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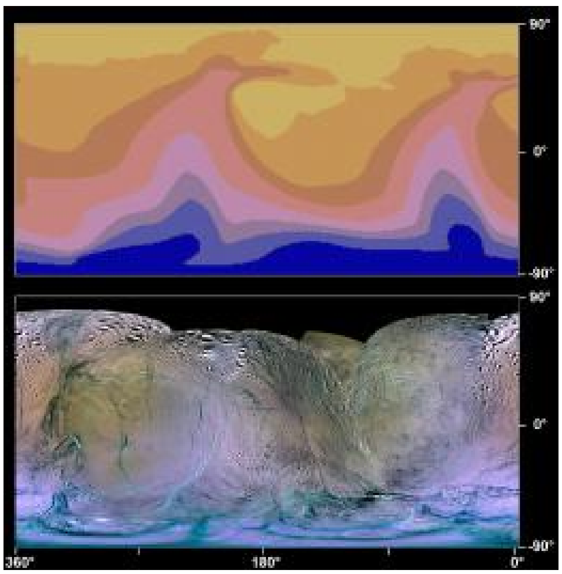
Enceladus weather: Snow flurries and perfect powder for skiing

October 3 2011

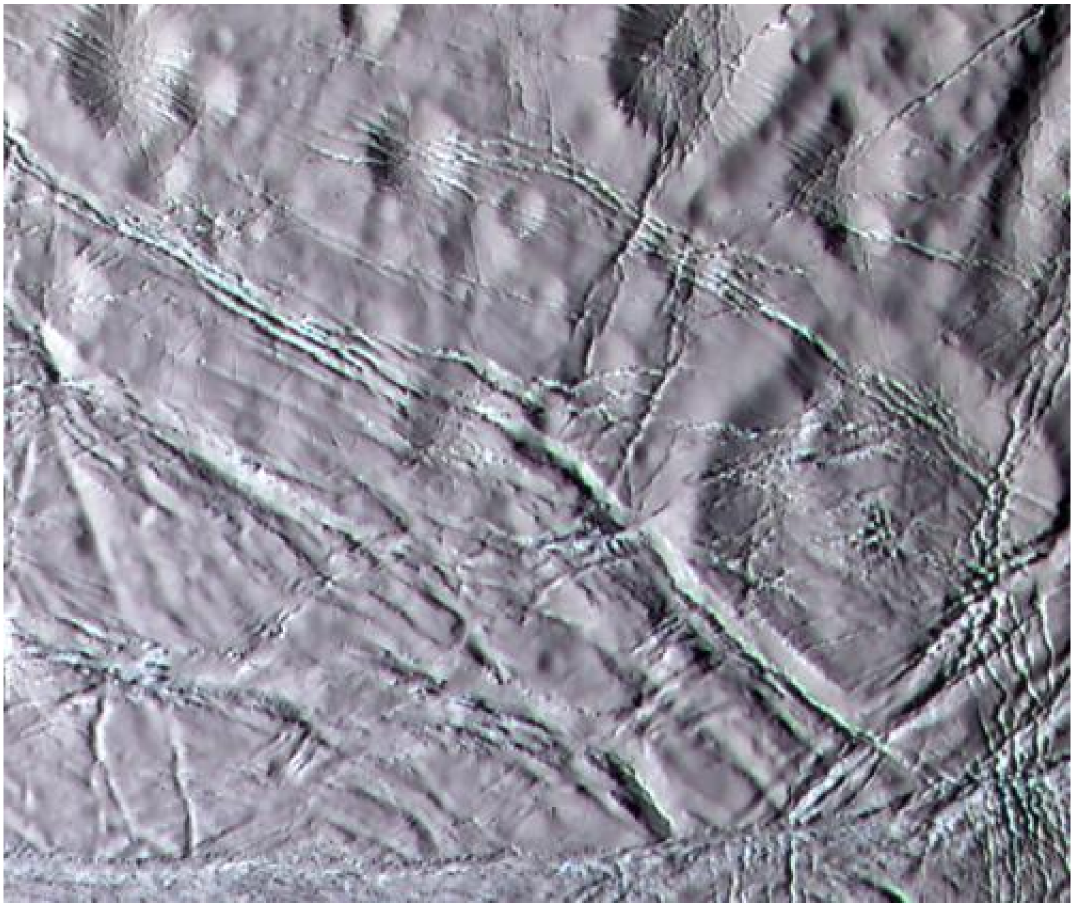


Global signature of frost deposition on Enceladus revealed in colour mapping. The top map shows a colorized map of the predicted pattern of fallout from Enceladus's icy plumes (bus represent thicker accumulations), with the global colour patterns observed by Cassini imaging camera. The bottom map is the global 3-color map of Enceladus showing areas that are relatively bluer. These areas correspond very well with areas predicted to have a deeper accumulation of plume-generated ice particles, or "snow". The global colour map takes advantage of Cassini's sensitivity at ultraviolet and near infrared wavelengths and shows an enhanced colour sensitivity compared to what our eyes might see. Plume deposition map from S. Kempf and J. Schmidt; global colour map from P. Schenk.

(PhysOrg.com) -- Global and high resolution mapping of Enceladus confirms that the weather forecast for Saturn's unique icy moon is set for ongoing snow flurries. The superfine ice crystals that coat Enceladus's surface would make perfect powder for skiing, according to Dr Paul Schenk of the Lunar and Planetary Institute (Houston, Texas), who will present the results at the EPSC-DPS Joint Meeting 2011 in Nantes, France on Monday 3rd October.

Mapping of global colour patterns and measurements of surface layer thicknesses show that ice particles fall back onto the surface of Enceladus in a predictable pattern. Mapping of these deposits indicate that the plumes and their heat source are relatively long-lived features lasting millennia and probably tens of million years or more, and have blanketed areas of the surface in a thick layer of tiny ice particles.

"The discovery by instruments aboard the Cassini orbiter that there's a currently active plume of icy dust and vapour from Enceladus has revolutionized planetary science," says Schenk. "Earlier this year, we published work that showed material from Enceladus's plumes coats the surfaces of Saturn's icy moons. Now, we've uncovered two lines of evidence that point to thick deposits of plume material coating the surface of Enceladus itself."

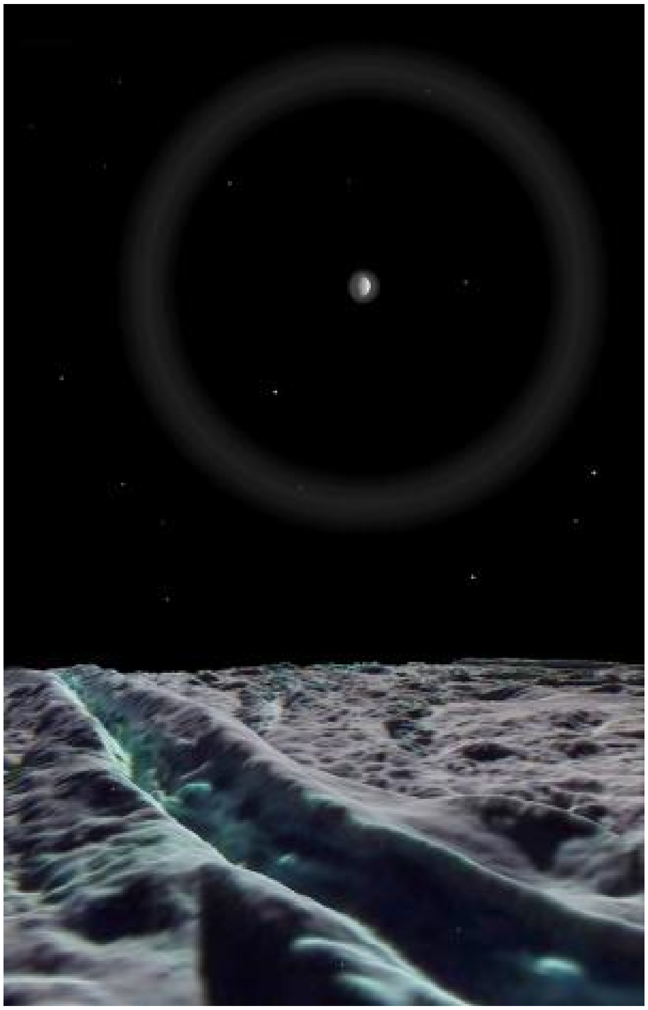


Cassini colour image of "snowy" landscape of Enceladus. This terrain lies north of the geologically active south polar ridges and features a rolling terrain crosscut by narrow fractures. These recent fractures have rugged edges with a distinctly bluish colour indicative of recently exposed ice. The rounded craters and older fractures have morphologies characteristic of thick accumulations of fine particulates, in this case fine particles of ice falling to the surface form the giant plumes to the south. This "snow" may be as much as 100 meters (325 feet) deep. The large fractured and "snow" covered crater at right is 22 kilometres (14 miles) wide. Resolution is approximately 70 meters (feet). Processing by Dr. Paul Schenk (Lunar and Planetary Institute, Houston).

Models of plume particle trajectories under the influence of Saturn's gravity show that some particles return to Enceladus in a distinctive pattern. This work by Dr Sasha Kempf of the Max Planck Institute and

Dr Juergen Schmidt and colleagues at the University of Potsdam published in 2010, predicts that the heaviest accumulation will be along two longitudes on opposite sides of the satellite. Global colour mapping of Enceladus by Schenk and colleagues also shows a globally symmetric pattern of bluish material along two longitudes on opposite sides of the satellite. Comparison of these two maps shows a very close correspondence in the predicted and observed patterns, confirming the prediction of particle deposition on the surface of Enceladus.

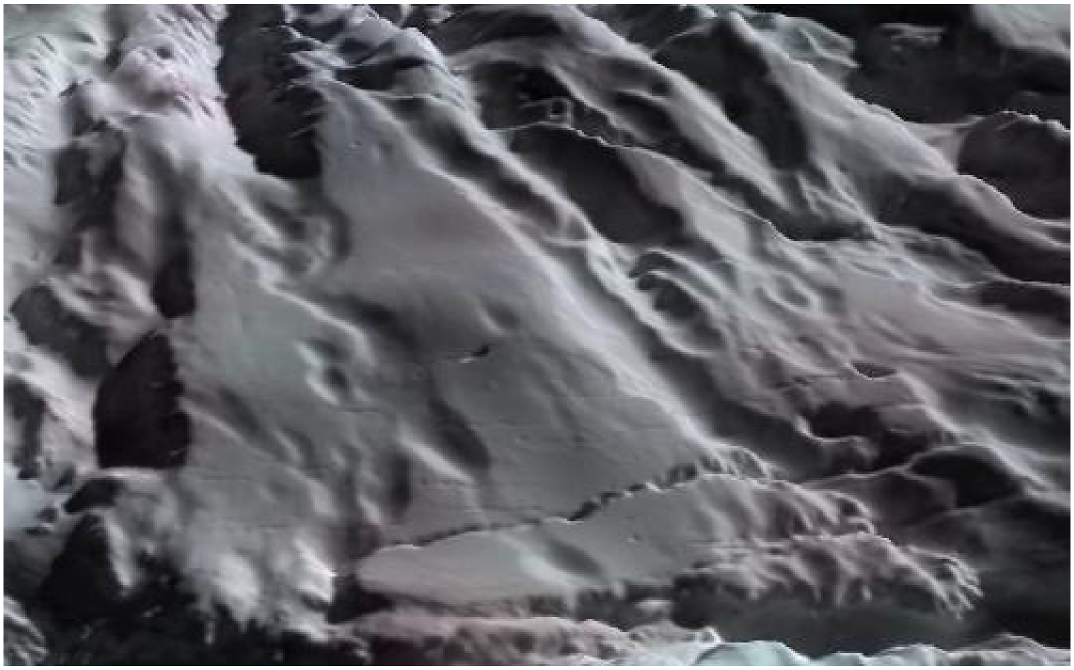
Confirmation of plume fallout led Schenk and colleagues to search for physical evidence of plume particle accumulation on the surface. They examined the highest resolution images north of the plume formation sites; the best of these has a resolution of 12 meters. The image reveals unusually smooth terrains with ghost-like topographic undulations indicating burial of older fractures and craters. Mapping the topography of the site at high resolution, they also found changes in slope along the rims of many of the deeper fractures, or canyons. The larger of these canyons are 500 meters (1650 feet) deep and 1.5 kilometres across, not unlike the Black Canyon of the Gunnison in Colorado. These breaks in slope occur approximately 75 to 125 meters below the rims of the canyon walls and correspond to elevations where more rugged crustal material is exposed part way down the canyon walls.



Artistic rendering of the surface of Enceladus. One of the active "tiger stripe" ridges crosses the scene in the foreground, its active areas a strong blue colour indicating freshly exposed water ice. The ridge is 5 km wide and rises 300 meters high (3 miles wide and 1000 feet high). A hazy bright Mimas hangs over the scene, surrounded by a faint moon ring or halo formed by refraction of light by fine snowy particulates slowly falling to the surface. These small grains originate from the active plumes venting from the south polar region. The brightness of the halo is not known but is brightened here for visibility. Perspective rendering of the surface is derived from colour imaging a stereo topography of Cassini images, produced by Dr. Paul Schenk (Lunar and Planetary Institute, Houston).

The ghost-like features on the plains and the slope breaks on steep canyon walls are interpreted as due to the formation of a loose poorly-consolidated material lying on top of more solid crustal ices (the craggy rugged exposures part way down the canyon walls). This layer is believed to be the accumulated plume deposits observed in the global colour mapping, forming a mantling blanket across the terrain. The layer is on average roughly 100 meters (350 feet or so) deep in this area. At least 3 additional sites show similar evidence of burial but the resolution of these images is not as good and measurements of thicknesses there are not yet possible.

So, given what we now know, what might conditions be like on Enceladus itself? The models of plume deposition indicate that the rate of deposition on Enceladus is extremely slow by Earth standards, less than a thousandth of a millimetre per year. To accumulate 100 meters of deposits would require a few tens of millions of years or so. This is important as it suggests that the thermal heat source required to drive the plumes and maintain any liquid water under the icy crust would also have to be similarly long-lived. Without replenishment, the E-ring formed by ejected plume particle would dissipate in tens to hundreds of thousands of year.



Perspective view of "snow" covered slopes of Enceladus. This heavily fractured terrain lies north of the edge of the active south polar region. The largest of these fractures in the foreground is roughly 1 kilometre wide and 300 meters deep (0.6 miles wide and 1000 feet deep). The fainter dimples on the plateaus are actually older craters and fractures that appear to be covered by thick accumulations of fine particulates, sub-millimetre sized ice grains falling to the surface from the giant plumes to the south. At 12 meters per pixel (~40 feet) this view is one of the highest resolution images Cassini has obtained of Enceladus. Perspective rendering of the surface is derived from colour imaging a stereo topography of Cassini images, produced by D. Paul Schenk (Lunar and Planetary Institute, Houston).

What about the surface itself? Could we go skiing on Enceladus?

"Bulky space suits and extremely low gravity aside (the surface gravity there is only roughly 1% that of Earth's), the particles themselves are only a fraction of a millimetre in size, roughly a micron or two across, even finer than talcum powder. This would make for the finest powder a skier could hope for," says Schenk, who admits he has never been on the slopes himself.

While much smaller than the typical snowflake, the persistence of this "flurry" of tiny icy particles gently snowing down from the plumes to the far south is directly responsible for the very slow but steady accumulation of very fine ice particulates, or "snow," across large areas of Enceladus today. Although long suspected, the global colour patterns and high resolution observations are the first direct confirmation and indication of how and where this fallout onto the surface of Enceladus occurs. This accumulation will have important implications for our future understanding of the internal heating mechanism driving the plumes, and for the insulating properties of the surface we see today. Additional work necessary to understanding this phenomenon will require new high resolution images during encounters with Enceladus planned for 2012 and 2015 during Cassini's extended mission.

Provided by Europlanet

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