NASA/USDA Workshop on Evapotranspiration

April 5 to 7, 2011

Hilton Washington DC/Silver Spring, MD
8727 Colesville Road,
Silver Spring, Maryland, USA, 20910.

Workshop Objectives:

1) To define the needs and requirements for evapotranspiration data in weather and climate studies, in natural and agro-ecoystem monitoring, and in water resource management
2) To review the methods used to measure and model evapotranspiration.
3) To assess surface and satellite observation systems required to support ET measurement, modeling and evaluation.
4) To assess the feasibility of developing a proposal for a task on evapotranspiration for the 2012-2015 GEO Work Plan.
5) To explore the level of support and consensus for developing a strategy for establishing evapotranspiration as an Essential Climate Variable (ECV) within the Global Climate Observing System (GCOS) framework

April 5, 2011

08:30 – 09:30: Registration

Opening Remarks (Chair: *Dave Toll)*
09:30 – 09:40 Greetings and overall workshop objectives (Bill Kustas, Brad Doorn)
09:40 – 09:50 ET incorporation into GEO workplan and ECV for GCOS (Rick Lawford)
09:50 – 10:00 ET white paper, ECV and need for cohesive ET community (Rick Allen)

Need and Requirements for ET Information (Chair: *Bill Kustas)*
10:00 – 10:15 Climate Change Implications: What do we need to know about ET? (Joe Barsugli)
10:15 – 10:30 ET information for water management in the Western US (Tony Willardson)
10:30 – 10:40 ET information for irrigation, water rights negotiations, and species protection (Dave Tuthill)
10:40 – 10:50 Practical Applications of the METRIC Evapotranspiration Model (Tony Morse)
10:50 – 11:05 ET information for water management in the Middle East (Ben Zaitchik)

11:05 – 11:35: *Coffee Break and Posters*

11:35 – 11:50 Remote Sensing Requirements for Scheduling Irrigations (Tom Trout)
11:50 – 12:05 ET information for the Water Census (Jerad Bales)
12:05 – 12:20 ET information for managing river basins (Alan Harrison)
12:20 – 12:35 Forecasting Evaporative Demand across the Conterminous US (Mike Hobbins)

12:35 – 13:50 *Lunch*

ET Processes and Modeling (Chair: *Brad Doorn)*
13:50 – 14:05 Overview (John Norman)
Land-surface models
14:05 – 14:20 Surface evaporation in Noah land model in NCEP operational weather and climate models (Mike Ek)
Remote sensing approaches and intercomparisons
14:20 – 14:35 Multi-model Multi-Platform Analysis of Global-scale Evapotranspiration for Climate Studies (Remi Meynadier)
14:35 – 14:45 METRIC/SEBAL (Rick Allen)
14:45 – 14:55 Two-Source Energy Balance (Bill Kustas)
14:55 – 15:05 Introduction to a MODIS Global Terrestrial Evapotranspiration Algorithm (Qiaozhen Mu)

15:05 – 15:35 *Coffee Break and Posters*

Data fusion and assimilation in mapping ET
15:35 – 15:45 Data Assimilation (Wade Crow)
15:45 – 15:55 Integration of Multi-Scale Thermal Satellite Imagery for Evaluation of Daily Evapotranspiration at Continental to Sub-Field Scales (Martha Anderson)
15:55 – 16:00 Introduction to the breakout groups (Rick Lawford)
16:00 – 17:00 Breakout groups - ET applications, modeling, and knowledge gaps

Applications (Ted Engman, Tom Trout)

This Working Group will review application areas where ET information could be used to enhance operational decisions and improved policies. The Group will also assess the degree to which ET is currently being used in these various applications as well as identifying new areas of applications that are expected to emerge in the near future. In addition, they will review the obstacles and limitations currently inhibiting the use of ET information and provide a list of criteria defining ET data requirements (e.g., spatial and temporal resolution, latency) for various applications.

Modeling (Bill Kustas, Mike Ek)

Users require ET information on different time and space scales depending on the application. It is recognized that different models satisfy different requirements and have different levels of complexity and requirements for input data. This working group will answer questions such as: What types of models work best for annual, monthly, daily and hourly (or instantaneous) requirements, and for predictions? What are the limitations of various modeling approaches in

terms of scale, input data needs, implicit assumptions, and context for the application (e.g., regional extent, terrain and landcover characteristics, climatic conditions)? Can the group define generic and specific improvements needed in current models and/or suggest new or hybrid approaches that can meet user requirements, and what steps should be taken over the next few years to ensure these needs are met?

Gaps in knowledge of ET processes (John Norman, Christa Peters-Liddard)

In addressing ET monitoring and prediction issues, it is important to have an understanding of the important processes on all scales. At the plant scale we do not know the precise rates of movement of water through different plants from the roots to the leaves, nor do we know how these fluxes respond to external forcings such as wind or water stress. At the larger scale we do not fully understand how to scale up these processes and combine their cumulative inputs with evaporation from wetlands and shrublands to get estimates that would be relevant over scales of kilometers. Moving to the scale of a model grid square there is also a need to understand how to average over larger areas such as a city or a watershed with small wetland, and to move from surface fluxes to fluxes in the boundary layer. This group is expected to review the knowledge gaps and to identify those which are most critical in terms of deriving better ET monitoring and prediction products.

17:00 – 17:30 Breakout group reports
17:30 PM Adjourn

April 6, 2011
08:30 – 08:45 Recap of Day 1 and goals for Day 2 Charlie Walthall

ET Measurement techniques (Chair: *Martha Anderson)*
08:45 – 09:00 Micrometeorological techniques (John Prueger)
09:00 – 09:15 Scintillometry (Massimo Menenti)
09:15 – 09:30 Measurement uncertainties (Joe Alfieri)

09:30 – 10:15 *Poster viewing with presenters, coffee*

Current and Planned ET Observation Systems (Part 1) (Chair: *Ted Engman)*
Ground-based networks
10:15 – 10:30 NEON (Brian Wee)
10:30 – 10:45 Fluxnet (Tilden Meyers)
10:45 – 10:50 Introduction to breakout groups (Rick Lawford)
10:50 – 10:55 Breakout groups - Future needs in research, observations

Ground-based ET Measurement Techniques and Networks (Tilden Meyers, Joe Alfieri)

Observations of ET, obtained over a range in vegetation and climate conditions, are required to evaluate modeling approaches, and to incorporate into models through assimilation systems. However, reliable ET measurements of ET are difficult to obtain, especially in real time, due to many factors. This group should formulate a statement that characterizes our ability to measure

ET, describing both the capabilities and limitations of current observational techniques and monitoring networks. What refinements are required, and what new instrumentation is on the horizon? What is the standard set of measurements that should be collected at an ET monitoring station? What are the gaps in the global observing network, and which are most crucial to fill? How can we ensure long term continuity in measurements, and better interoperability and integration between ET data systems?

Satellite systems and ET Measurements (Rick Allen, Martha Anderson)

The users of ET information have a range of requirements in terms of space and time resolution, data latency and data accuracy. In addressing these needs scientists have developed a number of approaches for using satellite data from different spectral bands to produce ET products. However, these products are limited by the nature of the ET algorithms, the availability of accurate information in the most appropriate spectral bands, overpass times, the extent and nature of calibration/validation activities, and product development and testing activities. This breakout group will address questions related to issues affecting satellite mission and science programs such as: Are we making the best measurements from space for ET products and, if not, what is needed? How can the cal/val activities be improved in terms of geographical representation and methodologies? Do we need more missions for ET measurements? Do we need new sensors for assessing ET? Are there new algorithms needed for ET monitoring and, if so, what needs to be done? What are the best avenues for developing new ET products with the current suite of satellites and measurements? What would be needed to generalize the current suite of ET products available over the USA to all parts of the world?

Research Needs (Brad Doorn, John Norman)

There is a range of research needs that must be addressed to produce better products for users. Better products depend on better assimilation models and algorithms that make use of all of the information available. Better models and algorithms require a better understanding of the fundamental processes that drive ET processes. This breakout group is expected to review the gaps in our knowledge about ET (see the April 5th breakout group on this topic) and to develop some priorities for general directions on future research to address these gaps. This could include the targeted analysis of existing data bases, field campaigns and process studies, model development and testing exercises, applications research on methodologies and research on new ways to disseminate information to users.

11:50 – 12:20 Breakout group reports

12:20 – 13:50: *Lunch*

ET topics (Chair: *Tony Morse)*

13:50 – 14:05 The Soil Moisture Active Passive Mission (SMAP) for soil moisture observations (Molly Brown)

14:05 – 14:20 ET for NIDIS, Water Census and FEWSNET (Jim Verdin)

14:20 – 14:35 Determine ET white paper writing groups (Dave Toll)

14:35 – 15:35 Breakout groups - ET White paper writing groups

(White paper writing groups)
Need and requirements for ET information (Tom Trout, Dave Toll)
Applications

ET processes (John Norman, Massimo Menenti)
Drivers, modeling techniques, gaps in knowledge

ET modeling (Bill Kustas, Mike Ek)
Summary of current modeling approaches, including strengths and limitations

ET measurement (Joe Alfieri, John Prueger)
Ground-based flux measurement techniques

Current and planned ET observation systems (Tilden Meyers, Rick Allen)
Includes both surface and satellite systems

Pathway to Attaining ECV Capabilities (Jared Entin, Rick Lawford)
What remains to be done before we can routinely generate an ET ECV?

15:35 – 16:05 *Coffee Break and Posters*

16:05 – 16:35 Breakout group reports
16:35 – 17:00 Open Discussion
17:00 Adjourn

April 7, 2011

08:30 – 08:45 Recap of Day 2 and goals for Day 3 (Brad Doorn)

Current and Planned ET Observation Systems (Part 2) (Chair: *Rick Allen)*

Spaceborne sensors
08:45 – 09:00 Landsat - TIRS (Betsy Forsbacka)
09:00 – 09:15 "Introduction of NOAA GOES and GOES-R Observations for ET Monitoring (Xiwu Zhan)
09:15 – 09:30 MODIS/VIIRS/Microwave sensors/GRACE (Jared Entin)
09:30 – 09:45 European satellites (Massimo Menenti)
09:45 – 09:50 Introduce breakout groups (Rick Lawford)
09:50 – 10:50 Breakout groups - ET White paper writing groups
10:50 – 11:20 Breakout group reports
11:20 – 12:00 Synthesis and final remarks (Rick Lawford/Brad Doorn/Bill Kustas)
12:00 Adjourn

Poster Presentations:

1) Molly Brown: The Soil Moisture Active Passive Mission (SMAP) for soil moisture observations
2) M. Tugrul, Yilmaz: Using Thermal Infrared Remote Sensing based ALEXI Evapotranspiration to obtain skillful Water Budget Estimations
3) Andrew Jarvis and Kaniska Mallick: A numerical scheme for partitioning terrestrial latent heat observation into evaporation and transpiration
4) Forrest, Melton: Satellite Irrigation Management Support with the Terrestrial Observation and Prediction System
5) Ayse Irmak: Evapotranspiration of Semi-Arid Sand Hills of Nebraska through Micrometeorological and Satellite-based Energy Balance Modeling (METRIC) techniques
6) Alan Lipton: Analyzing Evapotranspiration with Complementary Satellite Products
7) Hatim Geli, Christopher Neale, and John Osterberg: The Application of the Two-source Model Using High/Low Spatial Resolution Imagery and LiDAR Data to Estimate the Evapotranspiration of Tamarisk
8) Ray Anderson: The Regional Evaporative Fraction Energy Balance (REFEB) platform; a new technique to observe regional Evapotranspiration
9) Peyman Daneshkar Arasteh: Comparison of Remotely Sensed LAI and PAR with Ground Measurements in Qazvin Plain, Iran
10) Saleh Taghvaeian: Studying Water Balance Components Using Remotely Sensed Estimates of Evapotranspiration
11) Sumantra, Chatterjee: A modified crop coefficient approach for estimating regional evapotranspiration
12) Mike Hobbins: Examining the spatio-temporal variability of potential evaporation across the conterminous US
13) Suat Irmak: Nebraska Water and Energy Flux Measurement, modeling and Research Network (NEBFLUX)
14) Ayse Irmak, Ian Ratcliffe, Pariskit Ranade: Title: Monthly and Seasonal Evapotranspiration Mapping Using Land Surface Energy Balance with METRICtm and Daily Gridded Weather
15) Marzieh Azarderakhsh: Assessing remote sensing based ET estimates over the Amazon basin
16) Andrew French, Doug Hunsaker, Kelly Thorp: Combining Remote Sensing and Crop Growth Models to Estimate Evapotranspiration over Irrigated Lands at Daily Time Steps
17) Richard Allen: Fusion of Moderate Resolution Landsat-based Energy Balance with Daily Weather Grids to Produce High Definition Evapotranspiration over Hydrologic Time Periods
18) Rick Mueller: The Cropland Data Layer (CDL) Program
19) Gabriel Senay; Stefanie Bohms; James Verdin: Large Scale Evapotranspiration Estimation using Remote Sensing and Global Weather Datasets

20) Joshua Fisher: On uncertainty in global evapotranspiration estimates from choice of input forcing datasets
21) Tony Morse: Practical Applications of the METRIC Evapotranspiration Model
22) Xiwun Zhan: Intercomparison of an ET-based Drought Index Derived from Geostationary Satellite Data with Standard Drought Indicators
23) Qiaozhen Mu, Maosheng Zhao, Steven W. Running: Applications of Global MODIS Evapotranspiration Algorithm at AmeriFlux Tower Site and Global Scale
24) Timothy Martin: Satellite-Based Evapotranspiration Mapping and Water Use in Irrigation Systems of Morocco
25) Timothy Martin: Web-based Dissemination of Surface Energy Balance Evapotranspiration Estimates