

# 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

### Lamar Univ – assist emissions processing

- Prof. Tom Ho (co-PI)
- Prof. Jerry Lin

### 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

## Developers

### 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

### Baylor College of Medicine – Public web interface development

- Prof. Winnie Hamilton (co-PI)
- Mr. Shanti Ningthoujam

## UH AQF

## Software

## Hardware

### Emission models

- SMOKE
- EPS
- GIOBEIS3
- 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

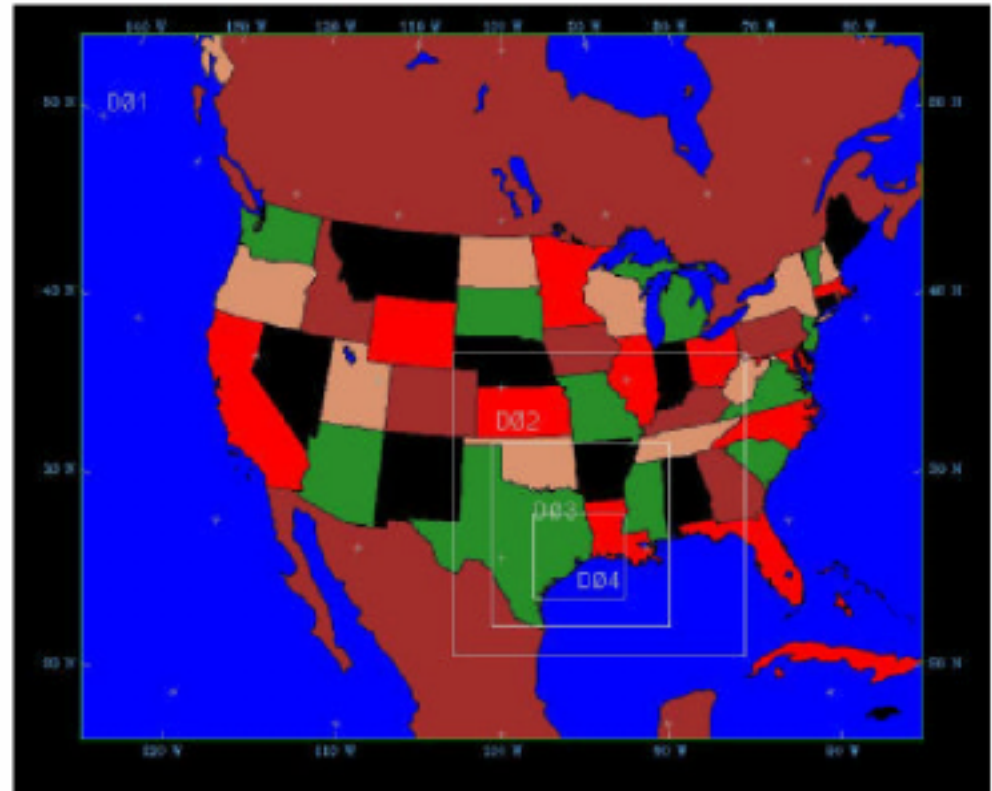
## Base Configuration of the Prototype UH AQF System

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

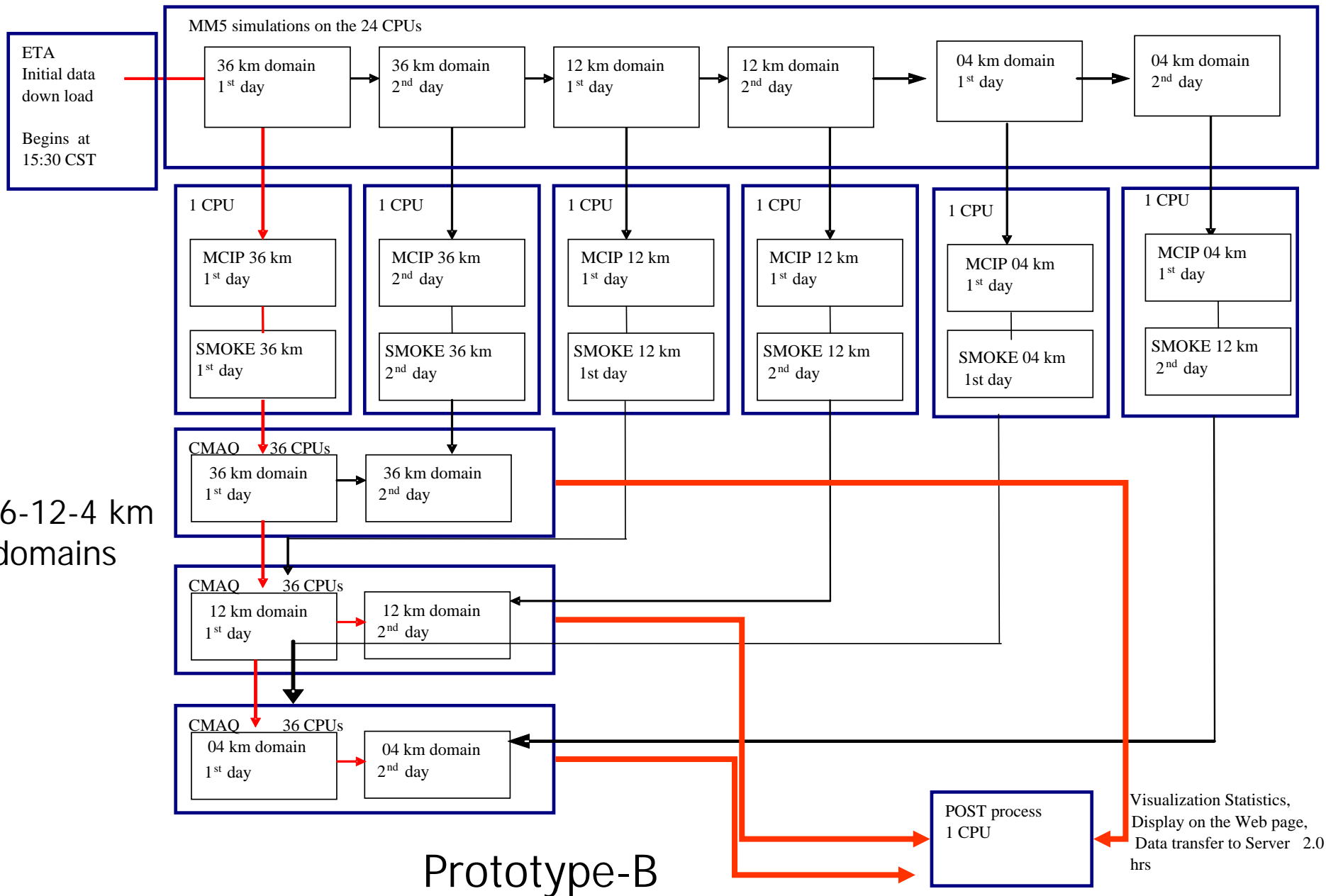
state-of-science tools for helping federal, state, and local governments to work with general public, academia and industry to solve national, regional, and local air quality problems

# 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/EP3
- 36km, 12 km, 4 km domain simulations
- Control scripts w/ Perl XML Dataspider – download ETA forecast outputs



# Job flow of UH AQF system



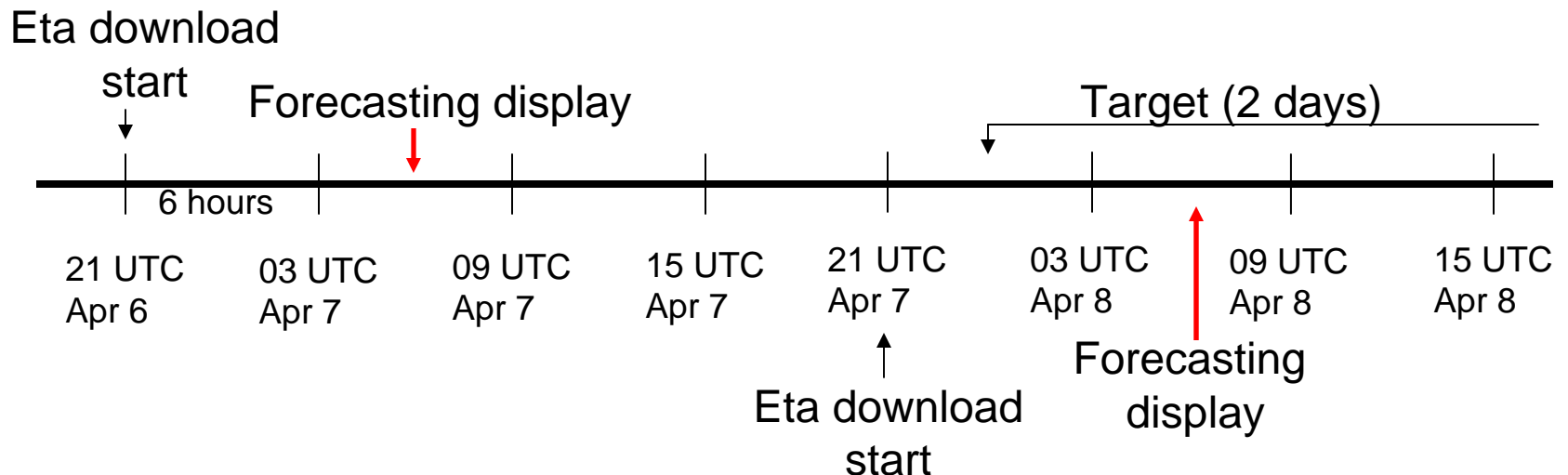
ETA download start: 21 UTC (15 LST) on Apr 6

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

## PREPARATION

**NOTE**  
**IMPORTANCE**  
Click on the icon  on each component for more detail explanation to avoid entering wrong information to trajectory model.  
  
Trajectory time is based on UTC time

**DATA LIST**

LATITUDE	LONGITUDE	HEIGHT
029.889	095.953	0500
030.594	097.085	0500

**ADD DATA TO LIST**

LATITUDE:  LONGITUDE:  HEIGHT:

Add data within map domain  
click "?" button above for instruction

**DATE**

Available Data for Date  
Range: From 08/05/2004 to current date

MONTH:  DAY:  YEAR:

**STARTING TIME** (when choosing current date, input data may not be available for certain starting time)


HOURS:

**TOTAL RUNTIME** (Enter from 0 to 12)

HOURS:

**RUN-TIME DIRECTION** (Forward direction is not available at this moment)

Forward  Backward



**IMAQS**

Scale: 0 100 200 300 Miles

232 %  
100 %

Select Coordinate  
Stop Select

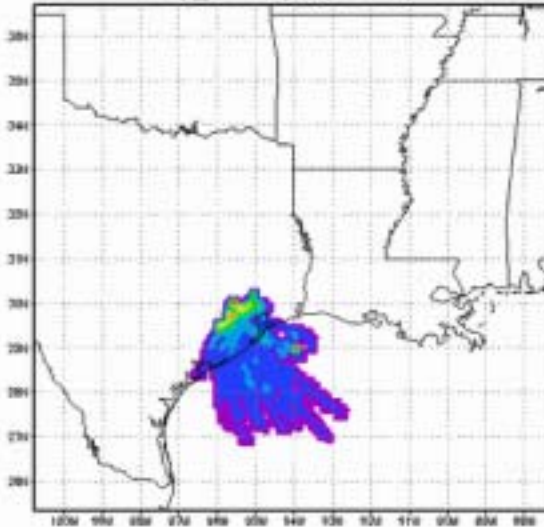
Height (m):

Longitude: Latitude: Height:

**DATA LIST**

# Example of Trajectory Source-Receptor Analysis

sp\_HGAregr1 (lev 10)

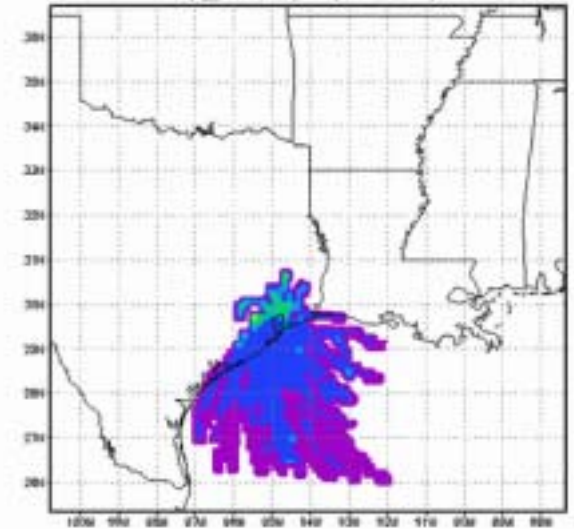


Stagnation Potential (SP):

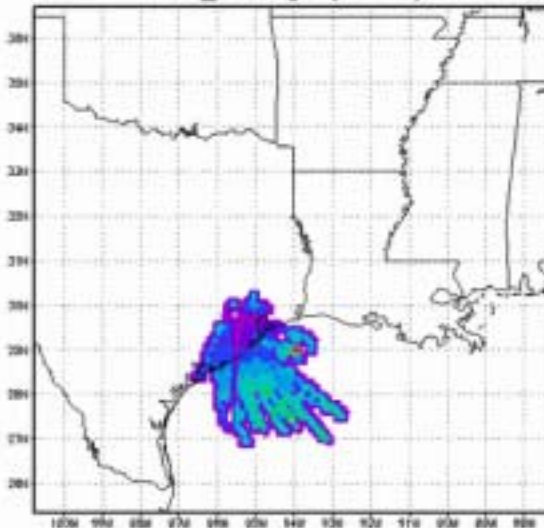
$$SP_{i,j} = \frac{1}{M_{i,j}} \sum_{m=1}^{M_{i,j}} v_{i,j}^m$$

sec/m

sp\_HGAregr2 (lev 500)



ttra\_HGAregr1 (lev 10)



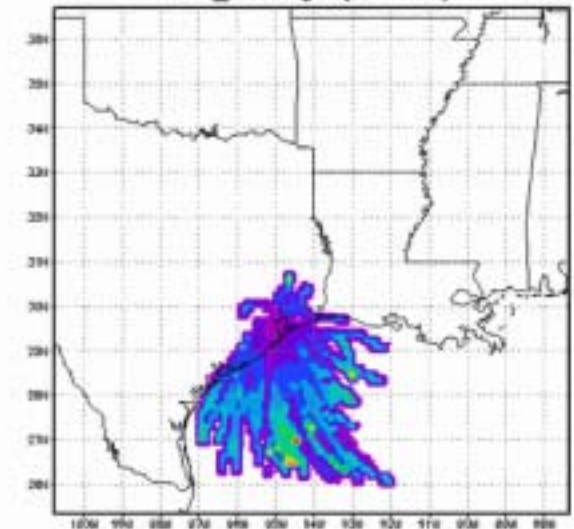
Trajectory  
Travel Time (Ttravel)

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

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

Hour

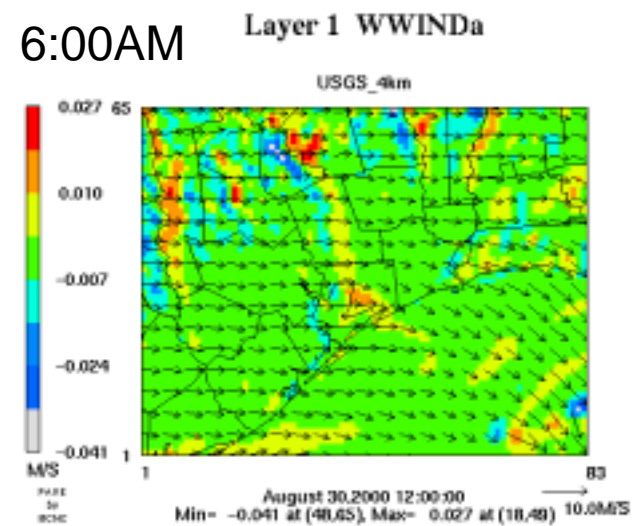
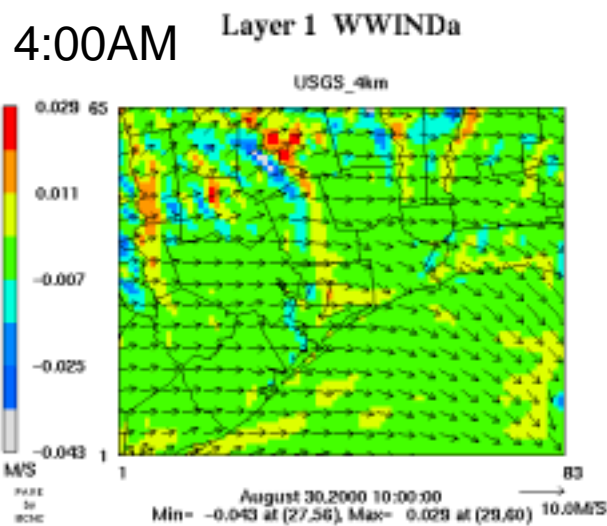
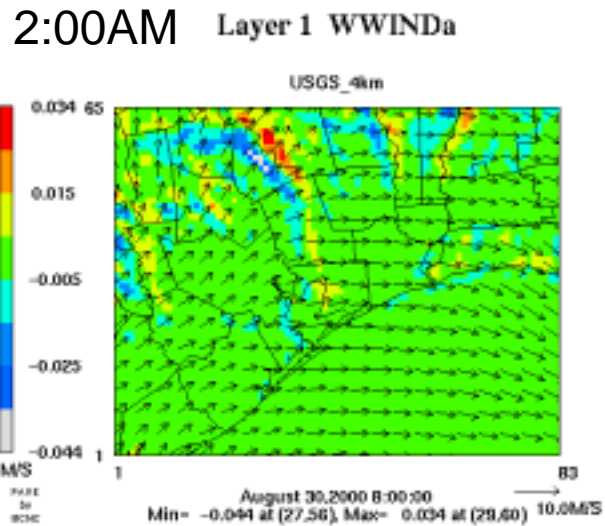
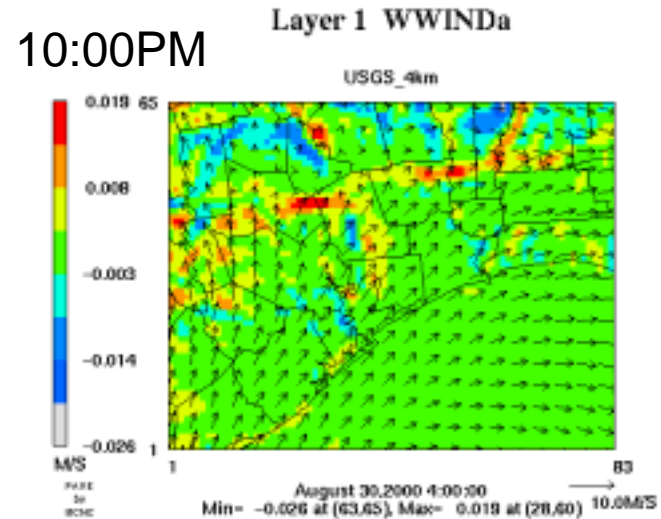
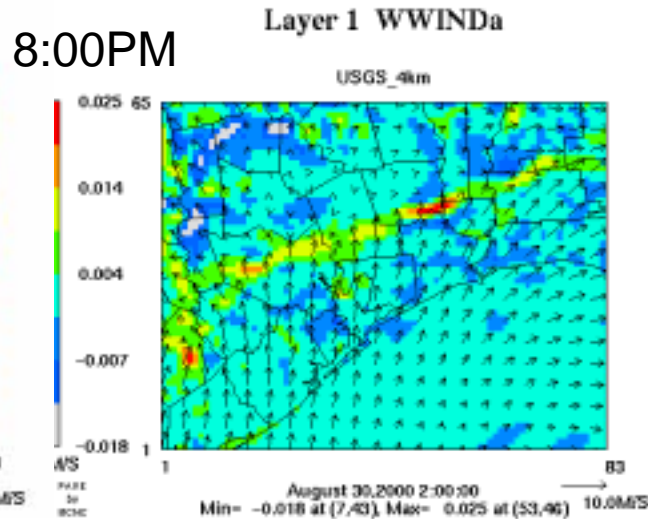
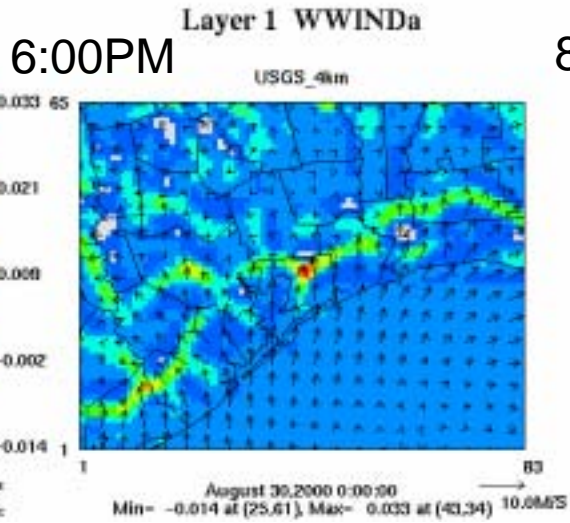
ttra\_HGAregr2 (lev 500)



# 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

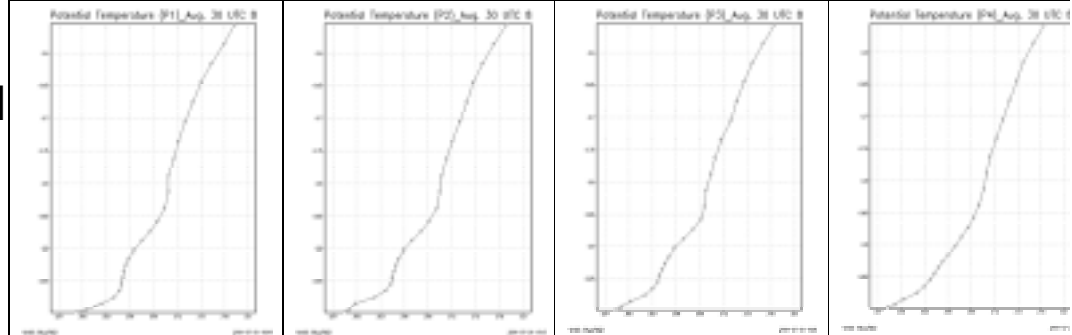
# Land-Sea Breeze Realization August 30, 2000 example



# Vertical Structure & Low Level Jet

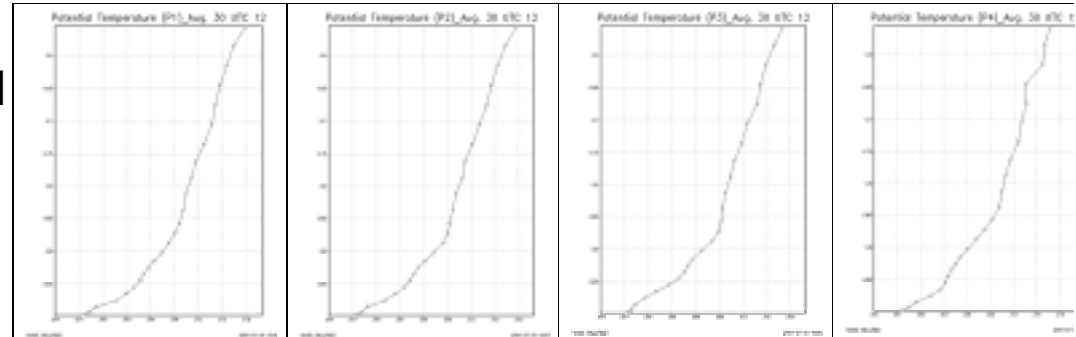
2:00AM

P1

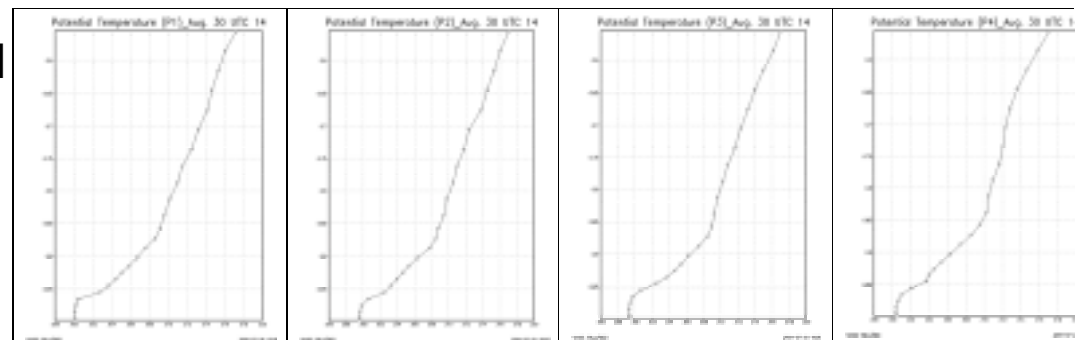


P4

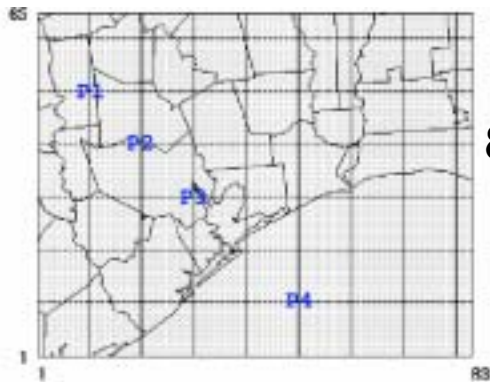
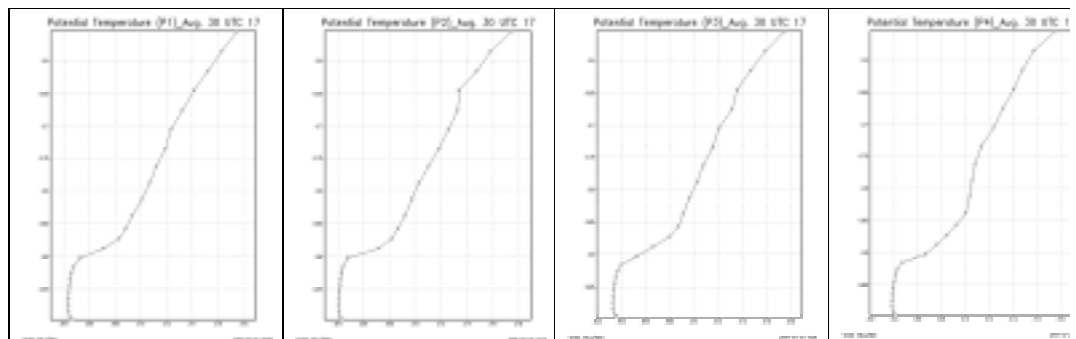
6:00AM



8:00AM



11:00AM



# Example of Model Evaluation (Heejin In, Craig Clements, and Sharon Zhong)

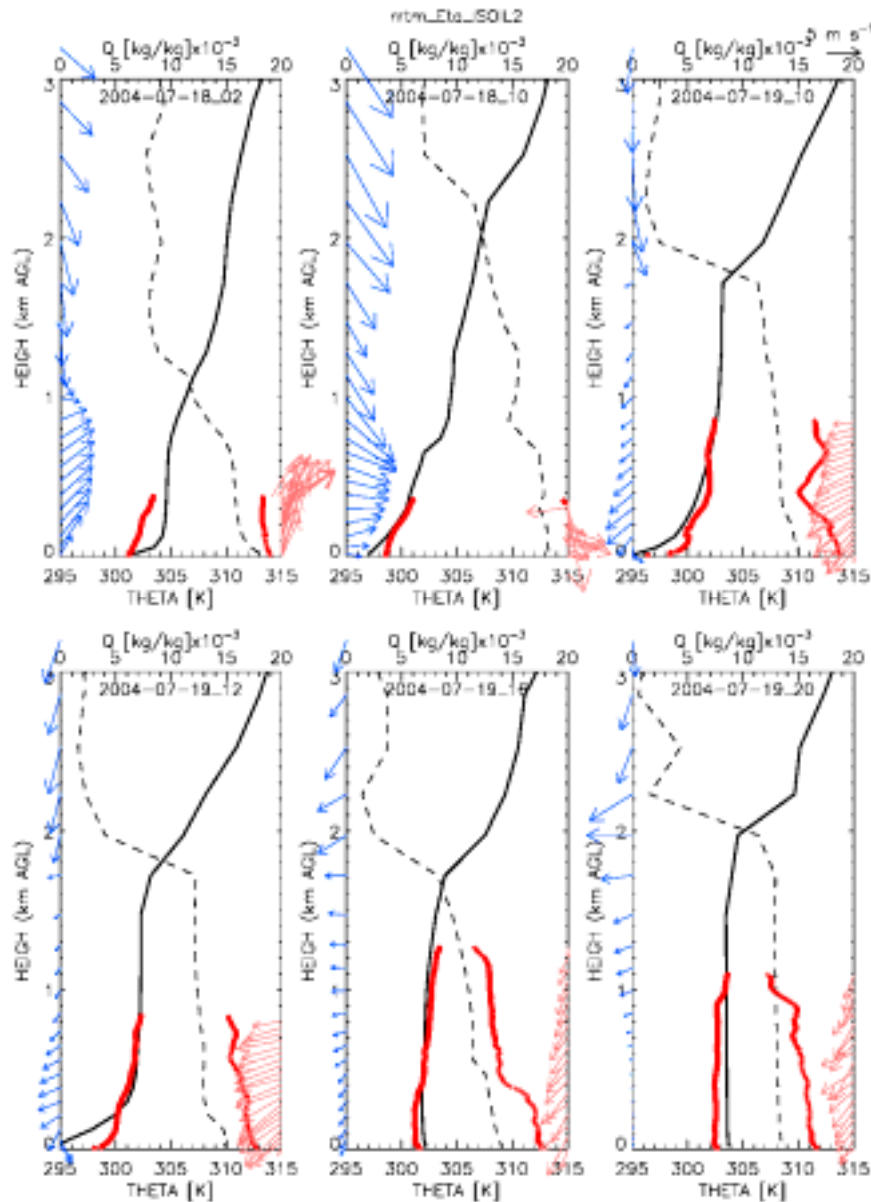
## August 2004 Case Study at UH Coastal Center

### 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

BASE RUN (0): **rrtm – Eta – NOAH(ISOIL2)**  
 PBL. sensitivity (1): rrtm – **MRF** – NOAH



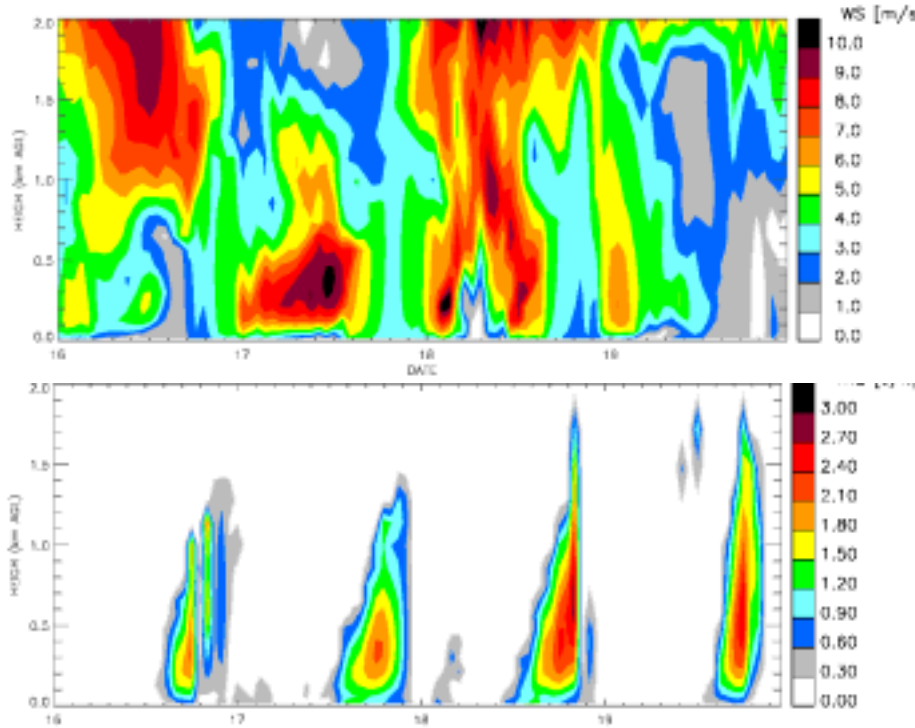
# Wind Speed

(Heejin In, Craig Clements, and Sharon Zhong)

UH Coastal Center  
rrtm\_Eta\_JSQIL2

EFDIX

rrtm\_Eta\_JSQIL1  
rrtm\_Eta\_JSQIL2



## TKE at UH coastal center

