Downslope windstorms of San Diego County

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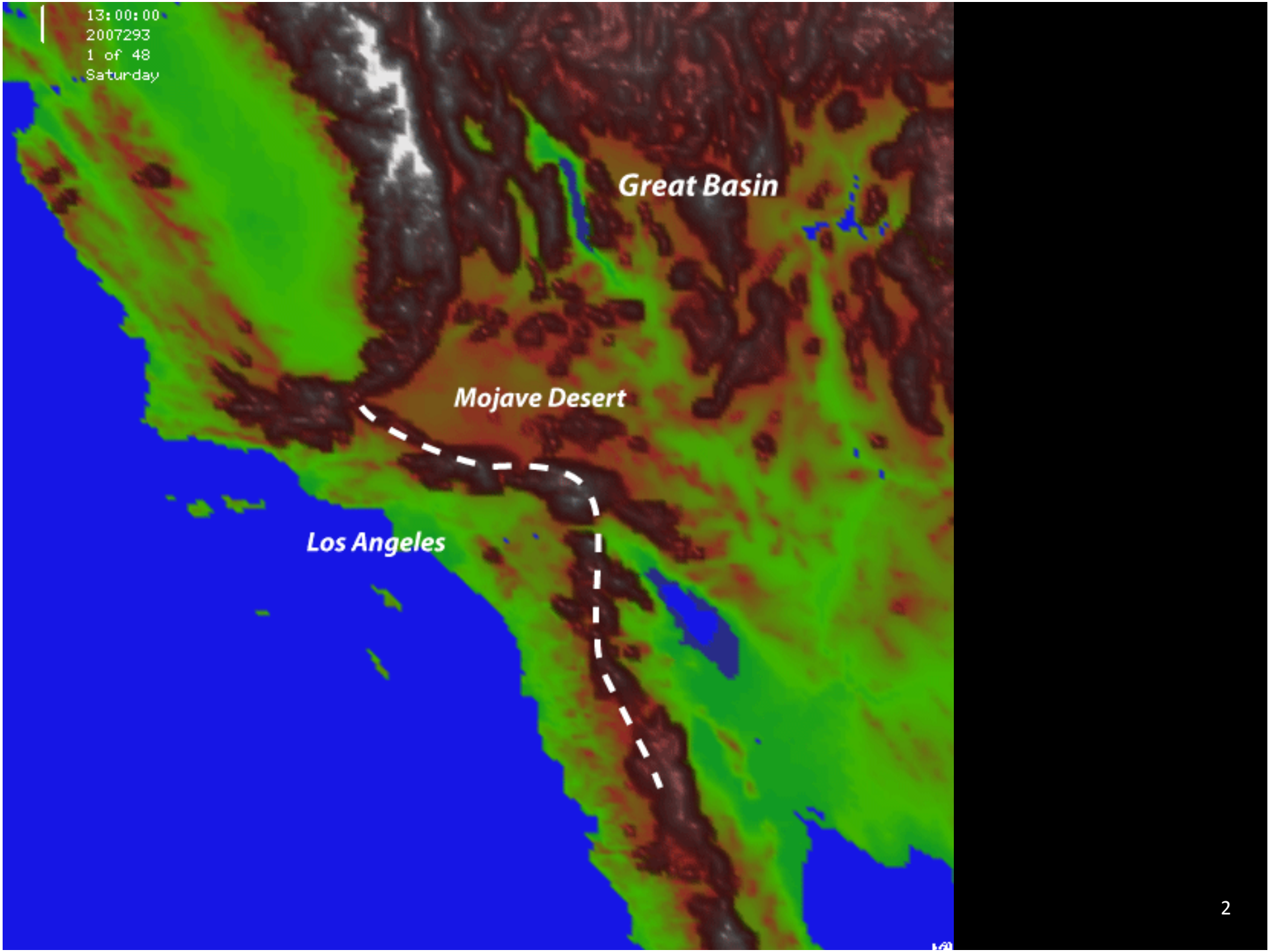
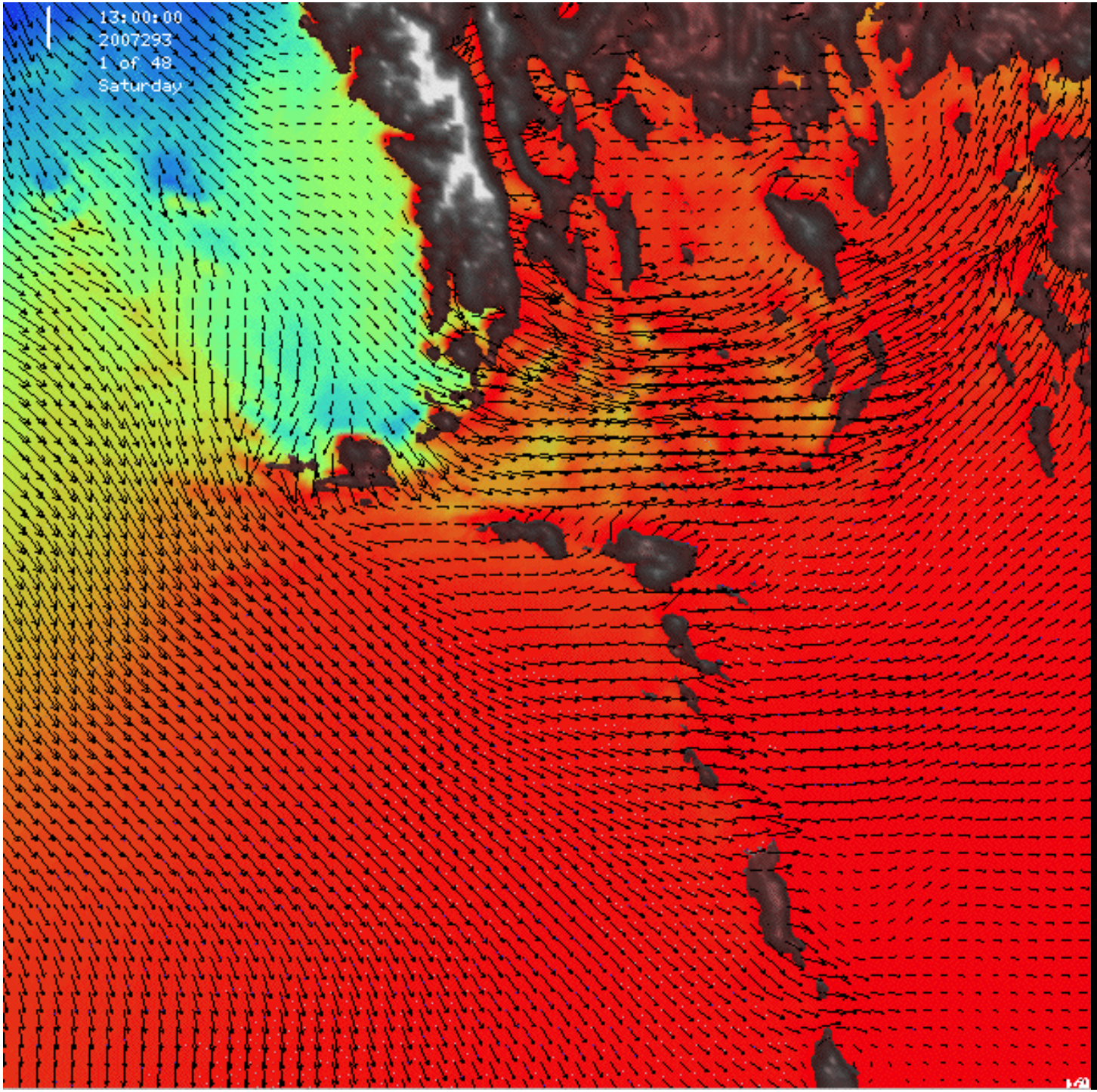
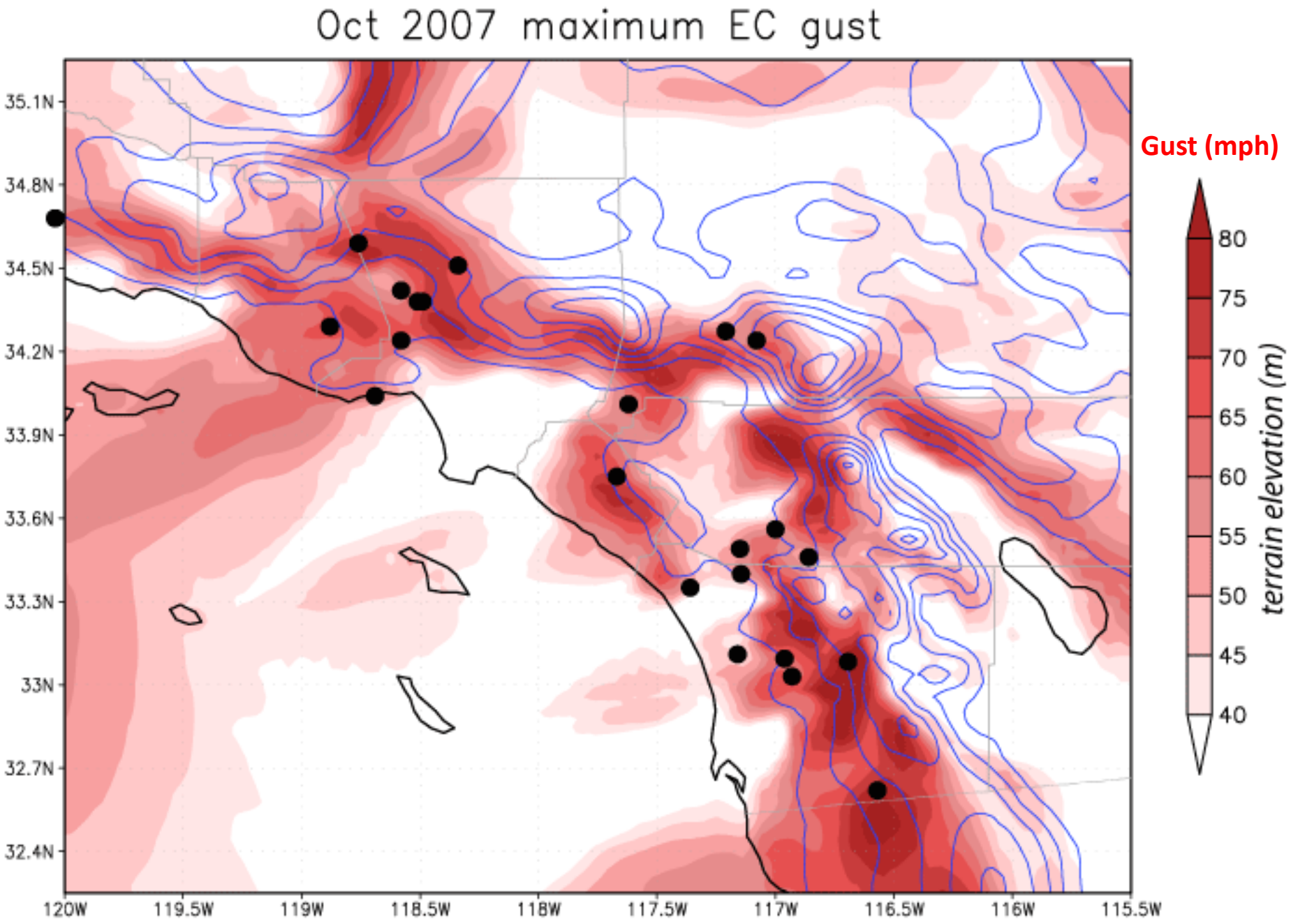
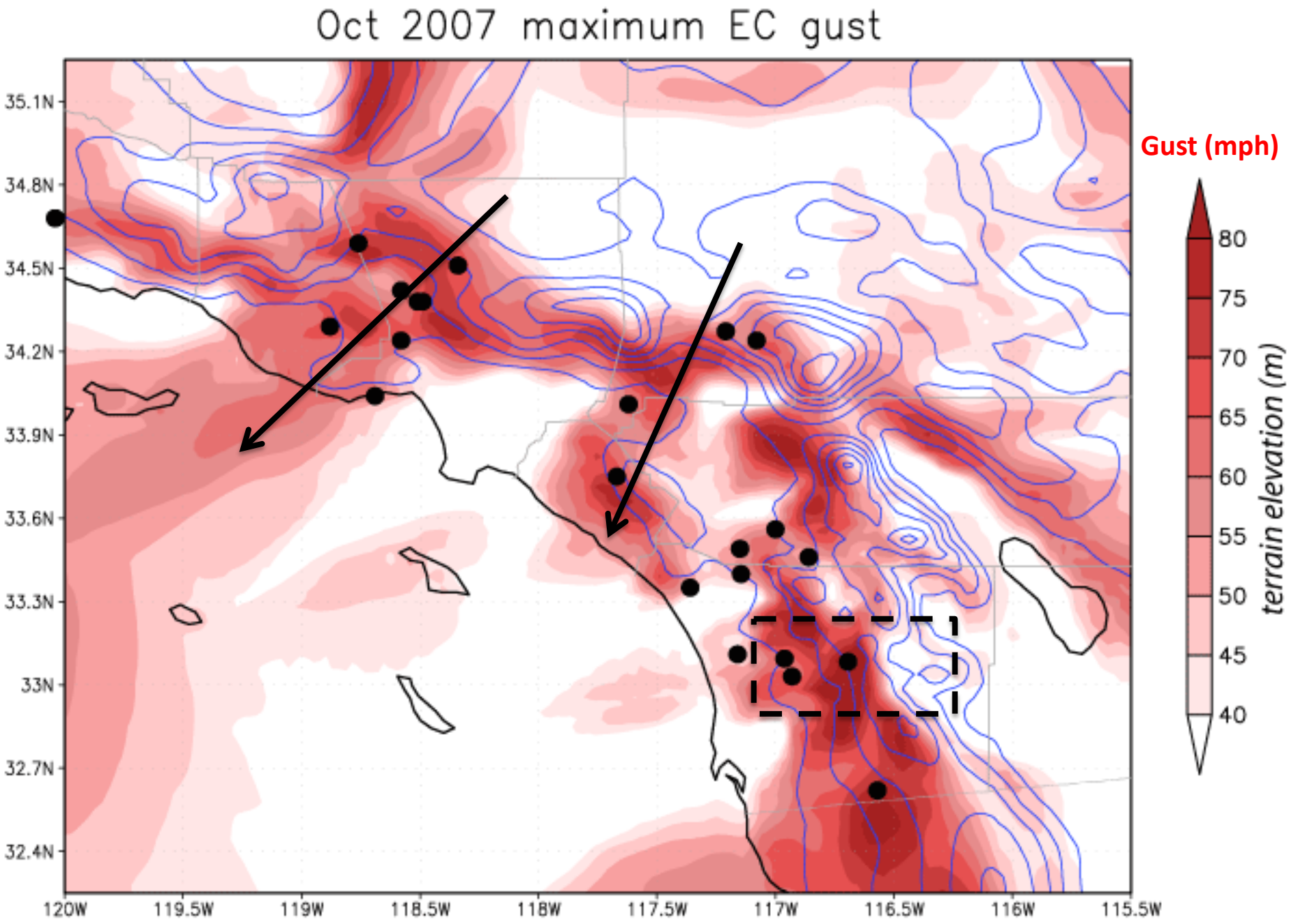

13:00:00
2007293
1 of 48
Saturday
Great Basin
Mojave Desert
Los Angeles



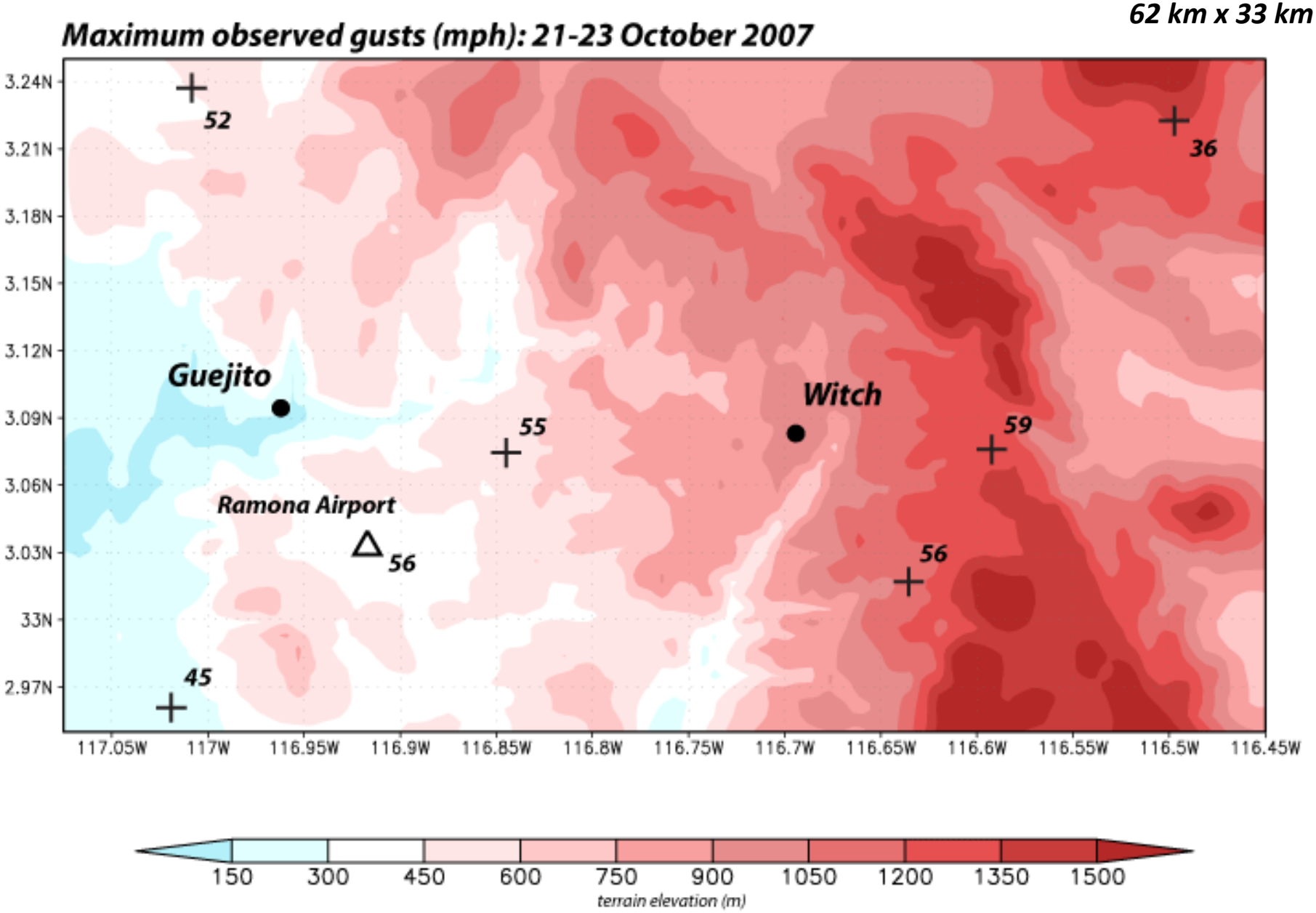
850 mb temperature & winds



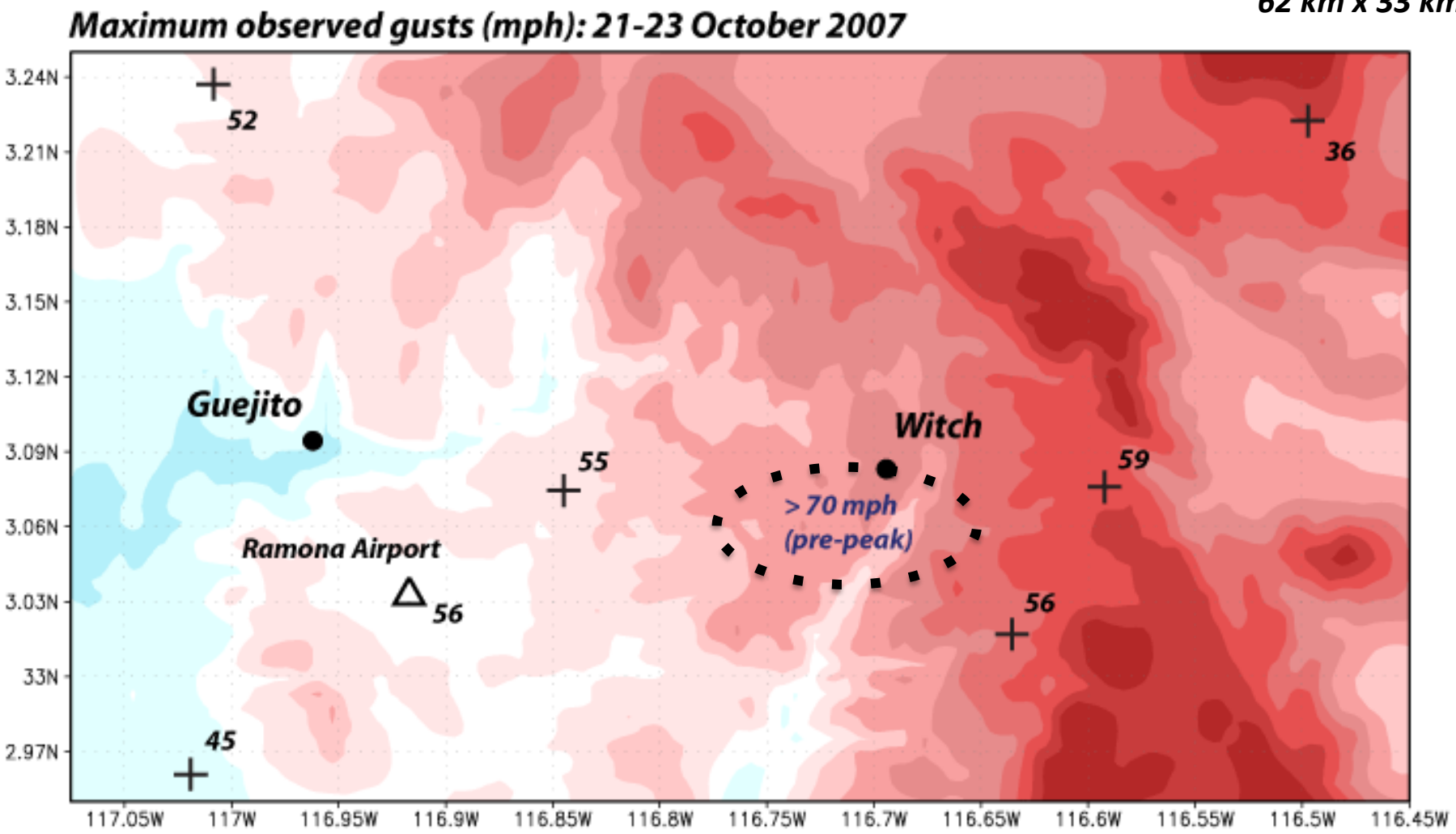
Event maximum gust (EC method) and fire locations



Event maximum gust (EC method) and fire locations


62 km x 33 km
Maximum observed gusts (mph): 21-23 October 2007
3.24N
3.21N
3.18N
3.15N
3.12N
3.09N
3.06N
3.03N
33N
2.97N
52
36
Guejito
Witch
55
59
Ramona Airport
56
56
45
117.05W
117W
116.95W
116.9W
116.85W
116.8W
116.75W
116.7W
116.65W
116.6W
116.55W
116.5W
116.45W
150
300
450
600
750
900
1050
1200
1350
1500
terrain elevation (m)

62 km x 33 km



Observation of SDG&E engineer John Hotta
3 h after Witch fire started

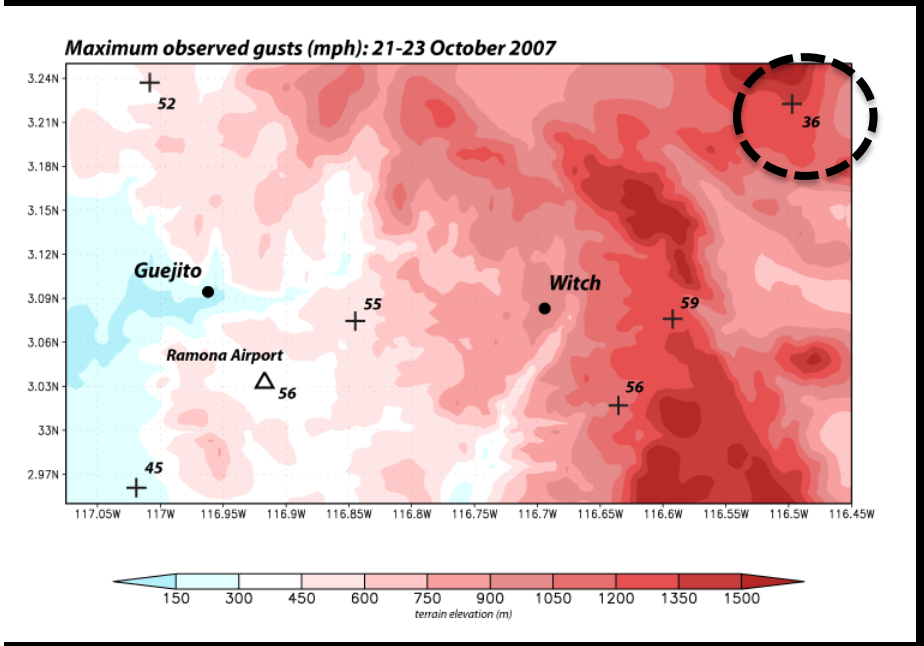
Could the winds have been much stronger at Witch?

YES

(1) RAWS winds are suspect
(2) Terrain amplified flow maximized there

Raw RAWS facts

- RAWS winds measured at 6.1 m (20 ft) NOT 10 m (33 ft)
  - Adjust model 10 m wind for height discrepancy
  - Depends on stability and surface roughness
- RAWS *sustained winds* are 10 min averages reported hourly
  - > 80% of hour goes unsampled for sustained wind
- Some RAWS sites rather poorly situated


Maximum observed gusts (mph): 21-23 October 2007
3.24N
3.21N
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52
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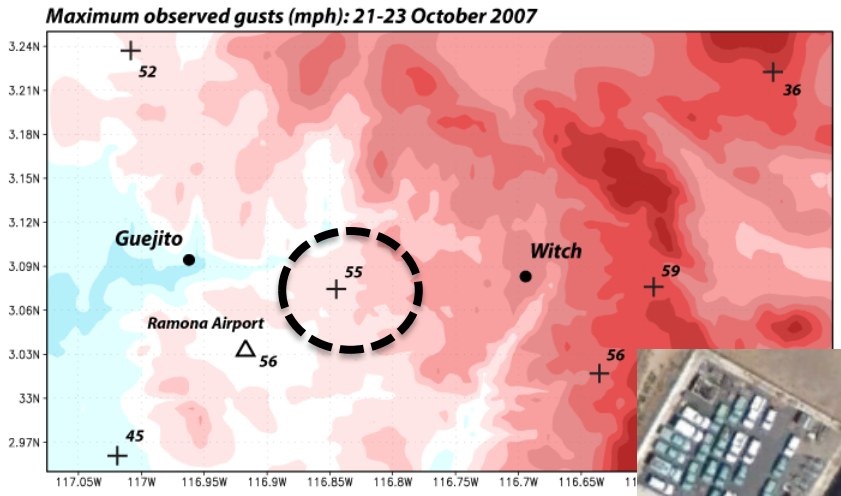
117.05W
117W
116.95W
116.9W
116.85W
116.8W
116.75W
116.7W
116.65W
116.6W
116.55W
116.5W
116.45W
150
300
450
600
750
900
1050
1200
1350
1500
terrain elevation (m)

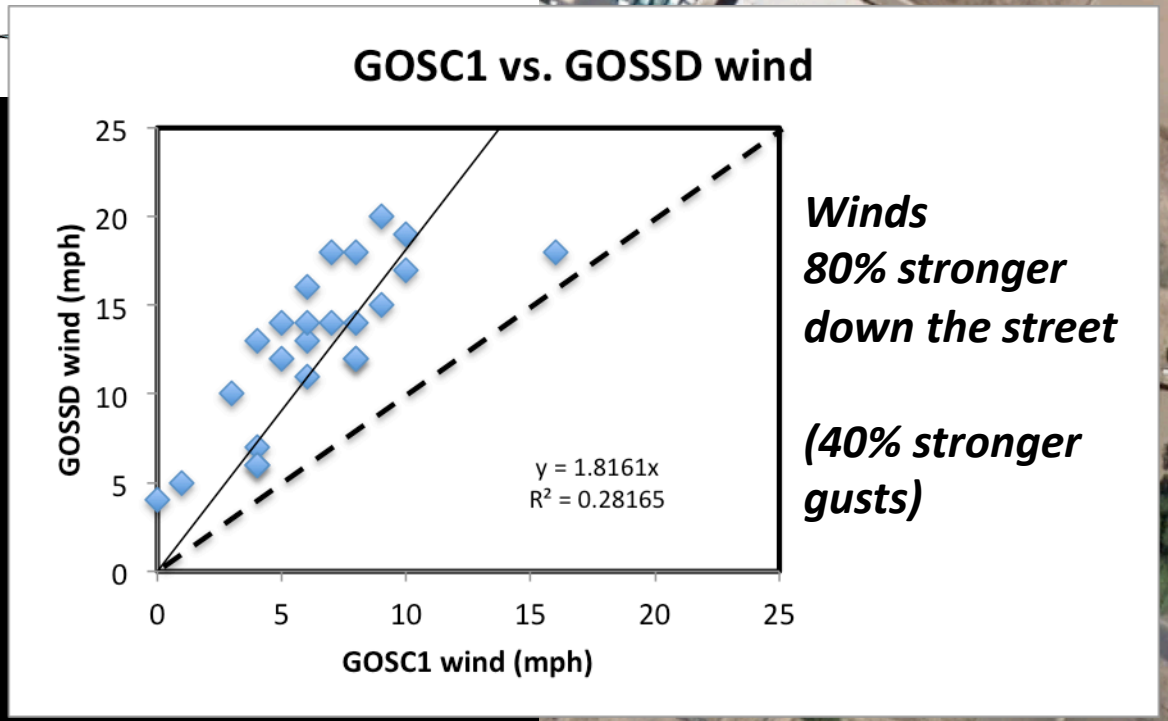

Ranchita RAWS (RCHC1)
N


SE


NE



Goose Valley RAWS (GOSC1)



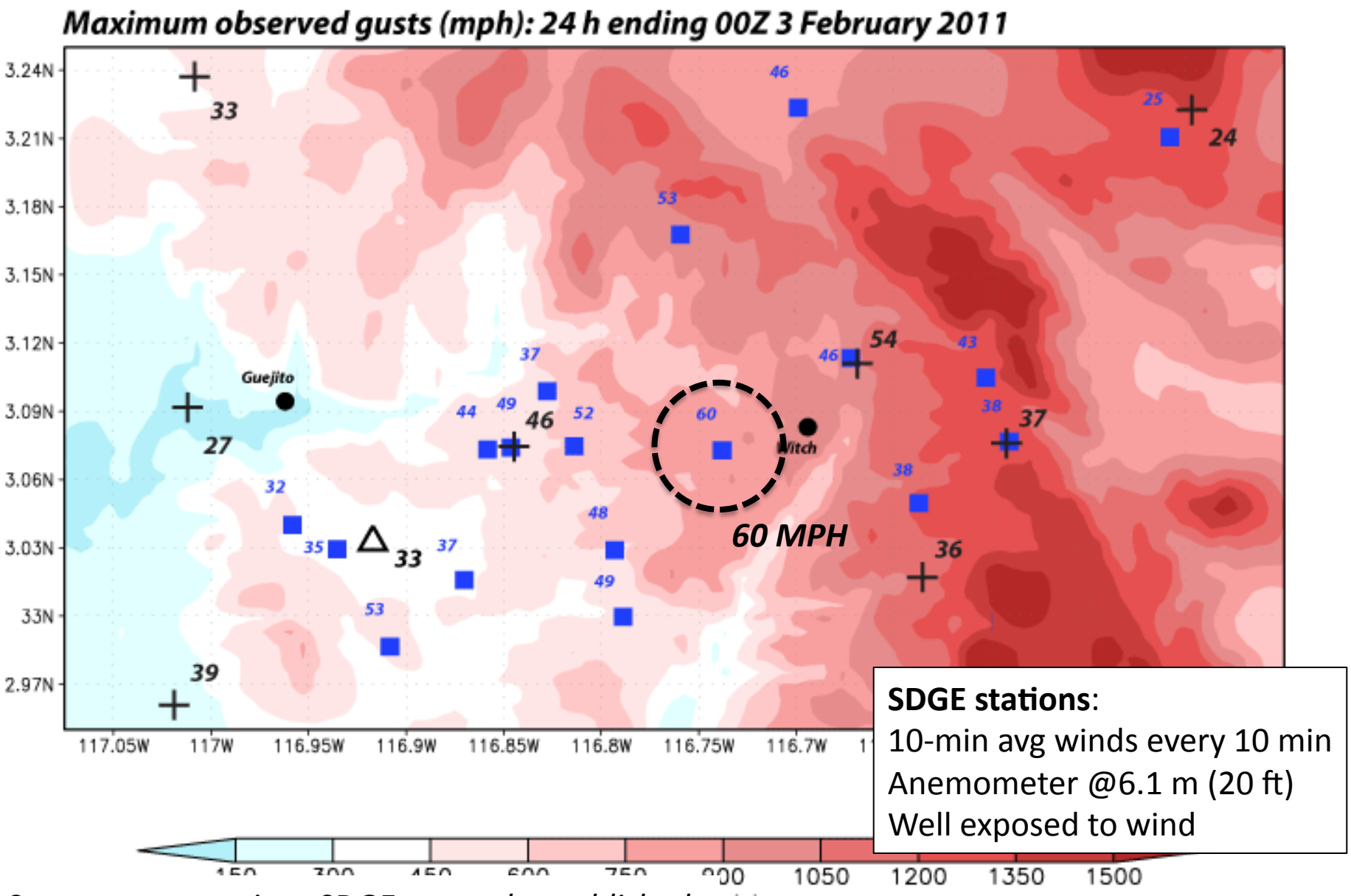
Winds 80% stronger down the street

(40% stronger gusts)

Dec 2011 Santa Ana event
(GOSSD resited Nov 2011)

February 2011 Santa Ana event

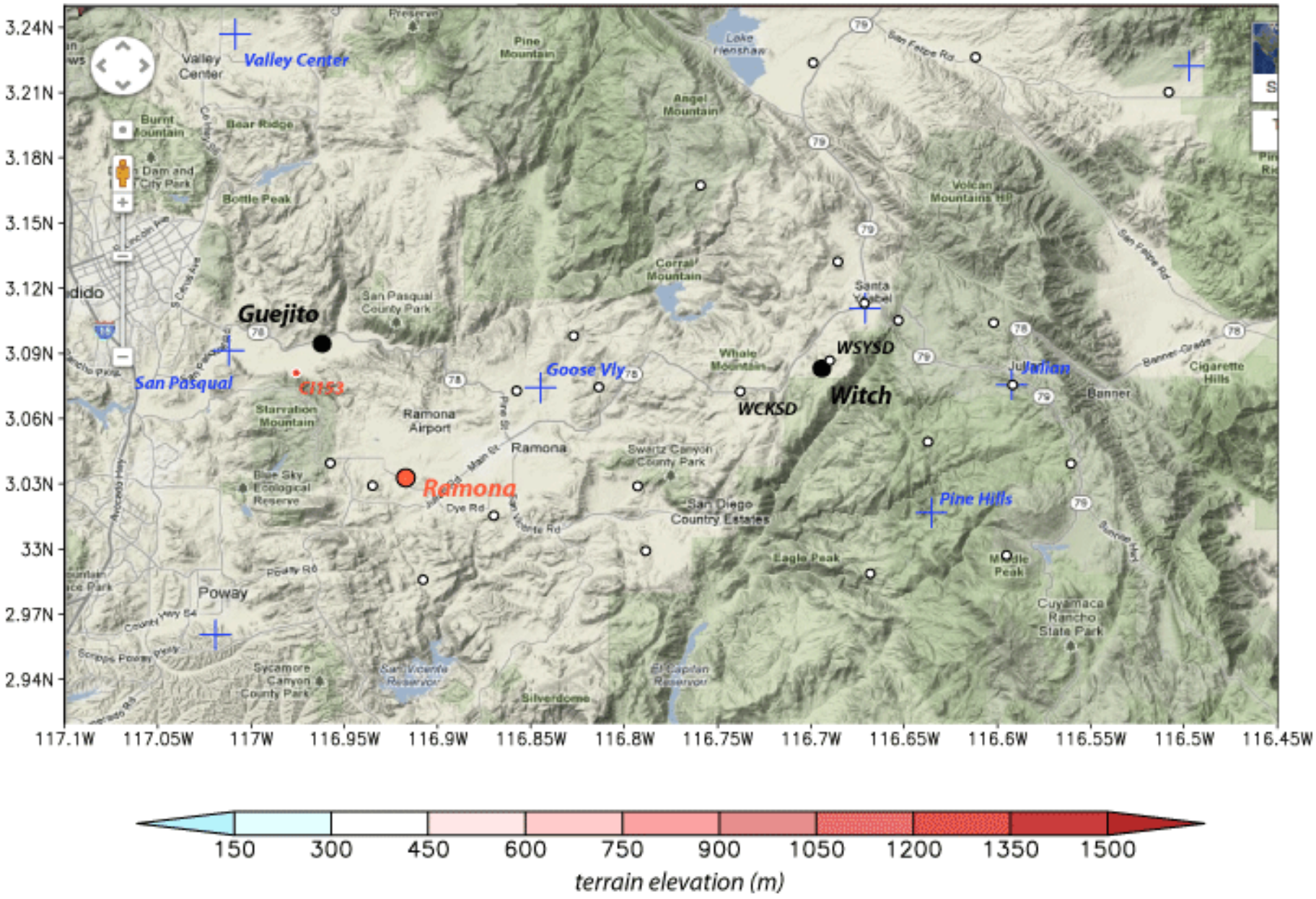
- New SDGE stations
- WCKSD near Witch: fastest gust (60 mph) in region
  - 30% larger than Goose Valley RAWS
  - 62% larger than Julian RAWS
  - 81% stronger than Ramona airport
- Event clearly weaker than October 2007

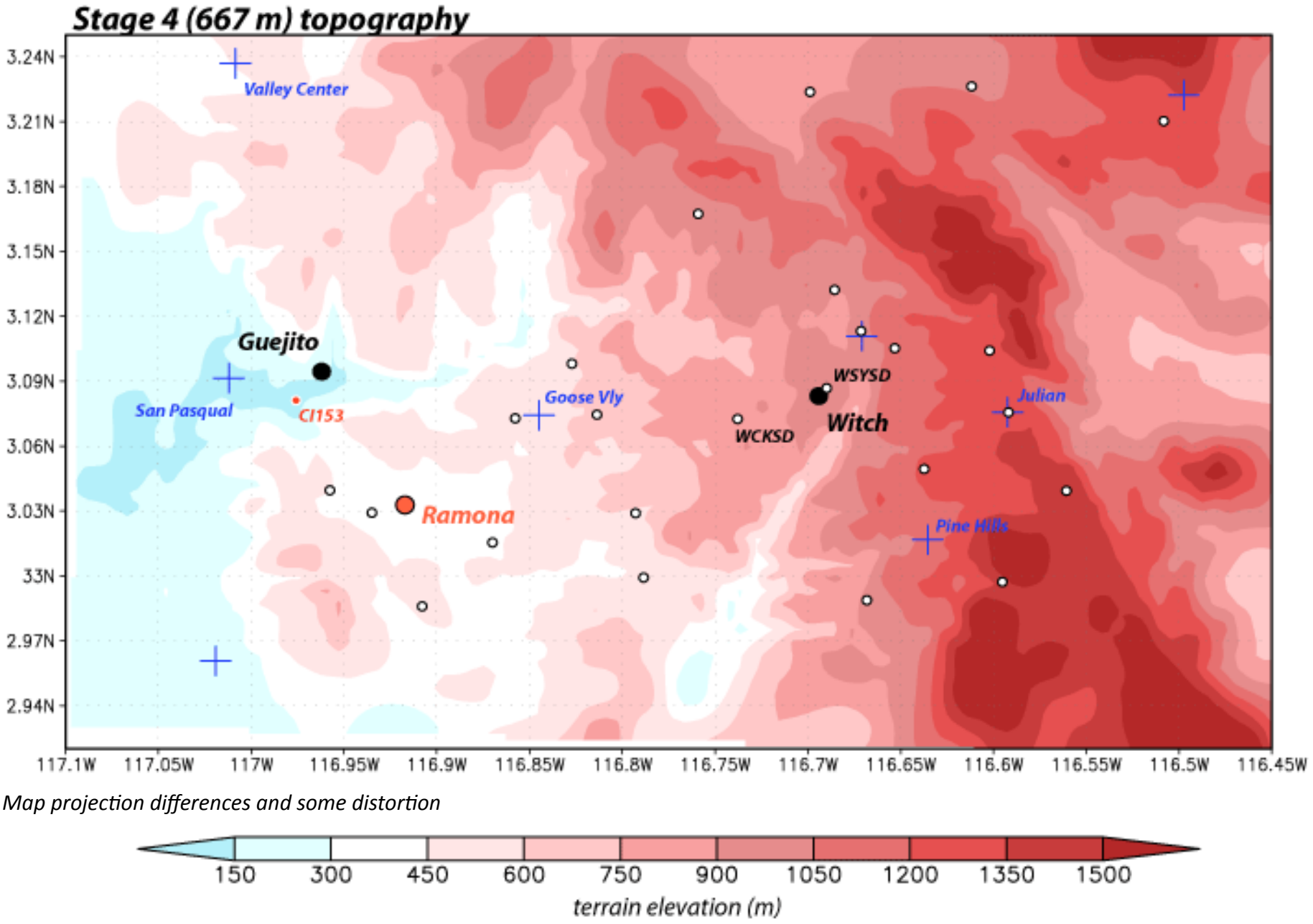


Strongest event since SDGE network established

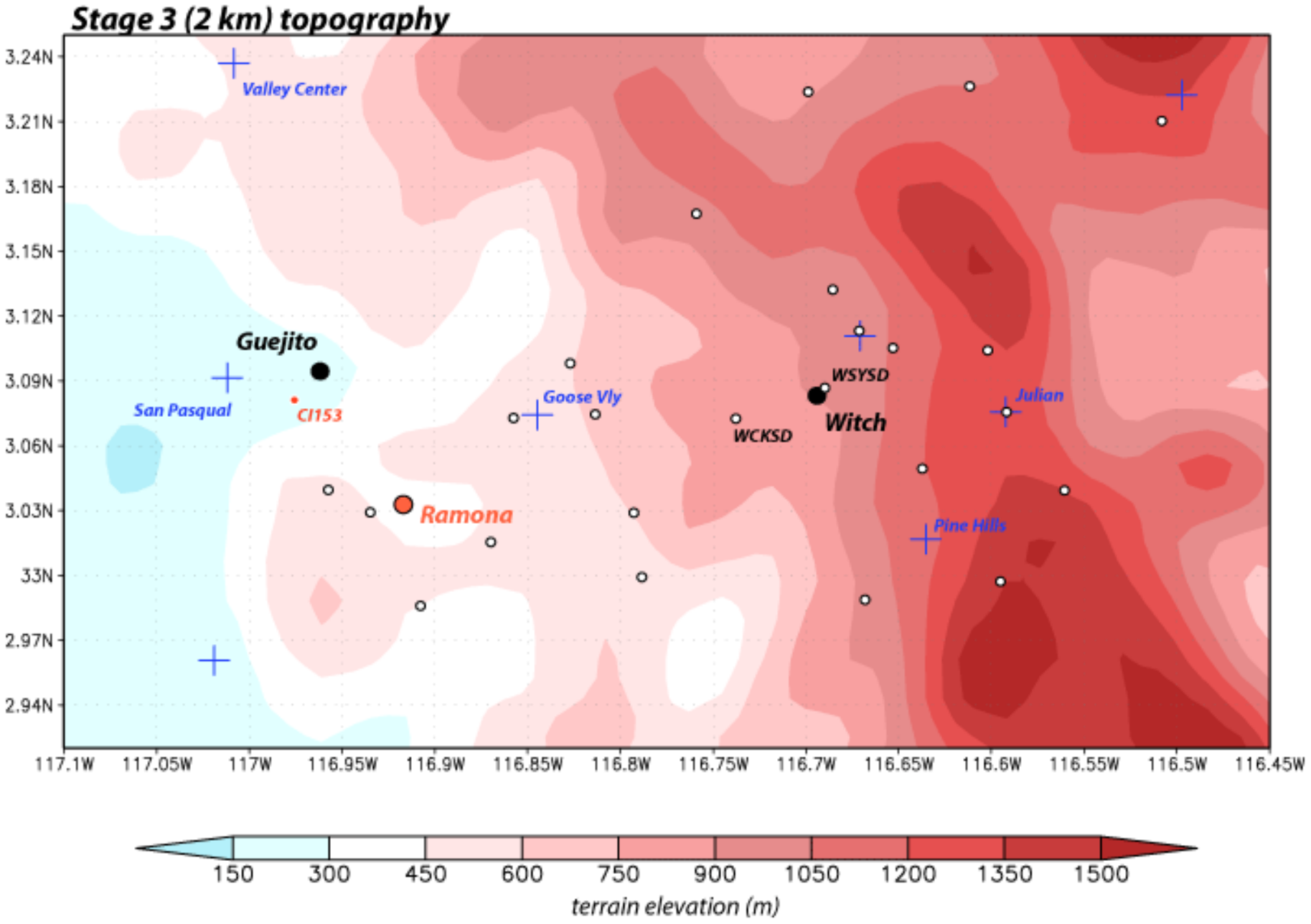
Resolution sensitivity

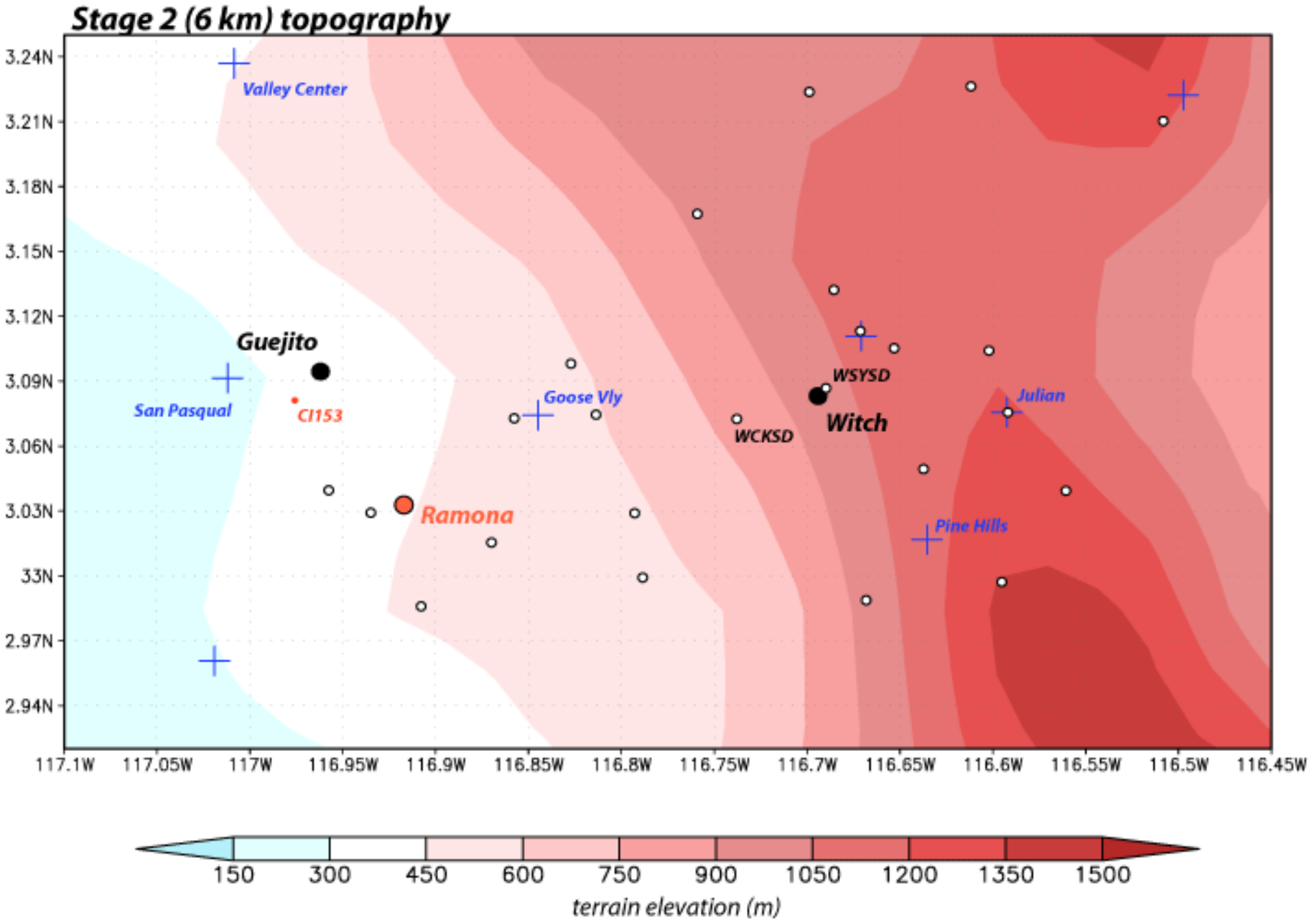
Witch/Guejito area terrain (Google Maps)

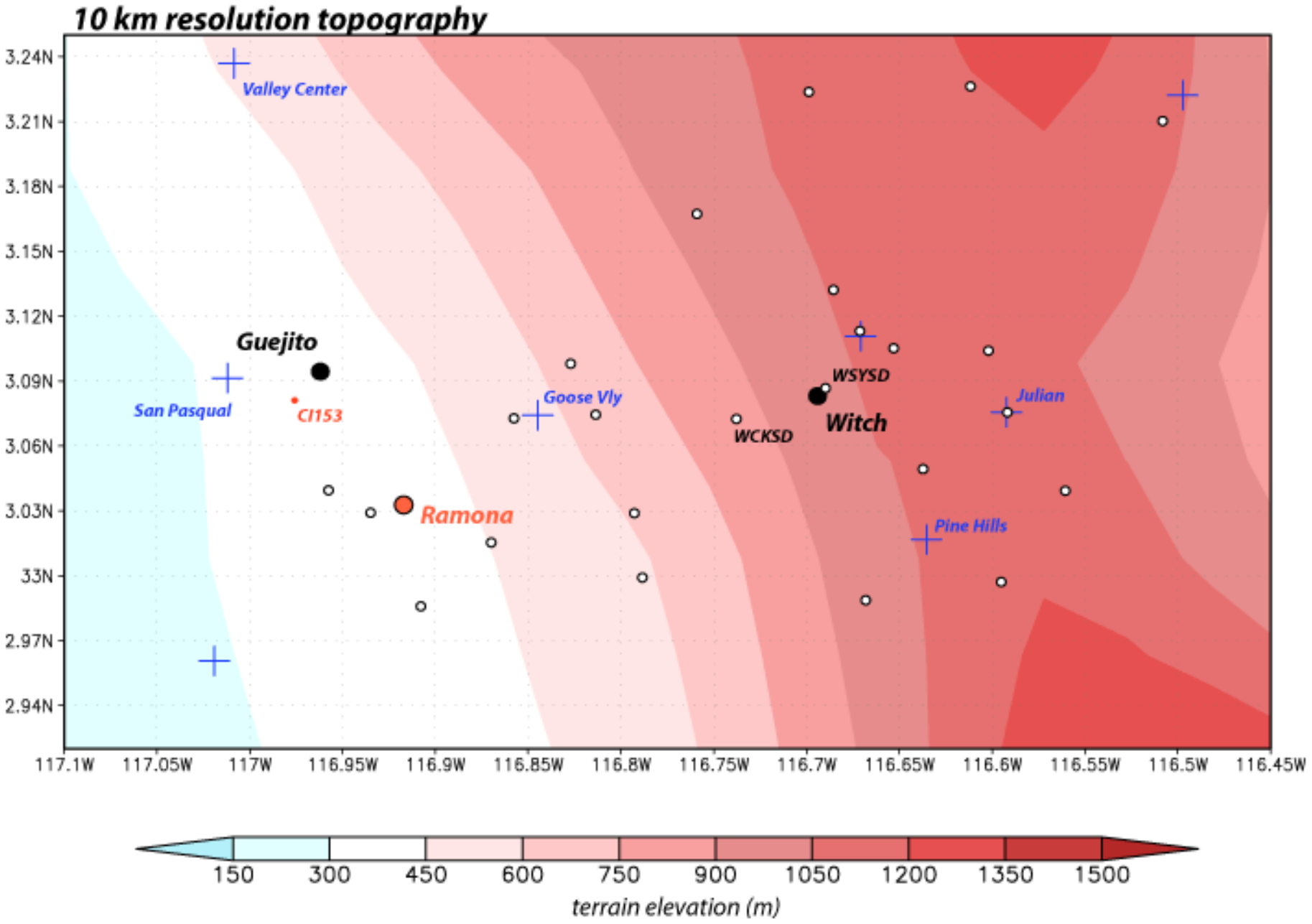




Map projection differences and some distortion


Stage 3 (2 km) topography
3.24N
3.21N
3.18N
3.15N
3.12N
3.09N
3.06N
3.03N
33N
2.97N
2.94N
117.1W
117.05W
117W
116.95W
116.9W
116.85W
116.8W
116.75W
116.7W
116.65W
116.6W
116.55W
116.5W
116.45W
Valley Center
Guejito
San Pasqual
CI153
Goose Vly
WSYSD
Witch
WCKSD
Julian
Ramona
Pine Hills
150
300
450
600
750
900
1050
1200
1350
1500
terrain elevation (m)


Stage 2 (6 km) topography
3.24N
3.21N
3.18N
3.15N
3.12N
3.09N
3.06N
3.03N
33N
2.97N
2.94N
117.1W
117.05W
117W
116.95W
116.9W
116.85W
116.8W
116.75W
116.7W
116.65W
116.6W
116.55W
116.5W
116.45W
Valley Center
Guejito
San Pasqual
CI153
Goose Vly
Ramona
WSYSD
Witch
WCKSD
Julian
Pine Hills
150
300
450
600
750
900
1050
1200
1350
1500
terrain elevation (m)


10 km resolution topography
3.24N
3.21N
3.18N
3.15N
3.12N
3.09N
3.06N
3.03N
33N
2.97N
2.94N
117.1W
117.05W
117W
116.95W
116.9W
116.85W
116.8W
116.75W
116.7W
116.65W
116.6W
116.55W
116.5W
116.45W
Valley Center
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Pine Hills
150
300
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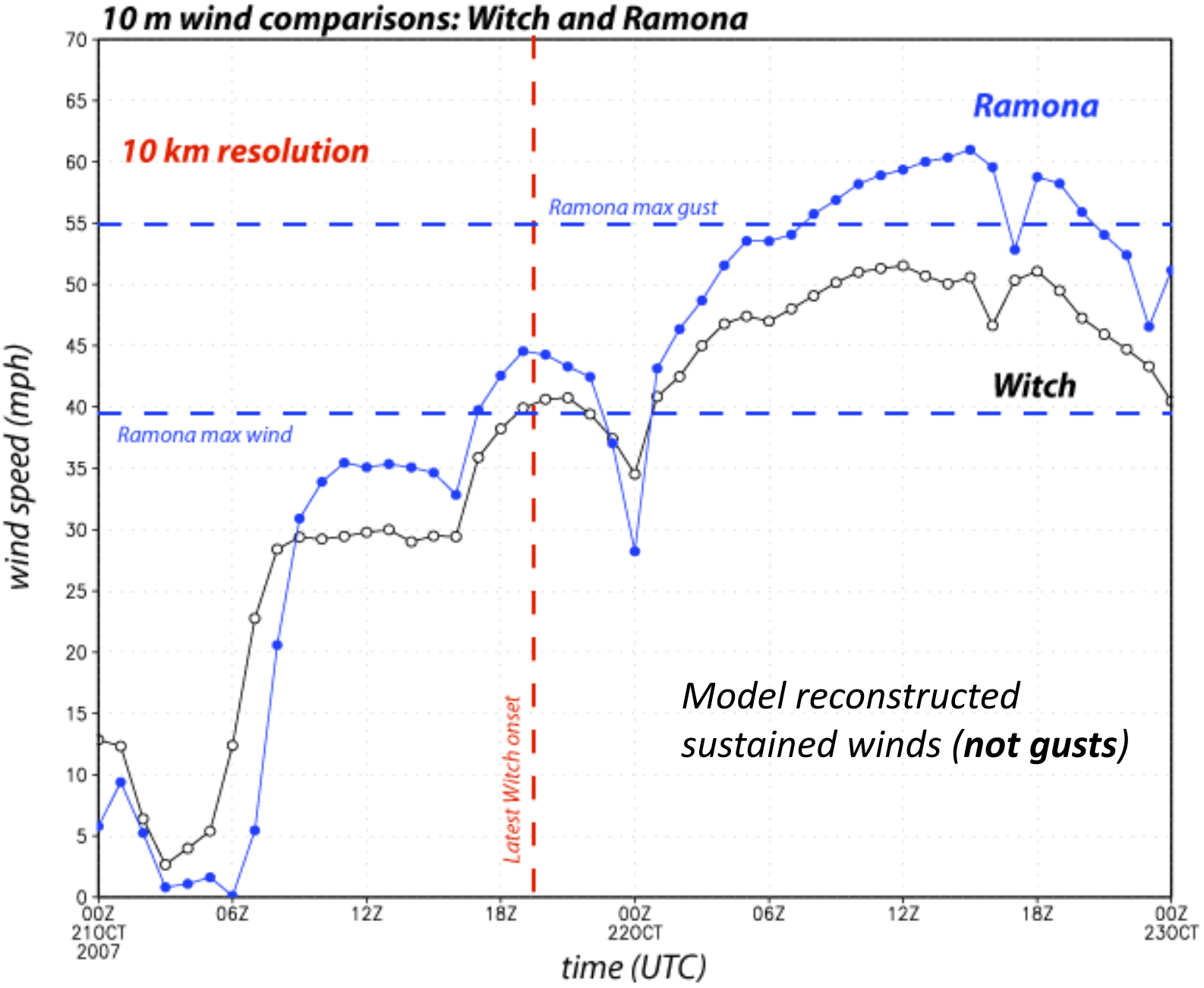
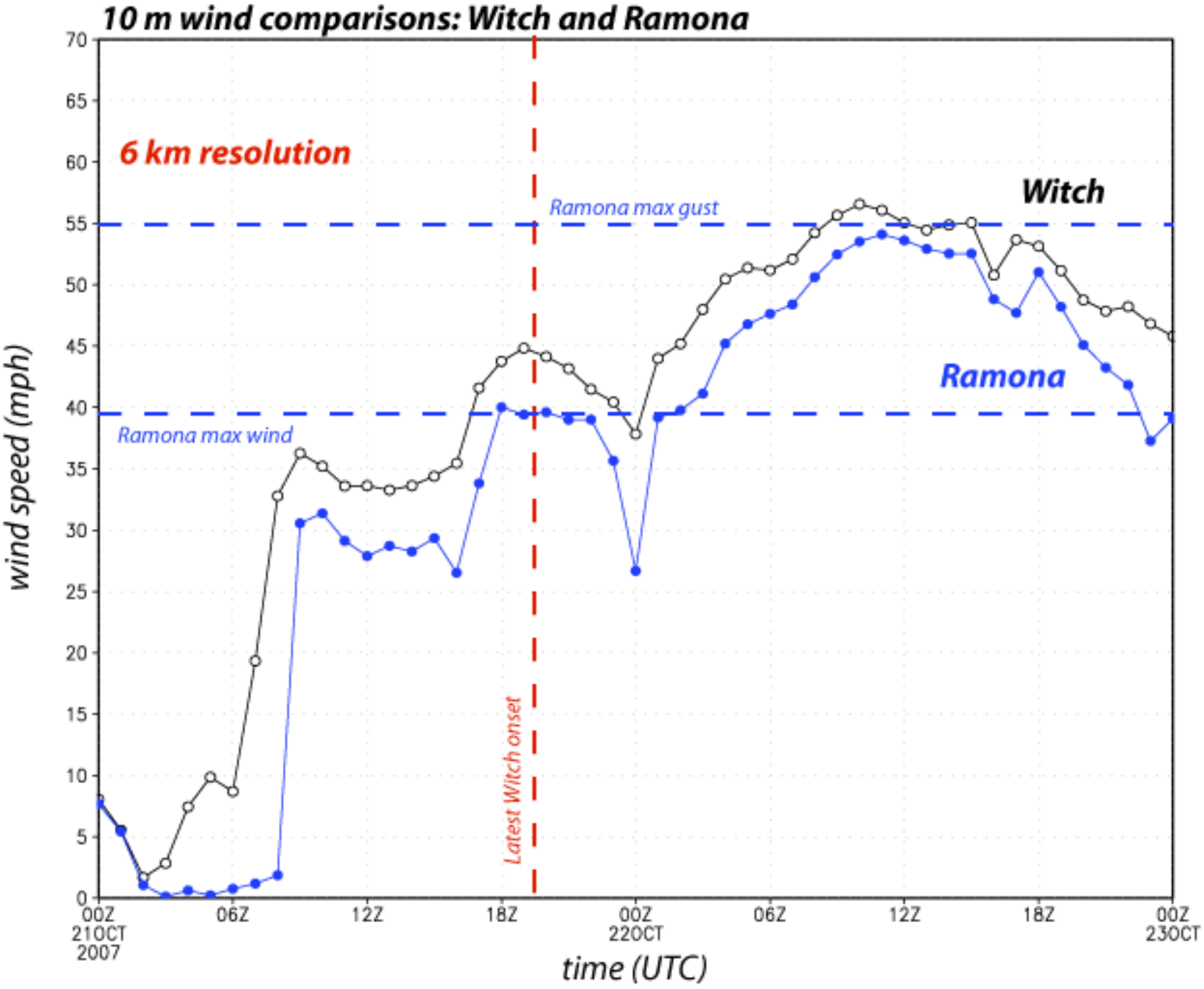
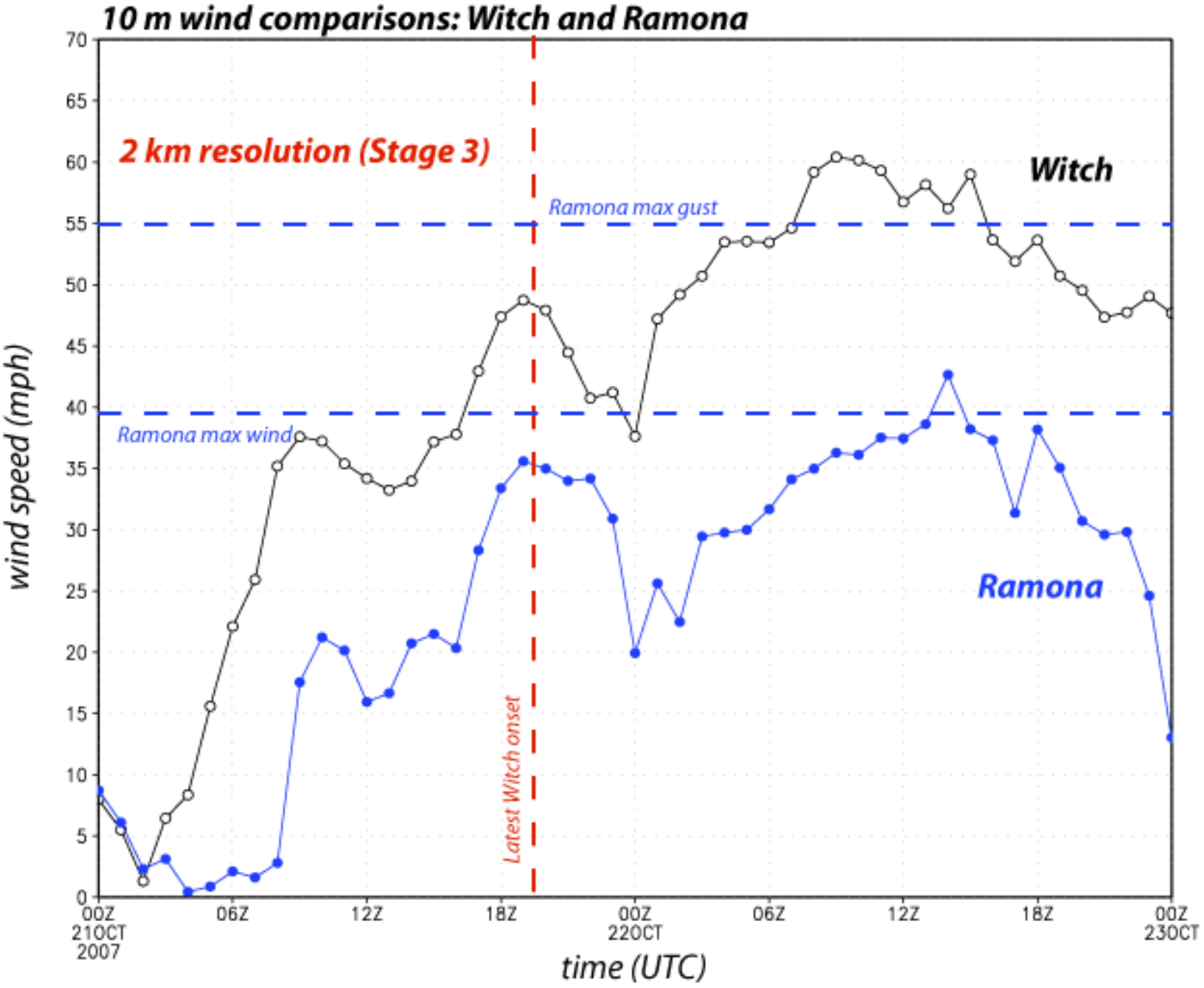
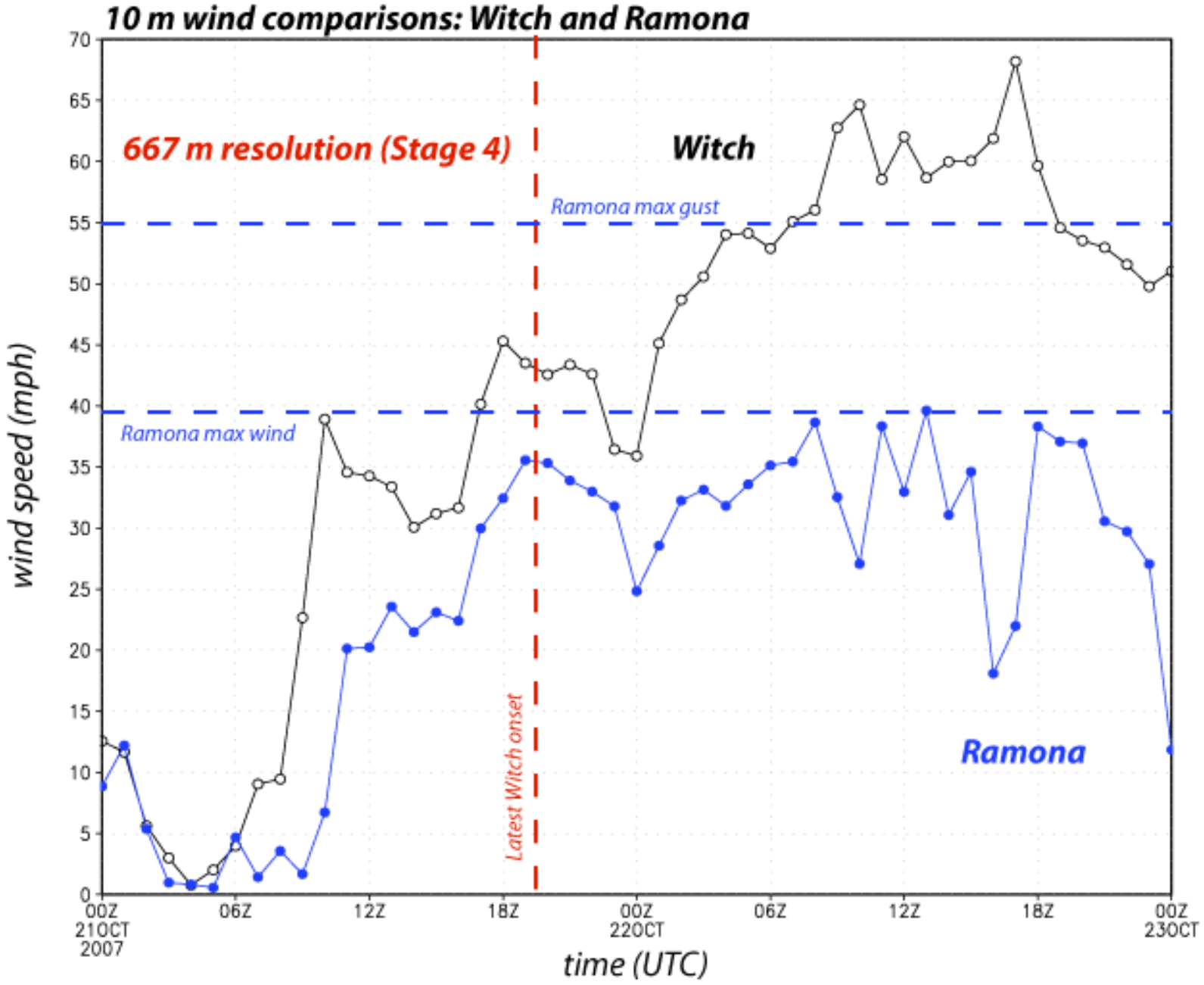
600
750
900
1050
1200
1350
1500
terrain elevation (m)

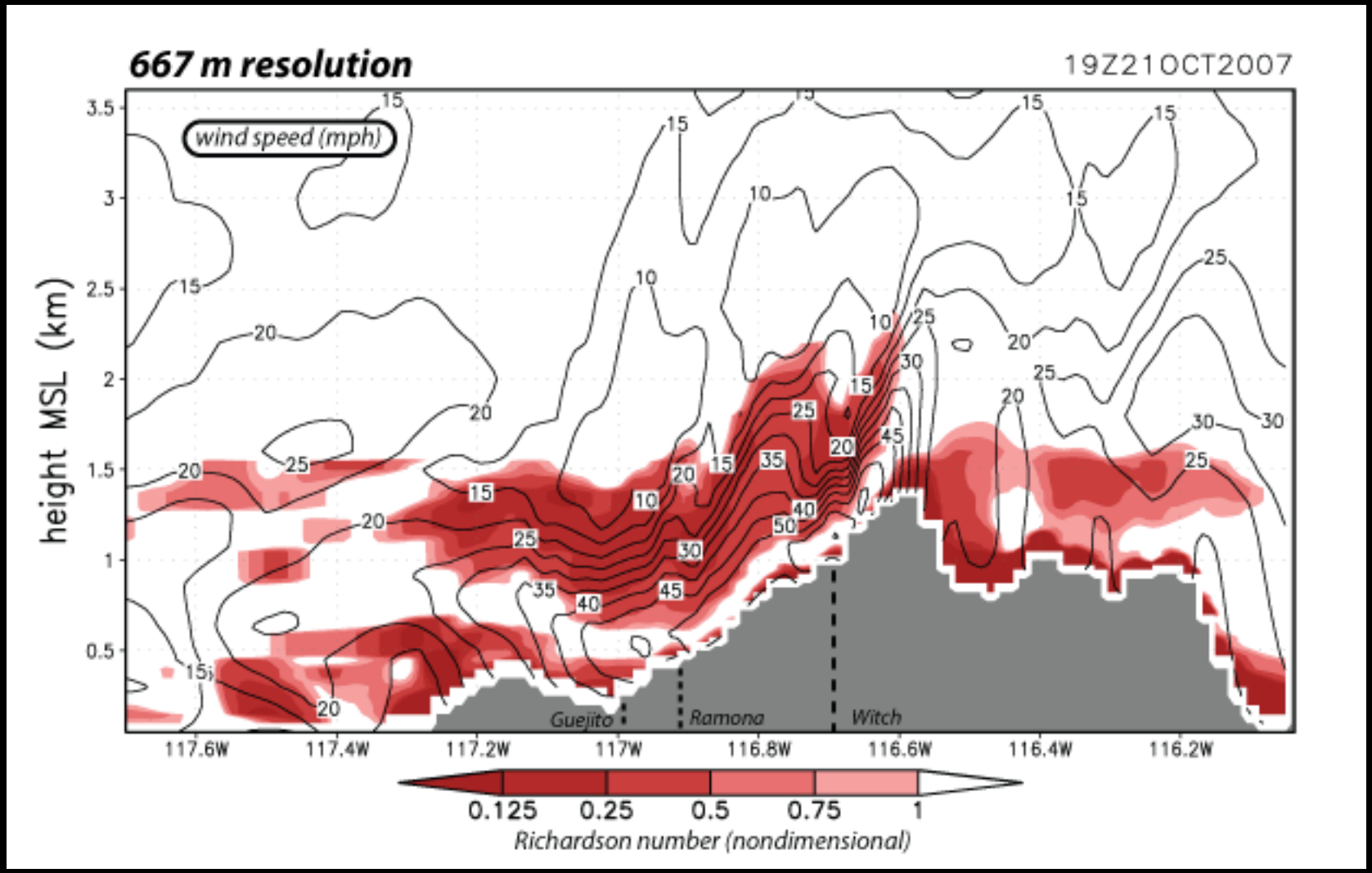

10 m wind comparisons: Witch and Ramona
10 km resolution
Ramona
Witch
Ramona max gust
Ramona max wind
Latest Witch onset
Model reconstructed
sustained winds (**not gusts**)
wind speed (mph)
time (UTC)
00Z
21OCT
2007
06Z
12Z
18Z
00Z
22OCT
06Z
12Z
18Z
00Z
23OCT


10 m wind comparisons: Witch and Ramona
6 km resolution
Witch
Ramona
Ramona max gust
Ramona max wind
Latest Witch onset
wind speed (mph)
time (UTC)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
00Z 21OCT 2007
06Z
12Z
18Z
00Z 22OCT
06Z
12Z
18Z
00Z 23OCT


10 m wind comparisons: Witch and Ramona
2 km resolution (Stage 3)
Witch
Ramona max gust
Ramona max wind
Ramona
Latest Witch onset
wind speed (mph)
time (UTC)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
00Z 21OCT 2007
06Z
12Z
18Z
00Z 22OCT
06Z
12Z
18Z
00Z 23OCT

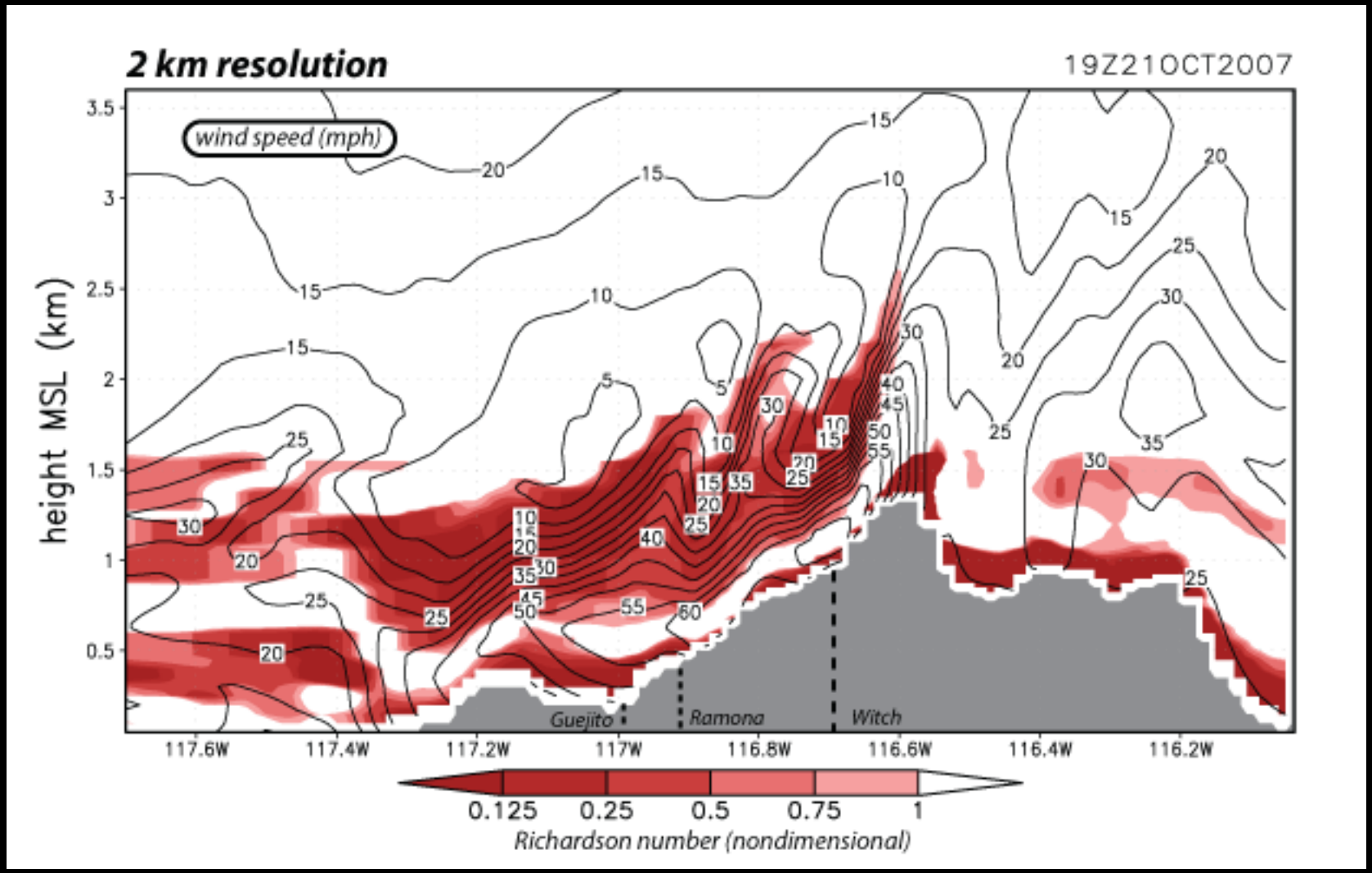

10 m wind comparisons: Witch and Ramona
667 m resolution (Stage 4)
Witch
Ramona max gust
Ramona max wind
Latest Witch onset
Ramona
wind speed (mph)
time (UTC)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
00Z 21OCT 2007
06Z
12Z
18Z
00Z 22OCT
06Z
12Z
18Z
00Z 23OCT

Wind speed (contoured) and Ri number (shaded)

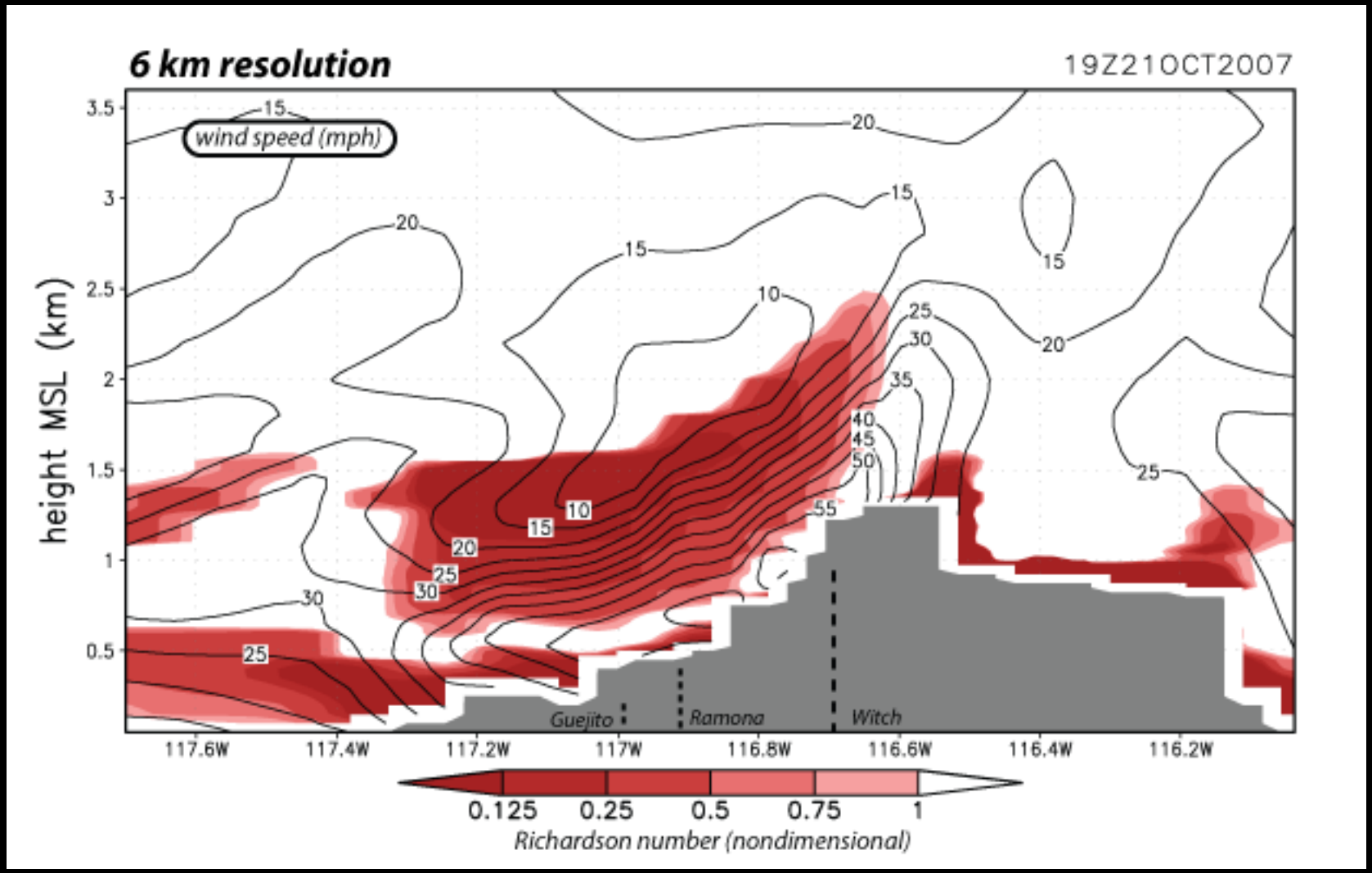


170 km x 3.6 km

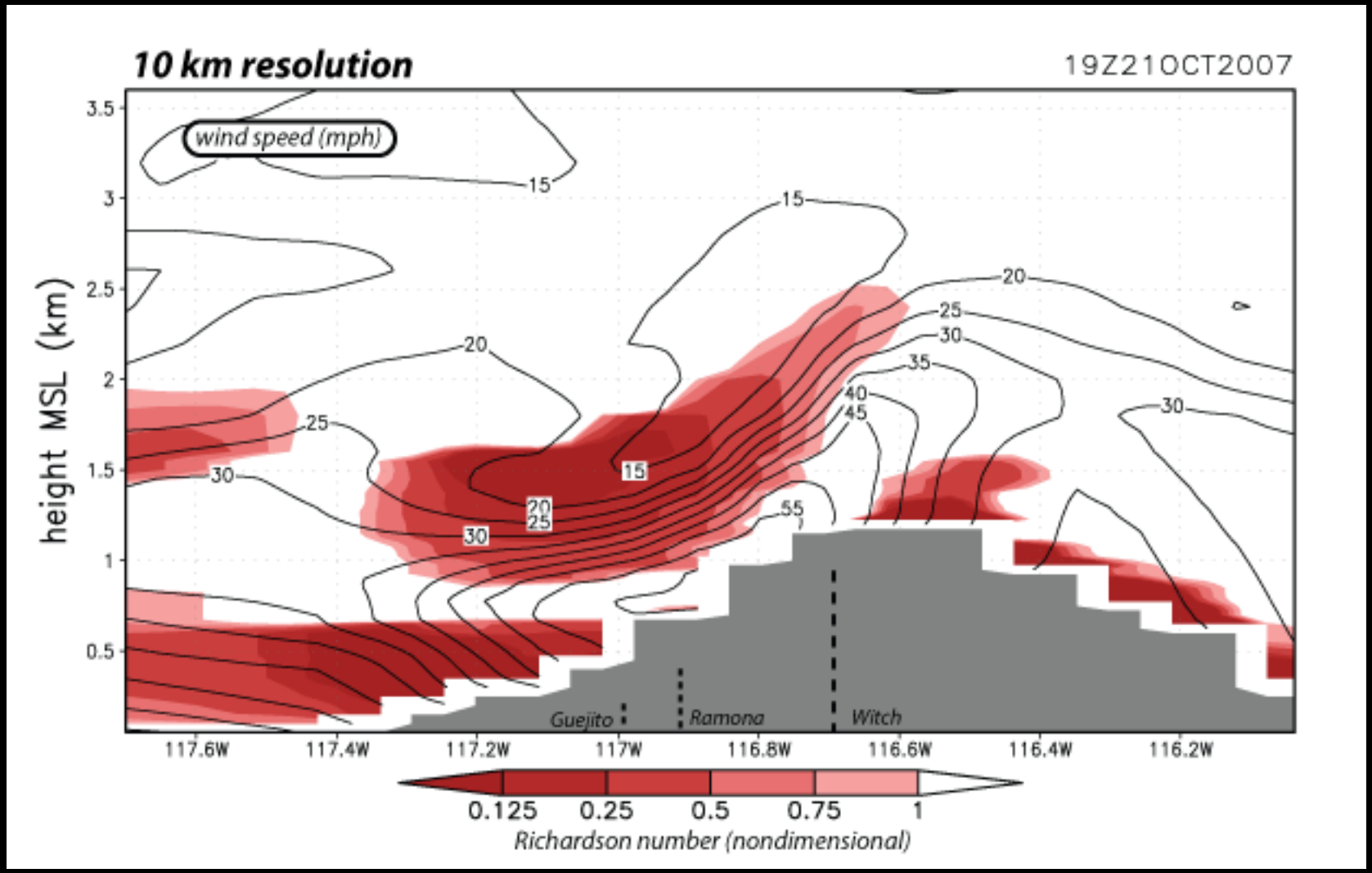
Wind speed (contoured) and Ri number (shaded)



Wind speed (contoured) and Ri number (shaded)



Wind speed (contoured) and Ri number (shaded)



The climatology may be acceptable,
but the meteorology is *not*.

Discussion

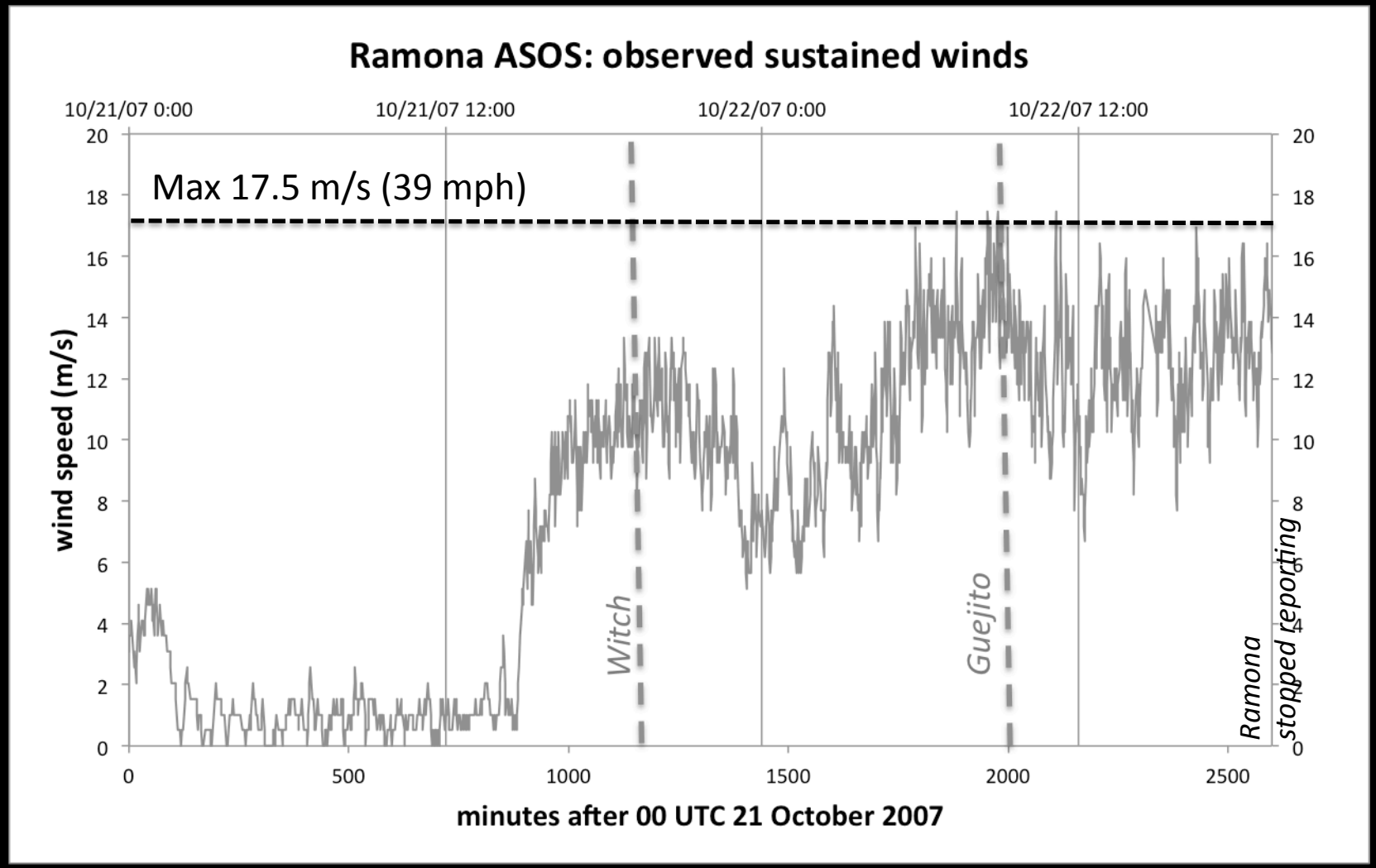
- Coarse resolution (> 2 km grid spacing) simulations do not properly capture terrain shape
  - Exaggerates the horizontal scale of downslope flow
  - Put the fastest winds in **wrong places**

Reconstruction for Ramona Airport

Anemometer at 7.9 m AGL (not 10 m)

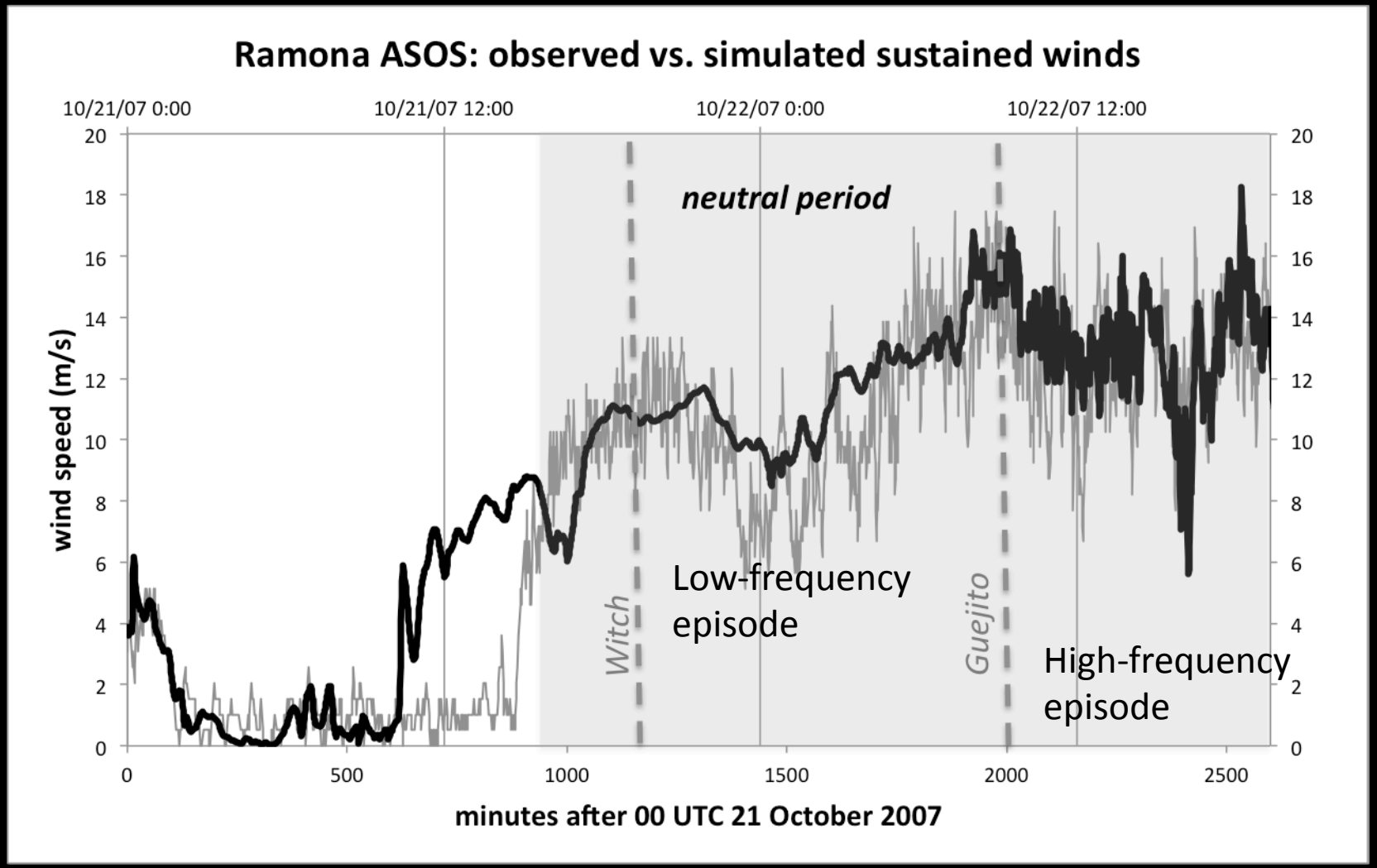
Ramona Airport observations

(1 min reports of 2 min average sustained winds; anemometer at 7.9 m [26 ft])



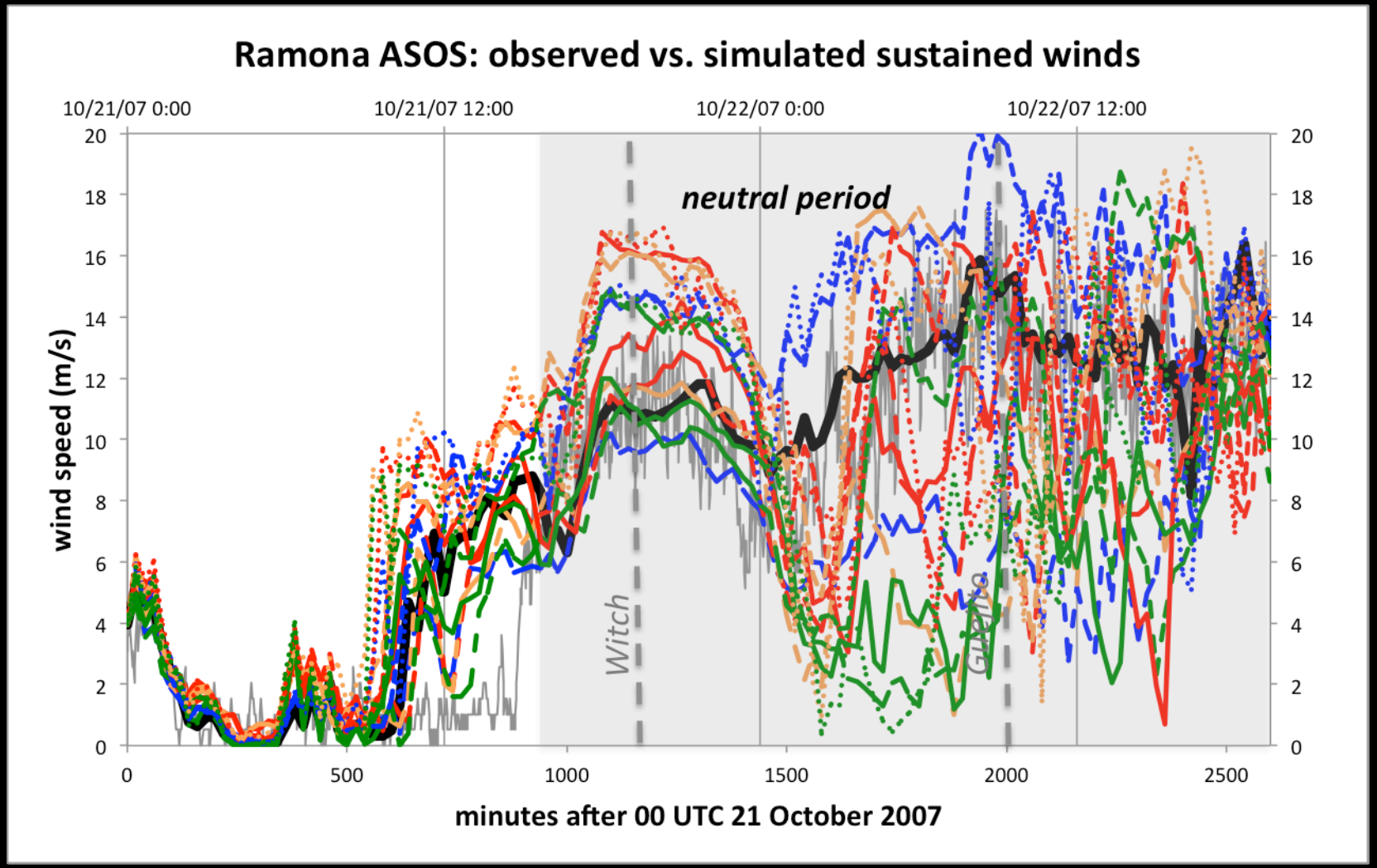
WRF v3.4 simulation

[YSU/RUC/NARR, 667m, 1-min elevation & stability adjusted]



WRF v3.4 physics ensemble

[15 PBL/surface combinations; 667m resolution; 20 min data]

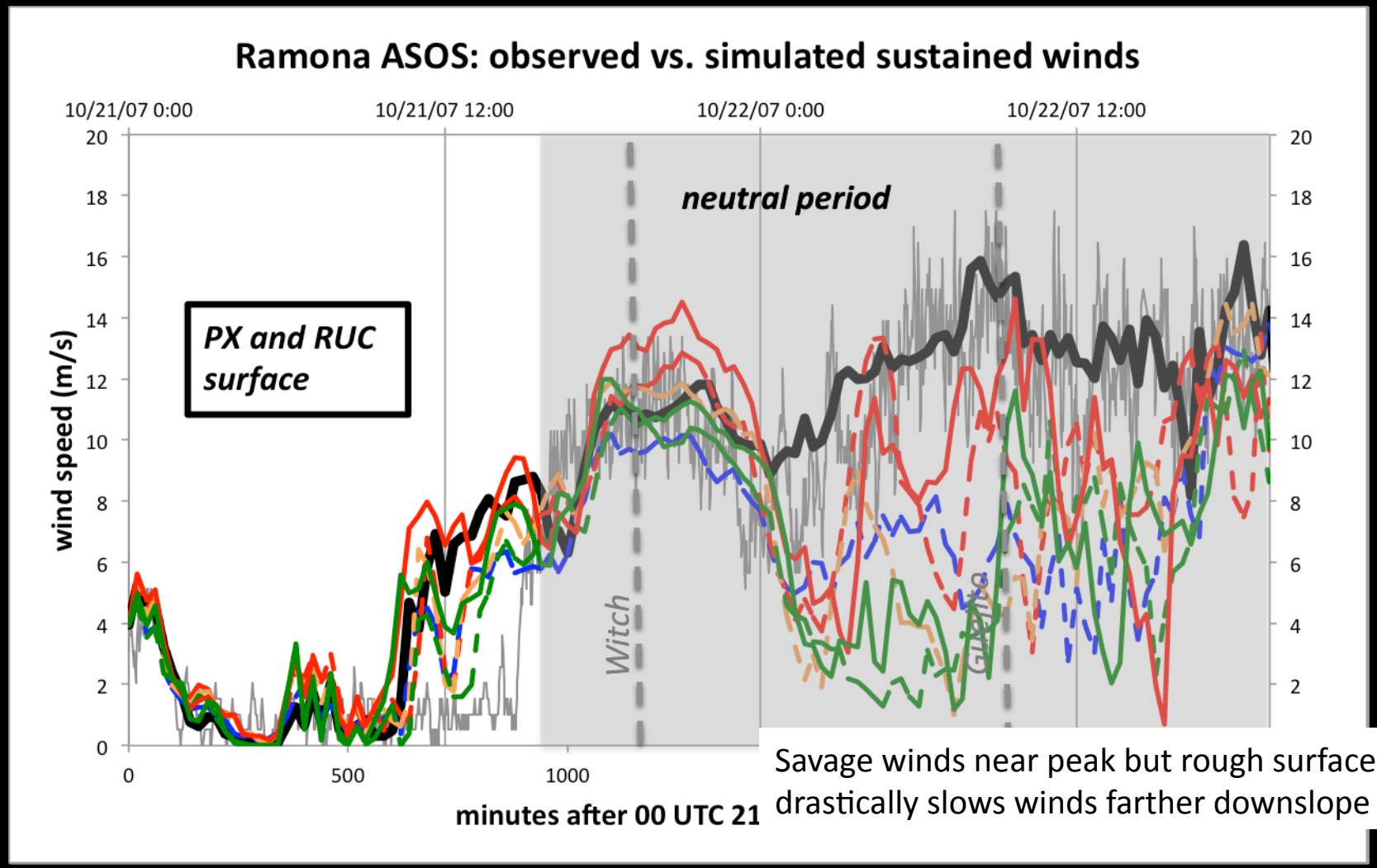


USGS landuse category 9 (mixed shrubland/grassland)

Surface scheme	*Roughness length (m) [winter]*
TD	0.01
NOAH	0.024
RUC	0.11
PX	0.20

WRF v3.4 physics ensemble

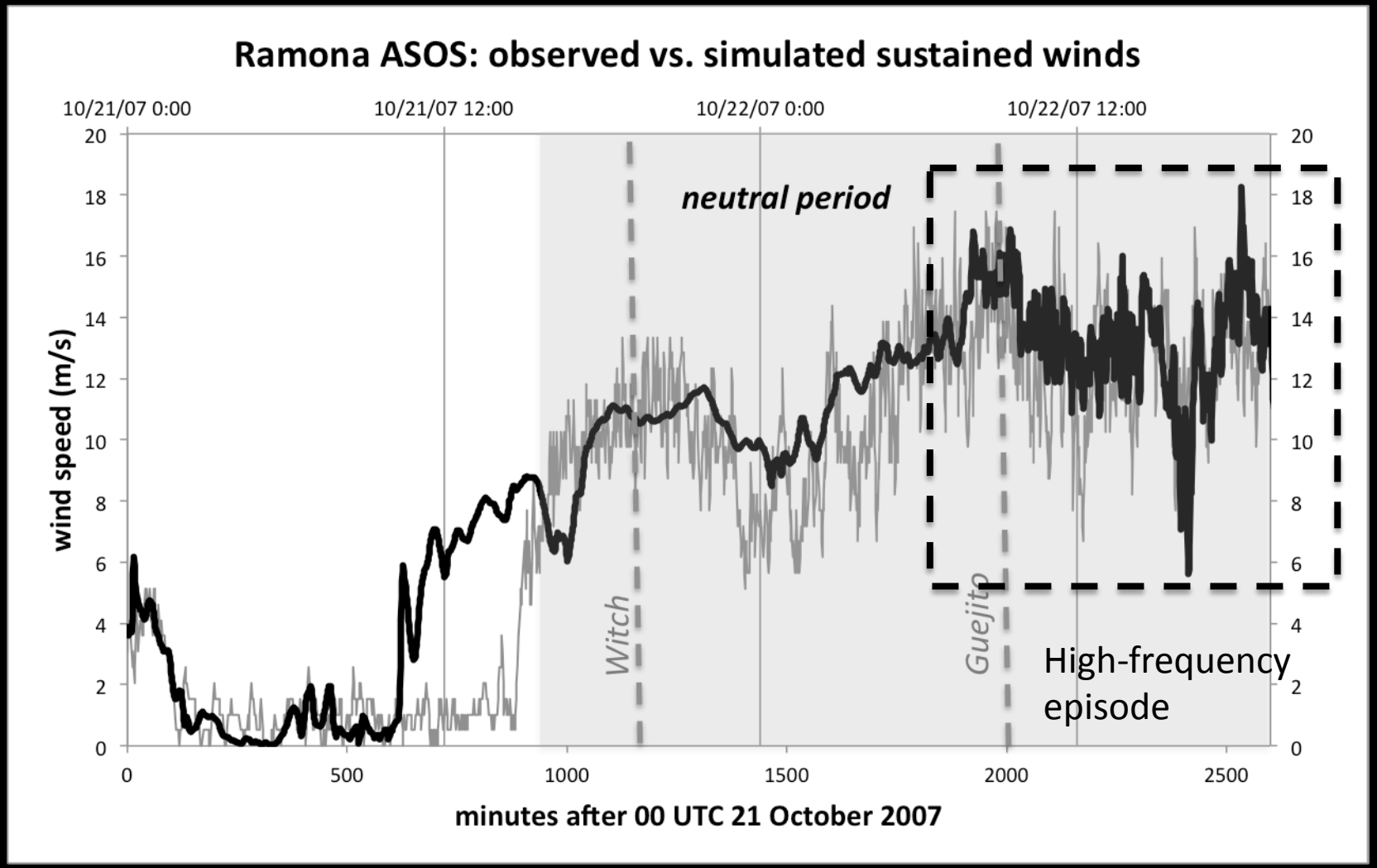
[PX and RUC surface scheme members only]



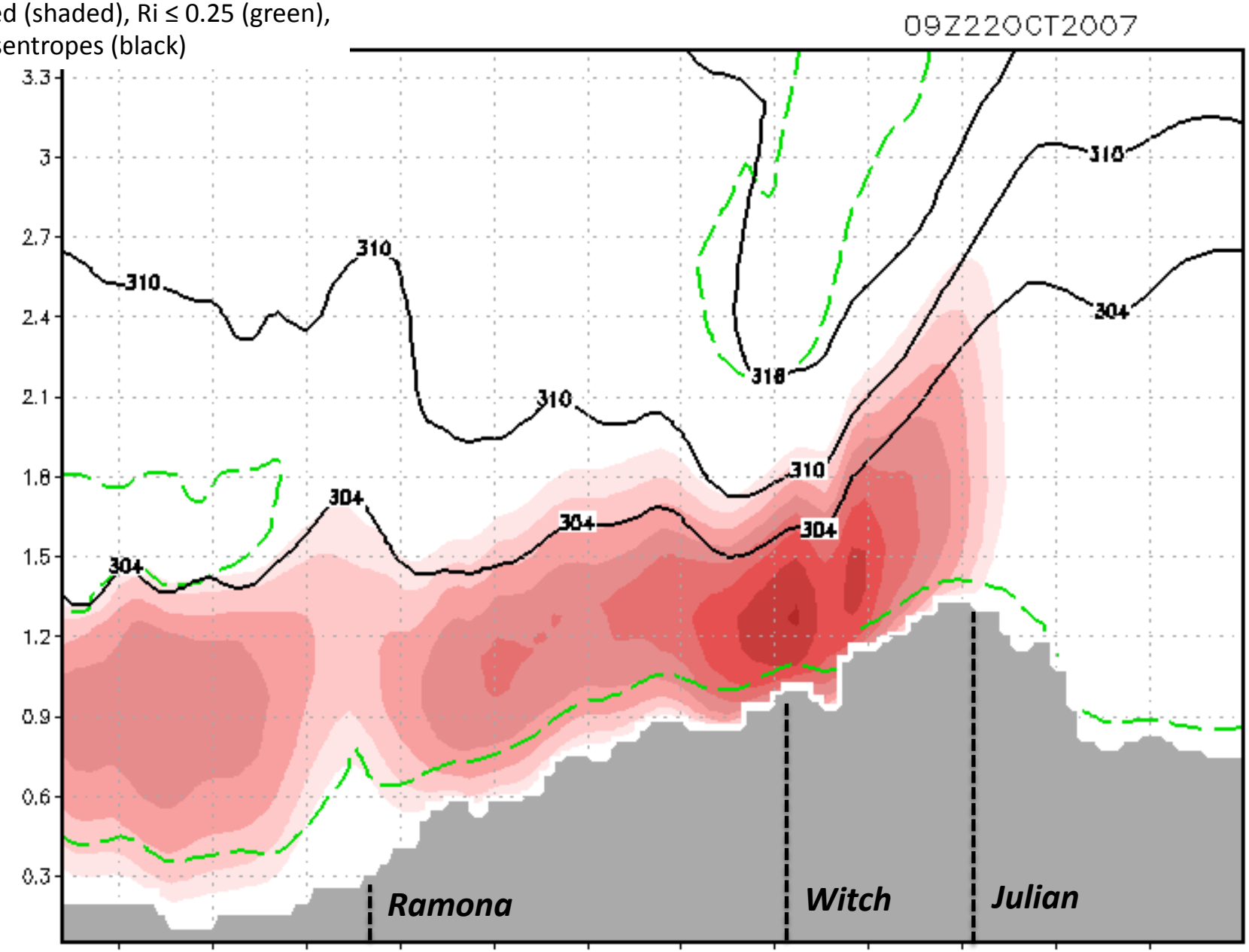
Savage winds near peak but rough surface drastically slows winds farther downslope

Apparent well-resolved shear instability

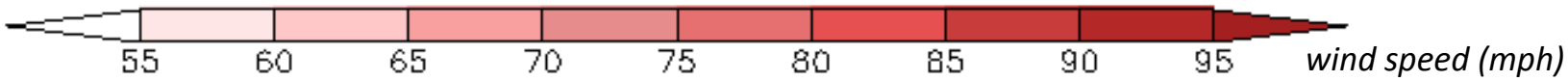
[compare to Scinocca and Peltier (1989), Smith (1991)]



Wind speed (shaded), Ri ≤ 0.25 (green),
Selected isentropes (black)

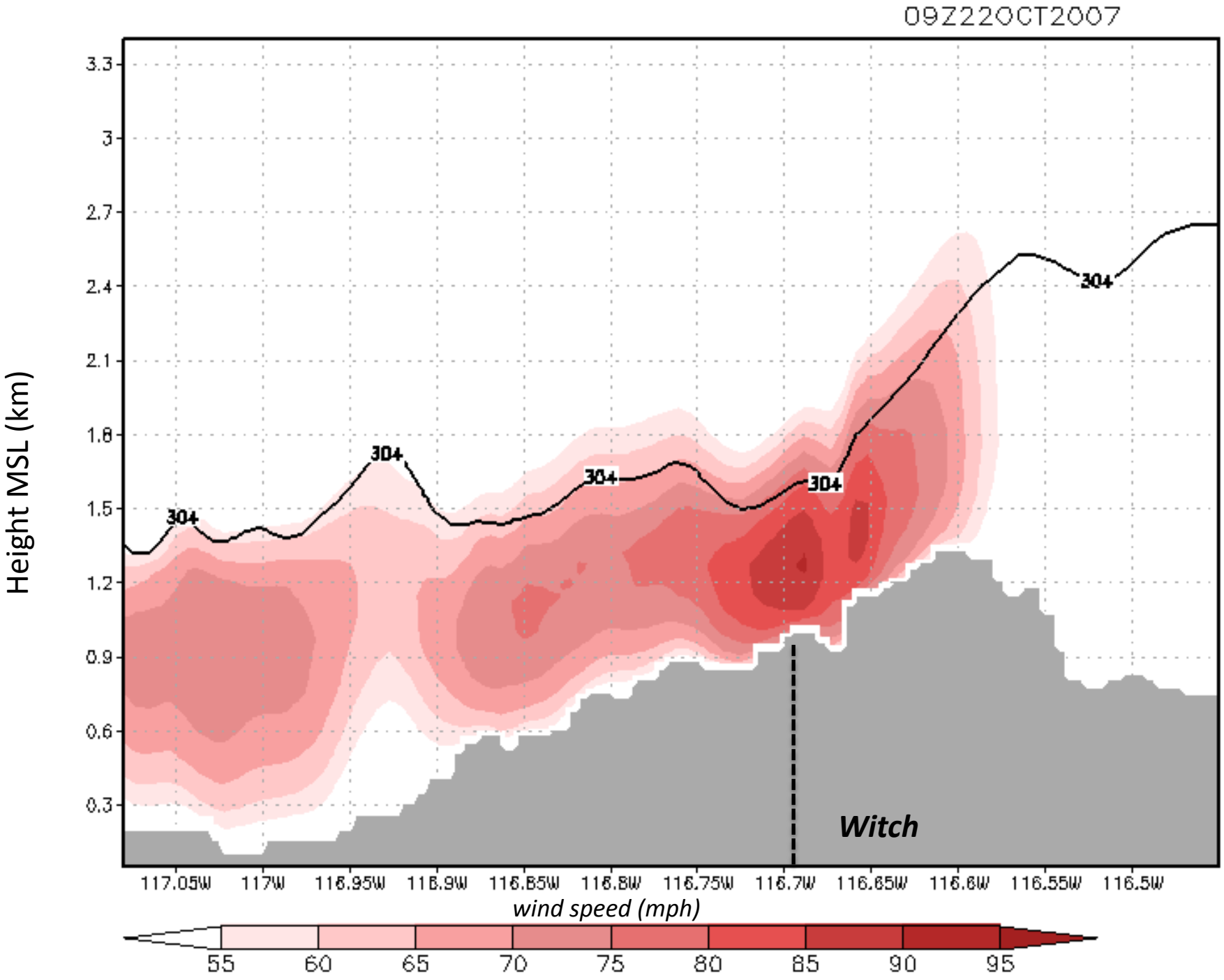


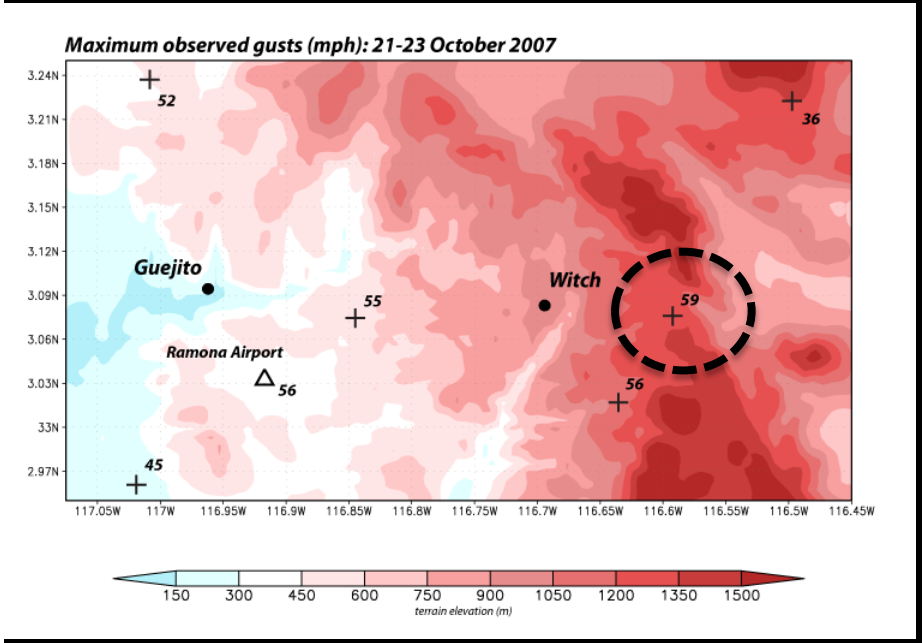
65 km x 3.4 km



Conclusions

- Santa Ana winds have downslope windstorm characteristics, especially in fire-prone San Diego county
- Simulations profoundly influenced by spatial resolution and model physics
- RAWS winds guilty until proven innocent
- High resolution simulations resolve shear instabilities that can locally amplify gusts


09Z22OCT2007
Height MSL (km)
3.3
3
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
304
304
304
304
Witch
117.05W
117W
116.95W
116.9W
116.85W
116.8W
116.75W
116.7W
116.65W
116.6W
116.55W
116.5W
wind speed (mph)
55
60
65
70
75
80
85
90
95



Julian RAWS (JULC1)

http://www.raws.dri.edu/

Looking North