

MOTIVATION

- For Eulerian field measurement at specific time instant
- Kolmogorov (K41) relation of second order structure function ($m = 1$) and spatial distribution
- Bandi (2017) found the asymptotic field limit for wind power power spectrum scale as $r^{4/3}$.
- Notation: $S^{2m}(r) = ((\Delta u^m(r))^2)$

DIMENSIONAL ARGUMENT

Dimensional argument: $S^m(r) \sim r^{m\alpha}$

Experimental data show for high order velocity moments: $\alpha \approx 1/3$

Time homogeneous

→ Laws of mechanics are the same for all and space points considered

STATISTICAL ANALYSIS

Second order structure function: $S^2(r) = ((\Delta u^2(r)))$

$m = 2$

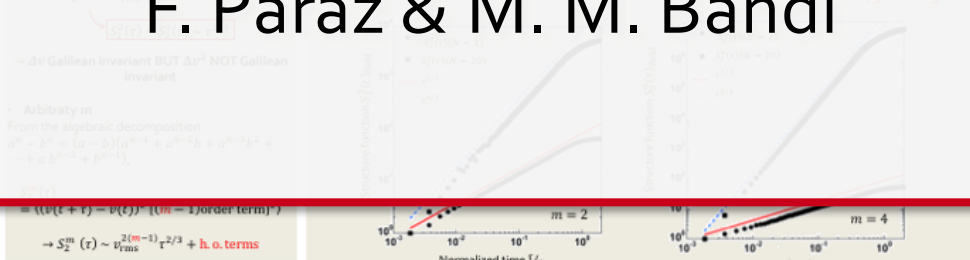
$S^2(r) = ((\Delta u^2(r))) = ((u(x) + v)^2 - (u(y))^2))$

$S^2(r) = ((\Delta u^2(r))) = ((u(x)^2 + v^2 + 2uv - u(y)^2))$

$S^2(r) = ((\Delta u^2(r))) = ((u(x)^2 - u(y)^2) + v^2 + 2uv)$

$S^2(r) = ((\Delta u^2(r))) = ((u(x)^2 - u(y)^2) + v^2 + 2uv)$

METHODS FOR ANALYSIS

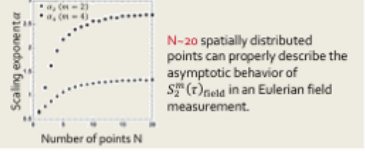


→ How does this scaling change from a single Eulerian point measurement to the asymptotic field average limit?

REFERENCES

- Taylor, *Proc. R. Soc. Lond. A* **164** (1938)
- Kolmogorov, *Dokl. Akad. Nauk SSSR* **30** (1941a)
- Dutton & Deaven, *Statistical Models and Turbulence. Lecture Notes in Physics* **12** (1972)
- Van Atta & Wyngaard, *J. Fluid. Mech.* **72** (1975)
- Bandi, *Phys. Rev. Lett.* **118** (2017)

Convergence of $S^{2m}(r)$ with N



CONCLUSIONS AND FUTURE LEADS

- In 3D turbulence, $S^m(r) \sim r^{2m/3}, \forall m$.
- Galilean invariance recovers for a sparse spatial sampling ($N \geq 20$ points).
- Original analysis of the second order structure function.
- In 2D turbulence, results will come up soon!
- Theoretical approach.

Échantillonnage et comportement asymptotique en moyenne spatiale en turbulence

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Échantillonnage et comportement asymptotique en moyenne spatiale en turbulence

- Pour une **mesure Eulérienne d'un champ turbulent à un instant spécifique donné**

Kolmogorov (K41)

$$S_2^1(r) \sim r^{2/3}.$$

- Correspondance pour une **mesure Eulérienne d'une série temporelle**
Hypothèse de Taylor (turbulence gelée)

$$S_2^1(r) \sim r^{2/3} \Leftrightarrow S_2^1(\tau) \sim \tau^{2/3},$$

avec $r = v_{\text{mean}} \tau$.

- Bandi (2017)
La limite asymptotique d'un champ turbulent dans le cas d'un champ éolien évolue comme $\tau^{4/3}$.



→ Comment les spectres temporels de vitesses d'ordre supérieurs $S_2^m(\tau)$ évoluent-ils pour $m > 1$?

1 point (N = 1)	Limite asymptotique (N > 1 points)
$S_2^m(\tau)_{\text{pt.}} \sim \tau^\alpha, \forall m$	$S_2^m(\tau)_{\text{field}} \sim \tau^\alpha, \forall m$
$\alpha = 2/3$	$\alpha \rightarrow 4/3 \text{ or } 2m/3 ?$