Linking Eta to CMAQ for AQ Forecasting

Tanya L. Otte*
Atmospheric Sciences Modeling Division
NOAA - Air Resources Laboratory
Research Triangle Park, NC

* On assignment to the National Exposure Research Laboratory, U.S. EPA.

CMAQ Model Peer Review Meeting
R.T.P., NC
December 17, 2003

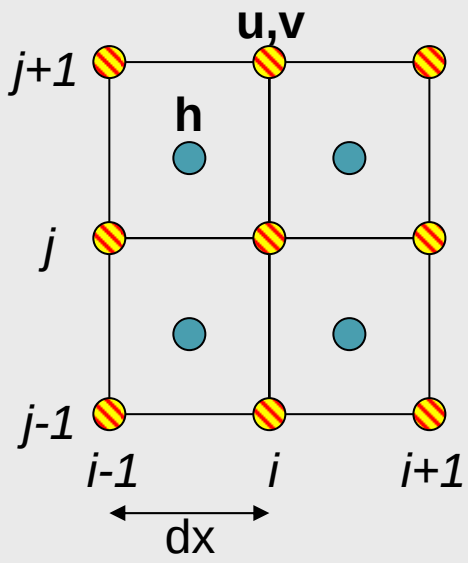
Practical and Technical Differences (1)

Eta	CMAQ
60 layers	fewer (~22) layers
step-mountain vert.	terrain-following vert.
continental	northeast U.S.
rotated lat-lon	Lambert Conformal
Arakawa-E	Arakawa-C
P_{TOP} = 25 hPa	P_{TOP} = 100 hPa

Practical and Technical Differences (2)

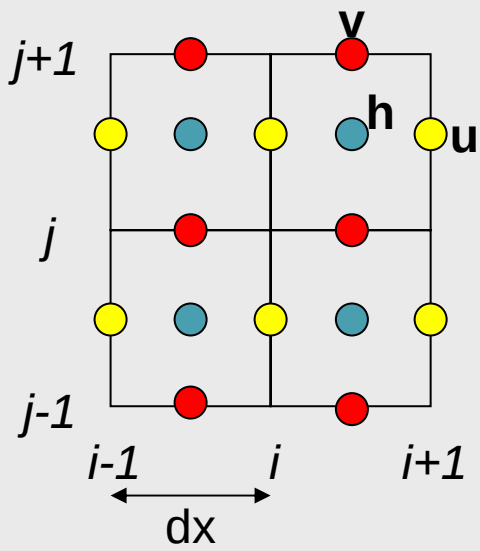
Eta	CMAQ
3-h output	1-h input
GRIB	I/O API (netCDF)
pressure-level output	terrain-following input
operational timelines	research environment
never linked to AQM	set up for MM5
one-shot simulation	adjust met as needed

B



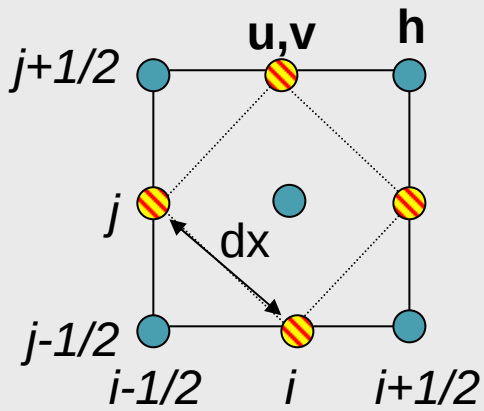
Used by: MM5

C



Used by: CMAQ, RAMS

E



Used by: Eta, NMM

Technical Questions…

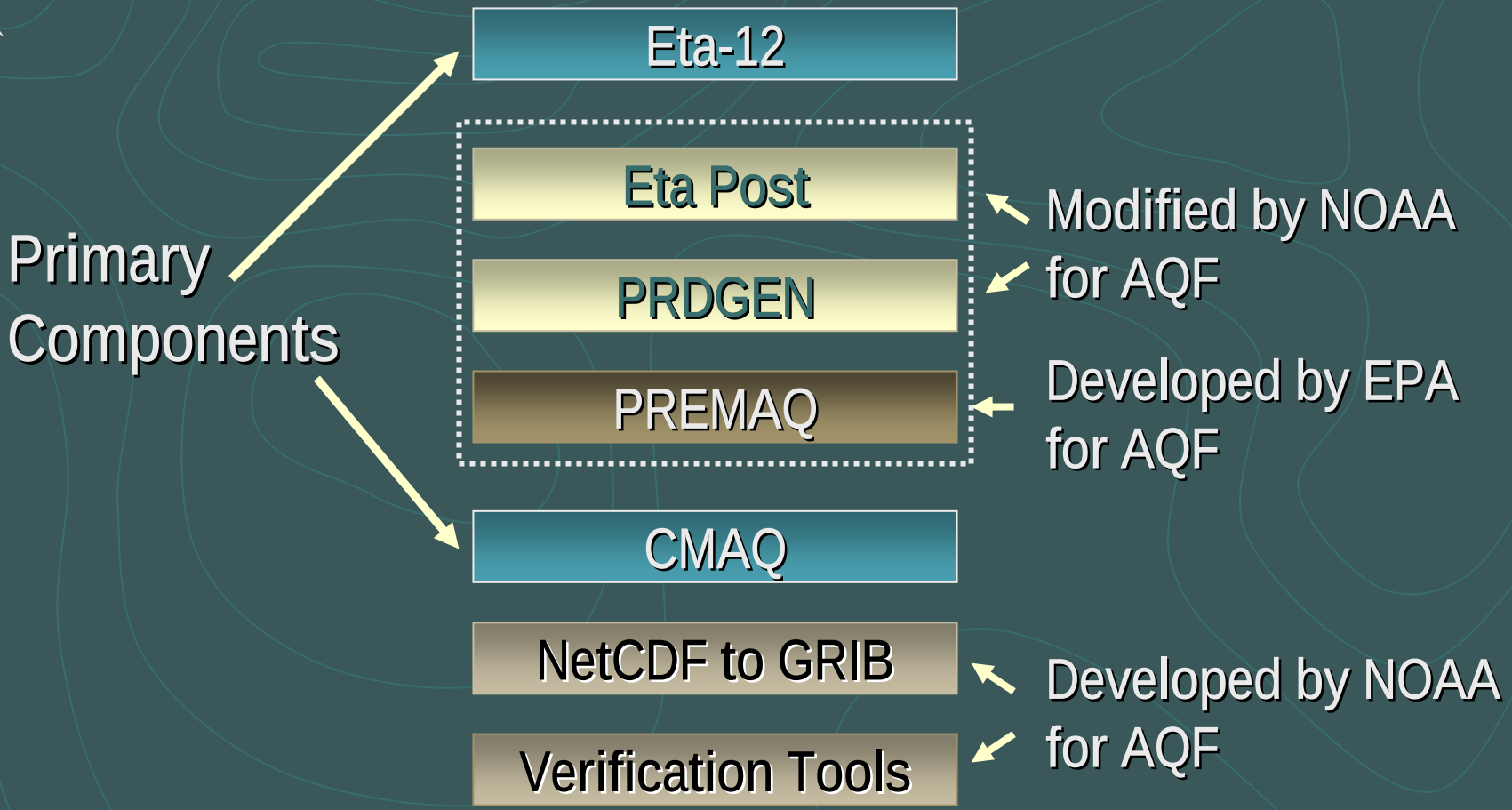
- Impact of multiple interpolations (horizontal and vertical structures) on mass conservation?
- Forecast model adequate input for CMAQ?
- Absence of FDDA through simulation?
- Handling different prognostic variables?
- CMAQ only “tuned” for MM5?

Why not use available Eta???

- Eta output processed at 3-h intervals for public
- Eta output generally available on pressure levels
- Several variables required for CMAQ not routinely available (e.g., PBL height, variables required for dry deposition velocity calculations)

- Thus…new software NOT “MCIP”

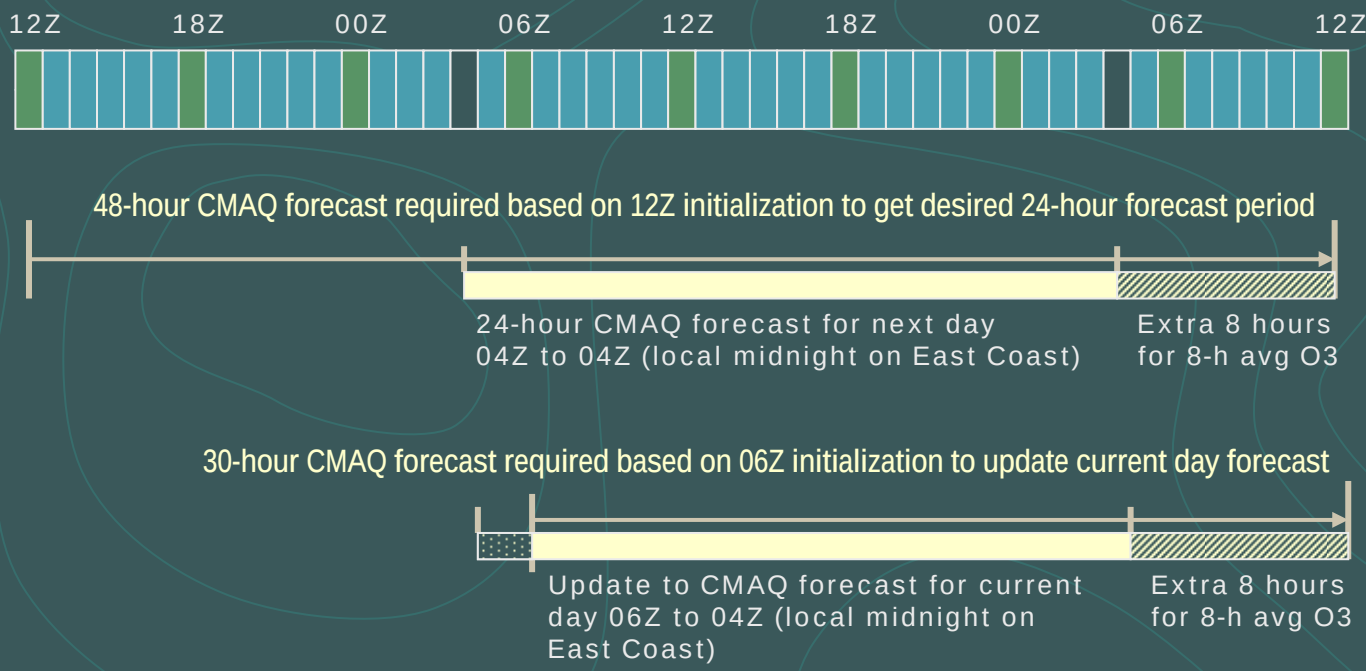
Eta-CMAQ AQF System



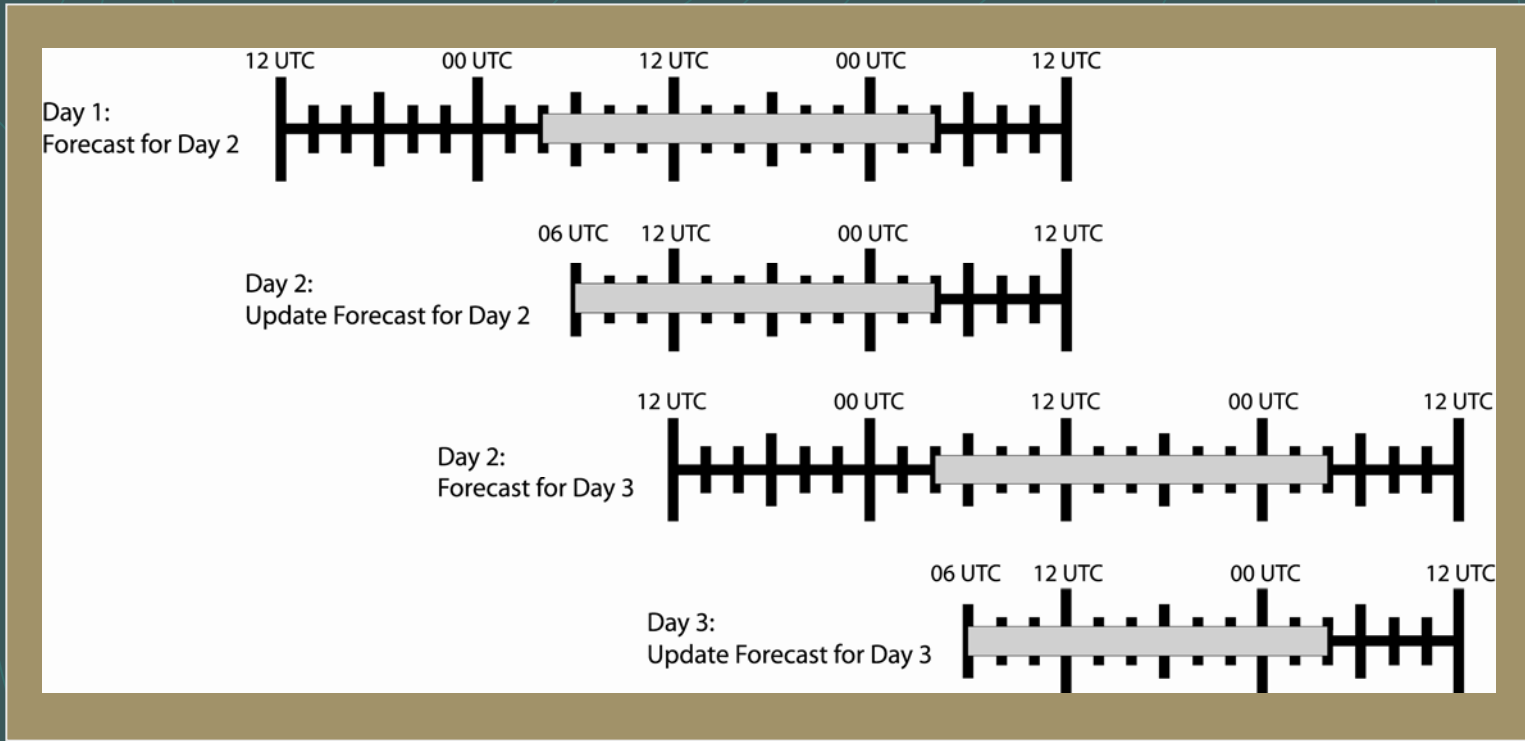
Changes to Eta at NCEP for AQF

- Hourly Eta output
- Hydrostatic σ-P structure to 100 hPa
- Additional forecast variables (PBL height, canopy conductance, plant canopy water, K_h, …)
- New GRIB grids for AQF

Forecast Timeline



AQF Operational Timeline



Northeast U.S. Forecast Domain

AQF System Components

- Eta Post: Creates diagnostic variables and performs vertical interpolations from Eta to sigma
- PRDGEN: Performs horizontal interpolations to intermediate (Arakawa-A) grid
- PREMAQ: Uses Eta output to generate CMAQ-ready meteorology and emissions fields
- NetCDF to GRIB: Creates O_3 fields for users

Linking Eta to CMAQ: NCEP Software

- Vertical interpolation – Eta Post
  - Interpolates Eta output to 22 σ layers for CMAQ
    - ~12 layers below 2 km AGL
    - Lowest layer thickness ~39 m
- Horizontal interpolation – PRDGEN
  - Uses bi-linear interpolation and nearest neighbor
  - Interpolates to Arakawa-A, Lambert conformal grid for CMAQ model in Northeast U.S. domain

PREMAQ (Pre-processor for CMAQ)

- Equivalent to MCIP processor in standard CMAQ model system
- Places interpolated Eta data into required CMAQ variable structure
- Computes needed derived variables for CMAQ (e.g., air density, deposition velocity)
- New: calculates meteorologically-dependent emissions for CMAQ (biogenic, mobile source)

New in PREMAQ (vs. MCIP)

- GRIB reader (2-D slices vs. full 3-D fields, Arakawa-A)
- Grid geometry calculations
  - Different method of defining grids in GRIB
  - GRIB precision insufficient for lat/lon
- Modifications to use different suite of variables
- New dry deposition routine
- Streamlined to reduce extraneous output
- Meteorology-dependent emissions included

Emissions for AQF

Point Sources	Pre-computed temporal emissions factors with met-dependent plume rise effects calculated each hour
Area Sources	Pre-computed for each day of year
Mobile Sources	Pre-computed emissions factors from MOBILE 5b with hourly temperature-dependent effects
Biogenic Sources	BEIS-3 using Eta temperature and radiation