AWRA-L and CABLE modelled Tb using CMEM

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A water information R & D alliance between the Bureau of Meteorology and CSIRO’s Water for a Healthy Country Flagship
Microwave brightness temperature modelling

• Add microwave brightness temperature (Tb) modelling component to AWRA-L
  • Forward model Tb from AWRA-L top-layer surface soil moisture estimates
  • Observation model to assimilate Tb’s (V/H polarisations)

• Investigation into use of satellite Tb as an indirect verification for modelled soil moisture estimates over large parts of the continent.
  • AWRA-L Vs CABLE surface soil moisture
  • MDB study area; Jan-Feb, Sep 2010
  • AACESS field campaign across MBG
Modelled soil moisture fields from:

CABLE
- Community (CSIRO?) Atmosphere-Biosphere-Land Exchange model
- Land surface model (LSM)
  - Use in NWP models & GCM
- Feeds into:
  - BoM ACCESS coupled model
- Design principle:
  - Climate and earth system simulator modelling energy, water & carbon cycles

Does hydrology well?
- Okay, but getting better
  (Haverd & Cuntz, 2010: J Hydrol., doi:10.1016/j.hydrol.2010.05.029)

AWRA-L
- Australian Water Resources Assessment model – Landscape
- Hybrid LSM & lump catchment model
  - Focus on water balance
- Developed for:
  - BoM national water accounts
- Design principle:
  - Comprehensive spatial water balance, with national coverage & local usefulness

Does hydrology well?
- Yes, and getting better
Spatial structure:
• grid based, variable resolution
• **daily time step**
• fractions of hydrological response units (HRUs)

Forcing:
• precipitation & short-wave radiation (~5km blended station-satellite products)
• optional: other atmospheric variables (currently temperature)

Processes
• 3 unsaturated stores (simplified Richards’ scheme)
• Linear groundwater and surface water stores
• ET: Penman-Monteith or Priestley-Taylor; limited by root water uptake
• Vegetation cover adjustment towards equilibrium (potential transpiration = water uptake)
CMEM – *almost* off-the-shelf runs for MDB

- **Community Microwave Emission Model (CMEM)**
  - Built on LSMEM and L-MEB; Tb modelling 1-20 GHz
  - **Attraction:** one package to test different soil dielectric, surface roughness, & veg OD models

- **Parameterisation for the Murray-Darling Basin (MDB)**
  - **Models** (follows de Rosnay et al, 2009: *J Geophys. Res.*, 114,D05108)
    - Soil dielectric: Mironov et al. 2004
    - Veg opacity: Kirdyashev et al. 1979
  - **Spatial inputs (static/slowly evolving)**
    - % sand & clay – Soils atlas (McKenzie & Hook)
    - Geopotential: Enhanced STRM DEM (Gallant et al, CSIRO Land & Water)
    - Veg type: IGBP
    - LAI: MOD15A2 – monthly averages

- **Dynamic inputs**
  - Tair: Modelled from Tmin/max interoplated surfaces (AWAP)
  - CABLE - Tskin, Tsoil (x3), SM (x3) – soil layer thickness: 2.2, 5.8, 7 cm.
Modelled TbV – Jan & Feb 2010

AMSR-E (A ~2 pm)

AMSR-E (D ~2 am)

CMEM software (ECMWF)

Vertically-polarized brightness Temperatures (Tb) from CABLE SM

5-km resolution

1 Jan – 28 Feb 2010

MIRAS (~6 am)
Comparison with AMSR-E Tb’s

Catchment average Tb (modelled & observed) for Murrumbidgee 1 Jan – 28 Feb 2010
Comparison with AMSR-E Tb’s

Difference in AMSR-E & CMEM modelled Tb_V

2010-10-19 2pm EST

RMSE = 15.2 K
MAD = 3.0 K
Bias = -14.9 K
SD = 2.9 K
Land surface temperature

(a) CABLE LST
- Complete/continuous coverage
- Hindered by “poor” model inputs

(b) MTSAT-1R LST
- Retrieved product
- Gappy in spatial & temporal coverage
Microwave brightness temperature modelling

• Next steps
  • CMEM modelled Tb from AWRA-L soil moisture
  • Process AMSR-E and MIRAS Tb observations
  • Experiment with some different inputs (e.g. MTSAT-1R LST’s) and parameterisations
  • Comparisons with in situ (modelled L-band Tb) & PLMR across the Murrumbidgee

• Down the track …
  • Sensitivity to different static & dynamic model inputs
    • Soil profile temperature and moisture fields
  • Strip down CMEM components for incorporation into AWRA-L