The Drought Research Initiative (DRI) Drought Characterization

Workshop Program

University of Manitoba,

Centre of Earth Observation Science

Environment and Geography

September 26, 2008

(Draft 9/15/2008)

Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)

Fondation canadienne pour les sciences du climat et de l'atmosphère (FCSCA)

DRAFT AGENDA FOR THE DROUGHT CHARACTERIZATION WORKSHOP
(9/16/08)
September 26, 2008
CEOS Board Room
University of Manitoba, Winnipeg, MB

08:30 – 08:40: Welcoming remarks and introduction to the purpose of the workshop (John Hanesiak, Ron Stewart)

08:40 – 08:50: Overview of DRI (Ron Stewart)

08:50- 09:20: Overview of Theme 1 and the drought characterization activity (John Hanesiak)

09:20 – 09:35: Summary of operational drought monitoring services and needs (Aston Chipanshi)

09:35- 09:50: Overview of societal impacts of the drought (Elaine Wheaton)

09:50- 10:10: Coffee

ATMOSPHERIC CONDITIONS FOR THE 1999-2005 DROUGHT

10:10 – 10:25: Circulation Control and Soil Moisture Variability during 1999-2003 Canadian Prairie Drought (Amir Shabbar)

10:25 – 10:40: Precipitation patterns during the drought (John Hanesiak)

10:40 – 10:55: Clouds and Solar Radiation during droughts (Henry Leighton)

10: 55 – 11:10: Water Cycle, Precipitation Extremes and related features (Ron Stewart, Kit Szeto, Hannah Carmichael, William Henson)

11:10 - 11:25: Flux measurements in a forest environment (Brian Amiro)

11:25 – 11:40: Additional short contributions related to convection and surface fluxes (Trudy McCormack, others)

11:40 – 11:55: DEWS and Drought data needs (Nancy Lee)

11:55 – 12:15: Discussion

12:15 – 13:00 Lunch (To be served in the Dean's Board Room)

SURFACE CONDITIONS

13.00 – 13:15: Characterizing the 1999-2005 Canadian Prairie Drought: Drought Indices and their Associated Input Variables (Alison Meinert)

13:15 – 13:30: Agricultural zone soil moisture estimates during the drought (Julian Brimelow)

13:30 – 13:45: Snow cover conditions during the drought (Chris Derksen)

13:45 – 14:00: Progress Towards Calculating Actual Evaporation over the Canadian Prairie Region during Drought (Robert Armstrong)

14:00 – 14:15: Vegetation conditions over croplands during the drought (Shusen Wang)

14:15 – 14:30: Implications of the drought for grain quality (Paul Bullock)

14:30 – 14:45: Regional hydrology: the drought in the SSRB (John Pomeroy)

14:45 – 15:00: GRACE Satellite Observations of Terrestrial Moisture Changes for Drought Characterization in the Canadian Prairie (S. Yirdaw)

15:00 – 15:15; Discussion

15:15 – 15:30: Coffee

15:30 – 15:45: Evaluating Gridded Datasets for Physically Based Hydrologic Modelling of Drought (Kevin Shook)

15:45 - 16:00: A few Regional Hydrological Aspects of the Drought (Rick Lawford)

16:00 – 16:15 DRI Data Services (Patrice Constanza)

16:15 – 17:00: Discussion and Action plan for completing the drought characterization paper

ABSTRACTS

The Severe Drought of 2001-2002: An Overview of Impacts of and Adaptations in Canada

Elaine Wheaton, Saskatchewan Research Council
wheaton@src.sk.ca

The severe and very extensive drought of 2001-2002 was a stern reminder of the importance of water supplies, of not taking water for granted, and the value of carefully managing water resources. Droughts are major hazards for the economy, environment, health, safety, and society. Canada and other parts of the Northern Hemisphere experienced drought unseen for at least 100 years in some regions during this time. National Assessments of impacts and adaptations to this drought were undertaken, with emphasis on the agricultural and water sectors. Even though the Prairie Provinces are more accustomed to droughts than other Canadian provinces, they were the most severely affected. Saskatchewan and Alberta shared most of the 2002 agricultural production losses, with each accounting for 45% of the Canadian total. The drought struck many economic sectors, but the major industry hit the hardest was agriculture. Adaptation to water scarcity was constrained by lack of knowledge concerning water supplies, uses, consumption, and water management, for example. Irrigation was an important adaptation option across Canada during the drought, but it incurred higher than average labor and energy costs, as well as management problems. Conservation, improved efficiency, reallocation, improved knowledge, and many other measures were also used to deal with inadequate water supplies. Economic costs inflicted in Canada totaled $3 billion for the two drought years, making the drought one of the Canada's worst natural disasters. Knowledge of the characteristics of past and future droughts, impacts, and adaptations must be radically improved to help reduce these significant vulnerabilities.

Circulation Control and Soil Moisture Variability during 1999-2003 Canadian Prairie Drought

Amir Shabbar, Environment Canada, Toronto
Amir.Shabbar@ec.gc.ca

This presentation will examine major circulation control and the role of various teleconnection indices during the 1999-2003 Canadian prairie drought. It will be shown that a coupled mode of ocean-atmosphere variability, as obtained by Maximum Covariance Analysis (MCA), played a significant role in the determination of warm and dry weather over the prairies. Additionally the changing nature of soil moisture, derived from a 1-layer water balance model, during the growing season will be shown.

Characterizing the 1999-2005 Canadian Prairie Drought:
Drought Indices and their Associated Input Variables

Alison Meinert, Environment Canada, Saskatoon
Alison.Meinert@ec.gc.ca

Between 1999 and 2005, the Canadian Prairies experienced severe drought conditions. However, throughout this period, the drought varied in intensity, duration, spatial coverage and associated impacts. The main objective of this study is to quantify the extent and severity of the 1999 to 2005 Canadian Prairie drought at a variety of spatial and temporal scales using several standard meteorological drought indices, including the Palmer Drought Severity Index (PDSI), the Palmer Z Index and the Standard Precipitation Index (SPI). Three gridded temperature and precipitation datasets were evaluated to determine which was best suited to quantify drought characteristics over the Prairies. These included North American ANUSPLIN data (McKenney et al. 2006), Canadian gridded climate data (CANGRID) and Climate Research Unit data (CRU TS 2.1, Mitchell and Jones, 2005). Results showed significant differences among the gridded datasets, particularly in terms of precipitation. The assessment indicated that the ANUSPLIN dataset appeared to capture several intense precipitation events, as measured by the smaller secondary climate stations, compared to the other datasets. SPI and PDSI values calculated using the ANUSPLIN data showed similar results. In both cases, drought conditions began to appear in southern Alberta in the summer of 2000 and had spread to cover most of southern and central Alberta and Saskatchewan by August 2001. Severe drought conditions persisted through to May 2002. In June 2002 in southern Alberta, and in August 2002 in central Saskatchewan, respectively, large precipitation events brought about major changes to the stable drought pattern that had persisted over the region. Drought conditions continued to be severe north of 52° latitude while to the south conditions became wet. These conditions continued through to June 2003 when once again it began to dry out across southern Alberta, Saskatchewan and Manitoba. The Prairie Provinces remained relatively dry up to April 2004. By May 2004 Manitoba was under normal to wet conditions, followed by Saskatchewan in August 2004, and Alberta in August 2005

Snow cover characteristics for the Canadian prairie provinces during the 1999-2005 drought

Chris Derksen[1] and Ross Brown[2,]
[1]Climate Research Division, Environment Canada, Toronto
[2]Environment Canada @ OURANOS Inc., Montréal

Chris.Derksen@ec.gc.ca

Various datasets were utilized to characterize snow cover over the Canadian prairie provinces during the 1999 to 2005 drought period. Snow cover duration (SCD) derived from NOAA weekly snow charts (1972-2007; ~200 km resolution) identified the 1999/2000 prairie snow cover season as the second shortest in the satellite record, but conditions rebounded to near normal for the remaining drought years. SCD anomalies calculated separately for August through January (sensitive to variability in snow onset date), and February through July (sensitive to variability in snow ablation date) showed a high degree of spatial variability with no statistical evidence of a consistent shift in the onset or end of the snow cover season during the drought period. Snow water equivalent (SWE) anomalies were calculated for the southern prairies from the satellite passive microwave data record (1978-2008; 25 km resolution). Regionally-averaged monthly snow depth anomalies were also computed over the 1979/80 to 2007/08 seasons using the North American snow depth analysis of Brown et al. (2003) and operational snow depth analyses from the Canadian Meteorological Centre. The data sets reveal persistent negative snow depth and SWE anomalies over the southern prairies during the 1999/2000 to 2004/05 seasons, particularly during December and January. Weaker negative SWE anomalies in the passive microwave record during late winter are likely the result of algorithm uncertainty – late season error sources (melt/refreeze events; ice layer and depth hoar formation) all contribute to SWE overestimation. The snow depth analyses also identified persistent negative anomalies during the drought years across the boreal forest of the prairie provinces. Previous issues in retrieving SWE across the boreal forest from passive microwave satellite data have been resolved with the combination of 18.7 and 10.7 GHz measurements from the Advanced Microwave Scanning Radiometer (AMSR-E; 2002-present), but full time series development remains problematic because 10.7 GHz measurements are not available from the Special Sensor Microwave/Imager (1987-present).

Progress Towards Calculating Actual Evaporation over the Canadian Prairie Region during Drought

Robert Armstrong, John Pomeroy, Lawrence Martz: University of Saskatchewan
robert.armstrong@usask.ca

Characterizing drought on a regional scale is difficult due to the variability of climate and surface state conditions, and moisture storage considerations. Spatial variations in actual evaporation relative to normal conditions can be very instructive descriptors of drought. The integration of climate data and remote sensing information with a physically-based evaporation model has the potential to be a powerful tool for mapping spatial patterns of evaporation over large regions. As shown by a recent demonstration for a field scale study in the aspen parkland region of central Saskatchewan, daily estimates of actual evaporation may be derived from one-time-day of day remote sensing imagery and daily observations of climate data, and a reference value of daily net radiation. The model applied for estimating daily evaporation is the Granger-Gray evaporation model (G-D model) which is based on the complementary approach. Potential sources of climate data needed for parameterizing the G-D model include Environment Canada observations, North American Regional Reanalysis 32 km resolution gridded outputs, and MODIS 1 km resolution imagery. Preliminary development and potential issues of constructing a dataset designed for calculating regional actual evaporation are outlined.

Evaluating Gridded Datasets for Physically Based Hydrologic Modelling of Drought

Kevin Shook; SGI Canada Research Fellow
kevin.shook@usask.ca

The model CRHM (Cold Regions Hydrological Model) will be used to determine the effects of the 1999-2005 drought for simulated basins in the Canadian prairies. By comparing the results of model runs for the drought period with those of runs over the pre-drought period, the effects of the drought can be estimated for variables which cannot be measured. In addition to common variables such as precipitation and air temperature, measurements of incoming shortwave solar radiation, Qsi, are required by CRHM. As measured solar radiation sites are sparse on the Canadian prairies, it is intended to use synthetic Qsi data to enable CRHM to model the entire region. Synthetic daily Qsi data from the NARR and NCEP datasets, as well as data determined from a simple algorithm, are evaluated against measured values to determine their usefulness.

GRACE Satellite Observations of Terrestrial Moisture Changes for Drought Characterization in the Canadian Prairie

Sitotaw Yirdaw
sitotaw@gmail.com

The essence of this paper is to undertake an investigation of the recent Canadian Prairie drought by employing total water storage anomalies obtained from GRACE (Gravity Recovery and Climate Experiment) remote sensing satellite mission. In order to successfully retrieve average terrestrial water storages from gravity measurements, a necessary procedure is to undertake the transformation of the GRACE geopotential spherical harmonic coefficients into spatially varying time series of geopotential heights that were subsequently converted into water equivalent amounts. These obtained GRACE-based total water storages were thereafter validated using storages estimated from the atmospheric-based water balance P-E computation in conjunction with the measured streamflow records for the Saskatchewan River Basin at its Grand Rapids outlet in Canada. Interestingly, the results from this study corroborate the potential of GRACE-based technique as a veritable tool for the characterization of the 2002/2003 Canadian Prairie droughts. Especially, this approach would prove resourceful for other regions globally where soil moisture availability is sparing or worst still, inexistent thereby making such studies impossible.