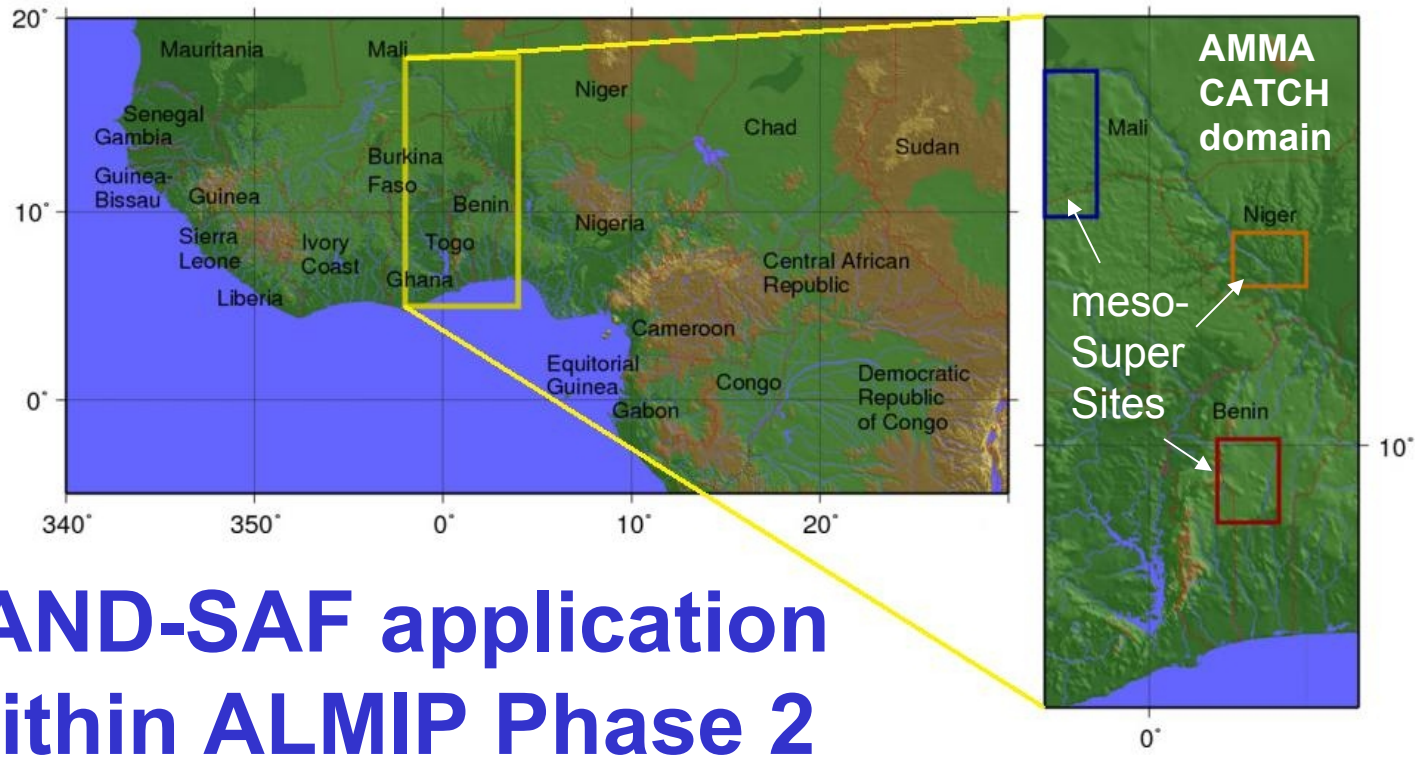
ALMIP AMMA Land surface Model Intercomparison Project Phase 2



LAND-SAF application within ALMIP Phase 2

Aaron Boone, CNRM-GAME Météo-France, Toulouse

with

A. C. V. Getirana, J. Demarty, B. Cappelaere, S. Galle, M. Gosset, M. Grippa, T. Lebel, E. Mougin, C. Peugeot, G. Quantin, L. Seguis, J. Viarre and T. Vischel + others!!!

METEO FRANCE Toujours un temps d'avance

ALMIP strategy:

A **high priority** of the African Monsoon Multi-disciplinary Analysis (AMMA) is to better understand and model the influence of the spatial and temporal variability of surface processes on the atmospheric circulation patterns and the regional scale water and energy cycles relative to the West African Monsoon (WAM). This is being addressed through a **multi-scale** modeling approach using an **ensemble of land surface models** which rely on dedicated **satellite-based forcing and land surface parameter products**, and data from the **AMMA observational field campaigns**

Break various components of complex coupled system into managable portions which can then provide insight into various processes: 1st step➔ Force LSMs in *Offline* mode

LSM (or SVAT) ➔ lower BC for atmospheric models, upper BC for hydrological model

For more on AMMA, See Redelsperger *et al.*, 2006, BAMS

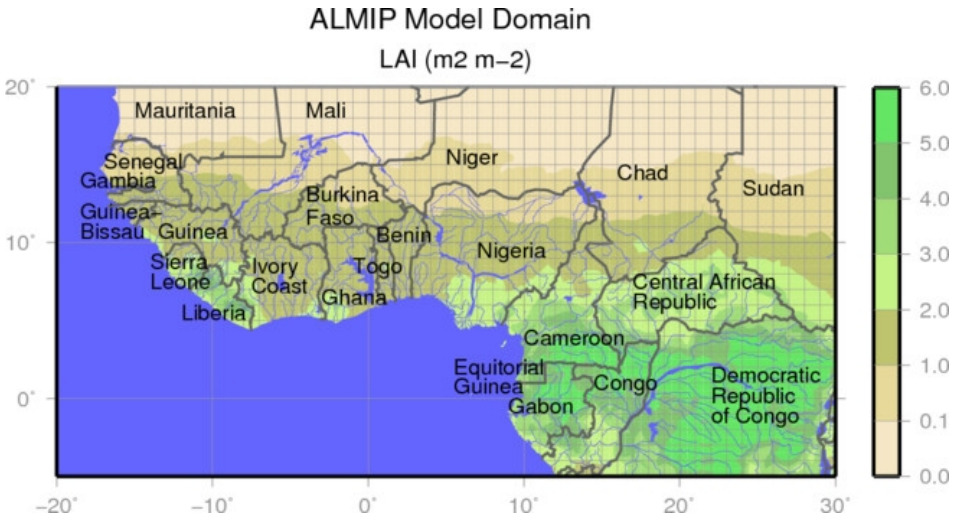
Context: why is the land surface important for the WAM?

- Surface conditions modulate PBL development, convective initiation
- Surface fluxes condition low level meridional gradients of moist static energy ➔ Rnet
- Surface albedo and meridional gradient influence radiative feedbacks
- Surface humidity and roughness influence flux of aerosols
- Long term surface memory effects from deep soil moisture reserves and vegetation extraction ➔ long term prediction
- Vegetation feedbacks and Carbon fluxes, impacts on hydrological cycle…
- LULC change and water resource management: population expansion/Society

Experiments:

Exp. Name:	Resolution	Time period
Exp 1: Regional NWP	0.5deg, 3h	2002-2007
Exp.s 2,3: Regional Merged	0.5deg, 3h:	2002-2007
Exp 4: Mesoscale Merged	0.05 deg, 30min	2005-2008
Exp5 : Local	3 + sites	2005-2008

ALMIP (Phase1) – Regional Scale



Exp1 – ECOCLIMAP sfc parameters, ECMWF atmospheric forcing

Exp.s 2,3 – as in Exp1, but atmospheric (state variables) forcing **merged** with satellite products for rainfall and downwelling radiative fluxes ➔ EPSAT-SG & TRMM 3B42 (rain), OSI & LAND-SAF radiative fluxes

ALMIP – Phase 1

Aaron Boone[1], Patricia deRosnay[2,3], Gianpaolo Basalmo[3], Anton Beljaars[3], Franck Chopin[4], Bertrand Decharme[1,5], Christine Delire[1,6], Agnes Ducharne[7], Simon Gascoin[7], Manuela Grippa[2], Françoise Guichard[1], Yeugeniy Gusev[8], Phil Harris[9], Lionel Jarlan[2], Laurent Kergoat[2], Eric Mougin[2], Olga Nasonova[8], Anette Norgaard[10], Tristan Orgeval[4], Catherine Ottlé[5], Isabelle Poccard-Leclercq[11], Jan Polcher[4], Inge Sandholt[10], Stephane Saux-Picart[5], Christopher Taylor[9], and Yongkang Xue[12]

1 Centre National de Recherches Météorologiques (GAME-CNRM / Météo-France, Toulouse)

2 Centre d'Etudes de la BIOsphere (CESBIO, Toulouse, France)

3 European Centre for Medium Range Weather Forecasts (ECMWF, Reading, UK)

4 IPSL, Laboratoire de Météorologie Dynamique, Paris, France

5 IPSL-Laboratoire des Sciences du Climat et de l'Environnement, Gif-sur-Yvette, France

6 ISE-Montpellier, Université Montpellier 2, France

7 Sisyphe, Université Pierre et Marie Curie (UMPC/CNRS), Paris, France

8 Institute of Water Problems, Russian Academy of Sciences, Moscow, Russia

9 Centre for Ecology and Hydrology, Wallingford, UK

10 Institute of Geography, University of Copenhagen, Denmark

11 LETG-Géolittomer, Université de Nantes, France

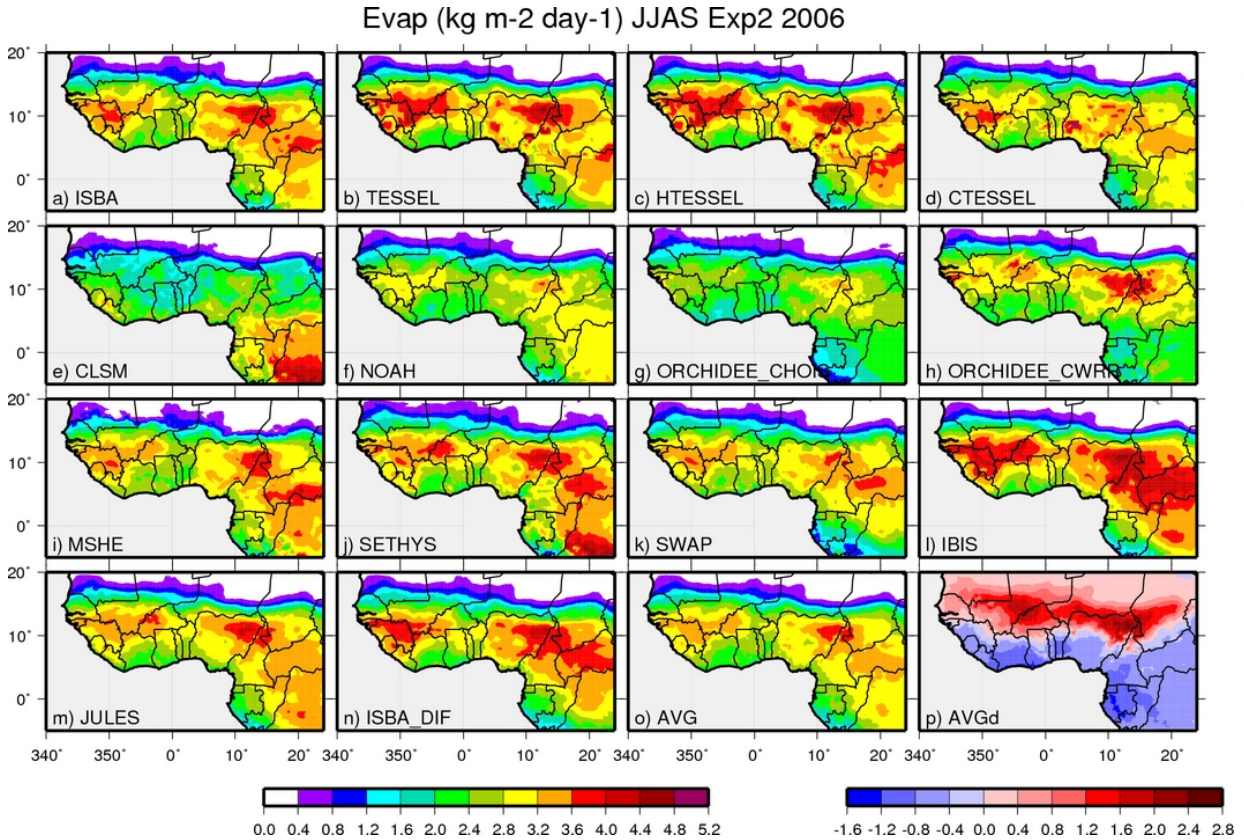
12 University of California at Los Angeles, USA

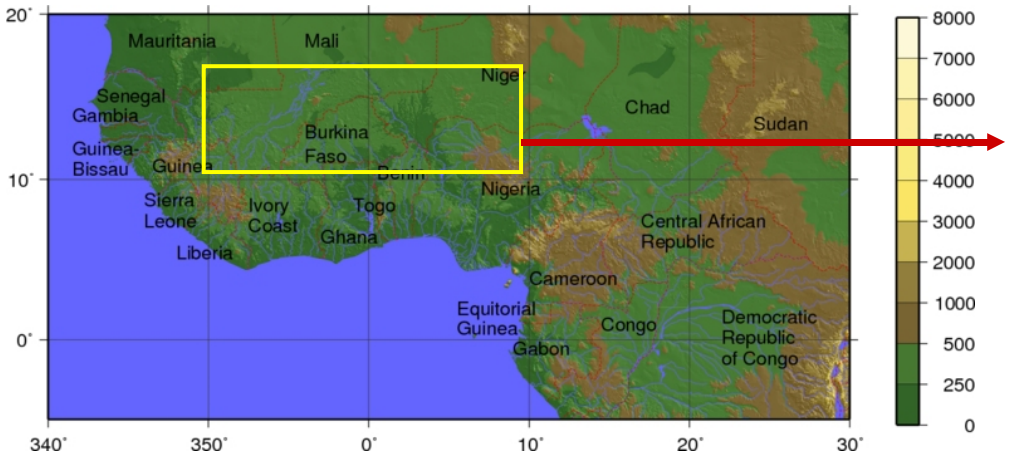
Overview paper in Bull Amer Meteor Soc, 2009

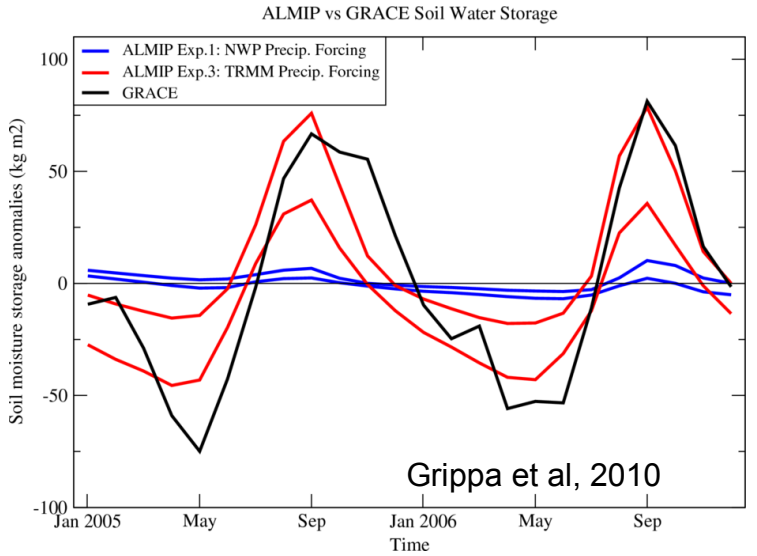
ALMIP (Phase1)

- Intercomparison, inter-model variability
- Products for atmospheric model studies & water budget
- Large scale evaluation

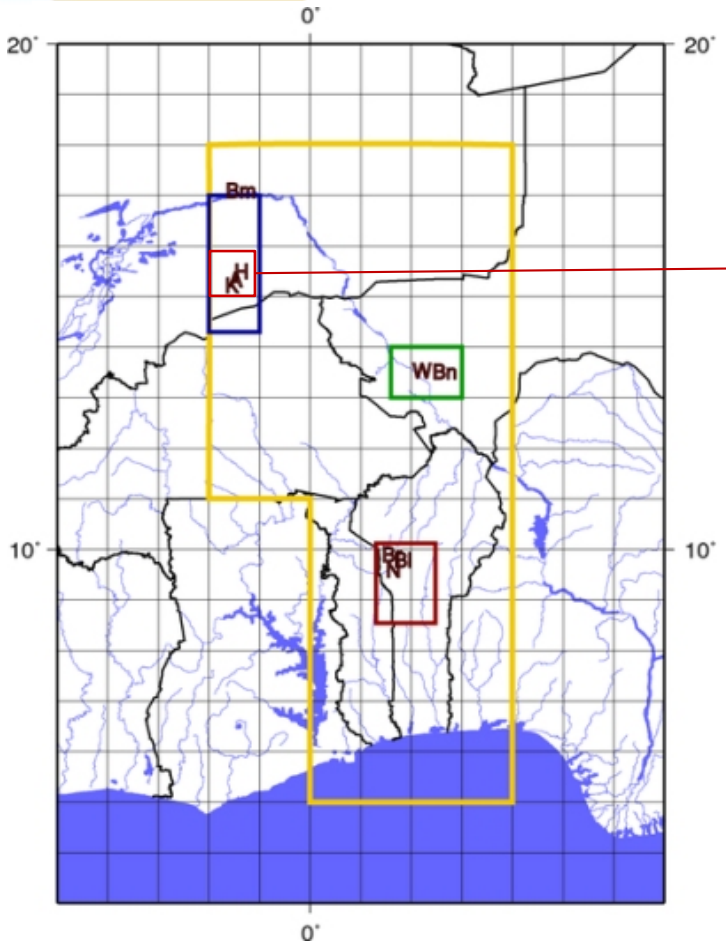
* 13 publications 2009-2010 so far…(and ongoing)







ALMIP AMMA Land surface Model Intercomparison Project Phase 2



Flux Sites:

A = Agoufou

Bm = Bamba

Bn = Banizoumbou

Bl = Belifoungou

Br = Bira

H = Hedgerit

K = Kelema

N = Nalohou

W = Wankama

Zones:

Sub-regional window

Oueme

Niamey

Gourma

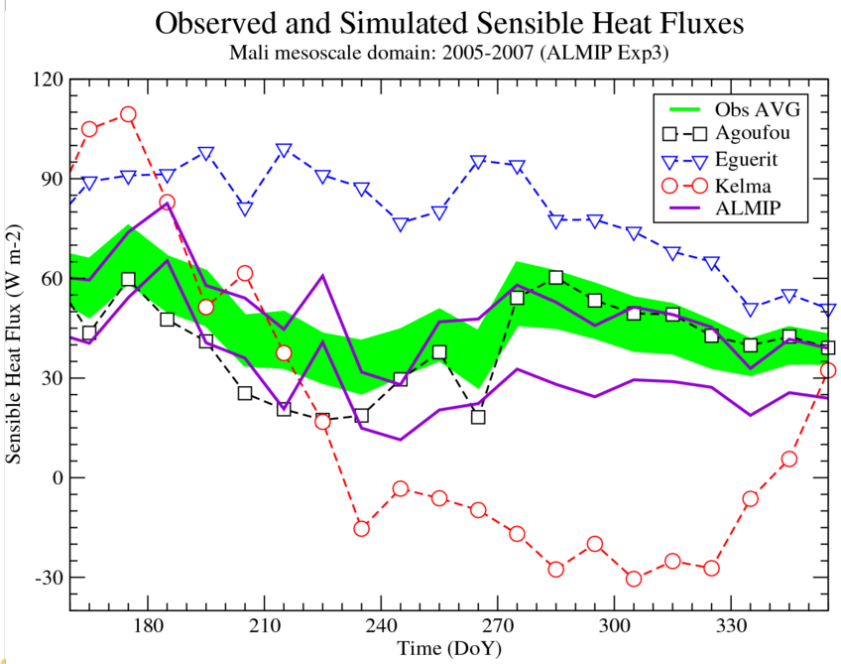


Fig. from Boone *et al.* 2010: Data from Timouk *et al.*, 2009

- Comparing regional scale grid point to aggregated local scale data
- Significant inter-site variability within same meso-square

ALMIP1➔ ALMIP2 Regional ➔ Meso & local scales

ALMIP2 Science Questions:

1. Which processes are missing or not adequately modeled by the current generation of LSMs over this region (infiltration over crusted soils, plants with defensive water strategies, endorheic hydrology...)?

2. How do the various LSM respond to changing the spatial scale (three scales will be analyzed: the local, meso and regional scales)? The relation between meso and regional scales will be made using ALMIP Phase 1 results.

3. Can relatively simple LSMs simulate the vegetation response to the atmospheric forcing on seasonal time scale (for several annual cycles) for the diverse climates/vegetation covers?

4. How can LSM simulate mesoscale hydrology given their relatively simple representation of such processes?

***5. What are the impacts of uncertainties/differences in the precipitation on the surface fluxes and hydrological responses of the LSM models?**

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LAND-SAF Products

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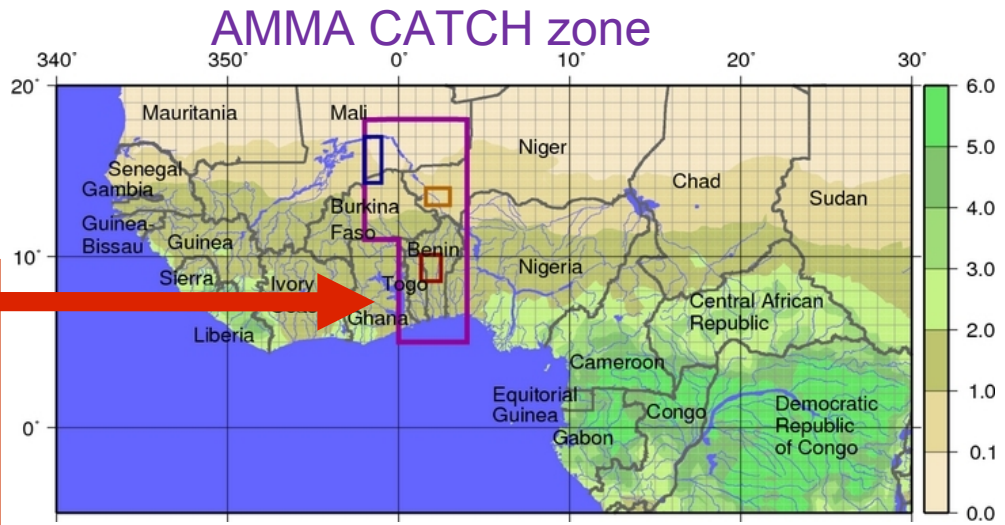
Model Domain (land points only)



Exp4a: Control experiments for the 3 meso-sites, 2005-2008
Exp4b: Additional precipitation inputs – radar based
Exp4c: as in 4a and 4b, but simulate the vegetation

Exp5a: Simulate local scale for at least 1 site (more!?) for each meso-square
Exp5b: as in 4a, but simulate the vegetation

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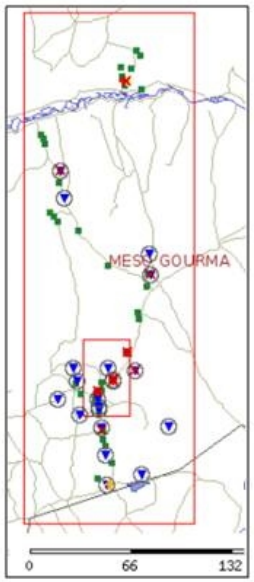
Local Scale Observational Data

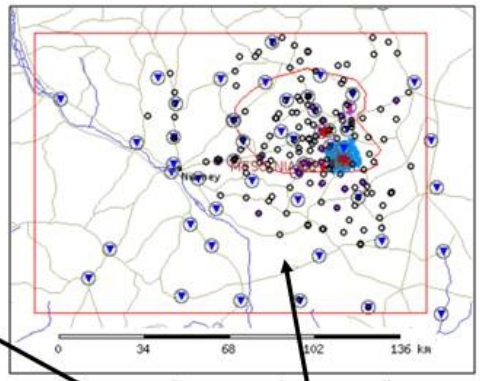
Forcing (input)

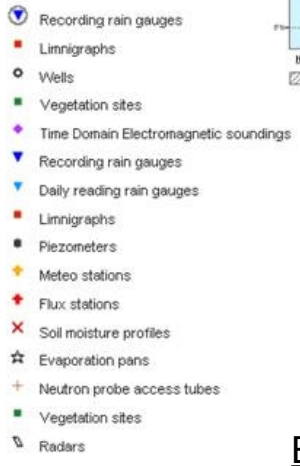
- Meteorological State: Air T, RH (2 m), surface pressure, Wind speed (10 or 2 m)
- Radiative Fluxes: Downwelling shortwave (SWdown) and longwave (LWdown) fluxes (30min)
- Precipitation Flux (30min)
- Soil (texture, hydrological & thermal parameters, albedo)
- Vegetation (cover type, characteristics: LAI, albedo, Rs_{min}, root depth, height...)

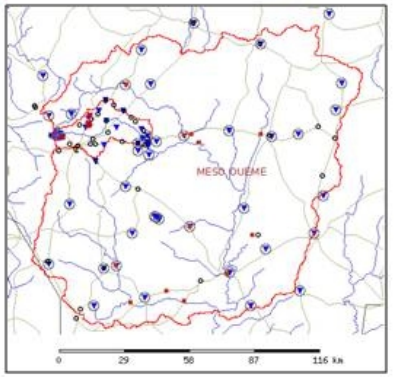
Evaluation (output)

- Turbulent fluxes: H (sensible heat), LE (latent heat/evapotranspiration)
- Radiative Fluxes: SWup (or albedo), LWup
- Surface temperature
- Soil temperatures
- Surface ground heat flux G
- Soil Moisture
- Vegetation evolution measures (LAI...biomass)
- Hydrology (runoff, discharge, water table depth…)









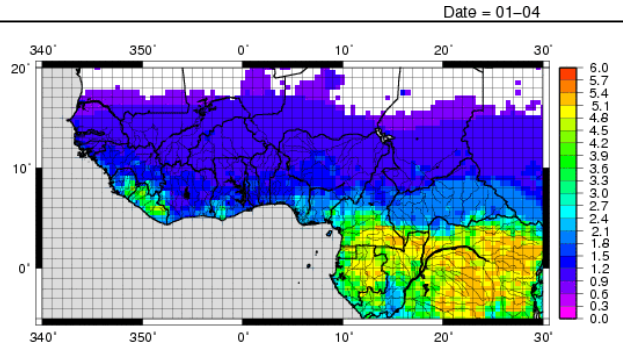
E.g. 2004

- 44 rain gauges
- 19 discharge sites
- 4 flux stations…

Land Surface Model Soil-Vegetation Parameters

- ECOCLIMAP – global 1x1 km2, decadal
- Operatioal NWP, Mesoscale research CNRM/Météo-France
- **ECOCLIMAP2** (inter-annual var) Kaptué & Roujean (CNRM)

LAI



LAND-SAF Downwelling radiative flux products

E.g. LAND-SAF Solar Radiation:

- MSG Data: 0.6µm, 0.8µm, 1.6µm
- Land/Sea Mask, Cloud Mask (SAF-NWC software)
- Total Column Water Vapour (ECMWF)
- Ozone Content (Climatology)
- Land Surface Albedo: Static Map, later AL product
- [Visibility -> Aerosol Optical Thickness]
- AMMA-SAT ➔ 0.05 deg., 30 min., July 2005+

(see Geiger et al)

Rainfall

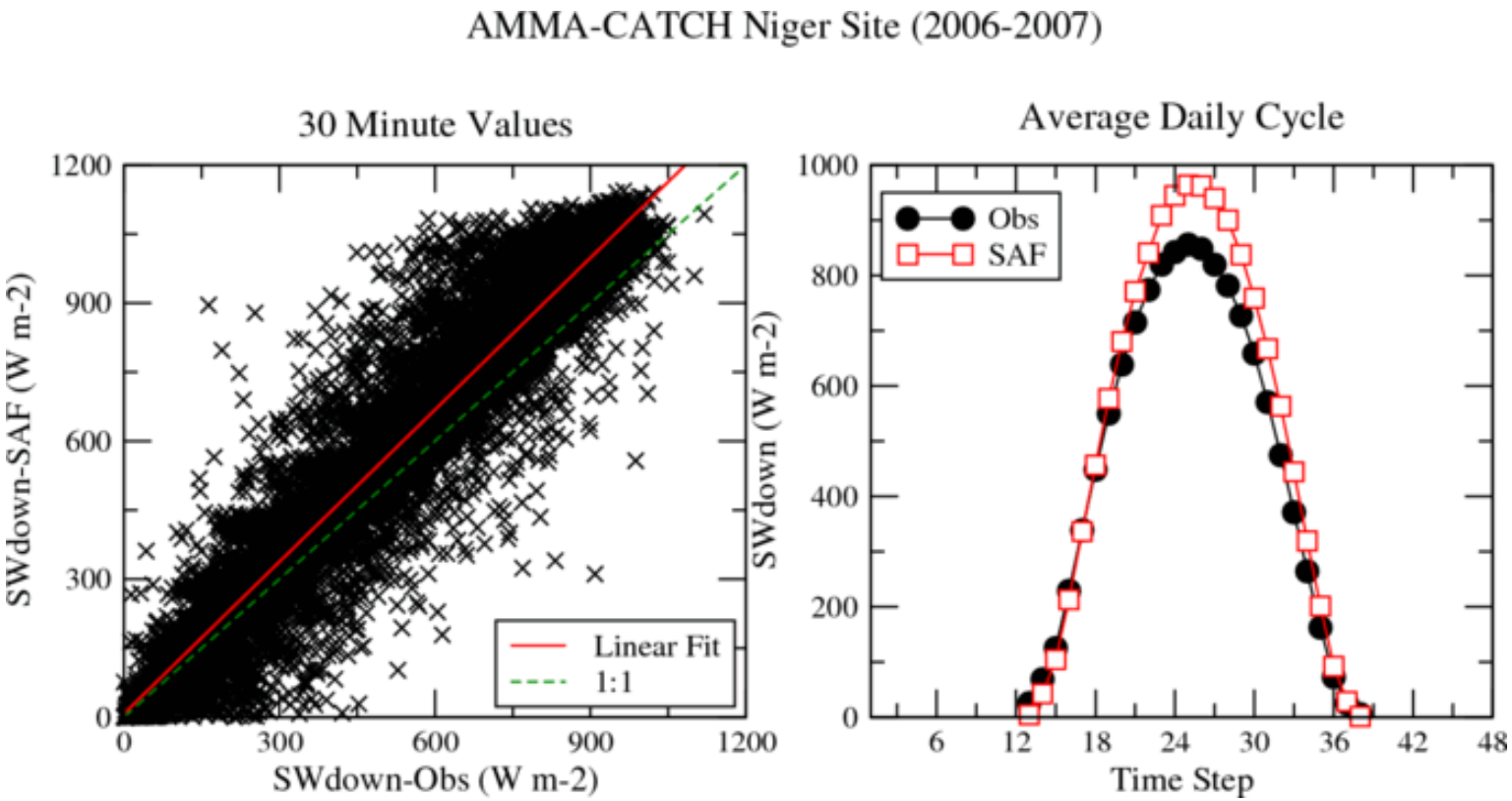
Krigged+Lagrangian: T. Vischel, G. Quantin, T. Lebel, M. Gosset, J. Viarre (LTHE, LMTG)

- 0.05 degrees, 30 minutes
- 2005-2008

Radar-based: M. Gosset, J. Viarre (LMTG)

Meteorology: ECMWF fcst

Forcing evaluation: satellite vs local obs:



Benin site:

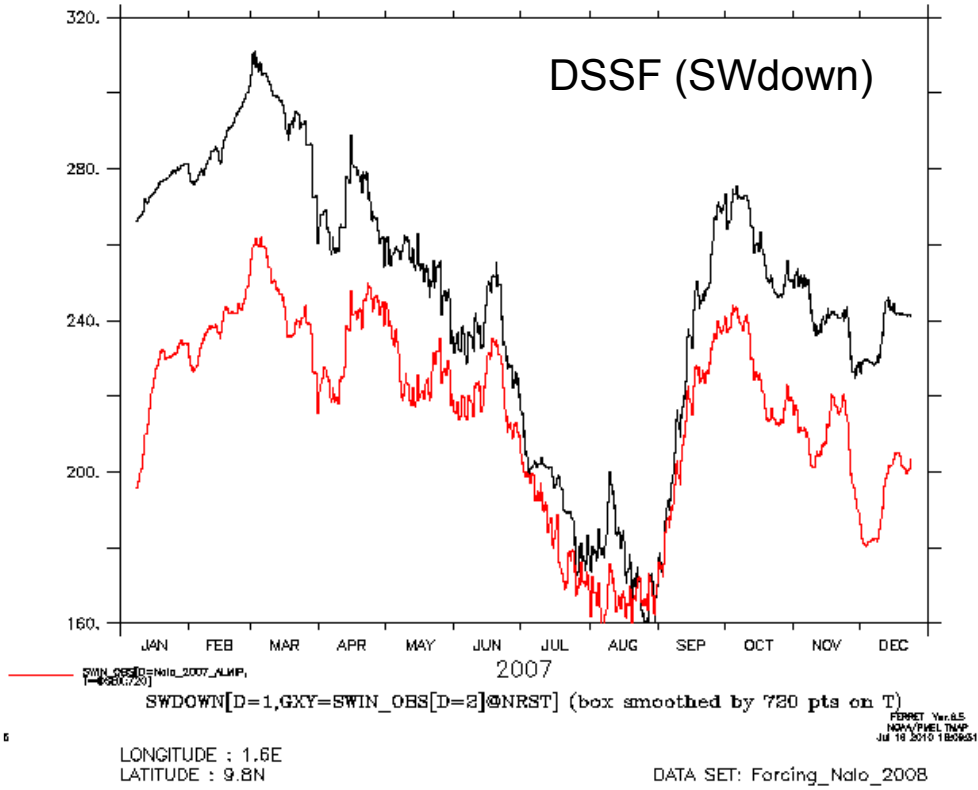
SAF ———

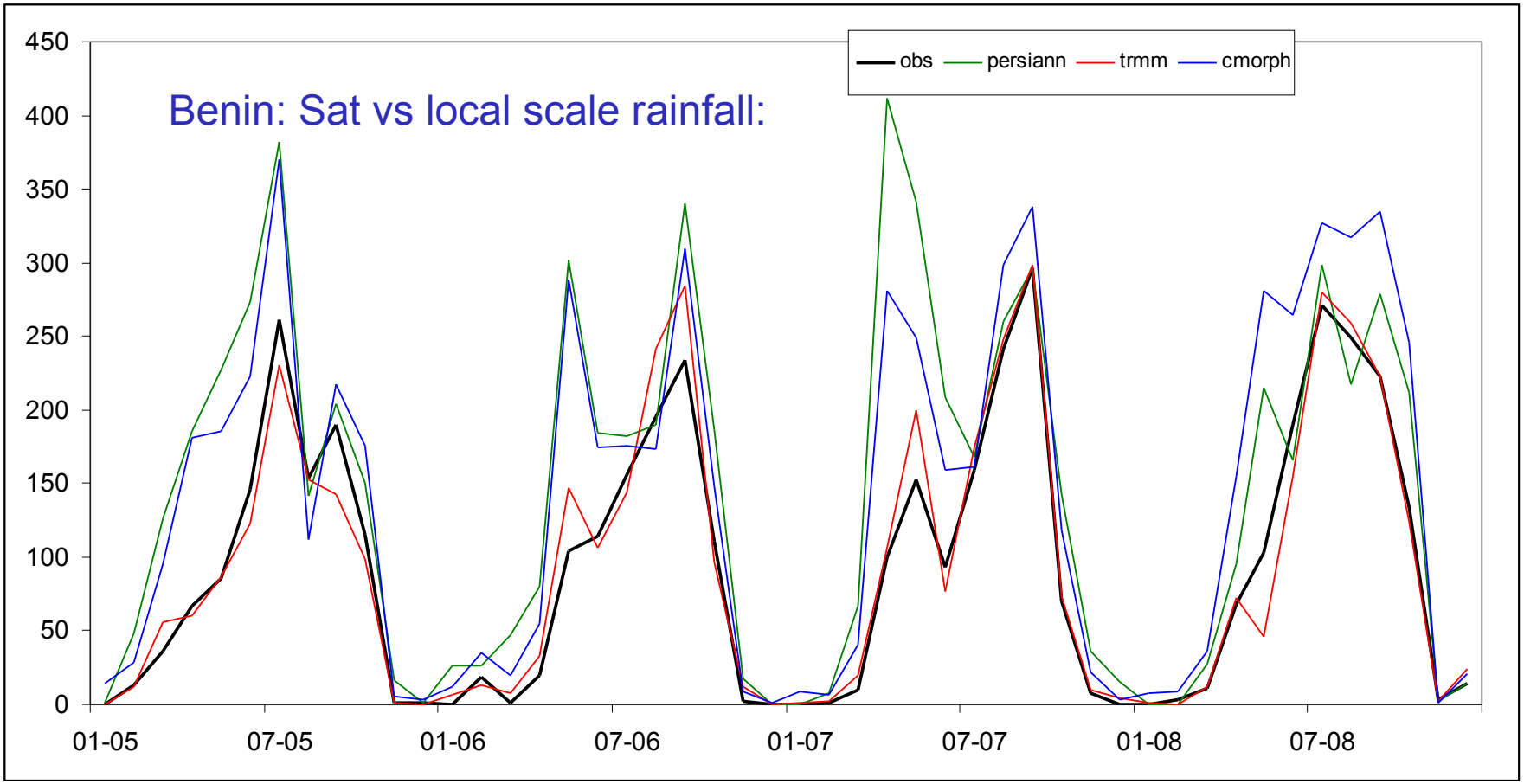
Obs ———

SAF has a + bias during the dry season…possible culprit is aerosol

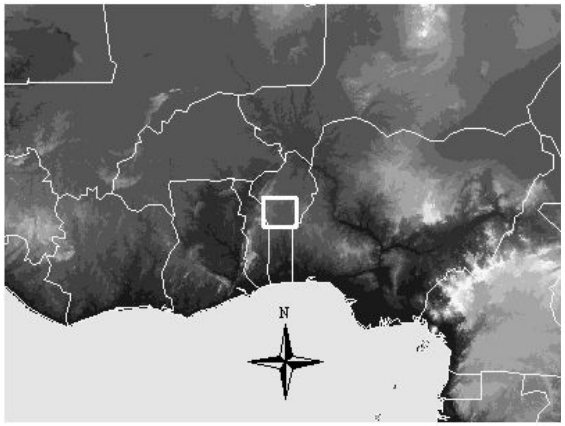
- correction testing…(Roujean, Kocha, Lafore)
- But peak bias during period when Evap is lowest
- DSLF & DSSF bias offsetting

Forcing evaluation: satellite vs local obs:





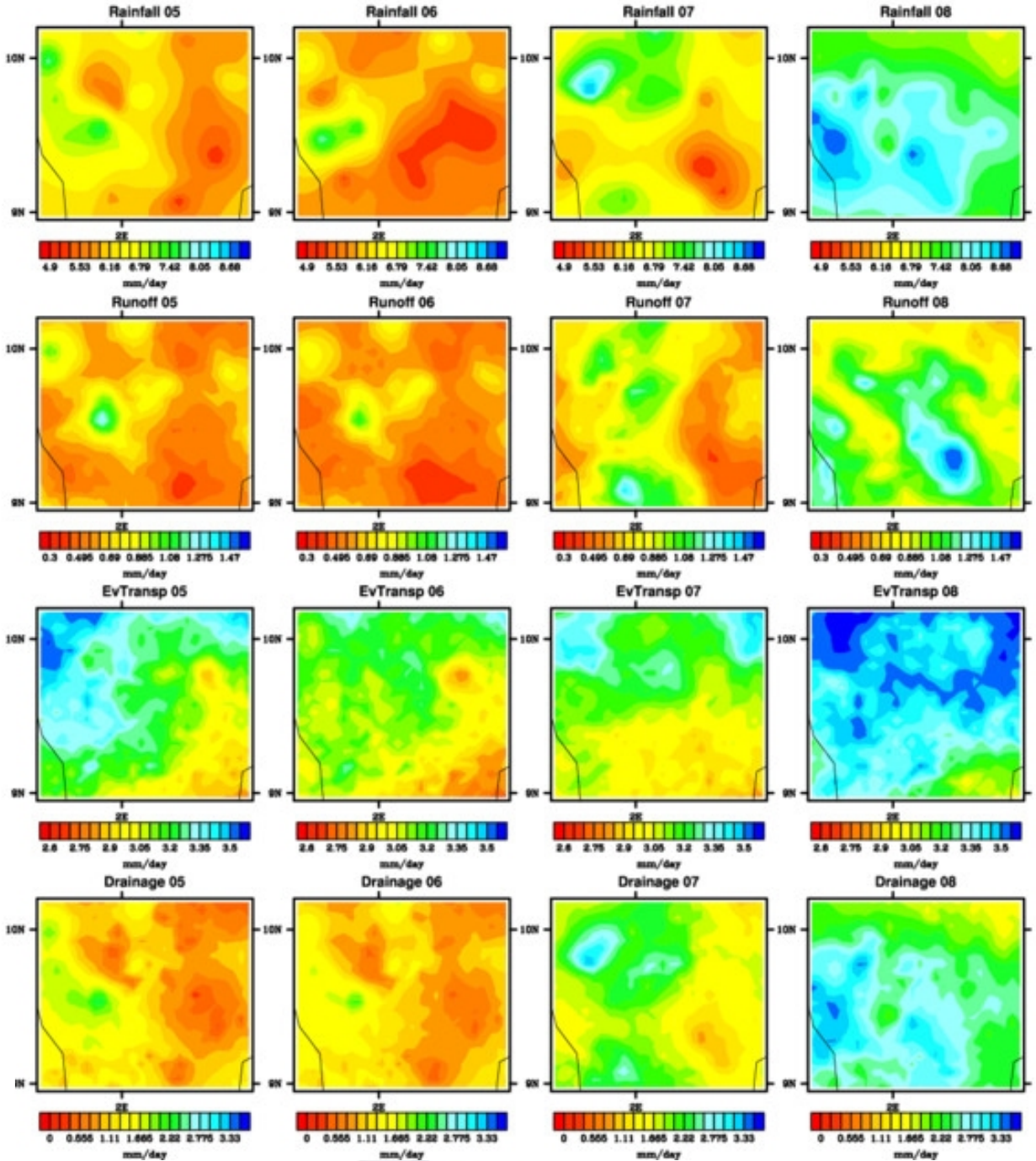
	obs	trmm	cmorph	persiann
Prec. med 2005-2008 (mm/day)	3.03	3.06	4.59	4.67



ISBA-SURFEX

- Considerable inter-annuel variability (forcing)
- Evaluation -LAND-SAF LST…
- Comparison- other sat-based (SAF) products?
- Evaluation- using discharge ➔

Hydrological components (JJAS) – Oueme meso site



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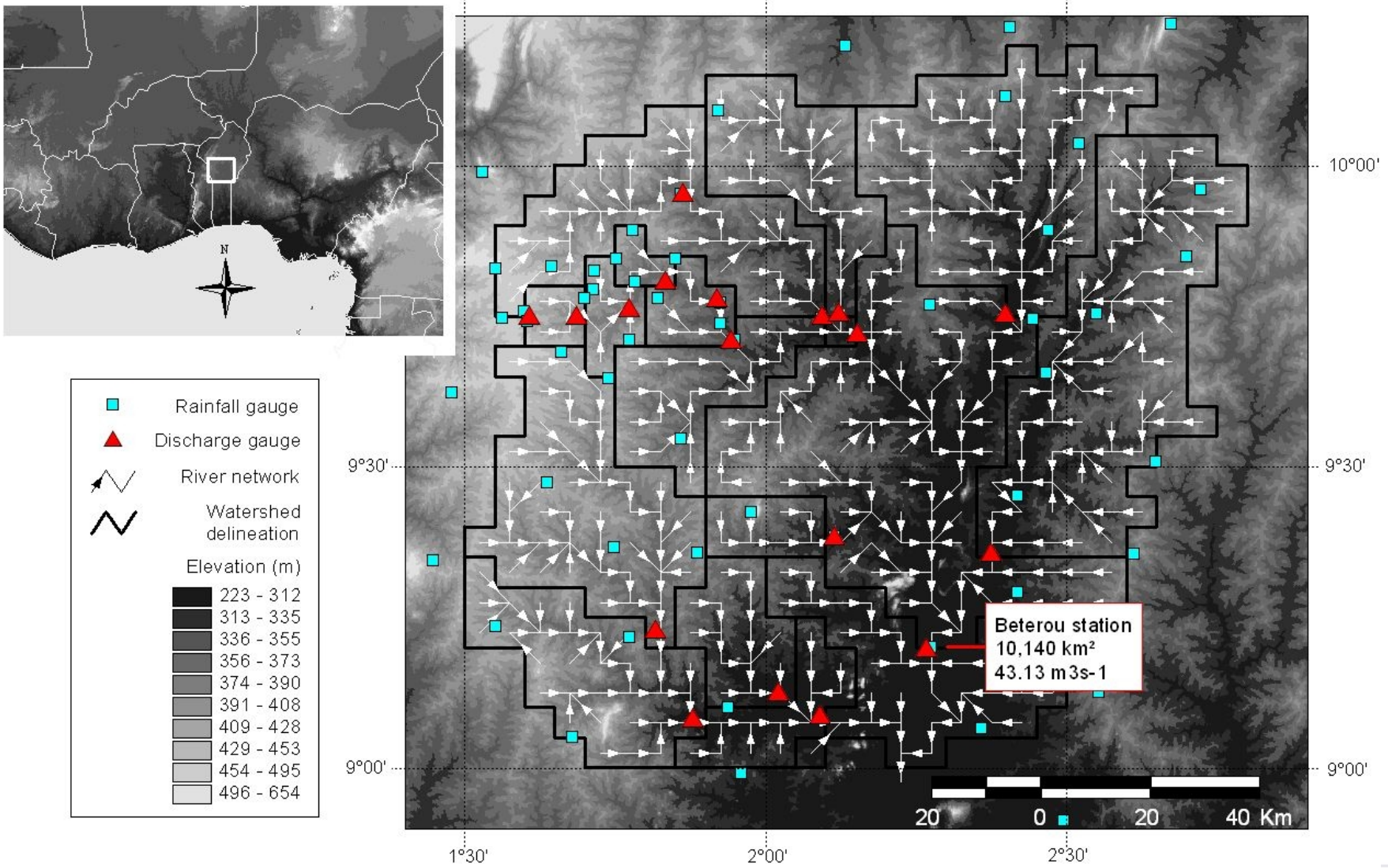

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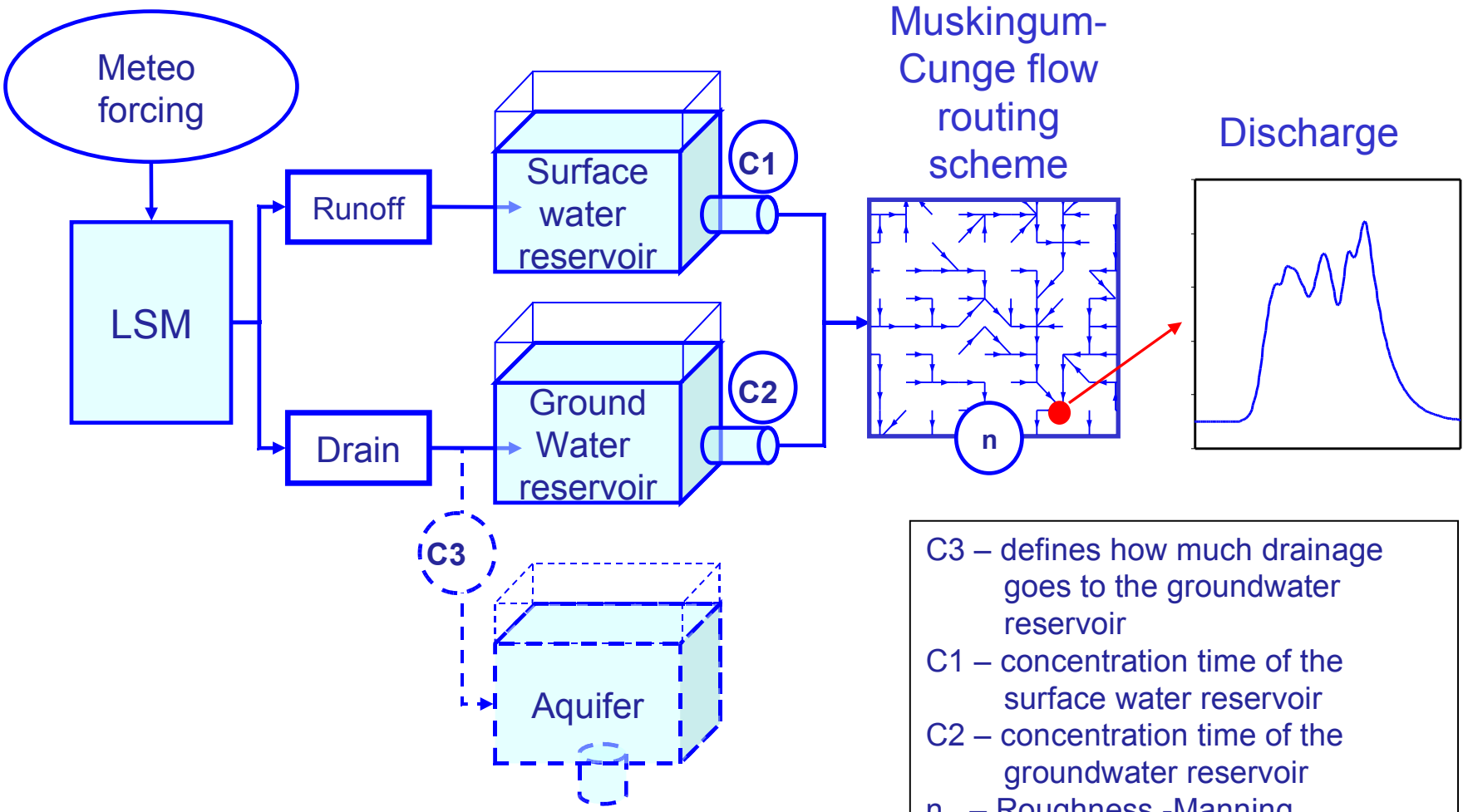
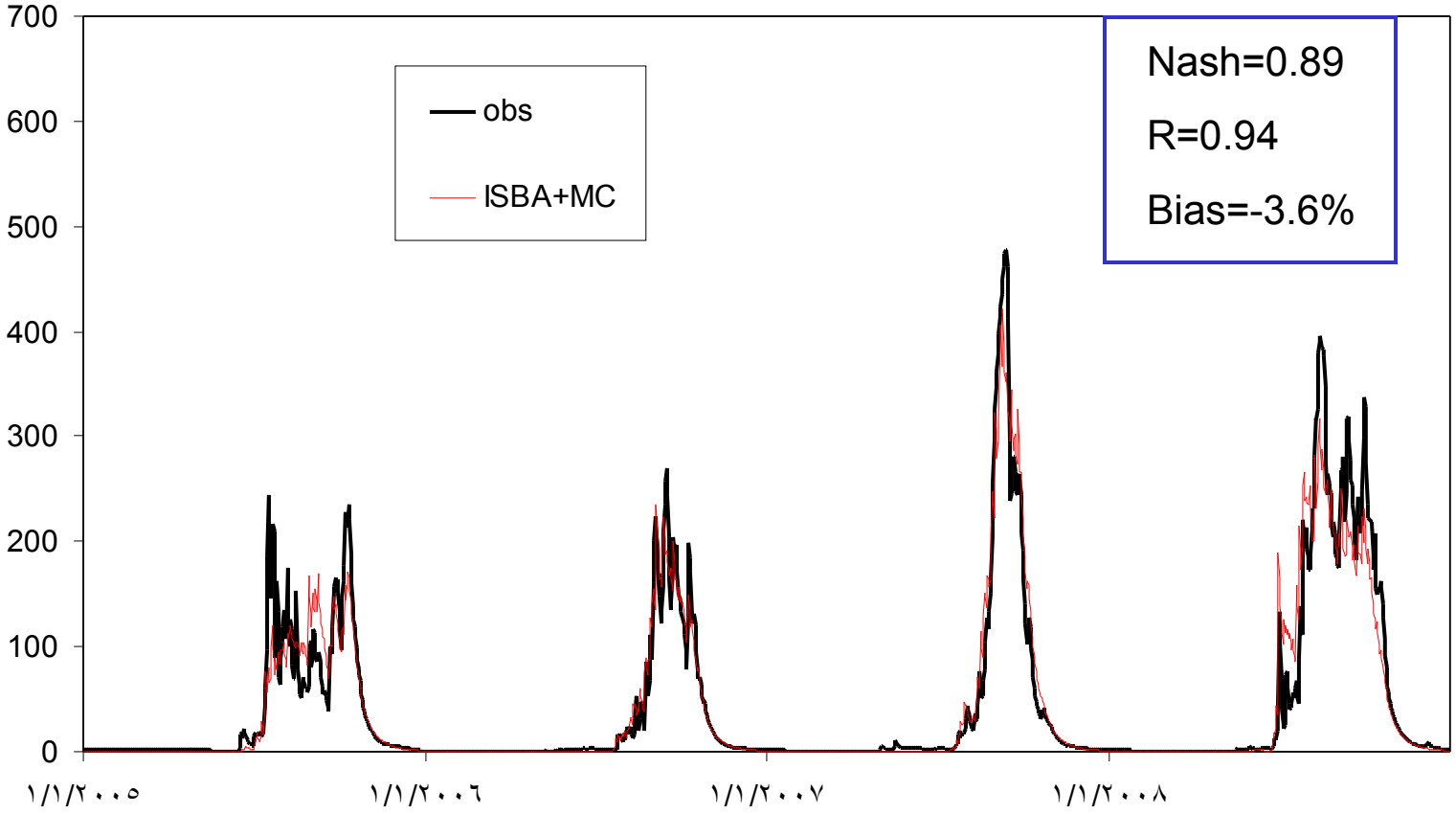


C3 – defines how much drainage goes to the groundwater reservoir
C1 – concentration time of the surface water reservoir
C2 – concentration time of the groundwater reservoir
n – Roughness -Manning coefficient

Getirana, Boone & Peugeot (2011)

Discharge: simulated by ISBA (SURFEX) with MC routing for the Ouémé basin (at Beterou):



ALMIP (Phase1)

Evaluation of LSM *Ts, Rnet* using LAND-SAF LST, albedo (Ottlé et al)

ALMIP2 - Planning/status:

- Finalizing beta forcings: possible bias corrections for radiative fluxes, radar-based rainfall still under development
- Testing routing scheme
- Examining, preparing local scale data (evaluation data)➔ C. Peugeot (MSE)
- Science Document to be finalized this fall
- Organizing different groups to share analysis (vegetation, remote sensing, hydrologists…)
- Mesoscale evaluation data: SAF-LST, SAF-LAI …other candidates?
- Make a formal call to participation near end of year
- End of analysis, workshop/meeting late 2011 early 2012…

GEWEX imperatives/objectives:

Model improvement! (processes, sub-grid representations for atmospheric models…)

ALMIP2 might become a highlighted GLASS-RHP “demonstration” project

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Thank you for your attention…

Studies using ALMIP results:

Agusti-Panareda, A., G. Balsamo, and A. Beljaars, 2009: Impact of improved soil moisture on the ECMWF precipitation forecast in West Africa. Geophys. Res. Letters, (in press).

Boone, A., P. de Rosnay, G. Basalmo, A. Beljaars, F. Chopin, B. Decharme, C. Delire, A. Ducharne, S. Gascoin, M. Grippa, F. Guichard, Y. Gusev, P. Harris, L. Jarlan, L. Kergoat, E. Mougin, O. Nasonova, A. Norgaard, T. Orgeval, C. Ottlé, I. Poccard-Leclercq, J. Polcher, I. Sandholt, S. Saux-Picart, C. Taylor, and Y. Xue, 2009: The AMMA Land Surface Model Intercomparison Project. Bull. Amer. Meteor. Soc., (in press), doi:10.1175/2009BAMS2786.1

Boone, A., Y. Xue, I. Poccard-Leclerq, J. Feng, F. de Sales, and P. deRosnay, 2009: Evaluation of the WAMME model surface fluxes using results from the AMMA land-surface model intercomparison project. Clim. Dynamics, (in press), DOI 10.1007/s00382-009-0653-1

Delon, C., C. Galy-Lacaux, A. Boone, C. Liousse, D. Serça, M. Adon, B. Diop, A. Akpo, F. Lavenu, E. Mougin, and F. Timouk, 2009: Atmospheric Nitrogen budget in Sahelian dry savannas. Atmos. Phys. and Chem., (in press).

Domínguez, M., M. A. Gaertner and P. de Rosnay, 2008: A regional climate model simulation over West Africa: parameterization tests and analysis of land surface fields. Clim. Dynamics, (accepted).

Guichard, F., N. Asencio, C. Peugot, O. Bock, J.-L. Redelsperger, X. Cui, M. Garvert, B. Lamptey, E. Orlandi, J. Sander, F. Fierli, M. A. Gaertner, S. Jones, J.-P. Lafore, A. Morse, M. Nuret, A. Boone, G. Balsamo, P. deRosnay, B. Decharme, P. Harris, and J.-C. Berges, 2009: An intercomparison of simulated rainfall and evapotranspiration associated with a mesoscale convective system over West Africa. Wea. and Forecasting, (accepted).

Grippa, M., L. Kergoat, F. Frappart, Q. Araud, A. Boone, P. de Rosnay, J.-M. Lemoine, and the ALMIP working group, 2009: Land water storage changes over West Africa estimated by GRACE and land surface models (under revision).

Studies using ALMIP results:

Hourdin, F., F. Guichard, F. Favot, P. Marquet, A. Boone, J.-P. Lafore and J.-L. Redelsperger, P. Ruti, A. Dell'Aquila, T. L. Doval, A. K. Traore, and H. Gallee, 2009: AMMA-Model Intercomparison Project. Bull. Amer. Meteor. Soc., (accepted).

Meynadier, R., O. Bock, F. Guichard, A. Boone, P. Roucou, J.-L. Redelsperger, 2010: The West African Monsoon water cycle. Part I: a hybrid water budget dataset. *J. Geophys. Res.*, (accepted).

de Rosnay P., M. Drusch, A. Boone, G. Balsamo, B. Decharme, P. Harris, Y. Kerr, T. Pellarin, J. Polcher and J.P. Wigneron, 2008: Microwave Land Surface modelling evaluation against AMSR-E data over West Africa. The AMMA Land Surface Model Intercomparison Experiment coupled to the Community Microwave Emission Model (ALMIP-MEM). J. Geophys. Res., 114, D05108, doi:10.1029/2008JD010724.

Steiner, A., J. Pal, S. Rauscher, J. Bell, N. Diffenbaugh, A. Boone, L. Sloan and F. Giorgi, 2009: Land surface coupling in regional climate simulations of the West African monsoon. Clim. Dynamics, DOI 10.1007/s00382-009-0543-6.

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Xue, Y., K.-M. Lau, K. H. Cook, D. Rowell, A. Boone, J. Feng, T. Bruecher, F. De Sales, P. Dirmeyer, L. M. Druyan, A. Fink, M. Fulakeza, Z. Guo, S. M. Hagos, S. S. Ibrah, K.-M. Kim, A. Kitoh, A. Konare, V. Kumar1, P. Lonergan, M. Pasqui1, I. Poccard-Leclercq, N. Mahowald, W. Moufouma-Okia, P. Pegion, J. K. Schemm, S. D. Schubert, A. Sealy, W. M. Thiaw, A. Vintzileos, E. K. Vizy, S. Williams, M.-L. C. Wu, 2009: The West African Monsoon Modeling and Evaluation project (WAMME) and its First Model Intercomparison Experiment. Clim. Dyn., (in press).

Etc…