



جامعة الملك عبد الله
للعلوم والتقنية
King Abdullah University of
Science and Technology

8th EGO Meeting and International Glider Workshop,
May 21-23, 2019, New Jersey

Physical and Biogeochemical Characteristics of the Central and Northern Red Sea During the Winter 2019

Eyouni, L., Kokkini, Z., Zarokanellos, N., Jones, B.





Introduction

Background

Introduction

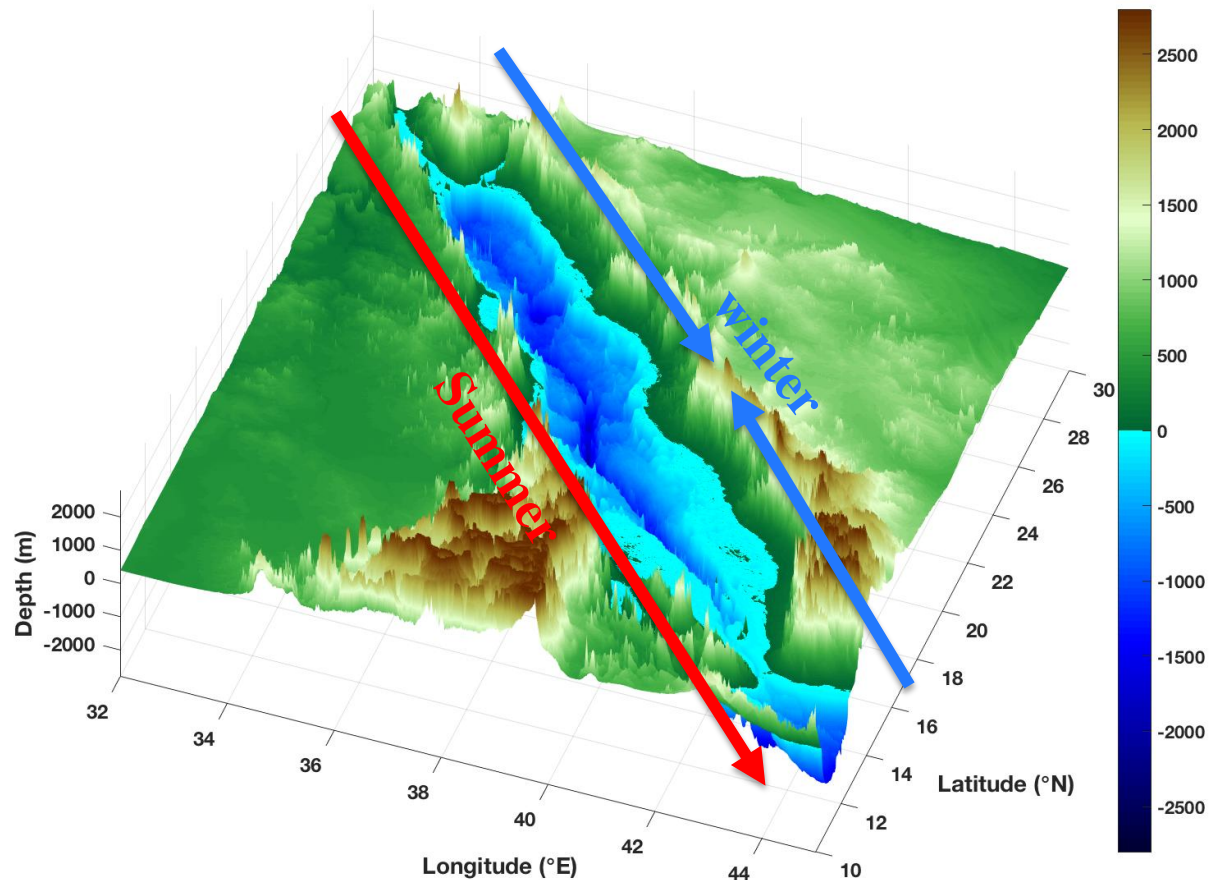
Red Sea Circulation

Objectives

Study Approach

Results

Summary



- Approximately 2000 km long, 200-300 km wide, maximum depth >2500 m
- Wind pattern (**NNW** during summer and **SSE** during the winter over the southern part
- Winds modulated by monsoonal dynamics



Red Sea Circulation



Background

Introduction

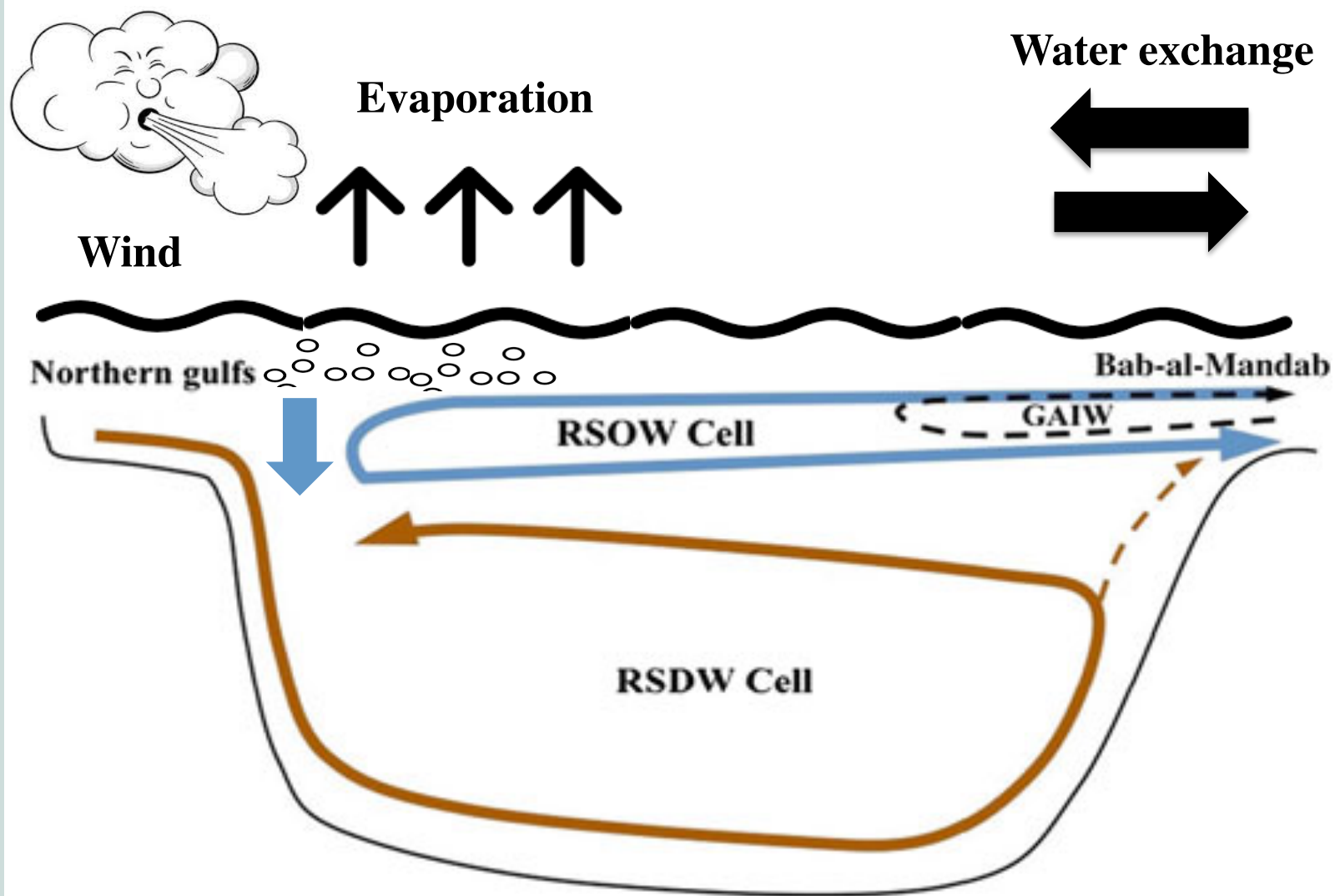
Red Sea
Circulation

Objectives

Study
Approach

Results

Summary



GAIW: Gulf of Aden Intermediate Water

RSOW: Red Sea Outflow water

RSDW: Red Sea Deep Water

Source: Sofianos and Johns, 2015



Red Sea Circulation- Northern Red Sea

Background

Introduction

Red Sea Circulation

Objectives

Study Approach

Results

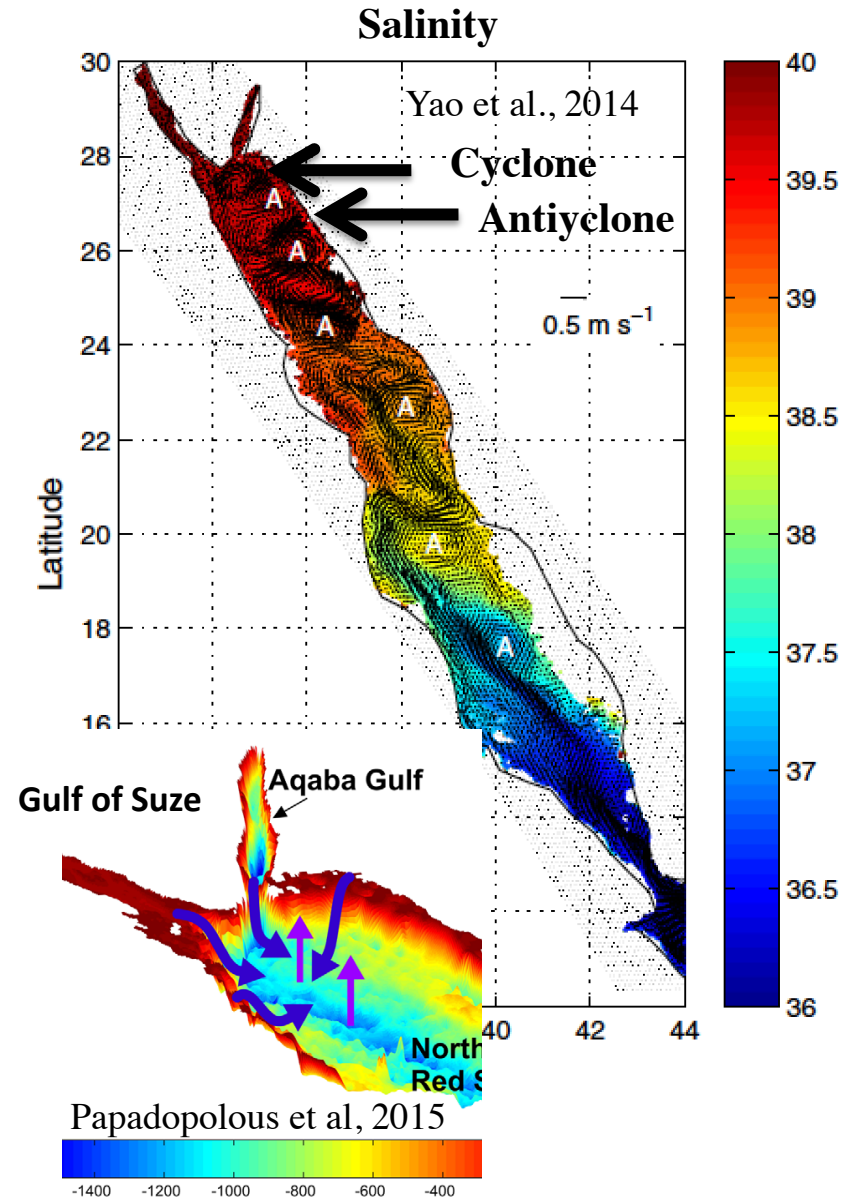
Summary

- Results from numerical modeling suggests a mean **cyclonic** circulation in the northern Red Sea

- Yao et al. 2014b JGR 119:2263-2289.

- Processes:
 - **Winter mixing/convection**
 - Yao et al., 2014
 - Sofianos and Johns 2003
 - **Cyclonic circulation**
 - Papadopoulos et al. 2015
- Anticyclonic eddy**
 - Yao et al., 2014

The region is spatially dynamic





Study Objectives



Background

Introduction

Red Sea
Circulation

Objectives

Study
Approach

Results

Summary

- Understand the **temporal variability** and processes that drive the **water mass transformation** in the northern Red Sea.
- Investigate the **biogeochemical response** to the **physical dynamics** in the Red Sea.

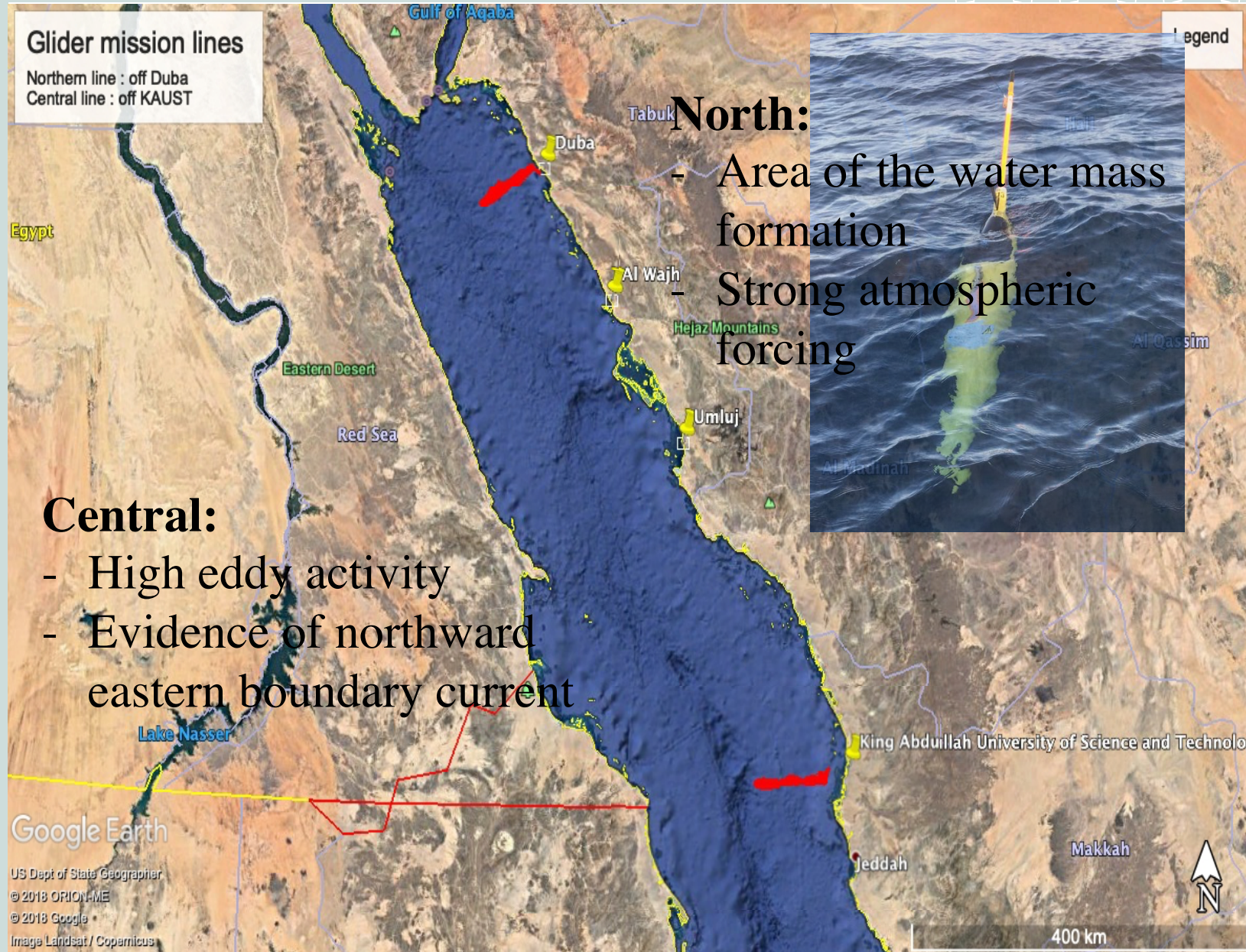


Study Area

Background

Study
Approach

Results
Summary

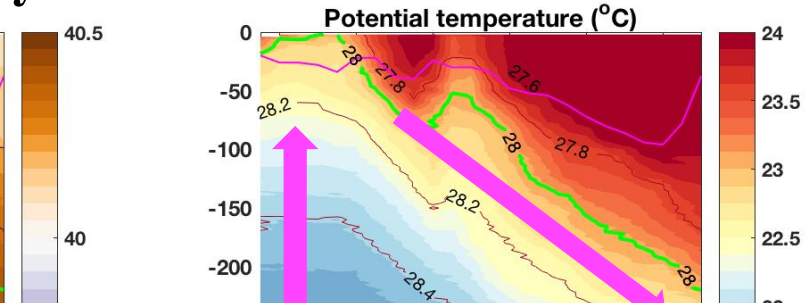
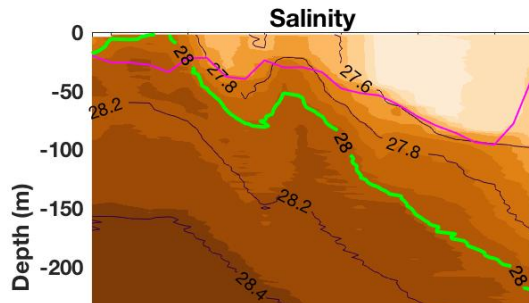




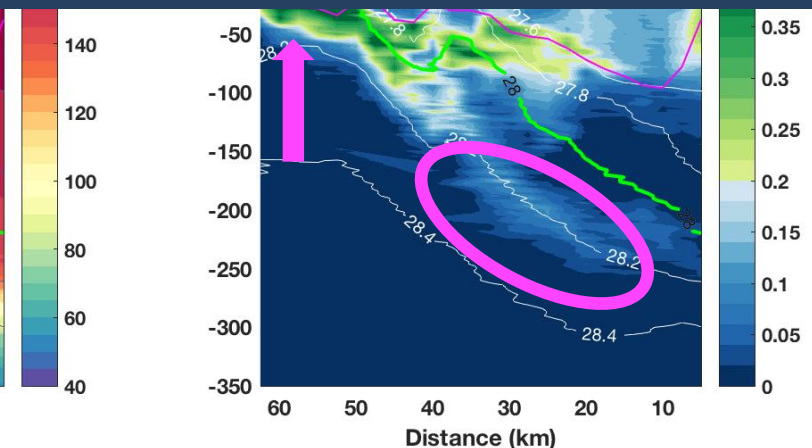
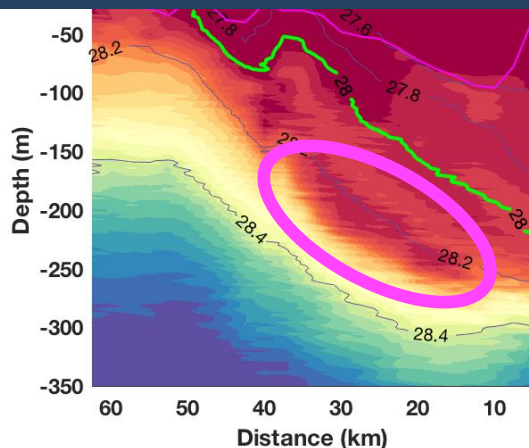
Transect 1 – Northern Red Sea

4/2/2019 to 10/2/2019

Cyclonic Phase



- Preconditioning phase: Cyclonic eddy
- Subduction
- Upper boundary of the nutricline penetrates the surface



Background

Study
Approach

Results

Cyclonic Phase

Mixing Phase

Anticyclonic
Circulation

Atmospheric
Forcing

Satellite
Images

Summary



Transect 1 - Central Red Sea

6/2/2019 to 10/2/2019

Background

Study
Approach

Results

Cyclonic Phase

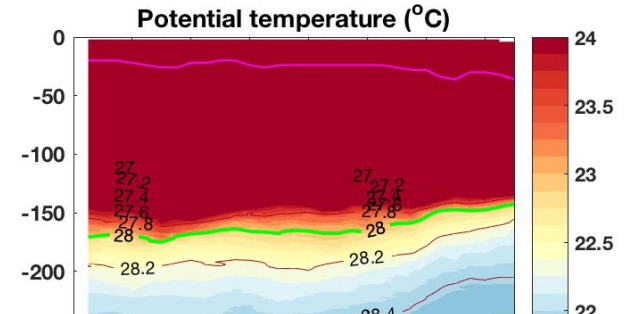
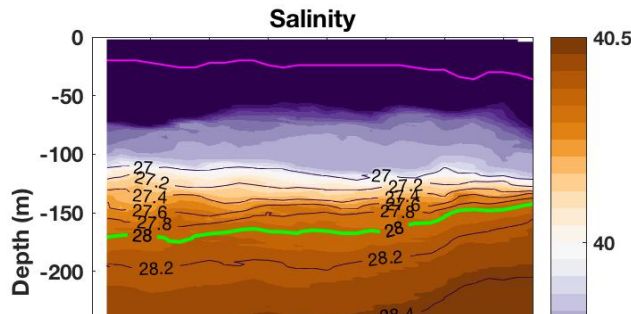
Mixing Phase

Anticyclonic
Circulation

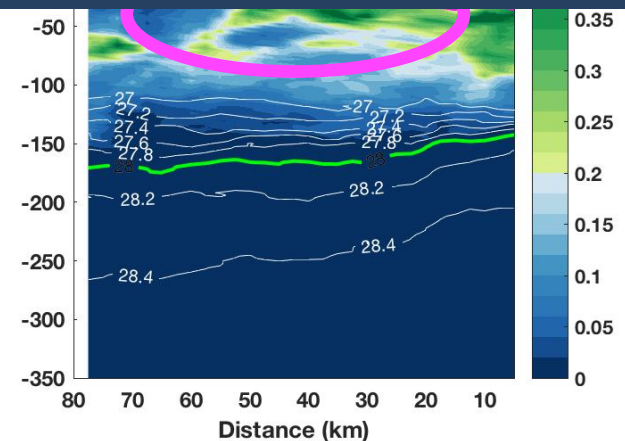
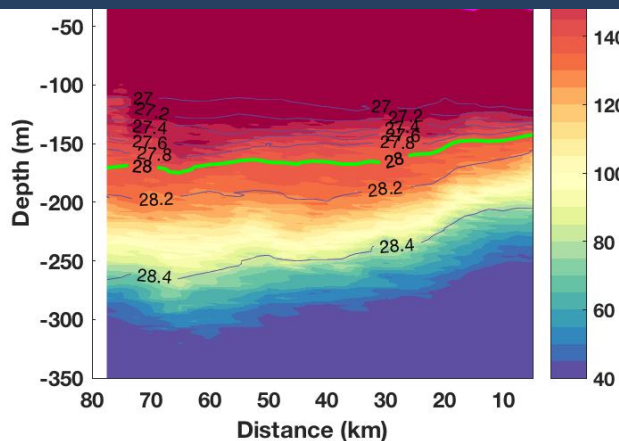
Atmospheric
Forcing

Satellite
Images

Summary

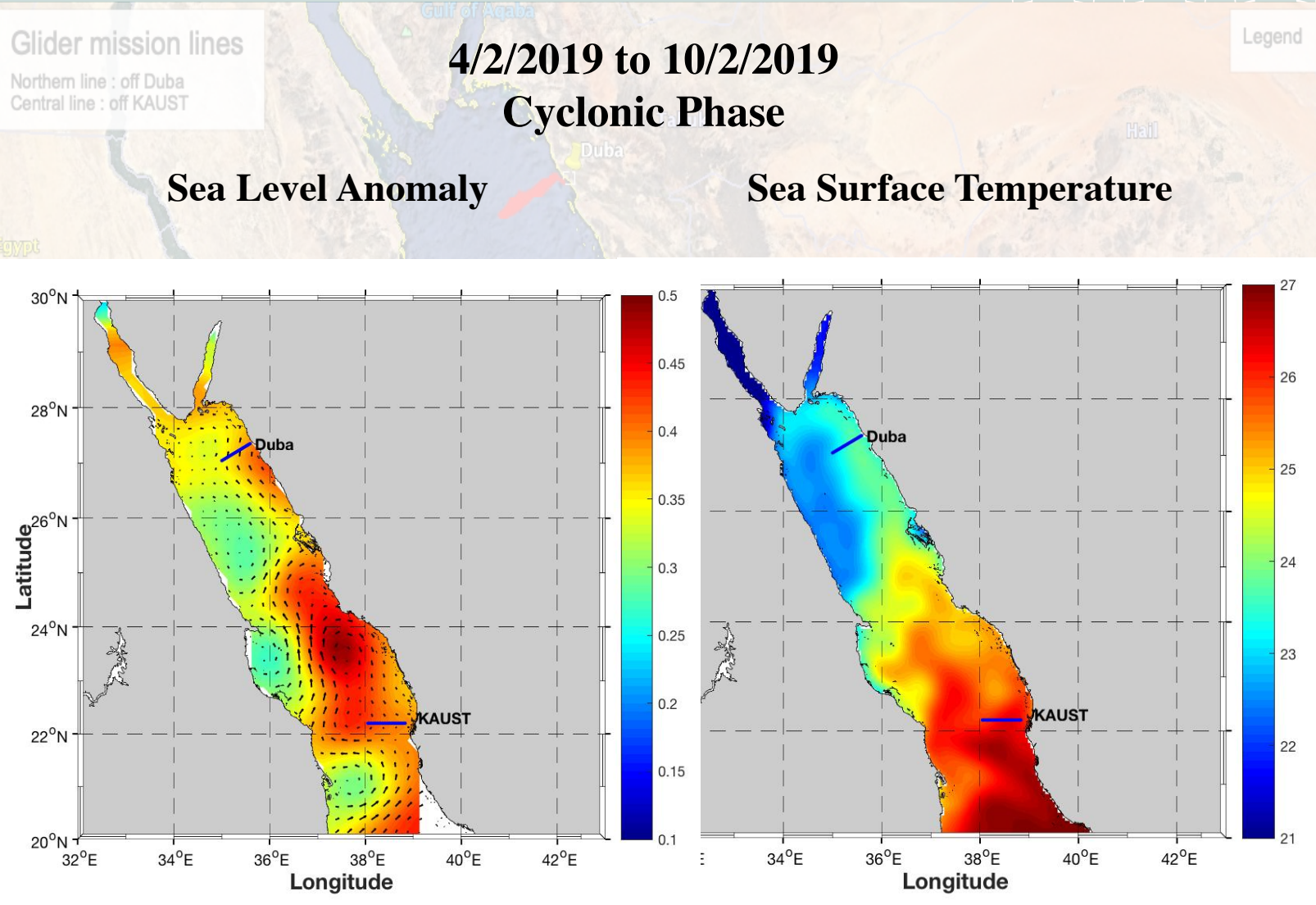


- Warmer and lower salinity water from the south.
- Stratified water column with shallow mixed layer.
- The 28 kg/m³ below 150 m.
- Subsurface Chl-a maximum.





Wintertime satellite images

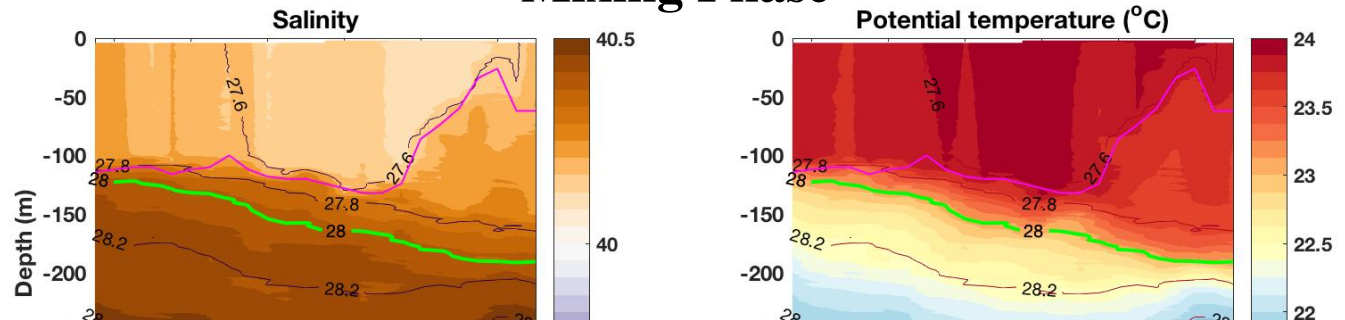




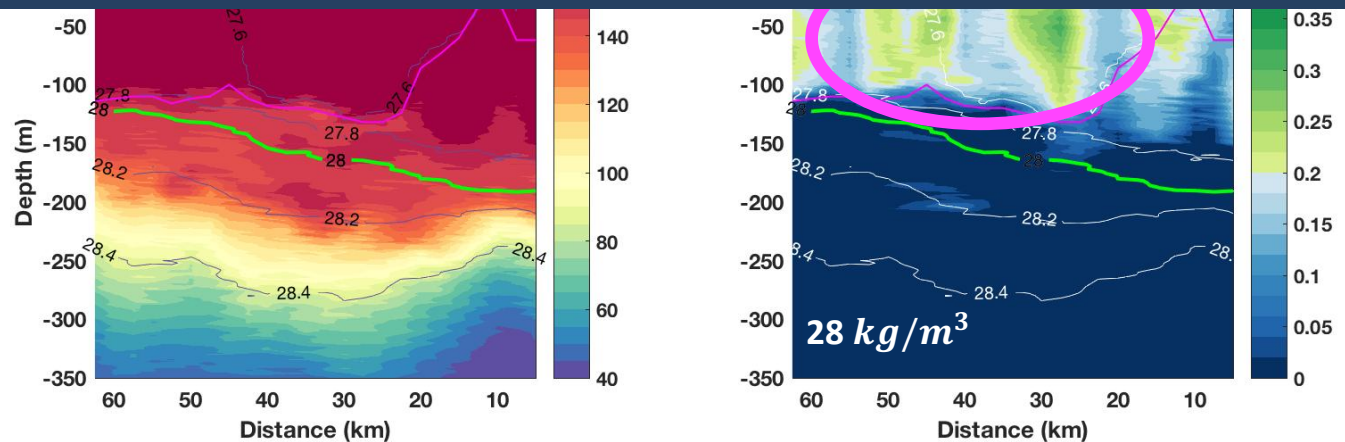
Transect 2 - Northern Red Sea

18/2/2019 to 22/2/2019

Mixing Phase



- Mixing phase: homogenous distribution of the vertical thermohaline characteristics
- Redistribution of the Chl-a above the 28 kg/m³
- Higher O₂ comparing with the previous transect



Background

Study
Approach

Results

Cyclonic Phase

Mixing Phase

Anticyclonic
Circulation

Atmospheric
Forcing

Satellite
Images

Summary



Transect 2 - Central Line

17/2/2019 to 24/2/2019

Background

Study
Approach

Results

Cyclonic Phase

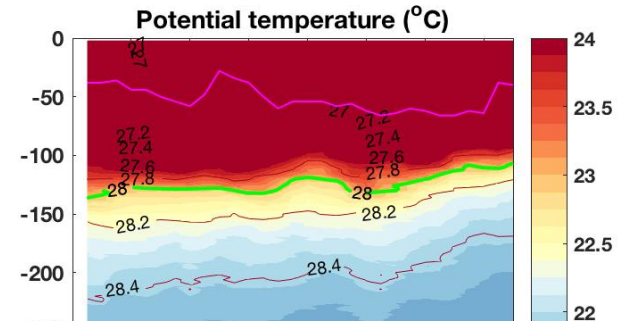
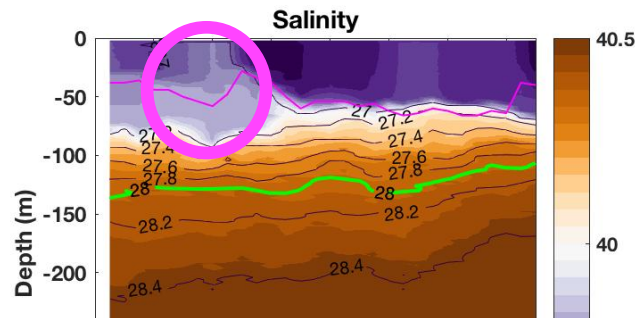
Mixing Phase

Anticyclonic
Circulation

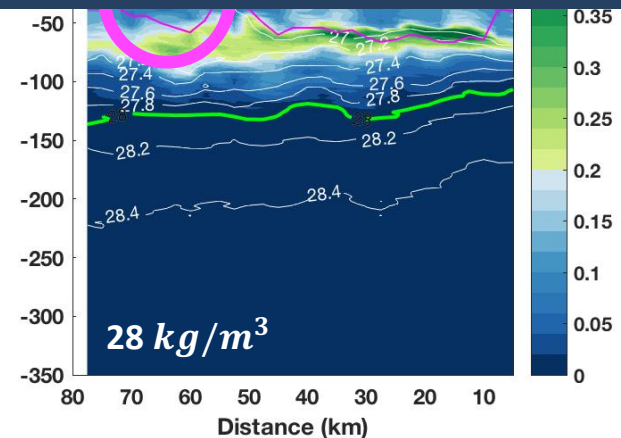
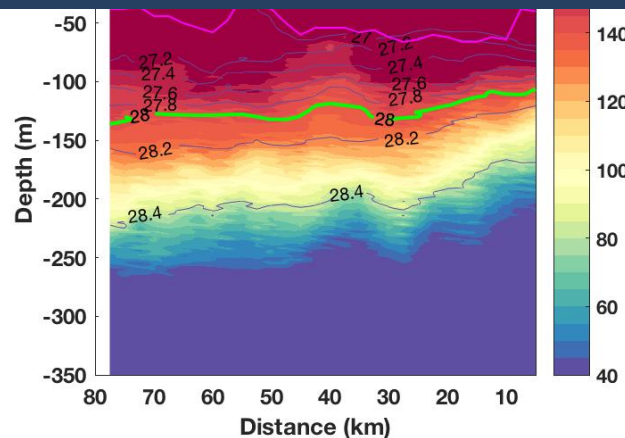
Atmospheric
Forcing

Satellite
Images

Summary

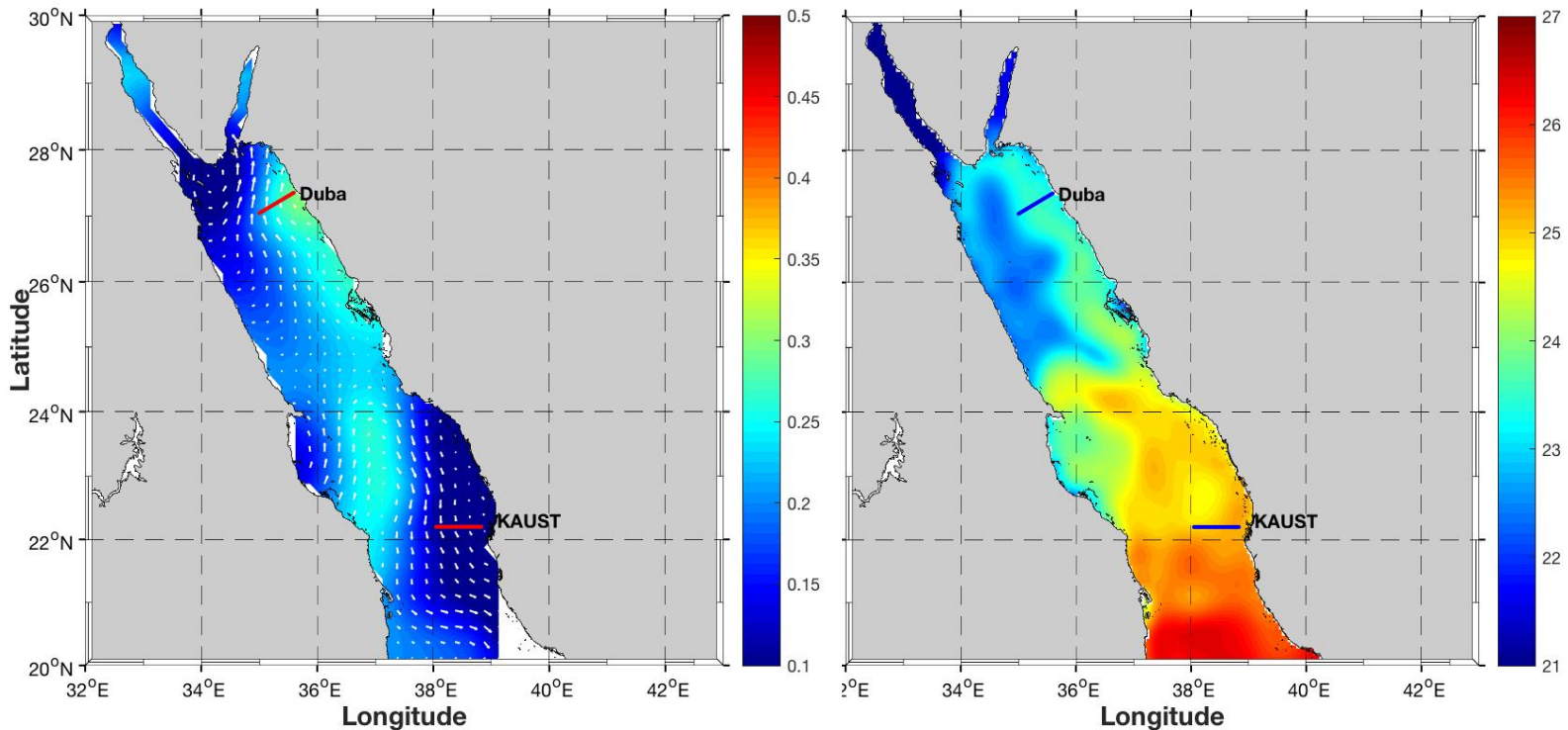


- Cooler and saltier water from the north.
- Weaker Chl-a offshore .
- The 28 kg/m³ below 120-150 m (becomes shallower).





Wintertime satellite images

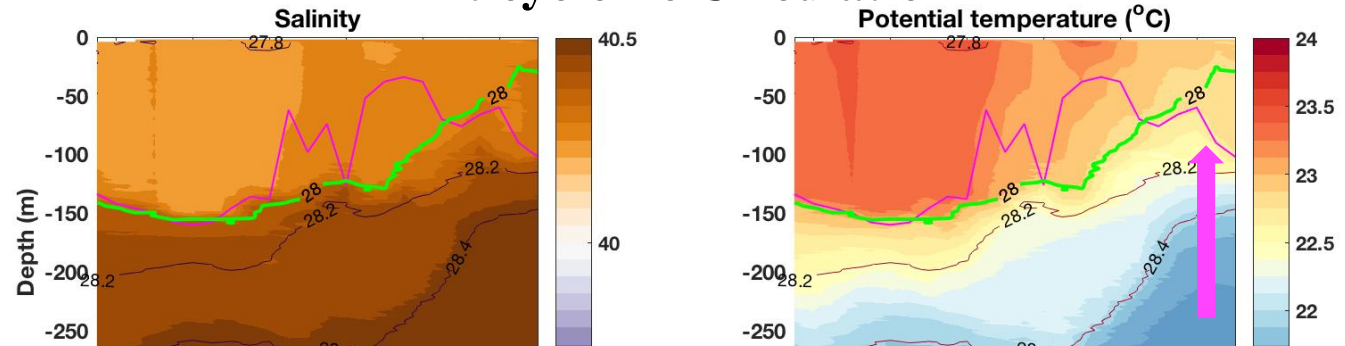




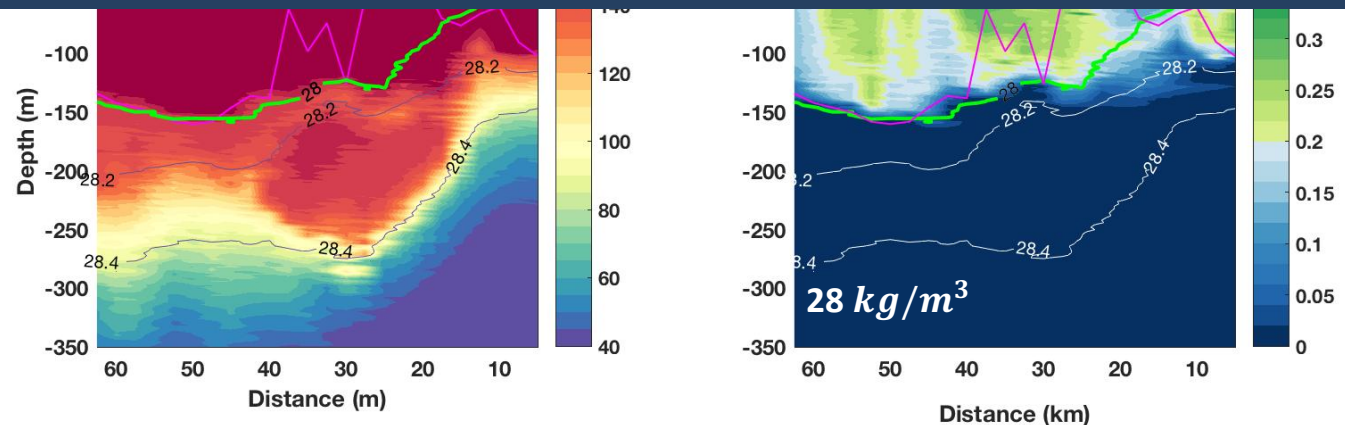
Transect 3- DUBA Line

1/3/2019 to 6/3/2019

Anticyclonic Circulation



- Changes in the Polarity of the eddy (changes from cyclone to anticyclone)
- Onshore upwelling.
- Very strong eddy activity.



Background

Study
Approach

Results

Cyclonic Phase

Mixing Phase

Anticyclonic
Circulation

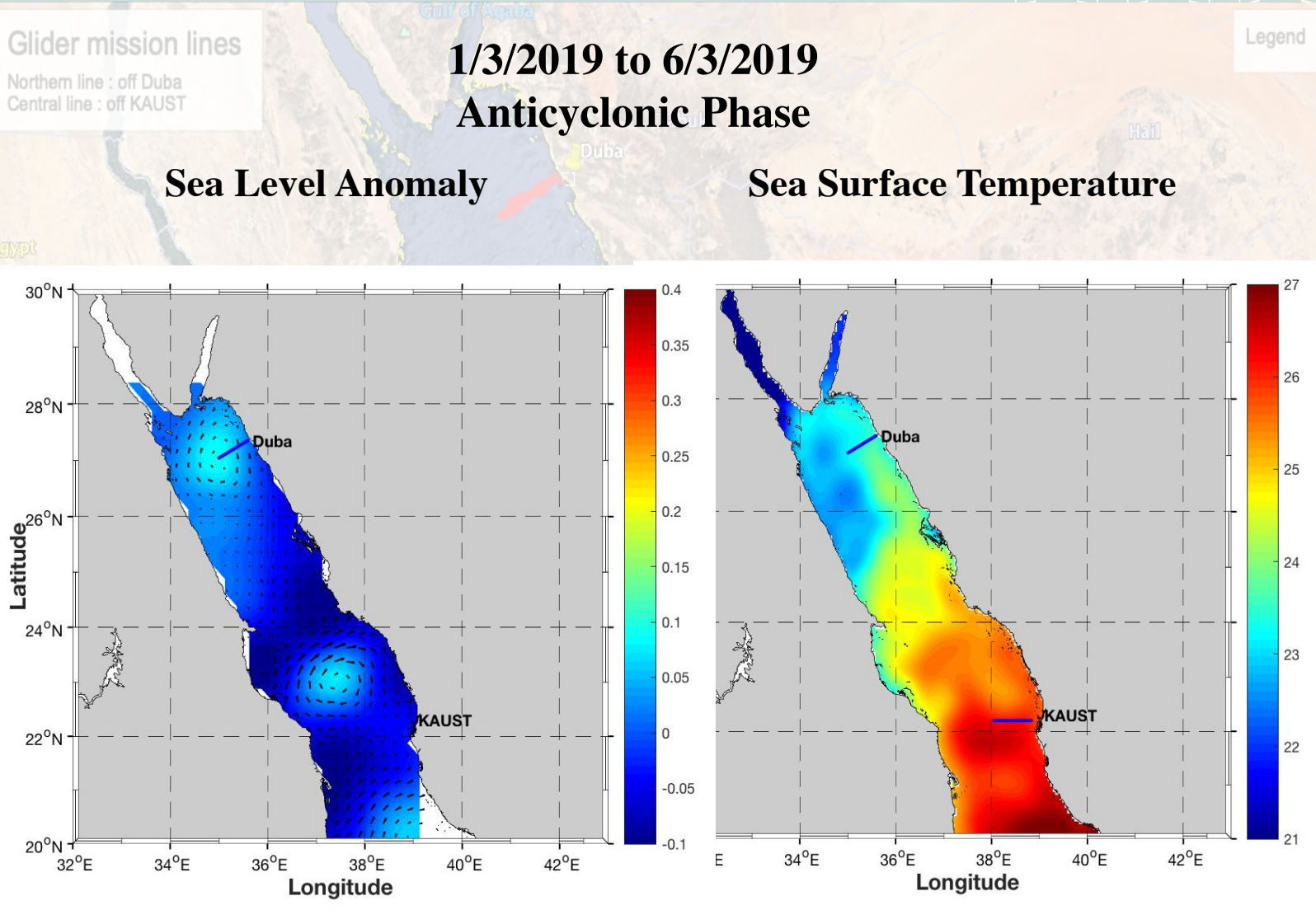
Atmospheric
Forcing

Satellite
Images

Summary



Wintertime satellite images





Atmospheric forcing- DUBA Line

Glider mission line

Northern line : off Duba
Central line : off KAUST

The dates are the same of the glider transects

Legend

Background

Study
Approach

Results

Cyclonic Phase

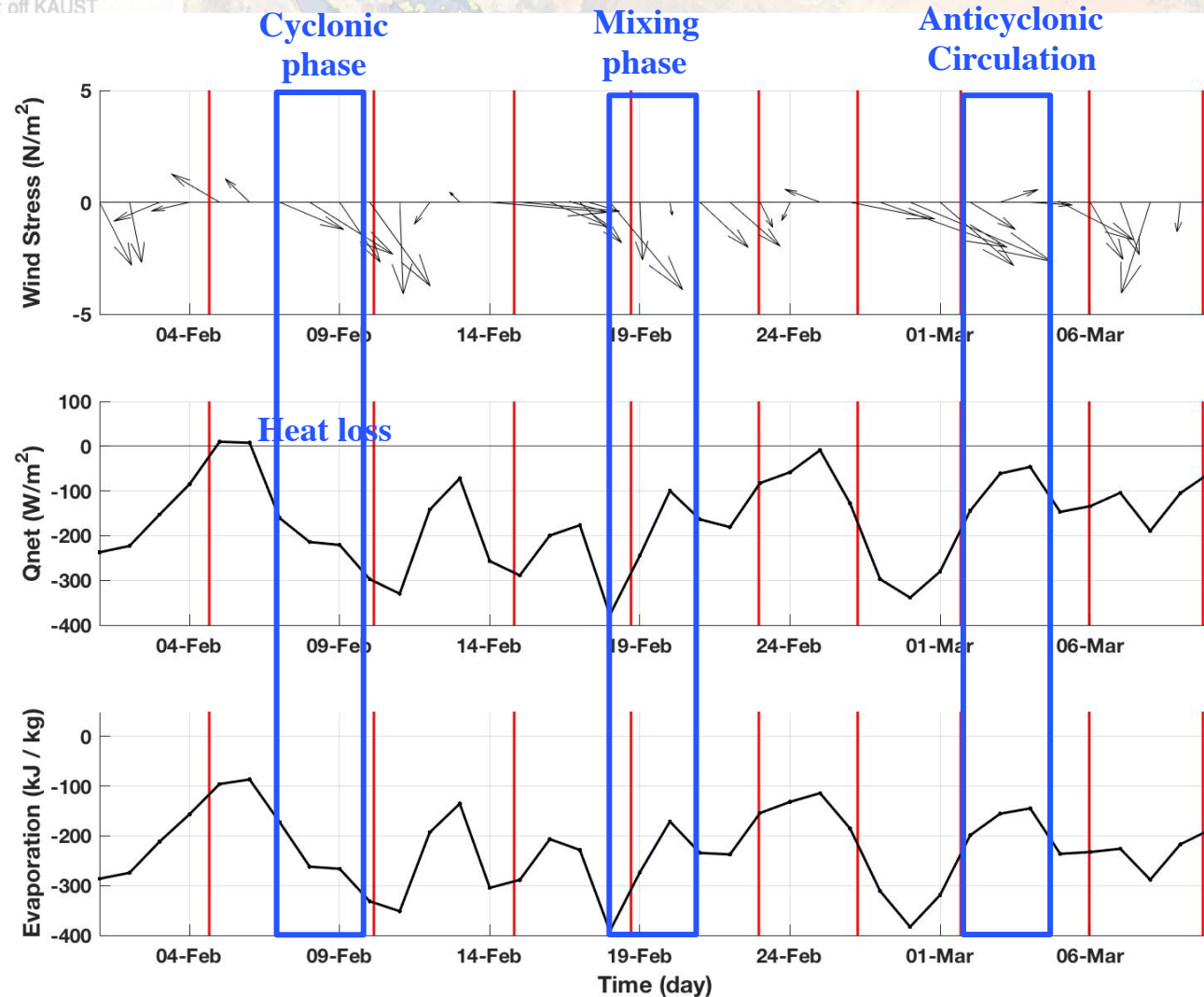
Mixing Phase

Anticyclonic
Circulation

Atmospheric
Forcing

Satellite
Images

Summary





Summary

Background

Study
Approach

Results

Summary

Glider mission lines

Northern line : off Dubai
Central line : off KAUST

Legend

North:

- Change in eddy polarity
- Deep winter mixing/ water mass formation (RSOW)
- Water column ventilation
- Subduction supported by deep O_2 and Chl-a signatures.
- 28 kg/m^3 isopycnal breaks the surface

Central:

- Water advection from the south (warmer, lower salinity)
- Strong stratification
- Subsurface Chl-a maximum.
- 28 kg/m^3 isopycnal deeper than 125-175m (below the euphotic zone)

Google Earth

US Dept of State Geographer

© 2018 ORION-ME

© 2018 Google

Image Landsat / Copernicus

400 km



Makkah

King Abdullah University of Science and Technology

Jeddah

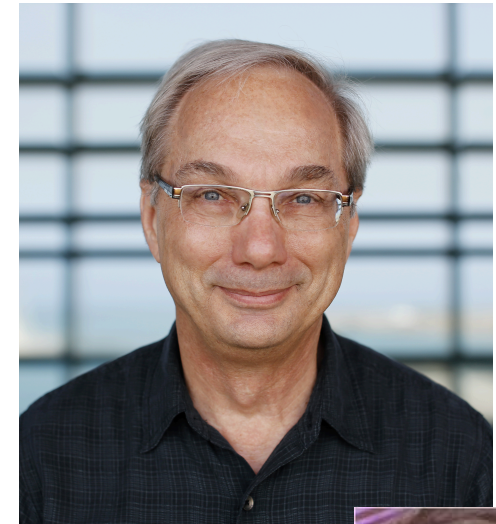




Acknowledgment



- **Prof. Burt Jones**
- Dr. Zoi Kokkini
- Dr. Nikolaos Zarokanellos
- CMOR (esp: Thomas, Samer, Mohammed, Andrew)
- Ute Langner
- Ronald Cadiz
- IOP Lab



Background

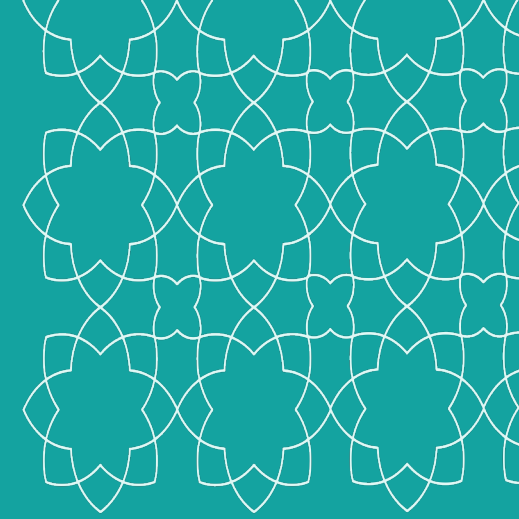
Study
Approach

Results

Summary



جامعة الملك عبد الله
للعلوم والتقنية
King Abdullah University of
Science and Technology



THANK YOU!!!

8th EGO Meeting and International Glider Workshop
May 21-23, 2019, New Jersey