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DISCOVER-AQ Forecast Briefings

Meteorology

Forecast maps – NWS surface and NAM upper air; today and the next 3 days

NAM/MOS time series – Denver and Ft. Collins; today and next 3 days;
T, TD, WS, WD, RH, POP, Sky cover

BUFKIT – NAM – time series of cloud amount by altitude, precip, and PBLH
– next 3 days

PBLH from NOAA/ARL WRF-ARW

Wind fields at several sigma levels from NOAA/ARL WRF-ARW

Cloud forecast maps – NAM, GFS, Canadian, GEOS-5

NWS forecaster comments/advice

Fly/no-fly recommendations



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DISCOVER-AQ Forecast Briefing

Air Quality

Air quality yesterday – surface station O₃ observations

Air quality forecast maps – NOAA/ARL CMAQ products – O₃, NO₂, HCHO
today and tomorrow

Ozone forecasts from State agency – today, tomorrow, beyond?

Air quality yesterday – surface station PM_{2.5} observations

AERONET and MODIS AOD – yesterday

Air quality forecast maps – NOAA/ARL CMAQ product – surface PM_{2.5}

Air quality forecast maps and time series – GEOS-5 aerosol extinction, AOD,
mass concentrations by aerosol type

PM_{2.5} forecasts from State agency – today, tomorrow, beyond?



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DISCOVER-AQ Forecast Products

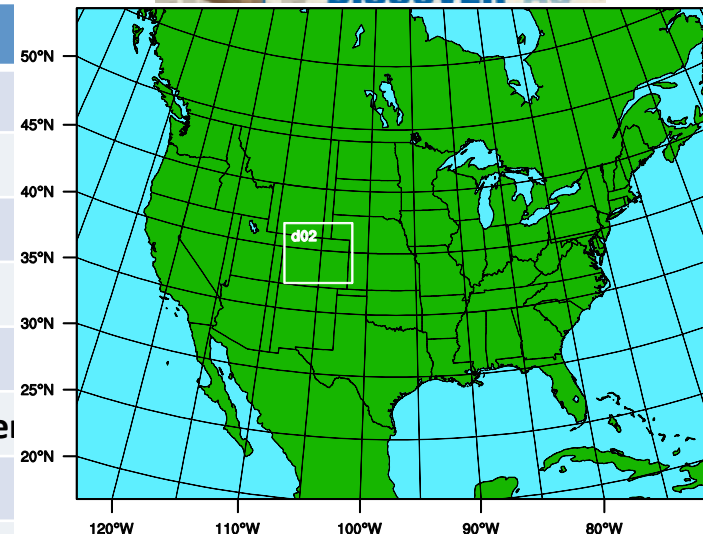
- **NAQFC - β Forecasting support (NOAA/ARL)**
 - Initialized at 00 UTC with 60 hours forecast duration
 - WRF-ARW (12km N-America & 4 km CONUS)
 - CMAQ 4.7.1 (12km CONUS & 4 km DISCOVER-AQ/FRAPPÉ region)
 - Includes Aero5 aerosol mechanism (not in NCEP operational version)
- **GEOS-5 (NASA/GSFC)**
 - Global at 25 km;
 - 5-day chemical forecasts twice daily (00 and 12 UTC)
 - Total column O_3 , GOCART aerosols, CO, CO_2 , SO_2 (simple chemistry)
 - QFED fire emissions
 - Includes aerosol assimilation (MODIS AOD)
- **QFED Fire Emissions (NASA/GSFC)**
 - Near real time estimates based on MODIS Fire Radiative Power (AQUA/TERRA)



NAQFC- β forecasting support: Initialized at 00 UTC with 60 hours forecast duration

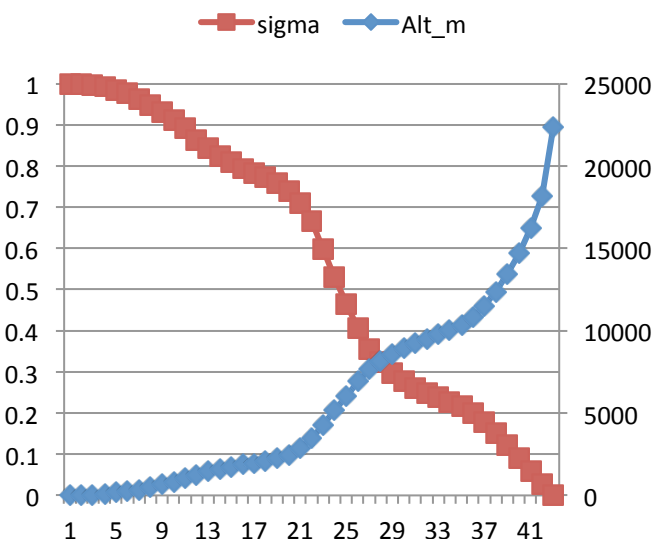


WRF-ARW	Both North America (12 km) & CONUS (4 km)
Map projection & grid	Lambert Conformal & Arakawa C staggering
Vert. co-ordinate	42 σ-p unevenly spaced levels
advection	RK3 (Skamarock and Weisman (2008))
SW & LW radiation	RRTMG (Iacono et al. 2008))
PBL Physics	Mellor-Yamada-Janjic (MYJ) level 2.5 closure
Surface layer scheme	Monin-Obukhov Similarity with viscous sub-layer
Land Surface Model	NCEP Noah
Cloud Microphysics	Thompson et al. (2008)
Cloud convective mixing	Betts-Miller-Janjic Mass adjustment



Forecast: 12 km nested to 4 km

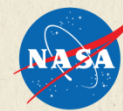
CMAQ4.7.1	Both CONUS(12 km) & DISCOVER-AQ/FRAPPE (4 km)
Map projection & grid	Lambert Conformal & Arakawa C staggering
Vert. co-ordinate	42 σ-p unevenly spaced levels
Gas chemistry	Cb05 with 156 reactions
Aerosol chemistry	Aero5 with updated evaporation enthalpy
Anthropogenic emission	2005NEI as base year, mobile projected using AQS*, area and off-road used CSPR^, point source uses 2012 CEM data
	WRAP oil and gas emissions data
Biogenic emission	BEIS-3.14
Lateral BC	RAQM (B. Pierce)



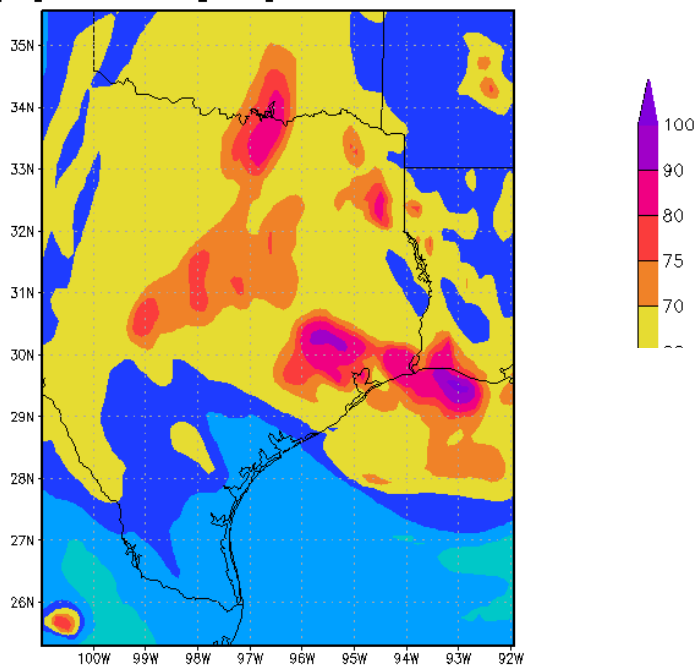
42 vertical layers



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O3 [ppb] at 1013 [hPa] Valid 20Z SEP 26 2013



GRADS: COLA/IGES

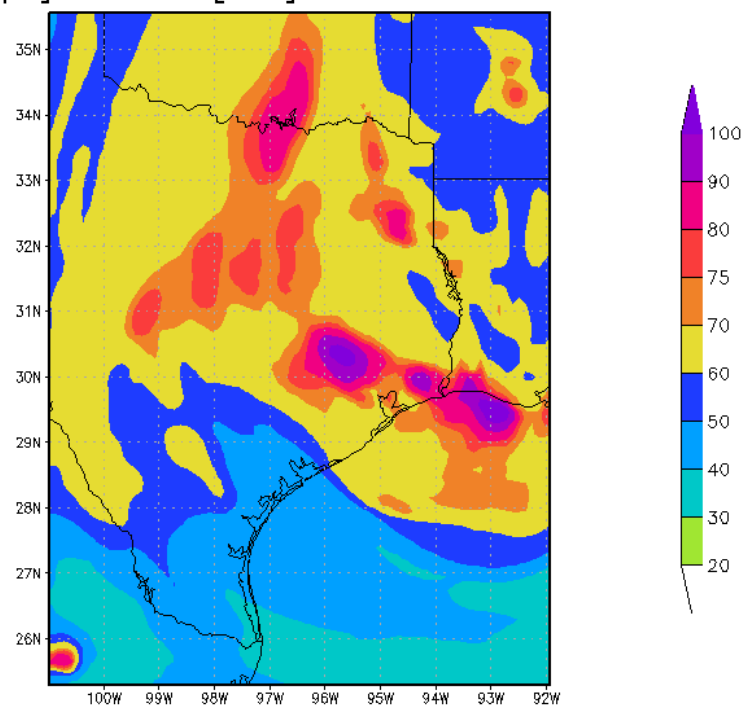
3 PM

Examples

NOAA Experimental CMAQ Forecast

5 PM

O3 [ppb] at 1013 [hPa] Valid 22Z SEP 26 2013



GRADS: COLA/IGES



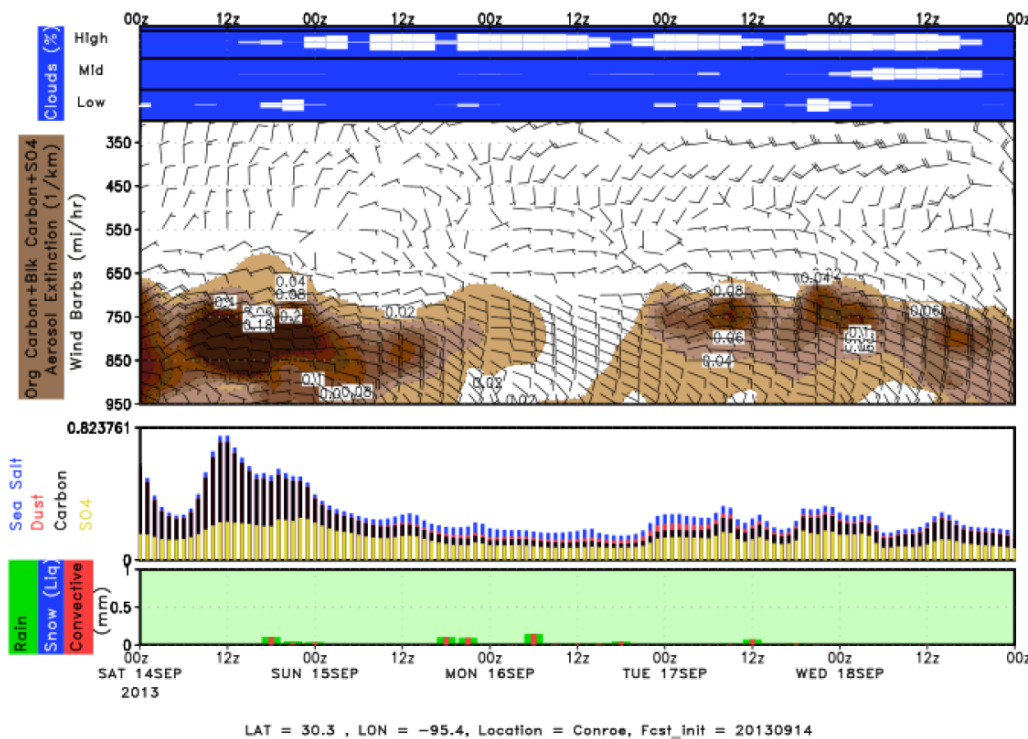
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NASA GEOS-5 aerosol forecast from: 00 UT 14 Sept.

Examples

CONROE

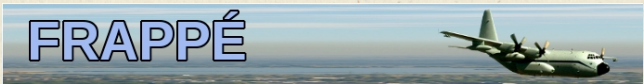


Cloud cover

Extinction

AOD

GEOS-5 global model at 0.25 deg. resolution;
GOCART aerosols, CO, SO₂; includes assimilation of MODIS AOD
Run by Arlindo da Silva at NASA/GSFC

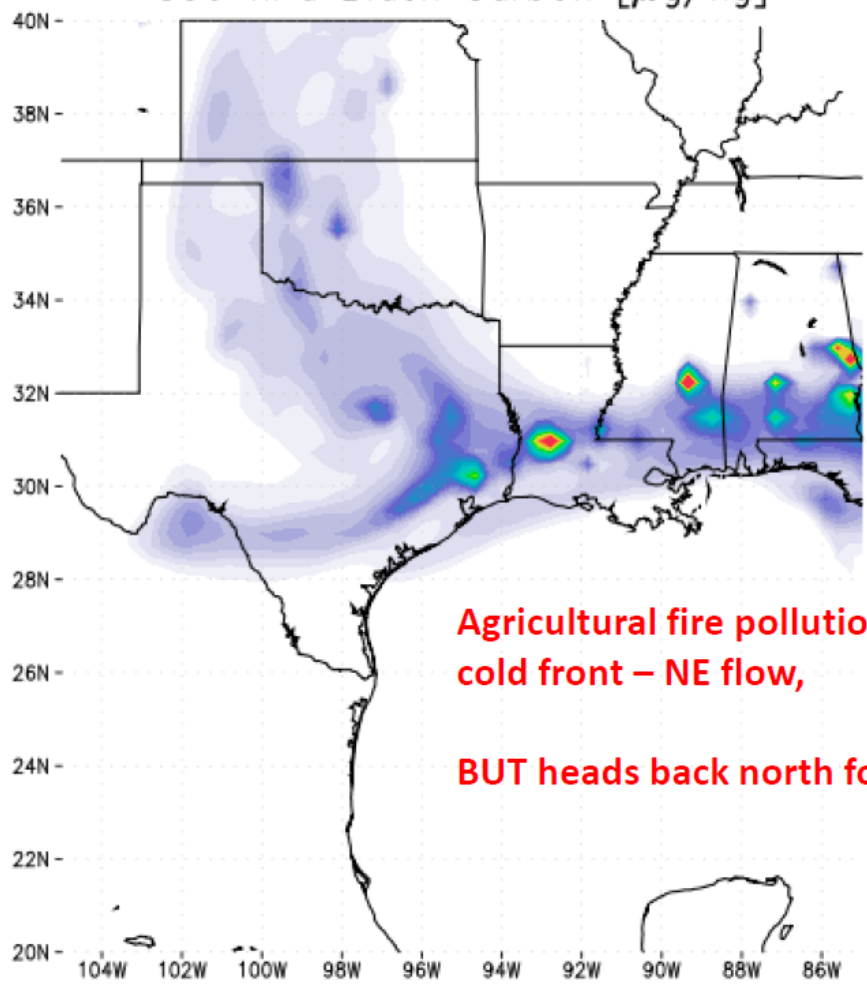


GEOS-5 Aerosol Forecast Maps

Examples

NASA/GMAO – GEOS-5 Forecast Initialized on 06z 2013-09-13

850 hPa Black Carbon [$\mu\text{g}/\text{kg}$]



1pm Saturday

Agricultural fire pollution pushed to south by cold front – NE flow,

BUT heads back north for Sunday – E flow.

Valid: Sat 18z 2013-09-14 ($\tau = 36$)



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FRAPPÉ Forecast Briefings

Jointly with DISCOVER-AQ

Additional Met & Chemistry Products

Short-term forecasts for aircraft and mobile vans

Decisions on Flight Day and Flight Pattern for C-130

- up to 3-5 days out, larger CO regions
- Flight Objectives: special events (fires, LRT,..), recirculation, emissions, ...

CDPHE/APCD

4 meteorologists will continue to issue statewide and Front Range forecasts for O₃ and other pollutants 7 days a week.

Includes 9 AM MDT update, a 24-36 hour forecast by 3 PM MDT, and a multi-day outlook. *(see presentation by Patrick Reddy)*



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FRAPPÉ Forecast Products

Satellite Products

- FINN near-real-time fire emissions (based on MODIS fire counts) (NCAR/ACD)
- MOPITT CO (within 1 day of overpass) (NCAR/ACD)
- IASI CO (~ 4-day delay) (NCAR/ACD)

Met Forecasts

- WRF with assimilation (NCAR-RAL)
 - 3DVar (no radar DA, 3h UC/12h fcst/1km)
 - 3DVar (with radar DA, 1h UC/12h fcst)
 - 4DVar (with radar DA, 3h UC/12h fcst)
 - RTFDDA (with radar DA, 3h UC/24h fcst)



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NCAR/RAL STEP - Short Term Explicit Prediction

Outside systems:

- NSSL (3DVar with radar DA, 1h UC*/12h fcst)
- GSD/FAB (LAPS with radar DA, 1h UC/12h fcst)
- UK MetOffice (UM-WRF, 6h UC/36h fcst)

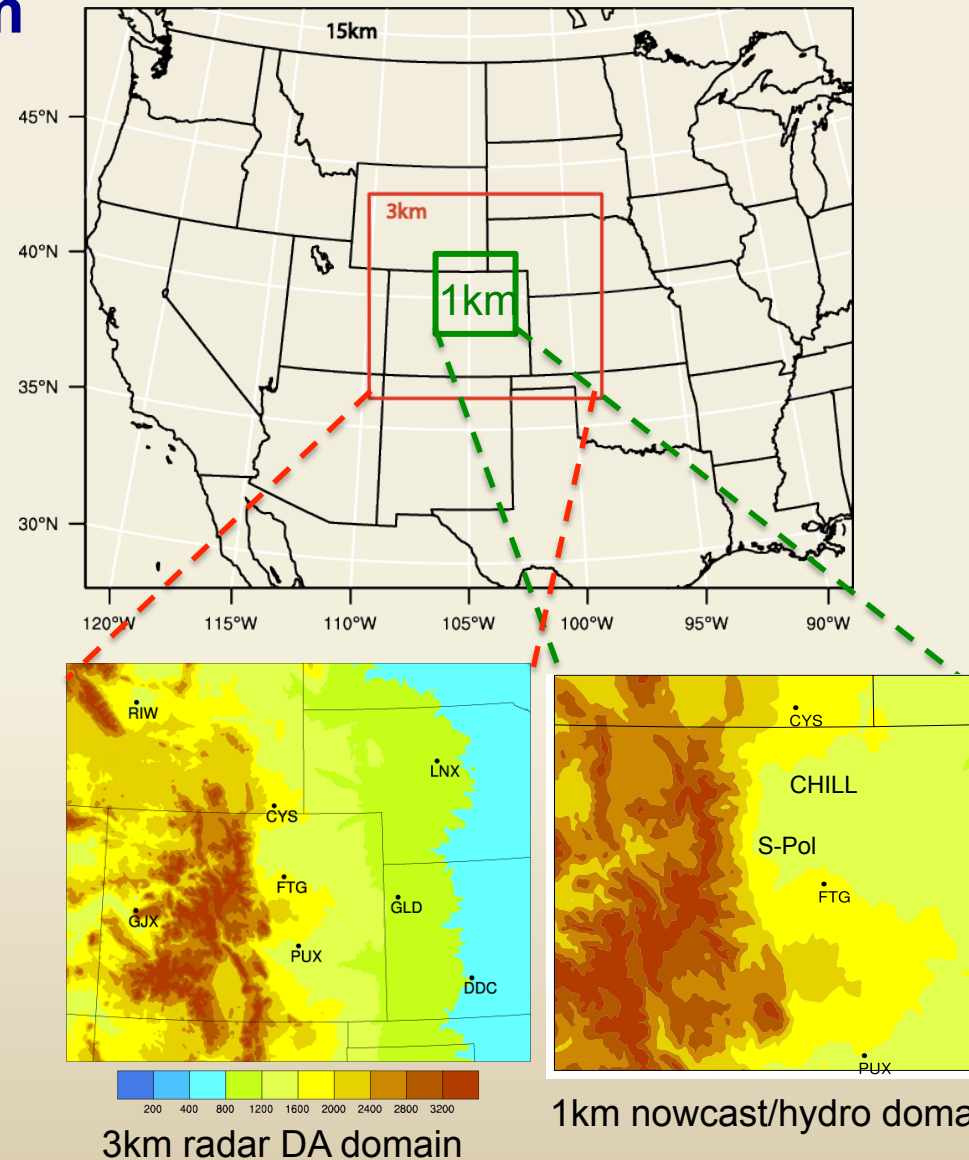
NCAR systems:

- WRF 3DVar (no radar DA, 3h UC/12h fcst/1km)
- WRF 3DVar (with radar DA, 1h UC/12h fcst)
- WRF 4DVar (with radar DA, 3h UC/12h fcst)
- RTFDDA (with radar DA, 3h UC/24h fcst)

* UC – Update Cycle

Examples

Nested WRF domain





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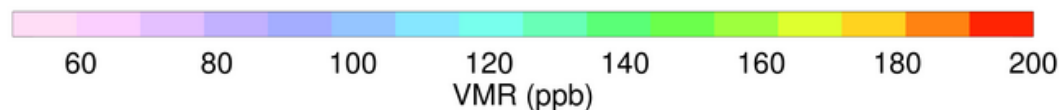
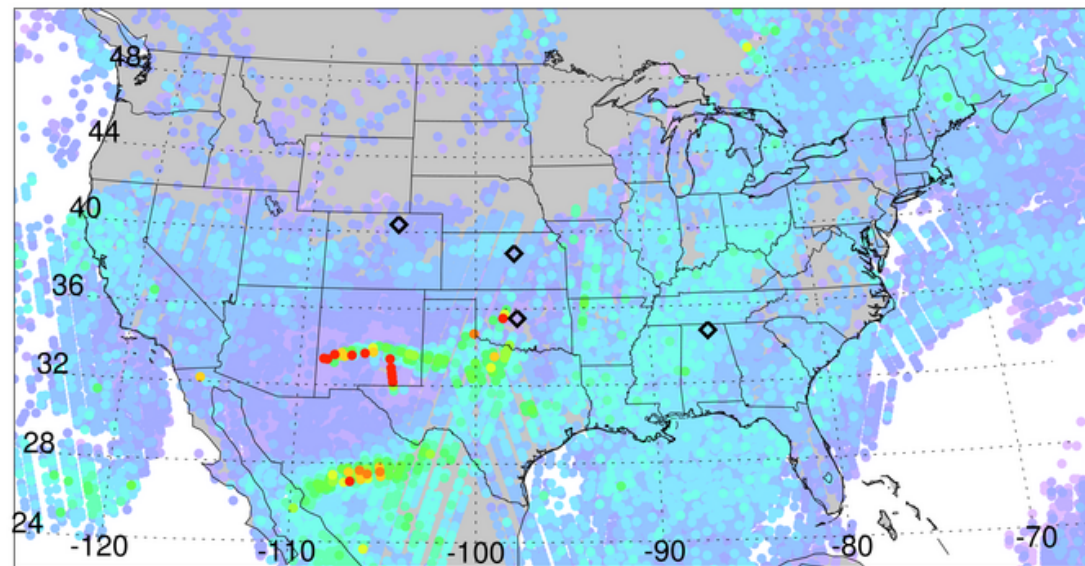
NCAR/ACD MOPITT and IASI CO

- MOPITT CO – available within a day of overpass
- IASI CO – about 4-day delay, global coverage 2x/day

NCAR/FORLI

IASI CO Total Column Effective VMR

24 May 2012





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FRAPPÉ Forecast Products

Chemical/Tracer Forecasts

- MOZART-4 global, 5-day forecast (NCAR)
 - Full chemistry at $1.9^{\circ} \times 2.5^{\circ}$ (possibly assimilation of CO)
 - Tracer forecasts at $0.5^{\circ} \times 0.5^{\circ}$ (CO, isoprene-like,)
- RAQMS (NOAA/NESDIS)
 - Global 1x1 degree on-line chemical and aerosol assimilation and forecasting system
 - Assimilation of MODIS AOD, MLS stratospheric O₃ profiles and OMI total O₃
- WRF-Chem (NOAA/ESRL)
 - WRF-Chem on RAPid refresh (RAP) 13km domain; 48 hour forecast
- WRF-Chem Tracers (NCAR/ACD) - added to RTFDDA
- FLEXPART (NCAR/ACD): Forward trajectories for defined sources

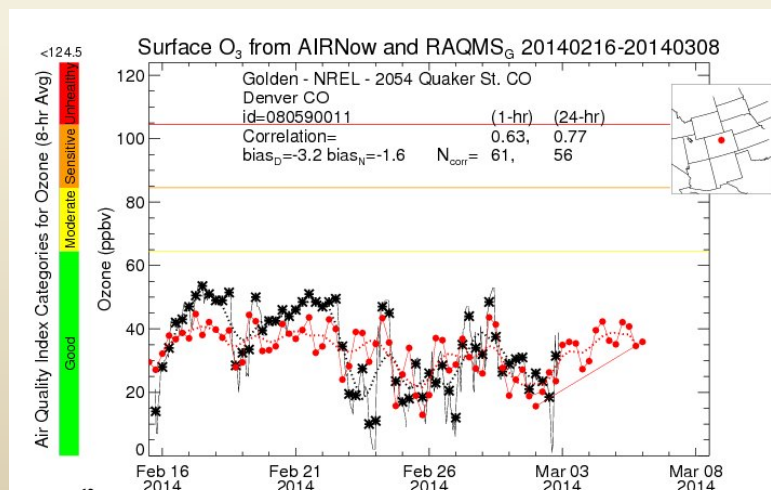
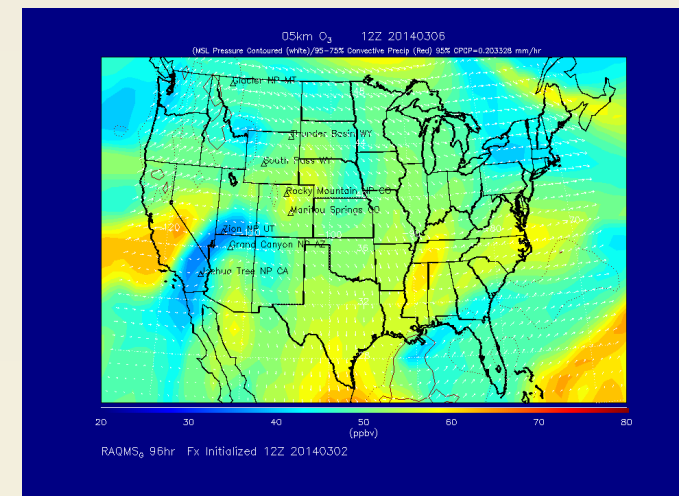


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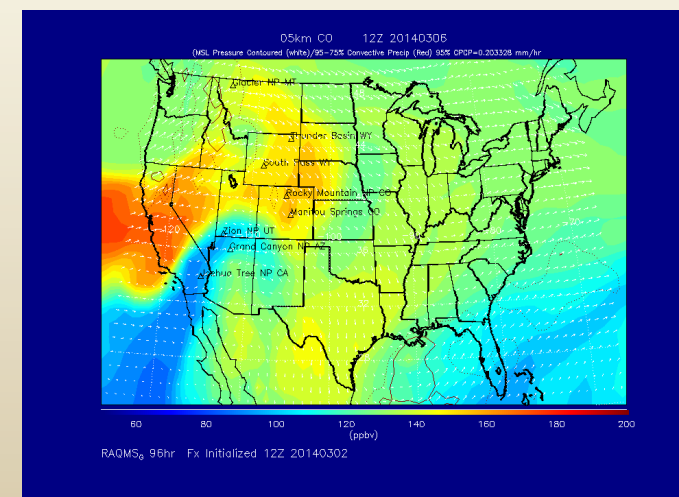


Cooperative Institute for Meteorological Satellite Studies (CIMSS) Real-time Air Quality Modeling System (RAQMS)

- Global 1x1 degree on-line chemical and aerosol assimilation and forecasting system
- Assimilation of MODIS aerosol optical depth, MLS stratospheric ozone profiles and OMI cloud cleared total column ozone
- MODIS fire detection and Ecosystem/Severity dependent fire emissions
- Real-time verification using US EPA AIRNow surface ozone and PM2.5 measurements



Examples





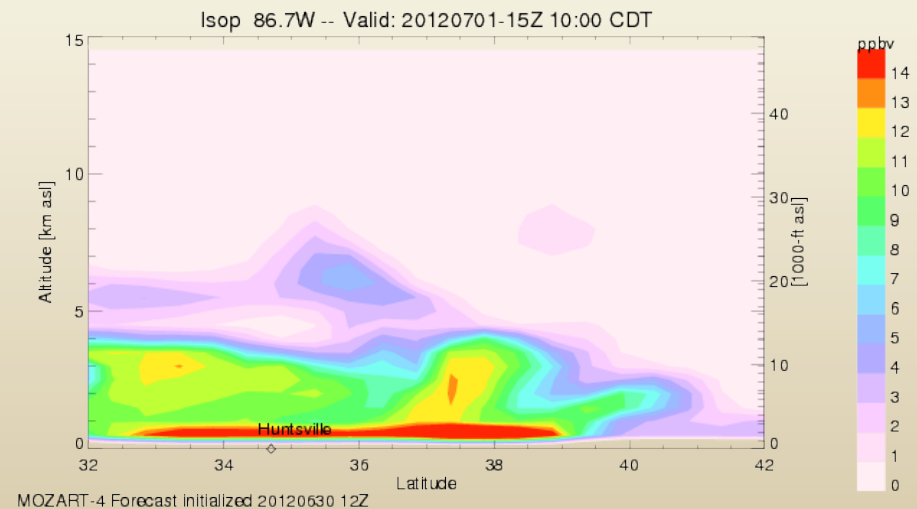
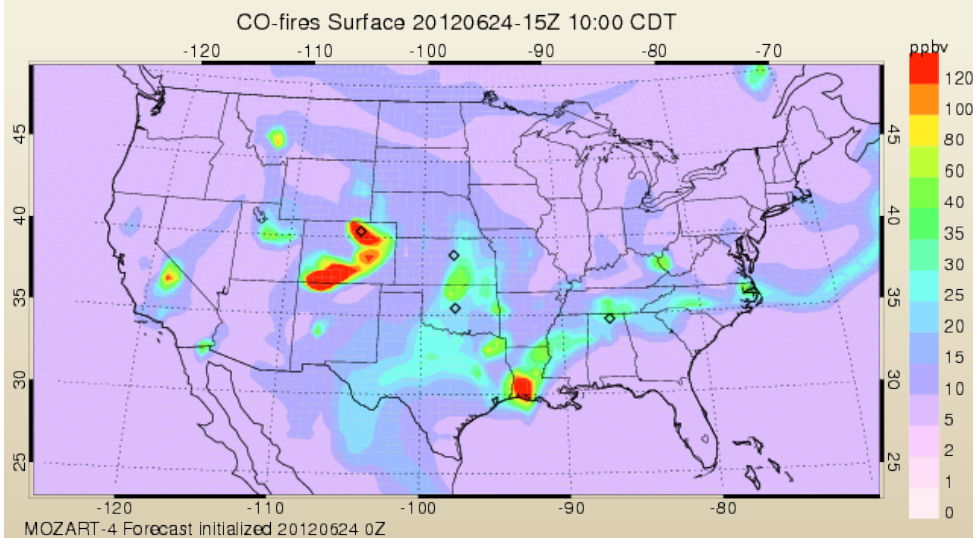
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NCAR MOZART-4 Forecasts

Examples

- **Full chemistry** at $1.9^\circ \times 2.5^\circ$ <http://www.acd.ucar.edu/acresp/forecast/>
5-day forecasts, hourly output, currently operational
- **Forecasts of tracers** at 0.5° horizontal resolution
 - Isoprene-like tracer based on MEGAN isoprene emissions
 - Anthropogenic NO_x tracer from individual cities and/or regions
 - Fire CO tracer for various regions
 - Others for discussion
 - Similar to forecasts for DC3, will be run specifically for FRAPPE



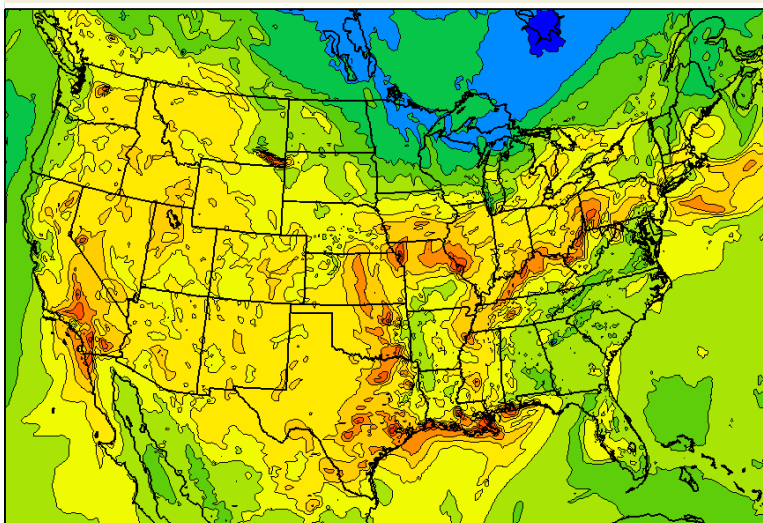


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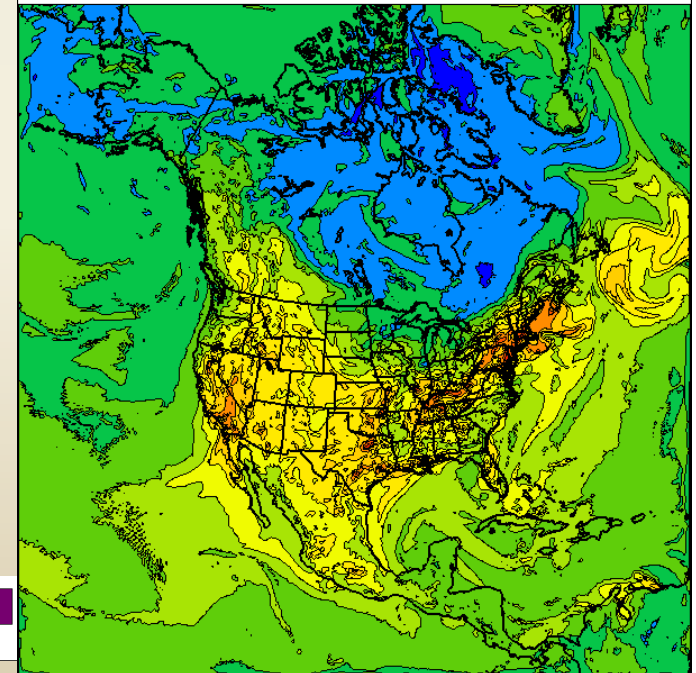
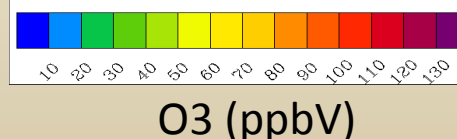


NOAA/ESRL RAP-Chem = WRF-Chem on RAPid refresh (RAP) domain

- Dx=13km, RAP (met): operational at NCEP with hourly forecast cycle
- Experimental RAP-Chem:
 - Includes gas-phase chemistry (O₃), aerosols (modal approach), Secondary Organic Aerosols (SOA, Volatility Basis Set approach)
 - Chemical boundary conditions from RAQMS or MACC – still to be decided
 - NEI 2011 emissions
 - 48-hr forecasts
 - http://ruc.noaa.gov/wrf/WG11_RT/ - different zooms and parameters possible

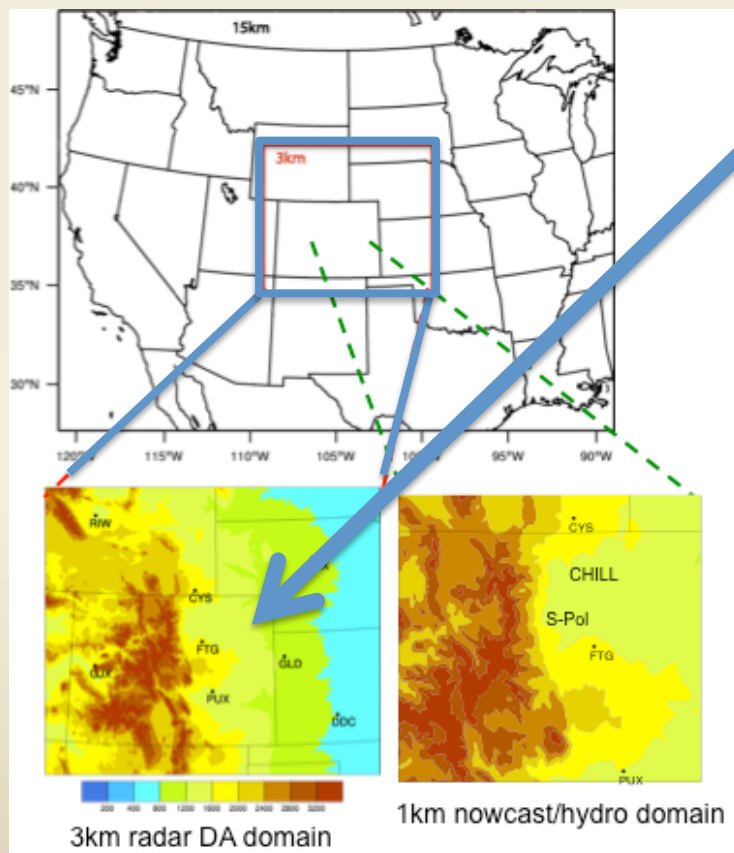


Examples





NCAR WRF-Chem with Tracers



Added to 3km STEP Forecast:
Inert tracers with specified lifetime

Suggested tracers:

- Anthro tracer (NO_x like)
(area, non-road, point sources)
- Mobile tracer (NO_x like)
- Oil & Gas tracer (ethane like)
- Agricultural tracer (emissions needed)

Examples



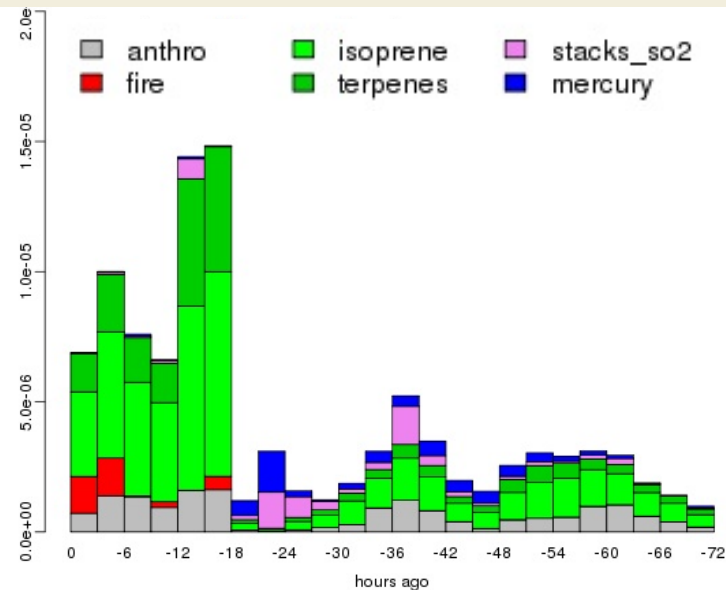
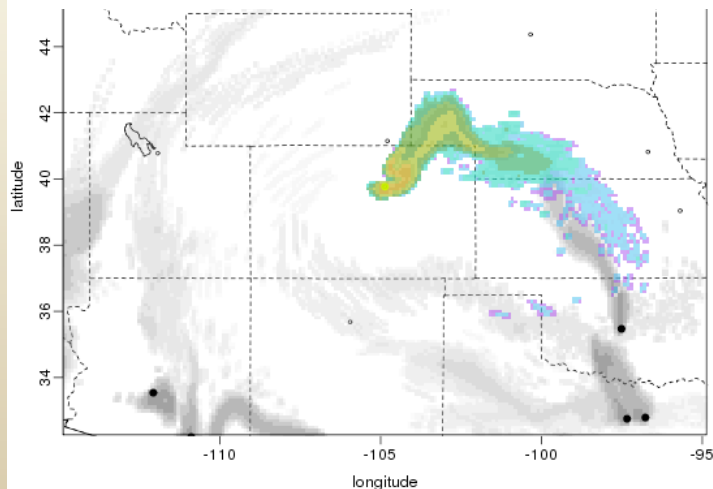
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NCAR/ACD: Lagrangian particle dispersion products with FLEXPART

- trajectories from ground stations / aircraft paths/ sources
- forward and backward in time
- based on GFS (global) and WRF (regional) model forecasts / analysis
- can be convolved with emissions
- provides: airmass history and emissions loading, horizontal and vertical information, deterministic trajectory, trajectory clusters, sensitivity maps

24-hr forward trajectory from Denver
on 2013082318 UTC (during SEC4RS)



Examples



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Forecast Schedule

- 8 - 10 AM** **Review meteorological and air quality products**
- 10 - 11 AM** **Consult with NWS forecaster and CDPHE air quality forecaster**
- 11 AM – 1 PM** **Prepare/finalize briefing**
- 1 PM** **Conduct briefing**