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# Tricks and tweaks for the global prediction of high radon levels and local pitfalls

Sebastian Baumann, Sara Antignani, Joan Frédéric Rey,
Niccolo Loret, Mario Caprio, Valeria Gruber

17.09.2025, GARRM, Prague

This project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 900009.

# Tricks and tweaks for the global prediction of high radon levels and local pitfalls

- Concepts
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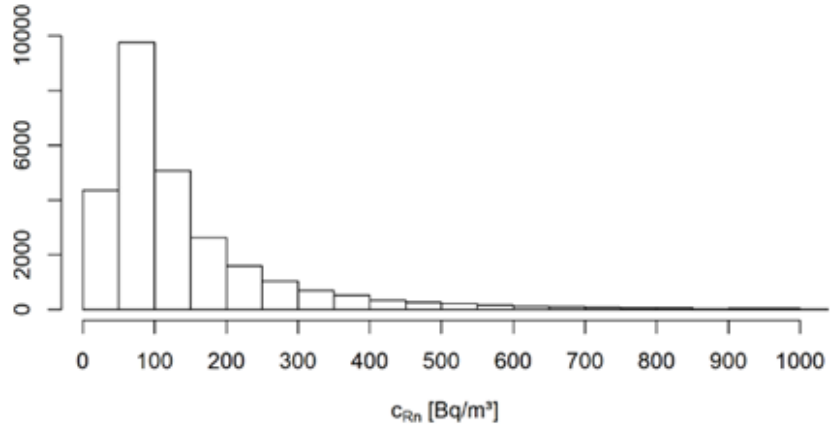
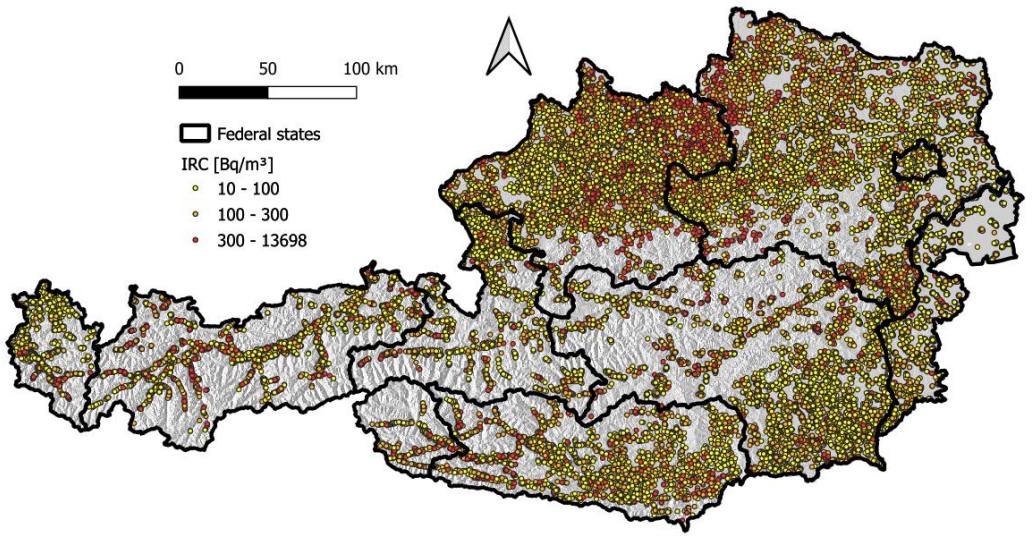
- Conclusion
- Suggestions

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# Concept

- Radiation protection measures usually follow conservative approaches
- Consequences for the prediction of indoor radon concentrations?
- What are the aims of predicting IRC?
- Are high radon levels more relevant as low levels?
- Are there models and techinques better suitable to predict high IRC?

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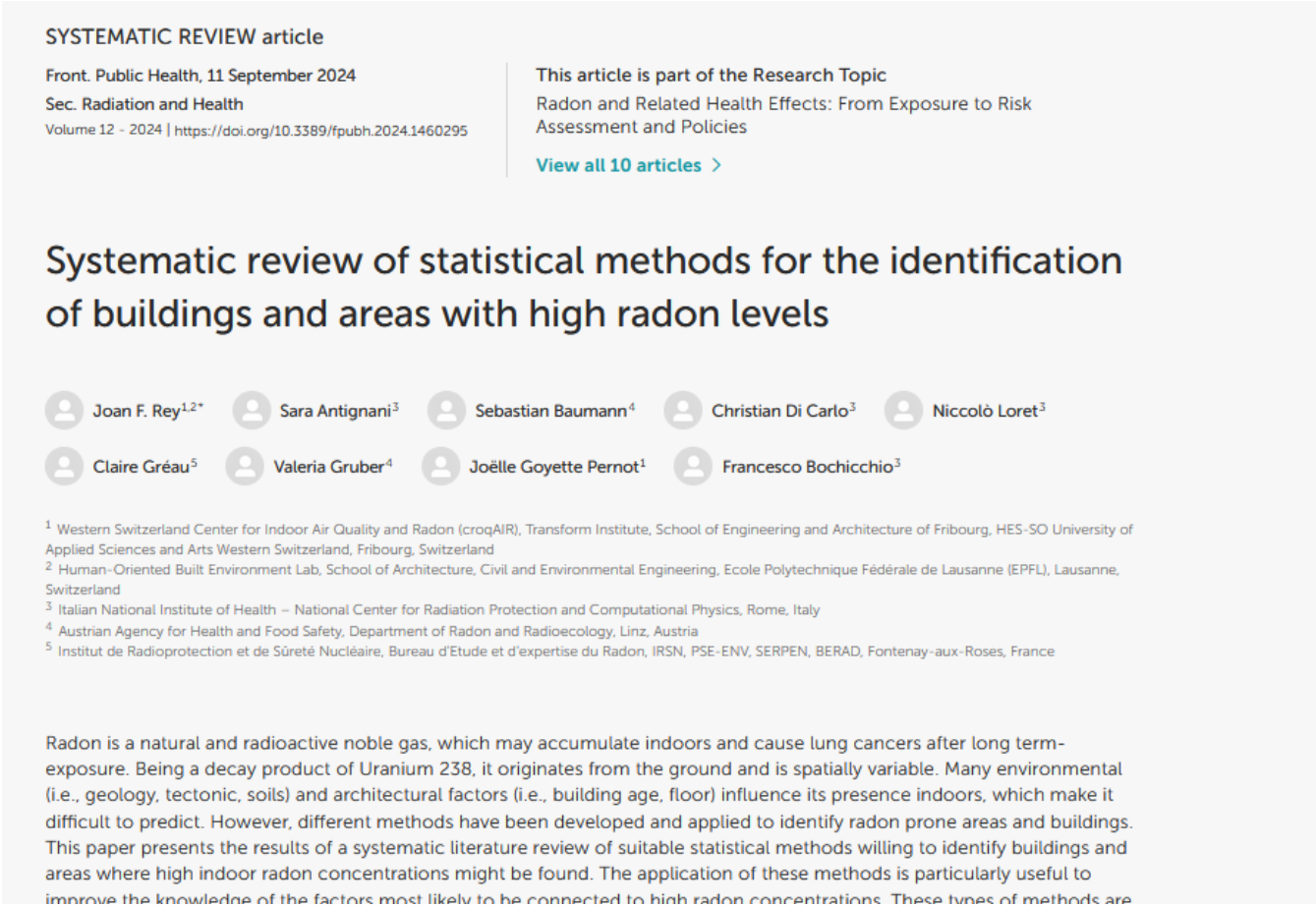
# Concept

- In Rey et. Al (2024) we suggested modifications of the target (IRC) in a predictive model to focus on the prediction of high radon levels.
- Today some of these model modifications and their performance are presented



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This article is part of the Research Topic
Radon and Related Health Effects: From Exposure to Risk Assessment and Policies

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## Systematic review of statistical methods for the identification of buildings and areas with high radon levels

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Radon is a natural and radioactive noble gas, which may accumulate indoors and cause lung cancers after long term-exposure. Being a decay product of Uranium 238, it originates from the ground and is spatially variable. Many environmental (i.e., geology, tectonic, soils) and architectural factors (i.e., building age, floor) influence its presence indoors, which make it difficult to predict. However, different methods have been developed and applied to identify radon prone areas and buildings. This paper presents the results of a systematic literature review of suitable statistical methods willing to identify buildings and areas where high indoor radon concentrations might be found. The application of these methods is particularly useful to improve the knowledge of the factors most likely to be connected to high radon concentrations. These types of methods are

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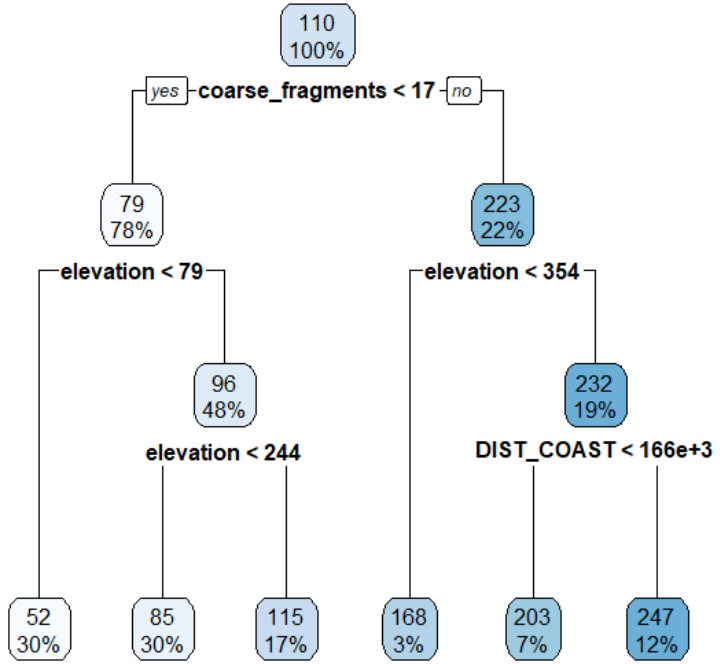
# Setup

- Target Variable ~ Model (Predictors)

IRC ~ Random Forest { Building Characteristics
Geogenic Factors
Climate ….




## Possible Goals:

- Estimate the average IRC of a country
- Develop a radon map
- Estimate the amount of buildings with IRC greater 300 Bq/m³
- Evaluation of influencing factors

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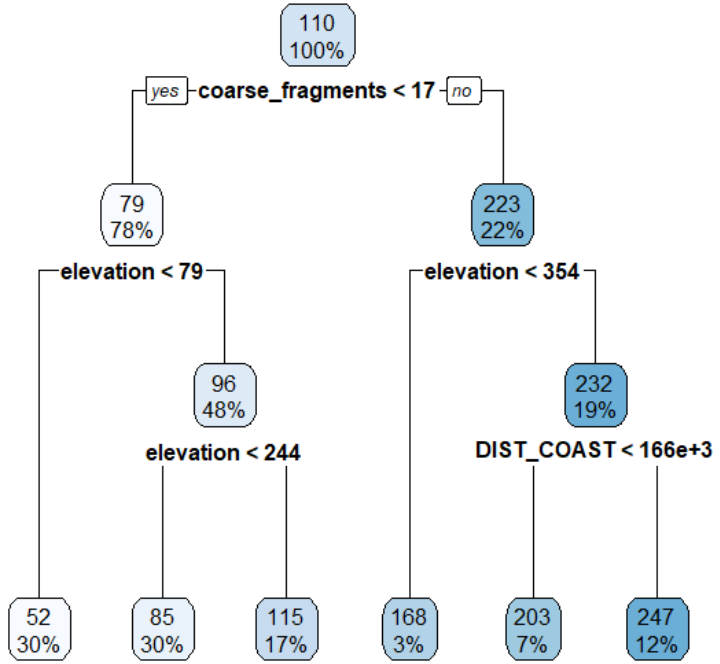


## Model characteristics

- ~ 50.000 indoor radon measurements
- Performance metrics on hold out random test set
- 20 Predictors from different categories: coordinates, floor level, geology, temperature, soil characteristics, building material …

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# The model - Predicting high radon levels

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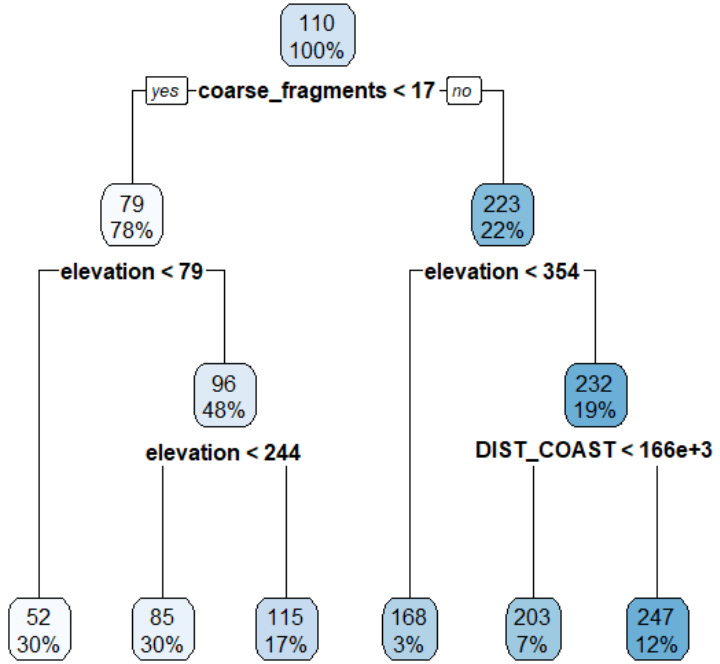


## Modifications:

- No modification
- Log-transforming
- Quantile regression forest
- Classification instead of regression

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# Performance – Example log-transformation

- No Modification of the target variable compared to log-transformation
- MAE = Mean absolute error of prediction and observation (the lower the better)

| | Non modification | Log-transformed |
|---|---|---|
| Overall MAE Bq/m³ | **90** | **79** |

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**Transforming the target value:**

- Usually, IRC follow a log-normal distribution and for prediction the IRC are often log-transformed

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| MAE IRC > 300 Bq/m³ | **333** | **398** |

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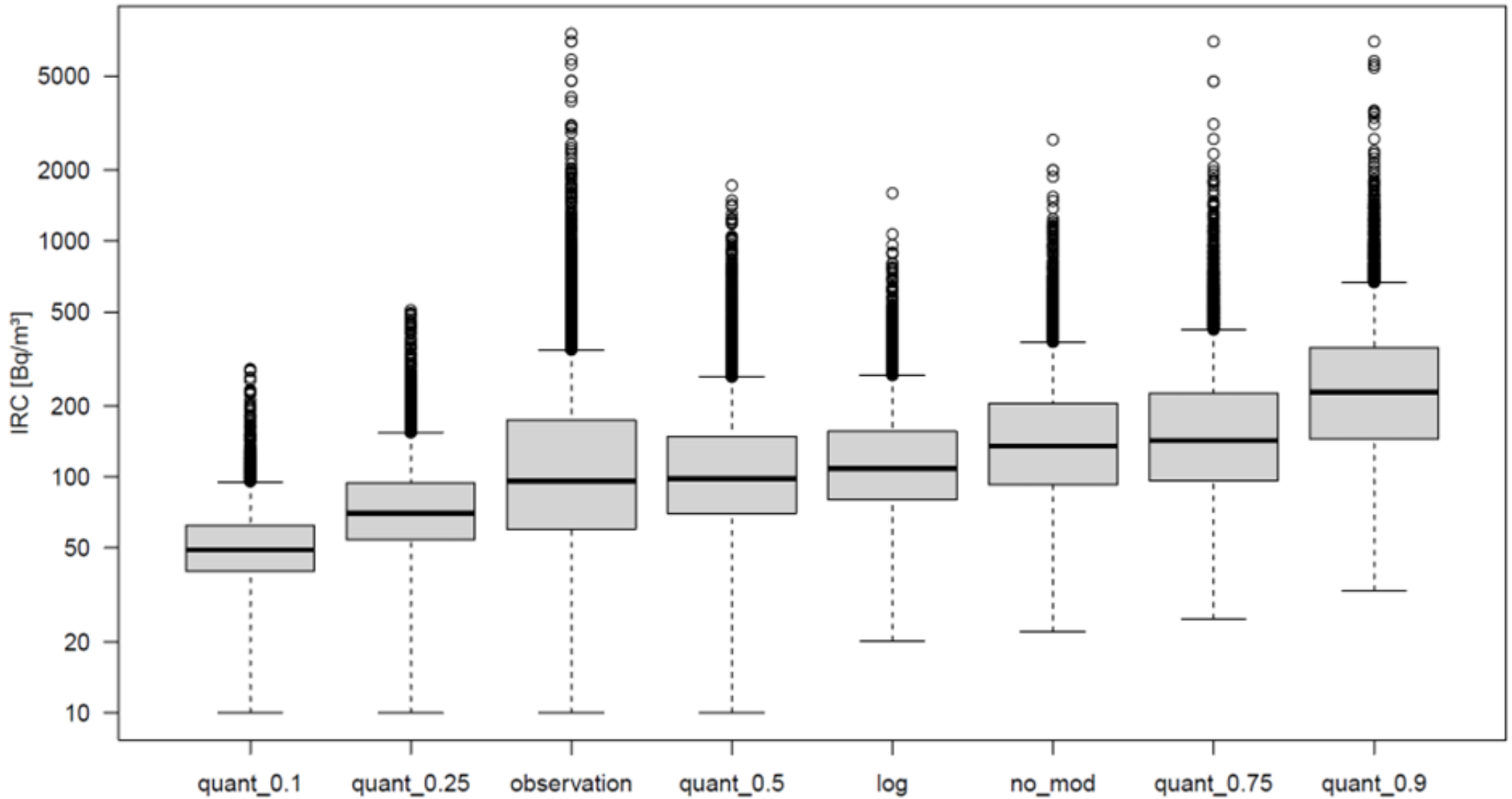
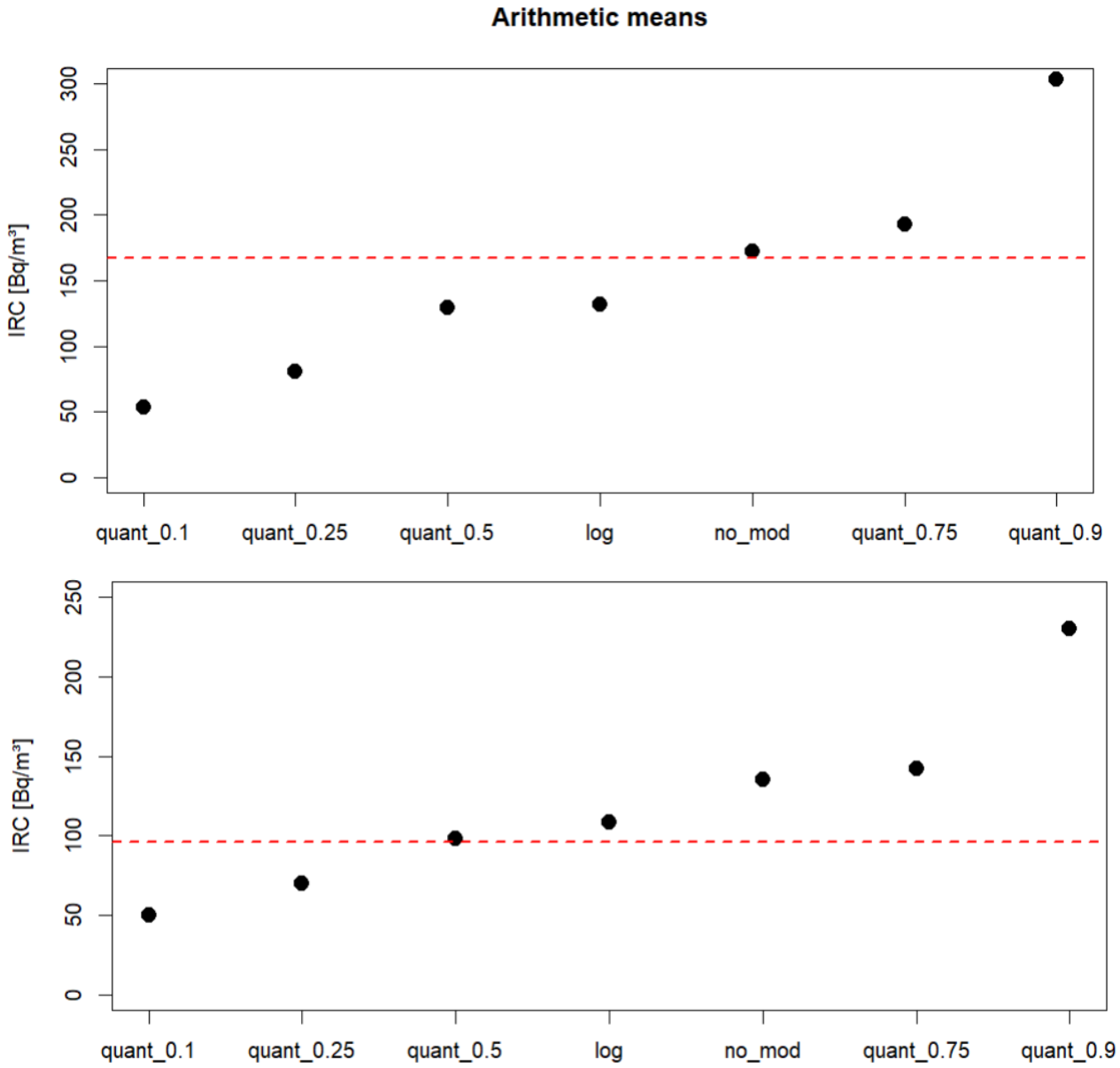
# Performance - Distributions of predictions



# Performance – Aggregates




- Arithmetic means of the model predictions, compared to the observation
- Medians of the model predictions compared to the observation

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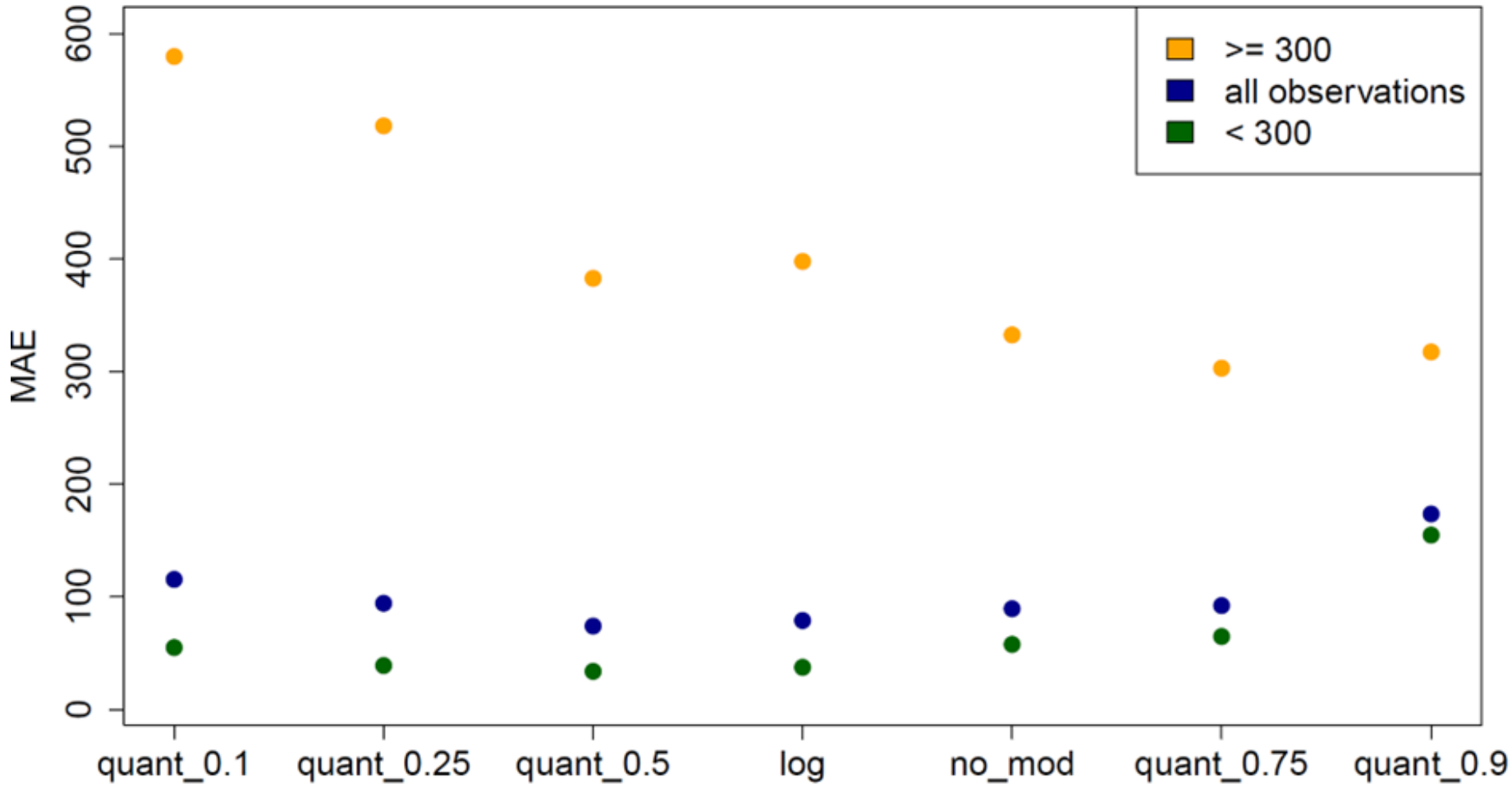
# Performance - MAE for different models

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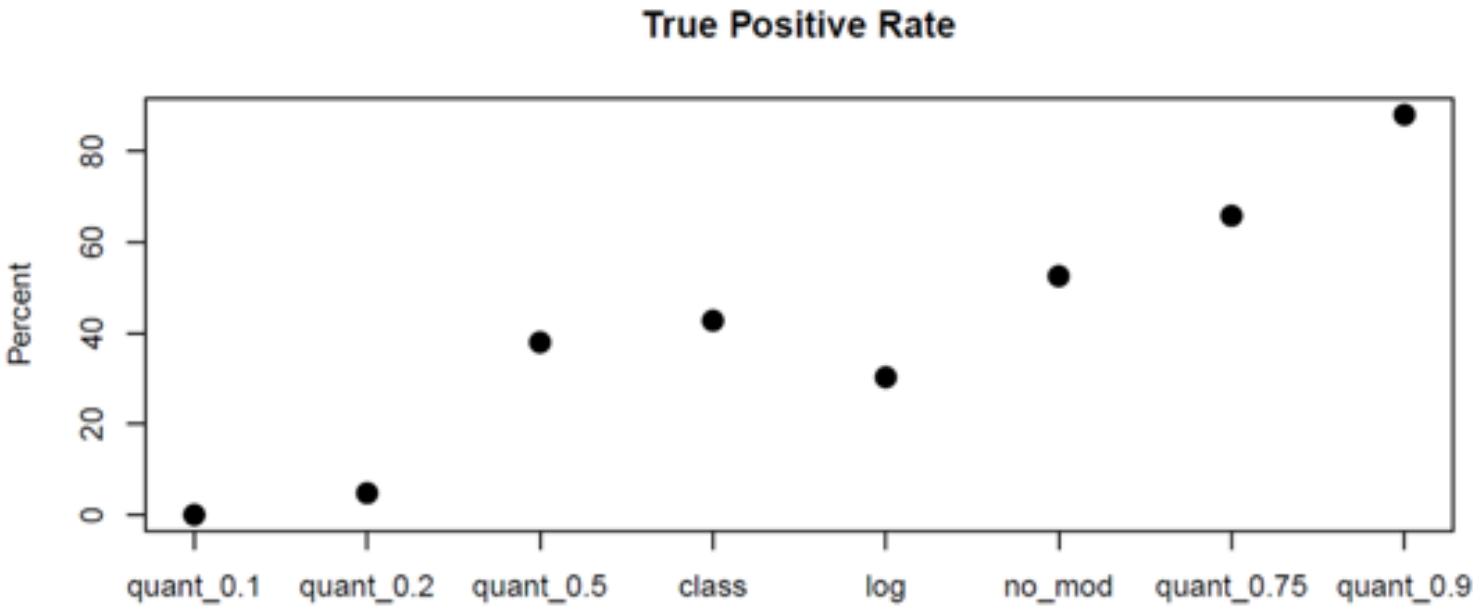
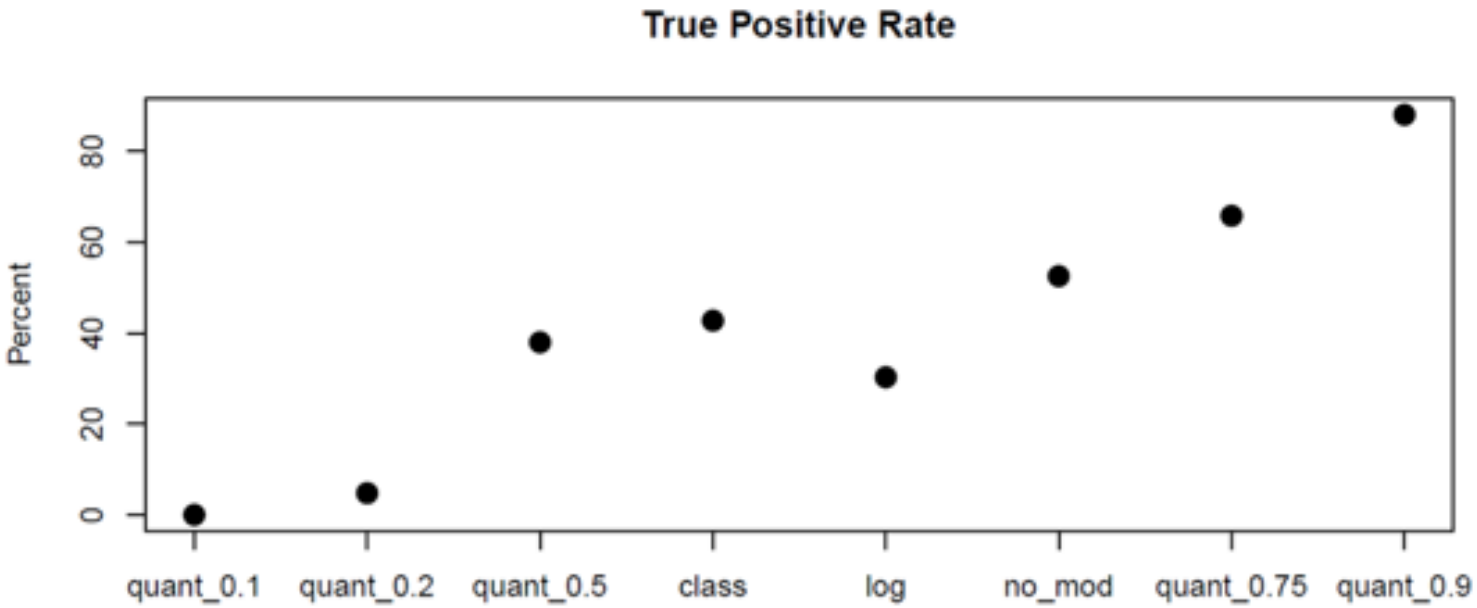
# Performance – TPR | TNR




- TPR: how many observations >= 300 Bq/m³ were classified correctly [%]

# Performance – TPR | TNR

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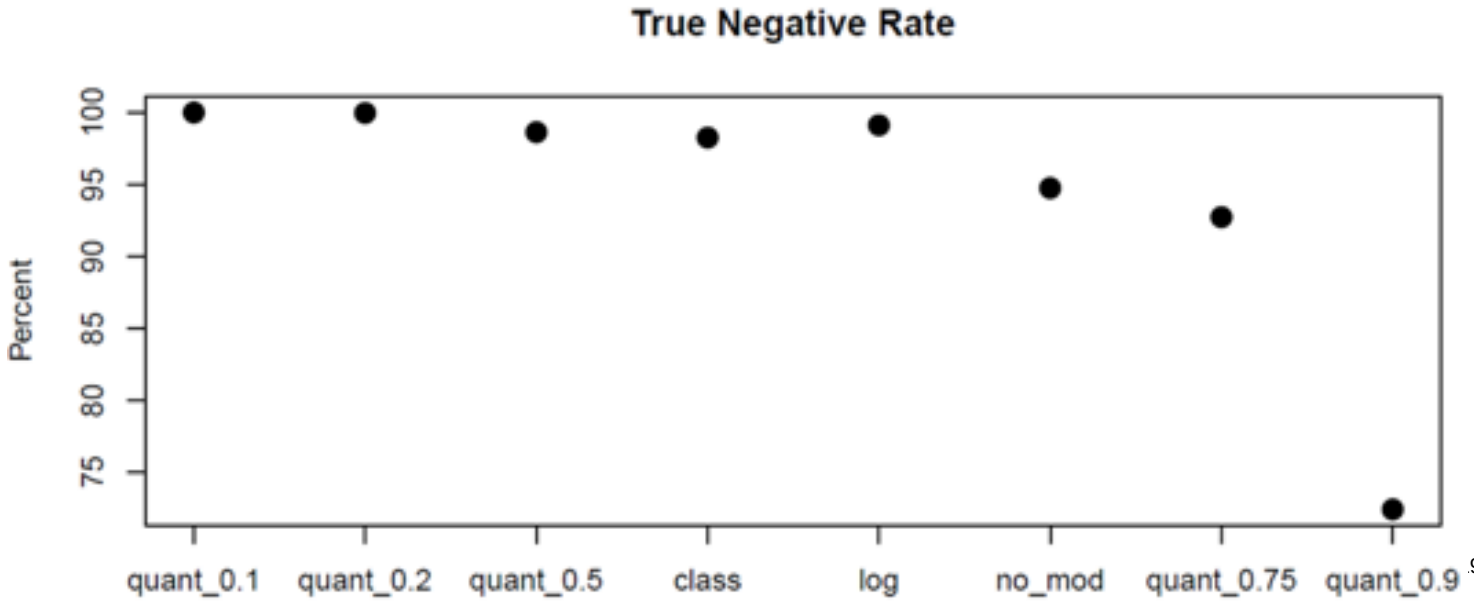


- TNR: How many observations <300 Bq/m³ were classified correctly [%]

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# Conclusions

- Transforming the target (IRC) in a predictive model has consequences, especially if the target follwos a log-normal distribution.
- This is seldom dicussed when using predictive models
- There may be aims where the averall performace might be less relevant, than the performance for certain IRC – Populations (e.g. > 300 Bq/m³)
- What is the goal of my prediction?

| | Non modification | Log-transformed |
|---|---|---|
| Overall MAE Bq/m³ | 90 | 79 |
| MAE IRC >= 300 Bq/m³ | 333 | 398 |
| MAE IRC < 300 Bq/m³ | 58 | 37 |
| TPR % | 53 | 30 |
| TNR % | 94 | 99 |
| MEAN DIFF [Bq/m³] | + 6 | - 35 |
| MEDIAN DIFF [Bq/m³] | + 39 | + 12 |

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# Suggestions

- There is no jack of all trades
- Use well working models (tree based) and focus on overall workflow:
  - DATA handling
  - Feature selection
  - Train / Test split (**Generalization!**)
  - Model evaluation
- Focus on the research question: What do I want to accomplish with my prediction? (Map, Mean, Distribution)

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