Numerical Weather Prediction Process

Changing requirements

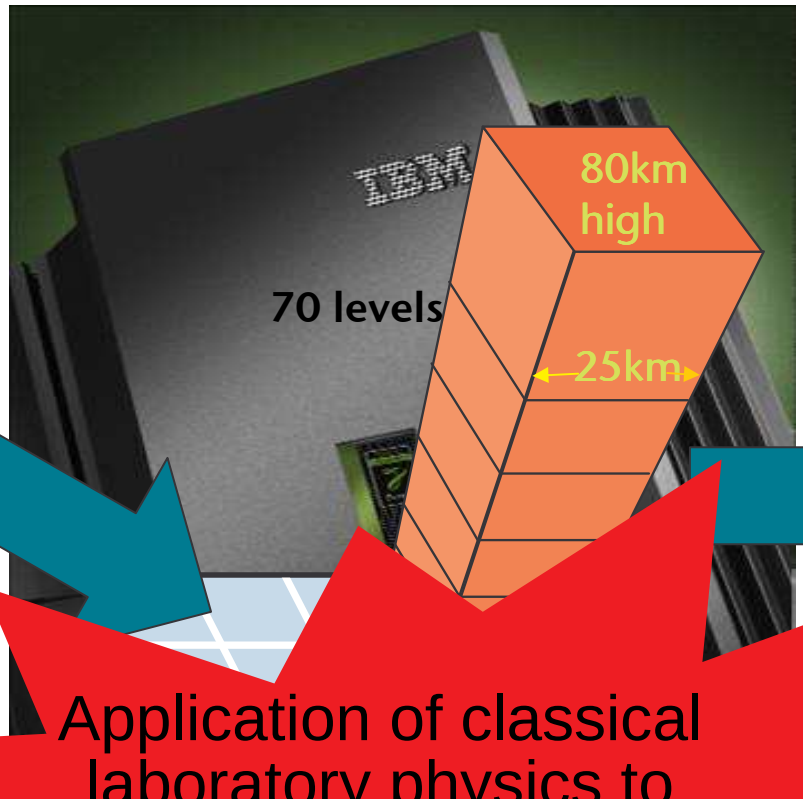
- Urban
- Climate change
- Renewable Energy
- Computing
- Communication
- Sustainability
- Mobility
- Focus on impacts

A short history of NWP

- 1904: Weather prediction approached from the standpoint of mechanics & physics
- 1922: Weather Prediction by Numerical Process
- 1950: The ENIAC experiment
- 1967: Predicting frontal precipitation with a 10 level model

Today's Numerical Modelling System

Observations



Risk Analysis & Communication

$$\frac{du}{dt} = \frac{\partial p}{\partial x} - fv$$

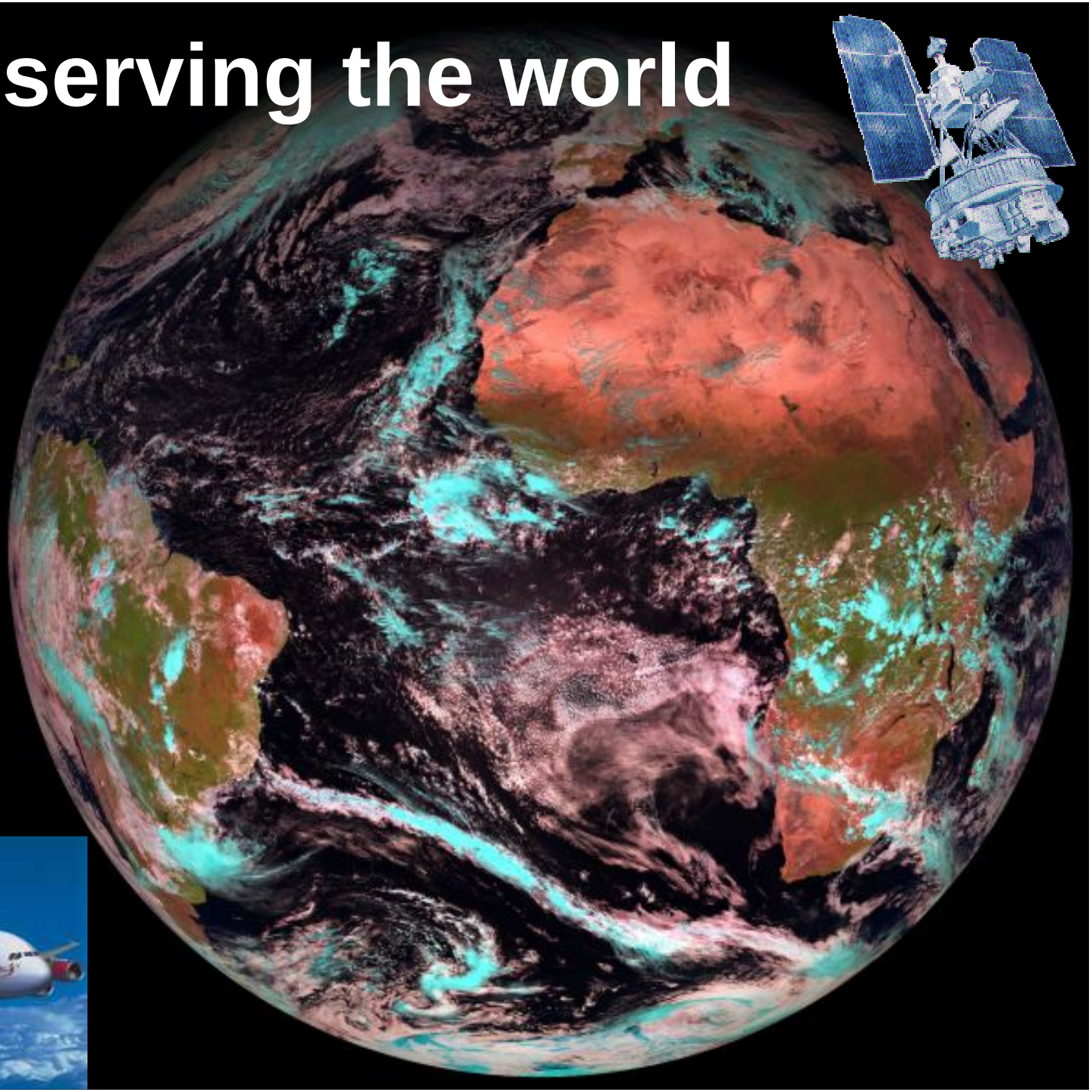
$$\frac{dv}{dt} = \frac{\partial p}{\partial y} + fu$$

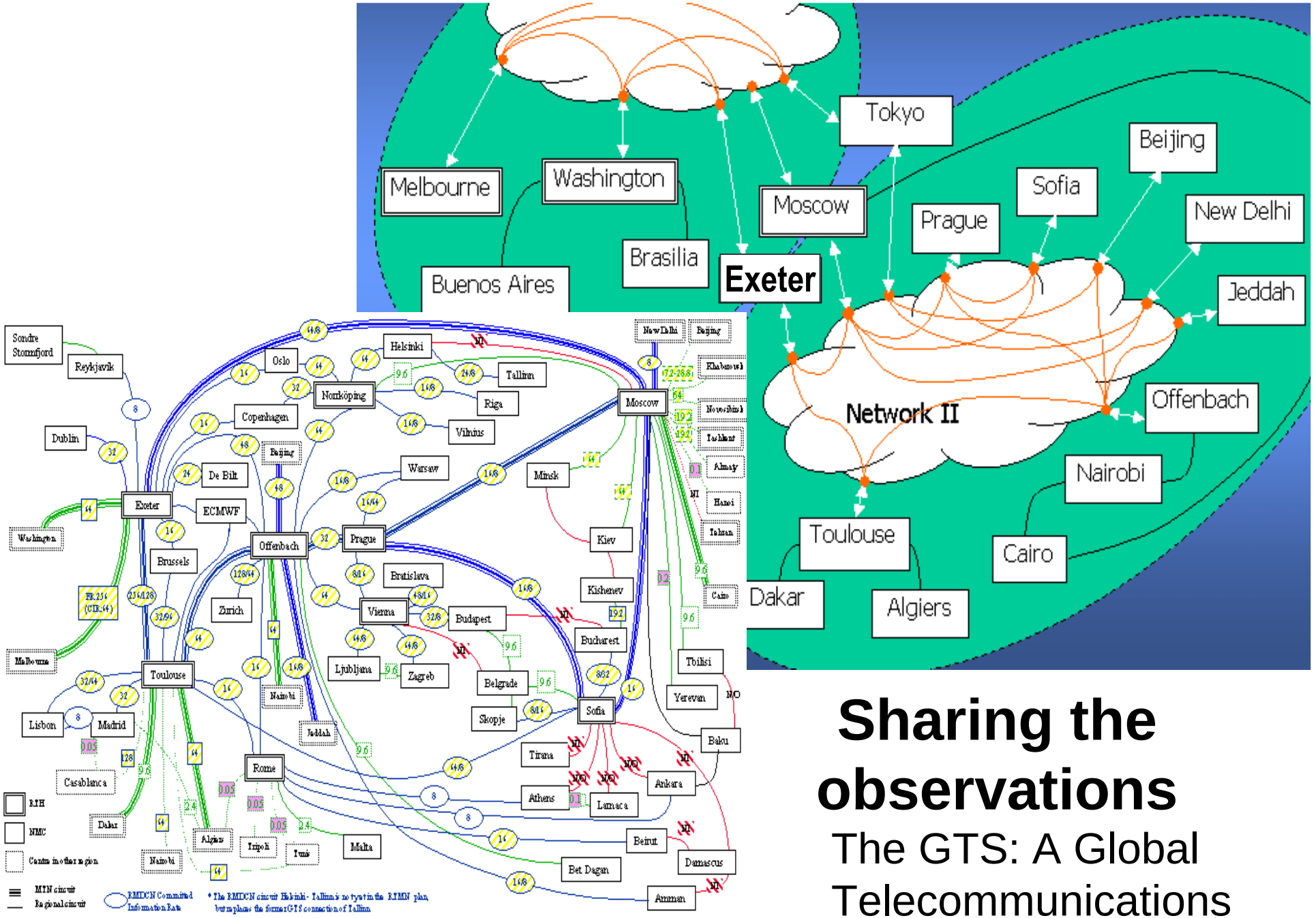
$$\frac{p}{\rho} = RT$$

Knowledge

Application of classical laboratory physics to the thin shell of turbulent gases that is our atmosphere

Observing the world





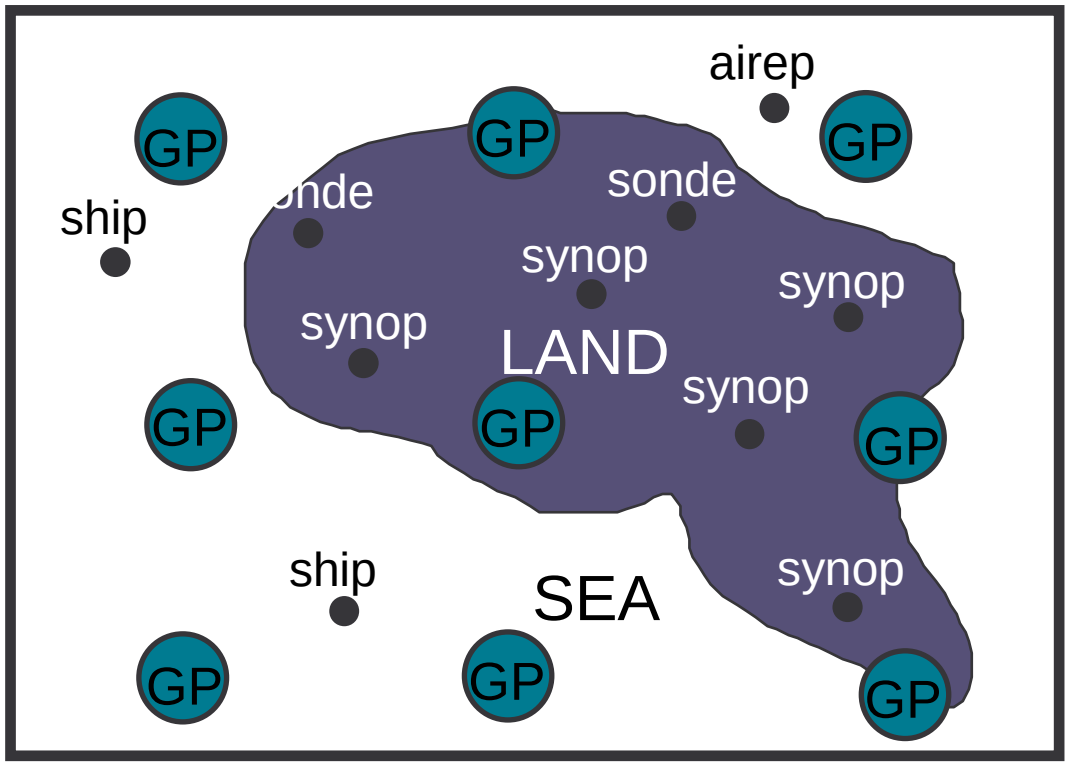
Sharing the observations

The GTS: A Global Telecommunications System

Using Observations

Quality control
- buddy checks
- climatology
- temporal consistency
- background field

Interpolated onto
the model grid points



Different types of data have different areas of influence

Using Observations

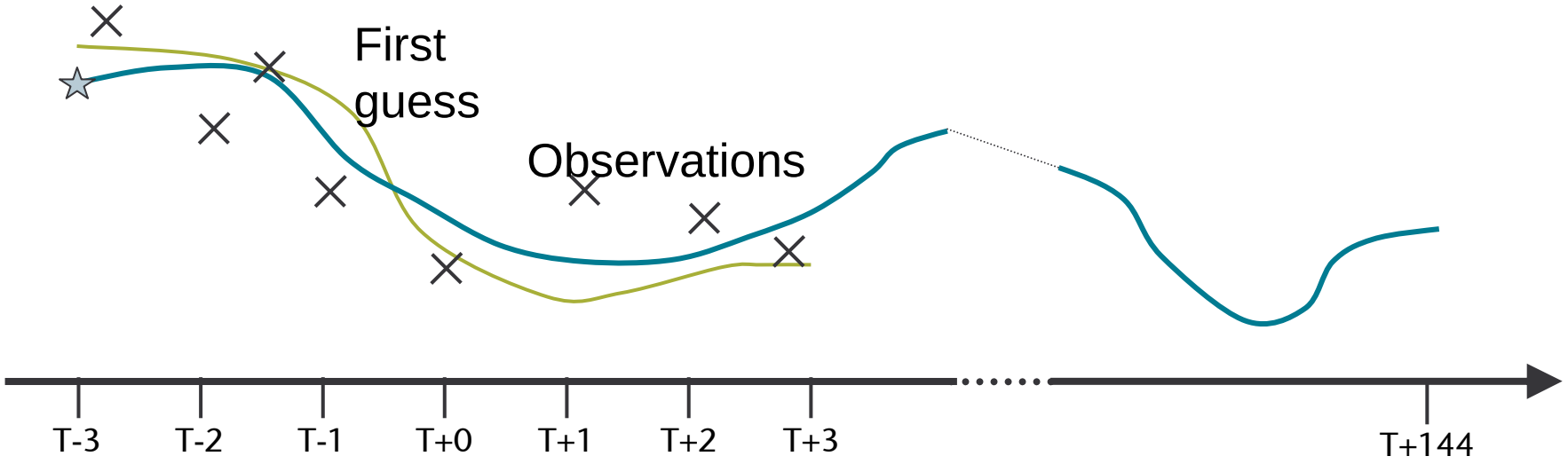
- NWP cannot rely solely on observations to produce its initial conditions
  - Why?
  - There are too few
  - Point observations may not be representative of a grid box

- A short period forecast from a previous run of the model fills the gaps
  - Model background field

Data Assimilation

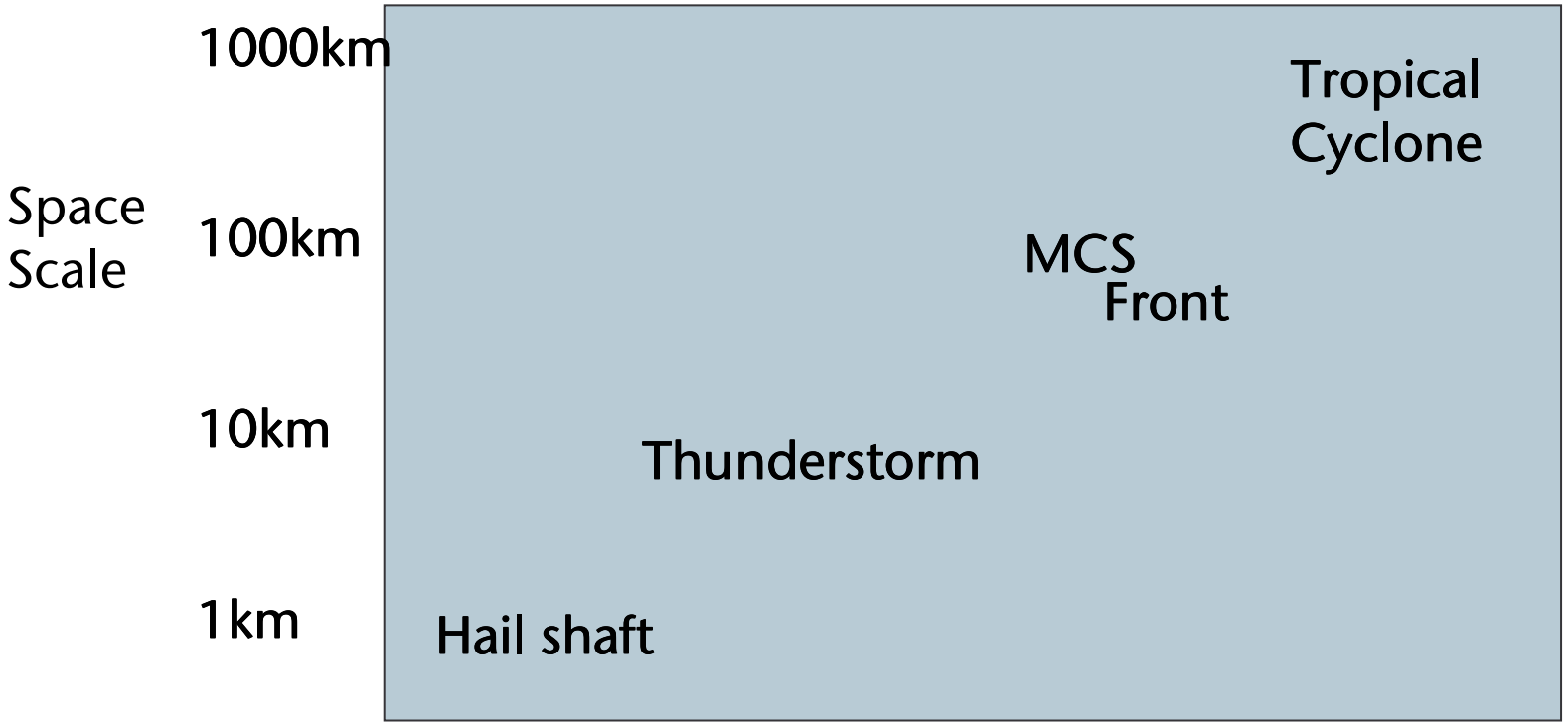
- Method used to blend real and model data
- Model is run for an assimilation period prior to the forecast
- Data is inserted into the run at or near their validity time to nudge the model towards reality

Data Assimilation



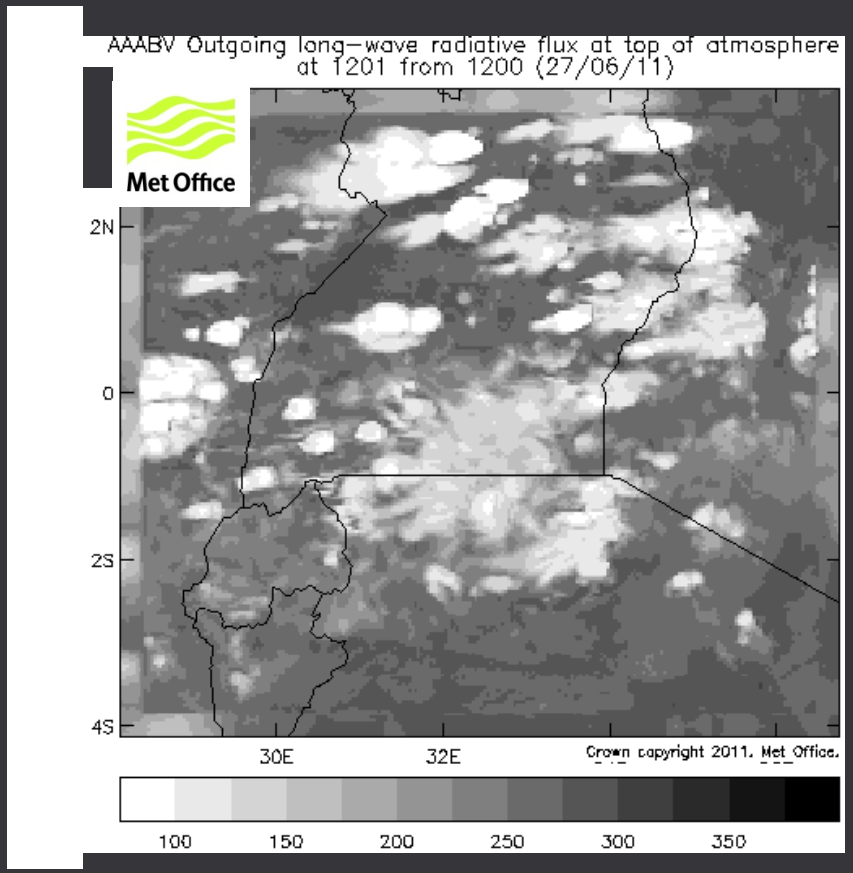
- The challenge:
  - To compute the model state from which the resulting forecast best matches the available observations

Temporal Resolution

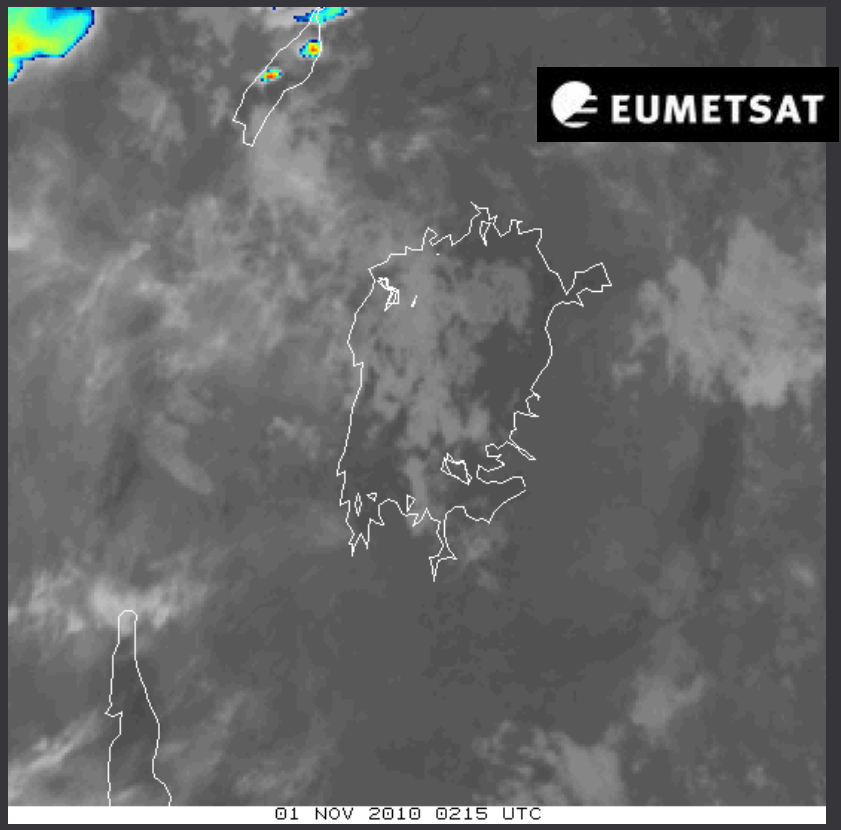


Lifetime	10mins	1 hr	12hrs	3 days
Predictability?	30mins	3 hrs	36hrs	9 days

Storm-permitting forecast:



High resolution weather forecast models



Satellite Observations

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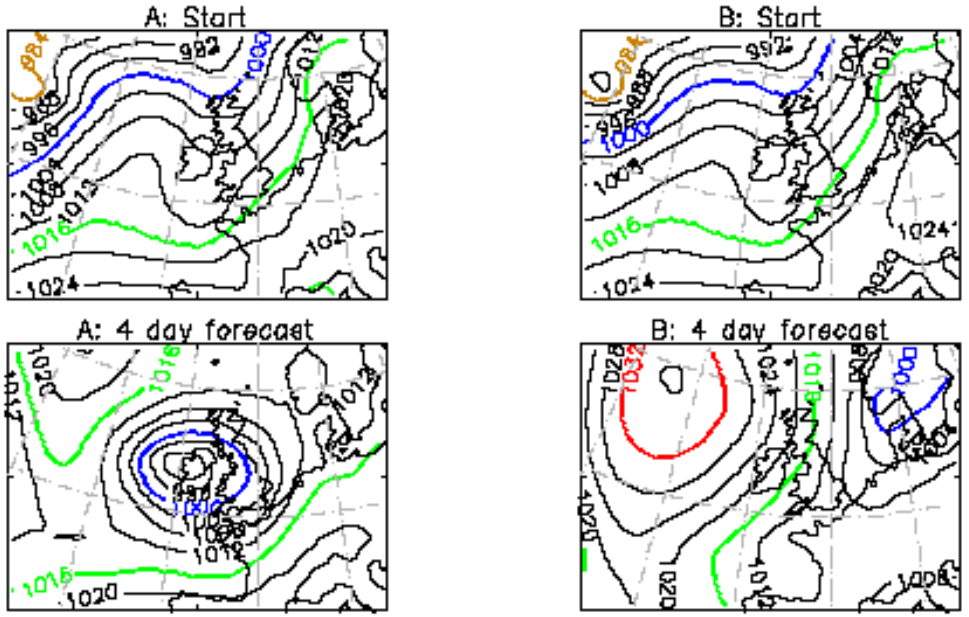
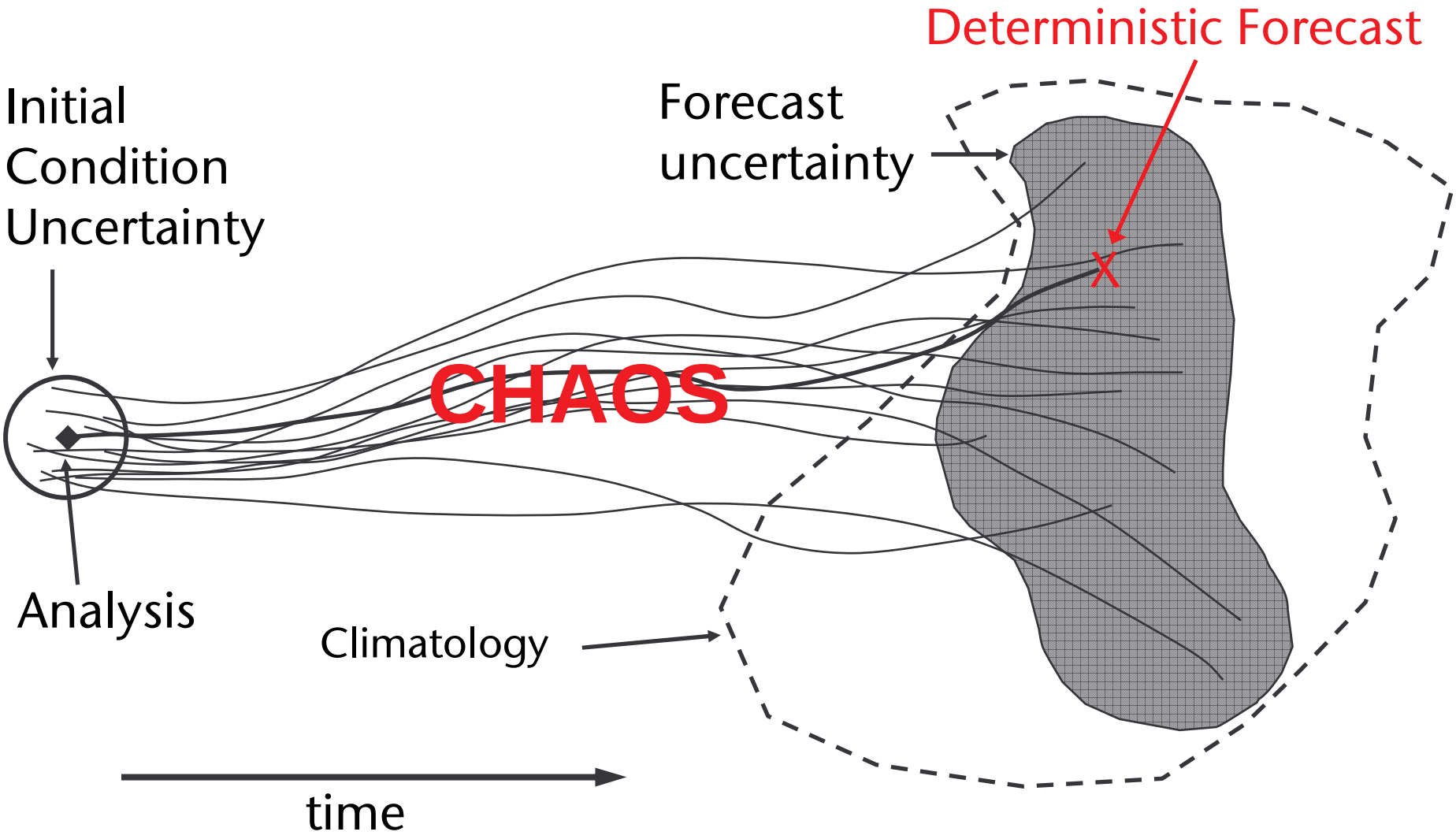
Chaos in the atmosphere

- When potential energy is available for conversion to kinetic energy & a trigger is present, small disturbances may grow rapidly into weather systems
- Small errors may rapidly lead to large forecast errors



The atmosphere is a chaotic system:
"… one flap of a seagull's wing may forever change the future course of the weather", (Lorenz, 1963)

Quantifying uncertainty with ensembles



Questions & Answers