4.2 Parameterization of Evapotranspiration Using Remotely-Sensed Data

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Objectives

1. To develop and evaluate parameterizations for the application of remotely-sensed data within operational evapotranspiration models.

2. To develop a framework for assessing GCM evapotranspiration algorithms using remotely-sensed regional data in conjunction with operational evapotranspiration models. (this remains as a long-term goal, and will be developed once the feedback algorithm has been successfully applied on a large scale)

3. To develop new parameterizations for the estimate of lake evaporation using remotely-sensed data.

Progress and Collaborations

1. During the 1997 snow-free season, data collection was continued at the Prince Albert and Whitehorse research sites. Technical progress, if relevant, is in terms of timelines given in previous proposal (methodology used, software development, data assimilation techniques, *etc.*). At the Prince Albert sites, five instrument towers are maintained (at Jackpine, mixed wood, a recent clearcut, a regenerating cut site, and a recent burn). At the Wolf Creek Watershed (Whitehorse), three instrument towers are maintained (at Jackpine forest, highbush taiga and alpine sites). Energy balance estimates were prepared using the data from these sites; the evapotranspiration estimates were used for the verification of the remote sensing procedures, and the observed surface temperature and net radiation values used for the calibration of the remote sensing algorithms used to estimate these parameters.

2. Collaboration was maintained with AES Downsview (N. Bussières) and with the Prince Albert Model Forest project. Collaboration is being initiated with Dr. B. Leblon, University of New Brunswick, for the estimate of evapotranspiration over the Mackenzie Basin, and with Dr. Richard Essery (NHRC, visiting scientist from Hadley Centre, UK) for the development of parameterizations for lake evaporation.

Scientific Results

1. The AVHRR channel 2 albedo (normalized using the cosine of the solar zenith angle) was shown to provide a reasonable estimate of the broadband surface albedo. The satellite-derived land surface albedo is used, in conjunction with easily-calculated values of clear sky solar radiation, to provide reliable estimates of the daily net radiation at the surface.

2. A split-window technique was successfuly applied to obtain estimates of the land surface temperatures for conditions where atmospheric corrections using standard atmospheric models are not feasible because of a lack of data (*i.e.*, from atmospheric soundings). A

feedback relationship was used in conjunction with remotely-sensed surface temperature observations to provide an estimate of the vapour pressure deficit in the air layer overlying the surface. An algorithm based on this feedback relationship was shown to be applicable to a variety of forest land cover types, as well as for the agricultural surfaces for which it was originally developed.

3. The satellite-derived estimates of net radiation and vapour pressure deficit were used as input to a conventional evapotranspiration model, allowing for evapotranspiration estimates derived using only the information provided by the satellite-mounted sensors. These satellite-derived evapotranspiration estimates compare favourably with estimates obtained with a conventional evapotranspiration model using data from a network of field stations.

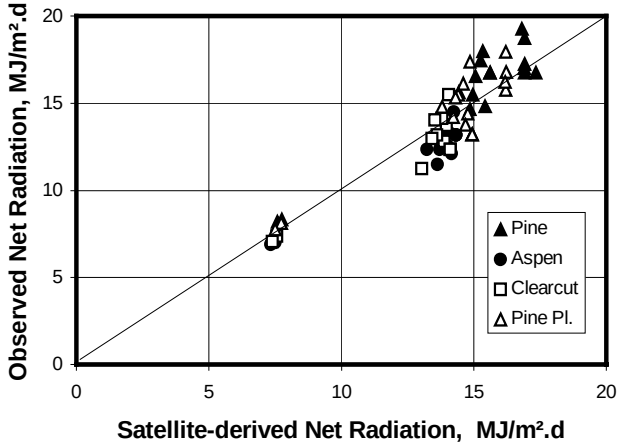

Figure 1 Comparison of daily net radiation observed over forest land covers with net radiation estimated using AVHRR-derived estimates of surface albedo. (data are from July and September)

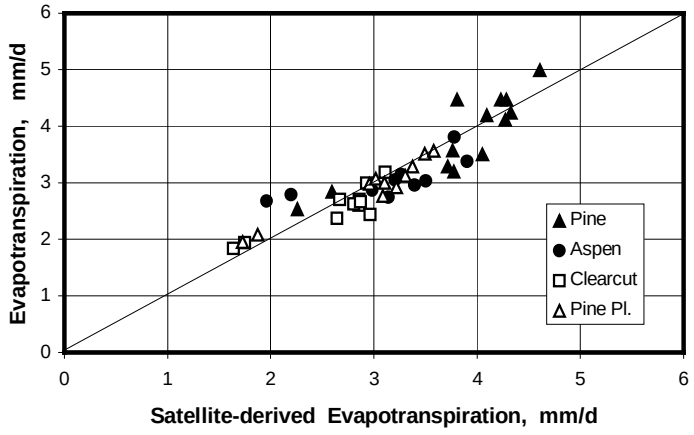

Figure 2 Comparison of daily evapotranspiration values obtained using a conventional model in conjunction with ground-based data with those obtained using satellite-derived data.

Summary

1. Data obtained from field observations were used in the development of parameterizations for the use of remote sensing in the estimate of evapotranspiration. Infrared surface temperature observations obtained from tower-mounted sensors were used to evaluate the split-window technique with NOAA-AVHRR data for obtaining reliable surface temperature estimates. Albedo measurements obtained from tower-mounted sensors above various forest stands were used for the development of a simple satellite-based albedo algorithm. These relationships were then applied in conjunction with NOAA-AVHRR images; the temperature, vapour pressure and net radiation estimates derived were applied within a conventional evapotranspiration model to produce daily estimates. These daily estimates of net radiation and evapotranspiration obtained using satellite data compared favorably with those obtained from the tower-mounted sensors.

2. A new approach which allows for the application of remotely-sensed data in conjunction with conventional evapotranspiration models is being developed. Remotely-sensed data can be used to derive both parameters (net radiation and vaapour pressure deficit) required for estimating evapotranspiration; the visible channels can be used to index the surface albedo, from which net radiation can be estimated, and the infra-red channels provide an estimate of the land surface temperature from which the vapour pressure deficit can be estimated using a feedback relationship. The result is a very simple method with which evapotranspiration can be obtained using only remotely-sensed data. For large areas, such as the Mackenzie basin, and many other northern regions, where relatively little ground-based information is available, this represents a very approach.

Breakdown of Mags Funding Use During Fiscal Year 1997/98

(similar to budget given in proposal.

Recent Publications and Presentations

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Granger, R.J. and J.W. Pomeroy, 1997. The role of summer energy and water use in the sustainability of mature and regenerating boreal forest. Presented to the Sustainable Site Productivity Workshop (Forestry Canada), Sault Ste. Marie, Ontario, 17-20 February, 1997. (in preparation to be submitted to *Canadian Journal of Forest Research*)

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Pomeroy, J.W. and R.J. Granger, 1997. Sustainability of the western Canadian boreal forest under changing hydrological conditions. I. Snow accumulation and ablation. In: *Sustainability of Water Resources under Increasing Uncertainty*, Proceedings of the Rabat Symposium S1, April 1997 (D. Rosbjerg, N-E. Boutayeb, A. Gustard, Z.W. Kundzewicz, and P.F. Rasmussen, Editors) IAHS Publ. No. 240, 1997, pp. 237-242.