Studies of the Urban Troposphere of Interior Alaska: Atmospheric Science Research Group Round-Table

Geophysical Institute
University of Alaska Fairbanks

ROUND TABLE MEETING FALL 2005

On 21 October 2005 several atmospheric science researchers met in 417 IARC for a formal discussion of collaborative research that they could conduct to address the meteorology of the urban environment in Fairbanks. This round-table meeting started with preliminary comments and scheduling of presentations, and was followed by a series of individual presentations and open discussion. Several presentations were made in Power Point® and these files are attached as an appendix.

Please contact the appropriate author if you wish to use any material from these presentations. Please contact Richard Collins (rlc@gi,alaska.edu) if you have any questions about the round-table or this document. The maps in this document were produced using the National Geographic TOPO! ® package.

BACKGROUND

Atmospheric scientists at the University of Alaska Fairbanks (UAF) have been interested in studying the troposphere and boundary layer in the city of Fairbanks and surrounding Fairbanks North Star Borough (FNSB) since the 1960's. The wintertime phenomena of strong temperature inversions and associated formation of ice fog attracted attention from both physical meteorology and public health perspectives. The U. S. Census Bureau reports that the population of the FNSB increased by 31.4% between the 1960 and 1980, and 53.5% from 1980 to 2000 and that the total population in the borough was 82,840 in 2000. As the FNSB population (and surrounding Tanana Valley) has grown, concerns about air quality have increased.

Public concerns about borough air quality have further increased in response to two recent phenomena:

(i) active wildfire seasons in the summer of 2004 (6.6 million acres burned) and 2005 (4.4 million acres through August) reduced air quality to hazardous levels,

(ii) rising home heating oil prices ($1.30 per gallon in winter 2002-2003, $2.45 per gallon in fall 2005) have borough residents considering the use of solid fuels for heating their homes during the winter.

Since the late 1990's, atmospheric science researchers at the Geophysical Institute (GI) have acquired a variety of new tools for studying the atmospheric environment under the University Partnering for Operational Support program. These acquisitions have complemented the ongoing development of techniques and tools by UAF researchers in their established programs with a variety of support (e.g., NASA, Department of Interior, NSF). These tools include both modeling (e.g., MM5 mesoscale model) and observational (e.g., chemical sampling, lidar, sonar) techniques. By fall of 2005, UAF researchers had ongoing collaborations with the FSNB air-quality program, while other researchers were preparing to conduct new observational studies in the urban area in 2006. Researchers had begun informal discussion of how they might extend the scope of these studies and begin to comprehensively study the urban atmospheric environment.

GEOGRAPHY OF TANANA VALLEY AND FAIRBANKS

The Tanana River rises at the confluence of the Chisana and Nabesna Rivers near Northway Junction and flows westward through Interior Alaska to the Yukon River near Tanana, ~850 km down stream and ~450 m lower in elevation (Figures 1 and 2). The river passes by the communities of Tanacross, Big Delta, North Pole, Fairbanks, Nenana, Old Minto, Manley and Tanacross. The cities of Fairbanks and North Pole represent the major communities. Pollution sources in Fairbanks and North Pole include several power plants, oil refinery, home-heating systems, and vehicles. The valley is primarily wooded and has experienced major forest fires with smoke trapped in the valley. The slope of the river allows drainage along the valley from east to west.

The city of Fairbanks (Figures 3) sits in an open bowel on the north side of the Tanana River. Low hills ring the city to the North, East and West. The Geophysical Institute on the campus of the University of Alaska Fairbanks sits on a hill to the Northwest of the city. The Geophysical Institute overlooks the city and provides a vantage point for path measurements across the city (Figure 4). This geography can support observational studies of the strong stable inversions that occur in Fairbanks.

The presenters made the following points,

(i) Study of fluxes (e.g., sensible heat, water vapor, momentum) demands dense networks of high-resolution measurements. Accurate characterization of these fluxes is a critical element in a complete study of the coupled meteorology of the urban environment. Researchers recognize that a complete meteorological study from these microscales (meters) to mesoscales (kilometers) will demand acquisition of a new generation of instrumentation.

(ii) Researchers are working with mesoscale models (i.e., MM5 and WRFchem.) that can address issues of dispersion in a stable boundary layer and compare the comparative performance parameterization schemes that model the micro-scales. These models

also allow study of the performance of chemical and dynamic packages that have been primarily designed and validated in the "lower-48" but are used in the Arctic.

(iii) Researchers are interested in a studying the interactions between the synoptic-scale weather systems and the boundary layer. In particular they would like to determine the critical characteristics of those synoptic-scale systems that disrupt the stable boundary layer and associated pollution problems in the city.

(iv) Researchers have a variety of active (e.g., lidar, sodar), passive (e.g., Raman spectrometers) and in-situ (e.g., aerosol and chemical samplers, optical particle counters) instruments that can be employed to map the sources, transformation, and dispersion of aerosols, chemicals and dynamic structures in the troposphere at mesoscale and synoptic scales.

(v) Researchers recognize the potential impact of well-designed comprehensive and integrated studies. To be most effective these studies should that coordinate and combine the theoretical, modeling and observational skills in the group.

GOAL OF MEETING AND FURTHER WORK

The goal of the meeting was to provide a forum for presentation and discussion of challenges, opportunities, and possible collaborations between theorists, modelers and observers in the Atmospheric Science Research group.

It is hoped that the presentations might serve as a starting point for researchers in the group to establish multi-investigator collaborative initiatives that would address environmental issues of interest in Alaska.

POWER POINT® PRESENTATIONS

(i) Requirements for Developing Parameterization Schemes for Turbulent Fluxes of Momentum, Sensible Heat and Water Vapor, Gerhardt Kramm

(ii) Pollution Dispersion in the Stable Boundary Layer (SBL) and over Complex Topography with MM5/CAMQ, Jing Zhang, Jeremy Krieger, and Catherine Cahill

(iii) Improving PBL & Air Quality Simulations with Data Assimilation, Xingang Fan, Jeremy Krieger

(iv) Boundary layer experimental data for evaluation of WRFchem, Nicole Mölders

(v) Boundary Layer Dynamics and Chemistry, William Simpson

(vi) Aerosols in the Boundary Layer, Catherine Cahill

(vii) Synoptic-Scale Influences on the Boundary Layer, David Atkinson

(viii) Winter Boundary Layer Experiment (WiBLEx), Javier Fochesatto and Richard Collins

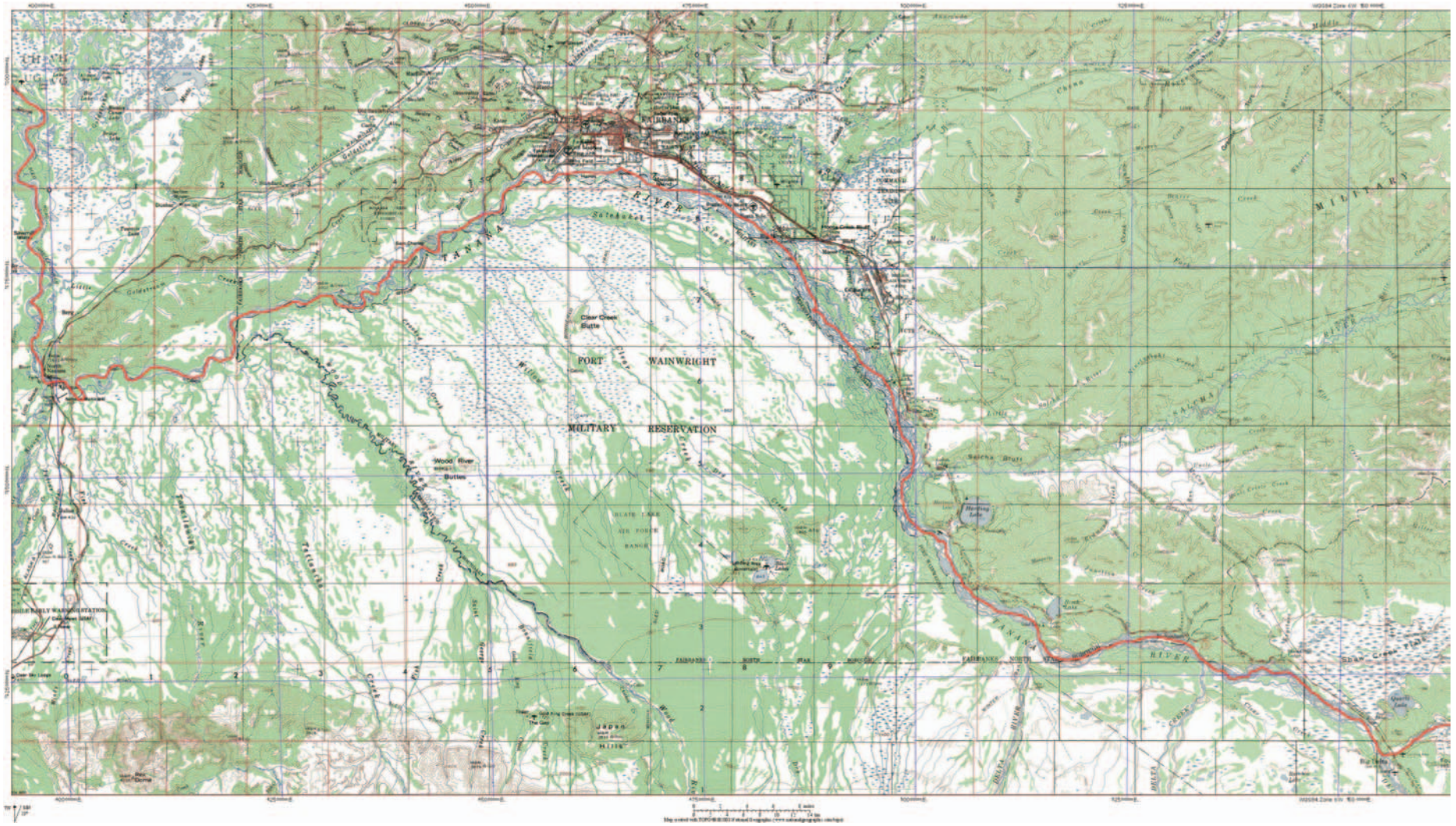

Figure 1. Map of Tanana Valley. The Tanana River highlighted in red.

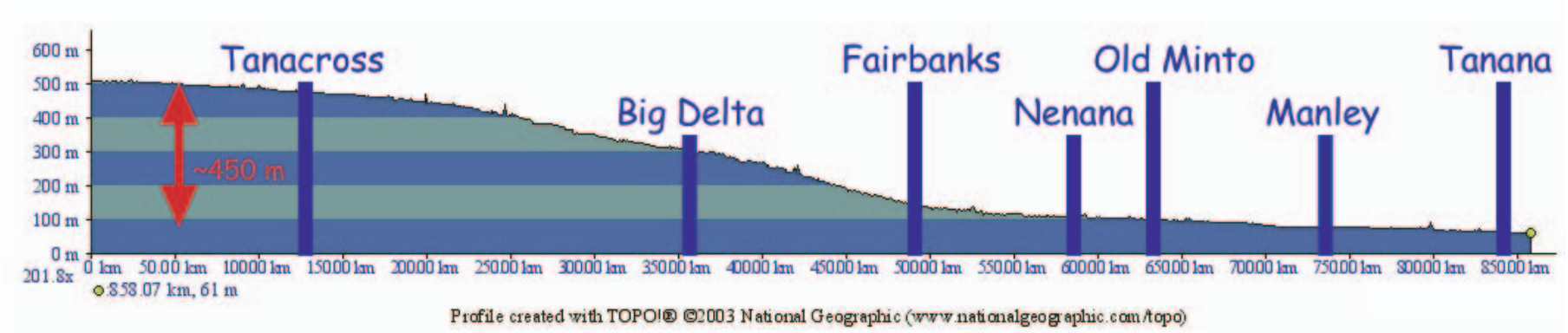

Figure 2. Elevation profile of the Tanana River. The profile follows the course of the river over 850 km from eastern Alaska to the Yukon River. The river drops about 450 m over this 850 km distance. Several communities along the river are indicated. The small spikes in the elevation profile represent points where the (hand held) tracking deviated off the river onto steep banks.

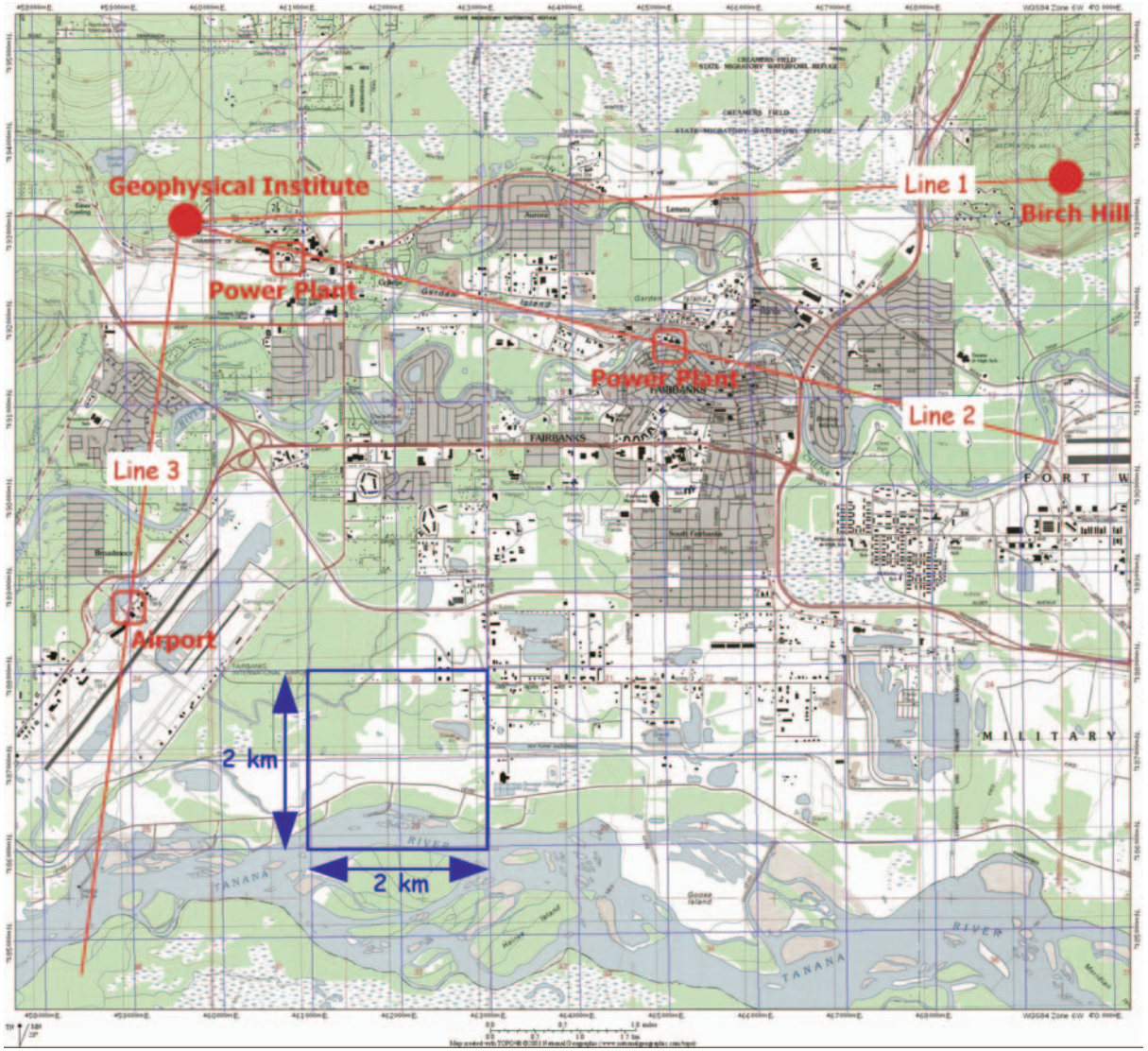

Figure 3: Map of area around Fairbanks showing Geophysical Institute, power plants, and airport. Three lines-of-sight for path measurements from the GI are shown. A 2x2 km grid (typical of current mesoscale models) is shown for reference.

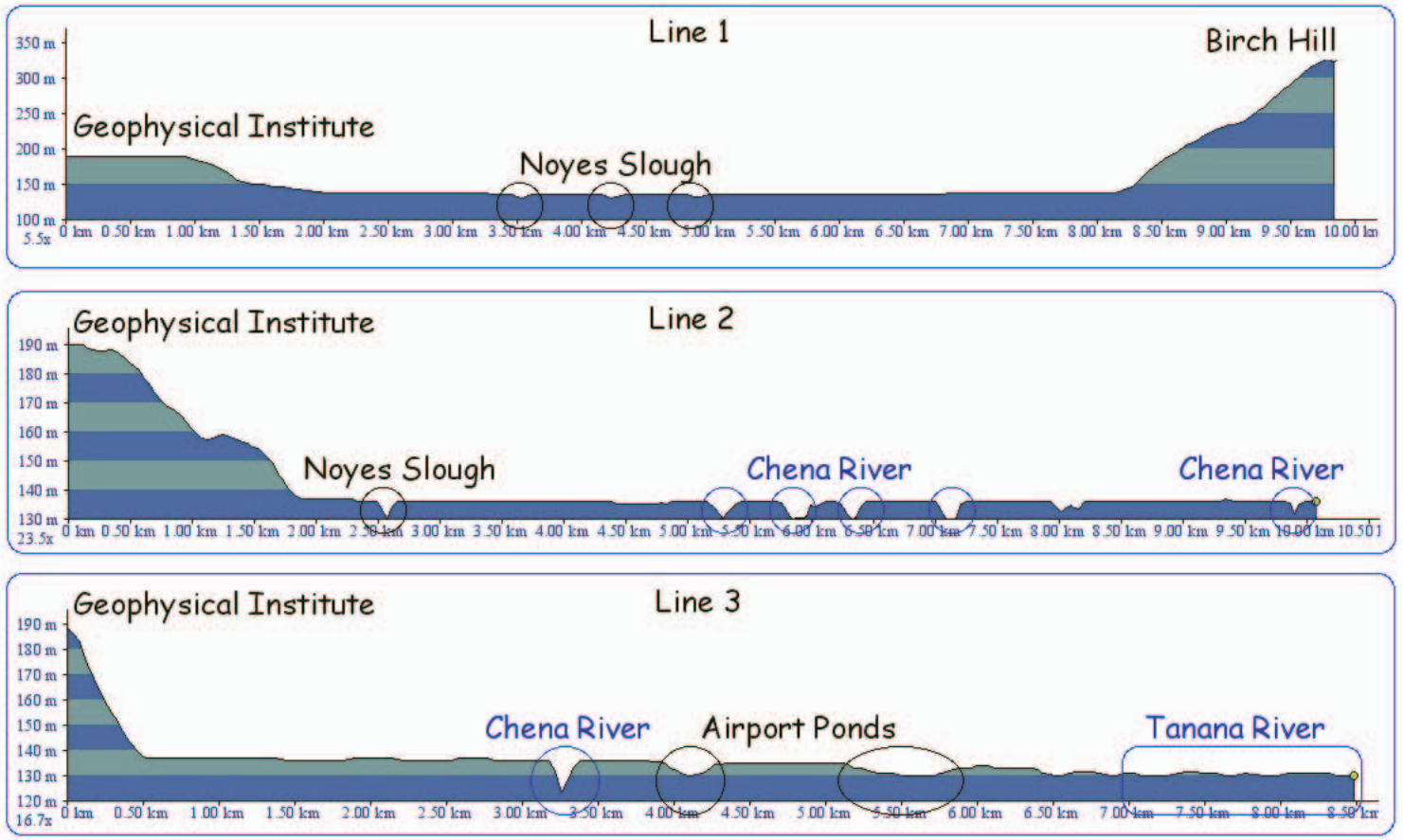

Figure 4: Elevation profiles of line-of-site from Geophysical Institute to Birch Hill (upper), across downtown (middle), across Fairbanks International Airport (lower).