InTheArt : a discussion group *(started ~1 year ago)*

about ***Art***ificial ***In***telligence

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Context

Various topics discussed within the group, from Physics to Biology

- IA used in many different topics :
  - Genomics:
    - Classical approach: statistical association between each unique variation of the genome and the disease
    - Human genome: 3 billion nucleotides, 3 billion potential variations + epigenetic factors
    - Today: poorly correlated results with the observation of familial transmission of some diseases
  - Climate (some examples presented in the following slides)
  - Detector

Idea of the group: share the knowledge, discuss and work together, through and open group.
Not only CEA people, your participation is more than welcome !

Participation from : CEA (DEN, DRT, DRF-IRFU and CNRGH), CEA-CNRS (IPhT, Neurospin, LSCE) and Paris-Sud university

Some grants from CEA-DRF

Goals:

→ **Organization of seminars** aiming at helping to understand the different "theoretical" problems in AI. And allow the exchange and the definition of a common language in order to solve them.

→ **In a second step, apply this knowledge to some particular problems** (genomics, climate)

Seminar

Edith Le Floch – CNRGH – Nov. 2017
Can we predict the phenotype of an individual from DNA ?

Özgur Sahin – IRFU – Jan. 2018
Machine learning technics at the LHC experiment

Davide Feranda – LSCE – Avr. 2018
New dynamical systems tools to study atmospheric flows

David Rousseau – LAL – Mai 2018
Advances in Machine learning in High Energy Physics

Etienne Thevenot – LIST – Juil. 2018
Omics data processing and analysis for high-throughput phenotyping

Michalis Vazirgiannis, DASCIM, Ecole Polytechnique – Sep. 2018
Graph Degeneracy for social nets and text mining

Jacques-Henri Sublemontier – Iramis – Nov. 2018
Locality-Sensitive hashing indexing schemes for metagenomics data

Adnane Hamid – IRFU – Feb. 2019
Machine Learning for climate prediction

Themes:

- Biology, medical app
- Machine Learning, computing
- Mathematic
- Others applications
- Chemistry
- Physics

Working group

About 60 persons from

- LSCE, CNRGH, IRFU
- DEN, DRT
- Paris-Sud university, etc.

- Roadmap:
  - Pedagogic presentation
  - Seminars
  - Research project
  - Training

- **Training**
  - For internship persons from LSCE and IRFU
  - Machine Learning technics for cahotics system

- **PhD thesis proposition**
  - Artificial Intelligence for a gamma-detector for high resolution PET imaging
    (dir. V. Sharyy, IRFU)

- **Web site:**

https://indico.in2p3.fr/event/17858/page/1967-intheart

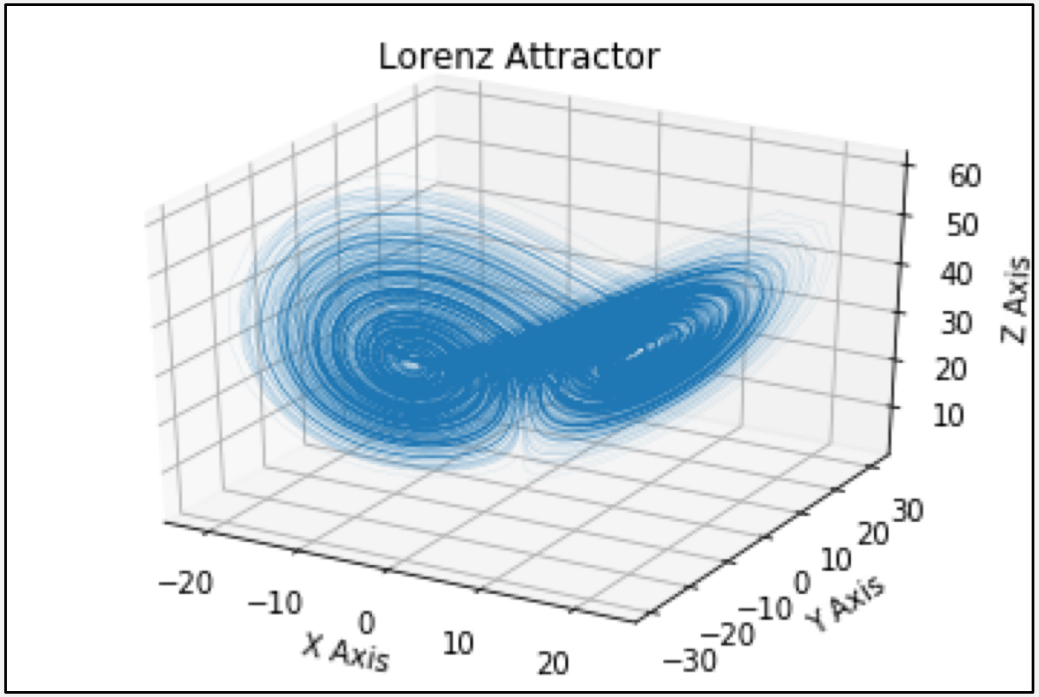
Use case

Prediction for chaotic systems

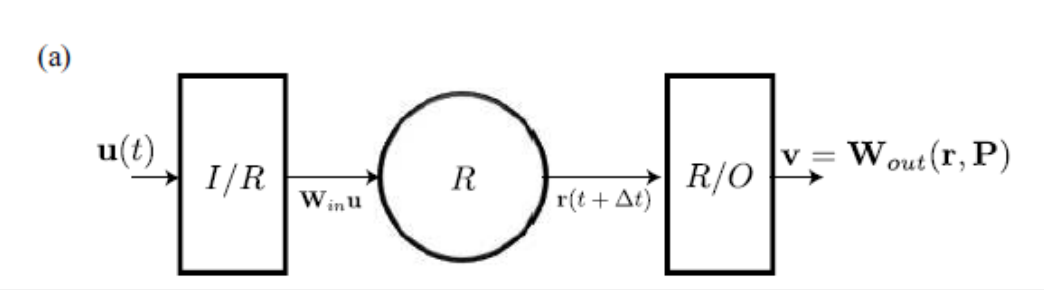
Original paper from Pathak et al., 2017

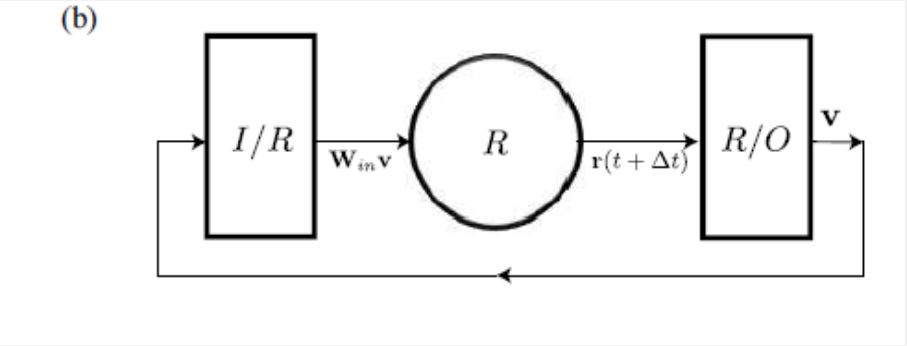
- **Predict the weather and characterize climate**
  - Many data recorded, but with some measurement errors
  - High sensitivity to initial conditions
  - Contribution of Machine Learning ?
  - Test on convective cells
  - Lorenz attractor: atmospheric Toy Model

- **(Re)find the published paper results**
  - Using Machine Learning technics



Method: Reservoir computing





$$\mathbf{r}(t+\Delta t) = \tanh[\mathbf{A}\mathbf{r}(t) + \mathbf{W}_{in}\mathbf{u}(t)]$$

Recurrent neural network

- A: adjacency matrix randomly generated. Weights the neurons graph.
- r(t): the states vector at time t. Represents the state of each neuron.
- W_{in}(matrix): weighting the effects of the inputs on the state.
- u(t): input at time t, here the real position at time t.
- v(t): the output at time t, which is the estimation of the position at time t.

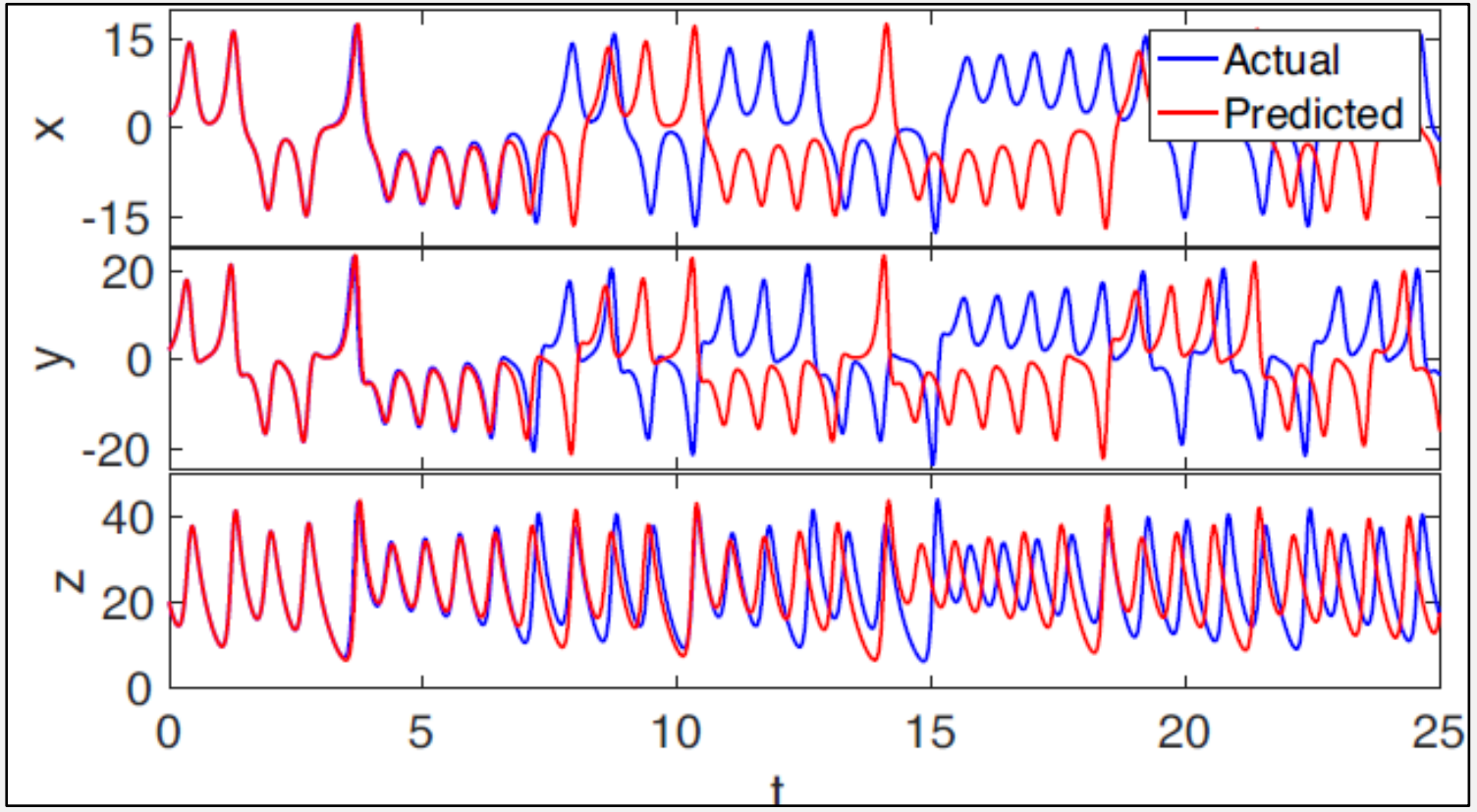
Use case

Results from original paper

Convection

Temperature

Symmetry



(days)

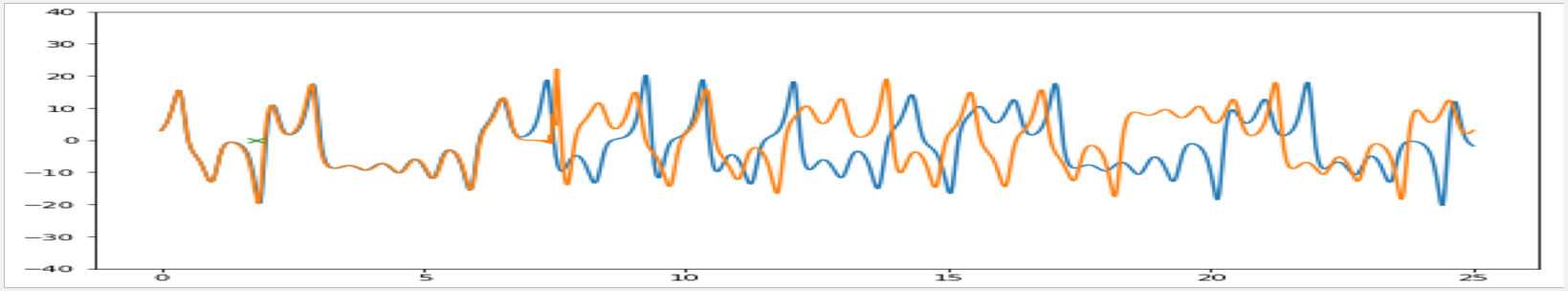
Thanks to the reservoir computing, trajectory approximation of the Lorenz detector

Source: Pathak et al 2017.

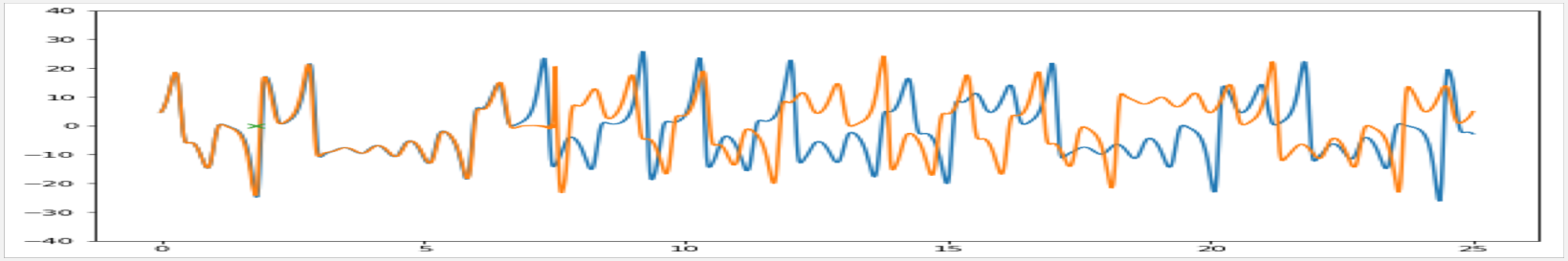
Use case

Results obtained with ML technics

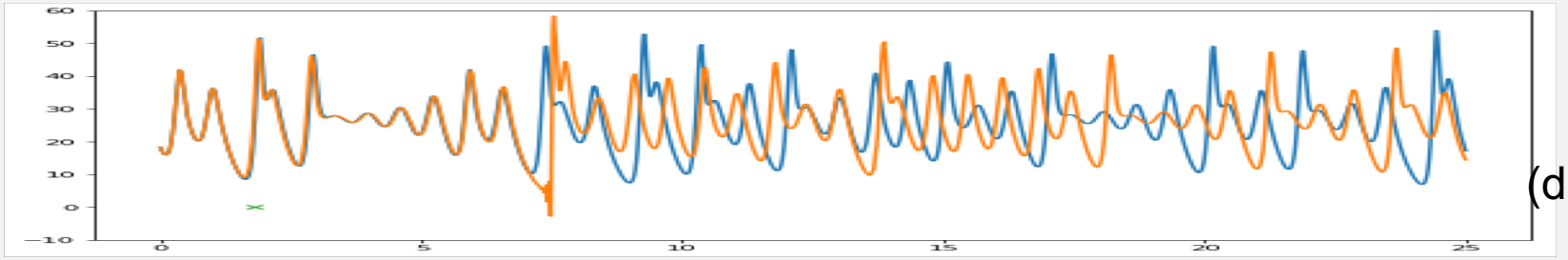
Convection



Temperature



Symmetry



(days)

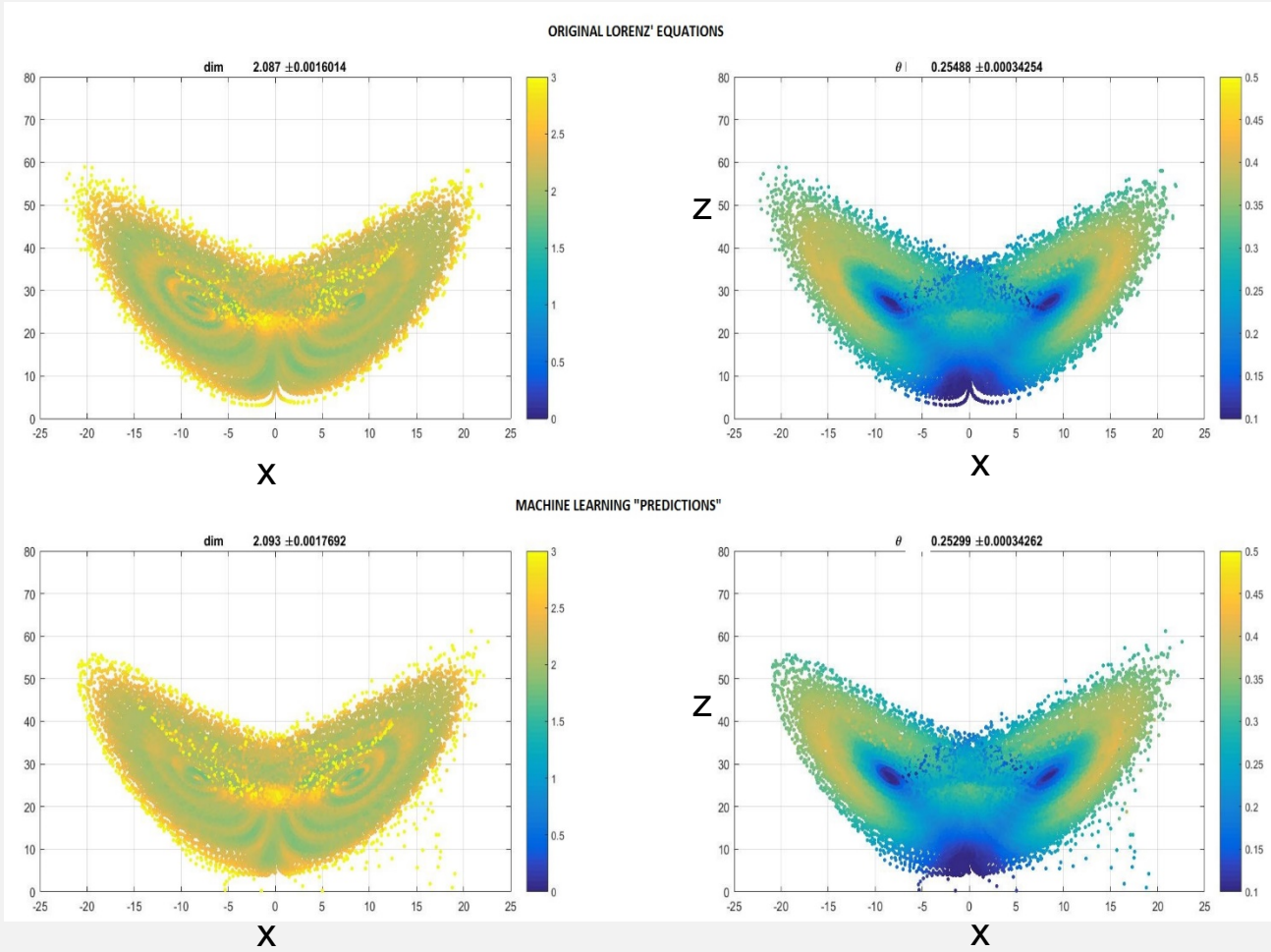
Use case

Long term behaviour:

Neural network running several steps after going away from the “real” trajectory

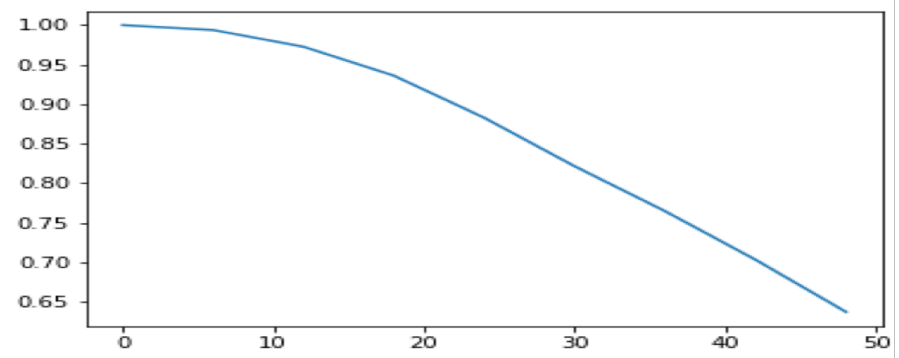
Coherent trajectory observed for X and Z variables

Could we predict long term climatic behavior using Machine Learning ?



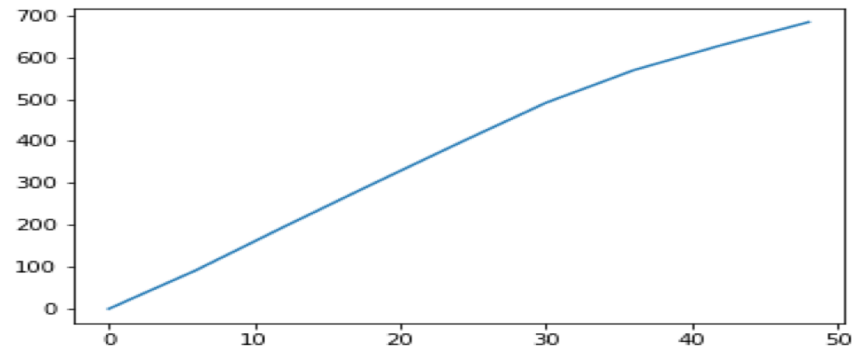
Pressure only

Spatial correlation



Hours

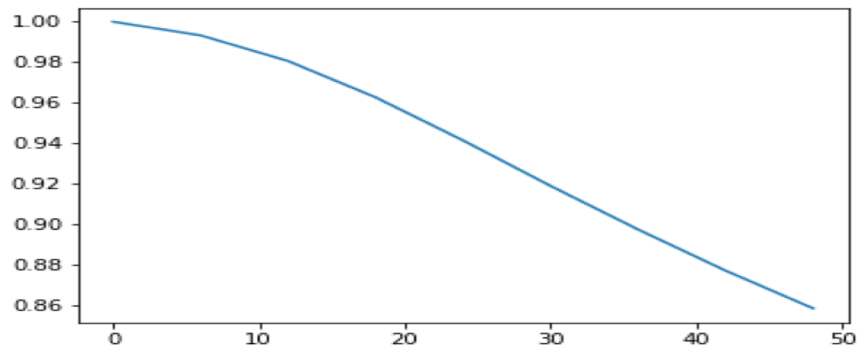
Rmse



Hours

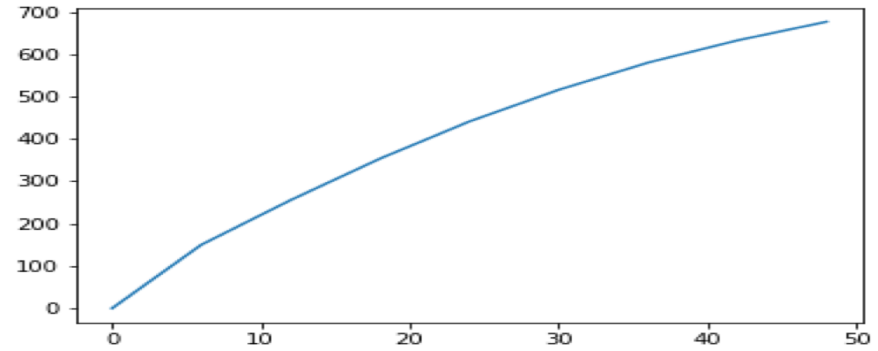
Pressure + temperature

Spatial correlation



Hours

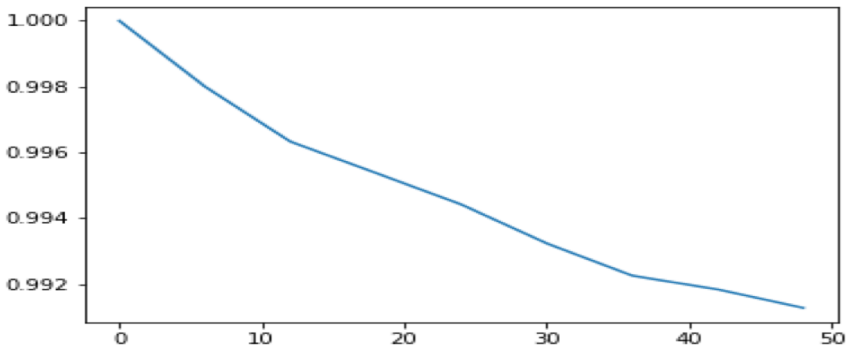
Rmse



Hours

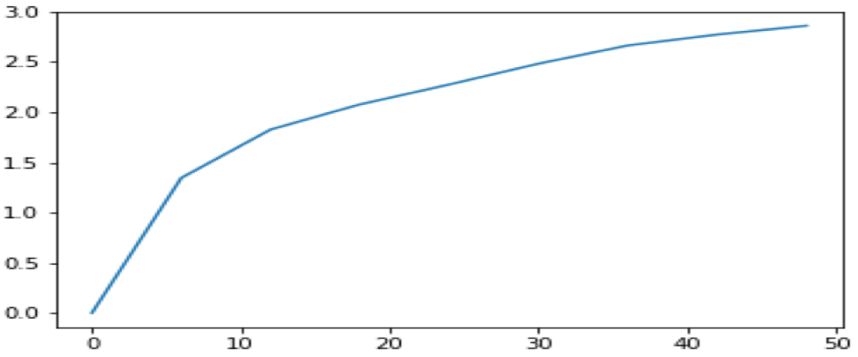
Temperature only

Spatial correlation



Hours

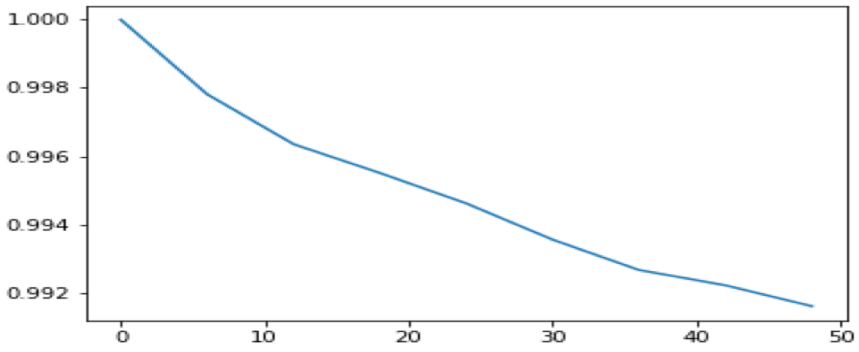
Rmse



Hours

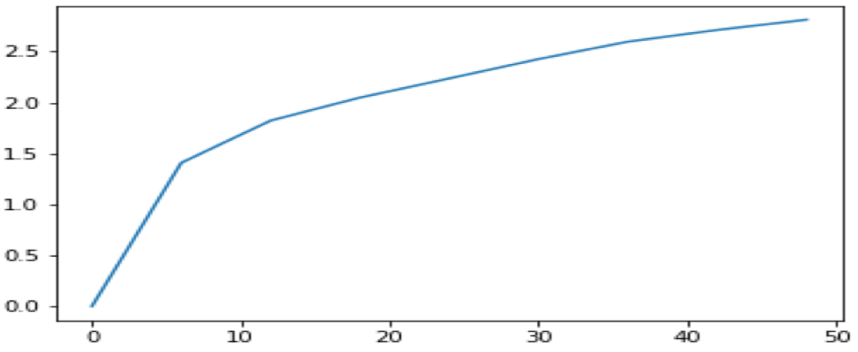
Pressure + temperature

Spatial correlation



Hours

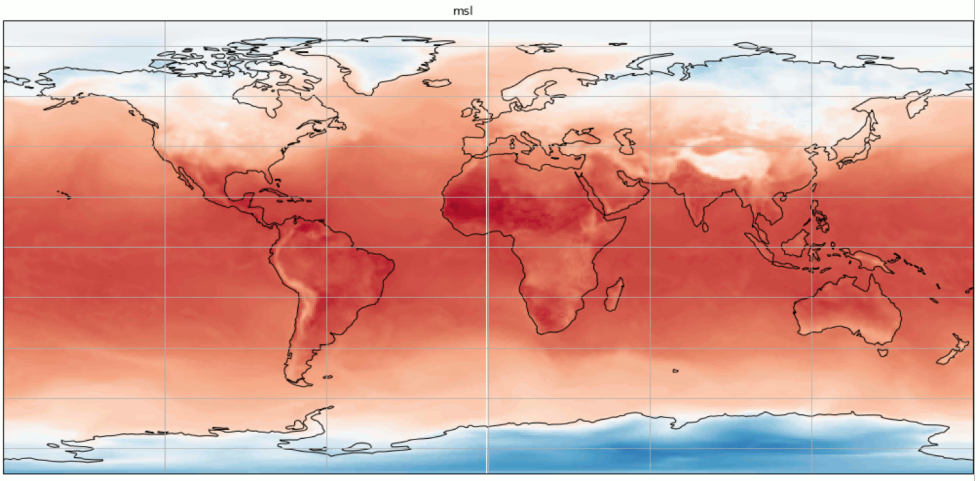
Rmse



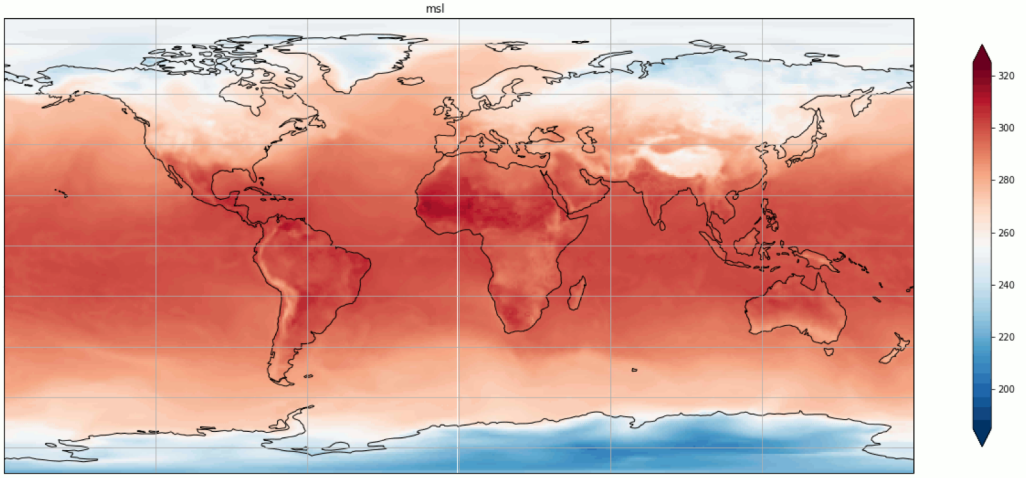
Hours

Temperature prediction

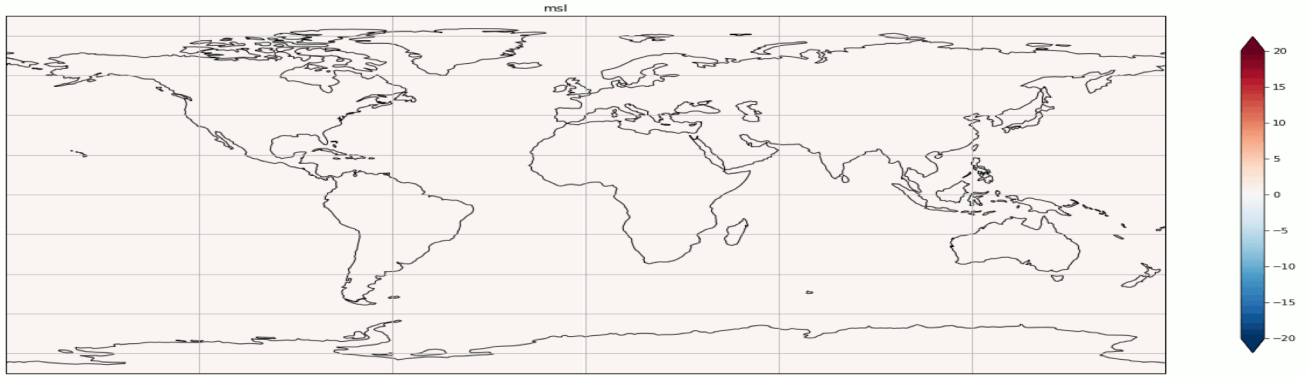
Target



Prediction



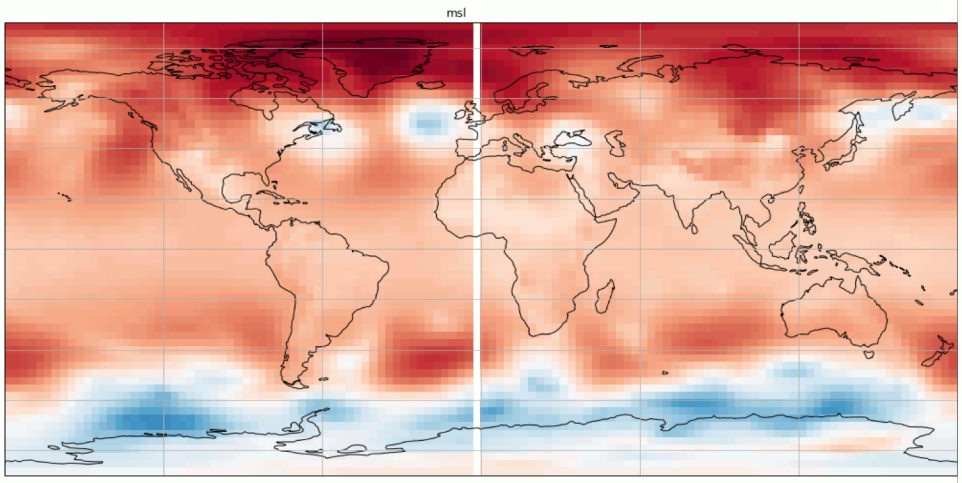
Difference: Prediction - Target



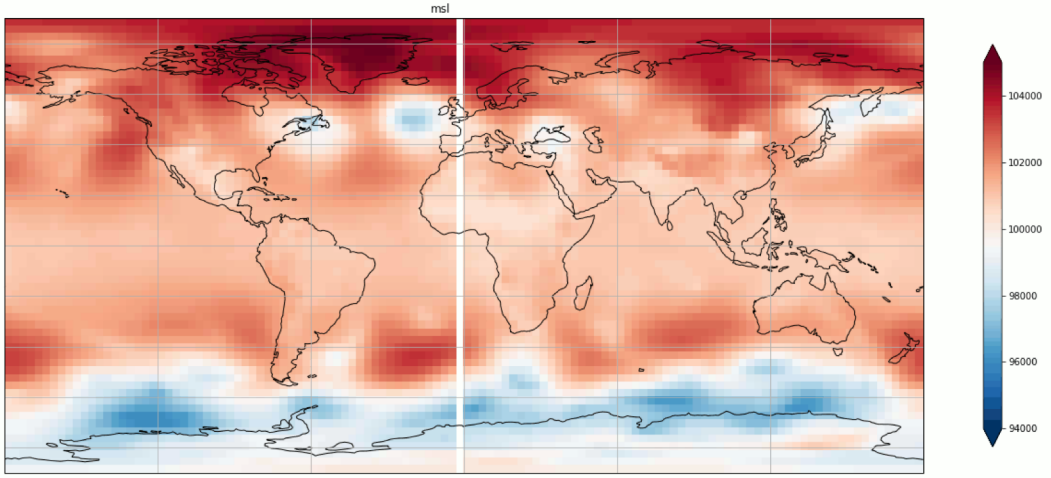
Unit: Kelvins
Duration: 5 days
Data: Temperature

Pressure evolution

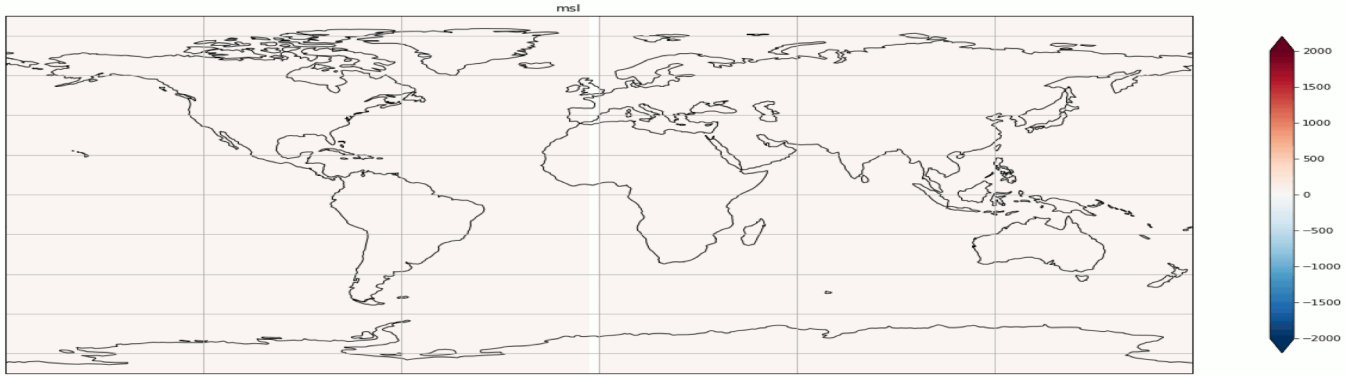
Target



Prediction



Difference: Prediction - Target



Unit: Pascals
Duration: 48h
Data: Pressure

Conclusion

- A motivated and active group from CEA, CNRS and Paris-Sud university
- You are welcome to participate to the group. Contact us !
  (to be in our mailing list, please send an email to: valerie.gautard@cea.fr)
- Study of different “use case”
- Try to attract and develop the group on complementary activities:
  - Involvement of geneticists, mathematicians, statisticians, physicists *but lack of chemists and biologists*
- Web site: *https://indico.in2p3.fr/event/17858/page/1967-intheart*