

Currents Observations and Source & Collection Funnel Calculations for VERTIGO

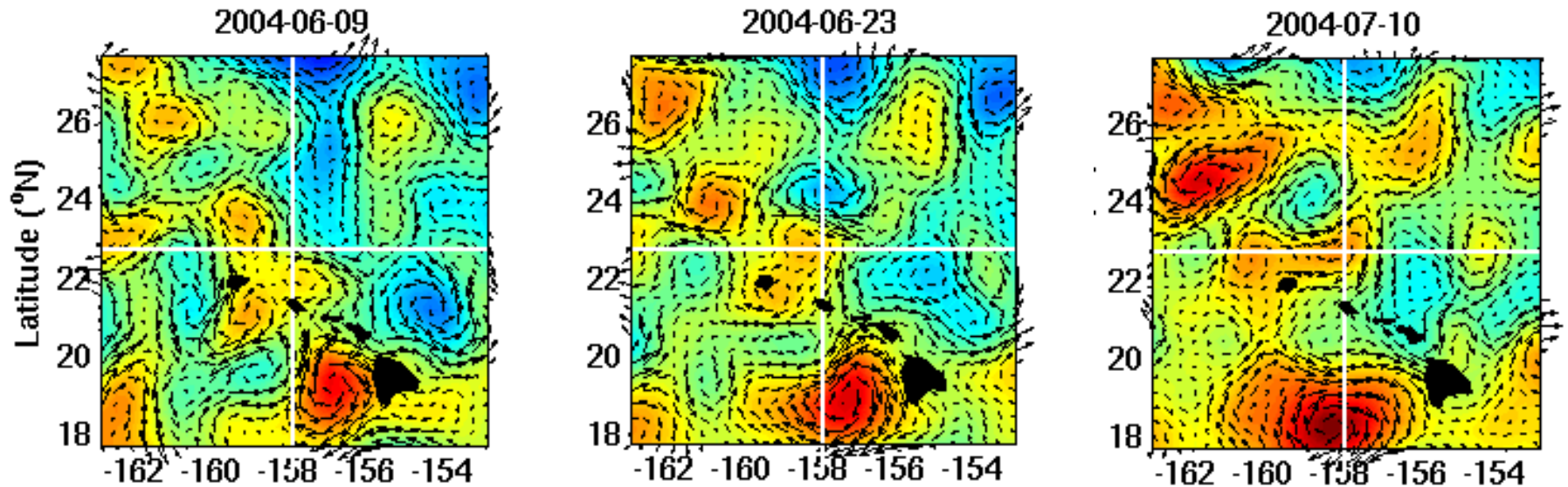
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UC Santa Barbara



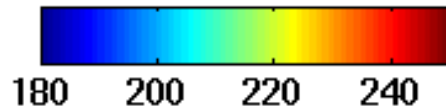
Outline

- Horizontal current observations
 - Sea level & ADCP data from Aloha & K2
- Assess sampling of the sinking particle flux using sediment traps
- Compare surface tethered, neutrally buoyant & bottom moored traps

Mapped Sea Level & Currents - ALOHA



absolute sea surface topography (cm)

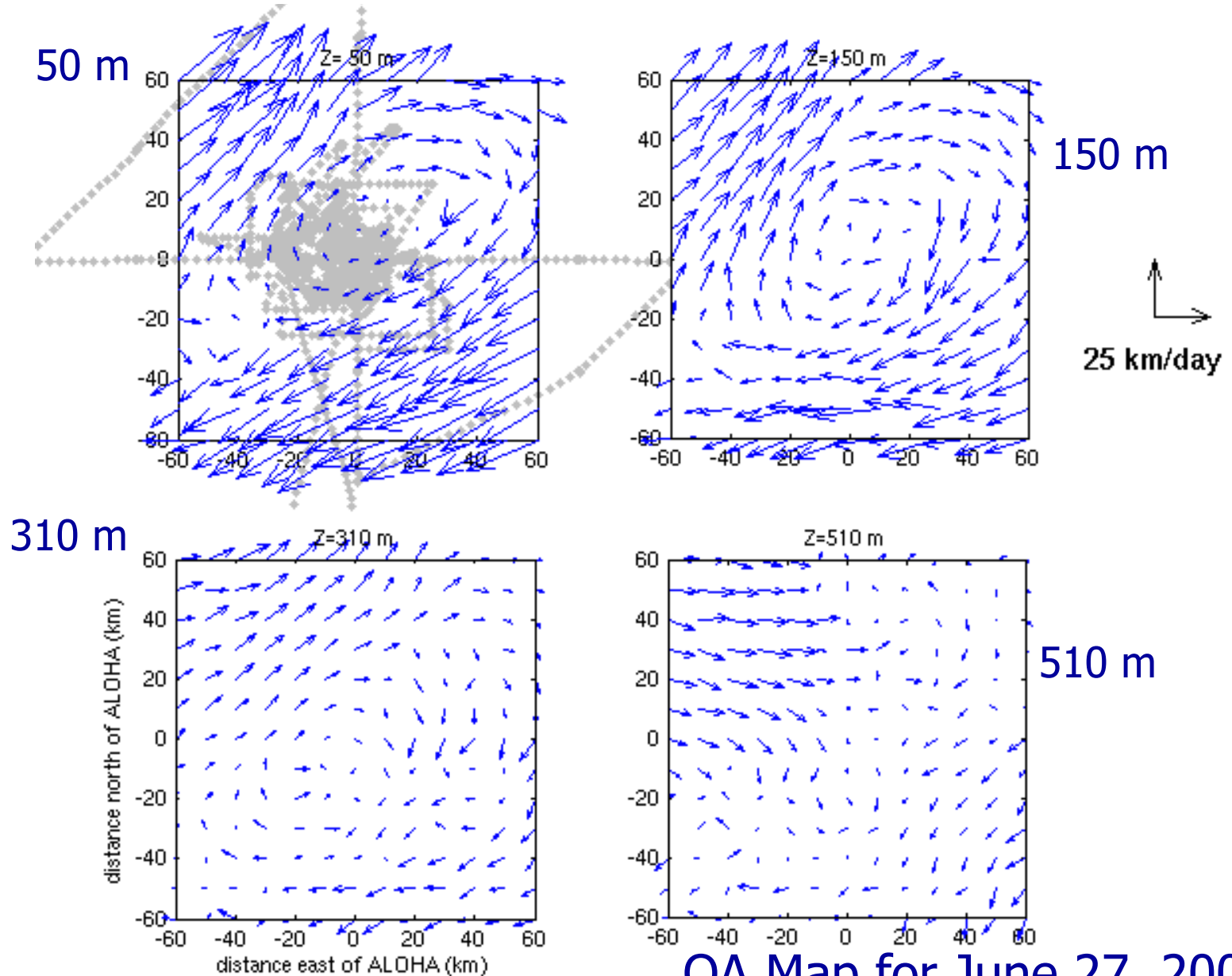


50 km/day

A small black arrow pointing upwards and to the right, indicating a scale of 50 km/day for the current vectors.

- SSALTO/DUACS merged SLA
- Absolute geostrophic currents
- Anticyclone eddy forms over ALOHA

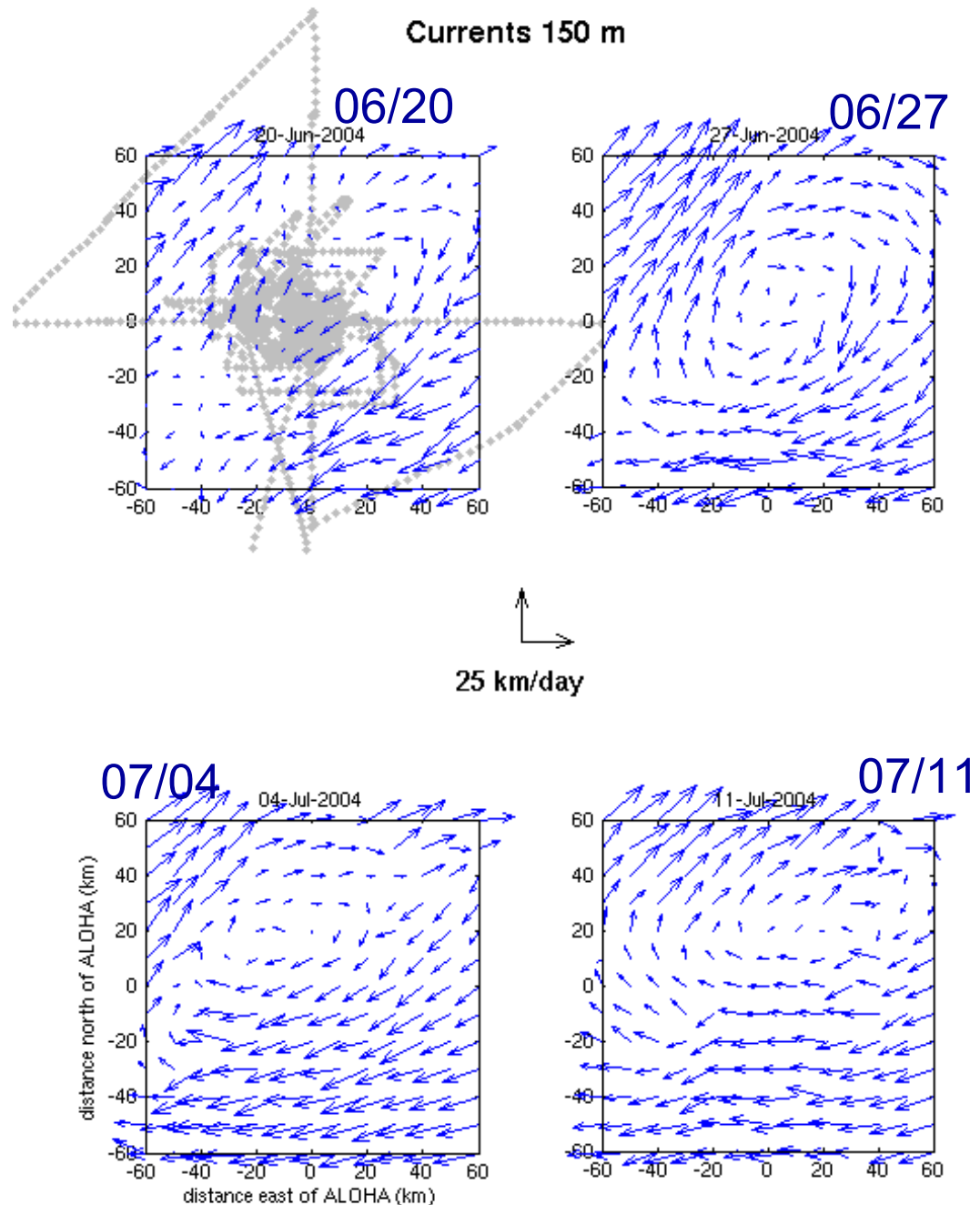
Mapped ADCP Currents - ALOHA



OA Map for June 27, 2004

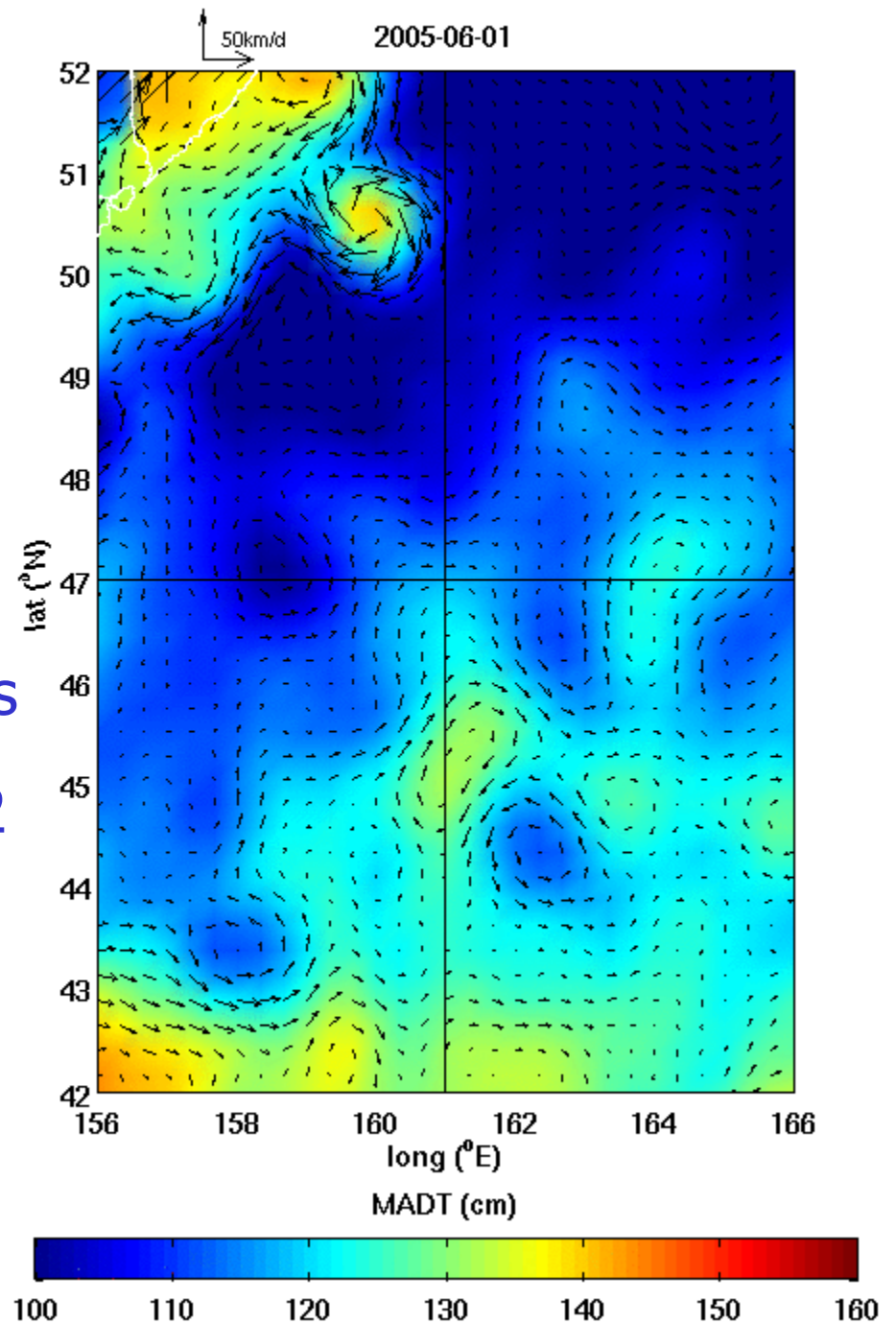
Mapped ADCP Currents - ALOHA

- Objective maps of ADCP currents
- Eddy moves west during Vertigo



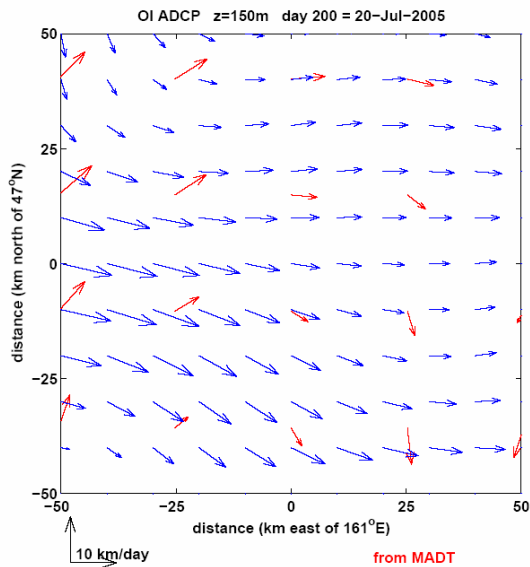
Sea Level @ K2

- June 1 to Sept 7, 2005
- SSALTO/DUACS merged SLA
- Absolute geostrophic currents
- Currents are westward AT K2
- Extensive eddy features

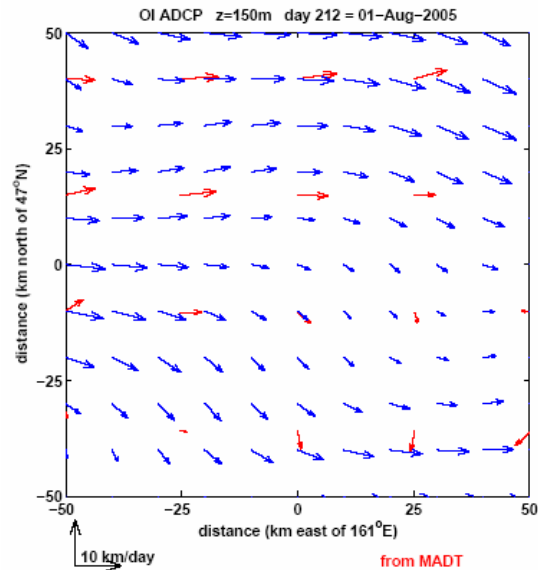


Mapped ADCP Currents – K2

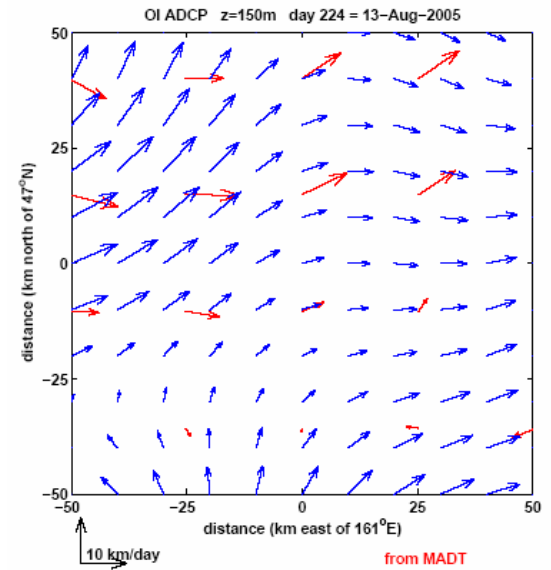
OA ADCP Maps with overlaid altimeter currents



7/20



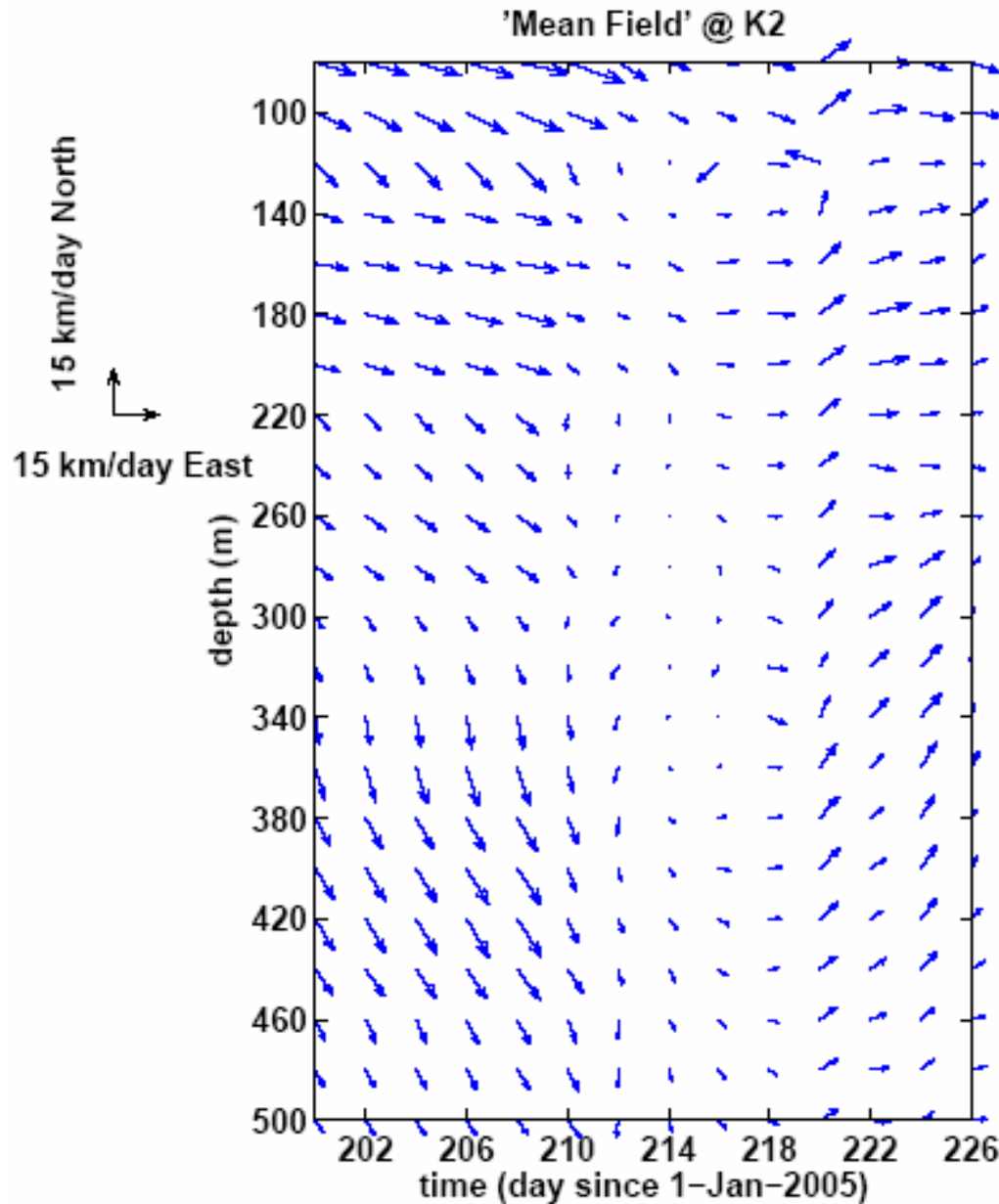
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- Flow is generally westerly (from W)
- Correspondence is fair between ADCP & SLA
- Edges are a bit scary...

Vertical Profile of ADCP Currents @ K2

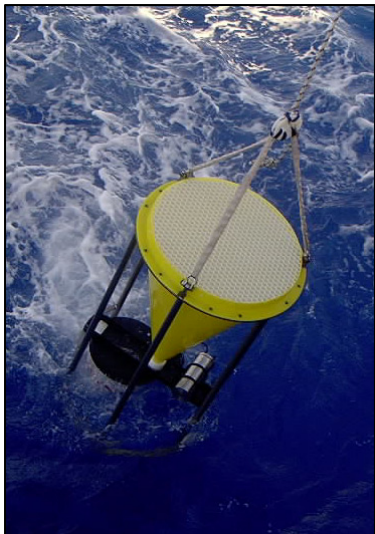
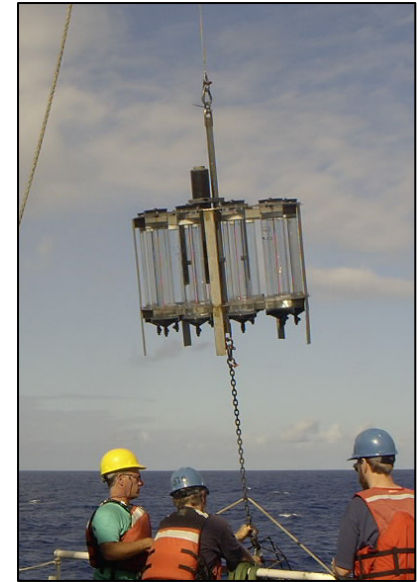


OA at the K2 site



NBST - neutrally buoyant sediment trap
follows water its local parcels to reduce
hydrodynamics & local collection issues

CLAP – surface tethered sediment trap
follows water motions (+ surface drag)
integrated over the length of the tether



Deep – bottom moored sediment trap
trap is fixed in an array to the bottom & water
flows past it

Theory

Use trap's position & 3-D current field to advect collected particles backward in time to their origin

$$\vec{x}_i(\vec{a}_j(T_i;t);t) + \int_t^{T_i} \vec{v}_i(\vec{a}_j(T_i;t);t') dt' = \vec{x}(\vec{a}_j(T_i;t);T_i) = \vec{a}_j(T_i;t)$$

An advected particle's motion is comprised of the horizontal currents acting on it & its sinking rate

$$\vec{v}_i(\vec{a}_j(T_i;t);t) = \vec{u}(\vec{x}_i(\vec{a}_j(T_i;t);t)) + S(\vec{x}_i(\vec{a}_j(T_i;t);t)) \hat{k}$$

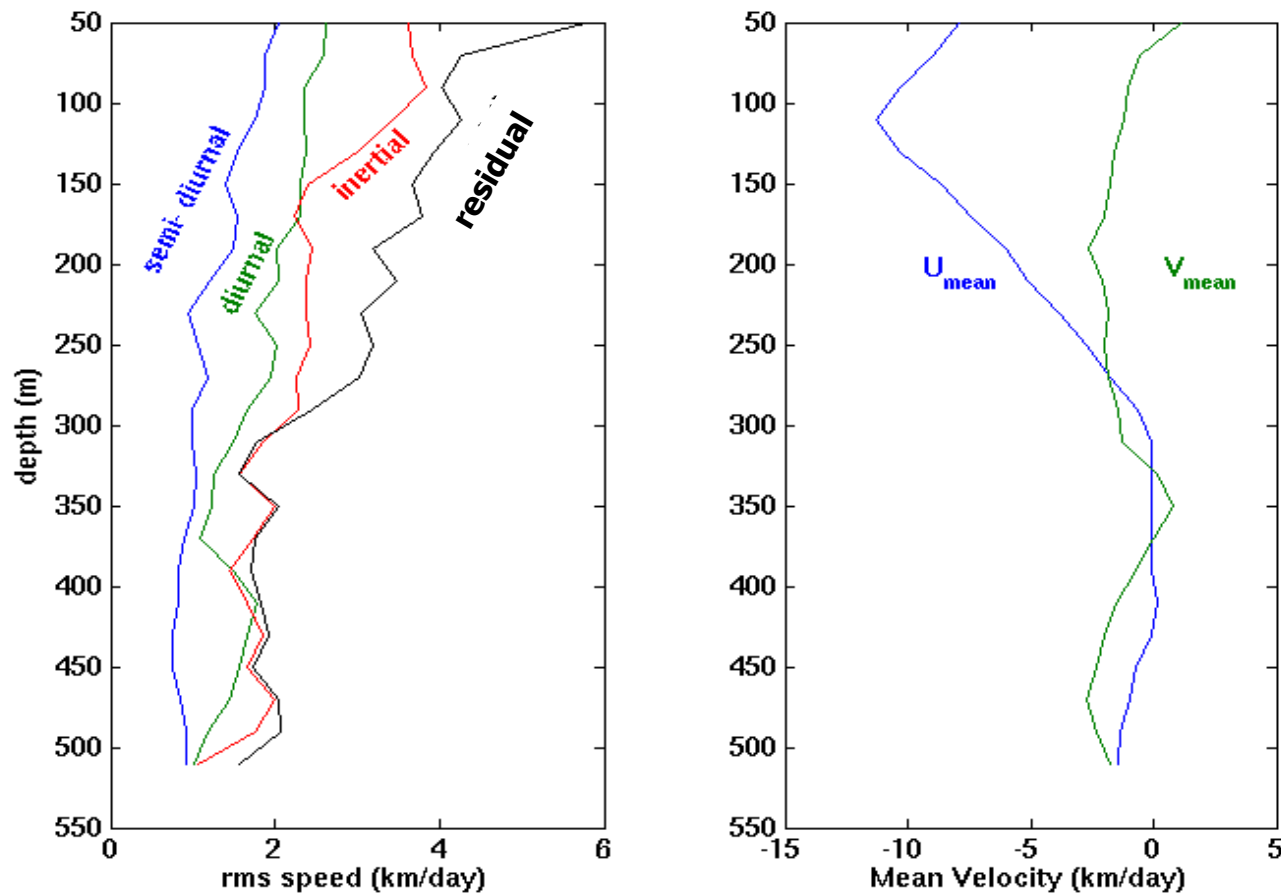
Advect particles back to euphotic zone (source) or back to when the trap collected the particle (collection)

3-D Current Field

- Need $\mathbf{u}(\mathbf{x},t)$ to advect particles
- Data & its uses will be scale dependent
 - 10's km from ADCP surveys (floating traps)
 - 100's km from satellite altimetry (moored traps)
- Decompose into spatial mean, tidal, inertial & residual components
- Advect rising particles backward in time to determine the funnel characteristics

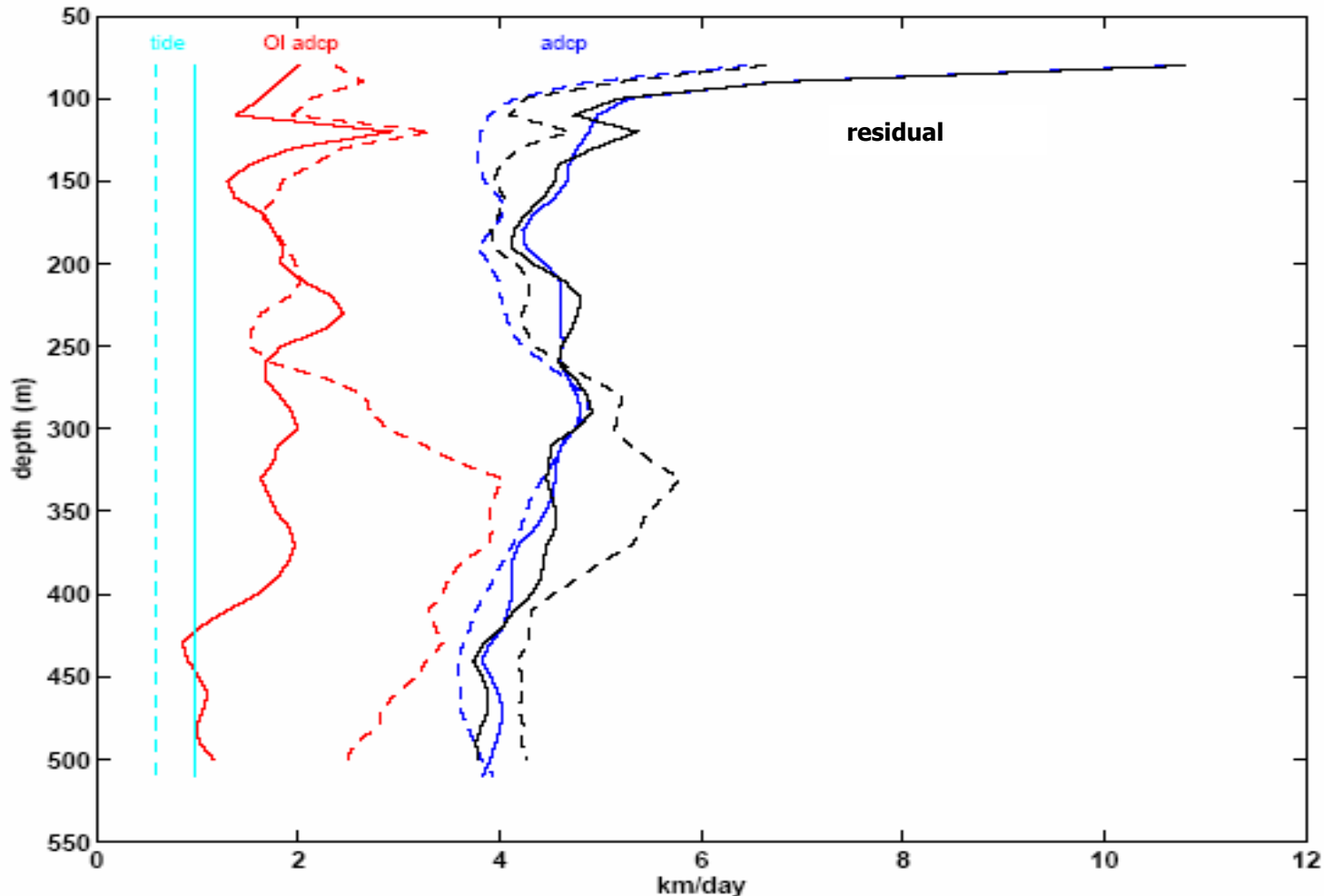
ADCP Current Decomposition - ALOHA

- Decompose currents into mean, tidal, inertial & residual components

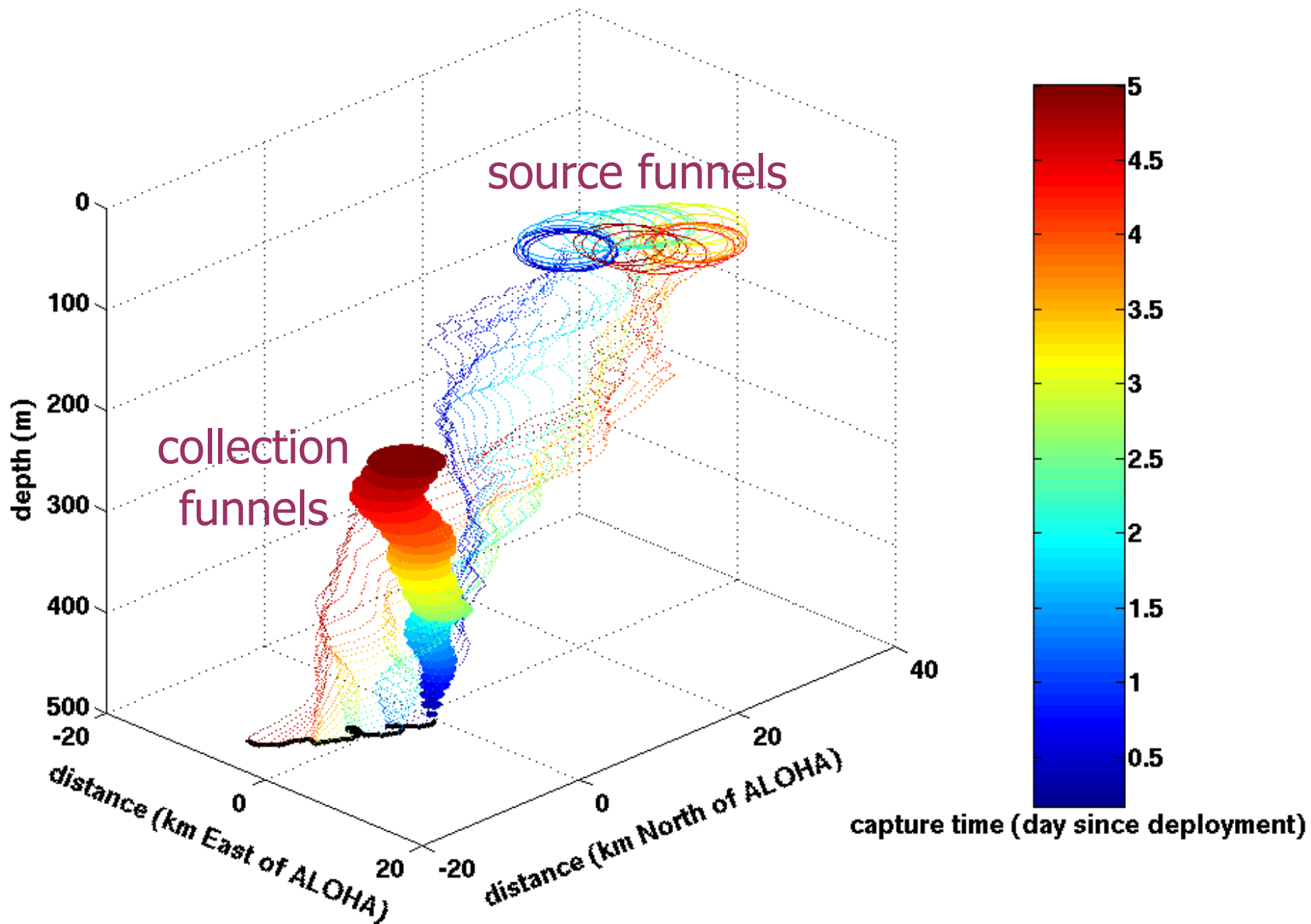


ADCP Current Decomposition – K2

- Decompose currents into mean, tidal, inertial & residual components

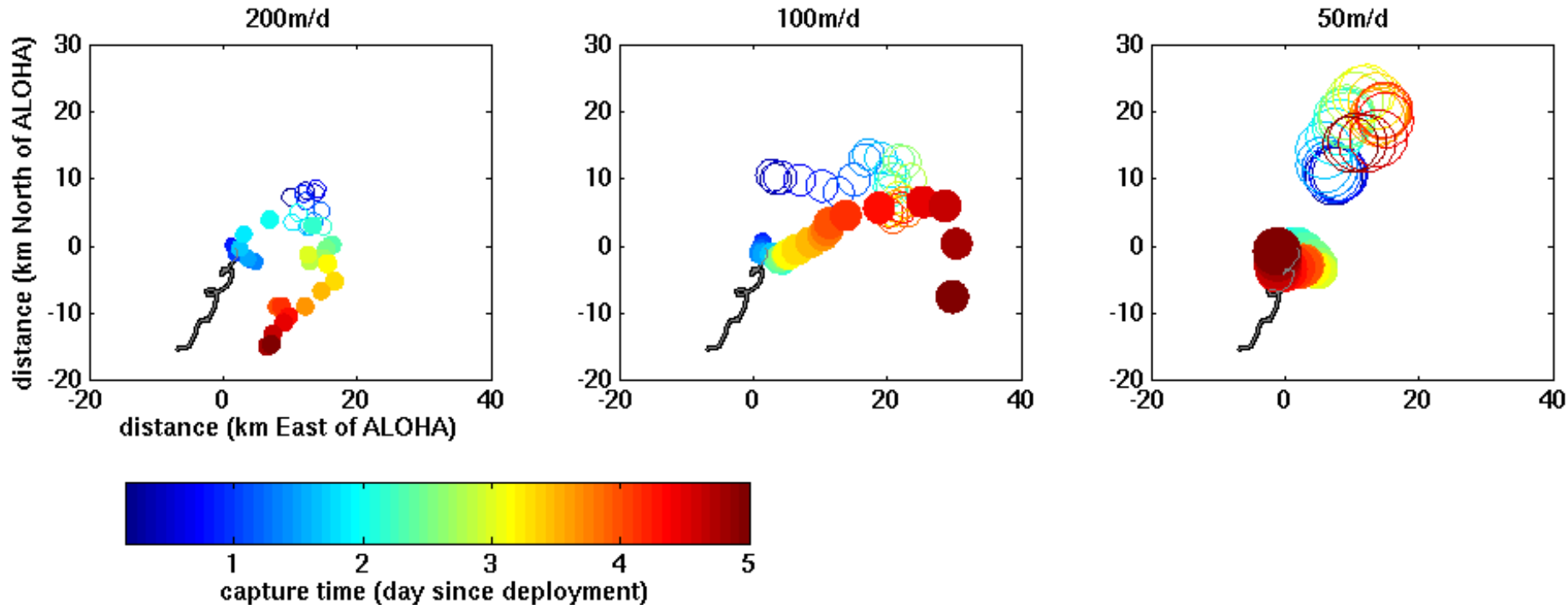


VERTIGO KM0114 NBST11 @ 500m 50m/d 2nd deployment



NBST 500 m – Aloha 2nd Deployment

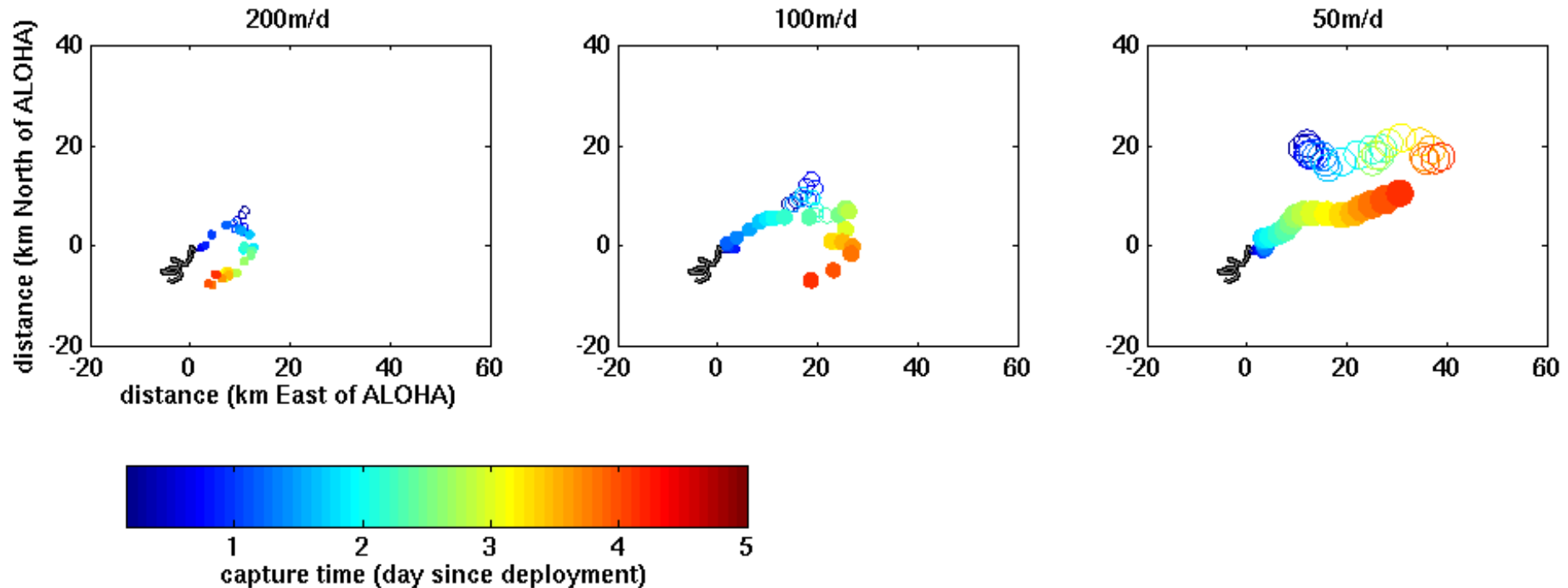
NBST trap #11
2nd deployment @ 500m



- Source & collection funnels are 0 to 40 km from NBST
- Funnel displacements & directions vary w/ sinking speed

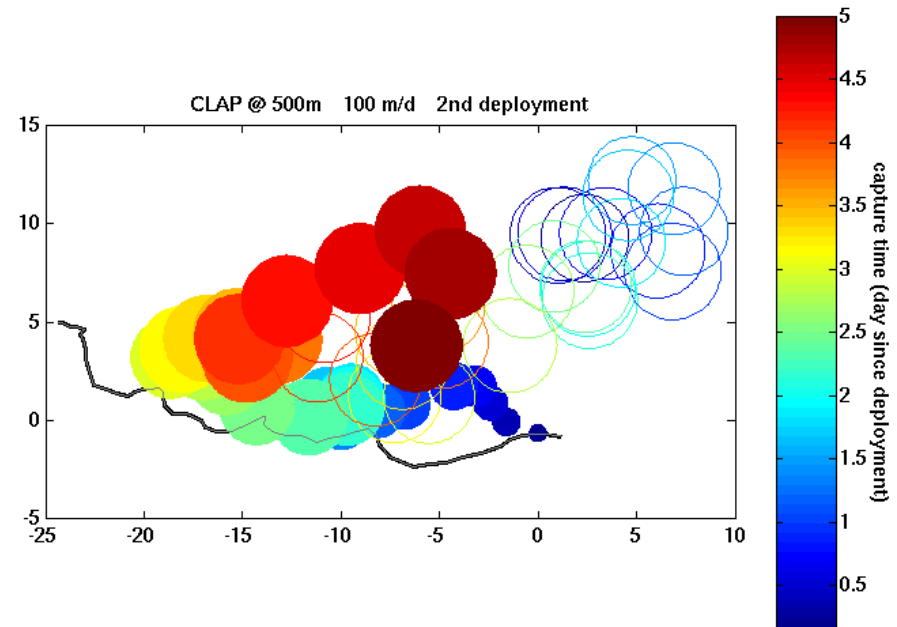
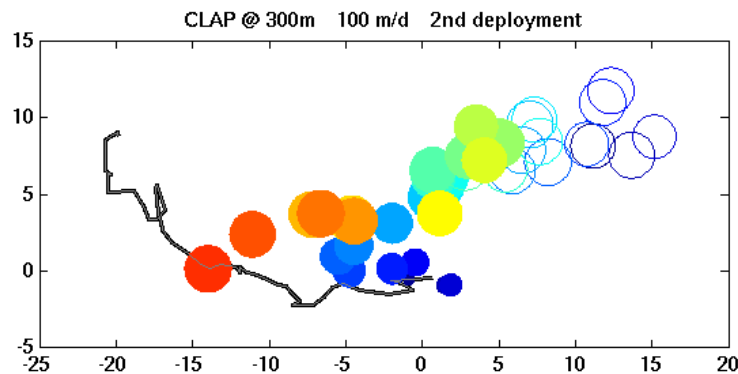
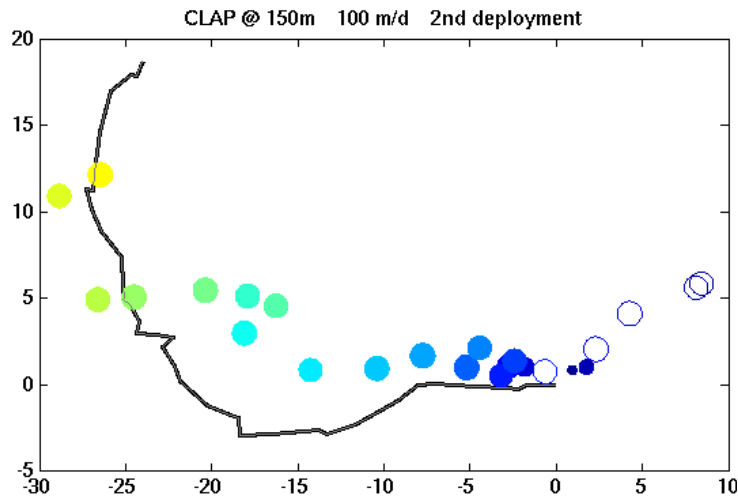
NBST 300 m – Aloha 2nd Deployment

NBST trap #16
2nd deployment @ 300m



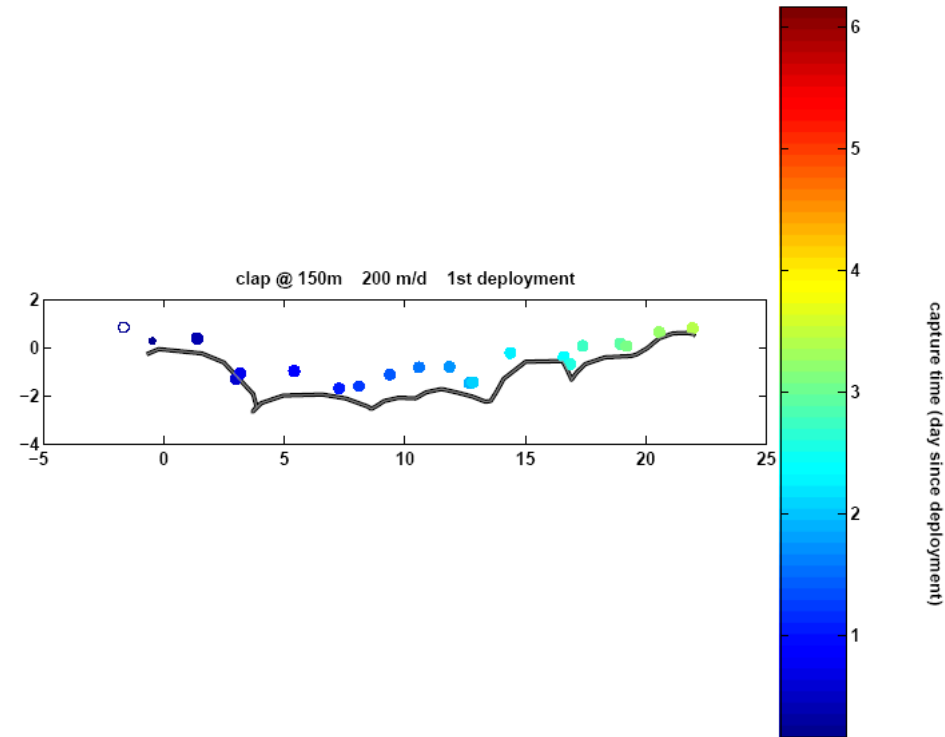
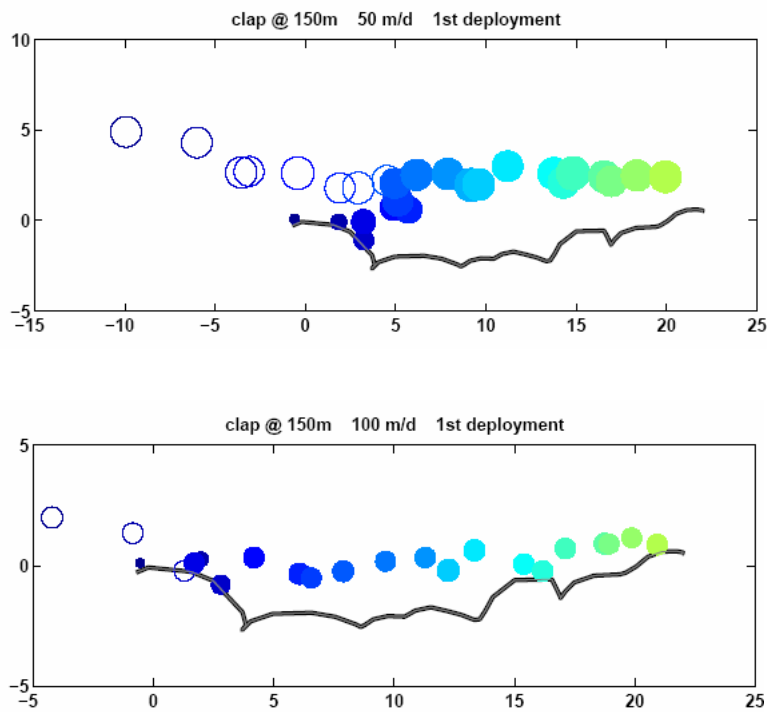
- Source & collection funnels are 0 to 40 km from NBST
- Funnel displacements & directions vary w/ sinking speed
- Source & collection funnels both separate & overlap

CLAP's – Aloha 2nd Dep – $W_s=100\text{m/d}$



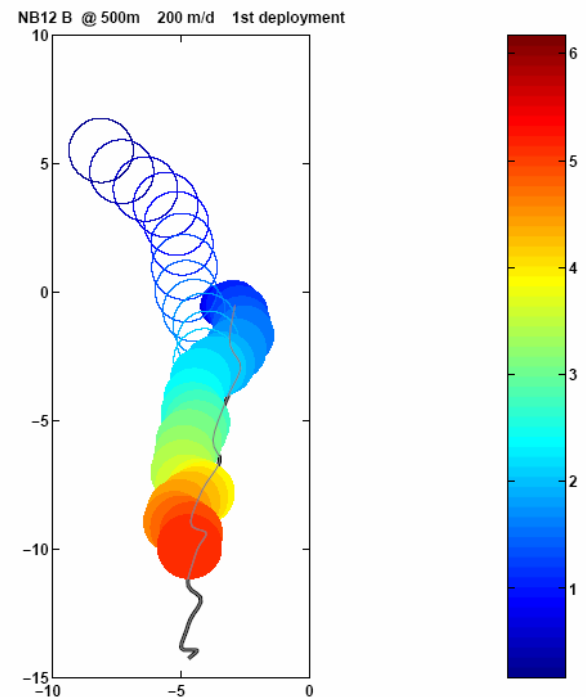
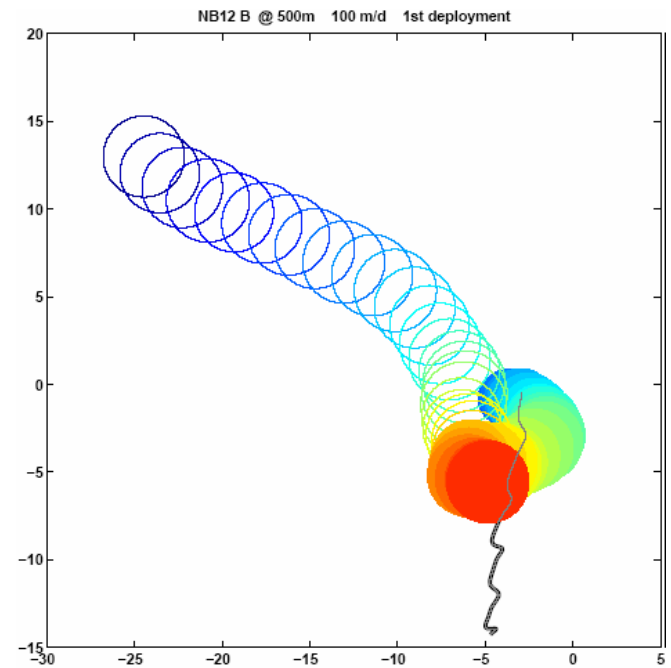
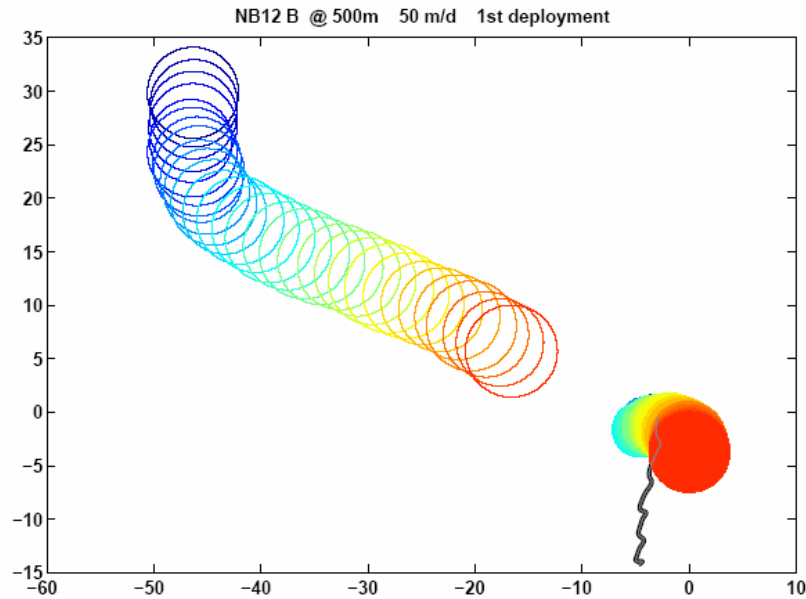
- Location (0,0) corresponds for all three traps
- Collection funnels follow trap drift (east of recovery location)
- Source funnels are mostly upstream (west)

K2 CLAP's – 150 m



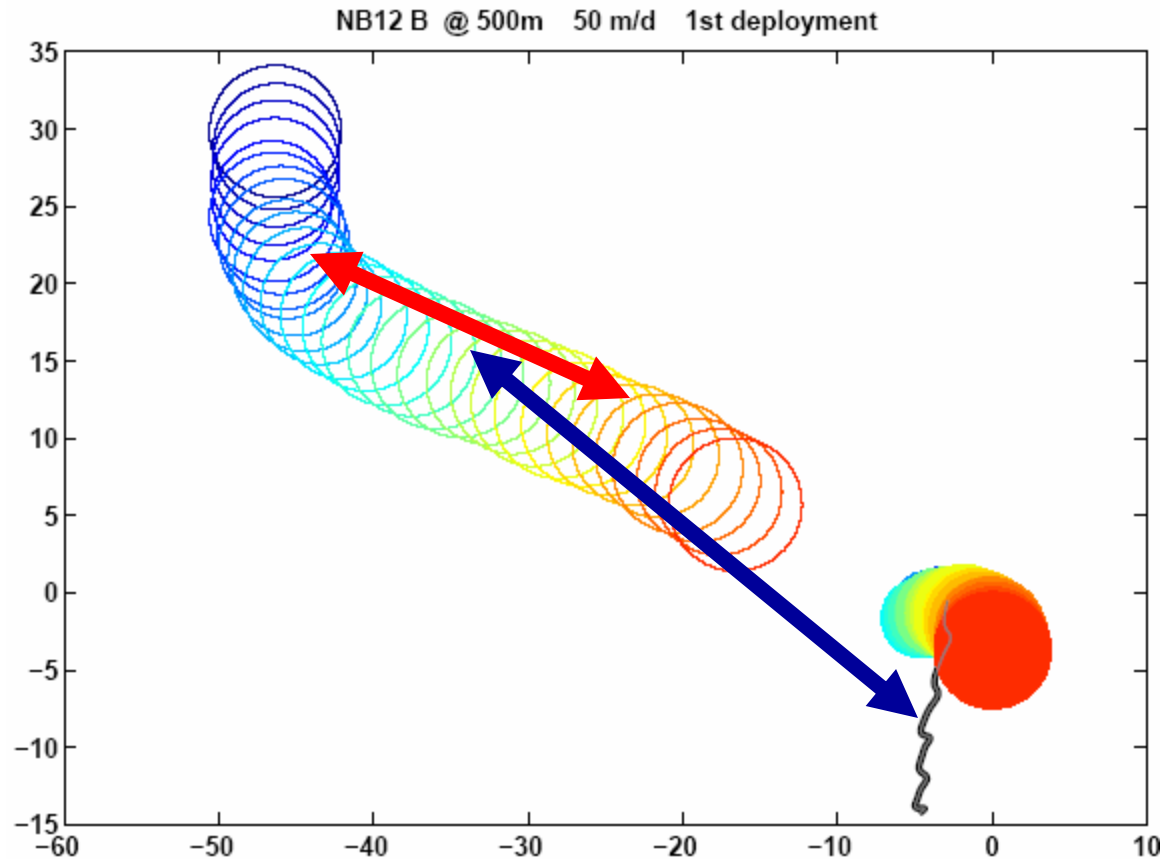
- Collection funnels follow trap drift
- Source funnels mostly correspond
- The few source funnels that do not correspond are mostly upstream

K2 NBST 500 m – Dep 1



- Collection funnels follow trap drift
- Source funnels mostly correspond
- The few source funnels that do not correspond are mostly upstream

Summarizing Funnel Properties



- Mean displacement for funnel is distance between mean trap location & mean funnel locations (blue arrow)
- Patch Scale of funnel locations is the rms of the funnel locations from their centroid location (red arrow)

Summarizing Funnel Properties for Aloha

- Mean source displacements

The deeper the trap *or* the slower the sinking, the further the displacement distance

For $W_s = 100$ m/d, mean source displacements vary from 4 to 26 km & increase at a rate of 1-5 km/d

CLAP trap displacements are about 1/2 NBST traps

- Source region patch scale

For $W_s = 100$ m/d, patch scales vary from 2 to 14 km

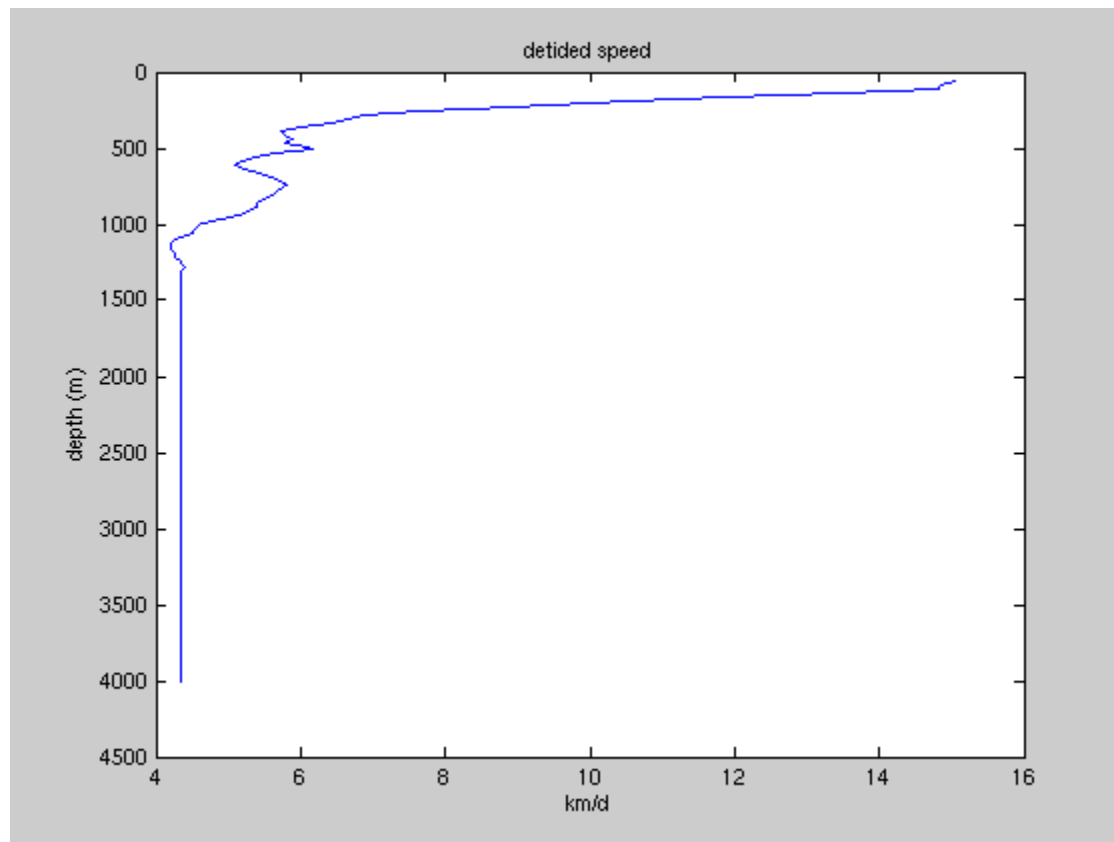
CLAP and NBST scales are about the same

Patch scale increases at a rate of 1 to 4 km/d

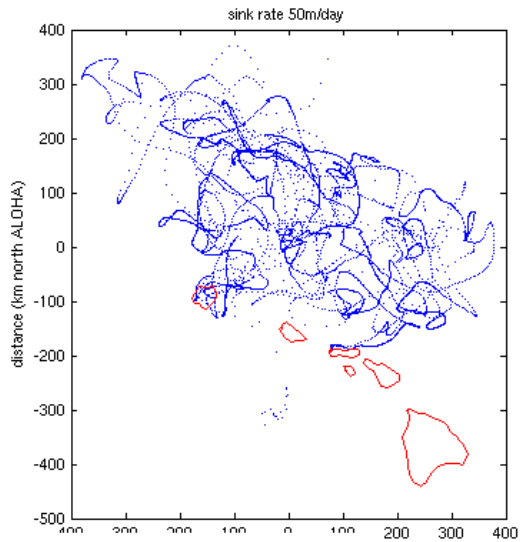
- Similar for K2 (mean displacements are a bit bigger)

Modeling Deep Traps – Aloha 5km Trap

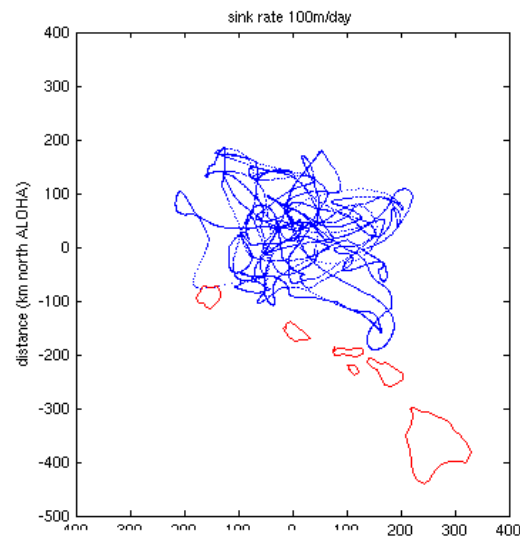
- Use the currents from altimetry to back advect rising particles from trap at depth



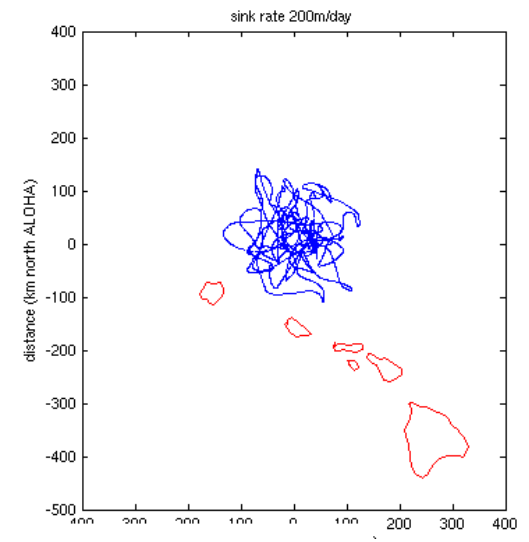
Deep Trap Funnels for Aloha 5000 m trap



$$W_s = 50 \text{ m/d}$$
$$R_{95\%} = 340 \text{ km}$$



$$W_s = 100 \text{ m/d}$$
$$R_{95\%} = 220 \text{ km}$$



$$W_s = 200 \text{ m/d}$$
$$R_{95\%} = 130 \text{ km}$$

- Mean funnel displacements are small ($< 50 \text{ km}$)
- Few trajectories go on the islands...

