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I am writing this letter to enthusiastically support the application of Dr. Mathieu Ardyna for a research position at CNRS. I have known Dr. Ardyna for approximately seven years - since meeting him at a joint ICESCAPE/Malina meeting in Villefranche-sur-Mer in 2012. I was Principal Investigator and Chief Scientist for both the ICESCAPE (2009-2013) and SUBICE (2012-2015) programs so I was keenly aware of the kind of work that Dr. Ardyna and his research group were doing. I knew that he was working on satellite remote sensing applications, so I was interested to hear what he had to say.

I was very impressed with his first piece of work, a satellite-based analysis of the impact on the subsurface chlorophyll maximum on primary production estimates that was the first chapter of his thesis. It was a little odd for me to see that he was working on this problem, because my research group had published a paper on this same topic in 2011 and showed that even though satellites cannot "see" the subsurface chlorophyll maximum, it probably isn't resulting in much of an underestimate of primary production. The approach we took was pretty theoretical, however, and Dr. Ardyna took a more mechanistic approach. He used a much more sophisticated bio-optical model and performed a very comprehensive analysis of the problem. He was able to calculate the magnitude of the productivity underestimate as well as the associated uncertainties. I was relieved to see that his more sophisticated analysis came to the same conclusion that our earlier study had – that vertical variations in chlorophyll have a limited impact on annual depth integrated primary production.

He took this analysis even further in his 2013 *Biogeosciences* paper where he looked at the dynamics that drives the formation of the subsurface chlorophyll maximum. His work showed that the depth of the subsurface chlorophyll maximum varied for oceanic and coastal stations, as did the composition of the phytoplankton community. He then developed an empirical model that agreed well with observed distributions of chlorophyll in the Beaufort Sea and illustrated the importance of properly specifying phytoplankton vertical distributions and species composition when estimating primary production from space-based data.

As nice a piece of work as that was, I was even more impressed with his next paper (Ardyna et al. 2014). In that study, he looked at the phenology of phytoplankton blooms

in the Arctic to see if there have been any significant changes in recent years associated with the dramatic losses of sea ice. He focused on the number of blooms that a particular region experiences in a given year. To my surprise, he discovered that the incidence of fall blooms has been increasing in some locations in recent years. While the Arctic is generally characterized has having either no bloom or a single phytoplankton bloom in the spring or summer, Dr. Ardyna showed that to an increasing degree, some areas experience a second bloom in the autumn. This is a very clever piece of work and one that I wish I had thought of myself. His analysis was highly rigorous and his results robust and environmentally relevant. I have no doubt that it will be a highly cited piece of work in the years to come. Certainly anyone interested in changing environmental conditions in the Arctic will be drawn to this excellent paper.

For the last three years, Dr. Ardyna has been employed as a Marie-Curie postdoctoral scholar working in my research group. Since arriving he has performed admirably. We have already co-authored five papers together, one of which described the first evidence linking surface phytoplankton blooms to hydrothermal vent activity far below the surface. Dr. Ardyna used BGC-Argo float data together with some field data and modeling analyses to show that iron released at the vent site had made its way to the surface and stimulated phytoplankton growth in iron-limited waters of the Southern Ocean (Ardyna et al. 2019). This is a truly groundbreaking piece of work that is sure to receive a large amount of attention in the years to come. Another of our papers is a review of the processes controlling primary production in the Arctic Ocean that was recently published in the journal *Nature Climate Change*. Two comprehensive reviews of phytoplankton productivity beneath sea ice were recently published in *Elementa* and *Frontiers in Marine Science*. Dr. Ardyna took the lead on these efforts, which show how current paradigms describing phytoplankton bloom dynamics in the Arctic and Antarctic need to be revised.

One of Dr. Ardyna's strongest assets is his people skills. He is very likeable and gets along well with everyone. He interacts particularly well with the students, who appreciate his excellent advice and direction. He treats them all with the respect that they deserve. Dr. Ardyna also interacts well with the academic staff, with whom he has to work to get proposals submitted, supplies ordered, etc. Most importantly, Dr. Ardyna is an excellent colleague. I value his opinion and perspective immensely. Having a background somewhat different from my own, I appreciate his unique points of view. He never hesitates to disagree with me when he sees the need, but always does so in a constructive way. We do share the same appreciation for interdisciplinary research and the importance of an interdisciplinary approach to science.

Dr. Ardyna's work is highly respected in the bio-optical field and I think that he is moving in the right direction with his research. His work focusing on bio-optics of Arctic Ocean waters has evolved to the point where he could soon be one of the world's leading experts in the field. He continues to push the envelope of what we can learn about the ocean from measurements of ocean color, as evidenced in his most recent papers focused on physical and chemical factors that control phytoplankton growth in polar waters. I'm not sure where this will lead – but if his research continues to be an integral part of a larger synthetic body of work, then he has the potential to have a real impact on the field of biological oceanography and ocean biogeochemistry. I hope to continue working with him in years to come, particularly on our proposed SUBICE 2 project in the Chukchi Sea.

In short, his work is highly respected by his peers and is of the highest quality. Plus, he has an eye for important and interesting questions, so I would expect him to remain near the top of his field for some time to come.

Sincerely,

Kevin R. Arrigo
Donald & Donald M. Steel Professor in Earth Sciences
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