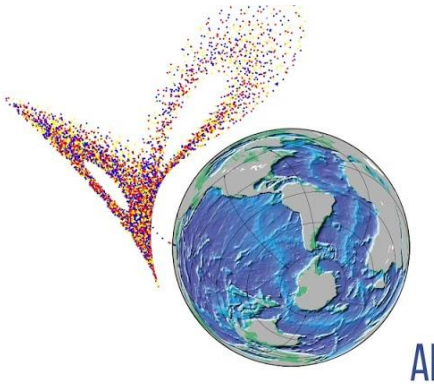


AML-CS

APPLIED MATH AND COMPUTER SCIENCE LAB

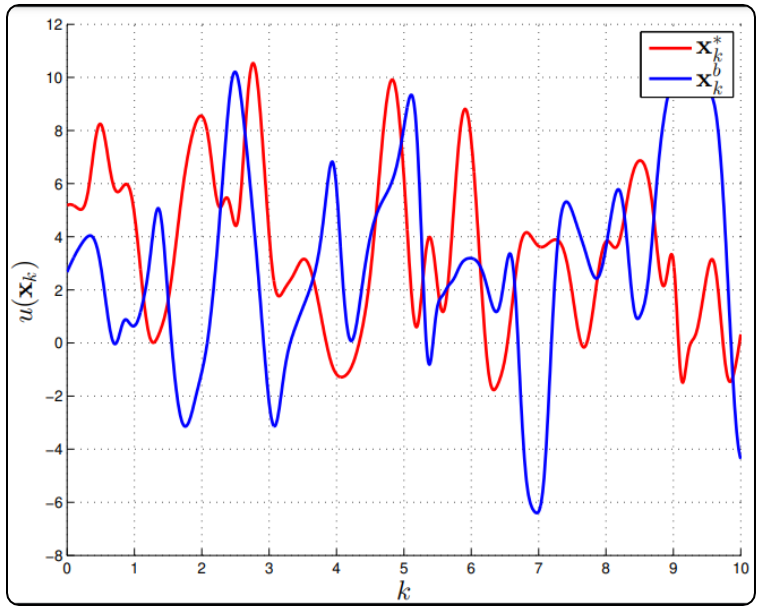
UN UNIVERSIDAD DEL NORTE

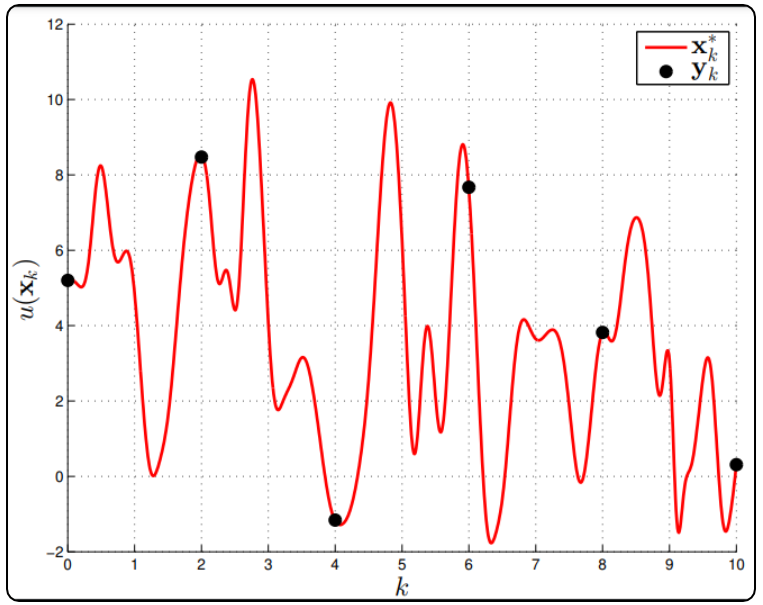
Data Assimilation

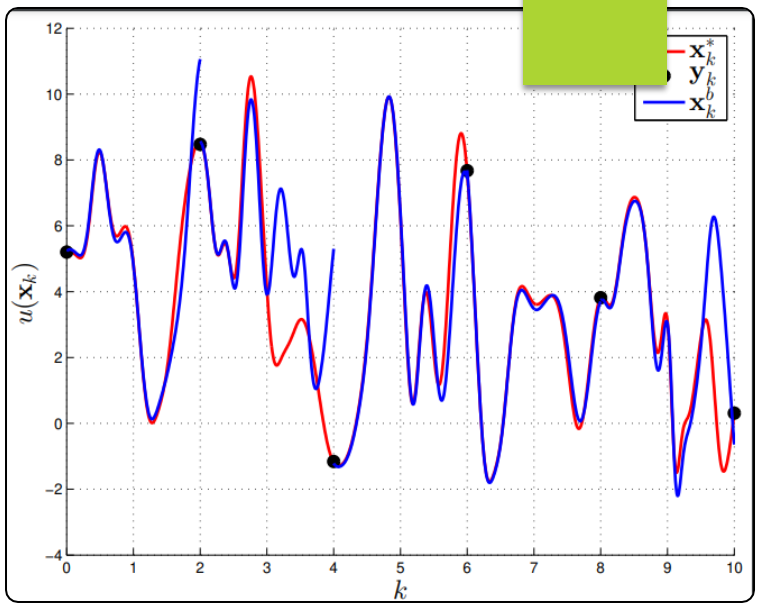
ELÍAS D. NIÑO RUIZ

What is Data Assimilation?

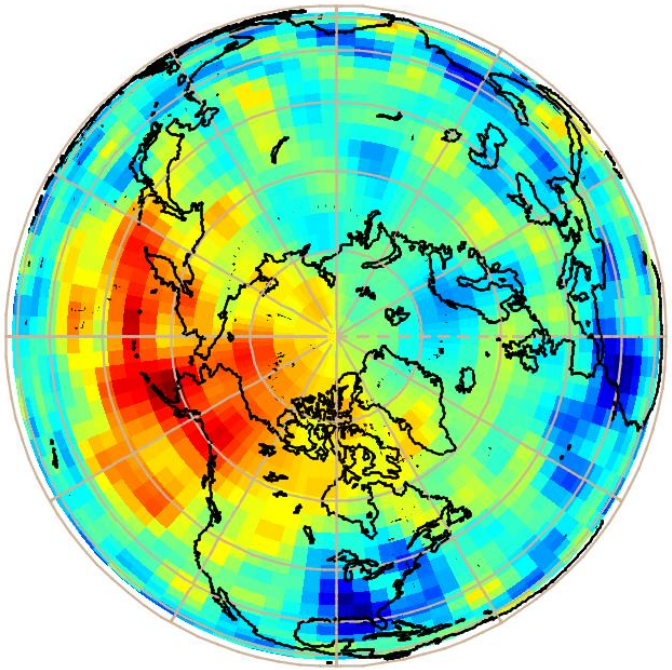
- Data Assimilation is the process by which an imperfect numerical forecast is adjusted according to real-noisy observations.







Data Assimilation Process (Sequential)



Are forecasts enough?

Forecasts

Numerical Models = Prior Knowledge

Initial Value Problem

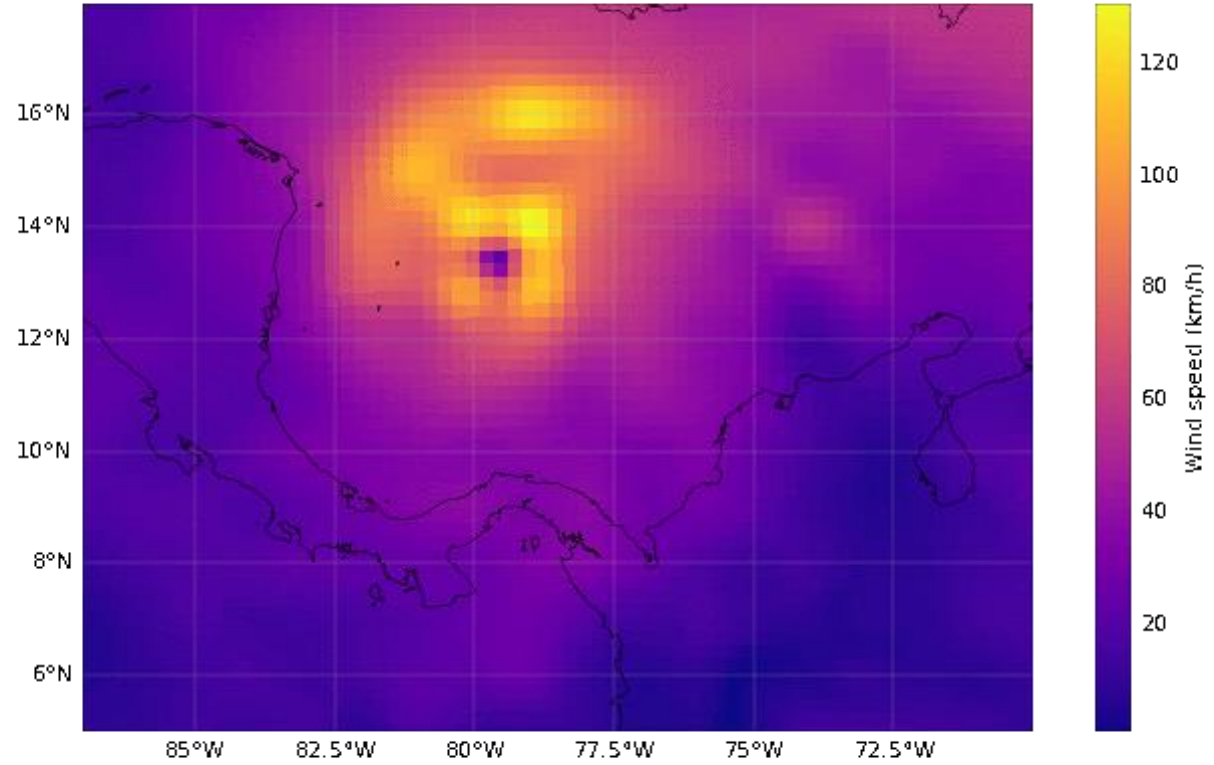
Errors on Initial Conditions

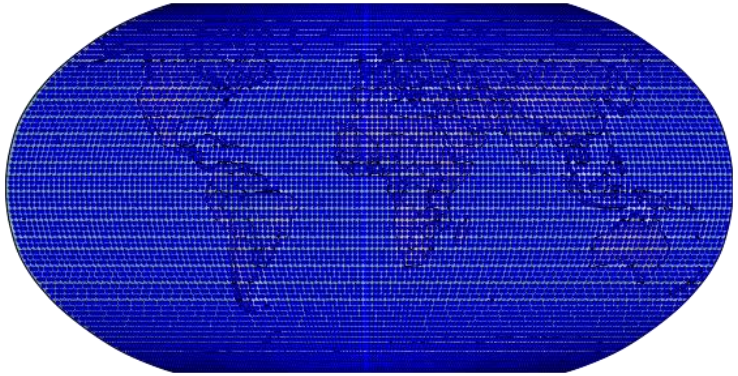
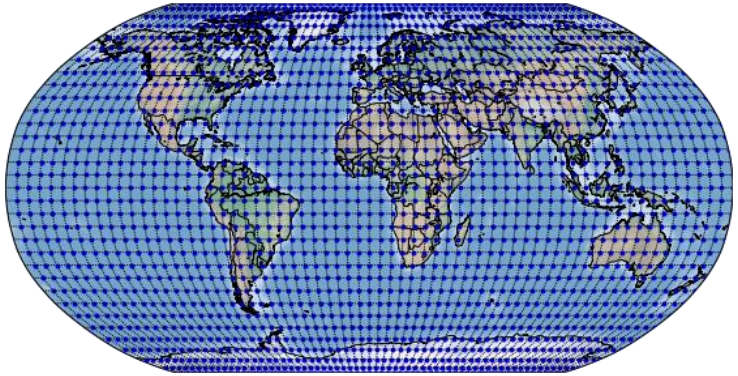
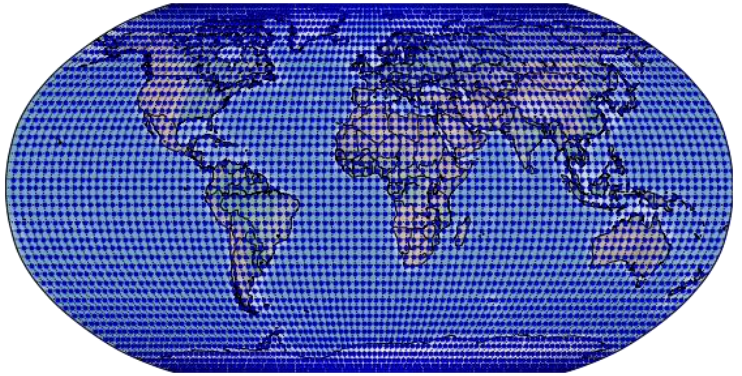
Discretization – Spatial Coverage

Discretization Errors

Numerical Integration

Iota Hurricane – Nov 16, 2022



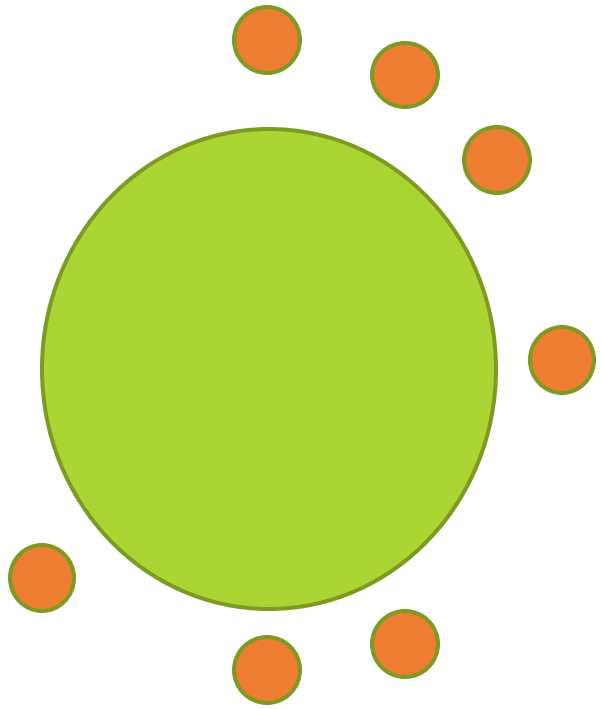




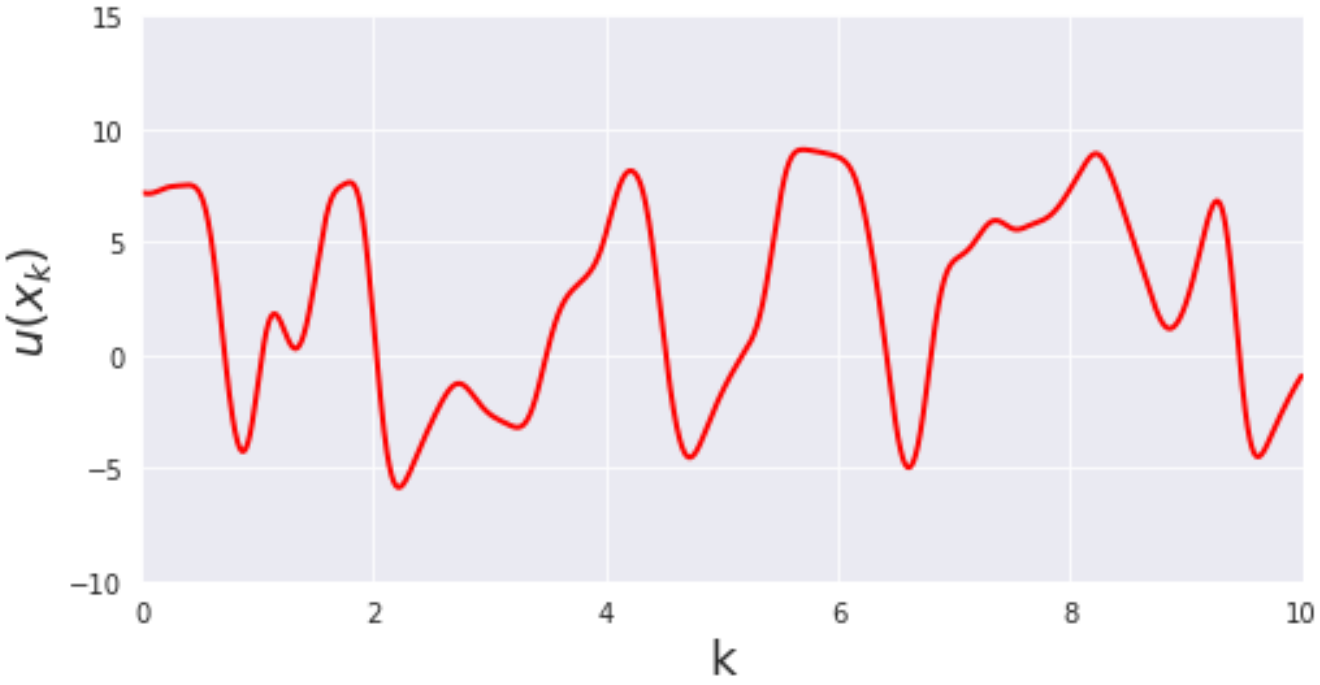
Discretization

Nature is Chaotic

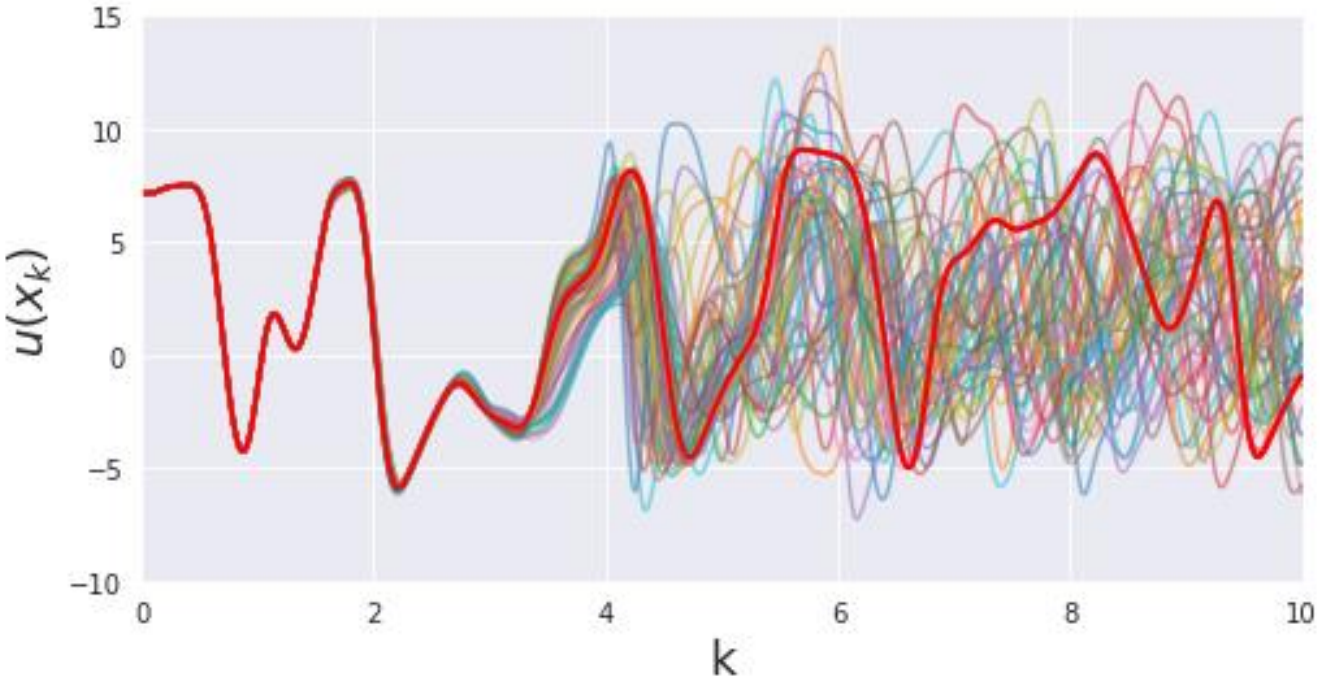
Lorenz 96 Model

$$\frac{\mathrm{d}x_i}{\mathrm{d}t} = (x_{i+1} - x_{i-2})x_{i-1} - x_i + F$$

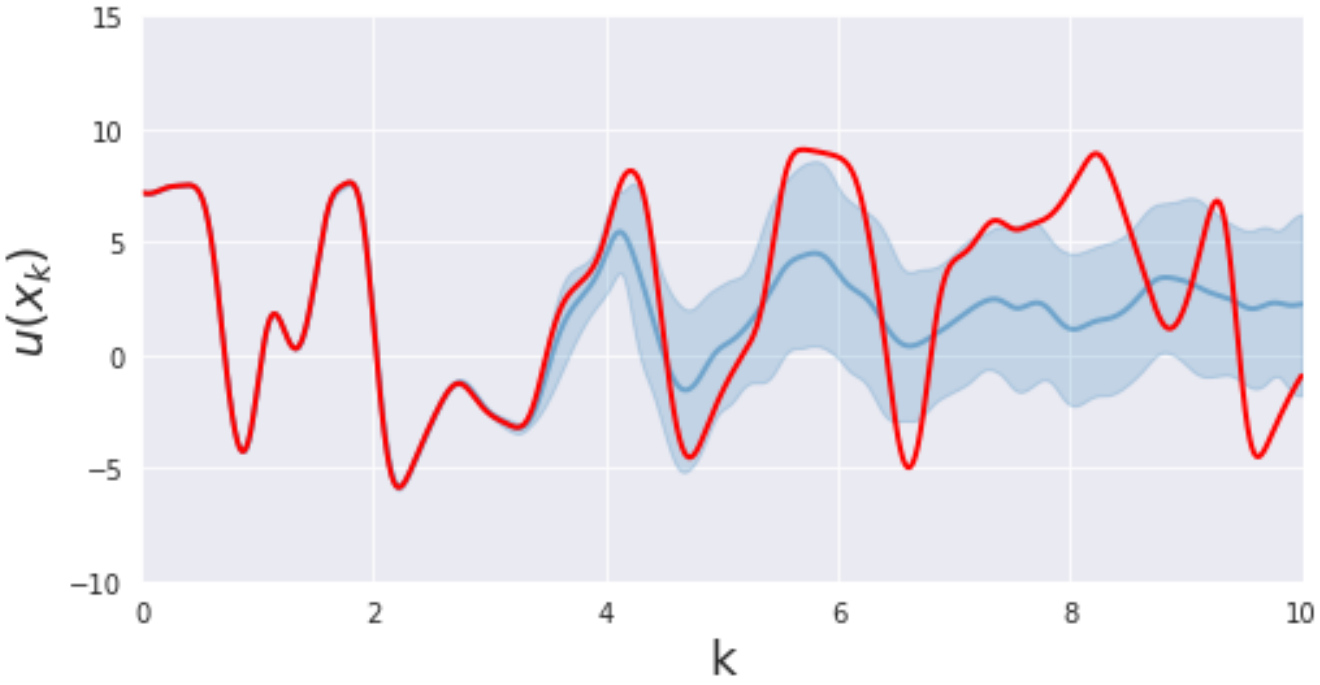




Lorenz 96



Lorenz 96



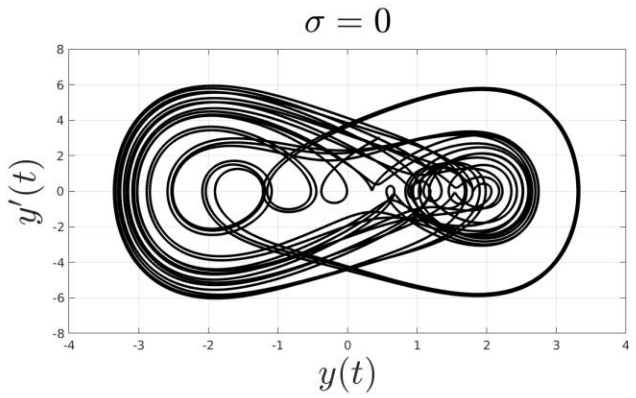
Lorenz 96

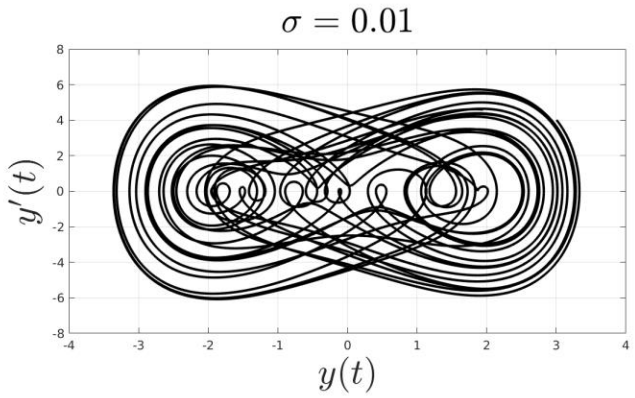
Duffing's Equation

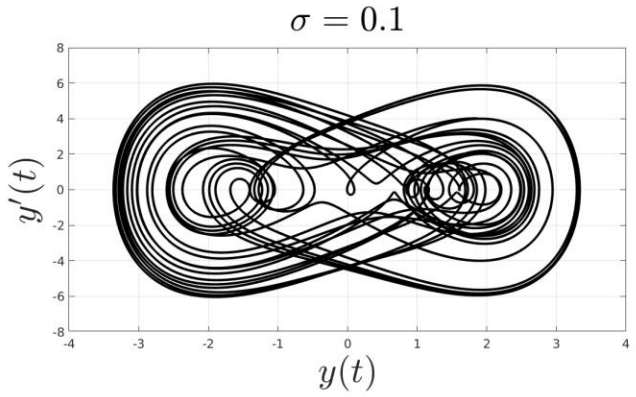
- Non-linear second order differential equation
- Damped and Driven oscillators

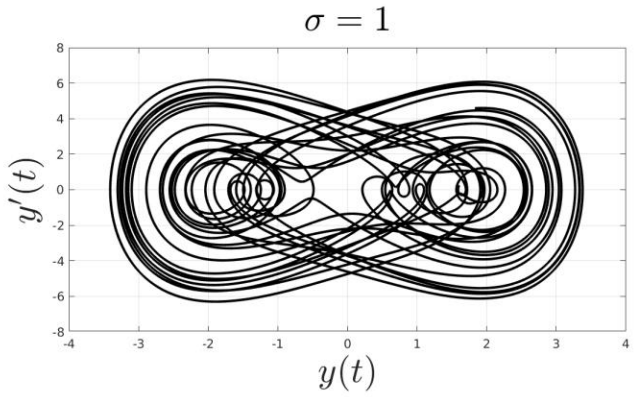
$$x'' + \delta x' + \alpha x + \beta x^3 = \gamma \cos(wt)$$

Duffing's Equation



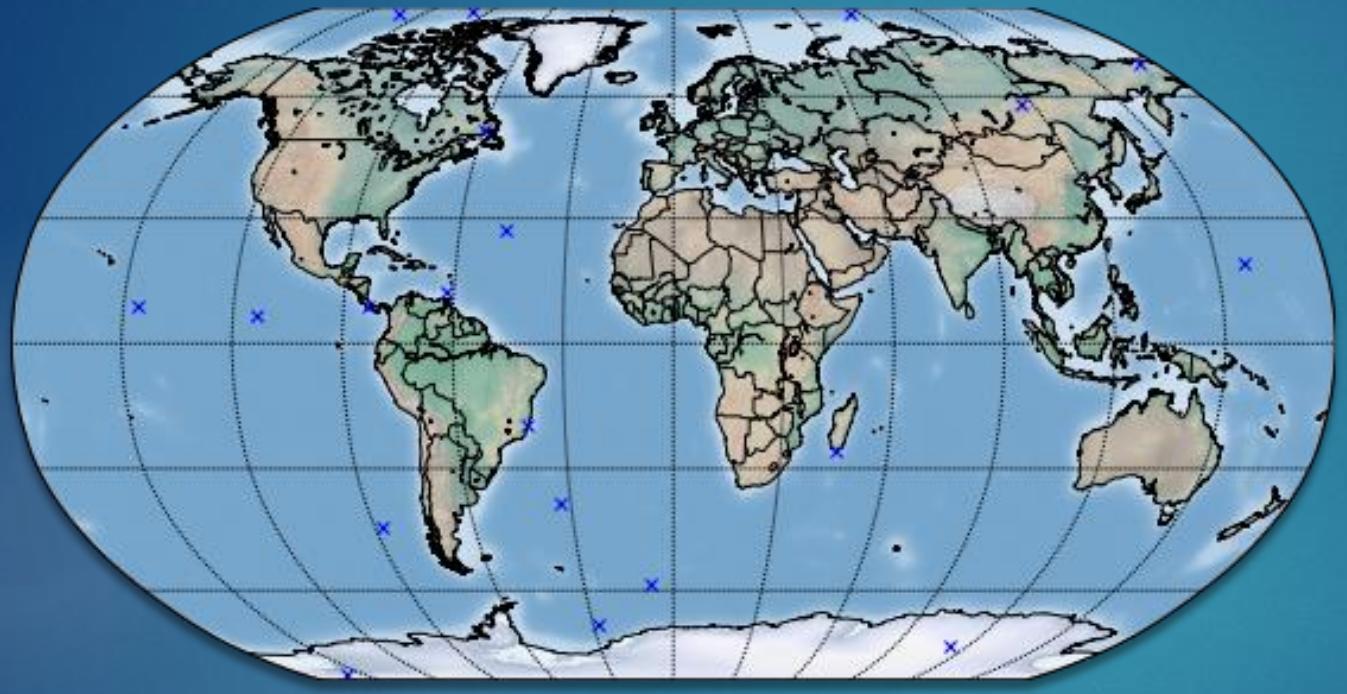






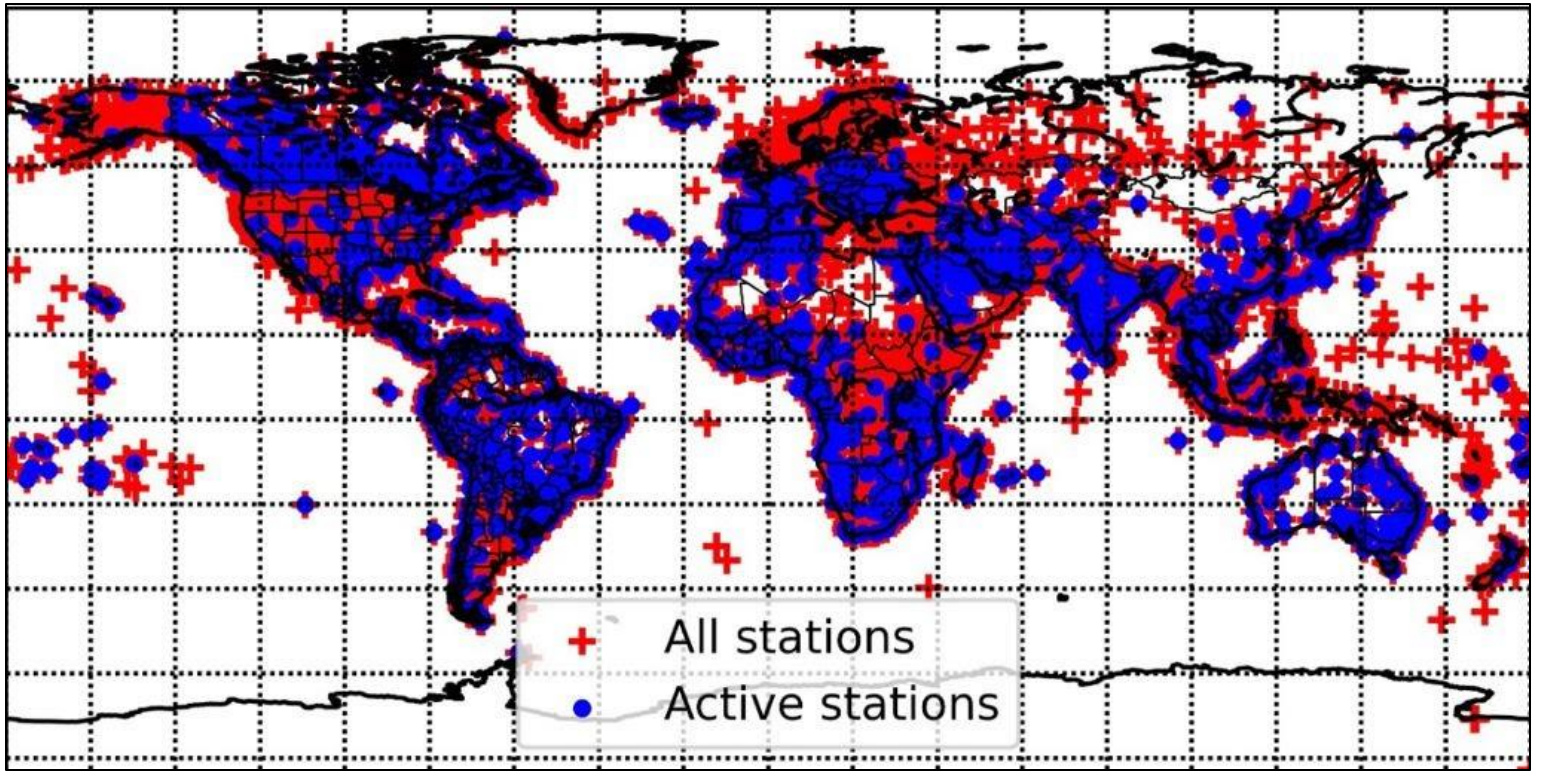
Forecasts

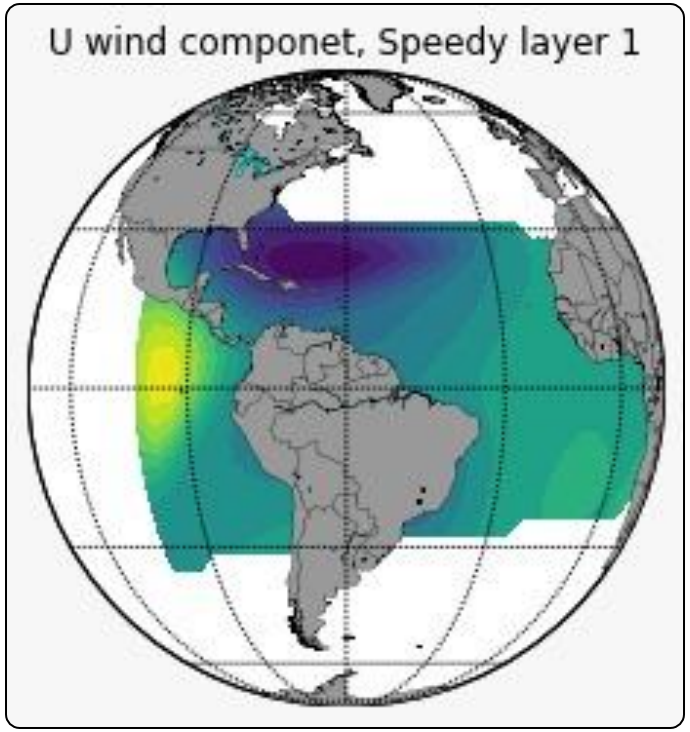
- Uncertainty
- Small errors are amplified
- Initial condition
- Computational cost
- Physics simplifications
- Understanding
- Discretization

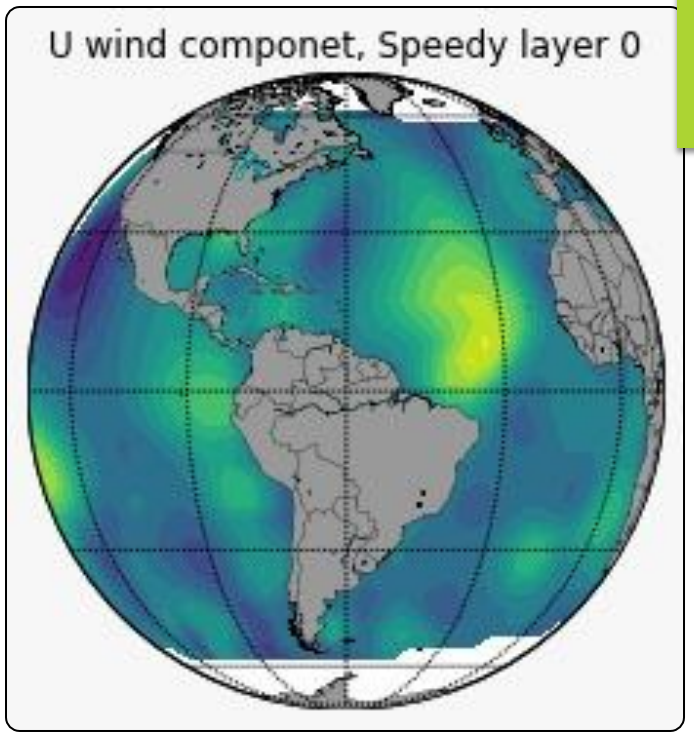


Are observations enough?

OGIMET Network







Machine Learning – Spatial Coverage

Observations

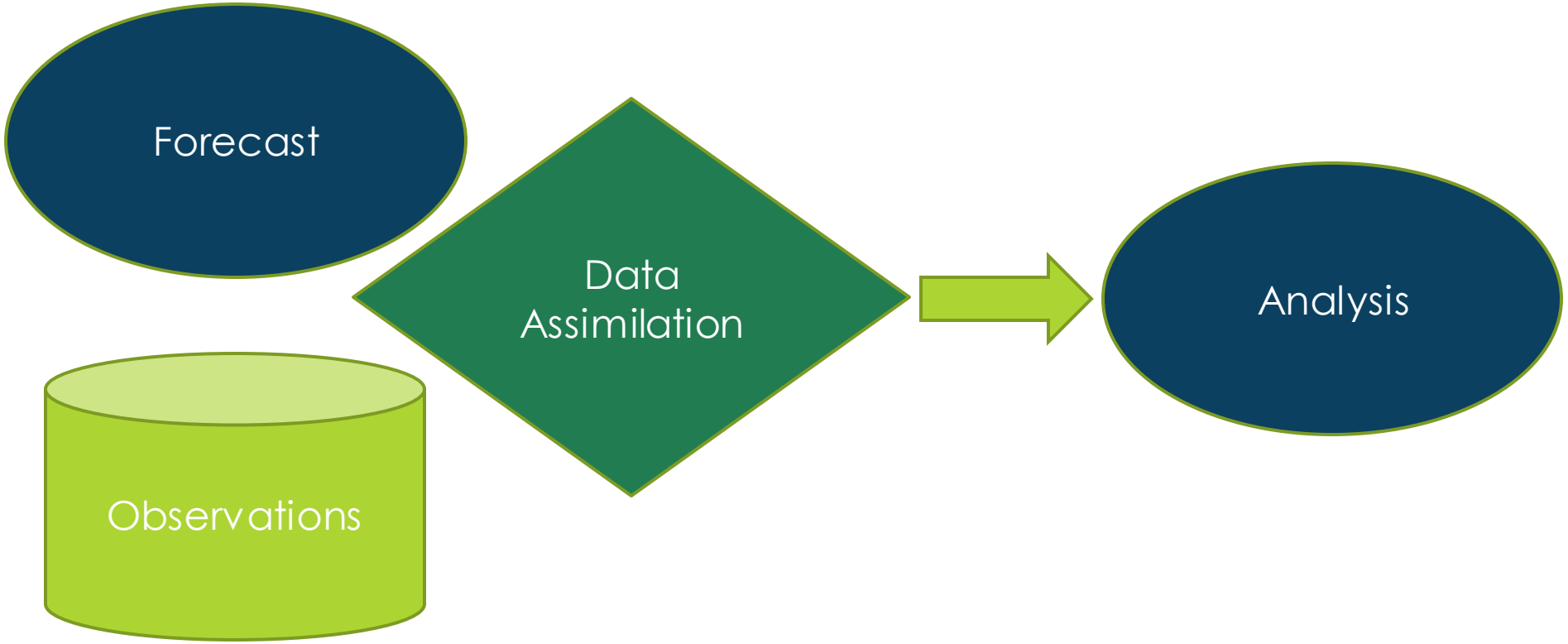
Sparse observational networks

Error estimation

Extrapolation (forecasting)

Can we combine both sources of information?

Sequential Data Assimilation



Errors

Background

Observation

Analysis

Topics

Background