Modelling and Data Assimilation With Remote Sensing and Oznet data

Robert Pipunic

Dept. of Infrastructure Engineering, The University of Melbourne

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Overview

- Motivation
- CABLE model/DA approach
- Experiments with remote sensing data for Kyeamba Creek and Yanco
- conclusions and issues identified

Motivation

- Data assimilation combines measurements and models for better hydrologic predictions on denser time-scales
- Research is required to maximise benefits for particular environments, data types, models
- Data assimilation has not been thoroughly tested with CABLE model (to be used in Australia's weather prediction system)
- Oznet provides opportunity for validating model/DA output and remote sensing data.

CABLE & Specs Relevant to Assimilation

- **Model forced at each time step by:**
  - Incoming short wave and long wave radiation;
  - Air temperature;
  - Rainfall;
  - Wind speed;
  - Specific humidity;
  - Air pressure.

- **Energy/water exchanges for vegetation and soil surfaces**

- **Soil Moisture and soil temperature for 6 soil layers are the prognostic state variables**
  - Traditional state updating applied with assimilation – no parameter optimisation.

Ensemble Kalman Filter (EnKF) used:

- **Ensembles of inputs used → Initial conditions, and forcing time series data (eg. Turner *et al*., 2008)**
    - Results in ensemble of model predictions for error covariance calculations

- **Model structure uncertainty not specifically treated, model or observation bias not addressed**

- **Observation ensembles → normally distributed random perturbations added to observation value**

Synthetic Twin Data Assimilation Experiment

- **Proof-Of-Concepts Study**

- **Investigate the assimilation of different remote sensing data types and their impact on CBM/CABLE**
  - Assimilate synthetically derived LE, H, soil moisture and skin surface temperature observations on remote sensing time-scales
  - Examine how different observations impact on key hydrologic variables.
  - Assimilation of fluxes produced better fluxes than soil moisture assimilation and vice versa

- **Published:**

  Pipunic *et al.*, 2008, Remote Sensing of Environment, vol. 112

One-D Field Data Assimilation Experiment

- Follow on from Synthetic-twin study, but with real field observations at point scale

- Assimilated into CABLE on remote sensing time-scales

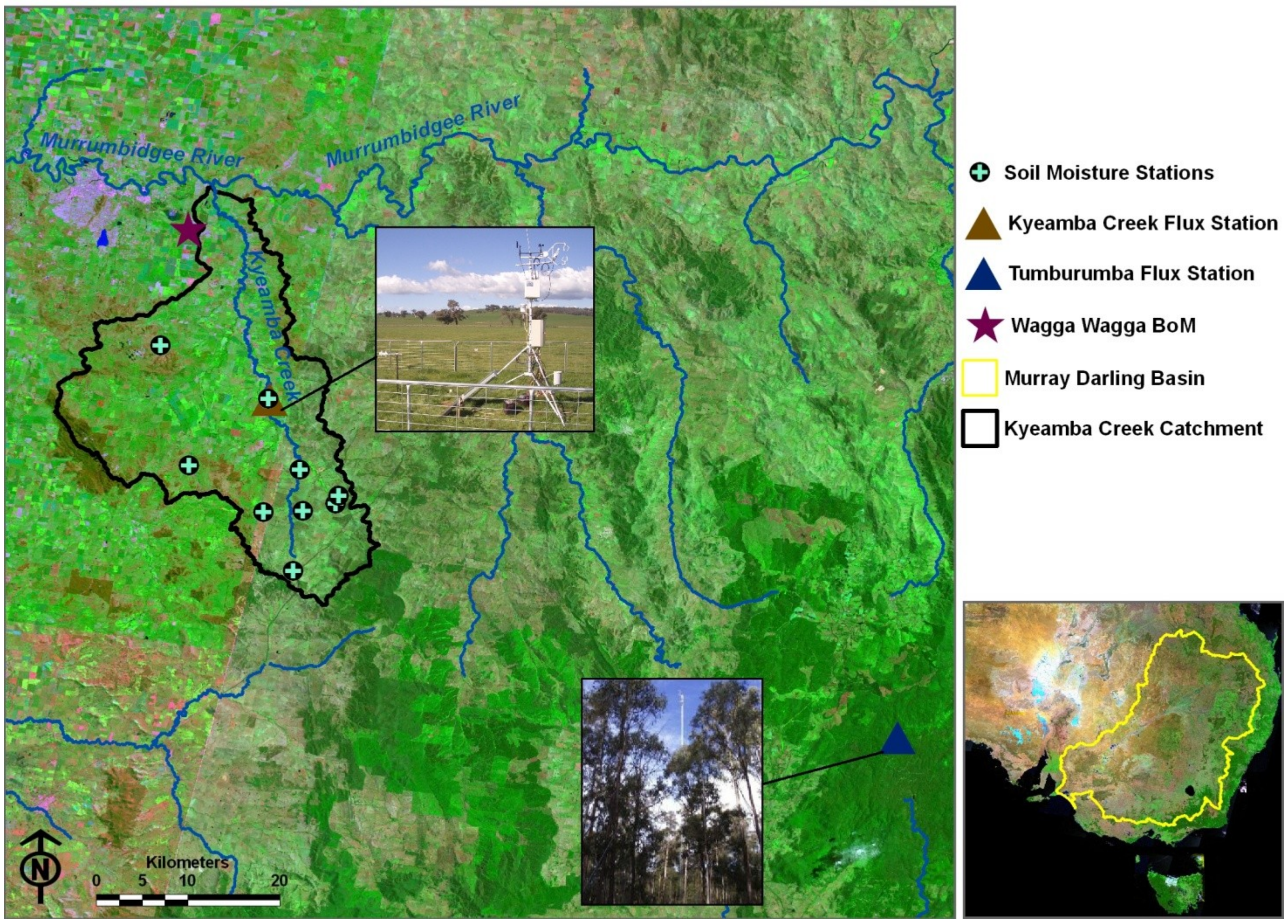
- Reinforced synthetic findings about CABLE → flux observations improved modelled fluxes best, surface soil moisture observations improve surface soil moisture best

- Highlighted limitations with the model.

- Submitted for Review

Pipunic *et al.*, 2011, to Remote Sensing of Environment

Kyeamba Creek – modelling/DA



- Shallowest surface moisture obs are 5-7cm
- profile observations are in 30cm intervals to 90cm
- Assimilated surface soil moisture product from AMSR-E (Owe et al., 2008)

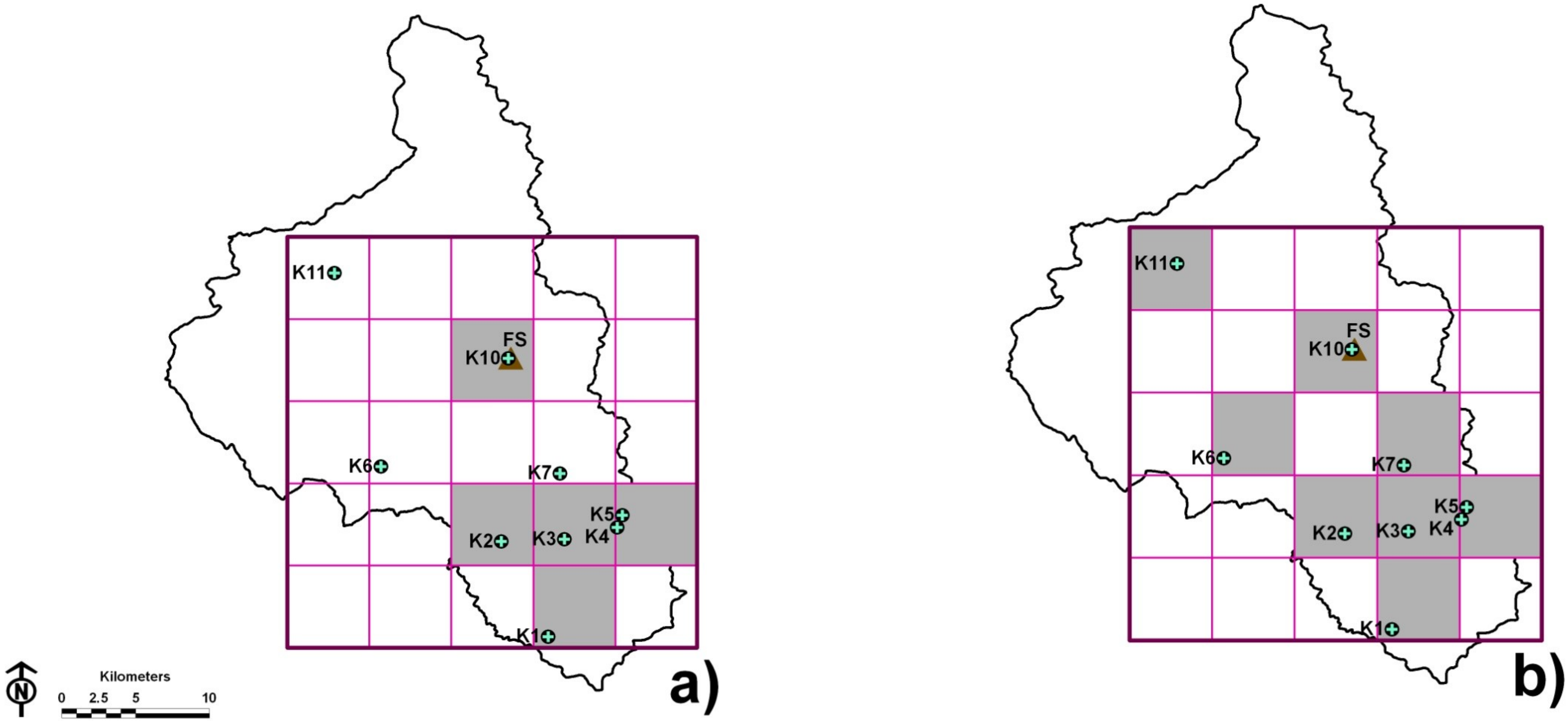
Kyeamba Creek – modelling/DA

- Assimilated surface soil moisture product from AMSR-E (Owe et al., 2008) provided on 25km resolution grid

- Observation is ~1-2cm of soil depth → assimilated into CABLE's top soil layer (2.2cm thick) once daily with ~2am local overpass observation

- Model simulation run at 5km resolution over a single 25km AMSR-E pixel domain → Used a single set of forcing data, soil parameters from detailed regional mapping, LAI 1km x 1km resolution derived from AVHRR fPAR data

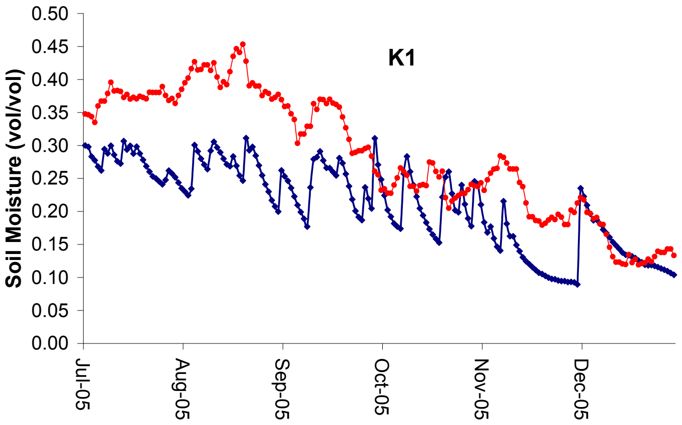
Kyeamba Creek – modelling domain

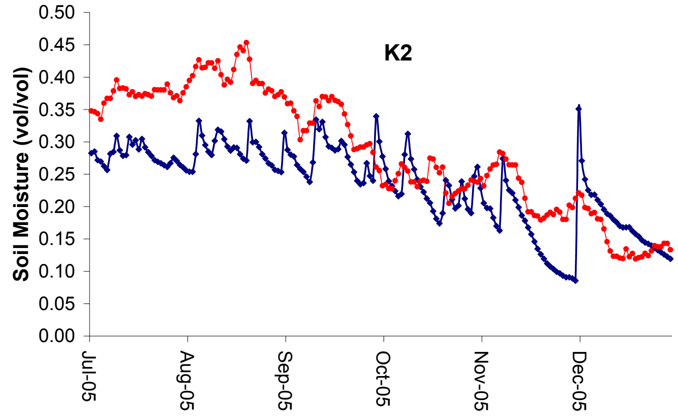


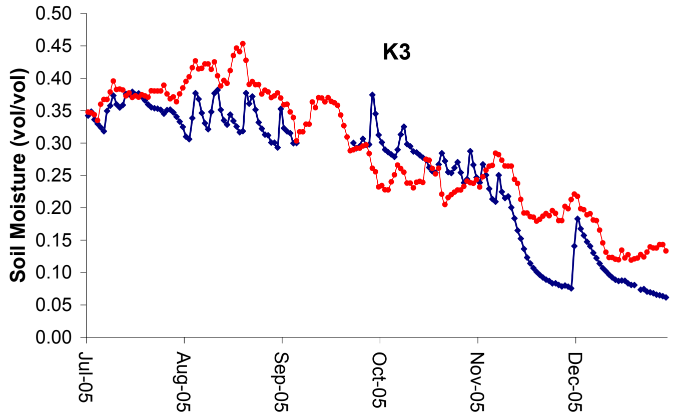
a) Available surface moisture

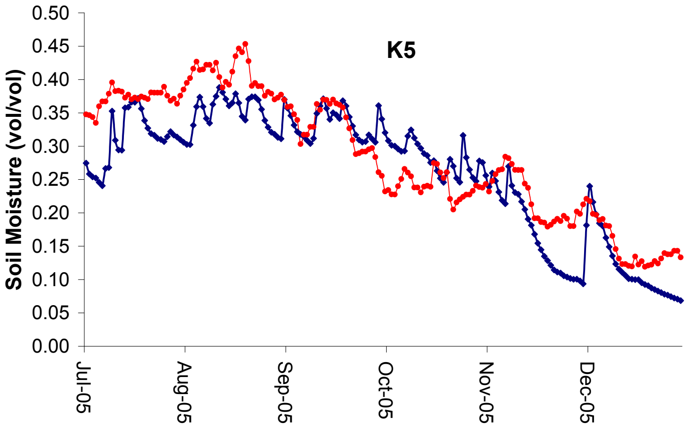
b) Available root zone (0-60cm) Moisture

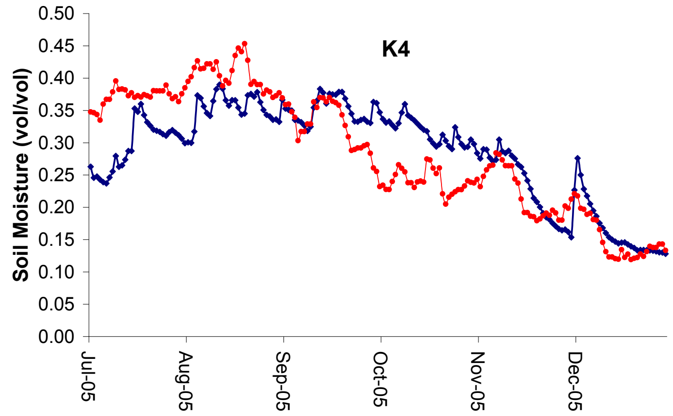
Kyeamba Creek station sites – AMSR-E Red, In-situ surface Blue

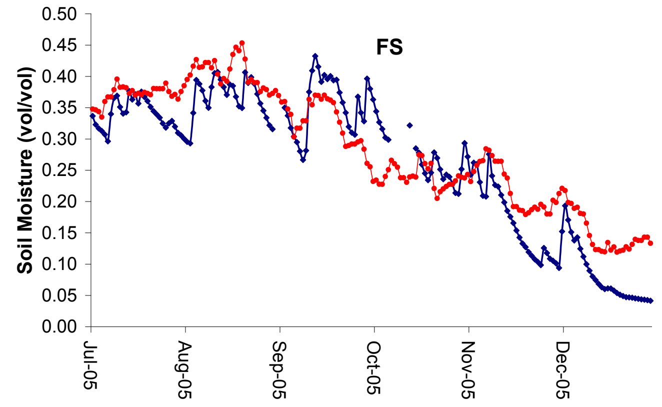






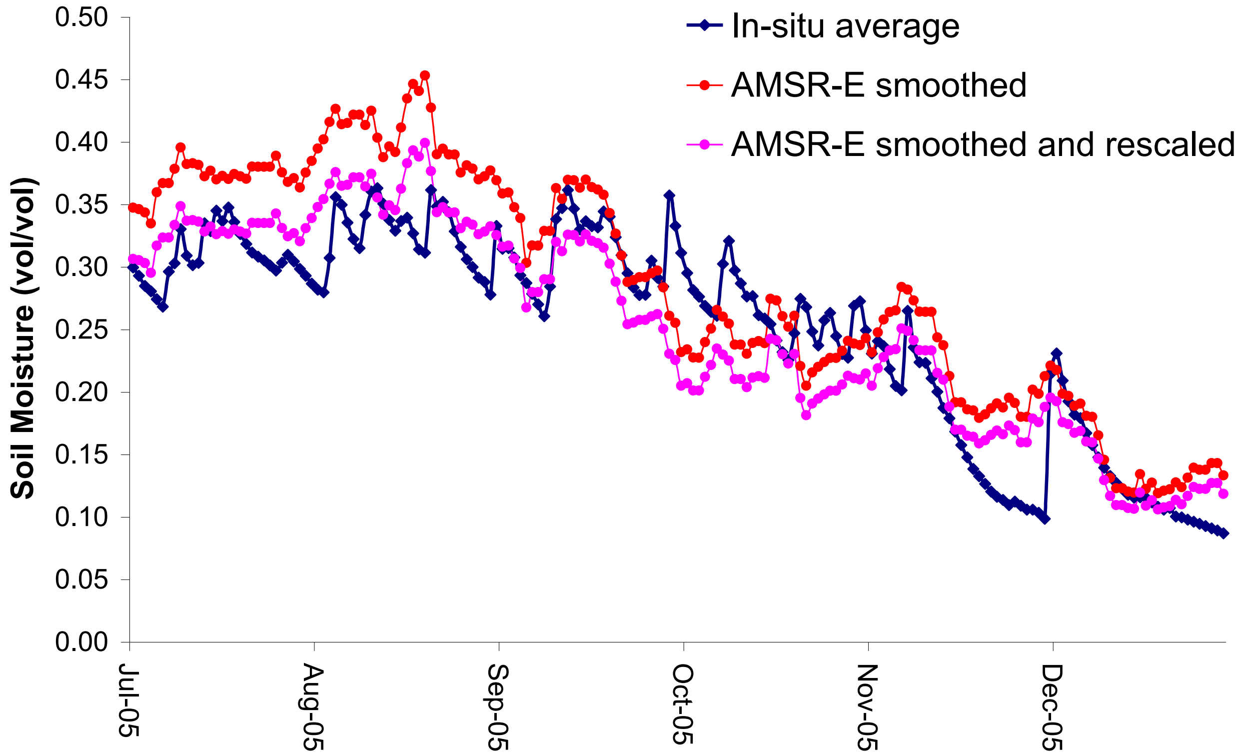




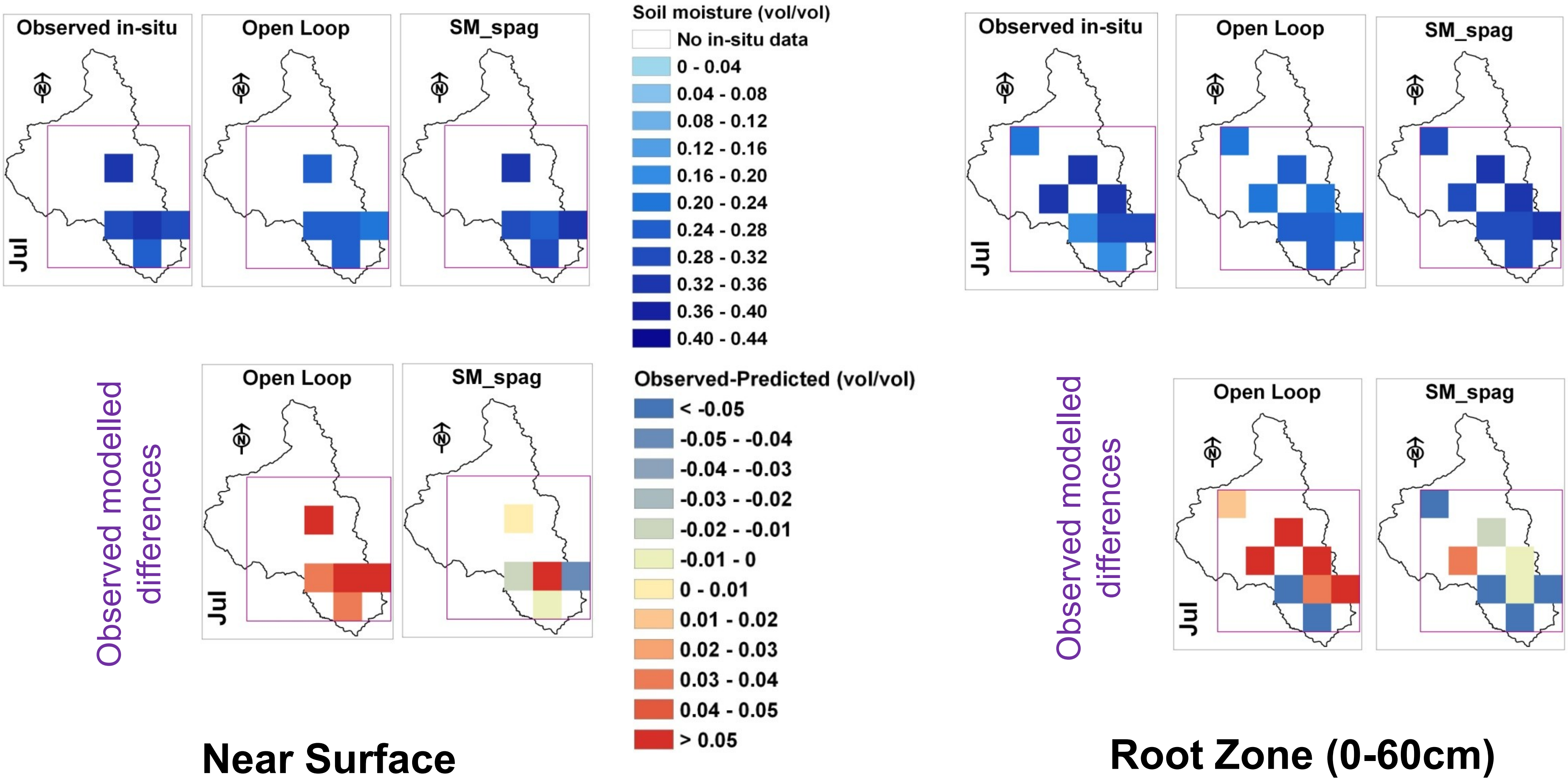


Kyeamba Creek

- AMSR-E was rescaled so that mean and variance matched that from the average of all available in-situ surface soil moisture observations (Draper et al., 2009).
- These were the observations assimilated.



Kyeamba Creek – Surface soil moisture results



Data Assimilation – Remote sensing, Oznet

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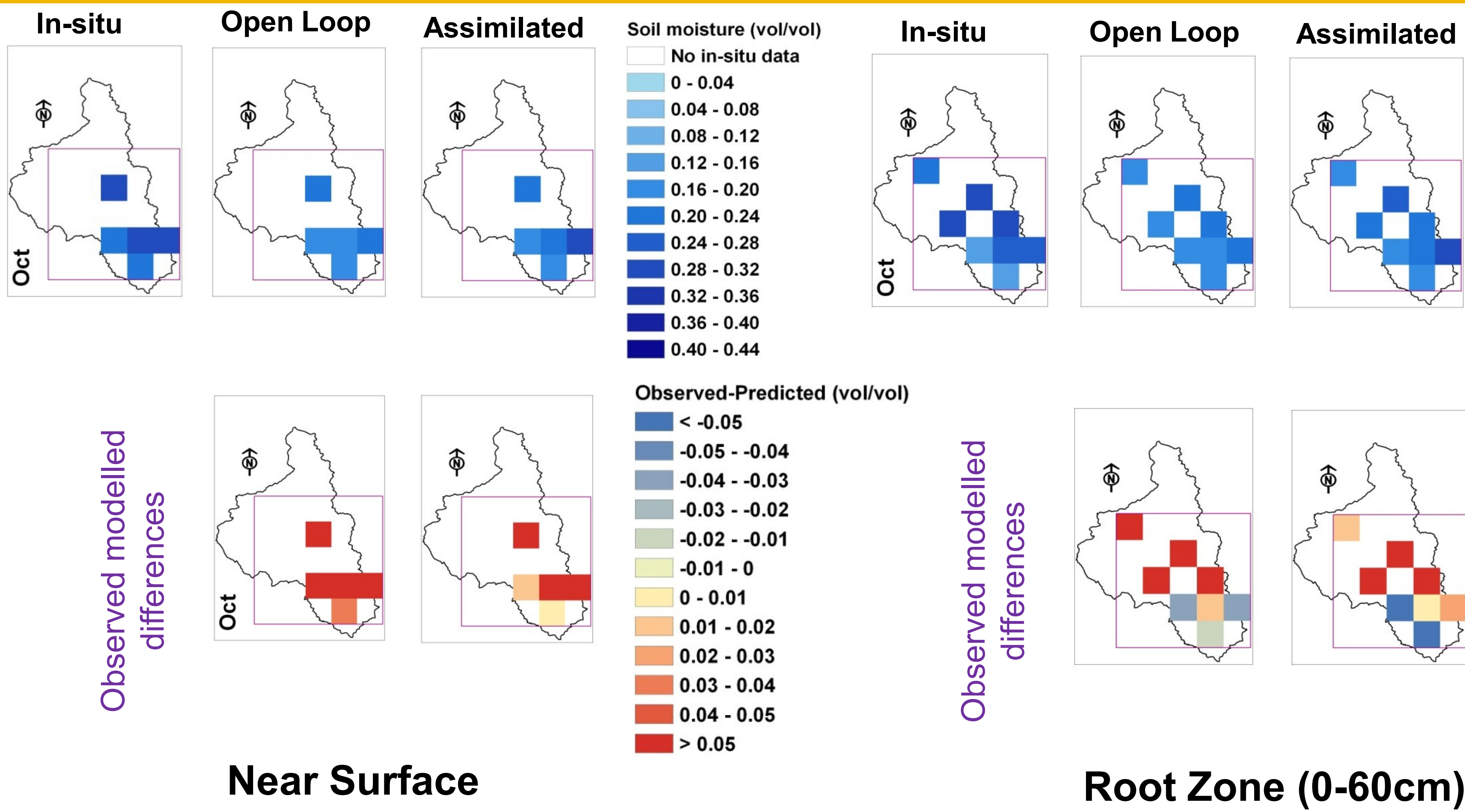
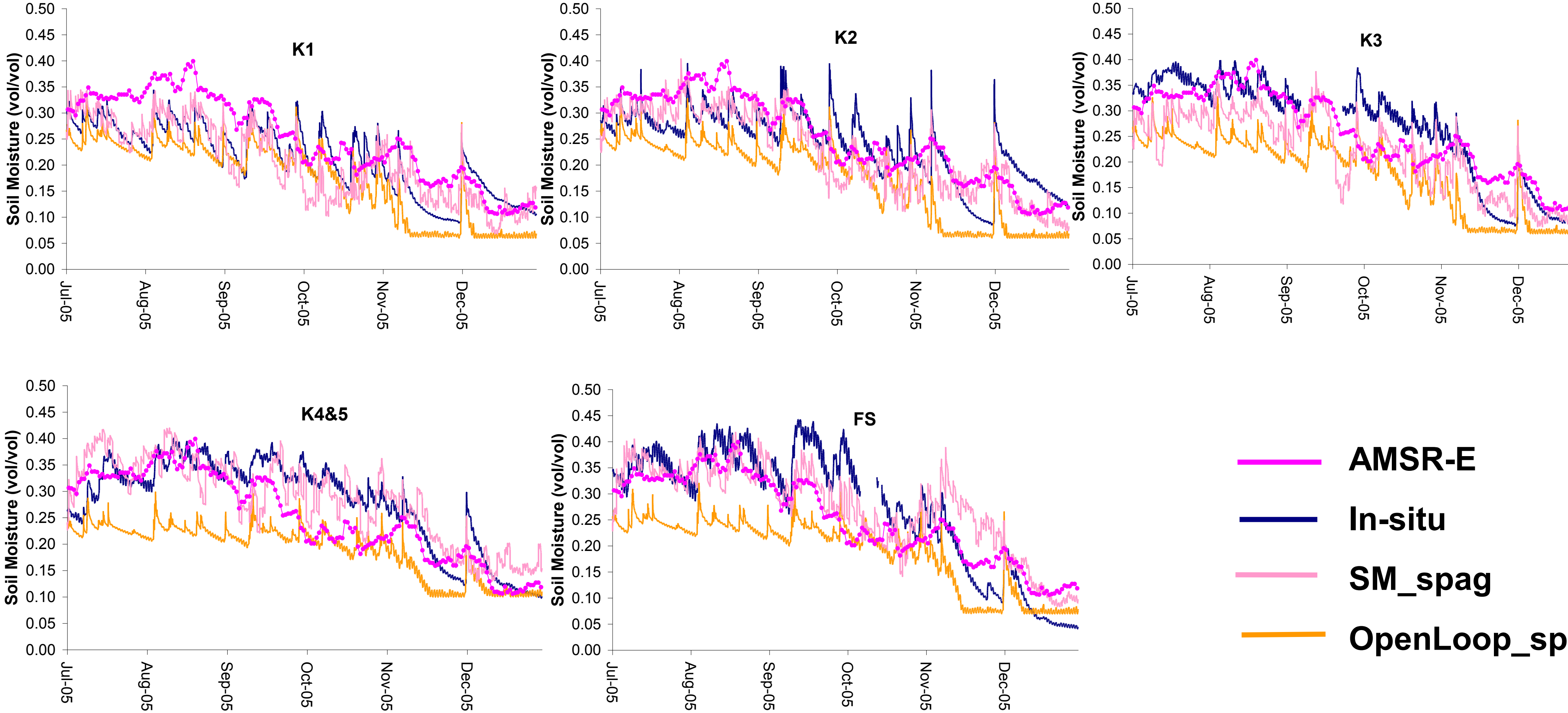
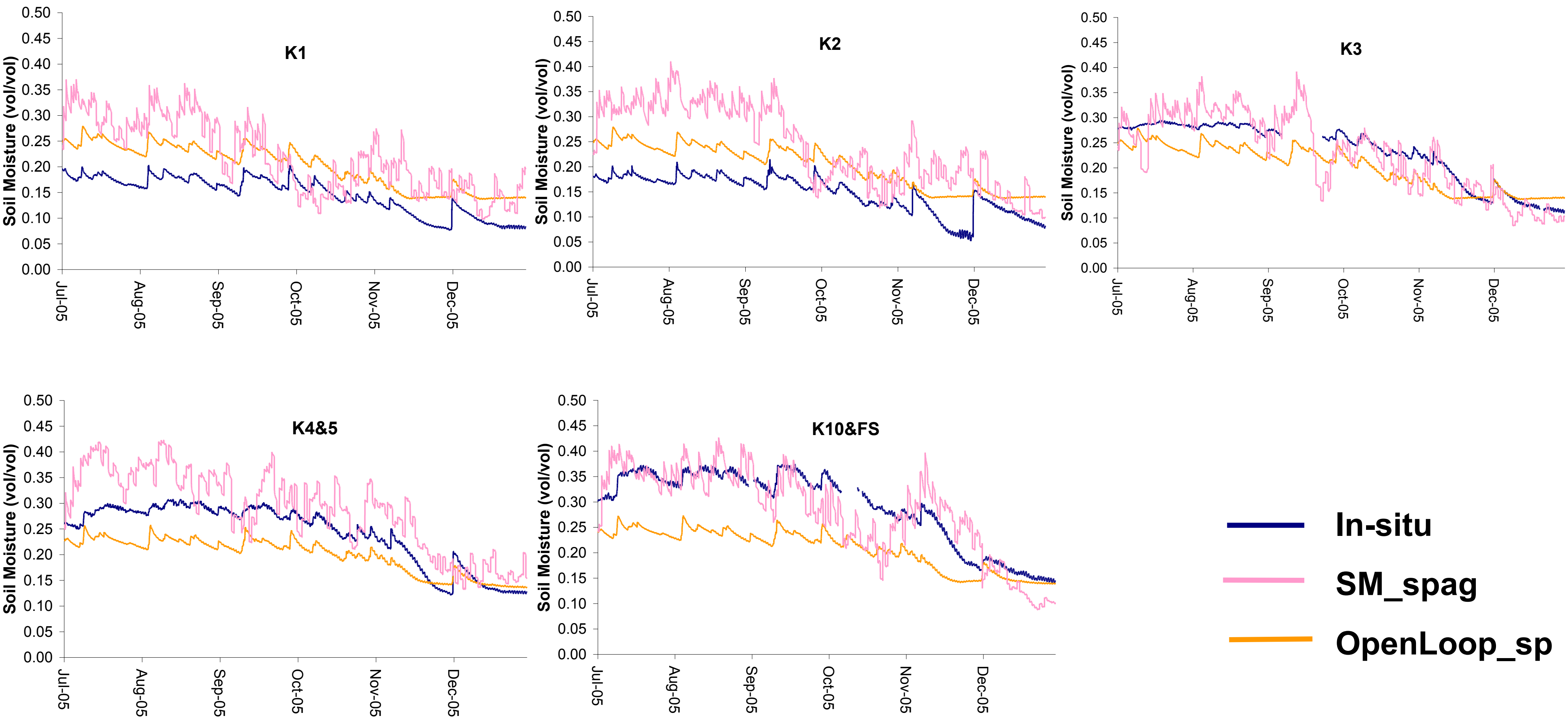


Kyeamba Creek station sites – near surface



Kyeamba Creek station sites – Root zone (0-60cm)



Yanco Area

Eddy Correlation x 2

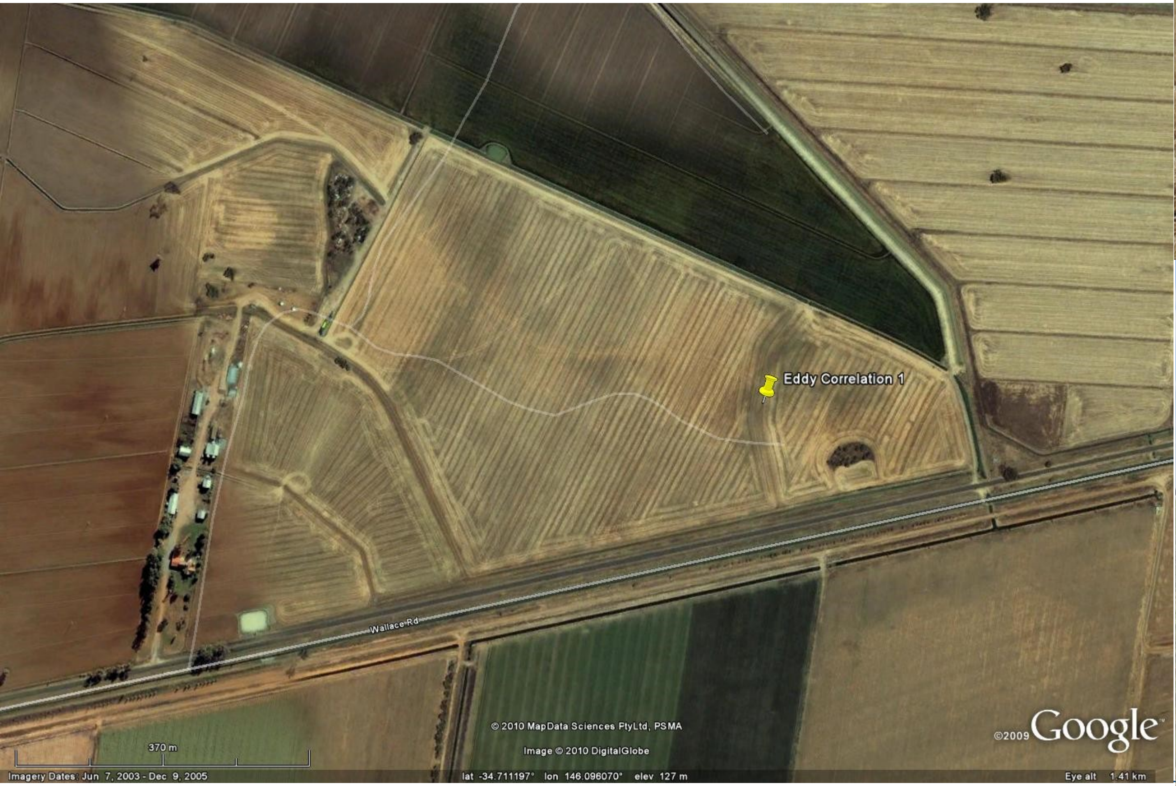
- 30min average, minimum 1 year operation.
- Net radiometers.
- Ground heat flux.
- Soil moisture and temp.
- Met variables: air temp, RH, Wind speed.

- Plus additional soil moisture, optical data from airborne surveys and short term ground surveys such as SMAPex and AACES campaigns.

Eddy Correlation1: Winter crop

Running since Early January 2010

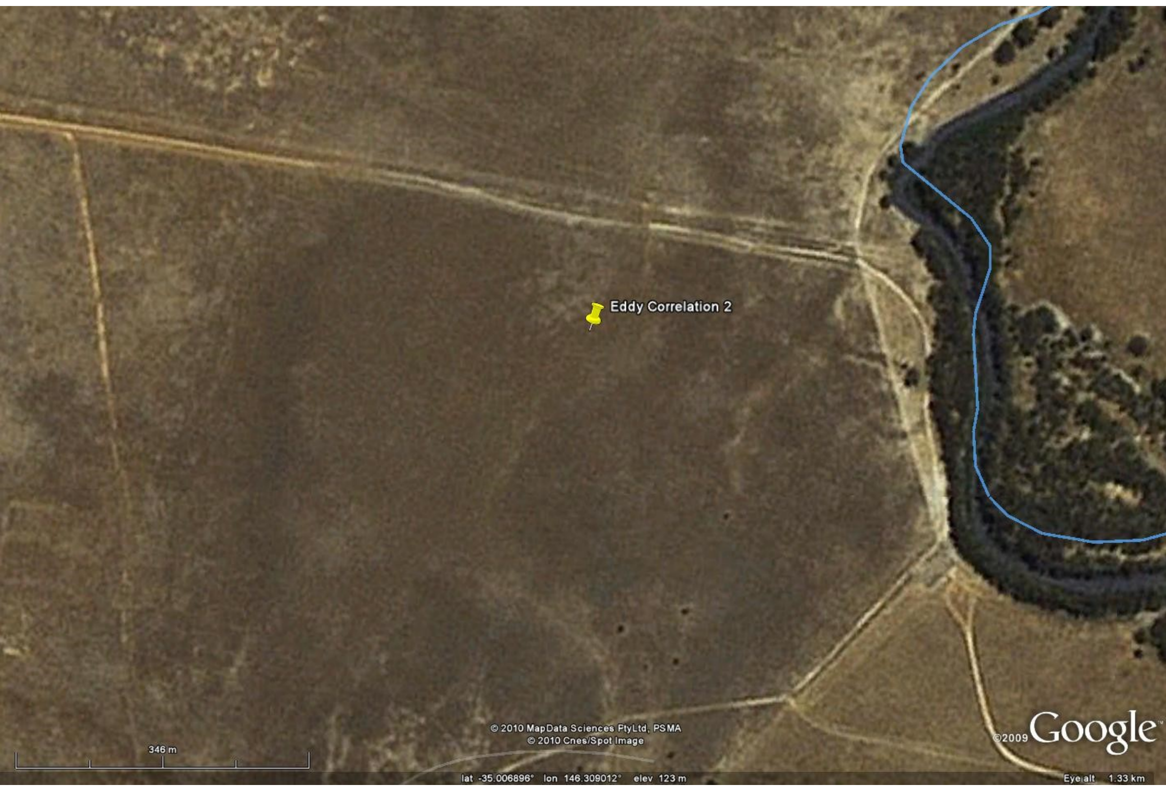
- Winter cereal crop site.
- EC ~3m high.
- Gap from April to August (~4months)

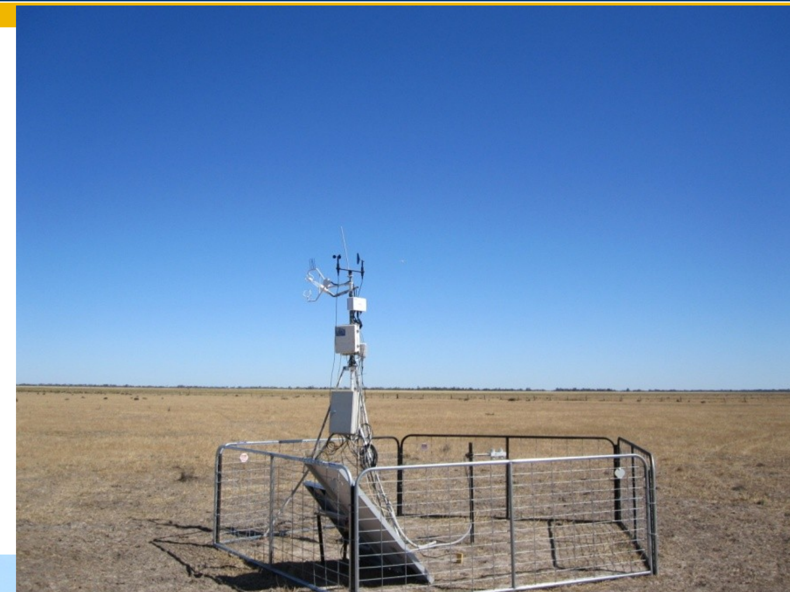


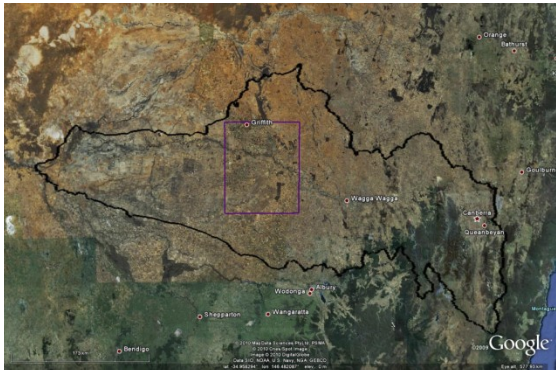
Eddy Correlation2: Dryland pasture area

Running since late November 2009

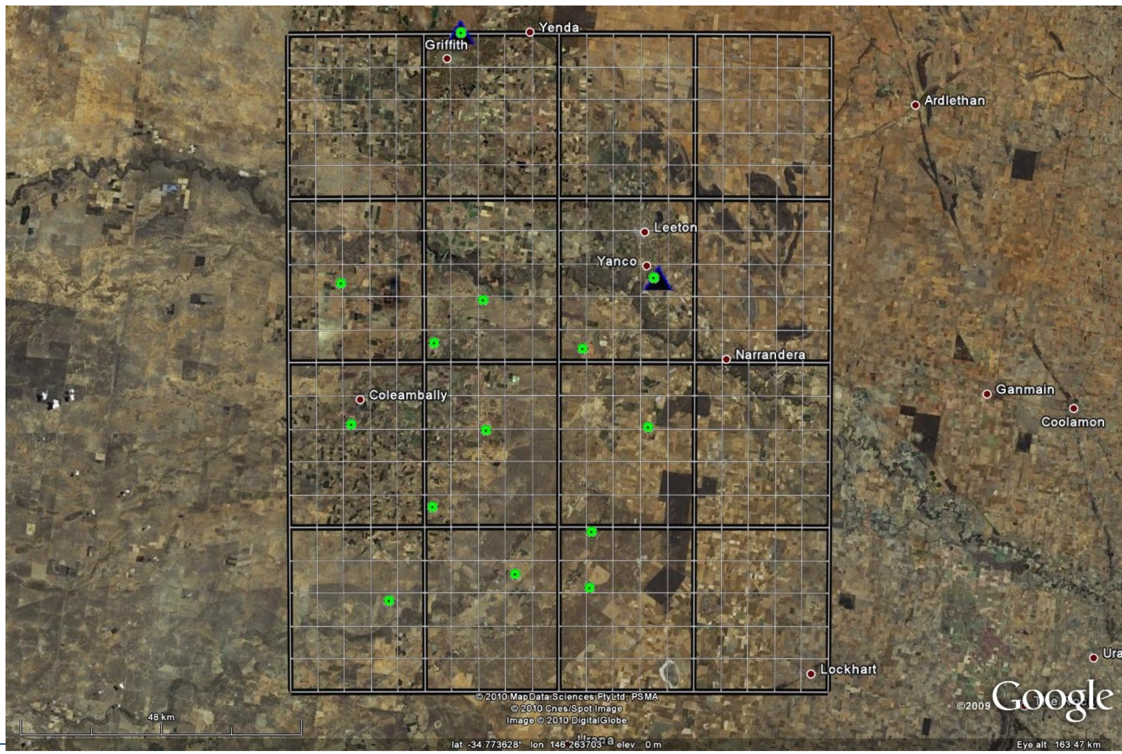
- Non-irrigated grazing pasture land.
- EC ~3m high.







Modelling/Data Assimilation domain - Yanco area



Different Model Inputs

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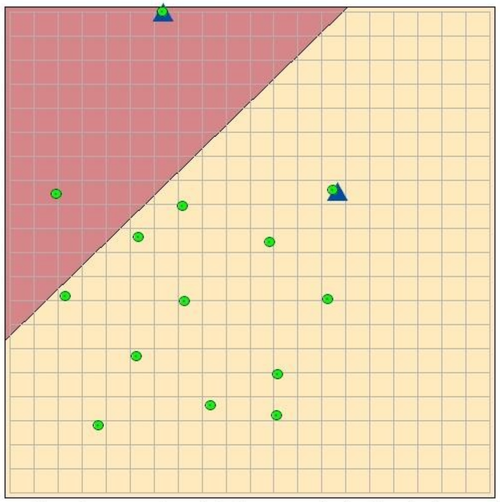
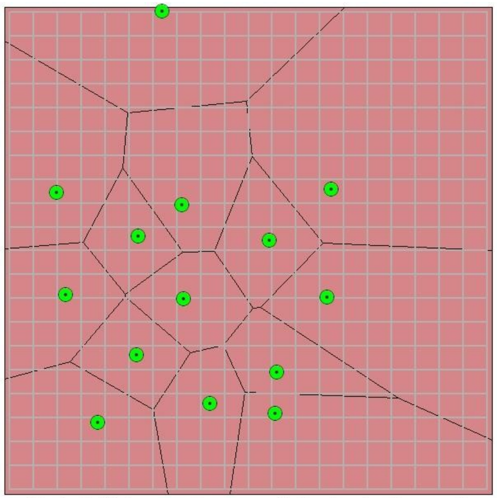
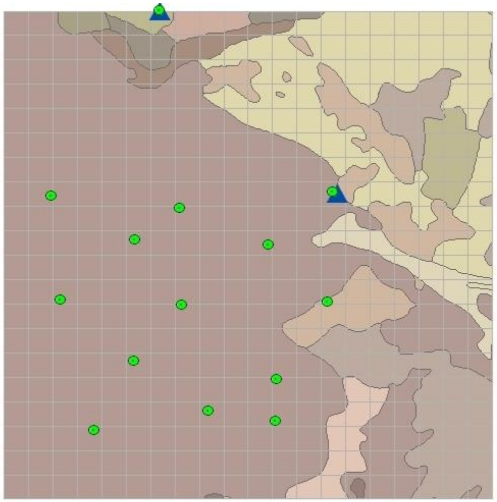


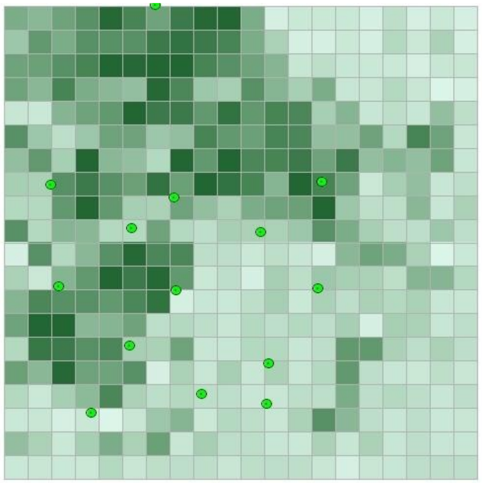
Forcing (except rain) for model pixels based on zones for the two meteorological stations



Rainfall input for model pixels based on zones for rainfall stations

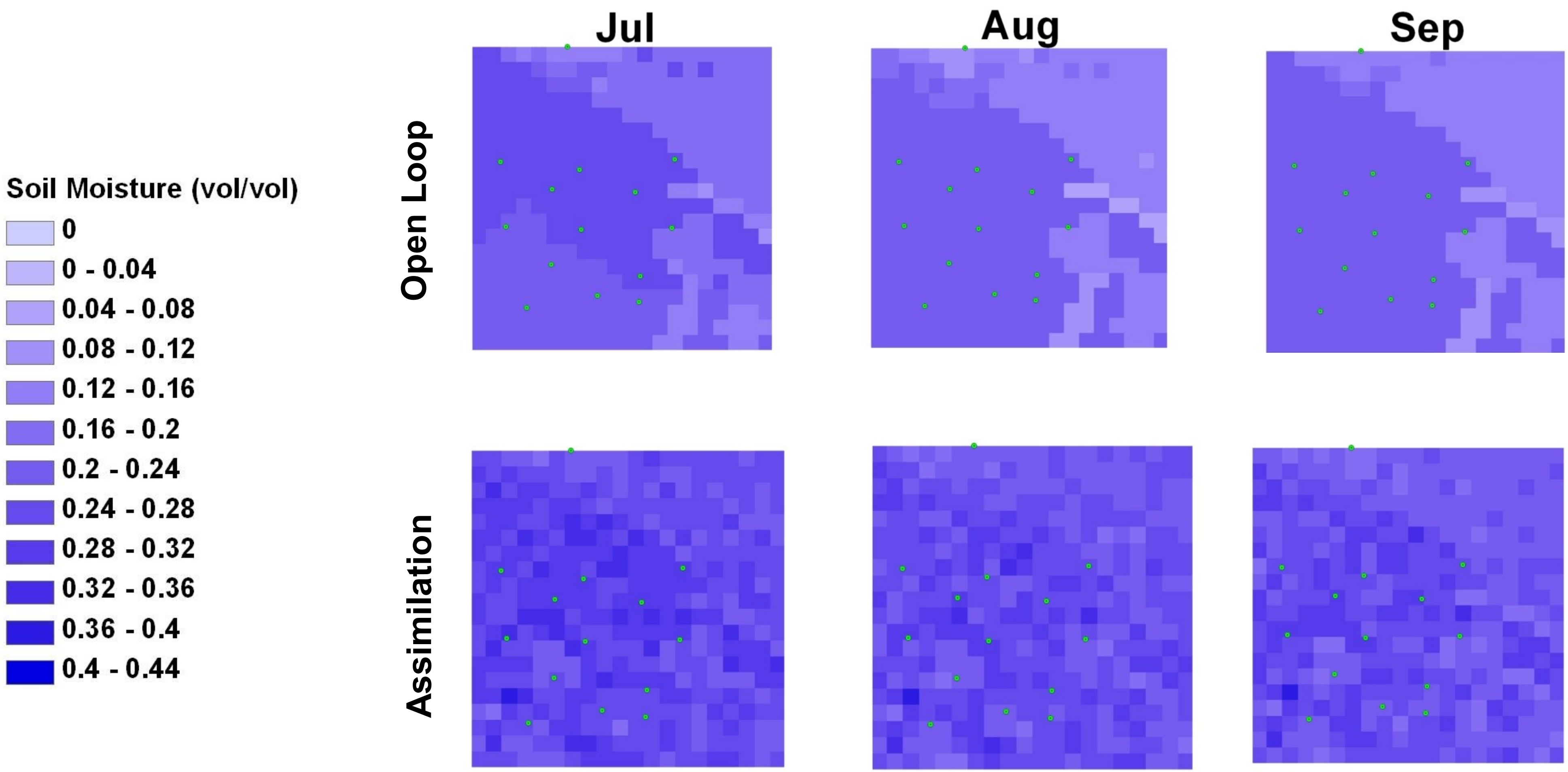


Map of Australian soil units from McKenzie et al., 2000 for soil parameters



Monthly LAI - derived from 1km AVHRR fPAR data derived by Donohue et al., 2008
January shown here: lightest (0.4) darkest (2.9)

Model Outputs of surface soil moisture



Summary

- A distributed network of in-situ measurements such as from Oznet that can be carefully monitored and calibrated are crucial for validating Remotely sensed products and model predictions...

- Continued efforts to better understand within pixel variation are needed, given scale mismatch between in-situ and remotely sensed data

- Attention needs to be paid to certain model structures to address limitations to improving root zone soil moisture from surface moisture assimilation such as is available from satellite information.