Rosetta (pictured), and ESA's JUICE mission will target Jupiter's icy moons. There is every chance of new insights into deep-space chemistry.

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Chasing ice: studying the stability of the Western Antarctica Ice Sheet

Out of all the world's glaciers, Pine Island Glacier (PIG) is currently making the single biggest contribution to global sea level rise. Scientists are trying to figure out why.

Tractor traverse on Pine Island Glacier. (Credit: Damon Davies)

Clinging onto the edge of western Antarctica, PIG is the fastest shrinking glacier on the planet. With 56 Gt of ice careering into the ocean each year, knowing the future stability of the ice sheet is essential.

"The West Antarctica Ice Sheet (WAIS) is a glaciological hotspot," says Andy Smith who works at the British Antarctic Survey (BAS) in Cambridge, UK. "At the moment, the area is contributing the largest amount to global sea level rise – at around 3 mm per decade. Although this doesn't sound much, the little changes add up over time."

With the return of the sun to the southern continent, scientists from BAS are kicking off the 2014 PIG research season. They will be setting off on the second of a 1000 km trek across the ice to measure snow accumulation at the top of the glacier. As they go, they will record snow density, collect ice cores and gather historical clues from rocks and isotopes to see how fast PIG is changing. "Over the six-year period we have been studying the melting so far, it has been getting worse," says Smith. "However what we don't know is if this is going to carry on or even off."

Living on the ice

To answer this question, the team will be spending 70 days living on the ice in temperatures barely reaching above -10 °C. Going out into the field involves transporting 80 tonnes of equipment including two tractors, tents, science kits and a shipping container, revamped into a dining room.

"Doing this means the science can happen more efficiently," says Simon Garrod, Field Operations Manager at BAS. "When you're living in the snow, a significant amount of time must be spent just living – pitching tents and melting snow for water. Being able to pull your dining room along with you means you have more time for science."

By pitching their tents at such chilly latitudes, they hope to figure out what's going on at PIG. "The reason why we think its changing so fast is because it's being forced by what's happening in the ocean," says Smith.

As warm water currents in the Amundsen Bay meet the underside of glacier's ice shelf, they speed up the melt. The amount of ice loss more than doubled in the past couple of decades. Ice discharge between 1992 and 2011 was reported at an average of 20 Gt per year but is now reaching 56 Gt per annum, which is equivalent to removing a block of ice 100 metres deep and about 1000 square kilometres wide from the ice shelf each year.

The WAIS is more vulnerable to oceanographic changes than the eastern side because the sheet sits on ground below sea level. The grounding line, the point where the ice lifts off the bed rock and starts

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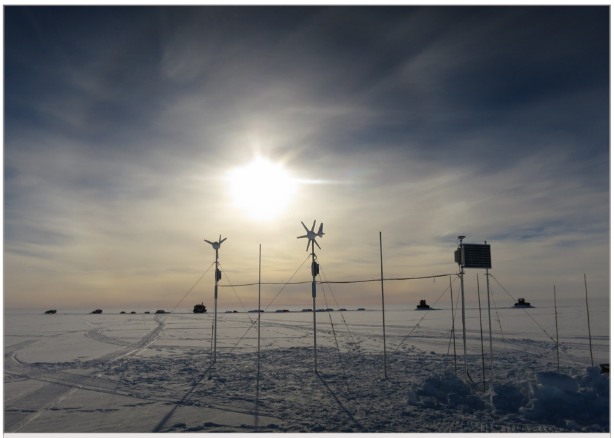

GPS stations on the glacier with the base camp in the background. (Credit: Jan De Rydt)

to float, has retreated by tens of kilometres. For example, between the same period of 1992 to 2011, Rignot et al. (2014) suggest PIG retreated 31 km at its centre. This means it was 400 metres deeper below sea level in 2011 than in 1992. As the ice recedes, the ocean drains into the grooves at the bottom of the glacier, which reduces the friction on the glacier bed. The ice starts to fast-track downhill into the sea. "It's like removing the brakes," says Smith.

The PIG team setting out in October are part of a larger project called the Ice Sheet Stability Research Programme, or iSTAR, of which Smith is the Science Programme Manager. As part of this project, data from nunataks – exposed areas of rock peaking out of the ice – will be combined with information collected by atmospheric balloons, by airplanes dropping sensors in crevasses and by ships, which will create the most integrated picture of a glacier ever attempted. "BAS is doing what no one has done before by studying the ice and the ocean in an integrated method of the whole system," says Smith.

Curious assistants

Hungry elephant seals are also playing their part to fill in the missing data gaps. Last year, scientists tagged female elephant seals with ocean profile collectors. As the seals dive down to hunt for food, the tags collect data on conductivity, temperature and depth. When they resurface, the data are beamed back via satellites to the University of St Andrews, UK.

"The seals give us a mass of data in places we just can't get to observe," says Michael Fedak, a biologist from the University of St Andrews. "They have been working their tails off since we tagged them."

The seals have so far collected almost 9000 ocean profiles around the edge of the ice shelf. In comparison, the ship in the same location managed to gather 120 profiles.

Being able to tag the females gave the researchers an unexpectedly complete record. Only male elephant seals had previously been seen on Edwards Island near the mouth of the glacier as they complete their annual moult. But males have one downside: they have the habit of going on a mid-winter break from feeding to take a rest onshore.

The females are different. They are out hunting at sea for long periods of time and do not require a break, diving intensively for up to 300 days to put on weight for breeding. So for the data record, this means a more comprehensive and uninterrupted profile.

"We were really surprised to find the females in [Amundsen] Bay. They are doing something not seen anywhere else so far south in the world – benthically feeding at the front of the glacier," says Fedak. "This was an odd place, as usually at this time of year the females are far out at sea intensively feeding and putting on body fat ready for producing pups – which use up to 35 per cent of their body mass."

Close-up of juvenile southern elephant seal. (Credit: Serge Ouachée)

The observations are combined with a wide range of oceanographic sampling methods from ship transects, sea gliders and underwater submarines. The information gathered from the water bordering the glacier will help the scientists build models to predict how much of WAIS could be heading seaward.

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