**Improving the simulations of biomass burning smoke and anthropogenic dust in E3SM**

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Motivation

• Goal: to interactively calculate fire plume injection heights based on fire properties and ambient meteorological conditions in the model.

• For ne30 res. application

• In one ne30 grid, difference in fire

intensities of many fires (fire size, heat release) leads to different injection

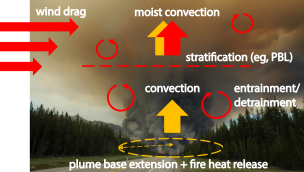
heights – the need for describing the fire intensity distribution.

ne30 grid

• Physics of 1D plumerise model • Embedded in host model (WRF Chem, E3SM, etc.)

• Solving 6 governing equations of �, T, and m.m.r. of cloud hydrometeors. • Inputs for initial conditions: fire size

and fire heat release, and ambient conditions (T, �, �, U, V, qv)

Paugam et al., 2016

Approach – Scaled-FRP and FRP×10 in this study • Four FRP bins + MODIS observations

• 0~10MW : 14% of BB emis.

• 10~100MW: 66% of BB emis.

• 100~500MW: 17% of BB emis.

• >500MW: 3% of BB emis.

• New emission files

• Total emissions of BC and POM are partitioned to these four FRP bins as four sectors

(emission∝ total FRP, Ichoku and Kaufman, 2005 ). • Note: vert. dist. of BB aerosols are still prescribed in the files.

F

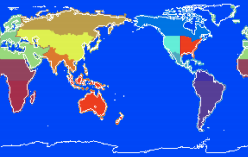
D

• In scaled-FRP method, we need to find maximum FRP over a certain area or biome and long periods (Val Martin et al., 2012). MaxFRP corresponding to 1 km2 of fire size

• In our study, MaxFRP is a function of (GFED regions, PFTs, months)

• We incorporate the LUT in the code and calculate MaxFRP before the plumerise calculation.

GFED geographic regions



P

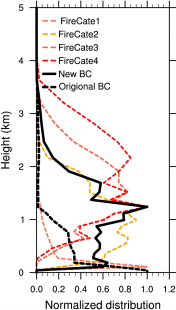
Preliminary results

Fire emissions % of four categories

Calculated and prescribed BC profiles

FRP: <10 MW FRP: 10-100 MW

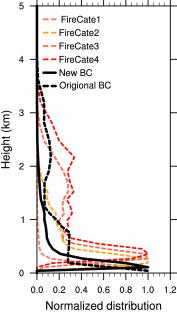
FRP: 100-500 MW FRP: >500 MW

**S. Africa** 

**Jan.7,2000**

plumerise

old

**N. Africa Jan. 7 2000** 

Preliminary results • Burden of mode 4 (mg/m2)

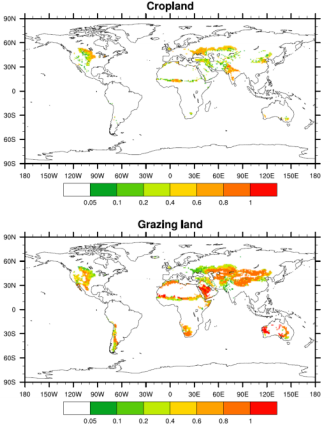
• Surface BC/POM emissions are turned off

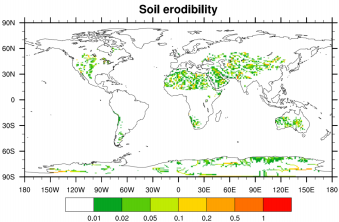
• Higher burden over SE. Asia, Australia, and Southern Africa.

• Lower burden over N. Africa

Plumerise Original

**Anthropogenic dust emission**

**Only at bare soil (Zender et al. 2003 ) Landuse (year 2010, from HYDE 3.2.1)** 

**Only regions with** 

**leaf area index<0.5**

**are plotted**

**Approach to account for dust emissions due to land use**

**(anthropogenic dust) by modifying the soil erodibility S in**

**dust emission parameterization:**

**Snew = Sdefault + C \* fland\_use**

**fland\_use: landuse fraction** from Goldewijk et al. (2017): Historical

Database of the Global Environment (HYDE version 3.2). Resolution

at 0.0833 degree (~9 km), 10,000 BCE to 2015 CE

Experimental design

• Zender et al. (2003) dust emission scheme is used, with SST and sea ice prescribed

**Experiments Soil erodibility (S)a Leaf and stem area index threshold (L+S)t**

**Threshold of S (St)**

• Where C represents tuning factor for

**Default** Geomorphic S (natural) 0.3 0.1

**Baseline** Geomorphic S (natural) 0.5 0.001 **LU\_1** Geomorphic S (natural) plus

land use fraction (C=1) 0.5 0.001

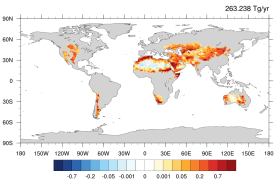
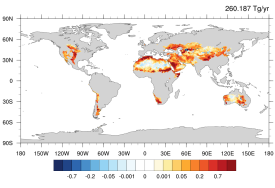
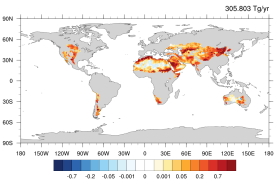
**LU\_001** Geomorphic S (natural) plus

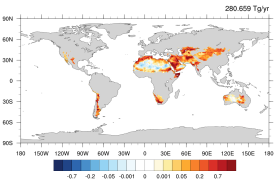
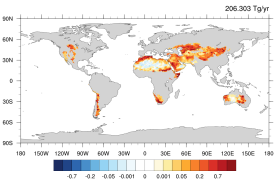
land use fraction (C=0.01) 0.5 0.001

• Model results are 2010-2012 averages with 2009 as spin-up

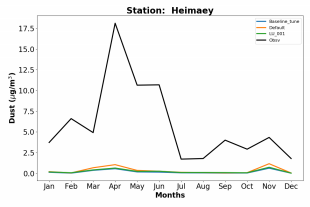
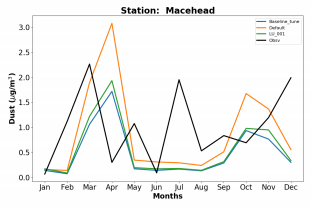
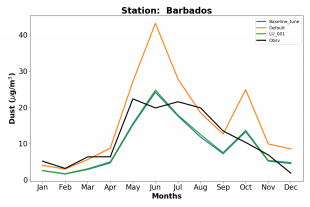
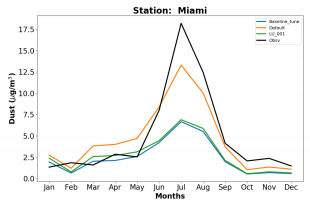
anthropogenic vs. natural dust emissions

Emissions Difference between LU\_001 and Baseline

263.2 65.0 76.5 Annual Dec/Jan/Feb Mar/Apr/May

70.2 51.6

Jun/Jul/Aug Sep/Oct/Nov

63.4˚N, 20.3˚W 13.2˚N, 59.4˚W 53.3˚N, 9.9˚W 25.8˚N, 80.3˚W 28.2˚N, 177.4˚W 28.3˚N, 16.5˚W