WMO

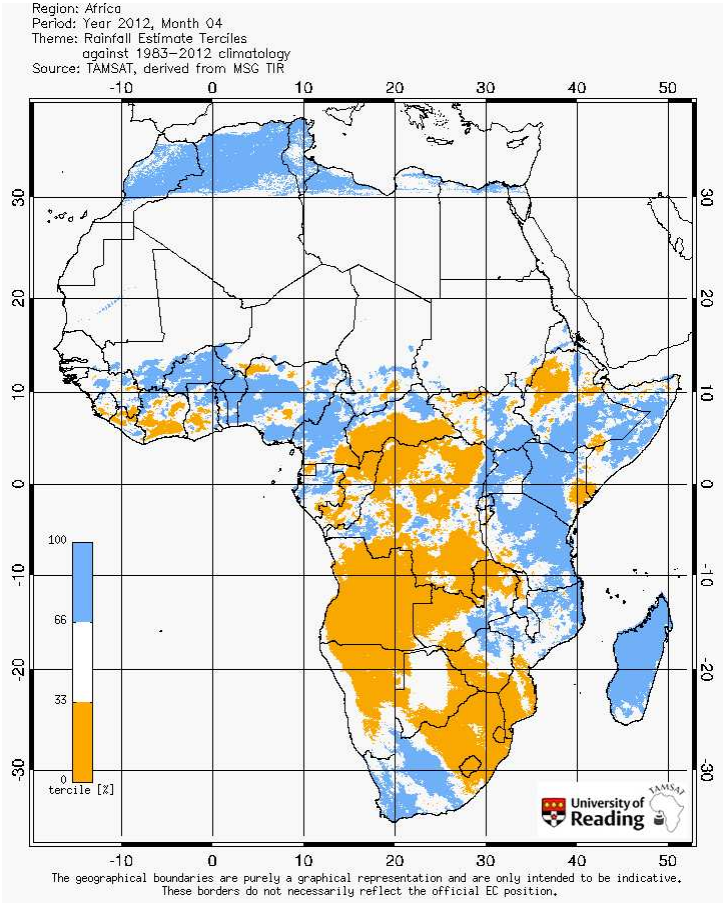
World Meteorological Organization

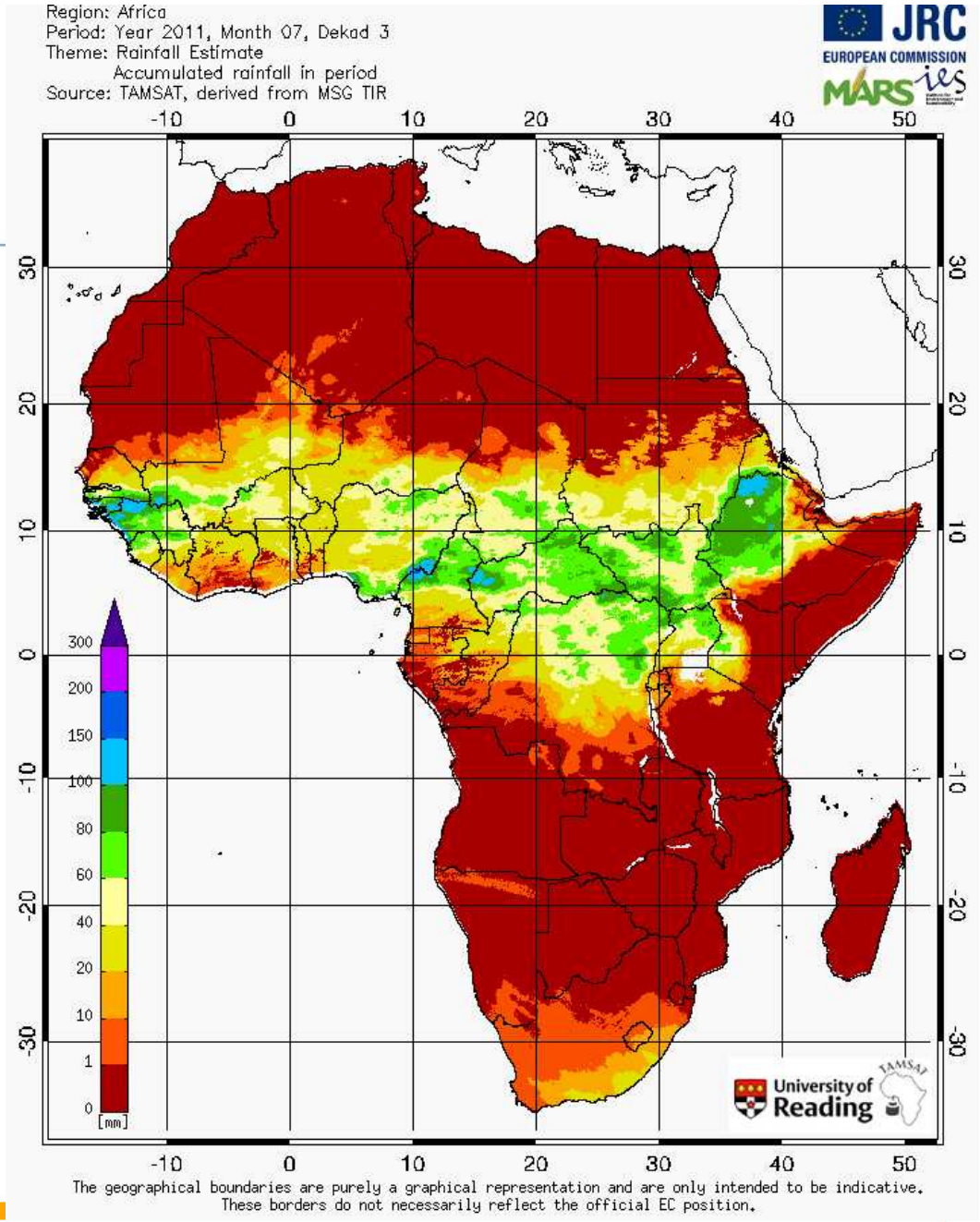
Working together in weather, climate and water

Estimation de la pluie aux tropiques

J. Camacho
Scientific Officer
Agricultural Meteorology Division. CLW/CLPA

Produits precipitation provenant d' information satellitaire





Precipitation retrieval methods

VIS/IR Méthodes

VIS – Plus brilliante, plus épaisse

IR – Plus froide, plus haute/developpée

Propietés chanel 1,6, 2,1 et 3,9 μm – Phase et forme des elements de precipitation

Multi-channel techniques. GOES Multi-spectral Rainfall Algorithm (uses cloud properties to cathegorize cloud/precipitation regimes)

Méthodes microondes passives (longueur d'onde quelques mm – 300 MHz-300 GHz)

Deux procesus: emision par les goutelettes d' eau et reduction par retro dispersion originée par les particles de gel. Bon methode sur ocean (emission de la mer petite et constante). Pas bon sur le terrain. Utilisation des données sol, schemas de radiation, models radiatifs. En general, meilleurs pour charateriser les genres de nuages que la precipitation au sol. Resolution 50 x 50 km

Precipitation retrieval methods (II)

Methodes microondes actives

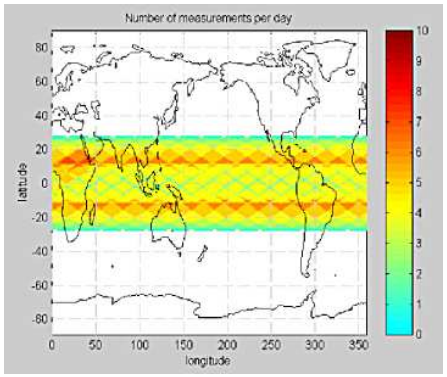
Radar. Detection des produits de precipitation. Signal proportionel a la sixieme puissance du diametre de goutelettes ou equivalente en glace et proportionel au numero de particles. Tres dificile de separer les particles de glace et d' eau. Solution: Radar frequence dual (DPR) at 13,5 and 35,6 GHz. Detection neige ou pluie a intensités equivalentes a 0.3 mm/h

Techniques multi-sensor

TMPA – TRMM + PMW+IR+données pluviometres
CMAP – IR+NCEP/NCAR reanalysis et données pluviometres
PERSIANN – Utilisation reseaux neuronales et données multisensor et multi-channel.
Techniques estimation mouvement: CMORPH, Lagrangian models

MEGHA-TROPIQUES

Le satellite **franco-indien** est destiné à la recherche atmosphérique. Les données recueillies par le satellite permettront d'améliorer nos connaissances sur la contribution du cycle de l'eau à la dynamique du climat dans l'**atmosphère tropicale** et notre compréhension des processus liés à la convection tropicale. Resolution 10x40 km2



Nombre d'échantillons
par jour pour MADRAS.

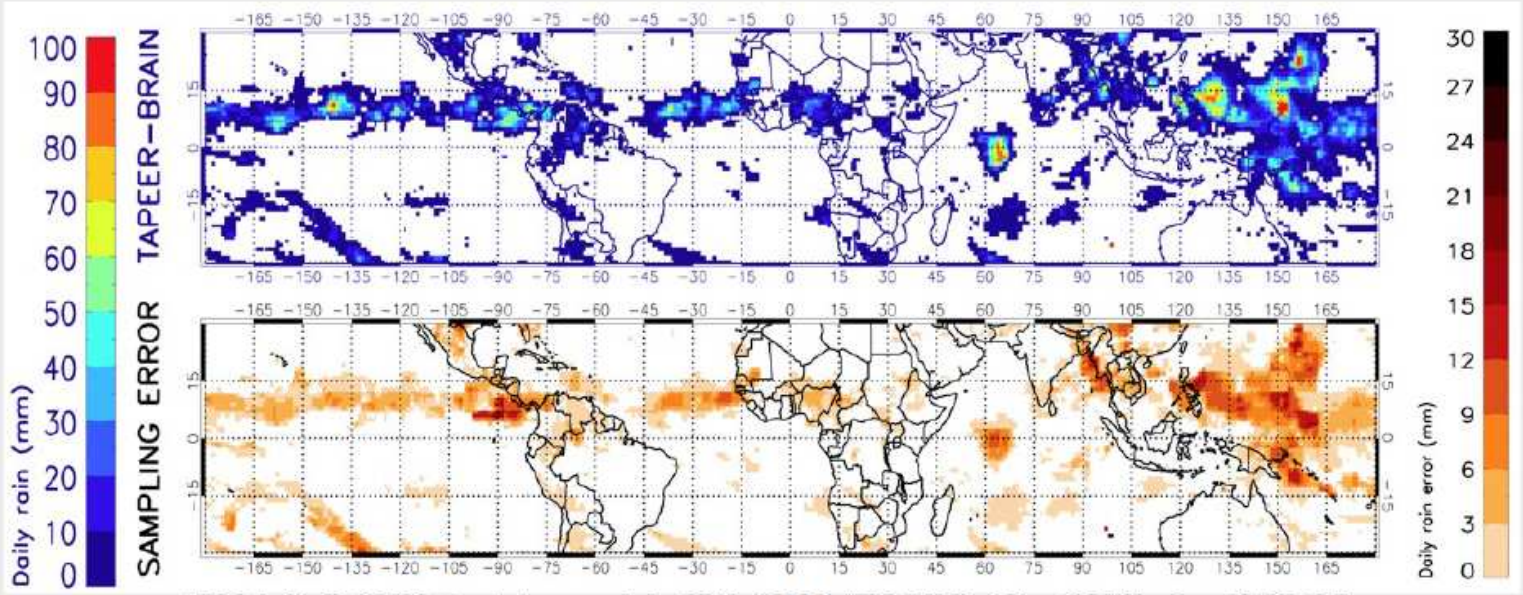
MEGHA-TROPIQUES est un mini-satellite utilisant une plate-forme indienne (IRS). Sa charge utile est contituée de :
MADRAS : un imageur micro-ondes principalement destiné à l'étude des précipitaions et des propriétés des nuages,
SAPHIR : un radiomètre micro-ondes à 6 canaux, permettant de restituer les profils verticaux et la distribution horizontale de la vapeur d'eau,
SCARAB : un radiomètre dédié aux mesures des flux radiatifs au sommet de l'atmosphère.

The **TAPEER-BRAIN** product is the **Megha Tropiques Level 4 product :**

It consists of **maps of accumulated rain and their associated errors with a 1°x1°x1 day resolution over the Tropical belt.**

The algorithm uses data, **independent from groundbased measurements**, from instantaneous rainrate measurements (**BRAIN,** the **MT level 2 product**) as well as TIR data to provide quantitative estimates of the precipitations and their associated errors.

=> **T**ropical **A**mount of **P**recipitation with an **E**stimate of **ER**rors (**TAPEER**)

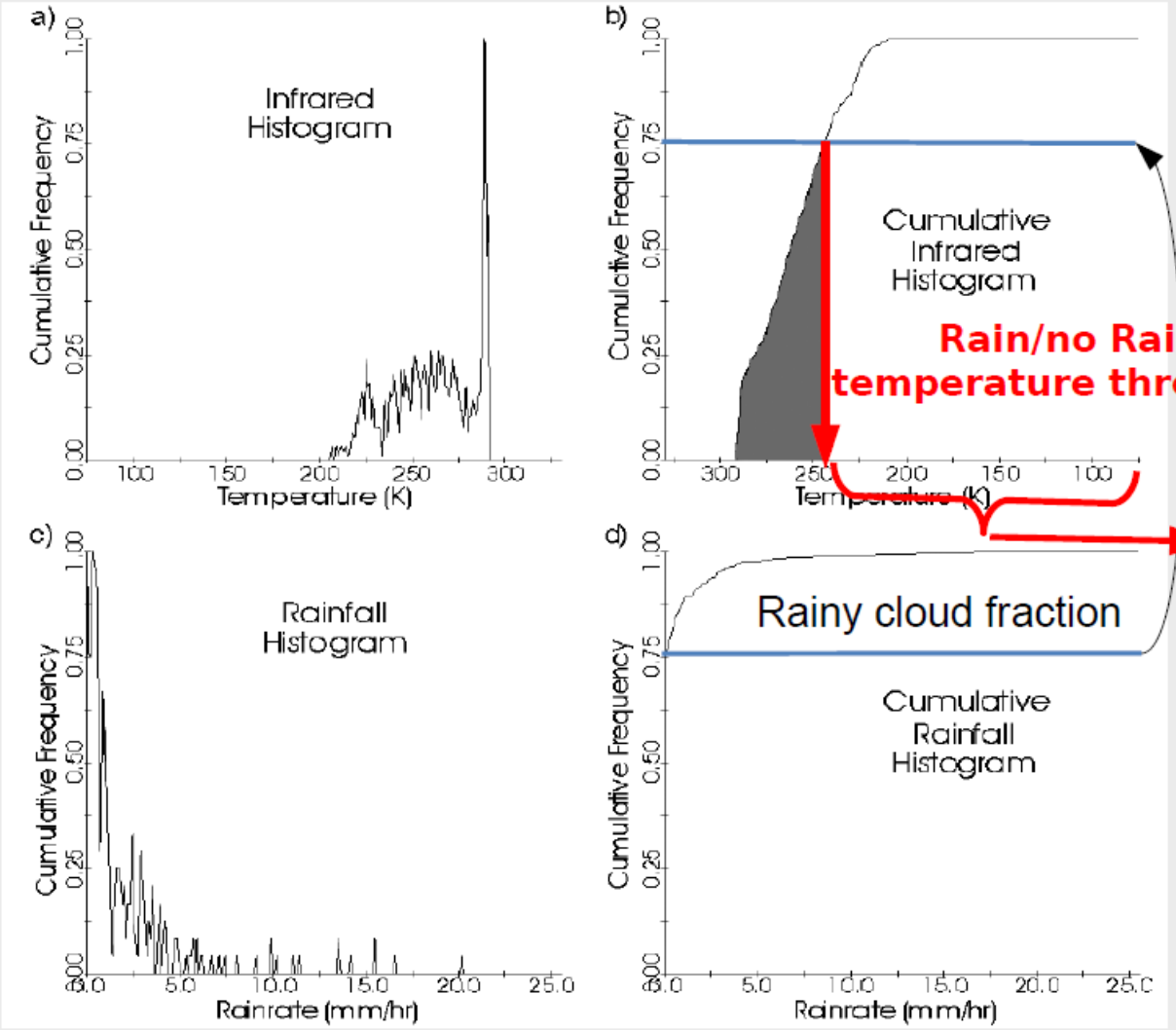


TAPEER-BRAIN Prototype - July 30th 2009 (BRAIN-TMI, -SSMI x2, -AMSRE)

The TAPEER method :

Assumption : IR pixels colder than a given threshold are rainy

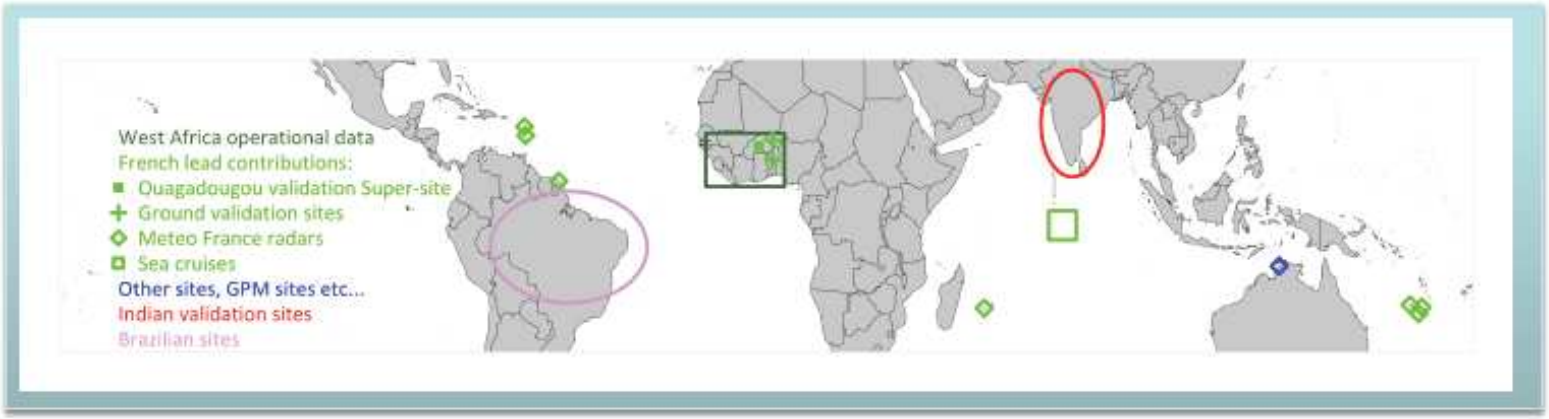
5°x5°x5days volume



Kidd et al., 2003

TAPEER – BRAIN

Validation sur les réseaux pluviométriques



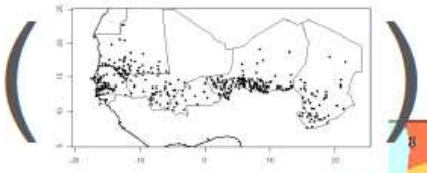
Marielle Gosset, Clément Guilloteau, Matias Alcoba, Guillaume Quantin, Subash Yeggina, Nicolas Taburet, et Rémy Roca
Et nos autres partenaires AMMA-CATCH / CEFIRSE

Cours applications télédétection en météorologie agricole, ***Ouagadougou, Burkina Faso 5-9 Mai 2013***

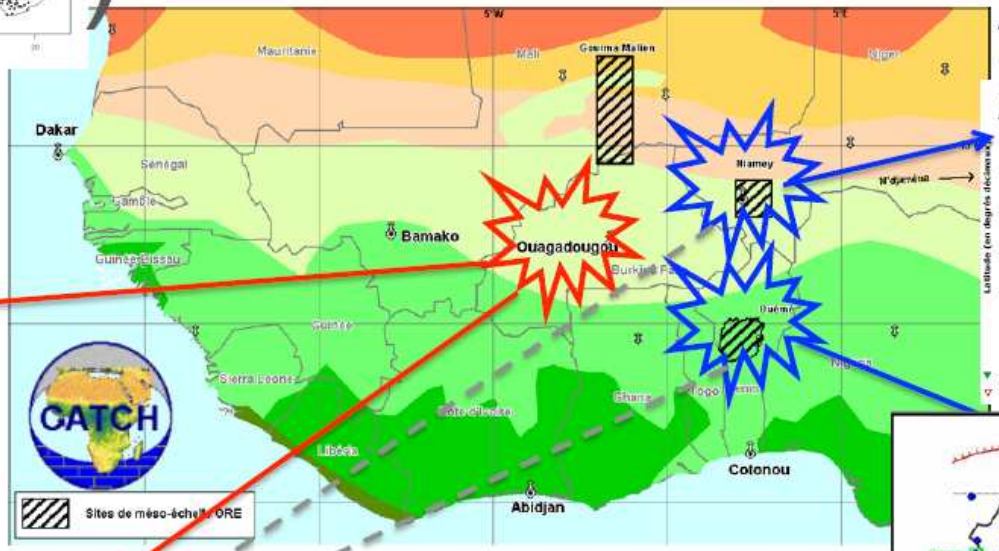
Reseau 'historiques' AMMA-CATCH
MTGV West African site BF

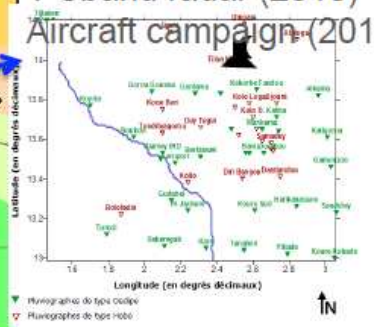
ISRO-CNES
megha-tropiques

CATCH

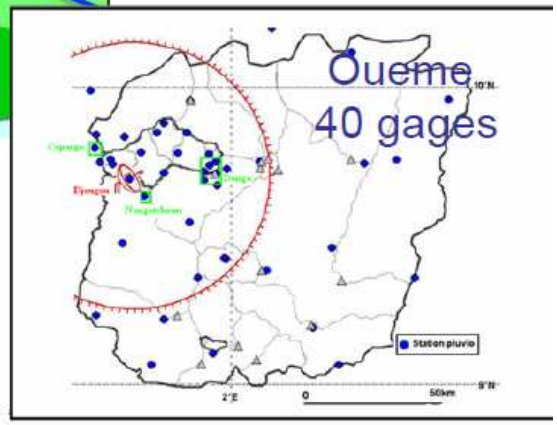


Niamey
40 gages
1 Cband radar (2010)
Aircraft campaign (2010)





Ouagadougou
2012->
15 gages
MW links

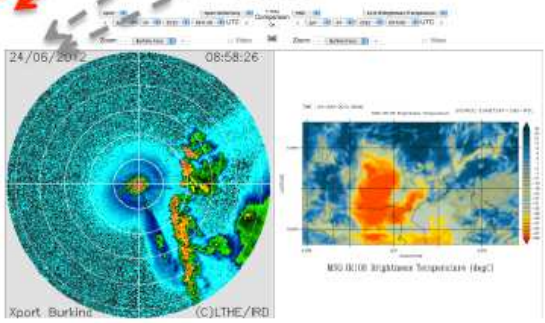


BENIN: OUEME's Hydrological Observatory (OHHVO)

2012-13

2010

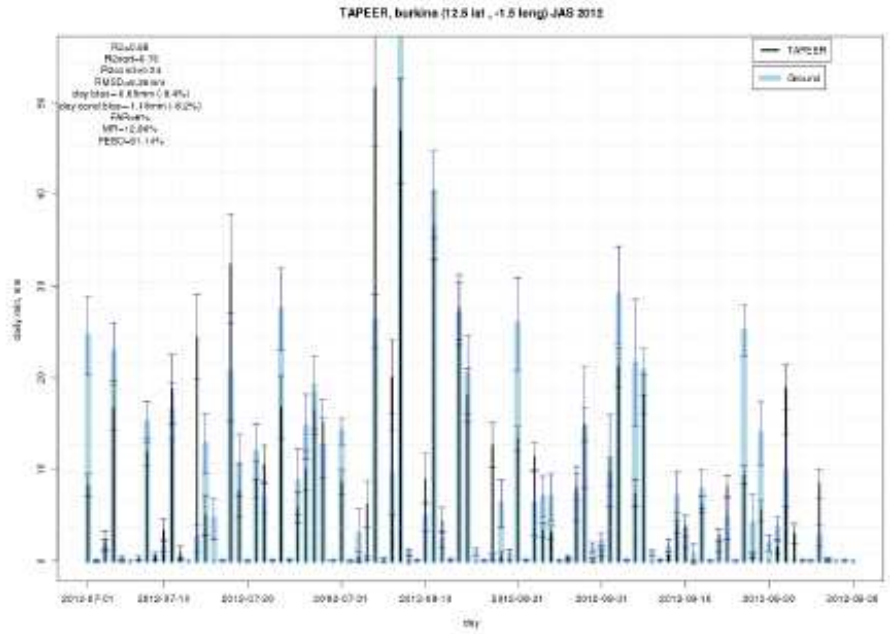
2006-7



Radar Meteorologique Xport de l'IRD

Evaluation quantitative à l'aide des réseaux sol

Analyse des séries temporelles



Zone Sahélienne
JAS 2012

Site	R^2	R^2_{sqrt}	R^2_{cond}	RMSD (mm/d)	Biais (%)	Biaisc (%)	FAR (%)	MR (%)	
TAPEER	0.6	0.7	0.4	7	-5	-5	11	20	sat
TMPA RT	0.4	0.6	0.2	9	16	12	16	13	sat
TMPA	0.4	0.6	0.3	9	3	0	16	15	Sat/pluv
GPCP	0.6	0.7	0.4	7	-5	-1	14	23	Sat/pluv

Conclusions et Perspectives

TAPEER GV

Le produit TAPEER avec MADRAS , satellite-only, montre des performances comparables aux produits GCPC et 3B42v7 qui utilisent des données sol !

- + cohérent que d'autres produits SAT only (TMPA RT)

- Encore quelques problèmes ponctuels à vérifier avec les développeurs TAPEER et BRAIN – Notamment tendance à la sous-estimation….
- A généraliser sur d'autres zones / périodes au fur et à mesure que TAPEER-BRAIN dispo et réseaux sol contrôlés.

Continuer à qualifier les erreurs/incertitudes

- Comprendre leur origine (feedback vers dev)
- Documenter leur structure (important pour les utilisateurs)
- Lien avec GPM / IPWG etc.. Methodologie de validation / Prise en compte des incertitudes dans la val.

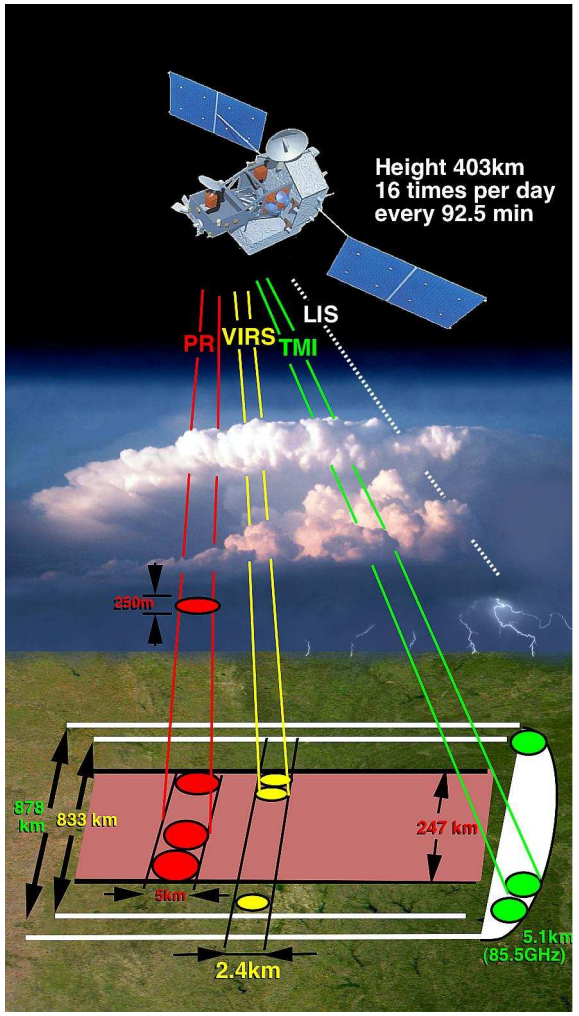
- Importance de réseaux sol bien qualifiés !!!! (ORE et partenariats internationaux)

- Utilisation de TAPEER et son modèle d'erreur pour l'étude intégrée du cycle de l'eau tropical
    - Applications hydrologiques
    - Validation Intégrée ou hydrologique
    - Liens avec autres missions spatiales

Télédetection active – TRMM

Tropical Rainfall Measuring Mission

Before TRMM's launch measurements of the global distribution of rainfall at the Earth's surface had uncertainties of the order of 50% and the global distribution of vertical profiles of precipitation was far less well determined. TRMM is providing some of the first spaceborne rain radar and microwave radiometric data that will measure the vertical distribution of precipitation over the tropics in a band between 35 degrees north and south latitudes.



Télédetection active – TRMM

Tropical Rainfall Measuring Mission

Precipitation **R**adar **(PR)**

TRMM **M**icrowave **I**mager **(TMI)**

Visible and **I**nfra**R**ed **S**canner **(VIRS)**

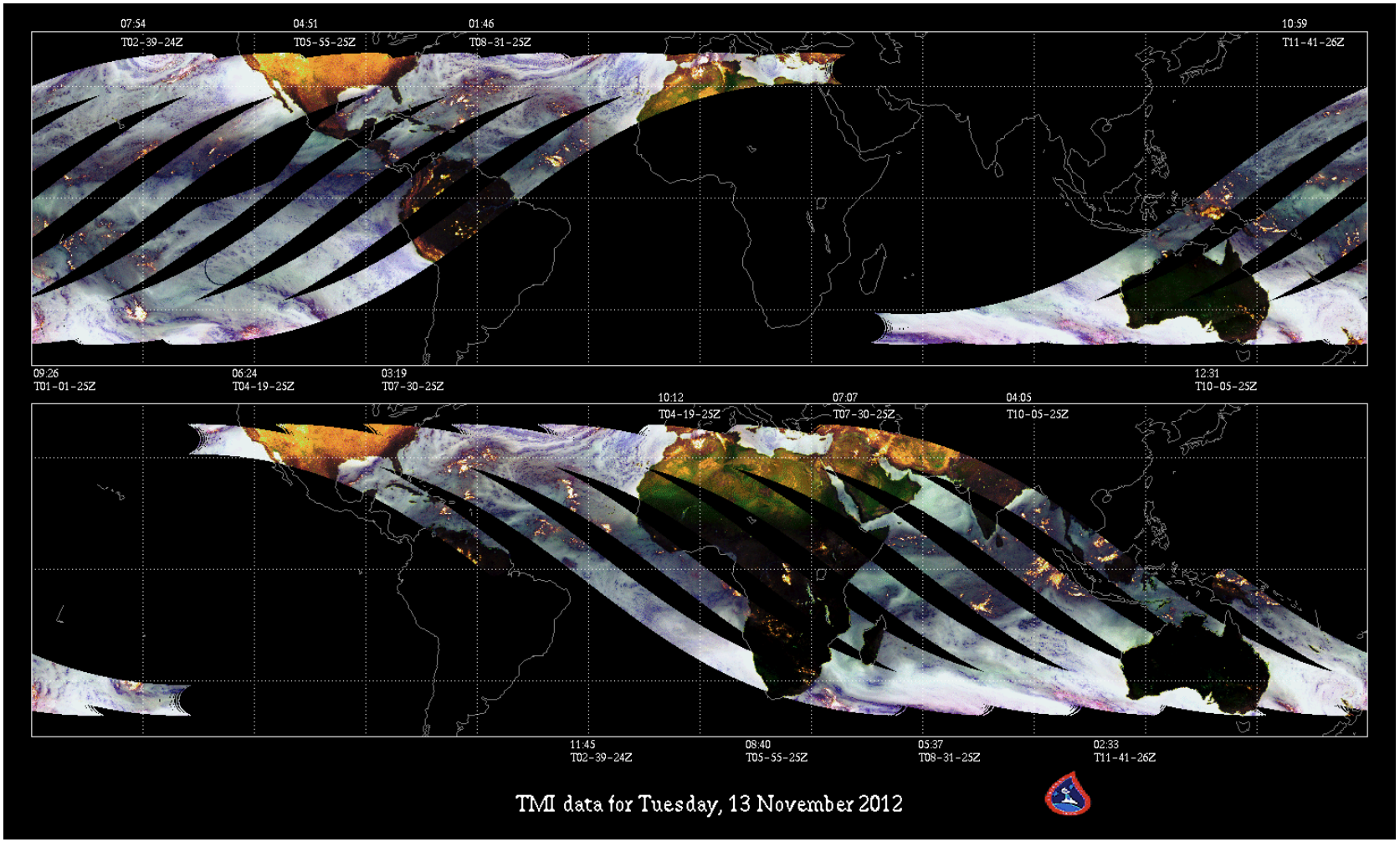
Cloud and **E**arth **R**adiant **E**nergy **S**ensor **(CERES)**

Lightning **I**maging **S**ensor **(LIS**

The Precipitation Radar has a horizontal resolution at the ground of about 3.1 miles (five kilometers) and a swath width of 154 miles (247 kilometers). One of its most important features is its ability to provide vertical profiles of the rain and snow from the surface up to a height of about 12 miles (20 kilometers). The Precipitation Radar is able to detect fairly light rain rates down to about .027 inches (0.7 millimeters) per hour. At intense rain rates, where the attenuation effects can be strong, new methods of data processing have been developed that help correct for this effect. The Precipitation Radar is able to separate out rain echoes for vertical sample sizes of about 820 feet (250 meters) when looking straight down. It carries out all these measurements while using only 224 watts of electric power-the power of just a few household light bulbs. The Precipitation Radar was built by the Japan Aerospace Exploration Agency (JAXA) as part of its contribution to the joint US/Japan Tropical Rainfall Measuring Mission (TRMM)

Teledetection active – TRMM

http://trmm.gsfc.nasa.gov/

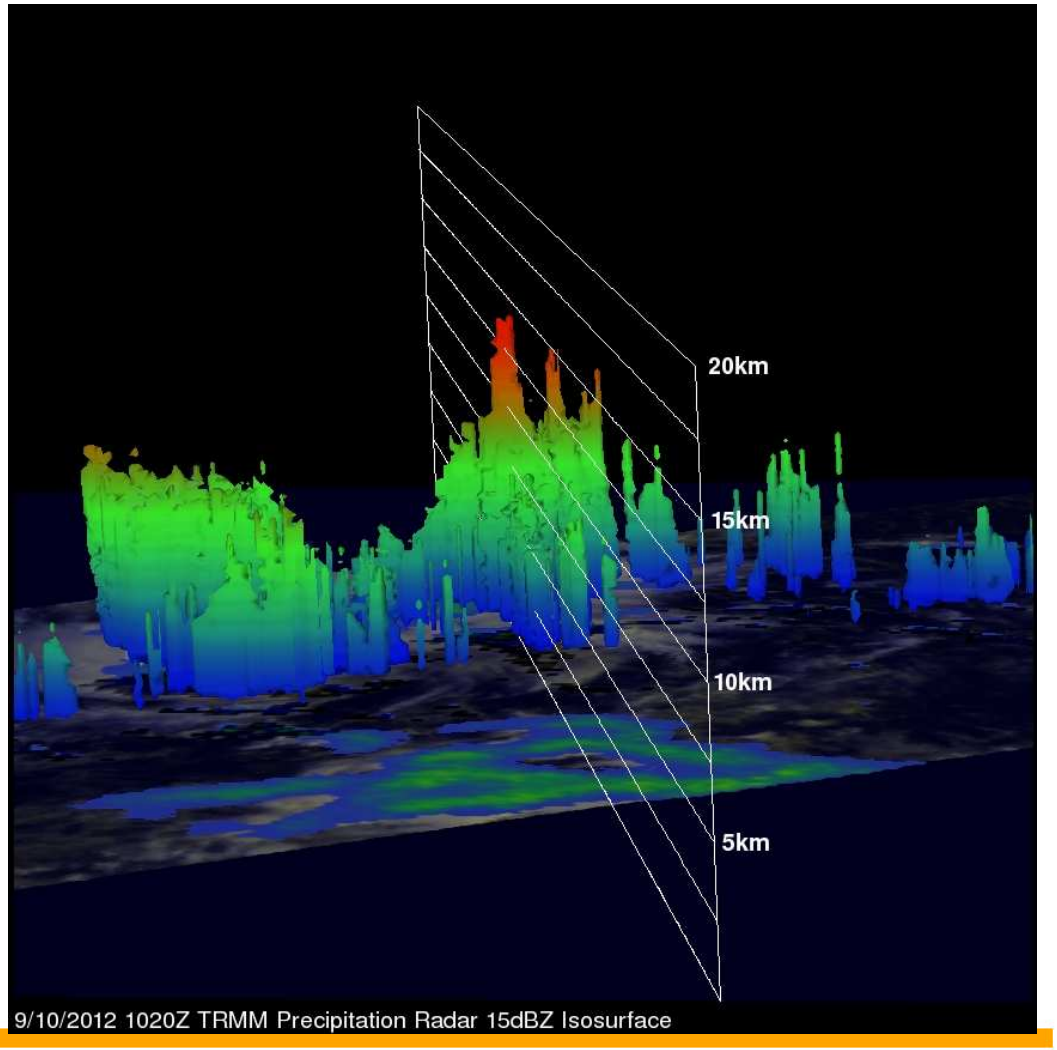


Teledetection active – TRMM

http://trmm.gsfc.nasa.gov/

TRMM Views A Forming Tropical Cyclone (later called Nadine)

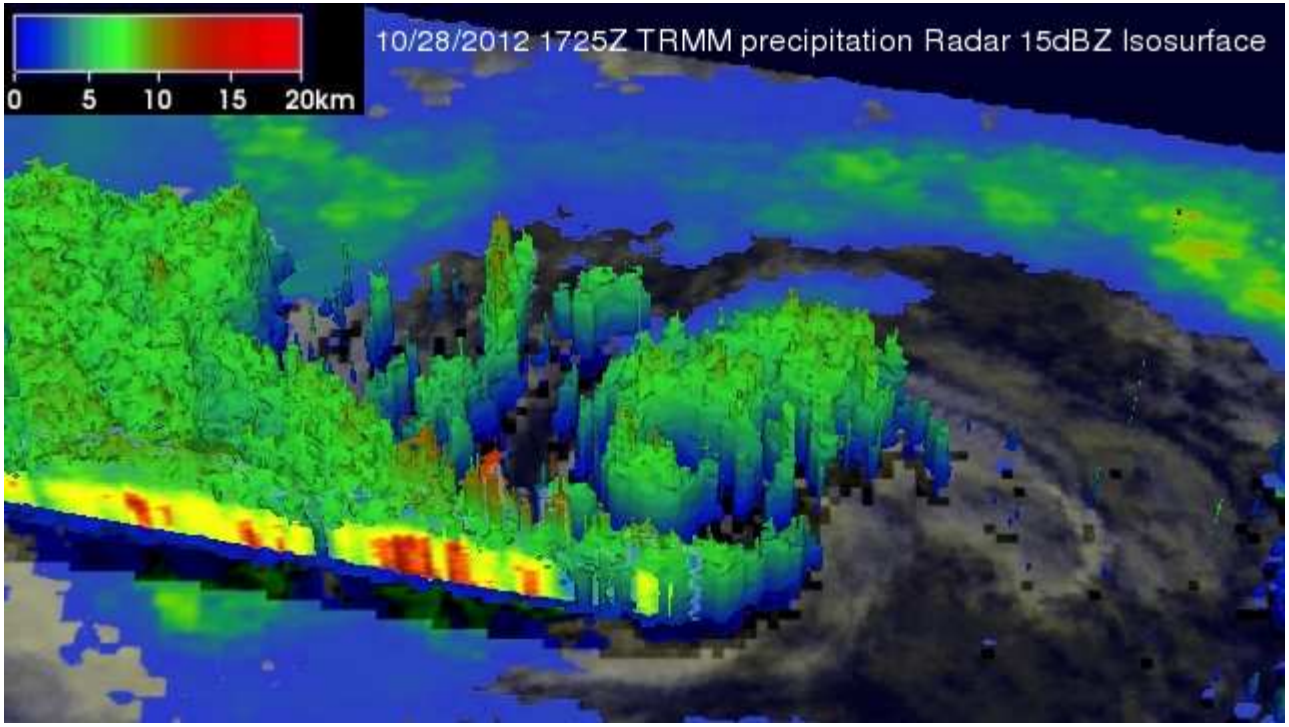
Tropical depression fourteen (TD14) was forming about 855 miles west of the Cape Verde Islands when the TRMM satellite flew over that area on the morning of September 10, 2012 at 1020 UTC (6:20 AM EDT). A rainfall analysis derived from TRMM's Microwave Imager (TMI) and Precipitation Radar (PR) is shown overlaid on a combination infrared and visible image from TRMM's Visible and InfraRed Scanner (VIRS). This image shows that the disturbance was getting organized and convective storms were dropping heavy rain to the northwest and northeast of the center of the circulation.



Teledetection active – TRMM

http://trmm.gsfc.nasa.gov/

The TRMM satellite collected data when it flew over hurricane Sandy on Sunday, October 28, 2012 at 1725 UTC (1:25 PM EDT). One of the most important features of TRMM's Precipitation Radar (PR) instrument is its ability to provide three dimensional data about rain and snow from the surface up to a height of about 12 miles (20 kilometers). The Precipitation Radar was built by the Japan Aerospace Exploration Agency (JAXA) as part of its contribution to the joint US/Japan Tropical Rainfall Measuring Mission (TRMM).Click here to see an animation showing a simulated 3-D flyby over hurricane Sandy's precipitation using TRMM PR data from that orbit



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Tropical Rainfall Measuring Mission

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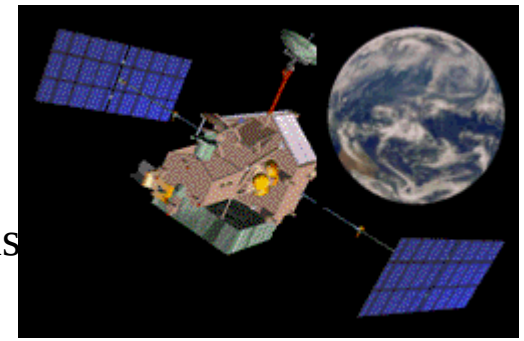
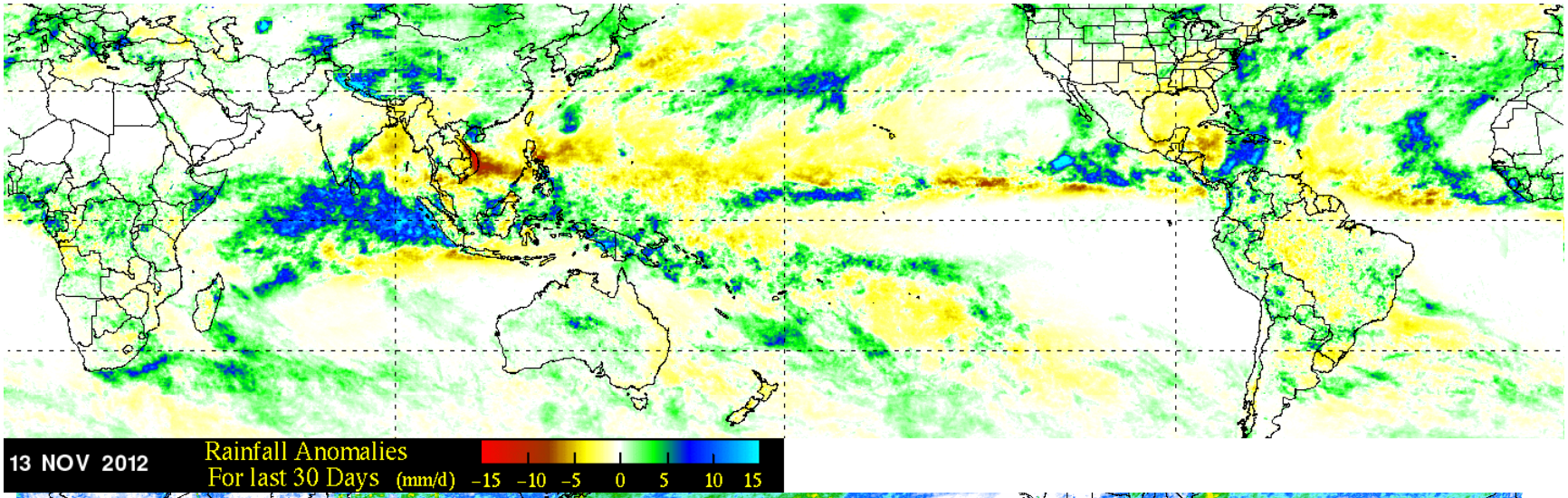
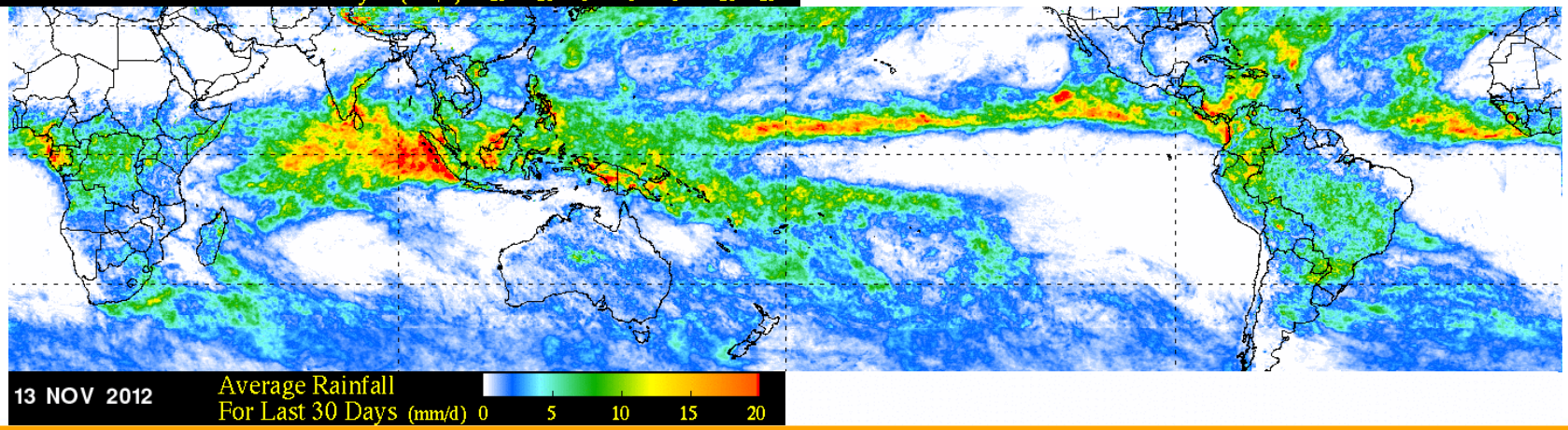


Teledetection active – TRMM

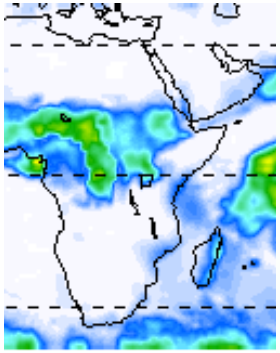
Tropical Rainfall Measuring Mission





Teledetection active – TRMM

Tropical Rainfall Measuring Mission

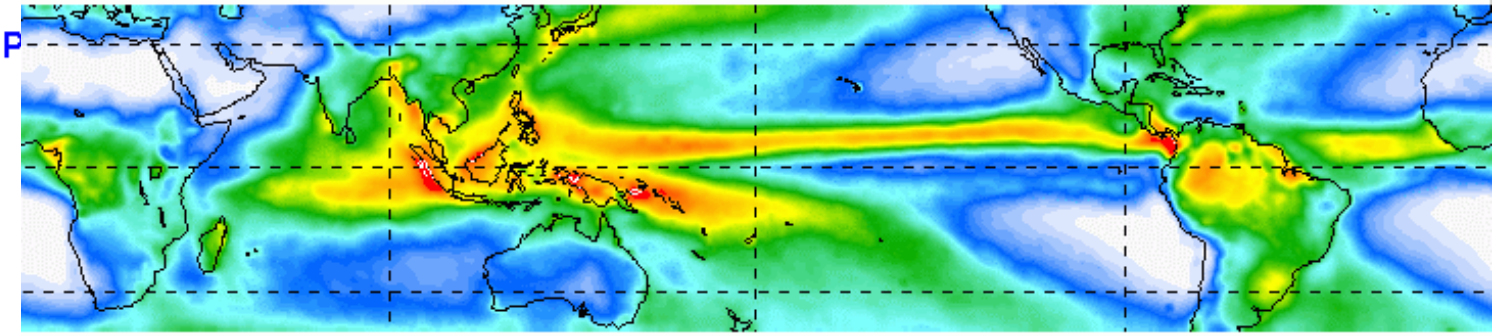


TRMM Merged P

http://trmm.gsfc.nasa.gov/data_dir/data.html

Tropical Rainfall Measuring Mission (TRMM)

Six – Year TRMM Climatology



TRMM Merged Precip Annual Climo (mm/d)

0 2 4 6 8 10+

January 1998 – December 2003

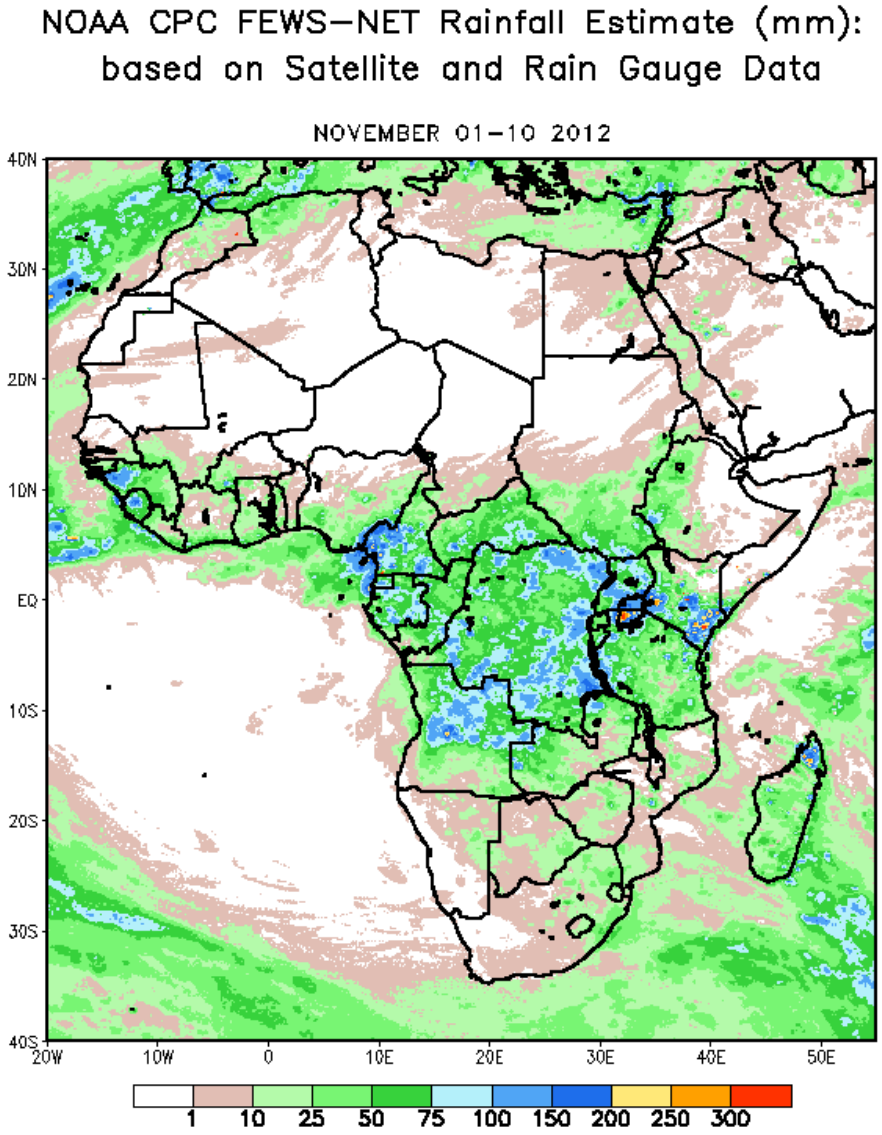
Blended products - CPC products

The NOAA Climate Prediction Center African Rainfall Estimation Algorithm Version 2 .0

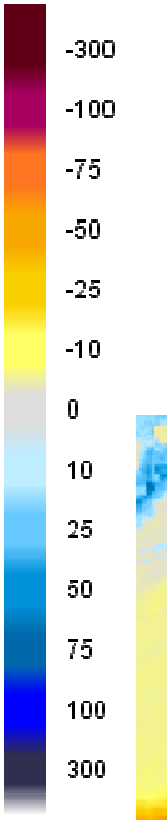
Beginning January 1, 2 001, the African Rainfall Estimation Algorithm Version 2 (RFE 2.0) was moved to operation al status, replacing the previous algorithm (R FE 1.0) (Herman et.al. 1997), used from June 1, 19 95 to December 31, 2000. The merging technique, the backbone of RFE 2.0, has been shown to significantly reduce bias and random error compared to individual precipitation data sources, thus increasing the accuracy of the rainfall estimates (Xie and Arkin, 1996). Due to modernization of data sources and programming techniques, RFE 2 .0 exhibits many improvements over its predecessor. Along with improved accuracy, increased speed and convenient portability make RFE 2.0 a much better method to estimate daily precipitation over Africa, although orographic rainfall effects are not incorporated. Following are some essential facts about RFE 2.0.

Input data used for operational rainfall estimates are from 4 sources;

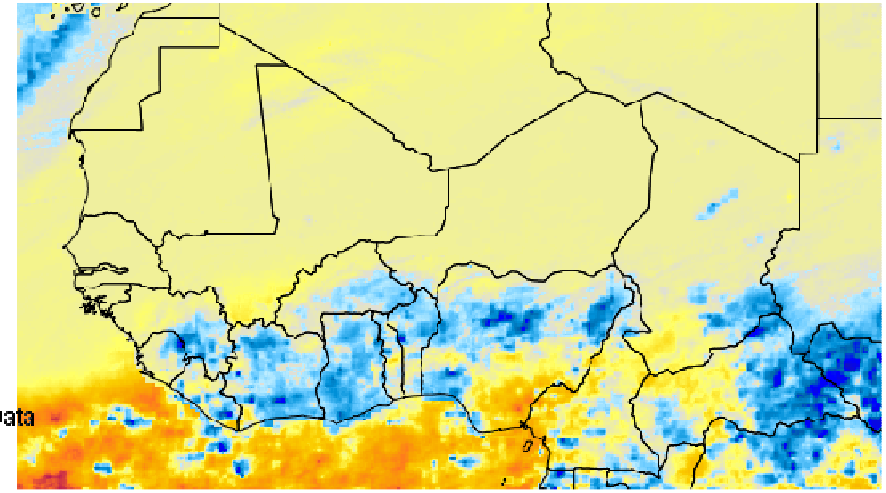
1) Daily GTS rain gauge data for up to 1000 stations
2) AMSU microwave satellite precipitation estimates up to 4 times per day
3) SSM /I satellite rainfall estimates up to 4 times per day
4) GPI cloud-top IR temperature precipitation estimates on a half-hour basis.

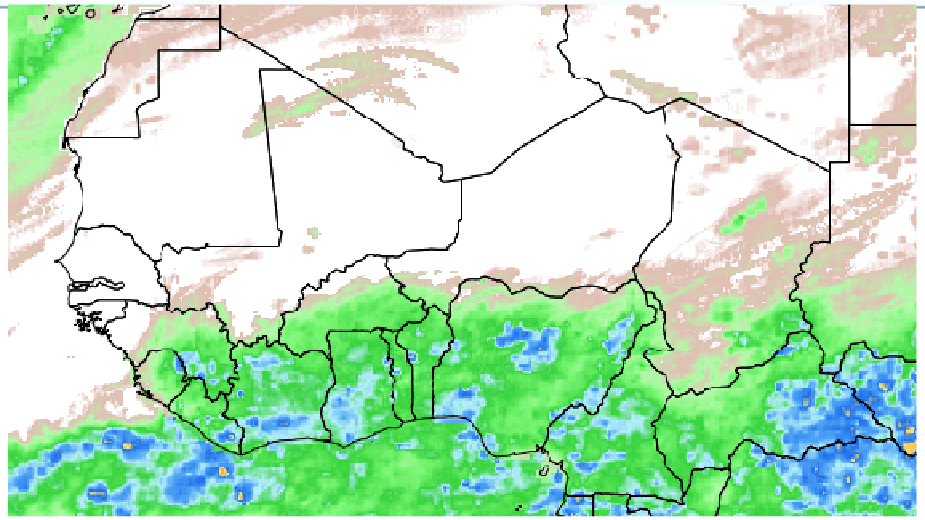


African Rainfall Estimation Algorithm Version 2 .0

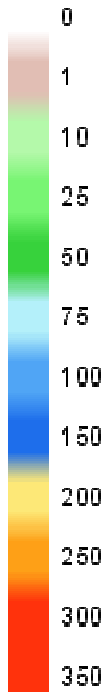


Anomaly – Dekad 11-20 April 2014





Raw data – Dekad 11-20 April 2014

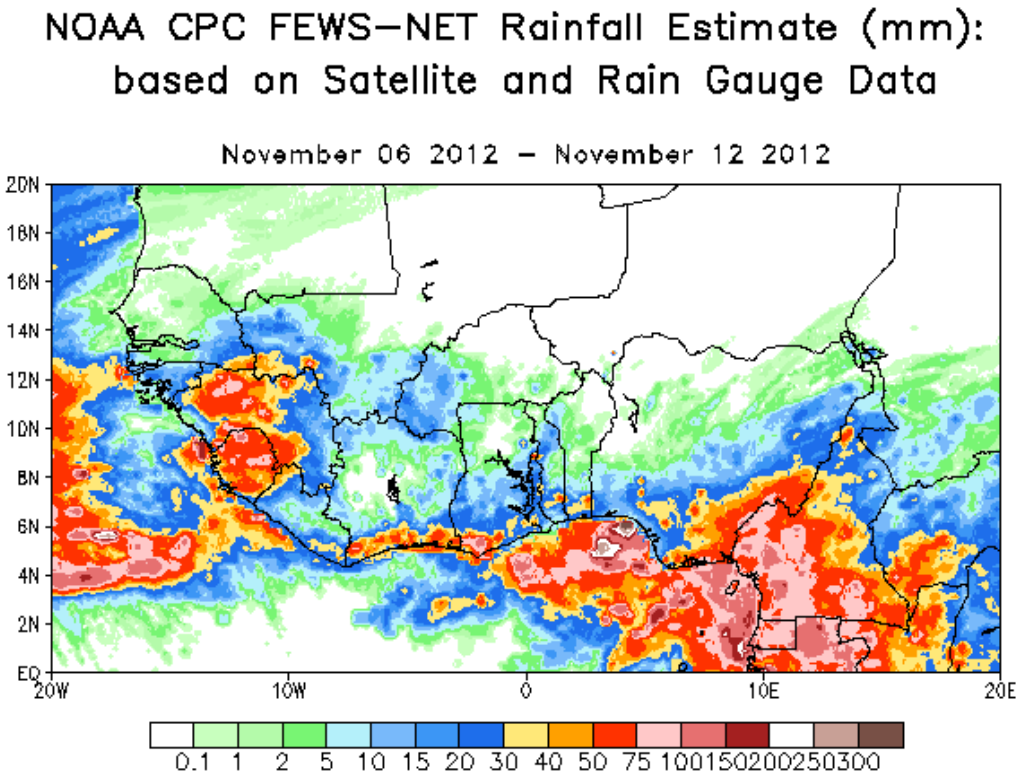


Blended products – African Rainfall Climatology ARC2

The recent acquisition of historical, recalibrated IR imagery and daily summary gauge data has enabled reconstruction of the ARC climatology dataset from 1983 – present. A new, reconstructed Africa Rainfall Climatology (ARC2) offers a number of advantages compared to other long-term climatological rainfall datasets that are widely used. First, high resolution historical rainfall estimates on a daily basis would help not only to monitor precipitation associated with synoptic and mesoscale disturbances, but also to undertake studies of extreme events, wet and dry spells, number of rain days (i.e. rainfall frequency), and onset of the rainfall seasons. Second, a 0.1° (~10km) spatial resolution allows users to see rainfall phenomenon on local scales that cannot be captured by coarser climate datasets. For the FEWS-NET program, this local scale resolution has also been instrumental in assessing impacts of rainfall on agriculture and water resource management. Third, the ARC2 maintains the same two inputs that remain continuous and homogeneous over time. This straight-forward estimation approach is expected to minimize the possibility of introducing bias associated with new satellite sensors. Lastly, because the same algorithm as the operational RFE2 is used, ARC2 precipitation estimates are also available in near real-time, allowing the dataset to be routinely updated on a daily basis. All of these features make the new ARC2 dataset unique.

Final sinthesis – CPC products

The three satellite estimates are first combined linearly using predetermined weighting coefficients, then are merged with station data to determine the final African rainfall. Daily binary and graphical output files are produced at approximately 3pm EST with a resolution of 0.1° and spatial extent from 40°S-40°N and 20°W-55°E. Additional data sets of 10 -day, monthly, and season al rainfall totals are created by accumulating daily data. Seven other daily binary output fields are produced using various combinations of input data, but these are not considered operational and will be discussed later. By default, each output field is created in GrAD S format, so the GrAD S graphics package will allow for easy image creation.



Pluviomètres simples

Merci !