Construction started in the end of December, 2010

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PANSY is derived from the French word, ‘pensee’, meaning ‘thought’
Thank you very much for your strong and continuous support to our project!
## Specifications of PANSY

- Height coverage: 1-500km
- Three dimensional winds and plasma parameters
- Fine time and height resolutions

<table>
<thead>
<tr>
<th>System</th>
<th>Pulse Doppler radar. Active phased array system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center freq.</td>
<td>47MHz</td>
</tr>
<tr>
<td>Antenna</td>
<td>A quasi-circular array consisting of <strong>1045</strong> crossed Yagi antennas. <strong>Diameter about 160m</strong> (18000m²)</td>
</tr>
<tr>
<td>Transmitter</td>
<td><strong>1045</strong> solid-state TR modules</td>
</tr>
<tr>
<td></td>
<td>Peak Power: <strong>520kW</strong></td>
</tr>
<tr>
<td>Receiver</td>
<td>55 channel digital receiving systems</td>
</tr>
<tr>
<td></td>
<td>Ability of imaging and interferometry obs</td>
</tr>
<tr>
<td>Peripheral</td>
<td>24 antennas for E-layer FAI observation</td>
</tr>
</tbody>
</table>
Performance of the PANSY radar

MST observation

Turbulence echo

3-d winds in the troposphere and stratosphere
\( \Delta t=1\text{min}, \Delta z=75-150\text{m} \)

3-d winds in the mesosphere
\( \Delta t=1\text{min}, \Delta z=300-600\text{m} \)

PMSE (Polar Mesosphere Summer Echo) observation

Much better than 3-d winds in the mesosphere

The MU radar
(35N, 136E)
Science of PANSY

- **Katabatic winds**: The role on the circulation in the Southern Hemisphere
- **Boundary layer**: Turbulence structure, Exchange with free atmosphere
- **Circulation in the troposphere**: Meridional circulation, Water circulation
- **Polar lows**: 3-dimensional structure and dynamics
- **Severe snow storms**: Generation mechanisms and 3-dimensional structure
- **Blockings**: Exchange with the middle atmosphere, wave generation
- **Tropospheric-stratospheric exchange**: Tropopause structure, turbulence, dominant disturbances, ageostrophic circulation
- **Ozone hole**: Dynamics and chemistry of ozone layer recovery
- **Polar stratospheric clouds**: Physics of generation and dissipation. Their radiative, chemical, and dynamical roles
- **Trapped waves on the polar vortex**: Roles on the exchange between the regions inside and outside of the polar vortex
- **Polar night jet**: Small-scale structures and secondary circulation
- **Sudden warming**: Dynamics. Transport and mixing
- **Gravity waves**: Dynamical characteristics, generation mechanism, vertical and seasonal variation, momentum fluxes, wave forces, horizontal propagation
- **Exchange between the mesosphere and thermosphere**: Mesopause structure, dominant disturbances, ageostrophic circulation
- **Polar mesospheric clouds** (Noctilucent clouds): Monitoring of climate effects by human activity, physics of generation and dissipation, roles on radiation
- **Barotropic and baroclinic instability**: Interaction with gravity waves
- **Polar mesospheric summer echoes/polar mesospheric winter echoes**: Mechanisms and relation with the polar mesospheric clouds.
- **Auroras**: 3-dimensional structure
- **Ionospheric disturbances**: Comparison between the Arctic and Antarctic atmospheres
- **Coherent scattering in the ionosphere**: Mechanism, structure, time variation
- **Irregularity in the ionospheric E region**: Structure, seasonal variation etc.
- **Solar proton events**: Effects on the neutral atmosphere
- **Diurnal, seasonal, inter-annual variations, solar cycle (11 years), and trends**: Mechanism and effects by GHGs.
- **Turbulence**: 4 dimensional imaging observation
Polar mesospheric clouds (Noctilucent clouds) appear in the coldest region around 90km in polar summer mesosphere. It is considered that they did not exist at least before the Industrial Revolution → “the canaries in a coal mine” of the Earth climate system.
PMSE (Polar Mesosphere Summer Echo) and PMCs

M. Rapp and F. J. Lübken: Review of PMSE

The PANSY radar has sufficient power to detect turbulence echoes irrespective of the existence of PMCs. Research on cloud physics using air motion data around PMC is possible.
Gravity wave simulation with a high-resolution general circulation model (KANTO project)

K. Sato, S. Watanabe, Y. Kawatani, Y. Tomikawa, K. Miyazaki, and M. Takahashi

(a) (b) AIRS (Alexander and Barnet, 2007)

(c) KANTO model (T213L256, Watanabe et al 2008)
Vertical momentum fluxes associated with gravity waves ($n>21$)

Gravity waves tend to take propagation paths toward the jet axes → decelerate the jets effectively

(Sato et al., 2009)
Recent satellite observations with high resolution

• Satellites provide the lower limit of absolute values of momentum fluxes.
• The PANSY radar provides accurate estimates of momentum flux vectors.

Alexander et al. (2008)
Estimation of momentum fluxes by an MST radars
(Vincent and Reid, 1983)

Using radial velocities of symmetric beams

Wind fluctuations \( V' (u', w') \)
\[
\begin{align*}
V'_{+\theta} &= u'_{+\theta} \sin \theta + w'_{+\theta} \cos \theta \\
V'_{-\theta} &= -u'_{-\theta} \sin \theta + w'_{-\theta} \cos \theta
\end{align*}
\]

Assuming homogeniety of wind variances
\[
\overline{u'^2}_{-\theta} = \overline{u'^2}_{+\theta}, \quad \overline{w'^2}_{-\theta} = \overline{w'^2}_{+\theta}
\]

\[
\overline{u'w'} = (\overline{V'^2}_{+\theta} - \overline{V'^2}_{-\theta}) / 2 \sin 2\theta
\]

The MU radar observation
(Tsuda et al., 1990)
Horizontal resolution corresponding to the beam width is $\sim 3$ km in the upper mesosphere.

The highest vertical resolution of the PANSY radar is 75m
The MST radars ($\Delta t=1\,\text{min}$) can observe a part of the spectral range that satellites and balloons cannot observe.
The MU Radar (Kyoto University)

Power consuming! (230kW)

Heavy! (>50kg)

(Shigaraki, Shiga, Japan)
**Feasibility Study**

- Start of the PANSY project 2000
- Field Survey (2002~)
- Development of power efficient class-E transmitters (2003~)
  
  Twice as power-efficient as conventional class-AB transmitters.

  Estimated total power consumption ~75kW

  
  Light-weight. Easy to set up and robust

**Position on JARE plan**

- Proposal was accepted as a principal observation in the VIII JARE observation plan (6 yrs starting at JARE52 (FY2010))
- Funded by the economic stimulus package by Japanese government in FY2009
## Construction and observation time schedule of the PANSY radar

<table>
<thead>
<tr>
<th>FY</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training system “Sumire” at the MU observatory with 22 antennas</td>
<td>manufacture</td>
<td>Start operation</td>
<td>Feedback as needed</td>
<td></td>
</tr>
<tr>
<td>Radar system at Syowa Station in the Antarctic</td>
<td>manufacture</td>
<td>Start observation with a limited system</td>
<td>Start observation with a full system</td>
<td></td>
</tr>
</tbody>
</table>

- FY2010: Startup of basic observation (e.g. turbulence echo observation) with 3 groups
- FY2011: Startup of multi-receiver system
Training system “Sumire” (2% model) at the MU radar observatory in Shigaraki, Japan

Sumire is used to confirm the radar system performance and for training the operator at Syowa Station.

Configuration
- 19 main antennas (1 group)
- 3 FAI antennas
- Receiver of 4 channels

Currently observations of $1\mu\text{sec} \times 8$ bit Spano codes in 5 beam directions were successful.

“Sumire” is Japanese name for small violets
8bit Spano code observation

Vertical
N
W
E
S
(Azimuth = 10°)
JARE51 wintering members cleared snow completely, before JARE52 members arrived for radar construction!
The first state of the radar construction that should be made this austral summer is to make antenna bases.

Start constructing 1098 bases
New year day
January 9, 2011

100th antenna base
The radar hut construction started.

January 16, 2011
500th antenna base

0 50 100 150 200 250
South–North (m)

0 50 100 150
West–East (m)

+ Base Only (426)

Antenna Construction Status at 20110123

January 23, 2011
February 1, 2011

Antennas and modules
February 11, 2011

The radar hut construction is completed.
The last (1098th) base was completed on Feb 15, 2010.

Kanpai! Cheers! Prosit! Toast! Tintin! ….
Sunshine duration in January

Antarctic Oscillation Index

The worst meteorological condition!
Comprehensive study of the polar atmosphere using the PANSY radar, in combination with various observations and high-resolution numerical models.

- Fine resolution observations of three dimensional winds in the troposphere/stratosphere/mesosphere & plasma parameters in the ionosphere
- A quantitative study on the momentum balance including gravity waves
- Virtual atmosphere model simulations
- Will start in early 2011.

Pre-existing instruments at Syowa Sta.

- Coordinated observations on the vertical coupling of the Antarctic atmosphere
- High-resolution global models