CoSMOS-2 Campaign
Nov/Dec 2005, Scone/Merriwa, Australia

Final Campaign Report
ESTEC Contract No. 19258/05/NL/FF

compiled by J.M. Hacker
(with material supplied by M. Hagel and P. Wursteisen)

10 March 2006

Airborne Research Australia / Flinders University
www.AirborneResearch.org.au

ARA Technical Report No. 01-2006
13 Nov 2005 ASSI pattern

Sunrise at 05:50. Planned take off at 05:50, actual takeoff at 6:55.

One hour delay because the power box switches in the cockpit were switched to OFF when the external power cable was pulled out. So, the whole system had to be restarted. Unfortunately, the INS lost its satellite almanac. Acquiring of new almanac took 1h.

During the first 12 min of the flight, the GPS coverage was poor with only 2 or 3 available satellites. Afterwards, the coverage went back to normal.

1. Calibration runs over Lake Glenbawn starting at 07:00.

2. Assimilation pattern with some low level runs over the sites (at 500ft) to measure their heights above sea level.

3. Calibration runs over Lake Glenbawn starting at 08:35 (600ft)

Landing at 08:46
14 Nov 2005 WATER pattern

Sunrise at 05:50. Planned take off at 05:50, actual take off at 05:52.

At 06:00, the voltage for the research system was observed to be too low. Troubleshooting revealed a problem in the circuitry that required maintenance. Consequently, the flight was aborted at 06:11. The problem was rectified on the ground.

Second take off at 09:59.

   1. Calibration run over Lake Glenbawn at 10:07 (600ft).
   2. First measurement over Roscommon and Illogan at 10:31.
   3. Calibration runs over Lake Glenbawn at 11:50.

Landing at 11:57
15.11.05 Assimilation and Glint flights

- **Takeoff at 7:27**

- **1st Calibration at 7:32**

  One Calibration at 1500ft and a second one at 600ft above lake level. Both without problems

- **Measurements**

  Merriwa leg at 7:44
  Midlothian leg at 8:05
  Dales leg at 8:10
  Pembroke at 8:20
  Stanley at 8:25
  Illogan and Roscommon at 8:33
  Glint flight at 8:47
    1. 8:47 Grassland from E – W
    2. 8:49 Forestland from W-E
    3. 8:54 Forestland from E-W
    4. 8:57 Grassland from W-E
    5. 9:02 Crossflight from S-N
    6. 9:06 Crossflight from N-S
    7. 9:12 Grassland from E-W at maximum Glint
    8. 9:14 Forestland from W-E
    9. 9:18 Several diving flights from E-W

1. **2nd Calibration after the Mesurement flights at 9:44**

  Calibration 600ft above lake
• Landing at 9:57
17.11.05 Assimilation flight

- **Takeoff at 5:45**

- **1st Calibration at 5:48**
  Calibration 600ft above lake

- **Measurements**
  6:07 Dales leg
  6:16 Pembroke
  6:21 Stanley
  6:25 Illogan
  6:33 Roscommon
  6:41 Cullingral
  6:44 Midlothian
  6:53 Merriwa

- **2nd Calibration after the Measurement flights at 7:09**
  Calibration 600ft above lake

- **Landing at 7:15**

- **Calibration with liquid Nitrogen after landing**
20.11.05 Assimilation flight

- **Takeoff at 5:37**

- **1st Calibration at 5:42**
  Calibration 600ft above lake

- **Measurements**
  At 2800ft MSL, a layer of clouds was present
  6:07 Merriwa leg
  6:15 Cullingral. The first part of the leg was about 200ft higher as usual due to clouds.
  6:19 Midlothian
  6:24 Dales
  6:33 Pembroke. The leg was 200ft higher as usual due to clouds
  6:50 Roscommon and Illogan

- **2nd Calibration after the Measurement flights at 7:18**
  Calibration 600ft above lake

- **Landing at 7:25**

- **Calibration with Nitrogen**
21.11.05 SCAL flight

• Takeoff at 5:51

• 1st Calibration at 5:55
Calibration 600ft above lake

• Measurements
6:18 line No. 36 started
7:46 line No. 28 completed

• Landing at 7:59

• Refueling

• Takeoff 8:31

• Measurements
08:49 line No.27 started
10:53 line No.15 finished

• 2nd Calibration after the Measurement flights at 11:16
Calibration 600ft above lake

• Landing at 11.23
22.11.05 Water flight

- Takeoff at 5:52

- 1st Calibration at 5:57
  Calibration 600ft above lake

- Measurements
  6:14 1st track from Culligral to Midlothian started
  7:51 15th track completed

- Landing at 8:11

- Refueling

- Takeoff 8:40

- Measurements
  8:52 16th track from Culligral to Midlothian started
  9:42 23th track finished

- 2nd Calibration after the Measurement flights at 10:02
  Calibration 600ft above lake

- Landing at 11:10
23.11.05 Assimilation flight and remaining tracks for SCAL

- **Takeoff at 5:55**
- **1st Calibration at 6:00**

Calibration 600ft above lake

**Measurements**

**Assimilation:**
6:15 Merriwa
6:23 Cullingral
6:26 Midlothian, flown 200ft to low
6:33 Dales
6:41 Pembroke, restarted at 6:46
6:54 Stanley
7:01 Roscommon
7:03 Illogan, taken again at 7:07
7:16 Midlothian taken again

**SCAL:**
partly flown in heavy clouds
7:28 line No. 14 started
8:07 line No.11 completed

- **2nd Calibration after the Measurement flights at 8:27**

Calibration 600ft above lake

- **Landing at 8:38**
- **Refueling**
- **Takeoff at 10:36**
• **Measurements**

**SCAL:**

11:05 line No.10 started

12:49 line No.1 finished

**Remarks:** Data of line No.1 – No.10 corrupted due to software problem as described in Patrick’s report

• **Landing at 13.42**
26.11.05 Assimilation flight

- **Takeoff at 10:03**

  Takeoff delayed due to missing ground power in the early morning. Some has switched off the ground power in the shed without asking.

  A thunderstorm was close to the area of Scone, the lightnings were visible

  **Flight aborted due to hardware problem.**
27.11.05 Assimilation flight

- **Takeoff at 5:50**

- **1st Calibration at 5:55**
  Calibration 600ft above lake

- **Measurements**
  6:09 Dales
  6:16 Merriwa leg
  6:22 Cullingral
  6:26 Midlothian
  6:34 Pembroke
  6:38 Stanley
  6:42 Roscommon
  6:47 Illogan

- **2nd Calibration after the Measurement flights at 7:09**
  Calibration 600ft above lake

- **Landing at 7:16**
29.11.05 Assimilation flight

- **Takeoff at 5:32**

- **1st Calibration at 5:43**
  Calibration 600ft above lake

- **Measurements**
  6:03 Dales
  6:11 Merriwa
  6:17 Cullingral
  6:21 Midlothian
  6:29 Stanley
  6:32 Pembroke
  6:40 Roscommon
  6:44 Illogan

- **2nd Calibration after the Measurement flights at 7:03**
  Calibration 600ft above lake
• *Landing at 7:12*
30.11.05 Assimilation flight

2. flight canceled

Due to a failure in the right engine magneto, the engine could not be started. The magneto needed to be replaced. The repair was done the next day.
02.12.05 Assimilation flight

3. flight canceled

The flight was canceled because of thunderstorm warnings.
03.12.05 Assimilation flight

- **Takeoff at 5:46**

- **1st Calibration at 5:52**
  Calibration 600ft above lake

- **Measurements**
  6:08 Dales
  6:17 Stanley
  6:22 Pembroke
  6:29 Roscommon
  6:33 Illogan
  6:41 Cullingral
  6:47 Midlothian
  6:55 Merriwa

- **2nd Calibration after the Measurement flights at 7:07**
  Calibration 600ft above lake

- **Landing at 7:15**
06.12.05 Assimilation flight

- **Takeoff at 6:19**

Takeoff was delayed because the JREX-Display did not work. The display was taken out and viewed. After no defect was found, it was reintegrated and worked.

- **1st Calibration at 6:24**

Calibration 600ft above lake

- **Measurements**

  6:42 Merriwa  
  6:47 Dales  
  6:54 Stanley  
  6:57 Pembroke  
  7:05 Roscommon  
  7:10 Illogan  
  7:19 Cullingral  
  7:22 Midlothian

- **2nd Calibration after the Measurement flights at 7:42**

Calibration 600ft above lake

- **Landing at 7:45**
4. *Flight canceled*

The flight was canceled because of high temperatures, thunderstorm warnings and a strong wind of 37kt on flight altitude.
08.12.05 SCAL flights

- **Takeoff at 6:05**

- **1st Calibration at 6:08**
  Calibration 600ft above lake

- **Measurements**
  While the measurements, the temperature in the instrumentation could not be stabilized. A stabilized temperature is required for reasonable results.

  6:42 line No. 10 started
  6:53 line No. 09 started
  7:04 line No. 08 started
  7:14 line No. 07 started
  7:24 line No. 06 started

  7:26 Trying to get the instrument temperature control working, the system was rebooted.

  7:35 line No. 07 repeated

  7:52 The flight was aborted because of unsatisfying results due to a still unstable temperature in the instrumentation.

- **Landing at 8:07**
09.12.05 SCAL flights

The temperature in the instrument was stable now. The reason was, that the ambient temperature is not too hot any more.

- **Takeoff at 6:46**

- **1st Calibration at 6:52**
  Calibration 600ft above lake

- **Measurements**
  7:15 line No. 10 started
  7:28 line No. 09 started
  7:35 line No. 08 started
  7:45 line No. 07 started
  7:55 line No. 06 started
  8:05 line No. 05 started
  8:15 line No. 04 started
  8:25 line No. 03 started
  8:35 line No. 02 started
  8:45 line No. 01 started

- **2nd Calibration after the Measurement flights at 9:15**
  Calibration 600ft above lake

- **Landing at 9:23**

- **Nitrogen Calibration at 9:51**
## Coordinates of the individual measurement sites

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Latitude (South)</th>
<th>Longitude (East)</th>
<th>Overflight direction (degrees true)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ilogan</td>
<td>32° 08.4000'</td>
<td>150° 04.0000'</td>
<td>290</td>
</tr>
<tr>
<td></td>
<td>(32° 08' 24&quot;)</td>
<td>(150° 04' 00&quot;)</td>
<td></td>
</tr>
<tr>
<td>Stanley</td>
<td>32° 05.6000'</td>
<td>150° 08.2310'</td>
<td>270</td>
</tr>
<tr>
<td></td>
<td>(32° 05' 36&quot;)</td>
<td>(150° 08' 13.86&quot;)</td>
<td></td>
</tr>
<tr>
<td>Pembroke</td>
<td>32° 02.4333'</td>
<td>150° 08.4667'</td>
<td>020</td>
</tr>
<tr>
<td></td>
<td>(32° 02' 26&quot;)</td>
<td>(150° 08' 28&quot;)</td>
<td></td>
</tr>
<tr>
<td>Roscommon</td>
<td>32° 10.4667'</td>
<td>150° 08.8000'</td>
<td>330</td>
</tr>
<tr>
<td></td>
<td>(32° 10' 28&quot;)</td>
<td>(150° 08' 48&quot;)</td>
<td></td>
</tr>
<tr>
<td>Dales</td>
<td>31° 56.9667'</td>
<td>150° 25.4333'</td>
<td>280</td>
</tr>
<tr>
<td></td>
<td>(31° 56' 58&quot;)</td>
<td>(150° 25' 26&quot;)</td>
<td></td>
</tr>
<tr>
<td>Midlothian</td>
<td>32° 01.2262'</td>
<td>150° 21.7333'</td>
<td>360</td>
</tr>
<tr>
<td></td>
<td>(32° 01' 13.57&quot;)</td>
<td>(150° 21' 44&quot;)</td>
<td></td>
</tr>
<tr>
<td>Cullingral</td>
<td>32° 09.7167'</td>
<td>150° 20.4667'</td>
<td>360</td>
</tr>
<tr>
<td></td>
<td>(32° 09' 43&quot;)</td>
<td>(150° 20' 28&quot;)</td>
<td></td>
</tr>
<tr>
<td>Merriwa</td>
<td>32° 05.8833'</td>
<td>150° 25.9000'</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>(32° 05' 53&quot;)</td>
<td>(150° 25' 54&quot;)</td>
<td></td>
</tr>
</tbody>
</table>

The flights for this campaign take place at sunrise, approx. between 05:30 and 06:00 local time.
First light at Scone:

<table>
<thead>
<tr>
<th>Date</th>
<th>First Light (UTC)</th>
<th>First Light (UTC+11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Nov 2005</td>
<td>18:24</td>
<td>05:24</td>
</tr>
<tr>
<td>17 Nov 2005</td>
<td>18:21</td>
<td>05:21</td>
</tr>
<tr>
<td>22 Nov 2005</td>
<td>18:18</td>
<td>05:18</td>
</tr>
<tr>
<td>27 Nov 2005</td>
<td>18:16</td>
<td>05:16</td>
</tr>
</tbody>
</table>
Calibration over Lake Glenbawn

A buoy is moored on the Lake Glenbawn. Flights will take place over this buoy at the start and at the end of each flight. The coordinates are:

32° 04.1280’ S  (32.0688 deg. S)
150° 58.4220’ E  (150.9737 deg. E)

The flight will take place in a straight and stable line from North to South, and will be the same as the one used with the NAFE aircraft (waypoints GLENBAWN-N and GLENBAWN-S).
**ASSI pattern**

- whole flight at approximately 500m AGL (1,500ft above terrain)
- Take-off from YSCO at 05:30 LT
- Fly to Lake Glenbawn
- Overfly lake from GLENBAWN-N to GLENBAWN-S
- Overfly 8 sites as defined in route file – each site requires specific ground track – see OziExplorer route files
- **REQUIREMENT: straight and level and on survey line at marked aypoints**
- Overfly lake from GLENBAWN-N to GLENBAWN-S
- Return to YSCO

- Total line distance: 278km = 150NM (without turns, lining up)
- Flying at 130kts: approx. 2 hours (incl. turns and lining up)

- Pattern to be flown every 3rd days (say, 2 flights per week)
- After rain event, fly this pattern daily for 5 consecutive days to capture dry-down period
- requires scheduling and planning regarding pilot duty hours - Patrick Wursteisen to liaise with ARA pilot about this

- A total of 11 (5+6) flights is expected (approx. 22 flight hours)
Waypoints for ASSI pattern:

- The name of the site designates the centre of the site
- site-N, site-S, site-E, site-W designates the end points of the overflight track
- YSCO is Scone Airport
- GLENBAWN-N/S are the Lake Glenbawn waypoints

<table>
<thead>
<tr>
<th>Name</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILLOGAN</td>
<td>-32.08.400</td>
<td>150 04.000</td>
</tr>
<tr>
<td>STANLEY</td>
<td>-32.05.600</td>
<td>150 08.231</td>
</tr>
<tr>
<td>PEMBROKE</td>
<td>-32.02.433</td>
<td>150 08.467</td>
</tr>
<tr>
<td>RO5COMMON</td>
<td>-32.10.467</td>
<td>150 08.800</td>
</tr>
<tr>
<td>DALES</td>
<td>-31.56.967</td>
<td>150 25.423</td>
</tr>
<tr>
<td>MIDLOTHIAN</td>
<td>-32.01.226</td>
<td>150 21.733</td>
</tr>
<tr>
<td>CULLINGFAI</td>
<td>-32.09.717</td>
<td>150 20.467</td>
</tr>
<tr>
<td>MERRWA</td>
<td>-32.05.683</td>
<td>150 25.900</td>
</tr>
<tr>
<td>STA-E</td>
<td>-32.05.600</td>
<td>150 10.139</td>
</tr>
<tr>
<td>STA-W</td>
<td>-32.05.600</td>
<td>150 06.323</td>
</tr>
<tr>
<td>MID-N</td>
<td>-31.59.602</td>
<td>150 21.733</td>
</tr>
<tr>
<td>MID-S</td>
<td>-32.02.951</td>
<td>150 21.733</td>
</tr>
<tr>
<td>YSCO</td>
<td>-32.02.200</td>
<td>150 49.900</td>
</tr>
<tr>
<td>GLENBAWN-N</td>
<td>-32.03.377</td>
<td>150 58.357</td>
</tr>
<tr>
<td>GLENBAWN-S</td>
<td>-32.06.366</td>
<td>151 00.738</td>
</tr>
<tr>
<td>IL0-W</td>
<td>-32.07.044</td>
<td>150 02.206</td>
</tr>
<tr>
<td>IL0-E</td>
<td>-32.08.955</td>
<td>150 05.794</td>
</tr>
<tr>
<td>BUOY</td>
<td>-32.04.128</td>
<td>150 56.422</td>
</tr>
<tr>
<td>PEM-N</td>
<td>-32.00.907</td>
<td>150 08.119</td>
</tr>
<tr>
<td>PEM-S</td>
<td>-32.03.960</td>
<td>150 07.814</td>
</tr>
<tr>
<td>RO5-W</td>
<td>-32.09.060</td>
<td>150 07.845</td>
</tr>
<tr>
<td>RO5-E</td>
<td>-32.11.874</td>
<td>150 03.755</td>
</tr>
<tr>
<td>CUL-N</td>
<td>-32.08.092</td>
<td>150 20.467</td>
</tr>
<tr>
<td>CUL-S</td>
<td>-32.11.341</td>
<td>150 20.467</td>
</tr>
<tr>
<td>MER-N</td>
<td>-32.04.283</td>
<td>150 25.569</td>
</tr>
<tr>
<td>MER-S</td>
<td>-32.07.483</td>
<td>150 26.232</td>
</tr>
<tr>
<td>DAL-W</td>
<td>-31.56.684</td>
<td>150 23.657</td>
</tr>
<tr>
<td>DAL-E</td>
<td>-31.57.249</td>
<td>150 27.310</td>
</tr>
</tbody>
</table>

OziExplorer waypoint and route files:

- sites.wpt
- assi.rte
**Flight SCAL**

General outline of the survey area for the SCAL Flight

UL Corner
Coordinates
31 deg 44' 36"
150 deg 08' 13"

Krui catchment
Merriwa catchment

LR Corner
Coordinates
32 deg 19' 31"
150 deg 23' 43"
Area to cover is approx 45 x 36 km.
The SCAL flights will take approximately 12 flight hours. Two consecutive days with two flights each day are required to perform this flight.

After some analysis of the operations involved with this flight, it appears that the flight should take place at an altitude of 2000 m above ground. The instrument swath width is then 1300 metres. The flight lines should be separated by 1000 metres to provide some decent overlap between the lines, ie 36 lines for the survey area.

The flight must be performed when stable meteo conditions are present for several days at the measurement sites. Flights will not take place after a rain event.

- Whole flight at approximately 2,000m AGL (6,500ft above terrain)
- Take-off from YSCO at 05:30 LT
- Fly to Lake Glenbawn
- Overfly lake from GLENBAWN-N to GLENBAWN-S
- Fly as many lines as possible
- REQUIREMENT: straight and level and on survey line at marked waypoints
- Overfly lake from GLENBAWN-N to GLENBAWN-S
- Return to YSCO
- Refuel (as quickly as possible
- Same procedure as first flight

- (Each line to be flown once only)

- Total line distance: 1,467km = 792NM (without turns, lining up, ferry)
- Flying at 130kts: approx. 7 hours (incl. turns and lining up, but excluding calibration over Lake and ferry to lines)
- A 3-hour flight is estimated to consist of 30 minutes of cal/ferry each way and 2 hours on lines
- This means, the whole pattern requires 4 flights = 2 days with 2 flights/day

- Pattern to be flown once only, but on consecutive days during stable meteo conditions

- Patrick Wursteisen to define exact period
• A total of 4 flights is expected (approx. 12 flight hours)
SCAL pattern:
Waypoints for SCAL pattern:

<table>
<thead>
<tr>
<th>N1</th>
<th>-31.44.670</th>
<th>150°08.522</th>
</tr>
</thead>
<tbody>
<tr>
<td>N2</td>
<td>-31.44.910</td>
<td>150°09.134</td>
</tr>
<tr>
<td>N3</td>
<td>-31.44.950</td>
<td>150°09.746</td>
</tr>
<tr>
<td>N4</td>
<td>-31.45.030</td>
<td>150°10.259</td>
</tr>
<tr>
<td>N5</td>
<td>-31.45.231</td>
<td>150°10.971</td>
</tr>
<tr>
<td>N6</td>
<td>-31.45.371</td>
<td>150°11.583</td>
</tr>
<tr>
<td>N7</td>
<td>-31.45.511</td>
<td>150°12.195</td>
</tr>
<tr>
<td>N8</td>
<td>-31.45.651</td>
<td>150°12.908</td>
</tr>
<tr>
<td>N9</td>
<td>-31.45.791</td>
<td>150°13.420</td>
</tr>
<tr>
<td>N10</td>
<td>-31.45.931</td>
<td>150°14.032</td>
</tr>
<tr>
<td>N11</td>
<td>-31.46.072</td>
<td>150°14.645</td>
</tr>
<tr>
<td>N12</td>
<td>-31.46.212</td>
<td>150°15.257</td>
</tr>
<tr>
<td>N13</td>
<td>-31.46.352</td>
<td>150°15.863</td>
</tr>
<tr>
<td>N14</td>
<td>-31.46.492</td>
<td>150°16.462</td>
</tr>
<tr>
<td>N15</td>
<td>-31.46.632</td>
<td>150°17.064</td>
</tr>
<tr>
<td>N16</td>
<td>-31.46.772</td>
<td>150°17.706</td>
</tr>
<tr>
<td>N17</td>
<td>-31.46.912</td>
<td>150°18.319</td>
</tr>
<tr>
<td>N18</td>
<td>-31.47.053</td>
<td>150°18.931</td>
</tr>
<tr>
<td>N19</td>
<td>-31.47.193</td>
<td>150°19.544</td>
</tr>
<tr>
<td>N20</td>
<td>-31.47.333</td>
<td>150°20.156</td>
</tr>
<tr>
<td>N21</td>
<td>-31.47.473</td>
<td>150°20.769</td>
</tr>
<tr>
<td>N22</td>
<td>-31.47.613</td>
<td>150°21.381</td>
</tr>
<tr>
<td>N23</td>
<td>-31.47.753</td>
<td>150°21.994</td>
</tr>
<tr>
<td>N24</td>
<td>-31.47.893</td>
<td>150°22.606</td>
</tr>
<tr>
<td>N25</td>
<td>-31.48.034</td>
<td>150°23.219</td>
</tr>
<tr>
<td>N26</td>
<td>-31.48.174</td>
<td>150°23.831</td>
</tr>
<tr>
<td>N27</td>
<td>-31.48.314</td>
<td>150°24.444</td>
</tr>
<tr>
<td>N28</td>
<td>-31.48.454</td>
<td>150°25.057</td>
</tr>
<tr>
<td>N29</td>
<td>-31.48.594</td>
<td>150°25.669</td>
</tr>
<tr>
<td>N30</td>
<td>-31.49.734</td>
<td>150°26.282</td>
</tr>
<tr>
<td>N31</td>
<td>-31.48.875</td>
<td>150°26.894</td>
</tr>
<tr>
<td>N32</td>
<td>-31.49.015</td>
<td>150°27.507</td>
</tr>
<tr>
<td>N33</td>
<td>-31.49.155</td>
<td>150°28.120</td>
</tr>
<tr>
<td>N34</td>
<td>-31.49.295</td>
<td>150°28.732</td>
</tr>
<tr>
<td>N35</td>
<td>-31.49.435</td>
<td>150°29.345</td>
</tr>
<tr>
<td>N36</td>
<td>-31.49.575</td>
<td>150°29.958</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S1</th>
<th>-32.05.501</th>
<th>150°01.947</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2</td>
<td>-32.05.641</td>
<td>150°02.652</td>
</tr>
<tr>
<td>S3</td>
<td>-32.05.782</td>
<td>150°03.376</td>
</tr>
<tr>
<td>S4</td>
<td>-32.05.922</td>
<td>150°03.791</td>
</tr>
<tr>
<td>S5</td>
<td>-32.06.062</td>
<td>150°04.495</td>
</tr>
<tr>
<td>S6</td>
<td>-32.06.202</td>
<td>150°05.020</td>
</tr>
<tr>
<td>S7</td>
<td>-32.06.342</td>
<td>150°05.624</td>
</tr>
<tr>
<td>S8</td>
<td>-32.06.482</td>
<td>150°06.249</td>
</tr>
<tr>
<td>S9</td>
<td>-32.06.622</td>
<td>150°06.864</td>
</tr>
<tr>
<td>S10</td>
<td>-32.06.763</td>
<td>150°07.478</td>
</tr>
<tr>
<td>S11</td>
<td>-32.06.903</td>
<td>150°08.093</td>
</tr>
<tr>
<td>S12</td>
<td>-32.07.043</td>
<td>150°08.707</td>
</tr>
<tr>
<td>S13</td>
<td>-32.07.183</td>
<td>150°09.322</td>
</tr>
<tr>
<td>S14</td>
<td>-32.07.323</td>
<td>150°09.937</td>
</tr>
<tr>
<td>S15</td>
<td>-32.07.463</td>
<td>150°10.551</td>
</tr>
<tr>
<td>S16</td>
<td>-32.07.603</td>
<td>150°11.166</td>
</tr>
<tr>
<td>S17</td>
<td>-32.07.743</td>
<td>150°11.781</td>
</tr>
<tr>
<td>S18</td>
<td>-32.07.884</td>
<td>150°12.396</td>
</tr>
<tr>
<td>S19</td>
<td>-32.08.024</td>
<td>150°13.010</td>
</tr>
<tr>
<td>S20</td>
<td>-32.08.164</td>
<td>150°13.625</td>
</tr>
<tr>
<td>S21</td>
<td>-32.08.304</td>
<td>150°14.240</td>
</tr>
<tr>
<td>S22</td>
<td>-32.08.444</td>
<td>150°14.855</td>
</tr>
<tr>
<td>S23</td>
<td>-32.08.584</td>
<td>150°15.469</td>
</tr>
<tr>
<td>S24</td>
<td>-32.08.724</td>
<td>150°16.084</td>
</tr>
<tr>
<td>S25</td>
<td>-32.08.865</td>
<td>150°16.699</td>
</tr>
<tr>
<td>S26</td>
<td>-32.09.005</td>
<td>150°17.314</td>
</tr>
<tr>
<td>S27</td>
<td>-32.09.145</td>
<td>150°17.929</td>
</tr>
<tr>
<td>S28</td>
<td>-32.09.285</td>
<td>150°18.544</td>
</tr>
<tr>
<td>S29</td>
<td>-32.09.425</td>
<td>150°19.159</td>
</tr>
<tr>
<td>S30</td>
<td>-32.09.565</td>
<td>150°19.774</td>
</tr>
<tr>
<td>S31</td>
<td>-32.09.705</td>
<td>150°20.388</td>
</tr>
<tr>
<td>S32</td>
<td>-32.09.846</td>
<td>150°21.003</td>
</tr>
<tr>
<td>S33</td>
<td>-32.09.986</td>
<td>150°21.618</td>
</tr>
<tr>
<td>S34</td>
<td>-32.10.126</td>
<td>150°22.233</td>
</tr>
<tr>
<td>S35</td>
<td>-32.10.266</td>
<td>150°22.849</td>
</tr>
<tr>
<td>S36</td>
<td>-32.10.406</td>
<td>150°23.463</td>
</tr>
</tbody>
</table>

OziExplorer waypoint and route files:

scal.wpt
scal.rte
**Flight WATER**

This flight will be performed twice during the campaign, at the campaign start and at the end.

The flight will be performed over 2 of the 6 farms at which detailed sampling is being performed. The actual sites will be selected shortly (1-2 days) before the flight, after discussion with the NAFE team. The criteria is that vegetation samples must be collected on the day of the flight.

The flight will take place on a rain-free day, possibly several days AFTER a day with rain.

The flight will take place from sunrise until 11:00 and consists in flights forward and backward between the 2 sites.

Due to the duration of the flight, the aircraft will be required to return to the airport for refuelling. The pilot will prepare the refuelling with the airport crew such that this break can be minimised. The first flight is the most important of the two. The second flight can be reduced to an effective duration (exc. transits) of 1 hour.

Detailed flight breakdown:

- Start flight at **sunrise**.
- Flight altitude 500 metres above ground,
- Fly to lake Glenbawn and perform a straight line (sensor calibration),
- Fly to the 2 test sites and perform the straight lines as long as possible
- Return to airport for refuelling,
- Refuel aircraft (minimise the time loss).
- Return to the 2 tests sites and continue measurements for a maximum of 1 hour,
- After conclusion of the measurements, return to lake Glenbawn and repeat the calibration overflight,
- Return to airport. (flight expected to be concluded at approx 12:00).

- avoid sun glint effects – thus flying at around (08:30 – 9:00) should be avoided but this depends on the location and the date
**Flight GLINT**

This flight will take place once during the campaign over the site of Roscommon. The flight will consist of 2 flight lines (at least 5km long) in the same azimuth as the sun’s position when the sun has an elevation of 40 degrees. One line will be over a forest, the other line will be over grassland. The two flights have to be performed in the direction towards the sun and in a direction with the sun in the back. In addition, one flight line will be measured perpendicular to the principal plane. This line will cross the first two lines performed over the forest and the grassland.

Roscommon Forest Site: 32º10.0748’S / 150º08.6442’E  
(150-08-38.654 / 32-10-04.486)

Roscommon Grassland: 32º10.9934’S / 150º09.7630’E  
(150-09-45.780 / 32-10-59.604)

OziExplorer waypoint file: glint.wpt

Azimuth direction of flight lines will be given at soon as the date for the GLINT flight has been fixed.

Once these 3 lines are flown, the pilot will perform several “dive” flights over the grassland line to cover the maximum range of instrument pitch angles. The pilot will perform several dives to maximise the chances to have a fully successful dive.

The flight GLINT will be performed in close coordination with the ground team from the Free Univ. Amsterdam who will perform specific sampling on the day of this flight. ESA will inform the team of the schedule.

**Straight lines**
“Dive” flight

The dive flight will take place over the grassland. The figure here below represents Altitude versus Time.

The purpose of this is to vary the pitch angle of the aircraft as best as possible. A different flight strategy might be required to achieve the desired result. The final strategy needs to be discussed with the pilot.
This dive is to be performed several times (5 ?) to maximise the chances of success.

Detailed flight breakdown:

- Flight altitude 500 metres above ground,
- Fly to lake Glenbawn and perform a straight line (sensor calibration),
- Fly to the 2 test sites and perform the lines (forth and back) over forest,
- Perform the lines (forth and back) over grassland,
- Perform the dive flights over grassland (5x)
- After conclusion of the measurements, return to lake Glenbawn and repeat the calibration overflight,
- Return to airport
Flight CALIB

Calibration measurements are scheduled for each flight, and take place over the lake Glenbawn. They are normally performed by the CoSMOS-2 aircraft independently of the NAFE airborne operations.

In addition to these routine calibration measurements, we will perform two calibrations over the lake in coordination with the NAFE calibration overflight and in coordination with the ground team who performs detailed lake measurements.

Hence, the two CALIB flights are not specific flights, they are part of the flights described earlier, but they require a specific coordination between ESA and the NAFE Team Leaders.

Detailed flight breakdown:

- Start flight when required
- Fly to lake Glenbawn and perform a straight line (sensor calibration),
- Fly to the test area and perform the rest of the flight.
### Number of Flights

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ASSI</td>
<td>$5 + 3 \times 2$</td>
<td>11 flights</td>
</tr>
<tr>
<td>WATER</td>
<td>$1 + 1$</td>
<td>2 flights</td>
</tr>
<tr>
<td>GLINT</td>
<td>1</td>
<td>1 flight</td>
</tr>
<tr>
<td>SCAL</td>
<td>$2 + 2$</td>
<td>4 flights</td>
</tr>
</tbody>
</table>

**TOTAL** | 18 flights in 20 days
**CoSMOS-2 Operations Timeline**

**version 1 6-Nov**

<table>
<thead>
<tr>
<th>Payload installation and test flights</th>
<th>TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>certification of the aircraft</td>
<td></td>
</tr>
<tr>
<td>Campaign operations and Flights</td>
<td></td>
</tr>
<tr>
<td>Meeting to review operations and timeline</td>
<td></td>
</tr>
<tr>
<td>ESA on Site</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assimilation of root zone soil moisture</th>
<th>ASSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scaling issues, 2000 metres alt. Sun Glint and Topography</td>
<td>SCAL</td>
</tr>
<tr>
<td>Effect of Water and dew on L-band measurements</td>
<td>GLINT</td>
</tr>
<tr>
<td>Effect of Water and dew on L-band measurements</td>
<td>WATER</td>
</tr>
</tbody>
</table>

**Please note:** the flight schedule is dependent on weather conditions and will be revised daily as the conditions require it.