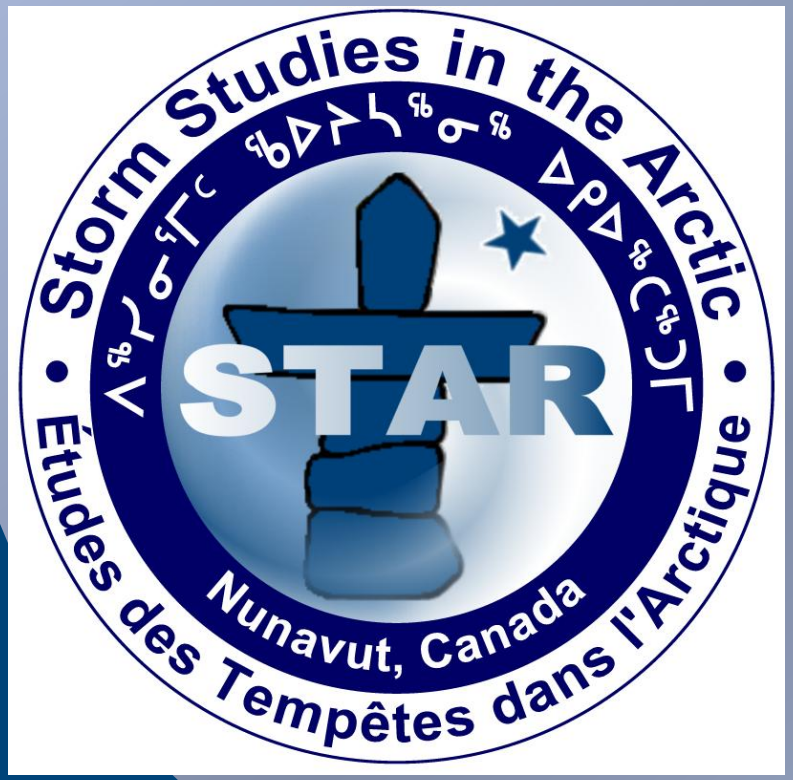
The Storm Studies in the Arctic (STAR) Project



CFCAS Network

John Hanesiak, Ronald Stewart, David Barber, Dylan Jones, Gordon McBean, Peter Taylor, Walter Strapp, Mengistu Wolde

Final STAR Workshop

Winnipeg, MB, June 14-15, 2010

www.starnetwork.ca

Outline

- STAR Team
- STAR Objectives
- STAR History and Future Timelines
- STAR Themes & Research thus far
- Data Management
- STAR Major Outcomes
- What's to Come?
- Beyond STAR
- Purpose of this Workshop
- Acknowledgements

What is STAR?

- Network of:
  - 6 investigators based at 4 universities
  - 8 collaborators from 5 divisions of Environment Canada and National Research Council
  - Data Manager, Network Manager, PDFs, Students
- Northern Partners NRI/NAC, INAC, Qulliq Energy, Nunavut Department of Education

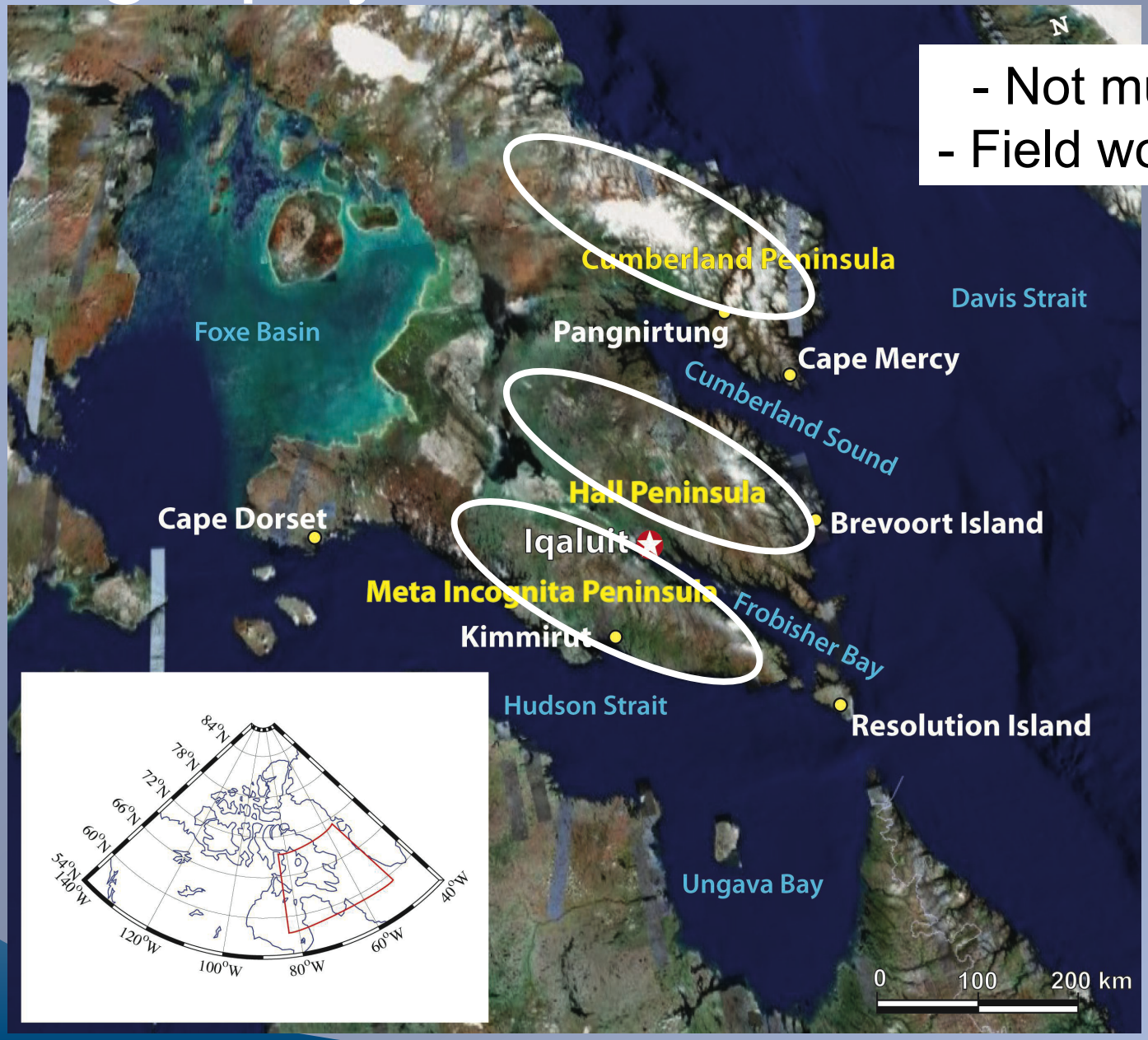
Objective

- To better understand severe Arctic storms and their associated hazardous conditions, and contribute to their better prediction
  - Realized through 4 main themes
    - Local Iqaluit area
    - Regional weather and sea ice
    - Modeling and Prediction
    - Community interactions
  - Strong winds, precipitation, blowing snow / low visibility, sea ice
- Main activity - major field deployment on S. Baffin Island Oct - Nov 2007 and Feb 2008

TIMELINE OF STAR (history)

2004	Spring	Call for new Network LOIs by CFCAS
	Jun	Initial LOI submitted to CFCAS
	Jly	LOI accepted by CFCAS
2004-05		
	Aug-Mar	Proposal Development
	Apr / 05	Proposal submission
	Jun / 05	Proposal Defense
	Dec / 05	STAR Proposal formally accepted
2006		
	Apr	STAR officially begins
	Nov 17	First STAR workshop
2007		
	spring/summer	purchase of equipment / mesonet plans
	Sep	Installation of radar, mesonet, wx office and other equipment
	Oct 10 - Nov 30	Field project
2008		
	Feb	Blowing snow project
		CFCAS Supplement proposal
	Apr	Dismantling of mesonet
	summer	CFCAS supplement awarded
	Nov 3-4	2nd STAR workshop (Toronto)
2009		
	spring/summer	BAMS article development ; CMOS special session
	fall	Bob/Teresa Iqaluit visit
	winter	BAMS article accepted
2010		
	spring	Teresa North Bay FSS visit / special CMOS session
	summer	Final Workshop

Geography



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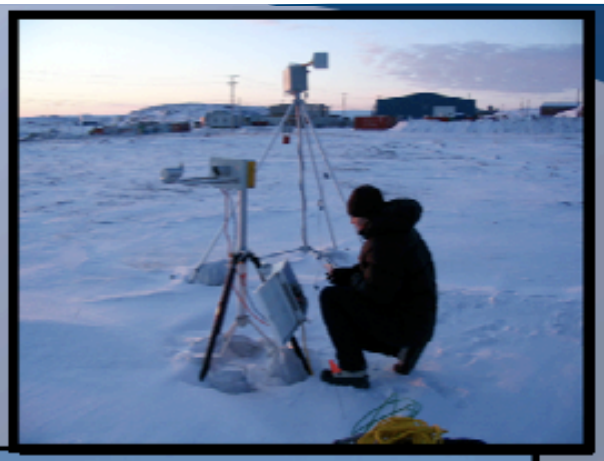
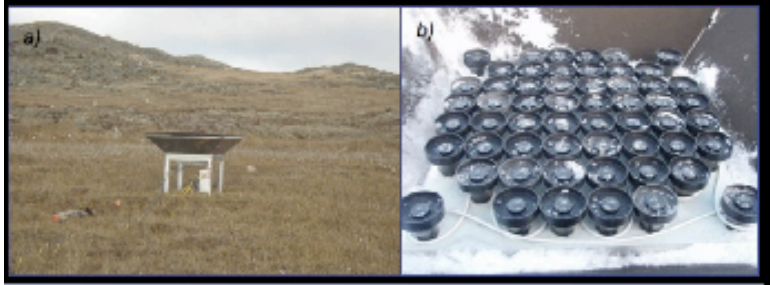
Overview of Field Accomplishments

- No major field deployment issues !
  - Dave Hudak, John Scott, Jim Young, Steve Brady
  - Wiz Mohammed, Jamal Shirley, Mary-Ellen Thomas, NRI, INAC (Jim Rogers, Andrea Cull)
  - Dave Sills for mesonet
  - NRC and EC aircraft crews
- Successful field campaign !

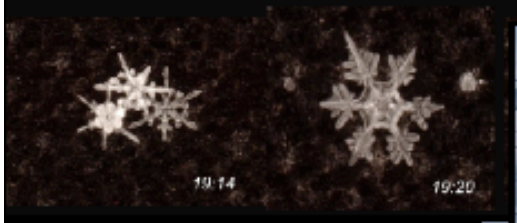
Phenomena / Purpose	Observations
Low Pressure System	7
Trough	3
Precipitation in YFB	9
Precipitation in XVP	3
Strong Winds/BS	2
Upslope Precipitation	5
Convergence Zone	2
Convection over Ocean	1
Rain/Snow Boundary	1
CloudSat	8

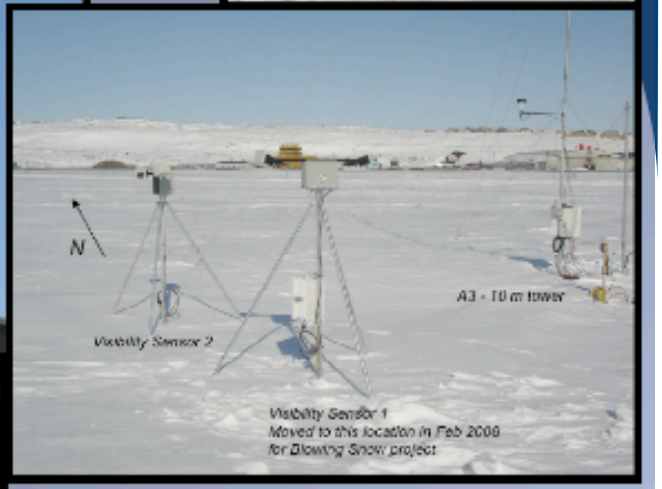
IOP	Start (UTC)	End (UTC)	# YFB sondes	Aircraft Flight	# Dropsondes
1	15 Oct 2100	17 Oct 1800	8		
2	20 Oct 1800	21 Oct 0000	2		
3	26 Oct 0600	27 Oct 0600	7		
4	29 Oct 1200	30 Oct 1800	3		
5	3 Nov 1200	4 Nov 1200	4 (2 in XVP)		
6	5 Nov 1600	6 Nov 0000	7 (4 in XVP)	yes	4
7	6 Nov 0000	7 Nov 0000	1	yes	
8	7 Nov 2100	8 Nov 0700	3	yes	13
9	9 Nov 2100	10 Nov 0200	1	yes	6
10	11 Nov 2100	12 Nov 1600	5	yes	6
11	16 Nov 1900	19 Nov 0000	23 (12 at XVP)	yes (3 flights)	16
12	20 Nov 1530	20 Nov 2230		yes (2 flights)	
13	22 Nov 1600	22 Nov 1900		yes	
14	23 Nov 1600	23 Nov 2000		yes	4
15	28 Nov 1500	28 Nov 1830		yes	5
16	28 Nov 1500	29 Nov 0000	3	yes	1

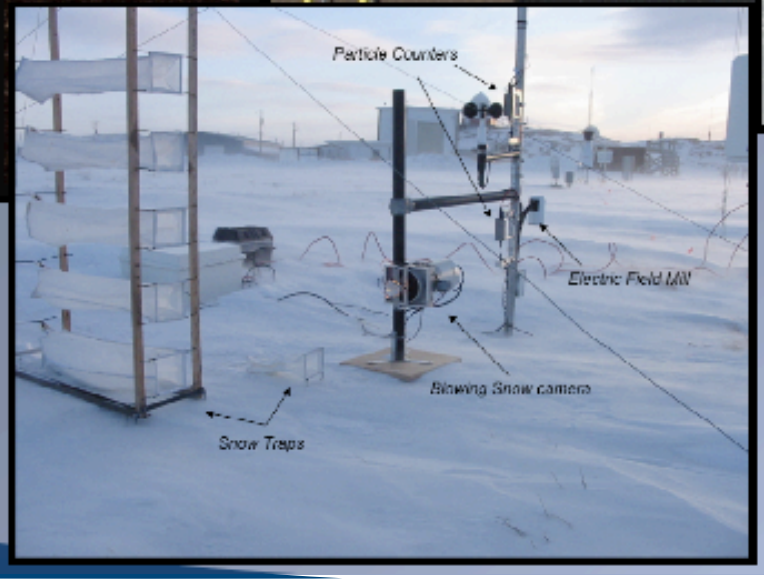


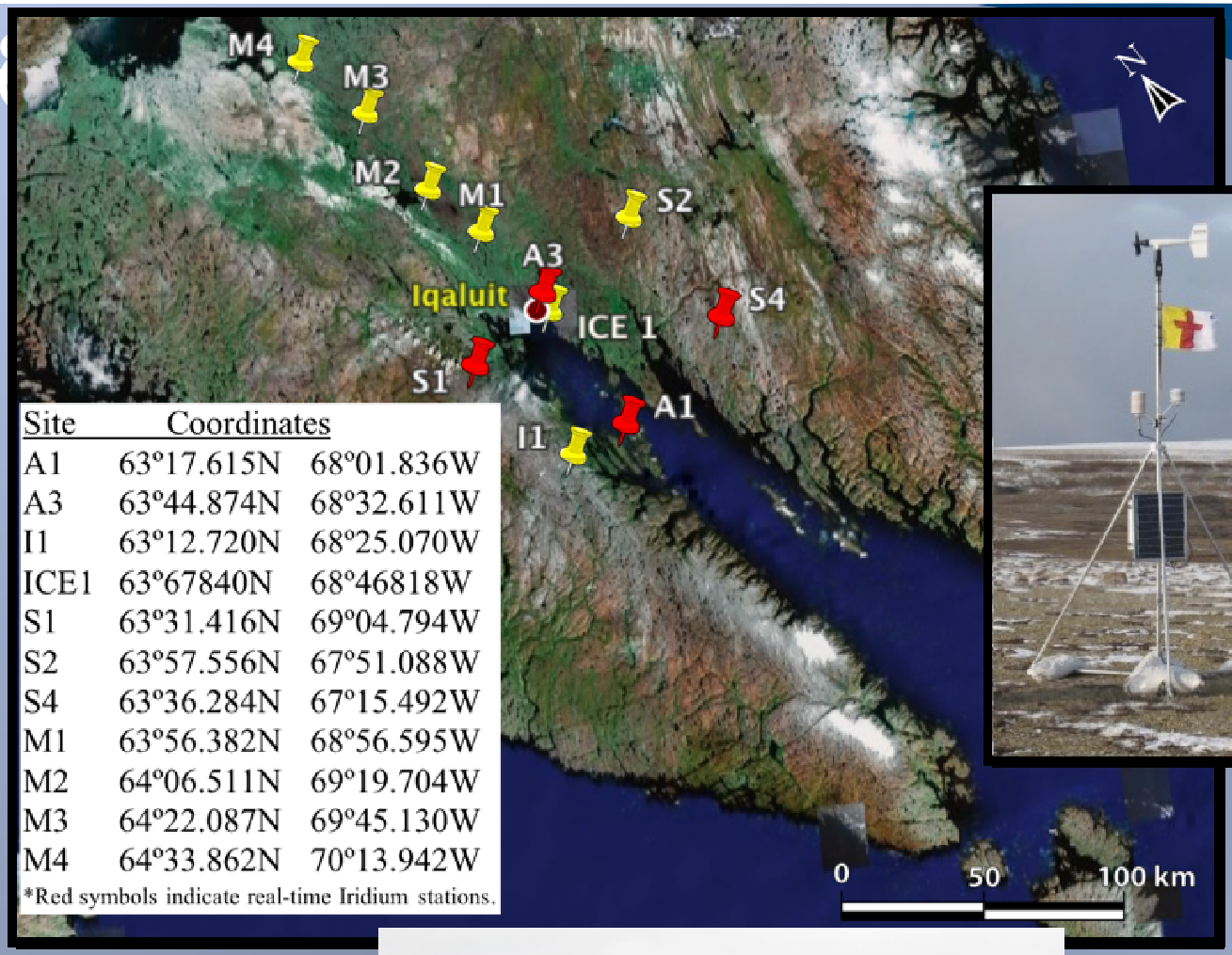


Snowflake Microphotography Iqaluit, NU: November 6, 2007







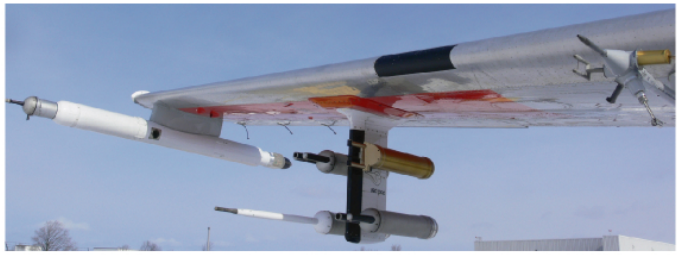


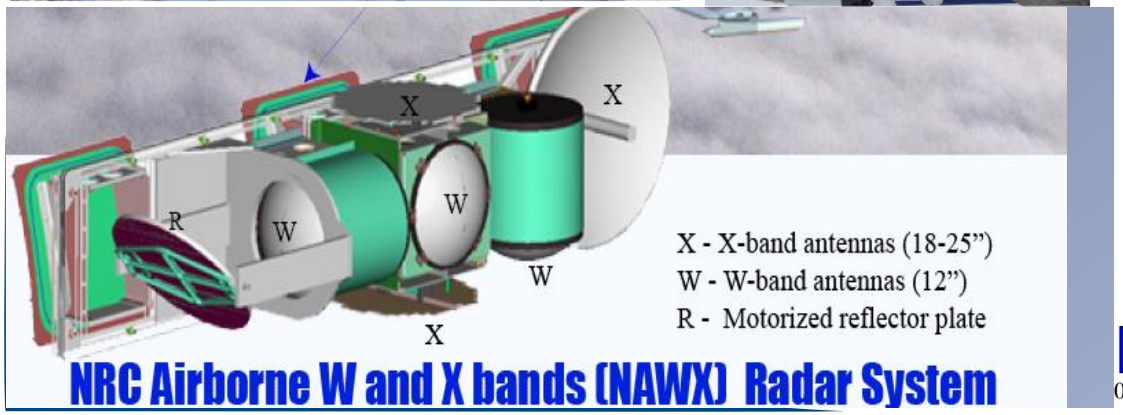
Site	Coordinates	
A1	63°17.615N	68°01.836W
A3	63°44.874N	68°32.611W
I1	63°12.720N	68°25.070W
ICE1	63°67840N	68°46818W
S1	63°31.416N	69°04.794W
S2	63°57.556N	67°51.088W
S4	63°36.284N	67°15.492W
M1	63°56.382N	68°56.595W
M2	64°06.511N	69°19.704W
M3	64°22.087N	69°45.130W
M4	64°33.862N	70°13.942W

*Red symbols indicate real-time Iridium stations.

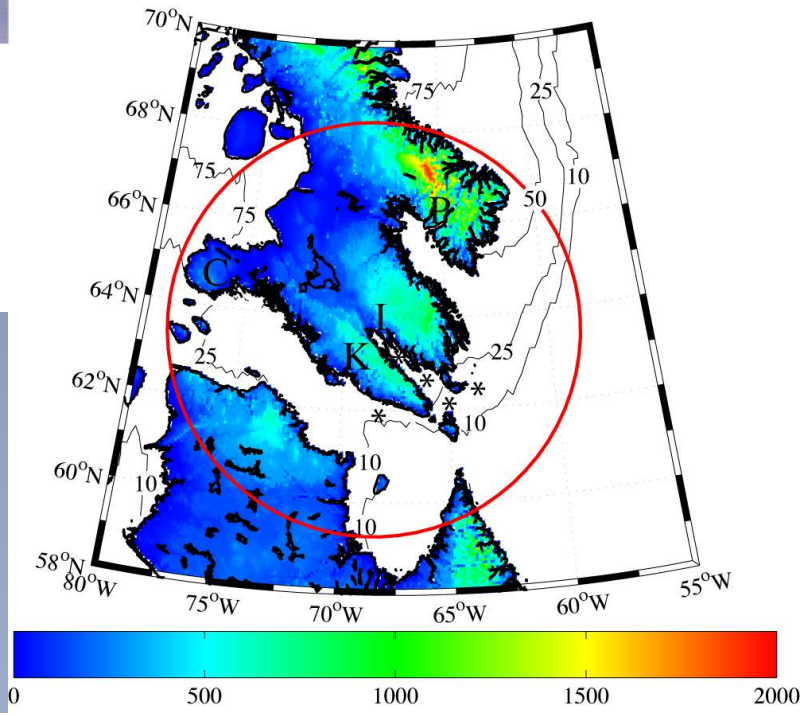
Research Aircraft (NRC Convair-580)

- 3 types of radars looking in various directions
- dropsondes

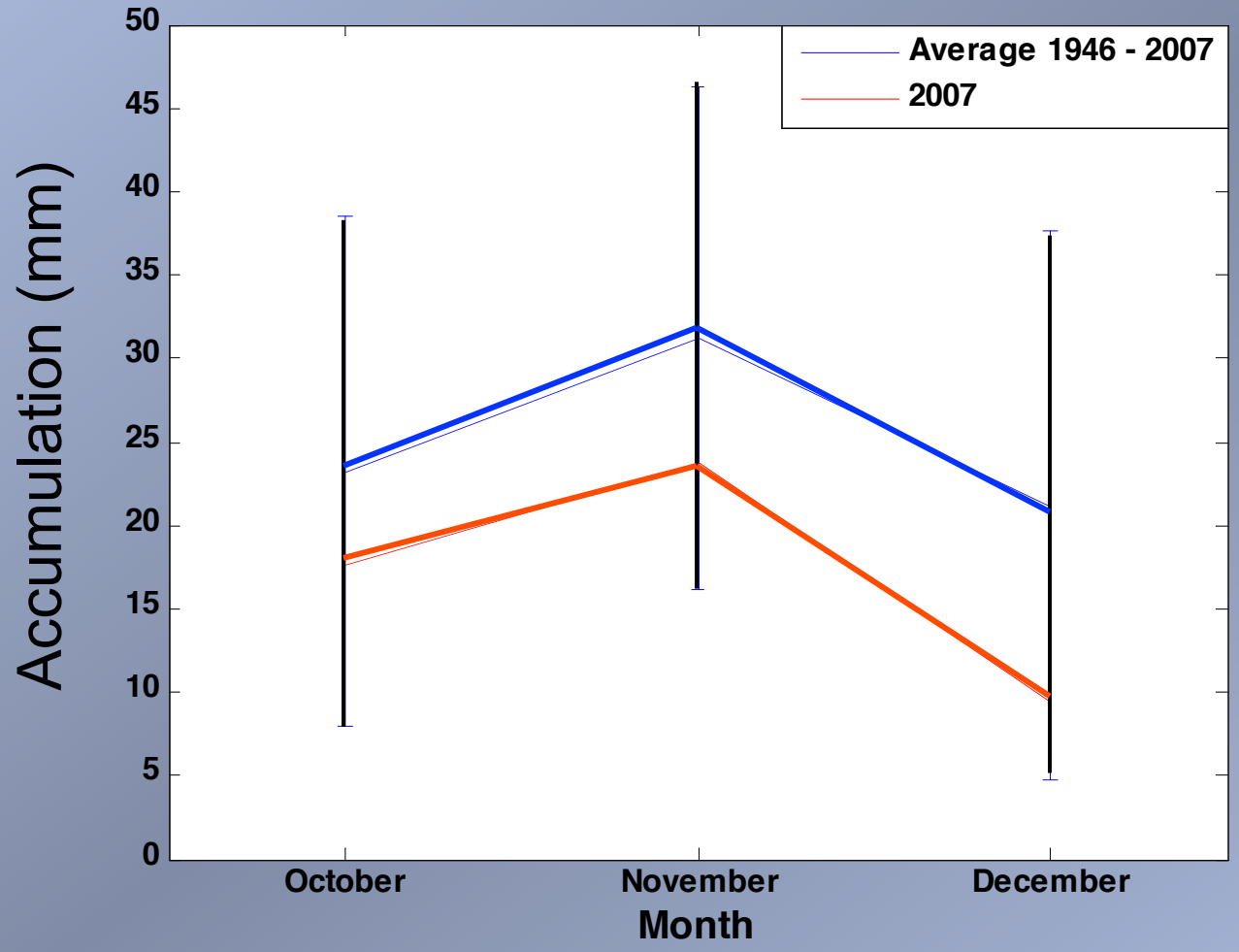




NRC Airborne W and X bands (NAWX) Radar System

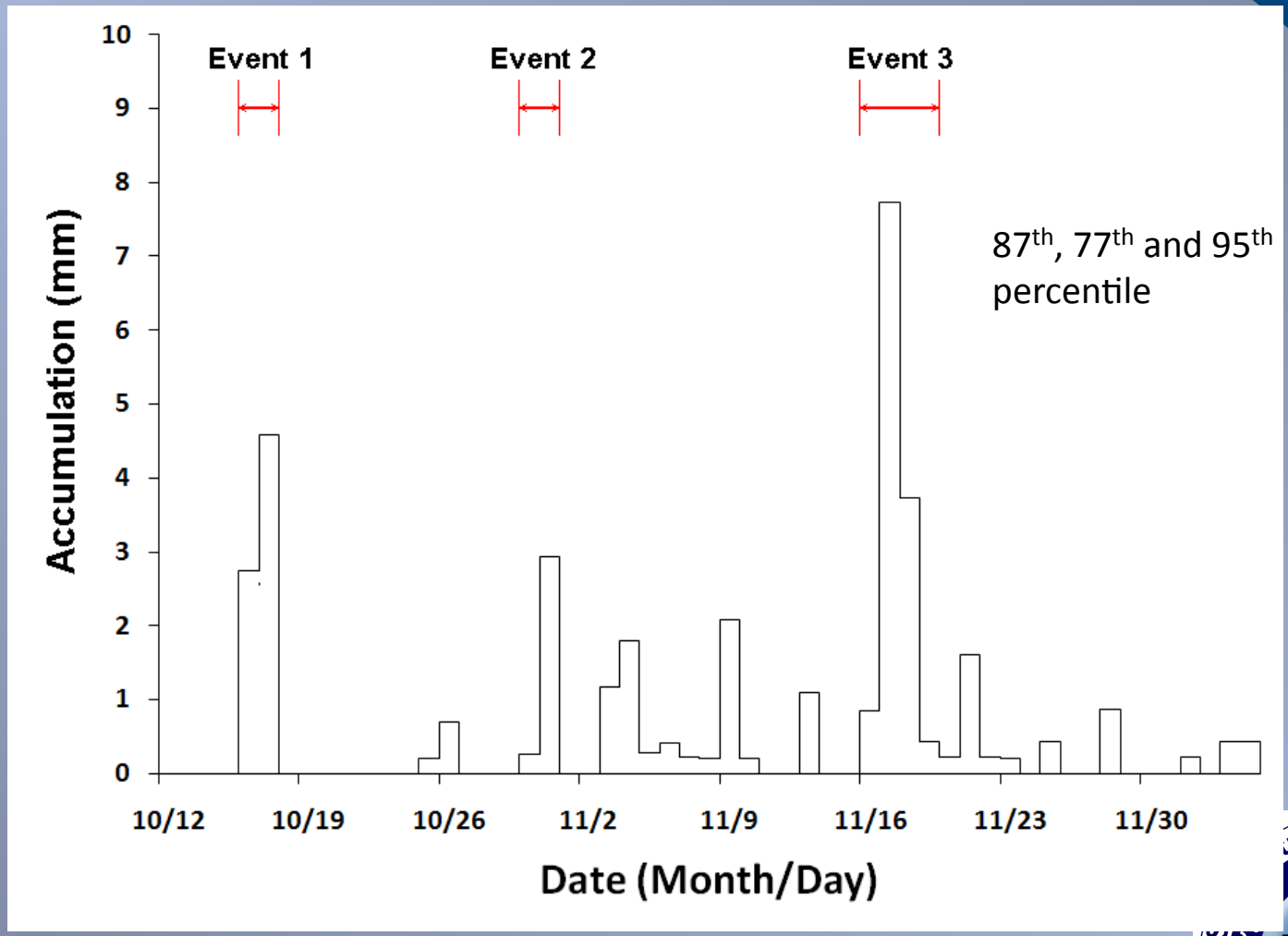


STAR Period in Context (Precipitation)



Slightly fewer / less intense storms than “normal”

Iqaluit Events During STAR



All precipitation was solid phase

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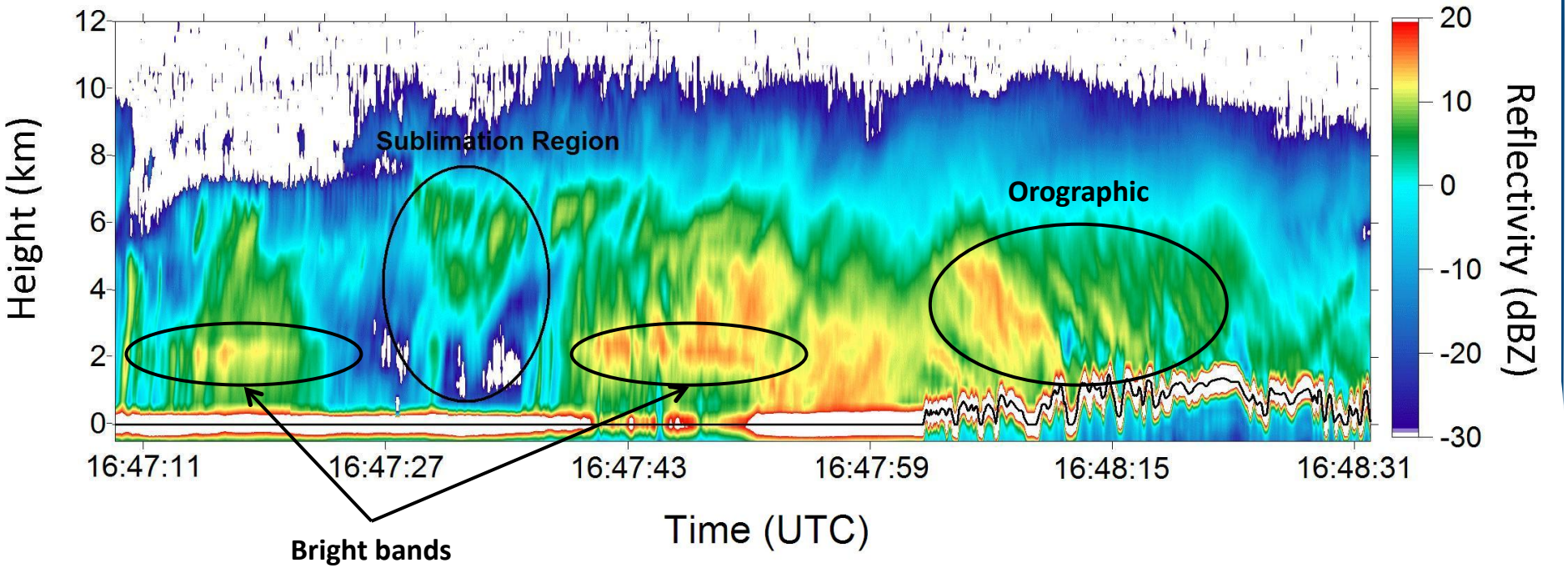
Theme 1 (Iqaluit and CloudSat)

- Blowing Snow - detailed characteristics (Biswas/ Gordon)
  - Gordon et al. 2010: Measurements of Drifting and Blowing Snow at Iqaluit, Nunavut, Canada during the STAR Project, A-O, 48, doi:10.3137/AO1105.2010
- Precipitation Characteristics (LaPlante/Henson)
  - Radar signatures/features
  - Forcing mechanisms, particle types, amounts, cloud structures, thermodynamics …
  - Critical for operational forecasting and modeling
  - Henson, W., R. Stewart and D, Hudak, 2010: Vertical reflectivity profiles of precipitation over Iqaluit, Nunavut during autumn 2007, Atmospheric Research (Conditionally Accepted)
- CloudSat (LaPlante/Henson)
  - Laplante, A., R.E. Stewart and W. Henson, 2010: Characterization of cloud and precipitation features over southern Baffin Island and nearby regions using satellite information. Atmos.-Ocean (To Be Submitted)

Precipitation features during STAR



- Sublimation, orographic/convective precipitation were all important processes
- Bright bands observed - some cases matched GEM
- Other major storms events during STAR have exhibited regions of sublimation at various points within the storm structure

Laplante et al.

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Theme 2 (Regional Weather & Sea Ice)

- Sea ice trends (Hocheim)
- Mesonet analysis (Albarran-Melzer)
  - First ever look at regional variations within Frobisher Bay
  - Important for terrain influences for forecasting and future modeling
- Convective processes over the ocean (Hanesiak)
  - Importance for precipitation forecasting inland
- Upslope precipitation processes (Fargey)
  - Major influence on precipitation - very little measurements
  - Models show this occurring frequently
- Major systems (Martin/Henson/Zhang)
  - Warm front
  - Evolution of storms - model comparisons to observations
  - Henson, W., R. Stewart and M. Wolde, 2010: The structure of a severe Arctic storm. J. Geoph. Res. (To Be Submitted)

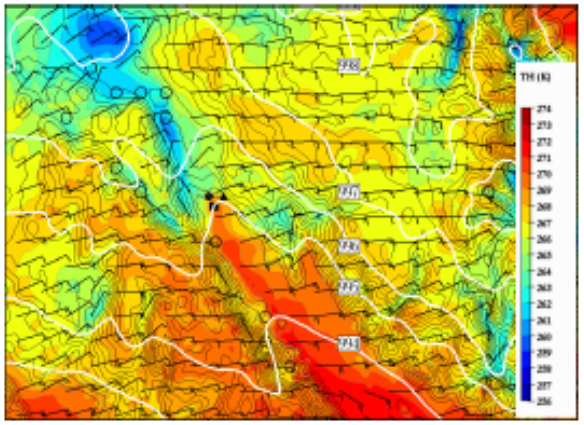
Theme 3 (Modeling & Prediction)

- Prediction skill (McBean)
- Mid-latitude to polar transition of remnant hurricane (Zhang)
- Major mid-latitude to polar transition storm (Zhang)
- Added value of high-resolution modeling (Goodson)
- Strong wind events in Frobisher Bay
  - Deacu, Zadra, Hanesiak. 2010: Simulating Wind Channeling over Frobisher Bay and its Interaction with Downslope Winds during the 7-8 November 2006 Wind Event, (in press) A-O
  - Examination of other events to see why Iqaluit experiences these winds in some cases while not in others (Martin et al.)

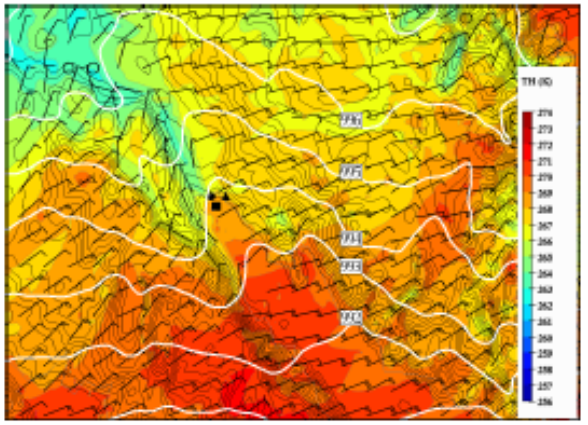
Strong Winds

Simulating wind channeling over Frobisher Bay and its interaction with downslope winds
(Deacu et al. in press)

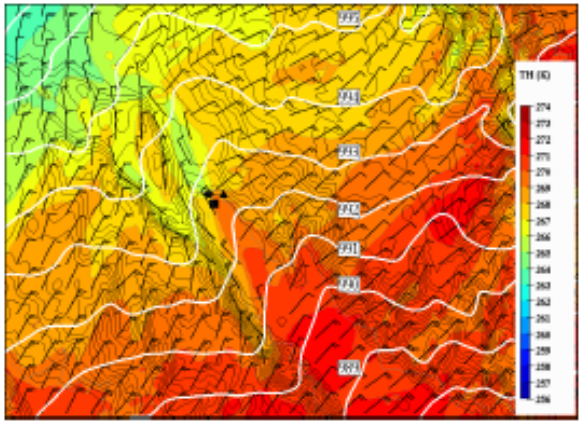
Why does YFB see strong winds in some cases and not in others?



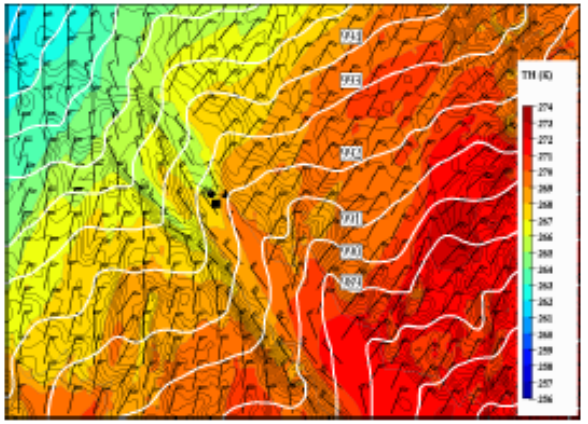
(a) 1200 UTC



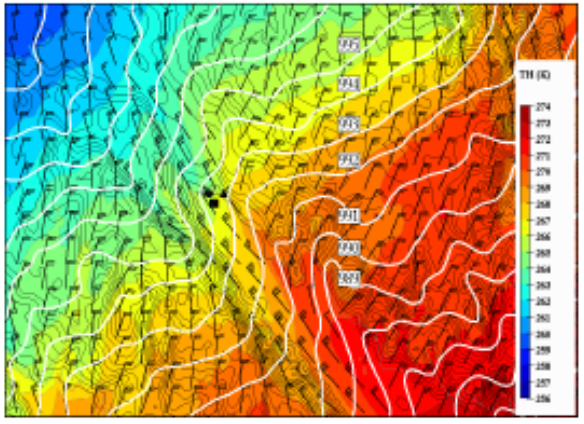
(b) 1500 UTC



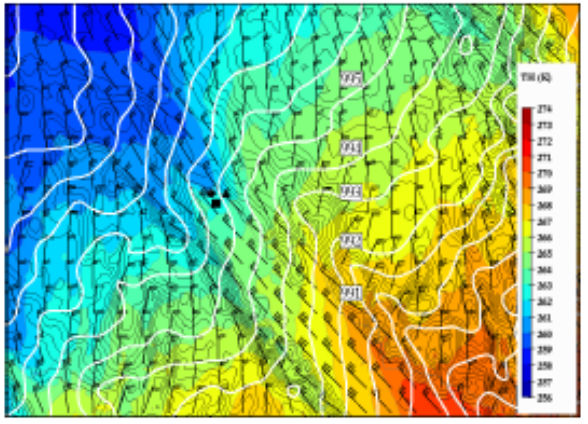
(c) 1800 UTC



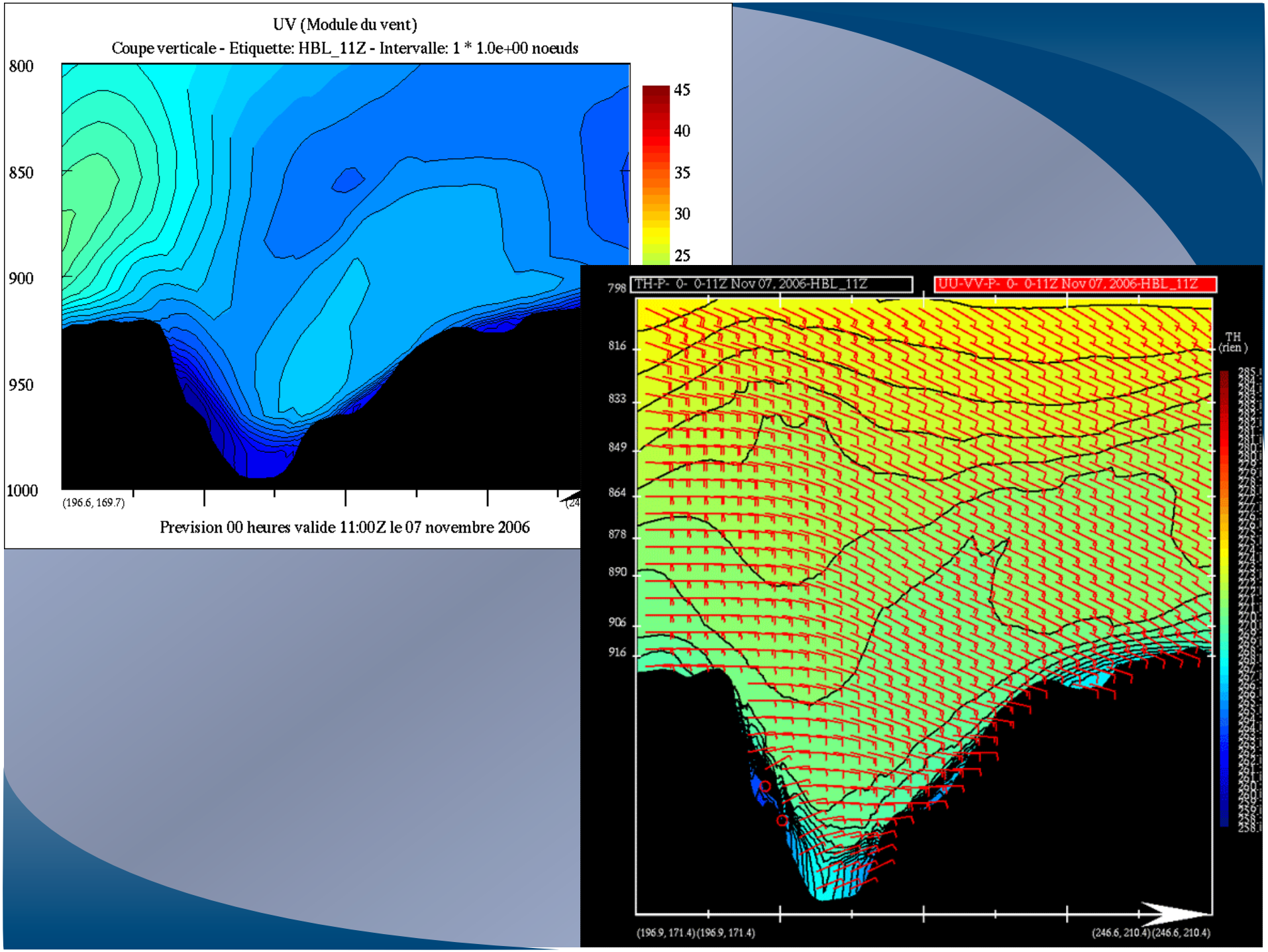
(d) 2100 UTC



(e) 0000 UTC (+1d)



(f) 0300 UTC (+1d)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(246.6, 210.4)(246.6, 210.4)

Theme 4 (Communities & Users)

- Understand how communities adapt to atmospheric-related hazards as well as how they produce, interpret and utilize predictions of such hazards (McBean, Folliot & Spinney)

- Community interactions
  - Weather office visit by NRI students
  - public talk at local Iqaluit museum
  - Visit to Pang students
  - NRI students data collection
  - Assisted with HTO interviews
  - NavCan FSS visits
  - Final Iqaluit visit with summary document
  - Creation of educational materials

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Theme 4

RESEARCH QUESTIONS

1. What are some common types of hazardous weather and other weather-related hazards in Iqaluit?
2. In terms of local weather knowledge, what do residents use to 'read', 'predict' weather and oncoming hazards?
3. How do residents acquire these skills?
4. What is the reliability of these cues today?
5. Who uses these cues?
6. How do residents incorporate their own ways of knowing the weather with the 'scientific' weather forecast?
7. Who incorporates the two systems of knowing?
8. What aspects of the 'scientific' weather forecast do residents use most, rely on, trust?
9. How can weather information be improved for use in the community?

McBean and Folliott

STAR and SILA – Where Outreach REALLY meets Education!

Who or what is SILA?

- New grade 12 Env. Sci. course being developed by the Nunavut Dept. of Ed.
- Focused on the Atmosphere and therefore unique in Canada
- STAR has committed to help the development of SILA

How does STAR benefit from SILA?

1. Dedicated audience of influential people in the STAR study area
2. Curriculum guaranteed to be used for 10 years +
3. Focused and deliverable product based on a 'User Needs' approach

Hodgson et al.

How does SILA benefit from STAR?

1. 'Free' additional support and contribution to the writing process
2. Sponsorship of teacher professional development
3. Access to input from leading scientists

Data Management

- Critical for Network
- It has:
  - enhanced our research efficiency and capability,
  - allowed for more interactions,
  - served as one legacy of our efforts
- Facilitated by Data Manager (George Liu)
- Long-term data archival at NCAR - Steve Williams

STAR Outcomes

- Accomplished what we intended - lots of data for further analysis !
- First field expedition in this region of its kind
- Unique dataset
- Multi-dimensional (link meteorology, topography, sea ice, fiords, communities)
- Contribute to prediction capabilities
- Other Legacy (educational materials)
- First CloudSat validation in the Arctic

STORM STUDIES IN THE ARCTIC (STAR)

BY JOHN HANESIAK, RONALD STEWART, PETER TAYLOR, KENT MOORE, DAVID BARBER, GORDON MCBEAN, WALTER STRAPP, MENGISTU WOLDE, RON GOODSON, EDWARD HUDSON, DAVID HUDAK, JOHN SCOTT, GEORGE LIU, JUSTIN GILLIGAN, SUMITA BISWAS, DANIELLE DESJARDINS, ROBYN DYCK, SHANNON FARGEY, ROBERT FIELD, GABRIELLE GASCON, MARK GORDON, HEATHER GREENE, CARLING HAY, WILLIAM HENSON, KLAUS HOCHHEIM, ALEX LAPLANTE, REBEKAH MARTIN, MARNA ALBARRAN MELZER, AND SHUNLI ZHANG

With 14 research flights from Baffin Island, surface- and satellite-based instruments, STAR aims to improve understanding and prediction of severe arctic storms and their hazards

Storms and their related hazards over the Arctic have profound effects, including loss of life and influences on industry, transportation, hunting, recreation, and the landscape itself (terrestrial, sea ice, and ocean). Over the past few decades, there has been evidence that the occurrence of extreme storms has increased (Stone et al. 2000; McCabe et al. 2001; Zhang et al. 2004) as well as their associated hazardous weather in some regions (Hanesiak and Wang 2005). Extreme weather directly affects the lives of communities and individuals living in the Canadian Arctic (e.g. NTI 2001; Hassol 2004). According to the *Nunatsiaq News* (5 April 2005), "erratic weather and changing ice patterns are leaving more Nunavik hunters stranded out on the land without traditional techniques to help them."

There are several recent examples of extreme weather events that have occurred in the southeast Arctic alone. In February 2006, warm temperatures (>5°C compared to a normal of −20°C) and rain showers occurred in association with an intense cyclone across south Baffin Island, breaking records in the Nunavut Territory. Icy conditions on runways grounded aircraft in Iqaluit (the capital city of Nunavut, with a population of more than 10,000) and 125 km h^{-1} winds destroyed one building and broke windows in Pangnirtung, Nunavut (*Nunatsiaq News*, 3 March 2006, and *CBC*, 28 February 2006). Another recent storm (7–8 June 2008) produced ▶

Ground blowing snow event during STAR at the primary meteorological installation in Iqaluit, Nunavut, Canada. (Photo: Peter Taylor)

BAMS Article
January 2010 issue

2010 BAMS, 91, 47-68

At the end of STAR we expect to say that:

- “We have greatly increased our understanding of Arctic storms through a major field experiment, modeling studies and data analysis focusing on southern Baffin Island and we have applied this to prediction.”

- “We have left a legacy of comprehensive datasets, improved observational and modeling techniques, a new generation of Arctic scientists, and have provided northern communities better information about these storms.”

What's to Come?

- All science completed by December 2010
- Complete articles
- Create public document
  - Format?
- Final Iqaluit visit
  - When and scope?
- Final CFCAS report

Purpose of Workshop

Day 1 and 2

- Highlight Research Done To Date

Day 2

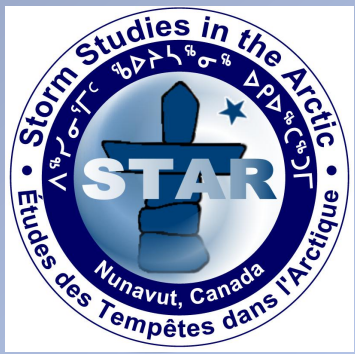
- What's Left to Do?
  - Develop task list
- Recommendations for Future Research
- Sci Comm and BoD meetings

Acknowledgements

- Mayor Sheutiapik, Mary-Ellen Thomas, Jennith Peart, Pascale Baillargeon

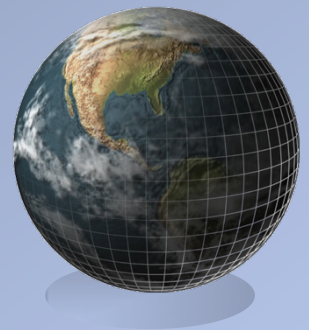
- BoD (Peter Johnson, Jamal Shirley, Gary Burke/Bob Kochtubajda)
- Teresa Fisico / Shannon Fargey - Network Managers
- George Liu - Data Manager

- CFCAS (Dawn, Tim, Erica, Colleen, Elianne, Kelly)
- NSERC
- CFI
- Environment Canada (monitoring, research, operations)
- NRC - Flight Research Lab
- Polar Continental Shelf Project
- NSTP
- QEC / INAC
- NRI / NAC
- Nunavut Department of Education
- Cities of Iqaluit and community of Pangnirtung



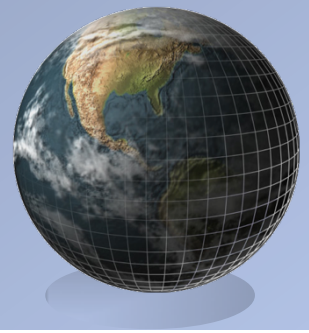
Day 2

- What's left to do?



Things to Do Collectively

- Work on Nov 17 case study
  - Shunli: WRF and GEM comparison to obs
  - William: continue with current analysis
  - Look at mesonet data of this case?
- Provide monthly wind roses from mesonet to PASPC
- ??



Beyond STAR?

- More analysis of strong wind events - targeted observations needed
  - STAR did not see “classic” NE wind events
- More targeted observations for upslope and convection processes - some things we would do differently !
- Data assimilation experiments
- PCW Satellite validation
- Sea ice sensitivities - modeling and observations