Cultural soundscape of the Grant-Kohrs Ranch NHS

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Outline

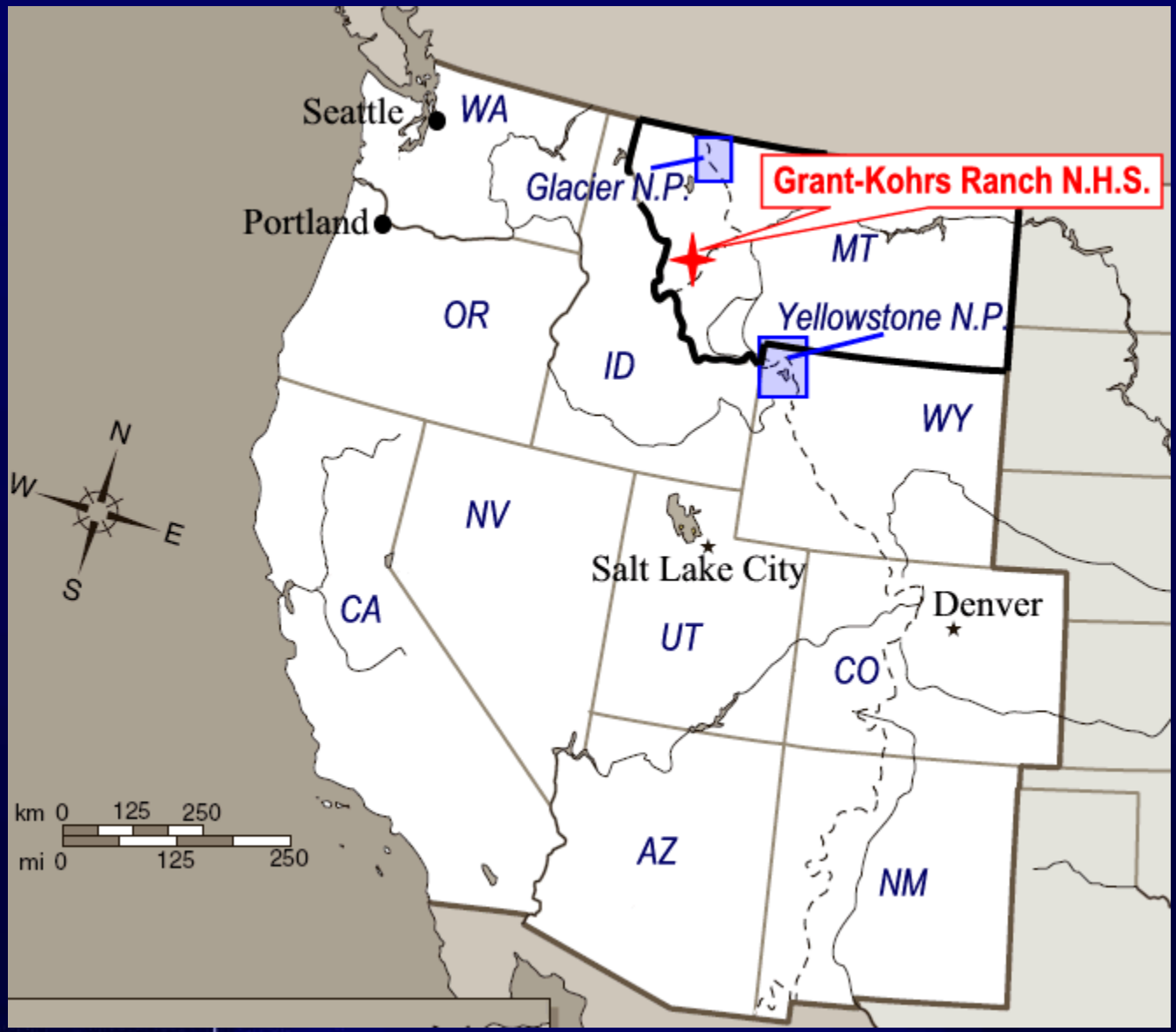
- Introduction
- Long-term acoustical acquisition
  - Sound level meter
  - Audio recorder
  - Anemometer
- Assessment and analysis
  - Biophony, Geophony, Anthrophony
  - 1/3rd octave band analysis
  - MP3 recording 8,760 hours long: automated analysis
- Conclusions

Introduction

- Grant-Kohrs Ranch (GRKO) history
- NPS sound monitor history
- GRKO soundscape: challenges and needs
- Acoustical Plan

Grant-Kohrs Ranch National Historic Site (1977)

- Deer Lodge, Montana
- A working cattle ranch commemorating the heritage of American cowboys, stock growers, and cattle operations during the 19th and 20th centuries.
- Congress: maintain the site as a working ranch.
- Cultural soundscape is essential: all the sights, sounds, and sensations associated with ranching.


Seattle
WA
Portland
Glacier N.P.
Grant-Kohrs Ranch N.H.S.
MT
OR
Yellowstone N.P.
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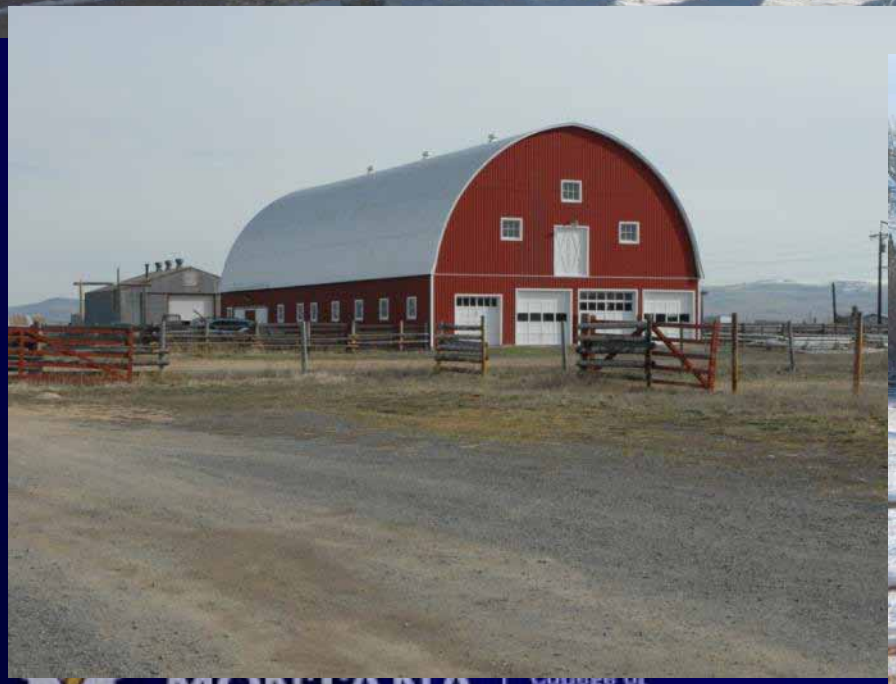

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Mountains & Minds

Soundscape

Three Sonic Components (*Krause*):

- ***Biophony*** -- animal and biological sounds
- ***Geophony*** -- geological, hydrological, and meteorological sounds
- ***Anthrophony*** -- sounds caused by humans and human activity

Grant-Kohrs Challenges

Substantial increase in transportation noise may impact the integrity of the ranch's cultural soundscape.

- Highway traffic noise: I-90 passes within 1 km of the GRKO Visitor Center
- Deer Lodge airport general aviation expansion (2.5 km southwest of the GRKO Visitor Center)
- Neighboring ranch was purchased, subdivided into luxury home sites. Some homeowners may now fly into the area in private jets and helicopters.
- Potential establishment of a rifle range in the vicinity of the ranch.

Site elevation: 1370 meters (~4500 ft) ASL
Coordinates:
46°24'27.24"N 112°44'27.60"W

National Park Service Act (1916)

- ***"...to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."***

Soundscape Regulatory Context

- 1872 Yellowstone National Park Act
- 1916 National Park Service (NPS) Organic Act
- 1949 Executive Order 10092 (Boundary Waters no-fly zone)
- 1964 Wilderness Act
- 1969 National Environmental Policy Act
- 1972 Noise Control Act
- 1987 National Parks Overflights Act (NPOA)
- 1988 Special Federal Aviation Regulation (SFAR) 50-2 (GRCA)
- 2000 National Parks Air Tour Management Act
- 2000 NPS Director's Order #47 (soundscape preservation)
- 2002 Winter Use Plan (Yellowstone)
- 2006 NPS Management Policies (soundscapes)

- Miller, Nicholas, P., "US National Parks and management of park soundscapes: a review," Applied Acoustics, vol. 69(2), pp. 77-92, February 2008

- R.C. Maher, J. Gregoire, and Z. Chen, "Acoustical monitoring research for national parks and wilderness areas," Preprint 6609, Proc. 119th Audio Engineering Society Convention, New York, NY, October 2005.

NPS Management Policies 2006

National Park Service *Management Policies 2006* include natural and cultural sound resources within park units.

- Section 4.9: Soundscape Management
  Excerpt: "The Service will restore to the natural condition wherever possible those park soundscapes that have become degraded by unnatural sounds (noise), and will protect natural soundscapes from unacceptable impacts." *http://www.nps.gov/policy/mp/policies.html#_Toc157232745*

- Section 5.3.1.7: Cultural Soundscape Management
  Excerpt: "The Service will preserve soundscape resources and values of the parks to the greatest extent possible ***to protect opportunities for appropriate transmission of cultural and historic sounds that are fundamental components of the purposes and values for which the parks were established."***

  http://www.nps.gov/policy/mp/policies.html#CulturalSoundscapeManagement5317

Engineering Considerations

- Long-term soundscape monitoring and statistical assessment (24/7/365)
- Low power audio recording equipment suitable for harsh environments
- Cost appropriate for widespread use
- Calibration and stability for both ecological research and regulatory monitoring

Acoustical Plan

- GRKO does not currently have any soundscape data
- A “baseline” is needed to document the seasonal and diurnal soundscape to enable management under 2006 NPS policies
- Automated measurement of sound levels and sound recordings continuously for 365 days

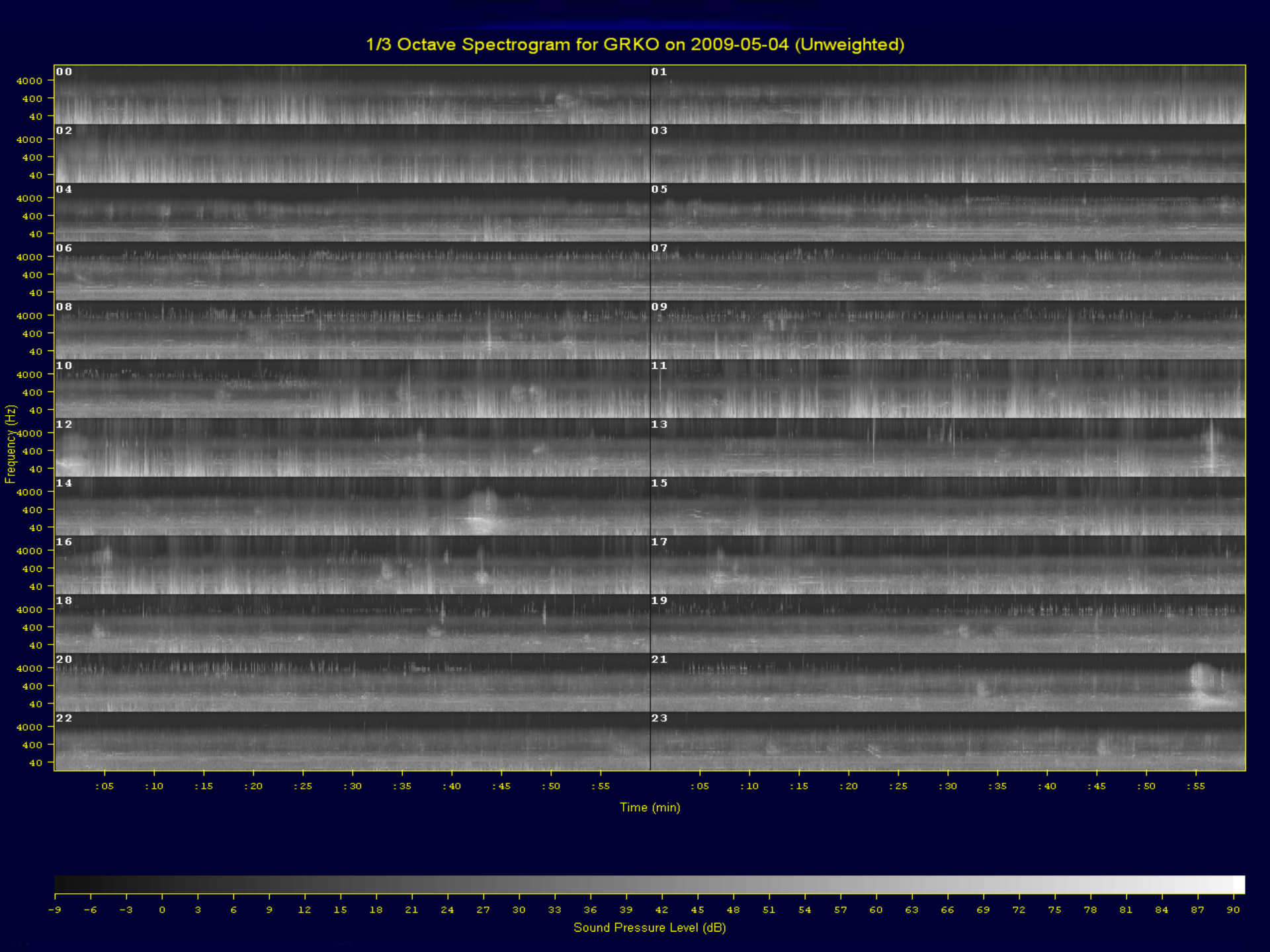
NPS Technical Requirements

- Wind speed and system temperature measurements logged automatically every 10 seconds.
- 1 second Leq ANSI Type 1 ⅓-octave sound levels (~427 MB per month)
- Digital audio (MP3) recordings: continuous 64kbps from sound level meter microphone (~25 GB per month)

Long-Term Collection

Project Status

- Data collection complete: one full year!
- Primary sounds:
  - Biophony: birds and occasional livestock
  - Anthrophony: distant highway traffic and nearby freight trains
  - Geophony: primary issue is wind
    - 10-40 km/hr not uncommon
    - Turbulence and audio signal cut-outs


1/3 Octave Spectrogram for GRKO on 2009-05-04 (Unweighted)
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22
23
4000
400
40
Frequency (Hz)
:05
:10
:15
:20
:25
:30
:35
:40
:45
:50
:55
Time (min)
-9
-6
-3
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12
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48
51
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57
60
63
66
69
72
75
78
81
84
87
90
Sound Pressure Level (dB)

Research Tasks

- Automated analysis procedures
  - Correlation of SPL, MP3, and wind data
  - Fast search of MP3 spectral data
  - Assisted identification of bird songs, etc.
- Integrity and sustainability of collection procedure
- Permanent archiving for subsequent use

Conclusions

- Basic data collection framework is useful
- Automated data analysis is essential
- Prefer higher quality uncompressed audio data
- Wind issue
- Site setup and maintenance issues

Acknowledgements

- **Grant-Kohrs Ranch NHS, Deer Lodge, MT**
  - Christine Ford, Integrated Resources Program Manager
- **NPS Natural Sounds Program, Ft. Collins, CO**
  - Kurt Fristrup, Emma Lynch, Damon Joyce
- **Rocky Mountain Cooperative Ecosystem Studies Unit (RM-CESU), Missoula, MT**
  - Kathy Tonnessen, Natural Resources Research Coordinator
  - Lisa Gerloff, Executive Coordinator

Sound Examples

- March 18, 2009 9:34PM MDT (45”)
- April 15, 2009 6:13AM MDT (before dawn)(1’)
- May 1, 2009 11:22AM MDT (5’)
- May 4, 2009 6:23AM MDT (after dawn) (2.5’)
- July 6, 2009 ~noon (6.5’)
- Dec 30, 2009 9:30PM MST (2.5’)
- July 6, 2009 ~1:30PM MDT (2’)

- http://ece.montana.edu/rmaher/audio_monitor/grko.htm

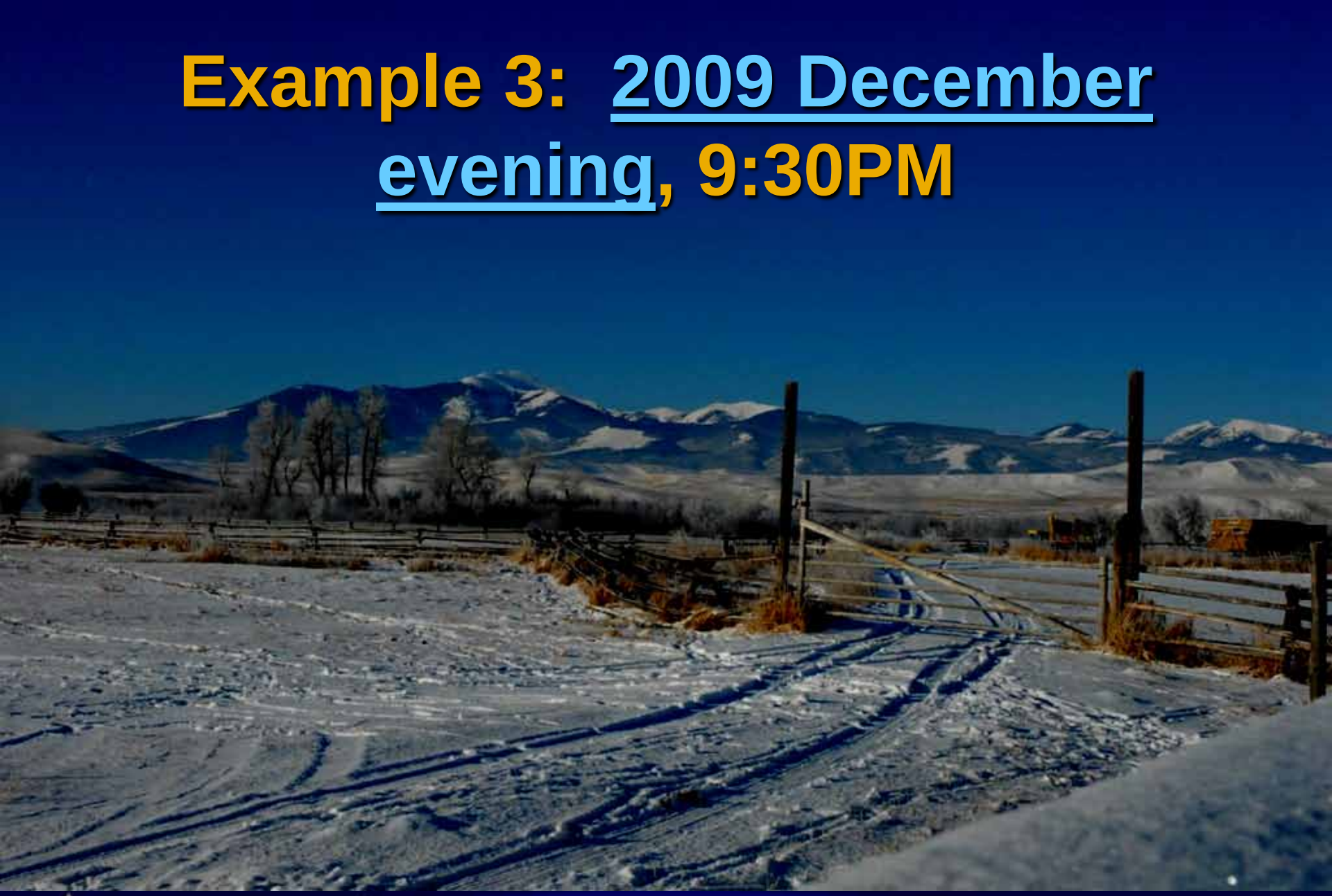
Example 1: 2009 April morning, just before dawn

090415_4.50.30.000.MP3

Example 2: 2009 May morning, just after dawn

090504_4.17.21.276.mp3

Example 3: 2009 December evening, 9:30PM



Example 4: 2009 July, around noon

Example 5: 2009 July, mid-afternoon