How can Machine Learning algorithms be used to develop innovative climate service products?

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GERICS offers in a scientifically sound manner products, advisory services and decision-relevant information in order to support government, administration and business in their efforts to adapt to climate change.
GERICS: Product development

with need for adaptation

tailored for user requirements
**Example: Climate Fact Sheets**

Concise climate characteristics of individual countries or regions

**Current climate**

- General mean values taken from literature and available observations
- Major climate zones (see climate diagrams: C21, 3)
- Geographical setting

**Historical climate trends**

- Observed warming
- Projected changes in mean temperature
- Increased precipitation
- Decreased snowfall

**Summary of projected future climate**

- The major patterns of climate change are expected to continue in the next 50 years
- Increased temperature and precipitation
- Decreased snowfall

**Available on request:**

www.climate-service-center.de/climate-fact-sheets

**Example-pages from CFS: Burkina Faso – Togo – Ghana**
**Data & data analysis**

**Climate model data:**
- Period 1950 to 2100, different emission scenarios
- >70 global climate model simulations (CMIP3/CMIP5)
- >50 regional climate model simulations for Europe

**Data size:**
- RCMs for globe (CORDEX-CORE):
  - ~1.5 PB in total for one regional climate model
  - ~1.5 TB for one climate variable (e.g. 2m Temp)
Data & data analysis

Data analysis:

- Statistical tools from standard (e.g. regression, sig. test) to more complex methods (e.g. cluster analysis)
  - Quicker methods & detection of extremes
  - Computation of complex indices (e.g. drought indices)
    - Improved indices for sectoral prediction of vulnerability
- Future development: sectorial models using additional datasets (e.g. flood risk models, biol. models)
  - Taking advantage of new large datasets
  - Going beyond to physical data & modeling
Example: ML in climate service for flood risk modeling

Aim:
- Compute damage function from storm surges

Opportunities:
- Using a range of additional datasets
- Possible new scientific insight

Going from:
Damage Function = f(water depth)

DF = f(water depth, warning time, waves height, …..)

Aim:
- Compute damage function from storm surges

Opportunities:
- Using a range of additional datasets
- Possible new scientific insight
Challenges: Sample Bias Problem

3-minute gust speeds in Typhoon Haiyan versus other cyclones (Philippines)

From: Wagenaar et al. resubmitted, Risk Analysis

Source: NASA
Example: ML in climate service for health

Aim:
- Impact of future heatwaves on human health

Opportunities:
- Large amount of data from different sources available

Challenges:
- Complex interactions between health, society, environment and climate
  - What are appropriate ML tools to tackle this problem?
  - Quality of the different datasets needs to be tested!
  - New workflow for data provision and analysis

Exploring ML methods in joint project of GERICS and Helmholtz Zentrum München (HMGU)

DIGITAL EARTH
Summary: Opportunities, Challenges and Risks for climate services

Opportunities
- Exploiting large climate model and sectoral datasets
- Integration of physical climate data with socio-economic data
- New innovative products using ML in addition to existing “standard” methods
- New scientific insights possible

Challenges
- Quality of heterogeneous input data from different sources
- Quality assessment of products based on ML methods
- Incorporate appropriate ML method in established workflow

Risks
- Incorrect use of ML methods might degrade products

need for transdisciplinary collaboration, e.g. climate science, data science, health etc.