Updates to the Aerosol-Aware Microphysics Scheme

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First: BUG fixes …

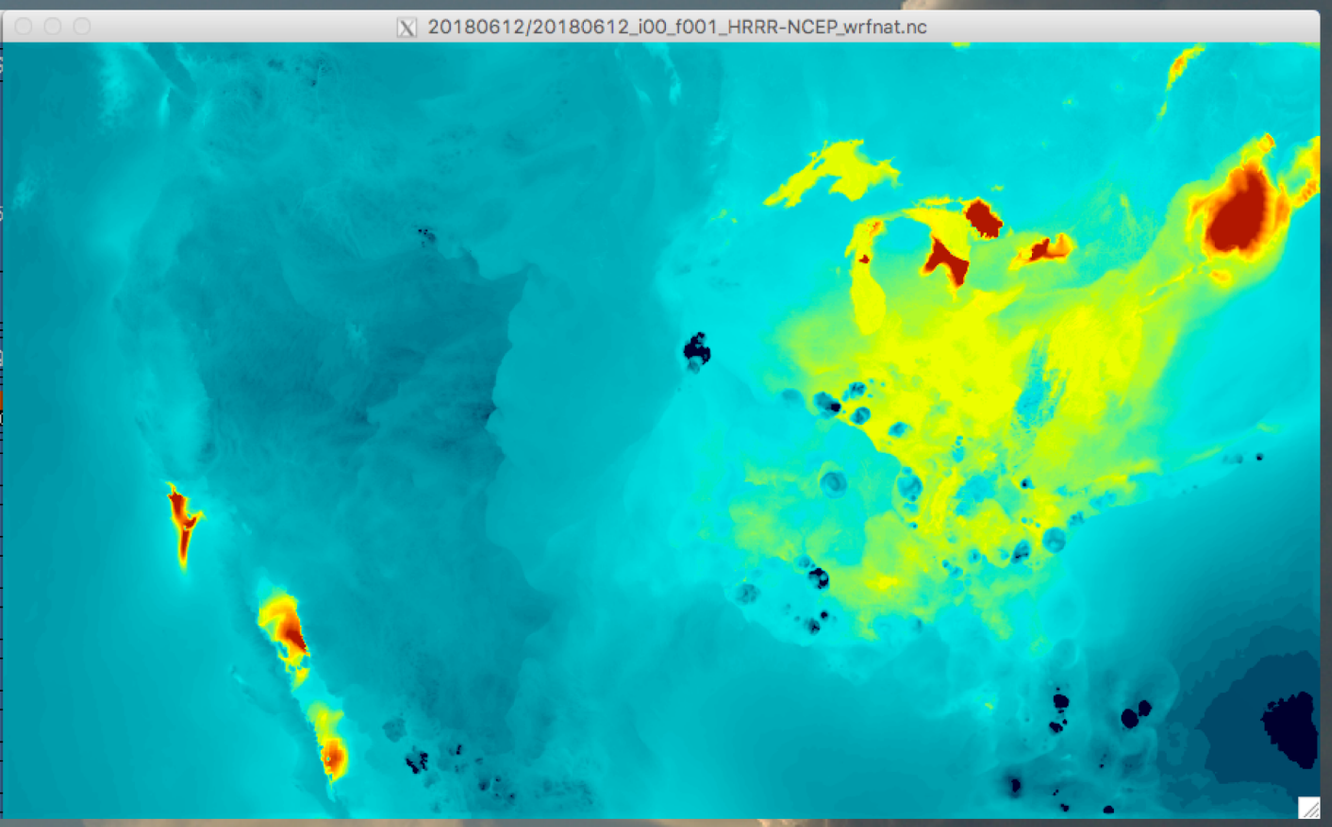
- ✓ **"2-moment" microphysics: REAL.EXE missing number concentrations**
  - **number of cloud droplets**
  - **snow, graupel, hail (Morrison 2-moment; NSSL; Milbrandt-Yau)**
- ✓ **Surface aerosol flux used grid space dependency**
  - **now mass-based thus the flux on nested grids is properly treated**

Next: Improvements

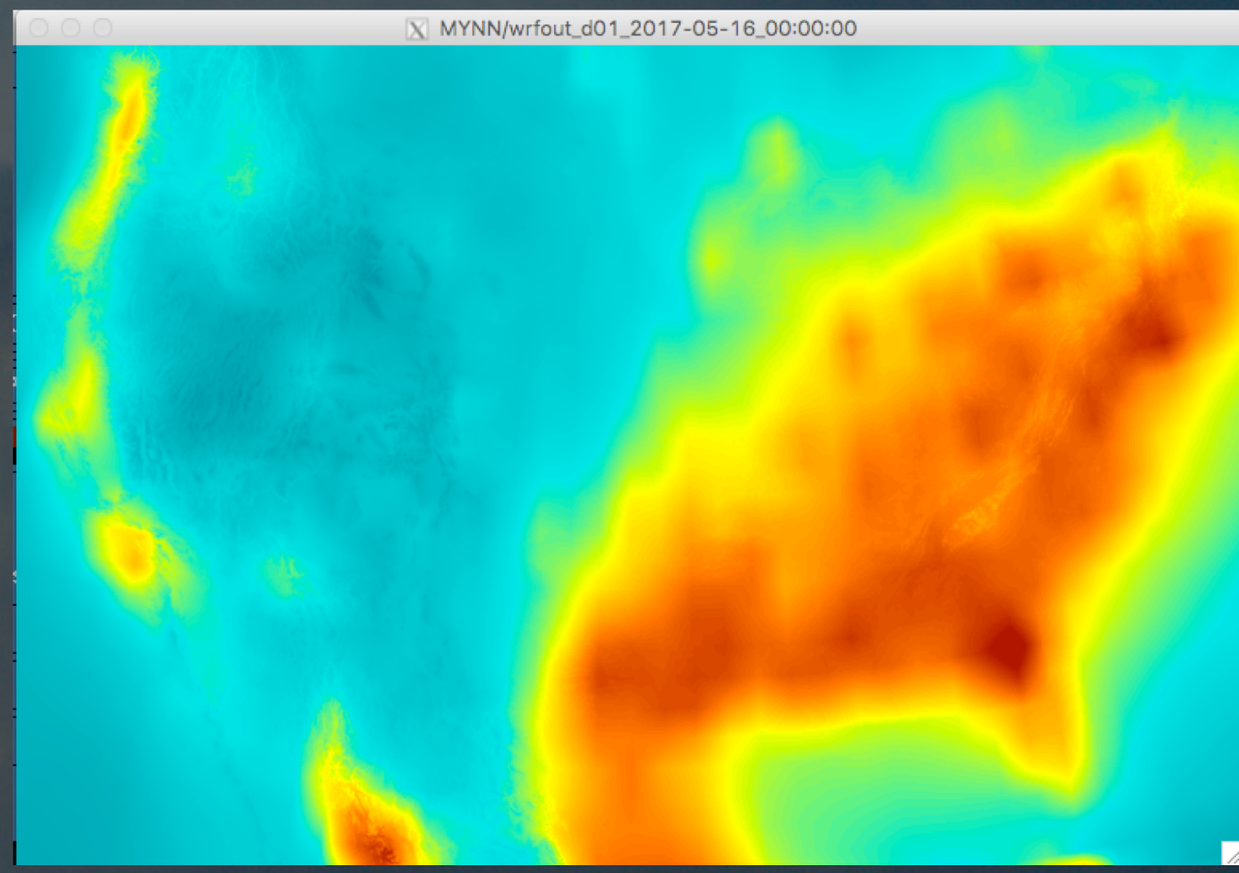
- ✓ **Separate CLIMO aerosols for surface flux calculation from 1st guess field**
  - **RAP/HRRR 1st guess aerosol values to initialize 3D aerosols but climo aerosols set the surface flux**
- ✓ **Proper time-varying surface flux aerosols from monthly climo**
  - **Regional climate model runs weeks to months to seasons**

Example problem & solution

HRRR 1-h forecast k=1 aerosols (cycled)



CLIMO (k=1 aerosols)



Moved the calculation of surface aerosol flux from microphysics initialization subroutine to module_initialize_real.F (real.exe into wrfinput_d0N)

This permits time-varying surface flux for weeks to years simulation using the sst_update=1 option

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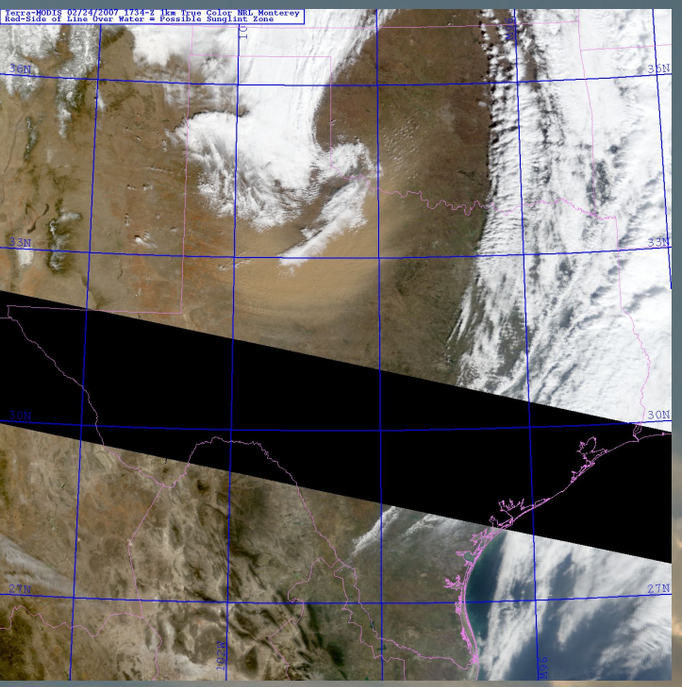
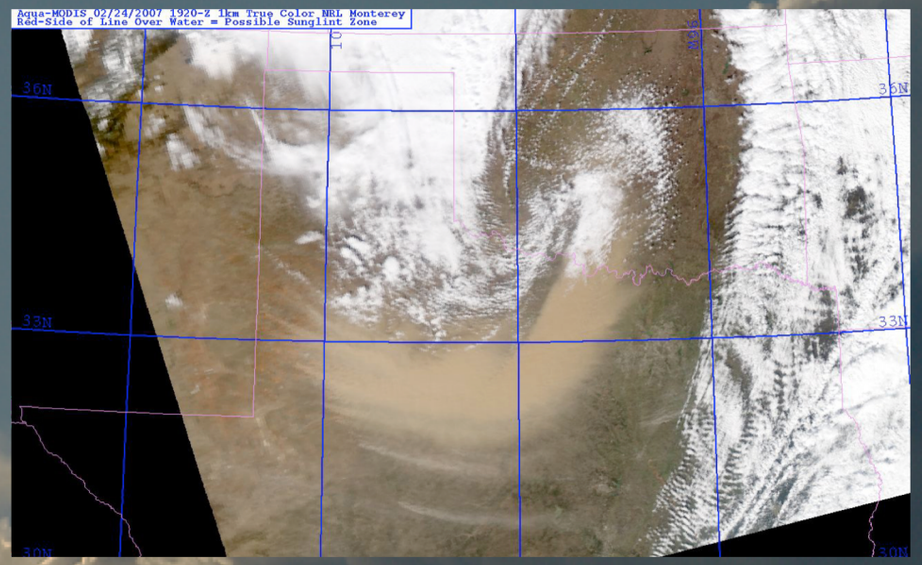
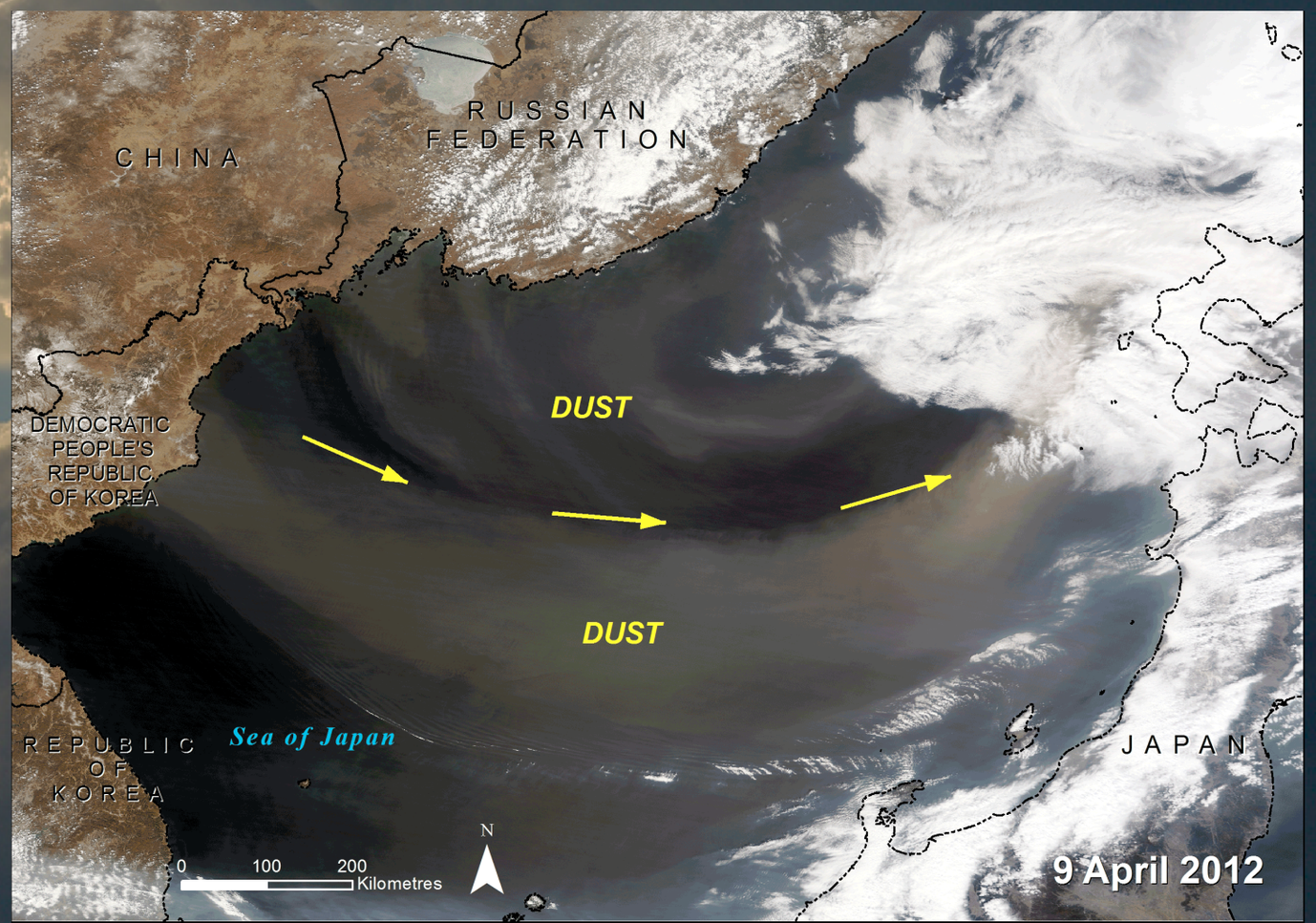
New addition: surface dust emission parameterization

Motivation: Dust act as primary ice nuclei







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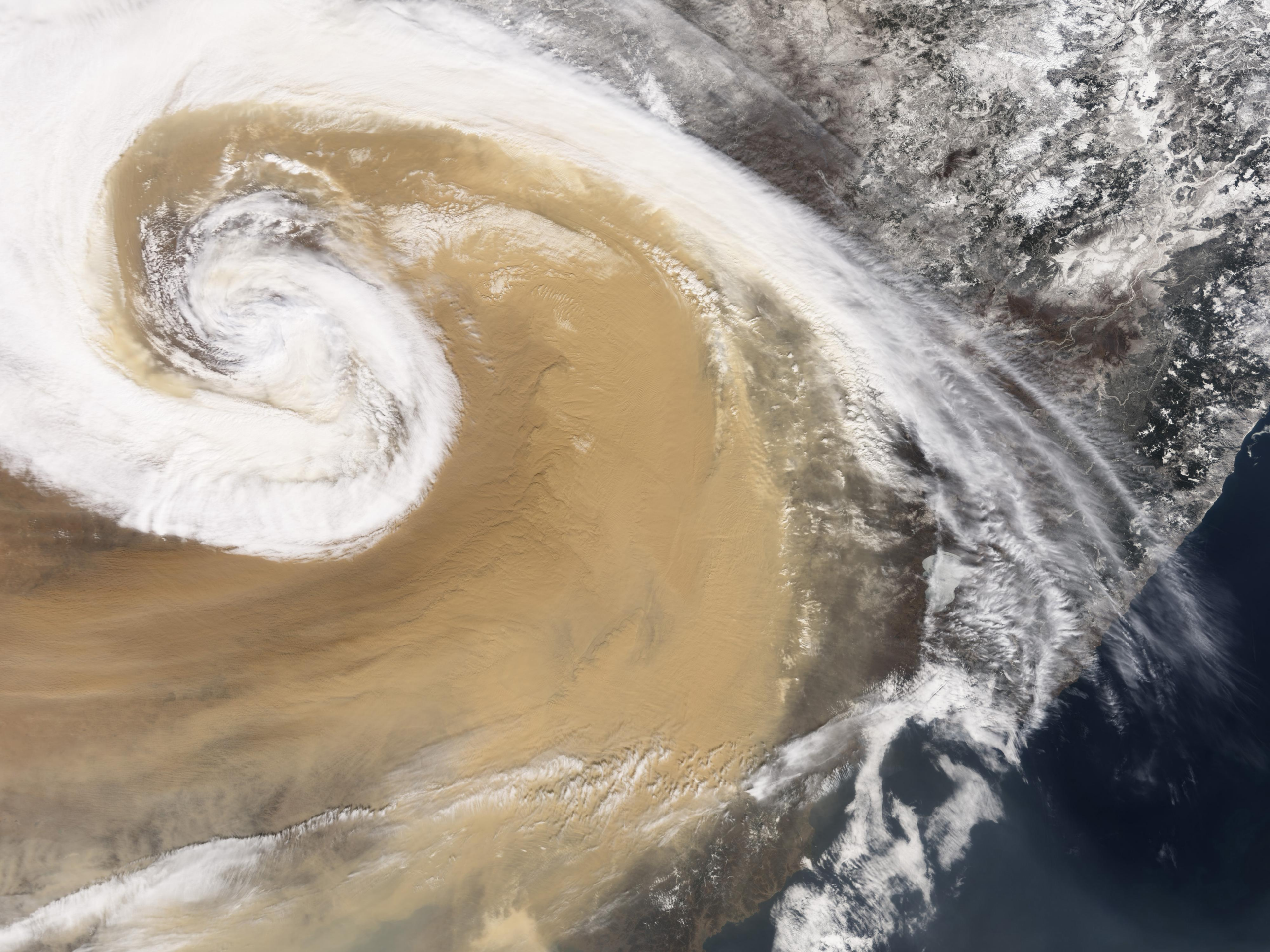
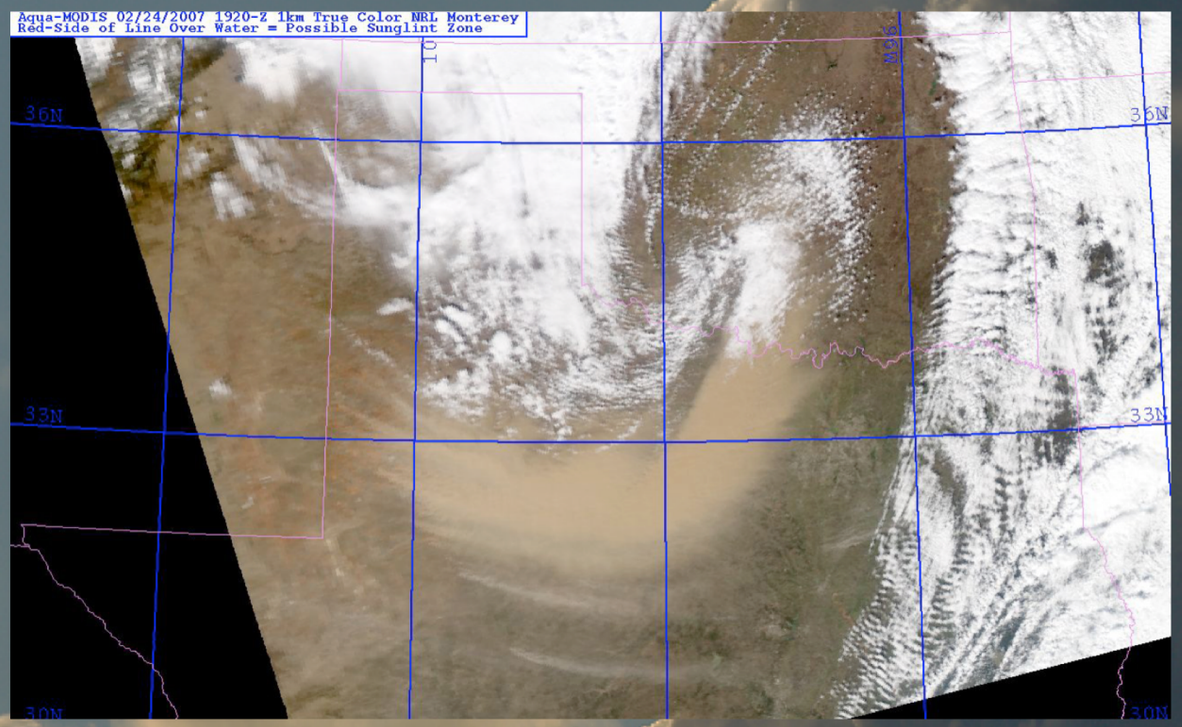
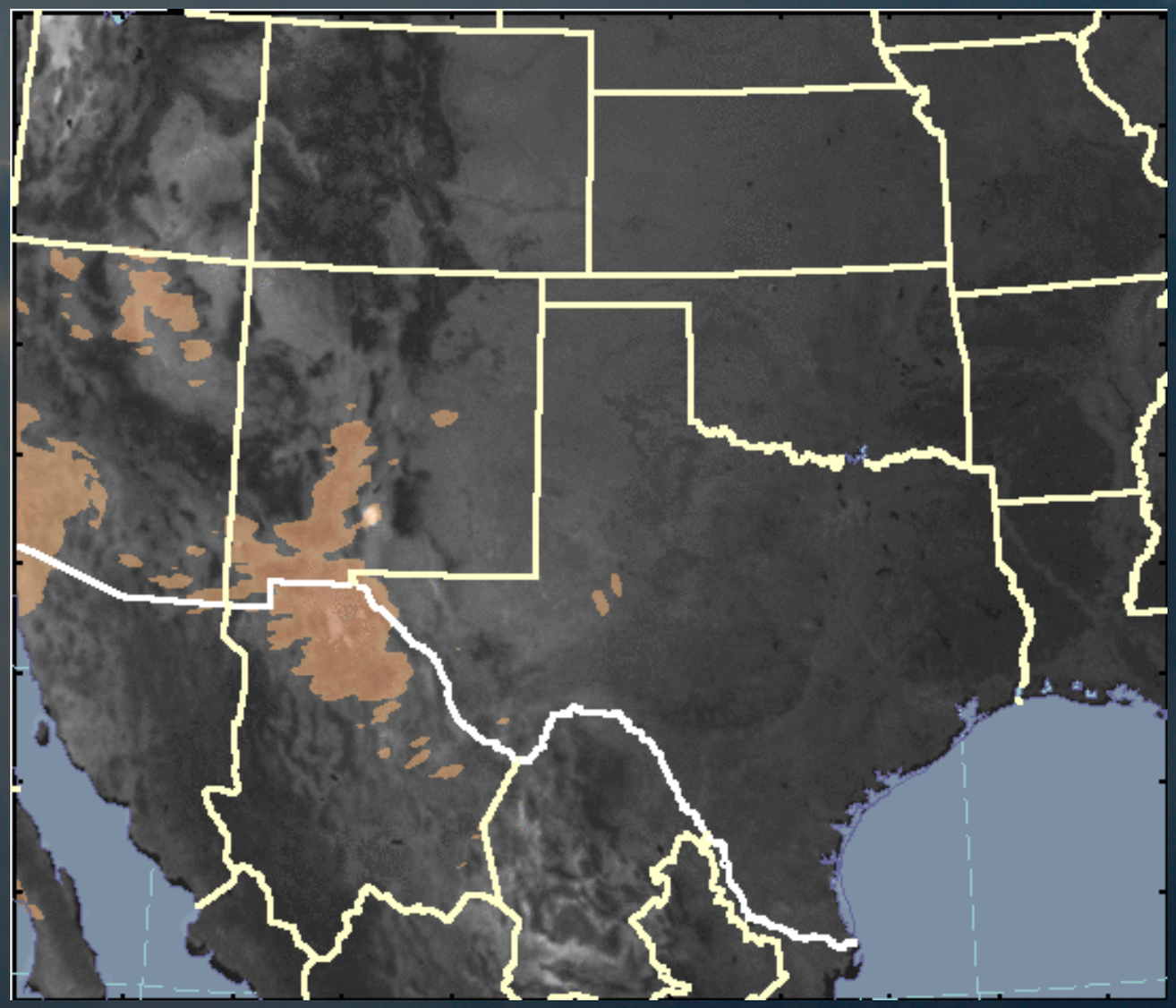


Dust emission test case

2007 Feb 24





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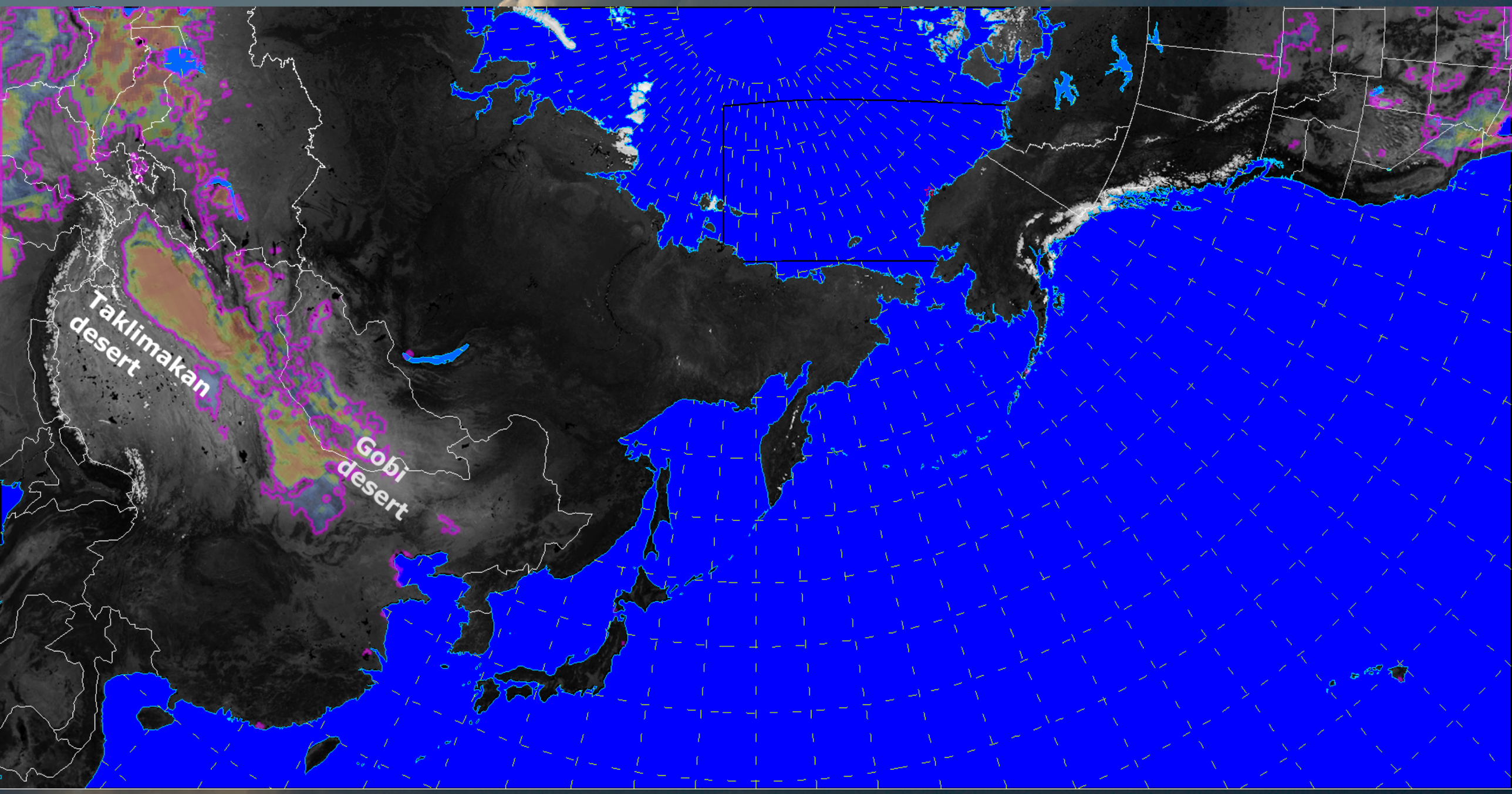
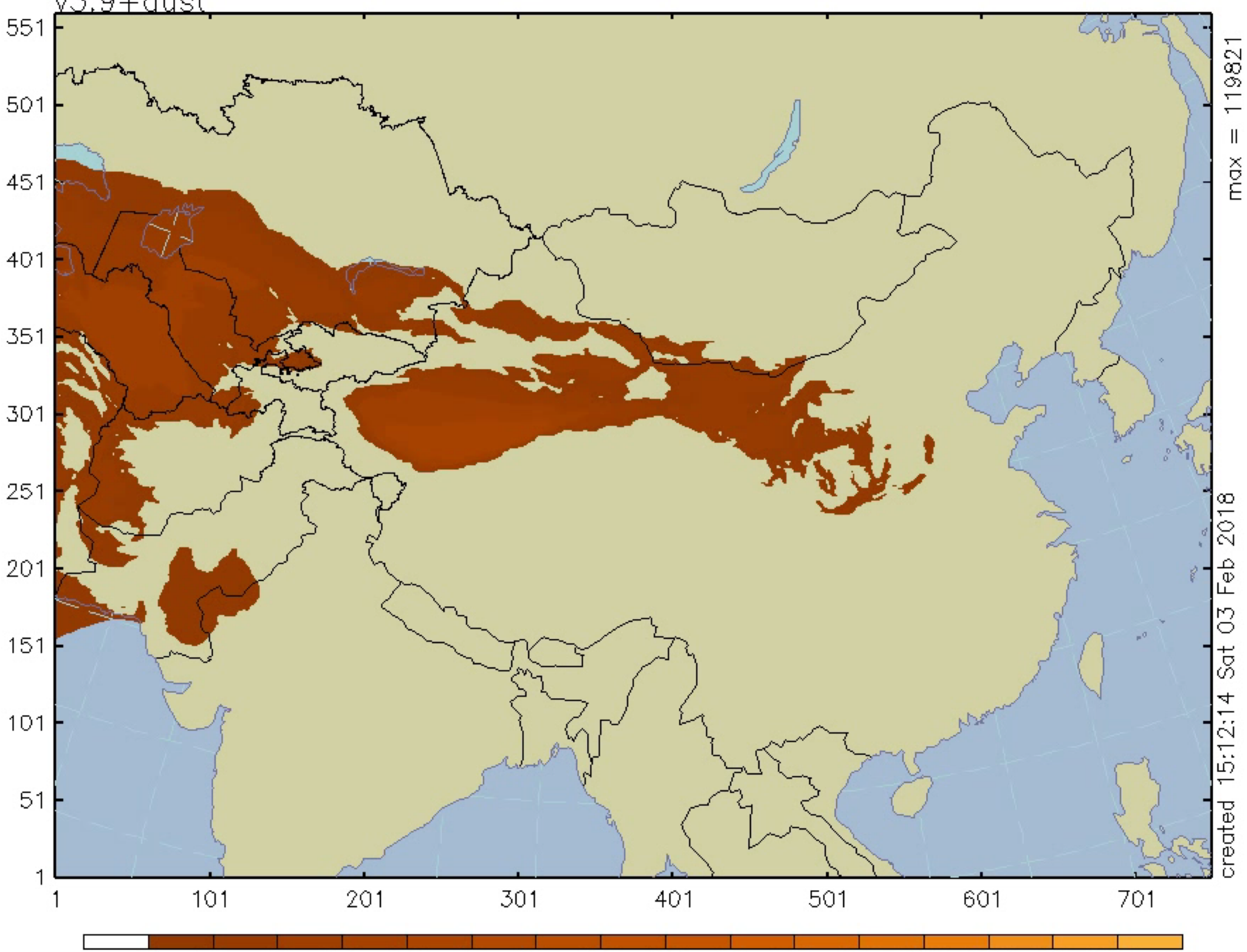
Putting it all together – Asian dust outbreaks

49-day WRF simulation, 9-km spacing, 12 Mar – 30 Apr 2012



Column-integrated dust path

0-hour forecast valid 00:00:00 UTC 10 Mar 2012 **initial time: 00z 10Mar**



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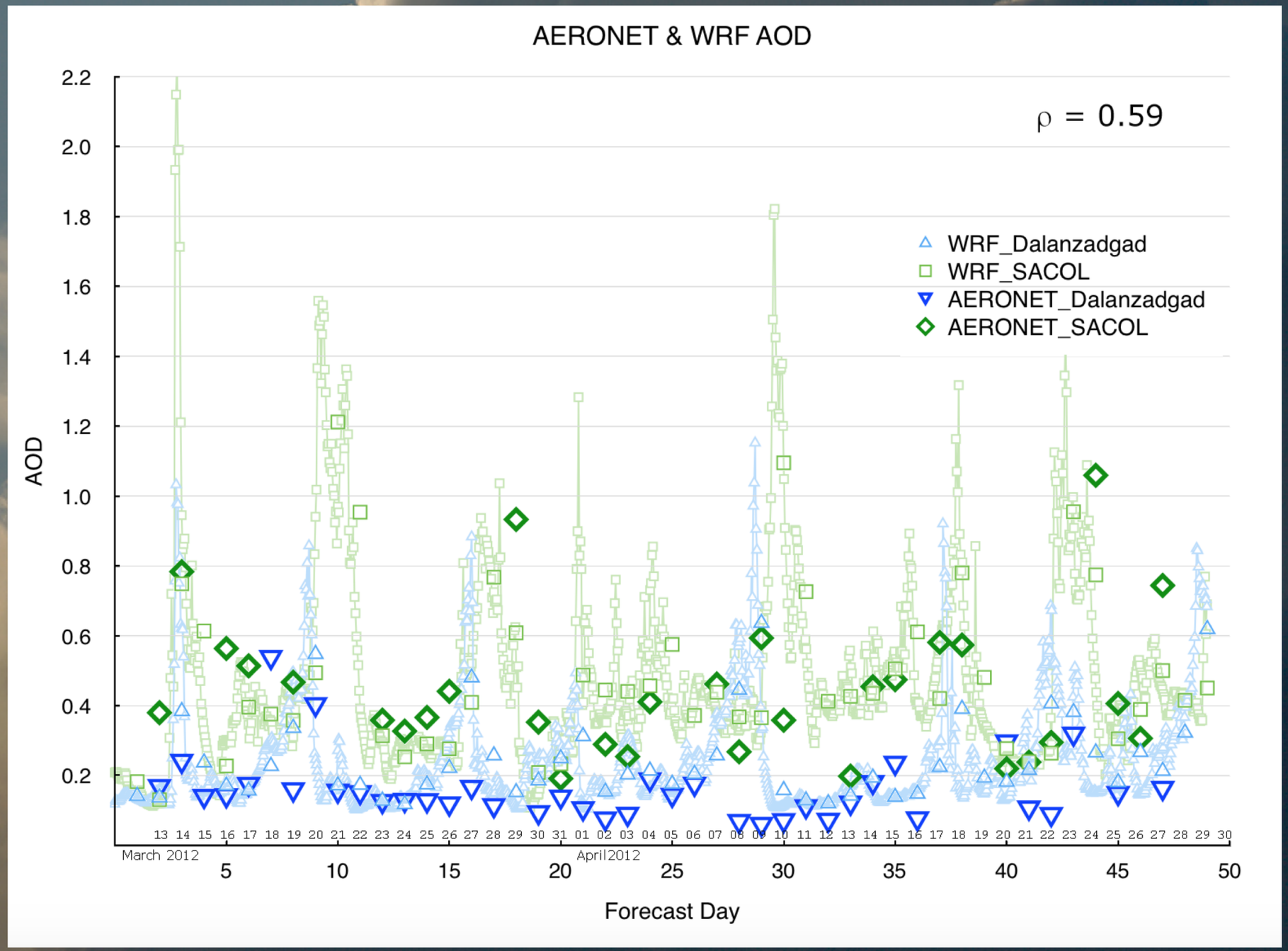
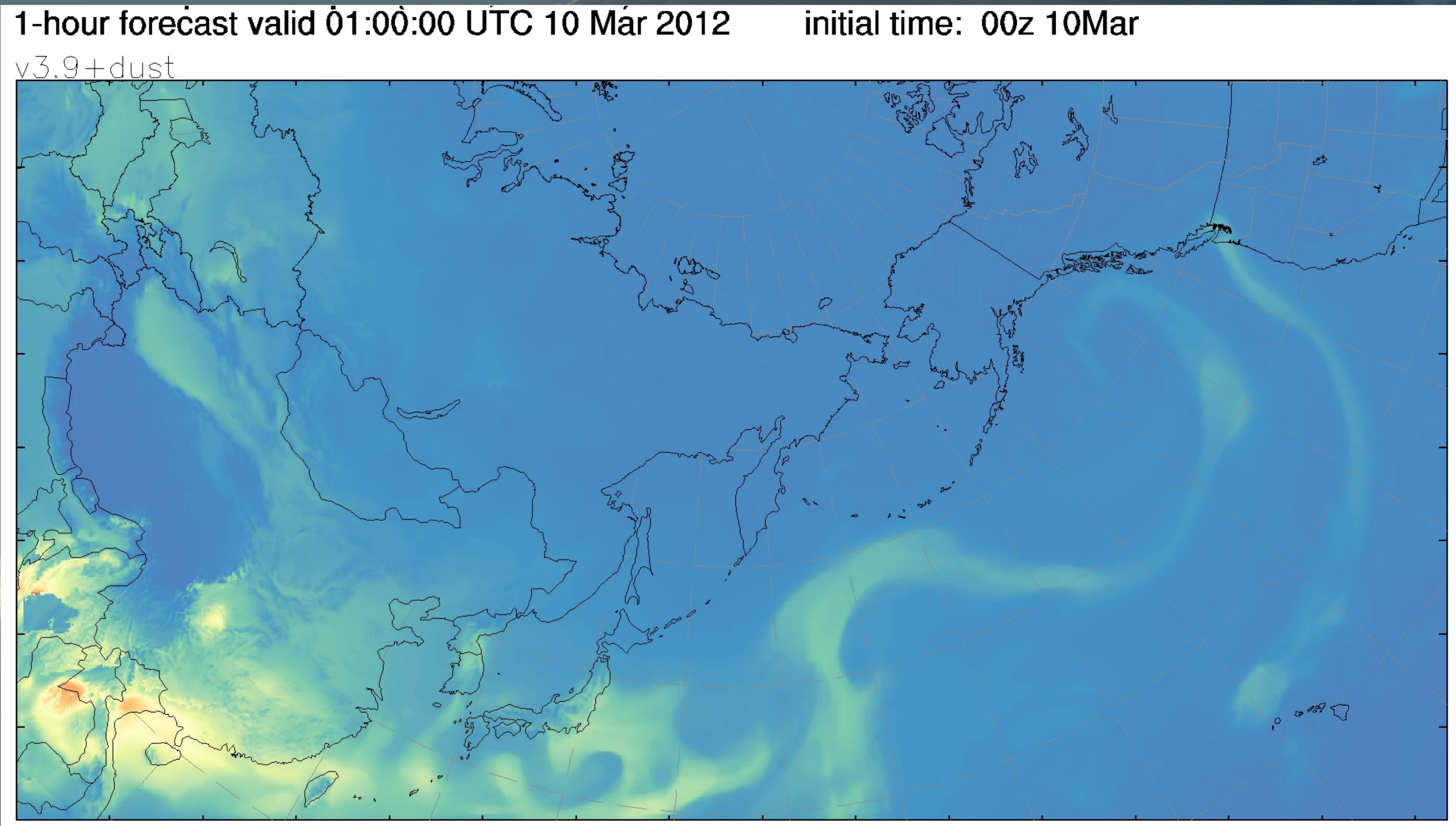


Putting it all together – cross-Pacific Asian dust transport

15-day WRF simulation, 9-km spacing, 10 Mar – 25 Apr 2012



Future Work

- ✓ More rigorous testing of dust emissions scheme (Kuwait project, RAL)
- ✓ "3-moment" hybrid graupel-hail category
  - permits variable density with proper fall-speed treatment
- ✓ Possibly more direct connections with WRF-Chem?
- ✓ "SingleTrack:" Merging best aspects of Morrison-Gettelman-Thompson

Acknowledgements

- FAA Aviation weather research project
- NOAA-ESRL-GSD
- Dave Gill, Jimy Dudhia, Wei Wang, …