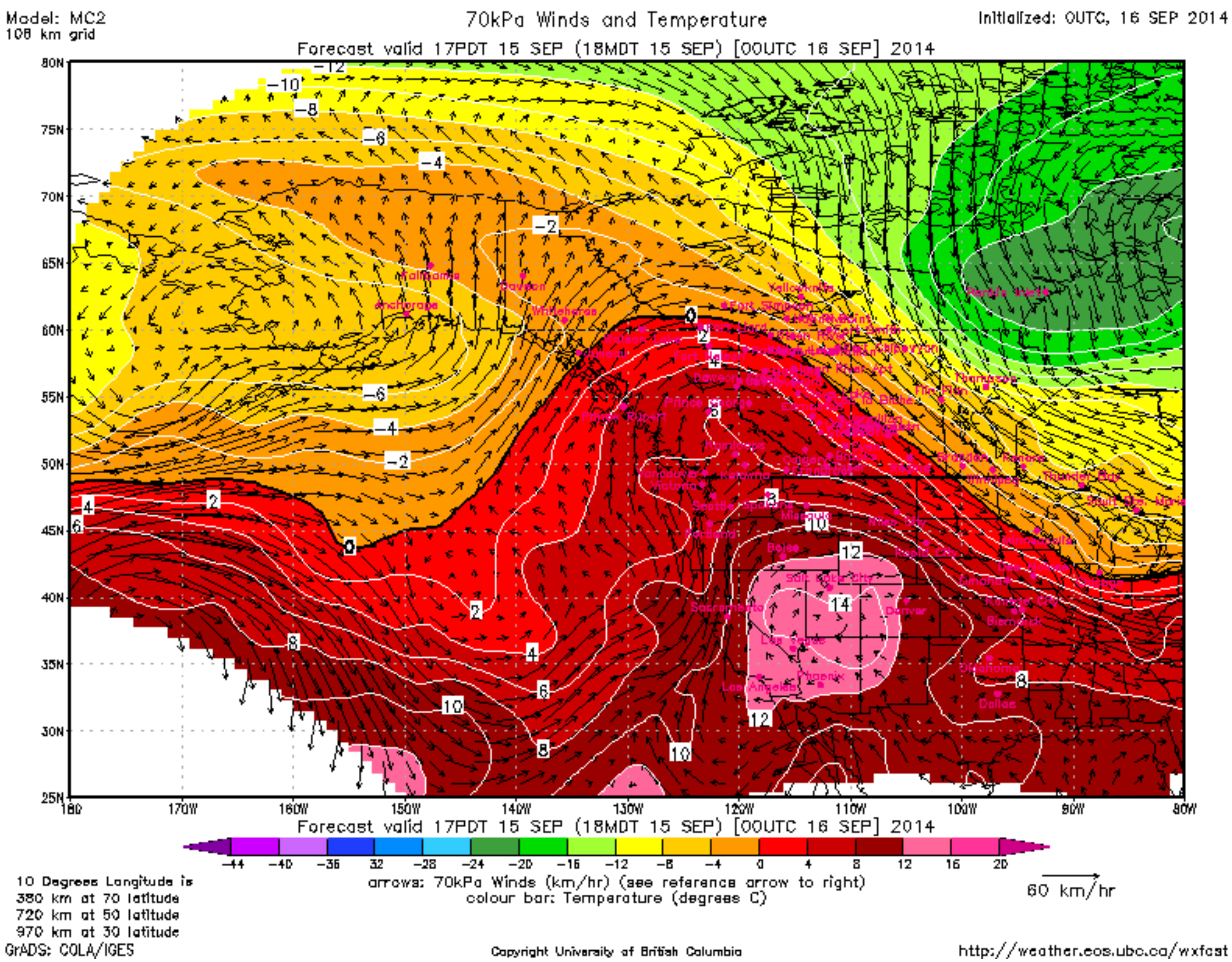
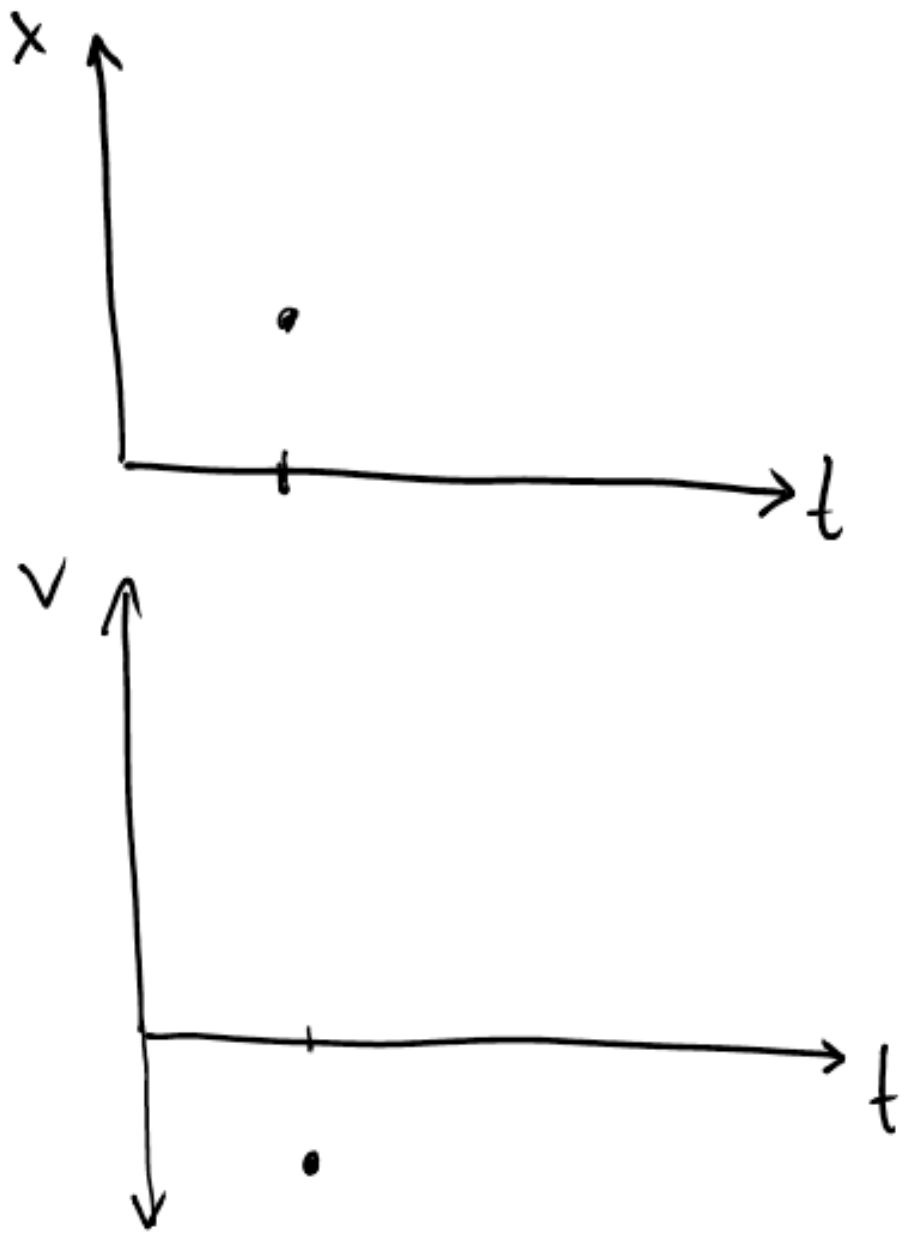
Clec5

Predicting the Future



Clicker Question

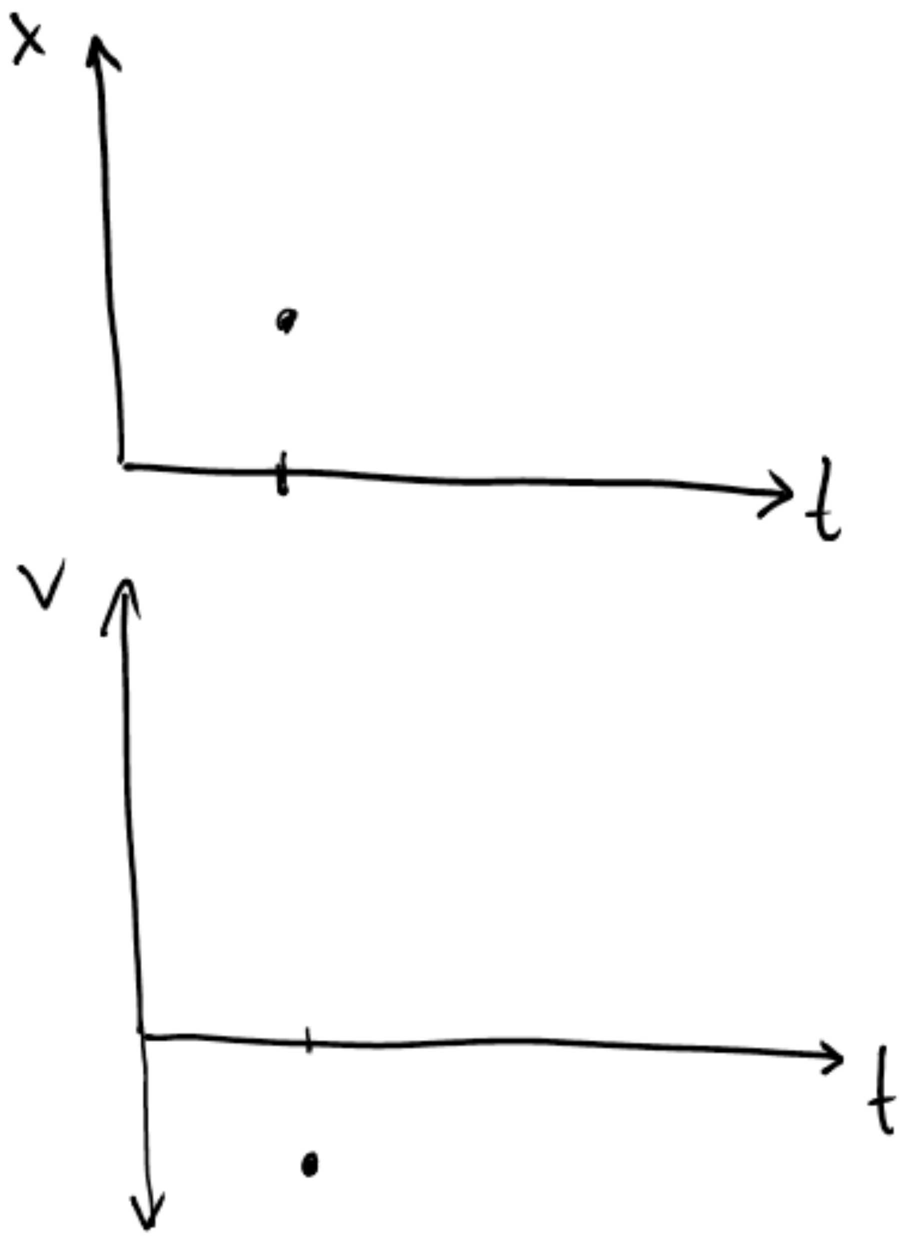


The graphs show the position and velocity of an object at some time. To predict the slope of the first graph, we need to use:

A) Newton's second law
B) the velocity from the second graph
C) both A and B
D) a measurement of the acceleration
E) none of the above would allow us to predict it

EXTRA: What to we need to predict the slope of the second graph?

Clicker Question



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↗ this gives us $\frac{dx}{dt}$, which is the slope

EXTRA: What to we need to predict the slope of the second graph?

→ Need Newton's 2nd law to predict $\frac{dv}{dt}$.

Solving Newton's Equations

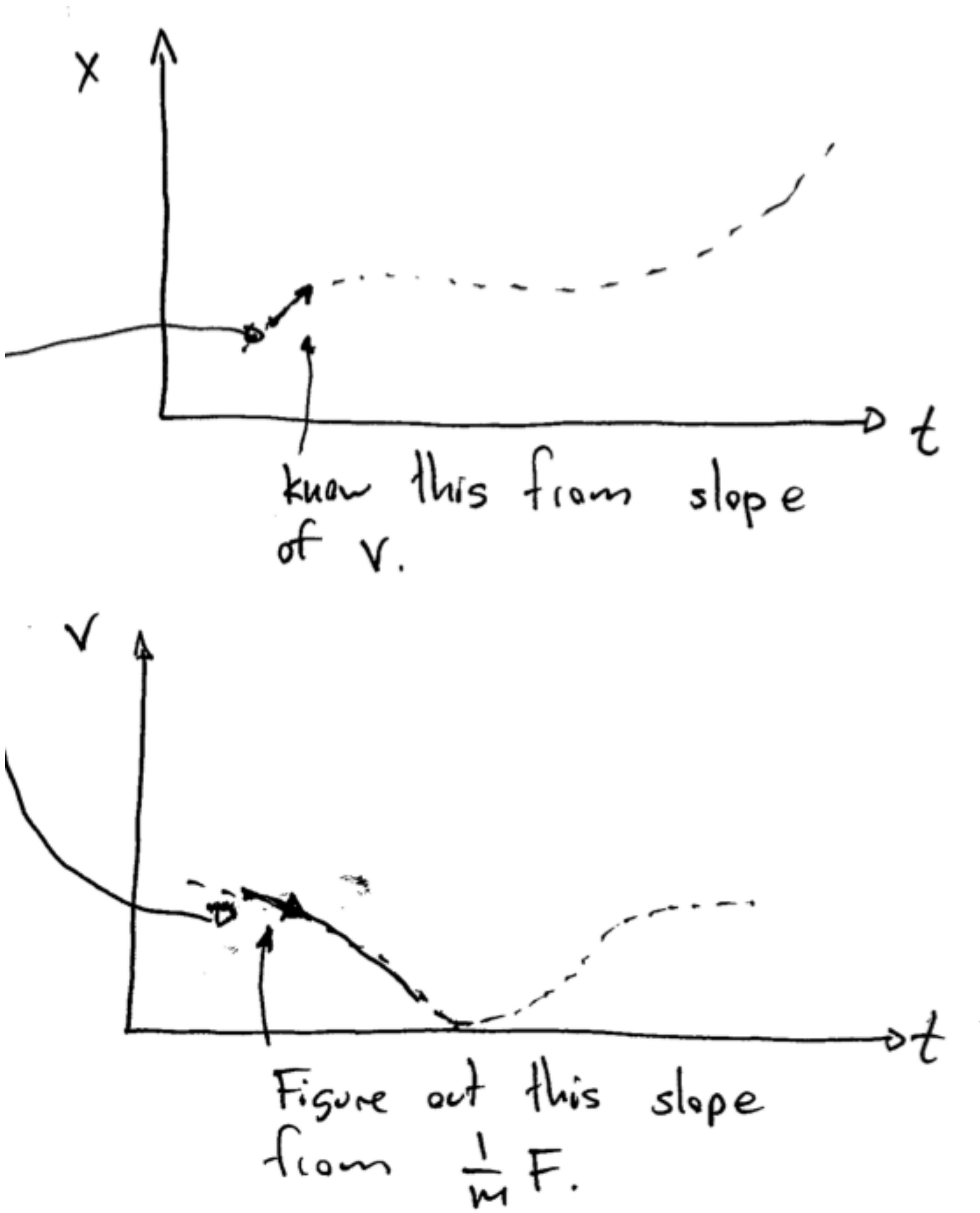
There are many ways to solve differential equations.

1) (*Simplest cases*) When the force depends on some known function of time (i.e., it doesn't depend on x or v) use integration.

2) (*Simple cases*) Directly find a function that satisfies the equations (Math 215 and 316) or "guess and check"

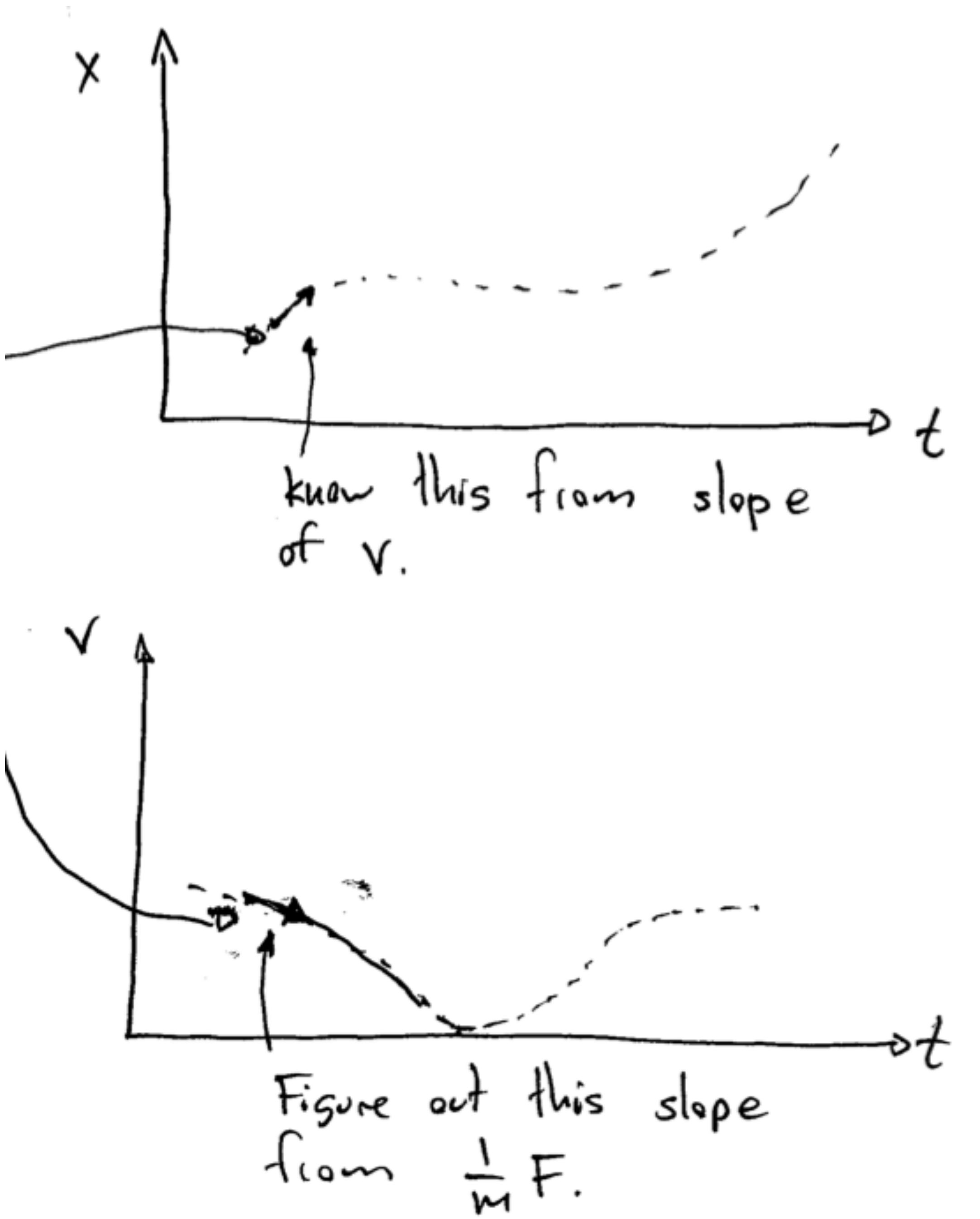
3) (*Everything else*) Numerically solve the equations. (e.g. using the Euler method)

Question



What is the minimum information we need to keep doing the Euler method forever?

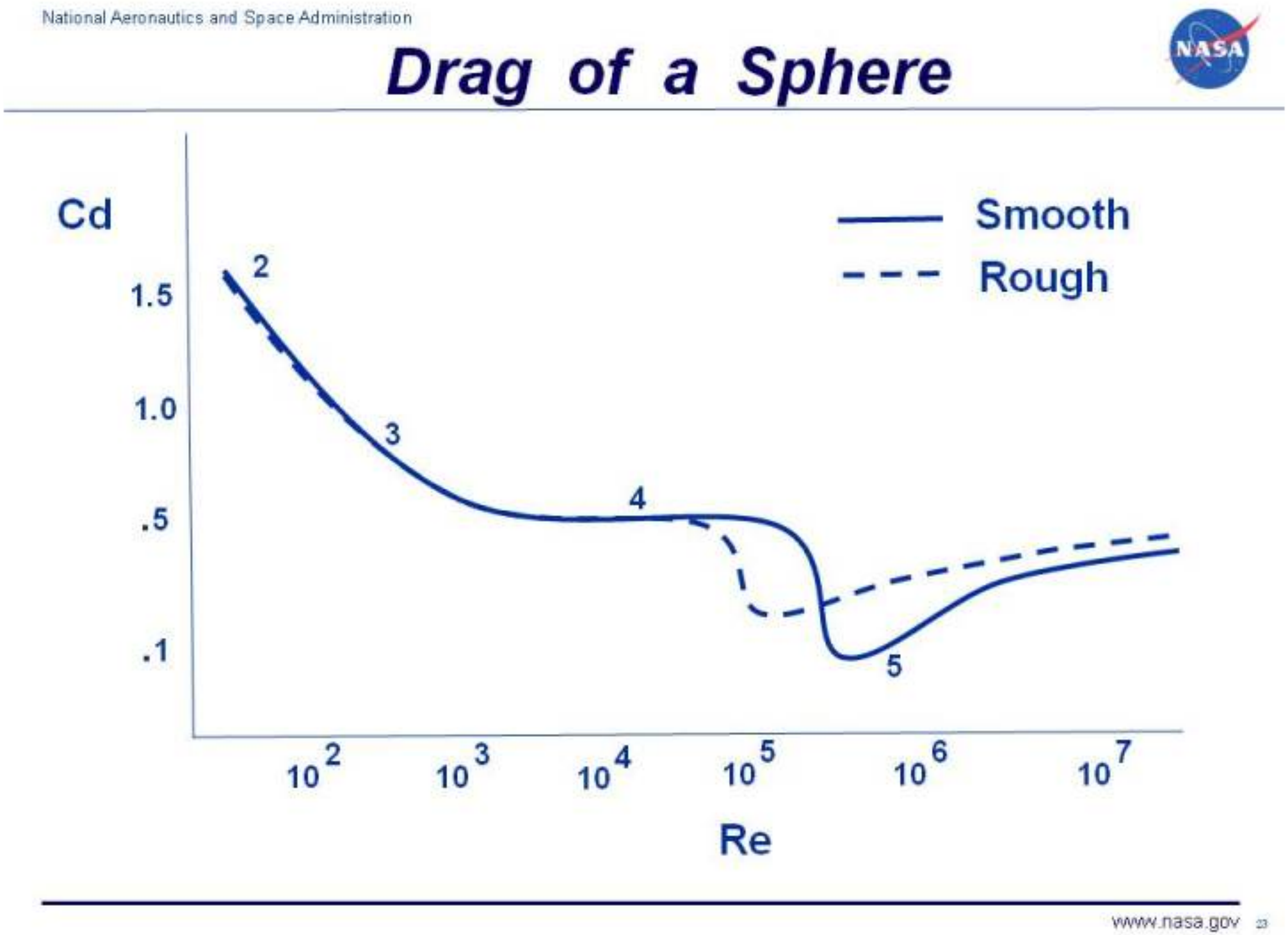
Question



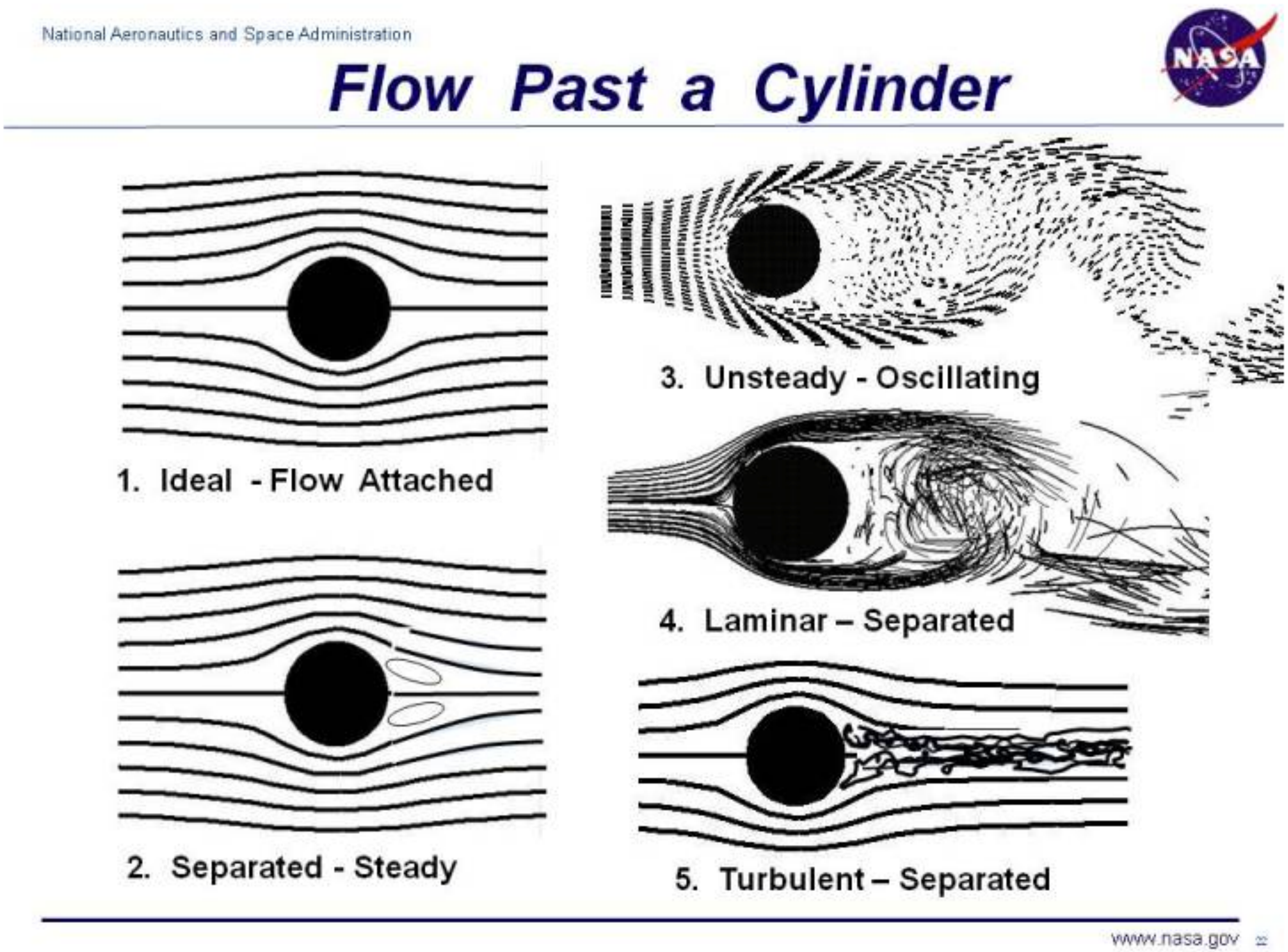
What is the minimum information we need to keep doing the Euler method forever?

We need x_0, v_0, and the force fr all *x* and *v*.

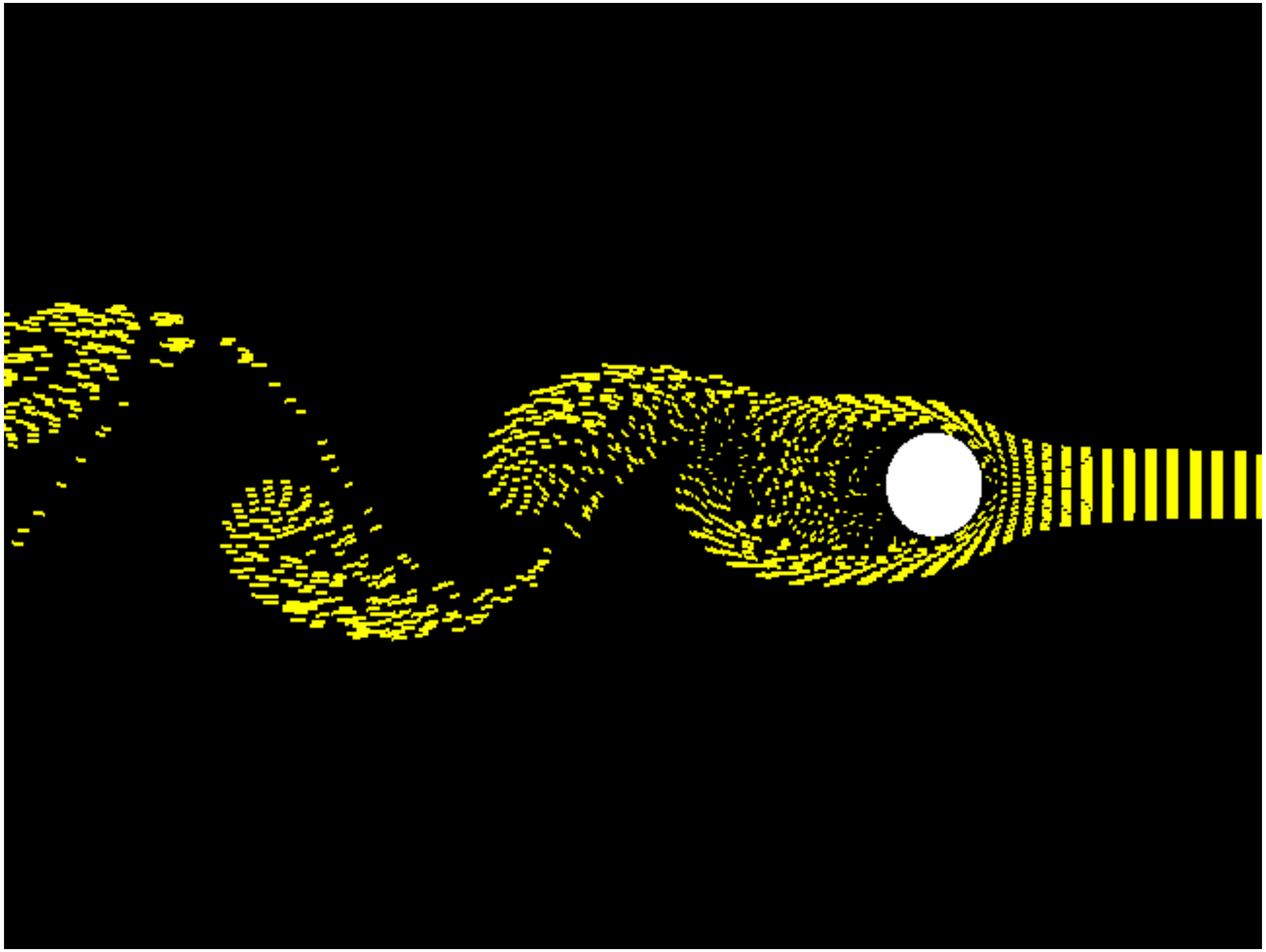
Fluid Dynamics

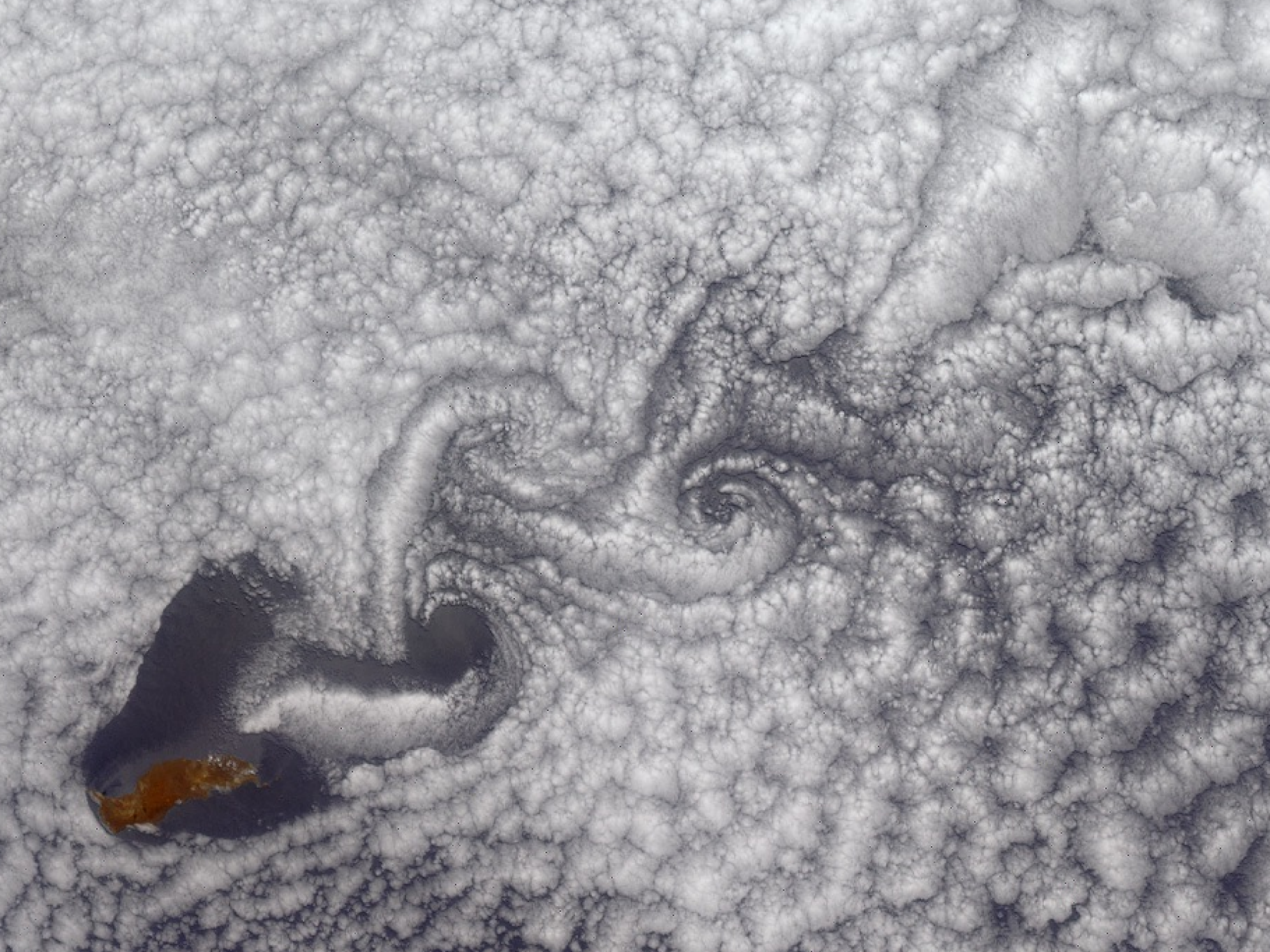


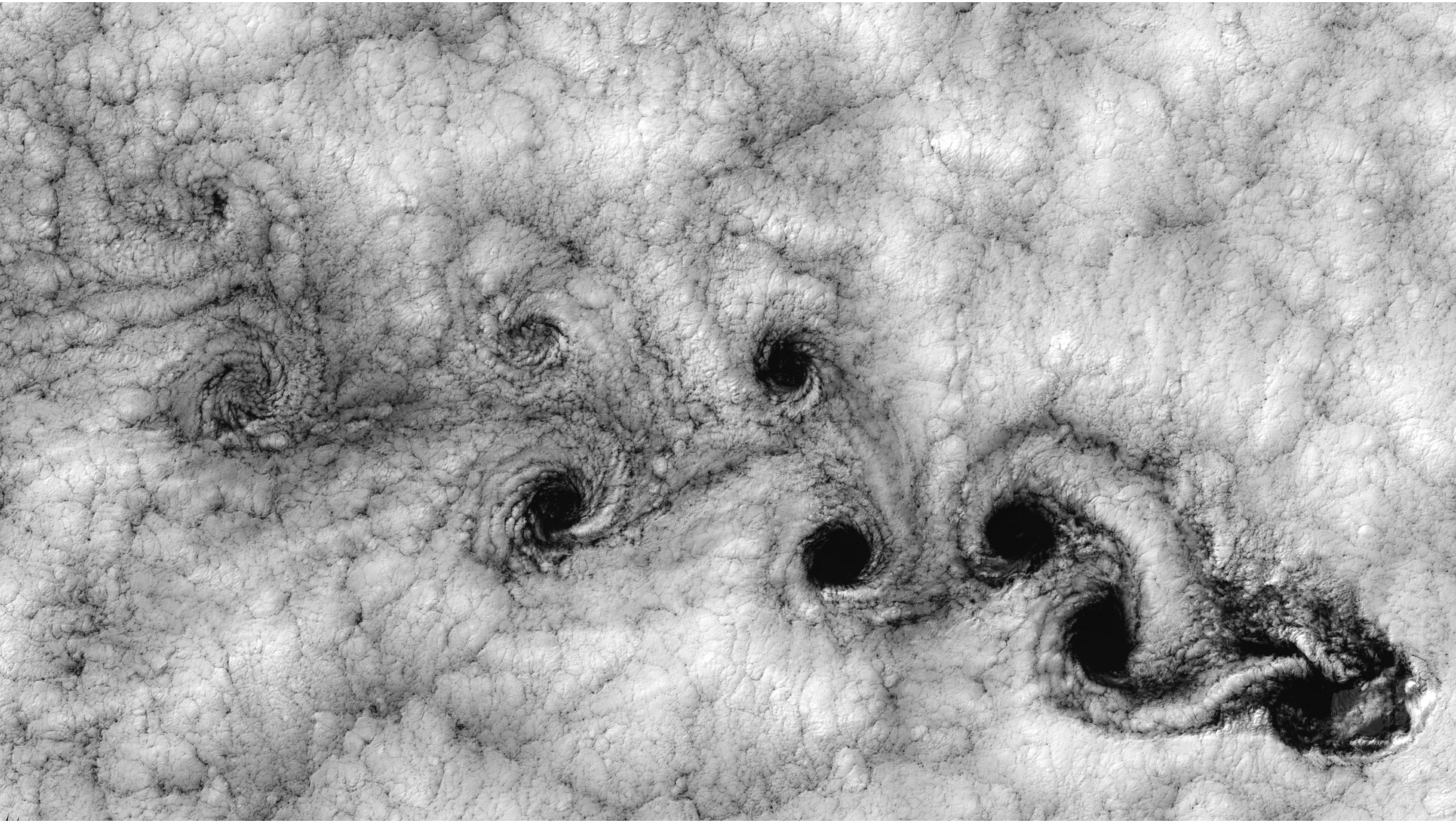
Fluid Dynamics



Fluid Dynamics

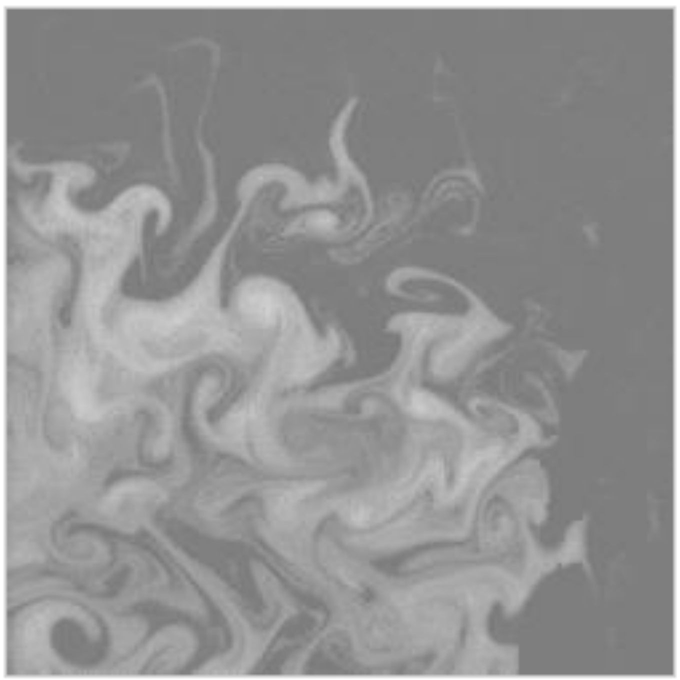






ABOUT PROGRAMS MILLENNIUM PROBLEMS PEOPLE PUBLICATIONS EUCLID EVENTS

Navier–Stokes Equation



This problem is: Unsolved

Waves follow our boat as we meander across the lake, and turbulent air currents follow our flight in a modern jet. Mathematicians and physicists believe that an explanation for and the prediction of both the breeze and the turbulence can be found through an understanding of solutions to the Navier-Stokes equations. Although these equations were written down in the 19th Century, our understanding of them remains minimal. The challenge is to make substantial progress toward a mathematical theory which will unlock the secrets hidden in the Navier-Stokes equations.

Rules:

Rules for the Millennium Prizes

Related Documents:

Official Problem Description

Related Links:

Lecture by Luis Cafarelli

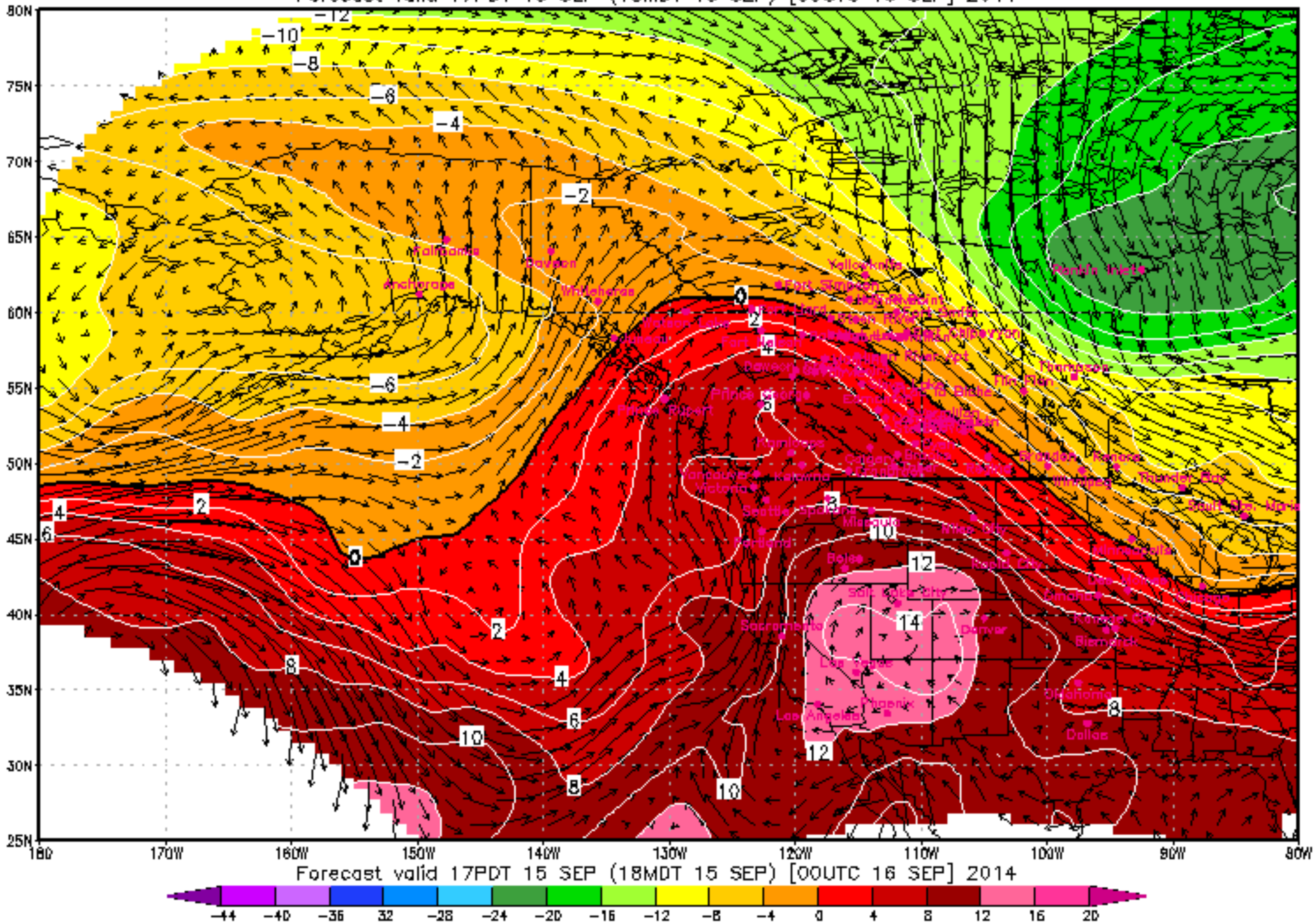
This is the equation which governs the flow of fluids such as water and air. However, there is no proof for the most basic questions one can ask: do solutions exist, and are they unique? Why ask for a proof? Because a proof gives not only certitude, but also understanding.

Model: MC2
108 km grid

70kPa Winds and Temperature

Initialized: 0UTC, 16 SEP 2014

Forecast valid 17PDT 15 SEP (18MDT 15 SEP) [00UTC 16 SEP] 2014



10 Degrees Longitude is
380 km at 70 latitude
720 km at 50 latitude
970 km at 30 latitude

arrows: 70kPa Winds (km/hr) (see reference arrow to right)
colour bar: Temperature (degrees C)

60 km/hr

GrADS: COLA/IGES

http://weather.eos.ubc.ca/wxfcst

Worksheet

Let's do the Euler method for the drag force of a ball travelling through the air.

$$\vec{r}(t+\varepsilon) \approx \vec{r}(t) + \varepsilon \cdot \vec{v}(t)$$
$$\vec{v}(t+\varepsilon) \approx \vec{v}(t) + \varepsilon \cdot \vec{a}(t)$$

Where the acceleration is determined by the drag force.