I. INTRODUCTION—M. O. Baringer and D. S. Arndt

The primary goal of the annual *State of the Climate* collection of articles is to document the weather and climate events in 2009 from around the world and put them into accurate historical perspective, with a particular focus on unusual or anomalous events. The year also marks the end of the first decade of the 21st century, so whenever possible the climate anomalies over this decade are highlighted.

This year the *State of the Climate* report brings together more than 300 authors from every continent and from over 160 different research groups to collaborate, share data and insights, and describe the observed changes in climate from different perspectives. The 2009 El Niño and the global consequences described herein highlight the global scope of connections between weather, climate, and, one could argue, climate scientists. In keeping with the increasingly global perspective of this report, the authors and editors seek to provide an inclusive synthesis of diverse weather and climate data to describe what took place across our planet last year. For example, recognizing the importance of providing error statistics, differing analysis products and datasets are included where possible (e.g., see sidebar on ocean heat content analyses in Chapter 3). We expect this trend to continue in future reports. Notably, the document's editors represented three disciplinary backgrounds (meteorology, oceanography, and biology). This composition reflects the increasing recognition that the natural world is embedded within, impacted by, and exerts influence on the physical climate system. We expect these connections to be explored in future issues of *State of the Climate*.

As a guiding principle behind the inclusion of certain climatic events into this report, the Global Climate Observing System has identified Essential Climate Variables (ECVs, see GCOS 2003) (see appendix for a full list of abbreviations) necessary to support the United Nations Framework Convention on Climate Change and the Intergovernmental Panel on Climate Change. These variables are defined as those required for international exchange and should be economically and technically feasible to acquire (Table 1.1). The *State of the Climate* report has evolved to include an increasing number of these climatically important variables as data availability increases and the analysis techniques and attributions improve. The degree to which each of these ECVs can be assessed and reported depends largely on the level of data availability both currently and as a homogeneous historical record and, hence, can be divided into categories: (1) being monitored, (2) partially monitored, and (3) not yet monitored. To be listed as monitored, the ECV not only must be observed across much of the world, but also needs a moderately long-term dataset with accompanying analysis. Also the dataset needs to be updated in near-real time and have a peer-reviewed article documenting the reliability of all of these steps. This year land cover/use is not reported because the data are only updated every five years and last year's report covers the most recent data available. Lake levels, biomass, and fire disturbance ECVs were included—at least partially-monitored—for the first time this year (see Chapter 2). Other variables important for research purposes are not included as ECVs, however the GCOS list of ECVs as well as the variables presented in this report are continually reassessed as improved observing technologies emerge. Continual advancement of the number of ECVs reported herein will not be possible without increasing international efforts to make the observations of the underlying variables and provide access to these data.

A brief overview of the findings in this report is presented in the Abstract and shown in Fig. 1.1. The remainder of the report is organized starting with global scale climate variables in Chapter 2, into increasingly divided geographic regions described in chapters 3 through 7. Chapter 3 highlights the global ocean and Chapter 4 includes tropical climate phenomena such as El Niño and hurricanes. The Arctic and Antarctic respond differently through time and hence are reported in separate chapters. For a regional perspective authored largely by local government climate specialists, see Chapter 7. Seasonal patterns are encapsulated in Chapter 8.

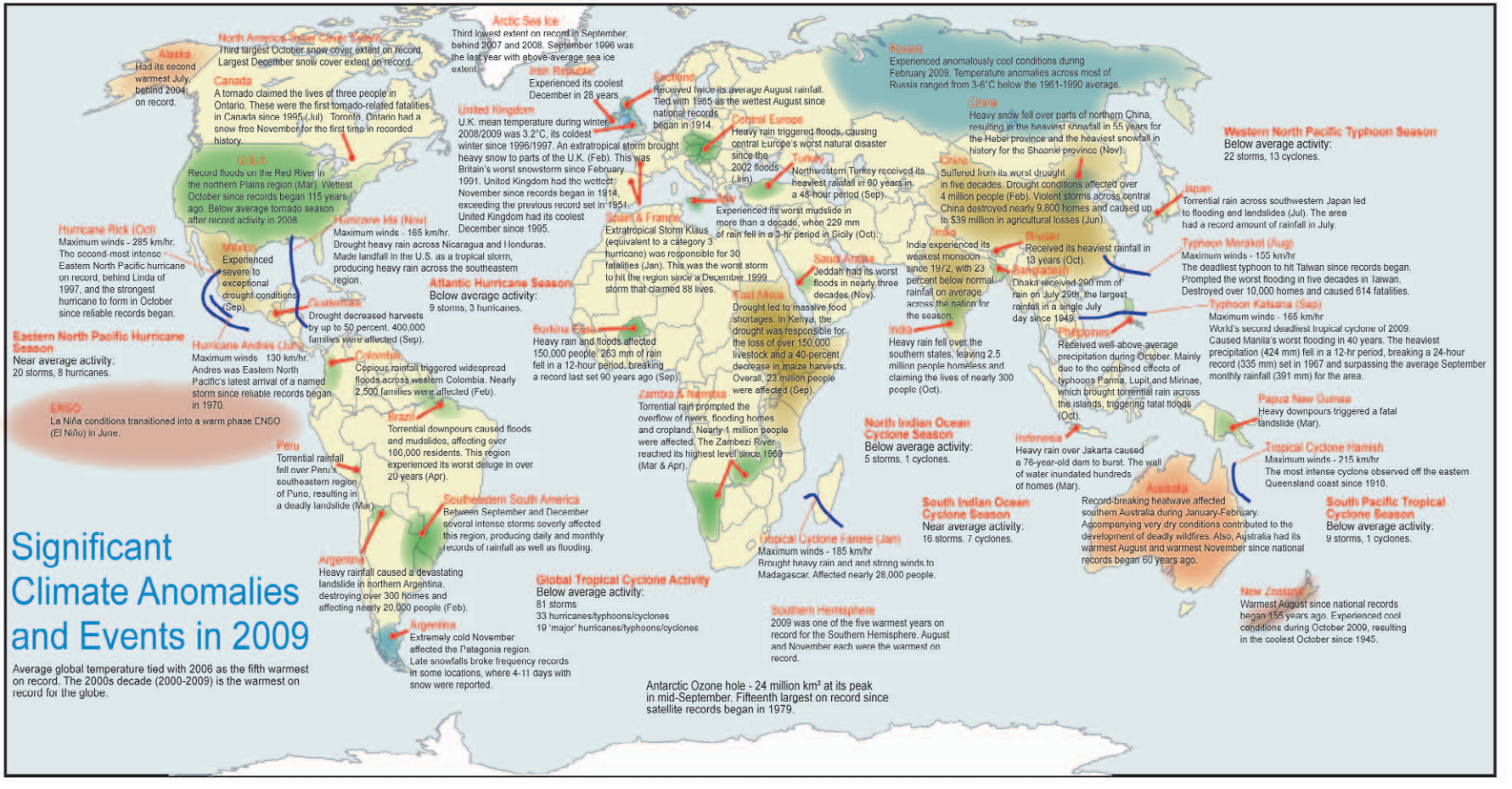

Fig. 1.1. Geographical distribution of notable climate anomalies and events occurring around the planet in 2009.

Table 1.1 The GCOS Essential Climate Variables (ECVs, see GCOS 2003) and their monitoring status, as reported in this and recent editions of the *State of the Climate*, are listed with the following color coding: Green indicates this ECV is being monitored on a global or near-global scale and that this report includes a section describing its changes over time; Yellow indicates the ECV is explicitly discussed in this year's *State of the Climate*, but the data are not updated globally through the year or a dataset has not yet been adequately documented in the peer-reviewed literature to prove it is an accurate indication of how this ECV has changed over time; Red indicates more work needs to be done in order to monitor this ECV. The missing ECVs in 2007 reflect the evolution and expansion of the GCOS list.

Essential Climate Variable	2007	2008	2009
Atmospheric Surface			
Air temperature	Y	Y	Y
Precipitation	Y	Y	Y
Air pressure	N	Y	Y
Surface radiation budget	N	N	N
Wind speed and direction	P	P	P
Water vapor	N	N	N
Atmospheric Upper-Air			
Earth radiation budget (including solar irradiance)	P	Y	Y
Upper-air temperature (including MSU radiances)	Y	Y	Y
Wind speed and direction	N	N	N
Water vapor	N	Y	Y
Cloud properties	P	Y	Y
Atmospheric Composition			
Carbon dioxide	Y	Y	Y
Methane	Y	Y	Y
Ozone	Y	Y	Y
[Other long-lived greenhouse gases]:	N	N	P
Nitrous oxide	Y	Y	Y
Chlorofluorocarbons	Y	Y	Y
Hydrochlorofluorocarbons	Y	Y	Y
Hydrofluorocarbons	Y	Y	Y
Sulphur hexaflurorides	Y	Y	Y
Perfluorocarbons	N	N	N
Aerosol properties.	Y	Y	Y
Ocean Surface			
Sea surface temperature	Y	Y	Y
Sea surface salinity	Y	Y	Y
Sea level	Y	Y	Y
Sea state	N	N	N
Sea ice	Y	Y	Y
Current	Y	Y	Y
Ocean color (for biological activity)	Y	Y	Y
Carbon dioxide partial pressure	P	P	P

Essential Climate Variable	2007	2008	2009
Ocean Subsurface			
Temperature	Y	Y	Y
Salinity	N	N	N
Current	P	P	P
Nutrients	N	N	N
Carbon	Y	P	P
Ocean tracers	N	N	N
Phytoplankton	N	N	N
Terrestrial			
Soil moisture and wetness	P	P	P
Surface ground temperature	N	N	N
Subsurface temperature and moisture	N	N	N
Snow and ice cover	Y	Y	Y
Permafrost	P	P	P
Glaciers and ice sheets	Y	P	P
River discharge		P	P
Water use		N	N
Ground water		N	N
Lake levels		N	Y
Albedo		N	N
Land cover (including vegetation type)[1]		P	N[1]
Fraction of absorbed photosynthetically active radiation (FAPAR)		Y	Y
Leaf area index (LAI)		N	N
Biomass		N	P
Fire disturbance		N	P

[1] The land cover data set used in the *State of the Climate* in 2008 (Di Gregorio and Jansen 2000) is updated once per five years.