VEÐURSTOFA ÍSLANDS

Report
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Ólafur Rögnvaldsson
(ritstjórar)

International Conference on Mesoscale Meteorology and Climate Interaction

Reykjavík, 24 - 28 May, 2004

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Institute for Meteorological Research
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International Conference on Mesoscale Meteorology and Climate Interaction

Reykjavík, 24 - 28 May, 2004

Organizing committee:

Jian-Wen Bao, NOAA/ETL
Jón Egill Kristjánsson, University of Oslo
Haraldur Ólafsson, University of Iceland
Ólafur Rögnvaldsson, University of Bergen
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Ministry of the Environment

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ICELANDIC
METEOROLOGICAL OFFICE

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The 2004 MMCI conference agenda

Monday, May 24:

8:30-9:30 **Registration and refreshments. Installation of posters.**
9:30-9:45 Welcome and opening remarks by Magnús Jónsson, director of the Icelandic Meteorological Office.

9:45 **Session 1 - Orographically Enhanced Precipitation**

9:45-10:15
Ólafur Rögnvaldsson, University of Bergen, Institute for Meteorological Research and Icelandic Meteorological Office and Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research:
Connections between the low-level airflow and the increase of precipitation with altitude.
10:15-10:45
Ronald B. Smith and Yanping Li, Yale University:
Far field disturbances from diurnal mountain flow.
10:45-11:15
Philippe Crochet, Icelandic Meteorological Office:
Validation of a precipitation mapping procedure over mountainous terrain in Iceland.

11:15-11:30
COFFEE BREAK

11:30-12:00
Laura Rontu, Finnish Meteorological Institute:
Scale-dependent parameterization of orographic related effects in HIRLAM.
12:00-12:30
Tómas Jóhannesson, Icelandic Meteorological Office, Oddur Sigurðsson, National Energy Authority, Helgi Björnsson and Finnur Pálsson, Science Institute, University of Iceland:
Use of glacier mass balance observations to derive spatial precipitation distribution in glaciated areas.
12:30-13:00
Sigurður Þorsteinsson, Icelandic Meteorological Office, Nils Gustafsson and Tomas Landelius, SMHI:
New humidity analysis in HIRLAM.

13:00-14:15
LUNCH AT THE ICELANDIC METEOROLOGICAL OFFICE
(PRICE IS 750ISK, APPROX 10US$)

14:15-15:00

Ronald B. Smith, Idar Barstad and Laurent Bonnet, Yale University:
Orographic precipitation and Oregon's climate transition (Invited Speaker).

15:00-15:30

COFFEE BREAK AND POSTER SESSION

15:30 Session 2 - Application of Mesoscale Meteorology to Hydrology

15:30-16:00

Gunnar G.Tómasson, VST - Consulting Engineers Ltd.:
Modeling of floods in the Þjórsá-Tungnaá river basin in Southern Iceland.

16:00-16:30

Jóna Finndís Jónsdóttir, National Energy Authority and University of Lund, Árni Snorrason, National Energy Authority and Cintia Uvo, University of Lund:
Multivariate analysis of Icelandic river flow and its relation to variability in atmospheric circulation.

17:30-19:00

ICEBREAKER AT THE CITY HALL

Tuesday, May 25:

9:00 Session 3 - Mesoscale Weather Systems and Ocean Circulation

9:00-9:45

Robert S. Pickart, Woods Hole Oceanographic Institute:
Deep convection east of Greenland - Atmospheric forcing and oceanic response (Invited Speaker).

9:45-10:15

Halldór Björnsson, Icelandic Meteorological Office:
Large scale vs. small scale - Is the thermohaline driven by large scale density differences?

10:15-10:45

Andrew Orr, J.C.R. Hunt, University College London, E. Hanna, University of Sheffield, J. Cappelen, Danish Meteorological Institute, K. Steffen, University of Colorado and A. Stephens, Rutherford Appleton Laboratory:
Characteristics of stable flows over Southern Greenland.

10:45-11:00

COFFEE BREAK AND POSTER SESSION

11:00-11:30

Rebekah Martin and G.W.K. Moore, University of Toronto:
Mesoscale Simulations of Greenland tip jets.

11:30 Session 4 - Extreme Weather in the North Atlantic

11:30-12:00
Trausti Jónsson, Icelandic Meteorological Office:
Daily pressure variability in Iceland 1822 to 2003.

12:00-12:30
Einar M. Einarsson, University of Iceland and Institute for Meteorological Research and Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research:
Extreme precipitation event in Norway.

12:30-13:00
Sigurður Þorsteinsson, Icelandic Meteorological Office, Guðmundur Freyr Úlfarsson, Washington University, Nils Gustafsson and Tomas Landelius, SMHI:
Assimilation of microwave satellite radiances over land and sea-ice.

13:00-14:15
LUNCH AT THE ICELANDIC METEOROLOGICAL OFFICE
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14:15-14:45
Bjørn Røsting, Norwegian Meteorological Institute and Jón Egill Kristjánsson, University of Oslo:
Improving NWP simulations through modifications of potential vorticity in sensitive regions (presented by Jón Egill Kristjánsson).

14:45-15:15
Trausti Jónsson, Icelandic Meteorological Office:
Some aspects of the taxonomy of storms in Iceland.

15:15-15:30
COFFEE BREAK

15:30-16:30
POSTER SESSION AND GENERAL DISCUSSIONS

17:30 RECEPTION AT BESSASTAÐIR, HOSTED BY HIS EXCELLENCY MR. ÓLAFUR RAGNAR GRÍMSSON, PRESIDENT OF ICELAND.

Wednesday, May 26

EXCURSION DAY - Departure at 9:15 from the Icelandic Meteorological Office.

Thursday, May 27

9:00 Session 5 - Effects of Meso- or Synoptic-Scale Mountains on Airflow

9:00-9:30
Hálfdán Ágústsson and Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research:
Simulating mesoscale wind structure in complex terrain.

9:30-10:00
Guðrún Nína Petersen, Reading University, Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research and Jón Egill Kristjánsson, University of Oslo:
Drag and wakes due to Greenland size mountains (presented by Haraldur Ólafsson).

10:00-10:30
Andrew Orr, J.C.R. Hunt and M. Light, University College London, G. Marshall, British Antarctic Survey, J. Sommeria, LEGI-Coriolis, Grenoble and C. Wang, Reading University:
Enhanced warming trend over the Antarctic Peninsula.

10:30-11:00
Guðrún Nína Petersen, Reading University, Jón Egill Kristjánsson, University of Oslo and Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research:
Numerical simulations of Greenland's impact on the Northern Hemisphere winter circulation (presented by Jón Egill Kristjánsson).

11:00-11:15
COFFEE BREAK

11:15-12:00
Mel Shapiro, NOAA:
THORPEX - A global atmospheric research program (Invited Speaker).

12:00-12:30
Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research:
Observations and simulations of the role of mountains in extreme weather.

12:30-13:00
POSTER SESSION

13:00-14:15
LUNCH AT THE ICELANDIC METEOROLOGICAL OFFICE
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14:15 Session 6 - Methods for Downscaling Numerical Analysis and Climate Scenarios

14:15-15:00

Sigbjørn Grønås, Erik Kolstad, Nils Gunnar Kvamstø and Yongjia Song, University of Bergen and Bjerknes Centre for Climate Research:

Arctic climate - coupled OAGCM experiments and downscaling (Invited Speaker).

15:00-15:30

Kristján Jónasson, University of Iceland:

Projected mean temperature in Iceland in this century based on IPCC climate scenarios and autocorrelative modeling.

15:30-16:00

Ólafur Rögnvaldsson, University of Bergen, Institute for Meteorological Research and Icelandic Meteorological Office and Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research:

Simulations of precipitation in the complex terrain of Iceland and comparison with glaciological observations.

16:00 Session 7 - Effective and Parallel Computational Infrastructure for Coupled Weather and Climate Modeling

16:00-16:30

Jeffrey Mayerson, Rizwan Ali, Yung-Chin Fang and Jenwei Hsieh, Dell Inc.:

A case study on the effects of shared file systems on the scalability of MM5.

16:30-17:00

GENERAL DISCUSSIONS

17:30

FORMAL END OF THE MMCI CONFERENCE

20:00-??:??

CONFERENCE DINNER AT LÆKJARBREKKA

The MMCI conference poster list

Session 1 - Orographically Enhanced Precipitation

1) Coastal Convergence and Precipitation in Southern Norway - Camilla Holmebakken, University of Bergen.
2) Estimating Precipitation from Snow Observations - Ríkharður F. Friðriksson, University of Iceland and Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research.
3) Precipitation Extremes in Iceland - Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research and Trausti Jónsson, Icelandic Meteorological Office.
4) Fine-Scale Simulations of Orographic Precipitation in Southern Norway - Roar Teigen, University of Bergen.
5) High-Resolution Simulations of Precipitation during the Reykjanes EXperiment (REX) - Ólafur Rögnvaldsson, University of Bergen, Institute for Meteorological Research and Icelandic Meteorological Office, Jian-Wen Bao, NOAA/ETL and Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research.
6) Predicting Summertime Rain in S-Iceland - Teitur Arason, University of Iceland, Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research and Ólafur Rögnvaldsson, University of Bergen, Institute for Meteorological Research and Icelandic Meteorological Office.
7) Observations of Precipitation in the Reykjanes Peninsula (REX) - Marcel E. de Vries, University of Wageningen and Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research.
8) Regionalization and Spatial Patterns of the Pentad Rainfall Data in the Semi Arid Area of Tunis - Testouri Sihem, University of Lund (presented by Cintia Uvo, University of Lund).

Session 3 - Mesoscale Weather Systems and Ocean Circulation

1) Mesoscale Atmospheric Influence on the Dense Water Production Processes in Storfjorden, Svalbard - Anne Sandvik, Bjerknes Centre for Climate Research.

Session 4 - Extreme Weather in the North Atlantic

1) Strong Winds over Open Ocean near the Marginal Ice Zone - Sigbjørn Grønås, University of Bergen.
2) Structure of Extreme Windstorms in Complex Terrain, Part I - Haraldur Ólafsson and Hálfdán Ágústsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research.
3) Structure of Extreme Windstorms in Complex Terrain, Part II - Haraldur Ólafsson and Hálfdán Ágústsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research.
4) Weather and Large Avalances - Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research, Svanbjörg H. Haraldsdóttir, University of Iceland, Icelandic Meteorological Office and Trausti Jónsson, Icelandic

Meteorological Office.

5) Thunder in Iceland - Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research, Þórður Arason and Trausti Jónsson, the Icelandic Meteorological Office.

Session 5 - Effects of Meso- or Synoptic-Scale Mountains on Airflow

1) Dynamical Downscaling of Precipitation Fields and Evaluation of Applicability for the Odra Catchment - Juliane Pestel, GKSS Research Centre.
2) Observations of the Greenland Tip Jet - Andreas Dörnbrack, Martin Weissmann, Stephan Rahm, Rudolph Simmet, Oliver Reitebuch and Reinhold Busen, DLR Oberpfaffenhofen Institut für Physik der Atmosphär (presented by Haraldur Ólafsson).
3) Meso- and Synoptic-Scale Orographic Effects and Impact of Latent Heat on Cyclones over the North Atlantic - Ragnhild Bieltvedt Skeie, Jón Egill Kristjánsson, University of Oslo and Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research.
4) Quasi-Geostrophic Flow Over Mountains - Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research.
5) Mapping the Wind Climate in Complex Terrain - Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research, Ólafur Rögnvaldsson, University of Bergen, Institute for Meteorological Research and Icelandic Meteorological Office and Einar M. Einarsson, University of Iceland and Institute for Meteorological Research.
6) Mean Gust Factors in Complex Terrain - Hálfdán Ágústsson and Haraldur Ólafsson, University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research.

Oral presentations

Session 1 – Orographically Enhanced Precipitation

Connections between the low level airflow and the increase in precipitation with height.

Ólafur Rögnvaldsson[1,2,3] and Haraldur Ólafsson[2,3,4].
[1]University of Bergen, [2]Institute for Meteorological Research, [3]Icelandic Meteorological Office and [4]University of Iceland.

A topographic precipitation gradient is established from 6 years of observations in the Reykjanes peninsula, SW Iceland. The precipitation gradient is compared to temperature, humidity and the speed of the flow impinging the mountain range. A clear positive correlation is found between the wind speed perpendicular to the mountain ridge and the precipitation gradient, while the connection between temperature, humidity and the precipitation gradient is more complex and related to the vertical profile below and above mountain top level. Knowledge of the link between key factors of the mesoscale airflow and the precipitation gradient in mountains is very important for mapping precipitation in mountainous regions of sparse and noncontinuous observations and the results from the present study will be applied in such regions.

Far field disturbances from diurnal mountain flow.

Ronald B. Smith and Yanping Li.
Yale University.

Using linear theory of stratified rotating flow, we address the following questions:

1) Can localized diurnal convective heating over the Rockies (or in other regions) generate disturbances at great distances.
2) What is the nature of these far field disturbances (waves or vortices)?
3) Can these far field disturbances trigger thunderstorms over the central and eastern United States?

Our work is motivated by the recent work of Carbone et al., in which progressive diurnal control of deep convection was seen using radar and satellite data. Our finding show that the Coriolis effect and the mean westerly winds reduce the ability of gravity waves to propagate eastward, but these same factors introduce another far field mechanism; the advection of potential vorticity pulses. In a shearing flow, theses PV pulses generate vertical motion that, in a conditionally unstable atmosphere, might be able to trigger convection. Our analysis uses schematic frequency diagrams and full FFT solutions to understand the relative role of gravity waves and PV pulses.

Validation of a precipitation mapping procedure over mountainous terrain in Iceland.

Philippe Crochet.
Icelandic Meteorological Office.

A precipitation mapping procedure (PMP) combining a simple statistical model and an interpolation procedure is used to produce precipitation maps of 1 km horizontal resolution, and accumulation periods of one month and more. A validation is presented using glaciological data over Hofsjökull glacier (central Iceland). Given the poor raingauge density in this part of Iceland, it is observed that

the PMP reproduces reasonably well the precipitation near the top of this glacier. For shorter durations (ranging from one day to a few days), the precipitation maps are derived by a direct interpolation of the ratio between observed precipitation and the 30 year averaged monthly precipitation estimated from the PMP. A validation over the Reykjanes peninsula is presented, using the REX data. The results show that the observed precipitation often exhibit small scale features that are difficult to reproduce without a dense gauge network. It is also observed that the rain shadow effect is in some cases overestimated.

Scale dependent parameterization of orographic related effects in HIRLAM.

Laura Rontu.
Finnish Meteorological Institute.

In this modelling study, parametrization of momentum fluxes due to orography in a synoptic scale NWP model HIRLAM is discussed. The problem of interaction between the parametrization schemes and model dynamics is addressed and tools to detect and understand these interactions in a limited area model are discussed. Proper separation of different subgrid scales, from the surface roughness to the mesoscale mountains, is shown to be important in the parametrization. The scaling starts from definition of the orography dependent variables needed by the parametrization schemes and resolved scale dynamics. The present day high–resolution elevation data bases provide better description of the orography. In HIRLAM, variables derived from the terrain elevation of a digital map, are used for the definition of the mean surface height (geopotential) at every grid point. Parameterization of mesoscale orography effects and small scale orographic stress require information of sub grid scale variations of the surface elevation. Derivation of the scale dependent orography variables is discussed.

Use of glacier mass balance observations to derive spatial precipitation distribution in glaciated areas.

Tómas Jóhannesson[1], Oddur Sigurðsson[2], Helgi Björnsson[3] and Finnur Pálsson[3].
[1]Icelandic Meteorological Office, [2]National Energy Authority and
[3]Science Institute, University of Iceland.

Glacier mass balance is measured once or twice annually on numerous stakes on the main ice caps in Iceland. Regular measurements have been carried out since 1988 on Hofsjökull, since 1991 and 1992 on Vatnajökull, depending on location, and for shorter periods on the other ice caps, Langjökull and Mýrdalsjökull. Scattered measurements are available from earlier years from some locations on the ice caps, e.g. a continuous series of mass balance measurements since 1954 at Grímsvötn in central Vatnajökull. Glacier mass balance depends on the amount of snow fall during the accumulation season and the melting or ablation of snow and glacier ice during the ablation season. The mass balance measurements are not direct observations of precipitation even during the winter season, except in some years at the highest altitudes on the ice caps where there is little ablation. Some of the precipitation falls as rain and is lost through runoff from the snow pack and a part of the snow pack is lost by melting and, therefore, not detected by the measurements. Glacier mass balance observations do, however, have several advantages for use in precipitation studies. They are typically from areas where there are few other precipitation measurements, but where precipitation estimates are important for many applications, such as the design and operation of hydroelectric power plants. Precipitation estimates based on mass balance measurements in glaciated areas are also not affected by the undercatch of traditional precipitation gauges, and they may provide a dense spatial coverage with a limited measurement effort because the measurements are only carried out a few times a year. The mass balance stake measurements do, on the other hand, not provide as high temporal resolution as traditional precipitation measurements and are, therefore, of limited use for some applications, such as studies of floods. They are also not always easy to interpret in terms of precipitation because of the effect of snow drift on the local distribution of snow depth on the glacier, and they may, furthermore, be affected by evaporation and sublimation from the surface of the glacier. Interpretation of glacier mass balance measurements in terms of precipitation on the glacier involves several steps. The spatial distribution of the precipitation needs to be described by appropriate assumptions that make it possible to formulate a relationship between meteorological observations at nearby weather stations and precipitation on the glacier. The fraction of the precipitation that falls as snow also needs to be estimated. Melting of snow and ice is, furthermore, simulated by a melt model that provides a link between glacier ablation and meteorological observations. If such a model can be calibrated for the glacier in question, separate estimates may be obtained for the total snow accumulation and ablation of snow and ice over the winter and summer seasons from mass balance measurements (accumulation minus ablation) over these periods. The sum of the precipitation over the year or shorter periods may then also be estimated. A precipitation estimate derived in this manner is in principle applicable over the whole area covered by the stake measurements and can to some extent be extrapolated to the surrounding area on the glacier. An important feature of this kind of precipitation estimates it that they may be independently verified by comparison with other glaciological observations such as changes in total ice volume determined by repeated geodetic mapping or information about the advance or retreat of glacier termini. Degree day mass balance models for the Hofsjökull ice cap, central Iceland, and the southern part of Vatnajökull, southeastern Iceland, have been derived by calibration against winter and summer mass balance observations. In these models, glacier accumulation and ablation are computed from daily temperature and precipitation observations at nearby meteorological stations. Ablation is parameterized by separate degree day factors for snow and ice, temperature on the glacier is found using a constant vertical temperature lapse rate and accumulation is computed using horizontal and vertical precipitation gradients and a constant snow/rain threshold. The models were calibrated based on winter and summer mass balance measurements over a number of years from the glacier in question using nonlinear least squares parameter fitting. The average yearly precipitation over the whole S-Vatnajökull area for the period 1981–2000 was found to be about 4 $m_{w.e.}$, which is substantially higher than for Hofsjökull where the average yearly precipitation over the whole ice cap for the same period was found to be about 2.4 $m_{w.e.}$. The mass balance modelling described above makes it possible to derive estimates of total precipitation over seasons or years for large areas covered by glaciers and ice caps. These estimates may in many cases be expected to be more accurate and often have a higher spatial resolution than traditional precipitation measurements at weather stations. They may, therefore, be useful for verification of precipitation parameterizations in high resolution numerical weather prediction models and for comparison with reanalysis datasets such as ERA40.

New humidity analysis in HIRLAM.

Sigurður Þorsteinsson[1], Nils Gustafsson[2] and Tomas Landelius[2].
[1]Icelandic Meteorological Office and [2]Swedish Meteorological and Hydrological Institute.

The assimilation builds on the assumption that involved variables have a Gaussian probability distribution. Most of the atmospheric variables (or at least forecast errors that are involved in data assimilation) can be considered to be Gaussian. Specific humidity can, however, not. The present

HIRLAM humidity data assimilation uses specific humidity increments. A new version of the humidity data assimilation uses a normalized relative humidity variable, accounting better for the wide variation in humidity in the vertical and at small scales in the horizontal. The statistical distribution of this new humidity variable has near Gaussian characteristics. The work to implement and test this new humidity variable has started. This is expected to be important for a proper assimilation of AMSUB radiances.

Orographic precipitation and Oregon' sclimate transition (Invited Presentation).

Ronald B. Smith, Idar Barstad and Laurent Bonnet.
Yale University.

We examine Oregon's sharp east-west climate transition using three approaches:

1) A comparison of a linear theory of orographic precipitation with interpolated raingauge data.
2) A spatial analysis of satellitederived precipitation proxies (vegetation and brightness temperature).
3) Stable isotope analysis of water samples from streams along an east-west cross mountain transect.

The success of the linear model against both raingauge and proxy data suggests that the key elements in the model (airflow dynamics, cloud time delays and lee side evaporation) are behaving reasonably. The satellite proxy data agree with model and raingauge data, illustrating the impact of precipitation on landscape, but not providing an improved verification field.
A key parameter in the linear model is the cloud physics delay time. A larger cloud delay time increases the downslope evaporation and decreases the atmospheric drying ratio and the isotope fractionation. We deduce this time from measured stable isotope ratios in stream water. River water samples collected during the dry season show a strong eastward decrease in deuterium and oxygen18 concentrations; from the coast to central Oregon. This decrease indicates an atmospheric drying ratio of about 43%. This ratio is consistent with an average cloud physics time delay of about 1200 seconds with an uncertainty of about 50%.
The amount of small scale spatial structure in the model fields and the sensitivity of the drying ratio to cloud delay suggest that the small scale elements of Oregon's complex terrain are controlling some of the important processes.

Session 2 – Application of Mesoscale Meteorological to Hydrology

Modeling of floods in the Þjórsá–Tungnaá river basin in Southern Iceland.

Gunnar G. Tómasson.
VST Consulting Engineers Ltd.

A hydrological weather–runoff model has been set up to simulate floods in the Þjórsá-Tungnaá river basin in Southern Iceland. The purpose of the modelling effort is to improve flood prediction in the area with respect to design floods for various hydropower plants, reservoirs and diversion structures owned by Landsvirkjun (the National Power Company of Iceland).
The hydrological modeling is performed in HECHMS (Hydrological Modeling System) from U.S. Army Corps of Engineers. The model simulates surface runoff and flood routing throughout the river basin. A separate model has also been developed to simulate snow melt and the associated

surface runoff. Meteorological input into the hydrological model is provided by MM5 model runs of Southern Iceland with a grid spacing of 36 km.
The model has been calibrated for two flood events, a rapid winter flood in early January 2002 and a long duration spring melt flood in May June 1992. Consequently the model will be used to predict probable maximum floods as well as design floods of different categories for hydraulic structures constructed in the area.

Multivariate analysis of Icelandic river flow and its relation to variability in atmospheric circulation.

Jóna Finndís Jónsdóttir[1,2], Árni Snorrason[1] and Cintia Uvo[2].
[1]National Energy Authority and [2]University of Lund.

The variability of the atmospheric circulation has great effects on the precipitation and runoff in Iceland. The island is situated in the middle of the North Atlantic Ocean in the path of the low pressure frontal systems that transport moisture and thermal energy from the South to the North.
A multivariate statistical analysis is performed on discharge data for several rivers in Iceland. The variability in the characteristics of the rivers is large since their watersheds are in various parts of the country, where glaciers and groundwater play a large role in the hydrology of some of the watersheds. The modes of variability are identified by a principal component analysis and the physical explanation of the modes is searched for by canonical correlation with data on precipitation, temperature, sea level pressure and sea surface temperature.
This study has the goal of identifying processes that relate the variability of the atmospheric circulation to the variability of the Icelandic rivers. It will thereby reveal the most suitable predictors for the hydrological conditions in Iceland based on indices and information on general prevalent circulation patterns.

Session 3 – Mesoscale Weather Systems and Ocean Circulation

Deep convection east of Greenland Atmospheric forcing and oceanic response (Invited Presentation).

Robert S. Pickart.
Woods Hole Oceanographic Institute.

Formation of deep water by open ocean convection is a fundamental component of the global overturning circulation that helps dictate earth's climate. There are only a few locations where it is known to occur in the world ocean. It is argued that an additional location exists east of the Greenland in the southwestern Irminger Sea, driven primarily by an atmospheric phenomenon known as the Greenland Tip Jet. A climatology of tip jet events is constructed from meteorological land station data and used to drive a regional oceanic numerical model. It is demonstrated that deep convection can occur in this region under high North Atlantic Oscillation conditions, in agreement with oceanic observations. The circumstances surrounding the convection are very different from those in the Labrador and Mediterranean Seas.

Large scale vs. small scale – Is the thermohaline driven by large scale density difference?

Halldór Björnsson.
Icelandic Meteorological Office.

The Atlantic branch of the thermohaline circulation (THC) brings warm waters into the high latitudes, where heat release to the atmosphere results in deep water formation and return flow at depth. In 1960 Stommel and Arons published a model of the deep water circulation (the Stommel-Arons model) which explained many of the features in the deep water circulation. The model assumed that deep water formation was limited to few regions that were limited in spatial extend, but that the production of deep water was balanced by a uniform upwelling. In 1961 Stommel published a paper on the dynamics of density driven flow. Box models, a class of models based on the 1961 Stommel paper, were later used to model the dynamics of the Atlantic THC. It has been shown that these box models (which are fairly simple) seem to reproduce the dynamics of much more complicated Ocean General Circulation Models (OGCMs). In the box models the large scale density gradient in the ocean is the driver for THC. However, it has been found that the density field that drives the THC in box models is inconsistent with the results of the Stommel-Arons model. Furthermore, the influence of transport processes within the southern hemisphere has been shown to affect the strength of the THC OCGMs. Indeed these latter processes have been proposed as a way to remove the inconsistency, but with the result of uncoupling the large scale density field from the THC driver. In this case the thermohaline circulation, which is clearly a large scale phenomenon, becomes dependent on mesoscale processes. This has serious implications for the instability properties of the THC that have been explored in various OGCMs and box models.

Characteristics of stable flows over Southern Greenland.

Andrew Orr[1], J.C.R. Hunt[1], E. Hanna[2], J. Cappelen[3], K. Steffen[4] and A. Stephens[5].
[1]University College London, [2]University of Sheffield, [3]Danish Meteorological Institute,
[4]University of Colorado and [5]Rutherford Appleton Laboratory.

Using a combination of mesoscale and synoptic scale numerical simulation, meteorological analysis, satellite imagery, and surface observations, the main characteristics of stable air flows over southern Greenland for four wind directions are investigated. The detailed features are identified using the concepts and scaling of stably stratified flow over large mountains with variations in surface roughness, elevation, and heating. For westerly and easterly winds detached jets form at the Southern tip, where coastal jets converge, which propagate large distances across the ocean. Near coasts katabatic winds can combine with barrier jets and wake flows generated by synoptic winds. Associated with the jets is rising/falling air and the formation of clouds to the west and clearer air to the east of the tip of Greenland. The strong winds and cold temperatures of the wind jets lead to enhanced heat loss in the ocean around southern Greenland. Together with the strong wind curl this forces oceanic downwelling. Results here suggest that downwelling associated with these jets might be more common than previously thought. For accurate simulations of these flows and the accompanying air sea interaction, mesoscale models are necessary with horizontal resolutions of order 20 km or less. Our studies should help improve the understanding of mesoscale meteorology around Greenland and improve the parameterization and interpretation of mesoscale processes in weather or climate prediction models.

Mesoscale simulations of Greenland tip jets.

Rebekah Martin and G.W.K. Moore.
University of Toronto.

Greenland lies in close proximity to the northern branch of the North Atlantic storm track, and as such can be a point of strong orographic interaction with atmospheric flow. The tip of Greenland is also frequently the source of high wind speed events called tip jets. These events can occur in a situation of westerly synoptic flow in the normal case, or they can be observed in easterly synoptic flow situations that produce a reverse tip jet event. The air sea interaction associated with tip jet event has been proposed to be of importance to climate because of the potential for deep ocean convection connected with the high wind speeds that characterize the tip jet. Because of their mesoscale nature, tip jets are not well resolved, or even at all resolved by most GCMs. In addition, the surface heat fluxes associated with these events may not be well estimated by model boundary layer parameterizations. Consequently, it is very important to simulate these events with a fairly high resolution mesoscale model in order to better understand the processes associated with the Greenland tip jet. In this presentation, we will show model output of some tip jet events and discuss the heat fluxes involved.

Session 4 – Extreme Weather in the North Atlantic

Daily pressure variability in Iceland 1822 to 2003.

Trausti Jónsson.
Icelandic Meteorological Office.

The magnitude of daily pressure variability has been used as an indicator of storm track locations in climate models. Here it is shown that there is a coherence between monthly averages of the daily pressure variability and the average wind speed at an aggregate of all synoptic stations in Iceland since 1950. The daily pressure record extends back to the 1820s and it is suggested that this can be used to augment the traditional NAO index.

Extreme precipitation event in Norway.

Einar M. Einarsson[1,2] and Haraldur Ólafsson[1,2,3].
[1]University of Iceland, [2]Institute for Meteorological Research and
[3]Icelandic Meteorological Office.

In August 2003 heavy precipitation occurred in the northern part of South Norway. The event is simulated from initial conditions at different times to gain insight into the predictability of the high impact weather event. A forty eight hours forecast fails to predict the intensity of the precipitation, while the event is reproduced reasonably well in a 24 hours forecast. The improvement between the forecasts is mainly associated with an increase in intensity and improved direction of low level winds that impinge the mountains. The errors in the winds in the 48 hours forecast were associated with a local underestimation of temperatures in the lower part of the troposphere in the analysis. This study is a part of the THORPEX programme on the predictability of high impact weather.

Assimilation of microwave satellite radiances over land and sea-ice.

Sigurður Þorsteinsson[1], Guðmundur F. Úlfarsson[2], Nils Gustafsson[3] and Tomas Landelius[3].
[1]Icelandic Meteorological Office, [2]Washington University and [3]Swedish Meteorological and Hydrological Institute.

Steps have been taken to extend the usage of Advanced Microwave Sounding Unit - A (AMSU-A) radiance data to land and sea ice in the data assimilation for HIRLAM. The main problems are related to the less homogenous land surface conditions over land and ice as compared to sea areas. The satellite's field of view includes more details of the surface conditions than the forecast model can simulate. The surface skin temperature, Ts, and surface emissivity in the AMSU-A field of view have been introduced as minimization control variables to minimize undesirable influences from these details, which are not represented by the model. For these two variables we only compute the cost function in the observations points since we do not intend to assimilate them explicitly. We have so far experimented with this extension over ocean areas only. The preliminary result is that the observation cost function takes smaller values with Ts as free control variable than without. This indicates that the surface skin temperature seems to work as a control variable over sea. Further tests are needed over ice and land areas since the radiance are more sensitive to the surface conditions over these areas. In addition, an improved cloud mask definition, utilising the improved surface condition control variables, is also needed over ice and land.

Improving NWP simulations through modifications of potential vorticity in sensitive regions.

Bjørn Røsting[1] and Jón Egill Kristjánsson[2].
[1]Norwegian Meteorological Institute and [2]University of Oslo.

Three cases of major forecast failures over Western Europe have been investigated. In all three cases, operational NWP models severely underestimated the explosive deepening of the extratropical cyclones under development. Two of the storms hit France in late December 1999, while the third struck the British Isles and Norway in late October 2000. A common feature is that the explosive deepening of the lows took place while they were located over data sparse areas in the North Atlantic. Errors in the initial state have been identified by comparing signatures in water vapour imagery to potential vorticity (PV) structures in the analysis. The potential vorticity fields were then corrected at levels indicated as sensitive by the fastest growing singular vectors. Subsequently, an inversion of Ertels PV was performed, resulting in a corrected initial state, from which new simulations using HIRLAM were conducted. In all three cases vastly improved simulations were obtained. Advantages and drawbacks of this methodology will be discussed during the presentation.

Some aspects of the taxonomy of storms in Iceland.

Trausti Jónsson.
Icelandic Meteorological Office.

An simple inspection of widespread windstorm events in Iceland reveals the existence of a few dynamically distinct types of storms, that have an interesting seasonal cycle. The frequency of each type also shows a considerable decadal variability that can at least partially be linked to the extent of the East Greenland sea-ice.

Session 5 – Effects of Meso- or Synoptic-Scale Mountains on Airflow

Simulating mesoscale wind structure in complex terrain.

Hálfdán Ágústsson[1,2,3] and Haraldur Ólafsson[1,2,3].
[1]University of Iceland, [2]Icelandic Meteorological Office and
[3]Institute for Meteorological Research.

Two severe windstorms hitting the complex terrain of East Iceland and Northwest Iceland have been simulated with horizontal resolutions of 9, 3 and 1 km. The overall simulated wind field agrees well with observations and shows limited sensitivity to the parameterization of the effect of surface friction. Local effects such as downslope windstorms and lee side sheltering are in general well reproduced. At a few locations, there is however significant difference between observed and simulated wind. This can generally be attributed to small scale non resolved terrain features. Wind gusts are predicted using output from the numerical simulations and the turbulence based method of Brasseur. For locations where the mean wind speed is well simulated, the predicted wind gusts are in general in acceptable agreement with observations.

Drag and wakes due to Greenland sized mountains.

Guðrún Nína Petersen[1], Haraldur Ólafsson[2,3,4] and Jón Egill Kristjánsson[5].
[1]Reading University, [2]University of Iceland, [3]Icelandic Meteorological Office,
[4]Institute for Meteorological Research and [5]University of Oslo.

A series of idealized simulations is conducted to investigate how the upstream wind direction impacts the flow in the vicinity of a large mountain. The upstream wind speed and stability are kept constant, there is no surface friction, the Rossby number is low and the nondimensional mountain height, Nh/U is varied from 1 to 4.5. The flow pattern varies greatly with wind direction and a number of features of orographic flows where the Coriolis force is important are found. For a given Nh/U the flow is blocked for low aspect ratio while it is not blocked for high aspect ratio. The upstream barrier wind, the drag force and the wake are more pronounced when the impinging winds are from the southwest, than if they are from the northwest. These features are linked and they can be explained by the interaction of the Coriolis force with the mountain and the low level flow anomalies. Application to real flow on the earth are discussed.

Enhanced warming trend over the Antarctic Peninsula.

Andrew Orr[1], J.C.R. Hunt[1], M. Light[1], G. Marshall[2], J. Sommeria[3] and C. Wang[4].
[1]University College London, [2]British Antarctic Survey, [3]LEGI-Coriolis and
[4]Reading University.

We demonstrate a mechanism whereby the impact of stronger circumpolar westerly winds on the mountains of the Antarctic Peninsula is partly responsible for the enhanced surface warming trend observed over its western side in the last 50 years. Numerical and laboratory meteorological modelling demonstrate how, when westerly winds impinge on this side, warm air below the height (1.52.0km) of the Peninsula is advected in a southerly direction. The strength of the annual mean westerly winds has increased by about 1520% since the 1960' swhile the modelling results indicate that contemporaneously the air advected to its western side originates from an increasingly northerly (and warmer) location. This gives rise to increased northerlies and a greater transport of warm air into this region. Consequently there is a reduction in the sea-ice extent, further amplifying the local warming. This "low level", orographic mechanism for the local climate trend is supported by observational evidence. The increase in the strength of the westerlies also makes the probability of the westerly flow passing over the Peninsula and descending on the lee (easterly) side more likely, transporting relatively warm air to the eastern side of the Antarctic Peninsula. The strengthening of the westerly winds is consistent with the trend towards the positive polarity of the Southern Hemisphere Annular Mode (SAM). The SAM increases most in the summer and so we would expect a higher proportion of winds to get over the Peninsula during this time. Perhaps this is contributing to the large summer warming observed over the northeastern Peninsula (e.g. at Esperanza) and the break up of the Larsen Ice Shelf.

Numerical simulations of Greenland's impact on the Northern Hemisphere winter circulation.

Guðrún Nína Petersen[1], Jón Egill Kristjánsson[2] and Haraldur Ólafsson[3,4,5].
[1]Reading University, [2]University of Oslo, [3]University of Iceland,
[4]Icelandic Meteorological Office and [5]Institute for Meteorological Research.

The impact of Greenland's orography on the general circulation is investigated. Two 10 year simulations are conducted using the NCAR Community Climate Model (CCM3) at T106 horizontal resolution (spectral truncation), a control simulation and a simulation where Greenland's orography is set to sea level. A comparison of the simulations indicates that Greenland has a significant impact on the general circulation of the Northern Hemisphere at both lower and mid tropospheric levels. The storm tracks over the North Atlantic are shifted southward in the presence of the mountain. There are significant differences between the two simulations over a large area in the Northern Hemisphere. It is argued that this difference pattern is linked to the damming of cold low level air masses west of Greenland that result in a decrease in the 500 hPa geopotential height on the upstream side of the mountain. Thus, Greenland's impact on the general circulation is fundamentally different from the impact of the Rocky Mountains and the Tibetan Plateau where westerlies impinging on a major mountain range create a trough downstream of the mountain.

THORPEX A global atmospheric research program (Invited Presentation).

Mel Shapiro.
NOAA.

THORPEX is an international research programme to accelerate improvements in the accuracy of one day to two week high impact weather forecasts for the benefit of society and the economy. THORPEX establishes the organizational framework that addresses weather forecast problems whose solutions will be accelerated through international collaboration between academic and operational forecast centres. Research topics include atmospheric weather predictability, data assimilation, targeted observations, and societal economic benefits of improved forecasts. The programme builds upon ongoing advances within the atmospheric science and operational forecasting communities and will make progress by enhancing international collaboration between these communities and users of forecast products. The success of numerical weather prediction represents one of the most significant scientific, technological and societal achievements of the 20th century. Despite the notable increase in forecast skill over the past quarter century, there is a necessity for further improvements, particularly, in high impact weather forecasts and in the use of weather information. High impact weather forecasts are defined by their effect on society and the

economy. They are typically associated with forecasting cyclones of extratropical and tropical origin that contain significant embedded mesoscale weather, such as localized flooding by convective and orographic precipitation; blizzard snows; destructive surface winds; dust storms. They also encompass meteorological conditions affecting air quality, periods of anomalous high/low temperature and drought, and non extreme weather with high societal impact. Improving the skill of high impact weather forecasts is one of the great scientific and societal challenges of the 21st century. THORPEX is a response to this challenge.
This paper will open with an overview of THORPEX, followed by the presentation of:

1) Recent examples of extreme orographic flows over and in the vicinity of the eastern lee of Greenland.
2) A proposal for high impact weather prediction and climate process studies as a collaboration between THORPEX and other programmes participating in the International Polar Year (IPY).

Observations and simulations of the role of mountains in extreme weather.

Haraldur Ólafsson.
University of Iceland, Icelandic Meteorological Office and
Institute for Meteorological Research .

Observations of wind and precipitation in most places in the complex terrain of Iceland suggest that the orography is important in creating local extreme weather during synoptic scale strong storms. Observations from the SNEX experiment in W-Iceland are presented where local windstorms are linked to the vertical profile of the atmosphere impinging the mountains. The role of winds and mountains in cases of extreme precipitation are also examined.

Session 6 – Methods for Downscaling Numerical Analysis and Climate Scenarios

Arctic climate coupled OAGCM experiments and downscaling (Invited Presentation).

Sigbjørn Grønås, Erik Kolstad, Nils Gunnar Kvamstø and Yongjia Song.
University of Bergen and Bjerknes Centre for Climate Research.

Modelling of climate variations in Arctic is for several reasons considered to be a major challenge (IPCC 2001). Severe problems are connected to proper representation of local physical processes, such as those connected to air/sea/sea-ice interaction. In addition, it is a problem to integrate the local processes in the general circulation of atmosphere and ocean to get correct influence from lower latitudes, with right heat fluxes etc. In Bergen, in a co-operation around Bjerknes Centre for Climate Research (BCCR), the Bergen Climate Model (BCM) has been developed with the aim to tackle the specific problems at higher latitudes in climate models (Furevik et al. 2003).
An ambition is to contribute to future climate projections from IPCC. As a first step, an ensemble of CMIP2 runs have been made to assess the effect of increased CO_2 in the atmosphere. We here report on some results from these experiments relevant for Arctic, stressing the large influence of natural decadal variability in the area.
In addition to global scenarios, BCCR has ambitions to prepare detailed regional climate scenarios for the future. Work has started to find a downscaling strategy for Arctic. As a first step, the potential of higher resolution global models of the atmosphere is investigated, in particular the use global model versions with higher resolution focussed to Arctic. We here report on preliminary

results that not only show improved mesoscale details, e.g. in flows over the Scandinavian mountains, but also improved structures of the regional-scale synoptic activity, e.g. improved storm tracks.

Projected mean temperature in Iceland in this century based on IPCC climate scenarios and autocorrelative modeling.

Kristján Jónasson.
University of Iceland.

A projection of the annual mean temperature in Iceland in the 21st century is presented. The projection is based on an autocorrelative model of the temperature series combined with a local estimate of greenhouse warming. The autocorrelative model is based on temperature measurements in Iceland 18302003 and partly on temperature series from nearby countries. An assessment of the local greenhouse warming is obtained from recently published research, both on global climate models and estimating the local development. Simulation is used to assess the error in the projection. The average Reykjavik temperature 20042013 according to the projection is 5.21°C. This may be compared to the rather cold period 19761995 when the average temperature in Reykjavik was 4.15°C. Possibly Iceland is currently experiencing a combination of global greenhouse warming and a relief from a naturally occurring cold spell.

Simulations of precipitation in the complex terrain of Iceland and comparison with glaciological observations.

Ólafur Rögnvaldsson[1,2,3] and Haraldur Ólafsson[2,3,4].
[1]University of Bergen, [2]Institute for Meteorological Research, [3]Icelandic Meteorological Office and [4]University of Iceland.

Precipitation in the complex terrain of Iceland has been simulated with a numerical model (MM5) for a period of 12 years. The simulations are made with a horizontal resolution of 8 km and they are forced with boundaries from the ECMWF. Validation of precipitation simulations is particularly difficult where precipitation falls largely as snow in strong winds, because of significant underestimation of true ground precipitation by conventional observations. In view of this, precipitation has been estimated from observations of snow accumulation on major glaciers in central and eastern Iceland. This glaciological dataset is compared to the simulated precipitation. The numerical simulations reproduce with quite good accuracy the amount of precipitation and the observed interannual variability. The results are promising for the use of glaciological data for precipitation mapping and for validation of numerical simulations. The usefulness of high resolution numerical simulations for mapping precipitation in data sparse regions is confirmed. This is important for downscaling results from general circulation models simulating future climate and for predicting changes in regional precipitation.

Session 7 – Effective and Parallel Computational Infrastructure for Coupled Weather and Climate Modeling

A case study on the effects of shared file systems on the scalability of MM5.

Jeffrey Mayerson, Rizwan Ali, Yung-Ching Fang and Jenwei Hsieh.
Dell Inc.

High Performance Computing Clusters based on open standards and defacto standards provide a proper architecture for running distributed memory applications such as MM5 MPP. This paper will study the scalability of the MM5 application and provide a method to overcome the scalability bottleneck. As the number of nodes (and therefore processors) increases, MM5 can reach a point of I/O subsystem saturation. This causes the performance of the system to decrease with an increase in node count. While multiple components of a cluster directly affect the performance, this paper studies the behavior of MM5, its relationship to shared file systems, and their impact on scalability and performance.
Using the MM5 T3_benchmark data set, a preliminary study was performed in which Network File System (NFS) was used as a cluster's shared file system to understand the scalability of the application. A file system comparison was performed to determine the effects of using Parallel Virtual File System (PVFS) as the shared file system.
This study will provide a methodology to understand an MM5 application's I/O requirements and to select an I/O subsystem which will allow the application to reach peak performance and continue scaling to larger node counts.

Poster presentations

Session 1 – Orographically Enhanced Precipitation

Coastal convergence and precipitation in Southern Norway.

Camilla Holmebakken.
University of Bergen.

Precipitation patterns of southern Norway show maximum amounts on the mountains slopes as a sign of orographic intensification. In addition, large amounts might occasionally fall at the southernmost coast (Sørlandet) due to coastal convergence. The PSU/NCAR Mesoscale Model (MM5) is used to examine the structure and dynamics of coastal convergence and large amounts of precipitation in such coastal cases. Experiments have been made on two different situations with large amounts of precipitation at the coast of Sørlandet, up to 117 mm in 24 hours. The results verify the hypothesis that the abrupt change in roughness across the coastline is responsible for parts of large mounts of precipitation at the coast. However, it is also shown that the effect of the mountains of southern Norway is more important than previously thought. In general, the model produced too small amounts at the coast, and too large amounts further inland. When the roughness length over land was multiplied with 10, the precipitation patterns were closer to the observations. This indicates that the results are sensitive to the specification of the surface roughness. The model did not succeed in reproducing more than 80% of the actual precipitation amounts at the coast.

Estimating precipitation from snow observation.

Ríkharður F. Friðriksson[1] and Haraldur Ólafsson[1,2,3].
[1]University of Iceland, [2]Icelandic Meteorological Office and
[3]Institute for Meteorological Research,.

A synoptic weather station has been operated at Hveravellir, central Iceland, since 1965. All main weather parameters are measured every three hours and during winter months comprehensive snow measurements are carried out as well. Observations of accumulated snow, wind and temperature are used to estimate precipitation, it is than compared to direct precipitation measurements. This comparison shows that conventional methods grossly underestimate the precipitation, especially during strong winds.
We propose a method to correct the conventional rain gauge data and find the true precipitation as a function of wind speed.

Precipitation extremes in Iceland.

Haraldur Ólafsson[1,2,3] and Trausti Jónsson[2].
[1]University of Iceland, [2]Icelandic Meteorological Office and
[3]Institute for Meteorological Research,.

On 10 January 2002 a new record of precipitation intensity was set in Iceland. 293 mm were observed in 24 hours at Kvísker, SE-Iceland. The previous record of 243 mm was from the same place and dates back to 1 October 1979. Both the records are characterized by very strong low level flow, but in the 2002 case the flow is from the southeast, while in the 1979 case, the flow is from the southwest. In both cases, there is very strong orographic response and numerical simulations indicate that the precipitation in a nearby mountain was much greater than the observed record.

Fine scale simulations of orographic precipitation in Southern Norway.

Roar Teigen.
University of Bergen.

The fifth-generation Pennsylvania State University/National Center for Atmospheric Research Mesoscale Model (MM5) have been used to fine scale simulation of precipitation over the western part of Southern Norway. Effects of increasing resolution, spatial variation in model skill and the impact of the microphysics scheme have been studied. The month of January 2000 is simulated and verified using 157 observer precipitation sites. There are signals indicating that the 9km MM5 produce too little precipitation at the coastline, and excessive precipitation along the fjords and valleys inland. The same signals is verified in the 3km MM5, but there is slightly more skill than at 9km. Twice the month was simulated with different microphysics scheme, Reisner 2 scheme and much simpler Schultz scheme. Schultz scheme produces more precipitation, but RMS errors for 9km was as good as 3km with Reisner 2. The results indicate that there is still much work to do for optimising the model microphysics. A simulation with 1km resolution was done for part of the month for a third domain covering the steep topography of the inner fjords. It showed more skill than 9km and 3km, indicating that there might be benefits of such high resolution for some areas.

High resolution simulations of precipitation during the Reykjanes EXperiment (REX).

Ólafur Rögnvaldsson[1,2,3], Haraldur Ólafsson[2,3,4] and Jian-Wen Bao[5].
[1]University of Bergen, [2]Institute for Meteorological Research, [3]Icelandic Meteorological Office, [4]University of Iceland and [5]NOAA/ETL .

During the Reykjanes experiment (REX), precipitation was observed in a dense network across a 20km wide and 700m high mesoscale mountain ridge in SW Iceland. The precipitation is simulated with the numerical primitive equation model MM5 with horizontal resolutions from 1 to 8 km and boundaries from the ECMWF and NCEP. As expected, the highest resolutions give the greatest precipitation extremes and they are closer to the observed maxima than the more coarse resolutions. The model tends in general to give a slight underestimation of the precipitation close to the mountain crest, while the downstream precipitation is underestimated more grossly in the simulations.

Predicting summertime rain in S-Iceland.

Teitur Arason[1], Haraldur Ólafsson[1,2,3] and Ólafur Rögnvaldsson[2,3,4].
[1]University of Iceland, [2]Icelandic Meteorological Office, [3]Institute for Meteorological Research and [4]University of Bergen.

Observations of precipitation in S-Iceland are compared with atmospheric stability and humidity indices and precipitation as simulated with the numerical model MM5 on a 8 km horizontal grid. The best indices give only limited information on the probability of rainshowers, while the numerical model predicts precipitation correctly in most of the cases. Failure of the model to produce precipitation is often during drizzle when only little precipitation is observed.

Observations of precipitation in the Reykjanes Peninsula (REX).

Marcel E. de Vries[1] and Haraldur Ólafsson[2,3,4].
[1]University of Wageningen, [2]University of Iceland,
[3]Icelandic Meteorological Office and [4]Institute for Meteorological Research.

During 6 weeks in the autumn of 2002, precipitation was observed in a dense network of raingauges in the Reykjanes peninsula, SW-Iceland. The observations revealed a large variability in the precipitation pattern. In some cases, most of the precipitation was on the upstream side of the mountains, while in some of the cases, the maximum precipitation was observed downstream. On the average, the maximum precipitation observed in the mountains was 3.5 times the precipitation upstream and 6 times the precipitation downstream (in Reykjavík). A study of individual events suggest that the vertical profile of the winds may be important for the precipitation pattern.

Regional and spatial patterns of the Pentad Rainfall Data in the semi arid area of Tunis.

Testouri Sihem (Presented by Cintia Uvo).
University of Lund.

Session 3 – Mesoscale Weather Systems and Ocean Circulation

Mesoscale atmospheric influence on the dense water production processes in Storfjorden, Svalbard.

Anne Sandvik.
Bjerknes Centre for Climate Research.

A recurrent coastal polynya situated at the lee side of Edgeøya and Barentsøya was inferred from SAR images in winters 1998 2002 during north-easterly winds. The prevailing offshore winds and the intense heat loss from the open water to the atmosphere result in an enormous ice production and subsequent brine release to the underlying water. Accompanying shelf convection underneath the polynya area leads to formation of dense, brine enriched shelf water that fills the depressions of the fjord to its sill level and subsequently descend like a bottom gravity current following the topography toward the shelf break. A three-dimensional wind and density driven numerical model, the Bergen Ocean Model (BOM), was used to simulate the circulation in Storfjorden. Two simulations were carried out, one where the ocean model was forced by high resolution (4km) wind from the non hydrostatic atmospheric model MM5 and one where it was forced by wind from the NCEP reanalysed fields. Similarities and differences between the two integrations are discussed and benefits from the high resolution atmospheric forcing are emphasized.

Session 4 – Extreme Weather in the North Atlantic

Strong winds over open ocean near the marginal ice zone.

Sigbjørn Grønås.
University of Bergen.

Structure of extreme windstorms in complex terrain, Part I - Breaking waves.

Haraldur Ólafsson[1,2,3] and Hálfdán Ágústsson[1,2,3].
[1]University of Iceland, [2]Icelandic Meteorological Office and
[3]Institute for Meteorological Research.

A windstorm over the complex terrain of Northwest-Iceland on 12 February is simulated numerically. Downwind of some of the mountains, observations and the simulation show local amplification of the surface winds. These local windstorms are associated with vertically propagating gravity waves. The waves are observed by satellite, and reproduced in the simulation where they are shown to break and generate strong turbulence between 700 and 500 hPa. The breaking of the waves is related to a reverse wind shear above 500 hPa. The numerical simulation correctly reproduces weak winds over some of the lee slopes. The absence of strong winds and wave breaking over these slopes appears to be related to the steepness of the slopes.

Structure of extreme windstorms in complex terrain, Part II - Horizontally and vertically propagating gravity waves.

Haraldur Ólafsson[1,2,3] and Hálfdán Ágústsson[1,2,3].
[1]University of Iceland, [2]Icelandic Meteorological Office and
[3]Institute for Meteorological Research.

The winds and pressure fields are analyzed during a windstorm over East-Iceland on 17-18 February 2003. The maximum wind speeds in the windstorm are found to be associated with a small scale anomaly in the surface pressure field. The anomaly is about 3 hPa and travels upstream with the speed of 10 km/hr. A numerical high resolution simulation reproduces a similar but weaker feature. The study indicates that the pressure anomaly is a result of a vertically and horizontally propagating gravity wave generated by the interaction of the flow and the orography.

Weather and large avalanches.

Haraldur Ólafsson[1,2,3], Svanbjörg Helga Haraldsdóttir[1,2] and Trausti Jónsson[2].
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Large avalanches in Flateyri, NW-Iceland and in Neskaupstaður, E-Iceland are identified and composite weather maps are drawn for the avalanche events at both locations. The maps reveal that low level winds are stronger and/or more persistent during avalanche events in NW-Iceland than in E-Iceland. The NW-Iceland avalances tend to be associated with slowly moving cyclones and low tropopause levels, while the E-Iceland avalanches are produced by faster moving cyclones. The E-Iceland avalanches occur in higher temperatures than the NW-Iceland avalances, suggesting that they may suffer more from global warming.

Thunder in Iceland.

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An investigation of synoptic observations and signals from an automatic lightning detection system

reveals large seasonal variability of thunder in Iceland. Thunder is most frequent during winter, but a secondary maximum occurs in the middle of summer. The airmasses in which the wintertime thunderstorms are formed are advected rapidly from N-America towards Iceland and the convection is powered by heating from the ocean. The summertime thunderstorms are on the other hand associated with convergence in flow from Britain and/or continental Europe. Numerical simulations indicate that the conditions in which the wintertime thunderstorms form are more easily predictable than the summertime thunderstorms.

Session 5 – Effects of Meso- or Synoptic-Scale Mountains on Airflow

Dynamical downscaling of precipitation fields and evaluation of applicability for the Odra Catchment.

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GKSS Research Centre.

The suitability of high resolution precipitation fields for a hydrological prediction system has to be evaluated. Here it is performed for predictions with the mesoscale model MM5 in the catchment of the Odra river. The simulated precipitation fields are downscaled to 4.4 x 4.4 km resolution, are calculated for the flooding event in 1997 and are evaluated against precipitation observations.

Observations of the Greenland tip jet.

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The Greenland tip jet is a strong windstorm that forms downstream of Cape Farewell in westerly flow. This periodically developing low level jet is an important mesoscale feature of the atmospheric flow regime in the Irminger Sea. Recently, it has been identified as an important factor in driving the deep sea circulation in this part of the Atlantic. Observations of the vertical structure of the tip jet wind field in the lee of Greenland are rare or non existing. Here, we present airborne Doppler wind lidar and dropsonde observations of a tip jet event on 24 November 2003. The observations were performed during the Atlantic THORPEX Regional Campaign (ATReC) when the DLR research aircraft Falcon was based in Keflavík, Iceland. The two dimensional wind cross sections of the scanning Doppler lidar have a maximum horizontal and vertical resolution of 10 km and 100 m, respectively. Along two north-south sections the wind lidar observations show the surprisingly complex structure of the tip jet event: there are at least two different branches of low level jets, of which the southernmost jet has greater vertical extension and is closer to the southern tip of Greenland. Synoptic scale and mesoscale analysis place the wind lidar observations into a meteorological context. Additional idealized model simulations of a baroclinic flow past Greenland are performed to study the influence of upstream conditions on the occurrence, strength and downwind extension of the tip jet.

Meso- and synoptic-scale orographic effects and impact of latent heat on cyclones over the North Atlantic.

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Two intense cyclones over the North Atlantic during summer/autumn 2003 are investigated to determine atmospheric factors contributing to their development. One of the cases, in August 2003, led to heavy precipitation and flooding in parts of Norway (Trondelag area). Locally more than 100mm of precipitation fell in a 24 hour period. The other event was a cyclone that led to hurricane force winds on the east coast of Greenland on the 20th of September 2003.
Simulations with the Penn State/NCAR Mesoscale Model, MM5, with different surface conditions (SST and topography), as well as with and without latent heat release have been conducted, to study how these factors contributed to the deepening and evolution of the cyclones.
The simulations show that the September cyclone is very strongly affected by the orography of Greenland. In the no mountain run, there is no secondary cyclone south of the original baroclinic cyclone, as in the control run. Simulations without Scandinavian mountains in the August case show that the mountains push the isobars closer together over southern Norway, and a lee trough appears over SE Norway. In the no mountain run, the precipitation in the most intense stage, when there were onshore winds was substantially reduced. Lowering of the SST in the August case had no influence on the deepening of the cyclone. On the other hand, latent heat release had a major impact on the cyclone deepening. The cyclone becomes significantly weaker without latent heat release, and it moves more rapidly eastwards.

Quasi-geostrophic flow over mountains.

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By solving a simplified version of the primitive equations for flow that is blocked by a mountain and assuming the flow that passes the edges of the mountain to be geostrophic, an equation for vertical motion downstream of the mountain is derived. To the left of the mountain wake there is ascending motion, while on the right hand side of the wake there is descending motion. It is suggested that the process presented here is at least partly responsible for the precipitation pattern in N-Iceland in southerly flow.

Mapping the wind climate in complex terrain.

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An attempt is made to map the wind climate of a region in NE-Iceland during periods of poor visibility because of blowing snow. The frequency of wind directions is analyzed from observations and winds from all directions associated with blowing snow are simulated with the numerical model MM5. The simulations are initialized with a constant wind speed of 15 ms^{-1} and a stability of $N=0.012\ s^{-1}$. A field of mean wind speed during windstorms is constructed and by applying the observed wind speed distribution in the region, a map is created, showing the proportion of time when the wind speed is above a critical limit.

Mean gust factors in complex terrain.

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Mean gust factors are calculated for wind speeds above 10 ms^{-1} in a large dataset from automatic weather stations in the complex terrain of Iceland. The mean gust factor decreases regularly with increasing wind speed, but there is no apparent connection between the atmospheric static and dynamic stability and the mean gust factor. A diagram for gust factors in flow downstream of mountains is constructed and the main result is that to obtain a mean gust factor of at least 1.7, there must be a mountain upstream of the weather station and the distance to the mountain may not be greater than 10 times the height of the mountain above the weather station.