

## Murray Darling Basin Water Balance Water Budget Project (MDB)

**Report Dates:** 2005-2006

**Starting Date:** 2003

**Ending Date:** 2010

**Chair:** Dr. Helen Cleugh

### Overview

#### *Objectives*

The major objectives of the MDB project are to:

- Observe, understand and model the dynamics of the coupled water, energy and carbon cycles
- Improve predictive tools for water management, including real-time forecasting products for use by water agencies in the MDB
- Strengthen interaction between the climate research community and decision-makers
- Promote education and international exchange to improve global change science capability and innovation in Australia and worldwide.

#### *Status*

An active program of activities is continuing in ANSTO, BMRC, CSIRO Land & Water, CSIRO Marine & Atmospheric Research, and Melbourne University. The research activities are also supported by the eWater Cooperative Research Centre, which has over 30 participating research and operational water agencies. Highlights of the activities over the last year are listed below, as they contribute to each objective of the program.

#### *Observe, understand and model water, energy and carbon cycles*

- GRACE satellite observations were used to estimate the variability of terrestrial water storage within the MDB
- Studies to evaluate the assimilation of GRACE observations into a lumped conceptual hydrological model were undertaken
- A study to evaluate the use of a land surface model to predict surface runoff over medium sized catchments was undertaken and improvements to the model were evaluated
- The soil moisture monitoring network in the Murrumbidgee was expanded
- A quality-controlled gap-filled dataset of energy, water and CO<sub>2</sub> fluxes at the Tumbarumba flux station has been developed from 2001.
- An algorithm to estimate land surface evaporation, using MODIS data, has been developed and tested using observations from the flux station
- The flux station data are being used to evaluate the assimilation of heat flux into CABLE, the land surface model used for NWP and climate models in Australia under the ACCESS initiative
- A project to evaluate the strength of the coupling between the land surface and the atmosphere over the MDB was undertaken
- An initial hydrological water budget for the Murray-Darling Basin has been developed, based on analyses of rainfall and streamflow data, engagement with river management agencies, and methods to account for ungauged sources and sinks
- A system, based on data assimilation into a terrestrial water balance model, has been developed with a resolution of 5 km and used to develop a 25-year record of monthly water budgets
- Methods are being developed to quantify the impacts of drivers, such as climate change, afforestation, farm dams and bushfires, on future water availability
- Measurements of deuterium and oxygen-18 are being used to detect and quantify water diversions from the Barwon-Darling River system
- The Global Network for Isotopes in Precipitation (GNIP) sampling network is being extended from August 2006 to include four more sites in the Murray-Darling Basin, as well as sites in Western Australia, South Australia and Queensland
- Analysis of isotopic data at Tumbarumba to delineate water and carbon exchange processes on diurnal and seasonal timescales has been completed

#### *Improve predictive tools for water management*

- A pilot project to provide forecasts of rainfall and evaporation directly to two catchment authorities continues
- The “Water and the Land” web site ( <http://www.bom.gov.au/watl/> ) has been developed to distribute hydro-meteorological observations and forecasts to the water industry

#### *New Directions*

- A multi-agency program, the South East Australia Climate Initiative (SEACI), has been established with a major element on seasonal prediction in the Murray-Darling region. In order to contribute to and perhaps benefit from the joint GEWEX-CLIVAR activity on seasonal prediction, the MDB project will include appropriate elements of SEACI.
- It is planned to include Australia’s CEOP activities, including both observations and modelling, in the MDB project
- As part of the evolution of the MDB project, it is planned to invite other water authorities to participate in activities linking research results to practical applications
- The Australian National Water Commission manages the National Water Initiative (NWI), which is the blueprint for national water reform across all jurisdictions. It is expected that the NWI will provide opportunities for research and development activities relevant to the MDB project

#### *Planned activities over next year*

- Finalise the MDB implementation plan
- Strengthen the hydro-meteorological aspects of the Australian Community Climate & earth System Simulator (ACCESS), including the application of large-scale models to tactical water management
- Develop techniques to present uncertainty in hydro-meteorological forecasts to end-users
- Develop a consistent hydrological framework to support water resource management (especially water accounting and water trading), based on existing tools: Catchment Water Yield Estimation Tool, River System Management Tool, and Groundwater Surface Water Interaction Tool
- Refine and test algorithm for estimating surface evaporation from MODIS data, and apply the algorithm in water budget models
- Extend the 5-km water budget system to cover all Australia
- Extend the isotopic measurement program along the Barwon-Darling River system, and to include isotopic measurements in class-A evaporation pans

#### *Issues and Recommendations*

- A dilemma for the MDB project is the balance between hydro-meteorology and climate prediction. The primary reason for the initial involvement of the participants in GEWEX was access to an international forum to consider and resolve problems on the interface between meteorology and hydrology. It would be unfortunate if GEWEX develops new projects with CLIVAR on seasonal prediction at the expense of its unique international role in providing a common forum for hydrologists and meteorologists to consider key issues of the water budget.
- In addition to the research carried out under the formal MDB project, there is significant research in Australia related to CEOP, including both observational and modelling studies. It is proposed that, in line with the likely evolution of GEWEX, the MDB project will also include the Australian CEOP activities in the Murray-Darling region.

#### **Contributions to WCRP strategic framework**

A key element of WCRP is the development of predictive systems for the benefit of society. Much of the research in the MDB project is aimed at improving the representation of water and carbon processes in weather and climate models. These models are used both to improve understanding of climate processes, and also to predict the future behaviour of the water and carbon budgets at the surface. Several aspects of the MDB project are aimed at the use of the models to assimilate observed data for real-time prediction and for the creation of climatologies of surface variables.

## Contributions to society

Some agencies involved in the MDB project have operational responsibilities and much of their research for the MDB is aimed at improving their operational systems. Moreover, the eWater Cooperative Research Centre (CRC) provides a forum for researchers and water authorities to develop joint projects, and the MDB project involves activities in which new systems and techniques are tested with specific water authorities.

## Key Publications

- Abramowitz, G., Gupta, H., Pitman, A., Wang, Y.P., Leuning, R. and Cleugh, H.A. (2006). Neural Error Regression Diagnosis (NERD): A tool for model bias identification and prognostic data assimilation. *Journal of Hydrometeorology* 7:160-177.
- Ellett, K. M., Walker, J. P., Western, A. W., Grayson, R. B. and Rodell, M., 2004. Assimilation of GRACE-type Observations to Improve Catchment-scale Hydrological Model Prediction in the Murray-Darling Basin, Proceedings of the 2nd International Workshop on Catchment-scale Hydrologic Modeling and Data Assimilation. Princeton, USA, 25-27 October, 2004.
- Ellett, KM, Walker, JP, Rodell, M, Chen, J and Western, AW, 2005. GRACE gravity fields as a new measure for assessing large-scale hydrological models, In: Argent R and Zerger A, (eds), MODSIM 2005 International Congress on Modelling and Simulation, Modelling and Simulation Society of Australia and New Zealand, 2911-2917.
- Ellett, KM, Walker, JP, Western, AW and Rodell, M, 2006a. A framework for assessing the potential of remote-sensed gravity to provide new insight on the hydrology of the Murray-Darling Basin, *Australian Journal of Water Resources*, 10(2): 125-138.
- Ellett, KM, Walker, JP, Western, AW and Rodell, M, 2006b. Investigating the potential for assimilation of terrestrial water storage observations from GRACE, *Eos Trans AGU Joint Assembly Suppl.*, Abstract H21B-02.
- Gibson, J.J., Sadek, M.A., Stone, D.J.M., Hughes, C., Hankin, S., Cendon, D.I. and Hollins, S.E. (2006) Stable isotope tracing of water exchange along a dryland river. 16<sup>th</sup> Annual V.M. Goldschmidt Conference, Melbourne ISBN 1 877040 52 5.
- Gibson, J.J., Sadek, M.A., Stone, D.J.M., Hughes, C., Hankin, S., Cendon, D.I. and Hollins, S.E. (2006) Evaporative isotopic enrichment as a constraint on reach water balance along a dryland river. In *Proceedings of International Workshop on Isotopic Effects in Evaporation: Revisiting the Craig-Gordon Model Four Decades after its Formulation, Pisa, Italy, pp 79-85.*
- Pipunic, R., Walker, J. P., Western, A. W. and Savige, C., 2004. Assimilation of Latent and Sensible Heat Flux Data into a Land Surface Model, Proceedings of the 2nd International Workshop on Catchment-scale Hydrologic Modeling and Data Assimilation. Princeton, USA, 25-27 October, 2004.
- Raupach, M.R., Trudinger, C.M., Briggs, P.R. and King, E.A. (2006). Australia Water Availability Project Final Report. CSIRO. 56 pp.
- Walker, J. P., 2005. Land Surface Model Data Assimilation for Atmospheric Prediction, Proceedings of the Hydrometeorological Applications of Weather and Climate Modelling Workshop, BMRC Research Report No. 111, pg. 111-114. Melbourne, Australia, 3-6 October, 2005.

## Planned Meetings

- MDB Science Steering Committee Meeting
- MDB Workshop in 2007

## Members

- Helen Cleugh, CSIRO Marine & Atmospheric Research
- Francis Chiew, CSIRO Land & Water
- Suzanne Hollins, Australian Nuclear Science & Technology Organisation (ANSTO)
- Michael Manton (Monash University)
- Alan Seed (BMRC)
- Jeff Walker, Melbourne University

**GHP scientific criteria for the assessment of CSE progress are presented in Table 1. Each criterion is rated as completed (C), progressing (Pr) or beginning (B).**

Table 1: Scientific criteria for CSE assessment.

Simulate the diurnal, seasonal, annual and interannual cycles.	B
Close water and energy budgets.	Pr
Determine and understand climate system variability and critical feedbacks.	Pr
Demonstrate improvements in predictions of water-related climate parameters.	Pr
Demonstrate the applicability of techniques and models to other regions.	B

The technical-logistical criteria are presented in Table 2. Each criterion is rated as functioning (F), initiating (I) or planned (P).

**Table 2: Technical-logistical criteria for CSE assessment**

NWP centre atmospheric and surface data assimilation and estimates of hydro-meteorological properties.	F
Suitable atmospheric-hydrological models and numerical experimentation and climate change studies.	F
Mechanism for collecting and managing adequate hydrometeorological data sets.	F
Participate in the open international exchange of scientific information and data.	F
Interactions with water resource agencies and related groups to address the assessment of impacts on regional water resources.	F
Evaluation of GEWEX global data products	I-F
Contributions to CEOP and transferability data bases.	F

Report submitted by Alan Seed