

AeroCom Biomass Burning Experiment Phase 1: Fire source strength adjustment

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AeroCOM BB Experiment Design

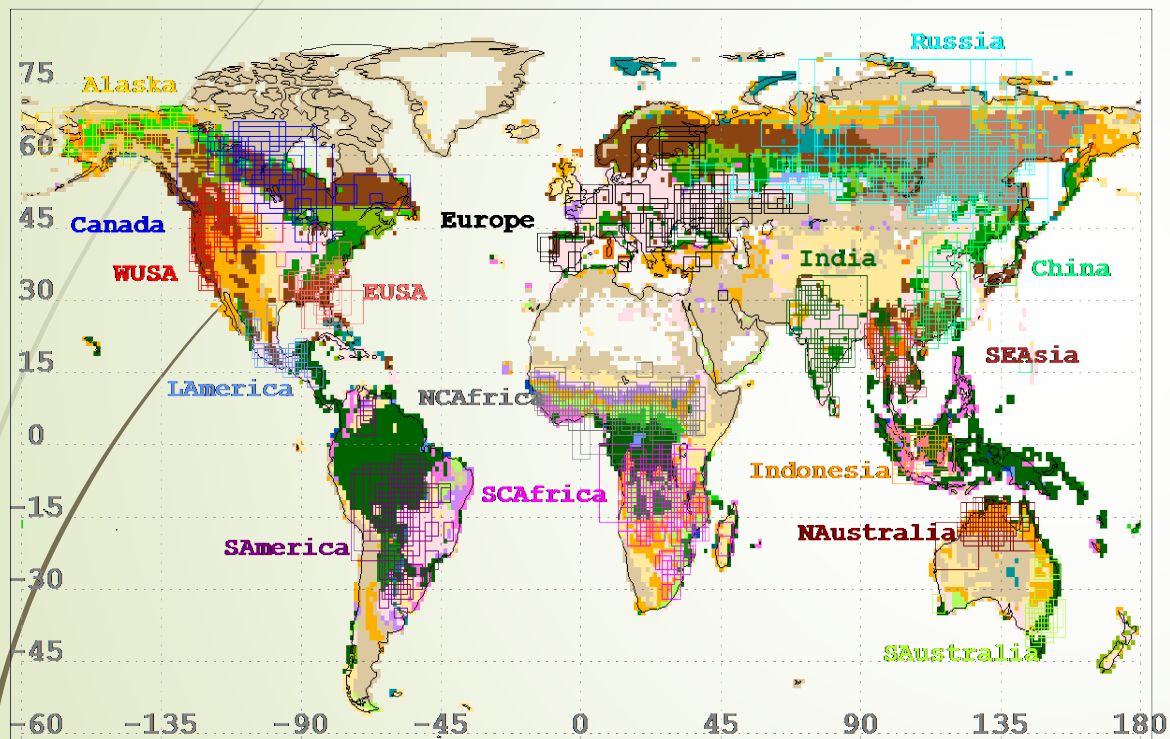
- ▶ We are **providing satellite-based constraints** (globally, stratified by season and biome-related regions) and leading analysis of the results on
 - ▶ **BB source strength** (Phase 1, M. Petrenko)
 - ▶ **BB emission injection height** (Phase 2, M. Val Martin)
- ▶ Year 2008
- ▶ 12 participating models
 - ▶ CAM5
 - ▶ CIFS (CAMS)
 - ▶ ECHAM6.1_HAM2.2
 - ▶ ECHAM-SALSA
 - ▶ GEOS-Chem
 - ▶ GEOS5
 - ▶ GFDL
 - ▶ GOCART
 - ▶ HadGEM3
 - ▶ INCA
 - ▶ OsloCTM2
 - ▶ SPRINTARS

AeroCOM BB Experiment

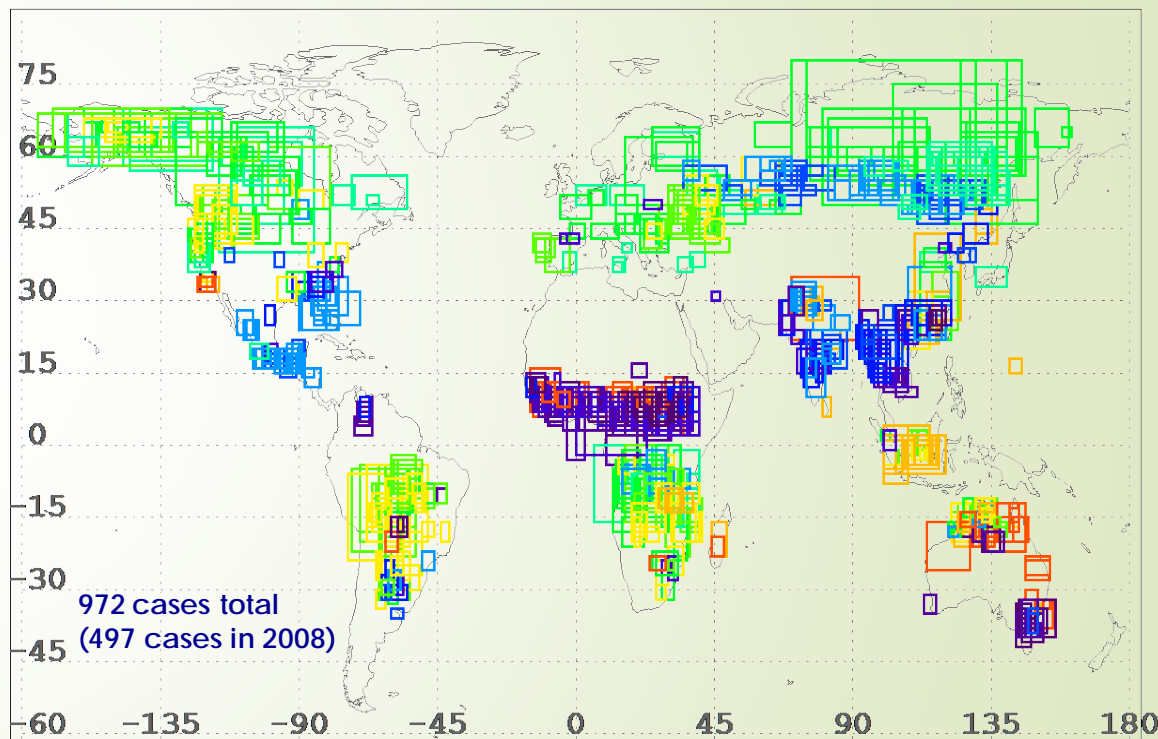
Objectives

- ▶ Inter-compare and **quantify model BB AOD accuracy and diversity**
- ▶ Evaluate factors that define **regional difference** between satellite and model AOD (Phase 1)
 - ▶ provide constructive summary to widely used GFED inventory
 - ▶ Identify modeling aspects to benefit from modification
- ▶ Develop and evaluate the use of measurement-based, statistical smoke injection height distributions, on simulated smoke climate and air quality effects (Phase 2)

Satellite Reference Observational Dataset 2004, 2006-2008



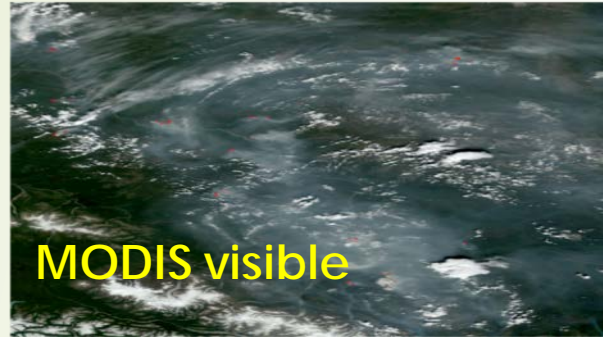
- | | |
|--|---|
| 1 Tree cover, broadleaved, evergreen | 10 Undefined |
| 2 Tree cover, broadleaved, deciduous, clo | 11 Shrub cover, closed-open, evergreen |
| 3 Tree cover, broadleaved, open | 12 Shrub cover, closed-open, deciduous |
| 4 Tree cover, needle-leaved, evergreen | 13 Herbaceous cover, closed-open |
| 5 Tree cover, needle-leaved, deciduous | 14 Sparse herbaceous or sparse shrub cover |
| 6 Tree cover mixed leaf type | 15 Regularly flooded shrub and/or herb. cov |
| 7 Tree cover, regularly flooded, fresh wa | 16 Cultivated and managed areas |
| 8 Tree cover, regularly flooded, saline wa | 17 Mosaic: Cropland/Tree cover/other veg |
| 9 Mosaic: tree cover/other natural veg | 18 Cropland/Shrub and/or grass cover |



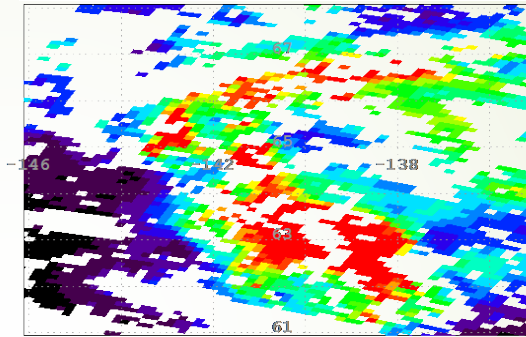
- | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

Month when case was observed by MODIS

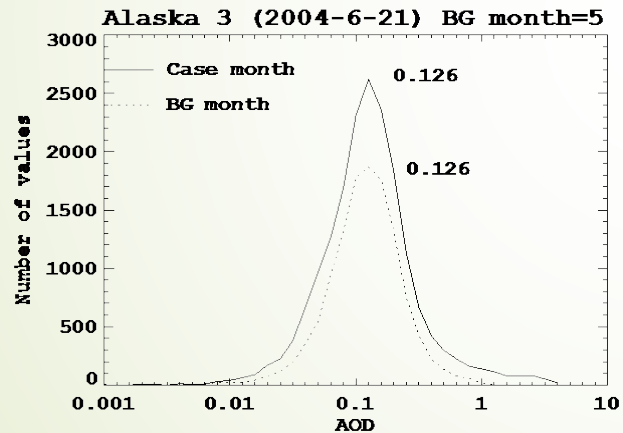
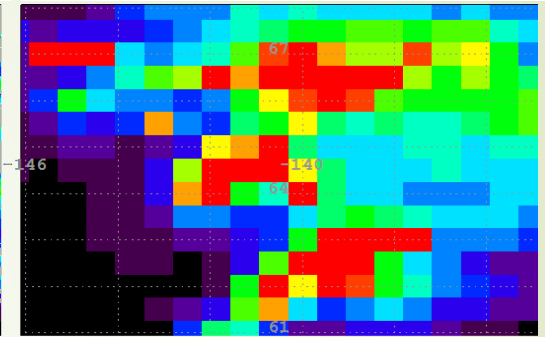
Deriving BB component of MODIS AOD



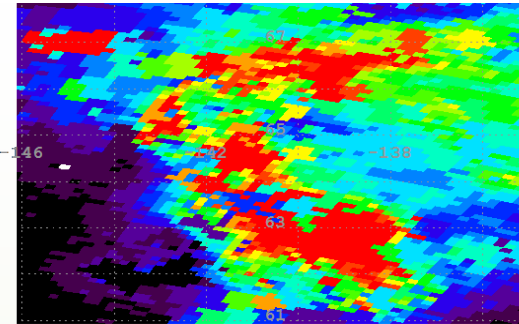
MODIS 10-km Dark target AOD



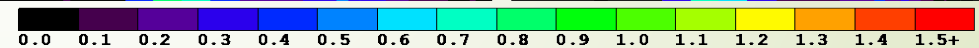
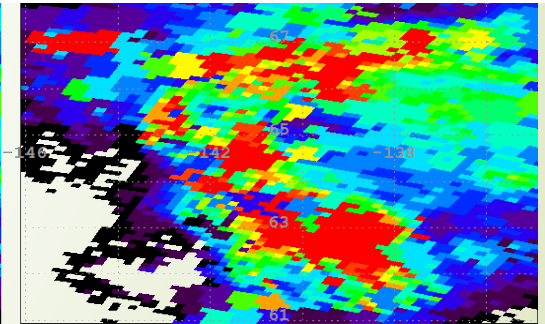
MERRA-2 Assim MODIS AOD



MODIS 10-km patched w. scaled assim.



MODIS BB AOD = full AOD - BG (0.126)

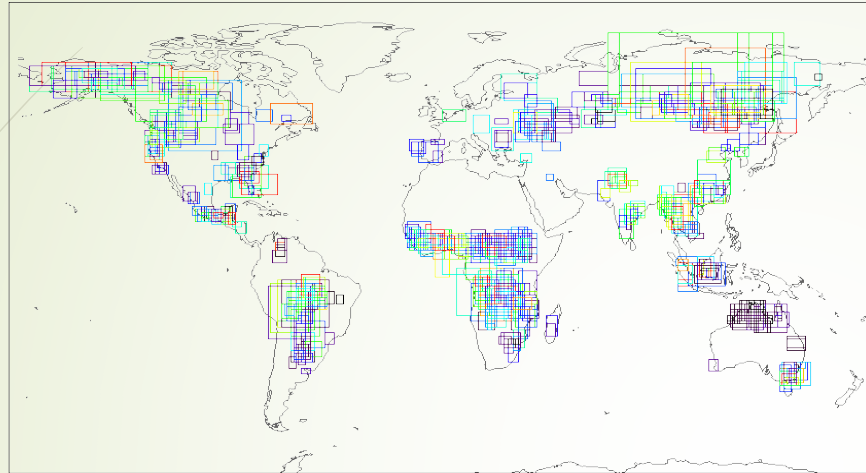


**MODIS BB AOD = Total AOD in the smoke plume
– Background AOD**

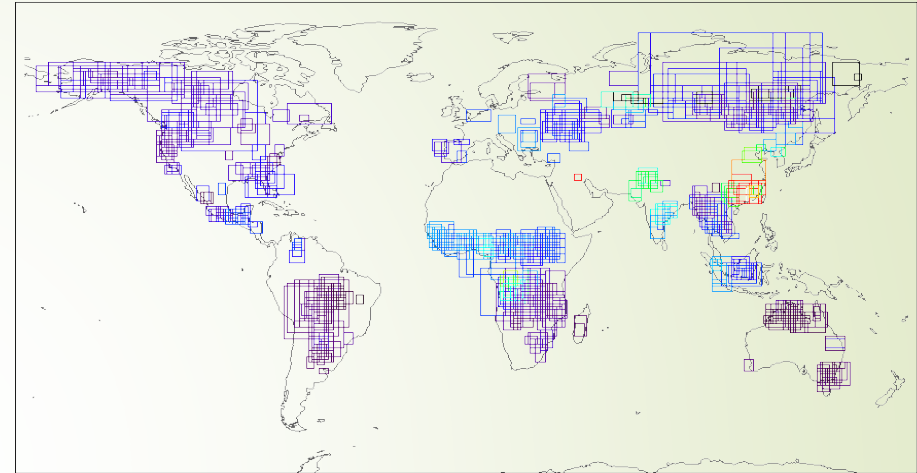
Background AOD is the modal mean AOD for the month (BG month) at the beginning of, or just before, the burning season. (Petrenko et al., 2016 in prep.)

BB component fraction in total MODIS AOD

Mean total MODIS AOD (filled w. adj. assim.) Background AOD from MOD08 statistics

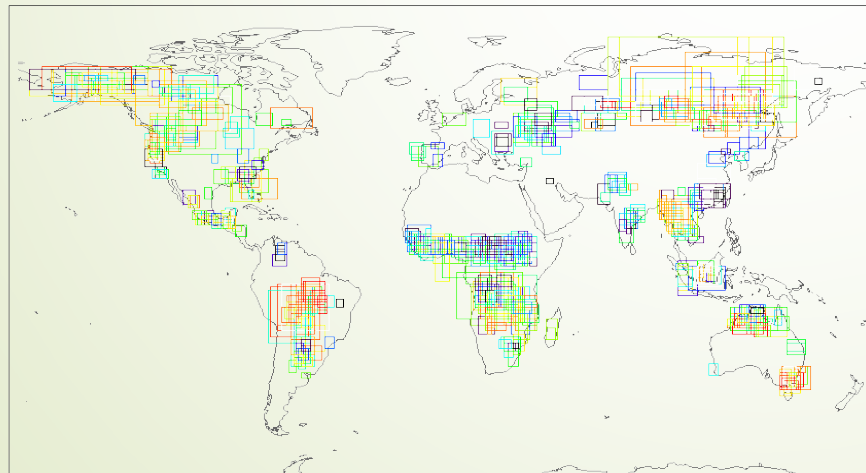


0.00 0.20 0.40 0.60 0.80 1.0000



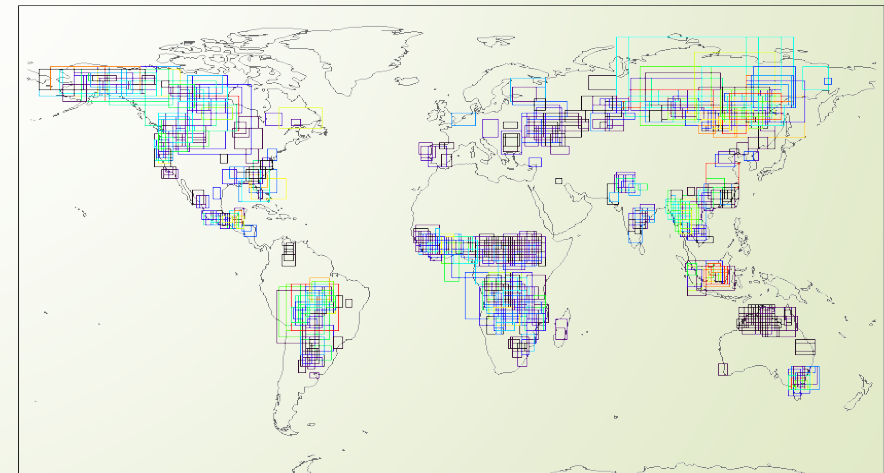
0.15 0.31 0.46 0.61 0.76

BB fraction of total MODIS AOD



0.00 0.20 0.40 0.60 0.80 1.000.00

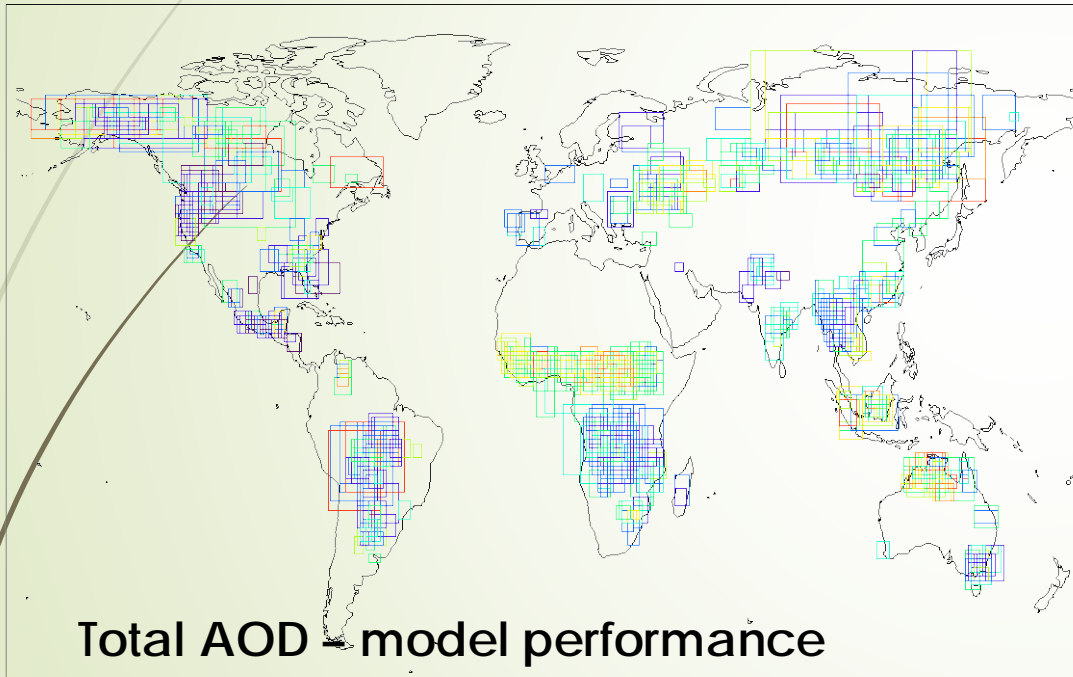
Mean BB AOD (mean total AOD - BG)



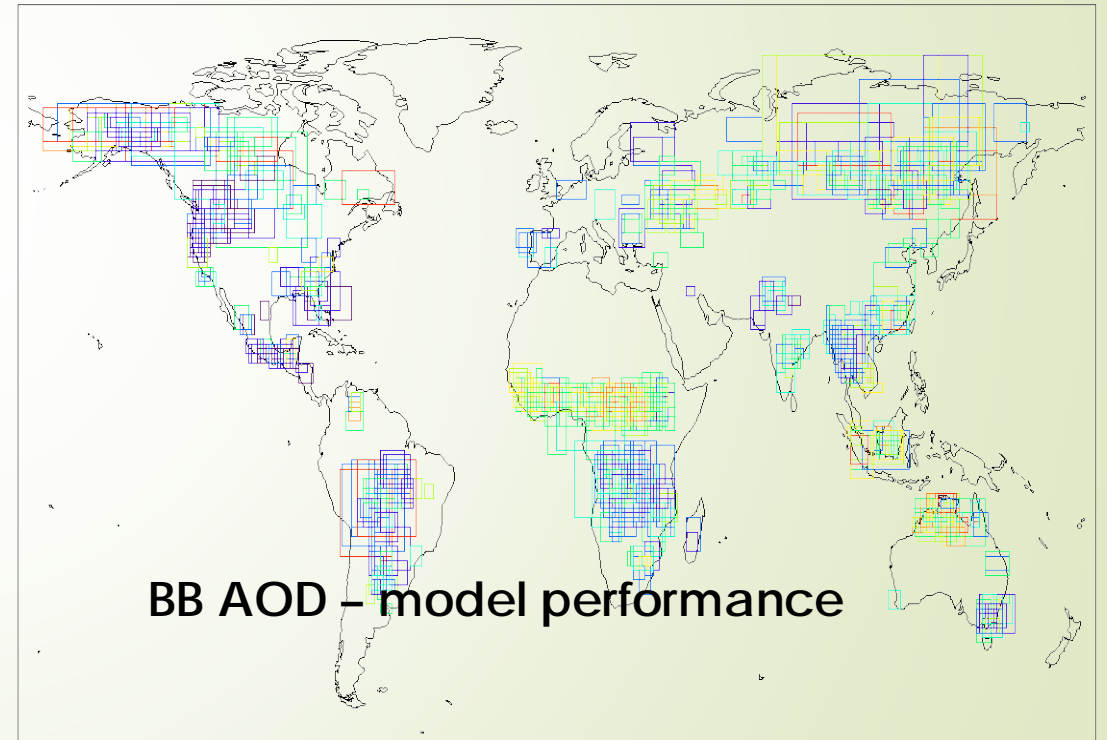
0.00 0.20 0.40 0.60 0.80 1.00

Using snapshots of satellite AOD to constrain model (GOCART) output

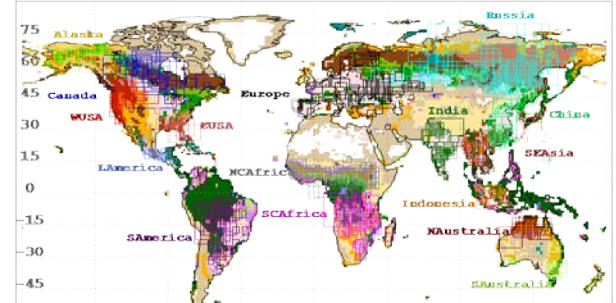
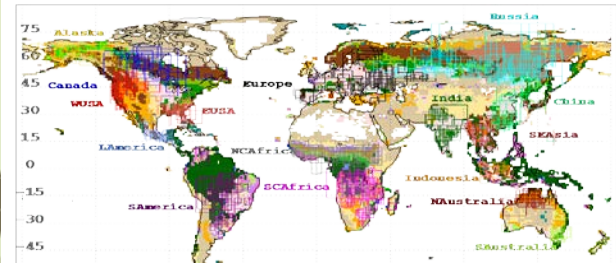
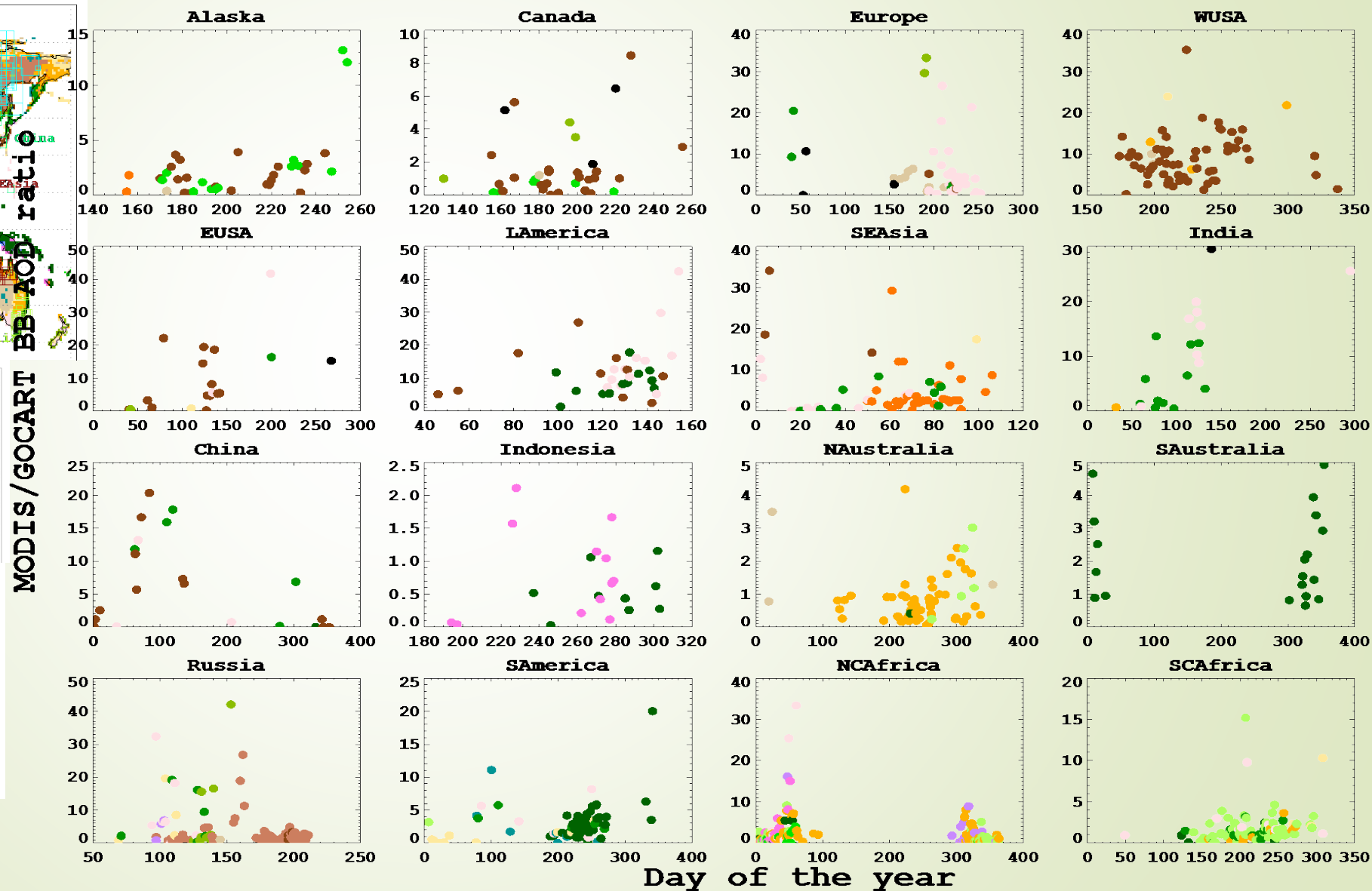
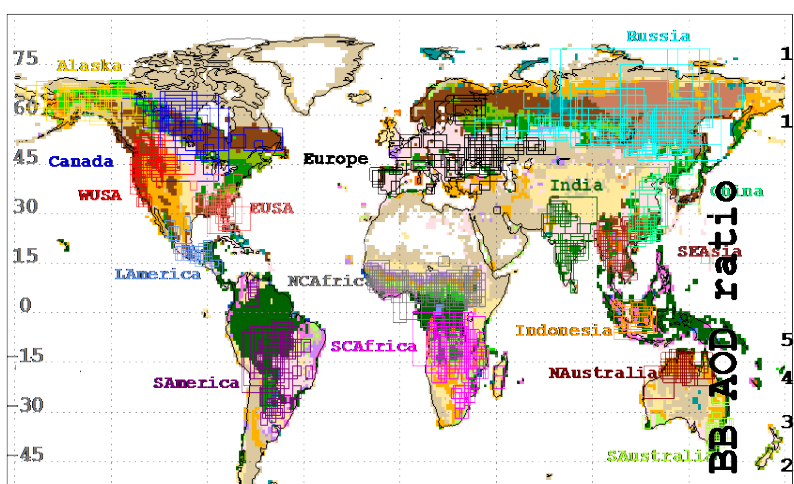
Mean total GOCART AOD / Mean total MODIS AOD (filled w. Assim.)



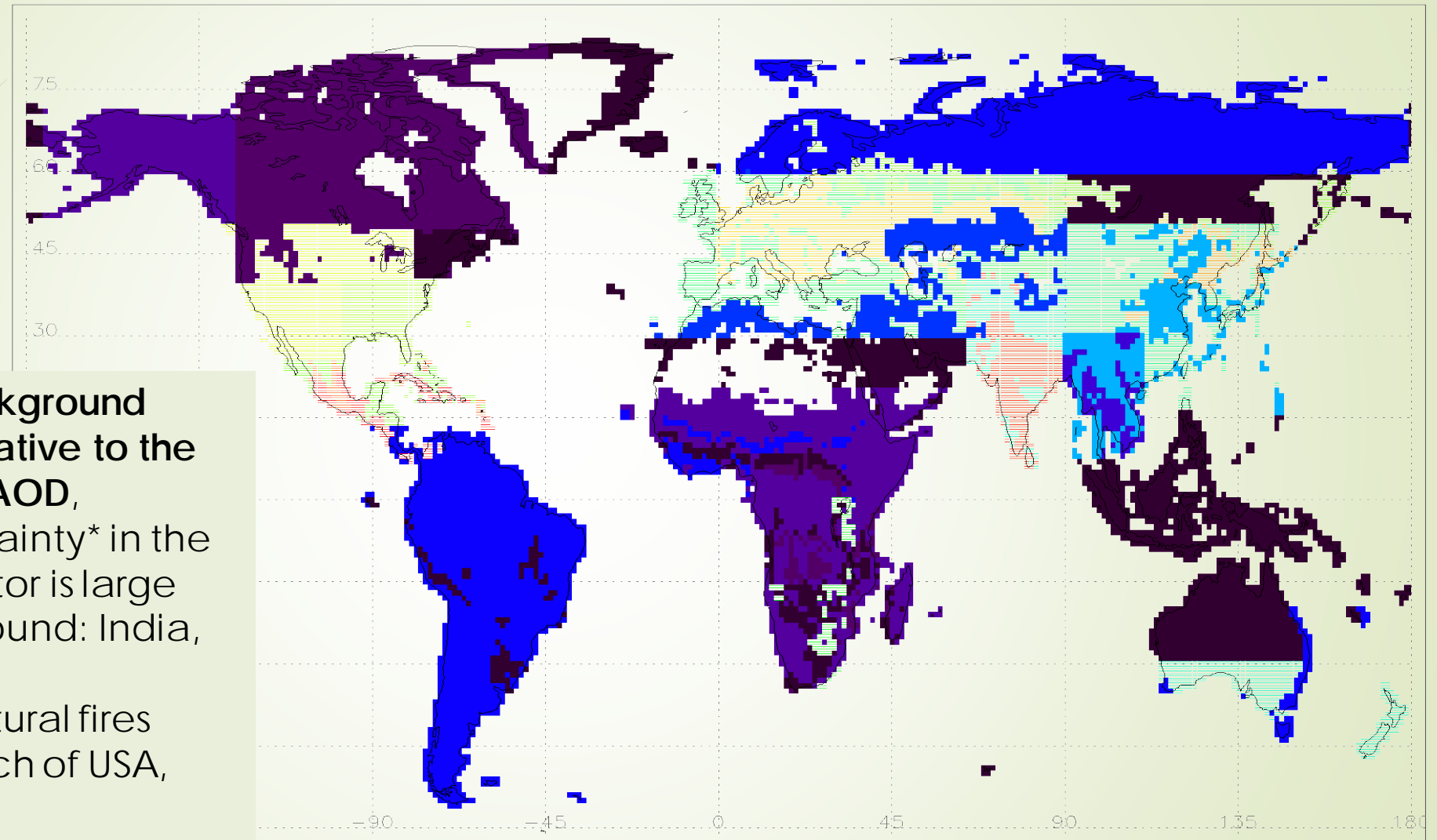
Mean total GOCART AOD / Mean total MODIS AOD (filled w. Assim.)



Deriving regional, vegetation type-related BB emission adjustment factors

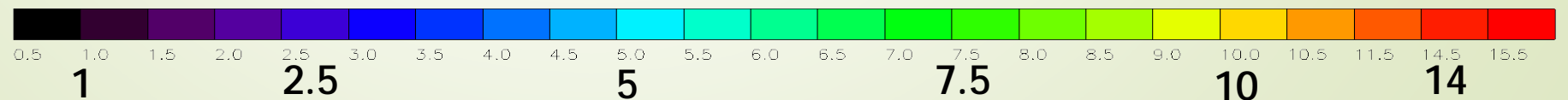


GOCART BB emission adjustment factors



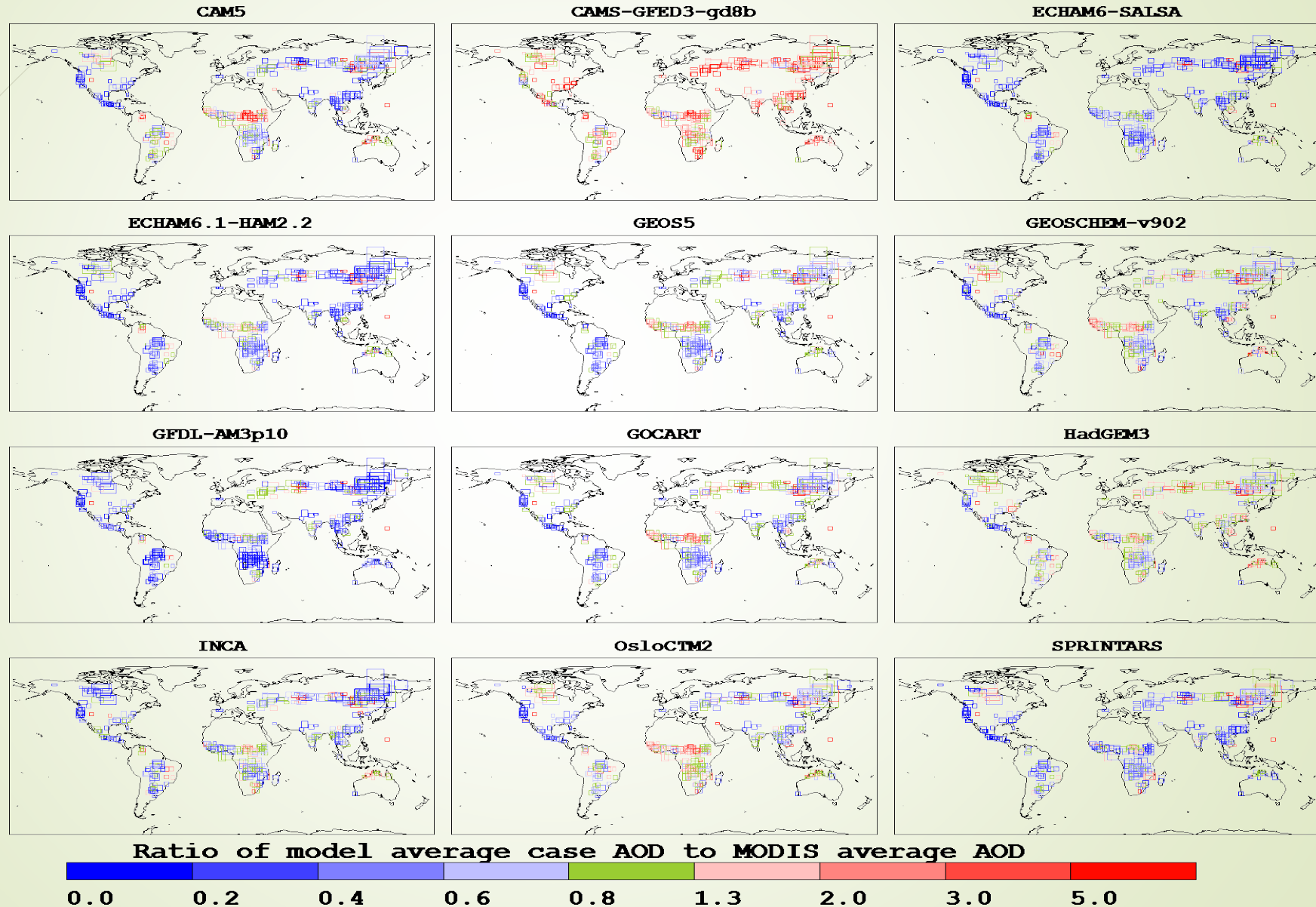
where the **background AOD is high relative to the smoke plume AOD**,
the **uncertainty** in the derived factor is large
-- high background: India, eastern China;
-- small agricultural fires dominate: much of USA, Europe

BB emission correction factor



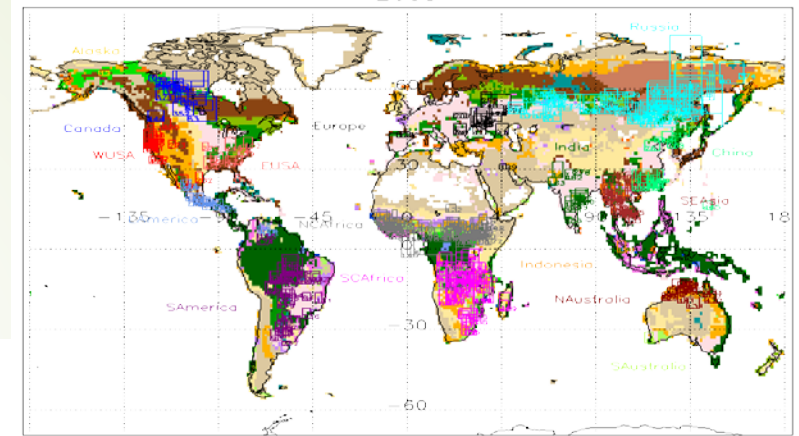
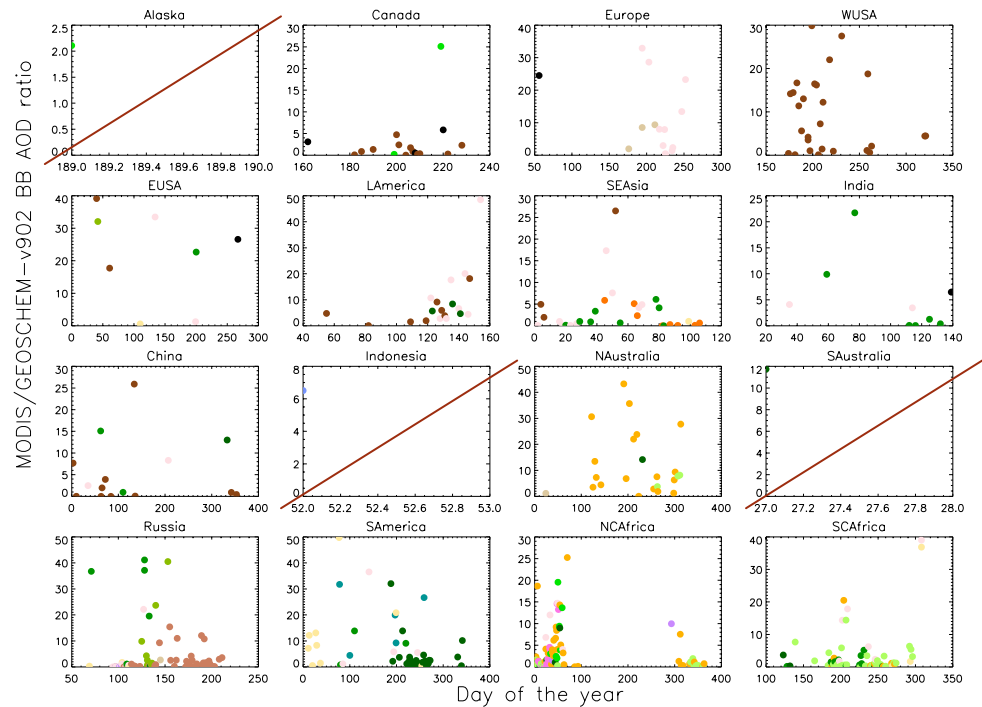
AEROCOM Model intercomparison

Ratio of total model/MODIS AOD (2008)

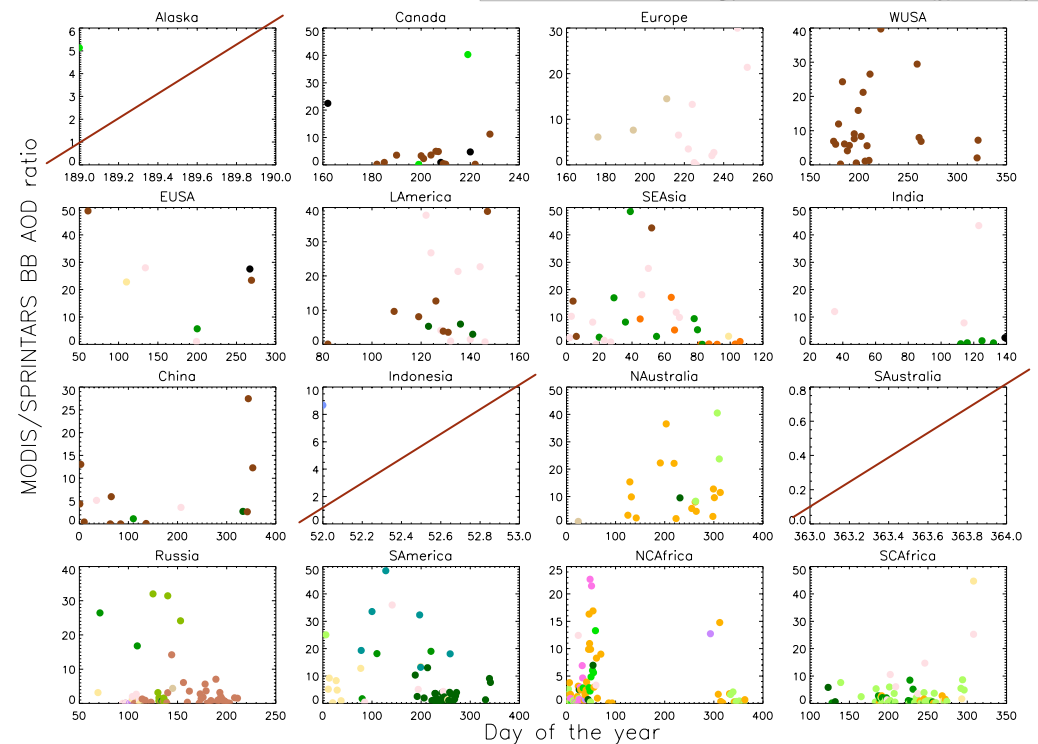


Same method applied to analyze correction factors in AEROCOM models

GEOS-Chem



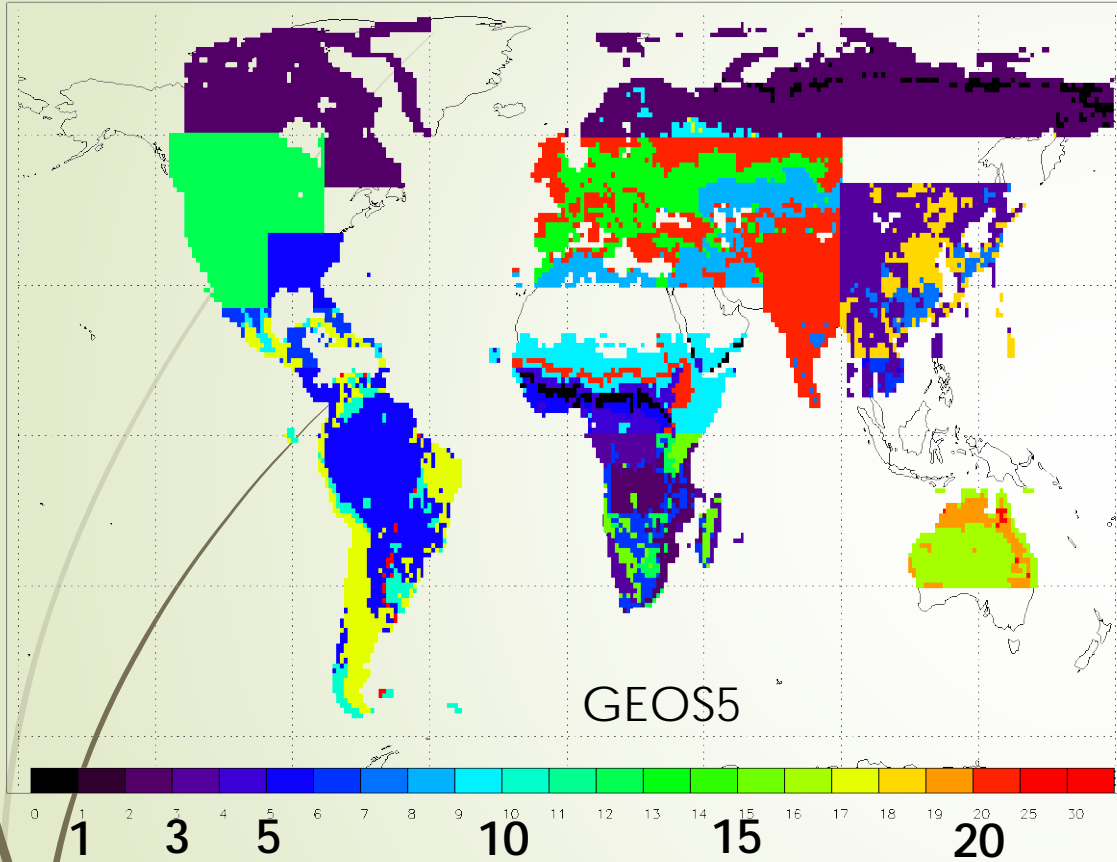
SPRINTARS



2 models as example, all 12 are available

BB Adjustment Factors for all participating models

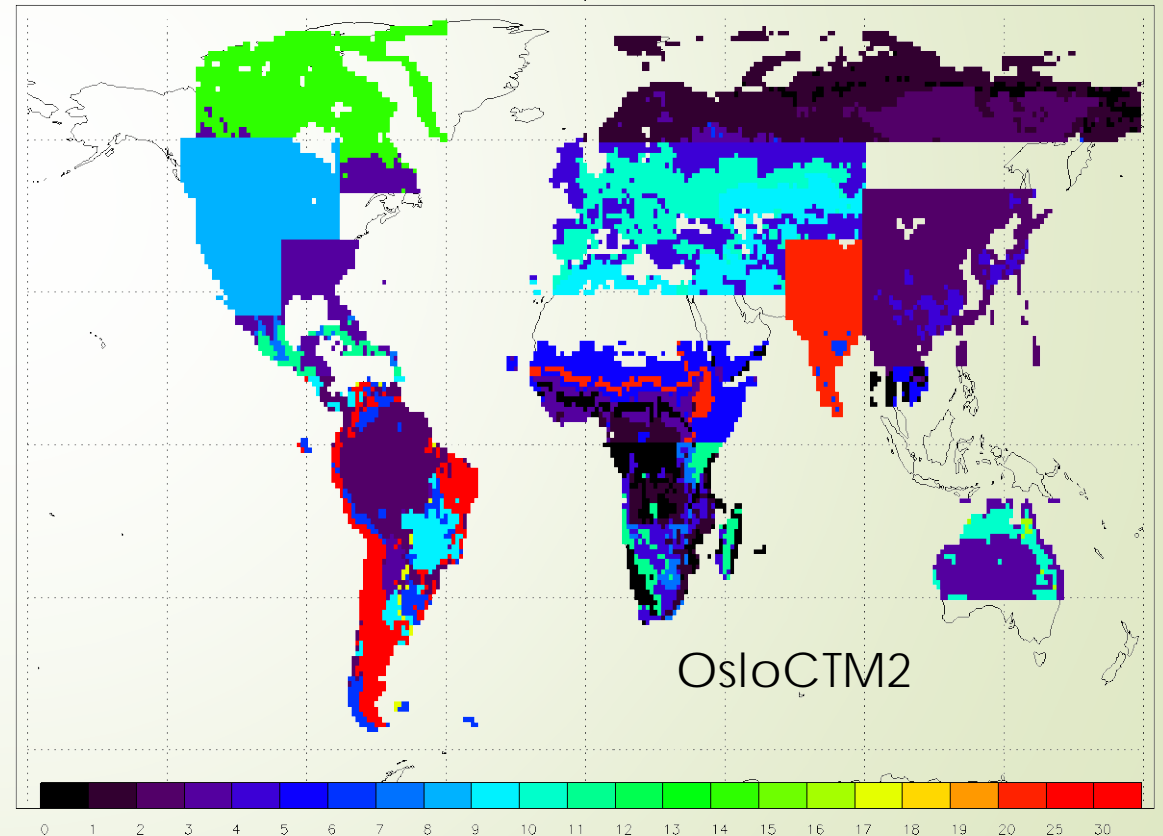
GEOS5 BB adjustment factors



2 models as example, all 12 are available

- **Caution:**
- Ratios of small numbers (uncertainties are high)
- Number of cases in some regions are within ~10

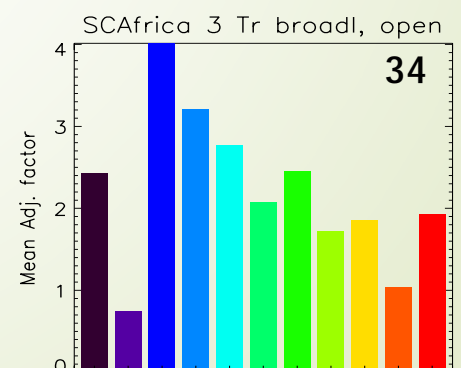
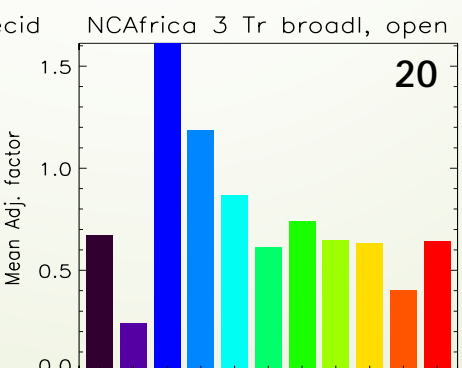
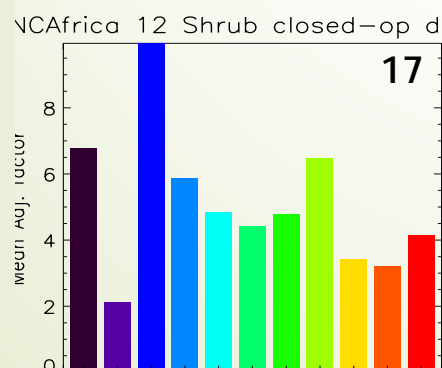
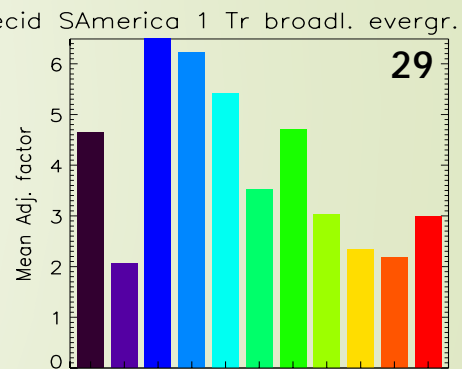
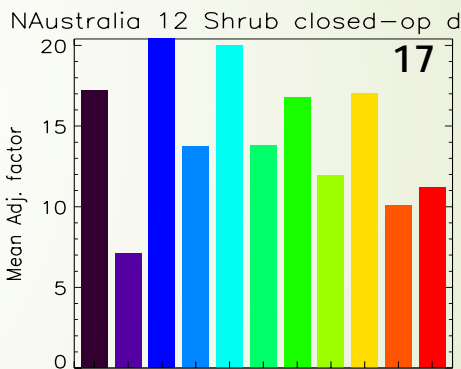
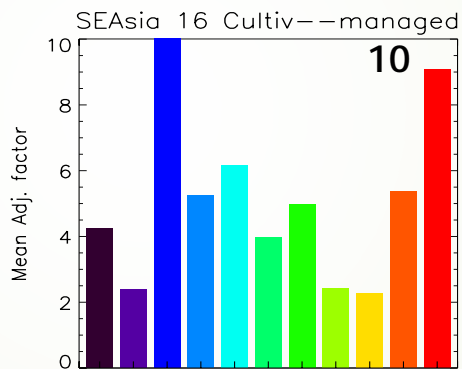
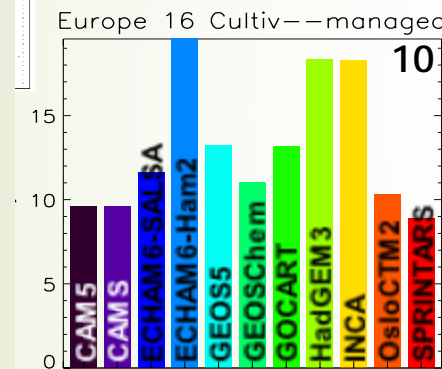
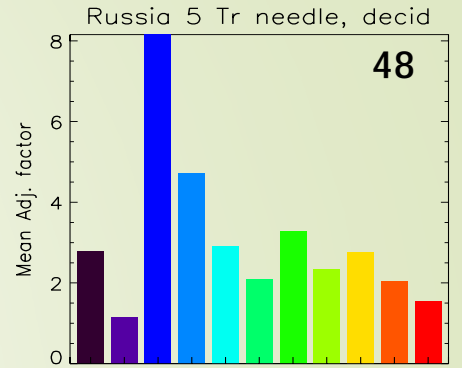
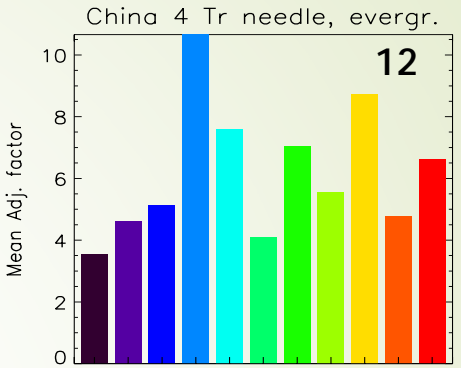
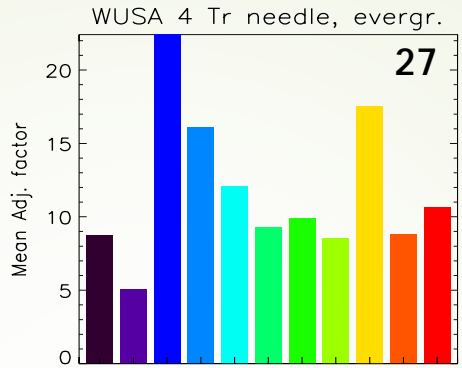
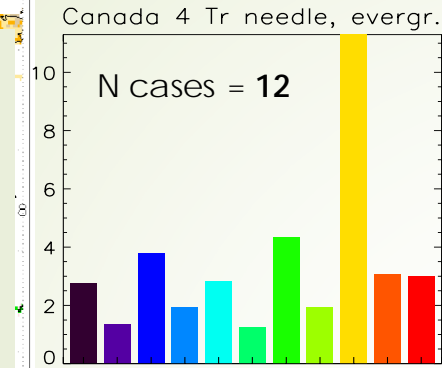
OsloCTM2 BB adjustment factors



BB Adjustment factors in [some] regions for AEROCOM models



- Systematic multi-model behavior reveals interesting patterns
- Stratification by **both region and vegetation type** is important
- Variation of the adjustment factors within region/biome is high
- **Regionally important factors** exist that define model-to-MODIS adjustment factors



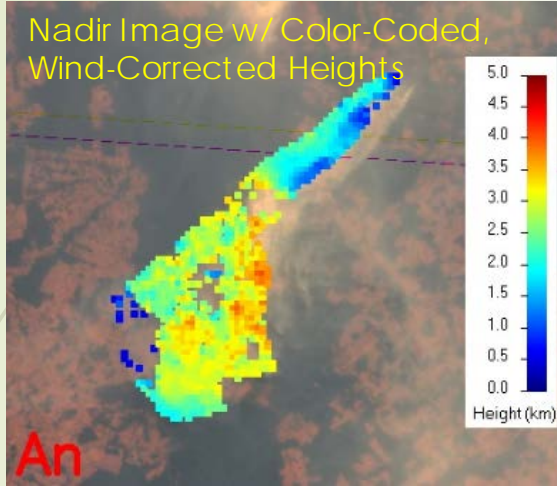
- CAM5**
- CAMS**
- ECHAM6-SALSA**
- ECHAM6-Ham2**
- GEOS5**
- GEOSChem**
- GOCART**
- HadGEM3**
- INCA**
- OsloCTM2**
- SPRINTARS**

Please upload the rest of the files to AeroCom servers by the end of November (This concludes model inputs for BB experiment Phase 1)

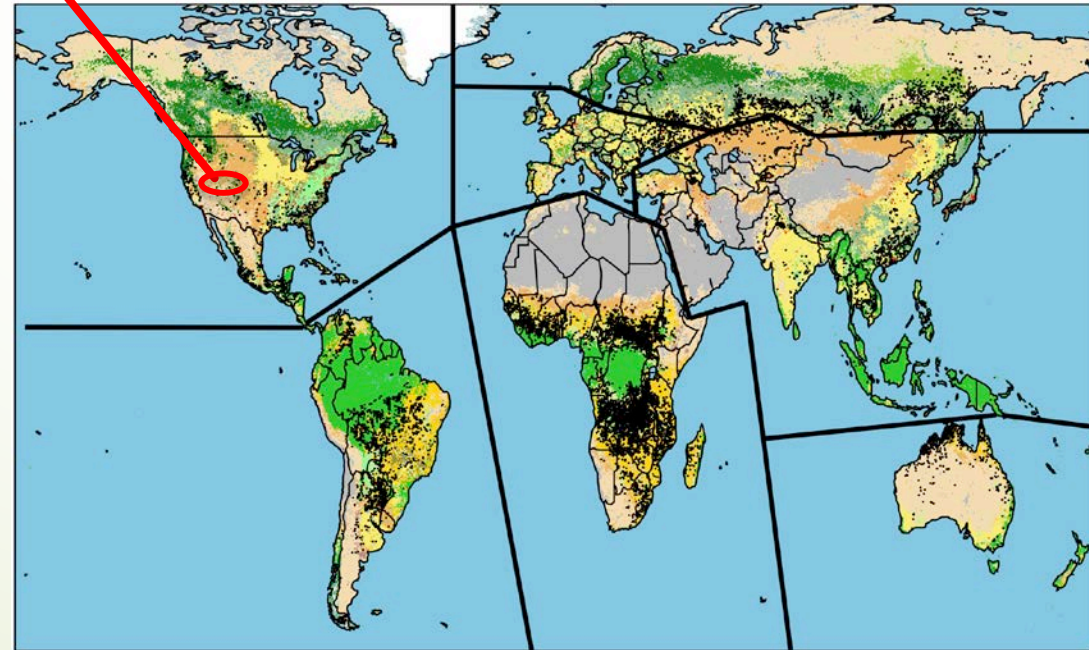
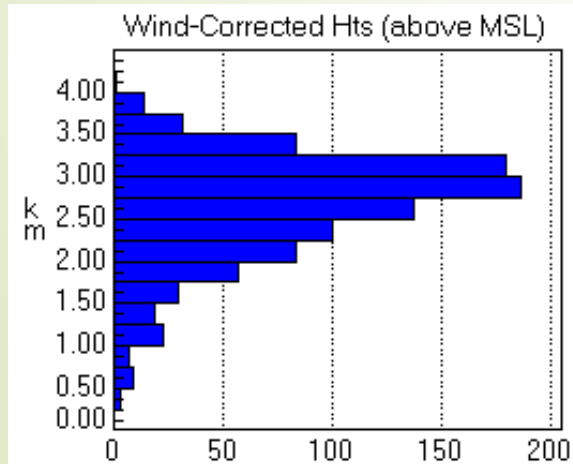
- ▶ GLOFIR0 (noBB) and GLOFIR1 (GFED3 x 1.0) runs
- ▶ Variables needed:
 - ▶ 2D:
 - ▶ Emissions of all model species (emiXXX)
 - ▶ Dry and wet deposition (dryXXX, wetXXX)
 - ▶ PBL height (Zmlay)
 - ▶ 10-m wind speeds (umidpbl, vmidpbl)
 - ▶ Angstrom exponent or blue and red AOD
 - ▶ Aerosol absorption optical depth
 - ▶ 3D:
 - ▶ Species concentrations, or mix.ratio+air.temp.+density+grid_cell_height (concXXX)
 - ▶ Aerosol extinction
 - ▶ Potential temperature (theta)
 - ▶ Grid box edges, latitudes, or levels and conv.coeff.

Thank you for the
filled Questionnaires!

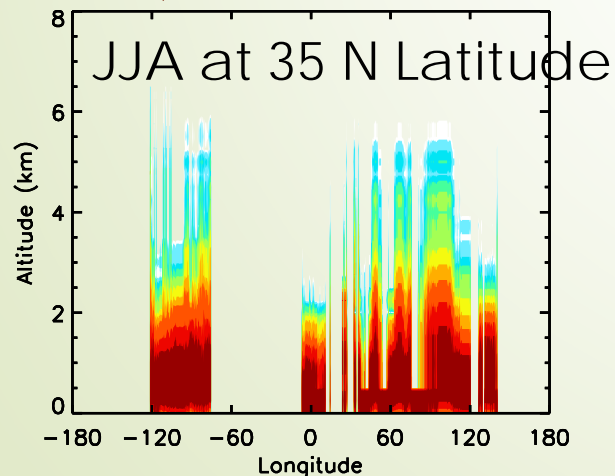
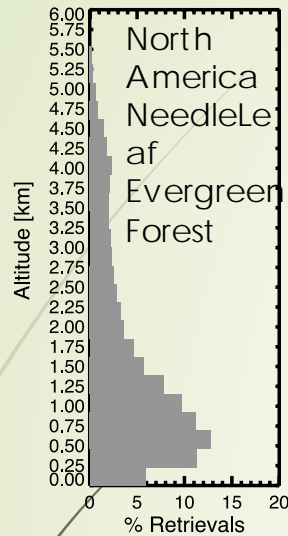
Biomass Burning Experiment PHASE 2: Fire Emission Injection Heights (by Maria val Martin)



About 16,000 smoke plumes were digitized with MINX for 2008. Each plume was operator-processed using MINXv4 and quality controlled.

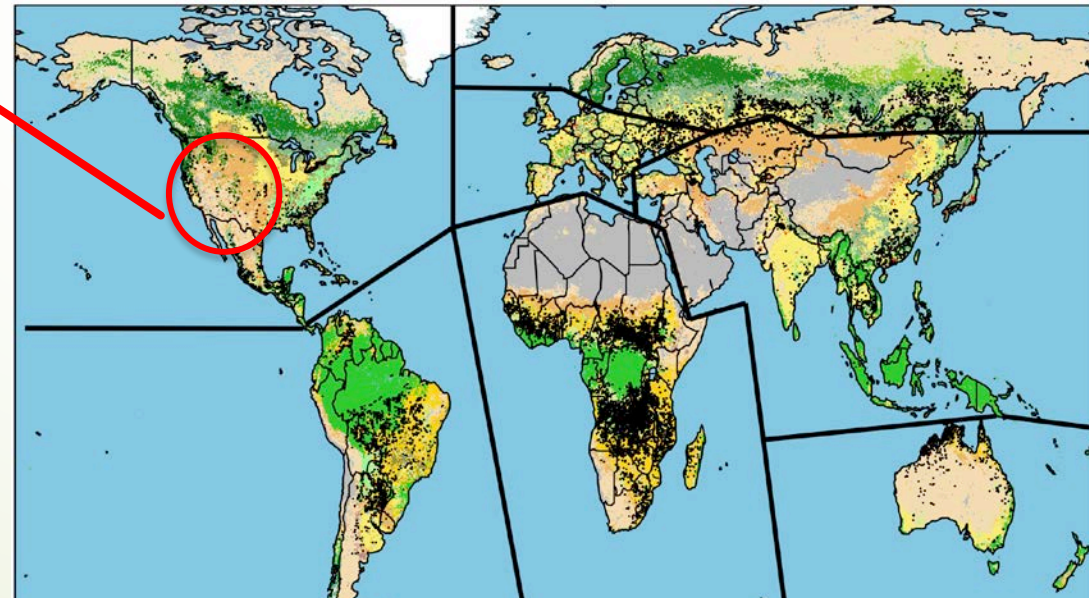


Biomass Burning Experiment PHASE 2: Fire Emission Injection Heights (Maria Val Martin)



We developed a parameterization with fire emission fractions by altitude, region, ecosystem and season from statistical summaries of worldwide MISR plume height observations

We invite AeroCom participants to run their models with these injection-height constraints



More information in poster by Maria Val Martin



Models BB AOD

