SOCIB Balearic Islands Coastal Observing and Forecasting System

HF RADAR: A KEYSTONE FOR VALIDATING HIGH-RESOLUTION OCEAN MODELS

E. Reyes, B. Mourre, J. Hernández,
E. Aguiar, M. Juza, A. Orfila and J. Tintoré

COASTAL HF RADAR FACILITY
ereyes@socib.es

ROW 2017, 19-21 SEP
LÜNEBURG (GERMANY)

OUTLINE

1. Goal
2. Study area
3. Data set description
    - HFR & met-ocean buoy
    - Model: WMOP operational
4. Results HFR vs. In-situ data
5. Results WMOP vs. HFR data
6. Conclusions

01 GOAL

HFR vs. in-situ data

- To validate the HF radar surface currents using in-situ current observations
- To quantify the quality of the HFR surface current measurements
- To evaluate the HFR performance
- To identify temporal periods of malfunctioning of the radar (or the buoy)

WMOP forecast model assessment vs. HFR

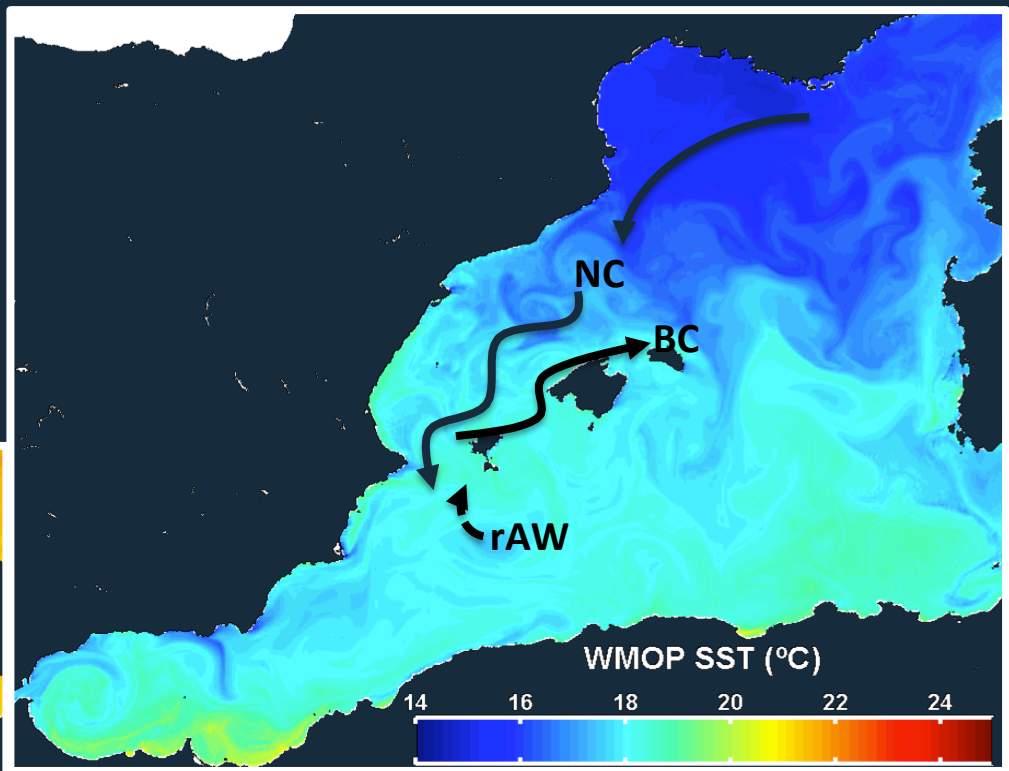
- To ensure that model simulation represents the dynamic of the ocean surface (prerequisite to DA)
- To characterize and understand the model errors
- To compare different versions and evaluate potential improvements

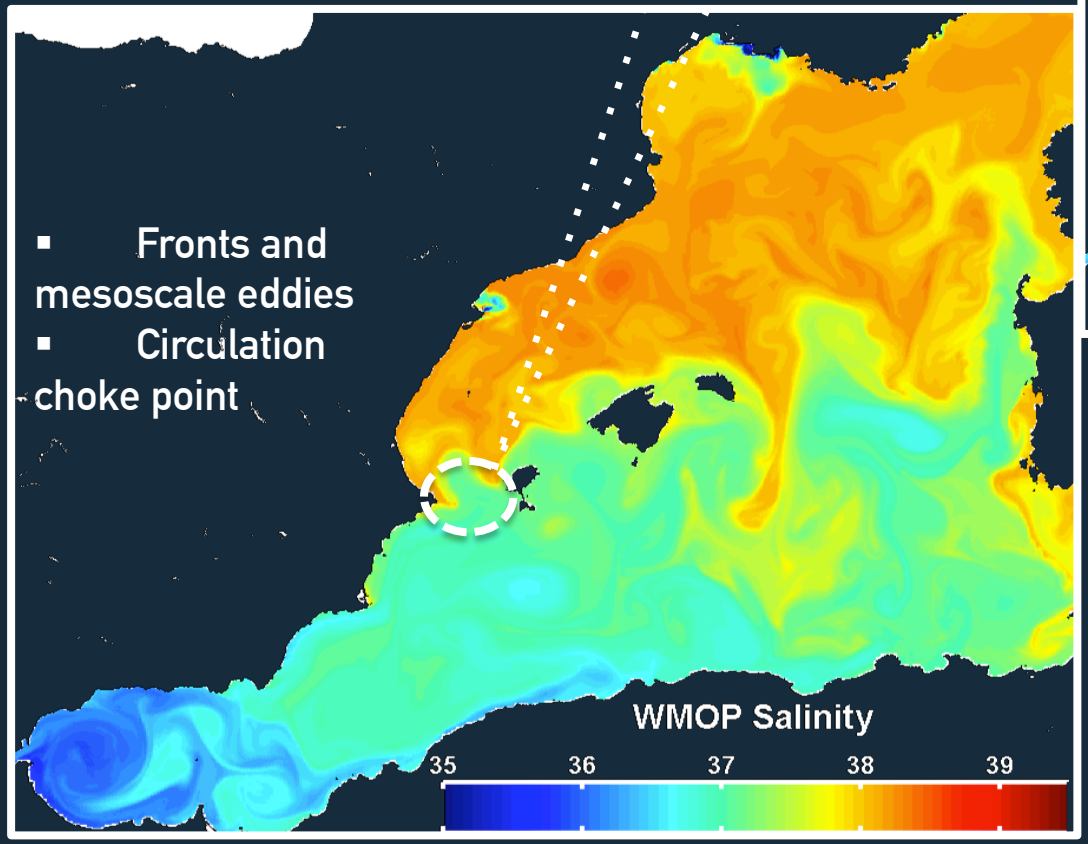
SOCIB

02 STUDY AREA

Ibiza Channel

Biodiversity hotspot





- Fronts and mesoscale eddies
- Circulation choke point

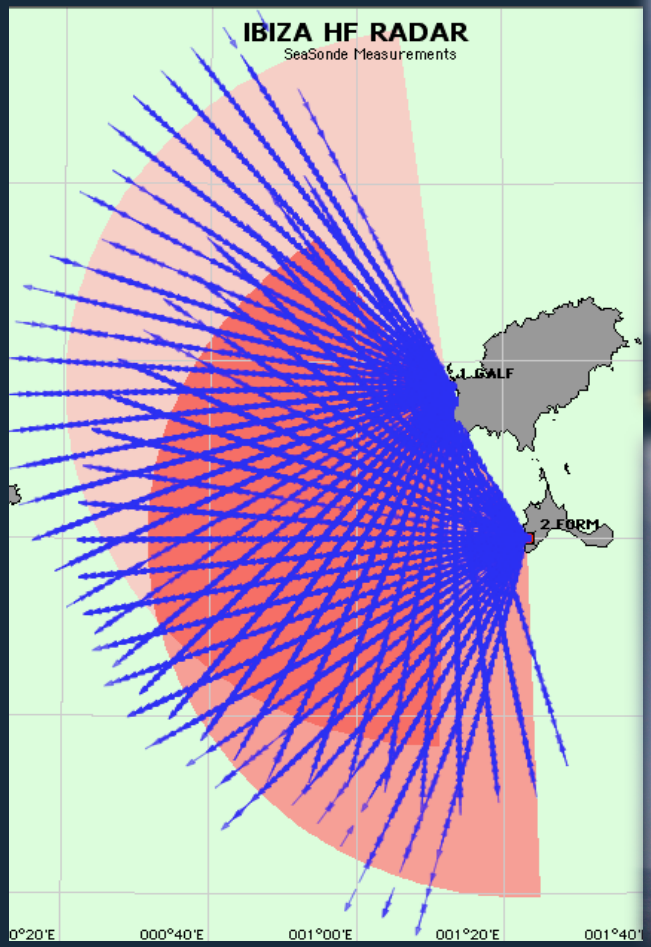
- Interaction between Atlantic and Mediterranean waters:
  - Southward NC: saltier and cooler waters
  - Northward BC: fresher and warmer waters
- Seasonality
  - Winter: larger southward transport
  - Summer: larger northward transport

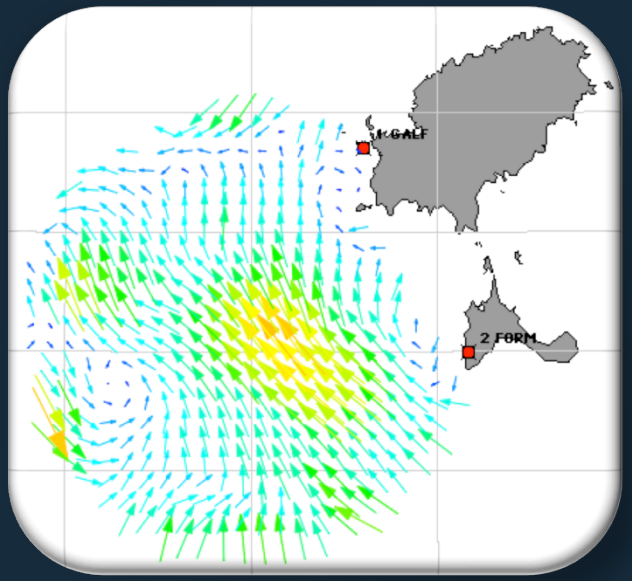
SOCIB

03 DATA SET DESCRIPTION: HFR

2 CODAR SeaSonde HF radar stations

Frequency= 13.5 MHz
Bandwidth= 90 kHz



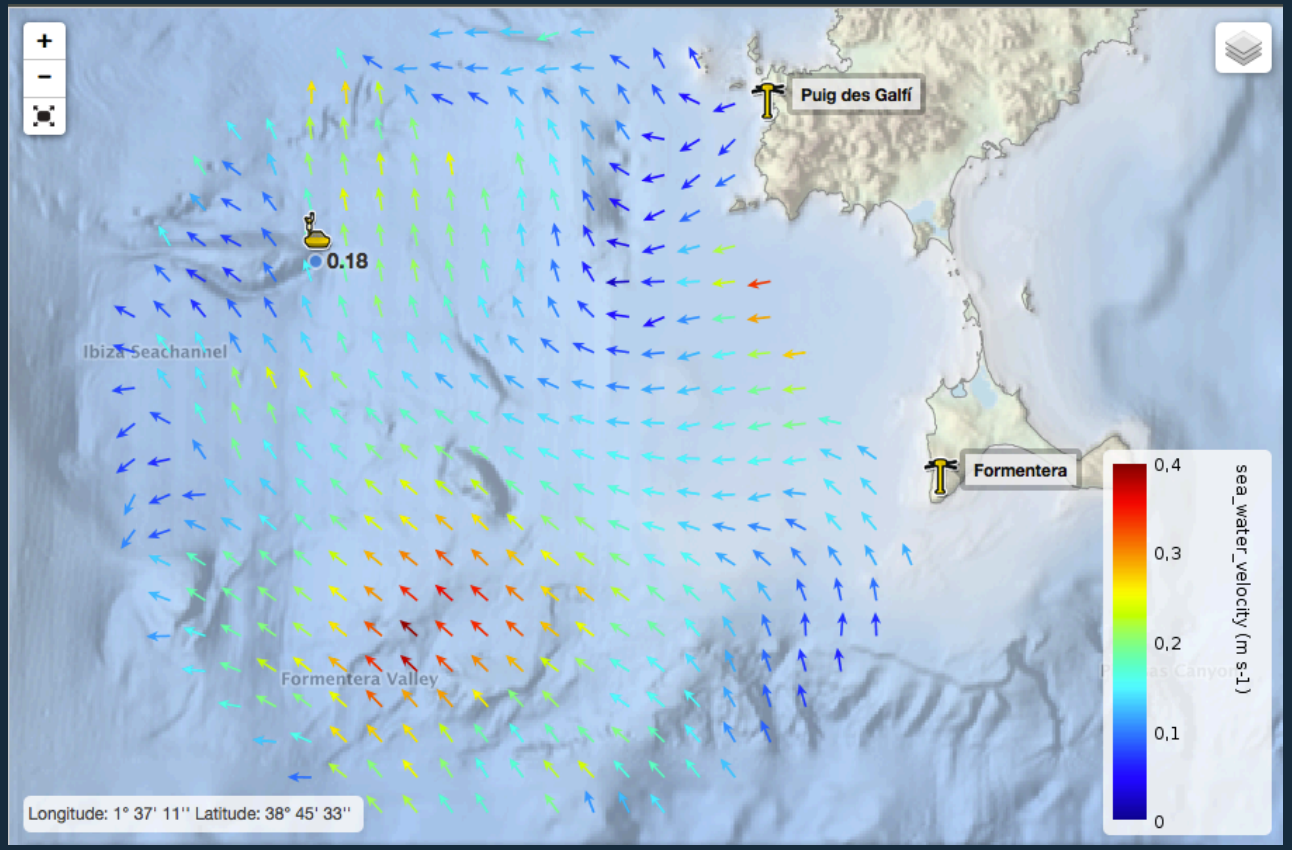


HF radar surface currents

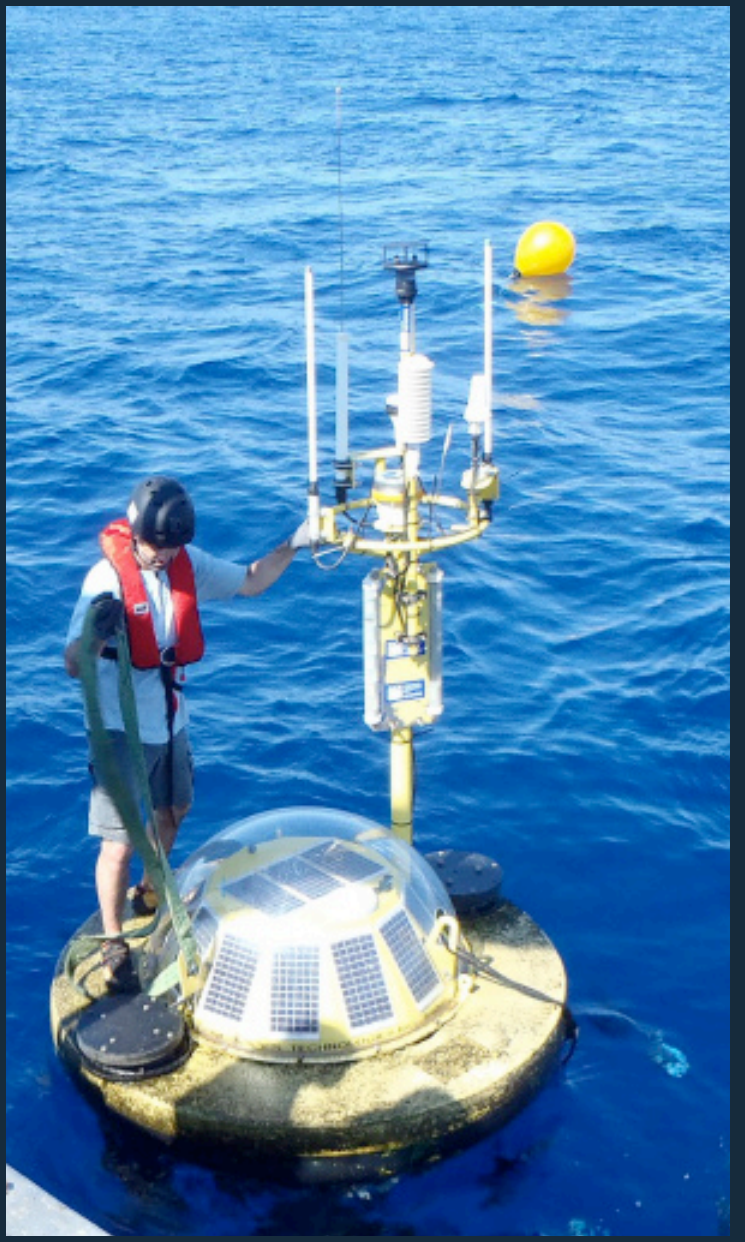
SETTINGS		
	Output interval	1 h
	Grid resolution	3 km
	Averaging radius	6 km
	Maximum range totals	65 km
	Azimuth range	5°
	Range cell / resolution	1.6 km
	Average Depth	~0.9 m
	Resonant Bragg condition	Λ_{radar}= 22.2 m Λ_{wav}=11.1 m

03 DATA SET DESCRIPTION: MET-OCEAN BUOY

Ibiza Channel Buoy- CM & ADCP



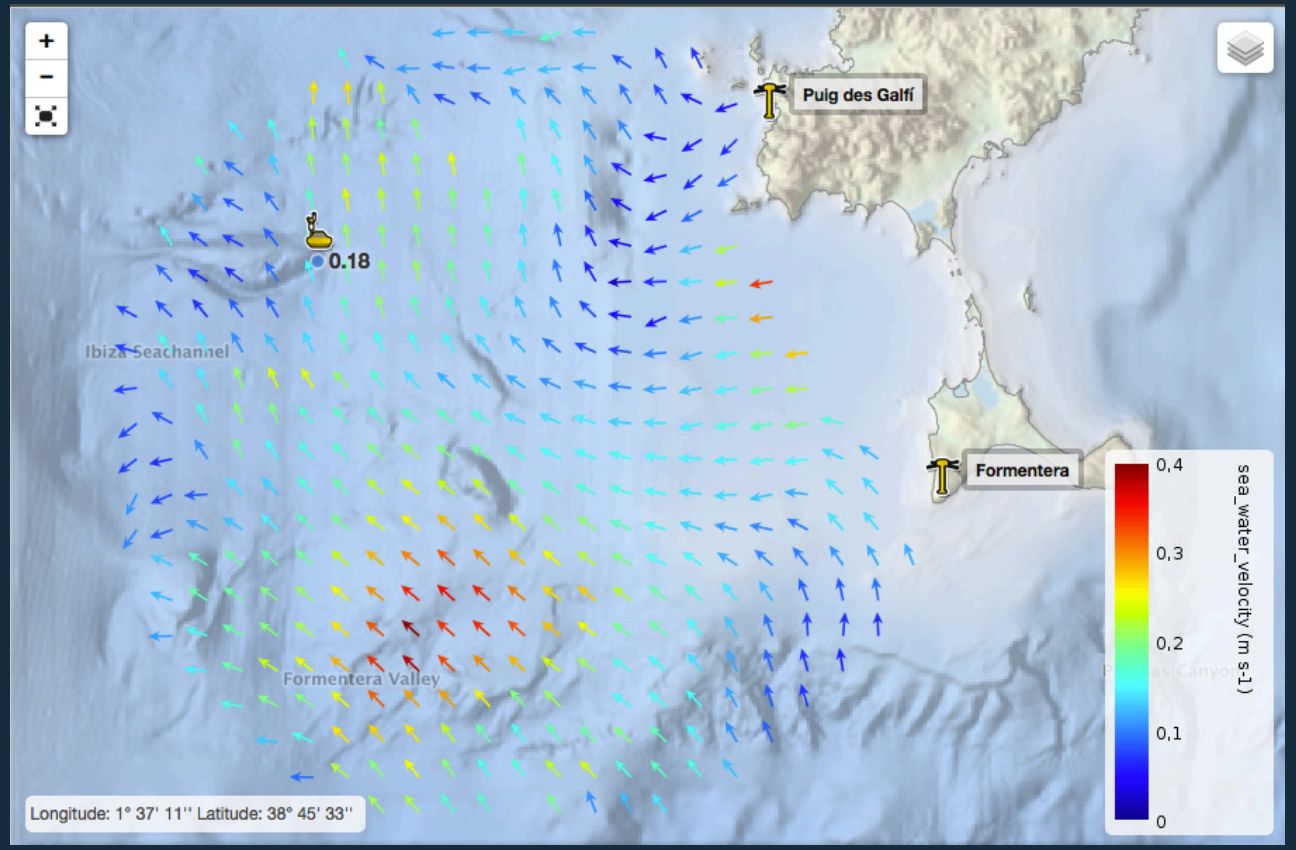
HFR total currents and meteo-buoy location inside HFR footprint



SOCIB

03 DATA SET DESCRIPTION: MET-OCEAN BUOY

Ibiza Channel Buoy- CM & ADCP



HFR total currents and meteo-buoy location inside HFR footprint

- Inside HFR total footprint
- NRE data availability
- Comparable depth of measurements with HFR

CM (SCB-DCS002)

CM [depth]= 1.5 m

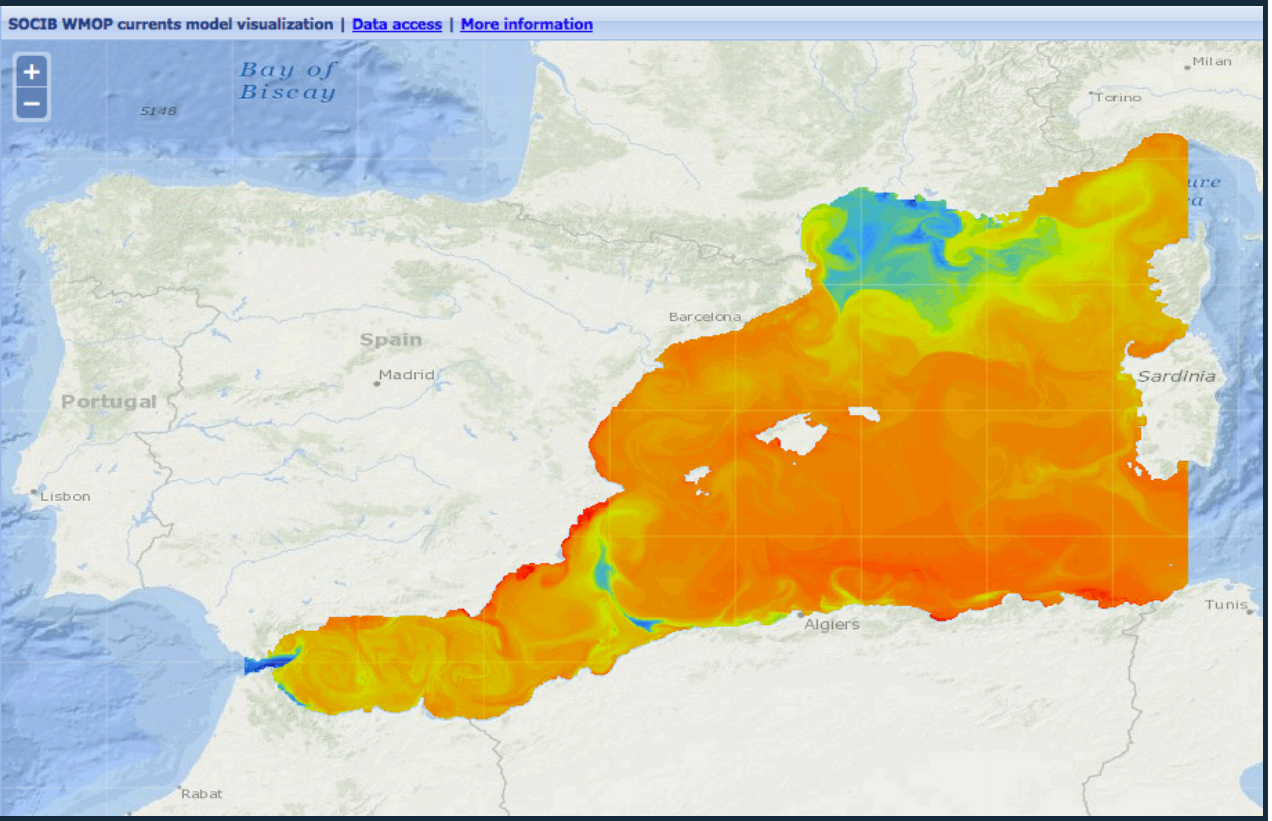
ADCP (SONTEK002)

ADCP [depth] = 5-125 m

Deployed: 24th Sep.2013
Loc: 38°49.46'N / 0° 47.02 W
Distance: 40 km from GALF
55 km from FORM
Distance CM-closest radar grid point = 1400 m
Re-deployed: Jun.2015
Re-deployed: Jun.2017

03 DATA SET DESCRIPTION: WMOP FORECASTING SYSTEM

WMOP (Westerm Mediterranean OPerational)



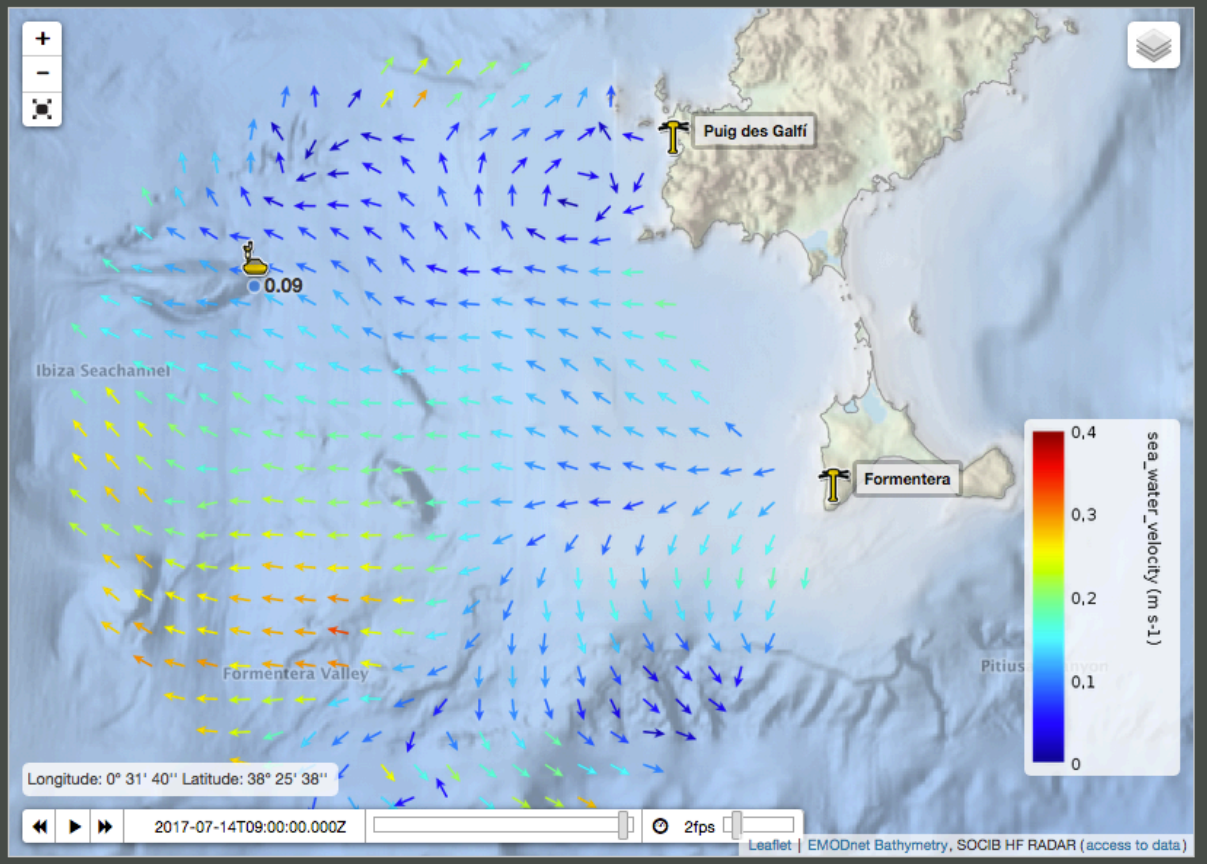
WMOP model spatial domain

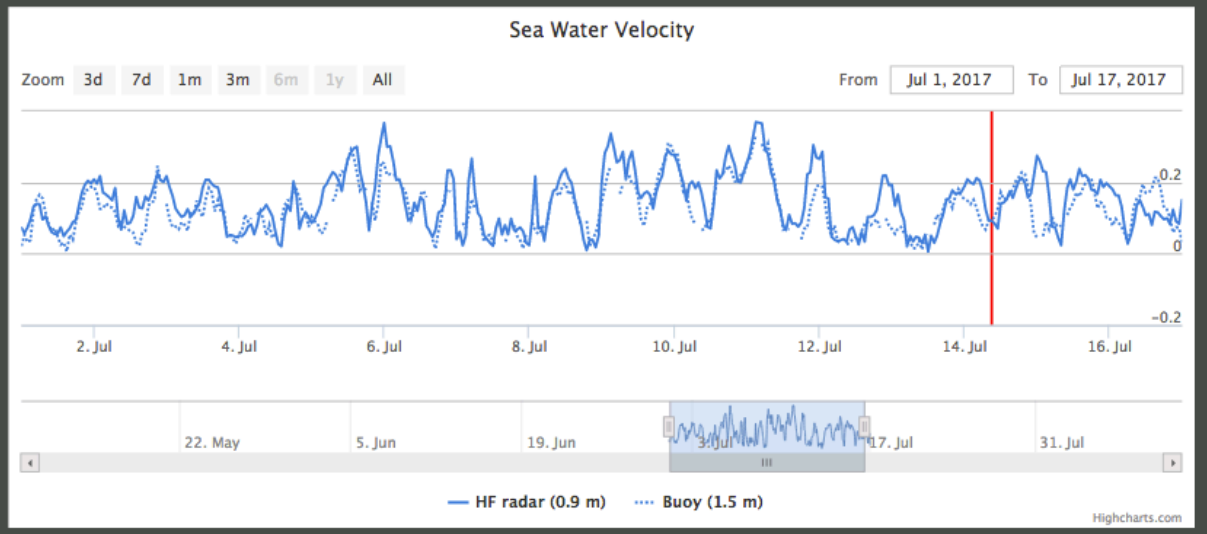
MODEL CONFIGURATION		
	Forecast Length	72 hours
	Spatial Resolution	1/50°~2 km
	Temporal Resolution	3 hours
	Temporal Coverage	27/08/2013-ongoing
	Update frequency	Daily
	Atm Forcing HIRLAM	3h; 1/20°
	Tides	NO
	Rivers	6
	Open boundaries	MED-MFC
	Assimilation	No
	Analysis release freq	Weekly (on Tuesday)
	Variables (3D, 13 levels)	Tem; Sal; U&V

SOCIB

04 RESULTS: HFR VS. IN-SITU

HFR vs. CM (NRT)

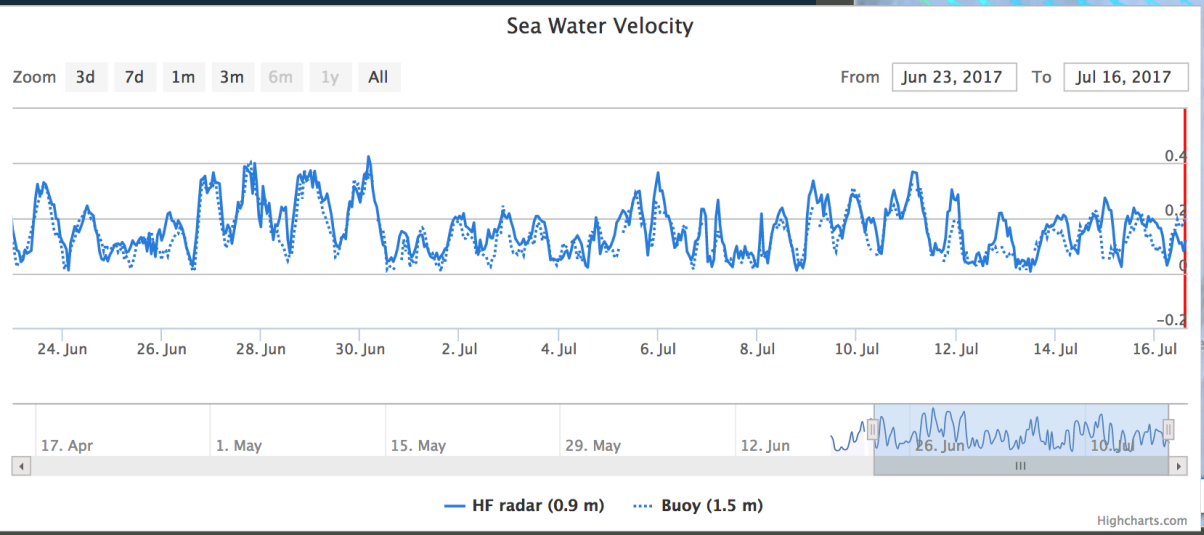


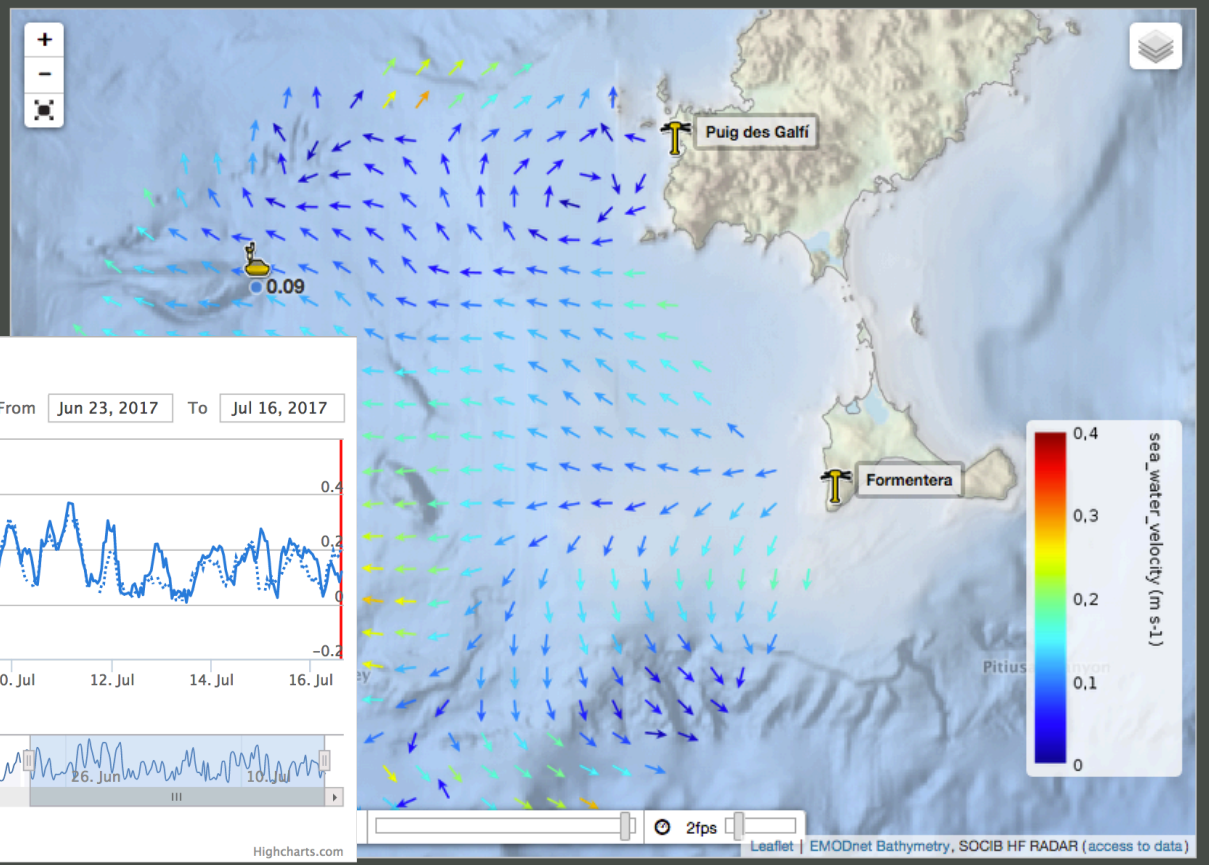


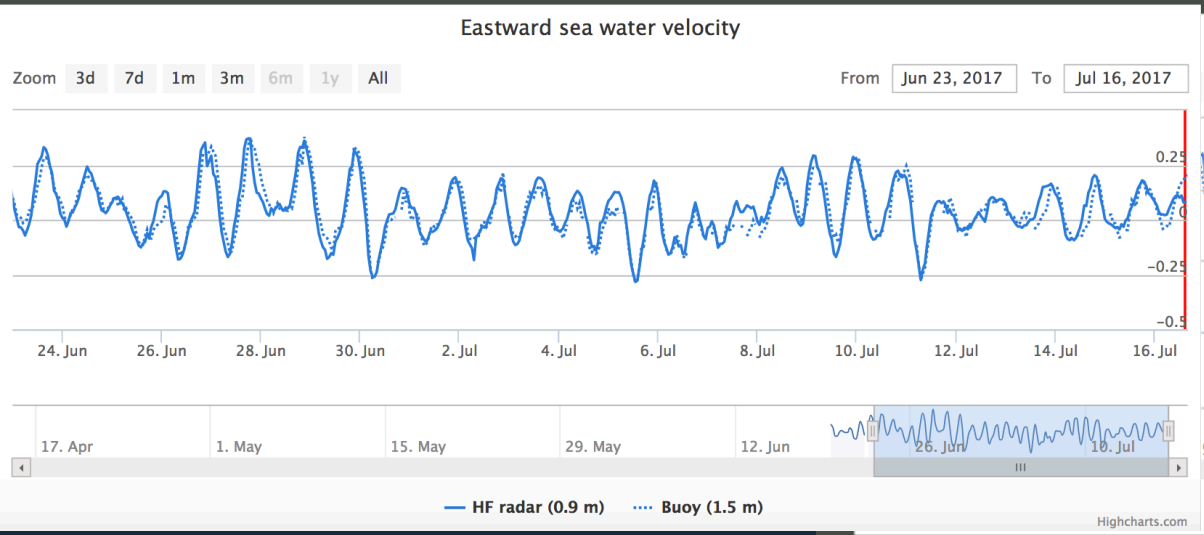
SOCIB

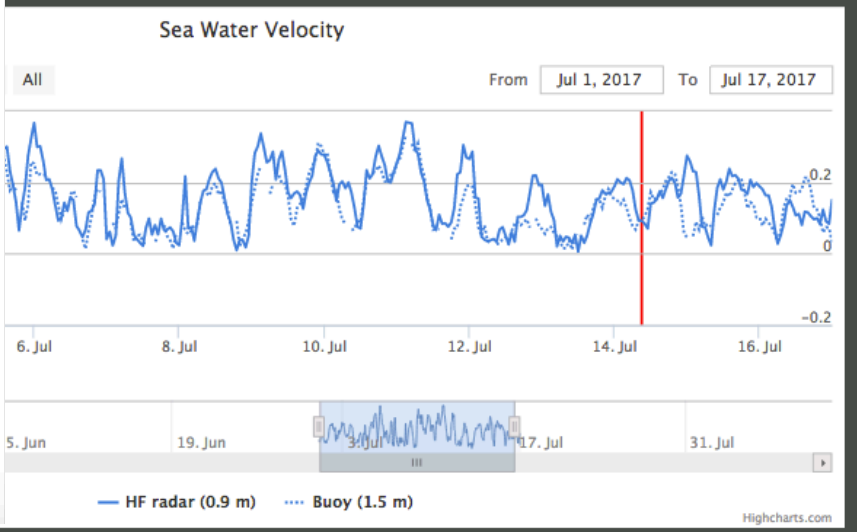
04 RESULTS: HFR VS. IN-SITU

HFR vs. CM (NRT)





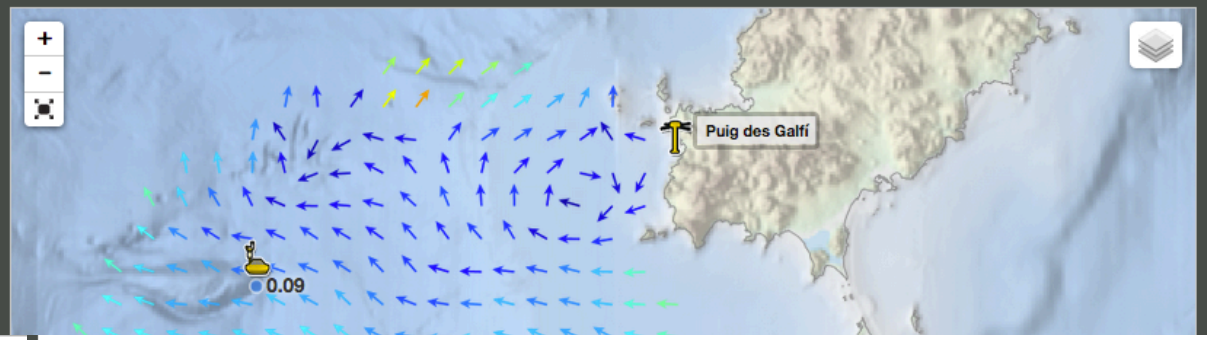


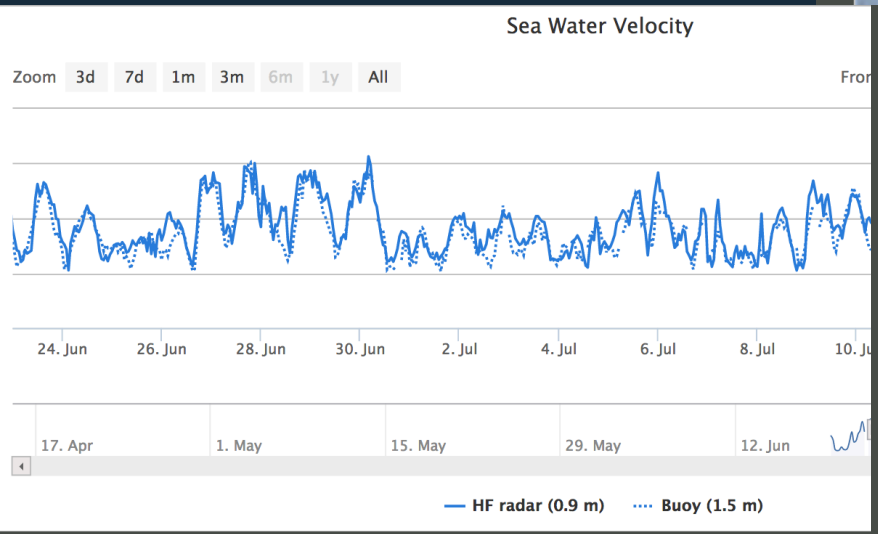


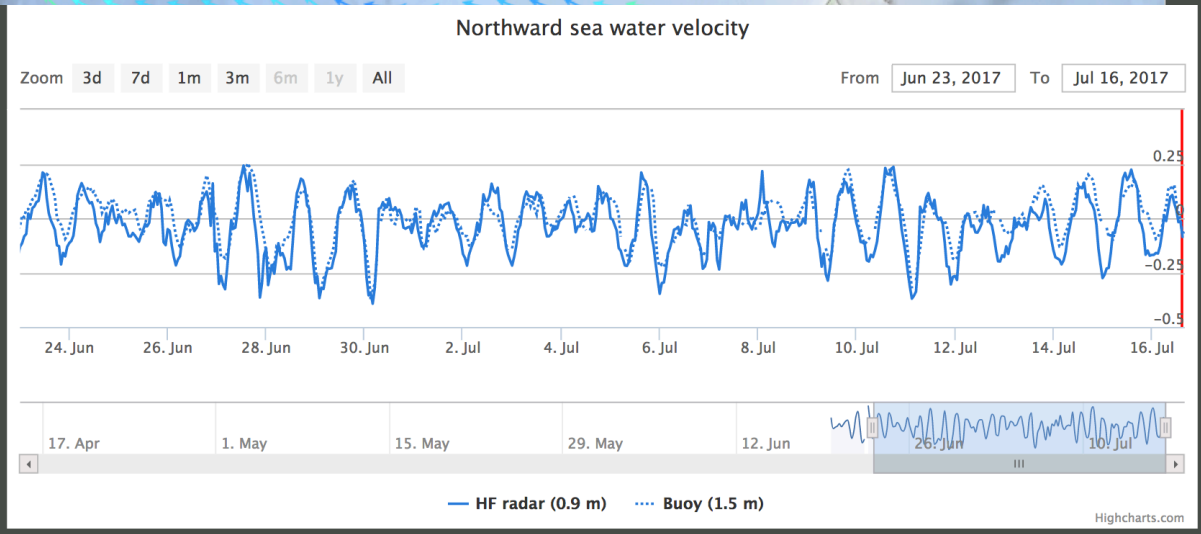
SOCIB

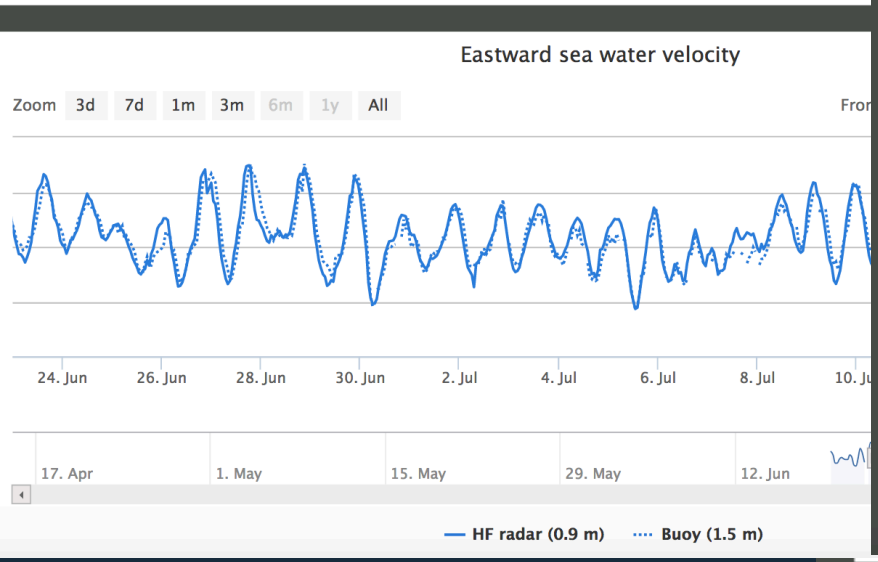
04 RESULTS: HFR VS. IN-SITU

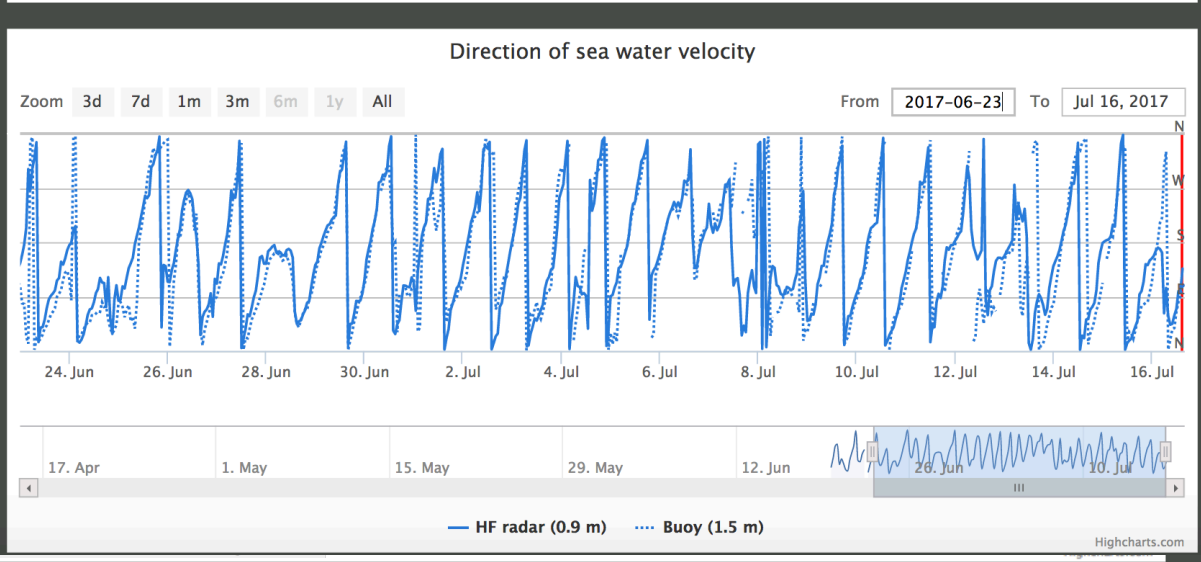
HFR vs. CM (NRT)







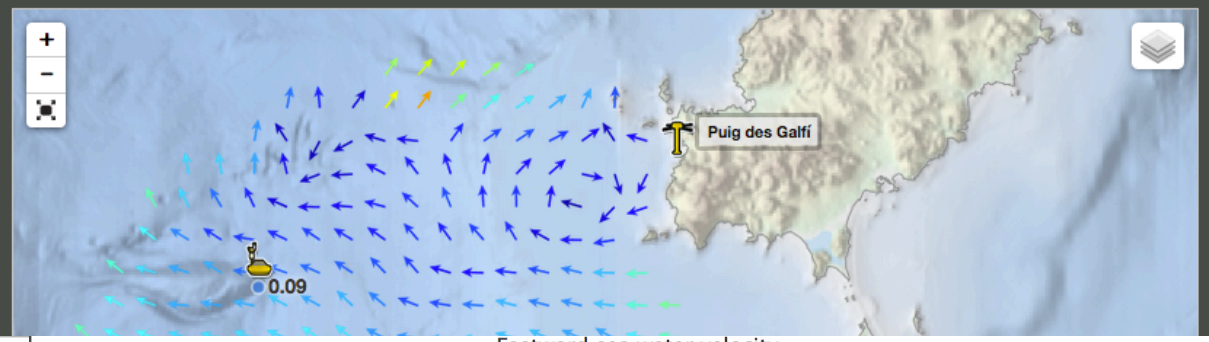


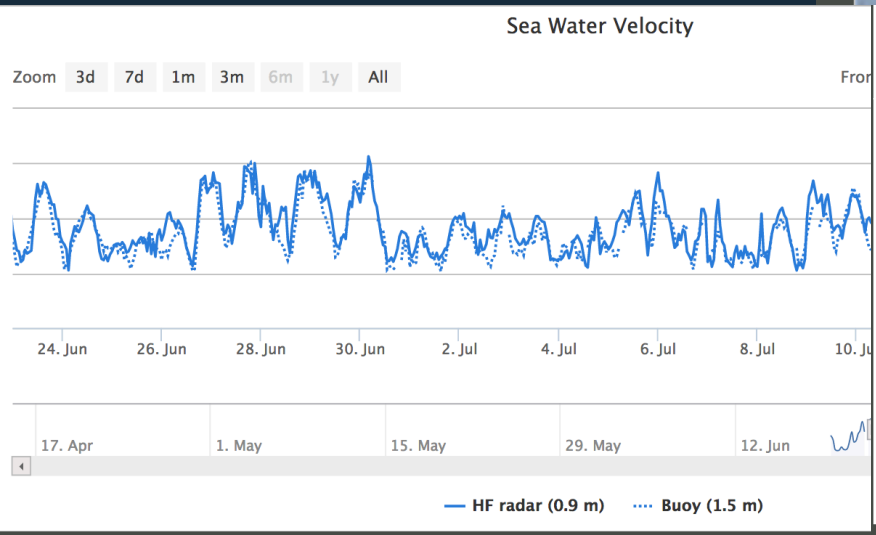


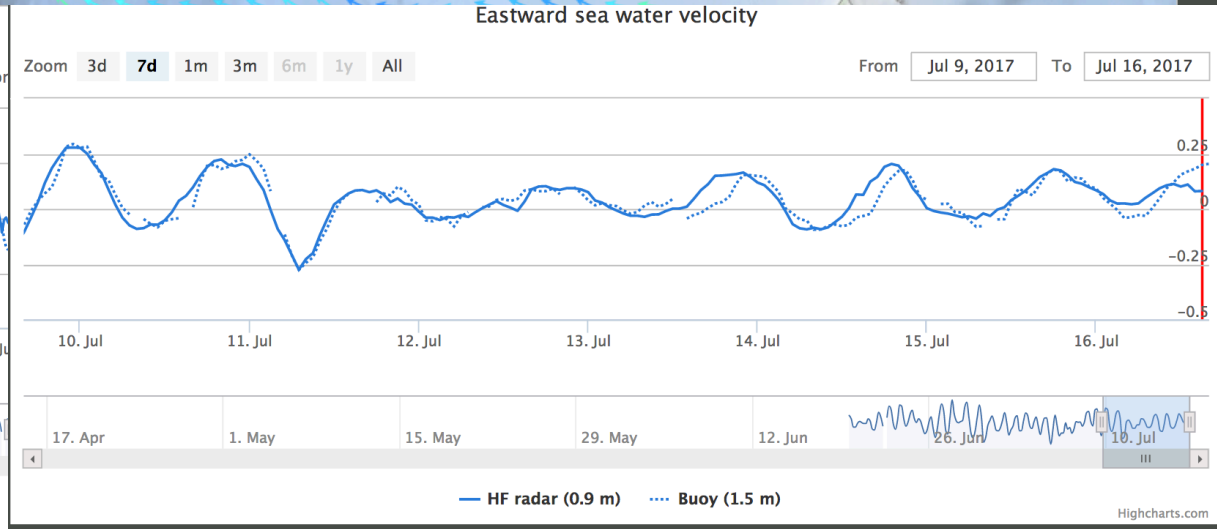
SOCIB

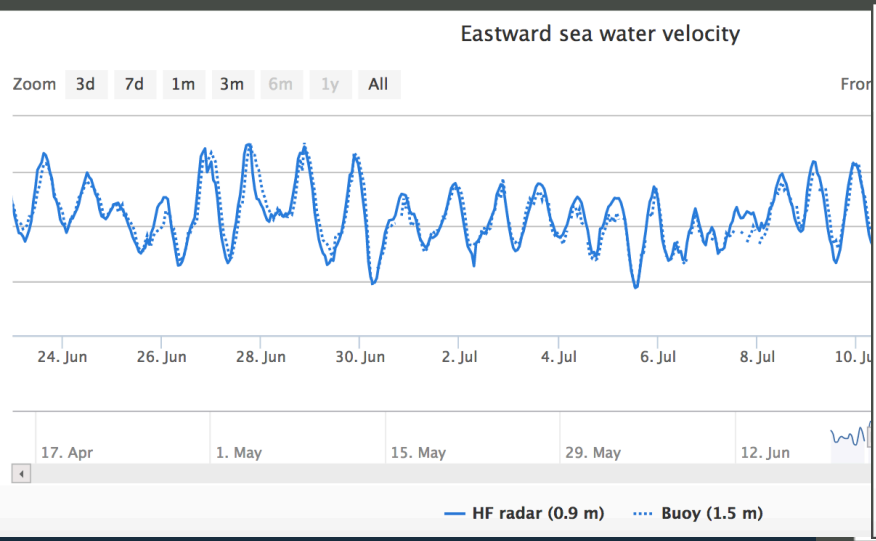
04 RESULTS: HFR VS. IN-SITU

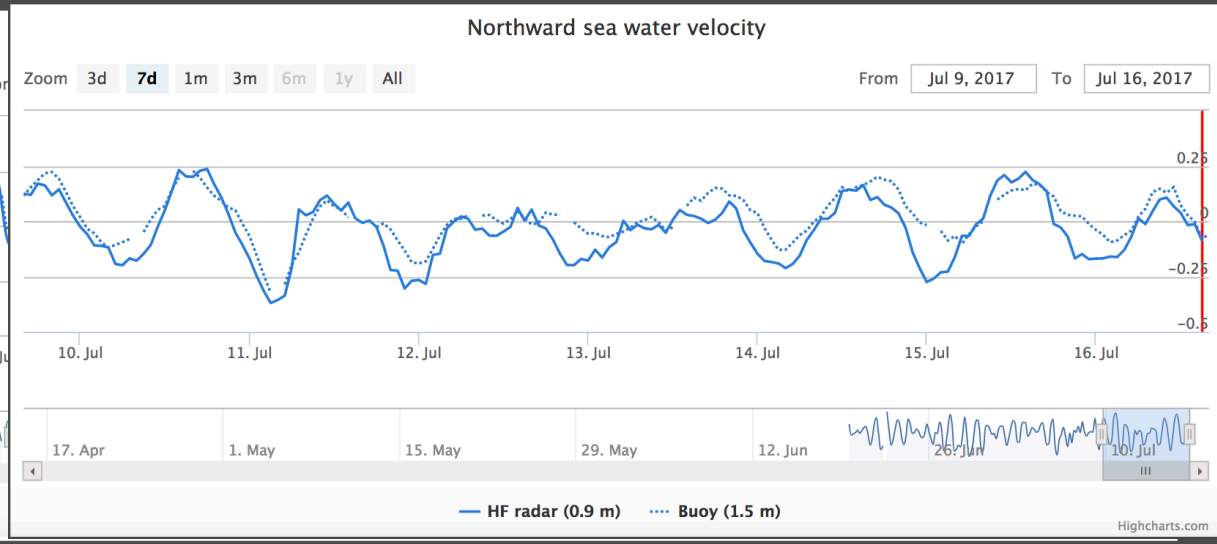
HFR vs. CM (NRT)







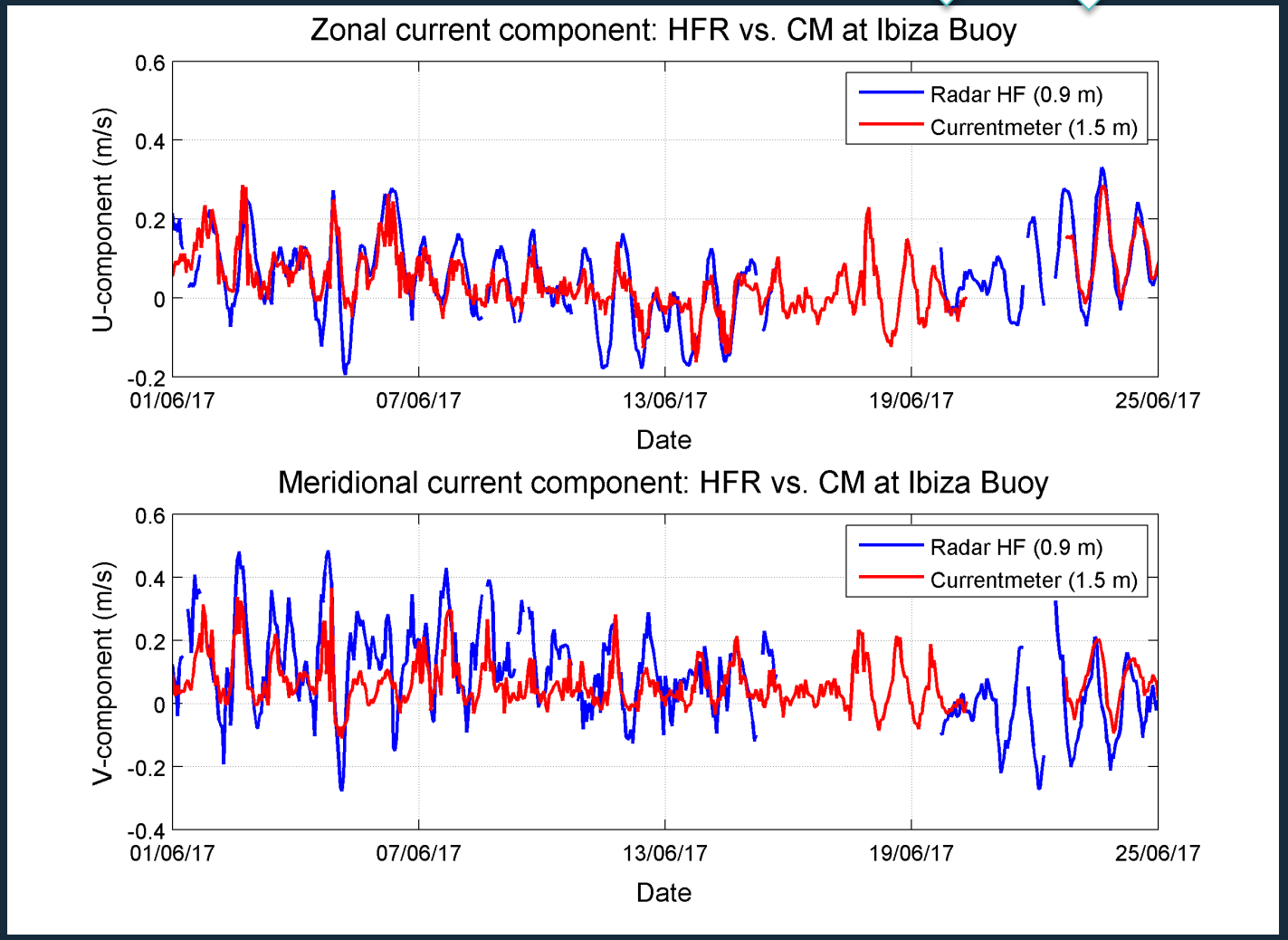


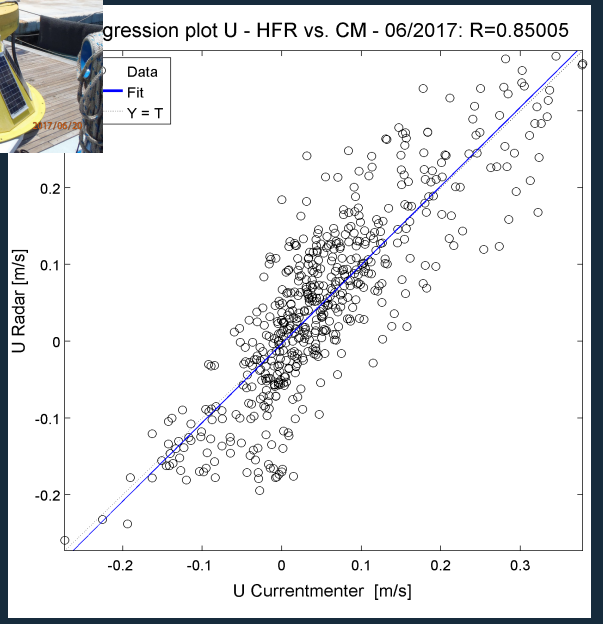


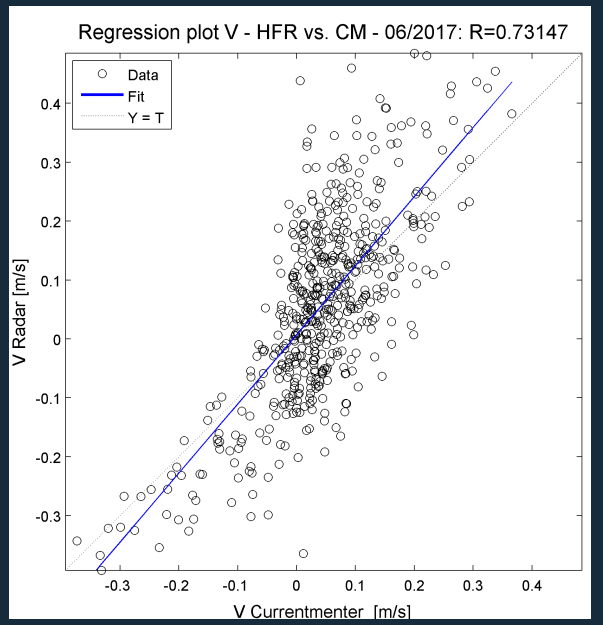
SOCIB

04 RESULTS: HFR VS. IN-SITU

HFR vs. CM (DM) – June 2017







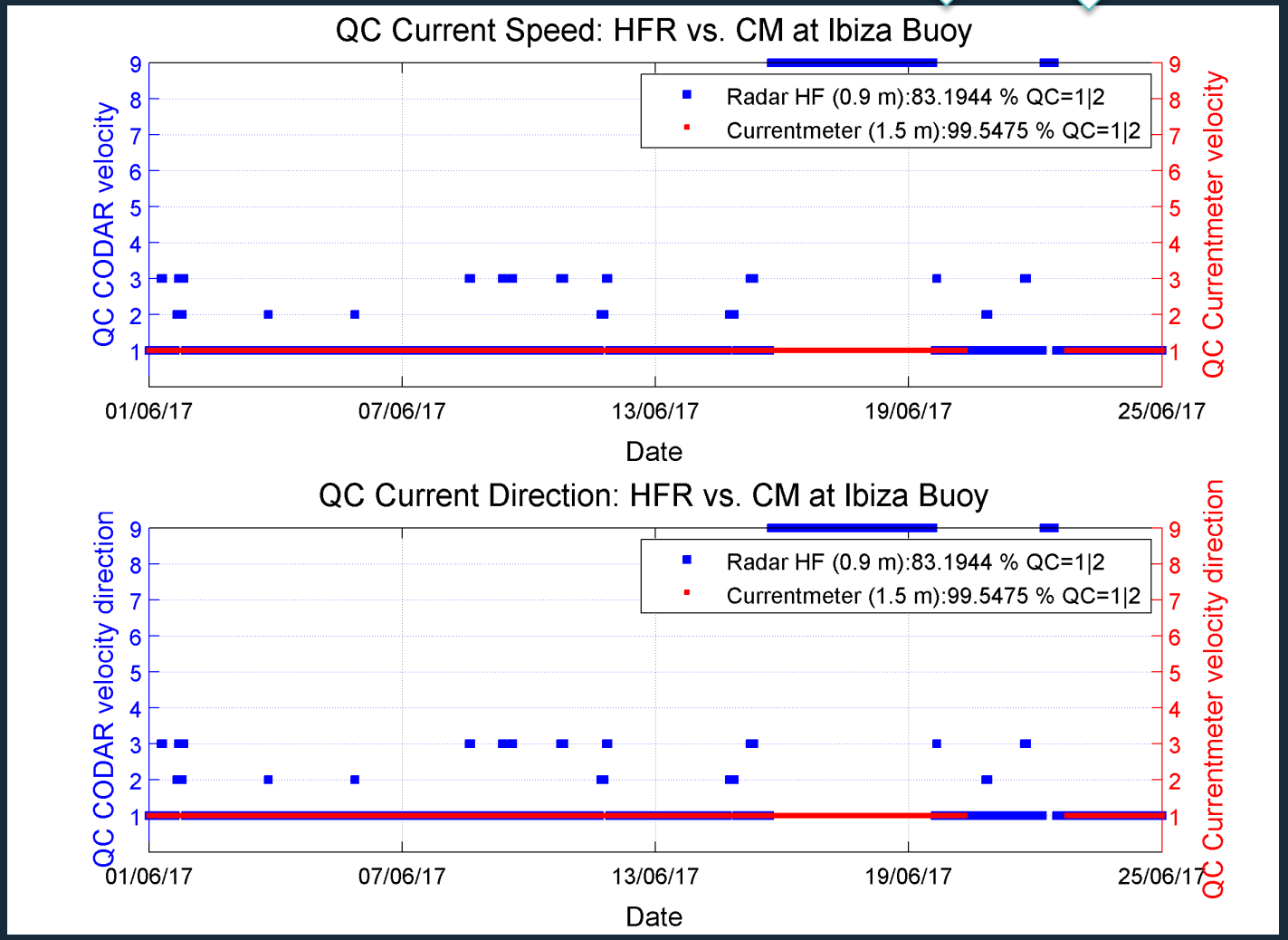
Time series

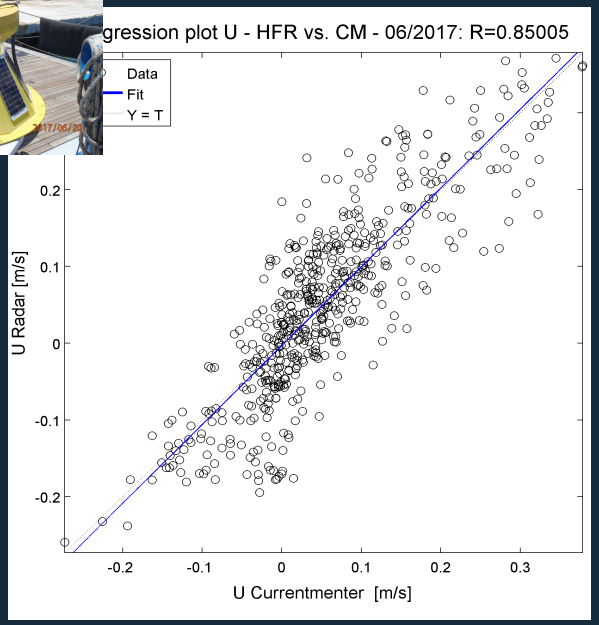
Scatter plots

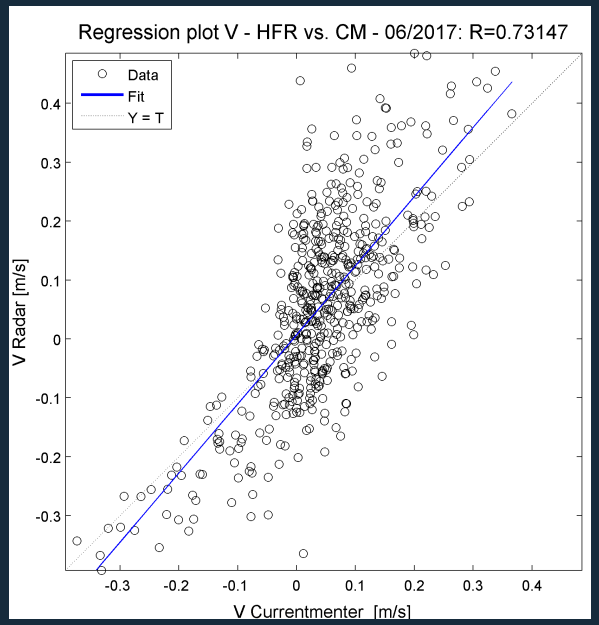
SOCIB

04 RESULTS: HFR VS. IN-SITU

HFR vs. CM (DM) – June 2017





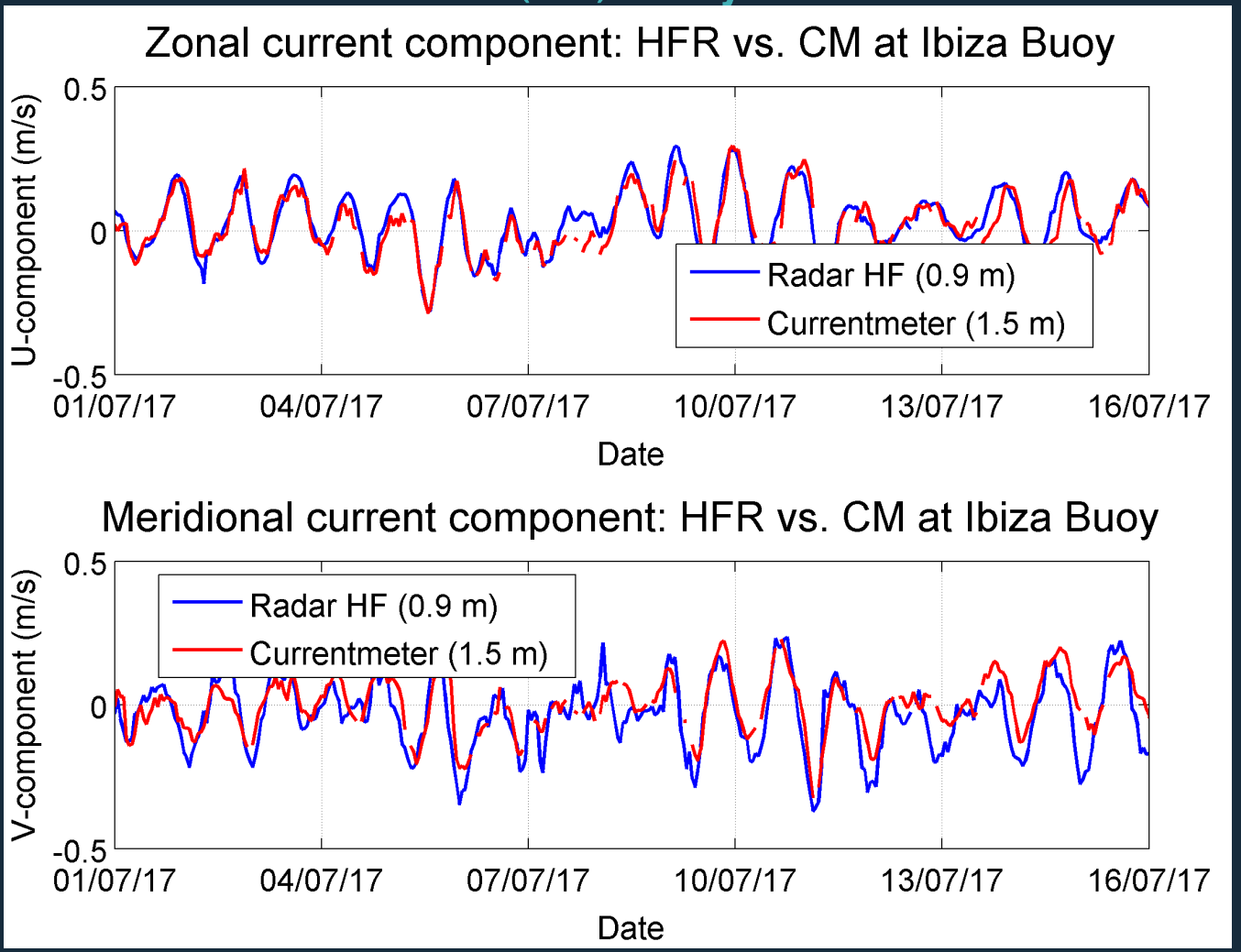


Time series

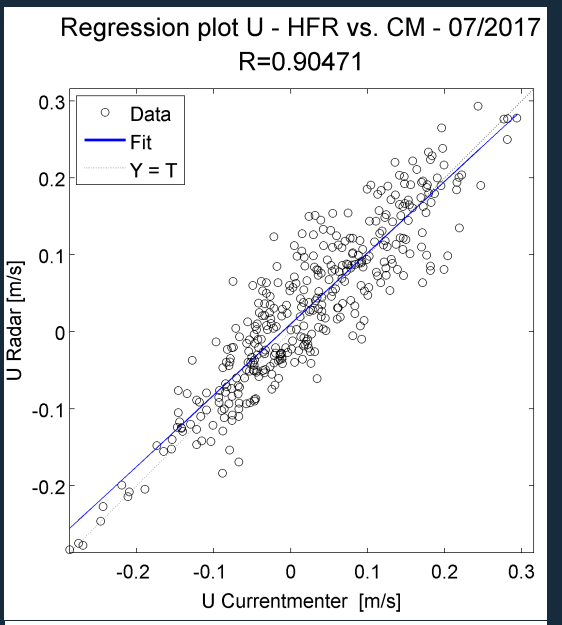
Scatter plots

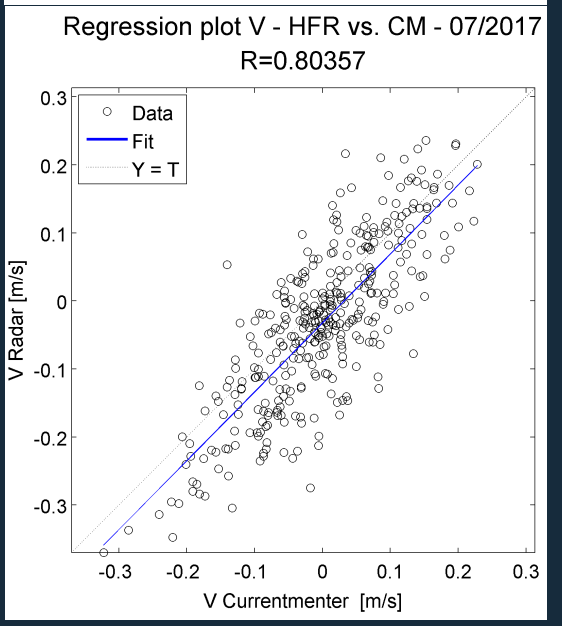
04 RESULTS: HFR VS. IN-SITU

HFR vs. CM (DM) – July 2017



Time series

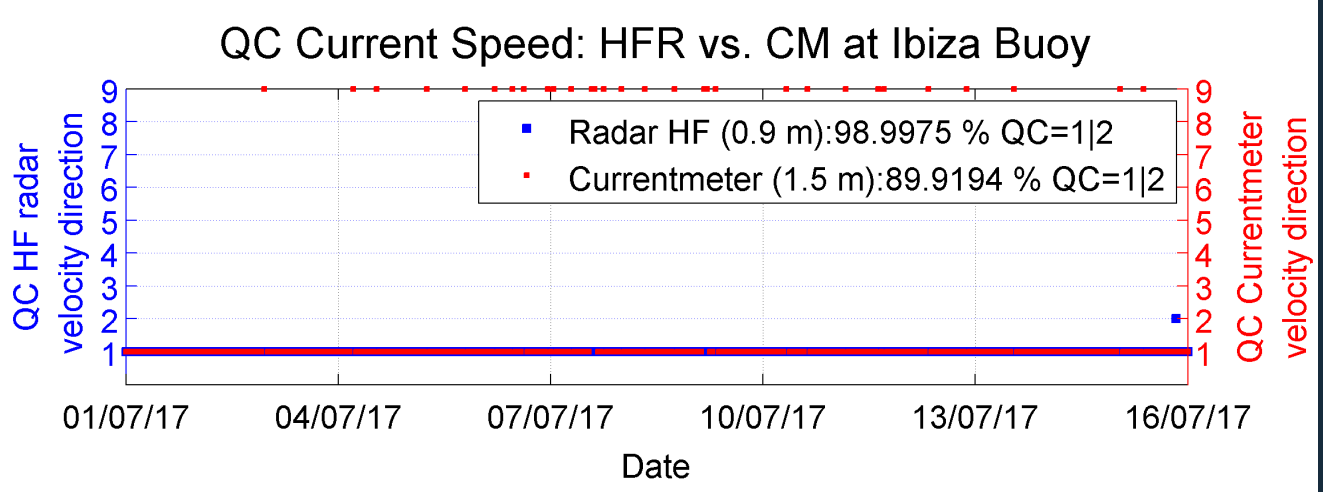


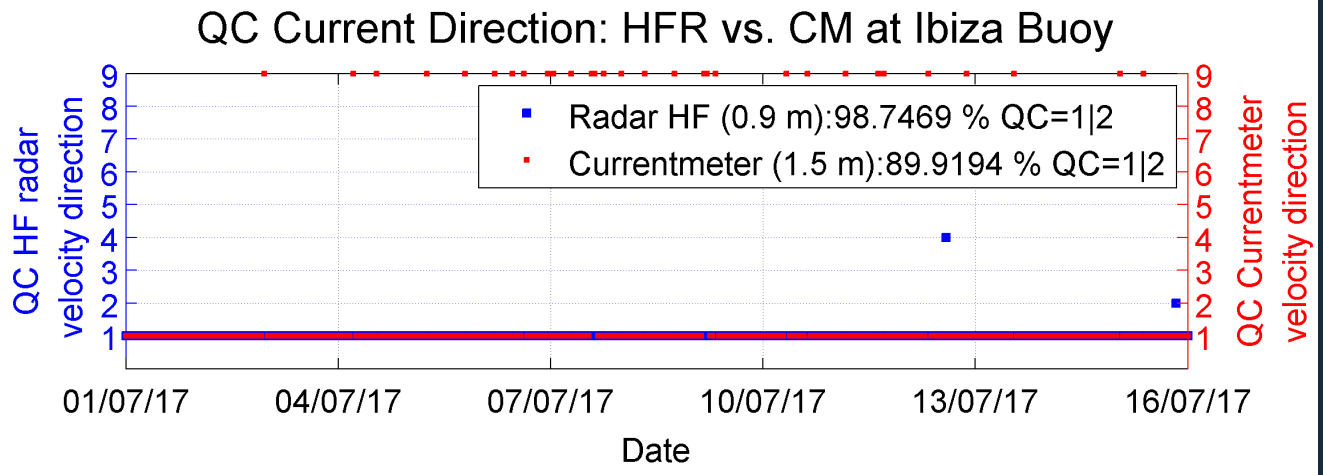


Scatter plots

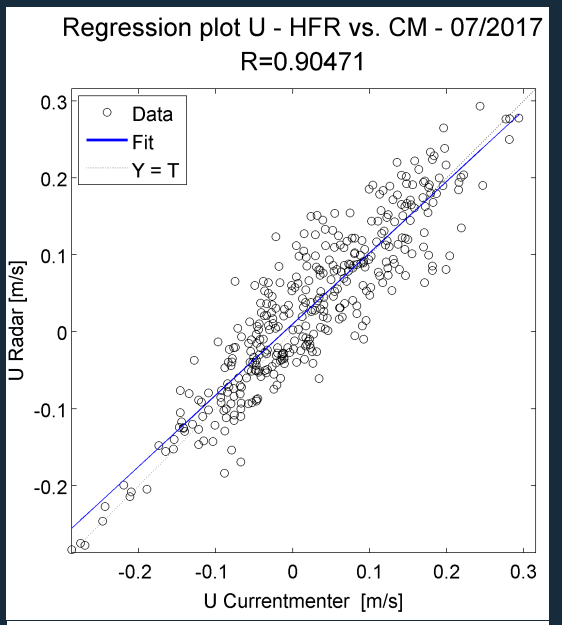
04 RESULTS: HFR VS. IN-SITU

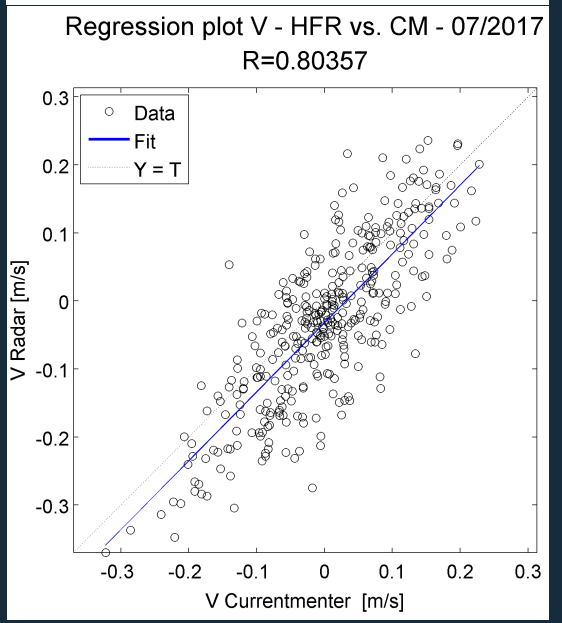
HFR vs. CM (DM) – July 2017





Time series



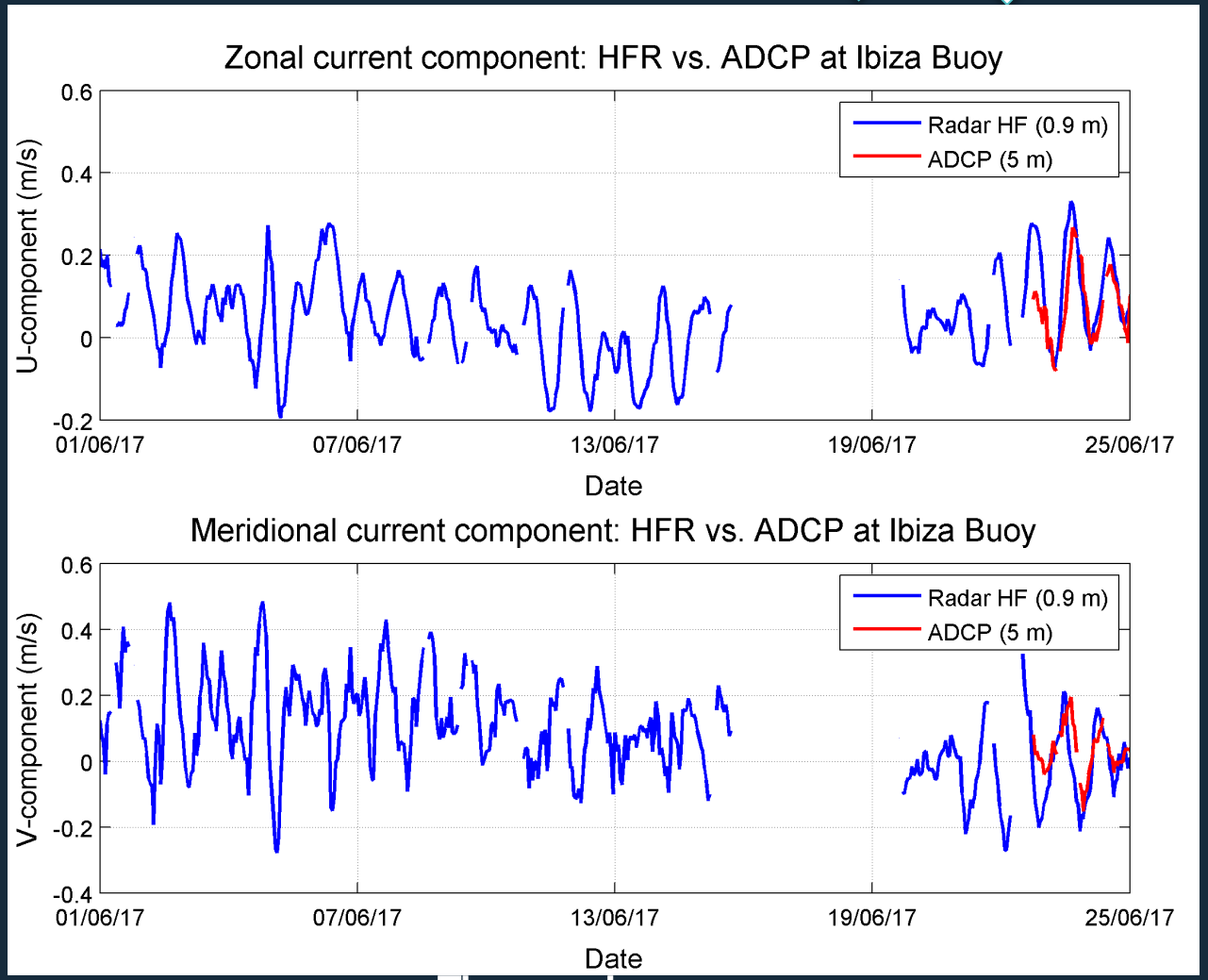


Scatter plots

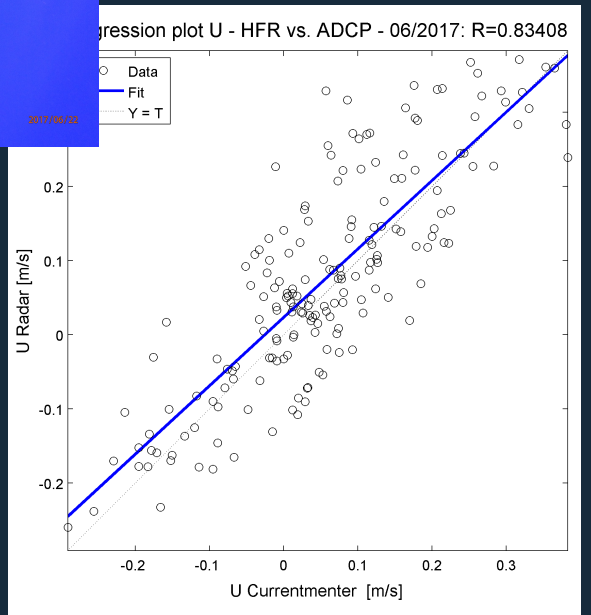
SOCIB

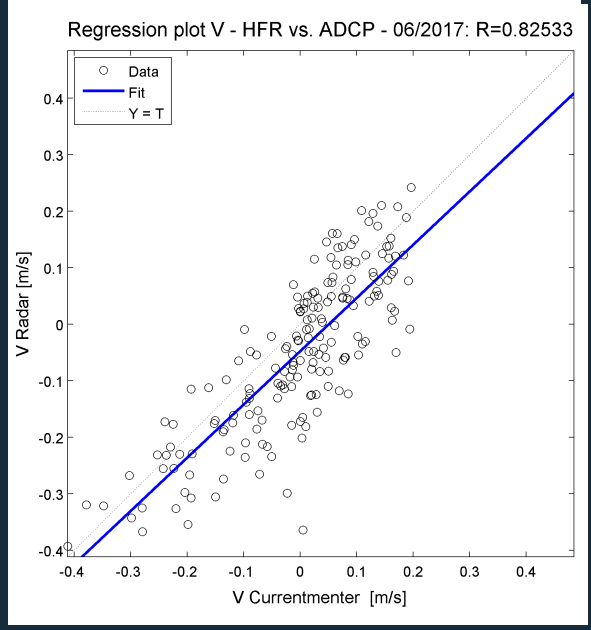
04 RESULTS: HFR VS. IN-SITU

HFR vs. ADCP (DM) – June 2017



Time series



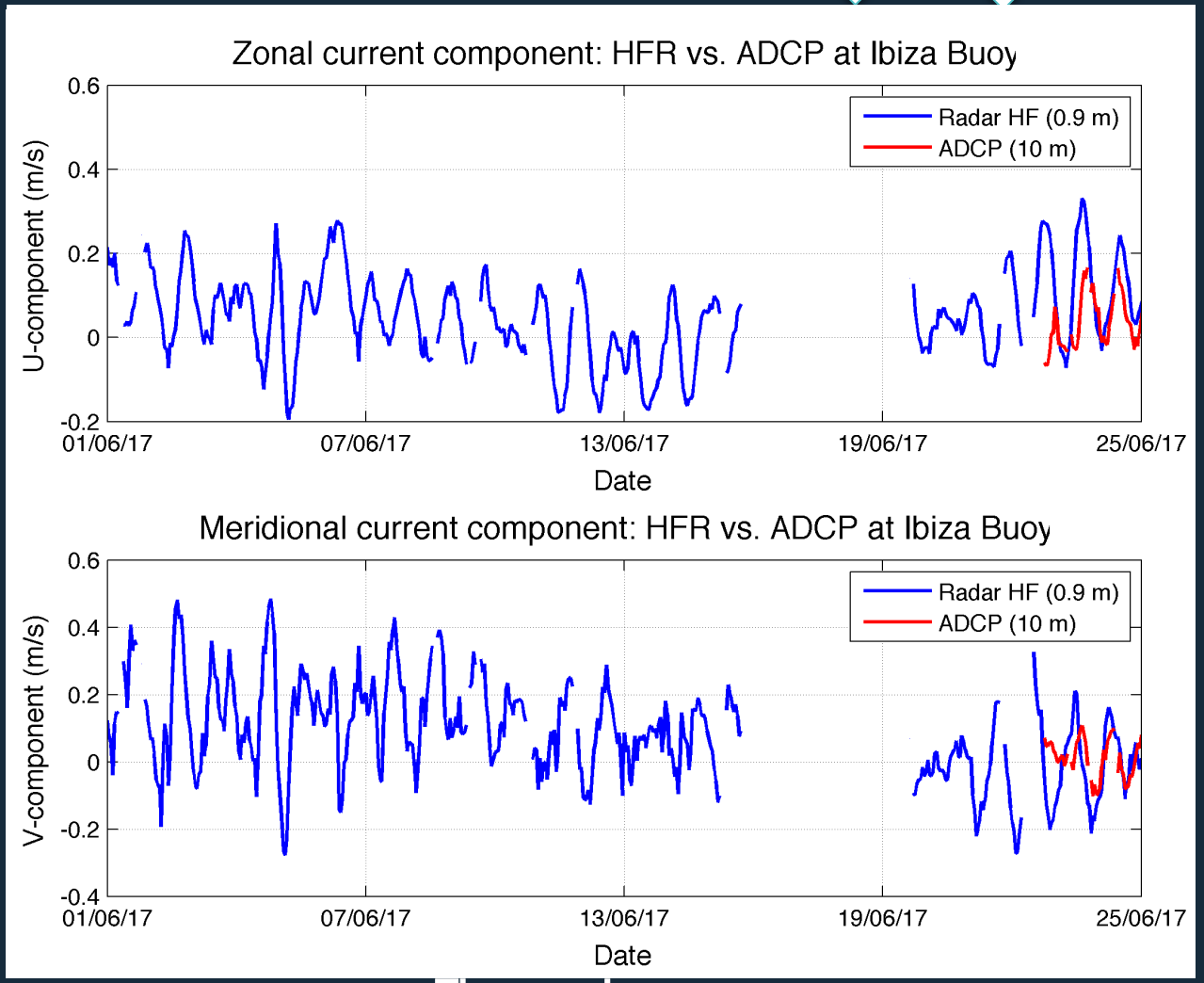


Scatter plots

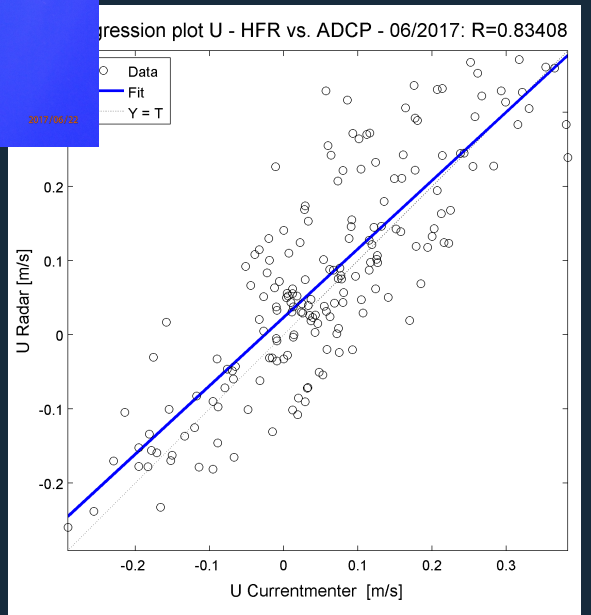
SOCIB

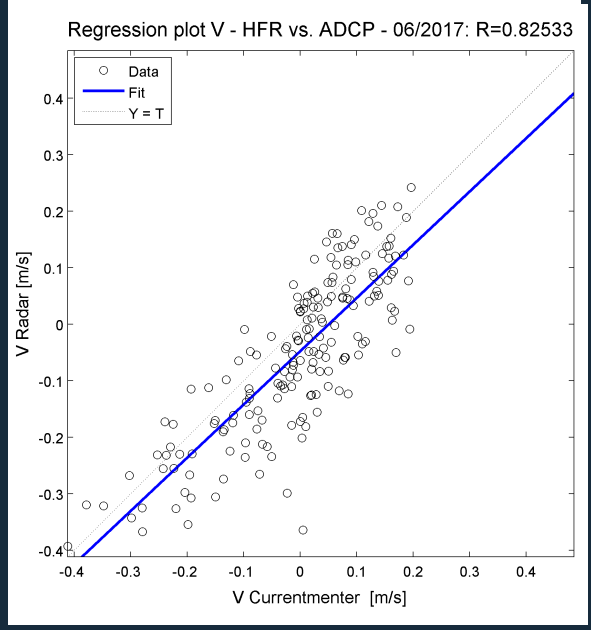
04 RESULTS: HFR VS. IN-SITU

HFR vs. ADCP (DM) – June 2017



Time series



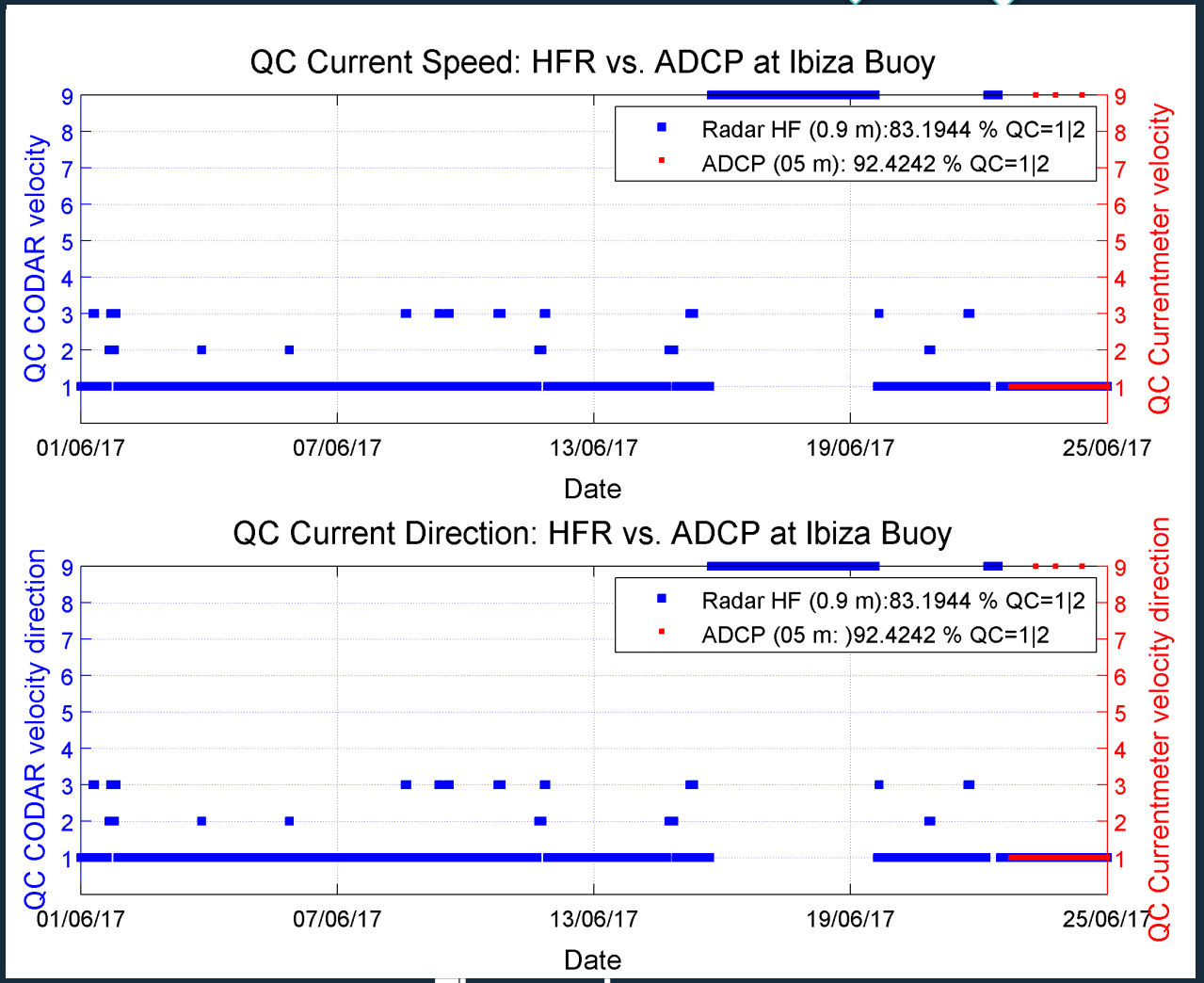


Scatter plots

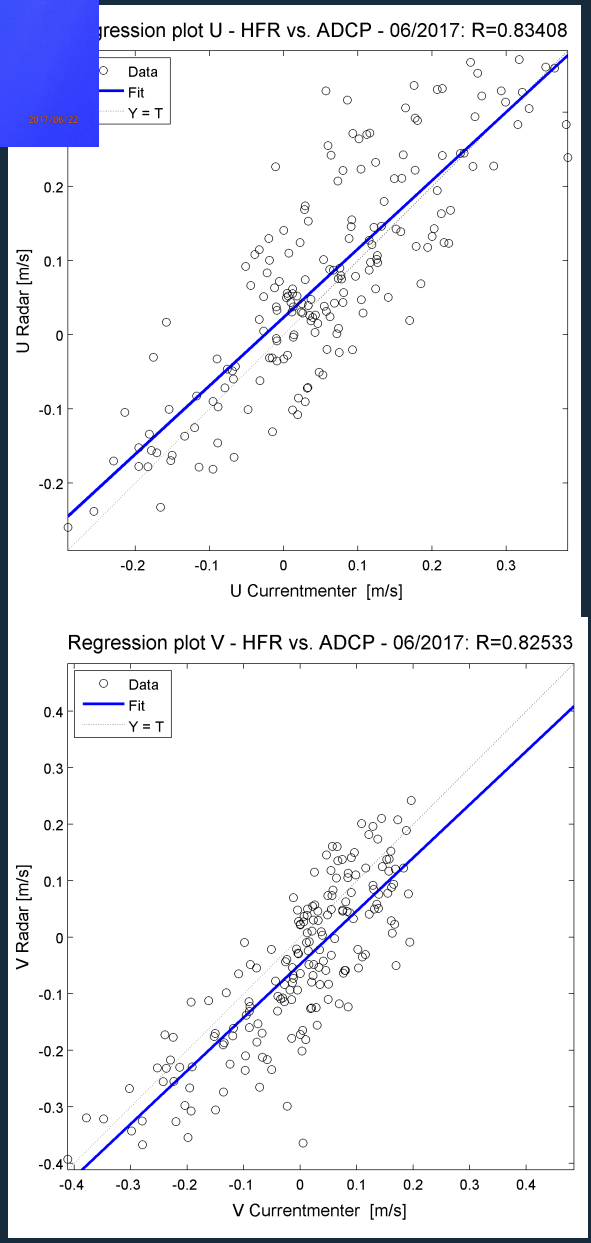
SOCIB

04 RESULTS: HFR VS. IN-SITU

HFR vs. ADCP (DM) – June 2017



Time series

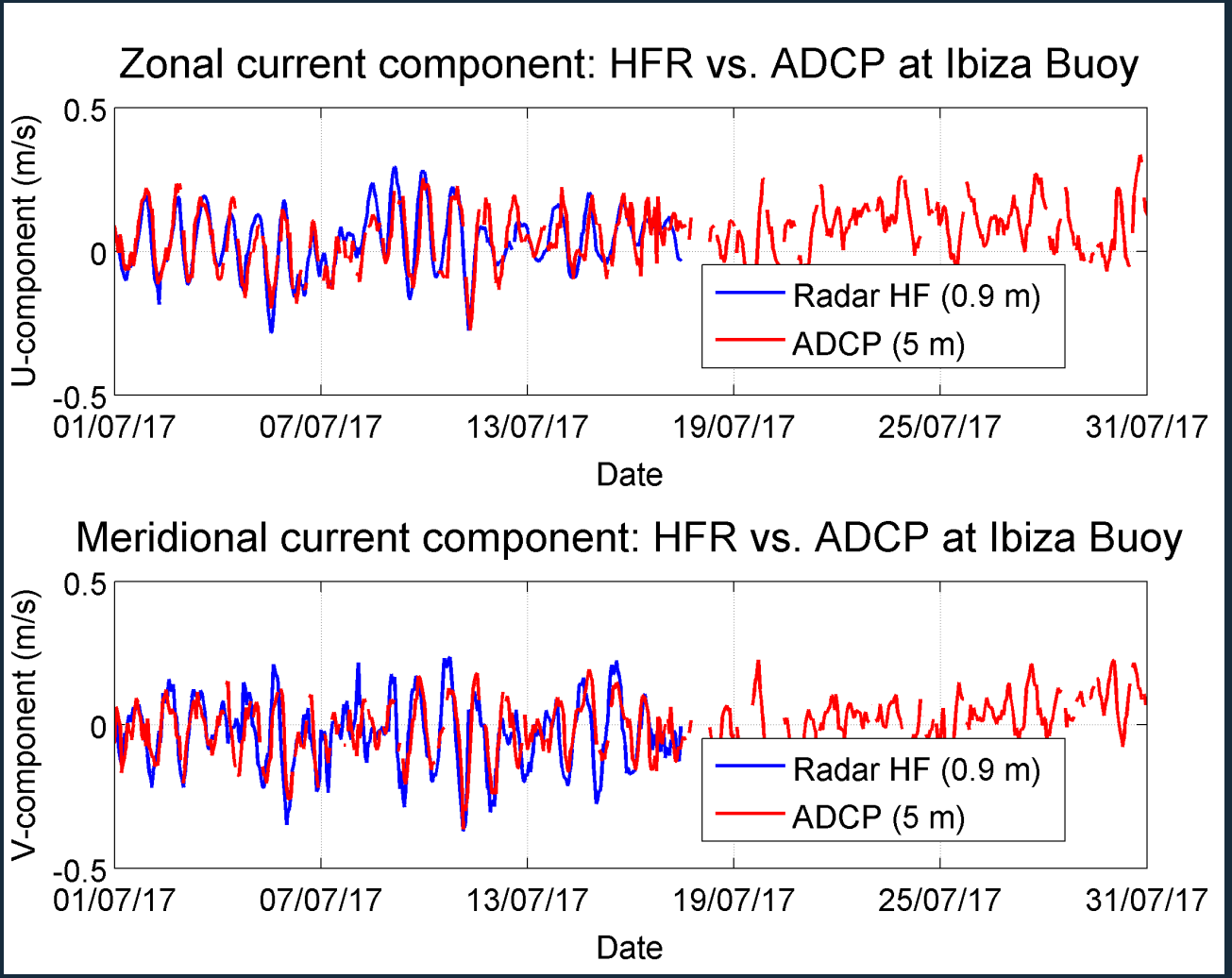


Scatter plots

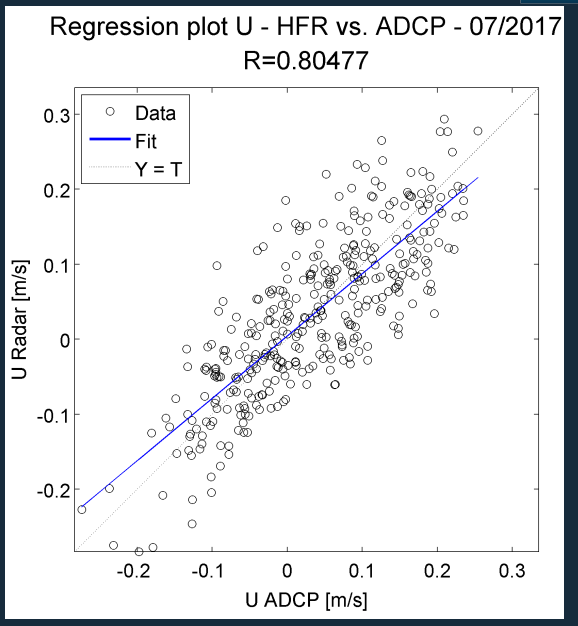
SOCIB

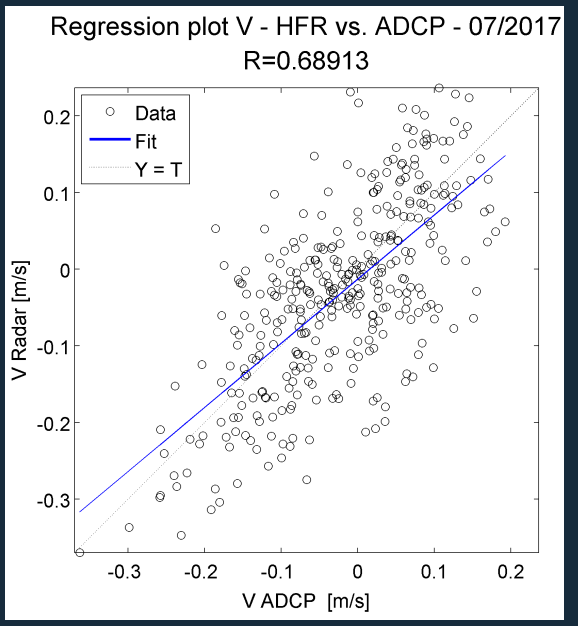
04 RESULTS: HFR VS. IN-SITU

HFR vs. ADCP (DM) – July 2017



Time series

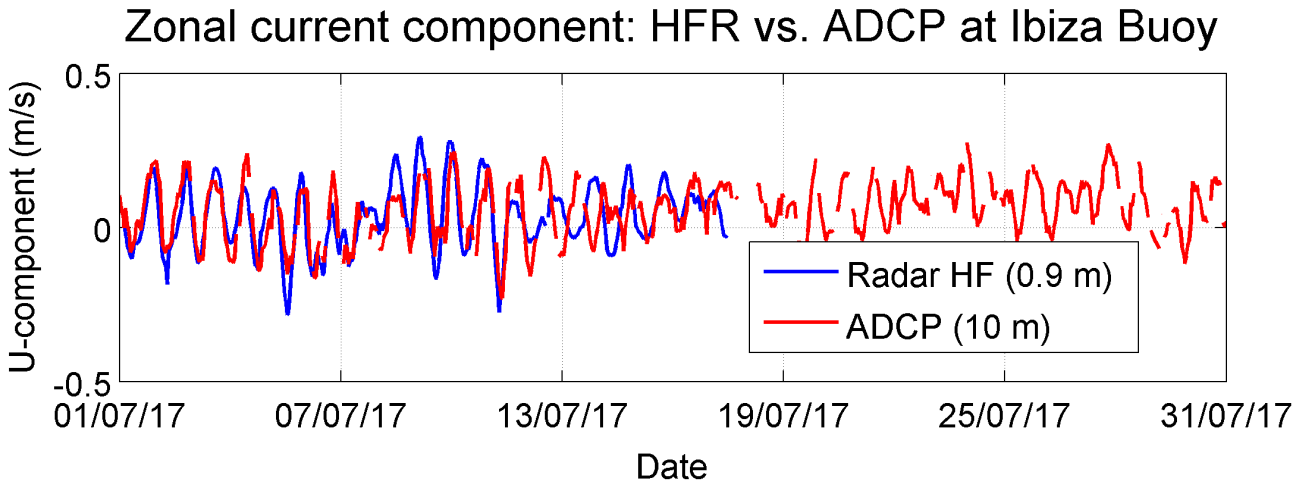


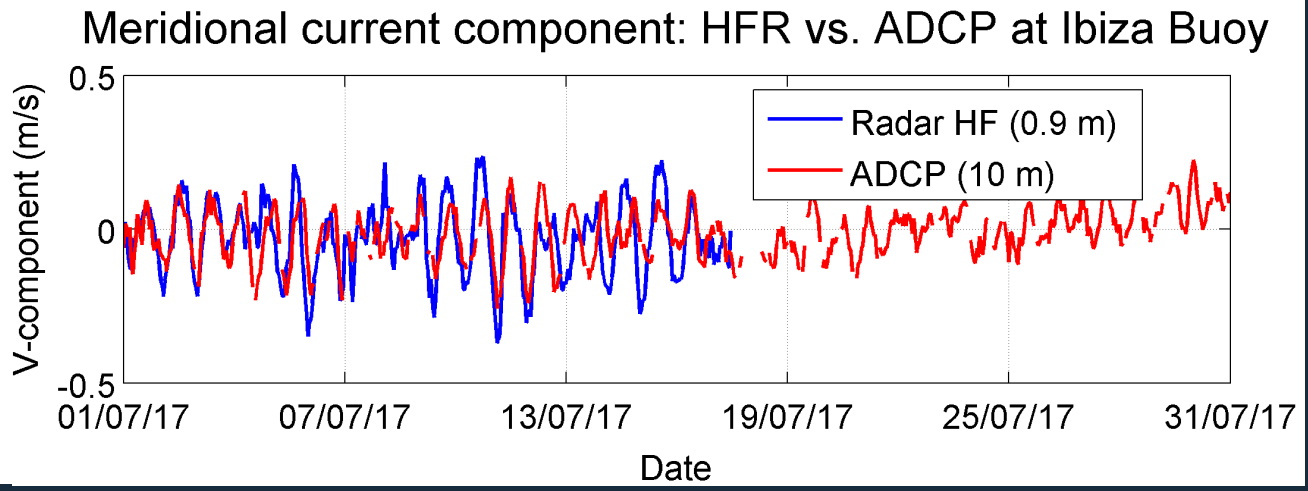


Scatter plots

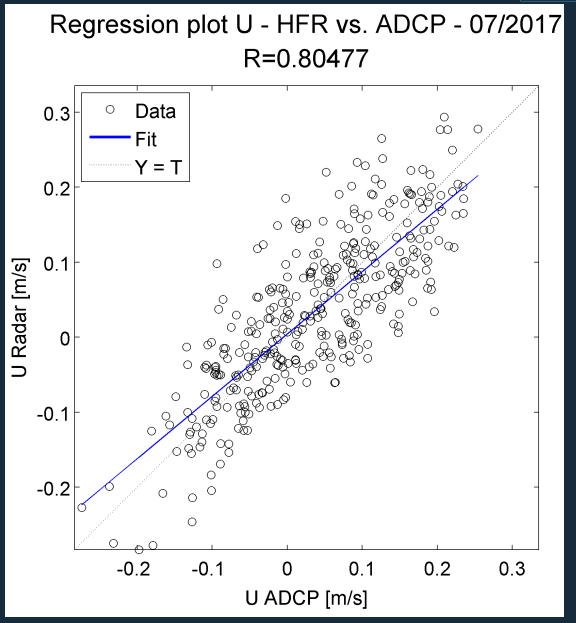
04 RESULTS: HFR VS. IN-SITU

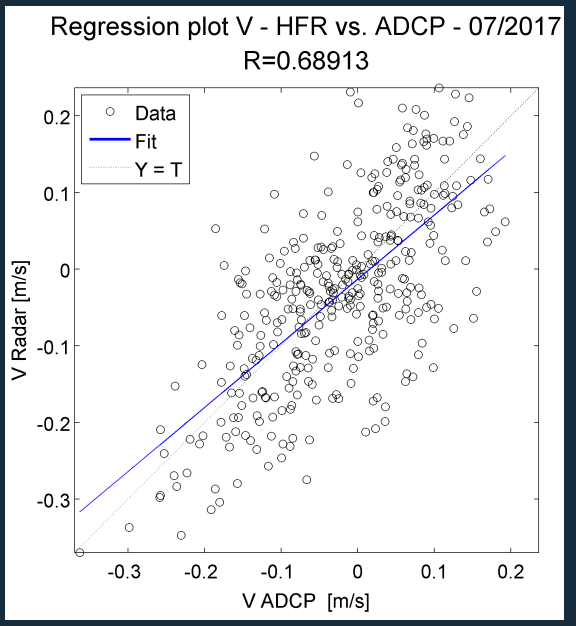
HFR vs. ADCP (DM) – July 2017





Time series



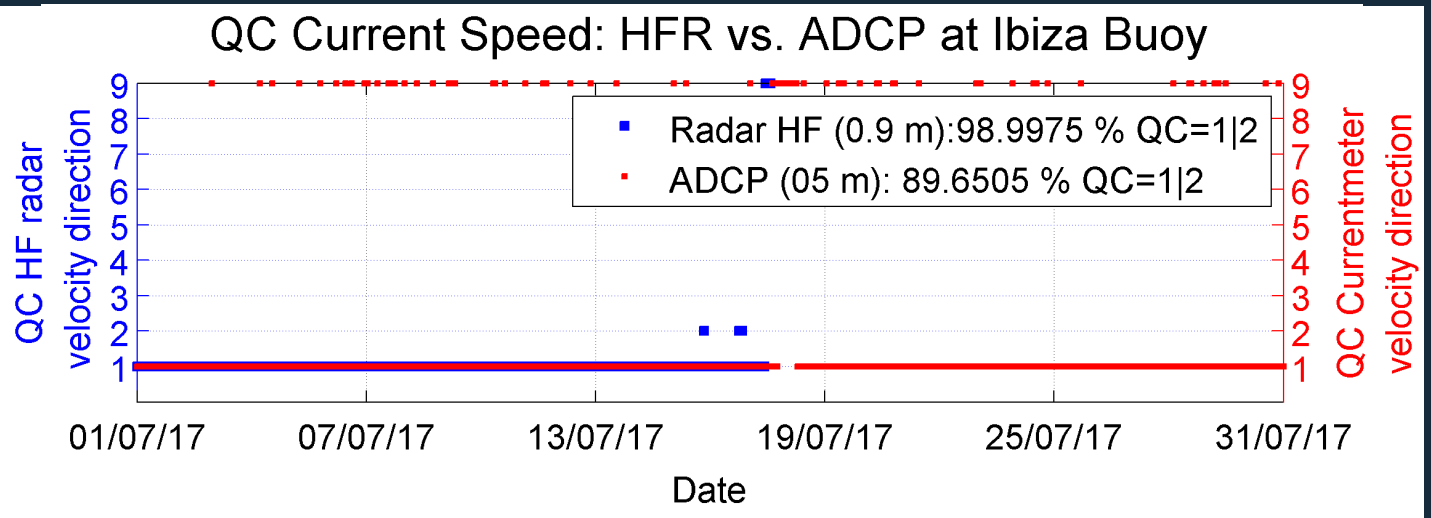


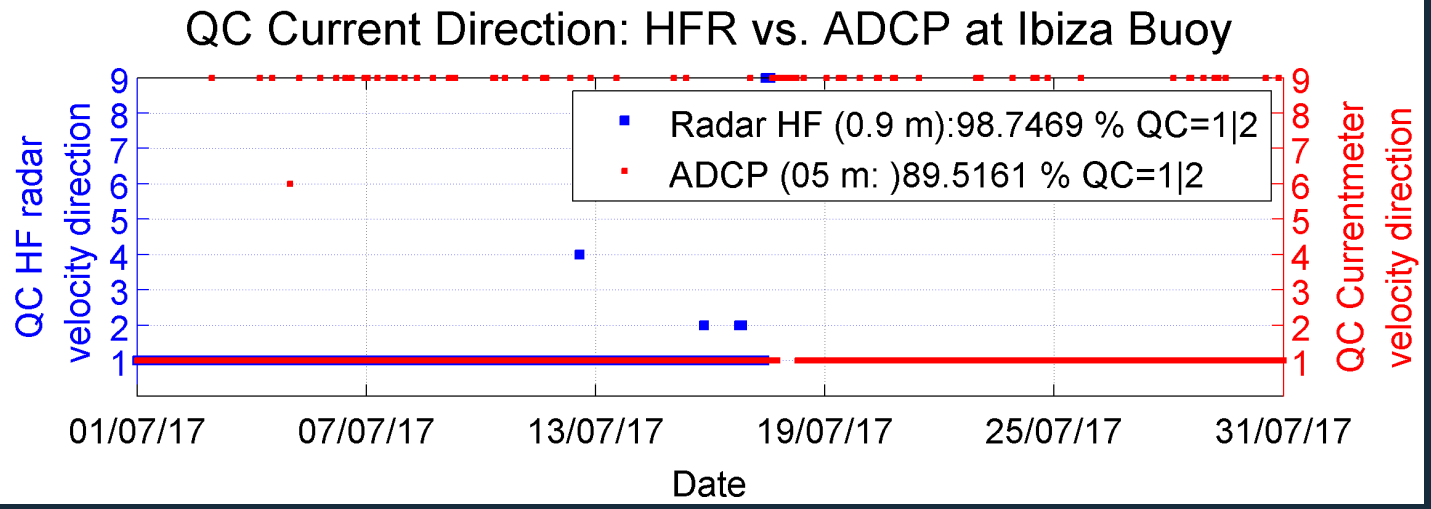
Scatter plots

SOCIB

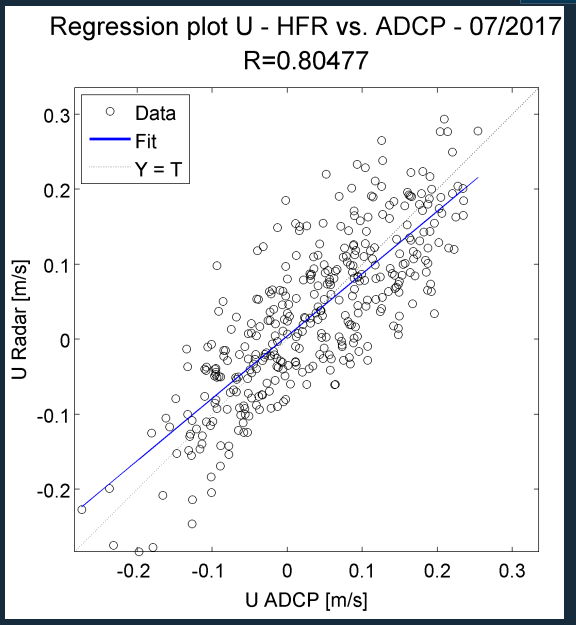
04 RESULTS: HFR VS. IN-SITU

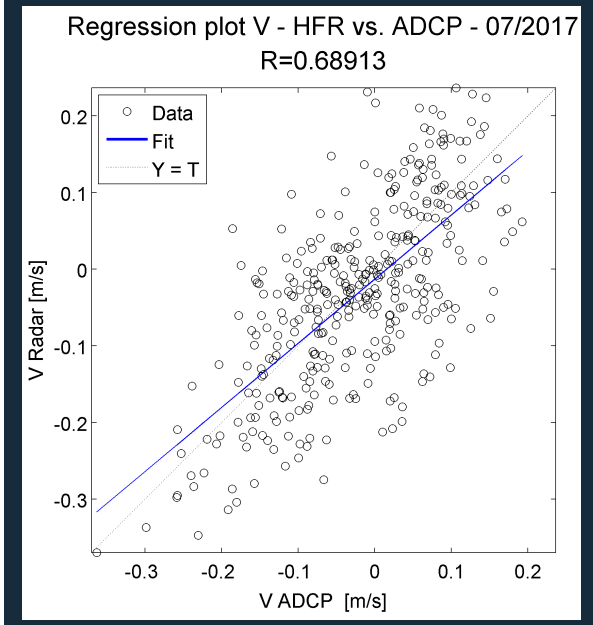
HFR vs. ADCP (DM) – July 2017





Time series





Scatter plots

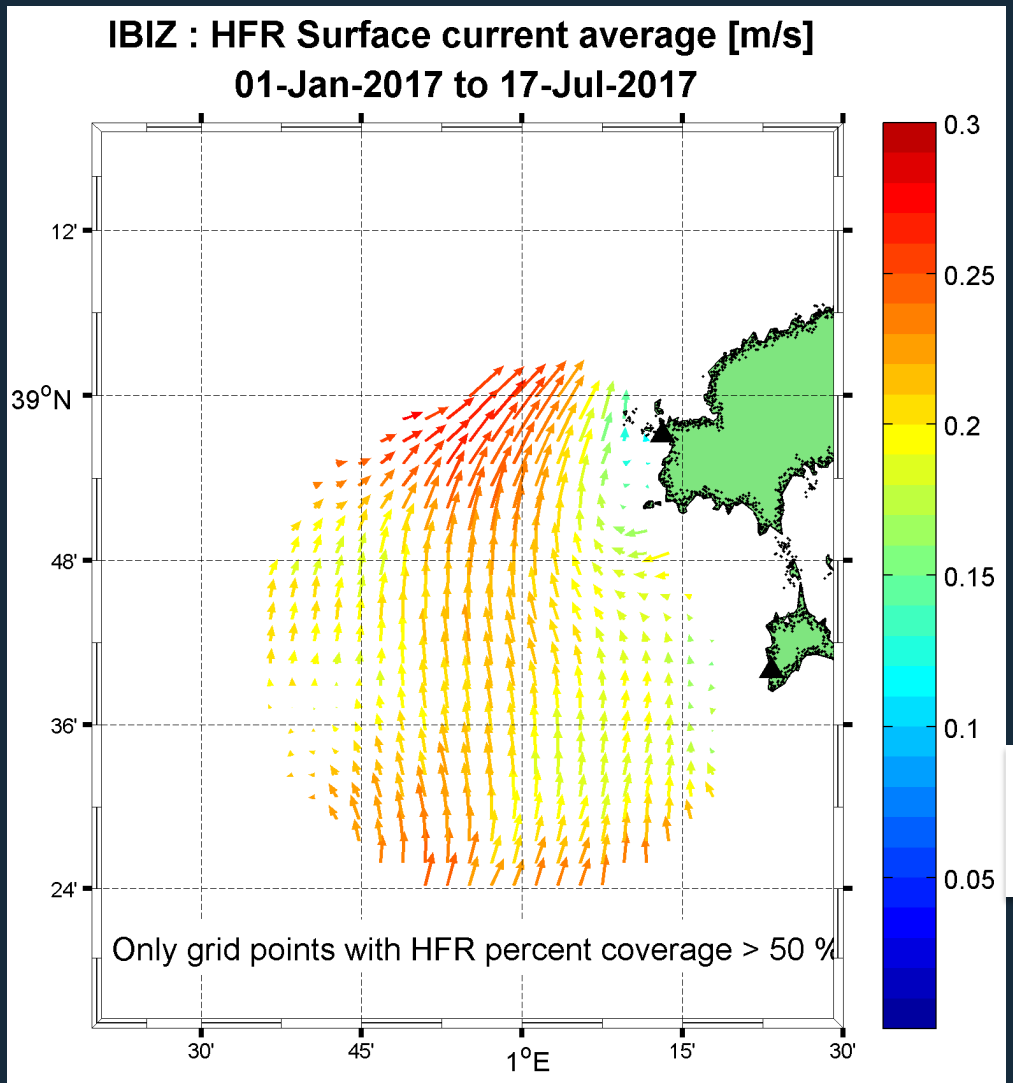
SOCIB

05 RESULTS: WMOP VS. HFR

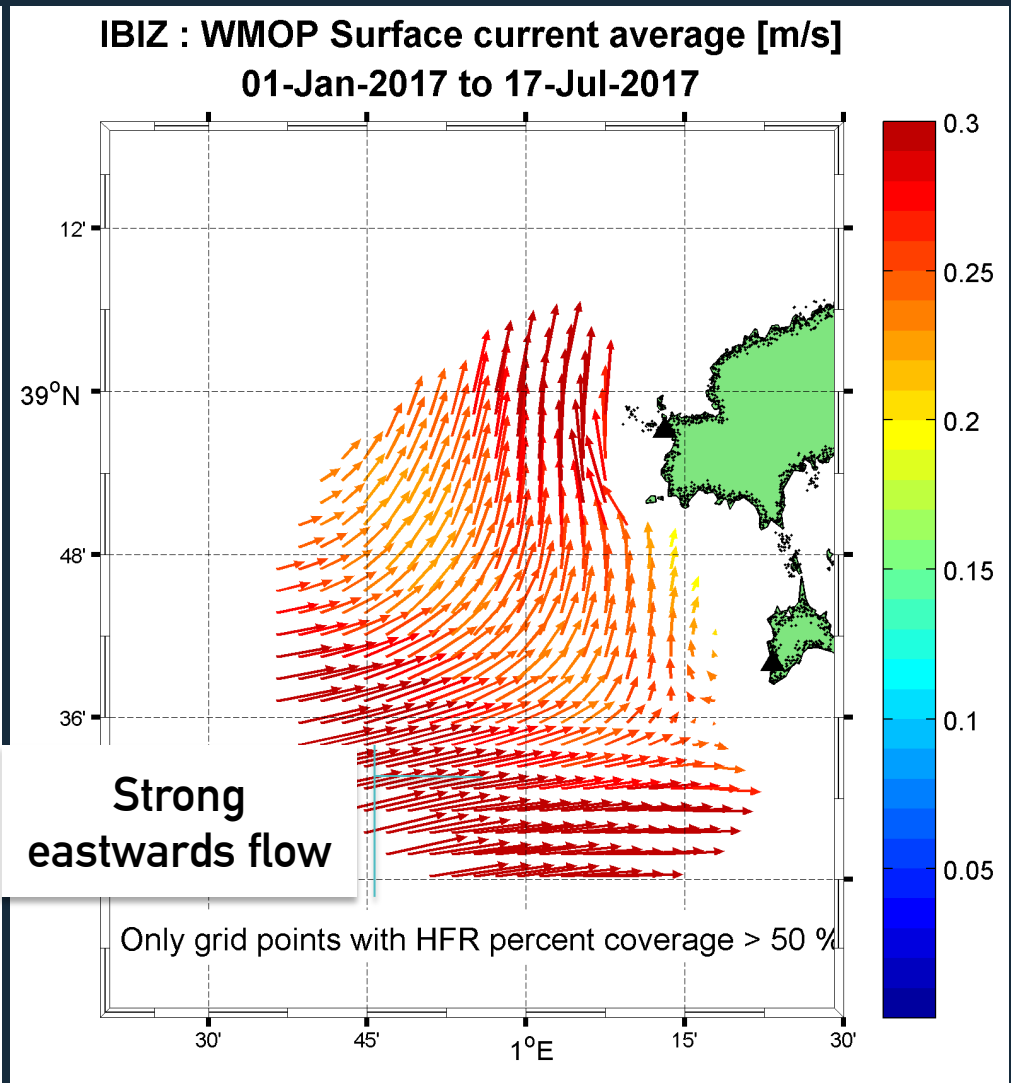
Temporal coverage > 50 % for the period Jan.2017-Jul.2017

Surface Current Average

HFR



WMOP

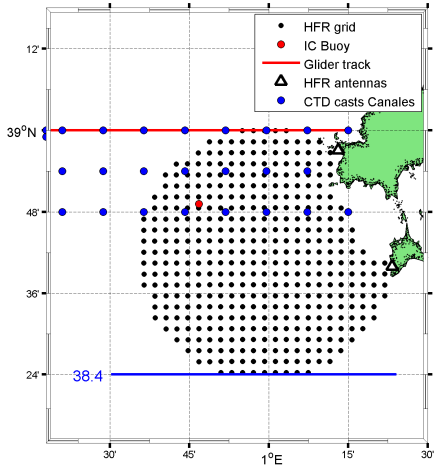


05 RESULTS: WMOP VS. HFR

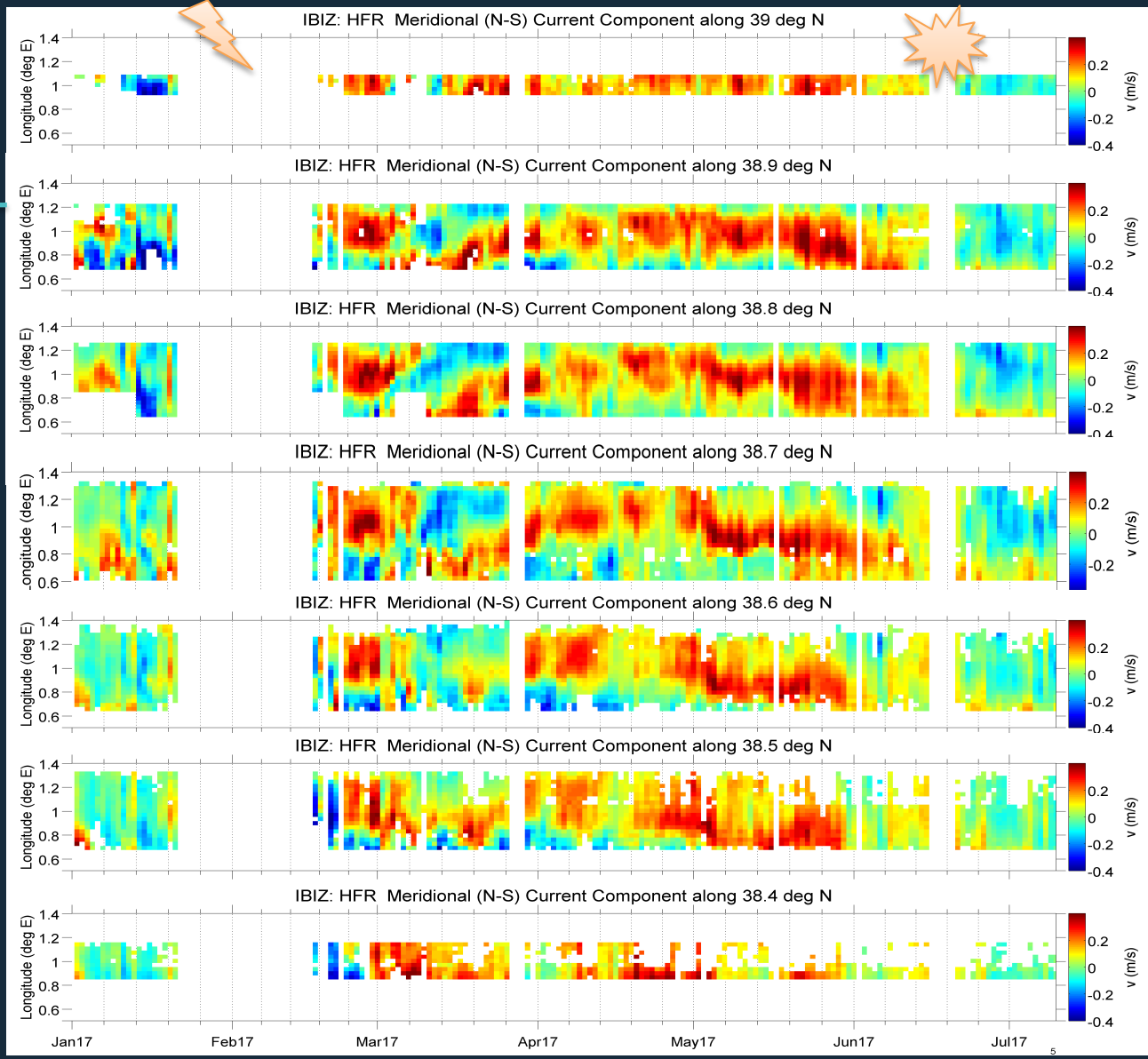
Hovmöller Diagrams

HFR Meridional component (N-S)

Zonal (west-east) transects



Jan.2017-Jul.2017



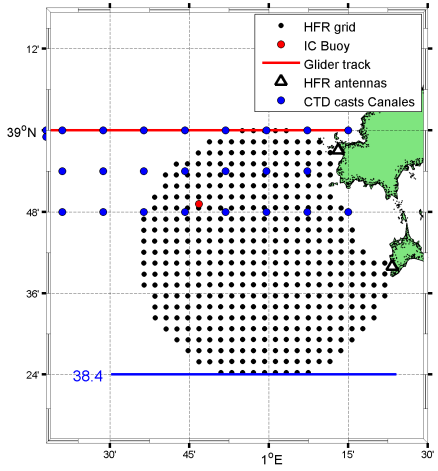
SOCIB

05 RESULTS: WMOP VS. HFR

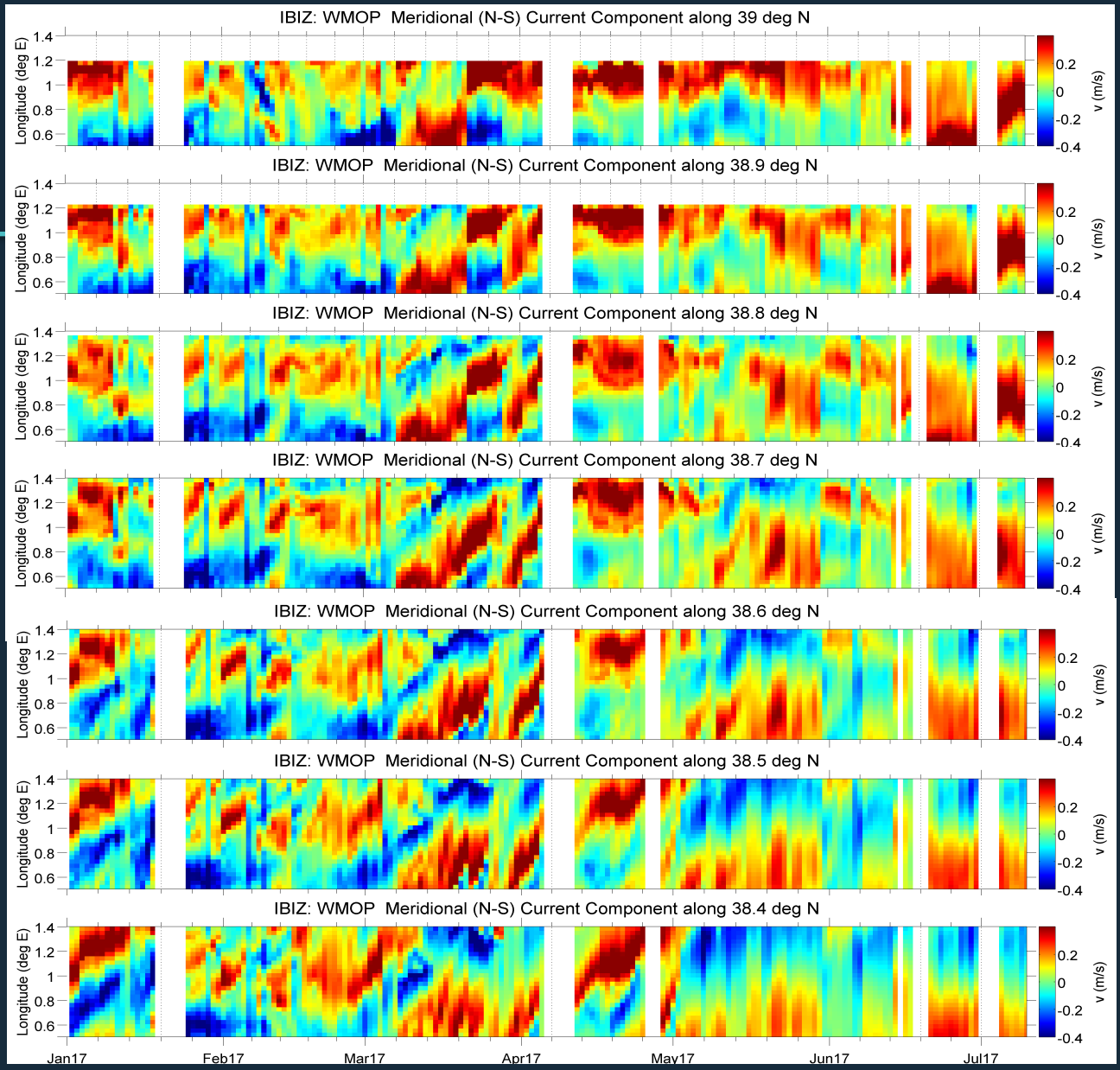
Hovmöller Diagrams

WMOP Meridional component (N-S)

Zonal (west-east) transects



HFR Meridional

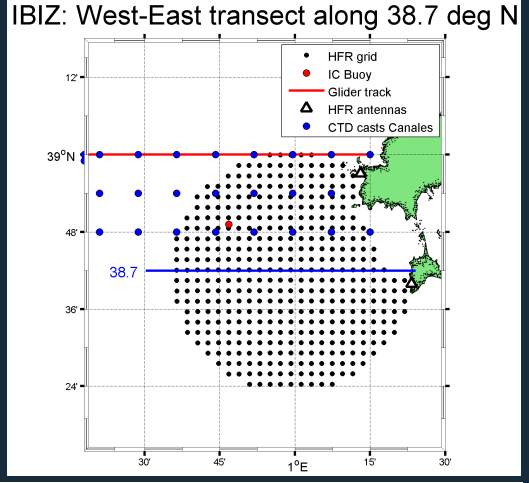


SOCIB

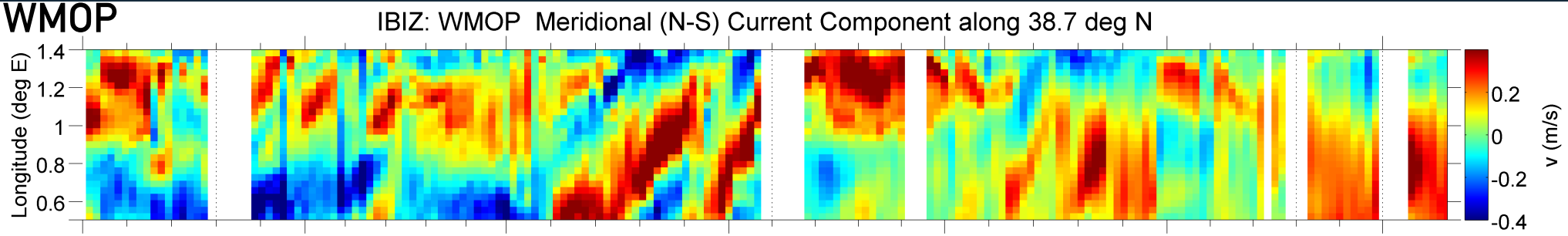
05 RESULTS: WMOP VS. HFR

Hovmöller Diagrams

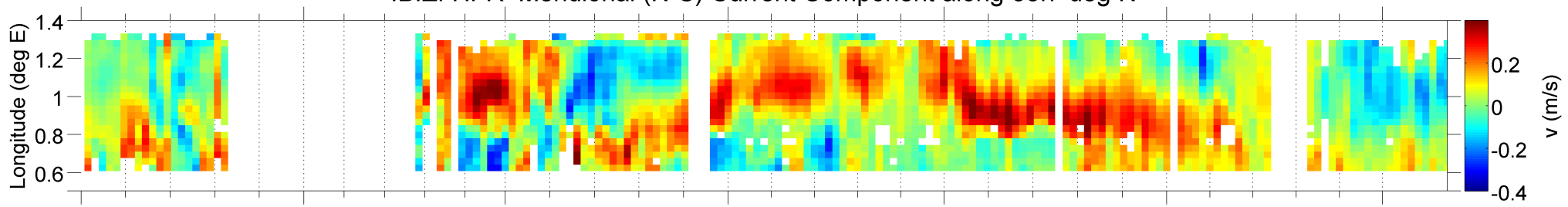
WMOP vs. HFR Meridional velocity (N-S)
Zonal transect at 38.7°N



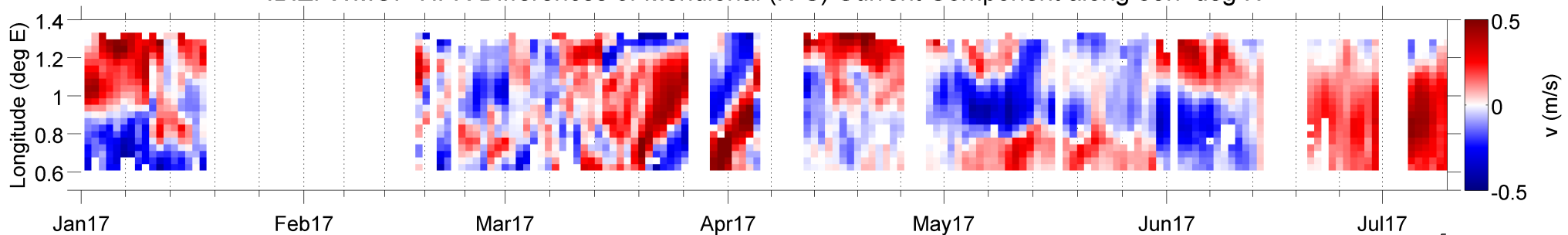
WMOP



HFR



WMOP - HFR

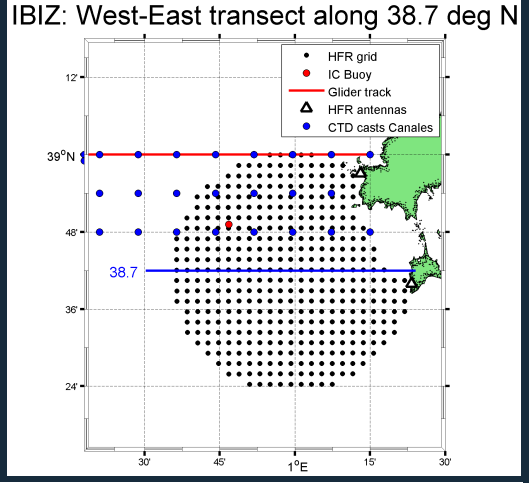


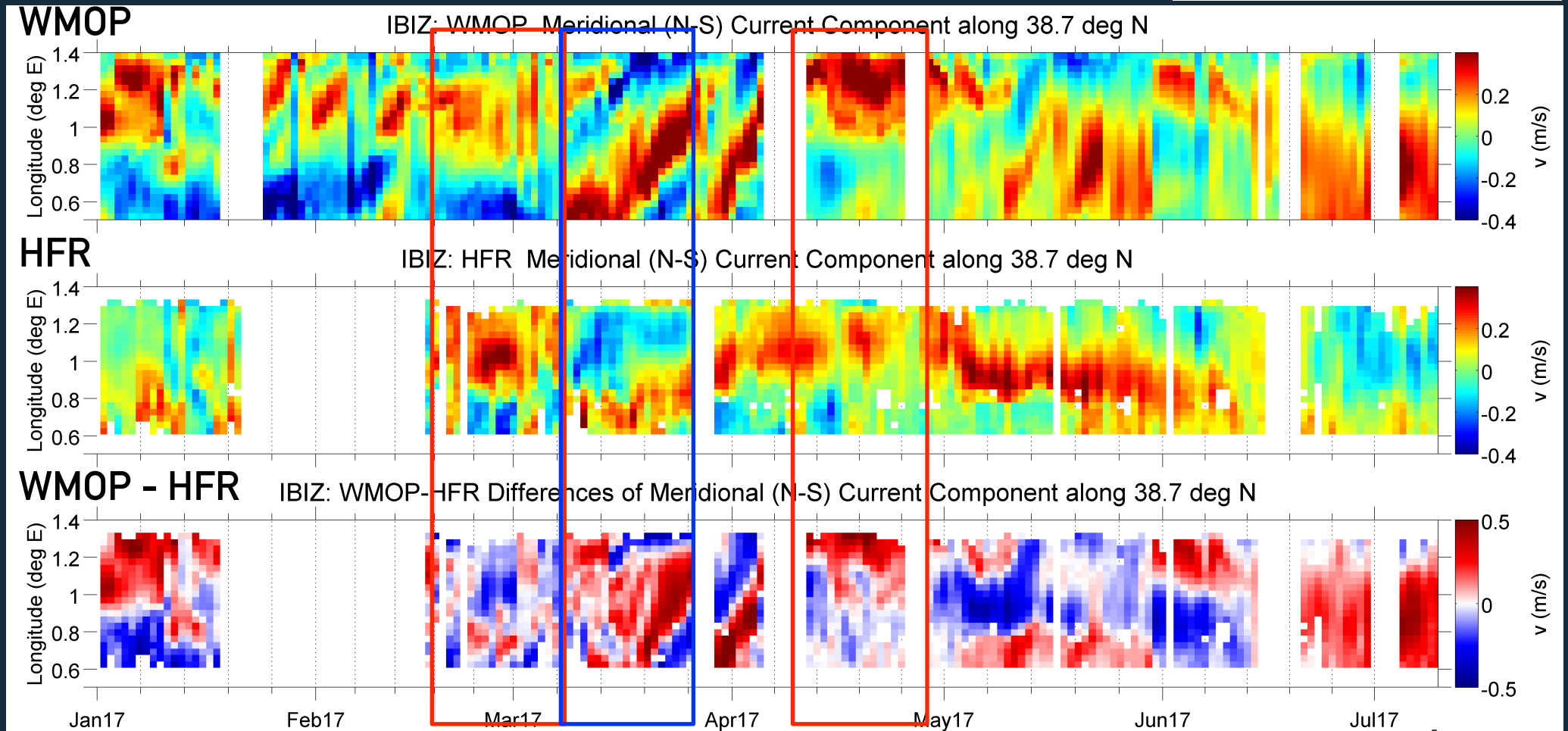
SOCIB

05 RESULTS: WMOP VS. HFR

Hovmöller Diagrams

WMOP vs. HFR Meridional velocity (N-S)
Zonal transect at 38.7°N



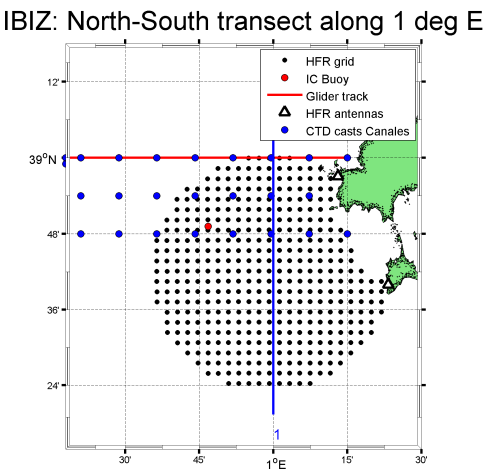


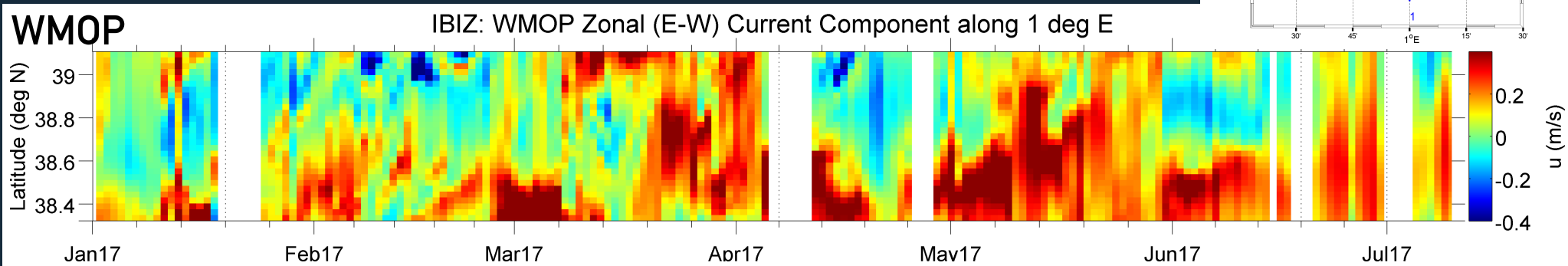
SOCIB

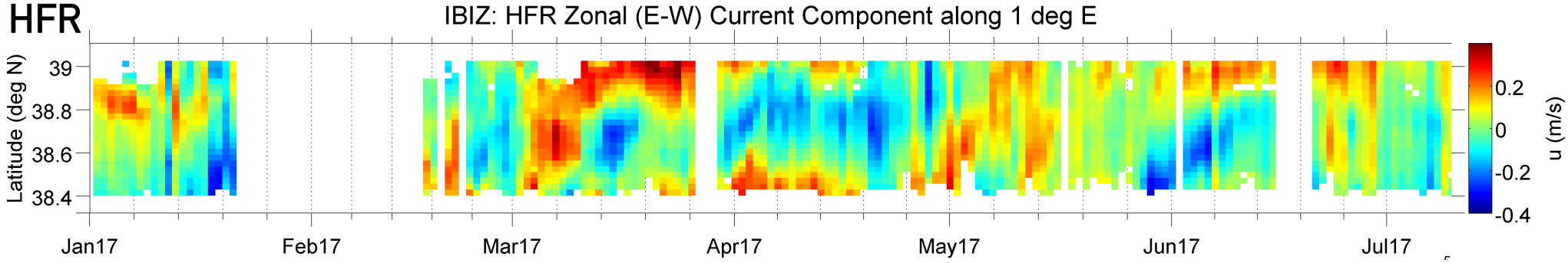
05 RESULTS: WMOP VS. HFR

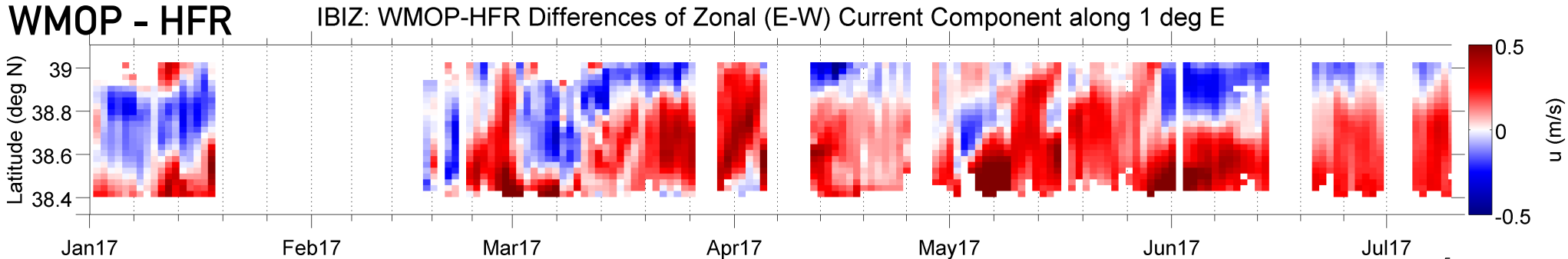
Hovmöller Diagrams

WMOP vs. HFR Zonal velocity (E-W)
Meridional transect at 1°E







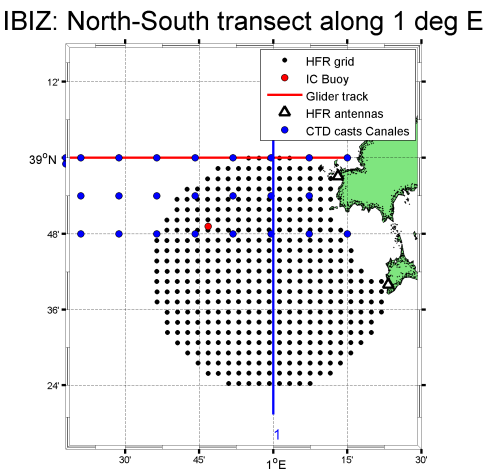


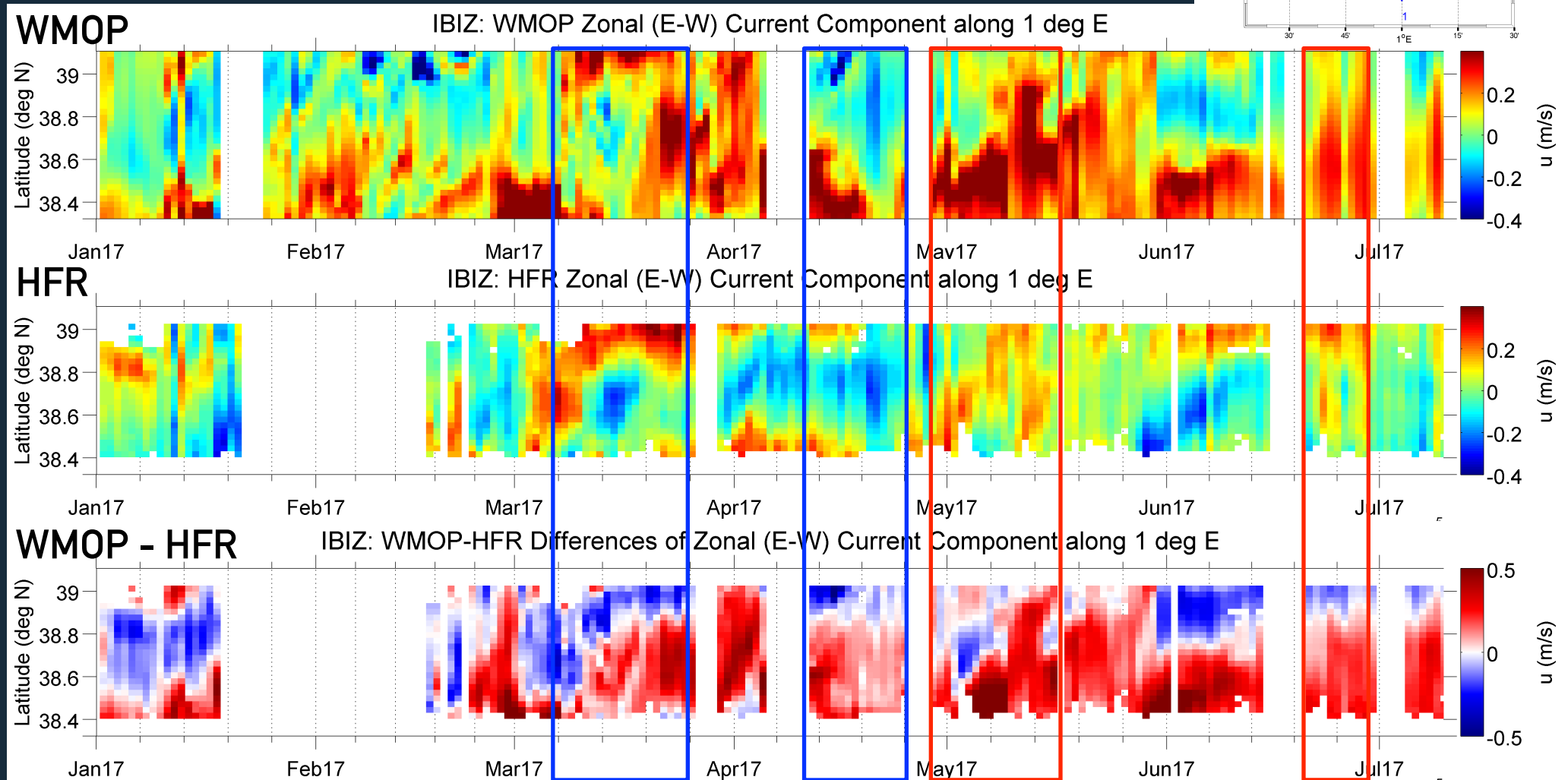
SOCIB

05 RESULTS: WMOP VS. HFR

Hovmöller Diagrams

WMOP vs. HFR Zonal velocity (E-W)
Meridional transect at 1°E

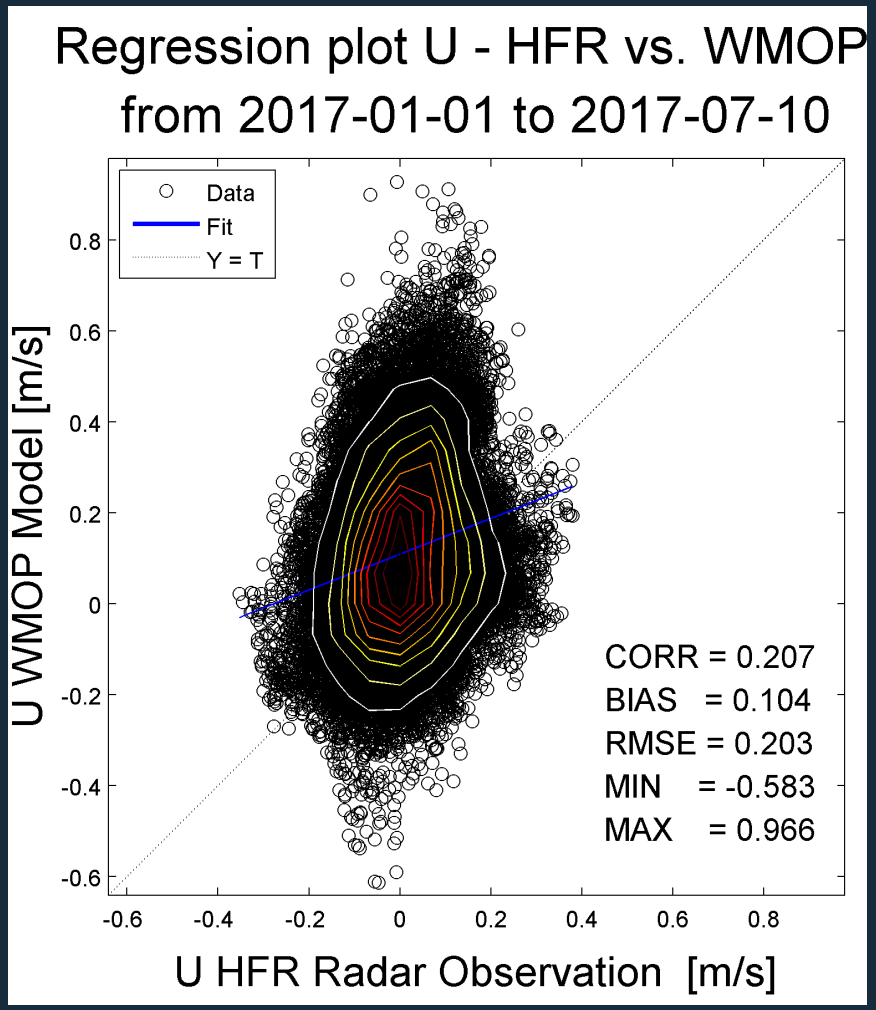




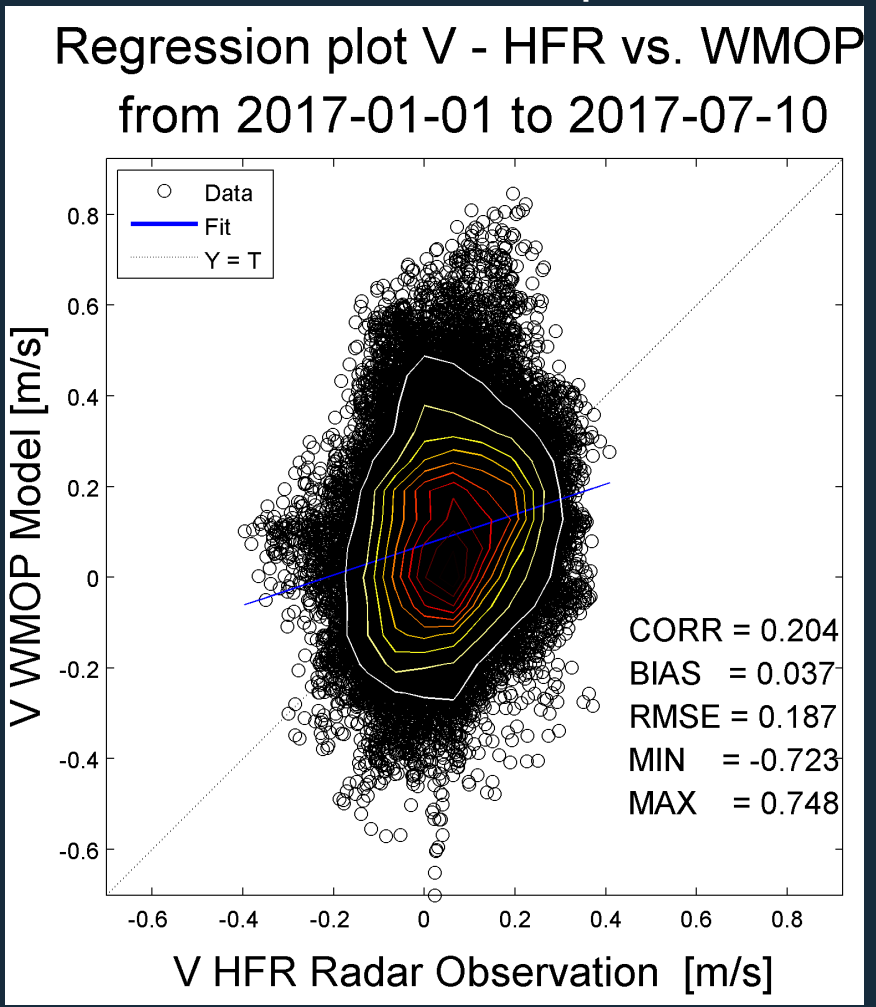
05 RESULTS: WMOP VS. HFR

Scatter plots of error (WMOP - HFR)

Zonal (E-W) component



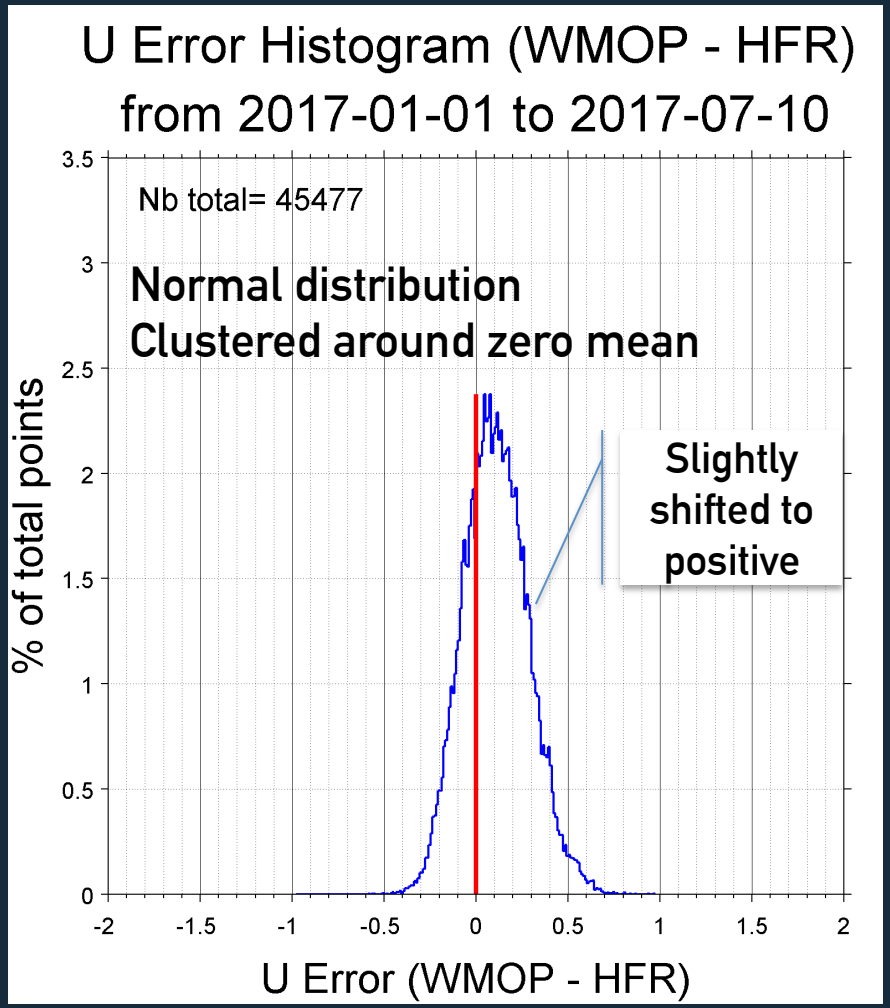
Meridional (N-S) component



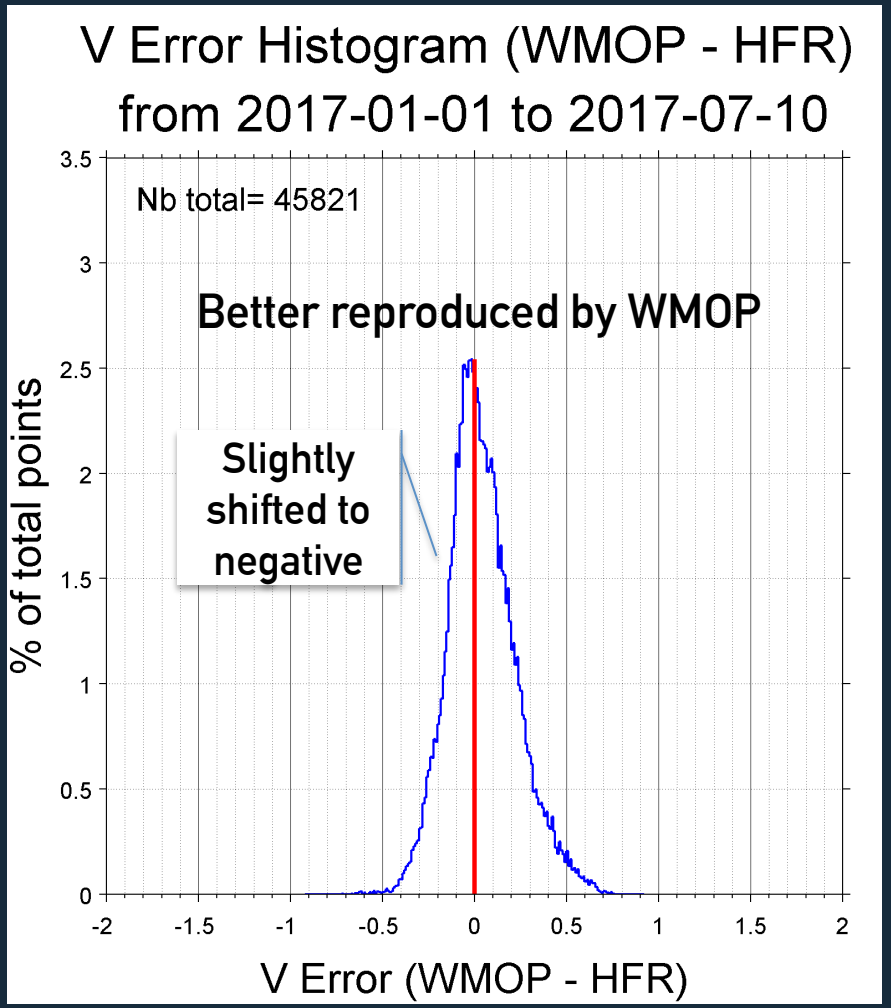
05 RESULTS: WMOP VS. HFR

Error histograms (WMOP - HFR)

Zonal (E-W) component



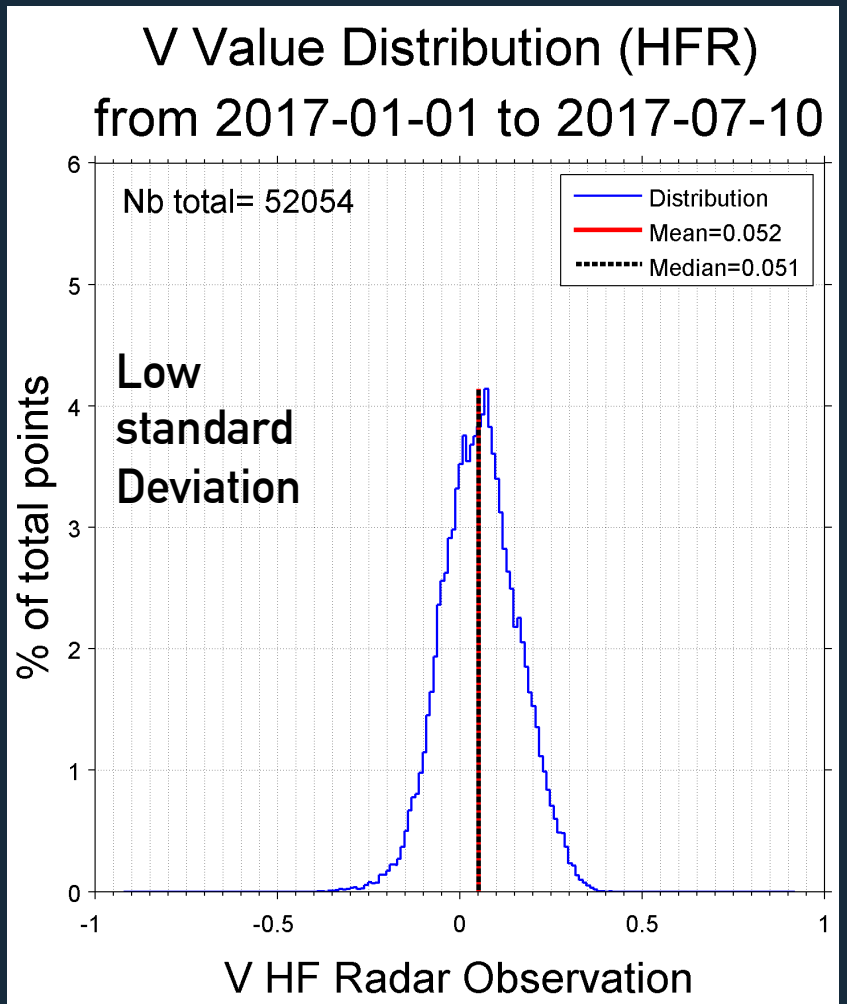
Meridional (N-S) component



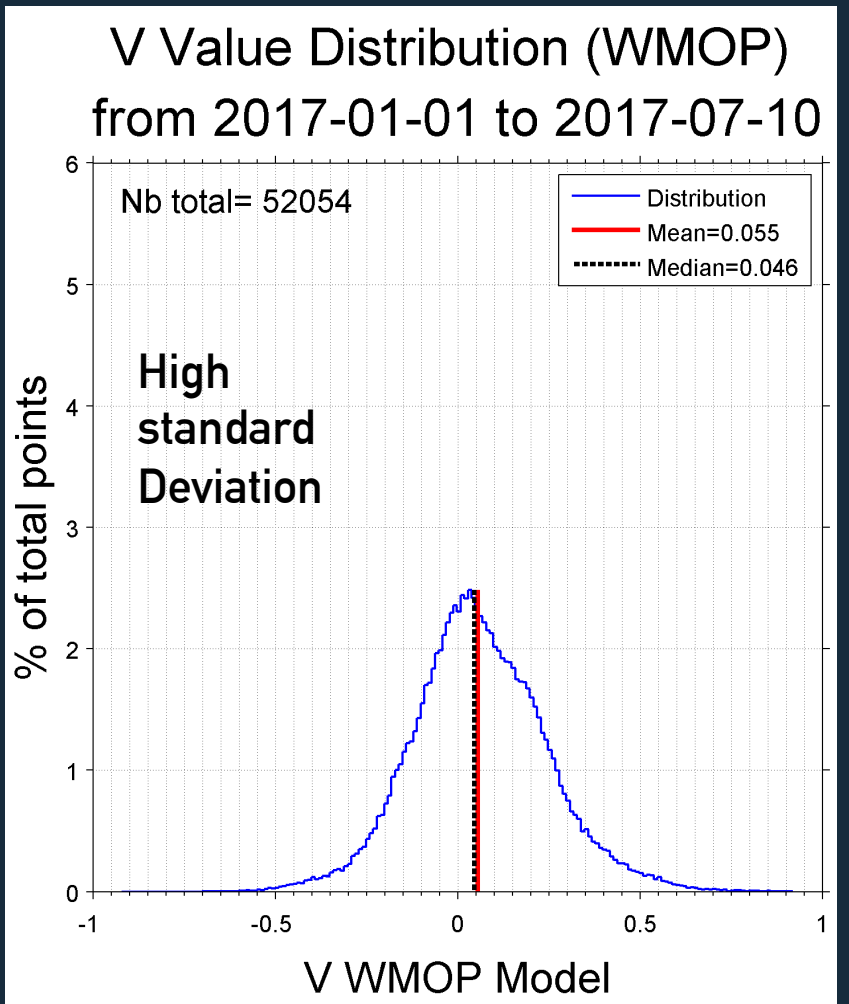
05 RESULTS: WMOP VS. HFR

Meridional component (N-S) value distribution

HFR



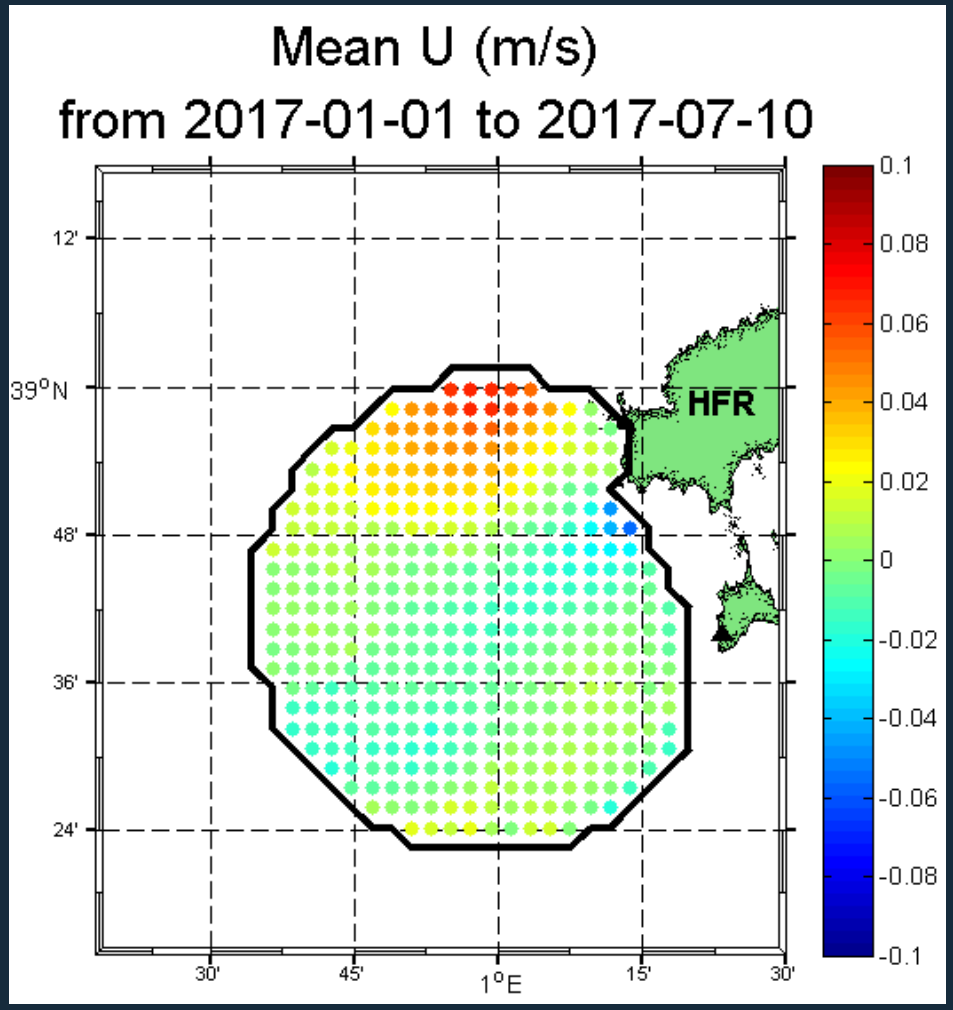
WMOP



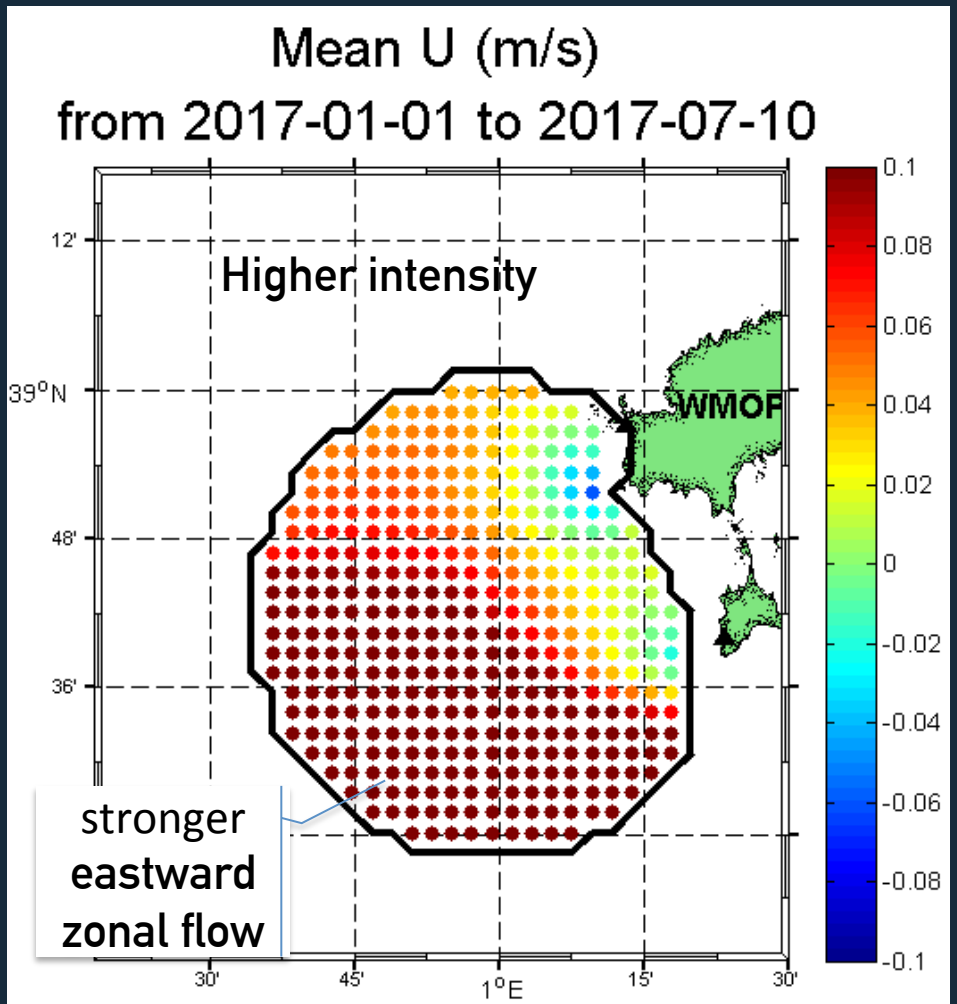
05 RESULTS: WMOP VS. HFR

Mean zonal (E-W) velocity component map

HFR



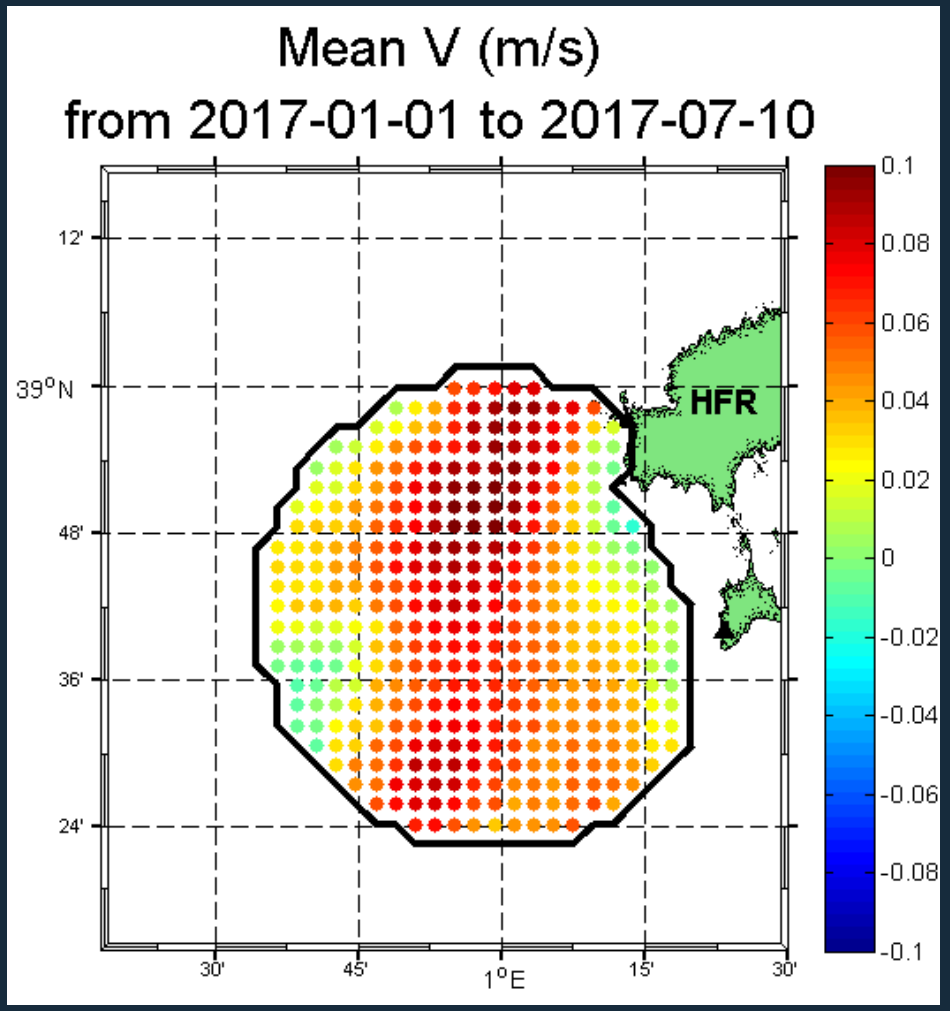
WMOP



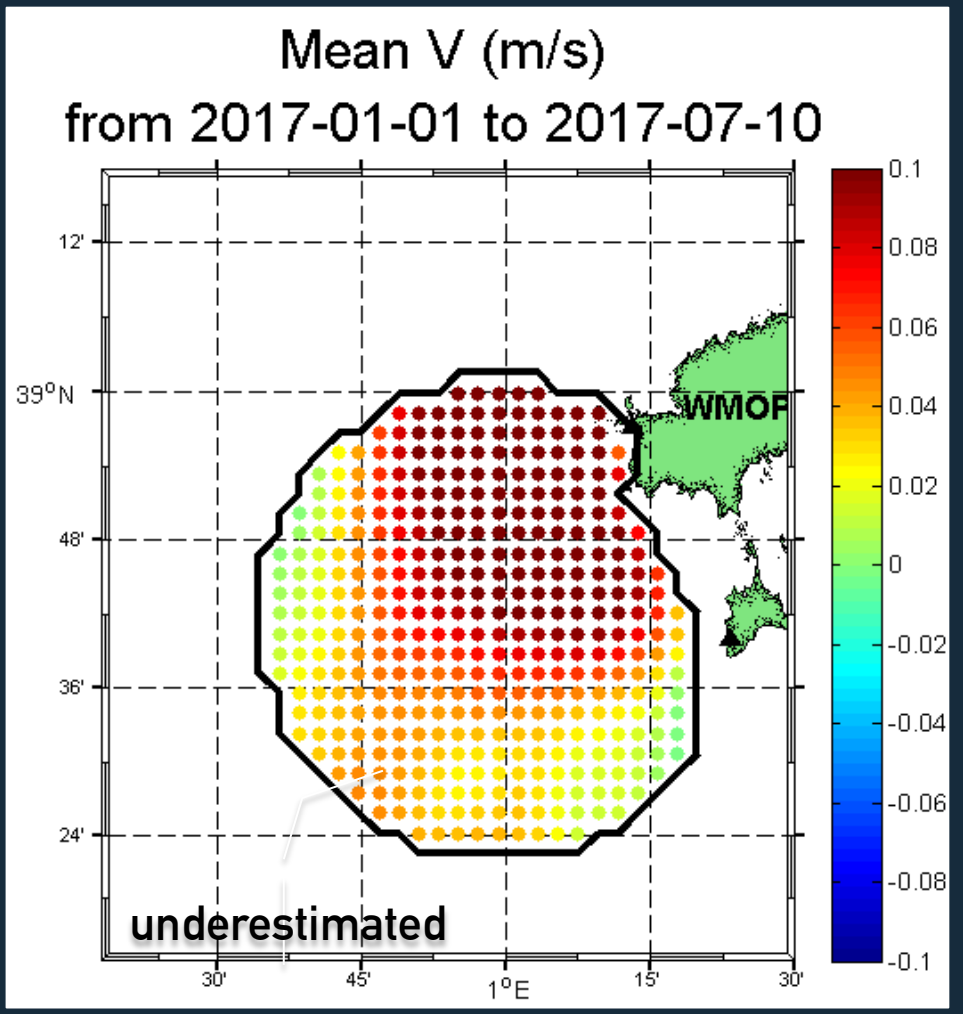
05 RESULTS: WMOP VS. HFR

Mean meridional (N-S) velocity component map

HFR



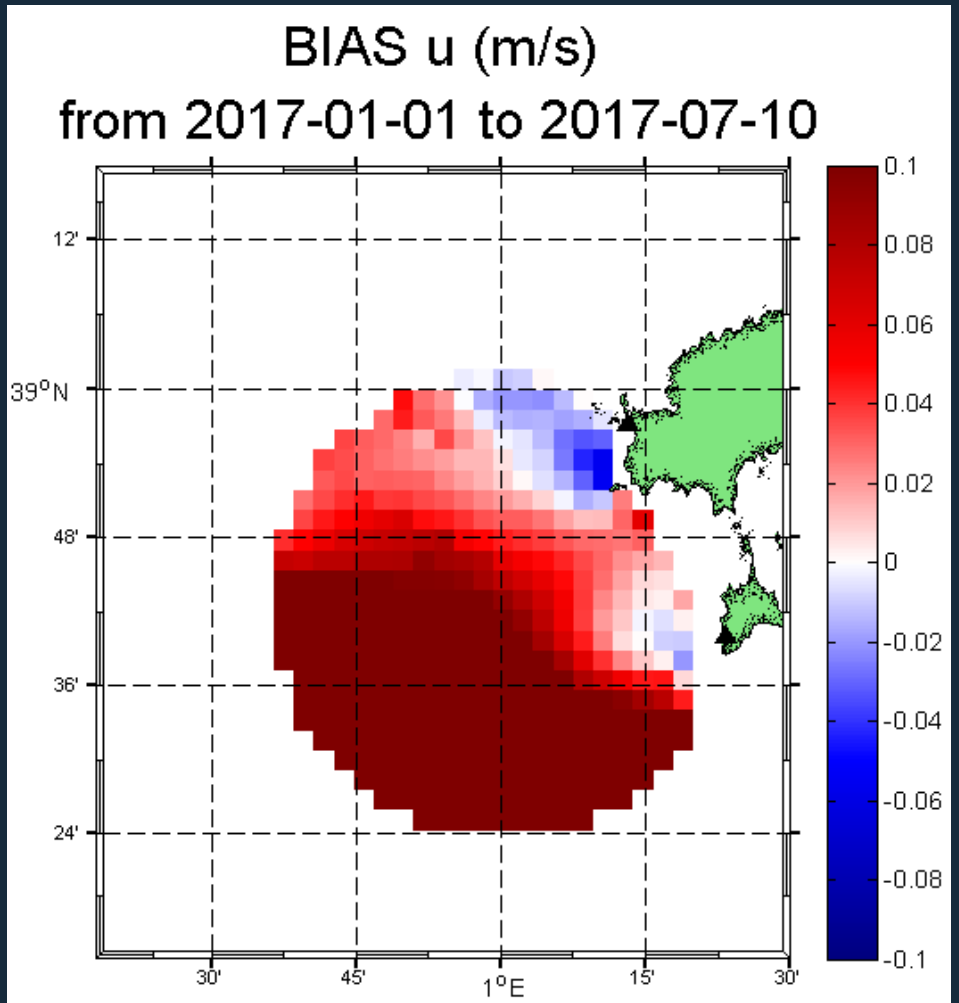
WMOP



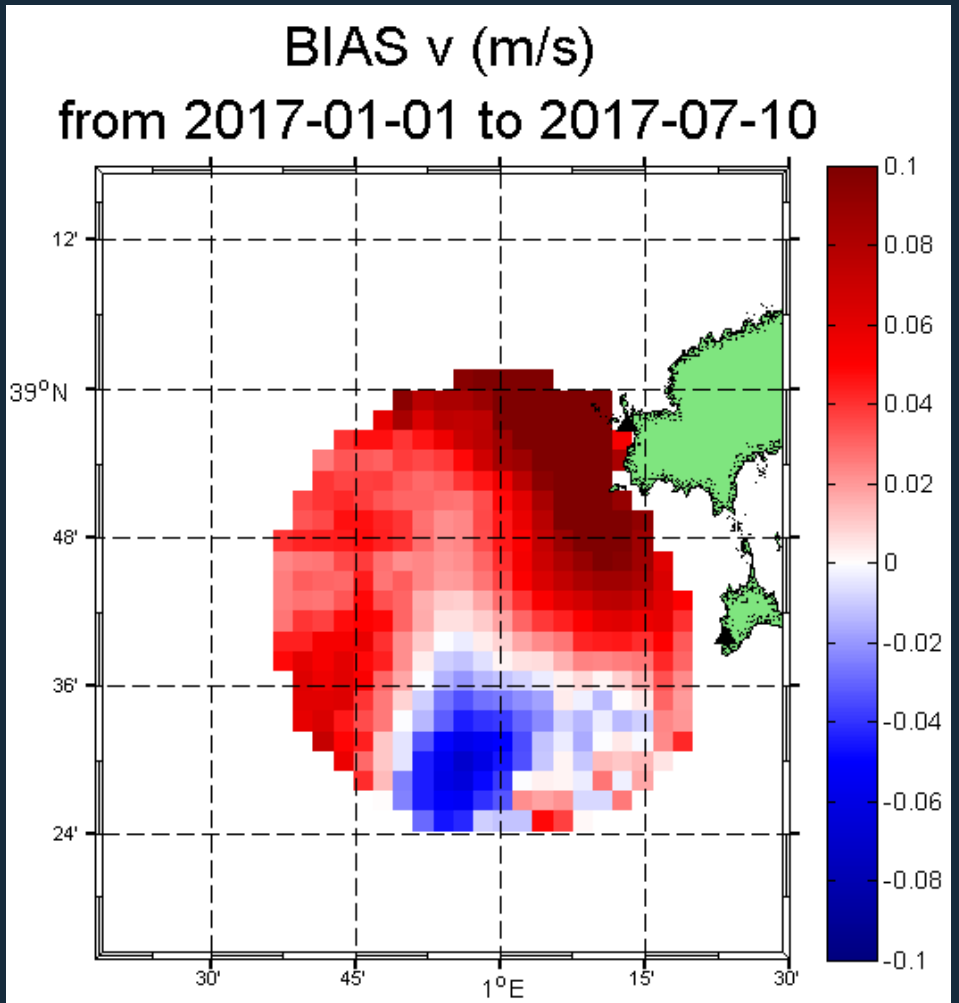
05 RESULTS: WMOP VS. HFR

BIAS (WMOP-HFR)

Zonal component



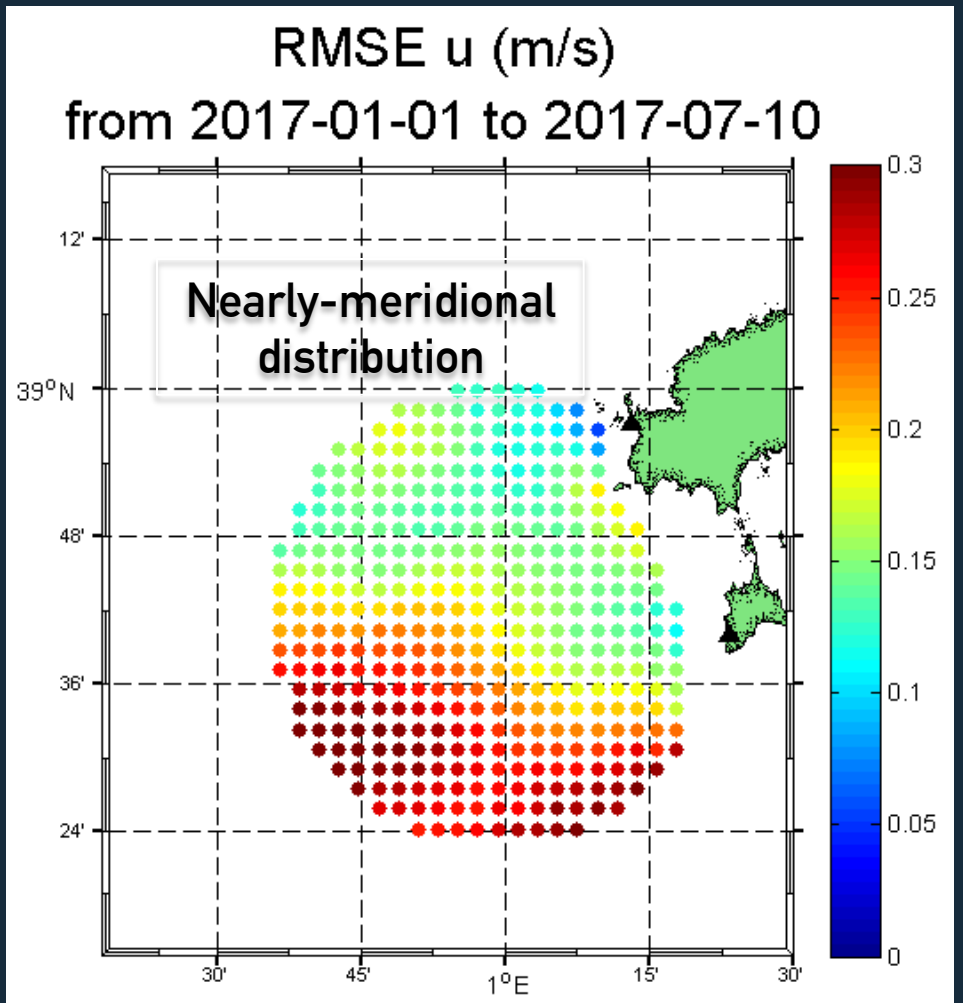
Meridional component



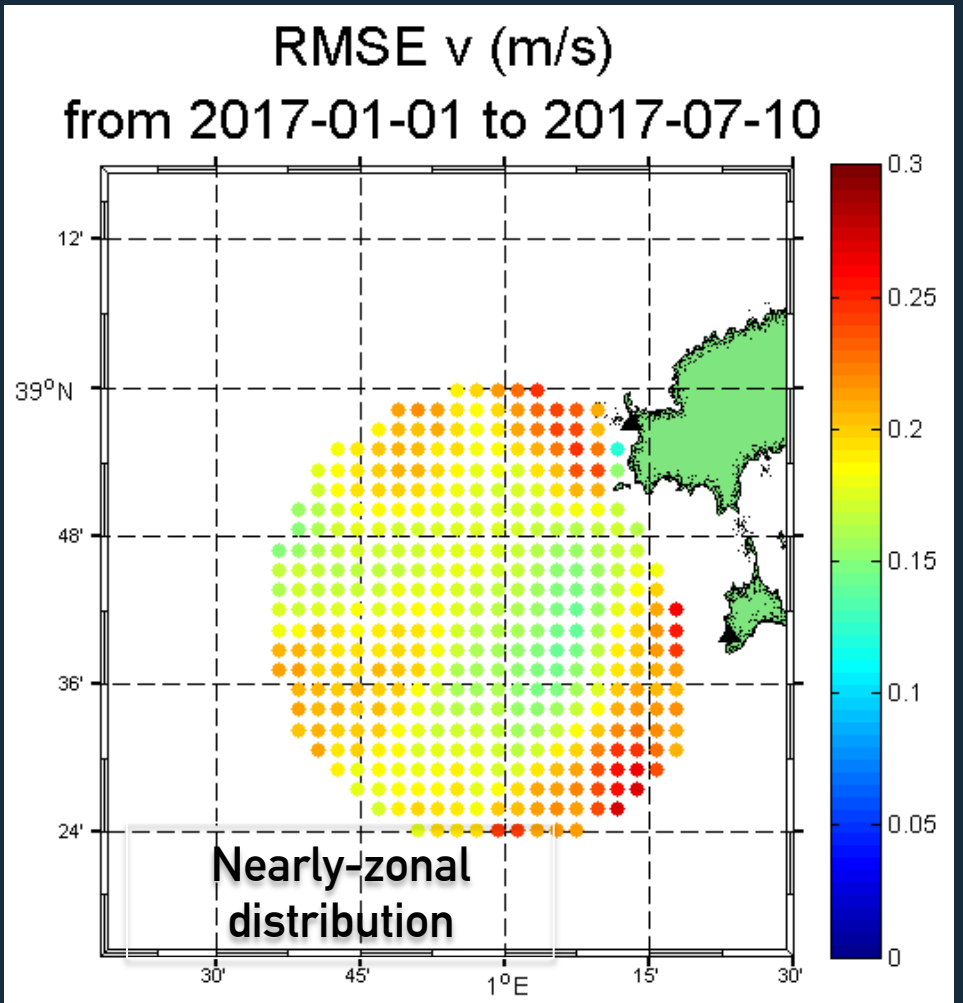
05 RESULTS: WMOP VS. HFR

RMSE (WMOP-HFR)

Zonal component



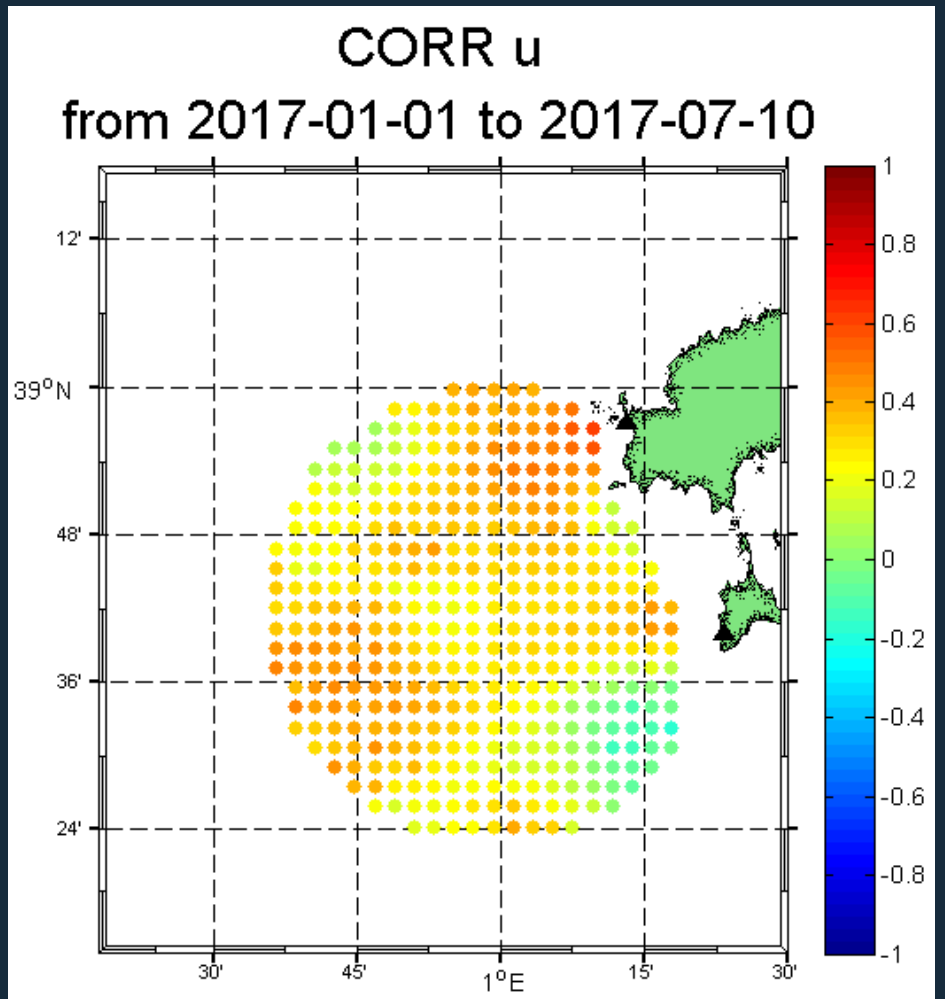
Meridional component



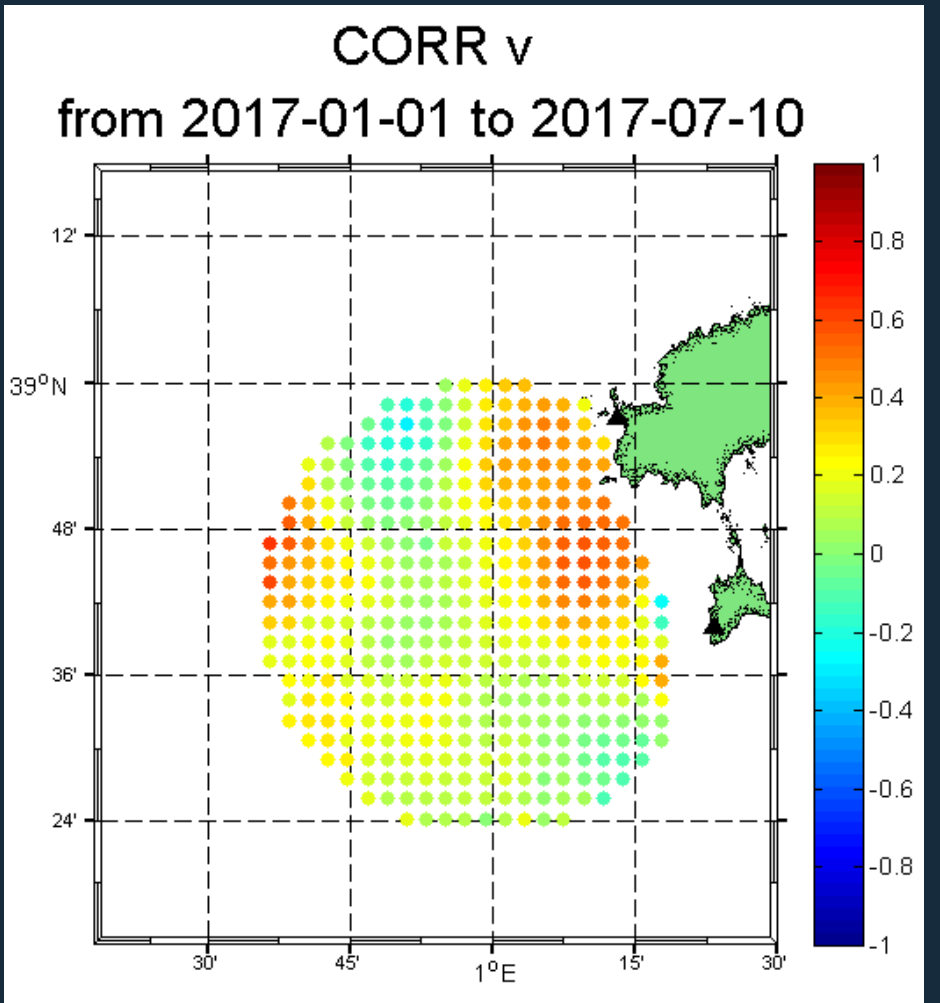
05 RESULTS: WMOP VS. HFR

Correlation (WMOP-HFR)

Zonal component



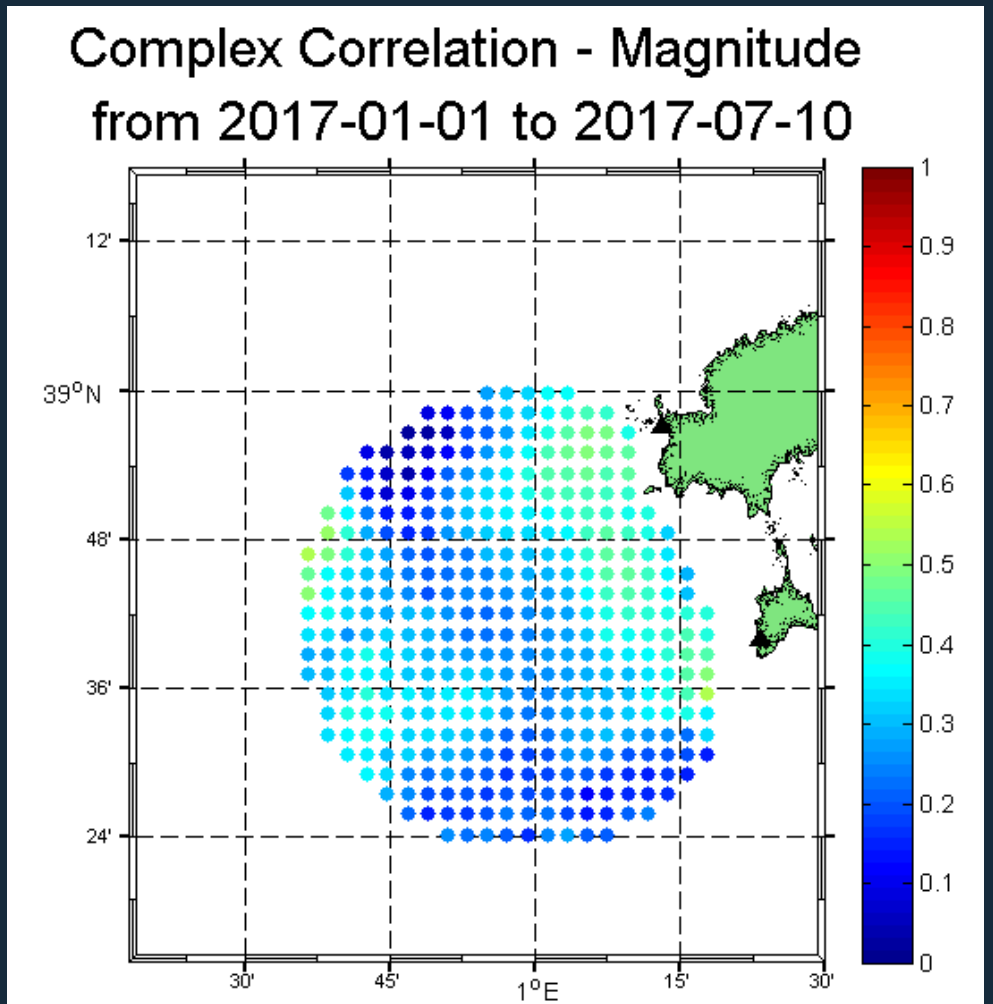
Meridional component



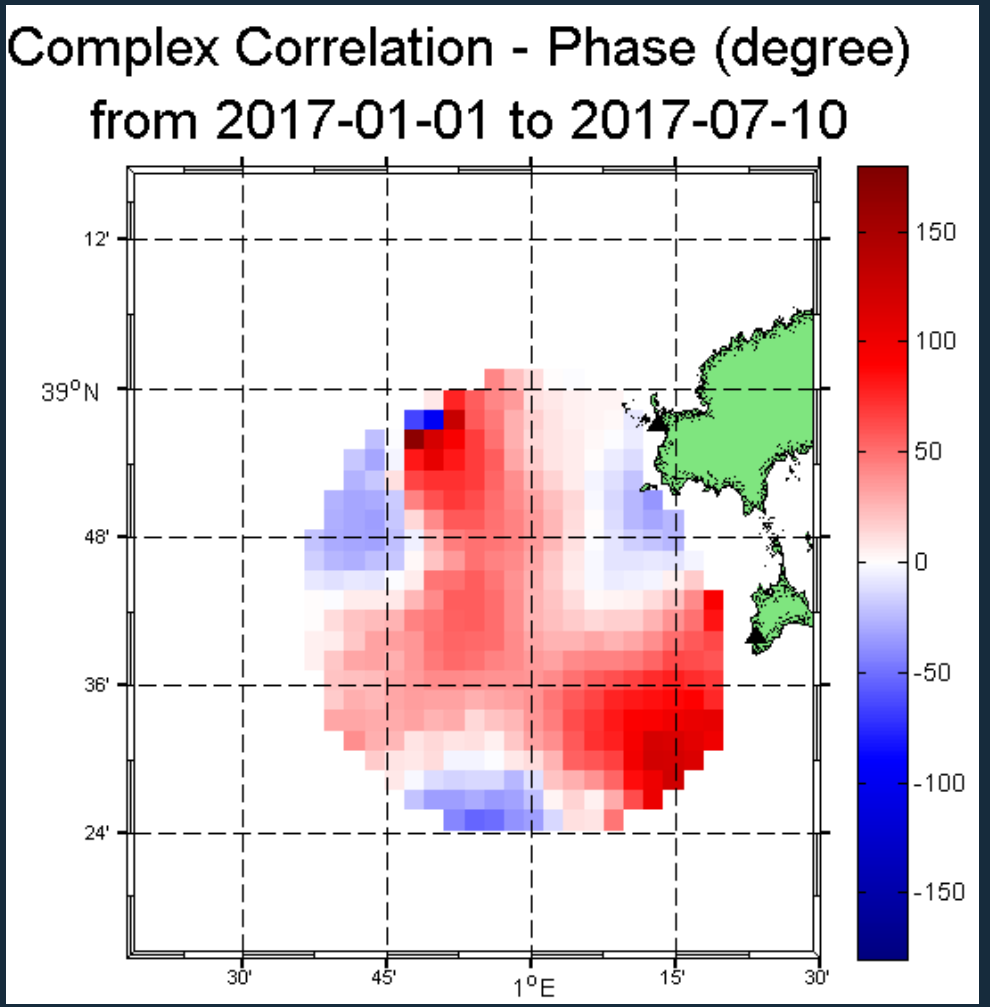
05 RESULTS: WMOP VS. HFR

Correlation (WMOP-HFR)

Magnitude



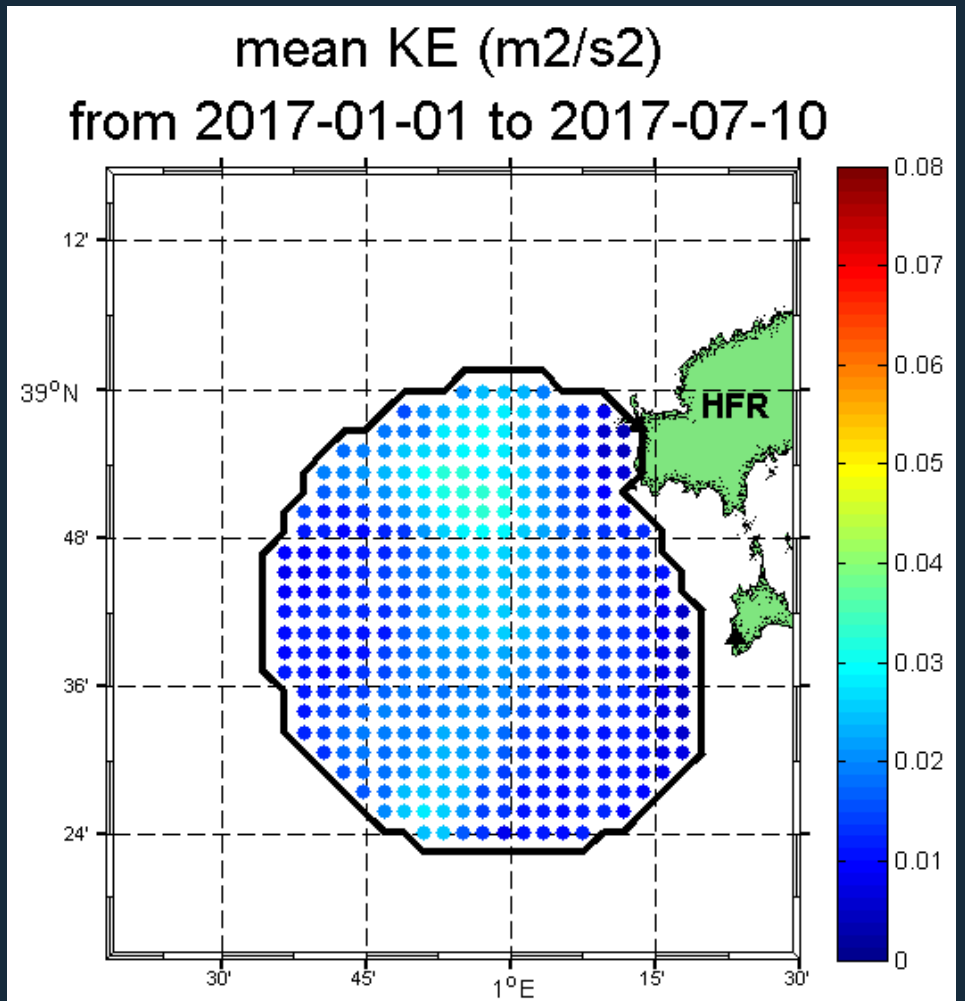
Phase



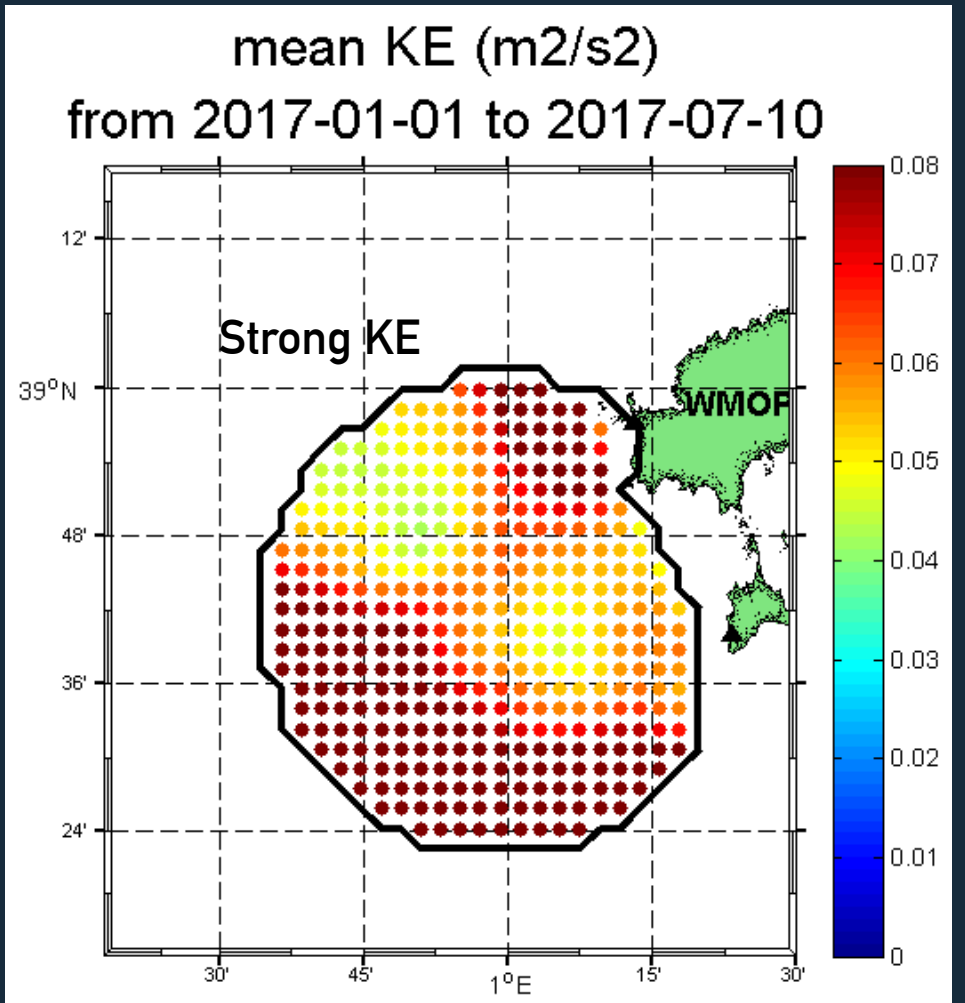
05 RESULTS: WMOP VS. HFR

Kinetic Energy (WMOP-HFR)

HFR

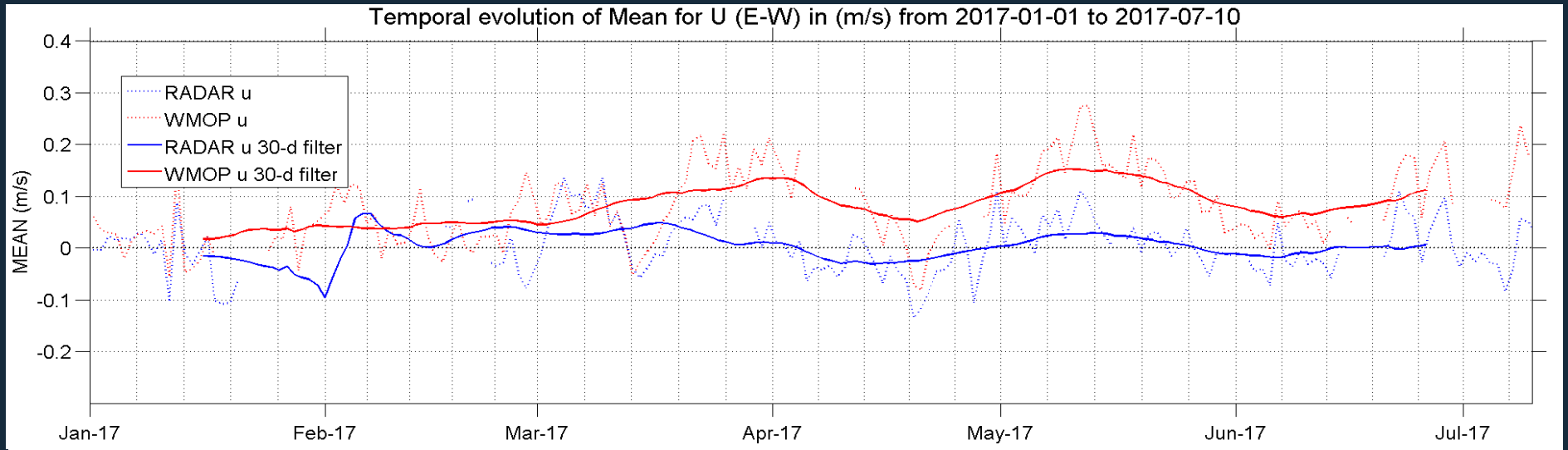


WMOP

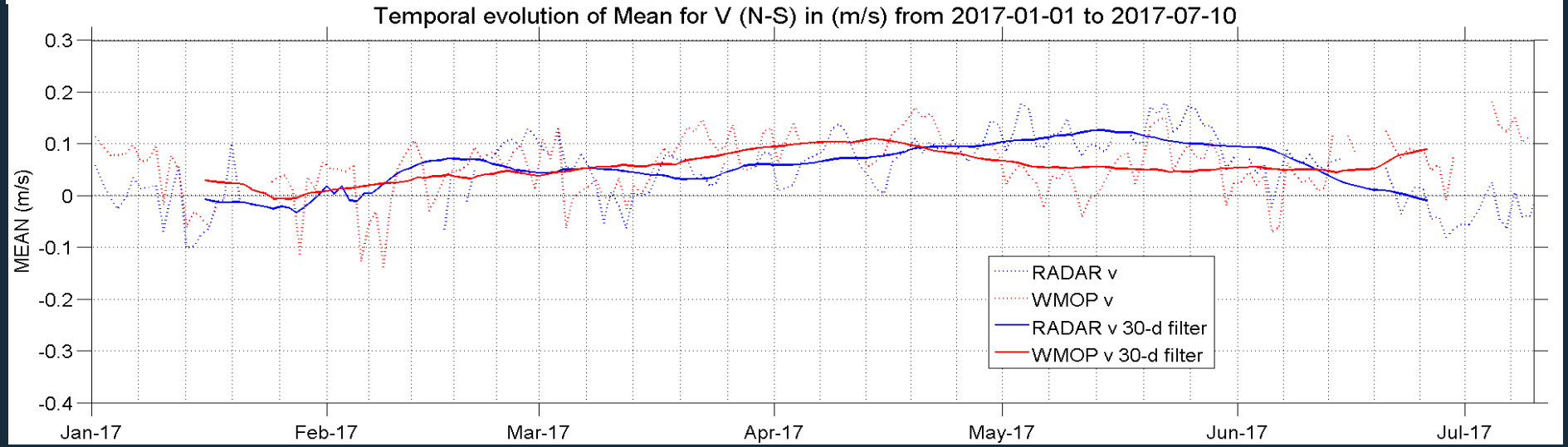


05 RESULTS: WMOP VS. HFR

Temporal evolution of mean zonal and meridional velocity components



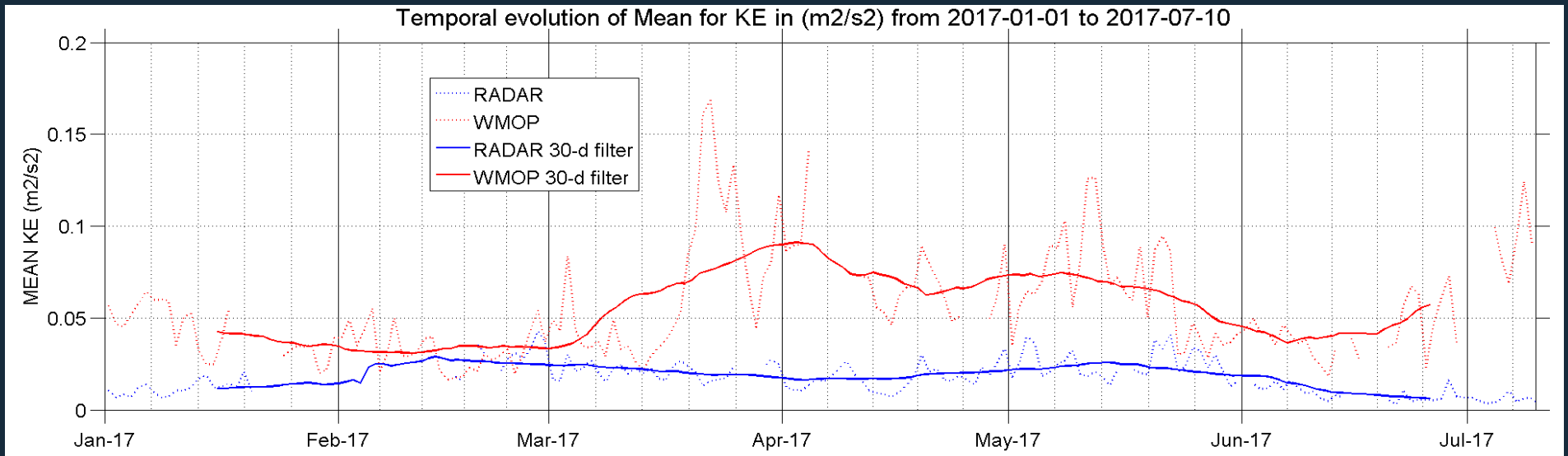
ZONAL



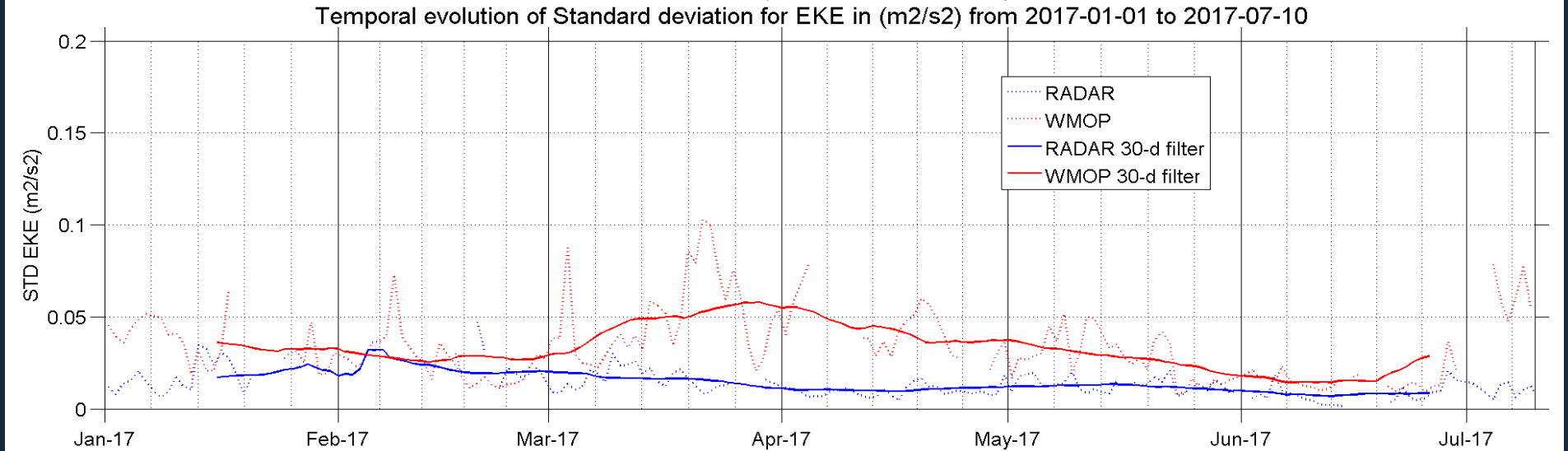
MERIDIONAL

05 RESULTS: WMOP VS. HFR

Temporal evolution of spatially-averaged KE and EKE



KE



EKE

06 CONCLUSIONS

HFR vs. independent in-situ data

- Near real-time validation of HFR data (vs. CM) is a powerful application
  - to detect gaps and malfunction period
  - to provide a quick qualitative assessment to the user
- HFR vs. in-situ data: shows a good agreement
- Both components CORR > 0.7 (in accordance with literature)
- Higher RMSE in the meridional component and for HFR.vs.ADCP
- HFR slightly overestimates total currents from the CM
- Instrument-to-instrument comparisons present intrinsic limitations
- Performance of in-situ instruments are important

WMOP model validation using HFR currents

- WMOP northward transport too strong
- WMOP model has higher surface velocities
- WMOP model presents a bias on the southern part of the domain
- WMOP model presents higher variability
- Leading to stronger kinetic energy
- Strong flow events are reproduced by WMOP
- One-single statistic is not enough
- Standardized validation methodologies and common comparison schemes

SOCIB

Balearic Islands
Coastal Observing
and Forecasting
System

THANKS FOR YOUR ATTENTION