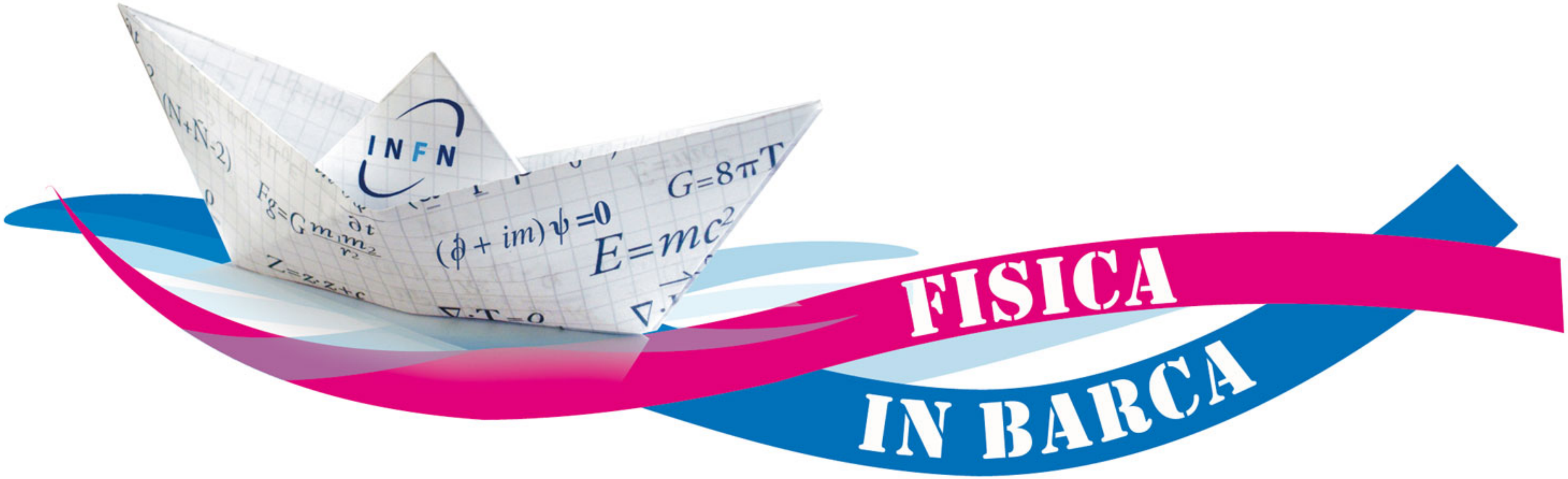



INFN
Istituto Nazionale
di Fisica Nucleare

**Trieste 23-24 maggio 2011**

# Vela 'estrema'

Marco Budinich

Università di Trieste & INFN

# Outline

1. Vela
2. Vela estrema…
3. Cosa occorre per andare a vela ?
4. C'è un eccezione…
5. Cerchiamo di capire
6. Torniamo all'eccezione
7. Conclusioni

# 1 - Vela

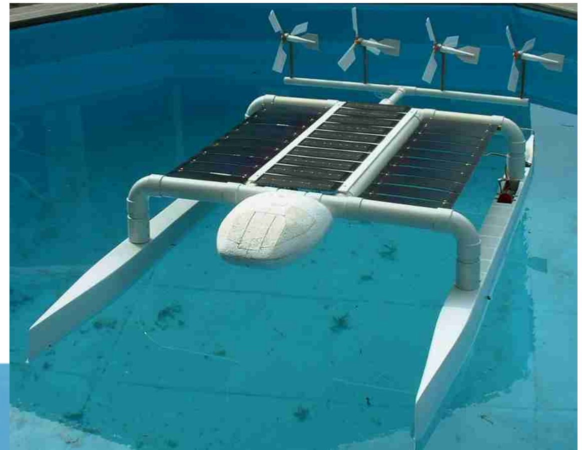

Nave Madre Amorosa
Cap.no Simeone
Budinich


173052
FIN
173056
FRA
173105
173027

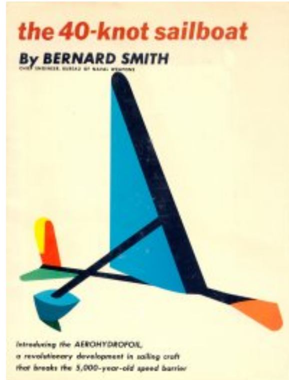
# 2 - Vela 'estrema'


9329
RONSTAN


BMW EfficientDynamics




ENSTA
DGA
DCN
TOULON
ENSTA


the 40-knot sailboat
By BERNARD SMITH

# 3 - Cosa occorre per andare a vela ?

# Il vento non basta...

*Hagedoorn's ultimate sailing machine. (The pickup boat is not shown.)*

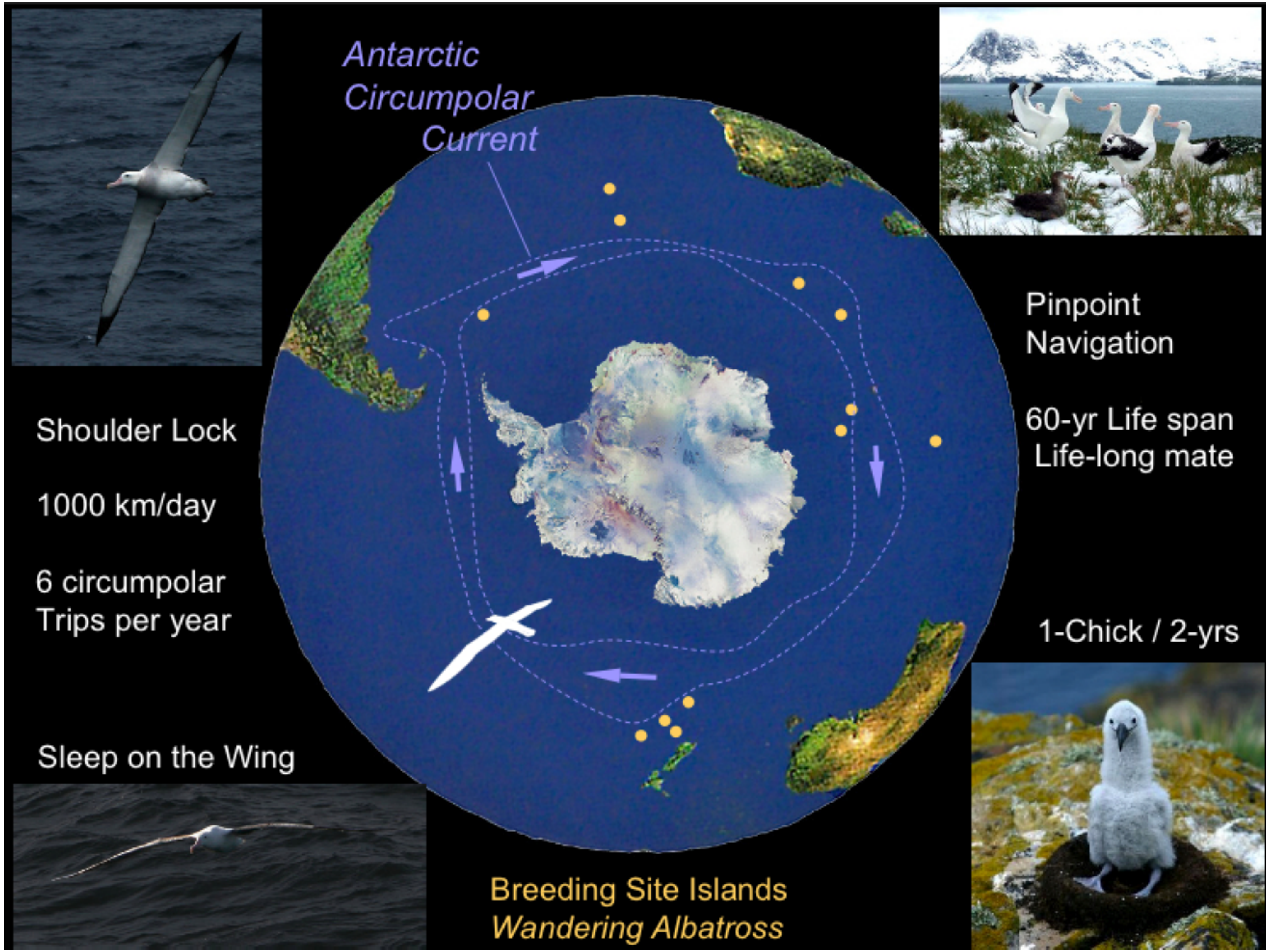
... ma la barca non serve

# 4 - C'è un eccezione...

# …. l'Albatros

# Volo

da: Il Popolo Migratore 45”


Antarctic
Circumpolar
Current
Pinpoint
Navigation
60-yr Life span
Life-long mate
Shoulder Lock
1000 km/day
6 circumpolar
Trips per year
1-Chick / 2-yrs
Sleep on the Wing
Breeding Site Islands
Wandering Albatross


009926-01
© 2007/Frans Lanting

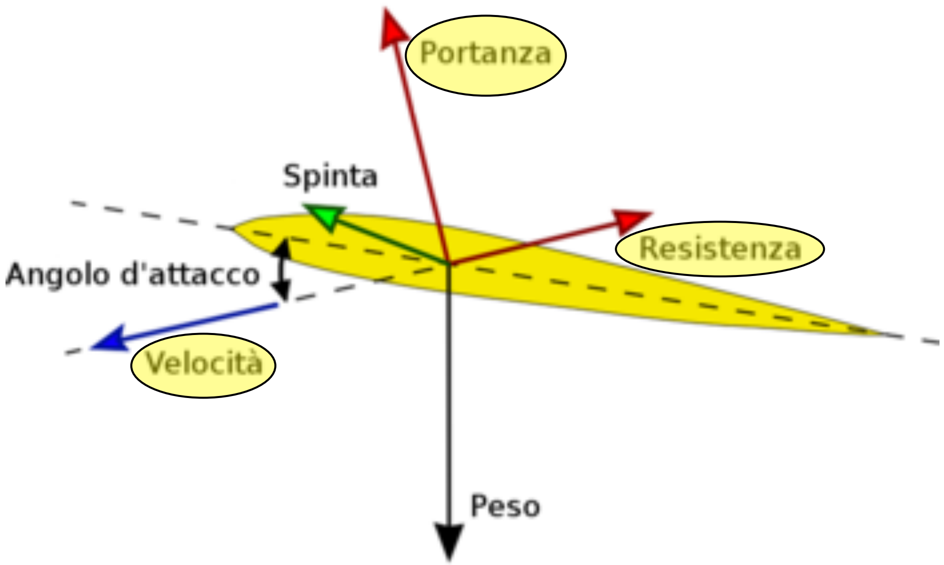

009939-01
© 2007/Frans Lanting


000948-01
© 2007/Frans Lanting

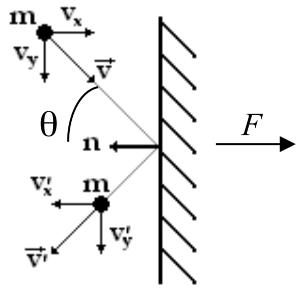
# 5 - Cerchiamo di capire

# Moto in un fluido

- <u>Portanza</u>: la forza ortogonale a $\vec{v}$
- <u>Resistenza</u>: la forza parallela a $\vec{v}$



# Origini della forza



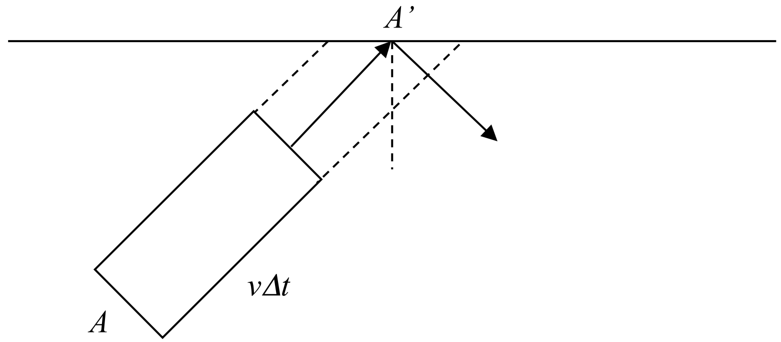

$$F = ma = m\frac{\Delta v}{\Delta t}$$

$$\Delta v = v\cos\theta - (-v\cos\theta) = 2v\cos\theta$$

$$F = m\frac{2v\cos\theta}{\Delta t}$$

$$F = Nm\frac{2v\cos\theta}{\Delta t}$$

$$Nm = \rho A v \Delta t$$

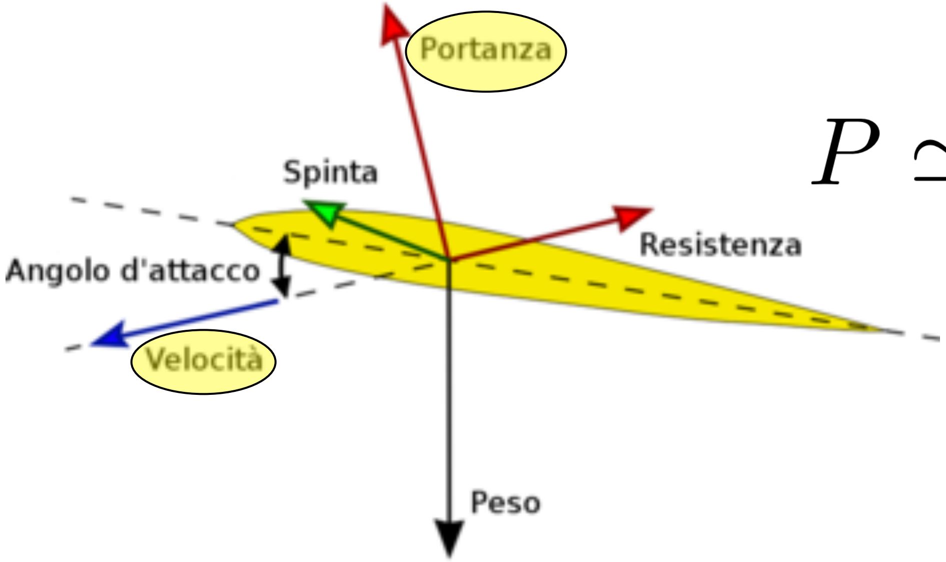



$$F = 2\rho A v^2 \cos\theta$$

$$p = \frac{F}{A'} = 2\rho v^2 \cos^2\theta$$

$$P \simeq pS = 2\rho v^2 S \cos^2\theta$$

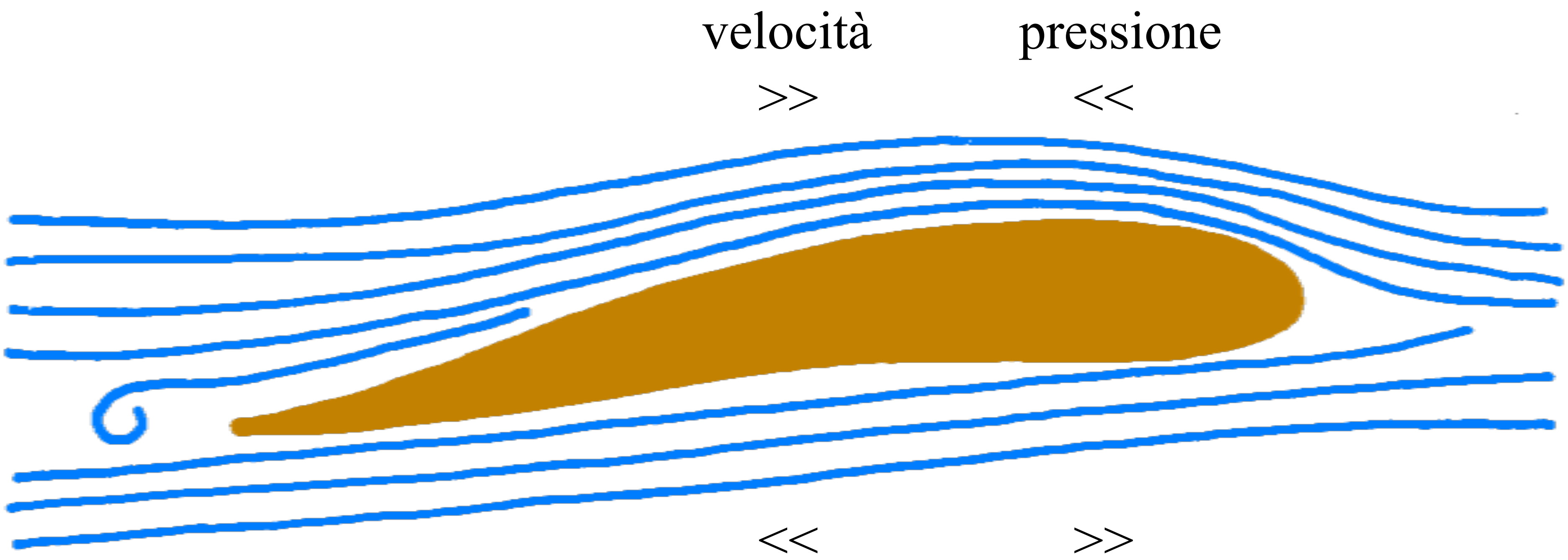
# Portanza




$$P \simeq pS = \rho v^2 S\, 2\cos^2\theta$$

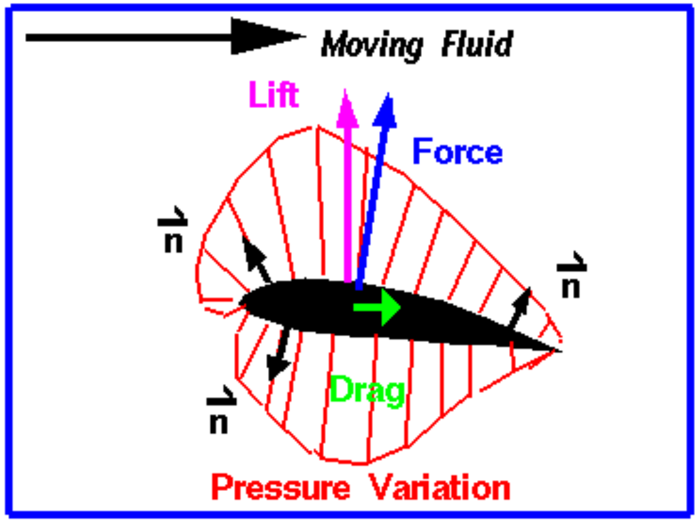
$$P = \rho v^2 S\, \frac{C_l}{2}$$

# Un modo più preciso di vedere



# Un modo ancora più preciso

**Aerodynamic Forces** — Glenn Research Center




Pressure forces act normal (perpendicular) to surface.
Force on the body is the vector sum of the pressure x area around the entire solid body.

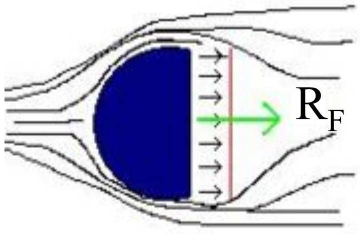
$$\vec{F} = \sum_{surface} p\,\vec{n}\,A = \oint p\vec{n}\,dA$$

Lift = $F_{normal}$

Drag = $F_{stream}$

Sito: http://www.grc.nasa.gov/WWW/K-12/airplane/bga.html

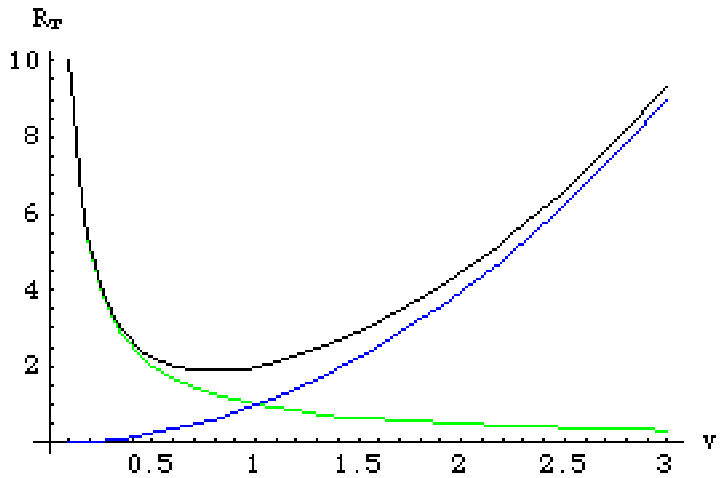
# Resistenza




$$R = R_F + R_V + R_I$$

$$R_F + R_V \propto v^2$$

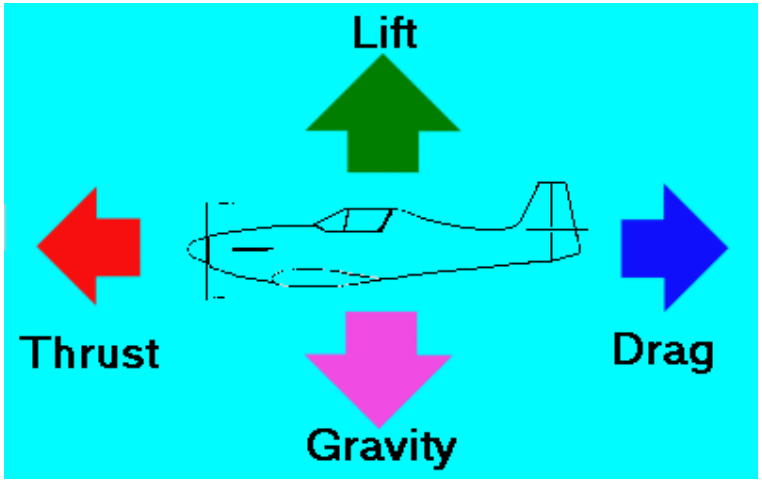
$$R_I \propto \frac{1}{v}$$



# 6 - Torniamo all'eccezione

?=

- Velocità minima (stallo: ciclista al semaforo)
- Spende energia per vincere la resistenza
- In discesa a velocità uniforme  mgh = vtR
- Efficienza $\epsilon = \frac{P}{R} \simeq \frac{v_h}{v_v}$

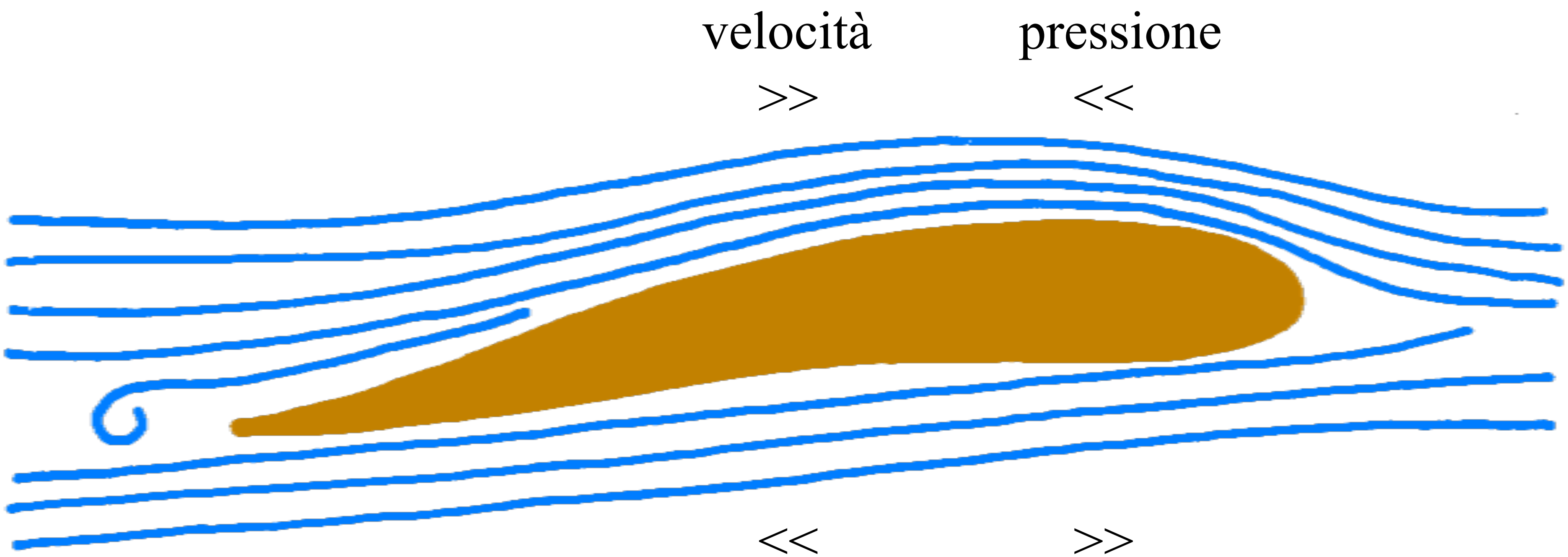

$$P = \frac{1}{2}\rho v^2 S C_l$$

$$R = R_F + R_V + R_I$$

$$\epsilon = \frac{P}{R} \simeq \frac{v_h}{v_v}$$

- Piper 10..20
- Aliante 30..72 (*)
- Albatros 22-23

# Un modo più preciso di vedere



# Aliante "eta" $\varepsilon = 72$

Siti: http://en.wikipedia.org/wiki/Eta_(glider)
http://www.sailplanedirectory.com/PlaneDetails.cfm?planeID=99

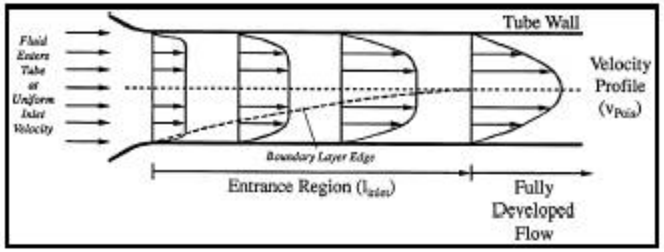
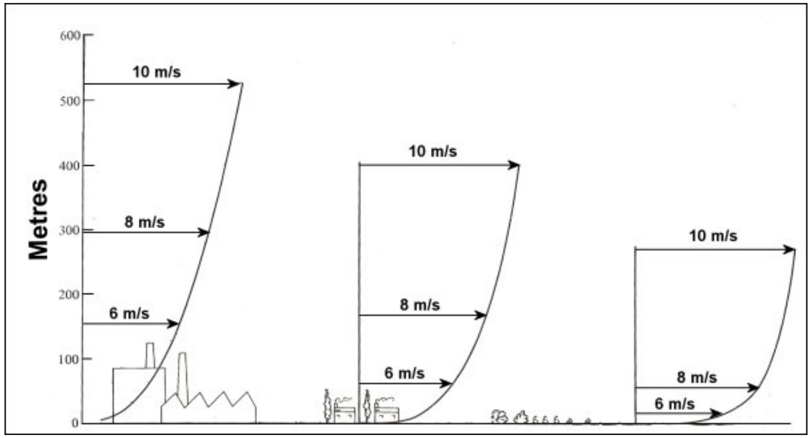
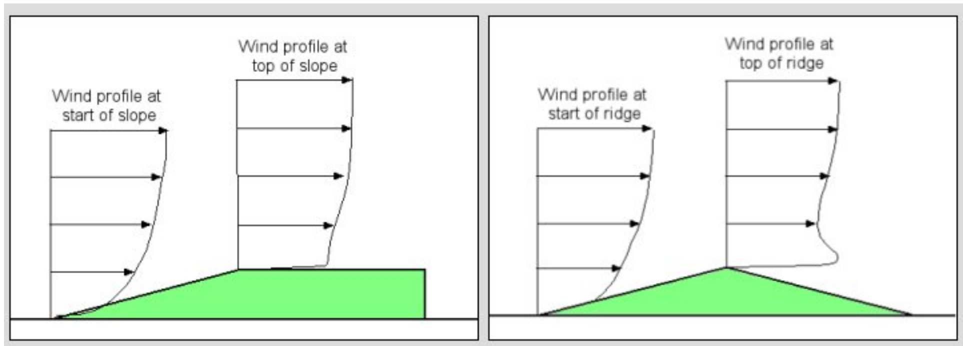
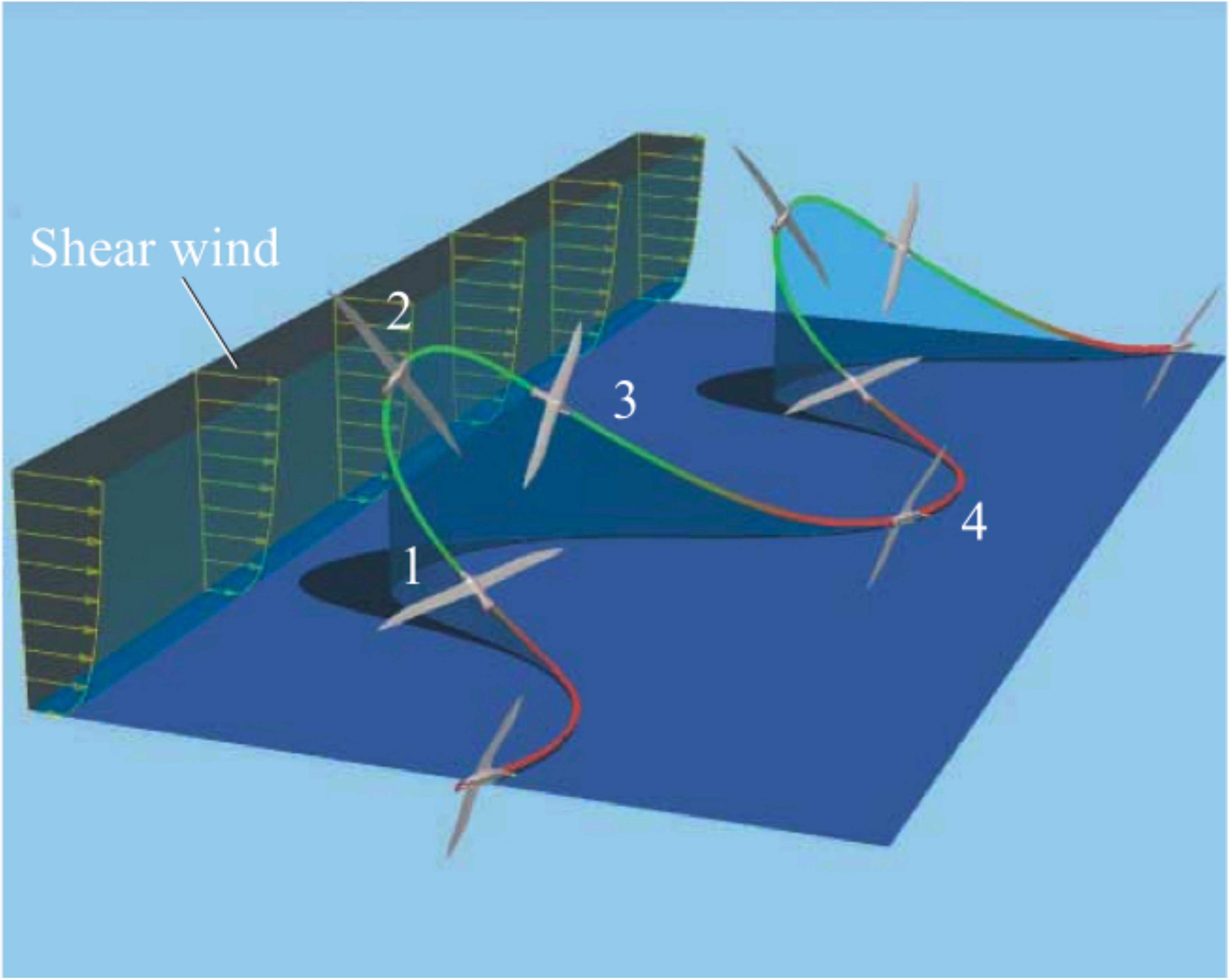
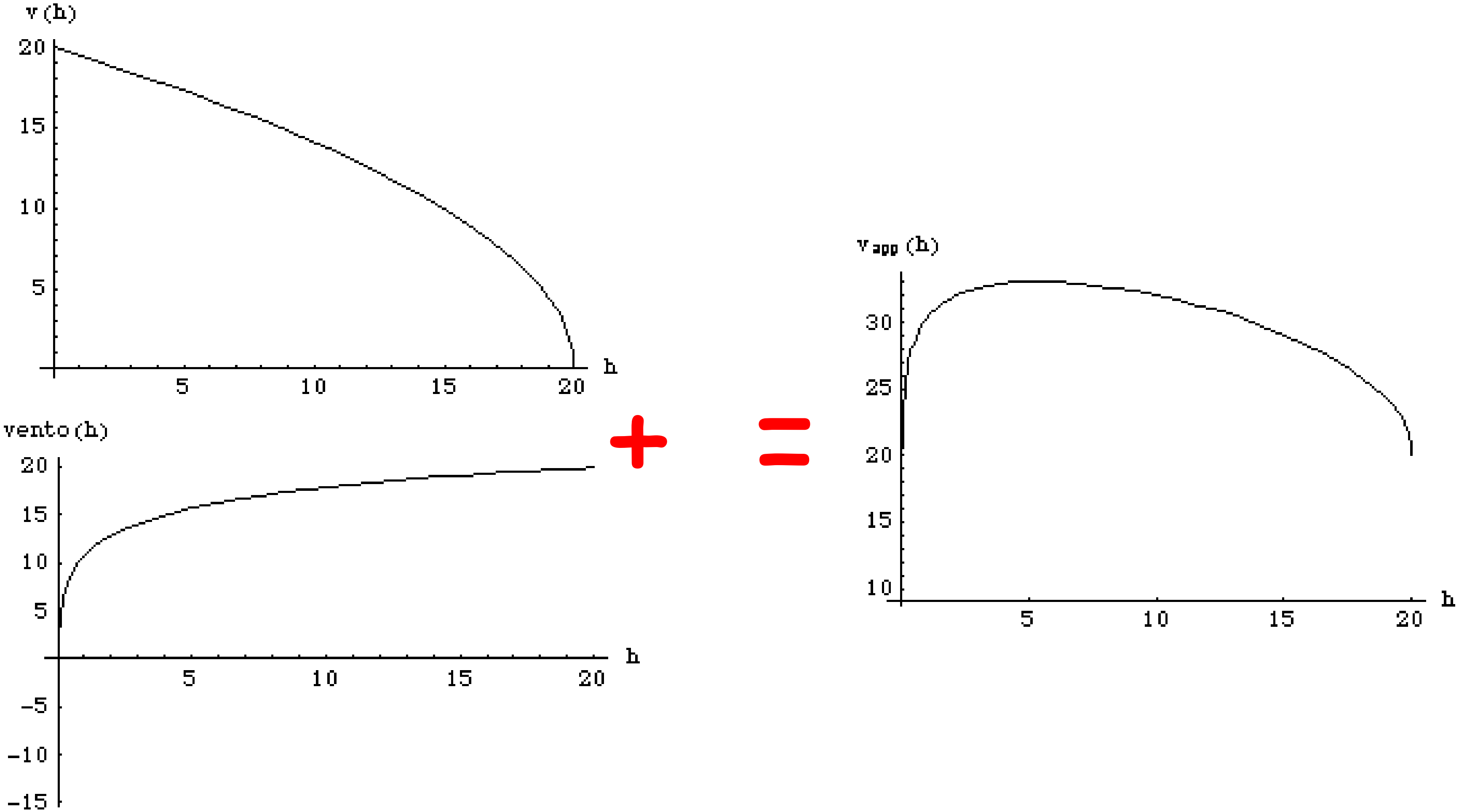


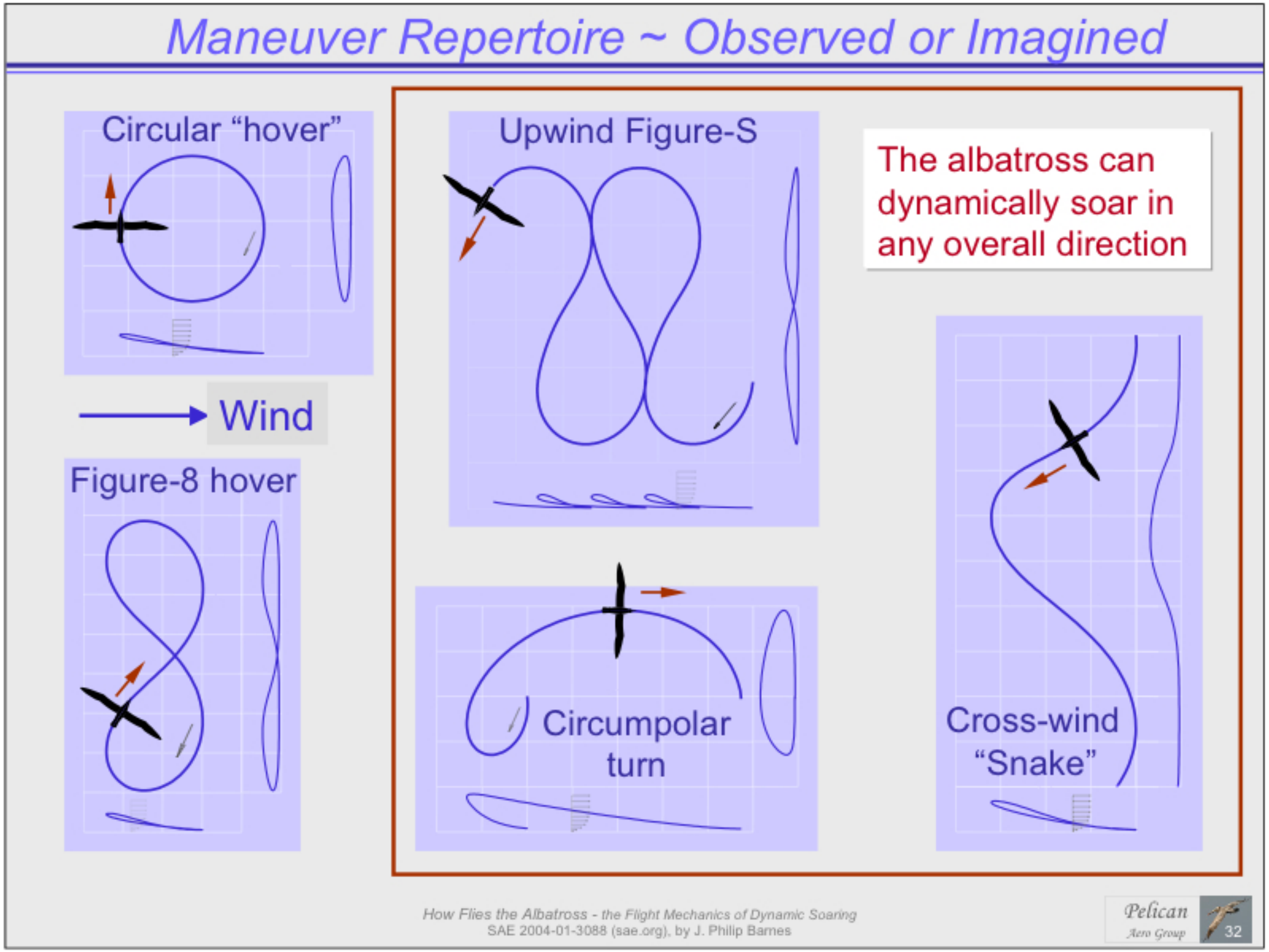

Fig. 9.14. Establishment of parabolic velocity profile in Poiseuille tube flow (redrawn from Goldsmith and Turitto[386]).



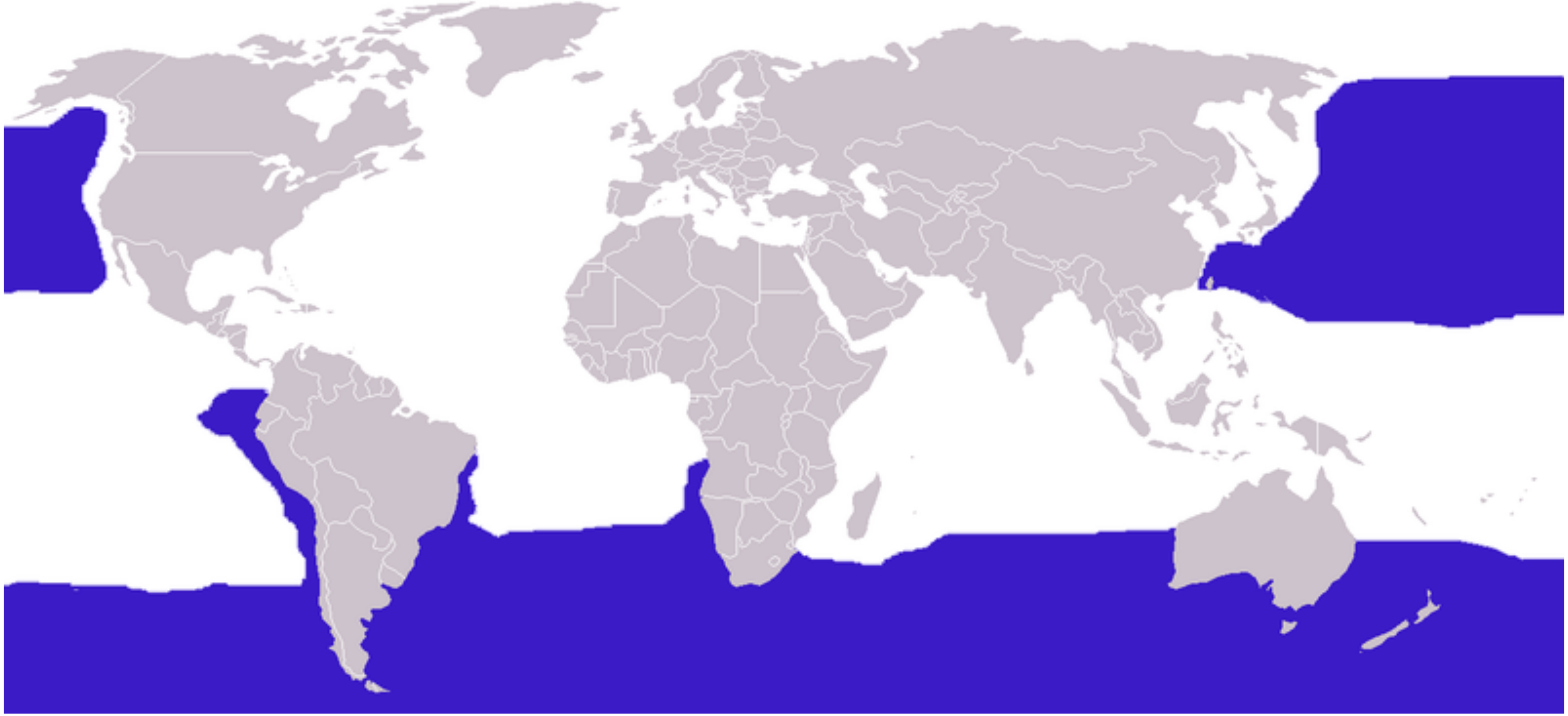




Shear wind
2
3
1
4


v(h)
20
15
10
5
5
10
15
20
h
vento(h)
20
15
10
5
5
10
15
20
h
-5
-10
-15
+
=
v app (h)
30
25
20
15
10
5
10
15
20
h


Maneuver Repertoire ~ Observed or Imagined
Circular "hover"
Wind
Figure-8 hover
Upwind Figure-S
The albatross can dynamically soar in any overall direction
Circumpolar turn
Cross-wind "Snake"
How Flies the Albatross - the Flight Mechanics of Dynamic Soaring
SAE 2004-01-3088 (sae.org), by J. Philip Barnes
Pelican
Aero Group
32

# Dove vive l'albatros



# 7 - Conclusioni

# Colonie

da: Il Popolo Migratore 26"

# Corteggiamento

da: Il Popolo Migratore 70”

# BBC's D.Attenborough

# Albatross' flight


... principe delle nuvole
Che abita la tempesta e ride dell'arciere;
Ma esule sulla terra, al centro degli scherni,
Per le ali di gigante non riesce a camminare.

da: Charles Baudelaire, I fiori del male: L'albatro