

# *Tropical Eastern North Atlantic Time-Series Observatory* **TENATSO**

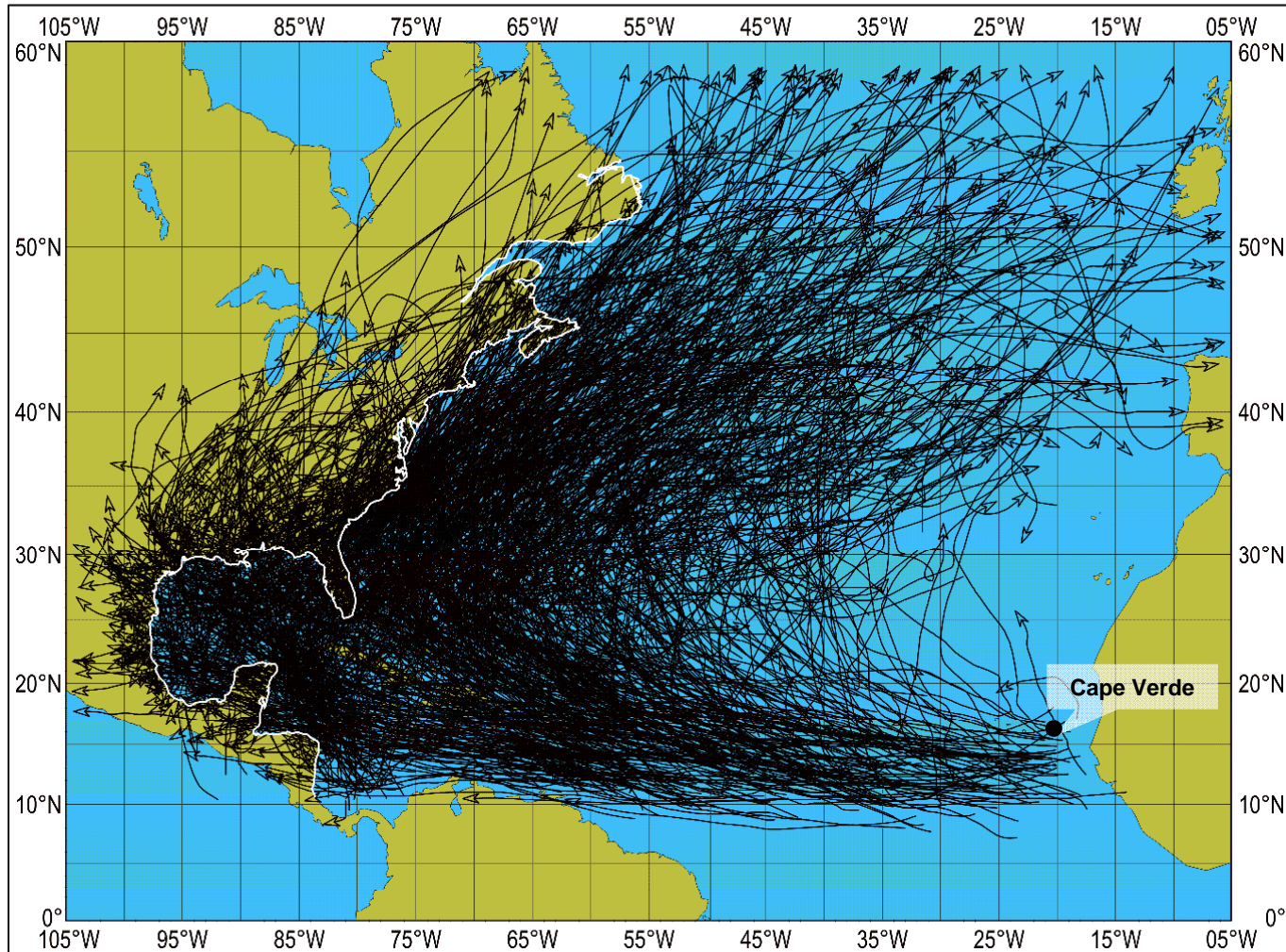


# Why Cape Verde?

- Location
  - Europe AND Africa
  - Ocean AND Atmosphere
- Time-Series AND Experiment
- Observation AND Capacity Building
  - Opportunities AND Needs

# Location

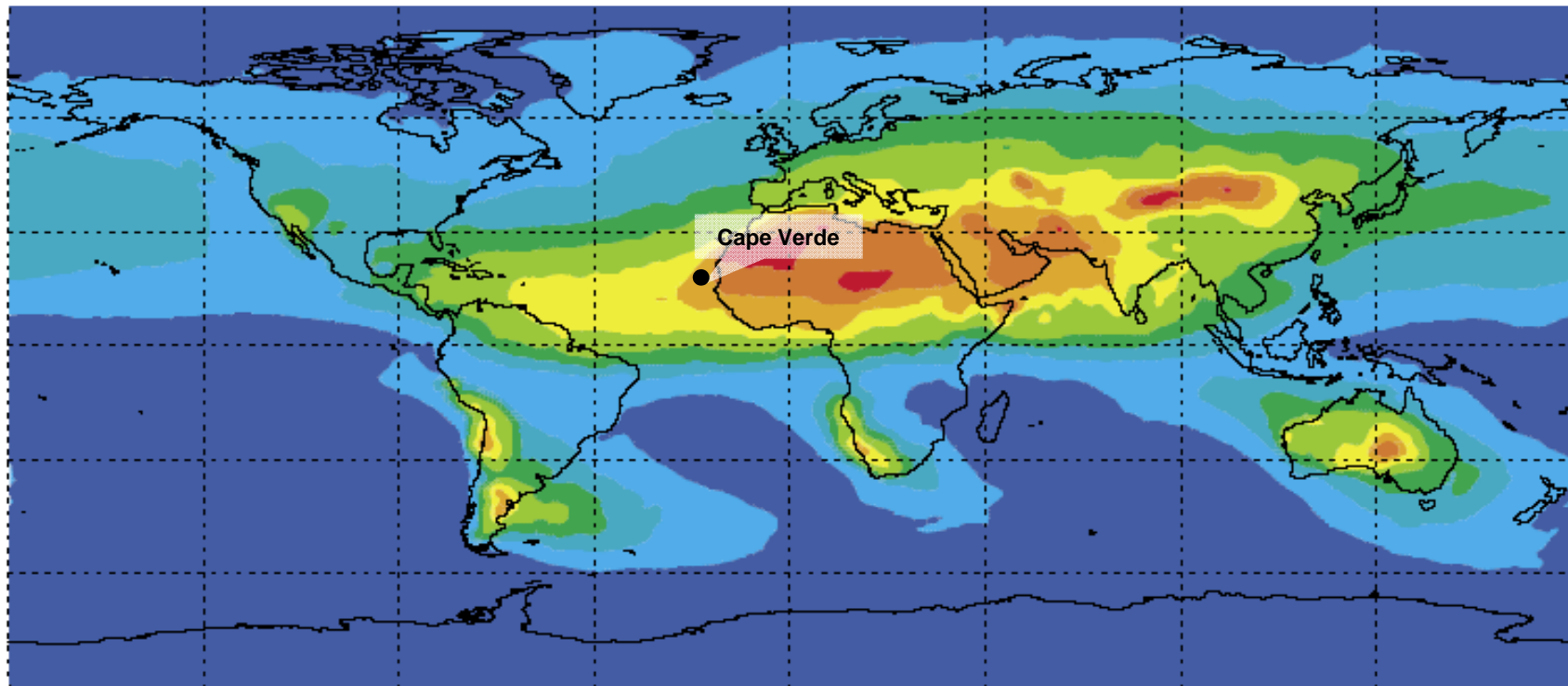
## Tropical storms, 1851-2004



**NORTH ATLANTIC TROPICAL STORMS AND HURRICANES, 1851-2004 (1325 STORMS)**  
NOAA

# Location

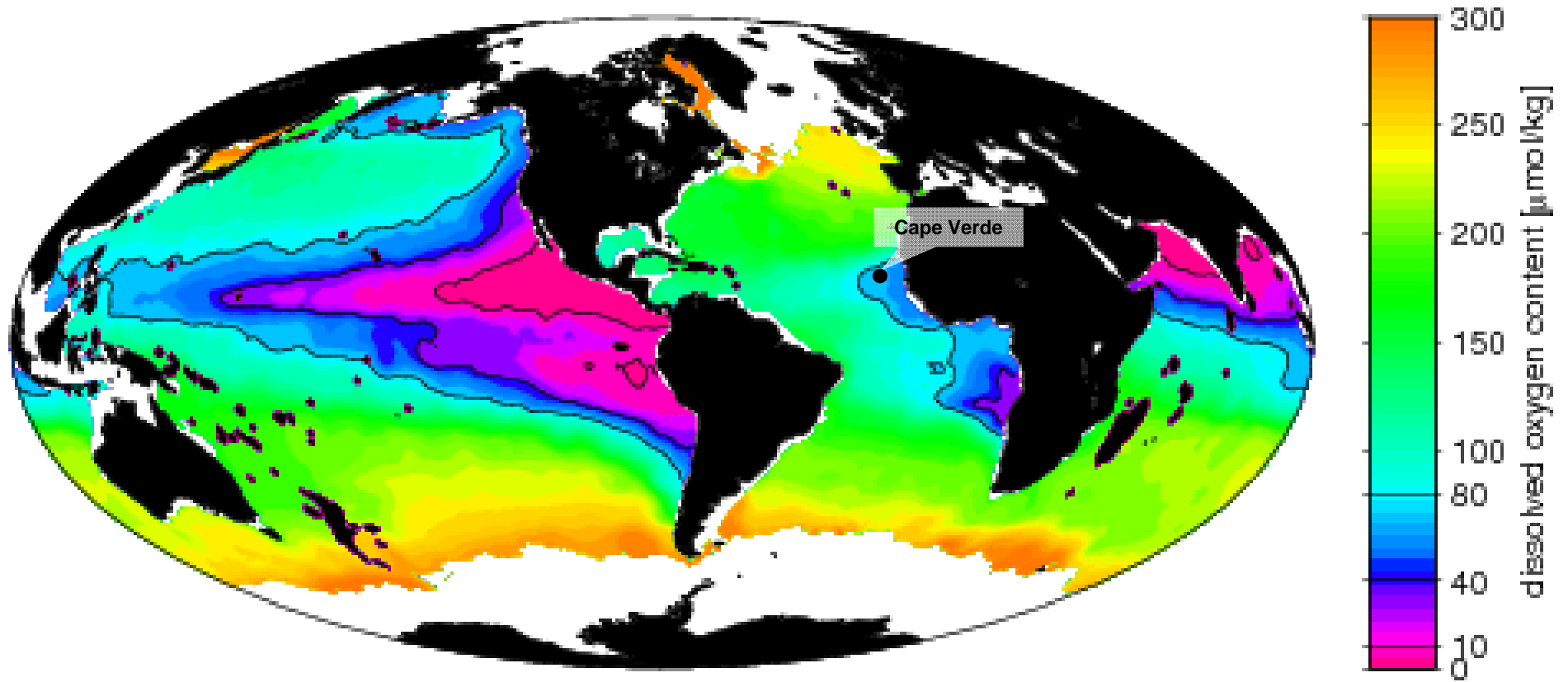
## Dust deposition on the surface of the Earth





# Location

Dissolved oxygen in the ocean (between 300-600 m)



# TENATSO:

Specific Support Action  
of the European Union

## Europe and Africa

### 2 Key Cape Verdean Partners



Basic Objectives of TENATSO project:

Establish capability to support long-term observation of **atmospheric** and **oceanic** conditions relevant to Global Change in the tropical Eastern North Atlantic region.

Train personnel from Cape Verde to co-operate the Observatory. Link site and training to local need to assess and manage Cape Verde regional environment.

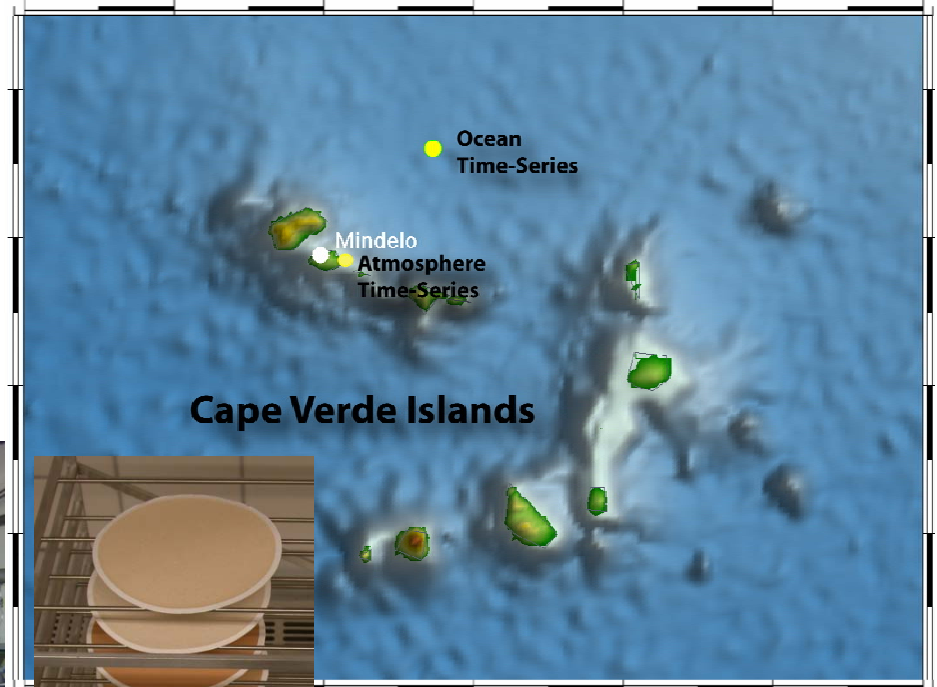
Integrate site within Global Earth Observation System of Systems.

Promote site as an international scientific resource (data / logistics / campaign support)

# Cape Verde Observatory

## (TENATSO)

### Ocean AND Atmosphere Observations



# Ocean AND Atmosphere



The Cape Verde Atmospheric Observatory has been host to a series of **international** research campaigns since 2006. A series of papers based on data collected from both ocean and atmosphere sites are emerging.



**CV *Ocean* Observatory –TENATSO has become regular station for *international* research vessels.**

<b>Ship</b>	<b>Year</b>	<b>Nation</b>
<i>Poseidon 328</i>	2006	UK
<i>Ron Brown</i>	2006	USA
<i>Meteor 68/2</i>	2006	Germany
<i>Meteor 68/3</i>	2006	Germany
<i>Discovery</i>	2007	UK
<i>Ron Brown</i>	2007	USA
<i>Poseidon</i>	2007	Germany
<i>Discovery</i>	2007	UK
<i>L'Atalante</i>	2008	France
<i>L'Atalante</i>	2008	France
<i>Merian</i>	2008	Germany
<i>Merian</i>	2008	Germany
<i>Pelagia</i>	2008	Netherlands
<i>Oceanus</i>	2008	USA
<i>Merian</i>	2008	Germany
<i>Meteor</i>	2009	Germany
<i>Meteor</i>	2009	Germany
<i>Polarstern</i>	2010	Germany
<i>Meteor</i>	2009	Germany
<i>Poseidon</i>	2010	Germany
<i>Knorr</i>	2010	USA
<i>Meteor</i>	2010	Germany
<i>Discovery</i>	2011	UK

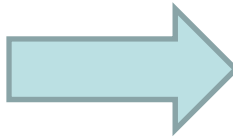


# Ocean AND Atmosphere

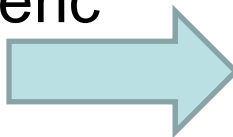


TENATSO (the Cape Verde Observatory) is now embedded within international programmes and GEOSS

Cape Verde Ocean Observatory



Cape Verde Atmospheric Observatory



Global Atmospheric Watch (GAW)

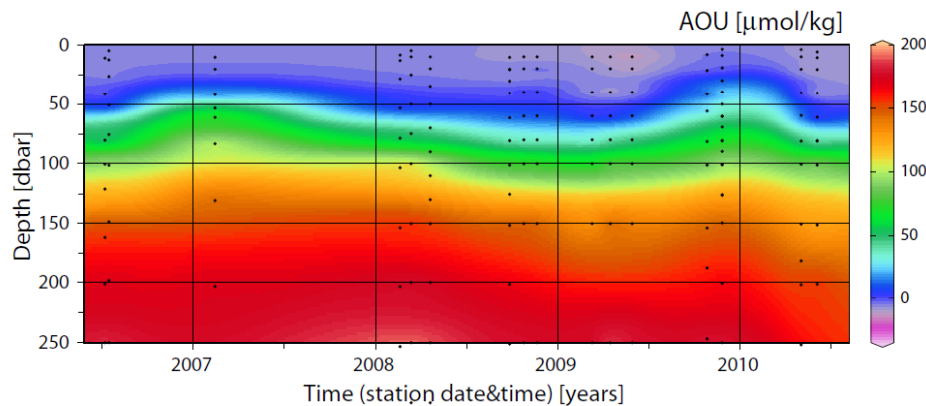
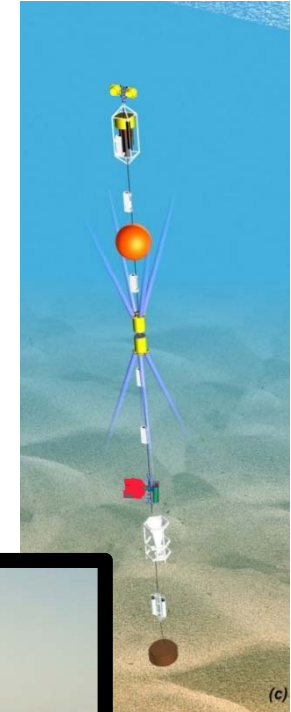
# Time Series and Experiment

Activities at the Ocean Observatory include:

Biogeochemical **mooring** (incl. sediment traps, O<sub>2</sub>, etc)

Regular **ship-based occupations** with RV *Islandia*\* (<monthly)

Ship-based **experiments** (with RV *Islandia*\* and on-shore labs)



## Available datasets:

- Temperature
- Salinity
- Nutrients
- DIC & TA
- TOC / TON
- Oxygen
- Chlorophyll



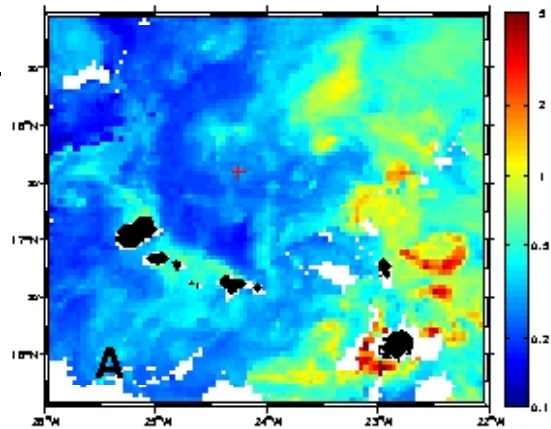


# Time Series and **Experiment**

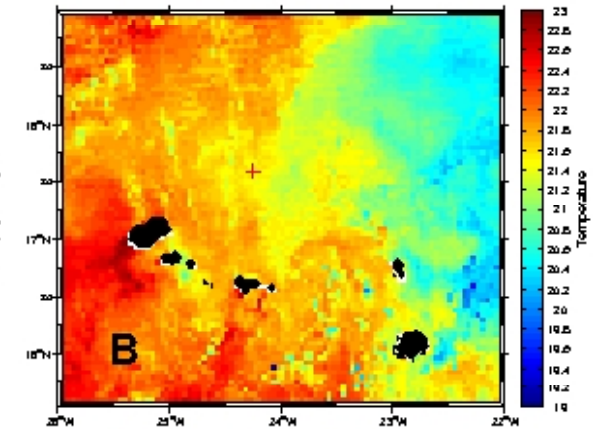
“A glider fleet to observe sub-mesoscale physical-biogeochemical coupling in the tropical ocean”

## Role of small-scale circulation:

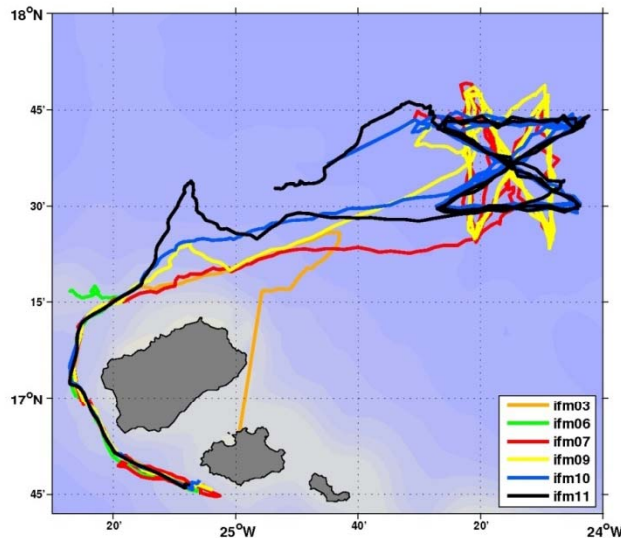
- Redistribution of heat, salt and biomass in the ocean
- vertical nutrient supply
- trigger of biochemical processes



Chlorophyll



Temperature



- Preparation at INDP (Mindelo)
- joint deployment of 4 gliders
- Period: 12 March – 5 May 2010
- study area of 50 km x 50 km around Tenatso observatory
- 3500 dives
- total distance 3800 km

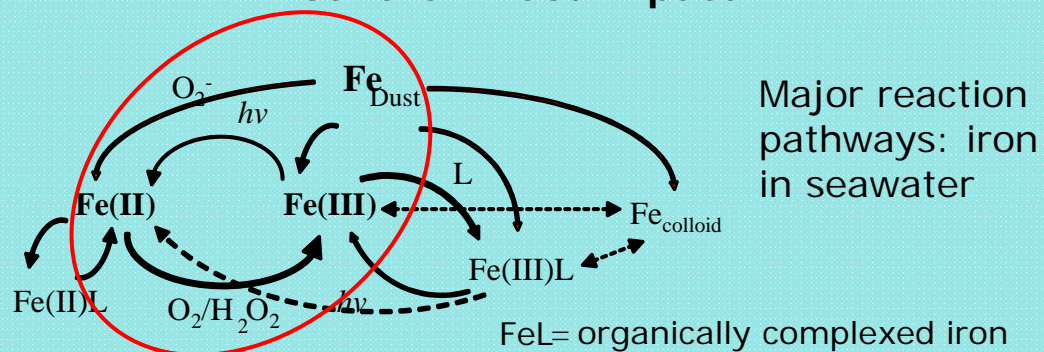




# Time Series and **Experiment**

## Aeolian particle flux and dissolution

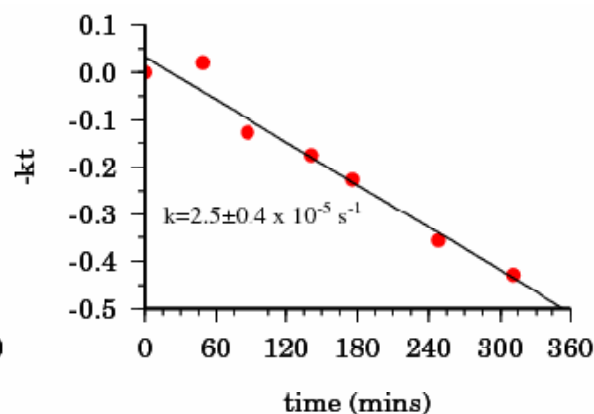
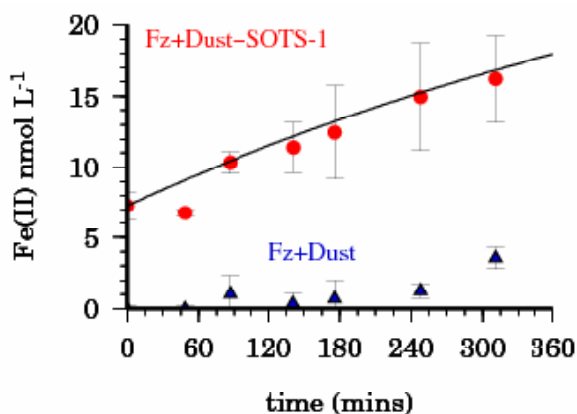
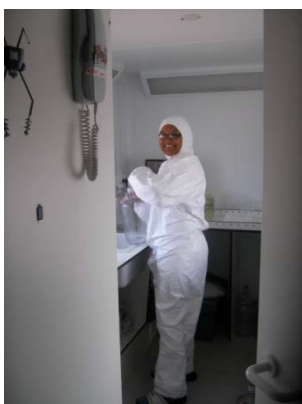
### Fe Redox cycling in the Tropical Atlantic: Saharan Dust impact



Candidate processes for Dust Dissolution:

Thermal dissolution, direct photochemical reduction (sunlight), ligand induced dissolution and...

reductive dissolution by Reactive Oxygen Species like superoxide ( $O_2^-$ )



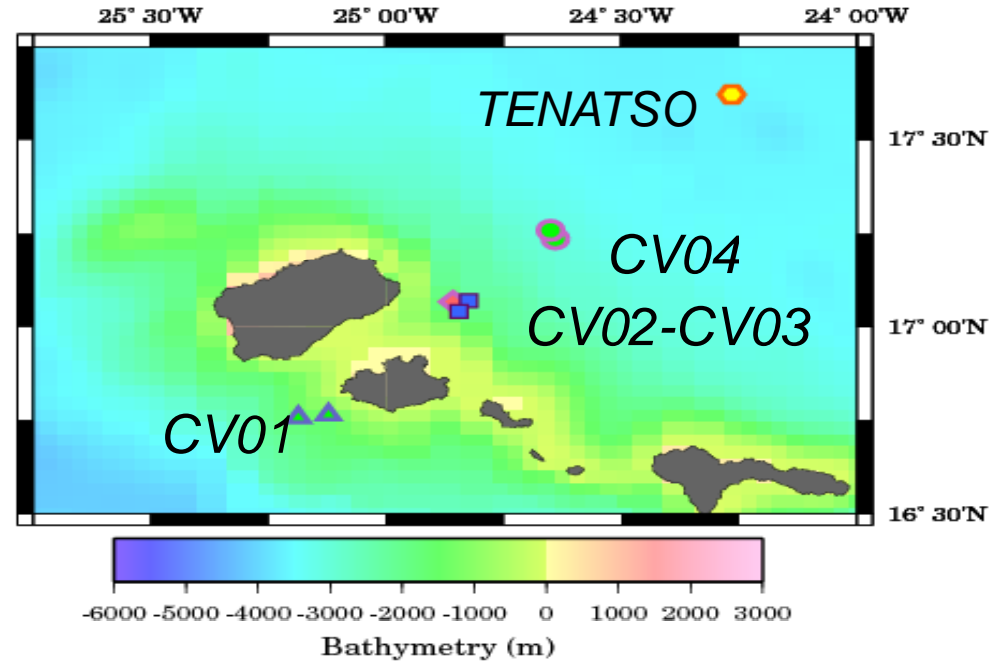
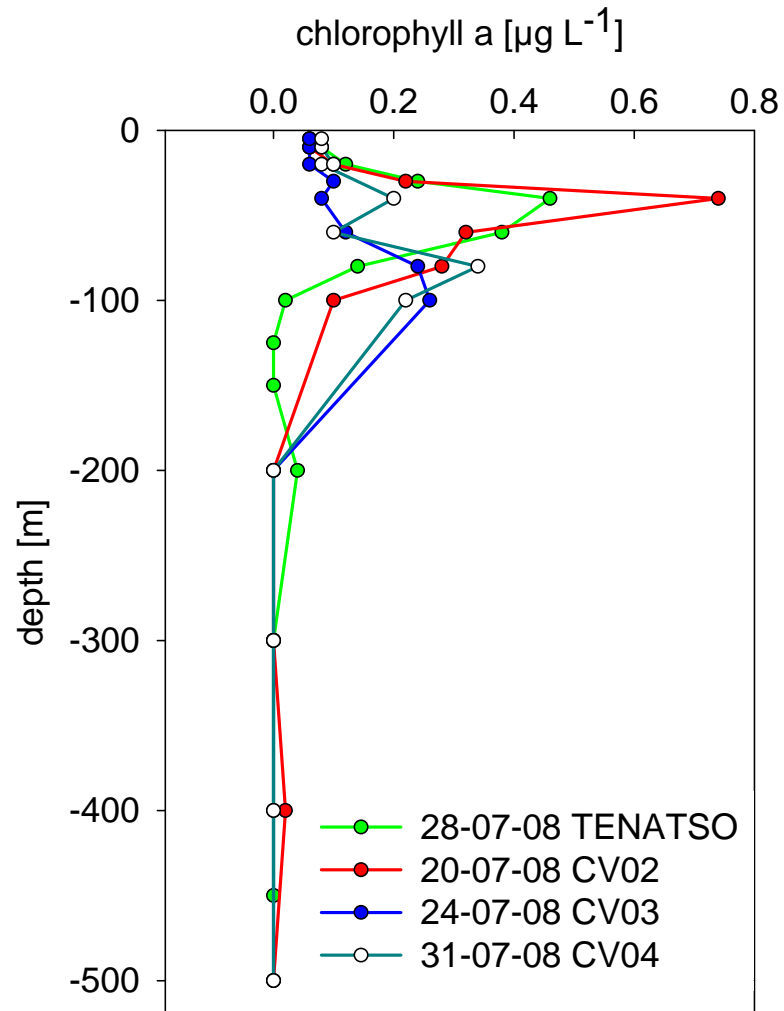
Fe(II) formation from dust suspended in seawater

2.5% of the superoxide ( $O_2^-$ ) flux produced Fe(II)

⇒ Under natural dust flux conditions,  $O_2^-$  mediates dust dissolution but is a minor process

# Time Series and **Experiment**

Bioassays of Nutrient Limitation incl. N<sub>2</sub>-fixation



- sub-surface maximum of *chlorophyll a* at all stations

- bioassay experiments were conducted at 4 stations in July 2008

# Nitrogen fixation

- very energy demanding process
- highly oxygen (O<sub>2</sub>)-sensitive
- high iron (Fe) requirement

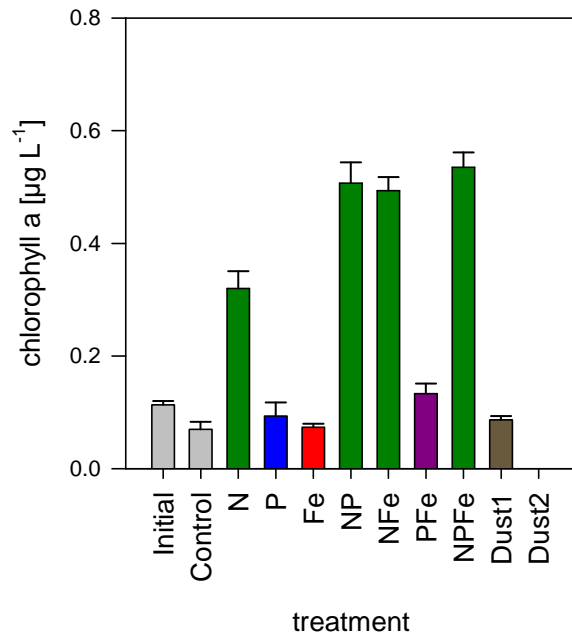


Cape Verde is an excellent area for studying nitrogen fixation

In principle, **repeated experimentation** is possible (without scheduling issues associated with large vessels)

# Cape Verde Islands / St.CV01

chlorophyll a



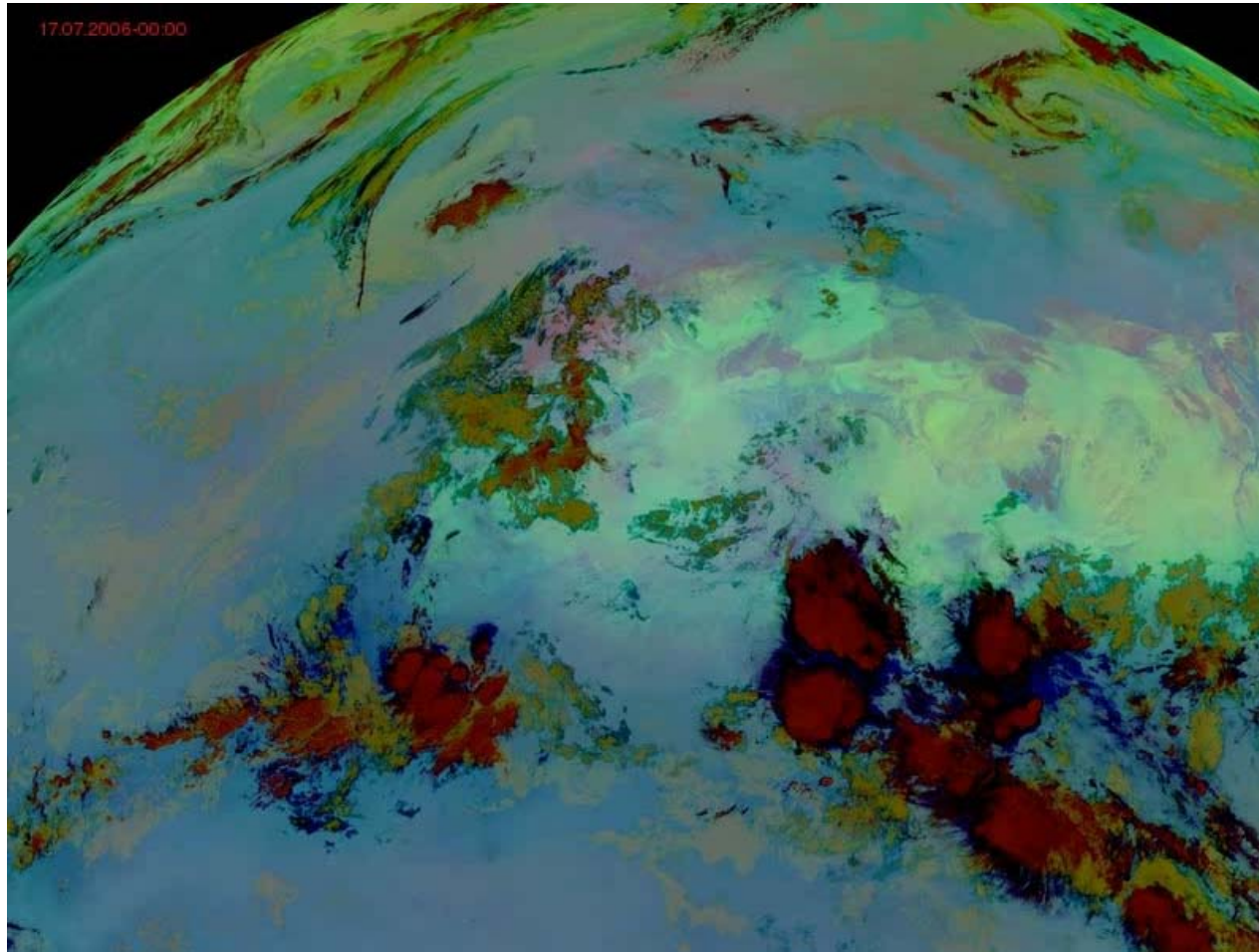
**Primary production was N-limited**

**Nitrogen fixation was enhanced by P, Fe, both or dust additions**



# Time Series and **Experiment**

**The Goal:** Ability to conduct event-based experimentation in context of time-series (e.g. To study effects of dust input on ocean biogeochemistry)



Brown = mid-level  
clouds  
Purple = Dust

METEOSAT  
IR Dust Index

Movie from  
Kerstin  
Schepanski  
IfT-Leipzig

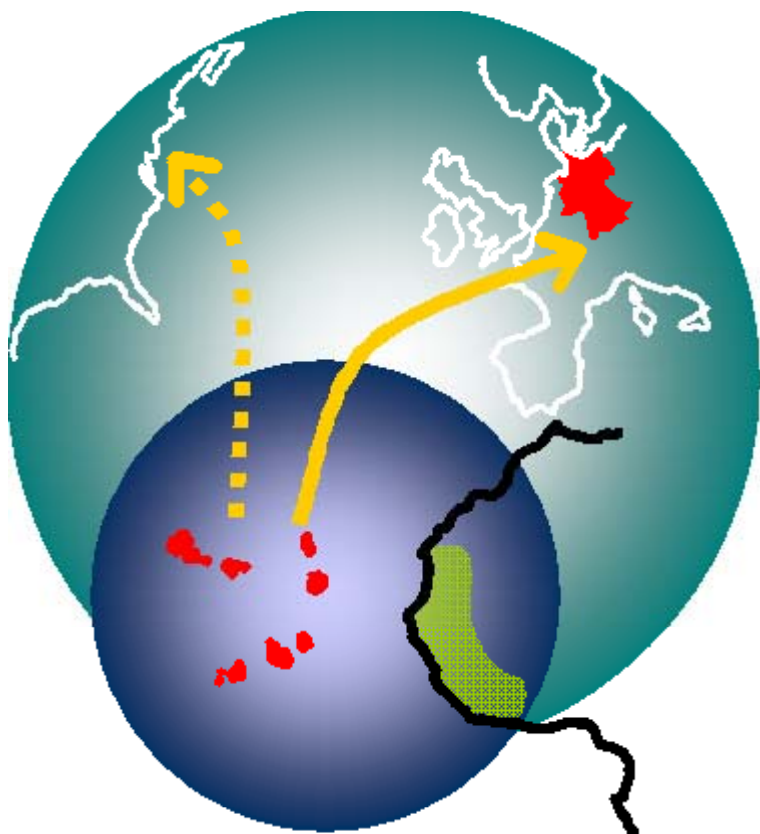
In reach: but not yet attained due to engine problems with RV Islandia

## Observation AND Capacity Building

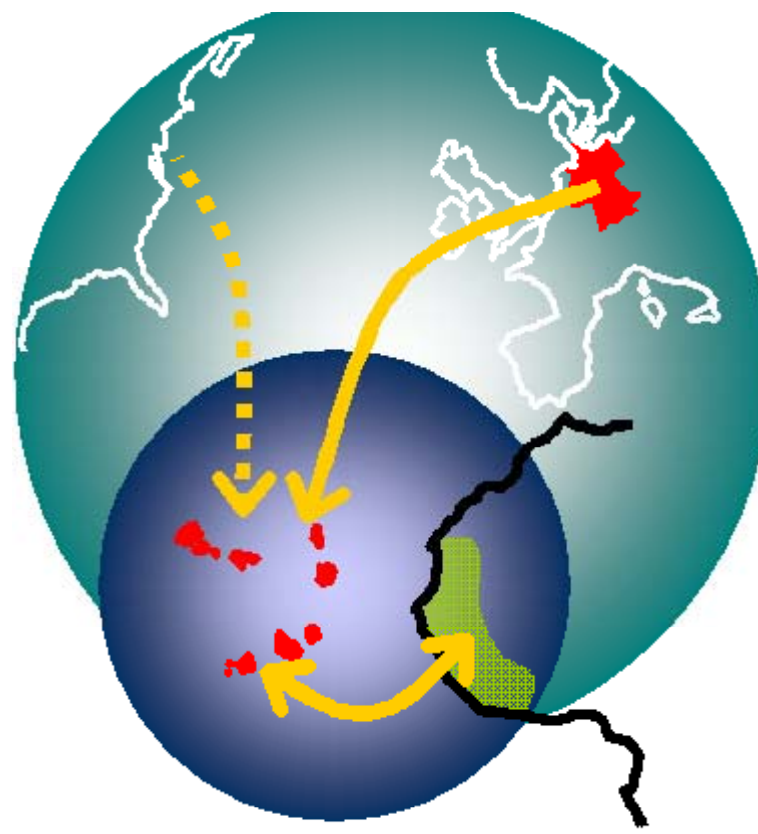
- TENATSO has raised the scientific capacity of Cape Verde for both marine and atmospheric science.
- Scientific capacity building takes time and requires a **long-term commitment**
- For scientists this depends on **long-term scientific interests** (and long-term funding)
- These are the same sustainability issues facing long-term observations.
- So it makes sense to tackle the two issues together. From TENATSO we have learned that the two go well together.

# Long-term strategy – **Estratégia a longo prazo** (North-South and South-South)

Scientific research and data



Education and Training



# What comes next for TENATSO?

- 1) **Improve infrastructure** (e.g. Labs and lab infrastructure)
- 2) Use the Observatory as a resource for scientific training and education of Cape Verdeans in West Africans *IN CAPE VERDE*.
- 3) Increase participation of Capeverdean scientists and students in EU and other projects associated with the Observatory.
- 4) Improve local logistics for research vessel support. Promote access by the international scientific community.

**The Cape Verde government is committed to this. Expressed personally and publicly by President Pedro Pires and Foreign Minister Brito.**

- 5) **URGENT need for African-European or International research vessel to be based in the region.**

**Note:** West African countries, including Cape Verde, have limited or no scientific access to their ocean waters which are exploited, increasingly, by other nations (including European nations), for fish, oil/gas, mineral resource, tourism, etc..