foreland basin: Response to sea-level change, *J. Sediment Res.*, *66*, 801–819.

Liu, J. P., J. D. Milliman, S. Gao, and P. Cheng (2004), Holocene development of the Yellow River's subaqueous delta, north Yellow Sea, *Mar. Geol.*, *209*, 45–67.

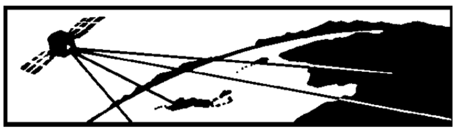
Walsh, J. P., C. A. Nittrouer, C. M. Palinkas, A. S. Ogston, R. W. Sternberg, and G. J. Brunskill (2004), Clinoform mechanics in the Gulf of Papua, New Guinea, *Cont. Shelf Res.*, *24*, 2487–2510.

Author Information

J. S. Crockett, C. A. Nittrouer, A. S. Ogston, and R. W. Sternberg, University of Washington, School of Oceanography, Seattle; N. W. Driscoll and J. Babcock, Scripps Institution of Oceanography, University of California, La Jolla; J. D. Milliman, College of William and Mary, Williamsburg, Va.; R. Slingerland, Pennsylvania State University, University Park; D. F. Naar, and B. Donahue, University of South Florida, St. Petersburg; J. P. Walsh, East Carolina University, Greenville, N.C.; W. Dietrich, University of California, Berkeley; G. Parker, University of Minnesota, Minneapolis; M. Bera and H. Davies, University of Papua New Guinea, Port Moresby; P. Harris, Geoscience Australia, Canberra; M. Goni, University of South Carolina, Columbia; and R. Aller and J. Aller, Stony Brook University, N.Y.

For additional information, contact J. S. Crockett; E-mail: crockett@ocean.washington.edu

SECTION NEWS



Section President, *Benjamin F. Chao*; **Section Secretary**, *Carine Bruyninx*

Forcing of Polar Motion in the Chandler Frequency Band: An Opportunity to Evaluate Interannual Climate Variations

PAGE 26

The Earth rotates about its axis once per day, but does not do so uniformly. The length of the day changes by as much as a millisecond from day to day, and the Earth wobbles as it rotates. That the Earth should wobble was predicted by the Swiss mathematician Leonhard Euler in 1765, but it was not until 1891 that the wobbling motion of the Earth was detected by the American astronomer Seth Carlo Chandler, Jr. In fact, Chandler observed that the Earth has two distinct wobbles, one with an annual period and the other with a 14-month period. The annual wobble is a forced motion of the Earth caused by seasonal variations in the atmosphere, oceans, and hydrosphere.

The 14-month wobble, now known as the Chandler wobble, is a resonant, free oscillation of the rotating Earth that exists because the Earth is not rotating about its figure axis. Dissipation processes associated mainly with the wobble-induced deformation of the solid Earth cause the Chandler wobble to freely decay on a timescale of about 30–100 years. Over the last century, the amplitude of the Chandler wobble has been observed to occasionally increase; therefore, one or more mechanisms must be acting to excite it.

Since its discovery, the excitation of the Chandler wobble has been an intriguing scientific problem that has stimulated research in various geophysical and geodetic fields. Nevertheless, the actual mechanism in the Earth system that is most responsible for sustaining the Chandler wobble is still under investigation.

In principle, the Chandler wobble can be excited by changes in the moment of inertia of the solid Earth (e.g., through earthquakes [see *Mansinha and Smylie*, 1970; *Chao and Gross*, 1987], or through surface loading [see *Chao et al.*, 1987; *Kuehne and Wilson*, 1991]), or by angular momentum exchange with the atmosphere, oceans, and core (see *Gross* [2005] and *Liao* [2005] for reviews). Recently, air pressure [*Plag*, 1997], tropospheric winds [*Aoyama and Naito*, 2001], and ocean-bottom pressure variations [*Gross*, 2000] have been independently proposed as major contributions to the excitation of the Chandler wobble. A 14- to 16-month oscillation (FSO) in the atmosphere-ocean system has also been proposed as a candidate mechanism that could force a wobble having a frequency close to that of the Chandler resonance [*Plag*, 1997; *Aoyama et al.*, 2003].

Outstanding problems concerning the excitation of the Chandler wobble were recently discussed at a workshop held in Luxembourg, 21–23 April 2004. The workshop discussions concentrated on several key issues:

- the quality and interpretation of observations of the Earth's rotation with particular emphasis on determining the observed Chandler excitation from wobble observations;
- the consistency and completeness of estimates of atmospheric and oceanic angular momentum and the models from which they are derived;
- the theoretical approaches being used to model the dynamics of the Earth's rotation, with particular focus on the period and damping of the Chandler wobble.

While the theory of the Earth's rotation is well developed, certain long-period approximations have typically been made in its derivation, such as assuming that the oceans wobble with the solid Earth and exhibit an equilibrium pole tide. Thus, while the theory can be accurately used to study the annual and Chandler wobbles, it may need revision when applied to wobbles having periods of a few days or less.

In addition, the model of the Earth itself in terms of its structure, rheology, and coupling at internal boundaries is rather simplistic, and the theory as numerically implemented is linearized. Nevertheless, uncertainties due to model deficiencies and simplifications of the theory are expected to be small, especially at the Chandler period [*Wahr*, 2005], except for a potentially larger effect due to unaccounted core-mantle coupling [*Dickman*, 2003].

Likewise, present-day Earth rotation observations are of high quality, and discrepancies between predictions and observations cannot be attributed to uncertainties in the observations. However, it is noted here that the separation of the Chandler wobble is still an issue under discussion [*Vondrák and Ron*, 2005].

The strong seasonal variations in atmospheric, oceanic, and hydrospheric processes excite a large annual wobble whose prograde component is made even larger by its close proximity in frequency to the 14-month Chandler resonance. While not in perfect agreement, predictions of the annual wobble based on models of the forcing are in reasonably good agreement with the observations.

Although much smaller than at seasonal frequencies, variations in atmospheric, oceanic, and hydrospheric processes also occur in the Chandler frequency band and thus can excite the Chandler wobble. While there is considerable evidence that the combination of such processes fully accounts for the Chandler excitation, there is uncertainty about the relative contribution of wind and ocean circulation on the one hand and pressure forcing due to atmospheric, hydrospheric, and oceanic loading on the other hand [*Brzezinski*, 2005].

This uncertainty is due to inadequate observations and models of relevant atmospheric, oceanic, and hydrospheric parameters such as the wind field. For example, different atmospheric models, and different methods of computing the angular momentum from the modeled wind fields, yield different estimates for the contribution of atmospheric winds to the Chandler wobble excitation [*Aoyama*, 2005].

Moreover, estimates of oceanic and hydrospheric excitation of the Chandler wobble derived from models that are forced with atmospheric fields will be inaccurate because, at a minimum, the forcing fields are inaccurate. Nevertheless, including the modeled oceanic excitation improves the agreement between predictions and observations [*Gross et al.*, 2003].

Consequently, a key to improved understanding of the excitation of the Chandler wobble lies in the improvement of the forcing models, which will also imply improved knowledge of the Chandler period and damping, and hence of the dissipation mechanisms causing the damping [*Wilson and Chen*, 2005].

Studies of the Earth's wobbles will continue to contribute to the validation of observational data sets as well as atmospheric, oceanic, and hydrospheric models. Earth rotation studies have a rich history, and we look forward to their future contributions to our knowledge of the Earth and its interacting systems.

Acknowledgments

The Workshop "Forcing of Polar Motion in the Chandler Frequency Band: A Contribution to Understanding Interannual Climate Variations" was organized by the European Centre for Geodynamics and Seismology (ECGS), Luxembourg, and supported and/or sponsored by the Ministere de la Culture, de l'Enseignement Supérieur et de la Recherche, Luxembourg; the U.S. National Aeronautics and Space Administration (NASA); the International Association of Geodesy (IAG); the National Museum of Natural History, Luxembourg; the National Funds for Research, Luxembourg; and the International Earth Rotation and Reference Systems Service (IERS).

References

Aoyama, Y. (2005), Quasi-14 month wind fluctuation and excitation of the Chandler wobble, in *Forcing of Polar Motion in the Chandler Frequency Band: A Contribution to Understanding Interannual Climate Variations*, edited by H.-P. Plag et al., Cah. du Cent. Eur. de Geodyn. et de Seismol., vol. 24, Walferdange, Luxembourg, in press.

Aoyama, Y., and I. Naito (2001), Atmospheric excitation of the Chandler wobble, 1983–1998, *J. Geophys. Res., 106*, 8941–8954.

Aoyama, Y., I. Naito, T. Iwabuchi, and N. Yamazaki (2003), Atmospheric quasi-14 month fluctuations and excitation of the Chandler wobble, *Earth Planets Space, 55*, e25-e28.

Brzezinski, A. (2005), Review of the Chandler wobble and its excitation, in *Forcing of Polar Motion in the Chandler Frequency Band: A Contribution to Understanding Interannual Climate Variations*, edited by H.-P. Plag et al., Cah. du Cent. Eur. de Geodyn. et de Seismol., vol. 24, Walferdange, Luxembourg, in press.

Chao, B. F., and R. Gross (1987), Changes in the Earth's rotation and low-degree gravitational field induced by earthquakes, *Geophys. J. R. Astron. Soc., 91*, 569–596.

Chao, B. F., W. P. O'Conner, A. T. C. Chang, D. K. Hall, and J. L. Foster (1987), Snow load effect on the Earth's rotation and gravitational field, 1979-1985, *J. Geophys. Res., 92*, 9415–9422.

Dickman, S. R. (2003), Evaluation of "effective angular momentum function" formulations with respect to core-mantle coupling, *J. Geophys. Res., 108*, 2150, doi:10.1029/2001JB001603.

Gross, R. (2000), The excitation of the Chandler wobble, *Geophys. Res. Lett., 27*, 2329–2332.

Gross, R. (2005), Oceanic excitation of polar motion: A review, in *Forcing of Polar Motion in the Chandler Frequency Band: A Contribution to Understanding Interannual Climate Variations*, edited by H.-P. Plag et al., Cah. du Cent. Eur. de Geodyn. et de Seismol., vol. 24, Walferdange, Luxembourg, in press.

Gross, R., I. Fukumori, and D. Menemenlis (2003), Atmospheric and oceanic excitation of the Earth's wobbles during 1980–2000, *J. Geophys. Res., 108*, 2370, doi:10.1029/2002JB002143.

Kuehne, J., and C. R. Wilson (1991), Terrestrial water storage and polar motion, *J. Geophys. Res., 96*, 4337–4345.

Liao, D.-C. (2005), A brief review of atmospheric and oceanic excitation of the Chandler wobble, in *Forcing of Polar Motion in the Chandler Frequency Band: A Contribution to Understanding Interannual Climate Variations*, edited by H.-P. Plag et al., Cah. du Cent. Eur. de Geodyn. et de Seismol., vol. 24, Walferdange, Luxembourg, in press.

Mansinha, L., and D. E. Smylie (1970), Seismic excitation of the Chandler wobble, in *Earthquake Displacement Fields and the Rotation of the Earth*, edited by L. Mansinha et al., pp. 122–135, Springer, New York.

Plag, H.-P. (1997), Chandler wobble and pole tide in relation to interannual atmosphere-ocean dynamics, in *Tidal Phenomena*, edited by H. Wilhelm and W. Zürn, Lect. Not. in Earth Sci., vol. 66, pp. 183–218, Springer, New York.

Vondrák, C. R., and C. Ron (2005), The great Chandler wobble change in 1923–1940 re-visited, in *Forcing of Polar Motion in the Chandler Frequency Band: A Contribution to Understanding Interannual Climate Variations,* edited by H.-P. Plag et al., Cah. du Cent. Eur. de Geodyn. et de Seismol., vol. 24, Walferdange, Luxembourg, in press.

Wahr, J. (2005), Polar motion models: Angular momentum approach, in *Forcing of Polar Motion in the Chandler Frequency Band: A Contribution to Understanding Interannual Climate Variations*, edited by H.-P. Plag et al., Cah. du Cent. Eur. de Geodyn. et de Seismol., vol. 24, Walferdange, Luxembourg, in press.

Wilson, C., and J. Chen (2005), Estimating the period and Q of the Chandler wobble, in *Forcing of Polar Motion in the Chandler Frequency Band: A Contribution to Understanding Interannual Climate Variations*, edited by H.-P. Plag et al., Cah. du Cent. Eur. de Geodyn. et de Seismol., vol. 24, Walferdange, Luxembourg, in press.

—H.-P. Plag, Norwegian Mapping Authority, Honefoss (now at University of Nevada, Reno); B. F. Chao, NASA Goddard Space Flight Center, Greenbelt, Md.; R. S. Gross, Jet Propulsion Laboratory, California Institute of Technology, Pasadena; and T. van Dam, European Centre for Geodynamics and Seismology, Walferdange, Luxembourg

MEETINGS

Workshop Launches International Coalition for GeoInformatics

PAGE 27

A global forum on sedimentary geology and paleobiology was launched at an inaugural meeting at the 32nd International Geological Congress, in Florence, Italy. The workshop developed a collaborative international effort that focuses on next-generation research and education and that provides a forum for individuals and organizations involved in conducting and sponsoring this research.

Thirty-five scientists and 20 representatives of European funding organizations met in the first of a planned series of workshops on "Coordinating GeoInformatics Efforts in Sedimentary Geology and Paleobiology."

Scientists from Germany, Austria, France, and the United States presented current projects and strategies on geoscience database and information management, and discussed issues concerning the necessary information technology (i.e., database interoperability, data sharing, etc.) and the characteristics and information needs of their respective geoscience communities.

The workshop was complementary to the meeting held 20 August 2004, by the International Union of Geosciences' Commission for the Management and Application of Geoscience Information (CGI, http://www.bgs.ac.uk/cgi_web), chaired by Kristine Asch (German Geological Survey BGR, kristine.asch@bgr.de). This first workshop on GeoInformatics concluded with an agreement to form the International Coalition for GeoInformatics (iGeoInfo). Close collaboration with CGI and other interested organizations, groups, and individuals is anticipated.

What is the Problem?

The ever-increasing amount and complexity of data and information accumulated in the geological sciences has become overwhelming and has led to a paradoxical situation. With the enormous number of publications each year—including hard-copy journals and, increasingly, e-journals—and data scattered in numerous formal and informal databases, it has become difficult for the individual researcher to find all data of interest.

The difficulty is exacerbated by the need to then compile these data into formats useful for analysis, whether graphical, statistical, or even map-based. Of particular importance are the unpublished data sources that tend to be heterogeneous in type and quality, organized in many different ways and stored at effectively inaccessible sites, including unpublished data in file cabinets of innumerable researchers. There is also a lack of standard approaches in the formatting of both published data and existing digital databases.

As a result, data collections are difficult to find, and nearly always incomplete, and it is difficult to seamlessly integrate data from different sources. Thus, despite the individual investment of effort in finding data sources, results are far from optimal, and this holds back sedimentary geology and paleobiology research.

Because the fields are at the cusp of defining next-generation research, now is the time to solve these geologic information issues. In addition, data and information management in the geological sciences, which are global sciences, requires coordination and integration on an international level.