Modeling Urban Impacts on Regional Weather of the Central U.S

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Motivation

- Urbanization and regional weather
- Urban Canopy Model (UCM)

Data and Methods

- Cities along the Ohio River
  - Evansville, IN
  - Louisville, KY
  - Cincinnati, OH
- Summer Precipitation Events
  - 11 June 2006
  - 17 June 2006
  - 23 June 2006
  - 29 August 2008

Parameterizations

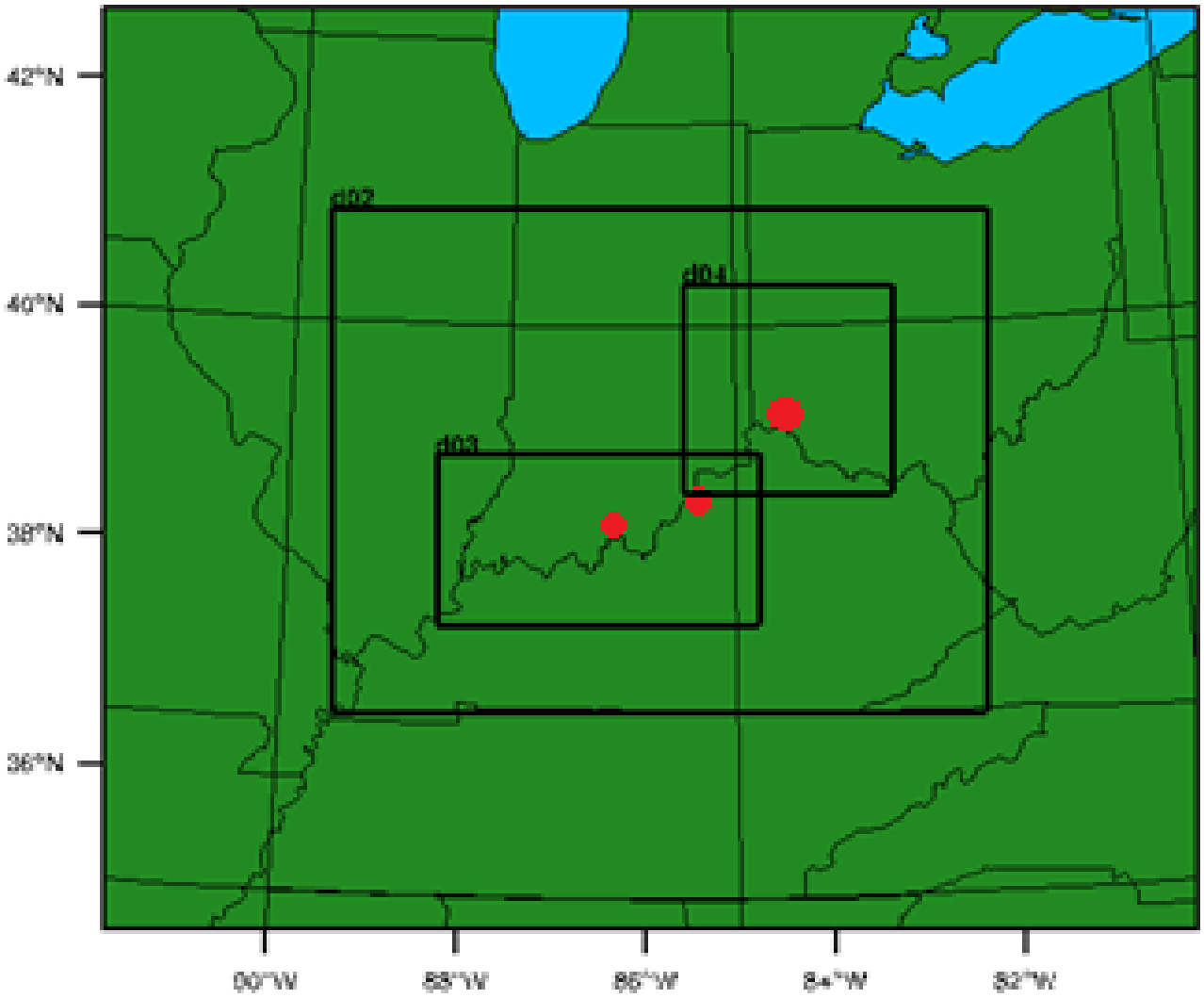
Microphysics
- WSM 6-class

Cumulus
- Kain-Fritsch

Radiation
- RRTM Long Wave
- Goddard Shortwave

Land Surface
- Noah

Boundary Layer
- YSU



Domain Sizes and Resolutions

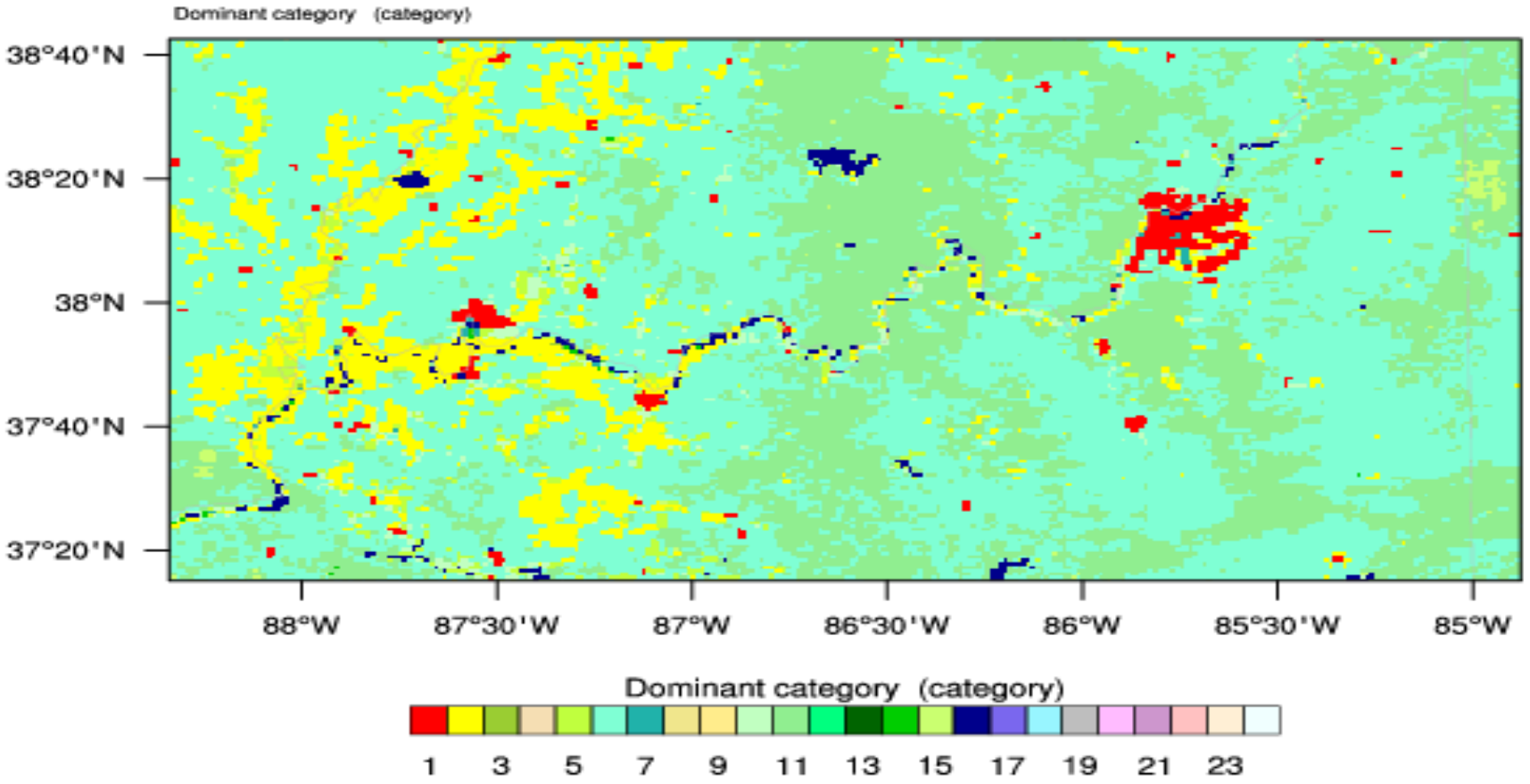
Domain 1 – 116 x 98 9 km

Domain 2 – 208 x 160 3 km

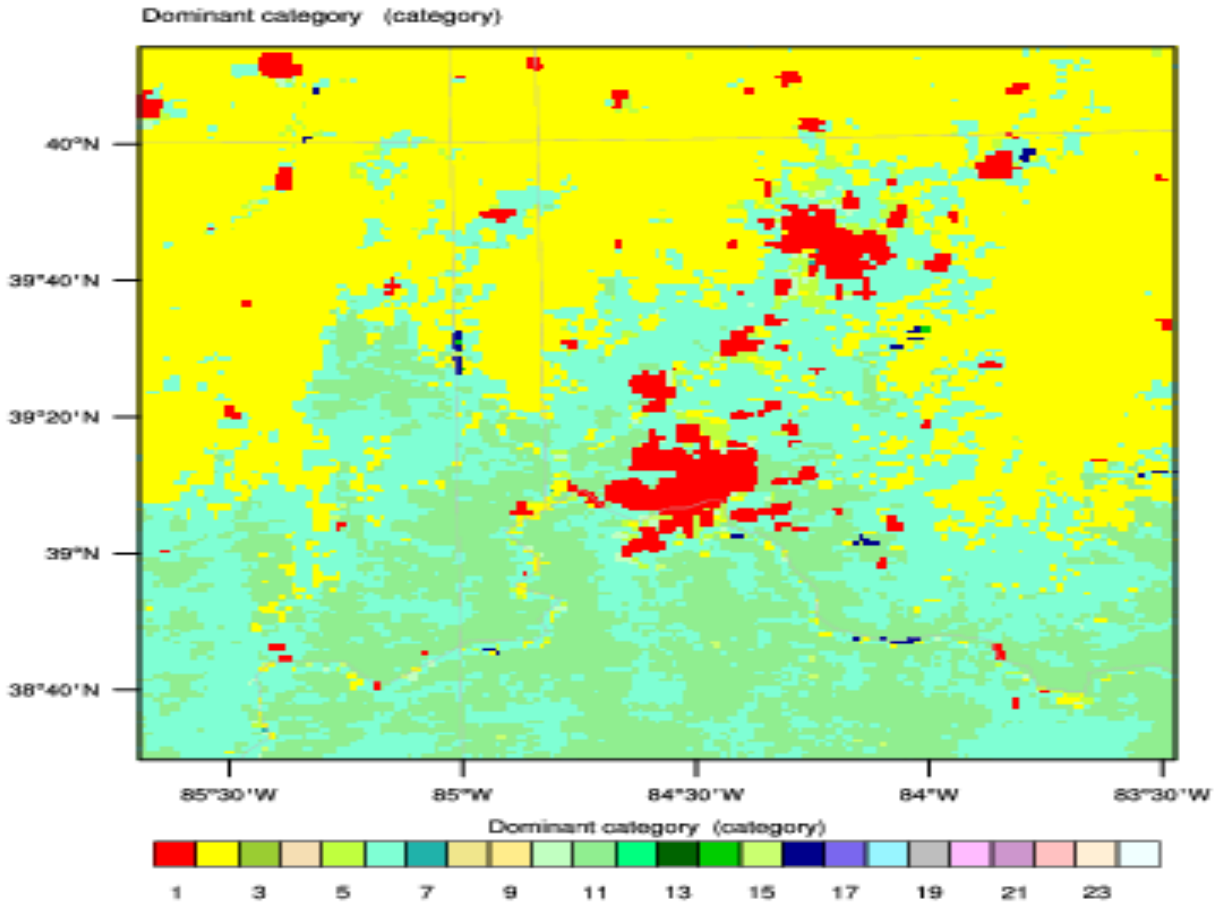
Domain 3 – 301 x 160 1 km

Domain 4 – 190 x 190 1 km

Land Use Categories, Domain 3



Land Use Categories. Domain 4



1 Urban	5 Crop./Grs. Mosaic	9 Mix Shrb./Grs.	13 Evergrn. Broadlf.	17 Herb. Wetland	21 Wooden Tundra
2 Drylnd Crop. Past.	6 Crop./Wood Mosc	10 Savanna	14 Evergrn. Needlf.	18 Wodded Wetland	22 Mixed Tundra
3 Irrg. Crop. Past.	7 Grassland	11 Decids. Broadlf.	15 Mixed Forest	19 Bar. Sparse Veg.	23 Bare Grn. Tundra
4 Mix. Dry/Irrg.C.P.	8 Shrubland	12 Decids. Needlf.	16 Water Bodies	20 Herb. Tundra	24 Snow or Ice

Analysis

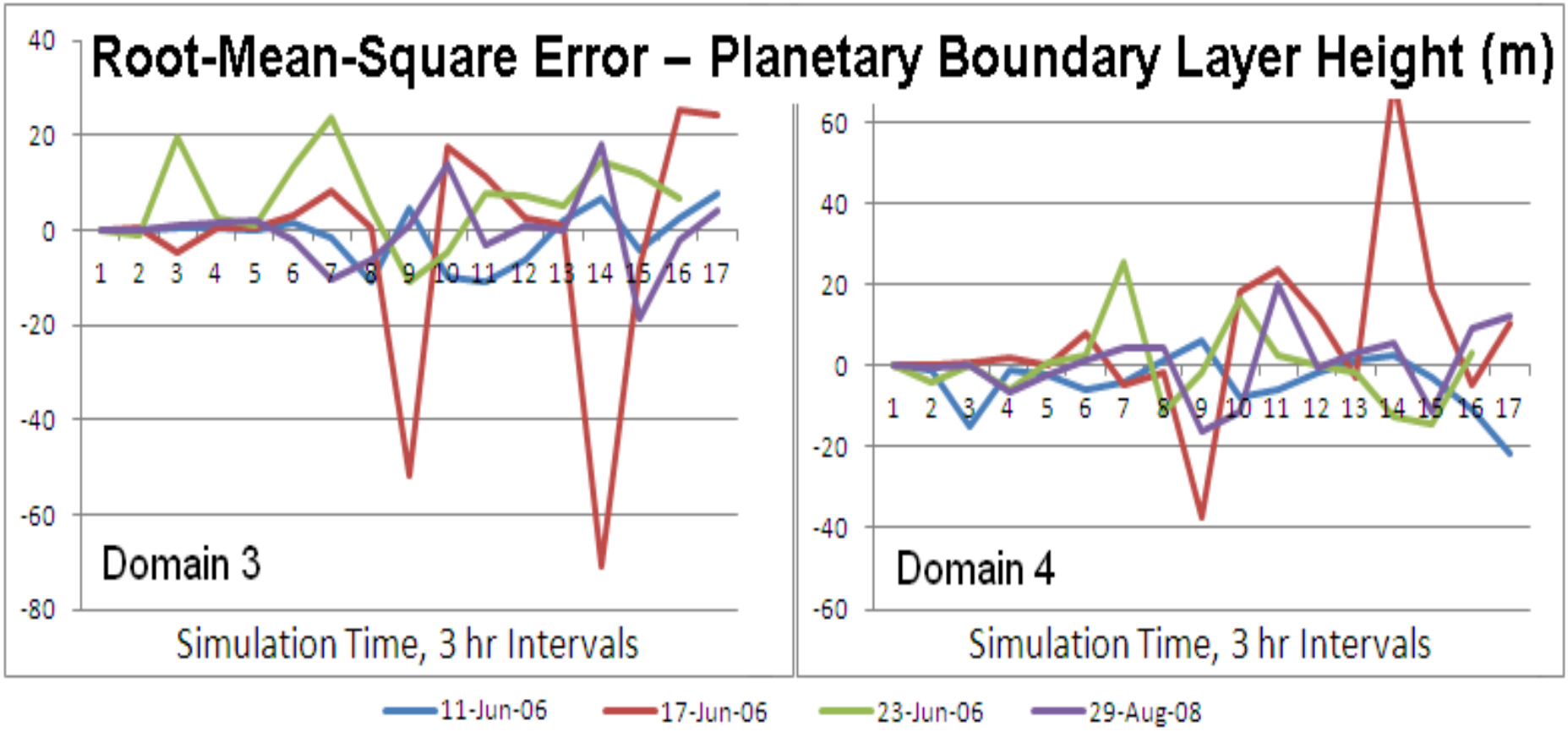
Model Output

- 1-km spatial resolution
- 54 hour run time
  - Began at 18 Z, previous day
- 1-hourly output

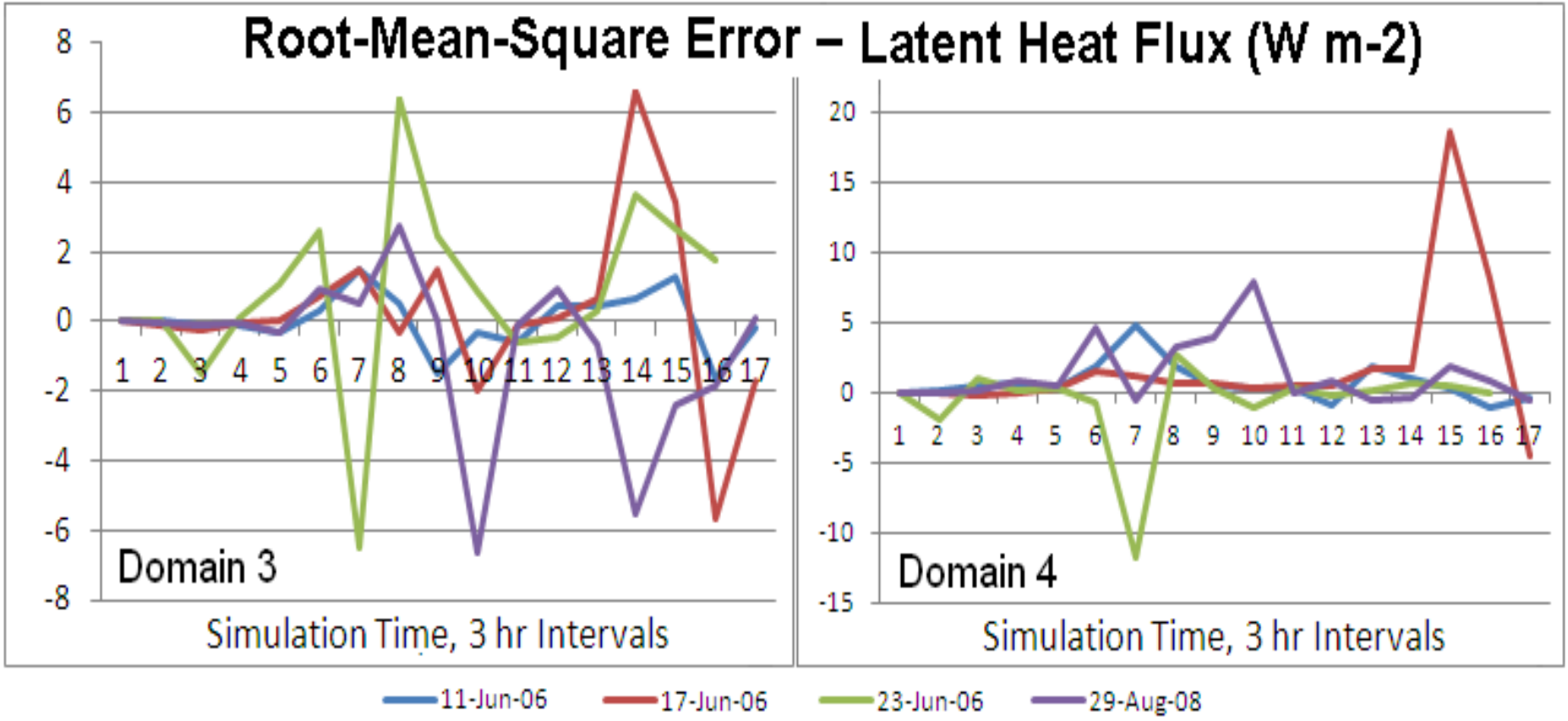
Comparison Data

- NARR data
  - 32-km resolution
  - 3- or 6- hourly outputs
- CPC unified precipitation
  - 0.25° lat (~28-km) resolution
  - 12 and 24 hour totals

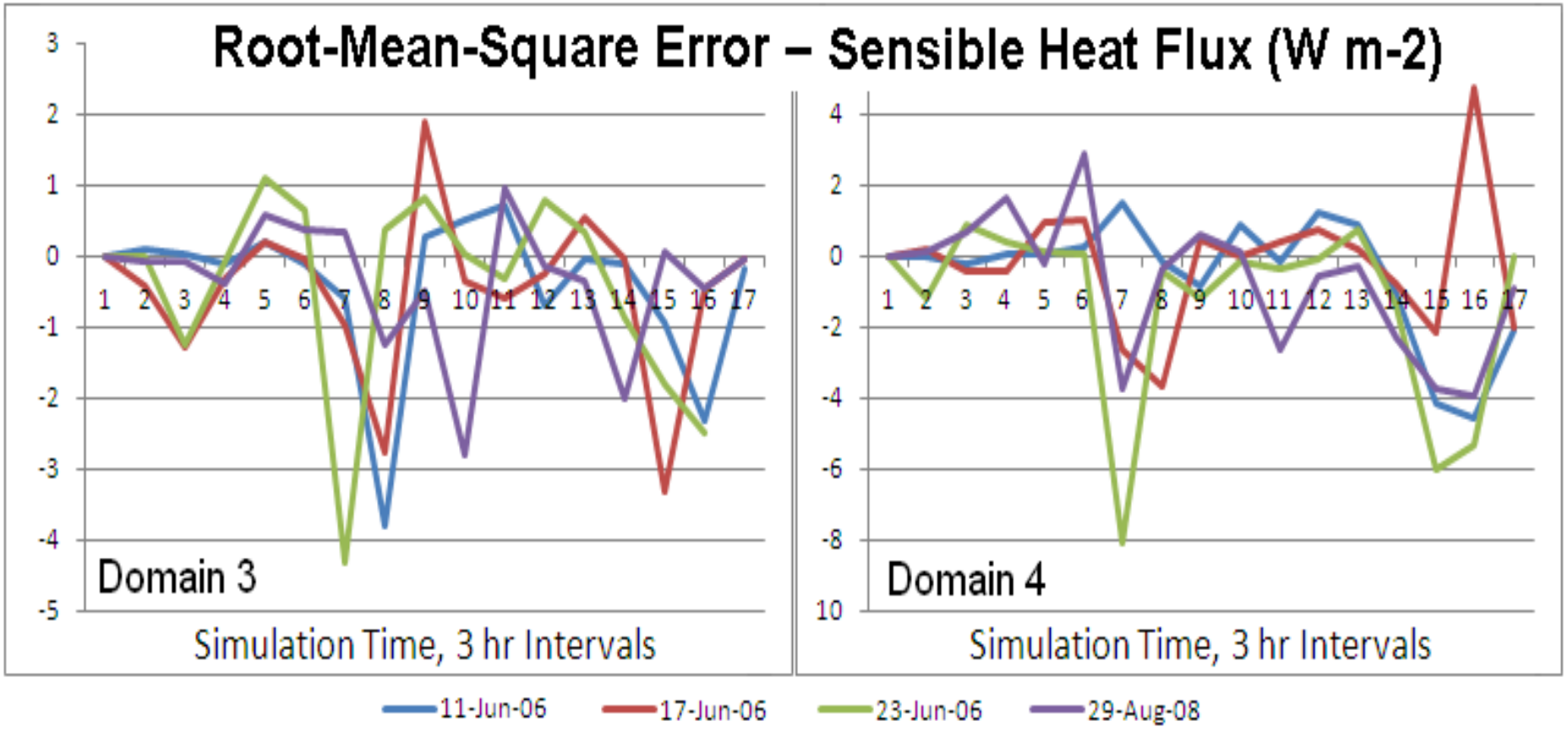
Analysis


Root-Mean-Square Error – Planetary Boundary Layer Height (m)
40
20
0
-20
-40
-60
-80
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Domain 3
Simulation Time, 3 hr Intervals
60
40
20
0
-20
-40
-60
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Domain 4
Simulation Time, 3 hr Intervals
11-Jun-06
17-Jun-06
23-Jun-06
29-Aug-08

Analysis

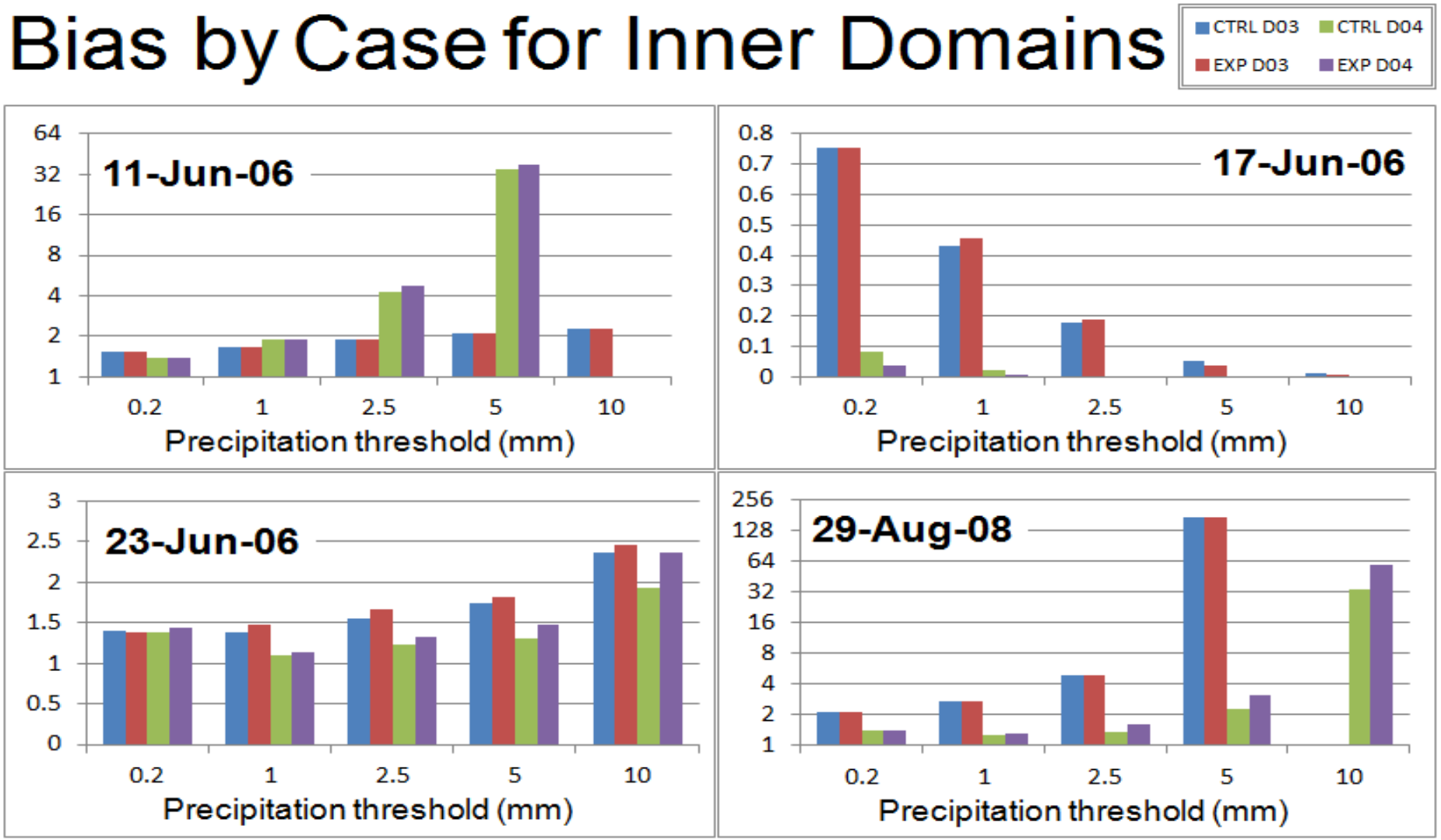

Root-Mean-Square Error – Latent Heat Flux (W m-2)
8
6
4
2
0
-2
-4
-6
-8
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Domain 3
Simulation Time, 3 hr Intervals
20
15
10
5
0
-5
-10
-15
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Domain 4
Simulation Time, 3 hr Intervals
11-Jun-06
17-Jun-06
23-Jun-06
29-Aug-08

Analysis


Root-Mean-Square Error – Sensible Heat Flux (W m-2)
Domain 3
Simulation Time, 3 hr Intervals
Domain 4
Simulation Time, 3 hr Intervals
11-Jun-06
17-Jun-06
23-Jun-06
29-Aug-08

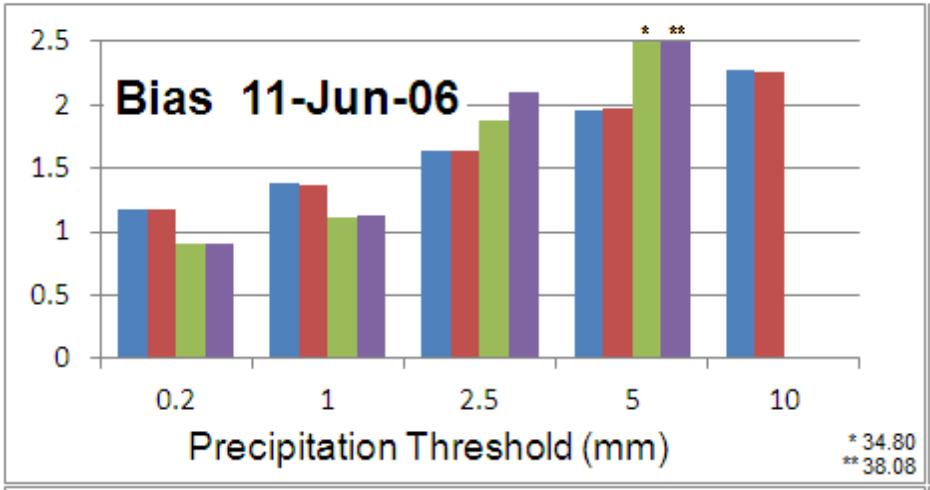
Analysis

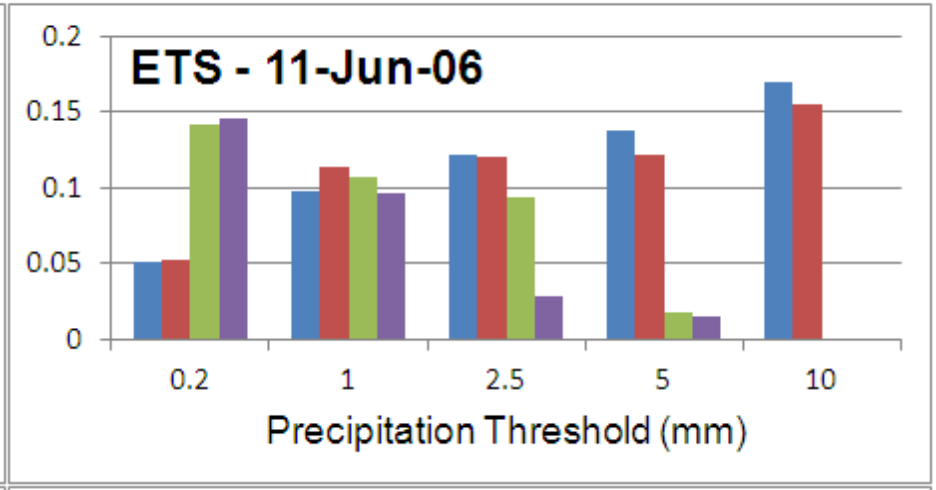
Bias by Case for Inner Domains

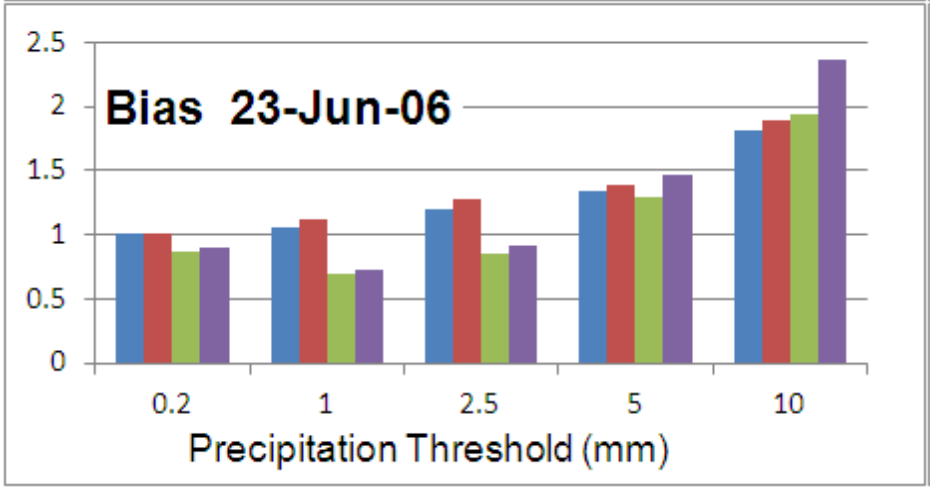


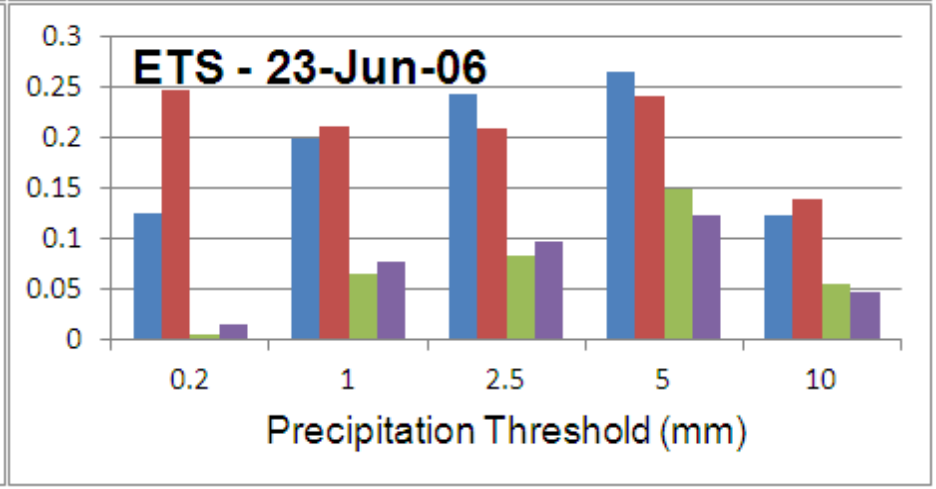
Analysis

Bias and ETS for Two Cases

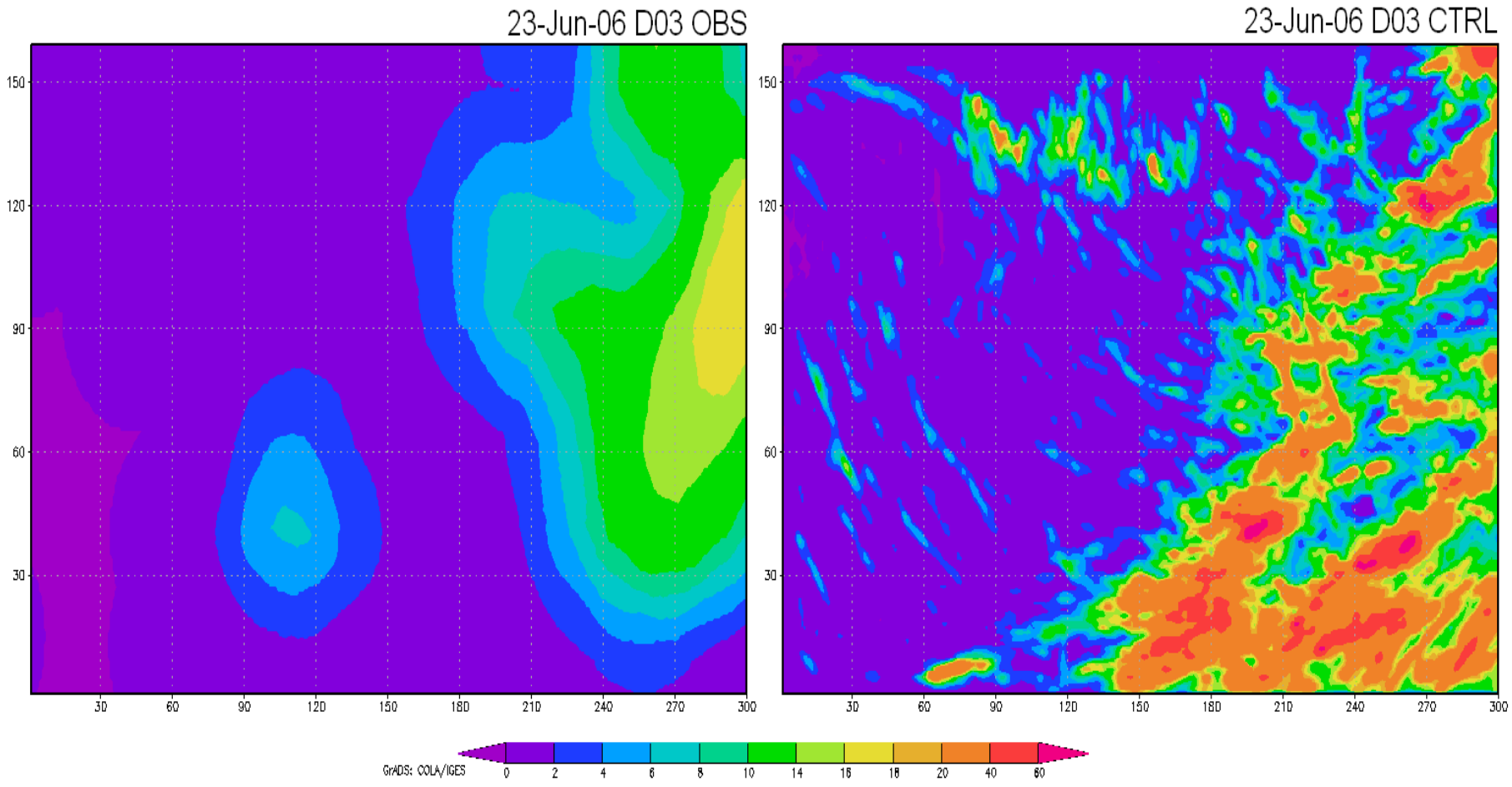




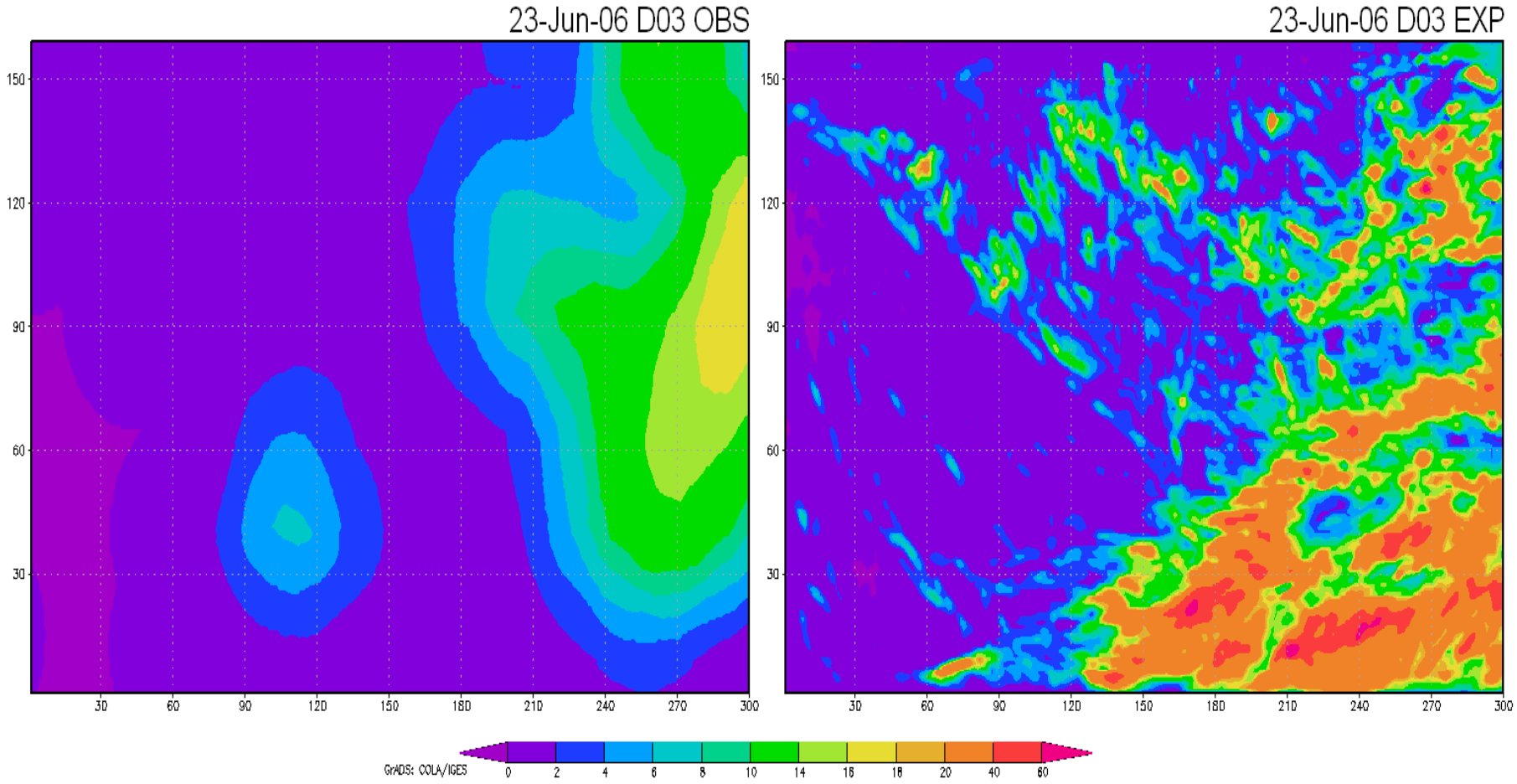




Analysis


23-Jun-06 D03 OBS
23-Jun-06 D03 CTRL
150
120
90
60
30
30
60
90
120
150
180
210
240
270
300
GrADS: COLA/IGES
0
2
4
6
8
10
14
16
18
20
40
60

Analysis


23-Jun-06 D03 OBS
23-Jun-06 D03 EXP
150
120
90
60
30
30
60
90
120
150
180
210
240
270
300
GrADS: COLA/IGES
0
2
4
6
8
10
14
16
18
20
40
60

Conclusions

- Greatest improvement:
  - Daytime sensible heat flux
- Also improved:
  - Daytime latent heat flux
  - Precipitation reliability (for low precipitation thresholds)

- Tendency to overestimate precipitation

Future Work

- Simulations with more recent (2001) USGS NLCD could improve model accuracy overall
- Higher resolution observational data
- More cases

Thank You

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