European Commission
Joint Research Centre

Dartmouth Flood Observatory

Hosted by

EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER
ESSIC
UNIVERSITY OF MARYLAND

3rd International Workshop on Global Flood Monitoring & Modelling

4-6 March 2013
University of Maryland
College Park, MD, USA

Outcomes

Draft version 15/03/2013

1 Summary

The 3rd International Workshop of the Global Flood Working Group on Global Flood Monitoring & Modelling was held from 4-6 March 2013 hosted by the Earth Systems Science Interdisciplinary Centre (ESSIC) of the University of Maryland, in College Park, MD, USA. The workshop gathered over 80 participants from over 33 organisations. The participants covered multiple scientific disciplines and humanitarian and development sectors. Participants came from organisations and countries spread over 5 continents.

The workshop consisted of 36 presentations from scientific and operational participants divided in 6 sessions ranging from flood observation to forecasting and modelling, from new scientific research to operational use and decisions making. Scientific progress was discussed and its applicability in operational contexts, including emergency response (early warning, evacuation and post-disaster recovery) and risk planning (mitigation measures and long-term climate change adaption).

There was an overwhelming interest to continue to work together, coordinate R&D, and meet up on an annual basis. In particular, the participants agreed to:

- **Reach out**: Publish results of workshop with recommendations on way forward and identified gaps in data and funding. The workshop co-organizers will publish an article on behalf of the working group.
- **Build Pilot Success Stories**: publish joint validation studies, involving selected flood-prone countries, focused on value of systems for emergency management. This will be done on ad-hoc collaboration between two or more organisations.
- **Create one voice**: create a single portal for access of information (research publications, live systems, data, and links) and tools for collaboration. The JRC agreed to lead this action point.
- **Demonstrate** added value by integrating existing systems useful for particular needs. This will push integration of systems beyond the current co-visualization.

Furthermore, it was recognized that simple coordination of current efforts will not result in a toolbox and data services appropriate for target users. To achieve this, the working group concluded that a firm and funded partnership is necessary. It was agreed that a core team of interested organisations will develop a concept for a Global Flood Partnership. The vision of such a partnership is ***to provide operational globally applicable flood monitoring tools and services, complementary to national capabilities, for better managing current and future flood risk and reducing flood disaster impacts***.

2 Participants

The participant organisations included:

- **UN and international organisations**: World Bank (GFDRR and Water sector), United Nations Office for the Coordination of Humanitarian Affairs (OCHA) and World Food Program
- **Humanitarian donors**: USAID/OFDA, European Commission
- **International operational centres**: CEMADEN (Brazil)
- **Space-related agencies and groups**: CRGL (Luxemburg, representing ESA), NASA (GSFC, JPL, headquarters, OAS), NOAA/NESDIS, Group of Earth Observation (GEO)
- **Meteo Centres**: European Centre for Medium-Range Weather Forecasts (ECMWF), NOAA/NWS
- **Dartmouth Flood Observatory**
- **Pacific Disaster Center**
- **Joint Research Centre**
- **7 US universities and hydrology labs:**
- **International public/private research centres**: Deltares (NL), Ithaca (IT), HKV Consultants (NL), ICF International (US), U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Institute of Remote Sensing and Digital Earth, Chinese Academy Of Sciences (China), International Center for Water Hazard and Risk Management (ICHARM, Japan)
- **Insurance industry**: FM Global

3 Presentations

The workshop consisted of 36 presentations from scientific and operational participants divided in 6 sessions ranging from flood observation to forecasting and modelling, from new scientific research to operational use and decisions making. In each session, there was ample time for a general discussion on the topics of the session.

The presentations were input for wider and deeper discussions about scientific, technical and practical issues for global flood monitoring. Several topics are recurrent in the workshops, such as accuracy and uncertainty of information; appropriate data formats to encourage sharing and use; scientific limits versus operational needs; integrating global, regional and local approaches.

3.1 Near real-time flood extent mapping

The first session covered the latest advances in flood mapping using optical and radar remote sensing. Optical remote sensing is the most used tool for (maximum) flood extent mapping, but suffers from lack of data during cloud coverage and low revisit periods for high resolution sensors. Synthetic Aperture Radar (SAR) can complement acquisitions under cloud circumstances. Several programmes have been set up globally to quickly task satellites after disasters, including Copernicus in Europe, UNOSAT in the UN, and the International Charter Space and Major Disasters. But for floods it is the freely available MODIS data with near-daily revisit period that is most used.

The real-time MODIS flood mapping system developed by the Dartmouth Flood Observatory and NASA/GFSC was presented in detail (***Fritz Policelli***, NASA/GSFC). An overview of NASA's satellite coverage for disasters was presented by ***Stu Frye*** (NASA/GSFC), with focus on Namibian and Caribbean pilot projects, as well as a platform based on web services (***Matt Handy***). CRPGL (represented by ***Guy Schumann***) presented ESA's automated SAR-based flood mapping application. Finally, ***Kevin Dobbs*** (Univ. of Kansas) presented a technique for estimating flood extent based on digital elevation models and real-time discharge, stage or surface measurements.

3.2 Flood measurement using passive microwave remote sensing

A relatively new technique suited for global flood monitoring with high temporal resolution is based on passive microwave remote sensing. Developed a few years ago, the JRC is calculating and publishing data in the Global Flood Detection System since 2006. Several research groups have used the data as virtual gauging stations or flood surface measurements for assimilation in flood models, flood detection or direct flood impact assessment.

Bob Brakenridge (DFO) discussed the strengths of the new technique and a wide range of applications. ***Graziela Balda Scofield***, of Brazil's national monitoring and alerting centre (CEMADEN), showed results of using GFDS for detecting floods in Brazil. ***Tom Hopson*** (NCAR) presented how GFDS data can be assimilated to improve hydrological models. ***Tom De Groeve*** (JRC) showed how the data can be used to calculate objective flood impact statistics for large flood disasters.

3.3 Satellite rainfall estimation

Given the critical importance for flood modelling of accurate rainfall estimates, a session was dedicated to the latest advances and future prospects of satellite-based rainfall estimation.

George Huffman (NASA/GSFC) gave an overview of current global precipitation products and the future Global Precipitation Mission of NASA. ***Robert Kuligowski*** (NOAA/NESDIS) discussed NOAA's research products in this area, and ***Sheldon Kusselson*** showed operational activities. ***Dennis Lettenmaier*** (Univ. of Washington) discussed an evaluation of TMPA real-time precipitation products for global hydrologic prediction.

3.4 Hydrologic modelling systems for global application

Some global and several regional or local studies were presented on various aspects of hydrologic modelling systems.

Yu Zhang (NOAA) discussed assimilation of satellite precipitation. ***Zac Flamig*** (Univ. of Oklahoma) discussed global applications of the CREST model and the NMQ/FLASH flash flood model. ***Guy Schumann*** (NASA/JPL) discussed new techniques for flood inundation forecasting and modelling (LISFLOOD-FP) in data sparse areas, with application in the Lower Zambezi, as well as the potential of new sensors (SMAP and SWOT). ***Mark Jourdan*** (USACE, ERDC) discussed his experience in supporting hydrologic emergencies, including challenges to build local flood models based on sparse data availability. ***Kris Shrestha*** (GA Tech) presented a case study for South Asia, using the VIC model and ECMWF forecasts, allowing propagation of uncertainty into discharge estimations. ***Elena Cristofori*** (Ithaca, Italy) presented updates on the Extreme Rainfall Detection System, which provides operational and global alerts for rainfall with potential for creating large floods. ***Curt Barrett*** (USAID/OFDA) discussed the Global Flash Flood Guidance System, which USAID has successfully deployed in Central America and Southern Africa, and will expand to 6 more regions. The challenges of integrating a new system in the existing local institutional context were discussed. ***Jun Magome*** (Univ. of Yamanashi, Japan; ICHARM) showed a prototype flood forecasting and alert system "Global Flood Alert System – Streamflow". ***Bob Adler*** (Univ. of Maryland) presented advances in the real-time global flood estimation system using satellite rainfall information and the VIC/DRTR model, including an increased resolution to 1km. ***Lorenzo Alfieri*** (ECMWF) presented the results of a 2-year verification period of the Global Flood Awareness System (GloFAS), based on ECMWF weather forecasts and the HTESSEL and LISFLOOD hydrological models.

3.5 Flood Risk and Global Flood Archives

Disaster risk reduction and adaptation to climate change require long-term investment in the most vulnerable flood-prone areas. In spite of many efforts to map the flood hazard at global level, this remains a major challenge. The scientific community must record and present flood information in such a way that it can provide guidance for future flood planning. This means working towards standards for a global flood record; having long-term time series of flood extents, discharge and rainfall; and methods for estimating flood risk.

Nicki Villars (DELTARES) presented an activity to convert the full Envisat ASAR archive into Global Flood Mapping products. ***Hessel Winsemius*** (DELTARES) presented progress of a project to provide global modelling of flood hazard and risk at 1 km scale. ***Jon Gottschalk*** (NOAA/NCEP/CPC) showed CPC products related to global tropics hazards and benefits outlook, providing seasonal information.

3.6 Bridging the gap between science and operations

Converting scientific data, satellite observations and model results into useful information for humanitarian practitioners is a huge challenge. Not only is it difficult to communicate uncertainty

and meaning of information, but it must be communicated at the right time in the right format and to the right people. More often than not, user organisations (be it national water authorities or international humanitarian organisations) have well established processes that cannot be changed easily to incorporate new information. Making new information compatible with these existing systems is one important challenge. In this session, participants discussed several of these issues.

Ana Prados (NASA/GSFC) presented NASA's Applied Remote Sensing Training Program (ARSET) and showed examples for building capacity for flood monitoring. ***Heather Bell*** (PDC) discussed many aspects of communicating science information to users and making connections built on trust. She used the PDC Disaster Aware product as an example. ***Erwin Wolters*** (HKV Consultants) presented a study of flood hazard assessment in the White Volta basin. ***Nate Smith*** (ICFI) was able to present multiple perspectives of a wide range of users and had recommendations for exploring and cultivating demand for flood hazard information products. ***Edward Beighley*** and ***Jeffrey McCollum*** (FM Global) showed the perspective of the insurance industry, as well as engineering applications, on assessing global flood hazards. ***Rashid Kashif*** (WFP) gave practical insights for bridging the gap between flood forecasting science and the end user, in this case an emergency response organisation. His colleague ***Emily Niebuhr*** (WFP) discussed how WFP currently uses weather data and presented a case study. ***Alanna Simpson*** (World Bank/GFDRR) had a presentation on how the World Bank performs flood impact assessment using remote sensing. ***Frank Raes*** (JRC) closed the session by discussing the challenges and pitfalls in transforming a continental and global flood forecasting system from research to operations. These are valuable lessons for all systems presented in the workshop.

4 Exercises and break-out sessions

Two sessions in the workshop were foreseen to stimulate lively discussions about scientific and practical aspects of global flood monitoring.

4.1 Existing data and services – Demonstration session Day 1

In one hour, all (pre-)operational global flood monitoring or modelling systems were demonstrated live. The purpose was to give short instructions to workshop participants on how to access and use the systems and the underlying data.

4.1.1 Demonstration content

In 5-10 minutes, the demonstrations provided:

- A **quick on-line demonstration** of existing, operational, pre-operational or experimental systems and datasets providing information on floods at global level
- A summary of the **supported standards or APIs** (for system integration)
- A summary of the **strong and weak points** ("don't use it if…; reliable if…; validated in region X")
- Indications on where to find **more information and guidelines**

4.1.2 Global integrated flood map

Most of these systems were already integrated before the workshop in the Global Integrated Flood Map, currently available at http://dma.jrc.it/map?application=floods. A technical report of the global integrated flood map summarizes a lot of information that was presented during the demonstrations.

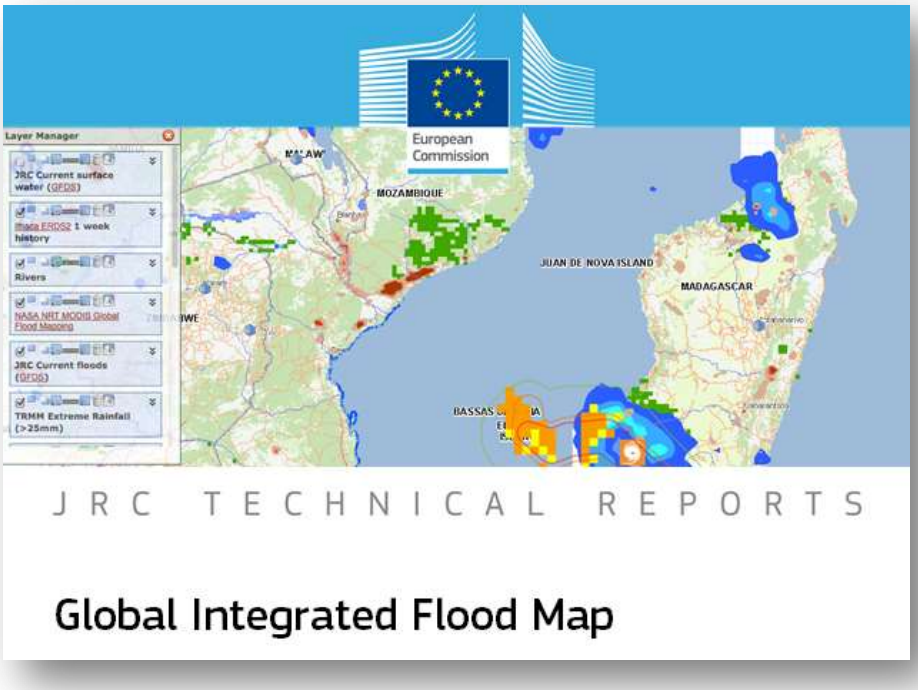
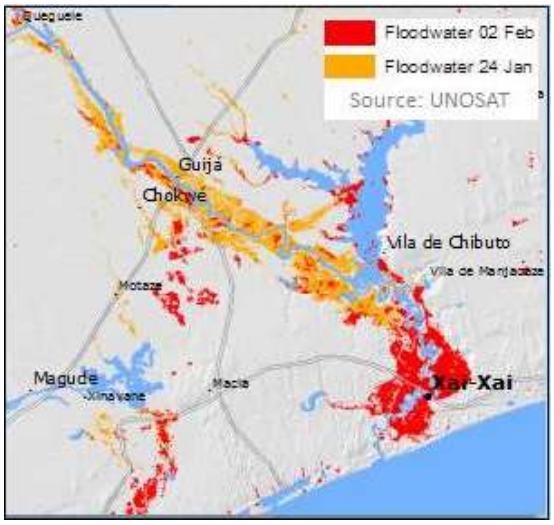


Figure 1. The document is available from the workshop web site: http://portal.gdacs.org/globalfloods2013.aspx

4.2 Case study: Mozambique Floods Jan-Feb 2013

4.2.1 Timeline of Mozambique floods

Sources: National Authorities, OCHA, ECHO, media



- 12 Jan: heavy rainfall started and continued for 2 weeks (>600mm)
- 23 Jan: flooding in 19 districts, 9 killed, 6K displaced. Chokwe (50K) at risk of flooding; evacuation towards Macia
- 25 Jan: 17 killed, 16K displaced. Reached city of Chokwe
- 28 Jan: 44 killed, 100K displaced. Reached city of Xai-Xai; Chokwe only accessible by boat
- 8 Feb: 41 killed, 213K affected
- 18 Feb: 111 killed, 186K displaced, 238K affected

4.2.2 Task: build a timeline of information

Participants were divided in three groups to discuss what data was really available at what time, how reliable it was, and whether it was used by operational organisations or not. The guiding questions were:

- What did you know (could you have known), and when?
- How sure were you (would you have been)
- What did you need to know at that time?

Topic	Issues	Moderators
Observation systems	What is the maximum flood extent? How long were Chokwe/Xia-Xia/fields flooded? What is the population affected	Bob Brakenridge Fritz Policelli
Forecasting systems	When will flood reach Chokwe/Xia-Xia? Is the situation getting better or worse? How much longer?	Bob Adler Frank Raes
Situation reports / maps	What was communicated? Info source? Was information correct, complete, relevant?	Tom De Groeve Alanna Simpson

4.2.3 Results

The time was too short to perform robust comparative analyses, but the exercise was enlightening. Having the system owners try to extract and evaluate information from their own systems shows the potential and the limits. Having end users trace back what information triggered them and where they found relevant information shows the need for communicating information in an appropriate format.

5 Outcomes

In general, there is a lot of interest in this new community to collaborate closely towards building useful tools for global flood forecasting and monitoring. Some of the highlighted issues were:

- **From practitioners at humanitarian / development organisations**: there is a lot of useful information, but it is hard to know where to find it. The scientific community should try to speak with "one voice" and clarify which information is best for what purpose and when. Often, products are too complicated to use. An effort must be made to make them simple and effective, to communicate in a clear way the relevant information.
- **From target and flood-prone countries**: it was recognized that this group of stakeholders was not present in the workshop and should be involved in the early stages, in order to make sure the tools and products are useful and relevant at national level. In particular the World Bank and WFP insisted that capacity building (and capacity maintaining) is essential in this area. At least one government (Namibia) expressed interest in participating in future workshops.
- **From research and operational organisations**: further research and development of tools (along the lines and recommendations identified in the workshop (see below)) requires funding. Transforming experimental systems into operational services also requires sustainable funding. It is important to set up mechanisms for coordinated funding which allows joint projects among international organisations.

The short-term recommendations of the workshop aim at continuing to **work together, coordinate R&D, and meet by**

- **Reaching out**: Publish results of workshop with recommendations on way forward and identified gaps in data and funding (action: co-conveners of workshop)
- **Building Pilot Success Stories**: publish joint validation studies, involving selected flood-prone countries, focused on value of systems for emergency management (action: JRC to initiate studies; interested parties to participate)
- **Creating one voice**: create a single portal for access of information (research publications, live systems, data, links) and tools for collaboration (action: JRC and all, on GDACS website)
- **Demonstrating added value** by integrating existing systems useful for particular needs (action: JRC to continue integration efforts with individual groups)

In parallel, it was recommended to work out a proposal for a Global Flood Partnership. This Partnership is envisaged to

> ***provide operational globally applicable flood forecasting and monitoring tools and services, complementary to national capabilities, for better managing current and future flood risk and reducing flood disaster impacts.***

A small working group will explore the feasibility and structure of such a partnership and gauge how widely this can be supported and funded.

6 Agenda of presentations

The workshop consisted of 36 presentations from scientific and operational participants divided in 6 sessions ranging from flood observation to forecasting and modelling, from new scientific research to operational use and decisions making.

All abstracts and presentations are available to workshop participants on the workshop web site: http://portal.gdacs.org/globalfloods2013.aspx.

NEAR REAL-TIME FLOOD EXTENT MAPPING

NASA Real-Time MODIS Mapping, Frederick S. Policelli (NASA/GSFC)
Caribbean Satellite Disaster Pilot Accomplishments and Program Planning Status, Stuart W. Frye (NASA/GSFC)
The Namibia Flood Dashboard, Matthew Handy (NASA/GSFC)
An Automatic Synthetic Aperture Radar-Based Flood Mapping Application Hosted On The European Space Agency's Grid Processing On Demand Fast Access To Imagery (GPOD Fair) Environment, Patrick Matgen (CRPGL)
Flood Monitoring With China's Resources, Environment, And Weather Satellite Images, Shanlong Lu (China Academy of Sciences, RADI)
Development of the Segmented Library of Inundation Extents (SLIE) and Applications for Rapid Flood Mapping, Kevin Dobbs (Univ, of Kansas)

FLOOD MEASUREMENT USING PASSIVE MICROWAVE REMOTE SENSING

Passive Microwave Radiometry of River Discharge for Early Warning of Damaging Floods, Robert G. Brakenridge (DFO)
A Study Case Using GFDS in Detection of Floods In Brazil, Graziela Balda Scofield (CEMADEN)
Application and Assimilation of GFDS in Flood Forecasts in South Asia, Tom Hopson (NCAR)
GFDS Flood Index: Measuring Flood Impact, Tom De Groeve (JRC)

SATELLITE RAINFALL ESTIMATION

Overview Of Current Global Precipitation Products and GPM, George J. Huffman (NASA/GSFC)
Operational NESDIS Products For Global Flood Forecasting, Robert Kuligowski and Sheldon Kusselson (NOAA/NESDIS)
Evaluation of the TRMM Real-time Multi-satellite Precipitation Analysis (TMPA-RT) for Macro Scale Hydrologic Prediction, Dennis P. Lettenmaier (Univ. of Washington)

HYDROLOGIC MODELLING SYSTEMS FOR GLOBAL APPLICATION

Assimilation Of Satellite Quantitative Precipitation Estimates And Streamflow Into Distributed Hydrologic Models For Flood Prediction, Yu Zhang
Global And Regional Flood And Storm Surge Prediction, Zac Flamig (Univ. of Oklahoma)
Flood Inundation Forecasting and Modeling in Data Sparse Areas, the Lower Zambezi Case Study, Guy J.-P. Schumann (NASA/JPL)
Usace Reachback Experiences In Providing Support For International Hydrologic Emergencies, Mark Jourdan (USACE/ERDC)
Flood Forecasting In South Asia, Kris Y. Shrestha (GA Tech)
ITHACA Extreme Rainfall Detection System: A Step Towards an Effective Alerts Dissemination, Elena Cristofori
Establishing A Global Flash Flood Forecasting System, Curtis Barrett (USAID/OFDA)
A Prototype Flood Forecasting And Alert System "Global Flood Alert System - Streamflow", Jun Magome (Univ. of Yamanashi, ICHARM)
Status Of A Real-Time Global Flood Estimation System Using Satellite Rainfall Information And A Hydrological Model, Robert Adler (Univ. of Maryland/ESSIC)

GLOFAS ENSEMBLE STREAMFLOW PREDICTIONS: RESULTS FROM A 2-YEAR VERIFICATION PERIOD, L. Alfieri (ECMWF, JRC)

FLOOD RISK AND GLOBAL FLOOD ARCHIVES

ENVISAT ASAR GLOBAL FLOOD MAPPING, Nicki Villars (DELTARES)
GLOBAL MODELING OF FLOOD HAZARD AND RISK AT 1 KILOMETER SCALE, Hessel Winsemius (DELTARES)
THE CPC GLOBAL TROPICS HAZARDS AND BENEFITS OUTLOOK, Jon Gottschalk (NOAA/NCEP/CPC)

BRIDGING THE GAP BETWEEN SCIENCE AND OPERATIONS

CONTINENTAL AND GLOBAL FLOOD FORECASTING: FROM RESEARCH TO OPERATIONS, Frank Raes (JRC)
NASA'S APPLIED REMOTE SENSING TRAINING PROGRAM (ARSET): BUILDING CAPACITY FOR FLOOD MONITORING, Ana I. Prados (NASA/GSFC)
DISASTER AWARE: MAKING CONNECTIONS, Heather Bell (PDC)
FLOOD HAZARD ASSESSMENT IN THE WHITE VOLTA BASIN, Erwin Wolters (HKV Consultants)
EXPLORING AND CULTIVATING DEMAND FOR FLOOD HAZARD INFORMATION PRODUCTS, Nate Smith (ICFI)
ASSESSING GLOBAL FLOOD HAZARDS: ENGINEERING AND INSURANCE APPLICATIONS, Edward Beighley And Jeffrey Mccollum (FM Global)
BRIDGING THE GAP BETWEEN FLOOD FORECASTING SCIENCE AND THE END USER, Rashid Kashif (WFP)
WEATHER OPERATIONS AND A CASE STUDY, Emily Niebuhr (WFP)
FLOOD IMPACT ASSESSMENT USING REMOTE SENSING, Alanna Simpson (World Bank)
USE OF SCIENCE AND TECHNOLOGY FOR INTEGRATED FLOOD RISK MANAGEMENT AT THE WORLD BANK, Rita Cestti (World Bank)

7 List and contact information of participants

Name	Affiliation
Abedalrazq Khalil	World Bank
Alanna Simpson	World Bank
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Jeffrey Mccollum	FM Global
John (Ebo) David	NASA/GSFC, SSAI
Jon Gottschalck	NOAA/NCEP/CPC
Jun Magome	ICHARM
Karen I. Mohr	NASA/GSFC
Kevin Dobbs	Univ. of Kansas

Kristofer Y. Shrestha	GA Tech
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Lorenzo Alfieri	ECMWF
Maksym Gusyev	ICHARM
Marisa Patrizi	Riverside
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Michael Goodman	NASA/MSFC
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Robert Adler	UMD/ESSIC
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Sarah N. Hemmings	NASA HQ, NASA/MSFC, SERVIR
Shanlong Yu	IRSA -> RADI China
Sheldon Kusselson	NOAA/NESDIS
Stuart Frye	NASA/GSFC
Thomas Hopson	UCAR
Tom De Groeve	JRC
Vladimir Tsirkunov	World Bank
Yang Hong / Zac Flamig	Univ. of Oklahoma
Yu Zhang	NOAA/NWS/OHD

Registered but could not attend

Carlos Frederico Angelis	CEMADEN
Jutta Thielen	JRC
Maryam Golnaraki	WMO
Sarah Telford	OCHA
Sezin Tokar	USAID/OFDA
Son V. Nghiem	NASA/JPL
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