ON THE CYPRUS EDDY KINEMATICS

Arthur Prigent[1,2] and Pierre-Marie Poulain[1]

[1]Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Trieste, Italy

[2]Ecole Nationale Supérieure de Techniques Avancées, Bretagne (ENSTA Bretagne),

Approved for release by: ……………………………………………

Dr. Paola Del Negro

Director, Oceanography Section

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1. Introduction

The general circulation in the Levantine Basin has been studied by several authors (Brenner et al. 1990; Zodiatis et al. 2004; Hamad et al. 2006), and these studies have always reported the presence of a semi-permanent eddy south of Cyprus. Called the Cyprus Eddy, this feature is a dominant component of the circulation in this part of the Mediterranean Sea. It is an anticyclonic eddy with a complex structure which is dominating the general circulation in the southeastern Levantine Basin, particularly the deviation of the mid-Mediterranean jet (MMJ) south of Cyprus (Zodiatis et al. 2005).

Three Surface Velocity Program (SVP) drifters drogued at 15-m nominal depth (Sybrandy and Niiler 1991), from OGS have been trapped in the Cyprus Eddy between February and August 2017. The aim of this report is to study the kinematic properties of this eddy.

2. Drifters in the Cyprus Eddy

a) Drifter design and data

The three Surface Velocity Program (SVP) drifters are drogued at 15-m nominal depth (Sybrandy and Niiler 1991). These instruments are the standard design of the Global Drifter Programme (GDP). The SVP drifter is a Lagrangian current following drifter designed to track currents at 15 meters beneath the surface. They consist of a surface buoy that is tethered to a holey sock drogue that is centered at 15 meters depth. A tension sensor, located below the surface buoy where the drogued is attached, indicates the presence or absence of the drogue. To transmit the data, the global full ocean coverage bidirectional satellite communication network (Iridium) is used. The three drifters used were manufactured by Metocean. Halifax, Canada.

The name of the three drifters are respectively, a300234063469260, a300234063663990 and a300234063665930. For the sake of clarity and coherence, in the following sections they will be called respectively: a260, a990 and a930.

The drifter data were processed following standard methods (Menna et al., 2017) to edit, interpolate and low-pass filter the drifter latitude and longitude data and to calculate velocities. The data used in this report at the positions and velocities low-pass filtered (36 hours) and interpolated at 6-h intervals.

b) Drifter trajectories

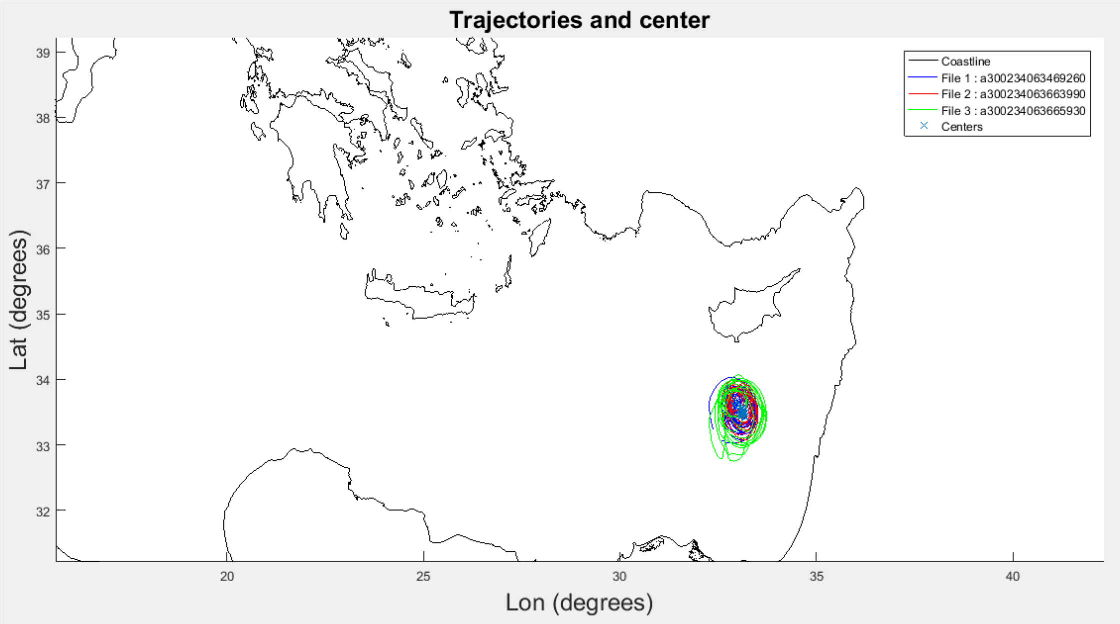

Figure 1: Centre locations and trajectories of the drifters.

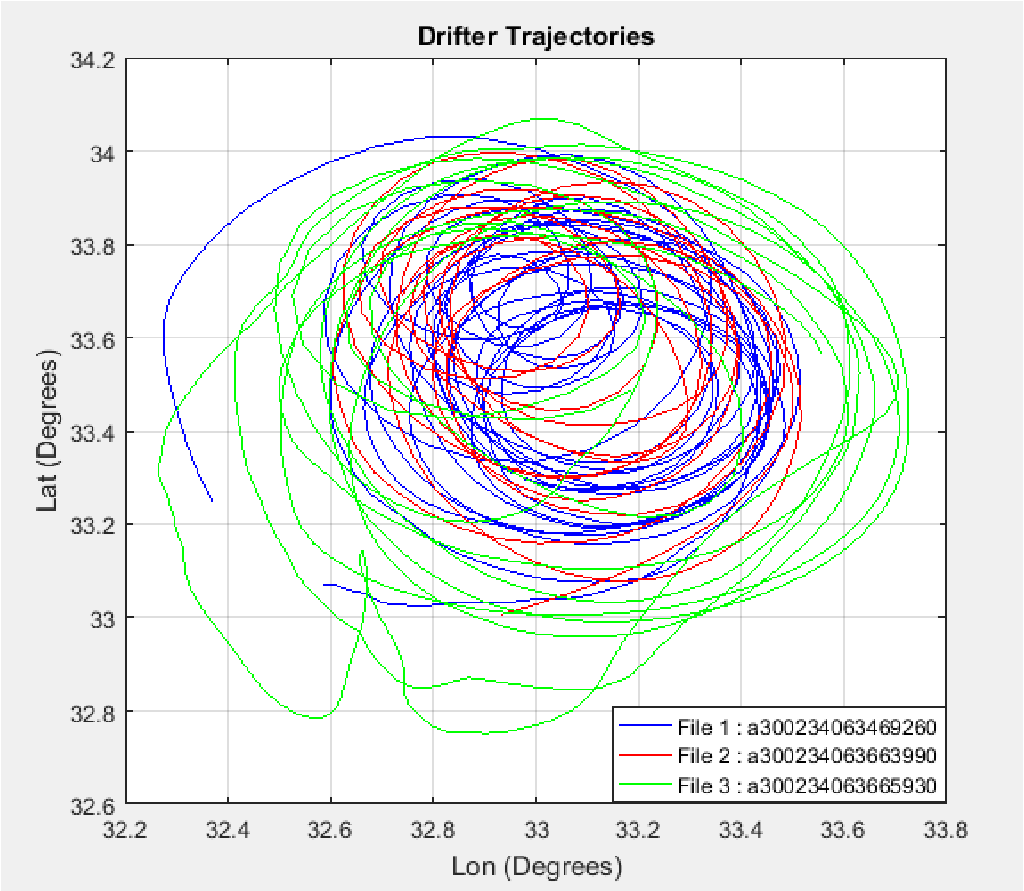

Figure 2: Drifter trajectories in the Cyprus Eddy.

In Figures 1 and 2 the 6-hour low-pass filtered drifter trajectories are plotted. According to Figure 2, three drifters were inside the eddy between February and May 2017. In May 2017, drifter a990 escaped the eddy. The other two drifters stayed in the eddy until August 2017. From the trajectories, it is possible to notice that the centre of the eddy is moving to the southeast. In order to convert the longitudes and latitudes in distance from the eddy centre, the motion of the centre was calculated.

3. Estimation of the centre of the Cyprus Eddy

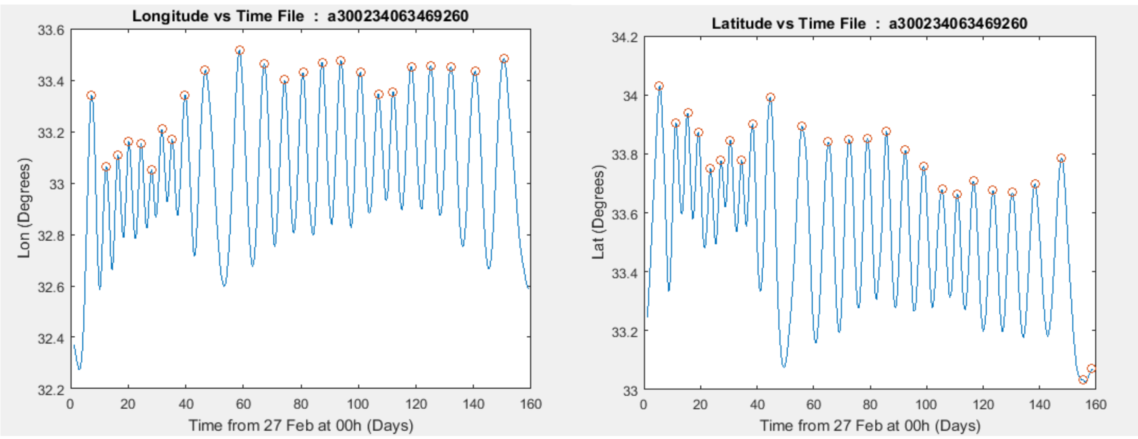

Figure 3: Longitude and latitude vs time of drifter a260.

To estimate the motion of the centre of the eddy, the centre of each loop was determined. A loop of the eddy is defined by all the longitudes and latitudes between two longitude maxima (see example in Figure 3). Then, the centre of each loop was computed doing the average of the longitude and latitude of the loop. This operation was performed for the three drifters, and the results are shown in Figure 4.

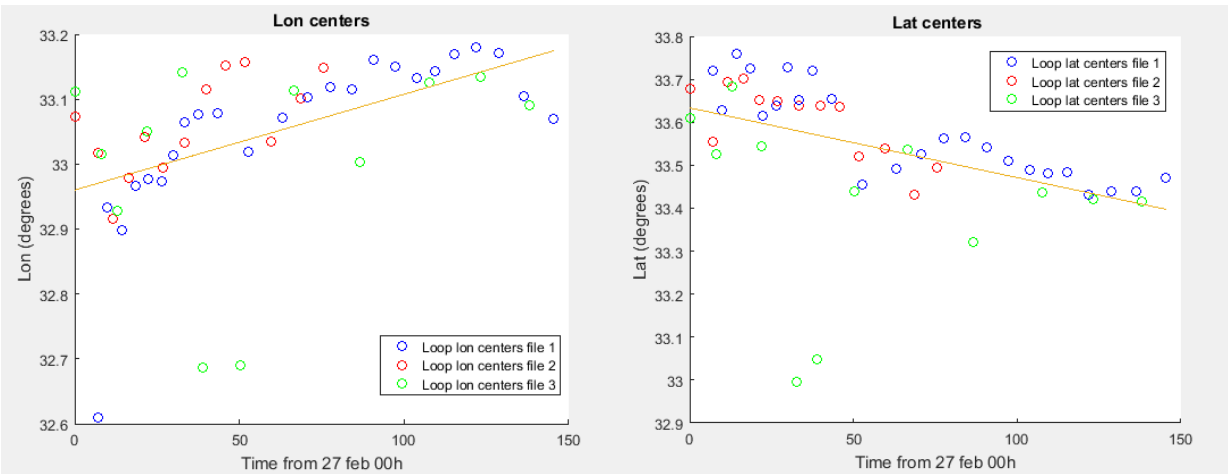

Figure 4: Longitude and latitude of the centre of each loop vs time.

The regression lines in Figure 4 provide the mean motion of the centre of the Cyprus Eddy as a function of the time:

$$Lon_{centre} = a + b.Time$$
$$Lat_{centre} = a + b.Time$$

Equation 1

Model	a	b	R^2
$Lon_{centre} = a + b.Time$	33.0	0.0012	45
$Lat_{centre} = a + b.Time$	33.7	−0.0015	37

Table 1 : Results of the regression on loop centres.

Using these regressions (See Table 1) the trajectories were corrected so that each loop had the same mean centre and longitudes and latitudes were converted to distances with respect to this centre (Figure 5).

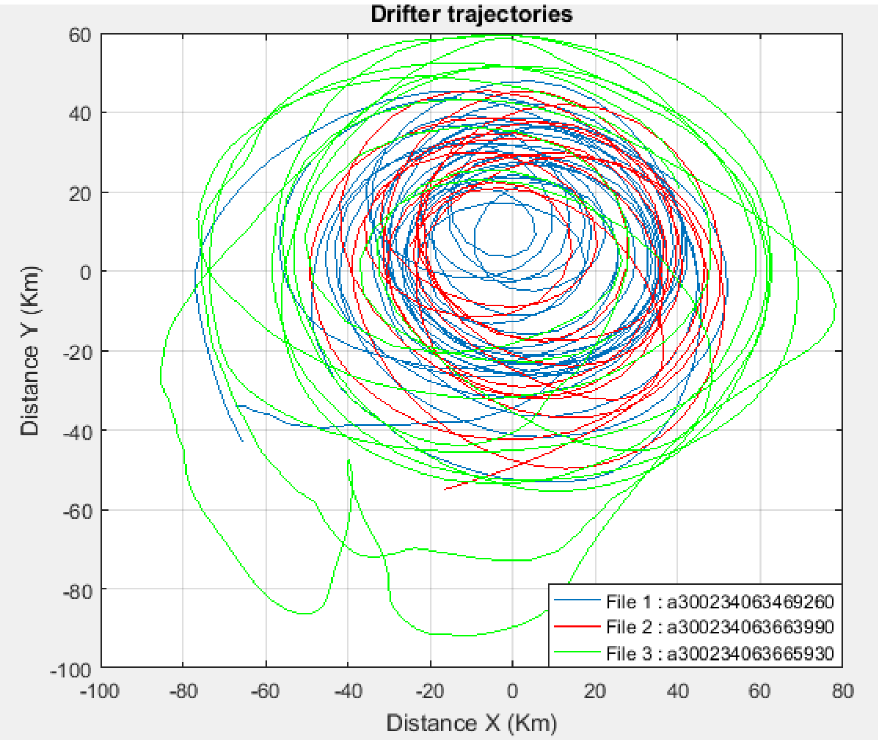

Figure 5: Drifter trajectories with respect to the mean centre and converted to distance.

4. Study of the radius and period of the Cyprus Eddy

Using the estimated mean centre, which is slowly moving to the southeast, we were able to estimate the radius of the eddy as a function of the time (Figure 6).

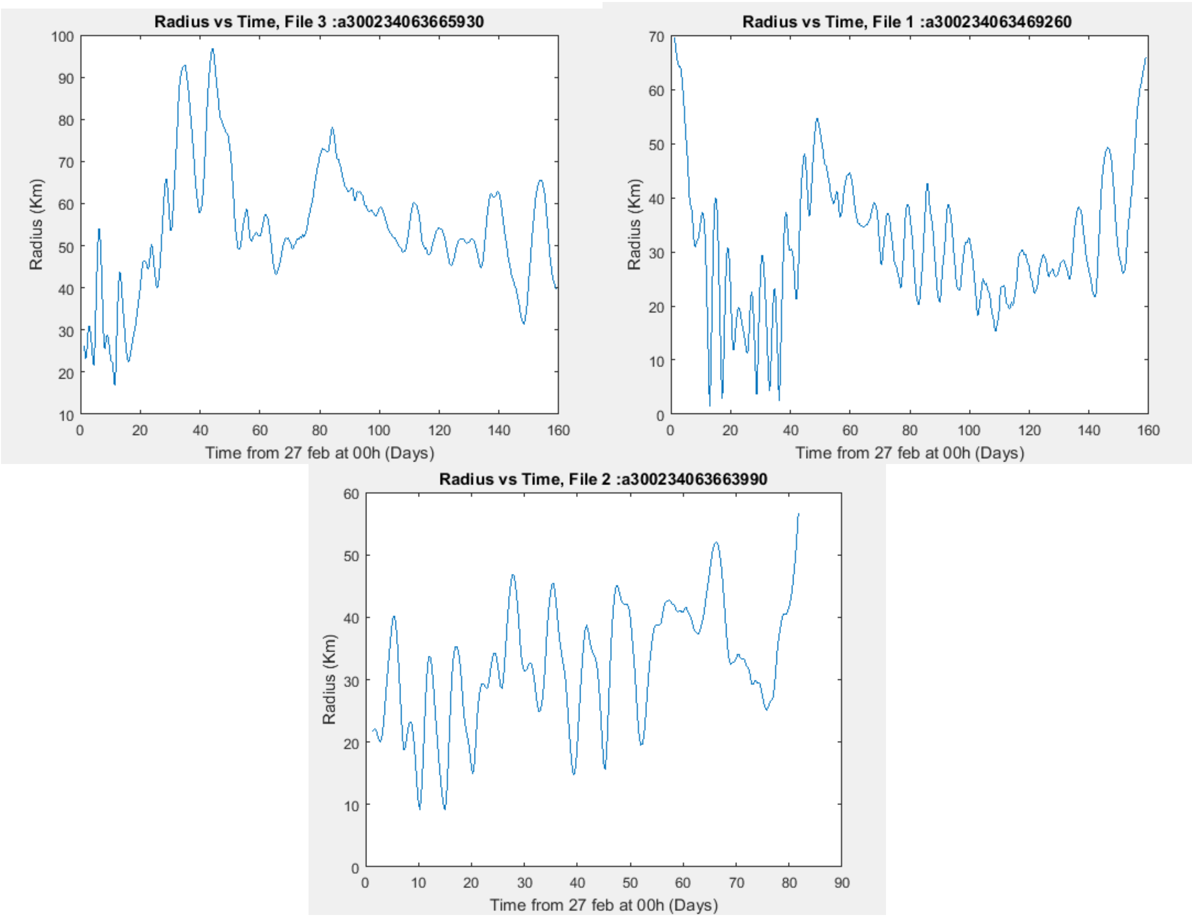

Figure 6: Radius vs time for the 3 drifters.

The radius is ranging between 1 to almost 100 km but the mean radius of the Cyprus Eddy seems to be around 40 to 50 km. In addition, in Figure 6, some oscillations are evident because the eddy is not exactly circular.

According to the distribution (Figure 7) drifters a260 and a990 seem to be centred on a radius of 35 km whereas drifter a930 was centred on a radius of 55 km.

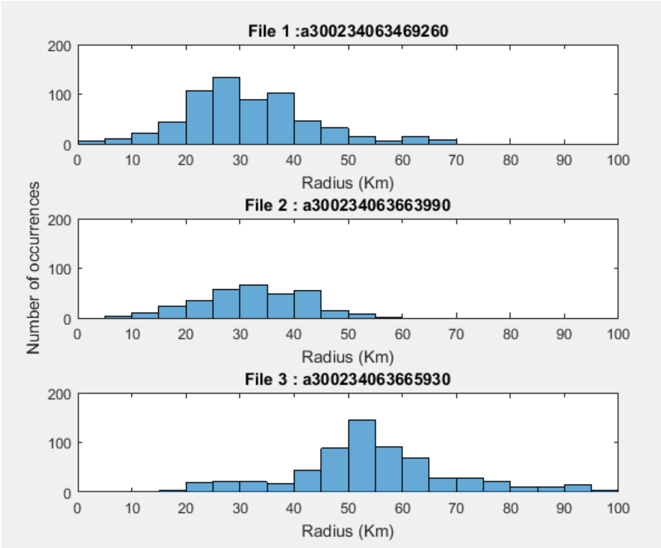

Figure 7: Frequency distribution of eddy radius for the three drifters.

On Figure 8 the period per loop is plotted, we can notice that for drifters a260 and a990 the period is similar between 5 and 10 days maximum whereas for drifter a930 the period goes to 25 days. These high values of period can be explained by the trajectory of the drifter a903 (Figure 5), indeed, the drifter was on the edge of the eddy.

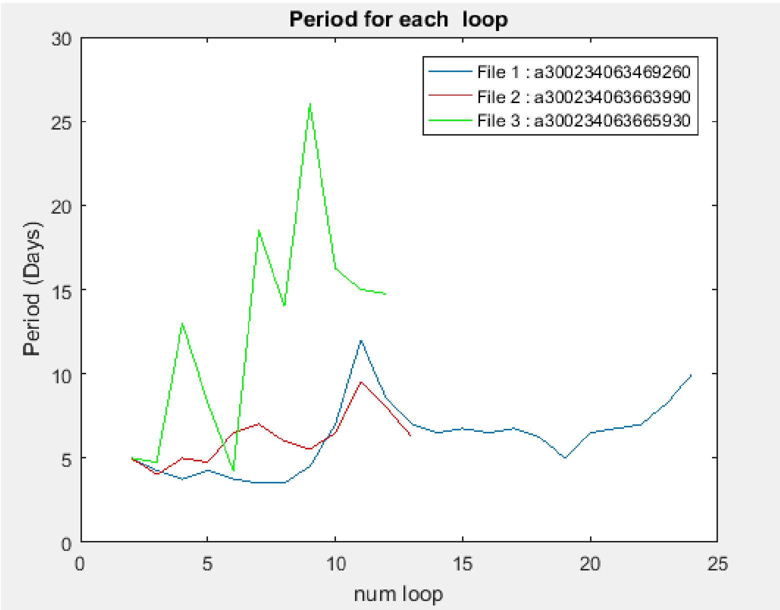

Figure 8 : Period of rotation for the 3 drifters (in days) vs loop number.

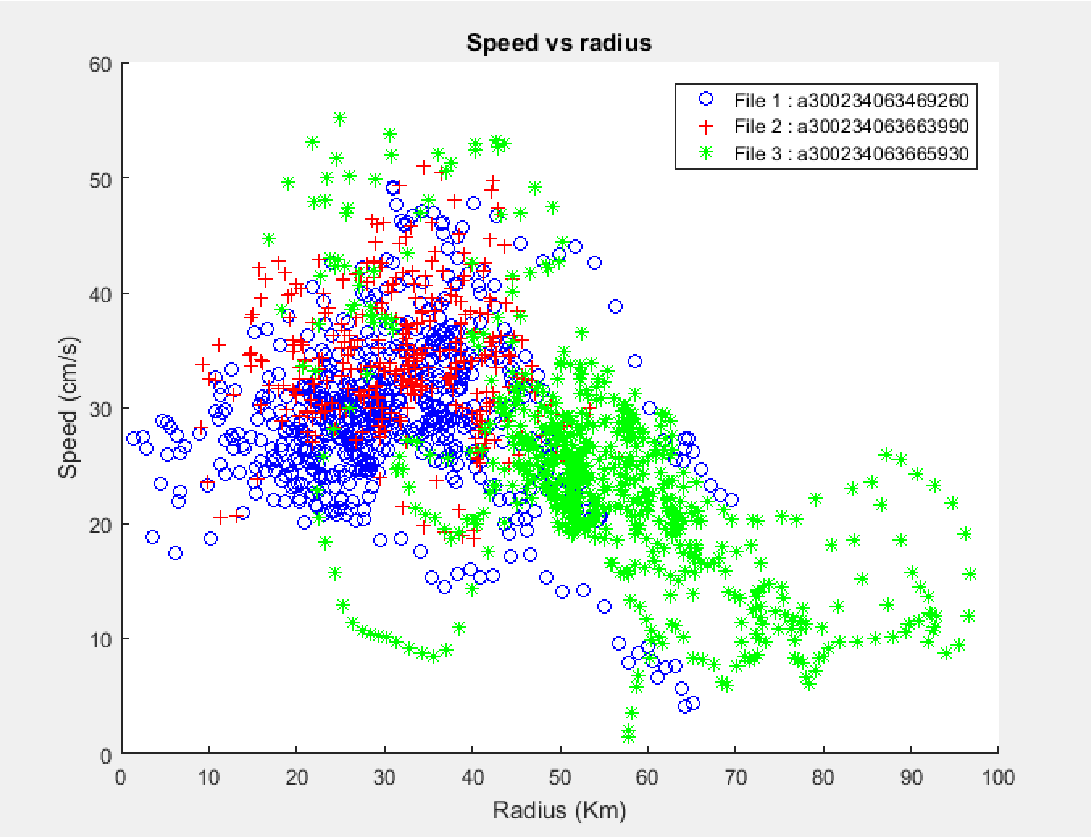

Figure 9: Speed of the drifter vs radius.

The speed of the drifters as a function of radius is depicted in Figure 9. The maximum speed (56 cm/s) is obtained for a radius of 25 km. The speeds of the drifters seem to increase with the radius from 20 cm/s up to about 50 cm/s and then they decrease slowly down to 20 cm/s. These results on the drifter speeds in the Cyprus Eddy are higher than those found by Zodiatis et al. (2005) which were about 30-35 cm/s.

5. Conclusions

Using the data of three drifters some kinematic proprieties of the Cyprus Eddy were estimated. First the motion of the eddy was observed. According to the results, the centre of the eddy is moving to the southeast with a speed about 150 m per day. Second, the radius as well as the period of the eddy were calculated. It was found that the radius of the eddy is about 40 km, but the shape of the eddy is not exactly circular. Furthermore, the period is ranging between 5 and 10 days depending on the distance between the drifter and the centre of the eddy.

6. References

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