DECLARATION OF ROBINSON HORDOIR, Ph.D.

I, Robinson Hordoir, Ph.D., state and declare as follows:

1. I am 36 years old and a resident of Norrköping, Sweden. I was contacted by Terrence J. O'Toole, the attorney for Claimant Marvin K. Davis. Mr. O'Toole advised me that Mr. Davis was making a claim for veterans benefits based on Mr. Davis' actual or presumed exposure to Agent Orange while serving aboard a United Stated Navy destroyer, USS Newman K. Perry, while cruising the coastal water of South Vietnam. Mr. O'Toole provided me with Deck Logs for the Newman K. Perry dated 21 Nov. 1966 to 30 Nov. 1966. I am not being compensated for my services in rendering the opinions expressed in this Declaration.

2. I am employed as a researcher by the Swedish Meteorological and Hydrological Institute ("SMHI"). SMHI is an agency of the Swedish government. Information about SMHI can be found at http://www.smhi.se/en/about-smhi. I am a French national and I am fluent in English, among other languages.

3. I received by doctorate degree from the University of Caen which is located in Caen, Normandy, France. I received my Ph.D. in 2007 in Physical Oceanography. My curriculum vitae is attached to this Declaration. A significant research topic that I undertook in earning my Ph.D. degree was an investigation into the extent to which freshwater discharged from the Mekong River influences ocean water in the coastal area adjacent to the Mekong Delta. The results of this study were published in *Journal of Geophysical Research*, a peer-reviewed journal of the American Geophysical Union (AGU). The article is referenced as: Hordoir, R., K. D. Nguyen, and J. Polcher (2006), *Simulating Tropical River Plumes, A Set Of Parametrizations Based On Macroscale Data: A Test Case In The Mekong Delta Region*, J. Geophys. Res., 111, C09036, doi:10.1029/2005JC003392 (hereafter referred to as the "Mekong Delta Plume Study")

4. The object of the Mekong Delta Plume Study was to model the Mekong River plume and its impact the coastal waters of southern Vietnam. Most rivers create plumes. A plume is formed when the outflow of fresh water from a river system empties into a larger body of water. The plume, generally

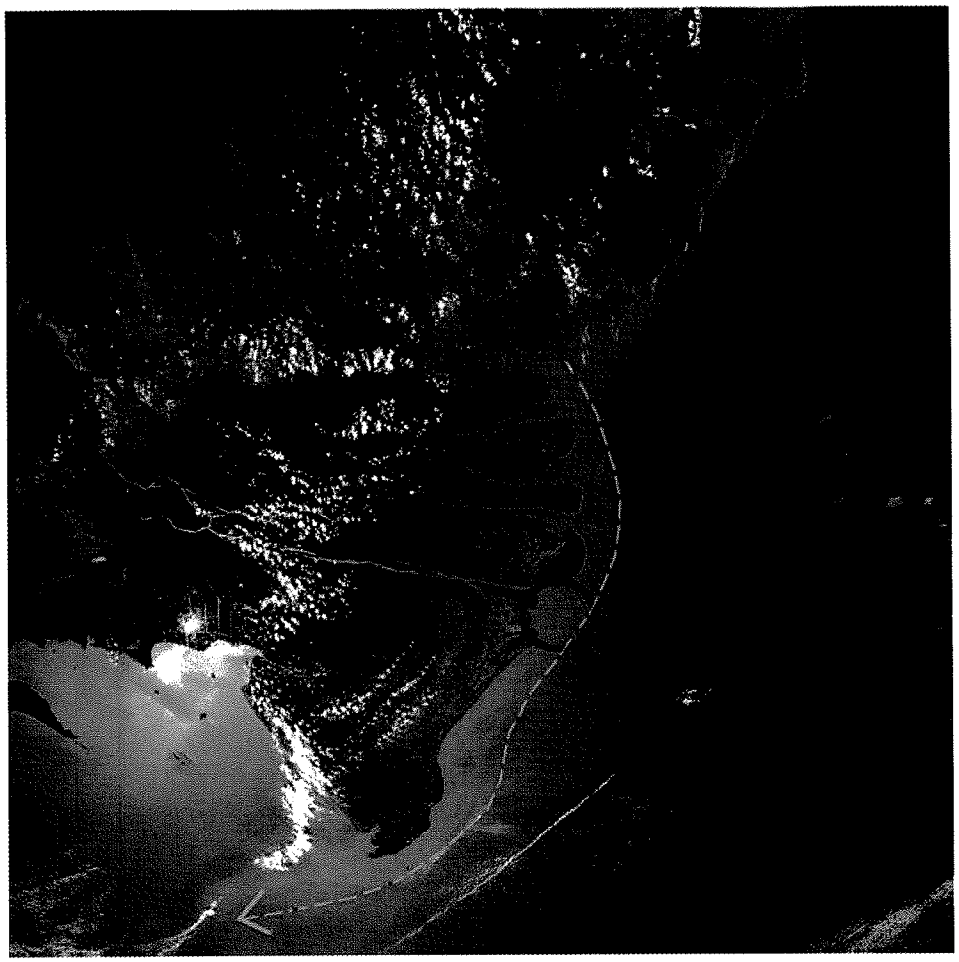
speaking, is the area of the larger body that is influenced by the fresh water discharge. The existence of the plume is mostly related to the salinity difference between river water (i.e. : freshwater) and that of the larger body that is the sea in most cases. Because of their density difference, river water and sea water do not mix immediately but create a density front. The presence of the front usually creates a coastal current that is influence by the Earth rotation (also known as the "Coriolis Force"). This phenomenon is extremely close, from a physical point of view, to that of "Thermal Wind" that most people also refer to as "Sea Breeze". The input of freshwater creates what is called a "baroclinic" current in the coastal area. "Baroclinic" is a term that is used both in Ocean and Atmospheric dynamics, and that refers to this density difference. This baroclinic current is made of two layers, the upper layer that is a mix of freshwater and sea water, and the lower layer that is mostly sea water. This dual system can be described as a "coastal overturning" : the input of freshwater attracts sea water below the river plume and that sea water eventually becomes mixed with freshwater when it

reaches the vicinity of the river mouth. This mix of freshwater and sea water is the main body of the upper part of the plume. If wind blows in the same direction as the coastal current, or if wind can be neglected, this coastal current becomes "coastally trapped". This means it flows with the coast on its right (in the Northern Hemisphere), and flows parallel to the coast. For major river systems, like the Mekong River, or the Amazon or Mississippi, the river's plume can be considerable. Depending on latitude, on meteorological, oceanographic and other conditions, a river's plume may extend hundreds of kilometers from the river's delta area. Some coastal currents like the Norwegian Coastal Current that flows all along the Norwegian coast, extend from the South of Norway up to the Arctic Ocean. In the case of the Norwegian Coastal Current, it is mostly explained by the freshwater outflow from the Baltic Sea. Because of their nature, the width of these currents are highly influenced by latitude. In tropical regions, such currents have a higher width because of the lower Coriolis force, whereas this width is smaller closer to the poles. Obviously, the closer the plume to the

mouth of the river, the higher the percentage of river water that is mixed in the water of the receiving body. These dynamics are now quite well understood to Physical Oceanographers around the world thanks to measurements and numerical models.

5. The Mekong River is one of the world's major rivers. It is the world's 12th-longest river and the 7th-longest in Asia. Its estimated length is 4,350 km (2,703 mi), and it drains an area of 795,000 km2 (307,000 sq mi), discharging 475 cu. km. (114 cu mi) of water annually. The Mekong flowing southwesterly through Vietnam and empties into the South China Sea through several channels that form the very extensive Mekong Delta. The following image is a satellite

photo of the Mekong and its delta:



6. Based on my review of the *Perry* deck logs, it appears that The *Perry* was anchored in various positions off the coast of the Mekong delta area between November 24th and November 30, 1966. Taking into account recorded longitude/latitude coordinates, water depth and on the narrative description of the *Perry's* location, the *Perry* sailed closed to the southernmost channels through

the Mekong delta which named "Tranh De" and "Din An". The black circle on the photo shows the approximate location of the *Perry* during this time.

7. Using this data, it is clear that the *Perry* never sailed or was never anchored less than 15 nautical miles off the coast of the Mekong delta, and that the *Perry* always sailed and was always anchored close to the southernmost tip of the Mekong delta. In fact, it is clear that, on some of these days, the *Perry* maneuvered very close to the coastline of Vietnam. For example, on 24 November 1966, the Deck Log reflects that the *Perry* anchored at the mouth of the Mekong River, 3 miles from the beach.

8. In southeast Asia and, specifically in the Mekong River basin, the month of November can be considered as the end of the wet season from a climatological point of view. During that period, I calculate the total freshwater discharge of the Mekong delta at 10,000 - 15,000 cubic meter per second (approximately 353,000 – 529,000 cu. ft per second). At that time of the years, the prevailing wind in the area of the Mekong Delta would be out of the Northeast

blowing Southwest.

9. Based on these meteorological and hydrological elements, in November 1966, a coastally trapped baroclinic circulation of Mekong River water would be headed in a southwesterly direction. Baroclinic flow would cause Mekong River water to be transported into the area where the *USS Newman K Perry* sailed or was anchored. Prevailing winds from the northeast contribute to the trapping of the freshwater close to the coast. This baroclinic current reaches its highest width off the southern-most point of the Mekong delta where all the freshwater from all the mouths of the delta meet to form a surface current flowing parallel to the coast. I would estimate the width of this current to be in a range from 20 nautical miles to 50 nautical miles. The dashed yellow arrow on the photo in ¶ 5, above, illustrates the baroclinic flow of Mekong River water and its direction.

10. Based on the kind of computer modeling used in the Mekong River Plume Study and using the specific data relevant to the *Perry*'s position between

24 November and 30 November, 1966, one can say that the surface salinity where the *Perry* sailed or was anchored between November 24th and November 30th 1966 ranged between 10 grams per liter and 24 grams per liter. These salinity values should be contrasted to he average salinity of that same region of 36 grams per liter. This means that the *Perry* sailed or was anchored between November 24th and November 30th 1966 in an area in which the surface water is heavily influenced by the freshwater outflow from the Mekong river.

11. Based on these salinity data, one can estimate that the percentage of Mekong river water at the sea surface of the area where the *Perry* sailed or was anchored between 24th and November 30th 1966, at between 51% and 72%. To put it more simply, using our modeling techniques, the about half to three quarters of the water surrounding the *Perry* would have been water from the Mekong River.

12. I am able to make a rough guess that the baroclinic current of circulating Mekong River water would have had a depth of anywhere from 5 to 10

meters.

13. It should be noted that during the monsoon season, the prevailing winds in the Mekong Delta are out of the southwest blowing to the northeast. This change in wind direction results in Mekong River water being driven away from the coast. A boat sailing miles away from the Mekong Delta coast, would therefore sail in an area which surface water is heavily influenced by the Mekong River. On the contrary, during that precise season, a boat anchored close to the Vietnamese coast but a few miles south west of the southernmost delta branch, would notice the presence of only a small percentage of Mekong river water at the surface of the sea. I say this to make the point that it is unscientific to believe that there is a precise boundary between river water (brown water) and ocean water (blue water) within what is referred as the "Region of Freshwater Influence" of the Mekong river. In a system like the Mekong Delta, the flow of river water and its mixture with sea water is complex and subject to a number of variable. I also wish to add that in the case of the Perry, the extreme proximity of the

Mekong river branches makes it very unlikely that the percentage of Mekong river water could have been less than 20% at the sea surface, and this regardless of the season. However, the end of the wet season (from October to December) coincides with the highest probability of having a high percentage of Mekong river water close to the coast, as the end of the wet season is this only time of the year that makes it possible to have both a high river discharge and wind blowing from the North East which ensure freshwater is trapped close to the Mekong delta coast and flows towards the South West.

Pursuant to 28 U.S.C. § 1748, I declare under penalty of perjury under the laws of the United States of America, that the foregoing is true and correct.

Executed this 28th day of May, 2010

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Robinson HORDOIR

Summary

RESEARCH SCIENTIST IN PHYSICAL OCEANOGRAPHY

Experience

2008 to date — **Permanent Researcher** — OCEANOGRAPHY RESEARCH DEPT., SWEDISH METEOROLOGICAL AND HYDROLOGICAL INSTITUTE, NORRKÖPING, SWEDEN

- Process analysis for the Baltic Sea
- Numerical modelling of the Baltic Sea thermo-haline circulation
- Biogeochemical analysis with a focus on eutrophication, carbon sources and sinks, benthic phosphorus resuspension

2004 to 2007 — **PhD thesis** — LABORATOIRE DE MORPHODYNAMIQUE CONTINENTALE ET CÔTIÈRE, UNIVERSITÉ DE CAEN, FRANCE

Parameterisation of river inflows in Ocean General Circulation Models. Supervisor : Dr. Jan Polcher from Laboratoire de Météorologie Dynamique, Paris

- Numerical modelling of river plumes and interaction with large scale circulation
- Created local numerical configurations using POM (Princeton Ocean Model) and ROMS, also used NEMO/OPA global ocean model
- Set parametrisations to take into account meso-scale processes using macro-scale accessible data
- Goal is to provide a parametrisation of freshwater fluxes between global ocean models and global land surface models from volumic, haline and energetic points of view.

2000 to 2004 — **Research engineer** — LABORATOIRE D'OCÉANOGRAPHIE ET DU CLIMAT, EXPÉRIMENTATION ET APPROCHES NUMÉRIQUES *(formerly LODYC)*, PARIS, FRANCE

NEMO/OPA global ocean model system team. I have interfaced with users on physical, numerical and computational aspects. Supervisor : Dr. Gurvan Madec

- Work on sea ice module
- Management of global runoff flow datasets required by the NEMO/OPA model
- Management of forcing datasets

1999 — **Development engineer** — WL DELFT HYDRAULICS, DELFT, THE NETHERLANDS

Water quality team

- Coupling between 1-D hydrodynamics and water quality module (chemical and biochemical tracers modelling)
- Develloped a coupling interface

1998, June to Sept. — **Research trainee** — CSIR, COUNCIL FOR SCIENTIFIC & INDUSTRIAL RESEARCH, STELLENBOSCH, SOUTH AFRICA

Coastal engineering team

- Simulation of coastal sediment transports in a non-stationary turbulent bottom boundary layer
- Wrote a non-stationary model to take turbulence related processes into account

1997, July to Sept.	**Research trainee**	INSTITUTE OF MECHANICS, HANOI, VIETNAM
		Numerical simulation team
		- Created, wrote and tested a code solving shallow water equations using a TVD scheme. Application to dam break problems and to river flood forecasting

Education

1997 to 1999	ENSEEIHT, TOULOUSE, FRANCE *French "Grande Ecole" System, "Ingénieur" in fluid mechanics and hydraulics* - Major in environmental dynamics - PhD prerequisite courses in environmental physics & chemistry
1995 to 1997	UNIVERSITÉ D'AIX-MARSEILLE II, MARSEILLE, FRANCE - Master's degree in fluid mechanics, with Honours, ranked second among all graduates - Bachelor's degree in mechanics, with High Honours, ranked first among all graduates - Selected as the first student to participate in an exchange programme with the Hanoi Institute of Mechanics, Vietnam
1992 to 1995	LYCÉE RASPAIL, PARIS, FRANCE - Intensive training courses for competitive admission exams to French national engineering schools - Ranked first in final year, passed competitive exams in physics and chemistry at Engineering Grand National Schools

Languages

English	Fluent; trips to and long term stays in Great Britain, Ireland, South Africa, the United States and Canada
Swedish	Good basic knowledge
German	Good basic knowledge
French	Mother tongue

Computer skills

Programming	Wide experience of data analysis and visualisation with IDL, extensive knowledge of Fortran programming and code porting on supercomputers including parralelisation
Systems	Linux, Unix, MS Windows
Software	Netcdf & NCO, LaTeX, OpenOffice

Some interests

Sailing	Experience as skipper and crew on a variety of sloops, dinghies and catamarans
Scuba diving	Experienced diver
Music	Transverse flute, focus on Celtic (Irish and Breton) folklore, participated to many courses in Ireland and Britanny
Software law	Active member of an Open Source community coaching consumers willing to get their "Windows Tax" back, if necessary in court. Adviser in more than twenty legal actions, won most of them.

Personal data

European Union citizen
Married, One Child

Publications in peer reviewed journals :

- **R. Hordoir** ; Meier M. - Freshwater Fluxes in the Baltic Sea - a model study, *J. Geophys. Res.*, doi :10.1029/2009JC005604

- **R. Hordoir** ; Polcher, J. ; Brun-Cottan, J-C. ; Madec, G. - Towards a parametrization of river discharges into Ocean General Circulation Models. A closure through energy conservation. *Climate Dynamics*, Volume 31, Numbers 7-8, DOI 0.1007/s00382-008-0416-4, Pages 891-908.

- **R. Hordoir** ; Nguyen, K. D. ; Polcher, J. - Simulating tropical river plumes, a set of parametrizations based on macroscale data : A test case in the Mekong Delta region - *J. Geophys. Res.*, Vol. 111, No. C9, C09036 doi : 10.1029/2005JC003392

Talks & posters :

- **R. Hordoir** , Nguyen K.D., Polcher J. - Simulating tropical river plumes, a set of parametrizations based on macro-scale data. Comparison with observations in the region of freshwater influence of the Mekong Delta, *Oral Presentation given at the EGU - General Assembly, Vienna, April 2006*

- **R. Hordoir**, Polcher J., Brun-Cottan J-C., Madec G. - Spotting what lacks to resolve properly river inflows in ocean general circulation models, *Oral Presentation given at the EGU - General Assembly, Vienna, April 2007*

- **R. Hordoir**, Polcher J., Brun-Cottan J-C., Madec G. - River inflows in ocean general circulation models : a closure through energy conservation, *Poster Presentation given at the EGU - General Assembly, Vienna, April 2007*