Open Source for Climate

Focus on WITNESS Integrated Assessment Model and health related aspects included

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Matthieu Meaux
Thierry Chevalier
Marie Morere
Valentin Joncquières
Linux Foundation Open Source for Climate (OS-Climate or OS-C)

Applying the community-based open-source approach that has enabled breakthroughs in Life Sciences & Tech to solve data & analytics challenges required for investment to achieve Paris Climate Accord goals

**OPEN SOURCE COMMUNITY**
- Governance, licensing, and collaboration structures enabling stakeholders to share cost, intellectual property, and effort.
- Joint projects for new data, modelling, standards, and supporting technology

**COMMONS**
- Curated library of public and private sources, for both transition and physical risk/opportunity
- More accurate corporate historical and forward-looking climate & ESG metrics as a public good

**GLOBAL DATA ANALYTIC TOOLS**
- Integrate climate-related risk and opportunity into decisions by investors, financial institutions, regulators, etc.
- Top-down and bottom-up modelling
- Scenario analysis tools
- Alignment tools

Visit [www.os-climate.org](http://www.os-climate.org) for more information
OS-Climate architecture overview

GOVERNING BOARD
OUTREACH LEGAL BUDGET

TECHNICAL ADVISORY COUNCIL

DATA COMMONS
Technical Steering Committee
SERIES LLC
DEV & DATA COMMUNITY

PORTFOLIO ANALYSIS
Technical Steering Committee
SERIES LLC
DEV & DATA COMMUNITY

PHYSICAL RISK & RESILIENCE
Technical Steering Committee
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DEV & DATA COMMUNITY

TRANSITION ANALYSIS
Technical Steering Committee
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DEV & DATA COMMUNITY

OS-C Technology Architecture

Public & Private Un-Groomed Data
DB Snapshots, FTP, fileshare

Public & Private Groomed Data
SOAP, REST APIDs

Prioritization & Prep
Unstructured Public Data
NLP, Scraping

OS-C Model running on virtual private machine in private cloud

OS-C Code integrated in 3rd party products & services

Physical Economic Models

Common APIs to feed inputs and model outputs into other models

- Smaller datasets
- Model outputs
- Simple analytic apps
- Common Scenarios
- Project Planning
Transition challenge

Inconsistent reports
on climate & energy transition risks / potential actions

Inconsistent opinions
on why reports reach different conclusions

No consensual strategy to overcome transition
due to inability to build a constructive analysis of differences as reports are in nature not reproducible, hard to audit, and might incur many conscious/unconscious biases/errors

Inconsistent actions and policies
that ultimately fail to address transition efficiently and make future highly unpredictable for anyone
Largely accepted and followed pre-competitive strategy leading to consistent actions & policies that ultimately efficiently tackle transition and make range of possible futures more predictable for everyone and efficiently associated manage risks.

"Coopetitive" elaboration of transition strategies between ecosystem actors at various level thanks to open, cooperative, transparent, reproducible multi-scenario analyses improve transition assumptions, impacts and dynamic knowledge.

Critical mass of actors sharing strategies for sustainable paths to overcome transition.

Open source transition analysis tool Open, transparent, collaborative multi-scenario tool allowing shared analyses.
Transition threat to economy growth

IHS, IEA and IPCC GDP assumptions are not reliable in the energy transition context. ‘Black box’ reports discrepancies & doubtful assumptions do not favor actors alignment...

WITNESS is coupling Energy and Economy in a new & disruptive way to better analyse transition scenarios.

IHS inputs are also out of range predicting even more growth.

WITNESS is evaluating possible energy mix that can be reached depending on energy & emissions.
**Transition threat to human survivability in large areas**

Critical environmental limit for humans
(source theconversation.com mentioning PSU H.E.A.T. project results)

Varanasi (India) June 22, 2022 – around 2PM
Temperature **102°F**, Dew point **82°F**
giving a relative humidity ~**50%**
(source WeatherSpark, then using Magnus formula)

3,6M+ people in Varanasi district
~200M people in Uttar Pradesh
(2011 data – source Wikipedia)

Do we wait for a massive 100M+ death event
likely to come in the next years?

This map shows zones where extreme air temperature and extreme humidity occurred during a short period (0.1% of maximum hottest daily temperatures) from 1979 and 2017. Darkest colors show most critical combination of extreme air temperature and humidity.

Map published by NOAA. Data: Radley Horton & al

This chart translates combinations of air temperature and relative humidity into critical environmental limits, above which core body temperature rises. The border between the yellow and red areas represents the average critical environmental limit for young men and women at minimal activity. (W. Larry Kenney, CC BY-ND)
World environmental Impact and Economics Scenarios (WITNESS)

How most IAMs work

- Gross Domestic Product depends on capital, labour and net energy output
- Need to have a population model to properly create world scenarios (as in World3 model)
- Access to net energy production to properly feed production function
- Earth is a finite system with many resources limits reflected in the framework

Integrating most aspects of existing IAM's thanks to disruptive simulation platform allowing models automated coupling
Which IAM usage and for whom

Assumptions
- what modules or couplings are activated?
- what are the initial conditions?
- what are fixed evolutions vs what are optimized ones?
  (e.g. fixed Carbon tax vs optimized energy technologies investment)

Public institutions, Finance
- global world quantities available in traditional IAM's
  (e.g. GDP, T° raise, CO² concentration, climate damages…)

Private businesses, Industry
- specific quantities that are key to their business
  and not always available in classical IAM's
  (e.g. specific material availability,
   specific energy availability & price in possible mixes…)

Financial reference data
  Legal taxes & constraints

Generic consequences analysis
- specific but wide ranging impacts
  (e.g. Physical risks, PCAF…)

Cherrypicking & collecting data
  from different data sources
  according to selected assumptions,
  and building a configuration file of it

Trading description
  manual data inputs

Scenario configuration

Transition scenario(s)
  (see IAMC ref. card)

Computing one or several
  transition trajectories

Computing one or several
  transition trajectories

New strategic IAM's usage

Pre-competitive open-source part
  Transparent, shared, auditable, trusted

Competitive private part
  Specific to own assets/policies, blended with private data/code
Cooperative platform suited to transition "coopetition" needs
Providing additional confidence to boards, shareholders, authorities and citizens.
Population & health aspects poorly addressed in current IAM's

Exogenous or non-existing... e.g. diet
Looping effects through the rest of the IAM
Population in WITNESS

**Based on existing literature(*) with modifications**
- One year time step and population divided into one year age group
- Evolution of the population depends on birth rate, and death rate per 5 years age group
- More detailed 1 year age classes and level of education are considered

**Birth rate**
- Function of economics activity and a proxy for education
  in case of degrowth we will not retrieve past level of birth rate because of all the knowledge acquired
  (e.g. better access to contraception, higher level of education...)

**Death rate**
- Classic death rate: function of **economics activity** and a proxy for **education**
- Improved death rate: classic death rate + sum of **climate and nutrition** effect
- Key endemic diseases considered

**Key model strengths**
- Population dynamic fully considered
- Flexible model allowing fast modelling improvements

**Improvement required**
- Better model of labour productivity
- Model additional effects on both birth rate & death rates
- Only at global level, need to work on population distribution

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Demo focused on health
Possible developments: Advanced damage functions

Proposal of a damage function based on geo-spatial data (1/3)

建構當地資訊與全球溫度變化之間的關聯

結果模型

- 全球溫度變化（Local T）
- 風災發生次數（Global T）
- 极端天气发生次数（Global T）

提取自CMIP5或未来CMIP6
Possible developments: Advanced damage functions

Proposal of a damage function based on geo-spatial data (2/3)

Resulting models

- Local temperature change (Global T)
- Flooding occurrences (Global T)
- Extreme weather occurrences (Global T)

Use models with population distribution data

Use models with capital/Industrialization distribution data

Climate induced death model

Physical damage & loss model
Possible developments: Advanced damage functions

Proposal of a damage function based on geo-spatial data (3/3)

- Climate induced death model
- Human Labor impacted by climate change
- Capital loss due to climate change
- Physical damage & loss model

Macro-economics impacts with advanced damage functions

We are looking for financing of this initiative
**SoSTrades Model DevSecOps**

1. **Develop your core model** (Python)
2. **Wrap your model**
   - check parameters ontology for your interfaces
   - write the wrapper code (Python)
     - grab inputs by name in proper namespace**
     - run your core model
     - transfer outputs by name in proper namespace**
   - add post-processing graphs (Plotly)
   - write the doc (markdown language)
3. Add your new wrapper in proper simulation namespace
4. Check in your developments and write validation tests
5. Wait next DevSecOps batch (triggered after a push on integration pipeline)
6. Use your new features (or fix regression or security issues 😃)

** according to the discipline I/O names, couplings variables are automatically identified, and multi-disciplinary analyses automatically built
Let's say you want to add impact of ODS\(^{(\star)}\) on health

\(^{(*)}\) ODS: ozone-depleting substances

1. Complete ontology with main elements/variables to be exchanged (ODS emissions, ozone layer thickness…)
2. Add ODS emissions from any relevant sources as needed (energy, macro-economics…)
3. Add environment system impact from all ODS emissions (ozone layer reduction, CFC contribution to green house effect…)
4. Add death rate impact in population model due to Ozone layer thickness reduction

Automated

- Collection of all ODS emissions
- Cumulating greenhouse effect of ODS on top of other factors
- Population evolution due to population damage generated by thinner ozone layer
- Impact on labor for macro-economics

Just add your model

Taking into account interactions and loop-back is automated
Verification and Validation in WITNESS as of Jan'24

V&V workshops
- Academic / Peers’s review (publications, conferences…)
- Comparison with other IAM’s (IAMC validation working group, validation workshops…)
- Calibration check with other IAM’s and past data

System of systems validation
- IT (user stories completion, previous bugs)
- Numerical (adjoint state, convergence robustness, speed…)
- Cooperative business experts (systems interactions dynamics order of magnitude…)
- Calibration check with past data & validated individual system results

Integrated system validation
- IT (user stories completion, previous bugs)
- Numerical (adjoint state, convergence robustness, stability…)
- Business Expert (model interactions dynamics order of magnitude…)
- Calibration check with past data & validated individual model results

Individual model validation
- IT (user stories completion, previous bugs)
- Numerical (gradients, stability…)
- Topic Expert (results & dynamics order of magnitude, domain of validity…)
- Calibration check with past data

WITNESS reference use cases
DevSecOps non regression tests
Validation reference use cases library
Follow-up or work with the project

**For users**

- Follow-up OS-Climate progress as a whole
  ➔ "All hands meeting"
  1h every second Tuesday of the month, 10:00 AM ET

- Follow-up Transition tool more specifically
  ➔ "Transition tool weekly"
  1/2h every Wednesday, 10:00 AM ET

- Specific interaction with Transition tool team
  ➔ "Come as you are"
  2h every Thursday, 08:00 AM ET

- User's training
  ➔ Training development in progress with Linux Foundation
  First MOOC’s should be available in Q2’24

**For developers**

- Start your own developments
  ➔ Setup development environment on your laptop
  (native or Docker containerized image available)

- Get specific support
  ➔ "Code as you are"
  2h every Wednesday, 08:00 AM ET
  register at [https://www.witness4climate.org/events/](https://www.witness4climate.org/events/)

- Contribute source code or documentation
  ➔ Contact project to get a GIT branch
  where to contribute your developments
  [https://github.com/os-climate](https://github.com/os-climate)

- Test integration of your code
  ➔ Automated through DevSecOps loops
  when your code is properly contributed on project GitHub

- Developer’s training
  ➔ Training development in progress with Linux Foundation
  First MOOC’s should be available in Q2’24
Barebone open source offer can be completed by commercial support if needed

**OS-Climate «Transition tool» source & documentation scope**
- Consulting to extend / adapt / specialize for specific business questions
- WITNESS energy & climate change framework (set of modules for SoSTrades)
  source code & documentation
- SoSTrades generic & multi-purpose simulation platform
  source code & documentation
- Consulting to install / support / operate platform & simulations

**Capgemini «Business for Planet modeling» commercial offer scope**
- Consulting to extend / adapt / specialize for specific business questions
- WITNESS energy and climate change framework (set of modules for SoSTrades)
  source code & documentation
- Strategic business modeling framework (set of modules for SoSTrades)
  source code & documentation
- SoSTrades generic & multi-purpose simulation platform
  source code & documentation
- Consulting to install / support / operate platform & simulations

**Open source**
- WITNESS world scale transition (IAM)
- High level regionalized & sectorized ecosystem
- Detailed regionalized & segmented ecosystem
- Generic strategic modeling
- Specific strategic modeling
- Specific strategy derivation

**Capgemini IP**
- Specific company add-ons

**Customers IP**
Thank You!

Interested in Learning More:

- [WITNESS presentation and links to OS-C](https://witness4climate.org)
- [Source code repositories (include all models documentation)](https://github.com/os-climate)
- [Stable public platform (basic github account needed)](https://stable.osc-tsa.com/)
Links to different resources

- *WITNESS presentation and links to OS-C*
  - [https://witness4climate.org](https://witness4climate.org)

- *Open Source for Climate*
  - [https://os-climate.org/](https://os-climate.org/)

- *Source code repositories on GitHub (include all models documentation)*
  - [https://github.com/os-climate](https://github.com/os-climate)

- *Stable*
  - [https://stable.osc-tsa.com/](https://stable.osc-tsa.com/)

- *Validation*
  - [https://validation.osc-tsa.com/](https://validation.osc-tsa.com/)

- *Integration*
  - [https://integration.osc-tsa.com/](https://integration.osc-tsa.com/)