Impact of Buildings and Trees on Temperature Forecasts

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CABLE WORKSHOP 2013

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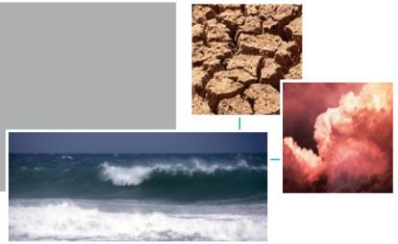
Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

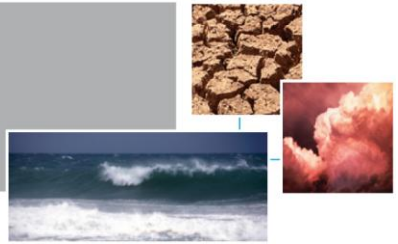
CSIRO

Context



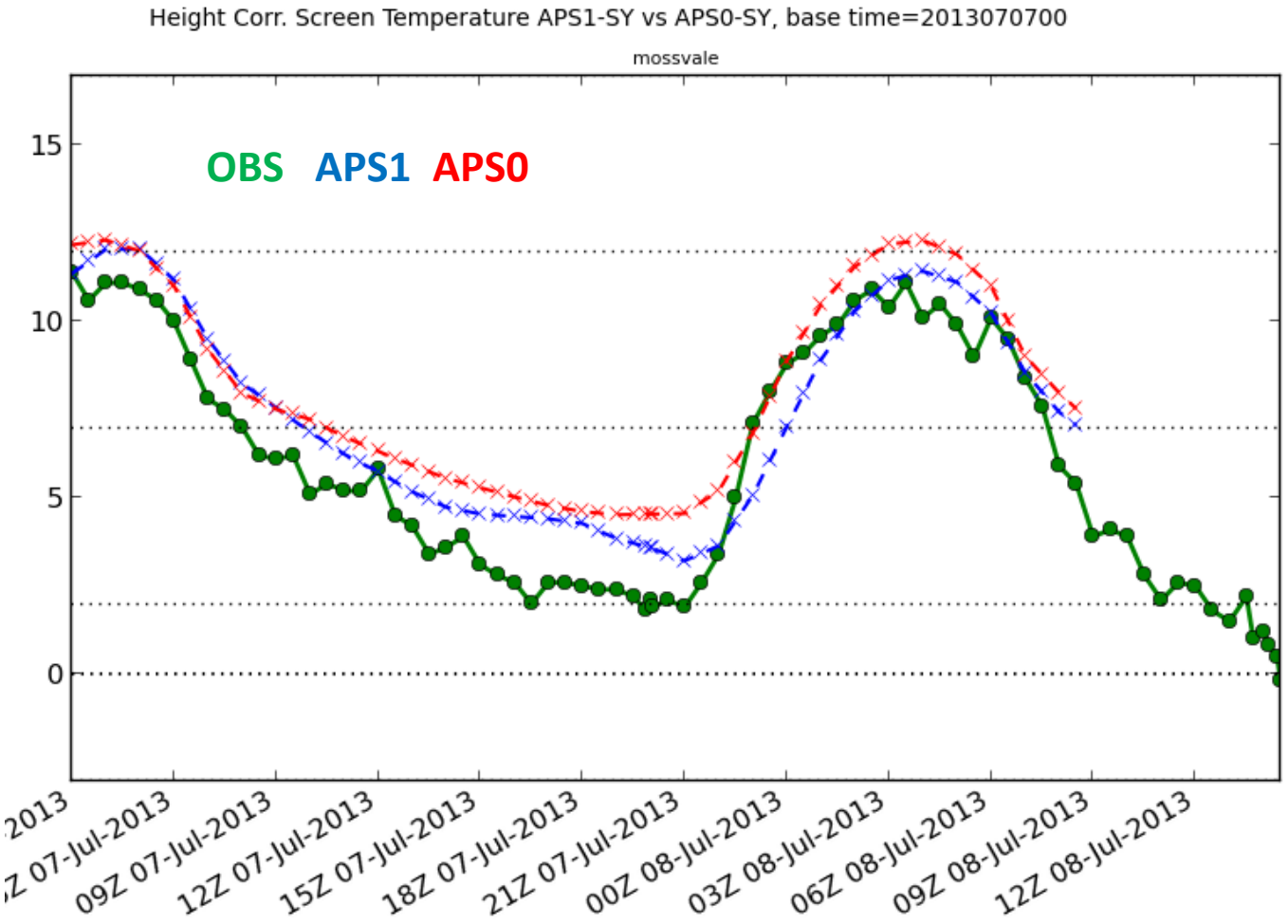
- Ideas in this talk may be relevant to many implementations of ACCESS
  - Climate Model
  - Global Numerical Weather Prediction (~20 km)
  - Regional NWP (~10 km)
  - City NWP (~1 km)
- Results shown in this talk are for the high resolution (~4 km horizontal) Sydney City model
  - NWP models use the MOSES2 land surface model
  - SY-APS0 based on UM6.4 (2008)
  - SY-APS1 based on UM7.6 (2011)

The Problem

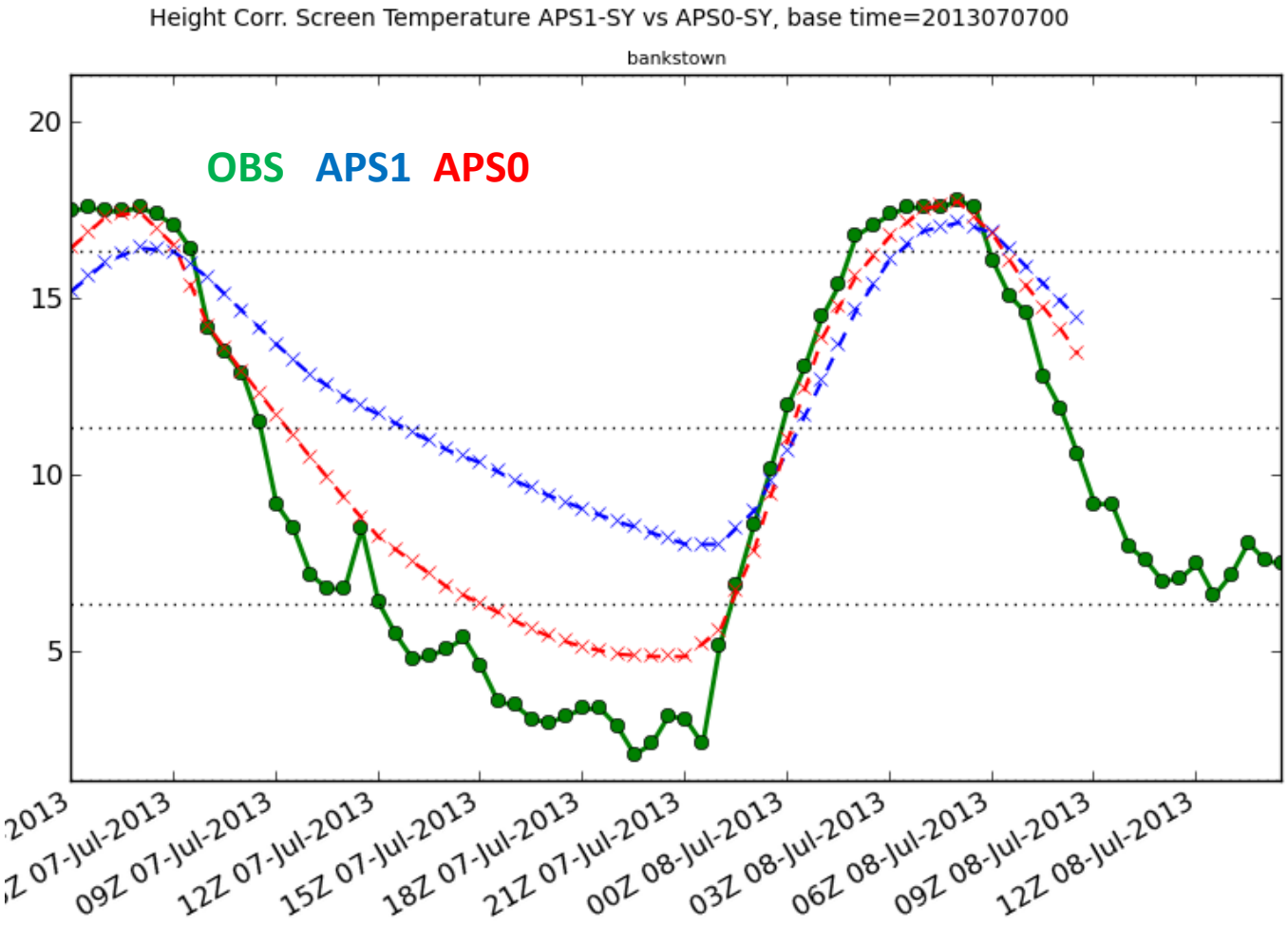


- APS0-SY provides significantly better forecasts than APS1-SY for screen level (2 meter) temperature
- For rainfall and screen level humidity forecasts, APS1-SY is better or similar

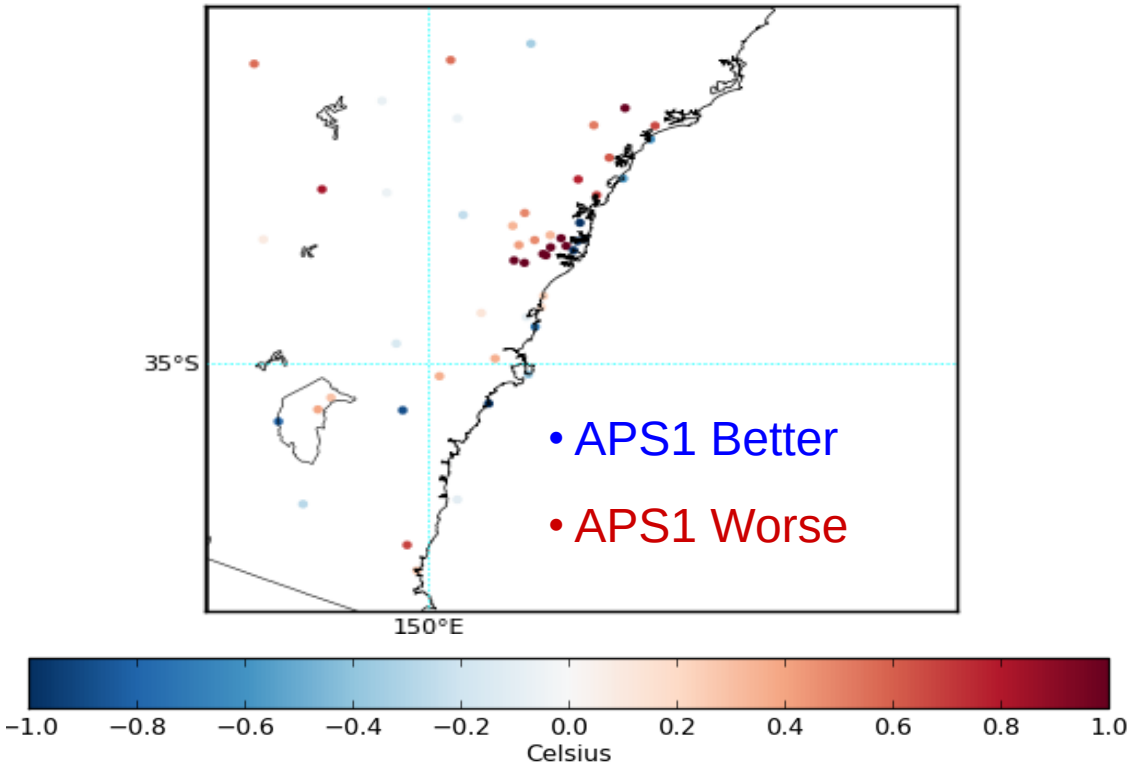
Good: Mossvale station – APS1 better



Bad: Bankstown station – APS0 better



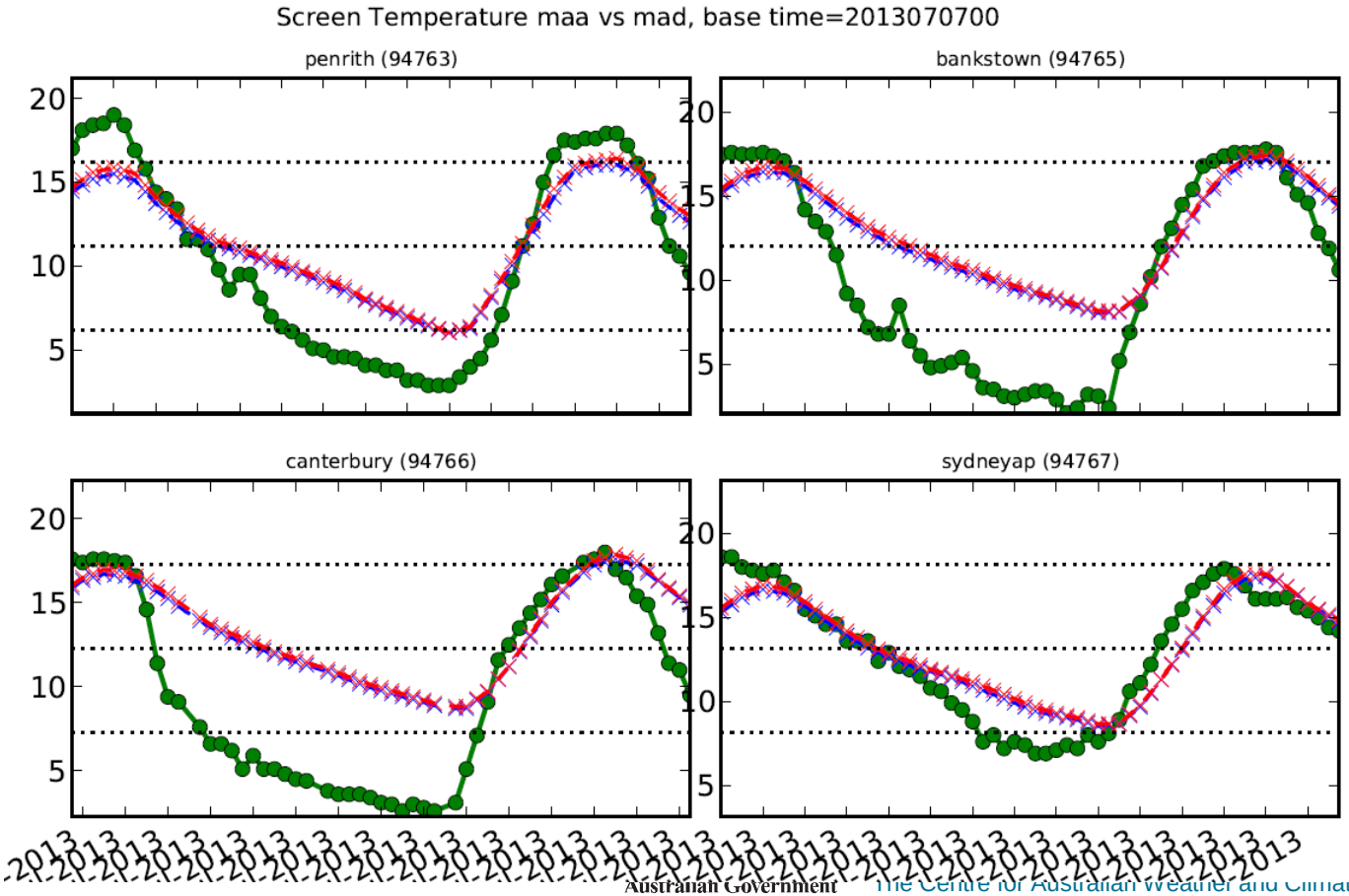
Ugly: RMSE difference APS1 minus APS0



APS1 problems are **not** due to soil moisture

- Experiment performed where APS1 model run with APS0 soil moisture and soil ancillaries

OBS **APS1** **APS1 model w APS0 soil moisture/ancils**

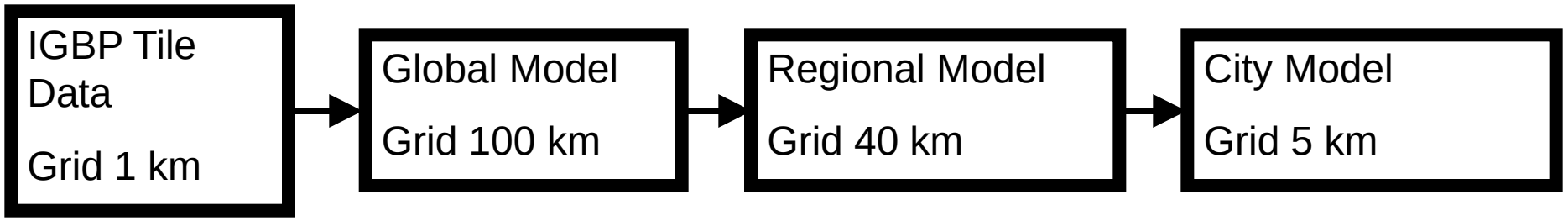


Differences in APS1/APS0 Urban and Trees Tile Fractions

	APS1		APS0	
	Urban	Trees	Urban	Trees
Mossvale	**1%**	**71%**	**0%**	**65%**
Bankstown	**67%**	**20%**	**3%**	**77%**

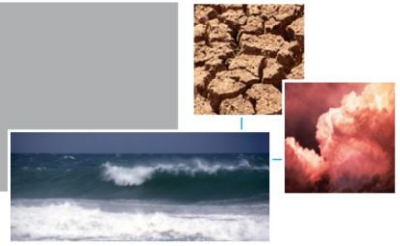
- Mossvale (Good verification results) shows little change in Tile fractions
- Bankstown (Bad verification) has significantly greater Urban tile fraction in APS1 Model

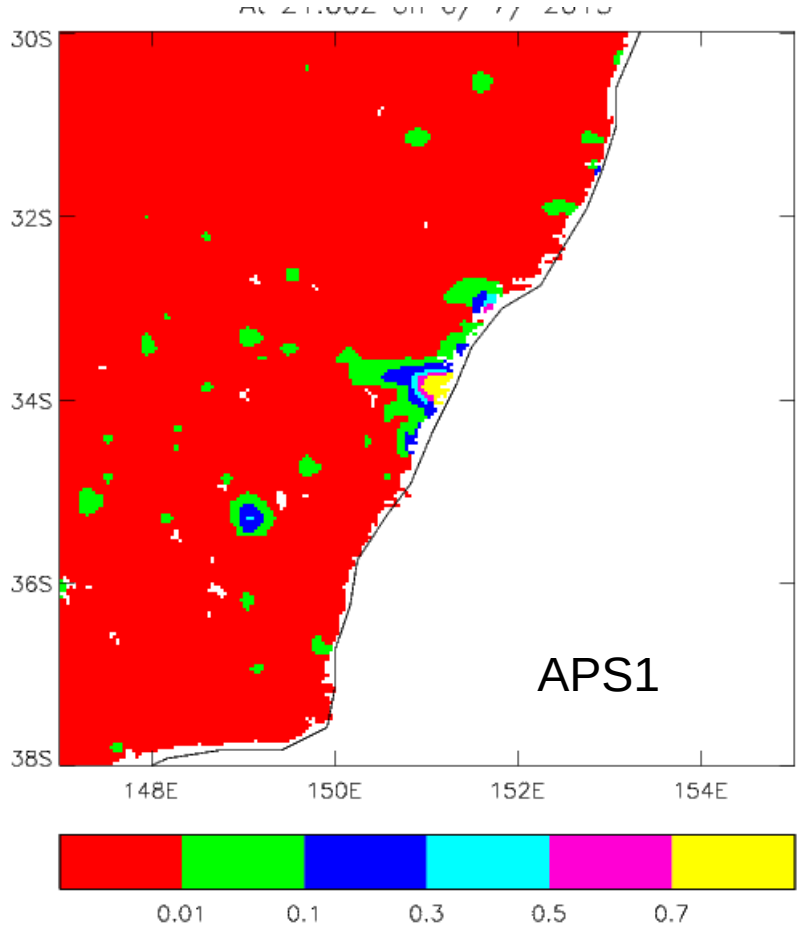
APS0 uses Blurry Interpolation for Tile Fractions

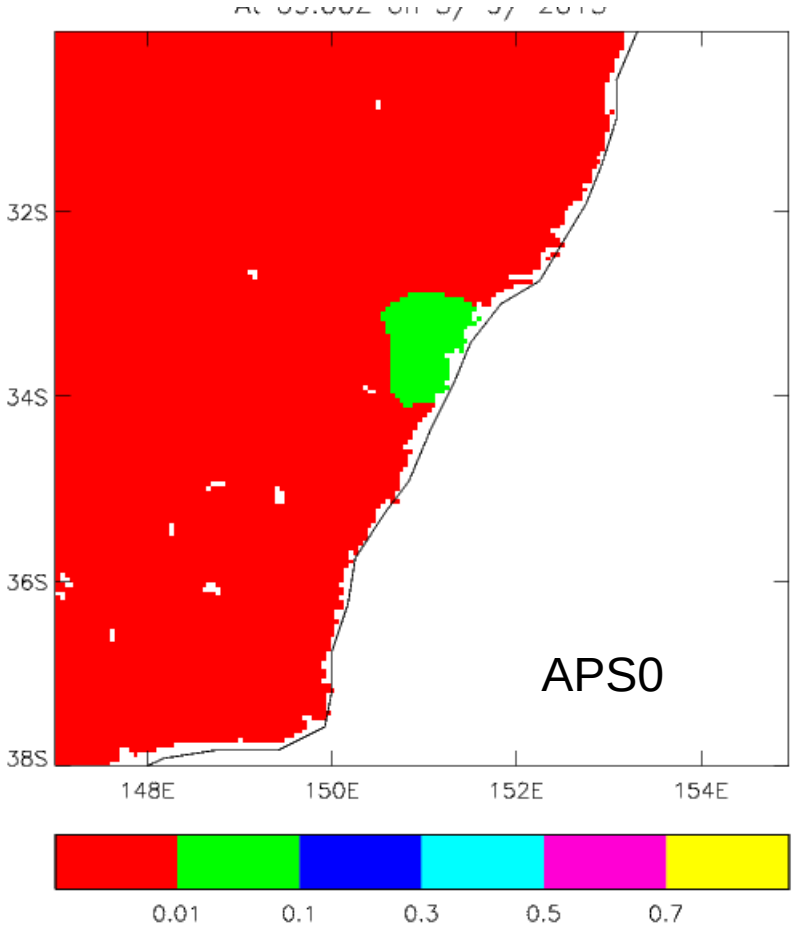


- Blurry Interpolation causes very large reduction of Urban and Sub-Grid Lake tile fractions
- Blurry Interpolation causes Trees near the coast to become significantly shorter

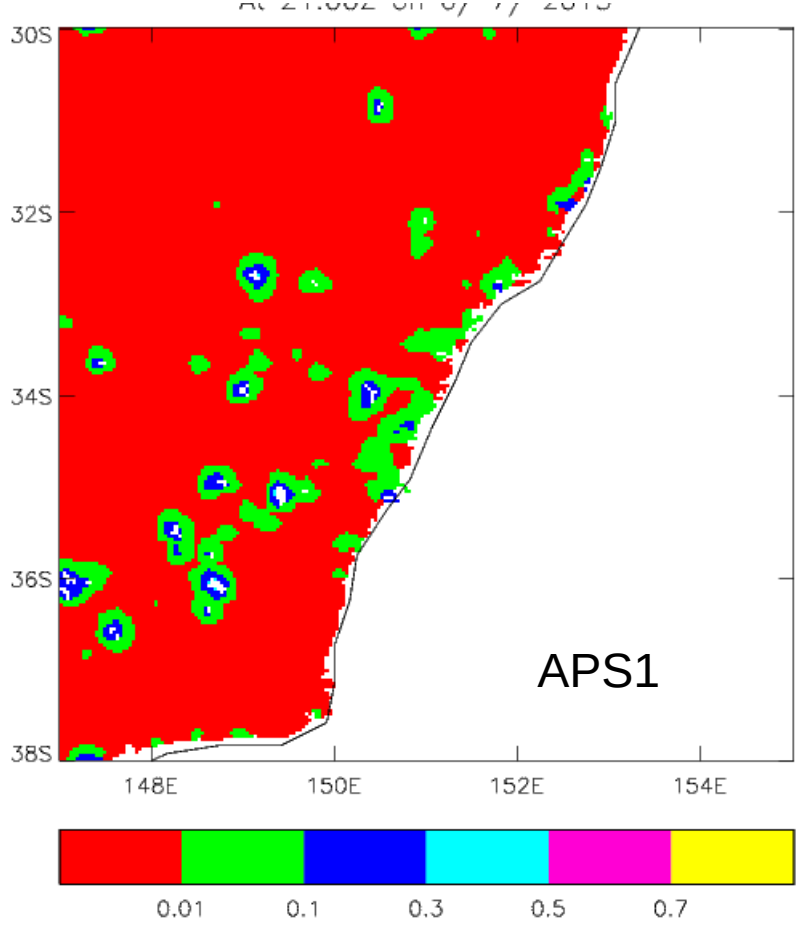
Urban Fractions Much Higher in APS1

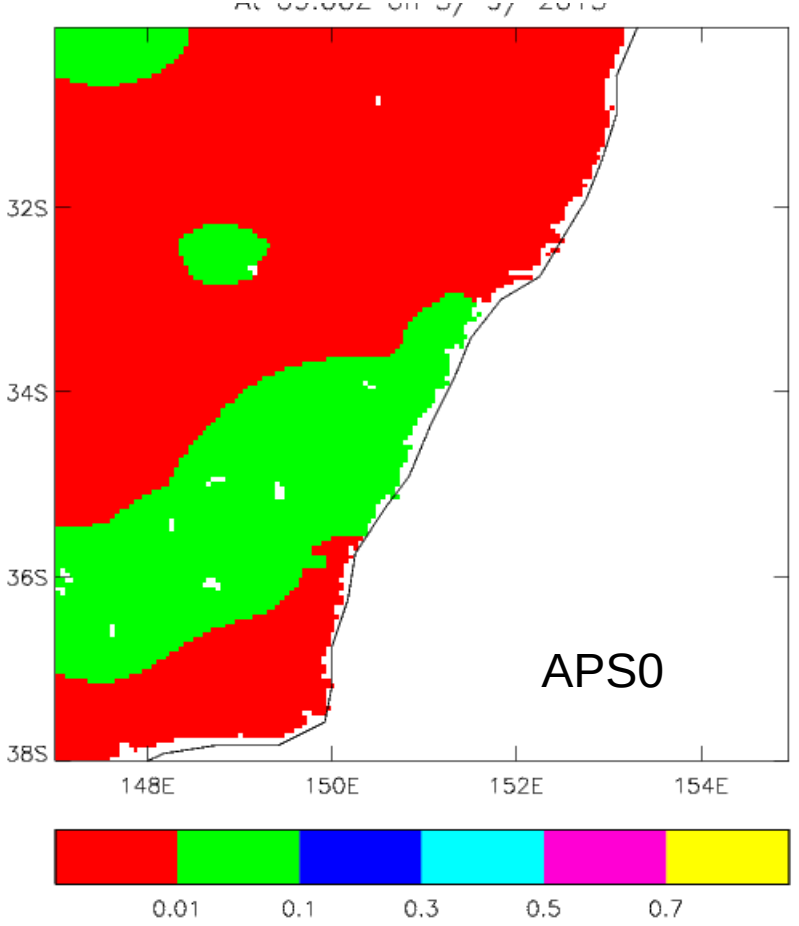




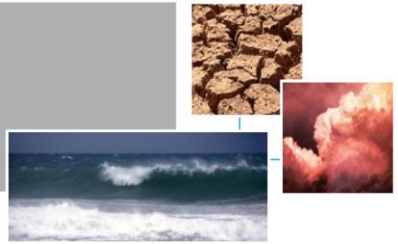


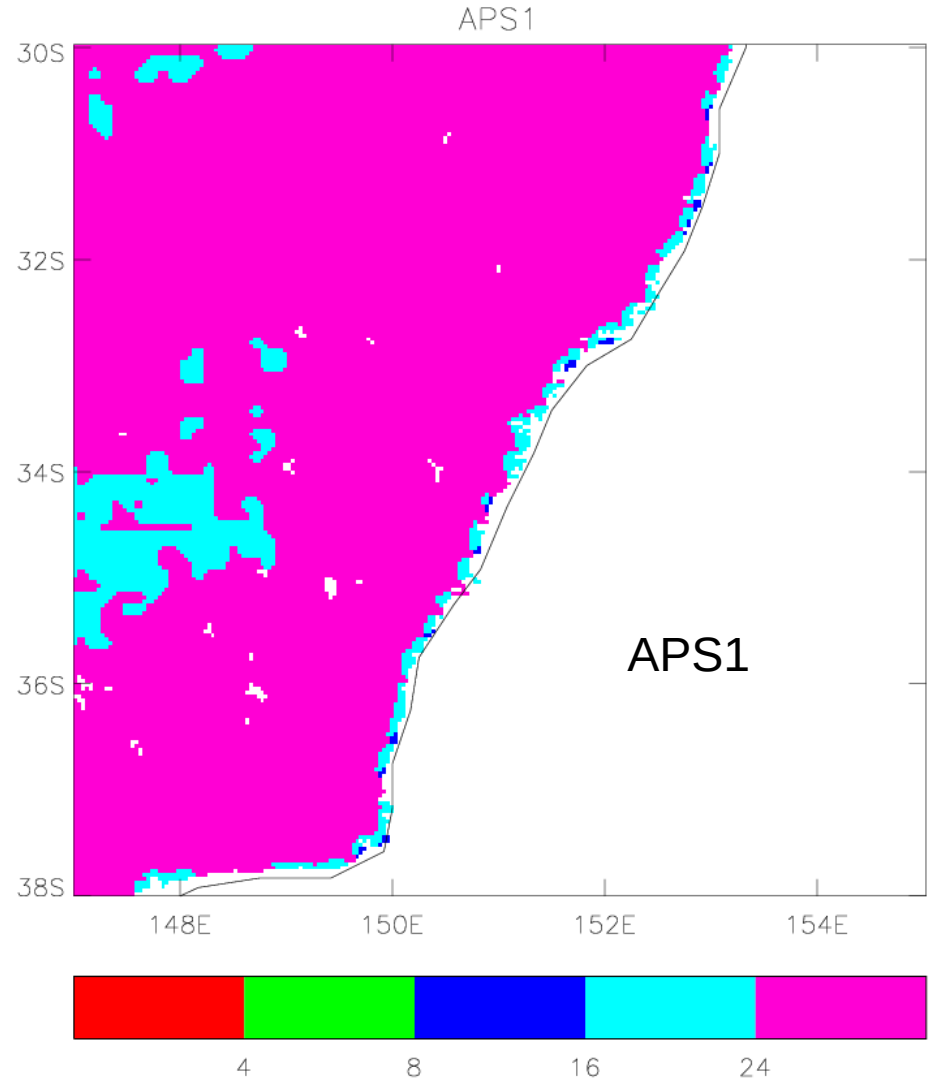
Subgrid Lake Fractions Higher in APS1

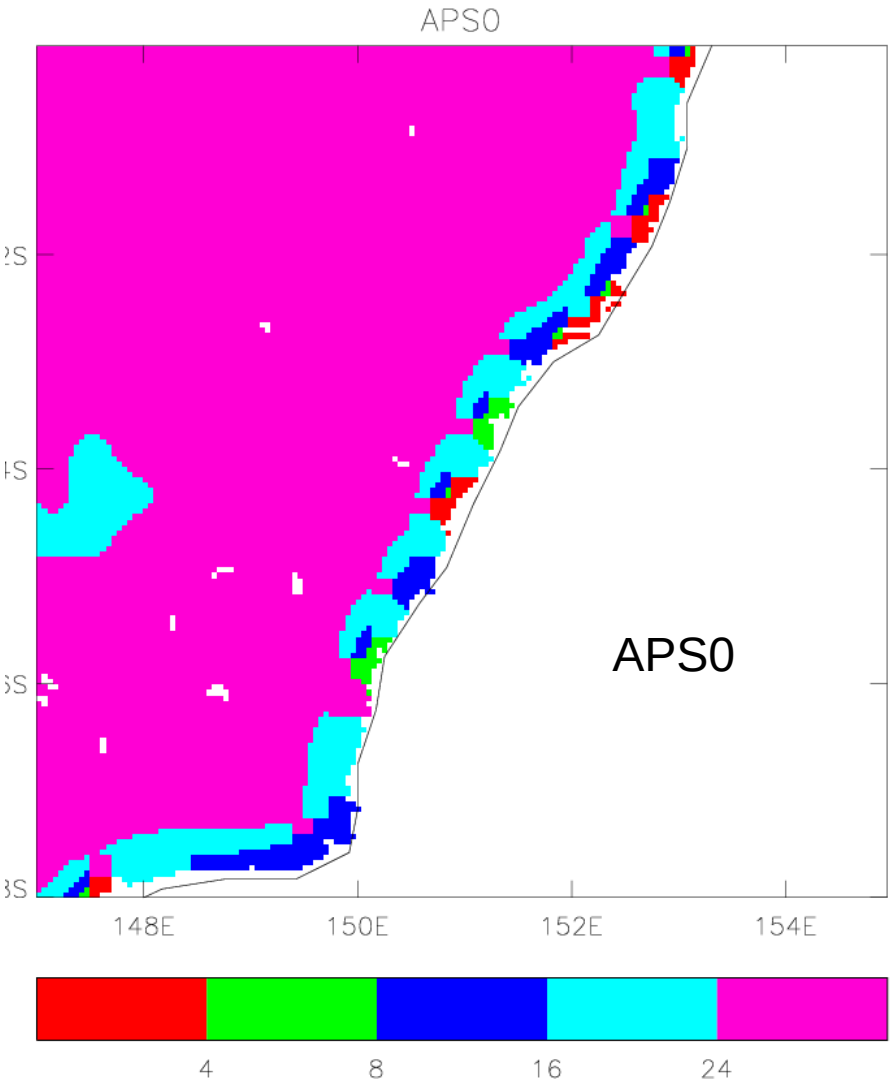




APS1 has taller trees along the coast







EVALUATION OF THE URBAN TILE IN MOSES USING SURFACE ENERGY BALANCE OBSERVATIONS

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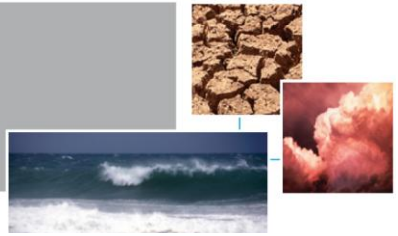
Abstract. The UK Met Office has introduced a new scheme for its urban tile in MOSES 2.2 (Met Office Surface Exchange Scheme version 2.2), which is currently implemented within the operational Met Office weather forecasting model. Here, the performance of the urban tile is evaluated in two urban areas: the historic core of downtown Mexico City and a light industrial site in Vancouver, Canada. The sites differ in terms of building structures and mean building heights. In both cases vegetation cover is less than 5%. The evaluation is based on surface energy balance flux measurements conducted at approximately the blending height, which is the location where the surface scheme passes flux data into the atmospheric model. At both sites, MOSES 2.2 correctly simulates the net radiation, but there are discrepancies in the partitioning of turbulent and storage heat fluxes between predicted and observed values. Of the turbulent fluxes, latent heat fluxes were underpredicted by about one order of magnitude. Multiple model runs revealed MOSES 2.2 to be sensitive to changes in the canopy heat storage and in the ratio between the aerodynamic roughness length and that for heat transfer (temperature). Model performance was optimum with heat capacity values smaller than those generally considered for these sites. The results suggest that the current scheme is probably too simple, and that improvements may be obtained by increasing the complexity of the model

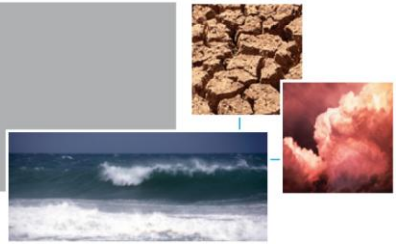
From Best et al (2006)



- "model runs revealed MOSES2.2 to be sensitive to changes in the canopy heat storage"
- "Model performance was optimum with heat capacity values smaller than those generally considered"
- The Urban tile canopy heat capacity parameter is "not well defined and cannot be measured"
- "we conclude that the basic canopy scheme in MOSES 2.2 does not adequately capture the physical processes of the urban atmosphere to accurately represent an urban area."

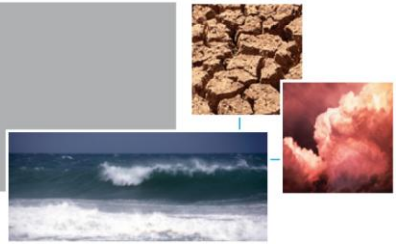
Experiments so Far

07/07/2013

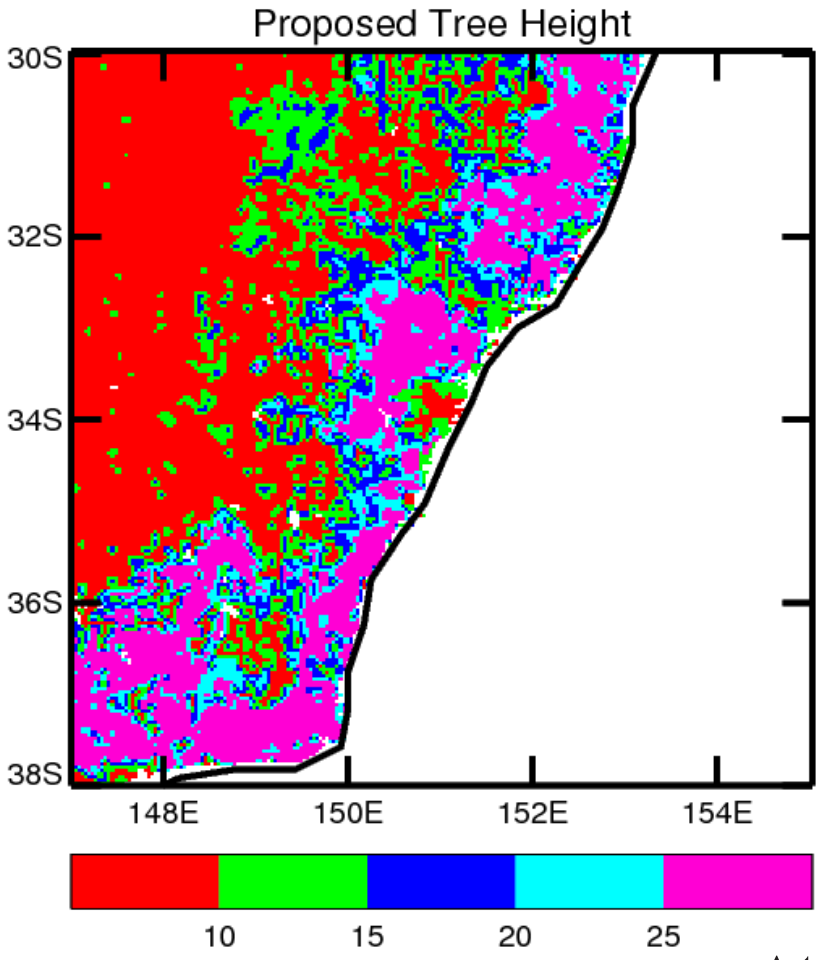


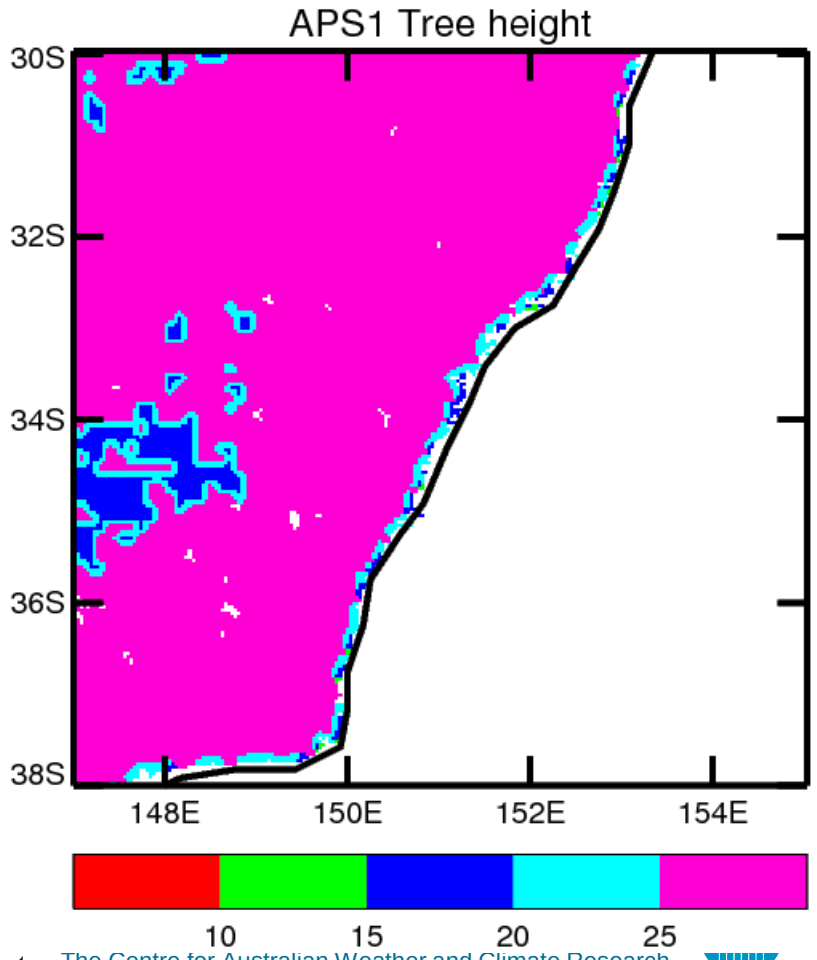
	APS0	APS1 Control	APS1 Revised Urban Parameters	APS1 Revised Urban Parameters Tree Height=10m
T_{2m} Forecasts RMS Difference from observed (K) 90 Stations	**2.1**	**2.4**	**2.2**	**1.9**

Future Work: Proposed New Tree height ancillary

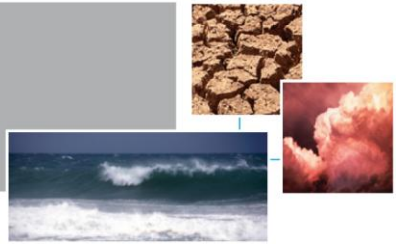


- Simard et al (2011). Mapping forest canopy height globally with spaceborne lidar, J. Geophys. Res., 116, G04021, doi:10.1029/2011JG001708



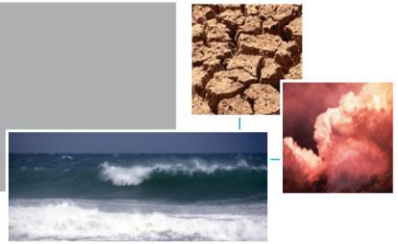


Future Work



- Need Comprehensive testing
  - Summer and Winter NWP Trials (City/Regional/Global)
  - Climate Simulations
  - Off-Line Land Surface Simulations

Conclusions



1) Many observing stations are in Urban areas
2) Properties of the Urban tile and Tree heights are important
3) Models make simplistic assumptions about tree heights
4) Need for an accurate spatial map of Tree heights
5) We intend to perform comprehensive NWP tests
6) Need for Improved Urban and Lake Tile Models for ACCESS