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Biomass burning in Southeast Asia and their impacts on convective systems

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Biomass burning in Southeast Asia and their impacts on convective systems

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https://www.nasa.gov/images/content/490656main_pyrocb2-720.jpg

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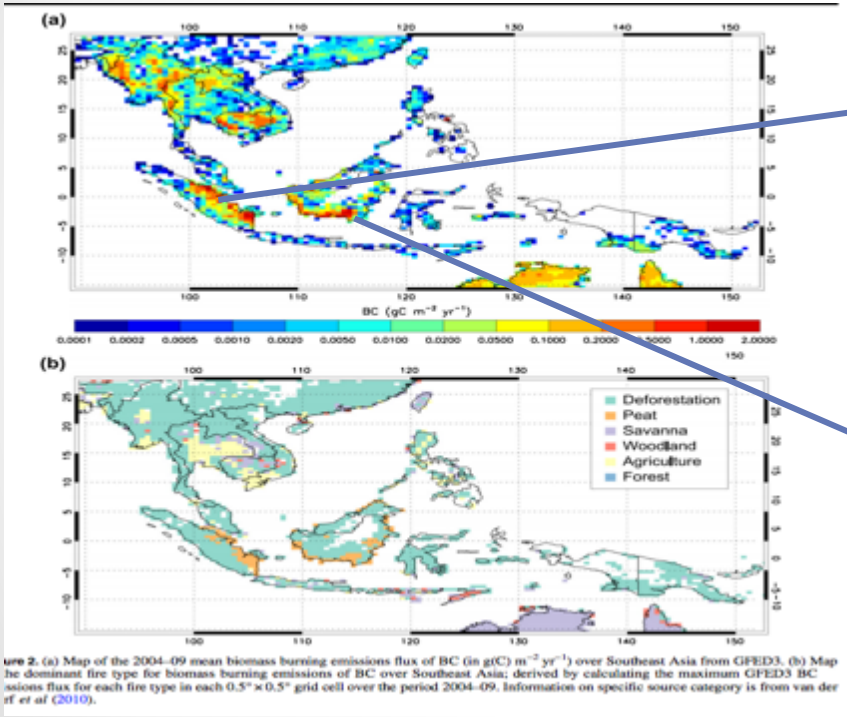
Singapore-MIT Alliance for Research and Technology

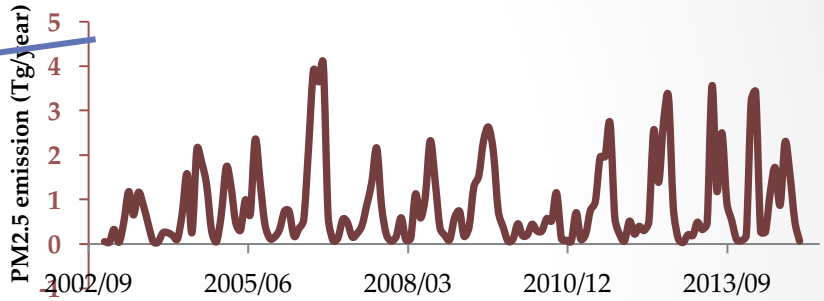
Introduction – Biomass burning in Southeast Asia



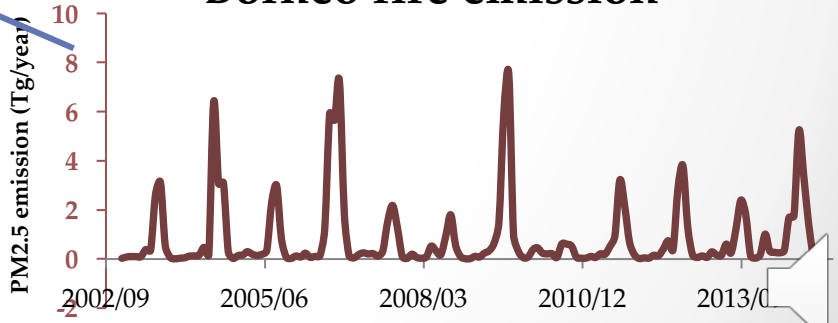
ure 2. (a) Map of the 2004–09 mean biomass burning emissions flux of BC (in g(C) m^{-2} yr^{-1}) over Southeast Asia from GFED3. (b) Map he dominant fire type for biomass burning emissions of BC over Southeast Asia; derived by calculating the maximum GFED3 BC ssions flux for each fire type in each 0.5° × 0.5° grid cell over the period 2004–09. Information on specific source category is from van der rf *et al* (2010).

(Reddington et. al, ERL 2014)

Sumatra fire emission



Borneo fire emission



(Lee et. al, ACP 2017)

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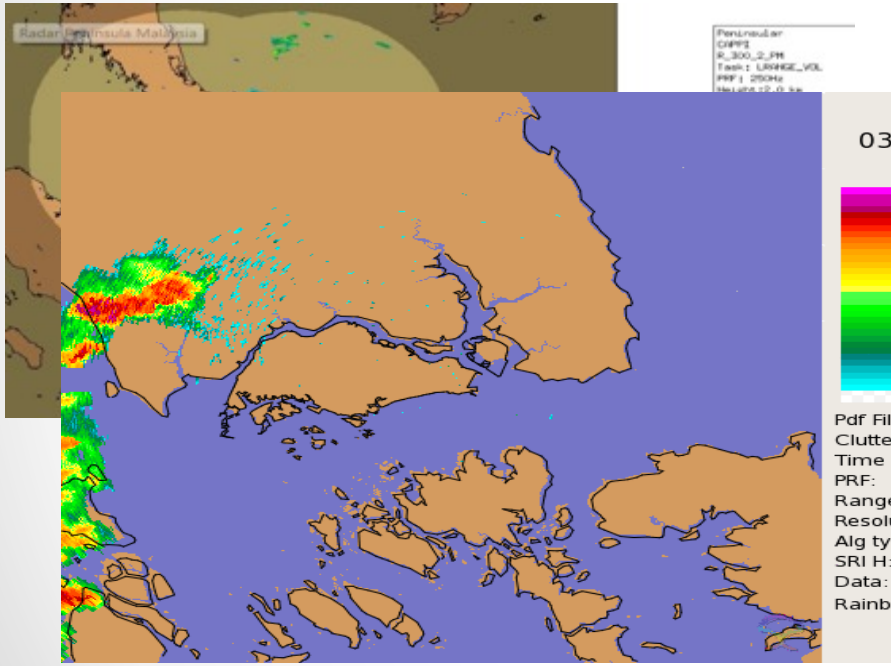
Introduction – Convective system in Southeast Asia

Sumatra squall



Diurnal rainfall over Borneo

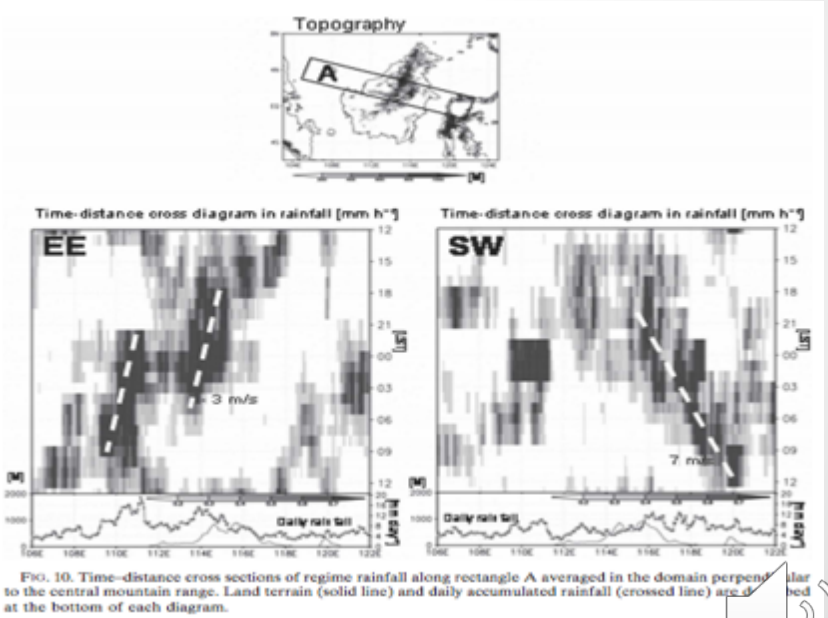


FIG. 10. Time–distance cross sections of regime rainfall along rectangle A averaged in the domain perpendicular to the central mountain range. Land terrain (solid line) and daily accumulated rainfall (crossed line) are displayed at the bottom of each diagram.

Ichikawa and Yasunari (J. Climate, 2005)

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Methodology – Model configuration

- Model: **WRF-Chem v3.6.1**
- Emission inventories:
  - Fossil fuel emissions: **2008 REAS emission**
  - Biomass burning emission: **2008 FINNv1.5 fire emission**
- Domain resolution: **25/5 km**
- Simulation period: **May–September, 2008**. May is spin-up run.
- Experimental design:
  fossil fuel emission only (**FF**) vs. fossil fuel + biomass burning emission (**FFBB**)
- Analyzed domain:
  Sumatra (r1): 0~6 Lat, 97~103 Lon.
  Borneo (r2): -1~5Lat, 109~115 Lon

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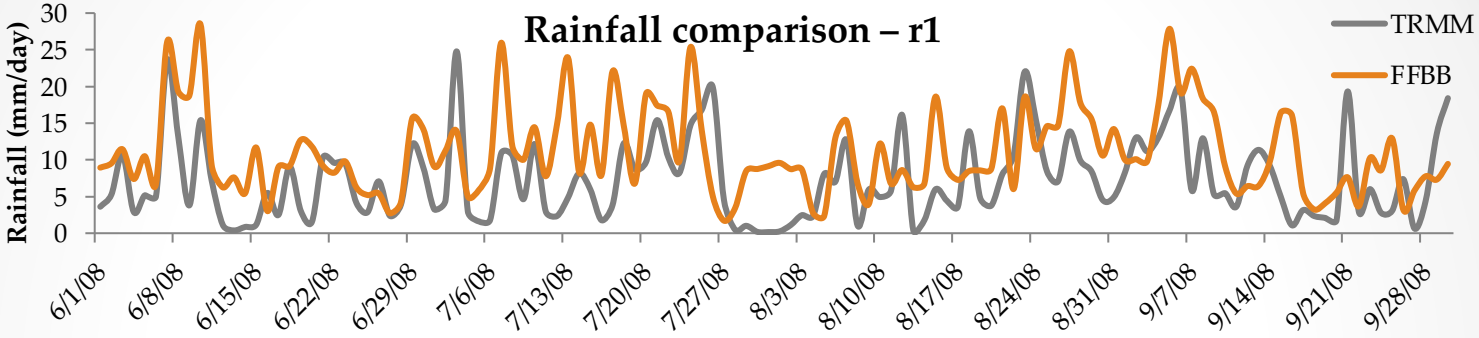
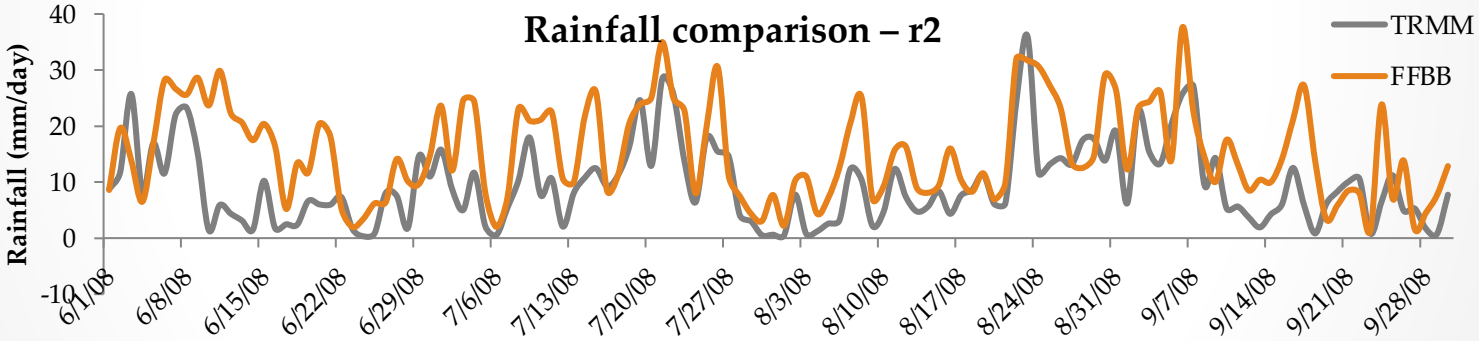
Model evaluation – Rainfall





Mean (mm/day)	Sumatra & Malay Peninsula (r1)	Bourne (r2)
TRMM	7.21±5.54	9.56±7.20
FFBB	11.01±5.90	15.40±8.49

Correlation	Sumatra & Malay Peninsula (r1)	Bourne (r2)
TRMM vs. FFBB	0.435	0.639

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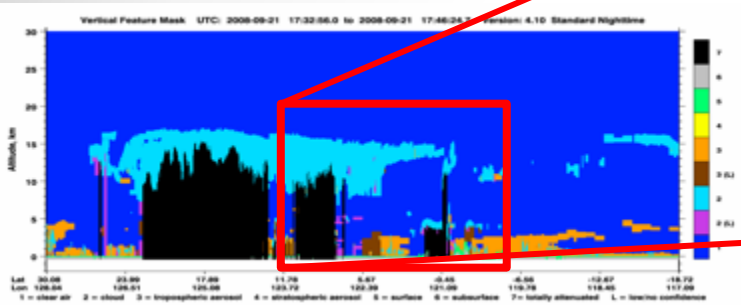
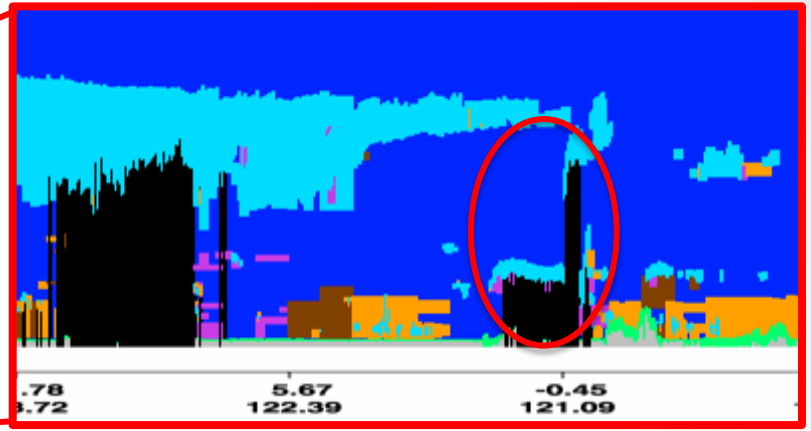
Model evaluation – convection

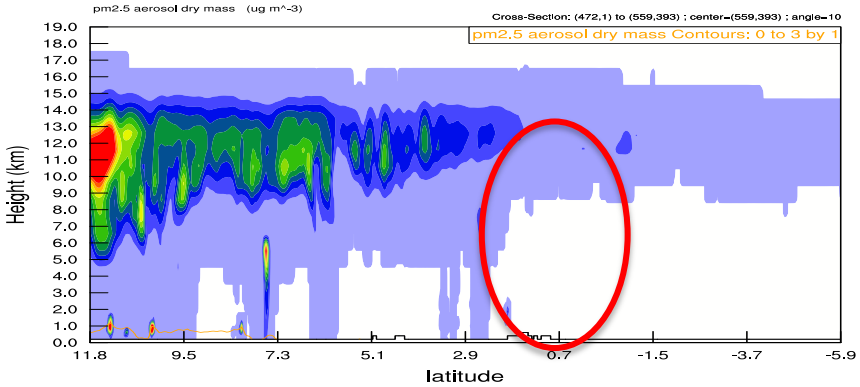




2008-09-21_18:00:00

Init: 2008-05-01_00:00:00
Valid: 2008-09-21_18:00:00

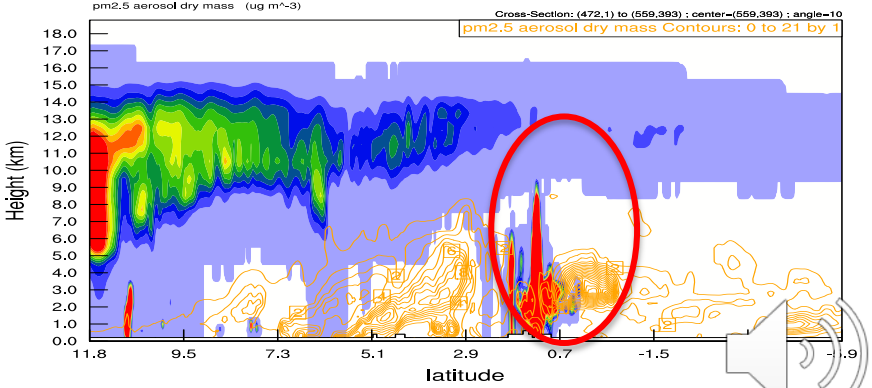
FF

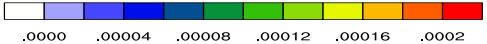


2008-09-21_18:00:00

Init: 2008-05-01_00:00:00
Valid: 2008-09-21_18:00:00

FFBB





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Longer term statistics – convection events during fire periods

Sumatra & Malay Peninsula (r1)
6/10 ~ 6/ 20
6/25 ~ 6/28
7/4 ~ 7/7
7/27 ~ 8/20
9/17 ~ 9/27

Borneo (r2)
6/21 ~ 6/27
8/3 ~ 8/8
9/10 ~ 9/30

Total **54** convection events during the fire periods

Total **35** convection events during the fire periods

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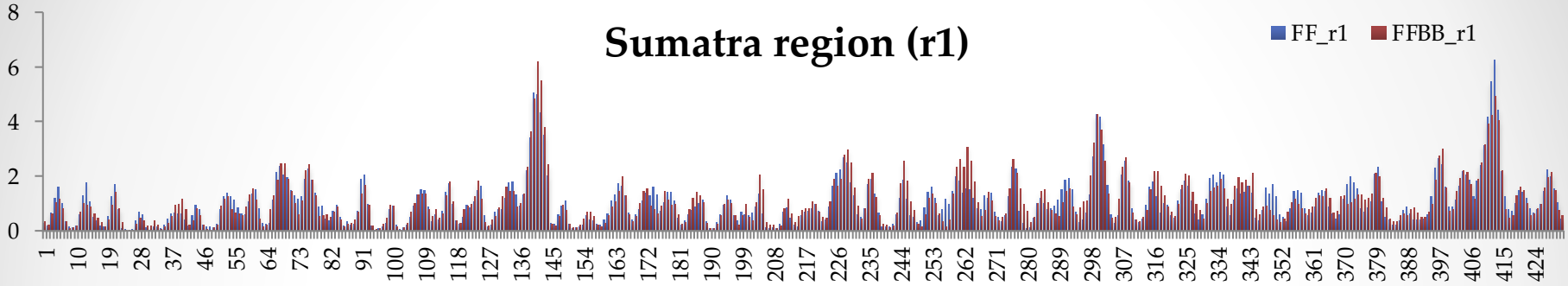
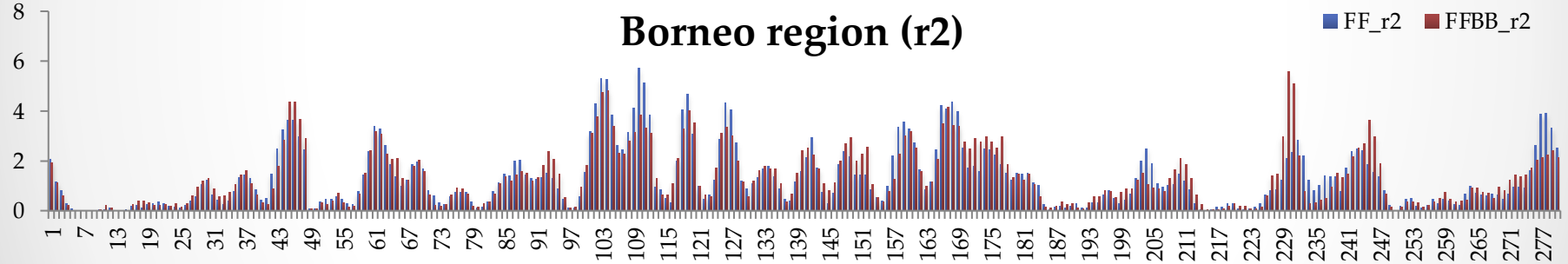
3 hourly rainfall for convection events





Mean (mm/3hrs)	FF	FFBB
Sumatra & Malay Peninsula (r1)	1.06±0.85	1.09±0.86 (+3%)
Borneo (r2)	1.32±1.20	1.35±1.14 (+2%)

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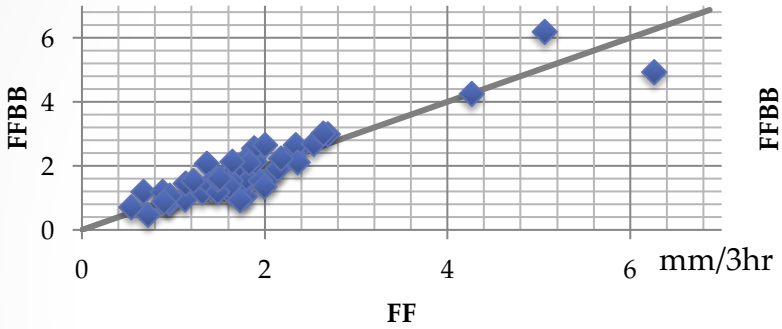
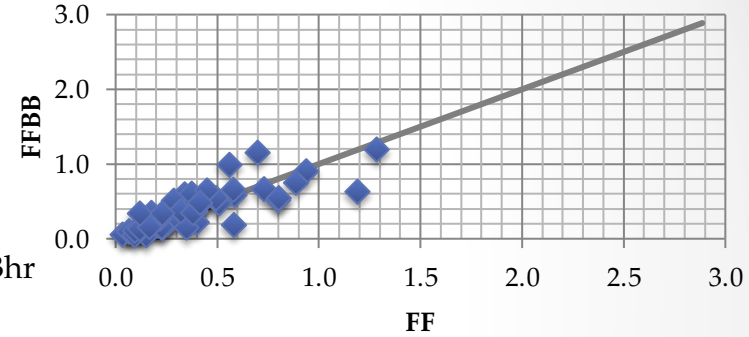
Daily maximum and minimum rainfall comparison

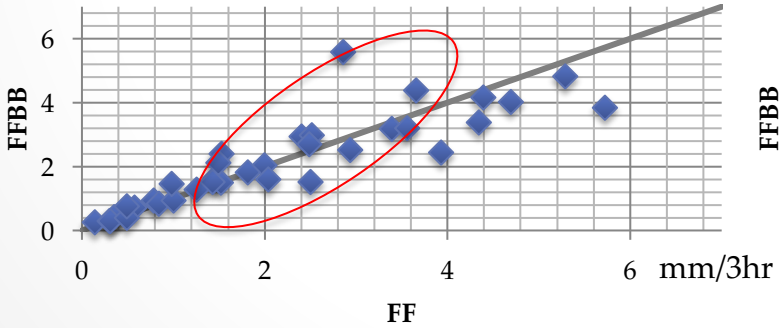
r1 max. rainfall



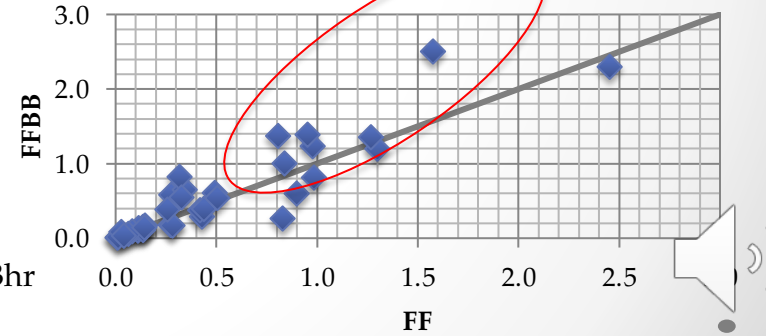
r1 min. rainfall



r2 max. rainfall



r2 min. rainfall



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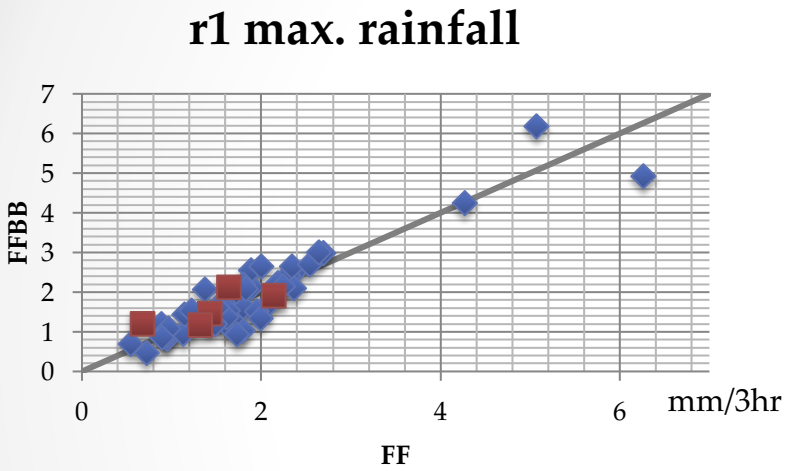
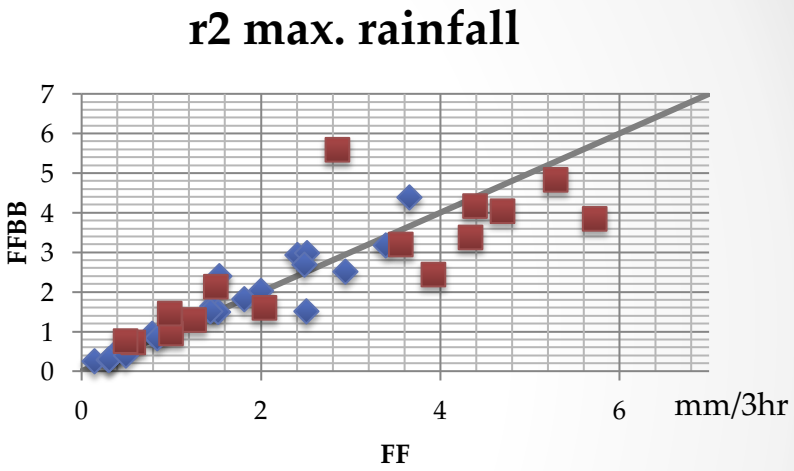
Max. rainfall in afternoon or midnight





Max. rainfall in the afternoon Max. rainfall in the midnight

- Borneo (r2) tends to have higher max. rainfall.
- High intensity of max. rainfall in Borneo (r2) most happens in midnight or early morning.
- Fire aerosols reduce max. rainfall intensity, especially for midnight convection.

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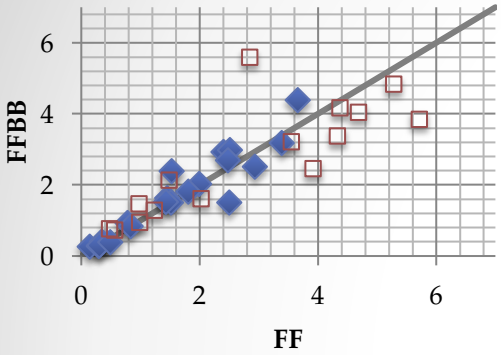
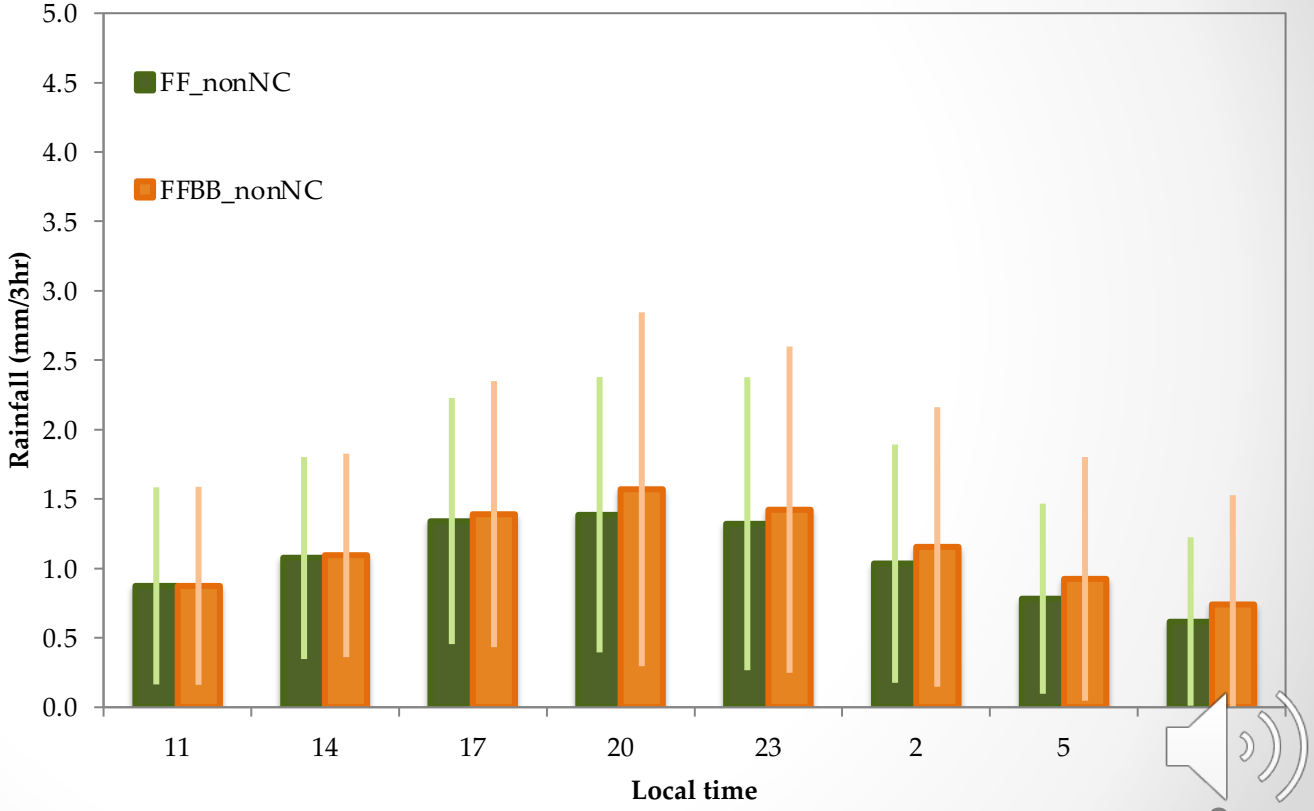
The diurnal time series of precipitation

r2 max. rainfall





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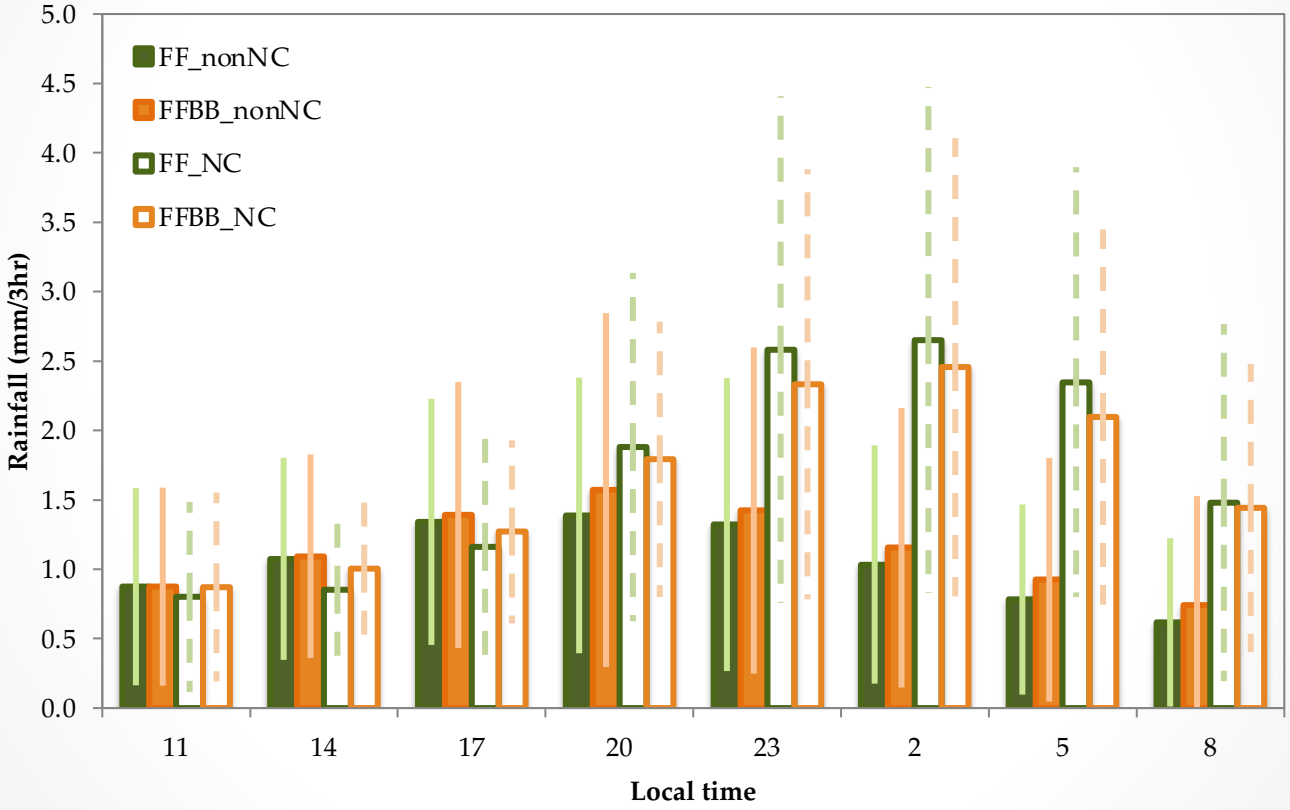
The diurnal time series of precipitation



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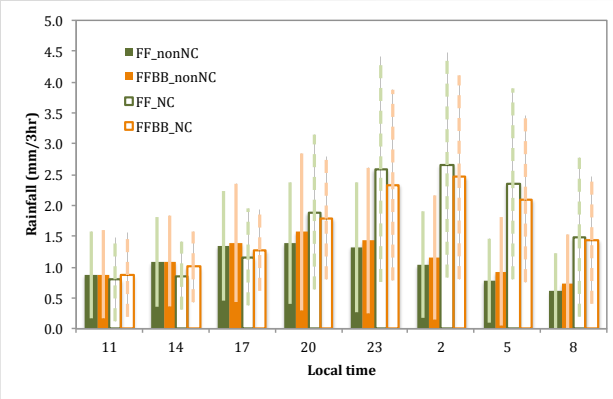
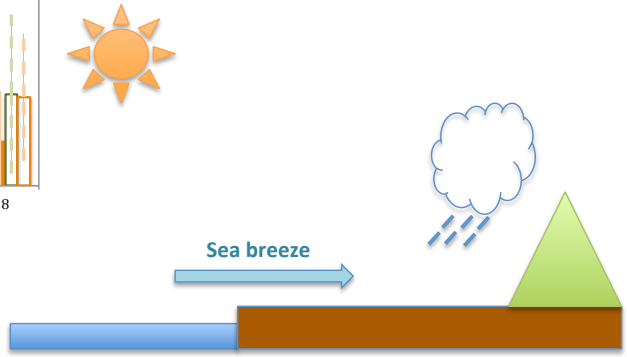
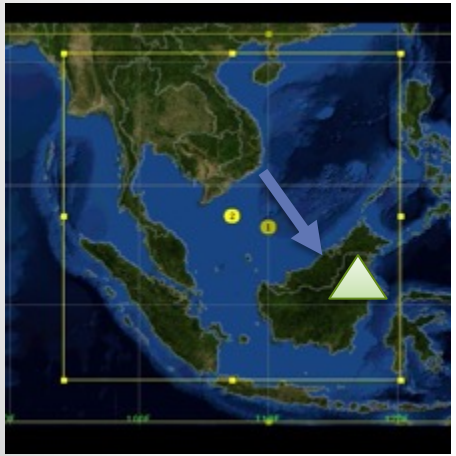
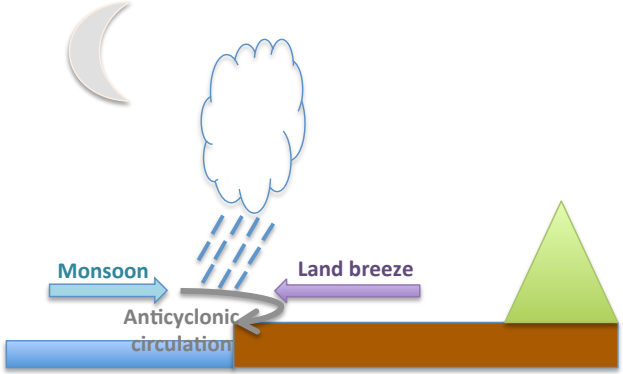


(a) Daytime – No fire





(c) Nighttime – No fire



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Summary

- Fire aerosols alter daily maximum and minimum rainfall intensity. In weak convection cases, fire aerosols lead to an increases in rainfall intensity during the entire convection life cycle, either in the Sumatra region (r1) or the Borneo region (r2).

- In the Borneo region (r2), fire aerosols activities have an opposite impact on the rainfall intensity, especially those low-level wind patterns associated with the weak westerly regime (nocturnal convection).

- Our results show that neither a single case study nor a simple statistical summary applied to the overall model simulation period without in-depth analyses could reveal the impact of biomass burning aerosols on convections under different windflaw regimes.

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Question?

lee1061@llnl.gov

Lee, H. H., and C. Wang, 2020: The impacts of biomass burning activities on convective systems over the Maritime Continent. *Atmos. Chem. Phys.*, **20**, 2533-2548.

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