Reviewing the Greenland Flow Distortion Experiment: Forecast sensitivity to observational error and steep orography

Ian Renfrew, Emma Irvine, Sue Gray, John Methven, Nina Petersen
Motivation

- Local weather systems
  - tip jets, barrier winds, lee cyclones, polar lows
- Climate system
  - thermohaline circulation
- Medium-range weather forecasting
  - targeted observations (a THORPEX campaign)
• Field programme: 17 Feb – 12 March 2007
• Detachment: Keflavik, Iceland
• 62 flight hours + 9 hours (EUFAR)
B268 Easterly Tip Jet
B269 Iceland Wake
B270 Targeted SAP
B271 Polar Low
B272 Targeted SAP & mesoscale low
B273 Targeted SAP, Lee cyclogenesis & Barrier Winds
Easterly Tip Jet

AVHRR Ch 1
14:35 UTC
21 February 2007

Renfrew, Outten and Moore (2009, QJRMS): I Aircraft observations
Outten, Renfrew and Petersen (2009, QJRMS): II Simulations and Dynamics
What model resolution is required?

The impact of targeted observations

- Run hindcasts for field campaign period (Feb-Mar 07)
- Focus on several case studies
- SAP from ECMWF and Met Office

**Model:**
- Met Office UM, 24km grid
- 4D-VAR data assimilation scheme

**Hindcasts:**
- Control – routine obs. only
- Targeted – routine obs. + targeted obs.
- All – routine obs. + all available dropsondes
- Covariance errors for dropsonde assimilation: operational & ½
- Verify forecasts against ECMWF analyses
Can we improve weather forecasts by adding observations in a clever fashion?

Sensitive area prediction (TESV)
Can we improve weather forecasts by adding observations in a clever fashion?

Sensitive area prediction (TESV)
Forecast impact
% reduction in forecast error

Observations added: dashed= Targeted
Forecast impact

Observations added:
dashed = Targeted
solid = All
dotted = No Greenland
Why do the drops sondes on the Greenland coast degrade the forecast?

- Sonde data is spread along terrain-following model levels – up steep orography

Conclusions

• Targeted observations into sensitive areas increased forecast impact by only 5%
  – Reducing covariance errors increased this somewhat

• Dropsondes close to high steep orography were degrading the forecast
  – Using alternatives changed forecast impact to 20%

• GFDex provided novel observations and analysis of a variety of mesoscale jets and weather systems, their representation and their impact on the climate system
THE GREENLAND FLOW DISTORTION EXPERIMENT


We present an overview of an aircraft-based field campaign focusing on the dynamics and air–sea interaction associated with tip jets, barrier winds, and mesoscale cyclones, as well as a targeted observation program.

A millennium ago pioneering Icelanders and Norwegians were exploring and settling the southern coastline of Greenland when, almost accidentally, they stumbled across North America. Their exploits are recorded in the Icelandic Sagas, some of the oldest writing in the western world, including the Vinland Sagas, which contain two largely consistent accounts of these events. In both of these narratives, stormy weather plays a pivotal role. In Eiríks Saga Eiríksdóms, Eirik the Red’s Saga Eiríks’s son, Leif Eiríksson, departs for Greenland, whereupon

After being tossed about at sea for a long time he chanced upon land where he had not expected to be found. Fields of self-sewn wheat and vines were growing there; also, there were trees known as maple.

In The Sagas of the Greenlanders, Bjarni Herjólfsson is blown off course,

Case studies
- Tip jets, barrier winds, lee cyclones, polar lows
- Climatological studies
- Model & reanalyses evaluation
- Impact of Targeted Observations
- Air-sea interaction:
  - Observations, comparisons, ocean simulations

10 articles in special issue
>25 articles in GFDex – see website
Comparison of model data and sonde data near Greenland

(a) Graph showing pressure (hPa) vs. temperature (°C) with lines indicating different data sets.

(b) Graph showing pressure (hPa) vs. windspeed (m/s) with lines indicating different data sets labeled NW, SE, and SONDE.

Map inset showing geographic locations with labels NW and SE.
Potential solution: Reject sonde data below 850hPa?

Green line shows an increase in forecast improvement when dropsondes near Greenland have data below 850hPa rejected