Meteorology and Air Quality Modeling Support for Measurement Projects

(1) Air Quality Forecasting
(2) High-resolution meteorological modeling

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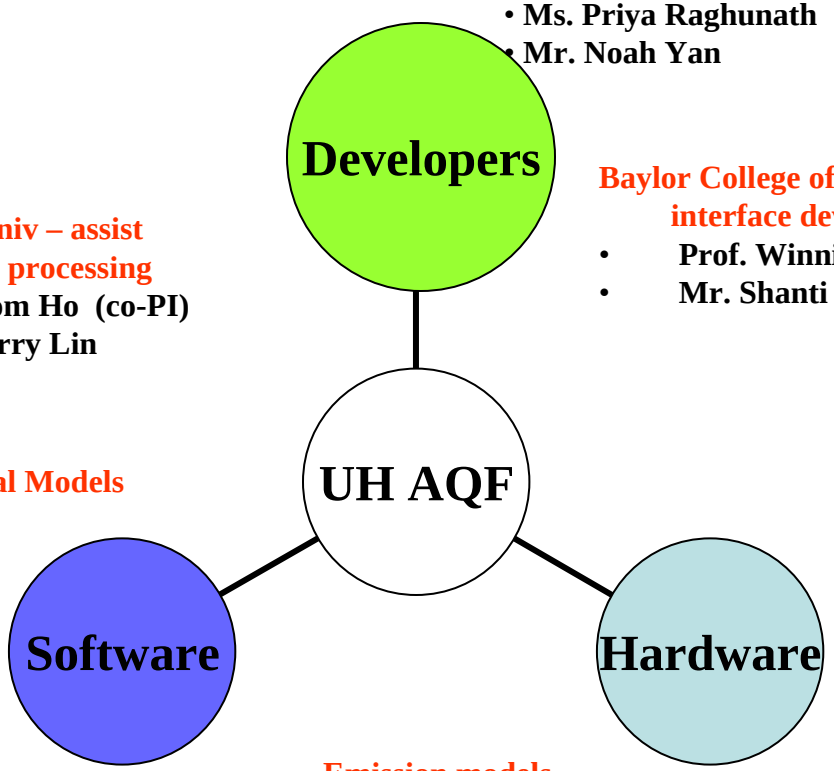
Objectives

- Air Quality Forecasting:
  - Phase-I (Until Aug., 2005): Provide Eastern Texas air quality forecasting at 12-km resolution and Houston-Galveston area at 4-km resolution.
  - Phase-II (Sept. 2005-Aug 2006): Add Dallas-Fort worth at 4-km resolution; Support real-time emissions modeling inputs for multiple air quality models

UH AQF Project Team & Components



(Main Development Group)
UH IMAQS - Lead
- Prof. Daewon W. Byun (PI)
- Dr. Seung-Bum Kim
- Dr. Chang-Keun Song
- Dr. Hee-Jin In
- Dr. M.-D. Jang
- Dr. Soon-Tae Kim
- Dr. Peter Percell
- Ms. Fong Nagn
- Ms. Bonnie Cheng
- Ms. Beata Czedar
- Ms. Violeta Coarfa
- Mr. Yupeng Li
- Mr. Trung Ng

UH Computer Sciences Dept.
- Prof. Barbara Chapman (PI)
- Ms. Priya Raghunath
- Mr. Noah Yan

UH HPCC
- Dr. B. Kim Andrews
- Mr. Tony Curtis
- Mr. Kiran Thyagaraja

Lamar Univ – assist emissions processing
- Prof. Tom Ho (co-PI)
- Prof. Jerry Lin

Baylor College of Medicine – Public web interface development
- Prof. Winnie Hamilton (co-PI)
- Mr. Shanti Ningthoujam

Meteorological Models
- MM5
- WRF

Chemistry Transport Models
- CMAQ
- CAMx
- WRF-chem

Trajectory Models
- ARL/UH HYSPLIT
- RTAS
- RUTS
- PDM

Graphic Software
- GrADs
- NCAR graphics
- PAVE
- IDL
- GIS

Emission models
- SMOKE
- EPS
- GlOBEIS3
- BEIS3
- Mobile6

Linux Servers (2+1)
- 2 Intel Zeon CPUs per system
- 2GB RAM per node
- 5 hard disk slots per system

Linux Beowulf systems (2+1)
- 24 nodes w/ 2 Intel Zeon CPUs at 2.4 GHz (48 processors)
- 4GB RAM per node
- 2TGB hard disk for each system

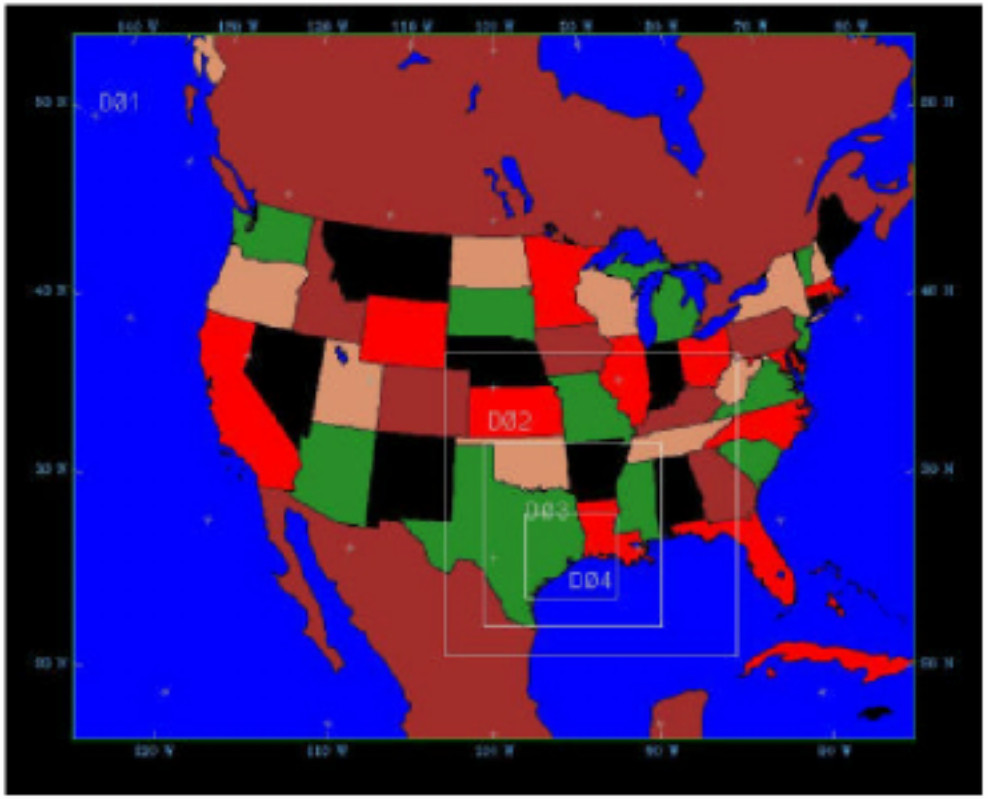
Base Configuration of the Prototype UH AQF System

- MM5 Meteorological modeling system
- SMOKE/BEIS-3 & EPS-3/GloBEIS-3
- The U.S. EPA Models-3 Community Multiscale Air Quality (CMAQ) system

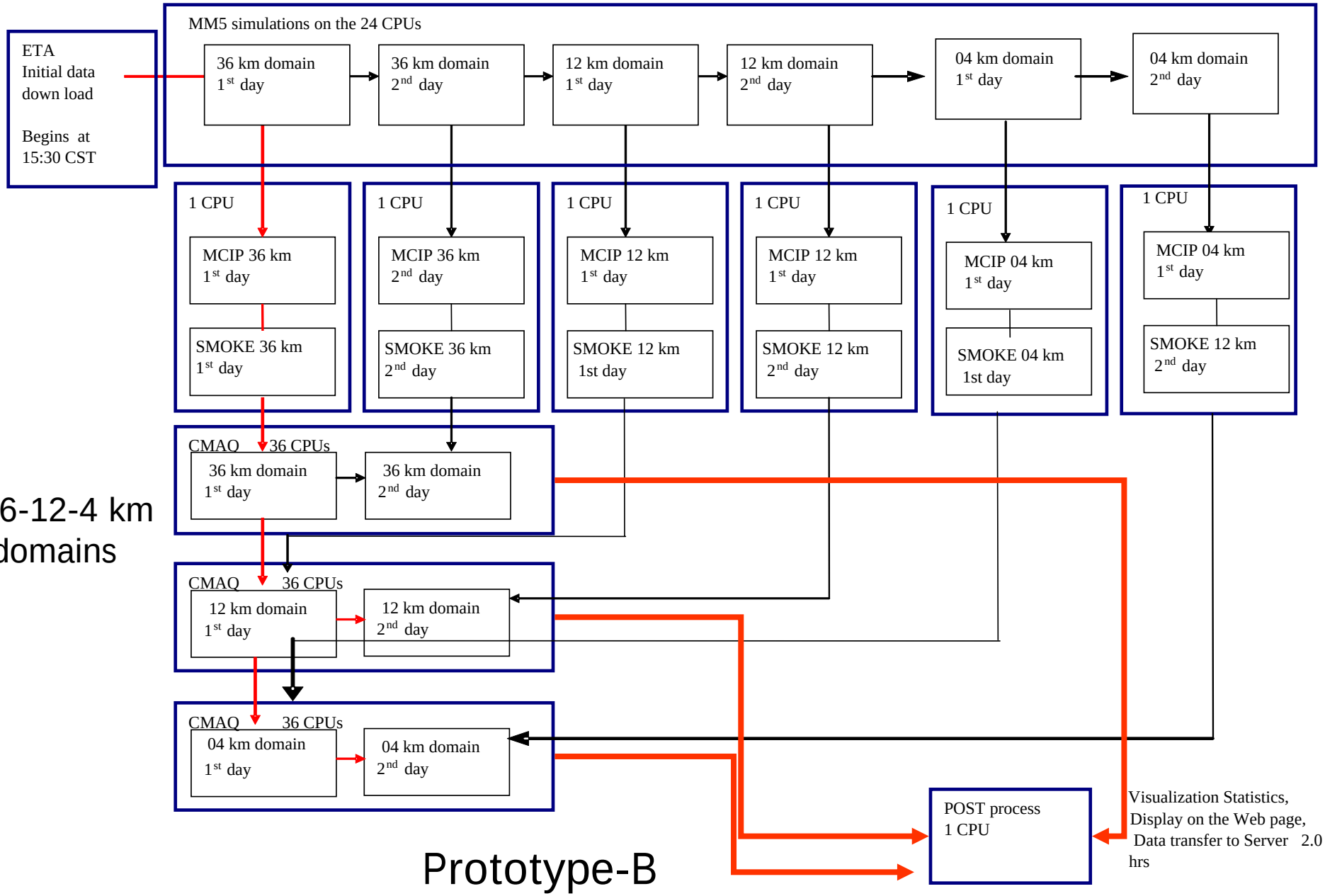
state-of-science tools for helping federal, state, and local governments to work with general public, academia and industry to solve national, regional, and local air quality problems

Modeling Domain and System Control: UH AQF system

- An AQF system is running on “texas-aqm” Linux Beowulf system at UH Dept. of Geosciences
- MM5 and CMAQ w/ SMOKE/EPS-3
- 36km, 12 km, 4 km domain simulations
- Control scripts w/ Perl XML Dataspider – download ETA forecas outputs



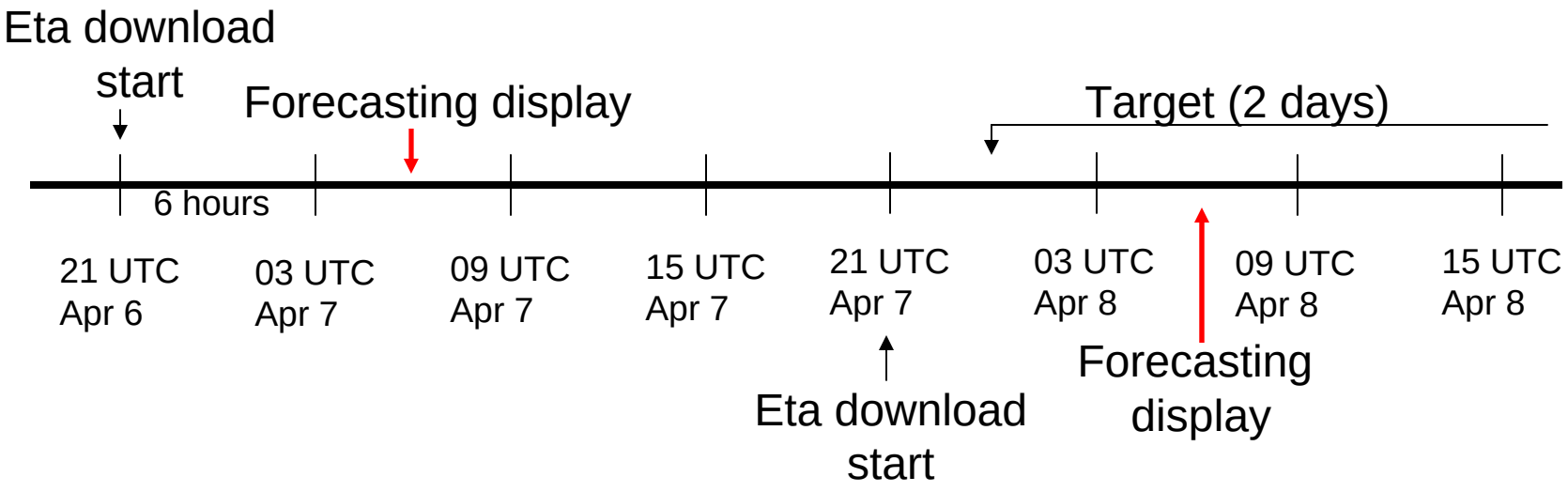
Job flow of UH AQF system



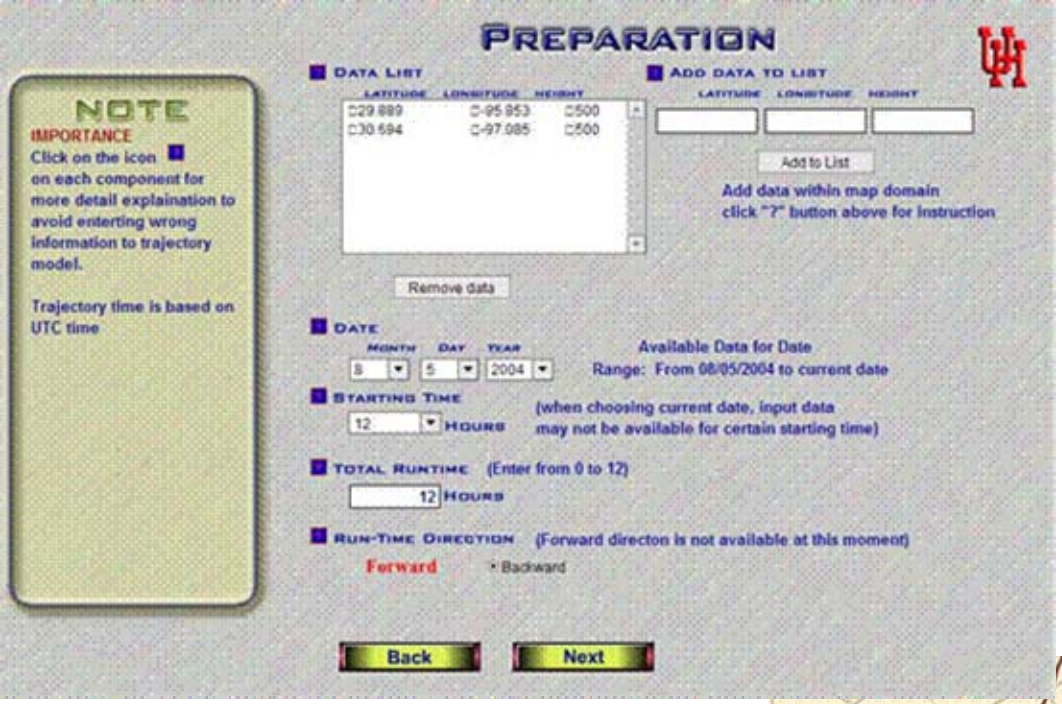
ETA download start: 21 UTC (15 LST) on Apr 6
Data content : 00 UTC Apr 8~ 00 UTC Apr 10 (2 days data)

Forecast display time : 06 UTC (00 LST) on Apr 7
(after 9 hours from ETA download)

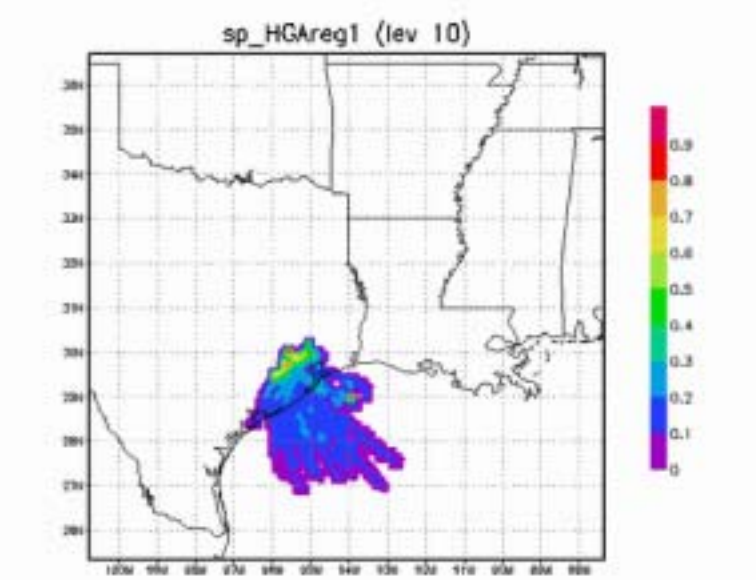
Forecasting target:
for 2 days from 18 hours in advance at display time
(00 UTC 8 Apr ~ 00 UTC 10 Apr)

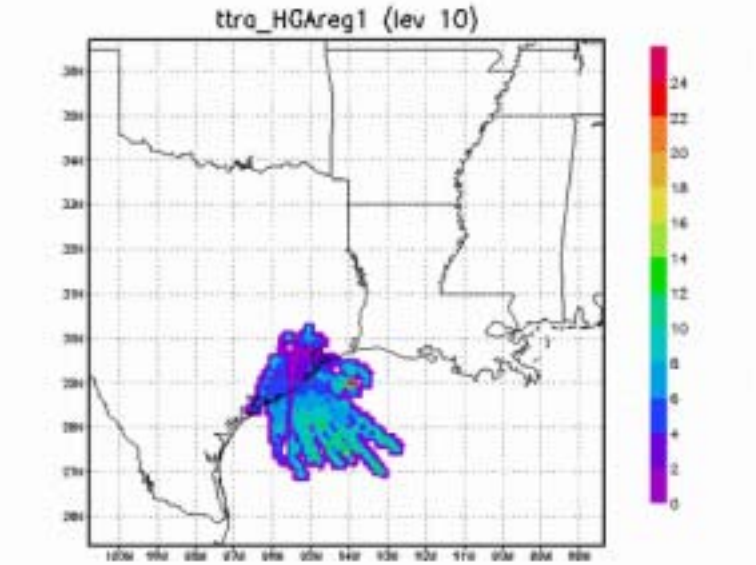


Interactive Trajectory Analysis



Example of Trajectory Source-Receptor Analysis





Stagnation Potential (SP):

$$SP_{i,j} = \frac{1}{\frac{1}{M_{i,j}} \sum_{m=1}^{M_{i,j}} v_{i,j}^{m}}$$

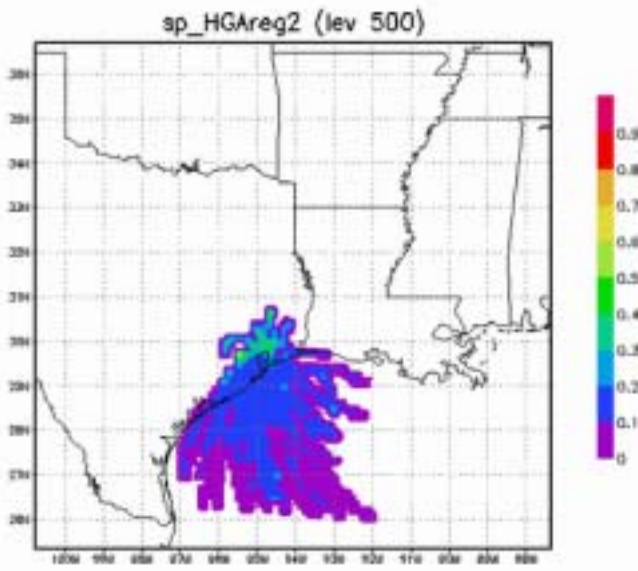
sec/m

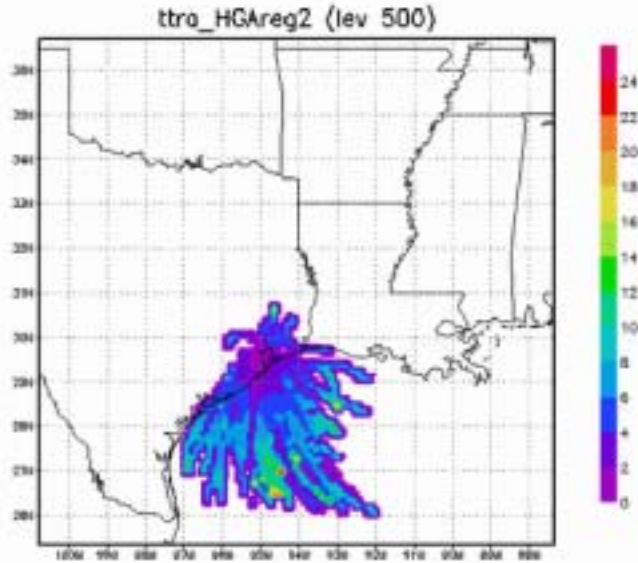
Trajectory
Travel Time (Ttrave

$$T_{travel} = SP_{i,j} \times D_{i,j}$$

$$D_{i,j} = \left[\left(x_{i,j} - x_0 \right)^2 + \left(y_{i,j} - y_0 \right)^2 \right]^{1/2}$$

Hour



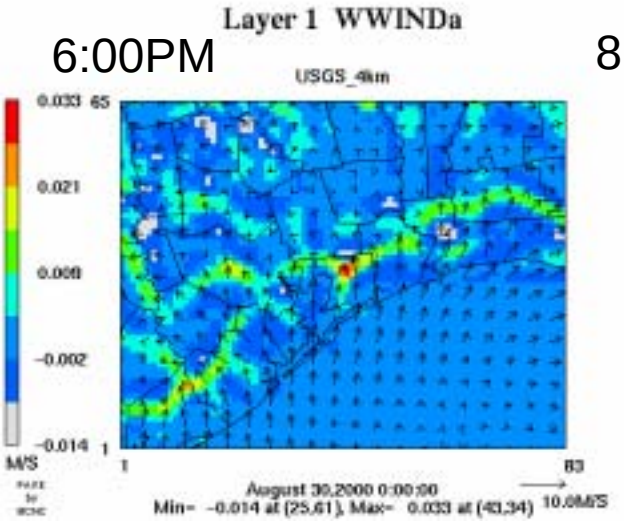


High-Resolution Meteorology for LLJ and LSB

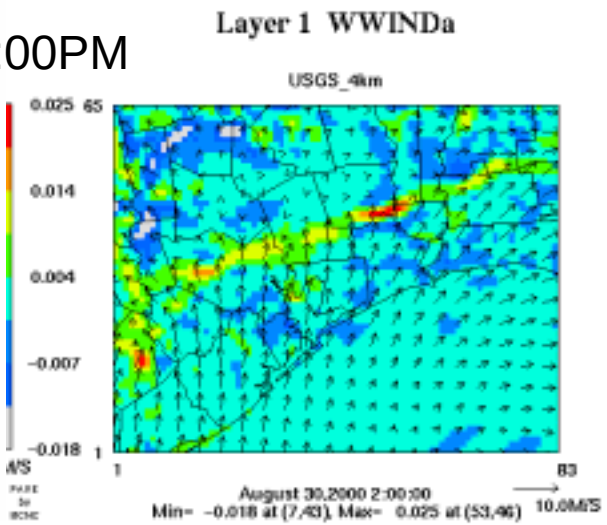
- Utilize 48-layer MM5 structure used for the urban canopy study to resolve low-level wind and temperature variations
- Perform sensitivity MM5 simulations with MRF PBL-NOAH LSM and ETA PBL – NOAH LSM
- Utilize most recent TFS LULC data instead of old USGS LULC

Land-Sea Breeze Realization
August 30, 2000 example

6:00PM



8:00PM



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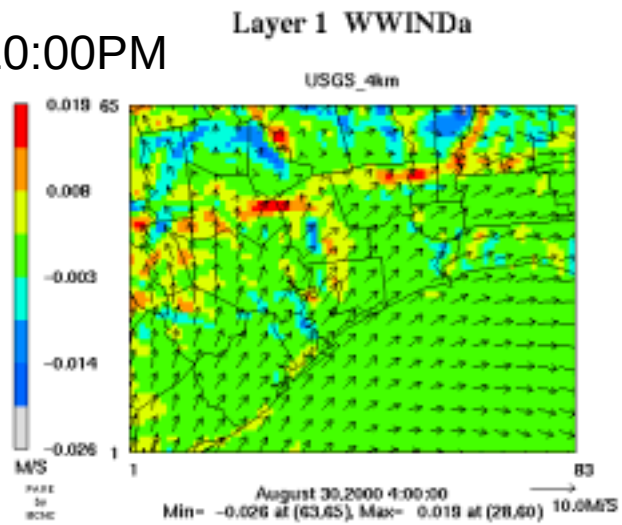

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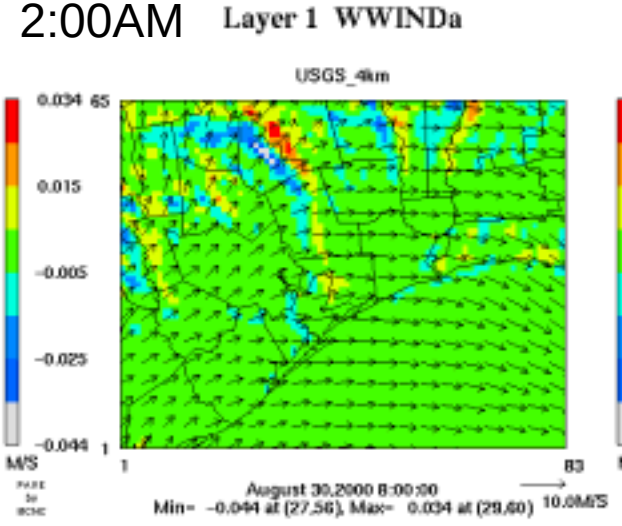

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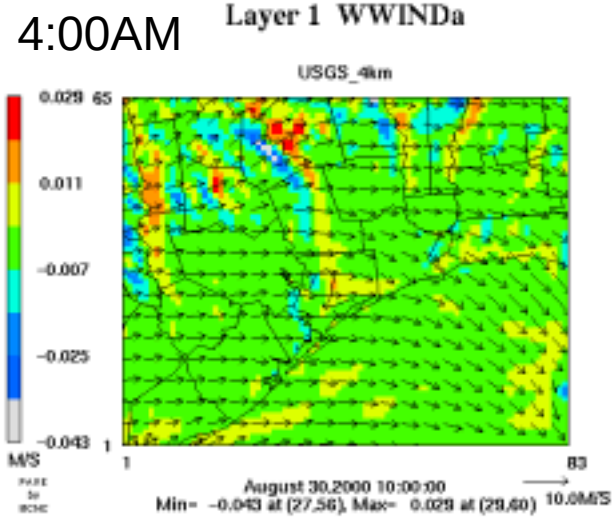

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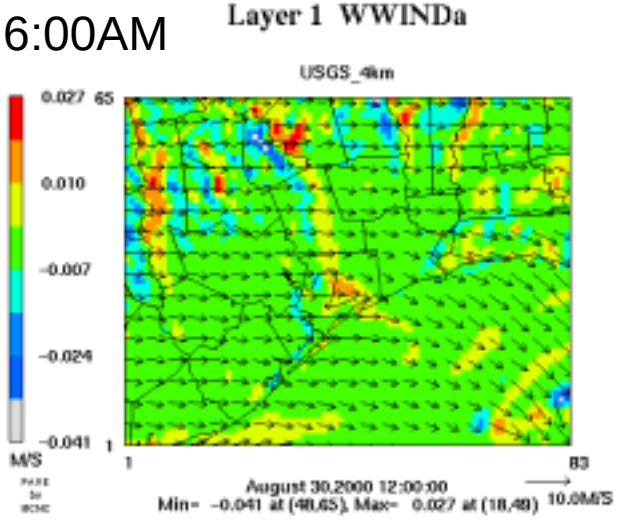
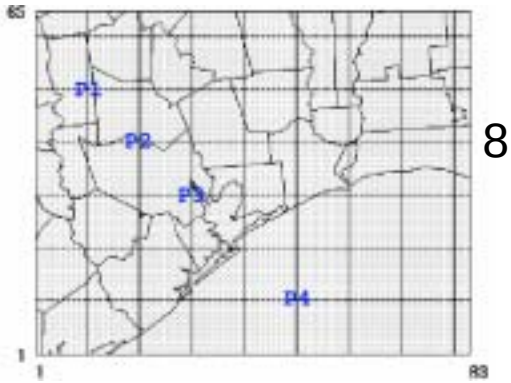


Vertical Structure & Low Level Jet



2:00AM

P1

P4

6:00AM

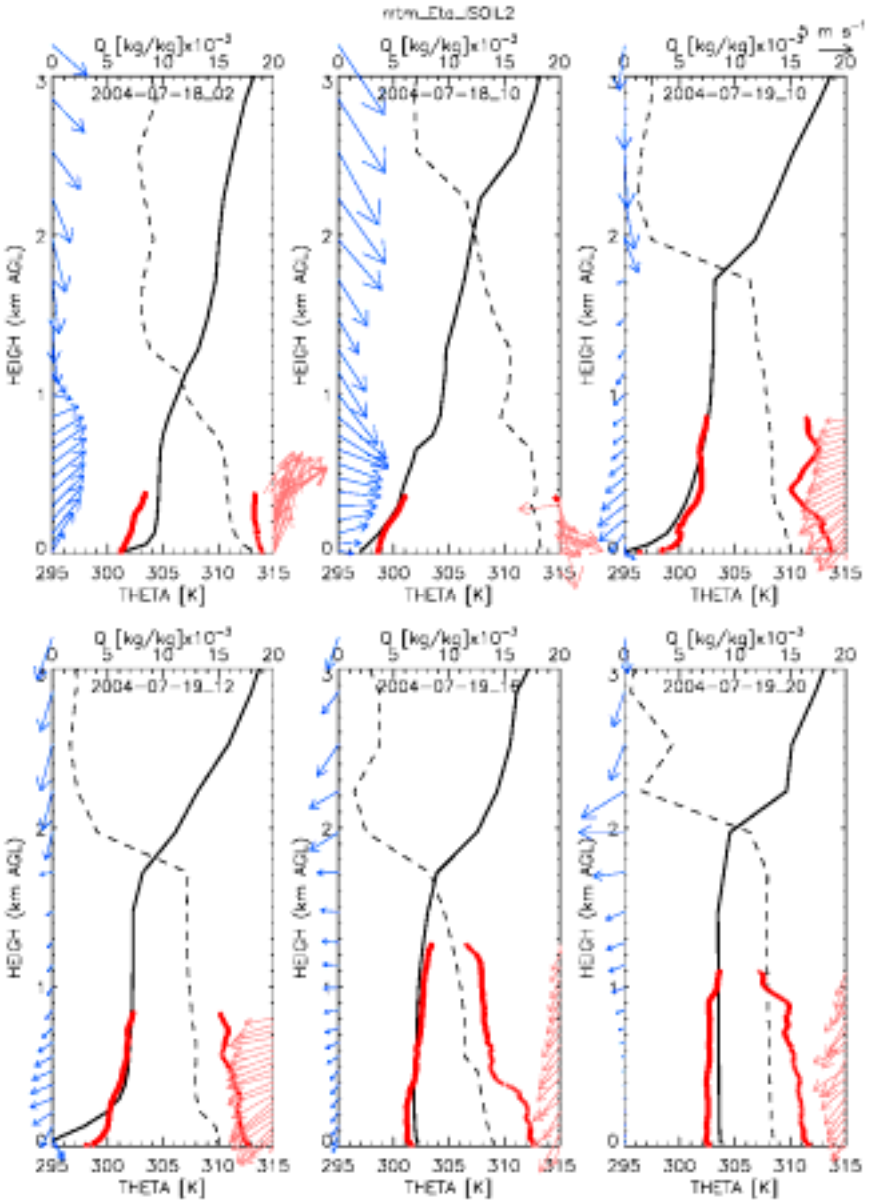
8:00AM

11:00AM

Example of Model Evaluation (Heejin In, Craig Clements, and Sharon Zhong) August 2004 Case Study at UH Coastal Center

OBSERVED DATA

UH coastal center : surface flux, tethersonde
CAMS (Continuous Ambient Monitoring Station) : T-2m, Td, WS, WD
NDBC (National Data Buoy Center) : T-2m, Td, WS, WD
NOAA Profiler : hourly U and V (~ 2.5 km) at Ellington Field
RICE Univ. Ozonesonde : T and Td (~ 20km) at every 14 CDT



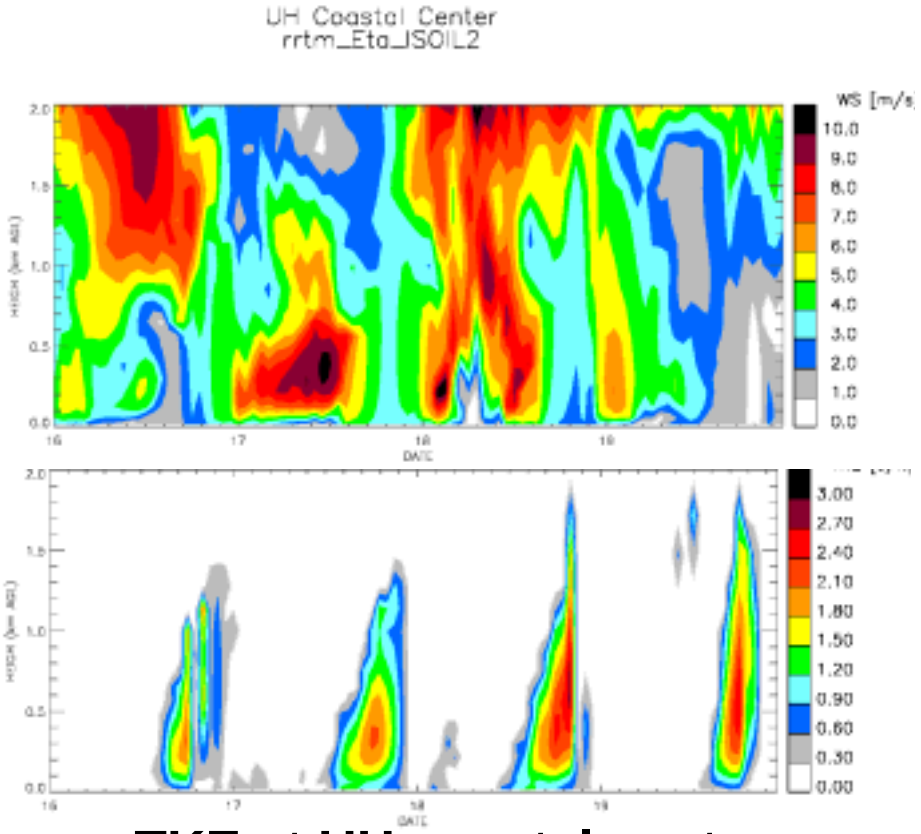
MM5 Sensitivity Study

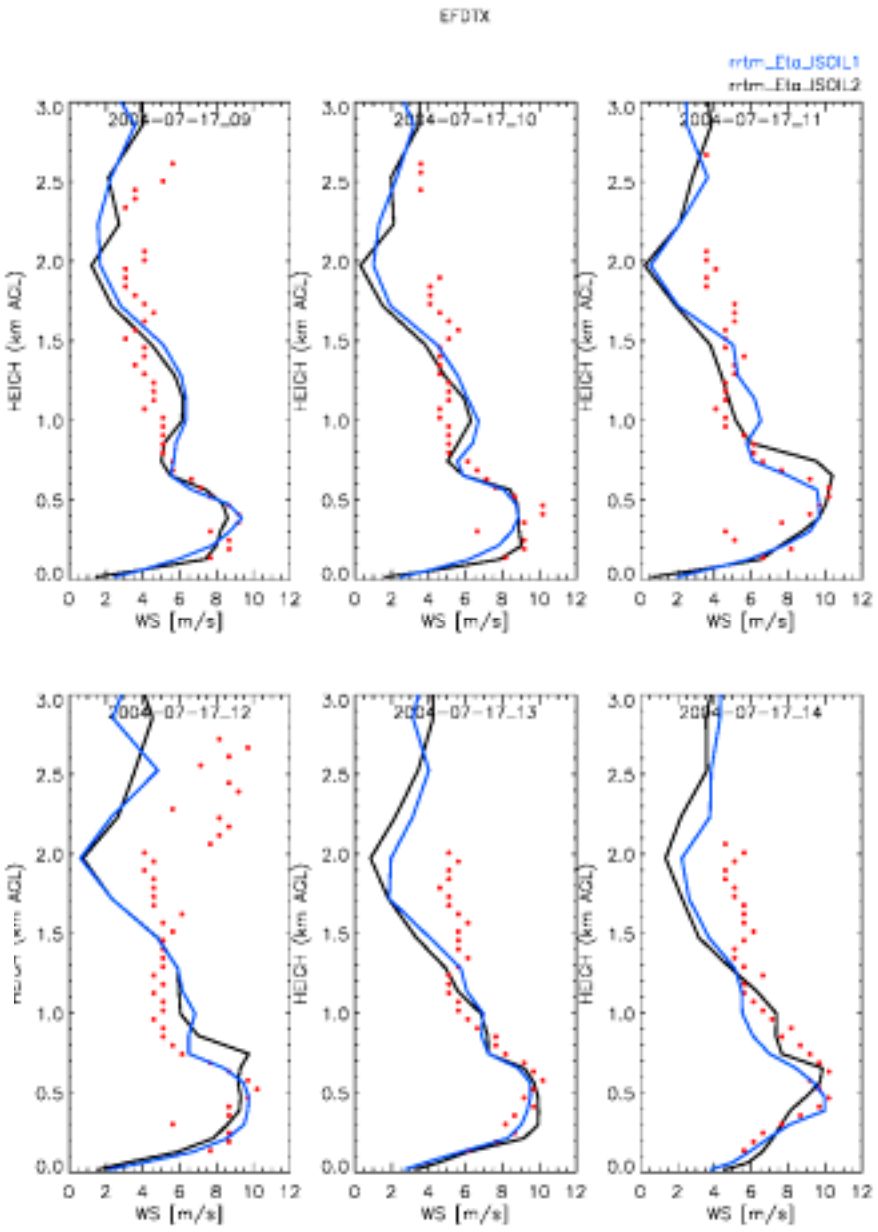
		RAD.	PBL.	LAND SFC.
BASE RUN	(0):	rrtm –	Eta –	NOAH(ISOIL2)

PBL. sensitivity (1) : rrtm – MRF – NOAH

Wind Speed

(Heejin In, Craig Clements, and Sharon Zhong)





TKE at UH coastal center