GFAS Methodology & Results

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European Centre for Medium-range Weather Forecasts

COPERICUS Europe's eyes on Earth Atmosphere Monitoring Service

- 1. Current status
- 2. New developments
- **3.** Case study: Portugal 2017

CURRENT STATUS OF GLOBAL FIRE ASSIMILATION SYSTEM

MODIS FRP-based

- FRP = Fire Radiative Power
- quality controlled

FRP corrections with Kalman filter

- partial cloud cover
- observations gaps
- use FRP=0 observations

spurious signal mask

- volcanoes
- gas flares / industry

FRP-to-combustion rate

- land cover-dependent
- regression against GFED3

Additional services

- GOES-E/-W FRP
- daily global injection heights

[Kaiser et al. BG 2012]

<u>GFASv1.2:</u>

- 1 day resolution
- 0.1° (~10 km) resolution
- 2003—present (2000-3 in GFASv1.0)
- 40 species
- daily operational production before 7UTC



PLOS ONE

Characterization of Peat Fires in Indonesia over the 2015 Fire Season Using a New FireBird Satellite









GFAS use in CAMS







Fire climate monitoring with CAMS-GFAS









-80 -40

NEW DEVELOPTMENTS



- implemented in the PC-based development version of GFAS at the developers' institution
- subsequently ported to the operational infrastructure at ECMWF





Approach for ingesting SEVIRI FRP in GFAS

user requirements:

- stable service provision, i.e. beyond MODIS
- 2. plume-resolving temporal resolution
- 3. improved accuracy
- 4. frequent service updates
- 5. 5-day forecasts

approach: assimilate geostationary FRP

- build GFAS version with 1-hour time step
- 2. mask regions with erratic FRP behaviour
- **3.** FRP uncertainty calculation
- 4. characterisation of bias w.r.t. MODIS FRP
- 5. repeat for VIIRS, GOES, Himawari
- 6. forecast extinction of large fires



7. dynamic emission factors

1-h time steps with model for diurnal cycle



Diurnal cycle parametrization from analysis of

- night-time "base" FRP
- daytime "peak" FRP
- as
- 24-h baseline plus
- Gaussian peak at 13:30

New GFAS version 1.4 in 1h resolution and hourly production steps!





Atmosphere Monitoring

Methods to evaluate performance



Mean absolute deviation (MAD) OR Root mean square error (RMSE)

	MAD	RSME
GFAS – 24h	0.60 MW	4.52 MW
GFAS – 1h	0.56 MW	4.79 MW

GFASv1.4 optimised w.r.t. MAD

(after scaling with single bias correction factor)



Mask erratic behaviour





GEMS Fire Intensity Products Wednesday 1 October 2008

- Huge positive bias for VA > 72°.
- Corrected by LSA SAF in August 2016: product limited to VA < 72°</p>
- GFAS now masks VA > 55°.



Satellite FRP uncertainty



fire satellite pixels

error propagation of signal/noise

no-fire satellite pixels

detection threshold



Gridded FRP uncertainty



gridded GFAS product

error propagation of satellite pixel products



Figure 4: gridded inverse variance of the FRP density $\frac{1}{\sigma_{a}^2}$ values for MOD14 and SEVIRI products

[Nikonovas al. CAMS 2016]



SEVIRI FRP bias

observed fire clusters

4% underestimation





assimilation in GFAS

- 45% underestimation (2016)
- used as first approximation



Merged assimilation

- GFAS using FRP observations by
 - MODIS (both)
 - SEVIRI
 - ◆ 0.1° / 1 hour resolution
- addition of many small fires evident
- better representation of diurnal variability to be tested against what?

mean FRP density 2016 [Wm^{-2}] - Mod+Myd+Sev



Long-term effect of additionally assimilating SEVIRI FRP





CASE STUDY: PORTUGAL 2017

of and

16-10-2017 11:55 + 12:00 UTC Terra / MODIS













Atmosphere Monitoring Service

> ODELPICUS Europe's eyes on Earth













Time series of observations and analysis



Summary

- CAMS-GFAS
 - operated by ECMWF (and IPMA)
 - developed further by MPIC, KCL, VUA
- FRP assimilation is being extended to improve usefulness and allow merging of different satellites
 - 1-hour time resolution
 - hourly production updates
 - physical FRP uncertainty treatment
 - simplistic bias correction
- individual events still rather uncertain
- further developments
 - 5-day forecasting
 - dynamic emission factors

SEVIRI FRP density 2016-01-01 hour 10

GFASv1.4 (MODIS+SEVIRI)

- Further needs
 - detailed FRP bias characterisation
 - better spurious signal mask
 - emission calibration with smoke observations
- GFAS-CLIM
 - nationally funded project
 - optimises GFAS for climate monitoring
 - contribution to GWIS, GEO

