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Modelling and forecasting tropical deforestation: advances and perspectives

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European Commission

cirad

1. Deforestation and demography in Africa
   - Model
   - Results
   - Valorisation
2. `forestatrisk` Python module
   - Functionalities
   - Improvements
   - Model performance
3. Forecasting spatial deforestation spatially
   - Pantropical scale
   - Computational challenge
   - Scenario choice
4. Perspectives

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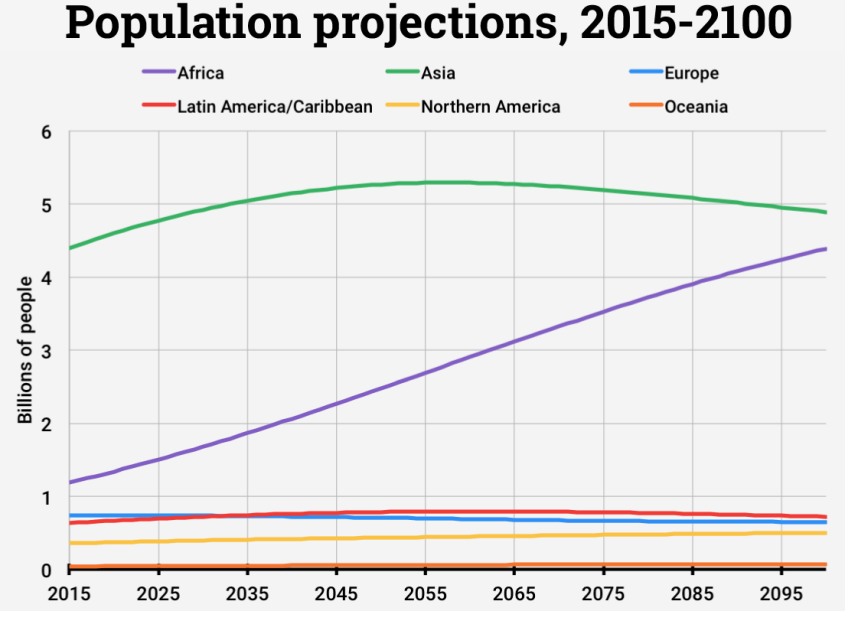
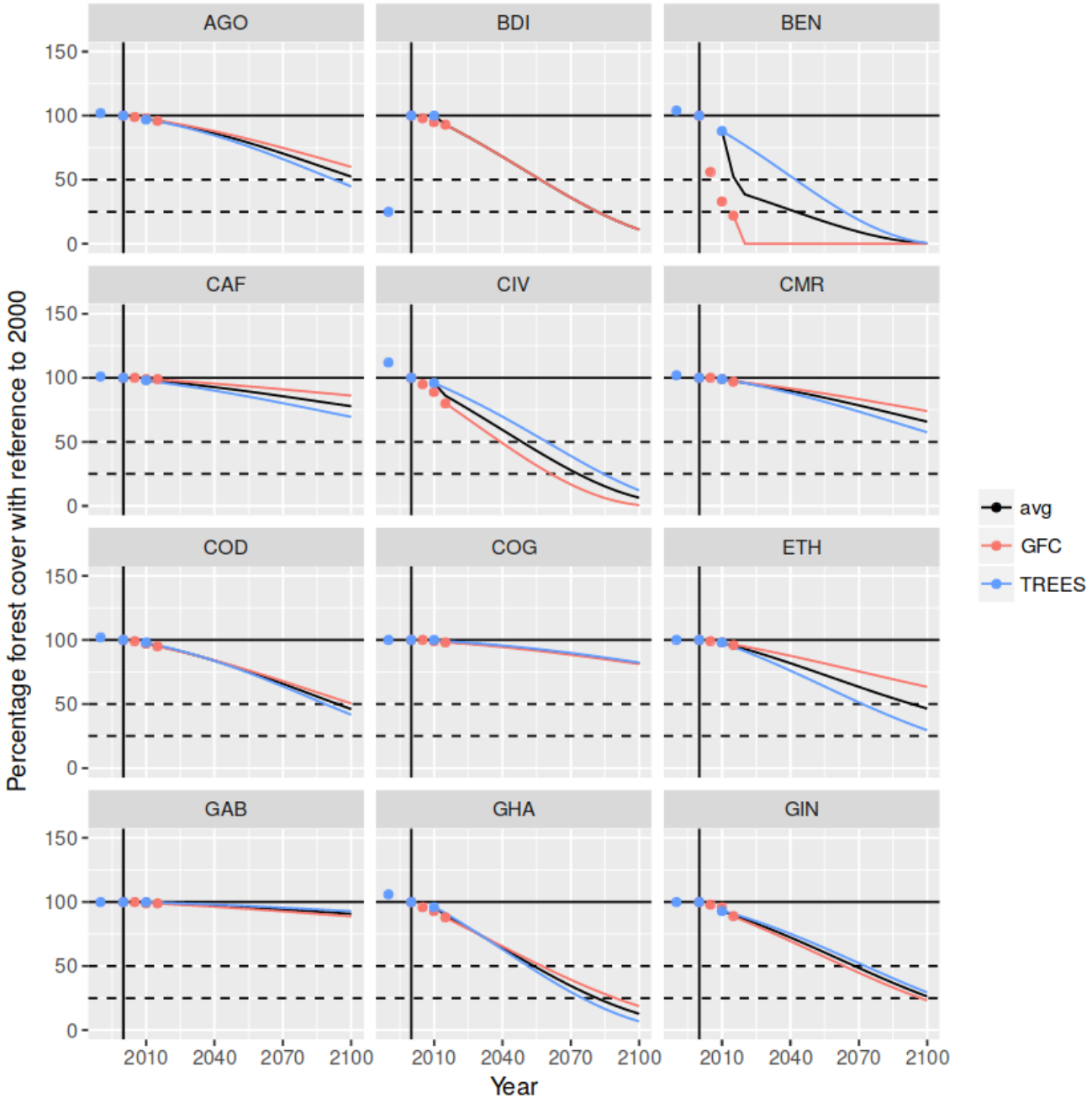
Model

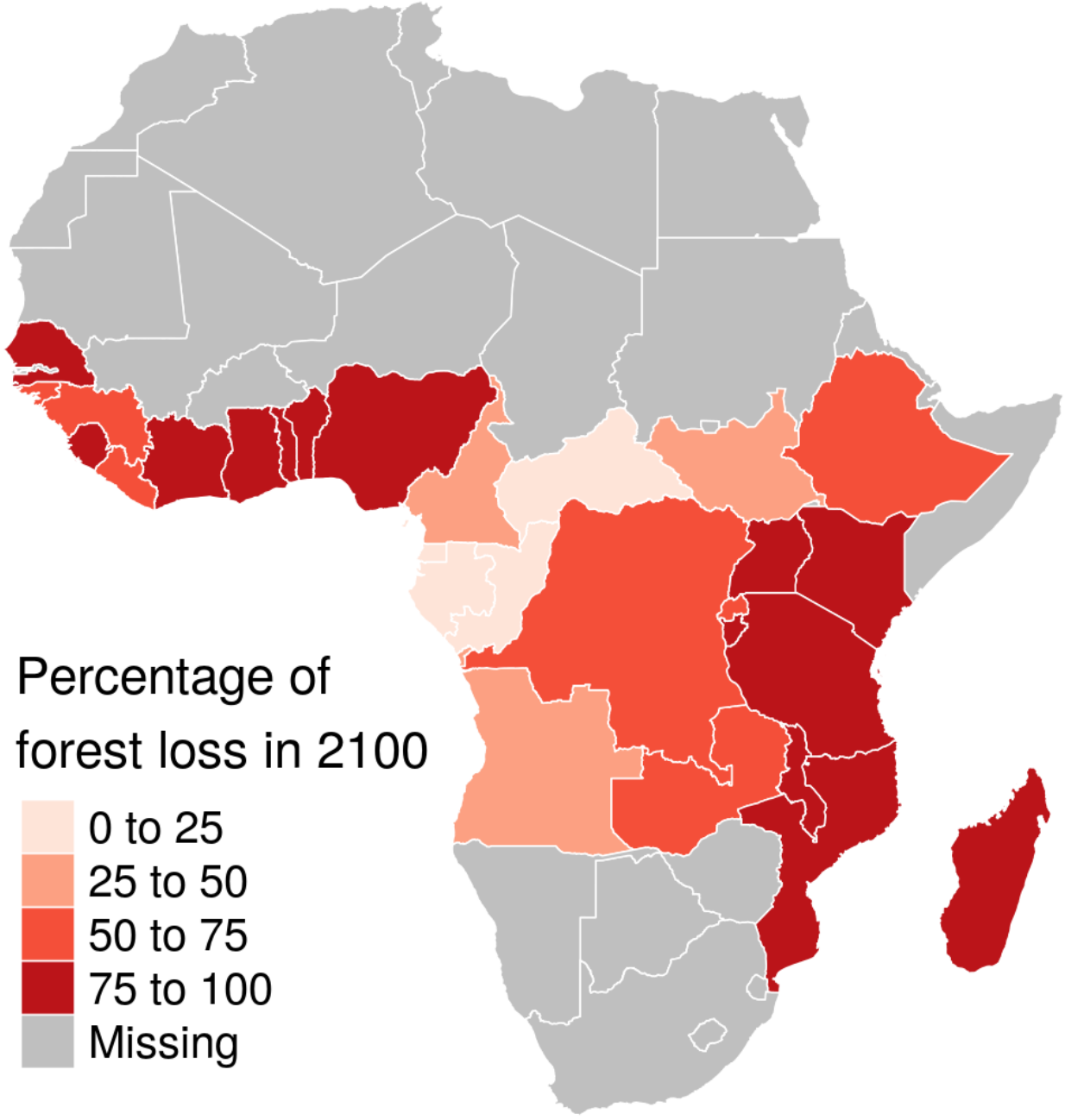
- The fate of African tropical forests
- Associated to demographic explosion
- $\log D = \beta_0 + \beta_1 \log F + \beta_2 \log P$
- Data on deforestation :
  1. JRC : 1990-2000-2010
  2. GFC : 2000-2005-2010-2015
- Projection of forest cover in 2050, 2100



Model averaging per country



Percentage of forest loss 21st century



Valorisation

- Scientific article
- Integration of Roadless data on deforestation ?
- Use of the results for future deforestation scenario in Africa
- Predictions in percentage of forest loss : $\sim$ independent of forest definition

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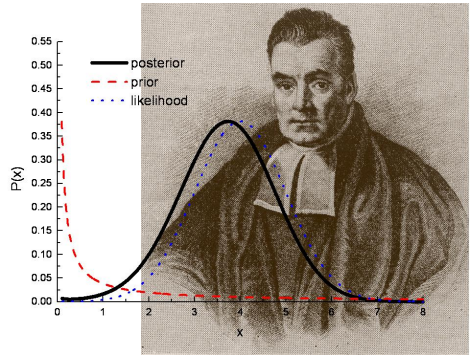
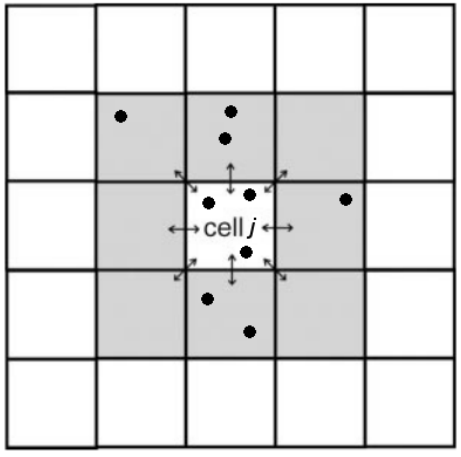
`forestatrisk` Python module specifications

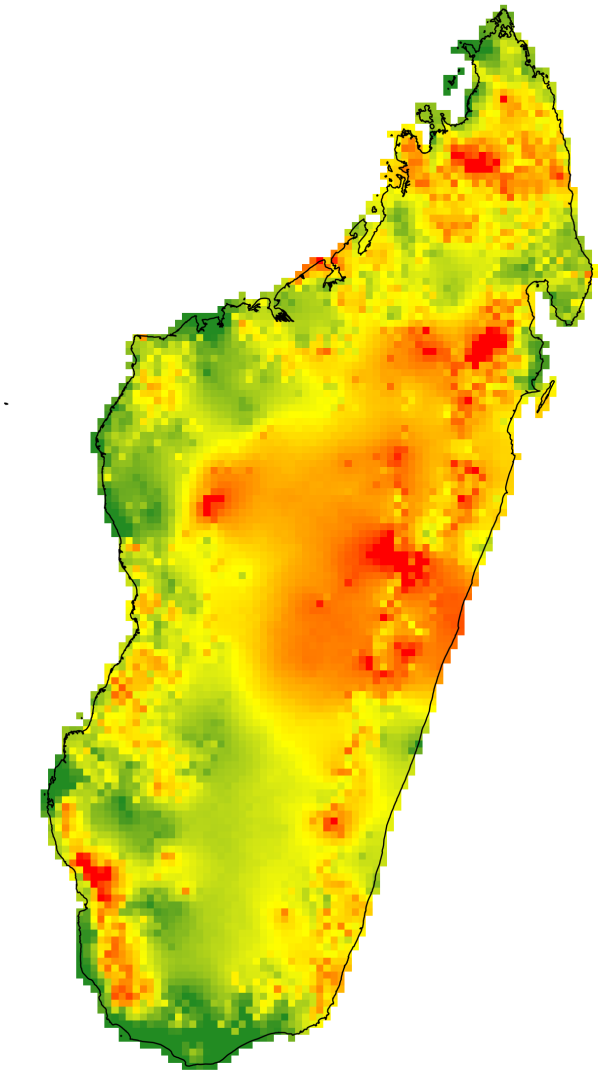
- Spatial probability of deforestation
- $\text{logit}(\theta_i) = f(\text{spatial factors}_i) + \rho_j$
- Factors : accessibility (dist. towns, roads, villages), landscape (dist. forest edge), land-tenure (protected areas)
- ρ_j : spatial random effect
- {\href{https://github.com/ghislainv/forestatrisk}}





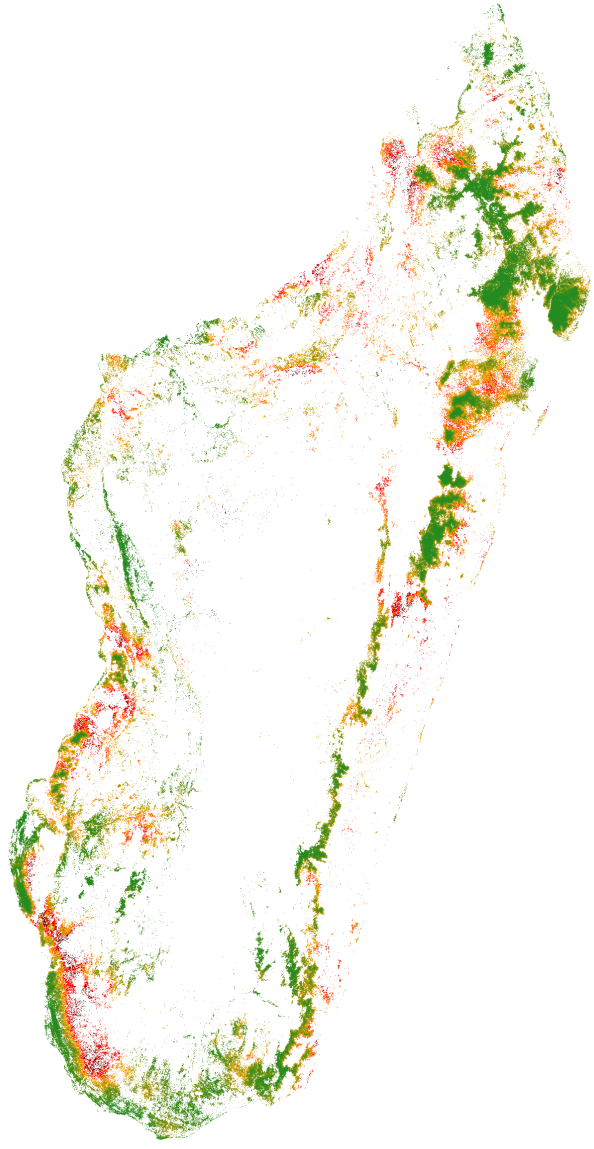
Spatial random effects

- Hotspots of deforestation
- Not explained by the fixed env. factors



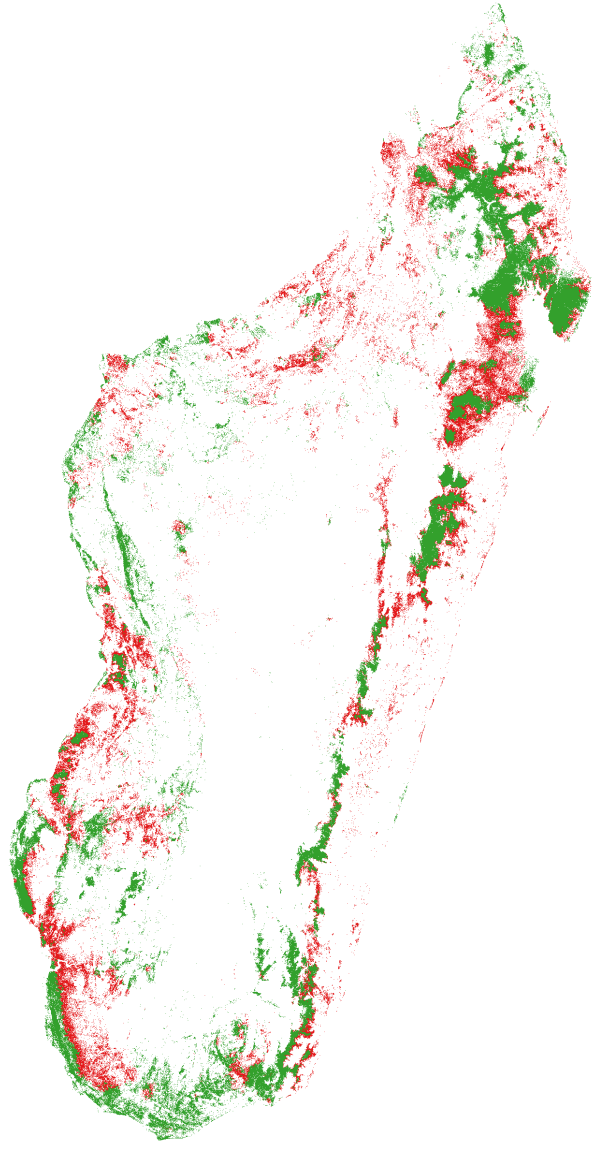
Spatial probability of deforestation

- Computed at 30 m resolution
- Greener : lower probability
- Darker red : higher probability



Future forest cover

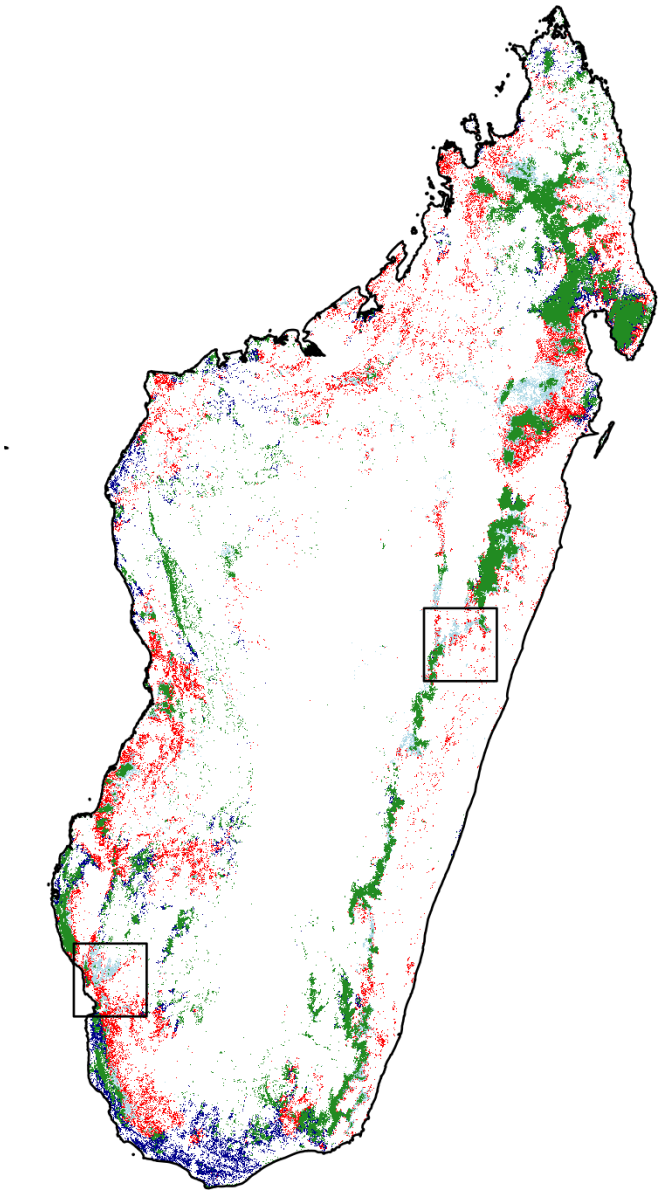
- green : residual forest in 2050
- red : deforested area 2010-2050

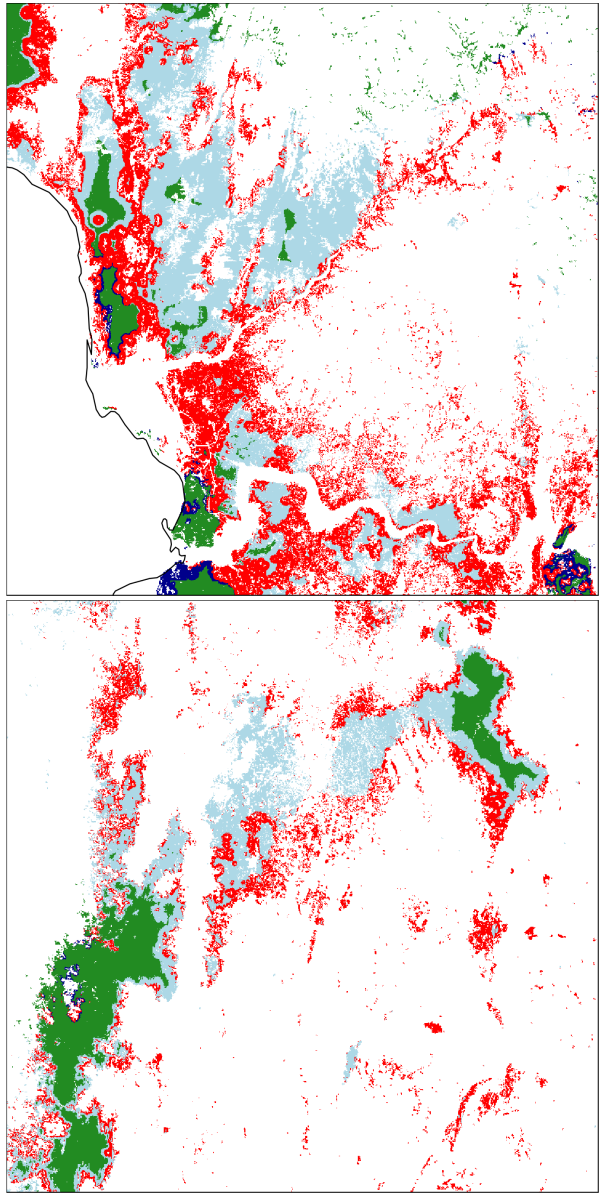


Improvements

- Python 2.7 and Python 3.x compatible
- Spatial random effects limited to country border
- Set of new functions for model validation
- Can be used from R with `reticulate`

Comparing predictions with GLM





Model performance

Performance estimated on an independent data-set of 20,000 points

model	Deviance	OA	Kappa
null	0	50	0
GLM	8	62	24
iCAR	30	79	58
full	100	100	100

Model validation

- Map of probability of deforestation in 2010 + known deforested area on 2010-2014
- Observed vs. projected deforestation on 2010-2014
- Area deforested in 10 $\times$ 10 km areas
- Pearson's correlation

model	Cor
GLM	12
iCAR	31

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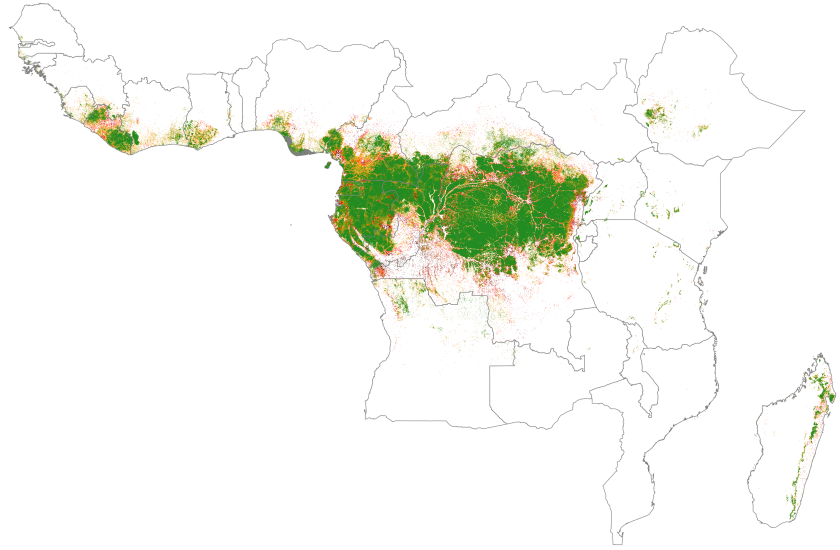
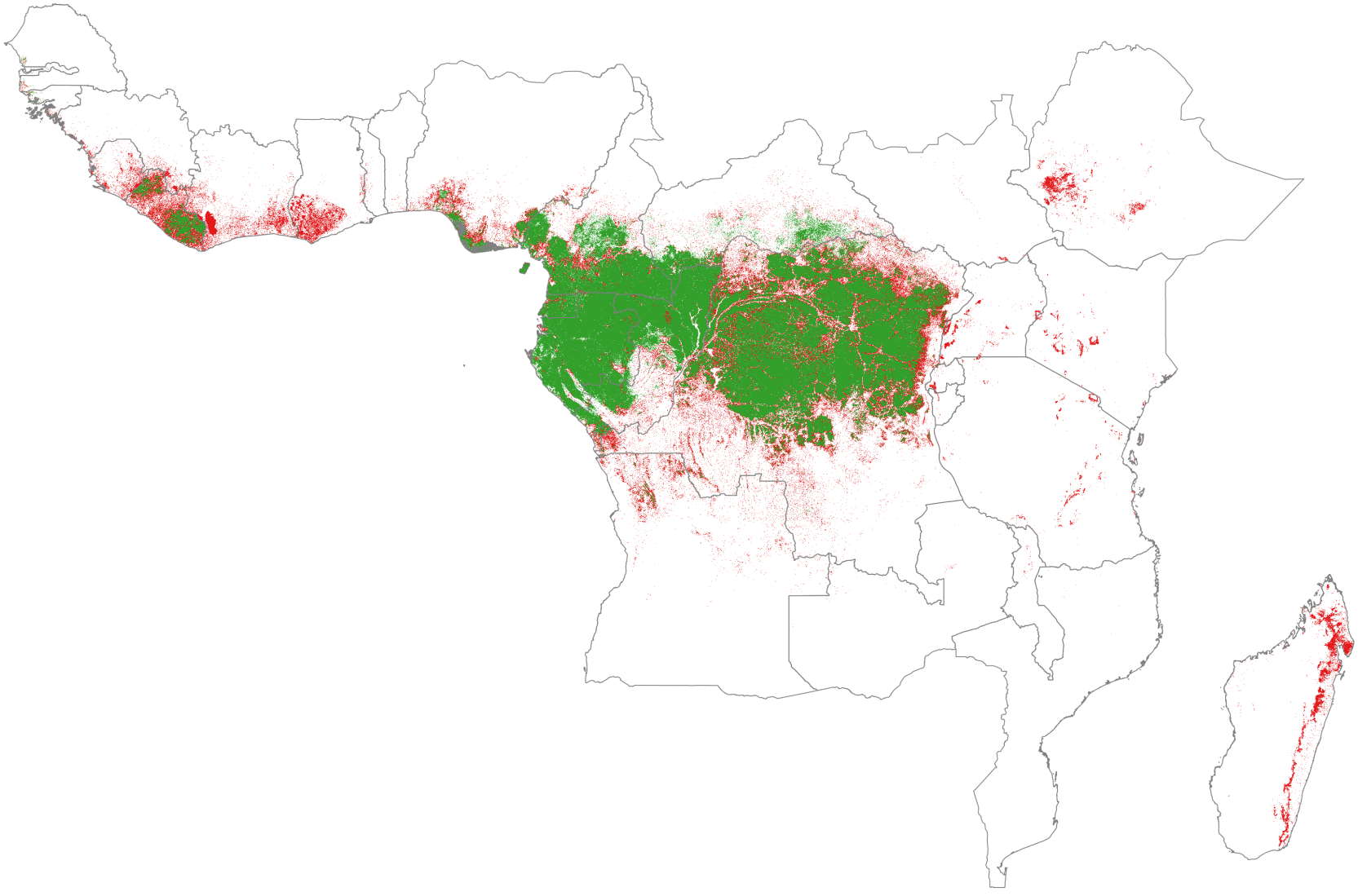
Africa

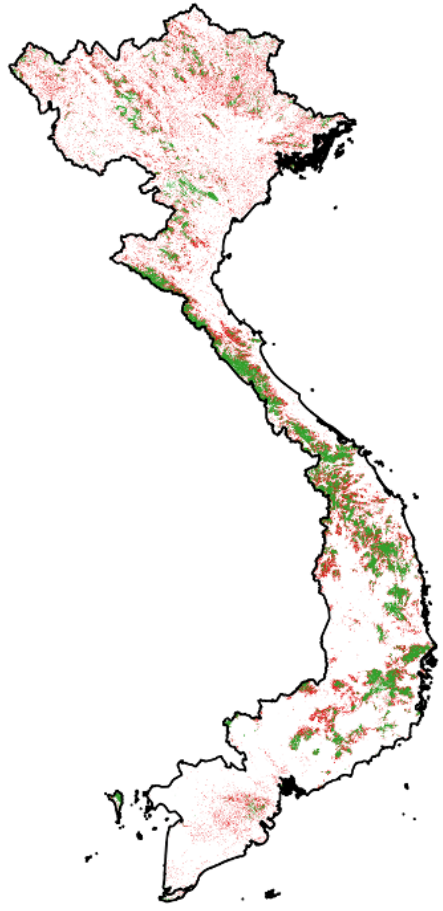
- Map of deforestation probability in 2015
- Future forest cover in 2050, 2100





Asia

- 11 countries in tropical Asia
- Including MMR, THA, KHM, LAO, VNM (ReCaREDD focus countries)
- Ex. Vietnam in 2050 (half current deforestation rate)



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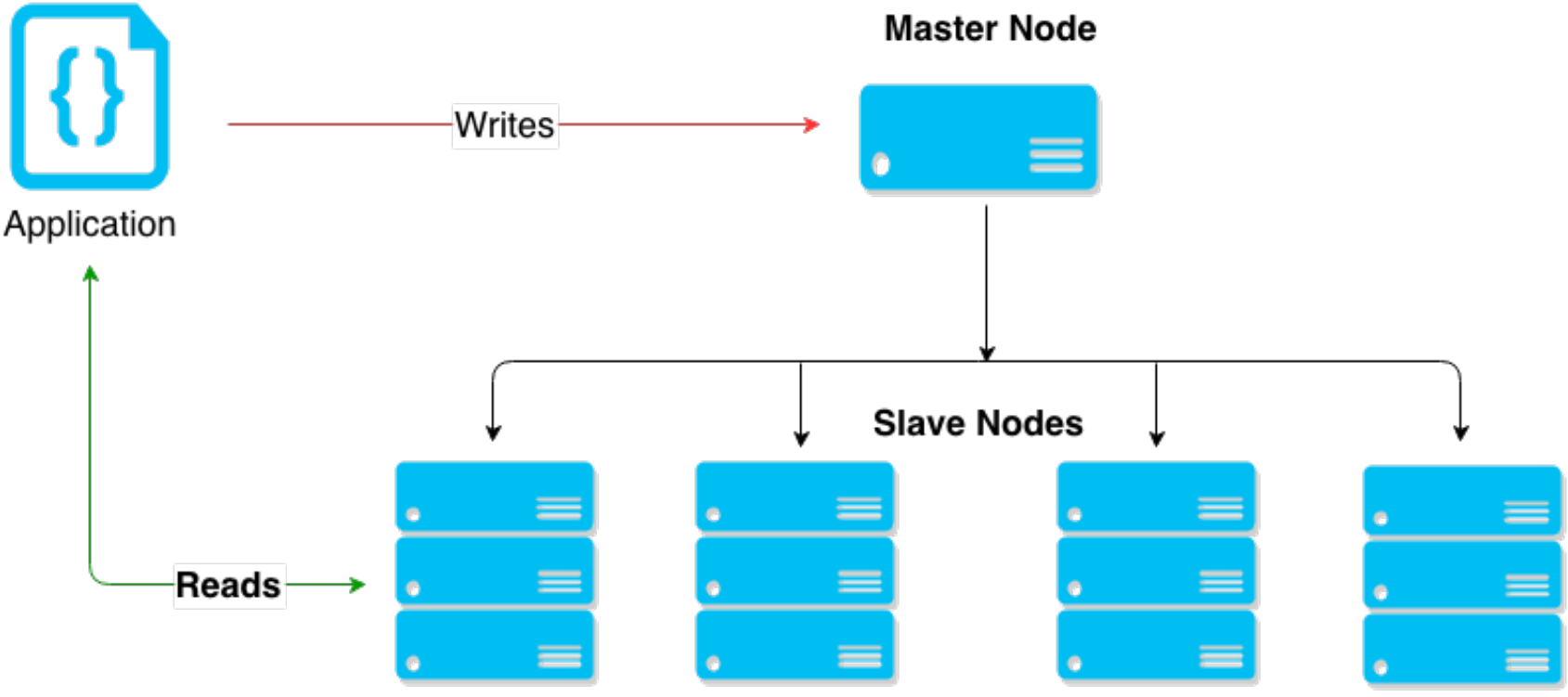
Computational challenge

- Use of Google Cloud Computing ($\neq$ GEE)
- Cluster of small machines with some cores
- Parrallelization : one country per machine



Scenario choice

- “business-as-usual”
- demographic growth for African country
- mitigation scenario (50% deforestation)

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Perspectives

1. Deforestation-demography study
   - consolidate the results
   - publish a first paper
2. `forestatrisk` Python module
   - polish the code
   - publish a methodological paper advocating our model choice
3. Pantropical map
   - re-run computation with new version of the model
   - extend projections to the pantropical world
   - produce maps for alternative scenario of intensity

. . . Thank you for attention . . .