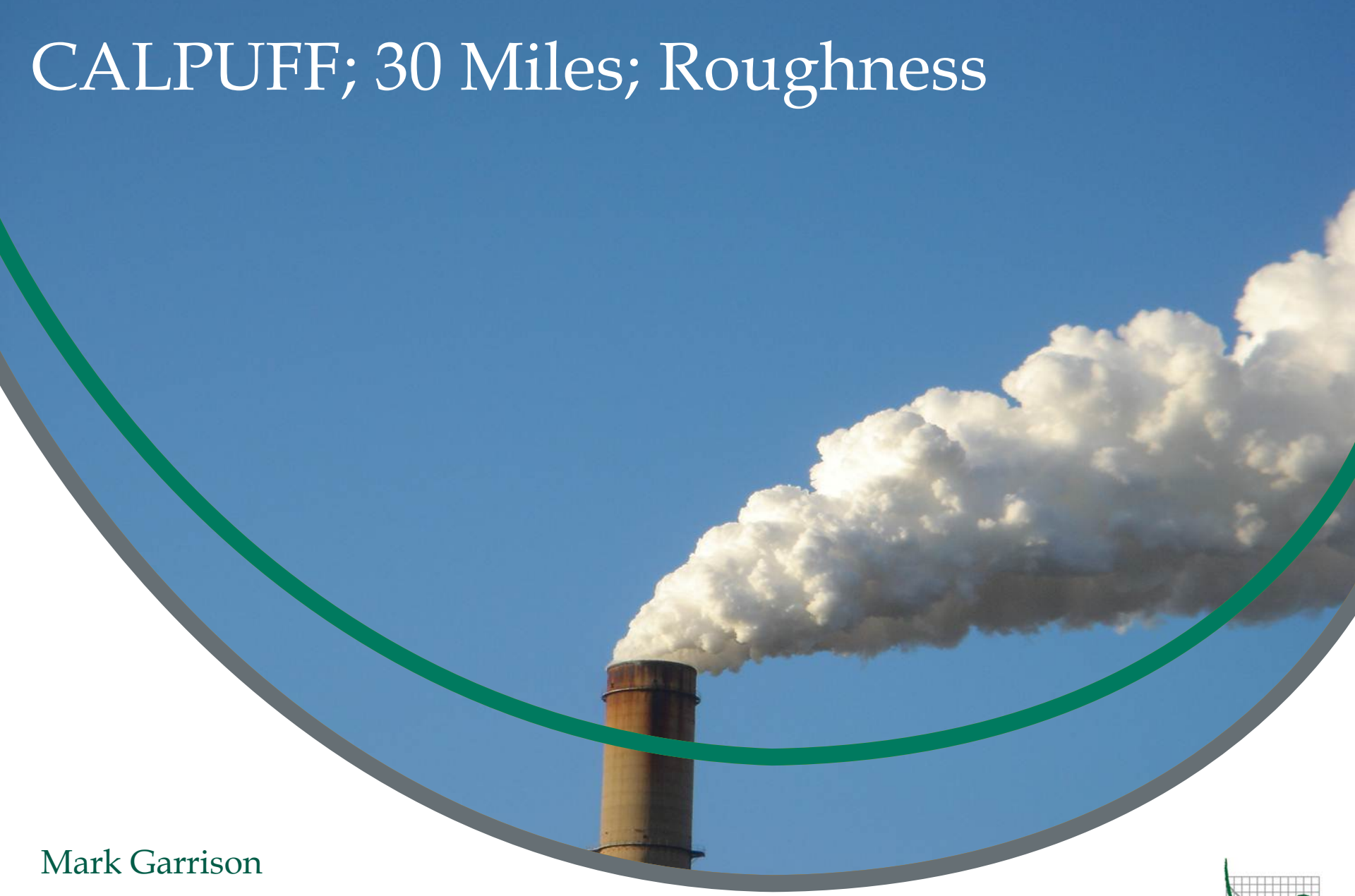
CALPUFF; 30 Miles; Roughness



Mark Garrison

EPA 11th Conference on Air Quality Modeling

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ERM

Overview

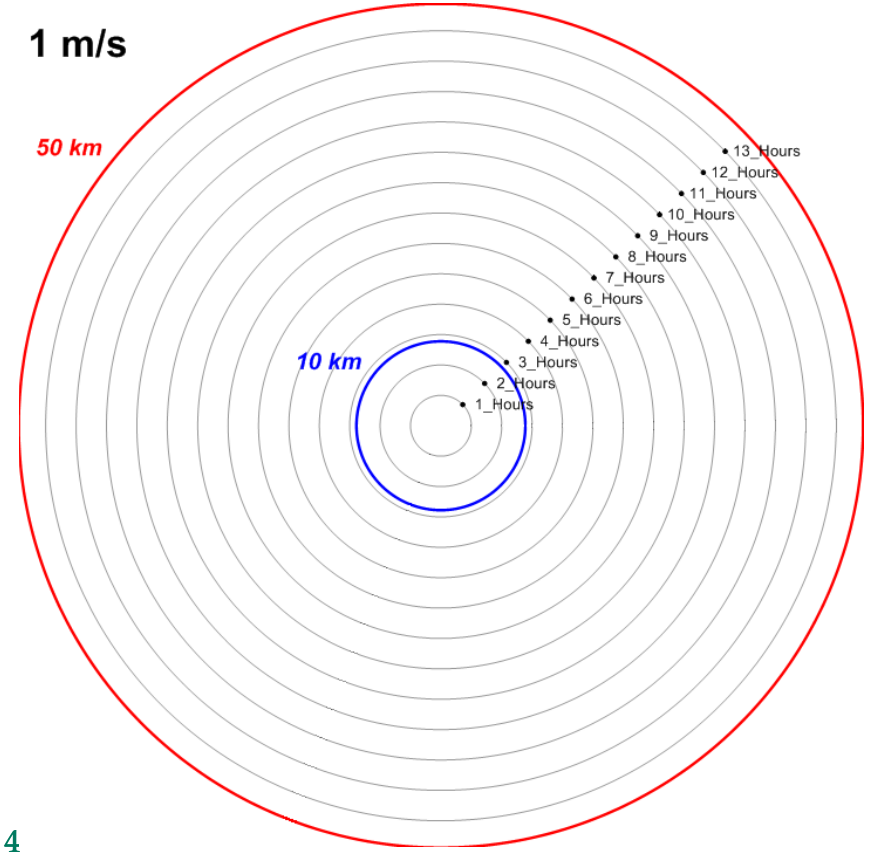
- Presentation deals with some issues that are currently considered "settled policy"
- Appendix W proposals point to a Brave New World for the modeling community
  - Use of prognostic model data for developing representative meteorological inputs to "local scale" models;
  - The development of guidance/policies related to the use of CTMs for ozone and PM2.5 on the "local" scale.
- No time like the present to re-consider settled policy in light of these developments.

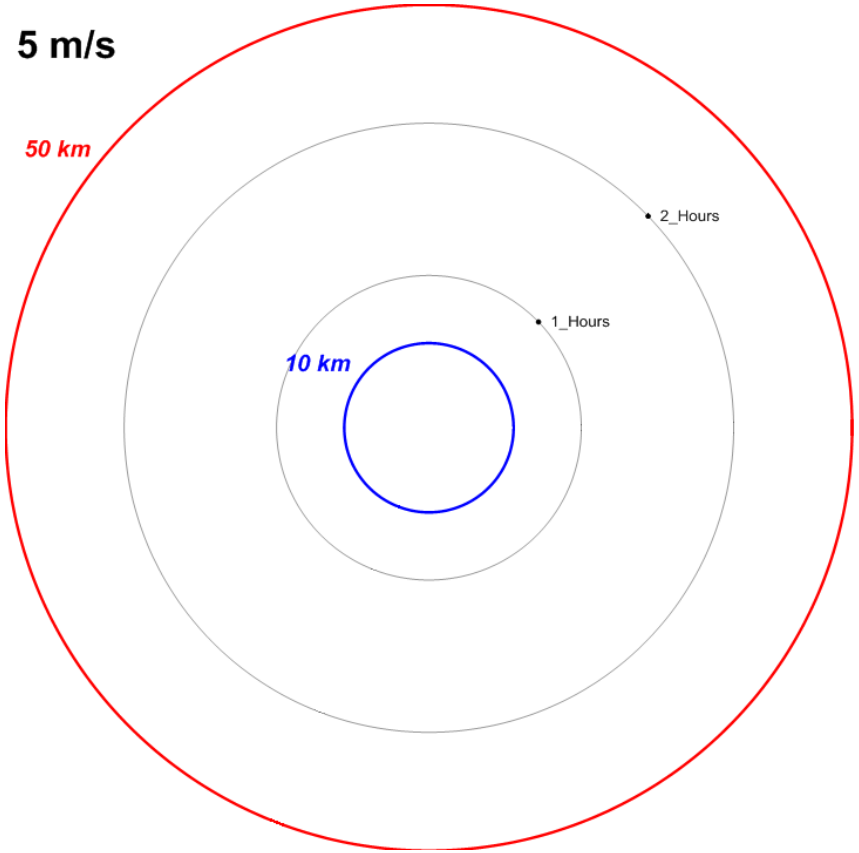
Today's Topics

- CALPUFF
  - As an Appendix A LRT model (comments by others)
  - Kept as a candidate for local scale analyses (this presentation)
- 30 Miles
  - (50 km) and straight line, steady-state models
  - Transition from steady state to non-steady state should not be a bright line with discontinuities
  - Lagrangian models, in theory, can simulate the transition without discontinuities
- Roughness – Measurement vs. Application Site

CALPUFF

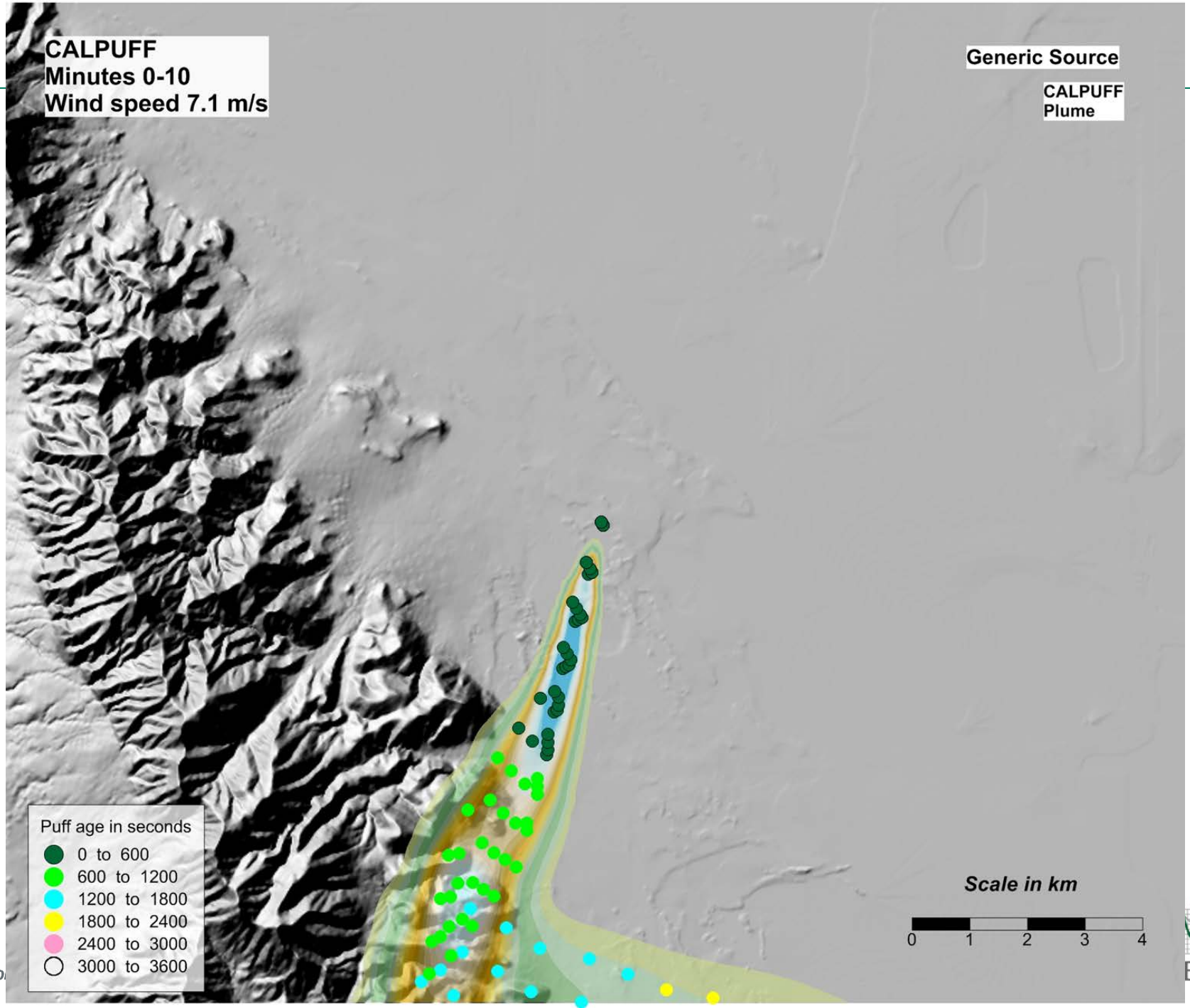
- Why do we need a Lagrangian Model?
  - At 50 km: 1 m/s = nearly 14 hours; 10 m/s = 1.4 hours
  - More often than not the 1 m/s cases are controlling

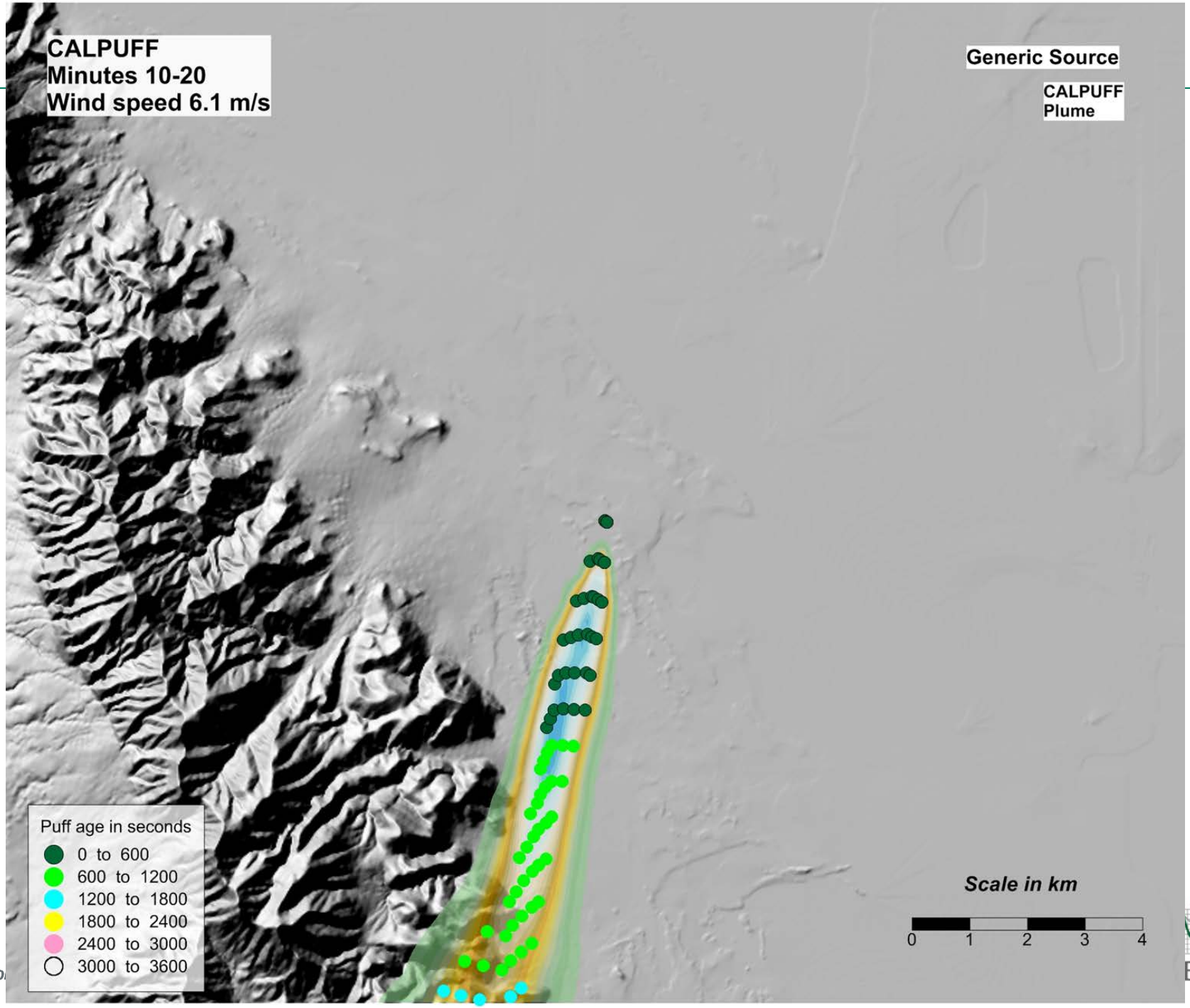


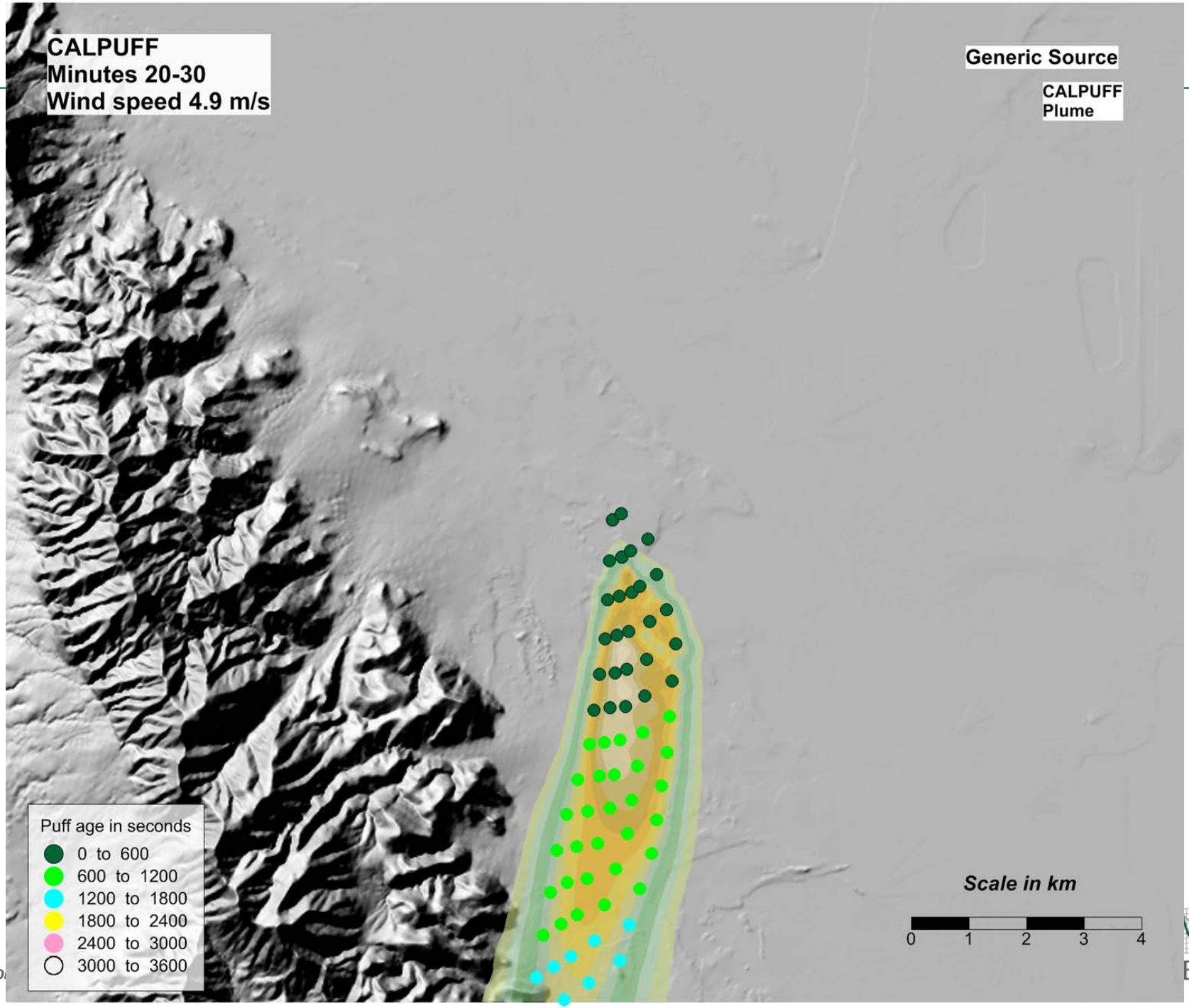


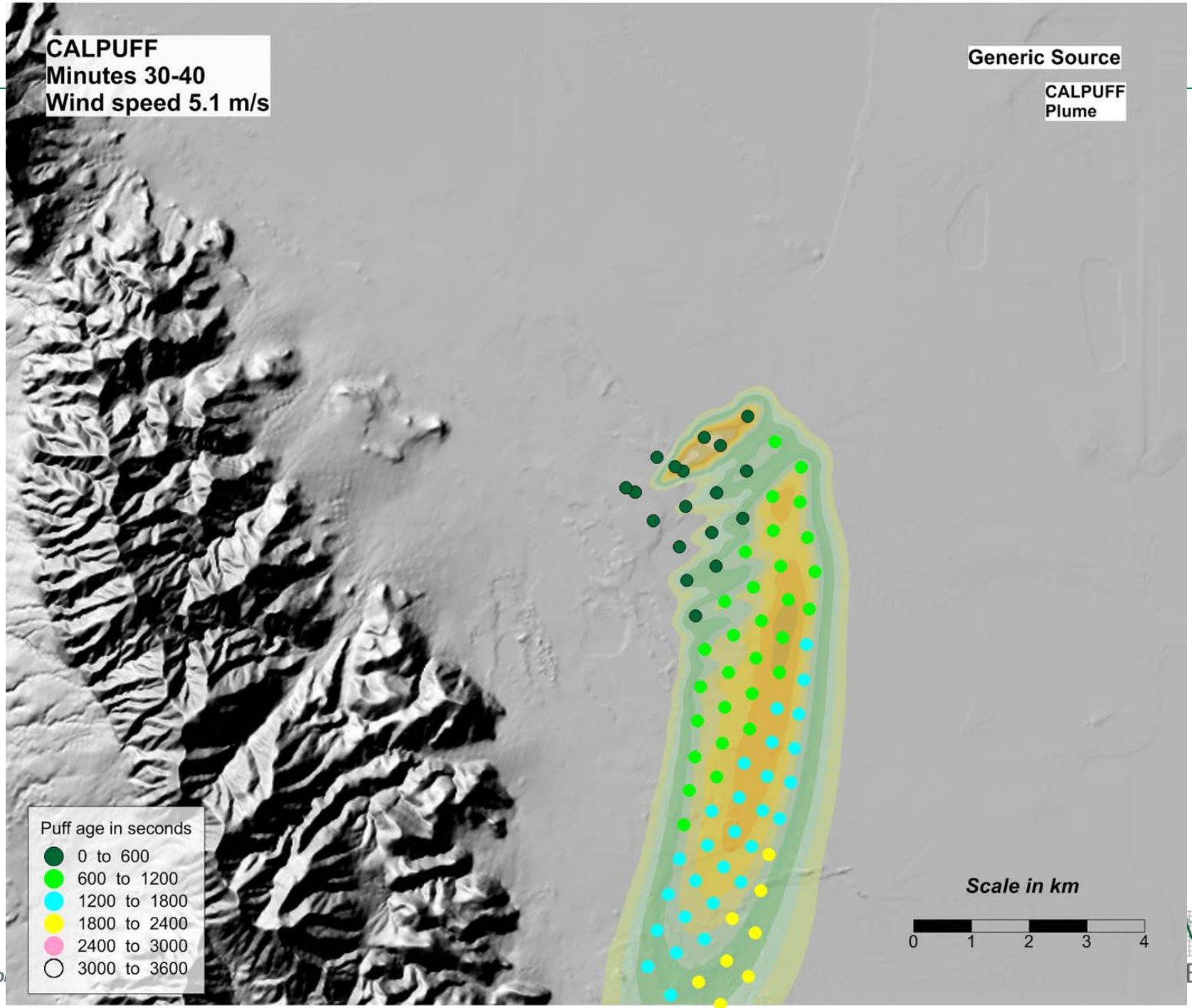
CALPUFF

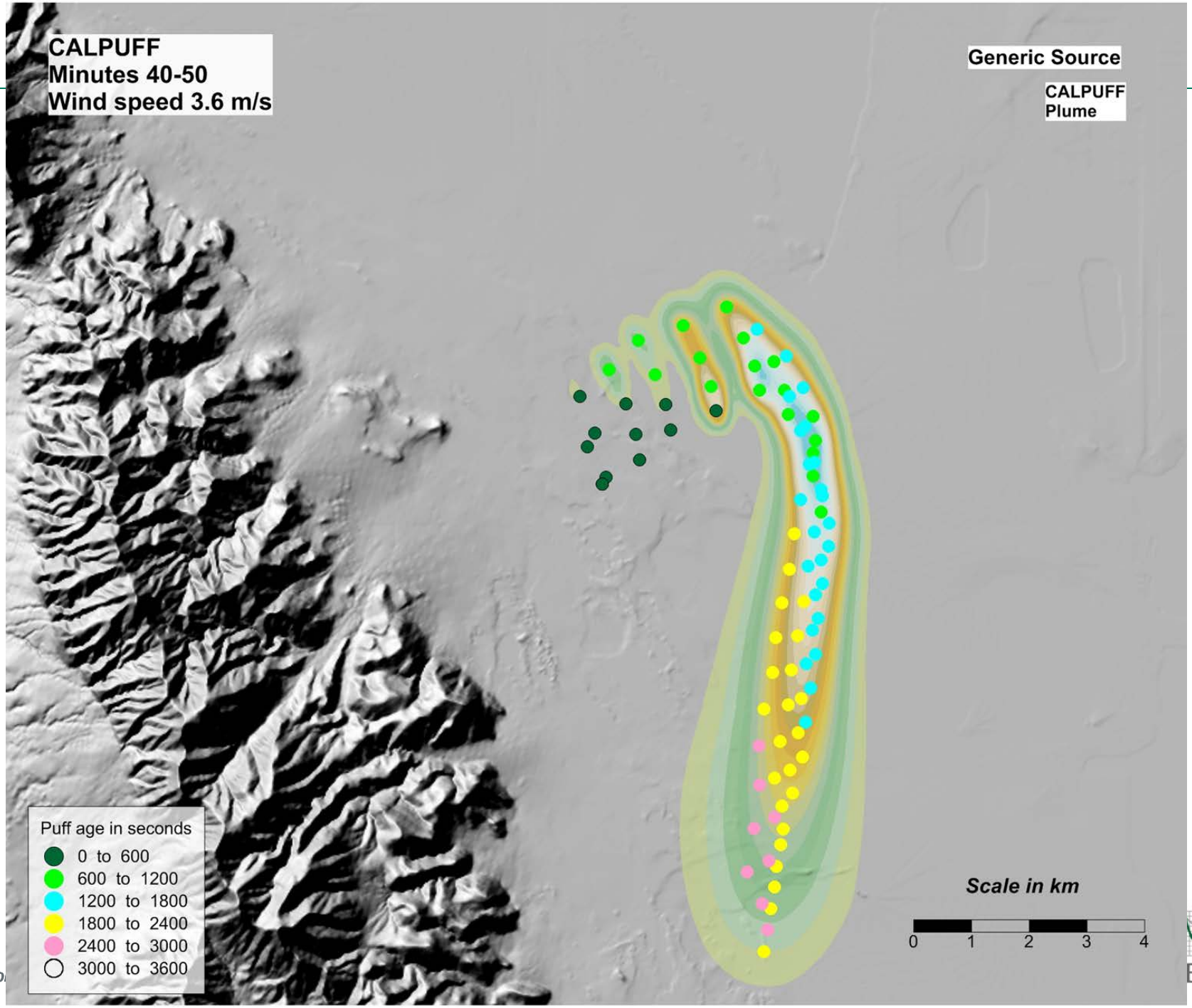
- Why do we need a Lagrangian Model?
- Complex winds exist even on the local scale
- Illustrations: 1 hour with variable winds
  - CALPUFF in 10 minute time steps
  - AERMOD – hourly average

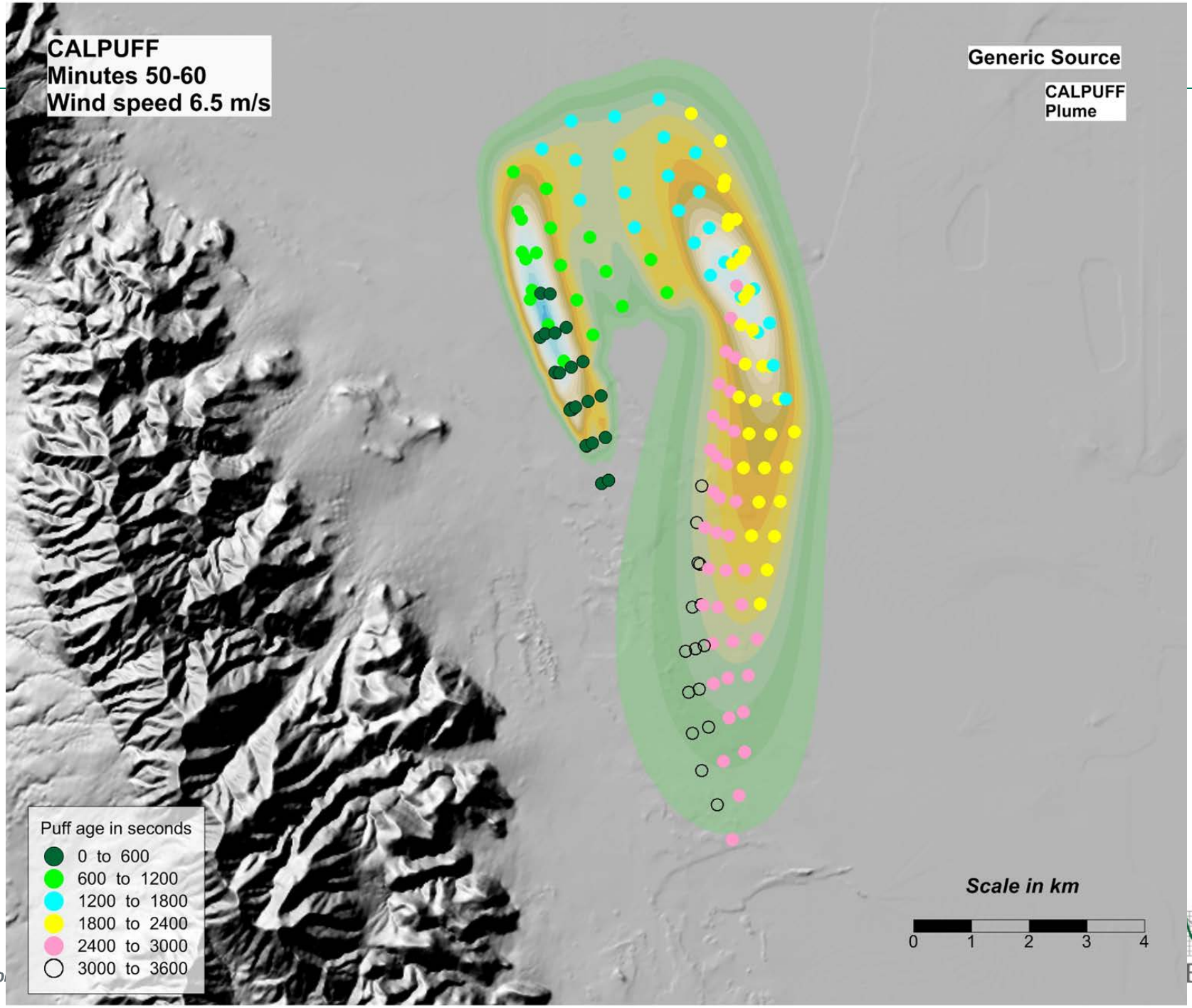

CALPUFF
Minutes 0-10
Wind speed 7.1 m/s
Generic Source
CALPUFF
Plume
Puff age in seconds
0 to 600
600 to 1200
1200 to 1800
1800 to 2400
2400 to 3000
3000 to 3600
Scale in km
0
1
2
3
4

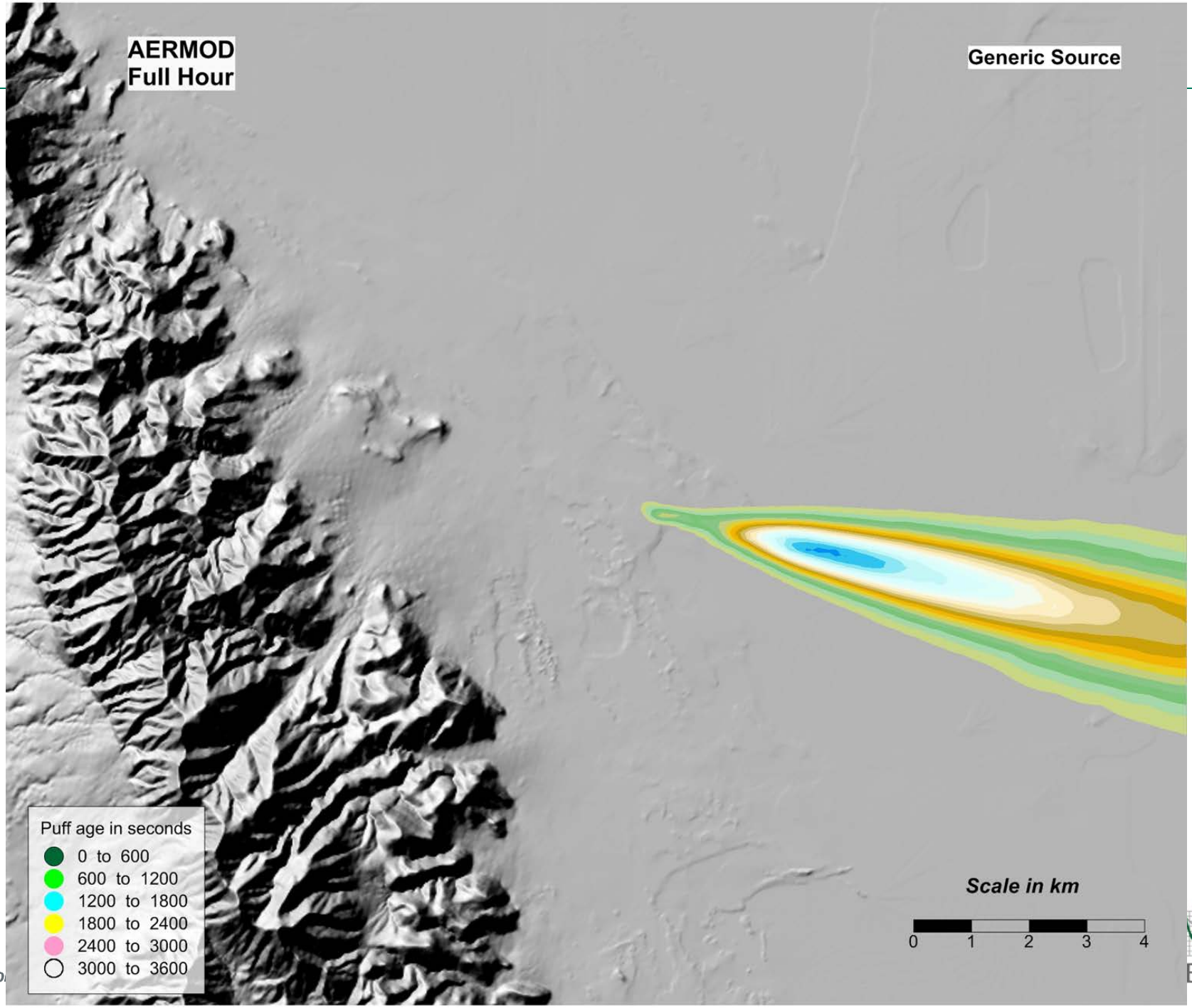

CALPUFF
Minutes 10-20
Wind speed 6.1 m/s
Generic Source
CALPUFF
Plume
Puff age in seconds
0 to 600
600 to 1200
1200 to 1800
1800 to 2400
2400 to 3000
3000 to 3600
Scale in km
0
1
2
3
4


CALPUFF
Minutes 20-30
Wind speed 4.9 m/s
Generic Source
CALPUFF
Plume
Puff age in seconds
0 to 600
600 to 1200
1200 to 1800
1800 to 2400
2400 to 3000
3000 to 3600
Scale in km
0
1
2
3
4


CALPUFF
Minutes 30-40
Wind speed 5.1 m/s
Generic Source
CALPUFF
Plume
Puff age in seconds
0 to 600
600 to 1200
1200 to 1800
1800 to 2400
2400 to 3000
3000 to 3600
Scale in km
0
1
2
3
4


CALPUFF
Minutes 40-50
Wind speed 3.6 m/s
Generic Source
CALPUFF
Plume
Puff age in seconds
0 to 600
600 to 1200
1200 to 1800
1800 to 2400
2400 to 3000
3000 to 3600
Scale in km
0
1
2
3
4


CALPUFF
Minutes 50-60
Wind speed 6.5 m/s
Generic Source
CALPUFF
Plume
Puff age in seconds
0 to 600
600 to 1200
1200 to 1800
1800 to 2400
2400 to 3000
3000 to 3600
Scale in km
0
1
2
3
4


AERMOD
Full Hour
Generic Source
Puff age in seconds
0 to 600
600 to 1200
1200 to 1800
1800 to 2400
2400 to 3000
3000 to 3600
Scale in km
0
1
2
3
4

CALPUFF (and 30 miles…)

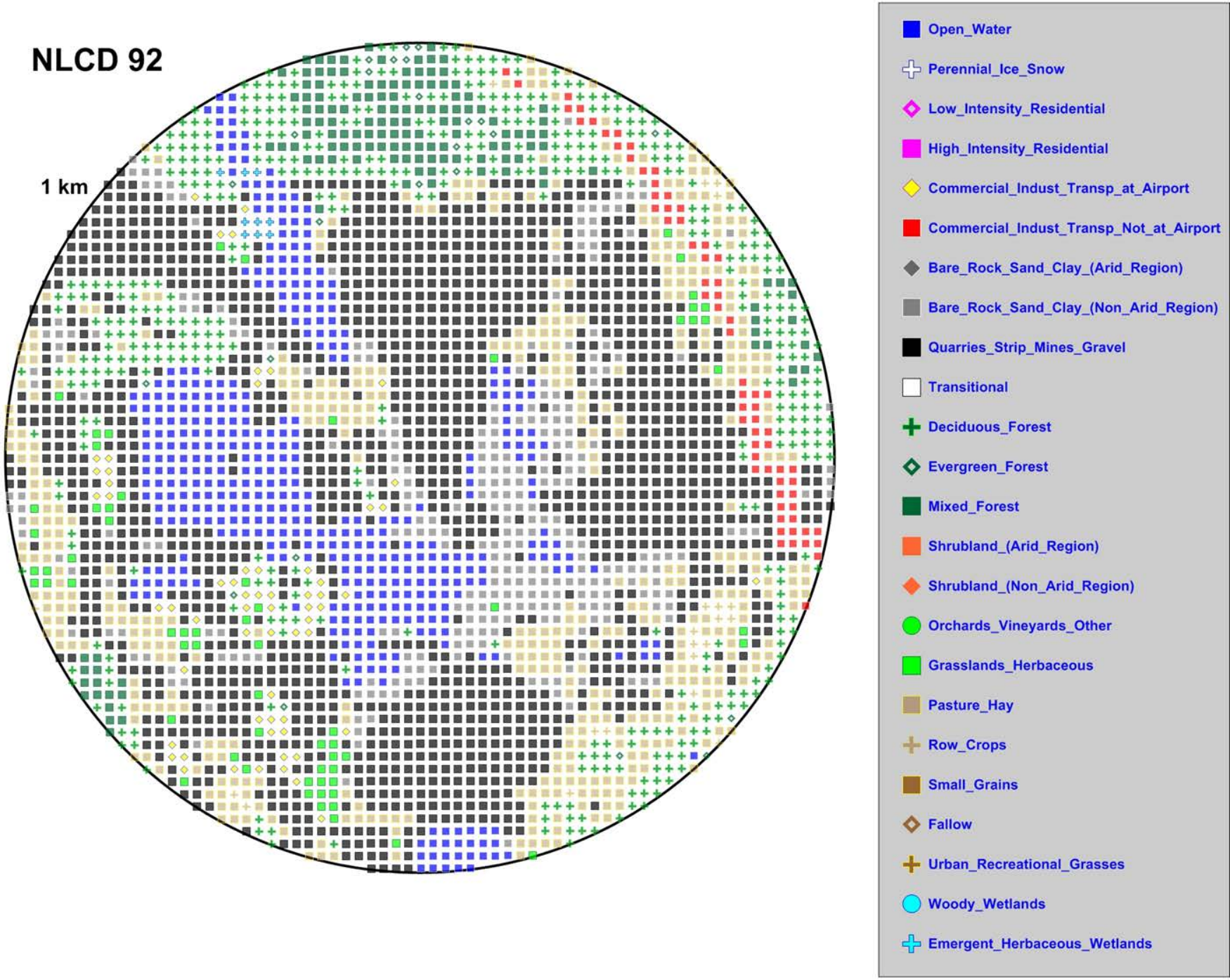
- Illustration not intended to invalidate AERMOD; also not intended to validate CALPUFF
- There is a need for a Lagrangian approach at all scales; ideally:
  - Simulates the steady-state result for the appropriate settings,
  - Simulates atmospheric chemical transformation at all scales;
- Only a non-steady state model can handle the transition from steady-state to spatial/temporal variation without discontinuities.

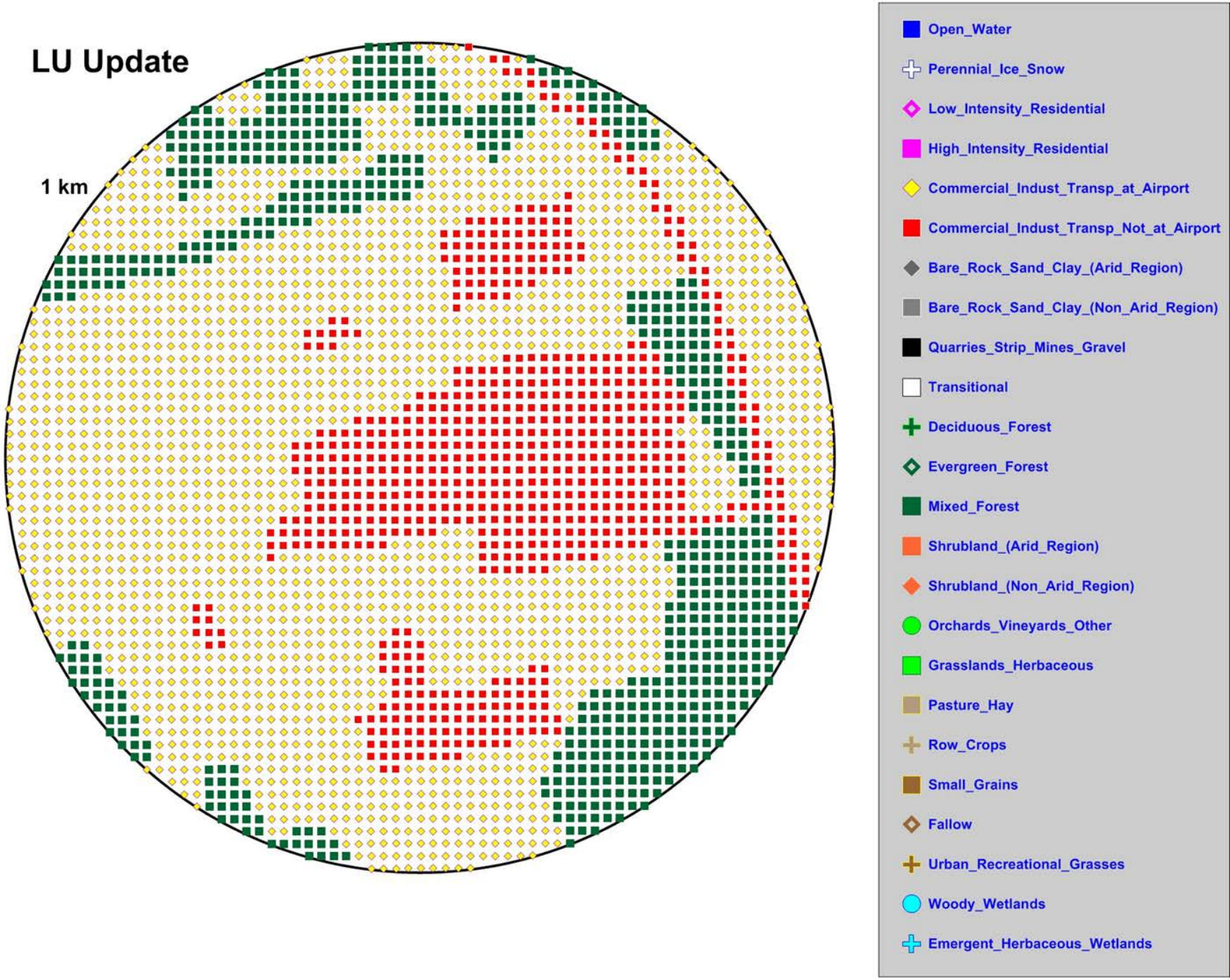
CALPUFF (and 30 miles…)

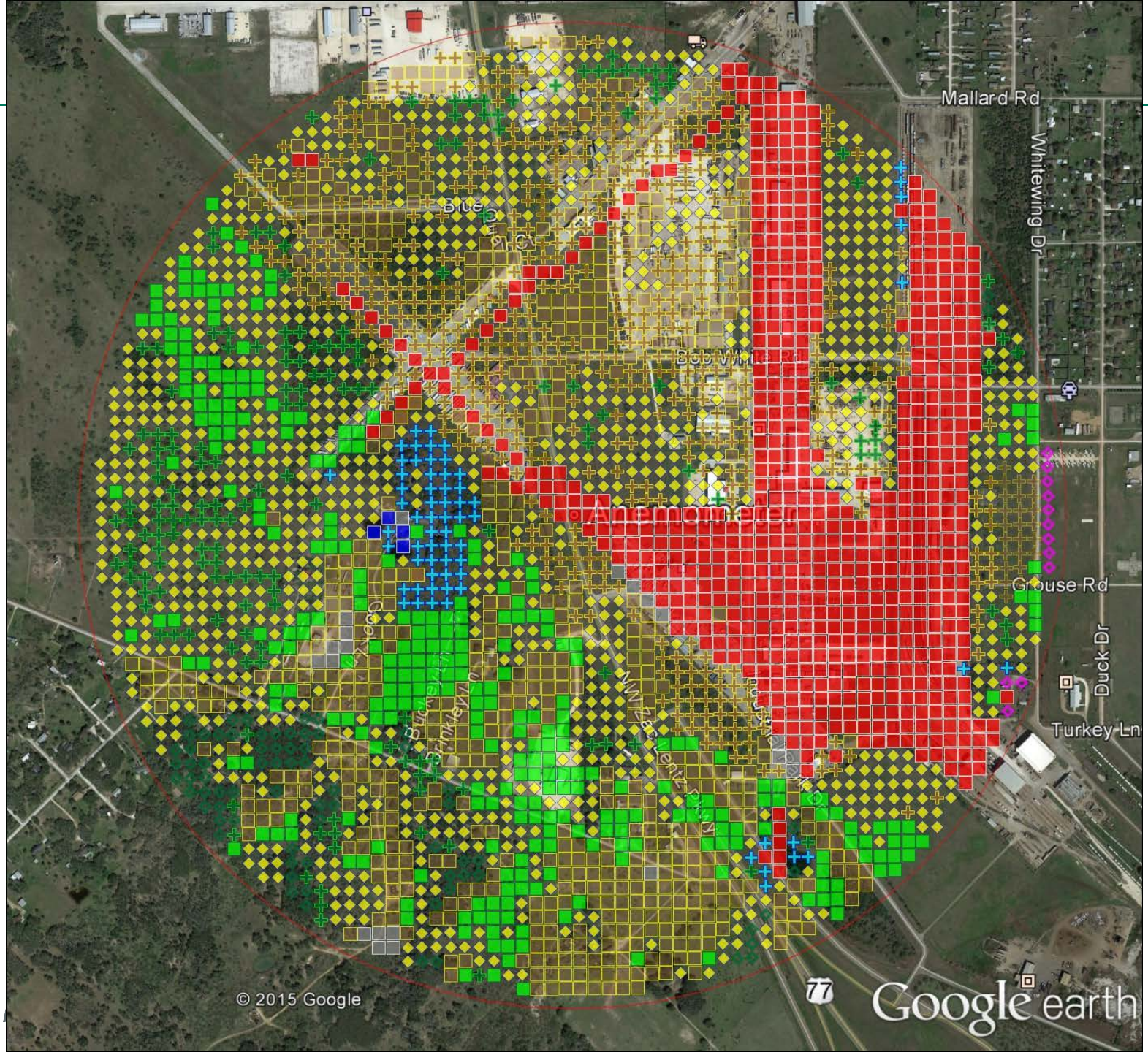
- The recommendation:
- Keep CALPUFF as a candidate for local scale analyses for the time being;
- As policy, guidance and models are developed for CTMs on a local scale consider re-evaluating the 50 km applicability range for AERMOD;
- Consider evaluating CALPUFF along with other approaches.

Roughness (z_0 focus)

- Current policy is to specify land use characteristics for the measurement site, using AERSURFACE to determine lu characteristics based on 1992 NLCD data
- Those characteristics inform the AERMOD interface in creating a full profile of winds, temperature, and turbulence
- This presentation:
  - NLCD 1992 can be out of date
  - Site characteristics vs. measurement location characteristics
  - Another look at upwind


NLCD 92
1 km
Open_Water
Perennial_Ice_Snow
Low_Intensity_Residential
High_Intensity_Residential
Commercial_Indust_Transp_at_Airport
Commercial_Indust_Transp_Not_at_Airport
Bare_Rock_Sand_Clay_(Arid_Region)
Bare_Rock_Sand_Clay_(Non_Arid_Region)
Quarries_Strip_Mines_Gravel
Transitional
Deciduous_Forest
Evergreen_Forest
Mixed_Forest
Shrubland_(Arid_Region)
Shrubland_(Non_Arid_Region)
Orchards_Vineyards_Other
Grasslands_Herbaceous
Pasture_Hay
Row_Crops
Small_Grains
Fallow
Urban_Recreational_Grasses
Woody_Wetlands
Emergent_Herbaceous_Wetlands


LU Update
1 km
Open_Water
Perennial_Ice_Snow
Low_Intensity_Residential
High_Intensity_Residential
Commercial_Indust_Transp_at_Airport
Commercial_Indust_Transp_Not_at_Airport
Bare_Rock_Sand_Clay_(Arid_Region)
Bare_Rock_Sand_Clay_(Non_Arid_Region)
Quarries_Strip_Mines_Gravel
Transitional
Deciduous_Forest
Evergreen_Forest
Mixed_Forest
Shrubland_(Arid_Region)
Shrubland_(Non_Arid_Region)
Orchards_Vineyards_Other
Grasslands_Herbaceous
Pasture_Hay
Row_Crops
Small_Grains
Fallow
Urban_Recreational_Grasses
Woody_Wetlands
Emergent_Herbaceous_Wetlands


Mallard Rd
Whitewing Dr
Bob White Rd
Anemometer
Grouse Rd
Duck Dr
Turkey Ln
Buckeye Ln
Brinkley Ln
W Zaplentz Pkwy
Industrial Park Dr
77
© 2015 Google
Google earth

Mallard Rd
Whitewing Dr
Blue Quail Ct
Bob White Rd
Anemometer
Grouse Rd
Duck Dr
Turkey Ln
Cook Ln
Buckey Ln
Brinkley Ln
NW Zac Lentz Pkwy
Industrial Park Dr
77
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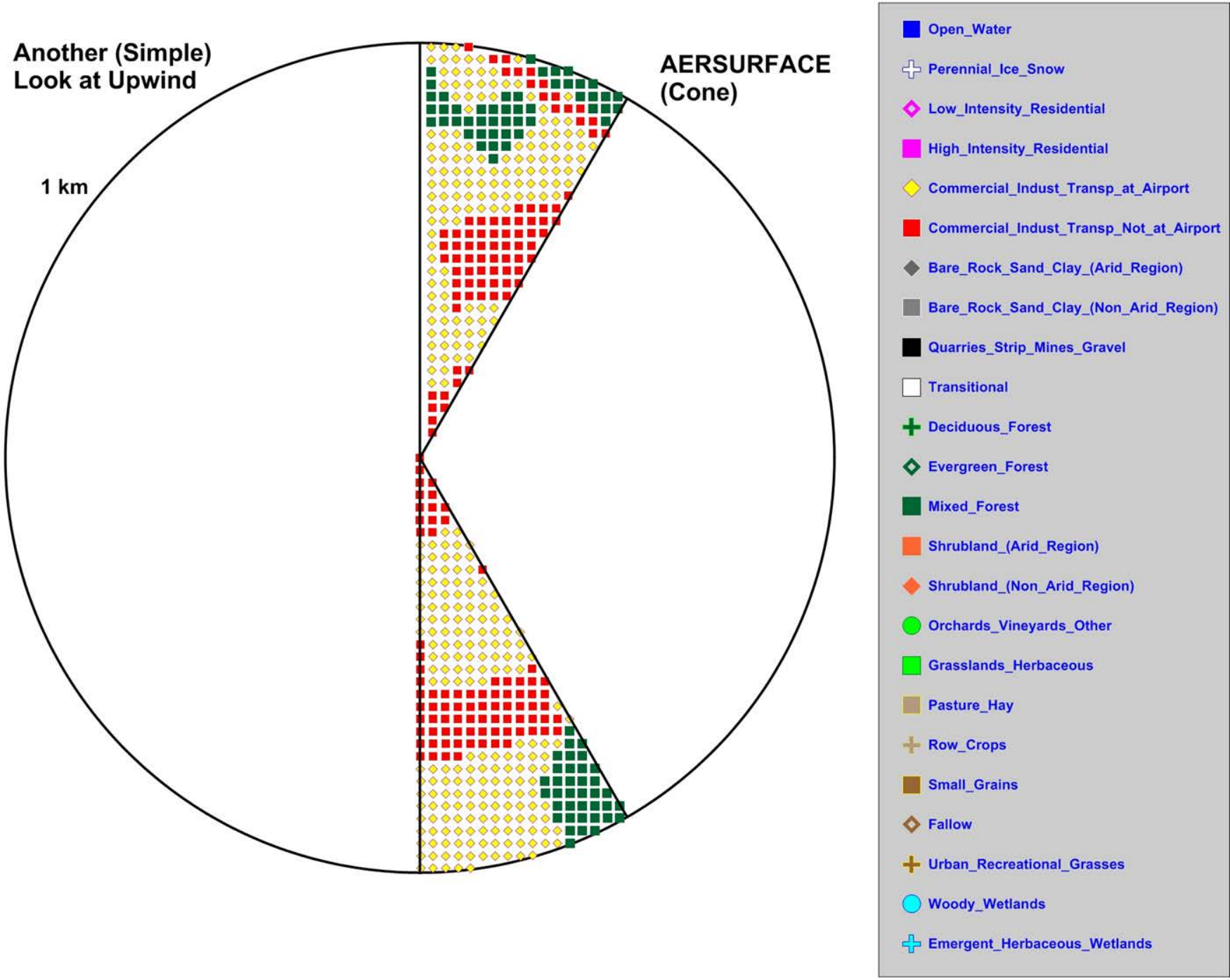
Roughness (Application v. Measurement Site)

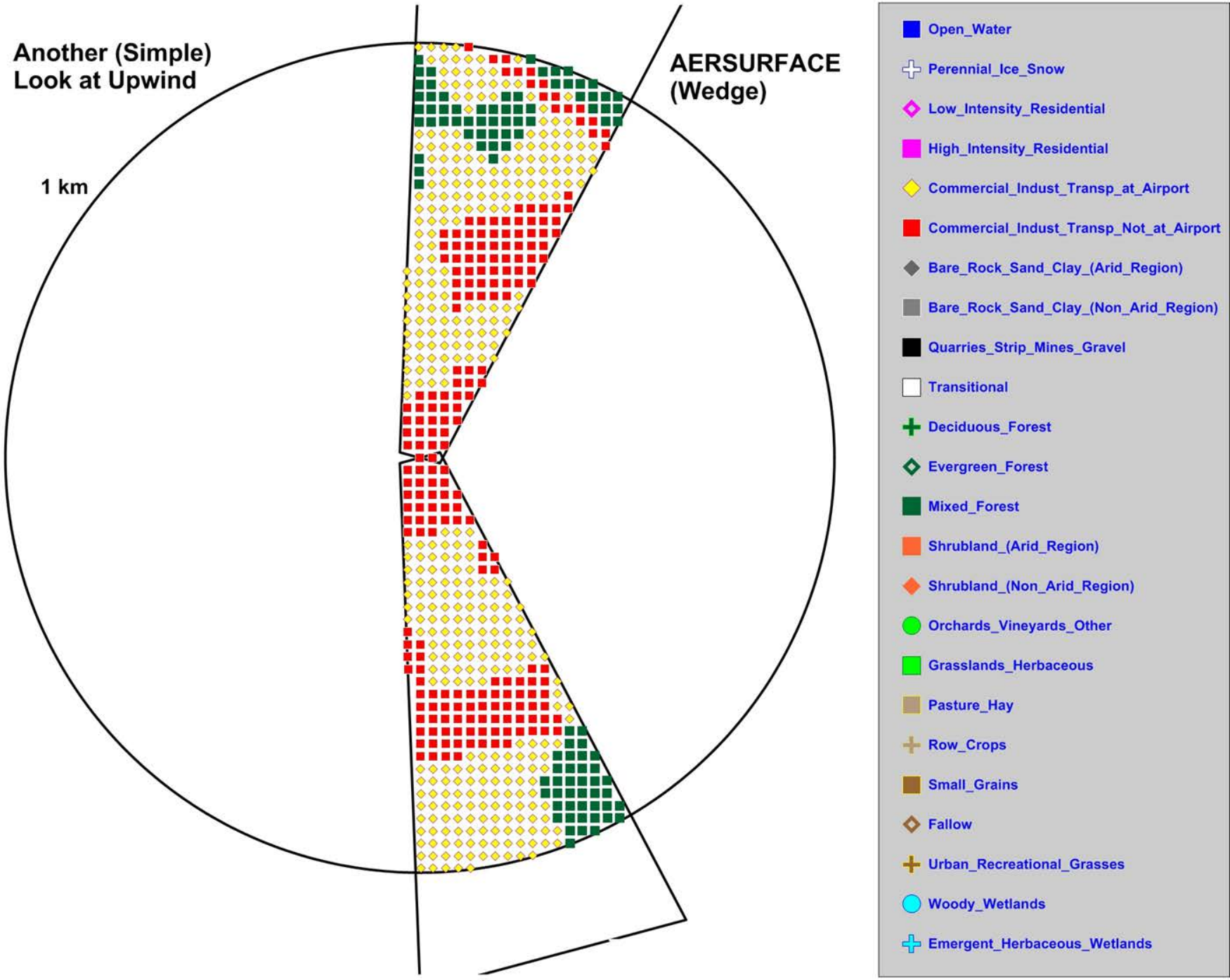
- Surface characteristics (especially z_0) inform the AERMOD interface in creating a full profile of winds, temperature, and turbulence
- Differences in roughness length: airport is not representative? ***or***, run AERMOD both ways; ***or***, using site roughness provides a better profile representation?
- The potential for using prognostic data (wind and temperature profiles) calls for consideration of how to characterize land use at the application site

Roughness

- This is what the AERMOD interface does:

	uref	ziconv	zimech	obulen	SFCHF	USTAR	SFCZ0	BOWEN	ALBEDO
Airport:	0.9	-999	22	4.0	-1.9	0.044	0.13	0.42	1
Site:	0.9	-999	68	12.0	-5.8	0.093	1.12	0.95	1
AIRPORT Z0					**SITE Z0**				
Ht	ws	TG	SV	SW	Ht	ws	TG	SV	SW
0	0.01	0.163	0.083	0.057	0	0.01	0.123	0.176	0.121
0.5	0.13	0.163	0.083	0.057	0.5	0.06	0.123	0.176	0.12
1	0.25	0.163	0.083	0.056	1	0.12	0.123	0.176	0.12
2	0.39	0.163	0.083	0.055	2	0.23	0.123	0.176	0.119
4	0.6	0.14	0.083	0.052	4	0.46	0.09	0.176	0.117
8	0.91	0.129	0.083	0.047	8	0.91	0.073	0.176	0.114
14	1.23	0.124	0.083	0.039	14	1.42	0.066	0.176	0.109
20	1.43	0.122	0.083	0.031	20	1.83	0.063	0.176	0.104
Zlm	----------								
30	1.48	0.12	0.083	0.029	30	2.37	0.061	0.176	0.096
40	1.48	0.12	0.083	0.029	40	2.79	0.06	0.176	0.088
50	1.48	0.119	0.083	0.029	50	3.12	0.059	0.176	0.081
60	1.48	0.119	0.083	0.029	60	3.37	0.059	0.176	0.075
					Zlm	----------			
70	1.48	0.119	0.083	0.029	70	3.54	0.058	0.176	0.07
80	1.48	0.118	0.083	0.029	80	3.54	0.058	0.176	0.07
90	1.48	0.118	0.083	0.029	90	3.54	0.058	0.176	0.07
100	1.48	0.118	0.083	0.029	100	3.54	0.058	0.176	0.07


Another (Simple)
Look at Upwind
AERSURFACE
(Cone)
1 km
Open_Water
Perennial_Ice_Snow
Low_Intensity_Residential
High_Intensity_Residential
Commercial_Indust_Transp_at_Airport
Commercial_Indust_Transp_Not_at_Airport
Bare_Rock_Sand_Clay_(Arid_Region)
Bare_Rock_Sand_Clay_(Non_Arid_Region)
Quarries_Strip_Mines_Gravel
Transitional
Deciduous_Forest
Evergreen_Forest
Mixed_Forest
Shrubland_(Arid_Region)
Shrubland_(Non_Arid_Region)
Orchards_Vineyards_Other
Grasslands_Herbaceous
Pasture_Hay
Row_Crops
Small_Grains
Fallow
Urban_Recreational_Grasses
Woody_Wetlands
Emergent_Herbaceous_Wetlands


Another (Simple)
Look at Upwind
AERSURFACE
(Wedge)
1 km
Open_Water
Perennial_Ice_Snow
Low_Intensity_Residential
High_Intensity_Residential
Commercial_Indust_Transp_at_Airport
Commercial_Indust_Transp_Not_at_Airport
Bare_Rock_Sand_Clay_(Arid_Region)
Bare_Rock_Sand_Clay_(Non_Arid_Region)
Quarries_Strip_Mines_Gravel
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Deciduous_Forest
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Shrubland_(Arid_Region)
Shrubland_(Non_Arid_Region)
Orchards_Vineyards_Other
Grasslands_Herbaceous
Pasture_Hay
Row_Crops
Small_Grains
Fallow
Urban_Recreational_Grasses
Woody_Wetlands
Emergent_Herbaceous_Wetlands

Summary

- In the Brave New World
  - Consider keeping CALPUFF as an alternative for local complex winds; CALPUFF as a screening model in that range?
  - Consider re-visiting the 50 km application distance for AERMOD (ideally substitute with a Lagrangian model)
  - Consider allowing the use of application site roughness
  - Use of WRF/MMIF should be encouraged
  - Consider/Evaluate different options for LU specification with MMIF-generated wind and temperature profiles