Role of Atmospheric Processes in Sea-Ice Land-Surface Interactions over Alaskan Tundra Vegetation

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Recent dramatic reductions in sea ice and changes in Arctic vegetation have been well documented and are of growing concern because of how they may impact the ecosystem at high latitudes, which includes permafrost, soils, fauna, as well as humans. It is hypothesized that an earlier ice melt forces atmospheric and landsurface temperatures changes, leading to increased summer warmth, higher NDVI and enhanced greenness of vegetation. To investigate the nature of these relationships, climate analysis techniques are applied to high-resolution passive microwave sea ice concentration and AVHRR land surface temperatures to evaluate the direct relationship between coastal ice and the adjacent land. The analysis employs 25 km resolution SSMI passive microwave Sea Ice Concentration (Comiso 1999) and AVHRR Surface Temperature (Comiso 2006, 2003) covering the 24-year period from January 1982 to December 2007. The spatial variations of the climate-vegetation relationships are examined by performing analysis on the Northern Alaska (Beaufort coast) both regionally (Treshnikov 1985) in a 50-km terrestrial zone along the Arctic and for specific sites of the North American Transect. These relationships are compared with those over Yamal, Russia.

We find a relationship between sea ice cover and nearby land surface temperatures that is generally consistent with the notion that cooler temperatures are found with above average ice conditions. The preceding spring season is dominated by large-scale climate forcing of the sea ice, whereas during the summer the local circulation plays a larger role in determining available warmth for increasing plant biomass. The North American Transect is more closely associated with variations of the Pacific Decadal Oscillation, while the Yamal is follows the North Atlantic Oscillation. Both of these large-scale climate variations result from persistent weather patterns at the large-scale. This work explores both large-scale and local-scale circulations as they impact sea ice and vegetation.

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A Climatology of Snowfall and Upper Air Patterns Associated with Heavy Snowfall Events at Fairbanks

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Fairbanks is known for its cold weather, but heavy snowfall events are not all that common. Although the 30-year average annual snowfall at the Fairbanks International Airport is a healthy 67.8 inches, nearly 94 percent of all daily snowfall events at Fairbanks are less than 1 inch. A daily snowfall in excess of 6 inches occurs on average of only once per year. The majority of the annual snowfall occurs during the fall and early winter, but interestingly some of the heavier snowfall events tend to occur later in the winter.

This investigation will explore a monthly climatology of snowfall events at Fairbanks and the upper air patterns that are associated with significant snowfall events. It is hoped that this ongoing research will provide operational forecasters with practical experience in visualizing the upper air meteorological patterns associated with significant snowfall events at Fairbanks

Observed and Modeled Temperature Inversions in Alaska

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Human populations in the Arctic are concentrated in complex orographic locations that are inadequately resolved by global climate models. Therefore, it is difficult to construct climate projections useful for humans based on GCM results only. A dynamical downscaling model approach is used over Alaska to provide high-resolution climate information, which aims to capture important local climate phenomena such as surface-based temperature inversions. The focus of this work is the analysis of inversion characteristics using observed radiosonde data in Alaska and to evaluate how well GCM and downscaled simulations capture key characteristics of inversions.

The model component of this project incorporates a multi-scale approach, using the National Center for Atmospheric Research (NCAR) Community Climate System Model Version 3 (CCSM3) and NCEP/NCAR Re-analysis for the large scale climate and the Arctic MM5, for high-resolution simulations. Downscaled Re-analysis results for the period 1994-2004 are compared to observed radiosonde data for the last half-century. These results are compared to downscaled CCSM climate.

The first step in this work develops a comprehensive climatology of observed local conditions in four stations in Alaska. Wintertime (October-March) surface-based inversions in Anchorage, McGrath, Fairbanks, and Barrow are analyzed from 1957-2005 using radiosonde soundings in order to determine characteristics and possible connections to the large-scale climate. Additionally, inversion characteristics were analyzed to determine any trends and variability over time. During the winter months there is a high correlation between inversion depth and inversion temperature difference at all stations. When the inversion is deep the temperature difference across the inversion is large. Subsequently, surface temperature is negatively correlated to both depth and temperature difference. When surface temperatures are warm, the inversion is shallow with a small temperature difference. Concurrently, when the surface is cool, the inversion is deep and the temperature gradient is large. Additional observed characteristics of inversions such as strength and frequency will be presented and then compared to inversion characteristics from the downscaled simulations.

Impact of the 2006 Augustine Volcano Eruption on Daily Weather

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The Augustine Volcano (located in Cook Inlet, South Central Alaska) eruption in January 2006 released water vapor, heat, and aerosols into the atmosphere; it also released large ash particles that settled out of the atmosphere quickly, leaving a dark layer of soot over the snow. To determine the impact of these four volcanic influences on local weather, 16 simulations are run using the Weather Research and Forecasting (WRF) model. The first simulation serves as a control run, where no volcanic factors are considered. The next four runs include individual consideration of heat release, water vapor release, CCN sized aerosol release, and ash fall. The other 11 simulations include all possible primary, secondary, and tertiary interactions between the four volcanic factors. To analyze the significance of the volcanic influences on daily weather, Analysis of Variance (ANOVA) is used. Significant volcanic influences on daily weather will be discussed as well as the synoptic conditions necessary for the eruption effects to achieve a significant impact on daily weather.

Development and Validation of Polar WRF

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Efforts to develop and validate a polar version of the Weather Research and Forecasting (WRF) model are on-going in several research groups in the United States. The Polar climate and Meteorology Group at the University of Colorado has interests in developing a Polar WRF for use in both operational weather forecasting applications and for use as a regional climate model. This presentation will discuss the problems encountered in applying WRF for polar applications and efforts to deal with those issues. Model results from climate-mode simulations of WRF during the Surface Heat Budget of the Arctic (SHEBA) experiment (September 1997 through September 1998) will be used to illustrate some of these issues. Results of WRF validation for operational weather forecasting applications in the Antarctic will also be presented. WRF is currently being used as the atmospheric model in the Antarctic Mesoscale Prediction System (AMPS). AMPS model validation has used the method of self-organizing maps (SOMs) to identify synoptic weather patterns characteristic of the study area (the Ross Ice Shelf) and to allow validation statistics to be calculated for a range of synoptic conditions. The talk will end with a brief discussion of plans for using WRF as the atmospheric component in a high-resolution regional Arctic System Model.

Treatment of Snow in the WRF Model

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This presentation describes the physics of snow, vegetation, and other processes on the land surface in the WRF model, as well as the feedback of processes from the land surface onto the Planetary Boundary Layer. The 5-layer, Noah, and RUC schemes are compared with respect to treatment of frozen soil, snow temperature and density, vegetation-snow interaction, and canopy moisture. The implications of the (in)consistencies between the land surface models in WRF and the NCEP North American Mesoscale Model (NAM) are discussed. Examples for the Alaska domain are shown alongside observations.

Optimizing the Impact of TAMDAR Data on WRF-ARW Simulations Over Alaska

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During the summer of 2007, AirDat added a version of the NCAR Advanced Research WRF (ARW) to the operational fleet of grid-scale mesoscale models that currently assimilate atmospheric measurements performed by the Tropospheric Airborne Meteorological Data Reporting (TAMDAR) sensor. The TAMDAR sensor measures humidity, pressure, temperature, winds aloft, icing, and turbulence, along with the corresponding location, time, and altitude from built-in GPS. These observations are transmitted in real-time to a ground-based network operations center via a global satellite network. Ongoing studies are being conducted over the continental US and Alaska. The objectives of this study are to (i) optimize the impact of TAMDAR data on the WRF-ARW forecast system by testing various assimilation methods, weighting schemes, background error covariances, and parameterization configurations, as well as (ii) monitor the accuracy, contribution, and health of the TAMDAR observing system. Preliminary results suggest that the proper assimilation of the TAMDAR data improves the short-range forecast skill of the WRF-ARW when parameters such as wind, temperature, and relative humidity are verified against observations. The ongoing studies will present these findings, as well as the various degrees of forecast impacts provided by the additional airlines currently being equipped with TAMDAR sensors.

PenAir-Based TAMDAR-Related Impacts on Short-Range Mesoscale Forecasts over Alaska

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The rugged and topographically-diverse terrain of Alaska, in conjunction with the data-sparse regions surrounding this area, make short-range mesoscale forecasting extremely challenging. The substantial lack of observations in this region combined with the complex mountainous terrain and land-sea interface has long plagued the success of numerical weather prediction in Alaska. The Alaska-based airline PenAir began equipping a fleet of 10 Saab 340s with Tropospheric Airborne Meteorological Data Reporting (TAMDAR) sensors in late June 2007. The sensor measures humidity, pressure, temperature, winds aloft, icing, and turbulence, along with the corresponding location, time, and altitude from built-in GPS. These observations are transmitted in real-time to a ground-based network operations center via a global satellite network.

Data-denial studies over this region are currently being performed by employing a version of the NCAR Advanced Research WRF (ARW). Parallel 60-h experimental (control) simulations include (withhold) the PenAir TAMDAR data. Case-specific and time-averaged forecast skill statistics, verified against other observing platforms (e.g., RAOBs, ASOS, etc.), are compiled and analyzed for various domains and model configurations in Alaska. The objectives of this study are to (i) quantify any impacts that TAMDAR data may have on high-resolution short-range mesoscale forecasts over Alaska, as well as (ii) monitor the accuracy, tuning, and health of the PenAir-based TAMDAR observing system. The PenAir equipage is still being refined; however, initial forecasts and simulations using only a partial data set show very promising results. The ongoing studies and more complete results will be presented at the time of the symposium.

Analysis of the Relation of Annual Pollen Release to the Weather in Fairbanks, Alaska

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Pollen irritates the human respiratory system to varying degrees depending upon individual sensitivity to these particulates and their concentrations. Research in other regions of the world has shown that weather is an important factor in determining the magnitude and timing of annual pollen release. Both the timing and especially the magnitude of pollen concentrations in Fairbanks vary considerably from year to year. In this study, statistical analysis of 23 seasons of pollen and weather data in Fairbanks is employed with the aim of developing a quantitative relation between weather and pollen concentration. Once developed, such a relation can be used with the local weather forecast to predict pollen concentration in Fairbanks for several days in advance. Such predictions could be helpful to medical personnel to decide in advance what treatment and medication would most benefit patients who are sensitive to pollen. Preliminary results of this study and the direction of further analysis will be presented.

Innovations in Monitoring and Nowcasting Orographic Precipitation by Weather Radar

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Recent progress and innovations for monitoring and nowcasting orographic precipitation by radar in the Alps will be presented. Radar measurements in mountainous terrain bear great potential but are more challenging than in flat terrain. The presentation will outline some of those challenges but will mainly focus on the usefulness of radar measurements to study kinematic and thermodynamic processes in mountains relevant to cloud formation, enhancement of precipitation, and outbreak of severe weather within thunderstorms. Main results from field campaigns such as Mesoscale Alpine Programme (MAP), Vertical exchange and orography in the Alpine foreland (VERTIKATOR), and Convective and orographically-induced precipitation study (COPS) will be shown. The main objectives of these field campaigns were to study kinematic and thermodynamic structures within orographic precipitation and use directly the three-dimensional information about precipitation and wind field to improve the estimation and forecast of atmospheric flow and precipitation. The second part of the presentation focuses on implementing some of the results into operational weather forecasting. The presentation addresses (1) the utility and feasibility of radar polarimetry for improving quantitative precipitation estimation and forecast in mountainous terrain; (2) the usage of radar-based rain fall rates for hydrological purposes; (3) the usage of radar data for data assimilation and numerical model output verification, and (4) the usage of wind and precipitation information for the onset and duration of orographic precipitation.

WRFV3/Chem: Recent Developments and Applications

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This paper will describe recent additions to the Weather Research and Forecasting (WRF) model as it is coupled to online chemistry. This model now includes many atmospheric chemistry routines covering biogenic emissions, deposition, photolysis, and chemical mechanisms. Among the new implementations are the MEGAN global biogenicmodule, the capability to use satellite data to initialize a fire plumerise module, a larger selection of KPP equation files (including a choice for a global chemical mechanism), and a new photolysis option. In addition, new atmospheric aerosol routines have been added to WRF/Chem. These include GOCART dust and sea-salt schemes. An initial chemical data assimilation capability is being developed.

A Multi-Year Arctic System Reanalysis

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In the polar regions, it is often difficult to place current weather and climate trends in a long-term climatological perspective as the meteorological records there are limited in time and space in comparison with other regions of the globe. The low spatial density of polar meteorological data makes it challenging to separate local changes from regional or even continental-scale changes. Reanalyses assimilate all available observations from the surface, atmosphere and satellites into physically-consistent, regularly-spaced and comprehensive datasets, and can be especially helpful in these latitudes. The pronounced impacts of global climate change seen recently in Arctic land ice, sea ice, and permafrost regions make such efforts especially timely.

Global reanalyses, which are not optimally designed for high latitudes, continue to face substantial challenges in these unique environments. A new physically-consistent integration of Arctic data will be achieved through a tailored high-resolution reanalysis of the northern high latitude region, spanning poleward from the headwaters of the northward flowing rivers. The Arctic System Reanalysis (ASR) is a collaboration of the Byrd Polar Research Center and Ohio Supercomputer Center along with the National Center Atmospheric Research (NCAR), the University of Colorado, the University of Illinois, the University of Alaska Fairbanks, and the Arctic Region Supercomputing Center. The initial phase of the ASR was recently funded by the National Science Foundation as an International Polar Year (IPY 2007-2009) project and will span the Earth Observing System (EOS) era of 2000-2010. The ASR will provide a high resolution description in space (~10 km) and time (1-3 h) of the coupled atmosphere-sea ice-land surface system of the Arctic. Ingested historical data streams will drive the ASR. Gridded output fields from the ASR will serve a variety of uses. For instance, the ASR will permit detailed reconstructions of the Arctic system's variability and change, thereby complementing efforts of the global reanalyses. The project will also shape the legacy observing network of the IPY by providing a vehicle for observing system sensitivity studies of the Sustained Arctic Observing Network (SAON). To achieve its goals, the ASR will require an Arctic-friendly atmospheric numerical model with state-of-the-art dynamics. Therefore, the Weather Research and Forecasting (WRF) is being optimized for the polar regions. Evaluations and improvements have already been performed in correspondence with simulations over the Greenland Ice Sheet and the Arctic pack ice. Work over the Arctic land mass is now beginning. Similarly, development work in preparation for the ASR is also proceeding with the WRF data assimilation system (WRF-Var) and the Noah land surface model.

Statistical Analysis of Alaska's Long-Term Observation Records

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Long-term observation records of near-surface temperature and precipitation obtained from Alaska's first-class observation stations and of some proxy data have been analyzed using statistical methods. The results of this statistical analysis are presented and discussed. Following Hartmann and Wendler (2005), even the influence of the Pacific Decadal Oscillation (PDO) is illustrated.

Reference:

Hartmann, B., and G. Wendler, 2005. The Significance of the 1976 Pacific Climate Shift in the Climatology of Alaska. J. Climate 18, 4824-4839.

Atmospheric Boundary Layer Parameters and Derived Fluxes for the ARM Northslope of Alaska Site of Barrow

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Surface-layer parameters crucial for calculating fluxes of momentum, heat and water vapor in the atmospheric boundary layer (ABL) were derived from vertical profiles of wind velocity, temperature and humidity for the ARM North Slope of Alaska (NSA) site in Barrow. The parameters include the friction velocity (u*), the temperature (Q*) and humidity scales (q*), the roughness length (z_o), and the zero-displacement (d). We have used surface and meteorological tower measurements from instrumentation with sensors at 2, 10, 20 and 40 meters for periods with different surface characteristics and atmospheric boundary layer stability in order to derive turbulent fluxes by means of statistical methods.

Strong seasonal changes of surface layer parameters resulted from different thermal stratification of the ABL. These changes have been partly neglected in the past in theoretical methods to derive parameters like z_o and d causing inaccurate formulation of vertical fluxes.

We compared resulting fluxes of heat and momentum with corresponding data from Weather Research Forecast (WRF) model runs. Discrepancies in derived fluxes have the potential to serve for improved model parameterization and better understanding of ABL fluxes at this site in the future.

An MM5 and WRF-Based Rapid-Cycling Multi-scale Weather Analysis and Forecasting System for Supporting the Test and Evaluation at the Army Cold Region Test Center

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In collaboration with the Army Test and Evaluation Command (ATEC), NCAR has developed a Real-Time Four Dimensional Data Assimilation and forecasting (RTFDDA) system. The RTFDDA system is built around the Penn State/NCAR Mesoscale Model version 5 (MM5) and the Weather Research and Forecasting model (WRF). RTFDDA is capable of continuously collecting and ingesting diverse synoptic and asynoptic weather observations from conventional and unconventional platforms, and provides accurate spun-up nowcasts and short-term forecasts. Operational RTFDDA systems have been implemented at seven ATEC test ranges in the last six years, providing rapidly updated, multi-scale weather analyses and forecasts, for the synoptic scale down to the mesogamma-scale, with the fine-mesh domain having 1 - 3 km grid increments, depending on the range. Among these modeling systems is one deployed at the Army Cold Regions Test Center, Alaska. The CRTC RTFDDA system began operation in 2002. Since then, the system has experienced many updates and enhancements which include improvements in the data-assimilation scheme and model physics parameterizations, the transition from MM5 to WRF, the inclusion of special observations from the test range, and the use of MODIS cloud-drift winds and other new data. Recently, the RTFDDA system has been expanded for generating ensemble analyses and probabilistic forecasts (E-RTFDDA). E-RTFDDA is currently available to be run "on-demand", i.e., for supporting special test events and case studies. In this paper, we'll briefly describe the RTFDDA modeling system, and the performance of the model operational forecasts for CRTC. A case study of a winter cold-air surge event over the CRTC region, from January 22 through 27, 2007, will be described to illustrate the ability of the RTFDDA and E-RTFDDA models, and also the challenges for future study. Finally, we will show that both RTFDDA and E-RTFDDA are globally relocatable, and thus can be easily adapted to support other weather-sensitive applications in different areas of Alaska.

Application of the Alaska WRF Data for Simulation of Refraction of the High-Frequency Radio Signals by the Meteorological Elements.

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The meteorological parameters (humidity, pressure, temperature) affect propagation of electromagnetic waves through the lower troposphere for high frequencies above about 1 GHz. We have used WRF-simulated data for the broad Alaskan region for deriving the 3-D time-dependent distribution of the atmospheric refraction coefficient for radio waves. This coefficient was applied to a rigorous simulation of effects of refraction and group-delay for L- and X-band radio signals (1.2-1.5 GHz and 3 GHz respectively) in the troposphere and lower stratosphere.

Previously developed for ionospheric applications full 3-D ray tracing model was modified to accommodate this new capability. It interpolates WRF 3-D data to the geometric heights along the ray path and supplies interpolated values for simulation of the radio signal refraction. The optimal computational parameters were established by varying the length increment along the ray path during the ray tracing procedure. For given spacial resolution of the ARSC WRF-simulated data, a reasonable accuracy of the ray tracing can be achieved at the tracing increment length as long as 200 meters.

The pilot study covered conditions and radio frequency ranges when atmospheric refraction is comparable and/or even exceeds the refraction in the terrestrial ionosphere. This developing model should be important for investigation and prediction of the radar performance effects in response to meteorological events and for evaluation of applicability of the WRF-derived radio refraction products.

Transformation of Larch-Dominated Forests and Woodlands Into Mixed Taiga – Permafrost Simulations with HTSVS' Soil Model

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A stand-alone version of the soil model of the Hydro-Thermal Soil Vegetation Scheme (HTSVS) that is to be loosely coupled with FAREAST was built. Soil specific parameters (porosity, permanent wilting point, specific heat capacity, pore-size distribution index, water potential at saturation, volumetric water content at field capacity and permanent wilting point) were calculated from the data on measured percentage fraction of clay and sand at the Yakutsk site, Russia. The stand-alone version was run for the episode from April 1, 2000 to October 30, 2000 for the Yakutsk site. The soil model was driven by observed soil temperature and moisture at the soil surface. The results show that the soil model captures the observed seasonal course of soil temperature well and moisture acceptably. Various sensitivity studies were carried out to examine the impact of soil ice on soil temperature evolution, the impact of the number of soil layers considered on the accuracy of the results, the sensitivity to the lower boundary condition, the sensitivity to the depth of the bottom of the model, the sensitivity to the choice of the soil type beneath 0.97m depth for which no soil profile data are available, and the forcing at the upper boundary conditions. The results show that 20 layers and a depth of -30m provide better results than 30 layers and a depth of -30m or than 20 layers and a depth of 20m. Assuming an annual course of soil temperature at the lower boundary in -2 or -3m depth provides typically larger discrepancies than between simulated and observed soil temperatures than the simulation with -30m depth and a constant soil temperature of -9.5^{o}C at the bottom of the model. Simulated soil temperature and moisture conditions are sensitive to the assumptions on the soil profile below 0.97m for which unfortunately no soil classification data are available. Soil temperatures will be predicted more accurately if frozen soil physics are considered. There is a slight sensitivity to the assumption on the initial partitioning of total soil water between the solid and liquid phase as well as the assumption on the total soil water content.

Comparison of CFFDRS and NFDRS Fire Indices Derived from WRF Forecast

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Standard indices used in the National Fire Danger Rating System (NFDRS) and Canadian Forest Fire Danger Rating System (CFFDRS) are calculated from Weather Research and Forecasting (WRF) model simulations and observations in Interior Alaska for June 2005. Comparison shows that fire-indices determined from simulations do not differ statistically significant from those determined from observations. WRF-data derived fire-indices of both systems acceptably capture the observed temporal evolution of fire-indices. Sensitivity to errors in predicted meteorological conditions differs for the various fire-indices. Failure to predict a peak does not necessarily occur at the same time for the various indices within and/or among the two systems. Out of the CFFDRS and NFDRS fire-indices, predicted buildup index and spread component, respectively, capture trends, the time of peaks and minima most reliably. In the CFFDRS, overall the lowest relative errors exist for fine fuel moisture content followed by buildup index while in the NFDRS energy release component followed by burning index has the lowest overall relative errors. For both systems as the fire risk increases it becomes more difficult to predict fire-risk and to identify the right site.

Will WRF at High Resolution Capture Fairbanks' January 2008 Major Snowfall Event?

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>From the Fairbanks Daily News-Miner, 18 January 2008 (by Tim Mowry):

Biggest snowfall in Years Blankets Fairbanks

Fairbanks dog musher Shannon Erhart went to sleep Wednesday night hoping the National Weather Service's forecast for an inch or two of new snow overnight would be right. She wasn't disappointed to wake up Thursday and find out they were wrong. "I woke up quite happy this morning; I think all dog mushers in the Interior did," said Erhart, who serves as president of the Alaska Dog Mushers Association. "This should fill in all the dips (in the trails)." Residents awoke Thursday to find 8 to 10 inches of new snow on the ground. It was the biggest single snowfall in Fairbanks in several years and ended what so far this winter has equated to a snow drought in Alaska's second-largest city. The heavy snow came as a surprise to residents as well as meteorologists at the National Weather Service in Fairbanks. "We were not expecting that kind of snow to develop," meteorologist Bob Fischer said. A cold front stalled over Fairbanks and mixed with an unstable air mass aloft to produce what Fischer called a "very localized" snowfall. The snow fell over such a small area within about a 50-mile radius of Fairbanks; that it was practically impossible to predict. "Smaller scale things like this the models aren't able to pick up," he said. "The resolution is just not there."

This presentation will attempt to re-create the significant snow event described above by using our current operational WRF over Alaska at an outer nest resolution of 18km with an inner nest of 6km resolution. Two control runs, initializing from NAM and GFS about 24 hours before the event, will be performed and evaluated. This will be followed by a data assimilation run, incorporating surface, raobs and satellite soundings. Results of these runs will be compared with the guidance available to forecasters at the time to determine whether WRF, at high resolution, can capture the event that coarser models missed.

On Simulating Near-Surface Wind Regimes in Prince William Sound Using the WRF Numerical Model and its Attendant Preprocessors

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The extremely complex terrain embaying Alaska's Prince William Sound (PWS)-combined with the relatively large number of low pressure systems in the northern Gulf of Alaska impacting PWS annually - presents a challenging environment for both numerical and human-assisted weather prediction. Furthermore, although the PWS is relatively rich in instrumented observation platforms, (especially by Alaska standards) it is still hard to quantify locally the distributed fields of such things as temperature and winds from such sparse point observations. This makes it difficult to verify numerical models, especially in remote regions. Fortunately Synthetic Aperture Radar (SAR) surface wind retrievals (over water only) present a great tool for looking at 2-d surface wind speeds over a large region. While SAR images of PWS are only available infrequently, still occasionally the SAR imager will capture a significant weather event occurring in our region of interest. Such images make the basis for a good modeling case study. This is the approach used for the study discussed here.

The case was simulated using WRF v2.2, with the main objective being to simulate the gap winds evident in the SAR image. It was found that the original model /boundary condition set-up was far from optimal in producing the channeled wind features seen on the satellite image. Tests were then performed on the treatment of the bottom boundary condition (i.e. topography) by the model preprocessors WPS and WRFSI. Several different realizations of the topography were created and tested with the model. A good deal of variety was found among the various simulations and will be a main focus of the presentation.

Investigations on the Dependency of Regional Average Accuracy on Network Density and Site Distributions

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The density and/or design of observational networks may introduce some uncertainty in regional averages estimated from observations. To assess this uncertainty and to develop the recommendation for network design to optimize their use for model validation, data obtained from simulations with the Weather Research and Forecasting (WRF) Model for July and December, 2005 over Siberia are assumed to represent the truth. Regional averages are determined for four networks with 500, 400, 200, and 100 arbitrarily taken grid-points as sites; and an actual historic network of 411 sites. They averages are compared to the true regional averages obtained from the full WRF-dataset. The historic network fails to reproduce the true regional averages for all quantities except relative humidity, precipitation and longwave radiation. It overestimates regional averages of 2m-air temperature, surface pressure, soil temperature and shortwave radiation by about 2.9K (3K), 4.1hPa (6.5hPa), 2.3K (2.3K) and 25Wm^{-2} (19Wm^{-2}) whereas it underestimates those of wind-speed by up to 0.69m/s (0.52m/s) in July (December). The 100-site network has difficulties to reproduce regional averages of surface pressure, cloud fraction and shortwave incoming radiation. Networks with 200 or more sites reproduce the regional averages of all quantities well. Biases, root-mean-square-errors and standard deviations of errors fall within the range of typical observational errors except for cloud fraction

The New Alaska Forecast Desk at the Hydrometeorological Prediction Center

Daniel K. Petersen

NOAA/National Weather Service/Hydrometeorological Prediction Center

The Hydrometeorological Prediction Center (HPC) has started forecasting for Alaska and collaborating with Alaska forecast offices for forecasts three to eight days into the future. The presentation will focus on the HPC Alaska product suite, composition, and plans. The presentation will address the relationship between the emerging North American Ensemble Forecast System (NAEFS) and the planned forecast products and conveyance of uncertainty in the forecasts for the Alaska region.

Investigation and Formation of a Ship Emission Inventory for the Gulf of Alaska

Stacy E. Porter and Nicole Mölders

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In every summer tourist season, the Gulf of Alaska experiences a mass influx of ship traffic with individual vessels emitting massive amounts of pollutants such as NO_x, SO_2, CO_2, VOC, PM, etc. With the exception of a few local stipulations, shipping emissions are, for the most part, unregulated which allows for significant damage to coastal regions within the vicinity of major shipping lanes by wet and dry deposition into coastal waters and ecosystems. Using previous route data and ship emission rates, an emission inventory for a typical summer tourist season that has been created for the Gulf of Alaska will be presented. The emission rates of the vessels have been obtained by categorizing the vessels depending on vessel type, engine type, fuel type, engine power, and operational mode. Subsequently, typical value emission factors are applied to each vessel category, and the emission rates were then calculated. First results of simulations without and with the impact of ship emissions are to be presented for an exemplary tourist season.

Upper Air Trend Analysis for Interior Alaska, 1948-2006 and Relationship of Parameters with Seasonal Wildfire Acreages

Michael A. Richmond

Analysis of upper air data from archived radiosonde balloon releases (period of record 1948-present) over interior Alaska has been conducted to assess trends, if any. Results of this and a regression analysis with different upper-air metrics and seasonal wildfire acreages over Interior Alaska will be presented.

A Diagnosis of the Extended Cold Period in Alaska During Spring 2007

Martha Shulski and Gerd Wendler

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During the late winter and early spring of 2007, much of Alaska experienced an extended period of low temperatures. The 45-day time period from mid-February through the end of March ranks as coldest on record for many locations throughout the state. Temperature departures were strongest for the continental climate region of interior Alaska and were in the range of 7 - 9C for valley locations such as Fairbanks, Tanana, and Northway. While cold periods such as these brought about by high pressure, clear skies, and radiative cooling, are common during a typical winter in Alaska, the duration of this event was extraordinary. This presentation will discuss the synoptic situation leading to this extreme event and present diagnostics on the reason for the extended duration. In addition, these results will be placed in historical climatological context.

Impact of Snow Pack on Temperatures in Fairbanks in October

Eric Stevens and Rick Thoman

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The impact of the presence of a snow pack on temperatures in Fairbanks during the month of October is investigated. The winter season's permanent snow pack in Fairbanks is typically established during October, and the arrival of the snow pack is often associated with a discontinuous drop in surface temperatures. Long-term climate records show a steady cooling trend in normal high and low temperatures in Fairbanks in October. It is hypothesized that in any single year the snow pack's alteration of the radiation balance in the boundary layer is responsible for a more abrupt cooling, and that the smooth character of the cooling trend in the climate record comes about because the permanent snow pack arrives on different days in different years.

Smoke Modeling in Alaska

Martin Stuefer[1], Anton Kulchitsky[2], Lee Higbie[2], Greg Newby[2]

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Alaska wildfires have strong impact on air pollution on regional and even hemispheric scales. In response to a greatly increased number of wildfires in Alaska, emphasis has been placed on developing a forecast system for wildfire smoke dispersion in Alaska. The US Forest Service Missoula Fire Science Laboratory has developed a smoke dispersion system, which has been adapted and initialized with source data suitable for a pre-selected Alaska domain. Alaska system modules include: MODIS wildfire location and extent detection, fuel moisture models, fire emissions calculated using a first order fire emission model. Emissions are vertically distributed in the atmosphere with a plume rise model to account for one-dimensional (vertical) concentrations of smoke constituents in the atmosphere above the fire. This information creates source data for high-resolution WRF/Chem runs. The Alaska WRF/Chem smoke forecast system's development is continuing with implementation of a special version of WRF including online chemistry and online plume dynamics; system improvements may also result from the change from the National Fire Danger Rating System fuel types to the Canadian Forest Fire Service Danger Rating System fuel types and fuel moisture models. System runs are performed at the ARSC Sun Opteron cluster Midnight.

Comparison of SAR imagery and Southeast Alaska WRF wind modeling

Paul Suffern

Forecaster WFO Juneau

Southeast Alaska's diverse topographical features make wind forecasting difficult for both computer and human forecasters. Correct surface wind and sea state forecasts can make a difference of millions of dollars each year for marine customers in Southeast Alaska's heavily navigated inside waters. Synthetic Aperture Radar (SAR) satellite imagery has recently proved to be a valuable addition to the sparse network of ground observations for the National Weather Service office in Juneau. SAR imagery has facilitated an improved meteorological understanding of the surface wind flow structure within the channeled terrain of Southeast Alaska. A local mesoscale Weather Research and Forecasting (WRF) computer model has been applied at WFO Juneau in hopes of more completely forecasting channeled wind conditions across Southeast Alaska. The two most challenging and critical situations for marine customers are intense northerly arctic outflow events and frontal-driven southeasterly gales. In northerly outflow events SAR wind imagery and real-time WRF forecast compare favorably across Southeast Alaska in large part because the low-level sounding structure in the WRF has been correctly initialized. In southeast flow cases, WRF wind forecasts are in much less agreement with SAR observations. A correct WRF surface wind structure depends heavily on the correct initialization of low-level sounding structure within the WRF. For cases where the WRF low-level sounding structure has a stable profile, the WRF compares favorably with observed surface winds and SAR imagery. In cases where the WRF low-level sounding structure has an unstable profile the WRF under forecast the surface wind speed and misplaces its structure. Identification of these types of initialization problems within the WRF will lead to improved forecasts for our marine customers.

Changes in Winter Temperature Distribution in Interior Alaska

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Changes in mid-winter (Dec-Feb) temperature distribution across the Pacific Decadal Oscillation shift in 1976 are examined at several Interior Alaska locations. Changes in distribution show that temperatures are not merely warmer post 1976 than before, but rather that the frequency of very low temperatures have greatly decreased while the high end of the distribution has shifted only slightly. This pattern occurs consistently at a number of different locations, ruling out urban influences at Fairbanks as the primary physical mechanism responsible for the observed changes.

The Prince William Sound Low and Associated Impact on Anchorage Significant Snowfall Events

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Anchorage is located on the shores of Cook Inlet, an occasionally ice-bound embayment that is bounded on three sides by the moderately high terrain of the Chugach, and Talkeetna Mountains to the east and north respectively, and the high mountains of the Alaska Range to the northwest. The Chugach Mountains form a barrier between Cook Inlet and Prince William Sound to the east and play a role in orographic snowfall in the greater Anchorage region. Storms entering the northern Gulf of Alaska will occasionally move through the high terrain surrounding Prince William Sound as they follow a northeasterly track towards the Yukon Territory. These systems are commonly referred to by forecasters as Prince William Sound Lows; (PWS Lows) and are believed likely to produce snowfalls with a significant impact on the public as well as local, state and federal agencies. A simple objective technique for identification of a PWS Low is presented. Using the technique it is possible to show that a large percentage of significant snowfalls in the last decade are associated with low pressure centers in PWS. The contribution of these events to seasonal snowfall totals is demonstrated, as is the contribution of PWS Lows to the total number of significant snowfall events for the last decade.

The Past, Present, and Future of the AWRP's In-Flight Icing Work in Alaska

Frank McDonough, Marcia K. Politovich, and Cory A. Wolff

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An overview of the FAA Aviation Weather Research Program's in flight icing effort over Alaska will be presented. This program has been providing icing information to forecasters and dispatchers for a number of years. Past work has included the development of the Current and Forecast Icing Products for Alaska (CIP-AK and FIP-AK), PIREP gathering and questionnaire solicitation to better document icing over Alaska, climatological studies of Alaskan icing clouds, a cost-benefit study of potential Alaska icing products, and a study of pilot needs for icing information. Research aircraft data from icing clouds in the Juneau and Arctic Coastal regions have also been collected and analyzed as part of this work. Currently, CIP-AK and FIP-AK are running on the NAM and the NCEP IC4D (Interactive Calibration in 4 Dimensions) project is using the FIP-AK as a prototype to allow forecasters to make changes to the algorithm outputs if they see corrections that need to be made. Future plans involve running both CIP-AK and FIP-AK on the WRF Rapid Refresh model when it becomes operational and the development of a fully-automated product for producing icing AIRMETs.

Beaufort Sea Coastal WInd Regime Study

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The Beaufort Sea coastal areas are prominent geographical features that are largely covered by sea ice on a seasonal basis over the ocean and bounded by the Brooks Range in the south on land. Arctic sea breeze effects, due to land/ocean thermal contrasts, and the complex orographic effects significantly complicate mesoscale weather systems and associated surface winds in this region. A study has thus been established to improve understanding of the mesoscale weather patterns and associated surface wind features in the Beaufort Sea coastal areas through data analysis and numerical model simulations. North American Regional Reanalysis (NARR) data (3 hourly) was used for both data analysis and the model forcing inputs. The NARR surface winds were validated against meteorological station observations and indicate that the NARR reanalysis basically captures the distribution and seasonal changes of the observed winds. However, an obviously bias exists in winter, in which the easterly (westerly) winds are overestimated (underestimated). In addition, a negative bias exists in the NARR wind speed. The NARR wind directions (1979-2006) were used to investigate the sea breeze along the Beaufort Sea coast. Due to the sea ice cover over ocean and snow cover over land, the Arctic sea breeze is only active for a short time during the year, mainly in July and August. In addition, the penetration of the sea breeze circulation is less than 100 km. Numerical simulations with a resolution of 10 km were conducted with the WRF model over a domain encompassing the Beaufort Sea coastal areas for June-September 2004, with emphasis placed on evaluating the capabilities of the model to simulate the sea breeze-influenced surface wind regime. The simulation results indicate that the WRF model performs reasonably well in estimating the surface winds and in accurately capturing the sea breeze effect. The weak wind speed bias seen in the NARR reanalysis has been reduced.