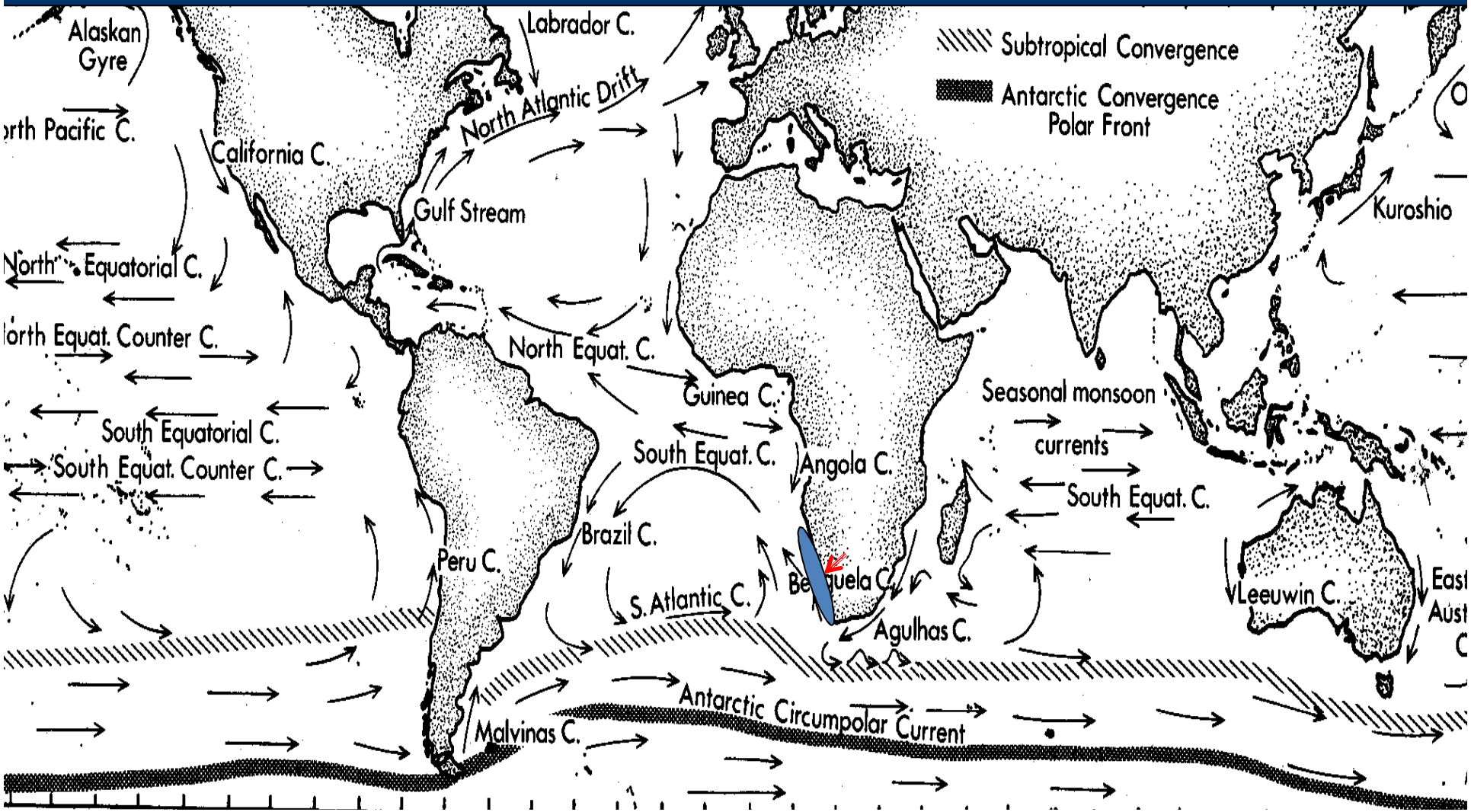
Overview of phytoplankton along the Namibian coast

Bronwen Currie

Deon Louw, Anja van der Plas, Chris Bartholomae, Richard Gaeb, Jan Gei-Khaub, Kathie Peard

1. Upwelling system
2. Productivity
3. Species
4. ? Change

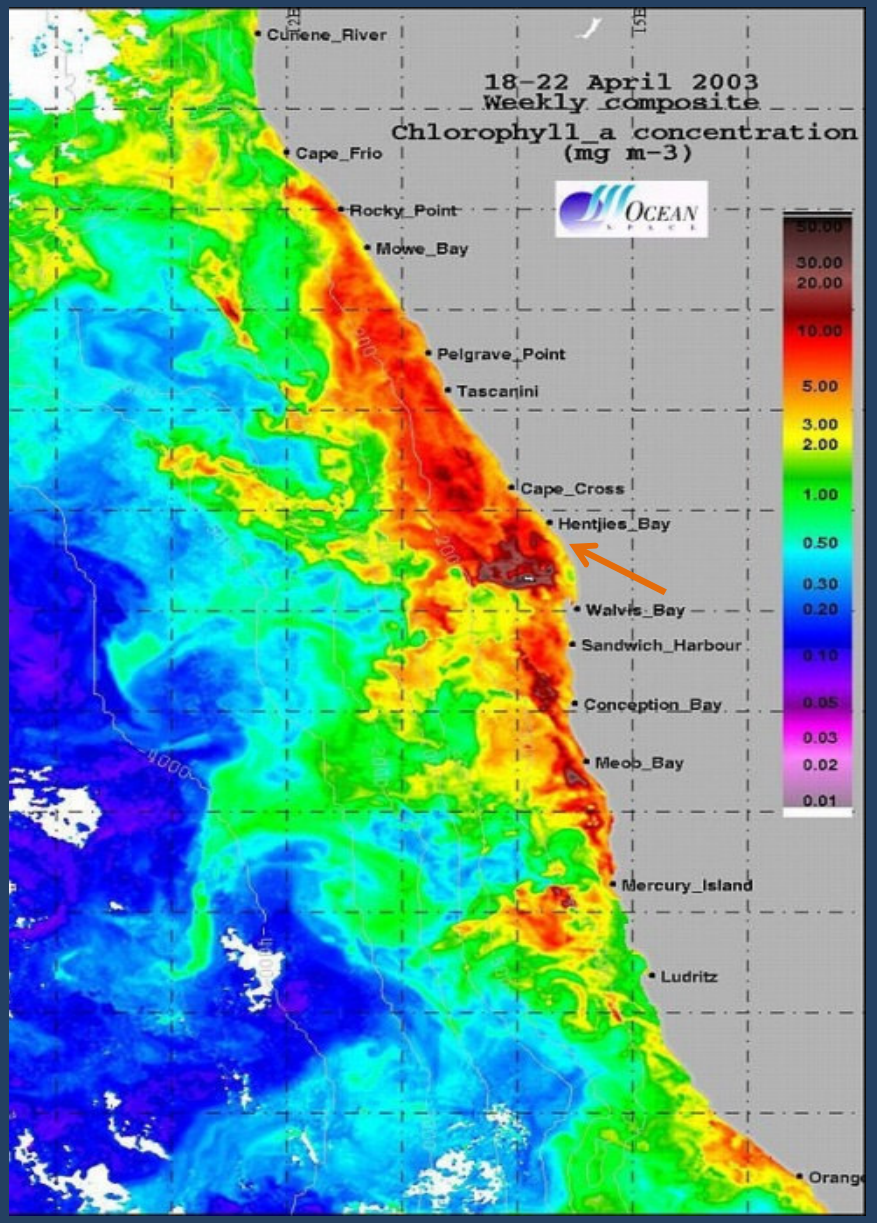
The Benguela Upwelling System
- Boundary upwelling system spanning South Africa, Namibia and Angola



The Benguela upwelling system is one of the major eastern boundary upwelling systems.

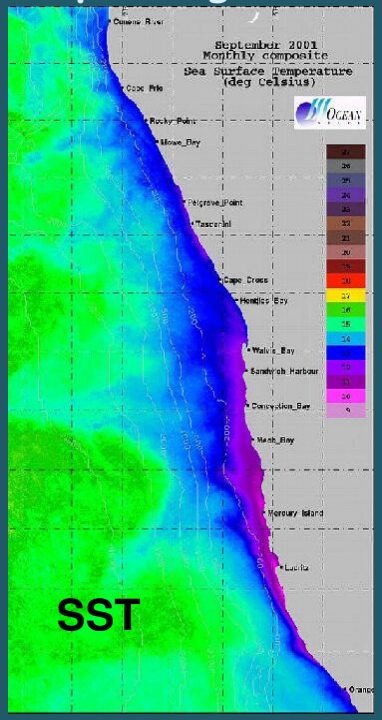
Perennial wind-driven coastal upwelling provides a continual supply of nutrients to fuel primary production.

Phytoplankton production is particularly intense along Namibia's central coastal region.

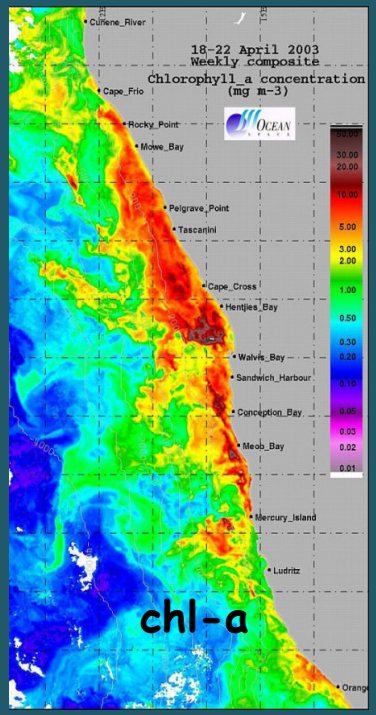


The northern Benguela along the Namibian coast provides:

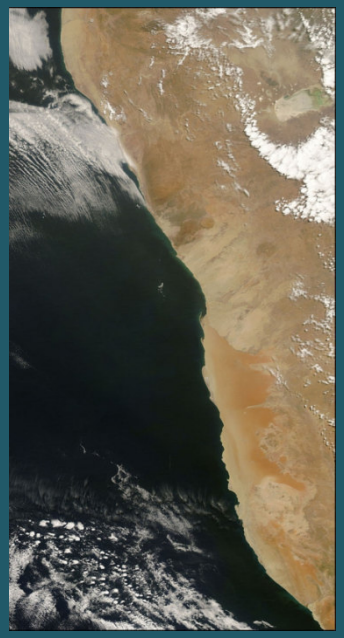
Upwelling



Phytoplankton



A high-energy desert coastline with no river runoff and a tiny coastal population



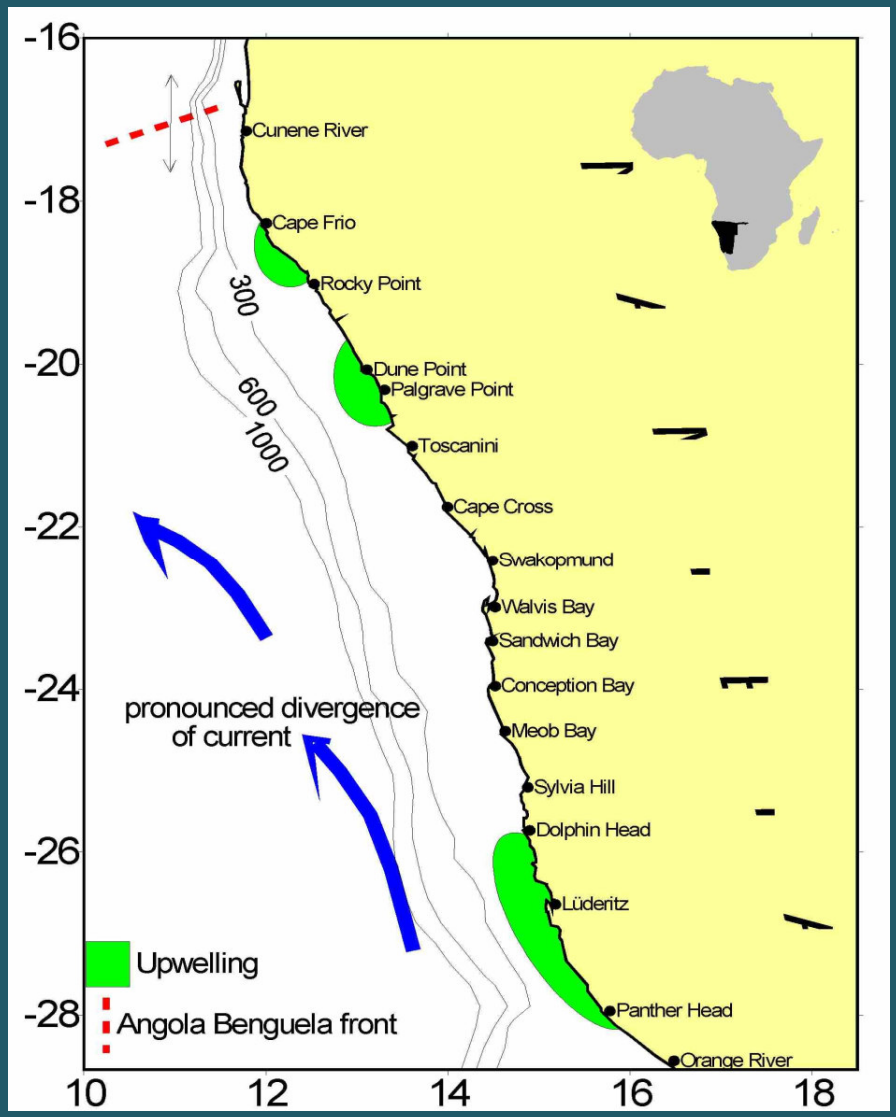
✓ upwelling nutrient rich water promoting abundant phytoplankton - high growth rates for filter feeders; year-round production

➢ unpolluted coastal waters

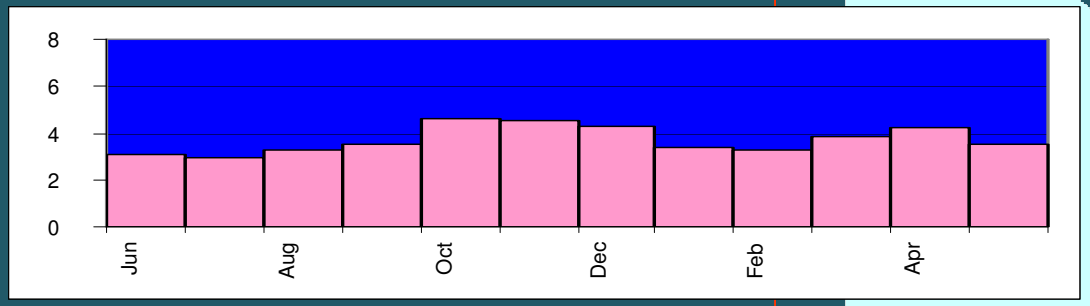
Longshore south-westerly winds drive upwelling of nutrient-rich water to the surface where primary production is maintained

Wind is **strongest** at recognized "cells".

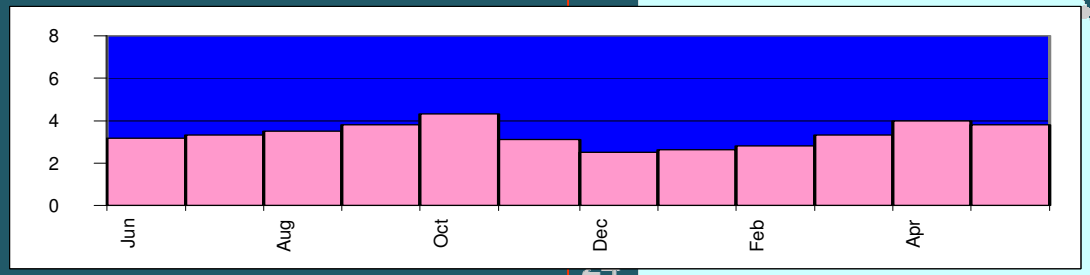
The Luderitz upwelling cell is considered to be the most powerful upwelling cell in the world



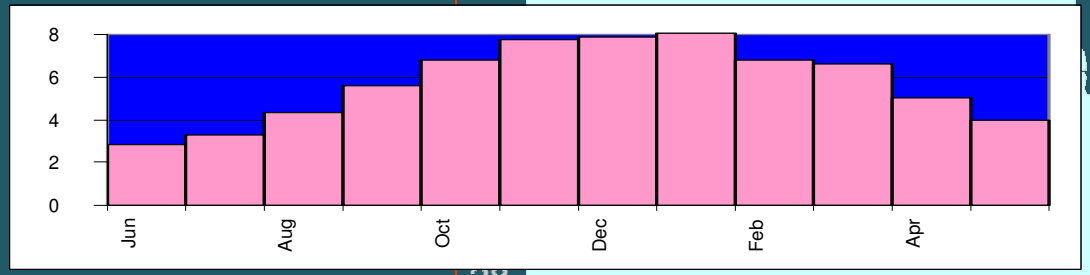
Wind data



South-North wind speed ms^{-1}



- analysed from the northern, central and southern coast of Namibia.



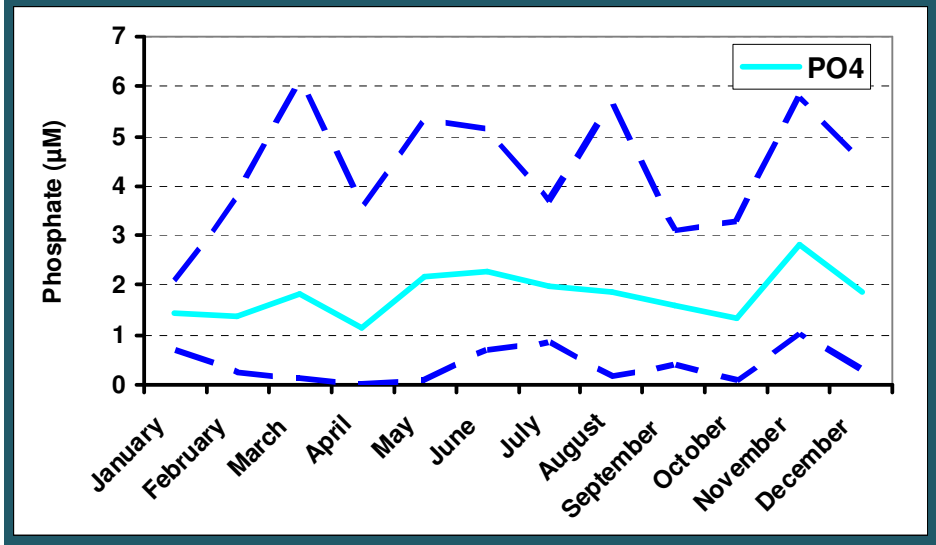
Kathie Peard

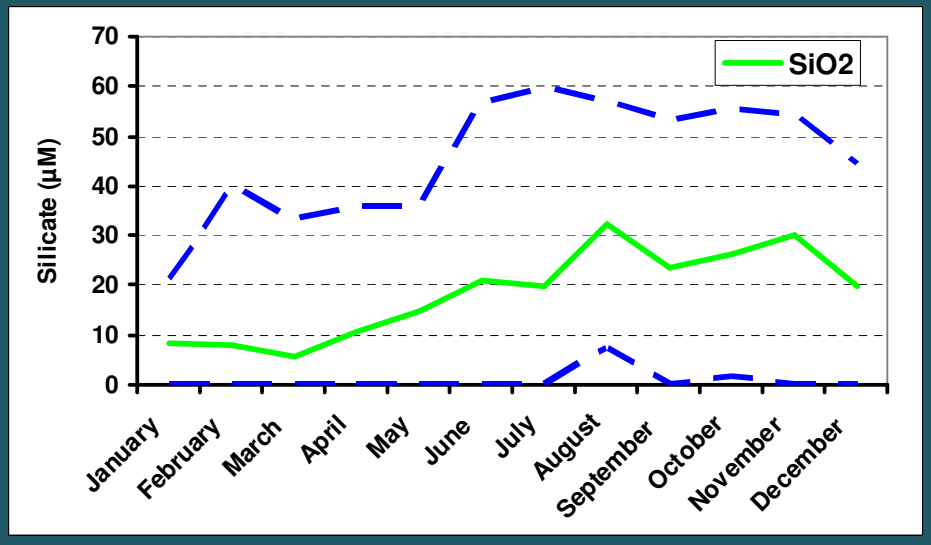
Nutrients

Area: 22°30 to 23°30S, 14°09E to coast
(2-10 nautical miles from coast)

Depth: Surface (+/-5m)

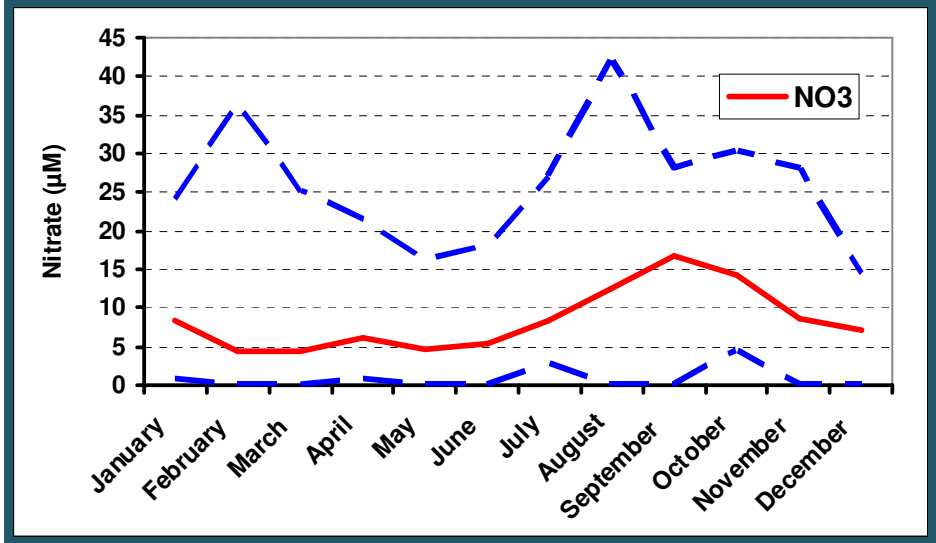
Period: 1990-2004

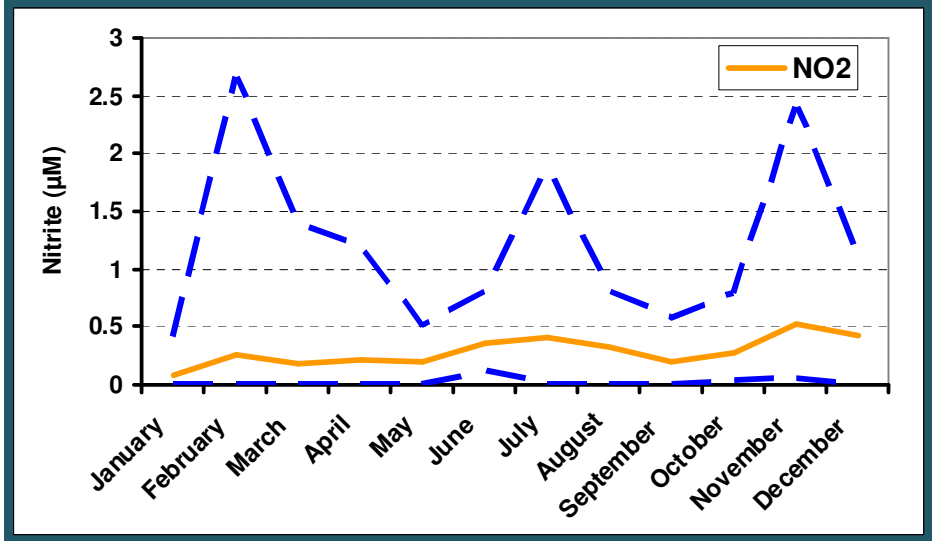




A.K. van der Plas

Nutrients cont.





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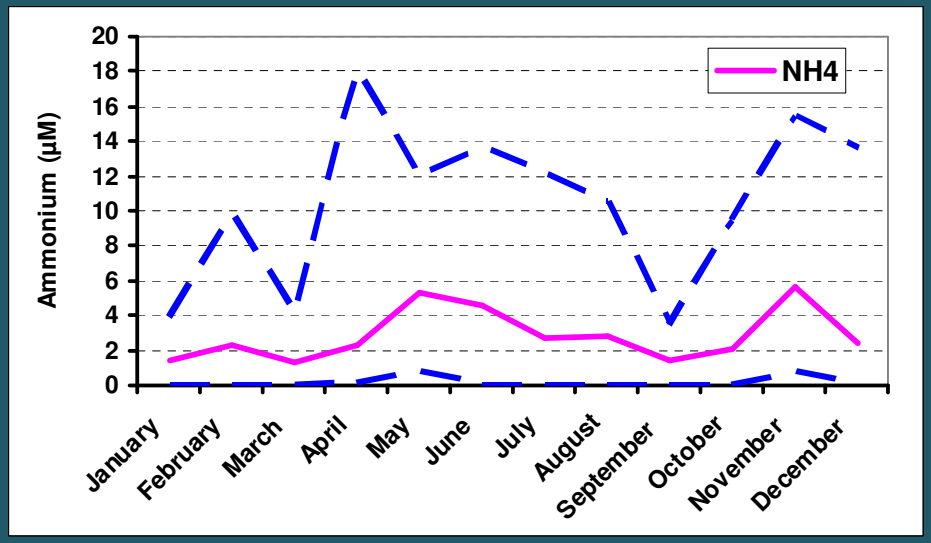
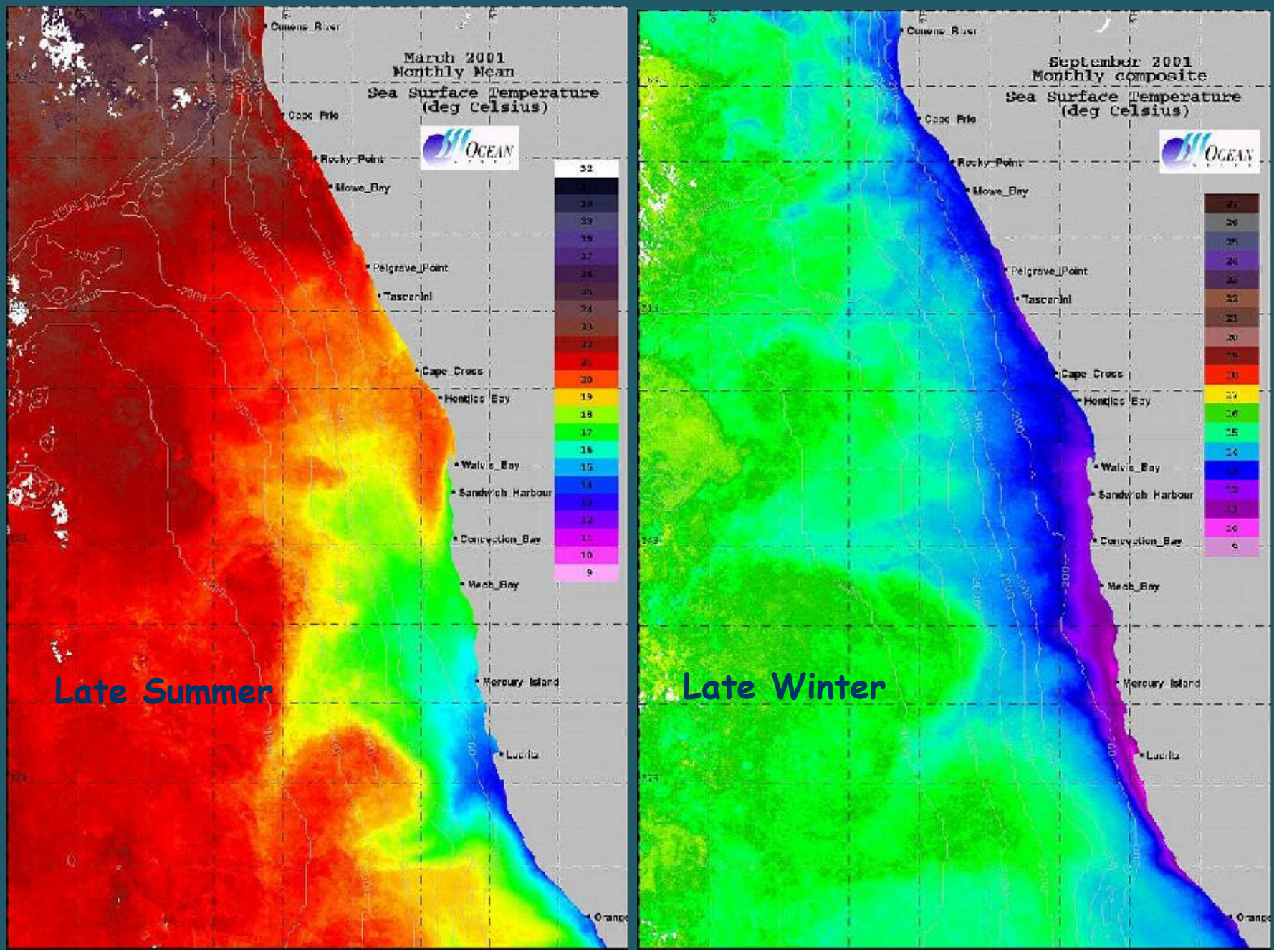
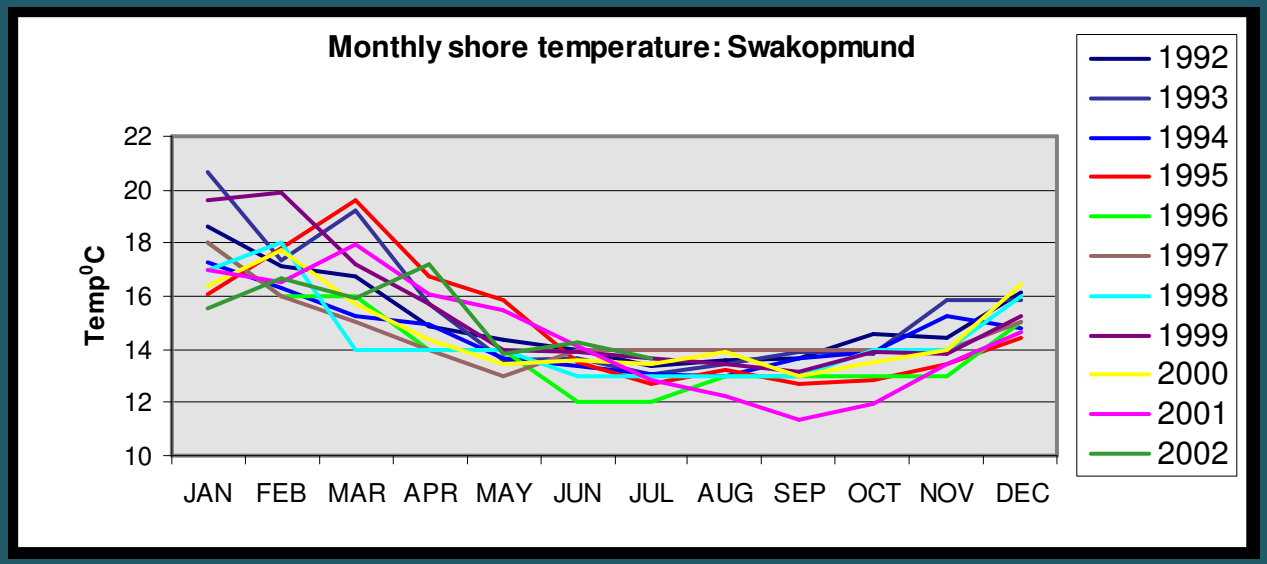
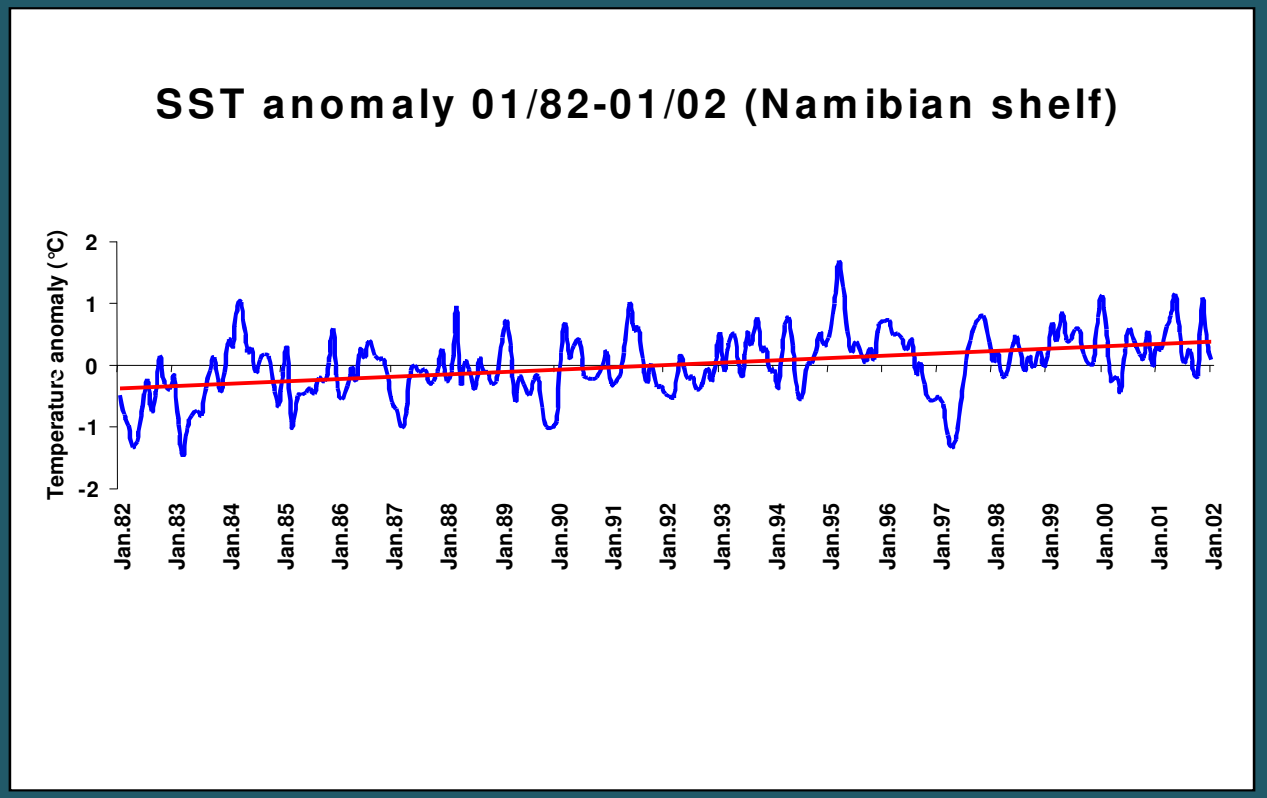


A.K. van der Plas

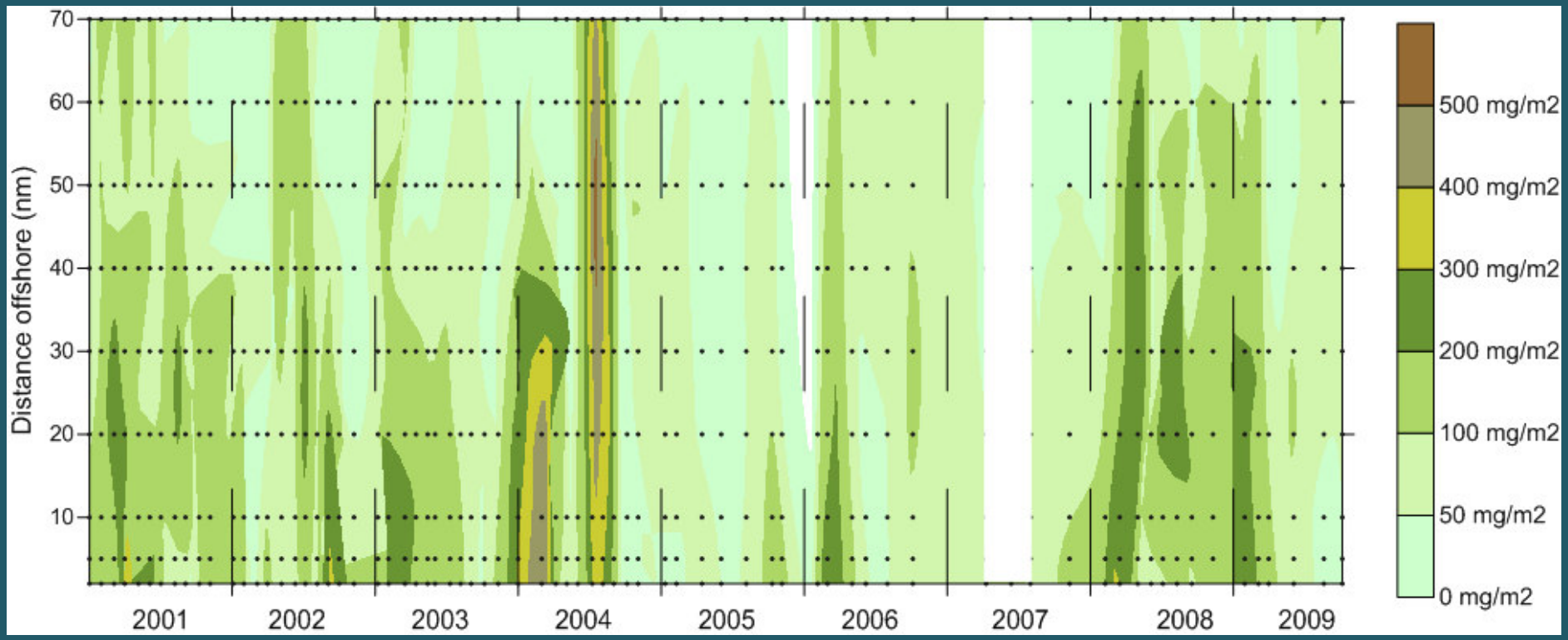
Wind-regulated seasonal differences (SST as proxy)




Monthly shore temperature: Swakopmund
Temp ^{0}C
22
20
18
16
14
12
10
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002

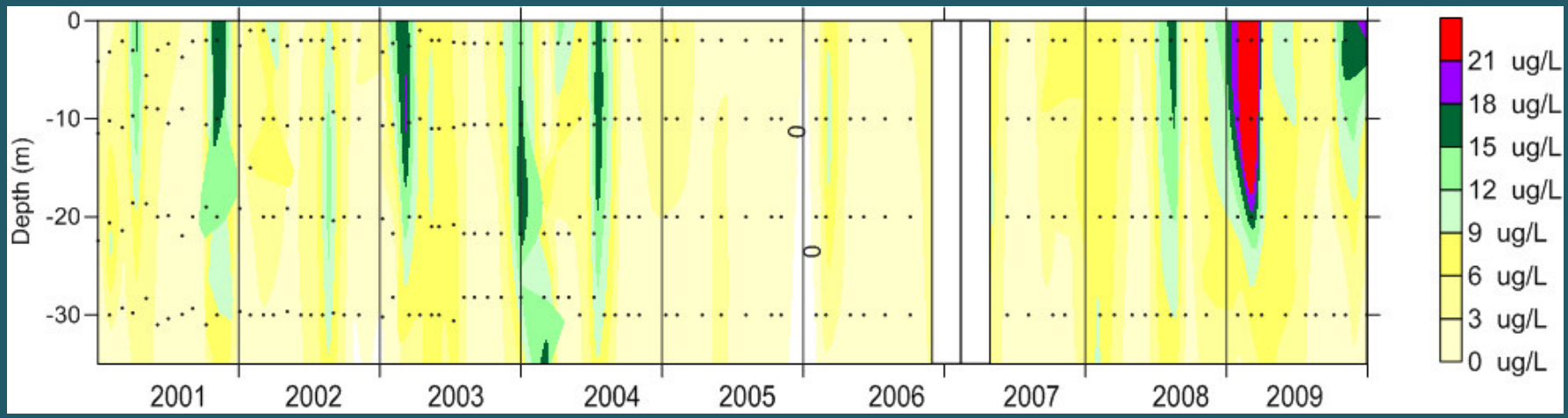

SST anomaly 01/82-01/02 (Namibian shelf)
Temperature anomaly (°C)
2
1
0
-1
-2
Jan.82
Jan.83
Jan.84
Jan.85
Jan.86
Jan.87
Jan.88
Jan.89
Jan.90
Jan.91
Jan.92
Jan.93
Jan.94
Jan.95
Jan.96
Jan.97
Jan.98
Jan.99
Jan.00
Jan.01
Jan.02

In-situ Chlorophyll-a [ ] 23° S Line



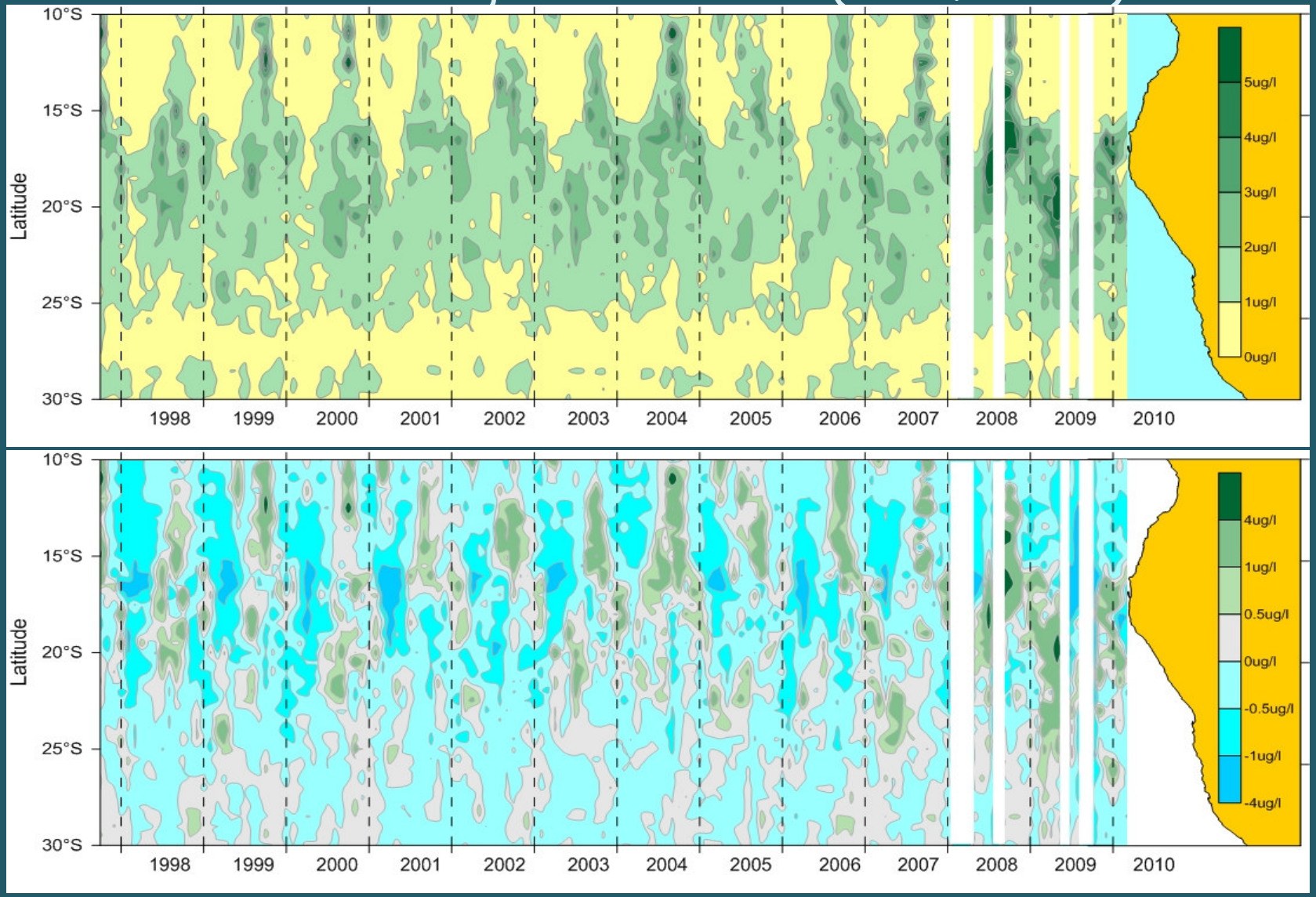
D.C.Louw

In-situ Chlorophyll-a [ ] at 10nm offshore, 23^0 S

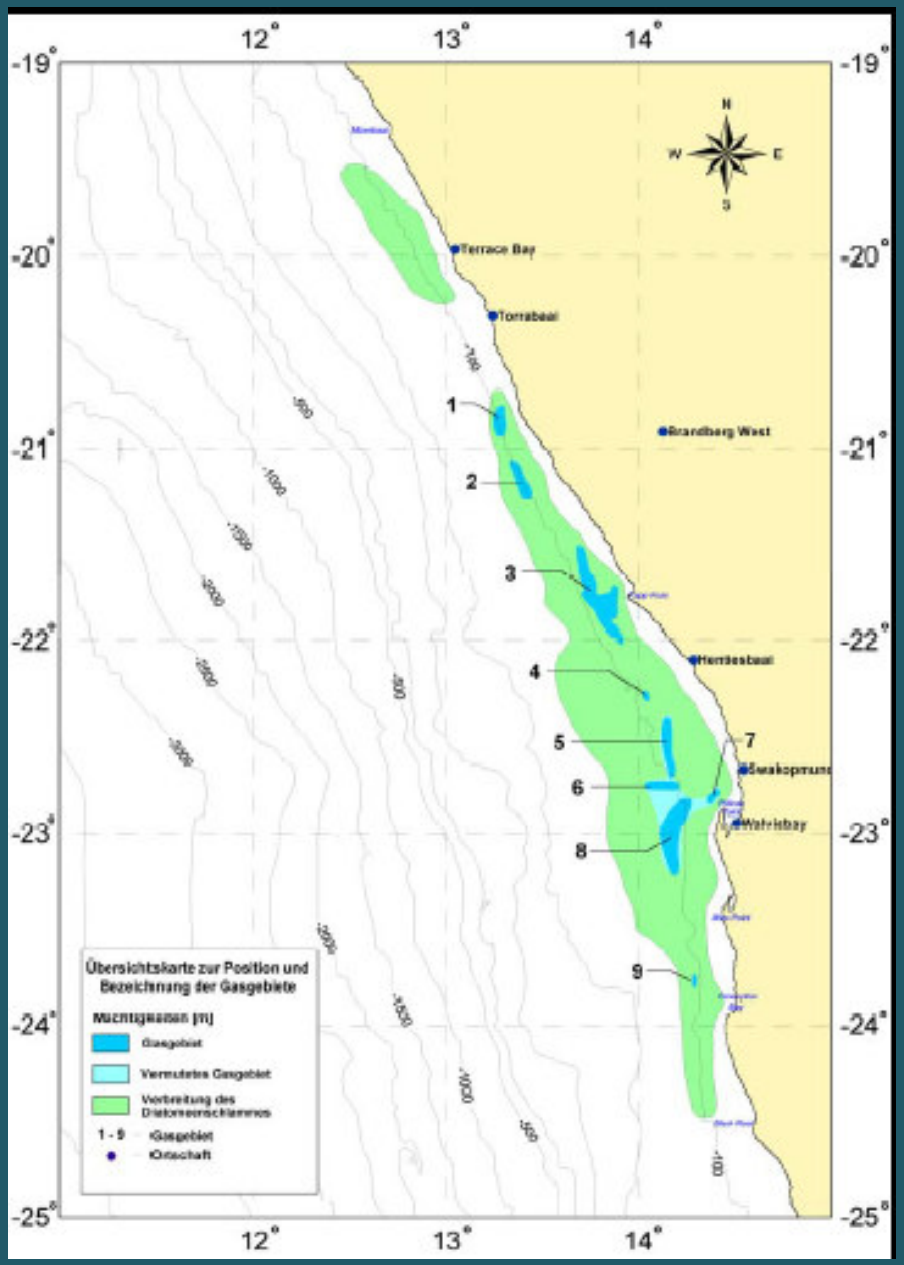


D.C.Louw

Surface chlorophyll (satellite): Monthly chl-a and anomalies along the Namibian and southern Angolan coastline (60km-band)



C Bartholomae



From Emeis et al 2004

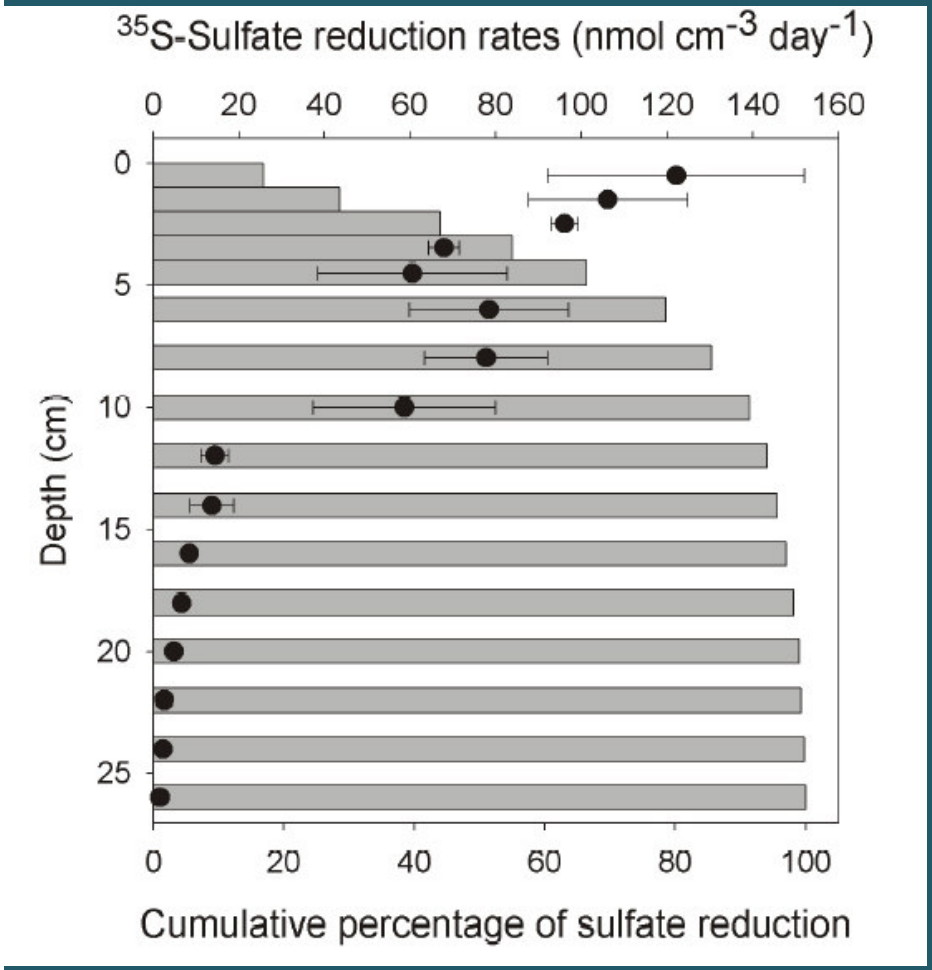
The excessive microalgal production along Namibia's coast falls to the seabottom where intense anaerobic decomposition takes place.

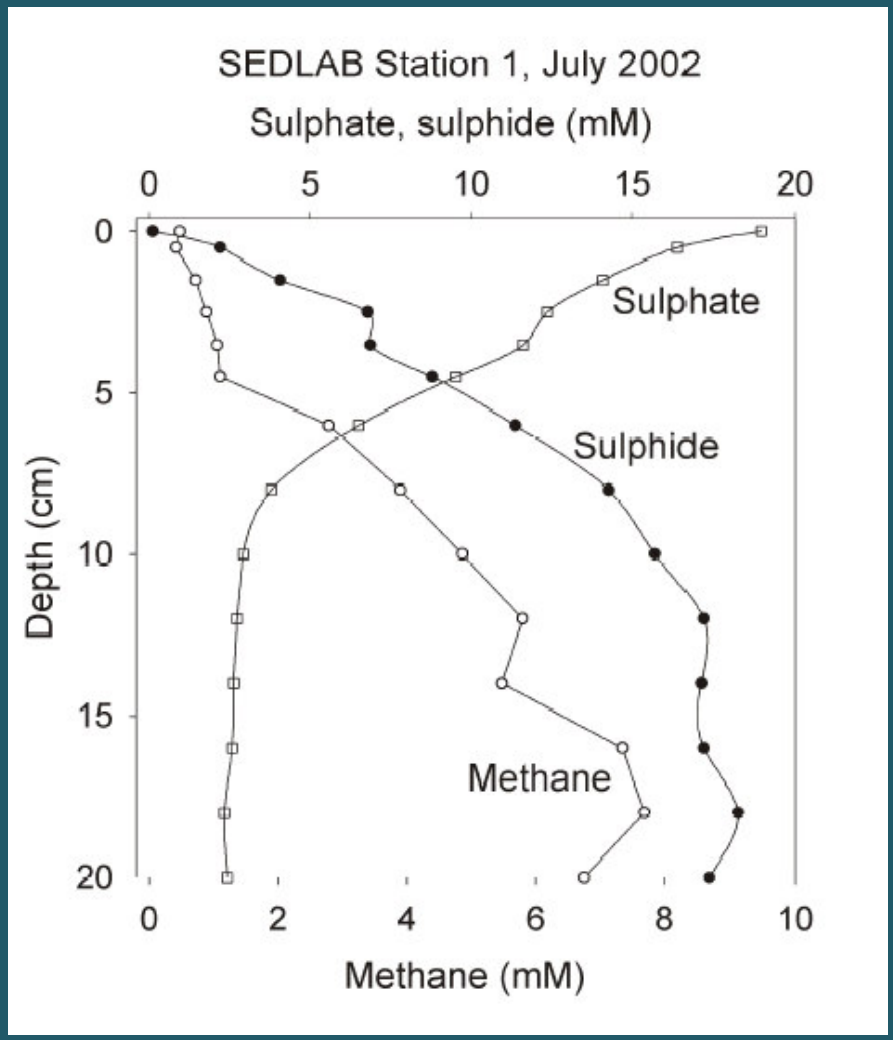
In the surface sediments hydrogen sulphide and methane are formed.

On occasion methane and hydrogen sulphide pervade the water – locally known as "sulphur eruptions"

Sediment Processes

1. Intense sulphate reduction in the top layer produces H_2S (2 – 22mM)
Methanogenesis with free methane gas occurs cm to m below the sediment surface

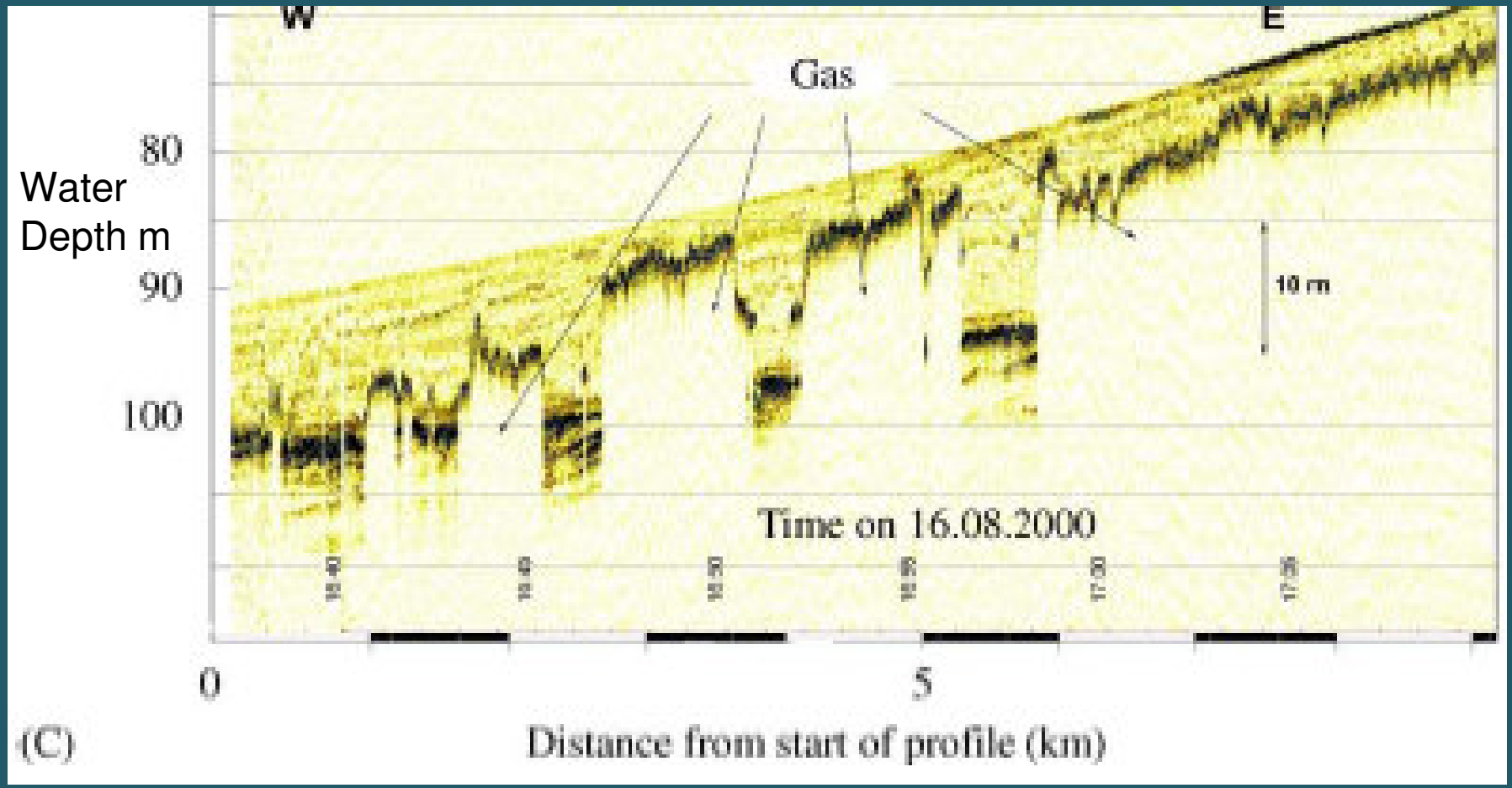




Bruchert et al., 2006

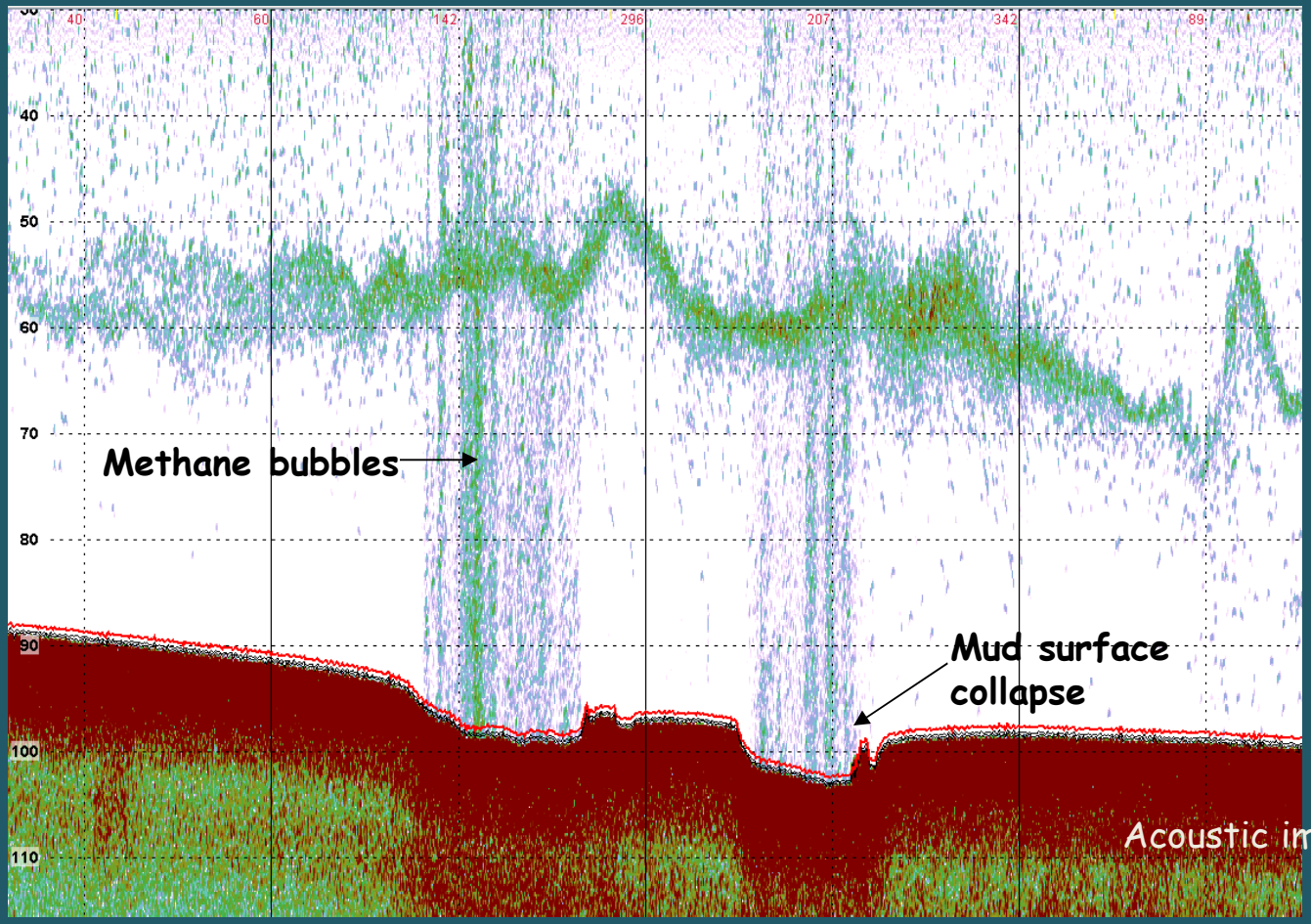
Methane gas in sediments

Parasound acoustic profiling of the sediments in 2000 showed free gas close to sediment surface



From Emeis et al., 2004
- RV Meteor 48/2 (2000)

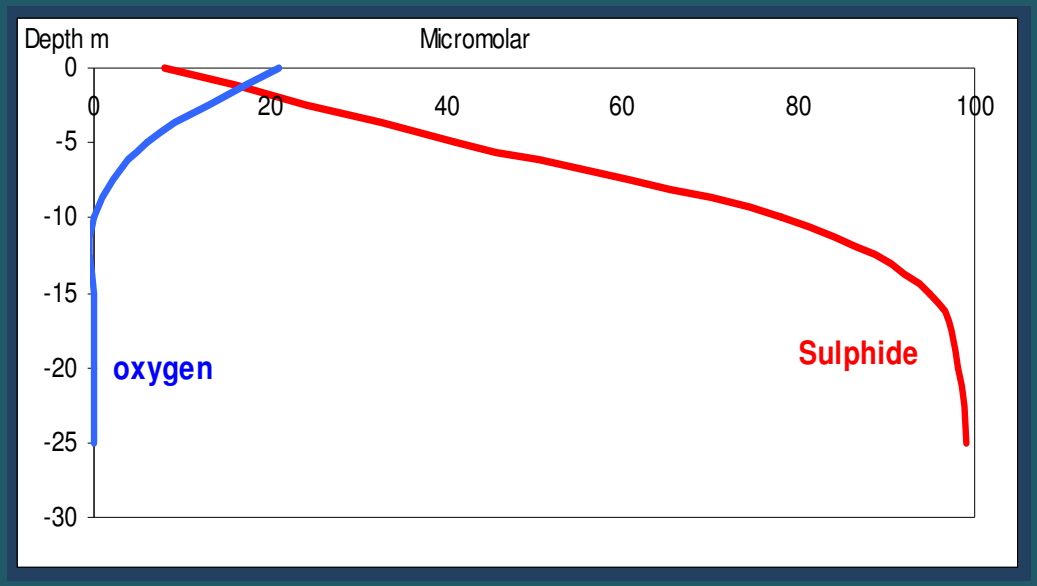
Outgassing of methane occurs on the inner shelf and is commonly observed:



e.g. 2008
RV *G.O.Sars*

Acoustic image: Stein Kaartvedt

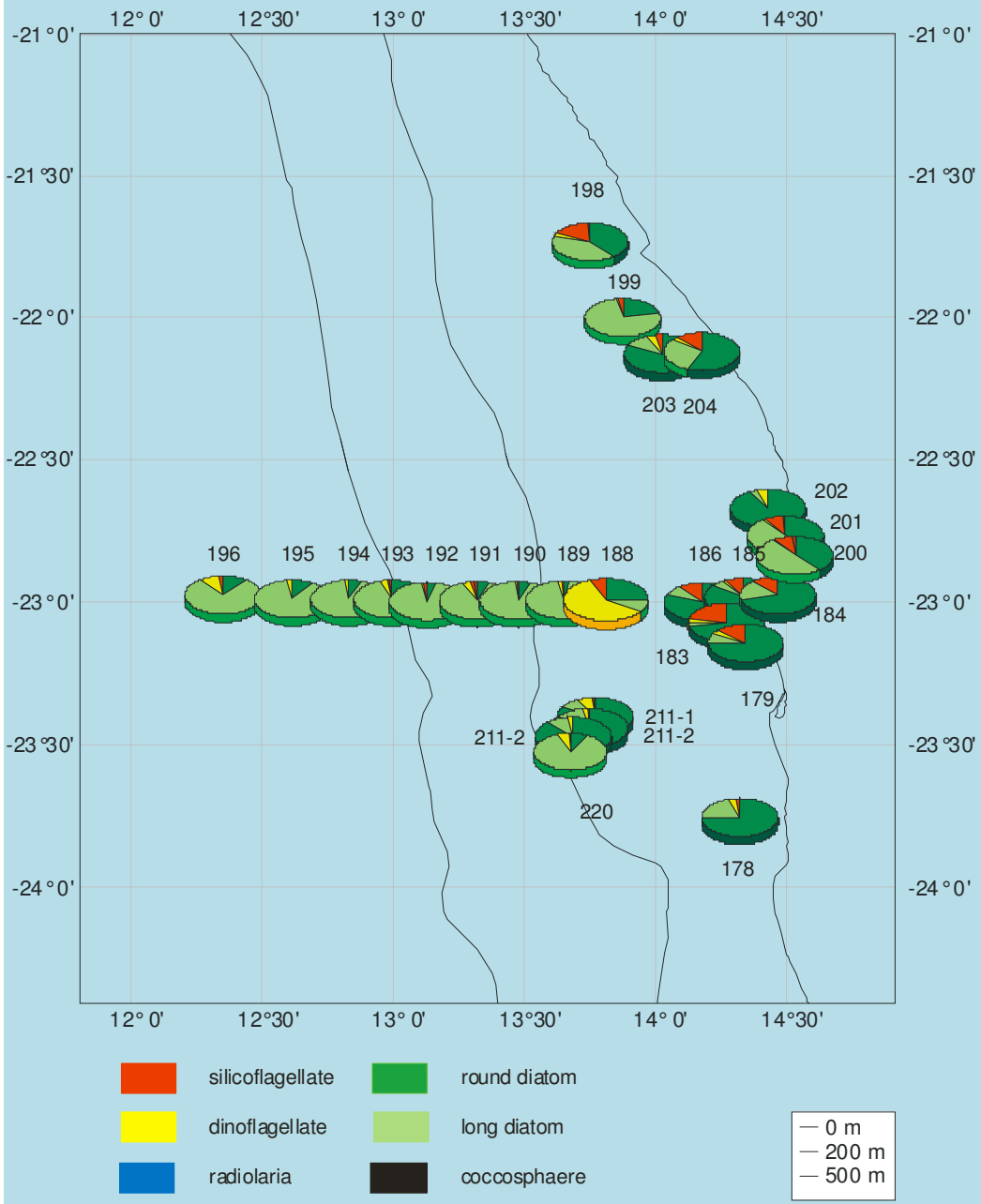
Sometimes, high concentrations of H_2S (>100 umol/L) from the sediment suddenly pervade the water column, with surface milky signature



Coastal event e.g. off Swakopmund 4 December 2001

22 June 2005

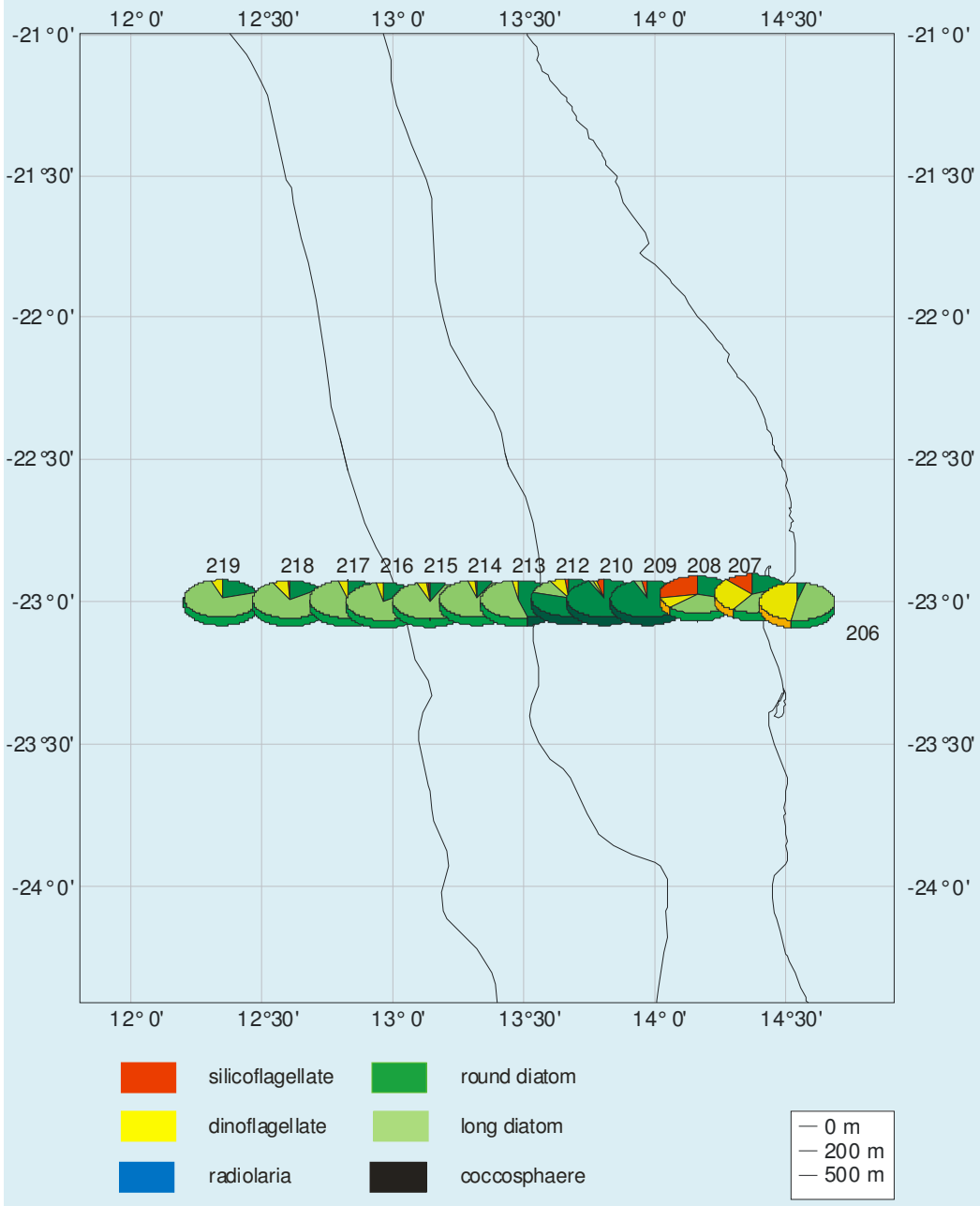
Weeks et al., 2002, 2004



2003 February
From cruise report R.V.Meteor M53

- Karin A.F. Zonneveld and Frank Bockelmann

(upwelling active)



2003 February
From cruise report R.V. Meteor M53

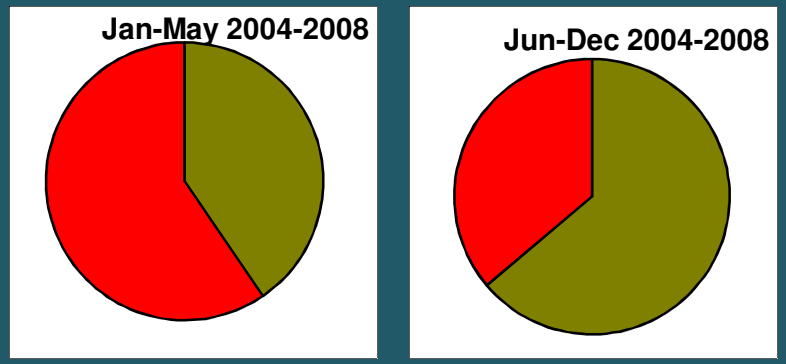
- Karin A.F. Zonneveld and Frank Bockelmann

(Relaxed upwelling)

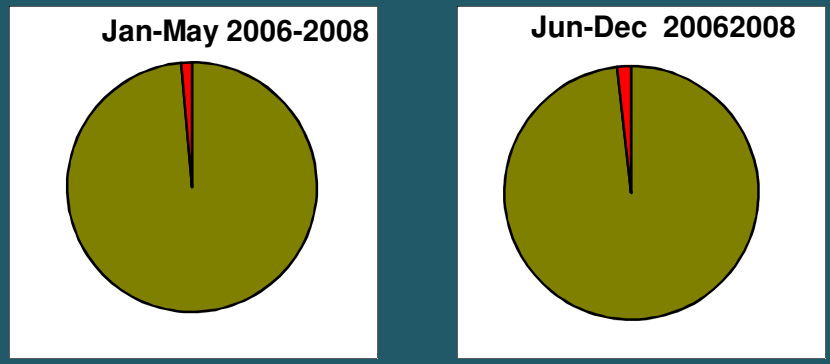
Composition of inshore microalgae

- Diatom-dominated (green)
- Dinoflagellate blooms more common in summer (red)

Central Swakopmund region



Southern Luderitz region



Most common species of diatoms and dinoflagellates

CENTRAL REGION	Southern LüDERITZ REGION
DIATOMS (in order of abundance)	
Thalasiosira anguste-lineata	***Navicula* sp.**
Skeletonema japonica	***Pleurosigma* spp.**
***Chaetoceros* spp.**	**Pennate *diatom* spp.**
Cylindrotheca closterium	***Skeletonema japonica***
Pseudo-nitzschia spp.	***Cosinodiscus* spp.**
***Navicula* sp.**	***Cylindrotheca closterium***
Rhizosolenia styliformis	***Pseudo-nitzschia* spp.**
***Cosinodiscus* spp.**	***Licmophora ehrenbergii***
Leptocylindrus daniscus	***Grammatophora marina***
DINOFLAGELLATES (in order of abundance)	
Heterocapsa ildefina	***Protoperidinium* spp.**
Heterosigma akashiwo	***Gyrodinium* sp.**
Karlodinium micrum	***Heterocapsa illdefina***
Scripsiella trochoidea	***Scripsiella trochoidea***
***Prorocentrum* sp.**	***Prorocentrum* sp.**
Prorocentrum cf. triestinum	***Prorocentrum micans***
***Protoperidinium* spp.**	***Dinophysis acuminata***
Gyrodinium sp.	***Dinophysis fortii***
Heterosigma akashiwo	***Alexandrium* sp.**
Ceratium furca	***Noctiluca scintillans***
Dinophysis acuminata	
Dinophysis fortii	
Noctiluca scintillans	

Inshore monitoring of phytoplankton is part of the mariculture monitoring programme. Land-based (jetty) and boat-base sampling is carried out by the mariculture staff

Henties Bay

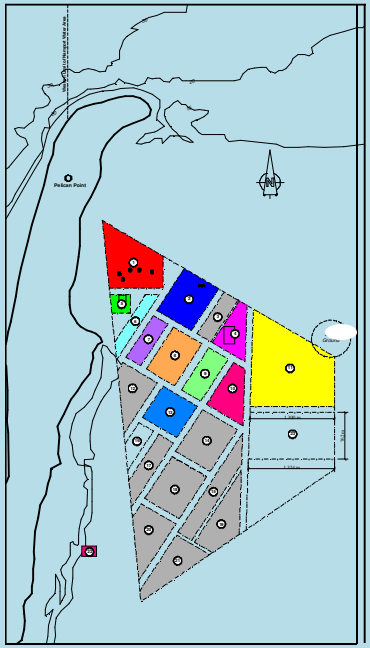
Swakopmund

Walvis Bay

Lüderitz

Orangemund

Walvis Bay Aquapark 1



Pacific oysters (*Crassostrea gigas*) European oysters (*Ostrea edulis*) and mussels are grown.

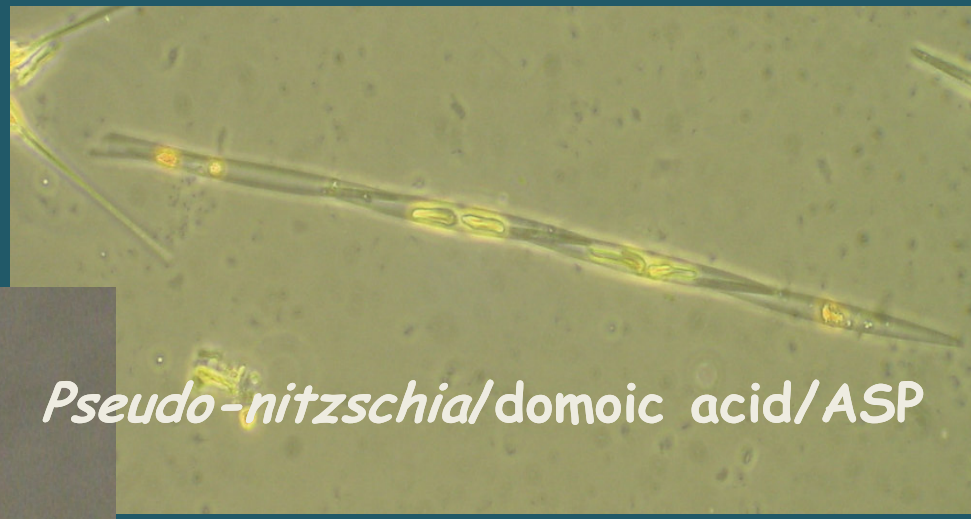
This capacity has been enhanced by the acquisition of a skiboat to monitor inshore water quality

The skiboat "Noctiluca" is used for the monitoring programme

Samples taken from the offshore Walvis Bay oyster farm areas

High Diversity of phytoplankton species off Namibia includes potentially toxic species

Alexandrium /saxitoxins/PSP

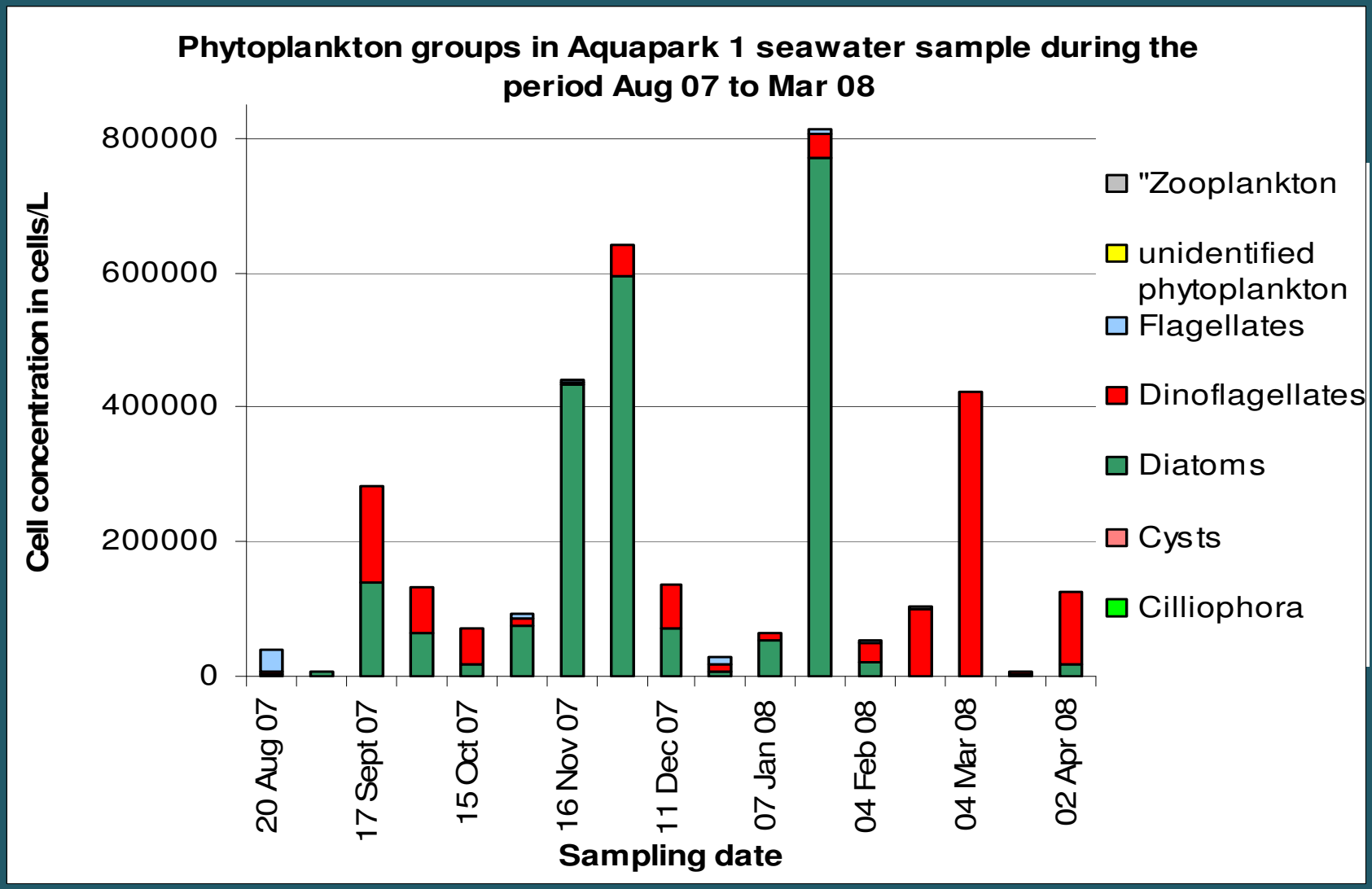


***Pseudo-nitzschia*/ domoic acid/ ASP**

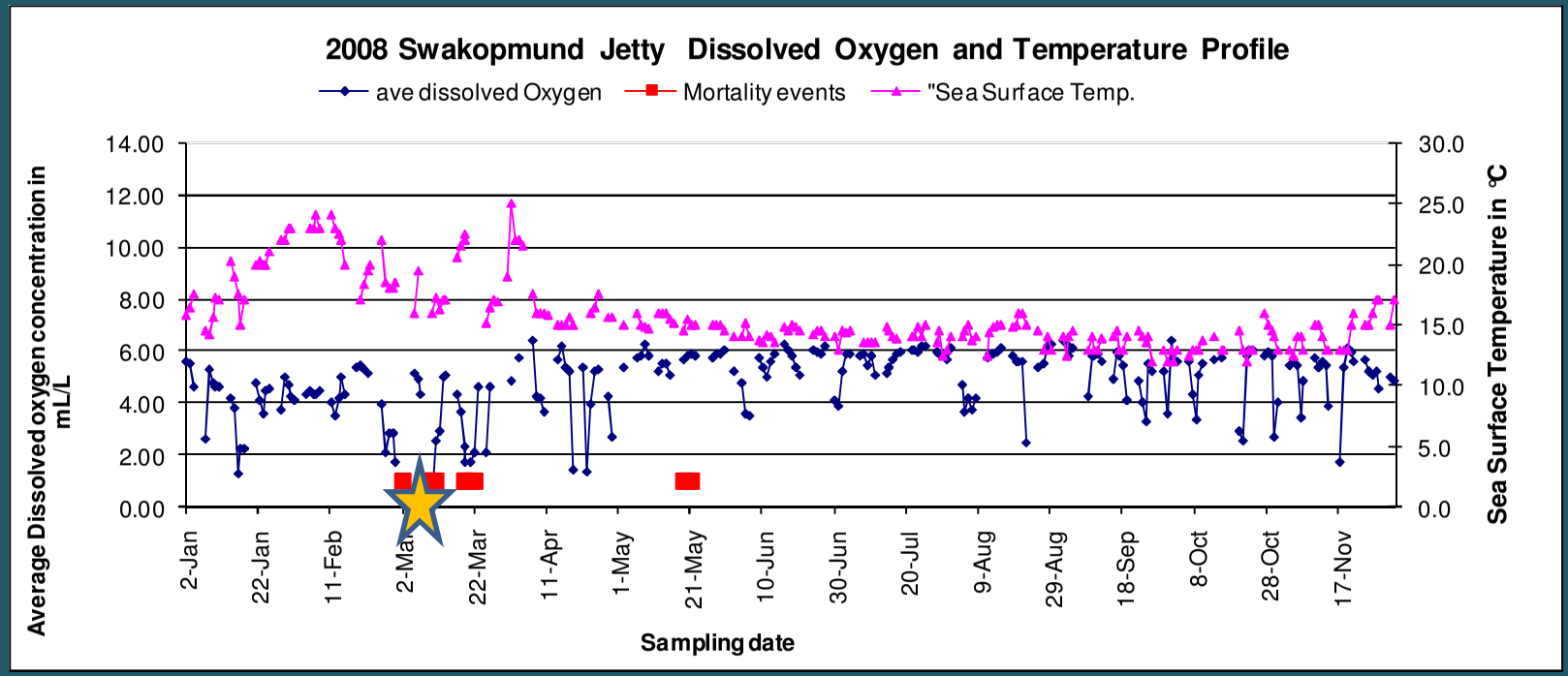
Dinophysis/ okadaic acid/DSP

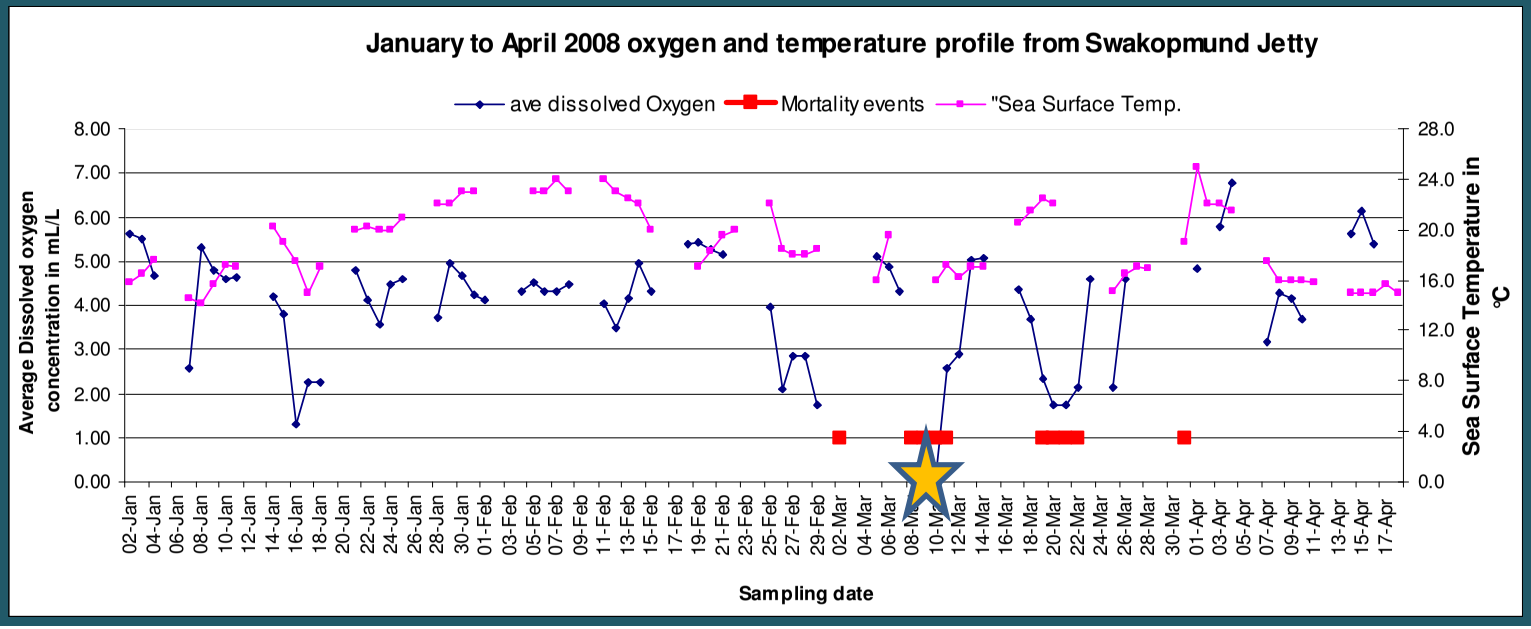
Photos Deon Louw

Recently summer conditions lead to in heavy dinoflagellate blooms
e.g. August 07 to April 08



Shore water showing the summer conditions in 2008 of high water temperature and low dissolved oxygen





Hydrogen sulphide

The bloom "crashes" caused extreme oxygen depletion in coastal water, with mortalities of fish, mussels, rock lobster, octopus and other littoral animals.

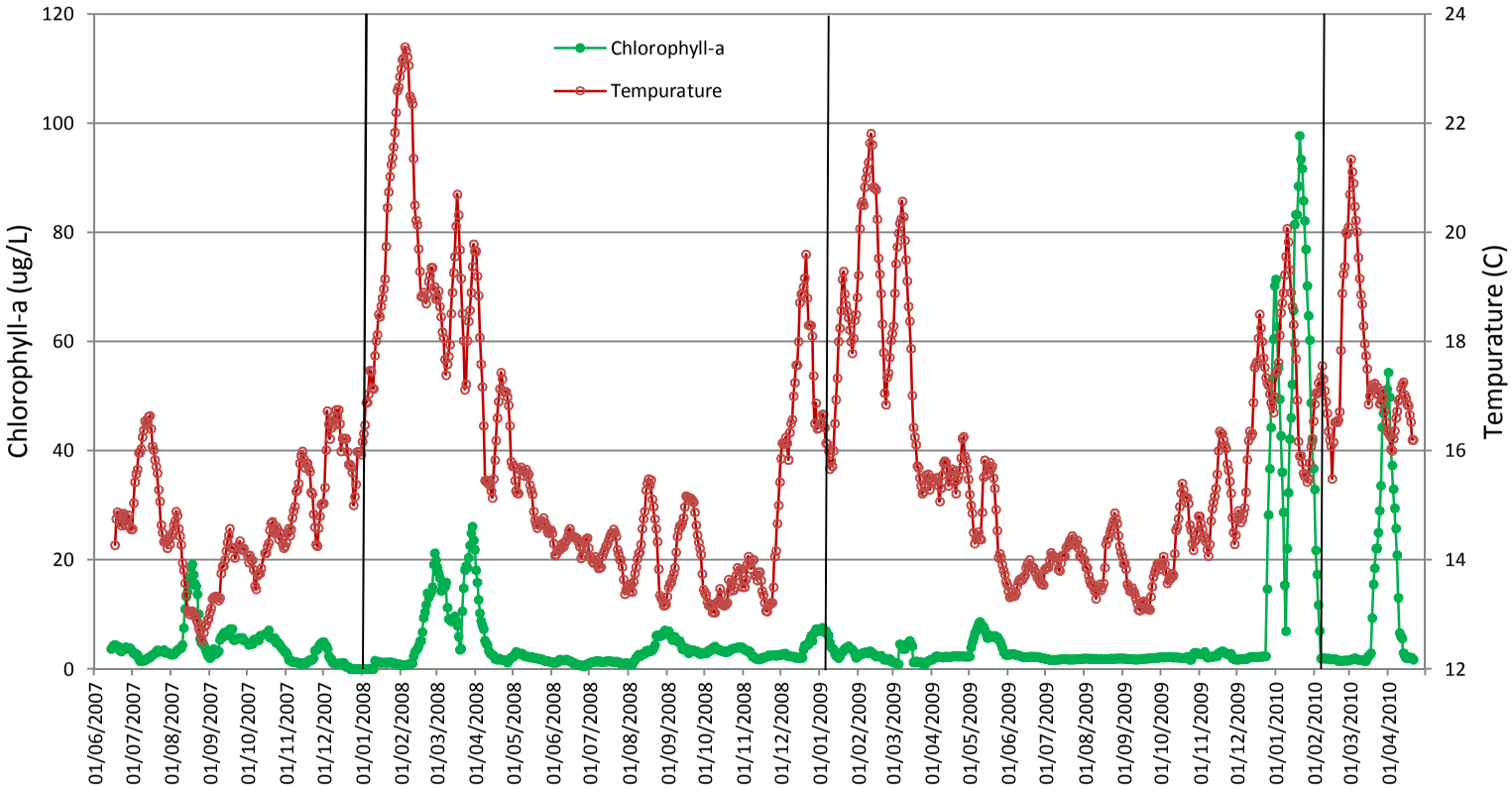
Dead mussels washed up

Fish dying in water and washed up

The oyster industry lost 80-100% of their stock

Dead rock lobster and octopus

Chlorophyll-a [ ] and Temperature at the Jetty in Swakopmund



D.C.Louw

Some problems from HABs - unknown, suspected

e.g. commonly found endemic species

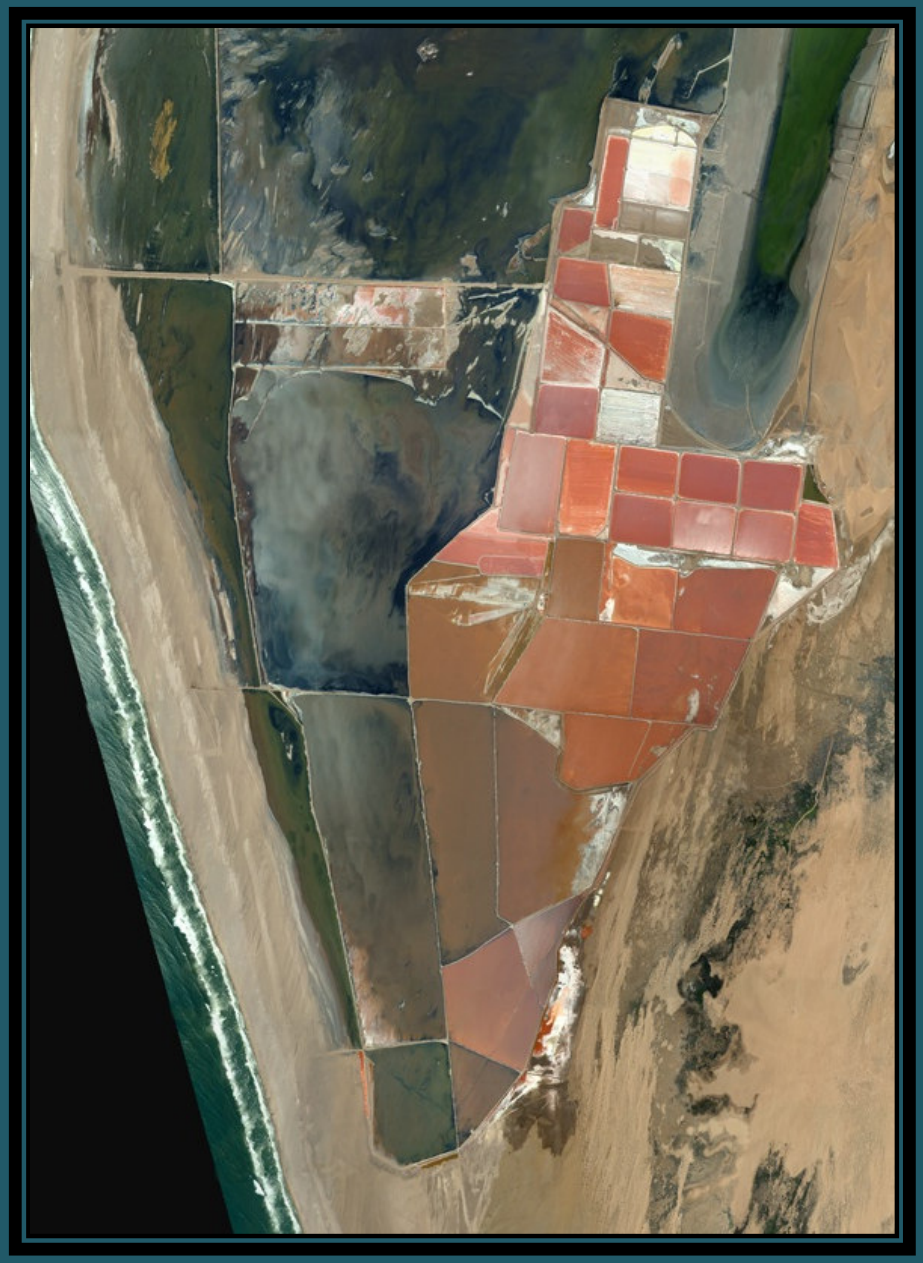
Karlodinium micrum (Gymnodinium galatheaem) causes fish kills and oyster mortalities

(known also from the US and Spain)
Heavy blooms in Walvs Bay, Swakopmund

June 2003
November 2005
September – December 2007

Pseudonitschia spp. – domoic acid into the food web
mortalities of fish , birds and

Salt pans along the coast have salinity-specific species



Walvis Bay Salt Pans

Swakopmund salt pans with high concentrations of *Dunaliella salina* (reddish-pink colouration)

C Bartholomae

Phytoplankton monitoring: the wider aspects and contributions to ecosystem-wide management

I. HAB monitoring:

Toxic effects are not limited to the aquaculture industry:

Various HAB species are toxic to fish (e.g. *Karldinium micrum*, some *Pseudo-nitschia* spp.) and some toxins e.g. domoic acid (ASP), saxitoxin (PSP) pass through the marine food chain, impacting trophic levels, from fish to seabirds/seals/whales

II Species diversity:

Species inventory with changes over time, ? climate change effects - ? 2008 events are "new" to our coastal system

International collaboration

- Active member of the IOC Intergovernmental Panel on Harmful Algal Blooms
- through regional programmes (BCLME, BENEFIT) we were able to access international experts e.g. Don Anderson, Jacob Larsen
- IAEA project (NOAA: Greg Doucette) for analysis of PSP toxins. Lab running at NatMIRC
- We are eager to develop competence through collaboration


Thank you !