Recent and Future Trends in U.S. Undergraduate Meteorology Enrollments, Degree Recipients, and Employment Opportunities

Bachelors degrees in atmospheric science and oceanography.
2 year averages 1967 & 68 through 2003 & 04.

Dr. John A. Knox
Atmospheric Sciences Program
University of Georgia
16th Biennial AMS/AGU Joint Heads and Chairs Meeting
Background For This Talk

• June 1996: Cliff Mass publishes *BAMS* article discussing meteorology enrollments, “tightening job market,” and possible responses to situation

• Since then: no subsequent thorough analysis of undergraduate situation

• Has anything big happened in meteorology since Mass’s paper was put to bed at *BAMS* on 12/26/1995?
Atmospheric Science Since 1995:
A Partial Public-Eye Pictorial History

1996: *Twister* grosses $241.7 million, creating national obsession with chasing

1997: The Web takes off, takes weather data/consumers with it

Late 1990s-: New private-sector niches emerge, collapse, re-emerge

1998: Record El Nino

2005: Hurricane Katrina

2006-7: Global warming claims Oscars, Nobel Peace Prize
What Else Has Changed Since 1995:
An Outline for the Rest of the Talk

Based on Knox, June 2008 Bulletin of the AMS

• Unprecedented numbers of undergraduates in meteorology programs in the U.S.
• Largest growth rates of undergraduates in meteorology programs since at least the mid-1970s
• Larger graduating classes, and more institutions offering degrees
• What is the employment outlook for the students?
• As Mass asked, “What should be our response?”
• Throughout this talk: analysis of quantitative data, avoiding anecdotal reports as much as possible
Primary Data Sources and Caveats

  – Degree recipient data for meteorology and other sciences
  – High confidence in trends, moderate confidence in numbers (Czujko)

• **AMS/UCAR online Curricula database** ([http://ametsoc.org/amsucar_curricula/index.cfm](http://ametsoc.org/amsucar_curricula/index.cfm))
  – Number of “current” and projected B.S. graduates; “current” majors
  – Employment choices of new graduates
  – **Spotty (< 50% of the 75 B.S.-granting institutions) out-of-date reporting; Penn State, others missing at time of study (PSU now lists degree recipients, no other data); worse reporting than in past**
  – Such poor reporting, didn’t attempt ethnic/gender analysis

  – Number of meteorologists employed, plus future trends
  – Numbers more believable than future projections

• **Meteorological Employment Journal 2006 job listings**
  – Incomplete, but many more listings than other online employment sites
Supply of B.S. Meteorologists: Outpacing All Fields and All Sister Sciences...

<table>
<thead>
<tr>
<th>U.S. College Degree Recipients in:</th>
<th>Long-Term Change 1968-2004</th>
<th>Recent Change 1994-2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meteorology</td>
<td>+161%</td>
<td>+47%</td>
</tr>
<tr>
<td>All fields</td>
<td>+122%</td>
<td>+20%</td>
</tr>
<tr>
<td>Physical sciences</td>
<td>-7%</td>
<td>-2%</td>
</tr>
<tr>
<td>Geosciences</td>
<td>+83%</td>
<td>+9%</td>
</tr>
<tr>
<td>Geography</td>
<td>+74%</td>
<td>+3%</td>
</tr>
<tr>
<td>Oceanography</td>
<td>+164%</td>
<td>-31%</td>
</tr>
</tbody>
</table>

Data from NCES; from Knox, June 2008 BAMS
...Soaring to Historic Levels
(research by Roman Czujko, AIP)

Bachelors degrees in atmospheric science and oceanography.

2 year averages 1967 & 68 through 2003 & 04.

AIP Statistical Research Center compiled from data collected by the National Center for Education Statistics.

8%/year increase at end of period; steepest jump in almost 30 years
Latest B.S. Meteorologist Trends
From AMS/UCAR Curricula Data

- Number of majors up 9%/year since late 1990s
- Number of degree recipients up 11%/year circa 2005
- Number of projected degree recipients up 5*-12%/year through 2011
- Large undercount due to underreporting: probable number of new B.S. degree recipients in meteorology is 600-1,000/year (latter figure based on extrapolation from estimates made at 1998 Heads and Chairs meeting)

From AMS/UCAR Curricula data; Knox, June 2008 BAMS
Growth Within U.S. Meteorology Programs: Comparison vs. Mass data from early 1990s

Knox (2008) data for 2003-05 (below): More large programs (six with > 50 graduates)

Mass (1996, Figure 6a) data for 1991-93: Small programs (only one with > 50 graduates)
Big Growth in “Small” Meteorology Programs

<table>
<thead>
<tr>
<th>Ten Largest B.S. Programs by number of majors in Fall 2005</th>
<th>Ten Programs With the Most Juniors/Seniors in the 2008-09 WxChallenge national forecasting contest</th>
</tr>
</thead>
<tbody>
<tr>
<td>(from AMS/UCAR Curricula)</td>
<td>(out of total of 709 jr-sr registrants)</td>
</tr>
<tr>
<td>1. Oklahoma (335 majors)</td>
<td>1. NC State (39 jr-sr forecasters)</td>
</tr>
<tr>
<td>2. Millersville (218; 140 met majors)</td>
<td>2. Florida State, Millersville (38)</td>
</tr>
<tr>
<td>3. Florida State (176)</td>
<td>4. Valparaiso (35)</td>
</tr>
<tr>
<td>4. Texas A&amp;M (149)</td>
<td>5. Penn State (30)</td>
</tr>
<tr>
<td>5. NC State (125)</td>
<td>6. UW-Madison (28)</td>
</tr>
<tr>
<td>8. Lyndon State (110)</td>
<td>Next five: Rutgers, Northern Colorado, Iowa State, Air Force, UL-Monroe</td>
</tr>
<tr>
<td>9. Missouri (102)</td>
<td></td>
</tr>
<tr>
<td>10. Iowa State (98)</td>
<td></td>
</tr>
</tbody>
</table>

NR: Penn State, Albany, Miss. State, Washington, CUP, UNCC (program began in Fall 2004, now has ~90 majors)
Demand for Meteorologists Doing Meteorology

- According to the Bureau of Labor Statistics (BLS), **number of employed meteorologists was flat from 1996-2004** (right)
- Combined with previous graduation statistics: **during 1994-2004, supply of new meteorologists increased at least four times faster than demand for meteorologists in meteorology jobs**
- **Future job growth rate**: about 1%/year from 2006-2016 (BLS)
- **Spiegler** (August 2007 *BAMS*) disagrees, claiming **9,000 private-sector meteorologists by 2012**
- **Latest stat**: jump to 8,800 in 2006 (blip like 1998, or trend?)

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Employed U.S. Meteorologists</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>6,600</td>
</tr>
<tr>
<td>1996</td>
<td>7,300</td>
</tr>
<tr>
<td>1998</td>
<td>8,400</td>
</tr>
<tr>
<td>2000</td>
<td>6,900</td>
</tr>
<tr>
<td>2002</td>
<td>7,700</td>
</tr>
<tr>
<td>2004</td>
<td>7,400</td>
</tr>
<tr>
<td>2006</td>
<td>8,800</td>
</tr>
</tbody>
</table>
How Many Meteorology Jobs Exist For New B.S. Meteorologists?

- Fine-grained analysis of data provided by the *Meteorological Employment Journal* for the calendar year 2006 (does not include NWS or military):

<table>
<thead>
<tr>
<th>Period of Record</th>
<th>Total U.S. Meteorology Job Listings</th>
<th>Jobs Requiring B.S. Degree</th>
<th>Jobs Without Degree Requirement</th>
<th>Entry-level Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>759</td>
<td>303</td>
<td>132</td>
<td>167</td>
</tr>
</tbody>
</table>

From Knox, June 2008 *BAMS*

- Estimate of *total* number of entry-level B.S. met positions, factoring in NWS and military positions: **285/year**

- Contrast these figures with > 600 B.S. meteorology degree recipients/year
# Salary and Career Choice Data

<table>
<thead>
<tr>
<th>NACE data on U.S. College Degree Recipients in:</th>
<th>Class of 2006 Average Starting Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Science</td>
<td>$50,744</td>
</tr>
<tr>
<td>Physics</td>
<td>$45,120</td>
</tr>
<tr>
<td>Geology</td>
<td>$45,091</td>
</tr>
<tr>
<td>Mathematics</td>
<td>$44,672</td>
</tr>
<tr>
<td>Chemistry</td>
<td>$39,804</td>
</tr>
<tr>
<td><strong>Meteorology</strong></td>
<td><strong>$35,211</strong></td>
</tr>
<tr>
<td>Environmental Science</td>
<td>$34,219</td>
</tr>
<tr>
<td>Secondary Education</td>
<td>$33,089</td>
</tr>
<tr>
<td>History</td>
<td>$33,071</td>
</tr>
<tr>
<td>Philosophy</td>
<td>$31,774</td>
</tr>
<tr>
<td>Marine Science</td>
<td>$31,643</td>
</tr>
<tr>
<td><strong>English</strong></td>
<td><strong>$31,385</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AMS/UCAR Curricula data on Fate of Met Graduates</th>
<th>Graduating Classes of 1997-99 (711 graduates)</th>
<th>Graduating Classes of 2003-05 (624 graduates)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civilian Gov’t (e.g., NWS)</td>
<td>9.99%</td>
<td>7.69%</td>
</tr>
<tr>
<td>Military</td>
<td>9.85%</td>
<td>10.10%</td>
</tr>
<tr>
<td><strong>Private Sector</strong></td>
<td><strong>28.69%</strong></td>
<td>18.59%</td>
</tr>
<tr>
<td>Further Univ. Educ.</td>
<td>19.83%</td>
<td><strong>29.33%</strong></td>
</tr>
<tr>
<td>Univ. Employment</td>
<td>0.56%</td>
<td>0.48%</td>
</tr>
<tr>
<td>Other</td>
<td>4.36%</td>
<td>6.09%</td>
</tr>
<tr>
<td>Unknown</td>
<td>26.72%</td>
<td>27.72%</td>
</tr>
</tbody>
</table>
Epstein’s Flow Diagram For the Annual Meteorological Job Market (all degrees, not just B.S.)

From Horn et al., 1974 BAMS

Approximately zero forced out of field; “any imbalance… is small compared to uncertainty”
My Guesses at Epstein’s Flow Diagram for the Annual Meteorological Job Market Today (B.S. only)

based on Curricula graduate job choice data, agency job estimates

207 (44%) to 272 (49%) forced out of field?? Likely fewer, but unlikely to be small.

250 (Curricula) to 333 (N-G) go to grad school?

467-550 to workforce?

>1000?, increasing 9%/yr

~800 B.S. degrees now, incr. 8-11%/yr

Total of 50, tops
My Conclusions Based on Imperfect Data

- The supply of B.S. meteorologists increasingly outstripped demand for entry-level meteorologists from 1994 into the mid-2000s

- Perhaps partly as a result of the trend above:
  - Salaries for B.S. meteorologists lag behind other physical sciences (and met salaries likely inflated by those who leave meteorology and get higher salaries in non-meteorology jobs!)
  - A greater percentage of B.S. recipients in meteorology are choosing to attend graduate school
  - Estimated attrition after B.S.: 0% in 1974, much larger today

- If recent trends in undergraduate meteorology enrollment and employment continue (a big if), future growth in meteorology enrollment/graduates could be a factor of 5-10 times larger than growth in meteorology jobs

- There will still be many student success stories in the future, but probably a lower percentage than in the past
What Should Be Our Response, If Any?

• Following Mass (1996):
  – Broadened meteorology curriculum
    • Some steps in right direction (e.g., 1999 AMS recommendations)
    • With < 10% of new graduates going straight into NWS, time to cut apron strings of civil service requirements?
    • New emphases on GIS, pre-college education, liberal-arts training?
  – Honesty (and timeliness) regarding the job market
    • AMS Career Center Web site: “A 1993 salary survey carried out by the AMS…”; “If you’re trying for a job with the NWS, or any other government agency… fill out the… SF171, with a typewriter rather than by handwriting it.”
  – Creation of employment database by AMS/UCAR
    • Inadequacies of online Curricula a big step backward since 1996
    • Depts must keep track of all student outcomes, post data on Curricula

• Meteorological “birth control”? Unlikely!
  – No top-down control of situation
    • Student interest, program creation largely out of AMS et al. hands
  – No one wants to be a “party pooper”
    • More, bigger programs please everyone from students/parents on up
    • What is the ethical thing to do?
Acknowledgments

• Thanks to Tony Hansen and the Planning Committee of the AMS/AGU Heads and Chairs Meeting for inviting me to speak

• Special thanks to Roman Czujko of AIP, AAG President Kavita Pandit, and Meteorological Employment Journal founder Paul Hamill for providing datasets on graduation numbers and employment data

• Thanks to Steve Ackerman, Toby Carlson, Tim Eichler, Andy Grundstein, Bill Hooke, Stino Iacopelli, Stephen Jascourt, Kurt Poeppel, Russ Schumacher, David Schultz, Steve Silberberg, David Stooksbury, Liza Thompson, Chris Tomer, and Stephanie Weiss for encouragement, criticism, and helpful comments

• Pam Knox performed the analysis of the Meteorological Employment Journal and NWS Focus employment data

• Thanks to Brad Illston of WxChallenge for permission to use the forecast contest’s enrollment statistics
Suggested Reading

• “Supply Without Demand,” former Stanford president and Science editor-in-chief Donald Kennedy et al. in 20 February 2004 Science, p. 1105


Common Rebuttals, and Responses

• “So what? A meteorology degree is just like history or English, with no guarantee of a job at the end.”
  – Does your department tell this to prospective students and freshmen?

• “This is just a cycle that will pass.”
  – The explosions of media attention to weather/climate and Internet access to weather data in the past decade are without precedent.
  – Weather/climate is on everyone’s radar screens from now on.

• “Meteorology is a liberal-arts degree, good training for many jobs.”
  – Is meteorology truly taught as a liberal-arts degree?
  – What other liberal-arts field has had its curriculum dictated for decades by civil service hiring requirements?
  – If a meteorology B.S. degree is not highly valued by the nation’s graduate programs in atmospheric science (ranked 11th out of 12 items in the Nielsen-Gammon study), who highly values this degree?
  – If a meteorology degree leads to a non-meteorology job, why not major in a different liberal-arts degree that pays better?

• “Students get jobs in other fields, or in climate.”
  – Little/no data exist for meteorologists obtaining jobs outside of the field.
  – Many climate policy job ads don’t emphasize training in atmospheric science.
  – Do today’s stormchasing students want to do research in climate?
Supply and Demand in Meteorology:
The Role of the Media?

Inspiration

TWC/TV
“Twister”
Global warming
Katrina etc.
Internet
Personal experience

Up to 15 years later

College Education

Meteorology
Geography
Mathematics
Physics/Chemistry
Environmental sciences
Communications/Social sciences

4-6 years later

Employment (B.S.)

NOAA/NWS
Broadcast
Private sector

Employment (M.S., Ph.D.)

Colleges, universities
Federal
Private sector

Graduate school
(not just in atmos sci!)

2-12 years later

Employment (B.S.)

Colleges, universities
Federal
Private sector

Graduate school
(not just in atmos sci!)
An obsession with weather
The forecast is in: It looks like Americans are becoming mesmerized by meteorology.
Josh Drobnyk of The Allentown, PA Morning Call, February 13, 2005

…Throughout the country, undergraduate meteorology programs report their numbers to be higher than ever. Penn State’s program, considered to be one of the best in the country, has grown about 20 percent in a decade, and that's modest compared with others. The meteorology program at Millersville University in Lancaster County, another top one, has nearly tripled in size in 15 years, from 55 students to 132, said Richard Clark, chairman of the school’s earth sciences department… “[Our growth] has pretty much followed the national trend.”

Oklahoma University, which boasts the country’s largest class of meteorology students, doubled its program size in eight years. “We constantly have to tell people that there are no jobs in storm chasing,” said the program’s director, Fred Carr. “There is an increase all over the whole country. Just about anybody that I talk to has had enrollment increases at the undergraduate level. There has been a greater awareness of the whole field.”

Whether all these meteorological hopefuls can hack the academic rigors is another story, and many programs still see attrition rates higher than 50 percent. But if they can, there is a slew of new jobs awaiting them. Chad Kauffman, head of the California University of Pennsylvania’s meteorology program, said meteorologists’ job prospects these days stretch across various industries. Airlines hire meteorologists to forecast their routes, companies often want in-house meteorologists, and The Weather Channel, which used to rely on the National Weather Service, now hires its own batch of behind-the-scenes forecasters, Kauffman said. He said the school’s meteorology program enrollment has jumped 25 percent in four years. “It is a great time to be a meteorologist,” he said. “It really is.”
Derek De Solla Price’s Graph About the Limits of Scientific Growth
Guess Who’s Coming to Grad School?

Sources: NSF/Bureau of Labor Statistics. Fluctuations obtained by subtracting the mean regression line from the absolute values.
Philosophy For This Talk

“In physical science the first essential step in the direction of learning any subject is to find principles of numerical reckoning and practicable methods for measuring some quality connected with it. I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind.”

– Lord Kelvin, 1883