# WRF/Chem Simulations of aerosol transport and dispersion for the ISDAC field campaign

Polluted Case Simulations

April 16-21, 2008

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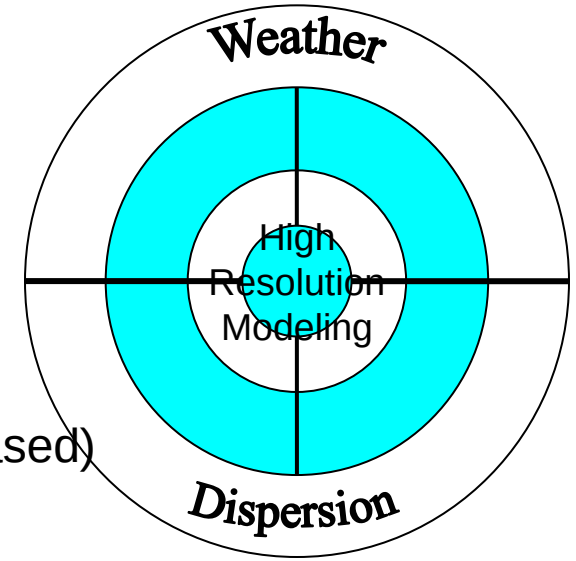
- Atmospheric modeling of aerosol effects requires
  - Accurate 3-D initial & boundary conditions for both meteorological and **particularly aerosol fields**
  - Appropriate **grid resolution** to resolve the smallest scales of interest
  - Grid techniques
    - Nested grid technique & Unstructured grid technique
  - Data assimilation (creating 3-D initial field)
    - *In-situ* observations (e.g., surface & balloon)
    - Remote sensing observations (e.g., satellite-based)

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# Goals / Tasks

- To specify both ICON & BCON for aerosols over various spatial and temporal scales.
- WRF/Chem mesoscale model simulations are done using aerosol data initialized from a global chemistry model (MOZART).
- Also use emissions databases (fire sources) for aerosol sources.
- Examine aerosol transport from model simulations and compare it with observations
- Investigate direct and indirect effects of aerosols on the radiation budget and cloud microphysics.

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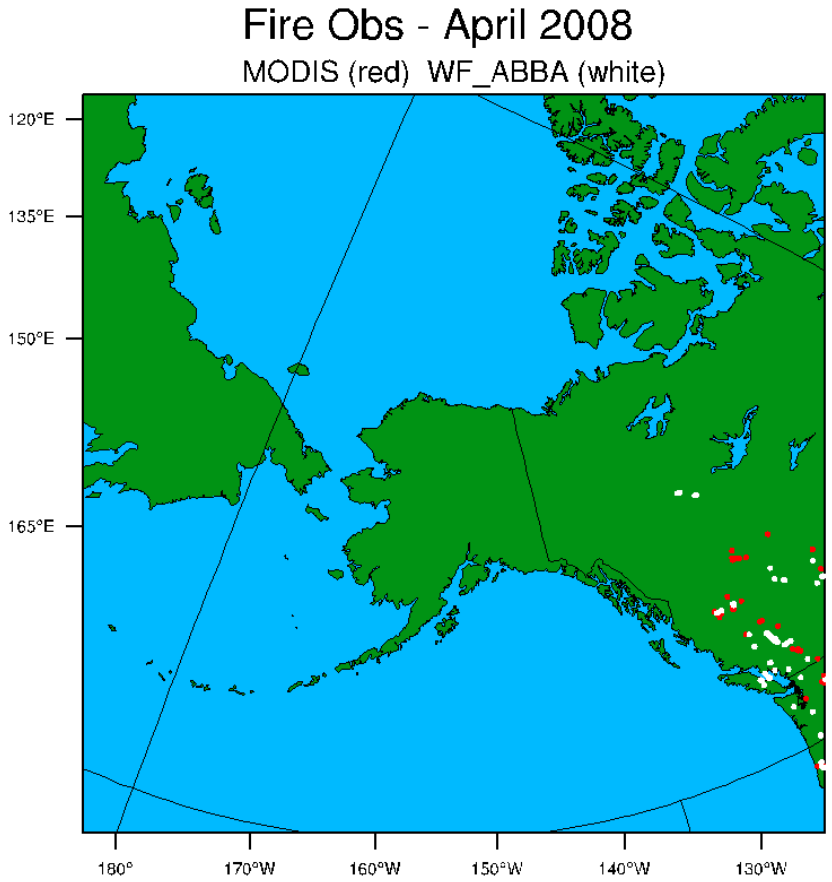


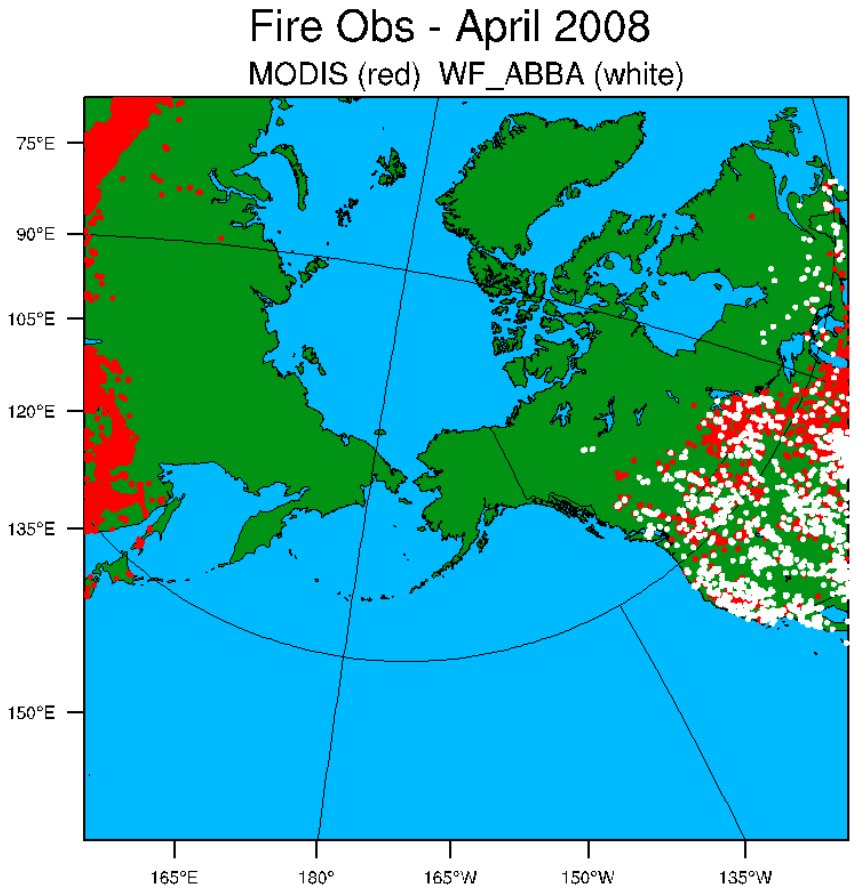


- Fire observations by MODIS (polar orbiting) and WF_ABBA (GOES) satellites for April, 2008 during ISDAC. LHS is actual domain used in this study, and RHS is for a hypothetical larger domain. Fire data is processed by WRF/Chem preprocessor ‘prep_chem_sources’

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# WRF/Chem Model

- WRF/Chem (Weather, Research, and Forecasting) mesoscale meteorological model for simulating chemical and aerosol species (incl. direct and indirect aerosol effects)

- **Initialization and lateral boundary conditions (updated every 6 hours) for meteorological data are from NCEP 6 hour final global reanalysis (FNL) data - 1 degree resolution, 26 pressure levels.**

- Use archived daily global SST 0.5 degree resolution data from NCEP archives, updated every 6 hours

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# WRF/Chem Model (con't)

- Chemistry component - RADM2 chemical component.
- MADE/SORGAM aerosol scheme - divides aerosols. into 3 modal distributions: Aitken, accumulation, and coarse, and assumes aerosols are internally mixed.
- Various aerosol species in the model are represented e.g. sulfate, nitrate, ammonium, organics, elemental carbon, etc.
- The chemistry component also includes emissions from anthropogenic, sea-salt, dust, biogenic, and biomass burning sources.

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# Initializing Aerosols / Chemistry

- Initial conditions (IC) and boundary conditions (BC) use *mozbc*, which supplies various chemistry and aerosol species from the offline global chemical transport model MOZART-4 (provided by NCAR/NESL). *Mozbc* converts and maps chemical and aerosol species onto WRF domain.

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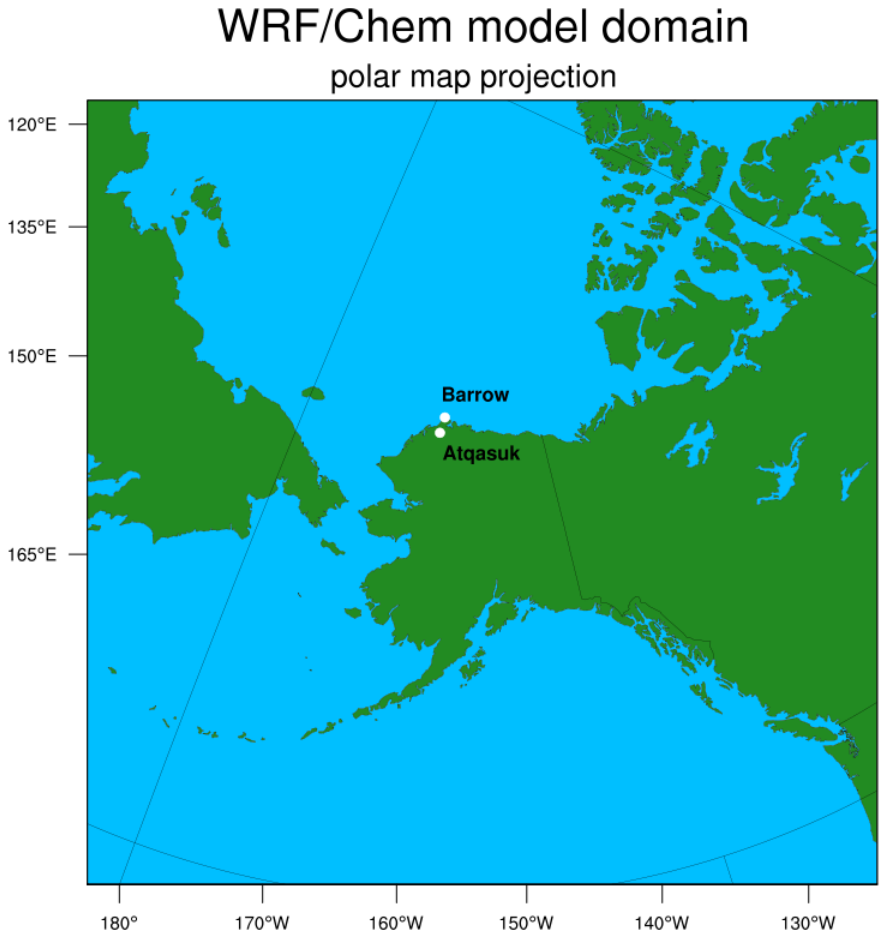


- Nh=300, dh=15km, 40 stretched vertical levels with top at 50mB, lowest dz~14m
- 5 day simulation (00Z 4/16/08-4/21/08)

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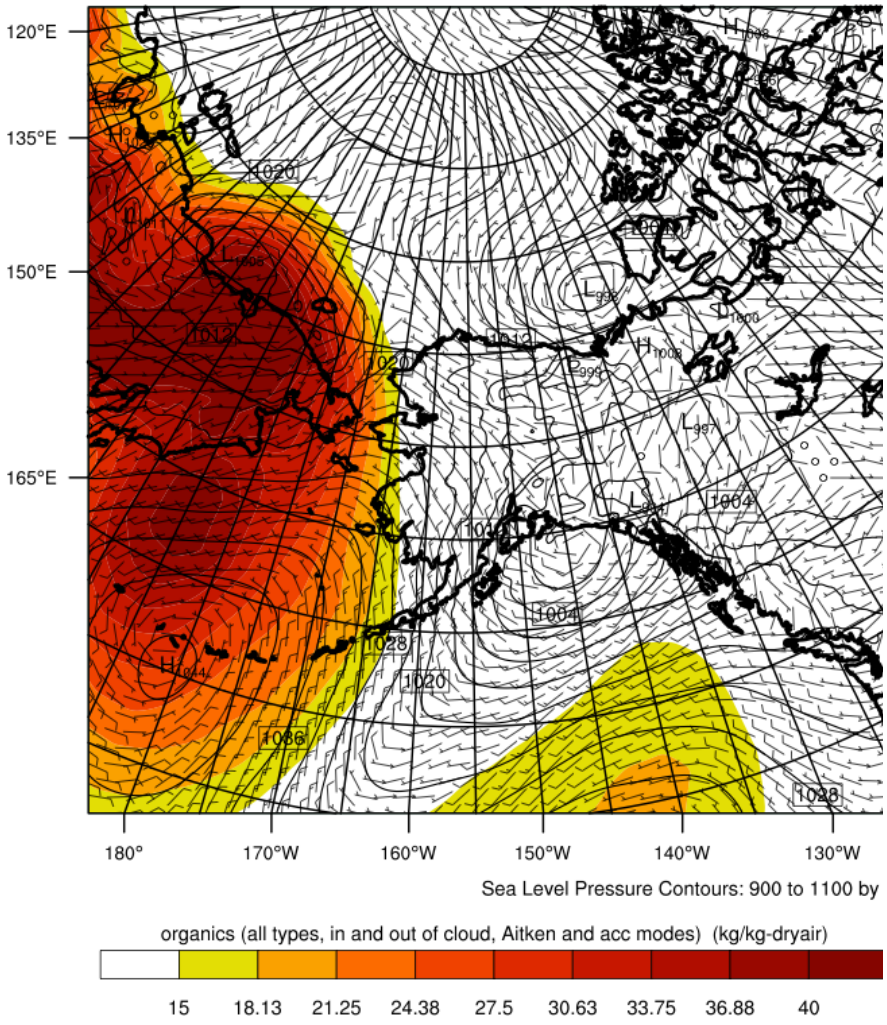
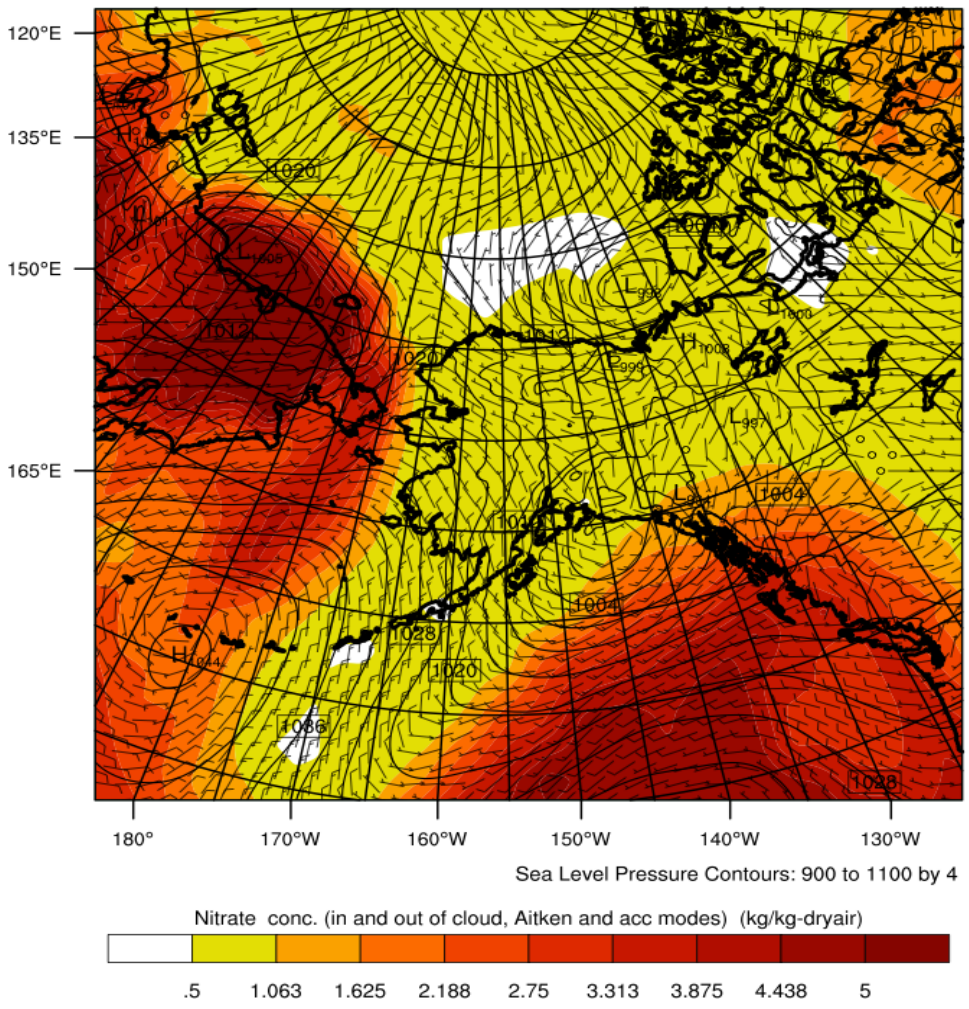
# Initial Conditions - individual aerosol species column-integrated

organics




nitrates

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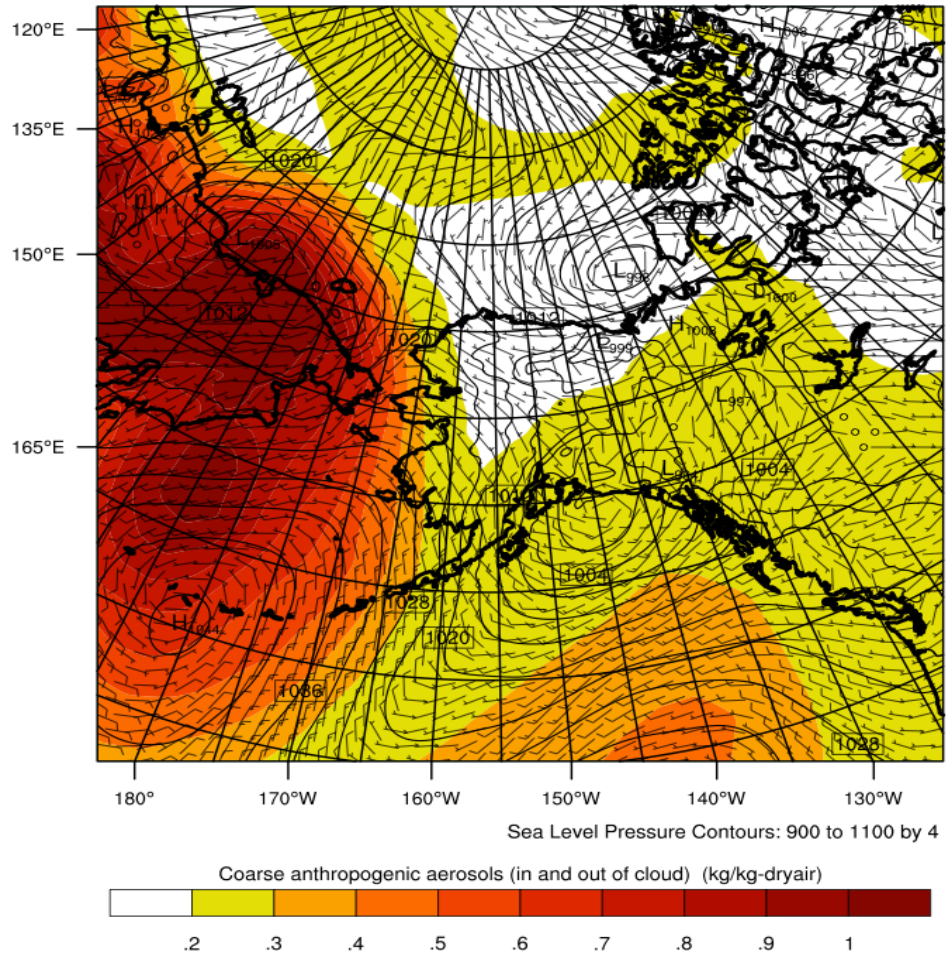
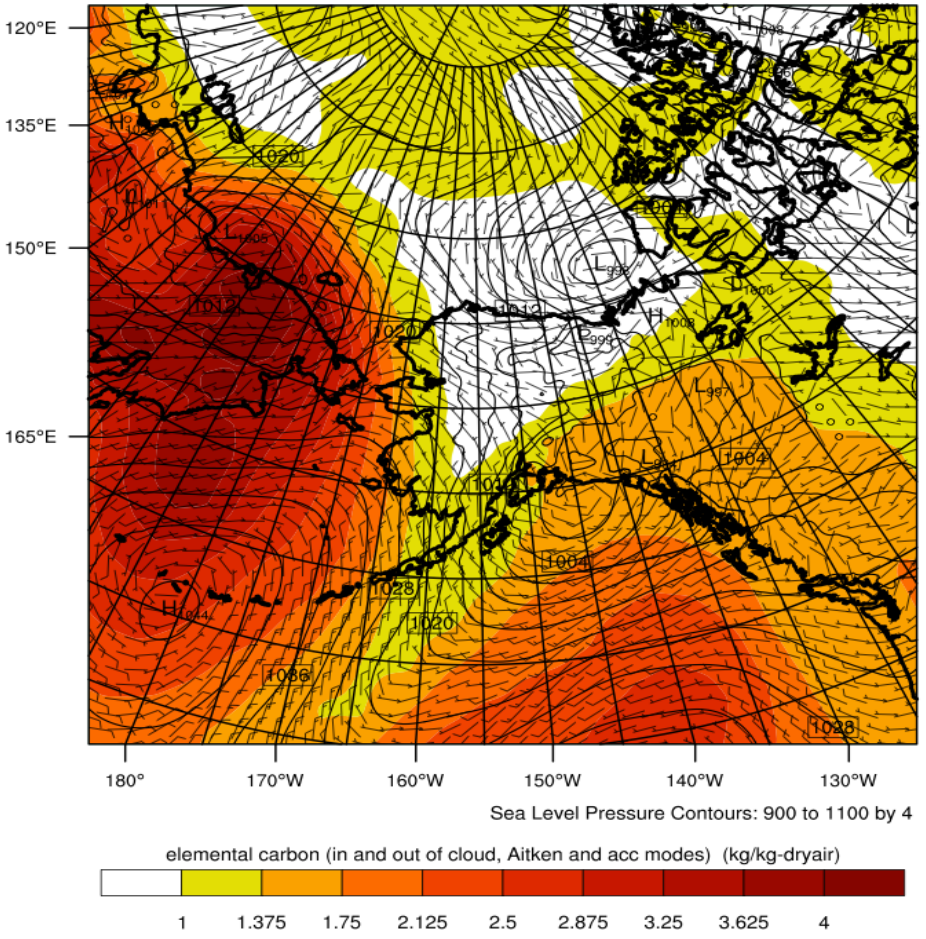
# Initial Conditions - individual aerosol species column-integrated

anthropogenic




elemental carbon

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# Initial Conditions – 16 April, 2008

- Concentration of aerosols (biogenic origin) is greatest over Siberia, western Pacific. Secondary maximum occurs south of Alaska.

- Aerosol concentration is low over northern Alaska (Barrow) and over the Arctic ocean.

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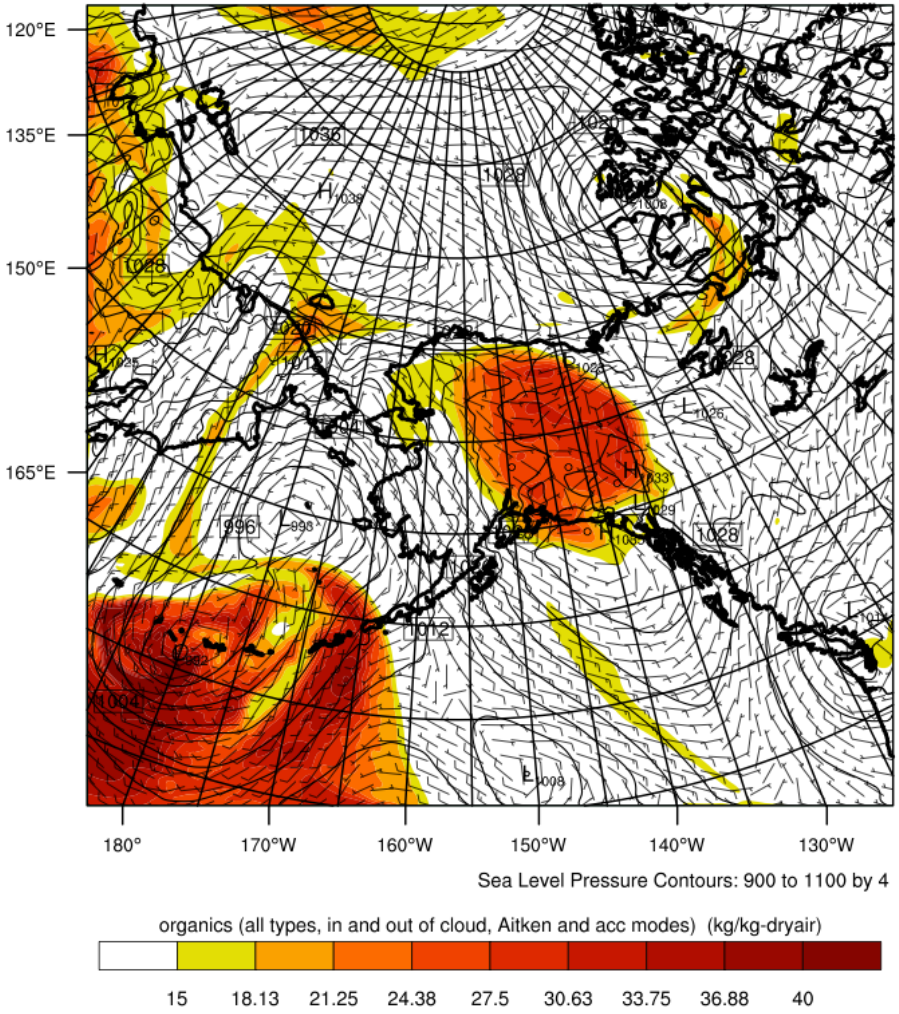
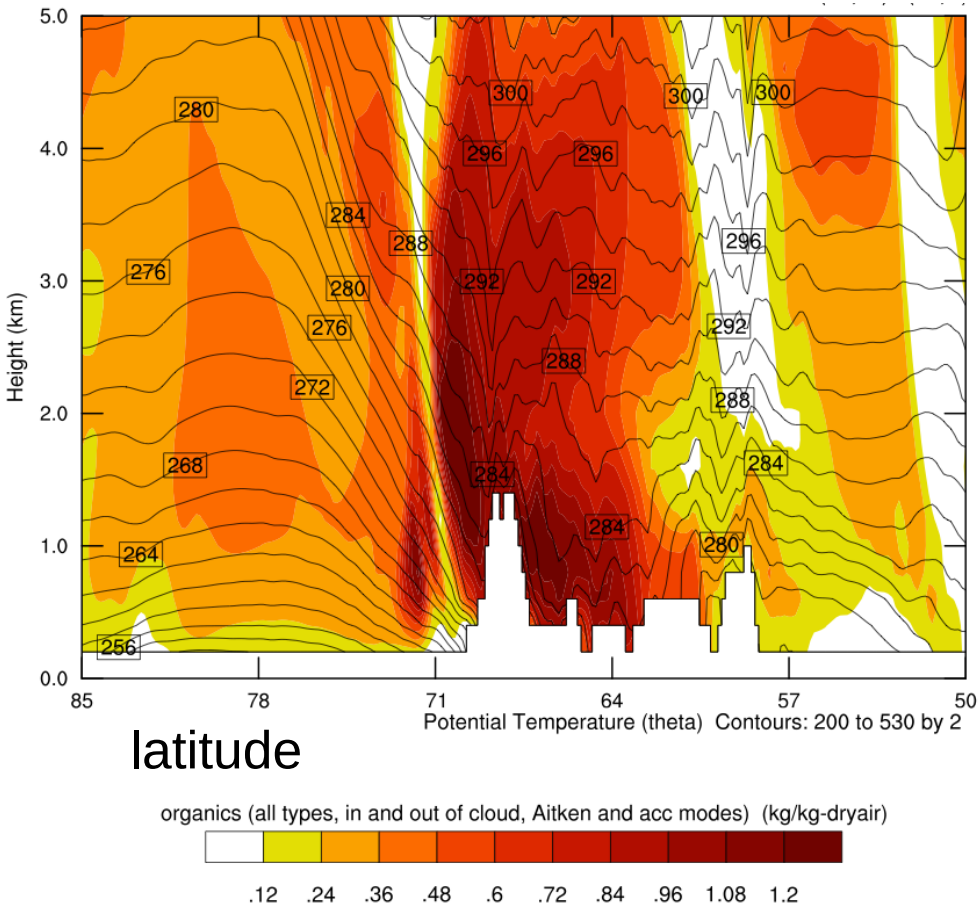
# WRF/Chem Simulation - Day 5 (00z, 4/21)




Organics - column integrated




Organics - north-south vertical cross-section along 155W longitude line

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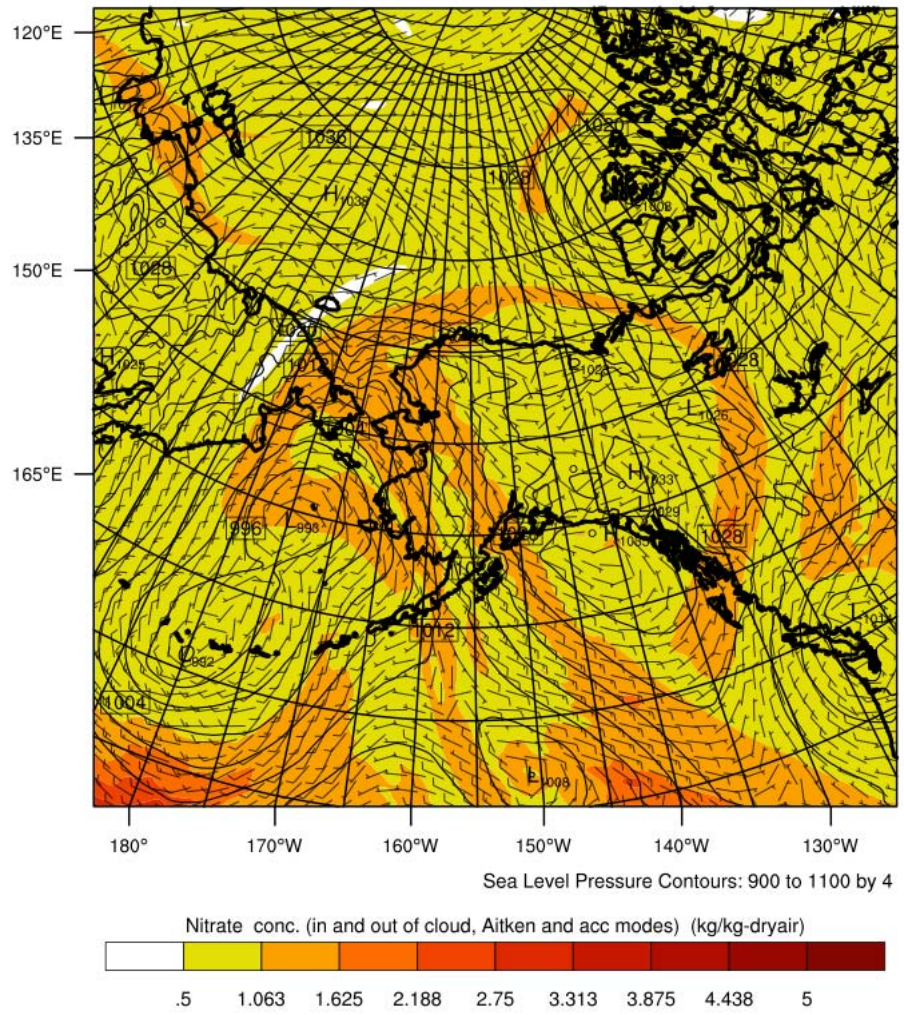
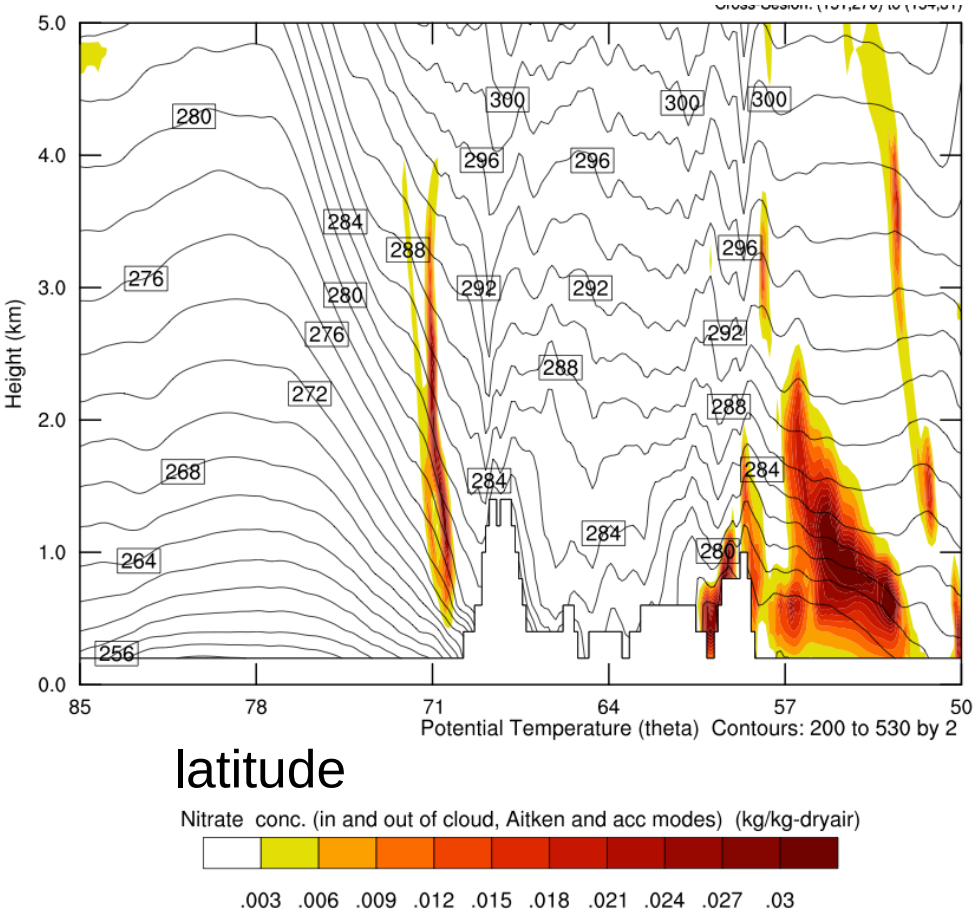
# WRF/Chem Simulation - Day 5 (00z, 4/21)




nitrates - column integrated




nitrates - north-south vertical cross-section along 155W longitude line

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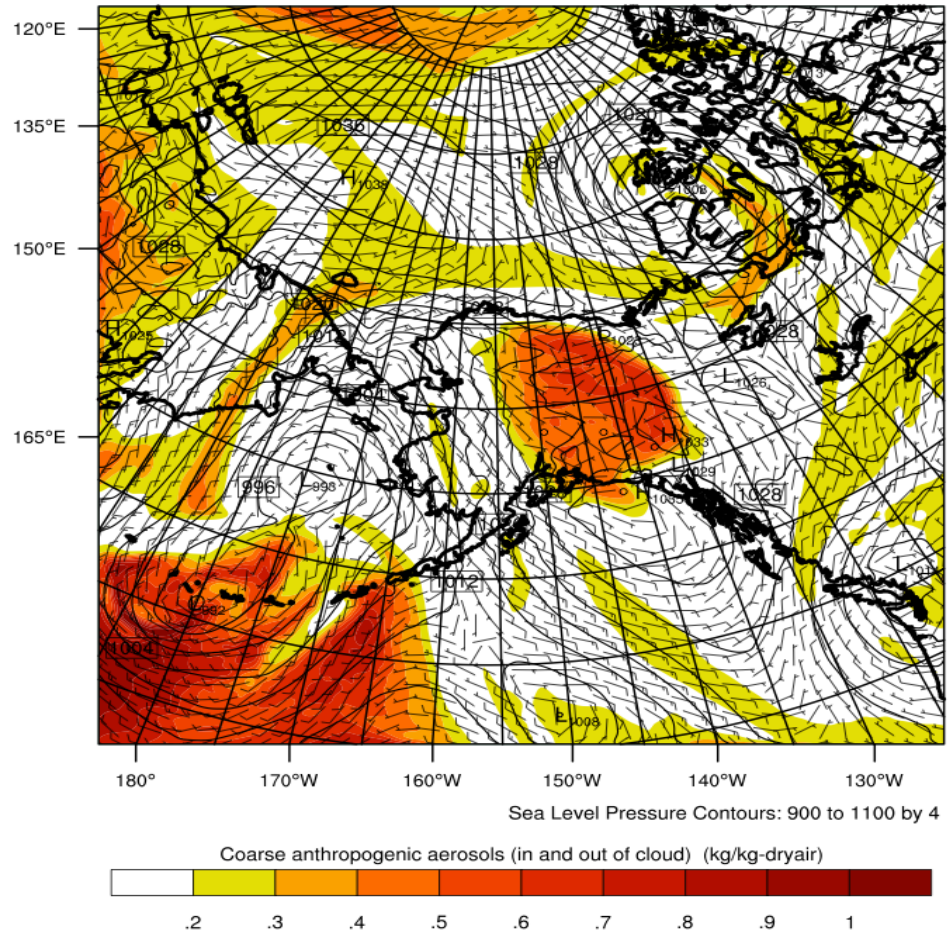
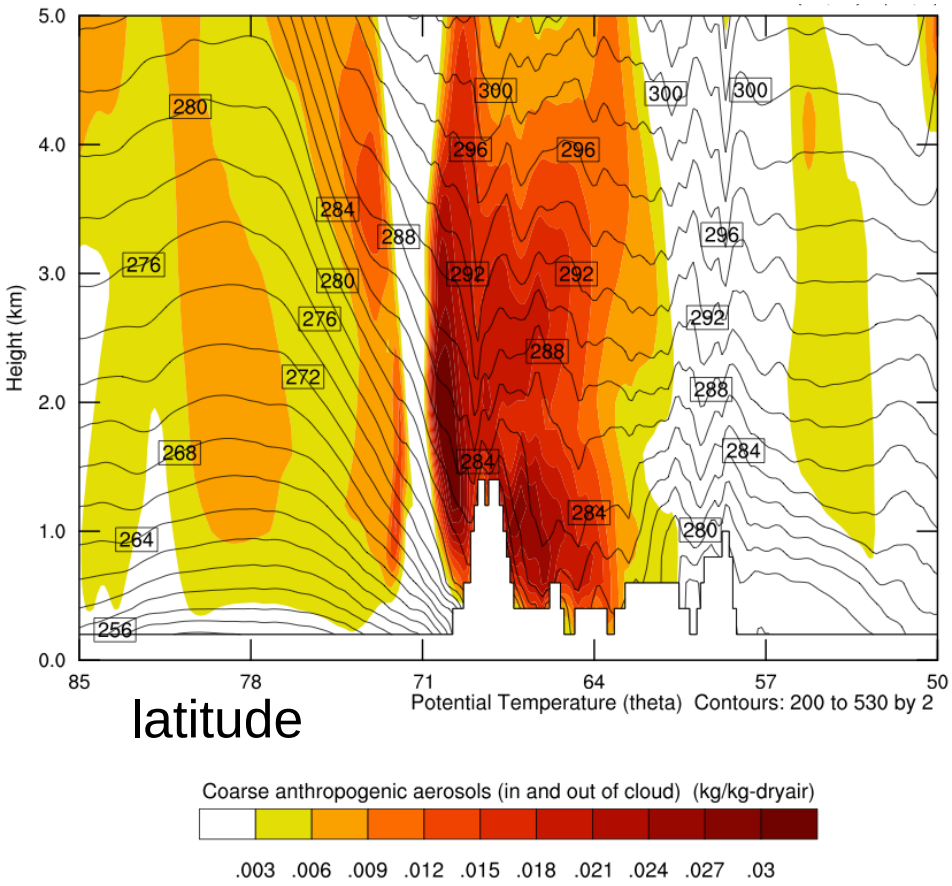
# WRF/Chem Simulation - Day 5 (00z, 4/21)




anthropogenic - column integrated




anthropogenic - north-south vertical cross-section along 155W longitude line

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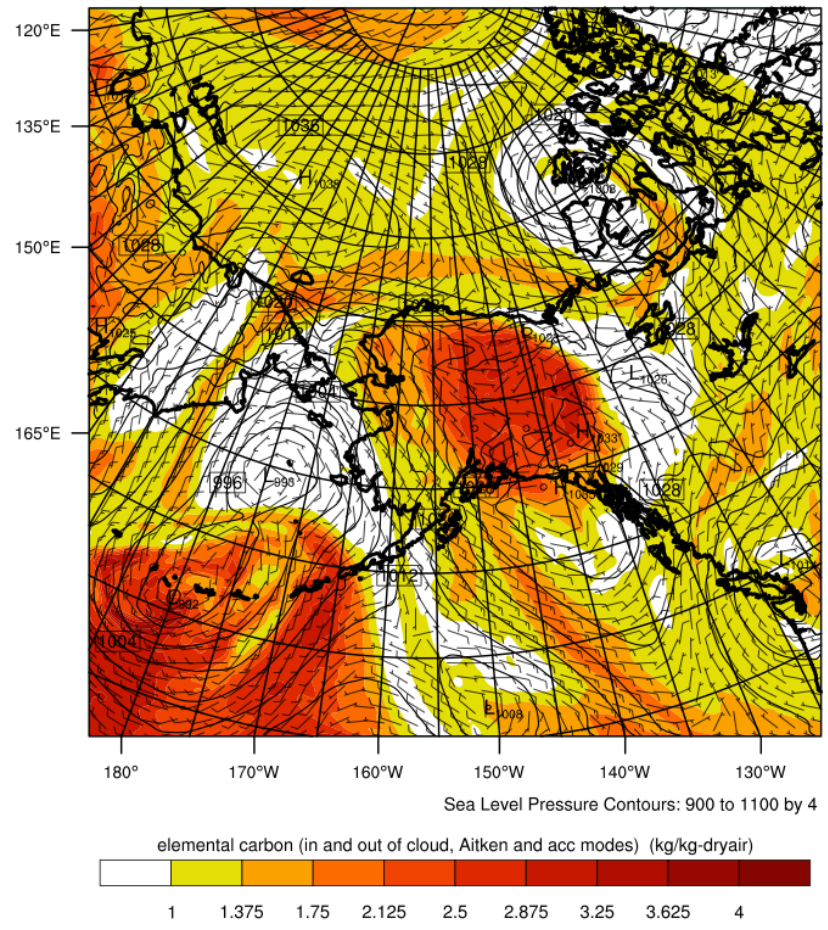
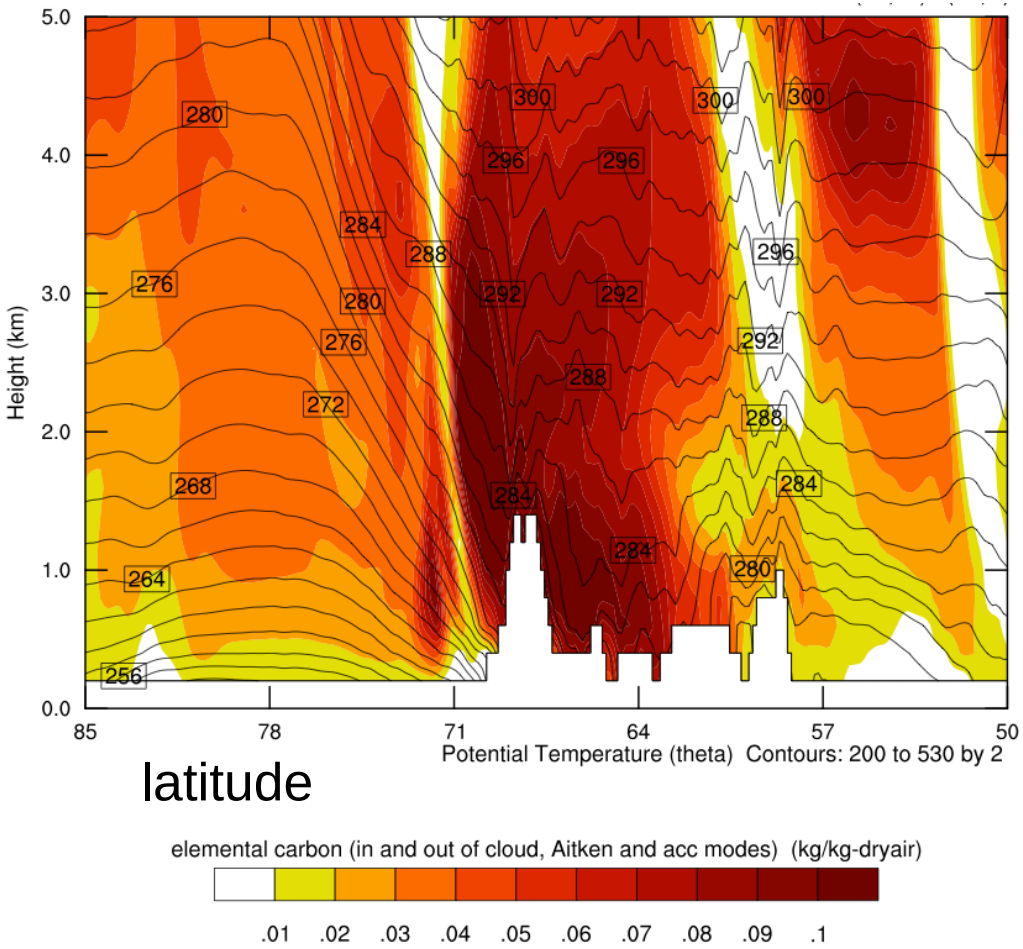



Elemental carbon - column integrated




Elemental carbon - north-south vertical cross-section along 155W longitude line

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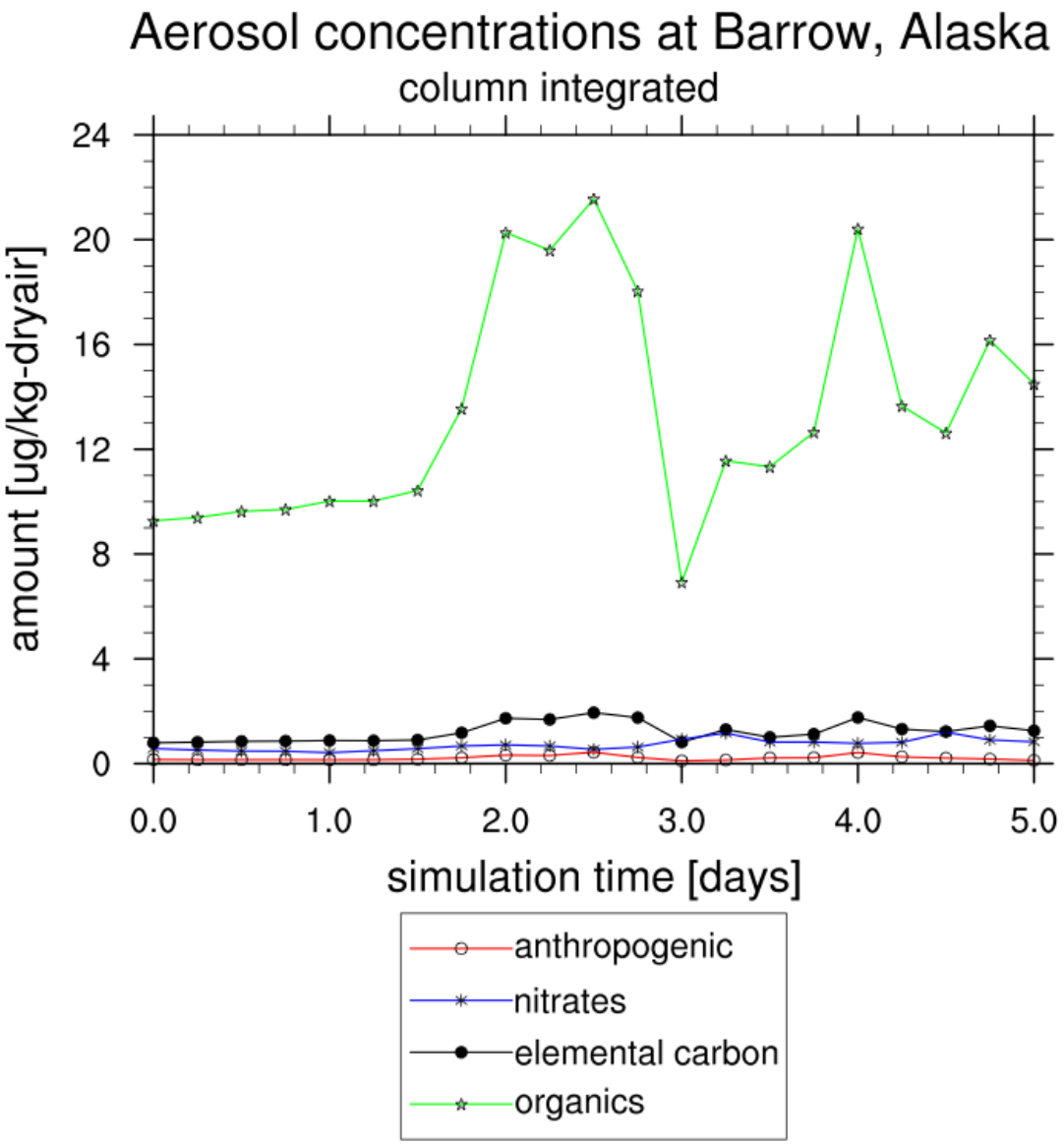
# WRF/Chem Simulation

- Aerosol concentrations over a period of 5 days.

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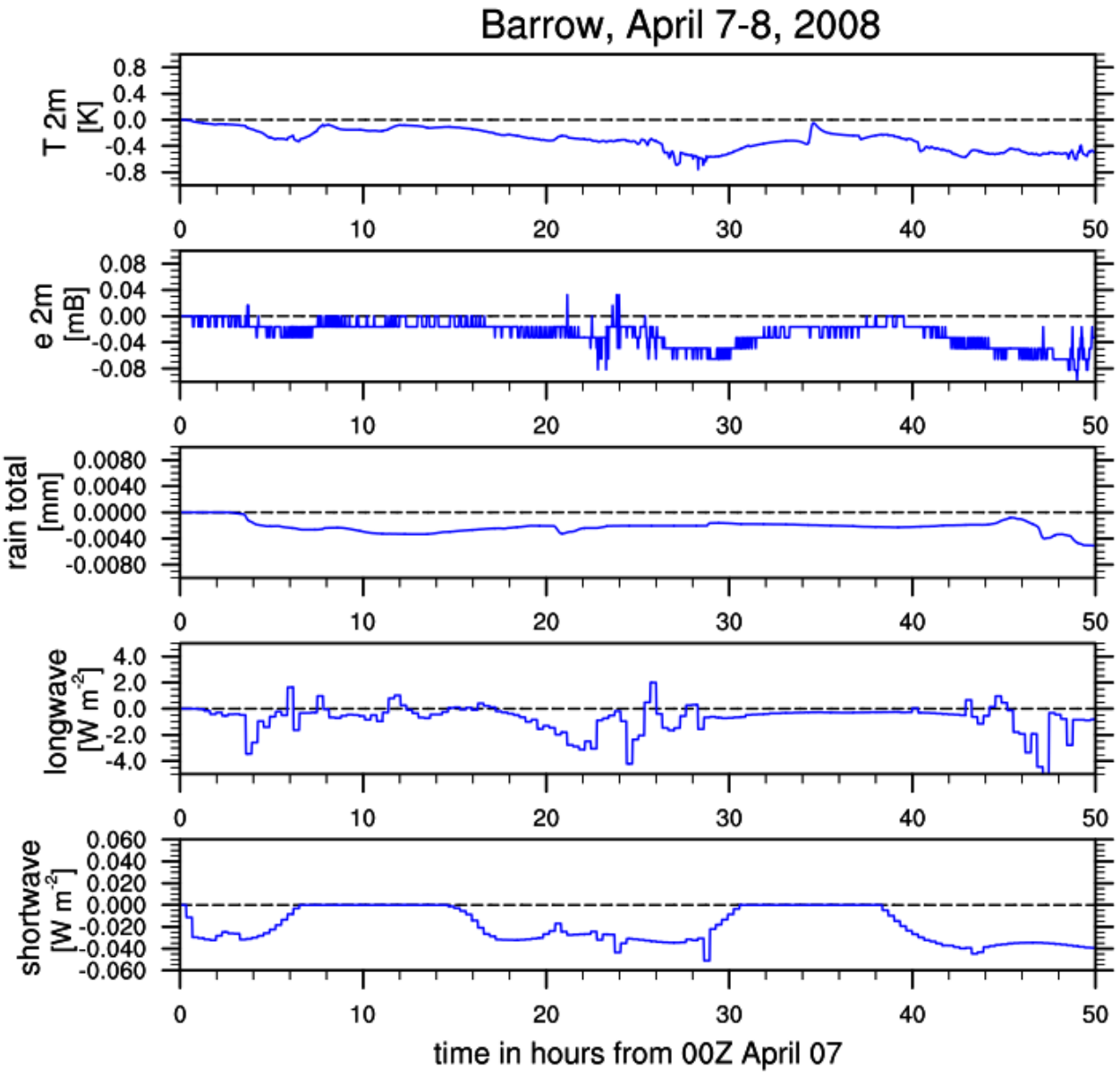
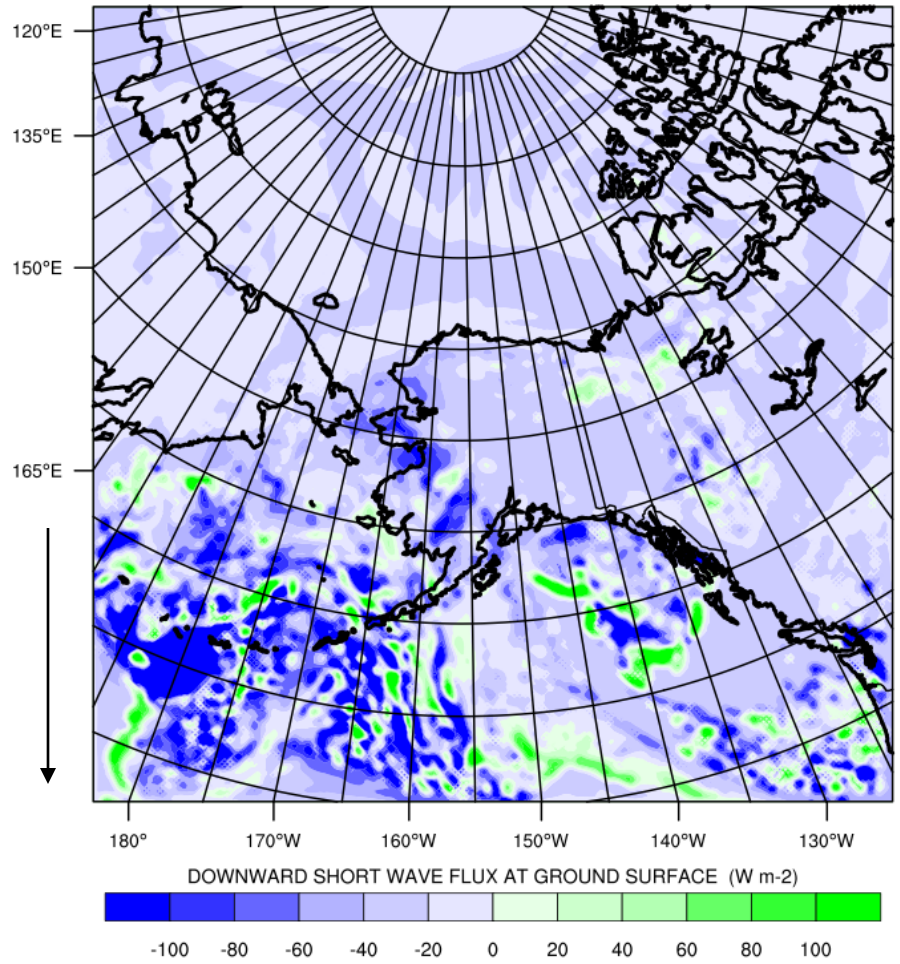


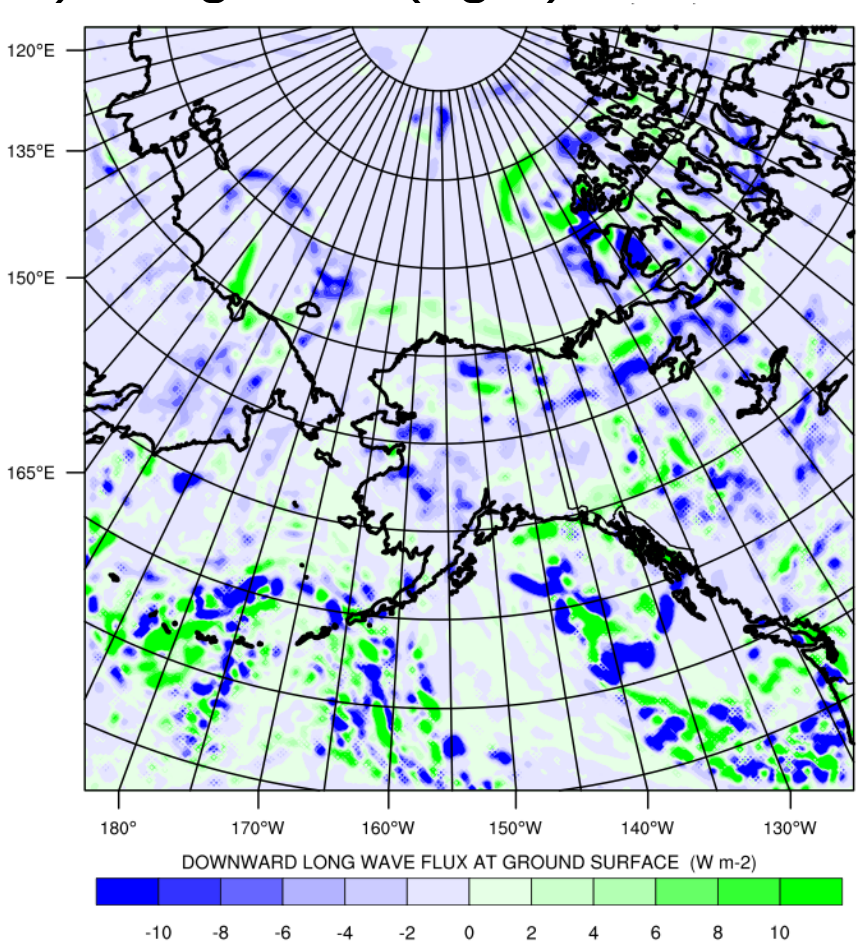

# WRF/Chem - *M*RF difference

WRF/Chem predicts slightly lower temperatures, less vapor pressure, lower total precipitation, and less downward longwave radiation and shortwave radiation than these of WRF. Possibly due to aerosol effects.

# WRF/Chem - WRF difference

## downward shortwave (left), longwave (right)




WRF/Chem predicts less downward shortwave radiation.

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# Conclusions

- **Major challenge is to obtain accurate representations of the aerosols over the remote regions.**
- **Higher resolution simulations combined with data assimilation (through nested simulations) can improve the understanding of aerosol effects on microphysics and the radiation budget.**
- Obtaining accurate initial conditions, boundary conditions, and emissions specifications for the aerosols are very important for accurate WRF/Chem simulations

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