Interactive comment on “Multifractal analysis of oceanic chlorophyll maps remotely sensed from space” by L. de Montera et al.

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While I am fairly satisfied with the overall response of the authors to my suggestions, I still feel that the issue of active versus passive scalars has not been resolved. Even if we agree that the zooplankton dominated scales are < 1 km (see however [Behrenfeld, 2010] for new evidence on the importance of grazing), we remark that growth rates as high as \( r = 0.5 \) day\(^{-1} \) are not unusual and values of the order of \( r = 0.1 \) day\(^{-1} \) are common (e.g. [Smith et al., 1999]). At these rates, growth could easily dominate the turbulence patch decay rate as we show below. Therefore, unless there is a “joint” nonlinear growth turbulence mechanism of the sort proposed by [Lovejoy et al., 2000] with \( 0 < H < 1/3 \), there will be a critical scale \( L_c \) beyond which growth (with \( H = 0 \)) will dominate turbulence (\( H = 1/3 \)), and this transition should be visible in the data.

To see this, recall that in a turbulence dominated regime, the patch lifetime is expected to vary as \( T \approx \varepsilon^{(1/3)} L^{(2/3)} \) where \( L \) is the patch size, and \( \varepsilon \) is the turbulent energy flux. For a given patch size, the growth mechanism will dominate when \( r > 1/T \) i.e. whenever \( L_c > \varepsilon^{(1/2)} r^{(-3/2)} \) where \( L_c \) is the critical patch size. This critical patch size should be visible as a spectral break at the corresponding wavenumber. In order for the authors to see the break with their imagery (which covers roughly 4 – 100 km in scale), we would need roughly 50 km < \( L_c < 10 \) km. Due to the intermittency, \( \varepsilon \) is highly variable, although drifter studies [Niiler, 2001] can be used to infer [Lovejoy and Schertzer, 2011] that it is often the range \( 10^{-7} \) to \( 10^{-9} \) m\(^2\)s\(^{-3}\), and SST spectra can be used to infer that a global mean is around \( 10^{-8} \) m\(^2\)s\(^{-3}\) (implying that planetary scale surface structures - eddies, gyres - live about 1 year, [Lovejoy and Schertzer, 2011]). In this case, we find that with weak turbulence and high growth rates (\( \varepsilon = 10^{-9} \) m\(^2\)s\(^{-3}\), \( r = 0.5 \) day\(^{-1} \)) that \( L_c \approx 2 \) km and at the opposite extreme, of strong turbulence and weak growth (\( \varepsilon = 10^{-7} \) m\(^2\)s\(^{-3}\), \( r = 0.1 \) day\(^{-1} \)) that \( L_c \approx 250 \) km. In other words, either we should see scaling with a nonstandard \( H \), or we should see a transition from a turbulent to a growth dominated regime. In order to partially address this problem, the authors could break up their spectral range into two parts one smaller, one larger than \( \approx 20 \) km. They could then compare the histograms of the spectral exponents of the two.

A last comment: I noticed that the new fig. 5 indicates an outer scale of the order of 2000 km whereas I would have expected something a bit closer to planetary scales (as in the atmosphere and in analyses of in situ SST temperatures in [Lovejoy and Schertzer, 2011]). I suspect that the sample used by the authors is not fully representative of the dynamical variability; this would require data sampled more or less uniformly over a period of the order of a year, (the lifetime of the largest near-surface eddies).

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References:

Interactive comment on Ocean Sci. Discuss., 8, 55, 2011.