Scientific context  The Theme-of-the-Year is a program to focus on specific areas of research that will benefit from intense collaborative effort. The topics are be selected by the IMAGe external advisory panel and are be coordinated by a Visiting Co-director.

The scientific leaders of NCAR\(^1\) recognized early on that in order to understand the dynamics of the atmosphere and oceans and the planetary boundary layer, the sun and solar-terrestrial interactions, investigating relevant turbulent processes at a fundamental level would be essential. Turbulence has remained both a vital and challenging field, taking on added importance as the geosciences tackles the multi-scale interactions that characterize the Earth-Sun system. The difficulty of solving classical problems in turbulence through direct mathematical analysis has engendered a multidisciplinary approach where mathematical and physical models, computational science, observations and experiments are combined to make advances.

The Theme-of-the-Year (TOY) for 2008 was designed to support the geophysical and mathematical communities in this effort through a series of workshops exploring turbulence from these different perspectives with the goal of increasing the interconnections among theory, computation and experiments. The final activity of the 2008 TOY was a summer school with the intent of bringing new researchers into this field and giving them a multidisciplinary perspective.

The events  The TOY-08 was led by Keith Julien (Applied Mathematics, University of Colorado at Boulder) and Annick Pouquet (Geophysical Turbulence Program, NCAR) with three workshops and a summer school being held in Boulder, Colorado:

- S4 “Summer School: Geophysical Turbulence.” 14 July - 1 August 2008

The workshops accommodated 20-30 people and were a blend of research presentations along with ample time for discussions and more informal interactions. The summer school included about 30 Ph. D. students from around the globe, and drew on the material from the preceding workshops and featured prominent researchers in turbulence.

\(^1\)NCAR is sponsored by the NSF cooperative agreement through UCAR
The main lecturers  The organizing committee of W1 included Jeffrey Weiss (CU) and Elizabeth Wingate (LANL). The invited speakers at W1 were Peter Bartello (McGill), Raffaele Ferrari (MIT), Uriel Frisch (OCA, Nice), Andrew Majada (Courant), James McWilliams (UCLA), David Nolan (Miami), Alan Norton (NCAR), Antonello Provenzale (Turin), Leslie Smith (Wisconsin) and Geoffrey Vallis (GFDL).

The organizing committee of W2 included Bjorn Stevens (UCLA) and Joe Werne (CORA). The principal lecturers at W2 were Mark Berliner (Ohio), Eric Chassignet (Florida State), John CLune (NCAR), Bengt Fornberg (CU), Hassan A. Hassan (North Carolina), Phillip Jones (LANL), Yukio Kaneda (Nagoya), Edward Kansa (U. Davis), Yoshifumi Kimura (Nagoya), Steve Krueger (Utah), Ed Lee (NCAR), Rich Loft (NCAR), Thomas Lund (CORA), Scott McRae (North Carolina), Mark Rast (CU), Damian Rouson (Sandia), Piotr Smolarkiewicz (NCAR), Amik St Cyr (NCAR), Peter Sullivan (NCAR), Chenning Tong (Clemson U.), Joe Werne (CORA), Grady Wright (Boisé U.), John Wyngaard (Penn State) and David Yuen (Minnesota).

The organizing committee of W3 included Lasrry Cornman (RAL, NCAR), Don Lenschow (ESSL, NCAR), Tom Horst (EOL, NCAR) and Steven Oncley (EOL, NCAR). The keynote speakers at W3 were Jakob Mann (Risøo), Harm JOnker (Delft U.), Andreas Muschinski (Amherst), Hans Peter Schmid (Karlsruhe) and Joe Fernando (Arizona).

Finally, the organizing committee of the school included Jeff Weiss (CU) and Beth Wingate (LANL). The principal lecturers at the three-week school were John Clyne (NCAR), Joe Fernando (Arizona), Andrew Majda (Courant), Leslie Smith (Wisconsin) and Joseph Werne (CORA).

Each workshop set the stage for the next ones and for the School. More details on outcomes can be found on the web at http://www.image.ucar.edu/ThemeOfTheYear/2008/. A lengthier report is in preparation for NSF. The workshops and school were made successful not only by the quality of the presentations from all the speakers, but also through the intense interactions which took place between sessions and between students and lecturers. The organizers would like to thank all of the participants, IMAGe, the CISL, EOL, ESSL and RAL laboratories at NCAR and the National Science Foundation for their continuing support on research into the nature of geophysical turbulence.

We cite week three of the school as an example of the effort and scale of the summer school and the participation it elicited from students. Week three was an intensive computational lab co-organized by CISLs Data Analysis Services Group (DASG) and the NorthWest Research Associates (NWRA). Intermixed with lectures on practical issues in numerical modeling and data analysis, students were provided a hands-on experience with end-to-end computational science: from numerical simulation to presentation of results. Broken into small groups, each was tasked with exploring a problem in atmospheric turbulence modeling (either Kelvin-Helmholtz instability or breaking
gravity waves) using one of two numerical methods: Direct Numerical Simulation or Large Eddy Simulation. Students relied on knowledge gained during the previous two weeks of the school to help them parameterize a 3D simulation code provided by NWRA. Tens of thousands of CPU hours on CISLs Blue Gene/L supercomputer, Frost, were then brought to bear to run the students experiments. After conducting their simulations and archiving results to NCARs Mass Storage System, the groups focused on analyzing the hundreds of Gigabytes of data generated, using CISLs Storm visualization cluster. The centerpiece of the students data analysis toolkit was the NCAR developed VAPOR software. Finally, the students presented the results of their efforts to their peers and to the summer school organizers and instructors.

This work supports NCAR strategic priorities by enhancing collaborations with the university community and by performing valuable education and outreach activities at the highest available level.