He talks about the Voyager spacecraft, the planets, winds, and clouds the way a child would about a science project at school. Rummaging through a locker in his disheveled office, he finds a round metal box. "Look at this! It's part of the radiometer we used in an early satellite to measure Earth's heat budget." Verner Suomi stares in wonder at the device in his hands. "That was in essence the first sample of solar-energy gain and heat loss over the whole planet. If I built one exactly like it and we flew it again in exactly the same orbit, I could see if there were any detectable changes to indicate warming." He thinks aloud, lamenting that an idea so simple would get buried "in a zillion reviews" at NASA.

Since the early days of exploring space—in the Fifties, when rockets blew up with his experiments onboard—University of Wisconsin meteorologist Suomi has studied the atmospheres of the planets Venus, Uranus, and Jupiter. His photographs and observations, gadgets and insights have changed the way we think about weather and climate. And he is as intrigued by the winds of Jupiter or Venus as by the storms of Earth. "I can hardly wait to see what's happening on Neptune," he says of the Voyager probe that carries sensors and experiments he designed. But as a member of NASA's panel on space station science, he has lobbied for hardware to explore the home planet. "The astronomers want to look out, but there's some urgency to looking down," he remarks.

Over the years atmospheric scientists have refined their theories and tested their equations in relative obscurity. For about 80 years one idea kept reappearing in their journals and papers: something about greenhouse effects. But no one seemed to care much about it—until recently.

PHOTOGRAPH BY ALAN D. LEVENSON
In 1988 a NASA scientist told Congress that global warming had begun. Then climatologists from the British Meteorological Office said the Eighties had seen the hottest years in a century. As the Environmental Protection Agency was warning of catastrophe, drought struck in the Midwest, a furious hurricane wrecked Jamaica, and weird weather everywhere affected everyone.

A cordial gathering of planetary researchers grew rancorous when atmospheric modeller William Kellogg declared, "We are in the grip of irreversible warming." Climatologist Arnold Court called Kellogg "Chicken Little." A few researchers proposed big policy responses, including a climate modification scheme whereby a group of nations would spread dust in the stratosphere to reflect sunlight and cool the planet.

Into the fray stepped the mild-mannered Suomi. He asked his colleagues to calm down, get more measurements, and fix up their computer models before scaring people. "We are not in a position to make comforting statements or dire predictions," he said. "A few degrees of warming over the whole planet is not in itself so important. It's what happens to the circulation and the weather. We haven't done the experiments to forecast that." The change in atmosphere—an increase in gases like carbon dioxide (CO₂) and methane—is real and dramatic, Suomi says. And greenhouse effects are well-known. The gases trap heat at the planet's surface. At this point consensus goes out the window, and questions breeze in. Is there evidence of warming? Can oceans absorb more CO₂? Will unseen changes, such as increased cloudiness, cause cooling?

Suomi is not one to sit by and speculate while the atmosphere's at stake. Scratched in Magic Marker colors on his office wall are plans for probing the question. How does the atmosphere interact with the water, ice, land, and plants? "Only by treating Earth as a unified system," he says, "can science find out what's happening and show us what to do."

Suomi's work puts fear of warming in perspective. When Hurricane Gilbert struck, observers said it was the "most severe hurricane ever" and blamed a hotter-than-usual ocean. But 1966 was the first time meteorologists ever photographed a hurricane. That's when Suomi's spin-scan camera aboard an Applications Technology Satellite yielded the first pictures of weather forces in motion over the planet. Only recently have researchers begun to measure ocean temperatures. It was in the Eighties that Suomi finally got sounders—infraed scanners that detect atmospheric temperatures—on geostationary satellites. NASA had been resiting the idea for a decade. And only since the late Seventies have climate modelers plugged numbers into equations that predict the greenhouse effect. From 1959 to the late Seventies Suomi spearheaded the Global Atmospheric Research Project, engaging scientists from 60 nations to measure and quantify the atmosphere.

Suomi was born in the small mining town of Eveleth, Minnesota, in 1915. His father was Finnish and his mother, who was of Swedish descent, came from the Aland Islands in the Baltic. His parents spoke Swedish to Verner, his brother, and five sisters, and the children replied in English. Suomi's father was a carpenter for a mining company, and using his father's tools likely contributed to Suomi's love of making things. He earned a Ph.D. in meteorology at the University of Chicago, where he studied with the renowned meteorologist Carl-Gustaf Rossby. After joining the University of Wisconsin faculty in Madison in 1948, he became chairman of the meteorology department in 1950. In 1966 he founded the Space Science and Engineering Center at Madison with a grant from NASA to develop spacecraft instruments. Director until 1988, he retired to become a professor emeritus. Today McIDAS, a system Suomi created to connect satellites with computers for the study of planetary atmospheres, whirs away in room after room of the center's 15-story building. McIDAS imaging systems are used by NASA launch teams, planetary scientists, severe-storm centers, and meteorologists in many countries.

Suomi entered the space race at the beginning, in 1955, when he built his radiometer. Those were pioneering days, when a young scientist could build an instrument, go to the Cape, and see it launched. His first radiometer fell into the sea on a Vanguard rocket, and his second burned up when a Juno rocket exploded. Newspaper reports from July 1959 describe it crashing in flames 50 yards from the blockhouse, trapping scientists inside for hours. "We could see the flames through the window," Suomi remembers. "When they let us out, I looked for our equipment, hoping we could use it again on the next launch."

Journalist Paul Bagne interviewed Suomi in his office at Madison. Over Suomi's desk are two 16-20 inch photographs: one of Earth, the other of Jupiter. As Suomi leans back in his chair, his voice takes on a Swedish lilt when an idea excites him. When talking about clouds, he goes to the window at one end of the narrow room to scan the sky.

Omni: Why did you choose meteorology as a career?

Suomi: When I took flying lessons the adiabatic chart in a pilot's handbook caught my imagination. The adiabatic chart told what happens to the atmosphere at different elevations or when there's water in it. World War II came along and the draft board was breathing down my neck. One evening I heard Rossby on the radio saying the war effort needed meteorologists. That got me involved. It was a happy accident. And the University of Chicago was absolutely the place to be. The Rossby wave—the jet stream—narrow rivers of high-speed winds encircling the globe about six miles up—was discovered there. Rossby encouraged someone to measure the heat budget of Earth. Omni: We didn't hear much about spacecraft Voyager's encounter with Uranus in 1986. What did you find out?

Suomi: In the middle of it the Challenger tragedy occurred, so excitement about our project just vanished. That's the way we left it, all saddened. But it's clear the encounter was a roaring success. You know, the TV camera we had onboard was really lousy: It had the speed of an old Kodachrome 1, with an ASA sensitivity to light rating of eight. Today you go into a drugstore and buy film with a rating of a hundred or thousand. I held that Vidicon in my hands once. My mistake was not dropping it on the floor.

Because Uranus receives four hundredths the sunlight of Earth, and the craft is zipping along at sixteen thousand kilometers per hour, if you take a time exposure with this camera, everything will blur. Well, these characters at JPL [the Jet Propulsion Laboratory in Pasadena, California] put a fictitious drift into the guidance system, fooling the craft into thinking it was off course, so it kept turning toward the planet. And the camera did so well that craters on some smaller satellites of Uranus came out round, just as they should. But oh, man, the camera-pointing mechanism got stuck, and there was a sticky bit in the computer memory, and they changed the program just hours before encounter. That takes guts! Well, we scientists got the pictures back, but the engineers made it possible.

Omni: What's Jupiter like?

Suomi: The scale is unimaginable. You could fit four Earths into this storm, the Great Red Spot. It's wound tightly. Winds blow at tens to hundreds of meters per second. There's a jet going around the Great Red Spot where the wind blows
fastest, like the top of a hurricane.

Omni: How can a storm like this persist?

Suomi: I think it's hurricane-like. On Earth, a hurricane is stable as long as it has warm water under it as a heat source. The bigger it is, the more stable it's likely to be. Perhaps this is the same—with Jupiter's interior as a great heat source to keep it running. We are trying to understand these phenomena with very few measurements. It's almost like the early meteorologists trying to understand what was happening on Earth.

Omni: You like simple ideas.

Suomi: In the early days, with just a transmitter going beep, beep, beep, we could tell the shape of the earth, its density, many things. These days we want to make things more complicated. Look at the bottom of the Vostok [a Soviet rocket]. There are many engines, each no bigger than a garbage can, not counting the nozzle. It's simple. The instabilities in a small engine are easier to control, and you can assure quality in production. Ours are bigger, more complicated, and efficient—but theirs are flying.

Omni: How did you get started in the space program?

Suomi: In 1953 I wrote a thesis called "The Heat Budget of a Cornfield" at the University of Chicago. About the time I graduated, everyone was excited about the use of satellites for meteorology. We had seen cloud pictures transmitted from rockets like Viking and Aerobee. I had no experience in space technology, but I proposed a sensor on a satellite to measure the earth's heat budget—just as I'd measured the heat budget of a cornfield. We were working on the satellite when we heard the Soviets had put Sputnik into orbit. When we heard their satellite weighed eighty pounds compared with our twenty-pound thing, that hurt. It was an emotional experience to be at the launch of my radiometer. When the second stage of the Vanguard rocket failed and my gadget fell into the ocean, it was almost like a death in the family.

Omni: When you finally got the radiometer into orbit on Explorer 7 in 1959, you collected data from your bedroom.

Suomi: We had many stations around the world, each with a radio tuned to fifty megahertz, a tape recorder, and a clock. I collected the [satellite] overpass of Wisconsin from my bedroom. In the middle of the night you could hear it going ee-ahh-ee-ahh. Instead of the megabits we talk about now, our rate was two bits per second. But we got plenty of information. With it we were able to see in a fairly crude way the energy input to Earth and the energy loss. We got patterns of the long-wave radiation. Lo and behold, they showed a variation of heat loss over a weather system or a high-pressure area. That didn't square exactly with the theory, and the albedo [reflected energy] we got—twenty-nine percent—was a lot less than the estimate. With all of today's fancy gadgets, we figure it's about twenty-nine and a half. So our simple gadget didn't do too badly.

Omni: Your next invention, the spin-scan camera, is the basis for weather satellite imagery, all the pictures on the evening news. Where did you get the idea?

Suomi: There was an article in an electronics magazine about this Applications Technology Satellite NASA planned to launch into geo [geostationary] orbit. It would spin at about one hundred rpm. I thought a telescope on it could scan the earth. With each swath of the satellite's turning, the telescope's mirror could be tilted down one step out of twenty-four hundred, so the whole planet could be scanned and photographed after twenty-four hundred revolutions.

The idea occurred to me in maybe five minutes. I did an experiment in my basement to simulate conditions in space. I needed sunlight, a scene, a spinning camera. The sunlight was already there—shining through a dirty window. To create the scene I took a paper plate and marked little grooves on the fluted edge with a pencil. The white of the plate was bright like the clouds we'd be scanning from space, and the pencil marks were dark like the ocean would be. Then I made a mock-up of the camera. I took a lens, and behind it I set up a photomultiplier tube [to detect and amplify light]. I picked a hole in a sheet of aluminum foil and put that in front of the tube so only a spot of light would come through—like the tiny streak of Earth the camera would see as it spins. When put together, the streaks would make a TV picture. There was no way I could spin my camera mock-up, so I got an electric fan [laughs] and stuck the paper plate to the blade—to spin my scene instead! I aimed the lens on the edge of the plate and turned on the fan. Guess what? I got nice clean signals from the tube. I knew my idea would work.

The problem of stability was not yet solved. The telescope on one of the Vanguard satellites tumbled, and the data got scrambled. Even though the camera eventually got onboard, people were betting it would never work. I wanted to watch the launch of the first camera, but every time I went to the Cape, something blew up. I figured I was a jinx. Finally I watched it at Goddard Flight Center [in Greenbelt, Maryland]. It went up.

Omni: What did you learn from those first pictures?

Suomi: From a geostationary platform the weather moves, not the satellite. This was the first time we could see weather in motion! It was beyond our comprehension. Instead of the atmosphere being truly turbulent and random, we found a surprising degree of organization—clouds that looked like someone was pulling taffy across the sky. What we saw partially changed our idea about the structure of
a storm. It also gave us a better idea of how large-scale weather controls small-scale events. The biggest change in our thinking came in the tropics, where there were very few weather stations.

Omni: You realized satellites wouldn't help forecasting until you learned how to process their data quickly.

Suomi: We had to wait twenty minutes before the picture completed its scan so you could reet the tape back up and look at it. So when we'd call a pilot and say, "Look out for the turbulence ahead," he'd say, "Thanks, I'm already in it." Or we'd call up a sheriff and say, "There's a big storm on the way," and he'd say, "Get off the phone! I have an emergency." They had a very low opinion of forecasting. We had more data coming in from space and the ground stations than we could use. So we developed McIDAS [Man Computer Interactive Data Access System].

This building is a kind of headquarters for McIDAS, with data on weather around the globe coming into the satellites—millions of bits at once. The satellites are spinning once every six tenths of a second. When they look at Earth, they gather information, when they look at space, they send it. We distribute data and pictures all over the country by phone line. Meteorologists can zoom in, overlay a grid, look at pressures, winds. With McIDAS navigation they can tell within a kilometer or two where a storm is. McIDAS today is so far beyond what I first had in mind it isn't even funny. I was just anxious to get pictures on the screen. Today we use it to study storms on Jupiter.

Omni: What's the weather like on Venus?

Suomi: Virtually unchanging, a steady state compared to Jupiter or Earth. We're still wondering about the basic driving mechanism—why the winds are so high. The atmosphere is almost all carbon dioxide. Near the surface, temperatures are about seven hundred degrees Kelvin: hot enough to melt lead.

Omni: Is Venus heated by a runaway greenhouse effect?

Suomi: That would mean a lot of sunlight filters through gases and particles in the atmosphere and strikes the lower layers to heat them. Then these gases and particles block the heat from radiating back into space. But our measurements show that seventy-seven percent of the sunlight striking Venus is reflected back by the clouds. Of the solar energy that isn't, about eighty percent still can't get through the clouds and is absorbed way up high. So only about five percent of the sunlight does get through. Its heat—trapped by CO₂, a near-perfect insulator—robs the surface layers to high temperatures. It's a measly greenhouse with a large effect.

Omni: Some say what happened to Venus could happen to Earth.

Suomi: If you were to get all the CO₂ out of the limestone, plants, and animals on Earth, you'd get as much as there is on Venus. But Earth's water and plants absorb CO₂. If you look in a coal bin you can sometimes see the imprint of a leaf. That's CO₂ absorbed from the atmosphere. Clearly, if we released all the carbon as CO₂, it would be a hell of a lot different on Earth.

Omni: Is Earth warming?

Suomi: I don't know. Nobody knows what normal is. Over the last two hundred years, climates may have been different. We are looking for a lousy degree or part of a degree over decades. And each day the temperature goes up and down thirty degrees. That's a very noisy signal.

Omni: Some British climatologists say the warmest years since measuring began in the late 1700's occurred this decade.

Suomi: One of them did an analysis of temperatures from ships. If you put a thermometer in a bucketful of sea water on a hot deck, sometimes the temperature goes up—not because the ocean has changed but because the deck has. If I take the temperature from one measly

ship in an area not traveled much and make it apply to a big chunk of ocean, I've made an enormous mistake. The sampling of ocean temperatures is terrible. And Earth is three quarters ocean.

Even on land you can't be sure. Most weather stations are in cities that get warmer as they grow. In the summer the city, versus the country, may be five to six degrees hotter from all the concrete and blacktop. As trees grow or get cut down, the exposure to detect tiny differences that might indicate global change.

Omni: What was the intensity of Hurricane Gilbert's evidence of warmer seas?

Suomi: We have no evidence the ocean is warming. We are just starting to get accurate temperatures of the tropical seas from satellites. A hurricane is a closed system. Its energy comes from the ocean right below it. Hurricanes dissipate when they graze land or turn north over colder water. The heat source is cut off. If the track is over warm water, say along the Gulf Stream, a hurricane can intensify. If the ocean warms, we will probably get more and perhaps stronger hurricanes. Their strength, as did Gilbert's, depend on the path.

Omni: Was last summer's drought caused by the greenhouse?

Suomi: Ordinarily the middle part of the United States is a kind of low pressure area, or "trough." Last summer it was just the opposite: a big, blocking high pressure in the middle with troughs on the coasts. The reason for that hot, dry summer is obvious: The jet stream had changed. But why? Some said it was the greenhouse. I just saw a paper by Kevin Trenberth of the Center for Atmospheric Research, however, showing it was due to a change in circulation [the way the atmosphere spins around the planet]. Trenberth showed that cold Pacific water and dry air at the equator caused warm water to settle farther north than usual. Satellite pictures showed this region, with its thick cloud cover and heavy rainfall acting like a rock in a river, diverting westerly winds northward. This pushed the moisture-bearing jet stream into Canada, allowing high pressure to build over the drought area.

Omni: Some meteorologists forecast drastic regional changes driven by the greenhouse. Is their work flawed?

Suomi: Our problem is we have a theory of weather but no theory of climate. Weather depends on the initial changes in the atmosphere—where it's warm, cold, windy, and so on. We assume the boundary conditions to be stable. Dry land is a boundary condition, as is the ice, snow, and ocean. And there's a lot of interaction between all these parts of the system. Climate depends on changes in boundary conditions. If it's dry over the Midwest, as it was last summer, it's also hot, because with no water to evaporate, heat goes to warming the atmosphere. The earth's climate is shocked violently every winter and summer. Why it doesn't change more than it does is really a surprise. That's why I say we have no theory of climate. Right now we can't predict accurately enough changes in the boundary conditions.

Omni: Do forecasts of a new ice Age have any credibility?

Suomi: In this millennium Earth is closest to the sun in January. In eleven thousand years it will be farthest from the sun in January—and it's going to be much colder. There was a lot of excitement and many stories about this idea. Forests were going to disappear and so on. Planetary changes are all very subtle, and cooling is on a scale of thousands, maybe tens of thousands, of years. Now we're concerned with a potential
change in a much shorter time. If optically active gases in the atmosphere increase as projected and the greenhouse accumulates, it will get warmer. Not in ten years but maybe in fifty or a hundred years. Then you're dam toothin' there could be trouble. We have to be very careful before we say the sky is falling.

Omni: How does cutting a forest change the atmosphere?

Suomi: The amount of CO₂ in the atmosphere fluctuates in a cycle, depending on seasonal changes in the Northern Hemisphere. As plants grow in spring, photosynthesis increases and CO₂ levels drop. Reducing the enormous amount of leaf area in a forest will reduce photosynthesis. If other plants replace trees, they will take out CO₂, too. But if I plant a wheat field, then cut it, I've got stubble. And that's not going to use much carbon dioxide.

Plants are important because they give moisture in the root zone a way to transfer to the atmosphere. In fallow land the ground dries out and acts like Styrofoam. Changing the vegetation, say from forest to grassland, will change the coupling to the root zone. Most plants are shallow rooted, but trees have taproots that go down a long way. And trees tops stand up in the wind like a forest of wet rags drawing water from the ground. Air cools as it flows over a forest. Grassland does not provide that cooling. Cutting down a forest, you disconnect the ground from the atmosphere.

Omni: What do we know for certain about the greenhouse?

Suomi: Carbon dioxide and other atmospheric trace gases are increasing. As you add CO₂, water vapor, and ozone, the temperature clearly goes up. If the CO₂ doubles and stays in the atmosphere, warming will occur, probably about one and a half to three degrees centigrade over a century. As the planet warms, the ocean temperature won't change much but the land's will. And that difference in temperatures is what makes the atmosphere run. Knowing the consequences depends on the quality of the computer models. But with global change we're not talking about publishing a few papers or seeing our theories on the nightly news. We are talking about the habitability of the planet.

Omni: What are the uncertainties?

Suomi: We know the sources of CO₂—fossil fuel, plants, and cars—but we don't know much about the CO₂ sinks [absorbers]. The oceans surface can absorb or release CO₂ over months. The deep ocean can absorb it over a longer time, depositing CO₂ on the bottom through plants and skeletal remains that fall down. We don't know how fast that's going on. Also, the solubility of CO₂ in water decreases as the temperature goes up. If things up if we get it wrong. For years, around Madison we burned our leaves. Then the city fathers decided we should bag and burn them. As the leaves decayed they produced methane. In a subdivision built on a landfill, so much methane leaked that a couple of houses exploded. So the city fathers put in vent pipes. Now, in the bone-dry stratosphere [roughly 40,000 feet and up] one molecule of methane will do as much damage as thousands of CO₂ molecules. Here the windows for outgoing radiation are very clear. Lower down, in the troposphere, there's more moisture, and the ratio is roughly twenty to one. But that's bad enough. And methane's rate of growth is much slower than CO₂'s. Though very low in concentration, methane and other trace gases add up to about half the effect of CO₂, so we can't ignore them.

Omni: What is a model?

Suomi: A beautiful woman to most people [laughs]. To a meteorologist it's synthetic weather or climate. Modeling is done with numbers. In a computer we have around six equations, and we place a grid over the planet. At each grid point are declarations that describe the atmosphere: At this elevation this is the temperature, moisture, pressure, and so on. That's our best estimate of what the atmosphere is like today—the initial condition. But if it's warm over here and cold over there, the atmosphere will rearrange itself. The equations are so powerful that you can play God: You can take Earth and declare the same temperature everywhere, then turn on the sun. Slowly the tropics get warmer and warmer and the poles get colder and colder. Soon you get the global circulation that makes the atmosphere run. In real weather and climate, events are intermeshed, so we go in little steps: This is the initial condition; and this is the atmosphere in five, then ten minutes. A three-day forecast is made up of small intervals. A big computer lets you take smaller steps and get better forecasts. Long-range forecasting, involving longer time scales, is much harder.

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Omni: What role do clouds play in shaping climate?

Suomi: When you look at the ocean from space, it's really black. Its albedo is about four percent. So almost all sunlight hitting the ocean enters and heats it up. If low clouds cover the ocean, the albedo changes to maybe fifty percent! So clouds act like shutters, profoundly affecting the amount of solar energy reaching the surface. The very high, thin clouds out there today don't reflect back much energy to space. When you look at them in the infrared [heat-detecting cameras], they stick out like a sore thumb. So they are keeping energy from escaping. Here's something else. Convective [rain] clouds represent a pipeline from the lower to the upper atmosphere. We call these hot towers. They carry significant quantities of heat upward, but they cover only one percent of the earth, occurring in little chimneys a few kilometers apart.

Omni: Is there any theoretical basis for modeling climate?

Suomi: Jerome Namias at the Scripps Institution of Oceanography, a teacher of mine, invented the term teleconnections. His theory was that if there were a variation in one part of the earth, you'd get one in another. Midlatitude temperature of the Pacific, for example, should relate to the climate in the United States. I said, "Jerome, are you trying to kid me?" Then along came the 1982 El Niño. It was so big, Earth was like a pinball machine that went tilt! After that, everybody and his brother found teleconnections in different parts of the world.

Another example: Radiation measurements from space reveal strong heat sources on Earth. If it's raining like mad, this releases heat into the atmosphere. Same thing over the Himalayas: In summer, with the sun on them, the high mountains act like a heat source. In winter they're cold and act like a heat sink. Other heat sources over Brazil, the Indian Ocean, and so on change global circulation; the monsoons and many other things are affected. If we had a way to evaluate these heat sources, we could put them in a model.

Omni: Would you describe what you call the water problem?

Suomi: Over the years, I've measured the winds on the planet by tracking the clouds. About a year ago I ranked planets according to how much solar energy they got, not counting Mercury, with no atmosphere. Amazingly, Earth gets the most solar energy but also has the lowest winds. The winds ought to be blowing like mad on this planet! But the water acts like a thermal short circuit. The water is crucial to our atmosphere and climate.

The ocean can store gob's of heat; it's a huge storage tank of heat. The upper part of the soil gets hot or cold, but below a meter or two it doesn't change much. But the ocean has an upper mixed layer that heats up and gets stirred by the winds. At many places it's several hundred meters deep. And the heat capacity of water is very high.

The ocean would get hotter and hotter if the surface did not evaporate thousands of tons of water per square kilometer. Later, when it rains, water changes from a gas to a liquid, and that releases a lot of heat. The heat changes the circulation of the atmosphere. We don't even know how much it rains over the ocean. The interaction between the atmosphere and ocean is so strong we can't ignore it. It takes data to get this information.

By 1995 many of the gadgets we need for these observations will be flying. And there's a new experiment proposed by a group of Americans and Japanese: the tropical rainfall measuring mission. Holy cats, if that thing were to go, it would be beautiful! We'd put microwave radar in low Earth orbit to look at half the planet. It could tell you what a cloud looks like, how hard it's raining, and from what altitude the rain is coming. People are perfectly willing to build it, but we have to convince NASA leadership.

Omni: You've served on one of NASA's space station panels. What capabilities will it give meteorologists?

Suomi: To say there are competing interests trying to get their hardware on the station is an understatement. Meteorologists want instruments on the space station to observe the big unknowns of the tropics. The tropics are half of Earth, and there is so much energy there that leaks to higher latitudes. We make occultation measurements [of atmospheric density by height] on the other planets, so why not do it for Earth? With the space station we could measure winds and temperatures on the ocean surface, winds high up, the structure of the atmosphere, and the distribution of moisture.

Omni: People love to complain about the weather forecast.

Suomi: If someone gets rained on in a thunderstorm, they squawk, "The forecast was wrong." But our ability to predict where a thunderstorm is going to be in a few days is zero because it's small-scale. We do pretty well on the planetary scale—when extended snow or drought, a big storm. We are getting excellent forecasts to three days, good ones to six, and useful ones to ten. That's pretty good, since the theoretical limit to forecasting is probably two weeks.

Omni: Do you have a weather forecast for tomorrow?

Suomi: Me? No way! When I went to Washington to get the National Science Award, President Carter whispered in my ear, "When is it going to snow?" It was late November. I thought about it and said, "Soon." Observe what's out there, yes, but forecasting I don't do.

grudge him that. He was media, too: That was the way things were with them both, so that was why she had deliberately left the channel unlocked. Besides, he was new, fresh out of journalism school. He still had some things to learn.

"Just the annual visit," she told him, bouncing down onto the desk and then to the floor. "Once a year the committee picks representatives from two different governments they feel need a special briefing." She never bounced for dirtside visitors because they never seemed to take her seriously if she did. She bounded along, pushing off with her hands, out into the reception area.

"Only two?" he asked, walking after her carefully. He'd adjusted to being on the moon, but more than once he'd trod on her hand by accident. She didn't hold that against him.

"Two seems to do it every time," she said, pushing herself up to a handhold near the elevator.

"Where were they from?" she shrugged. "I don't remember. They all sound the same."

"But what about the third country, the one they wanted to fight over? Maybe there really are terrible problems—"

"There are. There always are terrible problems. We've got him crews in there, sending footage all over—real footage, no distortions—around the clock. That's the best we can do, exposing them. We can't make them all behave. But we can keep them from blowing it all up. As long as they don't blow it all up, there's a chance things will straighten out down there. But it's got to still be there."

"Do you think this is right?" Di-Benedetto asked seriously.

He was very young, she thought, smiling at him, and pulled herself up higher on the handhold. "No. But it's as right as we've been able to get it. So far."

"Yeah, but—" he shrugged. "The dishonesty, the distortion of the facts..."

"Di-Benedetto's troubled look deepened. "I don't know. We're forcing them. It's like they're hostages."

"We're hostages. Just because we're on the moon doesn't mean we're not still part of the world. Because our continued existence depends on their continued existence. If we've got them, they've got us, too." She leaned in toward him, as if to tell him a particularly juicy secret. "Even if they didn't, I'd miss the world if they blew it up, pal. My legs are down there."

"The elevator came and she bounded into it."