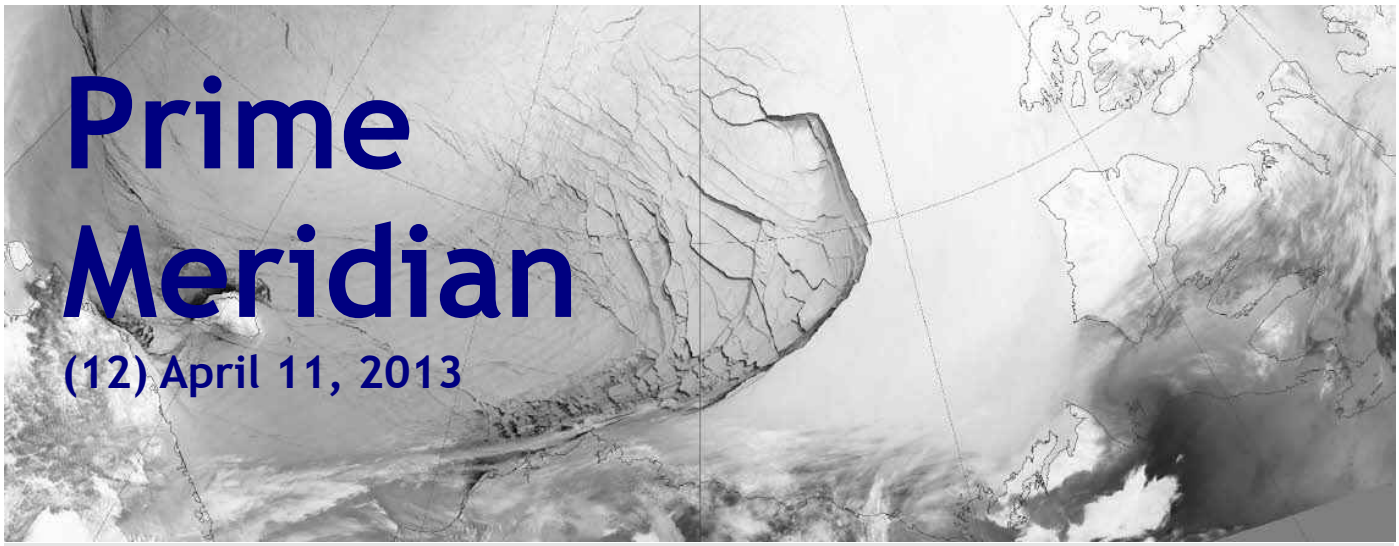


Prime Meridian

(12) April 11, 2013

The message from the poles.

On March 20, 2013, the day of the spring equinox, the Sun set at the South Pole and rose at the North Pole. This is an appropriate time to take stock of changes in the polar climate and how they could affect the rest of the planet.

At the north pole - thinning, more vulnerable ice.

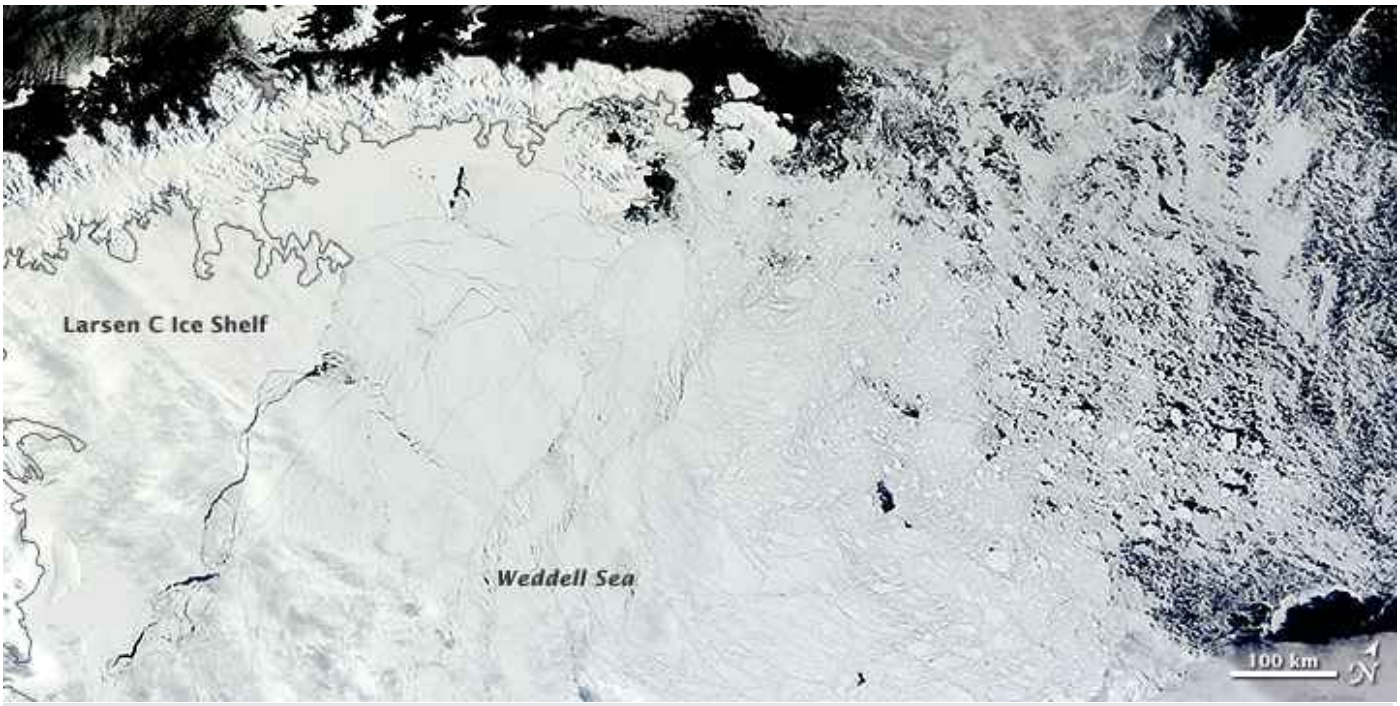
Last summer, the Arctic's cap of floating sea ice shrank to its most extreme minimum in the satellite record. During the long, dark polar winter it has re-formed. On March 15, it reached its winter maximum (15.13 million km^2 this year). However, the new ice is thinner than the long-established ice that has melted. It is only a metre or so thick, whilst the ever-dwindling mass of long-term ice may be many metres in thickness. Thinner ice is more easily broken up by storms, and a series of storms crossed central Alaska, beginning on Feb. 10. By Feb. 20 extensive fracturing began. It spread within a week across an area of sea ice in the Beaufort Sea, between Barrow in Alaska and Canada's Ellesmere Island (see NASA image above). Fracturing of sea ice is commonplace, but the speed with which the fracture system developed and its size (1,000 km long, with open water patches up to 70 km wide) were unusual. Re-freezing of the strips of open water will probably produce new sea ice only 30 to 70 cm thick. Because thinner ice can melt more easily, coming summers may see the ice cap continue to shrink, with significant feedback on our climate.

For those of us in the N. Hemisphere, there are implications close to home.

The cold spring across Europe and North America may be linked to last summer's extreme minimum of sea ice. Adjustments in weather systems have involved displacement of the high altitude jet stream (a ribbon of fast-moving air that steers the course of storms) to the south. Instead of Britain receiving warmer Atlantic weather, it has been swept by cold easterly winds.

Climate campaigns must address the confusion caused by weather's ups and downs.

One of the major problems facing climate campaigners is that climate is complex, whilst the most effective messages are those that have the simplicity of slogans. Not surprisingly, during cold spells, many people are reluctant to accept the reality of global warming. With the UK's coldest Easter on record and sporadic snow across southern England, rumours from some sections of the media that climate scientists no longer predict global warming are not falling on deaf ears – despite a statement from Prof. Sir John Beddington, on his retirement as chief scientific adviser to the UK government (BBC News; March 25, 2013). He warned: "*The evidence that climate change is happening is completely unequivocal*." He stated that current variations in temperature and rainfall were twice the average and saw a future of more frequent droughts, floods, sea surges and storms. The longer governments delayed tackling climate change, he feared, the more difficult this would become.



What is causing the Antarctic sea ice to expand?

Antarctica was emerging from polar night at our autumn equinox (Sept. 22, 2012) and its halo of sea ice had reached its maximum extent on September 26, 2012 – a record 19.44 million km^2. Since then, it has shrunk to a late summer minimum on February 20, when it covered 3.68 million km^2. Whilst the Arctic sea ice has shrunken disturbingly in recent years, Antarctic sea ice is spreading outwards from the continent. This fact is sometimes quoted by climate sceptics as if it were being ignored or played down by climate scientists. In reality, researchers have done neither (see for example the website of the USA's National Snow and Ice Data Center). To complicate the problem, sea ice has shrunken in some places around Antarctica. Climate scientists have sought explanations in terms of atmospheric temperature, ocean temperature, wind stress, precipitation, and atmosphere or ocean feedbacks. In late 2012, a paper in *Nature Geoscience* argued that satellite data from 1992 to 2010 revealed a significant relationship between winds and movement of sea ice (Holland & Kwok, 2012). However, a paper published online in the last few days (Bintanja *et al.*, 2013) accepted that atmospheric circulation could still be important regionally, but reasoned that "*melt water from Antarctica's ice shelves accumulates in a cool and fresh surface layer that shields the surface ocean from the warmer and deeper layers that are melting the ice shelves. . . . cool and fresh water from ice-shelf melt indeed leads to expanding sea ice in austral autumn and winter. This powerful negative feedback counteracts Southern Hemispheric atmospheric warming.*" Nearly all climate models have shown snowfall over Antarctica increasing with global warming. This would remove water from the ocean and reduce the rate of sea level rise from melting ice sheets, but there has been no significant increase in snowfall on Antarctica since the mid 20th C (Monaghan *et al.*, 2006). Bintanja and co-workers pointed out that this is consistent with melt-water cooling the sea around Antarctica. This means that future sea level rises have been underestimated.

One area in which weather helped sea ice to expand this year was the Weddell Sea (E of the Antarctic Peninsula). According to the National Snow and Ice Data Center, on Feb. 5, the edge of the ice lay 200 to 300 km north of its usual position for the time of year. The image at top was obtained by NASA on Feb. 22, 2013. Expansion of the ice has been attributed to an area of high pressure over the Bellingshausen Sea (W of the Peninsula).

Efforts to understand the Antarctic sea ice underline the reality that climate is complex and that research is a work in progress. Here is another problem that campaigners must tackle - there is good evidence that the world as a whole is warming, but the regional and local picture is intricate. This must be conveyed to politicians and the public, who should not expect researchers to jump straight to simple conclusions, but rather, to explore a range of possibilities as they work their way towards better climate models.

Why there must now be much better monitoring of West Antarctica.

Because the sea ice around the continent is already displacing its own weight of water, its growth and melting will not affect sea levels. Melting of the great ice sheet overlying the Antarctic continent is a different matter. West Antarctica is important for understanding climate change, not least because melting of its glaciers is making a significant contribution to rising sea levels. It may surprise many readers to learn that there has been just one weather station recording near-surface data here, namely Byrd Station in central West Antarctica (80°S 120°W) and there have been gaps in the weather record. Following a gap between 1975 and 1980, an automated station was installed. In 2011, this was returned to the University of Wisconsin-Madison, and David Bromwich and Julien Nicolas of the Byrd Polar Research Center, Ohio State University, and their co-workers identified and compensated for a temperature-dependent drift in the sensor. They reconstructed gaps in the long-term record by interpolating between data from other stations. They found that there had been a warming of 2.4 ± 1.2°C between 1958 and 2010 and that warming was particularly significant in the peak of the December-January melt season (see review by Steig & Orsi). Bromich and fellow authors stated (p. 139):

"These results argue for a robust long-term meteorological observation network in the region."

Key study gives better estimates of ice loss from Antarctica.

It is vital that we get to grips with the problem of exactly how fast Antarctica's ice sheets are melting. However, previous studies have been so uncertain that the Intergovernmental Panel on Climate Change wasn't able in its 2007 report to set limits on how fast the Antarctic might be melting. It is now probable that melting ice caps in Antarctica and Greenland are contributing about one fifth of the ongoing global sea level rise.

Late last year, Andrew Shepherd of the University of Leeds, UK, and 47 co-workers published details of their detailed study of Antarctica's ice sheets. They noted that since 1998, satellite observations (altimetry, interferometry, and gravimetry) have been used in at least 29 attempts to work out how much ice is being lost or gained form Greenland and Antarctica. Taken together, they could have been gaining 69 or losing 676 billion tonnes per year, corresponding to a sea level fall of 0.2 mm per year or a sea level rise of 1.9 mm per year. Unfortunately, the average period of observation providing data for these studies was just 4.5 years. Their own study, which combined different data sets, reconciled 19 years of radar altimeter data, 5 years of satellite laser altimeter data, 19 years of radar interferometer data, 8 years of gravimetry data, 32 years of surface mass balance model simulations, and inputs from several models of how the ground would respond to being loaded by ice sheets. They concluded that since 1992, the polar ice sheets have contributed, on average, 0.59 ± 0.20 millimetre year to rising sea levels around the world.

All told, between 1992 and 2011, Antarctica lost a total of 1,350 ± 1,010 billion tonnes and Greenland, 2,700 ± 930 tonnes of ice. This will have raised sea level by 11.2 ± 3.8 mm. Between 1992 and 2011, on the average, the ice sheets of Greenland lost 142 ± 49 billion tonnes per year, East Antarctica gained 14 ± 43 billion tonnes per year, West Antarctica lost 65 ± 26 billion tonnes per year, and the Antarctic Peninsula lost 20 ± 14 billion tonnes per year.

Anyone looking at the estimated errors for these figures will see that there are still large uncertainties about the rate of ice melt, and there are also uncertainties about how the melting ice sheets will behave in the years ahead. We have no reason to be complacent about our present knowledge. Note, for example, that the uncertainty in the estimate for ice build up in East Antarctica is actually three times bigger than the figure obtained. Ice could be accumulating as fast as 57 billion tonnes per year, or even melting at 29 billion tonnes every year. However, this study has been a major advance. A review in Nature (Heffernan, 2012) quoted Dr. Tom Wagner of NASA as saying: "*What is unique about this effort is that it brought together the key scientists and all of the different methods to estimate ice loss*".

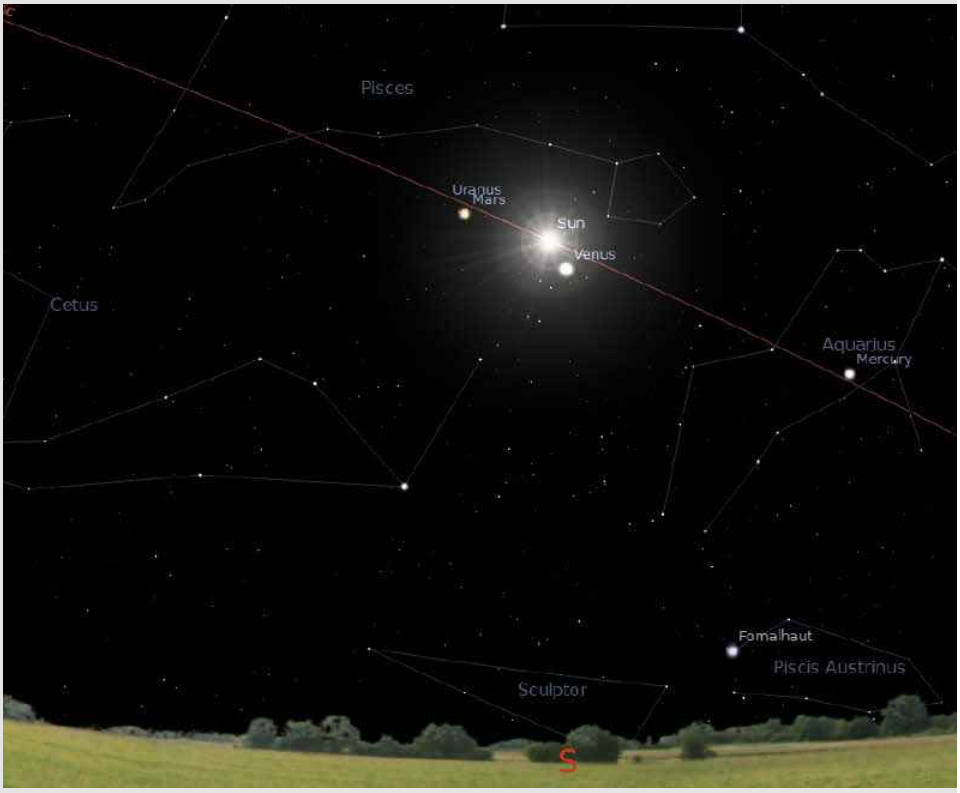
Antarctica references.

Bintanja, R. *et al.* (2013). Important role for ocean warming and increased ice-shelf melt in Antarctic sea-ice expansion. *Nature Geoscience* Advance publication online, March 31, 2013.
Bromwich, D. H., Nicolas, J. P. *et al.* (2013). Central West Antarctica among the most rapidly warming regions on Earth. *Nature Geoscience* **6**: 139-145.
Heffernan, O. (2012). Grim picture of polar ice-sheet loss *Nature* 29 November 2012.
Holland, P. R. and Kwok, R. (2012). Wind-driven trends in Antarctic sea-ice drift. *Nature Geoscience* **5**: 872-875.
Monaghan, A. J. *et al.* (2006). Insignificant change in Antarctic snowfall since the International Geophysical Year. *Science* **313**: 827-831.
Shepherd, A. *et al.* (2012). A Reconciled Estimate of Ice-Sheet Mass Balance. *Science* **338**: 1,183-1,189.
Steig, E. J. & Orsi, A. J. (2013). The heat is on in Antarctica. *Nature Geoscience* **6**: 87-88.

Through the 2013 spring equinox.

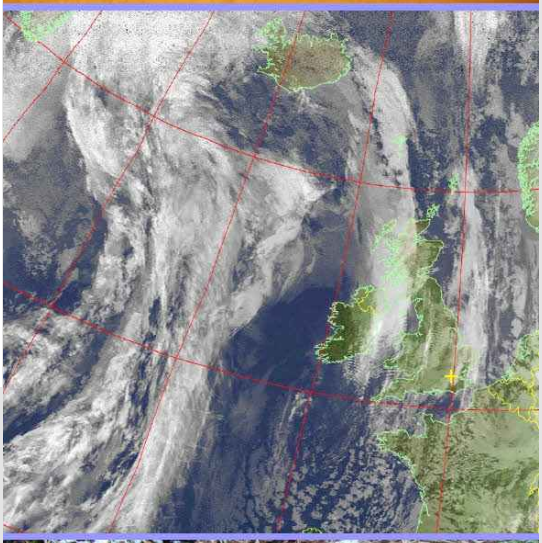
The vernal equinox took place this year on March 20, with the Sun in the constellation of Pisces and flanked by Mars and Uranus to the east and Venus and Mercury (both morning stars) to the west (*Stellarium* image below).

Left: Over South London, UK, the Sun shone sporadically through a grey overcast, and is seen left glinting through the branches of an alder (*Alnus glutinosa*), with its prominent male catkins. Right: At the South Pole Amundsen-Scott Station, the camera was pointed at the ground to prevent it being damaged by directly catching the Sun, which had been low in the sky.



Seasons in South East England

February, 2013



Above: Saxten's & Cage's Wood, Kent; Feb. 23, 2013.

More settled in the second half than the first, February saw the winter's longest dry spell. Snowfall was not abnormal, and the UK's mean temp. was 2.8 °C (0.9 °C below the 1981-2010 mean). The month began with rain clearing from the SE on the morning of Feb. 1, followed by a fine Feb. 2, and Feb. 3 saw patchy rain in the SE. Feb. 4 was dry for southern England, but wet and windy in the north. On Feb. 5, there were strong winds with gusts up to nearly 97 km per hour (60 mph) in the south. On Feb. 6, there was a northerly wind with showers in the east, becoming dry on Feb. 7. Patchy rain affected eastern areas on Feb. 8. Bands of rain, sleet and snow crossed the south on Feb. 9 and 10. There were snowfalls on Feb. 11 and after a dry but overcast Feb. 12, 12 cm of snow fell at High Wycombe (Buckinghamshire) on Feb, 13. Brighter weather followed with high pressure established to the south. London saw 12ºC on Feb. 14, whilst on Feb. 17, Kinlochewe (Ross & Cromarty) recorded the UK's maximum temperature of 13.9°C. Feb. 20 saw cold air from the east. Overnight the temperature fell to -6.7 °C at Preston Montford (Shropshire). The UK's minimum temperature (-10.0 °C) was noted at Aviemore (Inverness-shire) early on Feb. 22. Overcast conditions were typical until Feb. 26, and snow showers occurred in the SE on Feb. 23. Sunnier, drier conditions returned for February's final two days.

For SE and central S England, mean max. temp.: 6.0.ºC (-1.5 ºC.); mean min. temp.: 0.3ºC (-0.9ºC). Hours of sunshine: 67.4 (92 %). Rain: 36.7 mm (68%). Anomalies re. 1971-2000 norm in brackets. Respective figs. re. 1981-2010 norm are -0.9ºC; -0.6ºC; 86%; 67%. Data source: Met Office online.

Left (from top to bottom): Feb. 11. Snow in a South London street in the early hours. Feb. 8. Weather systems over the UK imaged from NOAA 19 (courtesy Geoff Hamilton). Feb. 23. Leaves of *Arum* push up through the carpet of last year's leaves in Saxten's & Cage's Wood, Kent; Below: Sunset near Ash, Kent. Feb. 20, 2013.

Global climate; February 2013.

The USA's National Oceanic and Atmospheric Administration continues to document a warming world. Despite the inevitable ups and down of climate from year to year, and from decade to decade, there is a clear trend for global temperatures at the end of the 20th C and early in the 21st C to cluster together at the warmest end of the data set which began in 1880. Globally, for land plus oceans, a January that tied with 1995 as the 9th warmest on record was followed by a February that tied with 2003 as the 9th warmest on record. February 2013 was 0.57 ± 0.12 ºC above the 20th C average of 12.1ºC.

For the world as a whole, the surface of the land was 1.0 ± 0.32ºC warmer than the average (11th on record with 2002 as the warmest), and the ocean was +0.42 ± 0.04ºC warmer (8th warmest with 2010 as warmest on record). For the Northern Hemisphere the combined result for land and ocean was +0.63 ± 0.17 above the 20th Century mean, making it the 10th warmest February (warmest was 2002). Land in the N. Hem. Was overall +1.04 ± 0.33ºC above the average, the 13th warmest February with 2002 as the record. In the Southern Hemisphere, the combined land and ocean temperature was +0.52 ± 0.07ºC above the mean, making it the 8th warmest February (warmest was 2010). The two-month-long trend for land temperatures in the Southern Hemisphere to hit record highs did not continue, and an average land temperature of +0.90 ± 0.12ºC above the average rated merely 7th (with 2010 retaining the record for February).

"*It was much warmer than average across much of Mexico, Central America, northern South America, parts of Africa, the Middle East, and Southeast Asia. It was cooler than average across the southwestern United States, part of western Europe, Mongolia, and eastern Siberia, where some regions experienced record cold.*"

The climate remained stuck in a neutral (La Nada) condition between relatively cool (La Niña) and relatively warm (El Niño) conditions and may well remain that way until the N. Hemisphere summer.

Sources: NOAA National Climatic Data Center, State of the Climate: Global Analysis for February 2013, published online February 2013, retrieved on March 1, 2013 from **http://www.ncdc.noaa.gov/sotc/global/2013/1**. Data provisional.

An essential Earth monitoring system begins to fall apart.

Concern continues to grow over the commercial and public safety implications of gaps in weather satellite data, which could, in the worst case, last from 2014 to 2019, and which could undermine scientists' ability to predict dangerous weather. A recent update in the US journal *Science* (Malakoff, 2013) offered little reassurance, outlining a problem that administrators are struggling to mitigate. Three US and a European polar-orbiting satellites feed data to forecasters. Under the NOAA $12.9 billion Joint Polar Satellite System, three new orbiters are to be deployed. One Suomi, was launched in 2011. Its name honours Vernon Suomi (1915 – 30 July 1995), who was a major figure in the development of meteorology using satellites. The lifetime of this satellite (which crosses the equator in the early afternoon) should be half a decade. However, the replacement may not be fully operational until 2018. In the worst case scenario Suomi would fail ahead of time and its replacement be long delayed. Two US military satellites that could replace current orbiters were built in 1990s and it is not known how long they would operate. Also, Europe may fail to keep early and mid-morning slots covered and from 2015, there could be a one year gap in US geostationary satellite which observe the USA. Malakoff reported: "*Although NOAA has yet to announce a plan or a price tag for closing the gap, in late January it received $111 million in the Sandy relief bill to establish a "data mitigation gap reserve fund." Legislators didn't specify how NOAA should use the money*". NOAA has started a website to collect ideas about how the problem may be mitigated (www.osd.noaa.gov).

Malakoff, D. (2013). Warning Issued for Looming Data Gap From Fleet of Weather Satellites. *Science* **339**: 895.

Ecospheres Project - Earth Campaign:
c/o prime-meridian01@hotmail.com
http://www.ecospheresproject.moonfruit.com/