Challenges in the road toward better FAIR support in downstream climate products

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I Impacts of Climate Change

2021 Germany Erftstadt, southwest of Cologne

2020 Hurricane Delta causes damage to Louisiana's Gulf Coast

- Urgent needs of impact assessments
- Identify mitigation/adaptation solutions
- Extreme events attribution
- Multiple domains: infrastructures, urban, agriculture, transportation, etc.
- Flexible tools needed for very diverse users

II Why Standards?

- Facilitate exchange of climate data
- Develop common tools
- Automate data processing
- Define precisely each variable and concept

- **Standards for what?**
  - Climate Data: model and products
  - Software: mostly data processing tools
- **Most Relevant RDA WG and IG**
  - FAIR Digital Object Fabric IG
  - FAIR for Research Software (FAIR4RS) WG
  - FAIR for Virtual Research Environments WG
  - Long tail of research data IG

III Existing Standards

- World Climate Research Programme (WCRP)/Working Group on Coupled Modeling (WGCM) establishes standards for climate modeling data exchange
- Coupled Model Intercomparison Project (CMIP): better understand past, present and future climate changes
- CMIP6 Data Request: defines all quantities from CMIP6 simulations that should be archived
- Also CMIP5, CMIP3, CORDEX, etc.
- Common Data File Format: NetCDF
- Common Metdata Conventions: CF Metadata Convention (CF: Climate and Forecast)

IV Climate indices & indicators

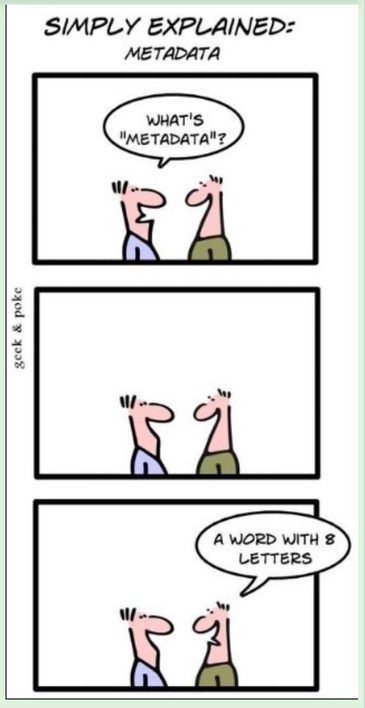
- Downstream climate products: climate indices and indicators
- Number of Summer Days, Number of Dry Days, Maximum consecutive wet days, etc.
- Several software: icclim, xclim, climpact, CDO
- **icclim**: open-source python package developed at Cerfacs
- Extension of CMIP Data Request and CF-Convention to climate indices and indicators: clix-meta
- Goals for climate indices and indicators
  - Have proper metadata description
  - Agree on definitions and units
  - Generate useful provenance and lineage when calculating

V FAIR Compliance

- Are climate indices data products FAIR?
- *Findable*
  - CF-Convention: ✅
  - Metadata for climate indices: 🚧
  - PID/DOI: 🚧
- *Accessible*
  - Yes if stored in open-data repositories
- *Interoperable*
  - Definitions should be harmonized or mapped to sectorial standards
- *Reusable*
  - Lots of work to do: proper provenance (W3C PROV-O) and lineage is needed

VI Next Steps

- Finalize current identified metadata needs in clix-meta
- Establish a provenance and lineage model based on W3C PROV-O
- Implement clix-meta and provenance in major climate indices software
- Coordinate with Stakeholders (scientific and institutional, e.g. IPCC TG-Data) using climate data, on FAIR practices for metadata, software in official reports.
- Extend clix-meta to climate sectorial indicators



IS-ENES: https://is.enes.org/ icclim 5.x: https://github.com/cerfacs-globc/icclim (`pip install icclim`) clix-meta: https://github.com/clix-meta/clix-meta

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