A novel parameterization for wildfire plumes in LPJ-GUESS

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Motivation

- Wildfire emissions have impact on:
  - Air-Quality (Human Health)
  - Climate (e.g. soot-on-snow)
  - Weather and Climate -> Radiative Transfer

- Transport
  - Inside PBL -> Local effects
  - Free troposphere -> Long range effects (5-18% of fires [Kahn et al. 2008])

- Different approaches to tackle the issue in future projections:
  - Satellite retrieval – based reanalyses (short term)
  - Fire-emission model based on vegetation projections
  - *Use a fire enabled LSM/DGVM*
  - *Fully coupled Earth System Models*

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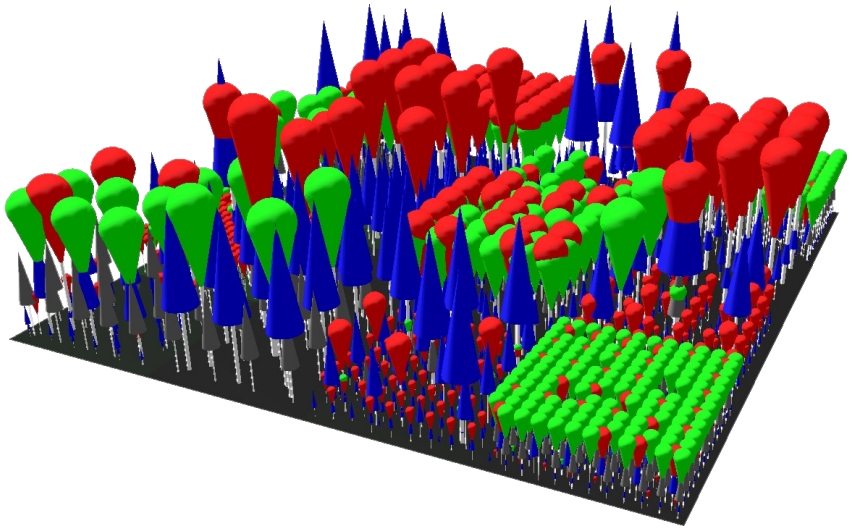
Fire in LPJ-GUESS

- 2nd Generation DGVM (Dynamic Global Vegetation Model) simulating
  - Age-Structure
  - Different types of plants (PFTs)
  - Mortality
  - …
  - Disturbances incl. fire



- Combustion model BLAZE
  - generates fire-specific parameters from available fuel and fire-weather
  - computes fire-mortality for individuals/cohort

→ *Fire-line Intensity, Rate-of-Spread, Total speciated emissions*

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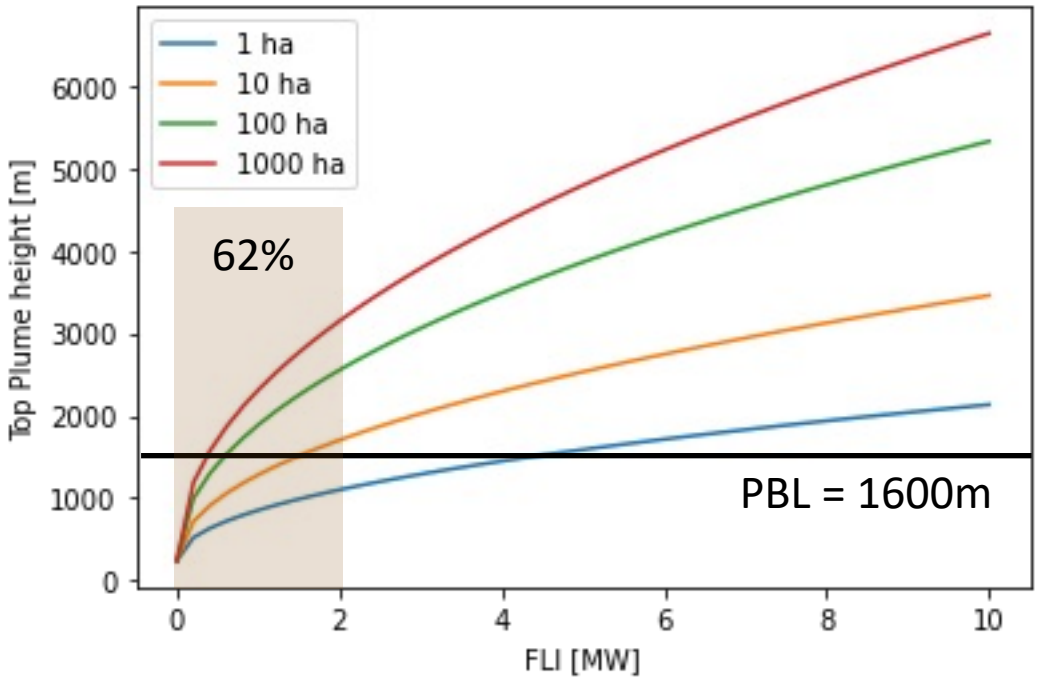
Based on Sofiev et al. (2012) we compute the top of the plume as:

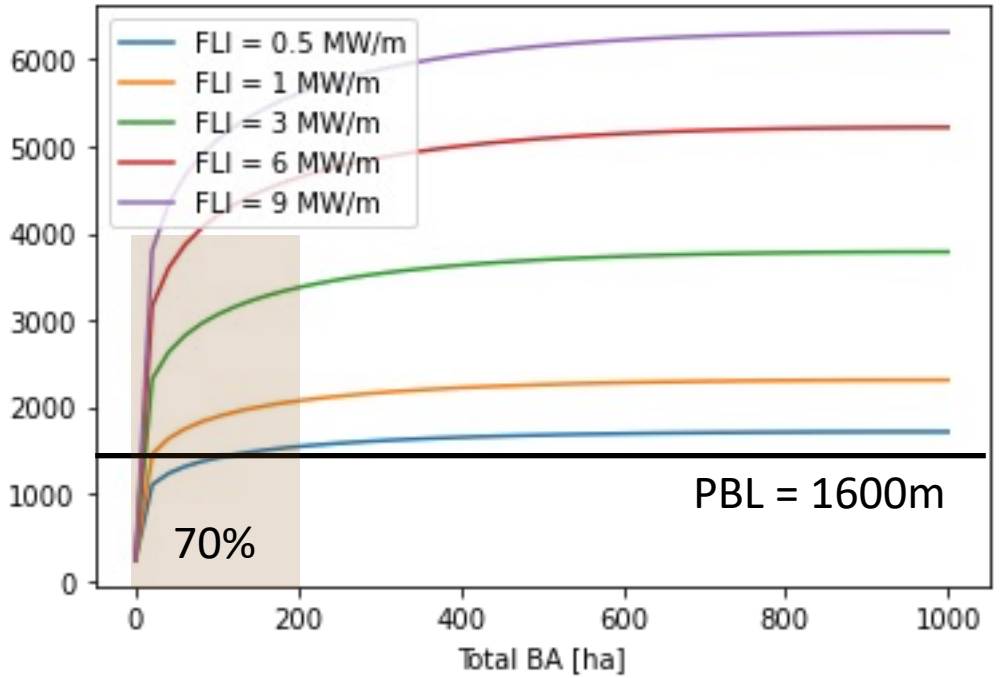
$$H_{Top} = \alpha \cdot H_{PBL} + \beta \cdot \left({}^{FRP}/_{Pf_0}\right)^{\gamma}$$

Where *FRP* is approximated by

$$FRP = c \cdot FLI \cdot \sqrt{BA} \cdot e^{{}^{-BA}/_{BA_0}}$$

- with *c* an empirical constant
- *exp(-BA/BA$_0$)* to account for over-representation at very high *BA*
- PBL-height latitude-dependent (can be fed from GCM/CTM)





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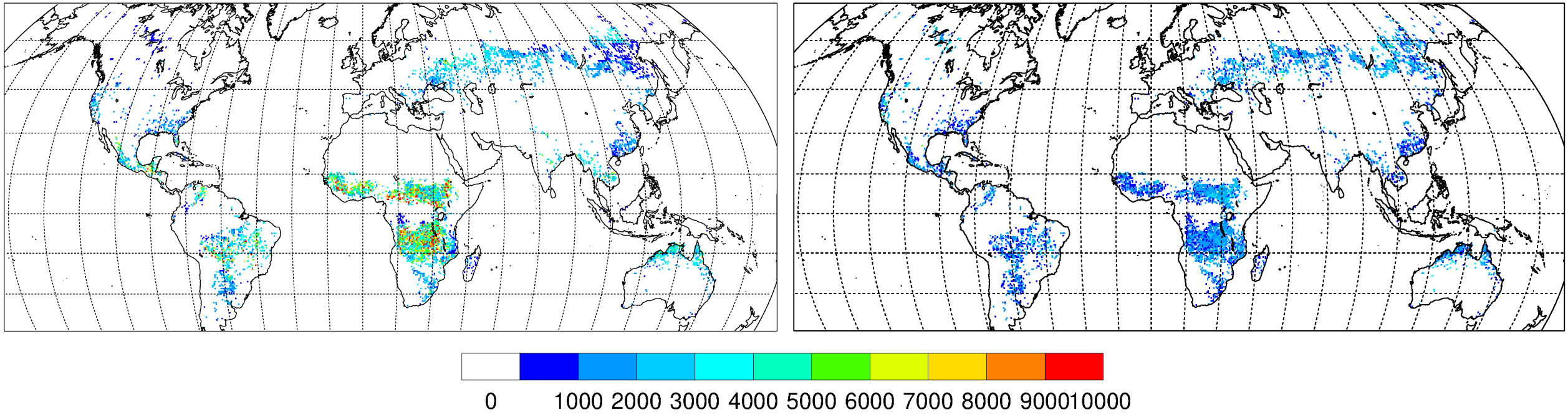
MISR-PLUME evaluation

Simulated Plume-Height based on GFED4.1 BA [m]

MISR Plume-height [m] (Kahn et al. 2008)



- Overestimation at low latitudes
  - Partly due to overrepresented BA (totalled over gridcell)
  - Mismatch between burning vegetation type in Model / Reality
- General remark
  - MISR pass-over 10:30 LT (not capturing max. extend of plumes [Ziming Ke et al. 2021])

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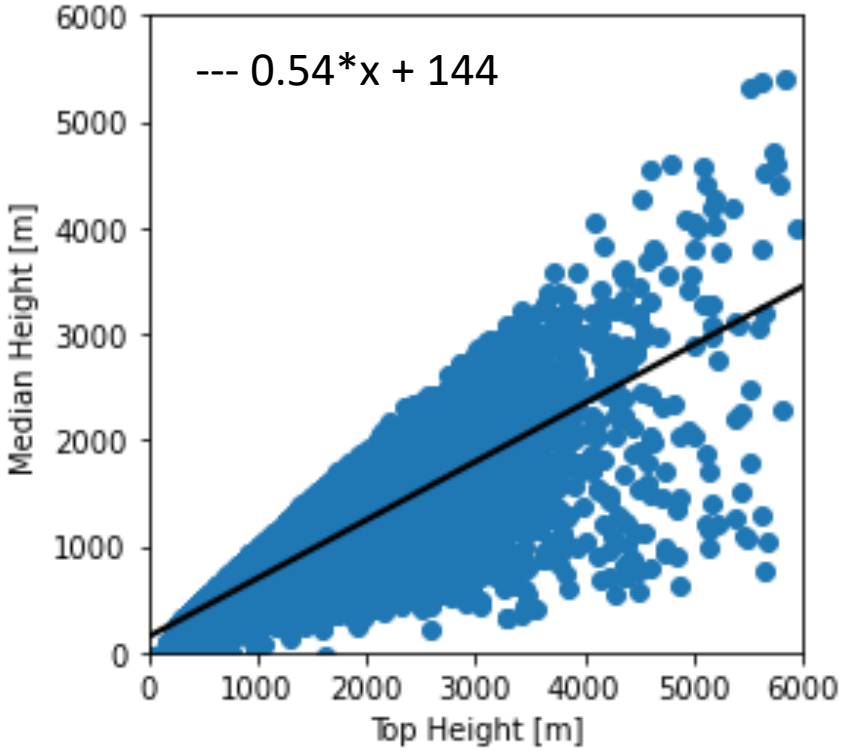
Summary…

- We get a rough estimate of Injection Height
- MISR median/top height ratio gives an estimate on above/below PBL separation



… & Outlook

- Would be great to have more data to constrain
- Next step: Application to long range transport model cases
- coupling to the ESM EC-Earth and ….
- Development of a dynamic – plume model in EC-Earth

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Thank you very much!