Using mesoscale atmospheric model output as a tool in decision making

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Photo courtesy Gary Williams Photography

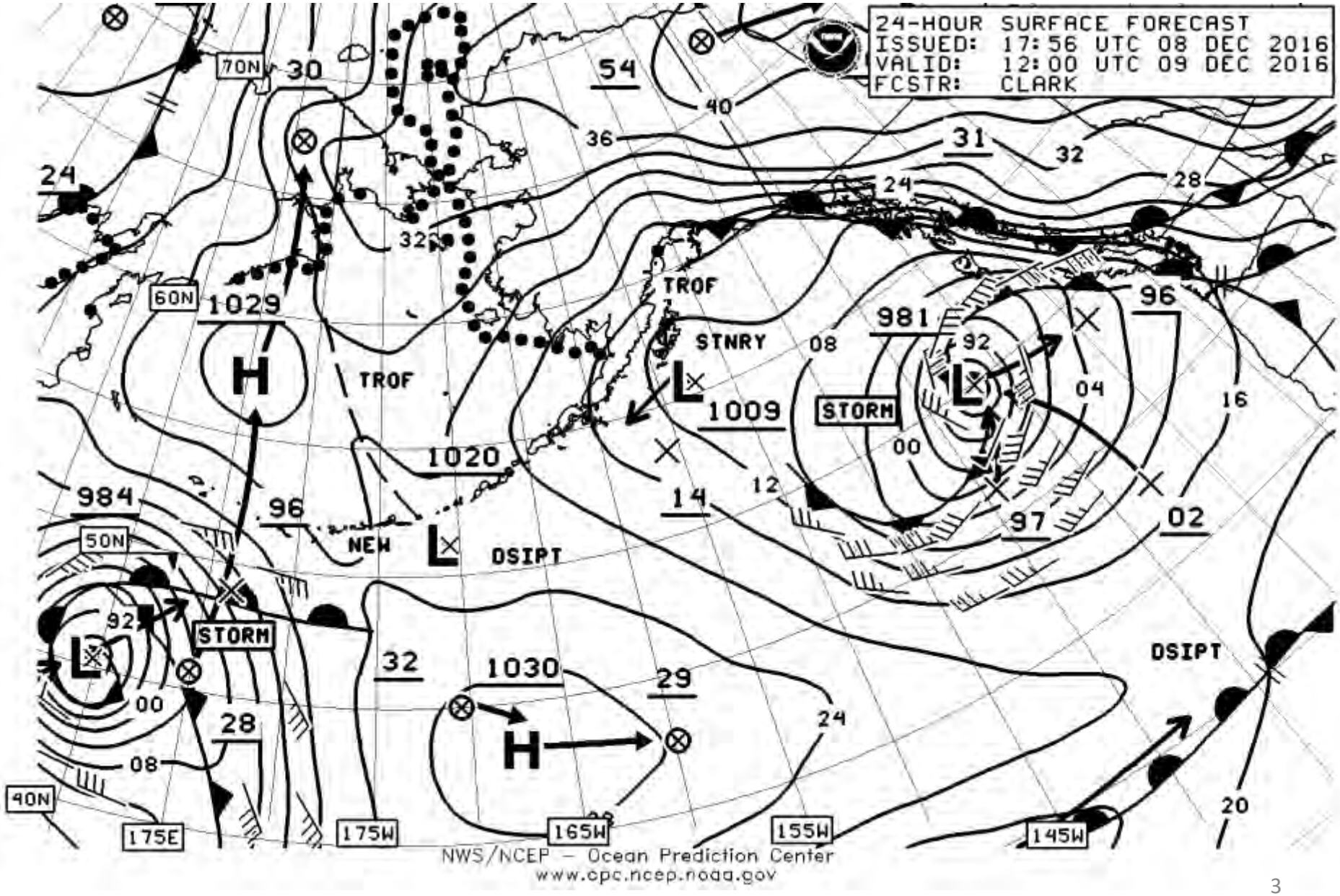
NOAA's ***National Centers for Environmental Prediction (NCEP)*** runs several forecast models daily

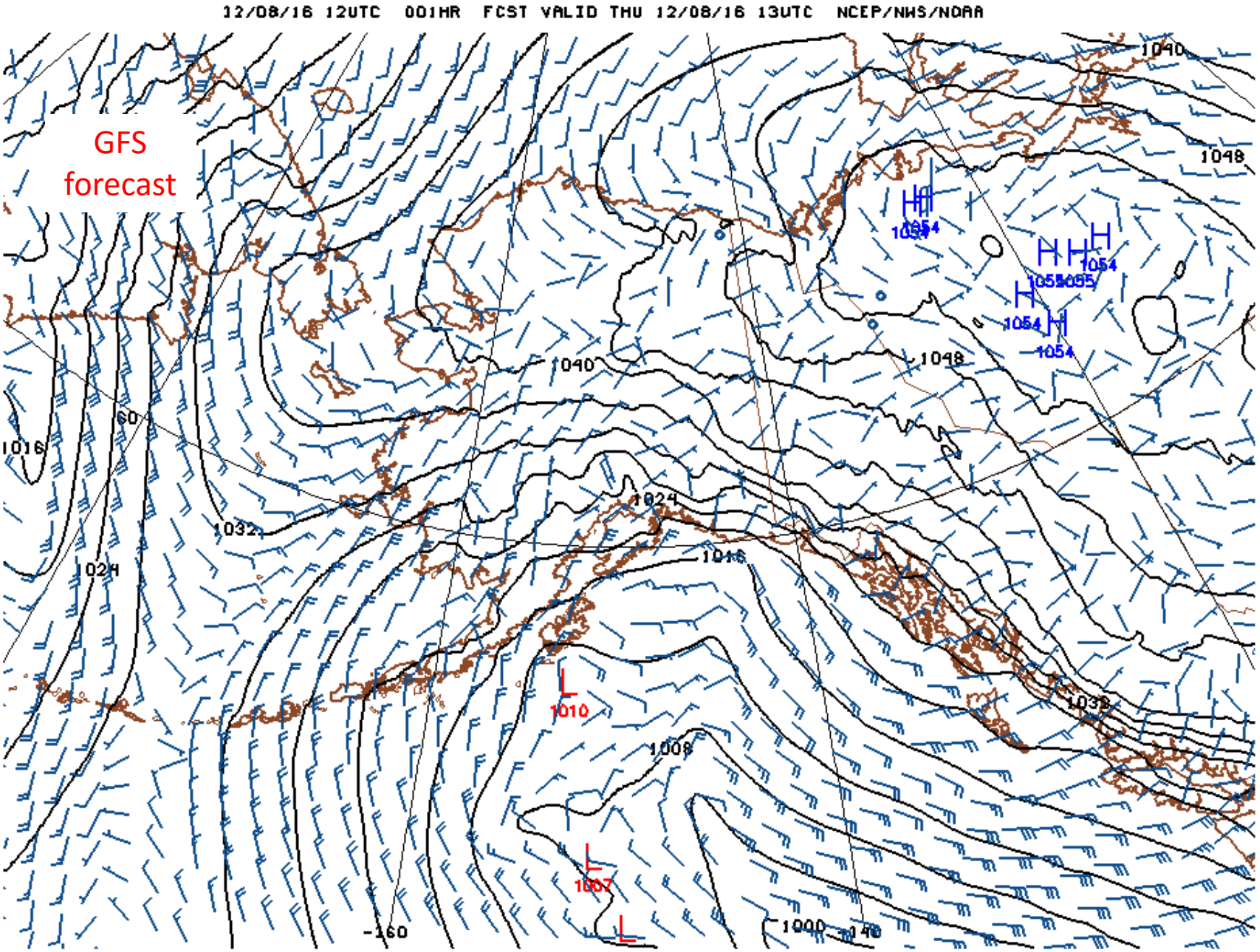
Why do something special here, especially when NCEP does a pretty good job?

The main reason is scale. NCEP models have a MUCH LARGER foot print, typically the CONUS. This mission typically requires:

- Larger grid spacing
- Physical parameterizations that must work suitably across very different weather conditions
- Graphics with inherently less detail

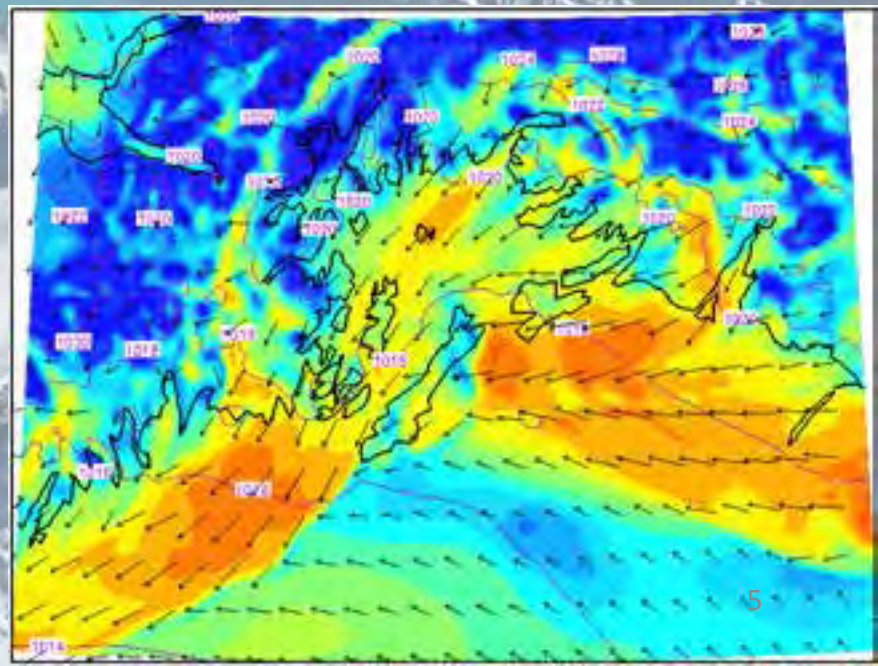
Hand Drawn NWS analysis



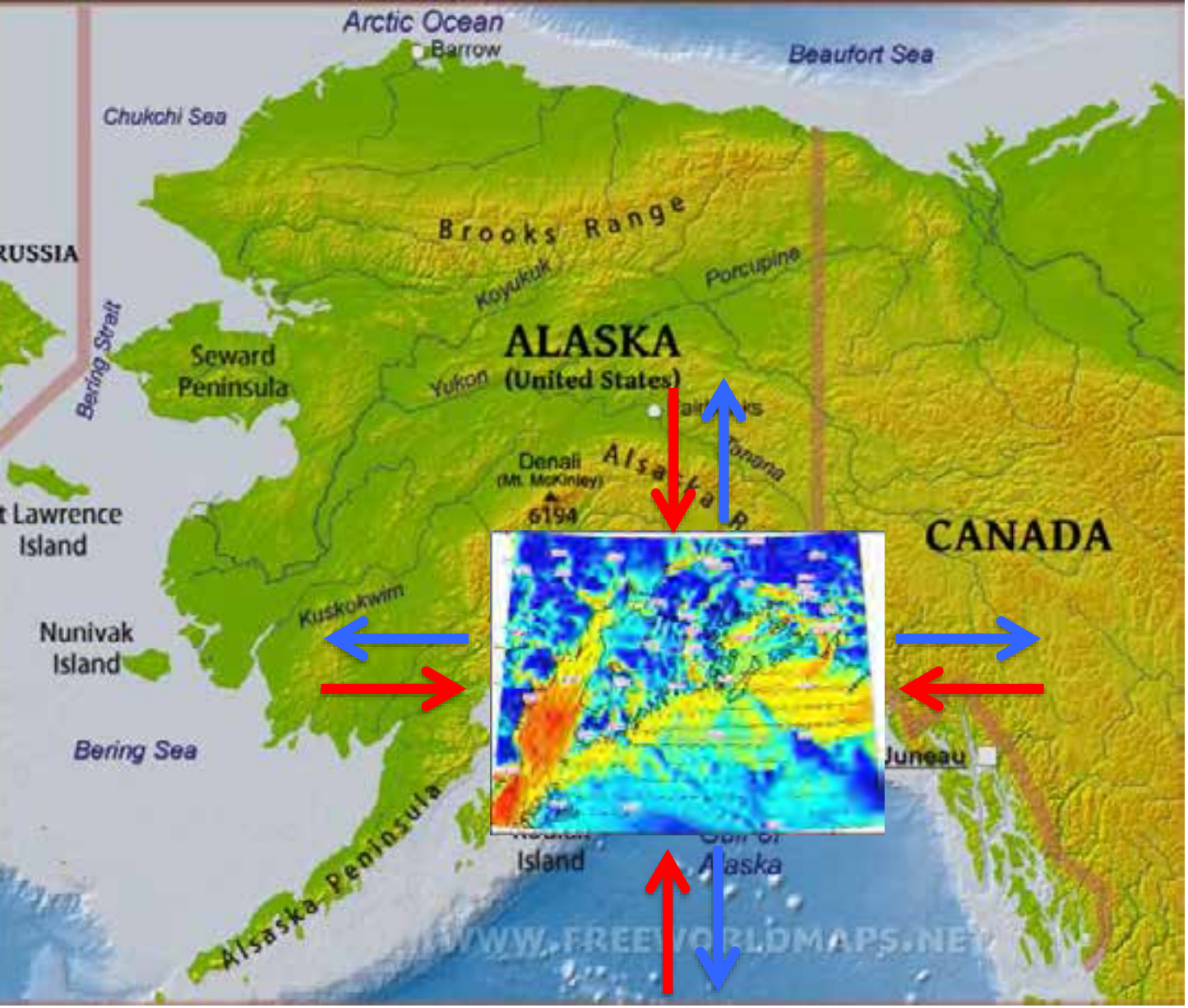

12/08/16 12UTC 001HR FCST VALID THU 12/08/16 13UTC NCEP/NWS/NOAA
GFS
forecast
1040
1048
1054
1040
1048
1016
1024
1032
1016
1010
1008
1032
1000
161208/1300V001 GFS EMSL 10M WND(KTS) 06HR PRCP(IN)

At the AEFF, we use a different, complementary approach with the PWS-WRF* model

We “nest” our model domain within a “host model”— usually the NCEP Global Forecast System (GFS). Our domain (below) is restricted to Cook Inlet and PWS writ large.



* **Weather Research and Forecasting (WRF)**



The host model provides ***lateral inflow and outflow BCs*** at every time step.

The host model also provides the ***initial starting conditions***.

The model is rerun for the forecast period, using high-resolution topography, model physics and a grid geometry specially suited to the North GOA

AEFF PWS-WRF Southcentral Alaska Domain

Primitive Equations for Dry, Inviscid Motion

(1) $$\frac{\partial u}{\partial t} + \mathbf{U}\times\nabla u - 2\,\Omega v \sin\phi = -\frac{1}{\rho}\frac{\partial p}{\partial x}$$

(2) $$\frac{\partial v}{\partial t} + \mathbf{U}\times\nabla v + 2\,\Omega u \sin\phi = -\frac{1}{\rho}\frac{\partial p}{\partial y}$$

(3) $$\frac{\partial w}{\partial t} + \mathbf{U}\times\nabla w = -\frac{1}{\rho}\frac{\partial p}{\partial z} - g$$

(4) $$C_p\frac{DT}{Dt} + p\frac{D\rho^{-1}}{Dt} = J$$

(5) $$\frac{1}{\rho}\frac{D\rho}{Dt} + \nabla\times\mathbf{U} = 0$$

(6) $$P = \rho RT$$

Six highly-coupled PDEs (5 prognostic and one diagnostic) in six unknowns (u,v,w,P,T,ρ)

Given suitable ***INITIAL*** conditions and ***BOUNDARY*** conditions, we can (in theory) solve these for any future time.

Of course, the highly nonlinear nature of the equations means ***CHAOS*** is just a few days away.

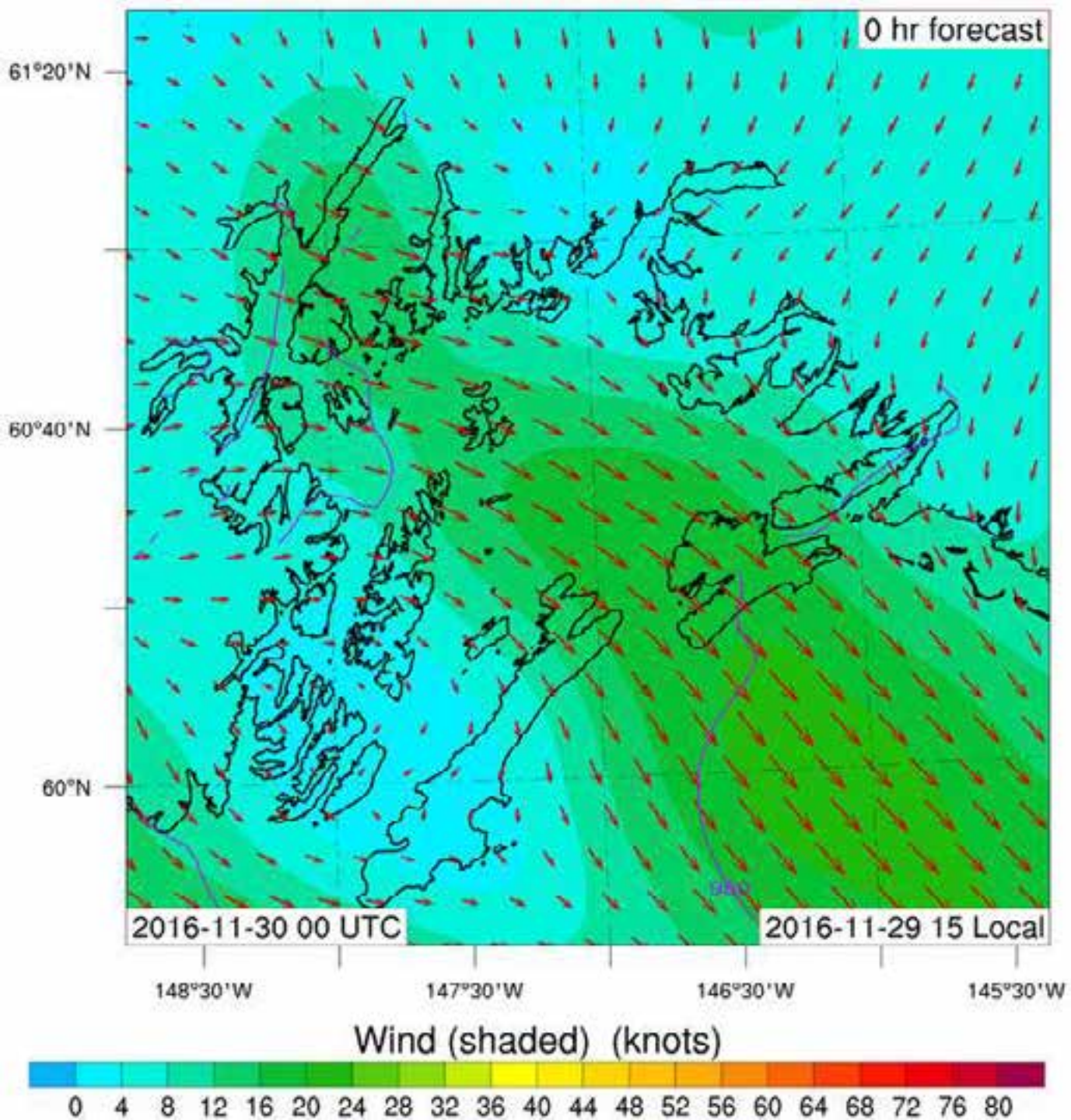
The Details

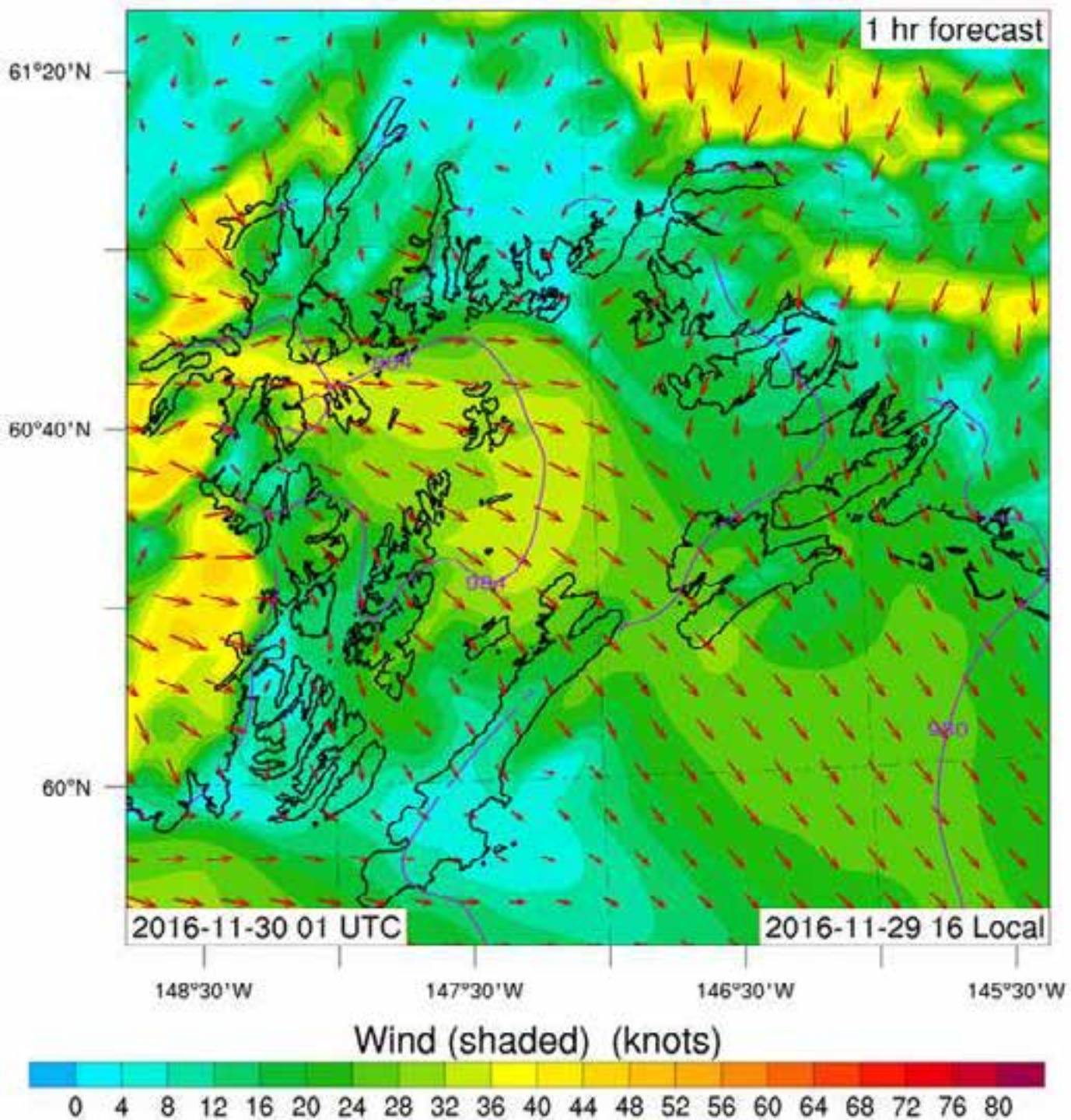
The model is run four times a day, at 00, 06, 12 and 18 UTC

A subdomain of the full PWS-WRF domain— the PWS region— is delineated and plots are created and (will soon be) placed on the PWS-WRF website.

Currently we are plotting two products on an hourly basis: surface winds and an experimental visibility plot. We want to hear more from you, the users, about what else would be useful.

And now for some plots…


0 hr forecast
61°20'N
60°40'N
60°N
2016-11-30 00 UTC
2016-11-29 15 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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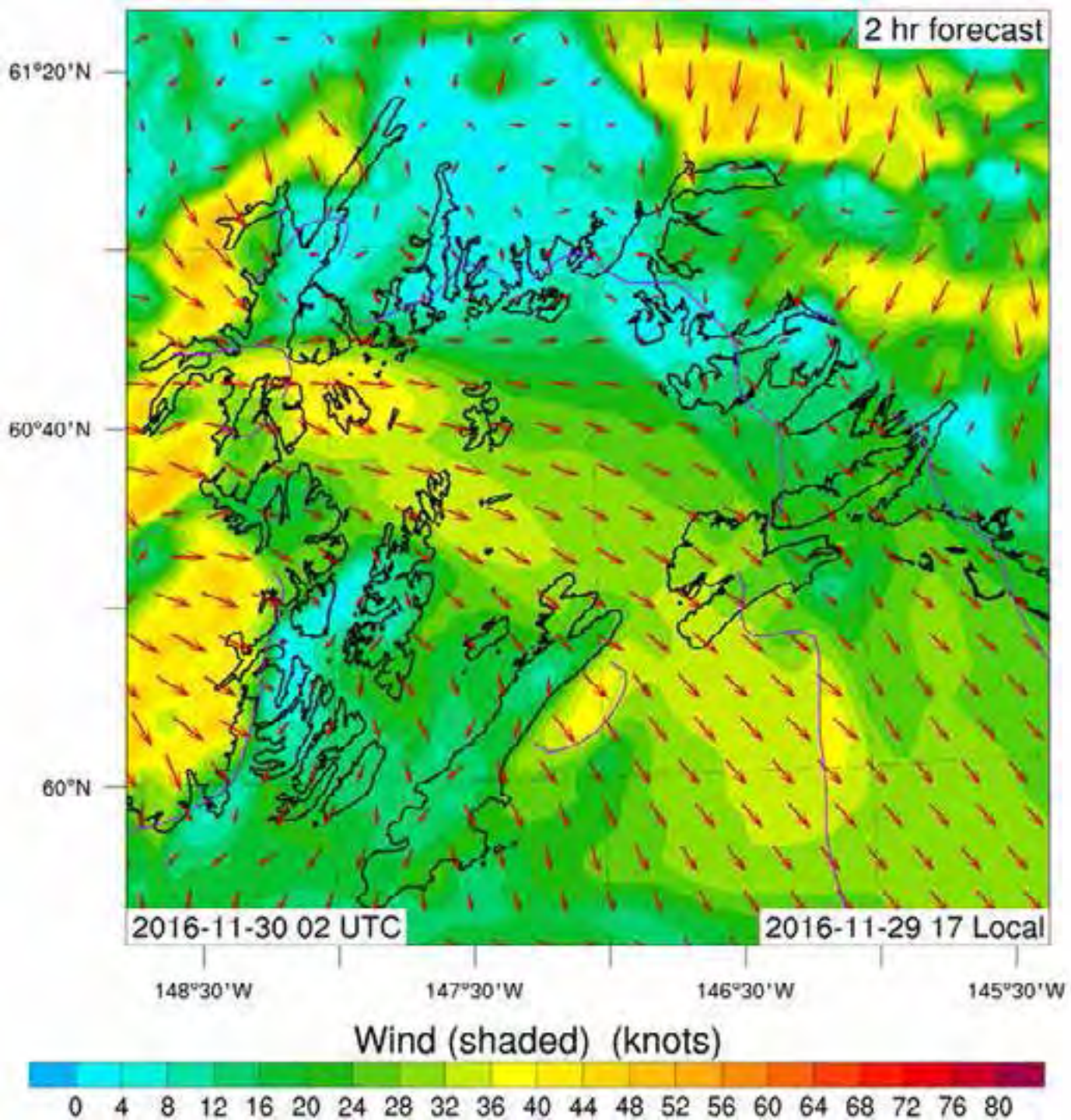
60°40'N
60°N
2016-11-30 01 UTC
2016-11-29 16 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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61°20'N
60°40'N
60°N
2016-11-30 02 UTC
2016-11-29 17 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
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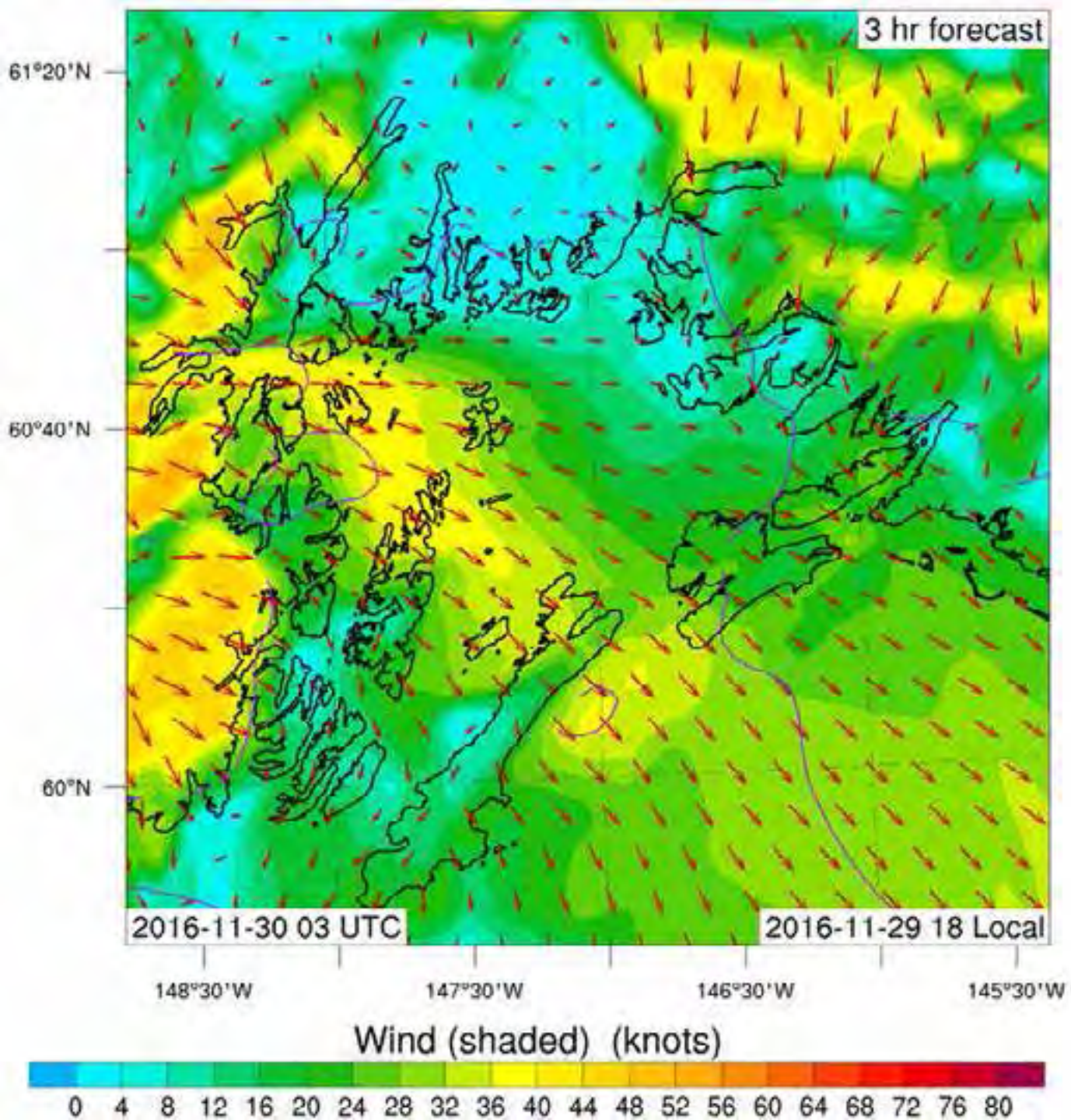
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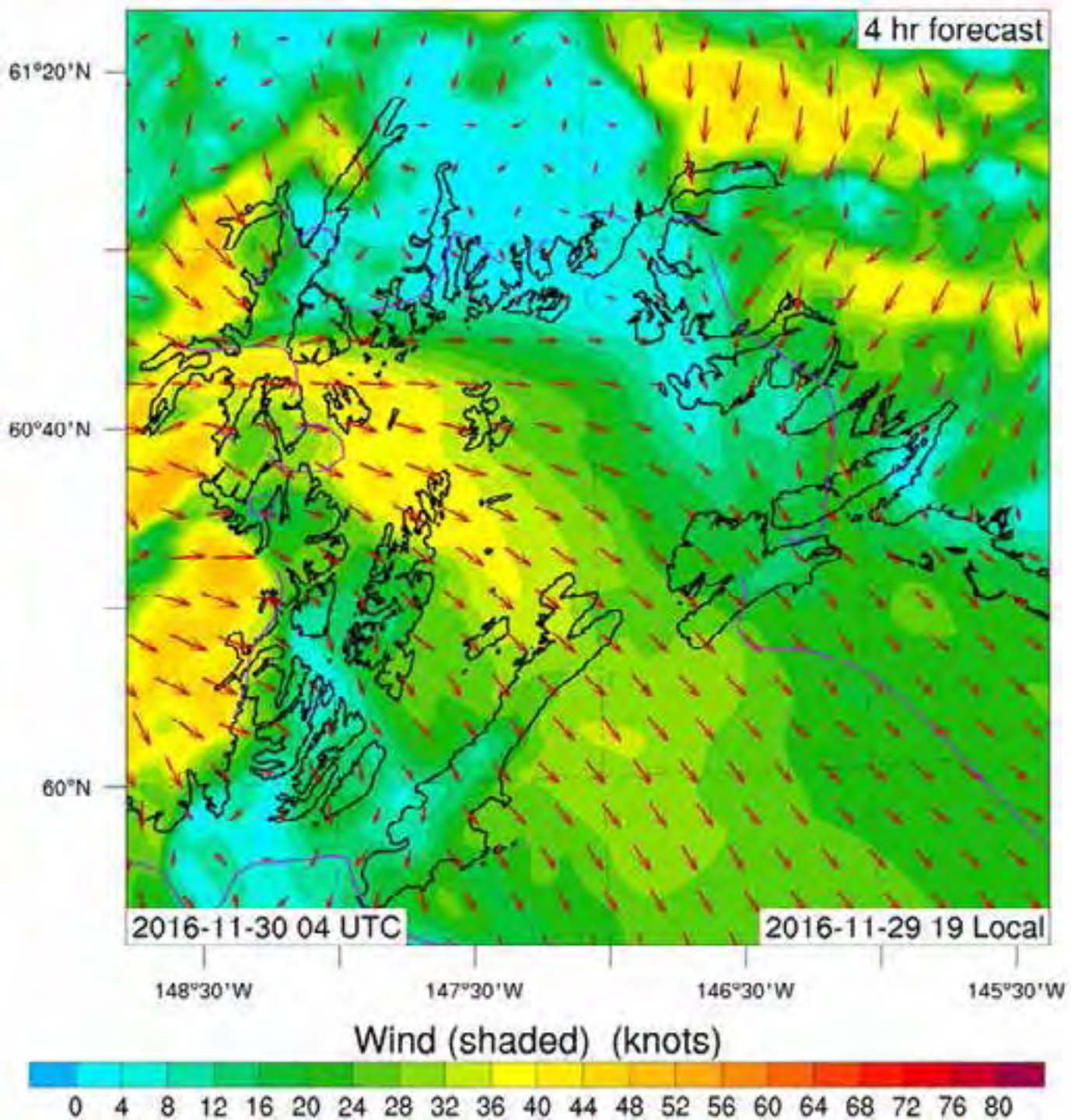
60°40'N
60°N
2016-11-30 03 UTC
2016-11-29 18 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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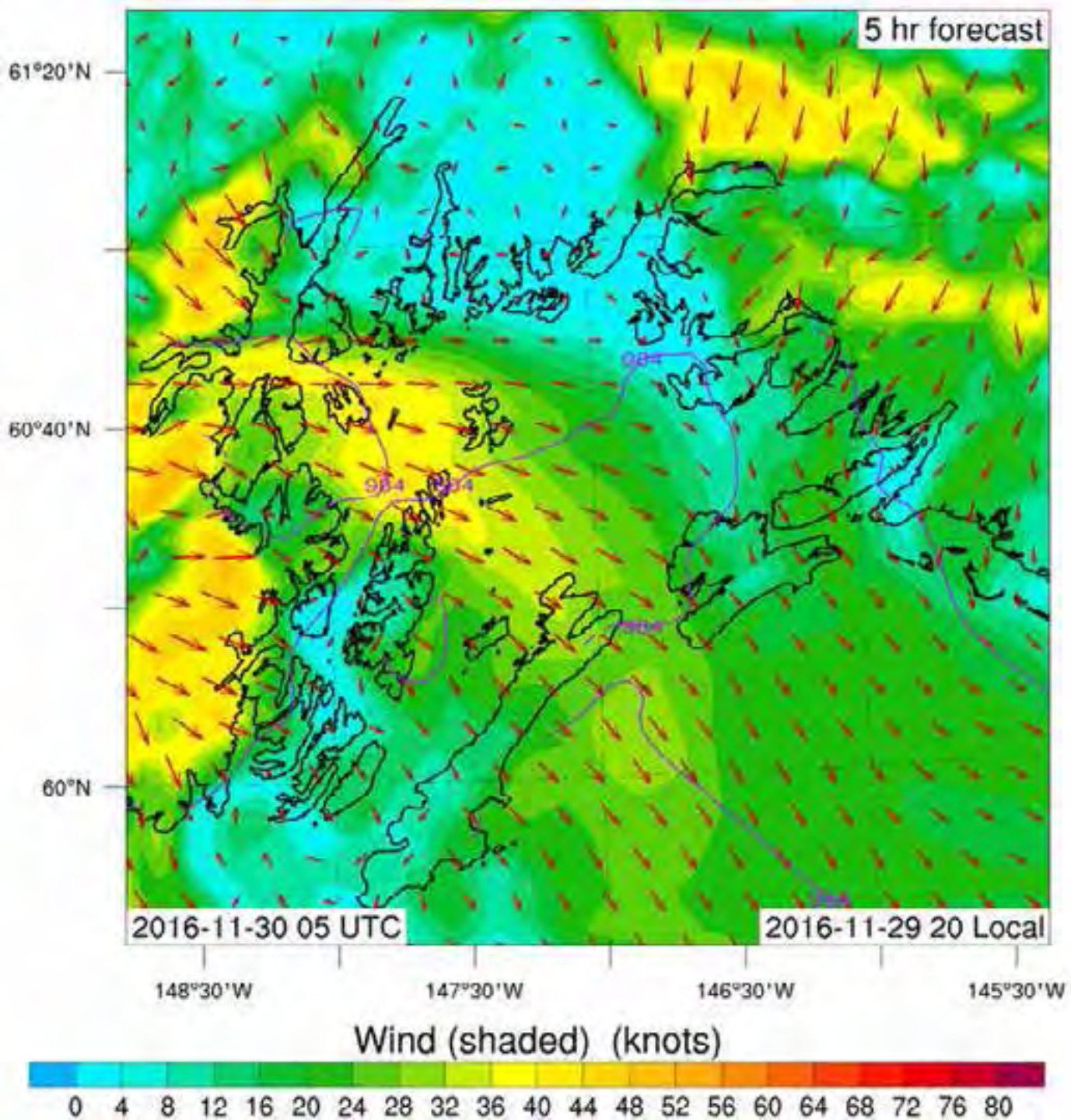
60°40'N
60°N
2016-11-30 04 UTC
2016-11-29 19 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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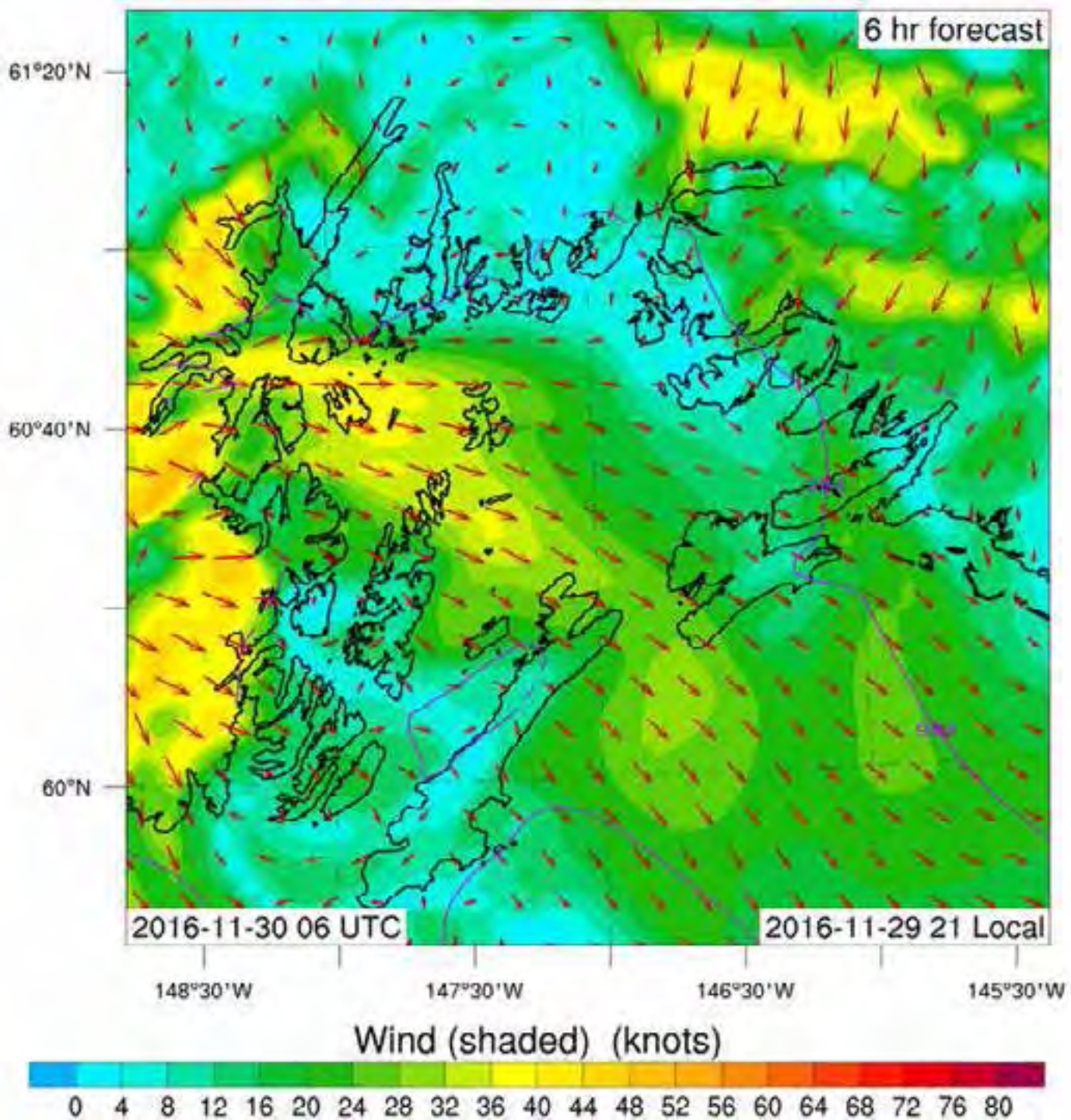
60°40'N
60°N
984
984
984
2016-11-30 05 UTC
2016-11-29 20 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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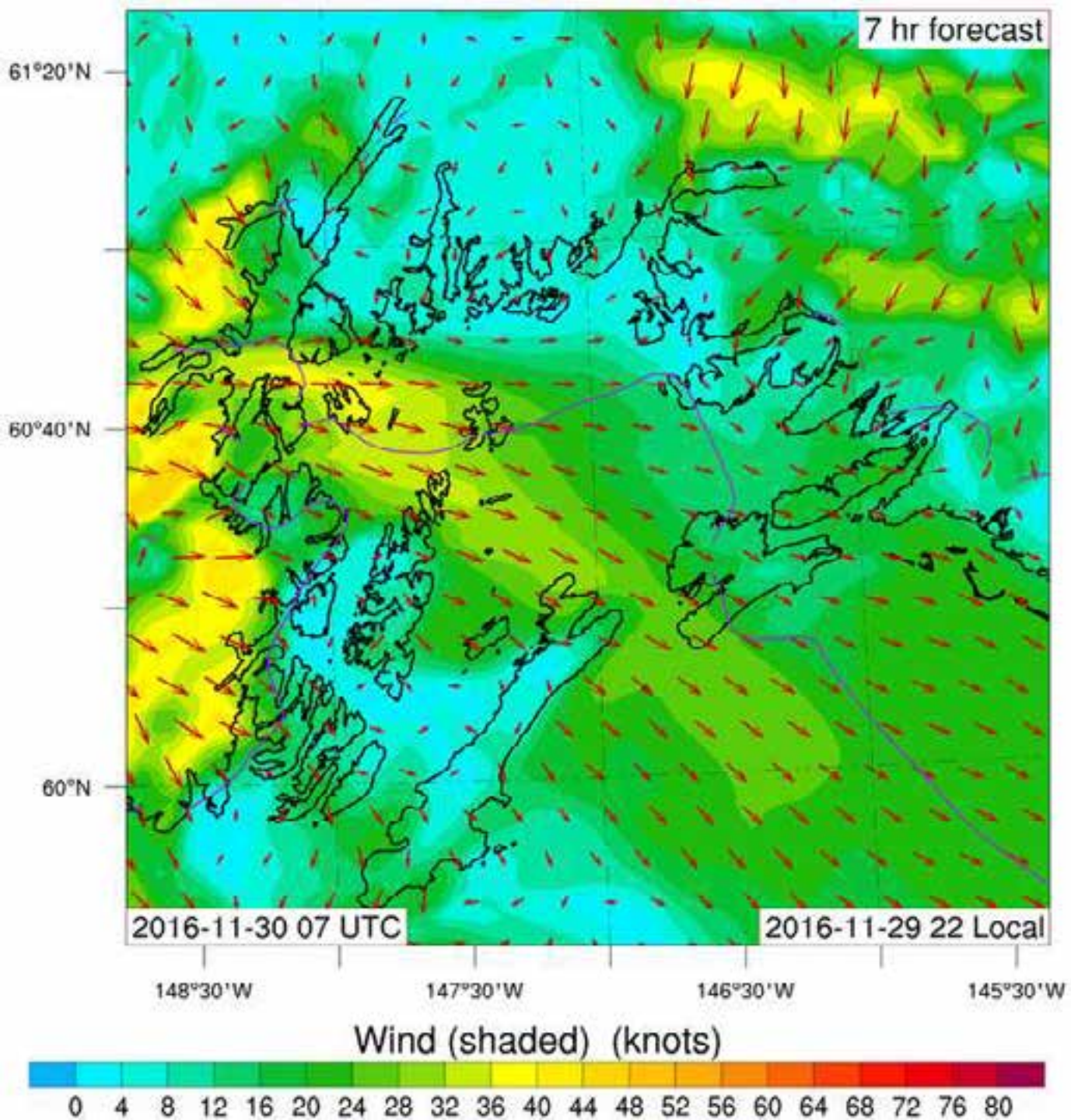
60°40'N
60°N
2016-11-30 06 UTC
2016-11-29 21 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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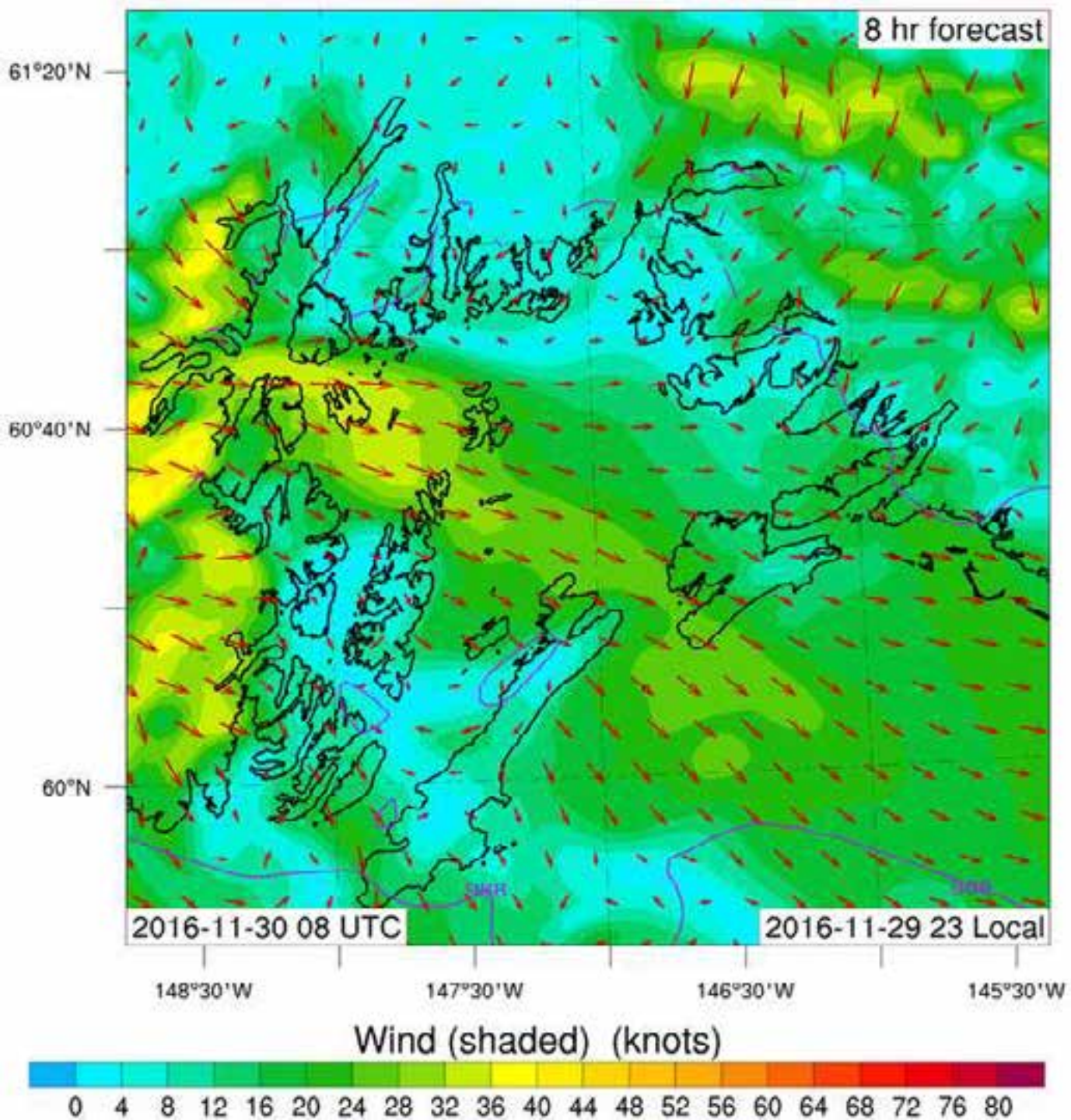
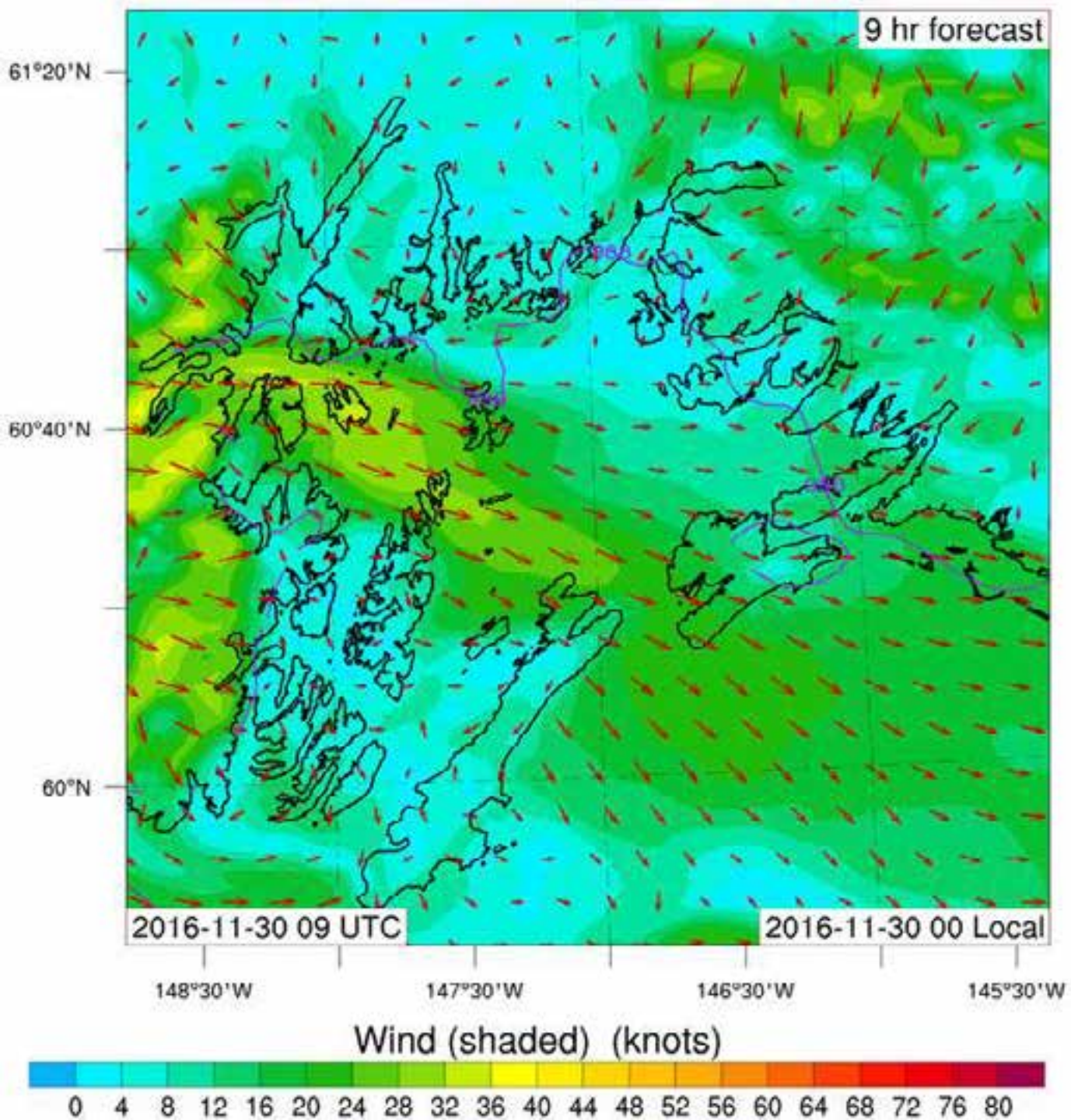
60°40'N
60°N
2016-11-30 07 UTC
2016-11-29 22 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80


8 hr forecast
61°20'N
60°40'N
60°N
2016-11-30 08 UTC
2016-11-29 23 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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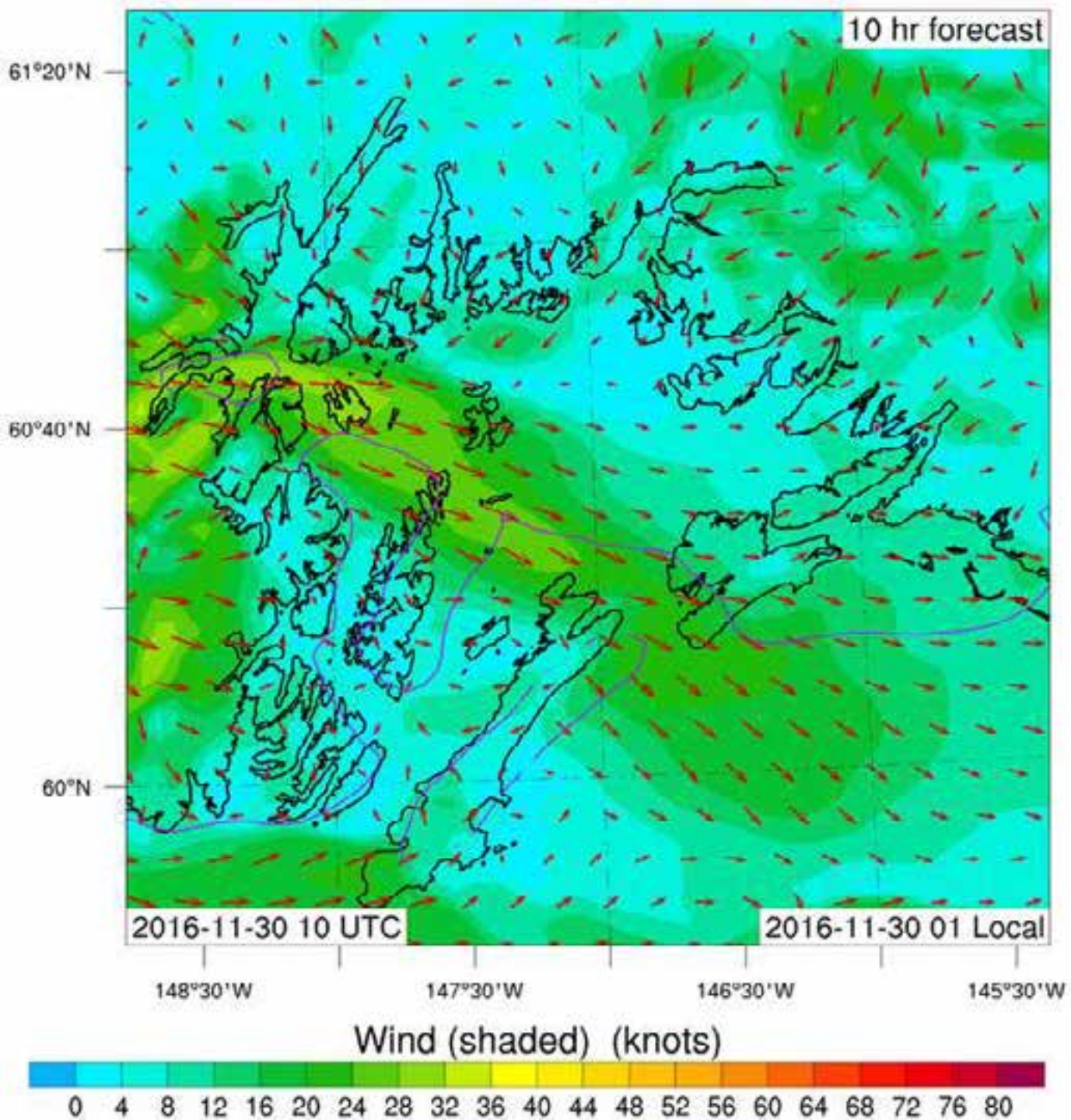
61°20'N
60°40'N
60°N
2016-11-30 09 UTC
2016-11-30 00 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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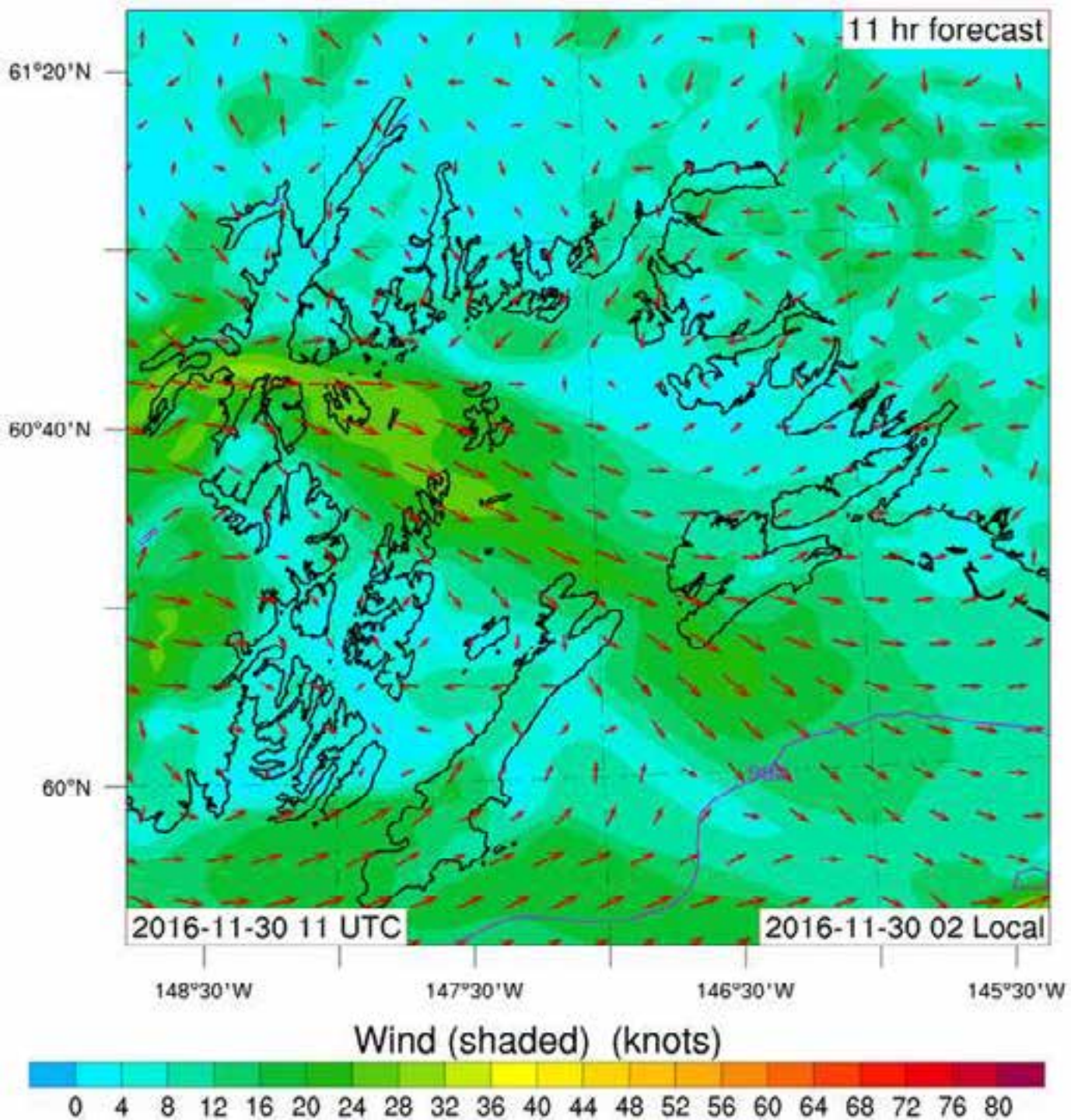
61°20'N
60°40'N
60°N
2016-11-30 10 UTC
2016-11-30 01 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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60°40'N
60°N
2016-11-30 11 UTC
2016-11-30 02 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
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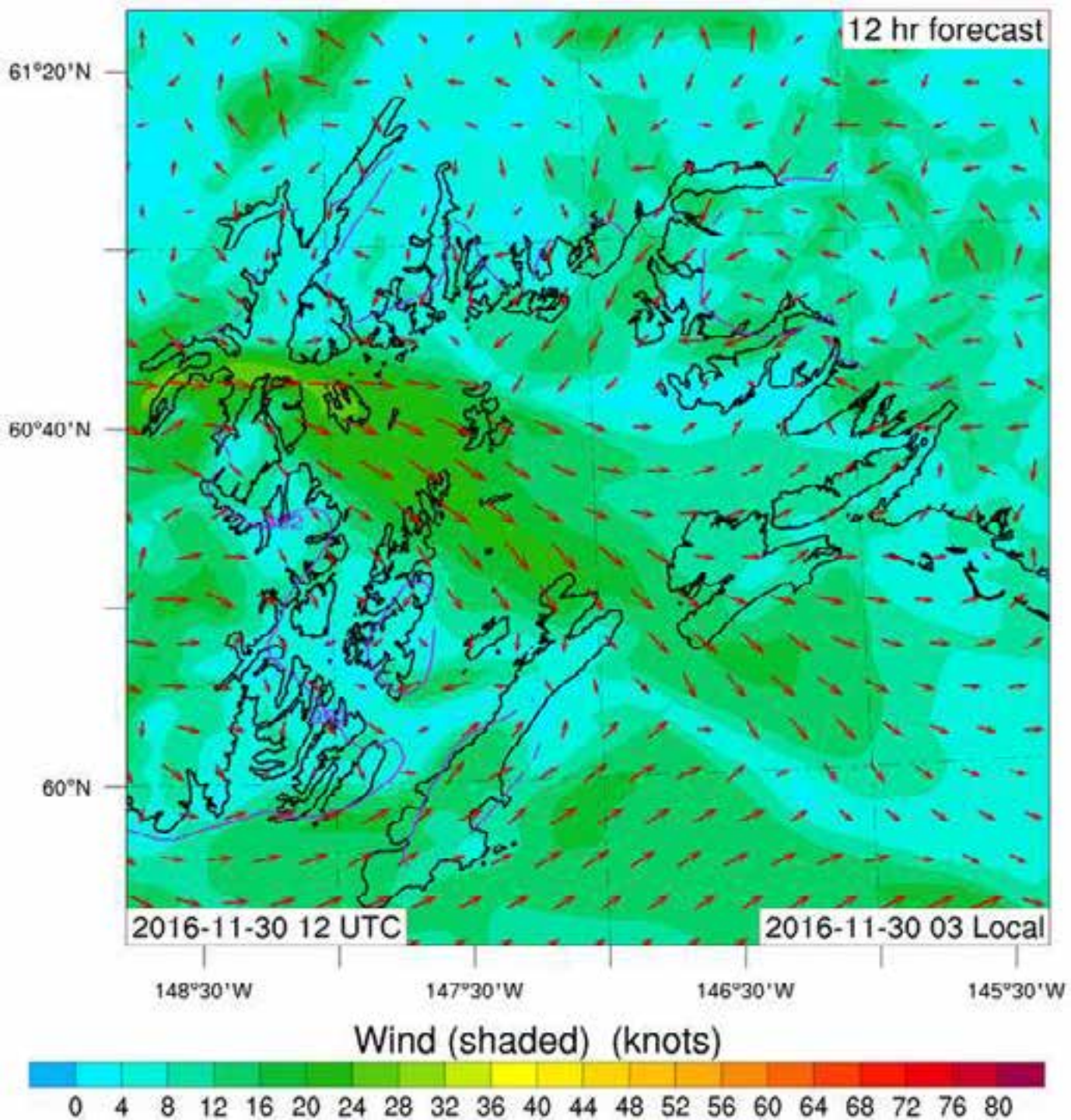
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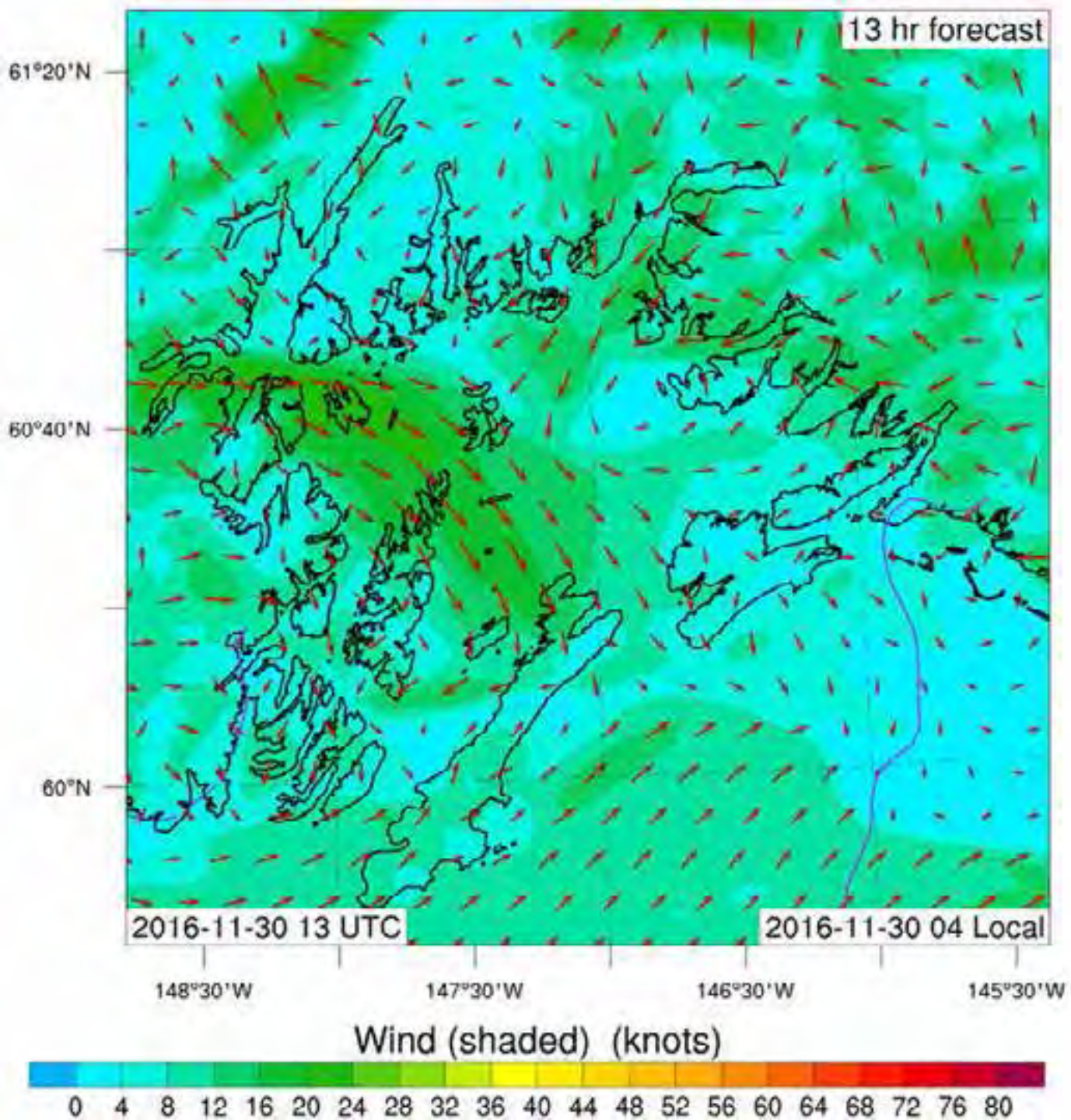
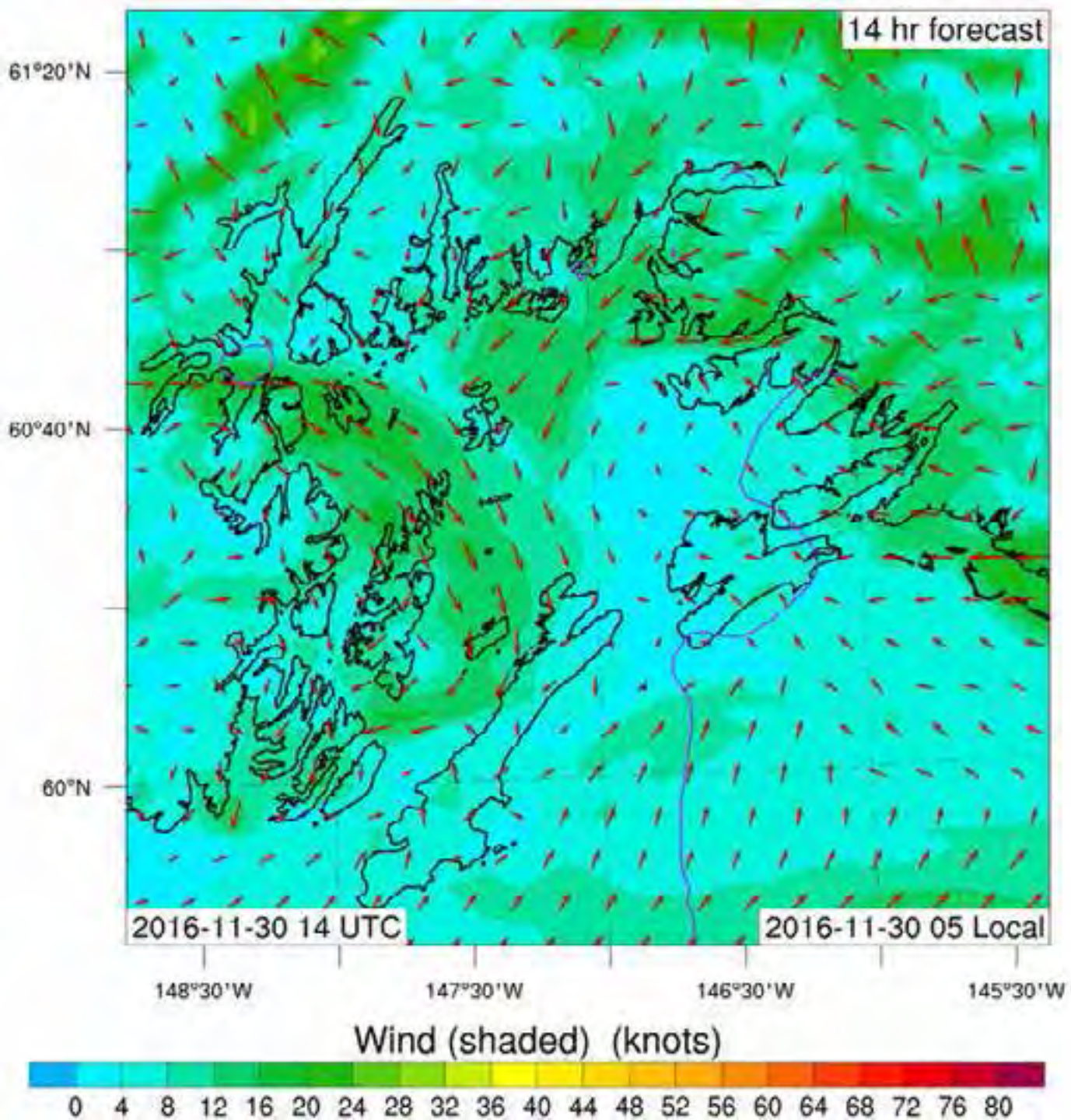
60°40'N
60°N
2016-11-30 12 UTC
2016-11-30 03 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80


13 hr forecast
61°20'N
60°40'N
60°N
2016-11-30 13 UTC
2016-11-30 04 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80


14 hr forecast
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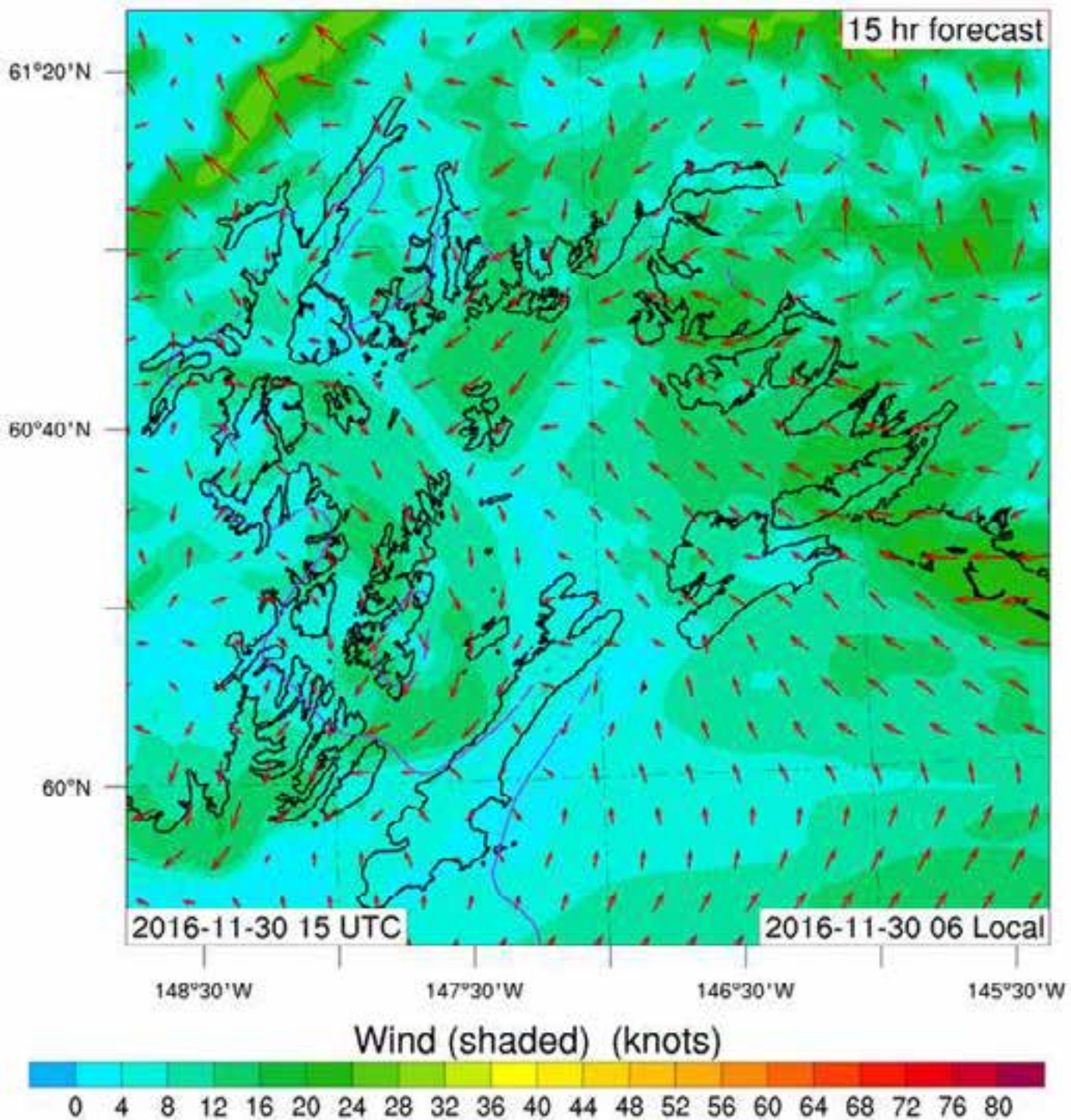
60°40'N
60°N
2016-11-30 14 UTC
2016-11-30 05 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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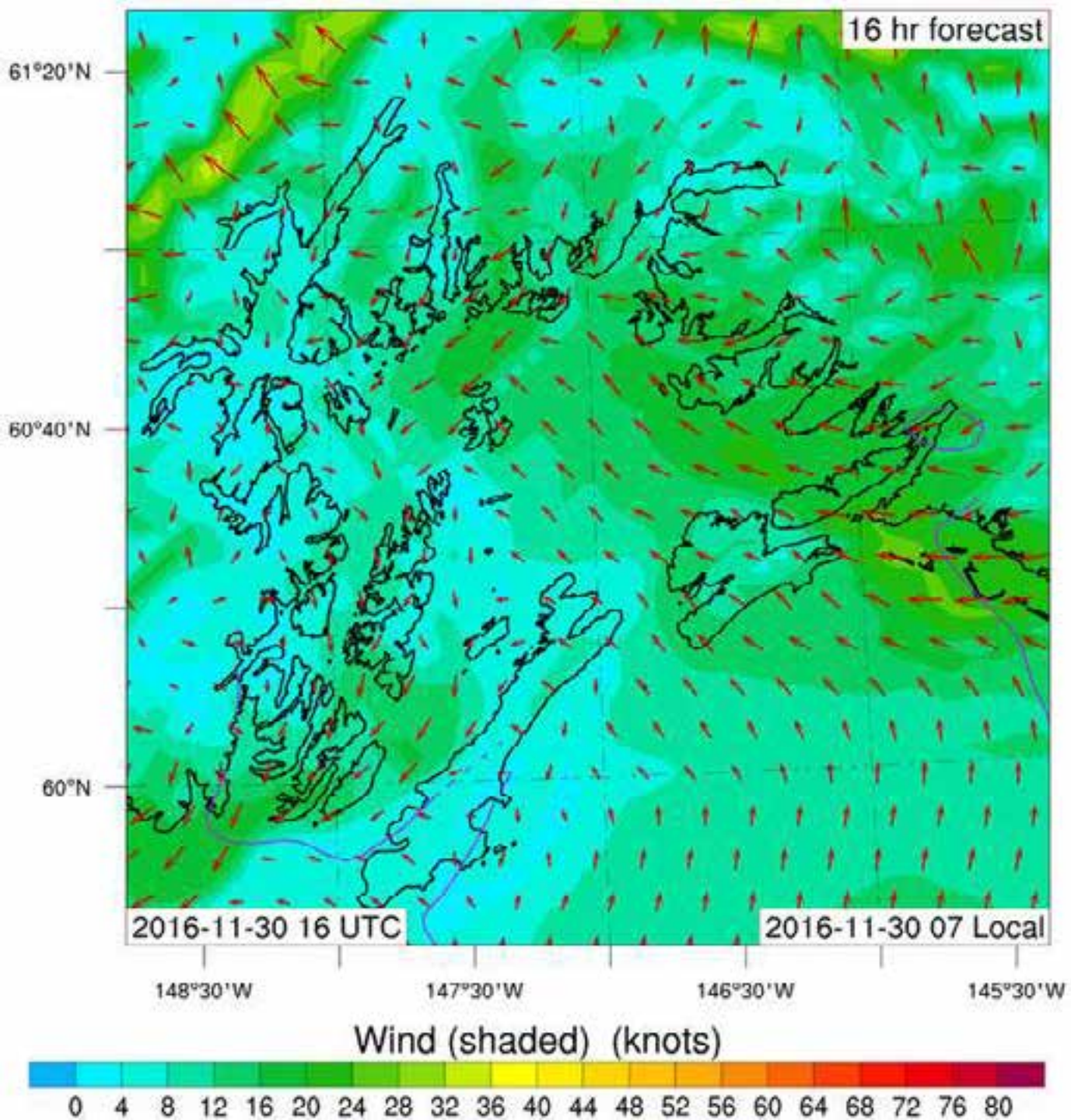
60°40'N
60°N
2016-11-30 15 UTC
2016-11-30 06 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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2016-11-30 16 UTC
2016-11-30 07 Local
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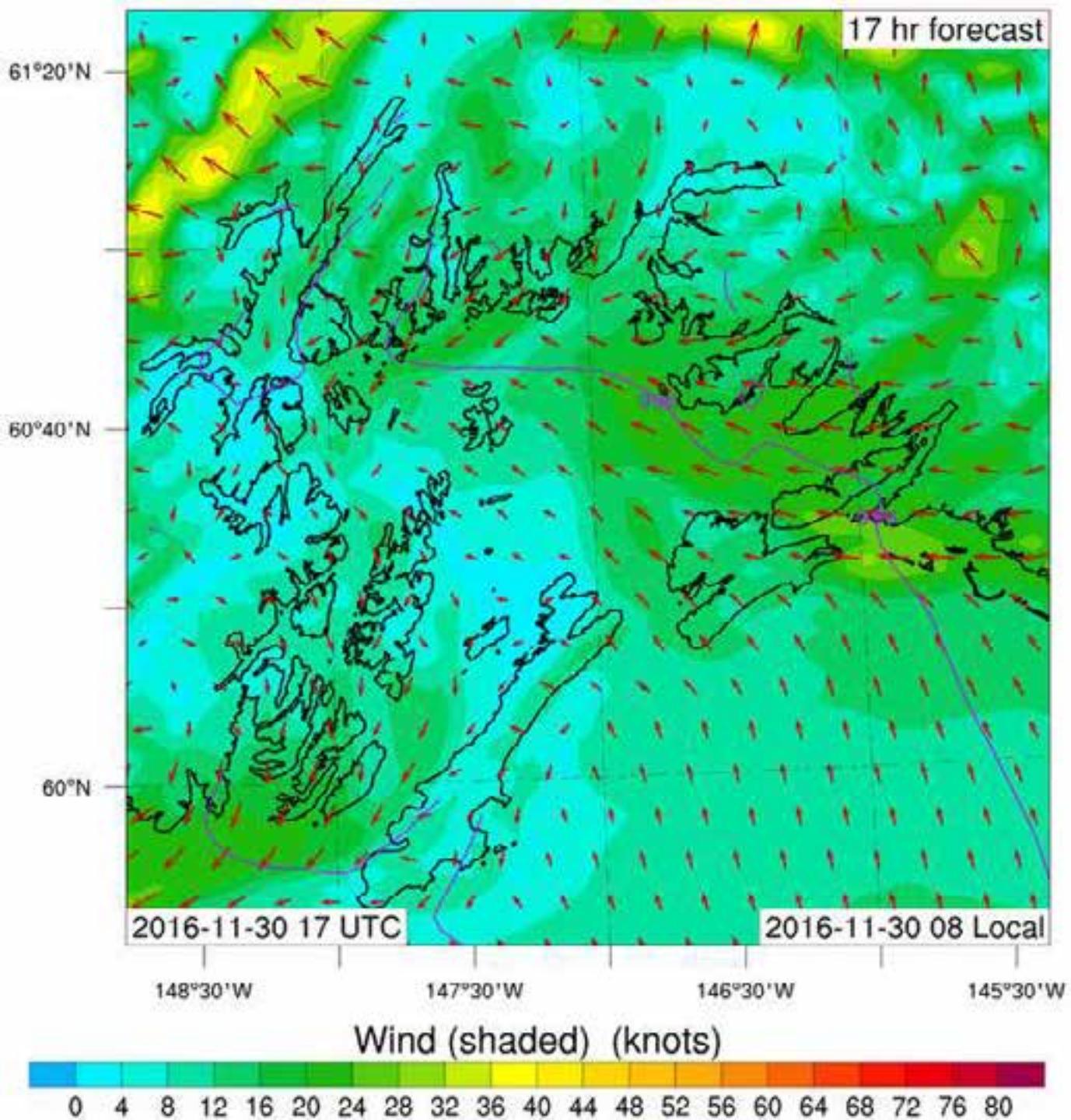
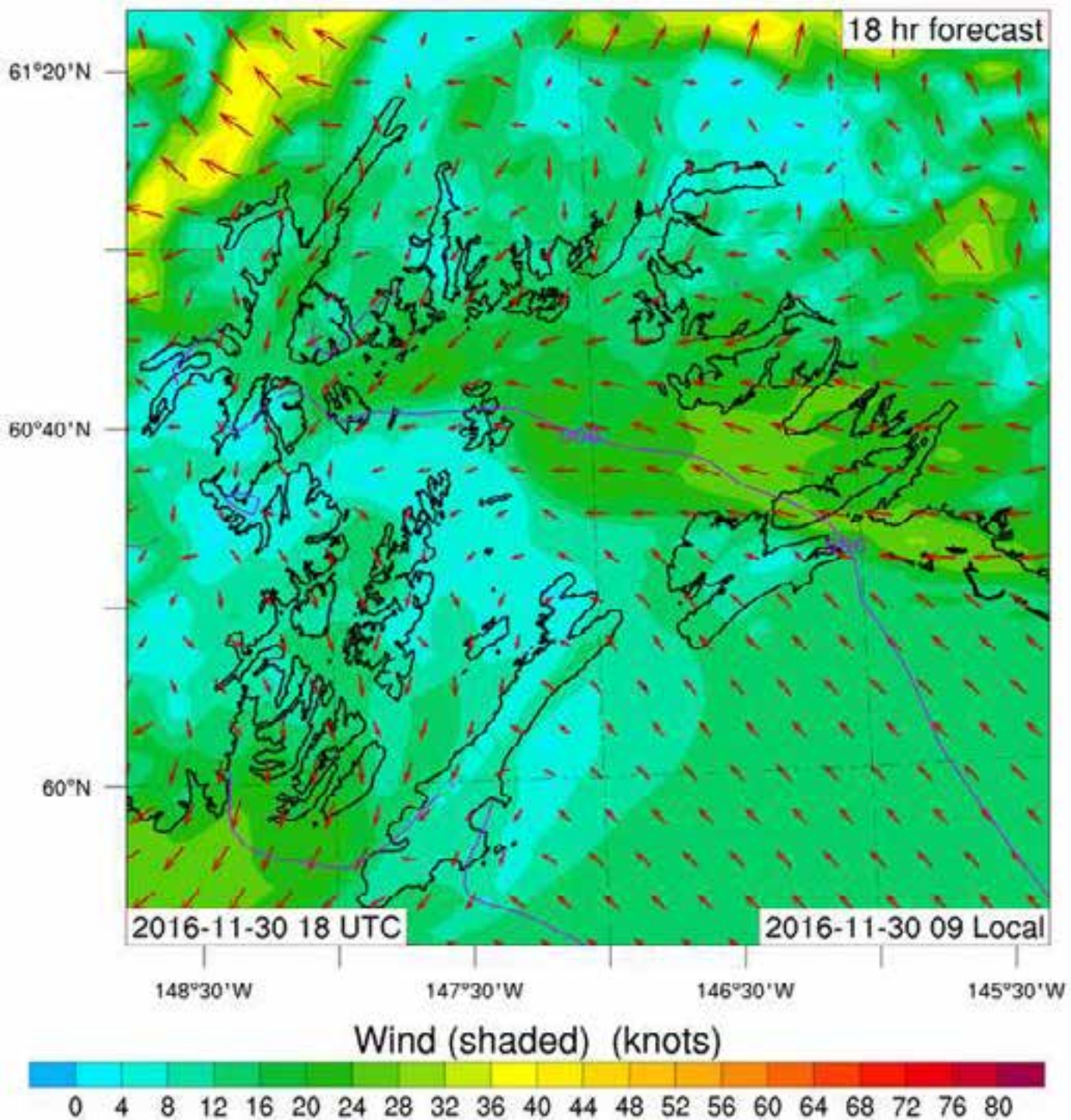
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80


17 hr forecast
61°20'N
60°40'N
60°N
2016-11-30 17 UTC
2016-11-30 08 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80


18 hr forecast
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60°40'N
60°N
2016-11-30 18 UTC
2016-11-30 09 Local
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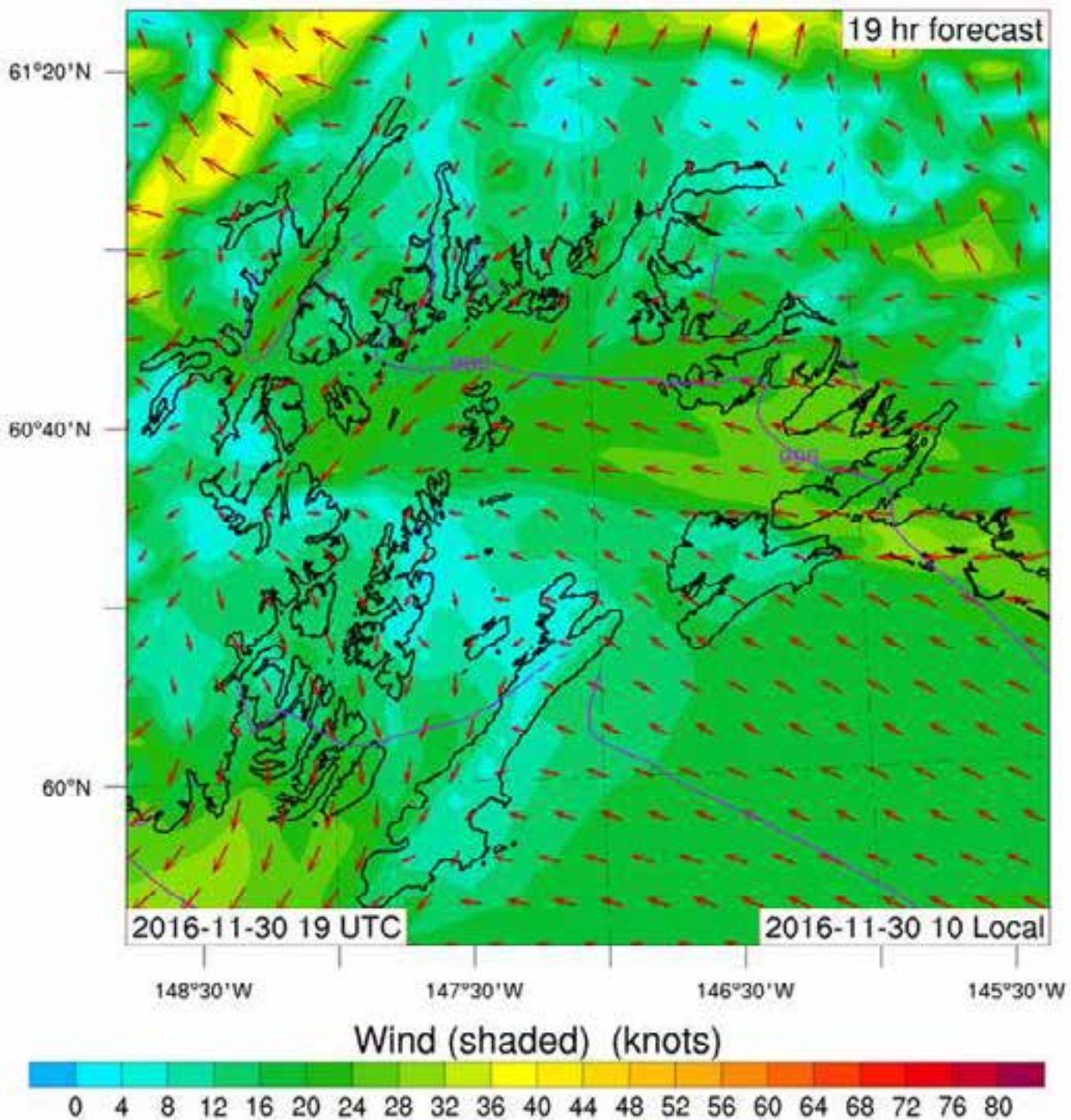
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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61°20'N
60°40'N
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2016-11-30 19 UTC
2016-11-30 10 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
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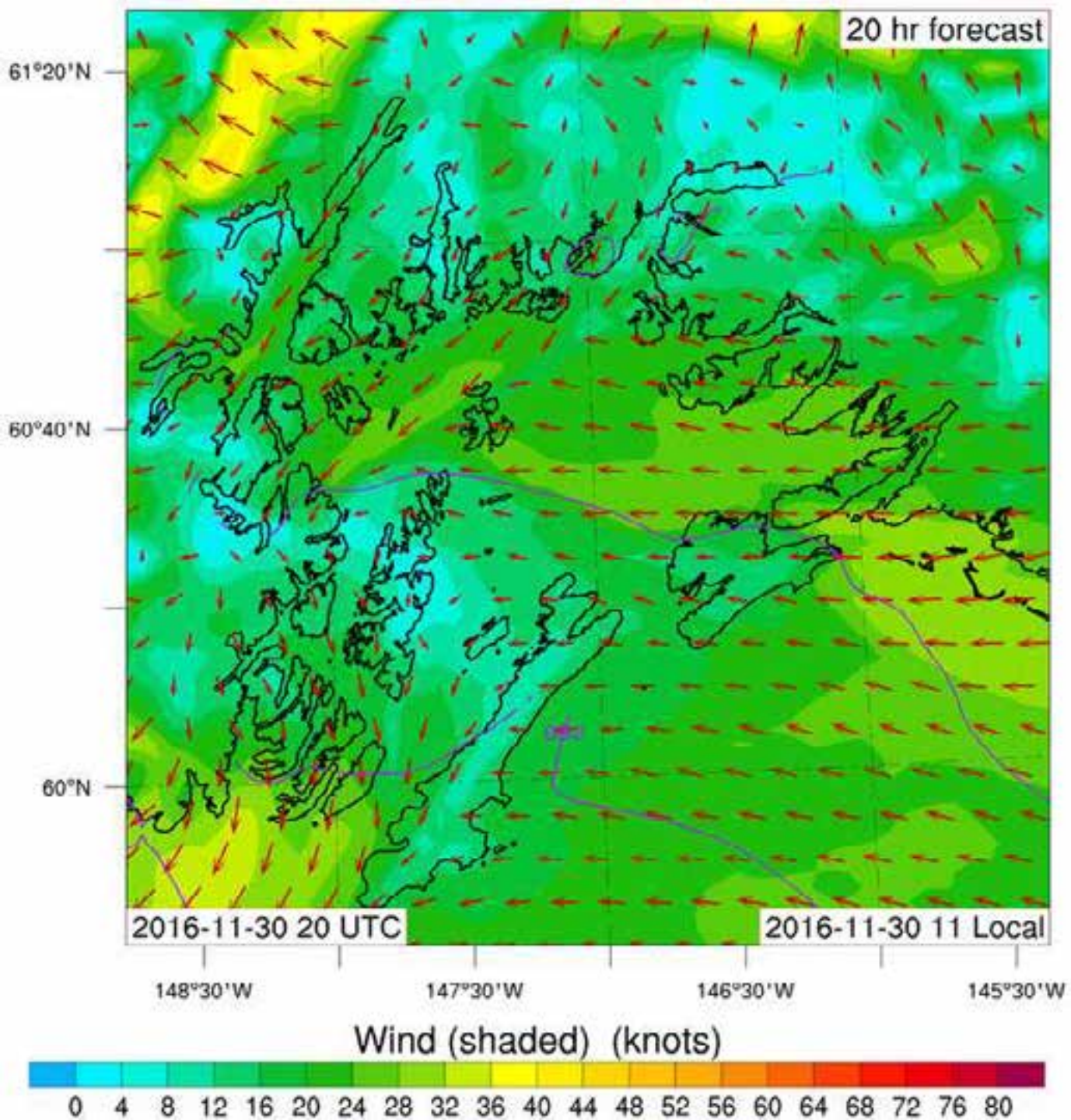
20 hr forecast
61°20'N
60°40'N
60°N
2016-11-30 20 UTC
2016-11-30 11 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
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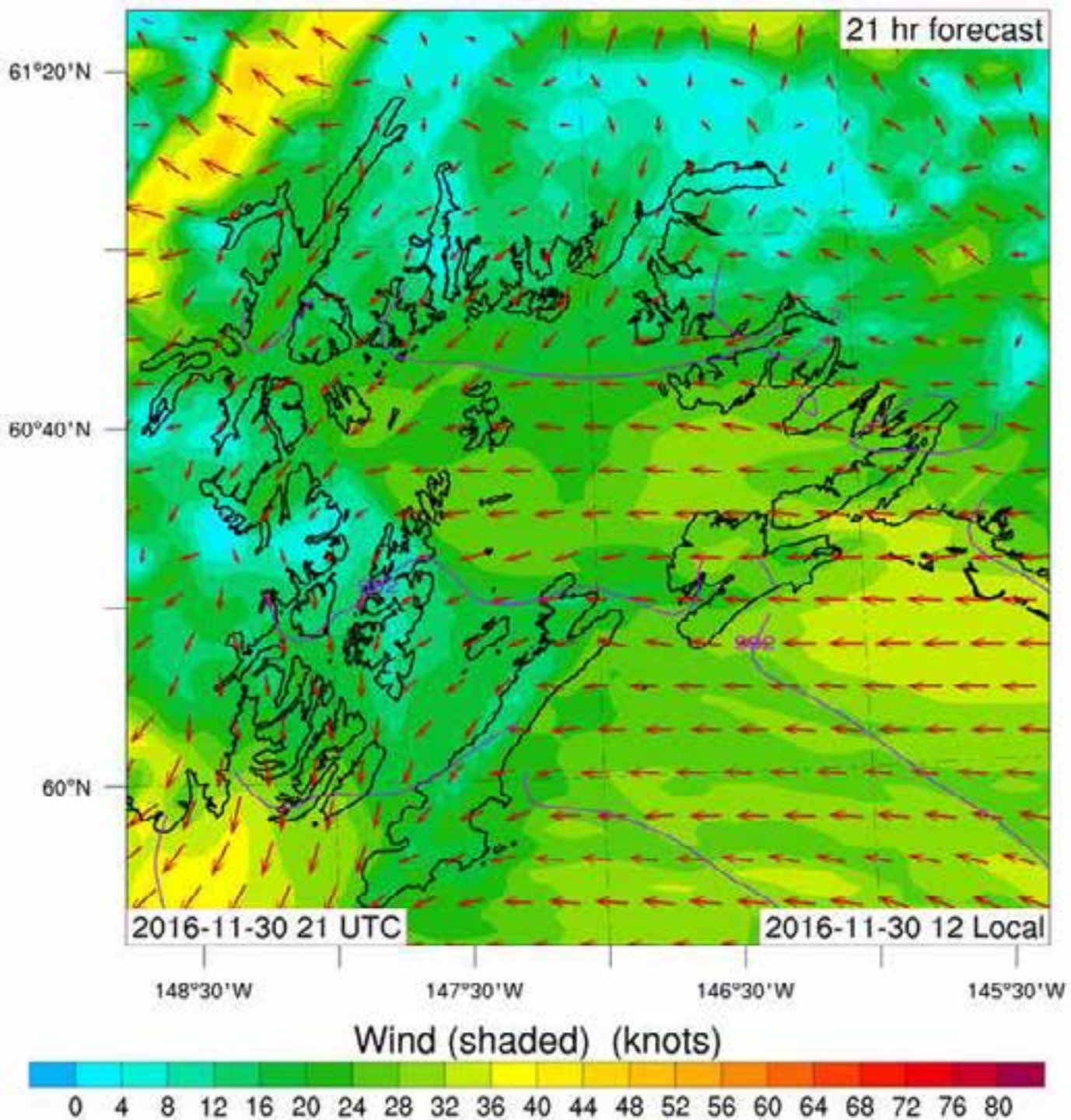
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60°40'N
60°N
2016-11-30 21 UTC
2016-11-30 12 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
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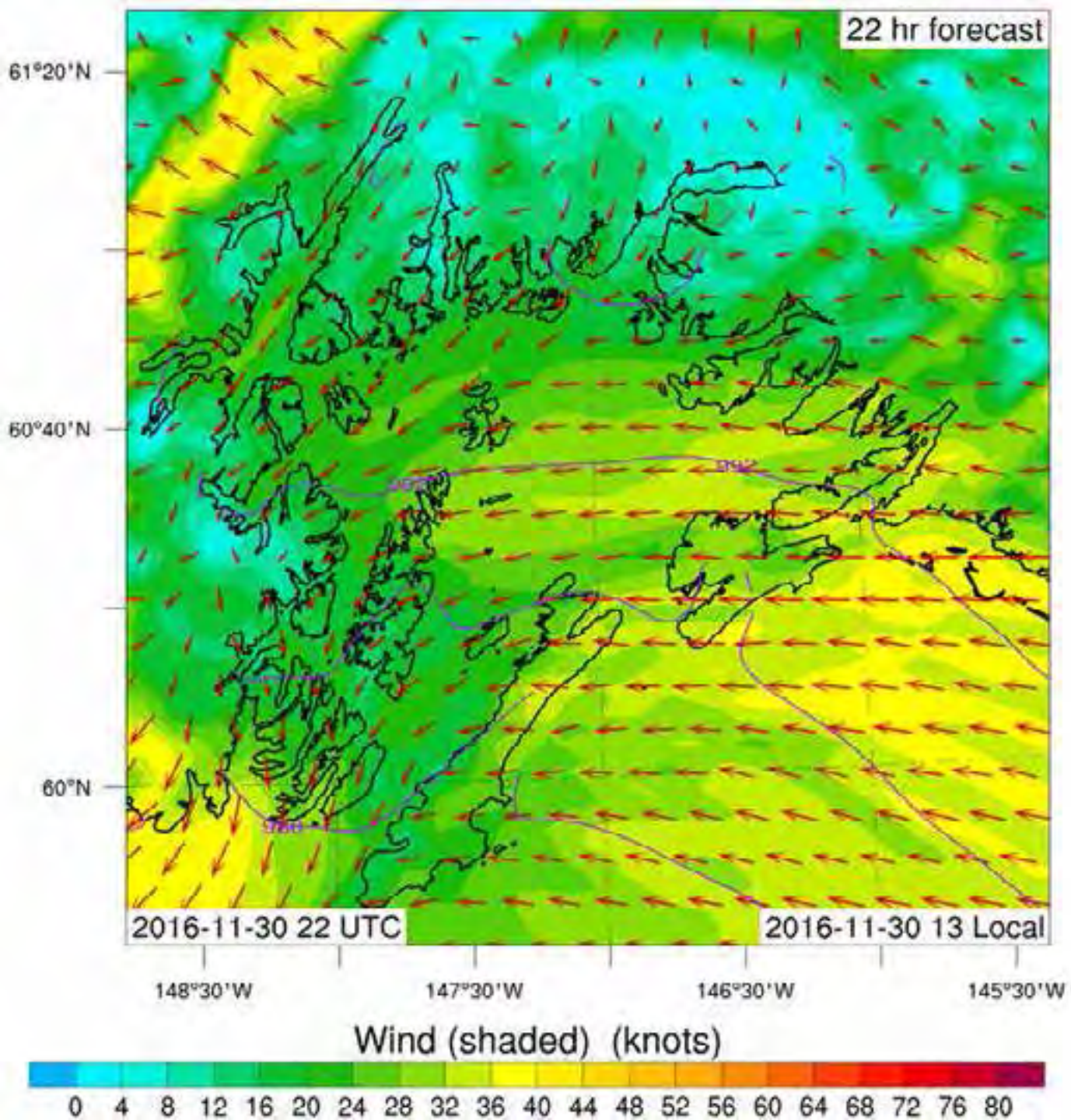
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2016-11-30 13 Local
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145°30'W
Wind (shaded) (knots)
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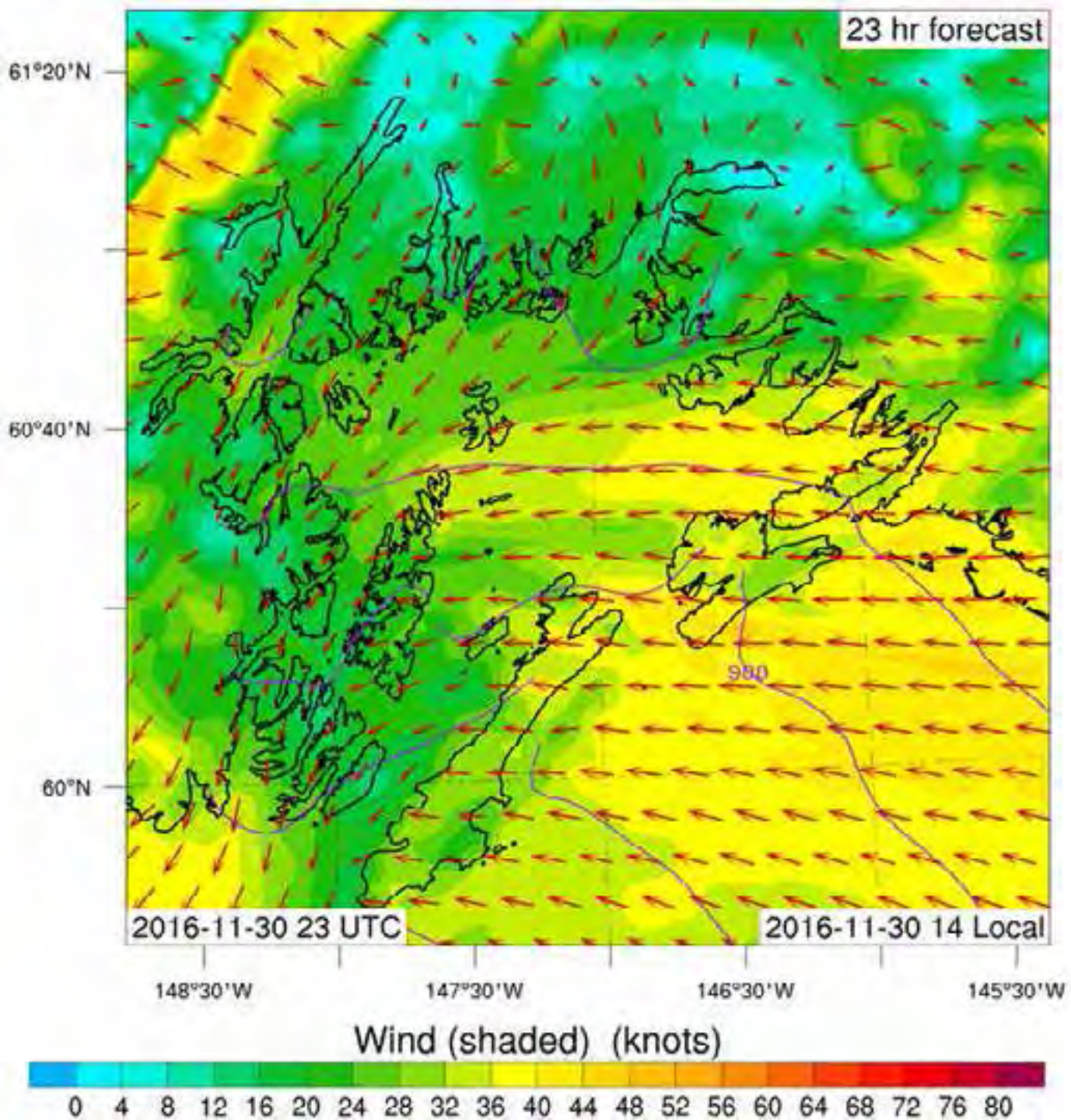
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60°N
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2016-11-30 14 Local
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146°30'W
145°30'W
Wind (shaded) (knots)
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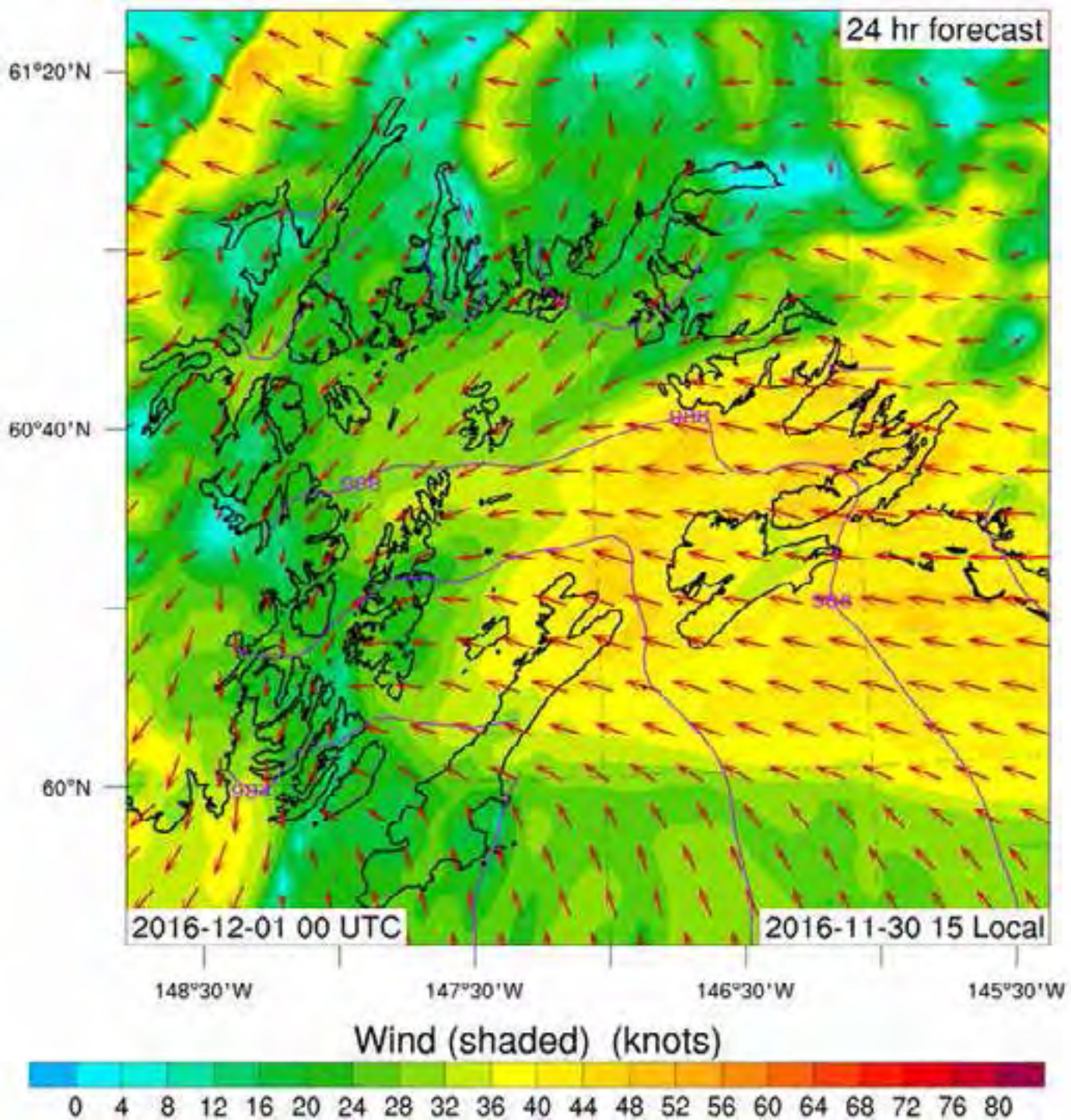
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60°40'N
60°N
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2016-11-30 15 Local
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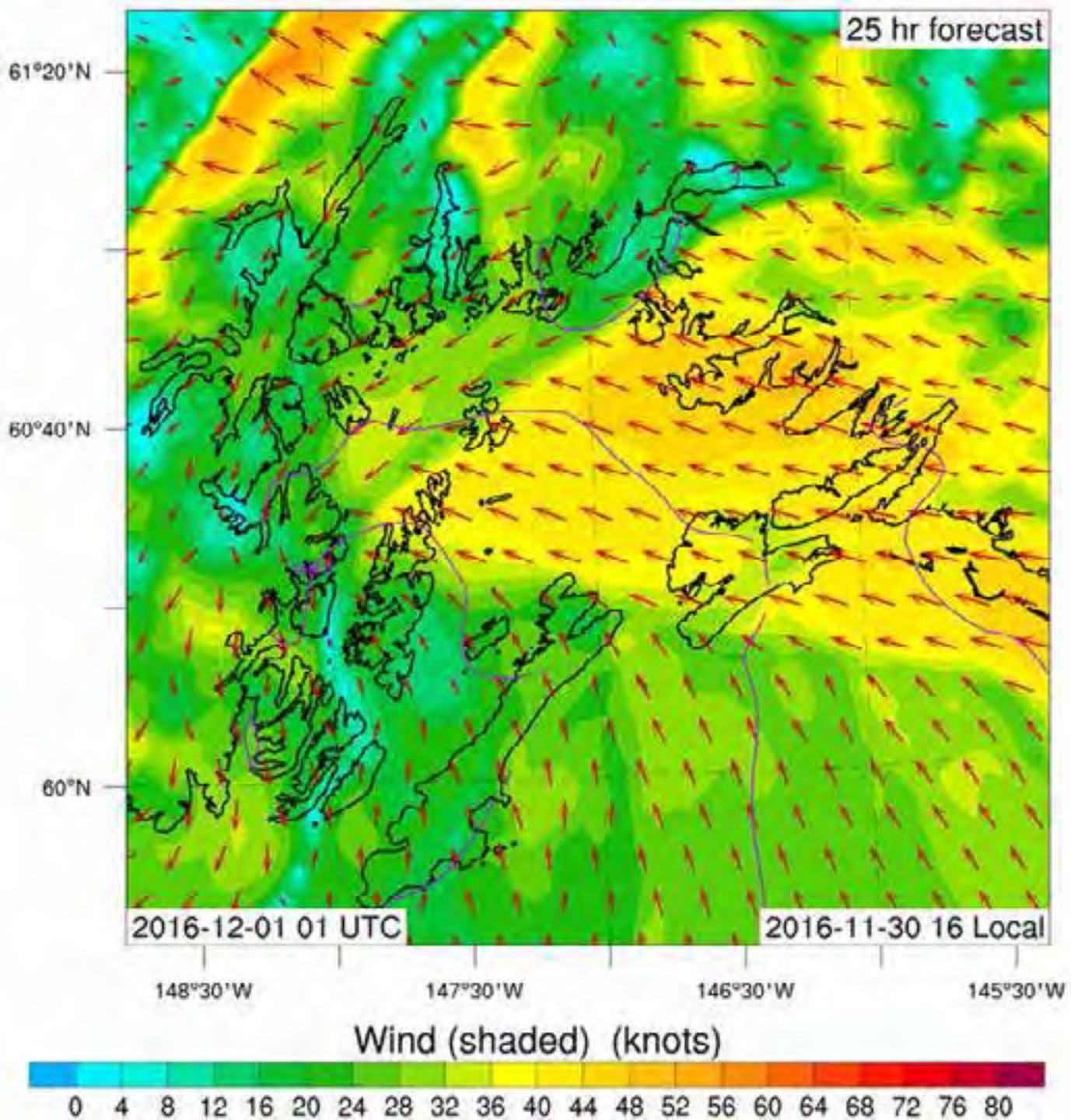
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80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60°40'N
60°N
2016-12-01 01 UTC
2016-11-30 16 Local
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147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
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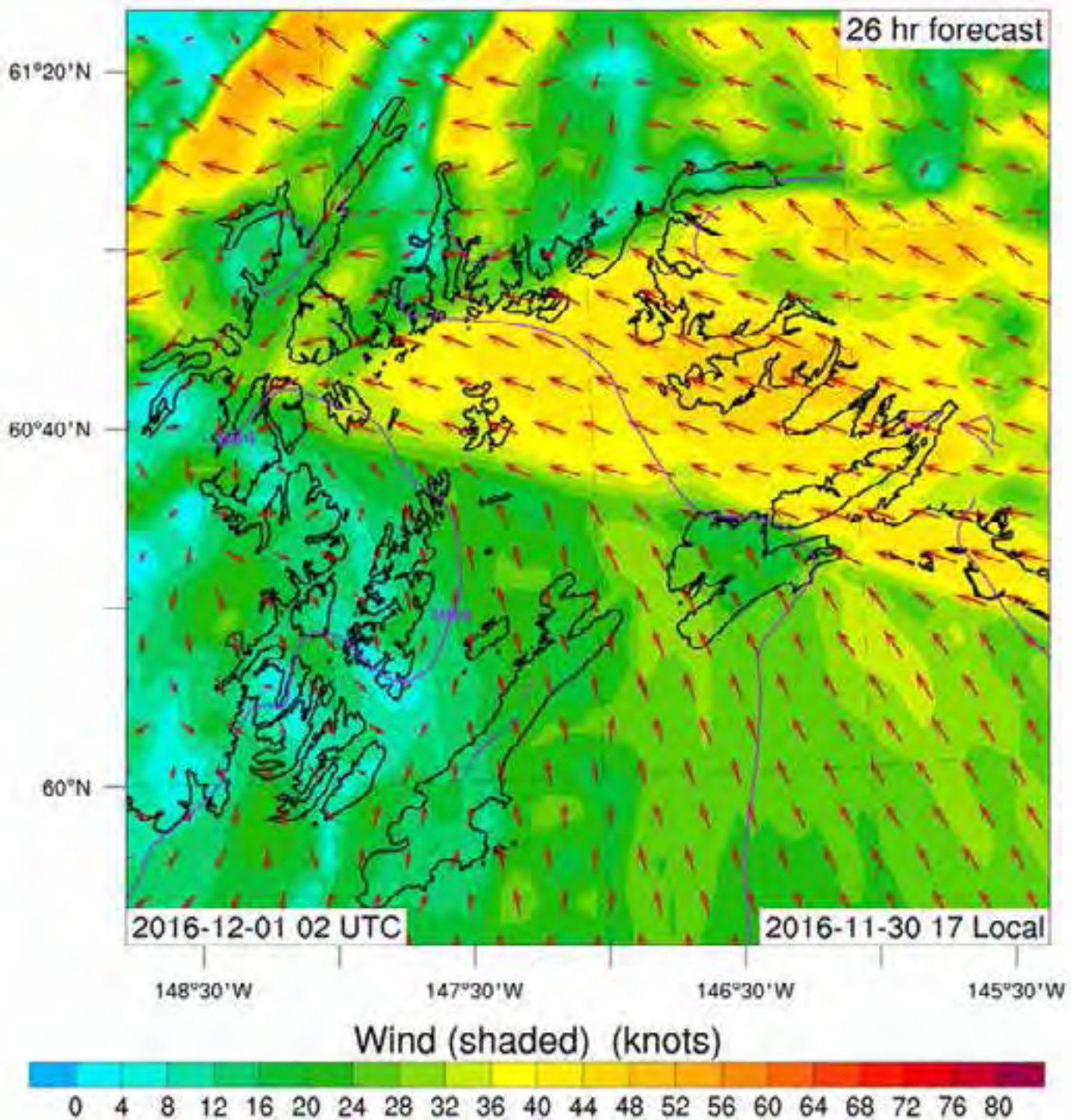
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60°40'N
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2016-12-01 02 UTC
2016-11-30 17 Local
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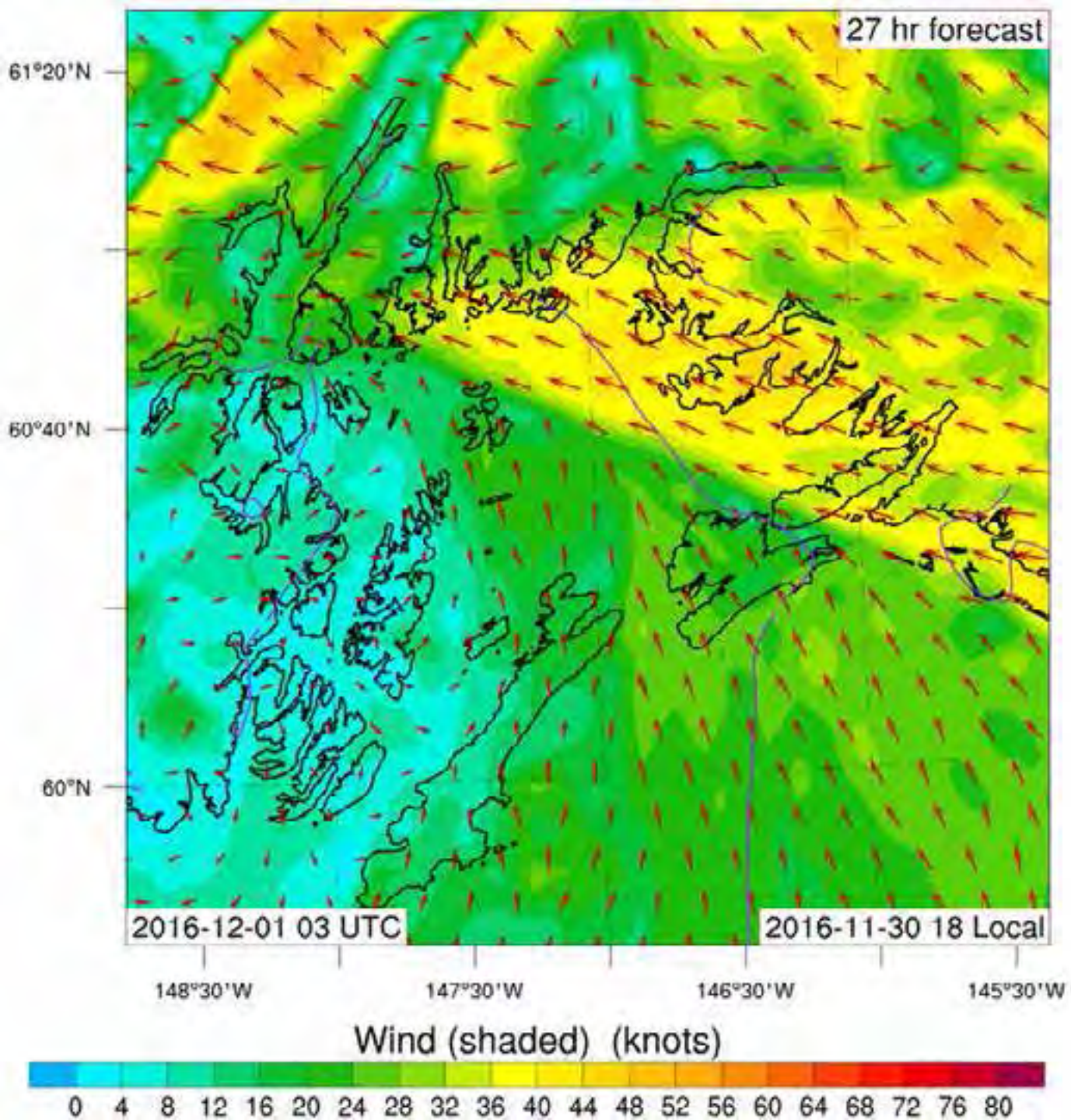
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80


27 hr forecast
61°20'N
60°40'N
60°N
2016-12-01 03 UTC
2016-11-30 18 Local
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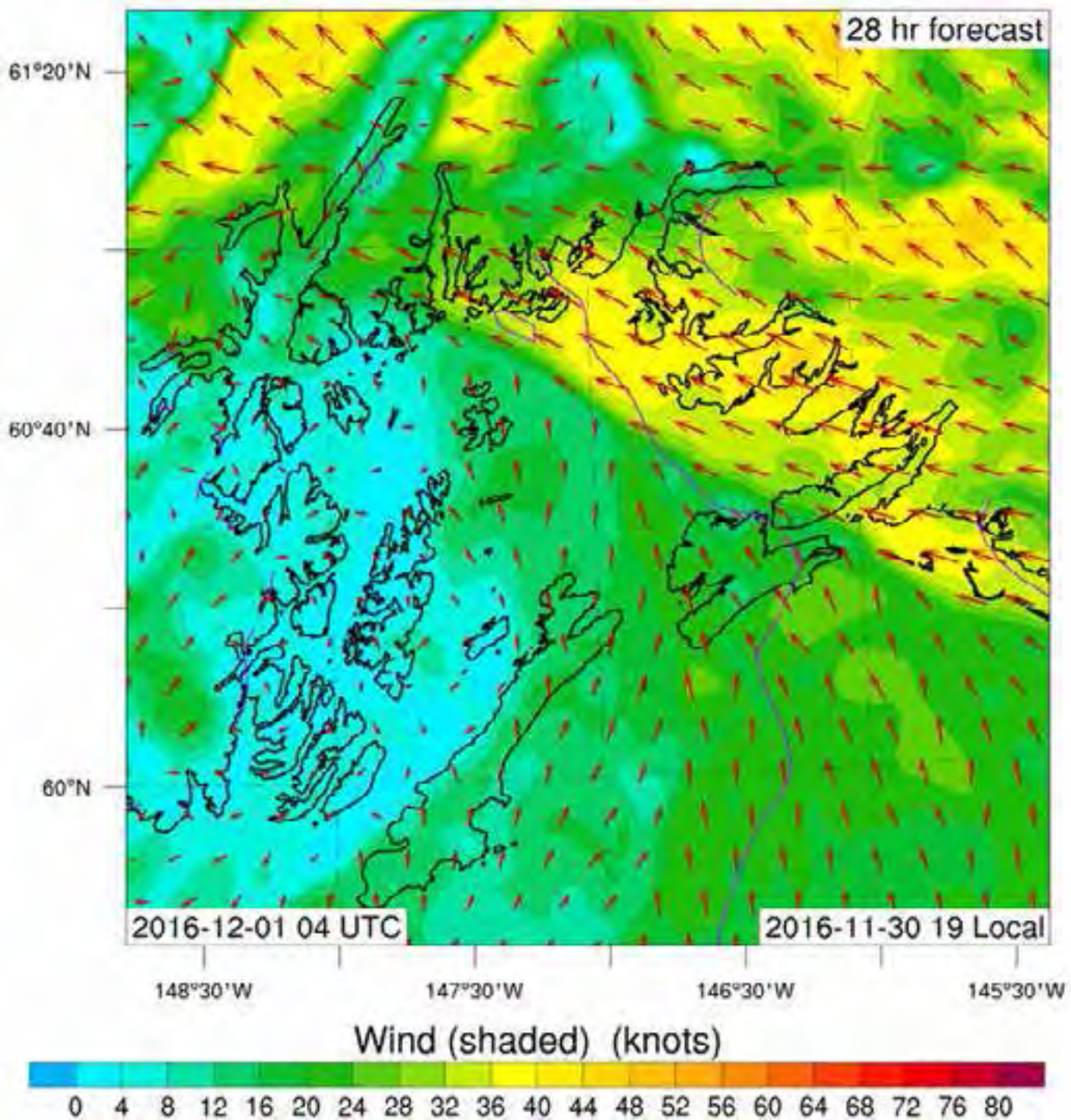
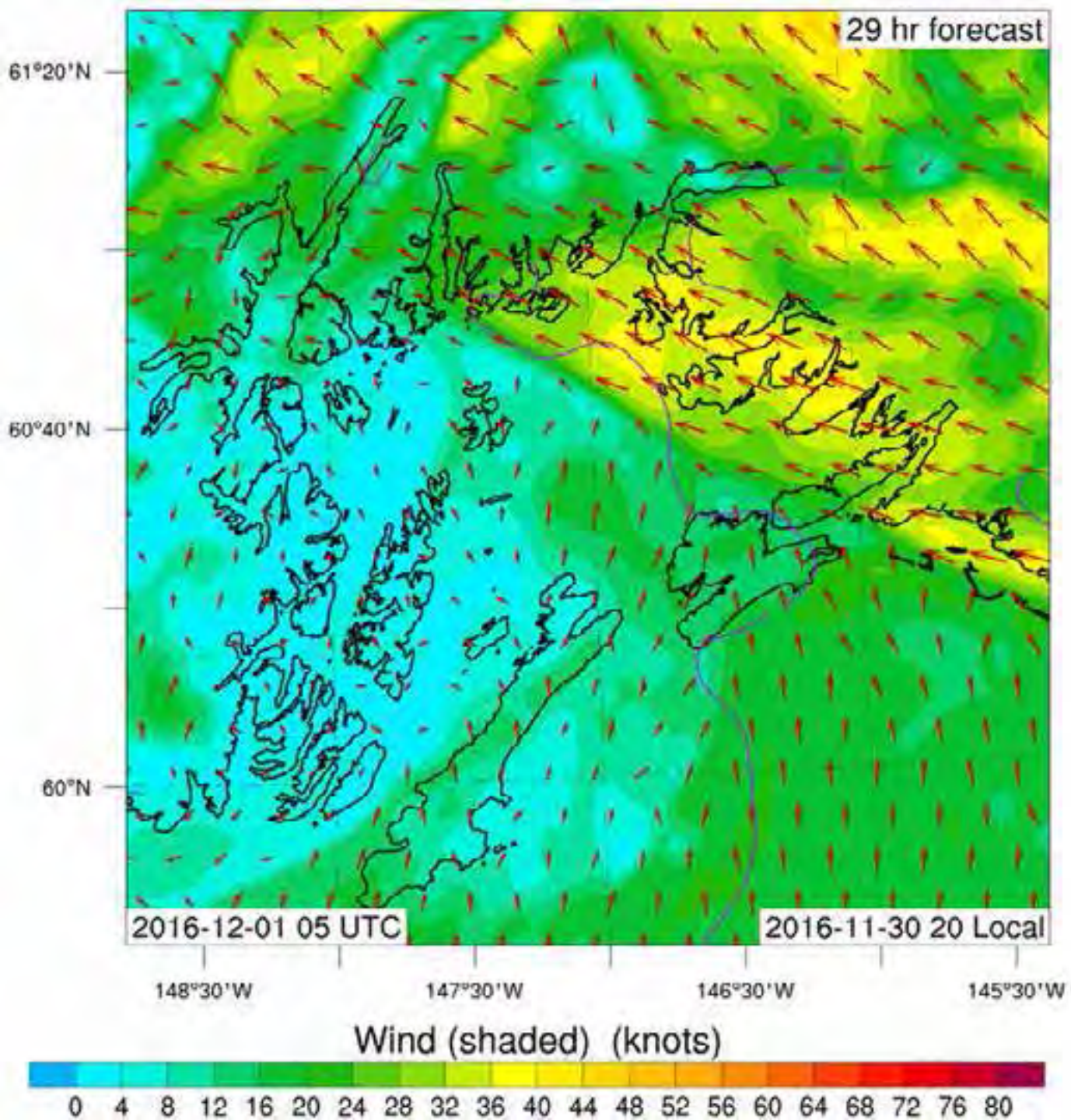
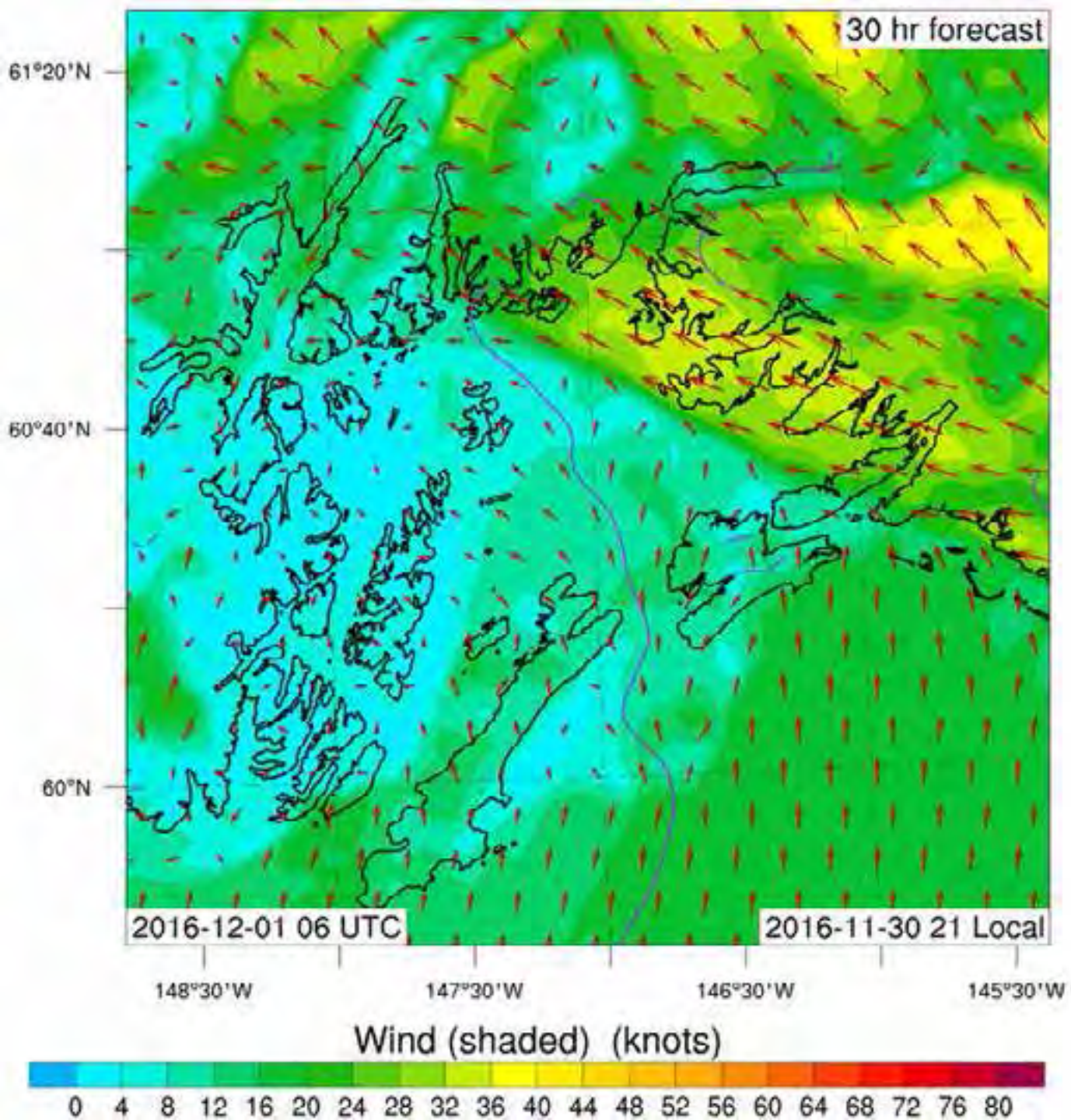
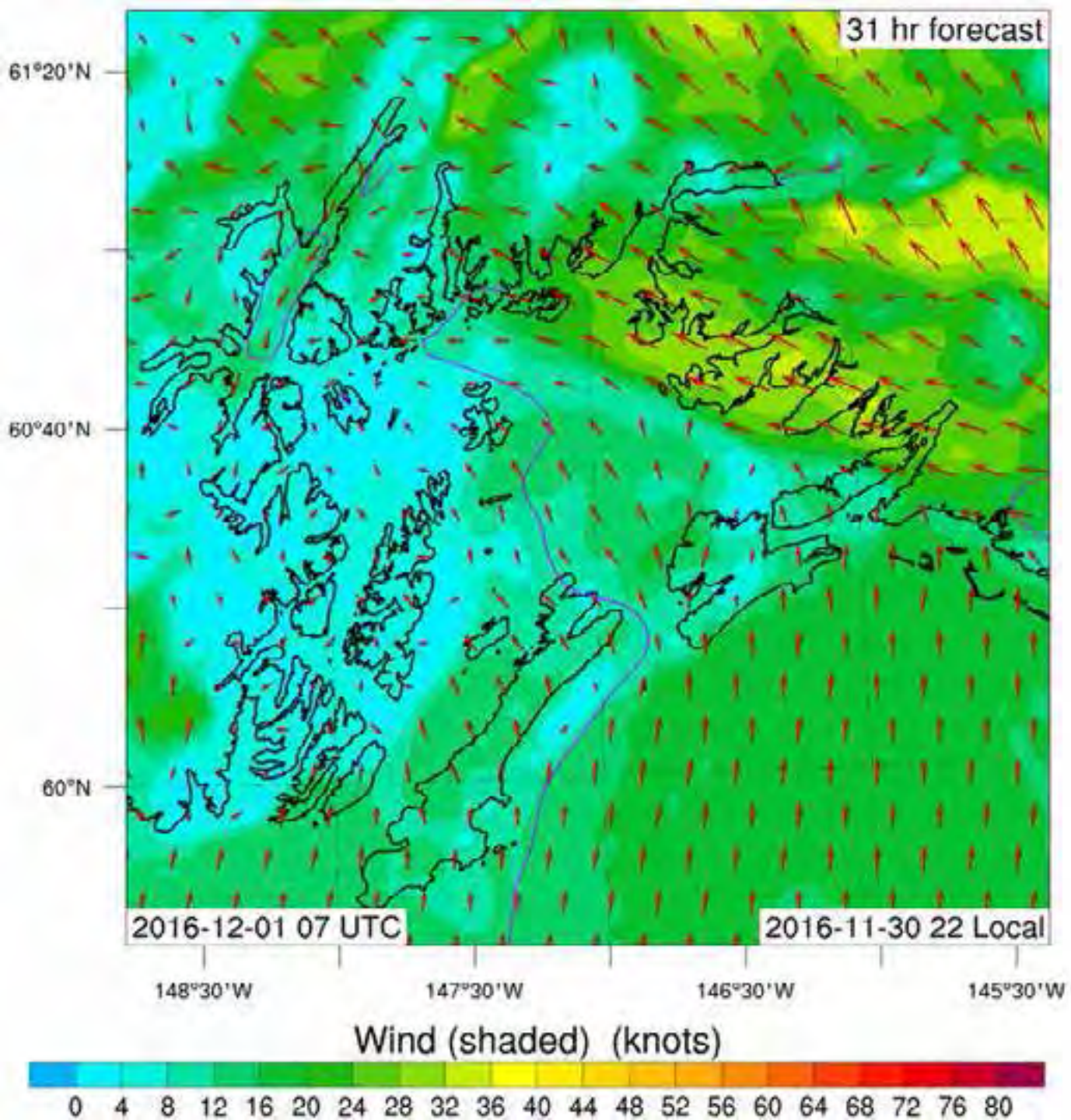
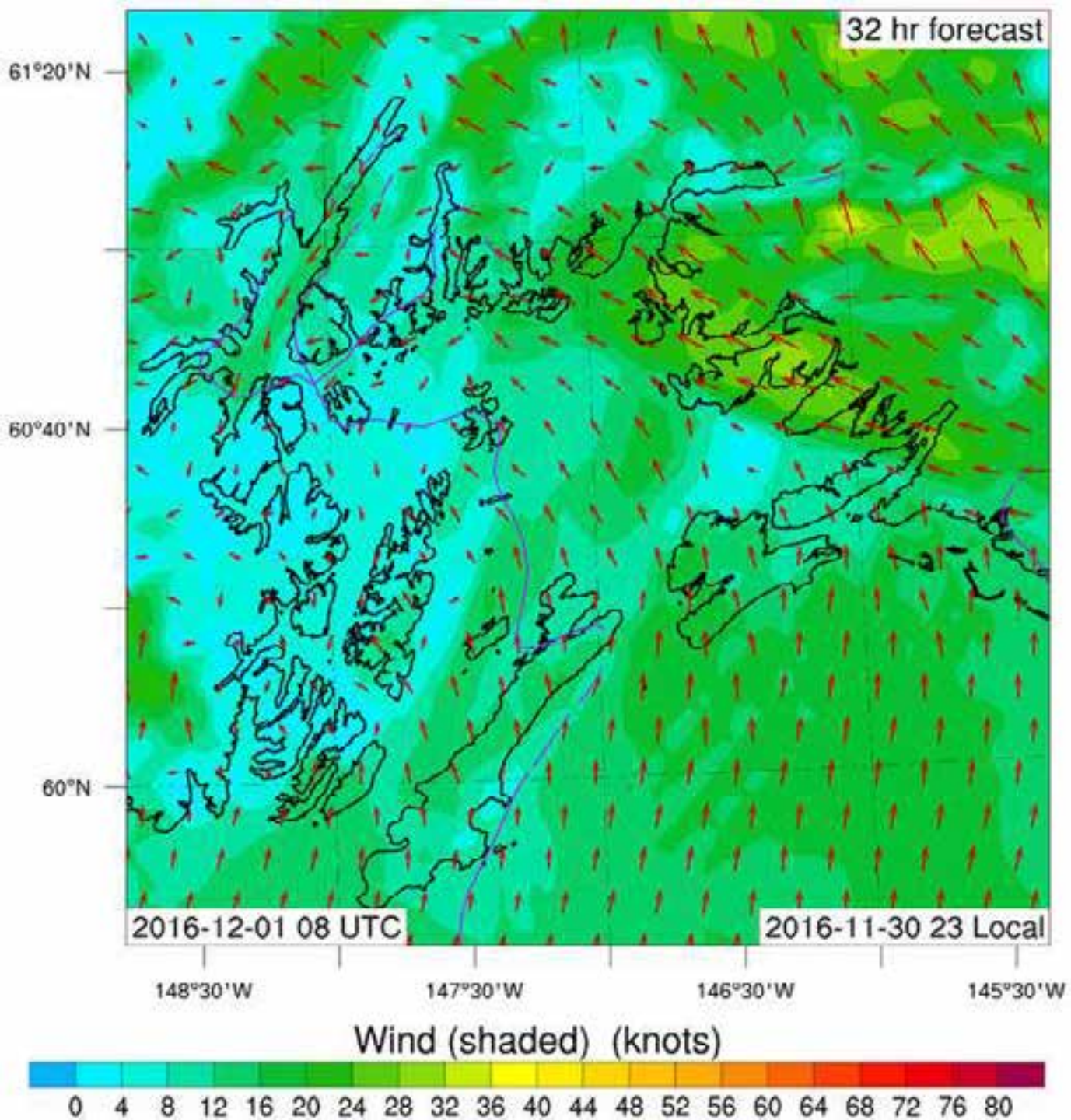
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80


28 hr forecast
61°20'N
60°40'N
60°N
2016-12-01 04 UTC
2016-11-30 19 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80

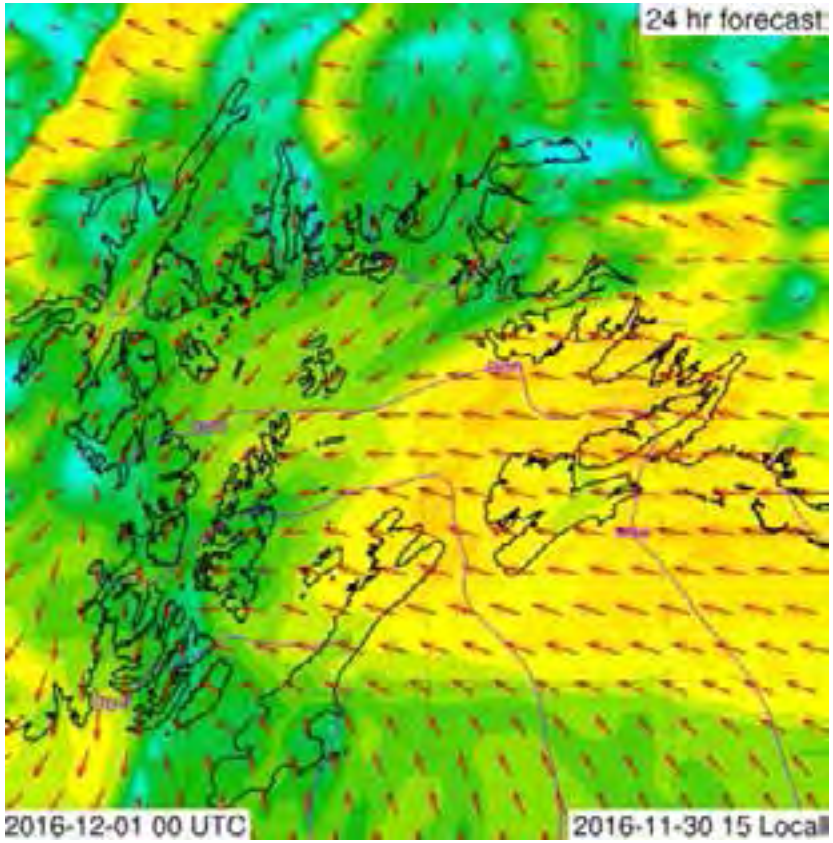

29 hr forecast
61°20'N
60°40'N
60°N
2016-12-01 05 UTC
2016-11-30 20 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80


30 hr forecast
61°20'N
60°40'N
60°N
2016-12-01 06 UTC
2016-11-30 21 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80

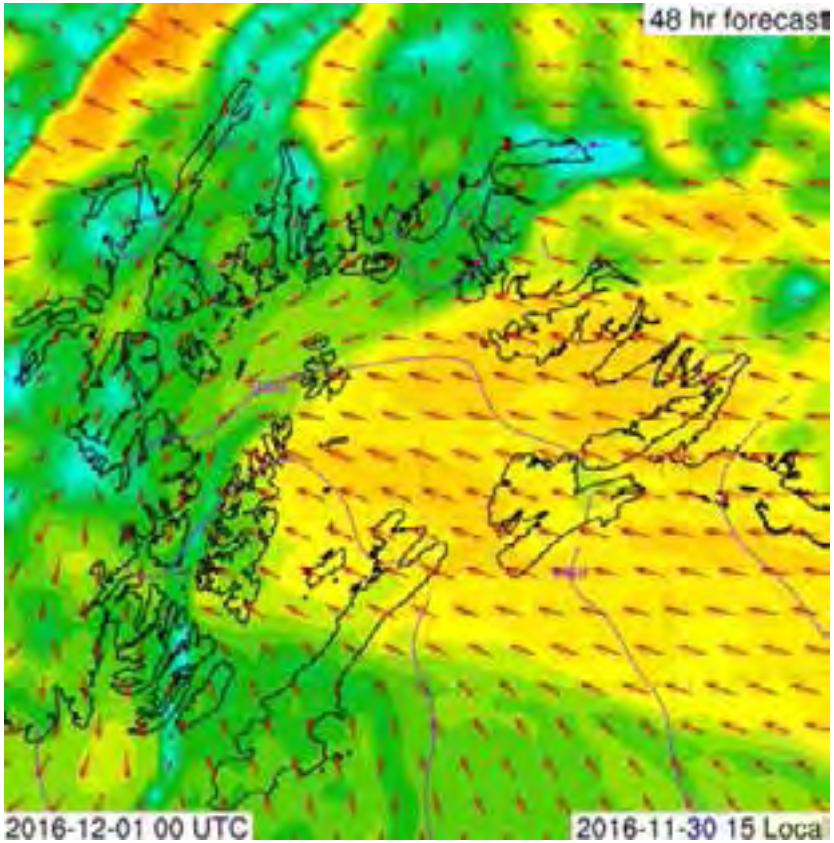

31 hr forecast
61°20'N
60°40'N
60°N
2016-12-01 07 UTC
2016-11-30 22 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80


32 hr forecast
61°20'N
60°40'N
60°N
2016-12-01 08 UTC
2016-11-30 23 Local
148°30'W
147°30'W
146°30'W
145°30'W
Wind (shaded) (knots)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80

So… how well does PWS-WRF do for longer times?



Forecast one day out



Forecast two days out

Pretty fair, if general agreement with more contemporary forecasts is any measure…

That’s all for now!

All feedback is welcome: ***pqolsson@alaska.edu***

Big whirls have little whirls that feed on their velocity
And little whirls have lesser whirls and so on to v
Lewis Fry Richardson