Oasis or dead zone in the open ocean?

Zooplankton distribution and migration in low-oxygen modewater eddies

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Motivation

$O_2 \, (\mu\text{mol kg}^{-1}) \text{ on } \Sigma-0 = 26.4 \, \text{kg m}^{-3}$

Cape Verde Ocean Observatory (CVOO)

www.sfb754.de
Motivation

**Oxygen [µmol kg**^{-1}]**

- O$_2$ past deployment
- O$_2$ recent deployment (telemetered)

40-60m O$_2$

300kHz ADCP at 65-70m

Karstensen et al., *Biogeosciences* 2015
Methods: Remote survey

- **mean SLA**
- **mean SST**
- **mean Chl-a**

Distance from Eddy center:

-150 -100 -50 0 50 100 150

Distance from Eddy center:

-150 -100 -50 0 50 100 150

Latitude:

16°N 17°N 18°N 19°N 20°N 21°N

Longitude:

15°W 18°W 21°W 24°W 27°W

Depth [m]:

0 25 50 75 100 150 200

Oxygen [µmol kg⁻¹]:

0 25 50 75 100 150 200
Methods: Site survey

- Shipboard ADCP (75kHz)
- CTD with UVP (Underwater Vision Profiler 5)
- Multinet (200µm, 5 nets)
Methods: Site survey – Multinet and UVP5

- Copepod
- Euphausiid
- Rhizaria
- Trichodesmium sp.
- Marine snow
- Gelatinous plankton

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Materials & Methods: Site survey

- **D Haul**
- **Eddy core**
- **N Haul**
- **Eddy margin**
- **D/N Haul**
- **Outside Eddy (CVOO)**

![Diagram showing the location of sampling sites in relation to an eddy.](Image)

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Results I: Shipboard ADCP section through the eddy

(a) Ship track and location of CVS

(b) ADCP data with "normal" situation and eddy situation

Mar 18 21 00 03 06 09 12 15 18 21 00 03 06 09

"normal" situation

Eddy situation

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Results II: UVP5 section through the eddy

Aggregates

Oxygen (μmol kg⁻¹)

Abundance (ind m⁻³)

Distance to Core (km)

Pressure (dbar)

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Results II: UVP5 section through the eddy

Copepods

Oxygen (µmol kg⁻¹)

Abundance (ind m⁻³)

Pressure (dbar)

Distance to Core (km)

Outside Eddy (n=7)
- mean abundance (±SD)
- Oxygen

Eddy Core (n=4)
- mean abundance (±SD)
- Oxygen
Results II: UVP5 section through the eddy

Collodaria

Oxygen (µmol kg⁻¹)  Abundance (ind m⁻³)

Pressure (dbar)

Distance to Core (km)

Outside Eddy (n=7)

mean abundance (±SD)

Eddy Core (n=4)

mean abundance (±SD)

Oxygen

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Results II: UVP5 section through the eddy

Jellies

- Oxygen (µmol kg⁻¹)
- Abundance (ind m⁻³)

Pressure (dbar)

Distance to Core (km)

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Results II: UVP5 section through the eddy

Euphausiids & Decapods

Oxygen (μmol kg⁻¹)

Positive observations:
- Eddy Core
- Outside Eddy

Pressure (dbar)

Distance to Core (km)
Results III: Multinet section through the eddy

Foraminifera

Calanoid copepods

Euphasiids

Siphonophora
Results III: Multinet section through the eddy

Foraminifera

Calanoid copepods

Euphausiids

Siphonophora
Results III: Multinet section through the eddy
Results III: Multinet section through the eddy

- **Oncaea sp**
- **Eucalanidae**
- **Polychaeta**
- **Ostracoda**

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Results III: Multinet section through the eddy

Polychaeta

Oncaea sp

Eucalanidae

Ostracoda

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Results III: Multinet section through the eddy

![Graph showing Abundance (ind m$^{-3}$) and Oxygen (µmol kg$^{-1}$) profiles across different pressure levels and distance to core (km).]
5-day average; $O_2$ 5-20\,µmol kg$^{-1}$

7-day average; $O_2$ 20-50 \,µmol kg$^{-1}$

54-day average; $O_2$ 100 to 250 \,µmol kg$^{-1}$
Strategies

1. OMZ avoidance / compression at the surface

2. Migration into shallow OMZ core during daytime, but paying O2 debt at the surface at nighttime

3. Permanently residing in the shallow OMZ day and night

4. DVM through the shallow OMZ from deeper oxygenated depths to the surface and back
Outlook

Cyclonic Eddies \((n=10)\)

Anticyclonic Mode Water Eddies \((n=17)\)

Schütte et al., *Biogeosciences Discussions* 2016
Thanks!

The „Starry Night“, Van Gogh 1889

„Our Perpetual Ocean“, NASA 2012