MODIS – SNPP VIIRS Land Science Overview

Chris Justice

Land Discipline Lead

Land Science Status

- MODIS Terra launched Dec 18 1999
  - Almost 20 years of global data
- MODIS Aqua launched May 4 2002
- *Kudos to the engineers and MCST*
- A suite of land products driven primarily by global modeling community
  - SR, VI,BRDF/Albedo, Surface Temperature, LAI/FPAR, NPP, ET, Fire/Burned Area, Snow and Ice/MAIAC
  - BRDF, LAI, Fire products rely on AM and PM observations
- PI and LDOPE QA and Validation integral part of the land product activities
- 5 full record reprocessing of the data
- Efficient data dissemination and user services – ESDIS: EDC, NSIDC, ORNL DAACs
- *Kudos to MODAPS, LAADS, LDOPE, Science Teams and the DAACs*
- Data also available via Google Earth Engine, Amazon S3
- MODIS instruments and products in the NASA Senior Review
- Terra orbit exit in view (2022) , Aqua A-Train exit fuel limitations (2022)

Land Science Status

- SNPP VIIRS launched Oct 28, 2011
  - NPOESS Preparatory experience
- JPSS-1/NOAA 20 launched Nov, 18 2017

BOTH missions with PM overpass

KUDOS to the IPO for pushing MODIS continuity

- SNPP Radiometric Inter-comparisons with MODIS
- A suite of NOAA operational land products driven primarily by NWS
  - SR, LST, Albedo, VI, Green Veg Fraction, Veg Health, Surface Type, Active Fire
  - IDPS>NDE
  - Data from NOAA CLASS system
- A suite of NASA Science products focused on MODIS Continuity
  - SR, VI, BRDF/Albedo, LST, LAI/FPAR, Day Night Band, Active Fire, MAIAC
- PI and LDOPE QA – little to no new validation, intercomparison with MODIS
- Data dissemination and user services – ESDIS: LAADS, EDC, NSIDC, DAACs
- Data processing of JPSS1 supported (V2 L1B) – dissemination via LAADS
  - currently porting SNPP Land Code to JPSS1
- Evaluation of Sentinel 3 underway w. AM overpass (Vermote, USPI)

Status of MODIS / VIIRS Land Product Validation Statements

These are updated annually, so users know the current validation status of the MODIS and VIIRS products.

Statements do not have to be updated annually, but the PIs need to verify the status information posted on their status pages are current.

Nickeson

Product	PI	Sensor	Last Review/ Update	Input/Review rec'd	URL for validation statement page
Surf Refl	Vermote	MODIS	Aug-2018	Nov-2019	https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD09
	Vermote	VIIRS	Oct-2017	Nov-2019	https://viirsland.gsfc.nasa.gov/Val/LSR_Val.html
LST2	Hulley	MODIS	Sep-2017	Nov-2019	https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD21
	Hulley	VIIRS	Oct-2019	Oct-2019	https://viirsland.gsfc.nasa.gov/Val/LST_Val.html
LST1	Wan	MODIS	Jul-2018		https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD11
BRDF/Albedo	Schaaf	MODIS	Oct-2019	Oct-2019	https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD43
	Schaaf	VIIRS	Sep-2019	Sep-2019	https://viirsland.gsfc.nasa.gov/Val/Albedo_Val.html
LAI/Fpar	Myneni	MODIS	Oct-2019	Oct-2019	https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD15
	Myneni	VIIRS	Oct-2019	Oct-2019	https://viirsland.gsfc.nasa.gov/Val/LAI_Fpar_Val.html
Fire	Giglio	MODIS	Jun-2018		https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD14
	Schroeder	VIIRS	Oct-2017	Nov-2019	https://viirsland.gsfc.nasa.gov/Val/Fire_Val.html
Burned Area	Boschetti	MODIS	Jun-2018	Nov-2019	https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MCD64
	Giglio	VIIRS	NA		
Land Cover/Dynamics	Friedl	MODIS	Oct-2018	Nov-2019	https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD12
Snow Cover (Sea Ice)	Riggs	MODIS	Oct-2019	Oct-2019	https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD10/29
	Riggs	VIIRS	Oct-2019	Oct-2019	https://viirsland.gsfc.nasa.gov/Val/Snow_Val.html
Sea Ice Cover	Tschudi	VIIRS		Nov-2019	https://viirsland.gsfc.nasa.gov/Val/SeaIce_Val.html
Ice Surface Temp	Tschudi	VIIRS		Nov-2019	https://viirsland.gsfc.nasa.gov/Val/IST_Val.html
GPP/NPP	Running	MODIS	Nov-2015	Aug-2019	https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD17
Veg Indices	Didan	MODIS	Jul-2018	Nov-2019	https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD13
	Didan	VIIRS	Mar-2018	Nov-2019	https://viirsland.gsfc.nasa.gov/Val/VI_Val.html
Veg Cont Fields	Dimicelli/Sohlberg	MODIS	Jul-2018		https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD44
Evapotranspiration	Running	MODIS	Nov-2015	Aug-2019	
MAIAC	Lyapustin	MODIS	Jun-2018		https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MCD19
	Lyapustin	VIIRS	NA		
DSR/PAR	Wang/Liang	MODIS	Jun-2018		https://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD18
Black Marble	Kalb	VIIRS		Nov-2019	https://viirsland.gsfc.nasa.gov/Val/BM_Val.html
Land Surface Phenology	Zhang	VIIRS	NA	Nov-2019	https://viirsland.gsfc.nasa.gov/Val/Pheno_Val.html

MODIS – VIIRS contribution to the GCOS Essential Climate Variables (ECV's)

- Albedo (MODIS / VIIRS)
- Fire Disturbance
  - Burnt Area (MODIS Only)
  - Active Fire (MODIS / VIIRS)
  - FRP (MODIS / VIIRS)
- LAI (MODIS / VIIRS)
- FAPAR, (MODIS / VIIRS)
- Land Cover (MODIS Only)
- LST (MODIS /VIIRS)
- Snow (MODIS)
- *Surface Reflectance (Fundamental Data Record)*

On going effort to update the CEOS ECV Inventory (Wenying Su, LARC) – "used to generate action plans for the space agencies".

"Not meeting the GCOS requirements does not disqualify a dataset to be included in the ECV inventory".

Land Science: Spatial/Temporal Resolution

- MODIS /VIIRS /Sentinel 3 are coarse res'n – DAILY coverage
- Landsat/Sentinel 1 and 2 are moderate resolution – global 3 day coverage becoming feasible but ……
- Digital Globe/Planet are Very High - frequency – daily but…

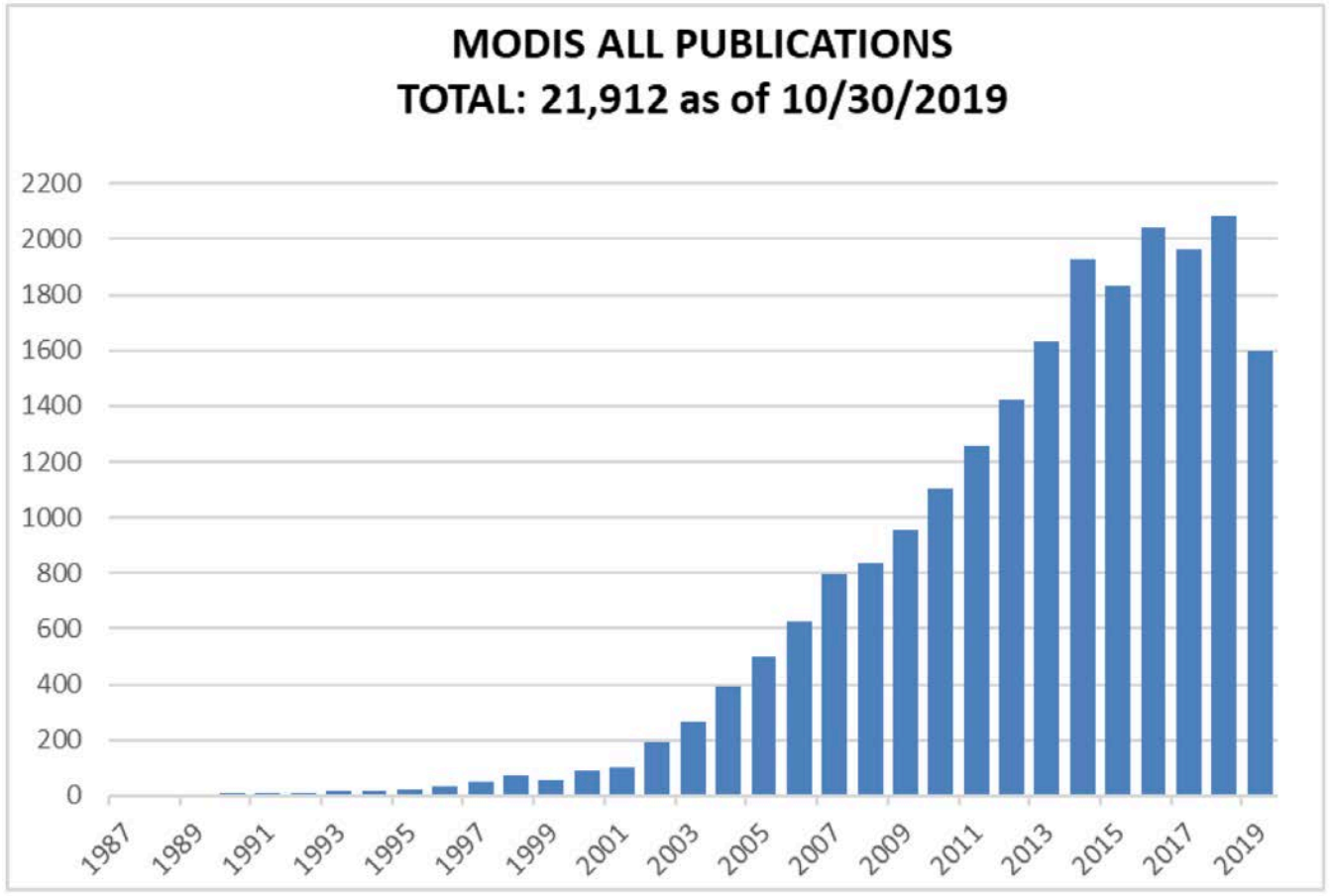
and so btw was AVHRR….

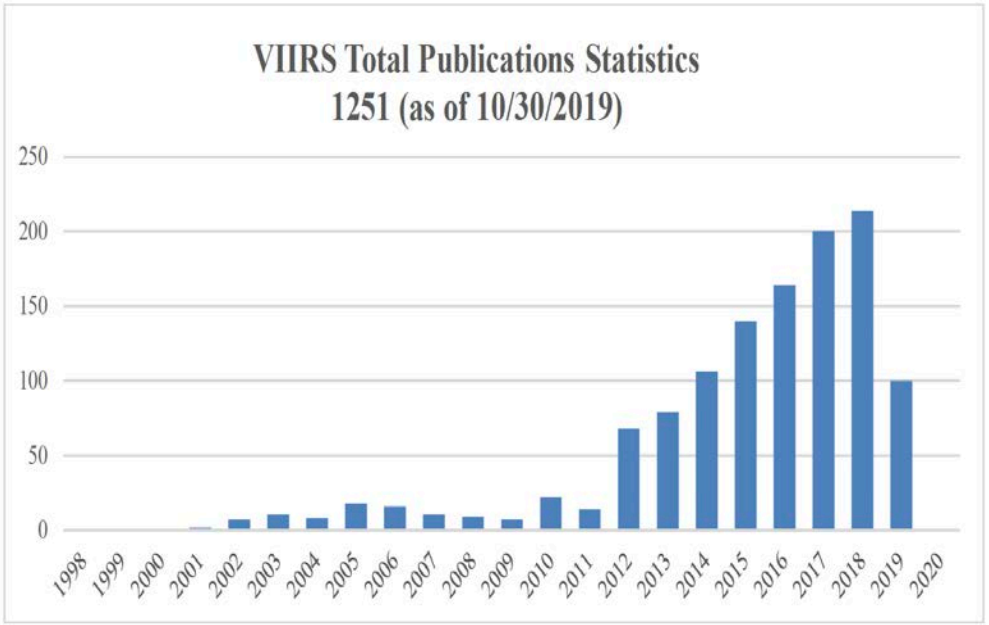
- Multilevel Sampling - 1970's remote sensing concept - approach now being extended to multiresolution time series
- Multi-source Land imaging (MuSLI-LCLUC) Prototype Products
  - Burned Area (sub-saharan Africa), Albedo (circumpolar), Phenology (N. America) – the future is TBD
- Global Moderate resolution land products are now being developed
  - Global Weld monthly/annual – 6 X 3 year epochs (MEASURES)
  - Landsat (GLCUC) yearly data record 2001-2020 (MEASURES)
- State of cloud-enabled moderate resolution 'global product' anarchy

Role of Coarse Resolution Data in Land Science

- Daily Global Products (250m-1km) basis for global monitoring and mapping (as appropriate)
- Multi-year science quality global time-series and analysis – unique role of NASA
  - Focus on dynamic continuity products (*AVHRR*> MODIS>SNPP>JPSS1)
- Input to Global Modeling and Assimilation input – GMAO, ECMWF
- Critical Role in NASA Terrestrial Global and Climate Change Science e.g.
  - Quantifying impacts of extreme events – droughts/flooding, phenology, snow extent/timing
  - Quantifying interannual variability and trends – vegetation phenology and production, snow/ice, fire occurrence, burned area,
  - Quantifying landscape-scale change in vegetation, landcover, snow/ice extent

MODIS VIIRS Publications – as of 2019





Courtesy Vince Salomonson

Role of Coarse Resolution Data in Land Applied Science

- Critical Role in NASA Applied Sciences Program (Societal Benefit Areas) e.g.
  - Agricultural Monitoring, Famine Early Warning e.g. Crop Mapping, Crop Condition, Crop Production – e.g. USDA, USAID, NASA Harvest, etc
  - Fire Management e.g. Fire Location and Extent – e.g. USFS, GWIS, etc
  - Flood Mapping – e.g. FEMA, UN ISDR etc
- National agencies around the World use NASA MODIS data
- MODIS/VIIRS Largest Downloads for LANCE NRT data access (see poster)
- MODIS/VIIRS Direct Readout – NASA code sharing

- Kudos to the Earth Observatory / Firms / GIBS-Worldview

Uptick in Amazon Fire Activity in 2019

August 19, 2019 JPEG

Satellites have detected an increase in fire activity early in the 2019 dry season in the southern Amazon.

Image of the Day for August 26, 2019

Instruments:
Aqua — MODIS
Suomi NPP — VIIRS
Terra — MODIS

Image of the Day | Atmosphere | Heat

https://www.earthobservatory.nasa.gov/images/145498/uptick-in-amazon-fire-activity-in-2019

Revealed: Some 2,000 new fires have broken out across the Amazon in the 48 hours since the Brazilian government banned burning

- In the two days since burning ban, data from the National Space Research Institute showed 3,859 new fires
- From January to the end of August, 51.9 per cent of Brazil's recorded 88,816 fires were in Amazon rainforest
- Brazil's Amazon region is in its dry season, but experts note that 2019 has been wetter than previous years
- No-burn decree may have been too little too late, and more of a political than practical gesture, analysts say
- Deforestation has surged as agencies tasked with monitoring illegal activities were weakened by Bolsonaro

https://www.dailymail.co.uk/news/article-7416171/Amazon-sees-2-000-new-fires-48-hours-Brazilian-government-banned-burning.html

ESA EarthObservation
@ESA_EO

@esa #EarthObservation: Taking the pulse of our planet from space.

esa.int/Our_Activities...

Joined April 2011

ESA EarthObservation
@ESA_EO

Follow

Thousands of #fires have broken out in the #Amazon rainforest. Satellite data shows almost 4 times as many fires this year compared to the same period last year. #Brazil, parts of #Peru, #Bolivia, #Paraguay and #Argentina have been affected. Read more👉esa.int /Our_Activities ...

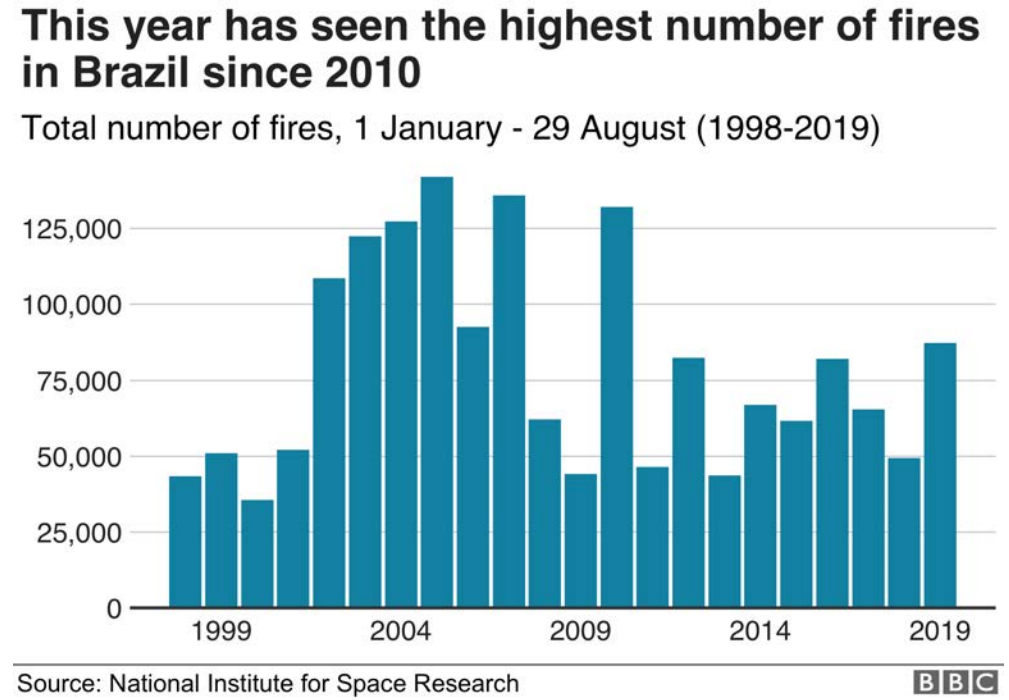
NASA Satellites Confirm Amazon Rainforest Is Burning at a Record Rate

By Passant Rabie August 27, 2019 Science & Astronomy

The ongoing fires are the most active in Brazil since the year 2010.

This map shows active fire detections in the Amazon rainforest in Brazil as observed by Terra and Aqua MODIS between Aug. 15-22, 2019. (Image: © NASA Earth Observatory/Joshua Stevens)

https://www.space.com/amazon-rainforest-fires-2019-nasa-satellite-views.html

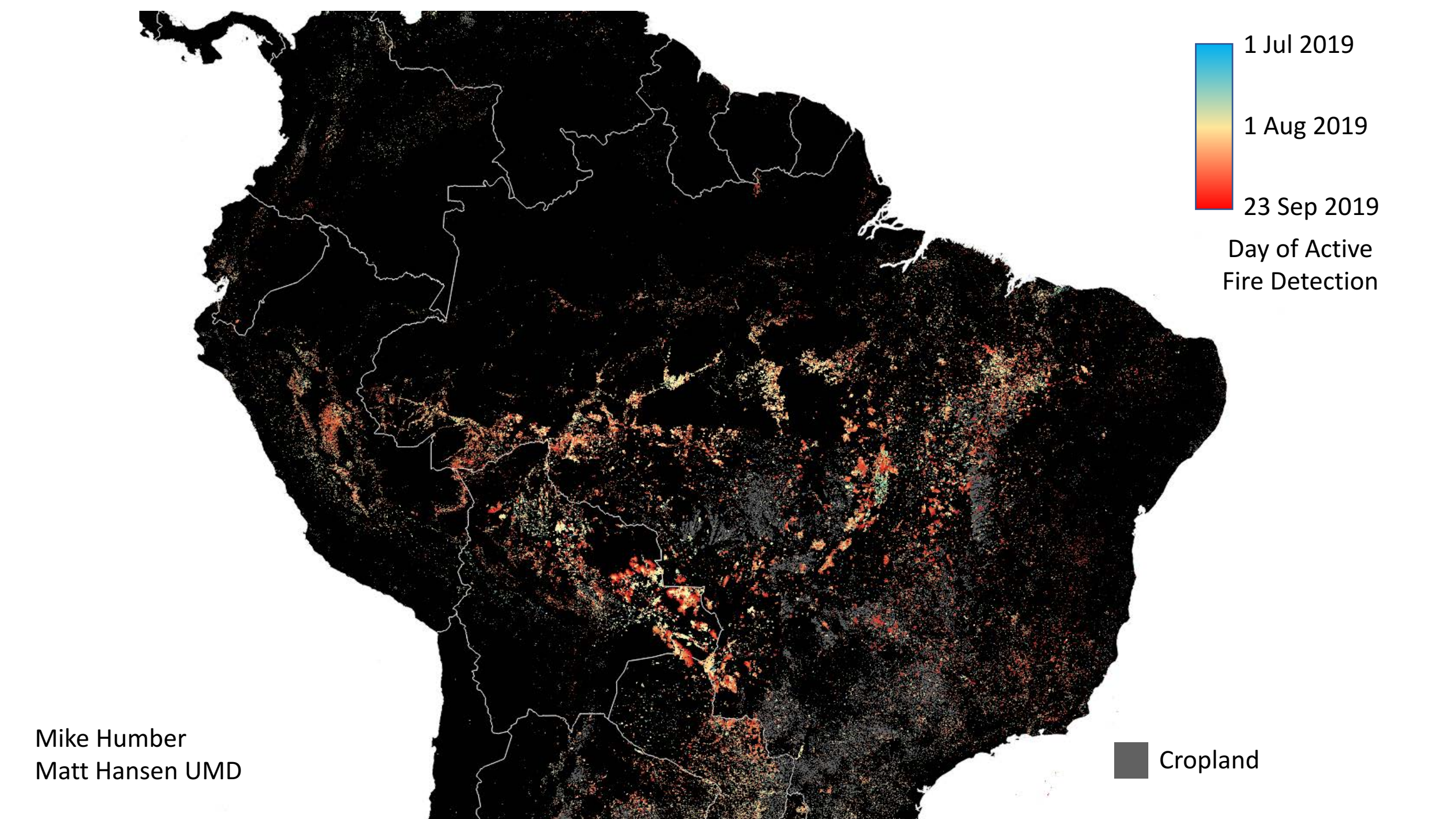


https://www.bbc.com/news/world-latin-america-49433767

2019 Amazon MODIS/VIIRS Fires: Timeline of Early Events

- August 10
  - “Day of Fire” – Origins in Novo Progresso
- August 11
  - NASA Earth Observatory ("Fires in Brazil”)
    - Data credit: GFED
- August 21-23
  - INPE reports a “record 72,843 fires this year, an 80 percent increase from last year”
  - Social media outcry – posts from Leonardo DiCaprio, Madonna, Kathy Griffin, etc.
  - Emphasis on “Lungs of the Earth”
- August 24
  - 44,000 troops deployed to fight fire spread
- August 26
  - G7 Summit
  - Beginning of social media outcry: Earth Alliance (DiCaprio) donates $5m
  - NASA Earth Observatory (“Uptick in Amazon Fire Activity in 2019”)
    - Data credit: Global Forest Watch Fires, INPE, GFED, FIRMS
- August 27
  - @ESA_EO tweet: “[…]Satellite data shows almost 4 times as many fires this year compared to the same period last year.[…]”
    - Data credit: Copernicus
- August 29
  - 60-day ban on burning by President Jair Bolsonaro

Mike Humber, UMD



Mike Humber
Matt Hansen UMD

MODIS SATELLITE-DERIVED INFORMATION USED TO INFORM DECISIONS ABOUT ALLOCATION OF SPECIFIC RESOURCES BY NATIONAL GOVERNMENTS & HUMANITARIAN ORGANIZATIONS

Business / Land & Agriculture

Dry and brown Southern Africa will need food ai

BY EMIKO TERAZONO AND ANDREW ENGLAND, FEBRUARY 15 2016, 05:52

AllAfrica

FINANCIAL TIME

Vegetation Status and Crop Production Perspectives

Report

Growing Season 2015-2016:

A Season of Regional Drought

Forbes

Drought And Starva

BBC Sign in News Sport Reel Worklife Travel Future

NEWS

Home Video World UK Business Tech Science Stories Entertainment & Arts

Asia China India

North Korea 'facing poor harvest' amid food shortages

OCHA

Figure 2: Crop Monitor (Source: GEOGLAM) (https://cropmonitor.org

Southern Africa: Maize Map

Conditions:

Exceptional

Favourable

Watch

Poor

Failure

Countries:

Crop Calendar:

Planting - Early Vegetative

Ripening through Harvest

Out of Season

Poor crop yields in El Salvador FAO

Joint Statement

tates and development partners to **determine the scale and extent** of the possible impact of the prolonged dry spell on the agricult
appropriate response actions for food security and nutrition and build the resilience of vulnerable populations in the region.
sed monitoring of the situation, ascertaining available cereal stocks, fast-tracking of planned crop assessments and annual vulner
ly action and increasing off season production where possible."

File: Crop conditions were also classified as poor in western Madagascar, southern Zimbabwe, southern

Zimbabwe and ea

Crop conditions we
western Madagasc
Malawi, northern N
producing areas of
Mozambique.

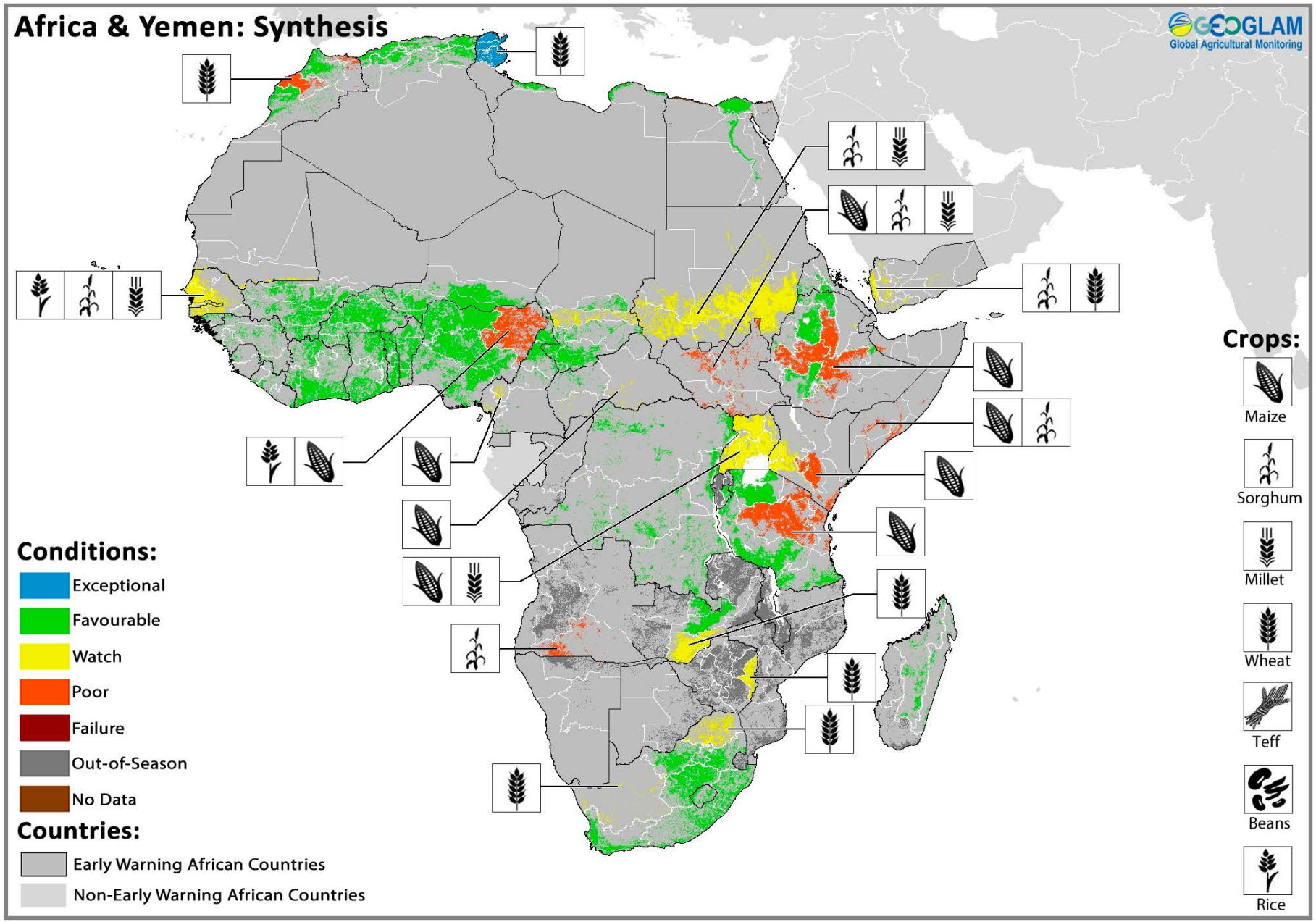
Drought
EWCM
Zimbabwe

World Food Programme

FEWS NET

Food and Agriculture Organization of the United Nations

El Niño Set to Have a Devastating Impact on Southern Africa's Harvests and Food Security



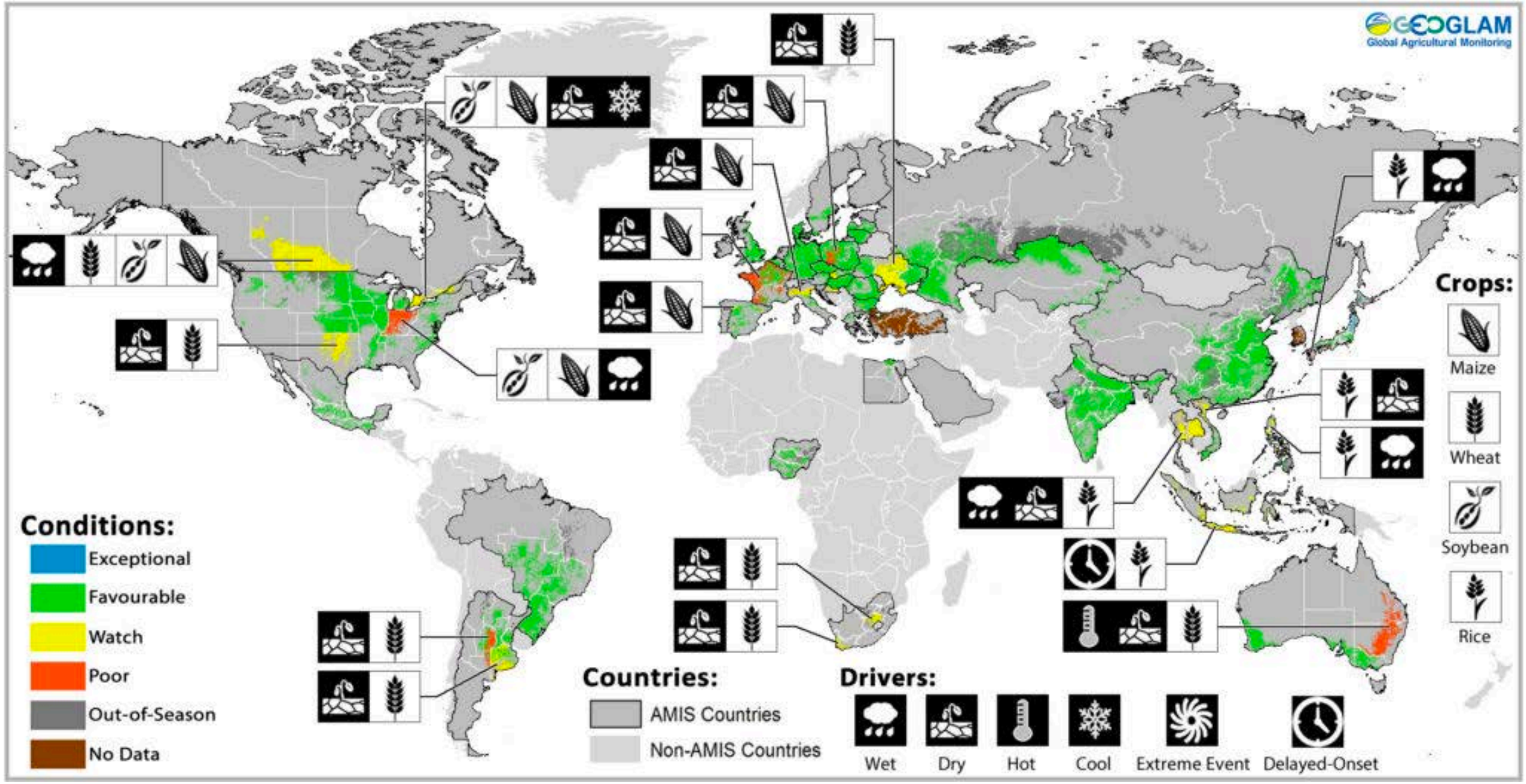
August 2019

- Monthly Consensus Bulletin used by Humanitarian / Aid Community
- MODIS a major input on vegetation condition

https://cropmonitor.org/index.php/2019/08/08/crop-monitor-for-early-warning-august-2019/

NASA Harvest

Monthly Consensus Global Crop Condition Bulletin (November 2019) provided to the Agricultural Market Information System (UNFAO)



Some Issues Raised at the TE Science Team session on Land Data Products

- Continuing NASA's global reputation for science quality global data products
  - NASA Land Data Product Activities more fragmented and relatively underfunded than before
  - Broad consultation needed on land products from Decadal Survey instruments
- NASA encouraging integrated use of international data from ESA/JAXA – more missions and more funding (e.g. Copernicus, CCI)
  - Different approaches and different standards re. data products, documentation and quality
- NASA Product Validation receiving much less funding across the board
  - CEOS Land Product Validation Sub-group – international forum for setting validation standards and protocols – coordinated resource sharing
    - NASA much less engaged in CEOS LPV than previously
    - International Validation Standards and Protocols more important than previously

Current MODIS/S-NPP activities

- MODIS Maintenance part of the Senior Review – upcoming 2020
- SNPP-VIIRS Production, Evaluation and Refinement underway
- 4 New MODIS/VIIRS Land Products in development
  - Sea Ice Leads
  - Global Reservoir Product
  - Night Lights Product
  - Volcanic Heat Flux Product
- 2 Multi-source Land Data Fusion Activities underway
  - Soil Moisture and Evapotranspiration
  - Snow Water Equivalent
- Presentations on all of the above in the Land Discipline Session

In Summary

- NASA Earth Sciences has a global reputation for science quality instruments, data and products
- The MODIS products and now VIIRS continue to contribute to this reputation for science quality products
- NASA's coarse resolution daily data have an important role to play in the study of global and climate change and a continuing long term science data record is required to quantify and study the change
- NASA's coarse resolution products are also used by a number of organizations around the World for operational monitoring
- There is a strong case for NASA to continue to develop and provide stewardship for a long term record of daily coarse resolution science quality data products
- A long-term affordable implementation strategy needed to sustain the NASA coarse resolution products and to bridge from MODIS/S-NPP to the JPSS instruments