Determining Forecast Skill in a Numerical Weather Model: Case Study – WRF NWP Results Compared Against the WBEA Air Monitoring Network

CPANS - Monitoring, Assessment and Management of Environmental Quality: Challenges and Opportunities

R. Chapman, D. Cherneski (RWDI)
M. Bundred (ESRD)

What is EAMAS?

RWDI
CONSULTING ENGINEERS & SCIENTISTS

Architecture Review

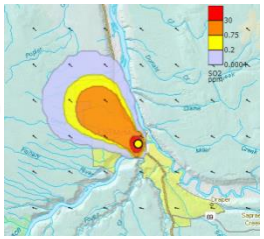
Sources:
Industry high risk sources - tanks, vessels, piping.
Industry Inputs Data

Meteorology:
WBEA Stations & NCEP Forecast

Processing
(Forecast and Dispersion Modelling H/W at Oxbridge)

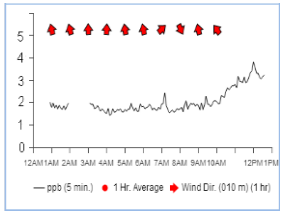
WBEA Station Analyzer Data

Secure EAMAS Website at Oxbridge



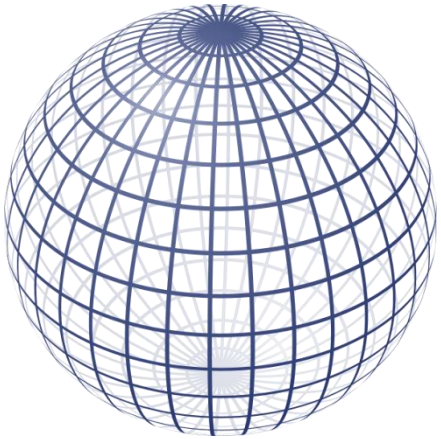
Assessment Team
(Industry, Municipality, **AER, ESRD** , etc)

GIS Web Services
For Mapping and Layers
at Service Alberta

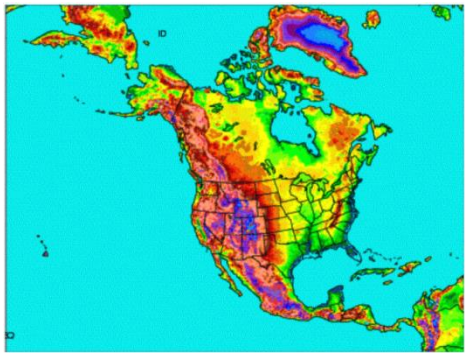


EAMAS Region

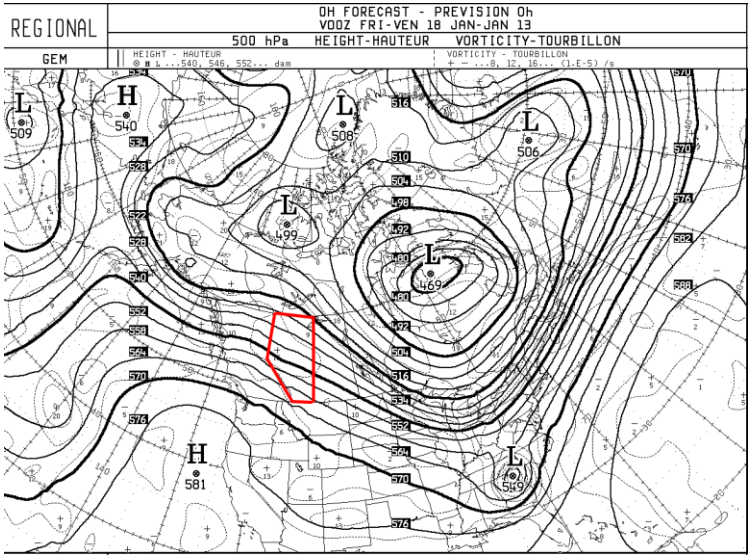
NCEP – North American Mesoscale System (NAM 12km)

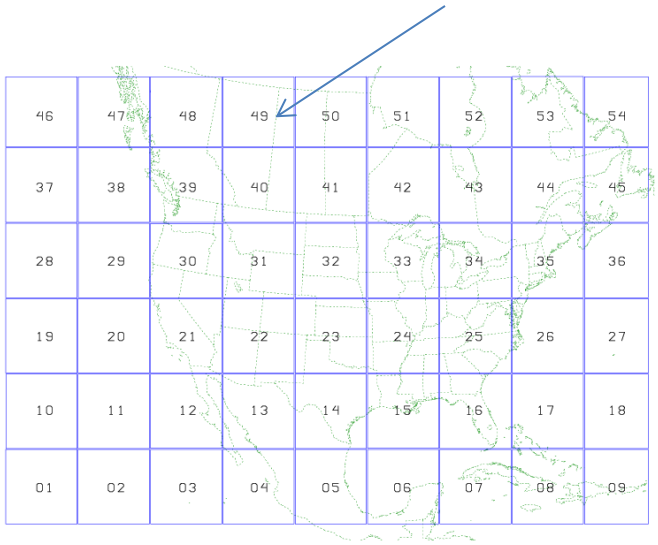


Global Forecast

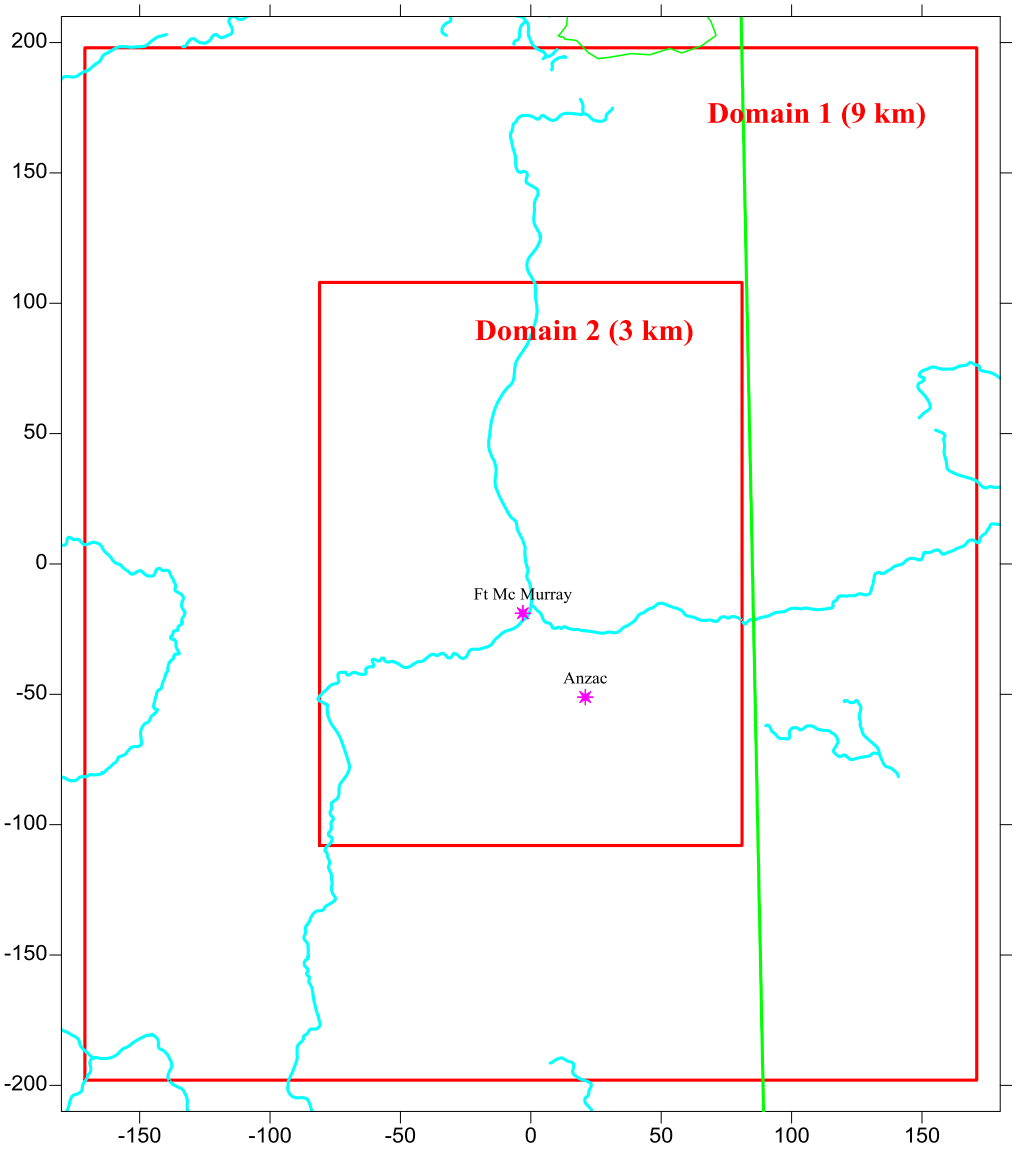


NAM 12km





EAMAS – WRF Modelling Domains



WRF Configuration Options

WRF Model Option	Option Selected
Microphysics	5 – Eta(Ferrier)
Long Wave Radiation	1 – RRTM
Short Wave Radiation	1 – RRTM
Surface-Layer Option	1 – Monin-Obukhov scheme
Land-Surface Option	2 – Unified NOAH land-surface model
Boundary Layer Scheme	1 - YSU scheme
Cumulus Option	1 – Kain-Fritsch for Domain 1 0 – None for Domain 2 (explicit convection)

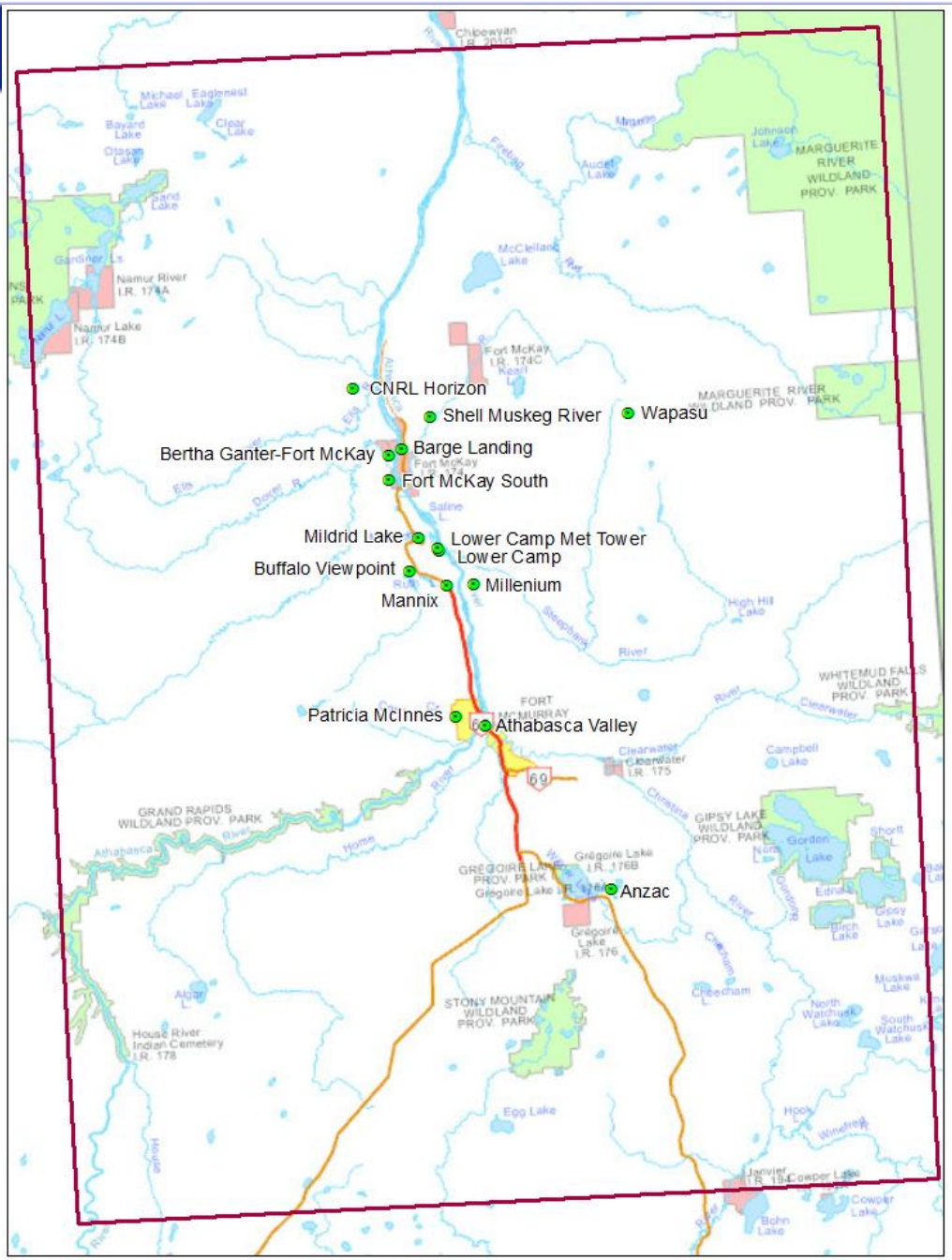
WBEA Monitoring Stations

Site ID	Description	Latitude	Longitude	Met instrument Height (m)	Air quality Compounds	Meteorological Variables
AMS 1	Ft. McKay	N 57°11.367'	W 111°38.427'	10 + 2m (T only)	SO_2, THC, NO, NO_2, NOx, NH_3, O_3, $PM_{2.5}$, VOC	Ws, Wd, T, RH
AMS 2	Mildred Lake	N 57°02.987'	W 111°33.829'	10 + 2m (T only)	SO_2, H_2S, THC	Ws, Wd, T
AMS 3	Lower Camp Met Tower	57°01' 54.9"	111°30' 23.8"	20, 45, 100, 167	-	Ws, Wd, T
AMS 4	Buffalo Viewpoint	N 56°59.790'	W 111°35.573'	10 + 2m (T only)	SO_2, H_2S, THC	Ws, Wd, T
AMS 5	Mannix	N 56°58.076'	W 111°28.918'	20, 45, 75,90 + 2m (T only)	SO_2, H_2S, THC, TRS	Ws, Wd,T
AMS 6	Patricia McInnes	N 56°45.081'	W 111°28.582'	10 + 2m (T only)	SO_2, THC, NO, NO_2, NOx, NH_3, O_3, $PM_{2.5}$, TRS	Ws, Wd, T
AMS 7	Athabasca Valley	N 56°43.961'	W 111°23.412'	10 + 2m (T only)	SO_2, THC, CO, NO, NO_2, NOx, O_3, $PM_{2.5}$, TRS	Ws, Wd, T, P
AMS 9	Barge Landing	N 57°11.894'	W 111°35.977'	10 + 2m (T only)	THC, TRS	Ws, Wd, T
AMS 11	Lower Camp	N 57°01.609'	W 111°30.050'	10 + 2m (T only)	SO_2, H_2S, THC	Ws, Wd, T
AMS 12	Millennium (NAD 83)	N 56°58.156'	W 111°24.039'	10 + 2m (T only)	SO_2, THC, NO, NO_2, NOx, $PM_{2.5}$, TRS	Ws, Wd, T
AMS 13	Syncrude UE-1	N 57°08.945'	W 111°38.557'	10 + 2m (T only)	SO_2, THC, NO, NO_2, NOx, O_3, $PM_{2.5}$, TRS	Ws, Wd, T
AMS 14	Anzac	N 56°26.957'	W 111°02.233'	20 + 2m (T only)	SO_2, THC, NO_2, NO, NOx, O_3, $PM_{2.5}$, TRS	Ws, Wd, T
AMS 15	CNRL Horizon	N 57°18.223'	W 111°44.377'	10 + 2m (T only)	SO_2, THC, NO_2, PM_{10}, $PM_{2.5}$, VOC, TRS	Ws, Wd, T
AMS 16	Shell Muskeg River	N 57°14.946'	W 111°30.514'	20 + 2m (T only)	SO_2, THC, NO, NO_2, NOx, $PM_{2.5}$,	Ws, Wd, T, P
AMS 17	Wapasu	N 57°14.302'	W 110°54.170'	10 + 2m (T only)	SO_2, H_2S, NO, NO_2, NOx, O_3, THC, $PM_{2.5}$, TRS	Ws, Wd, T, RH, P

Monitoring Stations

WOOD BUFFALO ENVIRONMENTAL ASSOCIATION
W B E A

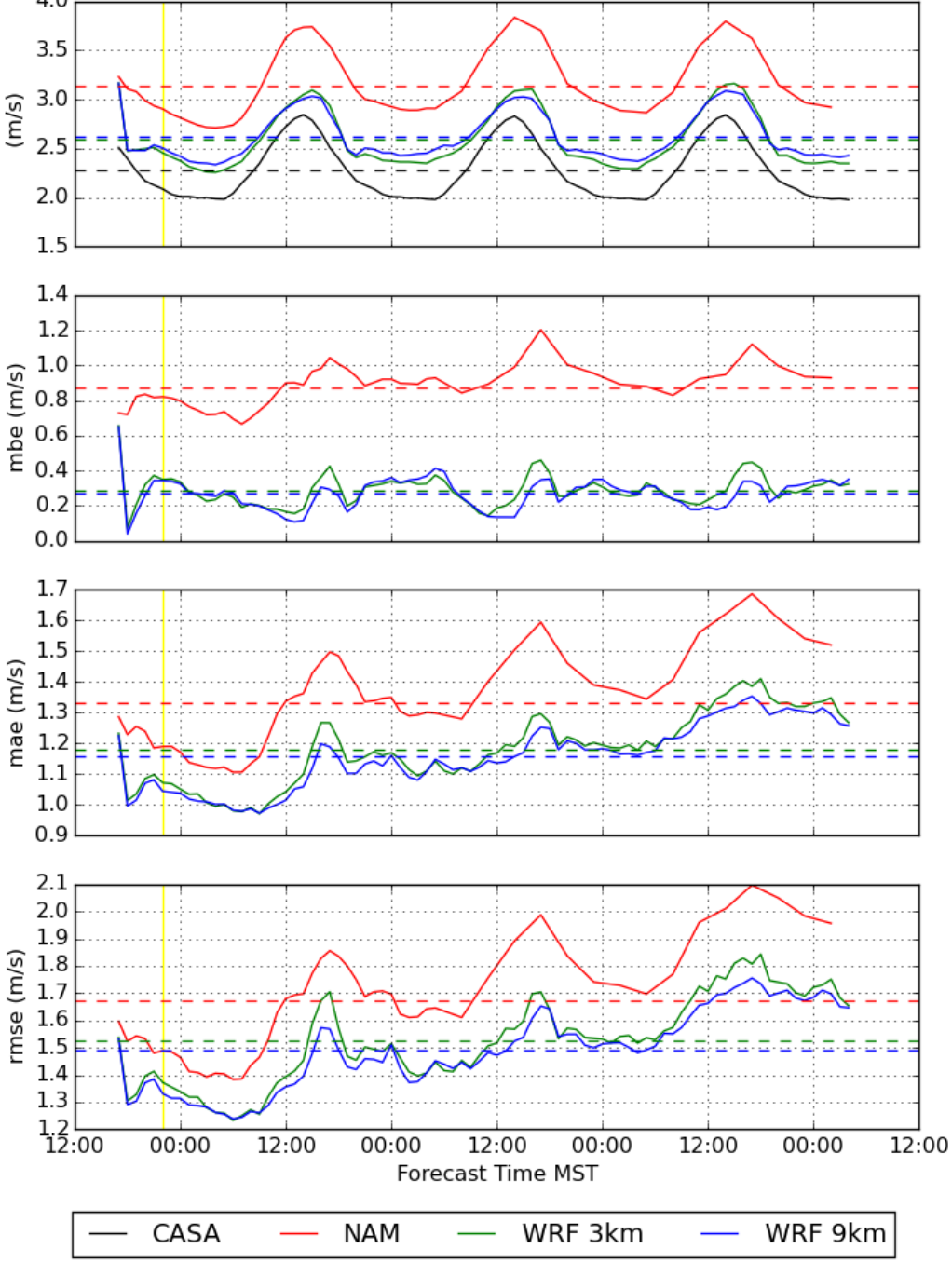
CASA
Clean Air Strategic Alliance
Data Warehouse



RWDI
CONSULTING ENGINEERS & SCIENTISTS

- Downloaded 1 year's worth of hourly data for 15 stations from CASA (Mar 1, 2013 to Feb 28, 2014)
- Downloaded daily NAM 12km 00Z (84 hours)
- Ran WRF with EAMAS production options
- WS, WD, T time series data were extracted for each 84 hour model run
- Comparisons were made against CASA data, NAM12, WRF 9, WRF 3
  - MAE, MBE, RMSE were calculated for monthly, seasonal and annual

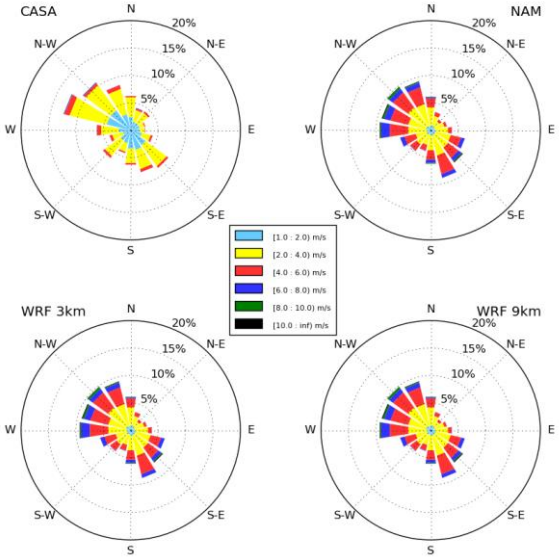
Wind Speed



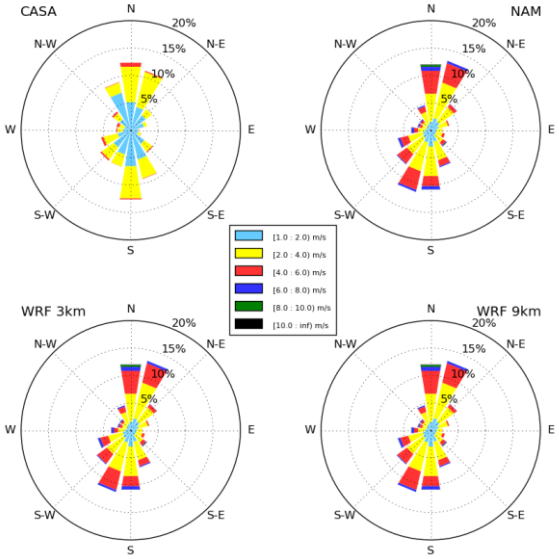
RWDI
CONSULTING ENGINEERS & SCIENTISTS

Wind Rose

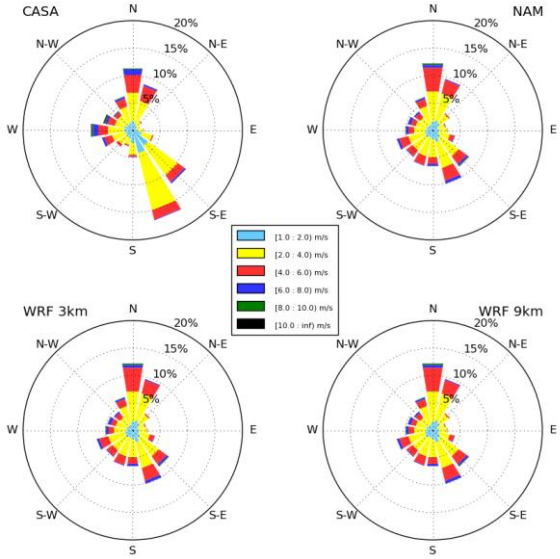
Anzac



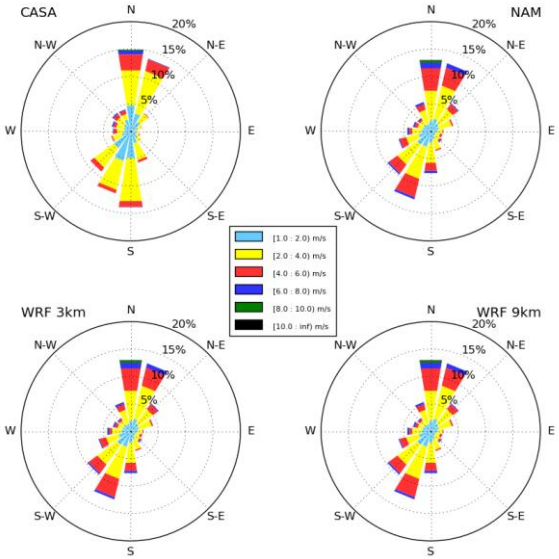
Barge Landing



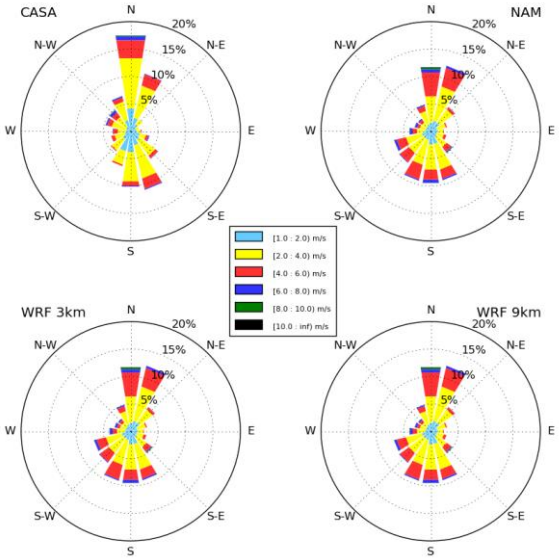
Mannix



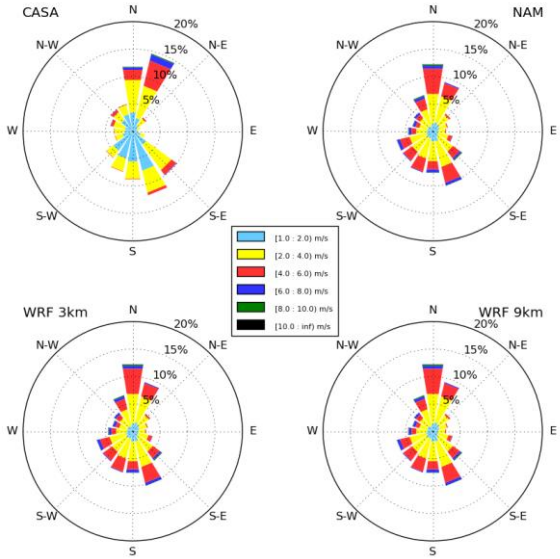
CNRL Horizon



Mildred Lake

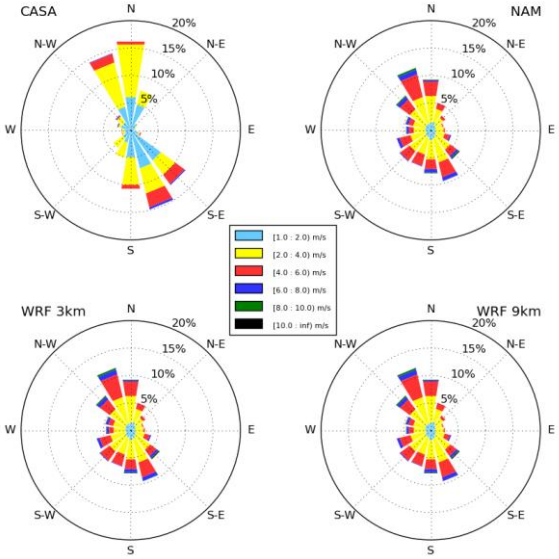


Millennium Mine

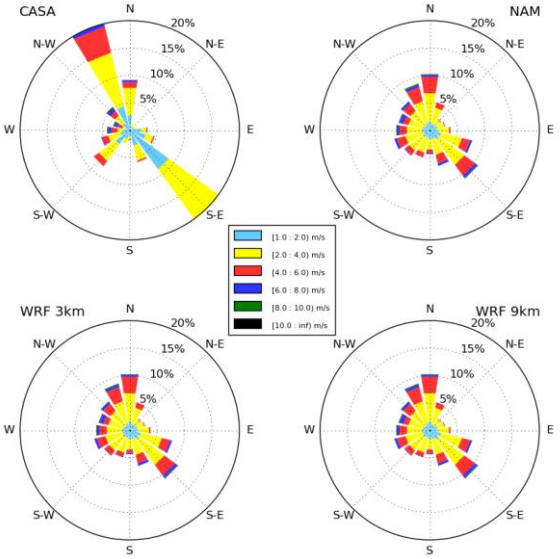


Wind Rose (cont)

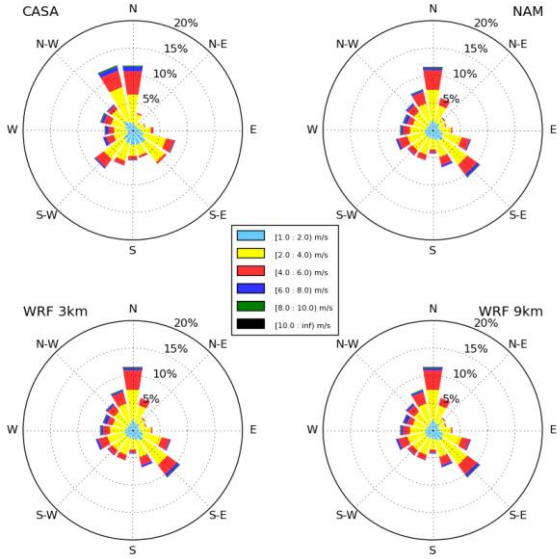
Wapasu



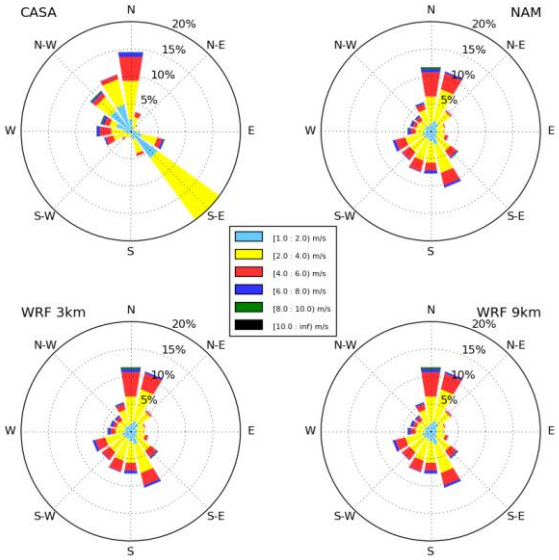
Athabasca Valley



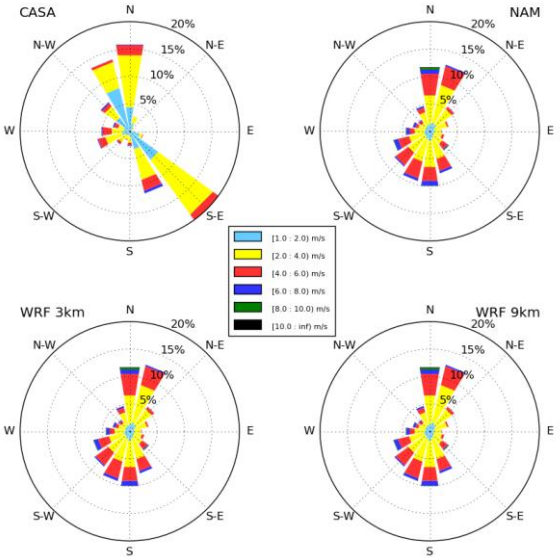
Patricia McInnes



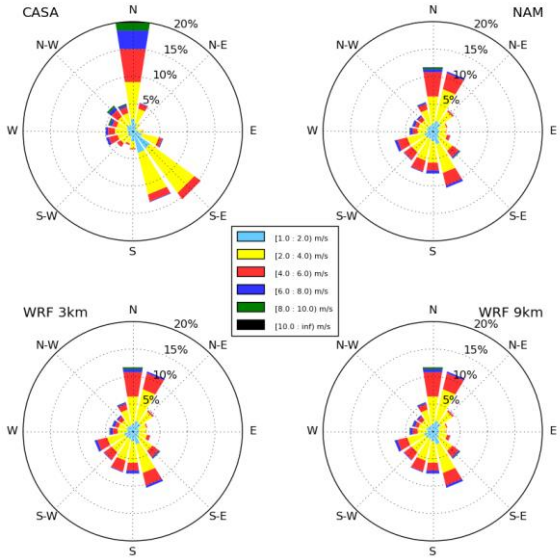
Lower Camp



Lower Camp (Met Tower)

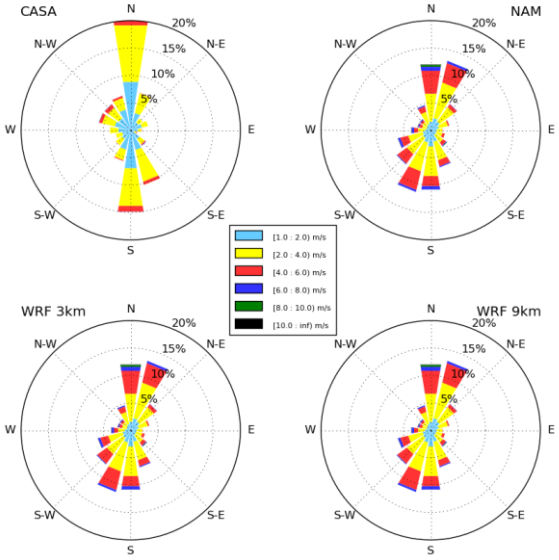


Buffalo Viewpoint

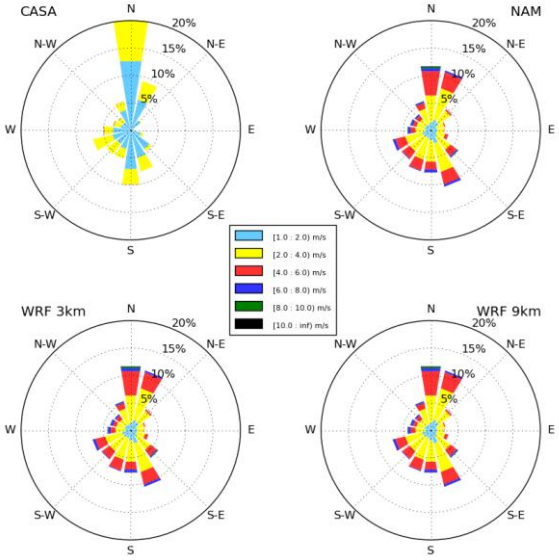


Wind Rose (cont)

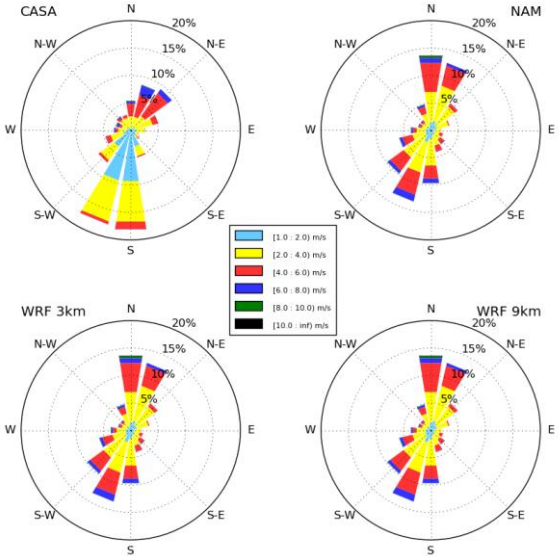
Bertha Ganther



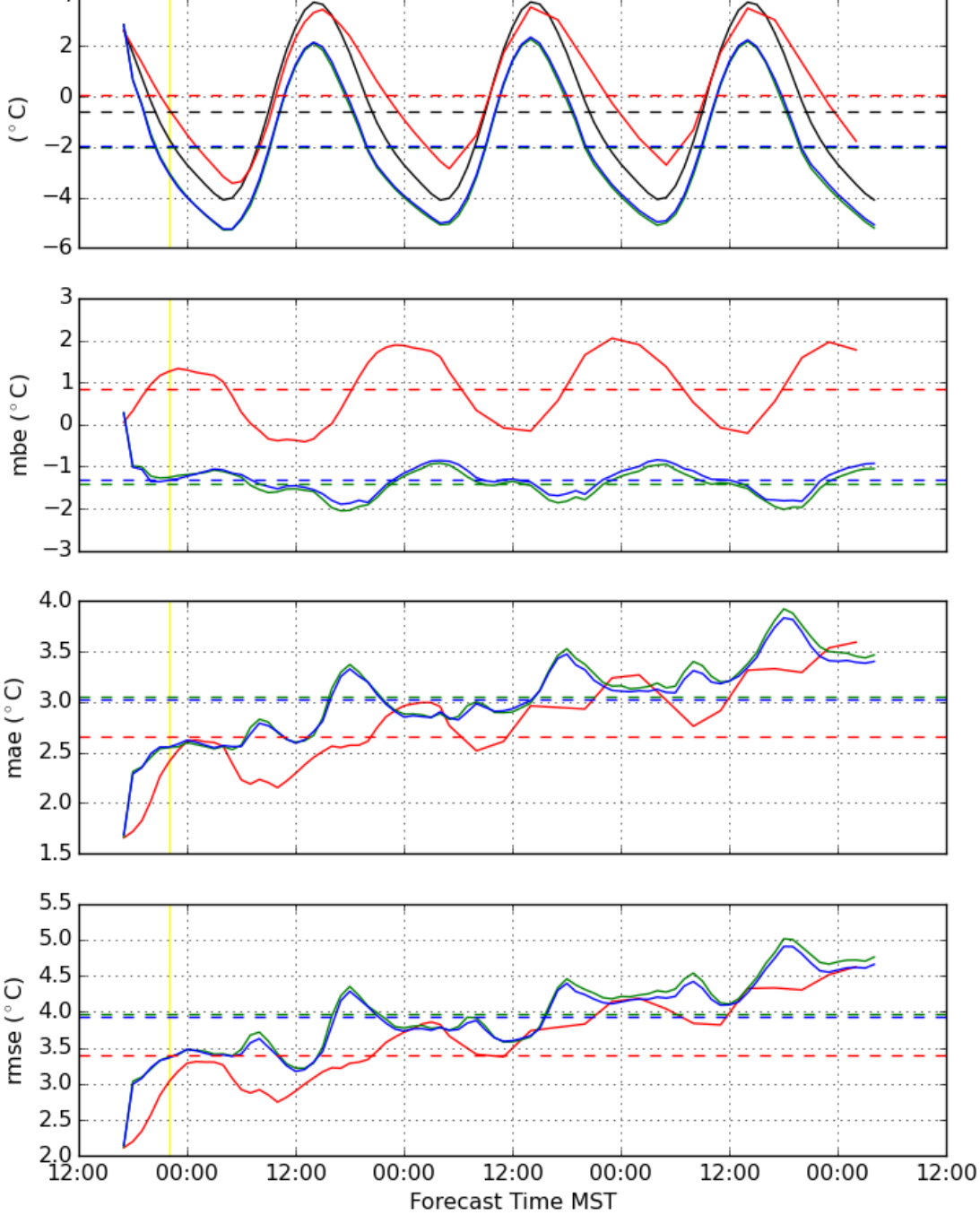
Fort McKay South



Muskeg River



Temperature

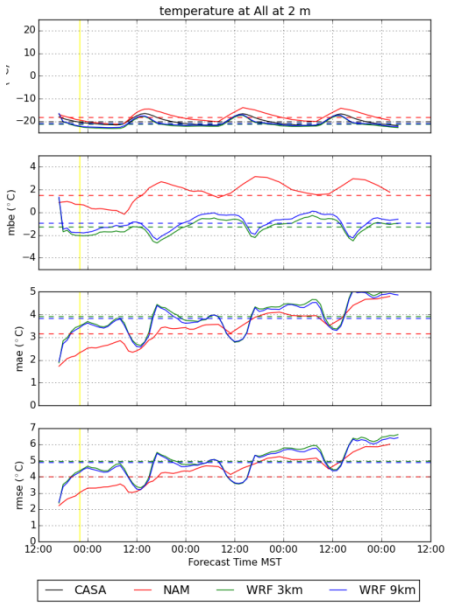


RWDI
CONSULTING ENGINEERS & SCIENTISTS

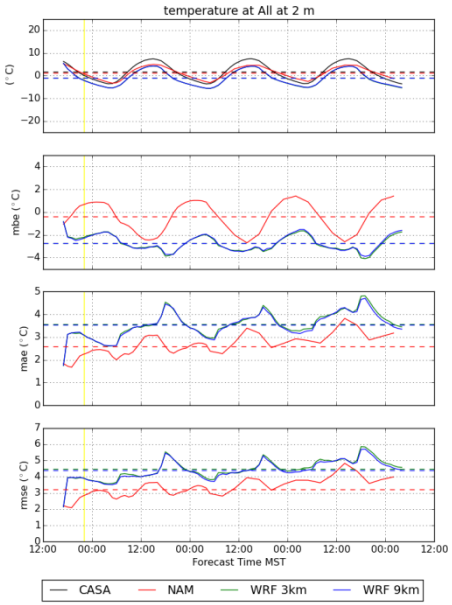
Seasonal Temperature

RWDI
CONSULTING ENGINEERS & SCIENTISTS

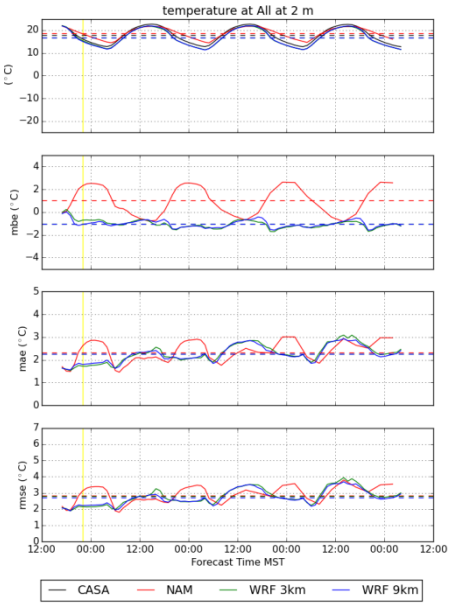
Winter



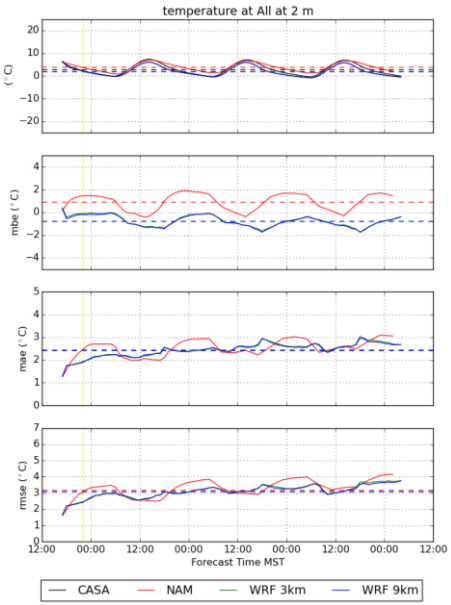
Spring



Summer

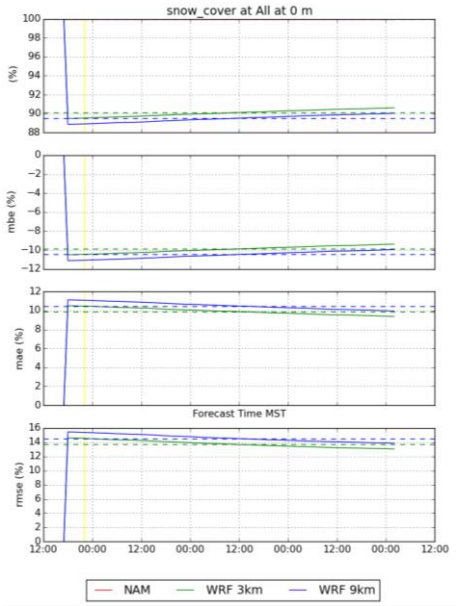


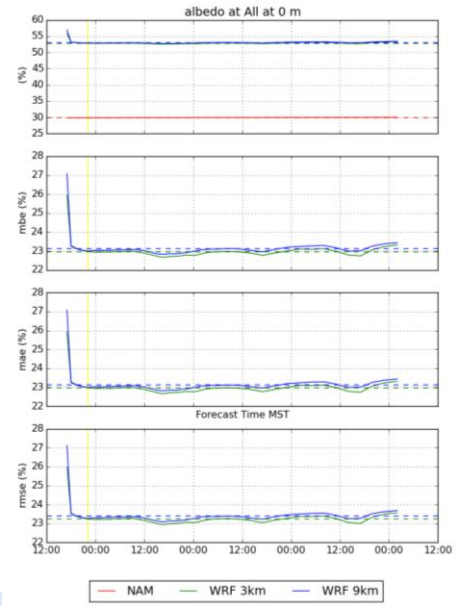
Fall



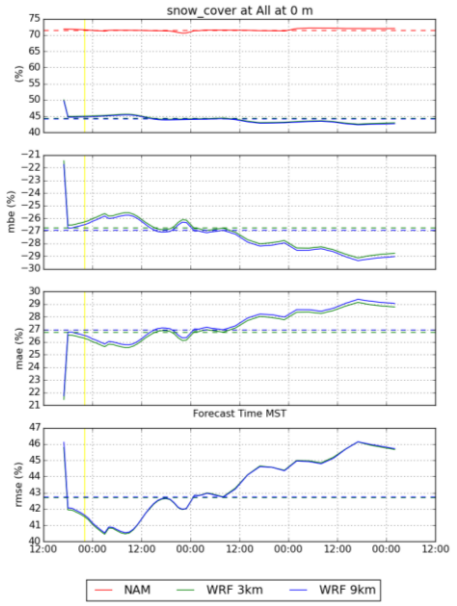
Snow Cover and Albedo

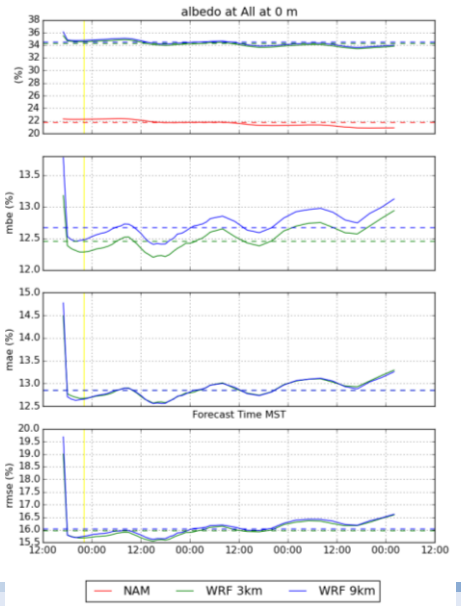
Winter



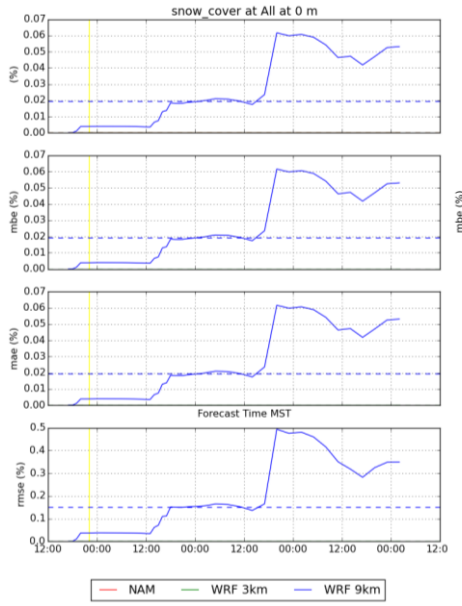


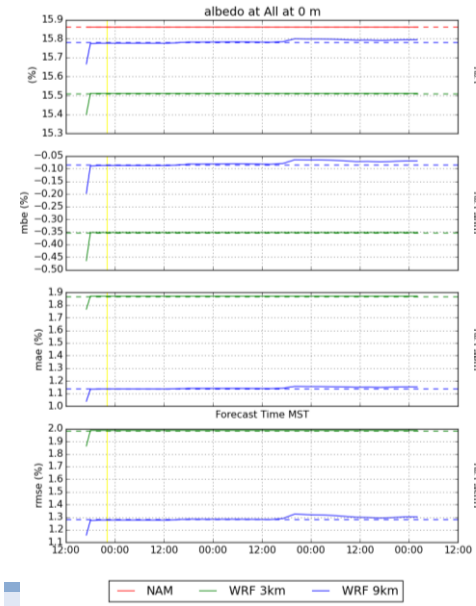
Spring



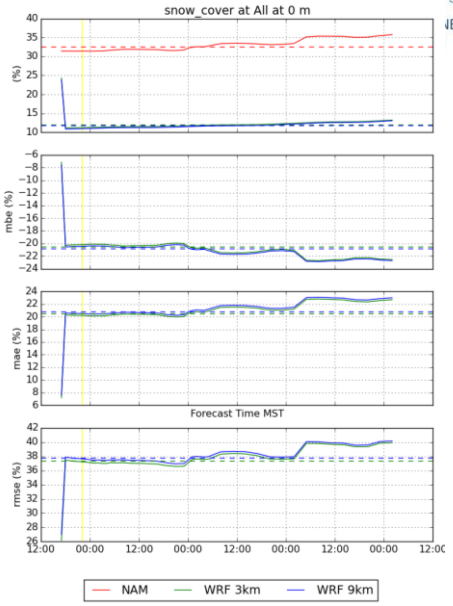


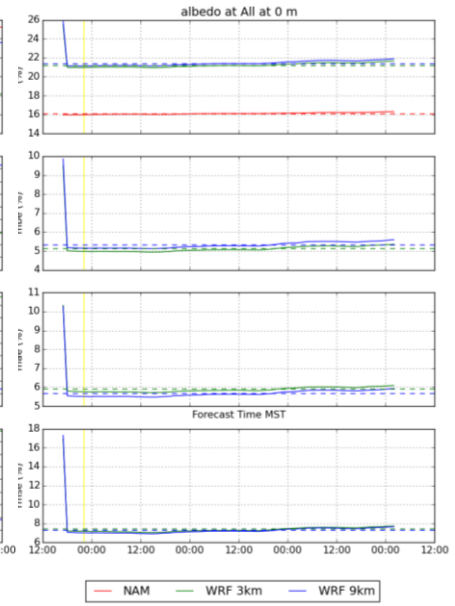
Summer





Fall





Case Study Conclusions

- WRF 9 and WRF 3
  - biased cold by 1.2C at ground
  - Provides value (Ws, Wd, T)
  - Vertical resolution, timing and intensity of small scale events (fronts), precipitation, convective activity
- WRF wintertime albedo was 33% higher than NAM12, spring was off by 15%
- Snow Cover was higher in NAM
- Data assimilation
- Different physics options
- Compare against regional and high res GEM

Questions

ron.chapman@rwdi.com
(403) 232-6771 ext 6270