Enhancements to GWIS: Fire Danger Rating and Applications in Indonesia

2018 update

Robert Field

BMKG

KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN REPUBLIK INDONESIA

BNPB

LAPAN

INSTITUT PERTANIAN BOGOR

Canada
Natural Resources Canada
Canadian Forest Service

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

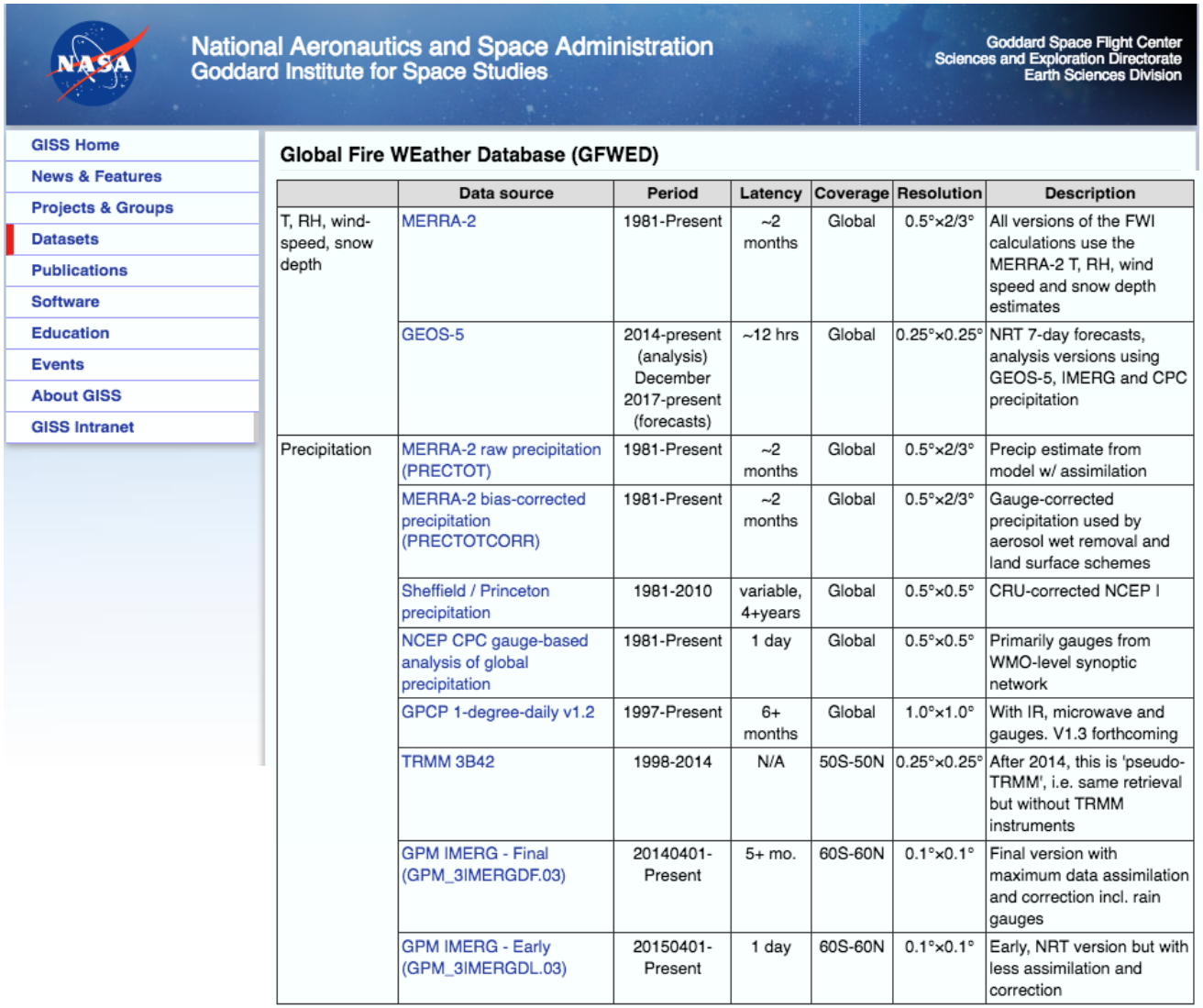
NASA
National Aeronautics and Space Administration
Goddard Institute for Space Studies
New York, N.Y.

Goals

1. Add short-term Fire Weather Index forecasts to Global Fire Weather Database for distribution through GWIS.

2. Work with agencies in Indonesia to:
   - Use GPM-based precipitation in their Fire Danger Rating Systems.
   - Develop and institutionalize FDRS training programs.

Global Fire Weather Database



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Global Fire WEather Database (GFWED)

	Data source	Period	Latency	Coverage	Resolution	Description
T, RH, wind-speed, snow depth	MERRA-2	1981-Present	~2 months	Global	0.5°×2/3°	All versions of the FWI calculations use the MERRA-2 T, RH, wind speed and snow depth estimates
	GEOS-5	2014-present (analysis) December 2017-present (forecasts)	~12 hrs	Global	0.25°×0.25°	NRT 7-day forecasts, analysis versions using GEOS-5, IMERG and CPC precipitation
Precipitation	MERRA-2 raw precipitation (PRECTOT)	1981-Present	~2 months	Global	0.5°×2/3°	Precip estimate from model w/ assimilation
	MERRA-2 bias-corrected precipitation (PRECTOTCORR)	1981-Present	~2 months	Global	0.5°×2/3°	Gauge-corrected precipitation used by aerosol wet removal and land surface schemes
	Sheffield / Princeton precipitation	1981-2010	variable, 4+years	Global	0.5°×0.5°	CRU-corrected NCEP I
	NCEP CPC gauge-based analysis of global precipitation	1981-Present	1 day	Global	0.5°×0.5°	Primarily gauges from WMO-level synoptic network
	GPCP 1-degree-daily v1.2	1997-Present	6+ months	Global	1.0°×1.0°	With IR, microwave and gauges. V1.3 forthcoming
	TRMM 3B42	1998-2014	N/A	50S-50N	0.25°×0.25°	After 2014, this is 'pseudo-TRMM', i.e. same retrieval but without TRMM instruments
	GPM IMERG - Final (GPM_3IMERGDF.03)	20140401-Present	5+ mo.	60S-60N	0.1°×0.1°	Final version with maximum data assimilation and correction incl. rain gauges
	GPM IMERG - Early (GPM_3IMERGDL.03)	20150401-Present	1 day	60S-60N	0.1°×0.1°	Early, NRT version but with less assimilation and correction

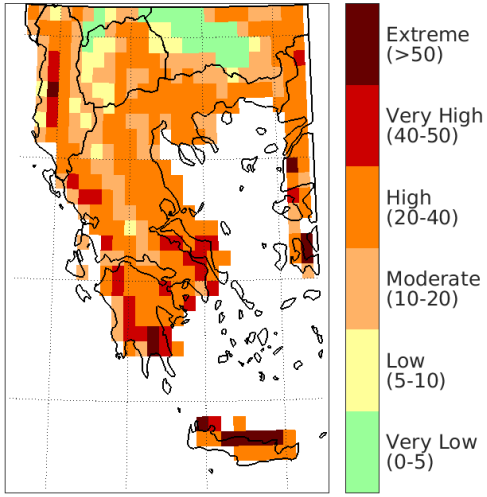
https://data.giss.nasa.gov/impacts/gfwed/

(Field et al., 2015, NHESS)

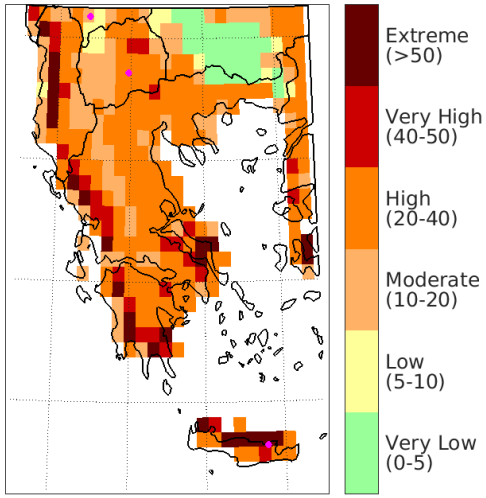
8-day Fire Weather Forecasts – DONE

3-day forecasts for July 23 Athens fires

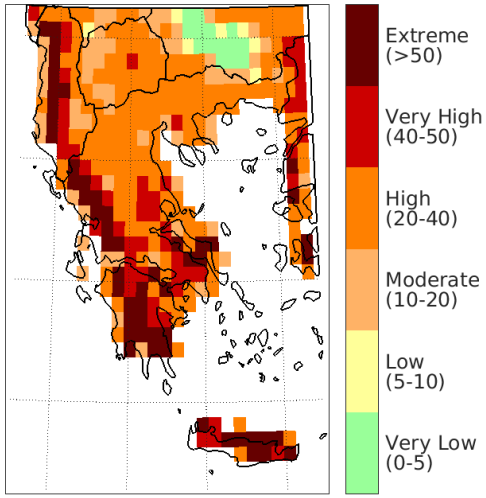
Observed GEOS-5 FWI 20180720
Observed MODIS active fires



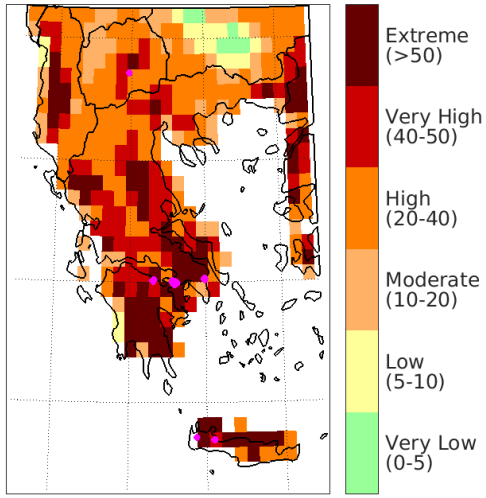
Forecast GEOS-5 FWI 20180721
Observed MODIS active fires



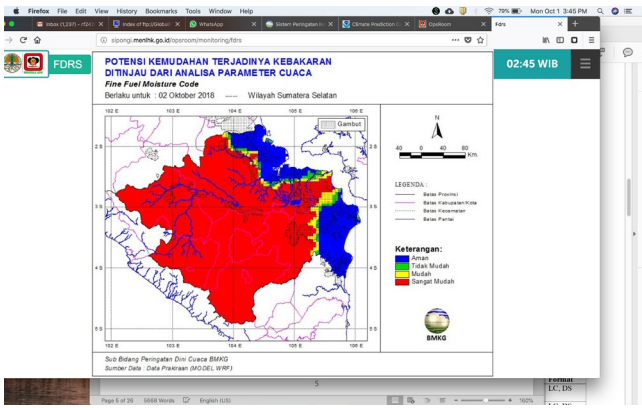
Forecast GEOS-5 FWI 20180722
Observed MODIS active fires



Forecast GEOS-5 FWI 20180723
Observed MODIS active fires



Indonesia

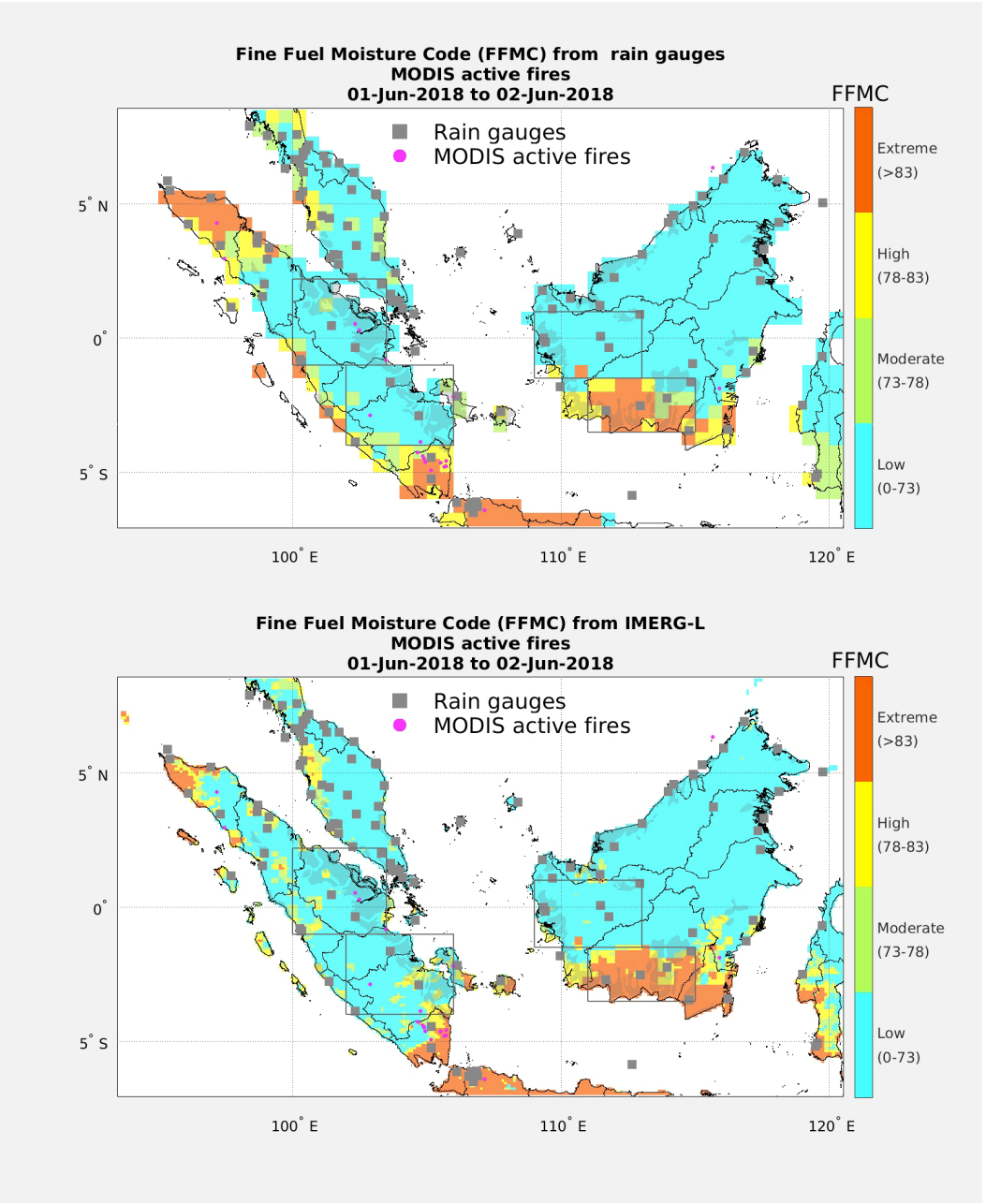


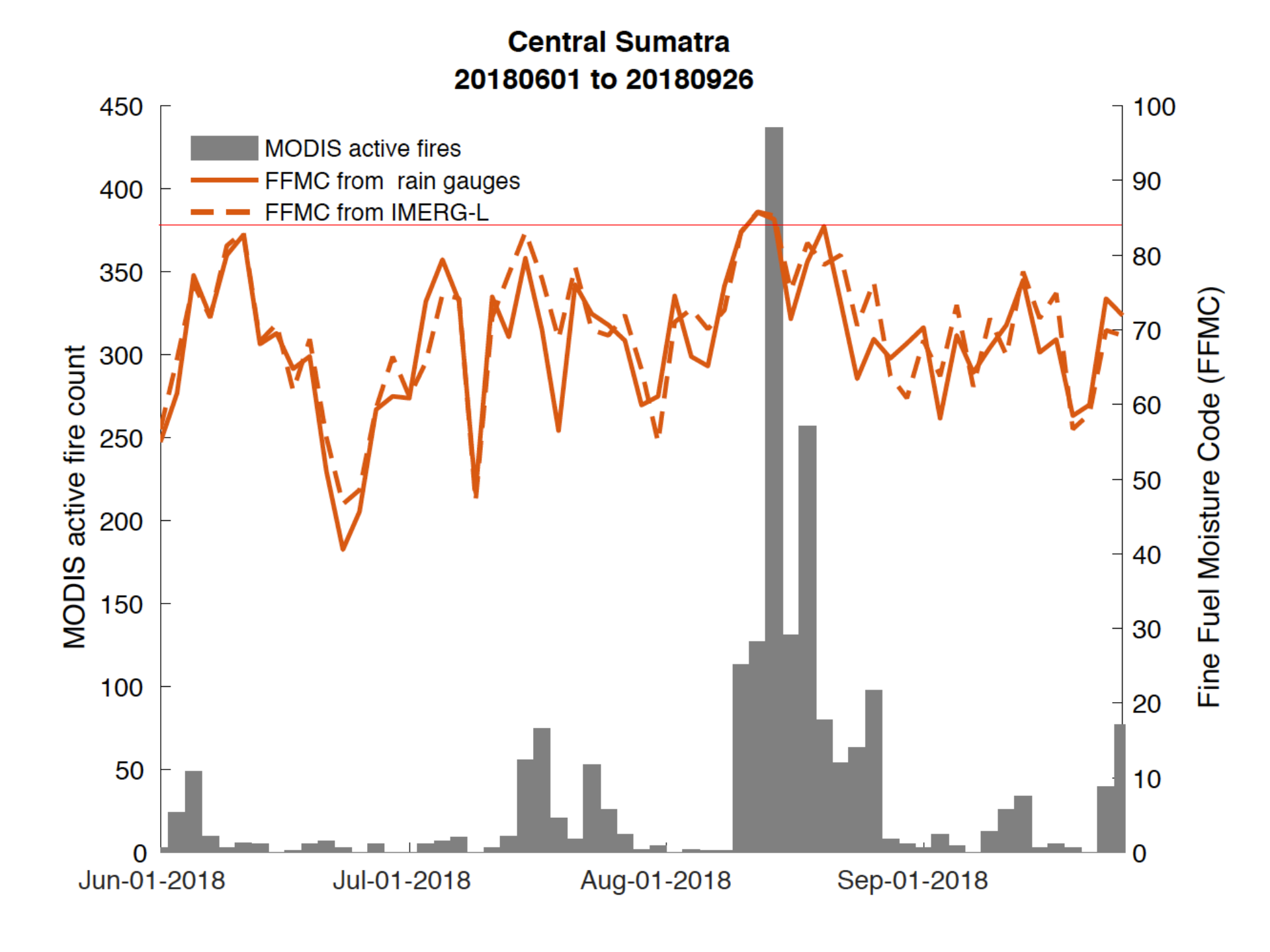
- Operational systems:
  - The Indonesian Agency for Meteorology, Climatology and Geophysics (**BMKG**) uses weather stations and WRF.
  - Indonesian National Institute for Aeronautics and Space (**LAPAN**) uses weather stations and pseudo-TRMM precipitation retrievals.
- Limitations:
  - Sparse weather station network in fire-prone regions.
  - Satellite precip. estimates based on secondary instruments only following end of TRMM.
  - FWI software is old.
  - Interpretation and decision-aid development not yet standardized.

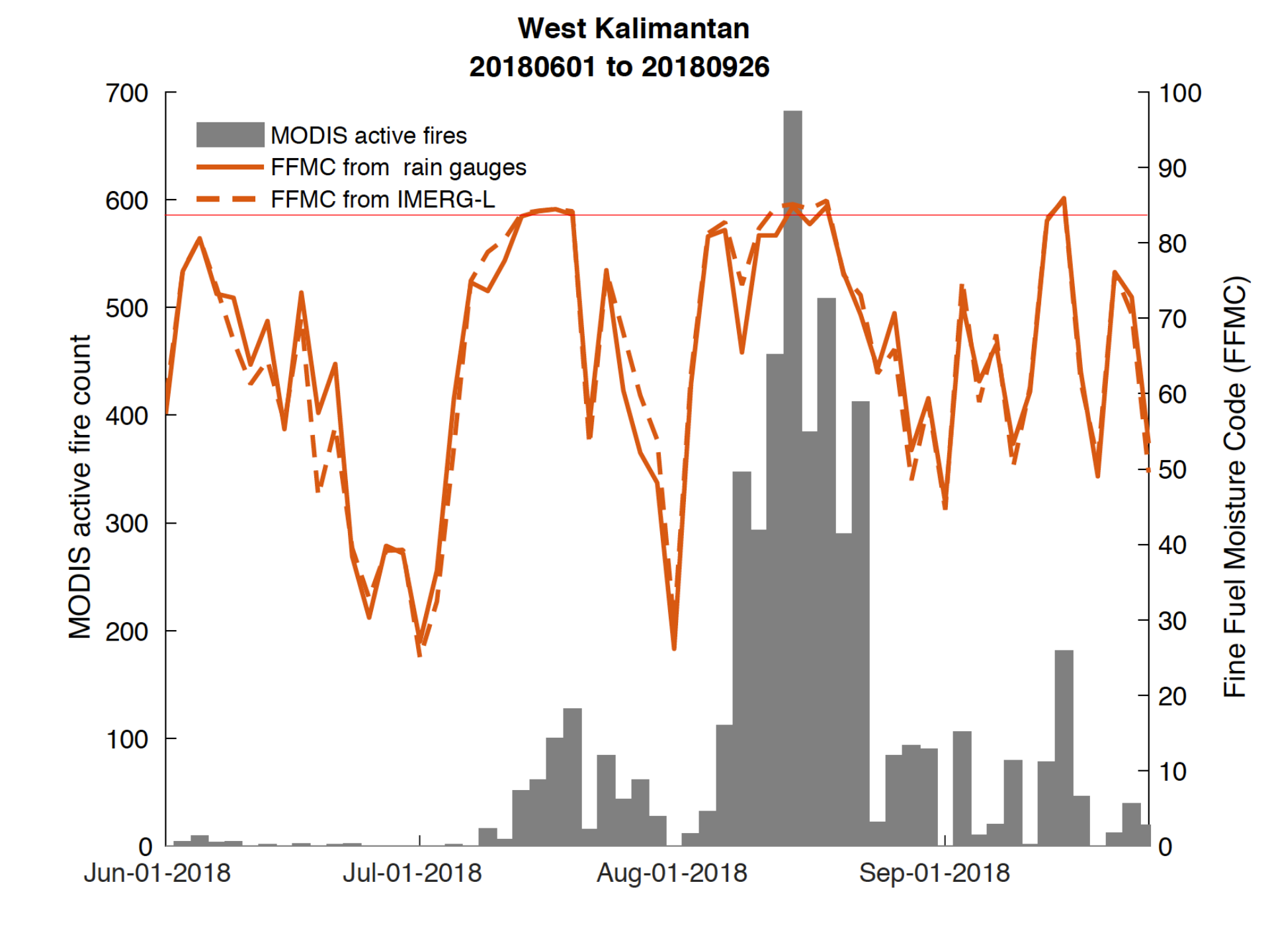
FFMC from rain gauges vs. IMERG for 2018 fire season

The Fine Fuel Moisture Code is used as an indicator of ignition potential in light fuels (e.g. tall alang-alang grass)

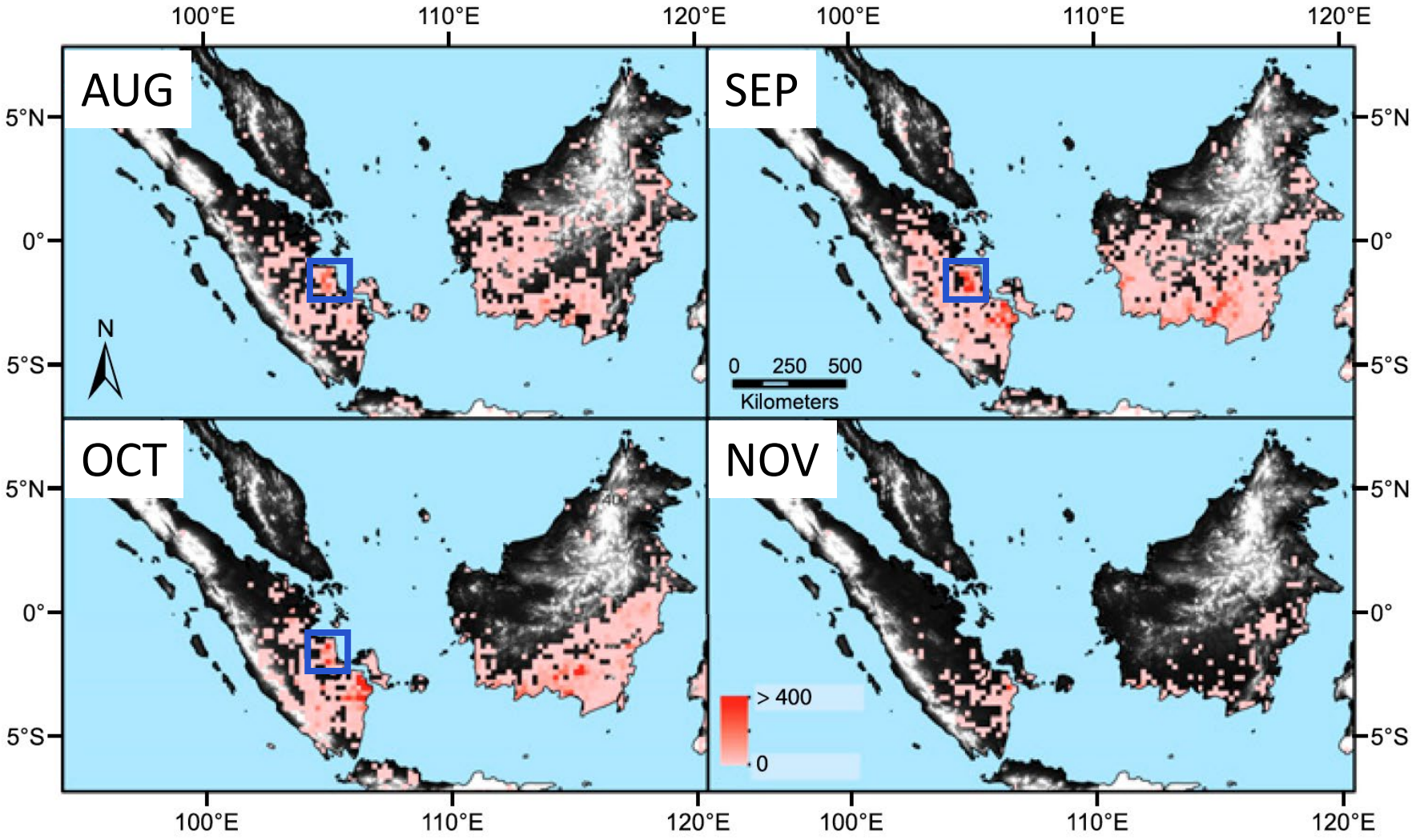
FFMC >= 83 is the important threshold (de Groot et al., 2006)




Central Sumatra
20180601 to 20180926
MODIS active fires
FFMC from rain gauges
FFMC from IMERG-L
MODIS active fire count
Fine Fuel Moisture Code (FFMC)
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
50
60
70
80
90
100
Jun-01-2018
Jul-01-2018
Aug-01-2018
Sep-01-2018


West Kalimantan
20180601 to 20180926
MODIS active fires
FFMC from rain gauges
FFMC from IMERG-L
MODIS active fire count
Fine Fuel Moisture Code (FFMC)
0
100
200
300
400
500
600
700
0
10
20
30
40
50
60
70
80
90
100
Jun-01-2018
Jul-01-2018
Aug-01-2018
Sep-01-2018

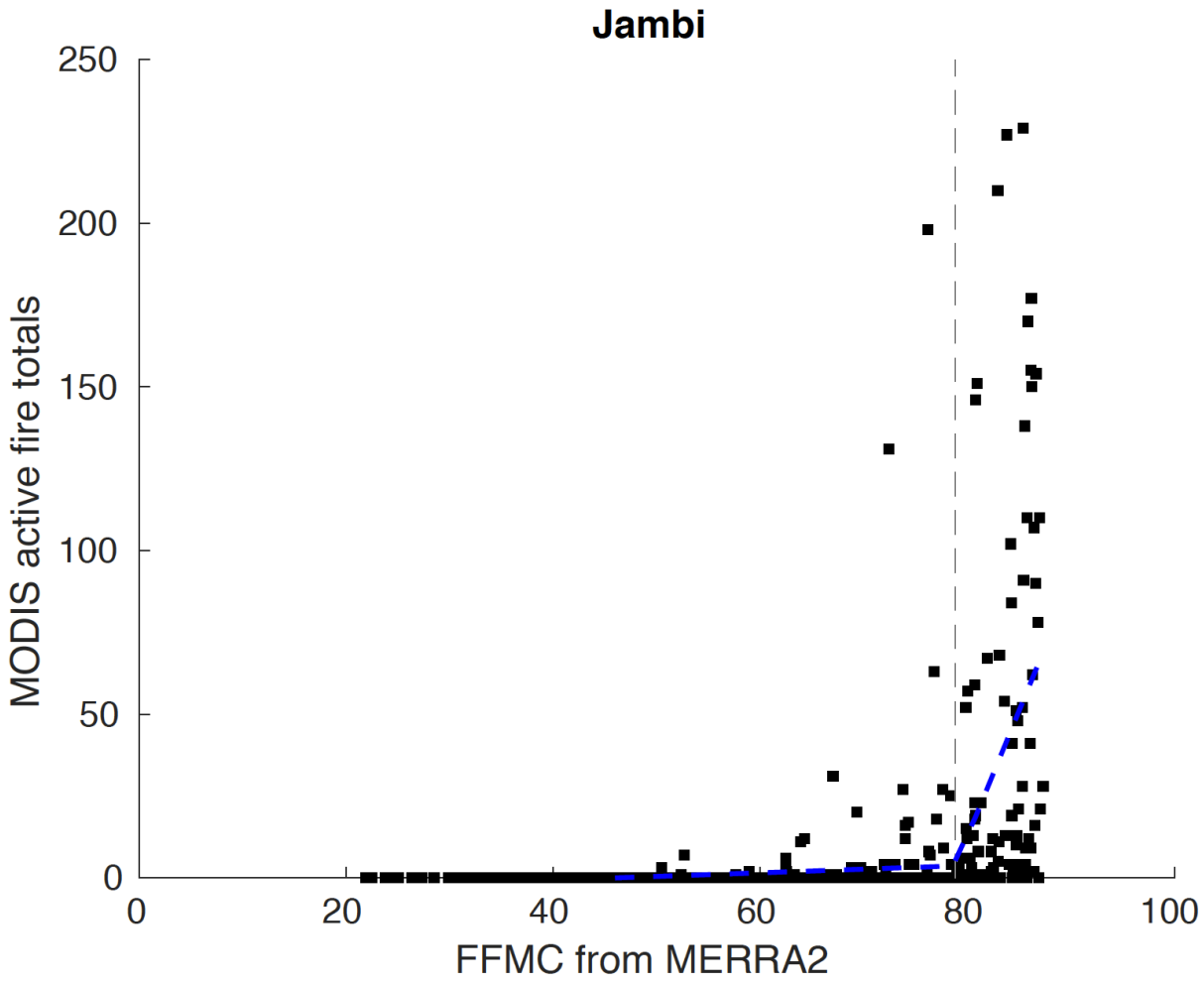
How does satellite precip perform over a serious burning region?



2015 monthly MODIS active fire density (Field et al., 2016, PNAS)

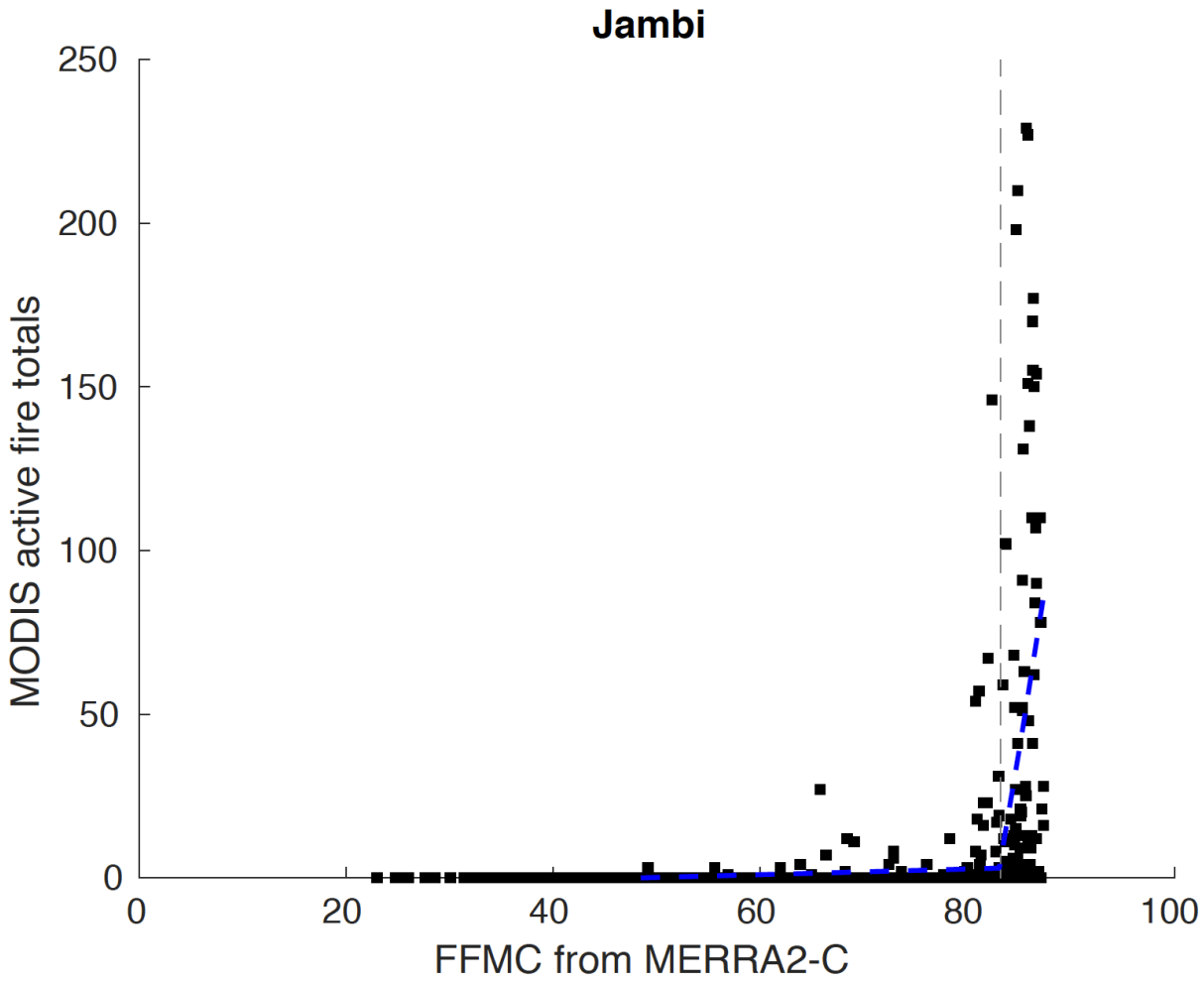
Daily MERRA2 FFMC vs. MODIS active fires, 2015-2018

Reanalysis FFMC sort of separates fire from no fire, but with a lot of below-threshold outliers.



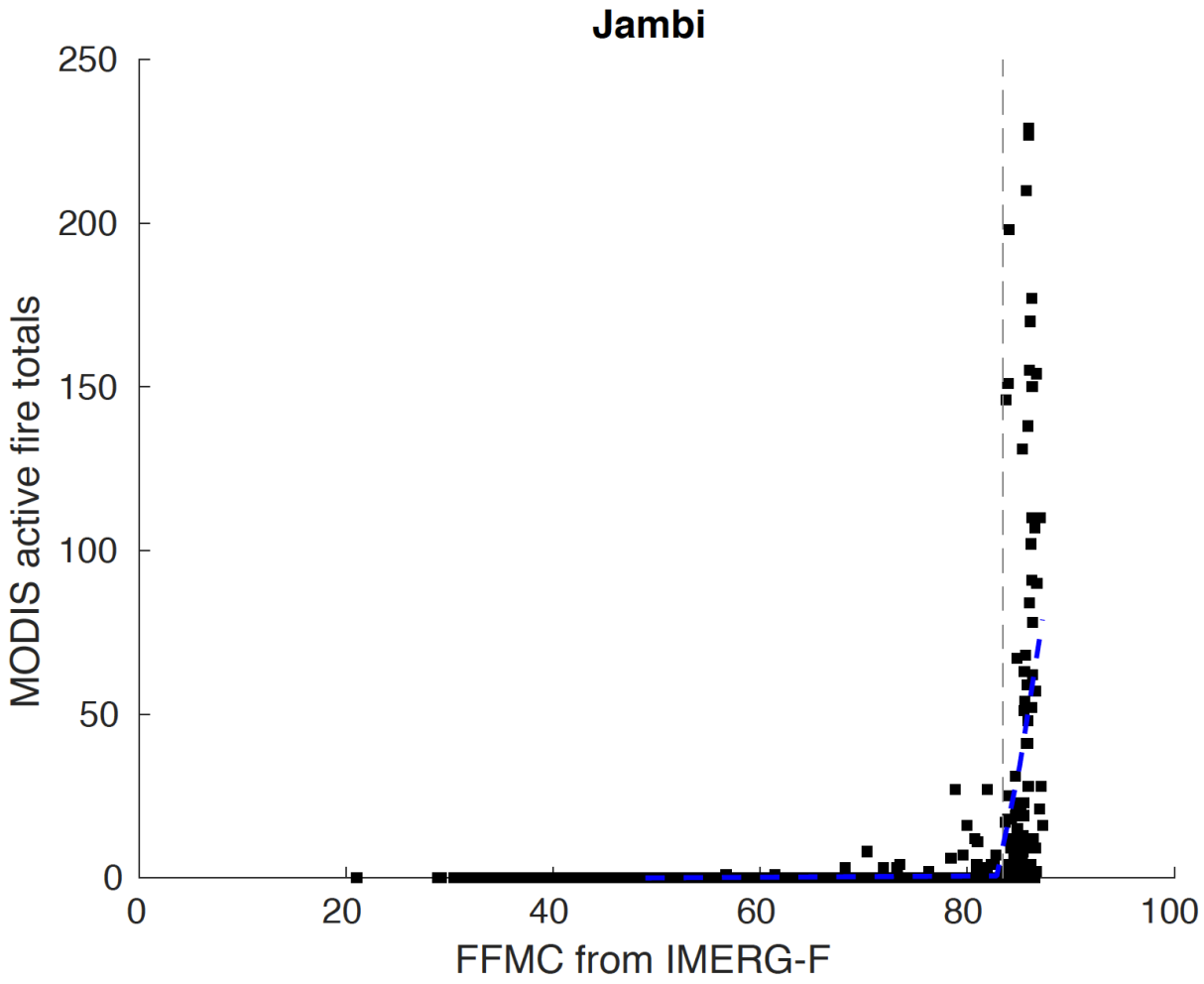
Daily gauge FFMC vs. MODIS active fires, 2015-2018

Better with rain gauges



Daily IMERG-F FFMC vs. MODIS active fires, 2015-2018

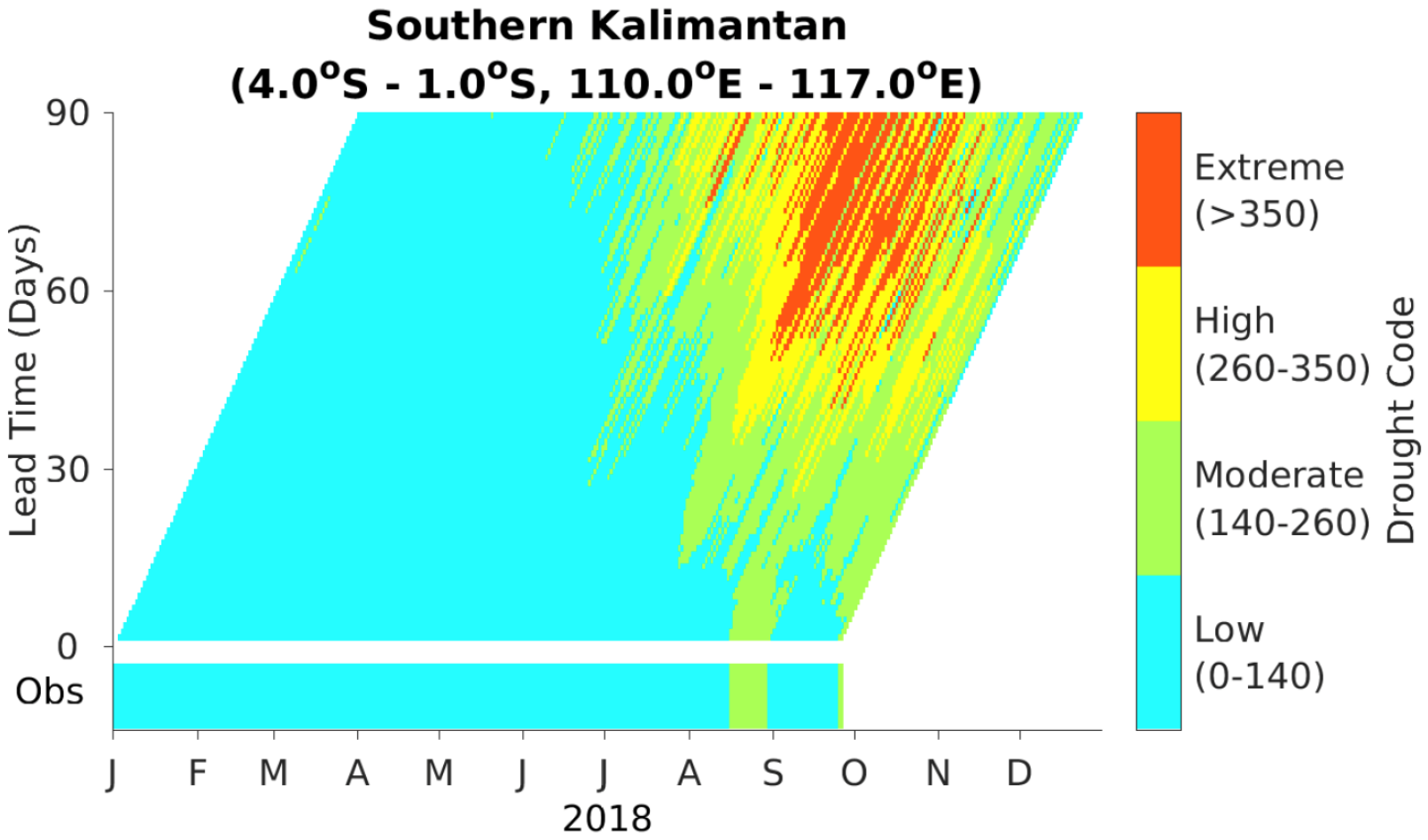
Best with rain gauges and satellites
(similar for S. Sumatra and Central Kalimantan)



2018 Seasonal Drought Code Forecasts

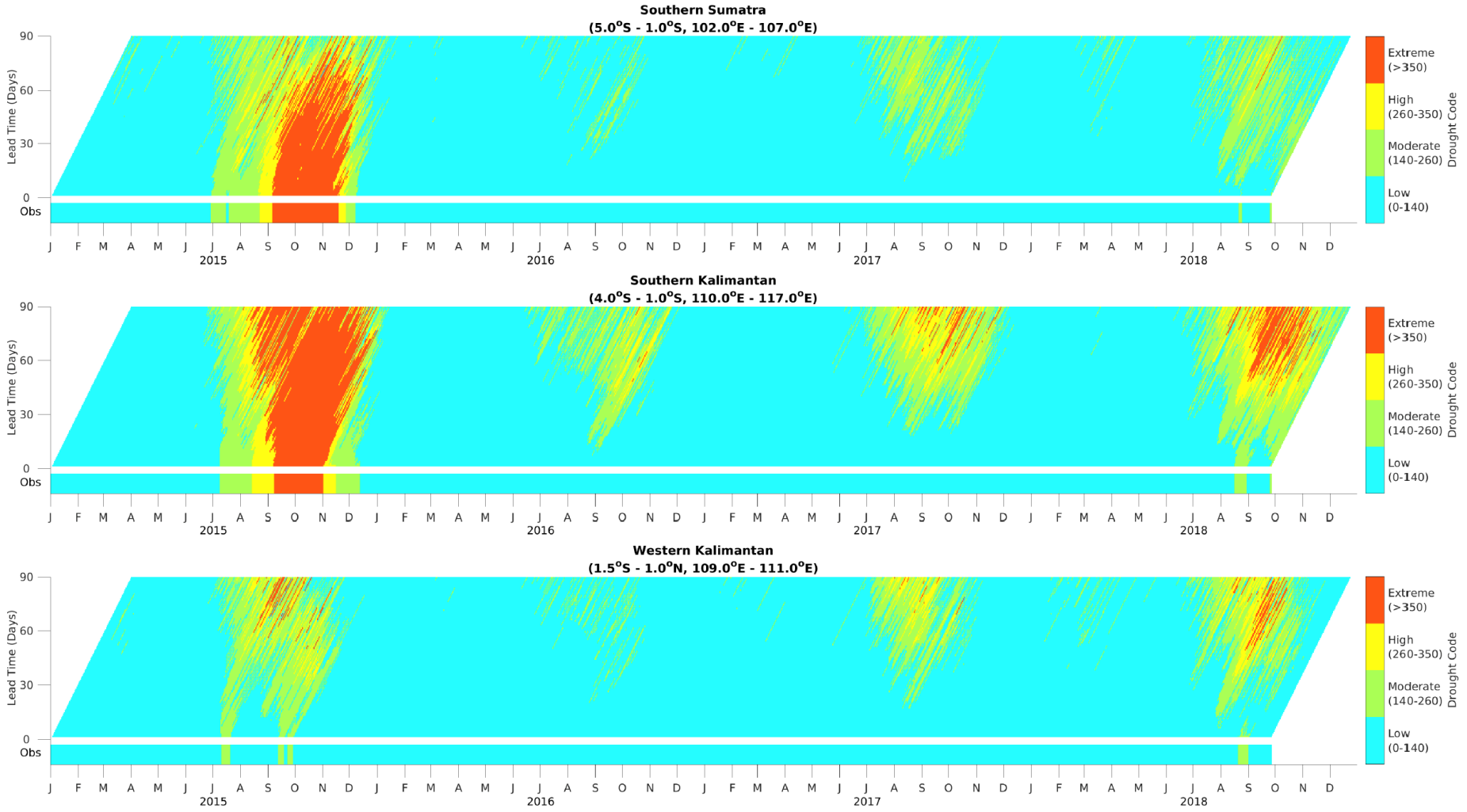
Seasonal DC forecasts based on NCEP CFSv2 forecasts (Shawki et al., 2017, *GRL*)

Early suggestions of El Niño have not verified.



DC forecasts in context

Hindcasts since 2015 show reasonable skill at 6-8 weeks lead time, persistent high bias bias at longer leads.



Indonesian Fire Danger Rating System: Training Program and Technical Enhancements

July 16th-July 20th, 2018

BMKG Headquarters, Jakarta, Indonesia

Activities

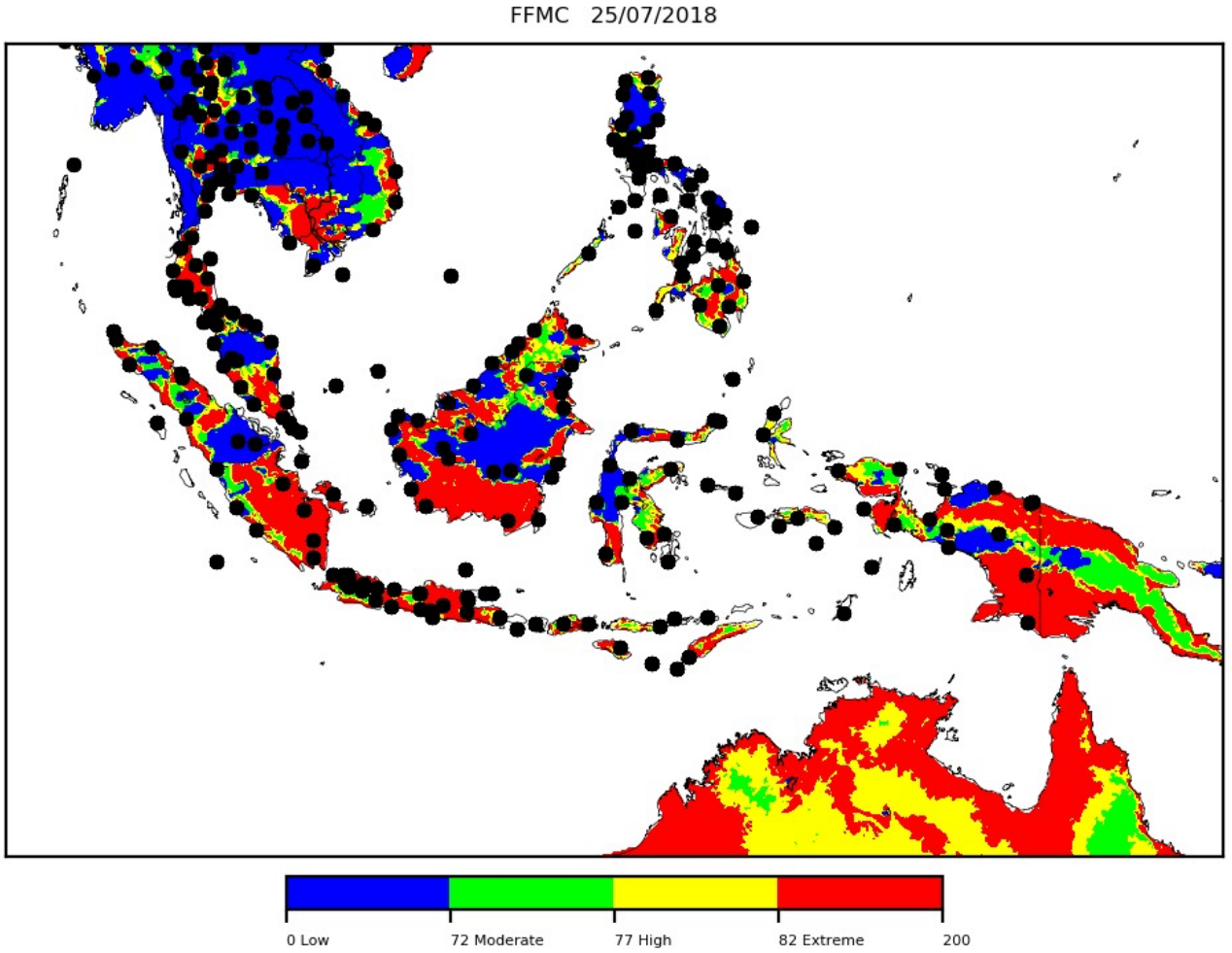
- Participants from BMKG, Indonesian Ministry of Environment and Forestry (KLHK)
- Identification of FDRS users, ranging from military to NGOs
- Review of existing operational systems and products, from national maps to calculations from KLHK wx stations
- Review of FDRS calibration
- Review of previous FDRS training, existing materials
- Review of existing training programs at BMKG and KLHK
- Development of basic and advanced course outlines

6 main recommendations

- Post “Indonesian Fire Danger Rating System Calibration Overview” document in both English and Bahasa to BMKG and KLHK Sipongi websites..
- Begin producing maps for all six FWI components at BMKG, with a priority on the FFMC, ISI and DC.
- Review performance of KLHK weather data instruments.
- Update the KLHK danger classes to reflect final calibration of danger class thresholds.
- Continue to develop in-house BMKG FDRS software using GPM-based precipitation estimates, in coordination with planned improvements to LAPAN’s FDRS.
- Propose development of basic and advance FDRS training programs to BMKG Center for Training Education, using WMO guidelines.

Update from BMKG

Recent progress calculating FWI from JAXA's GPM-based precipitation estimate, writing in-house software.



c/o Mr. Andersen Panjaitan, BMKG

Fire Danger activity ideas for GWIS

- Inventory / review of fire danger rating calibration around the world. Representative examples for different regions on GWIS website.
- Make underlying fire weather data easy available for users to interpret as they see fit, in addition to online map access. Or allow users to set fire danger classes.
- Comparison of different global products (GFWED, GWIS, GFEWS) to secondary, out-of-sample fire weather data from stations (i.e. how good are analysis/reanalysis-based FWI fields compared to non-assimilated station data).
- Forecast skill evaluation (fire weather only, fire prediction)

Mekong
(Manomaiphiboon et al., 2017)

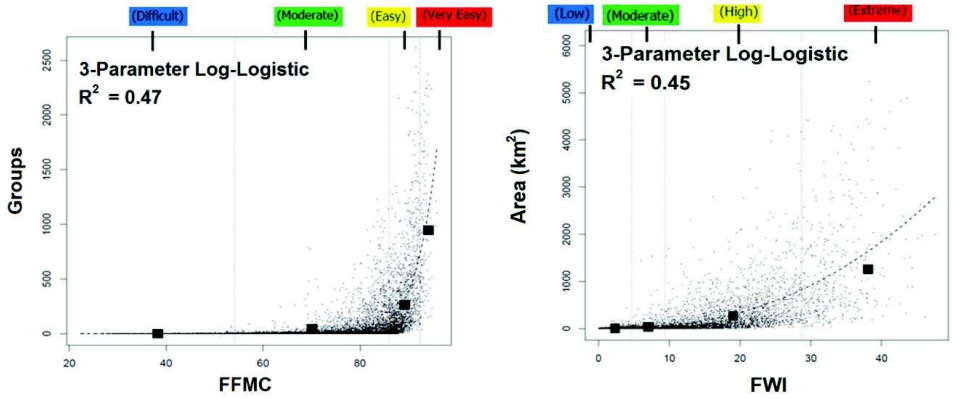
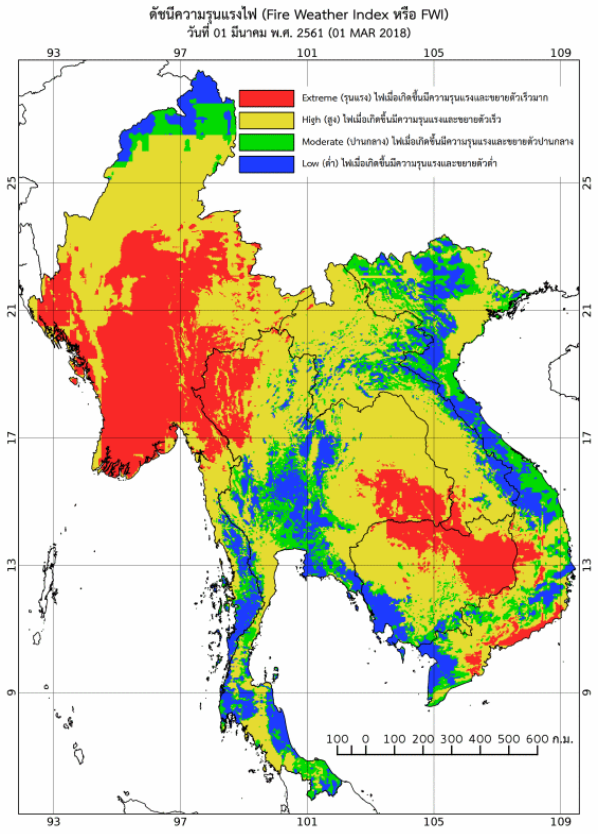


Figure 4. FFMC and FWI fitting, specified thresholds, and corresponding fire danger levels.

Figure 5. Example of fire danger signs at local fire control stations.

http://www2.dnp.go.th/gis/FDRS/FDRS.php



ดัชนีความรุนแรงไฟ Fire Weather Index (FWI)	
ชั้น Class	**ความหมาย** Description
รุนแรง Extreme	**ไฟเมื่อเกิดขึ้นมีความรุนแรงและขยายตัวเร็วมาก** When fires occur, very high degree of intensity and spread
สูง High	**ไฟเมื่อเกิดขึ้นมีความรุนแรงและขยายตัวเร็ว** When fires occur, high degree of intensity and spread
ปานกลาง Moderate	**ไฟเมื่อเกิดขึ้นมีความรุนแรงและขยายตัวปานกลาง** When fires occur, moderate degree of intensity and spread
ต่ำ Low	**ไฟเมื่อเกิดขึ้นมีความรุนแรงและขยายตัวต่ำ** When fires occur, low degree of intensity and spread

Seasonal DC forecasts