



DIRECTOR'S MESSAGE

Greetings all, 2015 has seen the closing of our old cooperative agreement with NOAA and the start of a new one. The transition has been demanding for everyone, from the ESSIC staff that supports the functioning of CICS to the scientists that respond to the requirements that a change of

this magnitude has brought. More significantly, the transition was completed without negatively affecting the quality and quantity of our research. I want to express my gratitude for your diligence and patience.

In terms of science, almost every other day an article involving a CICS-MD scientist is published. The annual CICS-MD Science Meeting held this past November continues to grow, this time with more than 100 registrants. The meeting combined posters, contributed and invited talks, and two keynote presentations.

Our people are frequently recognized. This time, Xi Shao, Bin Zhang and Yan Bai received a NESDIS Outstanding Science and Research Employees of the Year Award (for the Satellite Meteorology and Climatology Division, SMCD) for their work with colleagues on the VIIRS Day/Night Band. CICS-MD Scientist Yong Chen was awarded

the Best Proceeding Paper award during the 20th International TIROS Operational Vertical Sounder (TOVS) Study Conferences. Last but not least, Student Xiaoxu Tian received an award as Best Speaker (Second Place) at the CoRP Symposium.

In this edition of the CICS-MD Circular, Liqing Jiang reports on the first ever global climatology on ocean acidification. Graduate student Katie Lukens discusses her research on the dynamics of storm tracks and their relation to precipitation systems.

Best wishes for this Holiday Season and a Happy New Year to all, Hugo Berbery, CICS-MD Director



Participants of the NOAA/NESDIS Cooperative Research Program (CoRP) Science Symposium for students, hosted by CICS at the University of Maryland.

CICS-MD BACKGROUND

CICS is a partnership led by the Earth System Science Interdisciplinary Center of the University of Maryland at College Park engaged in collaborative research with several NOAA Centers and Laboratories. CICS comprises two main research centers, CICS-MD at the University of Maryland, and CICS-NC in Asheville, NC, which is administered by North Carolina State University. The CICS Consortium includes another 15 institutions as partners, including academic, non-governmental, and private research enterprises.

CICS-MD consists of about 60 scientists that implement the Institute's mission of supporting NOAA's ability to use satellite observations and Earth System models to advance the national climate mission.

RESEARCH TOPICS

CICS-MD research strengths focus in the following topic areas:

Data Fusion and Algorithm Development. This is research focused on the use of satellite and complementary observations to create geophysical data sets related to various aspects of the global climate system.

Calibration/Validation. This area of research is aimed at calibration and validation of satellite radiance data as well as products of algorithms that derive geophysical parameters to best represent the state of the Earth System.

Future Satellite Programs. Activities under this topic are directed at developing and implementing new NOAA meteorological satellite systems, particularly GOES-R and JPSS.

Climate Research, Data Assimilation and Modeling. This research topic aims at improving the understanding of the physics of climate through integration of information by data assimilation, particularly satellite-derived data sets, with models of the Earth System and its components.

Land and Hydrology. The focus of this topic area is on the enhancement, refinement and validation of algorithms that derive land surface products from satellite observations with the purpose of improving global land-atmosphere feedback mechanisms that impact all living forms on the planet.

Earth System Monitoring from Satellites. Research in this topic area focuses on the derivation and curation of data sets that describe crucial aspects of the Earth System (Atmosphere, Land, Ocean, Cryosphere) and the application of those data sets in the detection and monitoring of significant climate events.

Climate Science to Support Policy and Outreach. Activities include mentoring of undergraduate and graduate students on themes of relevance for NOAA, increasing awareness of climate science and changes in the climate system, and raising the understanding of how climate data is collected, observed, analyzed, and used in research purposes.

NOAA SPONSORS

- Center for Satellite Applications and Research (STAR)/National Environmental Satellite, Data and Information Service (NESDIS)
- Climate Prediction Center/National Centers for Environmental Prediction/National Weather Service
- National Centers for Environmental Information/NESDIS
- Air Resources Laboratory/Office of Oceanic and Atmospheric Research

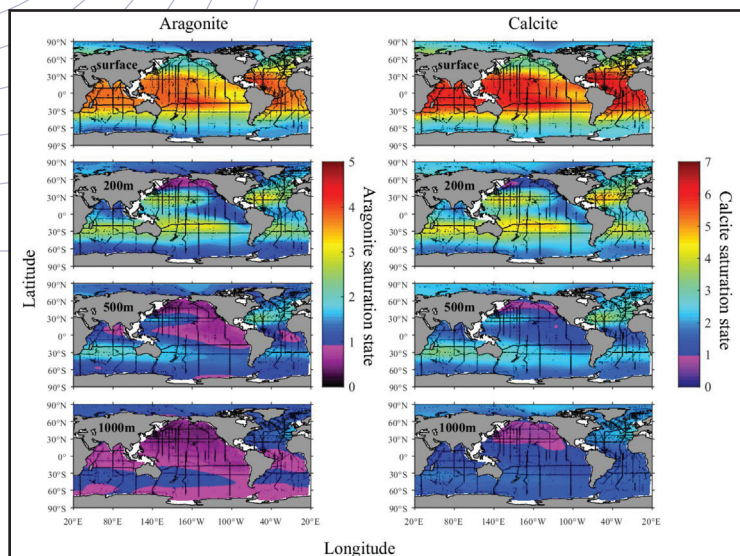
Climatological Distribution of Aragonite and Calcite Saturation States in the Global Oceans

(contributed by Li-Qing Jiang)

By taking up ~30% of the anthropogenic carbon dioxide (CO₂) emissions over the past 200 years, the mildly alkaline ocean has been experiencing an increase in acidity and decrease in carbonate ion concentration and calcium carbonate saturation states. These changes are collectively known as ocean acidification (OA). If not action is taken, by the end of the century, the ocean acidity would increase by ~150%. The saturation state of aragonite and calcite (two of the most commonly seen calcium carbonate minerals in the ocean) is an important indicator of the vulnerability of the marine ecosystem to OA. A first meaningful step towards understanding OA is to map out the global distribution of aragonite and calcite saturation states.

In this study, CICS-MD scientist Liqing Jiang collaborated with experts from NOAA's Pacific Marine Environmental Laboratory, National Centers for Environmental Information, and Ocean Acidification Program to compile data from the Global Ocean Data Analysis Project (GLODAP), the Carbon Dioxide in the Atlantic Ocean (CARINA), the Pacific Ocean Interior Carbon (PACIFICA), and recent cruise data sets. They then calculated saturation states from *in-situ* temperature, hydrostatic pressure, salinity, dissolved inorganic carbon (DIC), total alkalinity (TA), silicate and phosphate. The reported global distribution of aragonite and calcite saturation states as well as their controlling mechanisms will help us understand the current status of ocean acidification in the global oceans, identify the most vulnerable regions, and form a baseline for any future changes.

See Jiang, L.-Q., R. A. Feely, B. R. Carter, D. J. Greeley, D. K. Gledhill, and K. M. Arzayus, 2015: Climatological distribution of aragonite saturation state in the global oceans, *Global Biogeochem. Cycles*, 29, 1656–1673, <http://onlinelibrary.wiley.com/doi/10.1002/2015GB005198/full>.



Spatial distribution of aragonite and calcite saturation states at depth levels of surface, 100 m, 200 m, 500 m, and 1000 m in the global oceans. Colors show gridded values based on Data Interpolating Variational Analysis (DIVA). Black dots show the sampling stations.

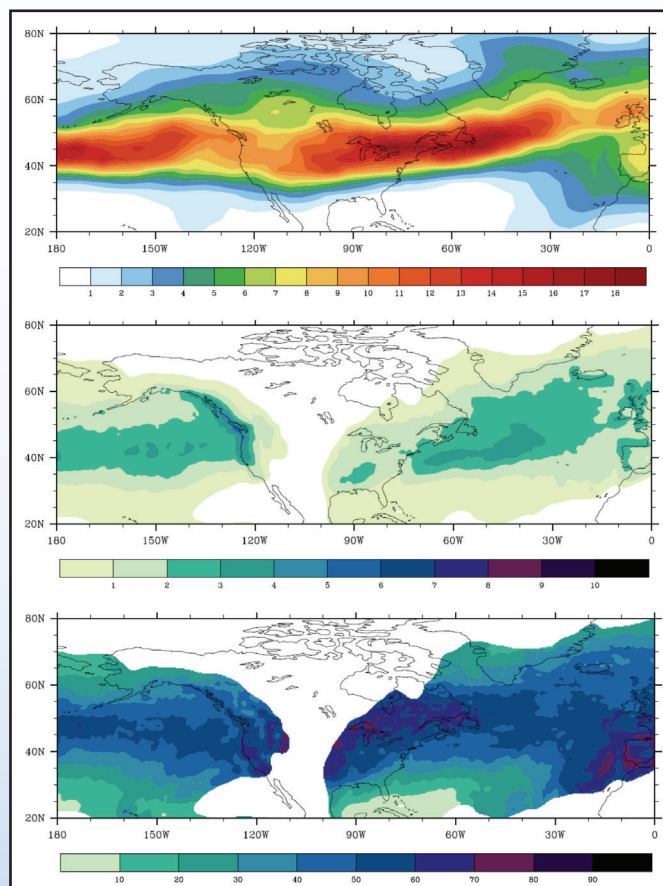
Boreal Winter Storm Tracks and Related Precipitation in North America

(contributed by Katherine Lukens)

Storm tracks, and the related cyclonic activity in the mid-latitudes, can have a profound impact on climate. Graduate Student Katherine Lukens, advised by Dr. Hugo Berbery, is investigating how the mid-latitude storm tracks relate to precipitation regimes by employing Climate Forecast System Reanalysis (CFSR) and observed daily precipitation (GPCP) data.

Regions of high cyclogenesis and cyclolysis are identified in a Lagrangian framework that employs isentropic potential vorticity as a tracer. The closest storm tracks that affect North America's climate are the Pacific (PAC) and the North American-Atlantic (NAA) storm tracks (*top figure*).

The dynamical diagnostics approach takes advantage of key attributes of the storm tracks (like density and intensity) to determine storm-related precipitation over North America. The results (*middle figure*) show that much of the observed precipitation from storms occurs in regions where the PAC and NAA storm tracks are strongest (i.e., over the oceans). The PAC and NAA tracks each produce about half of the total precipitation over the North Pacific and North Atlantic Oceans, respectively (*bottom figure*). Over land, the PAC and NAA tracks produce 50-60% of the total observed precipitation along the North American west coast and 60-70% in eastern North America, respectively.



Winter storm track climatology for the North American sector identified from CFSR potential vorticity anomalies in PV Units (top), GPCP precipitation in mm day⁻¹ produced by the storm tracks (middle), and the percentage of total observed precipitation produced by the storm tracks (bottom).