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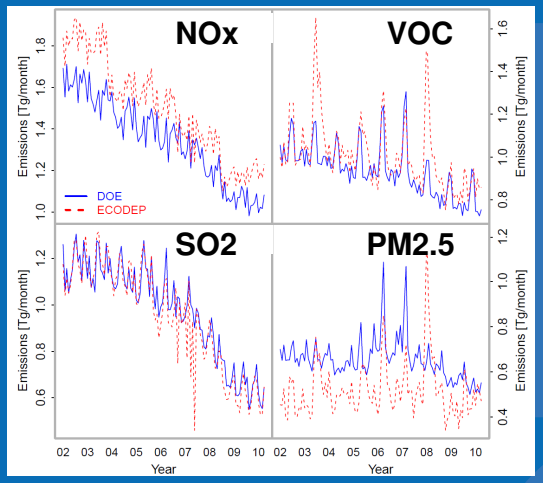
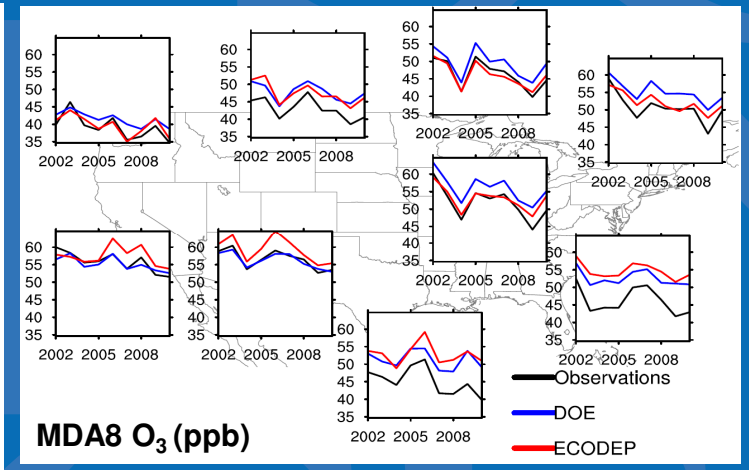
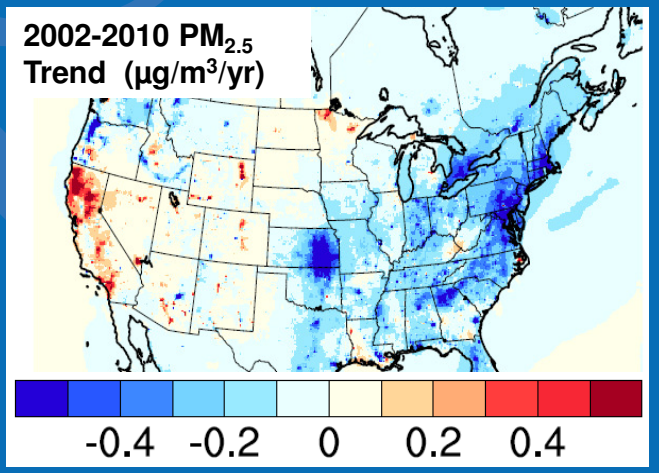
CMAQv5.3 Timeseries Project







Figures courtesy of Christian Hogrefe

CASTNET Monitoring Meeting
September 26, 2019

US EPA Office of Research and Development
National Exposure Research Laboratory

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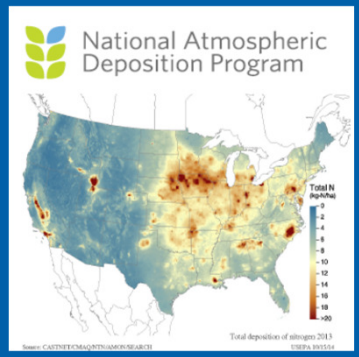
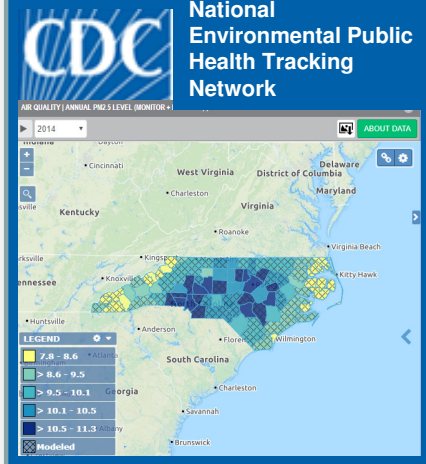
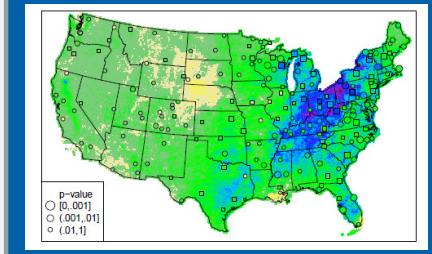
Background and Motivation

Decadal CMAQ simulations using CMAQv5.0.2 have been used for a diverse set of applications:

- Deposition trends to support **Total Deposition Maps** and nutrient assessments
- CMAQ+observed "fused" surfaces of ozone and $PM_{2.5}$ used **in CDC's Tracking Network**
- Time series-based epidemiological studies linking air quality to health endpoints
- Dynamic and diagnostic evaluation of the CMAQ system to build confidence in the use of the model for estimating trends







CMAQv5.0.2 vs NADP Wet Dep TNO3 Trend

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Background and Motivation

- New 2002 -2017 CMAQv5.3 time series offers advantages over existing modeling outputs:
  - Time series will cover more recent years, e.g. v5.0.2 time series ends in 2012
  - Development of a consistent methodology for model inputs is aimed at avoiding artificial step changes in trends analyses
  - New model versions (WRF, MOVES, CMAQ) provide an opportunity to address biases identified by dynamic evaluation of older simulations

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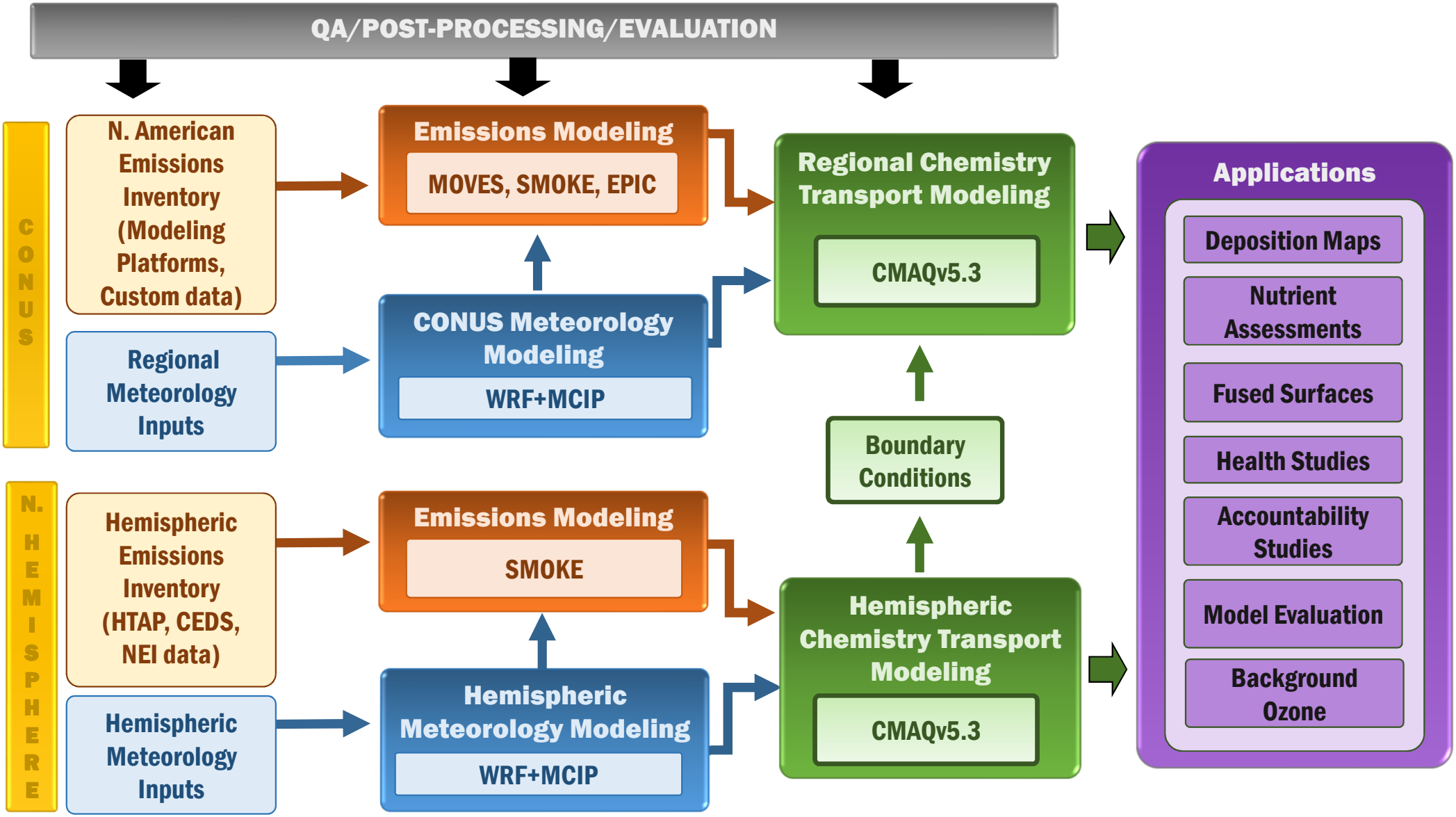
Overview of CMAQv5.3 Modeling Effort

- 2002-2017 CMAQv5.3 simulation over the Northern Hemisphere and the Continental US (CONUS) using meteorological and emissions inputs derived in a generally consistent manner across all years


QA/POST-PROCESSING/EVALUATION
CONUS
N. American Emissions Inventory (Modeling Platforms, Custom data)
Regional Meteorology Inputs
Emissions Modeling
MOVES, SMOKE, EPIC
CONUS Meteorology Modeling
WRF+MCIP
N. HEMISPHERE
Hemispheric Emissions Inventory (HTAP, CEDS, NEI data)
Hemispheric Meteorology Inputs
Emissions Modeling
SMOKE
Hemispheric Meteorology Modeling
WRF+MCIP
Regional Chemistry Transport Modeling
CMAQv5.3
Boundary Conditions
Hemispheric Chemistry Transport Modeling
CMAQv5.3
Applications
Deposition Maps
Nutrient Assessments
Fused Surfaces
Health Studies
Accountability Studies
Model Evaluation
Background Ozone

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Progress and Next Steps

- Summer 2019: Broke into workgroups to gather information and make decisions on creating a consistent set of modeling inputs.
- Fall 2019 – 2020: Finalize choices on input data set, begin development of model inputs followed by simulations.
- Simulations may need to be done in multiple phases, e.g. CONUS emissions for early years in the time series are expected to take the most time to develop and so will likely be done last.
- Tentative completion data for the entire series is currently FY2021 Q1.

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Extra slides

Overview of Existing Long-Term Model Simulations

	1990 – 2010 Simulations ("DOE")	2002 – 2014 Simulations ("ECODEP")
Model	WRF3.4 / CMAQ5.0.2 two-way, no Bidi	2002-2012: WRF3.4 / CMAQ5.0.2 offline, Bidi 2013: WRF3.7 / CMAQ5.1 offline, Bidi 2014: WRF3.8 / CMAQ5.2 two-way, Bidi 2015: WRF3.8/CMAQ5.2 offline, Bidi 2016: WRF3.8/CMAQ5.2 and 5.3beta, offline, Bidi
Grid Spacing	36km	12km
Emissions	Xing et al. (2013) • MOBILE6 mobile sources • Climatological fires scaled by year-specific activity • No marine vessel emissions	Various NEI / Modeling Platforms • MOVES mobile sources • Year-specific wildfires • Emissions from marine vessels included
Boundary Conditions	Hourly H-CMAQ (Xing et al., 2015)	2002-2004: Monthly median values from 2005 simulation of GEOS-Chem 2005 – 2012: Hourly GEOS-Chem 2013 - 2015: Hourly GEOS-Chem 2016: Hourly HCMAQ
References	Gan et al., 2015, 2016; Astitha et al., 2016	Zhang et al., JGR, 2019

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Meteorology for v5.3 Timeseries

Decision Points	Selected options
WRF Version	V4.1.1
Lightning assimilation: Yes/No	No
Land use data NLCD or MODIS?	500m MODIS enhanced with lake category
Sea surface temp data	GHRSST
VAD or RAOB wind data?	VAD
SNODAS snow cover: Yes/No	No
Data assimilation data for 12US WRF	40km AWIP for 2002-2005; 12km NAM for 2006-2017
Data assimilation data for HWRF	GFS 1 degree data for 2002-2013, higher resolution for 2014-2017 (0.5 or 0.25 degree)

North America Emissions for v5.3 Timeseries

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Key
- Decision made
- More work needed
- Have not discussed
- X Will not use

	2002	2003	2004	2005	2006	2006	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
onroad	Create ~5 years of new MOVES2014b runs (latest version) then scale remaining years															
onroad_ca_adj	Use California data for all years															
afdust_adj	Lots of year-to-year variability in dust emissions in previous NEIs															
ag	Concerns with previous NEIs, e.g. old NEIs don't have VOCs															
airports	Possibly could be scaled across years															
cmv_c1c2	Could aggregate 2017 inventory, then scale by fuel use. Consider how emission factors change over time.															
cmv_c3	Could aggregate 2017 inventory, then scale by fuel use. Consider how emission factors change over time, e.g. recent rule changes.															
nonpt	May need to break this down into subcategories by IPCC codes (e.g. residential, commercial, etc)															
nonroad	Could rerun every 3 years and interpolate															
np_oilgas	Basins change a lot from year to year. Could use scaling of state-level production.															
onroad_can																
onroad_mex																
othafdust_adj																
othptdust_adj																
othar																
othpt																

North America Emissions for v5.3 Timeseries

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	2002	2003	2004	2005	2006	2006	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ptagfire	George will create data for all years using his method															
ptegu	CEMS (EGUs and non-EGUs) data is available for al years. For non-CEMS EGUS may have issues with when smaller facilities are flagged as shut down.															
ptfire	Year specific fires from SmartFire2+Smoldering*															
ptfire_othna	FINNv1.5*															
ptnonipm	Could use NEI data and interpolate/scale for other years, but many issues to work through															
pt_oilgas	Use most recent version available for each year, but issues to work through, e.g. basins and SCCs have changed															
rail																
rwc	Some sources did not exist in early years (e.g. hydronic heaters), making back-casting more difficult; SCCs have change															
BEIS																
EPIC	EPIC inputs are available for the entire time series. Model runs much faster now.															
lightning	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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Northern Hemisphere Emissions for v5.3 Timeseries

Decision Points	Selected options
HCMAQ emissions inventory: HTAP+CEDS or wait for Edgarv5.0?	TBD (will first look at trends in annual totals for 2002-2010 to understand differences between the two options)
N. America emissions for HCMAQ: Same as for CONUS simulation or use CEDs to scale 2016 platform emissions	TBD
Biogenic Emissions	Climatological values from GEIA + seasonal diurnal profiles
Soil NOx: GEIA or some version of BDSNP parameterization	GEIA