Sub-km Numerical Weather Prediction at Environment Canada

Configuration for FROST-2014
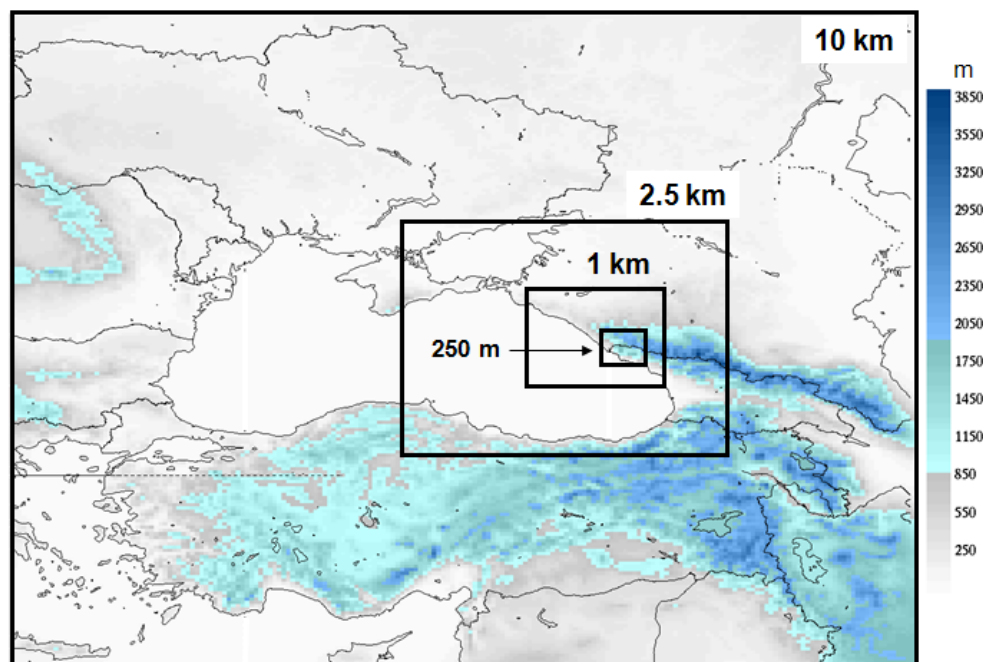
Stéphane Bélair
Jason Milbrandt
Sylvie Leroyer
Vincent Vionnet
Simon Pellerin
Anna Glazer

Environment Canada

10th International SRNWP Workshop, 13-15 May 2013, Offenbach, Germany
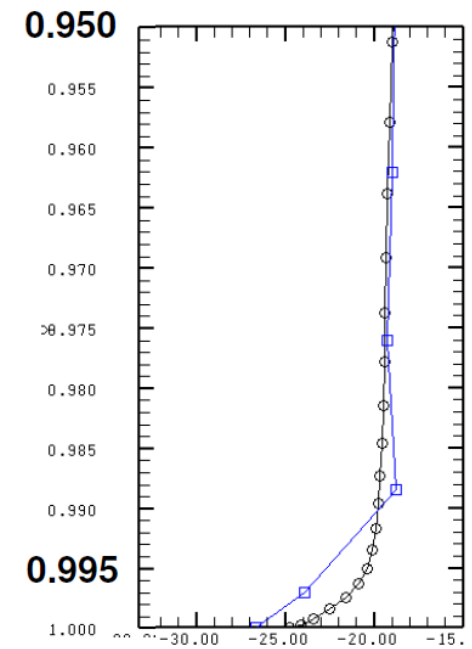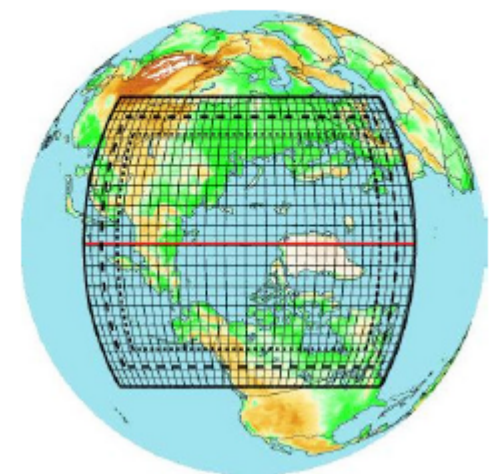
Going to 250-m grid spacing

Operational regional / short-range NWP going to 2.5-km grid spacing (previous presentation)
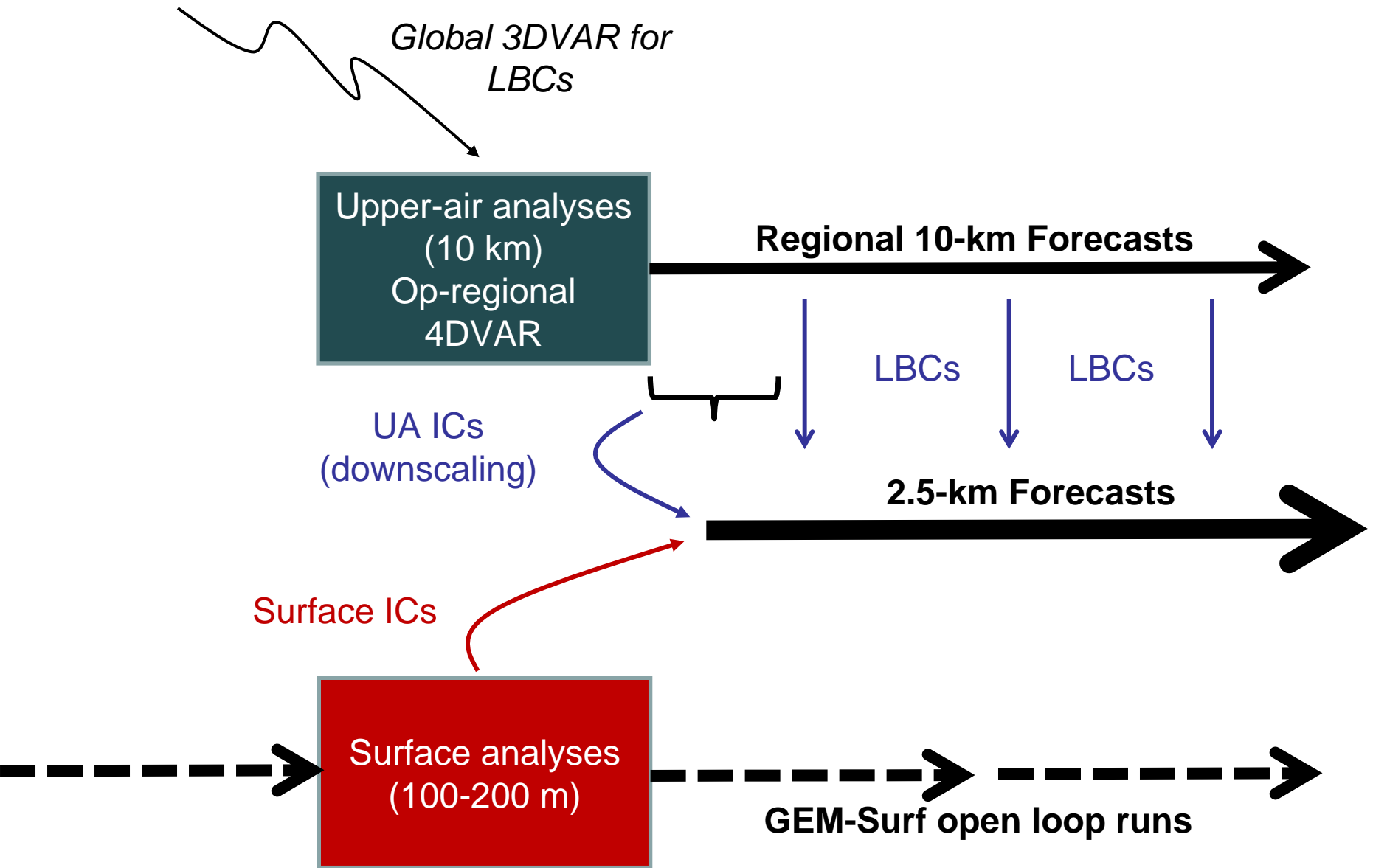
Need for higher-resolution for specific applications (e.g., hydrometeorology, coastal, urban, and mountain meteorology)

250-m systems to be implemented in experimental mode at CMC in 2015 or 2016 (over Montreal, Toronto, and Vancouver)

Limited Area (LAM)

Temperature (°C)

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Initial conditions

Global 3DVAR for LBCs

Upper-air analyses (10 km) Op-regional 4DVAR

Regional 10-km Forecasts

LBCs LBCs

UA ICs (downscaling)

2.5-km Forecasts

Surface ICs

Surface analyses (100-200 m)

GEM-Surf open loop runs

NOTE: for most of the tests shown afterward, surface ICs from regional 10 km

GEM configuration– Numerics/Dynamics

GEM = Global Environmental Multiscale model

Non-hydrostatic

Limited area version (GEM-LAM)

Fully implicit, semi-Lagrangian

Terrain-following hybrid vertical coordinate

Increased vertical resolution near the surface for most of the tests presented here (first level a few meters above the surface)

Computational grids on the order of 800 x 800 x 72

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GEM configuration– Physics

Land surface with ISBA (Interactions between Surface, Biosphere, and Atmosphere) and TEB (Town Energy Balance) – new land surface scheme being tested (SVS)

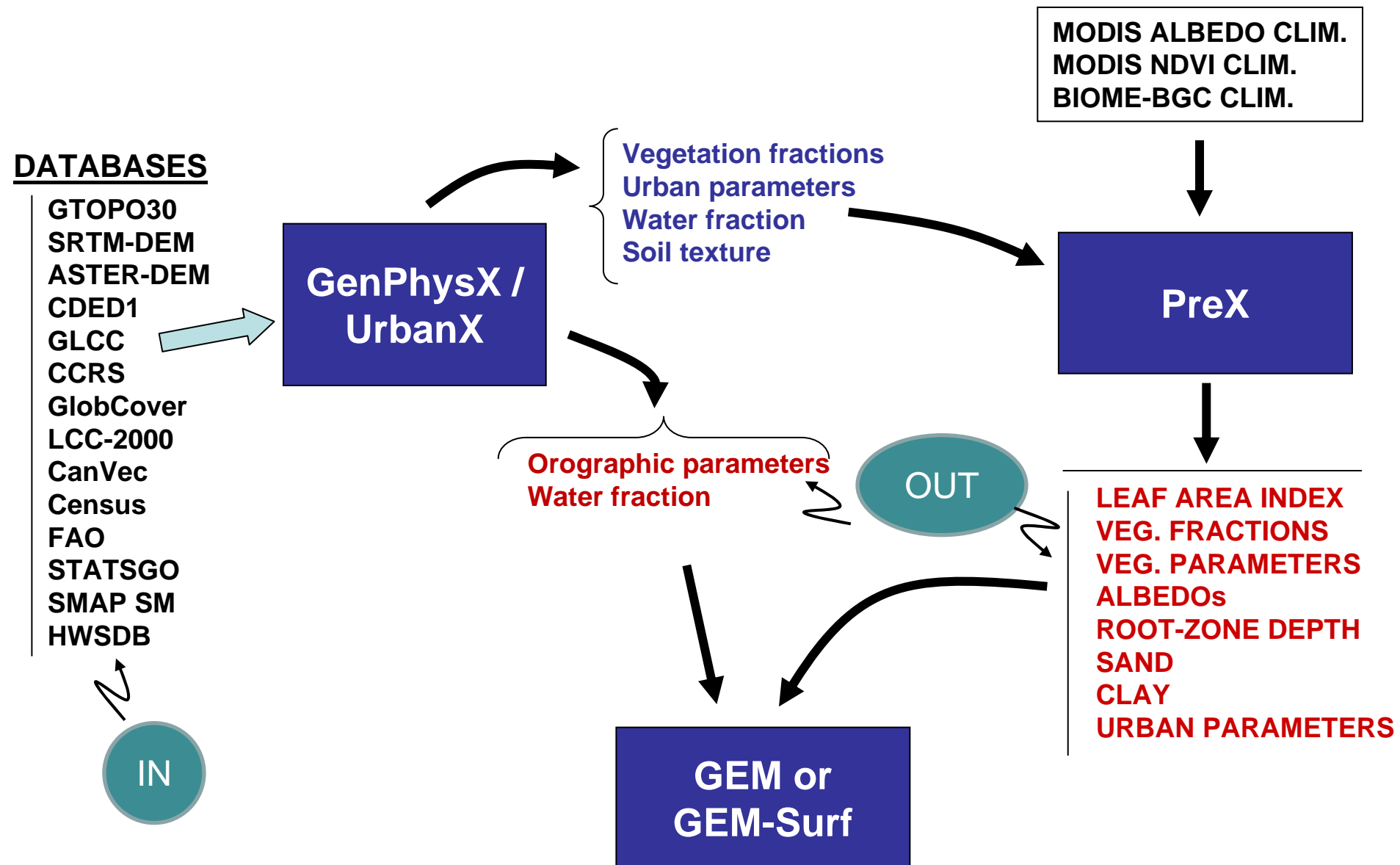*"Quasi-3D" TKE scheme for turbulence (1D with changes to the mixing and dissipation lengths)*

No deep convection parameterization

PBL clouds (as treated in the vertical diffusion scheme)
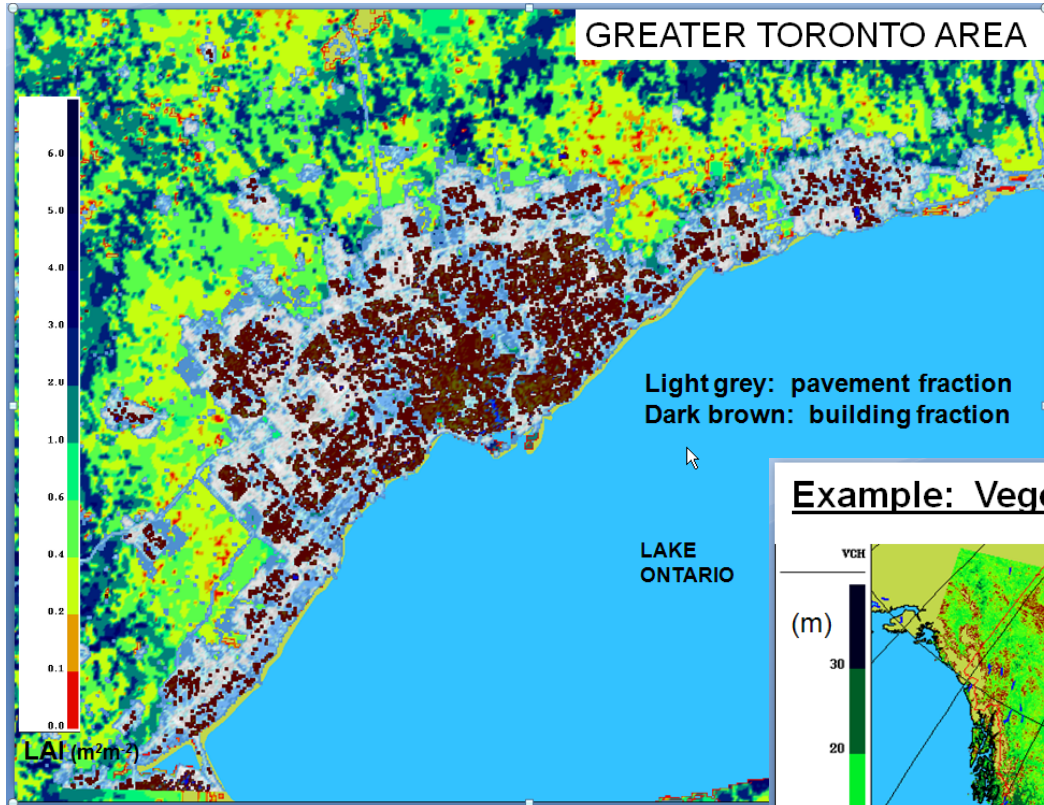
Shallow convection from Kuo Transient (Bélair et al., 2009)

No 3D aspects yet, i.e., full 3D turbulence, clouds and mountains shadows – not the most determinant aspect at this time.
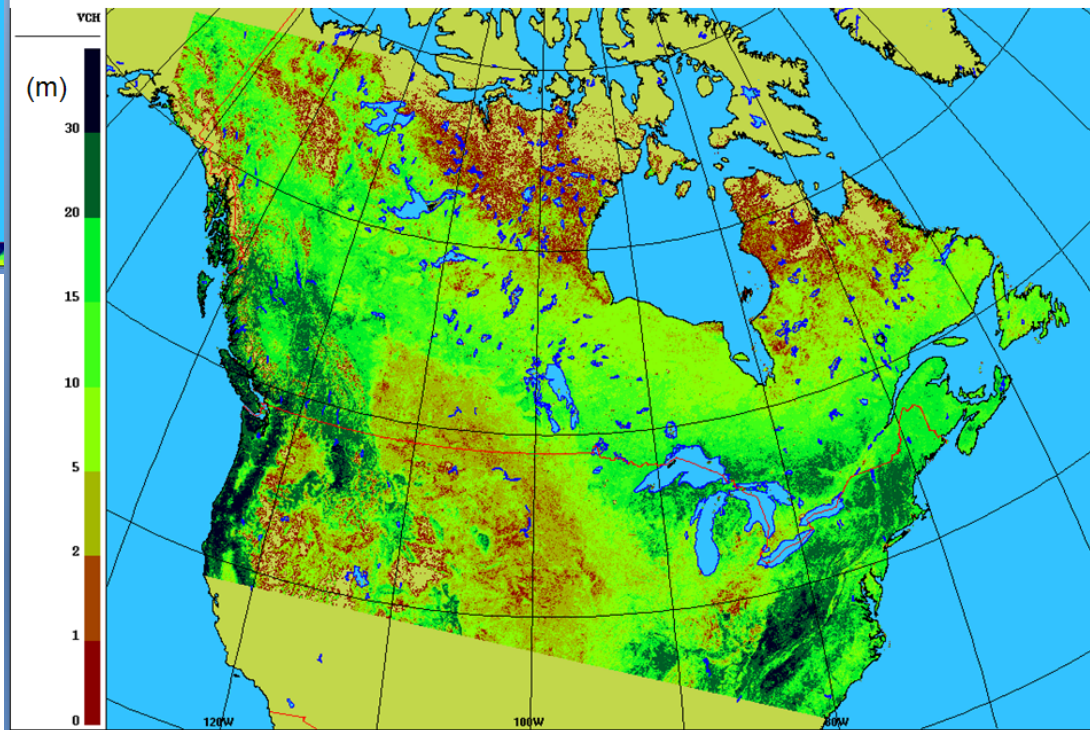
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Canada Canada

Land surface characteristics - method

DATABASES
- GTOPO30
- SRTM-DEM
- ASTER-DEM
- CDED1
- GLCC
- CCRS
- GlobCover
- LCC-2000
- CanVec
- Census
- FAO
- STATSGO
- SMAP SM
- HWSDB

GenPhysX / UrbanX

Vegetation fractions
Urban parameters
Water fraction
Soil texture

MODIS ALBEDO CLIM.
MODIS NDVI CLIM.
BIOME-BGC CLIM.

PreX

Orographic parameters
Water fraction

OUT

LEAF AREA INDEX
VEG. FRACTIONS
VEG. PARAMETERS
ALBEDOs
ROOT-ZONE DEPTH
SAND
CLAY
URBAN PARAMETERS

IN

GEM or GEM-Surf

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Belair et al. (in preparation)

Land surface characteristics- examples

Bélair et al. (in preparation)

GREATER TORONTO AREA

Light grey: pavement fraction
Dark brown: building fraction

LAKE ONTARIO

LAI (m²m⁻²)

Example: Vegetation height (JPL, GLAS mission)

VCH

(m)

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Land surface analyses (GEM-Surf)

GEM-Surf - 200m
Surf. temperature
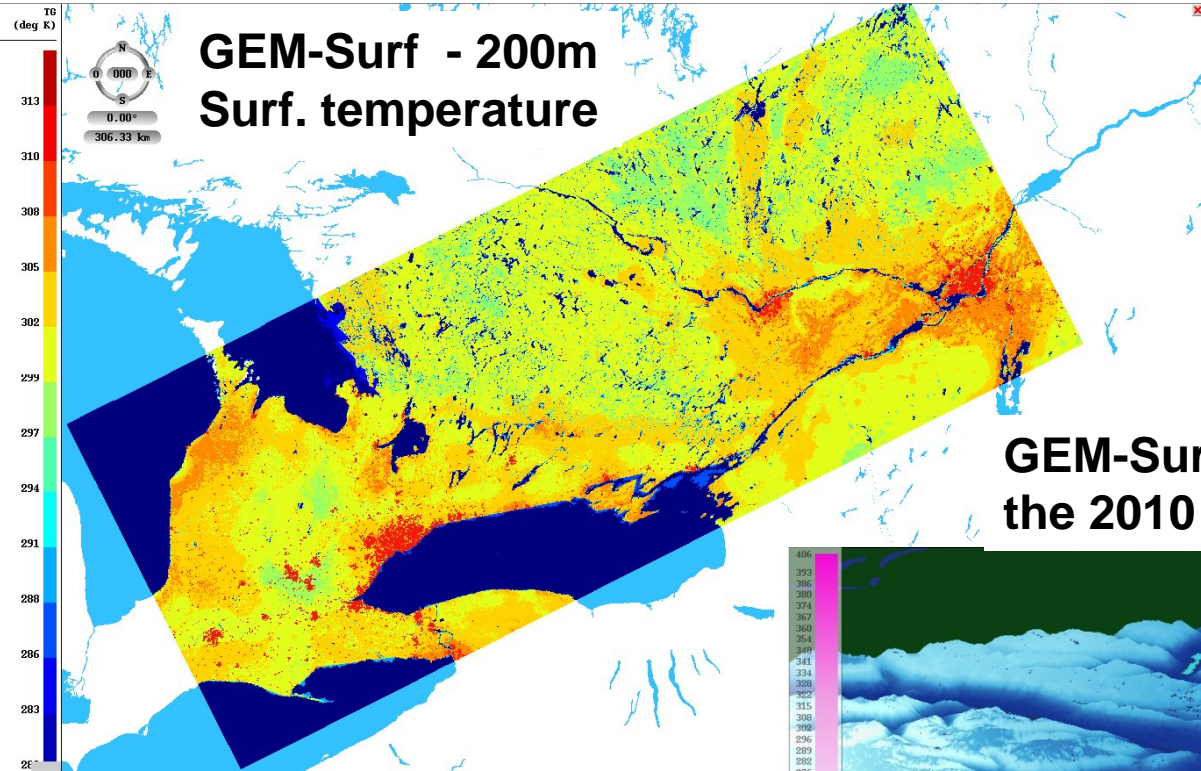
GEM-Surf - 100 m, snow depth for
the 2010 Vancouver Olympic Games
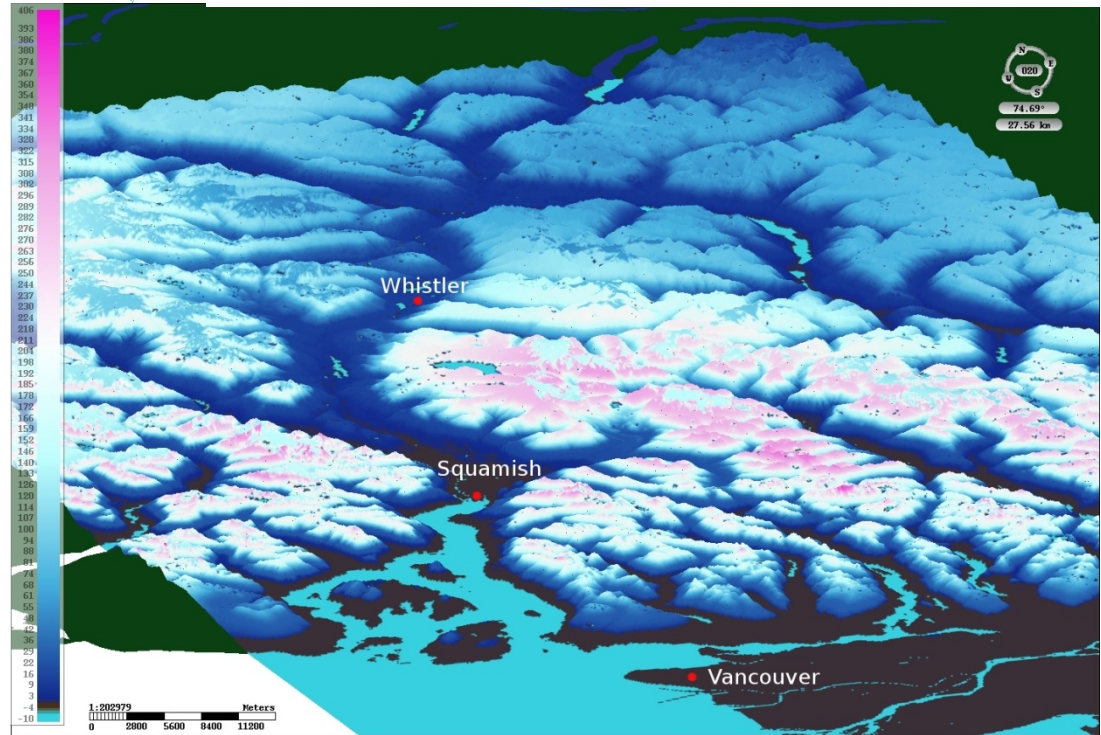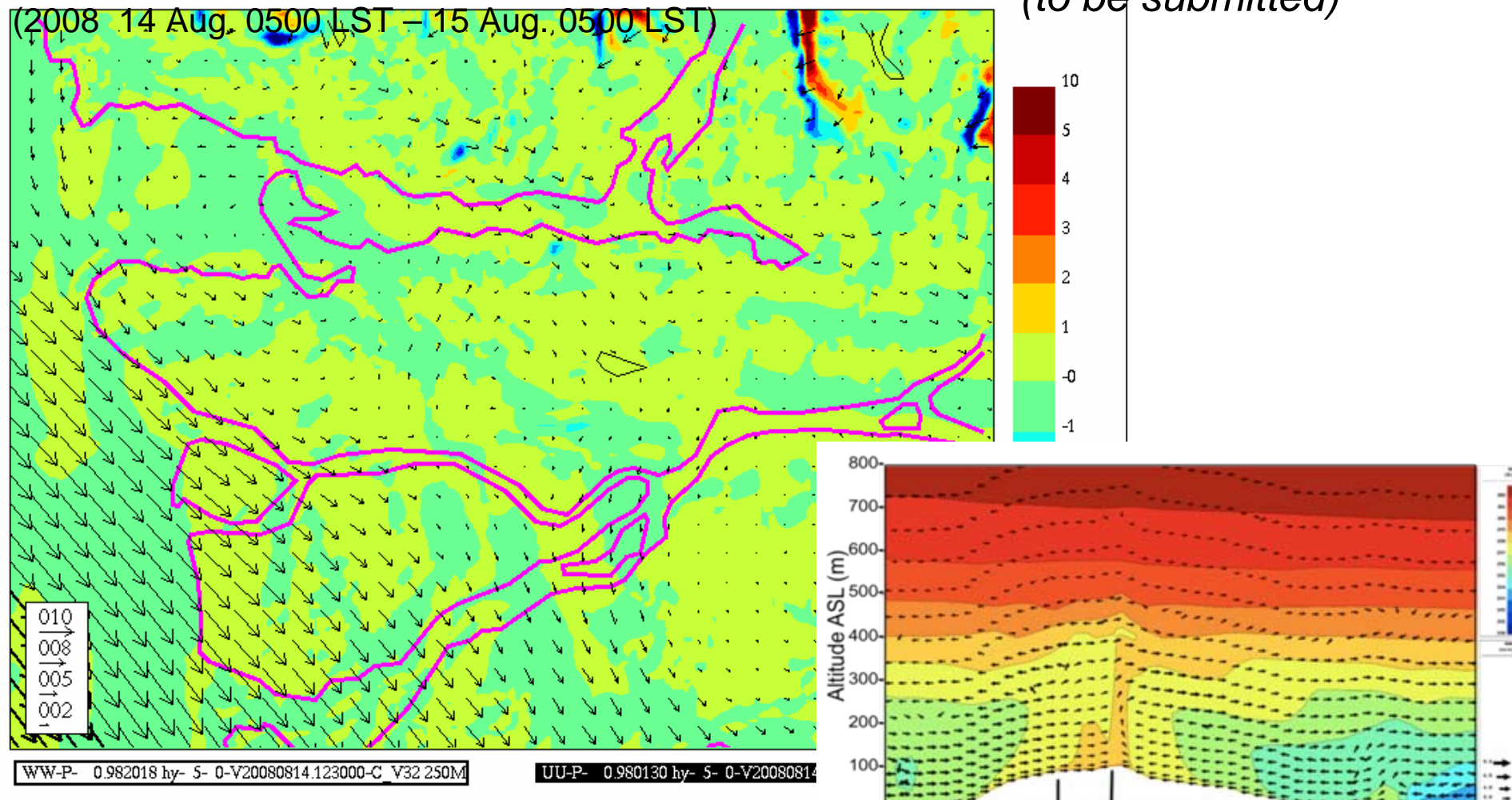
Bélair et al. (in preparation)

Bernier et al. (2011)

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Example: Convergence zone over Vancouver

Vertical Motion (pa/s) and Wind Vectors (knots) at ~ 160 m AGL
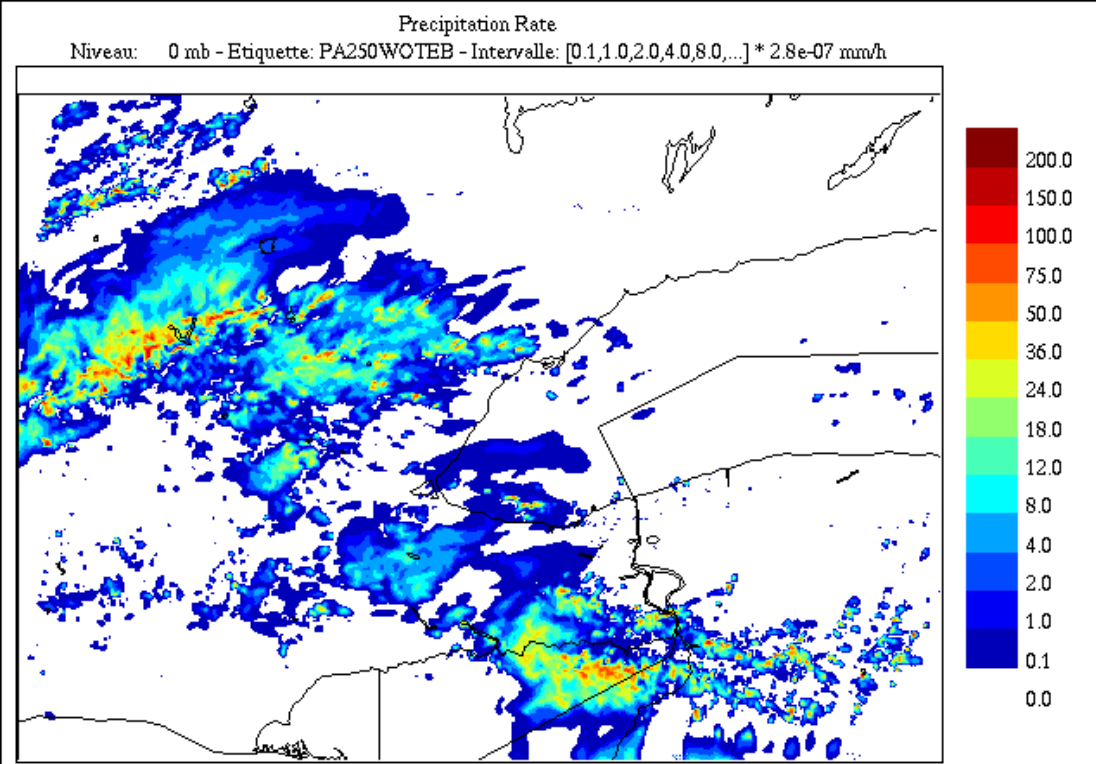(2008 14 Aug. 0500 LST – 15 Aug. 0500 LST)

Leroyer et al. (prep.):
250-m modeling of sea breezes over Vancouver (to be submitted)

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Example: Precipitation over Toronto
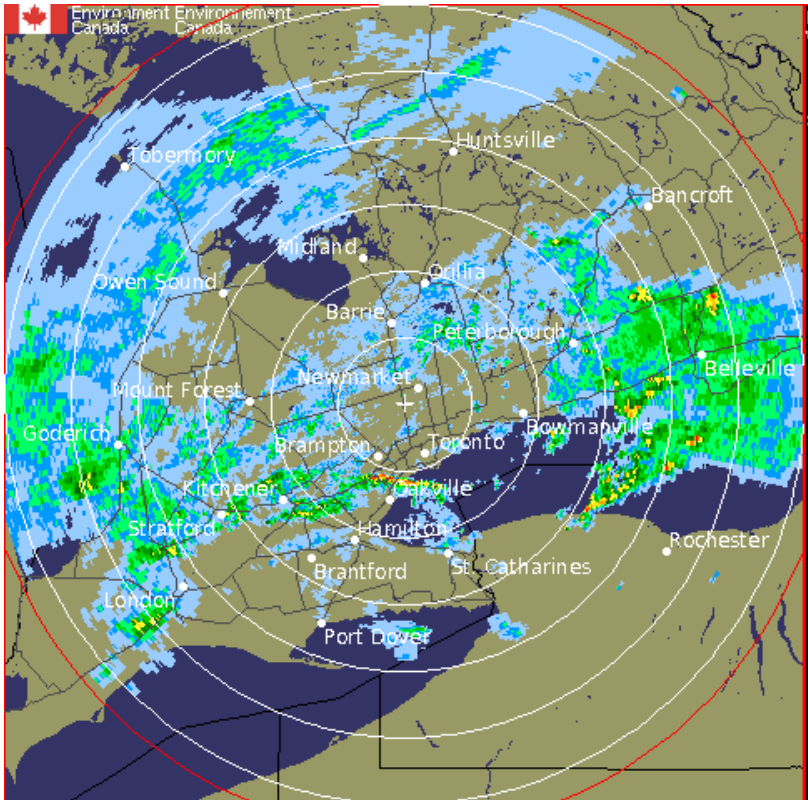
Current work
Severe convective activity
leading to local flooding
TORONTO – 4 September 2012 –
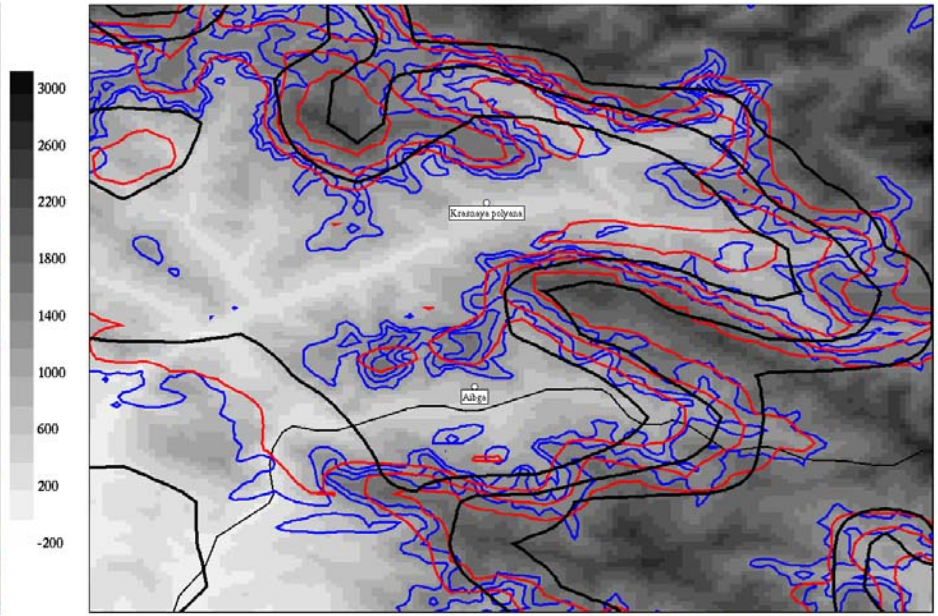Focus on 15 UTC – 18 UTC

Radar, frequency 10 min
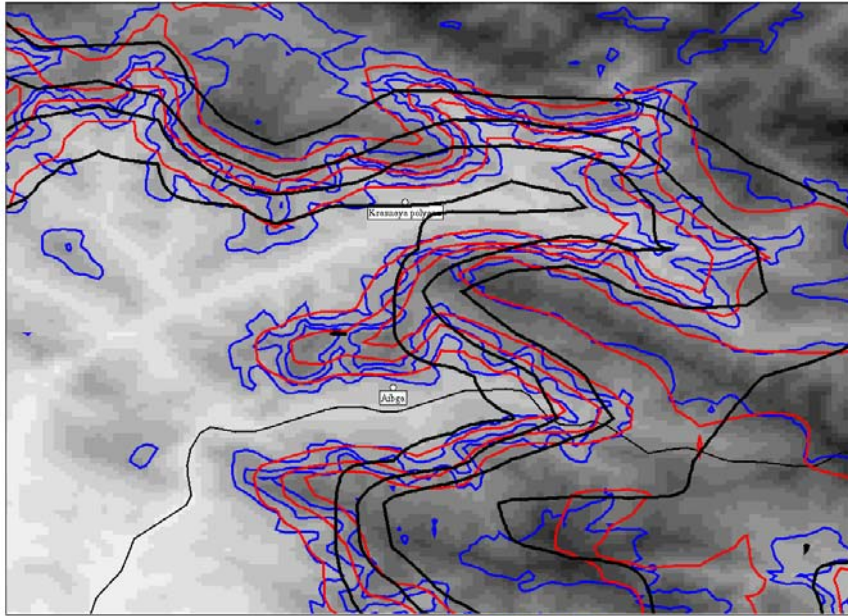
GEM-LAM 250 m
2 images/hr

Configuration for FROST-2014
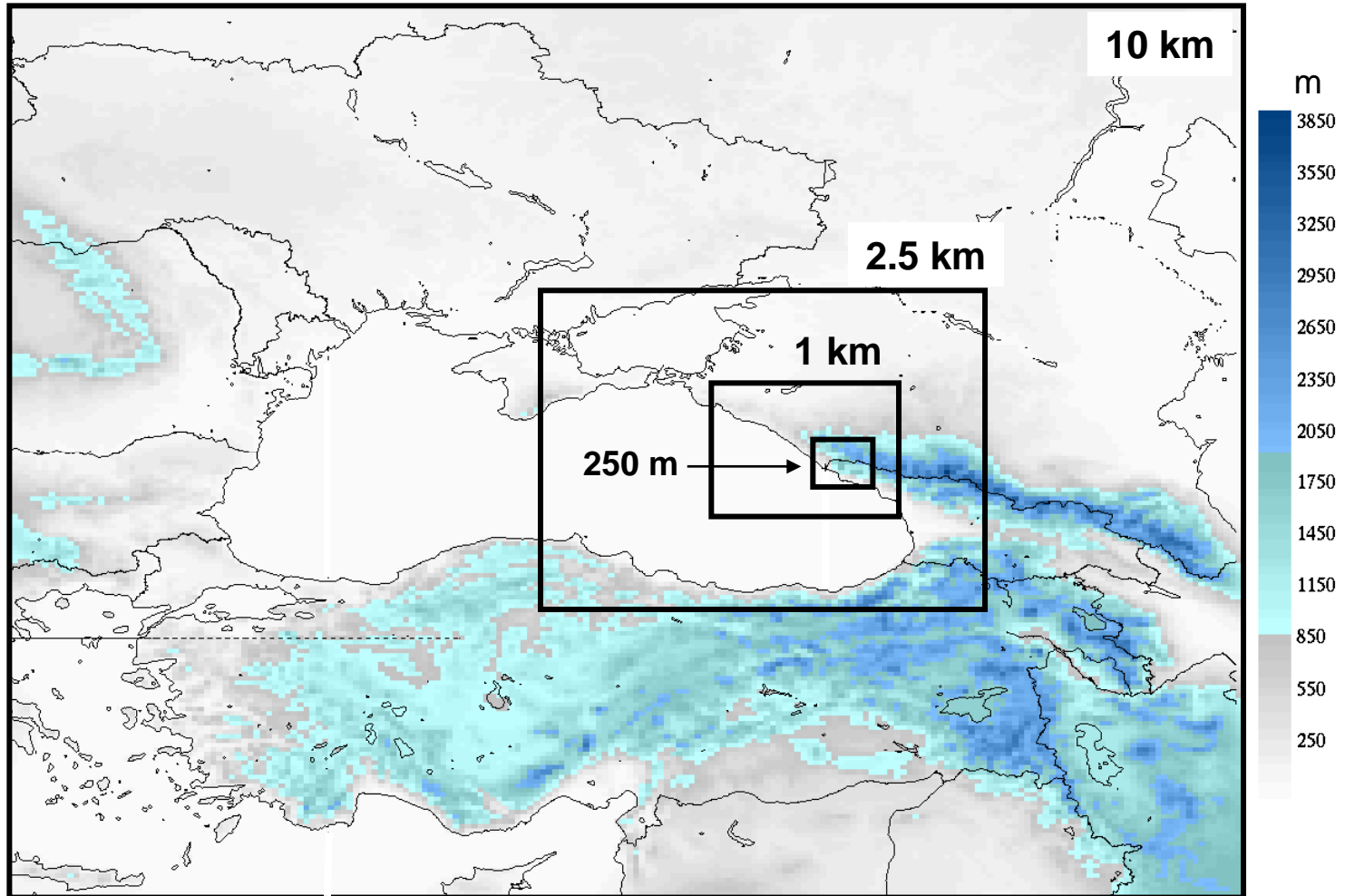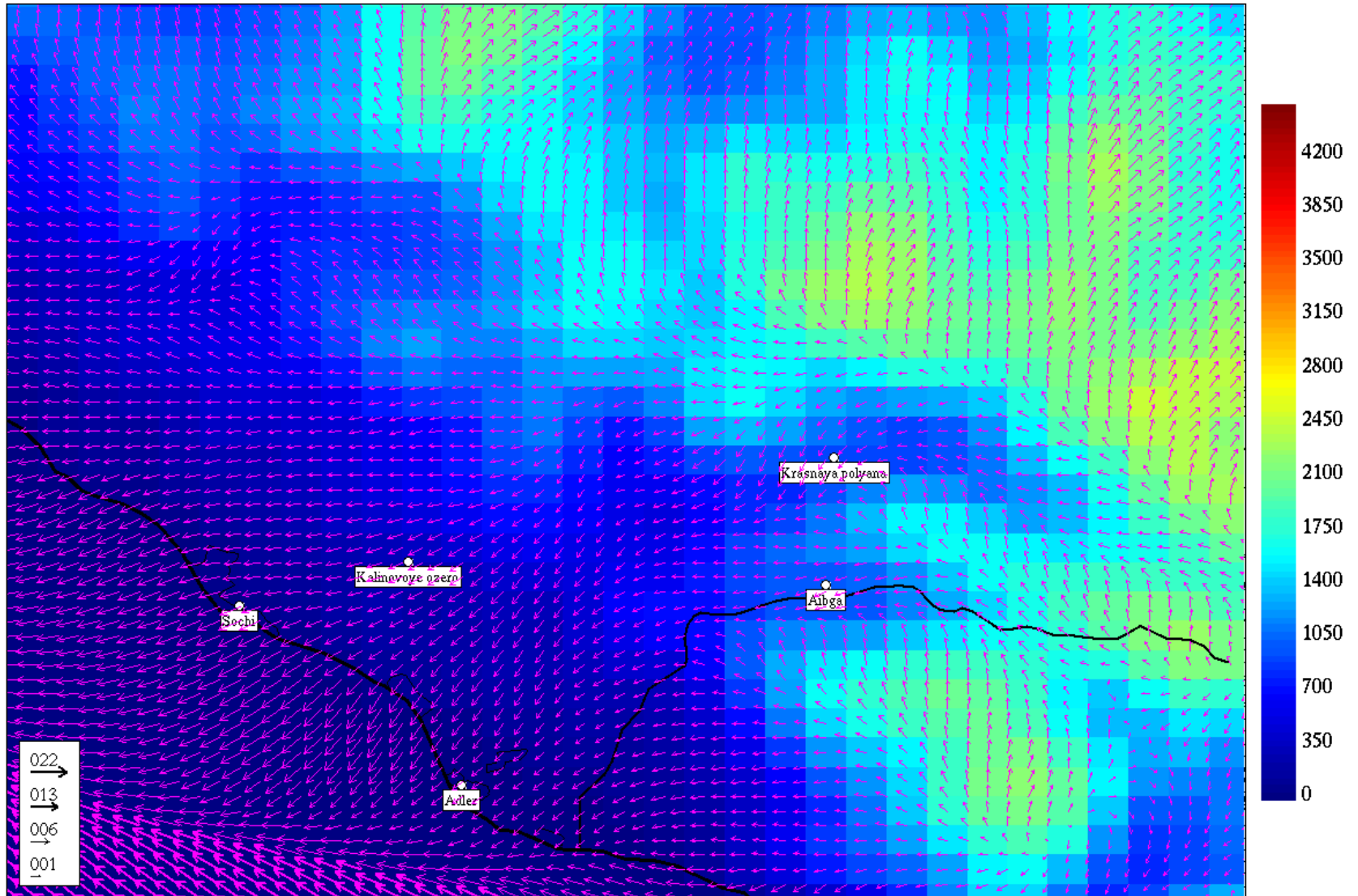
24-h SNOW

24-h RAIN

Differences are not due to precipitation phase;
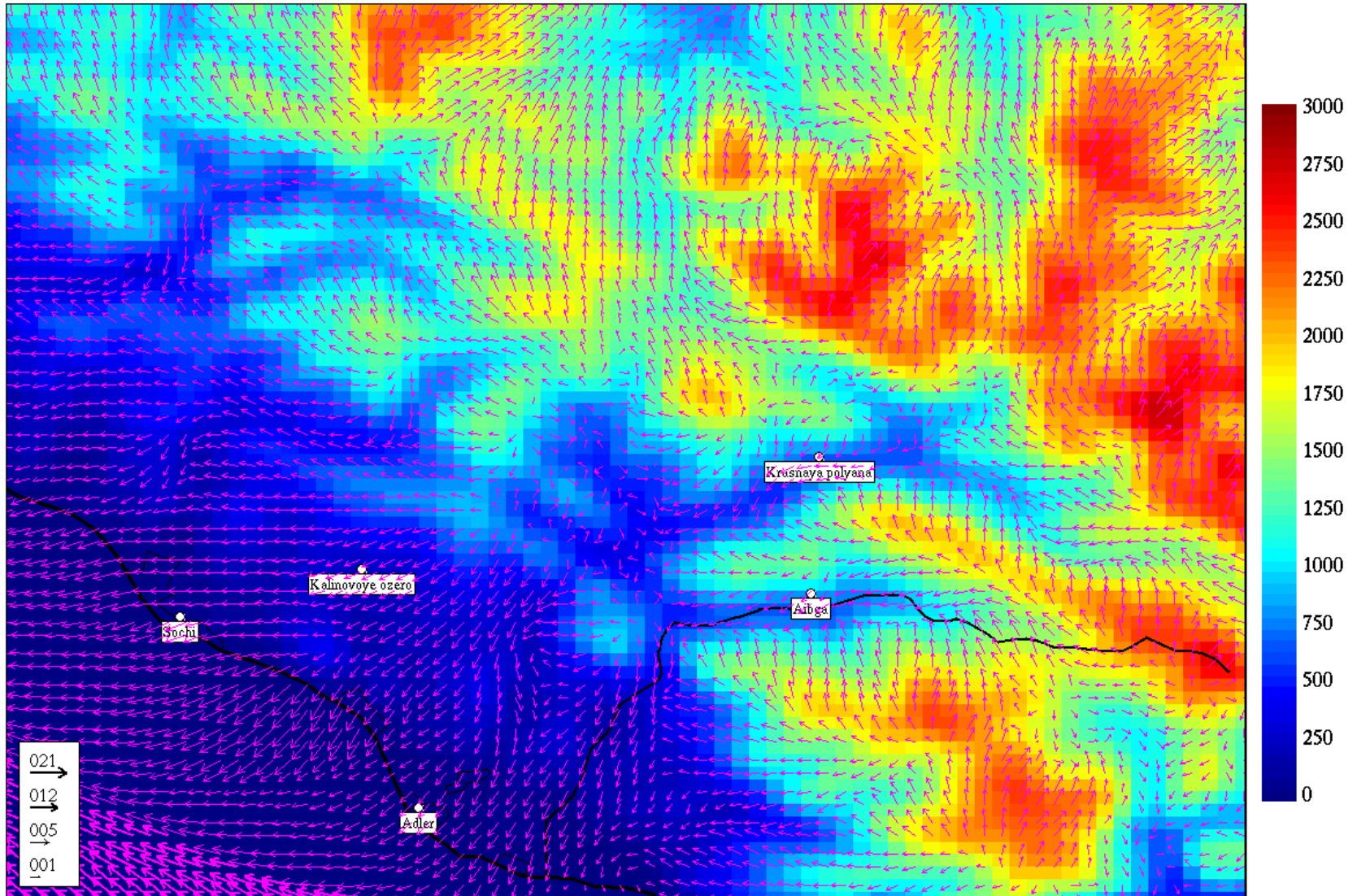2.5-km run appears to underestimate the
orographic enhancement

2.5 km
1 km
250 m

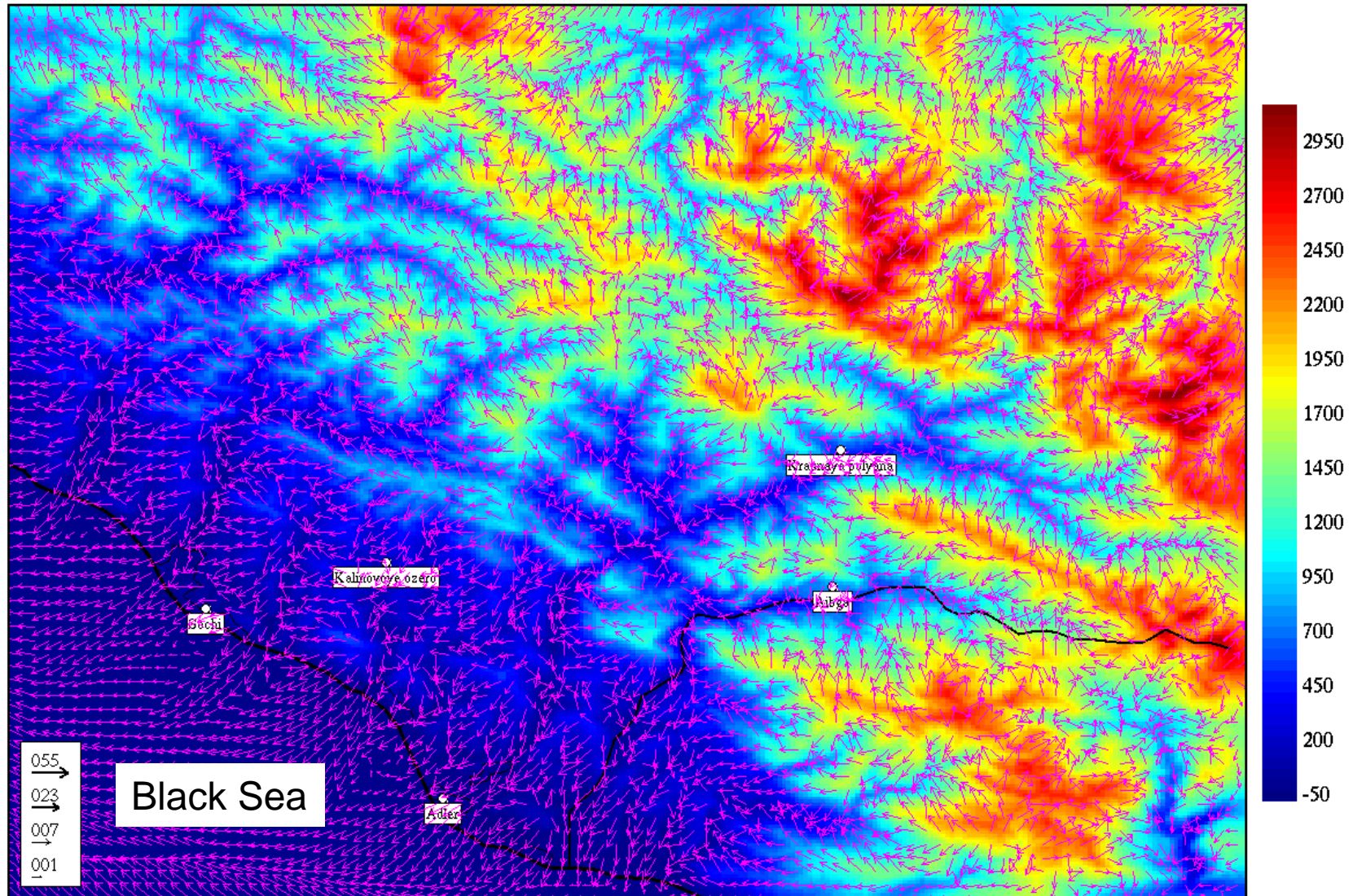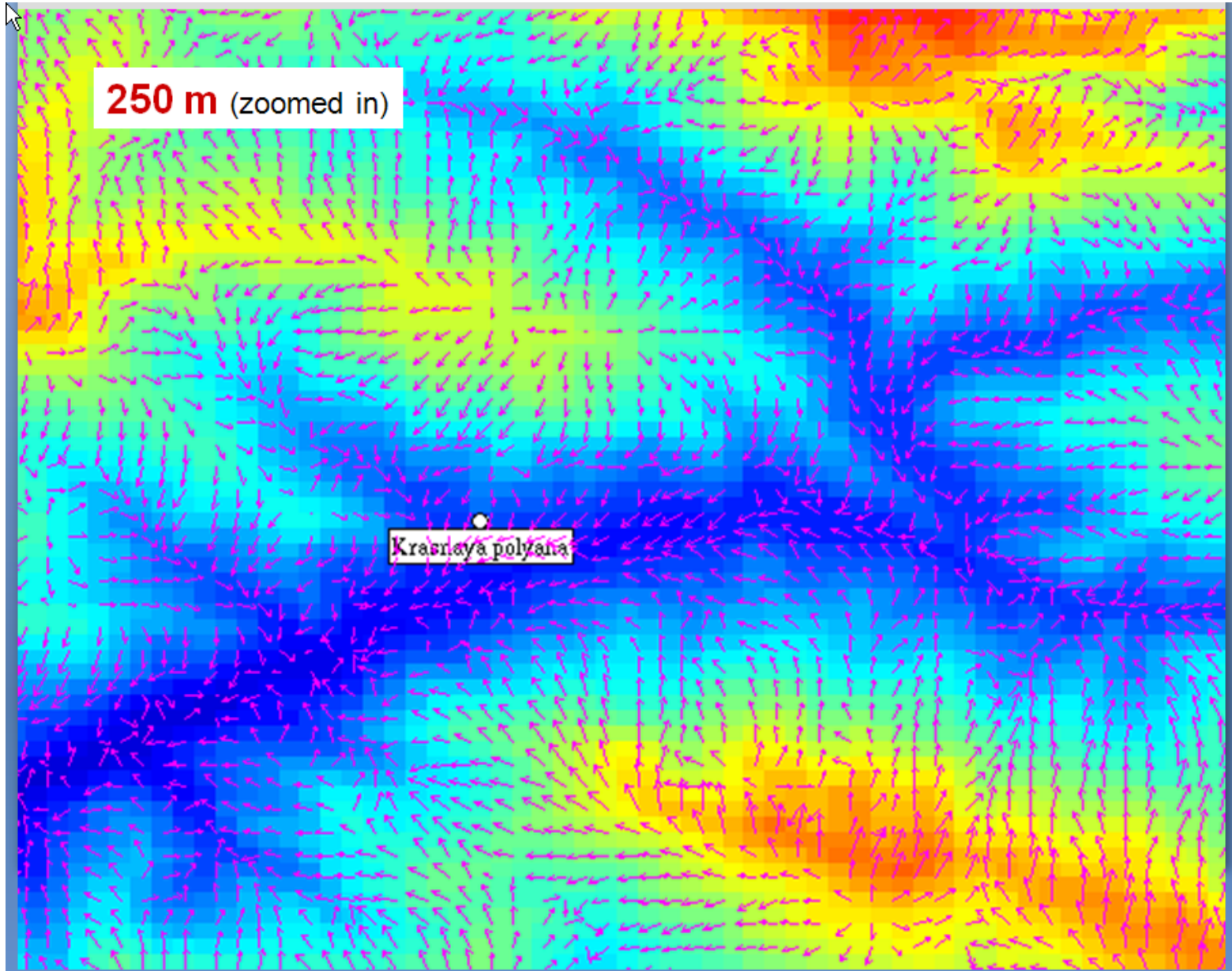# Near-surface winds:

2.5 km

Near-surface winds:

1 km

Example: Support for Sochi 2014

250 m

Near-surface winds

Example: Support for Sochi 2014

250 m (zoomed in)

Krasnaya polyana

Environnement Environment
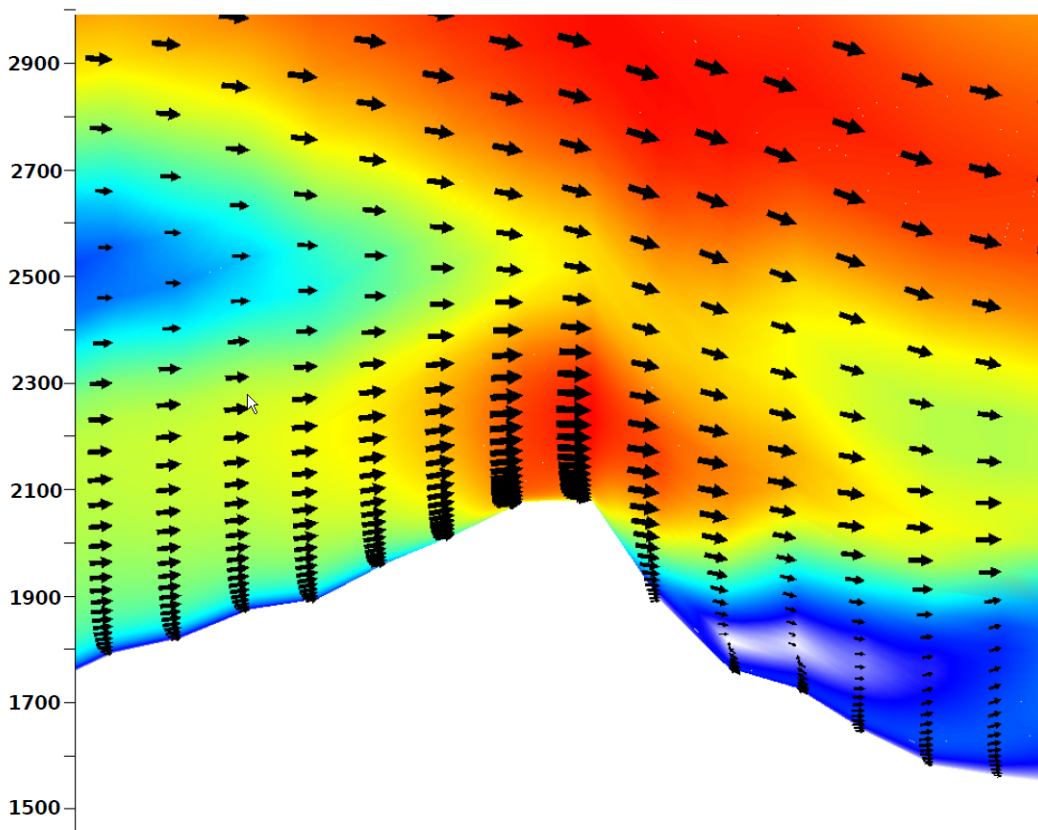Canada Canada

Example: Surface winds over the Canadian Rockies
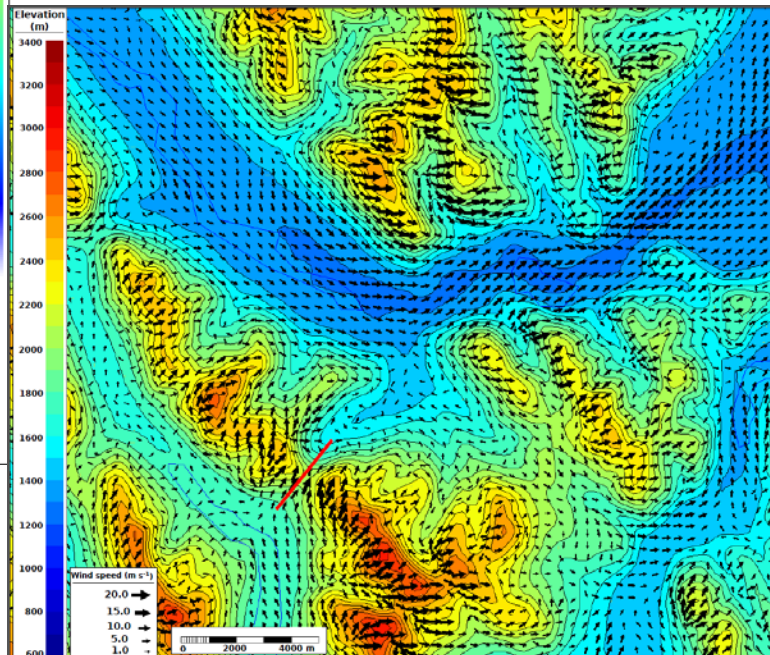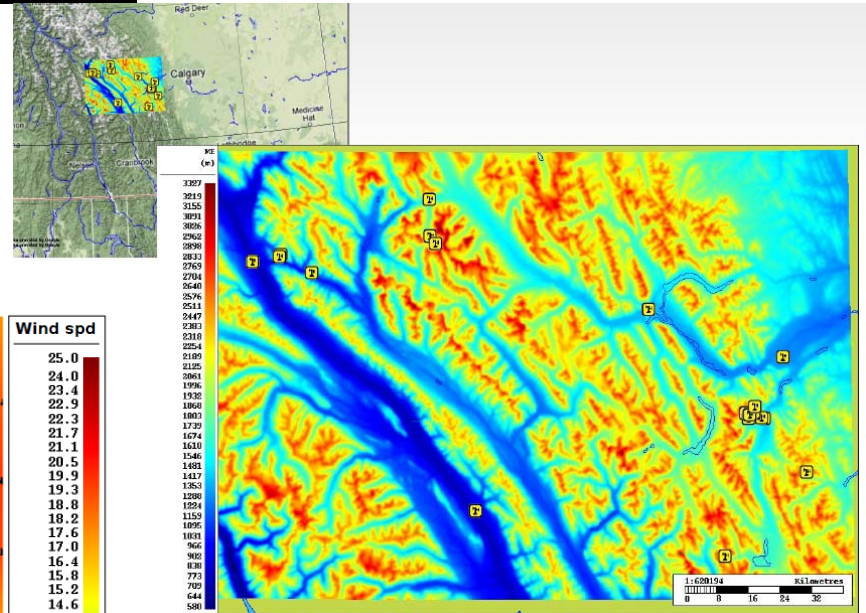
Outlook

Current and upcoming projects: FROST project over Sochi for 2014 Games, Pan American Games over Toronto in 2015, TOMACS project over Tokyo, modeling over the Canadian Rockies, high-resolution near-surface winds over water for oil spill events.

Offline GEM-Surf to be transferred as an experimental system in 2014 (200-m over Canada).

Need to include 3D aspects in the physics (e.g., cloud and mountain shading effects).