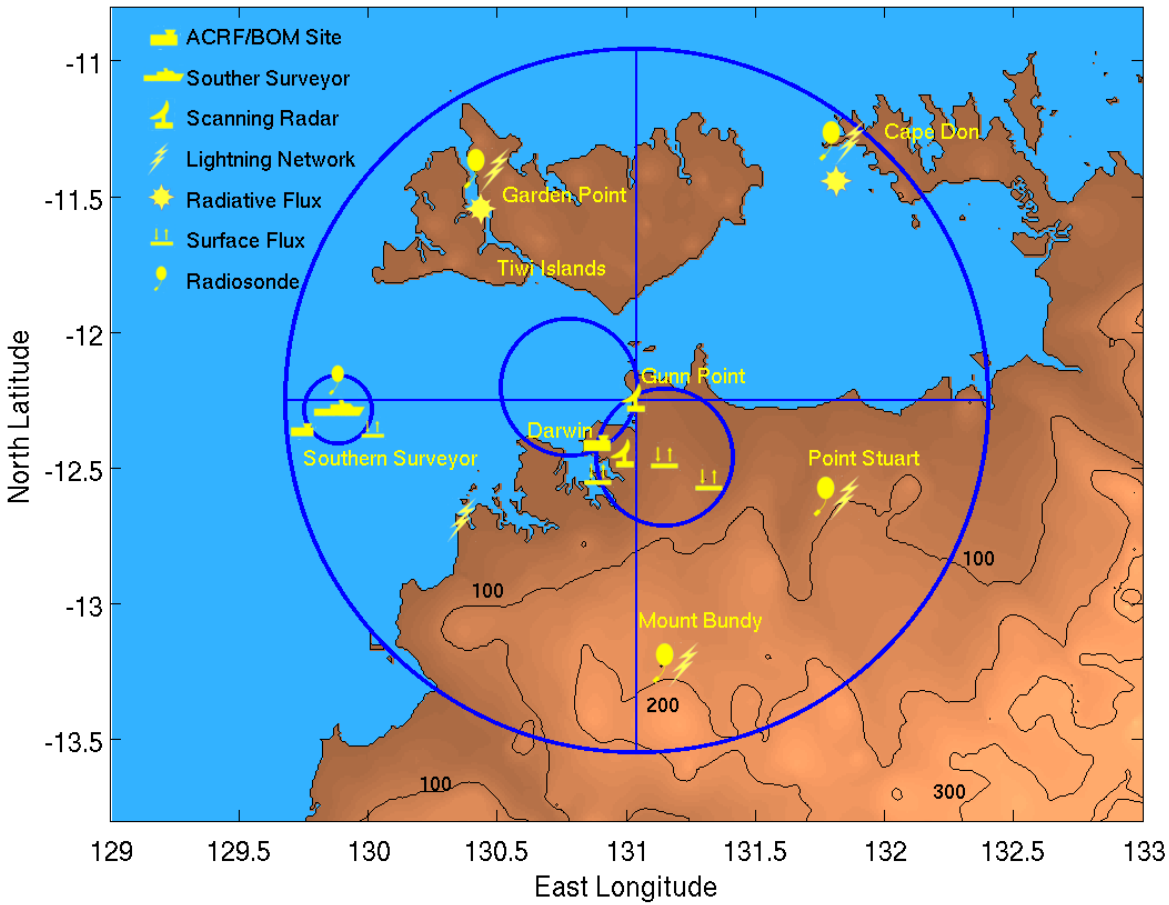
Challenges in measuring radiative flux profiles from an aircraft: The TWP-ICE experience



TWP-ICE
Experiment domain

Jim Mather
Pacific Northwest National Laboratory

Radiative Heating Profile Workshop
January 8-9, 2007

ARM-UAV/Proteus payload arrangement

Stable radiometer platform

Boom extension

Canard station, CIN

Iridium satellite phone

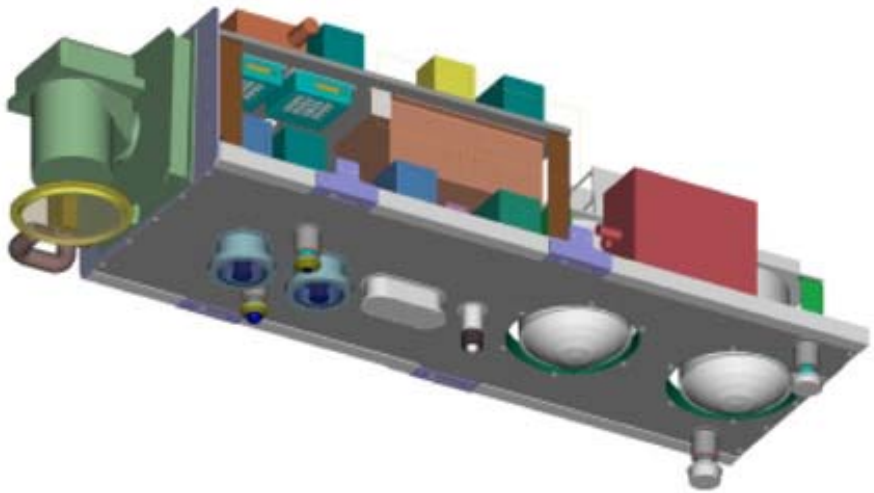
Canard station, CAPS

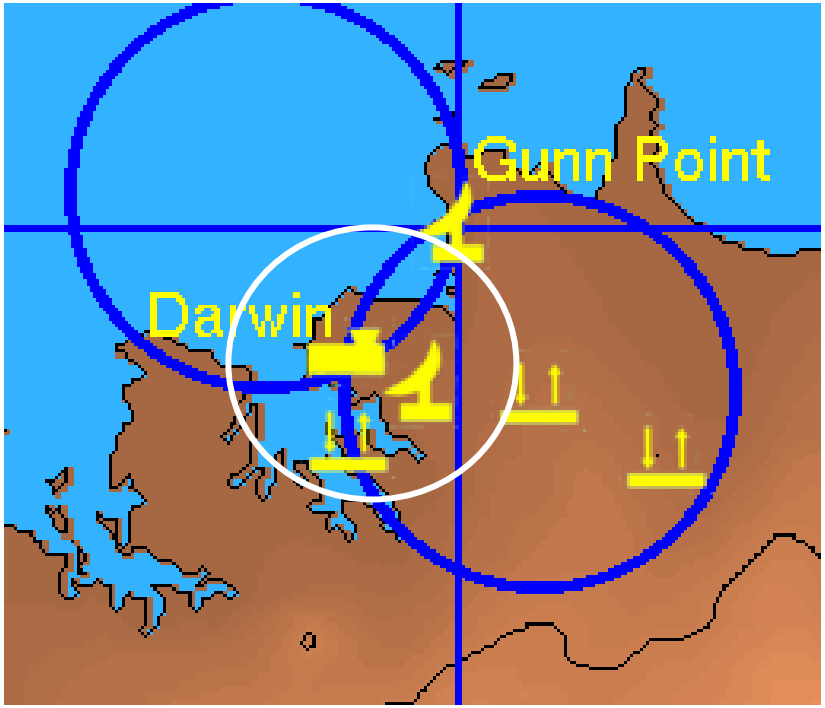
Payload pod

Iridium satellite data link

Proteus Payload - Remote Sensing

- **Broadband Radiometers Package** (BRP)
  - CM-22 pyranometers, 0.3 – 4um (zenith level, zenith fixed, nadir, nadir covered)
  - CG-4 pyrgeometers, 4 – 40u (zenith level, nadir, nadir covered)
- **Spectral Radiance Package** (SRP)
  - nadir mounted, NFOV
  - VIS 0.38-1 um, 2nm res,
  - A-Band 0.75-0.85 um, 0.07nm res
  - NIR 1.3-1.5 um, 2nm res
- **Solar Spectral Flux Radiometer** (SSFR)
  - nadir & zenith, hemispheric FOV
  - 300–1700 nm
- **The Diffuse Field Camera** (DFC)
  - VIS: 1300 x 1030 pixels x 12 bit, 645 nm cente
  - NIR: 320 X 256 pixels x 12 bit, 1610 nm cente
- **Scanning High-Resolution Interferometer S**
  - scanning interferometer, high spectral resolut
  - Spectral Coverage between 3.3 and 18.0 µm
- **Cloud Detection Lidar** (CDL)
  - 1.053 µm at 5 kHz, 48 µJ/pulse, nadir viewing
  - possibility of 2nd up-looking lidar mounted on boom extension for TWP-ICE
- **Infrared Thermometers** (IRTs)
  - Two upwelling IRT sensors, 2.5 deg NFOV
  - -100 C to 100 C; 8 to 10 µm; 9.6 to 11.5 µm



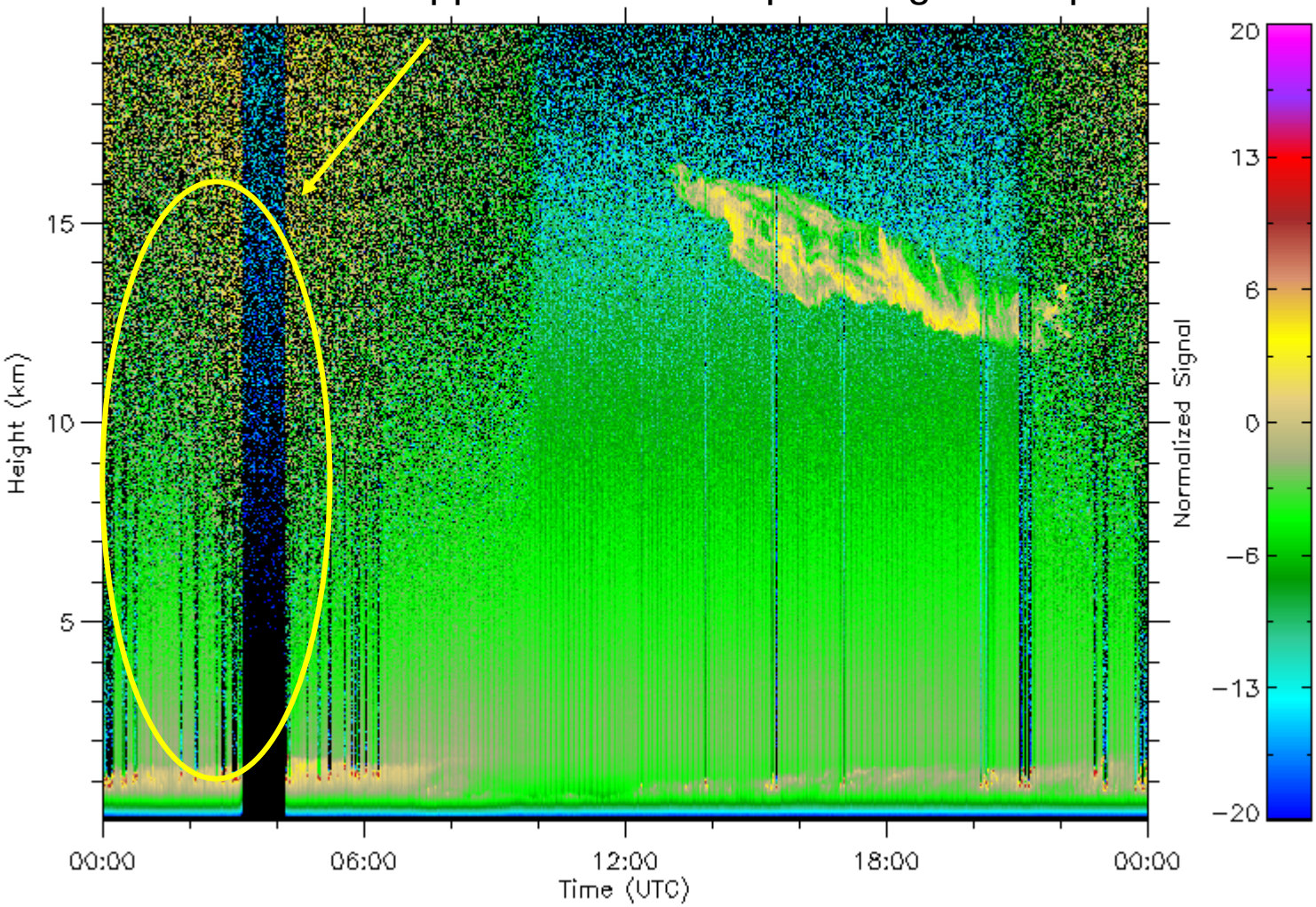


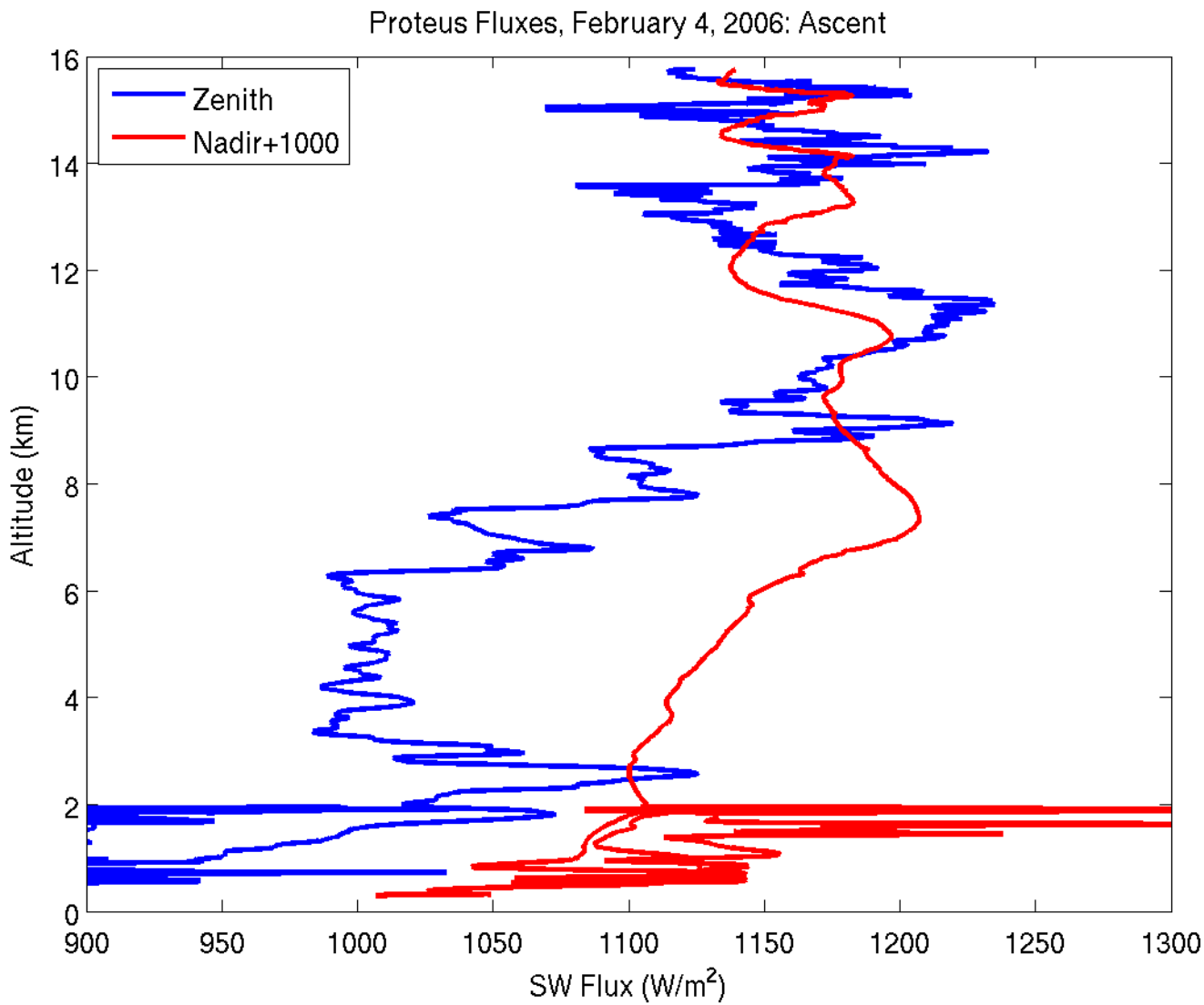
Vertical spiral on February 4, 2006 over Darwin ARM site.

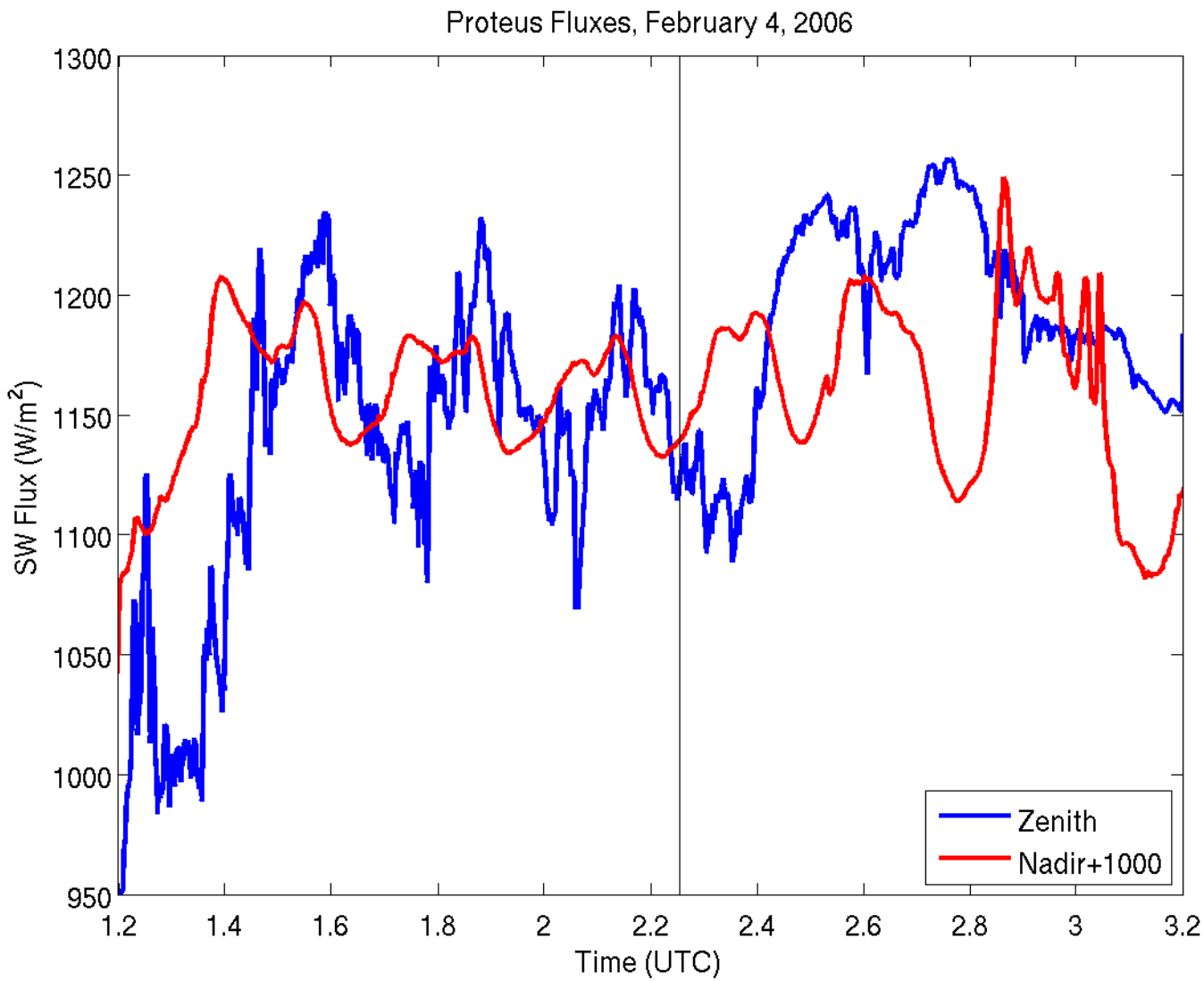
“Clear” sky conditions in support of carbon mission.

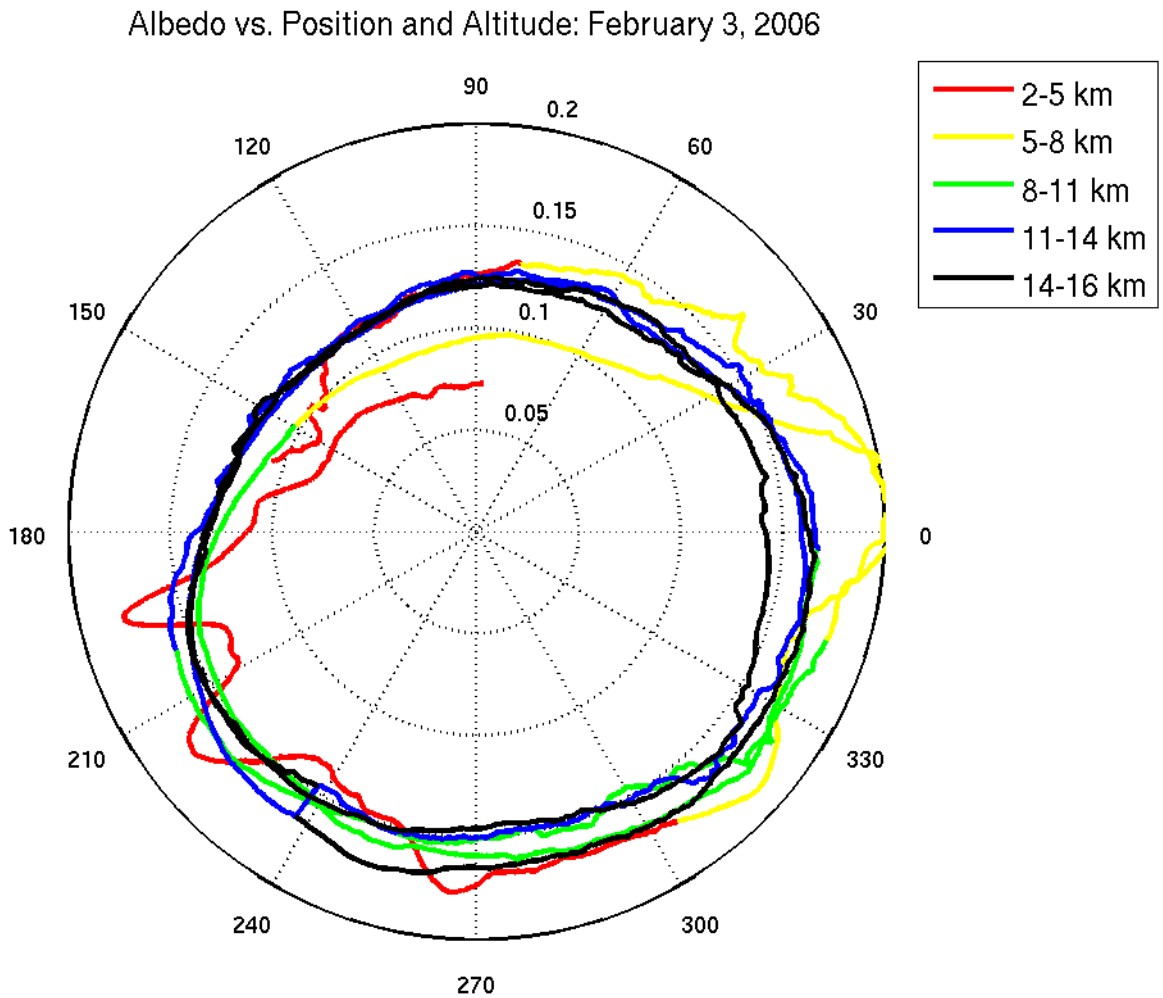
TWP C3 MicroPulse Lidar Observations, 04 February 2006
twpmplC3.a1

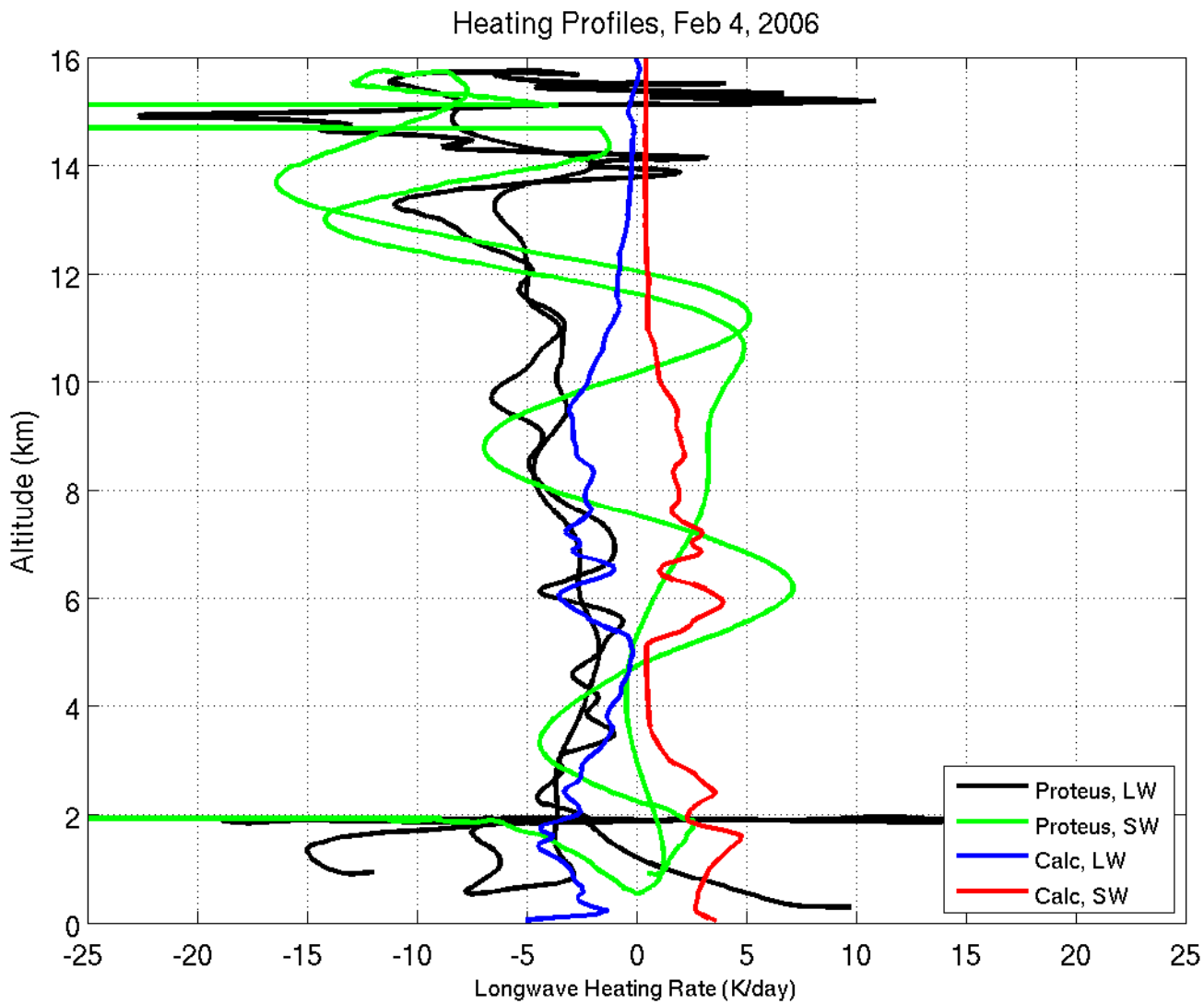
Approximate time/space region of spiral

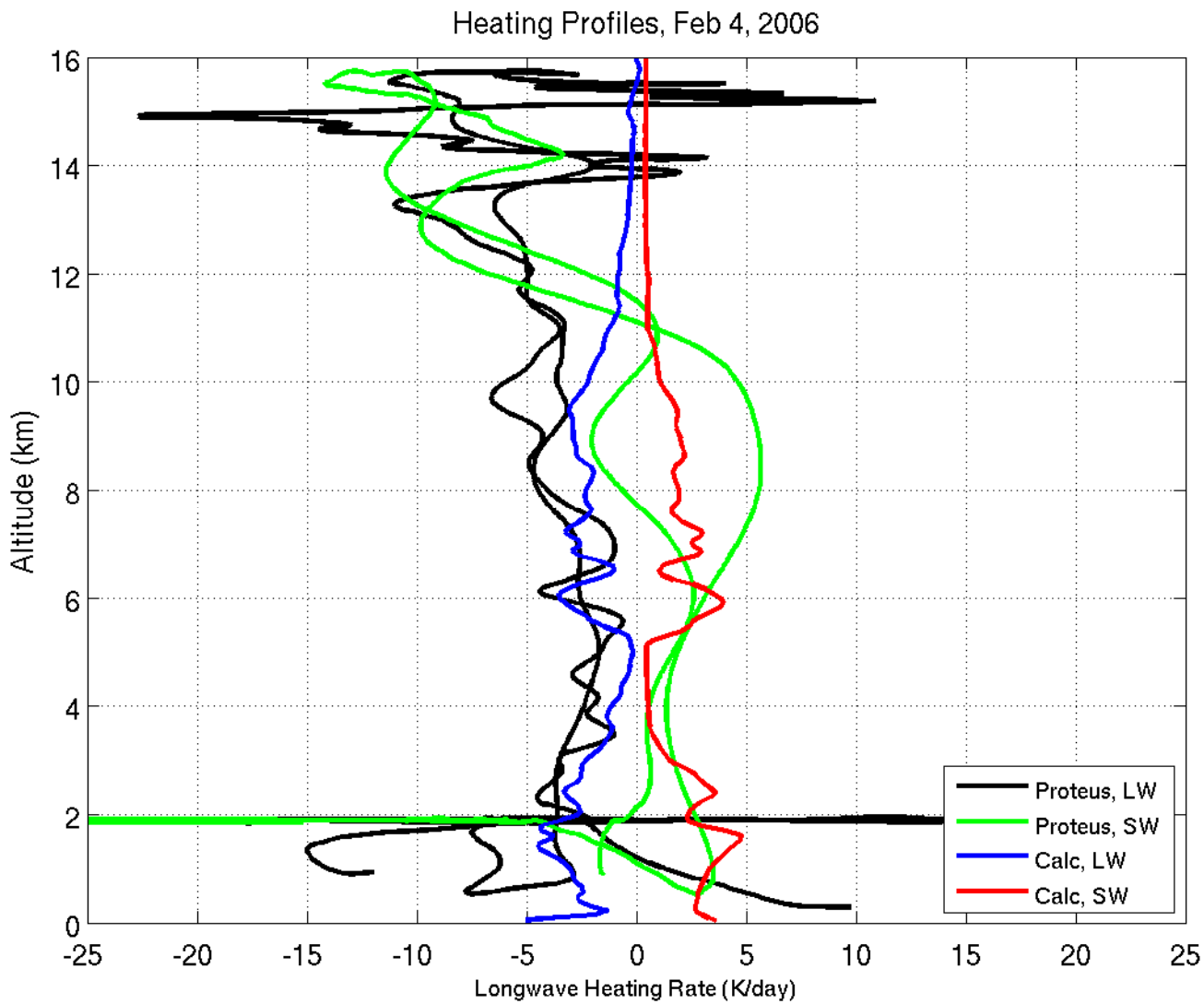


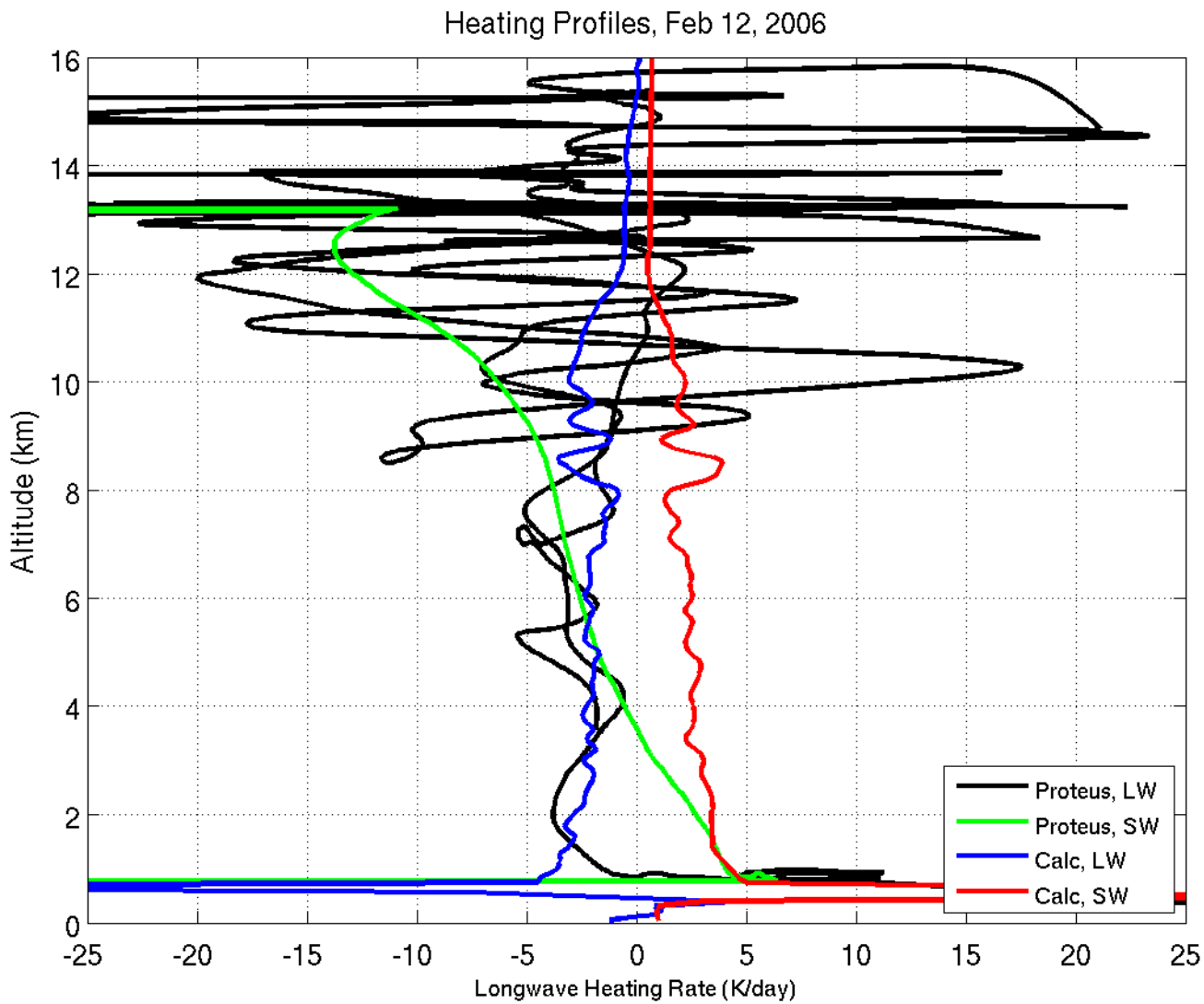

Proteus Fluxes, February 4, 2006: Ascent
Zenith
Nadir+1000
Altitude (km)
SW Flux (W/m^2)
0
2
4
6
8
10
12
14
16
900
950
1000
1050
1100
1150
1200
1250
1300

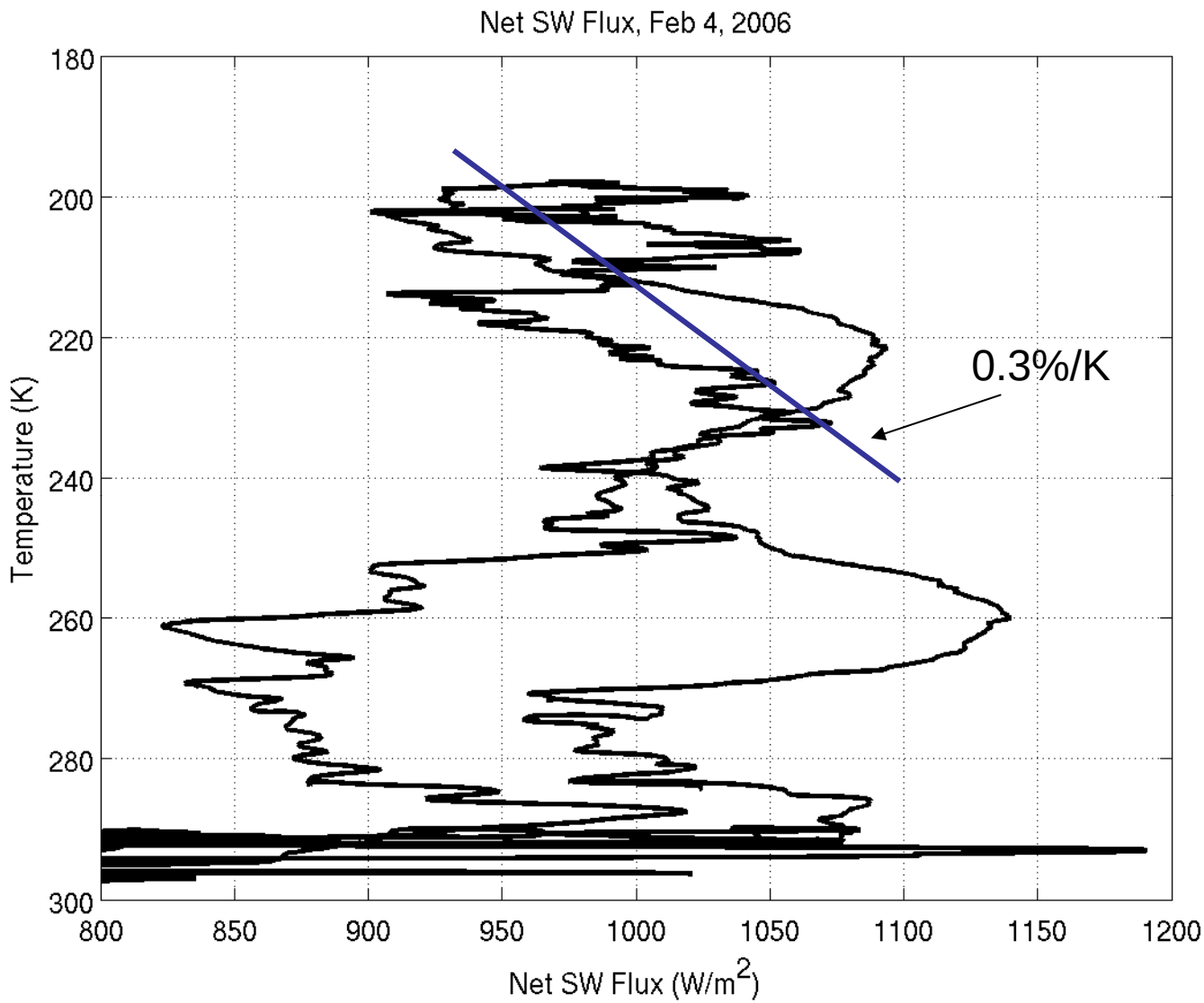

Proteus Fluxes, February 4, 2006
SW Flux (W/m^2)
Time (UTC)
1300
1250
1200
1150
1100
1050
1000
950
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
Zenith
Nadir+1000


Albedo vs. Position and Altitude: February 3, 2006
90
0.2
120
60
0.15
150
30
0.1
0.05
180
0
210
330
240
300
270
2-5 km
5-8 km
8-11 km
11-14 km
14-16 km


Heating Profiles, Feb 4, 2006
Altitude (km)
Longwave Heating Rate (K/day)
16
14
12
10
8
6
4
2
0
-25
-20
-15
-10
-5
0
5
10
15
20
25
Proteus, LW
Proteus, SW
Calc, LW
Calc, SW


Heating Profiles, Feb 4, 2006
Altitude (km)
Longwave Heating Rate (K/day)
16
14
12
10
8
6
4
2
0
-25
-20
-15
-10
-5
0
5
10
15
20
25
Proteus, LW
Proteus, SW
Calc, LW
Calc, SW


Heating Profiles, Feb 12, 2006
Altitude (km)
Longwave Heating Rate (K/day)
16
14
12
10
8
6
4
2
0
-25
-20
-15
-10
-5
0
5
10
15
20
25
Proteus, LW
Proteus, SW
Calc, LW
Calc, SW


Net SW Flux, Feb 4, 2006
Temperature (K)
Net SW Flux (W/m2)
0.3%/K
180
200
220
240
260
280
300
800
850
900
950
1000
1050
1100
1150
1200

Issues with measuring heating profiles with a single aircraft

- Instrument leveling
- Sky inhomogeneity/evolution in time of sky features
- Surface inhomogeneity
- Temperature dependence of sensors