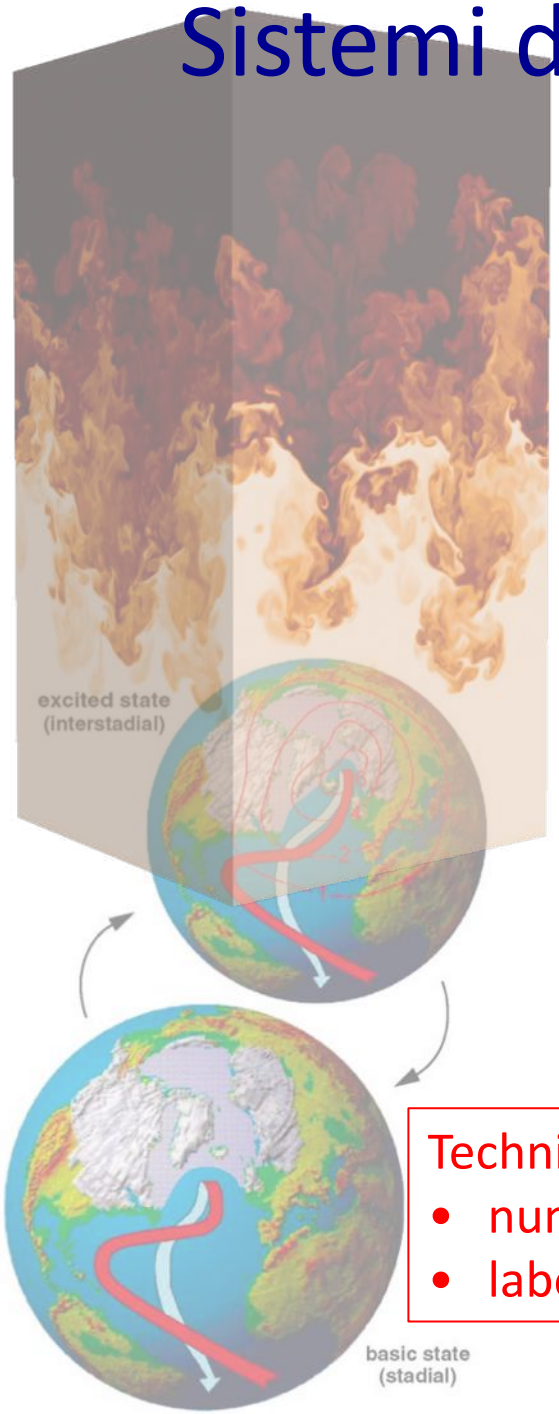
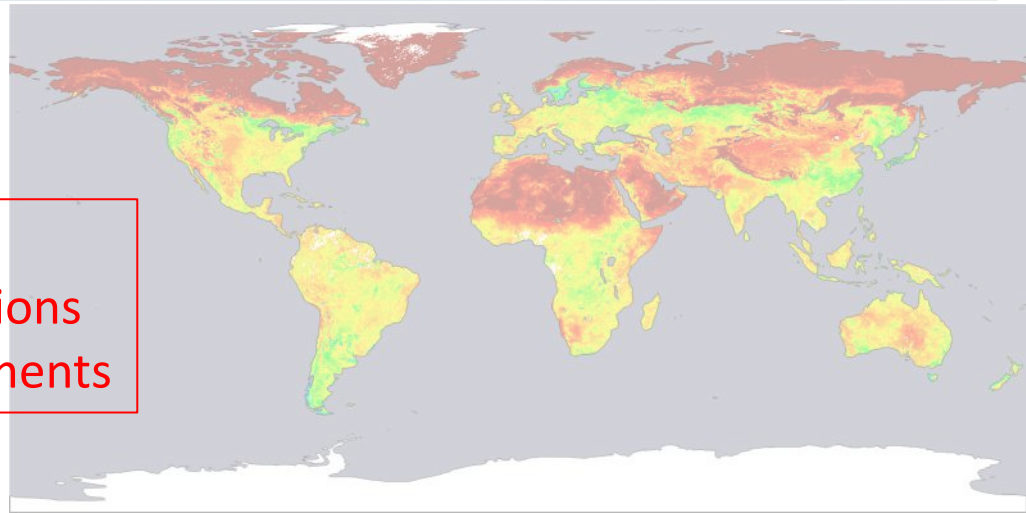
Sistemi dinamici, onde e turbolenza

- Dynamical systems
- Dynamics of extended systems
- Turbulence and dispersion
- Laboratory of fluid dynamics

Applications
- theory of turbulence
- theory of dynamical systems
- geophysical flows
- complex fluids
- climate dynamics

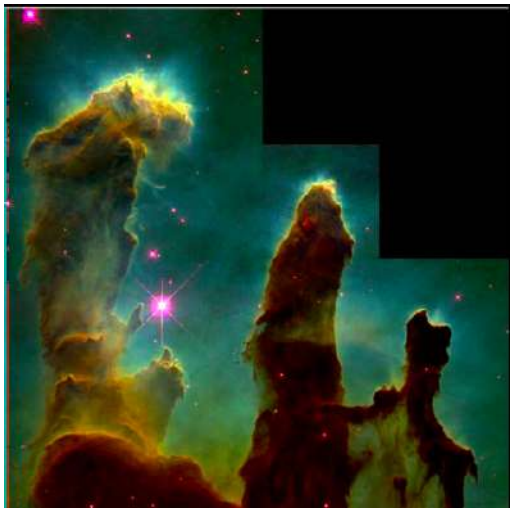


Techniques
- numerical simulations
- laboratory experiments

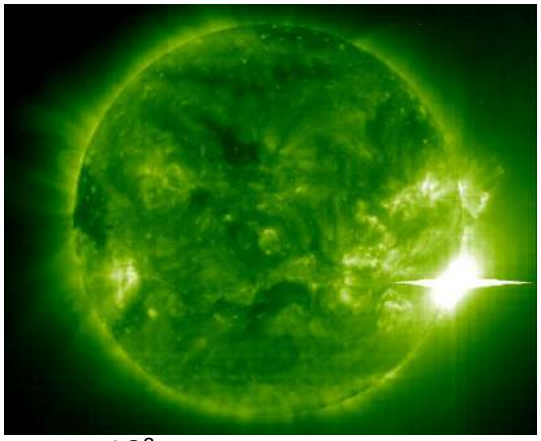


Ubiquità della turbolenza

M100 galaxy - 10^{23} m



Eagle nebula - 10^{18} m

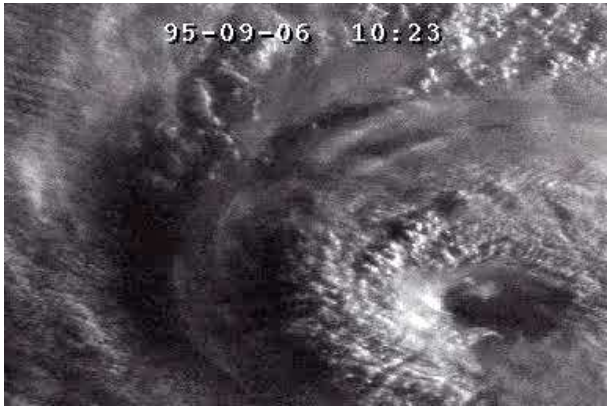


sun - 10^{9} m

Jupiter red spot - 10^{7} m (Cassini)

soap film - 10^{-2} m

M. St. Helen - 10^{3} m
(1980)



hurricane Luis - 10^{5} m

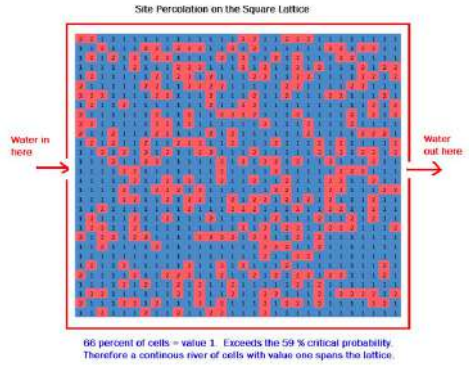
Turbolenza bidimensionale e meccanica statistica

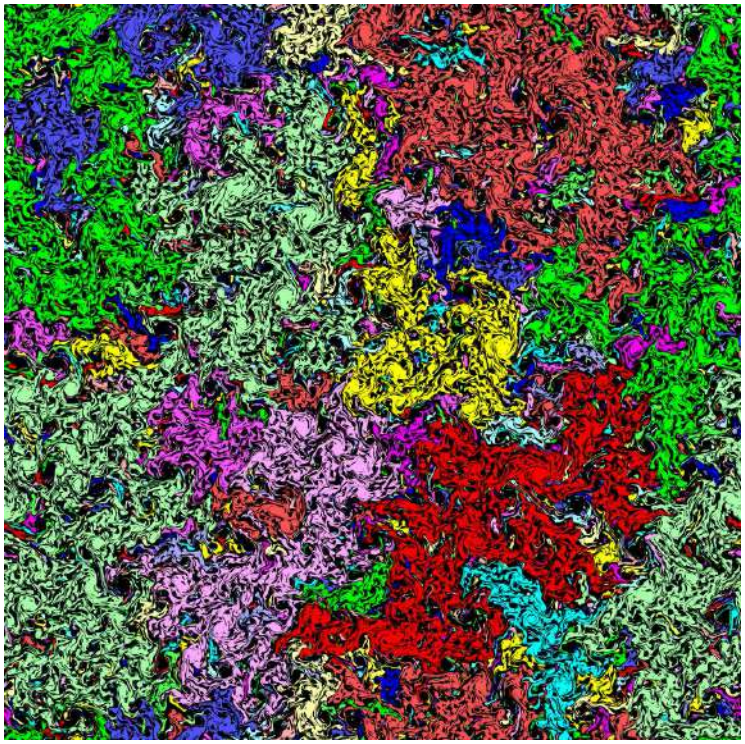
As in other physical systems, the statistical properties of turbulence depend on dimension.
In **two dimensions** turbulence displays special properties, in particular **conformal invariance** (*)

Film di sapone

Moti in atmosfera

Conformal invariance shows that turbulence in 2D has properties similar to percolation (one of the simplest systems displaying phase transition)

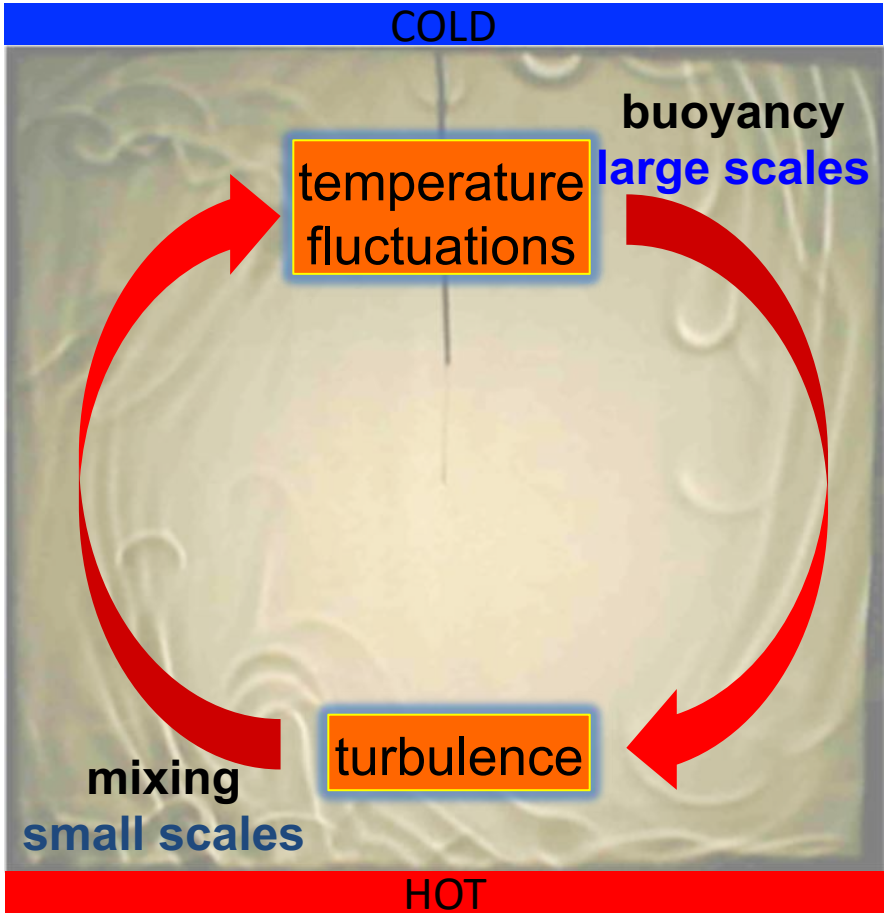


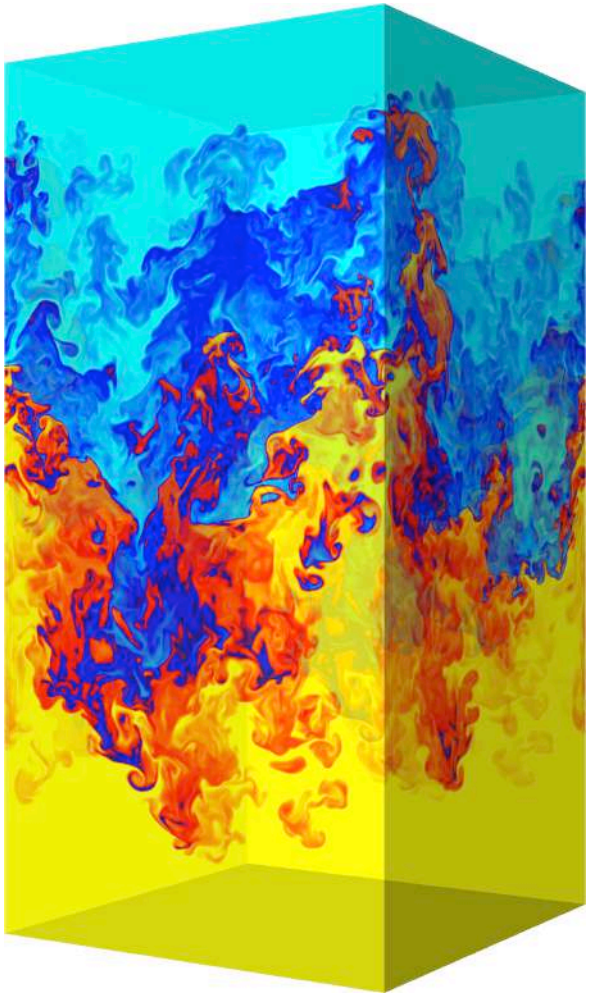


Positive vorticity clusters from a numerical simulations of two-dimensional turbulence

(*) Local scale transformations which preserve angles

Convezione turbolenta





$$Nu = \frac{\langle wT \rangle L}{\kappa \Delta T}$$

Which kind of turbulence is produced ?

Efficiency in heat transfer ?

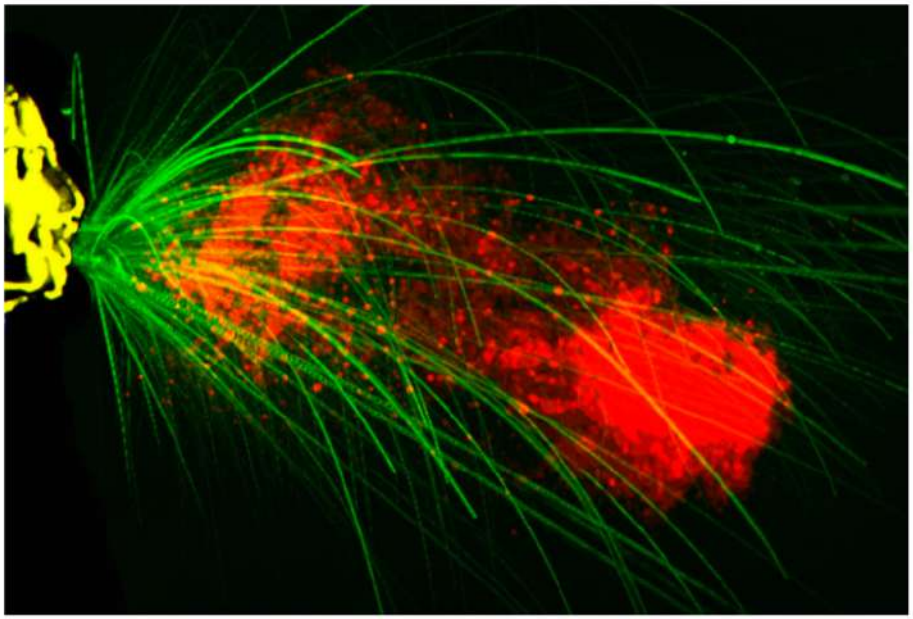
$$Nu = Ra^{\gamma}$$

$$Ra = \frac{\beta g \Delta T L^3}{\nu \kappa}$$

Fluidodinamica e COVID

Wells (1934): due diversi meccanismi per la trasmissione aerea
Particelle grandi (> 100 μm) sedimentano prima di evaporare (contagio diretto)
Particelle piccole (< 100 μm) evaporano prima di sedimentare (contagio a distanza)

Esperimenti di laboratorio
[Borouiba *et al*, 2017]



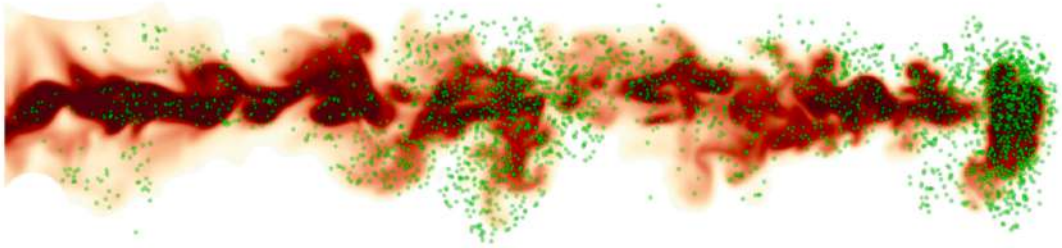


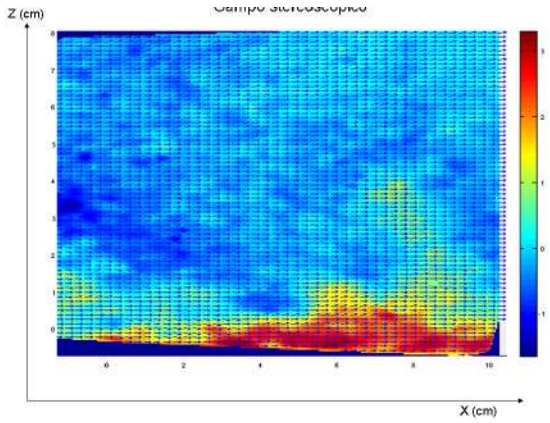
FIG. 1. Snapshot of the expiratory event 7.6 s after start coughing obtained from our numerical simulations. Different colors represent different values of the humidity field ranging between the 99% of the ambient humidity RH_a (red areas) and RH_a (white areas). Green bullets (shown not in scale) identify the position of the airborne droplets, initialized with the sizes taken from Ref. [11]. The streamwise extension of the puff at this time is 2.6 m.

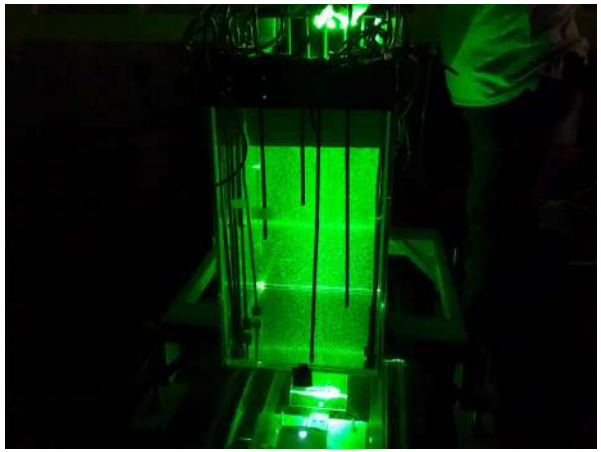
Simulazioni numeriche
[Rosti *et al*, 2021]

Il laboratorio Turlab: esperimenti di flussi geofisici

Stratified and rotating flows

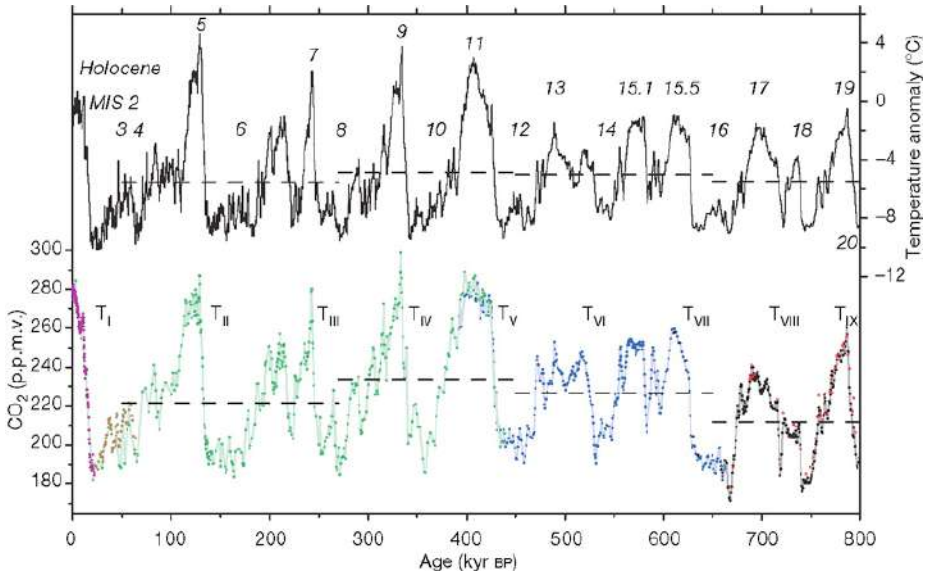
Experimental acquisition with PIV





Fisica del clima: dalle serie storiche ai modelli

Epica Dome C (740 kyr)



Forecast temperature anomaly