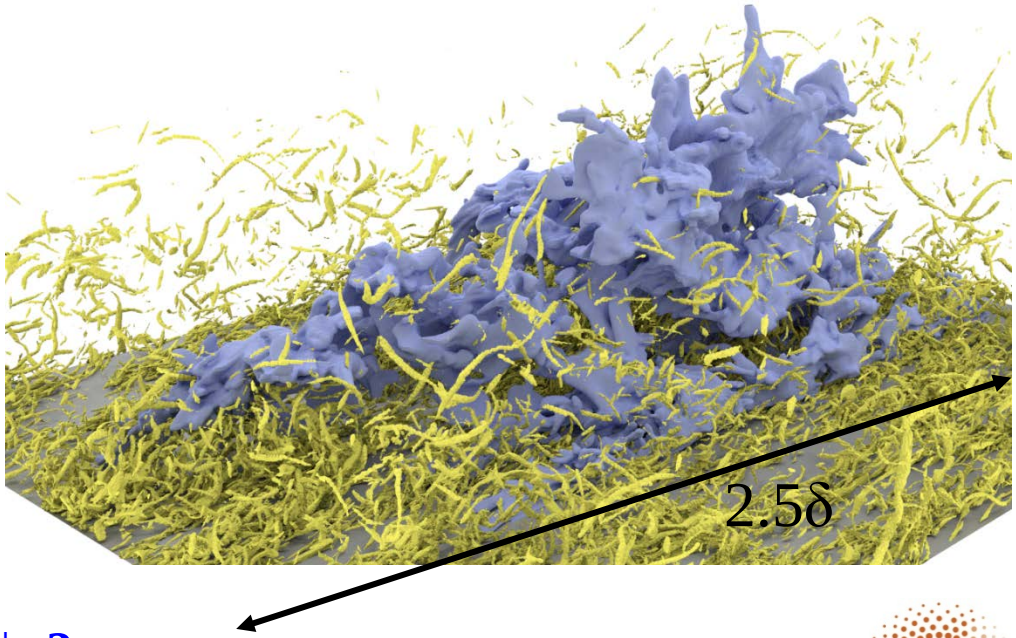
What can we gain by

Doing Turbulence Wrong?

Javier Jiménez

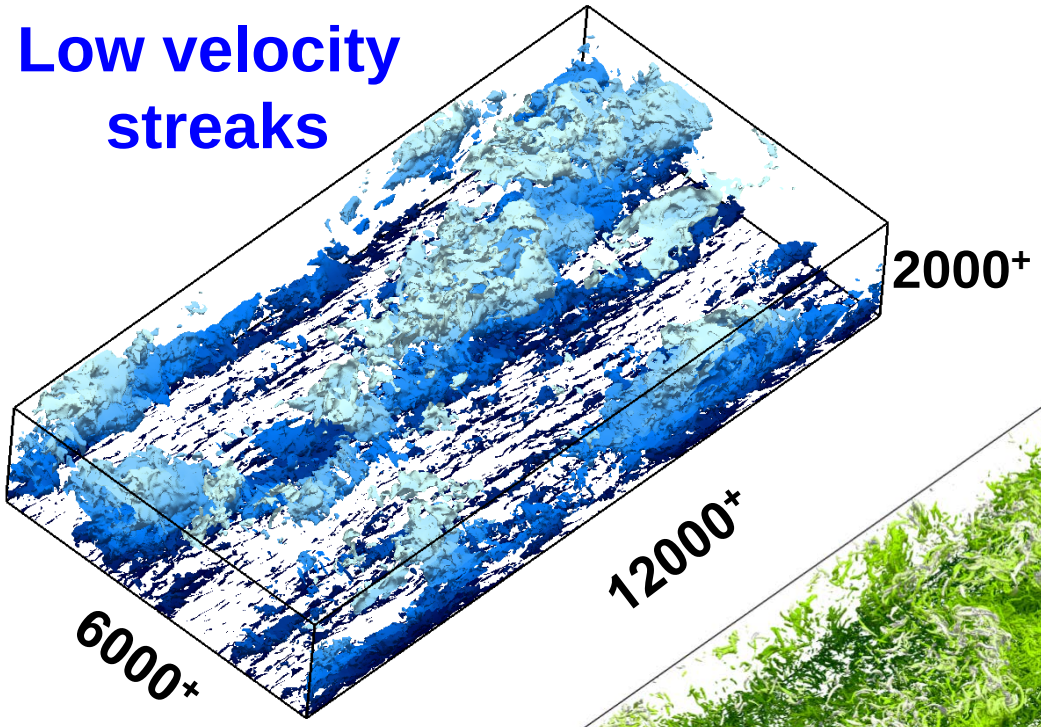
School of Aeronautics, Madrid

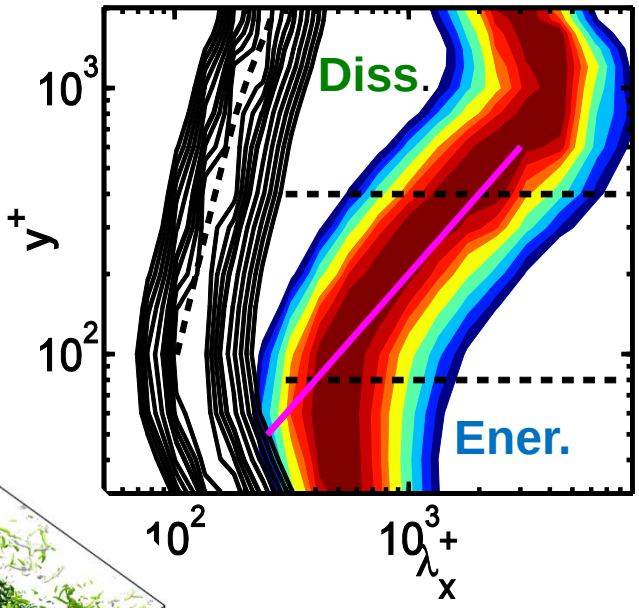


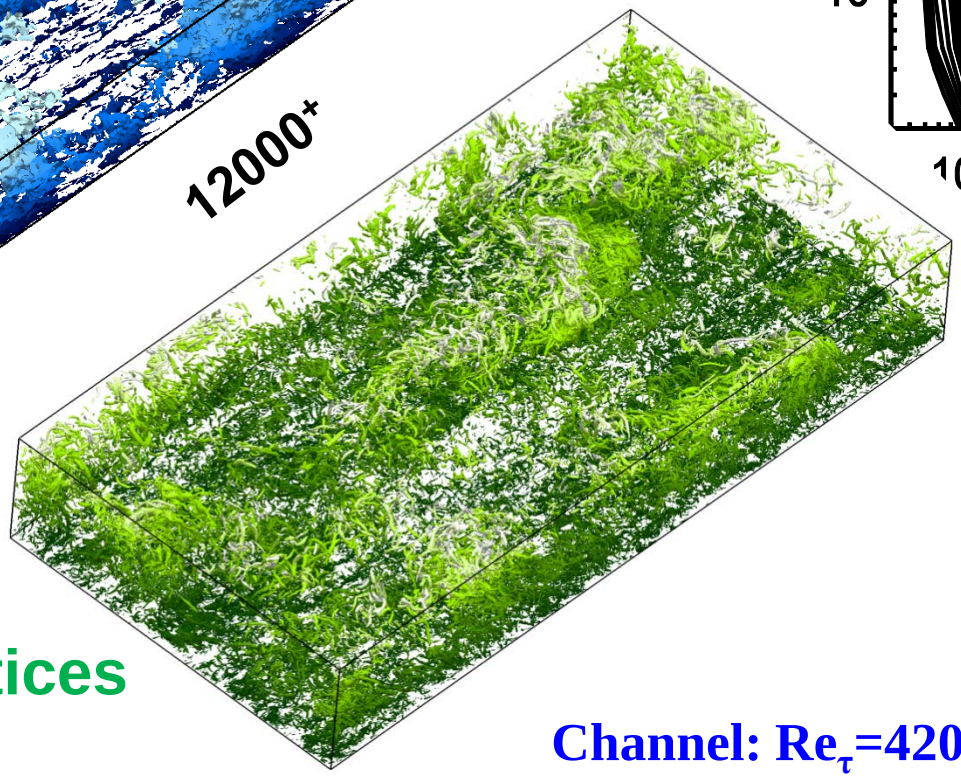
TBL: Re_τ=1800, u'$^+$=2
J.A. Sillero

Doing it Right (DNS):
Streaks and Vortices in the Log. layer

Low velocity streaks





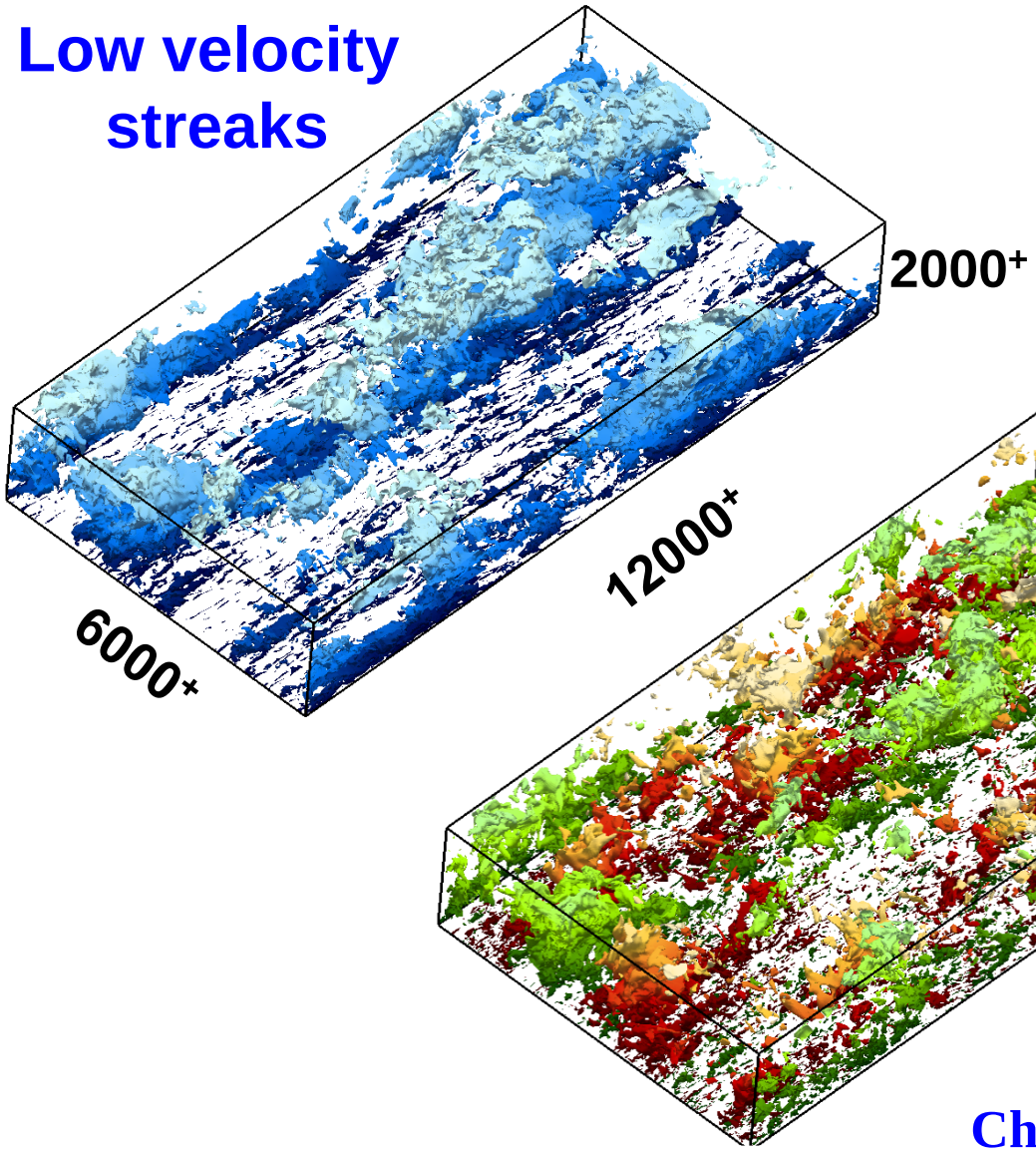


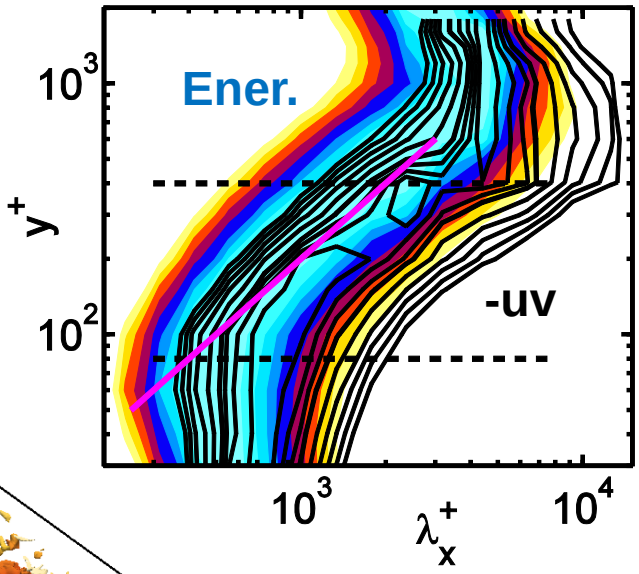
Vortices

Channel: Re_τ=4200. A. Lozano-Durán

Streaks and Reynolds Stress in the Logarithmic layer

Low velocity streaks



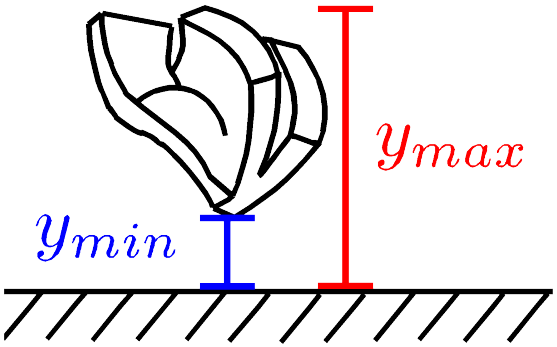


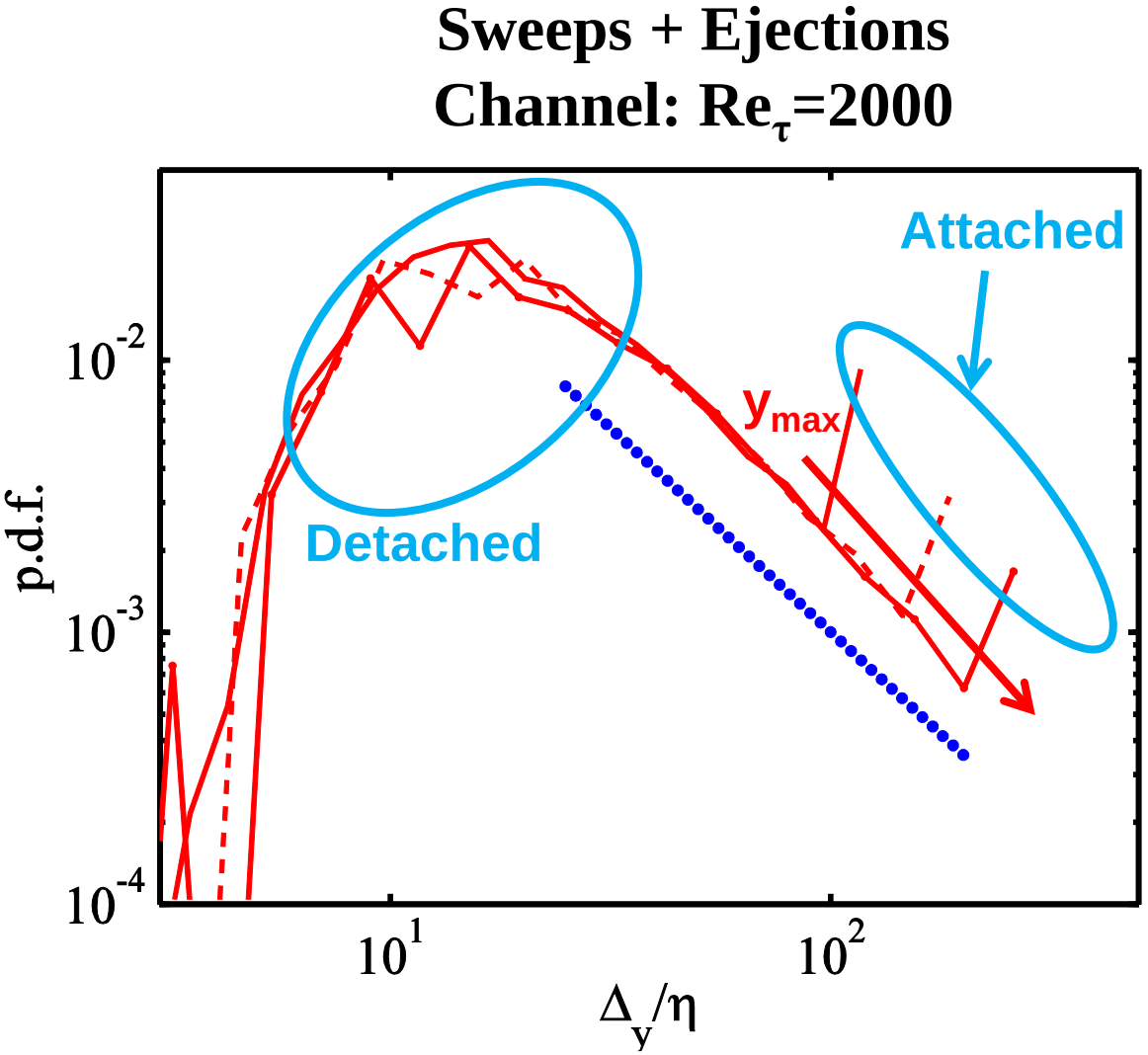
Ejections

Sweps

Channel: Re_τ=4200. A. Lozano-Durán

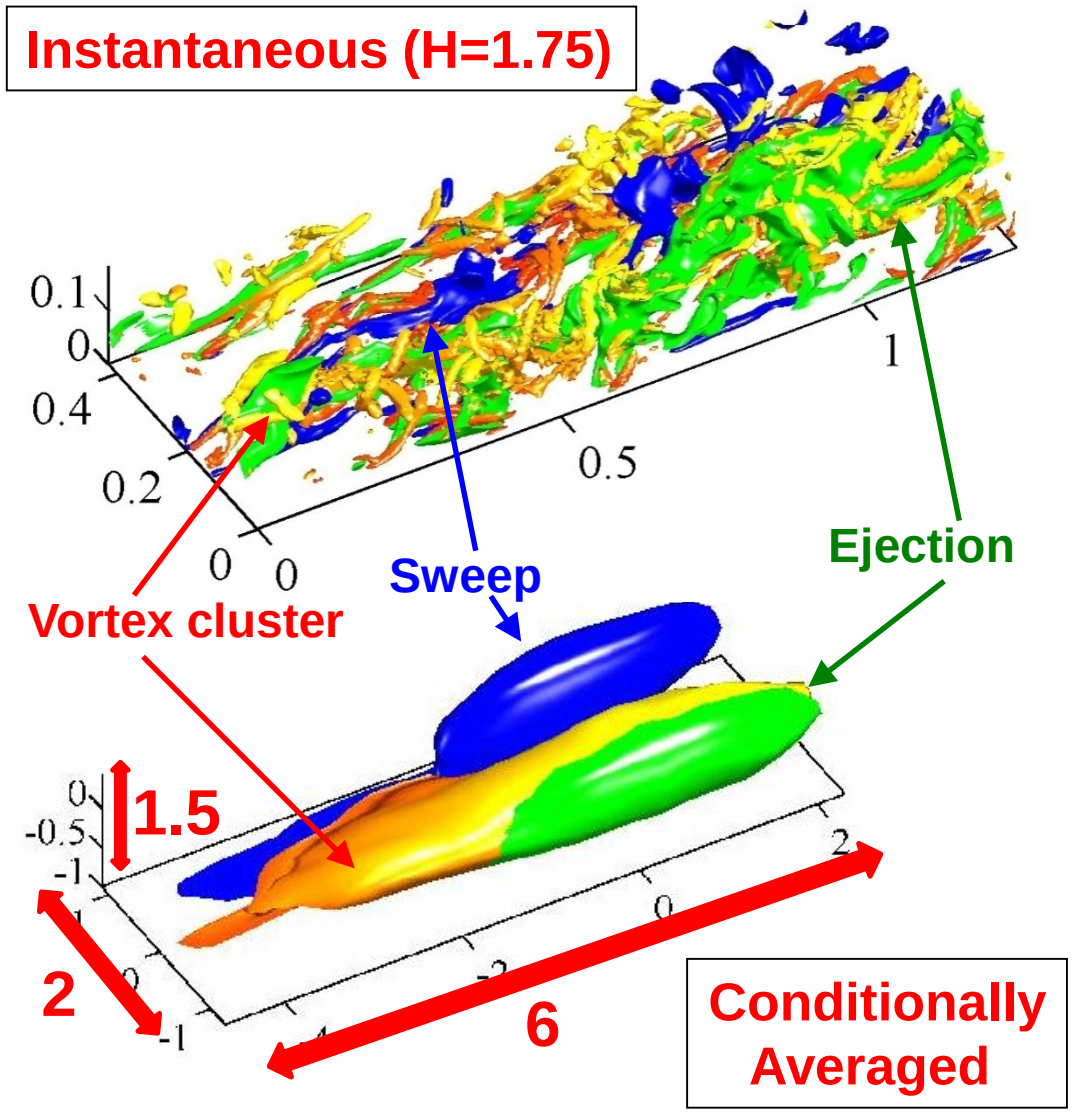
"Attached" Eddies in Wall Turbulence

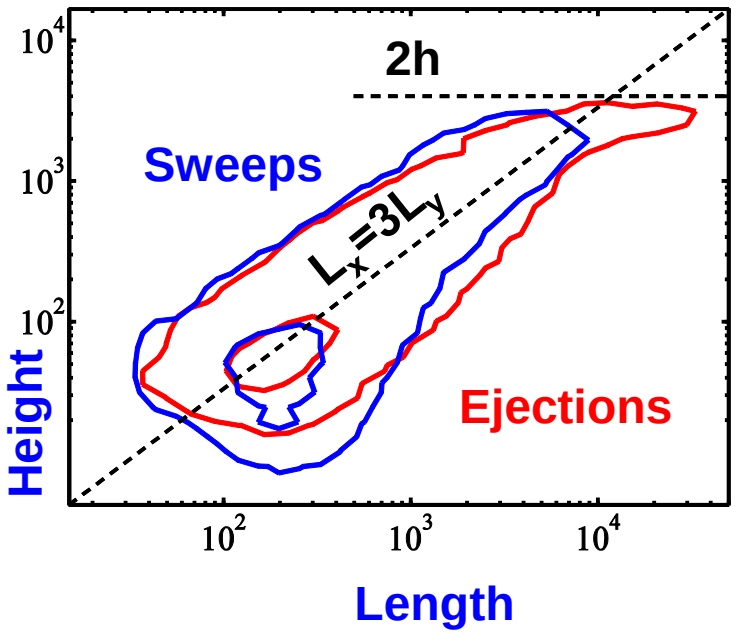




Lozano-Duran & J (2014)

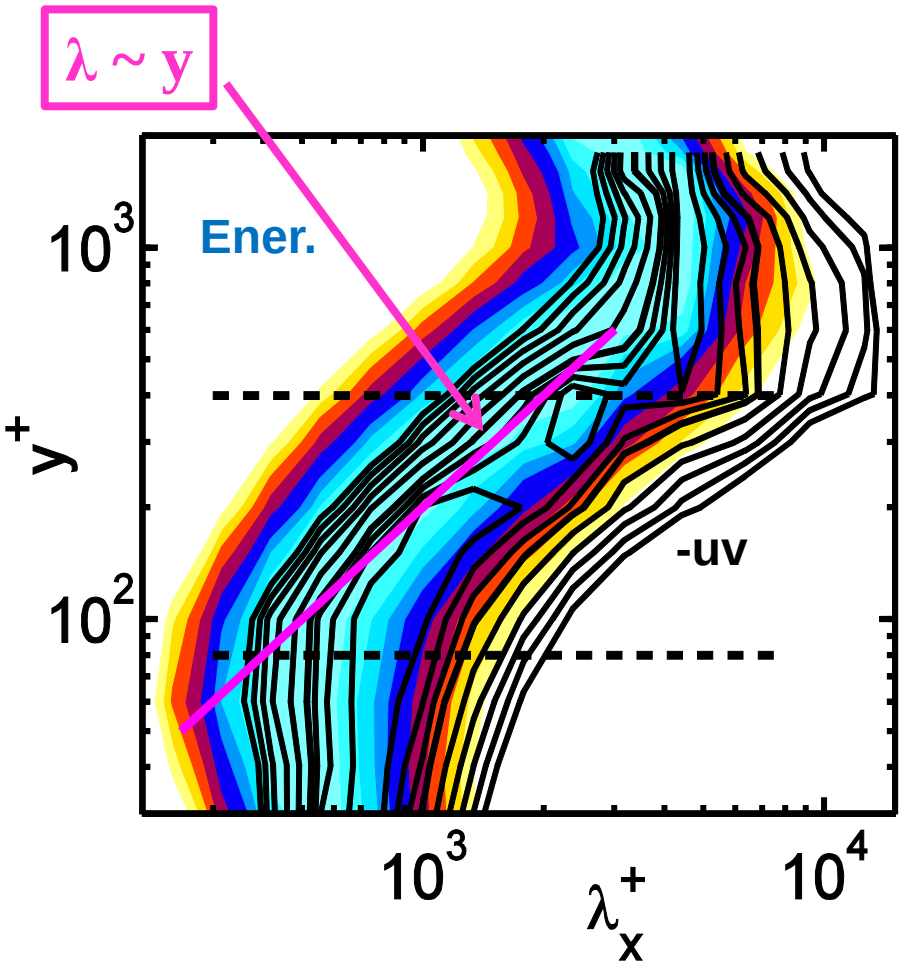
"Attached" Sweeps and Ejections



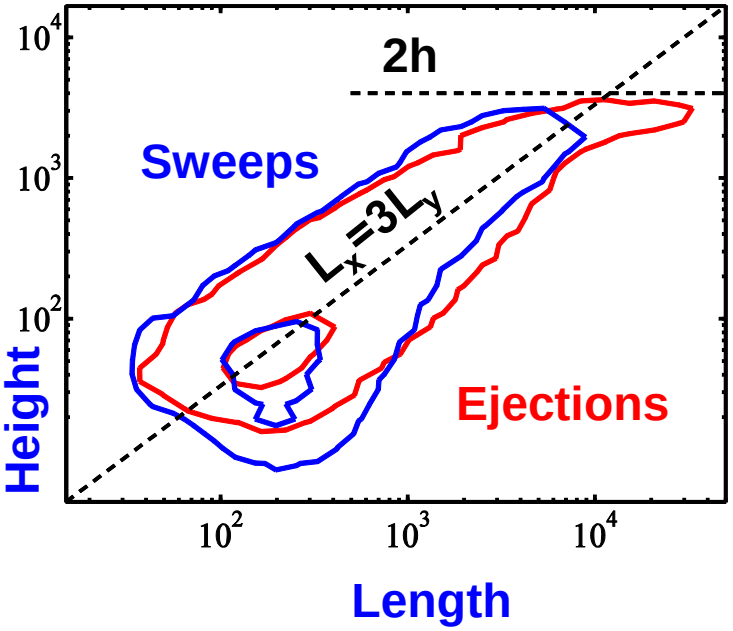


Lozano-Duran, Flores & J (2012)

Self-Similar Eddies are Good



Momentum Transfer is self-similar

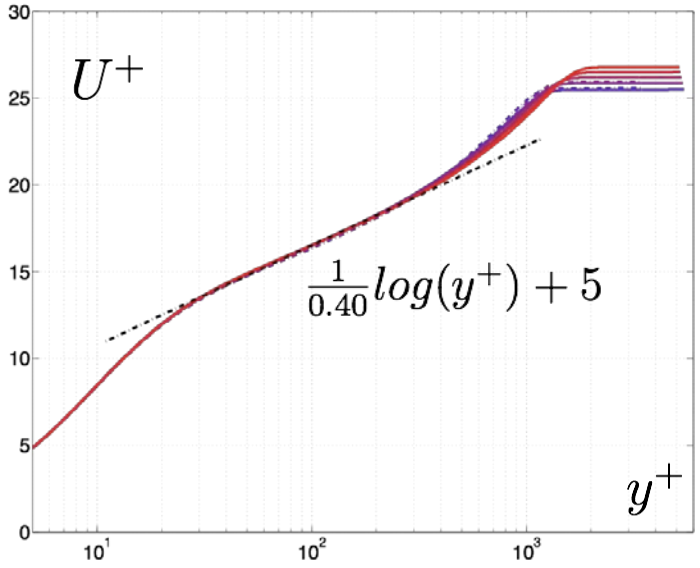


Self-Similar Eddies are Good

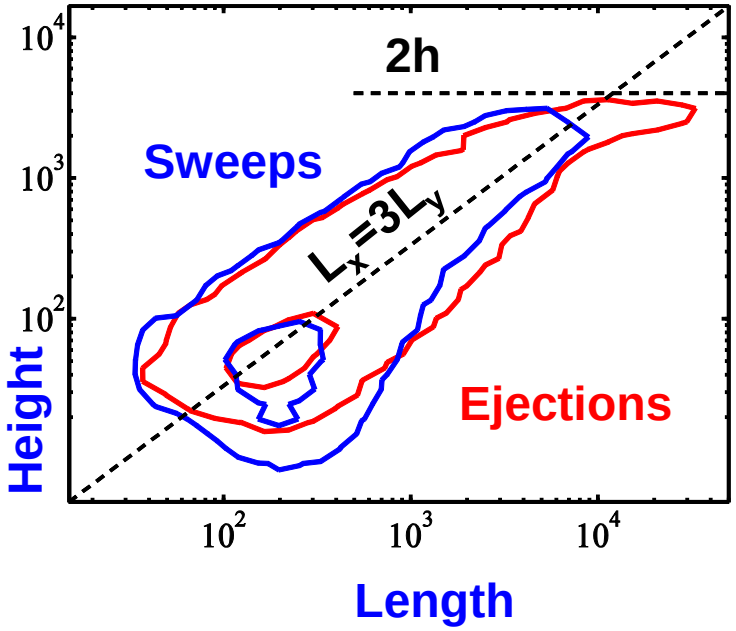
$$\nu_T = u_\tau L \sim u_\tau y$$

$$u_\tau^2 = \nu_T \partial U/\partial y$$

$$U \sim \log(y)$$



Momentum Transfer is self-similar



Therefore

DNS is Good,

because it makes people happy

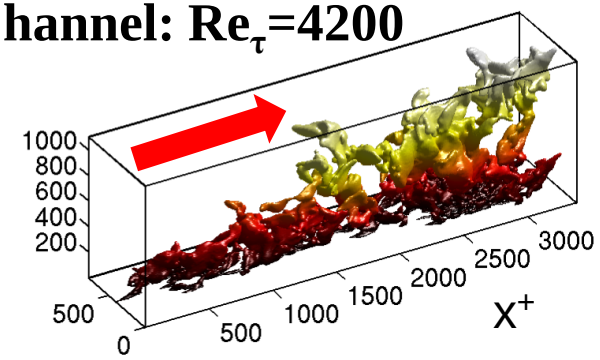
The cynical point of view

Do we really need so many riches?

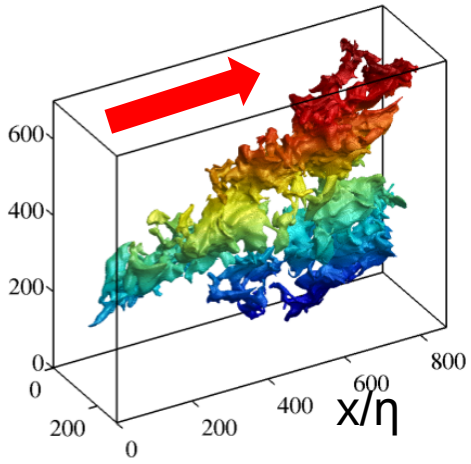
1.-Do you really need to be attached?

Ejections

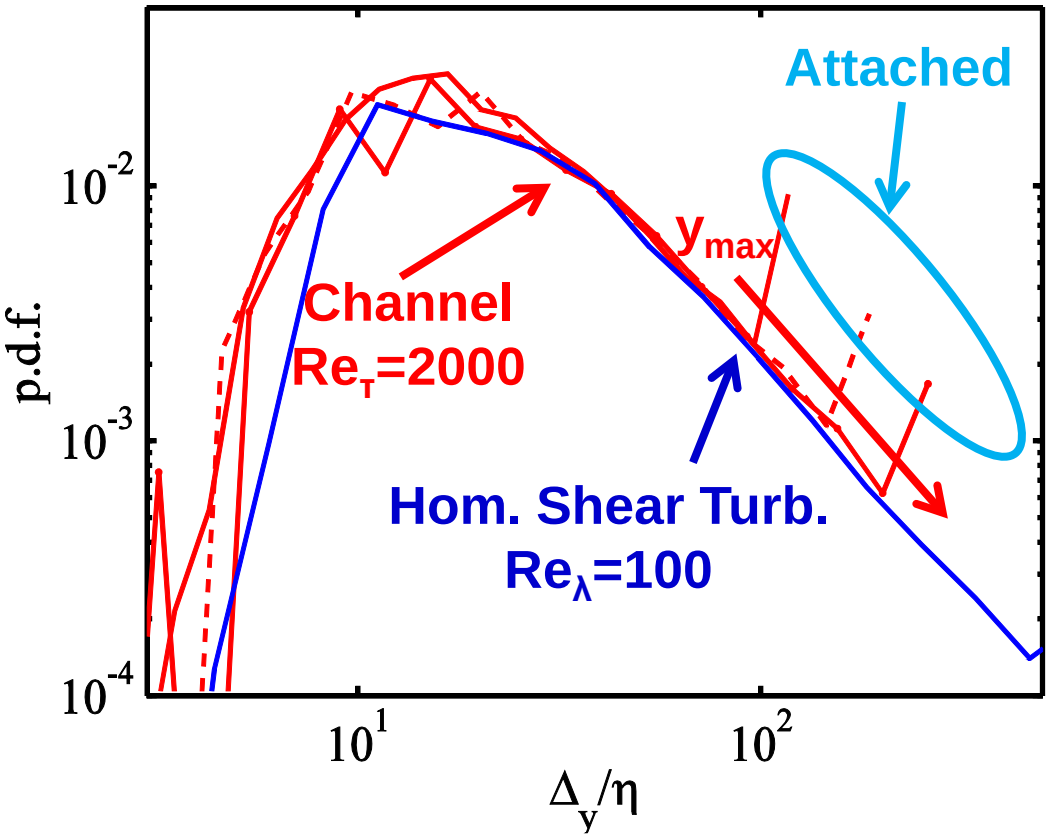
Channel: Re_τ=4200



Homogeneous Shear: Re_λ=100



Sweeps + Ejections



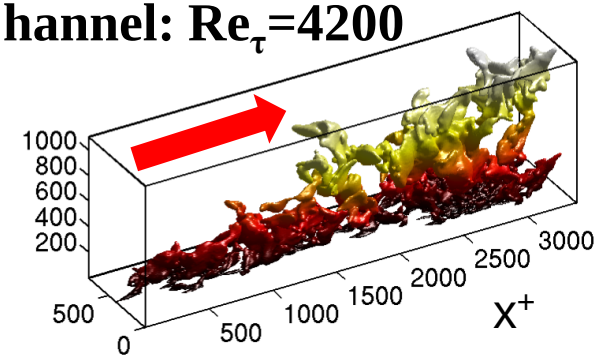
Dong, Sekimoto & J (2013), Lozano-Duran & J (2014)

1.-Do you really need to be attached?

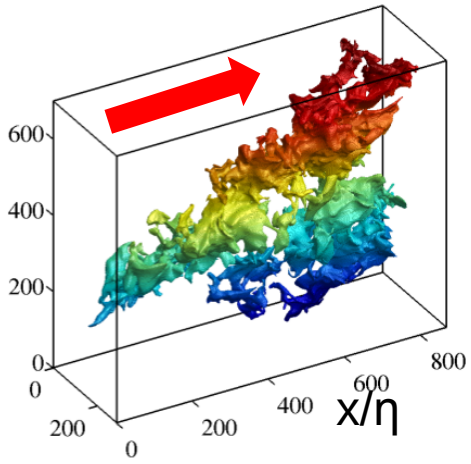
(no) Homogeneous Shear Turbulence

Ejections

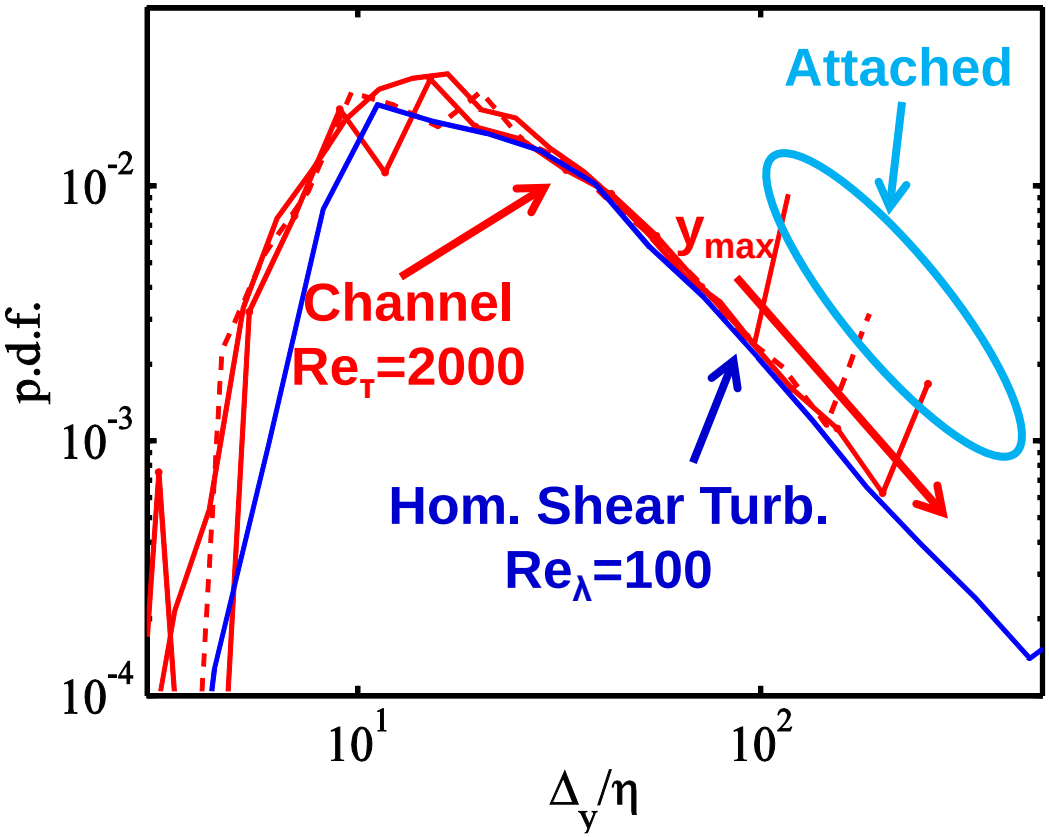
Channel: Re_τ=4200



Homogeneous Shear: Re_λ=100



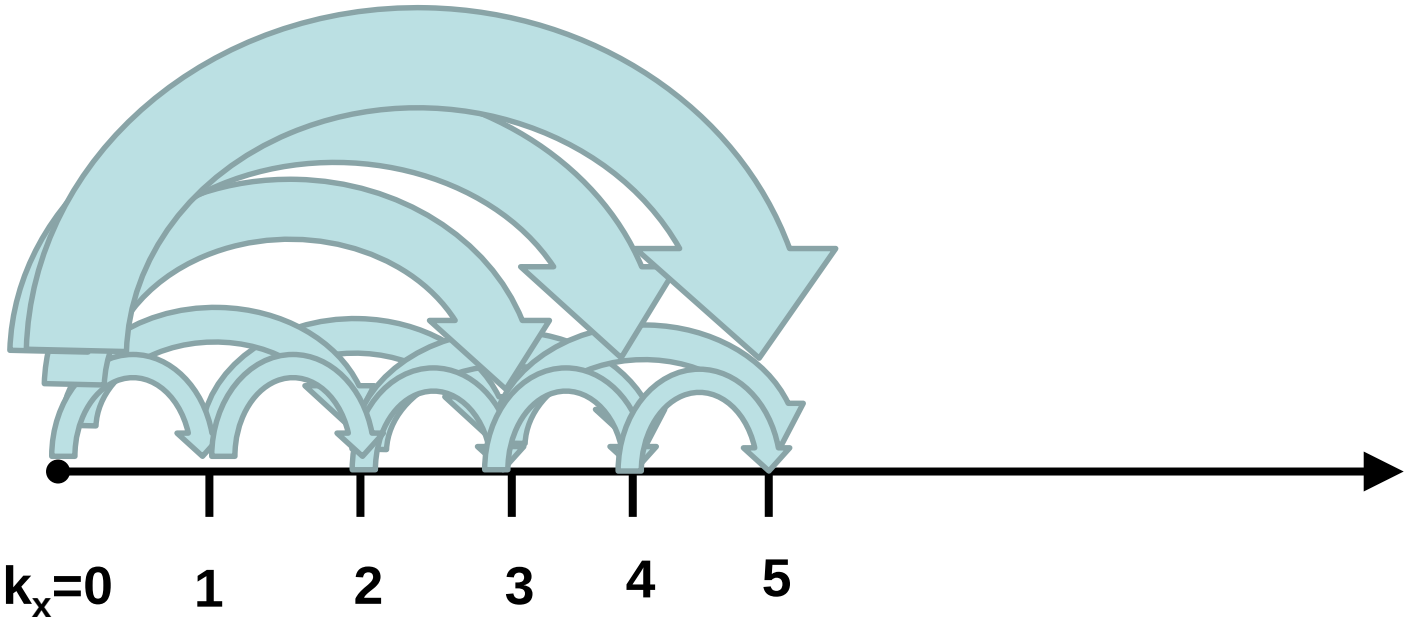
Sweeps + Ejections



Dong, Sekimoto & J (2013), Lozano-Duran & J (2014)

2.-Do we Need Nonlinearity?

Yes, of course, but ….

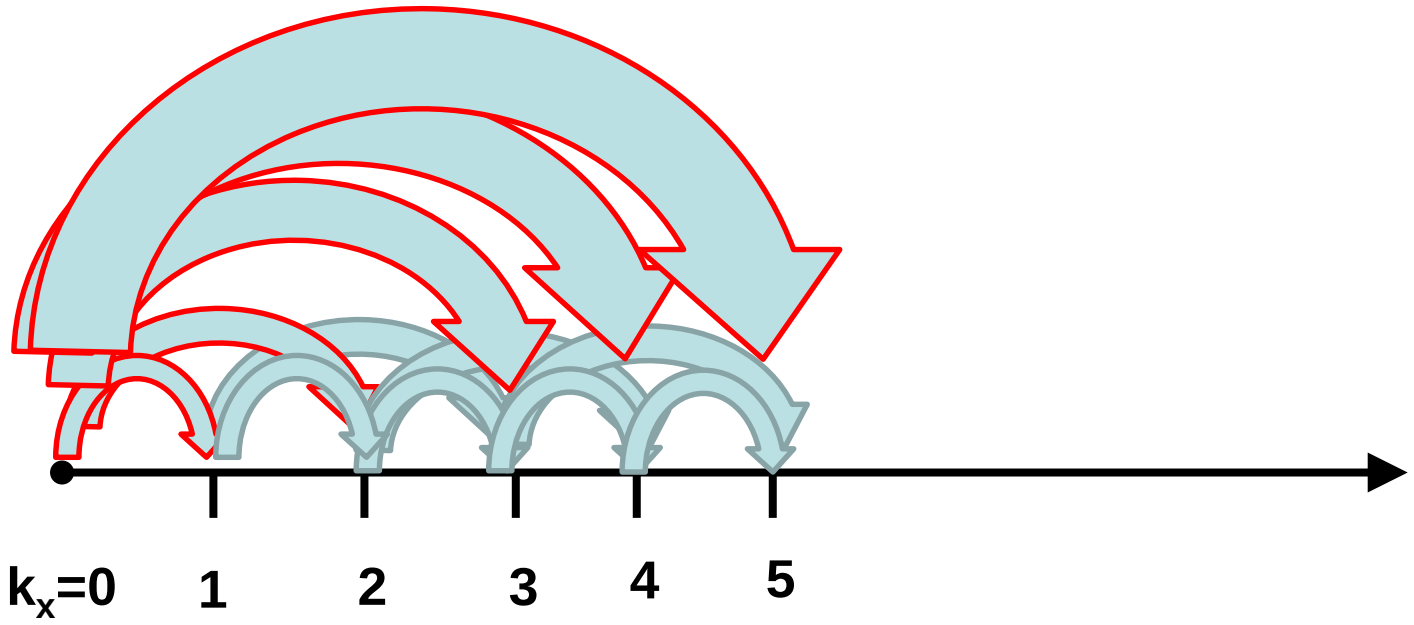


Fully Nonlinear NS

Constantinou, Lozano-Duran, Nikolaidis, Farrell, Ioannou & J. (2014)

Do we Need Nonlinearity?

Yes, of course, but ….

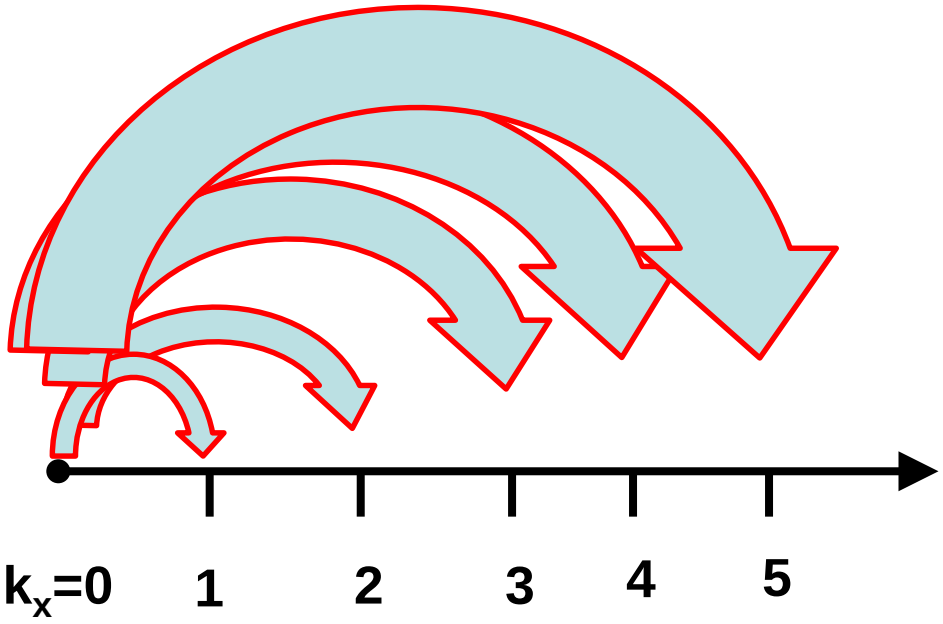


Reduced Nonlinearity NS

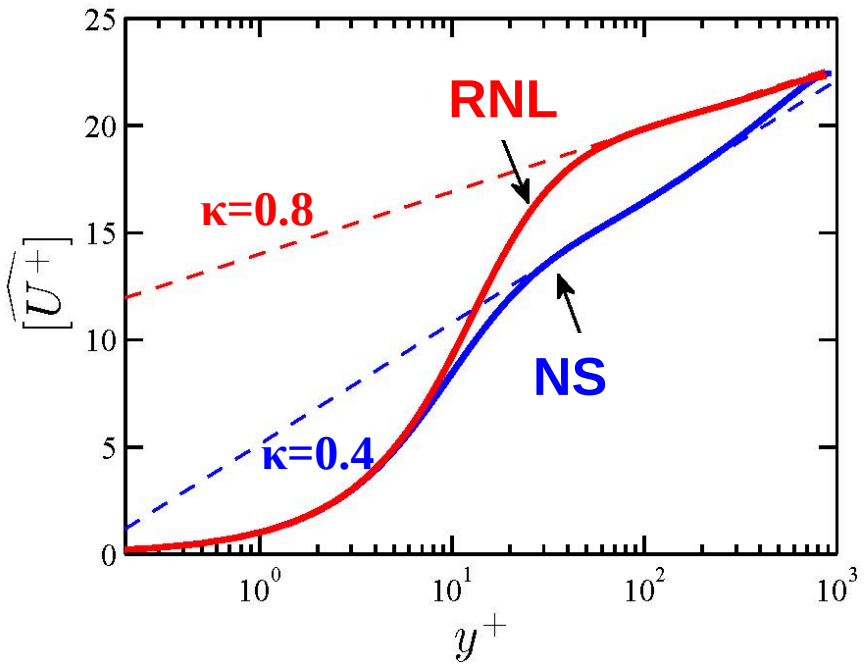
Constantinou, Lozano-Duran, Nikolaidis, Farrell, Ioannou & J. (2014)

Do we Need Nonlinearity?

Yes, of course, but ….



Re_τ=950



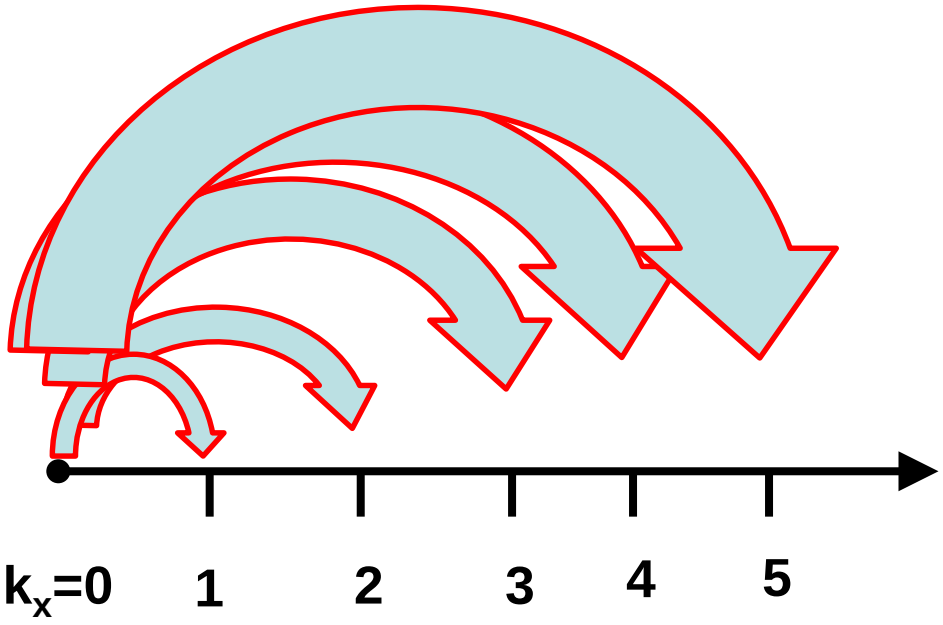
Reduced Nonlinearity NS

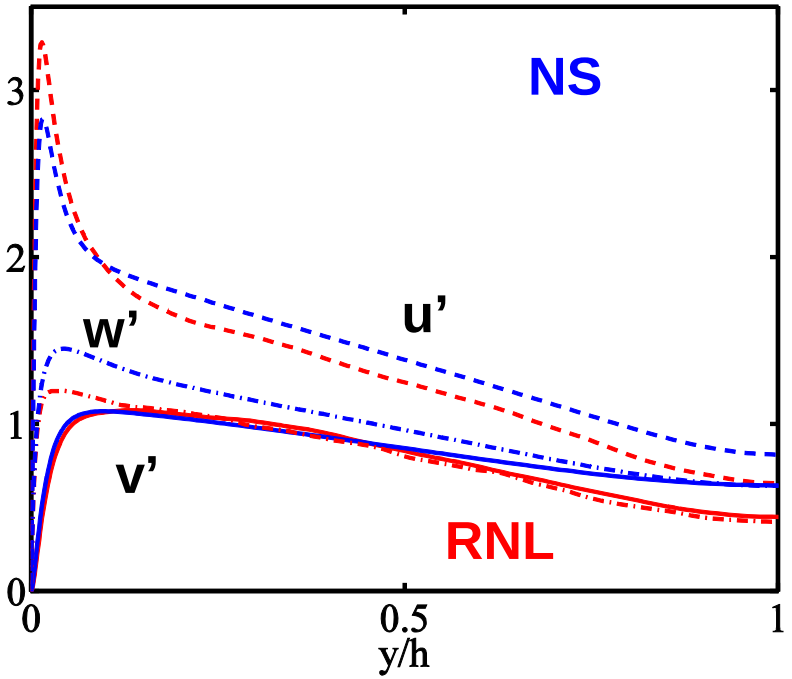
Constantinou, Lozano-Duran, Nikolaidis, Farrell, Ioannou & J. (2014)

Do we Need Nonlinearity?

Yes, of course, but ….

Re_τ=950



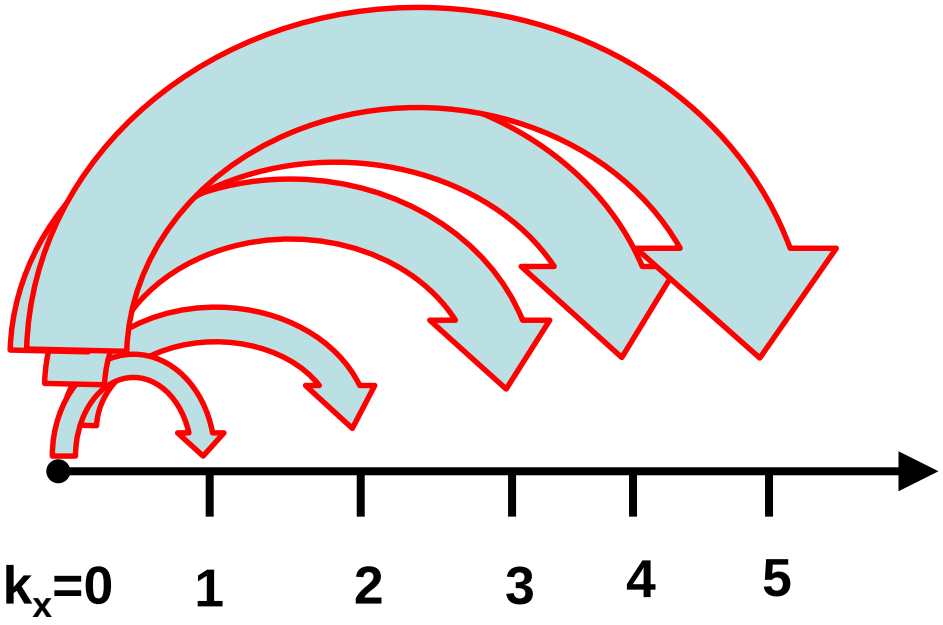


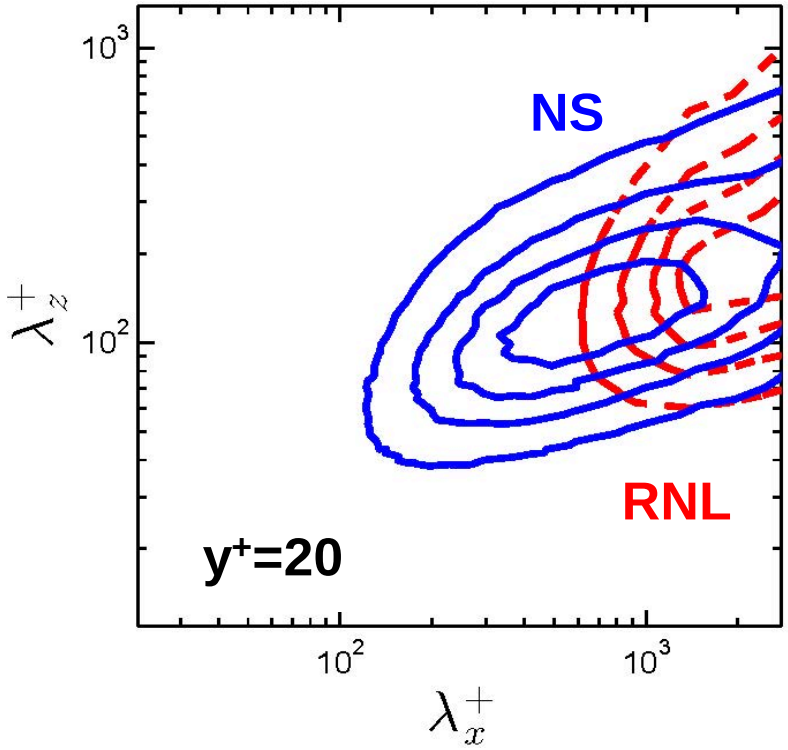
Reduced Nonlinearity NS

Constantinou, Lozano-Duran, Nikolaidis, Farrell, Ioannou & J. (2014)

Do we Need Nonlinearity?

Yes, of course, but ….



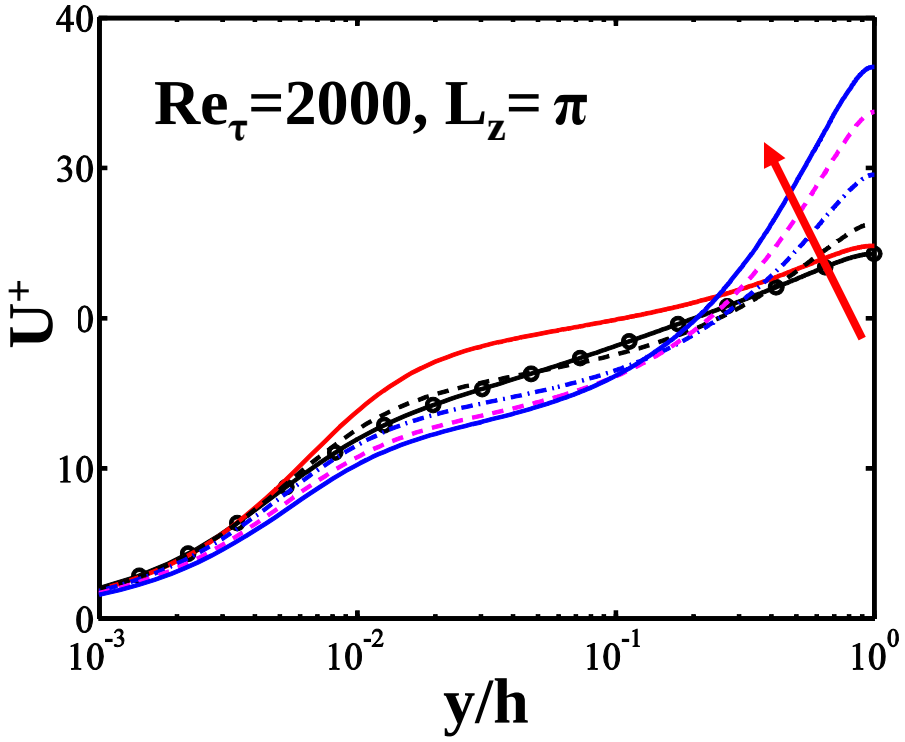


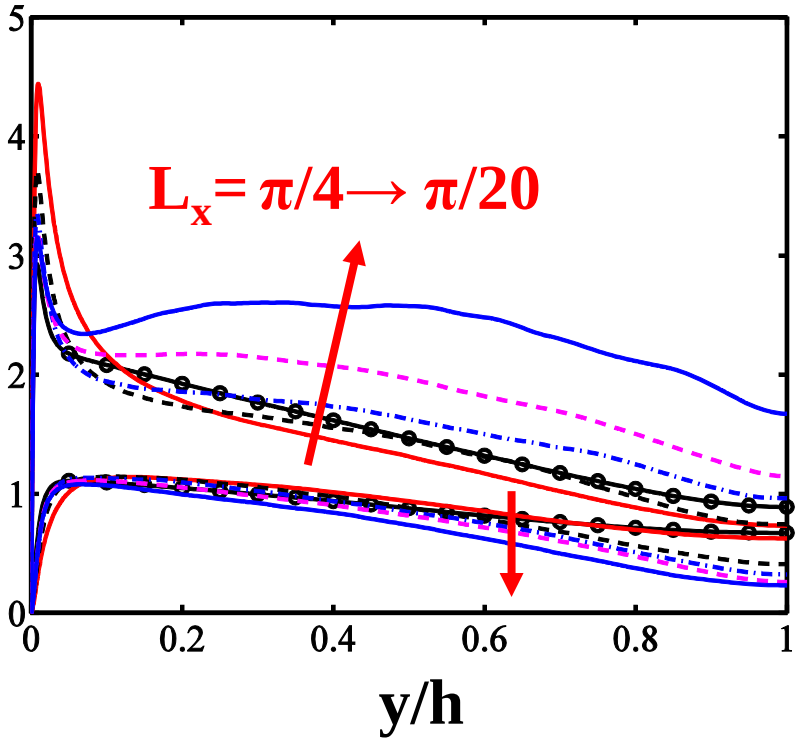
Reduced Nonlinearity NS

Constantinou, Lozano-Duran, Nikolaidis, Farrell, Ioannou & J. (2014)

3.-Do we need anything along x?

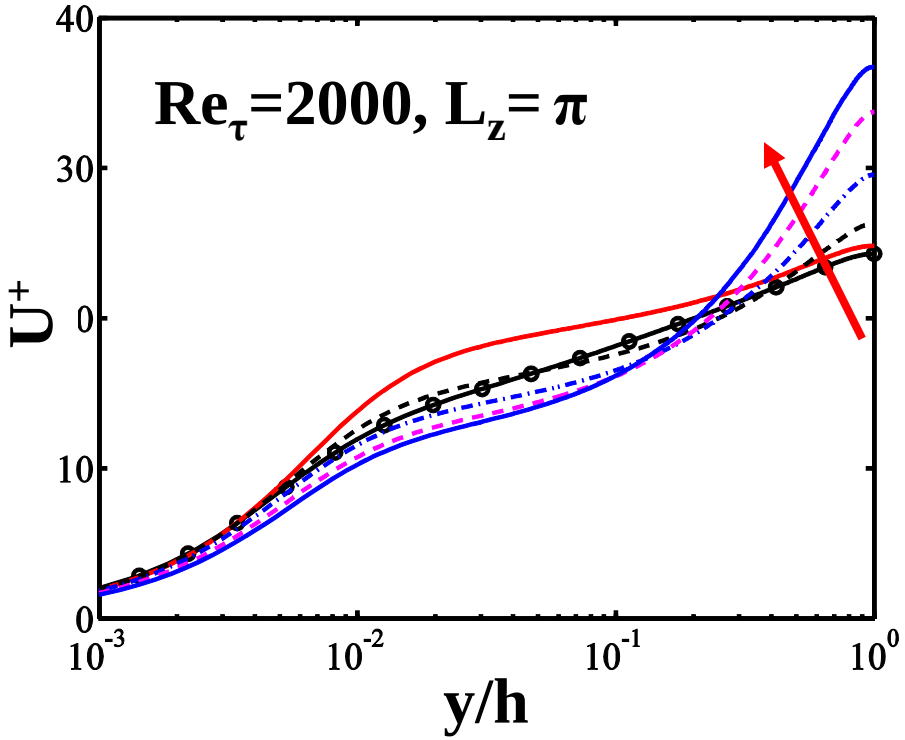
Yes, of course ….

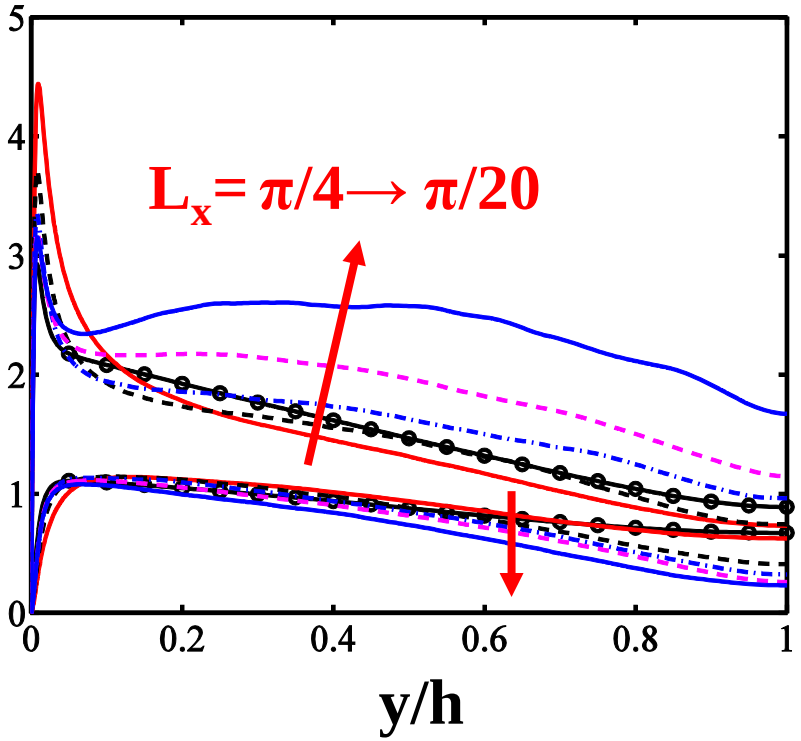




Do we need anything along x?

Yes, of course …. but not much





ONE streamwise Fourier mode!

Summary

Wall-bounded turbulence is full of
fascinating structures
(about which we know a lot)

And complex mechanisms
to maintain them
(about which we know much less)

Many of which are really “optional”

A Piece of Advice (to Paolo)

DNS

has taught us a lot about wall turbulence

but, Paolo

A Piece of Advice (to Paolo)

DNS

has taught us a lot about wall turbulence

but, Paolo

you are still in time to see the light,

and

If you really want to understand turbulence

A Piece of Advice (to Paolo)

DNS

has taught us a lot about wall turbulence

but, Paolo

you are still in time to see the light,

and

If you really want to understand turbulence

you have to do everything again (wrong)