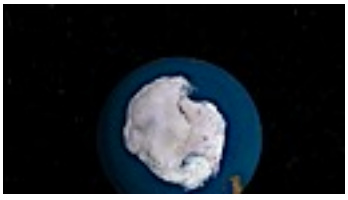
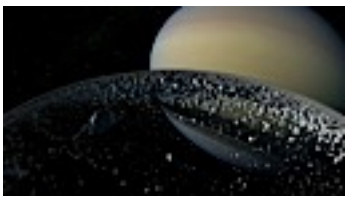
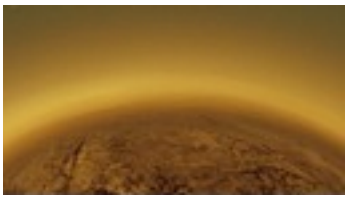
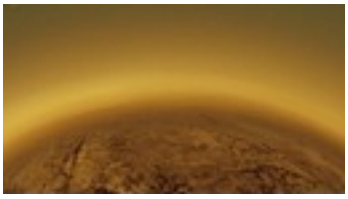
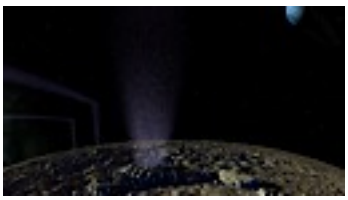
ICE WORLDS 2010

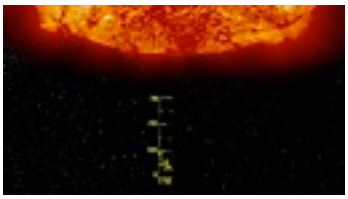
VERSION (SUBTITLES) REVISED: JULY 26, 2013

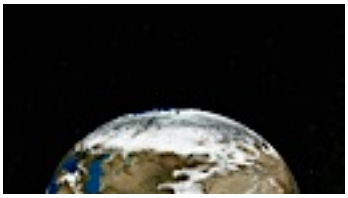
SCENE	TIME	SCRIPT
	00:00	Welcome to Ice Worlds, a tour of the icy landscapes of our solar system - especially our home planet Earth. The International Polar Year has focused attention on measuring changes at the poles of our own planet and on determining why these changes occur. We will explore the ice on Earth and on the other ice worlds in our solar system to understand why Earth's poles are changing, and to determine the role that ice plays in the future of our world.
TITLES		**OPENING TITLES**
	00:30	ICE WORLDS
	00:49	Earth has two polar caps. This one covers the northern part of the planet, the arctic region. It is a huge ice covered ocean, surrounded by land.
	01:02	Submarines can easily travel beneath it. Recent studies indicate that a sustained thinning and shrinkage of this ice cap is under way.
	01:17	In summer, some craft have surfaced at the North Pole itself. It's even possible that by the middle of the century there will be no ice here at all during late summer. Major changes are happening in the arctic and scientists are watching closely.
	01:35	At the Earth's South Pole a vast ice sheet covers the huge continent of Antarctica which is surrounded by the Southern Ocean.

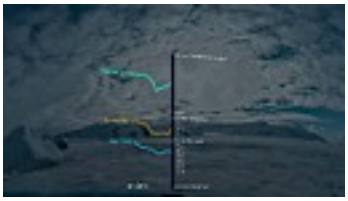
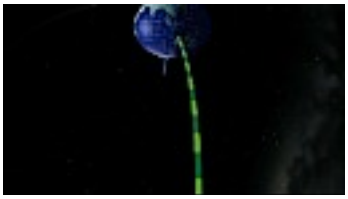
	01:54	Unbroken by other landmasses and driven by powerful winds the trip across this ocean to Antarctica is one of the roughest ocean passages in the world.
	02:07	Around the edge of Antarctica great ice rivers of ice called glaciers flow out to the sea, draining the inland ice sheet. Some of the last unexplored land on Earth lies buried under this blanket of ice.
	02:23	Mountains and even volcanoes peek through and hint at the diverse geology hidden beneath.
	02:36	Specialized instruments have penetrated the two and a half kilometers of ice to allow us to glimpse a picture of this lost world.
	02:49	It's a land as big as the United States with mountains and even lakes and rivers.
	03:03	In this dry valley in Antarctica wind patterns and mountains have prevented ice from accumulating. Here we can step on pristine land, walking on a surface that has changed very little in thousands of years.
	03:20	We know that Earth is not the only planet that can be locked in a cold embrace. This looks like Antarctica but it's actually Mars, a cold dry desert that has been in the grip of an ice age for millions of years.
	03:40	At its Poles there are great accumulations of water and carbon dioxide ice.

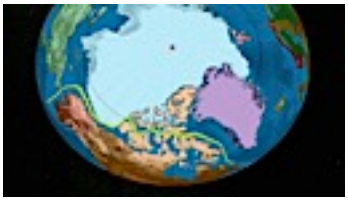
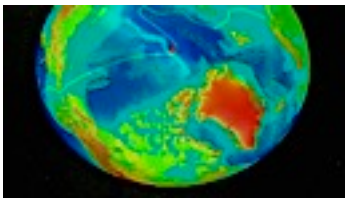
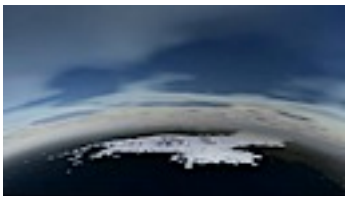
	03:46	Extensive layering of the ice suggests regular patterns of change over extended periods of time.
	03:55	In 2008 the Phoenix spacecraft successfully landed in the Martian Arctic. It detected falling snow as winter approached. The spacecraft also detected chemical compounds favorable for the existence of microbial life on Mars.
	04:16	This is a comet, a dusty ball of ice up to a hundred and sixty kilometers across. As it approaches the Sun the ice vaporizes, filling space with a huge trail. Scientists have speculated that comets furnished the early earth with half its water and perhaps even more complex chemicals.
	04:41	Comets come from beyond Mars. Here in the cold outer regions of the Solar System we encounter some of the strangest ice worlds.
	04:55	Europa is a planet-sized moon of Jupiter. Its icy surface shows signs of recent cracking and refreezing and maybe even floating.
	05:09	Beneath this frozen crust there may be an ocean of liquid water.
	05:14	Future spacecraft will try to probe its depths.
	05:24	Another frozen moon is Saturn's Enceladus. The Cassini Spacecraft has imaged fantastic fountains of vapor shooting out from its southern pole.

	05:37	Smaller than Europa, it still might harbor a watery interior, and the fountains suggest that some mechanism is keeping it warm enough to vent.
	05:52	Vapor from Enceladus might be helping form part of Saturn's ring system. It has been known for some time now that the main rings are formed of car-sized chunks of water ice. Their age and origin though remain a mystery.
	06:10	Even more mysterious is Titan, a moon of Saturn as big as the planet Mercury. We're dropping through its methane clouds with the Huygens Lander. This is a world that resembles the early Earth but in a deep freeze.
	06:28	Because of the extreme cold, ice acts like rock on Titan. There are Ice mountains, volcanoes, and possibly even methane snow. Lakes of natural gas cover vast areas and this chemical broth may harbor some of the most exciting finds for future explorers.
	06:48	Another giant moon, Triton orbits Neptune. Fountaining from its icy surface are giant nine kilometer high geysers. Some unknown mechanism causes them to be blown over by almost ninety degrees.
	07:07	NASA's LCROSS mission recently discovered that Earth's nearest neighbor has ice hidden deep in permanent shadows at its south pole. A NASA radar instrument on an Indian Moon probe has also found over six hundred million metric tons of water ice on the bottoms of craters at the Moon's North Pole.
	07:36	In our solar system, ice worlds greatly outnumber the actual planets. Far from being a dead cold substance, ice is very active, and very abundant. Some worlds even have volcanoes erupting through an icy surface. In 2010, a volcano under a glacier in Iceland spewed an ash plume to a height of over 10 kilometers. The jet stream carried this ash over the United Kingdom and northern Europe, grounding air travel. Larger eruptions can send ash higher and have an even greater effect on the earth's climate.

	08:27	The 1815 eruption of the Tambora volcano in Indonesia injected aerosols high into the upper atmosphere. This ash reflected sunlight, leading to a drop in global temperatures and a year without a summer in Northern Europe, Northeastern Canada, and the United States. The eruption of Mt. Pinatubo in the Philippines in 1991, made a similar, though more moderate impact on the climate.
	09:05	Solar Radiation reaching a planet's surface has a dramatic effect on temperature and ice melt. The Sun's brightness changes slightly from year to year in an eleven year cycle. This sunspot cycle, coupled with longer term variation in solar activity, is one of the processes that can lead to moderate global temperature changes on Earth and on the other planets.
	09:37	Earth is not the only planet with ice, but it is the only planet with liquid water. Much of the Sun's heat is absorbed by earth's tropical oceans, and carried around the globe by ocean currents moving from the hot equator toward the poles with returning cold, salty water at greater depths. Europe gets as much as thirty percent of its heat from such a current called the Gulf Stream. Changes in the arctic could slow this process or even switch it off.
	10:11	Earth is unique in having water on its surface in all three states; solid ice, liquid water, and water vapor. Liquid oceans absorb solar energy while ice covered polar caps reflect it.
	10:28	An iceberg is a reflector, floating on an absorbing ocean. Water gets less dense as it freezes, so icebergs and the ice cover on ponds and oceans float. Seven eighths of a floating iceberg lies below the water line.
	10:45	Ice turning to water, such as an early snow melt, melting ice cover on the ocean, or even the number of icebergs calved into a fjord, can amplify a small temperature rise into a larger change that can affect the whole planet.
	11:03	Every year the seasons cause dramatic changes as Earth's ice caps alternatively grow and shrink with the ice cover increasing on one pole while fading on the other. March is the time of maximum ice cover in the north and minimum coverage in the south. September brings the least ice at the North Pole and the most ice in the South. For both poles the maximum extent of the ice occurs as the Sun returns after the long winter.

	11:43	At the North Pole in winter, the Sun never rises and there are six months of twilight and darkness. Stars seem to circle the horizon as the earth spins. Sometimes great curtains of light called the aurora borealis shimmer in the long winter's night.
	12:05	We see what happens in spring as increasing solar energy melts ice and snow.
	12:12	To search for changes beyond those caused by natural cycles, scientists look for ice records in places like Alaska's Arctic National Wildlife Refuge. Two hundred years ago, this glacier was growing, but now it's shrinking at in increasing rate. The glacier to the right was once part of the McCaw glacier which is moving down the valley on the left. Both glaciers are retreating, leaving behind glacier debris called moraines. The McCaw glacier deposited the red colored moraines near the center of this scene.
	12:47	Much of the arctic is permafrost terrain where the ground stays frozen through the summer. This permafrost tunnel in Alaska lets scientist view the underside of ice wedges that extend over our heads. Mammoth bones and ancient tundra are visible throughout the tunnel walls. Clear striations in the ice were formed over thousands of years. Scientists explore the permafrost tunnel, looking for clues about past climates and future landscape changes. The change in this region of the tundra is more than twenty thousand years old.
	13:33	Scientists extract cores by drilling into the ice for other clues about the changing climate. By late April, the Sun sets around 3:00am on the McCaw glacier, bringing cooler temperatures that make drilling into ice and extracting ice cores much easier. Ice cores are removed in one meter sections from the drill's core barrel. Researchers extract ice cores as long as one-hundred fifty meters, showing over two centuries of climate change on the glacier.
	14:14	Drilling down though this ice like this is like traveling back in time. In places like Antarctica, ice has been laid down from the snows of successive winter for many thousands of years.
	14:27	Ice cores are collected, studied, and stored. In this room ice cores are preserved. Each layer of ice is like a time capsule. It contains gases and materials that reveal the temperature and atmospheric composition when it was laid down. Deep ice cores provide a record that can stretch hundreds of thousands of years into the past.

	15:01	Carrying records like a gigantic bar code, an ice core from Antarctica reveals conditions going back 400,000 years. Here we can read the amount of carbon dioxide and temperature across the ages and compare these data with companion sea level information from sediment cores. The amount of carbon dioxide has shot up since the industrial revolution and continues to climb. Scientists are recording dramatic evidence of an acceleration of ice melt in Greenland and the Arctic Ocean, not caused by the cycle of the ice ages.
	15:43	Periodic changes in the Earth's orbit and tiny wobbles over a one-hundred thousand year cycle have been accompanied by extreme periods of cold temperatures on Earth: the Ice Ages.
	15:57	At the height of the last great ice age about 20,000 years ago ice covered much of North America and Northern Europe.
	16:07	Near where New York is today the ice was over a kilometer thick.
	16:16	During an earlier ice age, a vast ice sheet covered two thirds of the British Isles.
	16:27	The site of present day London is where the advancing glacier stopped at the pinnacle of the second to last ice age.
	16:36	Even during the most recent ice age, there was so much water locked up in the ice that sea levels were lower than today.

	16:44	England was joined to Europe.
	16:46	As the ice melted, sea levels rose, and the British Isles were born, just ten thousand years ago.
	16:54	For centuries, sailors tried to penetrate the ice pack in the arctic left by the last ice age to discover a passage connecting the Atlantic and Pacific oceans.
	17:05	Now with the melting of Arctic sea ice, this Northwest passage has briefly opened through Canadian islands, past the coast of Northern Alaska, and into the Northern Pacific Ocean. This Northwest Passage reduces the ocean distance between Europe and Asia by thousands of kilometers. Melting sea ice may soon open up much of the Arctic Ocean to travel, shipping, and even to off-shore drilling for oil and natural gas.
	17:39	Five bordering countries can claim parts of the Arctic sea floor: Russia, Norway, Denmark (through Greenland), Canada, and the United States. Historically a country's boundary has been 200 nautical miles from its coastline, leaving the central Arctic Ocean unclaimed. However, according to the Law of the Sea treaty, countries can extend their claim in areas that are an extension of that country's continental shelf. Experts estimates that 22% of the world's undiscovered resources, including oil and natural gas, lie off-shore in the extensive continental shelves of the Arctic, bringing additional environmental risk with offshore drilling.
	18:24	An undersea ridge extends from the continental shelf that borders Canada and Greenland over the Pole to Russia's continental shelf. All three nations now claim this ridge and seek to extend their territory to the North Pole. In August 2007, two mini-submarines planted a Russian flag on the ridge near the North Pole. If recognized, this claim would give Russia control of almost half of the Arctic Ocean. The Cold Rush has begun.
	19:04	Towns and settlements in the arctic are adapting to changes in ice cover and to the resulting changes to their way of life. This glacier, near the town of Ilulissat, West Greenland, is one of nature's great bulldozers.

	19:18	In human history nothing has done more than ice to shape our world and drive the climate of the whole planet.
	19:29	Here, beneath a massive glacier, we see nature at its most powerful.
	19:37	Life near the glacier has changed dramatically. With very little ice on the bay over the last decade, travel is very different now. Boats have replaced dogsleds. This is a small sign of possible greater changes, which could affect vast regions of the planet.
	20:01	Researchers are also monitoring large polar creatures that have adapted to the cold and extreme weather changes of the arctic. Found only in the north, polar bears use the sea ice cover of the Arctic Ocean as a platform for hunting seals.
	20:19	As sea ice melts earlier each year, polar bears must flee to shore weeks before they have caught enough food to survive the period of scarce food in the late summer and early fall. Disappearing sea ice will lead to thinner bears, lower birth rates, and lower survival rates for young bears.
	20:41	While polar bears are retreating for melting sea ice during arctic summer, winter is coming to the Antarctic. Ice cover in and around Antarctica practically doubles in size as icy tendrils encroach further into the surrounding ocean during winter.
	21:00	The Antarctic ice cap contains two-thirds of all the fresh water on our world. Only now are we beginning to understand the importance of this to our planet and to life in the Antarctic.
	21:15	Polar scientists are searching for tiny life forms in Antarctic Lakes. Here divers have found life adapted to the bitter cold. Colonies live in mats on the lake bottom, below at least four meters of ice. Eventually these mats float off the lake bottom and rise to the ice above. Some scientists think that Earth life began in tiny pools of water trapped within the ice.

	21:42	Although few plants or animals can survive on the continent itself, or in its icy lakes, the ocean around Antarctica is one of the most prolific spots for life on Earth. Penguins may be the most well known Antarctic animals but the most important and most abundant are krill.
	22:02	Tiny plants called algae cover the sea ice as spring returns to Antarctica. When summer's heat melts the ice, algae released into the water feed the tiny krill. Krill are tiny crustaceans, just a few centimeters across. The become food for a great variety of seals, whales, birds, and penguins. Wherever they are measured, krill numbers have dropped alarmingly in recent years.
	22:28	Antarctica and the arctic present amazing and spectacular ice-scapes. The more we learn, the more we realize the important role these fantastic places play in making our world habitable. The poles of our planet are changing and some of these changes are rapid. Only by observing, learning and taking appropriate action can we ensure that Earth remains a healthy habitable spaceship for us and all its voyagers.
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Music		Shai Fishman
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Executive Producers		Terence Murtagh Kirk Johnson
Producer/Director		Michael Daut
Associate Producer		Dr. Carolyn Sumners
Writers		Terence Murtagh Michael Daut
Art/Animation Directors		Ken Carlson Marty Sisam
Additional Animations		Don Davis
Narrator		Emily Watson
Narration Recordist		Dom Bocher
Music		Alexander Van Bubenheim

Sound Design and Mix		Bob Edwards
Post Production Sound Services Provided By		Skywalker Sound A Lucasfilm Ltd Company Marin County, California
Post-Production Rendering		Bryce Buchannan
Post-Production		Michael Daut
Engineering Support		Neal Mayer Joyce Ringgenberg Mark Bloomenthal Lynn Buchanan Ben Buckwalter Nick Holland Karen Klamczynski Rie Matsubara Brian Moore Melinda Orms Fred Orrell Tammy Pfitzer Stanford Pitcher Kevin Scott Josh Whetstone Boyd Whiting Amy Wright Kathy Wright
Project Administration		Barbara McBride Christy Moore
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Production Management		Narrateo Limited
University of New Hampshire Science Advisors		Annette Schloss Mark Fahnestock Richard B. Lammers Jonathan Pundsack
Houston Museum of Natural Science Crew Animation		Adam Barnes Tony Butterfield
HMNS Curriculum/Software		Claire Parker Bessie Dawson Nancy Llamo Colin Law
Planetary Visions Crew Animator		Andrew Wayne
Planetary Visions Crew Data Specialist		Tim Wilkinson

Planetary Visions Crew Producer		Philip Eales
High Definition & Video Photography		Terence Murtagh
Still Photography		Nicholas Holdsworth Terence Murtach Sue Werner
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