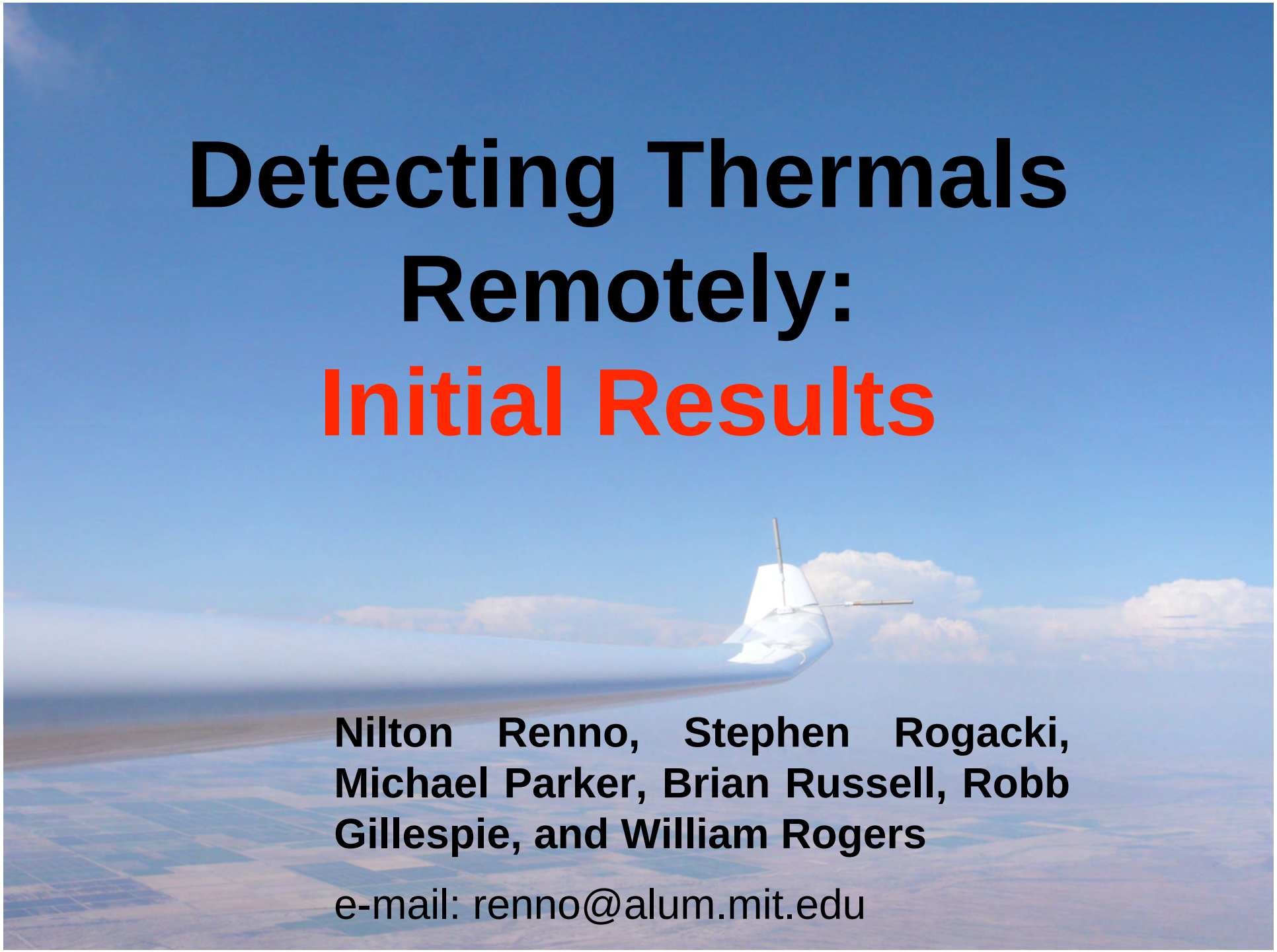

Detecting Thermals Remotely:
Initial Results

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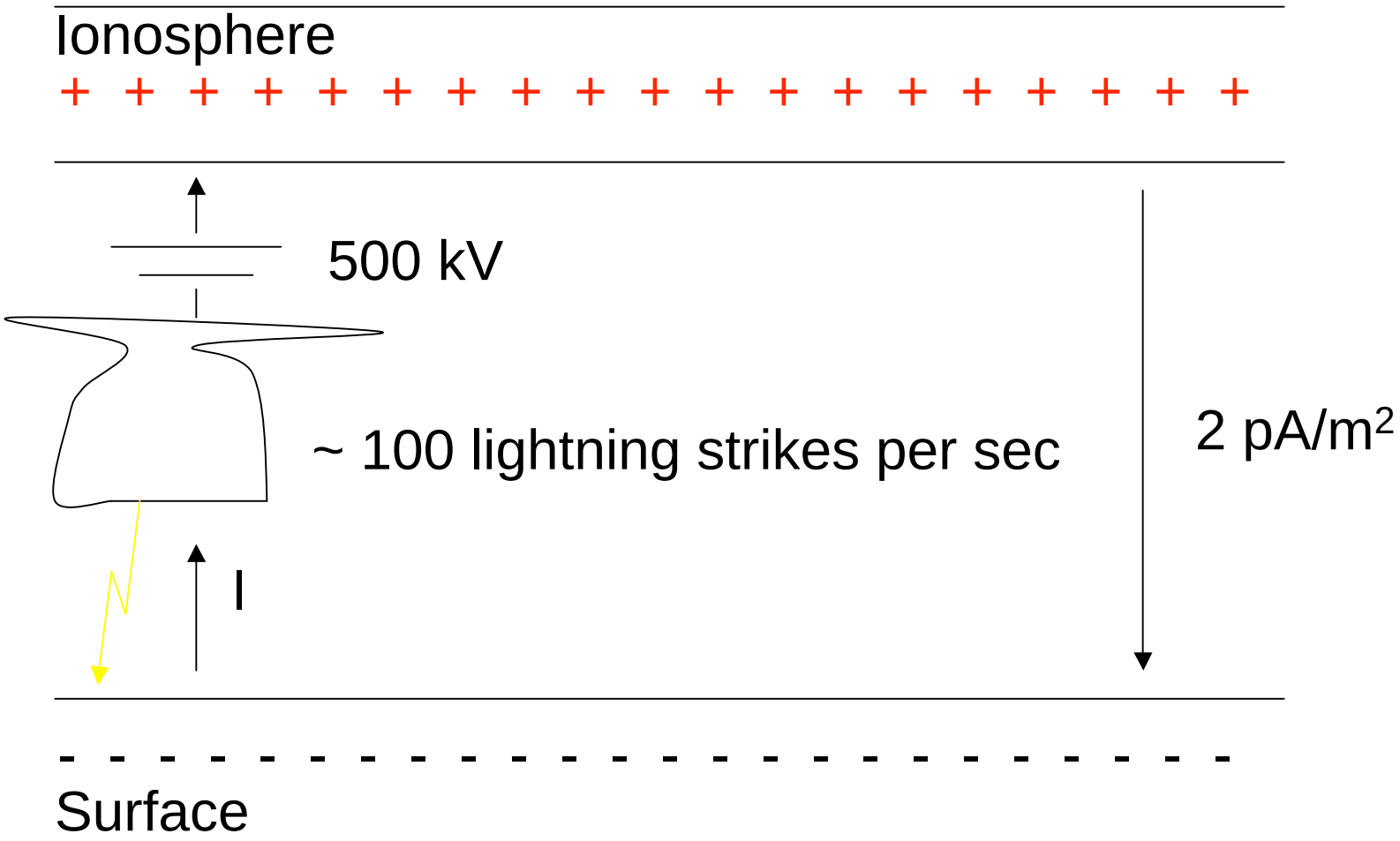
Outline

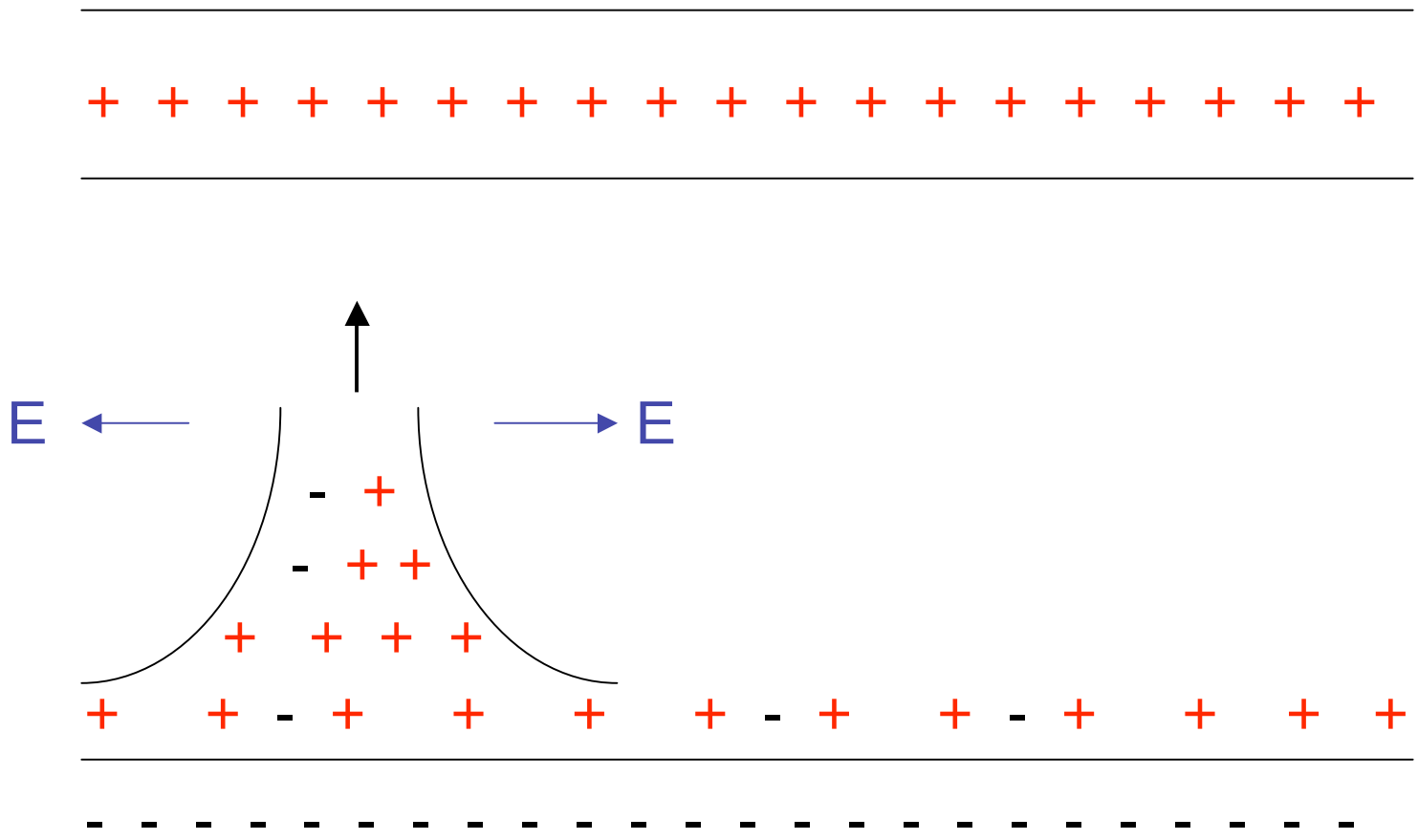
- **Fair weather electric fields**
  - The global electric circuit
  - Electric field in thermals
    - Previous investigations
    - Theoretical predictions
- **Our new electric field sensor**
- **Measurements**
  - From the ground
  - Airborne
- **Conclusions**


Fair weather
electric fields

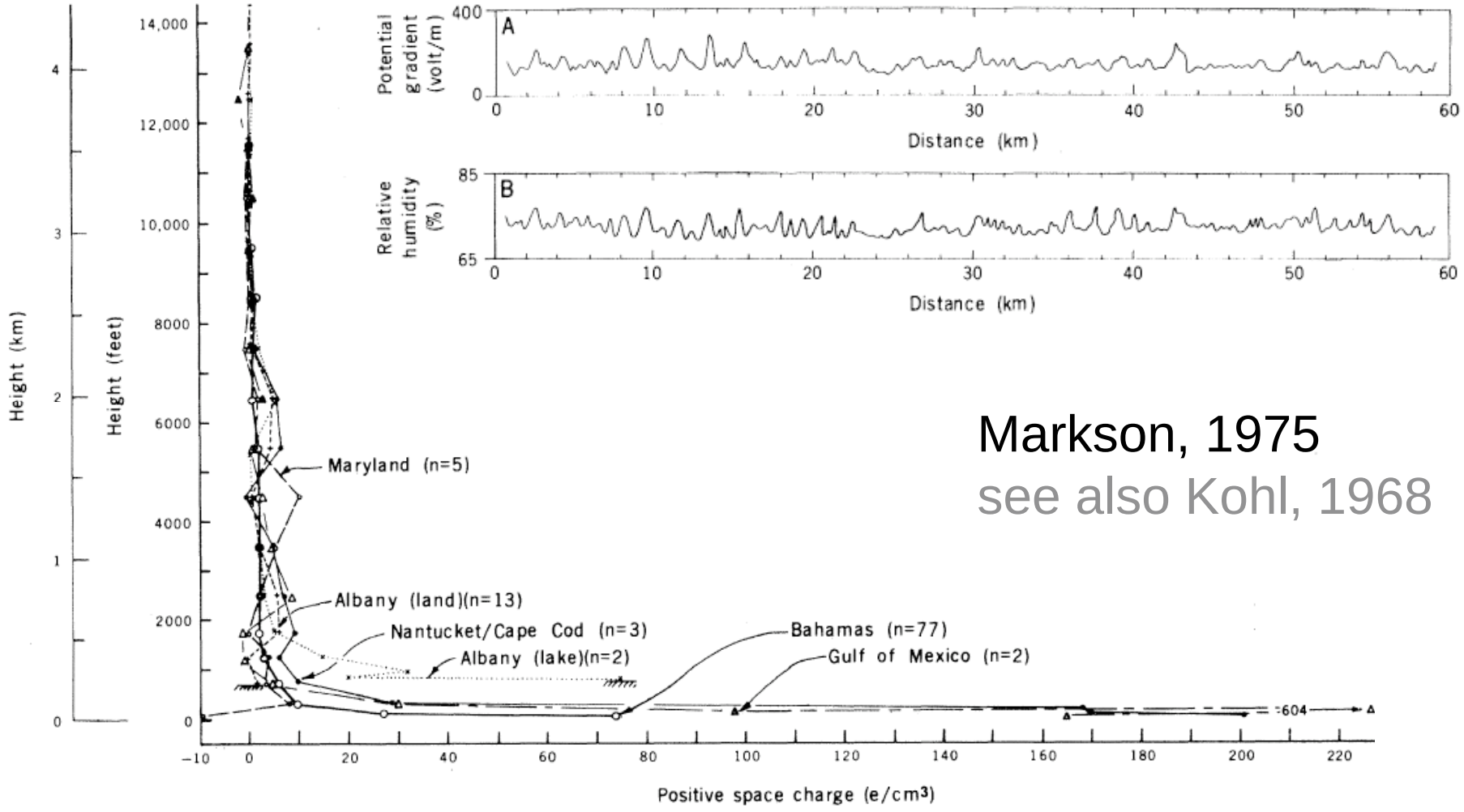
The global electric circuit



Electric fields in thermals



Results of previous investigations



Markson, 1975

see also Kohl, 1968

Theoretical predictions

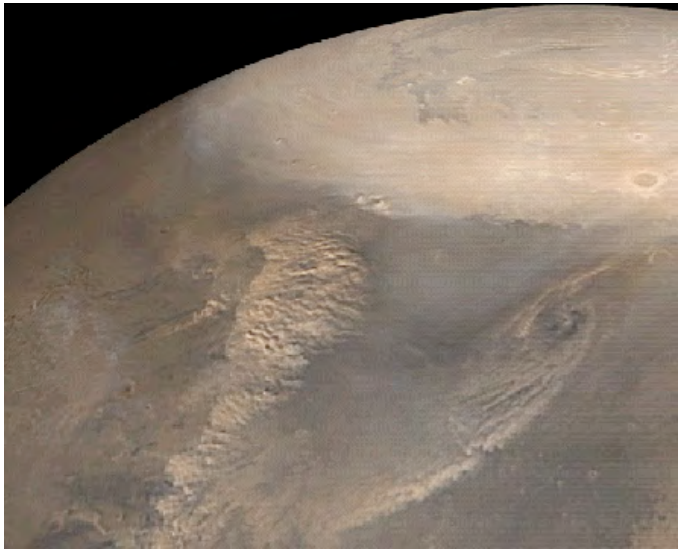
- **Assuming that thermals are uniformly charged (**-100 e/cm^3**), infinitely long cylinders** of ~100 m of radius, we get

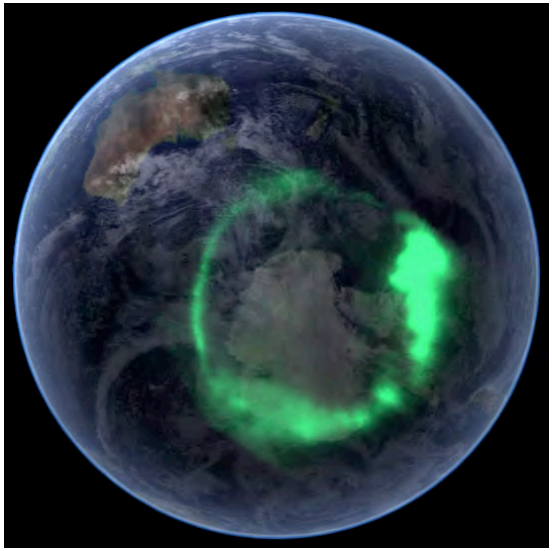
$$E \approx \frac{10^4}{d} \frac{\mathrm{V}}{\mathrm{m}}$$

where *d* is the distance from the thermal (in m).

- **Thus, the electric field at 1 km from the thermal is ~10 V/m.**

Our new electric field sensor

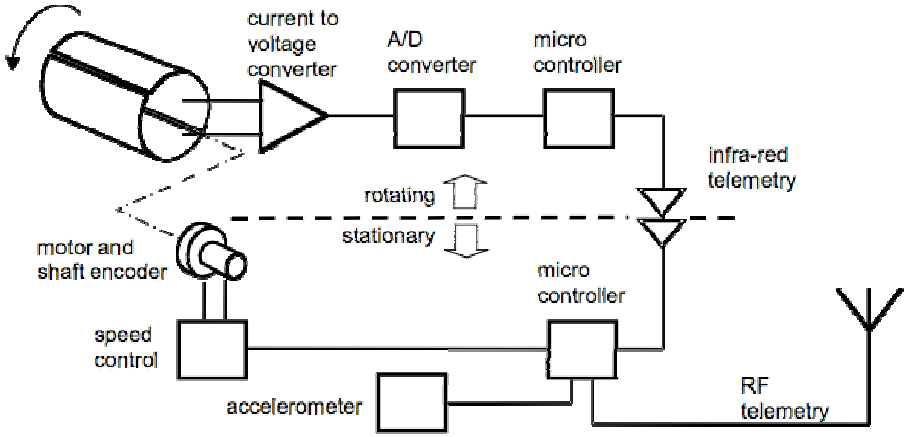


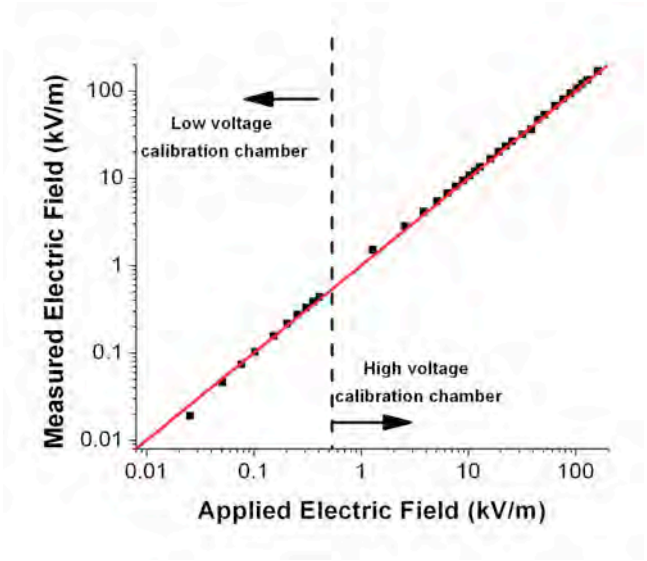


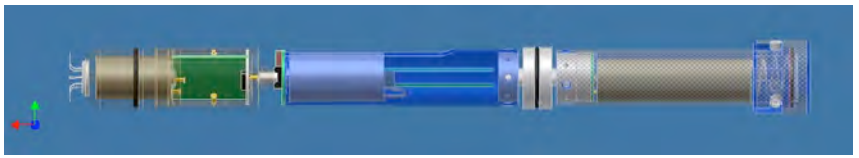
Requirements

- **To distinguish the ambient space field from the effects of charged particles colliding with the sensor**
  - Vary the rotation rate during measurements (Maruvada *et al.* 1983)
  - Add sharp points to limit the sensor potential
- **To measure the electric fields ~ 1 cm from the surface**
  - Instrument diameter ~ 1 cm

Our sensor (patent pending)







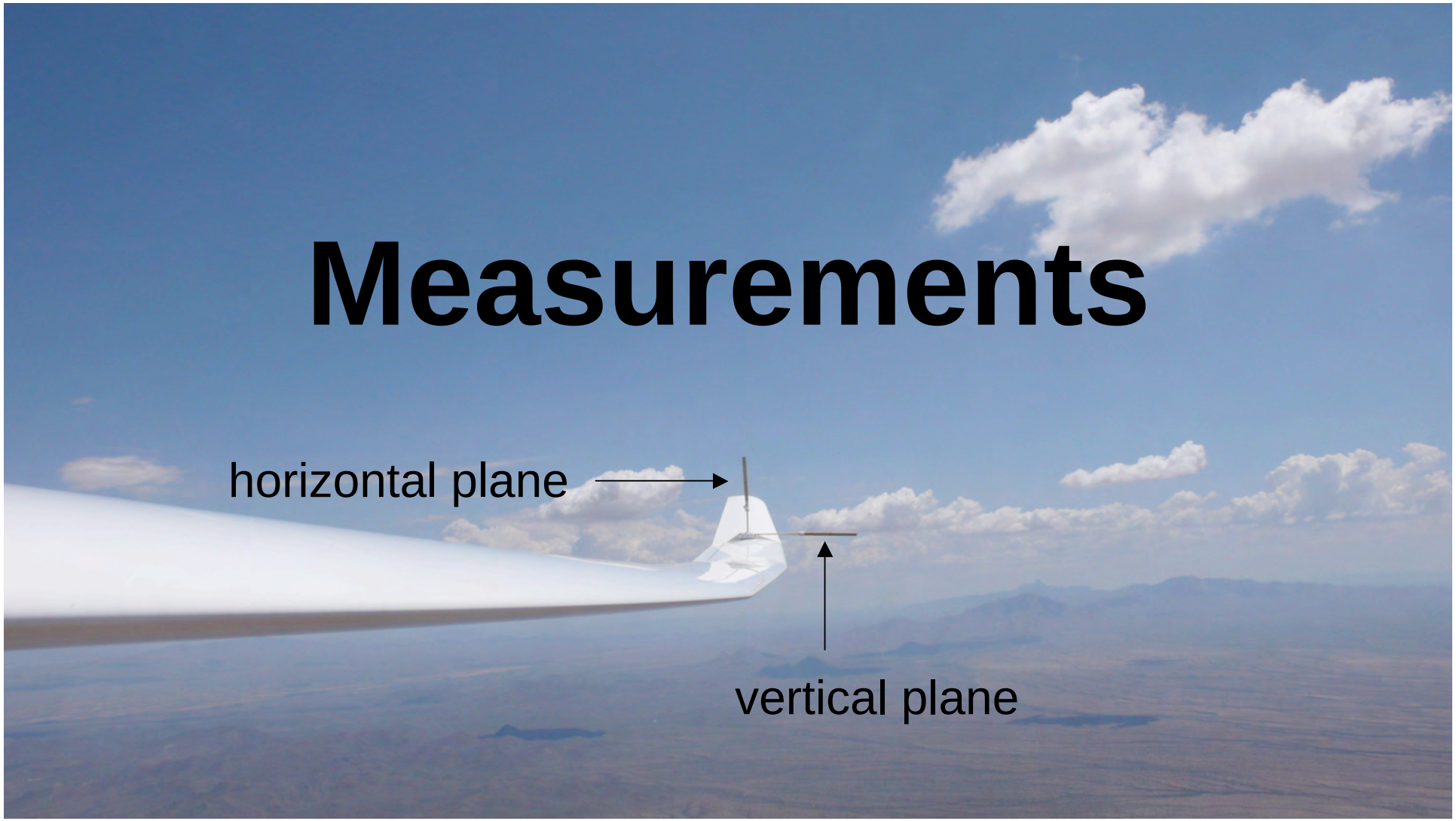
Sensor characteristics

- DC to > 10 Hz
- Range: 1 to 10^6 V/m
- Resolution: 1 V/m
- 2-d vector field (plane of rotation)

- A version of the sensor for gliders might be developed
  - The idea of installing it inside a winglet or the fin might be studied

Installation on EP

Measurements



relative to the glider

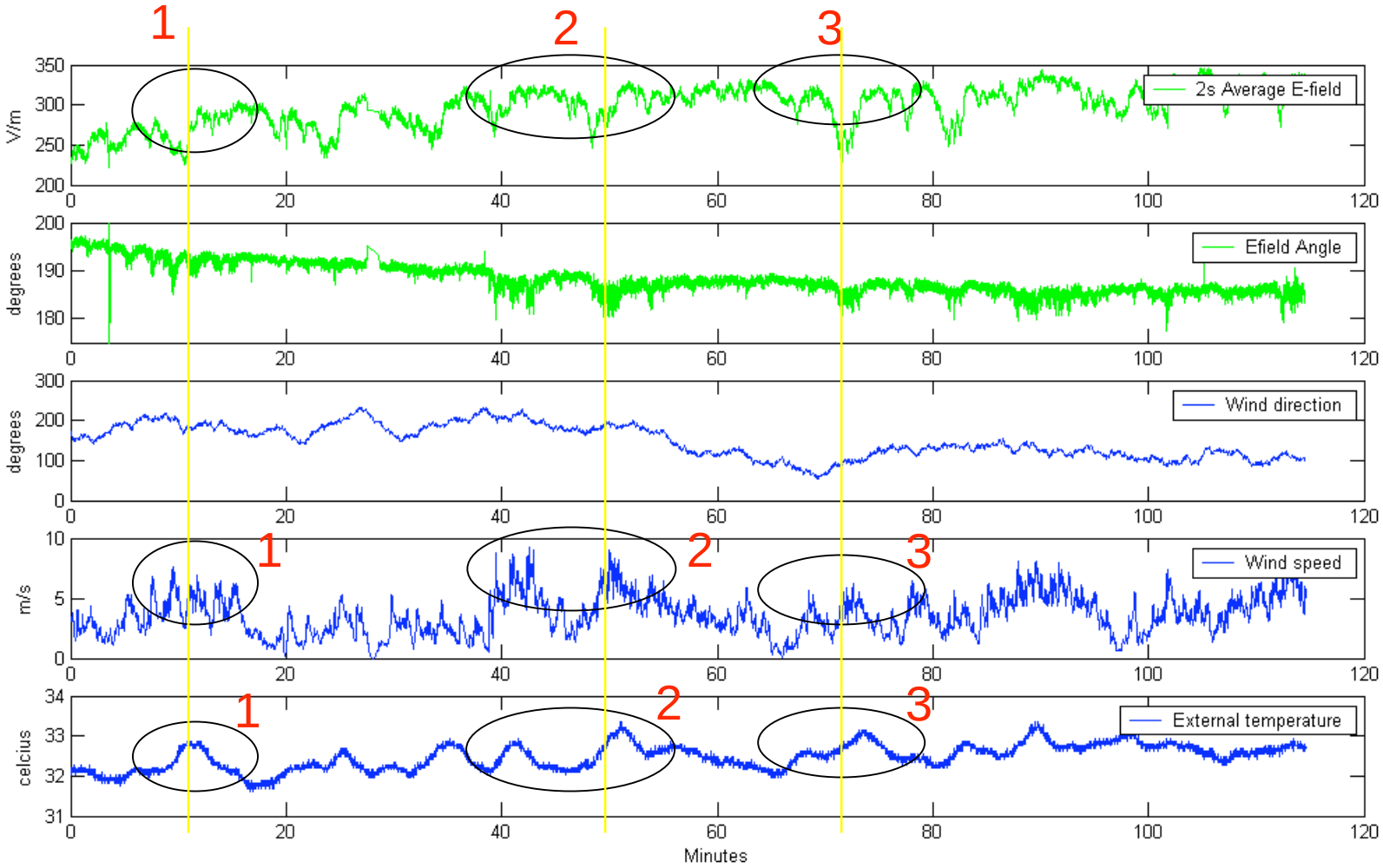
Measurements at the ground

Ground Measurements

May 28, 2008

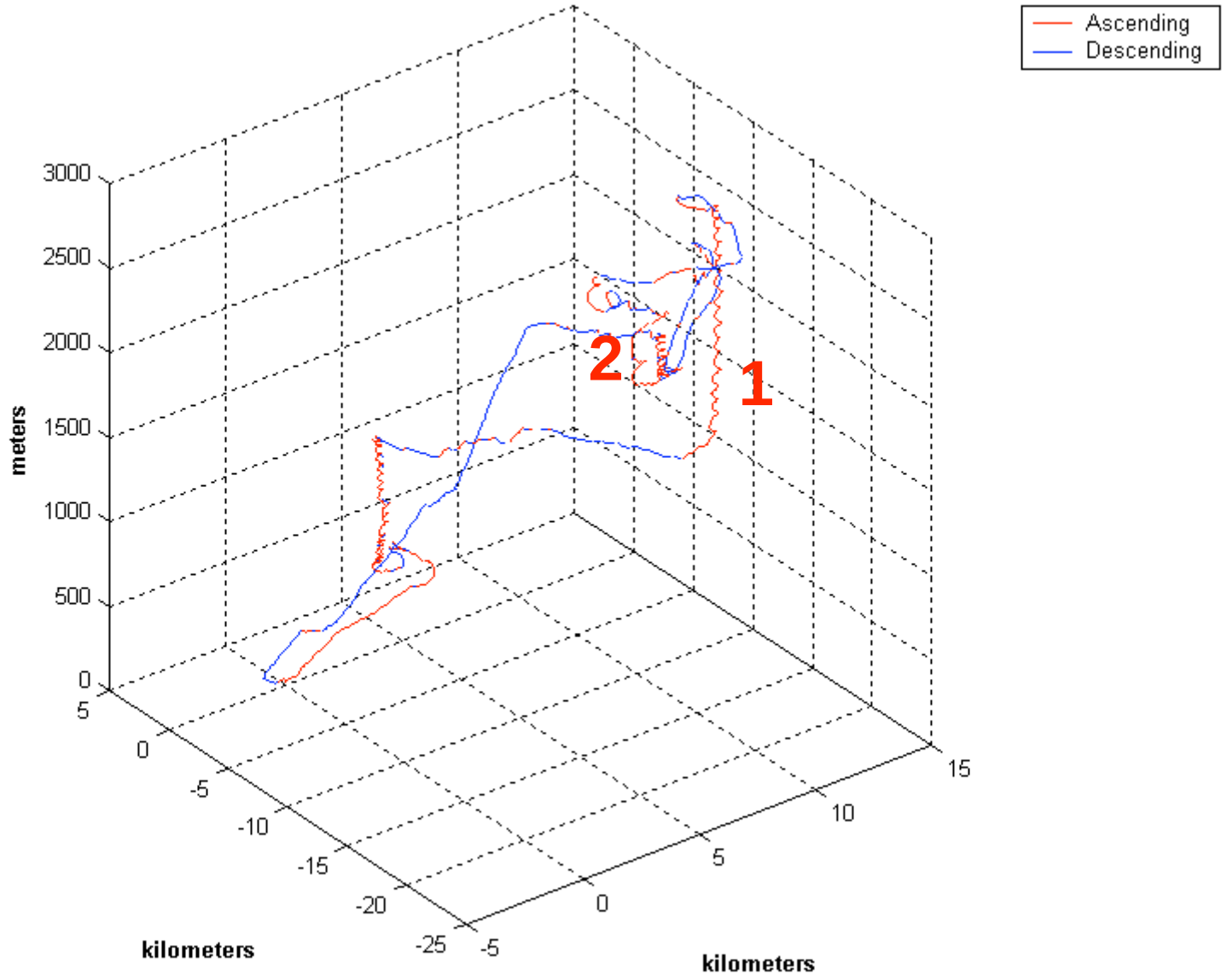
from 14:16:25 to 16:11:00 local time

Thermals selected for study

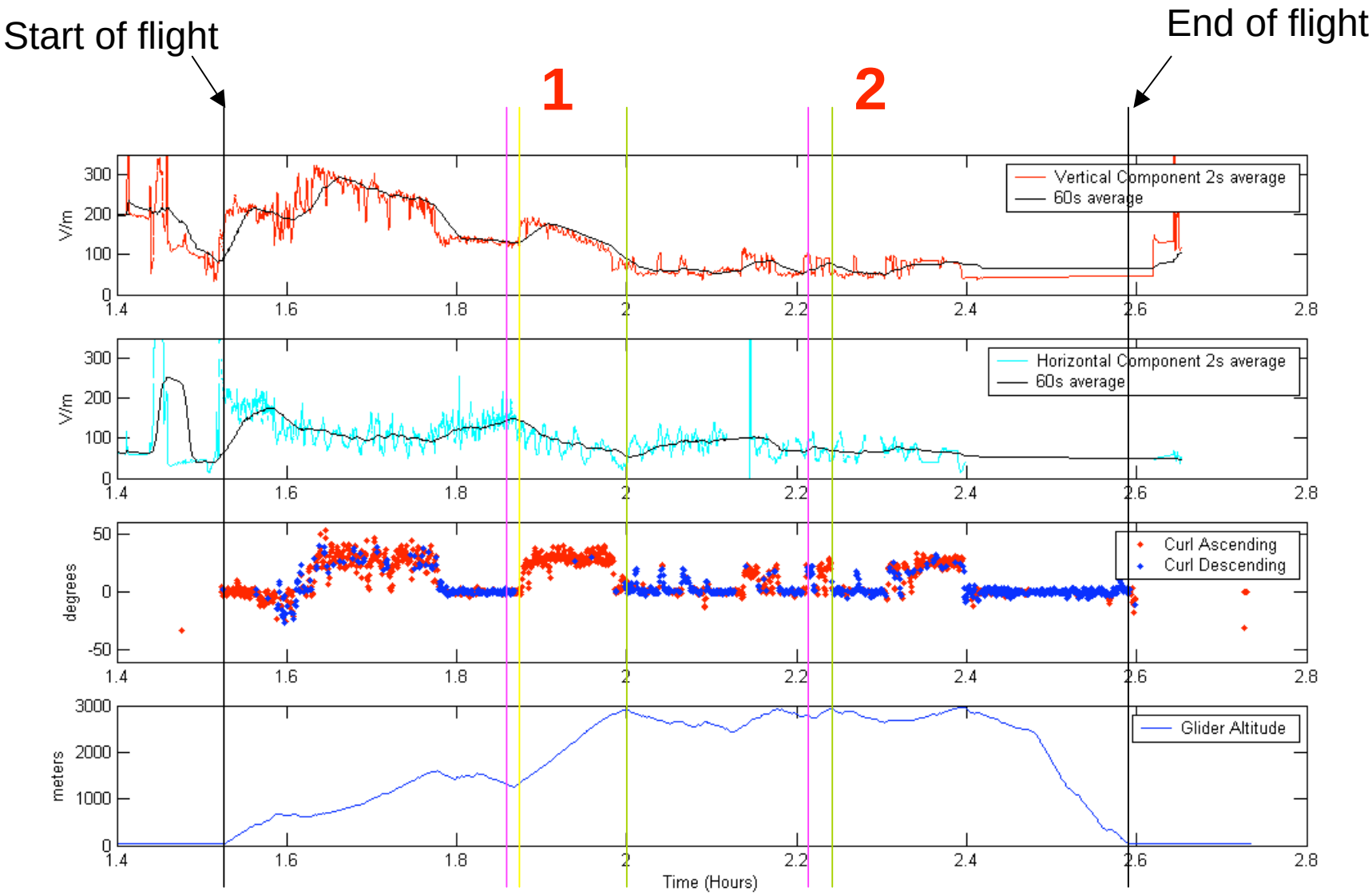


Flights at the TuSC in Arizona

Flight Path July 02, 2008

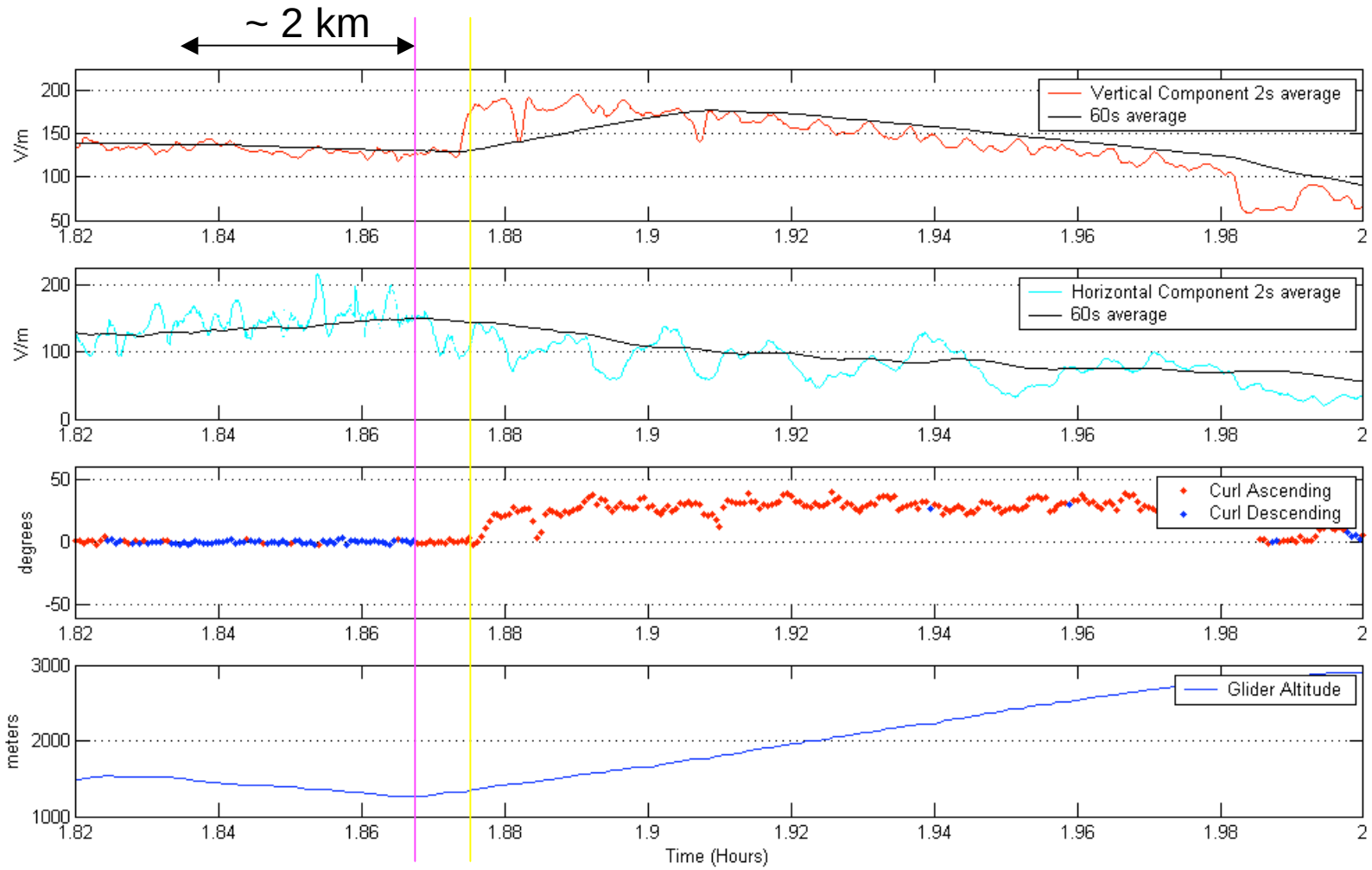


July 02, 2008


Start of flight
End of flight
1
2
Vertical Component 2s average
60s average
Horizontal Component 2s average
60s average
Curl Ascending
Curl Descending
Glider Altitude
V/m
degrees
meters
Time (Hours)

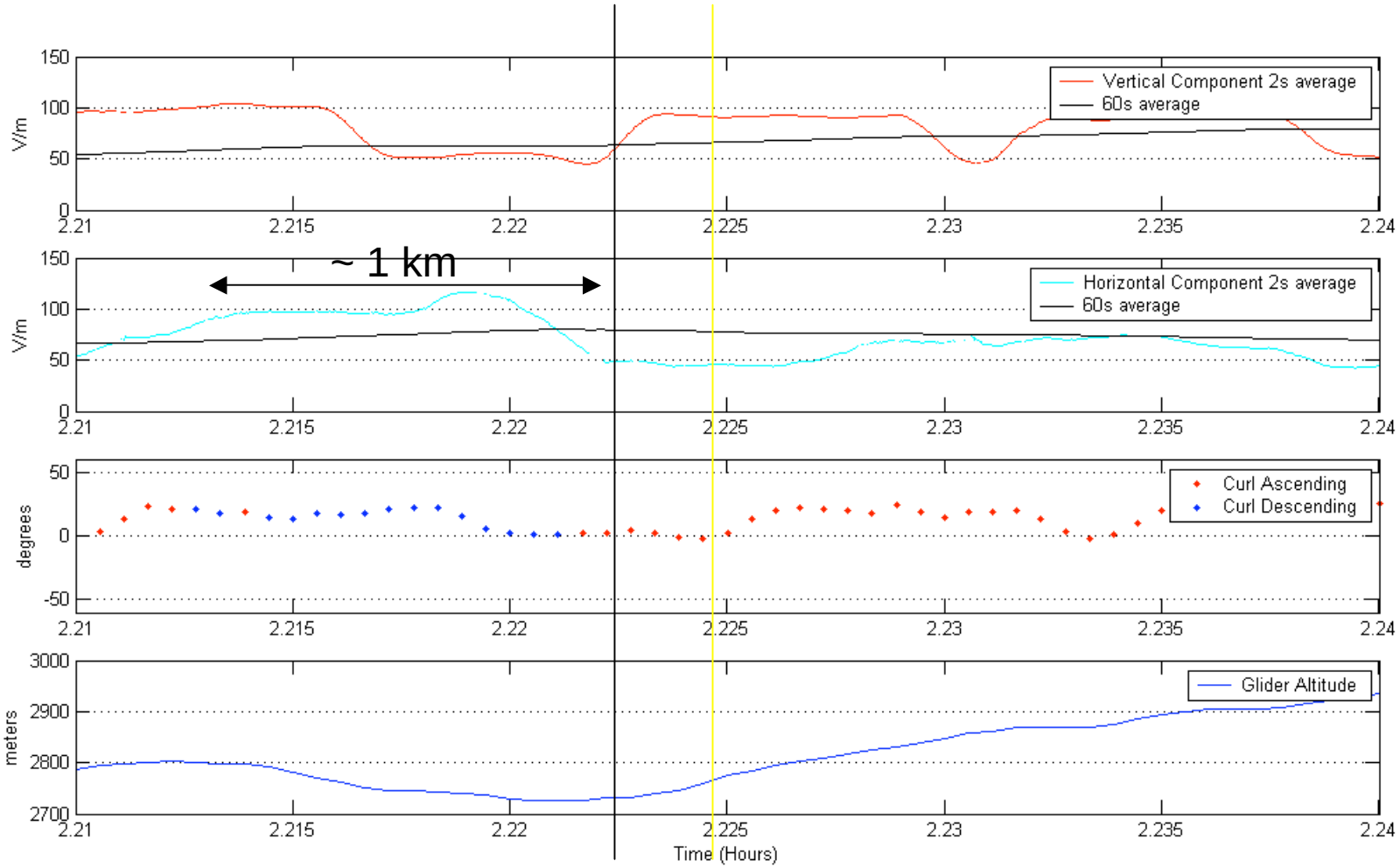
July 02, 2008

Thermal #1

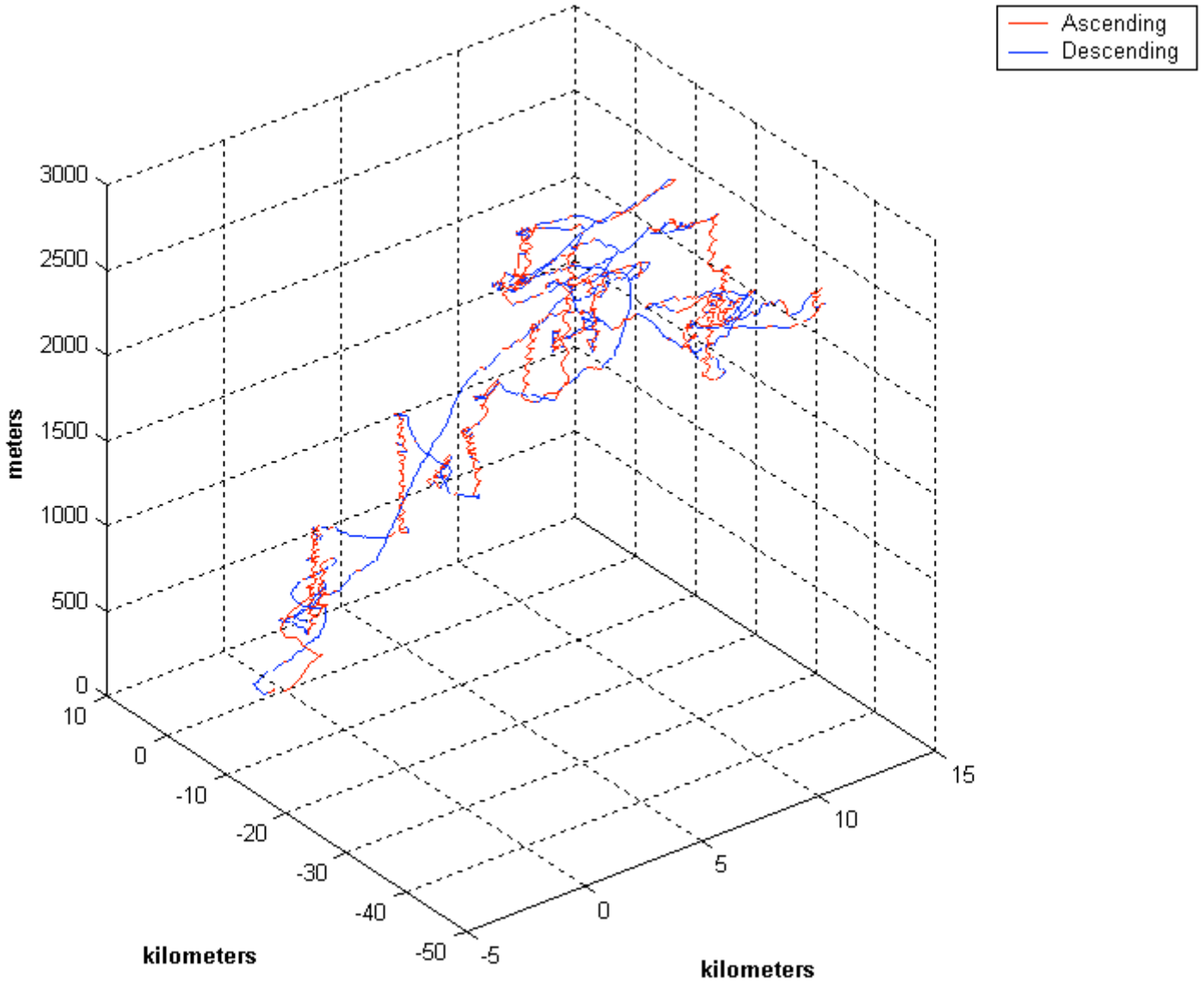


July 02, 2008

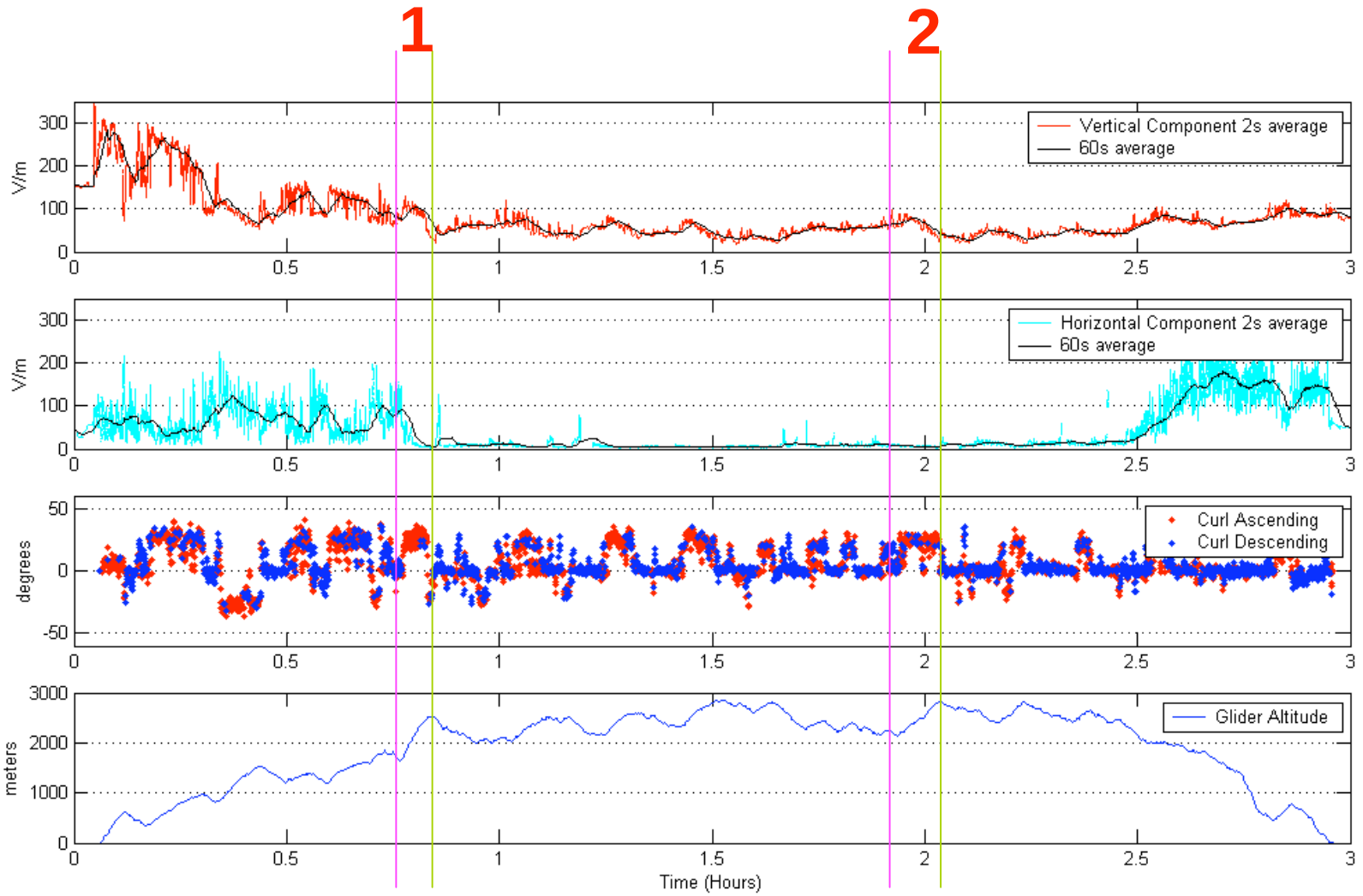
Thermal #2



Flight path July 04, 2008

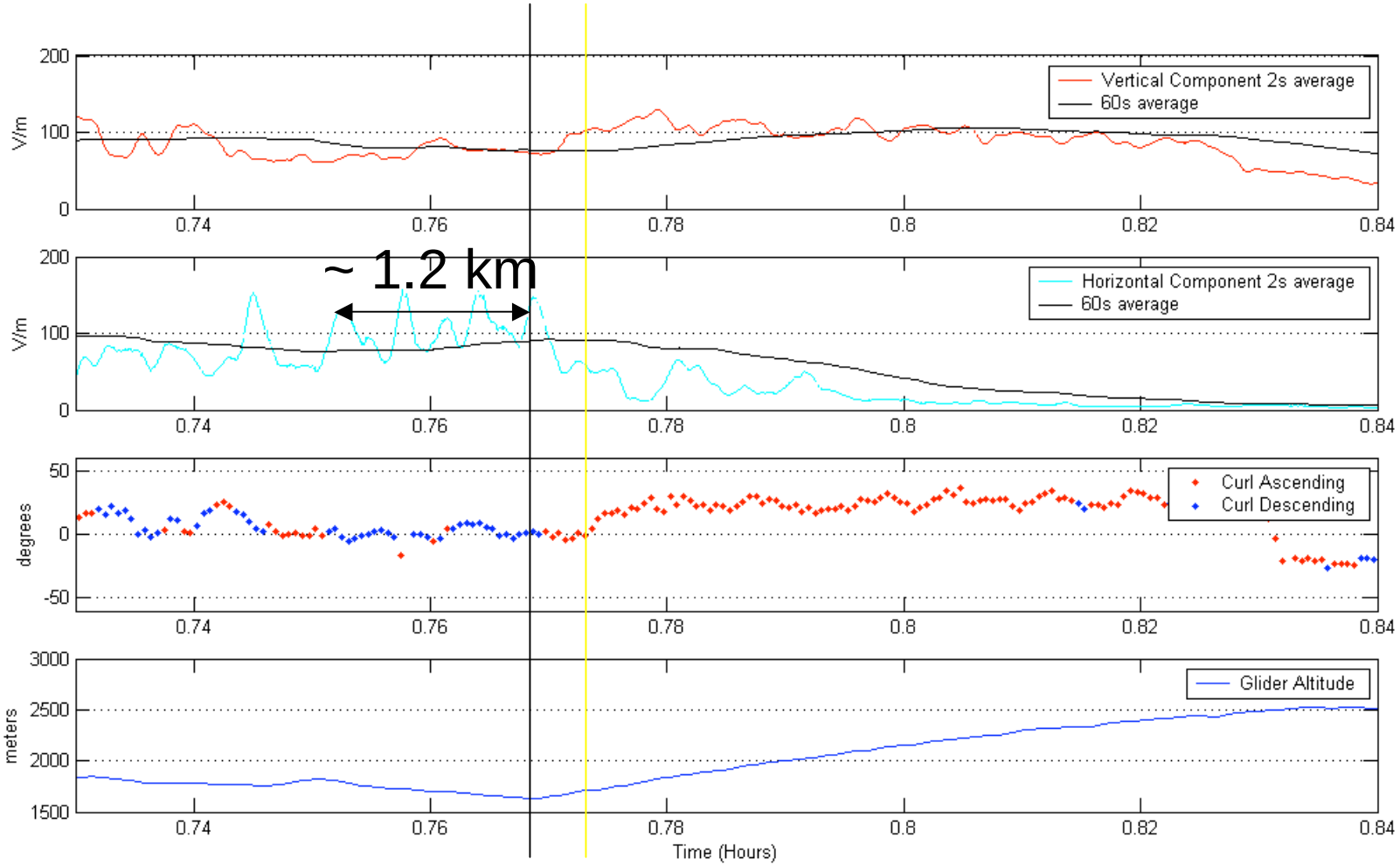


July 04, 2008


1
2
Vertical Component 2s average
60s average
V/m
Horizontal Component 2s average
60s average
V/m
Curl Ascending
Curl Descending
degrees
Glider Altitude
meters
Time (Hours)

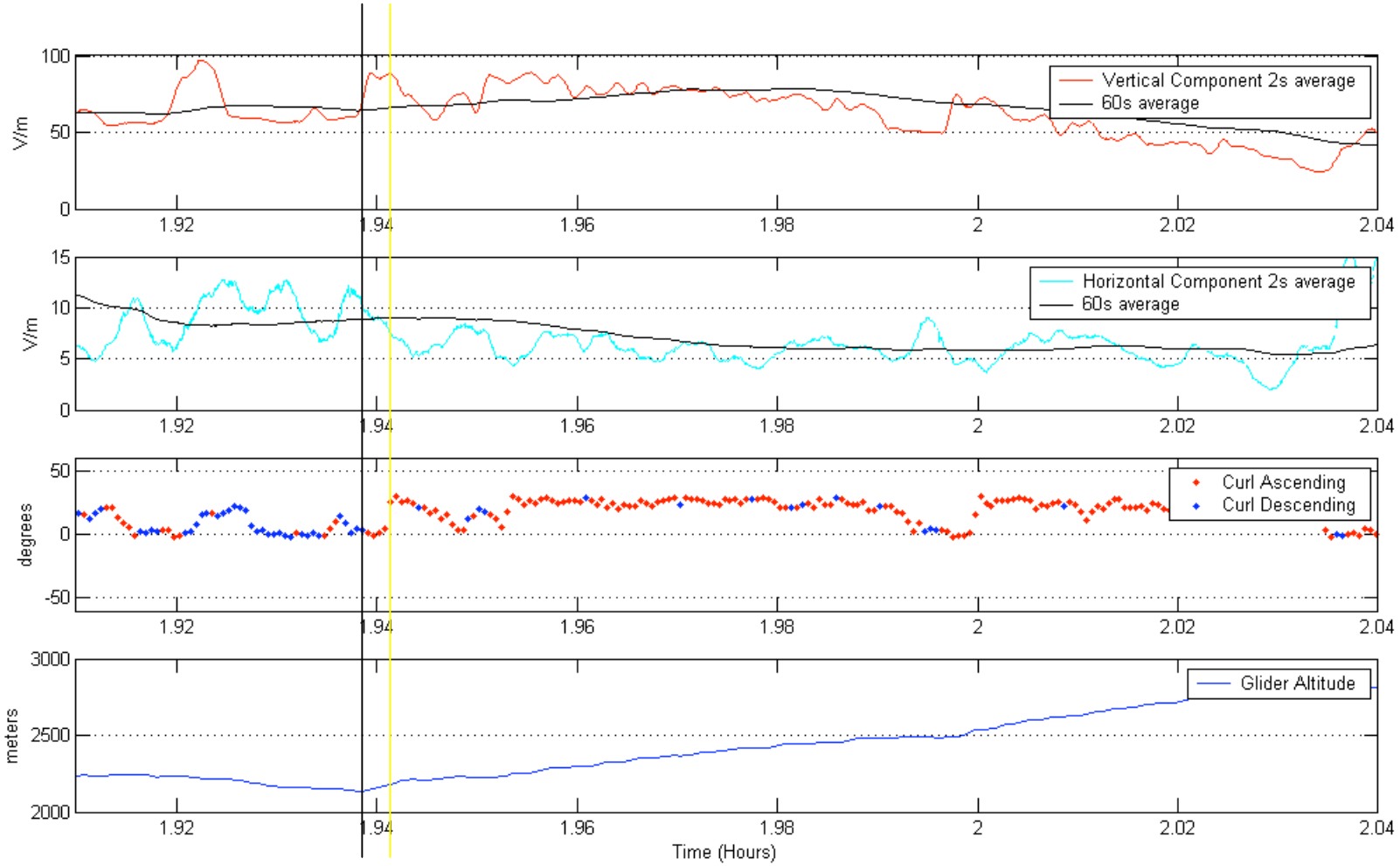
July 04, 2008

Thermal #1



July 04, 2008

Thermal #2




Conclusions

- **These were our first measurements**
  - There were problems with the direction of the e-field
  - The frame of reference was the glider
- **Theory and our initial measurements suggest that thermals can be detected remotely with a passive electric field sensor**
  - The signal is much larger than the sensitivity of the sensor
- **The 60 s average electric field increases steadily toward thermals**
  - The first derivative of the electric field might be a good indicator of the approach of a thermal
  - The direction of the local field might be a good indicator of the direction of the thermal

- **There are theoretical and observational indications that the electric field contain information about the nature (e.g., dust and moisture content) of the local air-mass**
  - It might contain information about regional circulations (shear lines, organization of thermals, sea breezes, etc)
  - This will be investigated

Plans for the future

- **Additional measurements will be conducted:**
  - In an inertial frame of reference
  - Including the direction of the electric field
  - In various regions and weather conditions
- **The position of the glider with respect to the thermals will be analyzed**
  - The idea of using the electric field to locate (find the direction) the thermals will be tested


Thanks!