Diving Behavior of Sperm Whales in Relation to Oceanographic Characteristics

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Presentation Outline

Diving behavior of sperm whales

foraging at depth – dive depth, buzz production (D-tag)

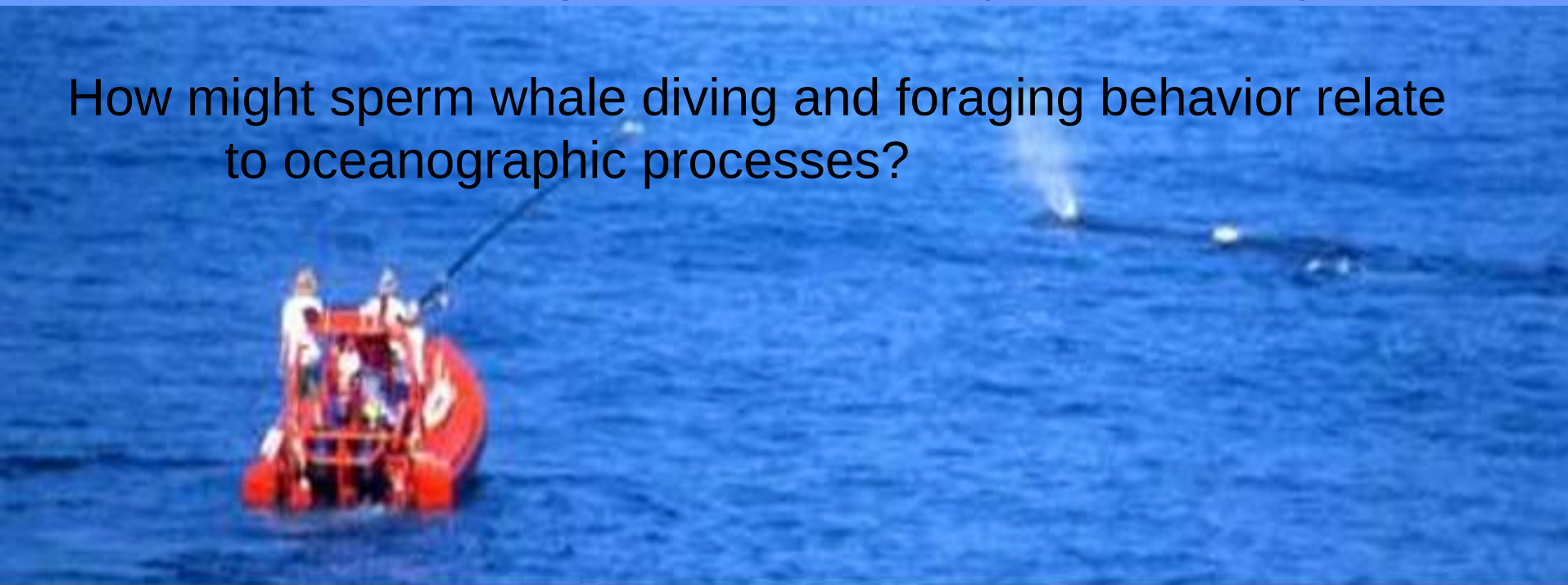
Oceanographic processes of the northern Gulf of Mexico

circulation – ocean height, currents (satellite, ADCP)

surface productivity – chlorophyll (satellite)

biomass vs depth – backscatter (38kHz ADCP)

How might sperm whale diving and foraging behavior relate to oceanographic processes?



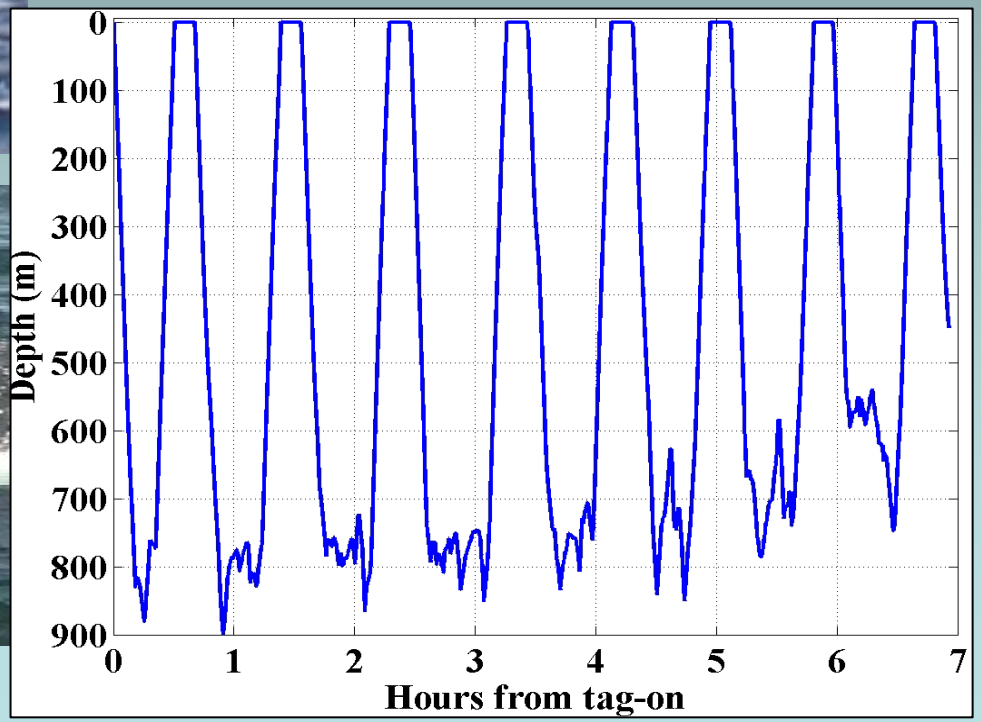
D-TAG: Synchronous Motion and Audio Recording Tag

D-tag Attachment

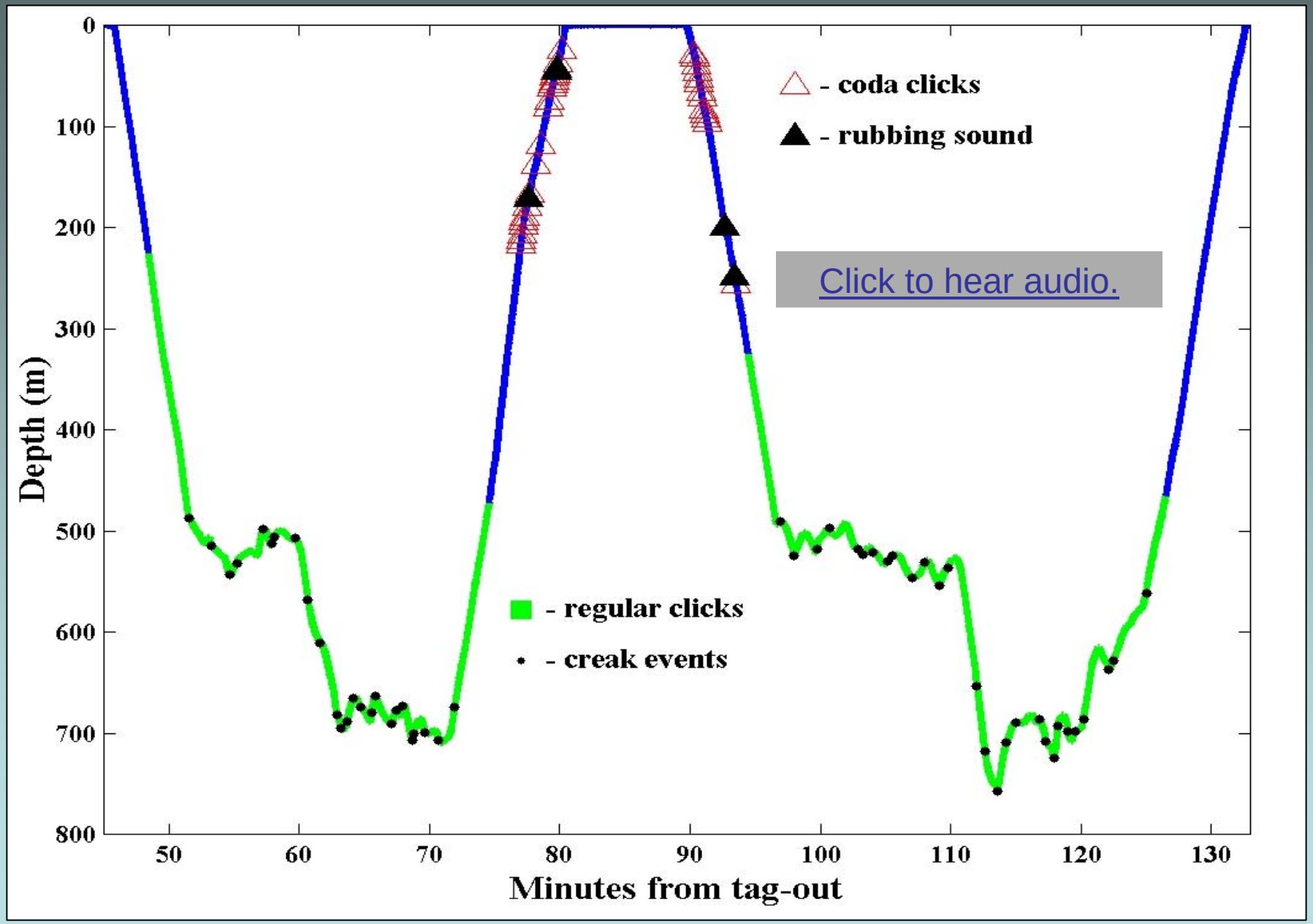
D-tag Recovery

Data from D-Tag

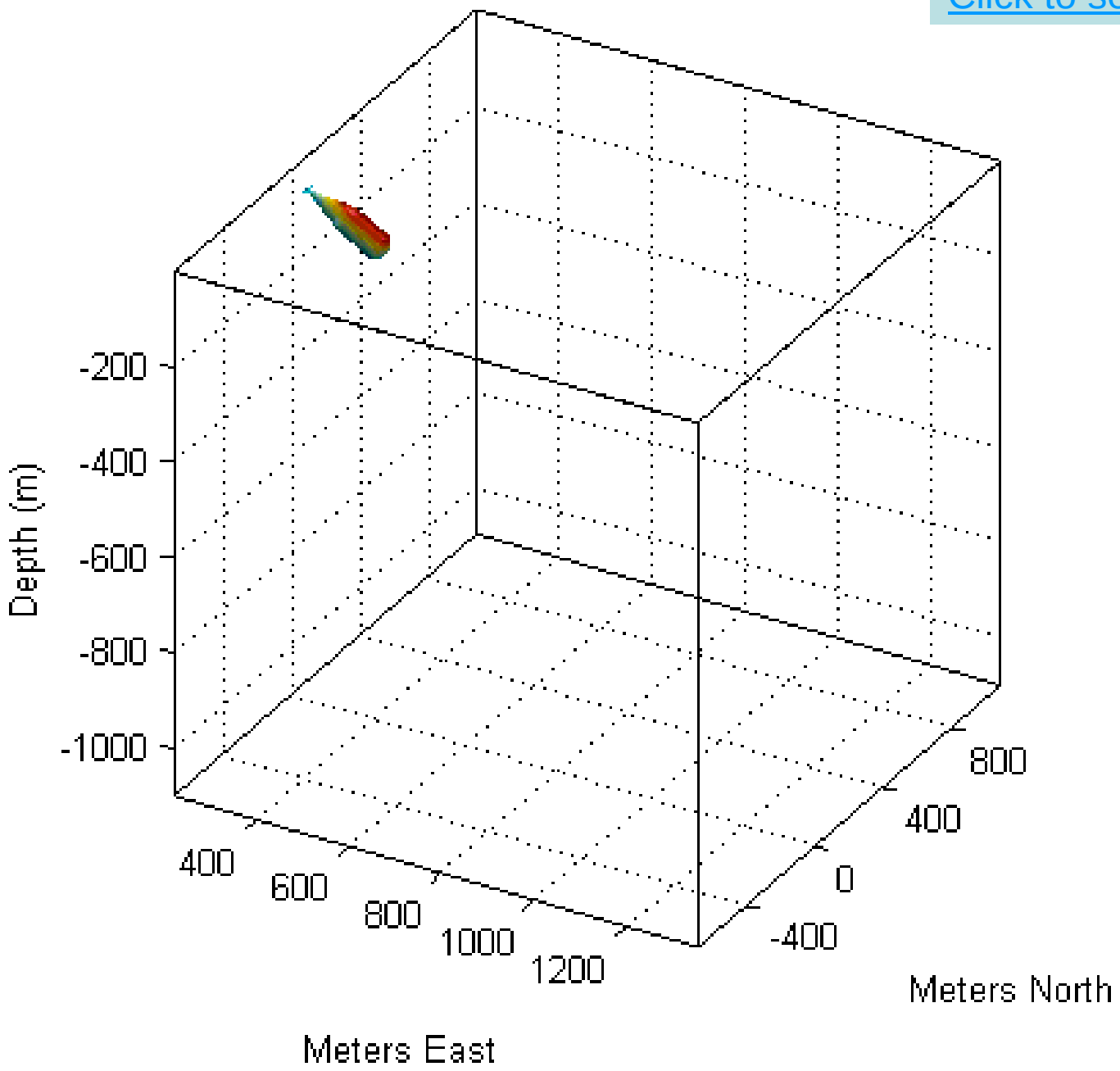
- Depth
- Sounds on the tag
- Animal orientation
- 3-axis accelerometer



Sounds Used by Sperm Whales Relative to Dive Cycle



Click to see video.



Sperm Whales Produce *Creak* Buzzes During Capture Phase

1.) Creaks occur at deepest depths
   – whales do not dive deep for other reasons

2.) Maneuvering increases during creaks
   – to overcome prey escape behavior

3.) Creaks occur at dive-inflection points
   – at the end of an approach or pursuit phase

Miller et al. 2004, Proc. Roy. Soc. B

Data Set for This Analysis

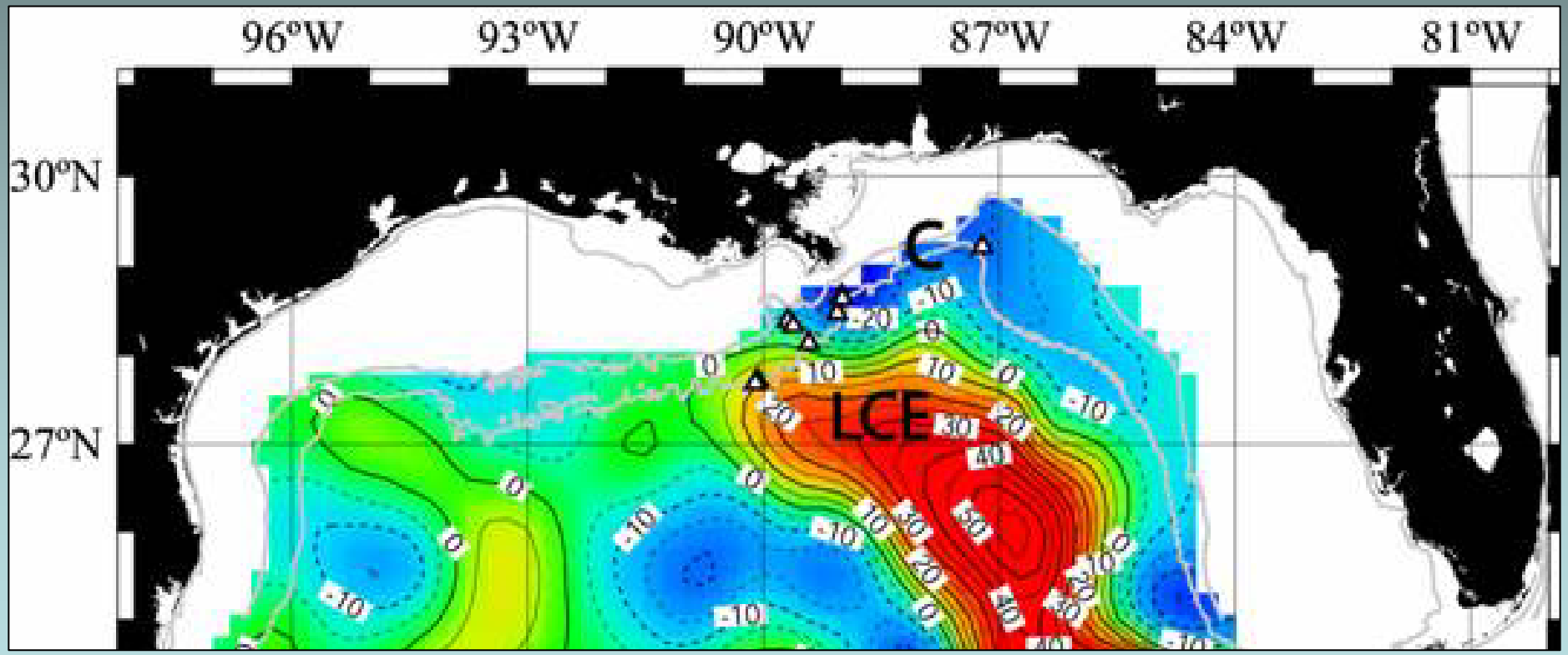
CRUISE	# whales	#dives
• 2001 SWAMP	4	20
• 2002 SWSS	14	72
• 2003 SWSS	8	52
• **TOTAL**	**26**	**144**

We tracked dive depth and depth of buzzes versus time of day for these whales.

CEEs did not affect dive depth, so those whales were also included.

Ocean Circulation: Sea Surface Height and Surface Currents

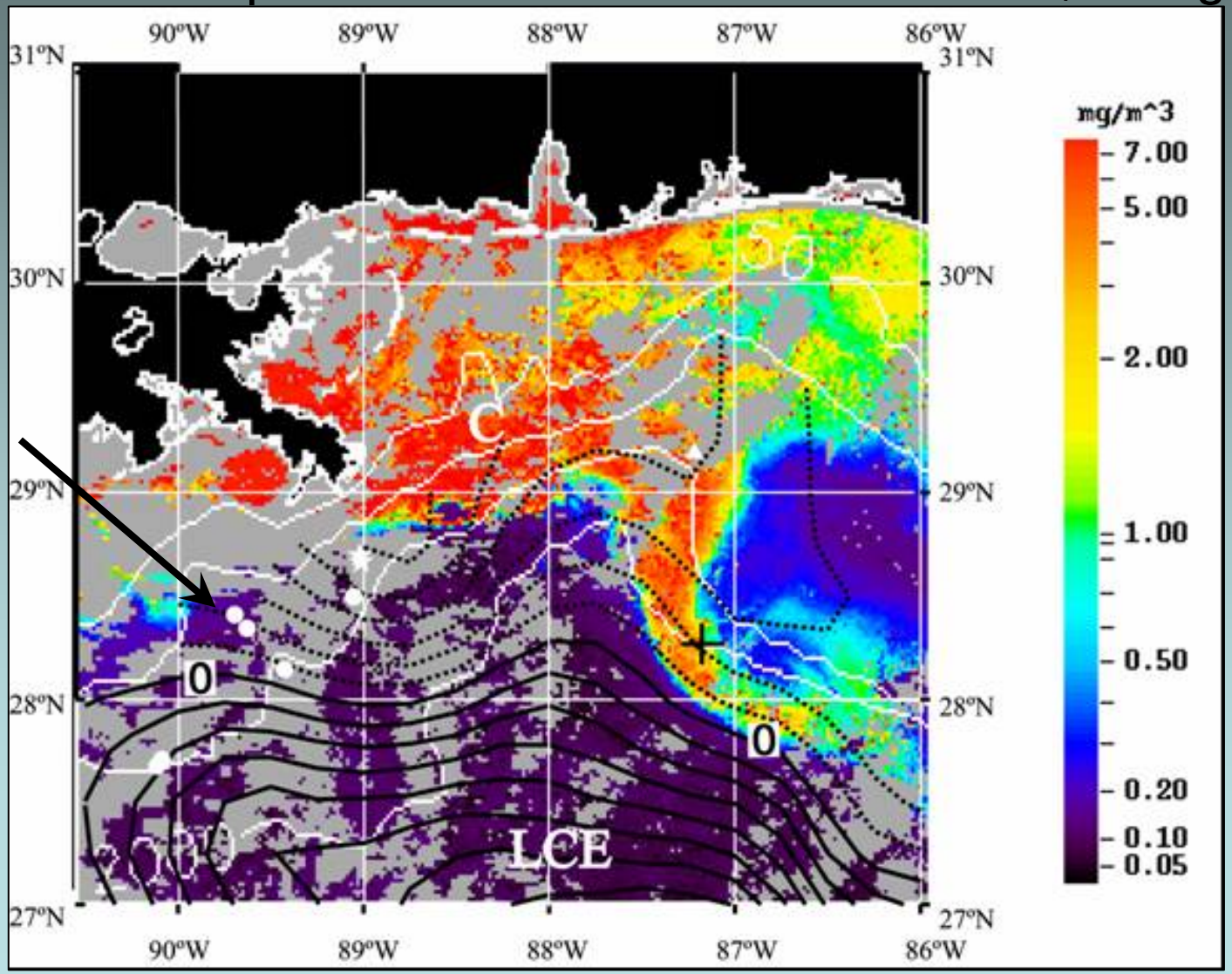
14 June 2003, D-tag cruise



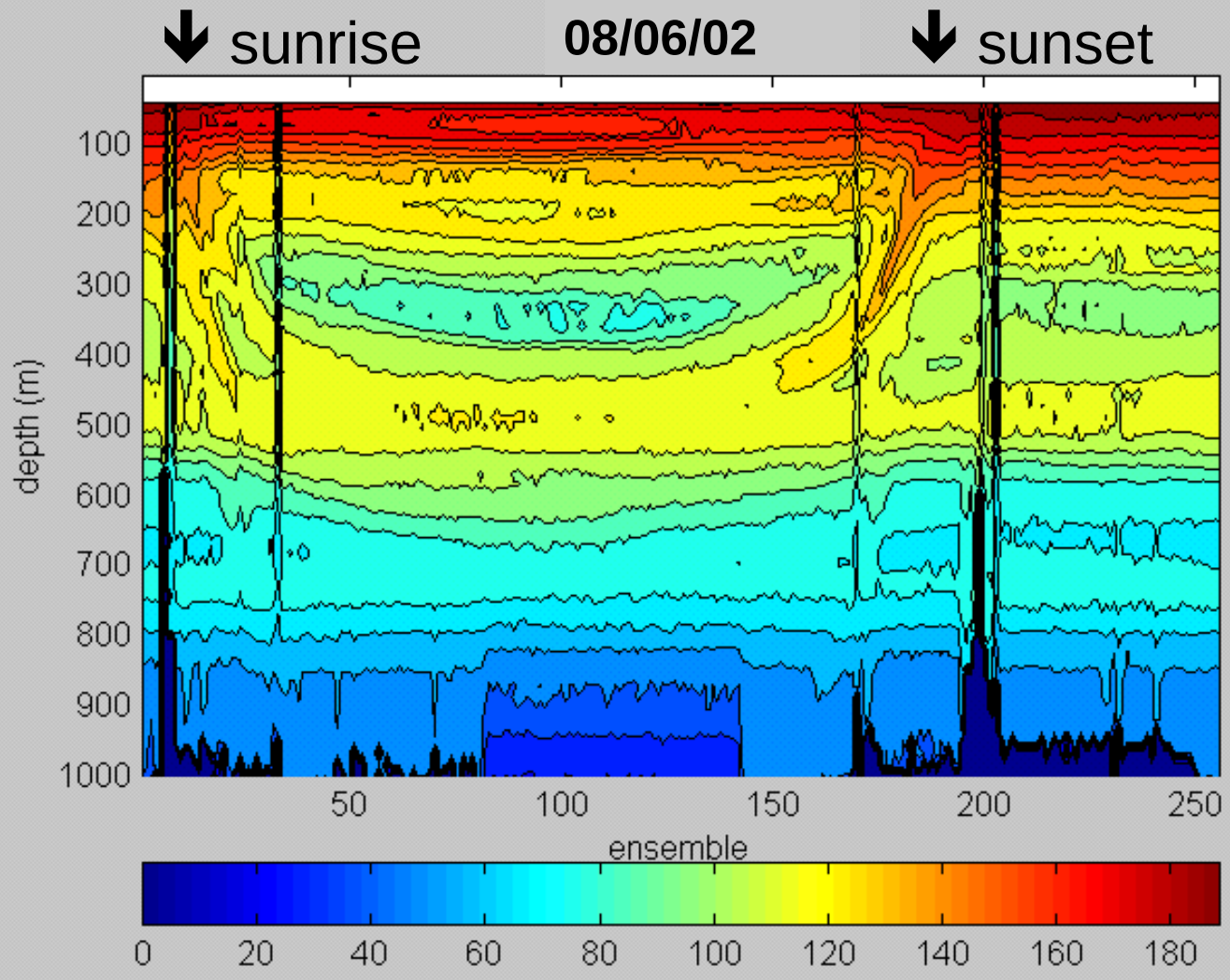
Ocean Circulation: Surface Currents and Productivity

Once week composite centered on 14 June 2003, D-tag cruise

D-tags deployed



Biomass vs Depth – 38kHz Backscatter



vertical migrations of migratory animals

} DSL also contains some non-migratory animals

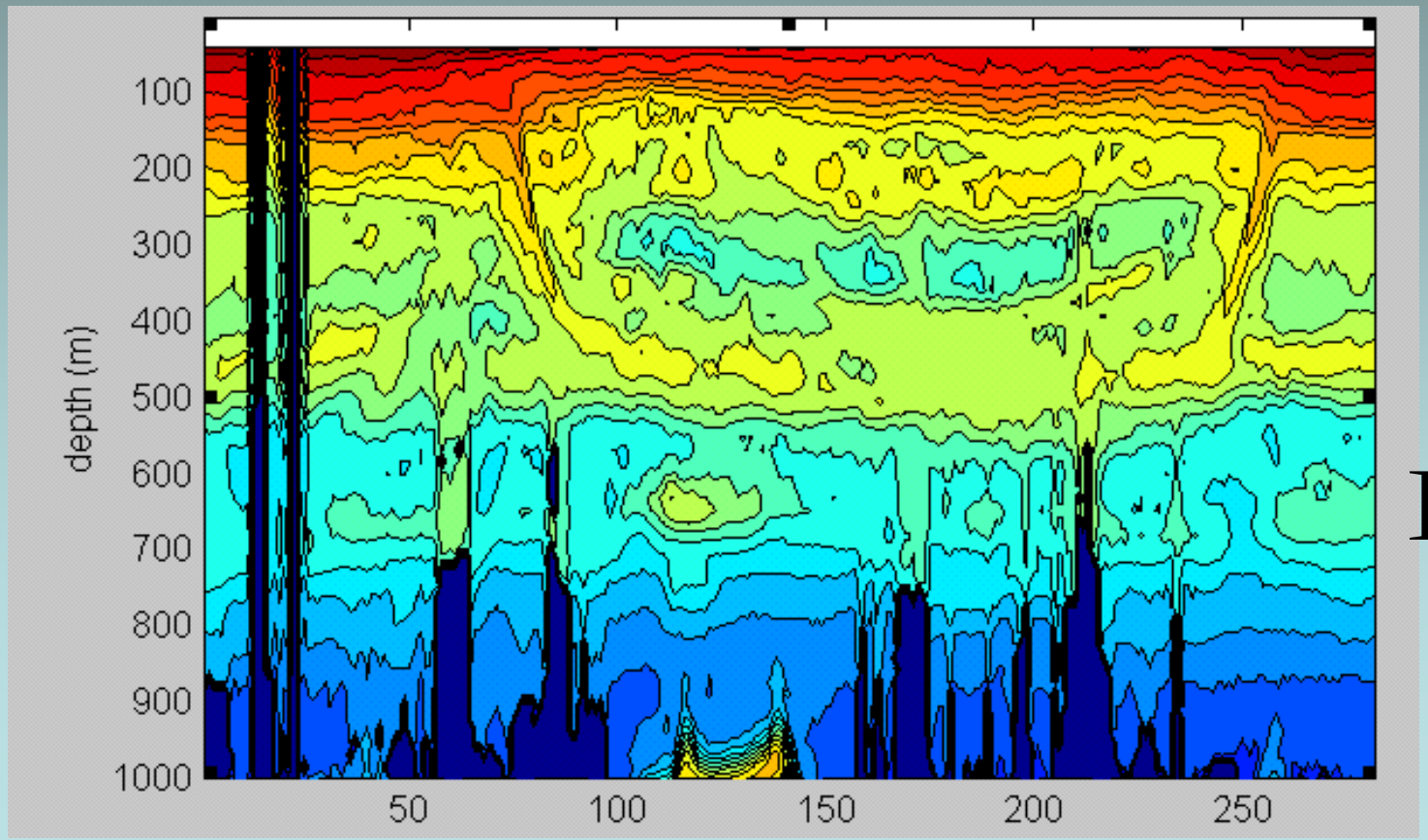
1 ensemble = 5 minutes
1 day = 288 ensembles

-Decrease of signal with depth because of sound attenuation.

Biomass vs Depth – Deeper Returns

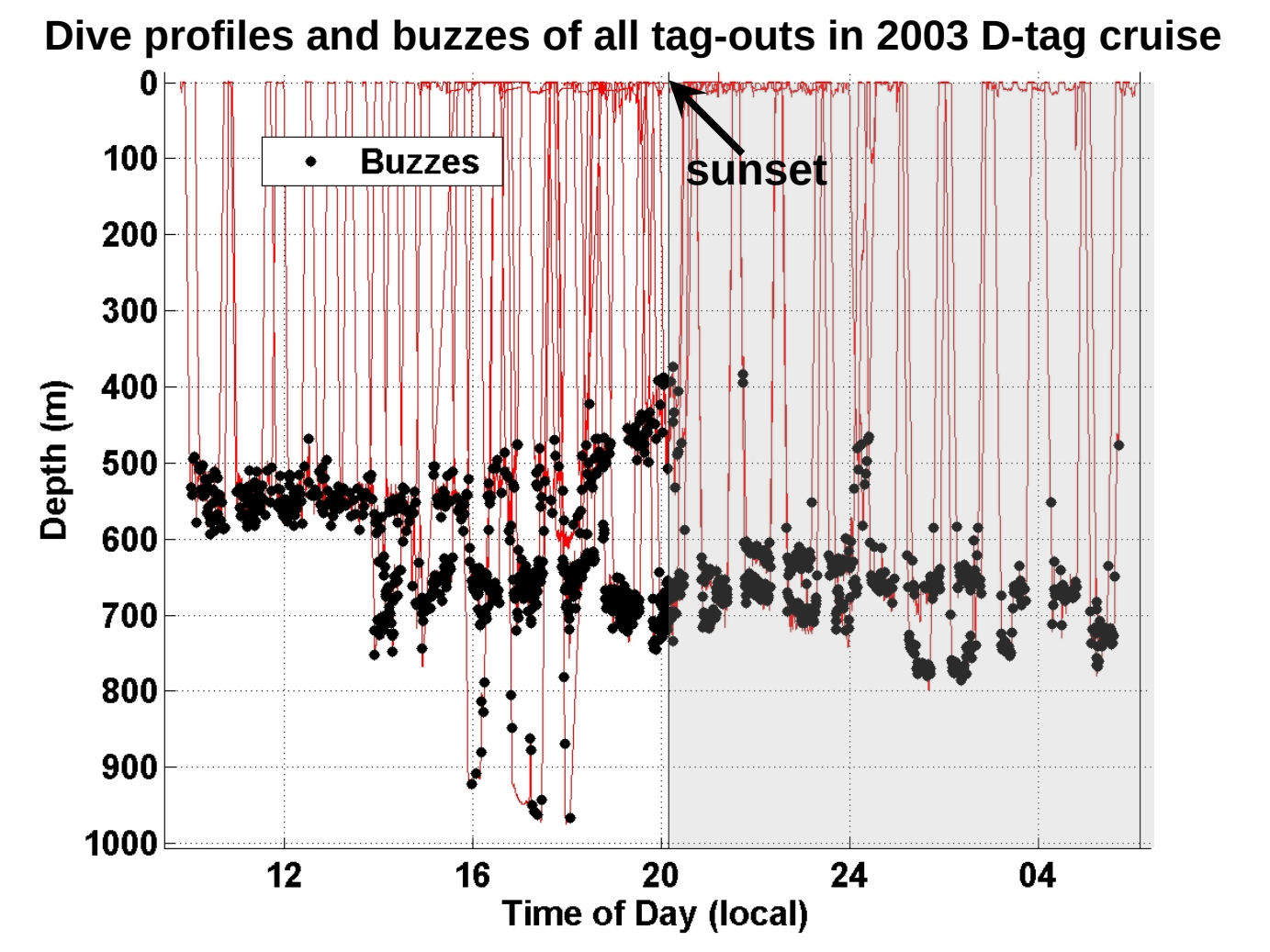
Backscatter deeper than the main DSL:

- Indicators of squid, or fish or crustacean prey of squid, living below daytime depth of DSL?



] deeper (patchy) returns

Sperm Whale Foraging Layers: Relationship to Backscatter



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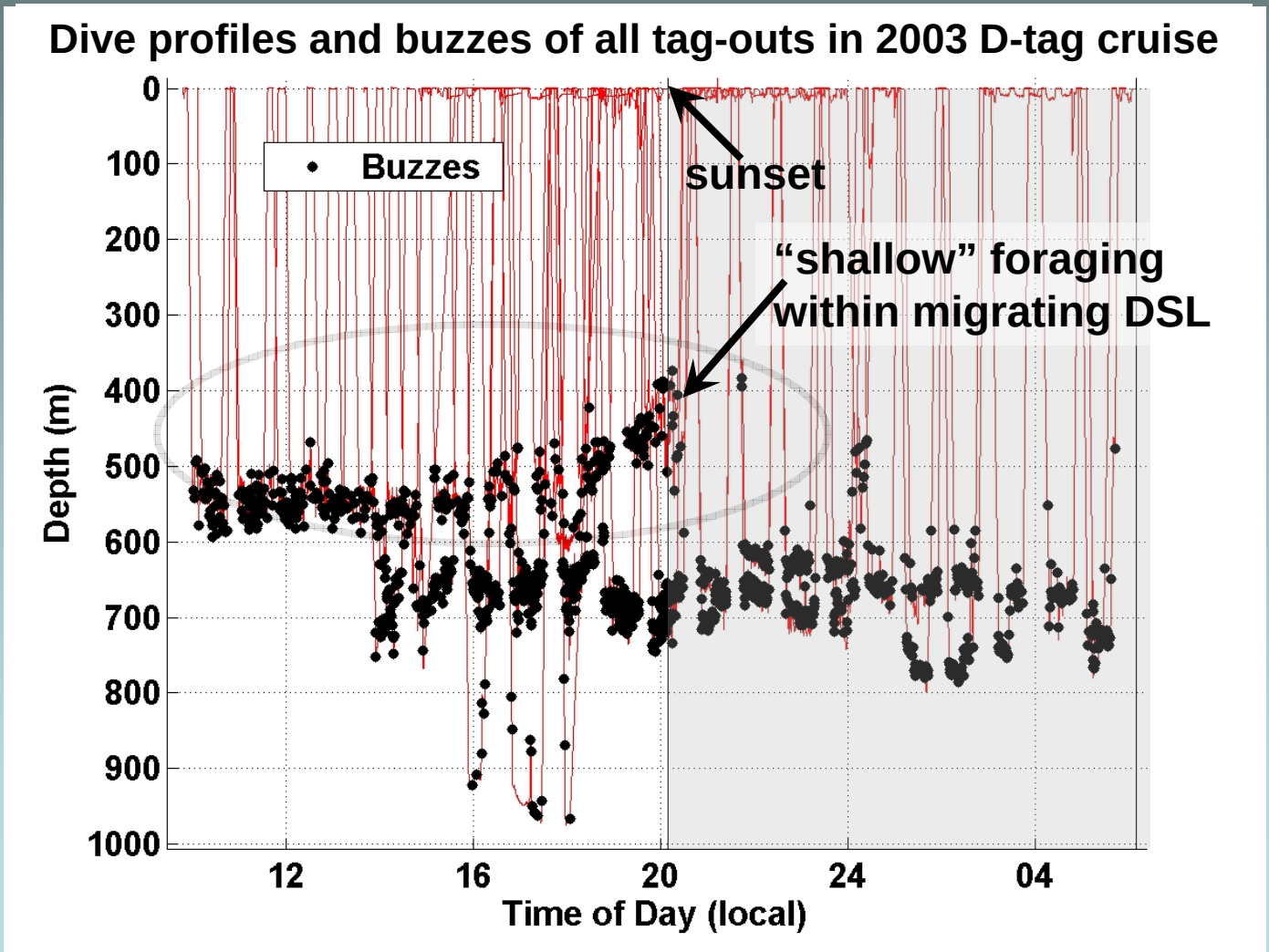

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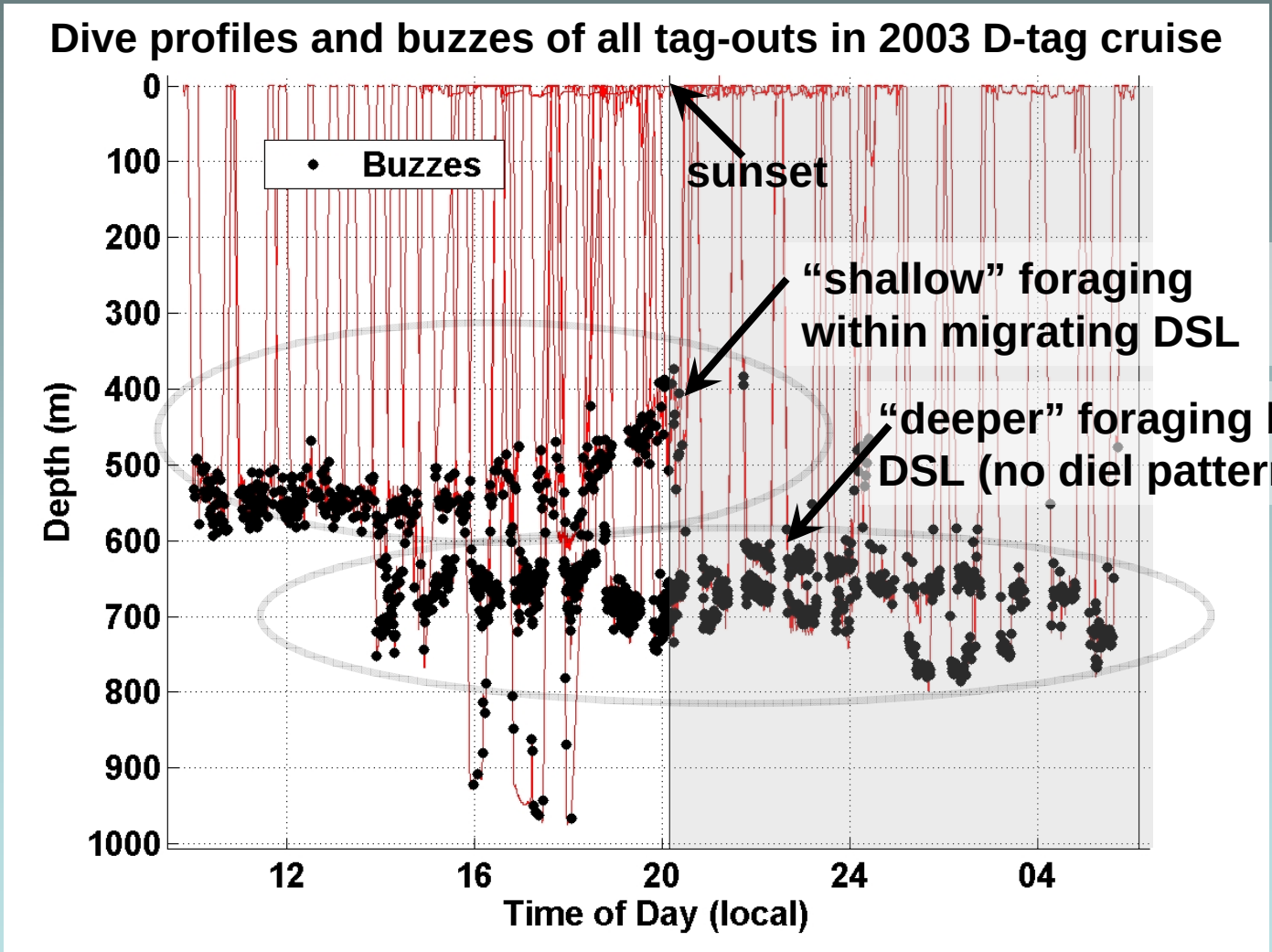

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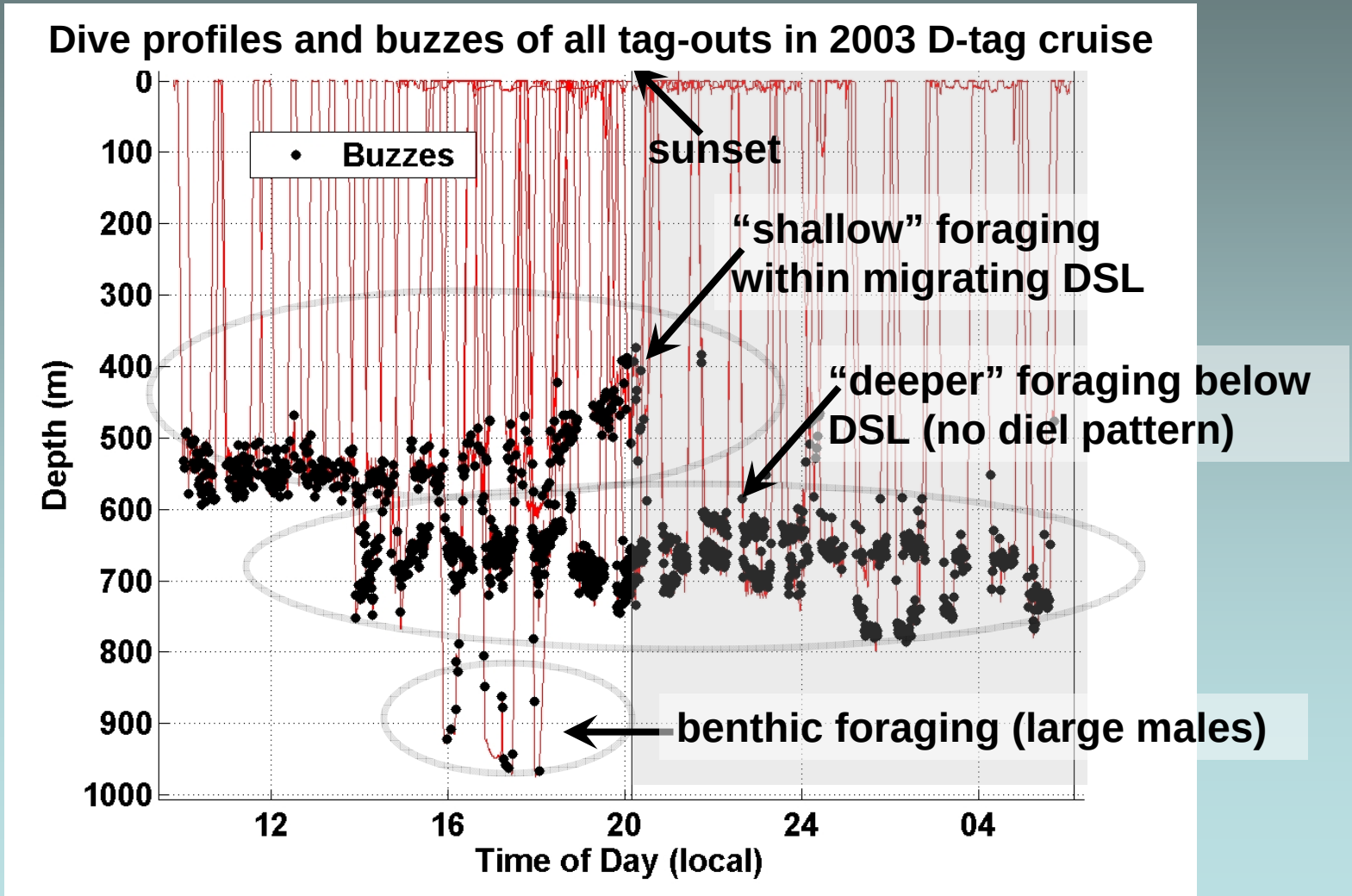
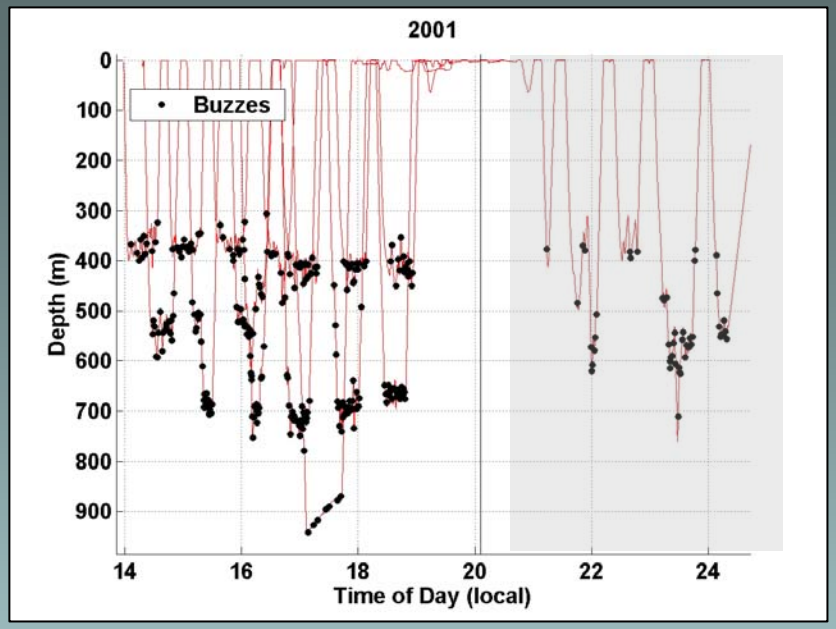
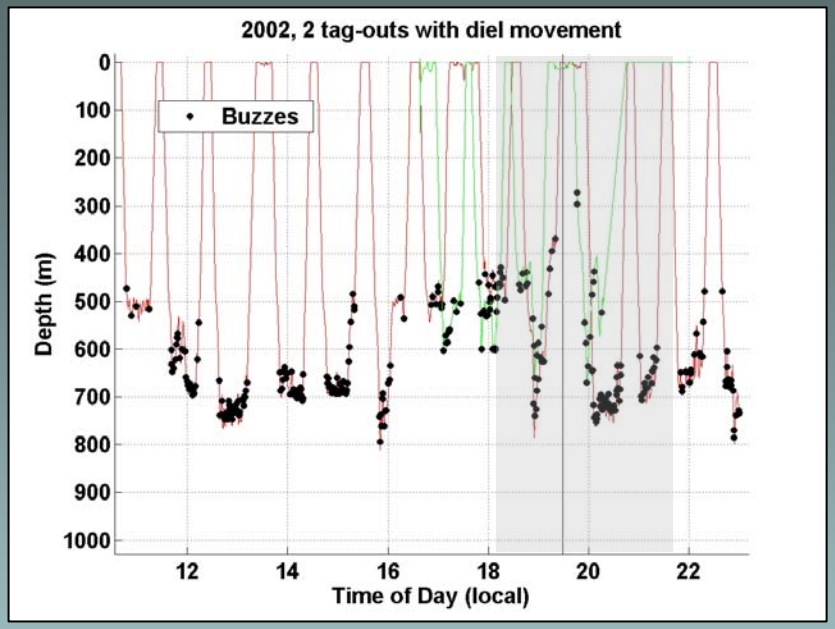
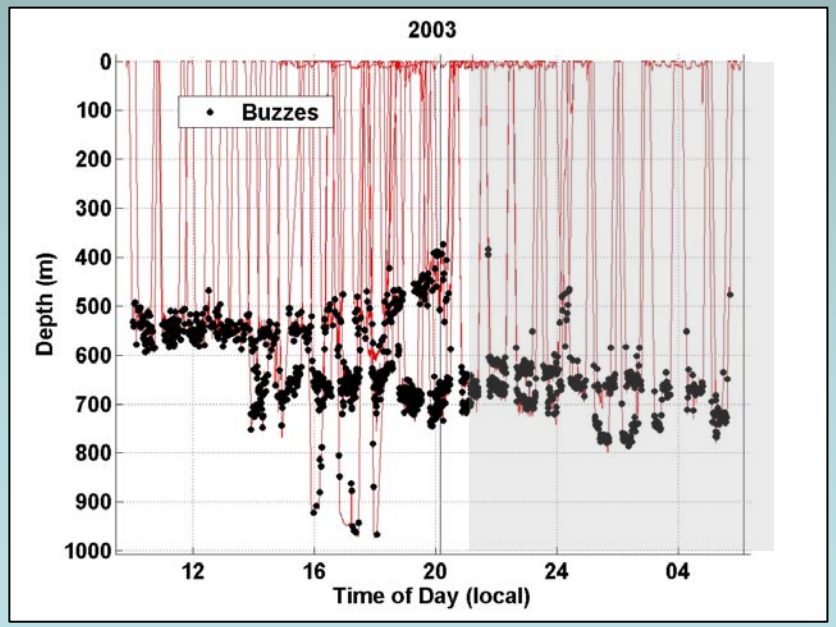
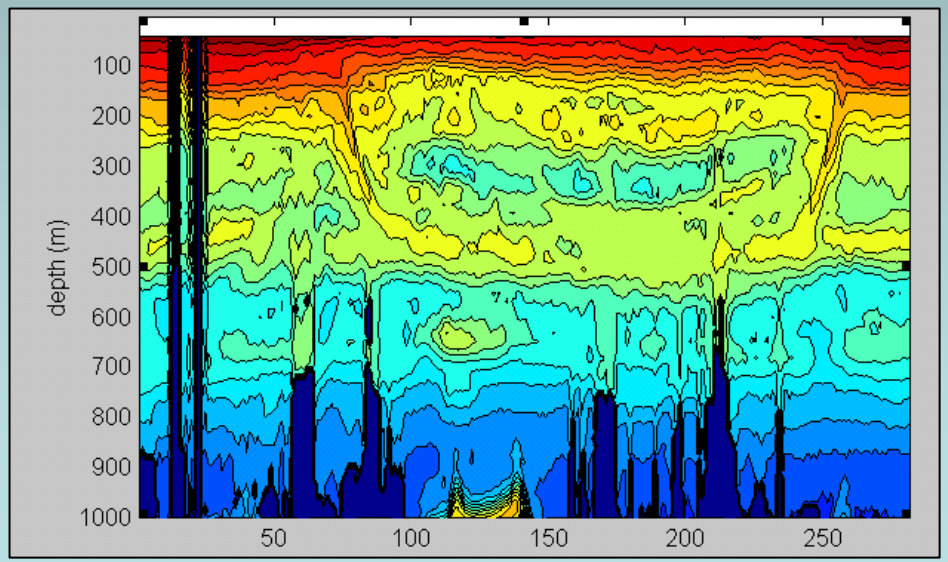


Sperm Whale Foraging Layers: All Years

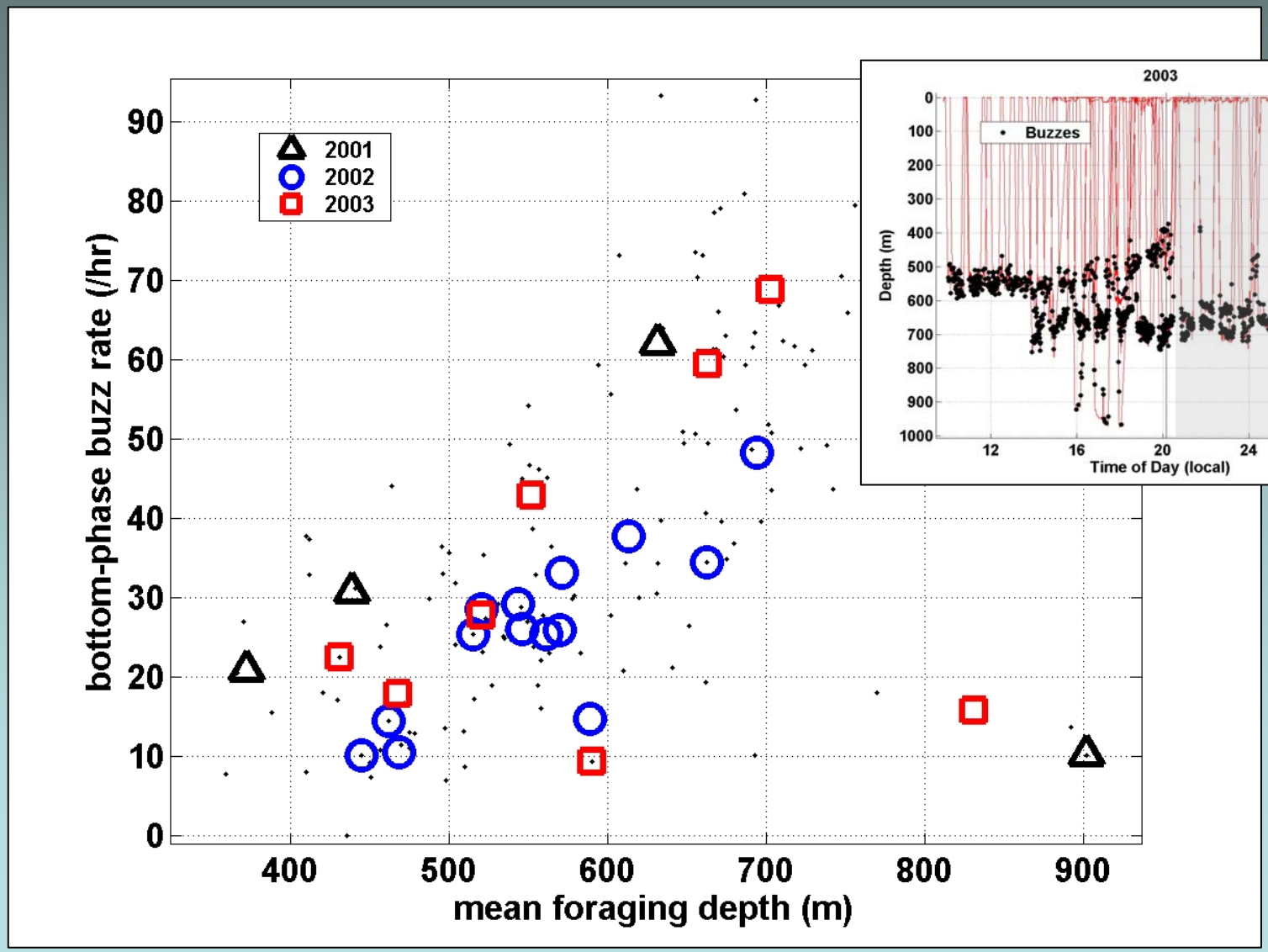








Sperm Whale Foraging: Capture-Buzzes Increase with Depth



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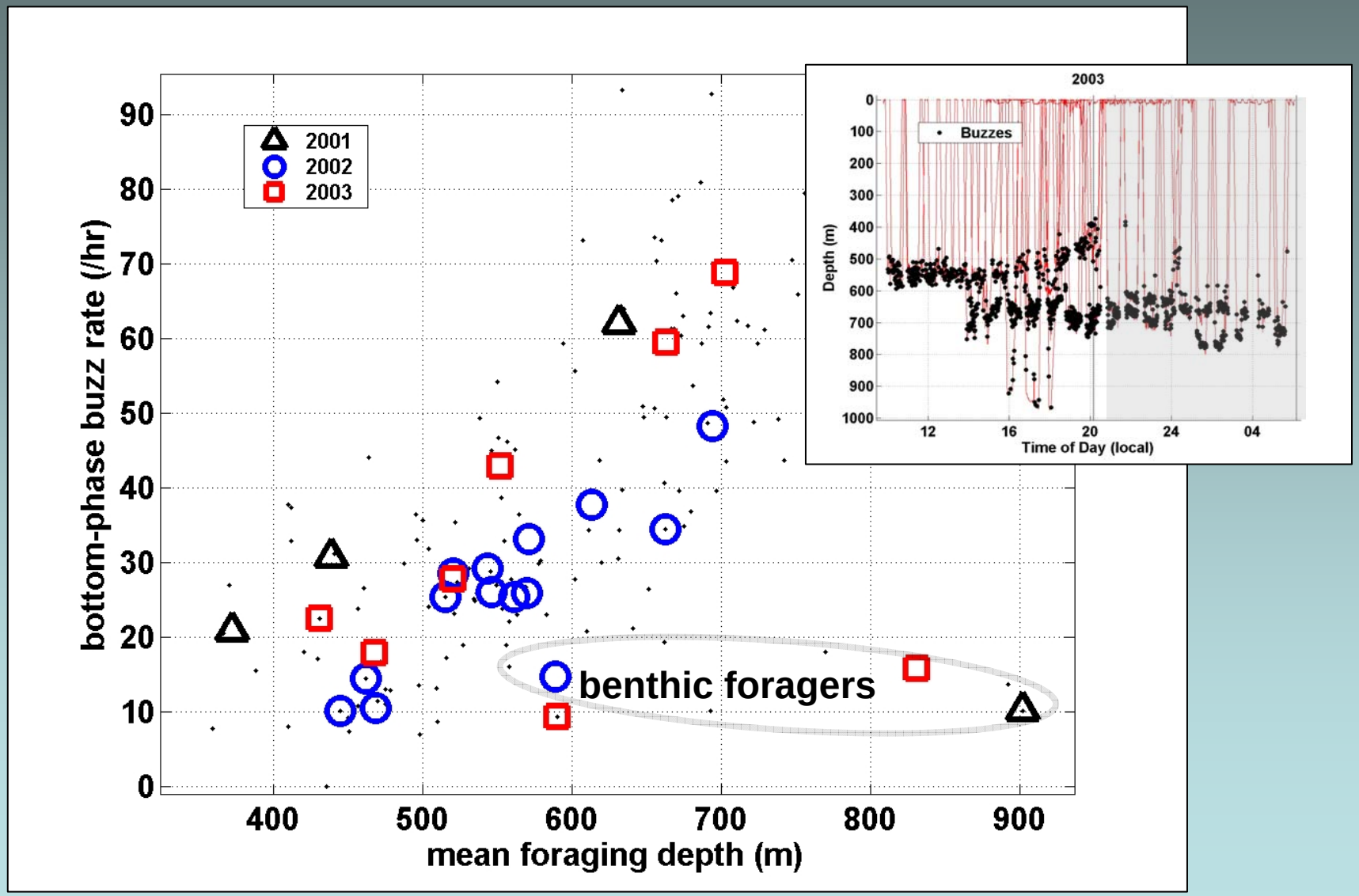


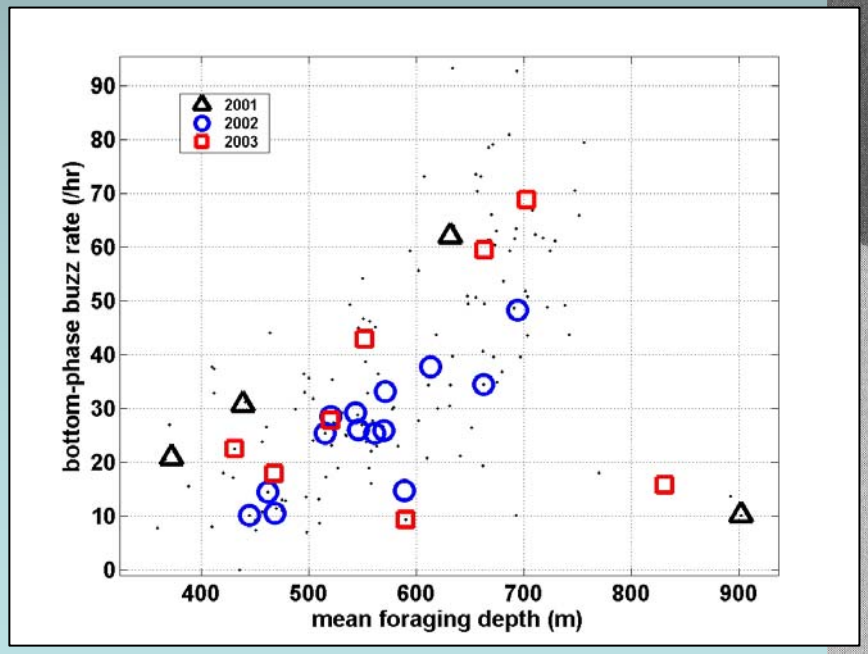
Squid prey of Sperm Whales:

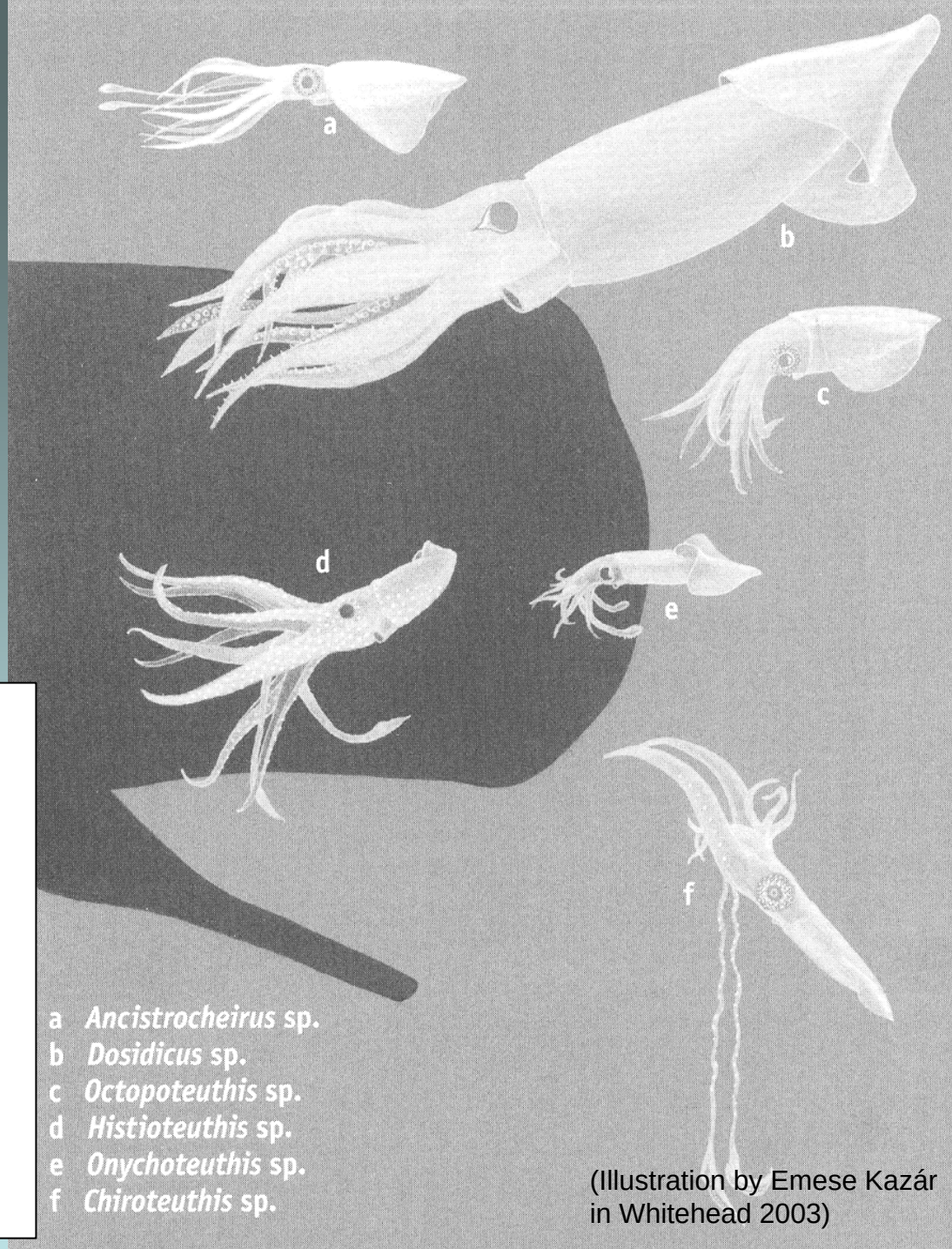
- diverse in time
- diverse in space

Estimate:

Whales need to eat ~3% of body weight per day

(Lockyer 1981)

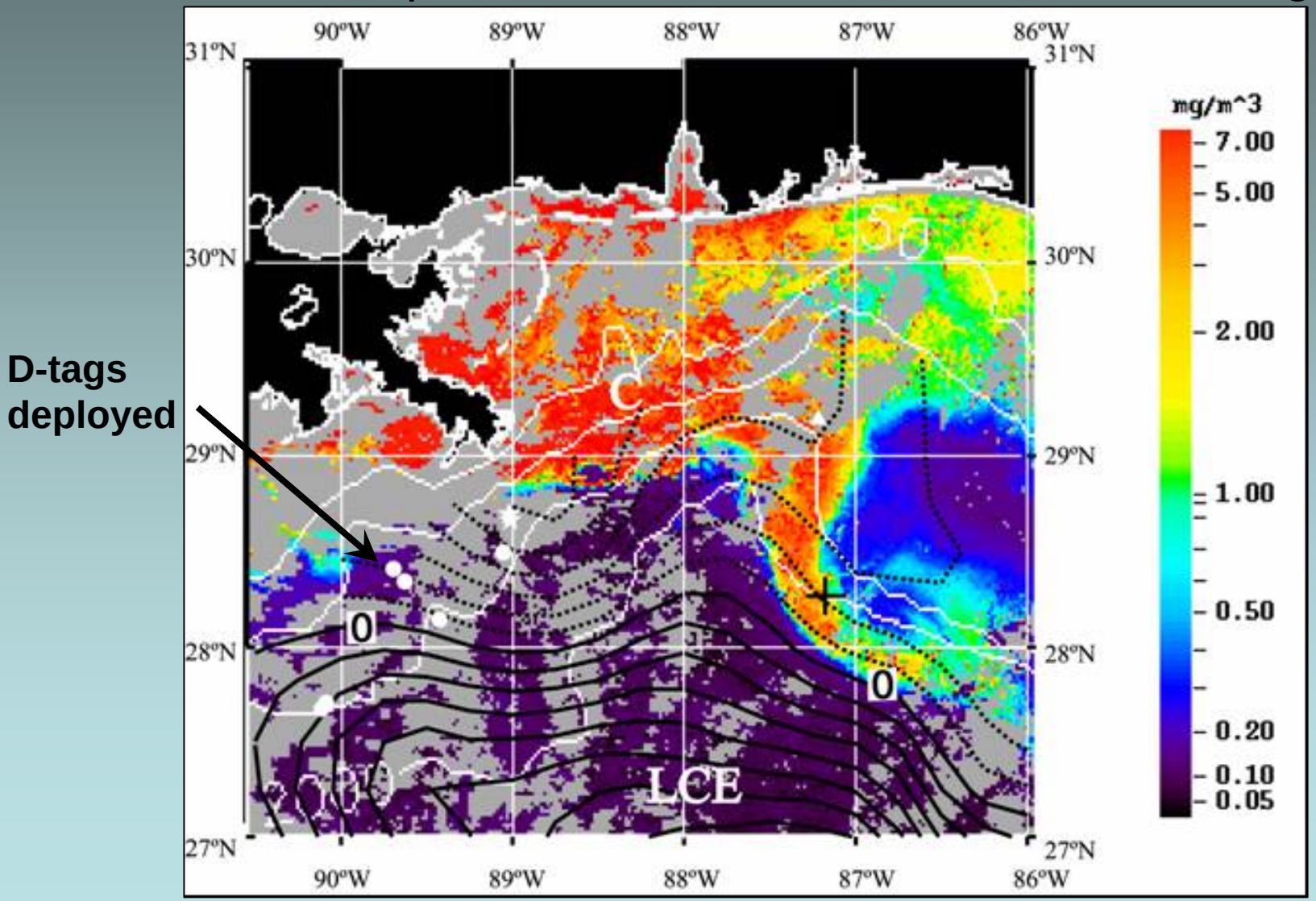




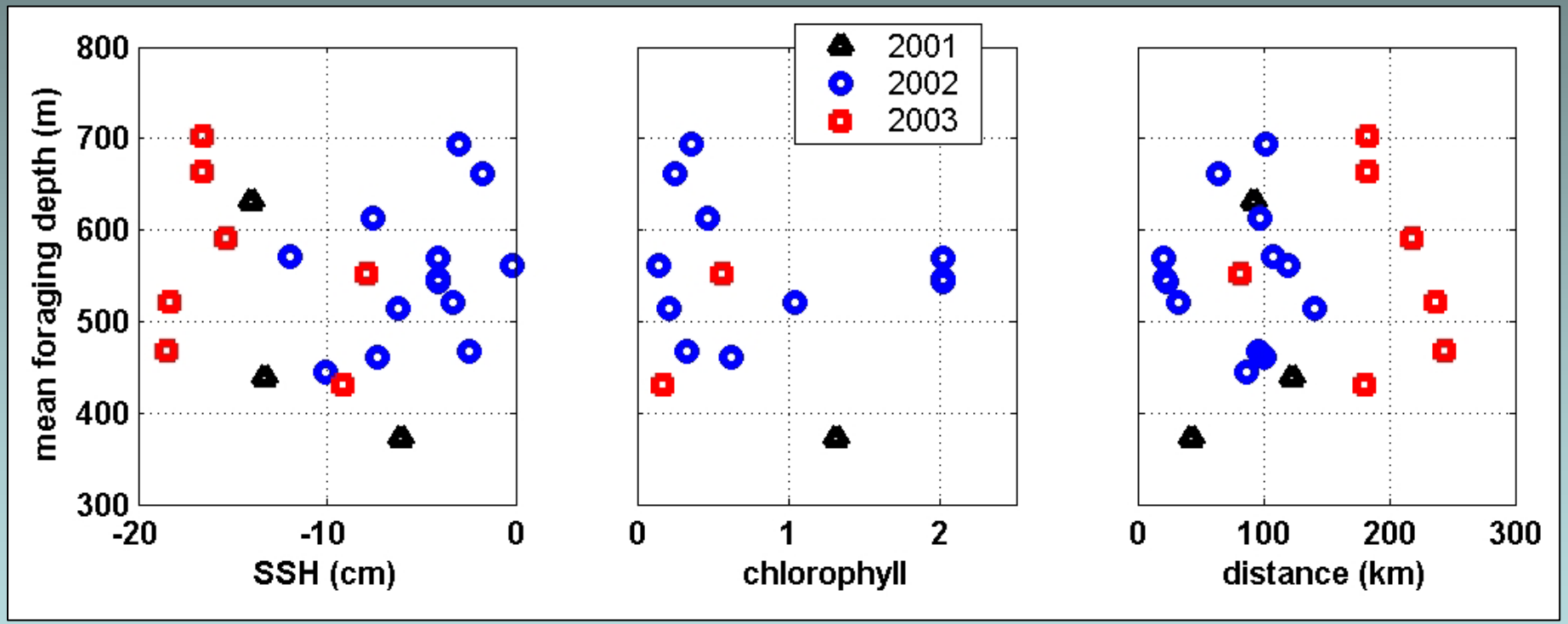
(Illustration by Emese Kazár in Whitehead 2003)

Is Diving Related to Surface Oceanography?

Once week composite centered on 14 June 2003, D-tag cruise



Is Diving Related to Surface Oceanography? — no evidence so far…



– benthic foraging whales not included

Conclusions

Sperm whales in the Gulf of Mexico forage at various depths

1) within diel-migrating Deep-Scattering Layer
2) below Deep-Scattering Layer (buzz rates increase)
3) benthic foraging by large males (larger prey items?)

Choice of depth to feed is likely dynamic. We recommend research to obtain information re. the prey at various depths during tag deployments.

Sperm whale diving not predicted by surface oceanography.

Sea-surface height, chlorophyll and distance from offshore flow blooms do not correlate with dive depth.

But, D-tagged whales already selected their location likely based on prey conditions. Perhaps migration movements are more closely linked to oceanography?

Acknowledgments

Mark Johnson for D-tag development and use, PI **Peter Tyack**, ship and science crews of SWAMP and SWSS cruises. Staff of **IAGC**, **LDEO**, **MMS**, **NOAA**, **TAMU**, and **WHOI**.

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The Woods Hole Oceanographic Institution Animal Care Use Committee approved this research.

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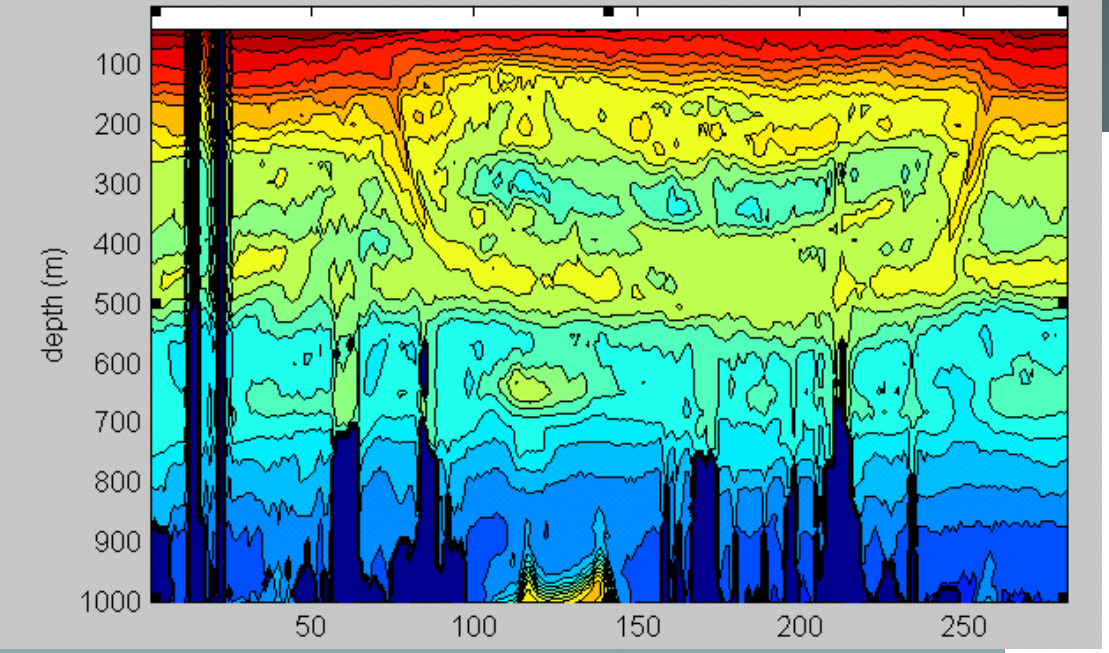

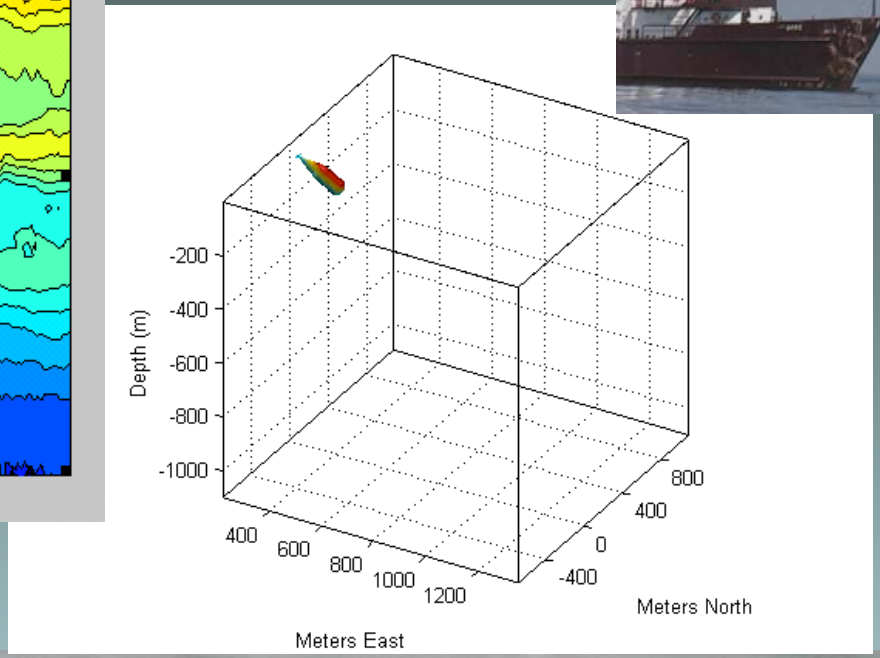

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