MODELLED LONG TERM TRENDS OF SURFACE OZONE OVER SOUTH AFRICA

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Background – research group

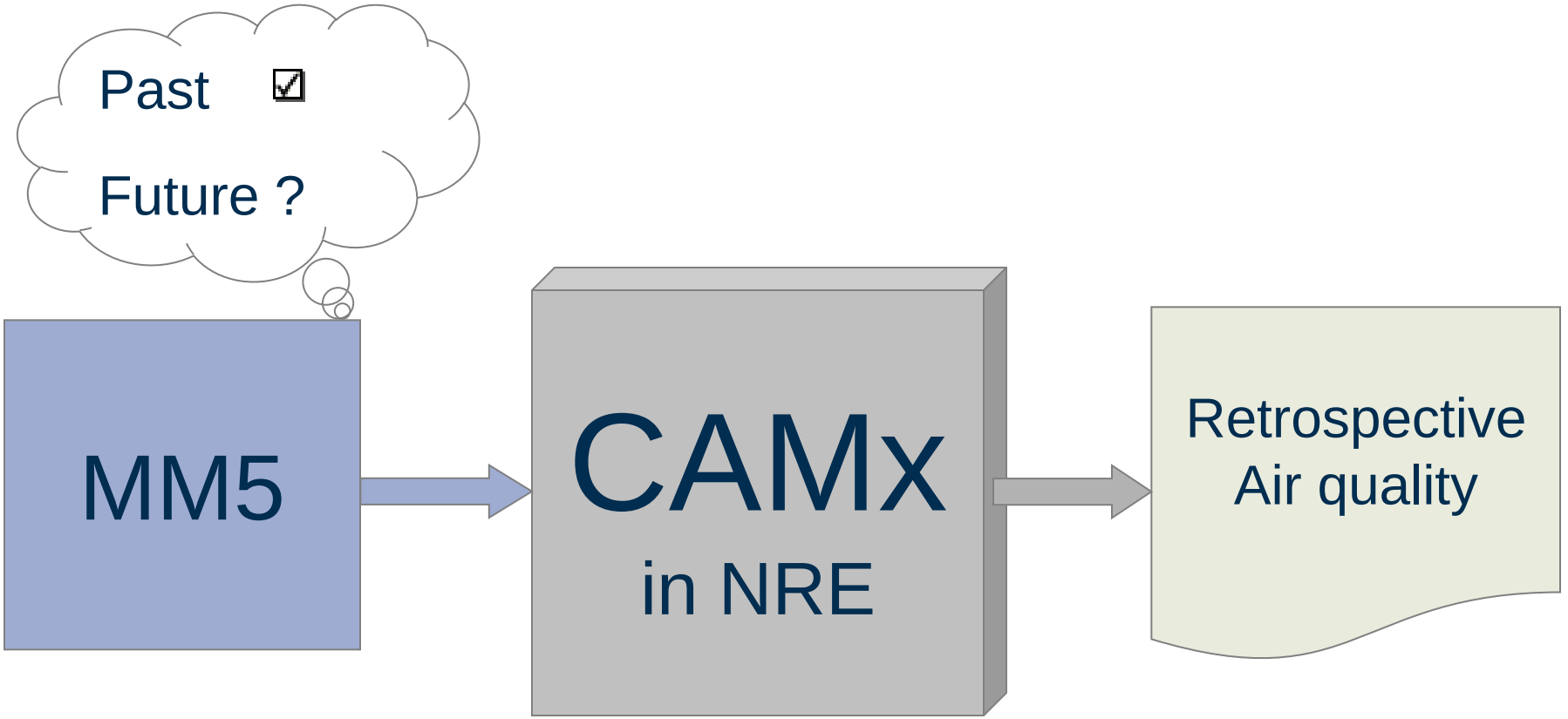
CSM&EH - Air quality

- Focus on ozone
- Secondary pollutant
- Comprehensive modelling
- CAMx

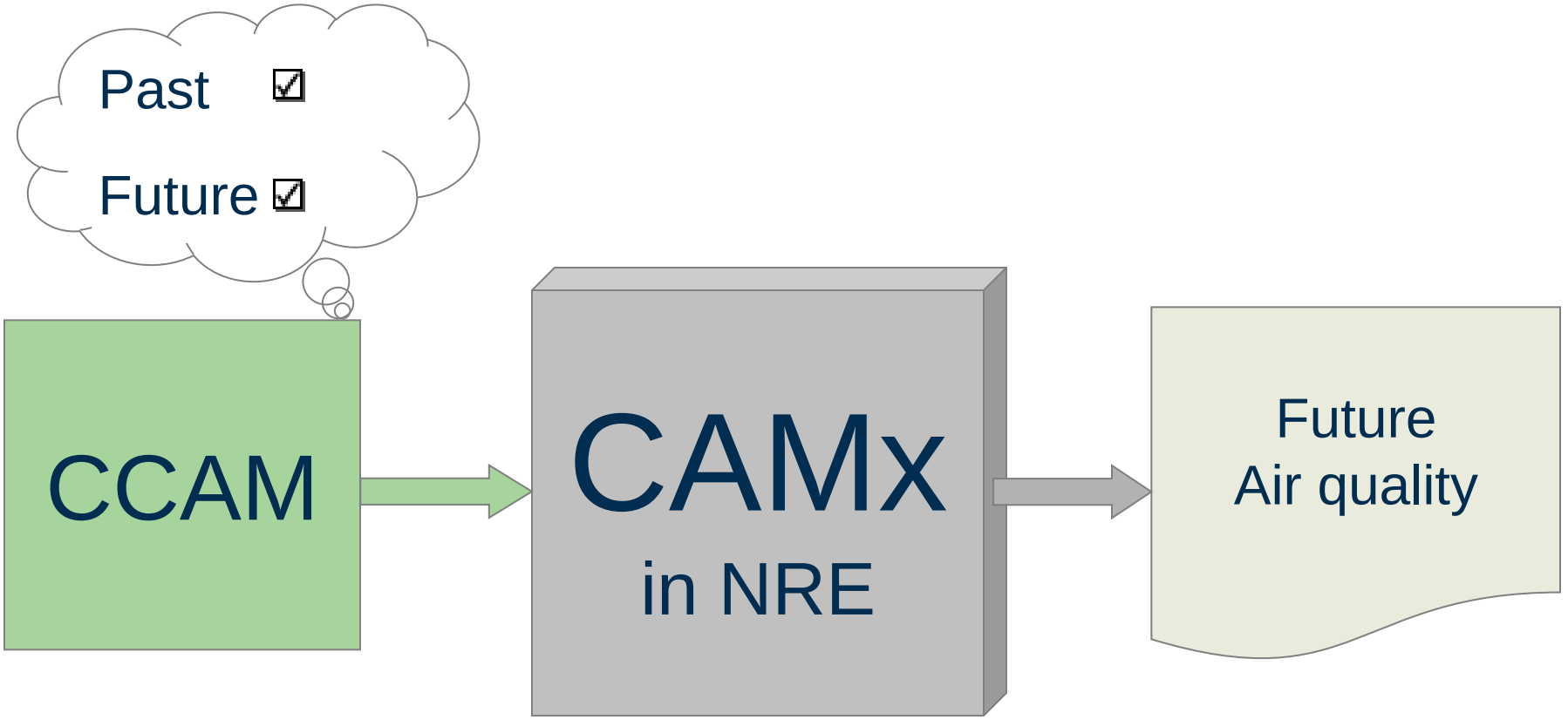
The CAMx model

- CAMx – Photochemical dispersion model
- Able to simulate ozone, particulate matter and other air toxics
- Regional to continental scale
- Used extensively in the United States for air quality management

Framework for retrospective studies – MM5/CAMx



New framework for air quality forecast – CCAM/CAMx

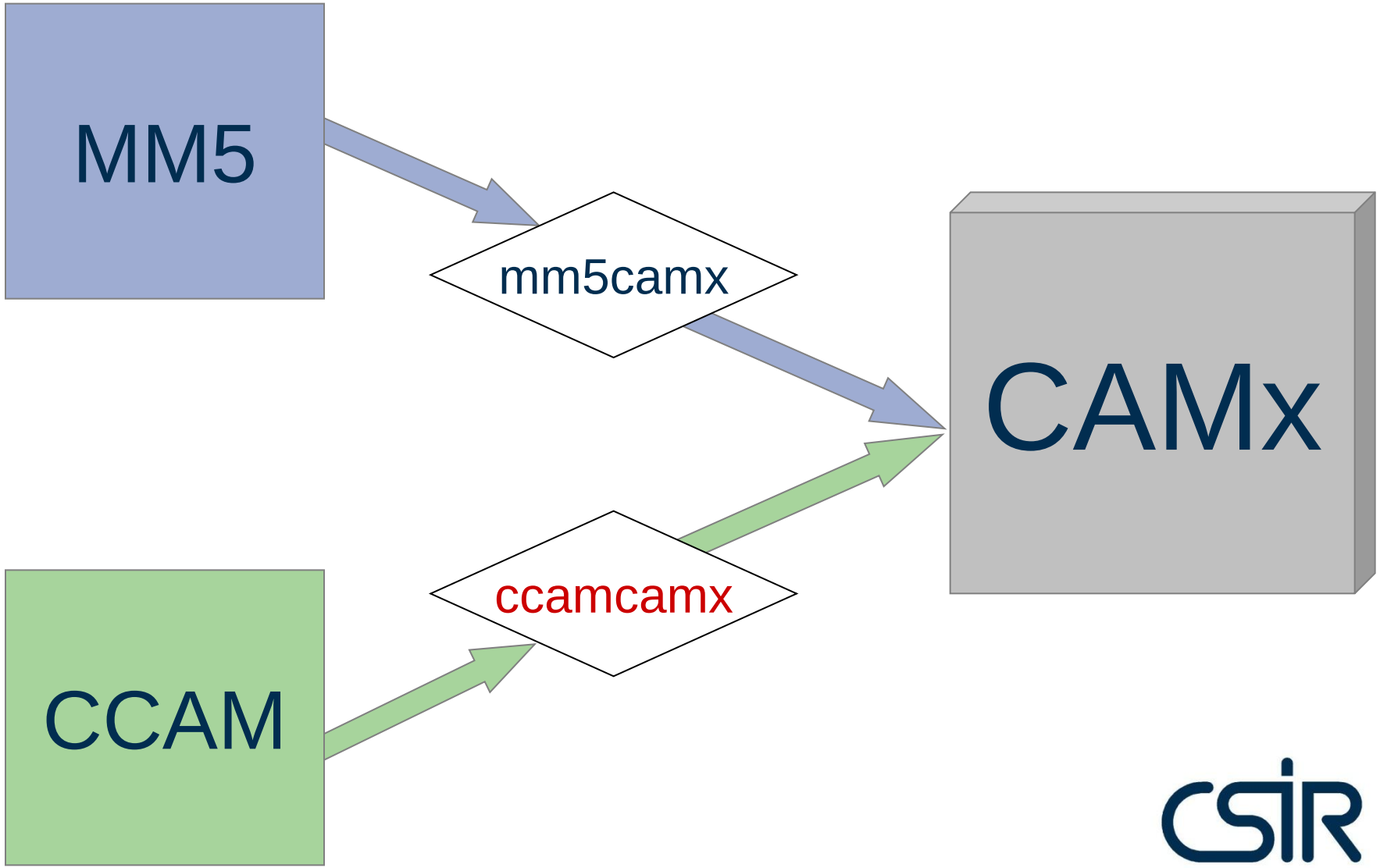


New research - air quality forecast

Current research focus

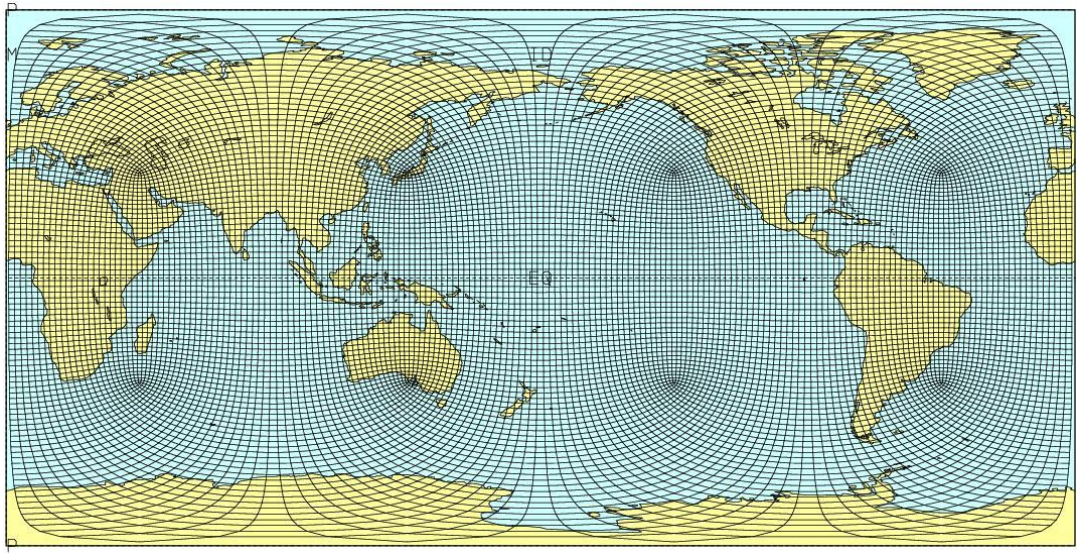
- The response of air quality to changes in climate
- Simulations on longer time scales
- Drive air quality models with long term forecasted meteorology
- Need a baseline (1989 – 2009)
- To date: Initial testing and 2 years (2003 and 2006)

Development of ccamcamx



The CCAM model

- Conformal-Cubic Atmospheric Model (CCAM)
- Developed by CSIRO (e.g McGregor, 2005)
- May be run on a global and regional scale simultaneously
- CCAM provides much of what CAMx needs, but not all variables



CCAM quasi-uniform C48 grid with resolution about 210 km

The CCAM/CAMx system

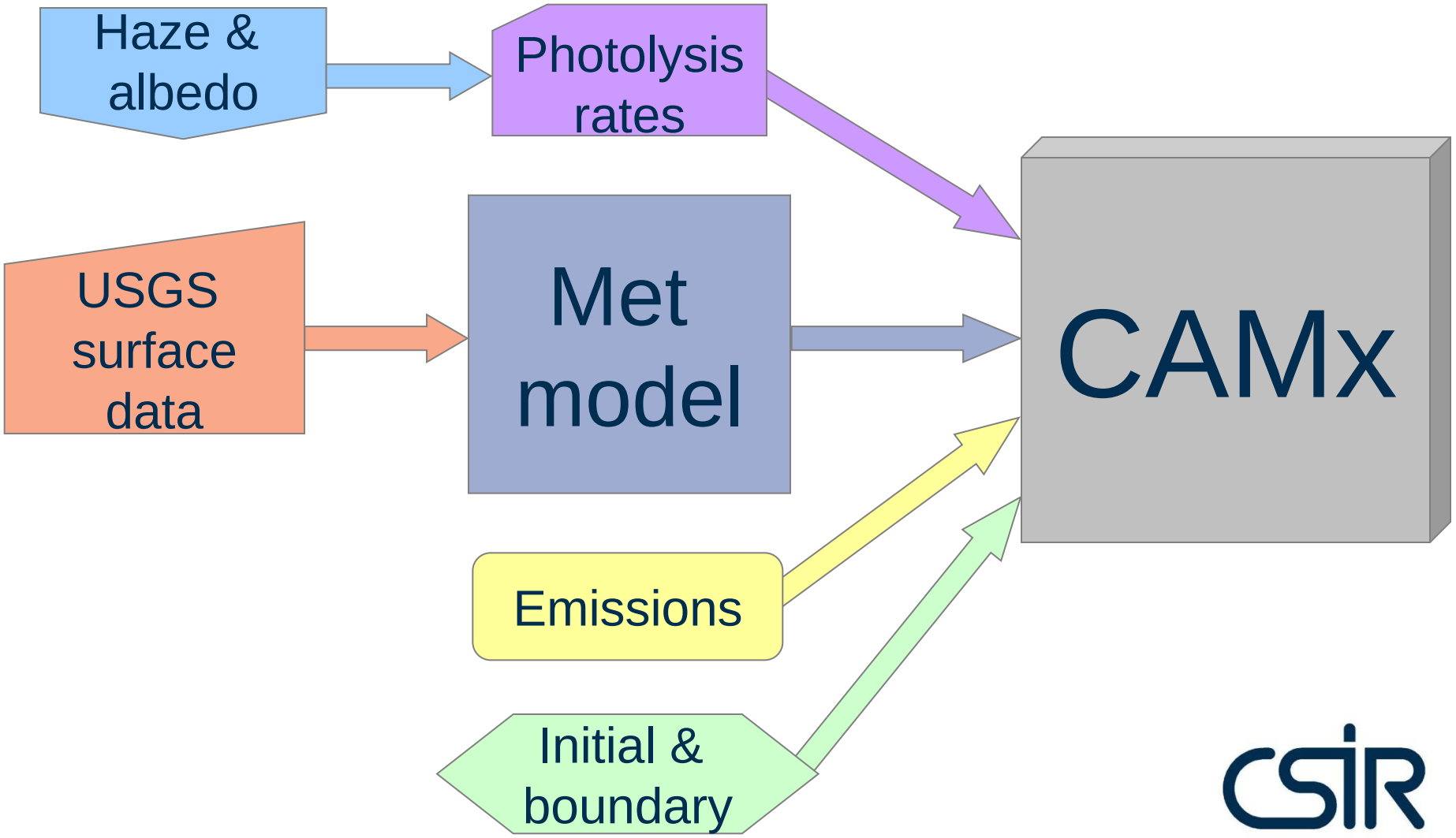
CAMx requirement	Direct from CCAM	Derived from CCAM
Land-use		
Topography	✓	
3D layer interface height		✓
3D layer average pressure		✓
3D layer average U Wind	✓	
3D layer average V Wind	✓	
2D temperature	✓	
2D rain precipitation	✓	
3D layer average temperature	✓	
3D layer average water vapour	✓	
3D layer average cloud water content		✓
3D layer average ice water content		✓
3D layer average rain water content		✓
3D layer average snow water content		
3D layer average graupel water content		
Column cloud optical depth		✓
3D layer interface vertical diffusivity		✓

Initial testing

Initial testing (7 day run)

- Comparison of CCAM/CAMx with
  - MM5/CAMx – performance against well tested system
  - Measured (monitored) data – performance in real world
- MM5/CAMx – previous ozone modelling study focused on SA Highveld, 2006
- Keeping all CAMx inputs “standardized”, leaving only meteorology as a variable

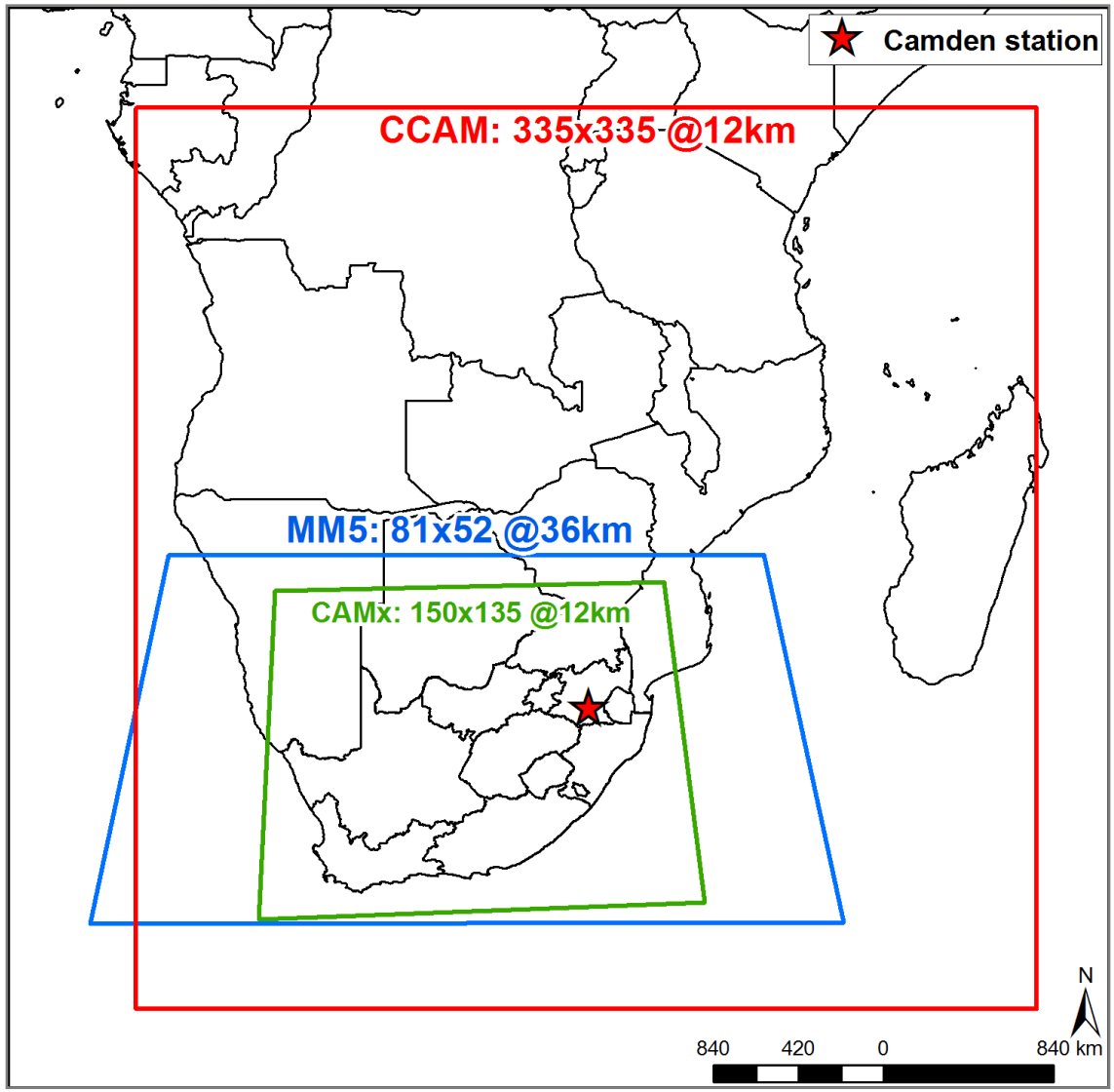
CAMx data flow



The emissions inventory

- Developed for a previous project (MM5/CAMx)
- Year 2006
- Pollutants – SO_2, PM, CO, NH_3, NOx and VOC
- Spatial domain – South Africa, at a resolution of 12 km
- Contains following categories
  - Residential – Domestic fuel burning
  - Transportation – Road vehicles, diesel trains and airport ground vehicles
  - Large Industry – Sasol, Eskom and refineries
  - Smaller Industry – Smaller more disperse industry
  - Biogenic – Vegetation and soils

Model domain

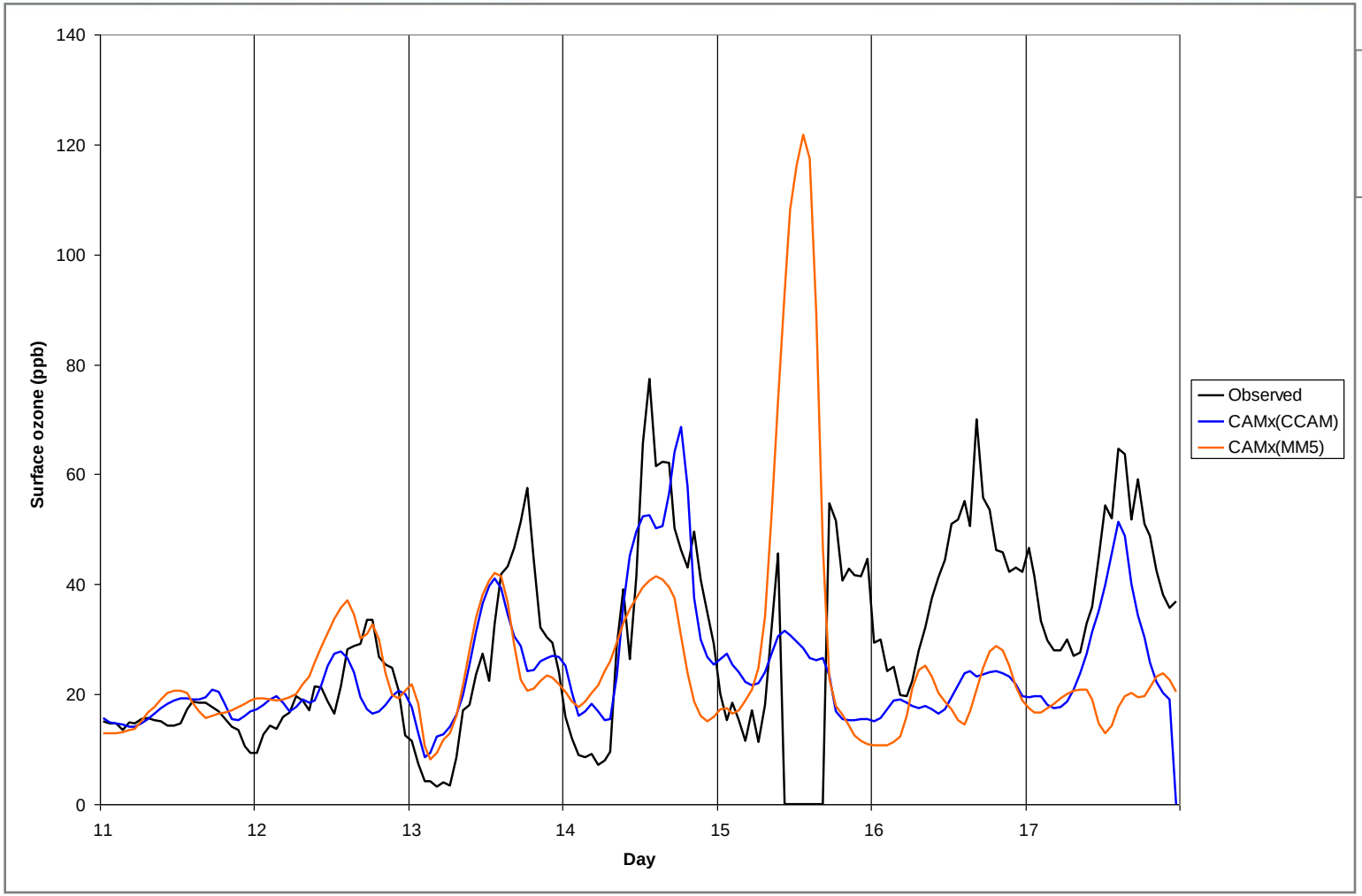


Initial results

- A comparison of surface ozone between
  - CCAM/CAMx vs MM5/CAMx
  - CCAM/CAMx vs monitored data

- Time period – 7 day (11 – 17 December 2006)

Surface ozone: CCAM/CAMx vs MM5/CAMx vs monitored



Average bias (ppb)

MM5/CAMx ~ -3

CCAM/CAMx ~ -4

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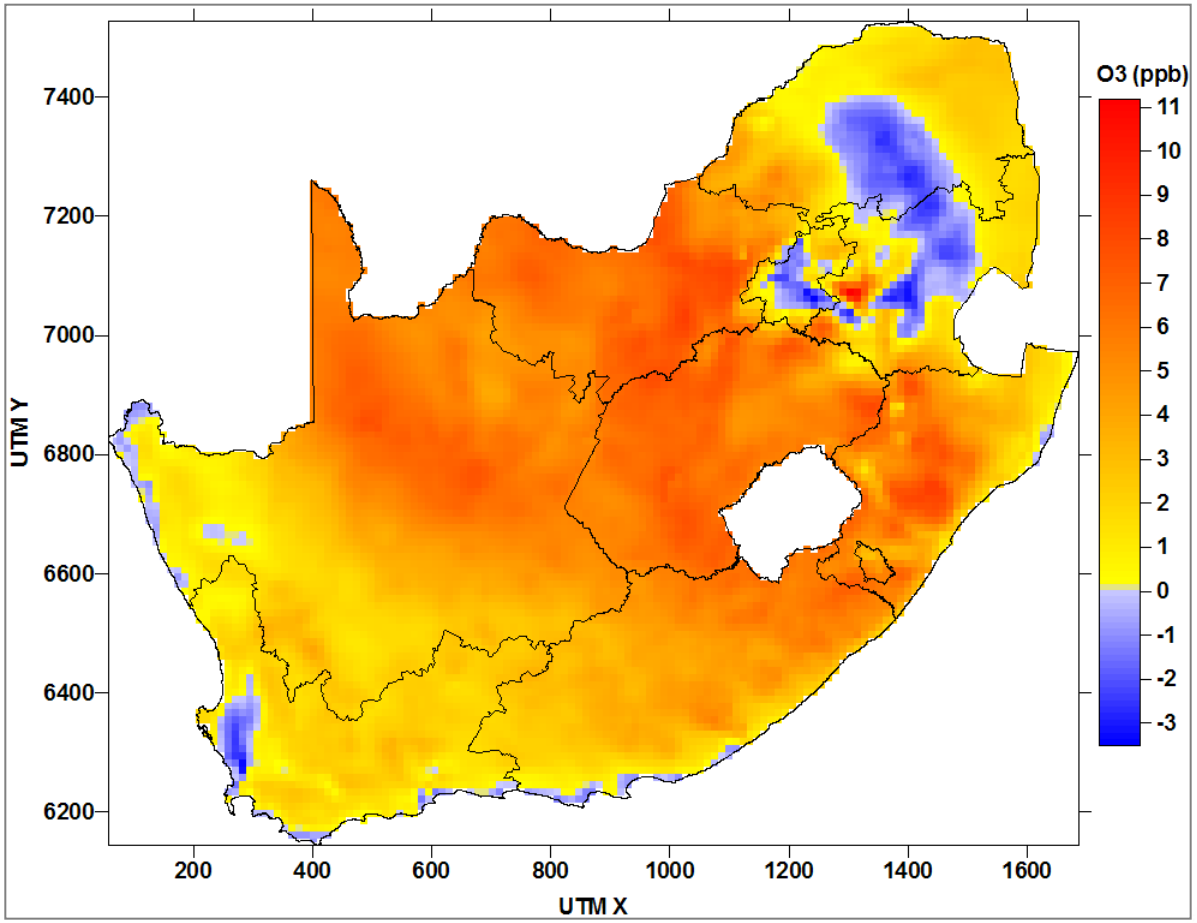
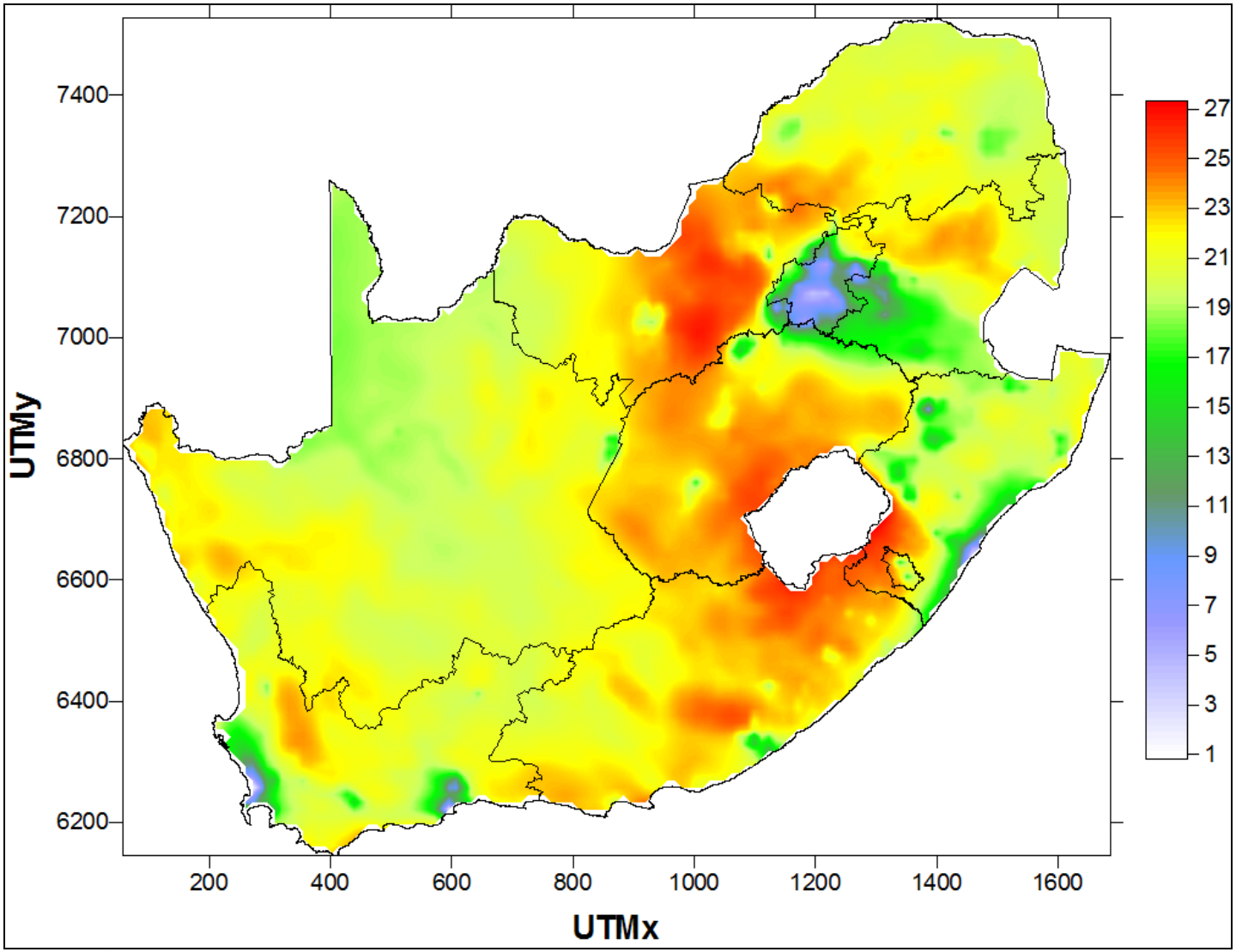
Spatial difference – average over 7 days

$$([\overline{O}_3]^{CCAM/CAMx}) - ([\overline{O}_3]^{CCAM/MM5})$$



2003 annual average



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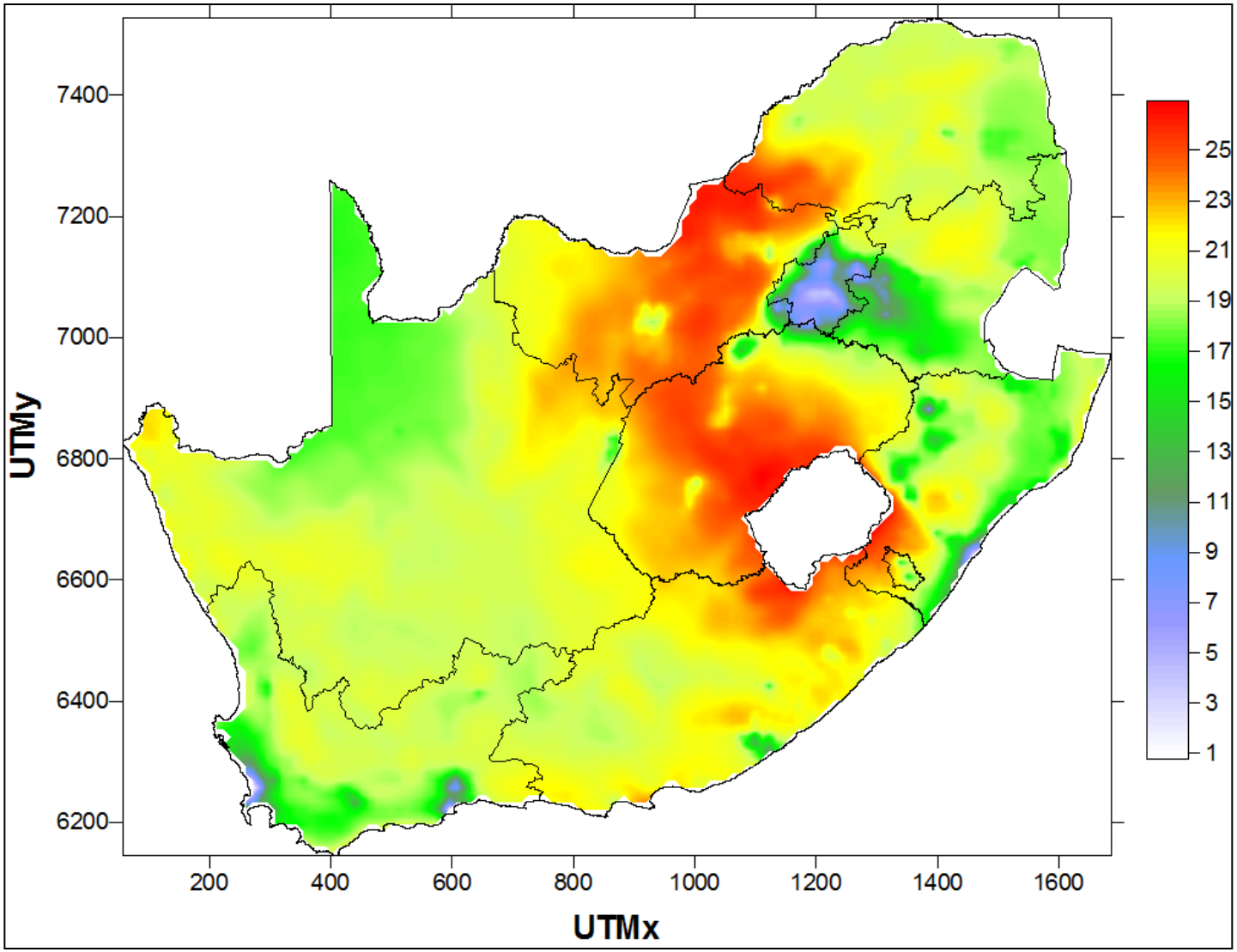
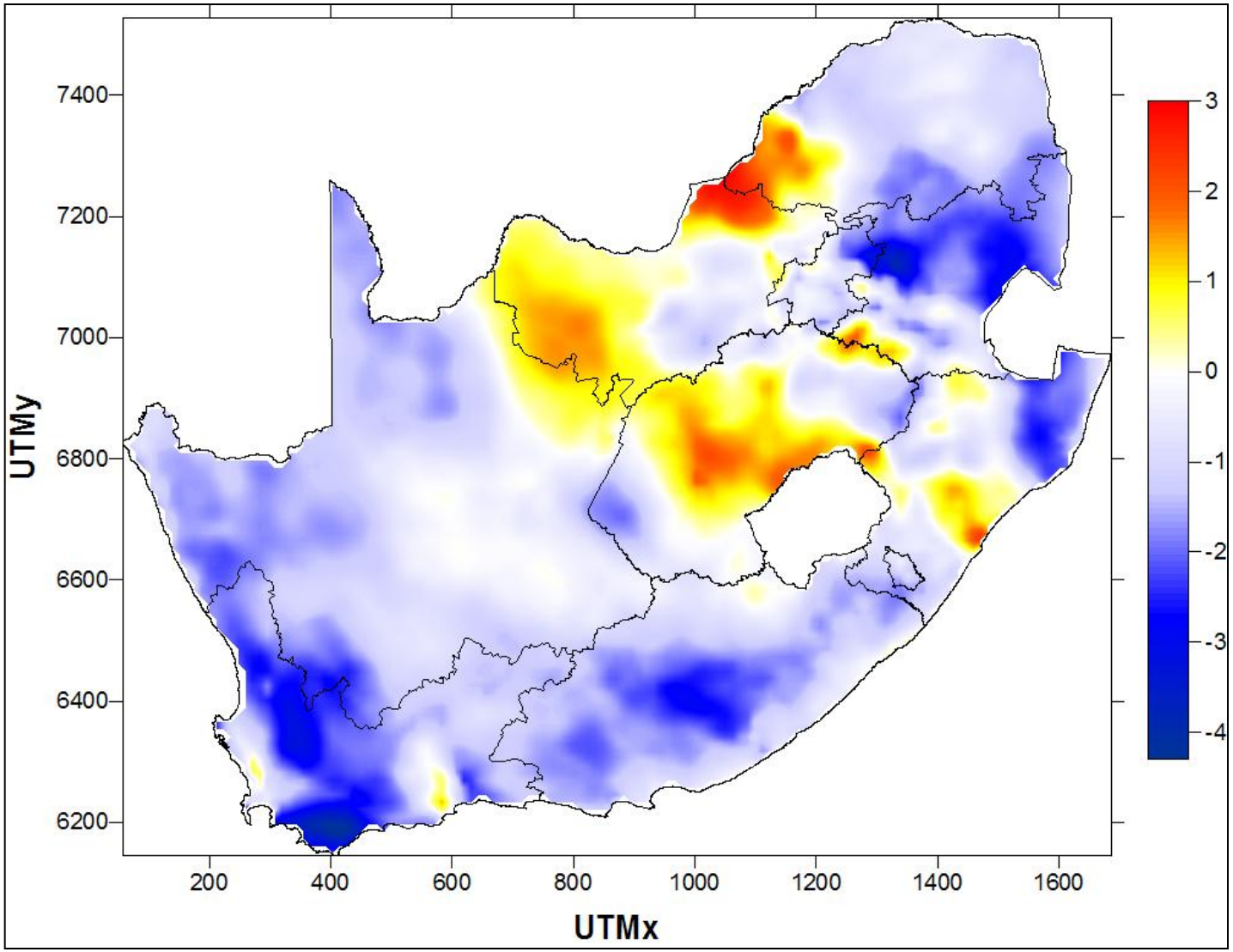
2006 annual average



Annual average (2006 – 2003)



7 day test

- Framework performs reasonably well for this analysis
- Room for improvement
  - Include land use variables from CCAM
- Benefits of CCAM
  - Computationally fast
  - Regional and global scale (long range influences)
  - Forecast at climate change timescale
  - Capacity to provide output

Thank you for your time

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