Evaluation of high-resolution MetUM and AMPS forecasts of near-surface meteorological variables over Larsen C ice shelf and northern Antarctic Peninsula

Andrew Orr, Amelie Kirchgaessner, John King (British Antarctic Survey)
Mark Weeks (UK Met Office)
Alan Gadian (University of Leeds, UK)
Peter Kuipers Munneke (University of Utrecht)

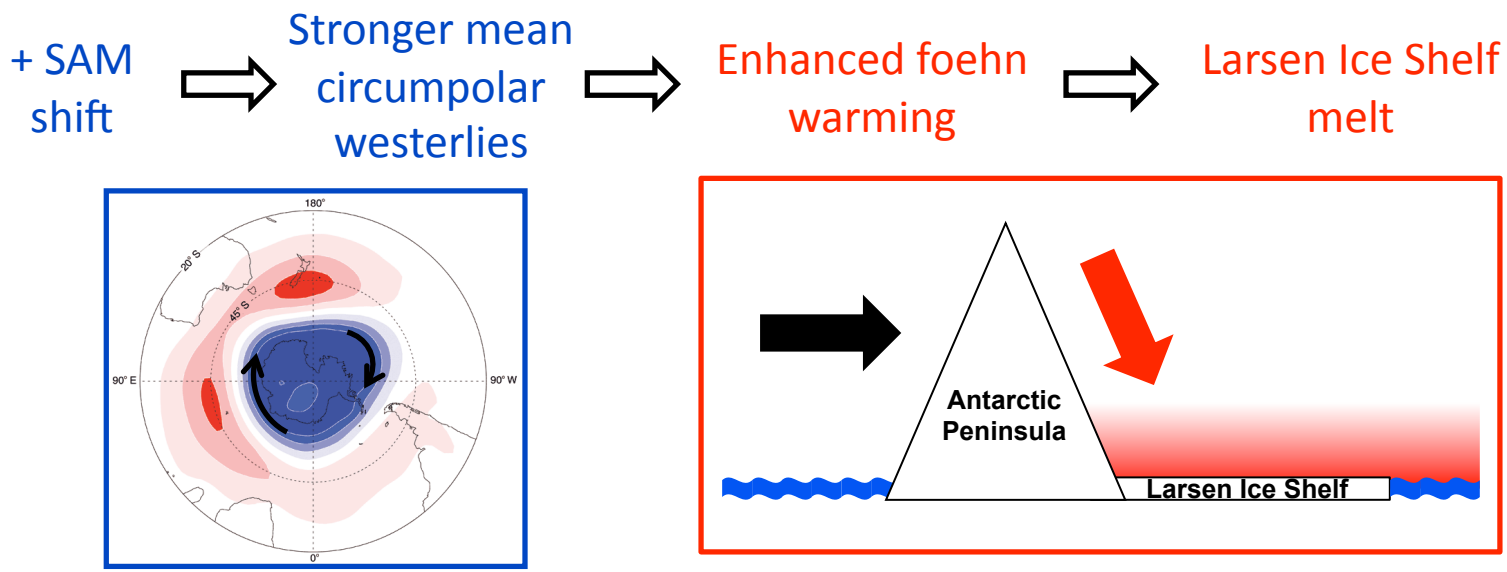
- **Orographic Flows and the Climate of the Antarctic Peninsula (OFCAP)**

- **High-resolution NWP forecasts used to predict onset of foehn wind events, as well as to provide additional in-depth understanding**

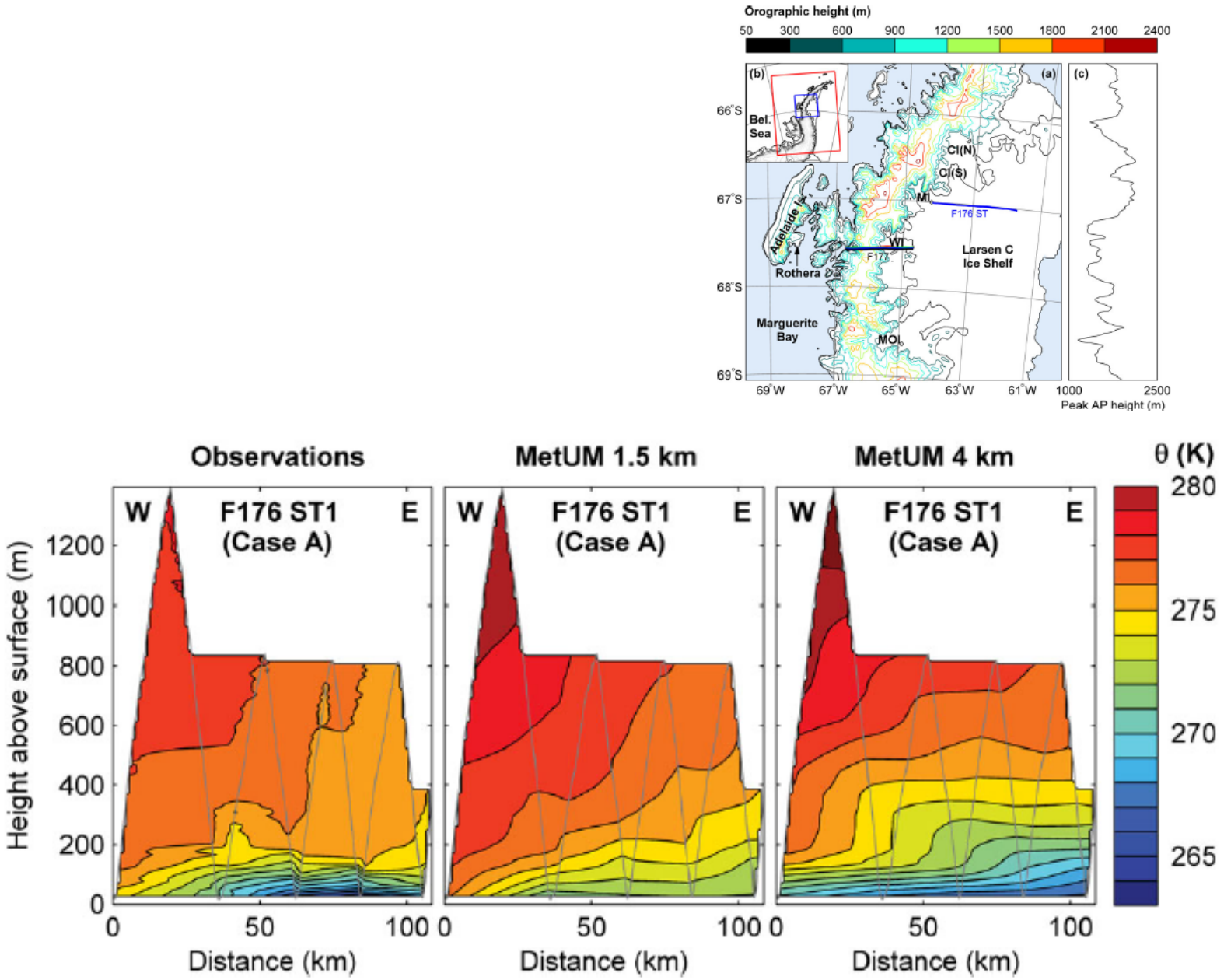
- **UK Met Office Unified Model (MetUM)**

- **Antarctic Mesoscale Prediction System (AMPS), based on Polar WRF**

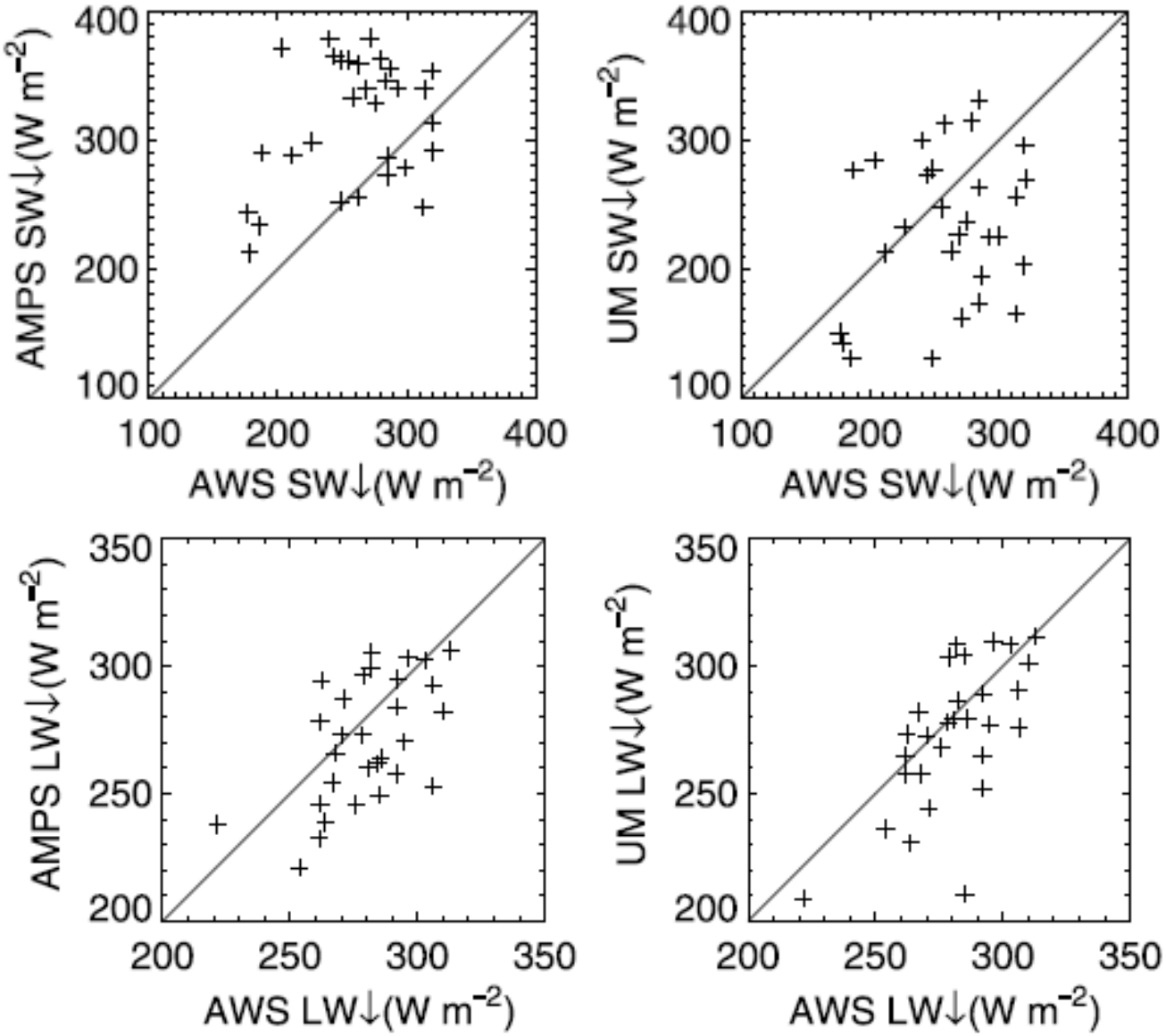
- **Representativeness of the MetUM and AMPS forecasts of considerable interest**



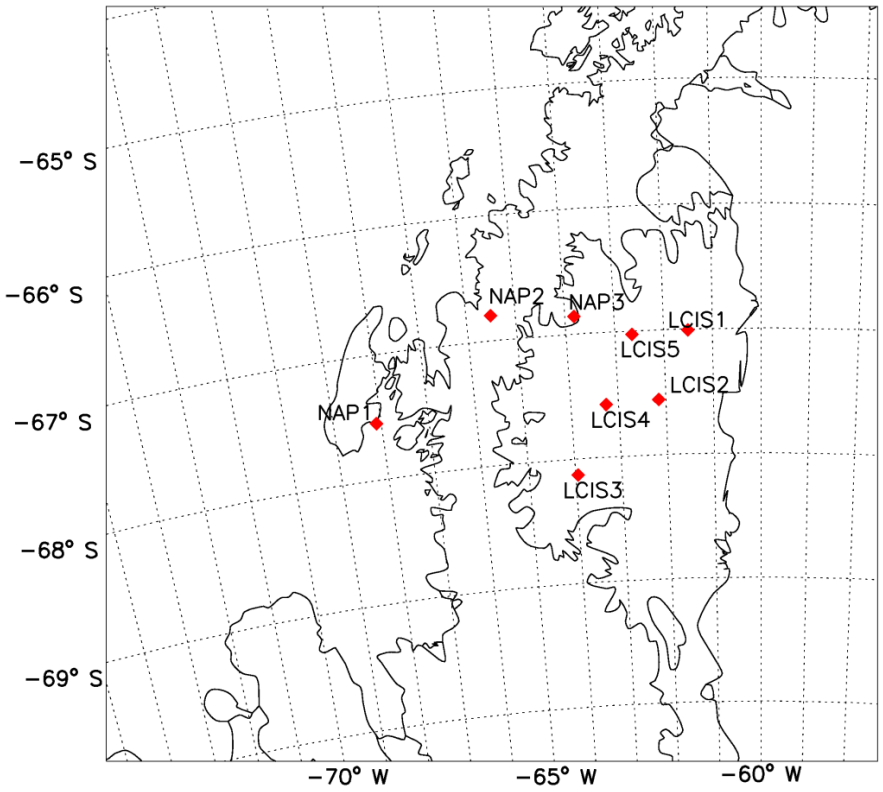
Slide courtesy of Andy Elvidge, U. East Anglia



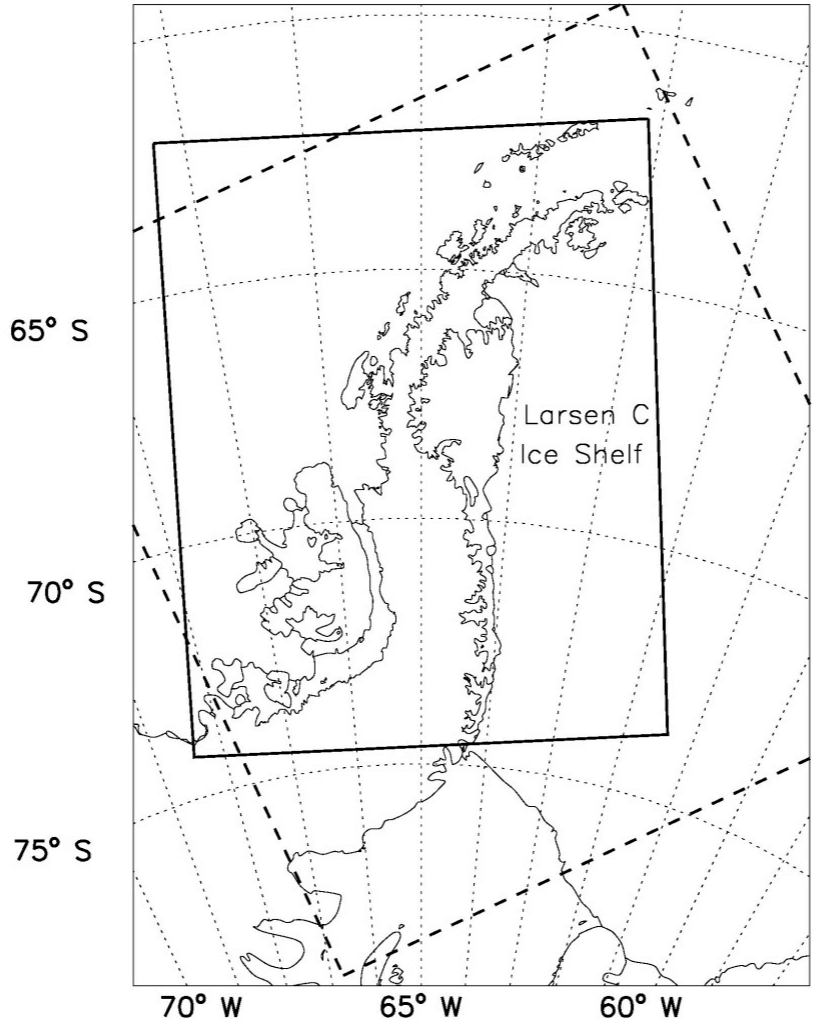
Cross sections of potential temperature between 0900 and 1000 UTC, 5 Feb 2011, comparing MetUM simulations at 4 and 1.5 km resolution with aircraft observations. From Elvidge et al., 2014.



AMPS and MetUM simulated daily mean downwelling SW and LW, plotted against measurements from an automatic weather station (AWS) on the Larsen C Ice Shelf for period 8 Jan to 8 Feb 2011. From King et al., 2015.

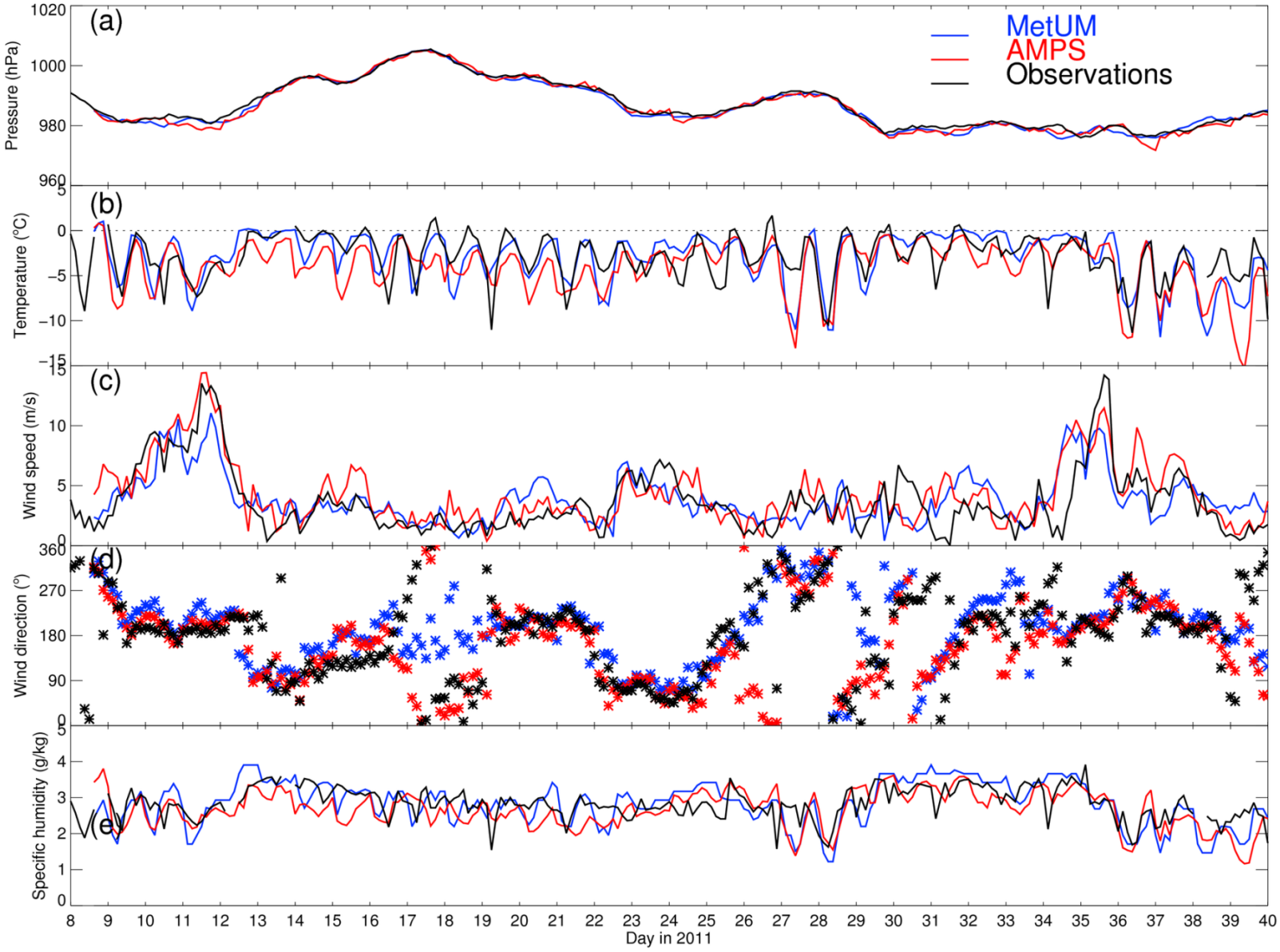


Map of Larsen C ice shelf and the northern Antarctic Peninsula and the position of the AWSs)used in this study.

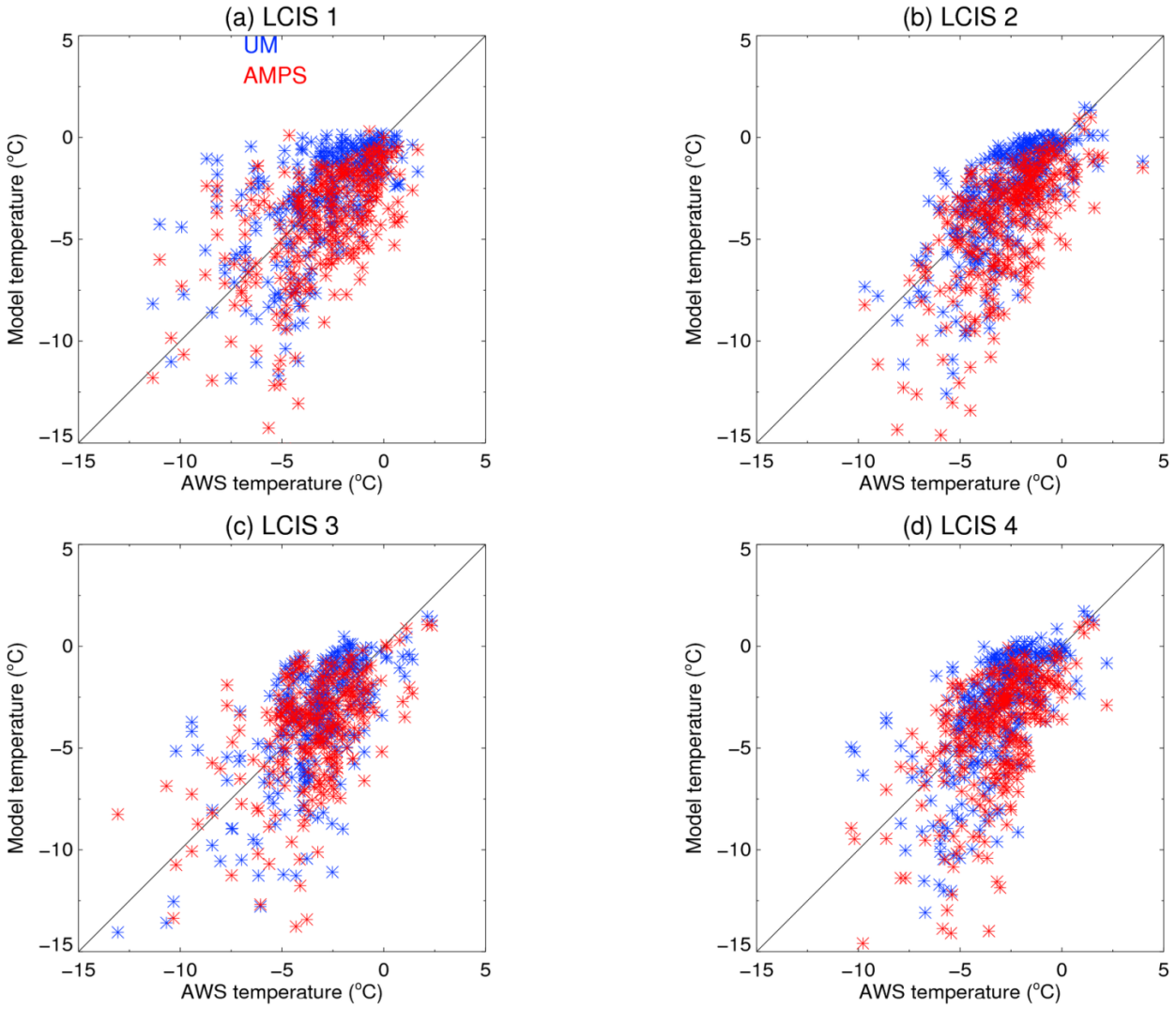


The MetUM 4-km horizontal resolution (solid line) and AMPS 4.5-km horizontal resolution (dashed line) domains covering the Antarctic Peninsula.

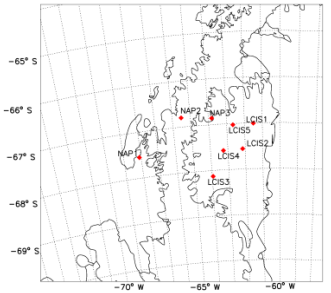
- **Forecasts investgated are for the range 12- to 24-h**
- **Initialised twice daily at 0000 and 1200 UTC**
- **Validation period is 8 Jan to 8 Feb 2011**
- **Comparison of simulated v measured timeseries**

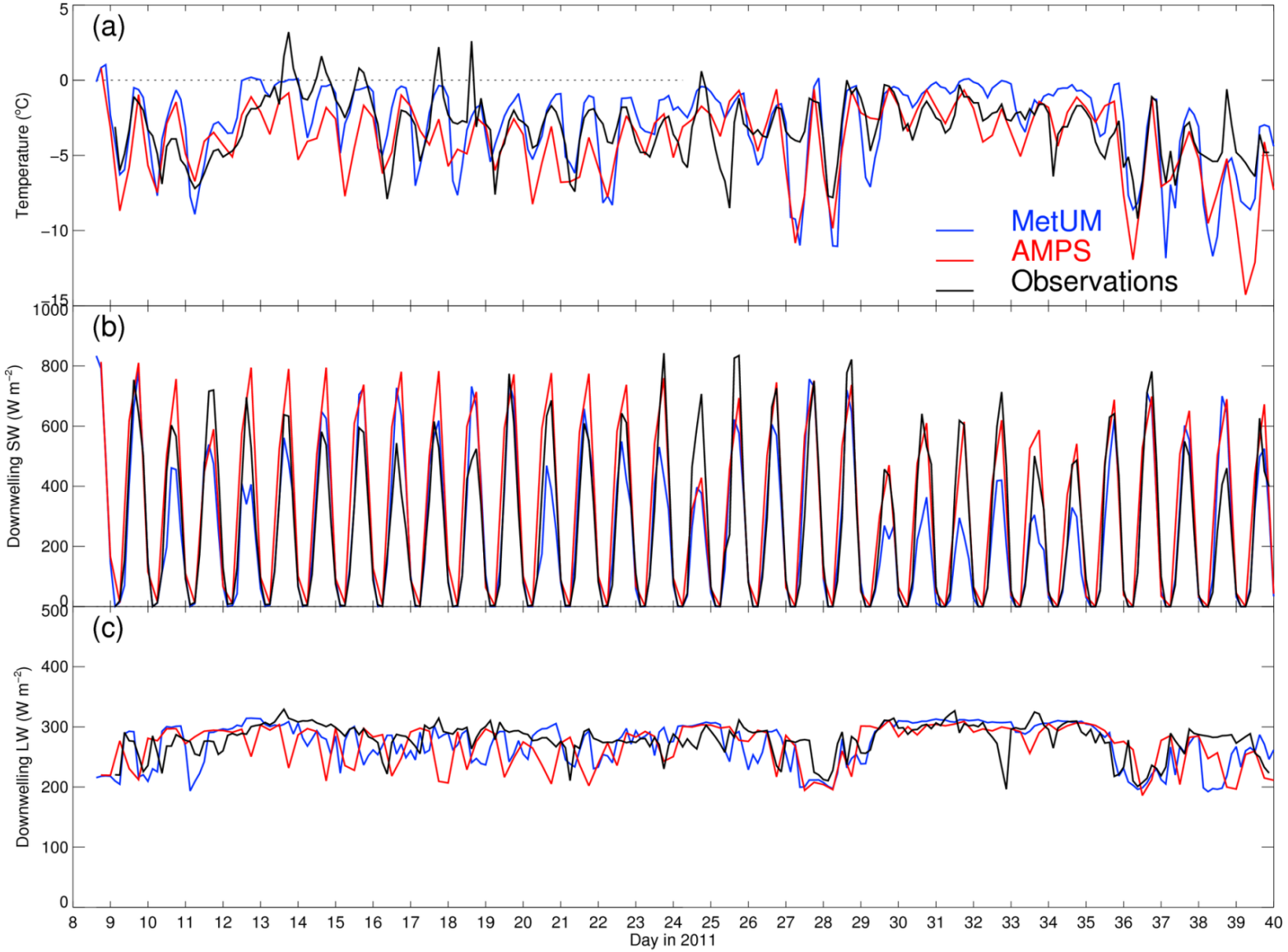


Monthly time-series of 3-hourly measurements from AWS (black) with corresponding output from the MetUM (blue) and AMPS (red) at the LCIS 1 site.

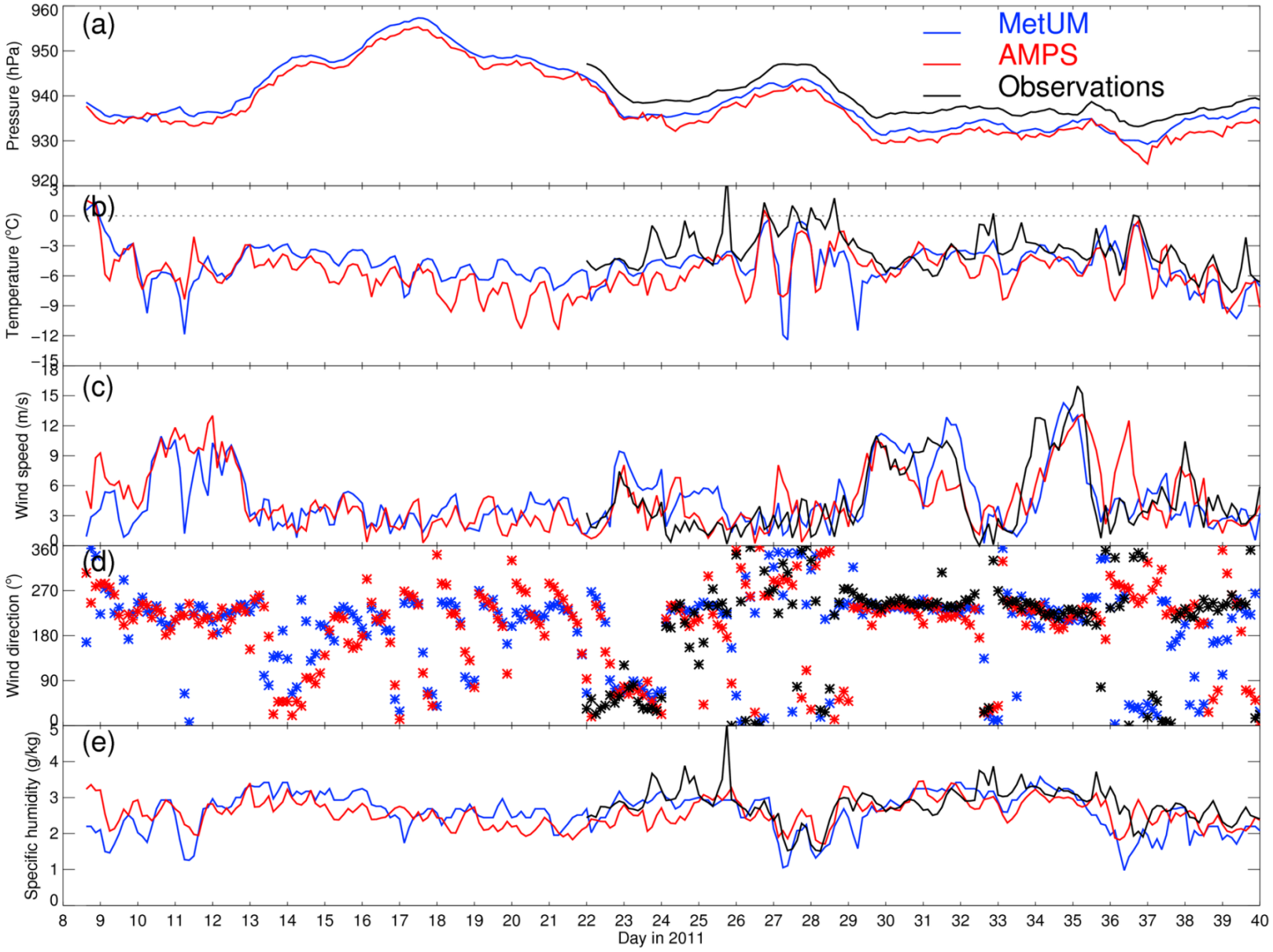


3-hourly measurements of surface temperature at LCIS 1, 2, 3 and 4 plotted against corresponding output from the MetUM (blue) and AMPS (red).

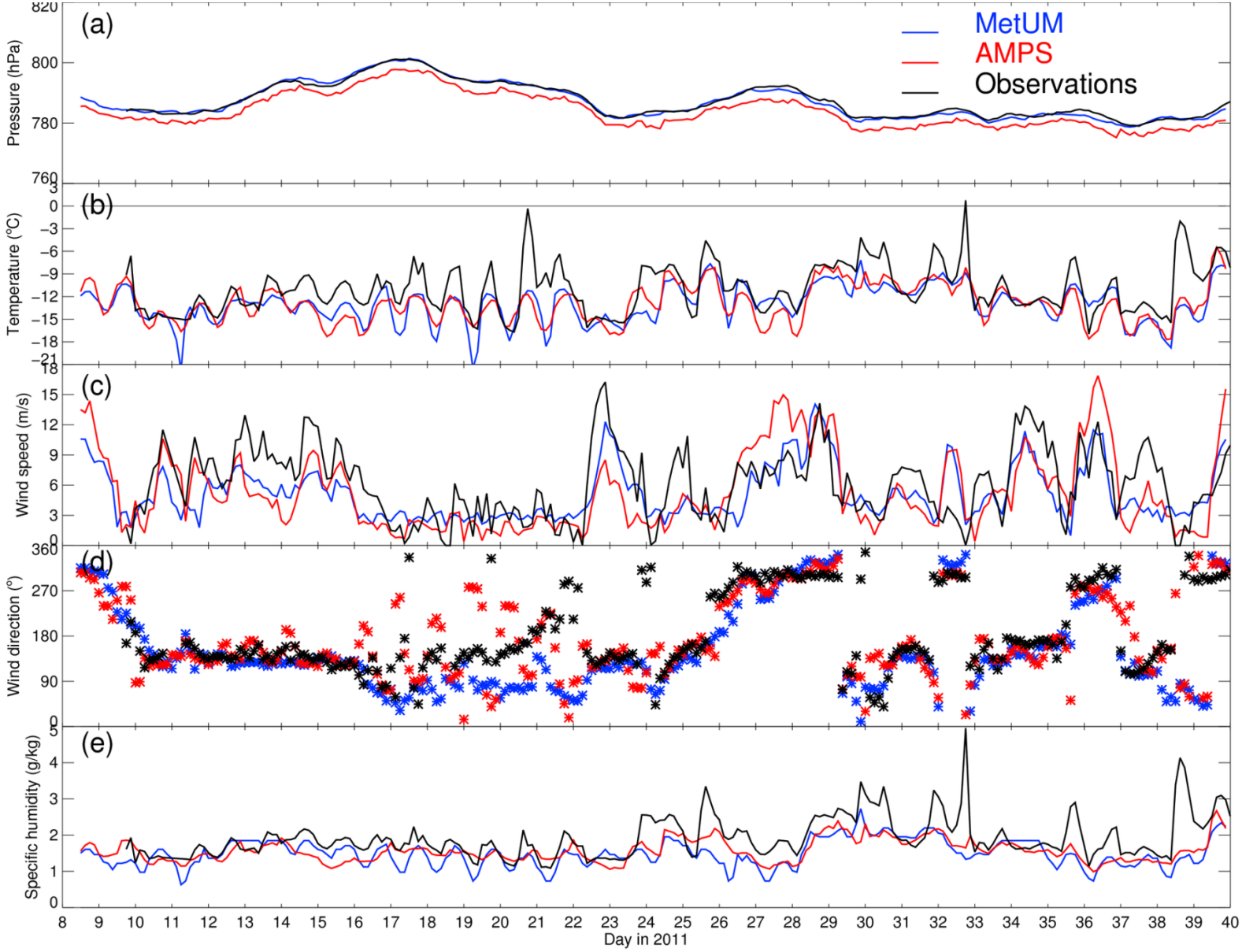




Time-series of 3-hourly measurements from AWS (black) with corresponding output from the MetUM (blue) and AMPS (red) at the LCIS 1 site.



Time-series of 3-hourly measurements from AWS (black) with corresponding output from the MetUM (blue) and AMPS (red) at the NAP 3 site.



Time-series of 3-hourly measurements from AWS (black) with corresponding output from the MetUM (blue) and AMPS (red) at the NAP 2 site.

Summary

- Biases in MetUM and AMPS models largely similar
- Both models struggle to represent near-surface temperature
- Likely due to problem representing stable boundary layer
- Models have negative bias in surface pressure at some locations
- Both models able to capture the occurrence of fohn events
- Wind speed and direction relatively well captured

Thanks to the Institute for Marine and Atmospheric Research, University of Utrecht and Cooperative Institute for Research in Environmental Sciences, University of Colorado for providing measurements.

Site	Pressure			Temperature			Wind speed			Specific humidity		
	Bias (hPa)	RMSE (hPa)	Corr.	Bias (°C)	RMSE (°C)	Corr.	BIAS (m s^{-1})	RMSE (m s^{-1})	Corr.	Bias (g kg^{-1})	RMSE (g kg^{-1})	Corr.
LCIS 1	-0.53	-1.15	0.99	0.09	2.16	0.63	0.12	2.00	0.68	0.02	0.44	0.80
LCIS 2	-1.00	1.42	0.99	-0.08	1.88	0.69	-0.34	2.08	0.74	0.05	0.43	0.71
LCIS 3	-0.24	0.98	0.99	-0.15	2.26	0.62	-0.18	2.12	0.72	0.03	0.49	0.58
LCIS 4	0.59	1.16	0.99	0.06	2.20	0.63	-0.44	1.84	0.70	-0.01	0.51	0.58
LCIS 5	-0.38	1.14	0.99	-0.14	2.17	0.61	-0.24	2.02	0.67	0.22	0.50	0.64
NAP 1	-0.28	0.73	1.00	-1.98	2.26	0.69	-0.55	2.48	0.38	0.13	0.40	0.74
NAP 2	-0.29	0.85	0.99	-1.93	2.99	0.67	-1.07	2.85	0.67	-0.43	0.65	0.50
NAP 3	-3.29	3.40	0.97	-1.49	2.47	0.50	0.29	2.70	0.70	-0.14	0.39	0.97

Site	Pressure			Temperature			Wind speed			Specific humidity		
	Bias (hPa)	RMSE (hPa)	Corr.	Bias (°C)	RMSE (°C)	Corr.	BIAS (m s^{-1})	RMSE (m s^{-1})	Corr.	Bias (g kg^{-1})	RMSE (g kg^{-1})	Corr.
LCIS 1	-0.58	1.28	0.99	-1.12	2.63	0.57	0.54	1.86	0.78	-0.16	0.50	0.73
LCIS 2	-1.13	1.61	0.99	-1.48	2.70	0.63	0.23	1.70	0.84	-0.16	0.47	0.61
LCIS 3	-0.40	1.22	0.99	-0.72	2.48	0.50	0.01	2.17	0.73	-0.04	0.42	0.56
LCIS 4	0.49	1.21	0.99	-0.97	2.52	0.57	-0.04	1.82	0.74	-0.14	0.49	0.54
LCIS 5	-0.49	1.30	0.99	-1.02	2.52	0.53	0.24	1.96	0.74	0.08	0.45	0.51
NAP 1	0.14	1.03	0.99	-1.45	1.67	0.75	-0.35	2.90	0.28	0.01	0.44	0.64
NAP2	-9.99	10.02	0.99	-2.36	3.28	0.68	-1.25	3.53	0.58	-0.38	0.58	0.61
NAP 3	-8.41	8.47	0.97	-1.66	2.35	0.63	0.26	3.23	0.54	-0.13	0.38	0.97

Error statistics for MetUM (top) and AMPS (bottom)