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AUSSIE GRASS: AUSTRALIAN GRASSLAND AND RANGELAND ASSESMENT BY SPATIAL SIMULATION: NEW DEVELOPMENTS AND APPLICATIONS

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INTRODUCTION

Calibrating a continental scale spatial model running at a daily time step is a challenging task. There are about 270,000 pixels for which a calculation is made. Parameters have to be estimated for about 186 pasture communities. Data for model calibration and validation fall into three main classes: (1) ground based observations, (2) satellite based observations and (3) production statistics. Model calibration and validation from all three classes of information are continually being improved and we firstly describe this recent work and then briefly outline application of the model to climate research.

GROUND BASED OBSERVATIONS

Pasture biomass

Pasture biomass observations can be used to test that the model correctly simulates pasture biomass. Because measurements are made at a point, many observations are needed to produce data suitable for model calibration. By the end of 2003 about 500,000 individual observations of pasture biomass had been collected by the AussieGRASS team using the method described in Hassett *et al.* (2000). Observations now cover many regions of Australia. Northern Australia and some other regions have good time series of observations. Biomass alone is not a good model constraint as it is the result of a number of processes (growth, herbivory, detachment and burning), and therefore needs to be combined with other types of measurements. Pasture utilisation in tussock grasslands can be visually estimated by observing tussock shape to give an estimate of utilisation. Using utilisation in qualitative and quantitative manner for model calibration will force model parameters to differentiate between high-growth-high-removal and low-growth-low-removal scenarios that result in the same biomass. Visual checking of Queensland data suggests that at a regional scale predicted patterns of utilisation match observations.

Ground cover

Total cover observations from rangeland monitoring sites in NSW, field surveys and from high resolution satellite data have been used to calibrate total cover as produced from the model. The challenge is to ensure that the observed and simulated cover are measurements of the same thing and that there are enough cover measurements over time and space to ensure that the resulting calibration can be applied at regional rather than point scale. Cover data from calibrated Landsat TM images across Queensland will provide a large increase in the amount of cover data available. Model estimates of cover can now be produced for Australia but are well calibrated only in western NSW.

Hydrology

AussieGRASS simulates all major components of the water balance. Validation of model runoff against measured stream flow provides a coarse validation of the model water balance. AussieGRASS now regularly produces an output of potential flow to stream as a percentile and as a forecast.

Estimates of long-term average rainfall and evapotranspiration are closely correlated with those empirically estimated by Zhang *et al.* (2001).

SATELLITE BASED OBSERVATIONS

The Normalised Difference Vegetation Index (NDVI) is widely used for ecological purposes. It is an index constructed from reflected light in the red and near-infra red parts of the spectrum. The NDVI data series (from the Advanced Very High Resolution Radiometer (AVHRR) time series is temporally dense (10-14 days, in cloud free areas), and has a long time series (nearly 20 years). The NDVI signal is rich in information (Carter *et al.* 2002), and can be used to constrain model parameters. Used alone NDVI provides only partial information about plant growth. Satellite measurements of surface temperature combined with air temperature data provide additional information about evapotranspiration. The differential between air and surface temperatures is directly related to the rate of evapotranspiration. Use of both NDVI and thermal data is improved by decomposing AVHRR composite data into images for individual days and correcting for bidirectional reflectance effects. Radar scatterometer data for land surfaces have the potential to provide information on surface soil moisture and potentially on pasture biomass (Jarlan *et al.* 2002). The spatial extent of these data is low, (about 500 sq km) but data are available every 1-3 days. This allows detection and monitoring of change such as bare soil drying after rainfall. This system is best suited to arid areas and indications are that soil moisture simulated by the AussieGRASS model is well correlated with satellite derived estimates. Soil moisture estimates from AussieGRASS can be now made available for input to a Global Climate Model to improve model initialisation prior to forecast runs.

PRODUCTION STATISTICS

Statistics from the grazing industry can be used to check and calibrate model outputs. These data are useful at Statistical Local Area (SLA) to national scale. Wool production is perhaps the easiest to use at the SLA scale. Time series data of meat production are much more difficult to use (even at the State scale) in calibration because of lack of spatial integrity due to significant local and interstate movement of animals for fattening and slaughter. Knowledge of stocking rates and animal outputs can be used to ensure pasture growth is at least sufficient to provide for the observed animal production. Research aimed at predicting animal production is underway. In addition it is now possible to estimate methane emissions from livestock for greenhouse gas inventory purposes.

CLIMATE DATA AND APPLICATIONS

Climate records for the period 1890 to 1957 have not been available on a spatial basis due to the low number of stations available as digital data. The *Computerising the Australian Climate Archives* (CLIMARC) project has yielded digital data from an additional 50 stations back to about 1900. Interpolated surfaces of the new data are being generated and checked. AussieGRASS now has the capability to run an increased array of climate forecast systems and can produce statistical probability maps for different forecast systems.

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