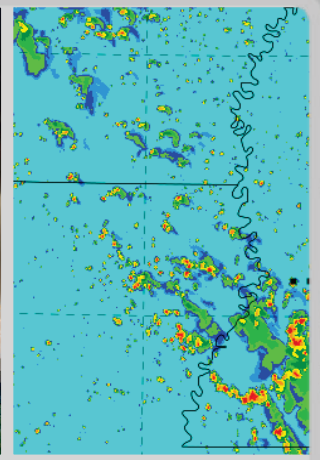
The influence of mesoscale atmospheric convection on local and regional infrasound propagation

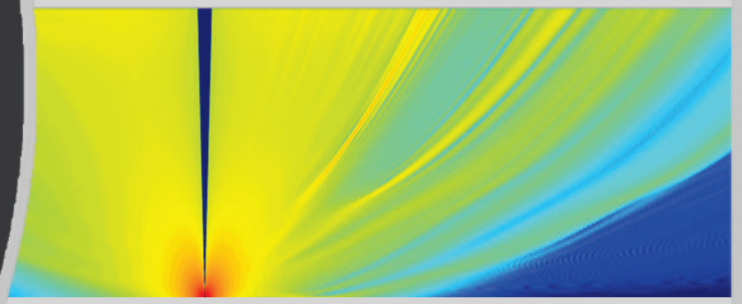
Ross Alter (ERDC-CRREL)
Michelle Swearingen (ERDC-CERL)
Mihan McKenna (ERDC)

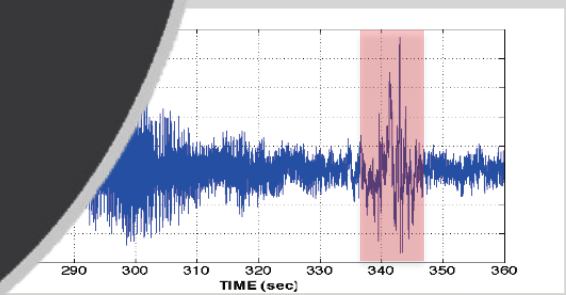
26 April 2021

Distribution A: Approved for public release. EGU21-13738









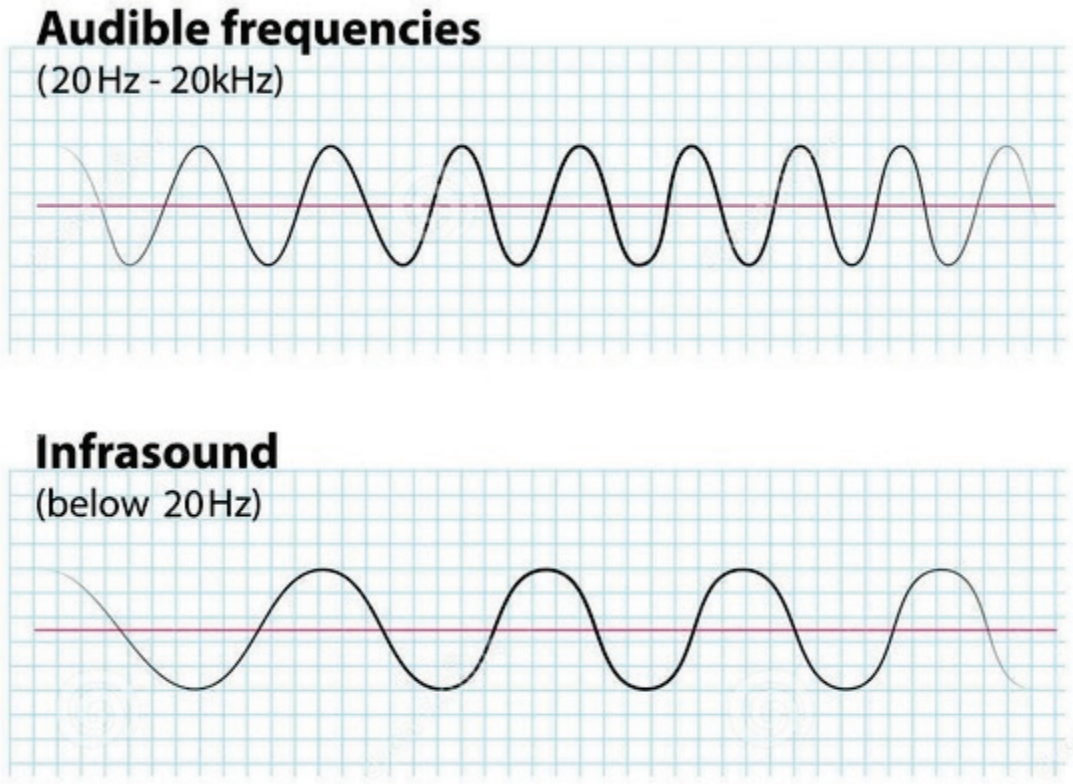


This work was funded by the Assistant Secretary of the Army (Acquisition, Logistics, and Technology) [ASA(ALT)] with portions funded under 62784/T40/24.

US Army Corps of Engineers

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

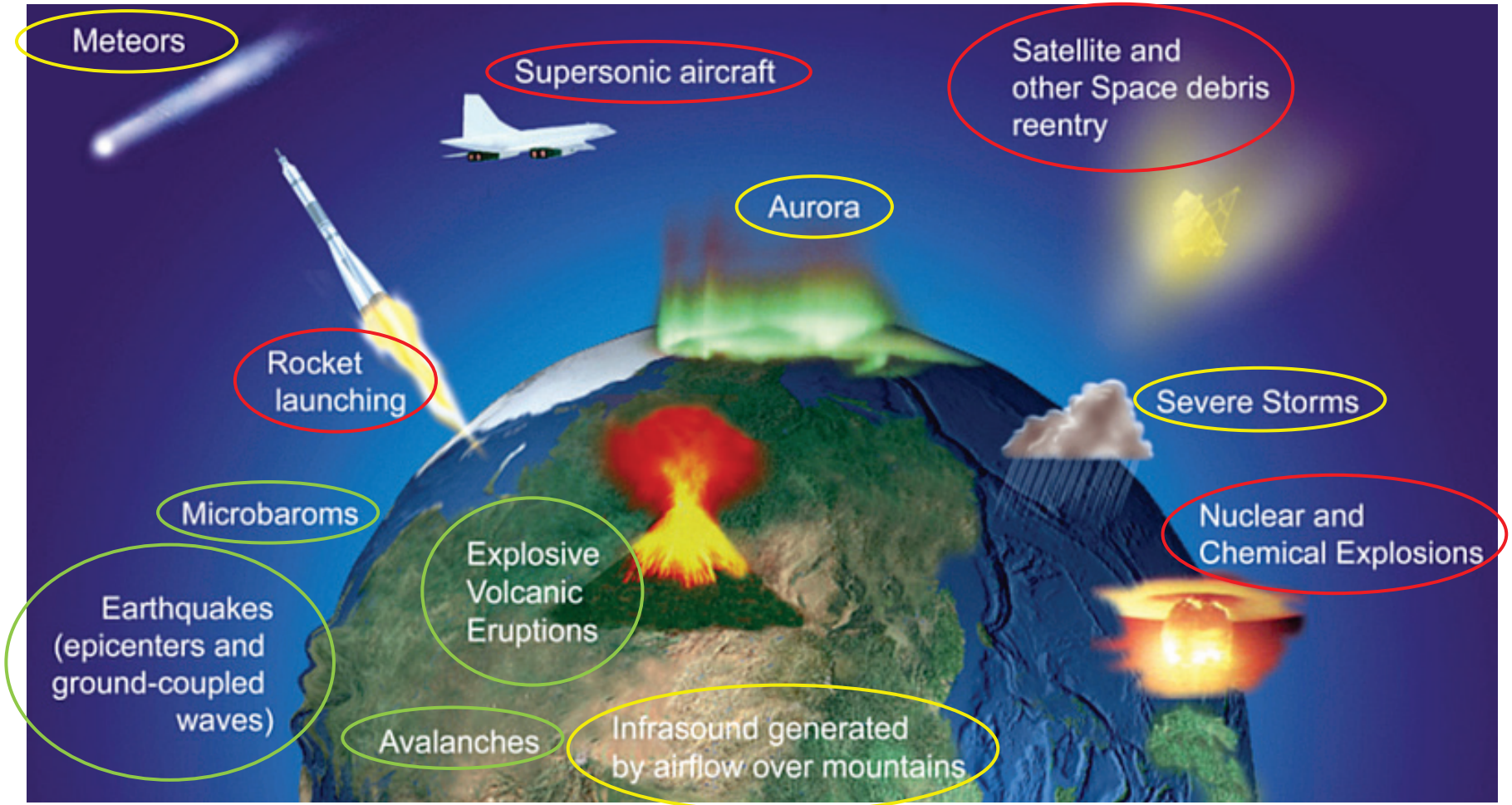
Infrasound is acoustic energy below human hearing



Hundreds to thousands of kilometers

Adapted from quora.com

Infrasound can be generated by a multitude of sources

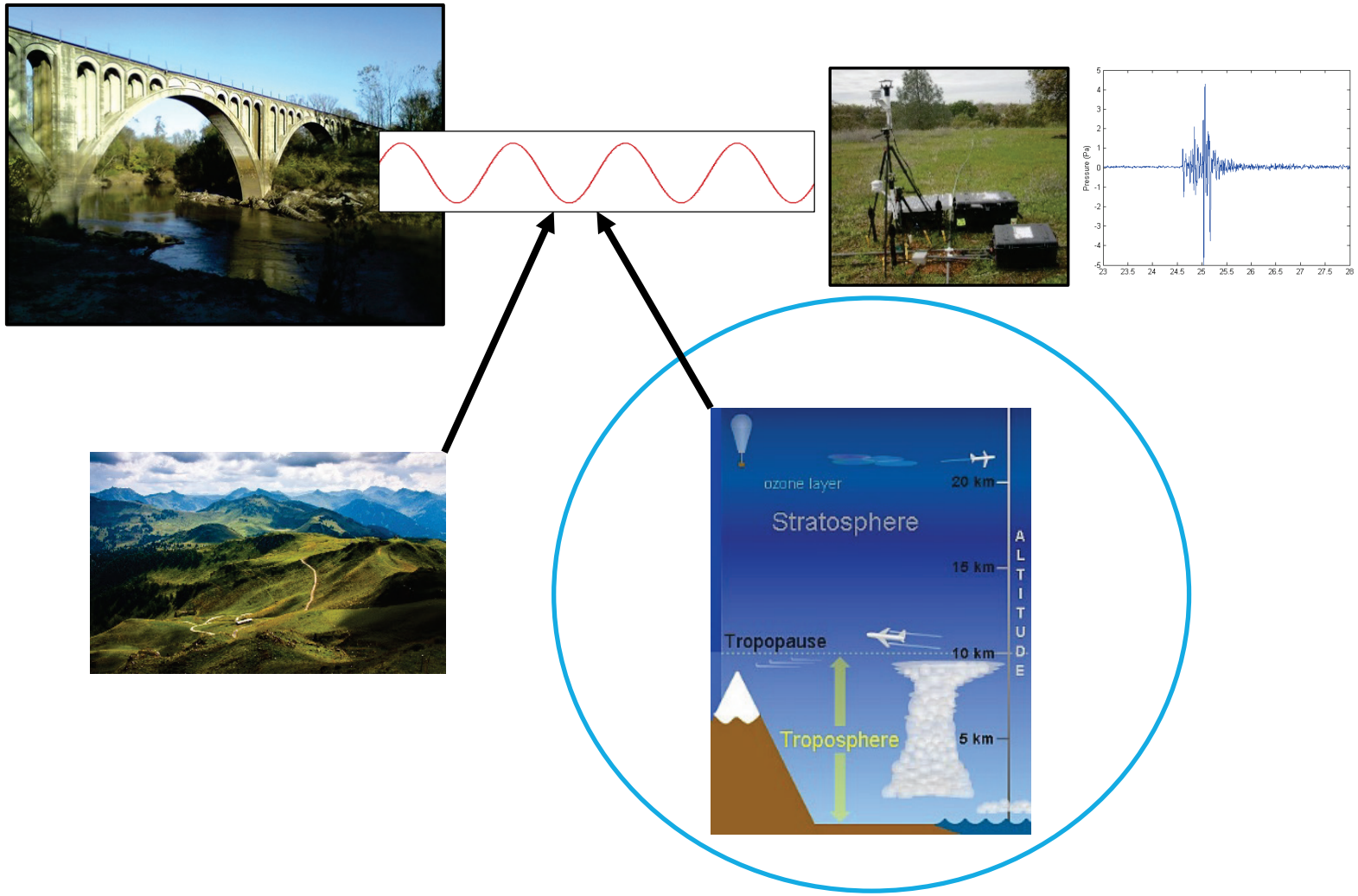


Adapted from ctbto.org

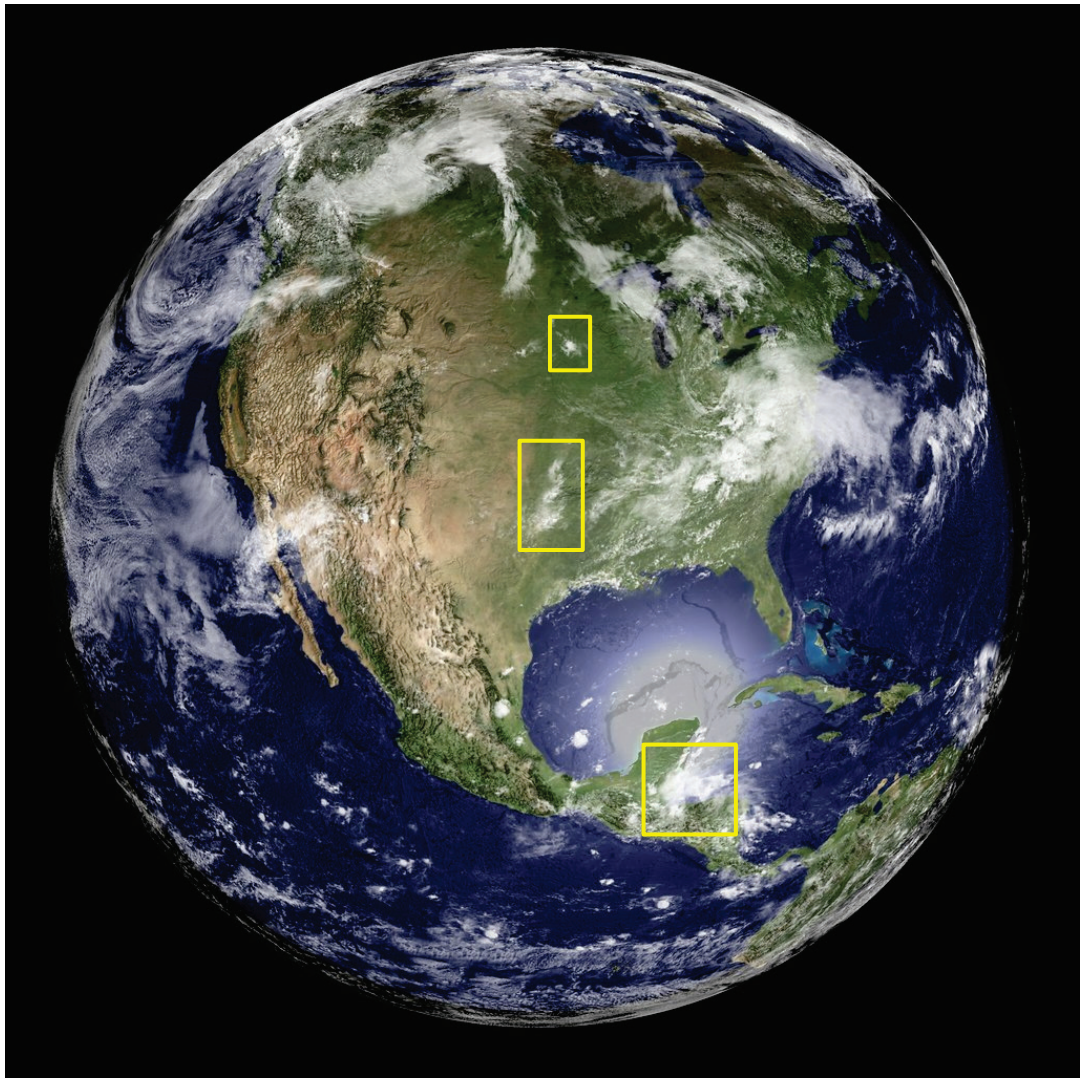
…including infrastructure



We can detect and monitor the infrasonic signals from infrastructure sources

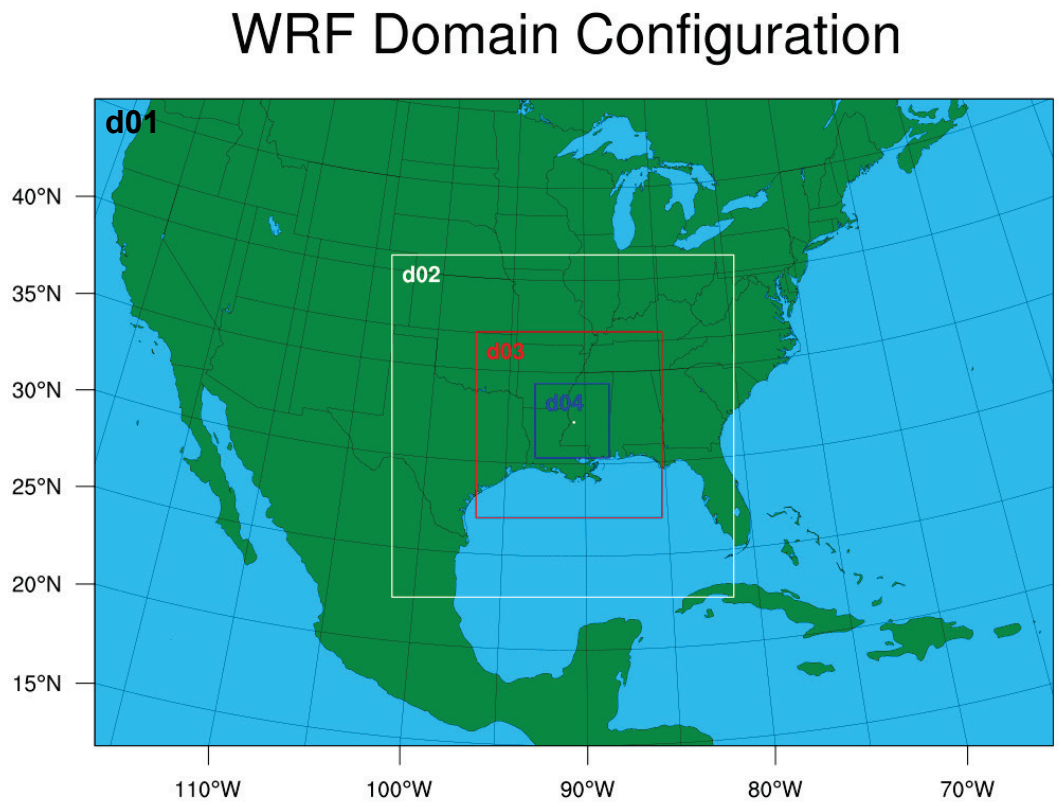


Problem: Global infrasonic reach, but local to regional influences



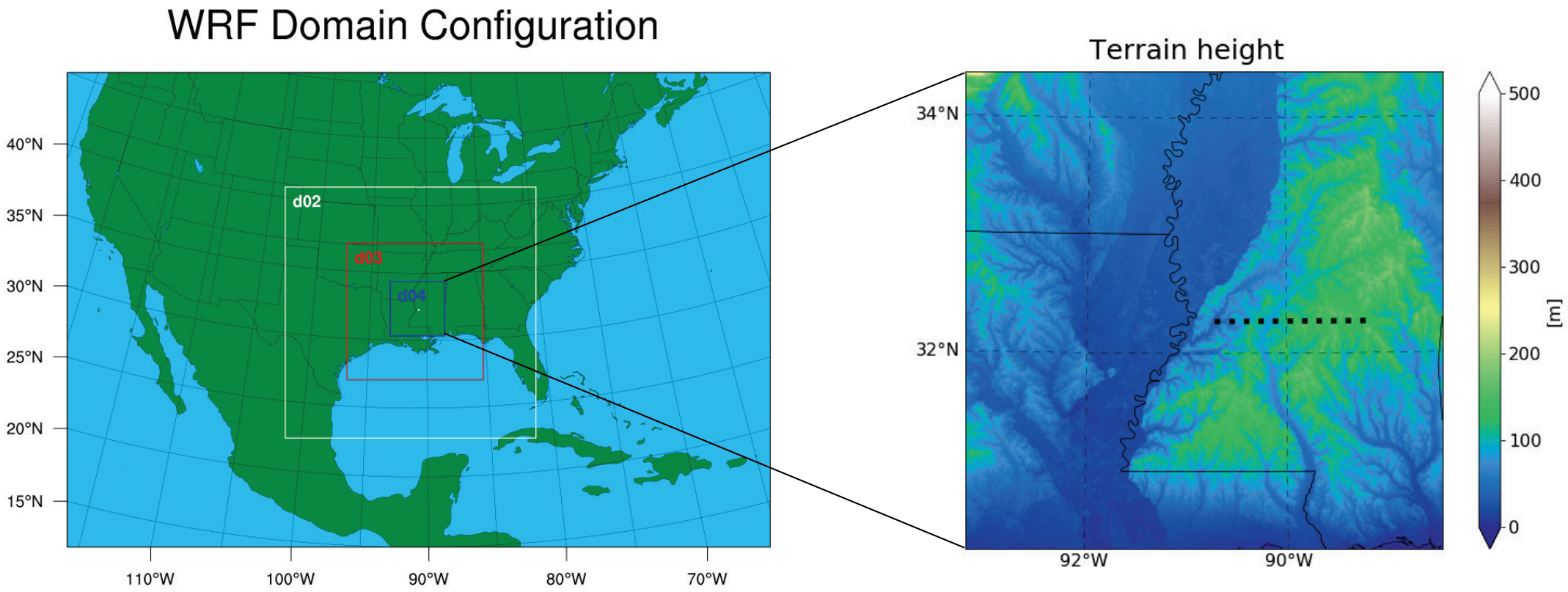
Adapted from an image by Kevin M. Gill

We conducted simulations with a regional weather model

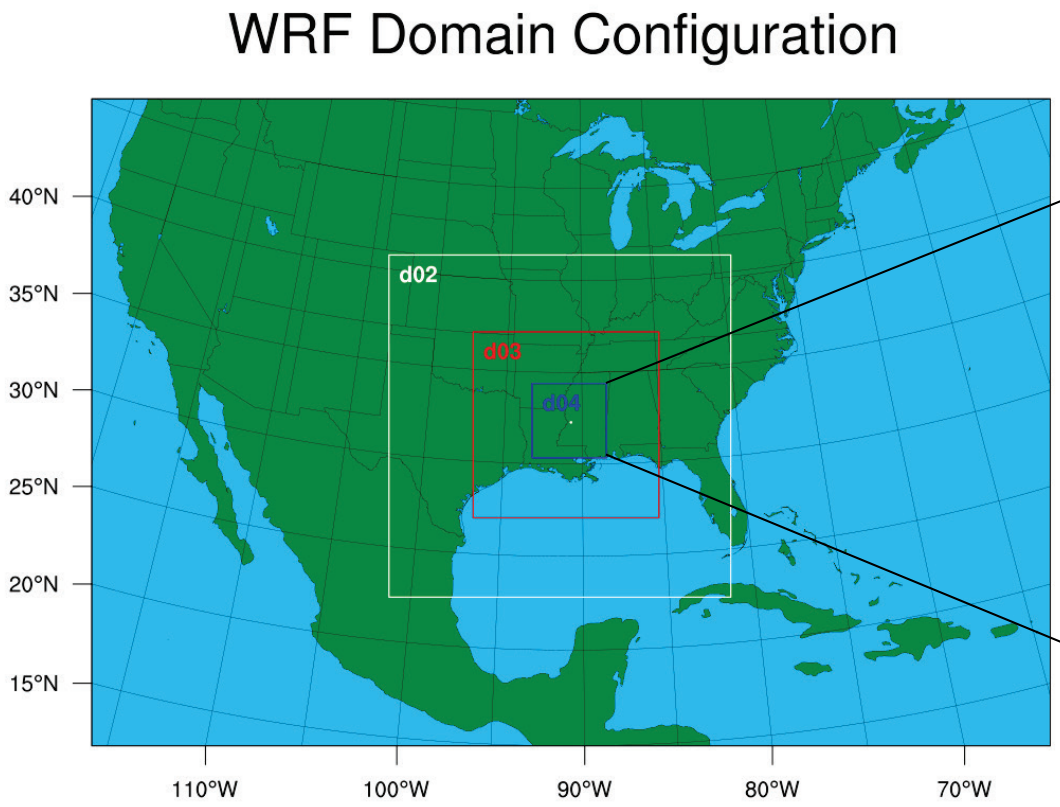


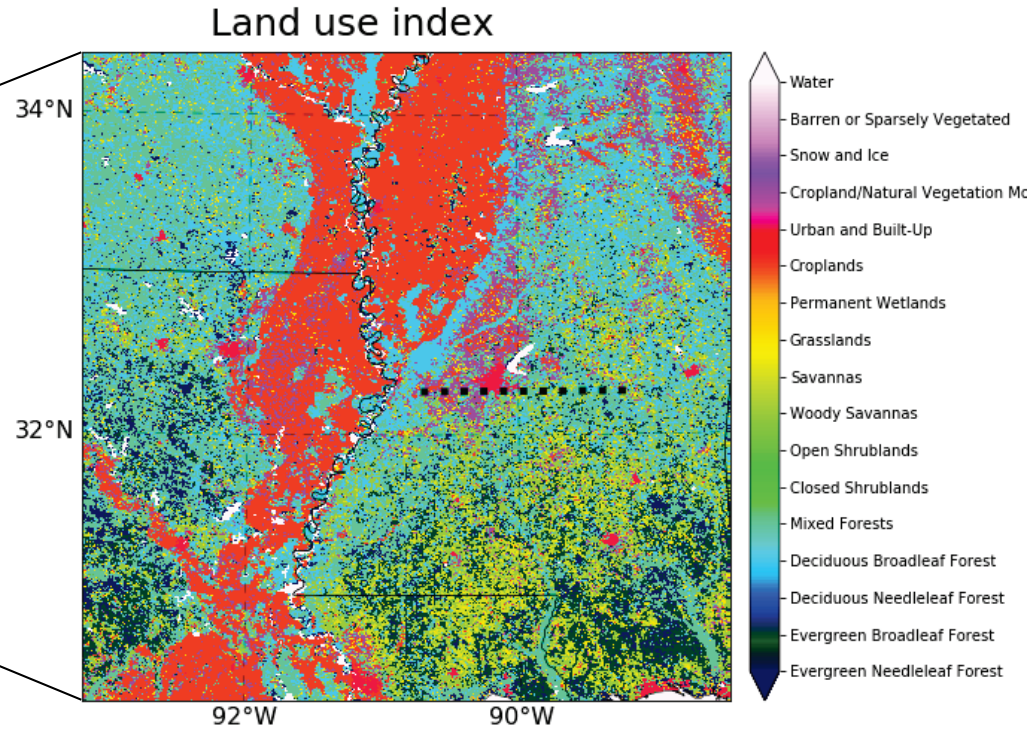
- Weather Research and Forecasting (WRF) meteorological model v3.9.1
- 4 simulations = 4 innermost horizontal resolutions
- 64 vertical levels
- Model top = 10 hPa (~32 km)
- Analysis time = 12 Aug 2011 at 1900 UTC (1400 local time)

We conducted simulations with a regional weather model

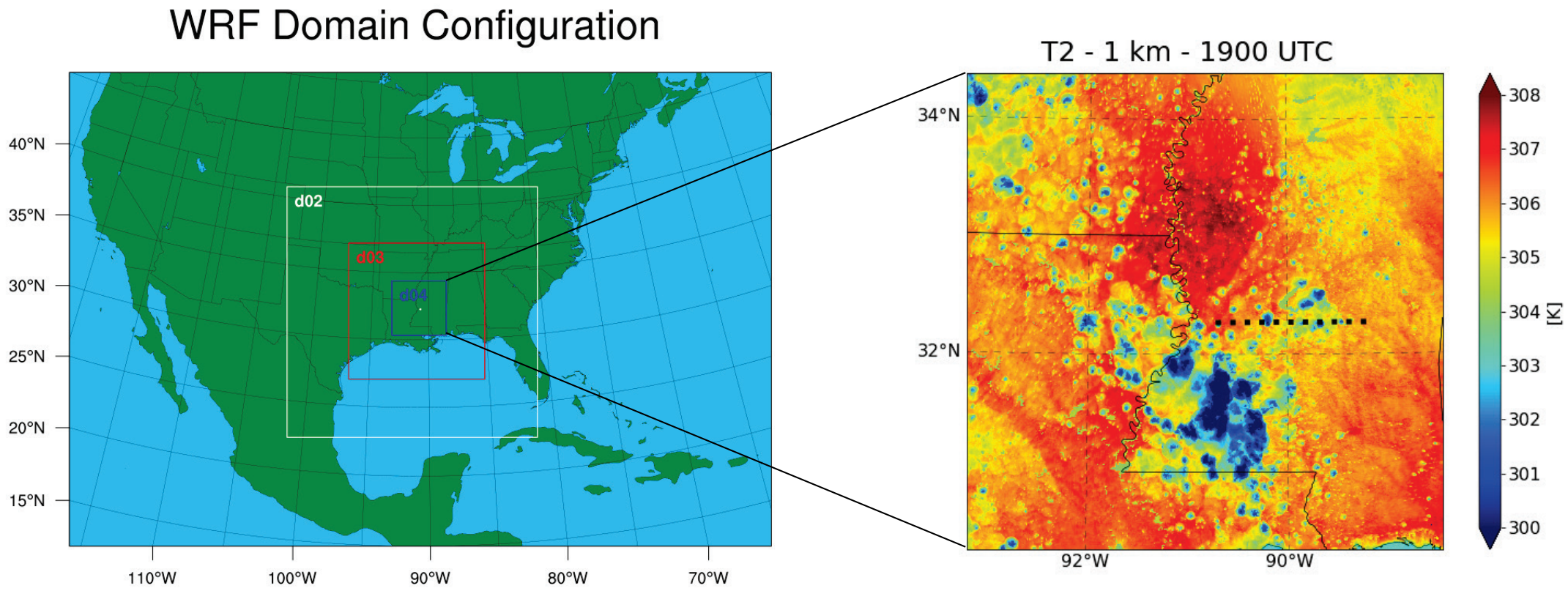


We conducted simulations with a regional weather model

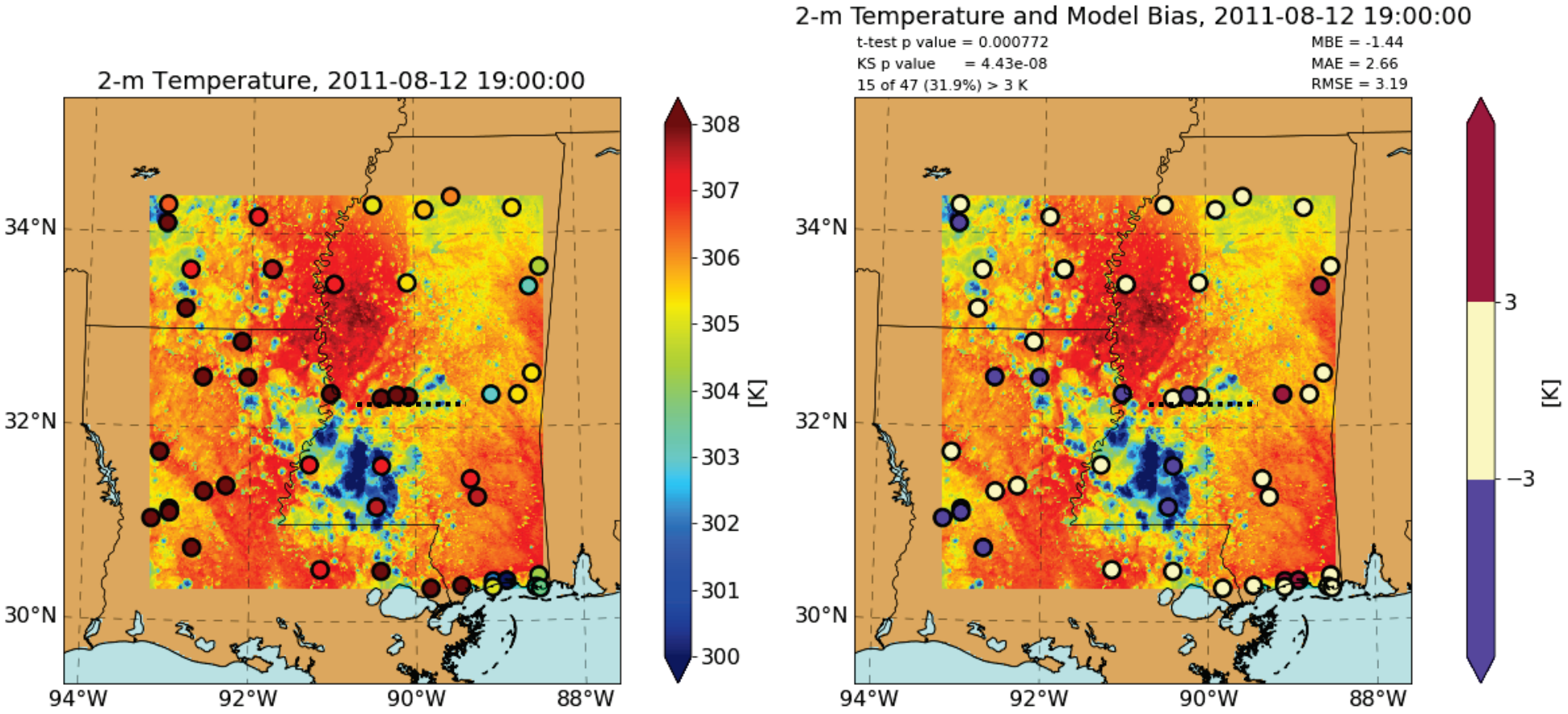




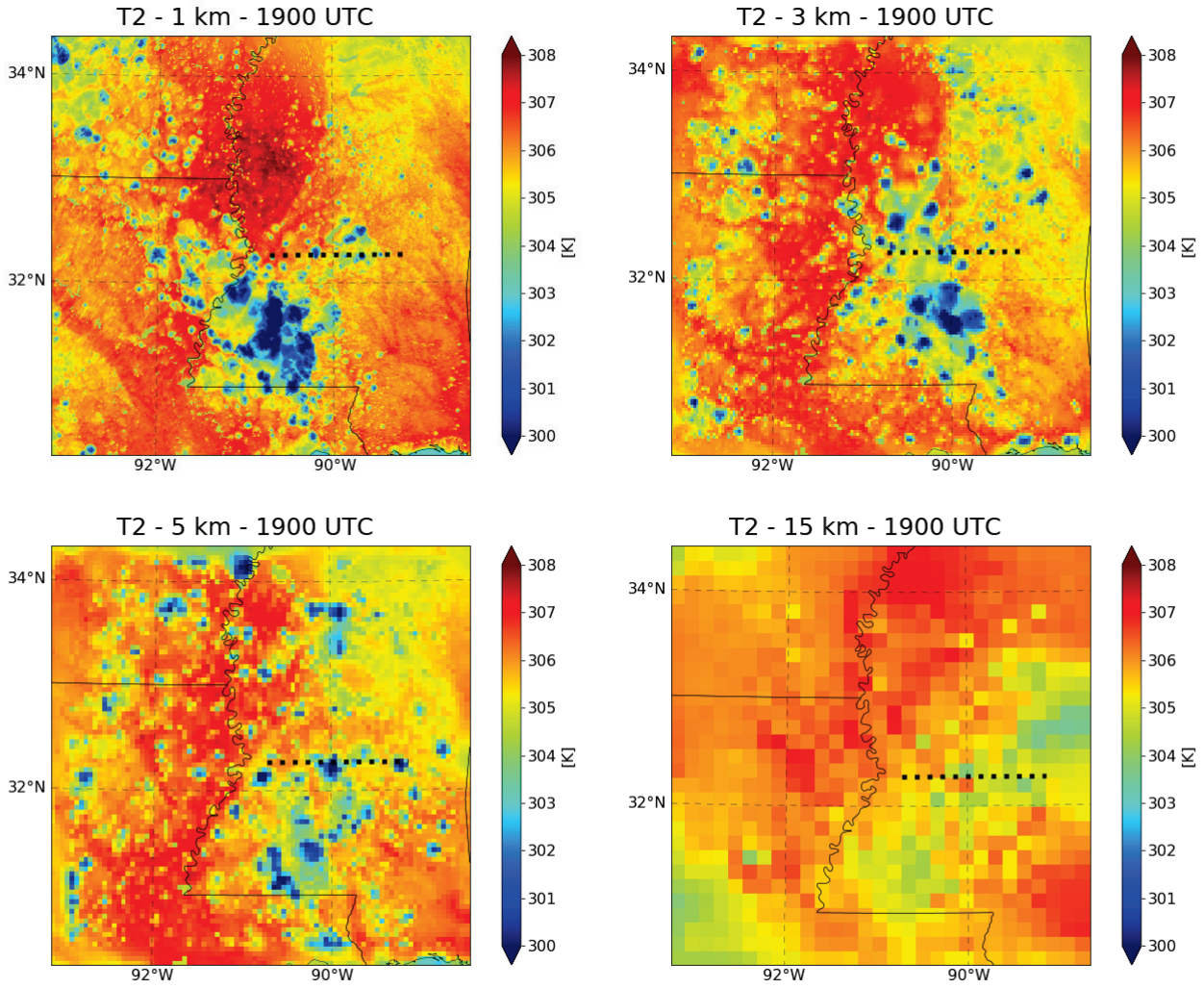
We conducted simulations with a regional weather model



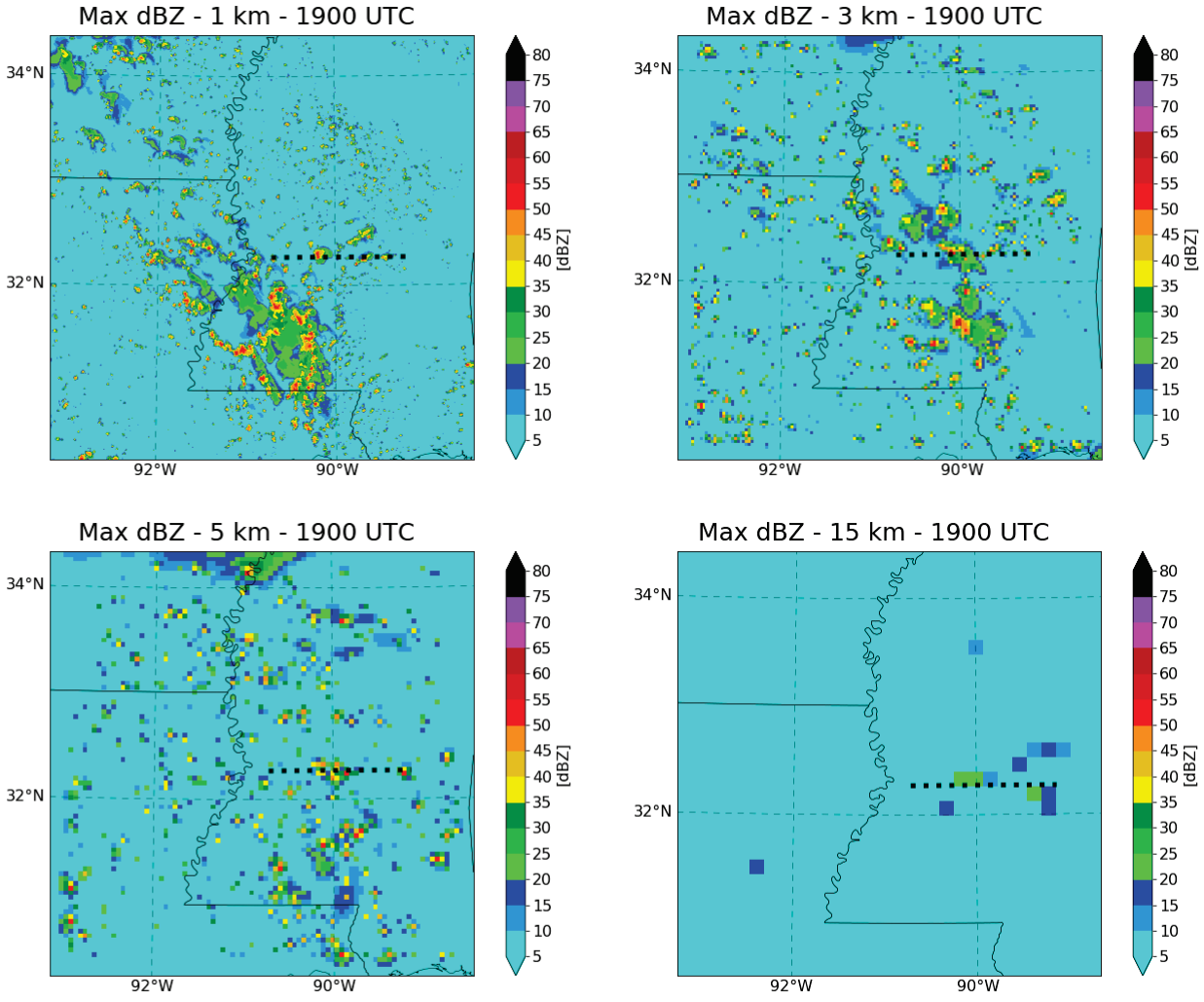
…"validated" it against observational data



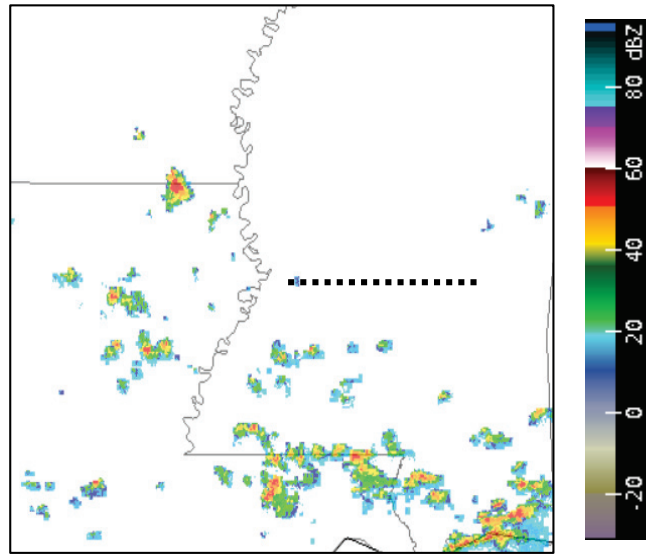
…and generated output for different horizontal resolutions



…and generated output for different horizontal resolutions

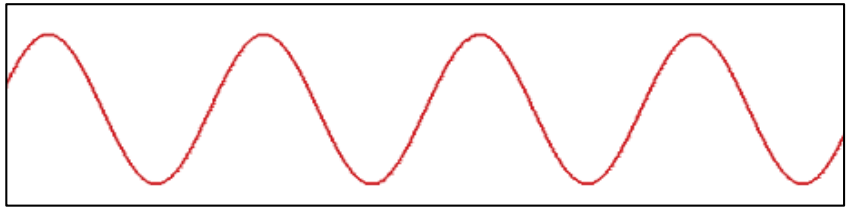


Observed dBZ

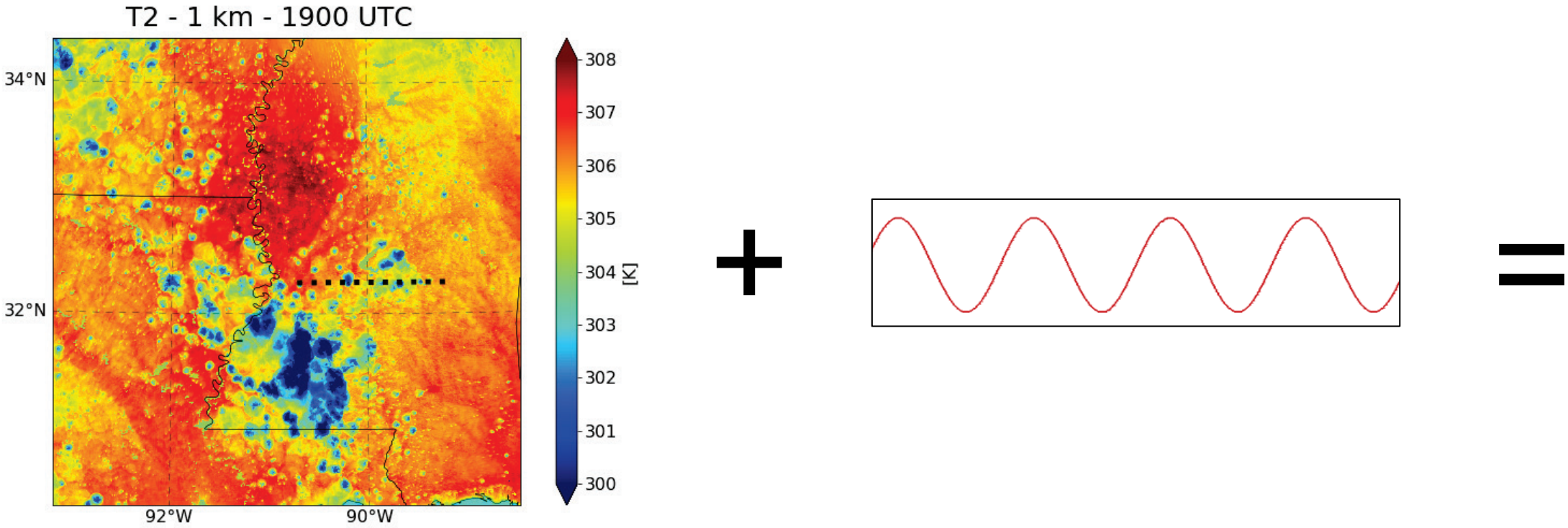


We then incorporated the weather model output into an acoustic model

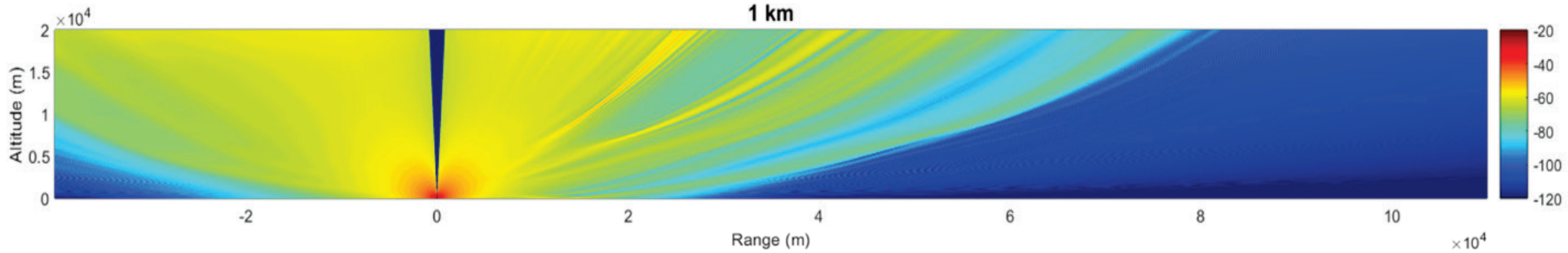
- Finite-element implementation of the Crank-Nicholson parabolic equation (CNPE) method
  - Wide-angle, up to 40°
- Effective sound speed approximation
  - Adiabatic sound speed + wind in the direction of propagation
- Propagation space: ground up to 20 km, horizontal range of 150 km
- Ground is considered to be flat, grassy surface



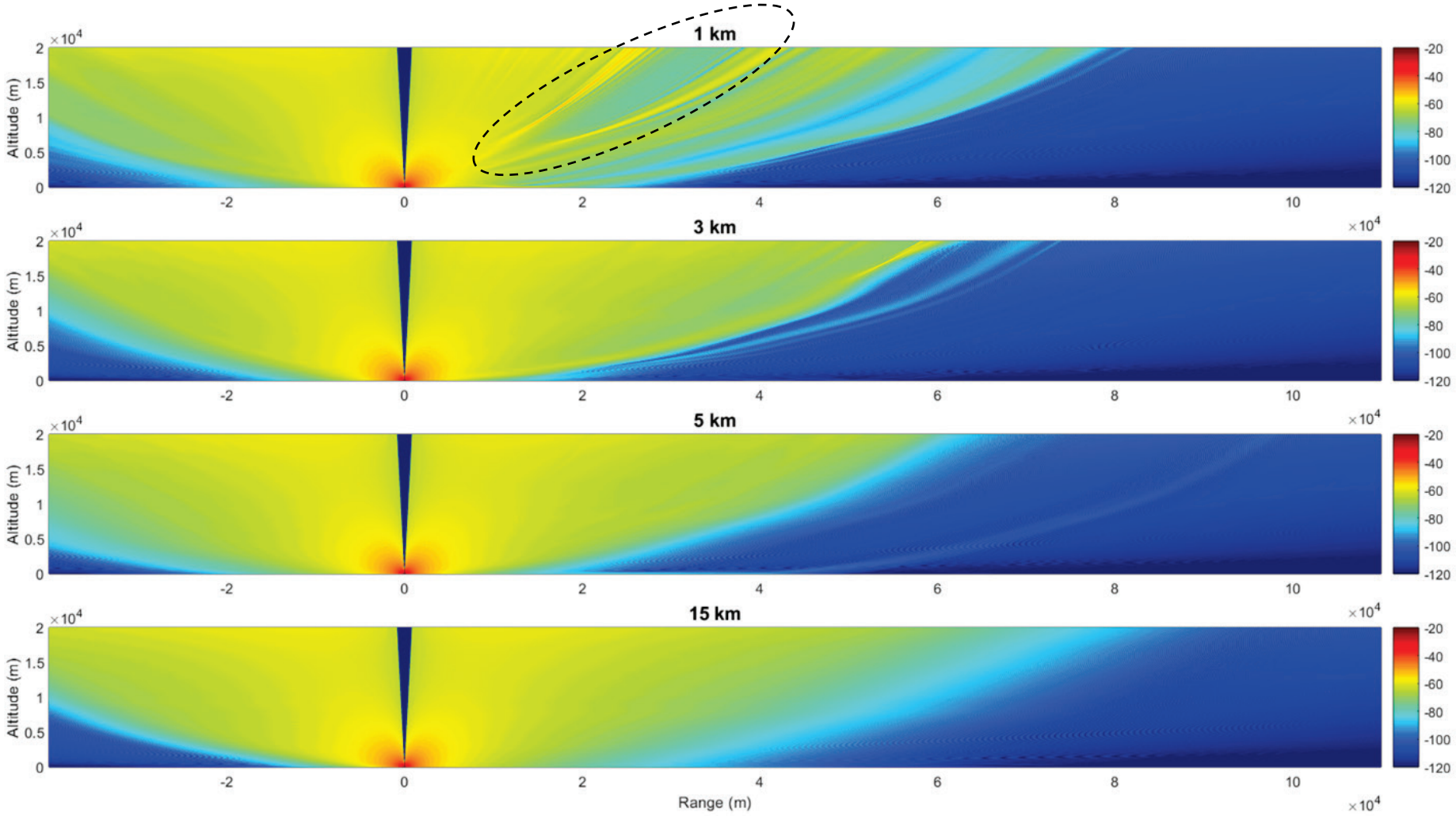
From these two products, we created…



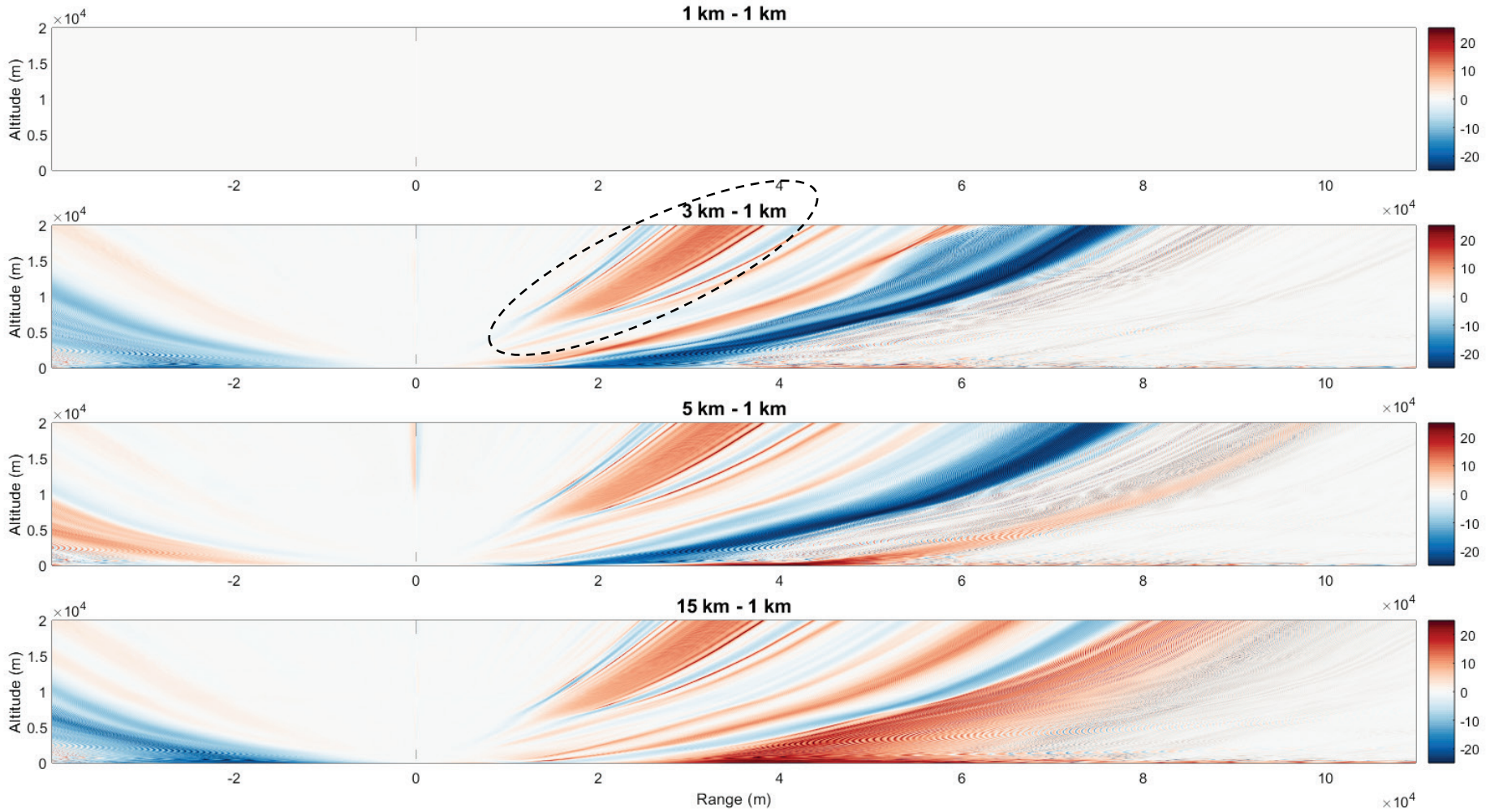
…plots of transmission loss (TL)



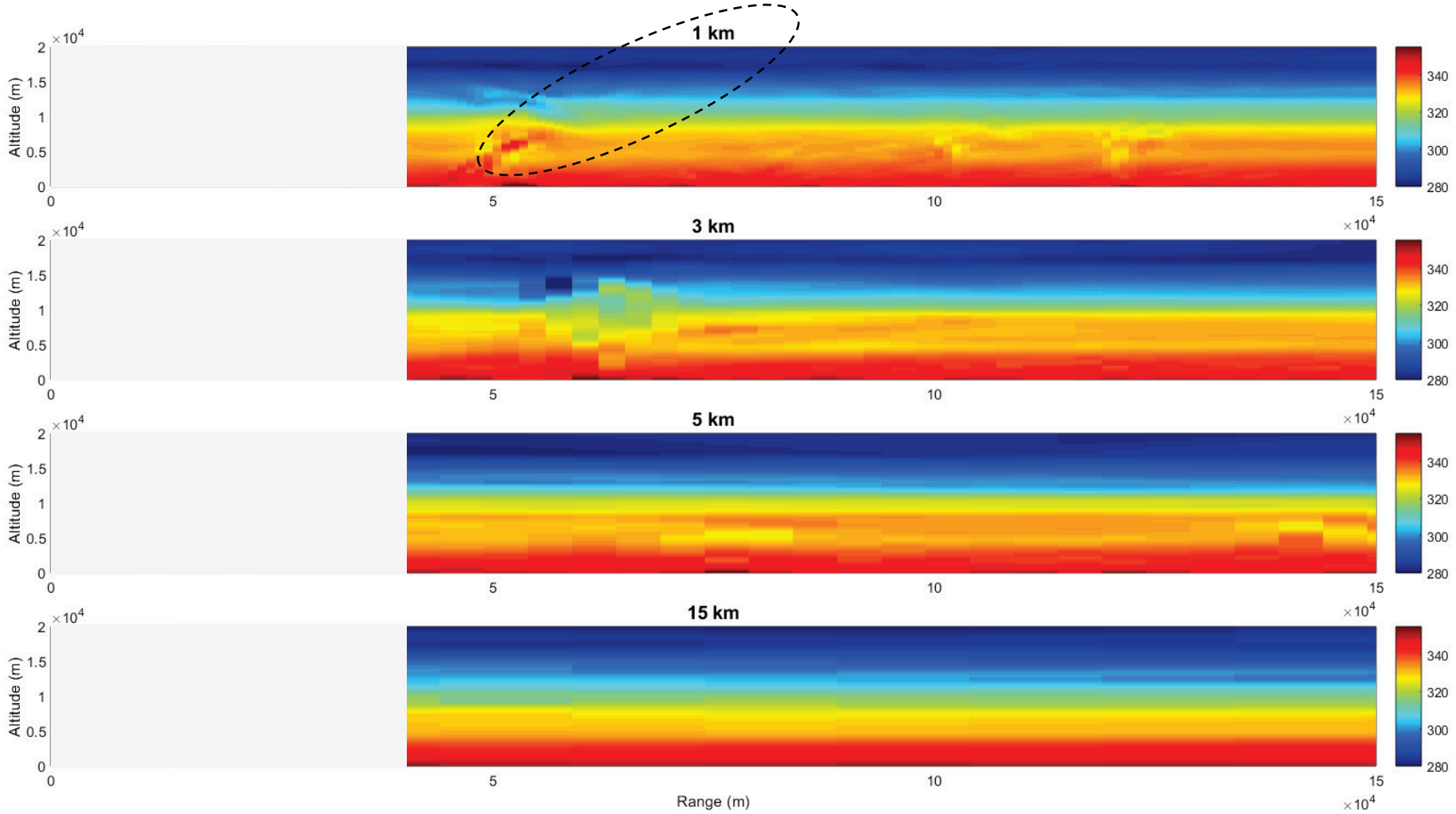
…for all four horizontal resolutions used in the weather model



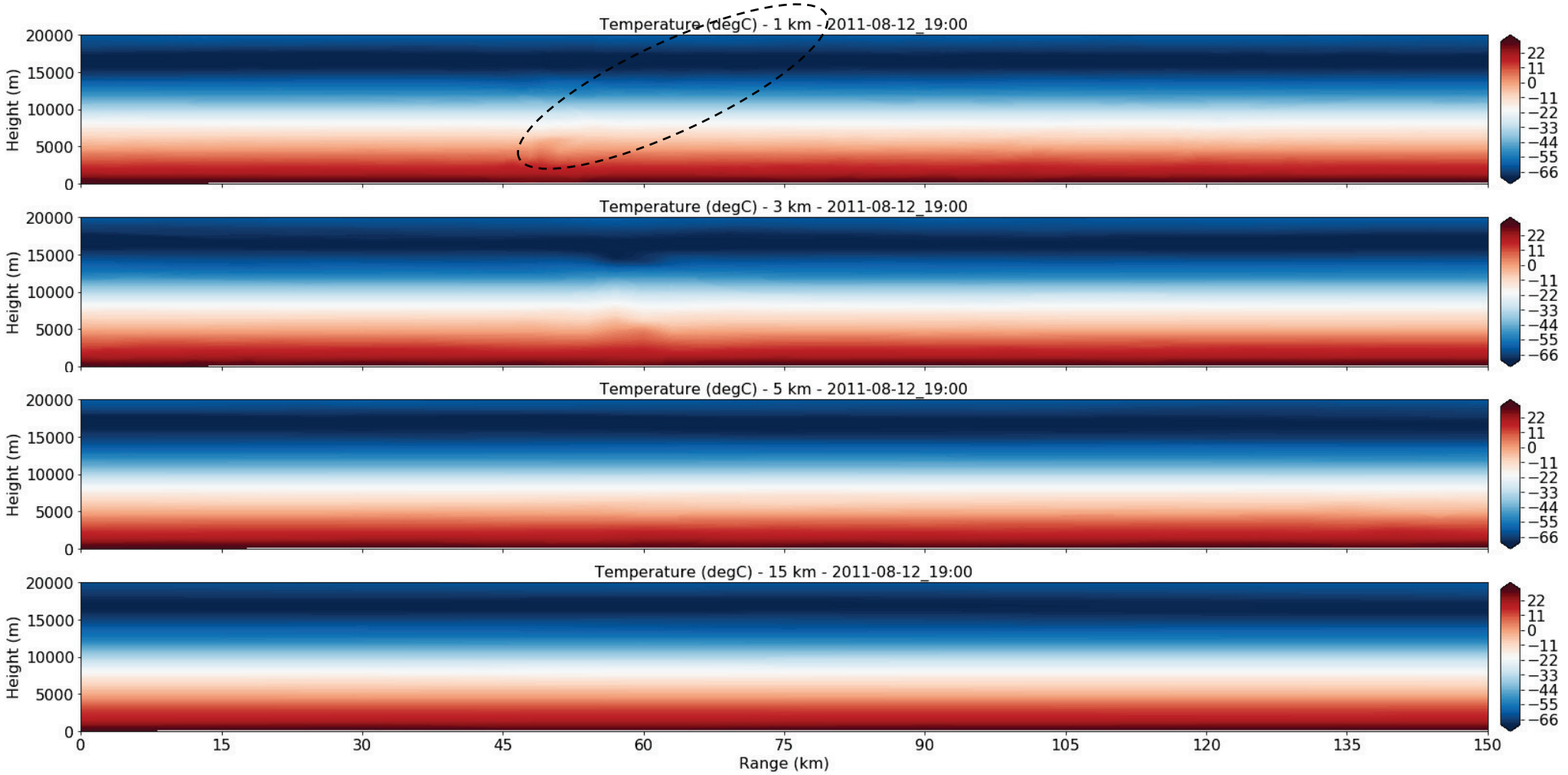
…and for their differences from the 1 km horizontal resolution



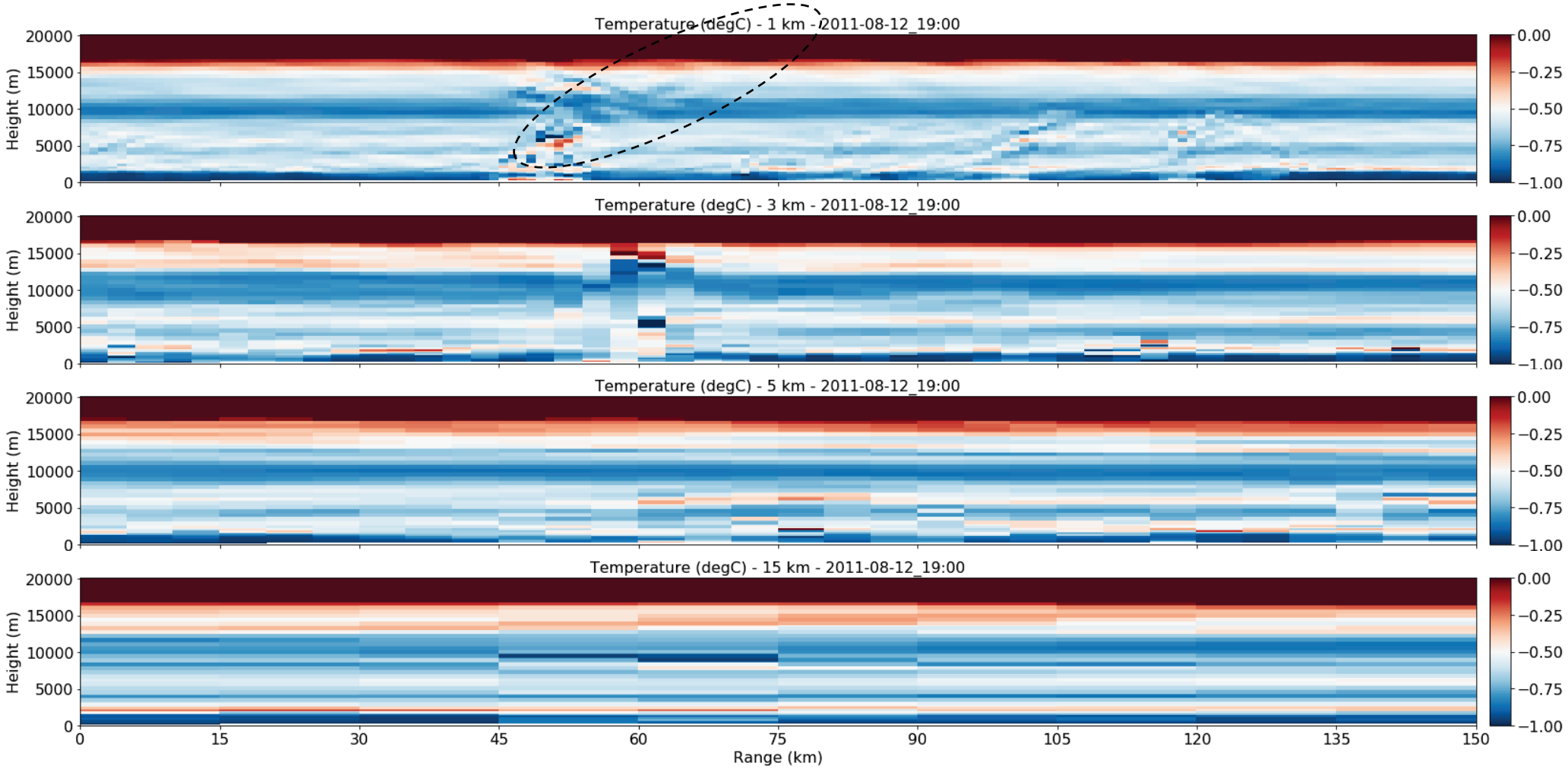
We also created plots of sound speed



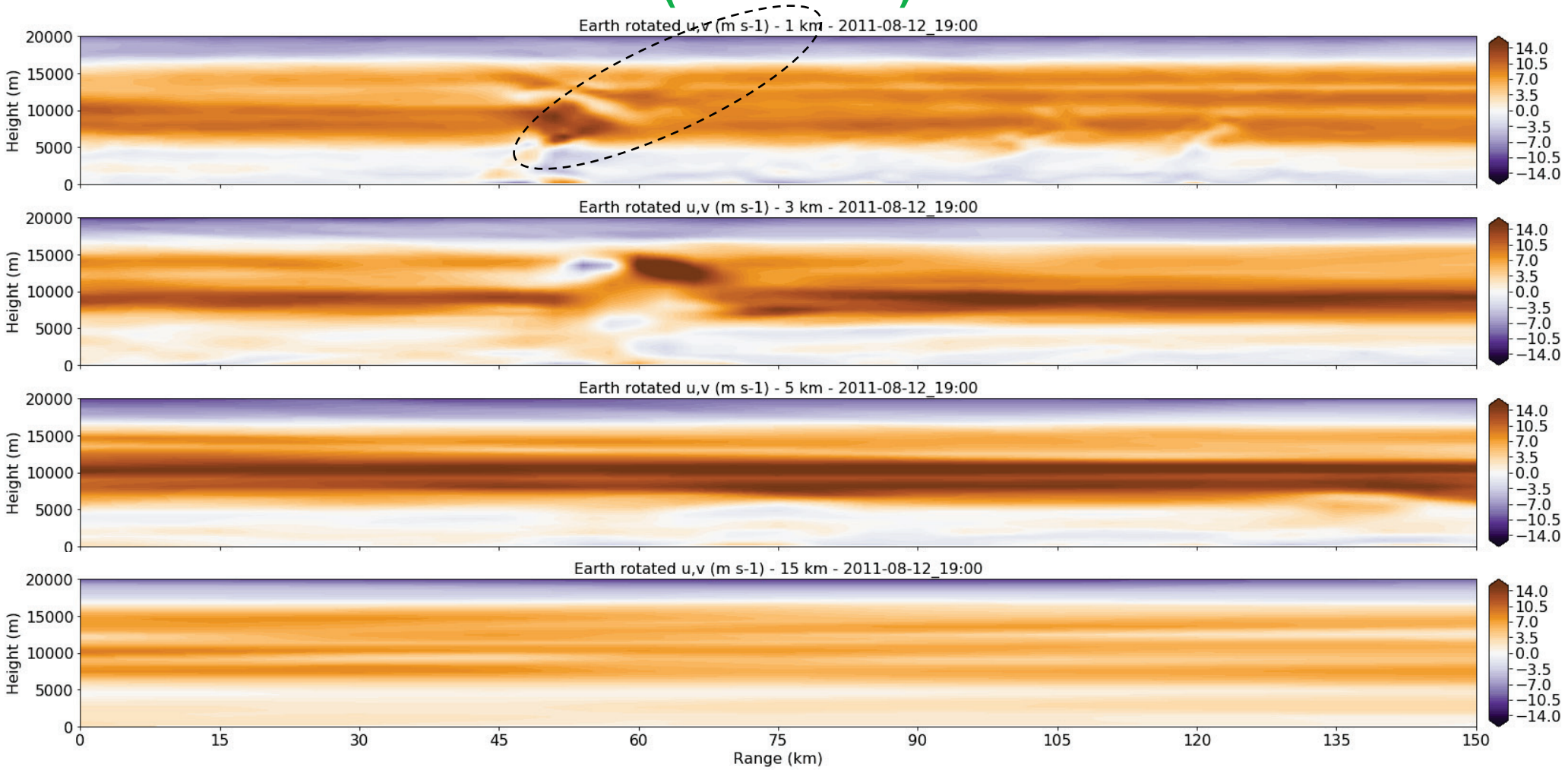
Next, we created plots of air temperature



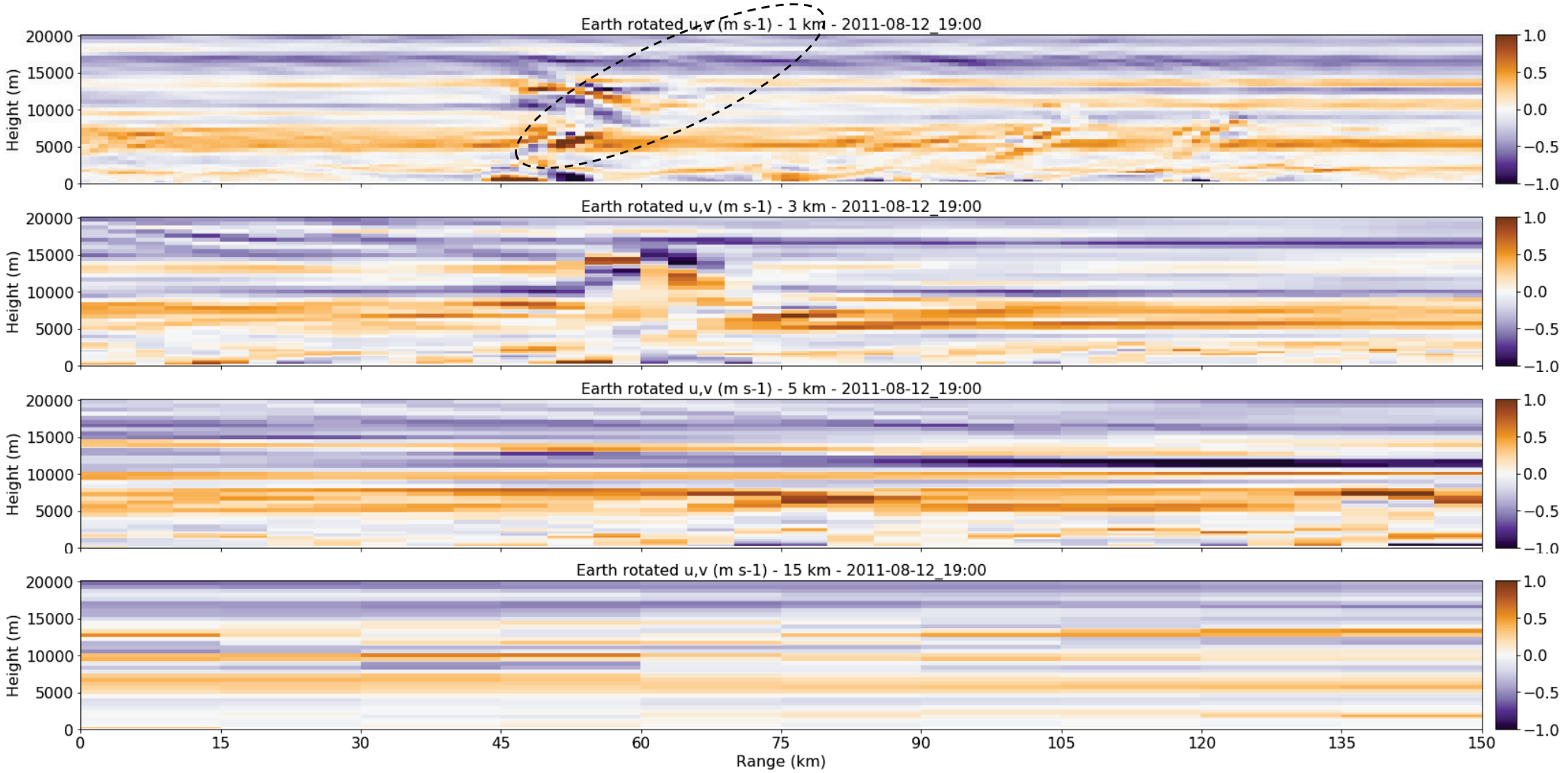
…and its vertical gradients



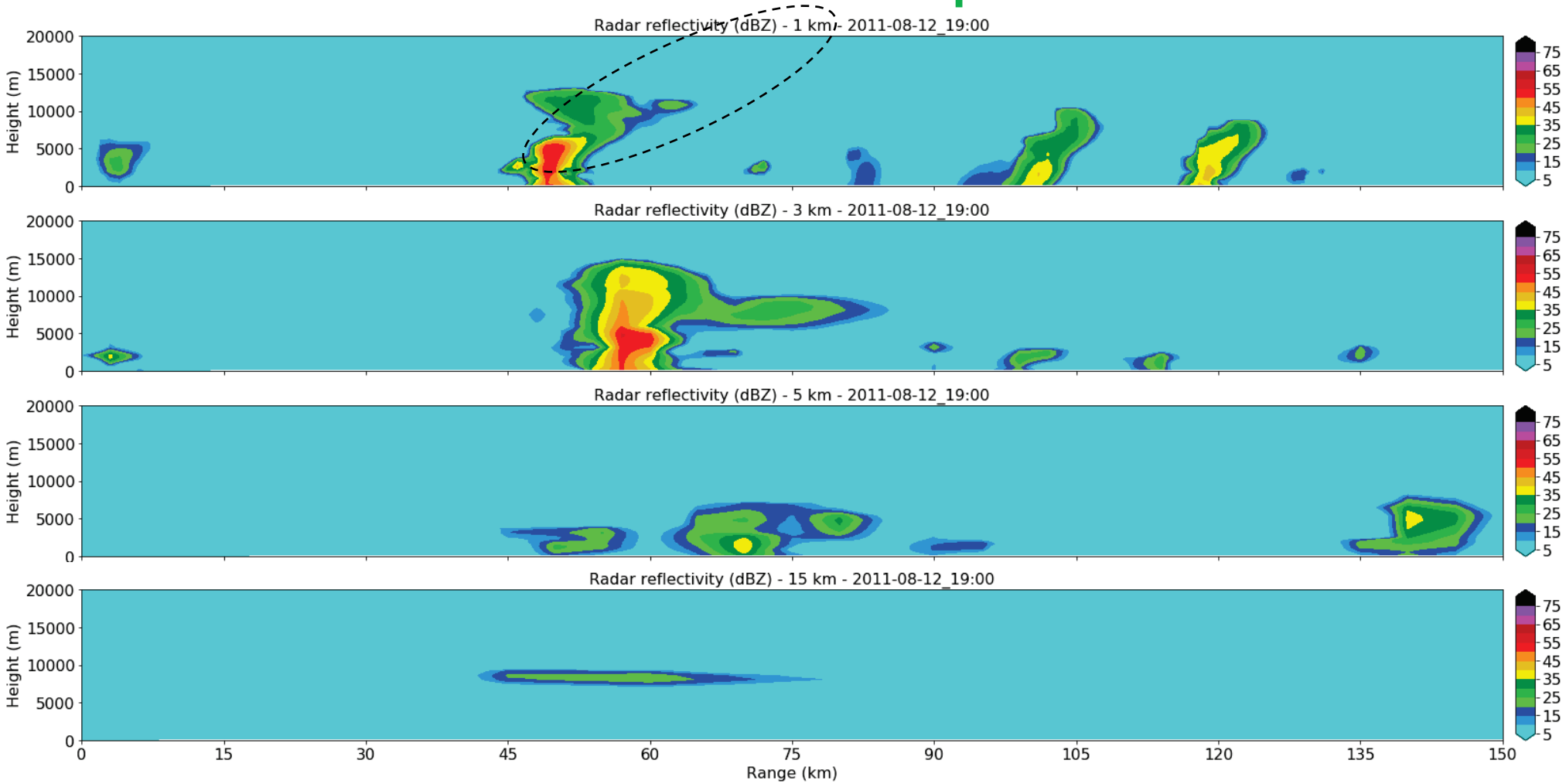
Similarly, we created plots of wind in the direction of propagation (west-east)



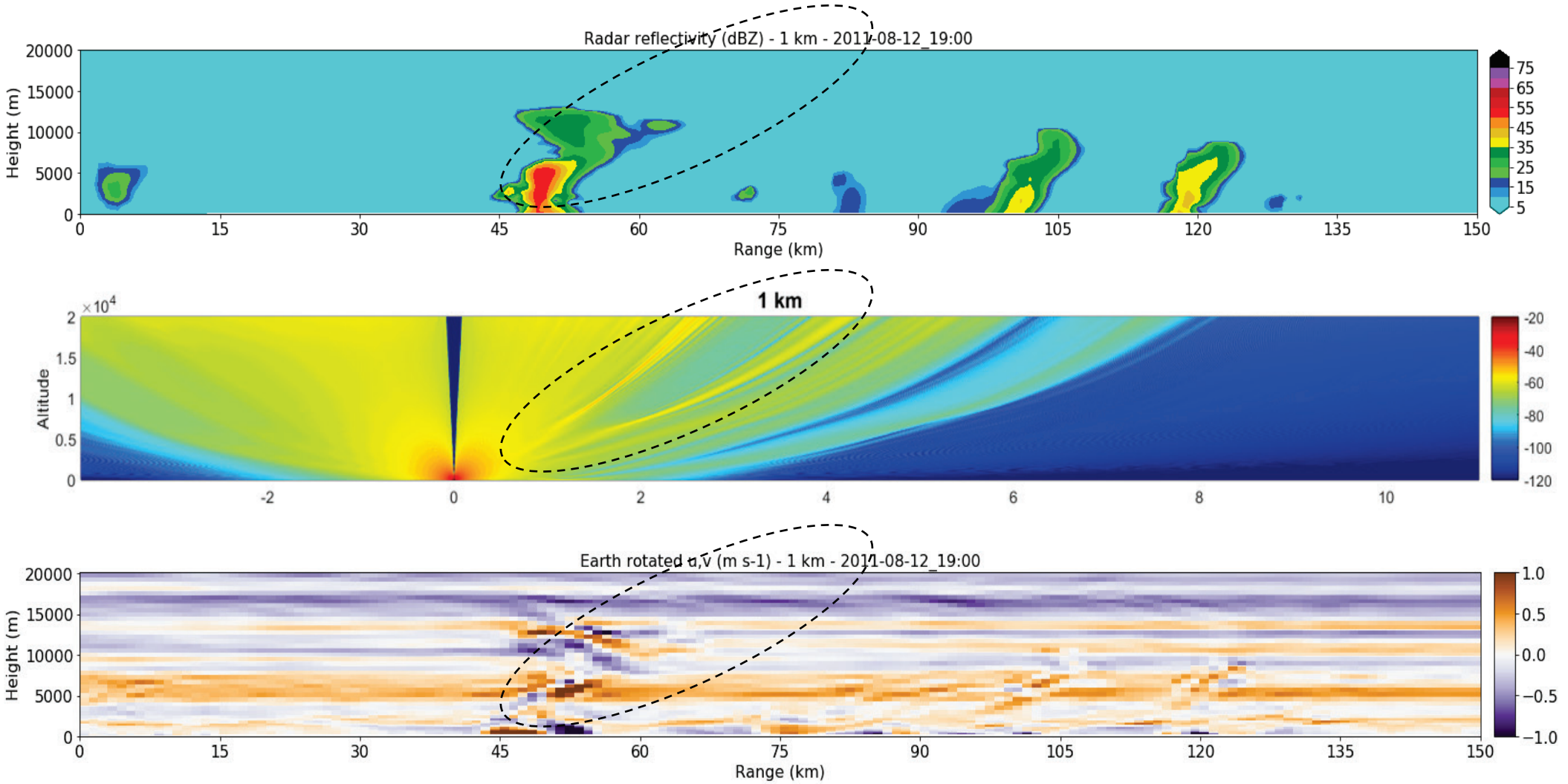
…and its vertical gradients



Simulated convective precipitation events seem to line up with areas of modified TL patterns

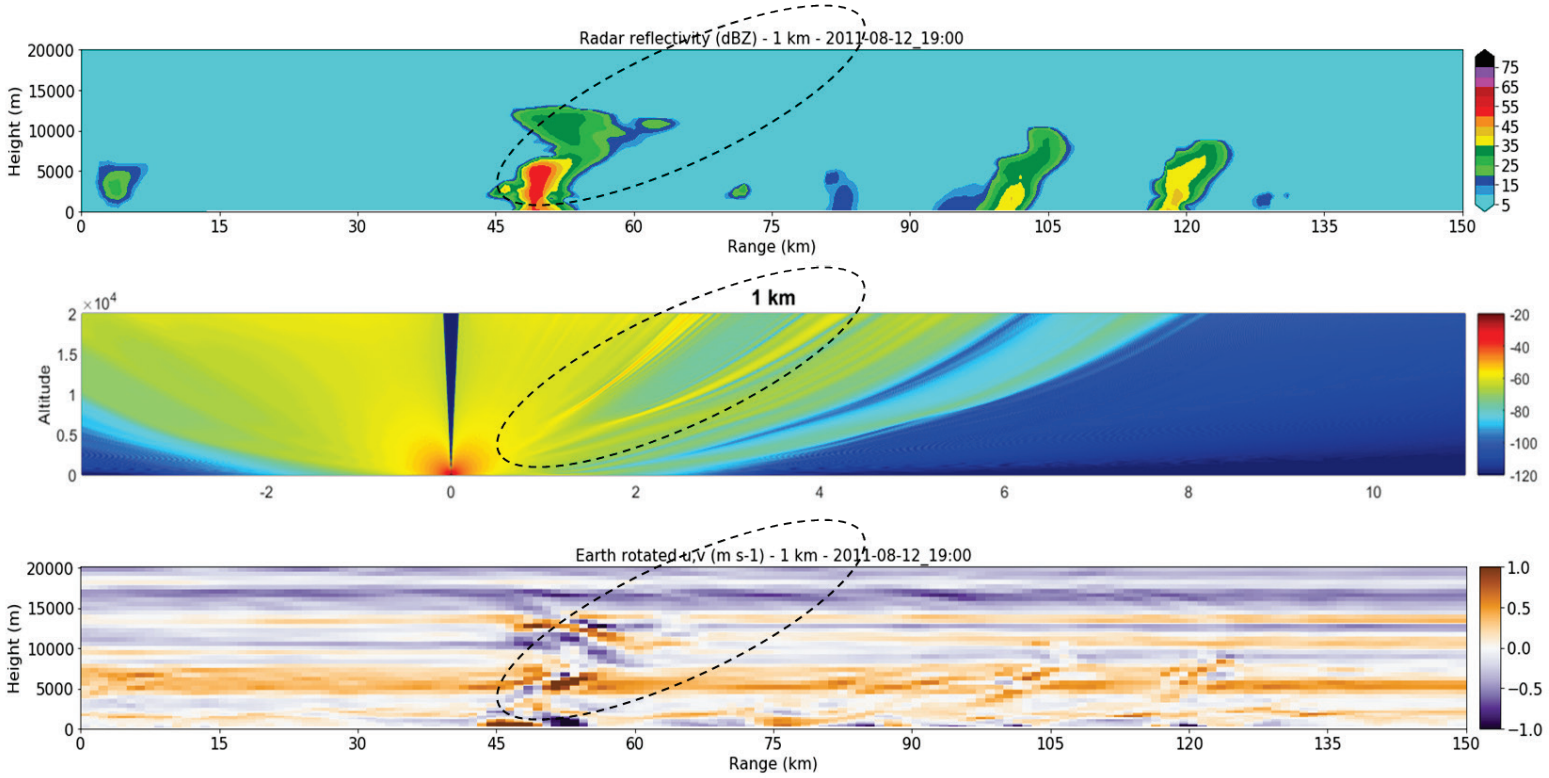


Thunderstorms + TL + vertical gradients = convective influence



Convective precipitation events can appreciably alter infrasound propagation patterns

- **Approach:** Incorporate high-resolution meteorological data from the WRF weather model into infrasound simulations
- **Result:** Local/regional infrasound propagation is strongly influenced by convective precipitation events
- **Mechanism:** Convective precipitation cells cause strong vertical gradients of temperature and wind



Email: Ross.E.Alter@usace.army.mil