



UKUQAPHA NGESO LOKHOZI ULWANDLE JIKELELE NGAMAROBHOTHI E-ARGO

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IPLANKTON

Umanyolo okhukhulekayo usuka emasimini uze ufike olwandle ukhulisa ulwelwe olubuhlaza oluntanta emanzini (the phytoplankton), lolulwelwe luyakwazi ukuzakhela ukudla lwalo lusebenzisa ilanga (phecelezi i-photosynthesis). Kanti kunamagciwane adla lona lolulwelwe nawo antanta emanzini (zoo-plankton). Zombili lezinhlobo(ulwelwe namagciwane) zibizwa ngeplankton.

Uke uzibuze ukuthi ososayensi bazi kanjani ngokwenzeka ekujuleni kolwandle? Kunezinhlobonhlobo zamarobhoti akwazi ukutshuza aze afike ekujuleni kolwandle abuye esequkethe imininingwano enzulu ngokwenzeka olwandle. Kunohlobo lwerobhoti olubizwa nge Argo float, loluhlobo luyaye luhambe luye ekujuleni kolwandle luhanjiswa imisinga yolwandle (ocean currents) ebese libuyela ngaphezulu kolwandle emumva kwezinsuku eziyishumi (10) ukwazisa ososayensi ngolwazi eliqukethwe yilo. Njengamanje abalelwa esibalweni esingangezinkulungwane ezine (4000) amarobhoti e-Argo aqaphe ulwandle ukuthola ngokwenzeka kulo nsuku zonke. Lamarobhoti acosha imininingwane emayelana nesilinganiso sokushisa kwamanzi/izinga lokushisa kwamanzi, usawoti oqukethwe amanzi olwandle, kanti amanye akwazi ukuthola imininingwane emayelana namakhemikhali kanye nemingcele yezinto eziphilayo. Amarobhoti e-Argo awusizo olukhulu kwizazi zolwandle ekutheni zazi ukuthi ulwandle lusebenza kanjani, umthelela elinawo hhayi kwizilwanyana zasolwandle kuphela kepha emhlabeni jikelele.

KUNGANI OSOSAYENSI BEHLEZI BEQAPHE ULWANDLE NGESO LOKHOZI?

Ulwandle lubaluleke kakhulu empilweni yomuntu ngoba lusinika ukudla, imithi, ezokuthutha/ ezokohamba kanye nezokungcebeleka. Ulwandle luyikhaya kwizilwanyana/kwizinhlobo ezahlukene zezilwane ezenza umhlaba ubukeke ungcono futhi umhle kubantu. Isibonelo, [iplankton](#) encane olwandle ikhiqiza amanani abalelwa kumashumi amahlanu amaphesenti (50%) womoya esiwuphefumulayo. Ulwandle lwakha amaphesenti angaphezu kwamashumi ayisikhombisa (70%) endawo yomhlaba liphinde lidlale indima esemqoka kwezemvelo emhlabeni jikelele.

ISIMO SEZULU

Amazinga emvula, noma okushisa noma okuvunguza komoya kanye nokuthi umoya ulibhekise ngakumaphi amagumbi omhlaba.

IZINHLOBO ZOMOYA (GASES) EZIBAMBA UKUSHIZA EMKHATHINI

Amagesi abamba ukushisa emkhathini okubalwa kuwo i-carbon dioxide, i-methane, i-nitrous oxide kanye namagesi a-fluorinated.

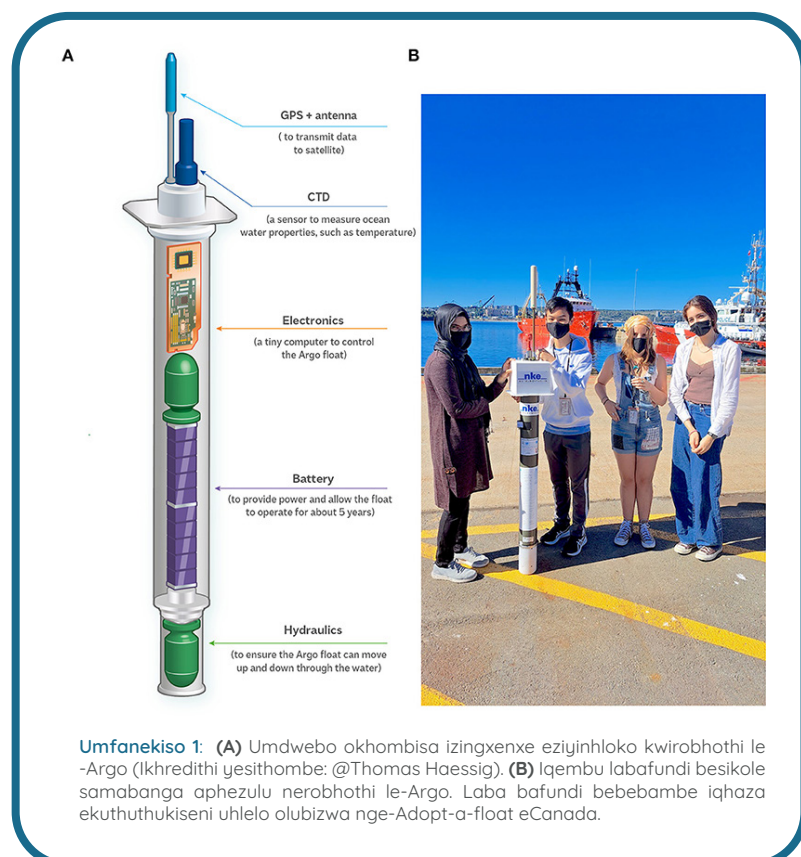
Ngakho ngenxa yalezizathu, ososayensi kudala bakubona ukubaluleka kokuqapha ulwandle ngeso lokhozi ukuze bezokwazi, baqondisise futhi bakwazi nokuqagela izinguquko ezingase zenzeke.

Ososayensi abafunda ngomkhathi bayakulangazelela ukuhlola ulwandle, bazi kabanzi ngalo, njengoba lunomthelela **kwisimo sezulu** esisithola nsuku zonke. Isibonelo, wake wabona amanzi ehawamuka emgwaqeni oshisayo? Kwenzeka okufanayo nasolwandle, lapho amazinga aphezulu okushisa olwandle edala ukuhwamuka kwamanzi olwandle. Ukuhwamuka kuthutha amanzi olwandle kuwase emkhathini, uma efika emkhathini ngohlobo lomuhwamuko afike akhe amafu, iqhwa kanye nemvula. Ngakho, ukuqapha izimo zasowandle kangcono kwenza isimo sezulu siqondakale kangcono.

Abanye ososayensi bangochwepheshe ekufundeni isimo sezulu somhlaba jikelele. Izifunda ezinesimo sezulu esishisayo zithola ukukhanya kwelanga okuningi onyakeni ngamunye. Lokho kwenza ulwandle lufudumale futhi kukhiqiza amafu kanye nemvula, ngakho isimo sezulu kulezifunda kujwayeleke ukuba sishise futhi sibenomswakama. Kodwa isimo sezulu ngokuhamba kwesikathi siyashintsha. Isibonelo, ezinye izinto ezenziwa ngabantu njengokushayela izimoto noma ukushisa amakhaya ethu kungaba nomthelela ekwandiseni inani **lwamagesi abamba ukushisa** emkhathini. Amagesi abamba ukushisa emkhathini asebenza okwengubo, abamba ukushisa aphinde afudumalise umhlaba. Ukucubungula nokuhlola ulwandle kusemqoka ukuze kwaziwe ukuthi abandakanyeka kanjani amagesi asemkhathini kwizinguquko zesimo sezulu, umthelela anawo kwisimo sezulu, njengoba ulwandle lukwazi ukumunca i-carbon dioxide kanye nokushisa emkhathini womhlaba maqede ikuyise kwezinye izizinda zolwandle ngokusebenzisa imisinga yolwandle.

AMAROBHOTI E-ARGO: IZIHAMBI EZIKHULULEKILE OLWANDLE!

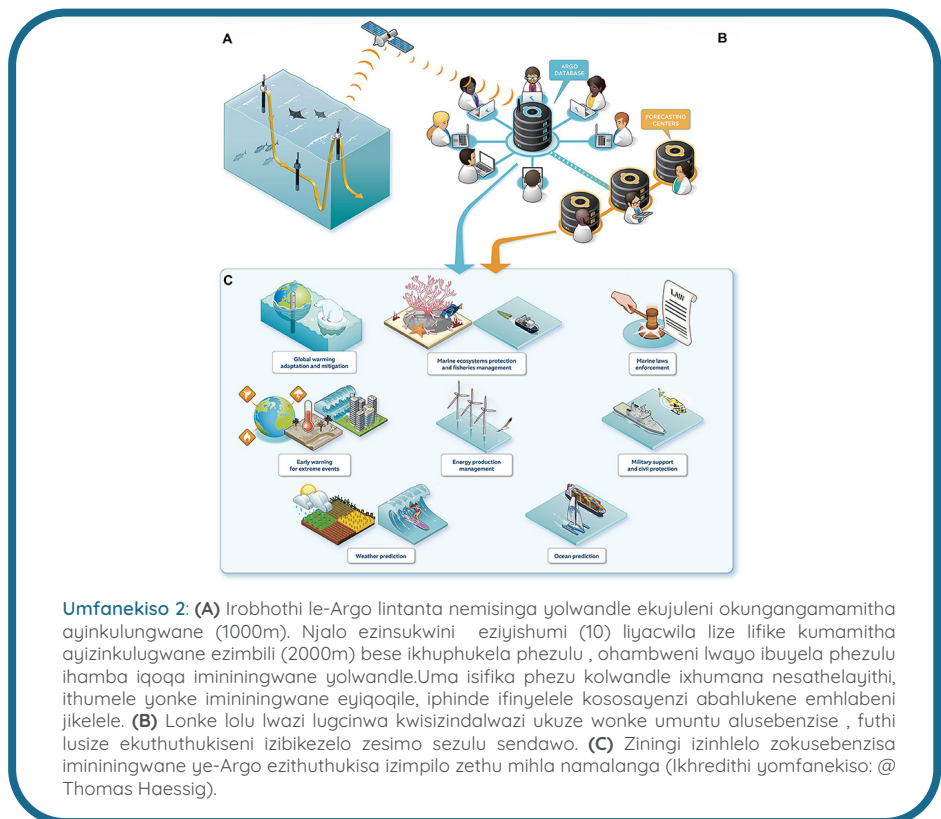
Ukufunda ngolwandle ososayensi kumele ngokungaphelimandla baqoqe ulwazi/ imininingwane yolwandle iminyaka ngeminyaka. Indlela esemqoka yokuqoqa lolulwazi ukuthi bagibele imikhumbi bayothatha izilinganiso zezinto adadinga ukuzicubungula (*Bheka kabanzi ngalokhu kwisihloko esithi- [Frontiers for Young Minds](#)*). Kodwa kunezindawo lapho imikhumbi ingakwazi ukufinyelela kuzo njenge Arctic ne Antarctic. Ebusika kuyaye kube nezimo lapho ulwandle lugubha amagagasi anodlame okwenza kubenzima ukuthi imikhumbi isebenze lapho. Ososayensi babe sebeqhamuka nesu lokwakha amarobhoti e-Argo azokwazi ukuthi aqoqe imininingwane/ulwazi kuzona zonke izinkathi zonyaka (*Umfanekiso 1*).



IZINZWA

Idivayisi ethola futhi iphendule kokwenzeka endaweni.

Amarobhothi -Argo abizwa ngokuthi 'ayantanta'-okusho ukuntanta emanzini, aqukethe **izinzwa** ezenza kubelula ukuqoqa imininingwano yendawo/ulwandle akulona ngalesosikhathi. Yize ebizwa ngokuthi ayantanta, awantanti kuphela kodwa ashona phansi ekujuleni kolwandle aphinde anyukele phezulu kolwandle (ehla enyuka olwandle). Ososayensi yibo abafaka amarobhothi e-Argo emanzini besebenzisa imikhumbi ukuwathwala. Uma esengenile olwandle ayacwila ekujuleni obulinganiselwe kumamitha ayinkulungwane (1000m), ebese ehamba ngokukhululeka esizwa imisinga yolwandle. Ahlala kulokukujula izinsuku eziyisishiyagalolunye (9), kuthi ngosuku lweshumi (10) iqhubekela ekujuleni obulinganiselwe kumamitha ayizinkulungwane ezimbili (2000m) iphinde ibuyele phezulu kolwandle ihamba ithatha izilinganiso njengoba inyukela phezulu. Uma esefika phezulu kolwandle athumela yonke lemininingwano yolwandle eqoqiwe kanye nendawo abeqoqa kuyo ayithumele kososayensi ngamasathelayithi, lokhu kwenza kube lula kososayensi ukuqoqa ulwazi ngaleyongxenywe yolwandle bayigcine kwisizindalwazi. Ngemumva kokuthumela yonke imininingwano kumasathelayithi, lamarobhothi aphinde aye ekujuleni kolwandle ayoqoqa ulwazi futhi (*Umfanekiso 2A*). Ososayensi basebenzisa izinhlelo zekhompyutha ukuhlola izinga lezilinganiso nokuthumela yonke imininingwano kwisizindalwazi (*Umfanekiso 2B*). Izilinganiso zitholakala mahhala kuwo wonke umuntu phakathi kwamahora angamashumi amabili nane (24) amarobhothi ebuyele phezulu kolwandle (*Umfanekiso 2C*).



USAWOTI

Isikalo sobungako bukasawoti olwandle/isilinganiso sokugcwala bukasawoti olwandle.

UKUMINYANA

Inani lento entweni (into enesisindo) uqhathanisa nokuthi ithatha isikhala esingakanani (umthamo wayo).

Amarobhothi e-Argo aqoqa izilinganiso zengcindezi, izinga lokushisa kanye nezilinganiso zasawoti oqokethwe ulwandle kuleyondawo. Uma sikhuluma ngosawoti olwandle sikhuluma ngesilinganiso sokugcwala bukasawoti olwandle. **Usawoti** kanye nezinga lokushisa, kukokubili kunquma izinga lokuminyana kwamanzi olwandle. Ingcindezi yamanzi olwandle itshela ososayensi ukujula kwamanzi lapho izilinganiso zezinga lokushisa kanye nosawoti zithathwe khona. Olwandle, ukujula okungangemitha elilodwa kulingana nedecibar eyodwa (dba) kwingcindezi. Emkhathini ukuncipha nokwenyuka kwengcindezi kwenza izinhlelo zethu zesimo sezulu. Olwandle, **ukuminyana** kwamanzi kakhulu nokuminyana kwamanzi kancane kudala imisinga yolwandle, okuyiyo enyakazisa amanzi amaningi emhlabeni jikelele. Ukuqondisa ukuthi amanzi ahamba kanjani olwandle, kubalulekile ukwenza ucwaningo ngesimo sezulu, kanjalo nokuvikela izitshalo kanye nezilwane ezihlala olwandle.

Ososayensi baqala ukuklama inethiwekhi yamarobhothi e-Argo ngasekupheleni konyaka wezi-1990, babefuna imininingwano igcwalise izilinganiso zobude bolwandle eyayiqoqwe isathelayithi ebizwa ngokuthi uJason. Ngokwezinganekwane zamaGreci, uJason wahamba ngomkhumbi obizwa ngokuthi i-Argo efuna uboya begolide. Ngakho-ke, ososayensi basolwandle babiza la marobhothi ngama robhothi e-Argo. Imininingwane yobude bendawo yolwandle evela Kuma isathelayithi ingahlanganiswa nemininingwane ye-Argo ukwazisa ososayensi ngezinguquko ezenzeka kwimisinga yolwandle. Amarobhothi e-Argo abelokhu ezulazula olwandle iminyaka engamamashumi amabili (20), asegoqe izilinganiso ezingaphezu kwezigidi ezimbili (2 million) emhlabeni jikelele¹. Namuhla kunamarobhothi e-Argo alinganiselwa kwizinkulungwane ezine (4 million) aqoqa izilinganiso zolwandle.

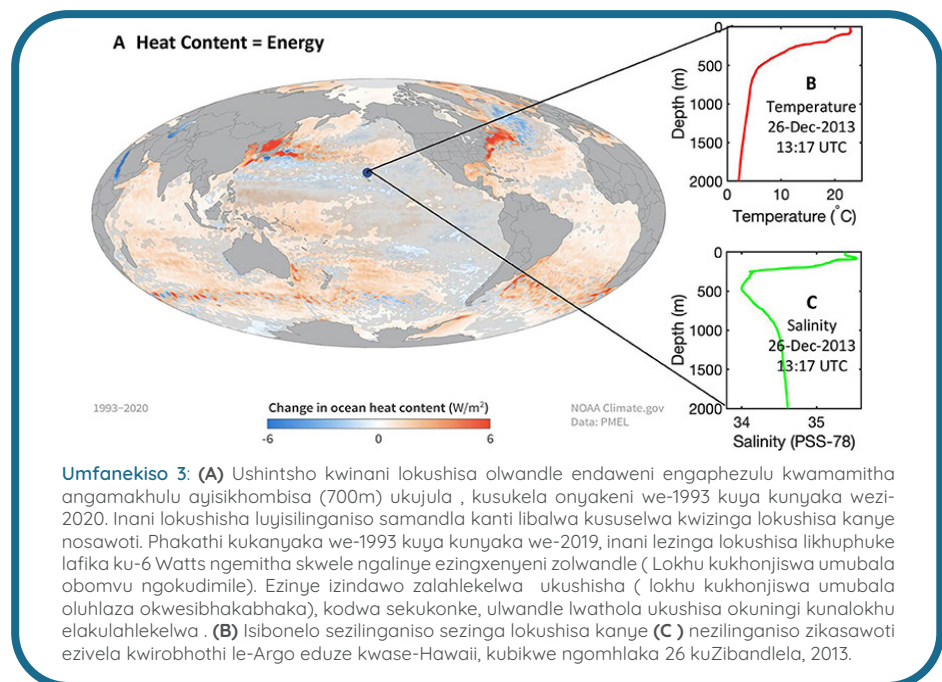
Amarobhoti E-Argo asebenzisa/anikwa amandla amabhethri futhi asebenza ubusuku nemini nsuku zonke zonyaka. Ngenxa yalamarobhoti, ososayensi sebekwazi ukuhlala beqaphe ulwandle lomhlaba kangcono kunaphambilini. Amabhethri esetshenziswa kulamarobhoti e-Argo avamise ukuhlala isikhathi esingaphezu kweminyaka emihlanu. Uma lamabhethri esephelile, amarobhoti e-Argo awabe esesasebenza ayazika aye ekujuleni kolwande. Nakuba lokhu kungabukeka njengokungcolisa ulwandle noma ukulahla olwandle kodwa umonakalo kwimvelo muncane kakhulu uma uqhathaniswa nomonakalo odalwa ezinye izinto ezingcolisayo, futhi ulwazi oluqoqiwe lubaluleke kakhulu ekuqondeni Umhlaba.

KUNGABE AMAROBHOTI E-ARGO ANGASITSHELANI NGOLWANDLE?

INANI LOKUSHISA OLWANDLE

Inani lamandla angesimo sokushisa agcinwe olwandle.

Kusukela ngonyaka we-1970, ulwandle seluthathe ukushisa okungaphezu kwamaphesenti angamashumi ayisishiyagalolunye (90%) okudalwe amagesi akhiqizwa izenzo/imisebenzi yabantu. Amazinga okushisa ezindaweni eziningi zolwandle anyukile. Enye indlela ososayensi abenza ngayo ukuqapha lokhu, ukusebenzisa izilinganiso zamazinga okushisa kanye nosawoti ukuze babale ukuthi kungakanani ukushisa okufakwe ongqimbeni lolwandle okubizwa ngokuthi **izinga lokushisa kolwandle** (*Umfanekiso 3*). Ngokusebenzisa imininingwane eqoqwe ngamarobhoti e-Argo, ososayensi bathole ukuthi izehlakalo ezifana nokushisa kwezulu isikhathi eside zenzeka kaningi olwandle, njengoba nje kwenzeka nasemkhathini. Lesi sikhathi sokushisa esinokushisa kwezulu isikhathi eside kudala izilwane zasolwandle ukuba zihambe ziye kwezinye izindawo lapho zizothola khona amanzi aphilile. Nokho, izitshalo kanye nezilwane ezingakwazi ukuya kwezinye izindawo noma ezingakwazi ukunyakaza zisuke zizohlushwa yilokhu kushisa kwesimo sezulu esinokushisa isikhathi eside.



Ukukhuphuka kwezinga lolwandle emhlabeni jikelele kuwumphumela omkhulu odalwa ukuguquka/ukushintsha kwesimo sezulu. Njengoba amanzi olwandle eya ngokufudumala, nawo ayanda, okungenye inhloko yezimbangela ezidala ukukhuphuka kwezinga lolwandle. Ukukhuphuka kwezinga lolwandle kunomthelela omubi kakhulu ezimpilweni zethu mihla namalanga/nsuku zonke njengoba kungunobangela wezikhukhula, ukuguguleka, futhi kuphinde kudale amanzi ahlazekile angabe esaphuzeka ngenxa yokuxubana namanzi asolwandle anosawoti ([Bheka kabanzi lesi sikhathi esithi Frontiers for Young Minds ukuze uthole ulwazi olengeziwe mayelana nokwenyuka kwezinga lolwandle](#)). Amarobhoti e-Argo ayithuluzi elibaluleke kakhulu ekuqapheni ukunyuka kwezinga lolwandle emhlabeni jikelele njengoba ehlezi eqaphe ngeso lokhozi kwi-zinguquko ezenzeka olwandle.

Ukulandelela ulwandle sekuholele ekuthuthukisweni kwesimo sezulu. Ukusebenzisa imininingwane yamazinga okushisa kanye nekasawoti ethungelwa amarobhoti e-Argo, ososayensi bengeze **imodeli yekhompyutha** yolwandle ekubaleni kwabo isimo sezulu. Ukuba nemininingwane yolwandle eyempela kulamamodeli kuthuthukisa indlela ososayensi abaqonda ngayo ukuxhumana komkhathi kanye nolwandle. Lokhu kusemqoka impela ekubikezeleni izimo zezulu ezizokwenzeka njengeziphepho, izivunguvungu, kanye nezishingishane ezithola amandla amaningi ezindawenu ezifudumele zolwandle.

KHOMPYUTHA MODEL

Uhlelo olusebenza kwikhompyutha ukwakha uhlelo lwempela lomhlaba njengomkhathi womhlaba noma ulwandle.

SIYAJULA FUTHI SITHATHA INDLELA ENTSHA

Emandulo/esikhathini esedlule, amarobhoti e-Argo ayekalelekile ukuthi aya ekujuleni okungakanani olwandle, ayekalelwe ukujula okulinganiselwe kumamitha ayizinkulungwane ezimbili (2000m) lokho okusho umthamo wamanzi ongaphansi kwamaphesenti angamashumi amahlanu (50%). Kuyinselelo enkulu ukusongoza amarobhoti angaya ekujuleni kolwandle, kodwa akubavimbanga lokho ososayensi kanye nabonjiniyela njengoba besanda kusungula amarobhoti akwazi ukuya ekujuleni kolwandle okulinganiselwe kumamitha ayizinkulungwane eziyisithupha (6000m)². Ukuthatha amasampula olwandle ukusuka phezulu kuye ekujuleni/phansi kuzokwenza ososayensi baqonde kangcono izinguquko ekushiseni nase nanini lamanzi ahlanzekile, futhi lokhu kuzohlizeka ngolwazi olungcono mayelana kwenyuka kwezinga lolwandle emhlabeni jikelele.

Njengamanje sisekuqaleni kwenkathi entsha, lapho amarobhoti e-Argo engakwazi ukuthatha izilinganiso ezihlangene namakhemikhali olwandle/asolwandle kanye nezinto eziphila khona olwandle³. Lokhu kuzohlizeka ngolwazi lwezinguquko kwinani lika moya-mpilo (oxygen) kanye ne carbon dioxide olwandle. Ulwandle jikelele lulahlekelwa umoya-mpilo (oxygen) futhi limunca i-carbon dioxide eningi/eyedlulele emkhathini woMhlaba. Lezi zinguquko zinomthelela ongemuhe kwezemvelo yasolwandle okungabalwa kuzo izindawo zokudoba ezondla iningi lethu.

Amarobhoti e-Argo ayithuluzi lokuqala kwibhokisi lamatuluzi ezazi zolwandle. Ayinxenye yohlelo lomhlaba wonke olubizwa ngokuthi iGlobal Ocean Observing System (GOOS). Sisonke kanye nabanye ozakwethu beGoos, ukuthuthuka kwamamarobhoti e-Argo kuzosisiza sakhe isithombe somhlaba wonke siveze impilo yolwandle kanye nokuthi lushintsha kanjani ngokuhamba kwesikhathi. Nawe ungaba yingxenywe yezibukeli zolwandle. Kanjani na? [Ngokwamukela ukuntanta](#). Ungakhetha i-roboti le-Argo, ulinikeze igama, uphinde ulandele uhambo lwalo lizungeza umhlaba. Ungaphinde ufunde kabanzi mayelana ne-Argo e-[Argo Online School](#) kanye nase [Ocean Observers](#). Uhambo lwaso lwandle lukulindile.

IZINKOMBA

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3. Bittig, H. C., Maurer, T. L., Plant, J. N., Schmechtig, C., Wong, A. P. S., Claustre, H., et al. 2019: A BGC-argo guide: planning, deployment, data handling and usage. *Front. Mar. Sci.* 6:502. doi: 10.3389/fmars.2019.00502

ITHUNYELWE: 13 kuNhlaba 2022

KWAMUKELWE: 21 kuMandulo 2023

ISHICILELWE KU-INTHANETHI: 06 kuMfumu 2023

UMHLELI: Pedro Morais, Florida International University, United States

ABELULEKI BEZESAYENSI: Laura Lorenzoni and Sagi Dalyot

UKUNGQUBUZANA KWEZINTSHISEKELO: Ababhali bamemezela ukuthi uchwane ngaphandle kobudlelwane kwentengiselwano noma bezezimali obungahunyushwa njengokushayisana/ukungqubuzana kwezintshisekelo okungenzeka.

YOUNG REVIEWERS

DENIZ, IMINYAKA: 12

Sawubona, igama lami ngingu-Deniz, ngithanda ukubuka izinkanyezi ngiphinde ngidlale imidlalo yevidiyo nabangani bami. Iqoqo lezinkanyezi engilithandayo yi-Messier 45 kanti umlaza engiwuthandayo i-Orion. Umdlalo wevidiyo engiwuthandayo kakhulu i-Call of Duty 2.

LÉO, IMINYAKA: 12

U-Leo wazalelwa eFlorida futhi uthanda ulwandle; uthanda kakhulu i-snorkeling. Uyazifela ngomlando kanye nezinganekwane, ikakhulukazi uma kwezangaphansi kwamanzi. Udlala i-cello futhi unezinja ezimbili, futhi ukuthokozelela kakhulu ukudlala imidlalo yevidiyo ngesikhathi sakhe sokuphumula.





OMER, IMINYAKA: 14

Nginentshisekelo enkulu kakhulu kwezombusazwe zamazwe jikelele, futhi ngithanda ukufunda ngezombusazwe, ifilosofi, kanye nemland. Ngithanda ukudlala imidlalo yevidiyo kwi-Nintendo switch kanye nekhompyutha yami, futhi ngithanda ukulalela ngiphinde ngidlale imidlalo yokulingisa njenge D&D kanye ne Warhammer 40K.

ABABHALI

BLAIR J. GREENAN

UBlair Greenan ungusosayensi wocwaningo esikhungweni semfundo ephakeme iBedford Institute of Oceanography ezinze eHalifax, eNova Scotia, Canada. Uphethe ezomnikelo waseCanada ohlelweni lwamazwe ngamazwe lwe-Argo. Ucwano lwa kwakhe lugxile ekusizeni imiphakathi egudle ugu ukuba ikwazi ukumelana nokushintsha kwesimo sezulu solwandle. Lokhu kubandakanya ukukhuluma ngezinkinga/ngezindaba zezingqalasizinda ngokuthi ahlizenke ngamathuluzi asekelwe yisayensi nolwazi olumayelana nezinguquko zezinga lolwandle endaweni ngenxa yokushintsha kwesimo sezulu.

ANNIE P. WONG

U-Annie ungusosayensi wocwaningo esikhungweni semfundo ephakeme iNyuvesi yase Washington eSeattle, WA, United States. Uyisazi solwandle esaqala kwisayensi yolwandle, eqoqa ulwazi/ iminingwane yolwandle ngemikhumbi/emikhunjini. Njengamanje usebenzisa iminingwane ayithola kumarobhoti eArgo ukufunda kabanzi ngo sawoti wolwandle futhi unentshisekelo yezilwandle ezizungeze i-Antartica. Uyingxenywe yethimba le Argo Data Management elisiza ukusabalalisa iminingwane eqoqwe i-Argo emphakathini.

TAMMY MORRIS

UTammy Morris ungusosayensi oseqophelweni eliphezulu oPhikweni Lwezsolwandle lwe-South African Weather Service oluzinze eKapa, eNingizimu Africa. Uyisazi sasolwandle esibukayo/ esiqaphelayo esesichithe izinyanga eziningi olwandle emikhunjini yocwaningo esebenza ngamathuluzi abuka ulwandle njenge-Argo floats, drifters kanye ne-mooring. Ucwano lwa kwakhe lugxile ohlelweni olukhulu lwe Agulhas Current, kanye nokusebenzisana okuningi ne Southern Ocean.

EMILY A. SMITH

U-Emily ungumphathi wezinhlalo ezahlukahlukeni ekubalwa kuzo i-U.S Argo Program, iGlobal Sea Level Observing System, izindiza zasolwandle kwimingcele yemisinga, kanye nemikhiqizo eqokethwe ukushisa kolwandle. U-Emily unomthwalo wemfanelo wokuphatha izabelomali kanye nokuhlela amasu ezinhlalo zokubuka. Uphinde aqondise uhlelo lwe-Adopt a Drifter, olusiza ebudlelaneni nezikole zase-U.S. naphesheya, ukuze bakwazi ukulandelela ama-buoy akhukhulekayo futhi basebenzise lemininingwane emakilasini abo. Ngaphambi kokusebenza ka-NOAA, u-Emily wachitha isikhathi esiningi efundisa abafundi bamabanga aphakathi, loluhlelo lwamsiza ngoba ekugcineni wacina esexhumana nomkhakha wezemfundo.

MARINE BOLLARD

UMarine unomthwalo wemfanelo abhekenenawo wezemisebenzi yokufinyelela kubantu ye-Euro-Argo European Research Infrastructure Consortium (ERIC). I-ERIC izibophezele ekuthuthukiseni umnikelo wesikhathi eside wase-Europe ohlelweni lokuqapha ulwandle lwe-Argo, ngenhloso yokulekelela ukwazi kangcono nokubikezela ngolwandle, iqhaza layo ohlelweni lwesimo sezulu kanye nempilo yolwandle. Uneziqu ezimbili zemaster's degree in hydrogeology engineering kanye nobuntatheli besayensi. Ngaphambi kokuza e-Euro Argo, uMarine wachitha iminyaka eminingi eshicilela izincwadi kanye nezindatshana ezidumisa/ezisabalalisa isayensi ngenjongo yokufunda kanye nokufundisa umphakathi.

CAPHUNA : Greenan BJ, Wong AP, Morris T, Smith EA and Bollard M (2023) Keeping an Eye on Earth's Oceans With Argo Robots Front. Young Minds 11:943491. doi: 10.3389/frym.2023.943491

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