Is long distance free-space quantum communication with the OAM state of light feasible?

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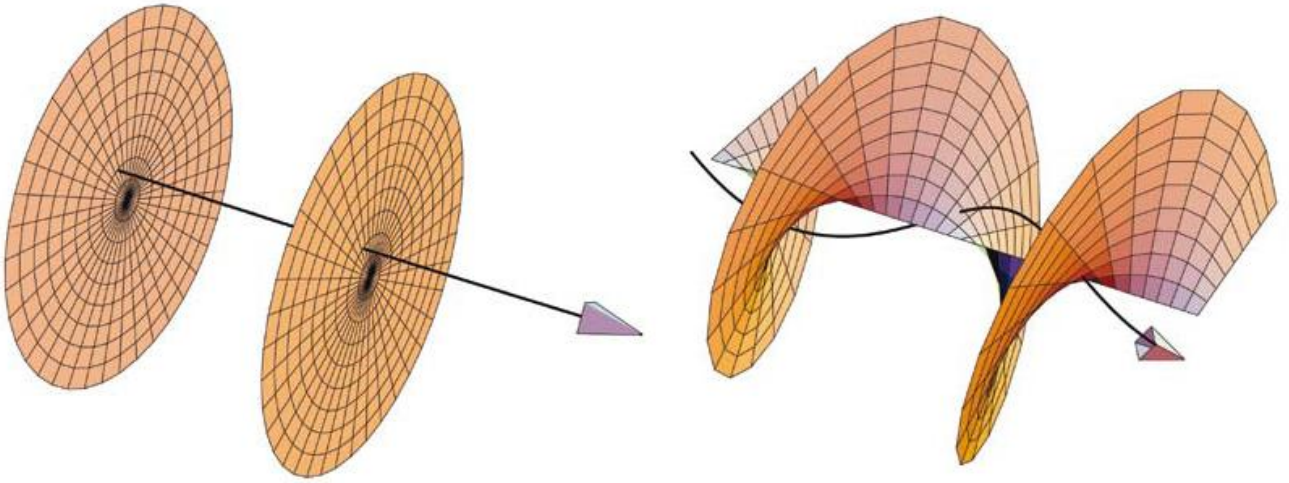
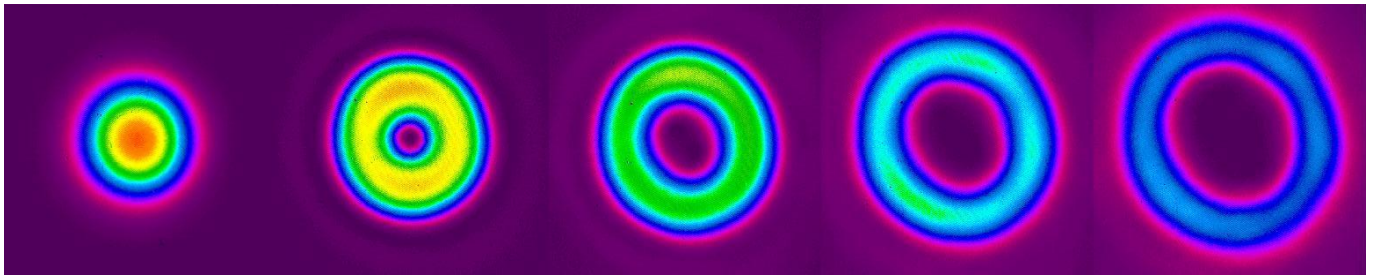
our future through science

Orbital angular momentum of photons

GAUSSIAN BEAM **LAGUERRE-GAUSSIAN BEAM**

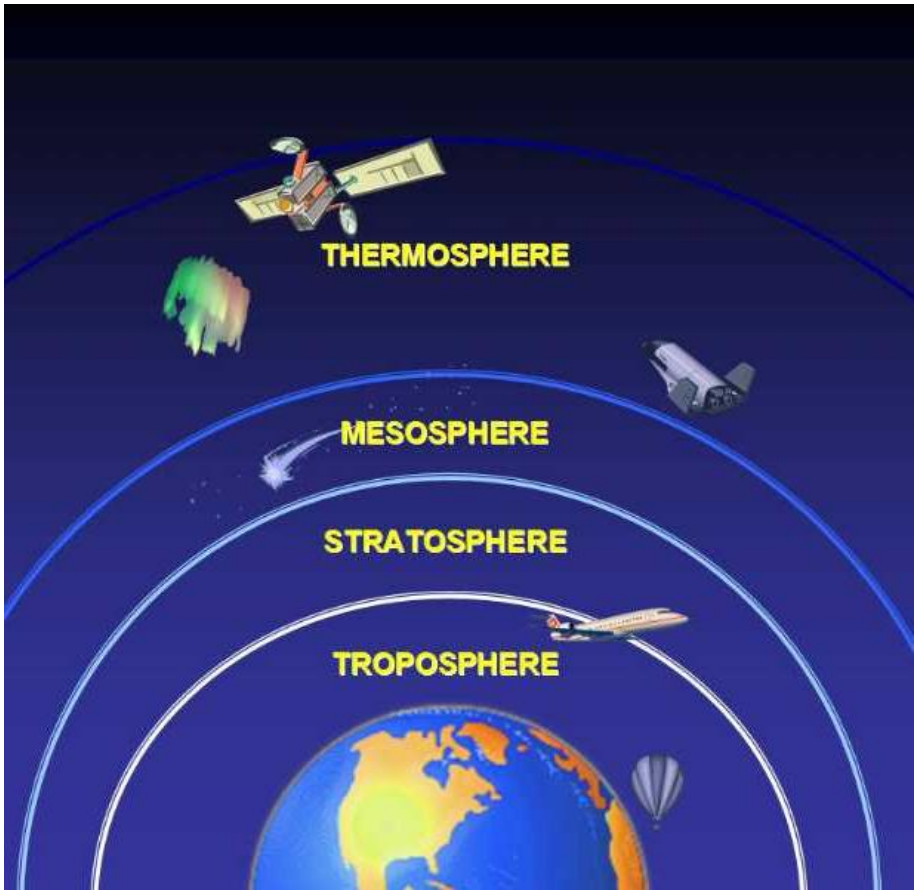


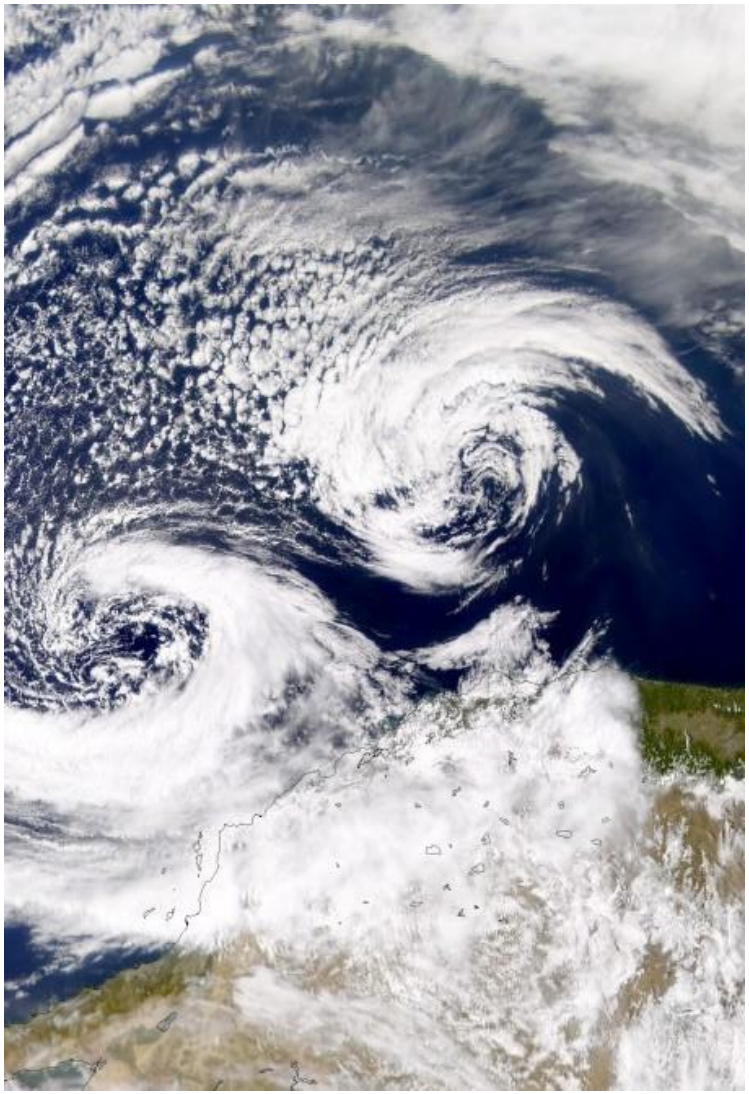
$$u(r,\theta,z) = u_0(r,z)\exp(i\ell\theta)$$



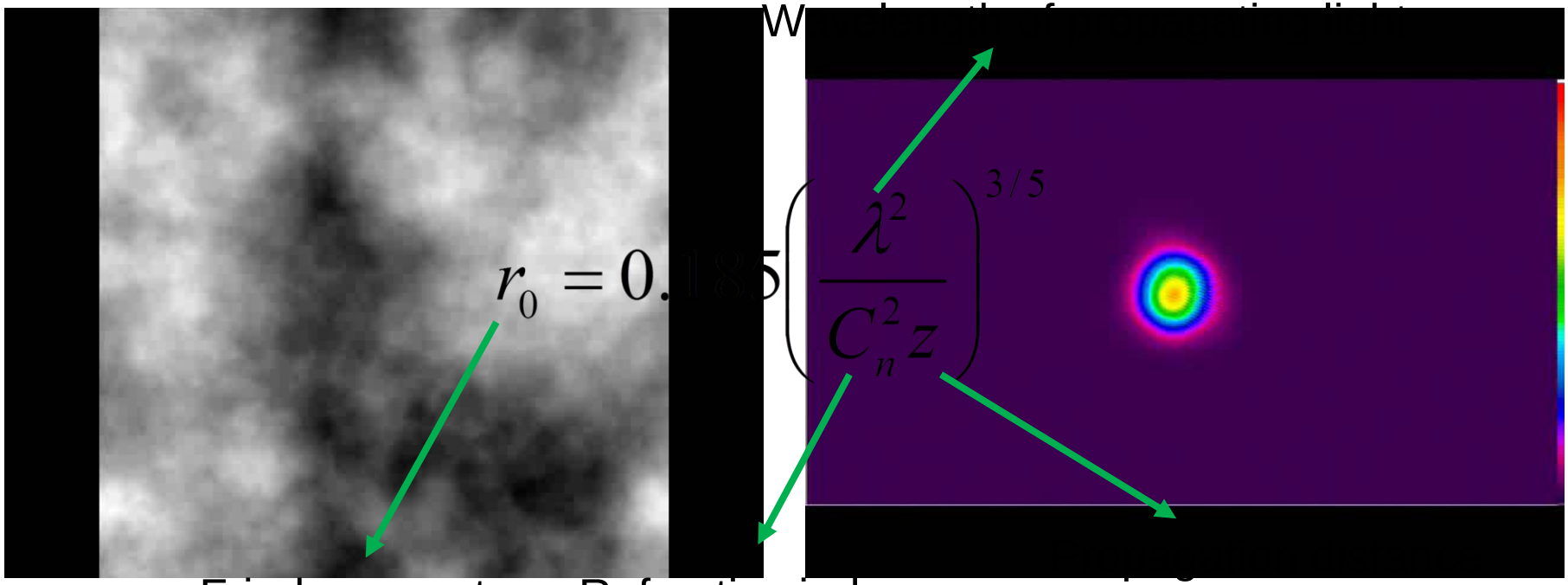
$\ell = 0$ 1 2 3 4

Free-space communication ➡ turbulence

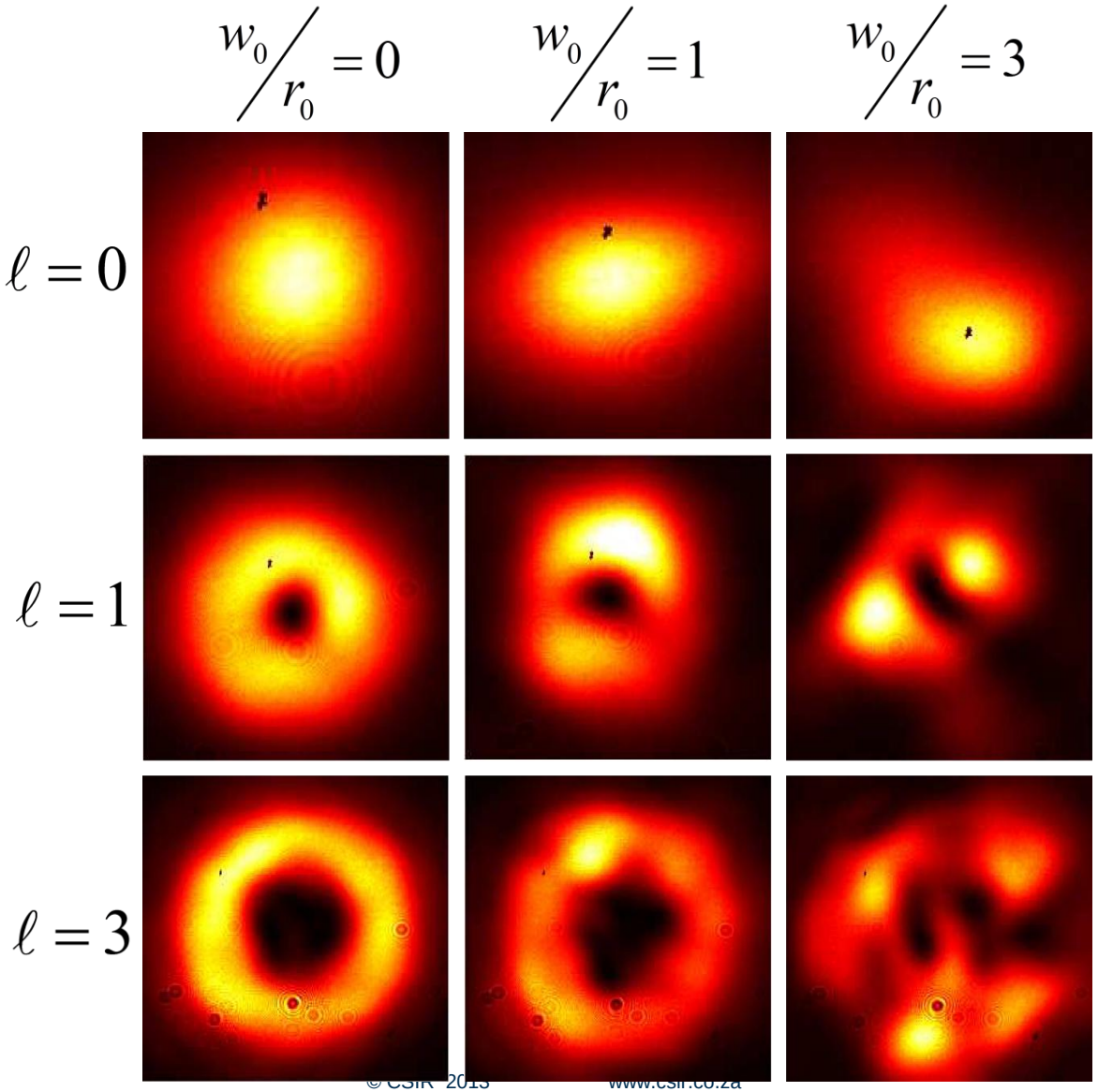




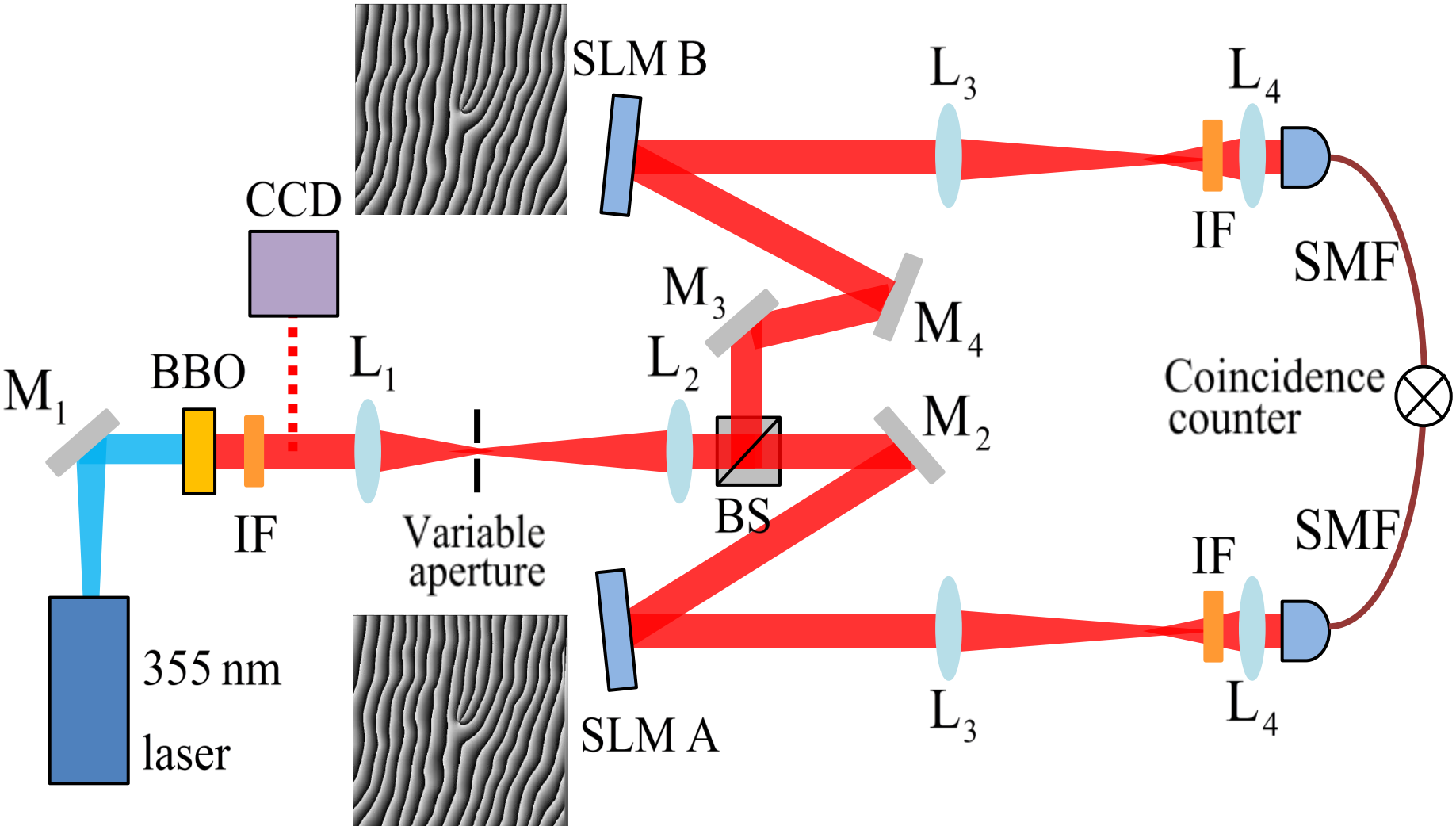
Simulating turbulence in the lab using spatial light modulators (SLMs)



Effect of turbulence on OAM modes

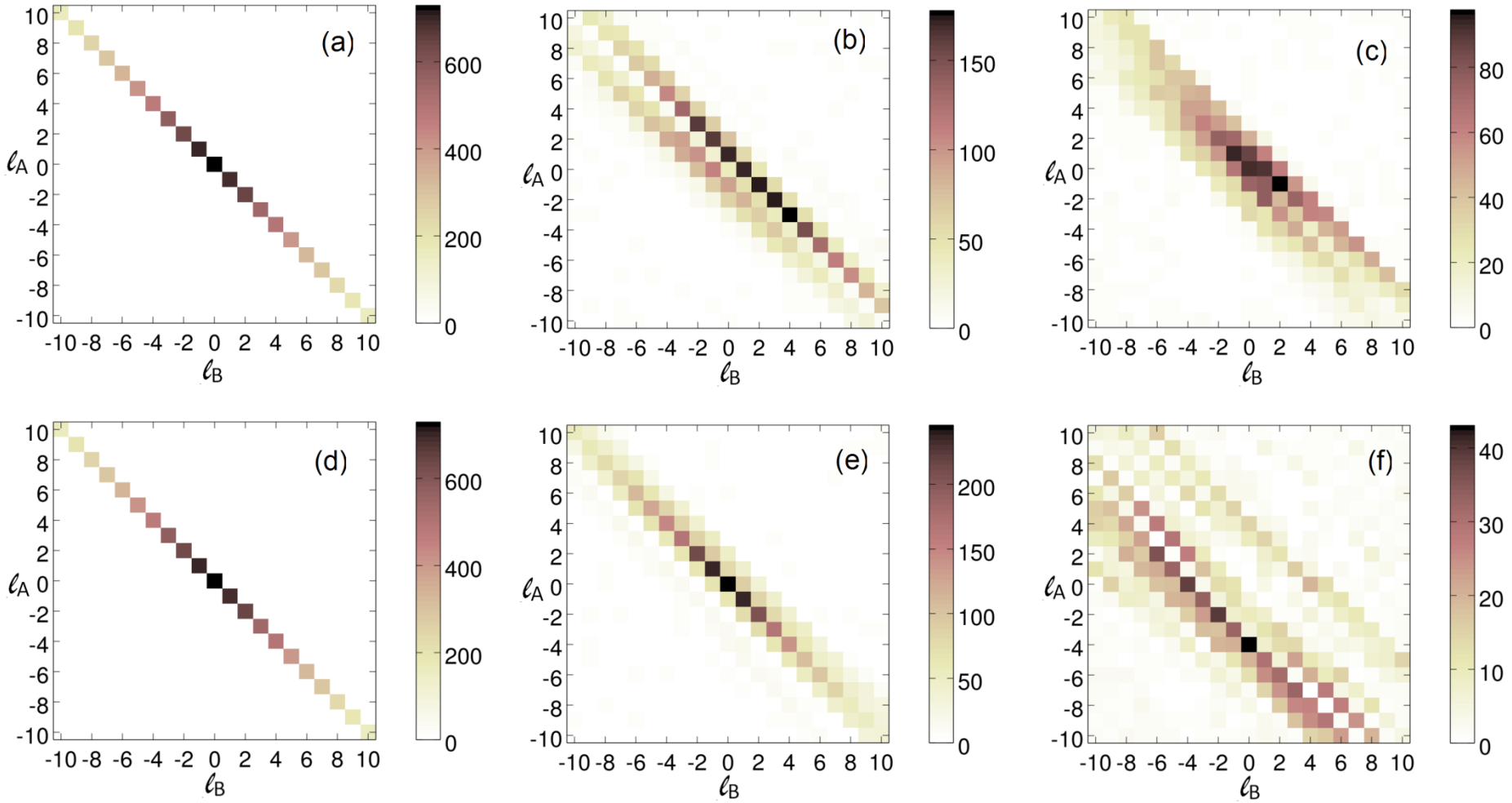


Experimental setup to measure OAM entanglement

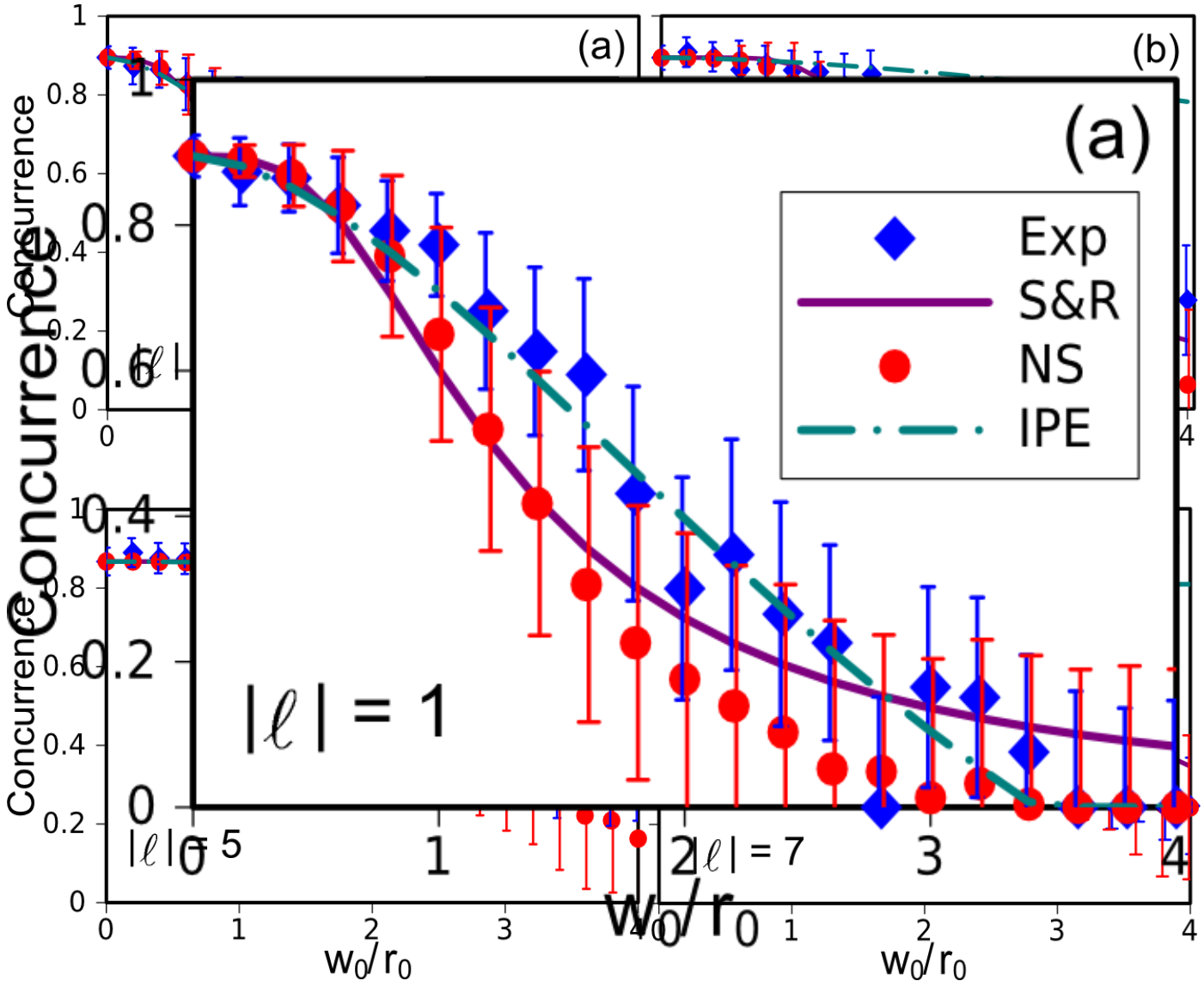


Effect of turbulence on the OAM correlations

$w_0/r_0 = 0$ $w_0/r_0 = 2$ $w_0/r_0 = 4$

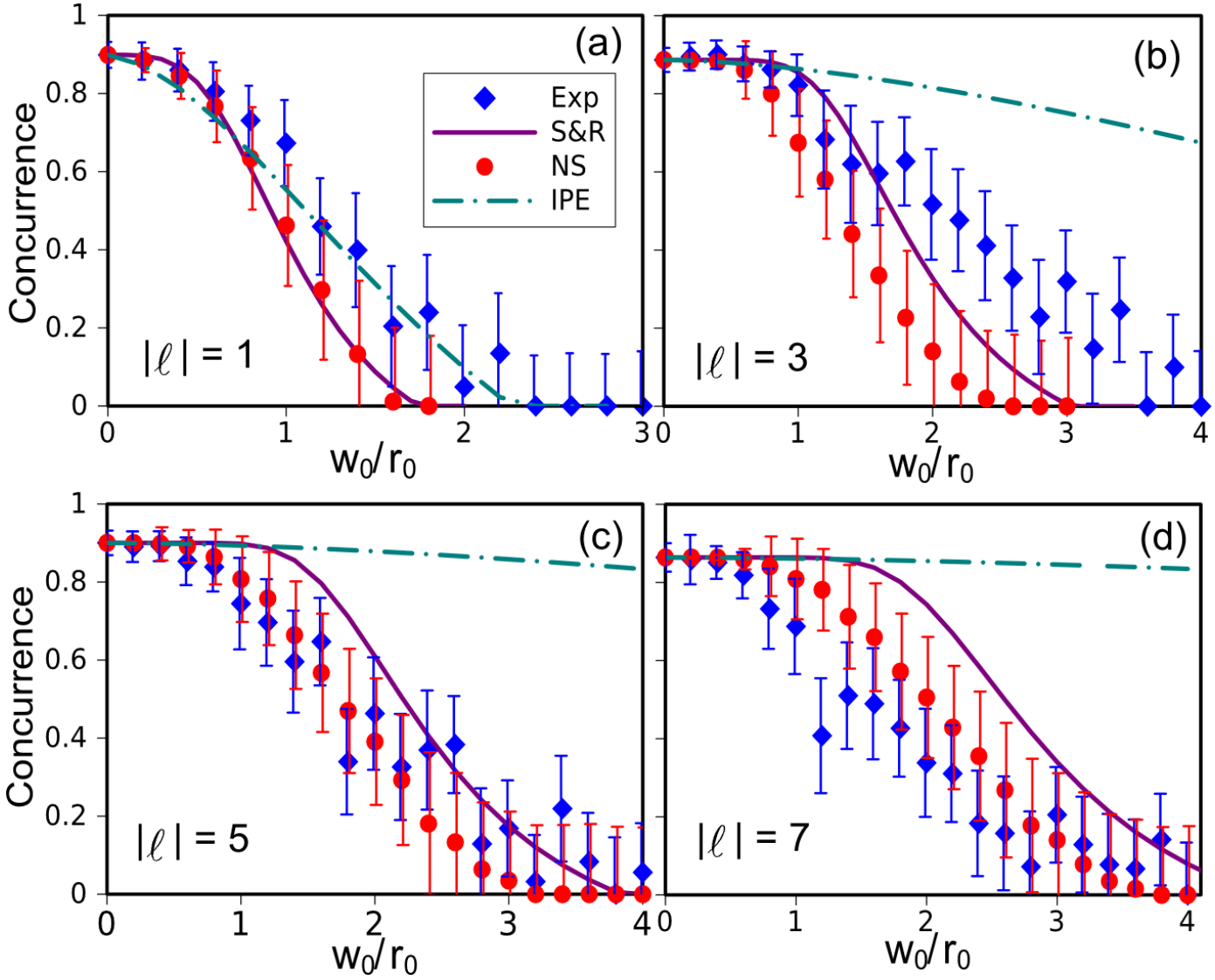


Single photon propagation through turbulence



A. Hamadou Ibrahim et al.,2013, *Phys. Rev. A*, accepted.

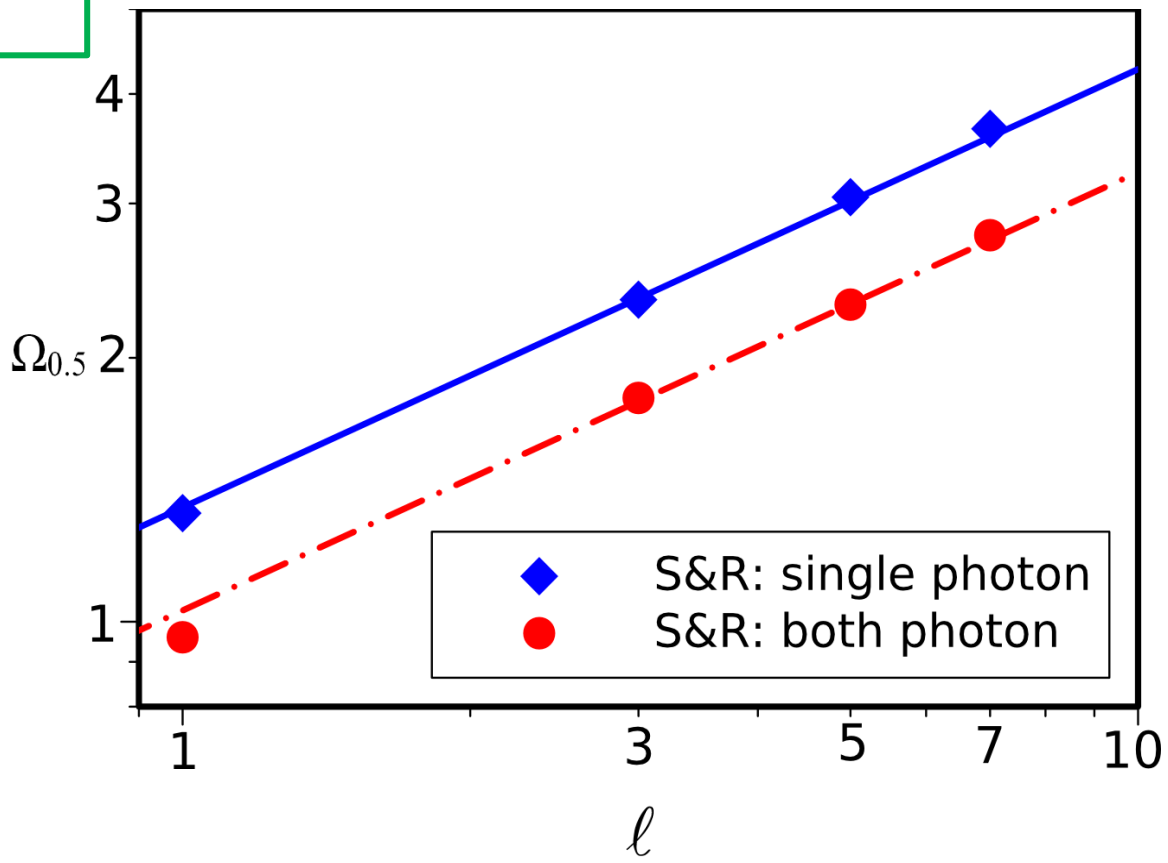
Photon pair propagation through turbulence



A. Hamadou Ibrahim et al.,2013, *Phys. Rev. A*, accepted.

Larger OAM values are more robust through turbulence

$$\Omega_{0.5} \equiv \frac{w_0}{r_0} \text{ for } C = 0.5$$



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Distance scale at which OAM entanglement decays

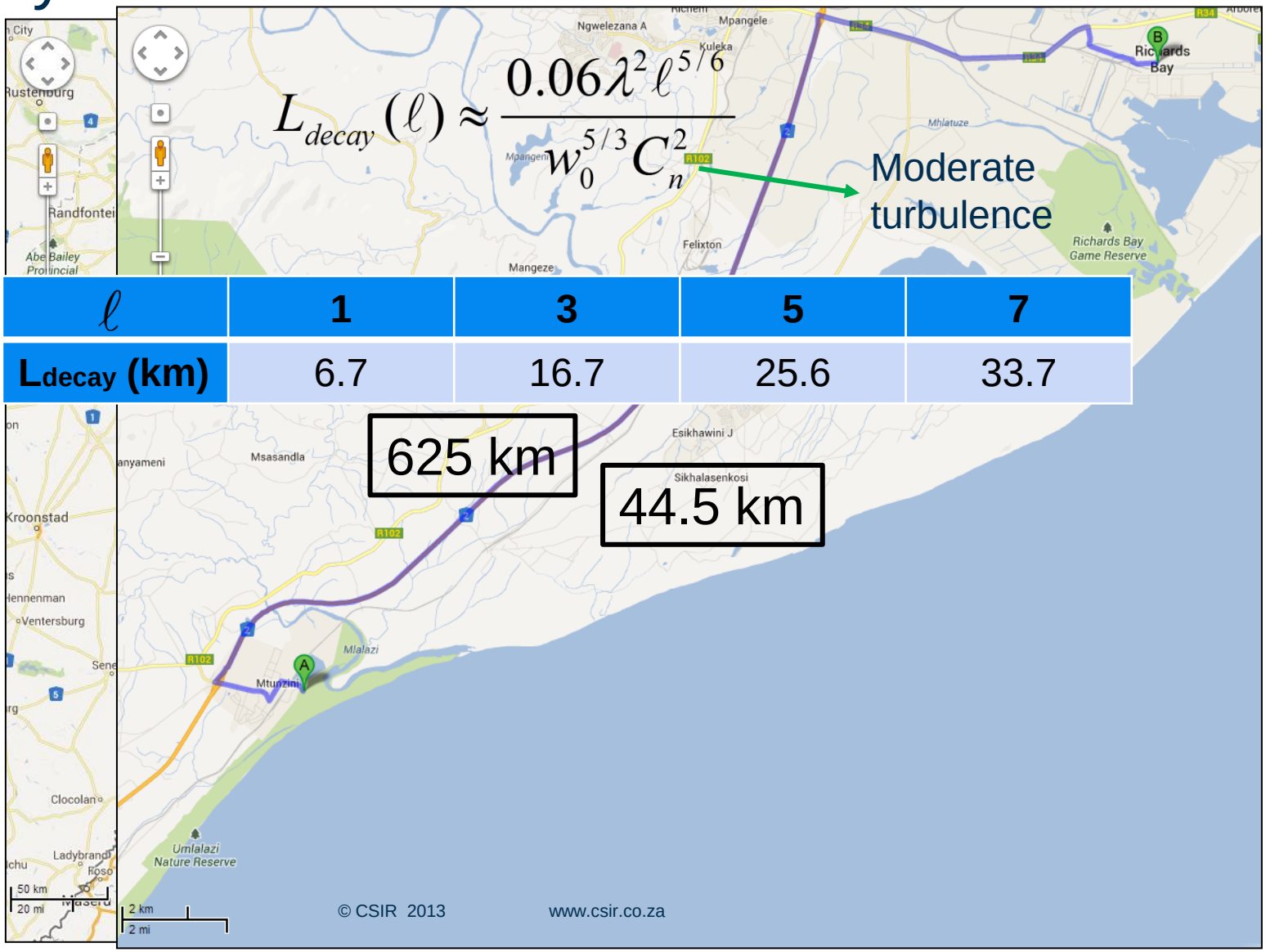
$$L_{decay}(\ell) \approx \frac{0.06\lambda^2 \ell^{5/6}}{w_0^{5/3} C_n^2}$$

Moderate turbulence

ℓ	1	3	5	7
L_{decay} (km)	6.7	16.7	25.6	33.7

625 km

44.5 km



Thank you