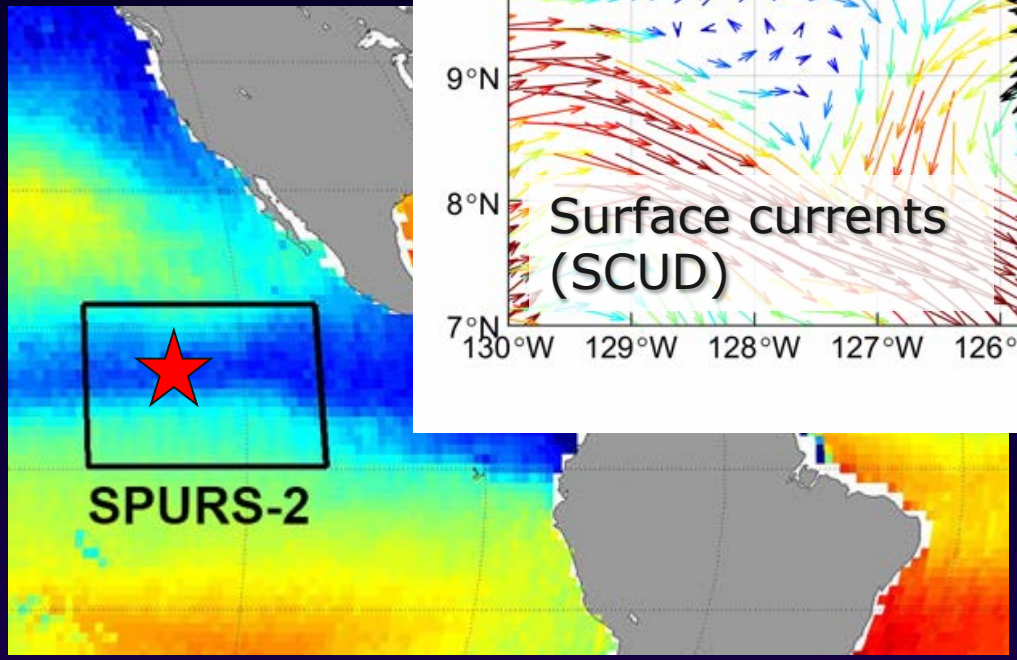
Seaglider 1(3)
CTD, PAL, Micro-structure
0 – 1,000m
L. Rainville et al.

R/V Lady Amber
Underway CTD&MET
L. Rainville et al.

Deployment – location is the key

Guided by remote sensing and reconnaissance drifters

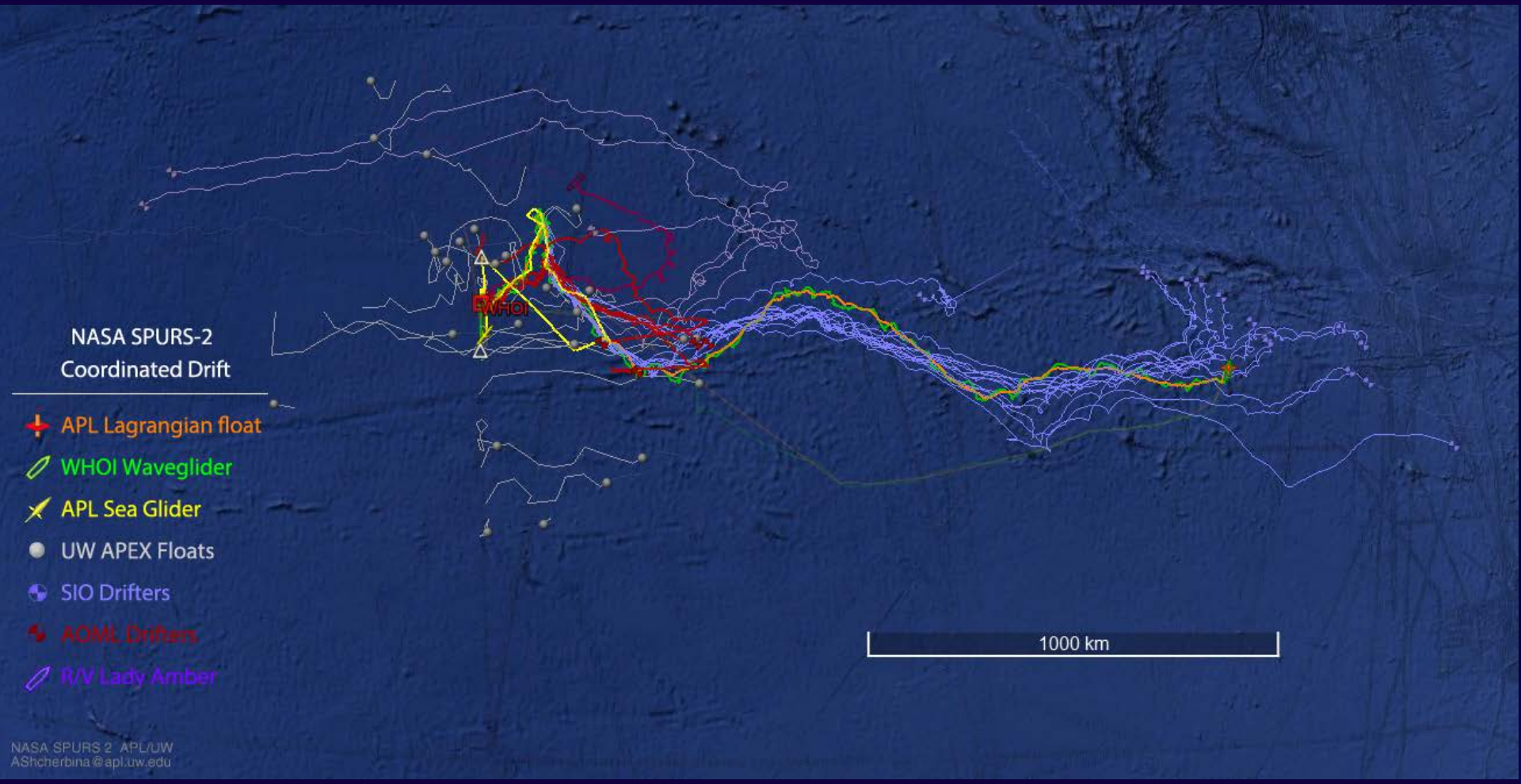




Surface current analysis (SCUD): N. Maximenko
Underway ADCP: A.Hasson & Revelle team
Drifters: D. Volkov (AOML)

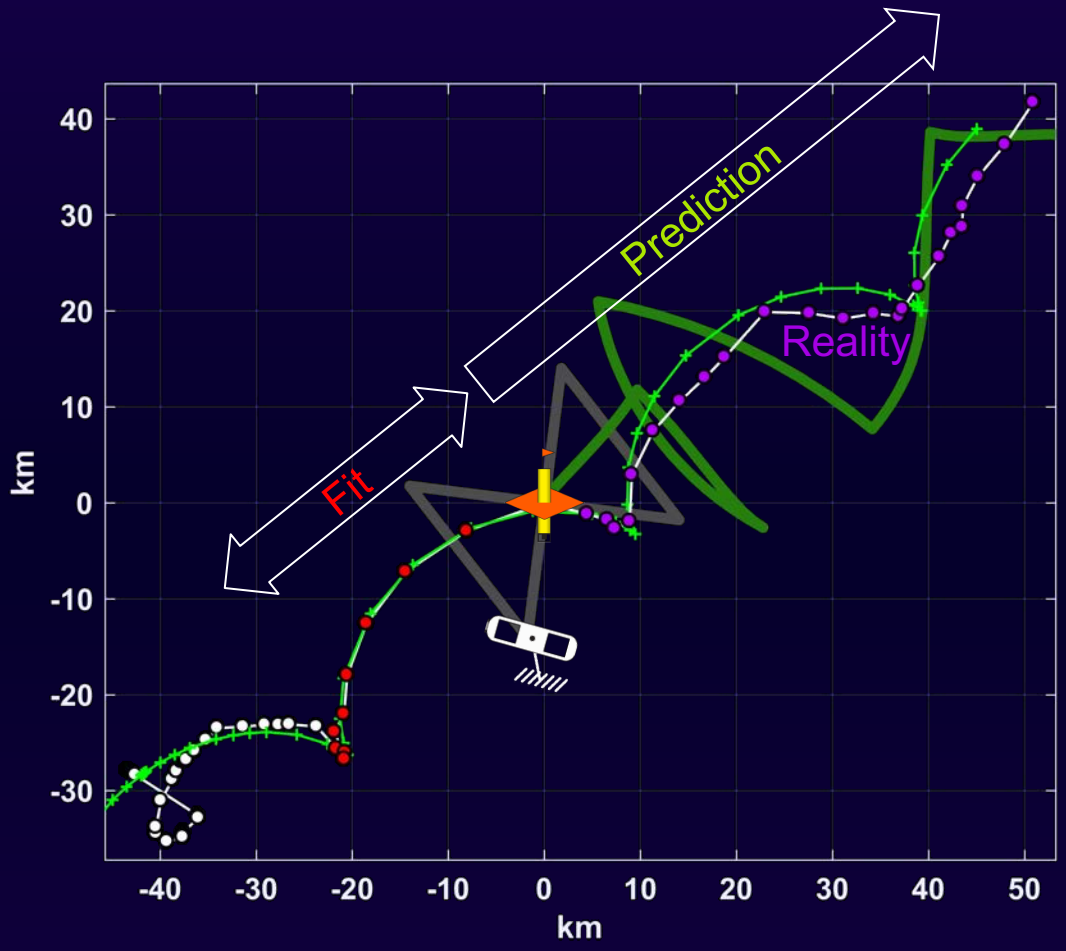
Coordinated Lagrangian drift: 100 days, 2,550 km

26 August – 12 December 2016

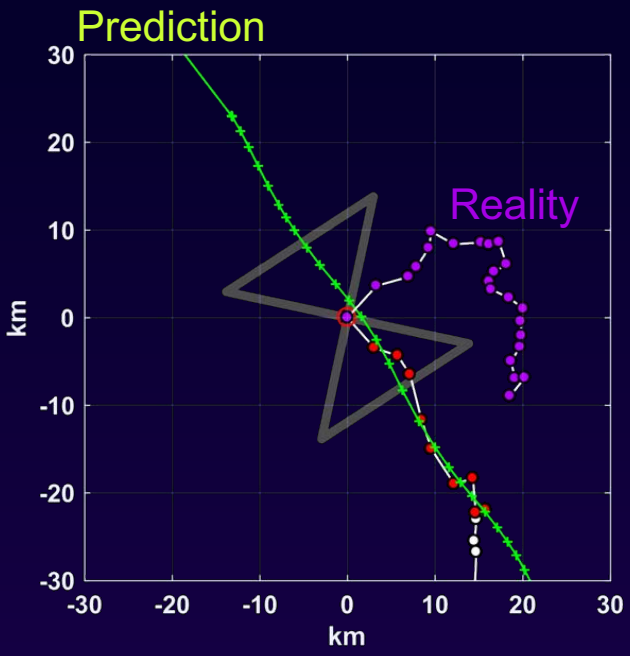


Drift prediction

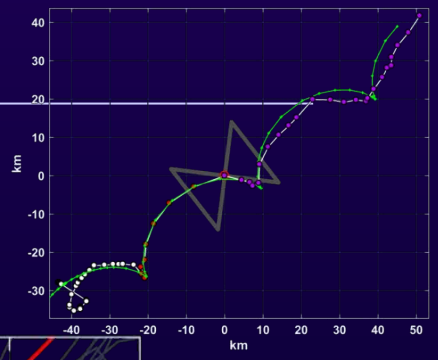
Semi-automatic procedure

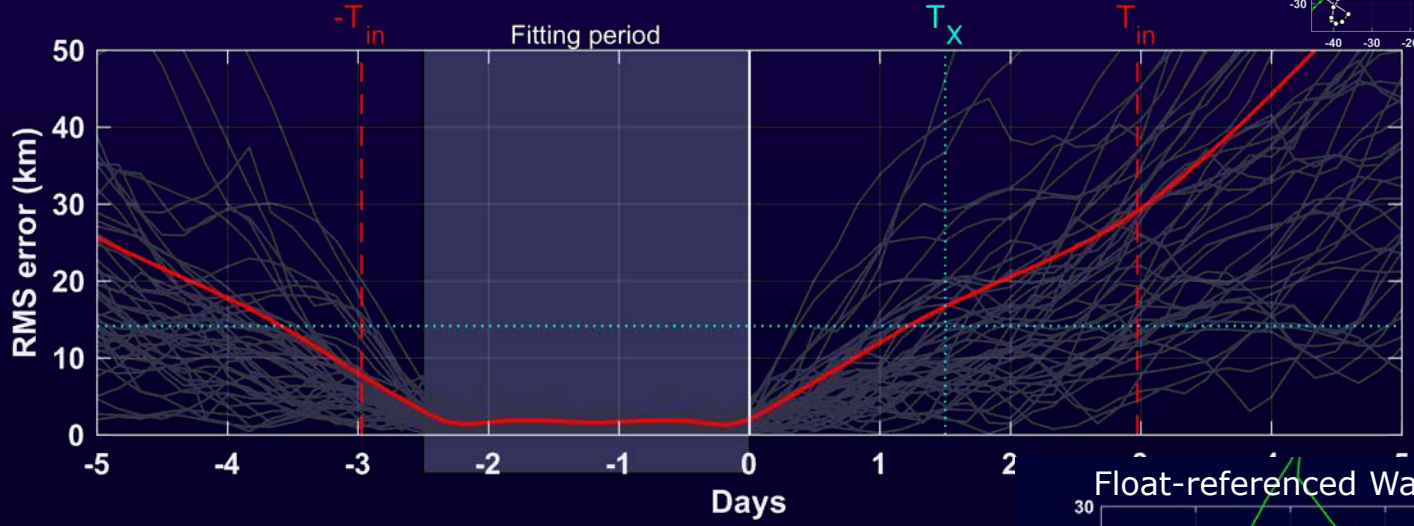


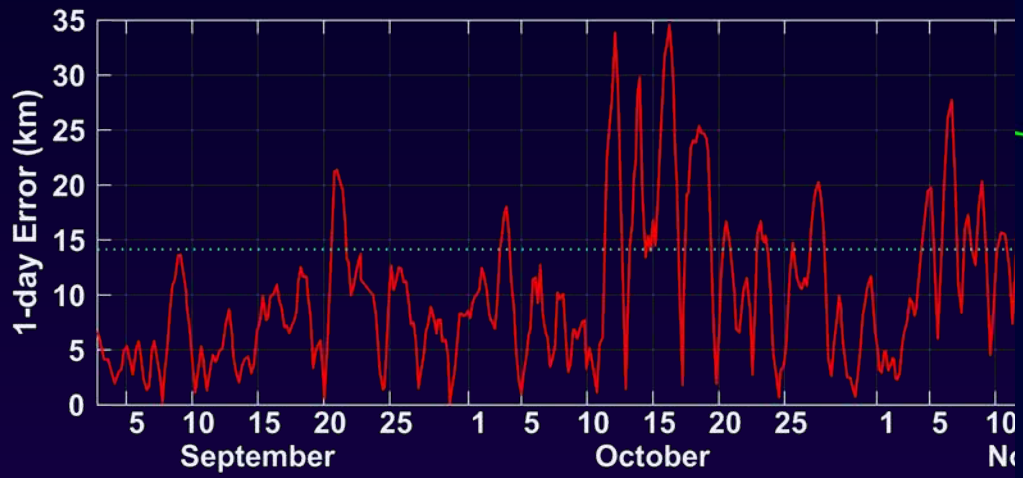
- $V_0 + V_{Inertial}$
- 2.5-day fit
- 5-day prediction
- Pattern distorted



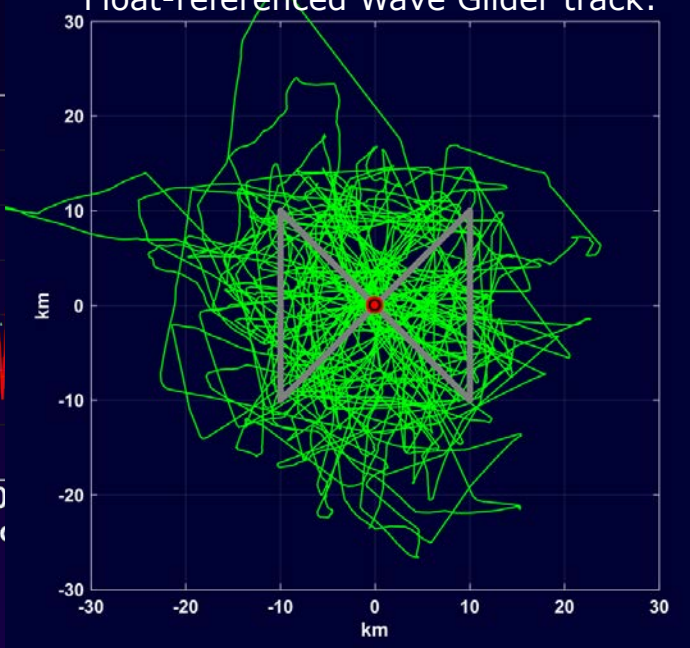
Prediction skill





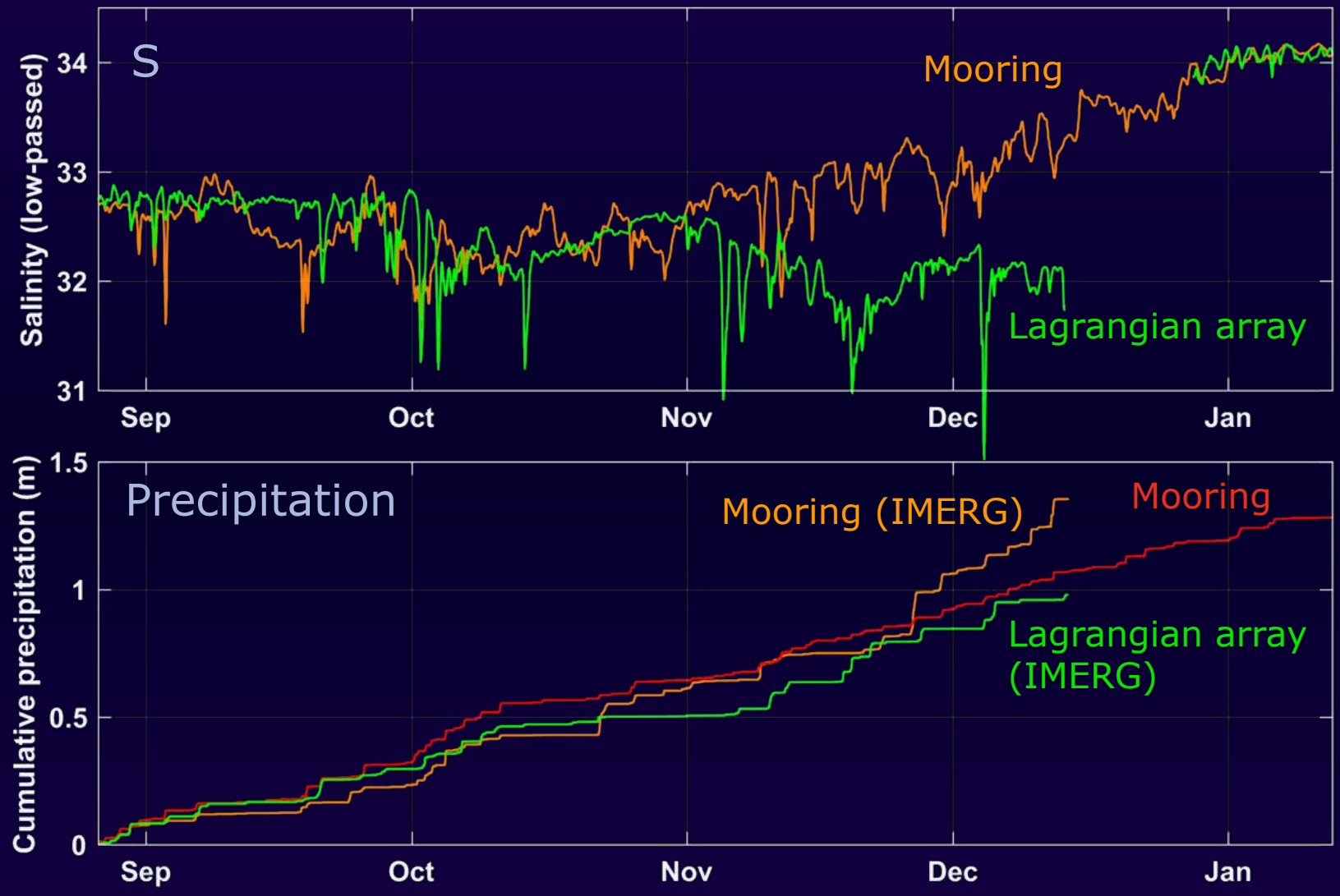


Float-referenced Wave Glider track:



As expected, Eulerian ≠ Lagrangian

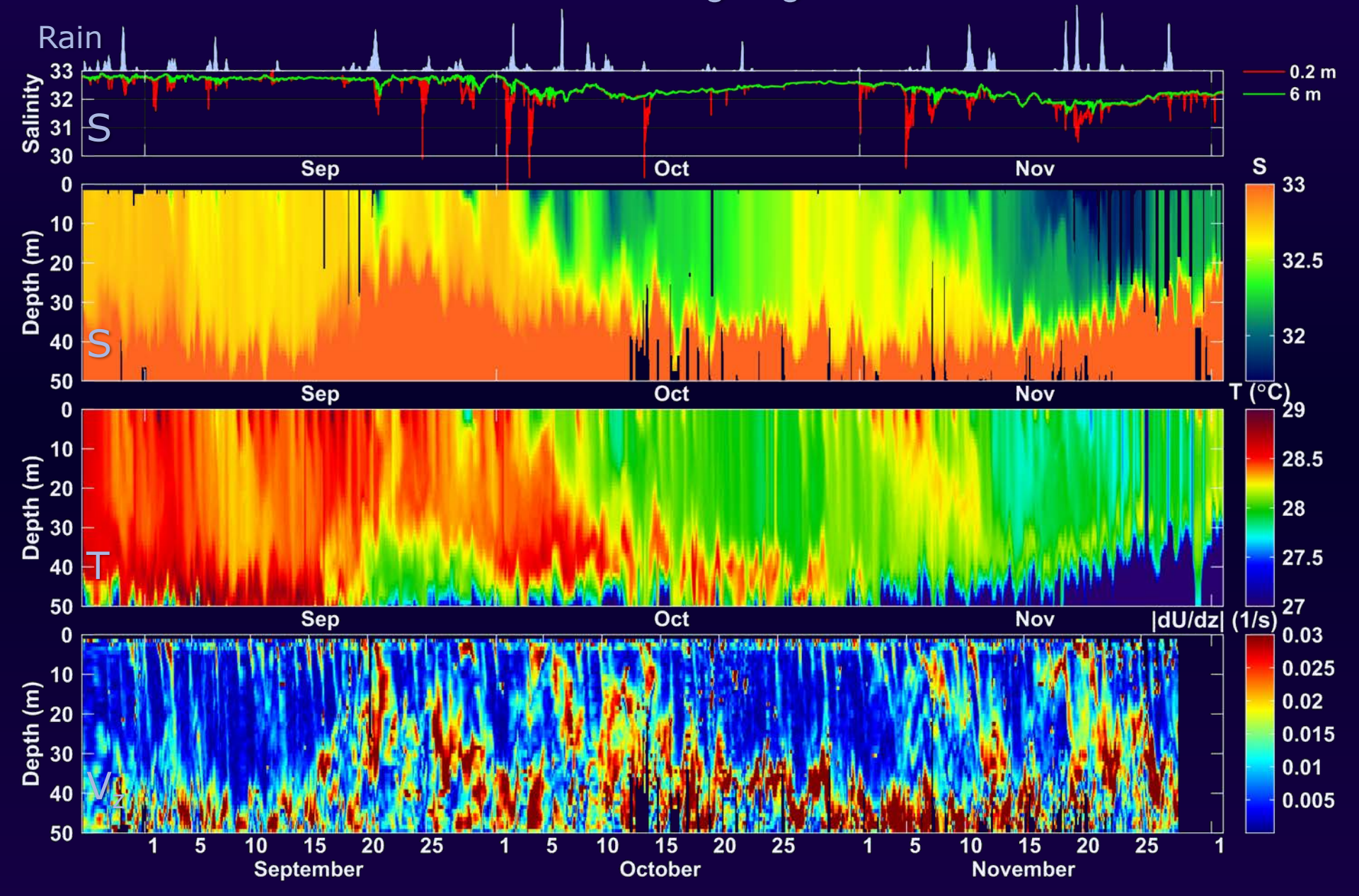
Combination of Eulerian & Lagrangian approaches is necessary to untangle time/space



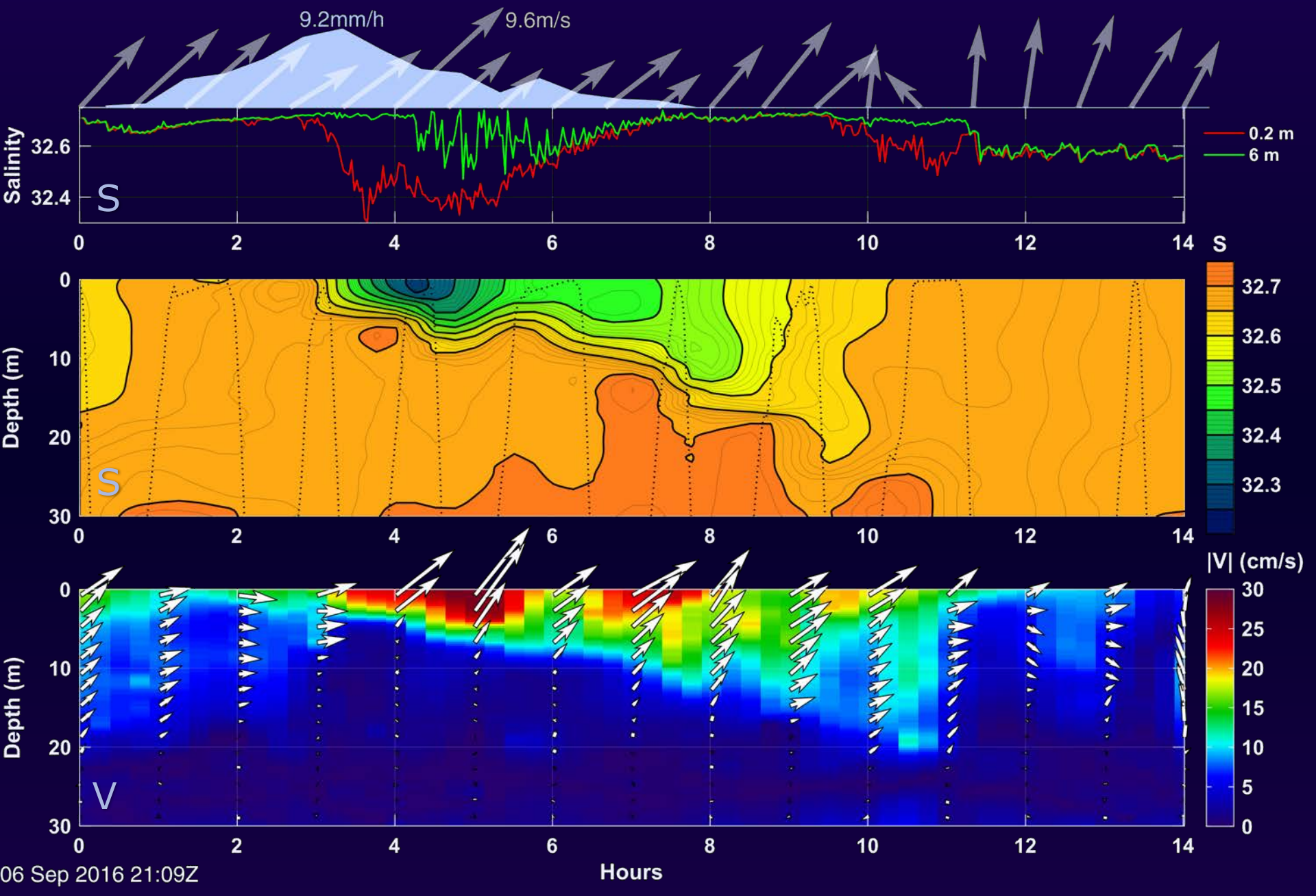
Data: WHOI mooring (Farrar), WHOI Wave Glider (Hodges), NASA IMERG (Thompson)

Coordinated drift record overview

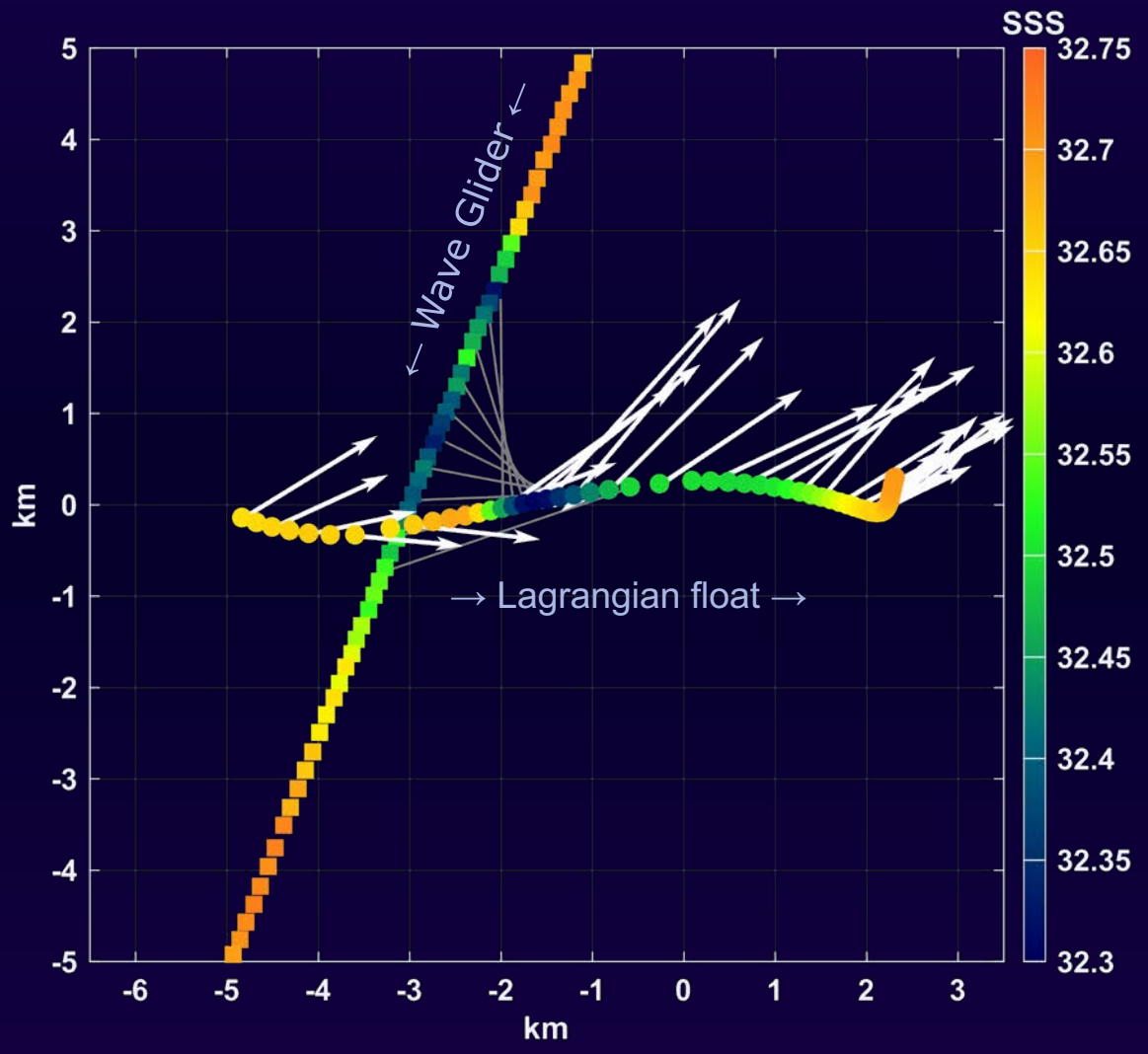
Wave Glider + Lagrangian Float



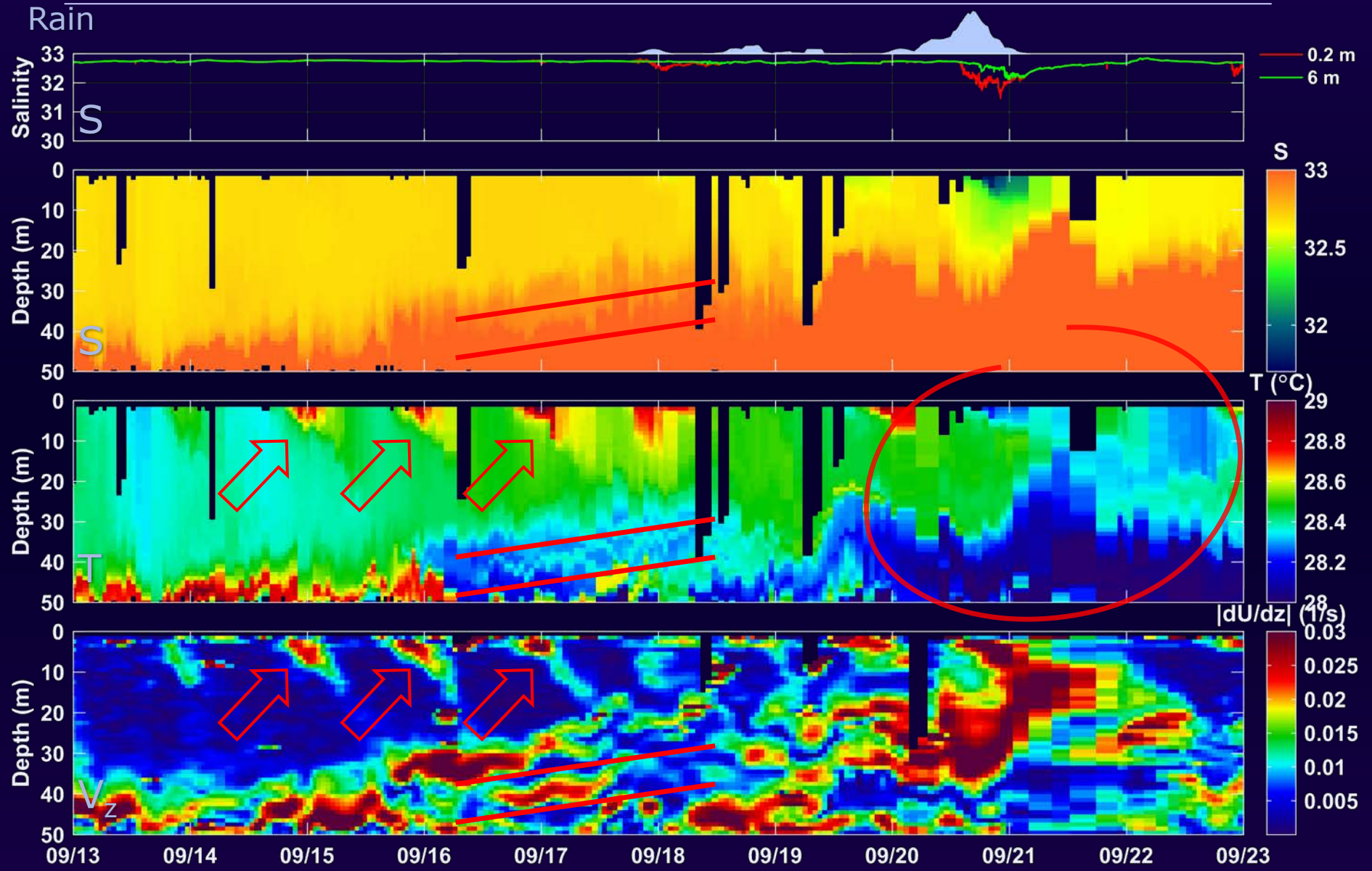
Rain puddle: evolution



Rain puddle: spatial structure

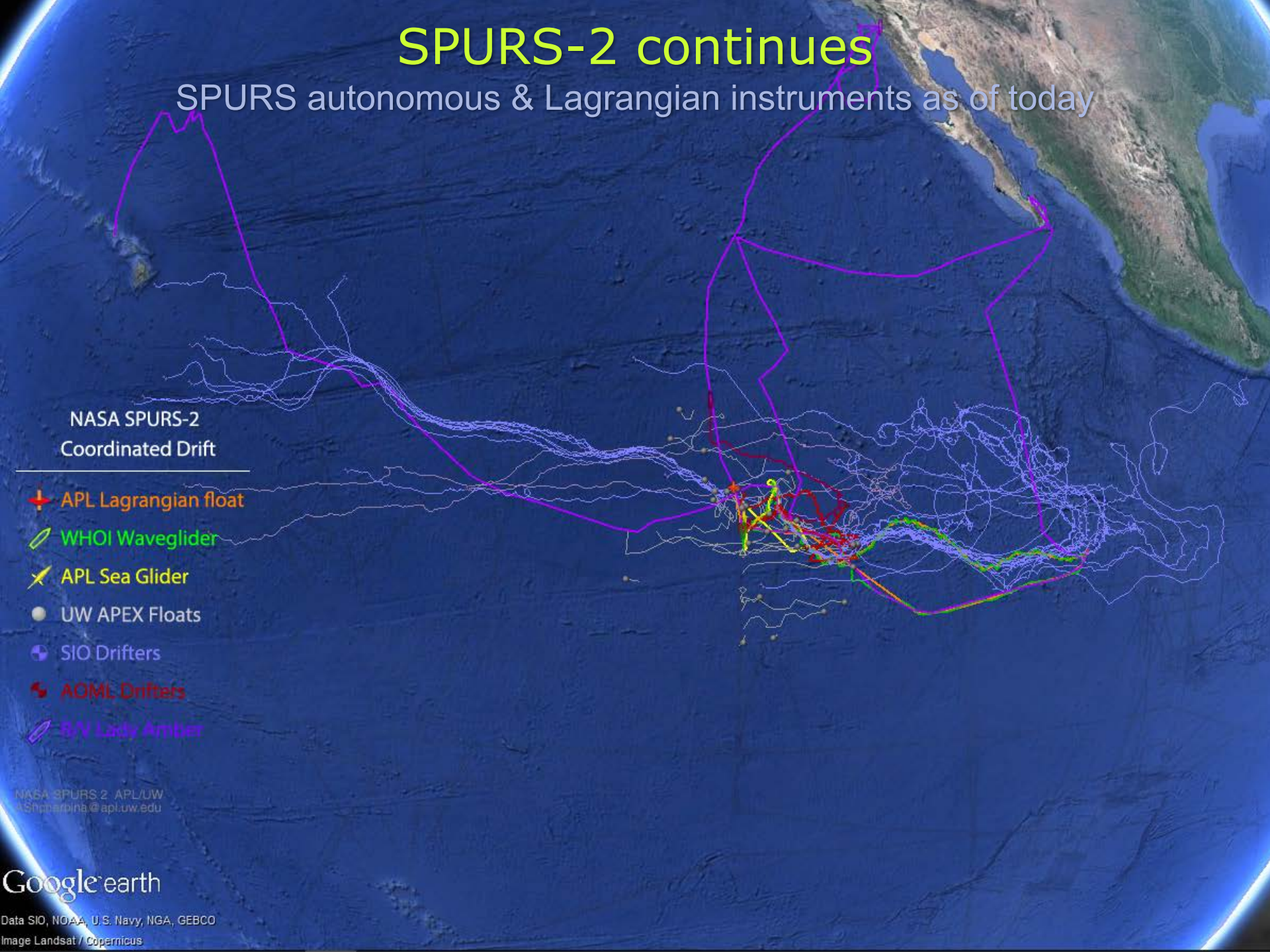


More features:
diurnal warming, slippery layers, interleaving…



SPURS-2 continues

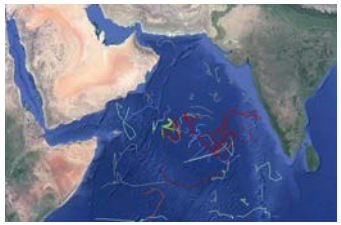
SPURS autonomous & Lagrangian instruments as of today

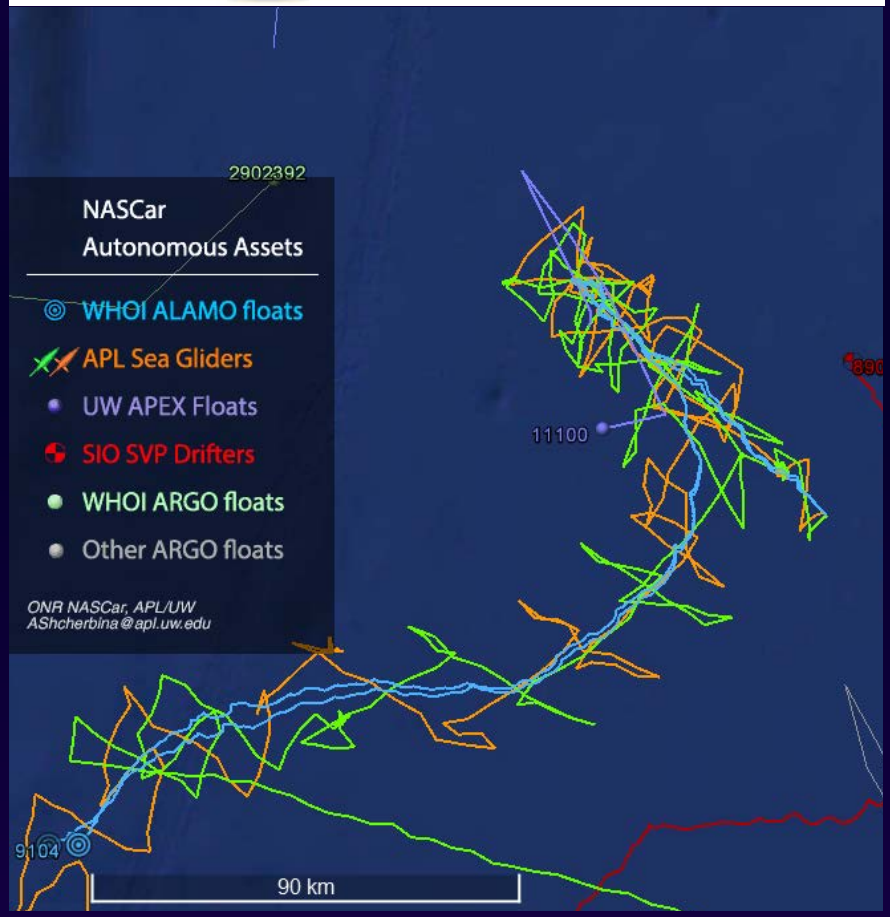


Beyond SPURS

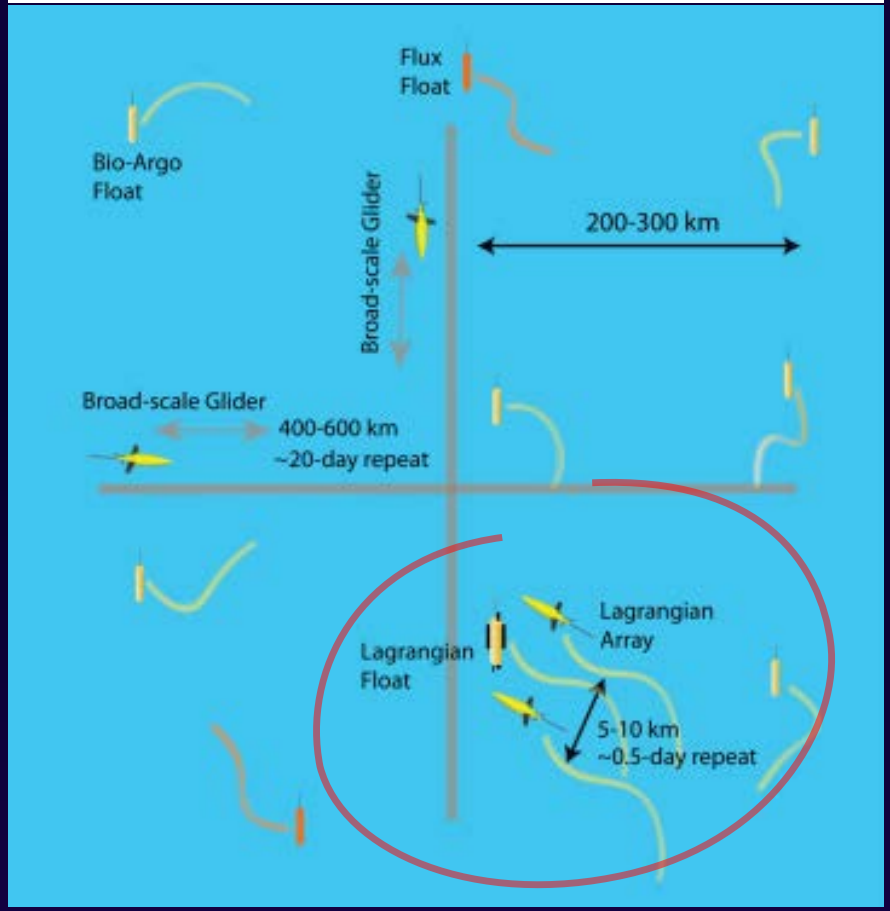
More coordinated Lagrangian experiments to look forward to

NASCAR
Northern Arabian Sea Circulation - autonomous research





EXPORTS
EXport Processes in the Ocean from RemoTe Sensing



NASA EXPORTS Implementation Plan, October 2016