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CMC Trajectory Application Using High Spatial / Temporal Resolution GEM fields During BAQS-Met

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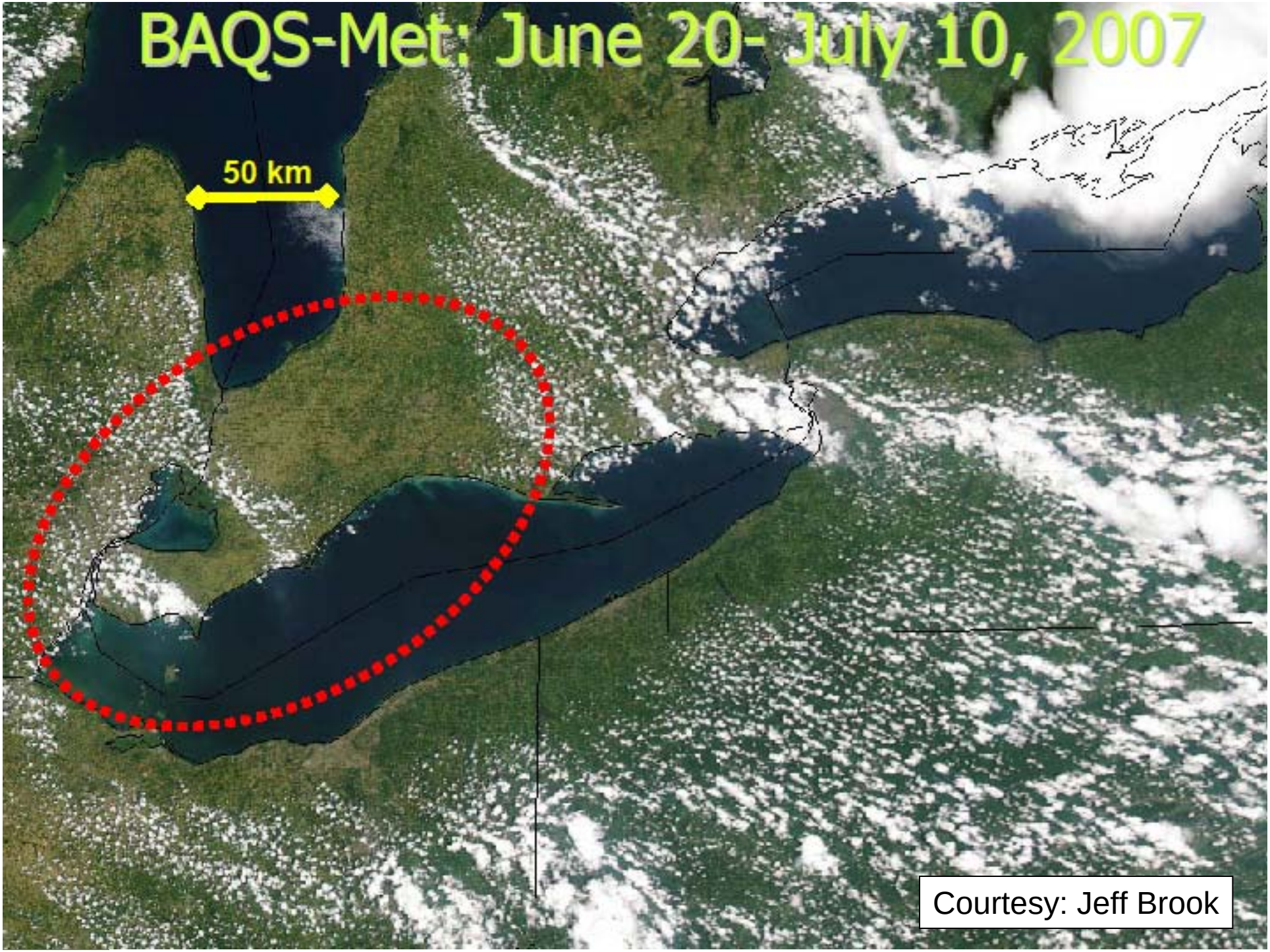
Acknowledgements: Jean-Philippe Gautier and Andrew Teakles


BAQS-Met: June 20- July 10, 2007
50 km
Courtesy: Jeff Brook

Presentation Overview

- Why Hi Resolution (HiRes) Trajectory
- CMC Trajectory Model with HiRes GEM-LAM-2.5 Fields
- Case Studies
  - July 6, 2007 at Harrow Supersite
  - July 7, 2007 along Aircraft Flight 13
  - June 25, 2007 south of the Lake St. Clair
- Summary and Future Work

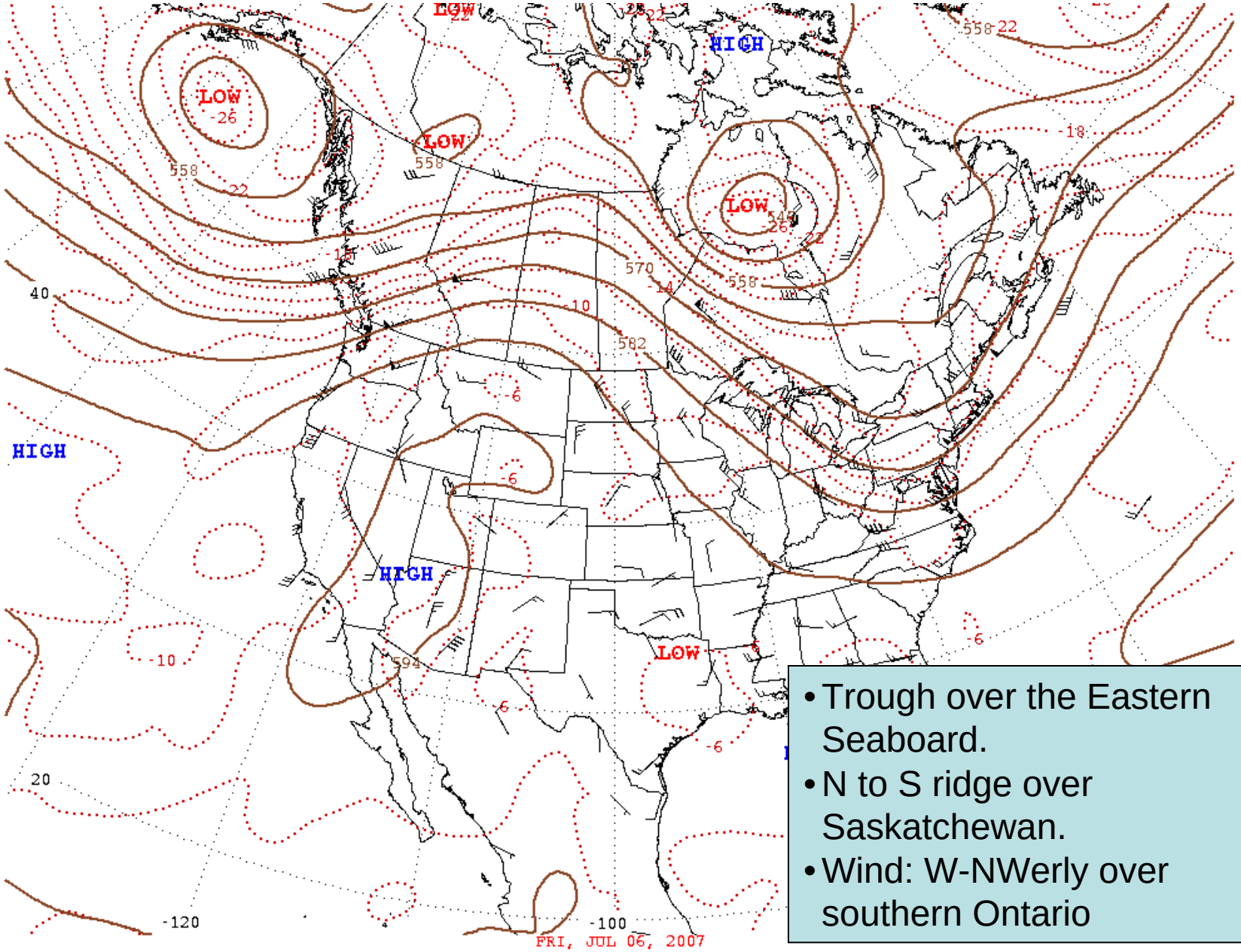
Why Hi Resolution (HiRes) Trajectory

- Subject to point evaluation of NWP model results
- Help in interpreting chemical measurements
- Visualization of atmospheric flow during AQ episodes
- Depends on NWP model resolution (15km for GEM and 12km for NAM)
- High spatial and temporal resolution models (e.g., LAM2.5 or MM5) offer a better representation of local conditions and physical processes at local/regional scale.
- This is very true for the BAQS-Met study

CMC Trajectory with GEM-LAM-2.5 Fields

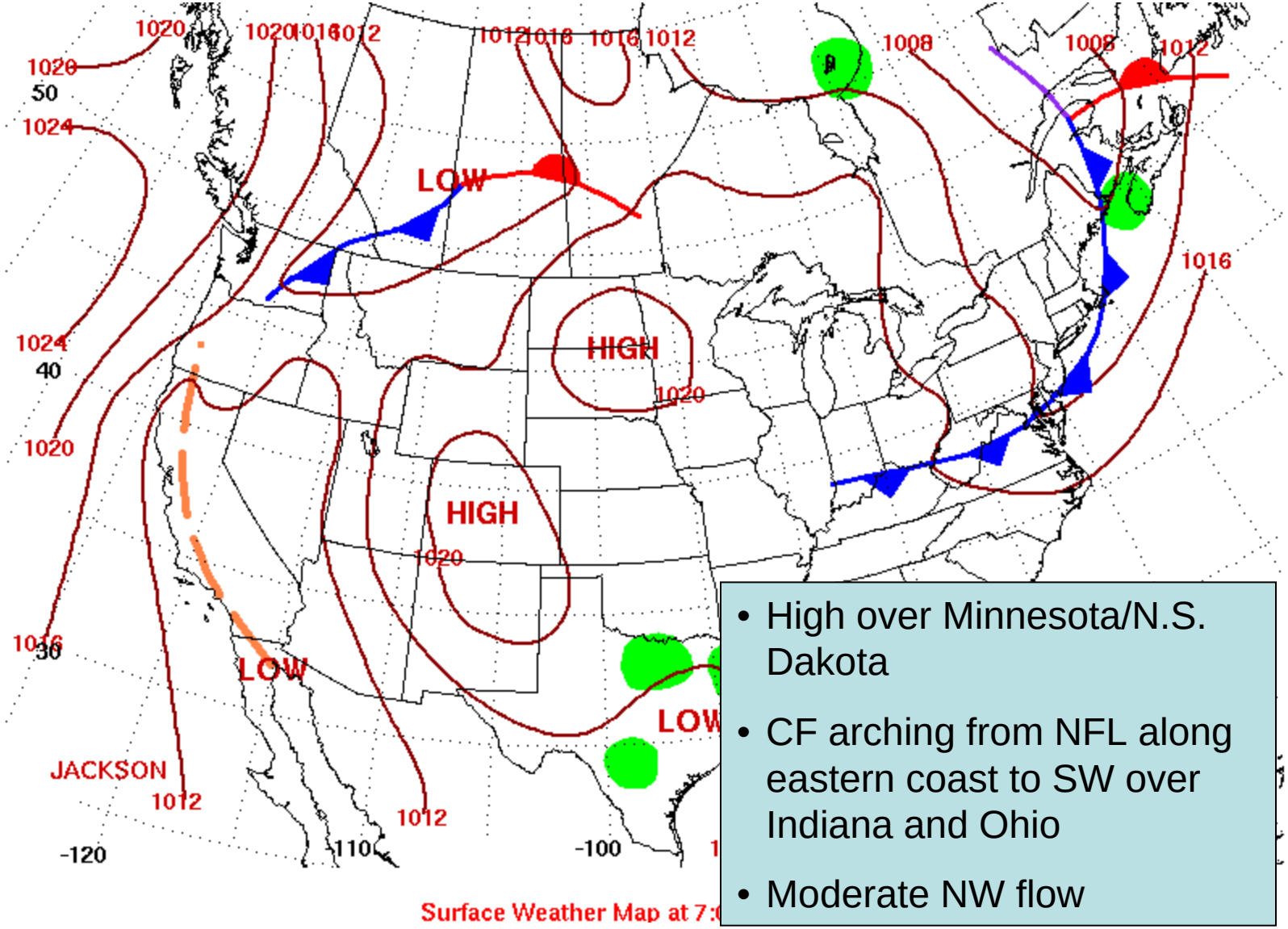
- Developed by the Canadian Meteorological Centre (CMC) (D'Amours et al., 2001)
- CMC Trajectory denoting successive 3-D positions of the air parcel as a function of time
- Use winds directly from GEM or GEM-LAM output (UU,VV,WW,P0,GZ)
- GEM-LAM-2.5 resolution for BAQS-MET:
  - Horizontal: ~2.5km
  - Vertical: 58 hybrid-coordinate levels
  - Temporal: 2-minute output interval

Case 1 - July 6, 2007 at Harrow: Importance of local emission and lake effect



500-Millibar Height Contours at 7:00 A.M. E.S.T.

- Trough over the Eastern Seaboard.
- N to S ridge over Saskatchewan.
- Wind: W-NWerly over southern Ontario



- High over Minnesota/N.S. Dakota
- CF arching from NFL along eastern coast to SW over Indiana and Ohio
- Moderate NW flow

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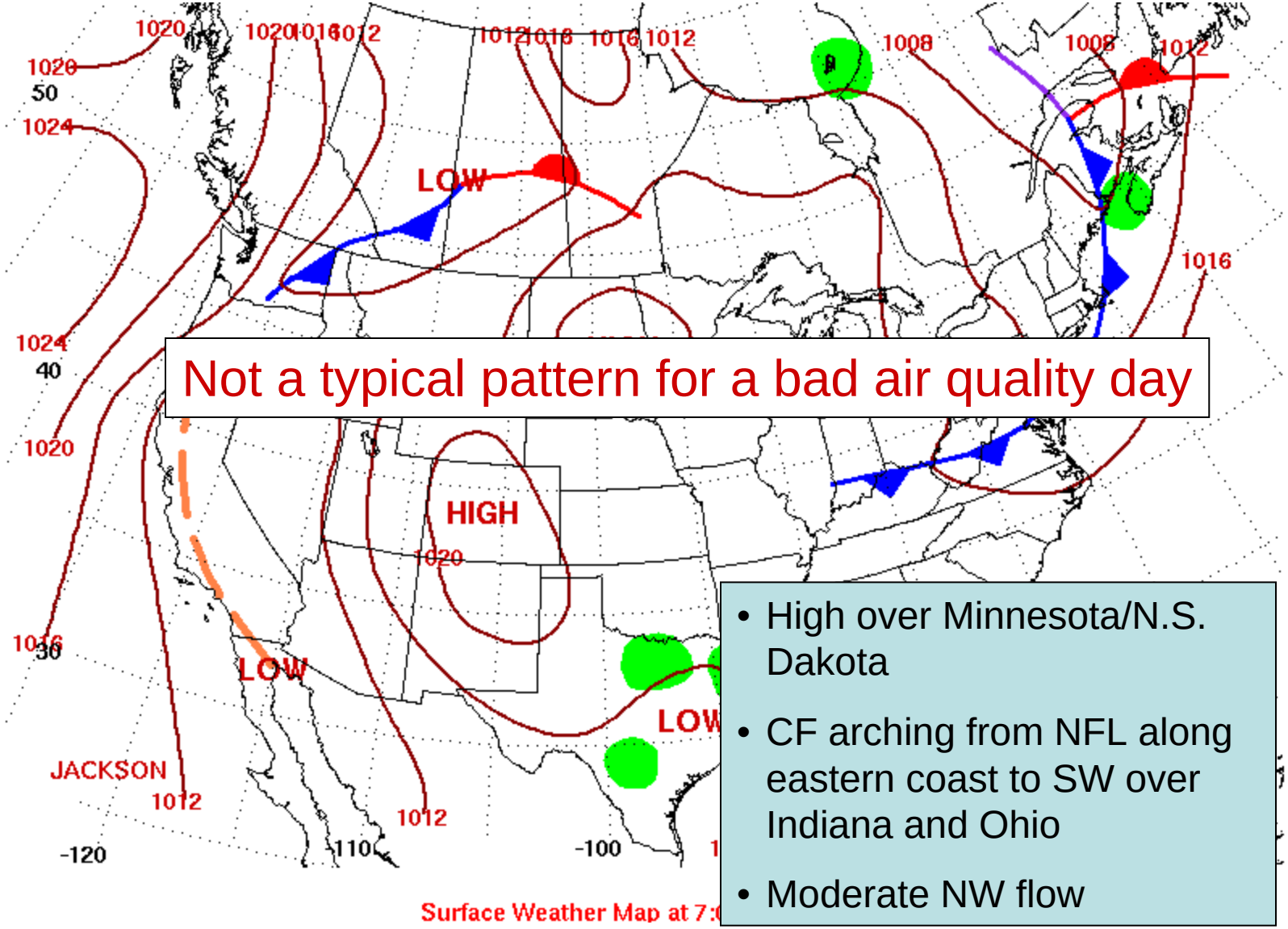

Not a typical pattern for a bad air quality day

- High over Minnesota/N.S. Dakota
- CF arching from NFL along eastern coast to SW over Indiana and Ohio
- Moderate NW flow

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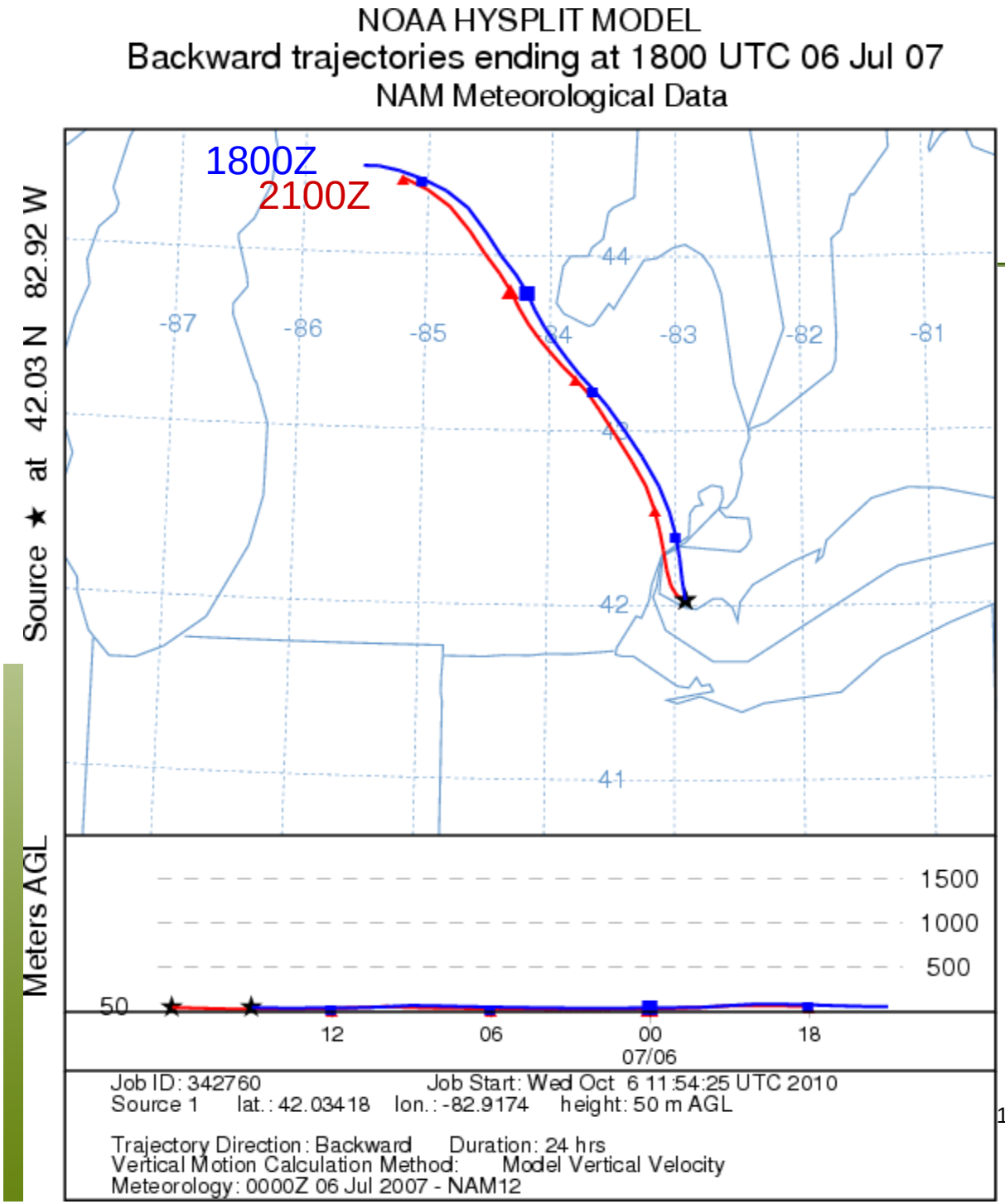

- Back-trajectories from HYSPLIT model with NAM12km data shown tracks of air parcels consistent with the synoptic pattern

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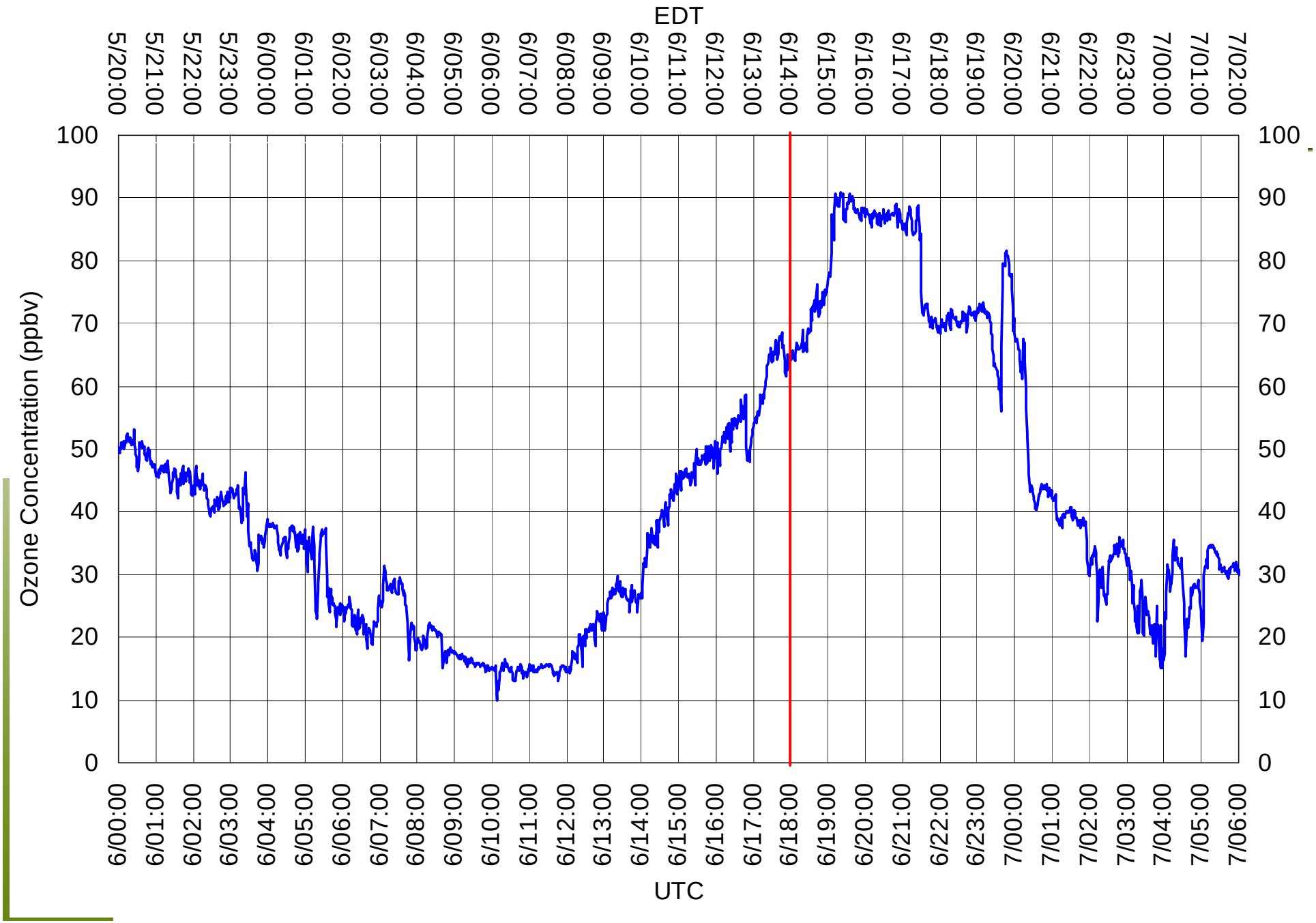
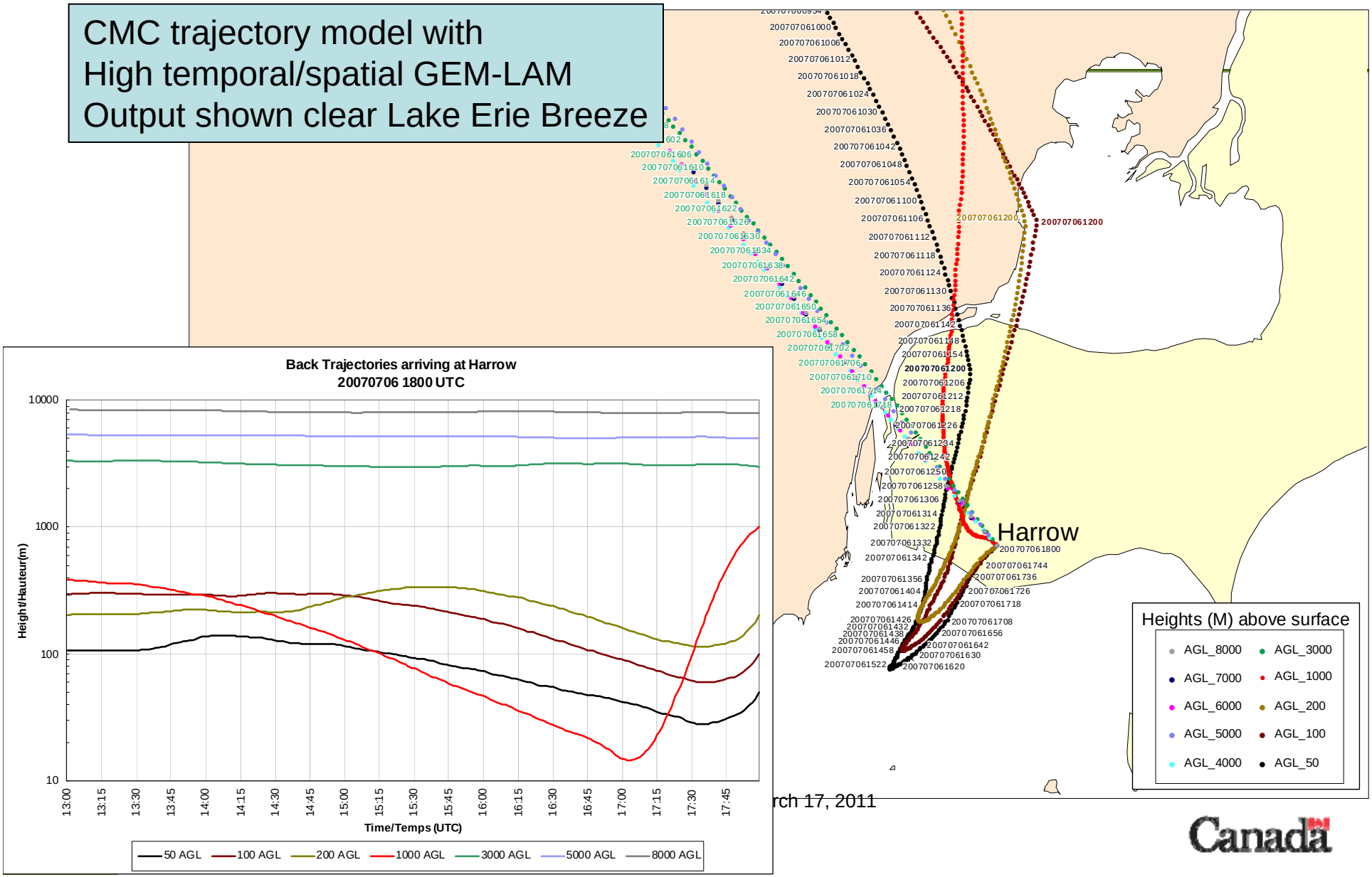
July 6 00Z – July 7 06Z 2007: Ozone Measurements at Harrow Supersite



Harrow: Back trajectory arriving at 20070706 1800 UTC

CMC trajectory model with
High temporal/spatial GEM-LAM
Output shown clear Lake Erie Breeze



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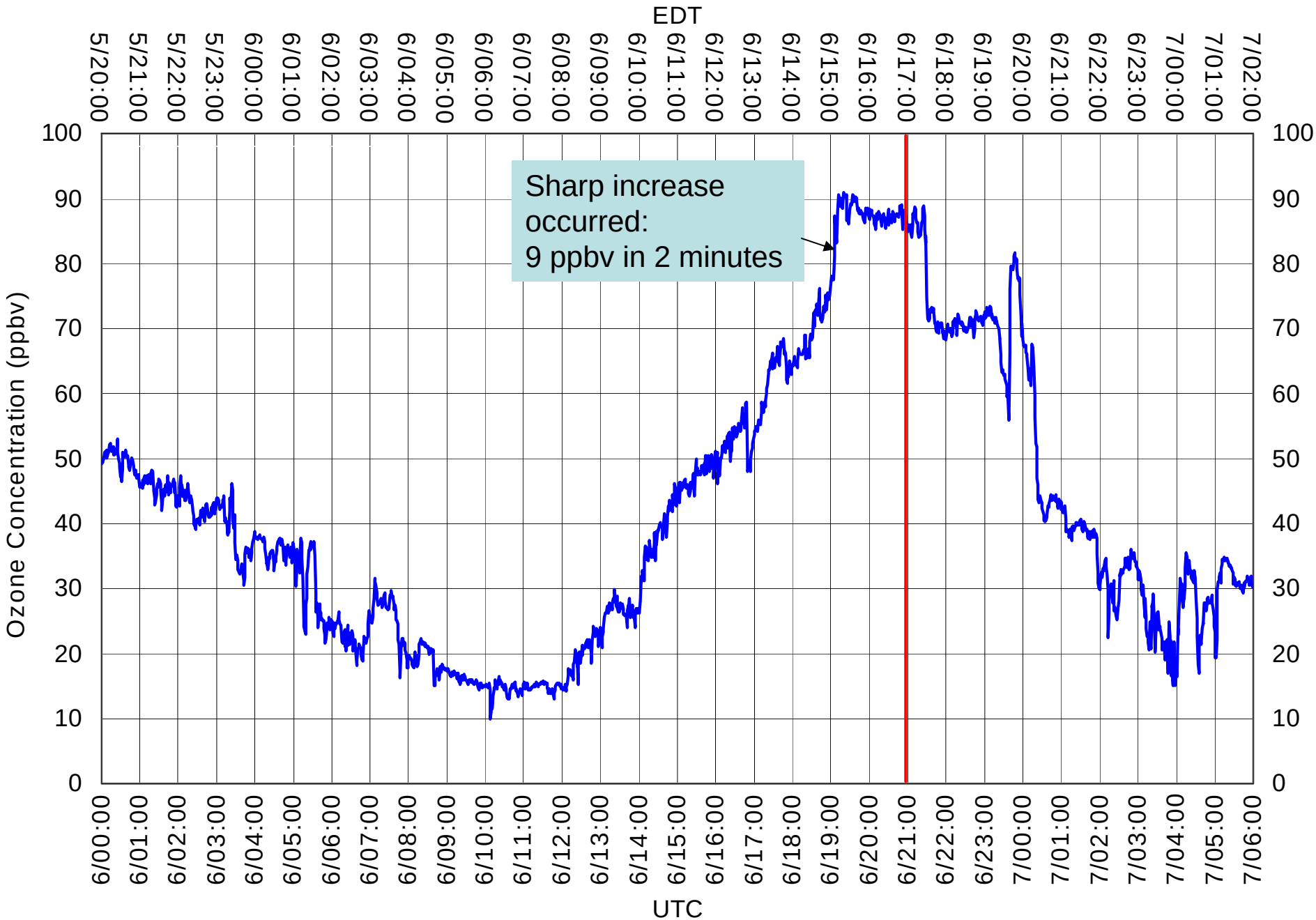
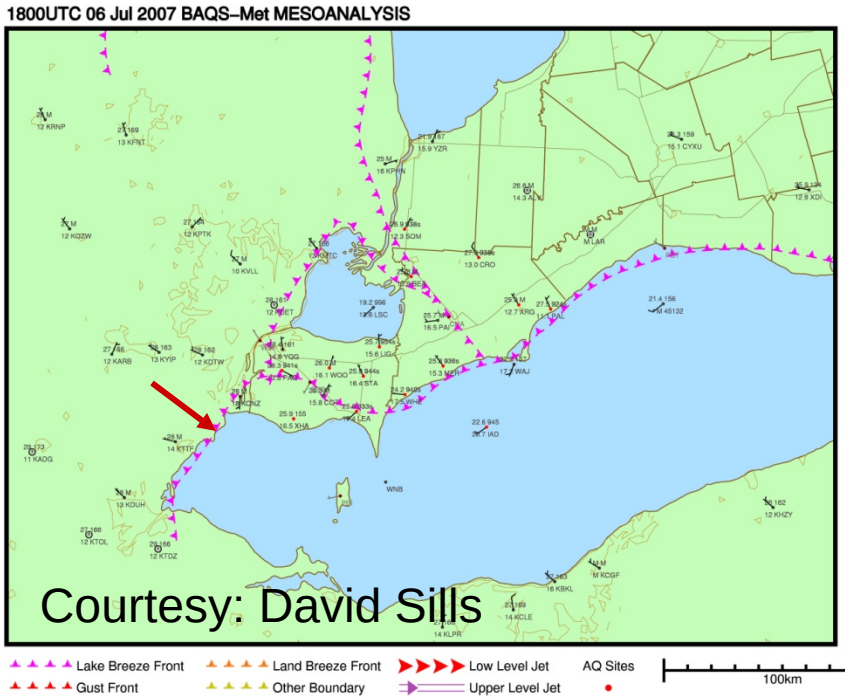
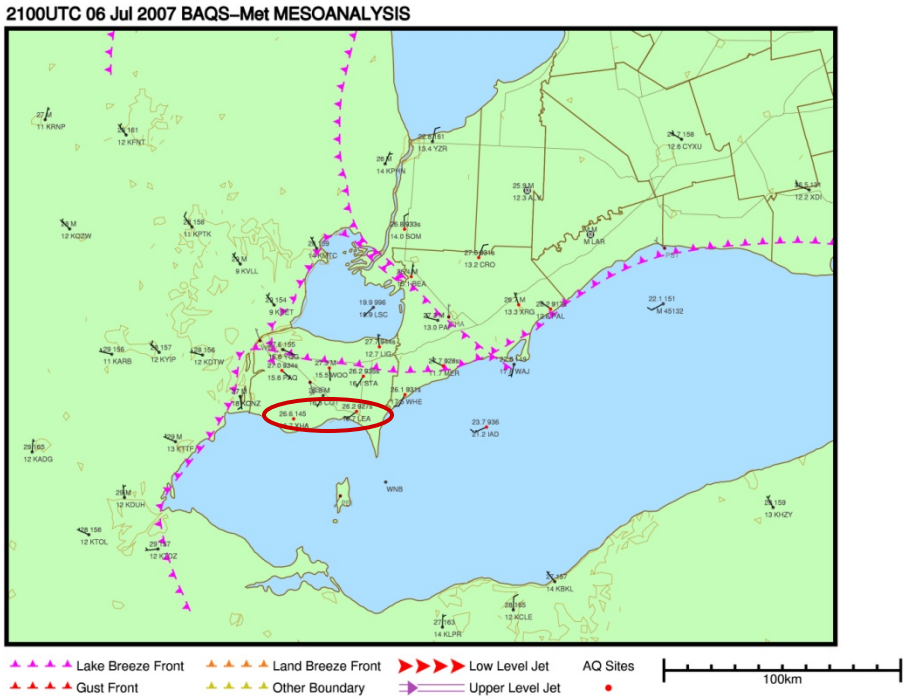
July 6 00Z – July 7 06Z: Ozone Measurements at Harrow Supersite

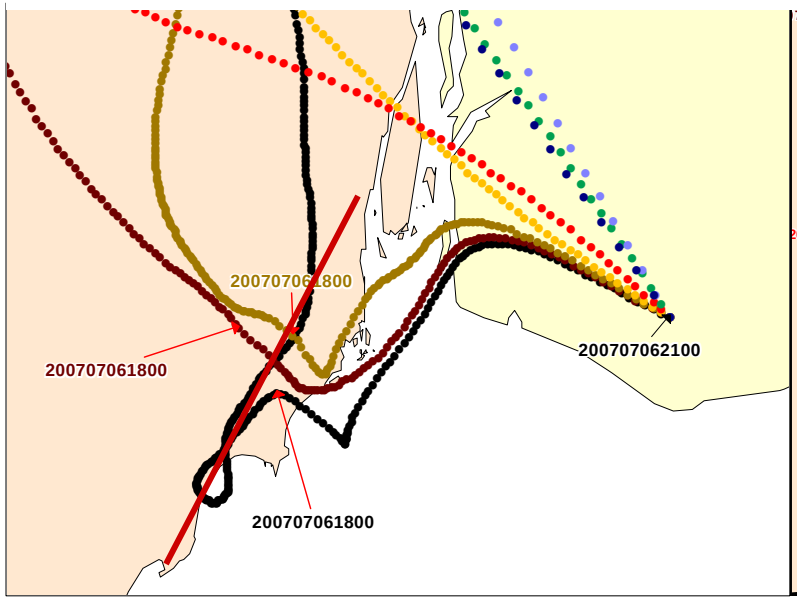


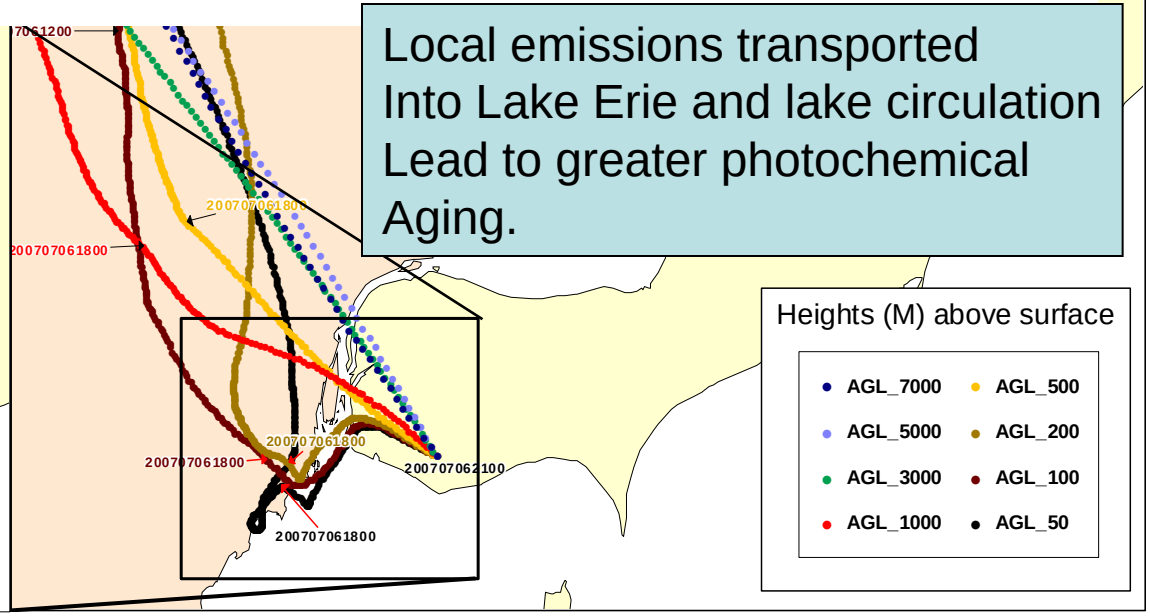
Harrow: Back trajectory arriving at 20070706 2100 UTC



Courtesy: David Sills







Local emissions transported
Into Lake Erie and lake circulation
Lead to greater photochemical
Aging.

Case 2 – Aircraft Flight 13: July 7, 2007
Understanding the Measurement data

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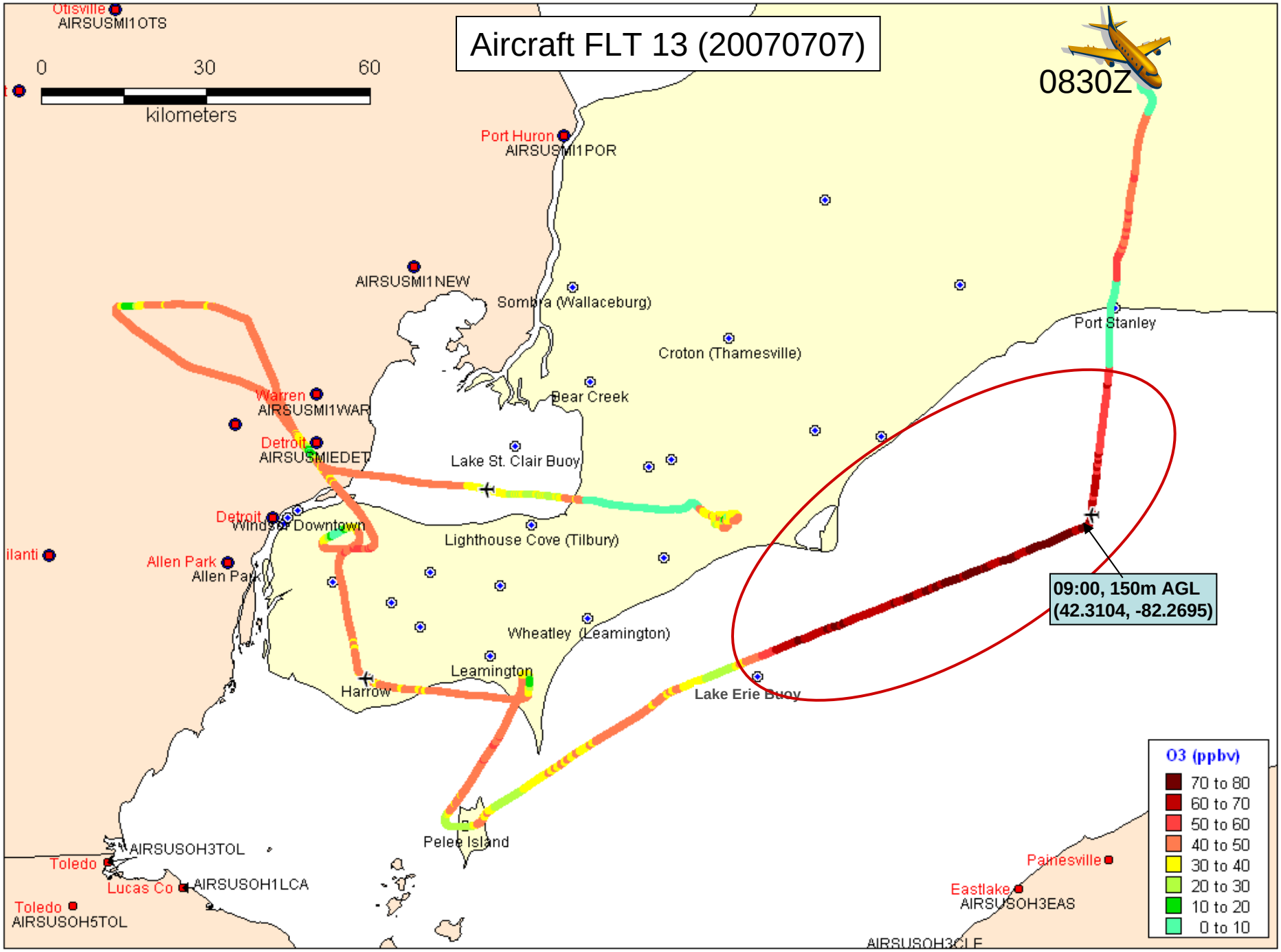
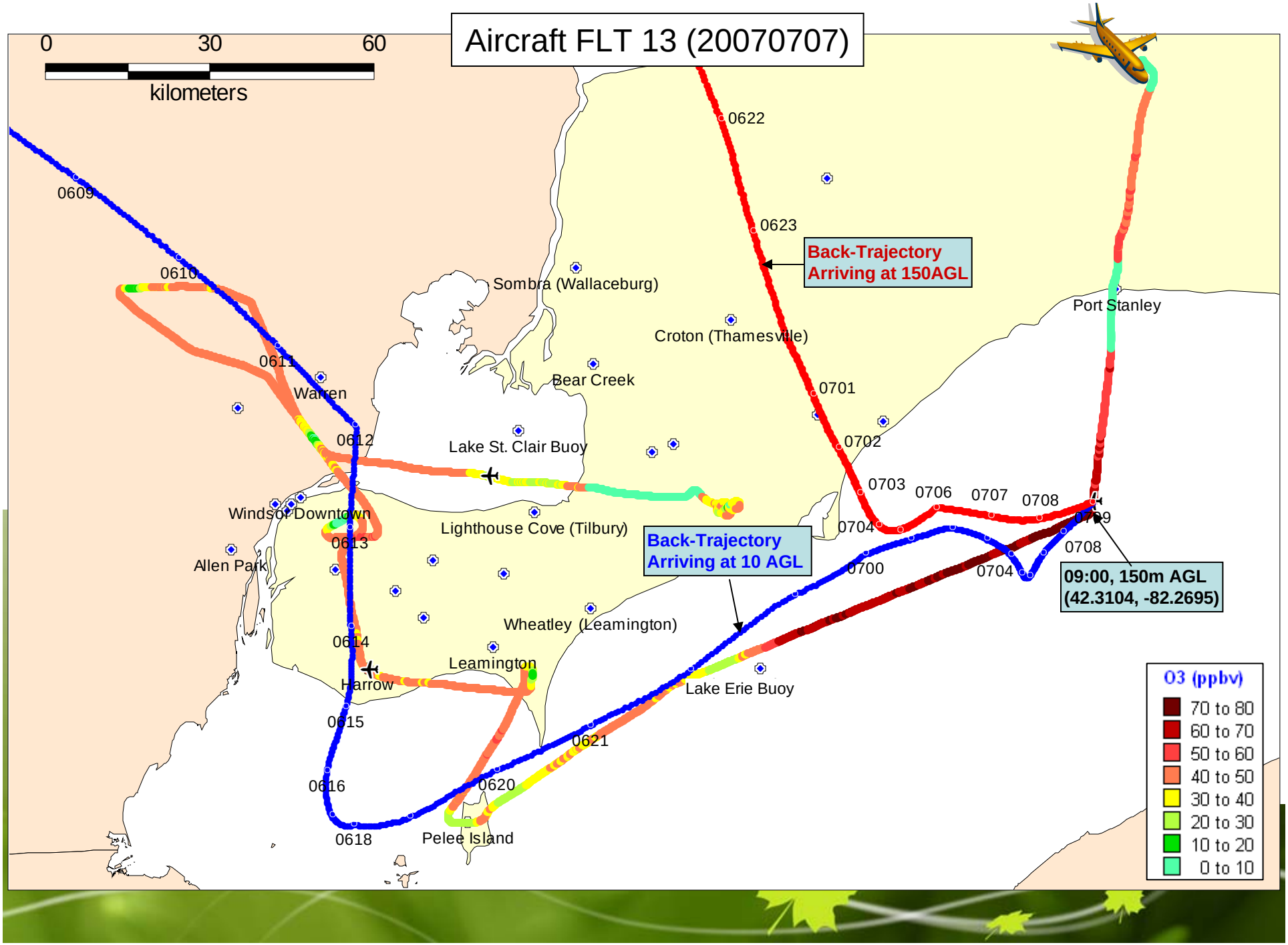

Aircraft FLT 13 (20070707)
0830Z
0
30
60
kilometers
Otisville
AIRSUSMI1OTS
Port Huron
AIRSUSMI1POR
AIRSUSMI1NEW
Sombra (Wallaceburg)
Croton (Thamesville)
Port Stanley
Warren
AIRSUSMI1WAR
Bear Creek
Detroit
AIRSUSMIEDET
Lake St. Clair Buoy
Detroit
Windsor Downtown
Lighthouse Cove (Tilbury)
Allen Park
Allen Park
Wheatley (Leamington)
Leamington
Harrow
Lake Erie Buoy
09:00, 150m AGL
(42.3104, -82.2695)
Pelee Island
AIRSUSOH3TOL
Toledo
Lucas Co
AIRSUSOH1LCA
Toledo
AIRSUSOH5TOL
Painesville
Eastlake
AIRSUSOH3EAS
AIRSUSOH3CLE
O3 (ppbv)
70 to 80
60 to 70
50 to 60
40 to 50
30 to 40
20 to 30
10 to 20
0 to 10


Aircraft FLT 13 (20070707)
0
30
60
kilometers
0609
0610
0611
0612
0613
0614
0615
0616
0618
0620
0621
0622
0623
0701
0702
0703
0704
0706
0707
0708
0709
0700
0704
0708
Back-Trajectory Arriving at 150AGL
Back-Trajectory Arriving at 10 AGL
09:00, 150m AGL (42.3104, -82.2695)
Sombra (Wallaceburg)
Croton (Thamesville)
Port Stanley
Bear Creek
Warren
Lake St. Clair Buoy
Windsor Downtown
Lighthouse Cove (Tilbury)
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Lake Erie Buoy
Pelee Island
O3 (ppbv)
70 to 80
60 to 70
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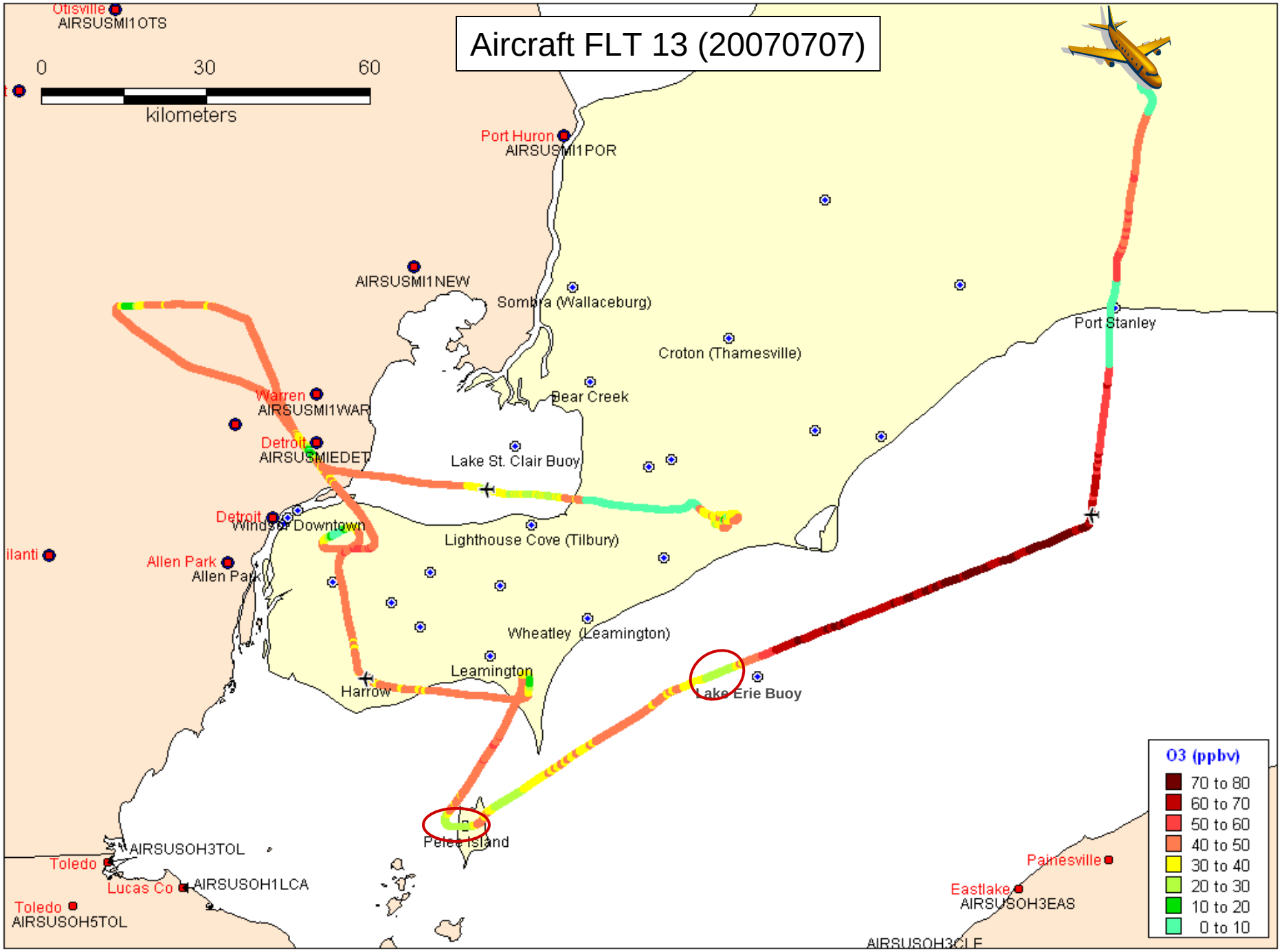
0 to 10


Aircraft FLT 13 (20070707)
0
30
60
kilometers
Otisville
AIRSUSMI1OTS
Port Huron
AIRSUSMI1POR
AIRSUSMI1NEW
Sombra (Wallaceburg)
Croton (Thamesville)
Port Stanley
Bear Creek
Warren
AIRSUSMI1WAR
Detroit
AIRSUSMIEDET
Lake St. Clair Buoy
Detroit
Windsor Downtown
Lighthouse Cove (Tilbury)
Allen Park
Allen Park
Wheatley (Leamington)
Leamington
Harrow
Lake Erie Buoy
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AIRSUSOH3TOL
Toledo
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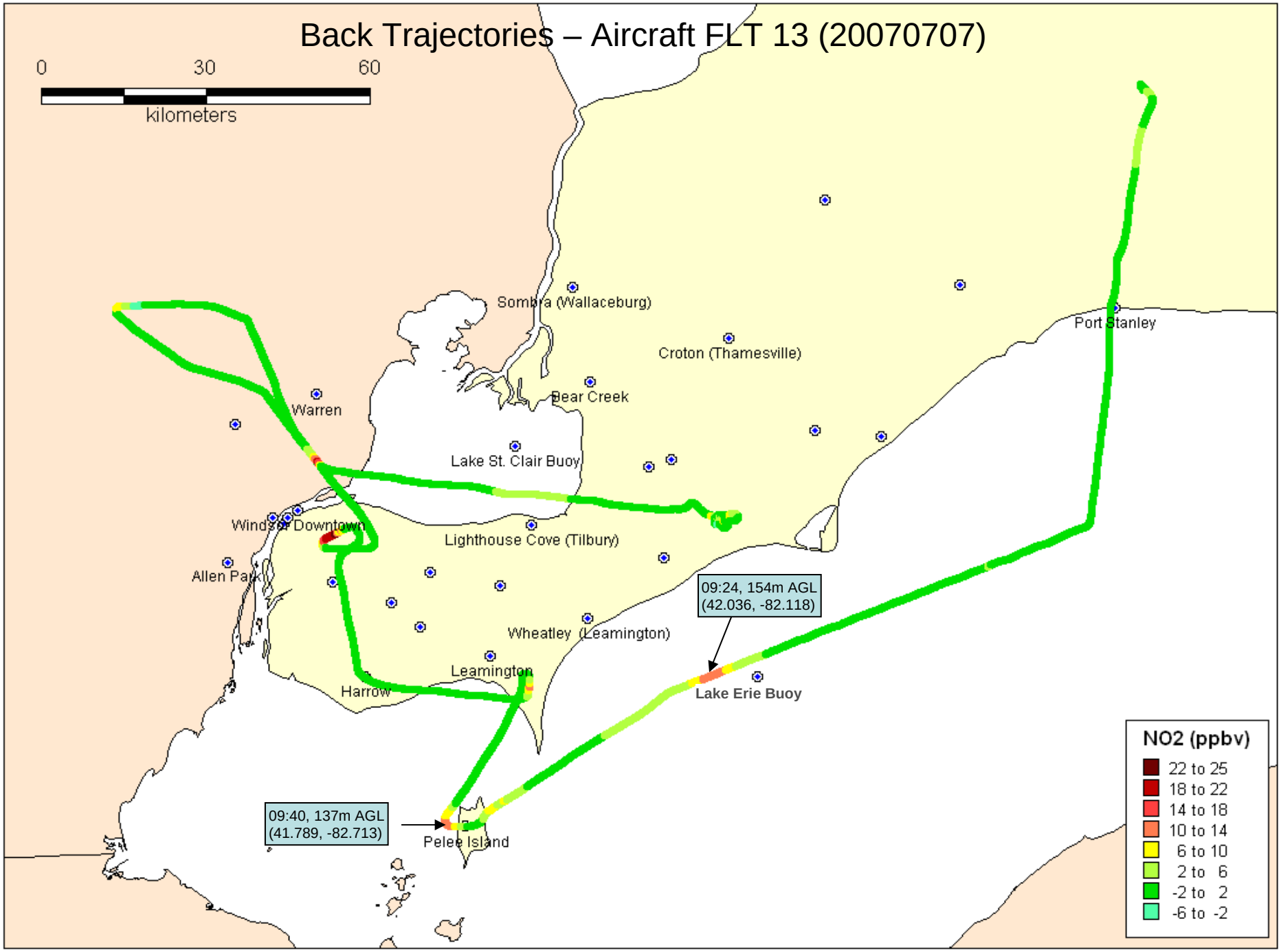
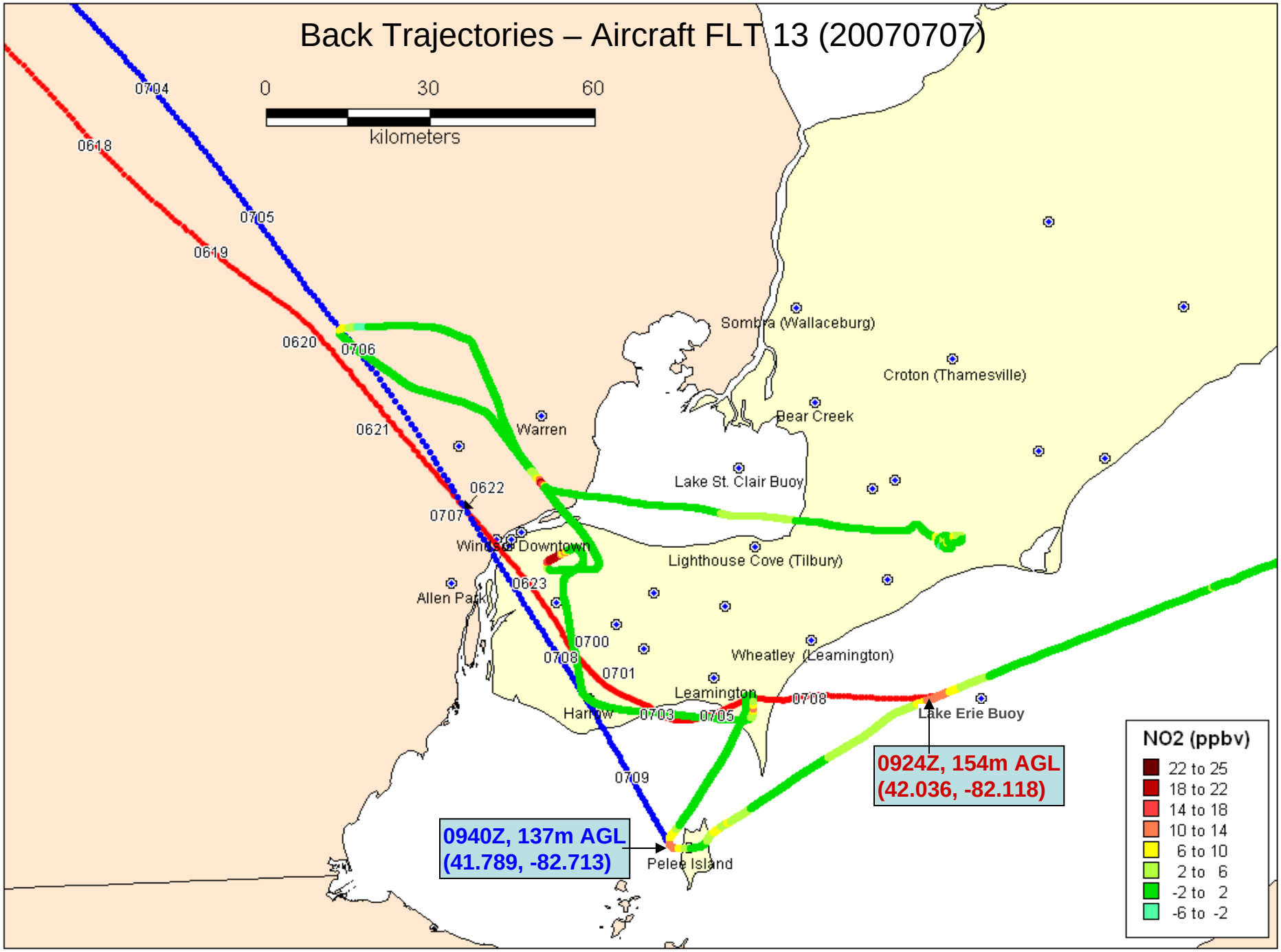
AIRSUSOH5TOL
Painesville
Eastlake
AIRSUSOH3EAS
AIRSUSOH3CLE
O3 (ppbv)
70 to 80
60 to 70
50 to 60
40 to 50
30 to 40
20 to 30
10 to 20
0 to 10

Back Trajectories – Aircraft FLT 13 (20070707)



Back Trajectories – Aircraft FLT 13 (20070707)



Case 3 – June 25, 2007
Investigating the Lake St. Clair (LSC) Lake Breeze Recirculation

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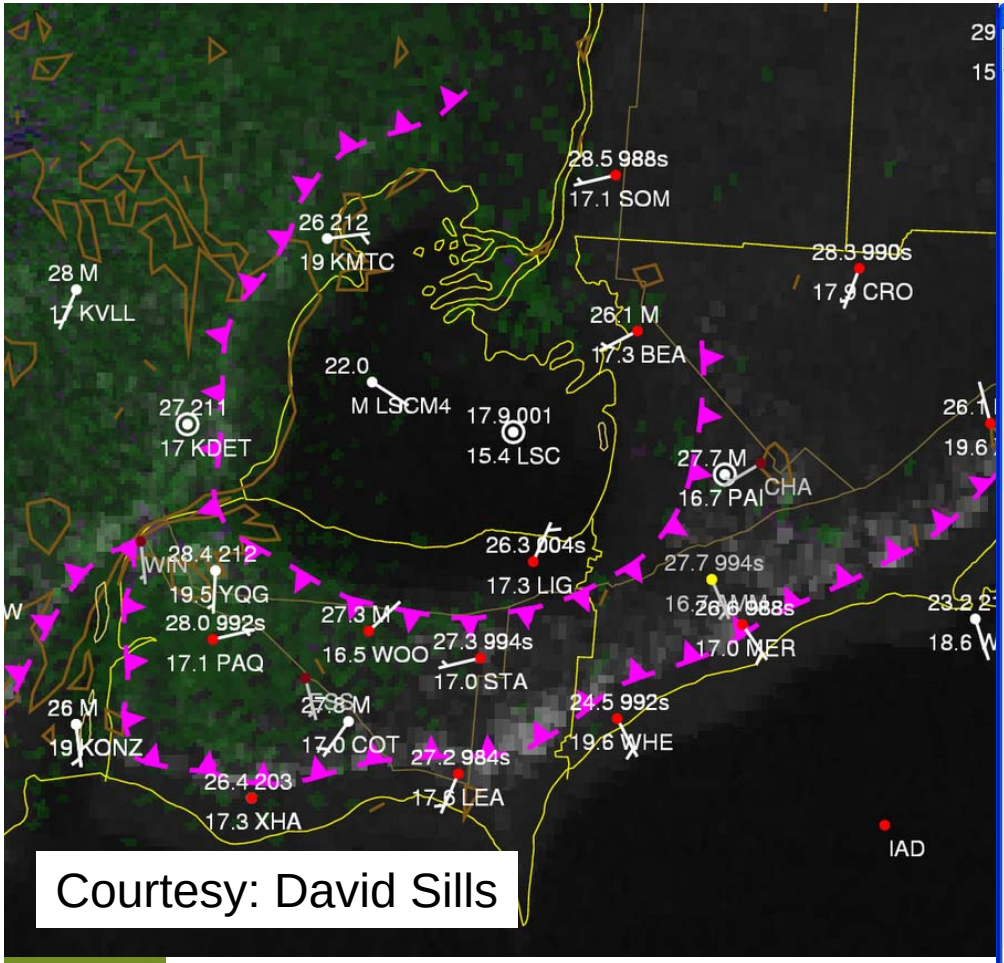
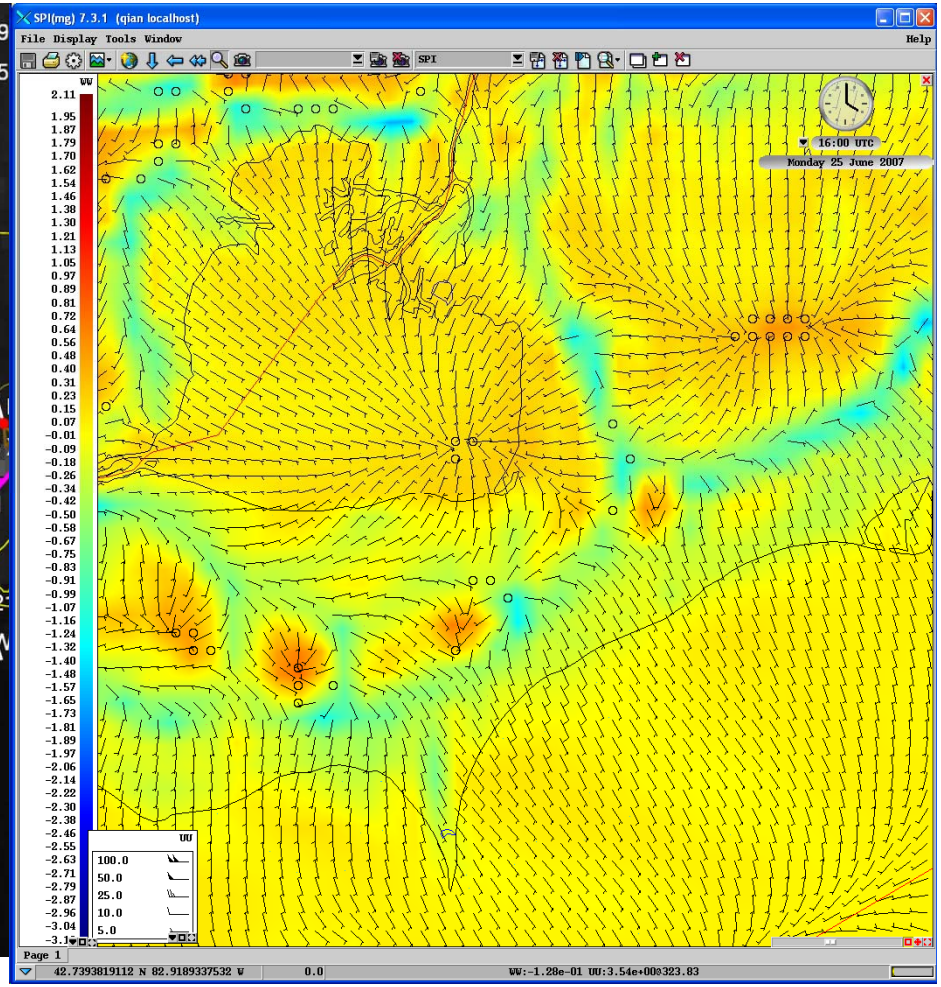
Observed vs. Modelled Surface Wind Fields at 1600UTC June 26, 2007



Courtesy: David Sills



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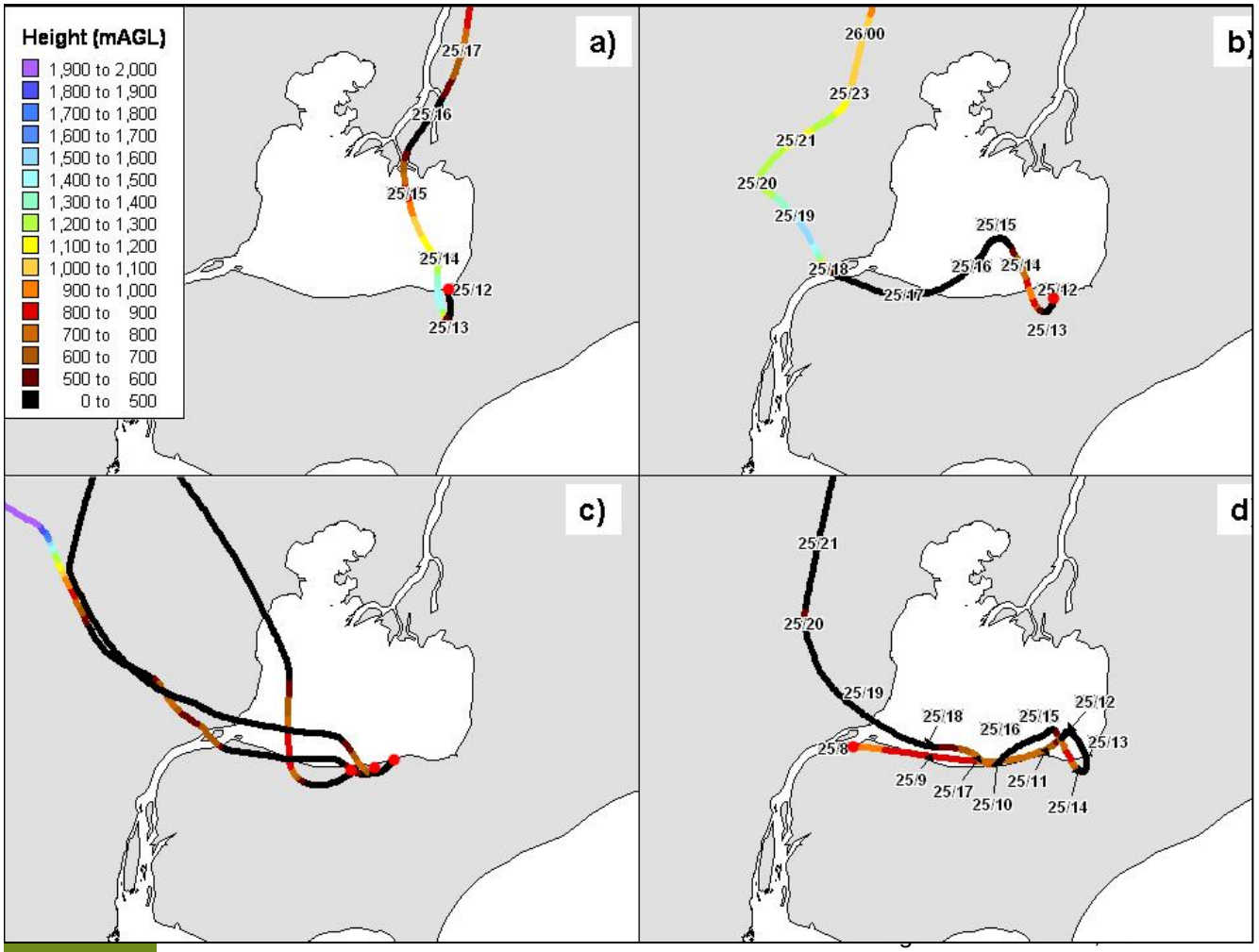
Forward trajectories (FWT) starting at points along the LSC shoreline at 1600 UTC and 225 m AGL



- Six testing points chosen along the south shoreline within the LBF inflow
- Point1 (figure a) shows nearly a completed circle of recirculation for 2 hours
- Moving toward western (figures b-d) the FWTs became helical, but all back down to the lake surface behind the front

Summary and Future Work

- CMC Trajectory model with HR GEM-LAM-2.5km fields showed ability to present the local-scale recirculation due to the water-land interactions
- GEM-LAM-2.5 model accurately predicted lake breeze occurrence, but predicted and observed timing and location of LBF still have some differences
- Trajectory analyses indicated some issues with the time "stitching" between consecutive GEM-LAM runs
- Develop long-term trajectory climatology (e.g. PSCF and CWT) for specified source or receptor locations (i.e., AQHI forecast sites)
- Help with other AQ activities (e.g. Whistler Summer 2010 Intensive Field Study)

Merci – Thank you

Contact: Qian.Li@ec.gc.ca

Questions & suggestions?

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