



# Cli-fi on the screen(s): patterns in the representations of climate change in fictional films

Michael Svoboda\*

Edited by Mike Hulme, Domain Editor and Editor-in-Chief

Fictional works about climate change, or cli-fi, have been hailed as a new genre. As a complement to previous WIREs studies of novels and plays, this article focuses on cli-fi films, providing an overview of some 60 films, including major theatrical releases, smaller festival films, and made-for-TV movies. Of the many possible impacts of climate change predicted by scientists, this study finds that filmmakers have focused on extreme weather events and the possibility of Earth slipping into a new ice age. These choices reflect filmmakers' predispositions more than any scientific consensus and thus demonstrate the challenge that cli-fi films pose to climate change communicators. Finally, noting the recent emergence of films that parody concerns about climate change or that depict attempts to mitigate its causes or ameliorate its effects as possibly more disastrous than climate change itself, this study recommends that researchers in the humanities and social sciences look beyond *The Day After Tomorrow*, which has received far more attention than any other film. © 2015 Wiley Periodicals, Inc.

How to cite this article:

WIREs *Clim Change* 2016, 7:43–64. doi: 10.1002/wcc.381

## INTRODUCTION

In a July 10, 2015 post,<sup>1</sup> on one of his many websites, Dan Bloom, the Taiwan-based journalist widely credited with having coined the term 'cli-fi,' recalled the challenges separately issued in 2005 by Bill McKibben<sup>2</sup> and Robert Macfarlane.<sup>3</sup> Where are the works of art, they asked, the fictional works about climate change? In the 10 years since these questions were posed, Bloom argued, they have been answered—by cli-fi novels and cli-fi films. In fact, by 2005 at least 14 novels about climate change had already been published in the UK and the United States, and what is still the most commercially

successful feature film about climate change, *The Day After Tomorrow*<sup>4</sup> (hereafter *TDAT*), had been released the year before (a point McKibben grudgingly acknowledged). But Bloom is right: in the 10 years since McKibben and Macfarlane issued their challenges, there has been an outpouring of work. So much so that the state of 'cli-fi' is now regularly updated in the pages of major news venues such as *The Guardian*<sup>5</sup> and *The New York Times*<sup>6</sup>; in magazines devoted to political/cultural commentary such as *Dissent*<sup>7</sup> and *Salon*<sup>8</sup>; in environmental newswires and websites such as *ClimateWire*,<sup>9</sup> *The Daily Climate*,<sup>10</sup> and *Grist*<sup>11</sup>; and in film-trade publications such as *Entertainment Weekly*.<sup>12</sup> Fictional works about climate change have also been addressed in the pages of *WIREs Climate Change*. In 2011, Adam Trexler and Adeline Johns-Putra provided an overview of 'Climate Change in Literature and Literary Criticism.'<sup>13</sup> Then, in 2012, Stephen Bottoms covered 'Climate Science on the London Stage.'<sup>14</sup> To this

\*Correspondence to: msvoboda@gwu.edu

Columbia College of Arts and Sciences, George Washington University, Washington, DC, USA

Conflict of interest: The author has declared no conflicts of interest for this article.

composite picture of artistic responses to climate change, this article adds a third piece: an overview of responses to climate change in fictional films.

This overview is presented in four parts. First, after very brief notices for six notable precursors, 55 films produced since 1984 are grouped by the climate impacts they depict; then these groups are reviewed for their unifying characteristics and distinguishing differences. Only then, second, is the limited academic literature related to cli-fi films reviewed. (Because the cli-fi designation is relatively new, because half of the films in this list are less than 3 years old, and because many made-for-TV and straight-to-DVD films receive few critical notices, this paucity of sources is not surprising.) To aid in applying this literature to the much broader set of films reviewed here, a critical framework is imported from work on communicating climate change. Third, the efficacy of these films is evaluated using this framework, supplemented by critical observations provided by the academic literature. The salient results of this overview, and their implications, are then summed up in a final conclusion.

## THE FILMS

'Cli-fi,' for the purposes of this overview, excludes documentaries and advocacy films even if, as in the case of *The Age of Stupid*,<sup>15</sup> they include fictive elements. And while 'film' or 'movie' most readily suggest feature films played in cinemas or theaters, this overview includes fictional works produced for much smaller screens, such as those found in art houses, film festivals, or in homes and apartments (i.e., television or computer screens). This means made-for-TV movies and movies released only on DVD or blu-ray are included, but only if they are full length (85 min or more) and self-contained (a one- or two-part production). On this basis film shorts and regular, multi-episode TV programs were excluded. Several strategies were used to find the films reviewed here. Keyword searches ('climate change' and 'global warming') were conducted at the International Movie Database (IMDB) website.<sup>16</sup> Websites and blogs that focus on cli-fi or on climate change and popular culture were scanned for the titles they listed. Other titles were found through the scholarly literature. And several scholars who have published relevant work were consulted by e-mail.

All but two of the films identified in this way were English-language productions. This reflects both the actual dominance of English language films in this 'genre' and the difficulty of obtaining the few

non-English cli-fi films that exist. The two such films that could be obtained (through a major online American retailer) are both German films, *Das Noah Arch Prinzip* (or *The Noah's Ark Principle*, 1984)<sup>17</sup> and *F4 (Vortex)*, 2006.<sup>18</sup> The former was included because it is the first full-length work by Roland Emmerich, the director of *TDAT*, and it likely inspired *The Storm*,<sup>19</sup> a movie made for TV in 2009. *F4* was included because it is discussed in one of the early academic surveys of cli-fi films.<sup>20</sup>

The full list of the 61 films identified for this project is presented in Table 1, which sorts each film by date and by the main impact of climate change depicted. Six columns sufficed to capture most of the variation across this sample: flooding/sea-level-rise, extreme weather events, into/in an ice age, melting poles, famine/drought, and preclima(c)tic stress disorder. (Films that address two related impacts, such as extreme weather and flooding, are positioned between those columns when possible.) A seventh column was added to account for films that discuss climate change but do not depict its impacts. The presence of an antagonist, a figure who wills the destruction shown or threatened, or who willfully obstructs efforts to address the threat, links the films in this final column. In addition to information about each film's major focus or theme, the table provides a rough measure of the size of its audience. Major theatrical releases are presented in black. Films made for television are listed in blue. Films shown primarily at festivals or in art houses are in green. And the few films released straight to the DVD market are indicated by orange. A bold font, in whatever color, indicates that the film was notably successful at that level. (These judgments were based on box office numbers, TV viewership, or, in the case of film festival releases, the number of reviews in the news and entertainment media.) The difference in scale across these levels is vast. *Twister*,<sup>21</sup> the most successful of the 61 films included in the table (as measured by inflation-adjusted box office figures<sup>22</sup>) had an audience at least 5500 times bigger than that of *The Last Winter*,<sup>23</sup> the 'smallest' film for which box office figures are available. Its multiple for one of the straight-to-DVD films could be another order of magnitude higher. The marquee value of actors no doubt influences these numbers—but not the issues reviewed here; for this reason, actors are not named when their films are discussed.

## Precursors

Six films merit brief notices as precursors to the cli-fi films discussed in the following sections. Although

**TABLE 1** | Cli-Fi Films: A Chronological and Thematic Listing

Year	Floods/SLR	Extreme Weather	Into/In Ice Age	Melting Poles	Famine/Drought	Preclima(C)tic Stress Disorder	Antagonists
1984		<i>The Noah's Ark Principle</i>					(see EW)
1993		<i>The Fire Next Time</i>					
1995	<i>Waterworld</i>						<i>The American President</i>
1996		<i>Twister</i>					<i>The Arrival</i>
2001		<i>AI: Artificial Intelligence</i> <sup>a</sup>					
2004		<i>Category 6</i>	<i>The Day After Tomorrow</i>				
2005		<i>Category 7</i>					
2006		<i>F4 Vortex</i>	<i>Absolute Zero</i>	<i>The Last Winter</i>			
2007		<i>The Flood</i>		<i>Ice Age: The Meltdown</i>			
2008	<i>Lost City Raiders</i>	<i>Storm Cell</i>				<i>Half-Life</i>	<i>Day Earth Stood Still</i>
2009		NYC Tornado Terror		<i>The Thaw</i>	<i>The Road</i>		<i>The Chaos Experiment</i> (see EW)
2010		<i>The Storm</i>		<i>Ice Twisters</i>			
2011		<i>Metal Tornado</i>	<i>Ice Quake</i> <i>Arctic Blast</i>			<i>Take Shelter</i>	<i>Glaring Emission</i>
2012		<i>Beasts of the Southern Wild</i>	<i>Ice 2020</i> <i>Ice 2012: Ice Age</i>	<i>Happy Feet 2</i>		<i>Future Weather</i>	
2013		F6 Twister <i>Seattle Superstorm</i> <i>Sharknado</i>	<i>100 Degrees Below Zero</i> <i>The Colony</i> <i>Snowpiercer</i>				<i>Cat.8</i>
2014	<i>Noah</i>	<i>Into the Storm</i> <i>Sharknado 2</i>			<i>Interstellar</i> <i>The Rover</i> <i>Young Ones</i> <i>The Last Survivors</i>		
2015		<i>Sharknado 3</i>			<i>Mad Max: Fury Road</i>	<i>Chloe &amp; Theo</i> <i>Tomorrowland</i>	<i>Kingsman</i>

Key: Black, Theatrical Release; Green, Film Festival; Blue, TV Movie, Orange, DVD Only, Bold, High (Re)Viewership; Underlined, includes an antagonist. Precursors: Early environmental films that acknowledge climate change: *No Blade of Grass* (1970), *Soylent Green* (1973), and *Day of the Animals* (1977). Nonenvironmental films that acknowledge climate change: *Our Man Flint* (1966), *Do the Right Thing* (1989), and *Batman Returns* (1992).  
<sup>a</sup> AI sets a conflicted relationship between an artificial boy and his human family in a world flooded by the melting of the ice caps. The film's cli-fi connection was discovered too late to include it in the text of this article: Spielberg S (Director). *AI: Artificial Intelligence*. Aldiss B, Waston I, Spielberg S, Screenwriters, 2001. Warner Home Video, 2011, blu-ray.

focused on other issues, three environmental films of the 1970s touched on climate change. Pollution and its impacts on agriculture is the focus of *No Blade of Grass* (1970),<sup>24</sup> but one character notes that global warming will eventually result in the flooding of coastal cities. The New York City of *Soylent Green's* dystopic ruminations on population (1973)<sup>25</sup> is enduring a multiyear heat wave, and the climate changes induced by greenhouse gas emissions, the two leads observe early in the film, have severely reduced crop yields. In perhaps, the most conspicuous example of many similar misattributions, *Day of the Animals* (1977)<sup>26</sup> blames violent encounters between humans and animals in the wild on the UV rays passing through the hole in the ozone layer. Three nonenvironmental films also include nods to climate change: the villainous scientists in *Our Man Flint* (1966)<sup>27</sup> manipulate the weather for socio-political purposes, the maddening heat of *Do the Right Thing* (1989)<sup>28</sup> is attributed by one character to global warming, and the arch-villain in *Batman Returns* (1992),<sup>29</sup> the Penguin, calls for 'global cooling' in his campaign for mayor of Gotham.

### Flooding/Sea-Level Rise

In this column are listed films that address local, regional, or global inundations. In the case of *Waterworld* (1995),<sup>30</sup> *Lost City Raiders* (2008),<sup>31</sup> and *Noah* (2013),<sup>32</sup> these inundations are total and long-term. In *The Flood* (2007)<sup>33</sup> and *Beasts of the Southern Wild* (2013),<sup>34</sup> portions of Great Britain and Louisiana, respectively, are temporarily flooded when major storms combine with high tides and/or rising sea levels; these films are thus positioned between the 'Flooding' and 'Extreme Weather' columns in the table.

*Waterworld* sets the climatic stage after the opening credits: 'The future: the polar ice caps have melted, covering the earth with water. Those who have survived have adapted to a new world.' Fresh water and dirt are precious commodities, even serving at times as forms of payment. Ocean-roving marauders terrorize the few communities still afloat. Pulled into this strife, the hero eventually prevails and, with a small band of survivors, finds the tip of a massive mountain just tall enough to be an island. In *Lost City Raiders*, the melting of the polar ice sheets has flooded coastal cities, creating a steady business for the family salvage operation at the center of this adventure film; the recovery of ancient relics enables a supernatural solution to the natural problem of sea-level rise. In *Noah*, director Darren Aronofsky's version of the Biblical tale, humanity's sin is its abuse

of the natural world. To redeem himself, Noah believes he must first save Earth's fauna and flora and then insure that his own line, the human species, dies out. When his daughter-in-law gives birth to twins, he is faced with a bitter choice.

A 3-h miniseries produced for BBC 1 in 2007, *The Flood* depicts a large cast of national and municipal authorities as they struggle to cope with a storm surge so unprecedented that it easily overtops the Thames river barriers designed to deal with rising sea levels. And in the obligatory emotional subplot, the flooding of London also tests and ultimately heals the relationships of a family of scientists and engineers involved in the planning, building, and management of the barriers. Magic realism pervades *Beasts of the Southern Wild*. Climate change is brought into the story when a teacher warns her students that they need to toughen up: 'Cause any day now, the fabric of the universe is coming unraveled. The ice caps gonna melt. Water's gonna rise. And everything south of the levee is going under. You all better learn how to survive now.' But it is when New Orleans' flood control system prevents a storm surge from draining out of the region known as 'the Bath-tub' that the community's way of life is threatened. After the residents blow up one of the levies to release the water, the authorities intervene and briefly subdue the charismatic young black girl at the heart of the film. When, back in the Bath Tub, her father dies, it seems likely that their way of life will perish, too.

### Extreme Weather Events

If one counts the films that share this classification with a related impact (i.e., Flooding/SLR or Into/In Ice Age), then films that deal with extreme weather events comprise the largest subset of cli-fi films, roughly 40% of the total (this contrasts starkly with what Trexler and Johns-Putra<sup>13</sup> and later Trexler<sup>35</sup> found with cli-fi novels, which focused to an even greater degree on floods/sea-level-rise). All but two of these films follow one of three basic plots: (1) scientists or storm-chasers test their knowledge of extreme weather as they compete to gather more data; (2) a scientist with a problematic reputation warns a community about an impending extreme weather event but is ignored or even mocked until a devastating storm strikes the community; or (3) with little warning an everyman faces the challenge of safely guiding his family and friends through an extreme weather event. Threaded through all three of these plots are one or more romantic or family subplots.

*Twister* (1996)<sup>21</sup> epitomizes the first plot. Set in tornado alley in Oklahoma, the film follows a team of university-based researchers through two tumultuous days of storm-chasing. Although the actual words are never uttered, some scholars have interpreted brief mentions of ‘record-breaking’ or ‘unprecedented’ conditions as references to climate change.<sup>36</sup> By the end of the film, the leader of a competing team has died because he ignored the warnings of the film’s hero and heroine, invaluable data are gained when an exceptionally powerful (F5) tornado takes up the instruments successfully placed in its path, and the protagonists have happily resolved their relationship issues. *Into the Storm* (2014),<sup>37</sup> updates *Twister* with better technology and a *cinema verite* style made possible by some of that technology. What viewers see on the screen appears to have been recorded by a camera held by one of the protagonists or mounted on or in one of the storm-chasing vehicles. *Into the Storm* edges closer to a direct acknowledgment of anthropogenic climate change: ‘What used to be a once-in-a-lifetime storm seems to be happening once a year now.’ But as with *Twister*, the only result of the dramatic encounter with the storms is a better understanding of tornados; survivors do not alter their behavior to mitigate the causes of climate change or to adapt to its extreme weather consequences.

The best examples of the second plot type are *Category 6* (2004),<sup>38</sup> *Category 7* (2005),<sup>39</sup> and *F6 Twister* (aka *The Christmas Twister*, 2012).<sup>40</sup> The first two were two-part, 3-h miniseries for CBS and were among the most widely viewed television programs in their respective years; *F6 Twister* was made for the smaller cable television market. In *Category 6*, an about-to-retire director of the National Weather Service struggles to understand the confusing patterns he and his team see on their computer screens, patterns they hesitantly attribute to climate change. They foresee but are reluctant to forecast a superstorm forming over Chicago when two already powerful storms, one from the south and the other from the north, converge over the city. After the city has survived the storm and the concomitant power failure, the film recommends, through the voice of the reporter who figures in one of the many subplots, some adaptive measures, most notably updating, strengthening, and protecting the power grid. For guidance in confronting the unprecedented storm that threatens Washington, DC in *Category 7*, the woman just appointed to head FEMA calls upon a climate scientist who had previously warned against a similar threat that failed to materialize. He now recognizes that his model had missed something: ‘Yes, global warming is creating new regions of

extreme weather but something else ... is turning ordinary storms into the worst weather recorded on the planet.’ That something else, he discovers, is the heat coming off large cities from the energy they generate and consume. Thus, the solution tested at the end of the film is to shut down Washington’s power grid. Several subplots, including assorted romantic and familial misunderstandings, complicate and propel this extreme weather story set in the American capital. The much less complicated plot of *F6 Twister* is set in Fort Worth Texas. A climate scientist now working in the Department of Atmospheric Science at the University of Northeast Texas sees climate change behind the off-season—just before Christmas—appearance of storm cells. Here, too, his first warnings are dismissed because previous predictions had failed to materialize, and this history has affected the hero’s personal relationships. But *F6* breaks new ground with its depiction of the conflict between TV meteorologists, who until recently were mostly skeptical about climate change,<sup>41</sup> and climate scientists. ‘These temperature increases are nothing to be alarmed about,’ the meteorologist tells the station’s news anchor (who is also the scientist’s somewhat disaffected wife): ‘They’re all part of a natural cycle.’ Six other films follow this second plotline. In two, the location provides the defining difference: *F4 Vortex* (2006)<sup>18</sup> is set in Berlin, Germany; *Storm Cell* (2008)<sup>42</sup> takes place in western Washington state. In the remaining four, other factors contribute to the generation of the superstorms. In *NYC: Tornado Terror* (2008),<sup>43</sup> the jet stream, destabilized by the warming atmosphere, loops and forms a standing vortex in the upper atmosphere. In *Metal Tornado* (2011)<sup>44</sup> and *500 MPH Storm* (2013),<sup>45</sup> attempts to generate clean energy by tapping solar and ambient energies go awry, releasing energies that create strange new storms that then threaten Philadelphia in the first case and the Gulf Coast of Texas in the second. In *Seattle Superstorm* (2012),<sup>46</sup> violent tornados form when fragments of a Russian satellite carrying a hyperreactive chemical compound crash in downtown Seattle.

The third plotline under Extreme Weather Events features an everyman—and thus far it is a man—who, once he recognizes the danger, takes the steps necessary to guide his friends and family to safety. Three of the four films that employ this plotline parody the extreme weather/disaster genre: *Sharknado* (2013),<sup>47</sup> *Sharknado 2* (2014),<sup>48</sup> and *Sharknado 3* (2015).<sup>49</sup> Deliberately absurd combinations of *Twister*,<sup>21</sup> *Jaws* (1975),<sup>50</sup> and *Army of Darkness* (with its chainsaw prosthetic, 1992),<sup>51</sup> these films attribute their extreme weather

phenomena, at least in part, to climate change. In the first, changing weather patterns have pushed a hurricane unusually far up the California coast, carrying sharks north and shoreward with its surge. When the storm creates funnels over the water, sharks are drawn up into the vortices, creating sharknados. In the second, two different storms converge over New York where they are supercharged by the urban heat island effect. (Amusingly, 'shark waves' are seamlessly integrated into the TV weather forecasts for NYC.) In the third, Washington, DC, and Orlando, FL are the targets of these storms, which are no longer explained only forecast. As is characteristic of Extreme Weather Event films, things return to normal at the end; no long-term changes are considered in response to the dramatic events just experienced.

The fourth film to place an everyman, rather than a scientist, at the center of its plot is *The Fire Next Time* (1993),<sup>52</sup> the two-part, 3-h movie made for CBS. A Category 5 hurricane that destroys much of coastal Louisiana, including the fishing operation and home owned by the everyman, is the major turning point in the movie. However, *The Fire Next Time* also addresses other impacts of climate change: heat waves, wildfires, drought, declining fish and shellfish stocks, invasive species (especially new, disease-bearing insects), and as a consequence of these impacts, the dislocation and migration of affected human populations. In telling the story of a family that migrates from Louisiana to Canada, *The Fire Next Time* incorporates different examples of low-carbon lifestyles and techniques for mitigating the causes or adapting to the consequences of climate change. It also includes a staged interview with climate scientist Stephen Schneider, who, playing himself, comments on the hurricane at the center of the plot. This first fictional film portrayal of climate change in the United States is also the most comprehensive.

Finally, three films include Extreme Weather Events in plots that are driven by an Antagonist rather than by the events themselves. In *Das Arche Noah Prinzip* (*The Noah's Ark Principle*, 1984),<sup>17</sup> director Roland Emmerich's final film school project, the US military hacks the main computer of an international space laboratory designed to moderate storm activity on Earth. In the scientists' struggle to regain control of their laboratory, the data stream that allows them to manage the energy beam directed at Earth's atmosphere is broken; unattended, the beam supercharges an Indian monsoon, killing thousands. *The Storm* (2009),<sup>19</sup> a two-part, 3-h miniseries produced for NBC, upgrades and expands Emmerich's plot. The billionaire funding the project to better manage the weather—'global warming will

be a thing of the past'—has secretly negotiated to sell the technology to the military. He pushes the team to demonstrate the technology before they have fully tested it. The result: out-of-control electrical storms. In *Eve of Destruction* (2013),<sup>53</sup> a two-part, 3-h miniseries produced for a Canadian cable channel, much the same plot is reprised, with some of the same actors. It is the CEO of an over-leveraged alternative energy company, rather than a military contractor, who pressures the scientists to ignore the warning signs as they power up their apparatus for extracting clean energy from dark energy.

### Into/In Ice Age

Extreme Weather events also figure in several films in this column. Still the most successful film explicitly devoted to climate change, Emmerich's *TDAT* (2004)<sup>4</sup> begins with tornados and thunderstorms, and its iconic ice age landscapes are the result of continent-spanning superstorms. Seven other films in this group also depict Earth, or at least of a portion of it, falling into ice age conditions. The two remaining films begin under ice age conditions. Three of the 10 films resemble the Extreme Weather Event films in one other way: conditions return to normal, more or less, at the end of the story. What distinguishes these films from each other is the cause or event that triggers the ice age conditions and the places where that change is depicted.

*TDAT* provides the model that the other films in this group vary. Through his work with polar ice cores, NOAA paleoclimate scientist Jack Hall has discovered that Earth's climate has changed abruptly in the past when freshwater from melting ice caps interfered with the saline mechanism that drives the Atlantic Meridional Overturning (AMO). When a series of bizarre weather events occur, including a cluster of tornados in Los Angeles, Hall is summoned to a meeting of fellow scientists. There he reveals that the network of research buoys maintained by their colleagues in Britain have recorded several sudden drops in ocean temperature. 'I think we may be on the verge of a major climate shift,' he concludes. That climate shift is initiated by massive, hurricane-like storms that instantaneously freeze anything they pass over by, Hall discovers, rapidly drawing superchilled air down from the stratosphere. Asked to brief the president and his advisors (which include the skeptical vice-president with whom he has argued before), Hall draws a horizontal line across a map of the United States. Everyone south of the line must be evacuated, he explains. 'What about those in the north?' the president asks. 'It's already too late for

them Mr. President,' Hall replies. The rest of the film tracks Hall's journey to rescue his son, who is stranded in a now snow-bound New York City, burning books to keep warm in a luxuriously appointed New York City Public Library reading room. By the film's end, Hall has found his son, the storms have dissipated, and all of the survivors now face the challenge of living in a new ice age.

The success of *TDAT* spawned a series of imitations. To achieve the same ends while telling a different story, each team of filmwriter(s) and director had to devise quick ways to freeze a particular locale. *Ice* (aka *Ice 2020*),<sup>54</sup> the 3-h mini-series produced by BBC in 2011, sets the process in motion by having an Arctic drilling rig break open a thermal vent in the ocean floor, dramatically speeding the melting of the Arctic ice and, thereby, stalling the AMO. Dramatic snow storms ensue. In *100 Degrees Below Zero* (2013),<sup>55</sup> aerosols and ash from the eruption of a new volcano in Iceland block the sun's light and heat, tipping the world into a new ice age, starting with Paris. Volcanic ash and aerosols also set in motion the climate flip in *2012: Ice Age* (2011),<sup>56</sup> which paradoxically results in a speeding glacier. An abrupt reversal of the magnetic field does the same for Miami in *Absolute Zero* (2006).<sup>57</sup> Other locales are more lucky, enduring only brief brushes with ice age conditions. When the field test of new weather-making technology in northern California goes badly wrong in *Ice Twisters* (2009),<sup>58</sup> vortices form, drawing superchilled air down from the stratosphere. By reversing the experiment, a visiting scientist and his former female protégé are able to halt the effect. In *Arctic Blast* (2010),<sup>59</sup> the quick freeze occurs when a weakened ozone layer can no longer hold back the superchilled air in the stratosphere, but by chemically recharging the atmosphere Australian scientists strengthen the layer and close the rift. In *Ice Quake* (2010),<sup>60</sup> the freezing air comes from below; global warming has melted the hydrates in the tundra and now rivers of liquid methane are flowing in the old mine tunnels that run beneath an Alaska town.

In the two films that begin and end in ice ages, the dramatic change of climate was caused by misguided efforts to ameliorate global warming. In *The Colony* (2013),<sup>61</sup> huge cloud-making installations had been assembled in key locations around the world to reduce the sunlight reaching the surface. So great was their output that Earth froze. The survivors of this abrupt climate change now live in underground installations, where their numbers are dwindling due to a new respiratory infection. When radio contact with another installation is broken, a small reconnaissance team is assembled, headed by the

colony's African-American leader. They discover that a roving band of marauders has slaughtered the inhabitants for food. Only a small remnant survive the battle that results when these marauders find the original colony. These survivors set out, in the killing cold, for an installation that now glows warm in the thermal sensors of a still functioning satellite. Someone has figured out how to reverse the cloud machines. The spraying of sun-blocking aerosols in the upper atmosphere produced the ice age in which a lone train, *Snowpiercer* (2014),<sup>62</sup> circumlocutes the world for the 17th time. Within the train, the remaining humans contend for survival, with the poor huddled in the dark and grimy cars at the rear and the wealthy enjoying the elegance of the first class cars—with restaurants, bars, a school, a greenhouse, and even a walk-through aquarium—at the front. The film follows a band of rebels as they make their way to the front of the car, where they learn that their insurrection was part of intended cull of the population. In a final act of rebellion, they derail the train. Just two children of color emerge from the wreckage—into a brightly lit, and warming, world.

### The Melting Arctic

The five films listed under this theme represent three very different genres. *Ice Age: The Meltdown* (2006)<sup>63</sup> and *Happy Feet 2* (2011)<sup>64</sup> are animated children's films in which anthropomorphized creatures—mammoths, sloths, saber tooth tigers, penguins, seals, and walruses—must deal with dramatic changes in their habitat. The global warming depicted—and named—in *Meltdown* is set at the end of the last ice age. In *Happy Feet 2*, set in present-day Antarctica, patches of green appear amid the white and blue landscape, and a massive ice wall opposite the penguins' nesting grounds is beginning to fracture. The very talkative animals do not refer to 'global warming,' but they do note the changes and some have had direct experience of the oil that is causing the warming. Two other films in this group represent the horror genre: *The Last Winter* (2006)<sup>65</sup> and *The Thaw* (2009).<sup>66</sup> The first tells the story of a small group of workers stationed on Alaska's tundra as they lay the groundwork for the next season of oil exploration. They are behind schedule because the tundra has been slow to freeze, the result, says the scientist writing the required environmental impact report, of global warming. But far more grave consequences follow: the melting tundra releases animal spirits that possess and derange the humans occupying their land. The menace released from the tundra in *The Thaw* is more tangible: a disease-bearing

parasitic insect that burrows into mammalian flesh. When a polar bear happens upon the thawing carcass of a mammoth, the parasite finds a contemporary host and, in its much warmer body, reproduces rapidly. A research team that then encounters the polar bear also becomes infected, which their leader, a scientist who has long advocated decisive action on climate change, sees as an opportunity. If he is flown south for treatment, he can spread the plague-ridden parasite in a major urban area. His colleagues foil his plan, but in the final scene of the film, in a wetland in a northern Midwest state, parasites bubble out of a fallen raven.

*The Road* (2009)<sup>67</sup> awkwardly spans two columns in the table—Melting Poles and Famine/Drought. No one in the film talks about climate change or global warming. The brief, early reference to ‘a series of concussions’ suggests that the screenwriter intends to portray the aftermath of a nuclear winter or the impact of a larger meteor. The dead forests, the dreary cold, and the shortage of food comport with these interpolations. But this world appears to be thawing as the man and his son make their way to the coast. As in *The Colony*, bands of marauders terrorize the remaining survivors, who also prey on each other. But when the father dies from the wounds and chills he has accumulated on their journey, the son is adopted by a family that appears ready to embrace a brightening world.

## Famine/Drought

Although one could point to possible precursors, the second and third *Mad Max* films, for example, films that address or incorporate climate change under the theme of famine and/or drought only began to appear in 2014. The most widely viewed of these is *Interstellar* (2014),<sup>68</sup> the film with the fourth highest world box office (adjusted for inflation) for a cli-fi film.<sup>69a</sup> Director Christopher Nolan uses documentary footage of the 1930s Dust Bowl to set the stage for his near-future film, when a new blight is slowly withering Earth’s food crops. Contrary to contemporaneous accounts of the original Dust Bowl,<sup>70b</sup> which implicated bad farming practices, the blight in *Interstellar* is blamed solely on nature; it is the planet that has failed humans rather than the reverse. On this basis, the lead scientist in the film argues that humans must return to space to find a new home for themselves: ‘The atmosphere is 30% nitrogen. Humans don’t breathe nitrogen. The blight does, and as it expands it sucks the oxygen from the air. In the end, those who don’t starve to death will suffocate.’ A former NASA pilot and now struggling farmer is

chosen to fly the next mission through a wormhole near Saturn to follow up on the reports sent back by the first explorers, while those left behind on Earth search for a way to lift a sort of ark into space. As both efforts are obstructed by scientists who falsify their data, *Interstellar* appears to favor the can-do attitude of engineers over the analyses and models of theoretical physicists and environmental scientists. At the end of the film, Earth is abandoned, without remorse, for a space station positioned near Saturn and a barren planet in another star system.

The remaining films in this column are firmly bound to Earth. The collapse of ecosystems, and of the human social systems that depend on them, is the starting point for *Mad Max: Fury Road* (2015).<sup>71</sup> Pollution and overconsumption are named as causes for this consequence; climate change is not mentioned. A decrepit warlord controls the only known well and surrounding oasis. Saving young and still vital women from his corrupt power provides the motive for the film’s protagonist: Furiosa. And when she succeeds, she releases enough water to green the desert hold and to humanize its inhabitants. A similar though less macabre story is told in *The Last Survivors* (2014).<sup>72</sup> In an Oregon of the near future, but ‘years since the last rain,’ farms have been reduced to dust; the few people who remain depend on what little water can still be pumped from their wells. One of them, a young woman, discovers that the gang terrorizing the survivors is led by the largest landholder, who is stealing their water. Against the odds, she succeeds in killing him; then she leaves the valley to find a better life.

Desert conditions also pervade *The Rover* (2014),<sup>73</sup> set in Australia ‘ten years after the collapse,’ and the *Young Ones* (2014),<sup>74</sup> set in the American West in the not-too-distant future. Western standards of living have been trimmed back, especially with respect to the use of water, but these are not dystopias. Trucks, trains, radios, computers, and even airplanes can still be seen. One infers that diversified economies still function in larger cities just over the horizon from these stories. In the hinterlands depicted in *The Rover*, however, people only subsist amid abandoned farms and towns. The protagonist enters the film, seemingly without purpose, at a dusty road stop. When his car is stolen, the film finds purpose in his violent quest to reclaim it—and the dead dog in its trunk. Because the small community depicted in *Young Ones* is still connected to a larger economy, most of its members have jobs. One of these involves carrying supplies—liquor, cigarettes, and pornography—to an encampment where state workers are digging a well and constructing a

pipeline to deliver its water where it is needed. Old disputes over land and water rights still motivate the next generation, the young ones, of the townspeople. The protagonists must adapt to changing configurations of power even as the community adapts—through appropriate, smaller-scale technologies—to the contracted, drier world of the new West.

### Preclima(c)tic Stress Disorder

The five films in this group focus on psychology, specifically on how the environment figures in the stresses of modern life, especially for those who lives are already troubled. *Half-Life* (2008)<sup>75</sup> tells the story of a young Vietnamese-American woman, Pamela, who lives in California's Diablo Valley with her mother, her younger brother, and her mother's underemployed American boyfriend. Running through this story of fluid identities and difficult relationships is a steady stream of dramatic news about the environment: coastal flooding, heat waves, other extreme weather events, and, somewhat anomalously, solar flares. These events never directly affect the characters in the film; nevertheless they have a cumulative impact, as evidenced by Pamela's comment to her closest friend, Scott, when they escape their families' tensions for a night: 'When I'm with you I worry less about the world ending.' Extreme weather events also loom in the background of *Future Weather* (2012),<sup>76</sup> the story of a young girl with a precocious command of the popular literature on climate change but whose confidence is repeatedly undermined by her broken family. When her mother abandons her to pursue yet another fanciful opportunity, Lauduree must find her place with her dutiful but resentful grandmother. At a critical moment in the film, Lauduree turns to her favorite teacher for stability and is gently rebuffed. Her disappointment, her fear, and her anger are then expressed in an environmental jeremiad delivered to passers-by on the sidewalk:

What are you looking at, huh? Are you ready for 23 feet of water flooding the eastern seaboard? Are you ready for refugees camping out in your backyard? What do you think the future is going to look like? Tropical paradise? Think it's going to be nice and warm? Well, there's not going to be any food. Welcome to my future.

Balance is only achieved when Lauduree and her grandmother genuinely choose, together, to make a new life elsewhere.

Actual extreme weather events do play a role in *Take Shelter* (2011),<sup>77</sup> a film about a drilling-rig

operator who repeatedly dreams about losing his family in catastrophic storms. Haunted by these dreams, he uses money intended for an operation to correct his daughter's hearing to construct a storm shelter under their backyard. When a severe thunderstorm strikes, his wife and child are grateful for the shelter but are alarmed when he refuses to let them leave. Finally persuaded to look outside, he sees the clear blue sky, breaks down, and agrees to seek help. Mellowed by medications, he takes his family to the coast for a restorative vacation on the beach. On the second day, black clouds mass on the horizon and the first lash of rain sprinkles them with greasy orange droplets. Silently, husband and wife agree to make their way back to their shelter.

The young heroine of *Tomorrowland* (2015)<sup>78</sup> is familiar with stories of disaster. She hears them regularly in school: 'The polar icecaps aren't waiting for us to decide if climate change is real. Rising coastal waters, intensifying weather patterns, they're all punching our one-way ticket to dystopia.' With its overly complex and often confusing plot, the movie as a whole disappoints, but *Tomorrowland* does succeed in conveying what these litanies of disaster might sound like to someone not in the choir. The heroine's can-do spirit eventually persuades the mysterious figures monitoring humanity's (lack of) progress to give the species another chance.

In *Chloe & Theo* (2015),<sup>79</sup> the most recent of the films reviewed in this article, Arctic Inuit elders, fearing that one of their apocalyptic myths is coming to pass, send one of their own, Theo, to New York City to call attention to their plight. There he meets a street-wise young woman, Chloe, with whom he succeeds in finding a public platform for his message. But Theo is killed before he can deliver that message, stabbed to death on the street for the high-priced sneakers he had just accepted from one of his new benefactors. Thus, the destructive materialism melting the Inuits' Arctic homeland claims the life of their messenger as well. But the people whose lives were touched by Theo are reformed and now champion his cause.

### Antagonists

The films in this final group are united by the fact that each includes a willful opponent, someone or something intent on doing harm to Earth and/or humanity—or intent on obstructing efforts to protect Earth and/or humanity. In *The Arrival* (1996)<sup>80</sup> and in the environmental remake of the Cold-War-era *The Day the Earth Stood Still* (2008),<sup>81</sup> aliens have come to Earth either to colonize it or to preserve its

fauna and flora. Both objectives entail the elimination of the human species. In *The Arrival*, the aliens hope to achieve this by accelerating global warming through massive injections of greenhouse gases. Two scientists follow separate lines of evidence to Columbia where one of these alien installations has been constructed. When they compare notes at a street-side café, they provide viewers with a quick lesson on climate change. By the end of *The Day the Earth Stood Still*, the one alien is won over by humans, as represented by a woman scientist and her African-American stepchild. In response, he shuts down the nano-technological swarm consuming humanity's built environment, trusting that humans will now respect the species and ecosystems with which they share the planet.

In *The American President* (1996), the antagonists are political figures. A romantic relationship with a lobbyist brought in by an environmental organization to pass a bill mandating more fuel-efficient cars (that will thus emit fewer greenhouse gases) creates an opening for the president's enemies. Forced to choose between the actual benefits of the environmental legislation promoted by his love interest and the political benefits of a feeble attempt at gun control, the president initially opts for the latter. But when his companion refuses to quit her cause, the president recovers his conscience and his convictions.

As in *The Noah's Ark Principle* and *The Storm*, two Antagonist films discussed under Extreme Weather Events, the military-industrial complex is the enemy in *Cat. 8* (short for Category 8, 2013).<sup>82</sup> An instrument designed to harness energy from the sun is reengineered to disrupt enemies' space-based defense capabilities. When the first test of this system goes awry, the Secretary of Defense overrules the scientists' recommendation to shut it down. Soon the country and the world face a Category 8 situation: the possible destruction of the planet.

Frail psyches and financial hucksters are the subject of the next two films. In *The Chaos Experiment* (2009),<sup>83</sup> a schizophrenic climate scientist threatens to kill hidden hostages unless his manifesto is published. (Although it was made many years after that event, this film appears to be a repurposing of the Unabomber story.<sup>84</sup>) In *A Glaring Emission* (2010),<sup>85</sup> a very young and unprincipled American entrepreneur trades fictional credits in the UK's carbon market—until his files are leaked to the authorities by the girl friend he has also bamboozled.

By contrast, *Kingsman* (2014)<sup>86</sup> has an arch-villain, a retired, black, Silicon valley entrepreneur who wants to save the natural world—from global

warming among other threats—by culling the human population. Opposing him is a new recruit to the Kingsmen, Britain's ultrasecret service, and his mentor, who share working class roots and a visceral resentment of upper-class snobbery. This attitude has a populist appeal when enacted in the well-heeled settings of the service, but questions of racism and homophobia arise when it is juxtaposed with the lisp-ing black villain with hip-hop accessories. More questions arise when his weapon of mass destruction is revealed to be a plastic card that provides free internet access and phone service. For some reviewers,<sup>87</sup> this provoked memories of the 'Obama phone' video that circulated among American conservatives in the final months of the 2012 election.<sup>88</sup> *Kingsman* may be for cli-fi films what Michael Crichton's *State of Fear*<sup>89</sup> is for cli-fi novels: a commercially successful fictional attempt to debunk and discredit climate science and its liberal supporters.

## CRITICAL LITERATURE ON CLI-FI FILMS

In the study of fictional films about climate change, two lines of inquiry converge: film studies and ecocriticism. For some students of film, the movies described above are examples of long-standing genres—such as disaster films or dystopias—that can achieve their dramatic ends without invoking an environmental problem like climate change. For these researchers, independent developments in the making and marketing of major motion pictures are responsible for much of what we see on the screen. In a frequently cited essay, critic Susan Sontag explained the social significance of the science-fiction films of the 1940s, 1950s, and 1960s, which she reclassified as 'disaster films.' Such films offer the guilty pleasure of watching compelling spectacles of destruction while addressing and allaying the widespread fears of the historical moment. But, she cautioned, 'the imagery of disaster in science fiction is above all the emblem of an inadequate response' (Ref 90, p. 224), as these films never engage in social criticism of the sort required to confront the problems underlying these fears. In his critical review of disaster films of the 1970s, Roddick<sup>91</sup> argues that the box office success of some key progenitors like *The Poseidon Adventure* resulted in a new formula, for which Hollywood screenwriters and directors then honed their talents. These films, Roddick speculates, assuaged the social and political anxieties of the time by reasserting, in the midst of indolent luxury, the survival skills and values of the American frontier. In the 1980s and

1990s, according to King,<sup>92</sup> the disaster film is reinvented on a grand scale. With the special effects made possible by computer image generation, filmmakers could more realistically depict the destruction not just of individual ships, planes, or buildings but of whole cities. In the ‘spectacular narratives’ of the 1990s, the characters are handled differently as well. Instead of as an ensemble trapped and struggling in the same space together, characters follow individual paths through the larger story. While these films rely on science and technology to make their spectacular narratives persuasive, Kirby,<sup>93</sup> who analyzed collaborations between scientists and filmmakers, cautions that most filmmakers are not interested in telling the story of a particular field of science; rather, they want to use that science to revive or reinvent an established movie story. With advances in digital technologies, Schroder<sup>94</sup> adds, the telling of the disaster story is now mediated by the computer, phone, and TV news screens that surround us. News and social media images become part of the film. Feil<sup>95</sup> argues that a camp sensibility, a mocking self-awareness, also emerges in the 1990s. Characters crack wise as iconic landmarks are destroyed and conventional disaster-movie moves are topped or tweaked. Both Feil and Keane<sup>96</sup> note that the 9.11 terrorist attacks called this sensibility, and the entire disaster genre, into question (see also Thomsen<sup>97</sup>). In their interpretations of *TDAT*, the first film to depict the destruction of New York City after 9.11, director Roland Emmerich walked a careful line between the camp spectacle of the 1990s disaster film and the earnest passion of a social problem film. [Haase acknowledges the change in tone with *TDAT* but questions whether it marks a genuine break ‘with the calculating and reactionary cinema Emmerich has produced throughout his career’ (Ref 98, p. 131). Thomsen<sup>97</sup> and Pirro<sup>99</sup> see in *TDAT*’s evocations of Caspar David Friedrich’s frozen landscapes evidence of a more reflective political perspective.] Within the context of this particular domain of film studies, the cli-fi movies that came after *TDAT* follow trajectories that are largely determined by film industry events, including the extraordinary commercial success of *TDAT*.

The second line of inquiry, eco-criticism, emerged within literature and American and/or cultural studies departments. The frameworks and perspectives used to interpret written texts were adapted for use in interpreting films about the environment. Ingram’s *Green Screen*,<sup>100</sup> one of the first book-length studies, examines how Hollywood films depicted wilderness, wild animals, and political-cultural disputes over land use. Global warming is

mentioned on just three pages, as a quickly noted detail in longer discussions of *The American President*,<sup>101</sup> *Soylent Green*, and films about the Amazonian rain forest. In their many studies of ‘ecocinema,’ Murray and Heumann have likely viewed more environmental films than any other researchers. Two of their four books include extended discussions of cli-fi films. In their analysis of *TDAT*,<sup>102</sup> Murray and Heumann focus on the scientist-father at the center of the film, arguing that this depiction of the ‘eco-hero’ redefines the hypermasculine ideal of the traditional hero. In *Happy Feet 2*,<sup>103</sup> they find an ‘enviro-toon’ that subtly links fossil fuels with global warming as the cause of the penguins’ problem and that then points to cooperative, collective action as the solution. A forthcoming book will address more recent cli-fi films.<sup>104</sup>

The Apocalypse—as a core myth underlying human thought, as a pop-cultural genre, and as a political problem—has figured in both lines of inquiry. Hulme<sup>105</sup> has argued that ‘Presaging Apocalypse’ is one of four basic myths of climate change, and he places *TDAT* squarely within the lineage of that fear-based myth. (The other three myths are Lamenting Eden, Constructing Babel, and Celebrating Jubilee.) Without Hulme’s three complementary myths, Heise<sup>106</sup> too sees *TDAT* ‘fall[ing] back on apocalyptic narrative,’ as do Zumbansen and Fromme.<sup>107</sup> (By contrast, Salvador and Norton<sup>108</sup> see a more specific apocalypse at work in *TDAT*: the flood myth.) In a book that predates *TDAT*, Dixon<sup>109</sup> reviews previous ‘spectacles of destruction in American cinema,’ demonstrating the centrality and vitality of the apocalyptic genre in American popular culture. McSweeney<sup>110</sup> places the bleak film version of *The Road* within that tradition. More broadly, Swyngedouw<sup>111,112</sup> argues that these end-of-the-world depictions of climate change reflect the limited and debilitated state of contemporary politics. In a ‘postpolitical’ discussion reserved for experts, bureaucrats, and executives, choice is ideologically reduced to capitalism or chaos. Methmann and Rothe<sup>113</sup> share Swyngedouw’s skepticism, and they clearly invoke Emmerich’s film in the title of their article—‘Politics for the Day after Tomorrow’—even though they do not discuss it.

Although the apocalyptic genre dominates academic interpretations of cli-fi films, other genres are discussed. Sturgeon<sup>114</sup> interprets Arctic documentaries and films, including *Happy Feet*,<sup>115</sup> through the genre of family values films. Justice<sup>116</sup> reviews several ‘eco-horror’ and science fiction films, including *The Last Winter*, to illustrate how the horror genre is transformed when it is transplanted to the

poles. Moore analyzes three animated children's films, including *Ice Age 2*, for their 'manifest' and 'symptomatic' meanings and finds that these films invite young people 'to approach the environment as self-interested consumers, a vantage point that fundamentally limits which solutions to environmental problems are considered viable' (Ref 117, p. 13). Finally, while he recognizes the film's use of magical realism, Johnson argues that 'the anarcho-liberal politics that define *Beasts of the Southern Wild* are cynical and offer little hope for addressing the broad ecological and social challenges we face' (Ref 118, p. 207). Burt<sup>119</sup> places the same film within the genre of the fairy tale, with a touch of Huck Finn.

Some researchers have compared climate change films with each other. In most of these articles, however, *TDAT* is compared with one or more documentaries. The one exception to this rule is 'Directing the Weather, Producing the Climate,' in which Murphy reviews two low-budget films (*F4* and *Ice Twisters*), three high-budget or feature films (*Waterworld*, *TDAT*, and *The Day the Earth Stood Still*), and four TV miniseries (*Category 6*, *Category 7*, *The Flood*, and *The Fire Next Time*) (Ref 20, p. 34–48). Murphy finds the scenarios in the TV miniseries the most plausible. But even with a plausible scenario, he argues, the environmental message is often overwhelmed by the personal narratives woven through the film or miniseries. Of the group as a whole, Murphy concludes, 'the weakest are those that contribute to a sense of a singular disaster, while the strongest are the ones that present a sense of systemic change and catastrophe' (Ref 20, p. 47).

It should already be clear that *TDAT* is the film most frequently addressed in academic analyses of films about climate change. Only *An Inconvenient Truth* (hereafter *AIT*, 2006)<sup>120</sup> comes close in the attention received, in part because *TDAT* is often compared with the Al Gore documentary. McGreavy and Lindenfield<sup>121</sup> examine *TDAT*, *AIT*, and *Sizzle*<sup>122</sup>, a comical documentary, for their underlying social and political messages. They find that *TDAT* and *Sizzle* perpetuate racial, ethnic, and gender stereotypes while *AIT* valorizes Gore as a mythic masculine hero. Filmmakers would do better, they conclude, to represent all those who will be asked to contribute to the solution for climate change. Hammond and Breton look at evocations of loss and mortality in *TDAT*, *AIT*, and *The Age of Stupid* and at how these affect perceptions of agency. They conclude that *TDAT* is 'a liberal fantasy' that depicts 'climate catastrophe as positive ... Nature intervenes to rebalance and reorder the human world at the same time as it reorders the ecosystem' (Ref 123,

p. 314). After comparing the same three films, and after reviewing some of the audience response studies done about them, Sakellari<sup>124</sup> concludes that *TDAT* confused viewers as much as it aroused their concern. The dramatic effects worked, emotionally, but if they were perceived as science fiction, as was often the case, the concern quickly dissipated.

Audience studies of the sort cited by Sakellari constitute the next body of critical work. Leisero-witz<sup>125</sup> surveyed viewers before, immediately after, and 6 months after seeing *TDAT*. He found that his American subjects generally reported higher levels of concern after seeing the film and a greater willingness to act on the issue, including in the voting booth at the end of that election year. These effects persisted, at lower levels, in the follow-up survey. Lowe et al.<sup>126</sup> conducted a similar study in the UK—with mixed results. *TDAT* made viewers more anxious but also more uncertain about the likelihood of extreme weather events as a result of climate change. And although they expressed an increased willingness to act, they did not know what they could do about the problem. In their surveys of German audiences, Reussig, Scwharzkopf, and Pohlenz<sup>127</sup> found that viewing *TDAT* lowered estimates of the likelihood that climate change would affect them personally; however, the film 'improved the public perception of science and the political role of scientists.'<sup>128</sup> Smaller studies in Italy<sup>129</sup> and Japan<sup>130</sup> came to more negative conclusions.

Others have attempted to evaluate *TDAT*'s success by examining the responses it evoked in the media and among groups already debating climate change in the public sphere. After reviewing the artfully orchestrated publicity for the film and the ways different environmental and political groups mobilized for its premiere, Branston<sup>131</sup> argues that *TDAT* provides a prime example of an 'event film,' a film that merits coverage as a news item, as something happening in the public sphere. Although she notes the inherent contradiction with its high-tech (and energy intensive) spectacle, Branston believes *TDAT* successfully promoted an environmental message. After surveying the many news stories, reviews, op-eds and analyses, Nisbet<sup>132</sup> concurs with Branston's assessment but then wonders exactly what messages about climate change the public actually received from *TDAT*. Rust<sup>133</sup> also reviewed the publicity surrounding the release of *TDAT*, the audience response analyses, and the impact of *AIT*, which was released just one year after *TDAT*. He concludes that *TDAT* and *AIT* did raise the public profile of climate change in the years that followed. According to Kirby, Michael Molitor, the scientist who consulted most

directly on *TDAT*, was convinced that his work on the film did more to promote awareness of climate change than anything he had done as a researcher or negotiator (Ref 93, p. 179–183). Part of that awareness is now focused on the contentious politics of climate science, a point also made by Perkowitz, who singles *TDAT* out for a special award for ‘illustrating the conflict that can and does occur when scientific findings clash with government policies or political agendas’ (Ref 134, p. 208). A different measure of *TDAT*’s effectiveness has been provided by Von Burg,<sup>135</sup> who analyzed how scientists and conservative skeptics debated the film’s merits. He argues that *TDAT*’s dramatic fictionalization of climate change required a special ‘not untrue’ framing. Had this been done consistently, he suggests, the burden of proof for inaction would have been placed on the skeptics. Writing ten years after *TDAT*’s release, Svoboda<sup>136</sup> offered one further measure of *TDAT*’s influence: it still serves as a ready point of reference for both scientific and news stories about climate change.

The results obtained by the surveys of audiences’ responses to *TDAT* are largely in line with the recent synthesis of research on communicating climate change by ecoAmerica and the Center for Research on Environmental Decisions.<sup>137</sup> The 10 principles for effective climate change communication enumerated in their report—see Box 1 for the full list—place an emphasis on connecting with the

## BOX 1

### GUIDELINES FOR EFFECTIVE CLIMATE CHANGE COMMUNICATION

1. Put yourself in your audience’s shoes
  - a Align messages with your audience’s values and worldviews
  - b Understand how identity shapes climate engagement
  - c Appeal to people’s desire to be ‘good people’
2. Channel the power of groups
  - a Recognize that people think and behave differently in groups
  - b Mobilize social groups and networks
3. Emphasize solutions and benefits
  - a Lead with solutions to boost engagement
  - b Show audience how they can become part of solution
  - c Highlight the benefits of taking action
4. Bring climate impacts close to home
  - a Focus on local impacts and highlight personal experiences
  - b Pair impacts with solutions to avoid emotional numbing
  - c Focus on the ‘what’ and not the ‘when’
  - d Be sensitive to recent losses and ‘near misses’
5. Connect climate change to issues that matter to your audience
  - a Connect climate change to issues that matter to audience using content frames
  - b Provide coherent narrative: match priorities with structure frames
6. Use images and stories to make climate change real
  - a Use images that inspire and empower
  - b Show people, not pie charts
  - c Use storytelling to strengthen engagement
7. Make climate science meaningful
  - a Know how your audience understands science
  - b Communicate on a human scale
  - c Use familiar concepts to help people understand
8. Acknowledge uncertainty, but show what you know
  - a Acknowledge role of uncertainty in climate change
  - b Focus on what is known
  - c Know how your audience responds to uncertainty
9. Approach skepticism carefully
  - a Understand why some people doubt climate change
  - b Identify sources of doubt, but don’t overload without facts
  - c Focus on solutions, not just the problem
10. Make behavior change easy
  - a Enable people to set specific targets for their behavior
  - b Make climate-friendly choices the default option
  - c Highlight the ‘green Joneses’
  - d Give people fewer choices, not more
  - e Incentivize behavior with appropriate rewards

lived experience of the intended audience and caution against making extreme claims or relying on appeals to fear. The report also stresses the importance of emphasizing solutions and benefits and providing audiences with ways to act on the concern, on the awareness, one is trying to arouse. With these principles in mind, the mixed responses to *TDAT* of British, German, Italian, and Japanese audiences make sense: the film creates an extreme and, if taken seriously, extremely frightening scenario, but it identifies no actions that can be taken to avoid that scenario. The more positive responses of American audiences may reflect a lower initial awareness or that, as Branston<sup>130</sup> and Rust<sup>132</sup> suggest, *TDAT* was a bigger event in the United States. (Hart and Leiserowitz<sup>138</sup> found some evidence of increased information-seeking behavior regarding climate change around the dates of the film's release.) But *TDAT* is just one film; the perspective gained from the foregoing review of literature and the critical framework provided by the ten principles must now be applied to the full set of 55 films, with the aim of identifying patterns across climatic impacts and trends over time.

### PATTERNS AND TRENDS

A tally of relevant observations from the survey in part two will make it easier to evaluate the films' efficacy using the criteria just extracted from the academic literature. In Table 2, the percentage of films addressing each impact is listed on the left. In the middle is a breakdown of the films by traditional

genres. And in the right column are tallies for elements noted, directly or indirectly, in discussing the films. The numbers in the table, the third column in particular, already point to problems with these films as vehicles for communicating climate change, problems that can now be addressed.

### The Genre Is the Message

Table 2 shows that three genres account for nearly 60% of the films reviewed (not including the precursors): disaster, apocalyptic, and dystopic. If one adds the films in which the central characters obsessively worry about disasters and endings of the world, that figure rises to 70%. Each of these genres presents climate change communicators with different challenges and opportunities.

With some imagination, viewers can readily connect extreme weather event disaster films with their own experience, especially in the United States where extreme weather events regularly appear on the news. Done well, these films can make the possible risks posed by climate change visually compelling. And if one of the main characters is a scientist wrestling with the same sort of personal and professional issues as the viewers, then the filmmaker has created a trusted messenger who can make climate science meaningful for them. Given the complexities of the relationship between climate change and extreme weather,<sup>139</sup> however, there is a risk of overstating the science. Conversely, the habitual return to normalcy at the end of disaster films risks understating the problem, turning it into a one-time event,

**TABLE 2** | Tally of Impacts, Genres, and Elements

% of Cli-Fi Films That Incorporate		% of Cli-Fi Films Classified As		% of Cli-Fi Films That Include	
Flooding/SLR	9	Disaster films	34	Disk/Examples of CC mitigation	4
Extreme weather events	40	Apocalyptic films	11	Disk/Examples of adapt. to CC	16
Ice age conditions	20	Dystopic films	13	Mitigation tech. as cat. risk	15
Melting poles	11	Dramatic films	14	Geo/Weather eng. as cat. risk	7
Famine/Drought	13	Suspense/Thrillers	11	Massive loss of human life	25
Preclima(c)tic stress	7	SF films (aliens, robots, space)	7	Proposed culling of human pop.	5
Antagonists	18	Horror films	4	Weaponized energy/weather tech	9
		Children's films	4	Scientist as main character	55
		Adventure films	2	Woman as authoritative figure	45

Because each cli-fi film can address more than one impact, the numbers for this column add up to more than 100. The numbers in the second column do add up to 100. Some of the genres, however, require further explanation: (a) For the purposes of this study, a Disaster Film depicts a crisis that is met and resolved. Things return to normal at the end of the film; major changes in lifestyle are neither implemented nor even considered; (b) In an Apocalyptic Film, after the crisis has ended the characters in the film must adapt to a new world, such as the ice age depicted in *TDAT*; (c) In a Dystopic Film, the civilization-ending (or at least the end-of-life-as-we-know-it) crisis has already occurred; (d) A Dramatic Film focuses on character development and personal/professional relationships, but it can include personal acts of violence. As with the first column, each cli-fi film could include more than one of these elements (or none at all); thus, the numbers do not add up to 100.

as Murphy<sup>20</sup> notes, rather than a systemic (or ‘chronic,’ in the words of Macfarlane<sup>3</sup>) problem. And as only one film in this group offered examples of successful mitigation and only a few others mentioned adaptive measures, it cannot be said that these films emphasize solutions and benefits or make behavior change easy.

The linked genres of apocalyptic and dystopic films fare even worse on these criteria. In an apocalyptic film, a movie in which disastrous events tip Earth into a new (sub)normal, there is typically still a scientist with which the audience can identify and, as a result, trust to make the science meaningful. However, that science is now so extreme as to strain credulity. In dramatically marking the end of the world as we know it, the apocalyptic film also disconnects viewers’ current lives from the possible future depicted on the screen. As in *TDAT*, it is already too late to emphasize solutions and benefits, and instead of learning how to change one’s behavior to reduce one’s impact on the climate, the changed climate forces one to change one’s behavior in order to survive. Earth has already solved the environmental problems created by humans by dramatically reducing their number (Hammond and Breton<sup>123</sup>). Thus, the makers of these films do not imagine effective responses to the challenge of living in the Anthropocene; rather, they recreate the Holocene. Likewise with the dystopic films in which some apocalyptic ending of civilization has already occurred. But in these films the role of the scientist disappears and all families are broken, forcing individuals to make temporary connections with others willing to share the risks. Once again, the disjunction between these worlds and the lived present of the viewers is so great that it is difficult to imagine any action in the present that could affect that future world. In Sontag’s terms,<sup>88</sup> these films do not lead to solutions, they are emblematic of inadequate responses to the problem.

### The Meanings in the Modes of Production

Table 1 shows that made-for-TV films, plus the straight-to-DVD films likely intended for TV, make up 50% of the cli-fi films produced between 1984 and the present. Most of these films are listed under Extreme Weather Events or share that designation with an adjacent column. Near the top of the Extreme Weather Events and Into/In Ice Age columns sit two major theatrical releases: *Twister* and *TDAT*. This is not an accident. The high concept and high

production values that characterize a major Hollywood film will, if successful, generate imitations. And as *TDAT* included tornadoes and a tsunami-like storm surge in addition to its ice scapes, it would have spurred imitations in both columns. These more quickly produced, low-budget films follow another mode of production, one that relies on permutation, escalation, and intensification.

Permutation means that each new imitation explores another possible variation of the basic plot. The Extreme Weather Event and Into/In Ice Age imitations accomplished this by varying their locations and the causes of their tornados, hurricanes, or ice storms. As a consequence, quite fanciful causes—dark energy—will be treated as equally plausible as causes, like the urban heat island effect, which have some support in climate science. Similarly, new places chosen for these films could include regions likely to be affected by extreme weather events in the future, or locations that have not yet been used in the genre and are unusually picturesque. Decisions like this confirm what Kirby<sup>93</sup> observed regarding the very different objectives with which scientists and filmmakers approach the task of incorporating science into the plot of a movie. This difference is often expressed as filmmakers taking poetic license with the science, but this understates the matter. It would be more accurate to say that filmmakers seek a scientific license to reinvent a story they have already told before. One can see escalation at work in two different sequences of cli-fi titles: *Category 6*, *Category 7*, *Cat. 8*, and *F4*, *F6*, *500 MPH Storm* (which would be equivalent to F10). With extreme weather events, it appears, each reinvention of the basic plot requires a bigger storm. Finally, there is intensification, by which is meant adding more elements to the plot, whether more storm events or more subplots. For communicating climate change, the cumulative effect of these three modalities is mostly negative. While permutation can yield regional variations with greater personal appeal for specific audiences, and while the frequent iteration of the basic plot could reinforce the underlying message, escalation will make that message increasingly implausible and intensification will increase the noise with which it must compete.

Together, the constraints of genre and the defaults in the modes of film production comprise a set of cinematic norms akin to the journalistic norms described by Boykoff and Boykoff,<sup>140,141</sup> norms that can systematically distort the representation of climate science in film. In their first analysis of reporting on climate change in American newspapers, for example, Boykoff and Boykoff found that after

accurately interpreting some aspect of climate science for their readers, reporters then confused the public's perception of the problem by compulsively 'balancing' the science with an opposing viewpoint—even if spurious.<sup>140</sup> The effects of cinematic norms are analogous. The drives to permutate, escalate, and intensify make it difficult for filmmakers to deliver a clear, coherent, and consistent message about climate message.

### The Changing Climate for Cli-Fi

For most researchers, including the author, Table 1 offers two immediate surprises: the large number of films included in the table and the early date for some of the more earnest made-for-TV productions. Contrary to what was expected, several of the most ambitious and scientifically explicit films appear in the top half of the table: *The Fire Next Time* (1993), *TDAT* (2004), still the most influential cli-fi film, *Category 6* (2004), *Category 7* (2005), and *The Flood* (2007). The films that follow these are neither as direct nor as sympathetic. In 2009, one begins to see a new kind of cli-fi film: films that shift attention away from the everyday causes of climate change. *Ice Twisters* and *The Storm* are the first two films to consider the weaponization of climate/weather technology. In 2011, this risk is attached to alternative or clean energy technologies, with the implication that action on climate change may be riskier than inaction. In 2013, catastrophic climate change is attributed to geoengineering schemes.

Since 2011, there has been a broadening of the range of climate impacts considered. At the same time, however, there is growing evidence of fatigue or skepticism regarding climate change. Of the 13 films released in 2014 and 2015, two (*Interstellar* and *Kingsman*) suggest that the attention devoted to climate change should be redirected elsewhere; two (*Sharknado 2* and *Sharknado 3*) parody concern about climate change; one (*Snowpiercer*) suggests that action on climate change could prove more catastrophic than inaction; and four films (*The Rover*, *Young Ones*, *The Last Survivor*, and *Mad Max: Fury Road*) imply but do not name 'climate change' or 'global warming.' Thus, while the box office success of *Interstellar*, *Mad Max: Fury Road*, and *Kingsman* would lead one to expect sequels or imitations, it is not clear that these would address climate change. [Over the same period, however, studios have released DVD and blu-ray versions of older cli-fi films from their catalogs, suggesting that they perceive a growing market for cli-fi films. The DVD for

*The Fire Next Time* (1993), for example, was only released at the end of July 2015.]

By contrast, over the last 10 years considerable progress has been made on the sort of social issues noted by McGreavy and Lindenfeld.<sup>121</sup> Screenwriters and directors, especially of made-for-TV movies, are more willing to acknowledge the changing character of the family and to meet changing expectations regarding gender and race. Some 45% of the cli-fi films reviewed here place women in positions of power—US Vice President, US Secretary of Energy, Director of FEMA, Director of Emergency Response for London, heads of science agencies, project managers, engineering consultants, and so on—and then show these women exercising that power effectively. Social criticism has clearly registered with these filmmakers even if few engage in social criticism within their films. This suggests that a more consistent, forward-looking message on climate change might be possible if filmmakers incorporated it as part of the socioeconomic environmental setting for their plots. More frequent peripheral glimpses of climate change may result in a more coherent vision of the challenge it poses than dramatic, but rare, close-ups.

To conclude this discussion of trends in cli-fi films over the past 30 years, one should note a prominent absence in the table of climate impacts: lethal heat waves. The directors of *The Fire Next Time*, *Category 6*, and *Category 7* make clear to their viewers, through the sweat glistening on their actors, that it is genuinely hot in coastal Louisiana, Chicago, and Washington, DC, respectively. But the potentially lethal consequences of a long, fierce heat wave are not noted. This is especially surprising with respect to the Chicago-based *Category 6*; in 1995, the city suffered a heat wave that killed over 700 people (Klinenberg<sup>142</sup>). New figures for the 2003 heat wave in Europe put the death total at over 70,000, over 15,000 in France alone (Keller<sup>143</sup>). Paris figures prominently in several cli-fi films—the Eifel Tower is toppled in at least three—yet none has addressed this most lethal impact of climate change.

### CONCLUSION

Even in more popular venues such as *The New York Times*, participants in discussions of cli-fi films have expressed concerns about the messages viewers receive. In a July 2014 Room for Debate forum, for example, Film and Media Studies professor J.P. Telotte<sup>144</sup> worried that films like *TDAT*, rather

than prompting action on climate change, ‘make us feel better about our ability to survive [its impacts].’ Author Sheree Renee Thomas<sup>145</sup> was more optimistic, seeing a positive role for storytelling if predicated on ‘the commitment to imagine community-based solutions as part of our shared future.’ Founder of the Climate Outreach Information Network George Marshall<sup>146</sup> would endorse Thomas’ emphasis on imagining community-based solutions but predicted that ‘cli-fi will reinforce existing views rather than shift them’; films like *TDAT* cannot communicate across the political divisions that separate people on climate change, especially in the United States. Asked to describe what a good cli-fi film could/should do, Marshall pointed to films that could be interpreted as analogical or metaphorical engagements with the issue: ‘I’m most interested in films which explore the processes of dissonance and denial, and how well informed and intelligent people can ignore the evidence that is in front of them.’<sup>147</sup> He offered Ibsen’s *Enemy of the People*<sup>148</sup> as one possible example, although he did not say which film version he had in mind. For a more specific example of collective denial he suggested *Jaws*,<sup>149</sup> and for collective avoidance of responsibility, *High Noon* (1952).<sup>150</sup> Asked the same question, Ezra Markowitz, one of the coauthors of the *Connecting on Climate* report, also responded with an analogical answer. He thought that *Sliding Doors* (1988)<sup>151</sup>—which depicts the very different futures that result when the main character remembers versus when she forgets to get off at her usual subway exit—could ‘show[] how different (climate-related) futures play out in parallel as a function of some decision or event.’<sup>152</sup>

Based on these answers, however, any film could be a cli-fi film, which would make the study undertaken here impossible. Instead, by focusing on films discussed or internally flagged as dealing with anthropogenic climate change—or with efforts to mitigate its causes or to adapt to its consequences—this study has arrived at the following conclusions, some of which echo points made by these commentators:

- Over the past 30 years, more films have addressed climate change than has previously been acknowledged.
- Extreme weather events, presented in the genre of the disaster film, make up the single largest subgroup (34%) of these films (by contrast, according to Trexler,<sup>35</sup> flooding/sea-level rise is the climate change impact most often addressed in cli-fi novels).

- The next largest subgroup, the 10 films that depict Earth slipping into an ice age (including *TDAT*, the best known cli-fi film), reflects filmmaking practices and norms more than climate science.
- Due to its success, *TDAT* has elevated a low-probability scenario into an iconic image for climate change while also influencing on-screen depictions of storms, including meteorological chimeras like flash-freezing superstorms, which still appear in cli-fi films.
- Successful examples of efforts to mitigate the causes of climate change are almost entirely missing from these films, and only a few address ways to adapt to its consequences.
- Modes of production for filmmakers producing lower-budget, made-for-TV movies place a premium on permutation (systematic variation), escalation, and intensification. Like the journalistic norms described by Boykoff and Boykoff,<sup>140,141</sup> these cinematic norms can systematically distort depictions of climate science.
- Among these distortions is the recent emergence of films that depict acting on climate change as more disastrous than not acting; while a logical (even inevitable) option from the filmmaker’s perspective, such scenarios are not warranted by the science.
- Cli-fi films have, however, made progress in getting beyond traditional cultural and social stereotypes, especially regarding gender. Were filmmakers to incorporate climate change into the broader context of their plots—rather than making it the focus of the story—they might deliver more consistent, forward-looking messages on climate change.
- The most recent films, especially the theatrical releases, appear less willing to engage climate change explicitly than the films of seven to ten years ago, but more of that older catalog of films is being released on DVD or blu-ray, suggesting that the studios recognize a growing market for cli-fi.
- The academic literature on cli-fi films is still largely focused on *TDAT*, a film now more than 10 years old.

The continued focus on *TDAT* is not entirely without justification, however. An informal survey of students in an Introduction to Sustainability course found that 95% had heard of *TDAT* and 67% had seen it. By contrast, only 40% had seen *AIT*. And of the most

recent cli-fi films to appear on the screens, only *Interstellar* had been seen by a majority (57%) of the students. One suspects McKibben and Macfarlane imagined a different future when they issued their 2005 calls.

## NOTES

<sup>a</sup> In this list of 550 films, eight of the film from the table appear: *Twister* (#82), *Ice Age: The Meltdown* (#110), *The Day After Tomorrow* (#144), *Interstellar* (#194),

*Waterworld* (#344), *Kingsman* (#475), *Noah* (#549), and *Mad Max: Fury Road* (#550).

<sup>b</sup> Nolan uses archival film and interviews from Ken Burn's PBS mini-series to create a pseudo-documentary for his blighted Midwest of the near future.

<sup>c</sup> Boykoff and Boykoff found that the journalistic norm of "balancing," finding opposing points of view, could result in a bias against a scientific consensus, effectively representing a scientific issue on which there is widespread agreement (90–10) as a 50–50 proposition.

## REFERENCES

- Bloom D. In 2015 will Bill McKibben and Robert Macfarlane update their 2015 calls for a cli-fi genre? *Cli-Fi.Net 3.0*; July 10, 2015. Available at: <http://pcillu101.blogspot.tw/2015/07/in-2015-will-bill-mckibben-and-robert.html>. (Accessed August 1, 2015).
- McKibben B. What the warming world needs now is art, sweet art. *Grist*; April 22, 2005. Available at: <http://grist.org/article/mckibben-imagine/>. (Accessed August 1, 2015).
- Macfarlane R. The burning question. *The Guardian*; September 23, 2005. Available at: <http://www.theguardian.com/books/2005/sep/24/featuresreviews.guardianreview29>. (Accessed August 1, 2015).
- Emmerich R (Director). *The Day After Tomorrow*, Emmerich R, Nachmanoff J, Screenwriters, 2004. Twentieth Century Fox, 2007, blu-ray.
- Haschard T. After *An Inconvenient Truth*: the evolution of the 'climate change film'. *The Guardian*; September 21, 2014. Available at: <http://www.theguardian.com/film/2014/sep/21/inconvenient-truth-evolution-climate-change-film>. (Accessed August 1, 2015).
- Room for Debate. Will fiction influence how we react to climate change? *The New York Times*; July 29, 2014. Available at: <http://www.nytimes.com/room-for-debate/2014/07/29/will-fiction-influence-how-we-react-to-climate-change>. (Accessed August 1, 2015).
- Tuhus-Dubrow R. Cli-fi: birth of a genre. *Dissent*; Summer 2013. Available at: <https://www.dissentmagazine.org/article/cli-fi-birth-of-a-genre>. (Accessed August 1, 2015).
- Berry M. The rise of climate fiction: when literature takes on global warming and droughts. *Salon*; October 26, 2014. Available at: [http://www.salon.com/2014/10/26/the\\_rise\\_of\\_climate\\_fiction\\_when\\_literature\\_takes\\_on\\_global\\_warming\\_and\\_devastating\\_droughts/](http://www.salon.com/2014/10/26/the_rise_of_climate_fiction_when_literature_takes_on_global_warming_and_devastating_droughts/). (Accessed August 1, 2015).
- Pyper J, Massey N. Climate change fiction gets hot in Hollywood (if you still don't get it, it'll get you). *ClimateWire*; June 11, 2014. Available at: <http://www.eenews.net/stories/1060001065>. (Accessed August 1, 2015).
- Waite T. What cli-fi can do to save the planet. *The Daily Climate*; June 25, 2015. Available at: <http://www.dailyclimate.org/tdc-newsroom/2015/06/climate-change-fiction-cli-fi-science-thomas-waite>. (Accessed August 1, 2015).
- Burdick D. Climate change: the hottest thing in science fiction. *Grist*; April 8, 2014. Available at: <http://grist.org/climate-energy/climate-change-the-hottest-thing-in-science-fiction/>. (Accessed August 1, 2015).
- The apocalypse issue. *Entertainment Weekly*; July 4, 2014.
- Trexler A, Johns-Putra A. Climate change in literature and literary criticism. *WIREs Clim Change* 2011, 2:185–200.
- Bottoms S. Climate change 'science' on the London stage. *WIREs Clim Change* 2012, 3:339–348.
- Armstrong F (Director). *The Age of Stupid*, Armstrong F, Screenwriter, 2009. Spanner Films/Docurama, 2010, DVD.
- Available at: [http://www.imdb.com/?ref\\_=nv\\_home](http://www.imdb.com/?ref_=nv_home). (Accessed July 28, 2015).
- Emmerich N (Director). *The Noah's Ark Principle* (originally *Das Arche Noah Prinzip*), Emmerich N, Screenwriter, 1984. Anchor Bay, 2002, DVD
- Linke A (Director). *F4 Vortex* (aka *Tornado*), Bohlinger D, Lacant S, Screenwriters, 2006, Grundy UFA Film Productions/Maverick Productions, 2010, DVD.
- May B (Director). *The Storm*, Abramowitz D, Chernov M, Pratt D, Rosiak D, Screenwriters, 2009. RHI Entertainment, 2009, DVD.
- Murphy P. Directing the weather, producing the climate. In: Alex R, Deborah S, Sachindev PS, eds. *Culture and Media: Ecocritical Explorations*. Newcastle upon Tyne: Cambridge Scholars Publishing; 2014.

21. de Bont J (Director). *Twister*, Crichton M, Martin AM, Screenwriters, 1996. Warner Home Entertainment, 2011, blu-ray.
22. Available at: <http://www.boxofficemojo.com/alltime/adjusted.htm>. (Accessed August 2, 2015).
23. Fessenden L (Director). *The Last Winter*, Fessenden L, Leaver R, Screenwriters, 2006. IFC Films, 2008, DVD/Box Office Mojo. *The Last Winter*, total gross: worldwide. Available at: <http://www.boxofficemojo.com/movies/?id=lastwinter.htm>. (Accessed August 2, 2015).
24. Wilde C (Director). *No Blade of Grass*, Forrestal S, Wilde C, Screenwriters, 1970. Warner Archive, 2012, DVD.
25. Fleischer R (Director). *Soylent Green*, Greenberg S, Screenwriter, 1973. Warner Home Video, 2011, blu-ray.
26. Girdler W (Director). *Day of the Animals*, Norton W, Norton E, Montoro E, Screenwriters, 1977. Inspired Studio, 1998, DVD.
27. Mann D (Director). *Our Man Flint*, Fimberg H, Starr B, Screenwriters, 1966. Twentieth Century Fox Film Corp, 2006, DVD.
28. Lee S (Director). *Do the Right Thing*, Lee S, Screenwriter, 1989. Universal Studios Home Entertainment, 2009, blu-ray.
29. Burton T (Director). *Batman Returns*, Waters D, Hamm S, Kane B, Screenwriters, 1992. Warner Home Video, 2010, blu-ray.
30. Reynolds K (Director). *Waterworld*, Rader P, Twohy D, Screenwriters, 1995. Universal Pictures, 2009, DVD.
31. De Segonzac J (Director). *Lost City Raiders*, Dewi T De Segonzac J, Screenwriters, 2008. Tandem Communications/First Look Studios, 2009, DVD.
32. Aronofsky D (Director). *Noah*, Aronofsky D, Handel A, Screenwriters, 2014. Paramount, 2014, blu-ray.
33. Mitchell T (Director). *The Flood*, Bodle J, Cope M, Doyle R, Morley N, Screenwriters, 2007. E1 Entertainment, 2007, DVD.
34. Zeitin B (Director). *Beasts of the Southern Wild*, Alibar L, Zeitlin B, Screenwriters, 2012. Fox Searchlight, 2012, blu-ray.
35. Trexler A. *Anthropocene Fictions: The Novel in a Time of Climate Change*. Charlottesville, VA: University of Virginia Press; 2015.
36. Schroder N. Framing disaster: images of nature, media, and representational strategies in Hollywood disaster movies. In: Volkman S, Grimm N, Detmers I, Thomson K, eds. *Local Natures, Global Responsibilities: Ecocritical Perspectives on the New English Literatures*. New York, NY: Rodopi; 2010, 289–306, 292.
37. Quale S (Director). *Into the Storm*, Swetnam J, Screenwriter, 2014. New Line Cinema/Warner Home Video, 2014, blu-ray.
38. Lowry D (Director). *Category 6: Day of Destruction*, Dorf M, Screenwriter, 2004. CBS Television, 2005, DVD.
39. Lowry D (Director). *Category 7: The End of the World*, Ford C, Soffer R, Luisa, Screenwriters, 2005. CBS Television, 2006, DVD.
40. Sullivan P (Director). *F6 Twister* (aka *Christmas Twister*), Wasserburger H, Sullivan P, Screenwriters, 2012. Production Media Group/Gaiam, 2014, DVD.
41. Maibach E, Cobb S, Leiserowitz A, Peters E, Schweizer V, Mandryk C, Witte J, et al. *A National Survey of Television Meteorologists about Climate Change: Education*. Center for Climate Change Communications: Fairfax, VA; 2011.
42. Monroe S (Director). *Storm Cell*, Konyves M, Ludlow G, Screenwriters, 2008. First Look Pictures, 2009, DVD.
43. Takacs T (Director). *NYC: Tornado Terror*, Cook T, Screenwriter, 2008. Fast Productions/Monarch Video, 2010, DVD.
44. Yang G (Director). *Metal Tornado*, Bourque J, Erin A, Screenwriters, 2011. Capital Productions/Arc Entertainment, 2012, DVD.
45. Lusko D (Director). *500 MPH Storm*, Lee K, Woon H, Screenwriter, 2013. The Asylum, 2013, DVD.
46. Bourque J (Director). *Seattle Superstorm*, Ray D, Renfroe J, Screenwriters, 2012. Sci-Films Channel/Arc Entertainment, 2013, DVD.
47. Ferrante A (Director). *Sharknado*, Levin T, Screenwriter, 2013. The Asylum, 2013, DVD.
48. Ferrante A (Director). *Sharknado 2: The Second One*, Levin T, Screenwriter, 2014. The Asylum, 2014, blu-ray.
49. Ferrante A (Director). *Sharknado 3: Oh Hell No*, Levin T, Screenwriter, 2015. The Asylum, 2015, Sci-Fi Channel.
50. Spielberg S (Director). *Jaws*, Benchley P, Gottlieb C, Screenwriters, 1975. Universal Pictures, 2012, blu-ray.
51. Raimi S (Director). *Army of Darkness*, Raimi S, Raimi I, Screenwriters, 1992. Universal Studios, 2009, blu-ray.
52. McLaughlin T (Director). *The Fire Next Time*, Henson J, Screenwriter, 1993. RHI Entertainment, 2015, DVD.
53. Lieberman R (Director). *Eve of Destruction*, Beattie R, Screenwriters, 2013. Sonar Entertainment, 2013, blu-ray.
54. Copus N (Director). *Ice* (aka *Ice 2020*), Follet J, Mewis R, Harding R, Screenwriters, 2011. Bridge Entertainment, 2011, blu-ray.

55. Braunstein R (Director). *100 Degrees Below Zero*, Horton H, Schenkman R, Screenwriters, 2013. Asylum Home Entertainment, 2013, DVD.
56. Fort T (Director). *2012: Ice Age*, Sinor P, Dadi V, Screenwriters, 2011. Asylum Home Entertainment, 2011, blu-ray.
57. Lee R (Director). *Absolute Zero*, Watson S, Screenwriter, 2006. Echo Bridge Home Entertainment, 2006, DVD.
58. Monroe S (Director). *Ice Twisters*, Birkett, P, Andrew E, Screenwriters, 2009. First Look Pictures, 2010, DVD.
59. Trenchard-Smith, B (Director). *Arctic Blast*, Bourque, J, Screenwriter, 2010. Arc Entertainment, 2011, DVD.
60. Ziller P (Director). *Ice Quake*, Ray D, Screenwriter, 2010. Anchor Bay, 2012, DVD.
61. Renfroe J (Director). *The Colony*, Renfroe J, Rouskov S, Screenwriters, 2013. Image Entertainment, 2013, blu-ray.
62. Bong J (Director). *Snowpiercer*, Bong J, Masterson K, Screenwriters, 2014. Anchor Bay, 2014, blu-ray.
63. Saldanha C (Director). *Ice Age: The Meltdown*, Gaulke P, Swallow G, Screenwriters, 2006. Twentieth Century Fox, 2011, blu-ray.
64. Miller G (Director). *Happy Feet 2*, Miller G, Eck G, Screenwriter, 2011. Warner Brothers, 2012, blu-ray
65. Fessenden L (Director). *The Last Winter*, Fessenden L, Leaver R, Screenwriters, 2006. IFC Films, 2008, DVD.
66. Lewis M (Director). *The Thaw*, Lewis M, Screenwriter, 2009. Lions Gate, 2009, blu-ray.
67. Hillcoat J (Director). *The Road*, Penhall J, Screenwriter, 2009. Sony, 2010, blu-ray.
68. Nolan C (Director). *Interstellar*, Nolan J, Nolan C, Screenwriters, 2014. Paramount, 2015, blu-ray.
69. Volnysky V. Top/highest grossing films worldwide (adjusted). *IMDB*; August 2, 2015. Available at: <http://www.imdb.com/list/ls077140585/?start=101&view=detail&sort=historian:asc>. (Accessed August 3, 2015).
70. Burns K (Director). *The Dust Bowl*, Duncan D, Screenwriter, 2012. PBS, 2012, blu-ray.
71. Miller G (Director). *Mad Max: Fury Road*, Miller G, McCarthy B, Lathouris N, Screenwriters, 2015. Village Roadshow Pictures/Warner Home Video, 2016, blu-ray.
72. Hammock T (Director). *The Last Survivors*, Forman J, Hammock T, Screenwriters, 2014. Dark Sky Films, 2015, blu-ray.
73. Michod D (Director). *The Rover*, Edgerton J, Michod D, Screenwriters, 2014. Lionsgate, 2014, blu-ray.
74. Paltrow J (Director). *Young Ones*, Paltrow J, Screenwriter, 2014. Screen Media, 2015, blu-ray.
75. Phang J (Director). *Half-Life*, Phang J, Screenwriter, 2008. Wolfe Video, 2009, DVD.
76. Deller J (Director). *Future Weather*, Deller J, Screenwriter, 2012. Virgil Films and Entertainment, 2013, DVD.
77. Nichols J (Director). *Take Shelter*, Nichols J, Screenwriter, 2011. Sony Pictures Entertainment, 2012, blu-ray.
78. Bird B (Director). *Tomorrowland*, Lindelof D, Bird B, Jensen J, Screenwriters, 2015. Walt Disney Pictures.
79. Sands E (Director). *Chloe & Theo*, Sands E, Screenwriter, 2015. Arctica Films.
80. Twohy D (Director). *The Arrival*, Twohy D, Screenwriter, 1996. Lions Gate, 2009, blu-ray.
81. Derrickson S (Director). *The Day the Earth Stood Still*, Scarpa D, North E, Screenwriters, 2008. Twentieth Century Fox, 2009, blu-ray.
82. Fair K (Director). *Cat. 8*, Martin D, Screenwriter, 2013. Sonar Entertainment, 2013, blu-ray.
83. Martinez P (Director). *The Steam Experiment* (released in DVD as *The Chaos Experiment*), Malkani R, Screenwriter, 2009. Cinepro, 2009, DVD.
84. Kurtz H. Unabomber manuscript is published. *The Washington Post*; September 19, 1995. Available at: <http://www.washingtonpost.com/wp-srv/national/longterm/unabomber/manifesto.decsn.htm>. (Accessed August 5, 2015).
85. Moorhead M (Director). *A Glaring Emission*, Moorhead A, Preston A, Screenwriters, 2010. AM Films/Babalu Productions, 2010, DVD.
86. Vaughn M (Director). *Kingsman: The Secret Service*, Goldman J, Vaughn M, Screenwriters, 2014. Twentieth Century Fox, 2015, blu-ray.
87. Anonymous. Could this be the most conservative movie of the decade? *Glen Beck Program*; July 22, 2015. Available at: <http://www.glennbeck.com/2015/07/22/could-this-be-the-most-conservative-movie-of-the-decade/>. (Accessed August 3, 2015).
88. Reeve E. Just how racist is the Obama phone video? *The Atlantic Wire*; September 27, 2012. Available at: <http://www.thewire.com/politics/2012/09/just-how-racist-obama-phone-video/57353/>. (Accessed August 3, 2015).
89. Crichton M. *State of Fear*. New York, NY: Harper Collins Publisher; 2004.
90. Sontag S. The imagination of disaster. In: Sontag S, ed. *Against Interpretation*. New York, NY: Farrar, Straus, Giroux; 1969, 209–225.
91. Roddick N. Only the stars survive: disaster movies in the seventies. In: Bradby D, James L, Sharratt B, eds. *Performance and Politics in Popular Drama*.

- New York, NY: Cambridge University Press; 1980, 243–269.
92. King G. *Spectacular Narratives: Hollywood in the Age of the Blockbuster*. New York, NY: I.B. Tauris Publishers; 2000.
  93. Kirby DA. *Lab Coats in Hollywood: Science, Scientists, and Cinema*. Cambridge, MA: The MIT Press; 2011.
  94. Schroder N. Framing disaster: images of nature, media, and representational strategies in Hollywood disaster movies. In: Volkman S, Grimm N, Detmers I, Thomson K, eds. *Local Natures, Global Responsibilities: Ecocritical Perspectives on the New English Literatures*. New York, NY: Rodopi; 2010, 289–306.
  95. Feil K. *Dying for a Laugh: Disaster Movies and the Camp Imagination*. Middletown, CT: Wesleyan University Press; 2005, 142–158.
  96. Keane S. *Disaster Movies: The Cinema of Catastrophe*. New York, NY: Wallflower; 2006, 95–105.
  97. Thomson C. 9/11, before and after. In: Thomsen C, ed. *Hollywood: Recent Developments*. Stuttgart/London: Edition Azel Menges; 2005, 9–27.
  98. Haase C. “Foil, toothpaste, ID4”: ideology and global appeal in the films of Roland Emmerich. In: Haase C, ed. *When Heimat Meets Hollywood: German Filmmakers and America, 1985–2005*. New York, NY: Camden House; 2007, 101–133.
  99. Pirro R. Aesthetic legacies and dashed political hopes: Caspar David Friedrich motifs in Roland Emmerich’s post 9/11 popcorn message movies. *Ger Rev* 2013, 88:400–417.
  100. Ingram D. *Green Screen: Environmentalism and Hollywood Cinema*. Exeter: University of Exeter Press; 2000, 165.
  101. Reiner R (Director). *The American President*, Sorkin A, Screenwriter, 1995. Warner Home Video, 2012, blu-ray.
  102. Murray R, Heumann J. *Ecology and Popular Film: Cinema on the Edge*. Albany, NY: The State University of New York Press; 2009, 6–10.
  103. Murray R, Heumann J. *Film & Everyday Eco-Disasters*. Lincoln, NE: University of Nebraska Press; 2014, xviii–xix.
  104. Murray R, Heumann J. *Monstrous Nature*. Lincoln, NE: University of Nebraska Press; forthcoming, 2016.
  105. Hulme M. *Why We Disagree about Climate Change: Understanding Controversy, Inaction, and Opportunity*. New York, NY: Cambridge University Press; 2009, 340–355, esp. 346.
  106. Heise U. *Sense of Place and Sense of Planet: The Environmental Imagination of the Global*. New York, NY: Oxford University Press; 2008, 205–210.
  107. Zumbansen N, Fromme M. Ecocatastrophes in recent American (non-)fictional texts and films. In: Volkman S, Grimm N, Detmers I, Thomson K, eds. *Local Natures, Global Responsibilities: Ecocritical Perspectives on the New English Literatures*. New York, NY: Rodopi; 2010, 273–287.
  108. Salvador M, Norton T. The flood myth in the age of global climate change. *Environ Commun* 2011, 5:45–61.
  109. Dixon W. *Visions of the Apocalypse: Spectacles of Destruction in American Cinema*. New York, NY: Wallflower; 2003.
  110. McSweeney T. “Each night is darker—beyond darkness”: the environmental and spiritual apocalypse of *The Road* (2009). *J Film Video* 2013, 65:42–58.
  111. Swyngedouw E. Apocalypse forever? Post-political populism and the spectre of climate change. *Theory Cult Soc* 2010, 27:213–232.
  112. Swyngedouw E. Apocalypse now! Fear and doomsday pleasures. *Capital Nat Social* 2013, 24:9–18.
  113. Methmann C, Rothe D. Politics for *The Day After Tomorrow*: the logical of apocalypse in global climate politics. *Secur Dialogue* 2012, 43:323–344.
  114. Sturgeon N. *Environmentalism in Popular Culture: Gender, Race, Sexuality, and the Politics of the Natural*. Tucson, AZ: The University of Arizona Press; 2009, 120–146.
  115. Miller G (Director). *Happy Feet*, Miller G, Collee J, Morris J, Coleman W, Screenwriters, 2006. Warner Brothers, 2007, DVD.
  116. Justice C. Cooling the geopolitical to warm the ecological: how human-induced warming phenomena transformed modern horror. In: Narine A, ed. *Eco-Trauma Cinema*. New York, NY: Routledge; 2014, 207–230.
  117. Moore E. Green screen or smokescreen? Hollywood’s messages about nature and the environment. *Environ Commun*. In Press.
  118. Johnson C. Watching the train wreck or looking for the brake? Contemporary film, urban disaster, and the specter of planning. *Souls* 2012, 14: 207–228.
  119. Burt JT. Once upon a time in Louisiana: the complex ideology of *Beasts of the Southern Wild*. *Cinesthesia* 2014, 3:1–7.
  120. Guggenheim D. *An Inconvenient Truth*, Gore A, Guggenheim D, Screenwriters, 2006. Participant Media/Paramount Home Entertainment, 2006, DVD.
  121. McGreavy B, Lindenfeld L. Entertaining our way to engagement? Climate change films and sustainable development values. *Int J Sustain Dev* 2014, 17:123–136.
  122. Olson R (Director). *Sizzle: A Global Warming Comedy*, Olson R, Njoku I, Screenwriters, 2008. Prairie Starfish Productions.

123. Hammond P, Breton H. Bridging the political deficit: loss, morality, and agency in films addressing climate change. *Commun Cult Crit* 2014, 7:303–319.
124. Sakellari M. Cinematic climate change, a promising perspective on climate change communication. *Public Underst Sci* 2015, 24:827–841.
125. Leiserowitz A. Before and after *The Day After Tomorrow*: a U.S. study of climate change risk perception. *Environment* 2004, 46:22–37.
126. Lowe T, Brown K, Dessai S, de Franca DM, Haynes K, Vincent K. Does tomorrow ever come? Disaster narrative and public perceptions of climate change. *Public Underst Sci* 2006, 15:435–457.
127. Reussig F, Schwarzkopf J, Pohlenz P. *Double Impact: The Climate Blockbuster 'The Day After Tomorrow' and Its Impact on the German Cinema Public*. Potsdam Institute for Climate Research: Potsdam; 2004.
128. Reusswig F. The international impact of *The Day After Tomorrow*. *Environment* 2005, 47:41–43.
129. Crespo I, Pereira A. Climate change films: fear and agency films. In: Gustafsson T, Kaapa P, eds. *Transnational Ecocinema: Film Culture in an Era of Ecological Transformation*. Chicago, IL: Intellect Books; 2013, 165–186.
130. Aoyagi-Utsui M. *The Day After Tomorrow*: a study on the impact of a global warming movie on the Japanese public. National Institute for Environmental Studies (NIES) Working Paper, 2004. Cited in Reusswig F. The international impact of *The Day After Tomorrow*. *Environment* 2005, 47:41–43.
131. Branston G. The planet at the end of the world: 'event' cinema and the representability of climate change. *New Rev Film Televis Stud* 2007, 5:211–229.
132. Nisbet M. Evaluating the impact of *The Day After Tomorrow*. *Skeptical Inquirer*; June 16, 2004. Available at: [http://www.csicop.org/specialarticles/show/evaluating\\_the\\_impact\\_of\\_the\\_day\\_after\\_tomorrow/](http://www.csicop.org/specialarticles/show/evaluating_the_impact_of_the_day_after_tomorrow/). (Accessed July 30, 2015).
133. Rust S. Hollywood and climate change. In: Rust S, Monani S, Cubitt S, eds. *Ecocinema Theory and Practice*. New York, NY: Routledge; 2013, 191–211.
134. Perkowitz S. *Hollywood Science: Movies, Science, and the End of the World*. New York, NY: Columbia University Press; 2007.
135. Von Burg R. Decades away or *The Day After Tomorrow*? Rhetoric, film, and the global warming debate. *Crit Stud Media Commun* 2012, 29:7–26.
136. Svoboda M. The long melt: the lingering influence of *The Day After Tomorrow*. *Yale Climate Connections*; November 5, 2014. Available at: <http://www.yaleclimateconnections.org/2014/11/the-long-melt-the-lingering-influence-of-the-day-after-tomorrow/>. (Accessed August 5, 2015).
137. Markowitz E, Hodge C, Harp G. *Connecting on Climate: A Guide to Effective Climate Change Communication*. New York, NY and Washington, DC: Center for Research on Environmental Decisions and ecoAmerica; 2014, 2–3.
138. Hart PS, Leiserowitz A. Finding the teachable moment: an analysis of information-seeking behavior on global warming during the release of *The Day After Tomorrow*. *Environ Commun* 2009, 3:355–366.
139. Herring SC, Hoerling MP, Peterson TC, Stott P. Explaining extreme events of 2013 from a climate perspective. *Bull Am Meteorol Soc* 2014, 95: S1–S104.
140. Boykoff MT, Boykoff JM. Balance as bias: global warming and the US prestige press. *Glob Environ Change* 2014, 14:125–136.
141. Boykoff MT, Boykoff JM. Climate change and journalistic norms: a case-study of US mass-media coverage. *Geoforum* 2007, 38:1190–1204.
142. Klinenberg E. *Heat Wave: A Social Autopsy of a Disaster in Chicago*. Chicago, IL: University of Chicago Press; 2003.
143. Keller RC. *Fatal Isolation: The Devastating Paris Heat Wave of 2003*. Chicago, IL: University of Chicago Press; 2015.
144. Telotte JP. Science fiction reflects our anxieties. *The New York Times*; July 30, 2014: Available at: <http://www.nytimes.com/roomfordebate/2014/07/29/will-fiction-influence-how-we-react-to-climate-change/science-fiction-reflects-our-anxieties>. (Accessed August 9, 2015).
145. Thomas SR. Imagination will help find solutions to climate change. *The New York Times*. Available at: <http://www.nytimes.com/roomfordebate/2014/07/29/will-fiction-influence-how-we-react-to-climate-change/imagination-will-help-find-solutions-to-climate-change>. (Accessed August 9, 2015).
146. Marshall G. Climate fiction will reinforce existing views. *The New York Times*. Available at: <http://www.nytimes.com/roomfordebate/2014/07/29/will-fiction-influence-how-we-react-to-climate-change/climate-fiction-will-reinforce-existing-views>. (Accessed August 9, 2015).
147. Marshall G. July 3, 2015. This is an email exchange.
148. Bogart P (Director). *Enemy of the People*, Ibsen H, Miller A, Screenwriters, 1966. WNET Channel 13 NY.
149. Spielberg S (Director). *Jaws*, Benchley S, Gottlieb C, Screenwriters, 1975. Universal Pictures, 2012, blu-ray.
150. Zinnemann F (Director). *High Noon*, Foreman C, Cunningham CW, Screenwriters, 1952. Stanley Kramer Productions.
151. Howitt P (Director). *Sliding Doors*, Howitt P, Screenwriter, 1988. Intermedia Films/Miramax.
152. Markowitz E. July 8, 2015. This is an email exchange.