Adaptive Sampling of Rain and Ocean Salinity from Autonomous Seagliders

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Analysis of simultaneous observations of ocean salinity profiles and rain

- Space and time variability of precipitation and surface freshwater anomalies
- How does the dependence of freshwater anomaly on rain rate vary when the history of the rain rate is taken into account?
- Links to satellite products

SPURS-1: North Atlantic: 2012-2013
Guam 2014, 2015

SPURS-2: Equatorial Pacific: 2016-2017

E-P June 2013

SSS June 2013
Adaptive Sampling using Autonomous Gliders

- Using satellite and local information for adaptive sampling from autonomous platforms.
- Adaptive navigation and sampling with Seaglider

Seaglider

- Cycle 0-1000 m, 4 km, 4-6 hours
- Horizontal velocity is about 20 km/day.
- Long-term (6-10 months+) deployments.
- 2-way Iridium comms.
- T, S, oxygen, F_chl, optical backscatter, spectral downwelling irradiance
- Microstructure sensors (mixing)
- Passive Acoustics (rain, wind, whales)
- ADCP (currents)

Guam deployments Mar-Apr 2015

- NEXRAD (230 km radius)
- IMERG 30 min 0.1° grid
Acoustic Rain Gauge from ALPS (Seagliders)

In addition to measuring the water column, gliders are equipped with a passive acoustic sensor to provide direct estimates of in-situ rain rate and wind speed.

Ambient sound spectra for different wind speeds and rain rates. Reproduced from Yang et al. (2015).
Acoustic Rain Gauge from Seagliders

**Guam, March-April 2015**
2 Seaglider missions, recording continuously at 200 kHz
ONR, for Marine Mammals
J. Luby, G. Shilling, et al. (APL)

Wind speed

Rain rate

Acoustic estimates of wind speed and rain, every 5 sec
NCEP-R2 wind estimates at the location of the glider
NEXRAD and IMERG rain rate estimates

Wind contamination
Acoustic Rain Gauge from Seagliders

**IMERG.** *(shaded inside NEXRAD range)*
- Global
- 30 min
- 12 km +

**NEXRAD**
- 230km radius from radar
- 15 min
- about 1-2km

Glider acoustic estimates
NEXRAD estimates
IMERG estimates
SPURS-2 Seaglider Program

Aug 2016 to April 2017 (Aug 2017)
3 Seagliders
7-month missions, with turbulence and passive acoustics

Lagrangian Drift
2 months chasing a float (Sep-Oct 2016)

Aug 2017 to Nov 2017
2 Seagliders
3-month missions, with turbulence and passive acoustics

Budgets
50-km boxes, 1-2 weeks

Seasonal changes
200-km line, 2 weeks
SPURS-2 Seaglider Program

Spatial section

11°N

13 December 2016

Time series

sg191 26 Aug 2016 to 28 Mar 2017 (214 days), 1492 profiles

TEMPERATURE

SALINITY
SPURS-2 Seaglider Program

Rain detection vs depth

Wind speed
- Seaglider
- NCEP
- mooring

Rain fall
- Seaglider
- IMERG
- NCEP
- mooring

Rain accumulation
- Seaglider
- IMERG
- NCEP
- mooring
Rain patchiness - SPURS-2

Acoustic sensors record the average noise in a cone above their depth (diameter $\sim 5 \times$ depth). Can profiling acoustic sensor estimate the patchiness of the rain?
In SPURS-2, the use of autonomous platforms enables us to capture many different events (persistence), which is essential to link the different scales important for the water cycle.

Collaboration with Farrar, Hodges, Riser, Asher, etc., for resolving gradients and tendencies.

Patchiness of the rain: PALs, moorings, ships.

From rain event to large scale: ships, Wave Gliders, Moorings, remote sensing, Argo, etc.

**Differences between 5 and 10m**

- Cooler at 5m
- Fresher at 5m

7276 profiles
Multi-month demonstration of adaptive sampling

We are planning the deployment of one or two Seagliders equipped with passive acoustics, microstructure turbulence sensors, etc. in a rain-dominated region.

Glider sensor sampling and piloting will be modified to respond to rain events.

Measuring ocean salinity and in-situ precipitation over long time periods can provide new insights in the evolution of upper ocean salinity.

Early 2019, Maldives? Guam?