Autonomous Platforms

Today's Floats & Gliders

Selecting a Platform

Argo Floats

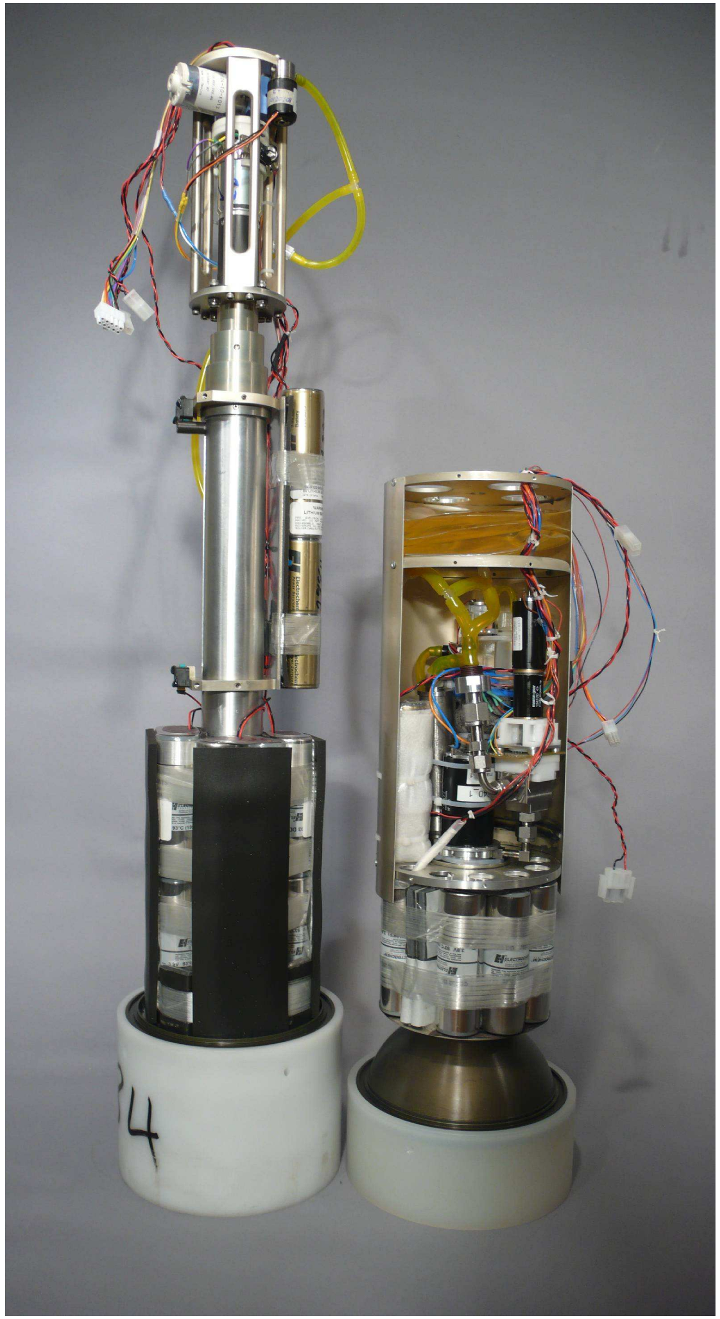
17 or 27 kg

200 cycles to 2000 m

~4 years life

Iridium/GPS or Argos

Pumped Sea Bird CTD



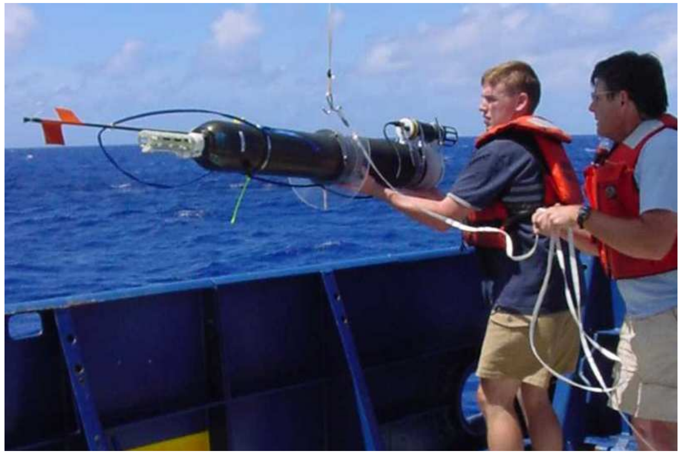
Float Deployment

C-130

VOS

Shipping
& Deploy
Box

Float Types

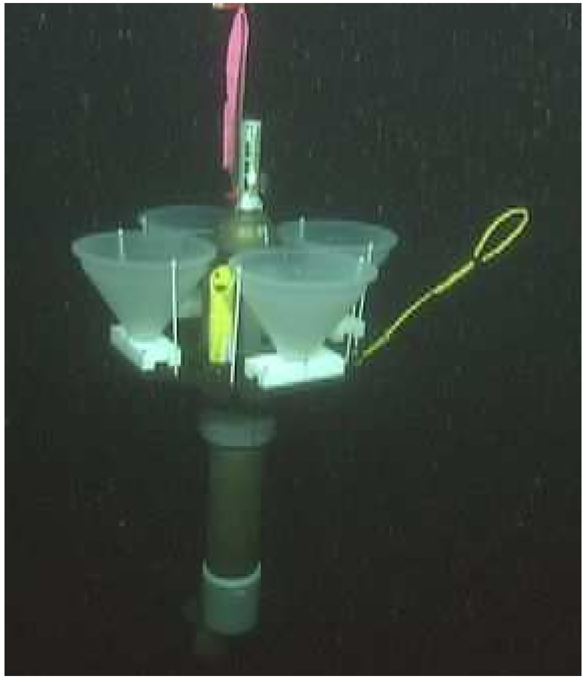


Long-term Autonomous
Micro-Temperature Profiler

Carbon Explorer (beam transmission
and optical backscatter)

Sea Bird
CTD with
Oxygen
Probe

Sediment
Trap



More Float Types

Vertical Current Meter

Seismic Observer

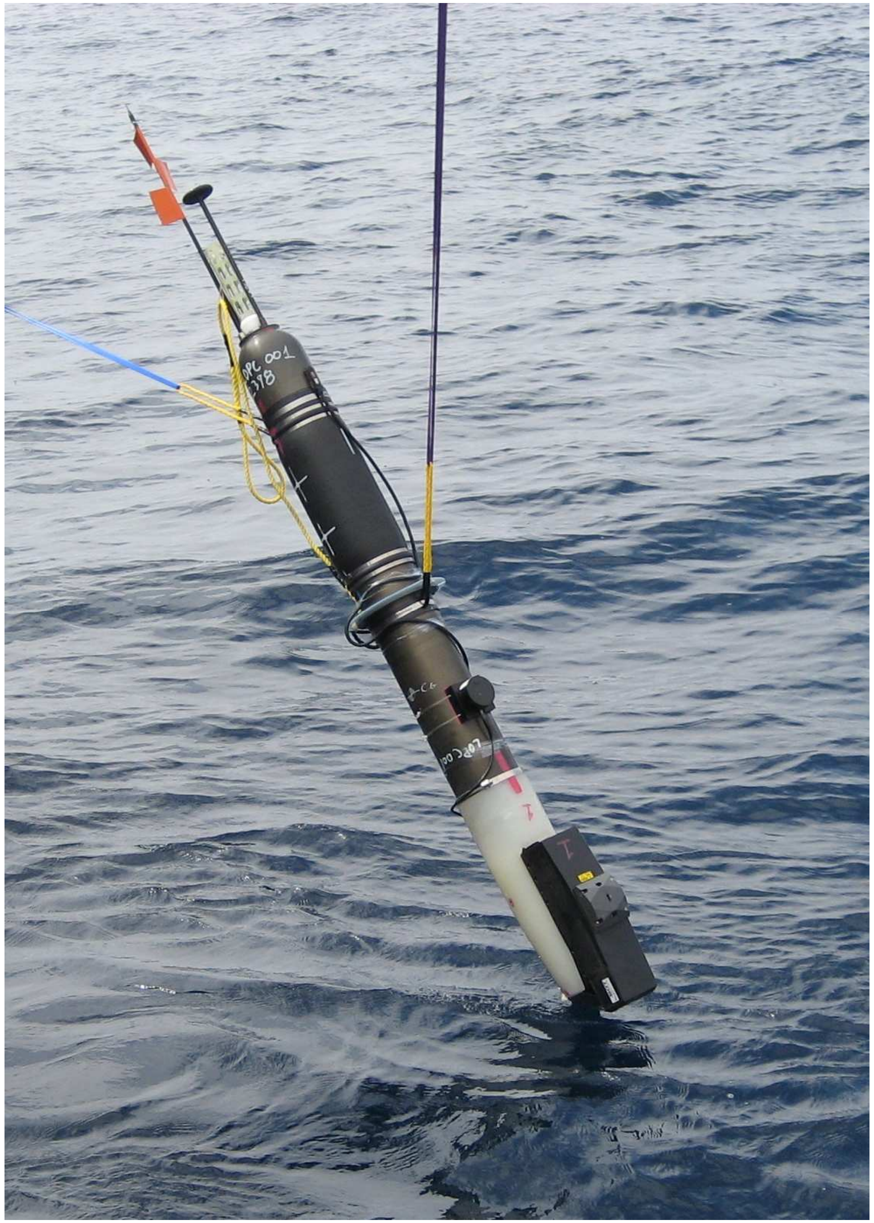
Downwelling radiation profiler (K-meter)

LOPC & OBS (SOLOPC)

Acoustic navigators

160 pound float with thermal buoyancy engine

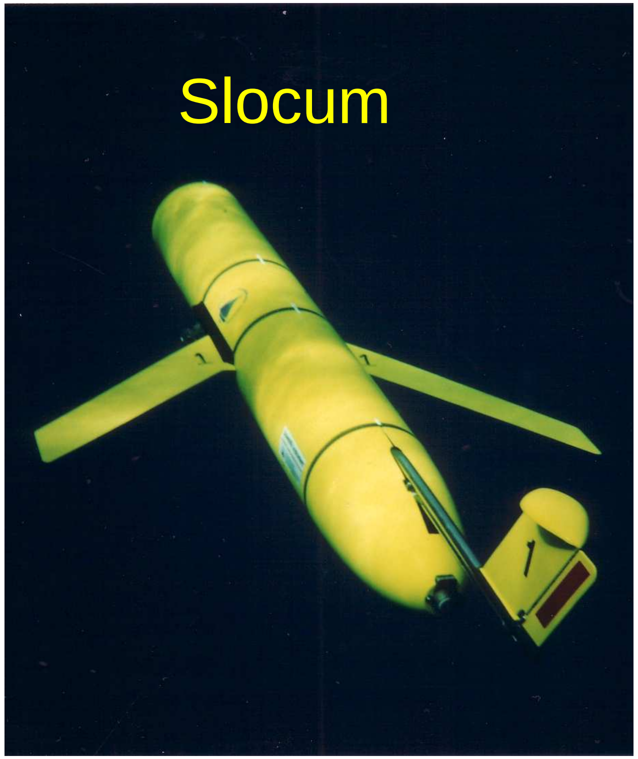
Adding an Acoustic Doppler Profiler easy



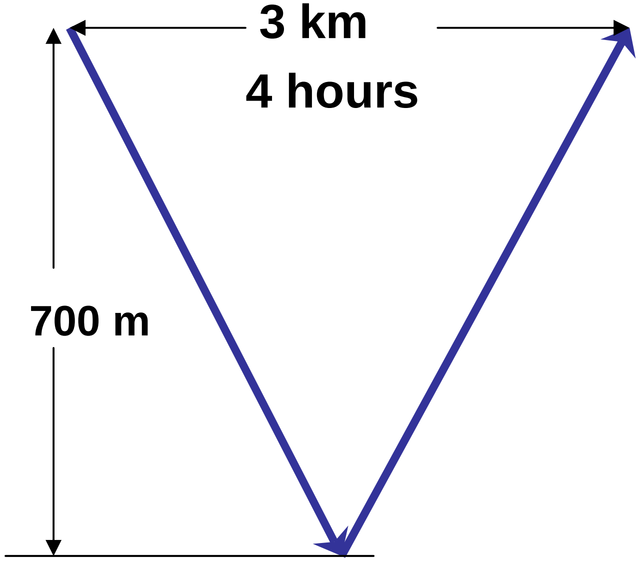
SOLOPC

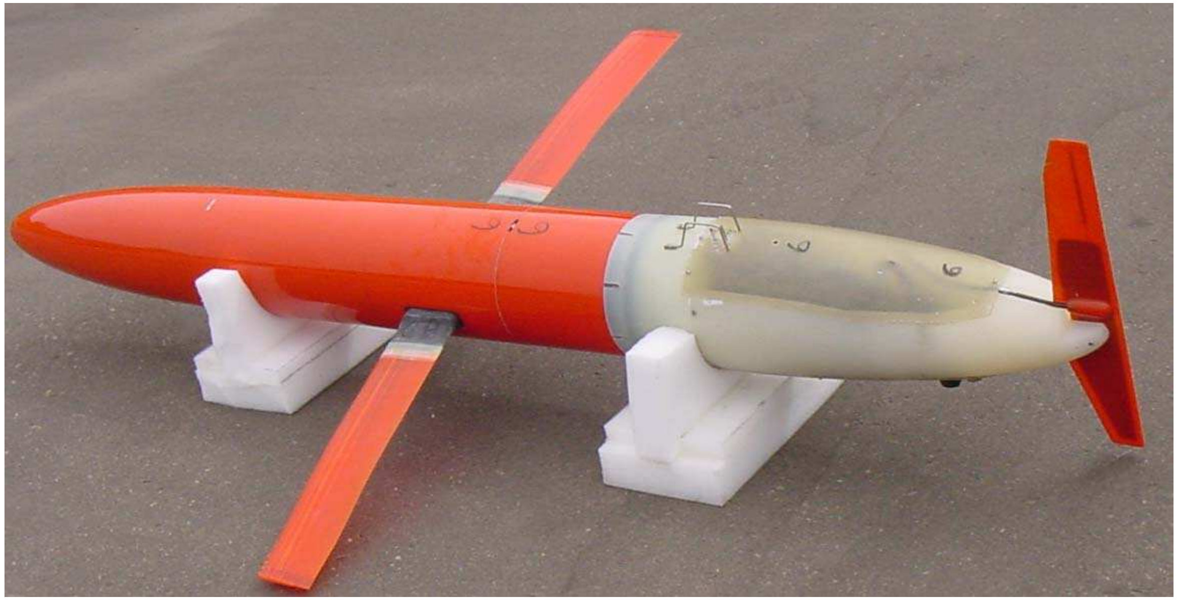
Today's Gliders

Three well-tested models, all derived from the same ONR program, have fairly similar characteristics



Typical Specifications: ‘Spray’





Speed ~ 25 km/day ~ 0.5 knot   Max depth ~ 1500 m

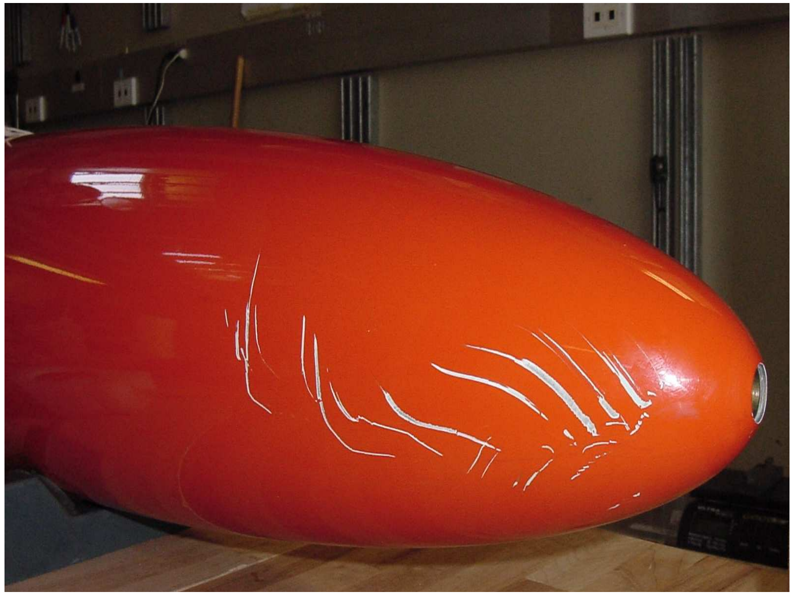
Duration ~ 4 months   Range ~ 3000 km

GPS & Iridium – Pumped SBE CTD

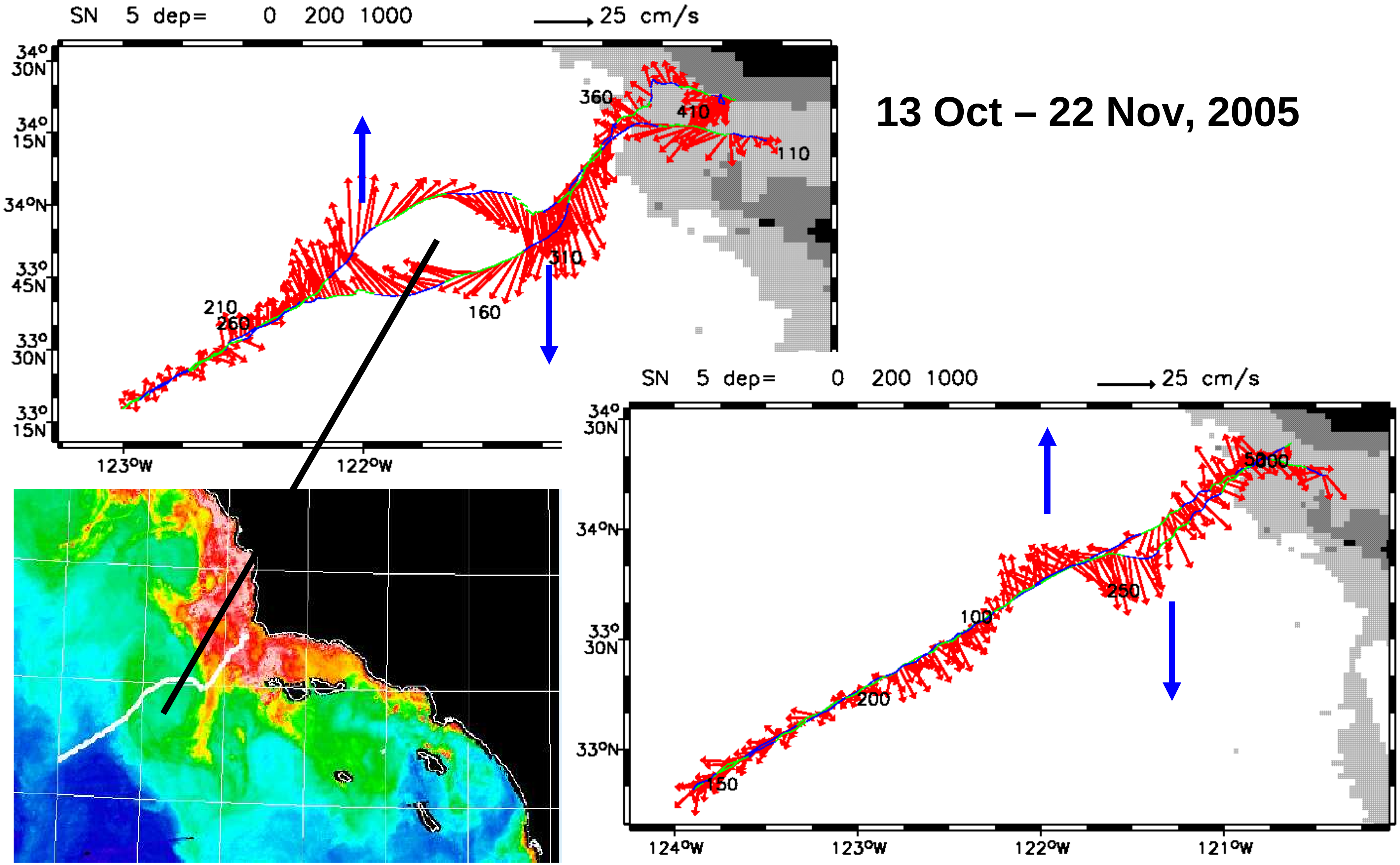
Optical Backscatter – Acoustic Doppler Profiler

Chlorophyll Fluorescence – O_2 – (Nitrate sensor)

Operations



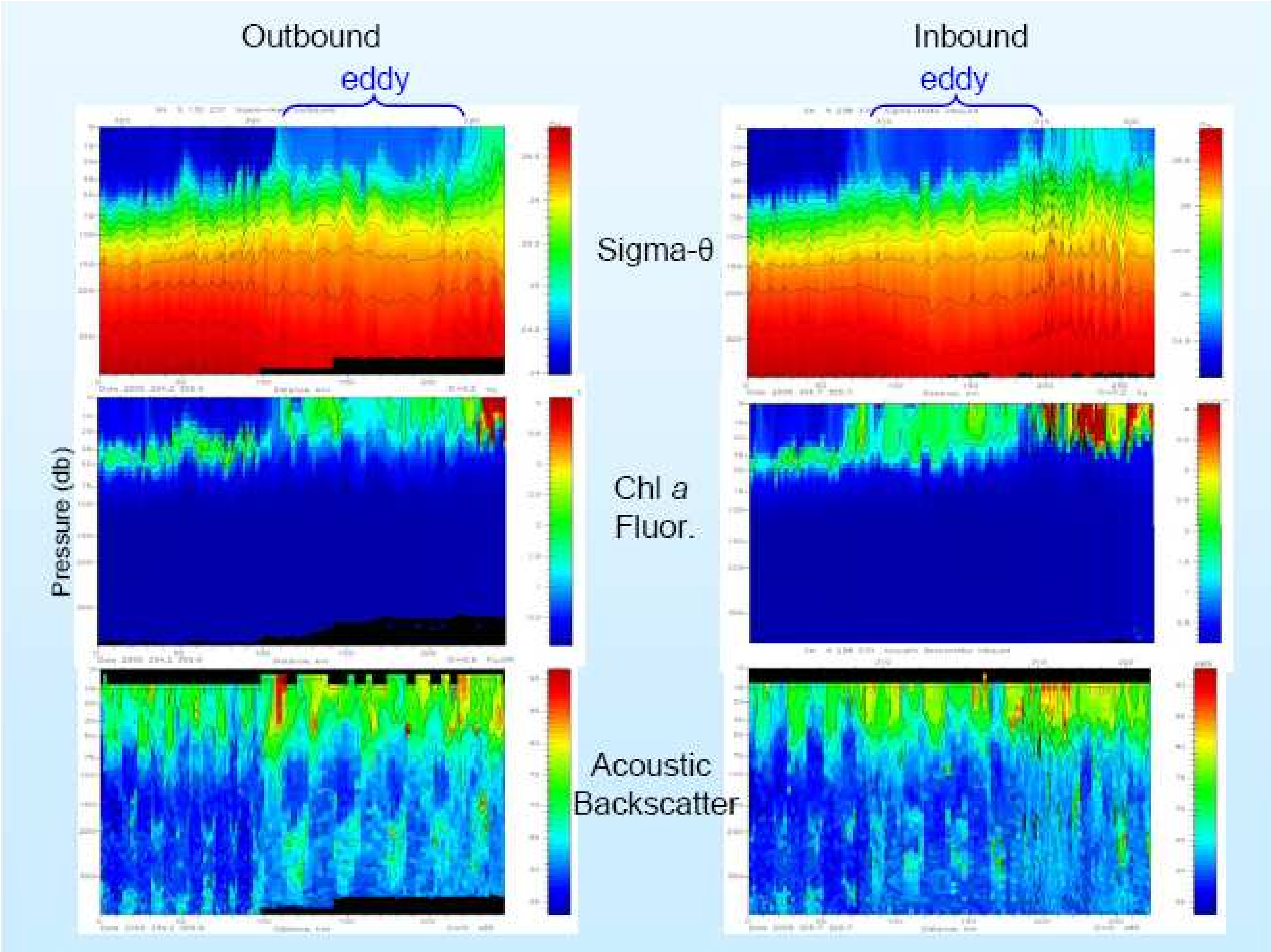
A Persistent Eddy



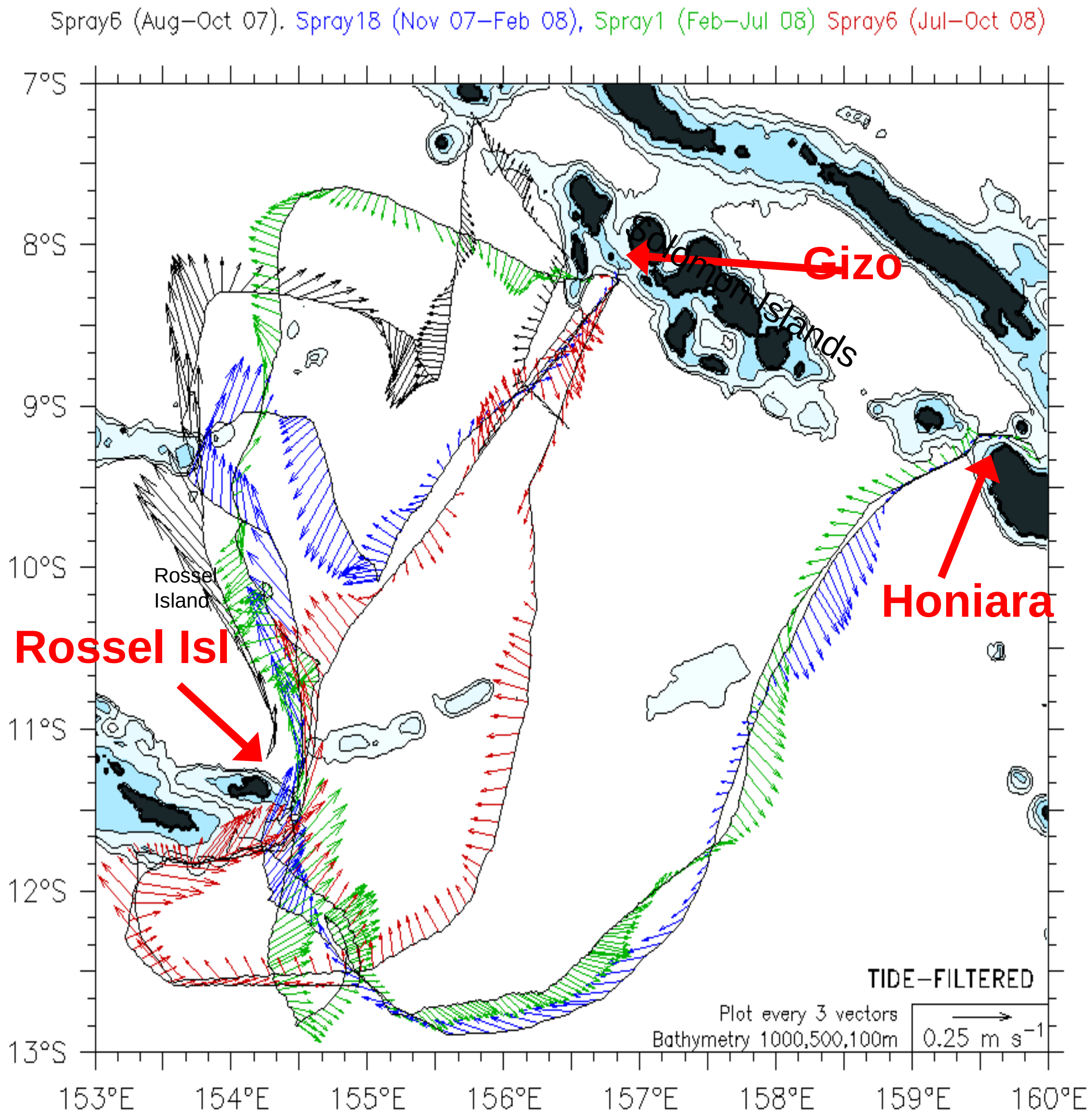
13 Oct – 22 Nov, 2005

27 Feb – 16 May, 2006

Property Distributions Through Eddy



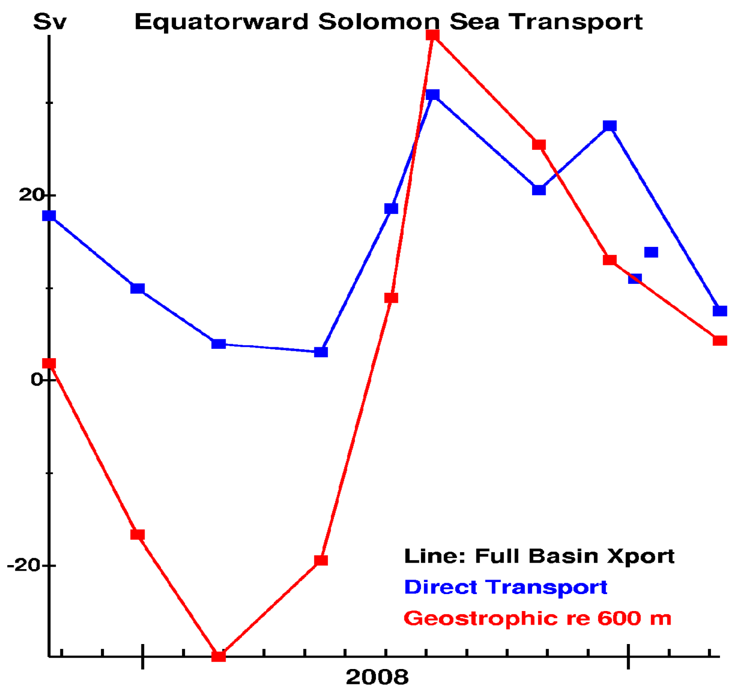
Repeated Long-range Sections



Solomon Sea, Velocity averaged 0-700 m

Primitive facilities and small pangas.

One-way 1000-1500 km and takes 4-6 weeks.



18-month transport time series

Floats or Gliders?

1. Gliders provide spatial structure (slowly) and simplify recovery
2. Glider measurements can (to some extent) be positioned
3. Floats provide (very approximate) Lagrangian time series
4. Floats are less expensive (purchase 15K$ vs 90K$)
5. Floats are <u>much</u> easier to adapt (more batteries, big sensors)
6. Floats are relatively immune to fouling – better for long duration

<u>Map with L/T (of signal) > 25 cm/s: </u>array of floats

<u>Map with L/T < 25 cm/s: </u>glider(s)

<u>Quasi-Lagrangian time series: </u>floats

<u>Many big co-located sensors: floats</u>

To Design a Float

Working from an existing design it is relatively easy to design a float to fit a sensor suite and general mission.

Basic rules: **Pump energy per cycle $E_{PUMP} \sim M_{TOT}$**

$M_{TOT} \sim$ Payload + K x $E_{PUMP}\, N_{CYC}$ K=kg/MJ

For cylindrical floats based on 6.5 inch 6061 Al SOLO II

$$M_{TOT} = \frac{[9.1 - 1.5\,Q(D_{DES})]\,kg + M_{SENS} + \gamma_{BATT} E_{BATT}}{1 - P(D_{OP})\,(N_{CYC}/1770) - 0.47\,Q(D_{DES})}$$

Where $P(D_{OPER})$ and $Q(D_{DESIGN})$ increase with operating depth

P(2 km) = Q(2 km) = 1

Examples

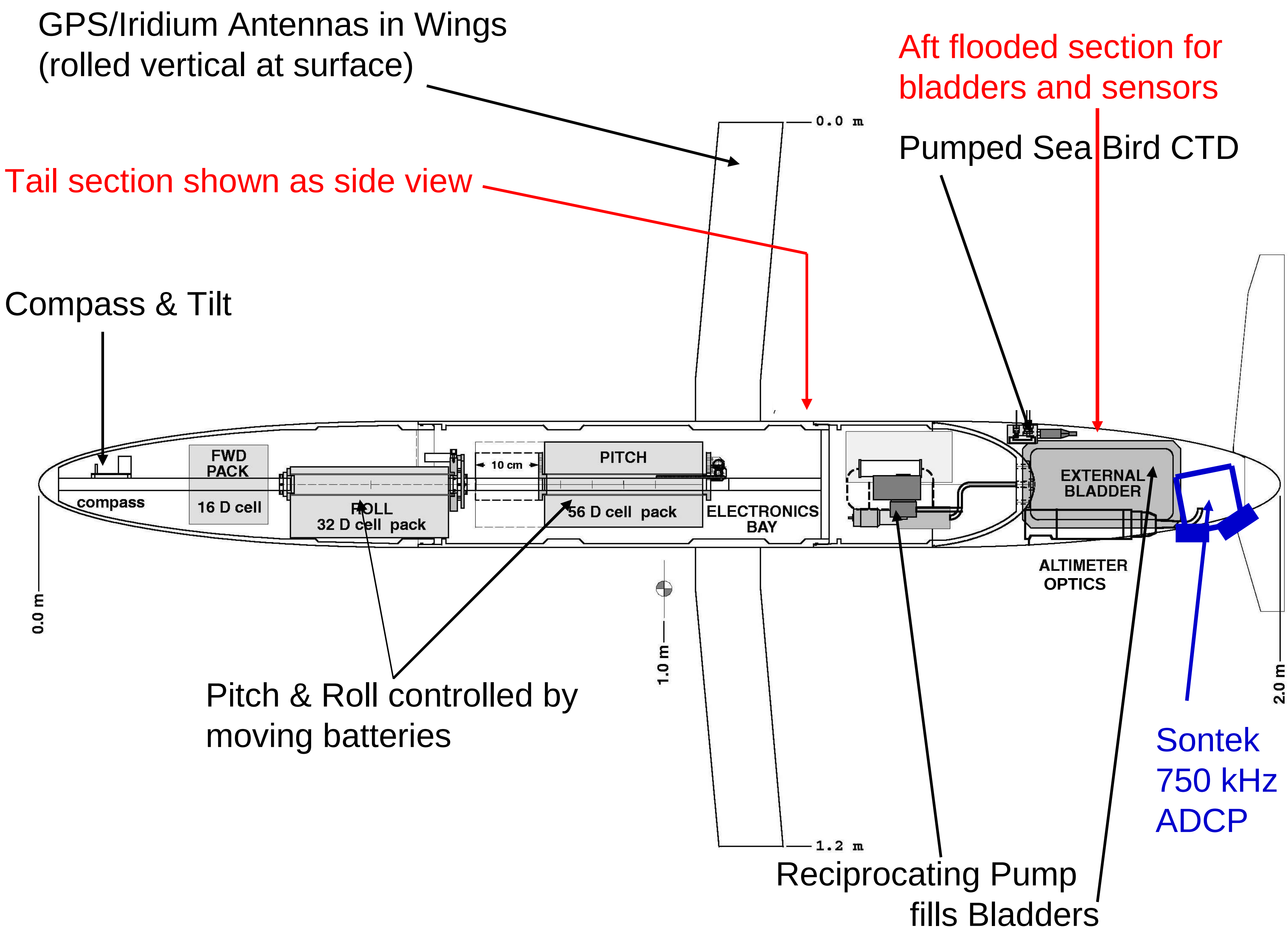
Depth, km	Cycles	Sensor Mass, kg	Sensor Energy, MJ	Total Mass, kg	Length, cm	Battery, MJ	Note
2	200	0	0	17.8	86	2	Argo Float
1	200	0	0	12.3	61	1.3	
1	965	0	0	20.7	99	6	
1	480	3	5	28.5	135	8	166 days at 1 Watt
1	200	3	8.7	29.8	141	10	102 days at 1 Watt

Floats based on SOLO II / Spray buoyancy engine, 6.5 inch cylinder of 6061 Aluminum

Based on Lithium Sulfuryl Chloride batteries delivering 1 MJ per kg

1 MJ is 1 Watt for 11.6 days


Questions?


GPS/Iridium Antennas in Wings
(rolled vertical at surface)
Aft flooded section for
bladders and sensors
Pumped Sea Bird CTD
Tail section shown as side view
Compass & Tilt
0.0 m
FWD
PACK
16 D cell
compass
ROLL
32 D cell pack
10 cm
PITCH
56 D cell pack
ELECTRONICS
BAY
EXTERNAL
BLADDER
ALTIMETER
OPTICS
0.0 m
1.0 m
2.0 m
1.2 m
Pitch & Roll controlled by
moving batteries
Sontek
750 kHz
ADCP
Reciprocating Pump
fills Bladders

Performance Statistics

Period	**Operate Days**	**Missions> 25 day**	**Complete Mission**	**Lost**	**Problems Affecting Mission Success**
2003-04	294	7	86%	1 – Run down	Clogged filter,
2005-06	1422	24	75%	2 – Roll motor, Unknown	Pump motor, Roll mechanism, Air in oil, Fisherman, Fish, Watchdog circuit, Compass
2007-08	3993	47	92%	1 – Unknown	Iridium, Tail, Compass, Fisherman, Fish, Air in oil (2)
Total	5711	78	84%	4	

1 loss per 1805 days (5 yrs) of operation over last 4 years

86% of missions completed as planned in last 4 years

Recurrent problems – Fishermen, Fish, Air in Oil, Compass level

Spray Recovery Vehicle

Improve methods for handling gliders at sea from large research vessels

Remotely operated ‘Glider Scooper’ designed and constructed.

Tested on Kuroshio cruises in fetch-and-retrieve and in scooper modes