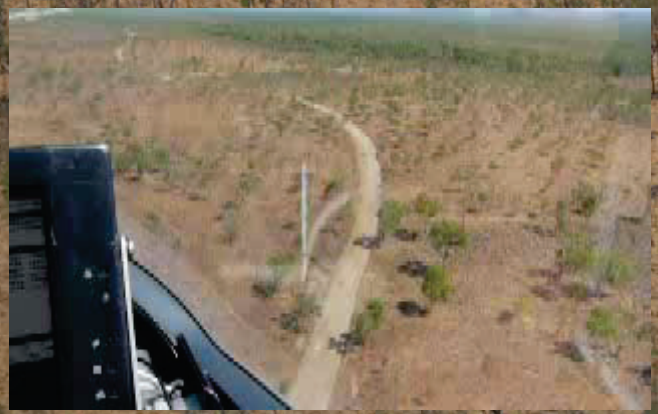
# Fluxes of Heat, Water Vapour and CO2 over the Northern Territory from airborne measurements during the TIPPEX Campaign



Jorg M. Hacker
Flinders University
Airborne Research Australia

FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA

# OVERVIEW of ARA activities and instrumentation

- 2 research aircraft, based at Tipperary Station
- Team of ~10 people
- VH-EOS: 41:05 mission hours; VH-OBS: 55:40 mission hours; both: 96:45 mission hours
- VH-EOS: 34:30 ferry hours; VH-OBS: 34:30 ferry hours; both: 69:00 ferry hours
- Grand total: 165:45 hours flown

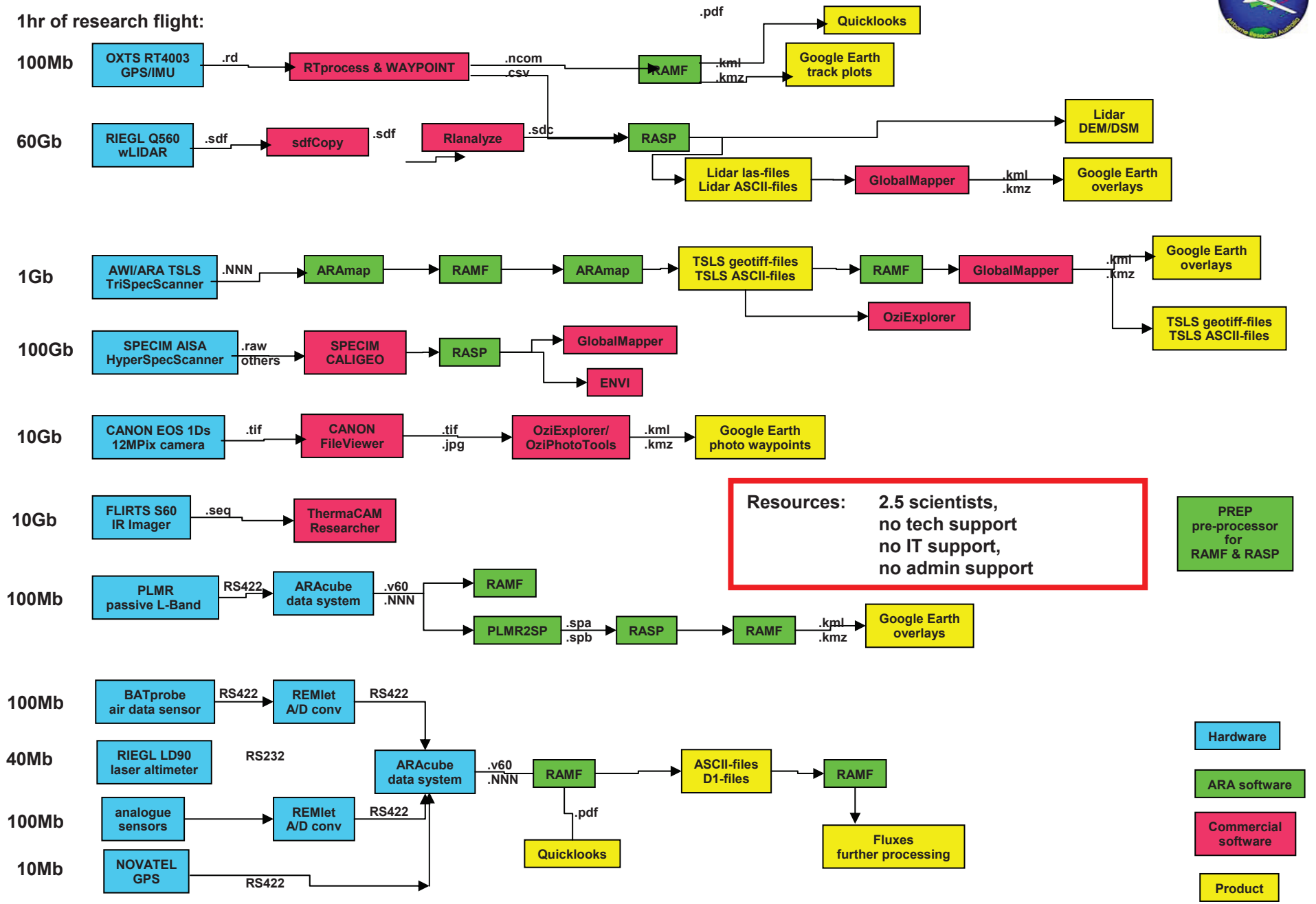
- Total amount of raw data: ~1TB

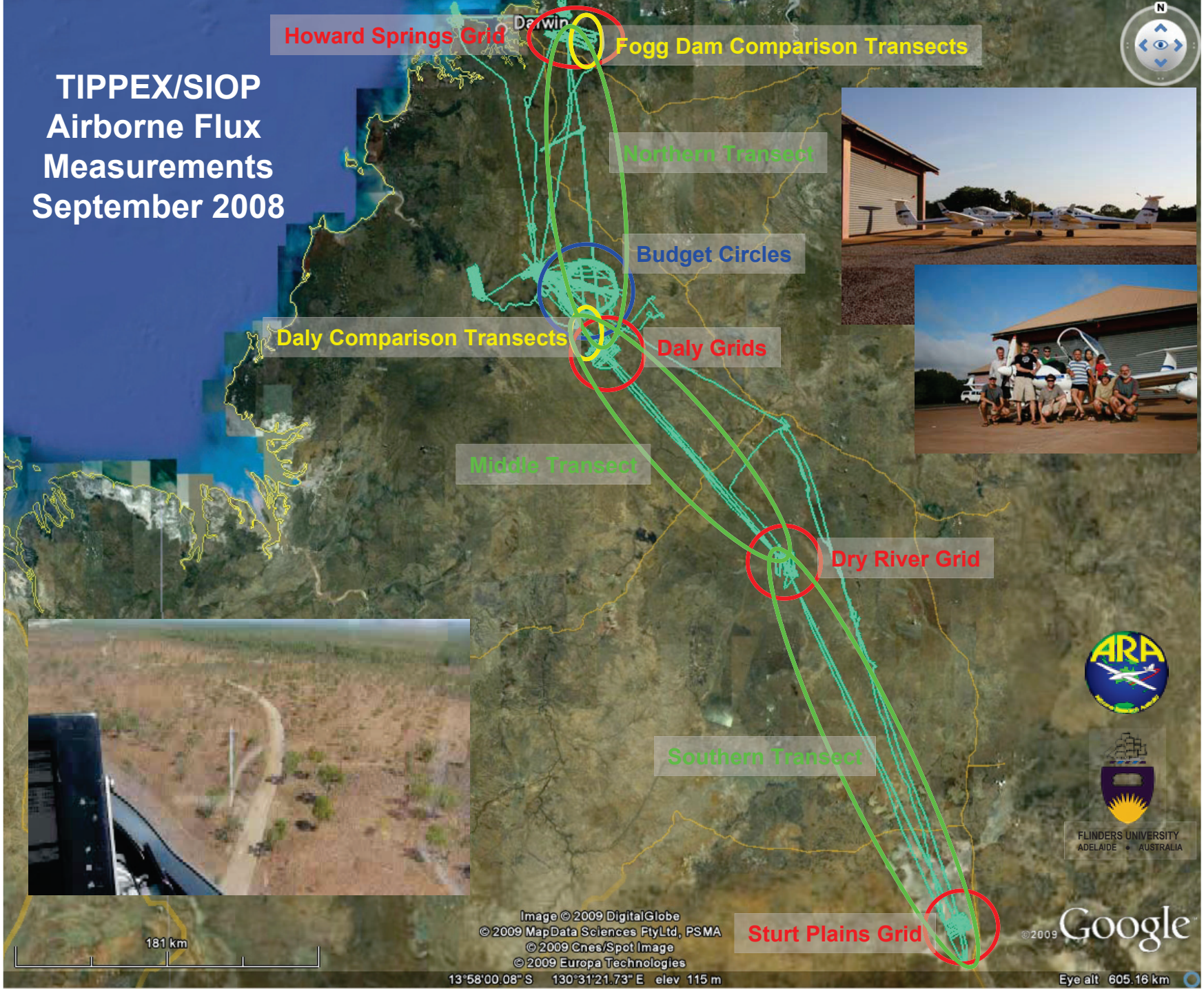
- Atmospheric parameters (BAT with FUST, LiCor 7500, Meteolabor TP3)
  - temperature, humidity, CO2, 3D-wind, turbulence, pressure
- Laser altimeters (Riegl LD90)
- IR surface temperature (Heimann KT15)
- Incoming and outgoing short- and long-wave radiation – radiation balance (Eppley PIR, PSP)
- Flux parameters (H, E, Cm)
- High accuracy CO2 (modified LiCor 6262)

- Full waveform lidar (Riegl Q560)
- Tri-spectral line scanner (AWI/ARA)
- Hyper-spectral scanner (SPECIM AISA+)
- 12Mpix camera (Canon EOS 1Ds)
- PLMR – soil moisture
- PodCams

- Aircraft position and attitude (3 x OXTS RT4003/RT3120 GPS/IMU)
- GPS Base Station (Novatel)

# OVERVIEW


1hr of research flight:
100Mb
OXTS RT4003 GPS/IMU
.rd
RTprocess & WAYPOINT
.ncom
.csv
RAMF
.pdf
.kml
.kmz
Quicklooks
Google Earth track plots
60Gb
RIEGL Q560 wLIDAR
.sdf
sdfCopy
.sdf
Rlanalyze
.sdc
RASP
Lidar DEM/DSM
Lidar las-files
Lidar ASCII-files
GlobalMapper
.kml
.kmz
Google Earth overlays
1Gb
AWI/ARA TSLS TriSpecScanner
.NNN
ARAmap
RAMF
ARAmap
TSLS geotiff-files
TSLS ASCII-files
RAMF
GlobalMapper
.kml
.kmz
Google Earth overlays
OziExplorer
TSLS geotiff-files
TSLS ASCII-files
100Gb
SPECIM AISA HyperSpecScanner
.raw
others
SPECIM CALIGEO
RASP
GlobalMapper
ENVI
10Gb
CANON EOS 1Ds 12MPix camera
.tif
CANON FileViewer
.tif
.jpg
OziExplorer/ OziPhotoTools
.kml
.kmz
Google Earth photo waypoints
10Gb
FLIRTS S60 IR Imager
.seq
ThermaCAM Researcher
Resources:
2.5 scientists,
no tech support
no IT support,
no admin support
PREP
pre-processor
for
RAMF & RASP
100Mb
PLMR passive L-Band
RS422
ARAcube data system
.v60
.NNN
RAMF
PLMR2SP
.spa
.spb
RASP
RAMF
.kml
.kmz
Google Earth overlays
100Mb
BATprobe air data sensor
RS422
REMlet A/D conv
RS422
40Mb
RIEGL LD90 laser altimeter
RS232
ARAcube data system
.v60
.NNN
RAMF
ASCII-files
D1-files
RAMF
100Mb
analogue sensors
REMlet A/D conv
RS422
.pdf
Quicklooks
Fluxes
further processing
10Mb
NOVATEL GPS
RS422
Hardware
ARA software
Commercial software
Product


TIPPEX/SIOP
Airborne Flux
Measurements
September 2008
Howard Springs Grid
Fogg Dam Comparison Transects
Northern Transect
Budget Circles
Daly Comparison Transects
Daly Grids
Middle Transect
Dry River Grid
Southern Transect
Sturt Plains Grid
FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA
Image © 2009 DigitalGlobe
© 2009 MapData Sciences Pty Ltd, PSMA
© 2009 Cnes/Spot Image
© 2009 Europa Technologies
13°58'00.08" S 130°31'21.73" E elev 115 m
Eye alt 605.16 km
181 km
©2009 Google

# TIPPEX / SIOP Sep 2008

# OVERVIEW of ARA activities (by day)

| DATE | EOS | OBS | FLUXES | BUDGET | LIDAR | TSLS | HYPER | CANON | PLMR | PODCAMS | OTHER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 Sep | | 3:40 | | | OS (1000m) | | OS (1000m)<br>OS (3000m) | | | | |
| 4 Sep | 0:20 | 2:10 | TP (test) | | TP (cal@1100m) | TP (cal@1100m) | TP<br>(cal@1100) | | | | |
| 5 Sep | 5:25 | 6:10 | ST(2), FC | | MT (800m),<br>ST (800m) | MT (800m),<br>ST (800m),<br>STG (1700m) | MT (800m),<br>ST (800m),<br>STG (1700m) | | | | |
| 6 Sep | 4:25 | 5:10 | MT(2),<br>FC(2),<br>DUC, DRG | | MT (430m) | MT (430m),<br>DUC (1350m),<br>DRG (2000m) | MT (430m),<br>DUC (1350m),<br>DRG (2000m) | | | | |
| 7 Sep | 0:25 | | TP, DD | | | | | | | | |
| 8 Sep | 4:55 | 5:50 | NT(2), HSG, FC | 2 / 1 AC | | | | | | | |
| 9 Sep | 4:40 | 5:35 | | 2 / 2 AC | | | | | | | |
| 10 Sep | 5:10 | 5:40 | | 2 / 2 AC | | | | | | | |
| 11 Sep | | 4:40 | | | | | | | | | CO2 |
| 12 Sep | 4:50 | 4:30 | MT(2),<br>DUC, DRG | | MN (550m),<br>DR (<400m) | MN (550m),<br>DR (<400m) | MN (550m),<br>DR (<400m) | MN (550m),<br>DR (<400m) | | MT (25m) | |
| 13 Sep | 6:20 | 6:10 | | | MT (900m),<br>ST (900m) | MT (900m),<br>ST (900m) | MT (900m),<br>ST (900m) | MT (900m),<br>ST (900m) | MT (900m),<br>ST (900m) | MT (900m),<br>ST (900m) | |
| 14 Sep | 5:00 | 2:05 | NT(2), HSG | | RW (500m),<br>Other (<500m) | RW (500m),<br>Other (<500m) | | | | NT (25m) | |
| 15 Sep | 3:35 | | | | | | | | NT (900m) | NT (900m) | |
| 16 Sep | | 4:00 | | | NT (600m),<br>HSG (600m)<br>AR (700m) | NT (600m),<br>HSG (600m)<br>AR (700m) | NT (600m),<br>HSG (600m)<br>AR (700m) | NT (600m),<br>HSG (600m)<br>AR (700m) | | | |

OS: Owen Springs / Alice Springs
TP: Tipperary Station
MT: Middle Transect
NT: Northern Transect
ST: Southern Transect
DD: Douglas Daly area

FC: Flux Comparison runs
DUC: Daly Uncleared Grid
MN: Mount Nancar area
RW: Richard Weinman's area
CO2: Darwin CO2 profiles
BUDGET: Budget/flux circles near TP

HSG: Howard Springs Grid
DRG: Dry River Grid
STG: Sturt Plains Grid
DR: Daly River
AR: Adelaide River

VH-EOS: "Flux"-Dimona
VH-OBS: "Remote Sensing"
and "Budget"-Dimona

# Fluxes …… what fluxes ?

**How does one estimate fluxes from such a data set ?**

- purpose ?
- validity ?
- diurnal course ?
- cloud ?
- other ? (“steps”)
- on what scale ?

**Aircraft data is fundamentally different from tower data**
**It adds another dimension – spatial changes**
**That’s great, but it complicates data processing tremendsously**

**In any case – one needs to process the data first (not the fluxes yet….) -**

- tested two independent processing procedures – BN (10Hz) / JMH (20Hz) – very similar results

**Then one can start to compute fluxes – and that’s where it becomes difficult -**

- averaging length ? Steps ? Filtering ? - no established method (*perhaps there is none…*)

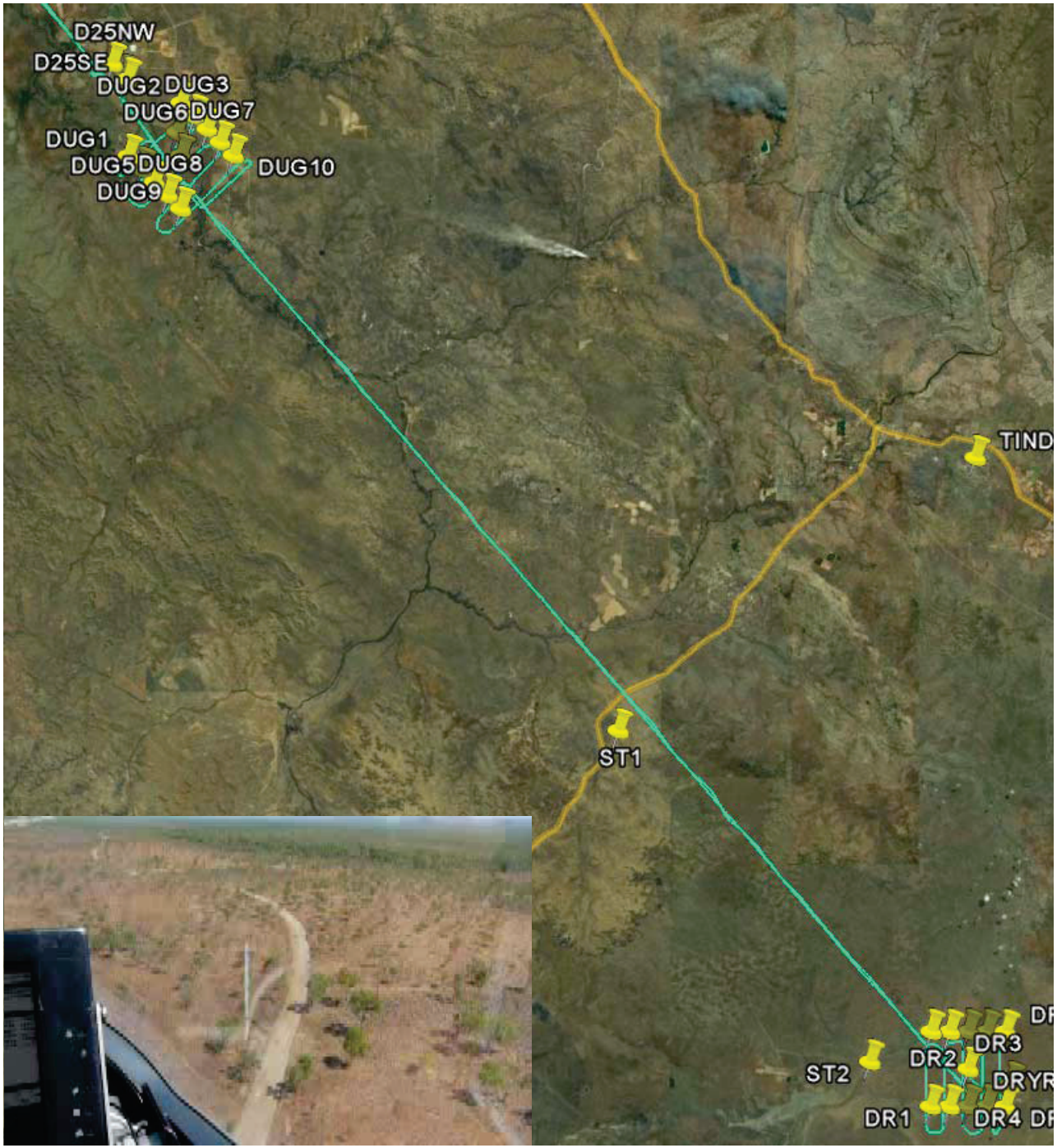
**Then one might want to attempt an intercomparison with “something” -**

- flux towers – “dumb” comparison normally not very useful, but one can start with that
- model estimates ?? What does it mean if there are large differences – or if it fits ??
- other estimates ??

**Visualisation of fluxes is useful** (except perhaps if flux estimates are only used for “dumb” model input) **–**
(“simple” and probably not necessary for towers, because there are far less variables)

- why visualisation ?
  - to be able to link the estimates to features in the landscape
  - to pick up problems
  - to find interesting features
  - more…..
- how to visualise ?
  - Google Earth is an attractive and relatively simple framework
  - transect plots showing all parameters measured, including landscape parameters
  - “re-fly” the transects – human eye and brain is most powerful tool to “see things”

# Middle Transect




6 Sep – MT1&2
NW-SE: 12:30-13:30LT
SE-NW: 14:00-15:00LT

175km each way

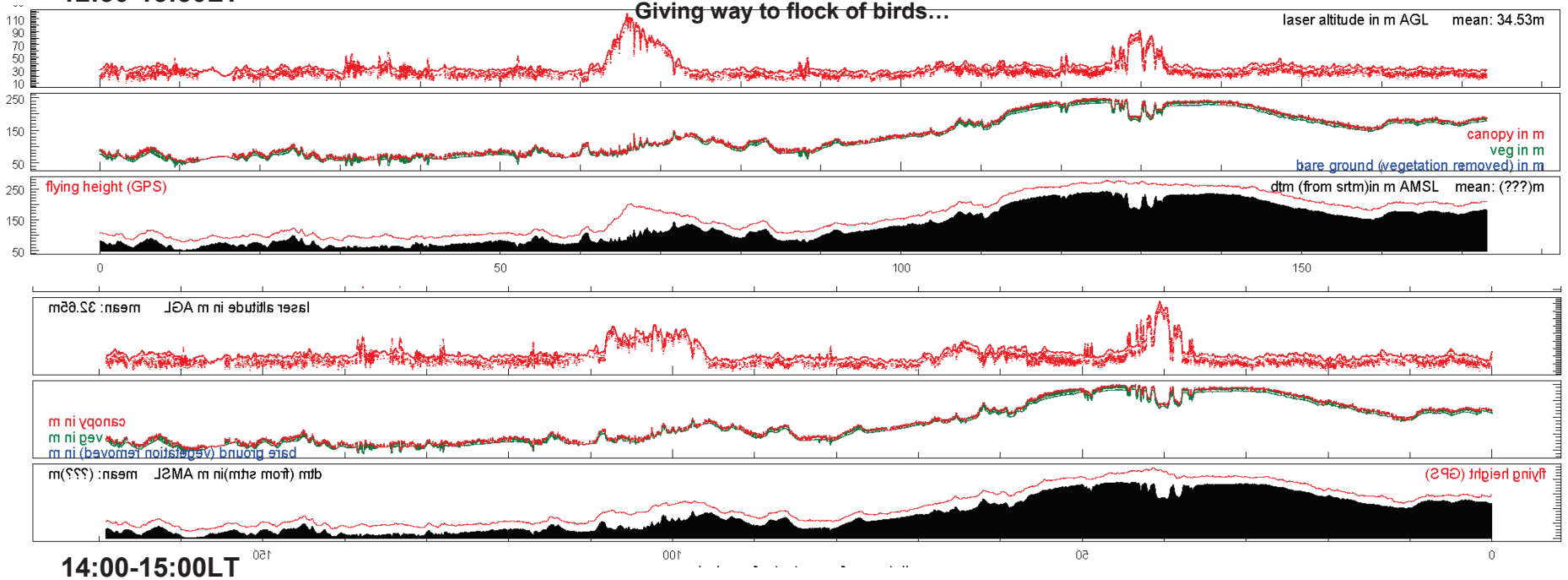
Flying altitude: 25m AGL

Wind:
At first ~4m/s Easterlies,
later nearly no mean wind

FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA

# 6 Sep – MT1&2 175km

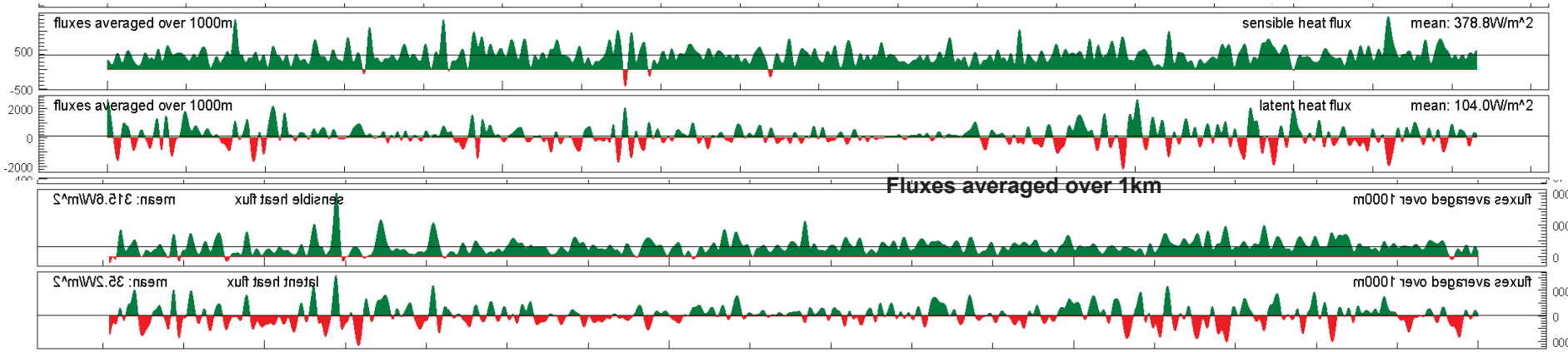
**12:30-13:30LT**




**14:00-15:00LT**

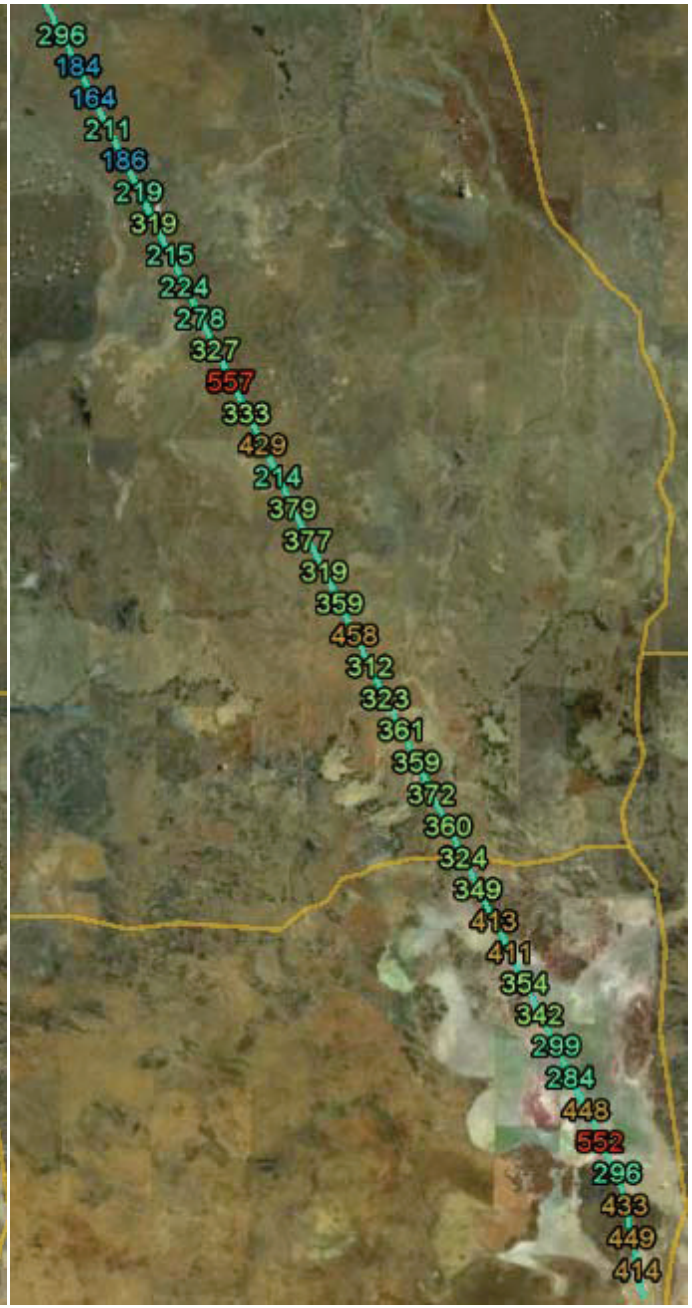
**NE** **SW**

**12:30-13:30LT** **H: 379 W/m2** **E: 104 W/m2**




**14:00-15:00LT** **H: 316 W/m2** **E: 35 W/m2**


NW-SE: 12:00-13:30LT




SE-NW: 13:30-15:00LT

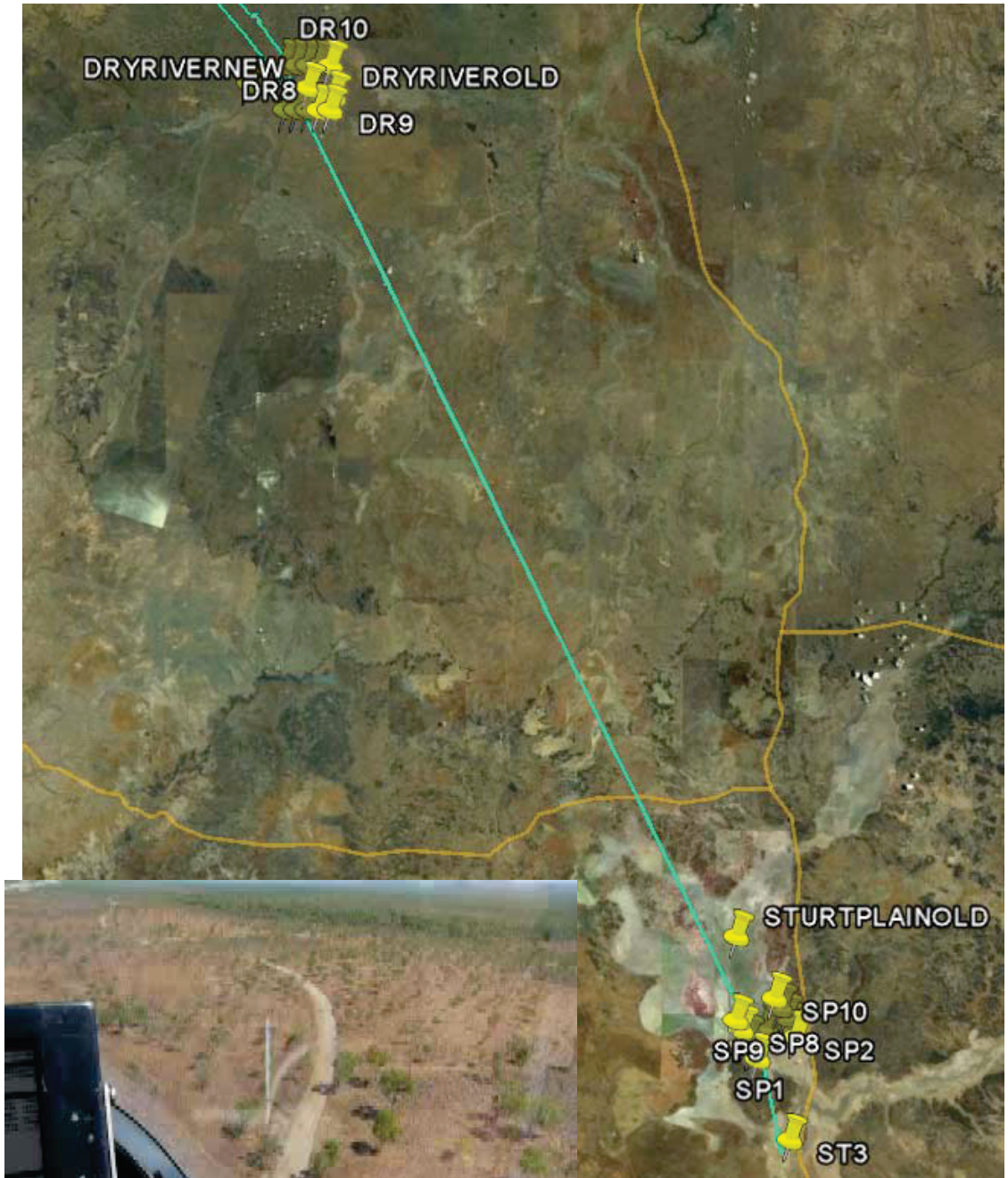
5 Sep – ST

Sensible Heat Flux (W/m2)

10km averages

FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA

# Southern Transect






5 Sep – ST1&2
NW-SE: 12:00-13:30LT
SE-NW: 13:30-15:00LT

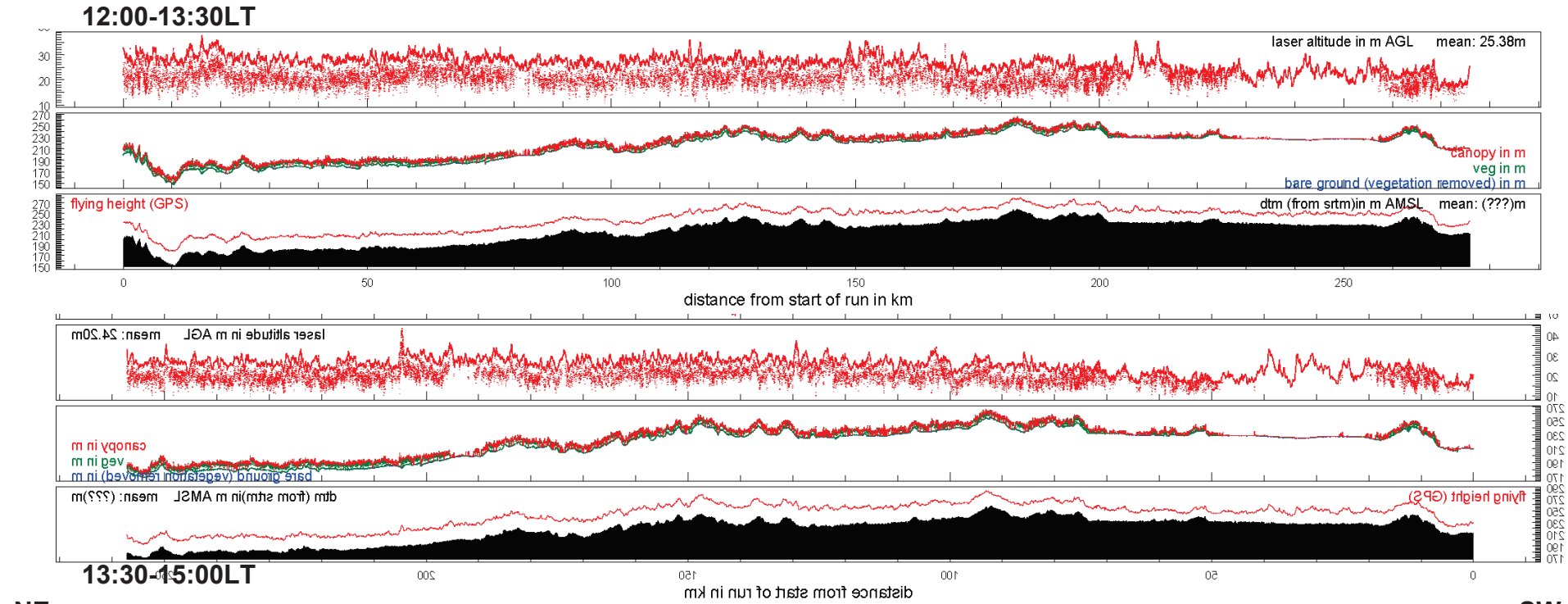
275km each way

Flying altitude: 25m AGL

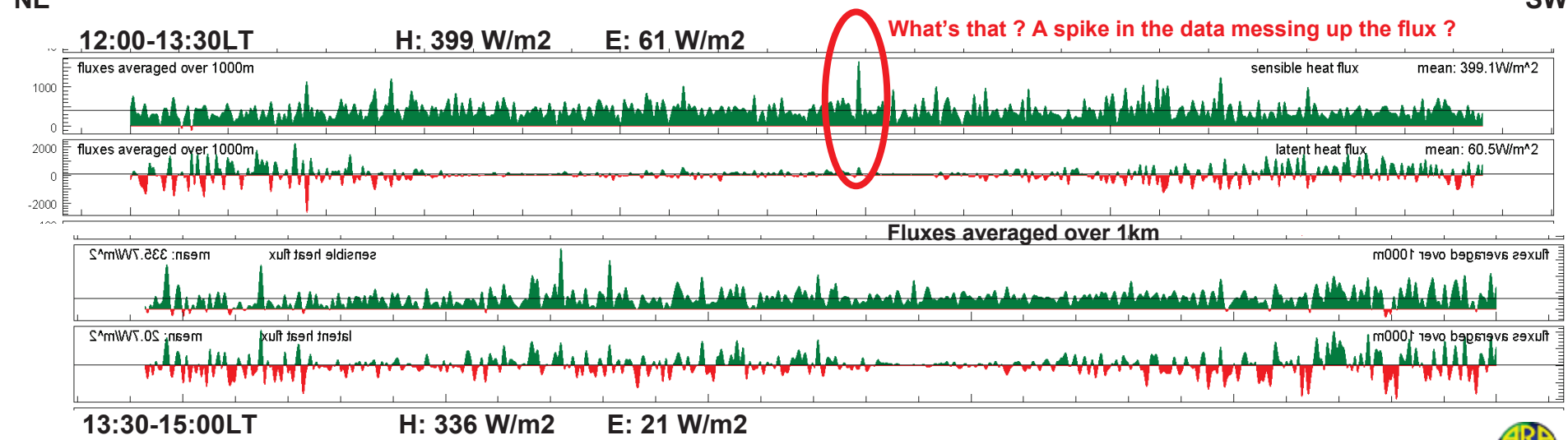
Low wind conditions
(~2m/s Easterlies)

FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA

# 6 Sep – ST1&2 275km



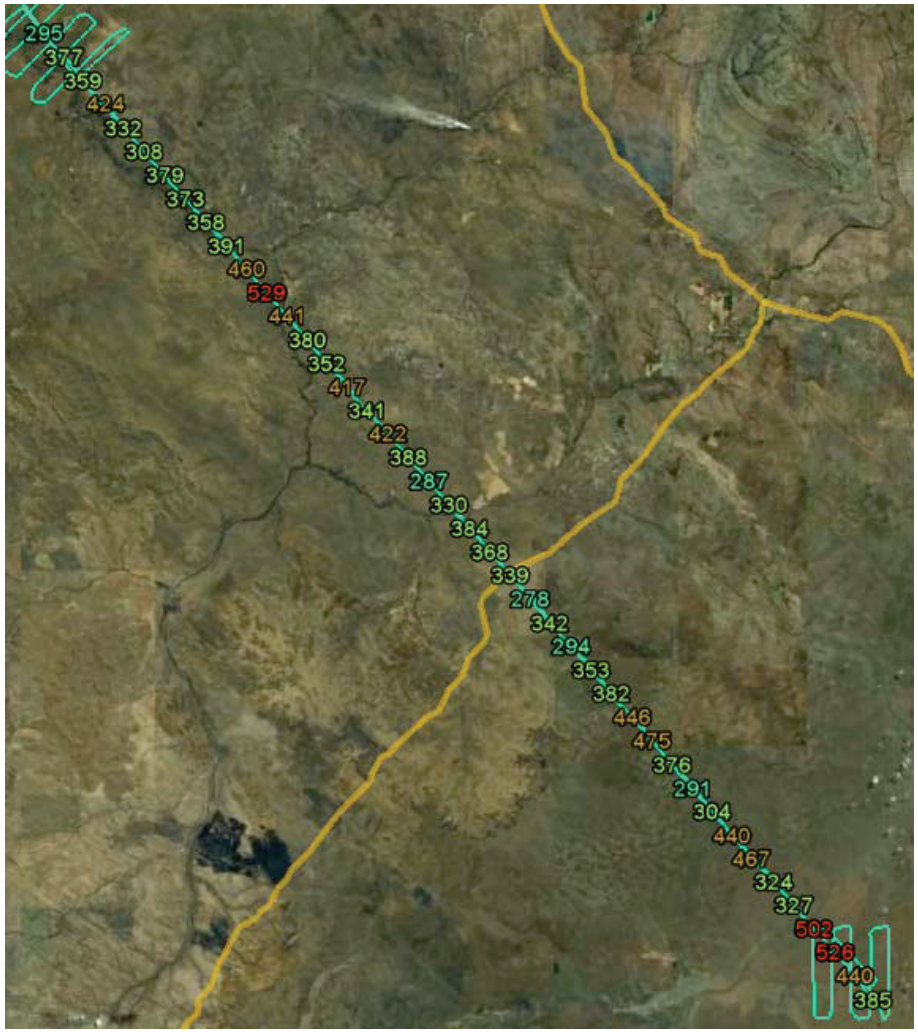

NE SW



6 Sep – MT

Sensible Heat Flux (W/m2)

10km averages

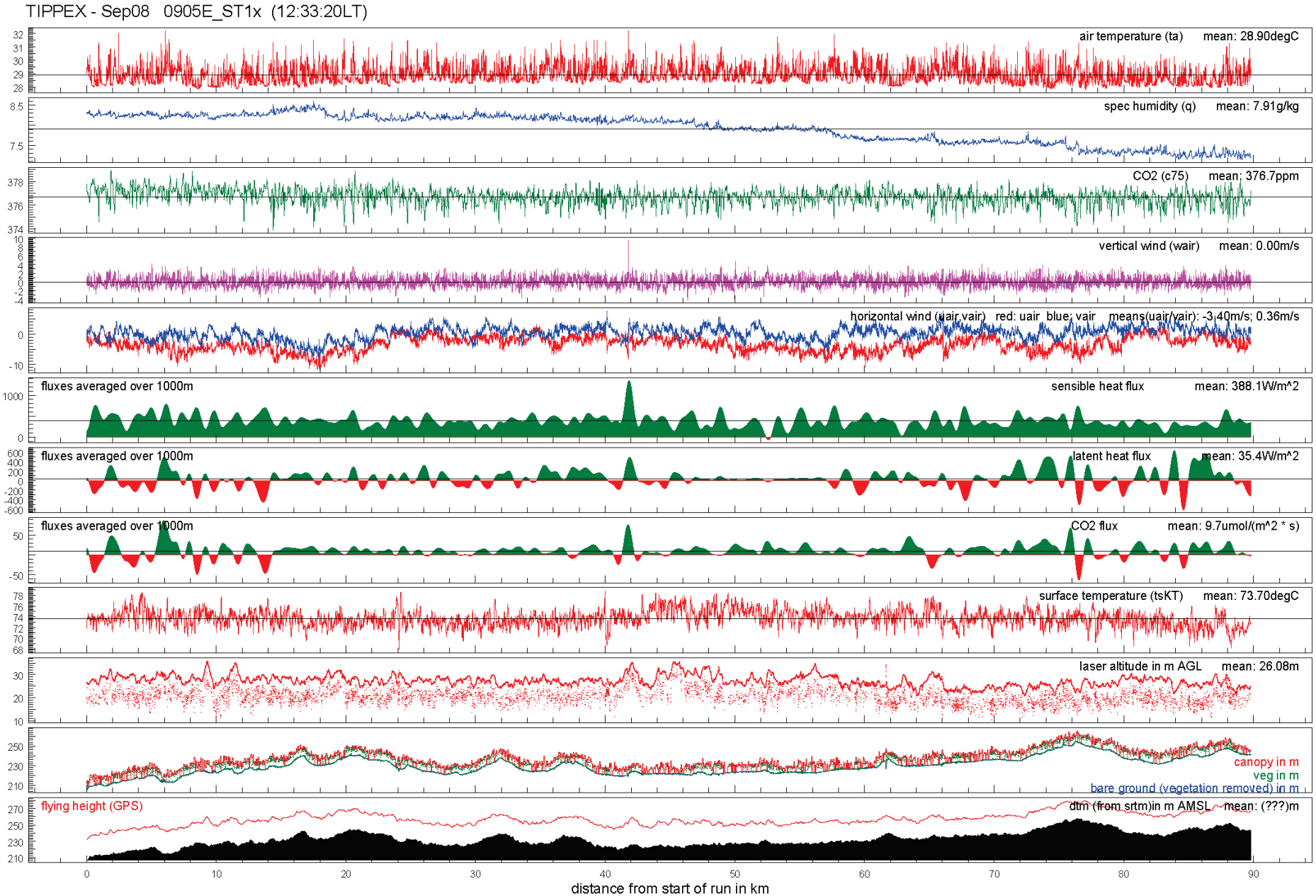



NW-SE: 12:30-13:30LT

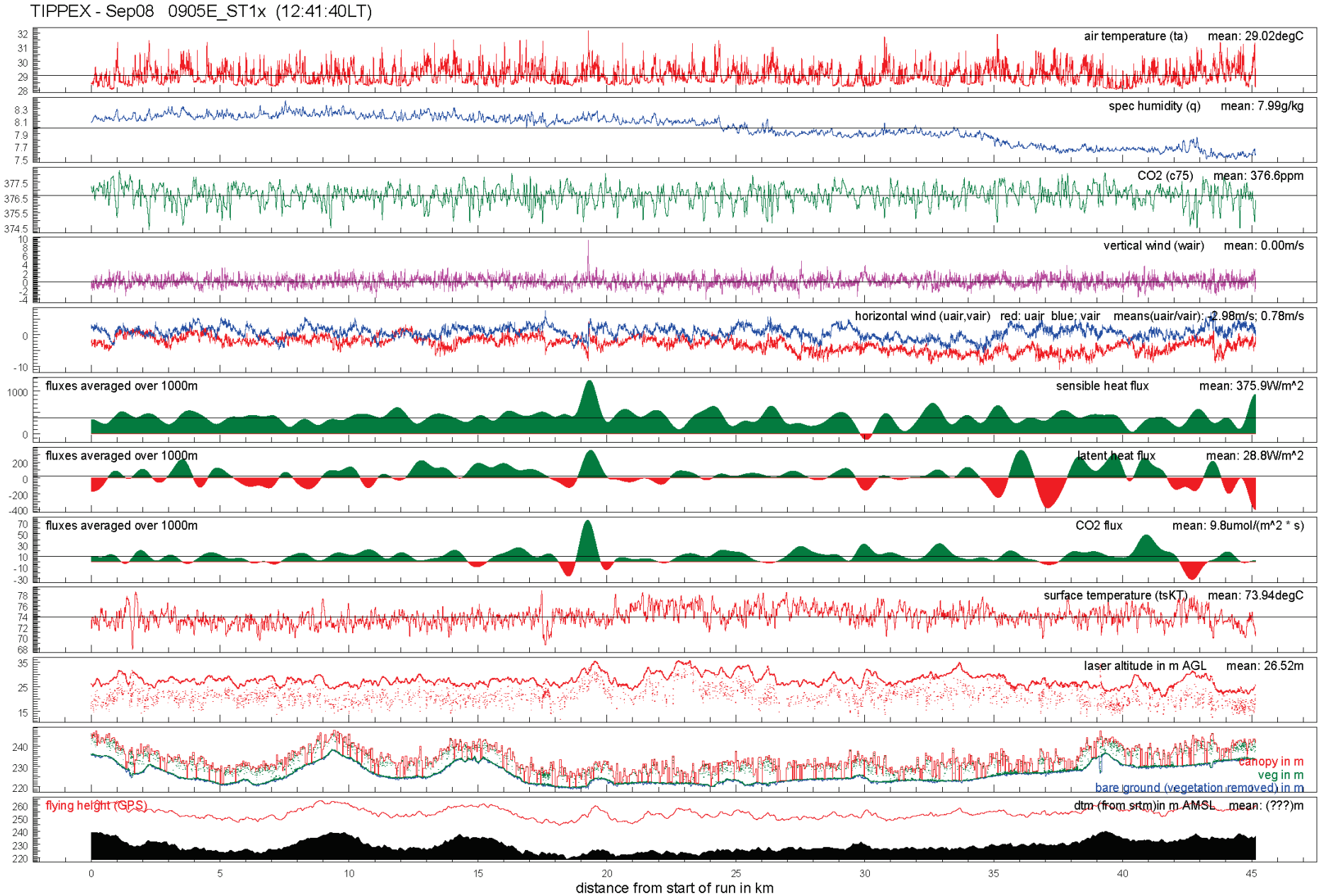
SE-NW: 14:00-15:00LT


FLINDERS UNIVERSITY
ADELAIDE • AUSTRALIA

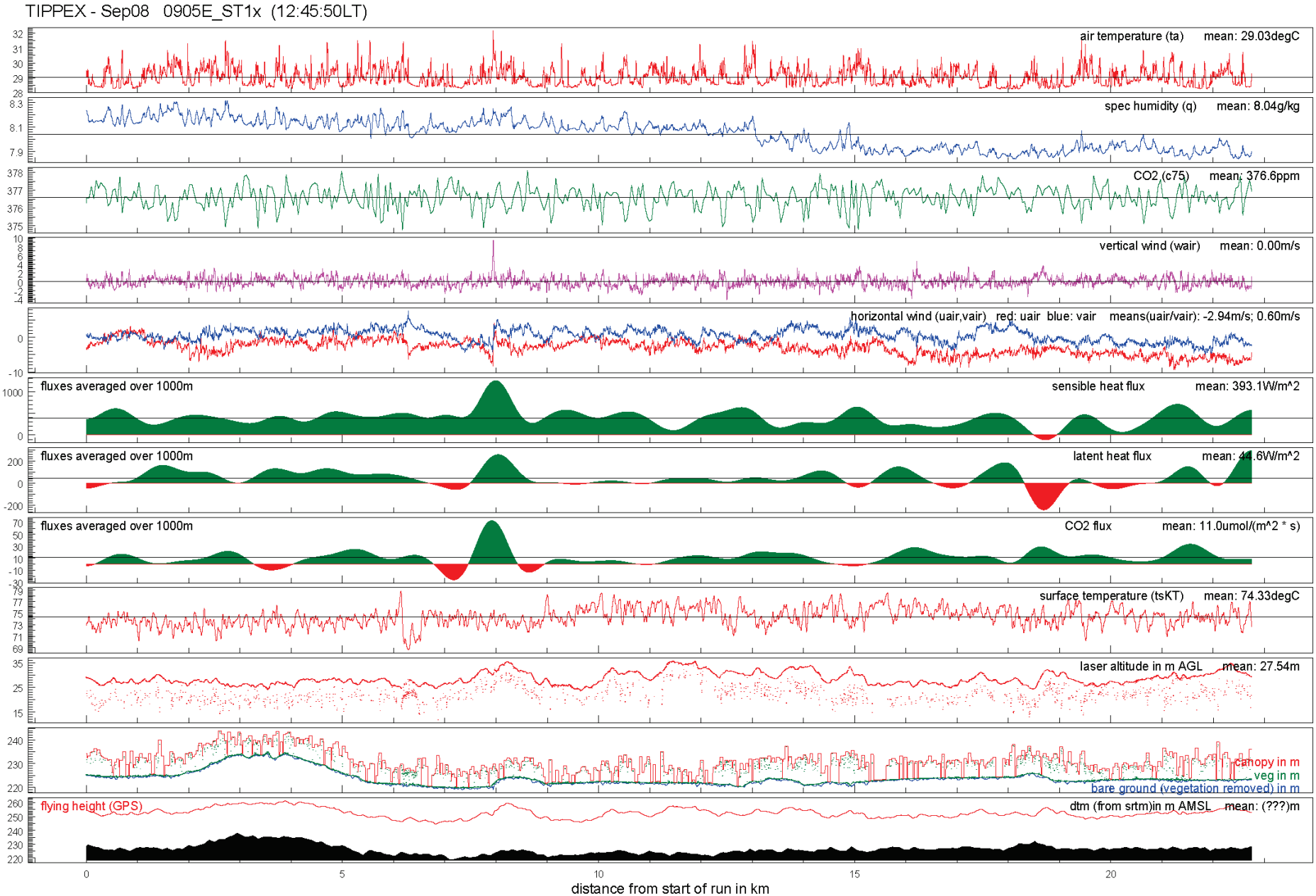
# Southern Transect
# Having a closer look…



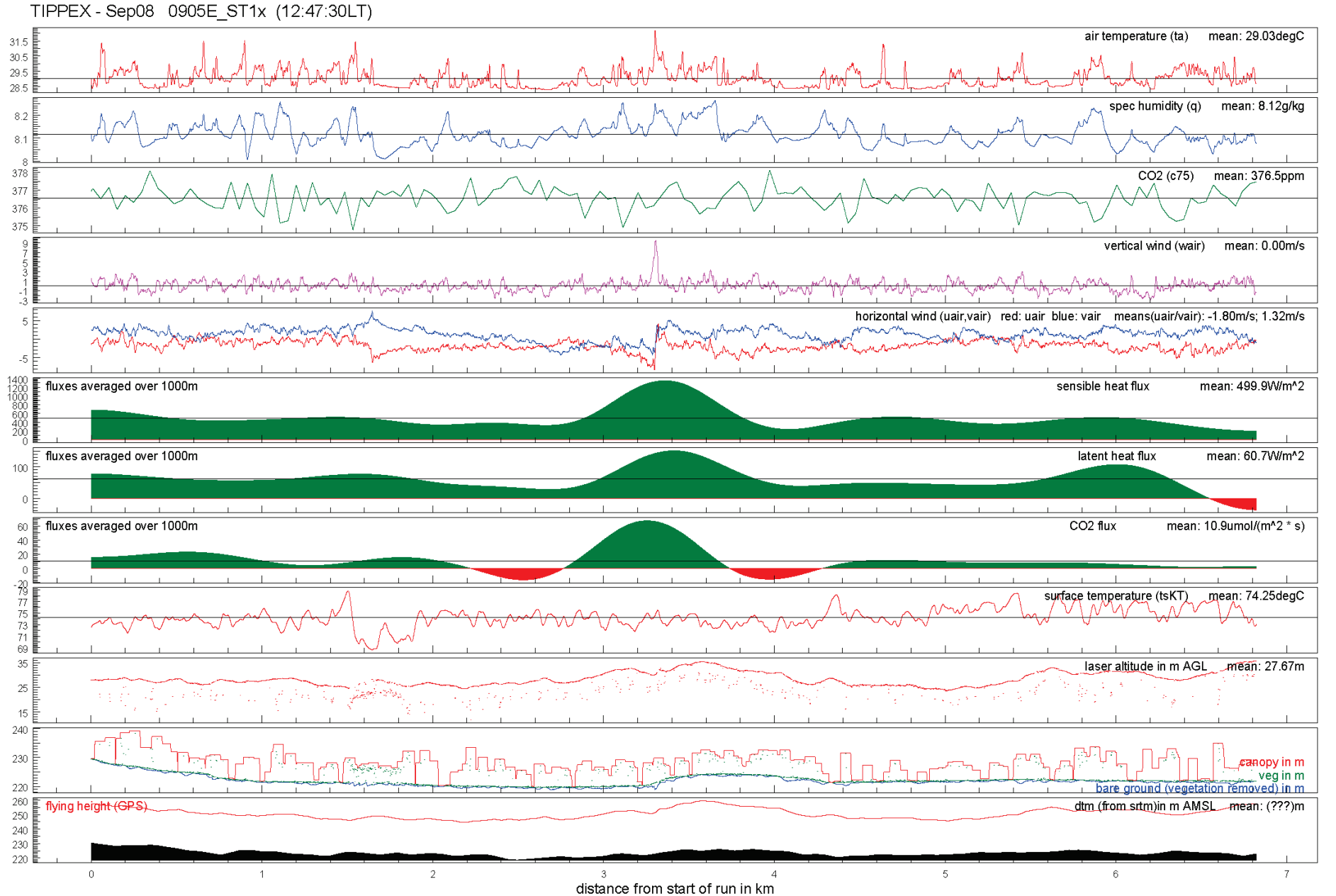

# 90km section



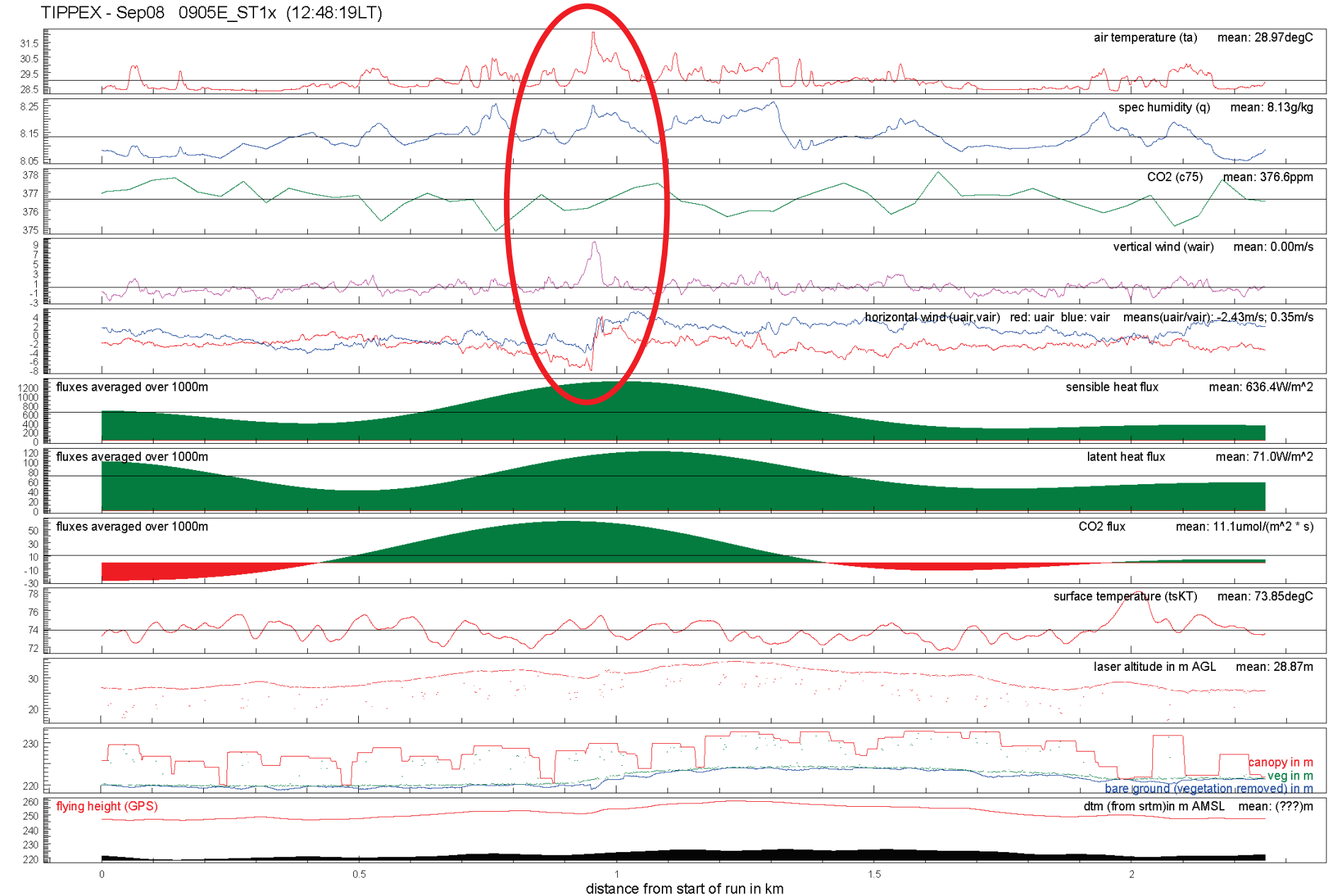

# 45km section




# 22km section

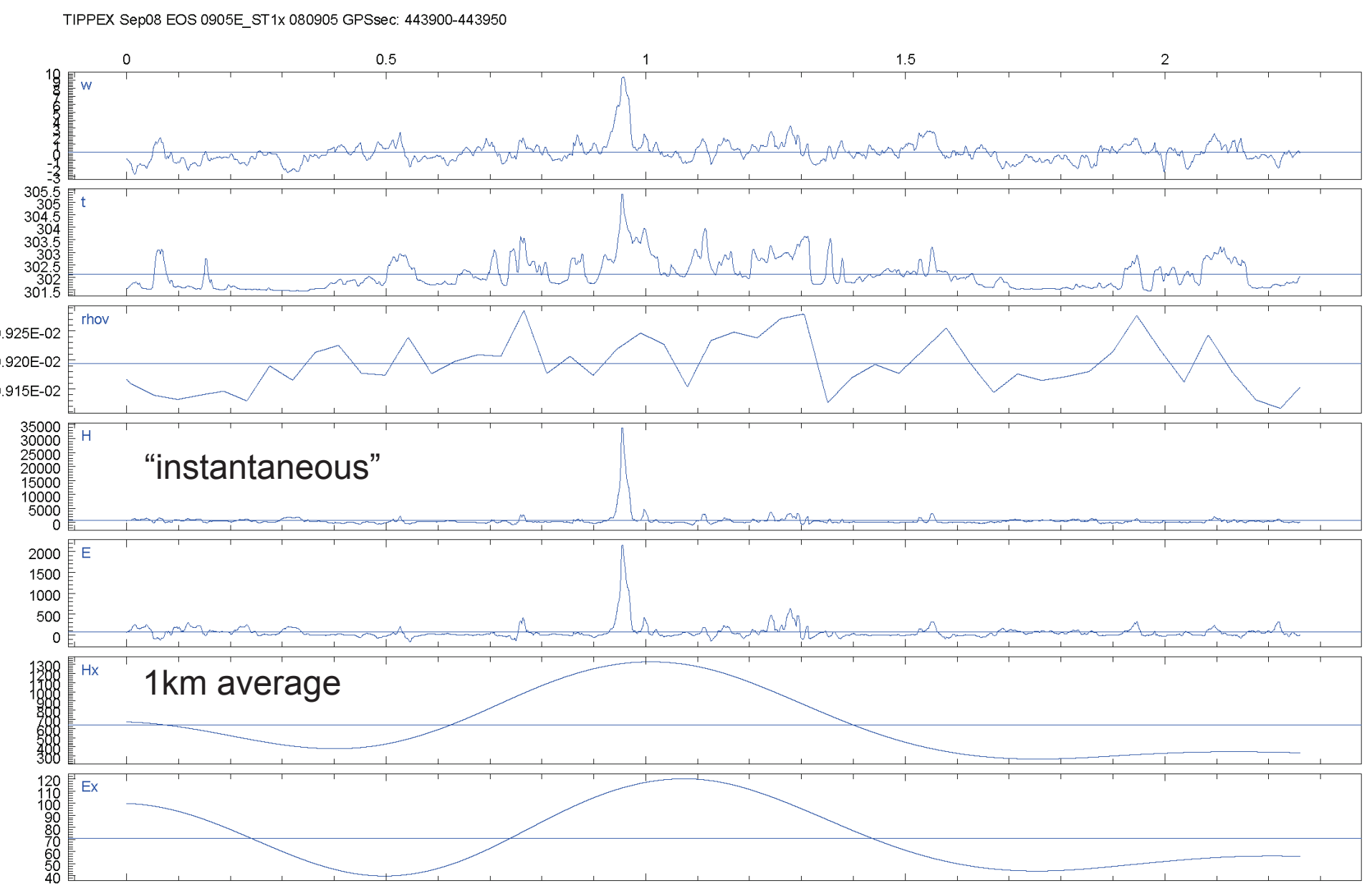

TIPPEX - Sep08 0905E_ST1x (12:47:30LT)
air temperature (ta) mean: 29.03degC
spec humidity (q) mean: 8.12g/kg
CO2 (c75) mean: 376.5ppm
vertical wind (wair) mean: 0.00m/s
horizontal wind (uair,vair) red: uair blue: vair means(uair/vair): -1.80m/s; 1.32m/s
fluxes averaged over 1000m
sensible heat flux mean: 499.9W/m^2
fluxes averaged over 1000m
latent heat flux mean: 60.7W/m^2
fluxes averaged over 1000m
CO2 flux mean: 10.9umol/(m^2 * s)
surface temperature (tsKT) mean: 74.25degC
laser altitude in m AGL mean: 27.67m
canopy in m
veg in m
bare ground (vegetation removed) in m
flying height (GPS)
dtm (from srtm)in m AMSL mean: (???)m
distance from start of run in km

# 7km section




# 2km section

**Very strong thermal – more that 3-times higher vertical velocity then second strongest one; max w=9m/s (at z=30mAGL!!); horizontal gust >10m/s; diameter ~70m; delta T: >3deg**




**2km section**

“it was quite a bump….”

# Tower Comparison
# “dumb” ones at this stage

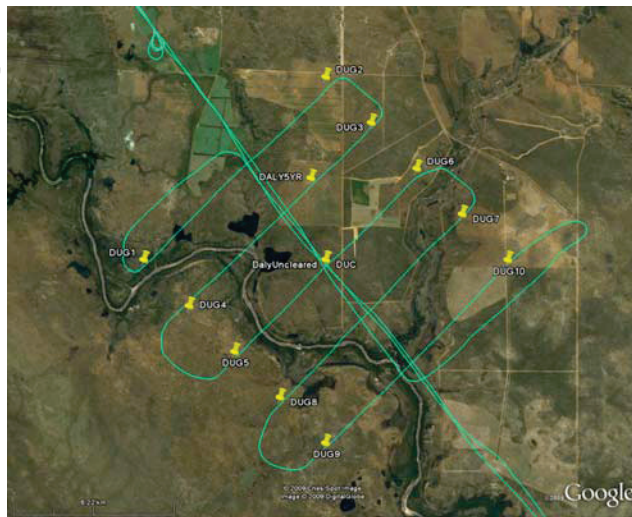
NORTHERN TRANSECT 14 Sep Aircraft: 5km averages at tower location

| | UTC | LT | LT | H | H | H | LE | LE | LE | Cm | Cm | Cm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | W/m2 | W/m2 | W/m2 | W/m2 | W/m2 | W/m2 | umol/m2/s | umol/m2/s | umol/m2/s |
| | | aircraft | tower | aircraft | a/c 1km | tower | aircraft | a/c 1km | tower | aircraft | a/c 1km | tower |
| HOWARD SPRINGS | | | | | | | | | | | | |
| 14/09/2008 | | | | | | | | | | | | |
| | 03:00 | 12:30 | 12:30 | 250 | | 267 | 200 | | 49 | | | |
| | 03:21 | 12:51 | 13:00 | 300 | | 269 | 150 | | 131 | | | |
| | | | | | | | | | | | | |
| FOGG DAM | | | | | | | | | | | | |
| 14/09/2008 | | | | | | | | | | | | |
| | 03:15 | 12:45 | 12:30 | 212 | | 294 | 250 | | 187 | | | |
| | | | 13:00 | | | 243 | | | 95 | | | |
| | | | | | | | | | | | | |
| ADELAIDE RIVER | | | | | | | | | | | | |
| 14/09/2008 | | | | | | | | | | | | |
| | 02:30 | 12:00 | 12:00 | 375 | | 314 | 126 | | 71 | | | |
| | 02:30 | 12:00 | 12:00 | 434 | | 314 | 105 | | 71 | | | |
| | 04:35 | 14:05 | 14:00 | 310 | | 312 | 156 | | 108 | | | |
| | 04:35 | 14:05 | 14:00 | 495 | | 312 | -88 | | 108 | | | |
| | | | | | | | | | | | | |
| DALY 5YR | | | | | | | | | | | | |
| 14/09/2008 | | | | | | | | | | | | |
| | 01:25 | 10:45 | 10:30 | 290 | | 241 | 200 | | 42 | | | |
| | | | 11:00 | | | 276 | | | 45 | | | |
| | 05:30 | 15:00 | 15:00 | 200 | | 173 | 360 | | 41 | | | |
| | | | | | | | | | | | | |
| DALY UNCLEARED | | | | | | | | | | | | |
| 14/09/2008 | | | | | | | | | | | | |
| | 01:25 | 10:45 | 10:30 | 300 | | 240 | 55 | | 144 | | | |
| | | | 11:00 | | | 222 | | | 54 | | | |
| | 05:30 | 15:00 | 15:00 | 200 | | 244 | 350 | | 56 | | | |

# Daly Uncleared Grid 6 Sep

| | UTC | LT | LT | H | H | H | LE | LE | LE | Cm | Cm | Cm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | W/m2 | W/m2 | W/m2 | W/m2 | W/m2 | W/m2 | umol/m2/s | umol/m2/s | umol/m2/s |
| | | aircraft | tower | aircraft | a/c 1km | tower | aircraft | a/c 1km | tower | aircraft | a/c 1km | tower |
| | | | | | | | | | | | | |
| DALY UNCLEARED | | | | | | | | | | | | |
| 6/09/2008 | | | | | | | | | | | | |
| | | 11:49 | | 420 | | | 146 | | | | | |
| | | 11:54 | | 320 | | | -39 | | | | | |
| | | 11:58 | | 380 | | | 66 | | | | | |
| | | 12:04 | | 323 | | | 128 | | | | | |
| | | 12:09 | | 401 | | | 123 | | | | | |
| | | 12:15 | | 305 | | | 135 | | | | | |
| | | 12:20 | | 323 | | | 38 | | | | | |
| | | 12:25 | | 392 | | | 92 | | | | | |
| | | 12:27 | | 328 | | | 111 | | | | | |
| | | 11:49-12:27 | 12:00 | 355 | | 369 | 89 | | 239 | | | |
| | | | 12:30 | | | 418 | | | 141 | | | |

**Aircraft: averages over individual transects of grid (10km – 2.5km lateral spacing), averages over 1km around tower site and average over all transects**



# Dry River Grid 6 Sep

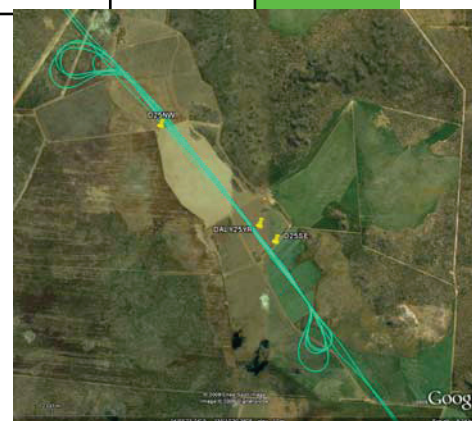
| | UTC | LT | LT | H | H | H | LE | LE | LE | Cm | Cm | Cm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | W/m2 | W/m2 | W/m2 | W/m2 | W/m2 | W/m2 | umol/m2/s | umol/m2/s | umol/m2/s |
| | | aircraft | tower | aircraft | a/c 1km | tower | aircraft | a/c 1km | tower | aircraft | a/c 1km | tower |
| | | | | | | | | | | | | |
| DRY RIVER | | | | | | | | | | | | |
| 6/09/2008 | | | | | | | | | | | | |
| | | 13:28 | | 469 | | | 114 | | | -3.2 | | |
| | | 13:35 | | 377 | | | 82 | | | -2.2 | | |
| | | 13:40 | | 400 | | | 89 | | | -6.1 | | |
| | | 13:45 | | 384 | | | 63 | | | -5.6 | | |
| | | 13:50 | | 419 | | | 78 | | | -2.3 | | |
| | | 13:55 | | 424 | | | 99 | | | -2.9 | | |
| | | 14:00 | | 326 | | | 83 | | | -4.2 | | |
| | | 14:05 | | 332 | | | 63 | | | -4.8 | | |
| | | 13:28-14:05 | 13:30 | 391 | | 402 | 84 | | 91 | -3.9 | | -4.3 |
| | | | 14:00 | | | 312 | | | 58 | | | -3.5 |

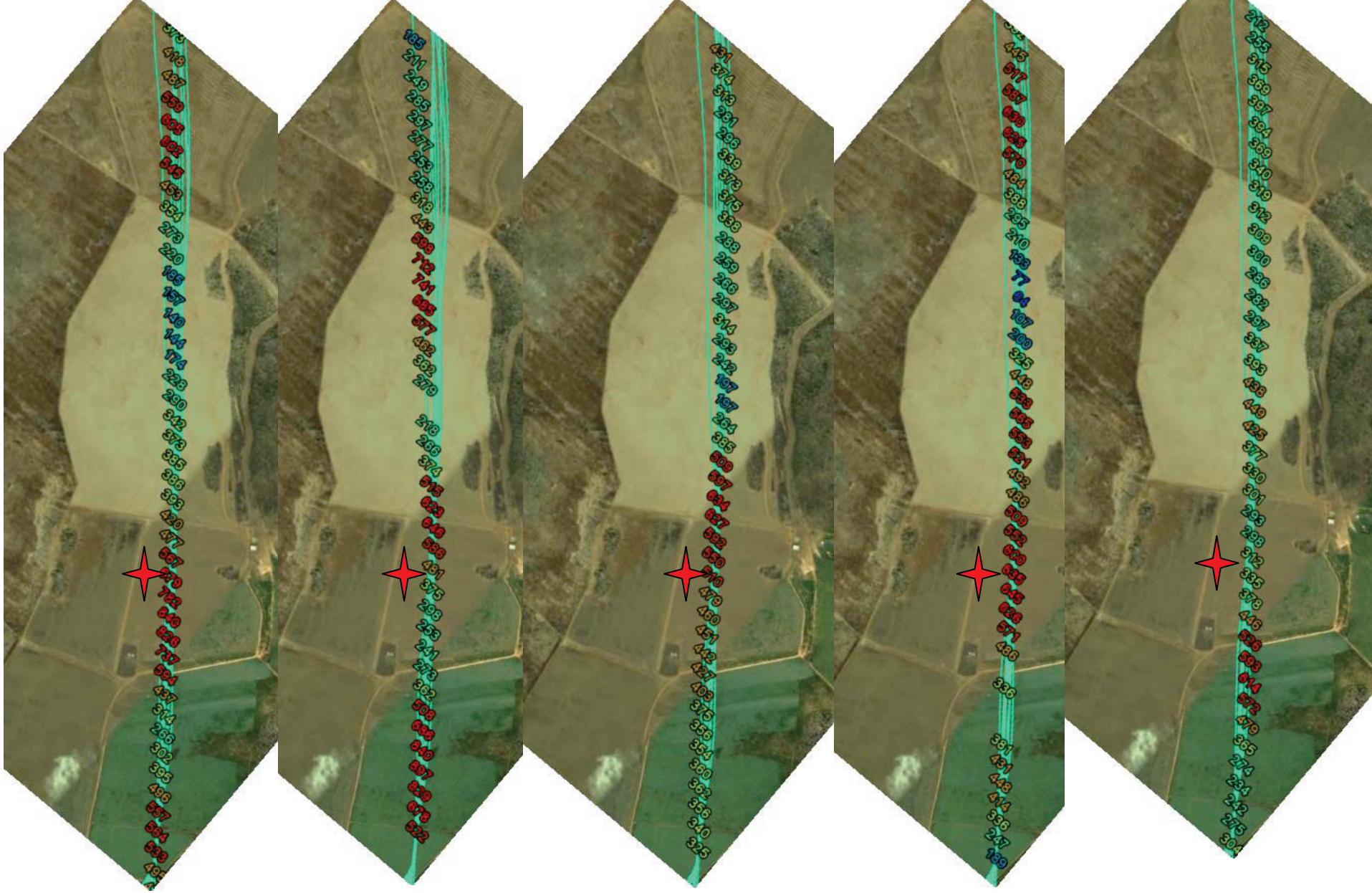
**Aircraft: averages over individual transects of grid (10km – 2.5km lateral spacing) averages over 1km around tower site and average over all transects**

# Daly 25Yr Intercomparison Transects 6 Sep

| | UTC | LT | LT | H | H | H | LE | LE | LE | Cm | Cm | Cm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | W/m2 | W/m2 | W/m2 | W/m2 | W/m2 | W/m2 | umol/m2/s | umol/m2/s | umol/m2/s |
| | | aircraft | tower | aircraft | a/c 1km | tower | aircraft | a/c 1km | tower | aircraft | a/c 1km | tower |
| | | | | | | | | | | | | |
| DALY 25YR | | | | | | | | | | | | |
| 6/09/2008 | | | | | | | | | | | | |
| | | 11:33 | | 447 | 375 | | 64 | 226 | | 4.8 | 18 | |
| | | 11:36 | | 382 | 479 | | 13 | 3 | | 9.5 | 21 | |
| | | 11:39 | | 420 | 635 | | 35 | 152 | | 11.7 | 13 | |
| | | 11:42 | | 359 | 300 | | -5 | 68 | | | 5 | |
| | | 11:45 | | 439 | 567 | | -21 | -30 | | | 12 | |
| | | 11:33-11:45 | 11:30 | 409 | 471 | 296 | 17 | 84 | 10 | | 14 | 0.924 |
| | | | | | | | | | | | | |
| | | 15:07 | | 200 | | | 35 | | | | | |
| | | 15:10 | | 116 | | | 18 | | | | | |
| | | 15:13 | | 138 | | | -2 | | | | | |
| | | 15:17 | | 145 | | | 9 | | | | | |
| | | 15:20 | | 119 | | | 18 | | | | | |
| | | 15:07-15:20 | 15:00 | 144 | | 167 | 16 | | 16 | | | |
| | | | 15:30 | | | 134 | | | 7 | | | |

**Aircraft: averages over individual transects along same track (5km),**
**averages over 1km around tower site and average over all transects**



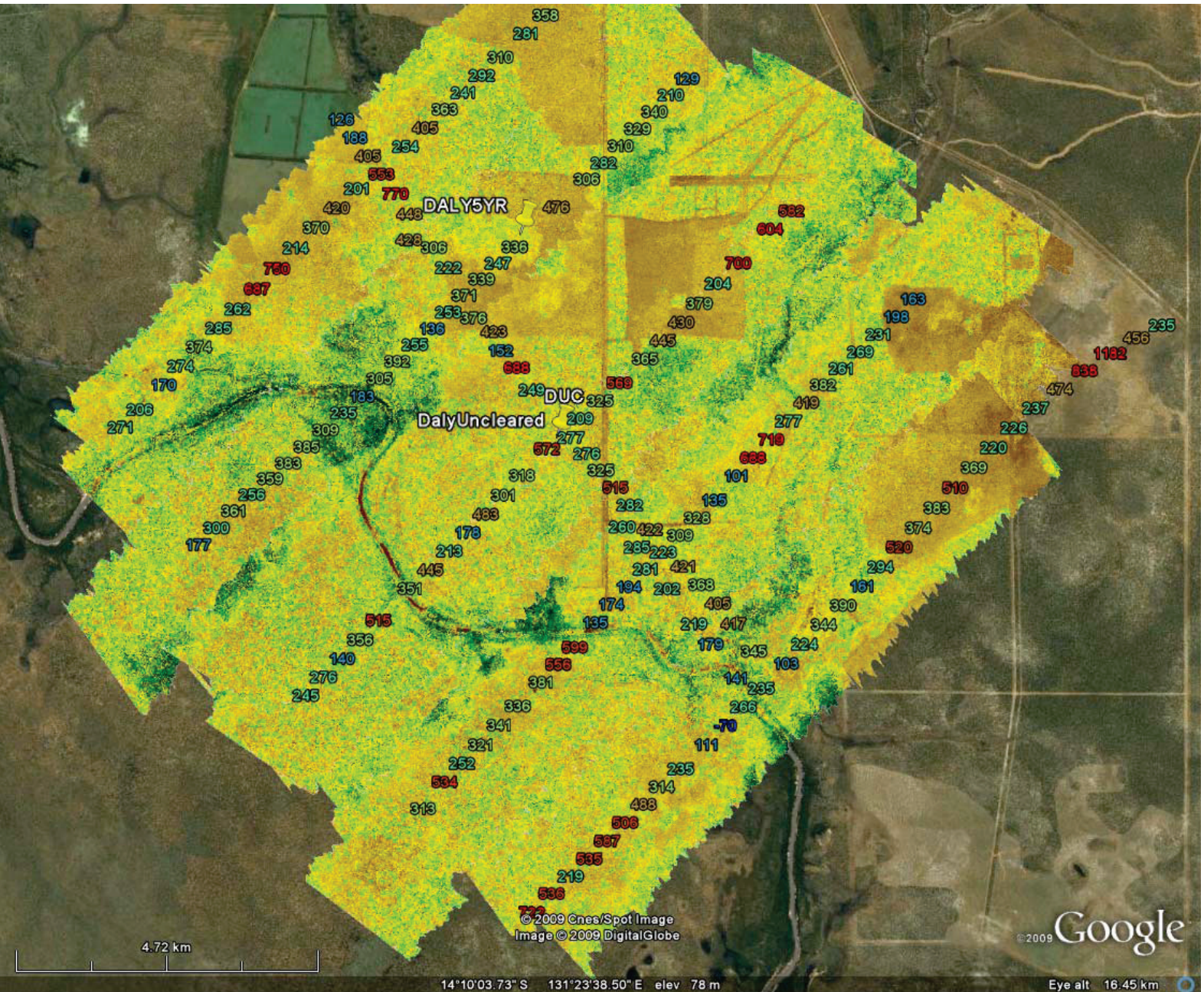


1km averaged sensible heat flux for successive transects at 10m AGL
DALY 25yr

Tower (296 W/m2)

# Grids

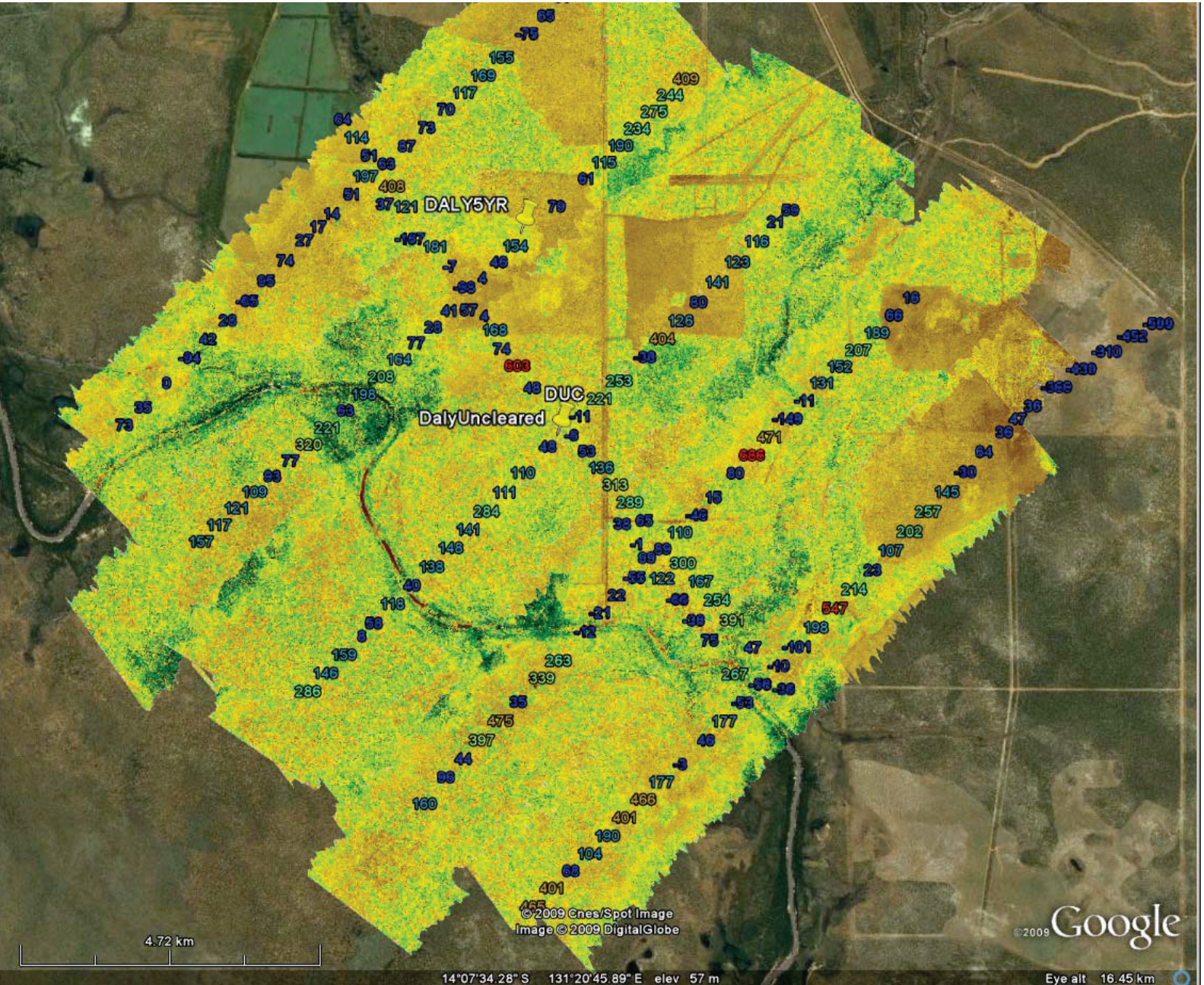
# 1km averaged sensible heat flux for DALY GRID (6 Sep – 11:50-12:30LT)




H in W/m2

ndvi

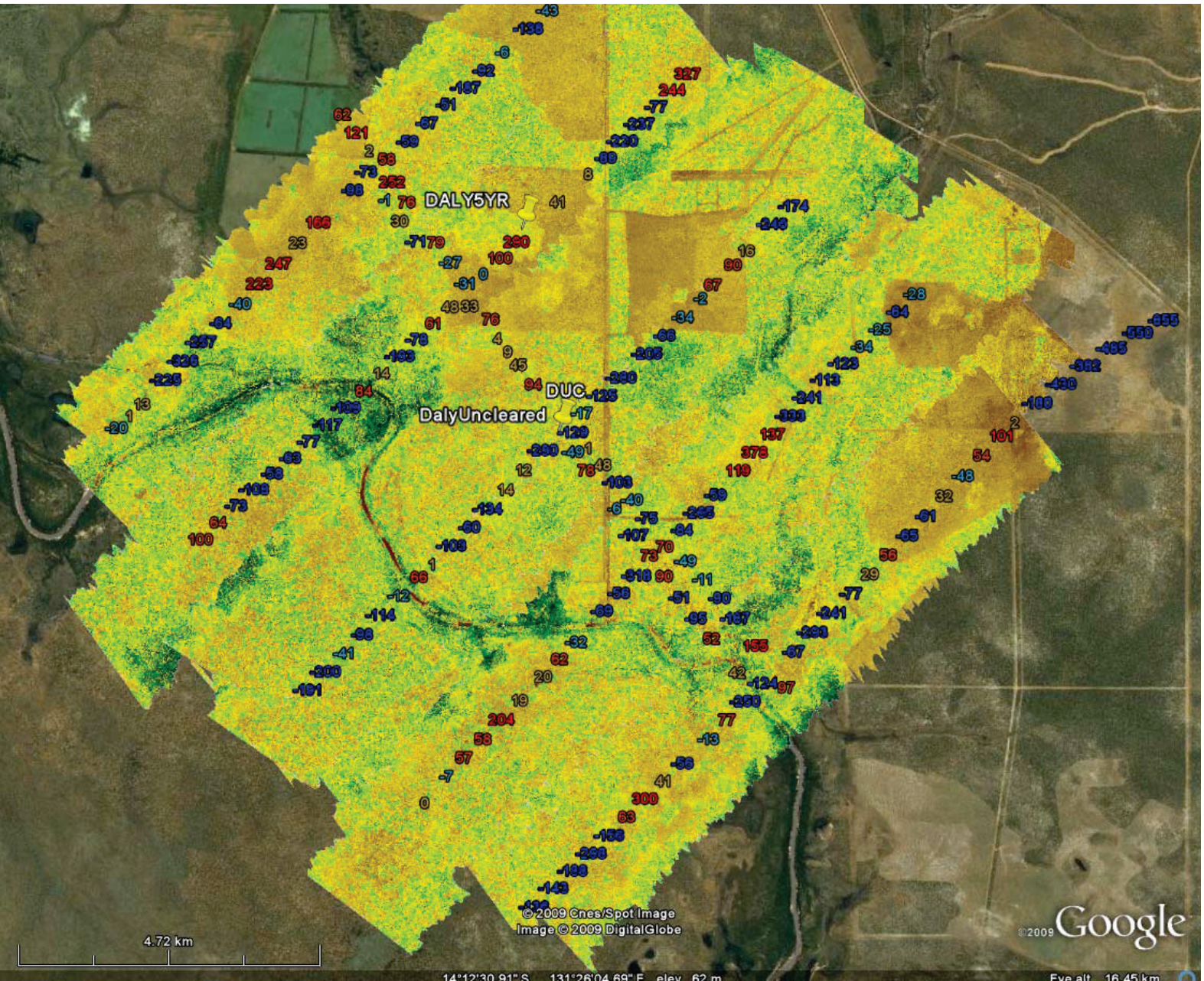
# 1km averaged latent heat flux for DALY GRID (6 Sep – 11:50-12:30LT)




E in W/m2

ndvi

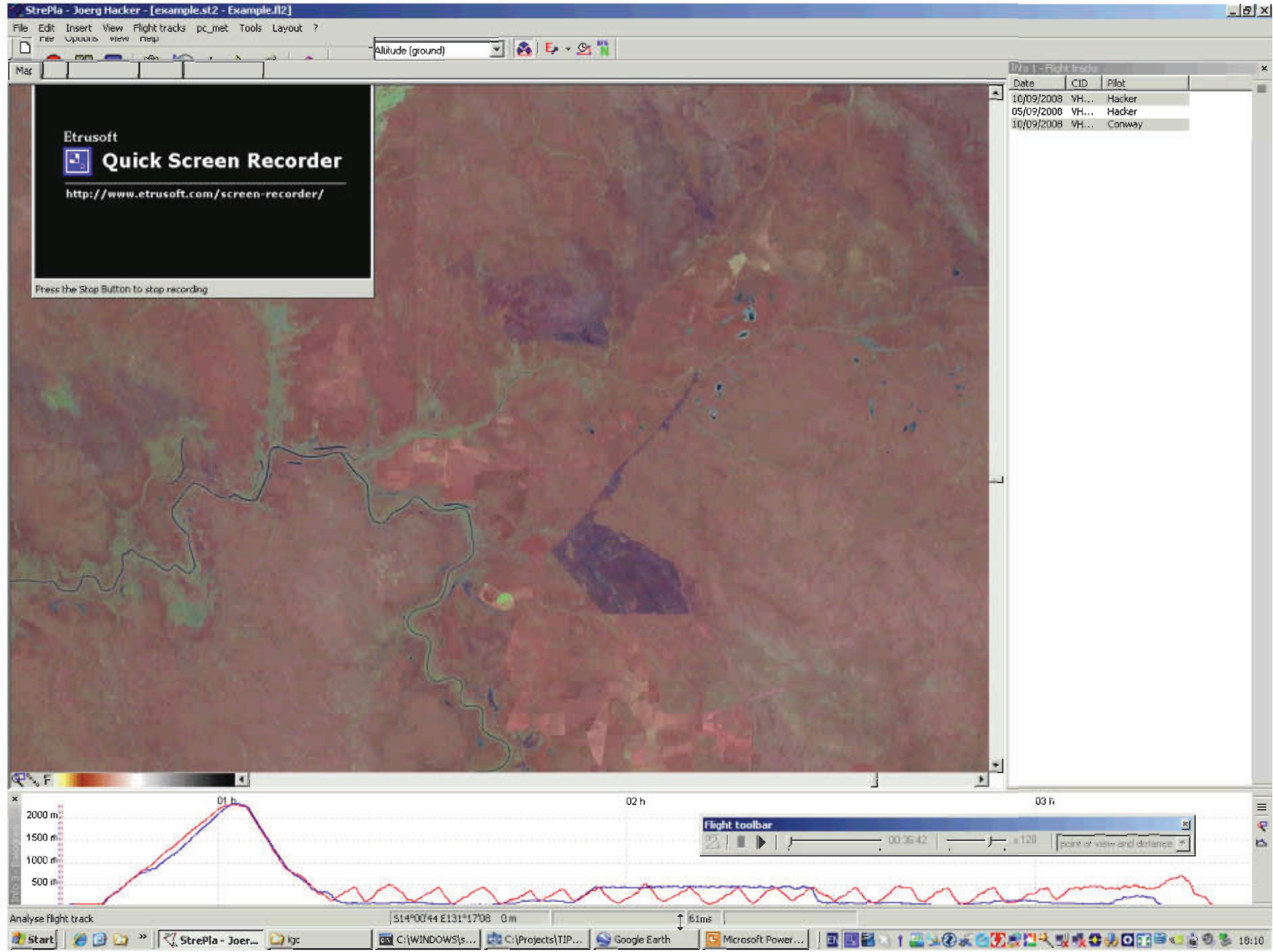
# 1km averaged CO2 flux for DALY GRID (6 Sep – 11:50-12:30LT)

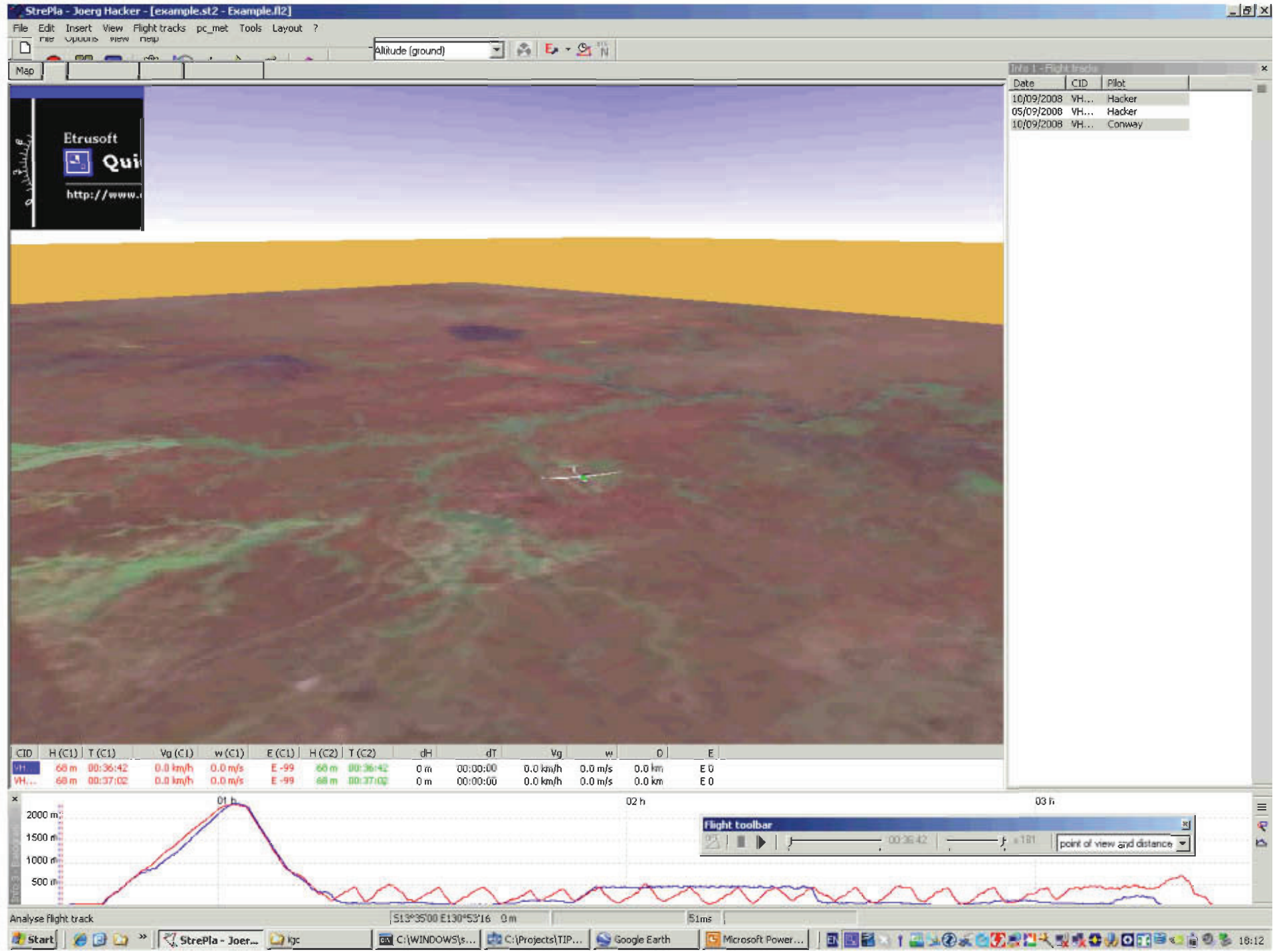



Cm in 10umol/m2/s

ndvi

# Budget Circles


StrePla - Joerg Hacker - [example.st2 - Example.fl2]
File Edit Insert View Flight tracks pc_met Tools Layout ?
Altitude (ground)
Map
Etrusoft
Quick Screen Recorder
http://www.etrusoft.com/screen-recorder/
Press the Stop Button to stop recording
Info 1 - Flight tracks
Date CID Pilot
10/09/2008 VH... Hacker
05/09/2008 VH... Hacker
10/09/2008 VH... Conway
01 h
02 h
03 h
2000 m
1500 m
1000 m
500 m
Flight toolbar
Analyse flight track
Start
StrePla - Joer...
igc
C:\WINDOWS\s...
C:\Projects\TIP...
Google Earth
Microsoft Power...
16:10

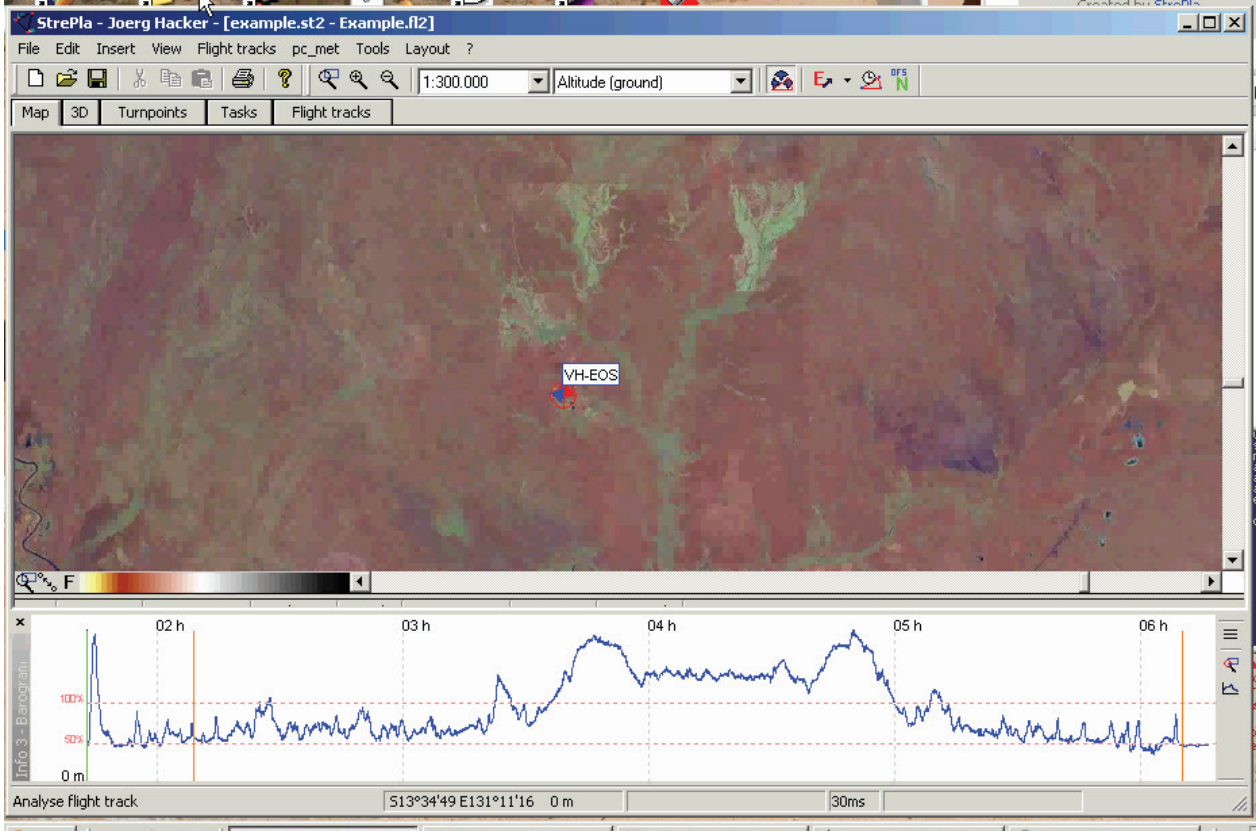

StrePla - Joerg Hacker - [example.st2 - Example.fl2]
File Edit Insert View Flight tracks pc_met Tools Layout ?
Altitude (ground)
Map
Etrusoft
http://www.
Info 1 - Flight tracks
Date CID Pilot
10/09/2008 VH... Hacker
05/09/2008 VH... Hacker
10/09/2008 VH... Conway
CID H (C1) T (C1) Vg (C1) w (C1) E (C1) H (C2) T (C2) dH dT Vg w D E
VH... 68 m 00:36:42 0.0 km/h 0.0 m/s E -99 68 m 00:36:42 0 m 00:00:00 0.0 km/h 0.0 m/s 0.0 km E 0
VH... 68 m 00:37:02 0.0 km/h 0.0 m/s E -99 68 m 00:37:02 0 m 00:00:00 0.0 km/h 0.0 m/s 0.0 km E 0
01 h
02 h
03 h
2000 m
1500 m
1000 m
500 m
Flight toolbar
00:36:42
x 181
point of view and distance
Analyse flight track
S13°35'00 E130°53'16 0 m
51ms
Start
StrePla - Joer...
igc
C:\WINDOWS\s...
C:\Projects\TIP...
Google Earth
Microsoft Power...
16:12

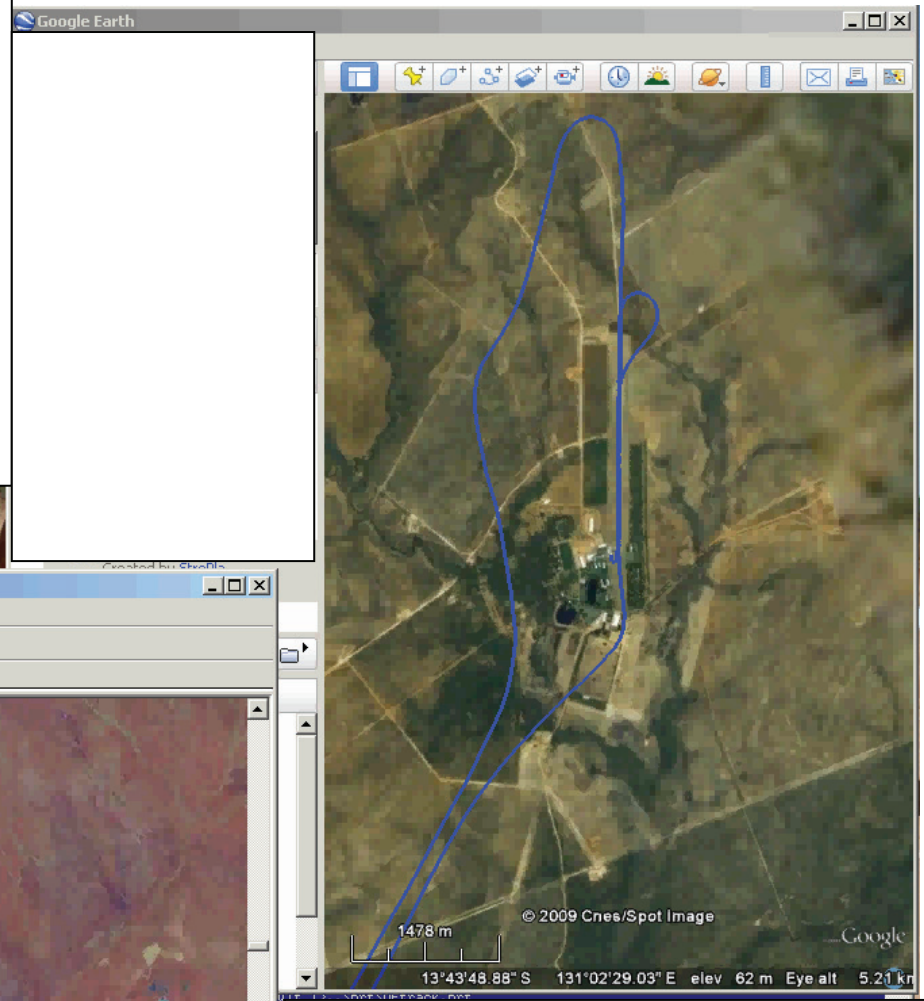
# “Re-flying” the patterns

“Re-flying” the pattern using a combination of:

- Google Earth and
- StrePla (gliding software) –
  to be modified to display measured and derived parameters,
  such as fluxes (currently only showing altitude);
  also use lidar/tri-spectral/hyper-spectral/other
  as background maps

Non-aircraft-derived parameters could also be included

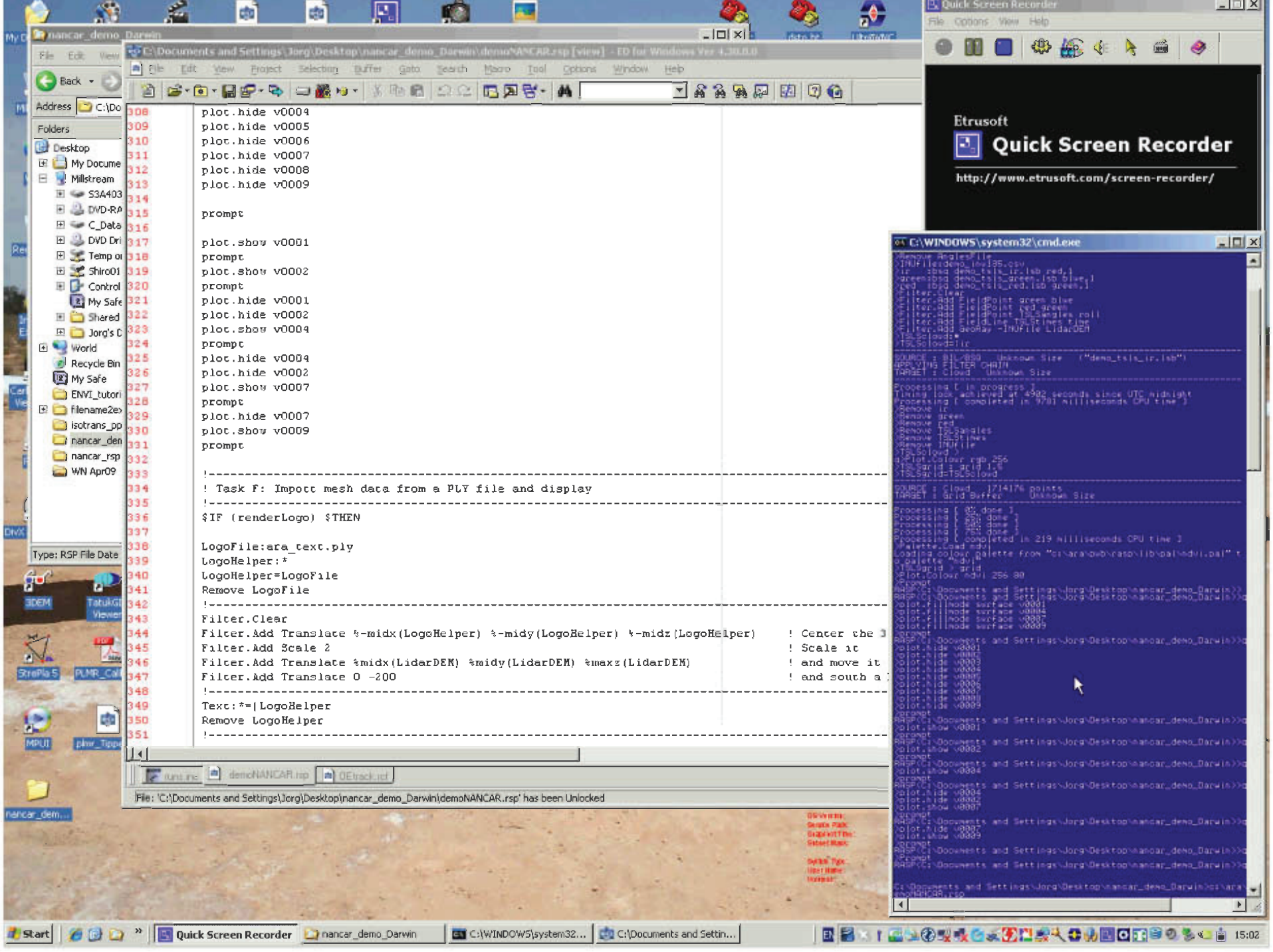



# RASP

**Data from less than 5 mins of flight in Sep 09 over the Daly River:**

- **wLIDAR**
- **Tri-spectral scanner**
- **hyper-spectral scanner**
- **hi-res digital photography**


plot.hide v0004
plot.hide v0005
plot.hide v0006
plot.hide v0007
plot.hide v0008
plot.hide v0009
prompt
plot.show v0001
prompt
plot.show v0002
prompt
plot.hide v0001
plot.hide v0002
plot.show v0004
prompt
plot.hide v0004
plot.hide v0002
plot.show v0007
prompt
plot.hide v0007
plot.show v0009
prompt
! Task F: Import mesh data from a PLY file and display
$IF (renderLogo) $THEN
LogoFile:ara_text.ply
LogoHelper:*
LogoHelper=LogoFile
Remove LogoFile
Filter.Clear
Filter.Add Translate %-midx(LogoHelper) %-midy(LogoHelper) %-midz(LogoHelper)
Filter.Add Scale 2
Filter.Add Translate %midx(LidarDEM) %midy(LidarDEM) %maxz(LidarDEM)
Filter.Add Translate 0 -200
Text:*=|LogoHelper
Remove LogoHelper
Etrusoft
Quick Screen Recorder
http://www.etrusoft.com/screen-recorder/
C:\WINDOWS\system32\cmd.exe
Start
Quick Screen Recorder
nancar_demo_Darwin
C:\WINDOWS\system32...
C:\Documents and Settin...
15:02

# RASP

**Open Source**

**Written in Free Pascal**

**Runs under Windows, Linux, MacOS, others**

**Paired with ARA's two other opens source packages (RAMF/R12 and PPREP)**
**It offers a totally integrated system to process and combine all ARA aircraft data**
**To a stage, where "scientific" processing can start (and beyond)**

**Batch/script-driven**
**Rudimentary GUI**

# Conclusions

- Aircraft-derived flux measurements are very different to tower-based ones
- need to inspect every transect and make subjective decision about validity
- there is no “standard” method to compute fluxes
- needs to be tied to landscape parameters – visualisation essential – interactive process

- great potential to study “convective processes in the landscape”
- no other flux tool can do that
- especially in combination with other measurements derived simultaneously
    - laser altimeter; lidar; tri/hyper-spectral scanners; micro-wave scanners
    - complex processing – no standards available

- change of turbulence structure depending on landscape parameters

In summary: There is a lot more that **CAN** be done with this data than is being done !!