Comment on "Turbulent dispersion properties properties from a model simulation of the western Mediterranean" by H. Nefzi et al.

Anonymous Referee #2
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The study describes particle dispersion processes in two-dimensional turbulence using ROMS model. The study is however poorly written taking into account both language and content. It is not mentioned why this study is important and what new aspects it introduces. In addition, the terminology is very confusing, e.g. we can find 'asymptotic regime', 'anomalous regime', 'Richardson regime', 'intermediate regime', 'intermediate range', 'inertial range' – all without a clear definition how they are different. Further- more, the results are meager with mismatching text and figure information.

WE THANK THE REFEREE FOR EVALUATING OUR WORK. WE HOPE THAT THE FOLLOWING ANSWERS WILL IMPROVE HIS/HER ASSESSMENT OF OUR PAPER

Abstract

Analyze dispersion properties, which properties?
THE RELATIVE DISPERSION PROPERTIES; THE SINGLE PARTICLE DISPERSION PROPERTIES WERE STUDIED IN OUR 2010 PAPER.

Why those two depths?
THESE TWO DEPTHS WERE CHOSEN TO ANALYZE THE DISPERSION PROPERTIES NEAR THE SURFACE WHERE MESOSCALE TURBULENT ACTIVITY IS INTENSE, AT THE DEPTH WHERE THIS ACTIVITY IS ATTENUATED. THE AIM WAS TO FIND DIFFERENCES IN THE DISPERSION PROPERTIES BETWEEN THESE TWO LEVELS.

'Three well- known regimes of relative dispersion' – then what is new?
INDEED THE THEORY IS NOT NEW, BUT THE FACTS THAT
(A) THE DISPERSION PROPERTIES OF 2D HOMOGENEOUS ISOTROPIC TURBULENCE HOLD WELL IN A COMPLEX ENVIRONMENT LIKE THE WESTERN MEDITERRANEAN SEA, WHERE DENSITY STRATIFICATION, EARTH ROTATION ACT AND
(B) THE MODEL CAN REPRODUCE WITH A REASONABLE ACCURACY THESE DISPERSION PROPERTIES IN THIS REGION, ARE NEW.

Why it is important that this model gives such day intervals for different regimes?

IT IS IMPORTANT THAT THE MODEL GIVES THESE TIME INTERVALS FOR DIFFERENT REGIMES TO PUT THEM IN PERSPECTIVE WITH THE EDDY TURNOVER TIME IN THE MODEL WHICH IS ON THE ORDER OF TWO WEEKS. ONE CAN ALSO RELATE SHORTER TIME SCALES WITH SMALLER SCALE FEATURES AS FILAMENTS.

Introduction
First paragraph has weak argumentation, better to delete it at all.

FIRST PARAGRAPH WAS DELETED.

Fails to introduce new aspects in this study. After all, the authors agree that there are many numerical studies showing the three regimes.
THE INTRODUCTION WAS CORRECTED TO BETTER STRESS ON THE NEW ASPECTS OF THIS STUDY (SEE IN PARTICULAR ABOVE).

ROMS model
Who developed it? - Reference is needed earlier
THIS REFERENCE HAD BEEN ADDED EARLIER.

Relative dispersion
Very short and confusing description. Richardson regime is described for 3D and 2D isotropic homogeneous and stationary flows. Does the study investigate 2D flow or 3D? In 3D the authors talk about one asymptotic regime, while in 2D about two inertial ranges. Again confusion in terminology.

THE FULLY 3D DISPERSION PROPERTIES WERE GIVEN HERE FOR COMPLETENESS. SINCE THIS INTRODUCES CONFUSION AND SINCE FULLY 3D, ISOTROPIC DYNAMICS OCCUR IN THE OCEAN ONLY AT VERY SMALL SCALE (MUCH SMALLER THAN THOSE CONSIDERED HERE).
THE 3D DISPERSION THEORY IS CANCELLED ALTOGETHER.
TERMINOLOGY WILL BE CORRECTED WHERE NEEDED, BUT INERTIAL RANGES ARE NOT ASYMPTOTIC REGIMES. INERTIAL RANGES REFER TO THE ENERGY SPECTRUM.

Eq.1 should be average instead of sum.
Eq. 1 HAD BEEN CORRECTED.

Equation in (1104) line 18 has bad notation: the second term in the equation should have brackets inside the square brackets. Here Dx, but everywhere else just D.
CORRECTIONS WAS ACHIEVED WHERE NEEDED, BUT Dx IS THE ZONAL COMPONENT OF D.

Results

Why those depths are chosen? Here authors do not talk about regimes, but about phases - again change in terminology.

FOR THE JUSTIFICATION OF THE CHOICE OF DEPTH, SEE ABOVE FOR THE CHANGE IN TERMINOLOGY, IN FACT, AS EXPLAINED ABOVE, THERE WAS NO CHANGE IN TERMINOLOGY BEFORE. HERE THERE IS NO CHANGE IN TERMINOLOGYY EITHER: EACH STAGE (OR PHASE) OF THE TIME EVOLUTION OF DISPERSION CORRESPONDS TO ONE PARTICULAR REGIME. THIS IS EQUIVALENT AND FREQUENTLY USED.

(1106) line 5 – should be - ’until about day 10’, not ’until about day 20’.
YES INDEED, SORRY FOR THE TYPO

(1106) line 13- units of 0.05?
THIS REFERS TO THE KINETIC ENERGY
WE HAVE CONVERTED THE DEGRE TO KILOMETERS. NOW THE UNIT OF THE ENERGY IS is m^2s^{-2}.

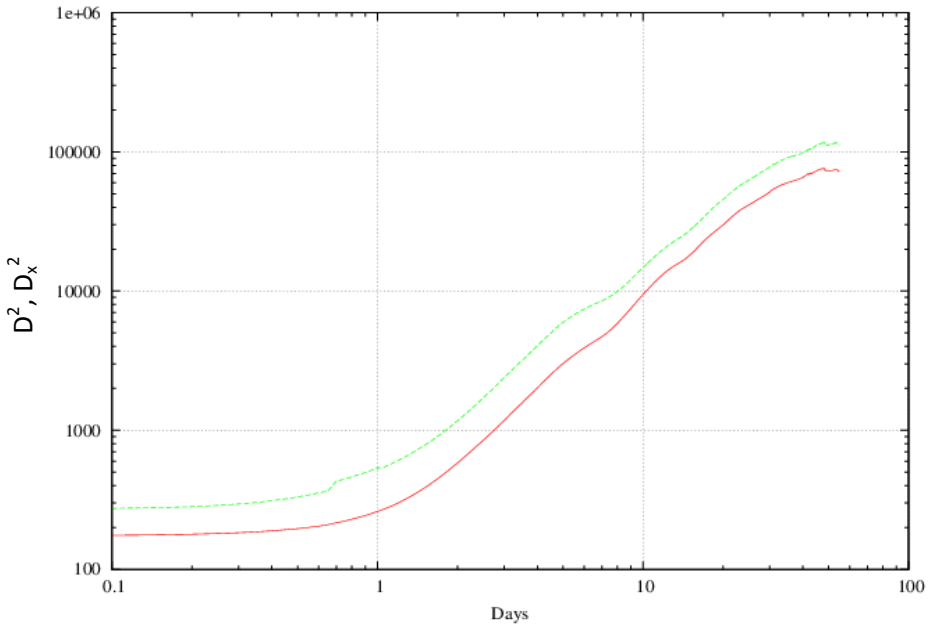
Figure 3a – strange symbols in ordinate axis
THIS HAS BEEN CORRECTED

Figure 3c – label of this and other figures could be more informative. E.g. what D0 is in 3a. Why is this figure in logarithmic scale, while 3a in linear scale. Show in the figure that b is roughly equal 1.
INDEED, THE FIGURE CAPTION IS NOT ENOUGH INFORMATIVE; THIS WILL BE IMPROVED. WE WILL ALSO INDICATE WHEN WE USE LOGARITHMIC SCALES WITH THE AIM OF SHOWING A POWER LAW. WE have ADDED THE SLOPE.

(1106) Lines 17-18: a link to equation how Z is computed would be useful
IT HAS BEEN ADDED

(1106) Lines 19-21: why only zonal dispersion investigated?

IN THE MEDITERRANEAN BASIN, THE ZONAL MOTION IS DOMINANT. WE ADDED A NEW FIGURE (Figure 4a) TO SHOW THAT THE BEHAVIOURS OF THE TOTAL RELATIVE DISPERSION AND THE ZONAL ONE ARE SIMILAR.



Relative dispersion (green curve), zonal relative dispersion (red curve) for D_0=16.65km.

Figure 4a – absolute disagreement between day intervals in text and in the figure. In text it says that regimes change at day 3 and day 20 – in the figure though it seems more like day 1 and 20. What is the criteria for choosing the number?

THE THIRD DAY CORRESPONDS TO THE LIMIT OF THE PERIOD WHERE THE PARTICLE VELOCITIES ARE CORRELATED (INSET OF FIGURE 4b OR FIGURE 8). FROM FIGURE 4b THE $20^{ÈME}$ DAY MARKS A NEW PHASE WHERE FOUR TIMES THE EDDY KINETIC ENERGY AND THE MEAN SQUARE RELATIVE VELOCITY ARE CORRELATED.

Can not see in figure that the growth in second phase is between 1.6 and 3. The figure must be more self-explaining. Can not see that after day 20 the growth is linear.

WE HAVE ADDED A NEW FIGURE (figure 5c) TO SHOW THE ZONAL RELATIVE DISPERSION IN THE SECOND PHASE (3<t<20 DAYS) FOR D_0=5.55Km (BLUE CURVE) AND D_0=16.65Km (RED CURVE). THE TWO CURVES ARE FITTED BY THE LINEAR LAWS : 10 $t^{2.3}$ AND 200$t^{1.66}$. THE RELATIVE ERROR ARE SHOWN.

Overall, why logarithmic scale?
THE LOGARITHMIC SCALE EVIDENCES THE POWER LAW

Almost no discussion about different D0s.
WE HAVE ADDED DISCUSSION WHEN NEEDED.

Besides, the shape of all D0s look almost the same.
Comment
(1107) line 5. Sentence is not understandable. First linear than exponential, so which one? All three D0 cases look very similar, so why in text only two D0 mentioned? Do not see in figure that k varies between 0.74 and 0.82.

WE ADDED ON FIGURE 5b THE TWO CURVES αexp(0.74 t) et βexp(082 t). THEN THE LINEAR EVOLUTION IS MORE CLEAR.

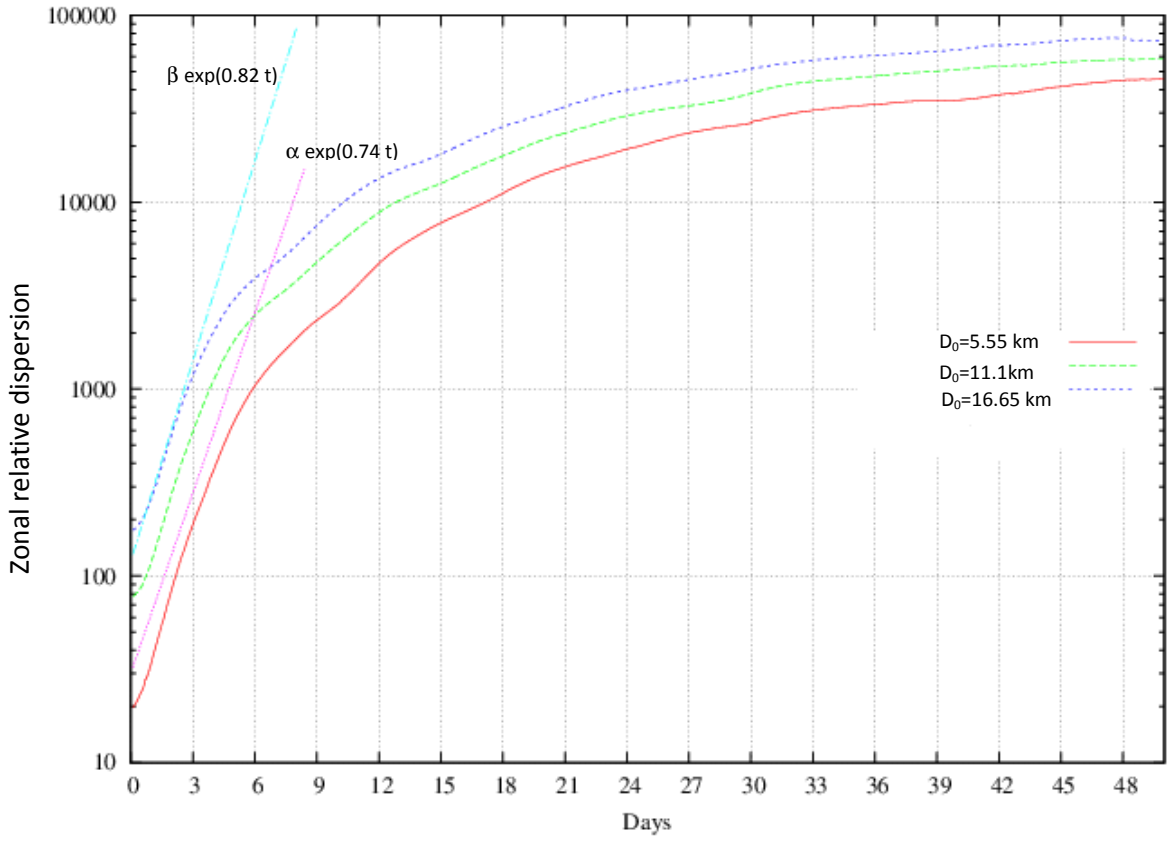


Figure 5b: The zonal relative dispersion versus time and D_0. The $\alpha\exp(0.74\ t)$ and $\beta\exp(0.82\ t)$ laws are given with α=30 and β= 120.

(1107) lines 12- 19. Again all three D0 cases are very similar, just shifted (Figure 5a). However, only two are described as having plateau. Plateau width is computed just for the first D0, but actually is observed in all. Overall description inconsistent.

IN THE REVISED VERSION, Figure5a WAS REPLACED BY A NEW ONE (Figure 6a) WHICH SHOWS THE RELATIVE DIFFUSIVITY AS FUNCTION OF D and D_0 FITTED RESPECTIVELY BY 0.4 D^2 AND THE 3$D^{4/3}$ IN THE TWO INERTIAL RANGES.

Even less can be found about Figure 5b. Why 11km and 55km in Figure 5b? Mark it. Actually, plateau of red line starts at about 6 km, green line 12km, and blue 20 km. How do you define those positions, by visual inspection, or have some criteria?

IN OUR REVISED PAPER Figure 5b WAS REPLACED BY Figure 6a, THE POSITIONS ARE READABLE DIRECTLY IN KILOMETERS.

(1108) line 11: where do 5 and 15 days come from? Which figure? When compared figures 4a and 7 it seems that the first phase is only 1-2 days longer.

- Figure 9 WAS REPLACED BY A NEW ONE (Figure 8) AND THE PLATEAU OF THE 500m DEPTH IS DELIMITED BETWEEN TWO DOTTED LINES.

-THE FIRST PHASE REFERS TO THE PHASE WHERE THE PARTICLE VELOCITIES ARE CORRELATED.

(1108) line 14: Do not see that at 500m turbulent processes are much different from 44m. Therefore this last sentence is not appropriate.

IN OUR REVISED PAPER, WE COMPARED THE RELATIVE DISPERSION FOR D_0=5.55km FOR THE TWO DEPTHS AND THE DIFFERENCE BETWEEN THEM IS WELL observed (Figure 8).

(1108) lines 16-18. how consistent? Really consistent?

IMPROVEMENTS OF THE FIGURES HAVE ANSWERED SEVERAL QUESTIONS AND FACILITETAD THE RESULTS INTERPRETATION.

Conclusion

What is new in the study? Looking through comments in Result section, I find results overall dubious. I would recommend the author first to make the figures self-explaining; such that all the results would be clearly visible on them. Because now one asks oneself where do the results come from?

WHAT IS NEW IN THIS STUDY IS THREEFOLD

a) THOUGH THE MEDITERRANEAN SEA HAS A COMPLEX DYNAMICS, WITH AREAS OF STRONG VERTICAL CONVECTION, WITH FLOW OVER SILLS, AND WITH A NOTICEABLE IMPACT OF ATMOSPHERIC FORCING, THE LAWS OF RELATIVE DISPERSION OBTAINED WITH THE STATISTICAL THEORY OF 2D TURBULENCE ARE WELL OBEYED BY PARTICLES SEEDED NEAR THE SURFACE.

b) THE REVISED FIGURES AND TEXT INDICATE THAT THE THREE REGIMES OF RELATIVE DISPERSION EXIST NEAR THE SURFACE AND THEIR DURATION CAN BE RELATED TO THE SCALES AND VELOCITIES OF TURBULENT MOTION; THIS DURATION IS MADE EXPLICIT BY FITTING THE LAWS OF TURBULENCE ON THE EXPERIMENTAL CURVES AND BY MINIMIZING THE DIFFERENCE BETWEEN THEM; THIS CLARIFIES THE ORIGIN OF THIS FINDING.

c) THE COMPLEMENTARY ANALYSIS AT 500 M DEPTH SHOWS THAT THE EFFECT OF THE MESOSCALE EDDIES, PRODUCED IN PARTICULAR BY THE BAROCLINIC INSTABILITY OF BOUNDARY CURRENTS, IS MOST INTENSE AT THE LEVEL OF THEIR THERMOHALINE CORE (THAT IS, ABOVE 500 M DEPTH), THOUGH IT IS KNOWN THAT MANY EDDIES HAVE A DYNAMICAL INFLUENCE BELOW THIS CORE AS SHOWN BY THE VERTICAL SECTION OF HORIOZONTAL VELOCITY.