ML4LM project introduction & prospectives

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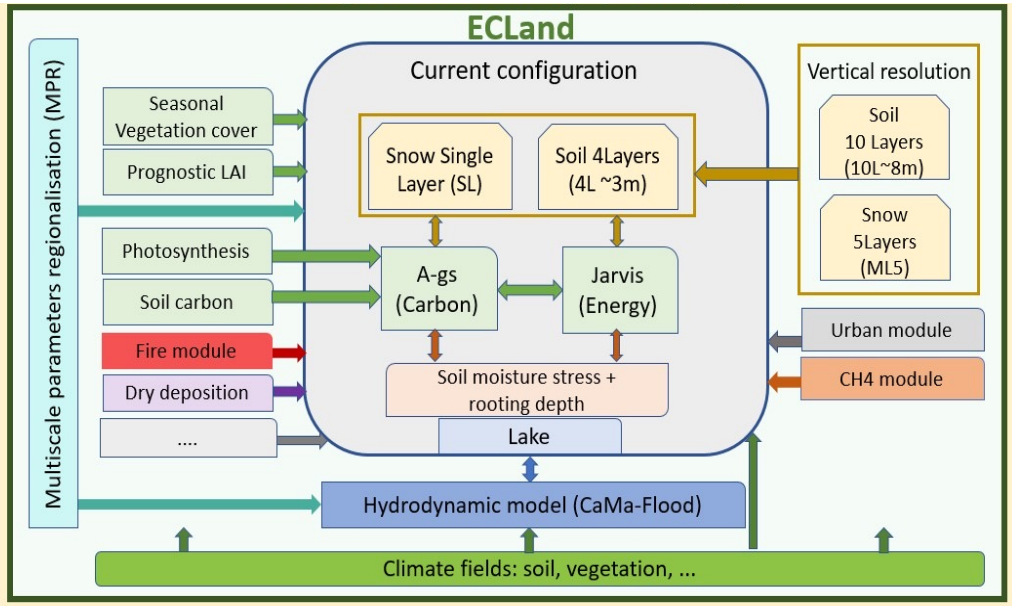
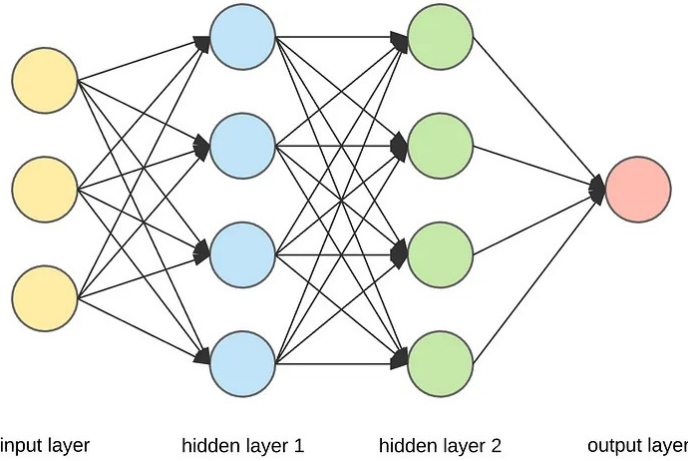
GLASS GEWEX / Land - Atmosphere System Studies

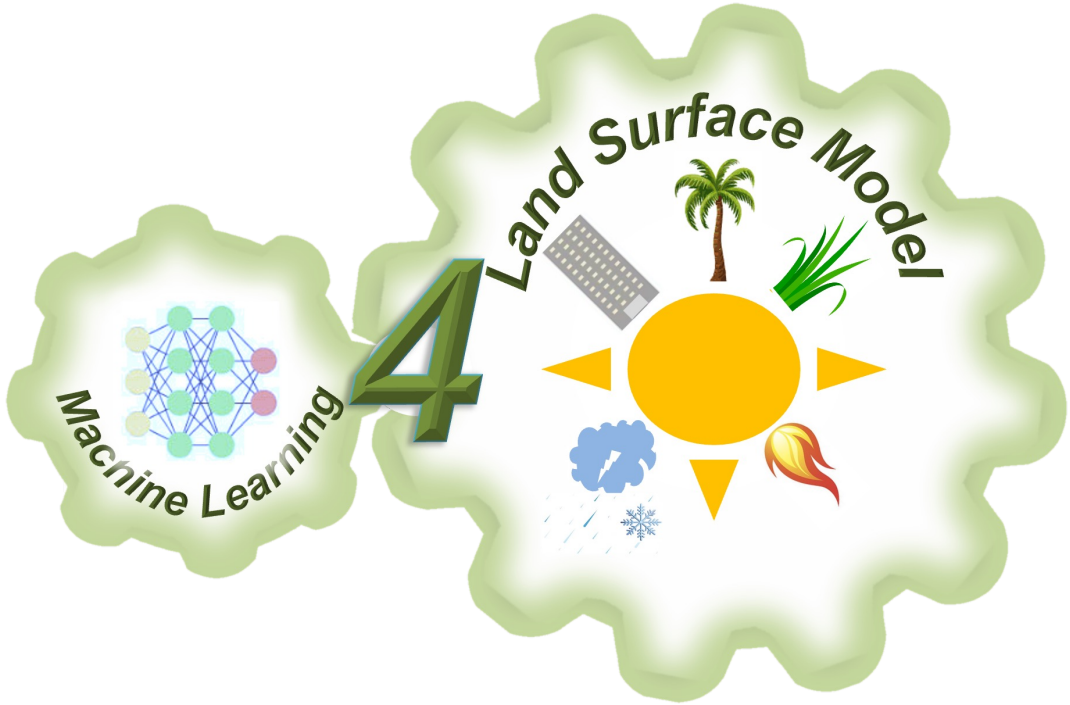
Combining the gears for efficient and safe driving

Land surface model/processes



Machine Learning





Is it inclusion or complementarity ?

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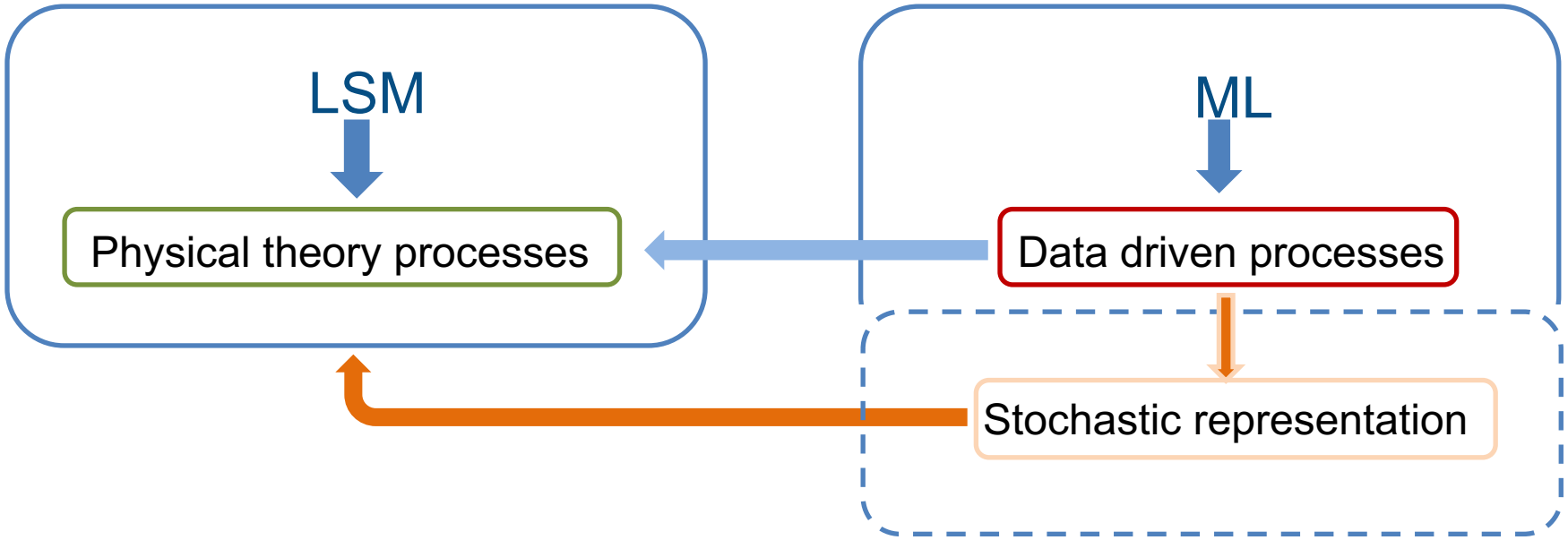
Are we really drifting from the physics?



Identifying **Where** and **How** ML can be used **for/with** land model to improve predictability

- Model optimization
- Model/sub-models/modules emulation
- Combined approach can foster process understanding (Observations are not always representatives of subprocesses)

==>link with:

  - very high resolution and related unresolved heterogeneity
  - Anthropogenic related processes (which are very complex to represent in physic-based way)

- Model Evaluation
- Links with Data Assimilation and Obs data integration

Challenges with ML for/with land model

- Data availability and accounting for data uncertainties
- Focus on ML-Land model as LSM within climate/NWP model vs focus on ML-Land model as application driven model (hydrology, flood/drought, agriculture/crops, deforestation/LU, CO2, Fire, Urban...) Which approach to go for? Both?
- Seamlessness in space (including resolution challenges) and time (from climate projection to sub/seasonal to short range forecasts)
- Handling Extremes

==> depend on data availability /physic hypothesis

  - Use of ML for "standard" case + use of physical theory to handle special/extreme cases
  - Use of fully ML trained model
  - Used of physical-constrained ML

- Better Physical interpretation of ML predictor/outputs
- Computational cost + new infrastructures

Project prospective activities?

- **Recommendations on uses and challenges for LM4LM**
- **Interaction with other Earth system groups/projects** (Institutions, GEWEX panels and others)

Pilots/cases studies

Which:

- Physical processes
- ML methods
- Target (time/space resolutions, extremes...)
- Configuration
- Data
- Prospective groups

Inventory of Data for emulation

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ML4LM-MIP ?

Need definition of:

- Focus/science question
- Configuration
- Data
- Prospective groups
- ...

White Paper Topics

- Model calibration/postprocessing
- Model/sub-models/modules emulation
- Extremes and long-range handling …..

Regular webinars

That would tackle:

- Potential improvable aspects of LSMs
- Suitable ML techniques for LSMs with pro/con
- Success and failures examples for different ML-LM applications

(Aiming at 1 webinar per month for 2025)

Workshops &conferences

- GEWEX OSC 2024
- **"Ancillary" data workshop as part of the 50th ECMWF anniversary (April 2025)**

ML4LM Working group

Gab Abramowitz	Climate Change Research Centre at UNSW , Sydney, Australia
Andrew Bennett	Hydrology & Atmospheric Sciences, University of Arizona, Tucson, United States
Mariana Clare	Model uncertainty and ML, ECMWF
Alan Geer	Data assimilation and MW Observations , ECMWF
Pierre Gentine	Learning the Earth with Artificial intelligence and Physics (LEAP), Columbia University, US
Paula Harder	Mila Quebec AI Institute, Canada
Marouane Temimi	Stevens Institute of Technology, New York, New York, United States
Kun Yang	Department of Earth System Science, Tsinghua University, China
Bianca Zadrozny	Spatiotemporal Modeling at IBM, Rio de Janeiro Brazil
Souhail Boussetta (lead)	Land surface modelling and L-A coupling, ECMWF